B1620

MOST Project 12

WP11-2-41006

THU -

1966

AD A036513

INTERIM REPORT ON THE SURFACE-DUCT PROPAGATION MODEL FOR C/P SONAR PREDICTIONS

JULY 1966

SUBMITTED TO:
U.S. NAVY ELECTRONICS LABORATORY
SAN DIEGO, CALIFORNIA

CONTRACT NO.:
NObsr-93023

REPORT NO.:
TRG-023-TM-66-24

TRG / A SUBSIDIARY OF CONTROL DATA CORPORATION
ROUTE 110 • MELVILLE, NEW YORK 11749 • 516 531-0600

~~WP11-2-41006~~

(9) (6)

INTERIM REPORT, ~~ON THE~~ SURFACE-DUCT PROPAGATION MODEL FOR C/P SONAR PREDICTIONS.

by

(10) A. NOVICK, R. SEEGAL, [redacted] S. GINSBERG

(14) ~~Report No.~~ TRG-023-TM-66-24

Contract No. N0bsr-93023 (15)

Submitted to:

U. S. Navy Electronics Laboratory
San Diego, California

Approved:	Approved:
W. Graham	
Walton Graham Department Head, TRG	Marvin Baldwin Project Technical Director, NEL
	Isidore Cook Deputy Project Technical Director, DTMB

Submitted by:

TRG Incorporated
A Subsidiary of Control Data Corporation
Route 110
Melville, New York 11746

(11) July 1966

(12) 83p.

CHANGE SHEET

CHANGE NUMBER	PAGE NUMBER	EFFECTIVE DATE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS AND TABLES

SECTION 1

INTRODUCTION

This report is an extension of TRG's previous surface ship bottom bounce sonar prediction model ~~(Reference 1)~~ to include the case of direct path* propagation both to the potential target and reverberation sources. The tenets of valid sonar prediction are unchanged: in addition to an accurate estimate of the target echo level, one must include <u>all</u> significant reverberation components and sonar noise level to successfully forecast the sonar performance. The scattering sources for the surface duct problem are the same as for the bottom bounce mode (it's the same ocean!); their relative importance depends upon the mode of operation.

Using moderate depression angles (near 20°) in the bottom-bounce mode, the dominant reverberation source is, generally, the sea surface, followed in importance by the bottom, and then, by biological scatterers. On the other hand, in the surface duct mode, sea surface reverberation is usually negligible after a few seconds; this rapid decay in time results from the sea-surface grazing angle which must quickly approach zero for rays propagating in the surface duct. Since the surface back-scattering strength drops off rapidly with decreasing grazing angle, surface reverberation is, in general, not a limiting factor for surface-duct sonars.

Accordingly, the dominant reverberation sources are the bottom and the biological scatterers. At short ranges, the biological component dominates, since bottom reverberation begins at a time corresponding to target range equal to the water depth. At longer ranges, the predominant reverberation depends upon the particular circumstances. Figure 1 is a sketch of the direct path detection problem, illustrating some of the reverberation paths to be considered.

A comparison of the surface duct and bottom bounce reverberation calculations reveal the following important differences:

---

*The phrases "direct path" and "surface duct" are used interchangeably in this report.

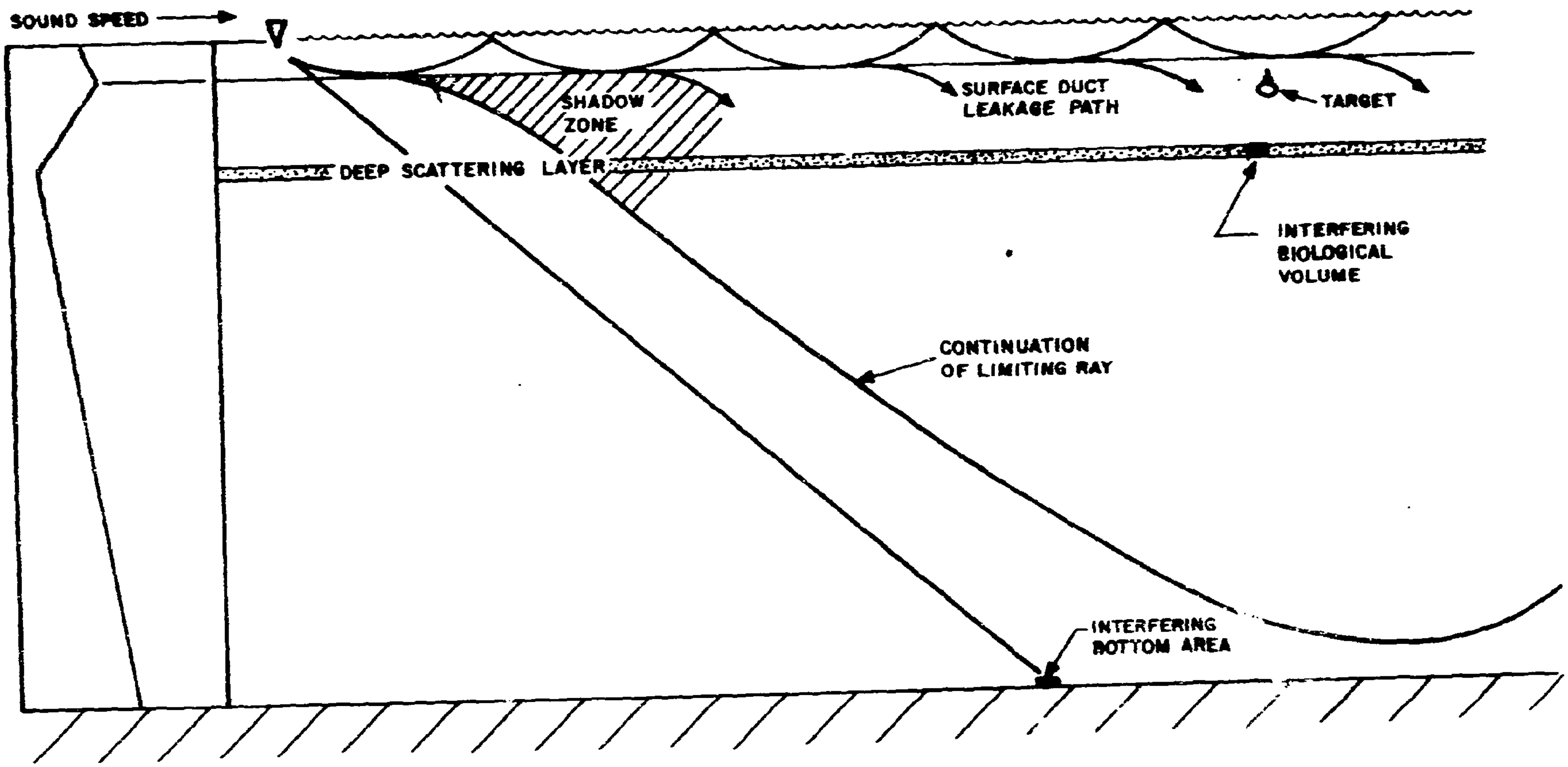


Figure 1. DIRECT PATH GEOMETRY

1. Surface reverberation is negligible for the surface-duct problem.
2. The deep-scattering layer (abbreviated DSL), lumped as a small addition to the surface reverberation in bottom-bounce calculations, must be considered explicitly in the surface duct calculation because of the critical relation between the propagation losses to the biological scattering layer and to the target.
3. Ray solutions are often invalid (or non-existent, as in the shadow zone). The propagation losses must be computed by an alternative method over paths where ray-tracing may lead to difficulties.

The bottom reverberation calculations for these two modes of sonar operation are identical. The reader is referred to the bottom-bounce report (Reference 1) for the details of the bottom-bounce calculations. This report will emphasize the direct-path echo and DSL reverberation calculations which differ from the corresponding work in the bottom-bounce discussion. After a discussion of the theoretical background for these calculations, illustrative calculations are performed for a conformal/planar (C/P) sonar.

