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ARCTIC OCEAN PROPAGATION MEASUREMENTS.(U)
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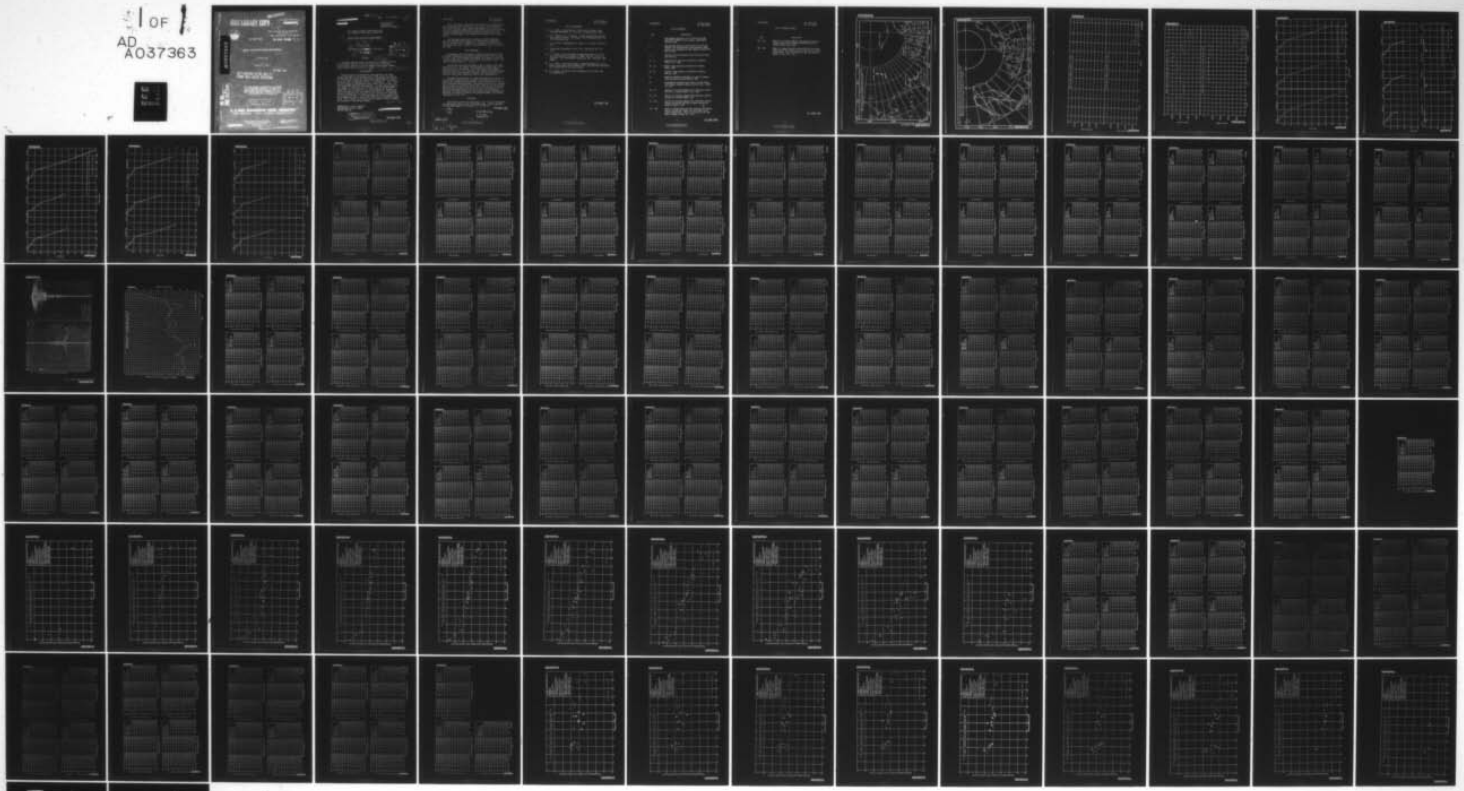

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USL Technical Memorandum No.
911-010-61,
USL Problem No. 1-407-00-00

ARCTIC OCEAN PROPAGATION MEASUREMENTS

25 July 1961

by
Richard J. Hecht

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U. S. NAVY UNDERWATER SOUND LABORATORY
FORT TRUMBULL NEW LONDON, CONNECTICUT

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USL Problem No.
1-407-00-00
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U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

(6) ARCTIC OCEAN PROPAGATION MEASUREMENTS •

by

(10) R. J. Hecht

(9) USL Technical Memorandum No. 911-010-61

(11) 26 July 1961

(12) 83 p.

ABSTRACT

The basic data that have been reduced to analyzable form as of 15 February 1961 and figures showing velocity structure, ambient noise, spectra of received charges, and acoustic energy level versus range are presented.

(14) USL-TM-911-010-61

INTRODUCTION

Sound propagation measurements using explosives as sound sources were made in the western Arctic Ocean during the summers of 1958 and 1959. The sound transmission experiments were carried on at ice stations Alpha and Bravo (T-3) during 1958, and Charlie and Bravo (T-3) during 1959 (see Fig. 1 and refere a)). Inter-station propagation measurements were carried out both years, but only those from 1958 have been analyzed. In 1958 signals from 1/2 lb. charges of TNT detonated at 50-foot depth by the USS BURTON ISLAND were also received at T-3. During August and September of 1959 a P2V aircraft made six flights over the Arctic Ocean making acoustic transmission runs while both ice stations were operating as receiving stations. In this way nearly all of the Beaufort Sea and neighboring parts of the Arctic Ocean were investigated acoustically. Fig. 2 shows the locations of the tracks of the six flights and locations of the charges dropped.

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While the acoustic experiments were carried out, positions of the ice stations were determined by sun lines. The positions of the dropped practice depth charges were supplied by the aircraft. At the ice stations hydrographic stations were taken at more or less regular intervals as well as measurements of water depth. The accuracy of the ranges in the figures is considered to be $\pm 5\%$ or better.

The explosive sounds were received on a DT-98 hydrophone, amplified and recorded broadband on a dual channel Magnecorder. During 1959 many of the signals were recorded in the FM mode also. The signals were also recorded on a dual channel paper recorder vs. GMT time.

DATA PROCESSING

The magnetic tape recordings of signals from explosives were processed by passing the broadband signals through a set of logit filters. Each filter output was detected by a square law detector and integrated over the time during which the signal arrived. The result is proportional to $\int p^2 \, dt$.

The ambient noise was processed on the 11 channel data reader (reference (b)). The reader would average one second samples at a sampling rate of two seconds. Any given ambient noise sample covered a period of 1 to 2 minutes. The ambient noise spectra that show very quiet conditions may represent electronic system noise, therefore some caution should be used in the interpretation.

The paper recordings of the charge detonations and signals received were of such accuracy to permit the determination of the travel time between the ice stations to within an accuracy of $\pm$ .25 sec. during the 1958 experiment. The range between the two stations and the range to a detonated charge from a P2V run were obtained by measuring the distances between the two plotted points on a transverse Mercator projection of the polar area. The temperature, salinity, and depth information from the hydrographic stations were converted to velocity profiles with Kuwahara's tables and formulas (references (c) and (d)).

CONCLUSION

This report presents all basic data so far reduced and analyzed from the Arctic Project as of 15 February 1961. Partial analyses of these data appear in references (e), (f) and (g).

R. J. Hecht

R. J. HECHT
Mathematician

LIST OF REFERENCES

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(b) F. G. Weigle and L. C. Maples, "A Semi-Automatic Eleven-Band Data Analysis System," USL Research and Development Report No. 464, 2 February 1960.

(c) J. W. Horton, "Fundamentals of Sonar," U. S. Naval Institute, 1957.

(d) "Processing Oceanographic Data," H.O. Publication No. 614, 1957.

(e) R. J. Hecht, "Sound Propagation Experiments Under the Polar Ice Pack Conducted the Summer of 1958," JUA Vol. 10, No. 3, July 1960. Also USL Research Report No. 465, 9 February 1960 (CONF).

(f) R. J. Hecht, "Preliminary Report of Sound Transmission in the Arctic Ocean August and September 1959," USL Technical Memorandum No. 1110-014-60, 28 July 1960 (CONF).

(g) R. J. Hecht, "Explosive Sound Propagation in the Polar Sea" (in preparation).

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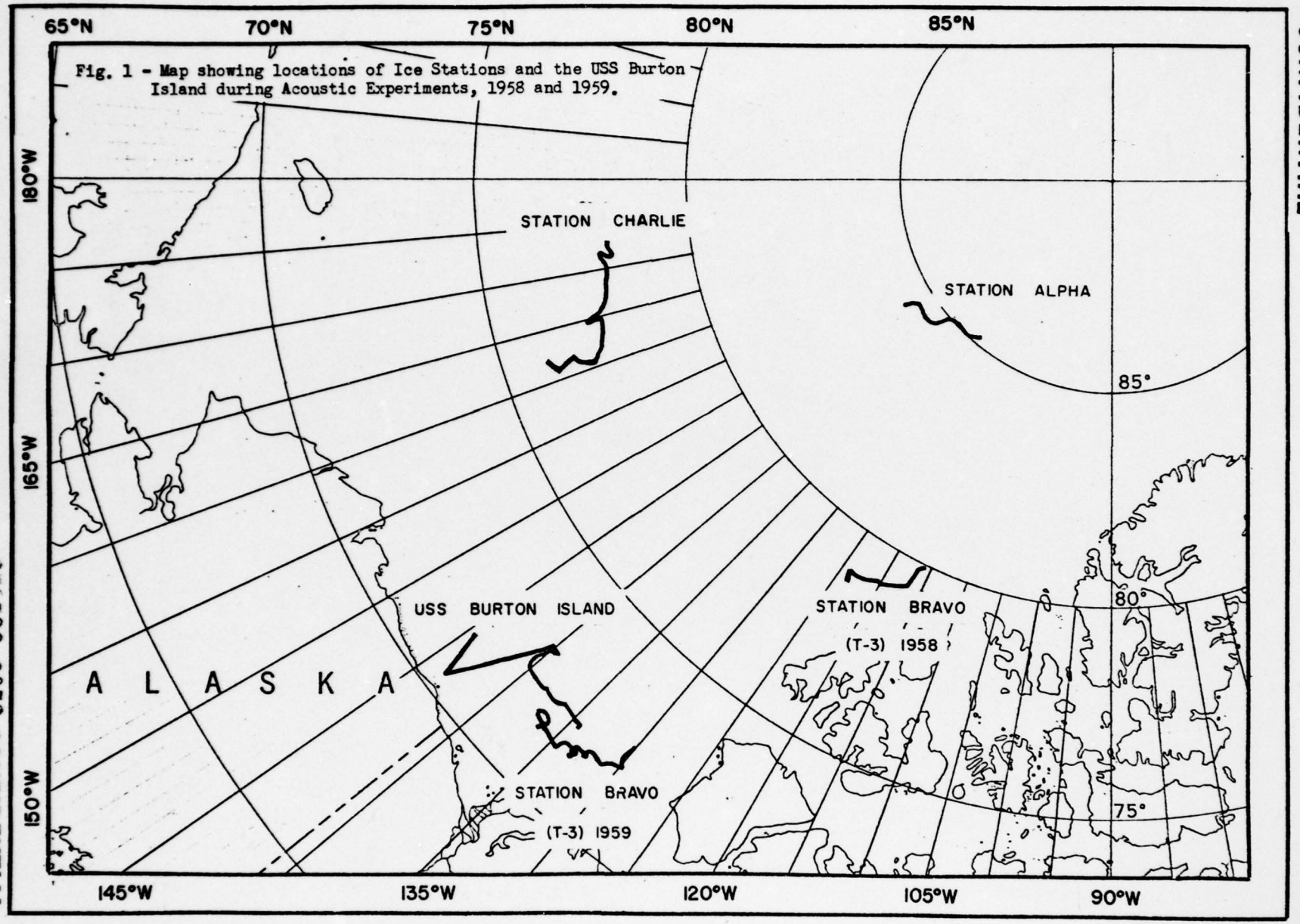
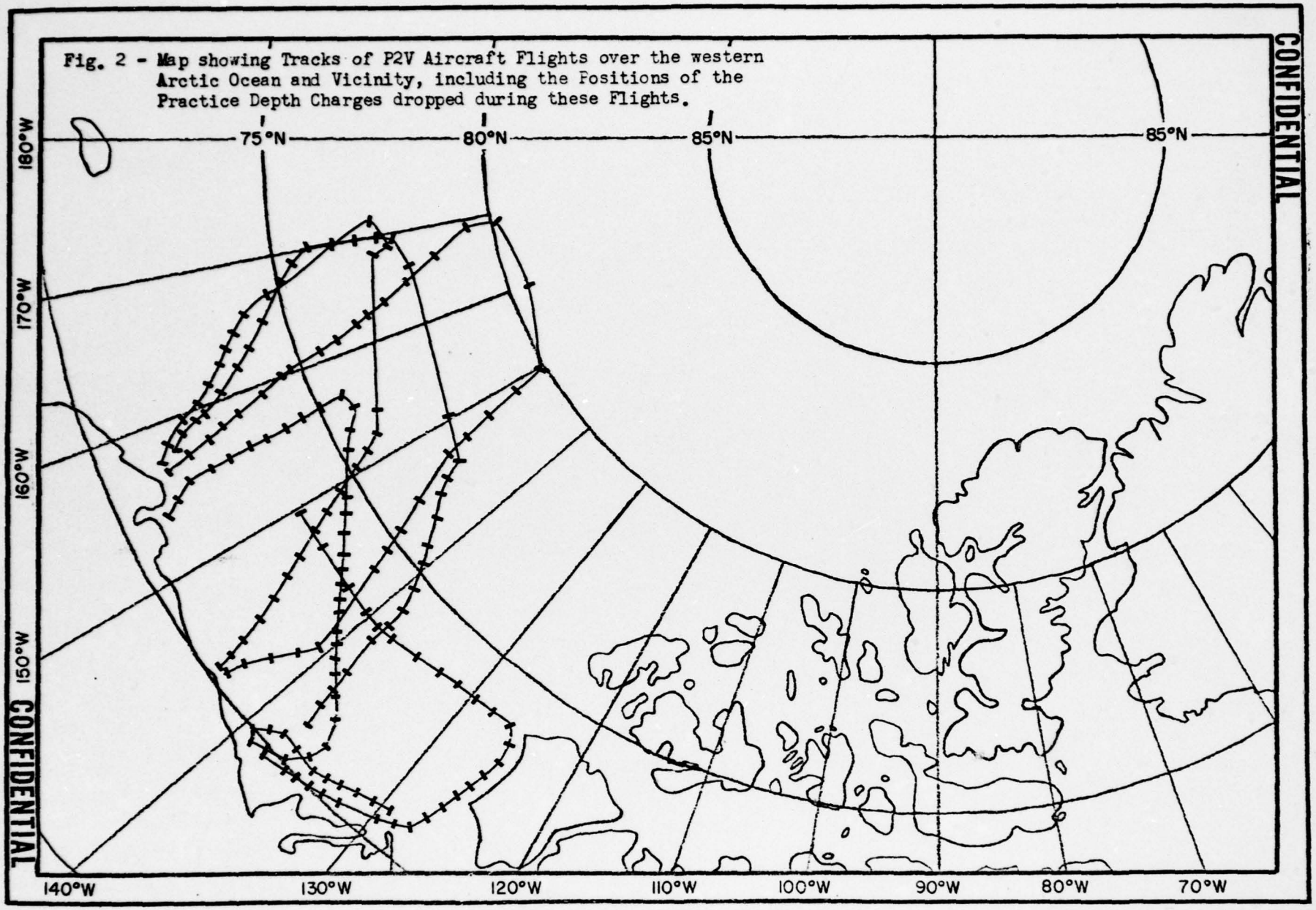


Fig. 1 - Map showing locations of Ice Stations and the USS Burton Island during Acoustic Experiments, 1958 and 1959.



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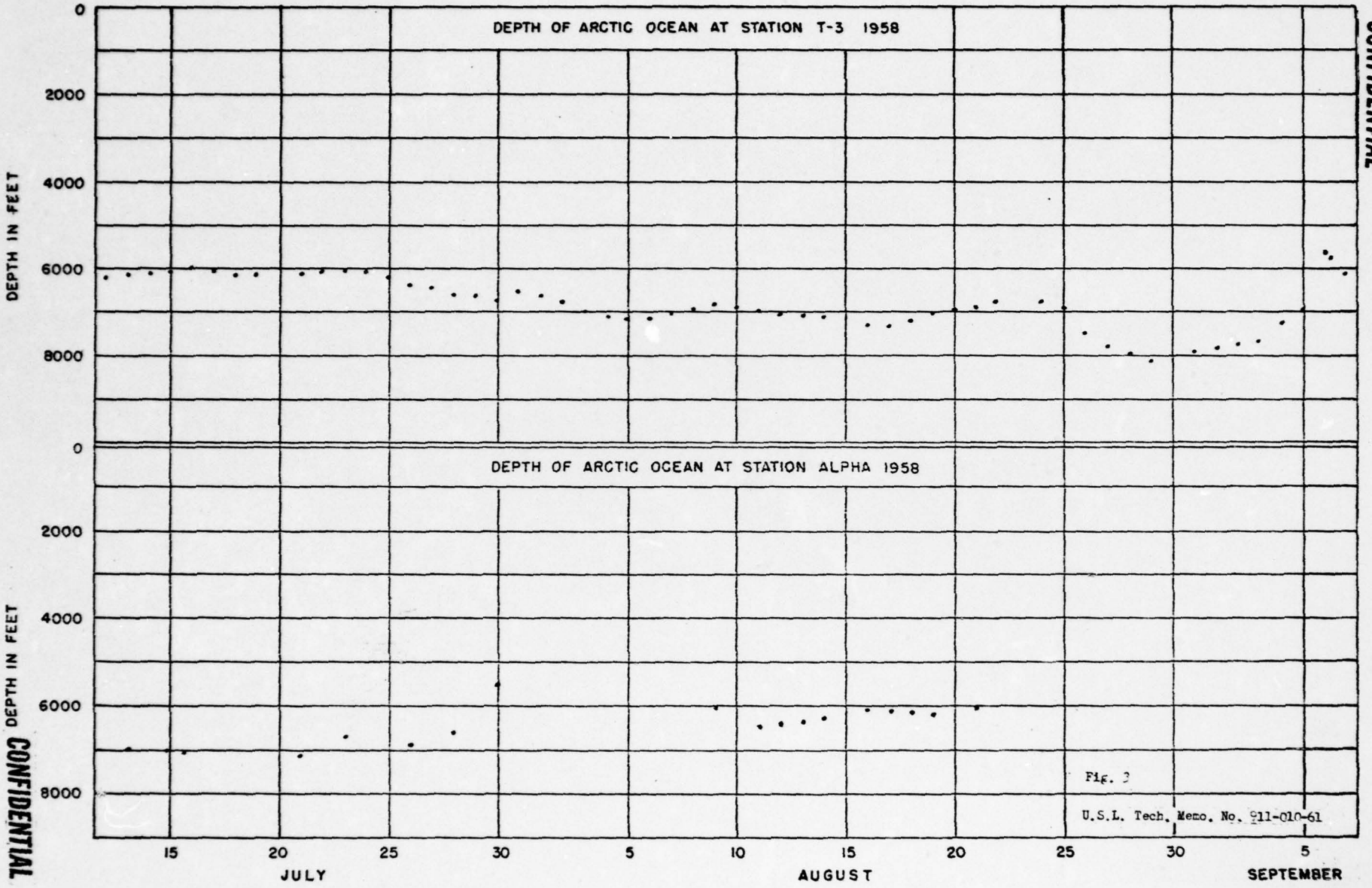

Fig. 3

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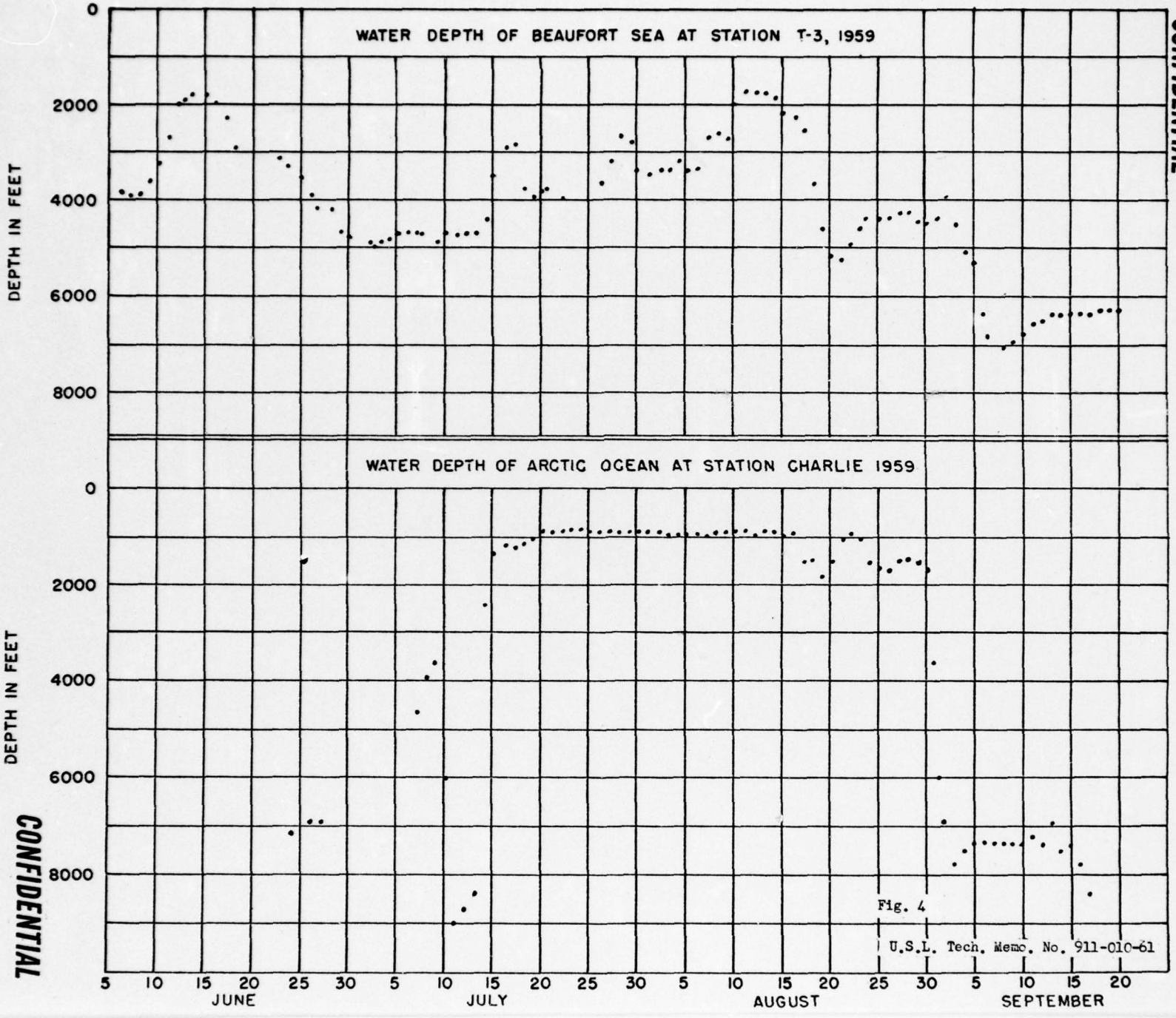

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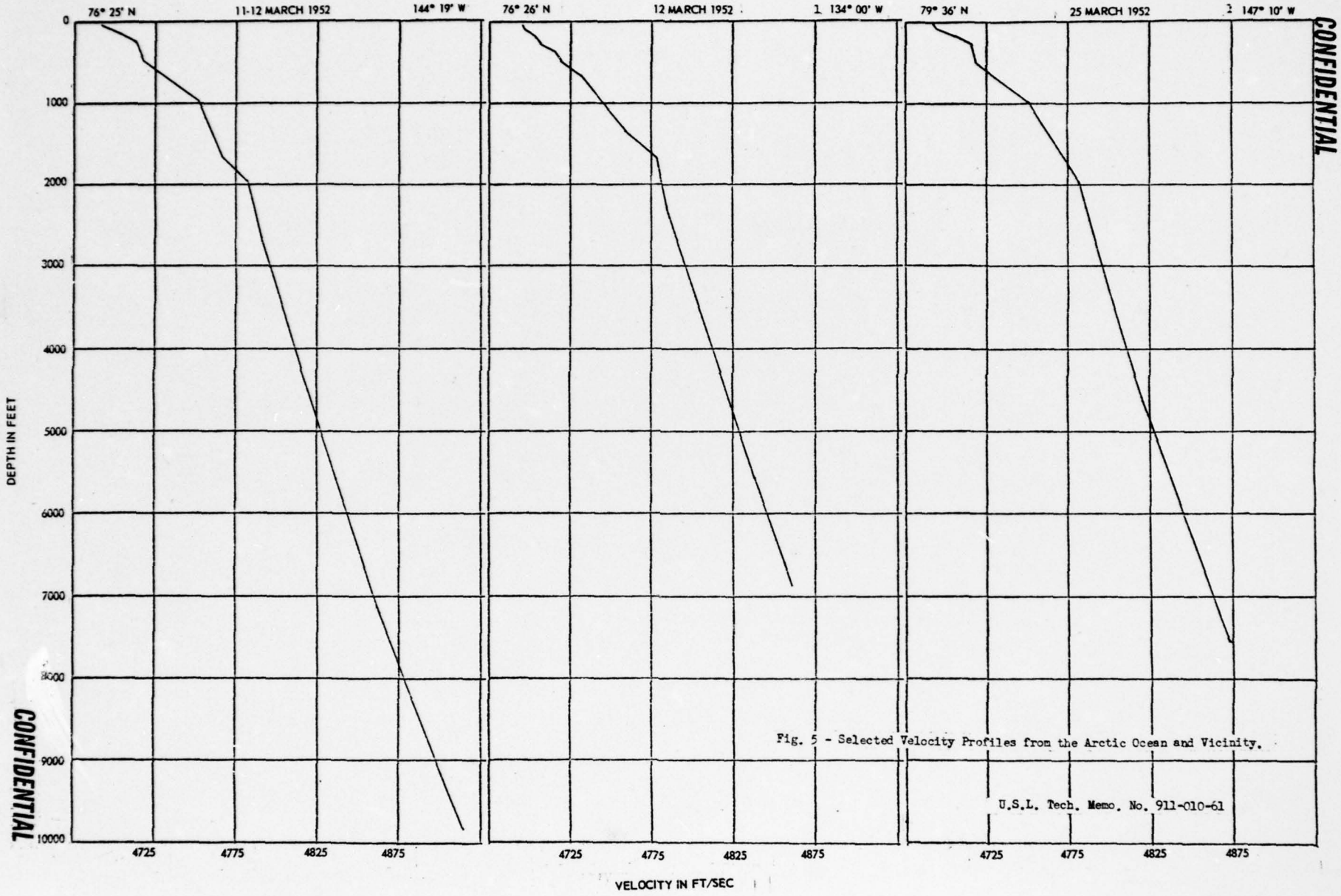

Fig. 5 - Selected Velocity Profiles from the Arctic Ocean and Vicinity.

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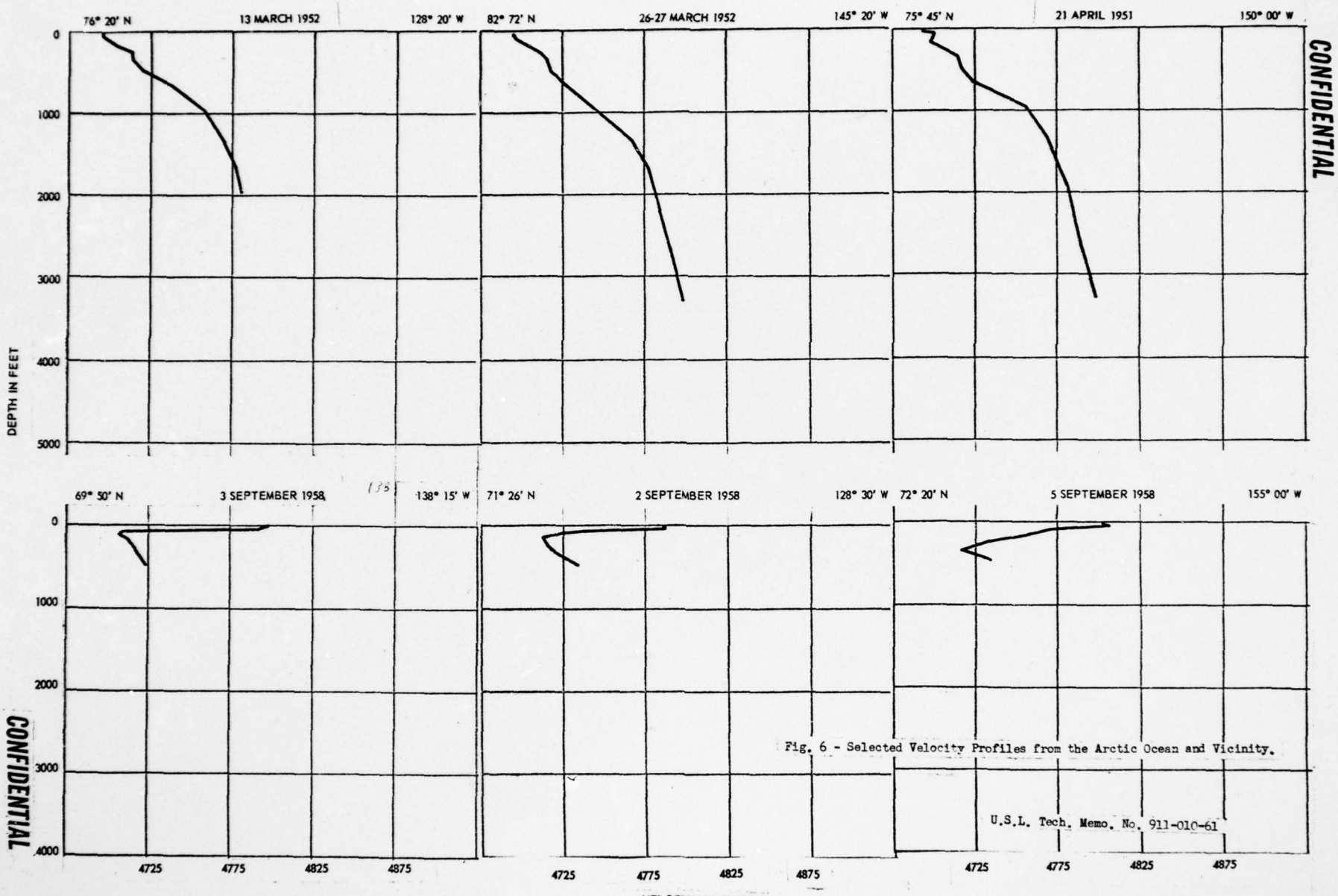

Fig. 6 - Selected Velocity Profiles from the Arctic Ocean and Vicinity.

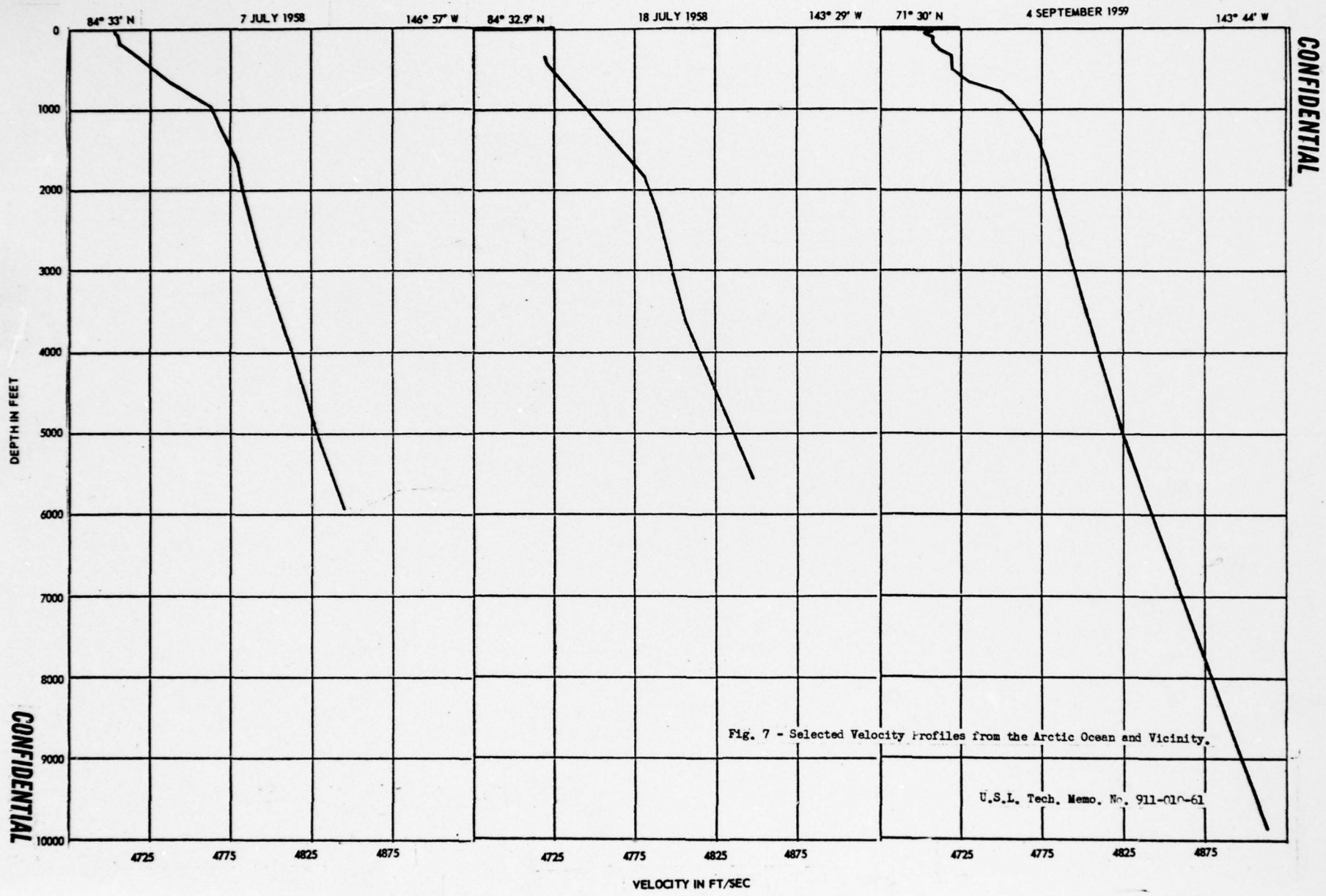

Fig. 7 - Selected Velocity Profiles from the Arctic Ocean and Vicinity.

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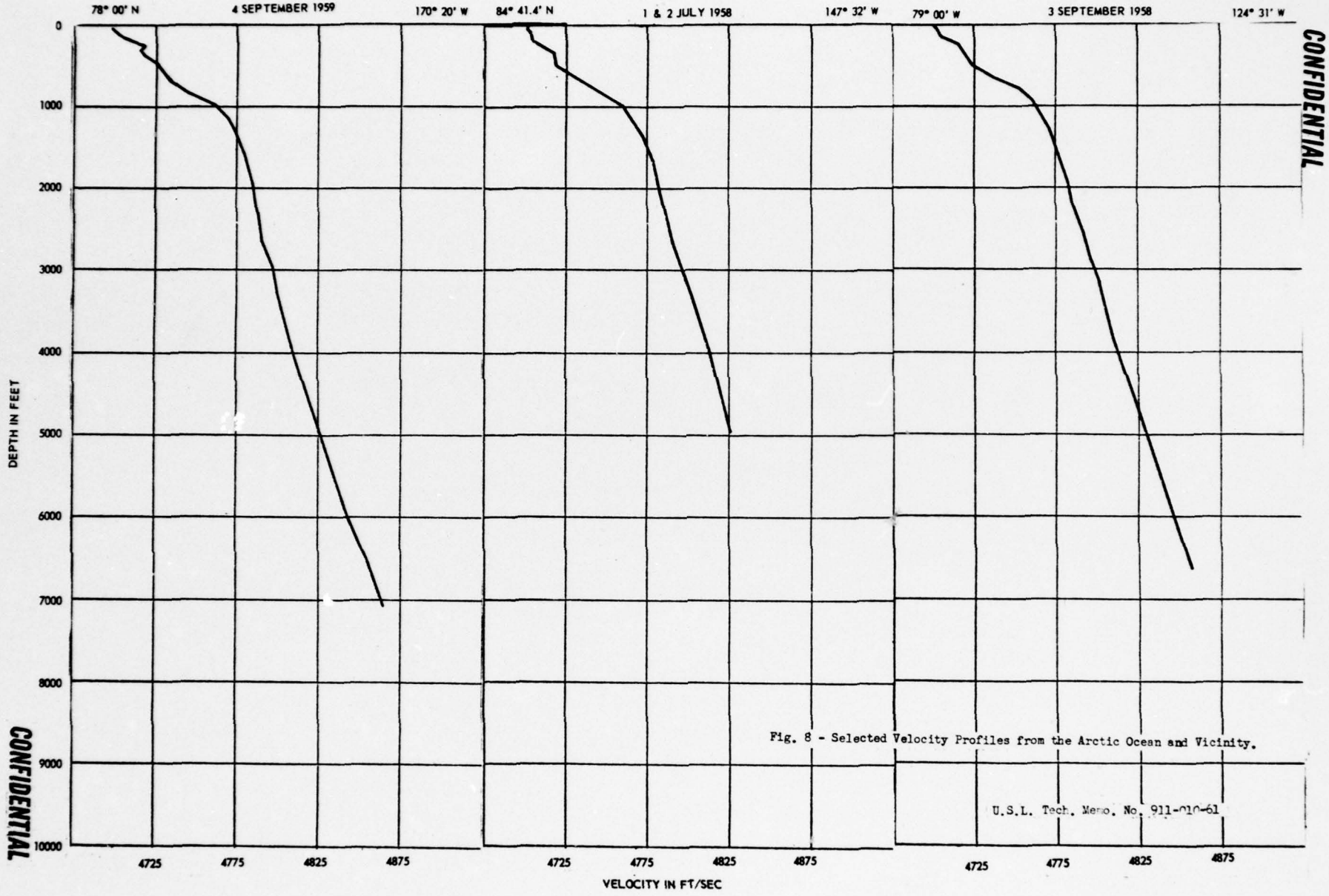

Fig. 8 - Selected Velocity Profiles from the Arctic Ocean and Vicinity.

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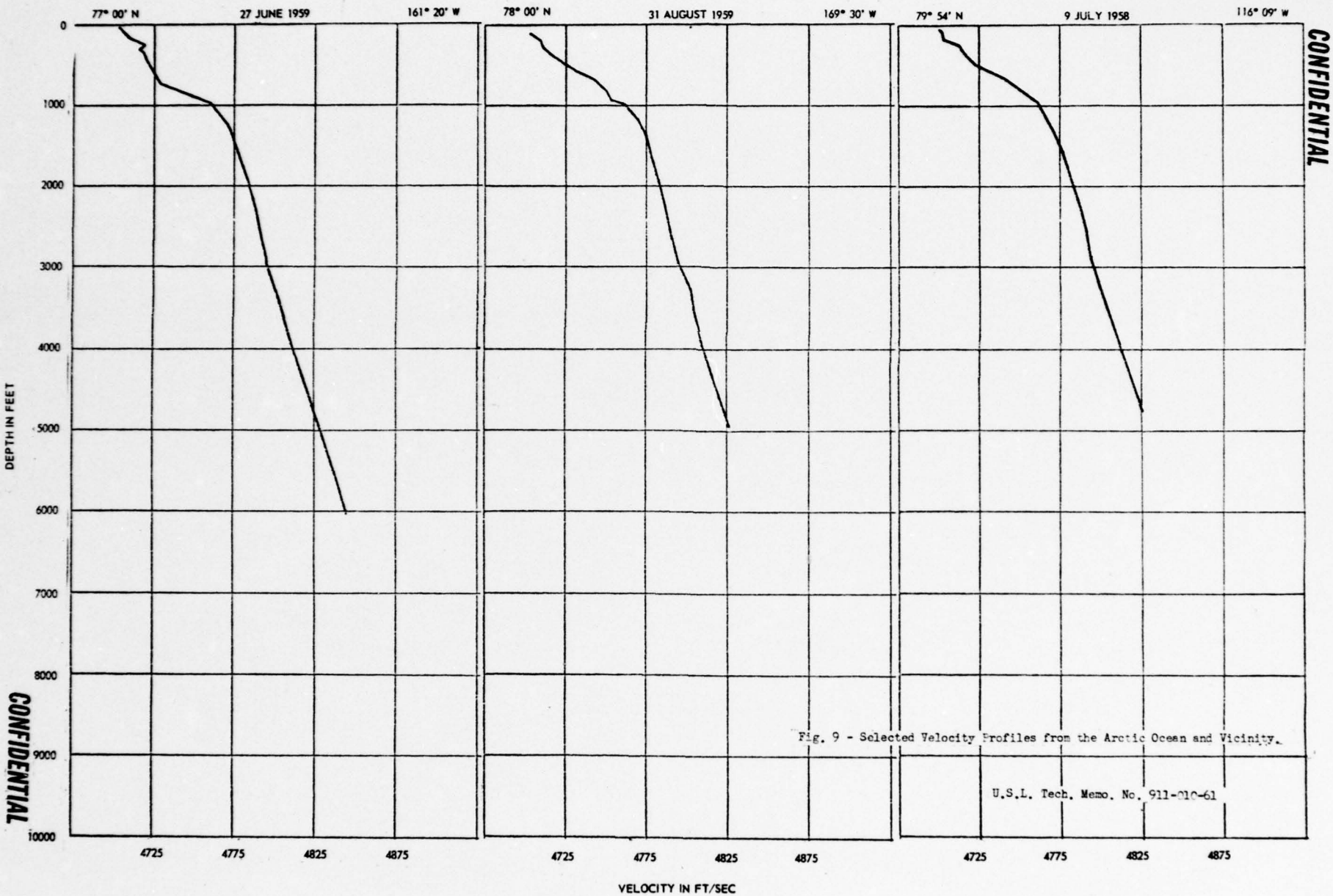

Fig. 9 - Selected Velocity Profiles from the Arctic Ocean and Vicinity.

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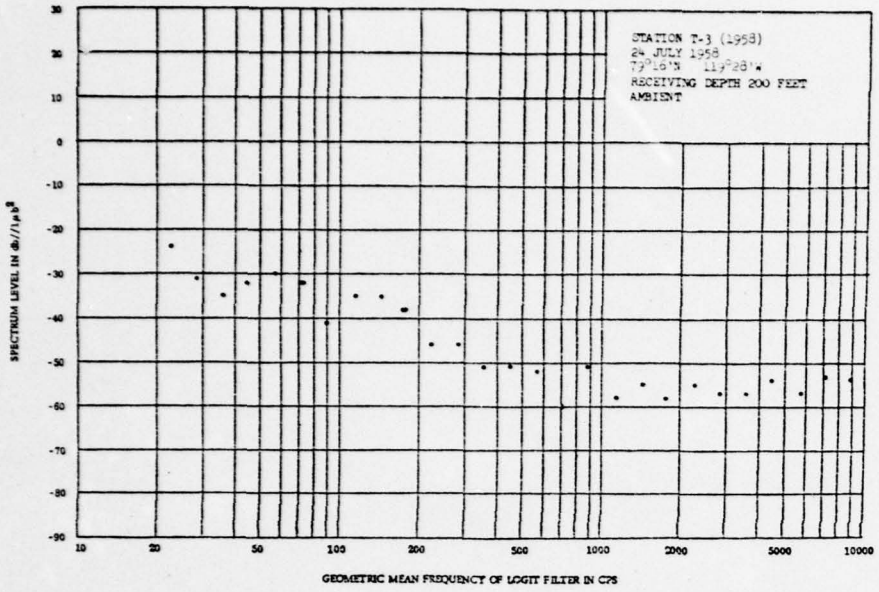

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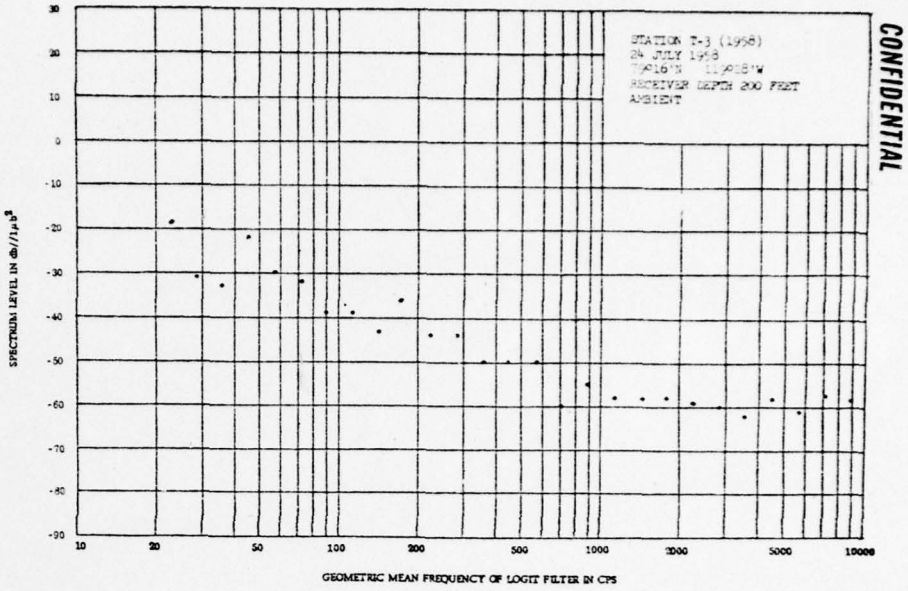

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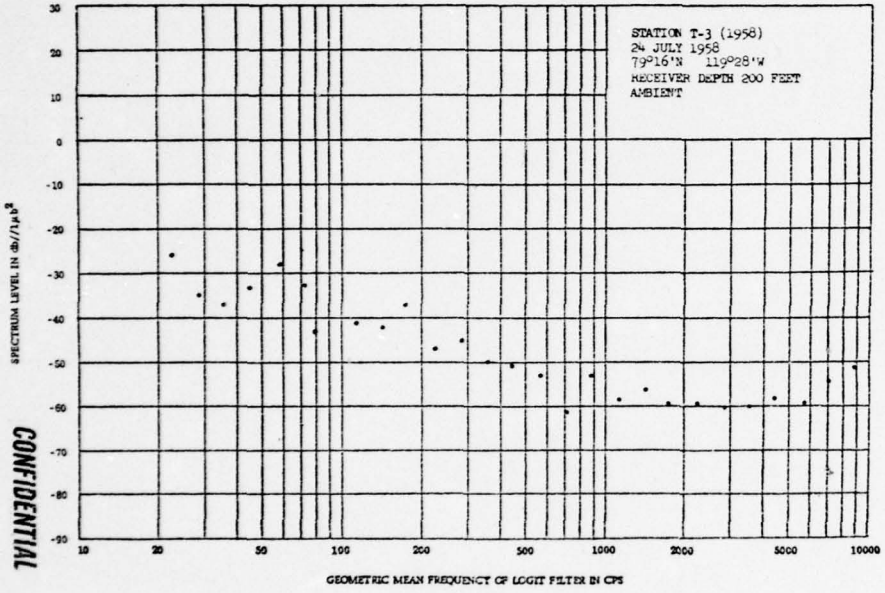

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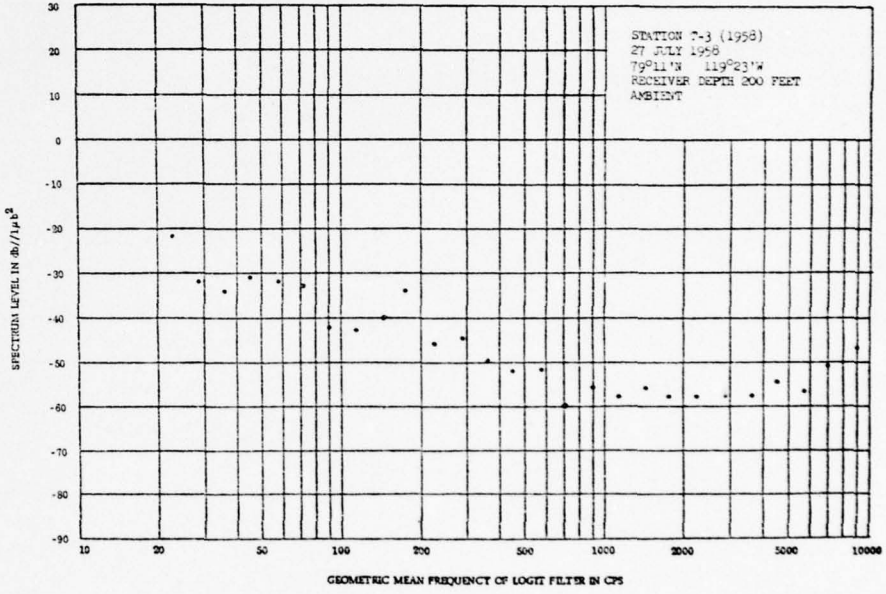

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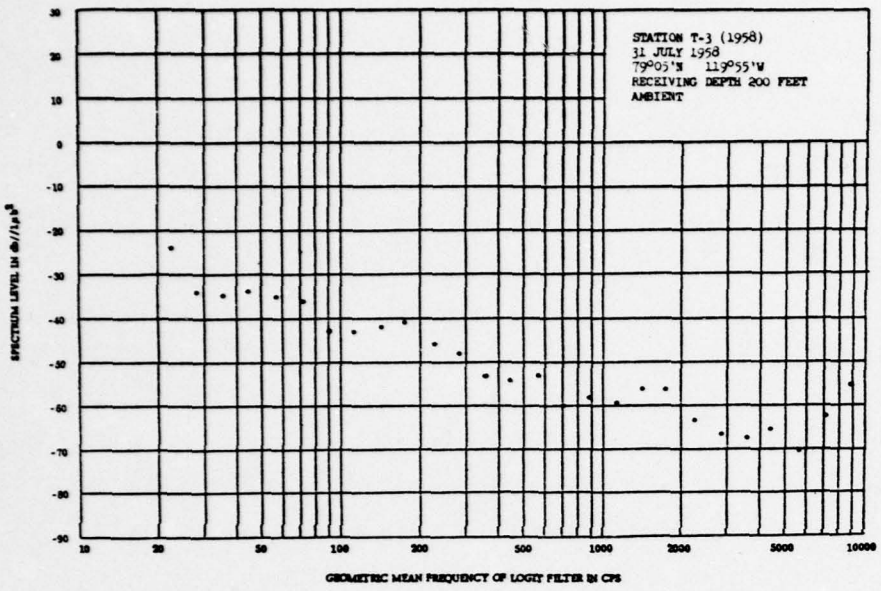

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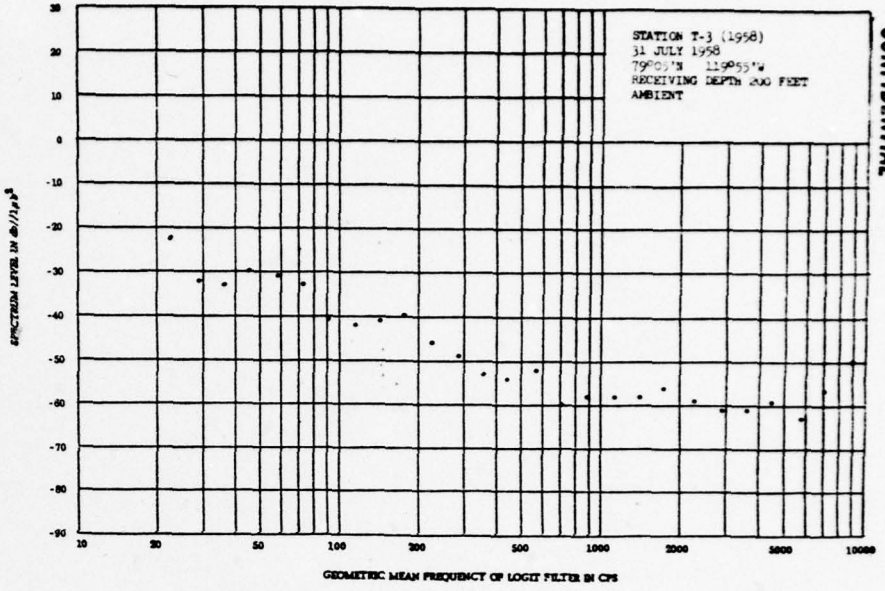