A. SURFACE DUCT PROPAGATION

Thermal processes and mixing near the surface often create a layer adjacent to the surface in which the temperature and sound velocity of the water increases with depth (isothermal water will show a positive sound velocity gradient due to the effect of hydrostatic pressure,) until the thermocline, a region characterized by a negative velocity gradient. Acoustic rays with source angles less than the limiting ray angle (see Figure 1) vertex before reaching the thermocline boundary and return to the surface, where they are reflected; these processes of reflection and refraction repeat as these rays propagate. This combination of the reflective surface and the positive velocity gradient ducts the sound, producing propagation conditions quite different from those experienced in the bottom-bounce mode.

Direct path propagation losses could be derived from the exact solution to the wave equation with appropriate boundary conditions. A truncated expansion of the solution in terms of the normal-mode eigenfunctions provides a good approximation to the propagation loss (Reference 2). However, this method is computationally inconvenient for system performance calculations; furthermore, the boundary conditions are difficult to express in terms applicable to a normal - mode calculation and are not accurately known.

On the other hand, refractive ray-tracing, using the constant gradient approximation, involves simple calculations, but has a restricted domain of applicability. Ray-tracing yields valid results only where conditions are slowly varying over a distance measured by a wavelength.* Ray acoustics will not be a good approximation to the propagation whenever:

1. The radius of curvature of the rays is near the order of one wavelength. The ray direction must change slowly over distances measured with respect to the wavelength.
2. The velocity of sound changes appreciably over the distance of one wavelength.
3. There is a large percentage change in the amplitude over the distance of a wavelength.

At short ranges, before the first vertex, normal mode theory, ray-tracing, and the empirical AMOS formulae (Reference 4) give essentially identical results. At longer ranges, however, ray-tracing may lead to spurious results. For example, ray theory predicts caustics, at which the intensity becomes infinite, which are not observed in practice, and fails to indicate caustics which are observed. The sharp shadow zone, predicted by ray acoustics, is not observed. (Understandably, since conditions at the boundary of the surface layer with the thermocline violate the conditions for validity of ray acoustics.) Thus, surface duct ray path loss computations beyond the first vertex are subject to question.

---

*See Reference 6, Section 3.6 "Validity of Ray Acoustics".

Accordingly, an empirical method of calculating propagation losses in the surface duct seems desirable. Since the loss equations resulting from Project AMOS are based on a large volume of experimental data, they provide a good alternative to loss calculations based on refractive ray-tracing, which have the limitations discussed above. The AMOS formulae take into account the following oceanographic factors:*

1. Depth of the isothermal (positive gradient) layer.
2. Sea State.
3. Water temperature.
4. Acoustic frequency.
5. Target geometry.

The AMOS equations consider the propagation as broken into three zones. The first, the near zone, is bounded by the limiting ray which leaves the source, touches the bottom of the surface channel, and returns to the surface. In the near zone, the energy travels by a direct path, spreading spherically. The third zone, the far zone, is bounded by the same limiting ray after two or more surface skips. In the far zone, cylindrical spreading, thermal absorption, and a surface scattering loss describe the energy loss.

The second zone, the middle zone, is a region of transition between the near zone with spherical spreading, and the far zone with cylindrical spreading and a surface scattering loss. For a target in the layer, the AMOS equations give the propagation loss directly. A target below the layer is insonified by energy penetrating the surface duct by the following mechanisms:

1. Diffuse scattering from the rough sea surface.
2. Diffractive leakage from the surface channel. (Recall that ray-tracing assumes that there are no changes in the medium over a distance the order of the wavelength. Diffraction effects account for the failure to meet this requirement).
3. Diffractive leakage into the shadow zone from rays

*This discussion of the AMOS equations is based on a discussion appearing in Ref. 3.

downward out of the layer.

The first two mechanisms are accounted for by a depth dependent loss factor. Diffractive leakage from the direct beam is handled separately. For a given situation, the dominant mechanism may be of any of the three mentioned above. Loss calculations are made following both routes; the one yielding the least loss is retained. Because the AMOS formulae result from an evaluation of a large amount of data, they are a reasonable alternative to refractive ray tracing for propagation loss calculations. These empirical formulae are valid to a depth of about 600 feet.

The propagation loss is given by the sum:

Propagation loss = spreading loss + reflection losses + absorption loss.

When valid, ray-acoustics predicts the spreading loss. The empirical AMOS formulae account for a spreading loss, and handle reflection losses and absorption losses explicitly.

The absorption loss accounts for energy lost through dissipative mechanisms. This loss is clearly proportional to the distance traveled through the water. The constant of proportionality is given by a temperature-dependent constant times some power of the frequency. (For example, the absorption formula for leakage out of the duct varies as $f^{3/2}$; while the AMOS dissipative absorption formulae, at low frequencies, represents the loss as proportional to f^2.)

On reflection from the boundaries, some portion of the incident energy is lost from the signal. For operation in the surface duct mode, losses on specular reflection from the surface are represented by empirical formulae since there is no definitive theoretical work in this area. Contradictory reports in the current literature do not permit a reliable estimate of the surface reflection coefficient at the frequencies of interest for conformal sonars.*

However, the surface may act in three ways to reduce the propagated signal:

*See bibliography in Ref. 1

1. It can scatter energy out of the propagation path.
2. It can absorb energy from the signal through the action of entrapped air bubbles.
3. Reflections from the faceted sea surface can degrade the phase coherence along the wavefront. (A potentially serious loss for highly-directional sonars, this loss applies only to the echo level, since the reverberation is considered to be incoherent.)

The AMOS FORMULATION represents the scattering attenuation coefficient (db/kyd) as a constant (depending on sea state) times (Frequency/Layer depth)$^{1/2}$, accounting separately for leakage loss from the sound channel. Where ray-tracing is used, the loss on specular reflection from the surface (in db) is given by a constant times the number of surface contacts. (Ray-tracing is not used when leakage from the sound channel is of concern.)

B. THE ECHO LEVEL DETERMINATION

With the propagation losses to the target calculated as specified above, the echo level calculation is essentially identical to the bottom-bounce model except that the signal processing gain has not been included in the echo levels in this report. The equation is:

Echo Level = Source Level + Target Strength
- Two-Way Propagation Loss
- Transmission Deviation Loss
- Reception Deviation Loss

(all in db).

(See Reference 1 for the definitions not appearing in this report). Often in surface duct echo-ranging, the cone angle of rays which usefully insonify potential targets is very small (on the order of a degree or so). Since most sonars have vertical beamwidths of 10 or 20 degrees, the corresponding transmission and reception deviation losses are negligible in this mode.

C. SURFACE REVERBERATION

Propagation conditions peculiar to the surface duct influence the relative sizes of the components of the total reverberation. With the sonar trained to take advantage of surface duct propagation, bottom reverberation encounters a large deviation loss (Ray paths to the bottom are general[illegible] well off the main beam.) However, propagation conditions often [illegible]e such that the losses for paths to the bottom are much less than propagation losses to the target and DSL. The favorable propagation conditions to the bottom compensate for the large deviation losses, and bottom reverberation can become a significant background component. The determination of the bottom reverberation level is detailed in the bottom-bounce report.

Because of the characteristics of ray paths in the surface duct, and the shallow grazing angles involved, surface reverberation considered as a function of target range, falls off quite rapidly and does not usually present a problem for surface duct sonars. However, when a deep layer is present (very good sonar conditions), the duct can support ray paths which strike the surface at moderate grazing angles (on the order of 10°) and return an appreciable amount of surface reverberation to the sonar. This reverberation is only significant over the relative[illegible] small regions of time (or equivalent target ranges) when the ducted rays strike the surface at these sizable cycles. On a scope, this reverberation shows up as a series of annular rings, which may be readily identified and discounted by a trained operator. Accordingly, one may omit surface reverberation calculations in the surface duct mode.