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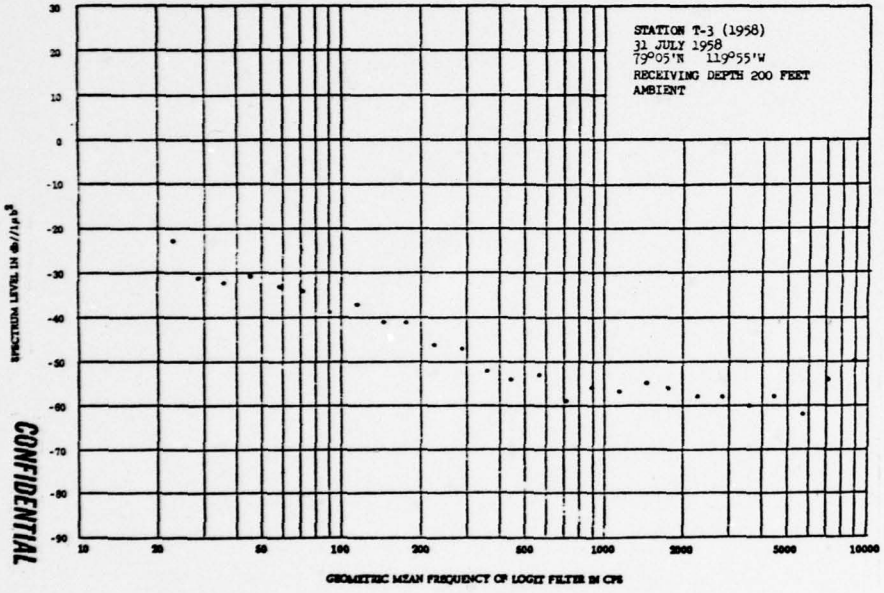

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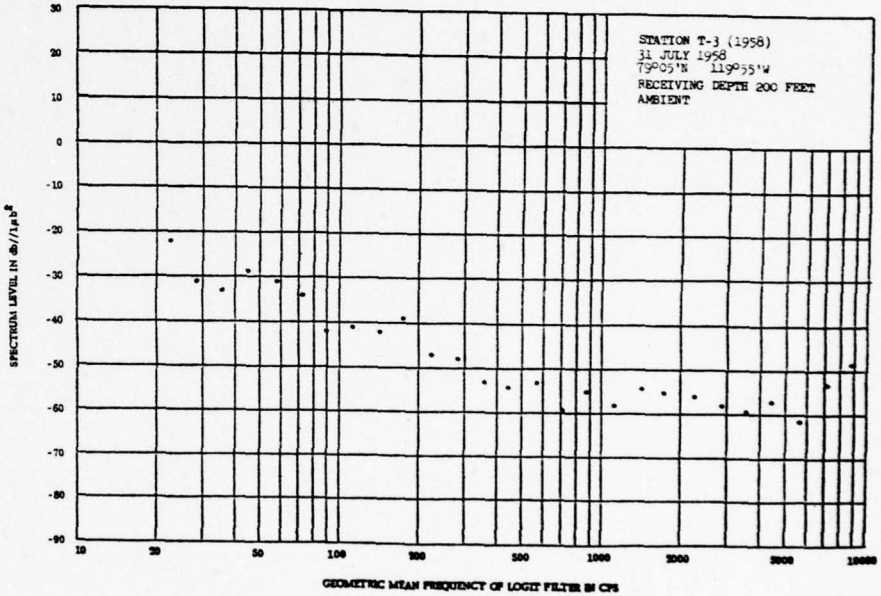

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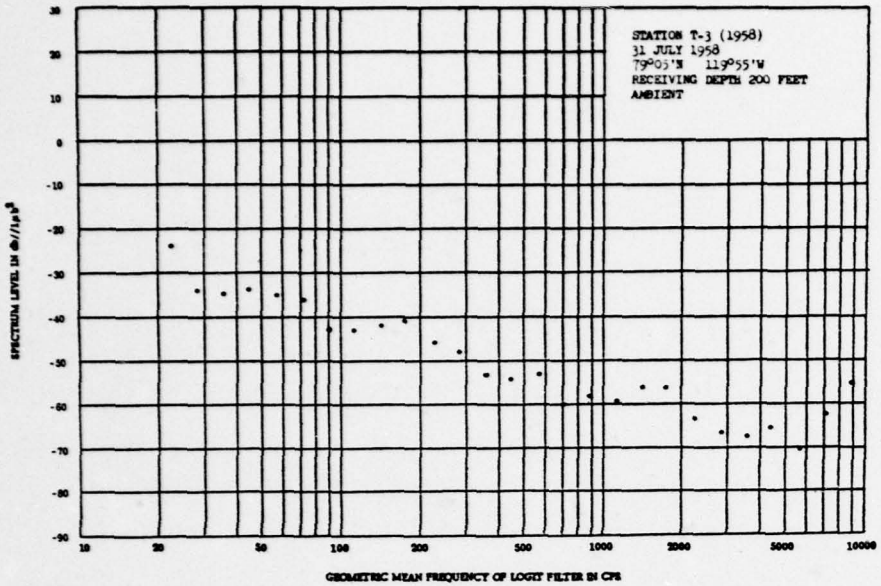

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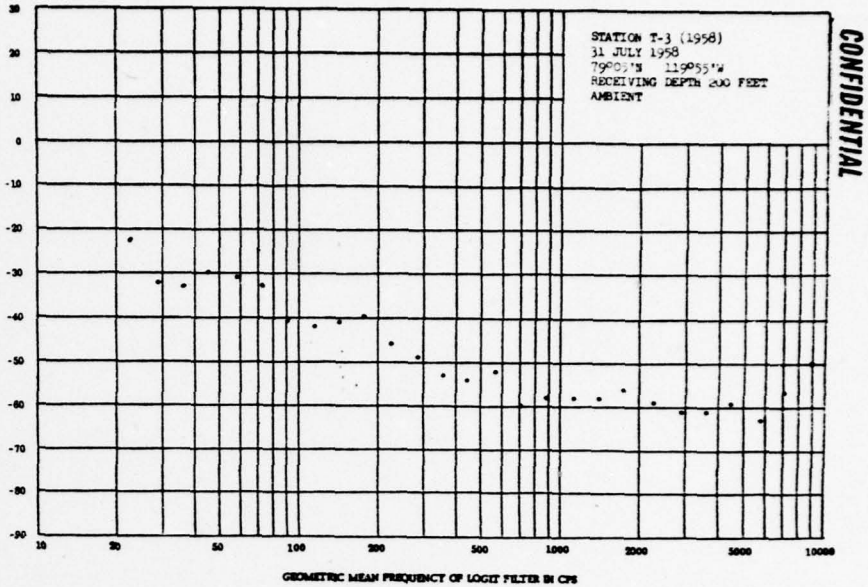

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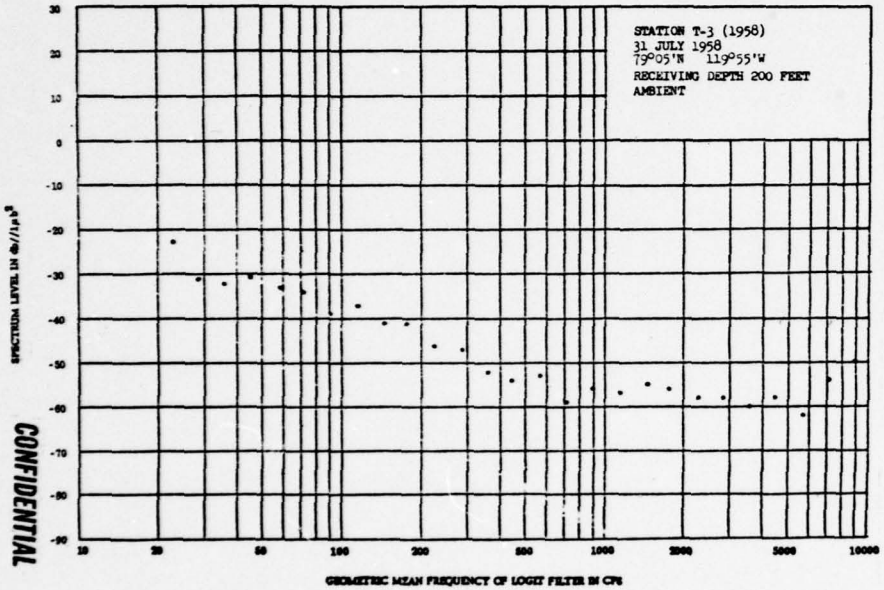

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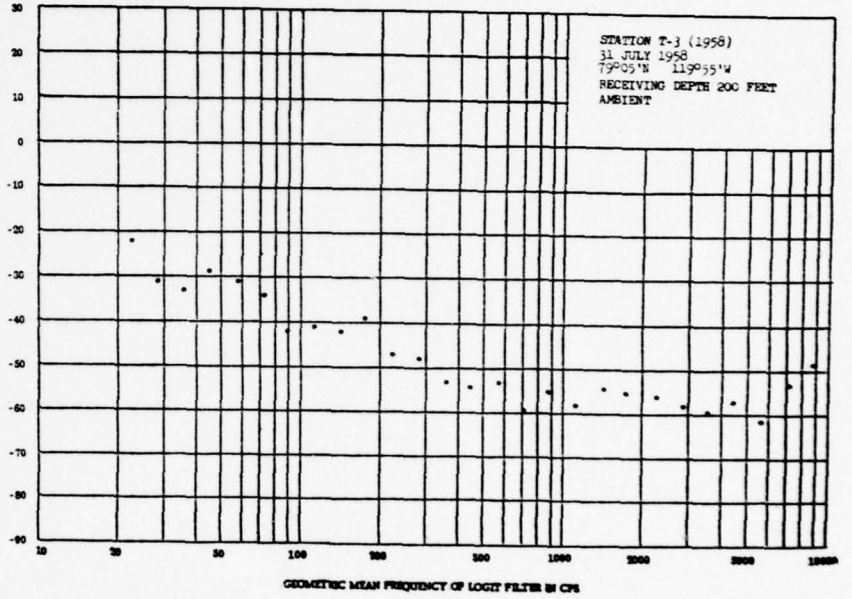

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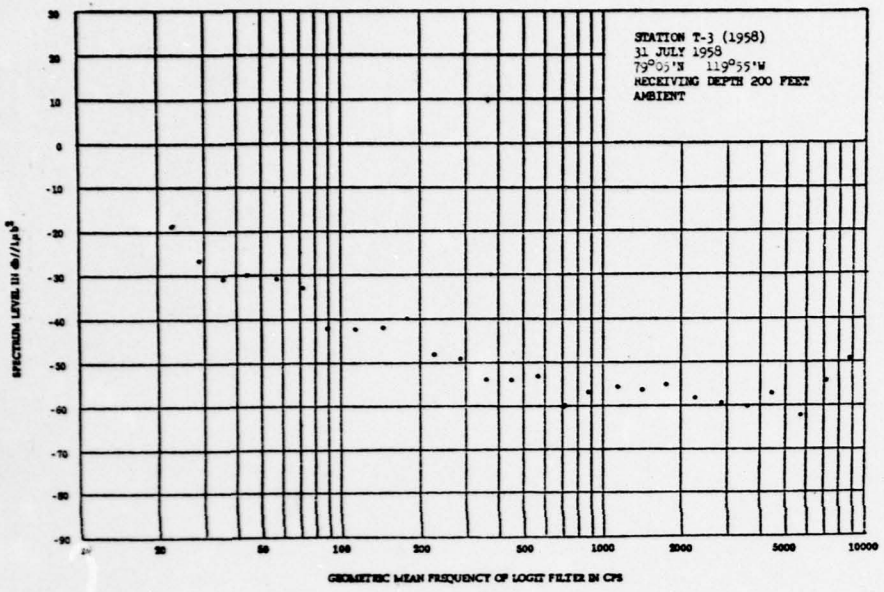

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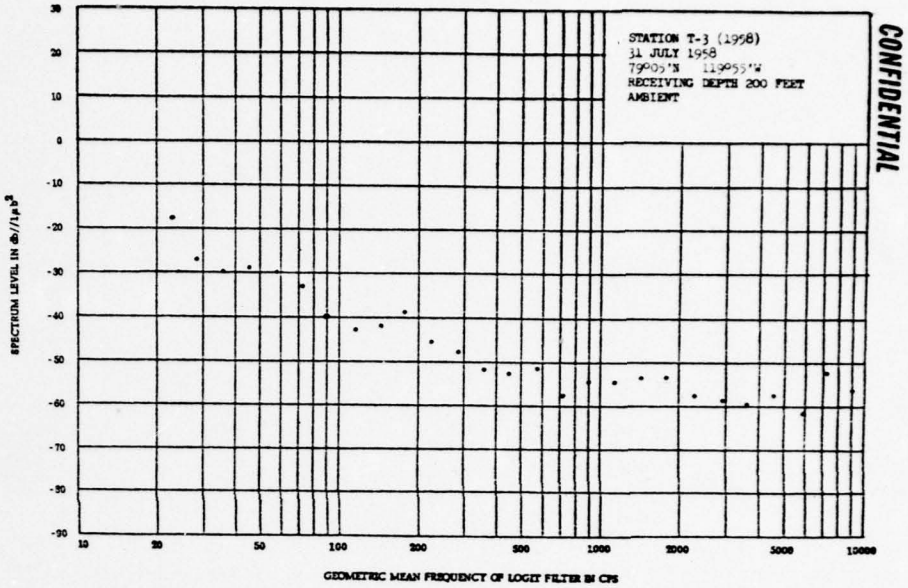

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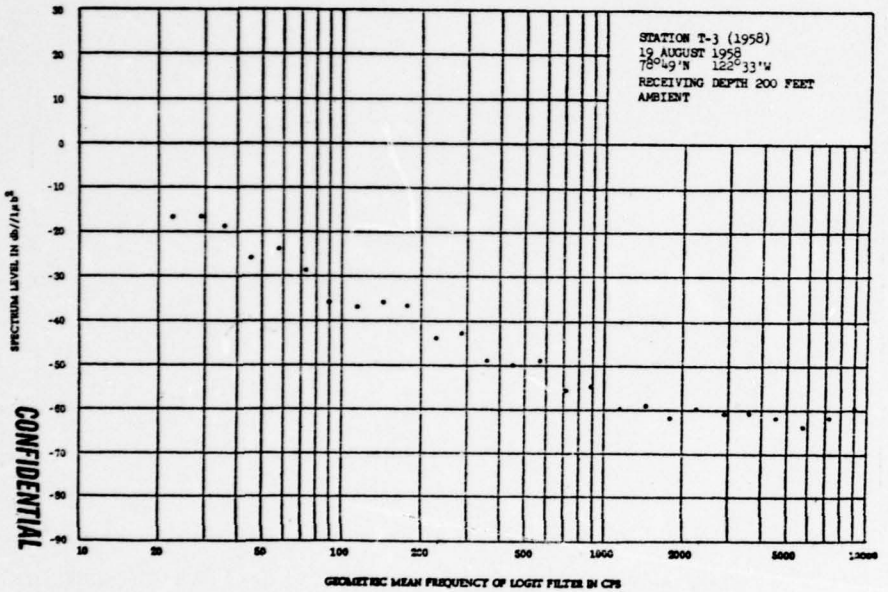

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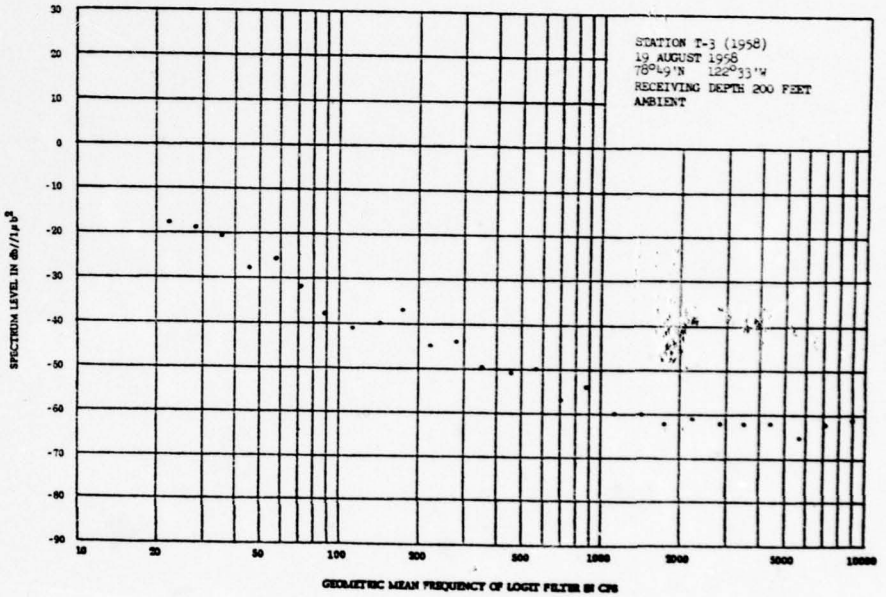

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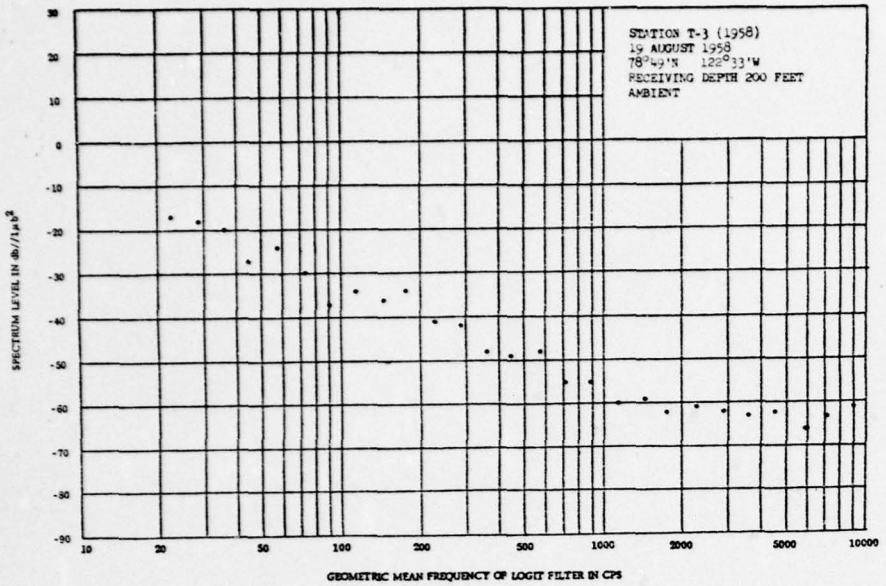

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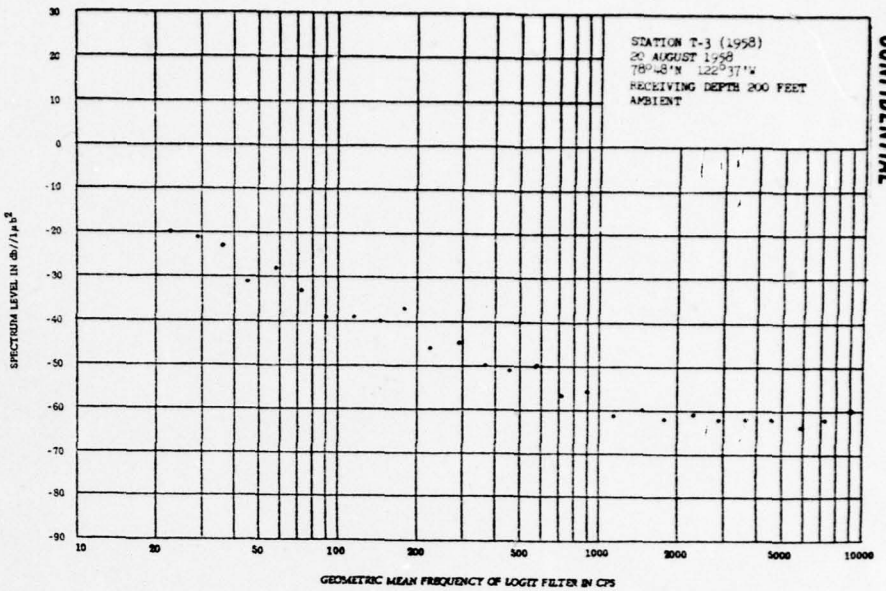

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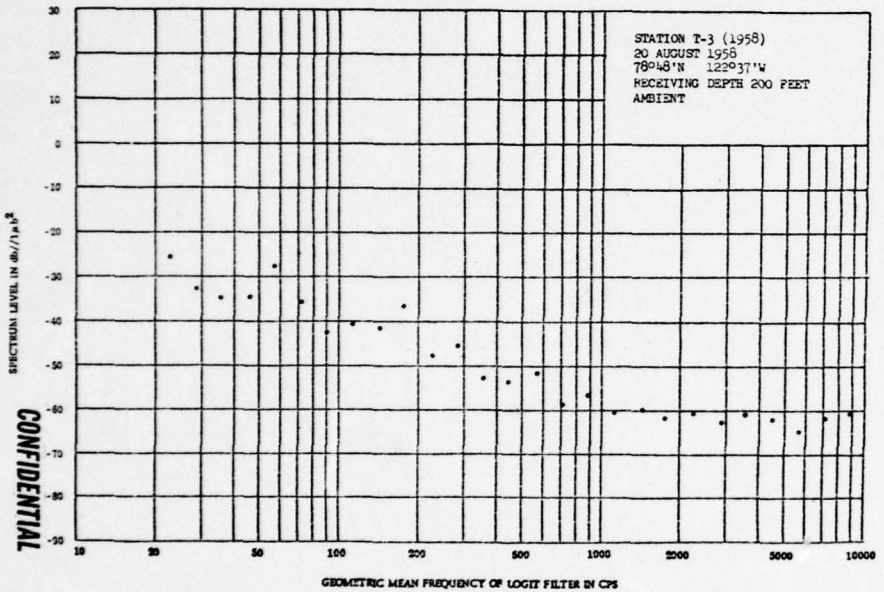

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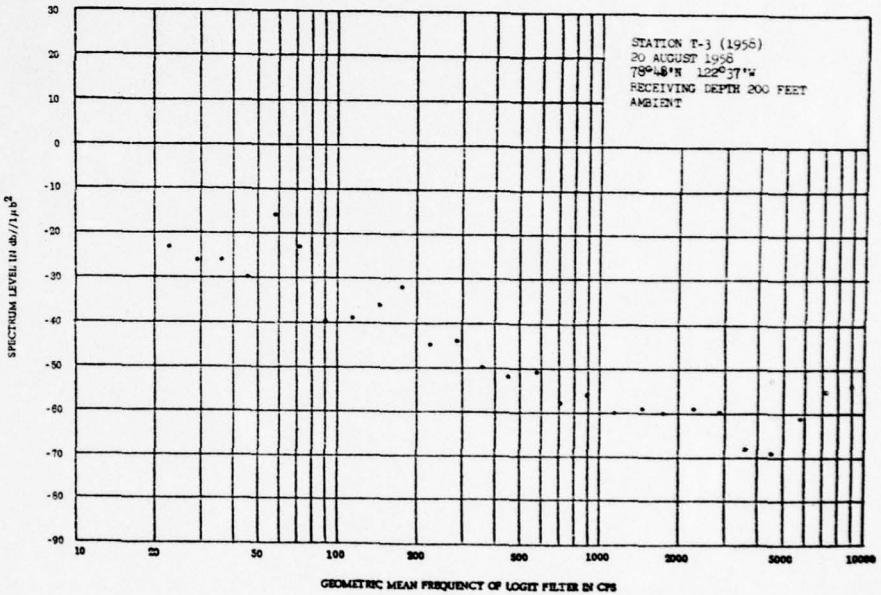

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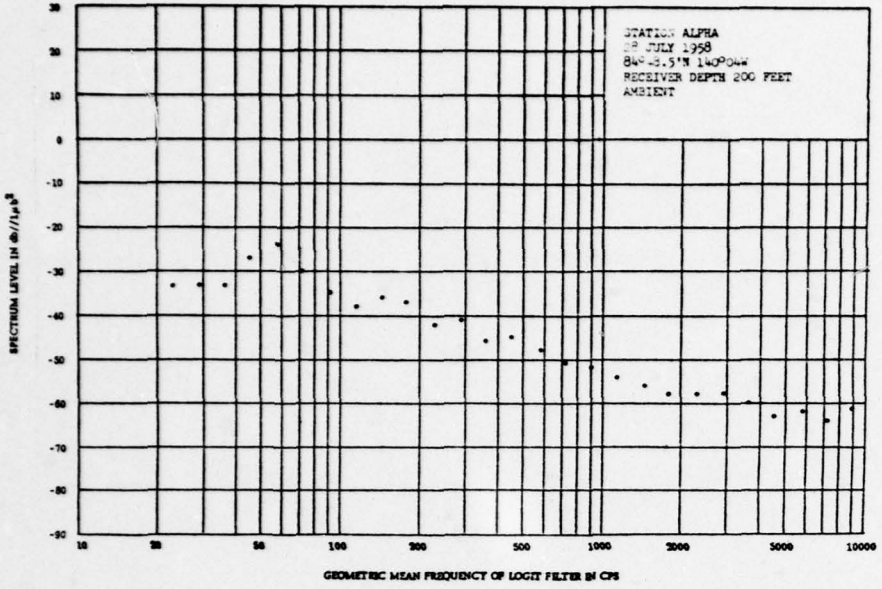

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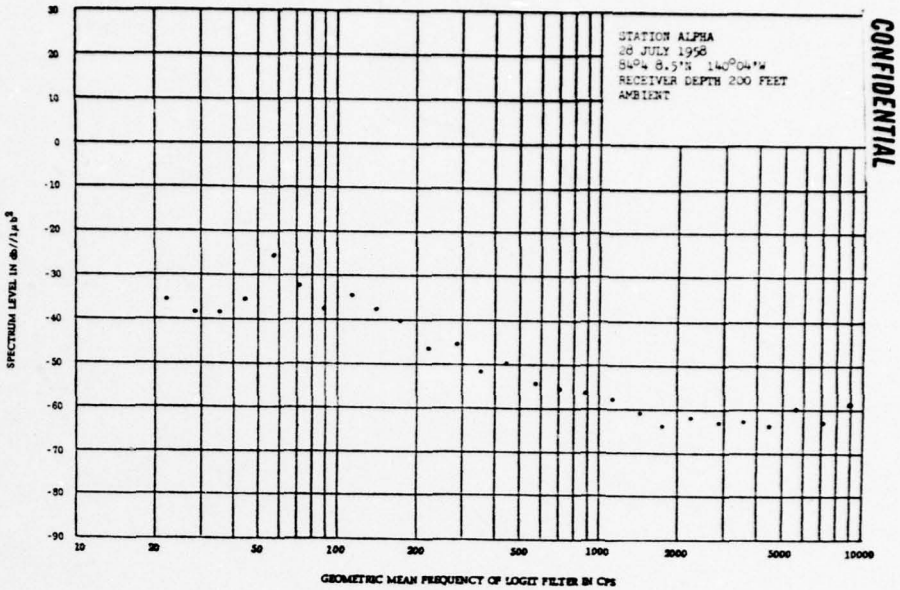

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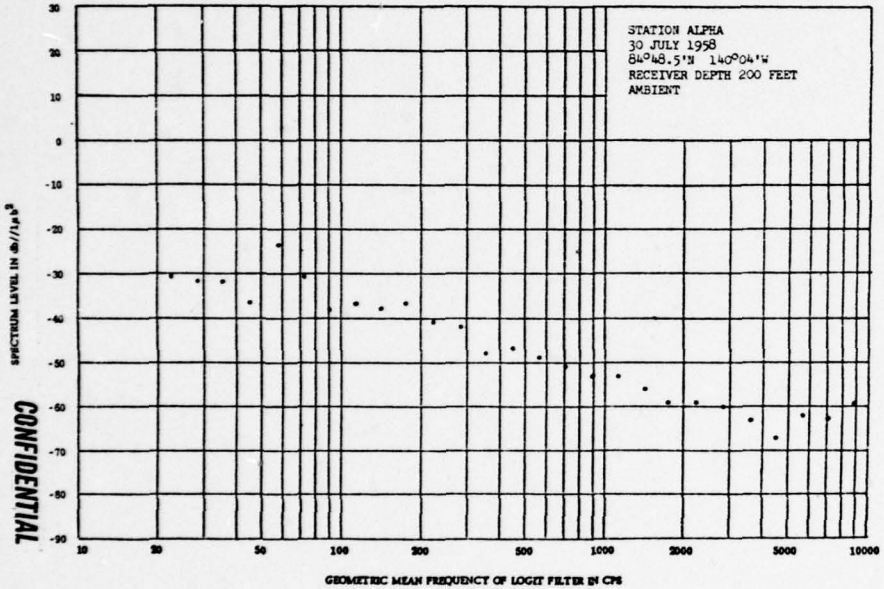

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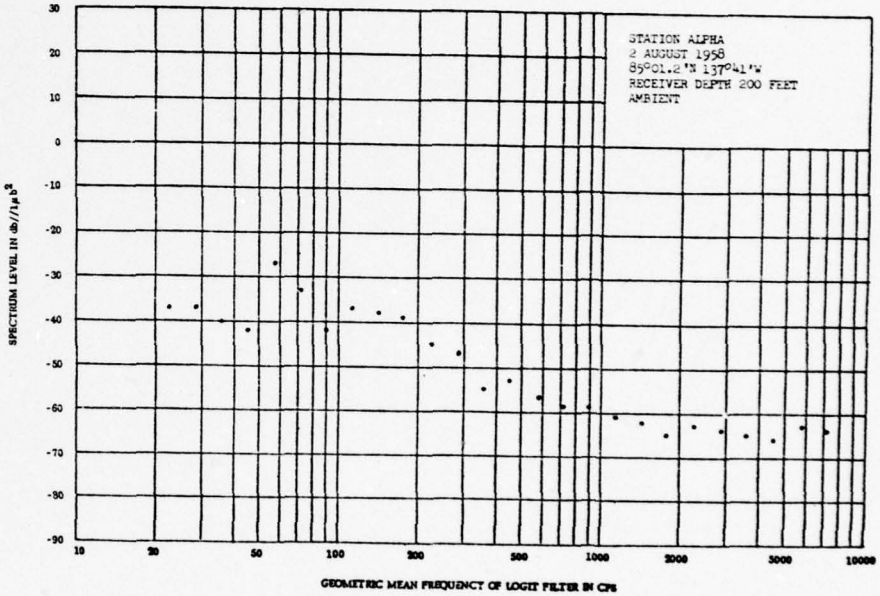

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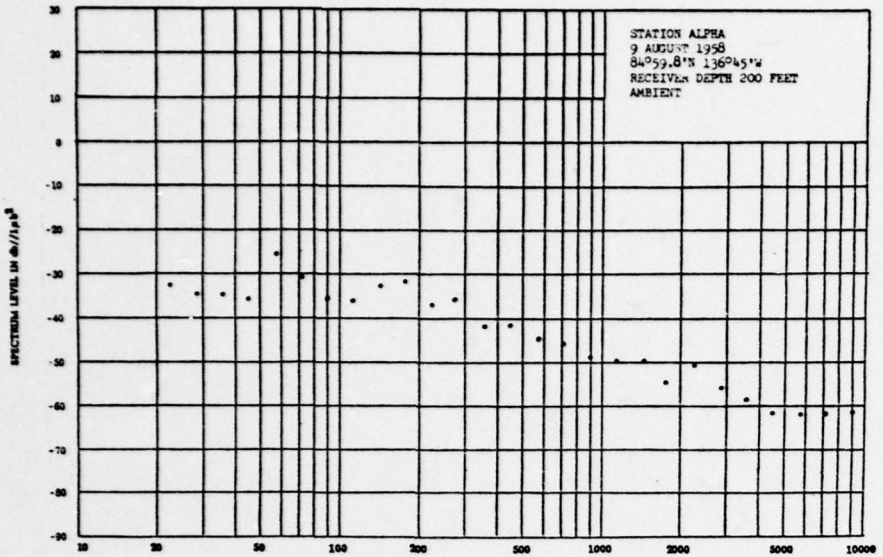

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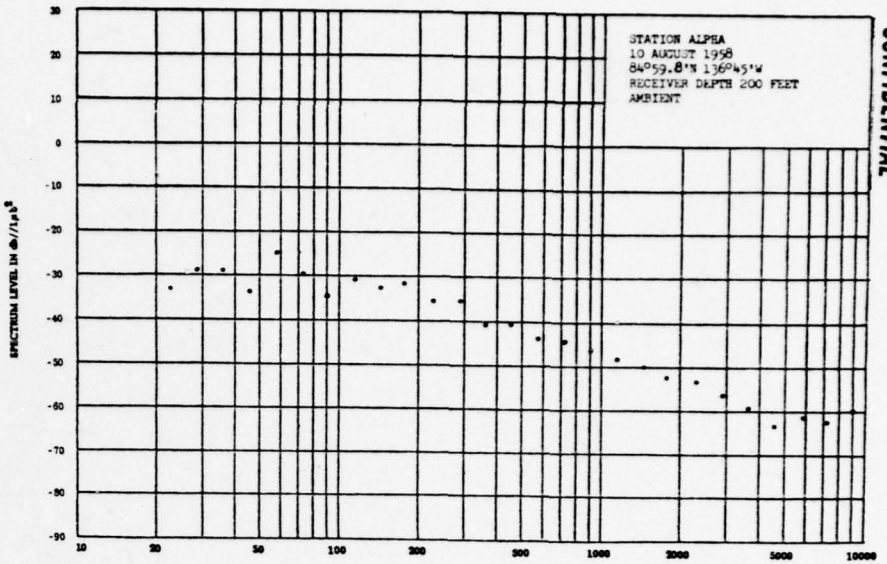

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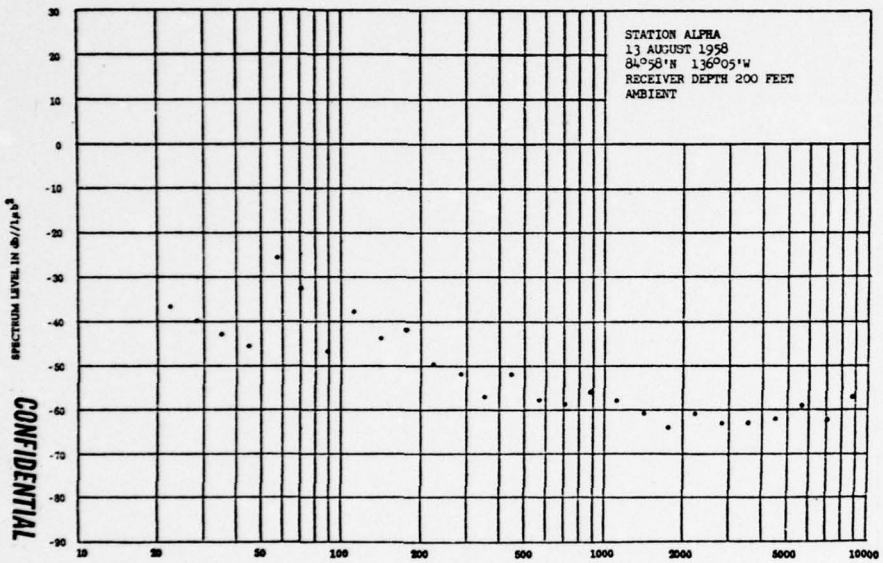

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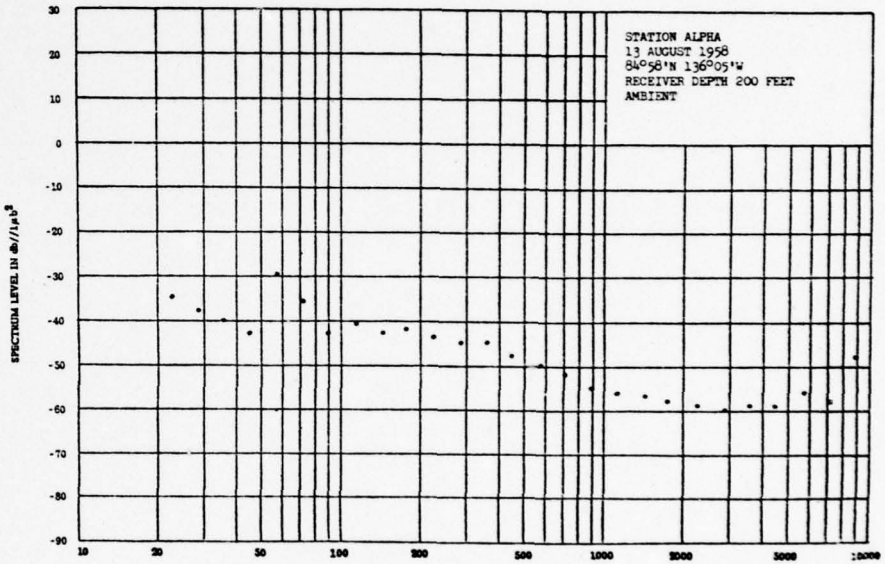

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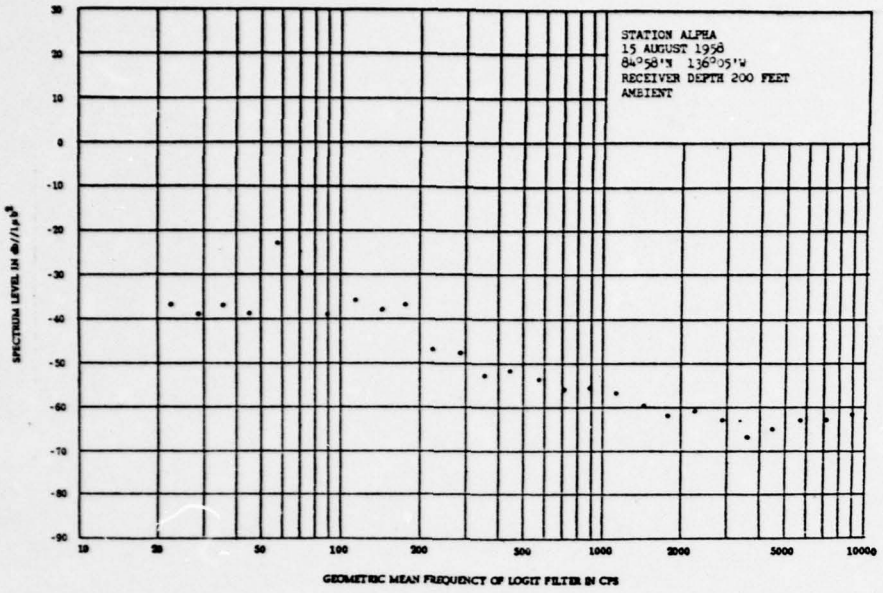

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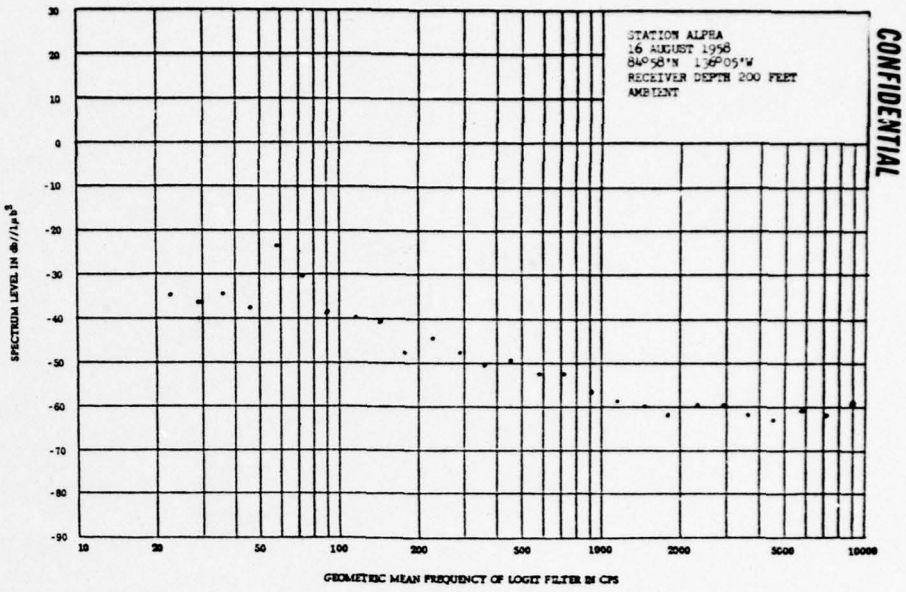

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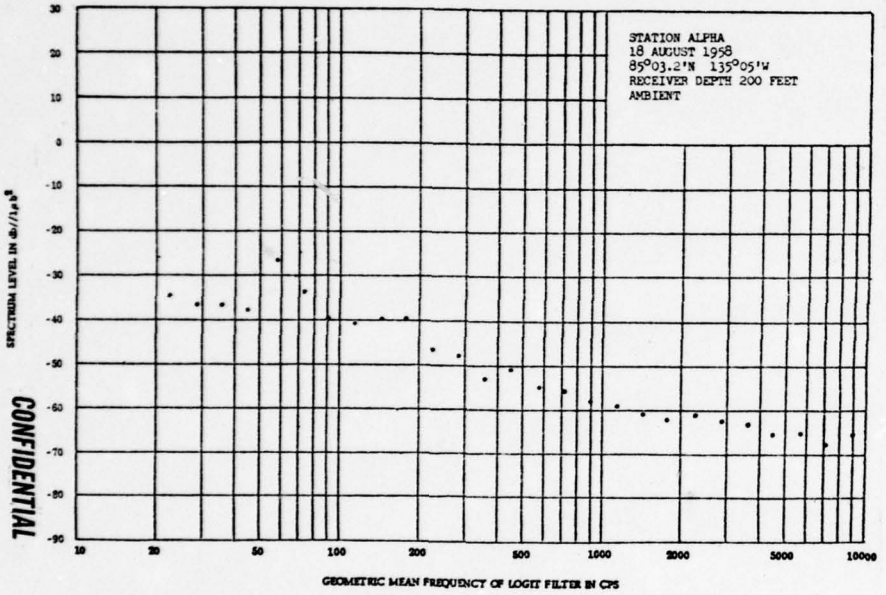

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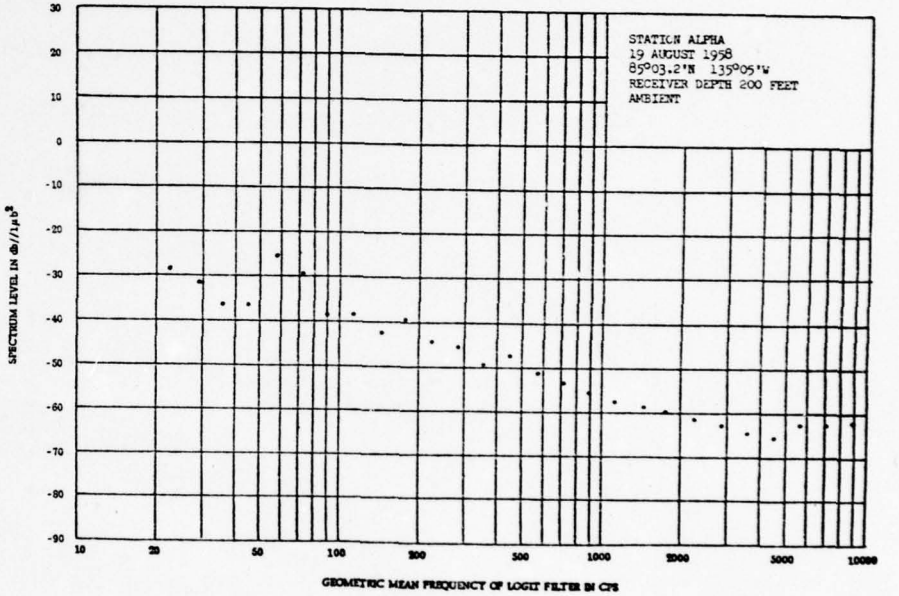

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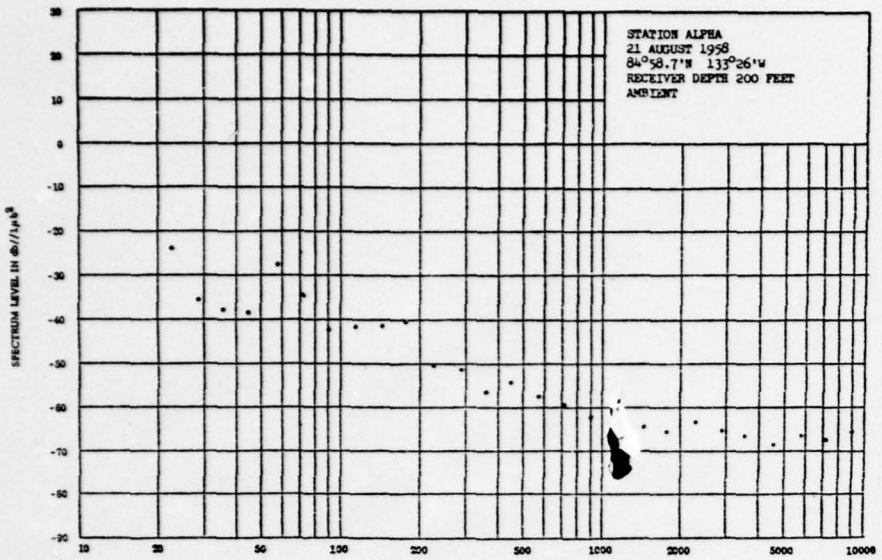

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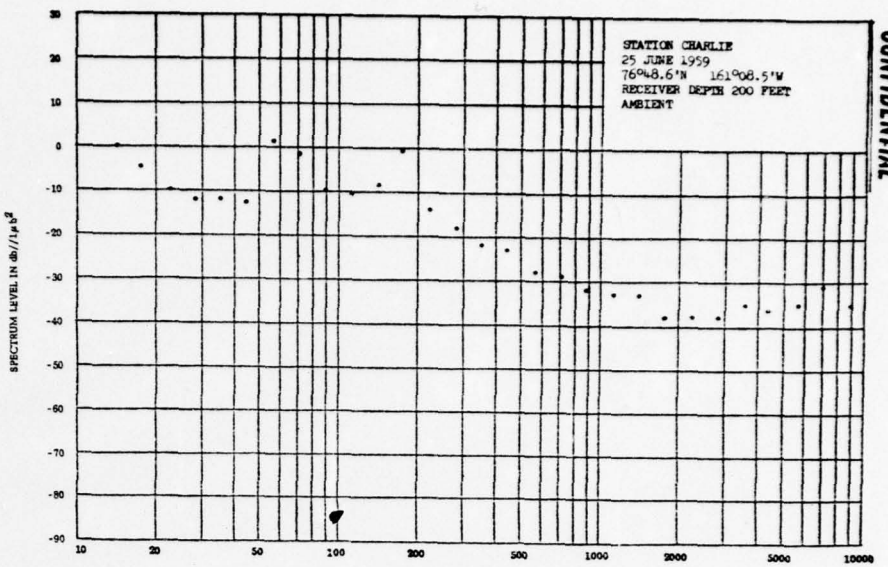

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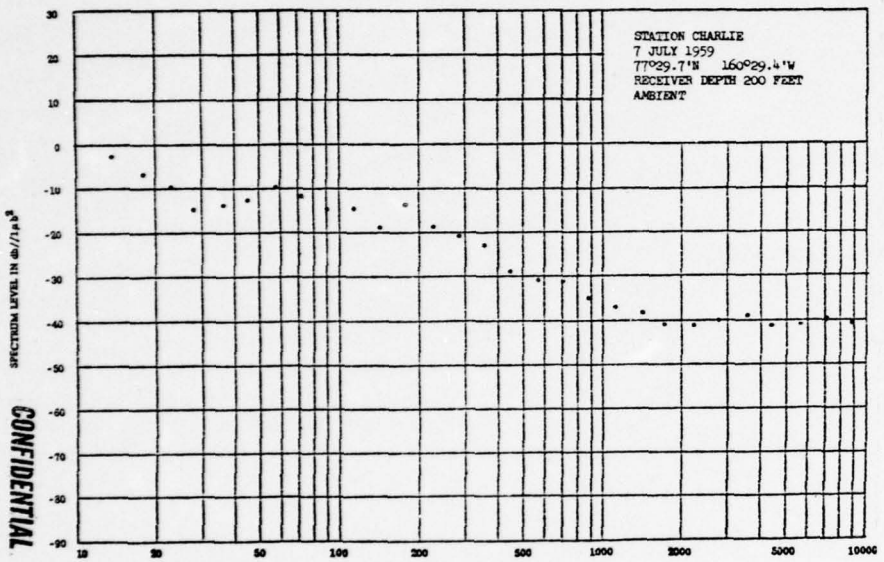

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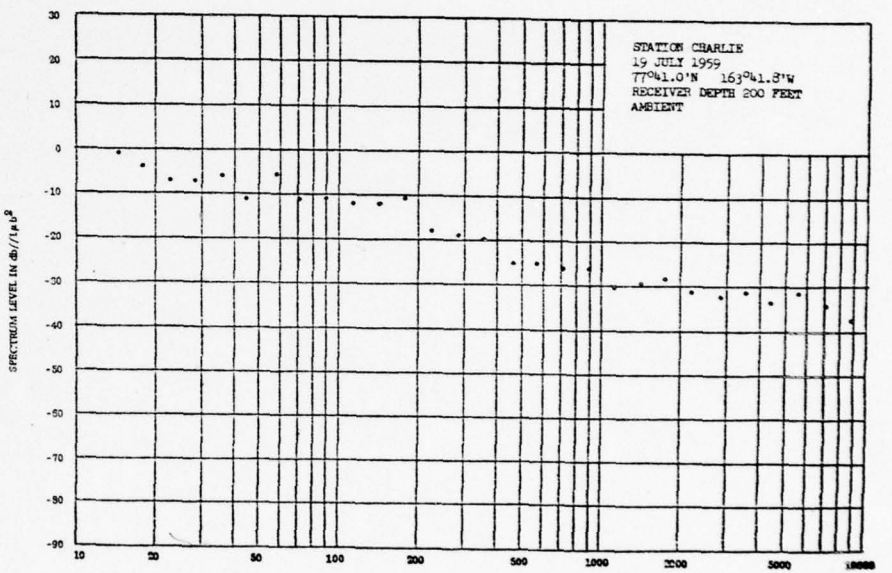

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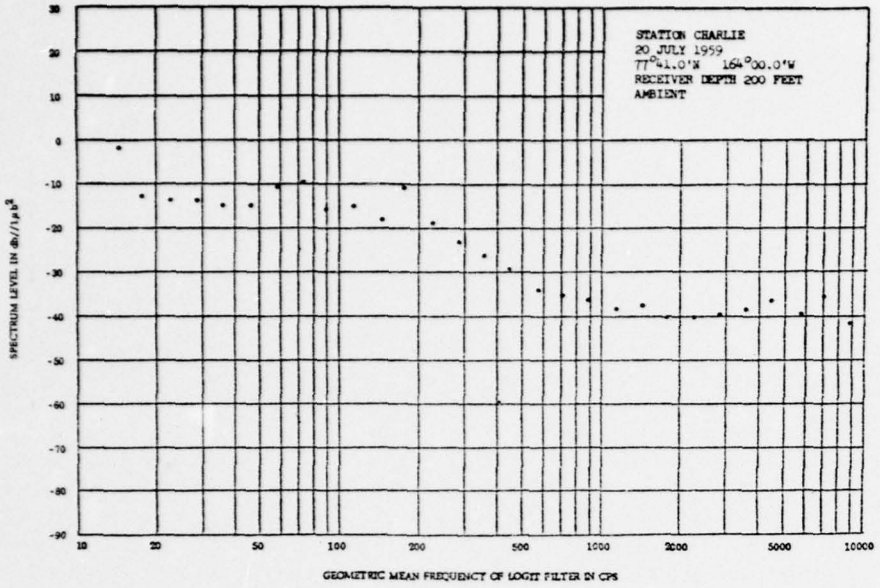

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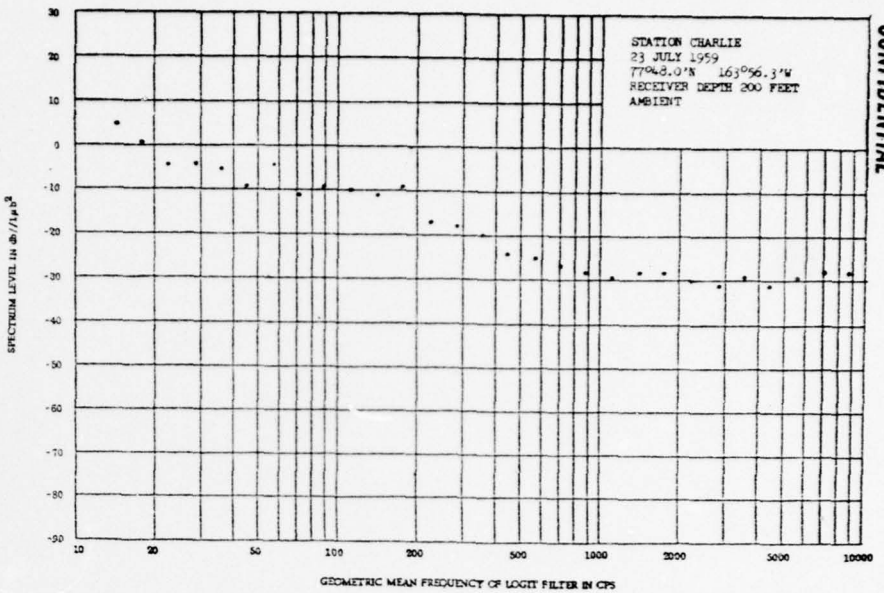