D. BIOLOGICAL REVERBERATION

The main source of biological (or volume) scatterers at frequencies of interest to bottom bounce sonars are fish with air bladders. These scatterers are generally observed in well defined layers (50 to 100 yards thick), exhibit diurnal movement, and are commonly referred to as the deep scattering layers. The characteristics of the DSL are discussed and additional references given in Reference 1. Propagation paths to the deep scatte ing layer have the same losses (or often lower) as the echo path. (Note, for example, that the shadow region occurs later for the DSL in Figure 1 than for the target submarine.) The calculation of the DSL reverberation level follows the method described in Reference 1; energy accounting leads to the general expression for the differential reverberation intensity:

$$dI = \mu(\theta_t', \theta_r') \kappa(\theta_t) \kappa(\theta_r) I_e(\theta_t, \phi) V_r(\theta_r, \phi) \cdot dA$$

where: μ is the scattering coefficient, per unit area, characteristics of the deep scattering layer,

θ' is a grazing angle at the deep scattering layer (determined by ray-tracing),

V_r is the receiving intensity pattern function,

I_e is the transmitting source intensity function, which, for a single pulse, is given by

$$I_e(\theta_t, \phi) = I_o V_t(\theta_t, \phi)$$

with θ_{ot}, ϕ_{ot} fixed ;
and for RDT, is given by

$$I_e(\theta_t, \phi) = \max_{\phi_{ot}} [I_o(\phi_{ot}) V_t(\phi_{ot}, \theta_t, \phi)]$$

for θ_{ot} fixed.
where V_t is the transmitting intensity pattern function,

I_o is the peak source intensity function, and

dA is the differential area of concern.

The propagation losses on the transmission and reception paths are determined from ray tracing, where valid, or from the AMOS formulae as discussed earlier. The propagation factor for each path, including spreading, reflection and absorption losses, is denoted by κ .

To obtain the total reverberation, the differential DSL reverberation is integrated by numerical methods. The contributing area of the DSL is the locus of points on the DSL surface that have two-way travel times to the source and receiver equal to the echo travel time. For computational purposes, the specification of the contributing area of the deep-scattering layer is identical to the method used for bottom reverberation. It is generally assumed that the DSL scattering coefficient is omnidirectional hence, independent of the incident and scattering angles. The DSL reverberation integral completes the calculation of the echo-to-background ratio for systems using the surface duct mode.

The next section presents a numerical example, illustrating the methods discussed in the section.

SECTION II

ILLUSTRATIVE CALCULATION

This section presents the details of an illustrative calculation for the prediction of surface-duct performance for a C/P array. The numerical values of the input parameters used in this section were specified by Code 2110 of NEL. Some of the intermediate quantities required for this analysis were determined from various computer programs at TRG.

A. ARRAY AND ENVIRONMENTAL PARAMETERS

The following is a brief summary of the array and environmental parameters assumed.

Sound velocity profile:

Depth (ft)	Speed (ft/sec)
0.0	4900.0
100.0	4901.8
200.0	4892.0
315.0	4880.0
700.0	4840.0
1100.0	4824.0
2000.0	4820.0
3000.0	4828.0
5000.0	4845.0
6000.0	4860.0
12000.0	4960.0

Bottom scattering coefficient: -27 db (Lambert's Law)
Bottom porosity: 0.69 (Watson's formula)
DSL coefficient: -45db
Absorption coefficient: .033 $f_{kc}^{3/2}$
Pulse Length: 500ms.
Frequency: 2500 cps.
Bandwidth: 100 cps.
Array dimensions: 8' (height) x 150' (length)
Array tilt: 20°

Beam depression angle: 1°
Ship speed: 25 knots
Single ping operation

B. SOURCE LEVEL

Based on a power output of 0.6 watts/cm^2 x .556 kw/ft^2 of effective area the source level of this array was found to be 155.6 db re 1 μbar^2 at 1 yd. It was computed as follows :

The source level equation is

Source level (db re 1 μbar^2 at 1 yd) = 101.6 + 10 log(Power out, kw) + Transmitting directivity index, db.

Based on the prescribed power density and an array factor $= \frac{\text{total active area}}{\text{aperture area}}$ of 100%, the power out is .556 kw/ft^2 x 1200 ft^2 = 670 kw.(28.3 db). The broadside directivity index (DI) is 10 log(4π x aperture area in wavelengths) using a nominal wavelength of 2 feet at 2.5 kc, the DI is 35.7 db.

For this illustrative example, the variation in source level which occurs when the array is steered away from broadside was ignored and the above source level was used for all beams. For a 100% array factor, the source level is 165.6. The actual value used; 155.6 db, corresponds to an array factor of 10% and a power output of 67 kw. While the intent of this investigation was for a 100% array factor, the results and conclusions will not be altered greatly by using this lower value for the source level. This insensitivity to the source level is due to the rapid increase in propagation loss with range in the shadow zone. This source level discrepancy was found after all of the calculations had been performed and since the essential conclusions would be unaffected, the calculations were not rerun. Also note that when one is in a reverberation-limited condition (which was generally true in this study), the echo-to-background ratios are independent of source level.

C. SURFACE LOSS (SPECULAR REFLECTION)

A prescribed loss of 7.11 db per surface contact was used in evaluating propagation losses from ray tracing calculations.

D. ABSORPTION LOSS

An absorption coefficient of $.033f_{kc}^{3/2}$ (= 0.13 db/kyd) was used to account for all absorption losses.

The absorption loss calculation was controlled by input in the TRG computer programs using ray tracing and the correct absorption losses were automatically included in the calculations. However the AMOS propagation losses, which were used were calculated by a separate program. A fixed absorption coefficient (proportional to f_{kc}^{2}) and different from that given above is incorporated into this program. A simple hand-calculation sufficed to make all absorption losses used consistent.

E. SPREADING LOSS

The spreading losses to the targets at various depths were computed by interpolating smoothed data of propagation loss vs range produced from ray-tracing calculations performed on the IBM 7094. Ray solutions could not be found at target ranges beyond 3 to 5 kyd (depending on depth) and, for consistency, the AMOS equations to calculate propagation loss were for all target ranges beyond 3 kyd. This transition from ray tracing to AMOS is indicated by a dashed segment in the echo level curves plotted in Figures 2 through 11. A surface layer depth of 100 feet was used for this velocity profile.

The TRG OCEAN SWEEPER program, an IBM 7094 program used to compute bottom bounce echo and reverberation levels, was used to compute the bottom and DSL reverberation levels. This program automatically computes the spreading loss where a ray path exists. For the DSL at 600 feet, AMOS losses were used for ranges beyond the limiting ray path.

F. BOTTOM LOSS

The bottom losses used for the higher order bottom reverberation calculations were obtained from the empirical equation developed by Dr. W. Watson of NEL (see Reference 1). A bottom porosity of 0.69 was assumed.

G. DSL REVERBERATION

The general reverberation intensity equation is given in Section 1. For convenience, it is rewritten below in decibel form:

$$\text{DSL Level} = (\text{source level}) + (\text{DSL coefficient}) - 2N_w + (\text{integral of pattern functions}) + 10 \log R + 10 \log \Delta R$$

where R = range in yards,
ΔR = width of reverberation annulus, in yards, and
N_w = one way propagation loss.

(All quantities are in decibels, unless specified)

The integral of the pattern function and the width of the reverberation annulus were evaluated by the OCEAN SWEEPER program.

For this study two DSL depths were considered: 600 and 1200 feet; these depths correspond to typical night and daytime DSL depths, respectively. Propagation losses to the deep-scattering layer were computed by ray-acoustics techniques where permissible. It was found that, for the 600 foot layer, ray-tracing was valid for times corresponding to target ranges out to 4 kyds, while the 1200 ft. layer allowed ray-tracing to 6 kyds. Otherwise the AMOS propagation losses for a path equivalent to the path length to the DSL were used in hand calculations in the above equation for DSL reverberation. However, in the region in which it is valid, ray-tracing is preferred to AMOS values since the ray-path allows an accurate computation of the deviation losses yielding generally lower, more realistic, values for the reverberation level.

The effects of the array pattern are reflected in the E/B ratio. At near ranges, the convoluted Echo/Background curves (Figures 12 through 23) are due, in part to the characteristics of the DSL reverberationas determined by the deviation losses.