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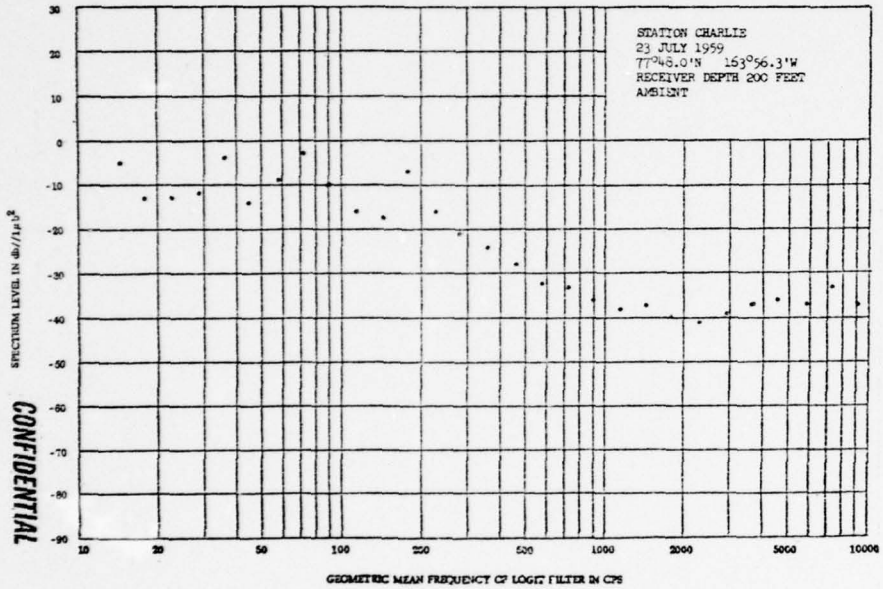

Fig. 44

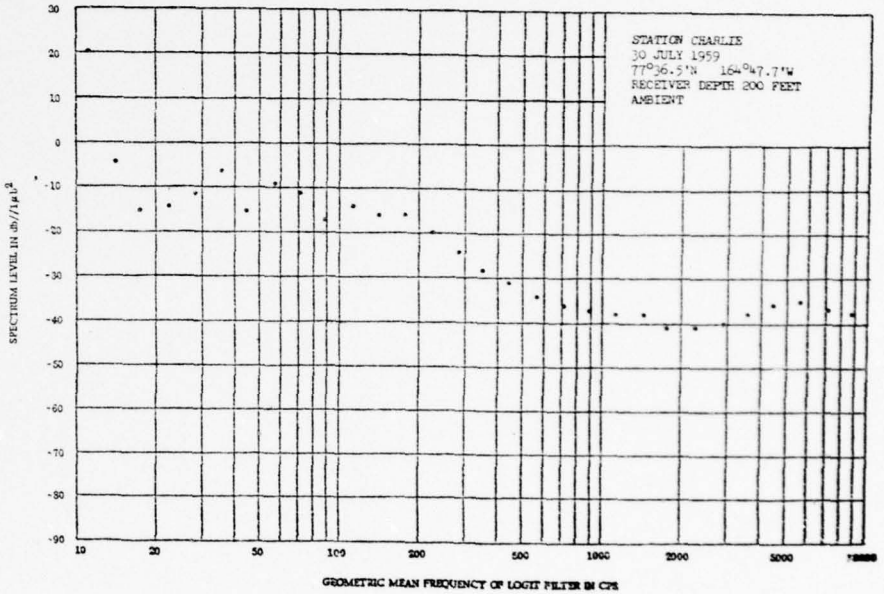

Fig. 45

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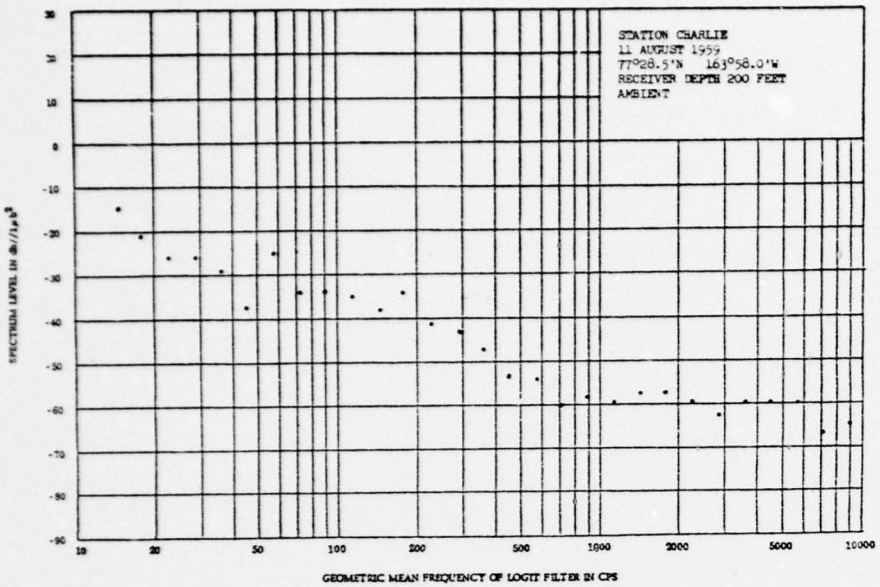


Fig. 46

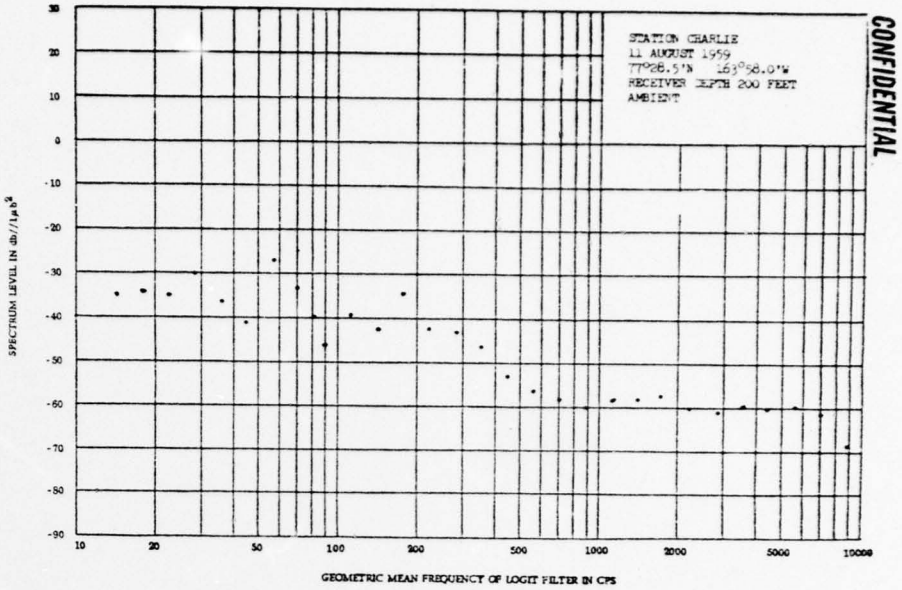
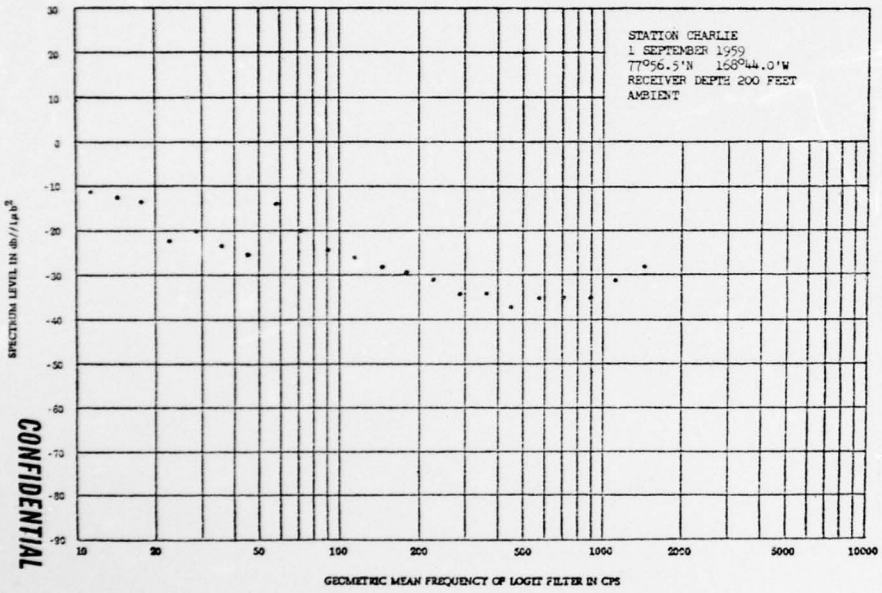


Fig. 47



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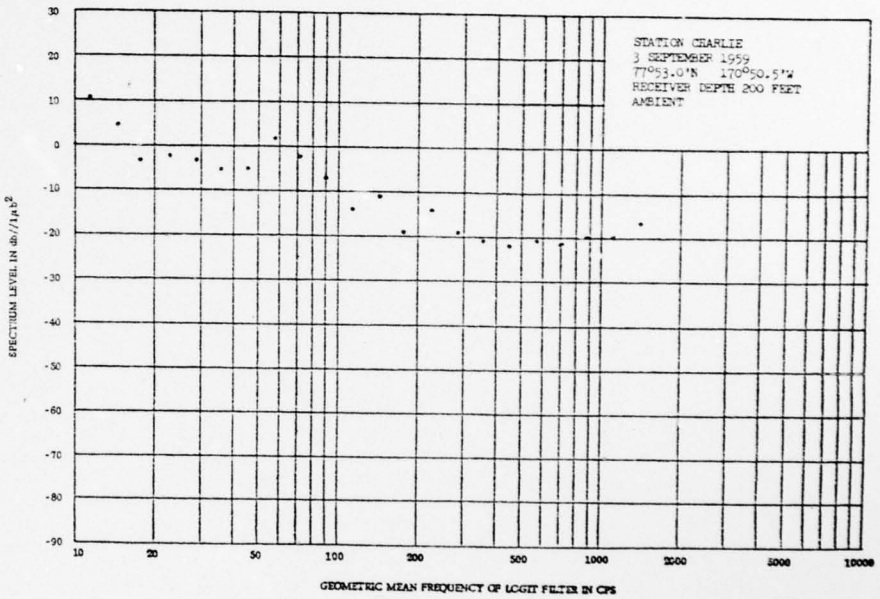

Fig. 49

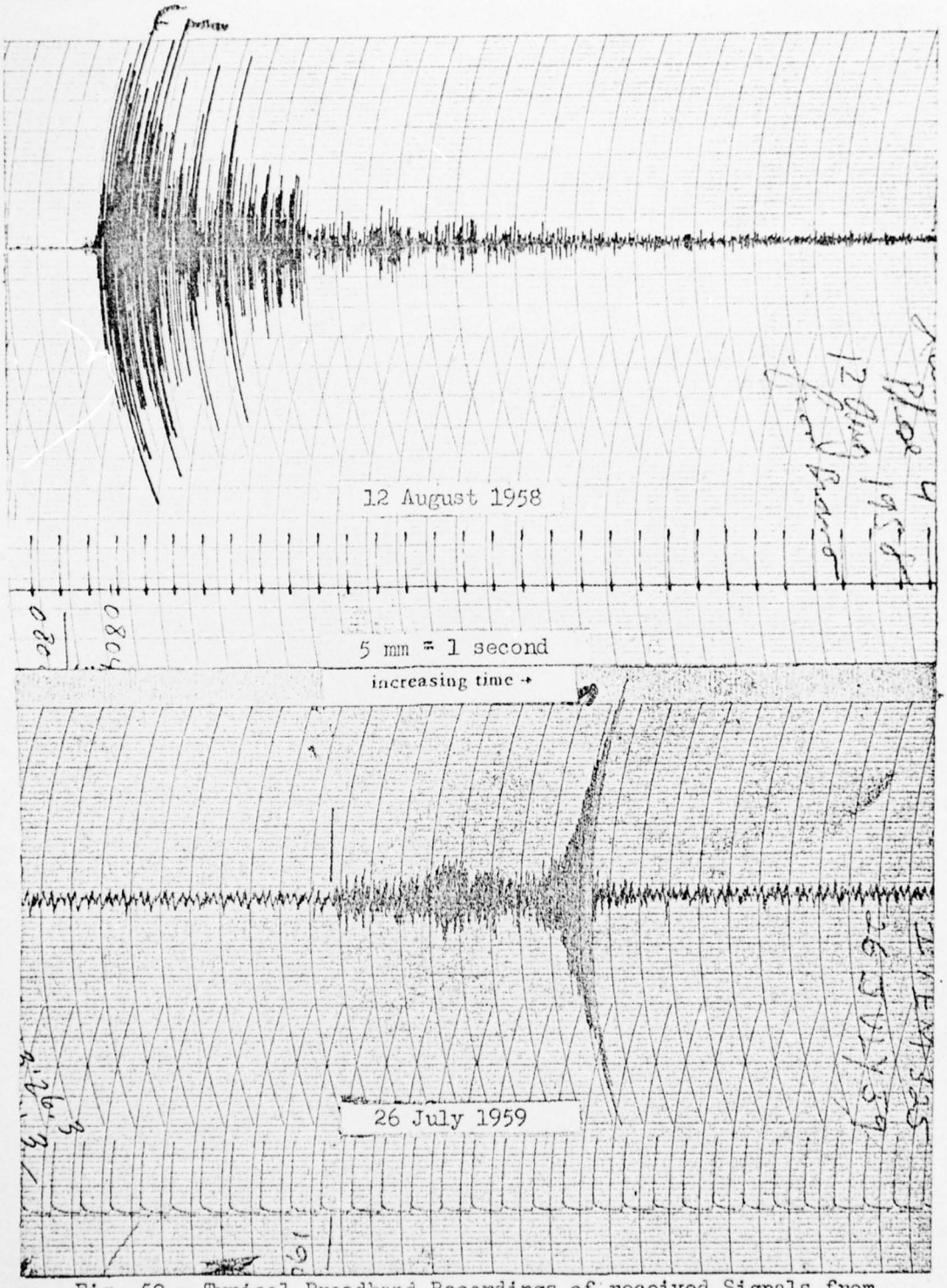

Fig. 50 - Typical Broadband Recordings of received Signals from Explosives during 1958 and 1959.

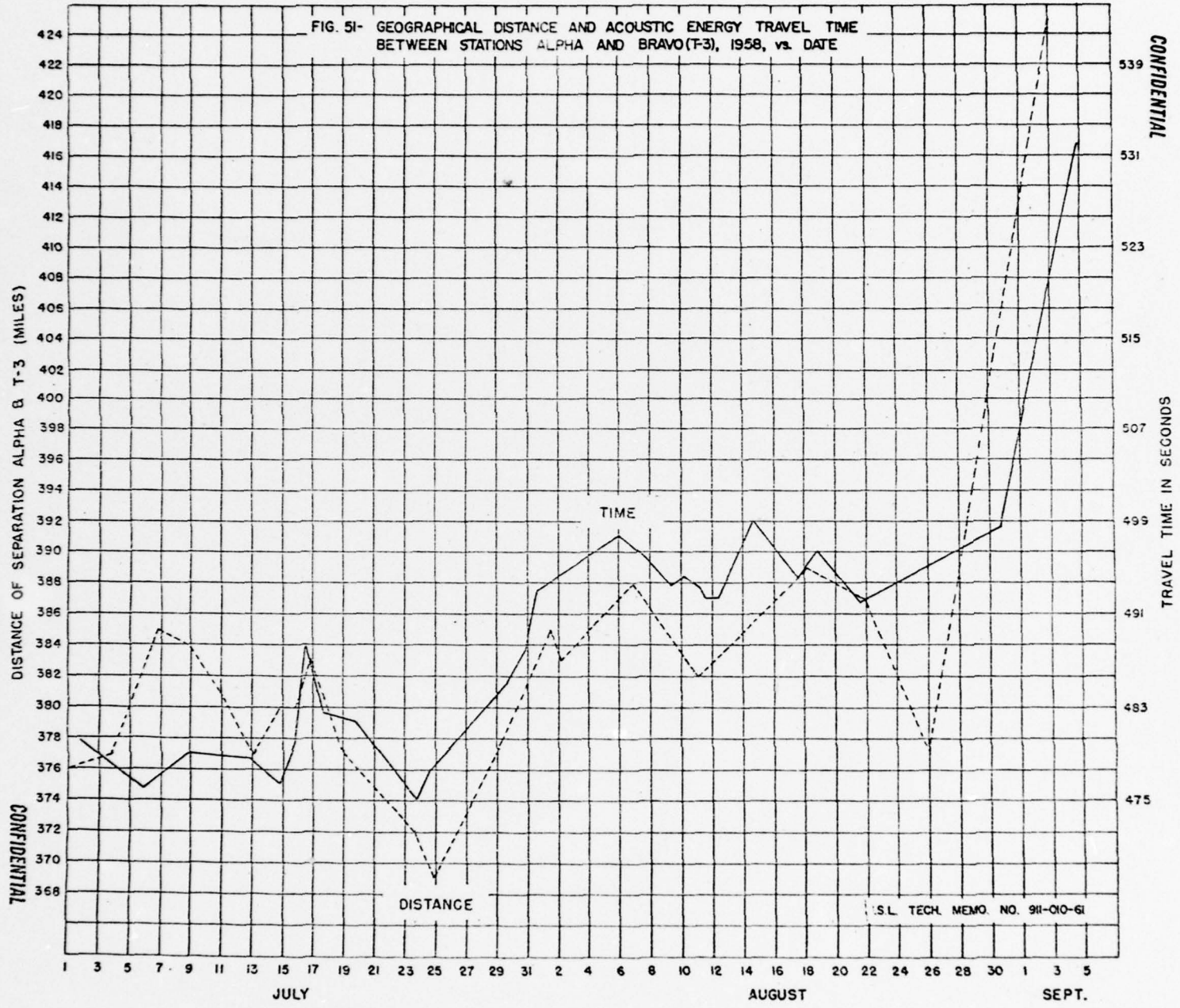
FIG. 51- GEOGRAPHICAL DISTANCE AND ACOUSTIC ENERGY TRAVEL TIME BETWEEN STATIONS ALPHA AND BRAVO (T-3), 1958, vs. DATE
DISTANCE OF SEPARATION ALPHA & T-3 (MILES)
TRAVEL TIME IN SECONDS
TIME
DISTANCE
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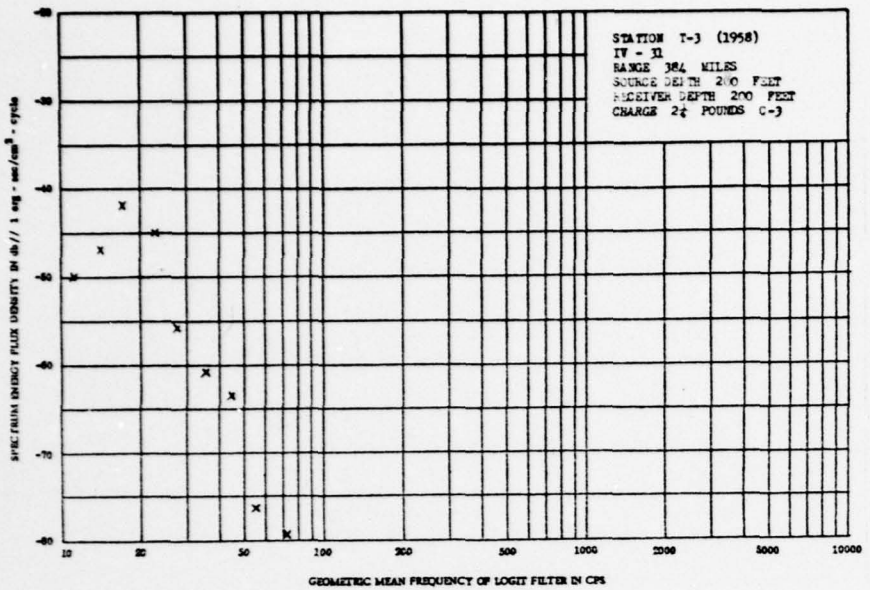

Fig. 52

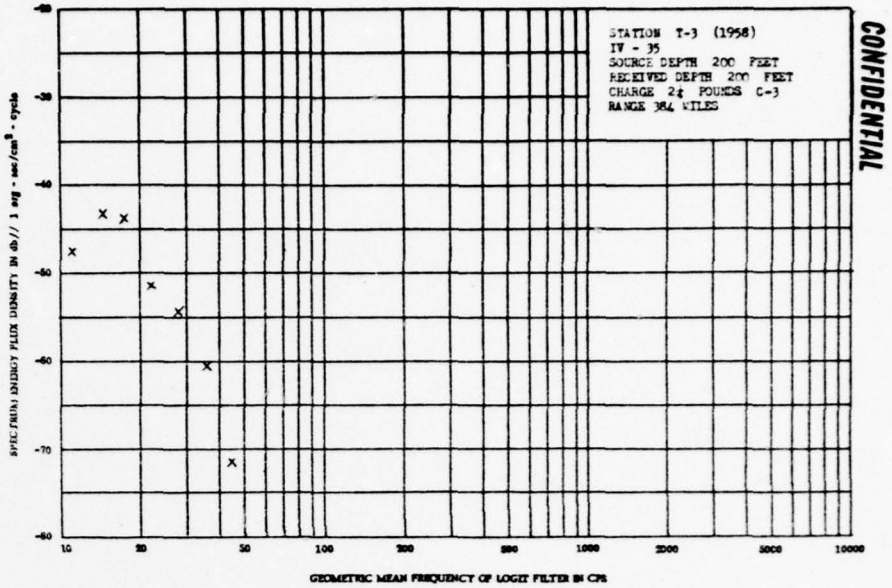

Fig. 53

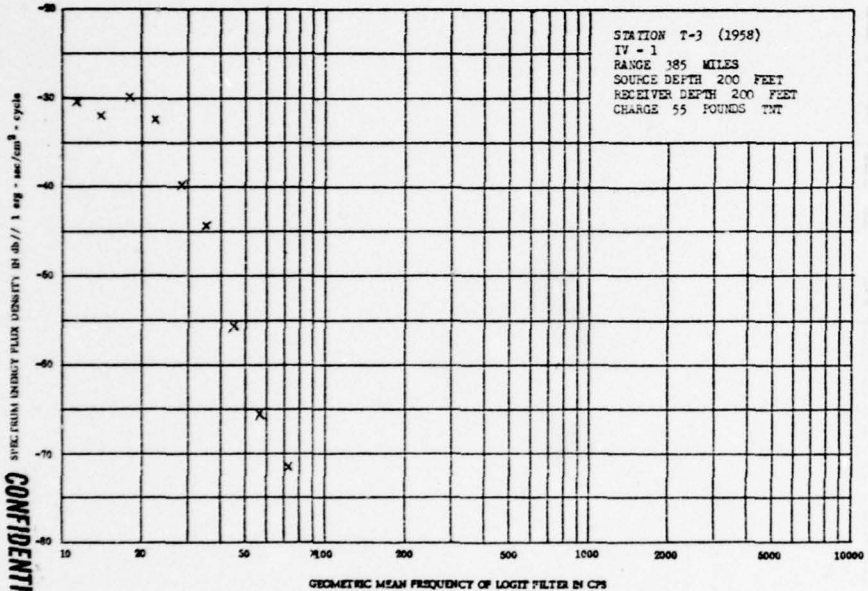

Fig. 54

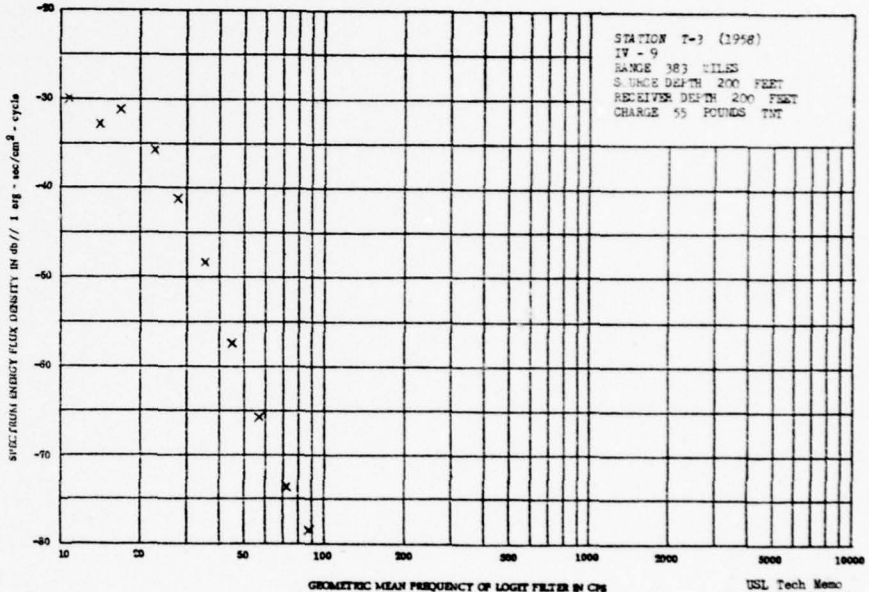

Fig. 55

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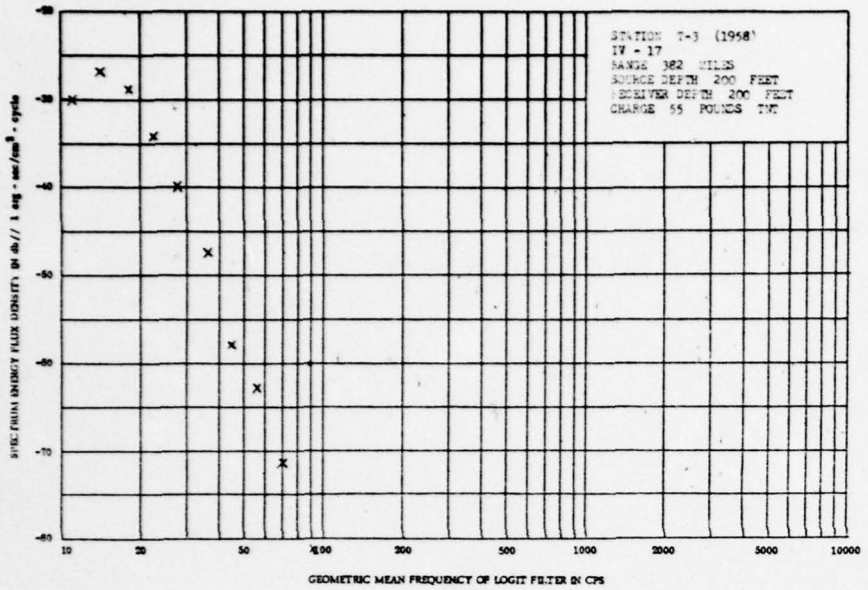

Fig. 56

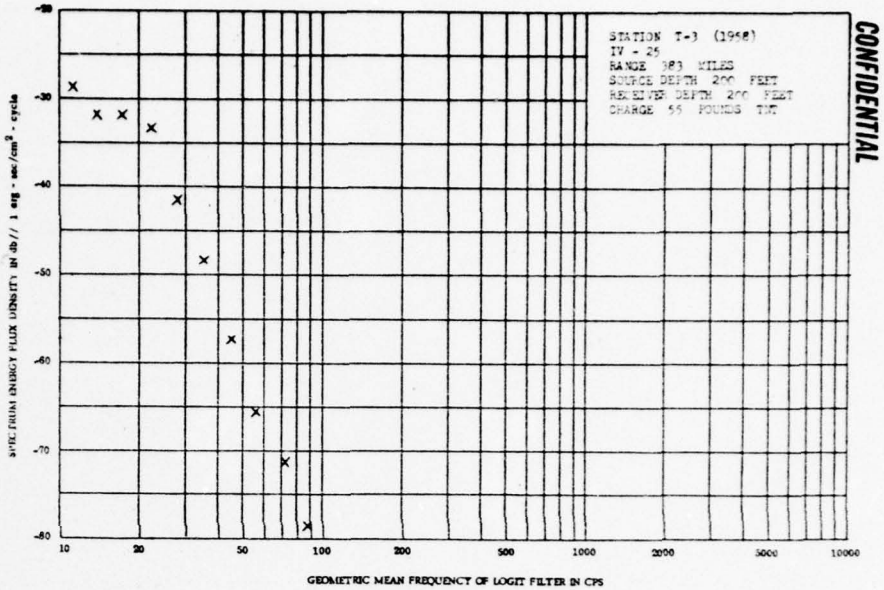

Fig. 57

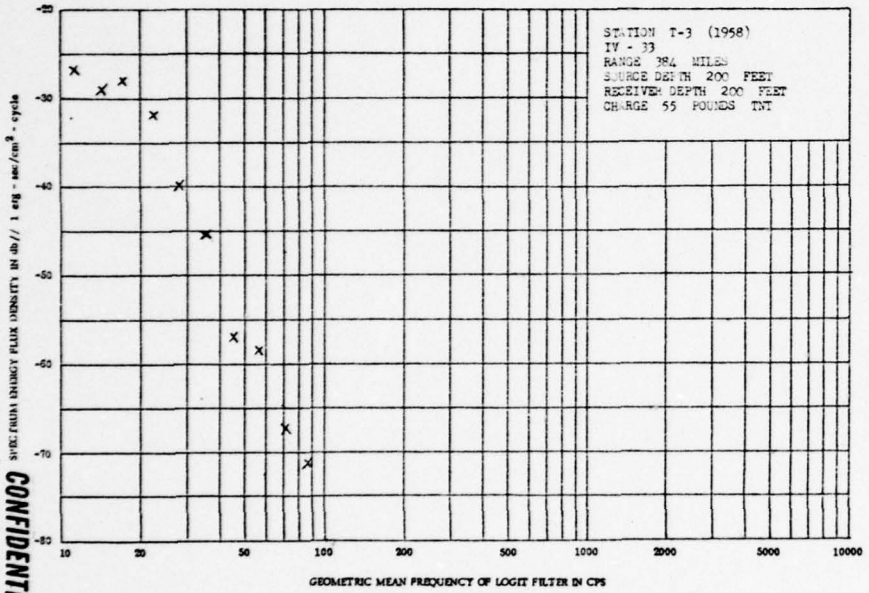

Fig. 58

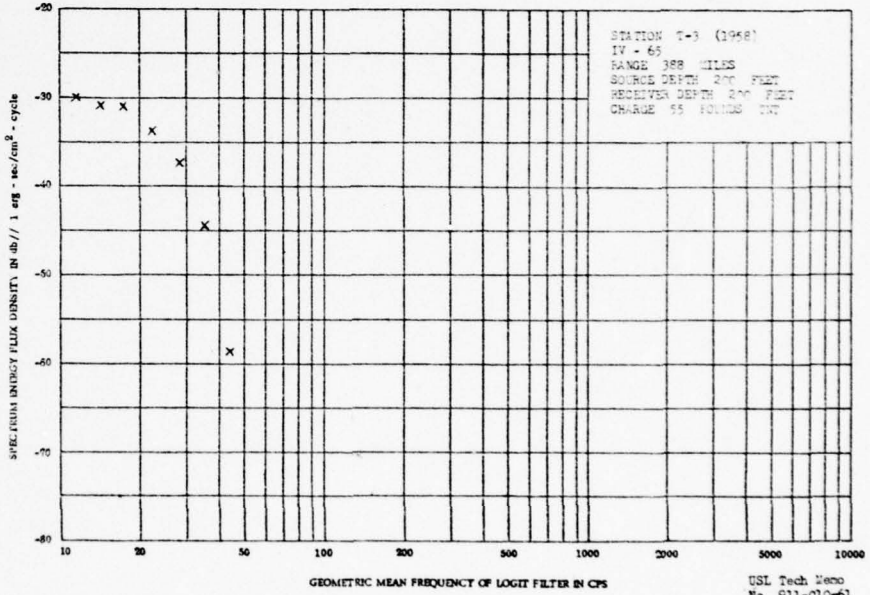

Fig. 59

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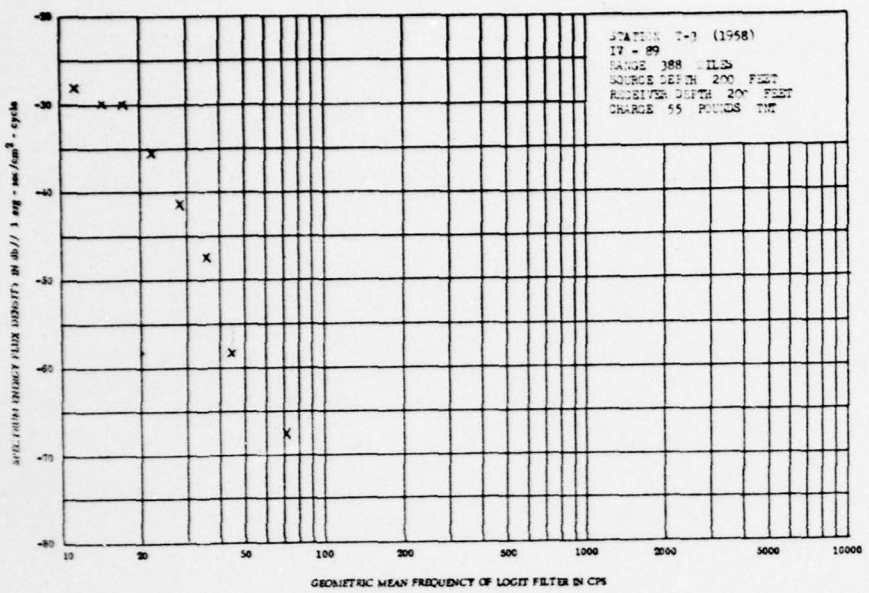


Fig. 60

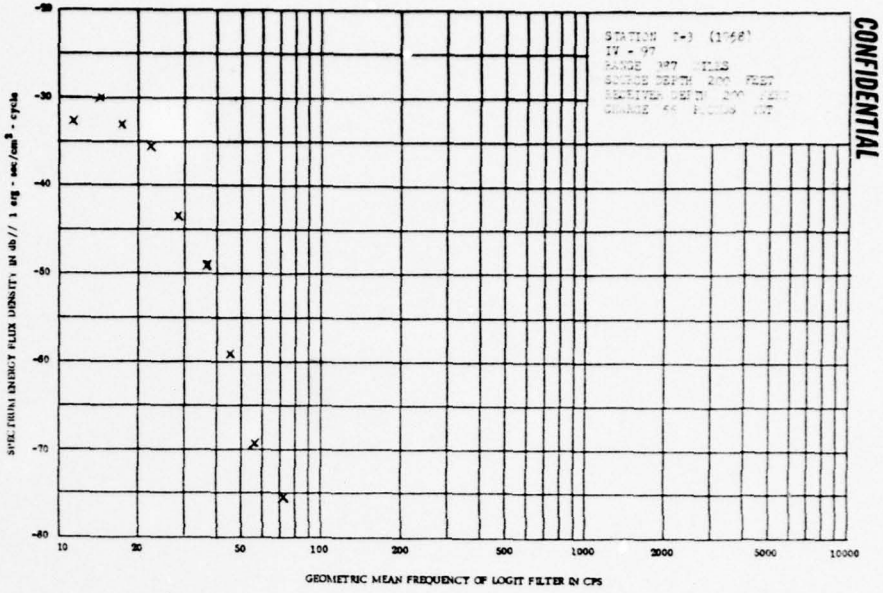


Fig. 61

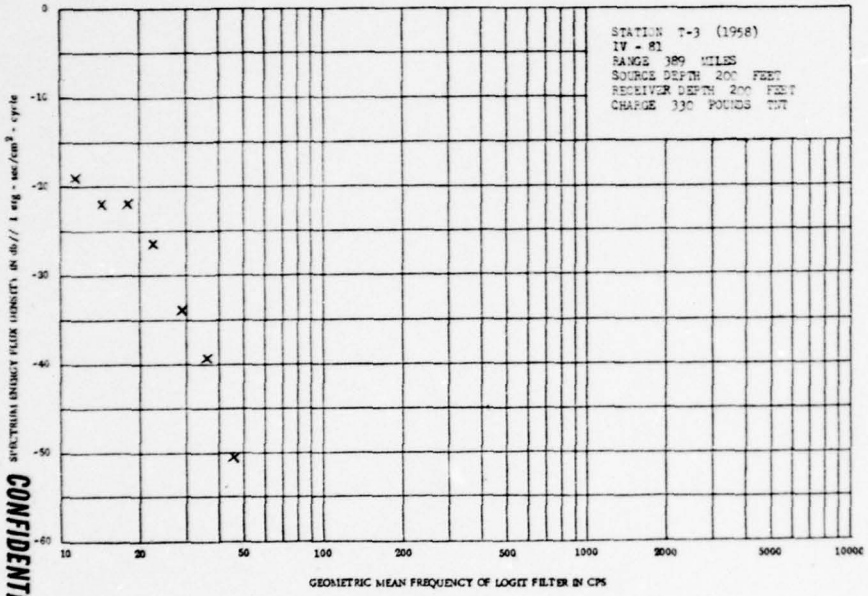


Fig. 62

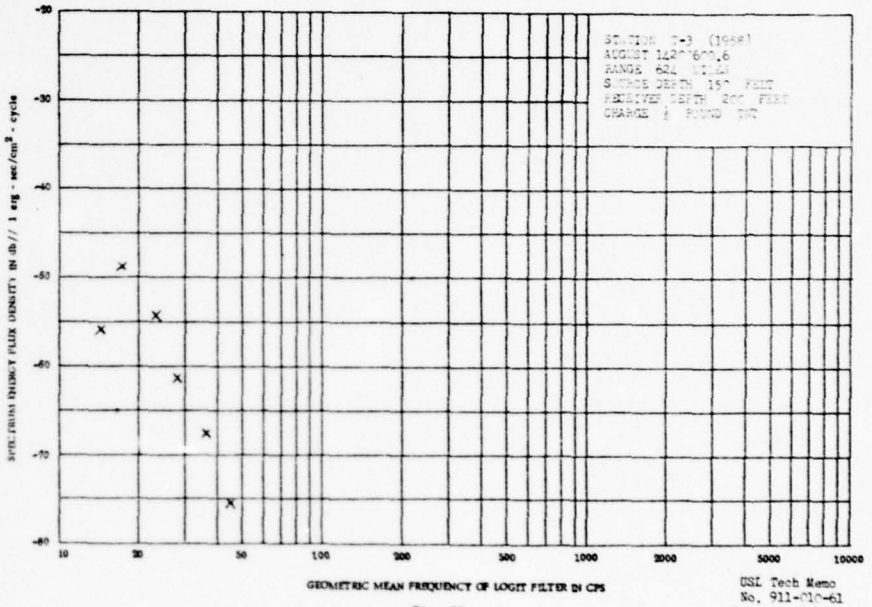


Fig. 63

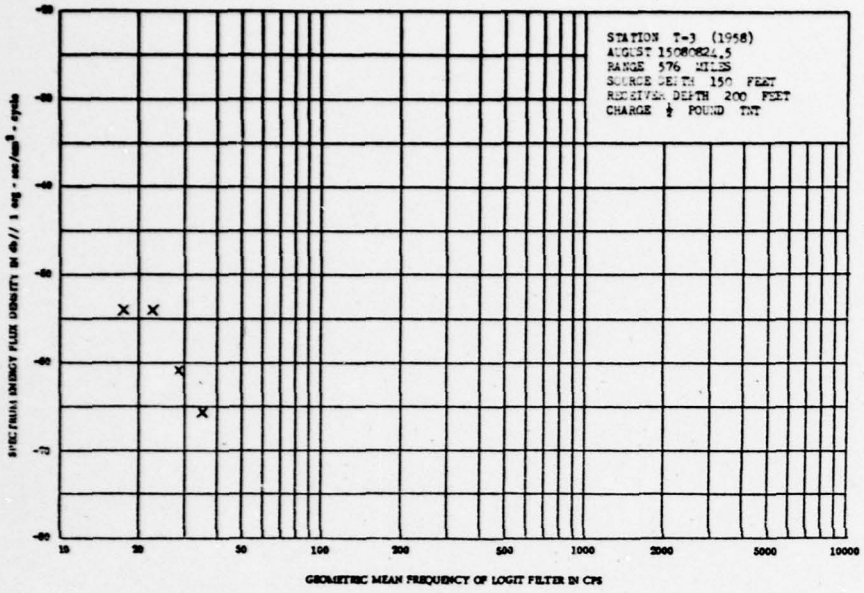
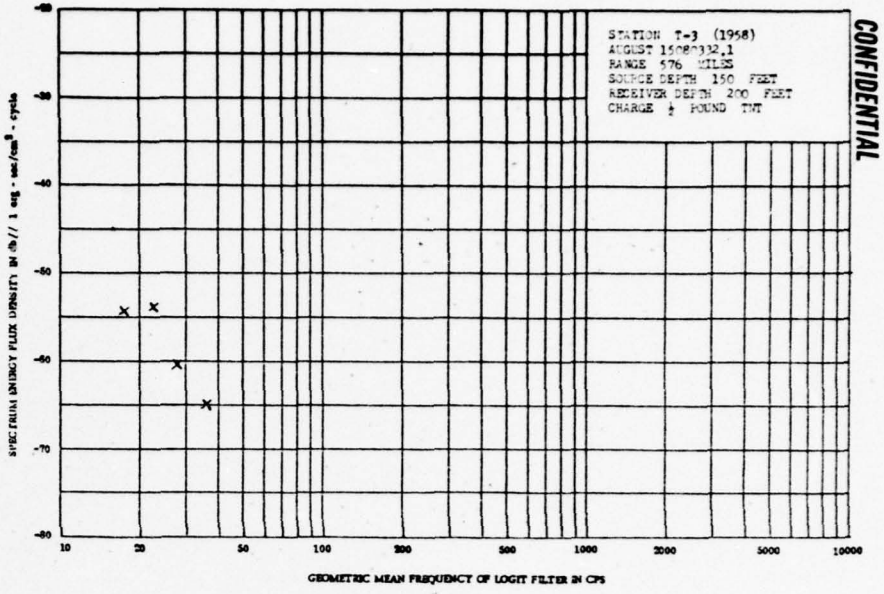


Fig. 64



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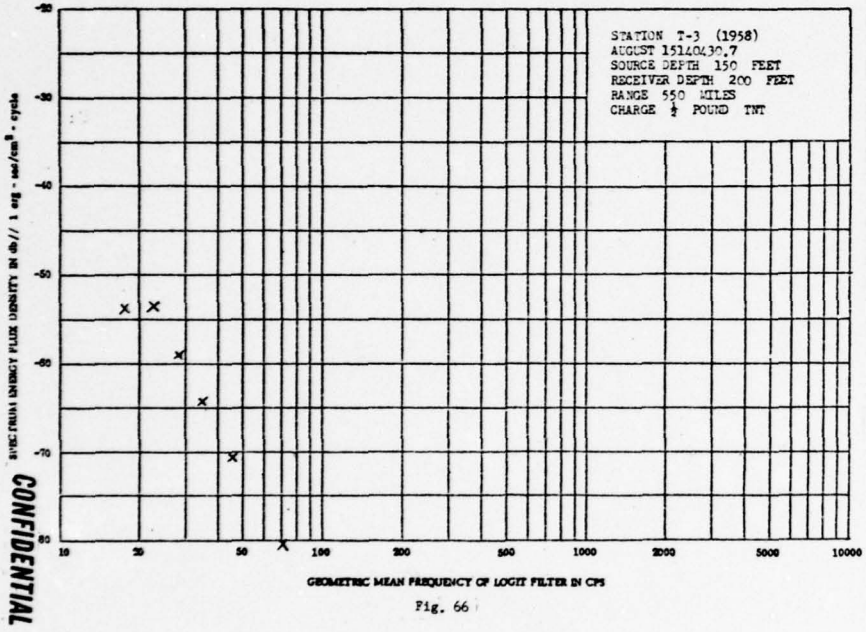

Fig. 66

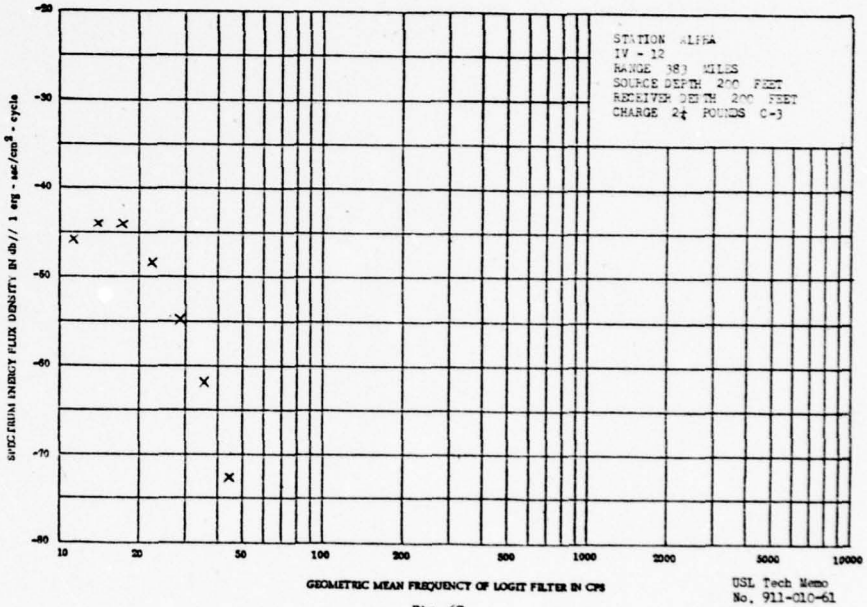

Fig. 67

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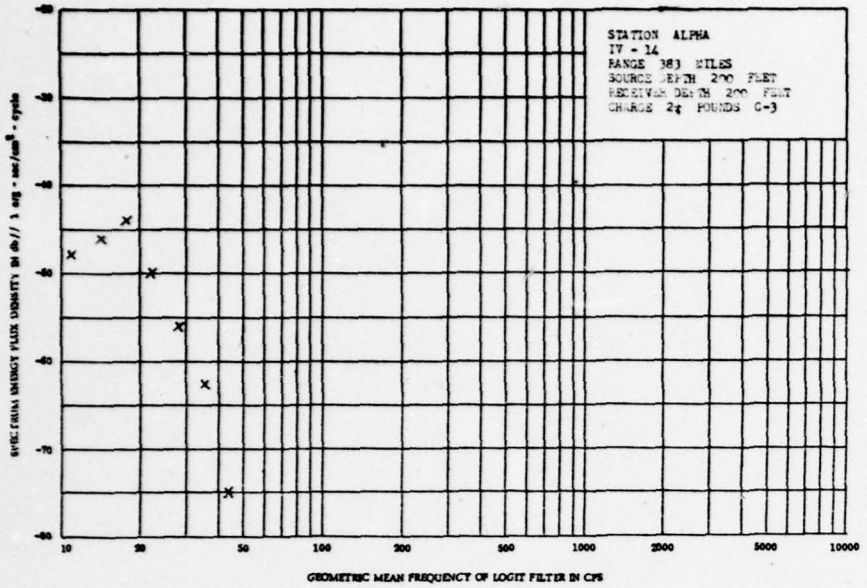

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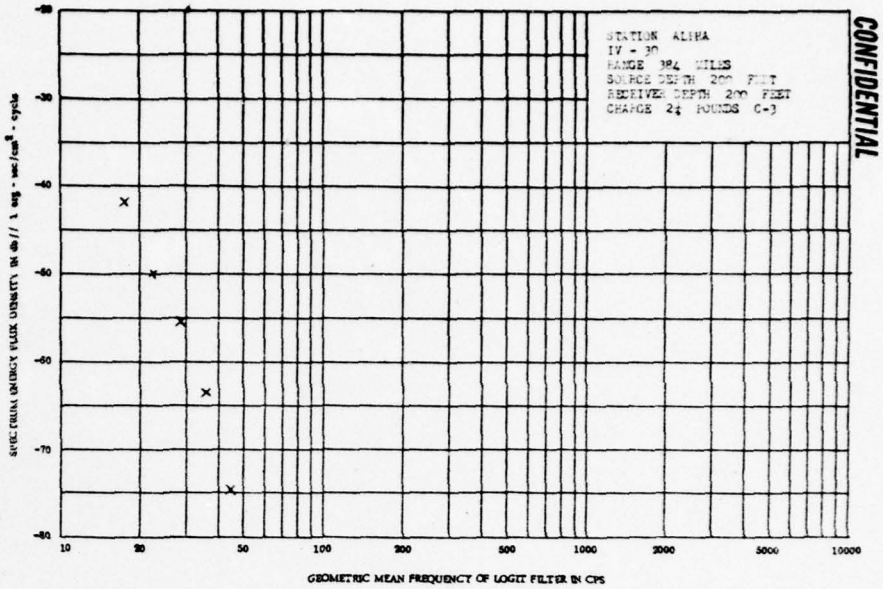

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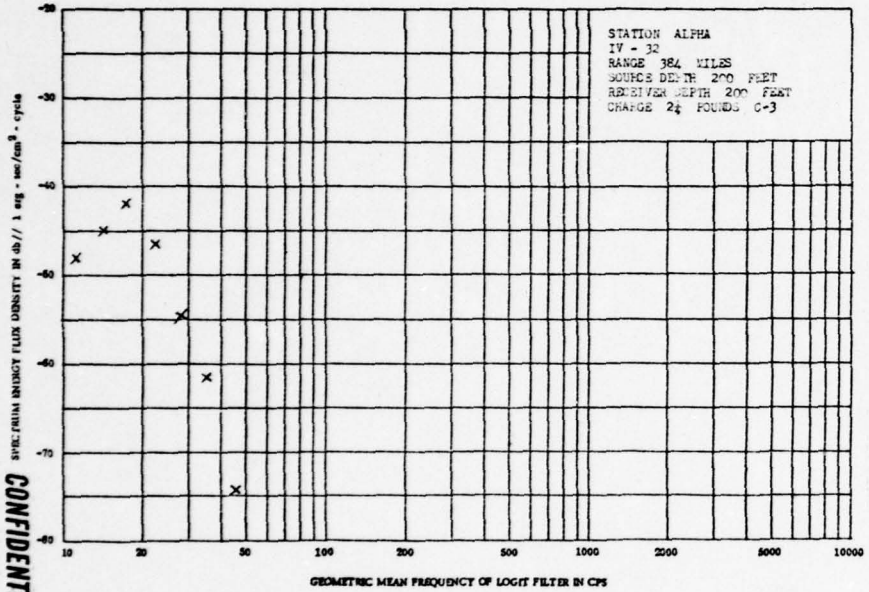

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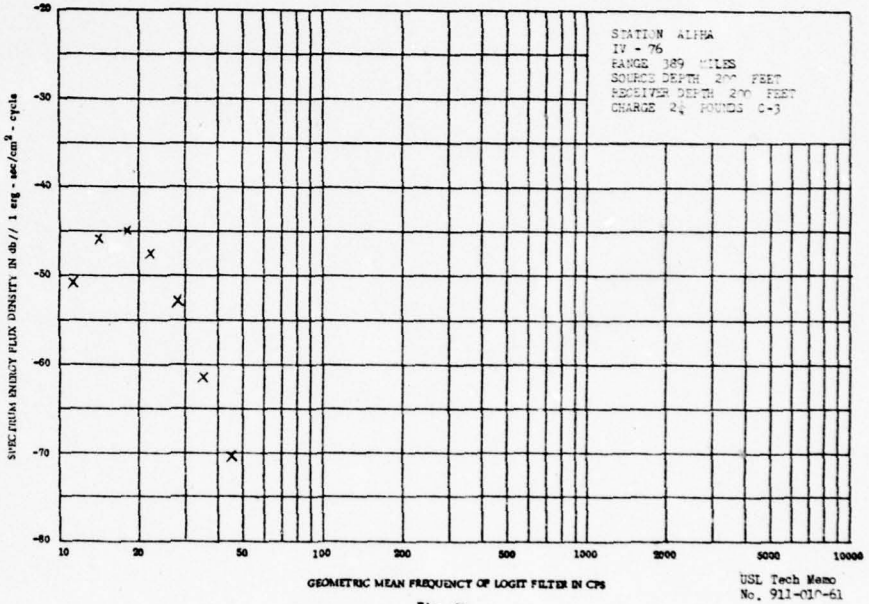
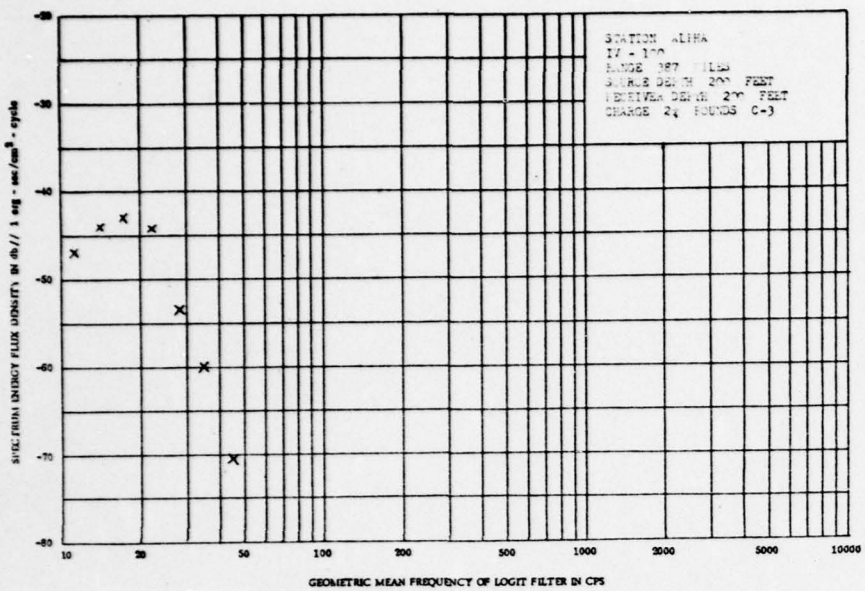


Fig. 71



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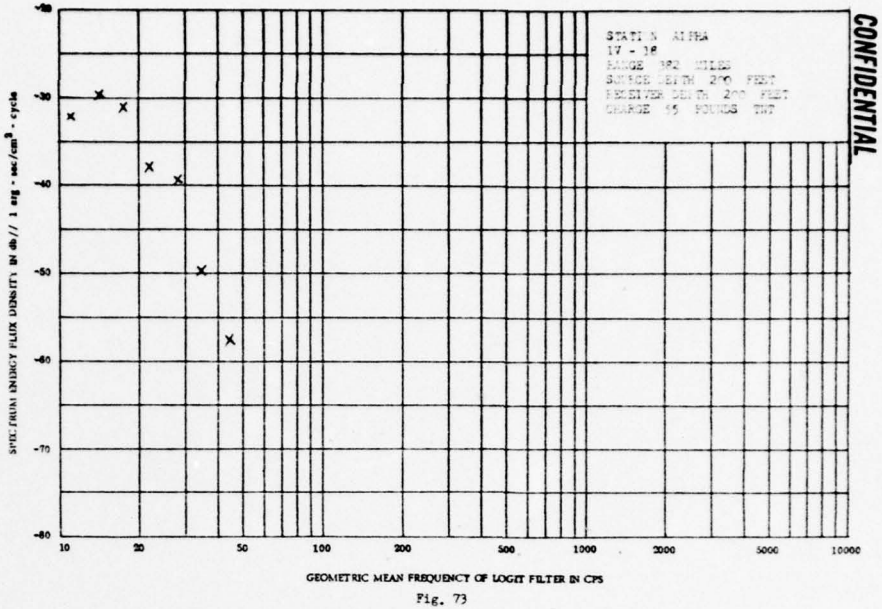

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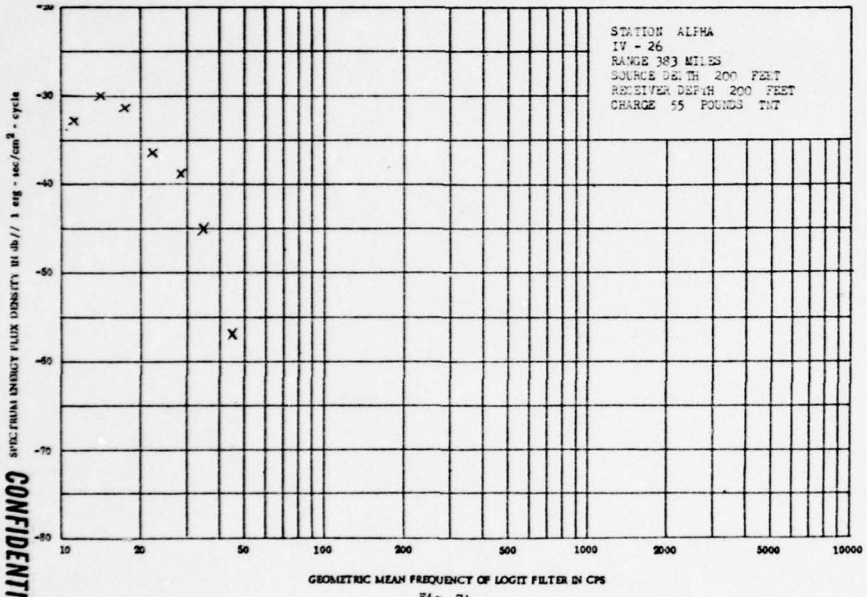

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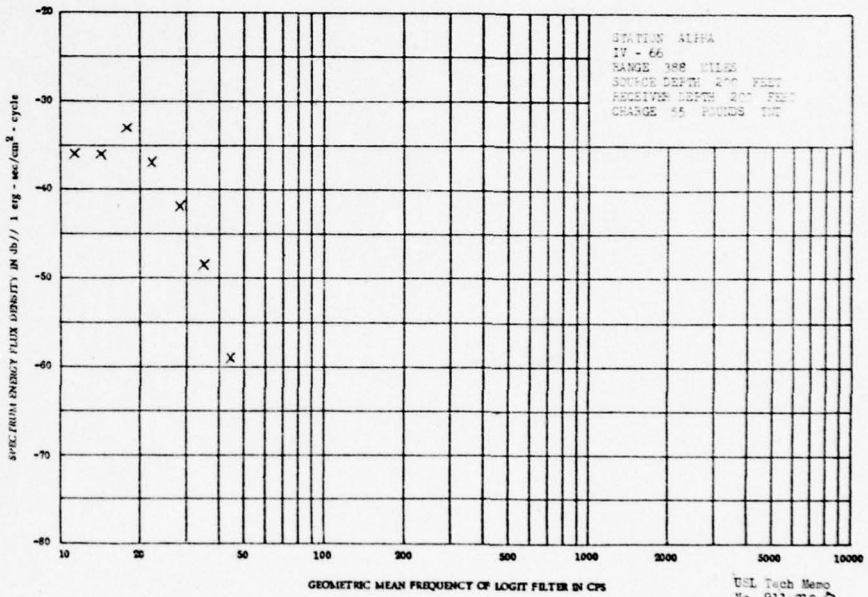

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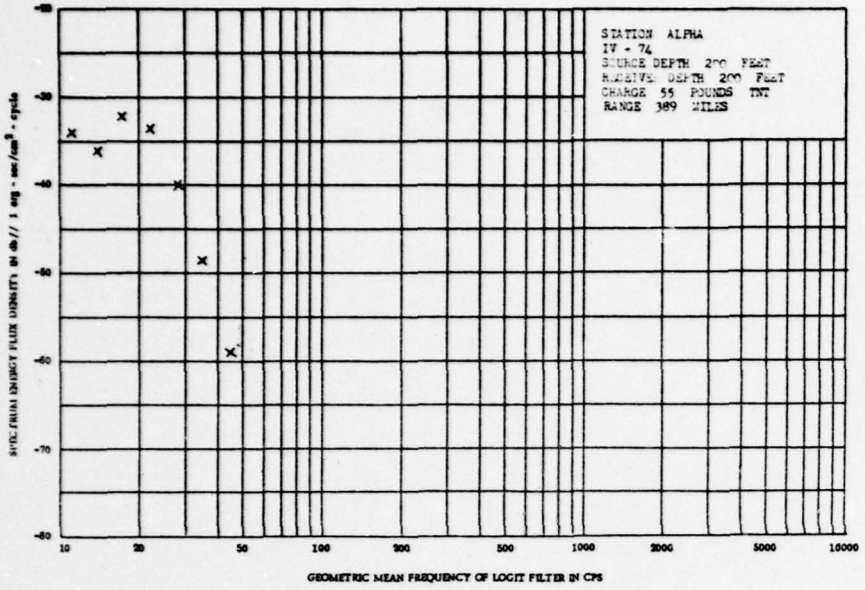

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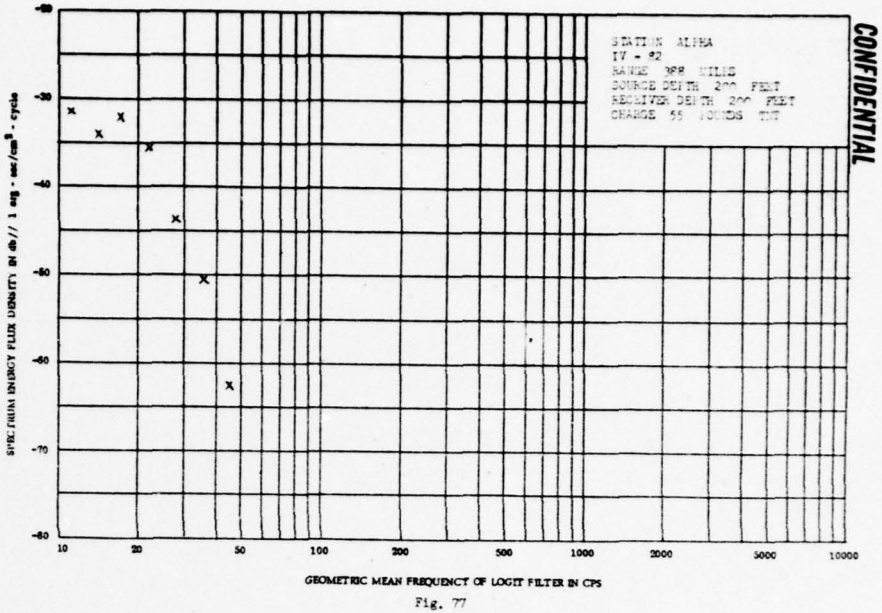

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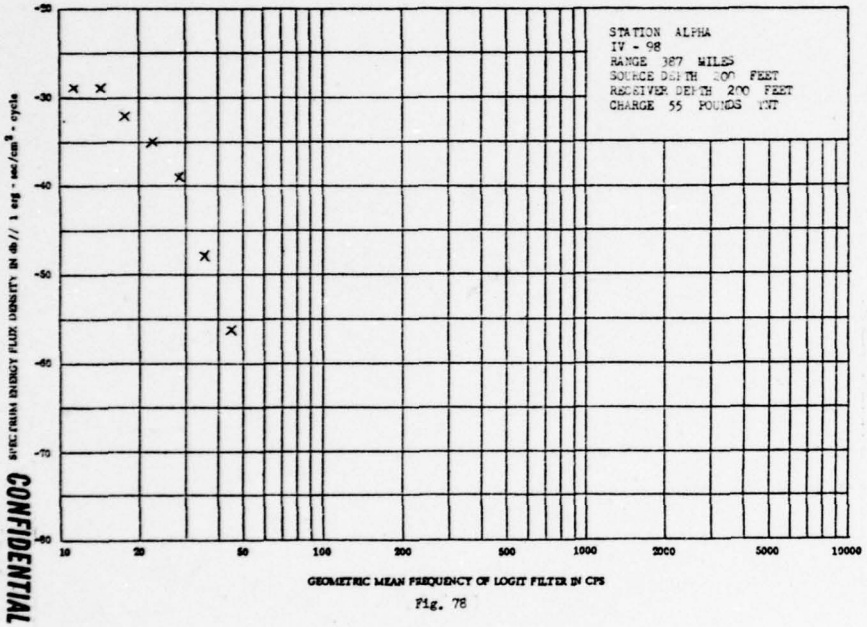

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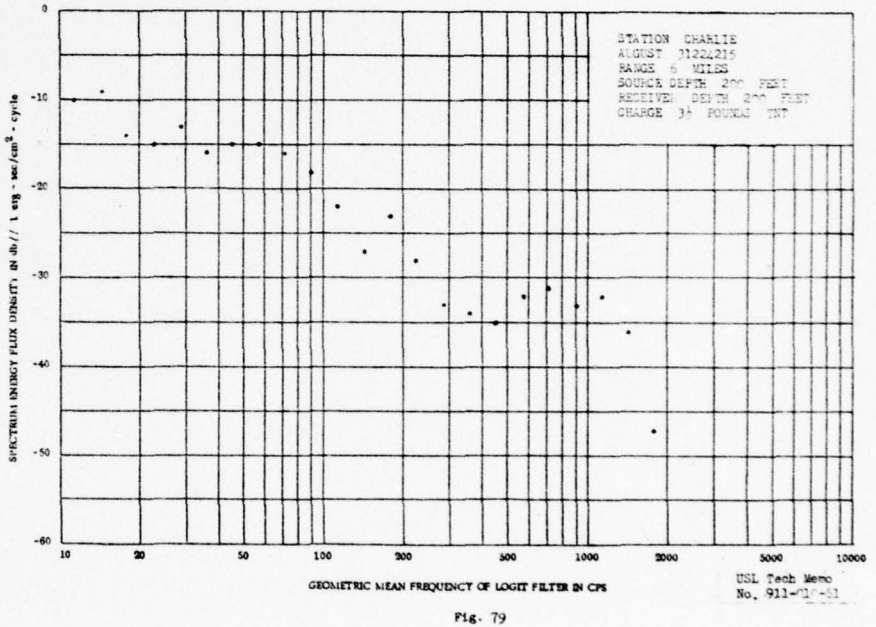

Fig. 79

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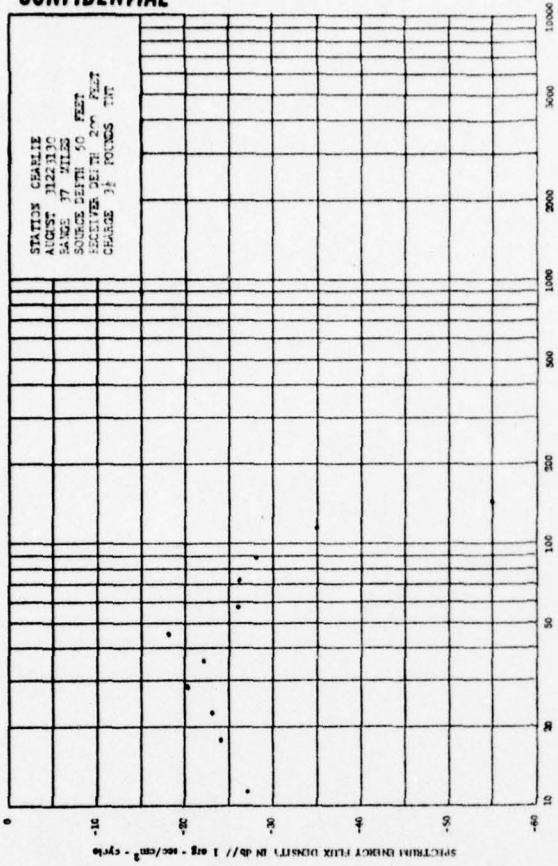

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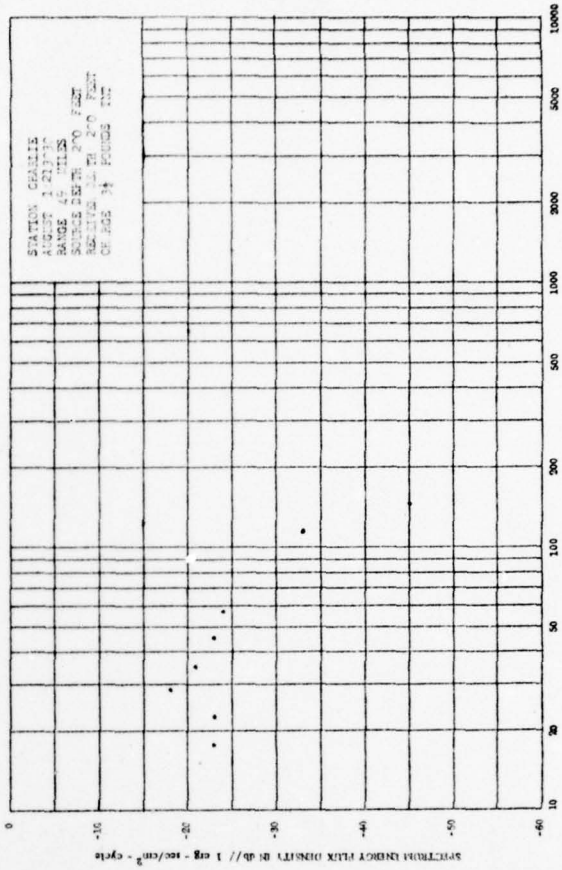

Fig. 83

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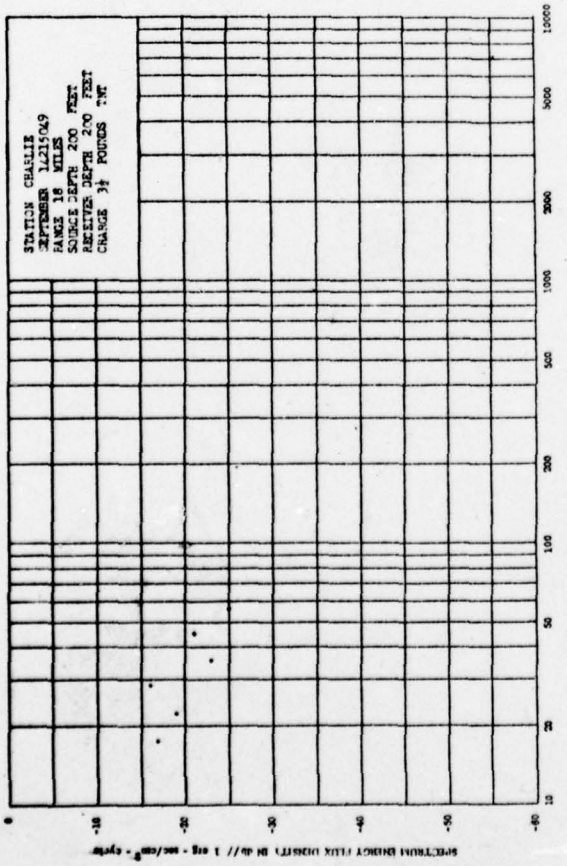

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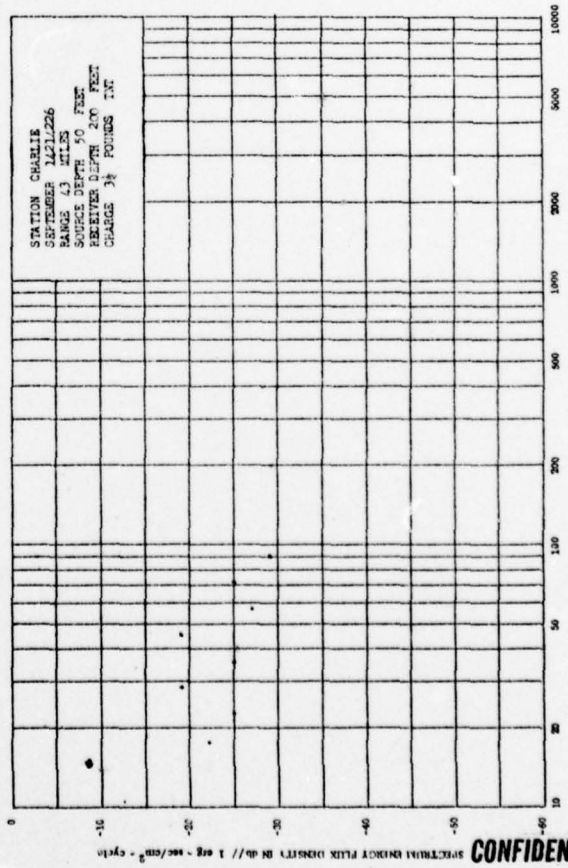

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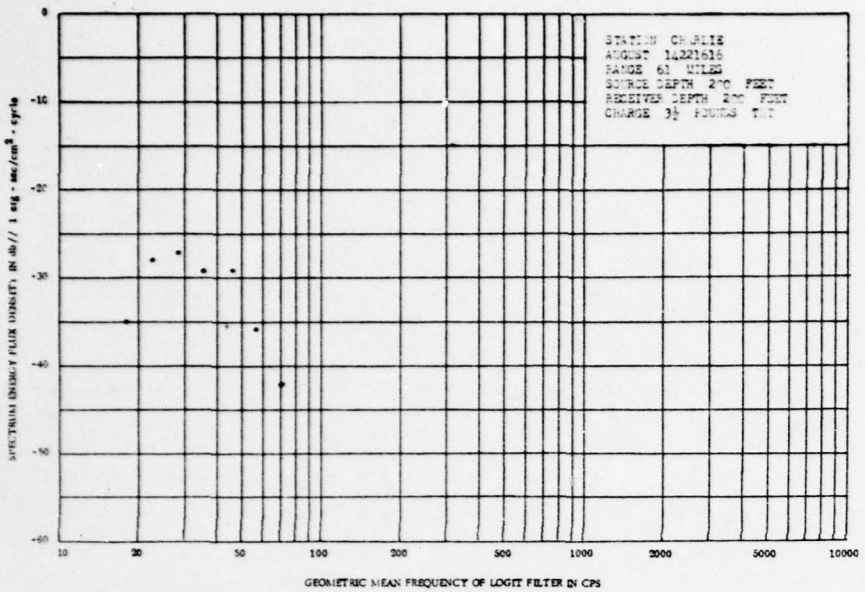
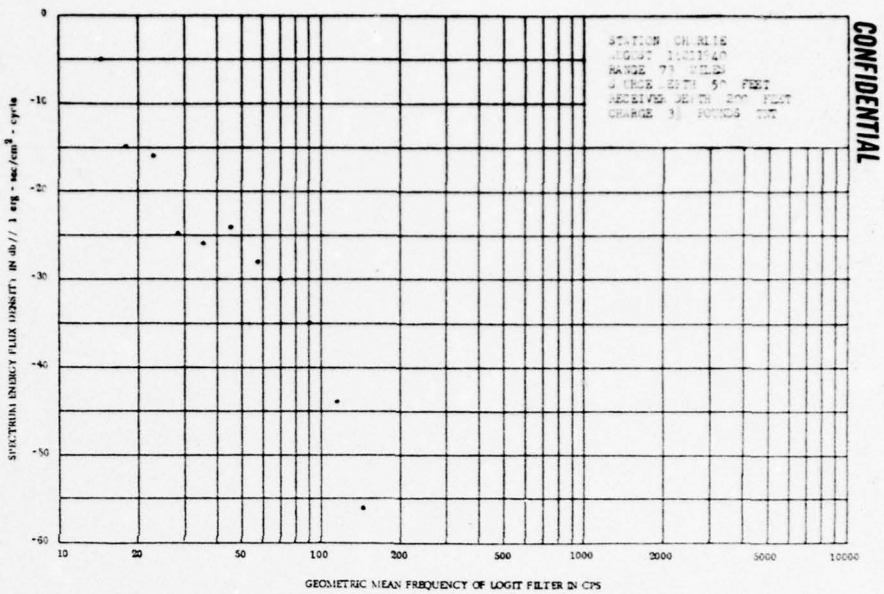


Fig. 84



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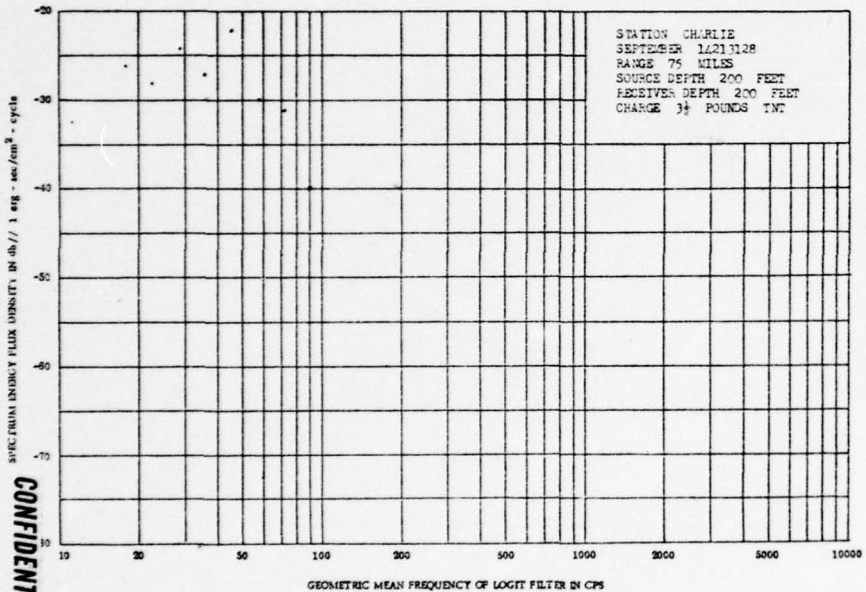

Fig. 86

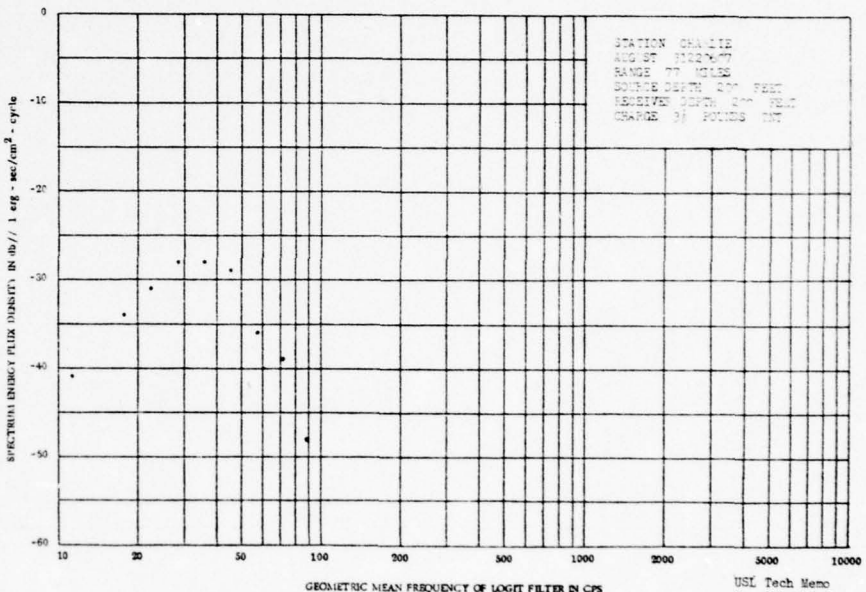

Fig. 87

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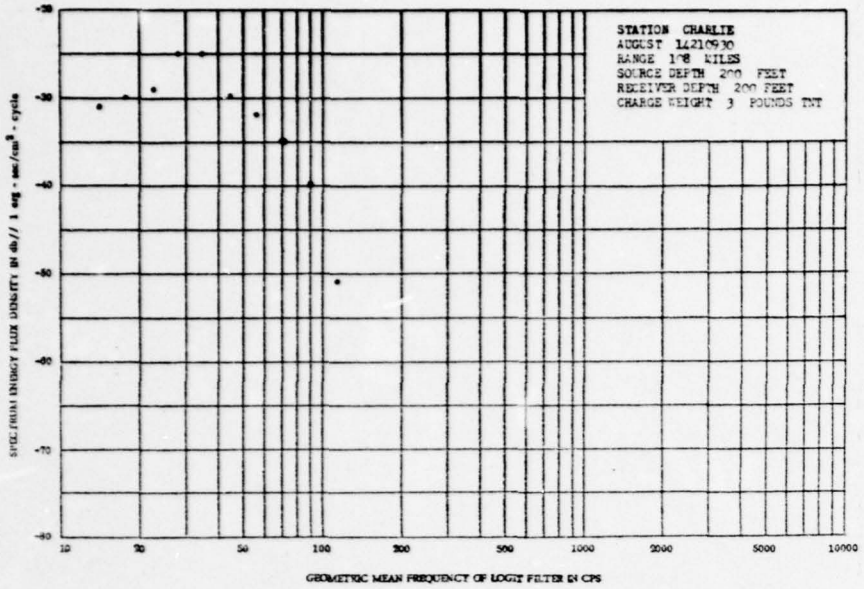


Fig. 88

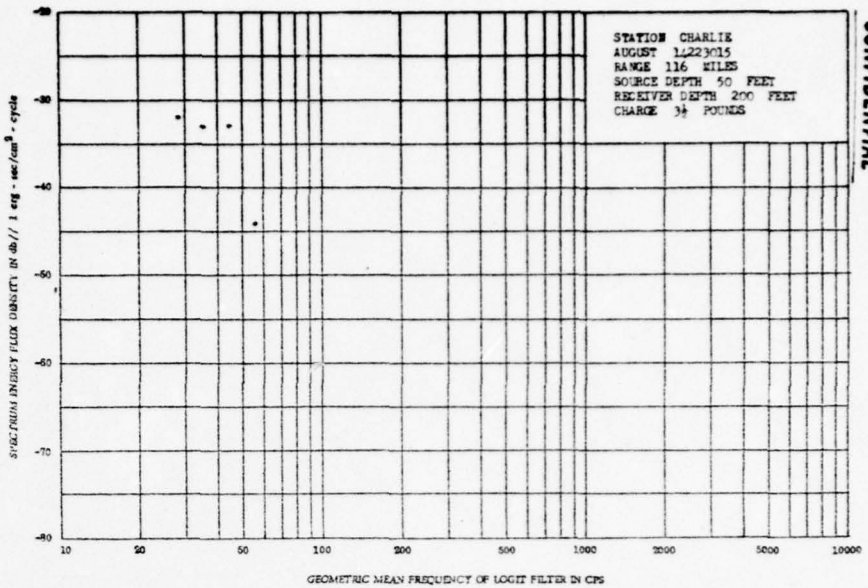
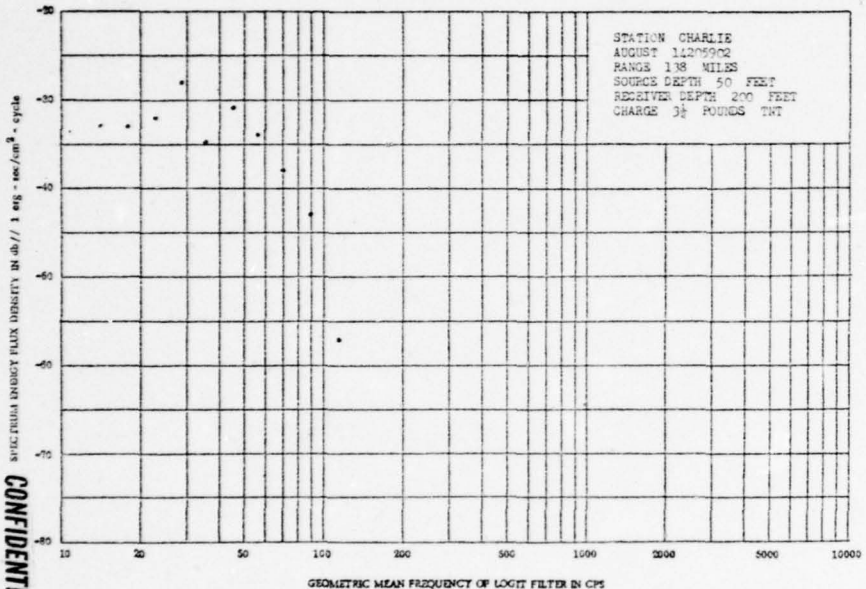


Fig. 89



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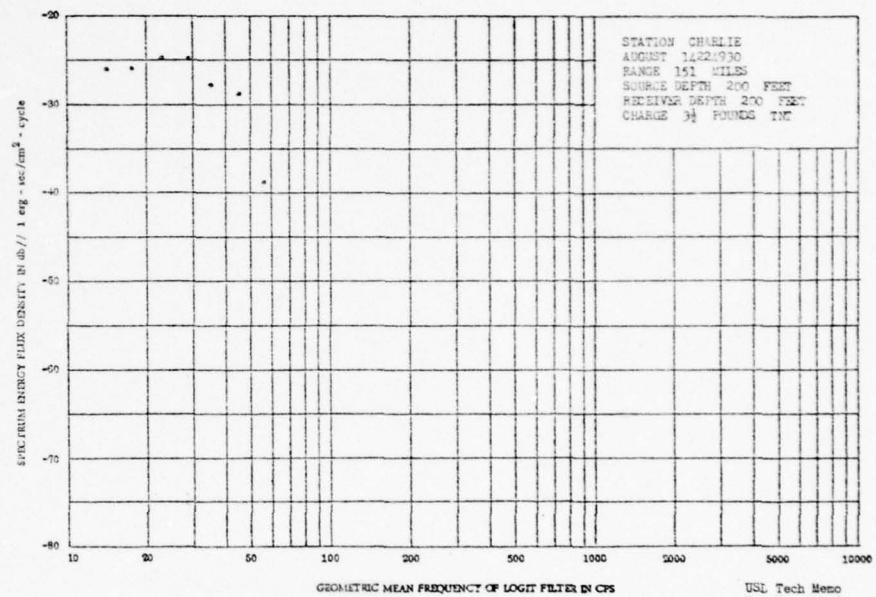

Fig. 91

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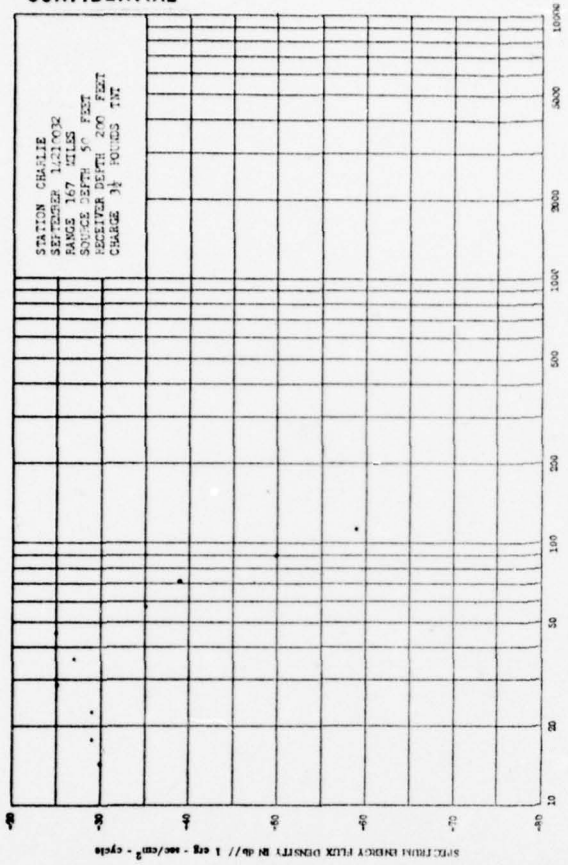

Fig. 93

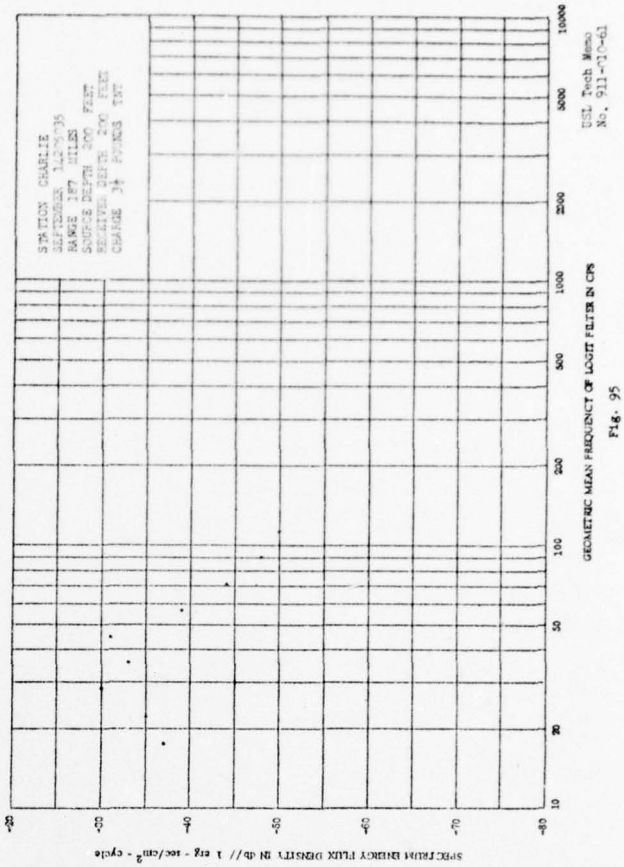

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Fig. 95

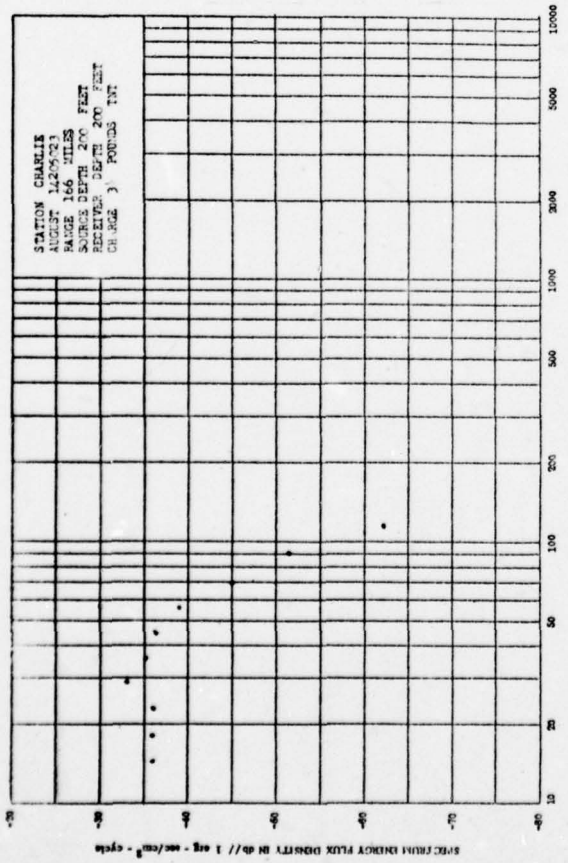


Fig. 96

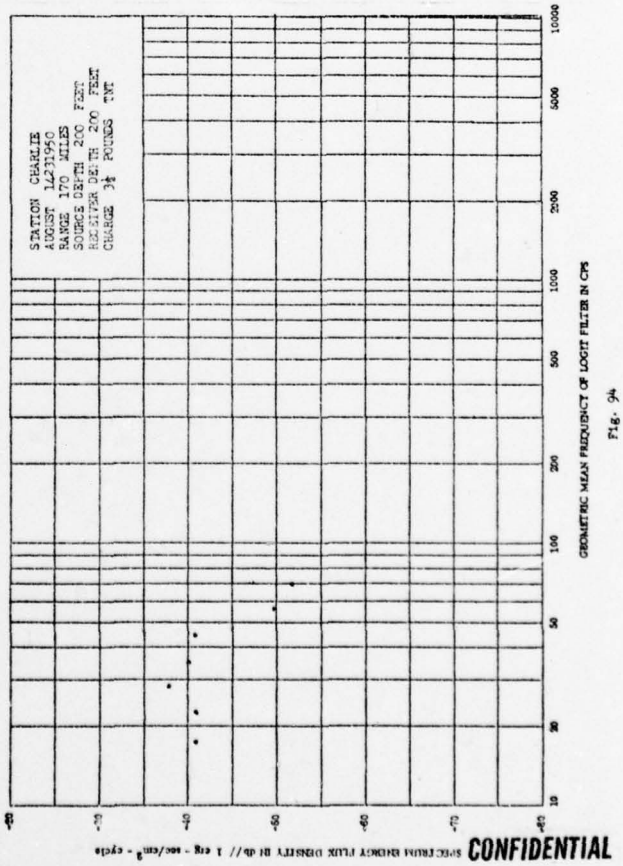


Fig. 94

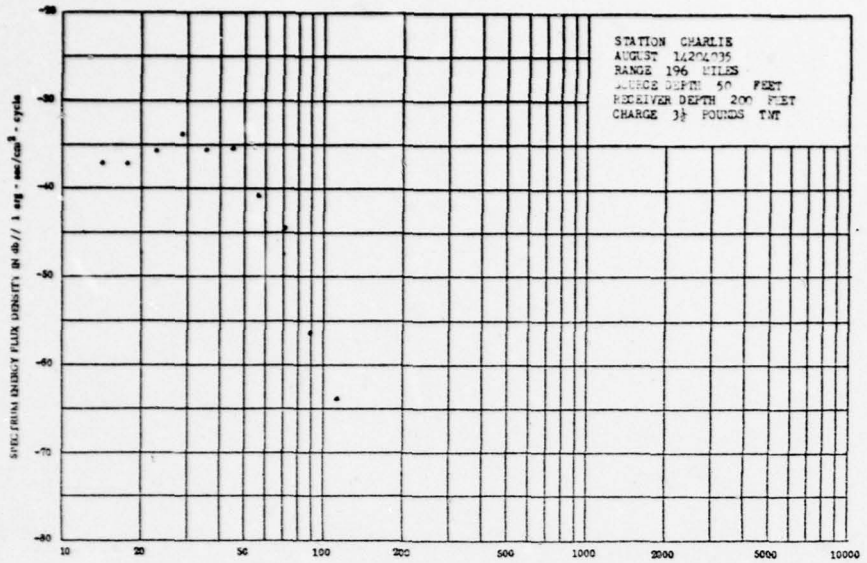


Fig. 96

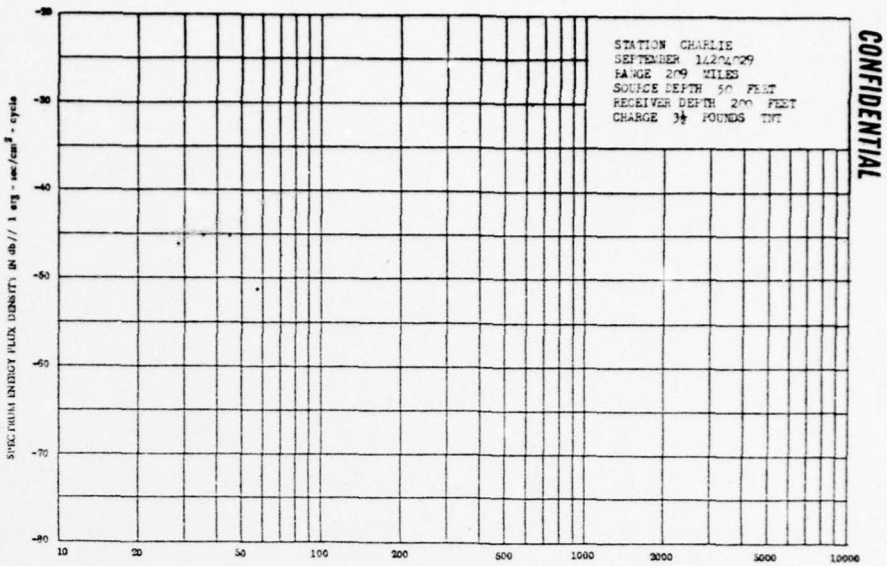
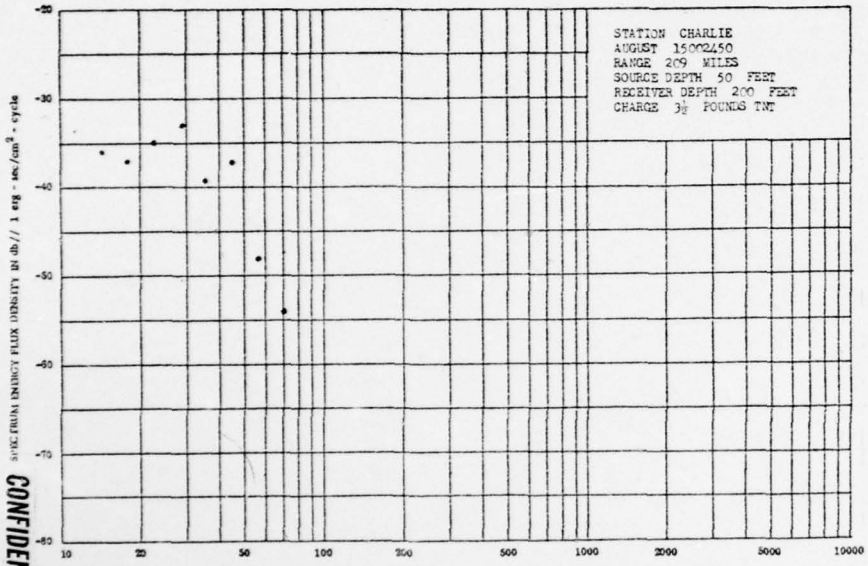


Fig. 97



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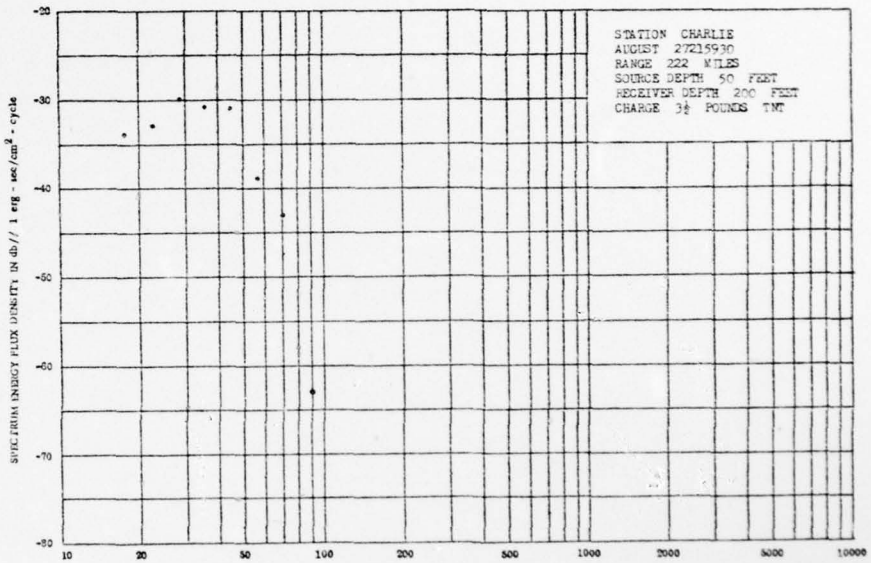

Fig. 99

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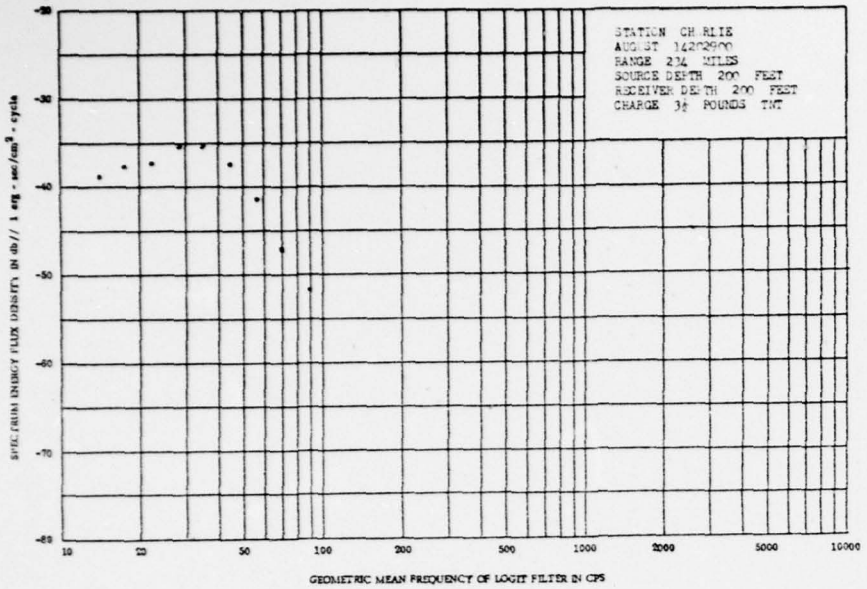

Fig. 100

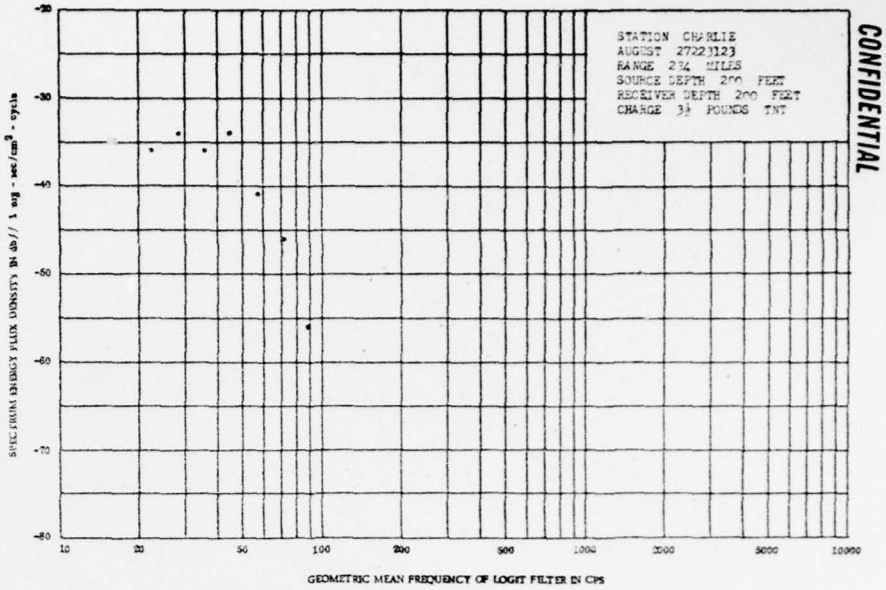

Fig. 101

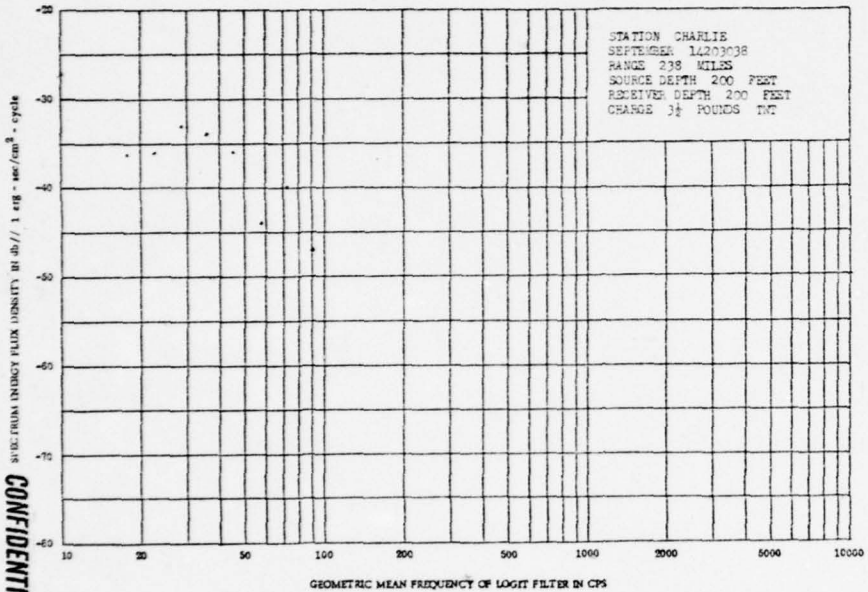

Fig. 102

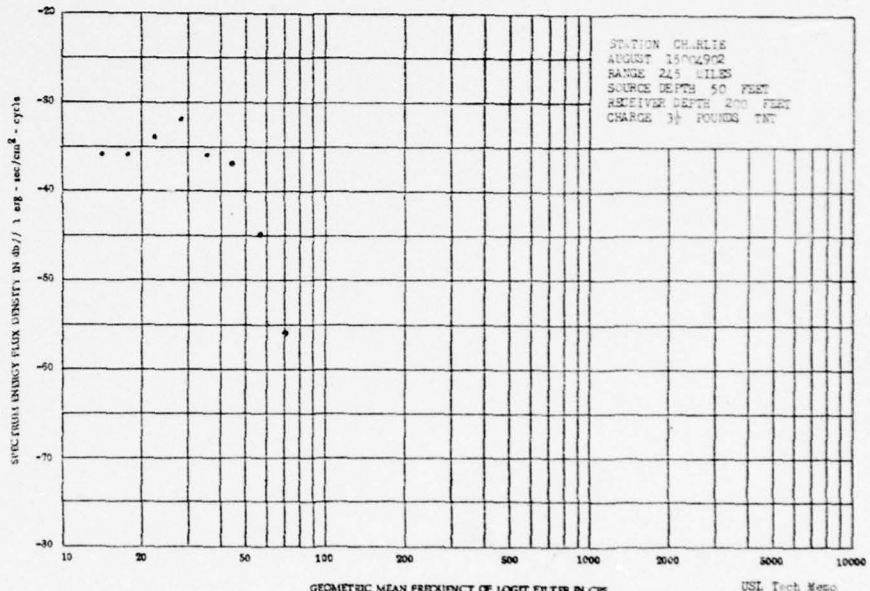

Fig. 103

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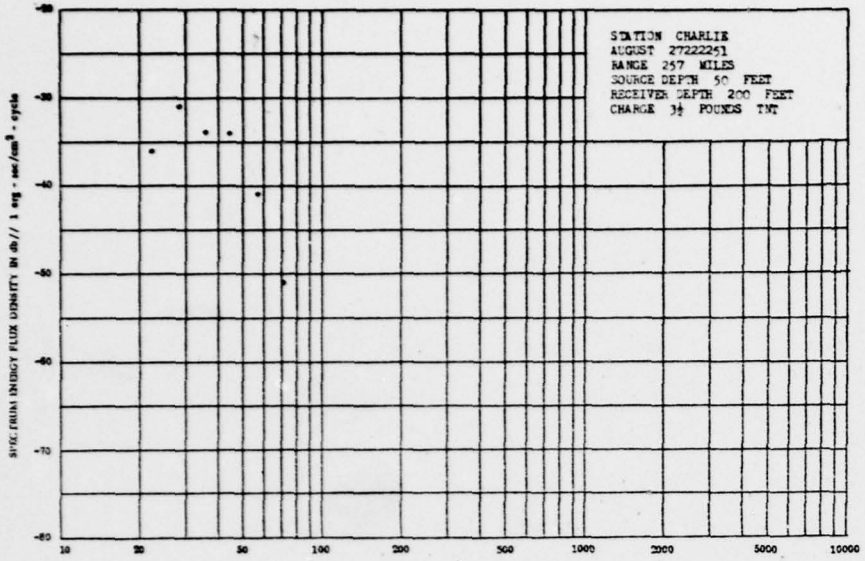