H. BOTTOM REVERBERATION

Bottom reverberation is computed directly, by the OCEAN SWEEPER program as described in Reference 1.

For this velocity profile, first and second order bottom reverberation do not exist beyond 30 kyds. Where the trailing edge of the first order bottom reverberation curve cannot be plotted exactly, the curve has been extended with a dot-dash-dot line to fall off just below 30 kyds.

Second order bottom reverberation is evident only for an azimuth steering angle of 90 degrees. The low values of second order bottom reverberation at the other steering azimuths is due partially to an effect dubbed C/P "beam skewing" (See Reference 1 for discussion of C/P beam pattern behavior.)

I. SURFACE REVERBERATION

High initial values of the background-level curve are due to surface reverberation, which, in some instances, dominates the background level at 1 kyd. Beyond this range, it is negligible.

J. FLOW NOISE LEVEL

The equivalent isotropic spectral flow noise level was calculated from the formula supplied to TRG by NEL:

$$\text{Spectrum level} = -41.8 - 16.67f + .857v$$

where f = frequency in kc/sec and
v = ship speed in knots.

The spectral noise level was calculated as -27.1 db re 1 microbar/cps., for all cases considered here.

The equivalent plane wave noise level (see Reference 1) for the array is then given by:

L_{epw} = Equivalent isotropic-spectrum level
- Receiver directivity index + 10 log(bandwidth).

For this array, at a ship speed of 25 knots, the flow noise level was -43 db re 1 microbar.

K. BACKGROUND LEVEL

This quantity is a power level summation of flow noise, surface, bottom and DSL reverberation. In Figures 2 through 11, the background level has been sketched in as a dashed line only where it does not rollow the contour of the highest of its component levels.

L. ECHO LEVEL

The echo level is calculated from the formula presented earlier; viz.,

Echo Level = Source level + Target strength $-2N_W$.
- Reception deviation loss - Transmission Deviation loss.

A random aspect target strength of 15 db was assumed. Target depths of 80, 150 and 300 feet were investigated; these are typical best, average and worst case target depths for this layer depth.

M. RESULTS

Figures 2 through 11 present curves of echo level vs range for the three target depths and also show the corresponding background components. Figures 2 through 6 are for a DSL depth of 600 feet and for azimuthal steering angles of 1, 10, 30, 45, and 90° (broadside), respectively. Figures 7 to 11 are corresponding graphs for a DSL depth of 1200 feet. This latter set of curves is not physically correct in the decay of the DSL; this is due to the lack of an alternative propagation loss equation once ray tracing was invalid. (Recall AMOS is valid only to a depth of about 600 feet.) However, it is interesting to note the change in the shape of the background curves for the two DSL depths at the shorter ranges. For the shallower DSL, the background peaks sooner and higher; it also dies off sooner. Figures 12 to 23 are the corresponding plots of echo-to-background (E/B) ratio vs azimuth and range. The lack of smoothness in some of the plots is due to a discontinuity between the AMOS and ray tracing losses at the transition ranges. (See Figure 24).

In Section I, it was noted that propagation conditions often favor paths to the bottom over paths to the DSL and the target. This situation overcomes the discrimination against bottom reverberation provided by the array pattern, and bottom reverberation becomes a significant component of the background. Figure 13 provides a good illustration of the effect of bottom reverberation. The local minimum in the E/B ratio for steering azimuths away from endfire is due to the sudden appearance of first order bottom reverberation just as the DSL reverberation is dying off around 9 kyd (target range). The peak in the E/B near 15 kyd, is due to a reduction in the limiting bottom reverberation, due to a minimum in the vertical pattern of the array. (Figures 4 to 6 show the corresponding relative levels of the background vs. target range.) Typical azimuthal and vertical cuts through the beam patterns are shown in Figures 25 to 30. Near endfire, the vertical pattern is quite narrow, whereas near broadside, the vertical beam is relatively wide. The narrow vertical beams of the pattern for azimuthal steering angles near endfire provide more discrimination against bottom reverberation than the wide broadside beams. Consequently, higher E/B ratios are obtained for the azimuths near dead-ahead.

The tabular data for the sonar calculations are presented in Tables 1 through 30 which follow the figures.

The maximum detection range* in this mode (assuming a recognition differential** of 12 db) corresponds to an echo-to-background ratio of -5 db (-5 + 17 db of processing gain = +12 db.) For the 150 ft target depth, one may observe that the maximum detection range increases as the beam is steered away from broadside. In this region, the limiting background component is bottom reverberation.

N. CONCLUSION

The particular example considered here involved too many simplifying assumptions to be realistic. For example, it would not be possible to use single-ping and a half-second pulse in a sonar of this size and still have a high enough data rate for successful detection. Another major limitation was the assumption of constant source level, independent of steering angle.

One may observe, from these calculations, the general characteristics of a C/P sonar using the surface duct mode, particularly the relatively good performance which can be achieved towards dead-ahead.

This model will be used for forthcoming C/P design and trade-off analysis. The simplifying assumptions made for this analysis were made for convenience. In the final design, a more general analysis will be performed.

---

*Defined as maximum range at which one obtains 50% probability of detection.