Fig. 104

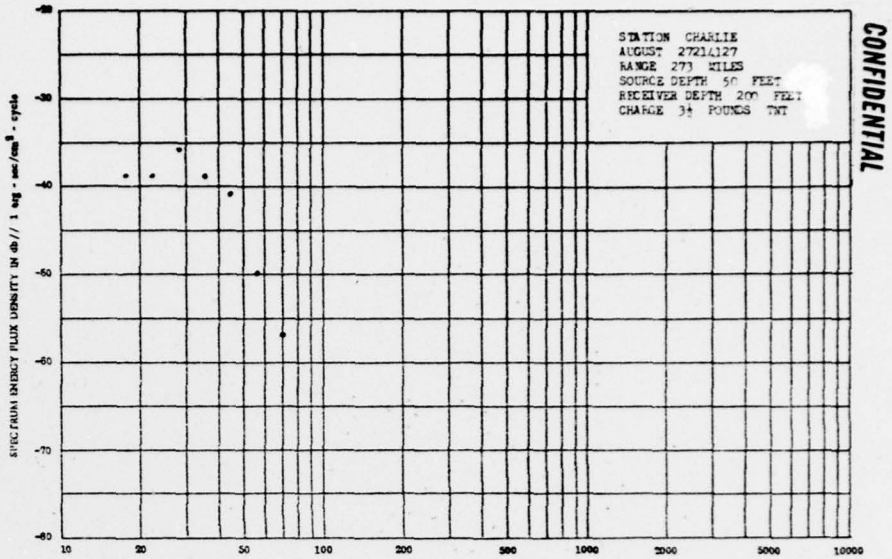

Fig. 105

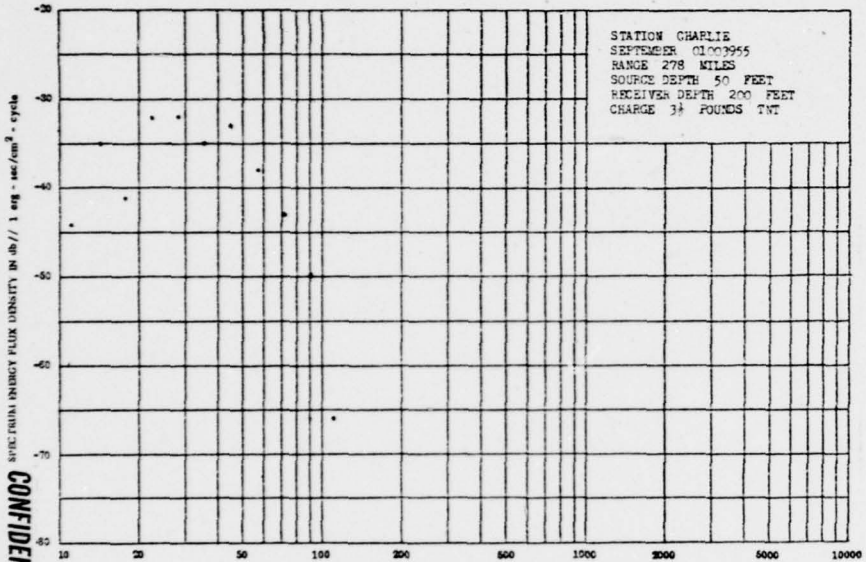

Fig. 106

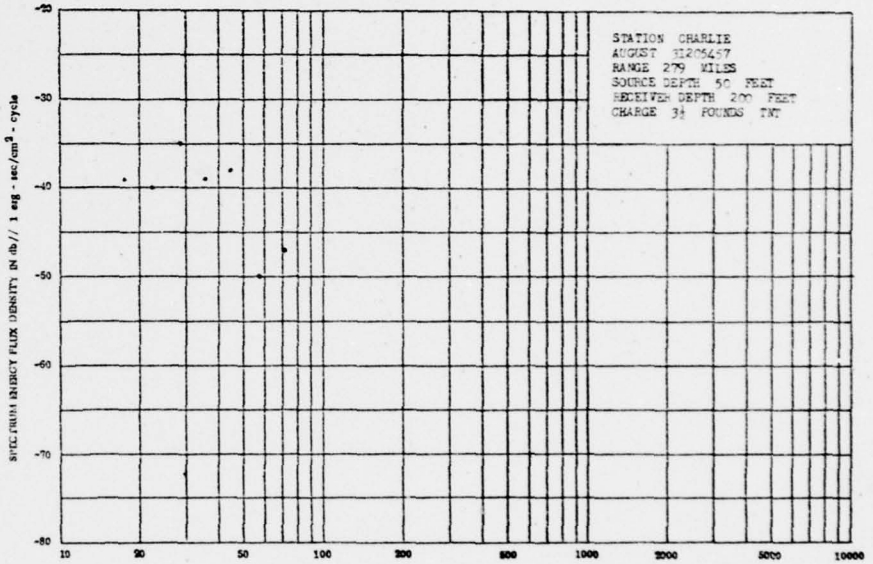

Fig. 107

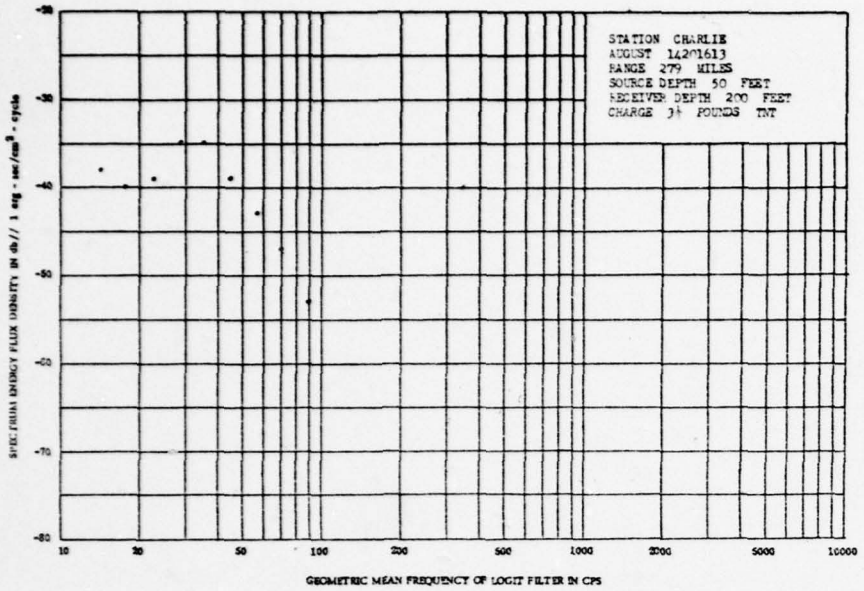

Fig. 108

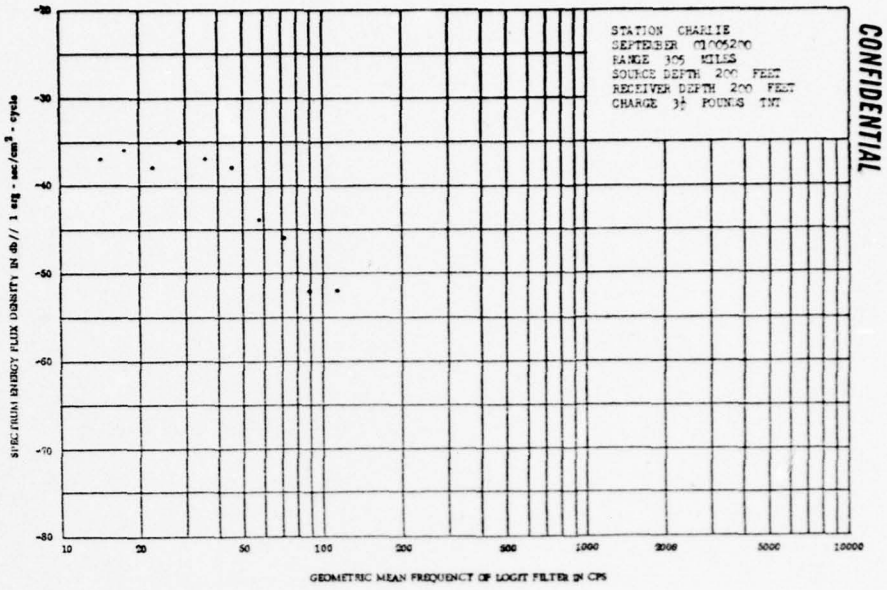

Fig. 109

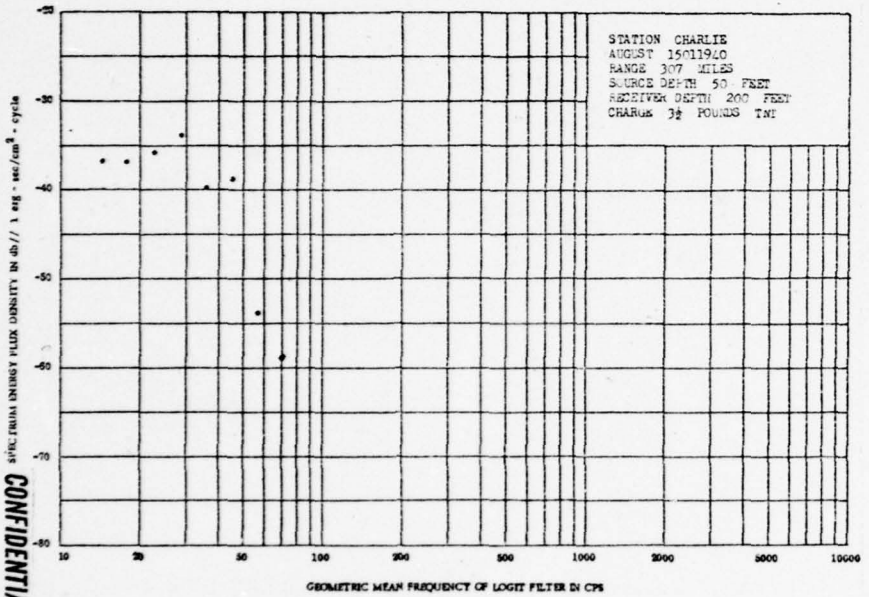

Fig. 110

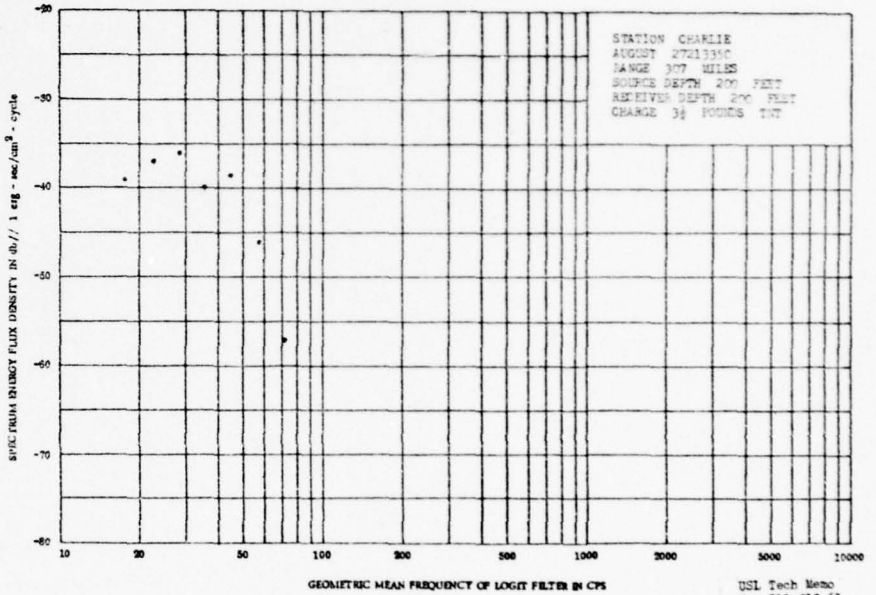

Fig. 111

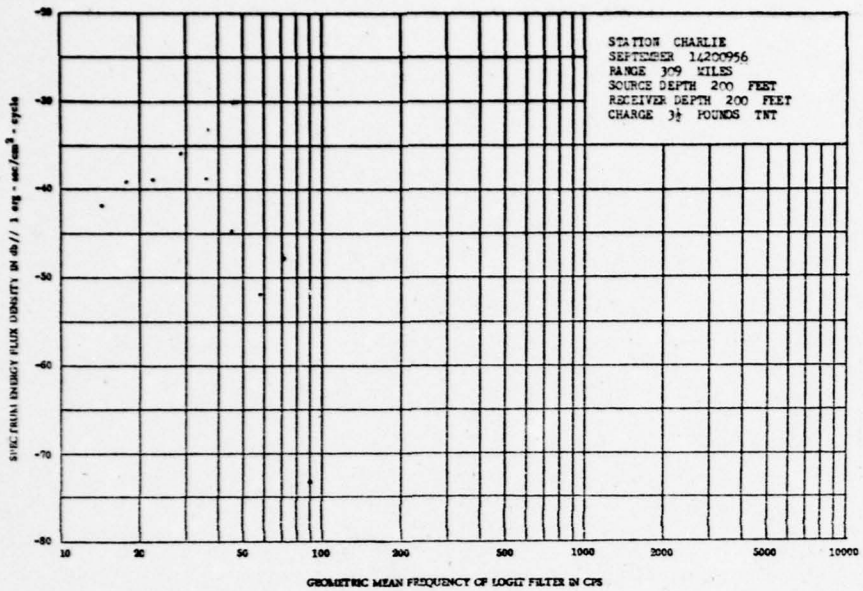

Fig. 112

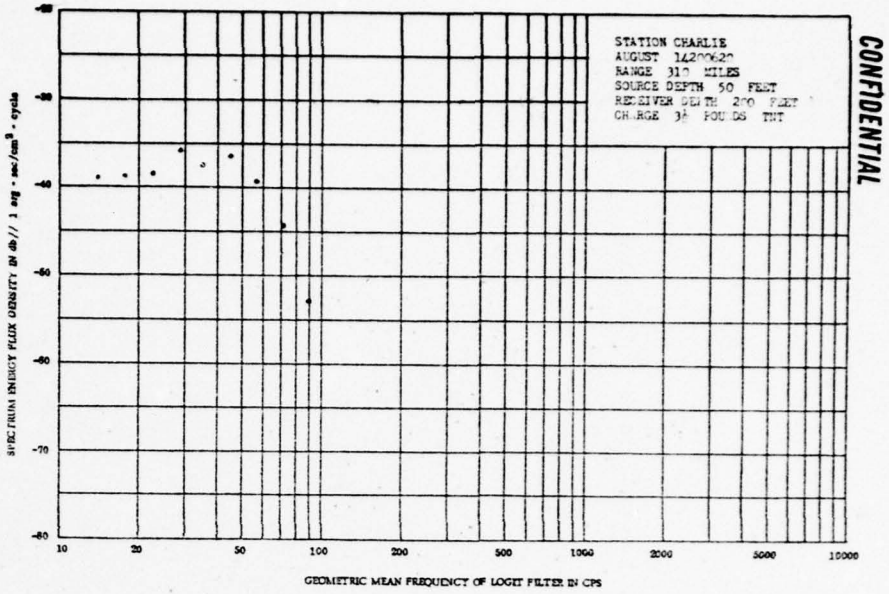

Fig. 113

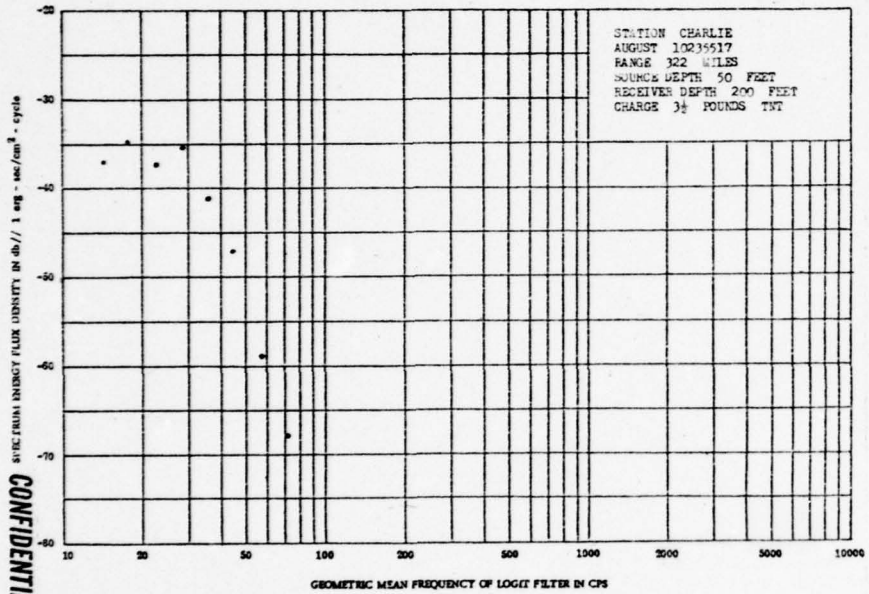

Fig. 114

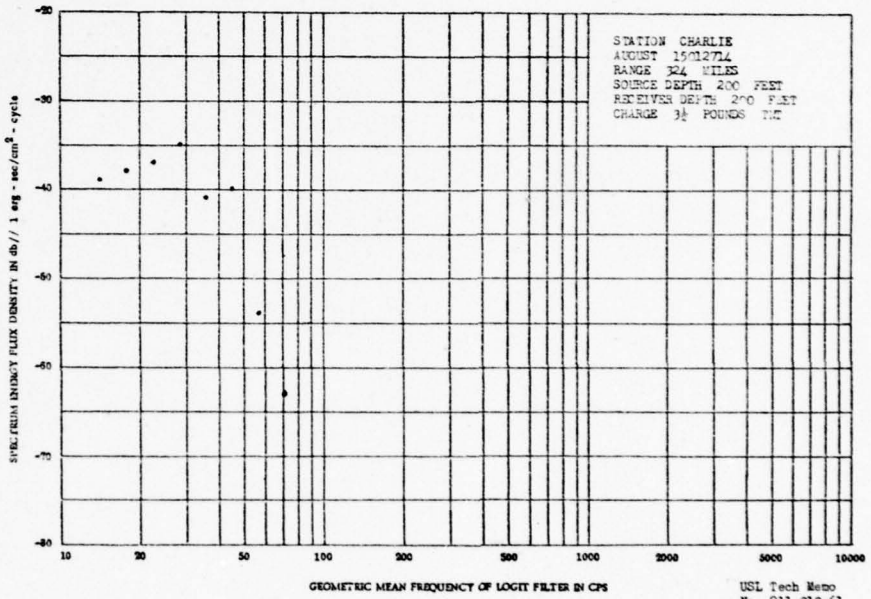

Fig. 115

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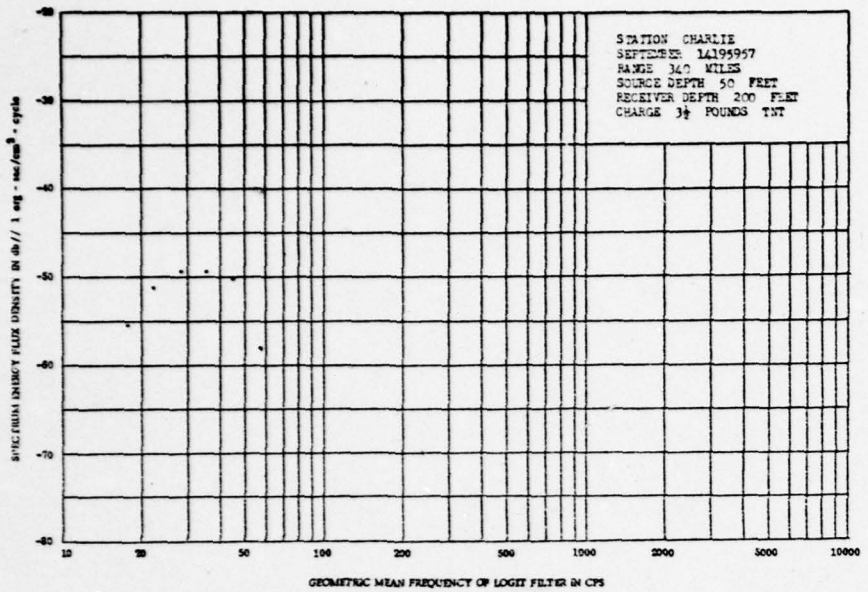

Fig. 116

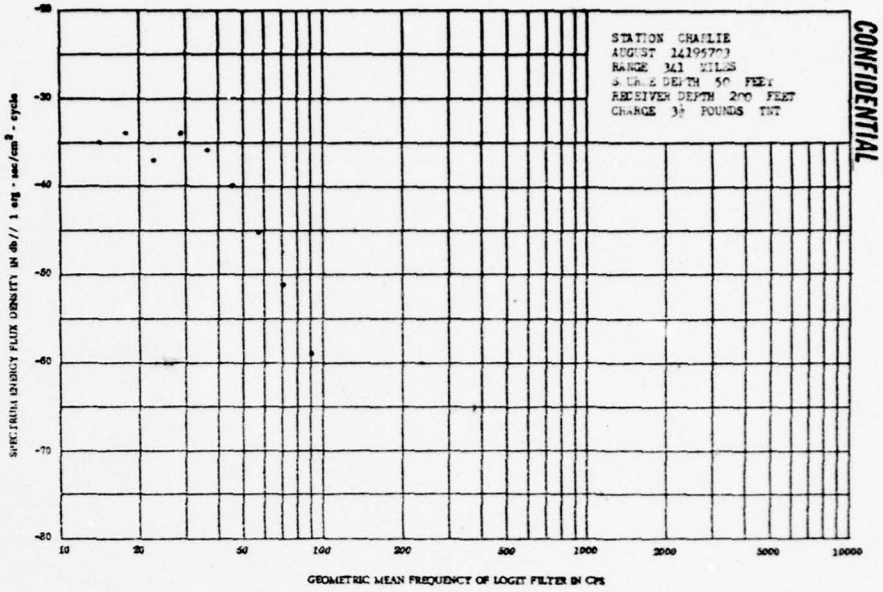

Fig. 117

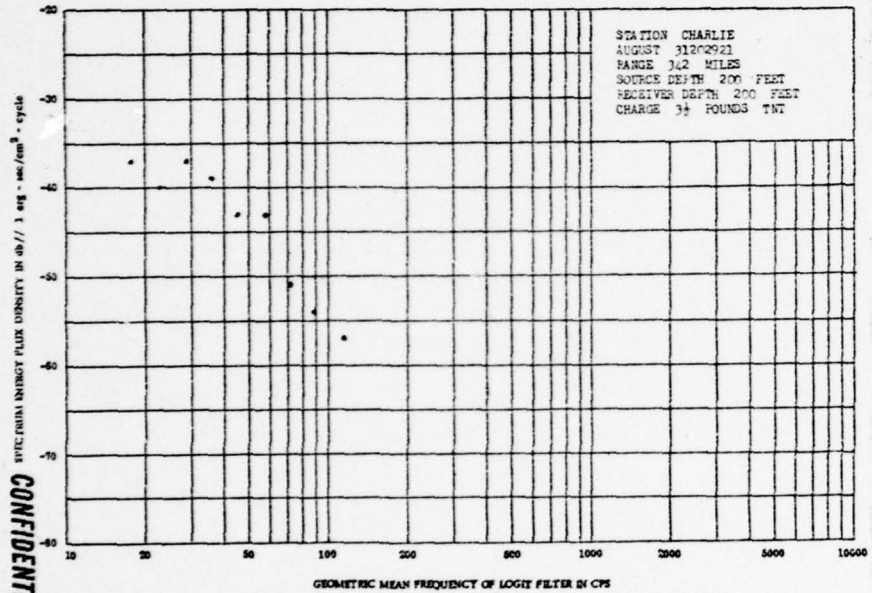

Fig. 118

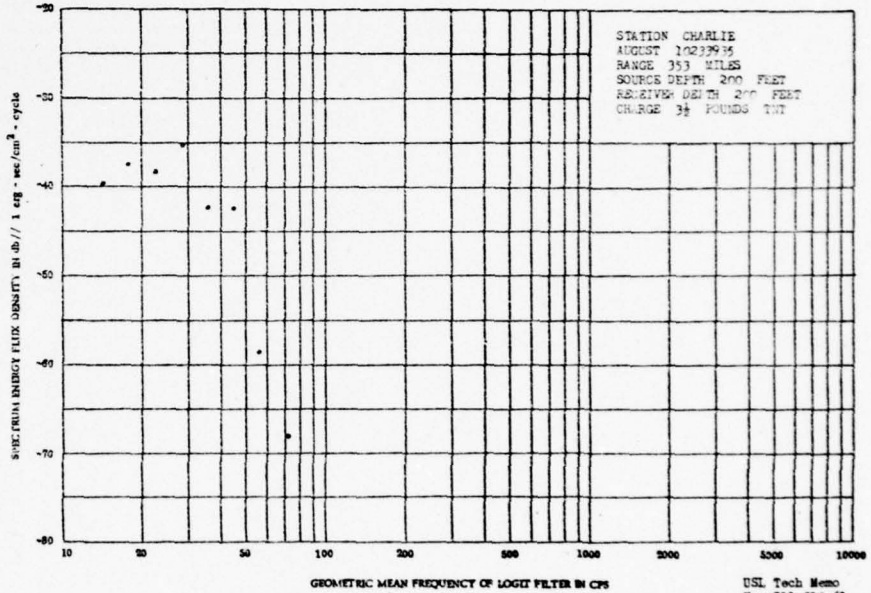

Fig. 119

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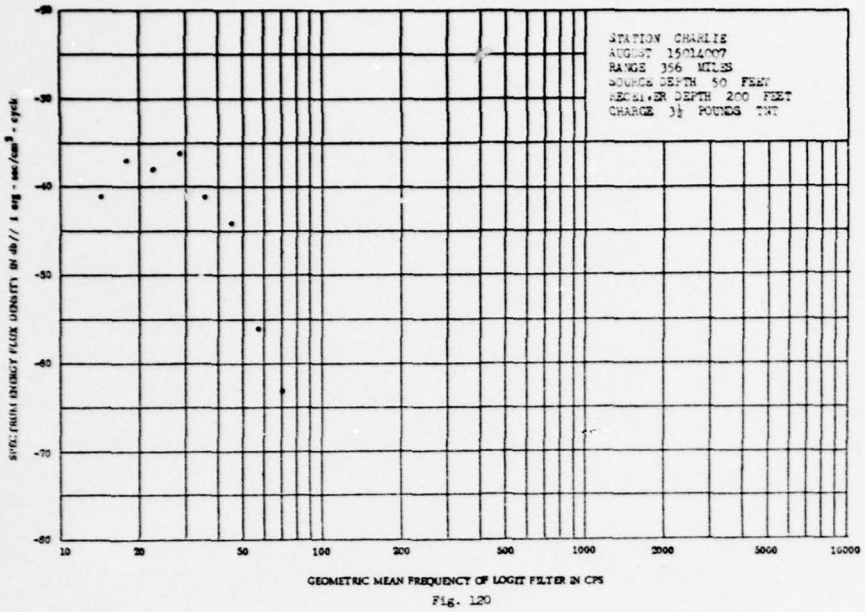

Fig. 120

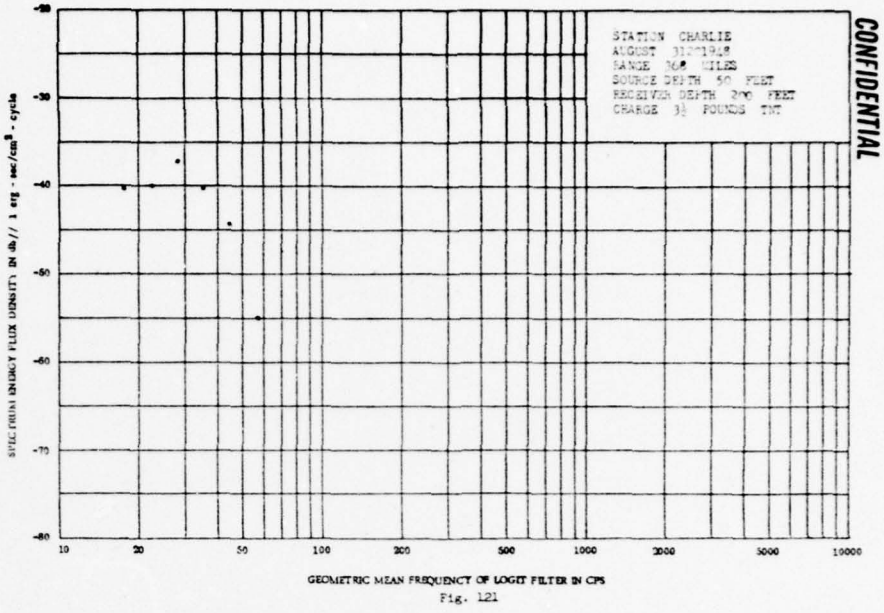

Fig. 121

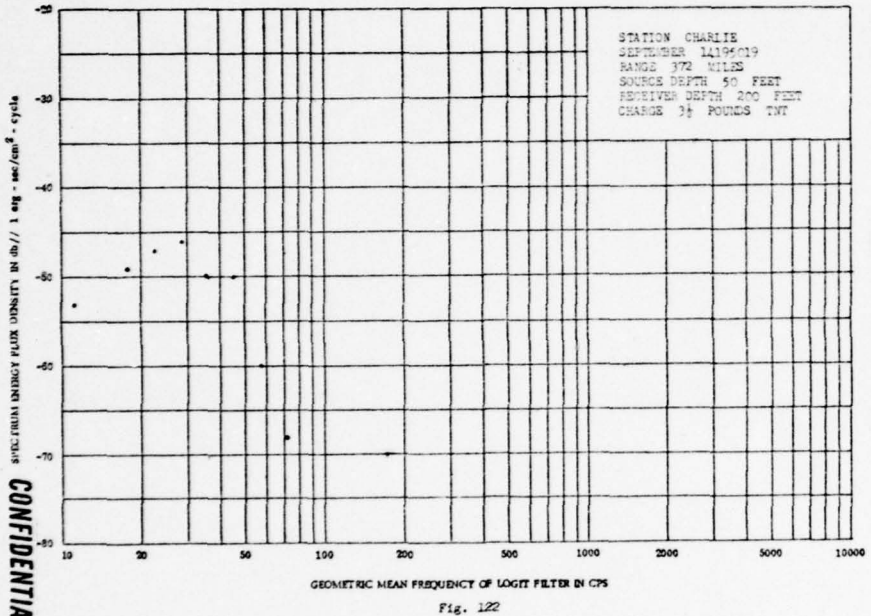

Fig. 122

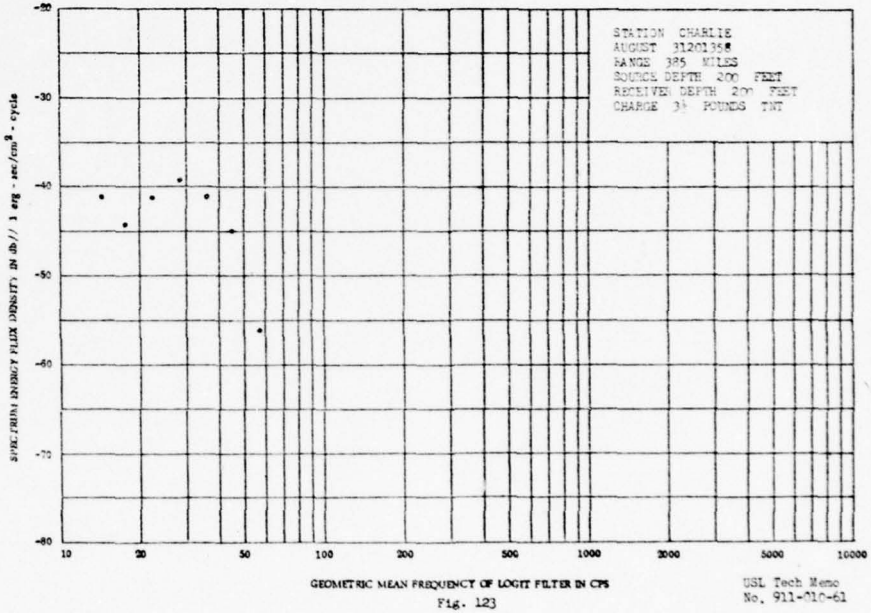

Fig. 123

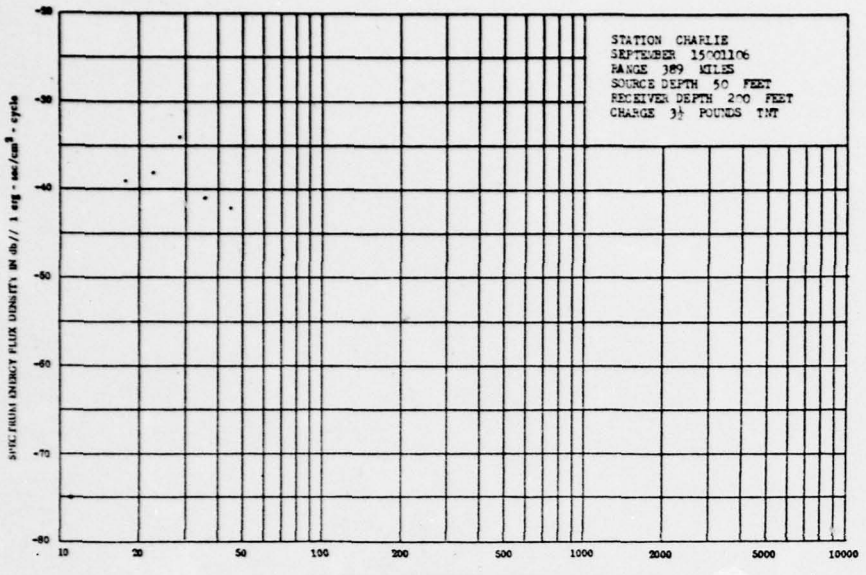

Fig. 124

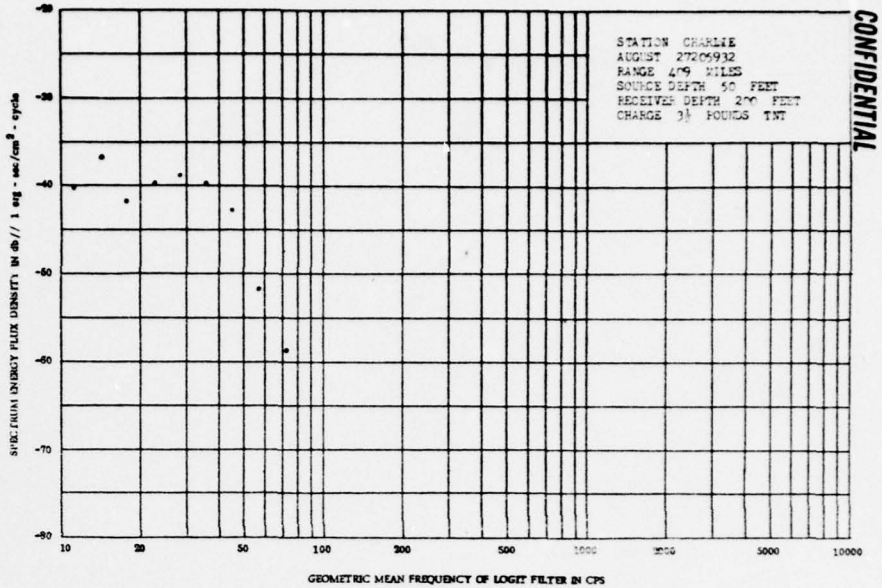

Fig. 125

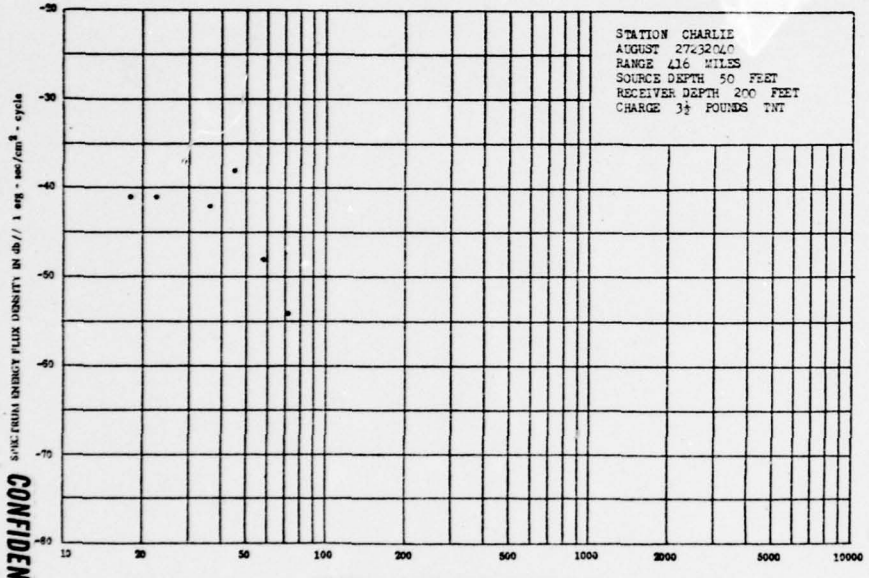

Fig. 126

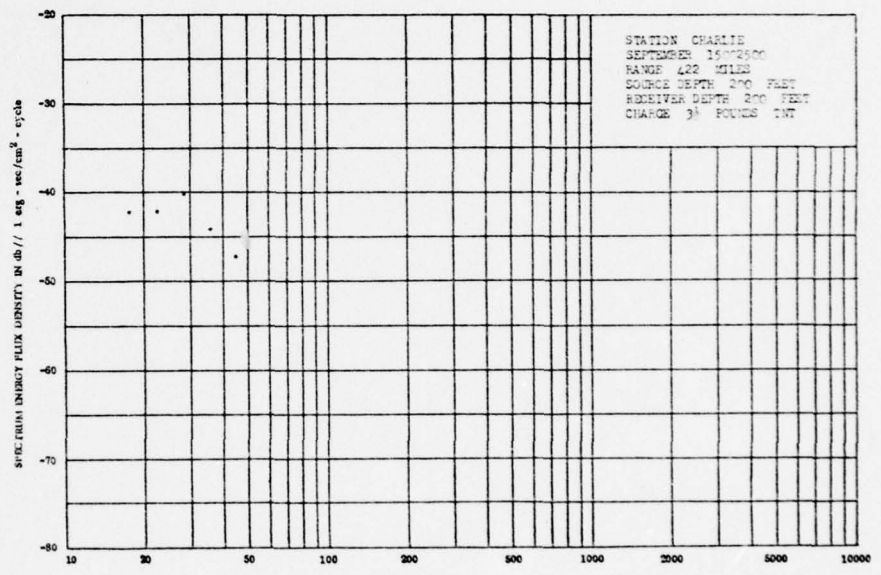

Fig. 127

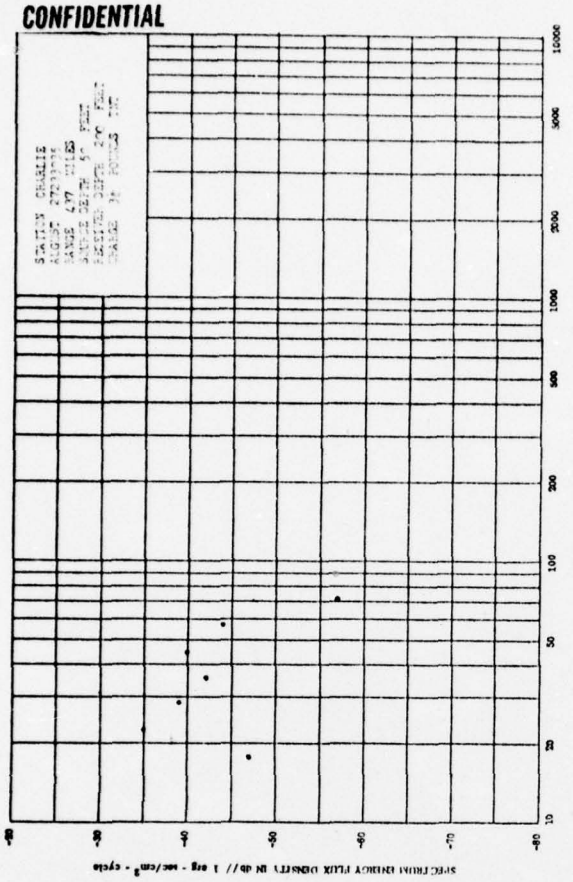

Fig. 129

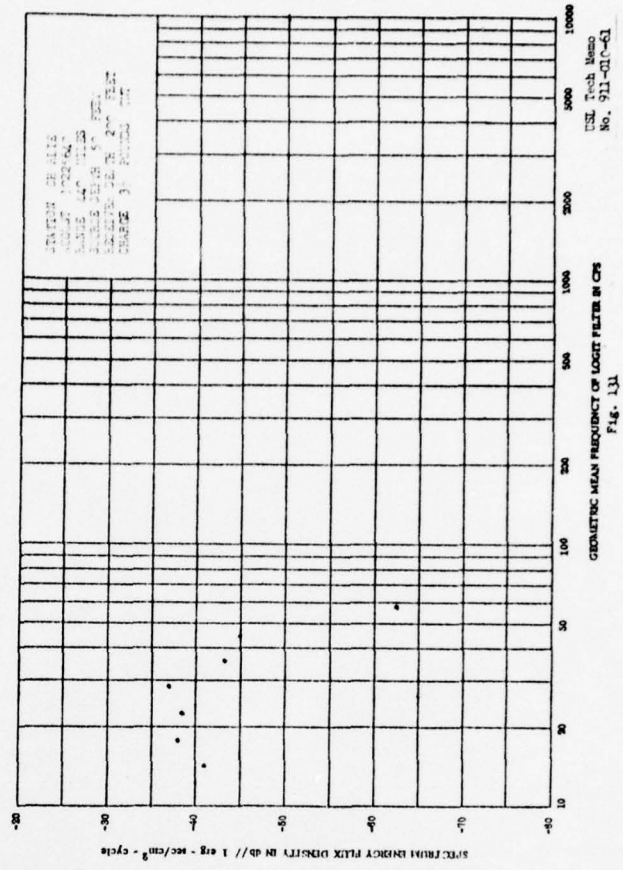

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Fig. 131

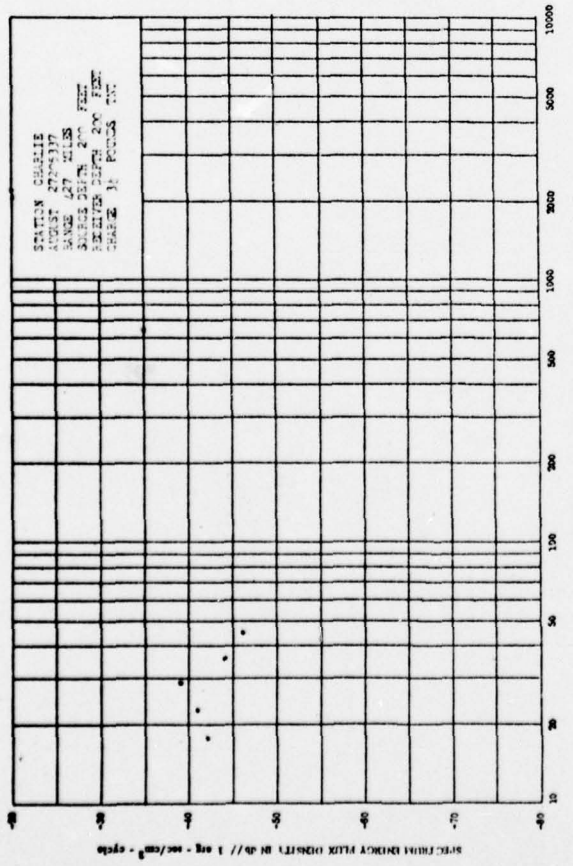

Fig. 128

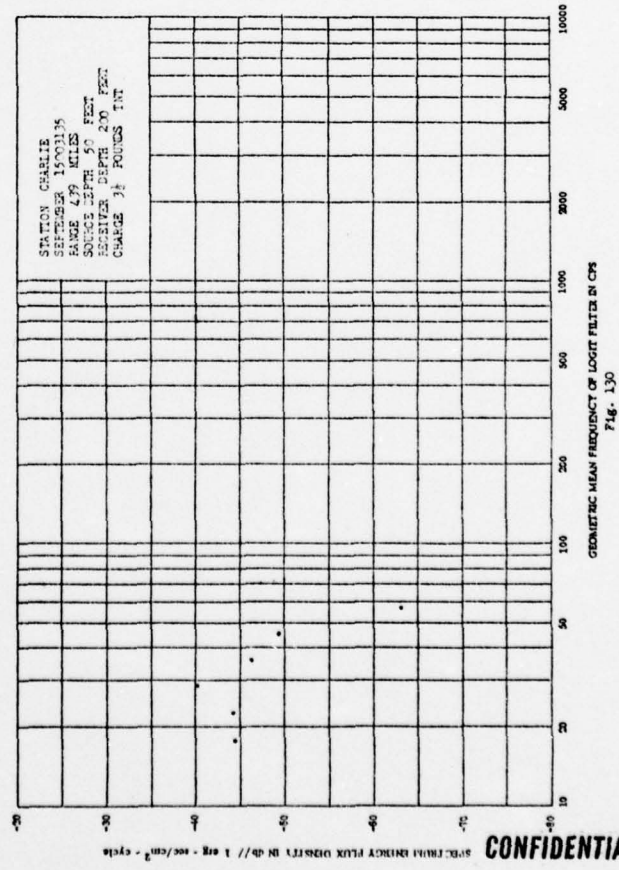

Fig. 130

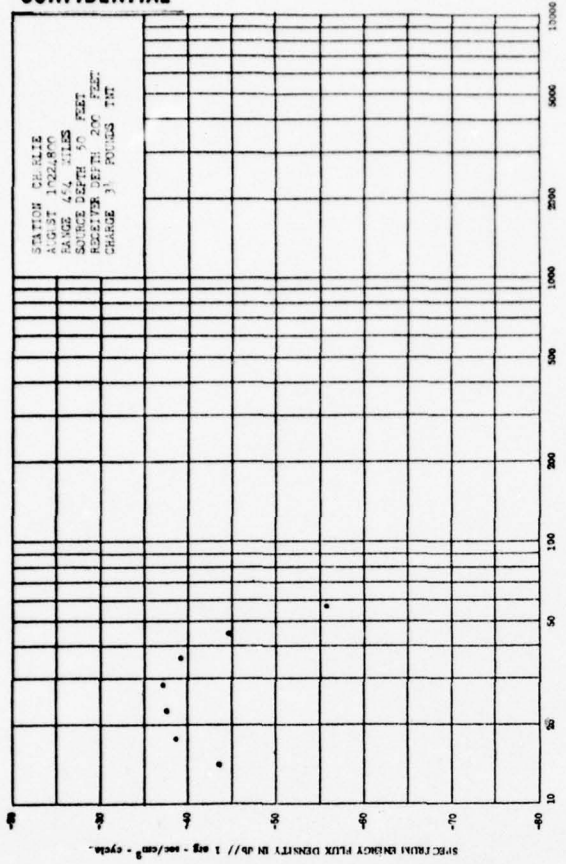

Fig. 133

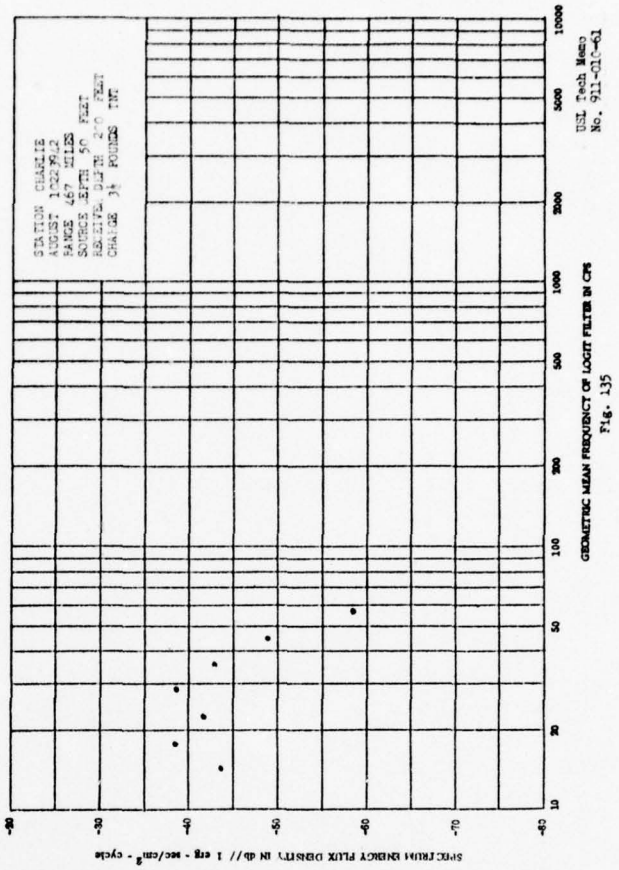

Fig. 135

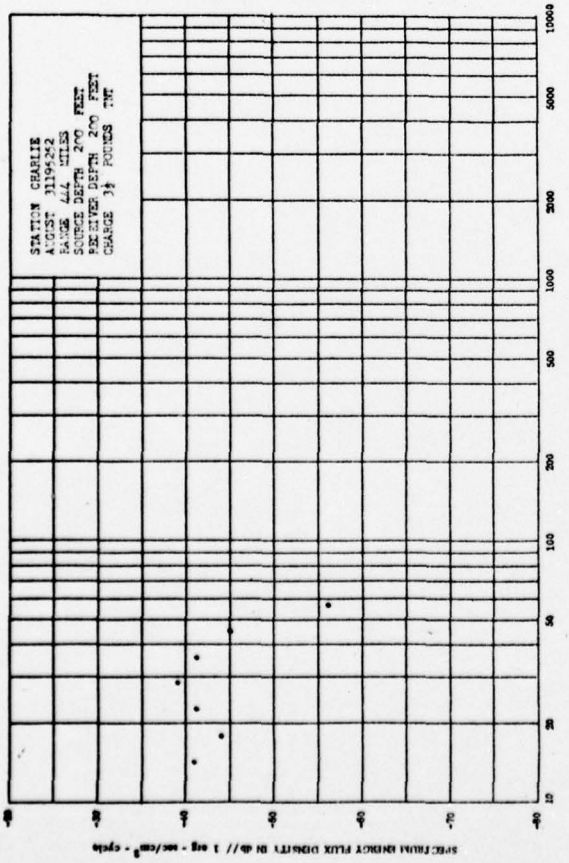

Fig. 132

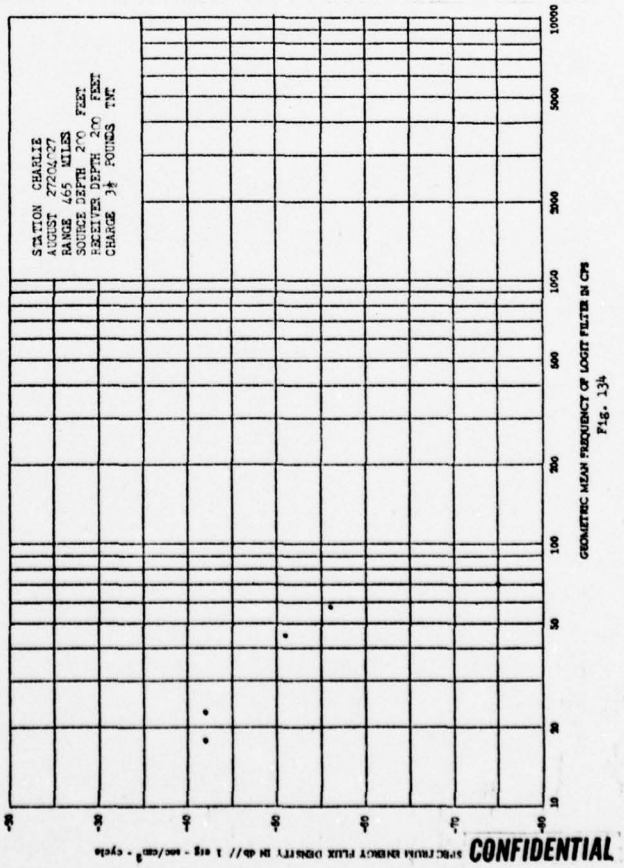

Fig. 134

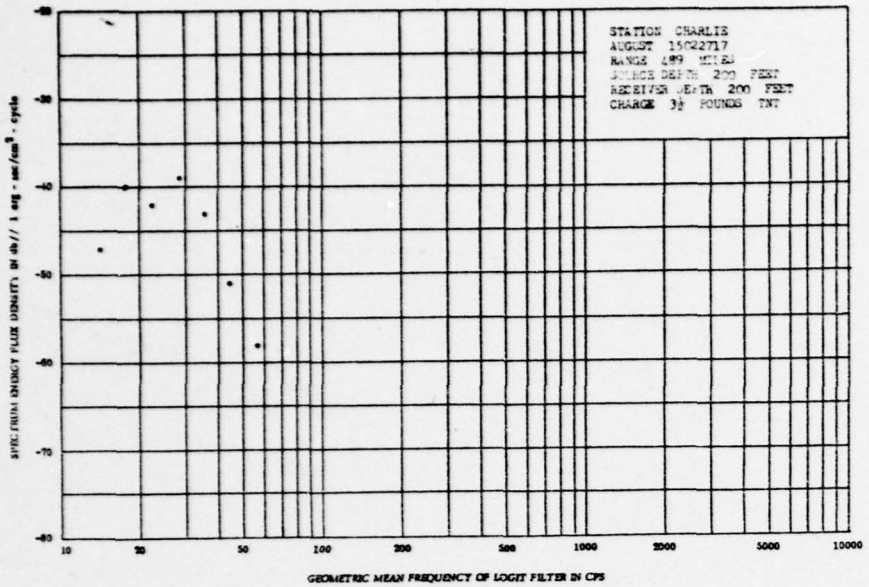

Fig. 136

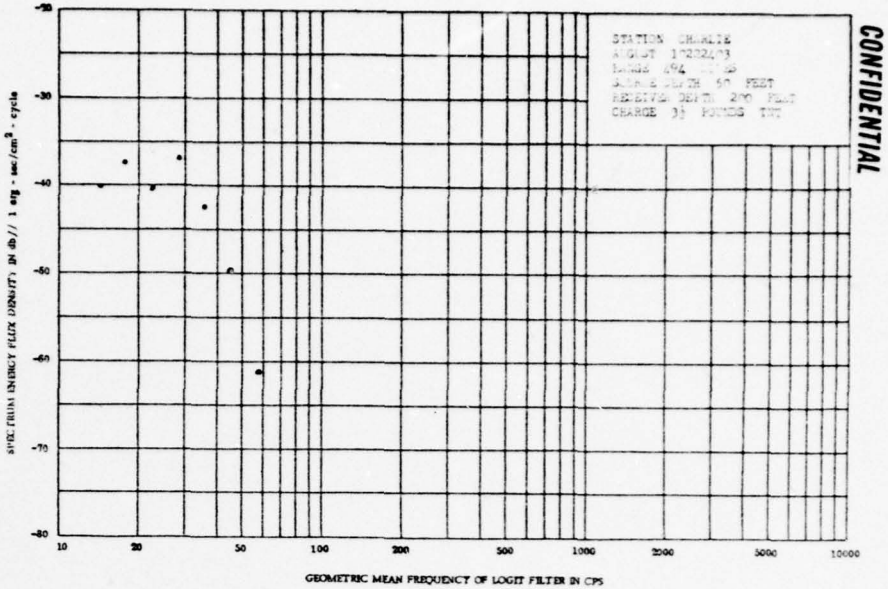

Fig. 137

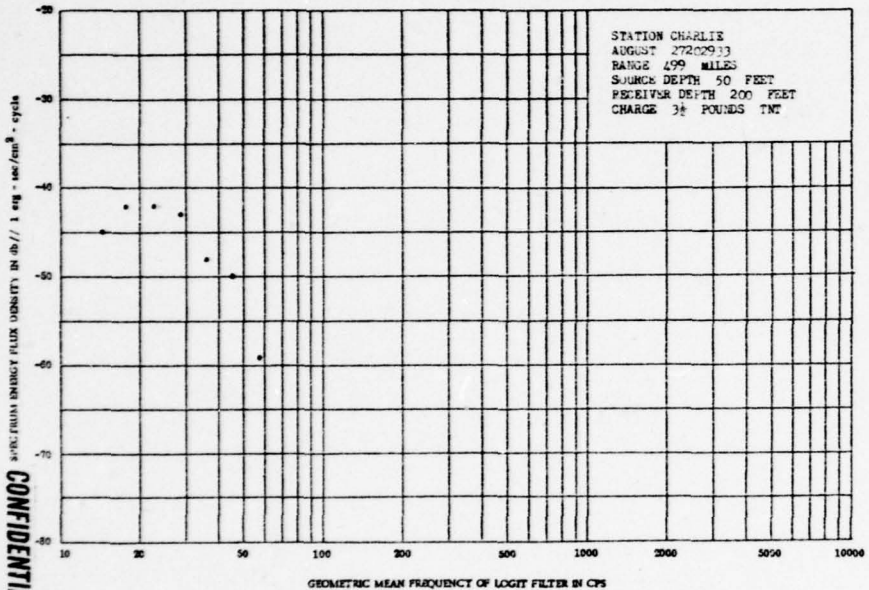

Fig. 138

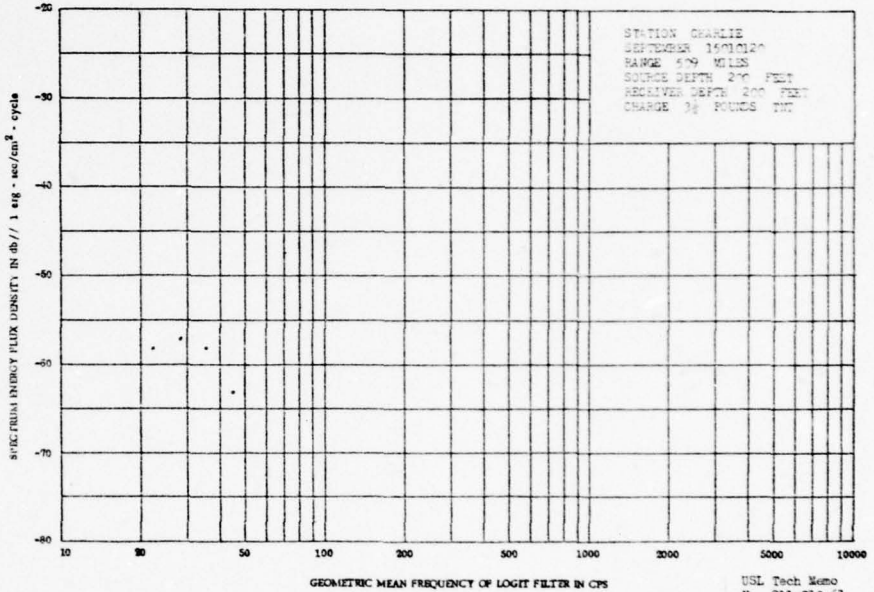

Fig. 139

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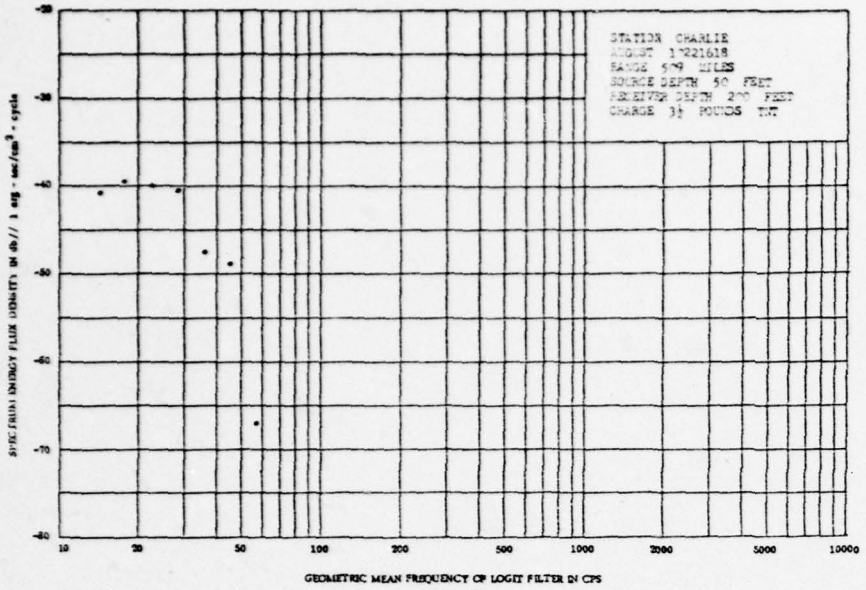

Fig. 140

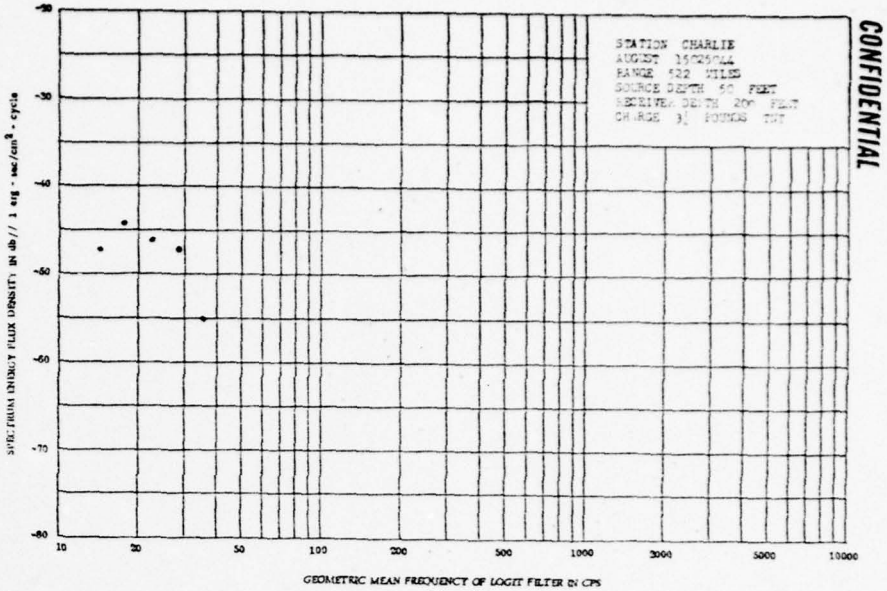

Fig. 141

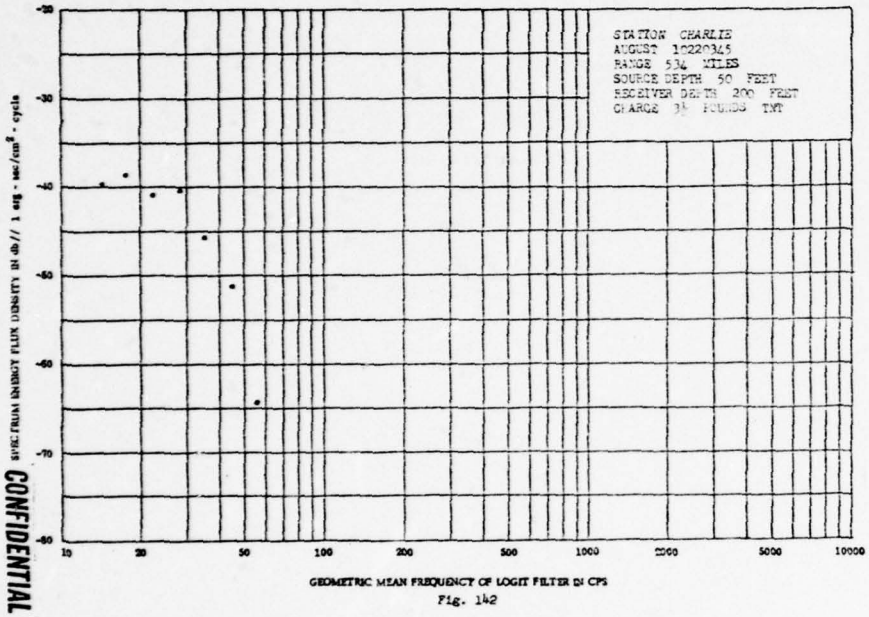

Fig. 142

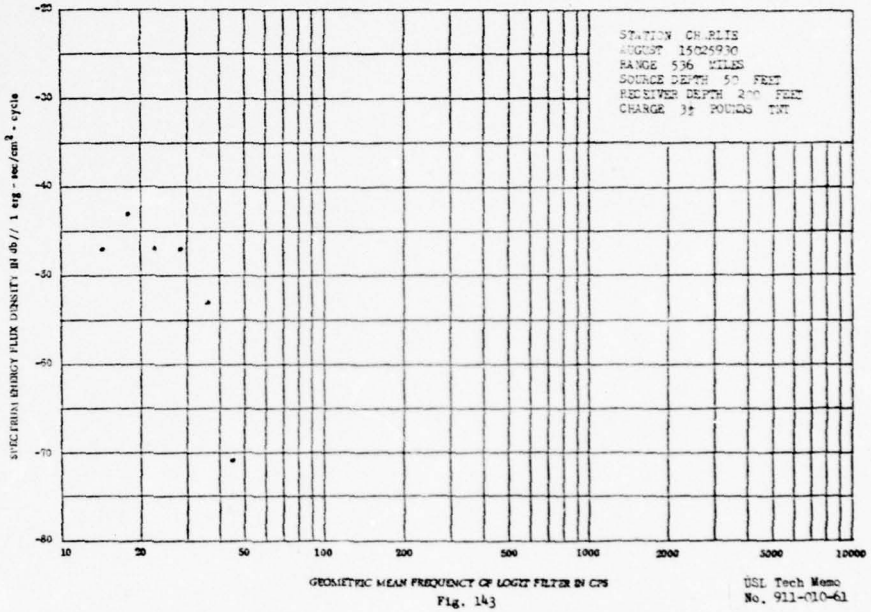

Fig. 143

Fig. 145

Fig. 147

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Fig. 144

Fig. 146

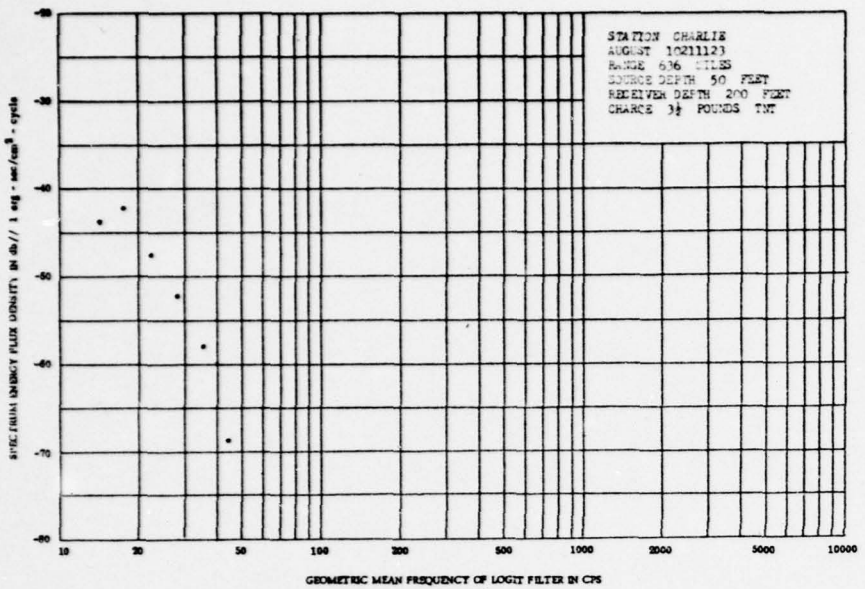

Fig. 148

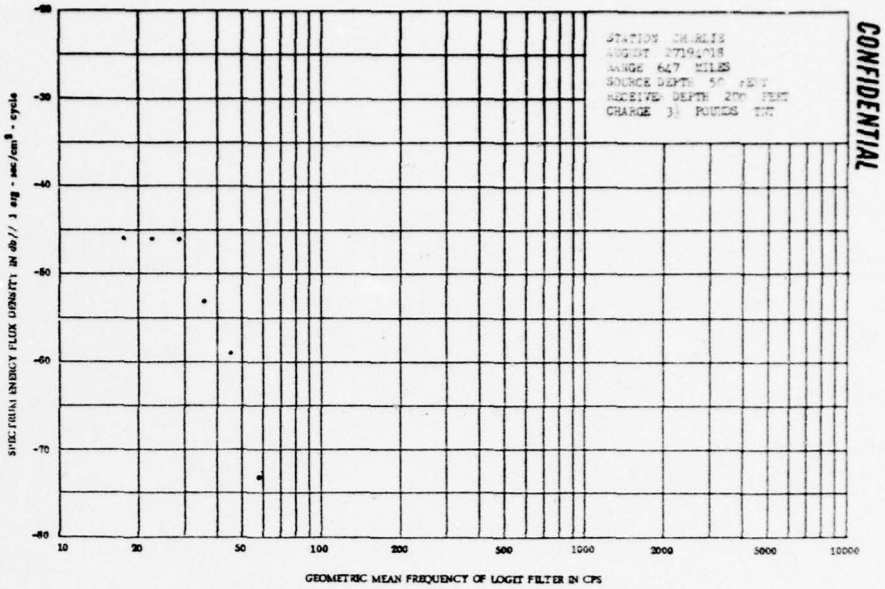

Fig. 149

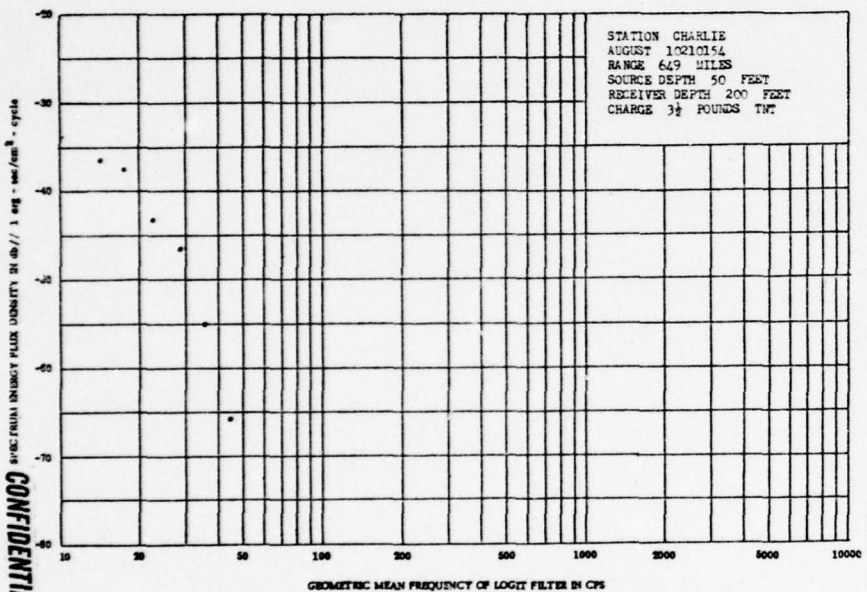

Fig. 150

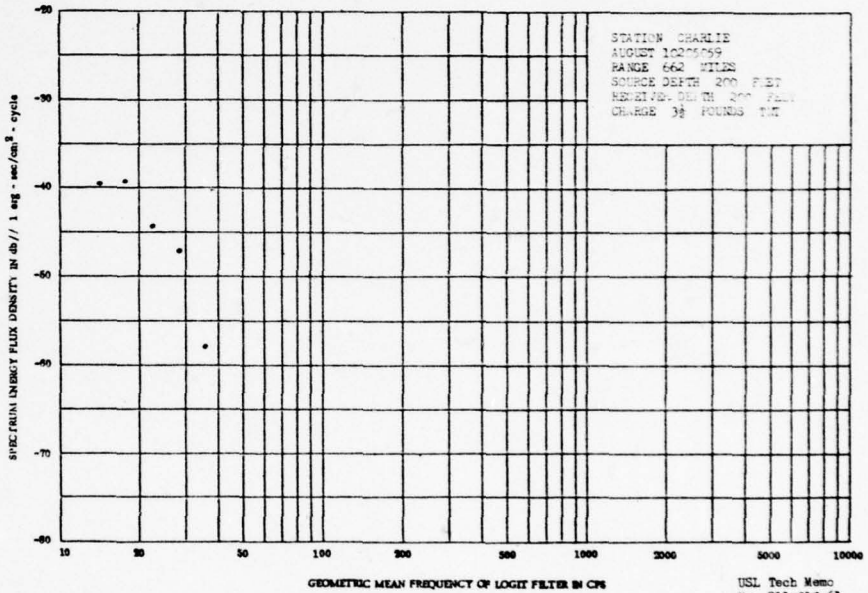

Fig. 151

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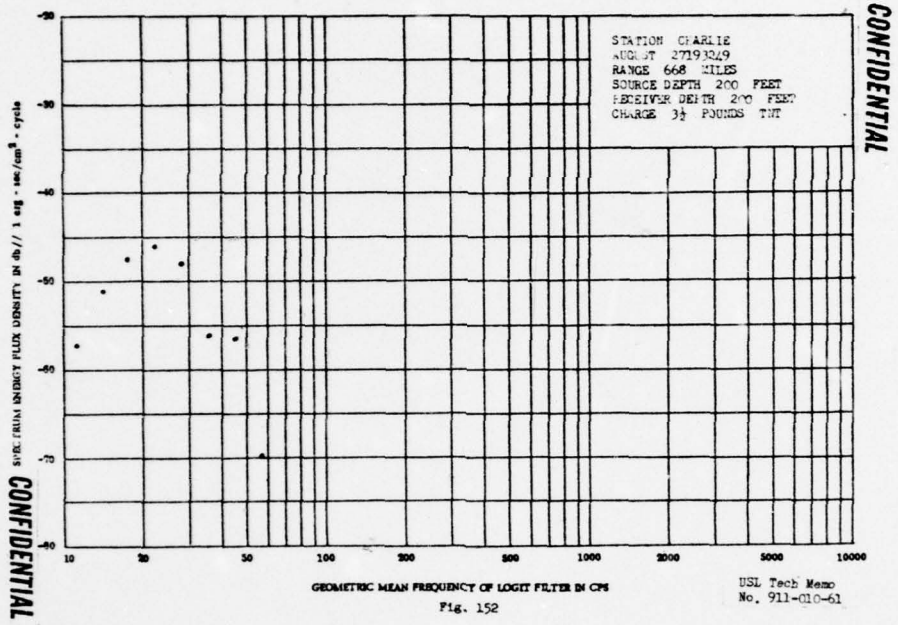

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Fig. 152

Fig. 153 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 11.2 cps.

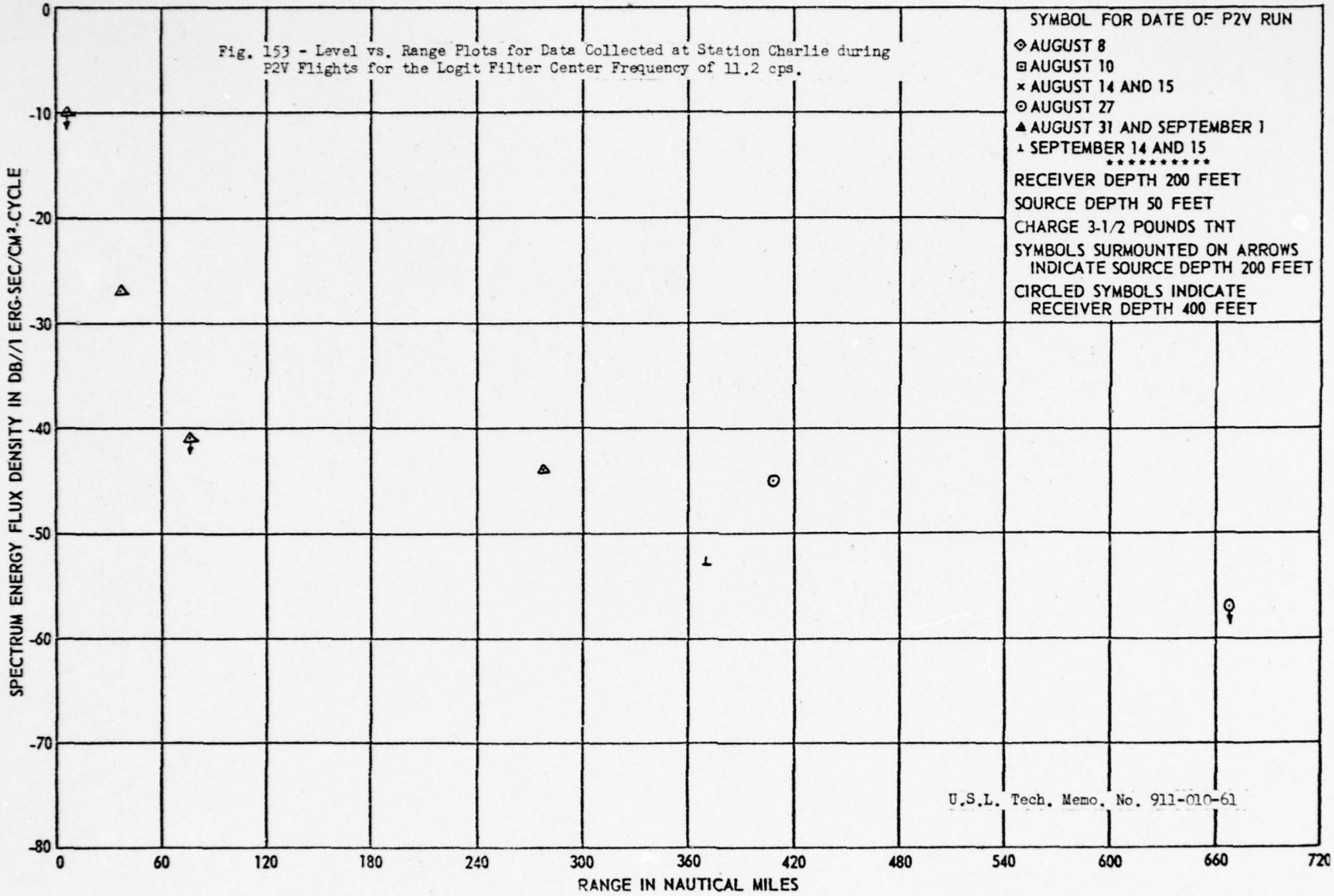
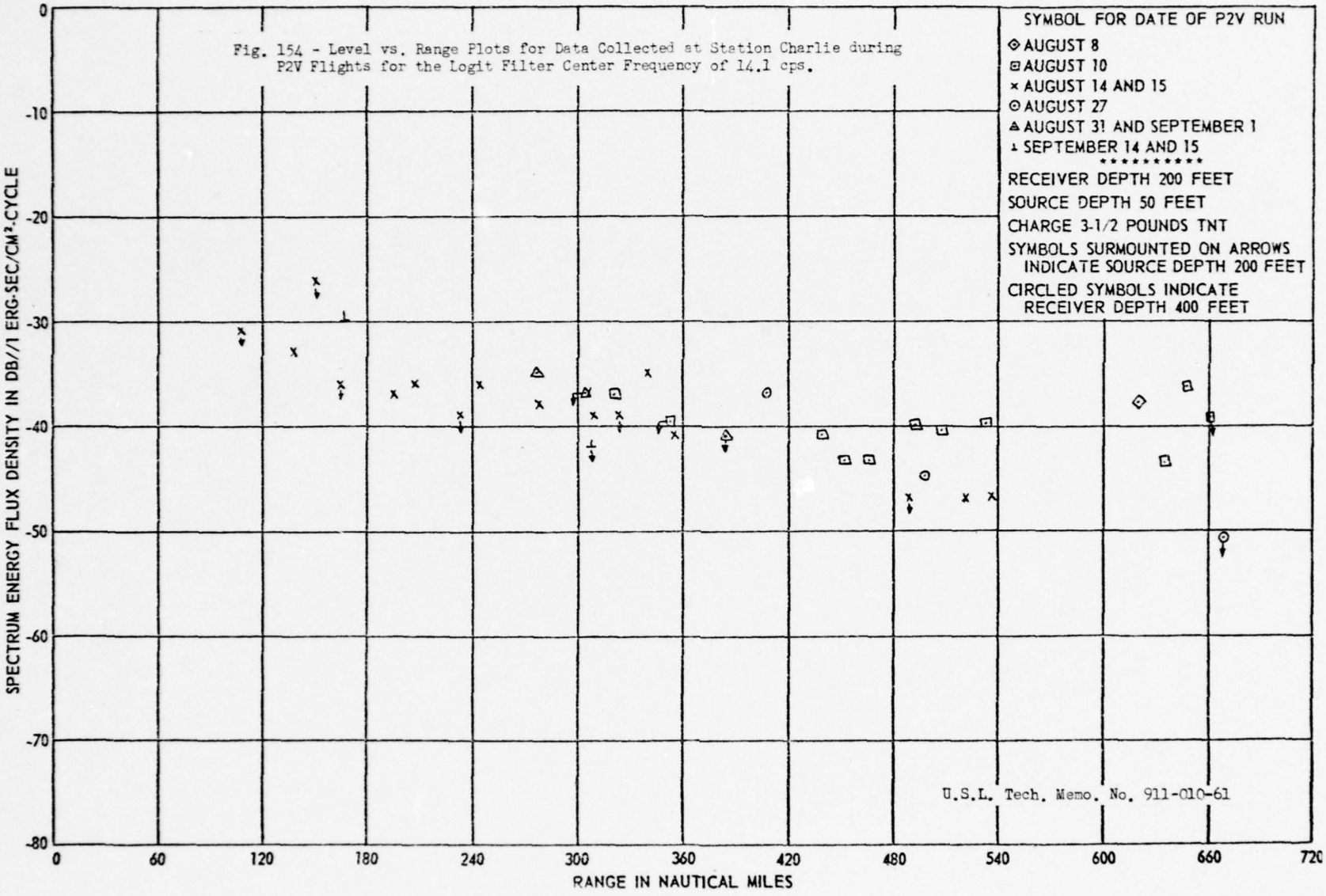


Fig. 154 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 14.1 cps.



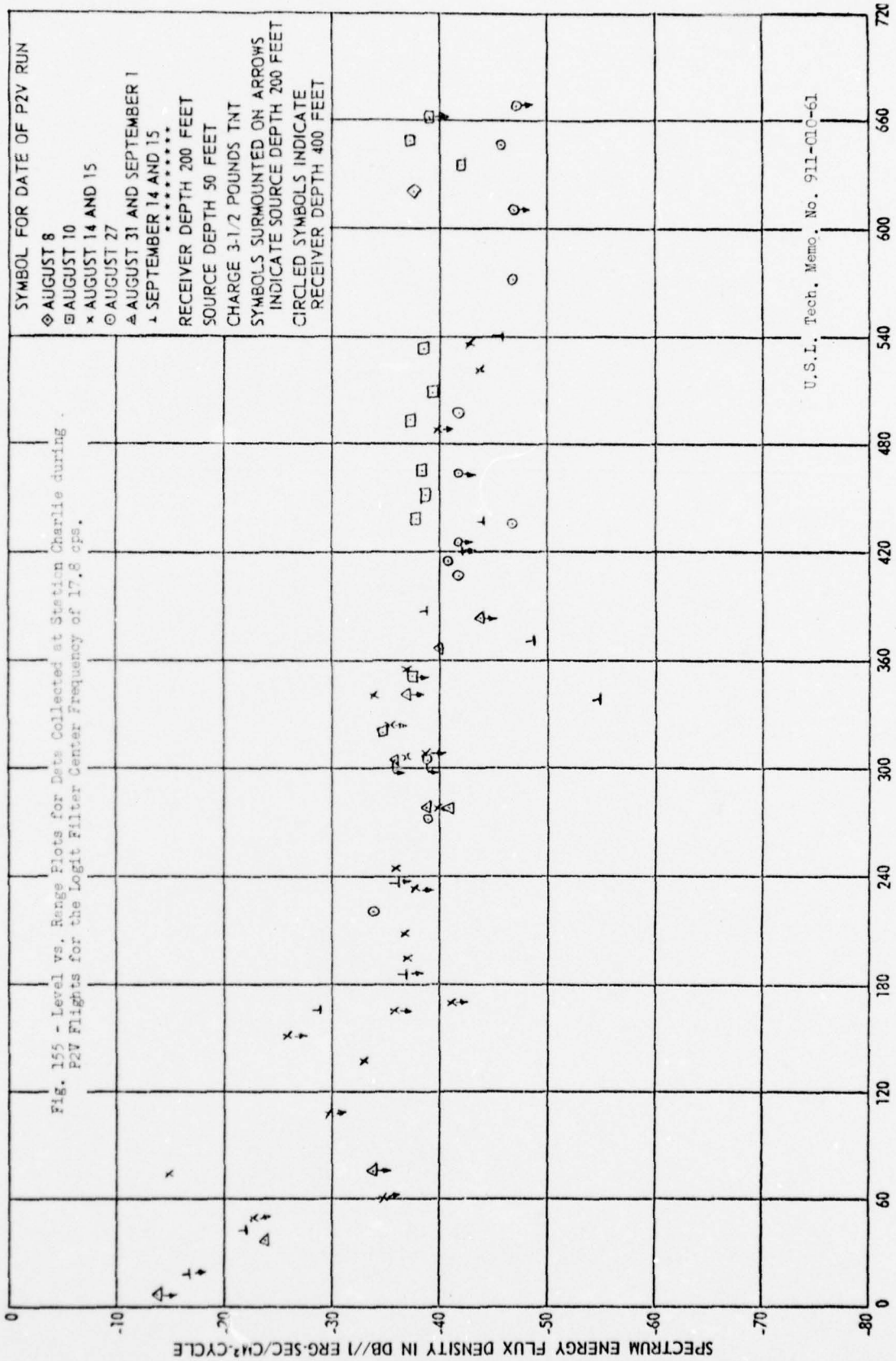
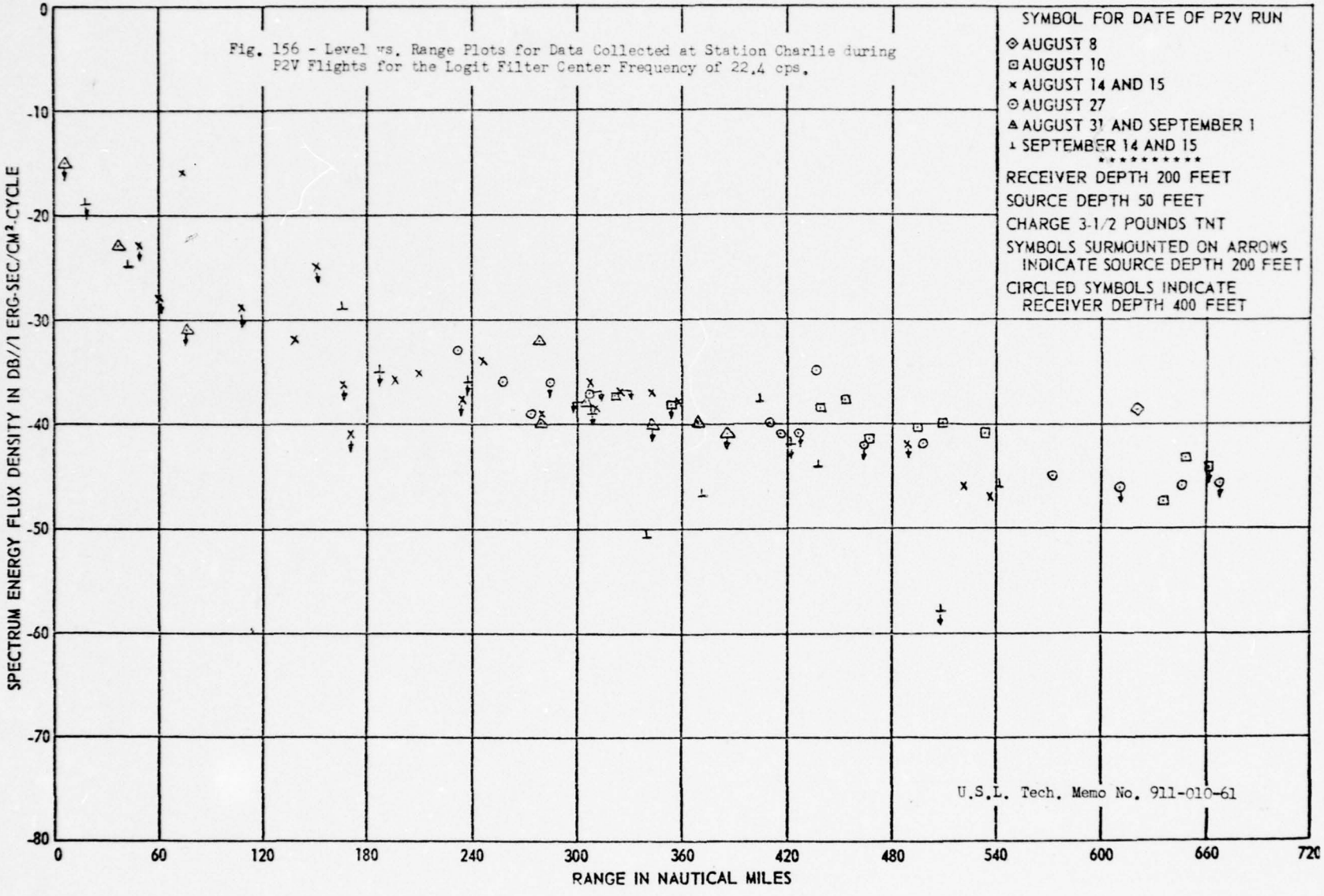


Fig. 155 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 17.8 cps.

Fig. 156 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 22.4 cps.



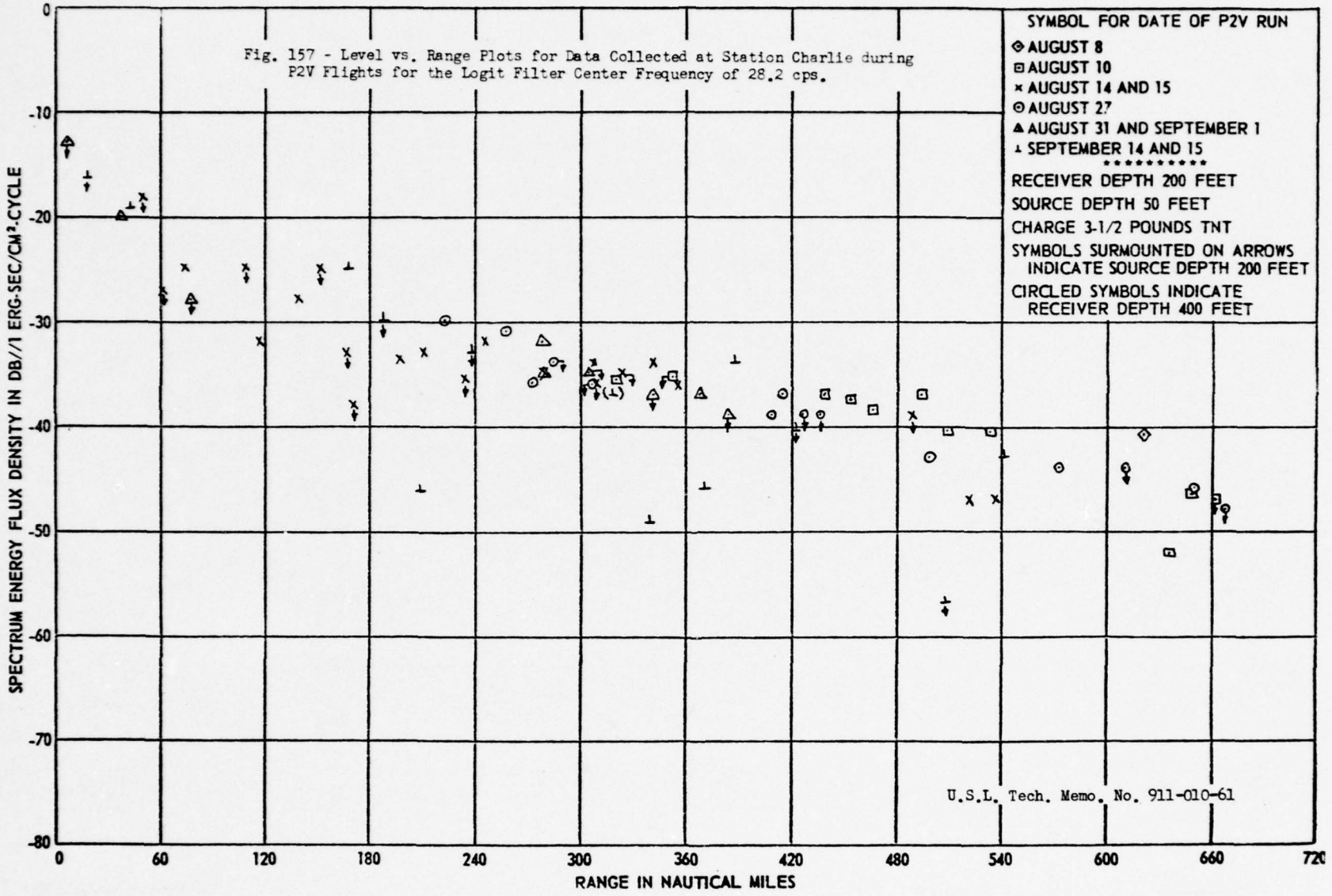


Fig. 157 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 28.2 cps.

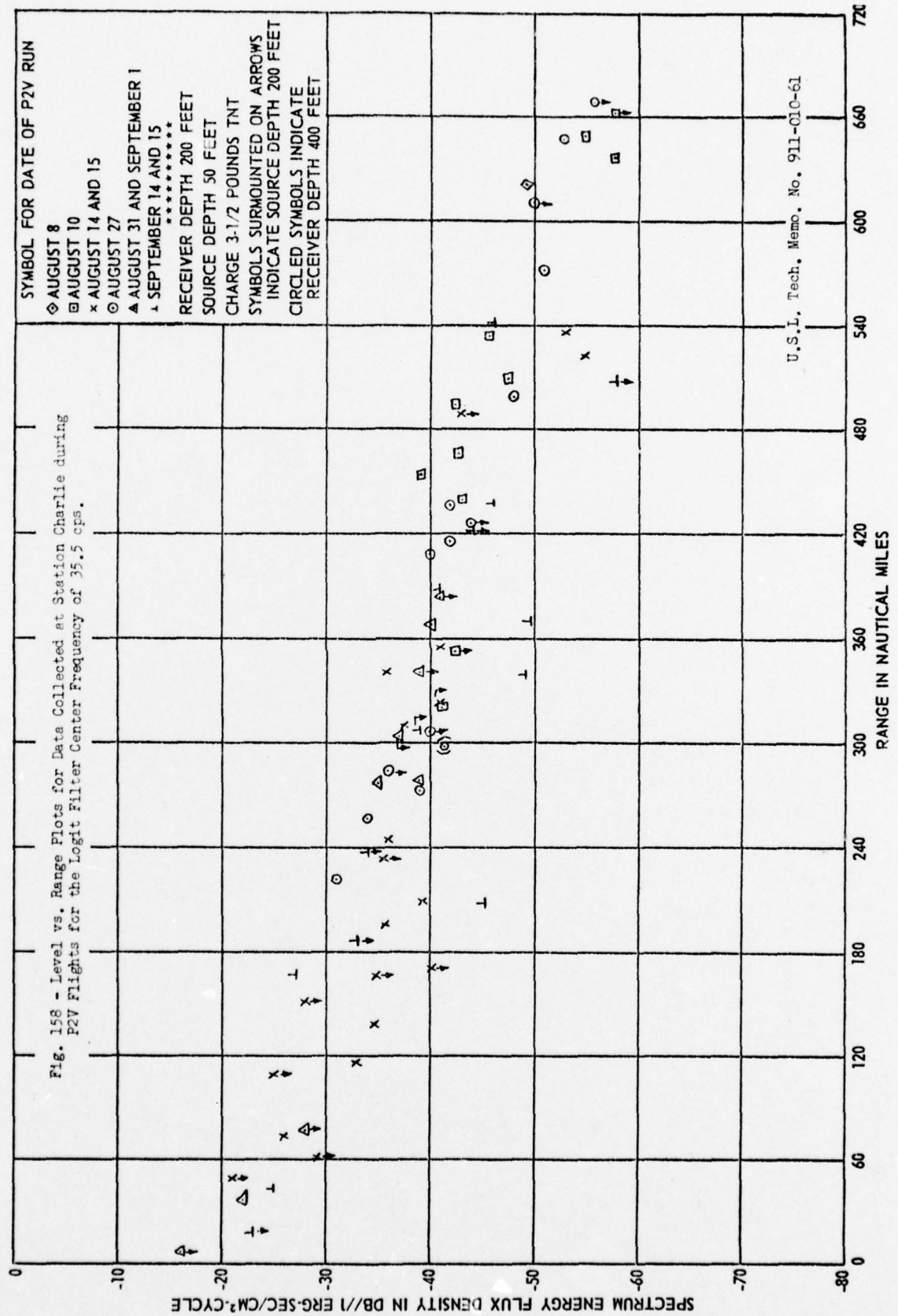


Fig. 158 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 35.5 cps.

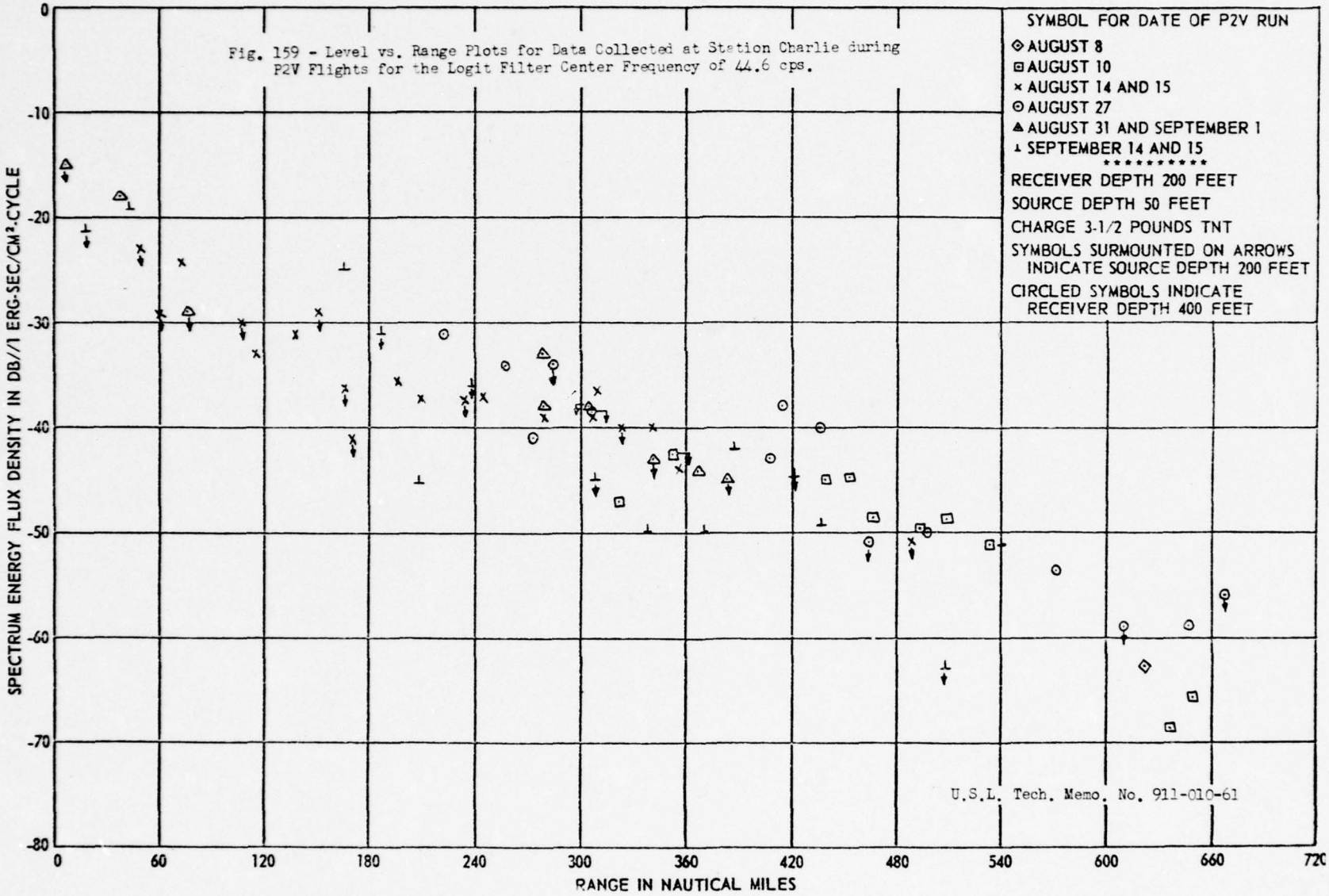


Fig. 159 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 44.6 cps.

Fig. 160 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 56.2 cps.

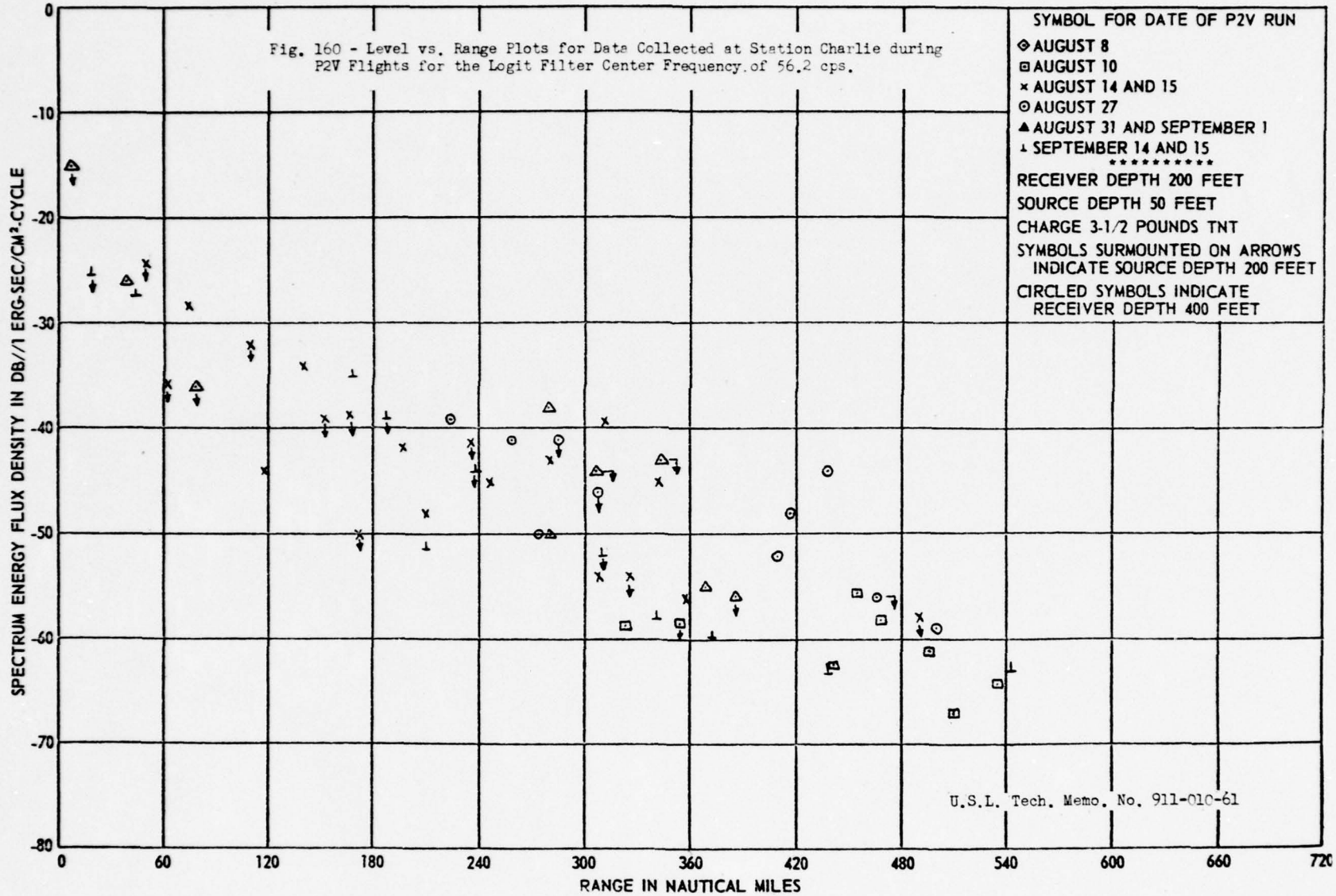


Fig. 161 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 70.7 cps.