**Required echo-to-background for 50% probability of detection.

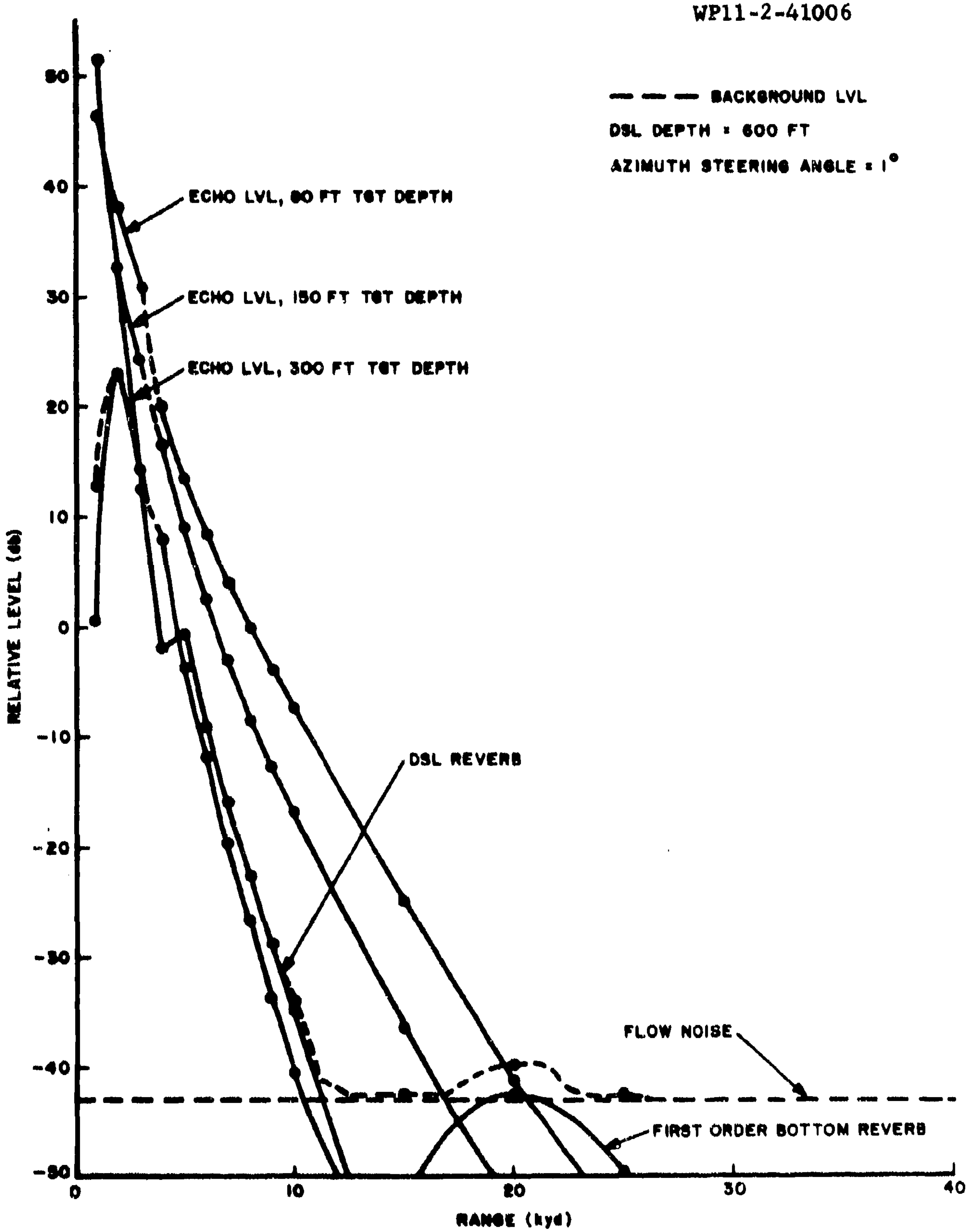


Figure 2. RELATIVE LEVELS VS RANGE

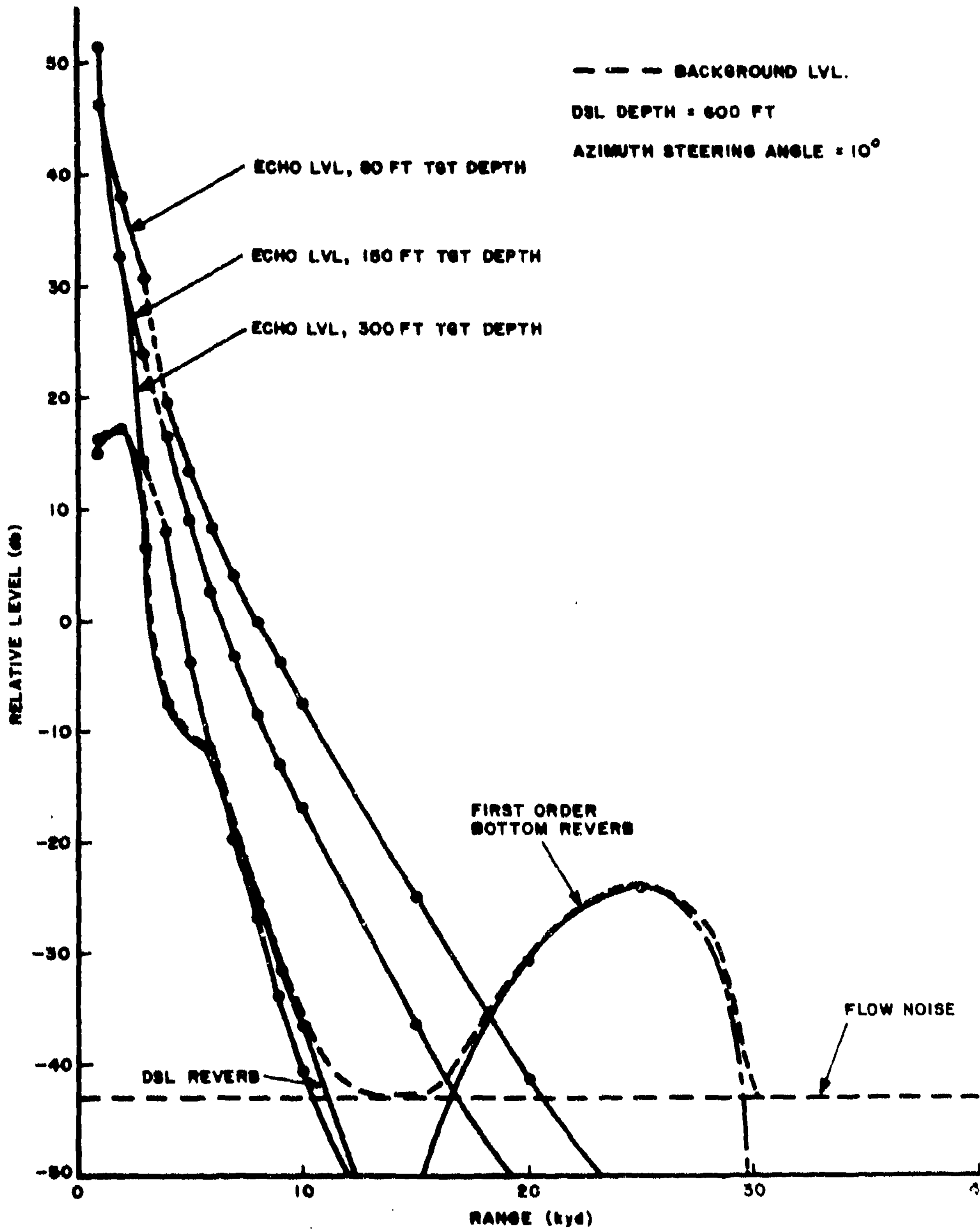


Figure 2. RELATIVE LEVELS VS RANGE

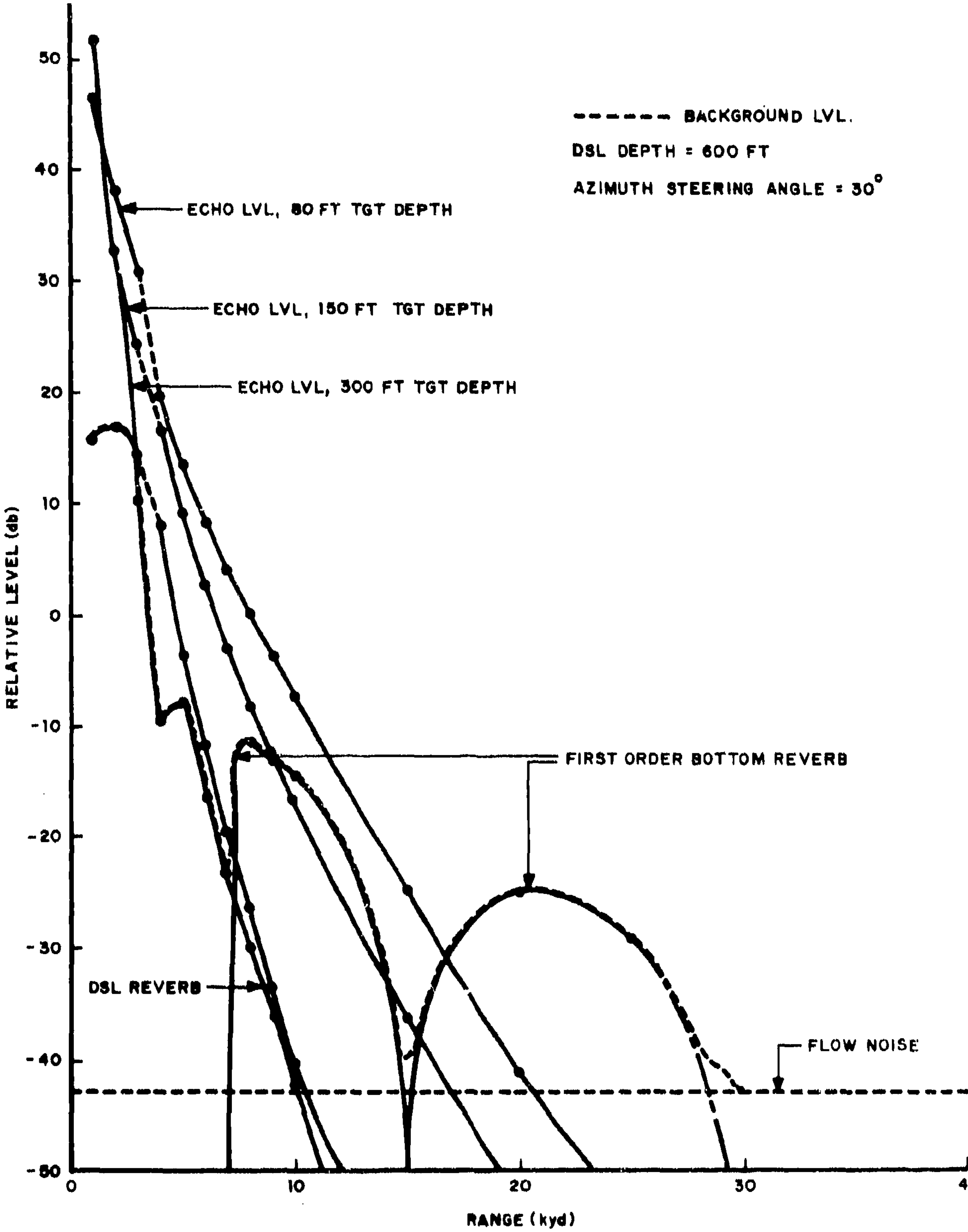


Figure 4. RELATIVE LEVELS VS RANGE

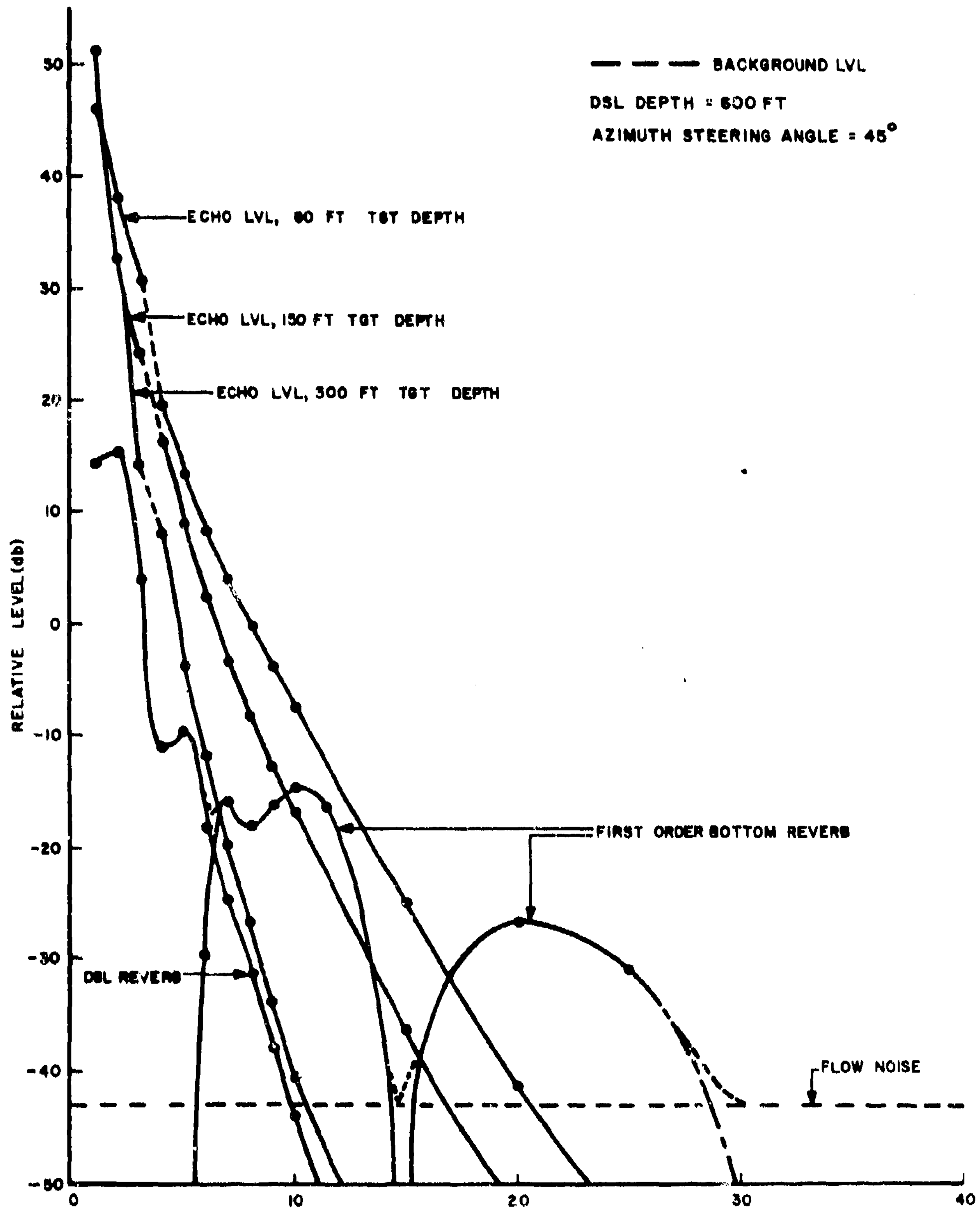


Figure 5. RELATIVE LEVELS VS RANGE