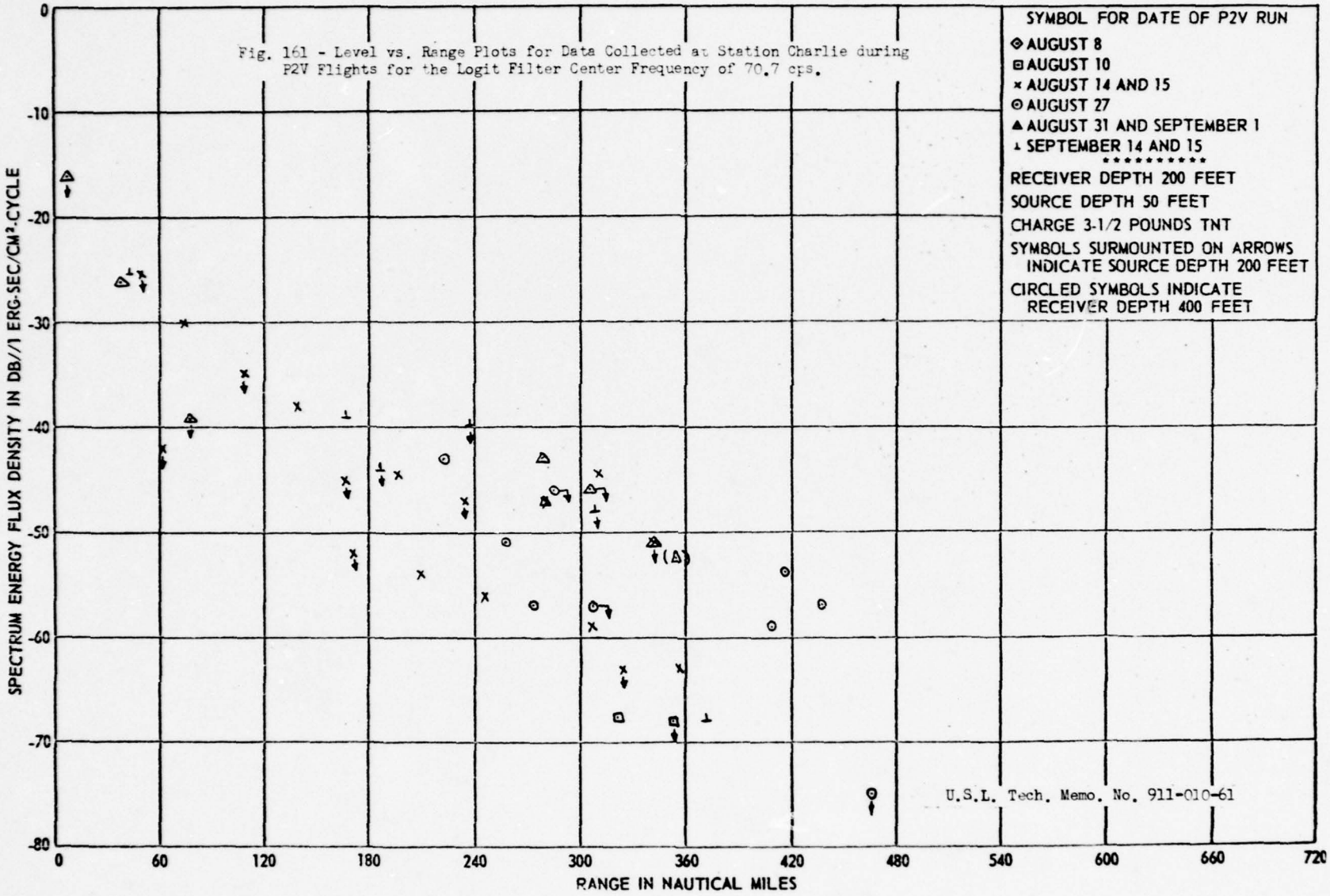
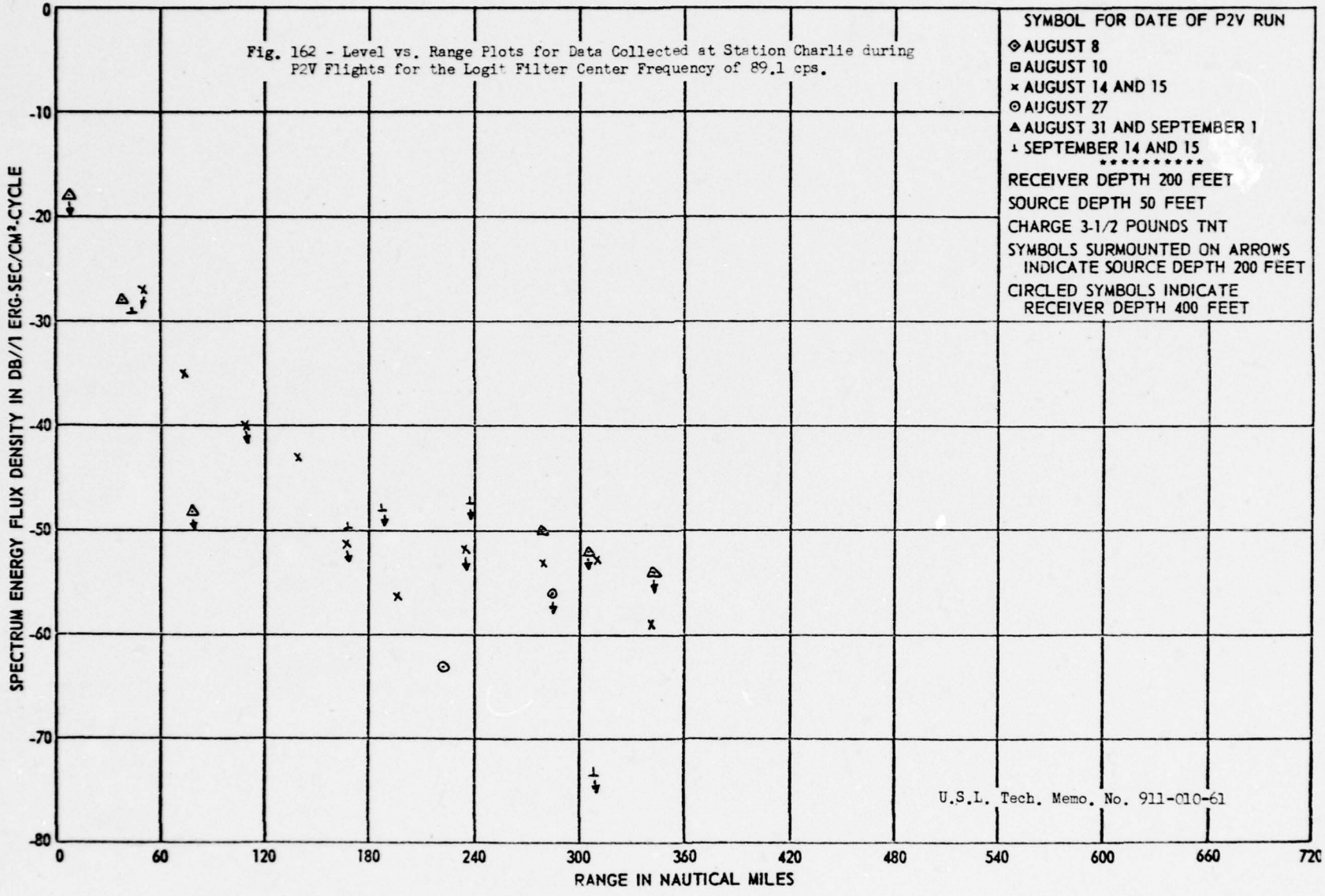


Fig. 162 - Level vs. Range Plots for Data Collected at Station Charlie during P2V Flights for the Logit Filter Center Frequency of 89.1 cps.



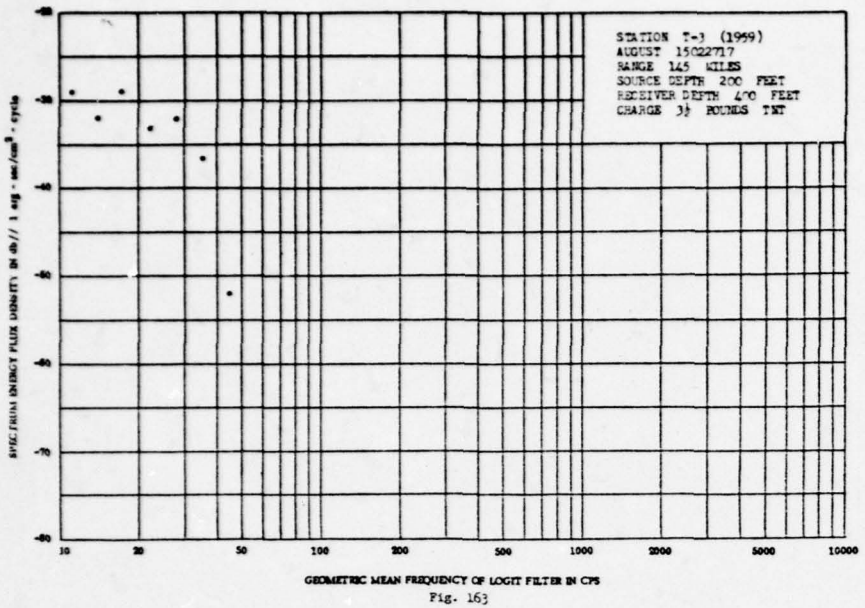


Fig. 163

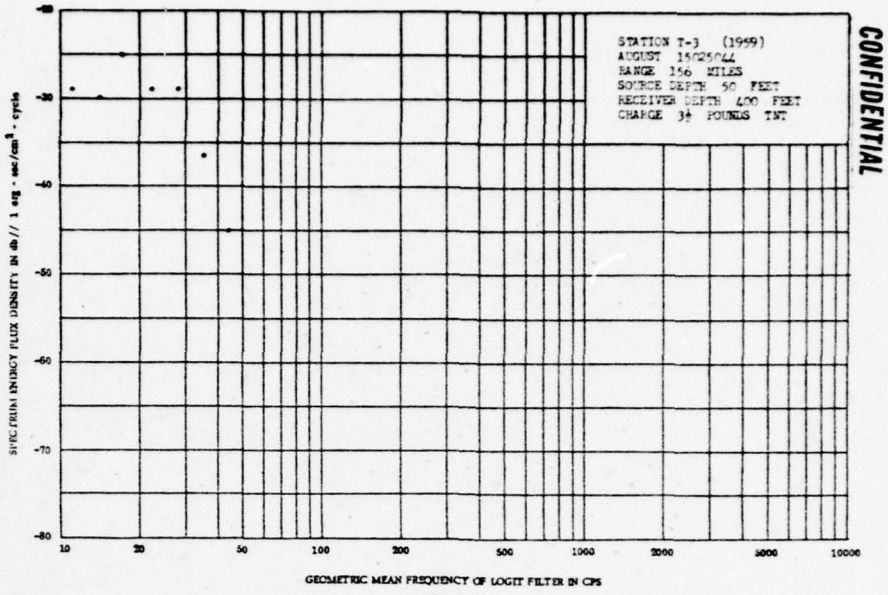


Fig. 164

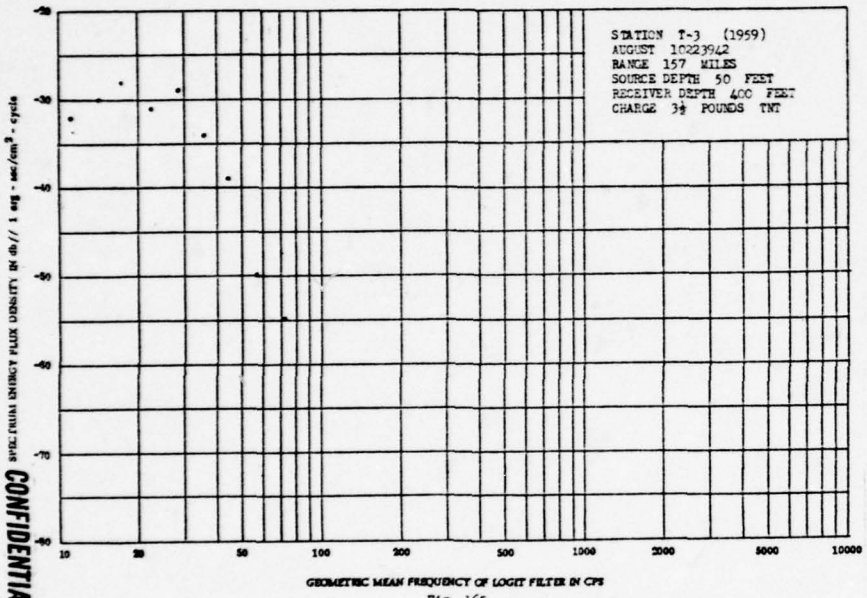


Fig. 165

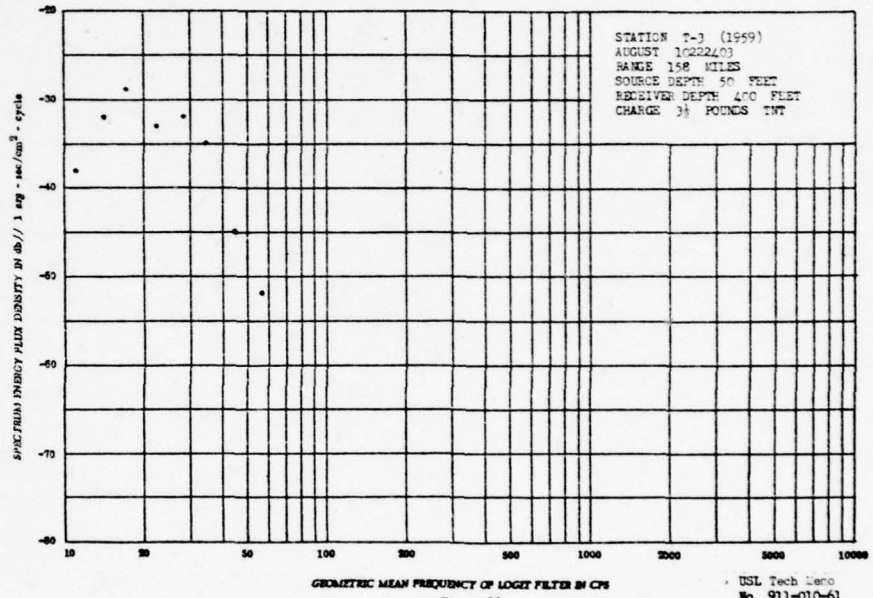


Fig. 166

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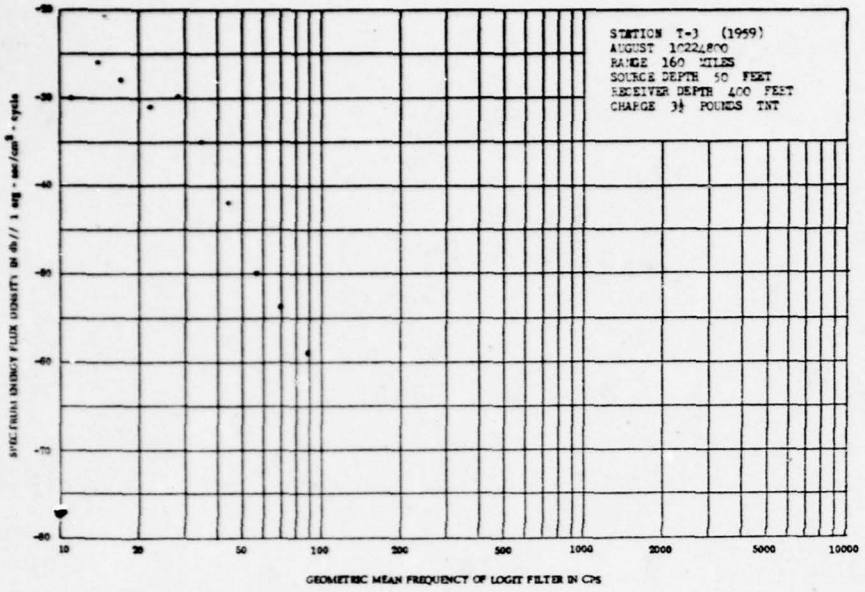

Fig. 167

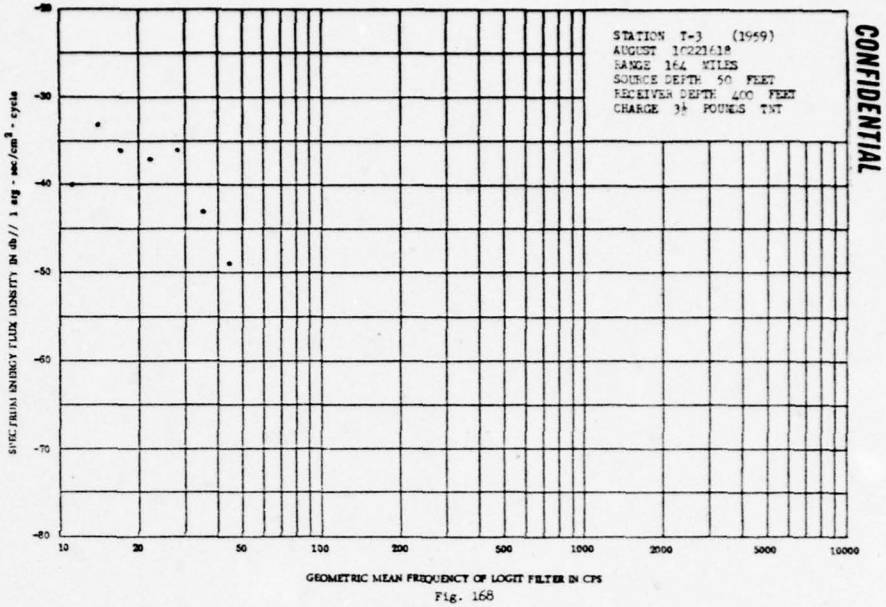

Fig. 168

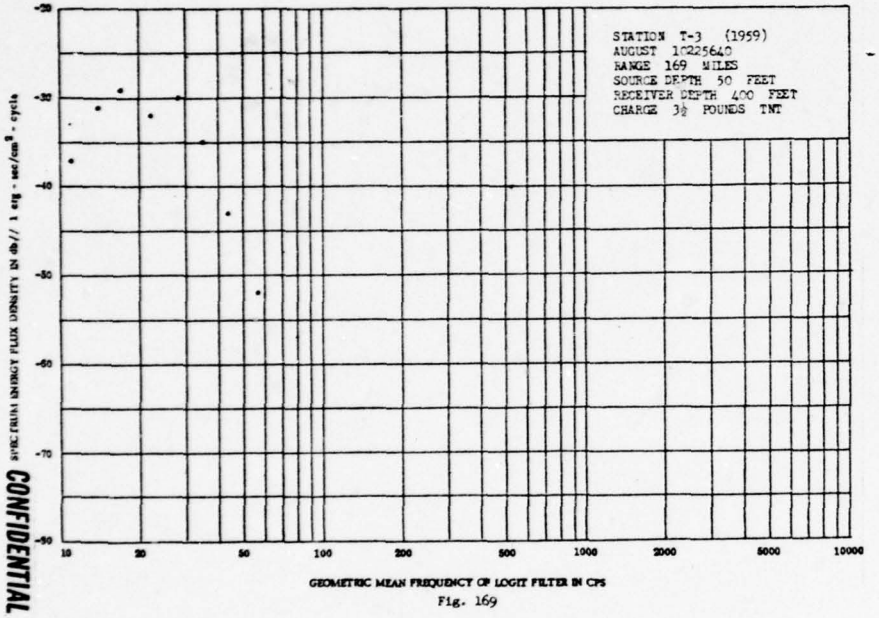

Fig. 169

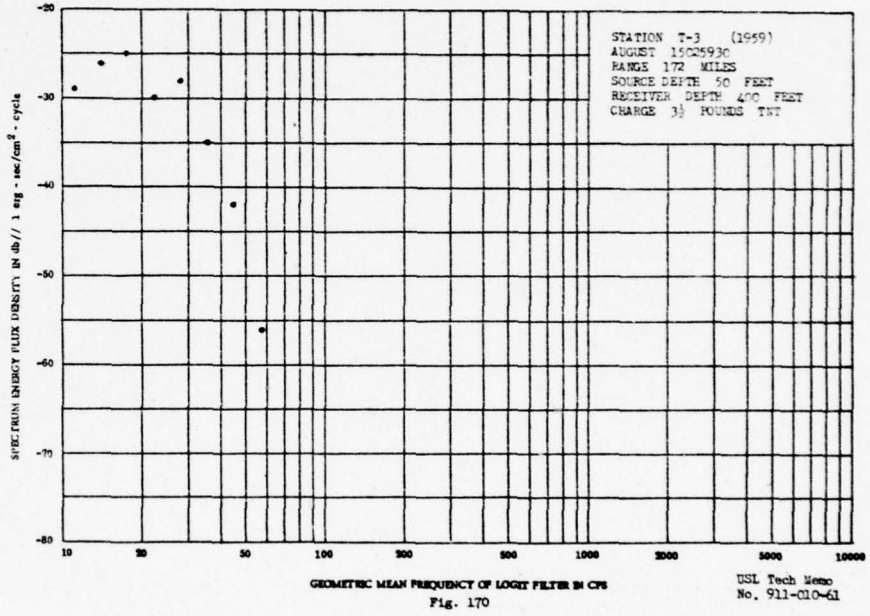

Fig. 170

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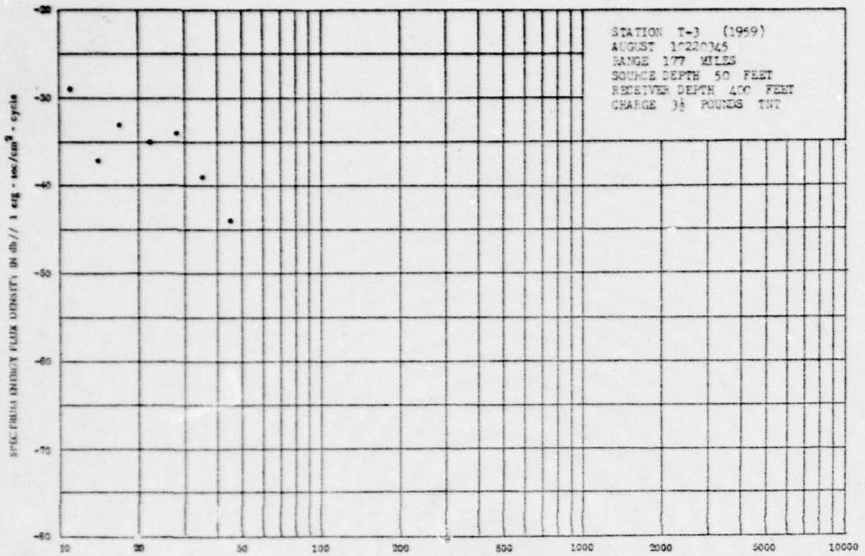


Fig. 171

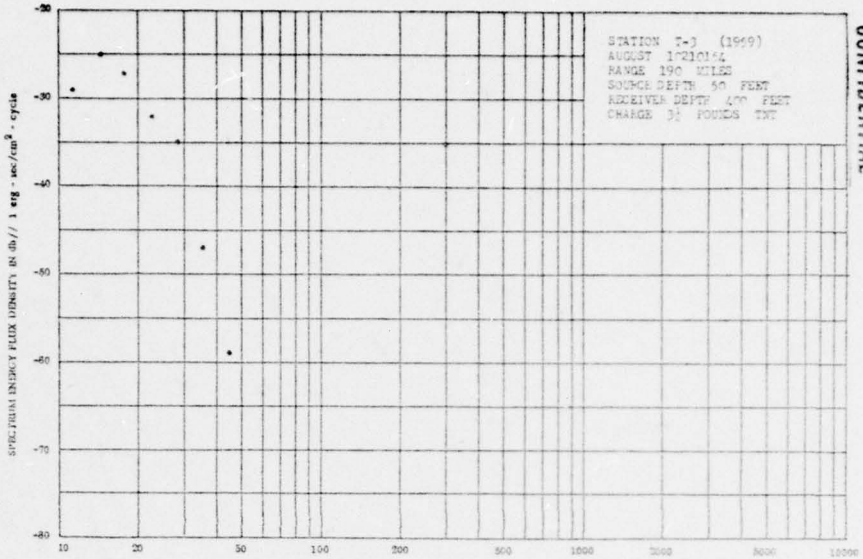
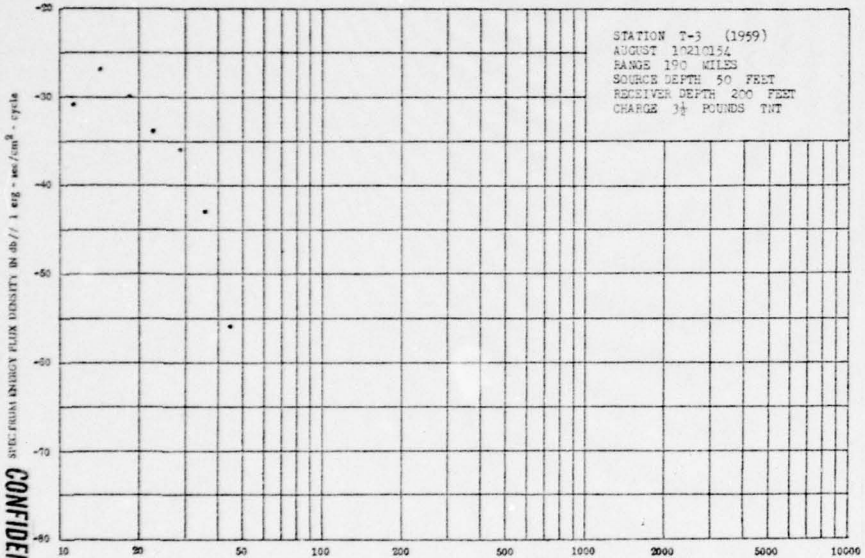


Fig. 172



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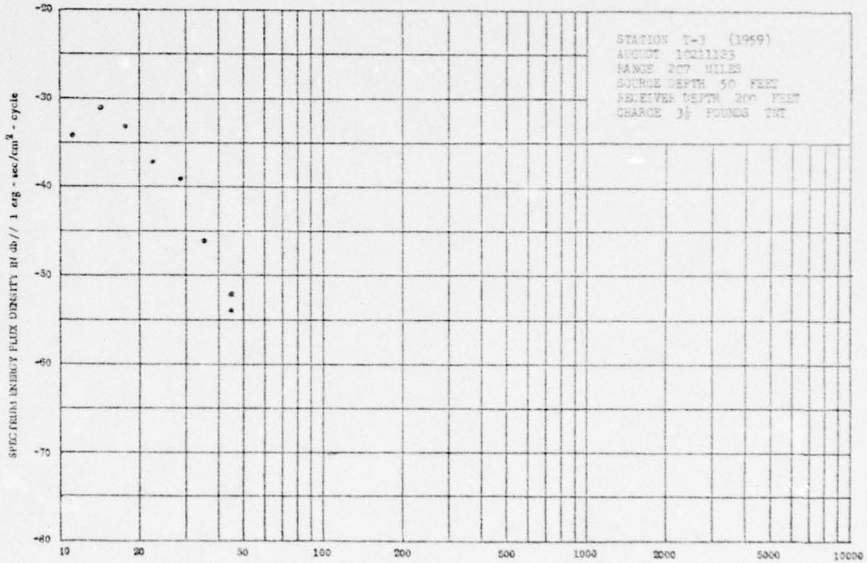

Fig. 174

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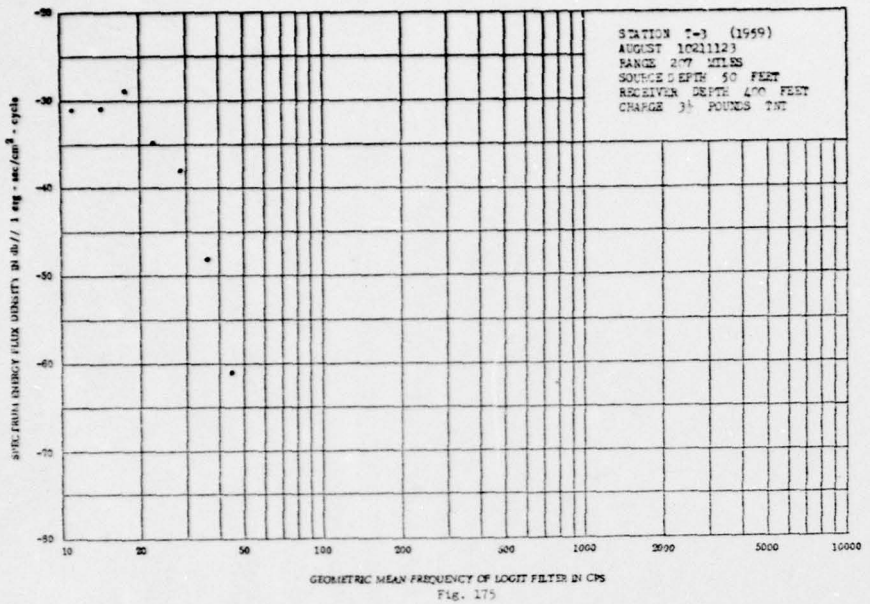

Fig. 175

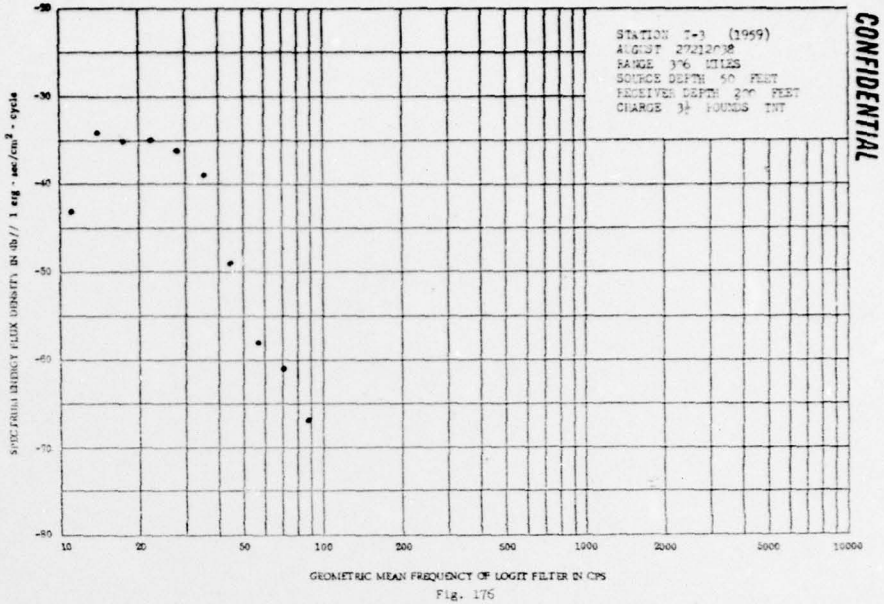

Fig. 176

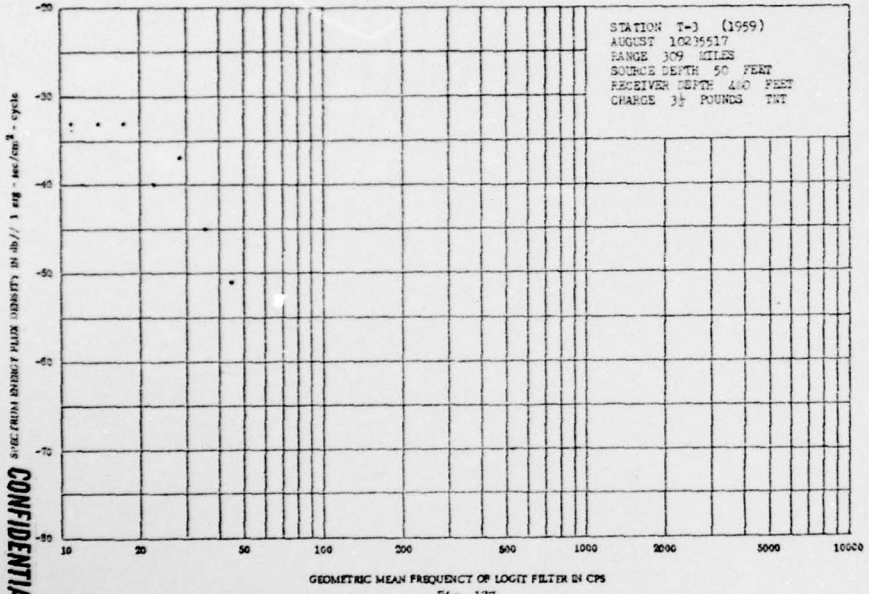

Fig. 177

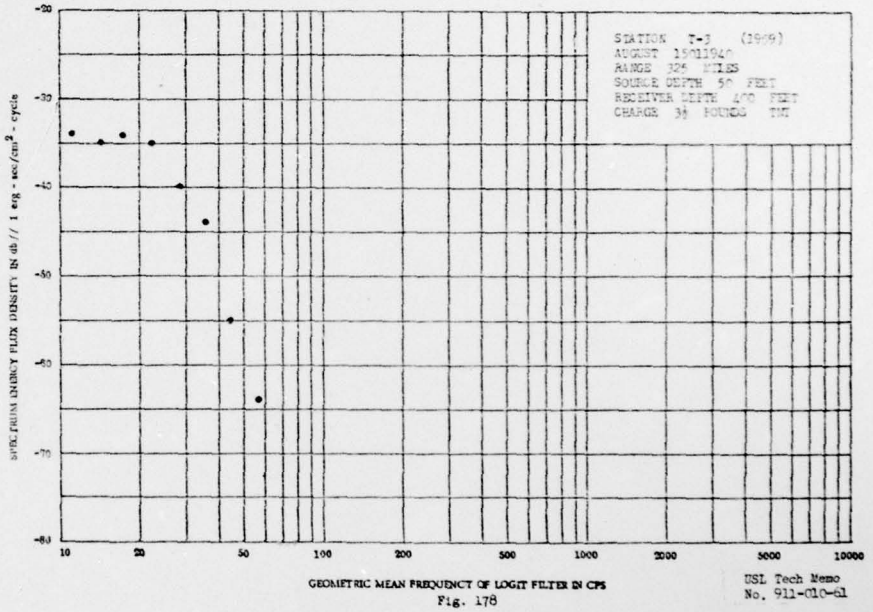

Fig. 178

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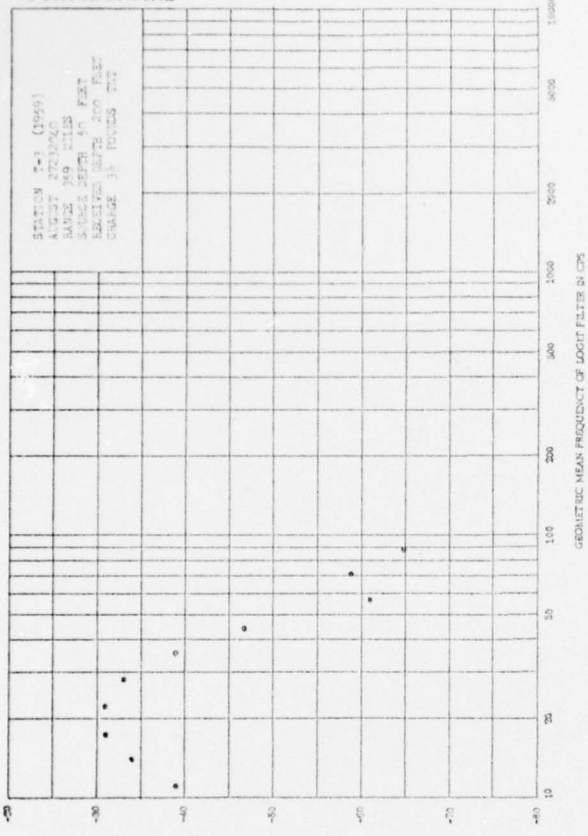
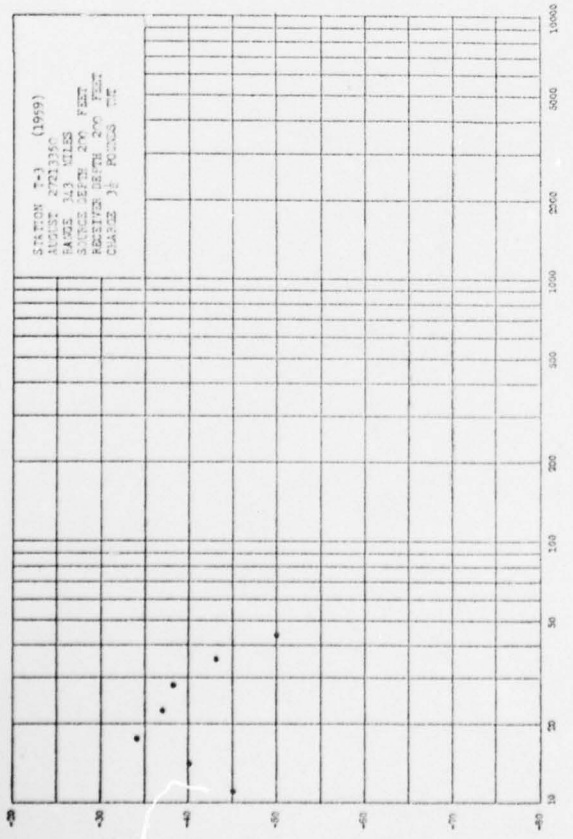


SPECTRAL ENERGY FLUX DENSITY IN db// 1 erg - sec/cm^2 - cycle

GEOMETRIC MEAN FREQUENCY OF LOGIT FILTER IN CPS

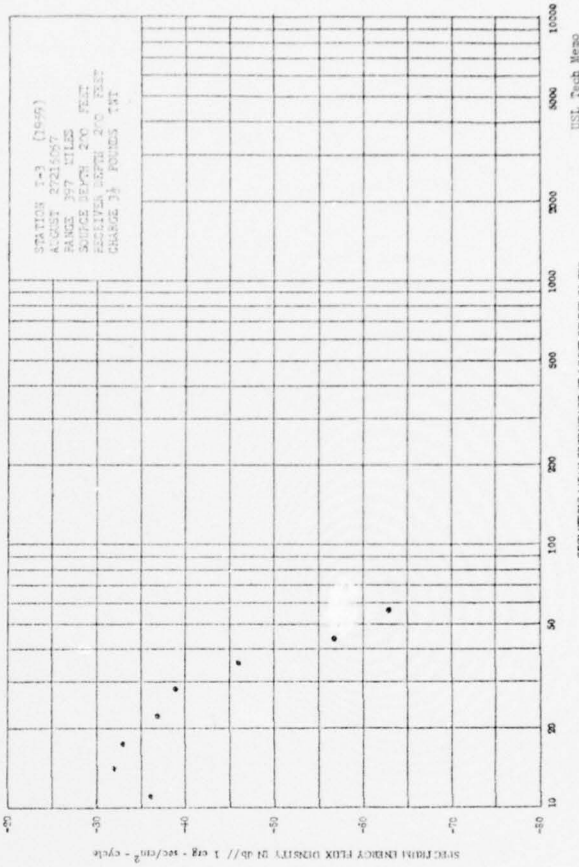
Fig. 180



SPECTRAL ENERGY FLUX DENSITY IN db// 1 erg - sec/cm^2 - cycle

GEOMETRIC MEAN FREQUENCY OF LOGIT FILTER IN CPS

Fig. 179



SPECTRAL ENERGY FLUX DENSITY IN db// 1 erg - sec/cm^2 - cycle

GEOMETRIC MEAN FREQUENCY OF LOGIT FILTER IN CPS

Fig. 182

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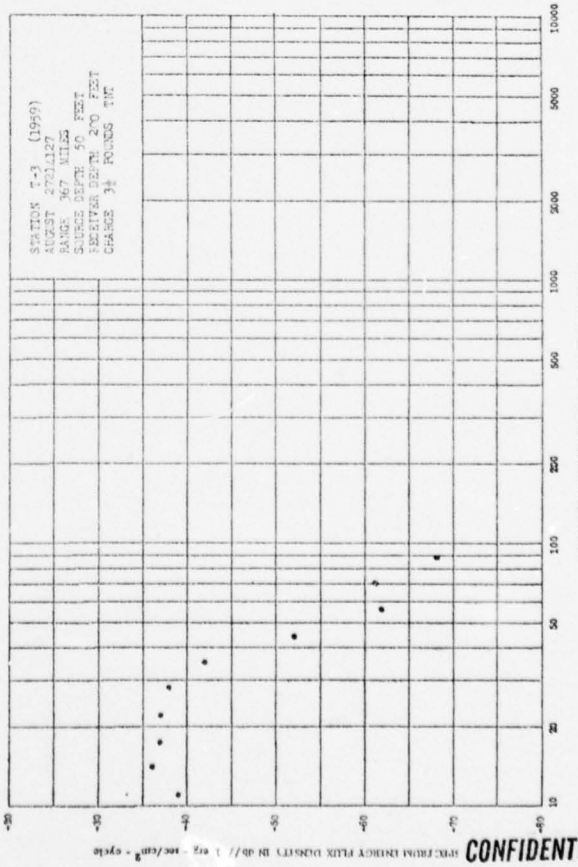

SPECTRAL ENERGY FLUX DENSITY IN db// 1 erg - sec/cm^2 - cycle

GEOMETRIC MEAN FREQUENCY OF LOGIT FILTER IN CPS

Fig. 181

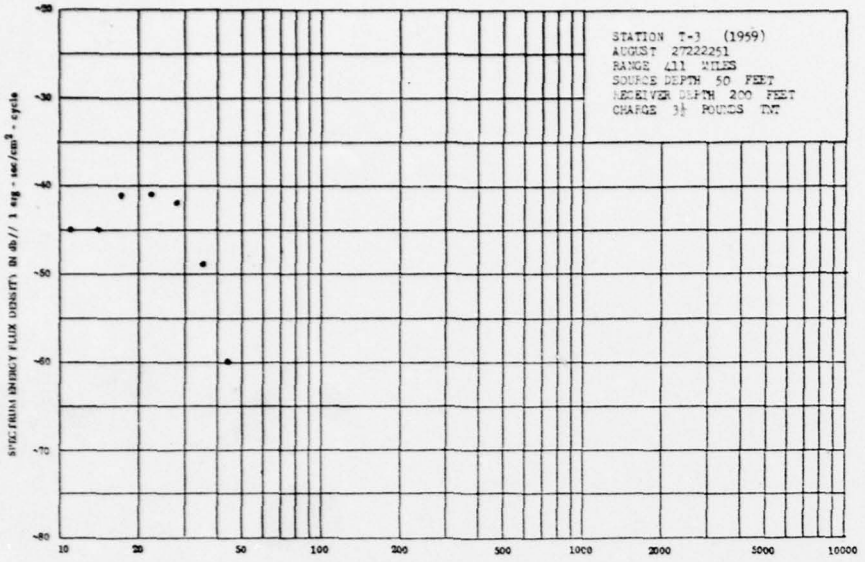

Fig. 183

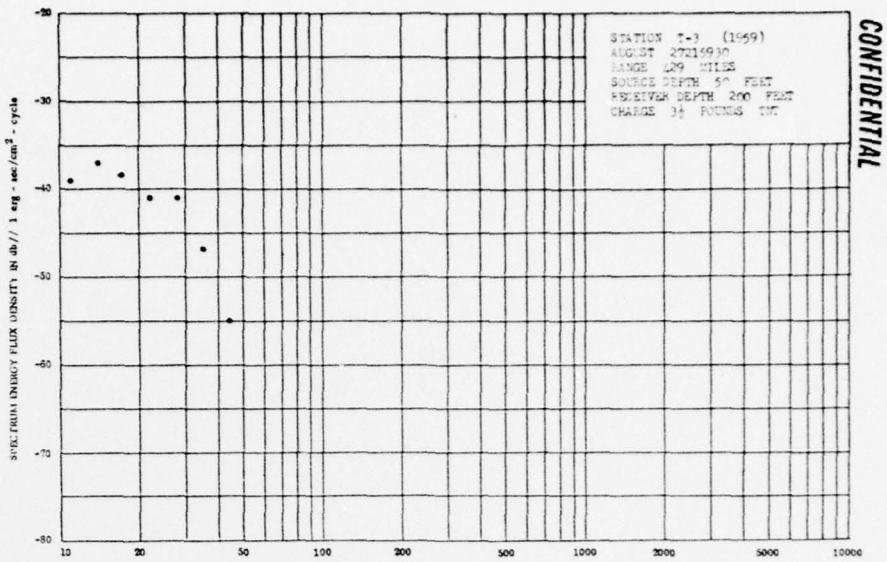

Fig. 184

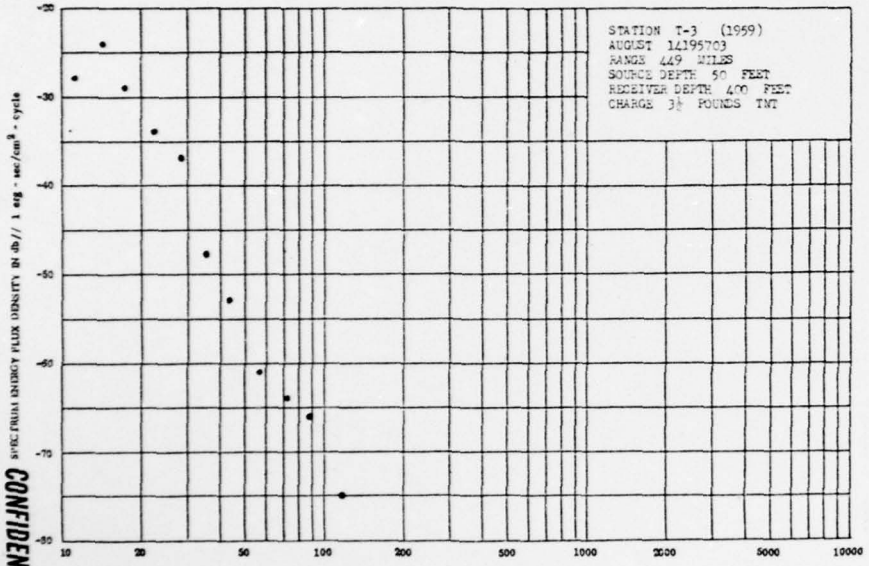

Fig. 185

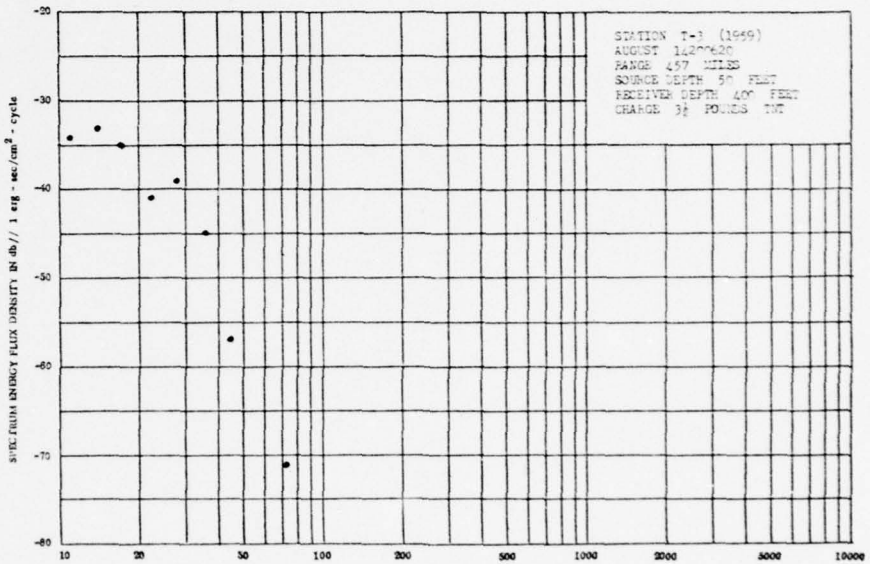

Fig. 186

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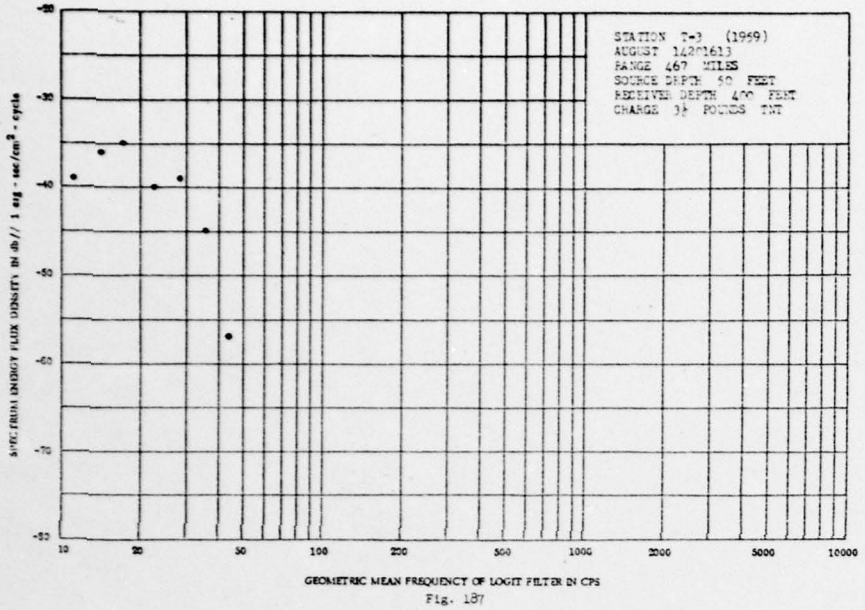