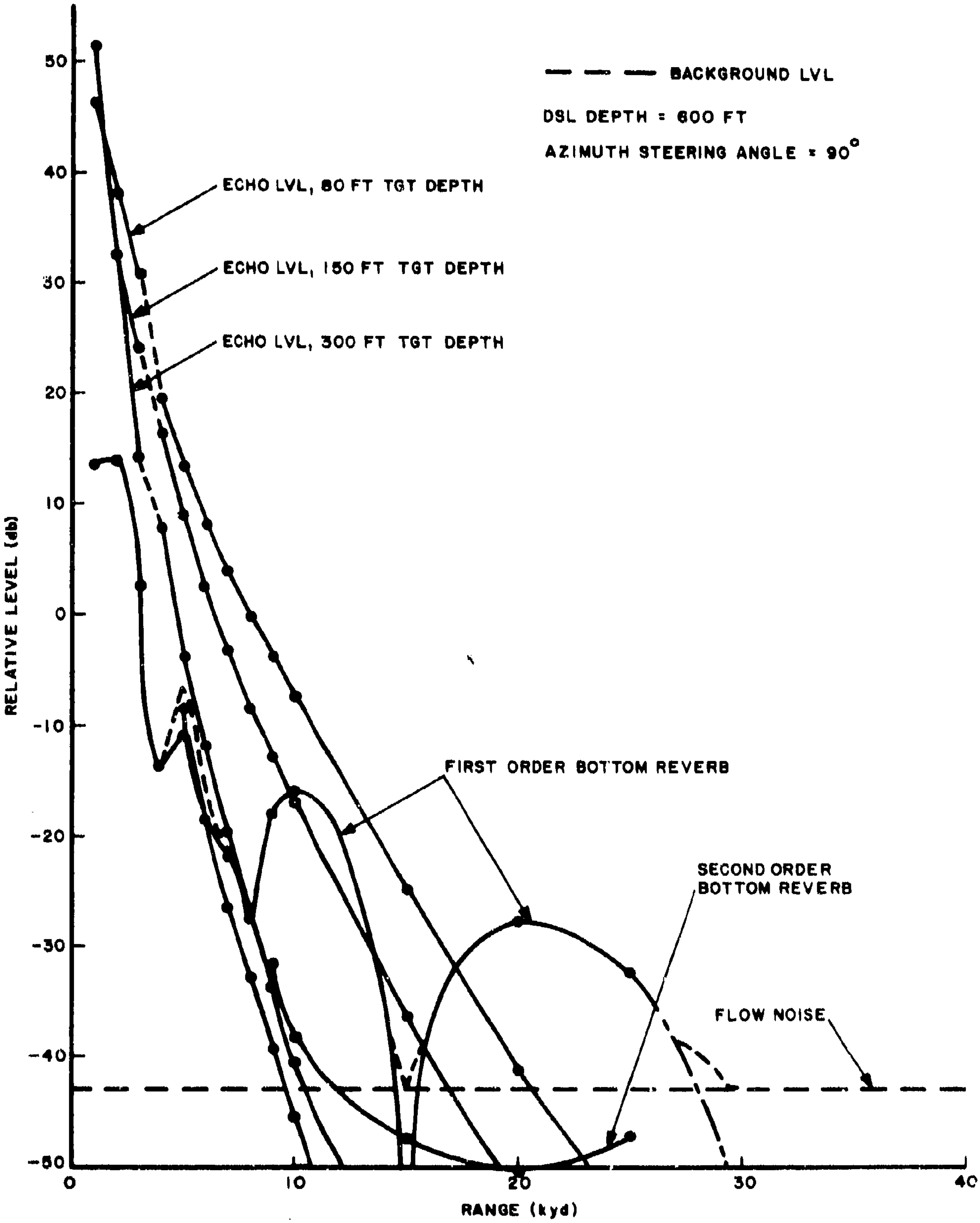


Figure 6. RELATIVE LEVELS VS RANGE

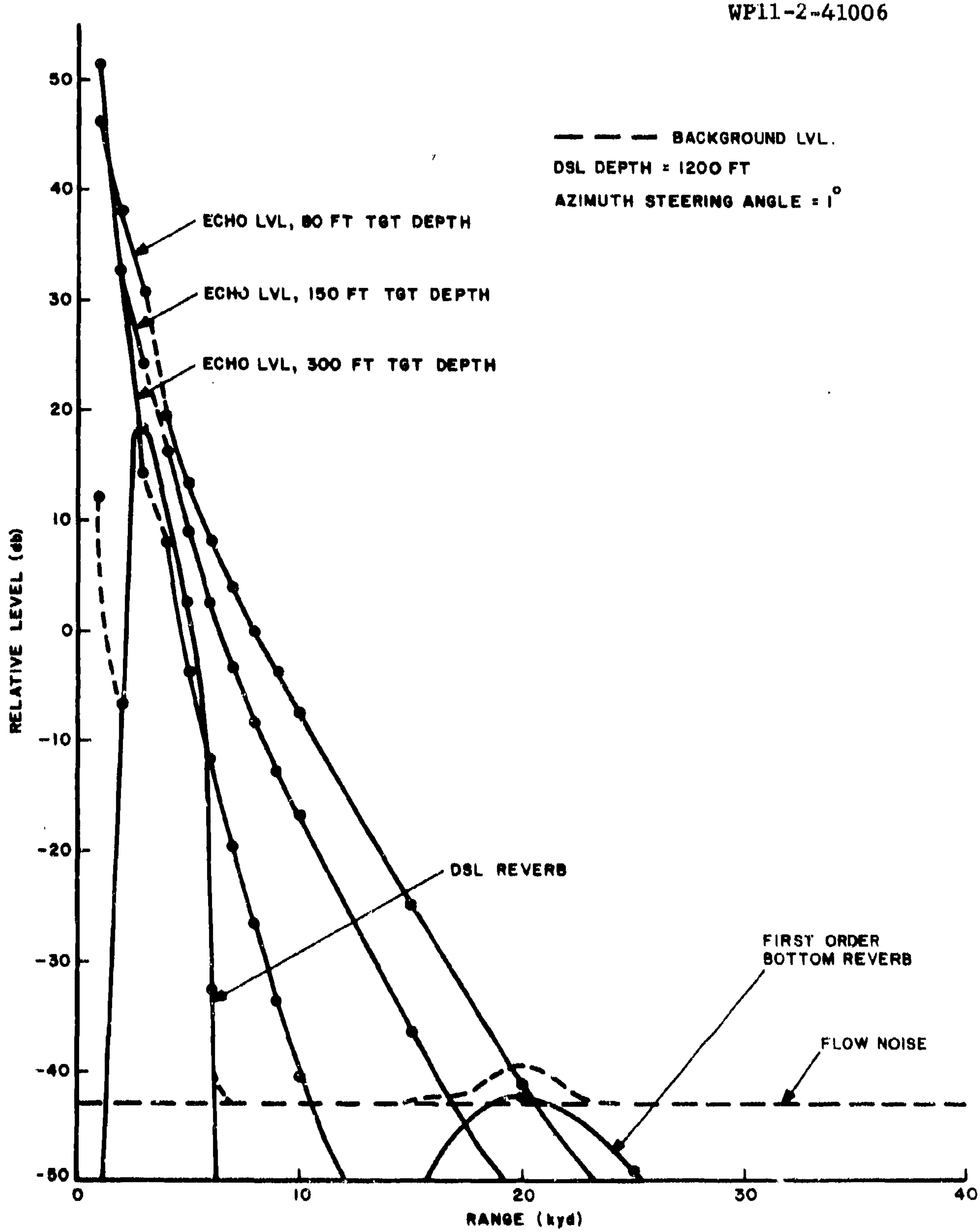


Figure 7. RELATIVE LEVELS VS RANGE

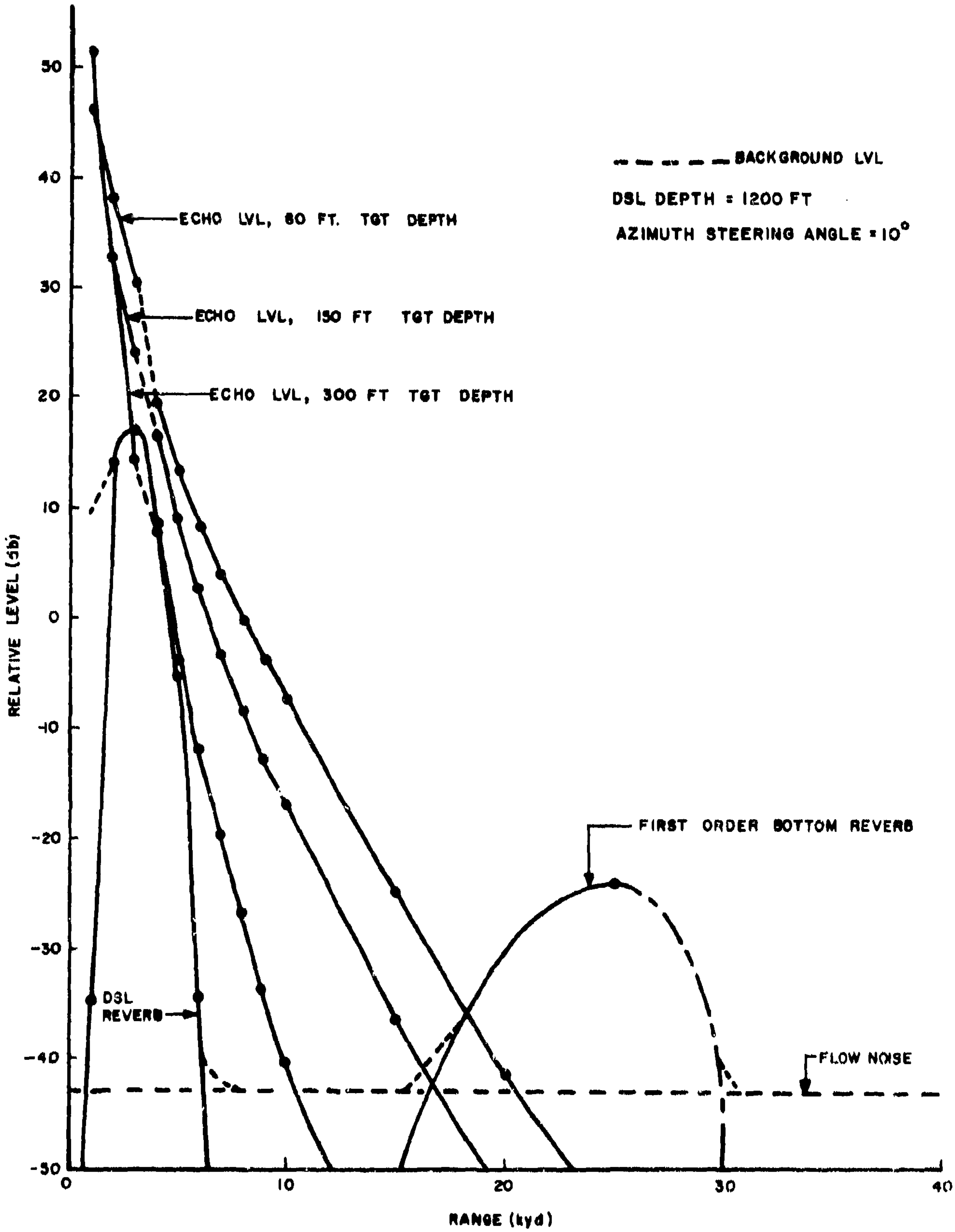