Fig. 187

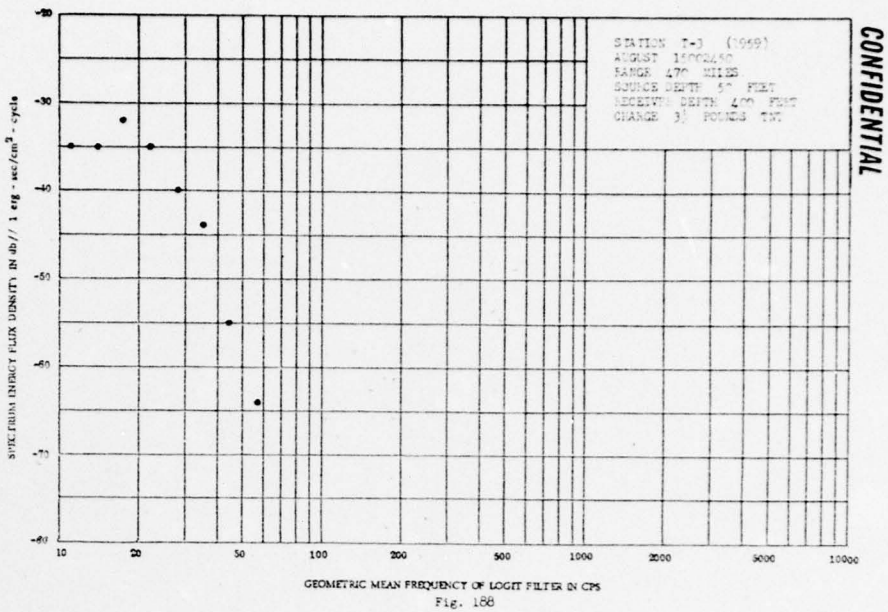

Fig. 188

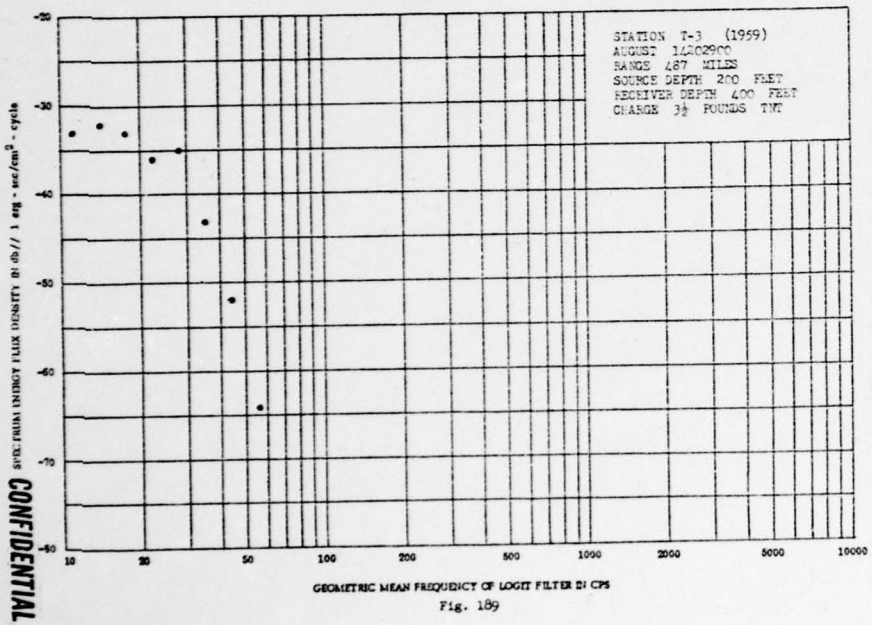

Fig. 189

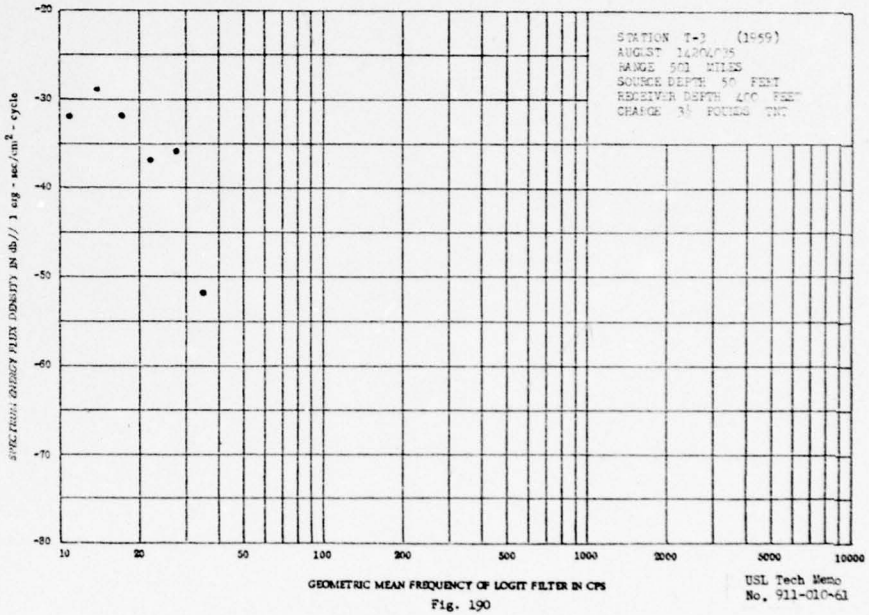

Fig. 190

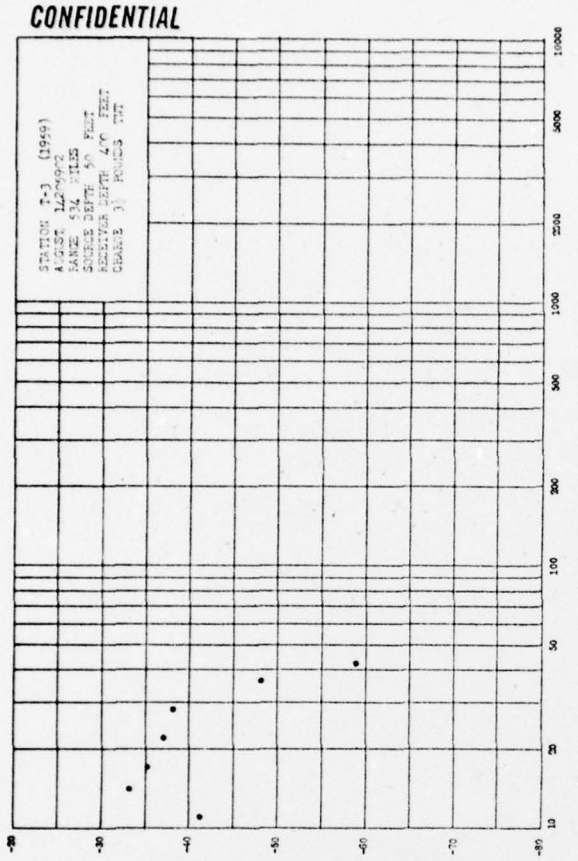

Fig. 192

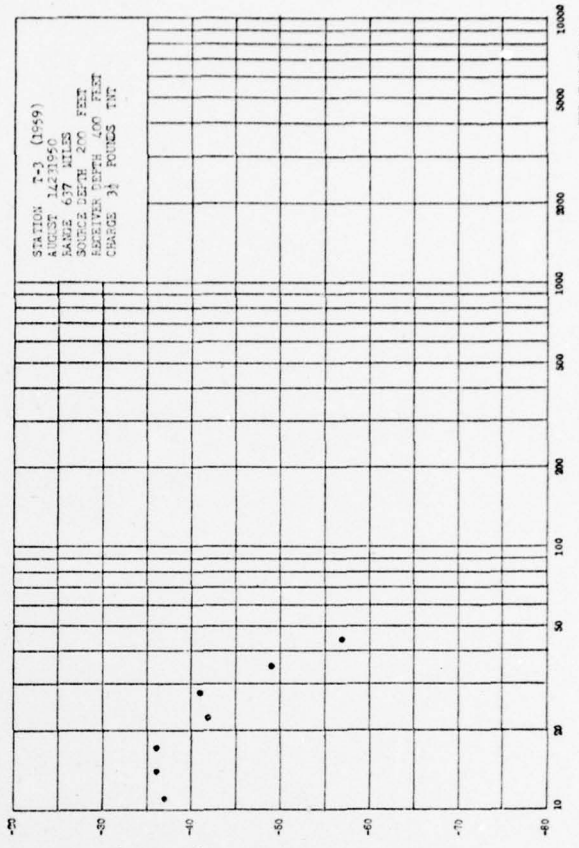

Fig. 194

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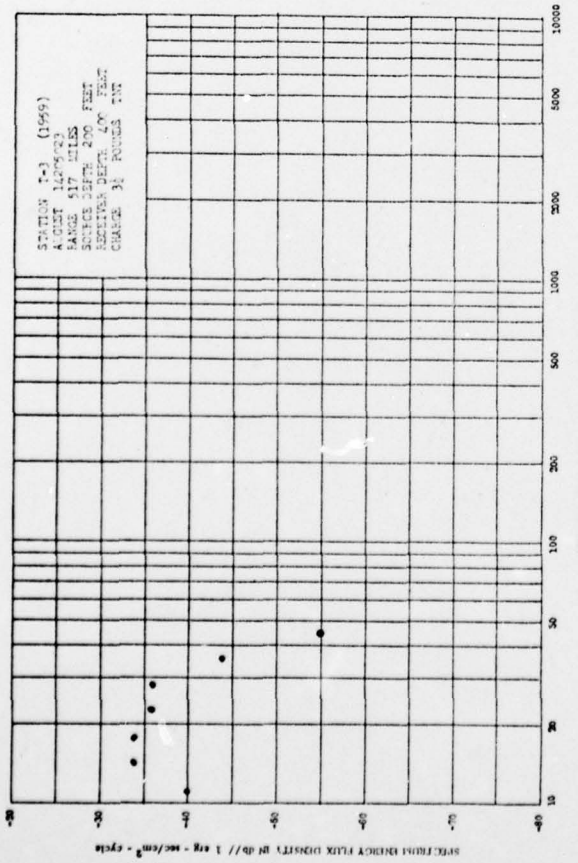


Fig. 191

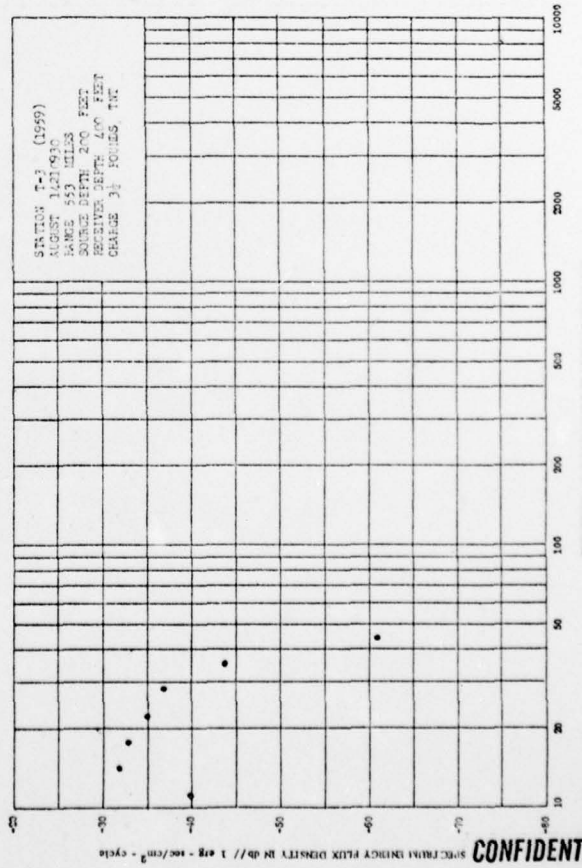
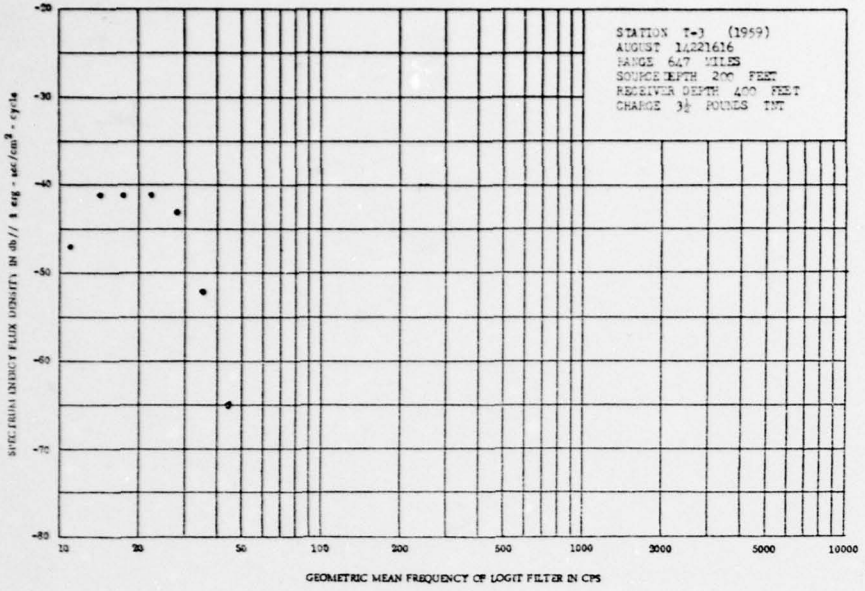


Fig. 193



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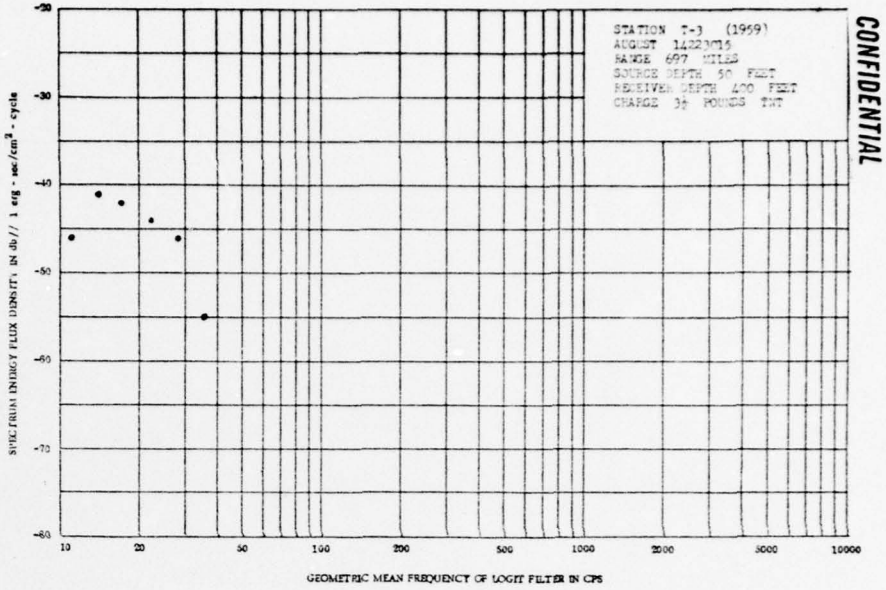

Fig. 196

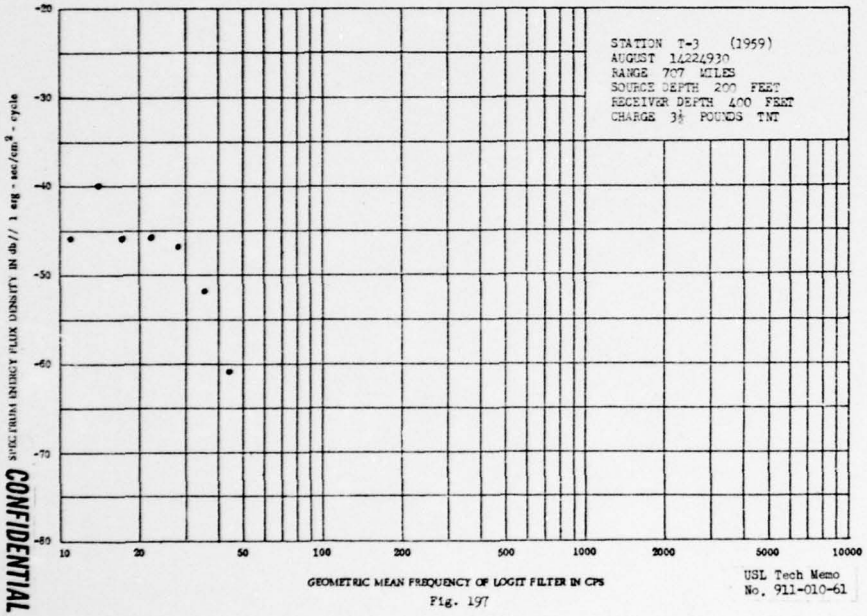

Fig. 197

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Fig. 198 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 11.2 cps.

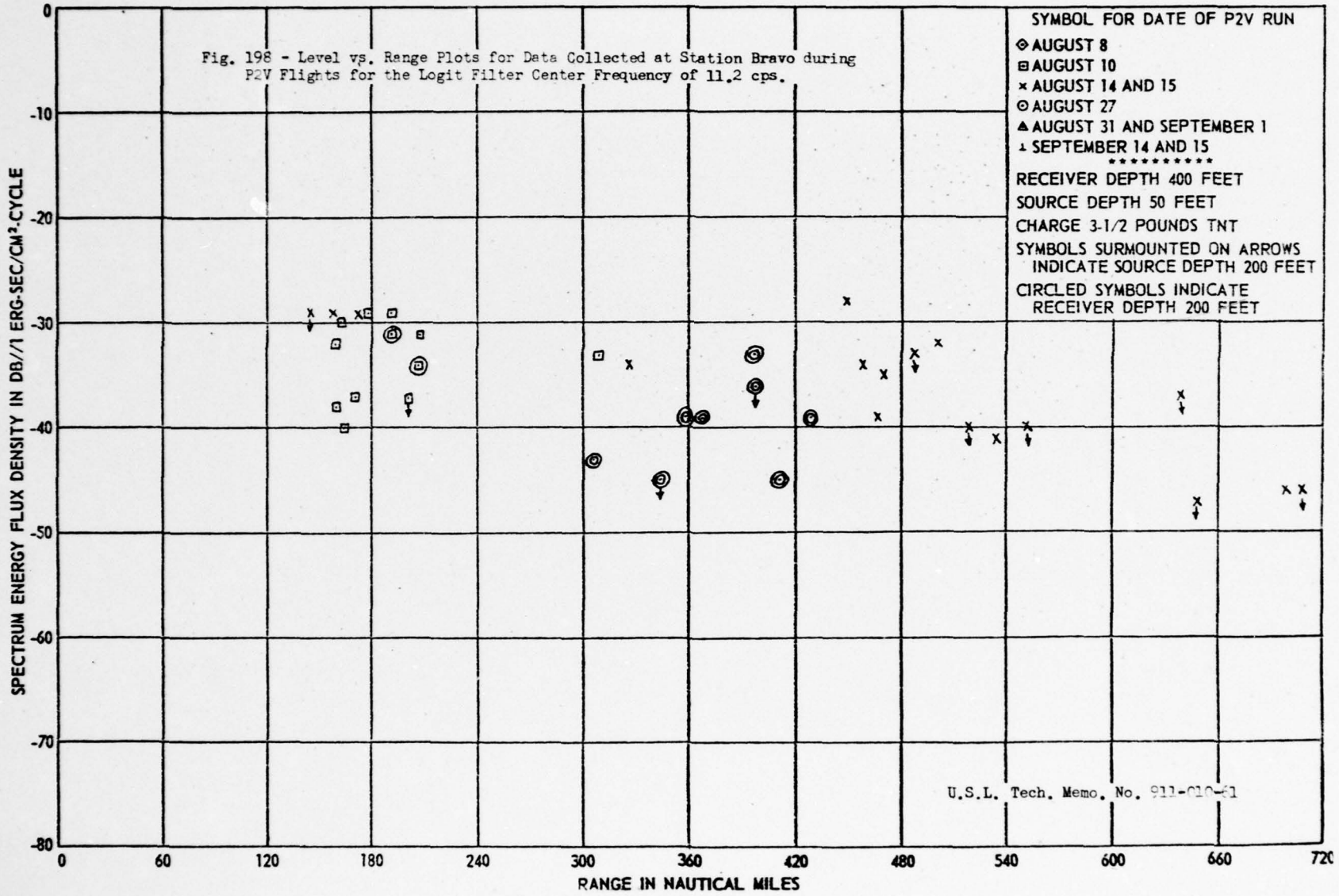


Fig. 199 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 14.1 cps.

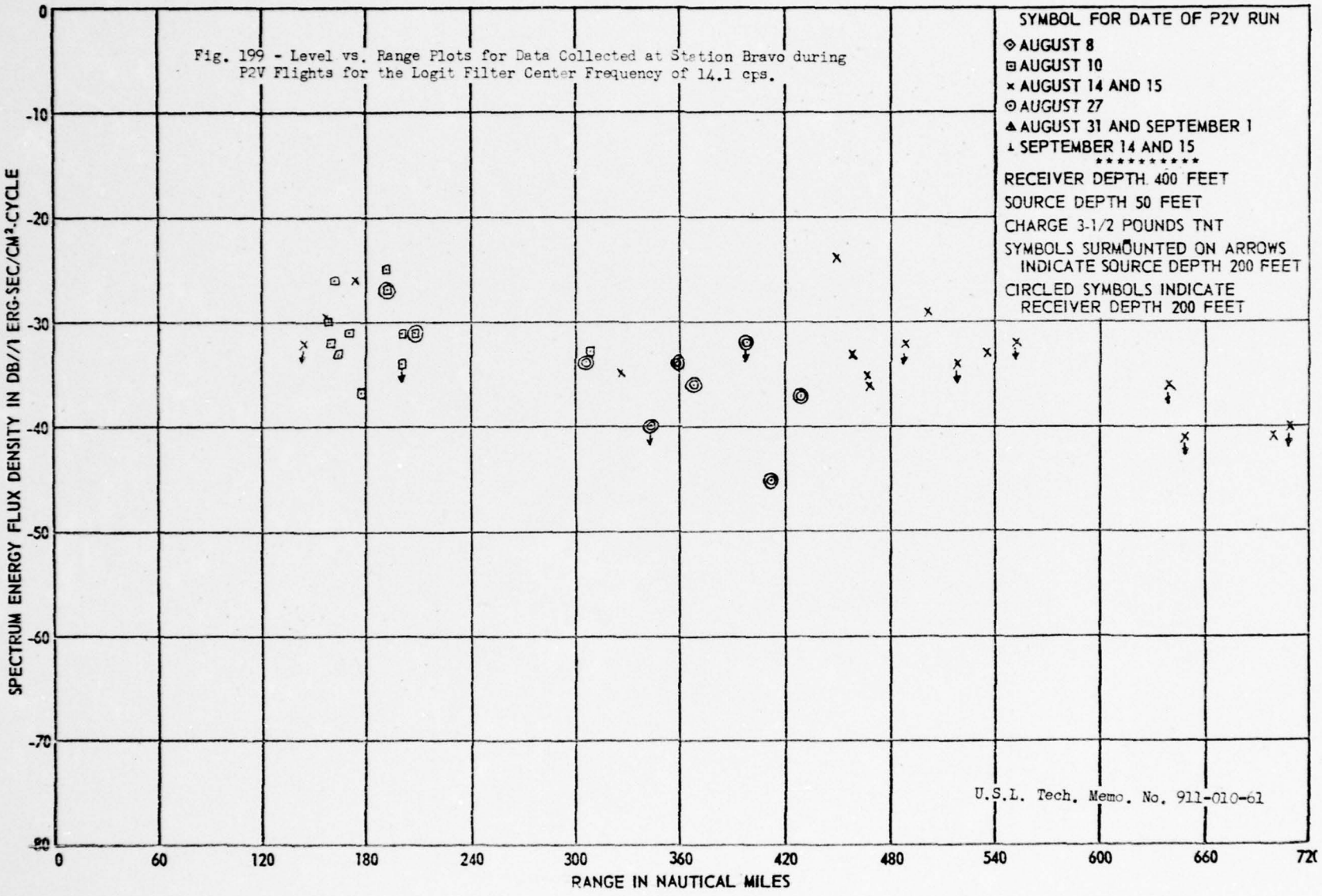


Fig. 200 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 17.8 cps.

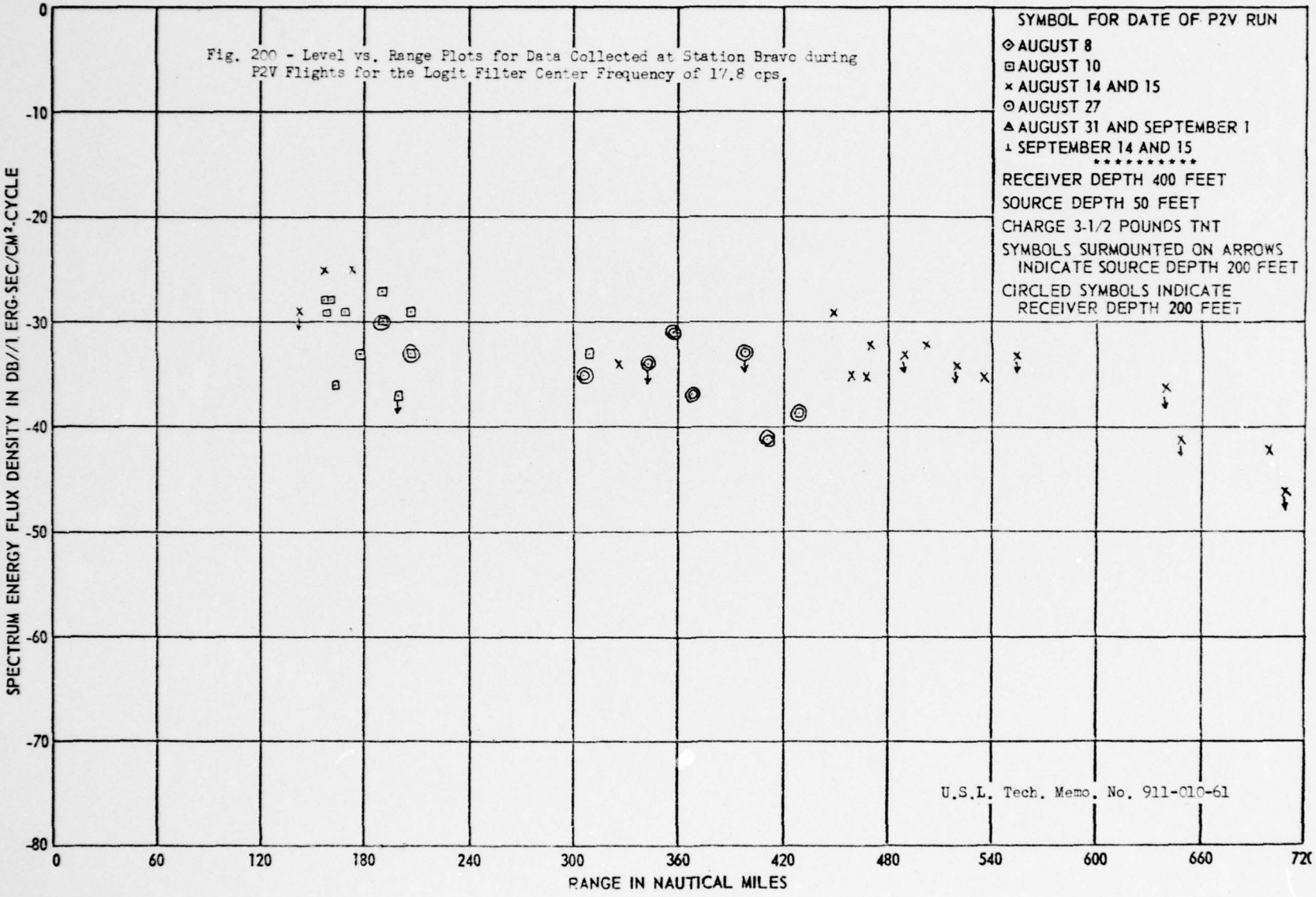
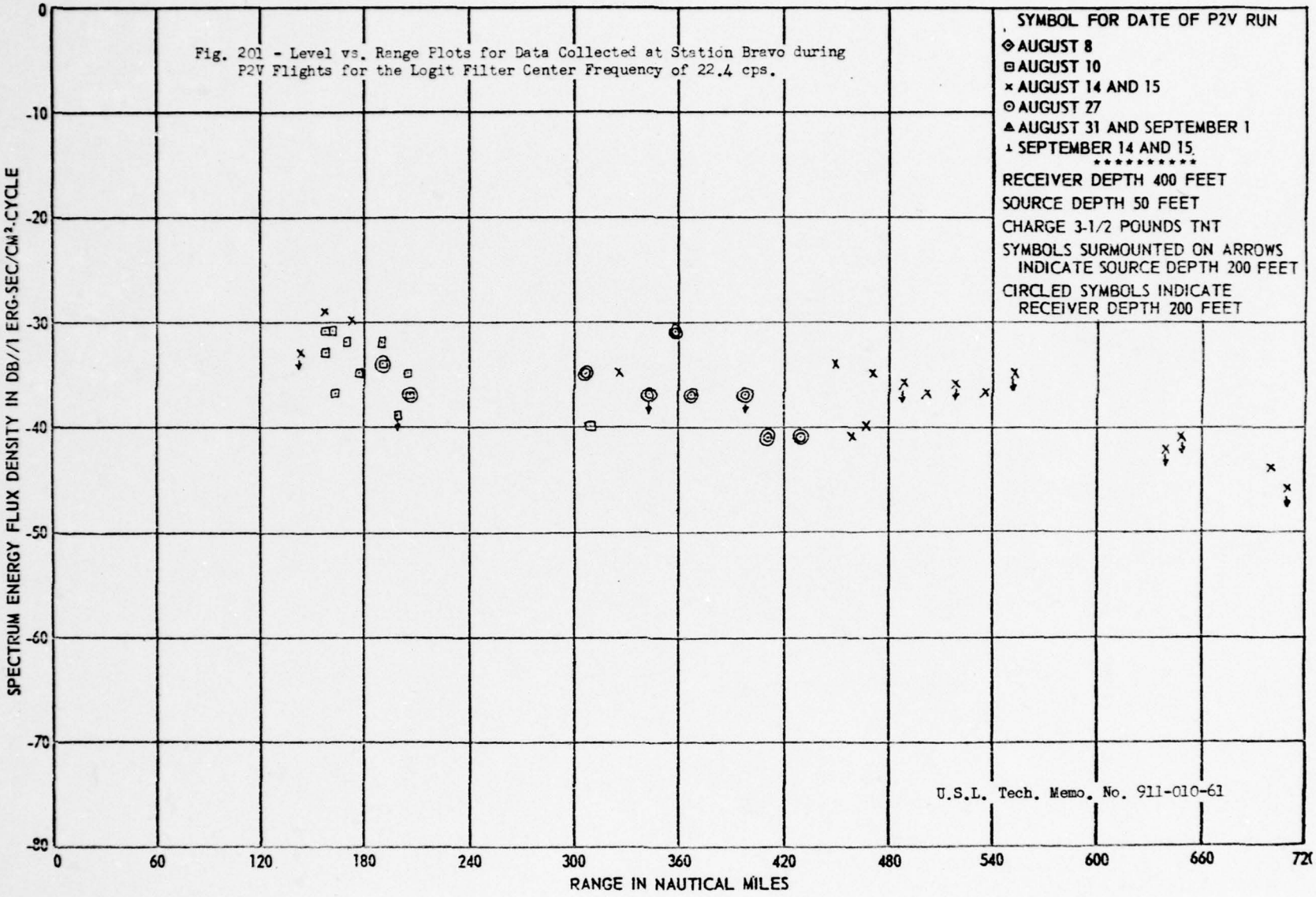


Fig. 201 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 22.4 cps.



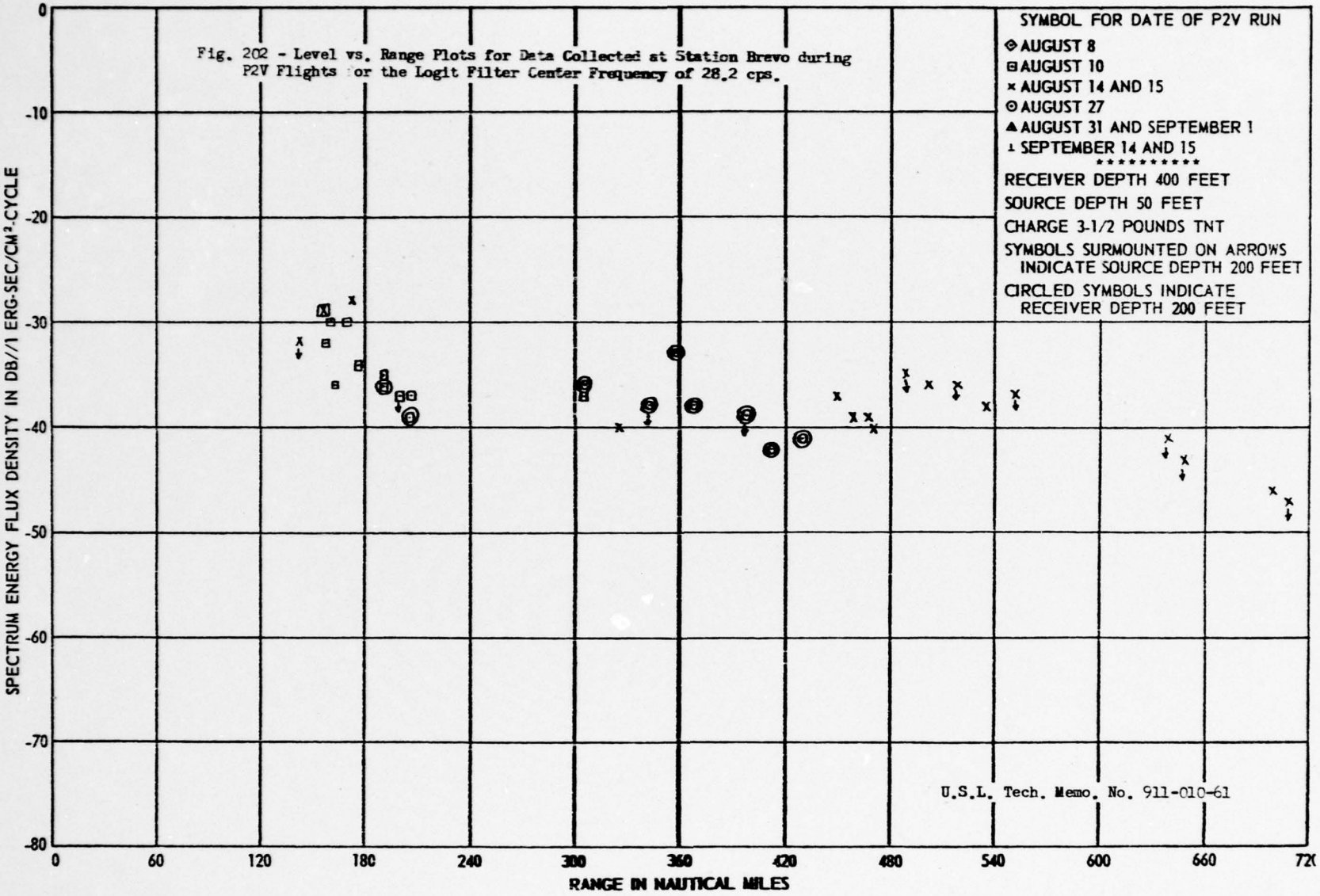


Fig. 202 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 28.2 cps.

Fig. 203 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 35.5 cps.

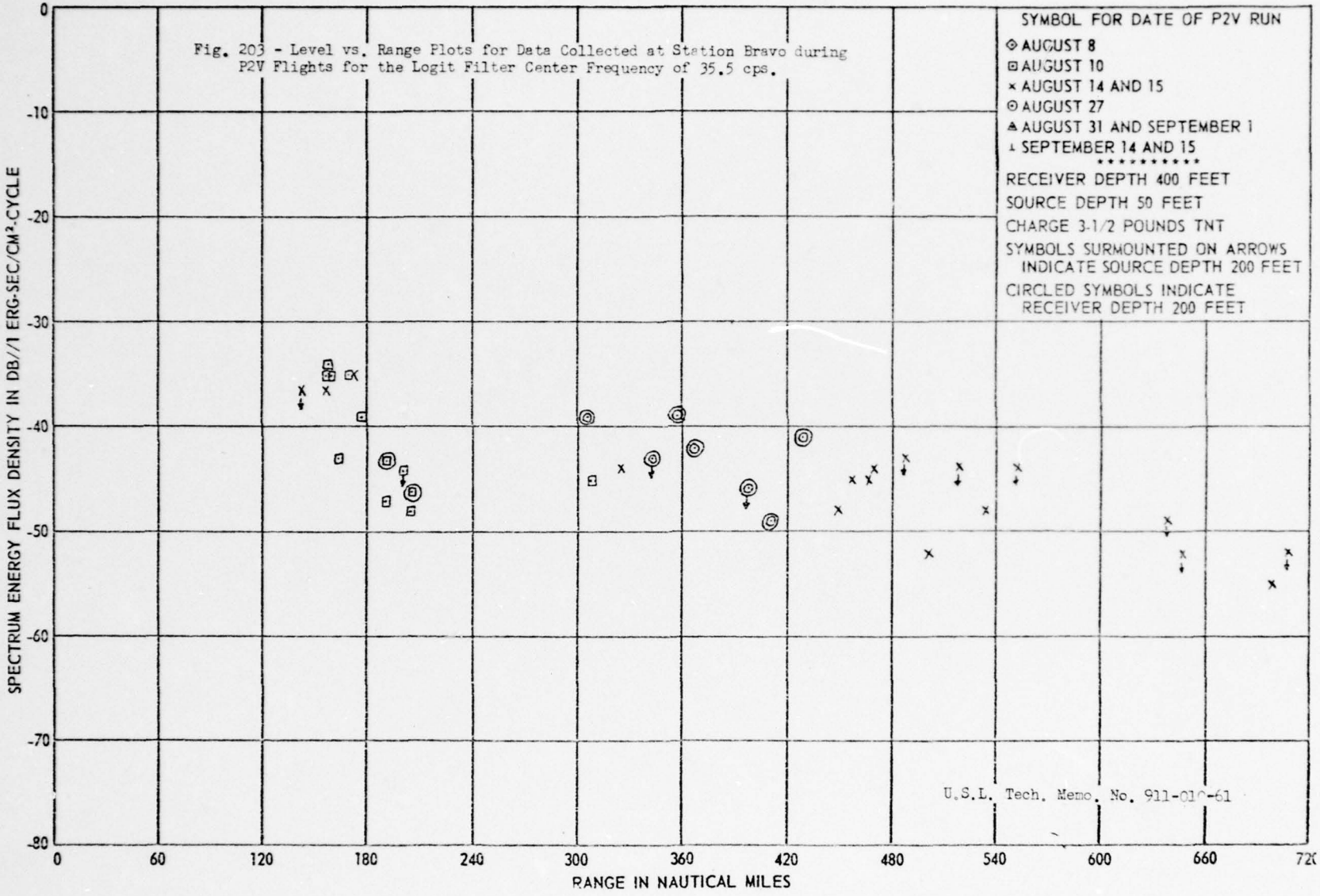
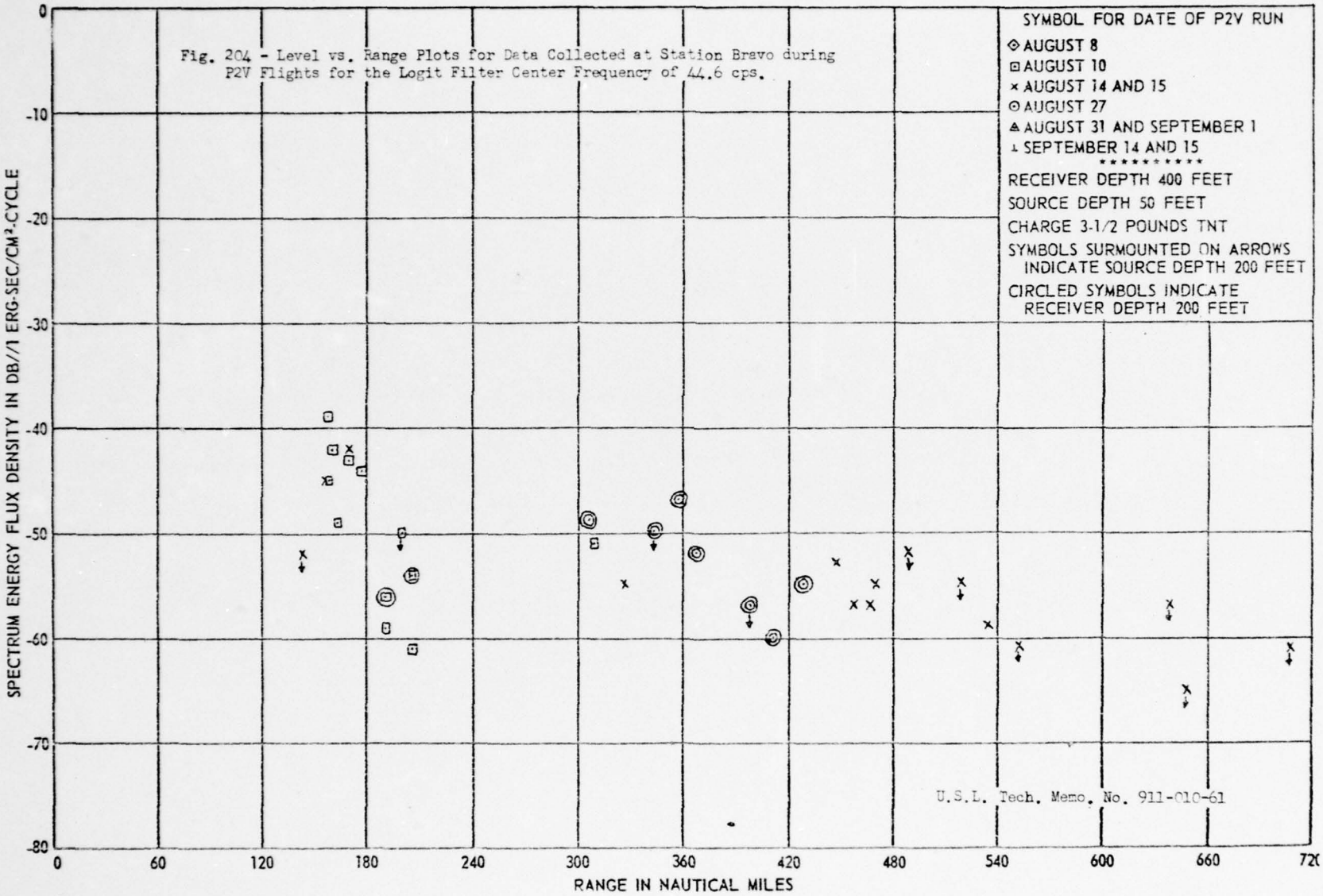


Fig. 204 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 44.6 cps.



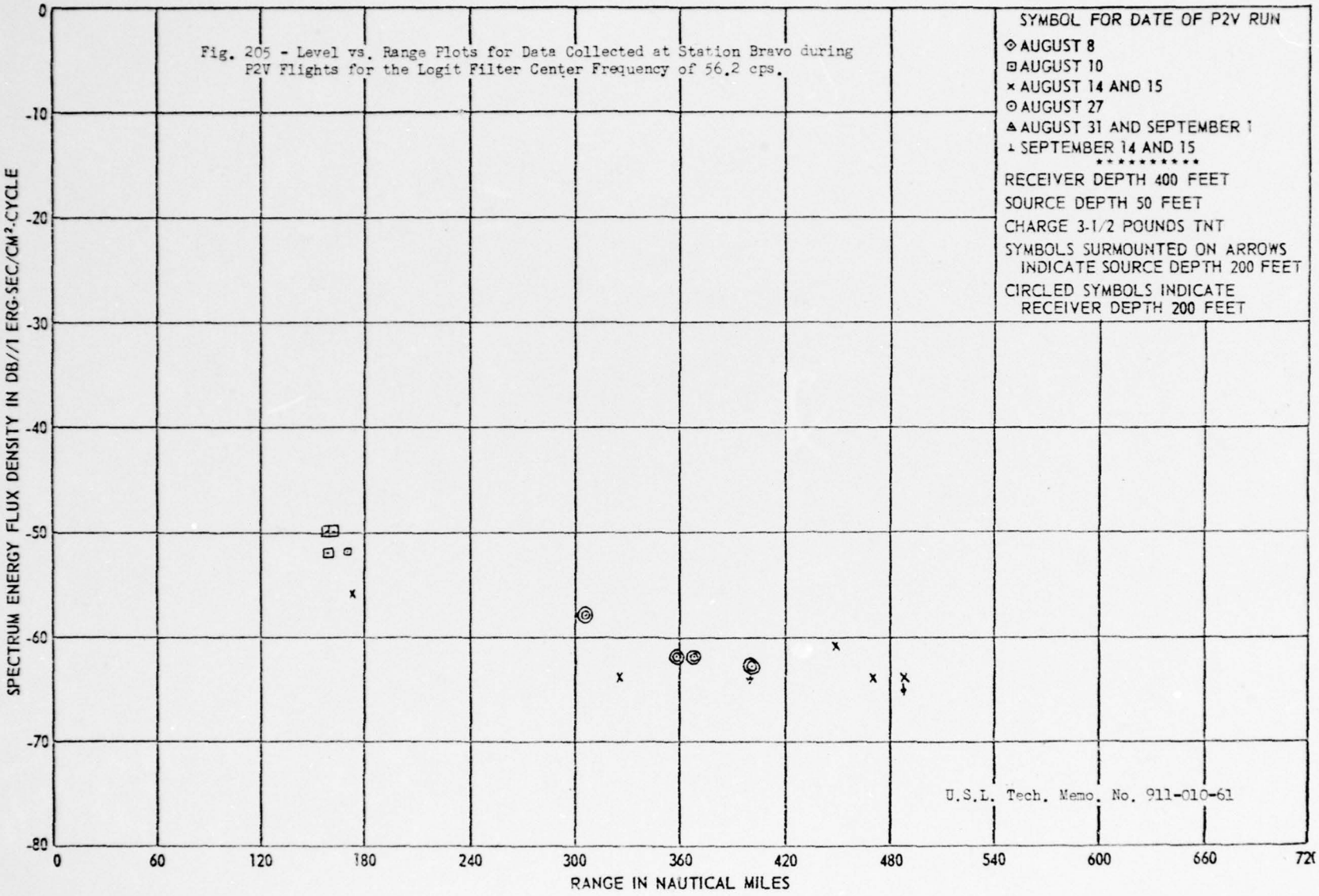
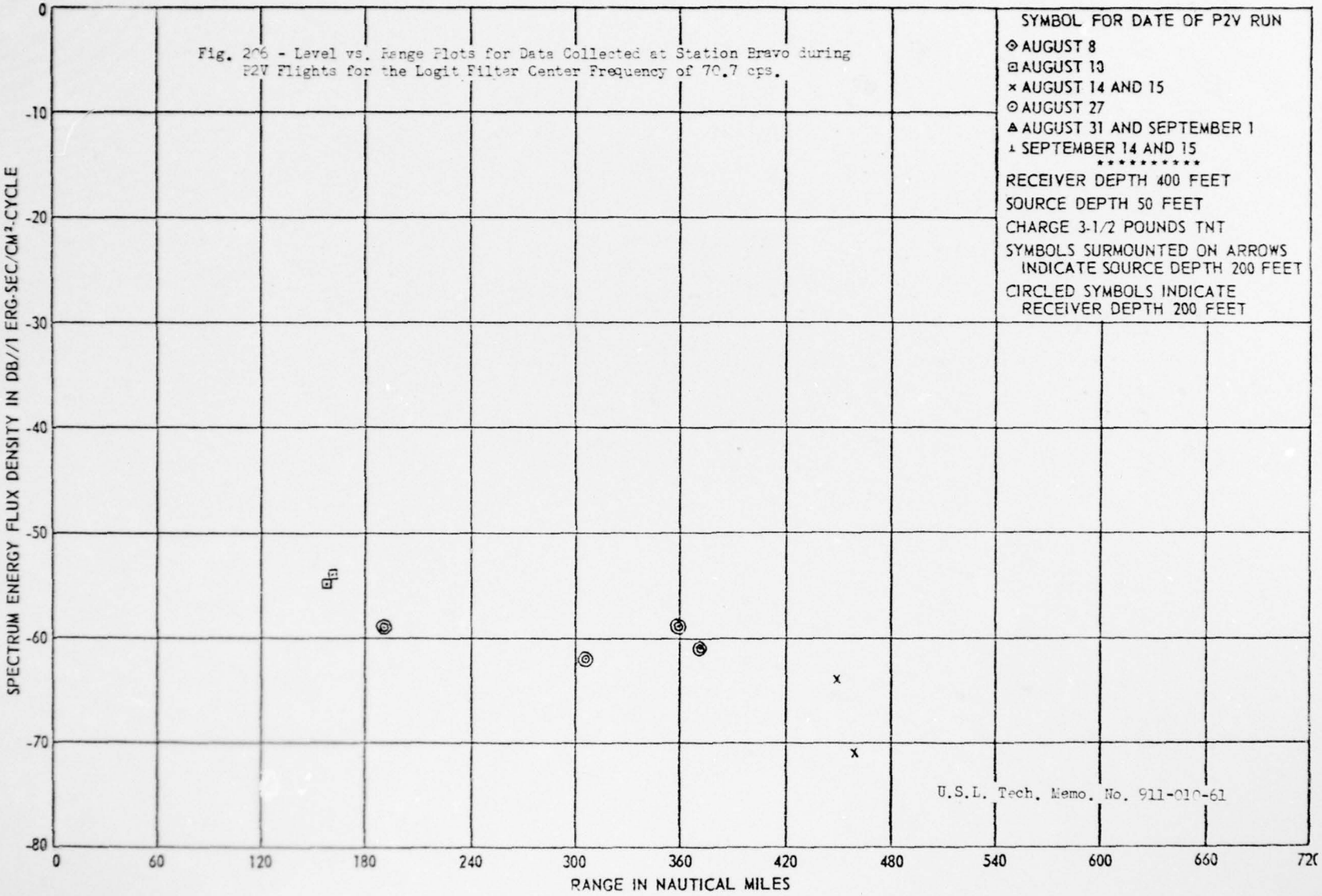


Fig. 205 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 56.2 cps.

Fig. 206 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 70.7 cps.



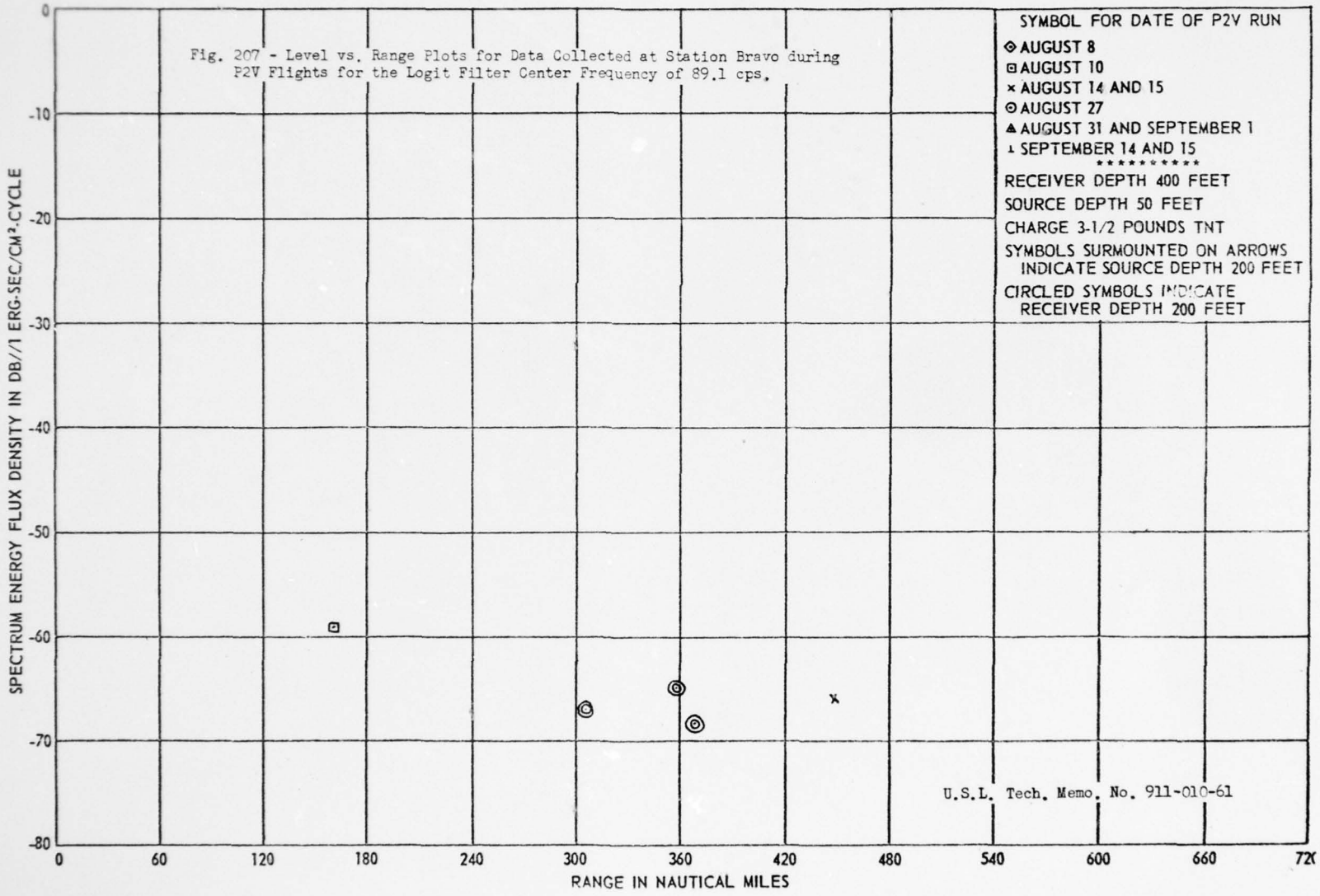


Fig. 207 - Level vs. Range Plots for Data Collected at Station Bravo during P2V Flights for the Logit Filter Center Frequency of 89.1 cps.

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