Figure 8. RELATIVE LEVELS VS RANGE

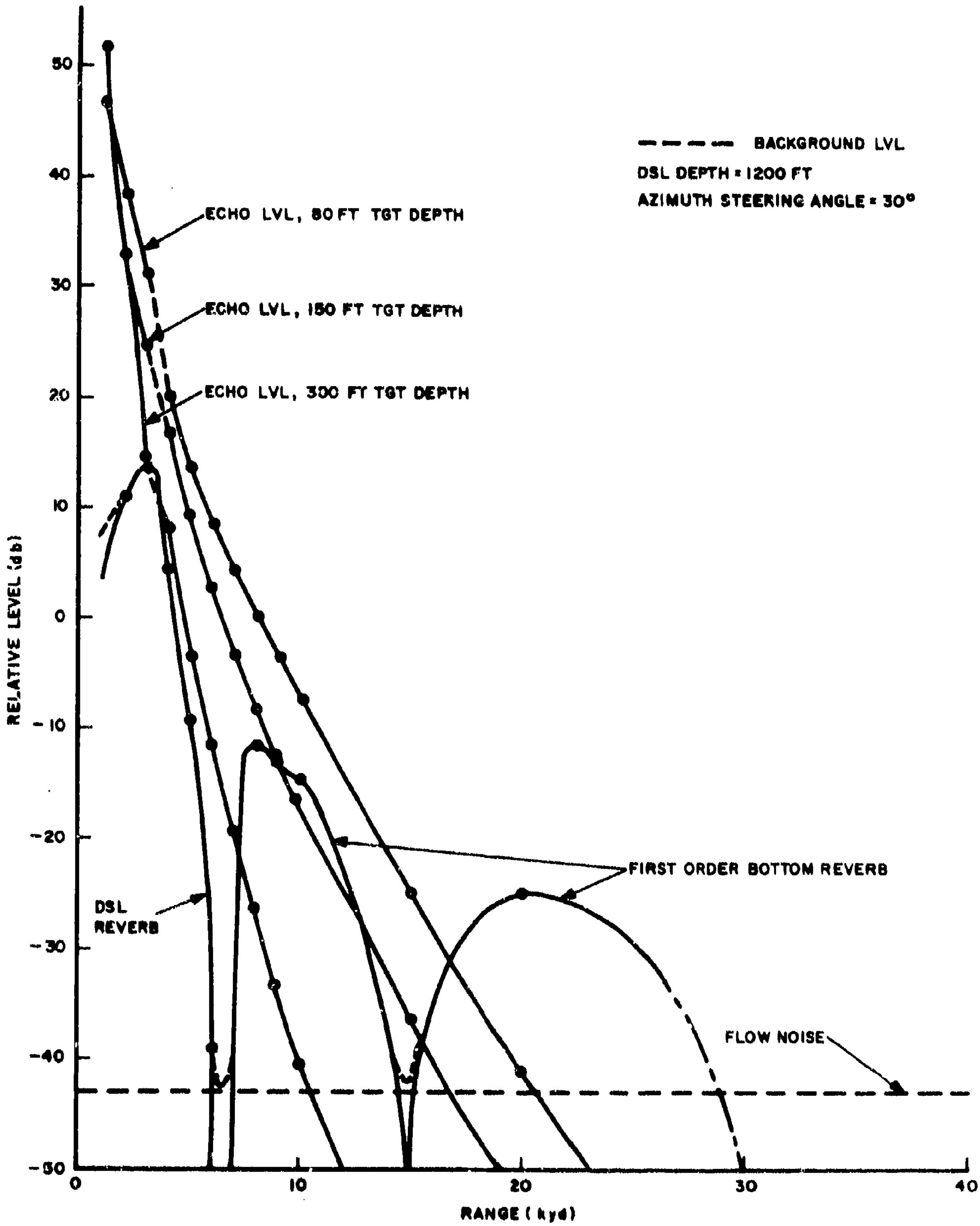


Figure 9. RELATIVE LEVELS VS RANGE

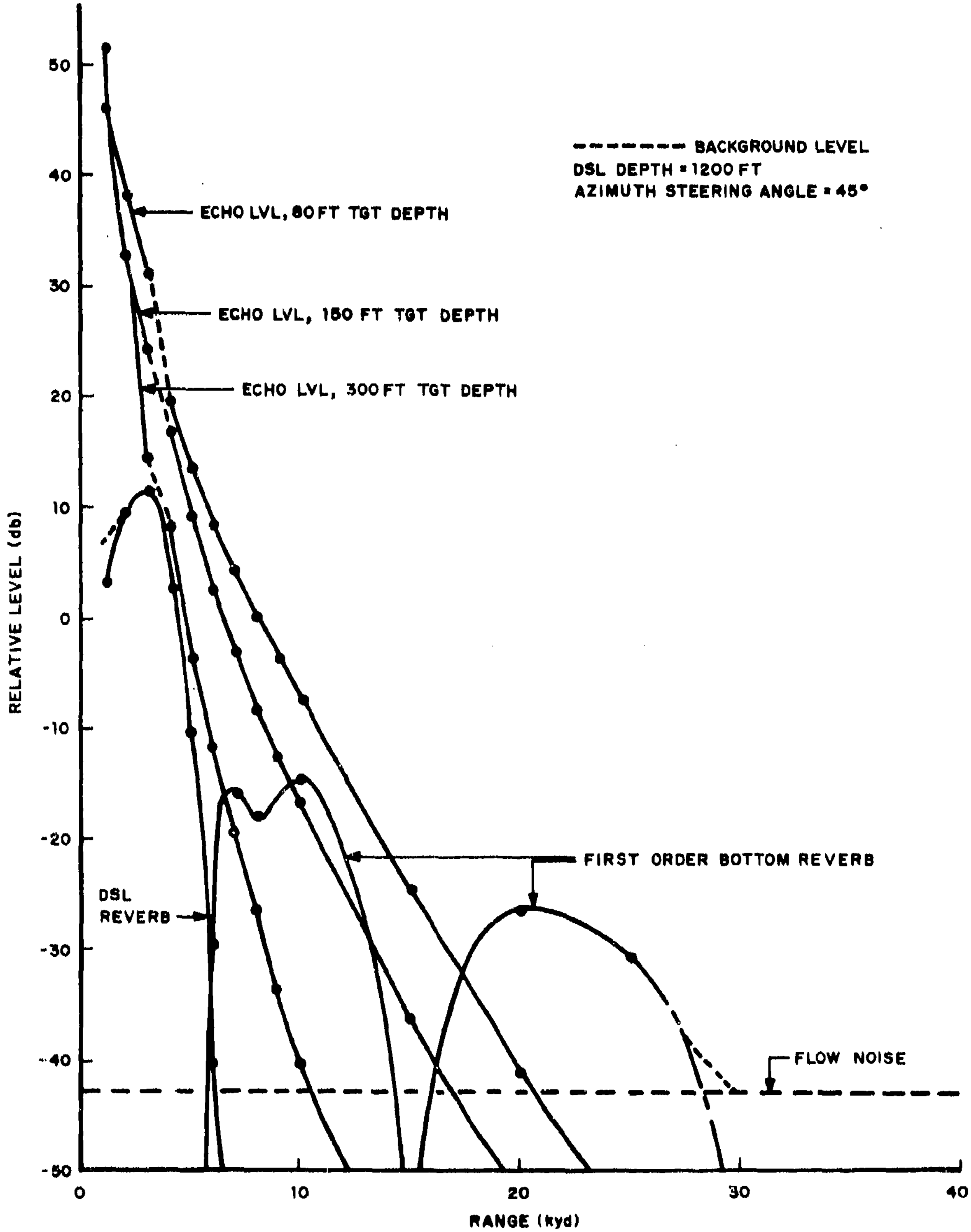


Figure 10. RELATIVE LEVELS VS RANGE

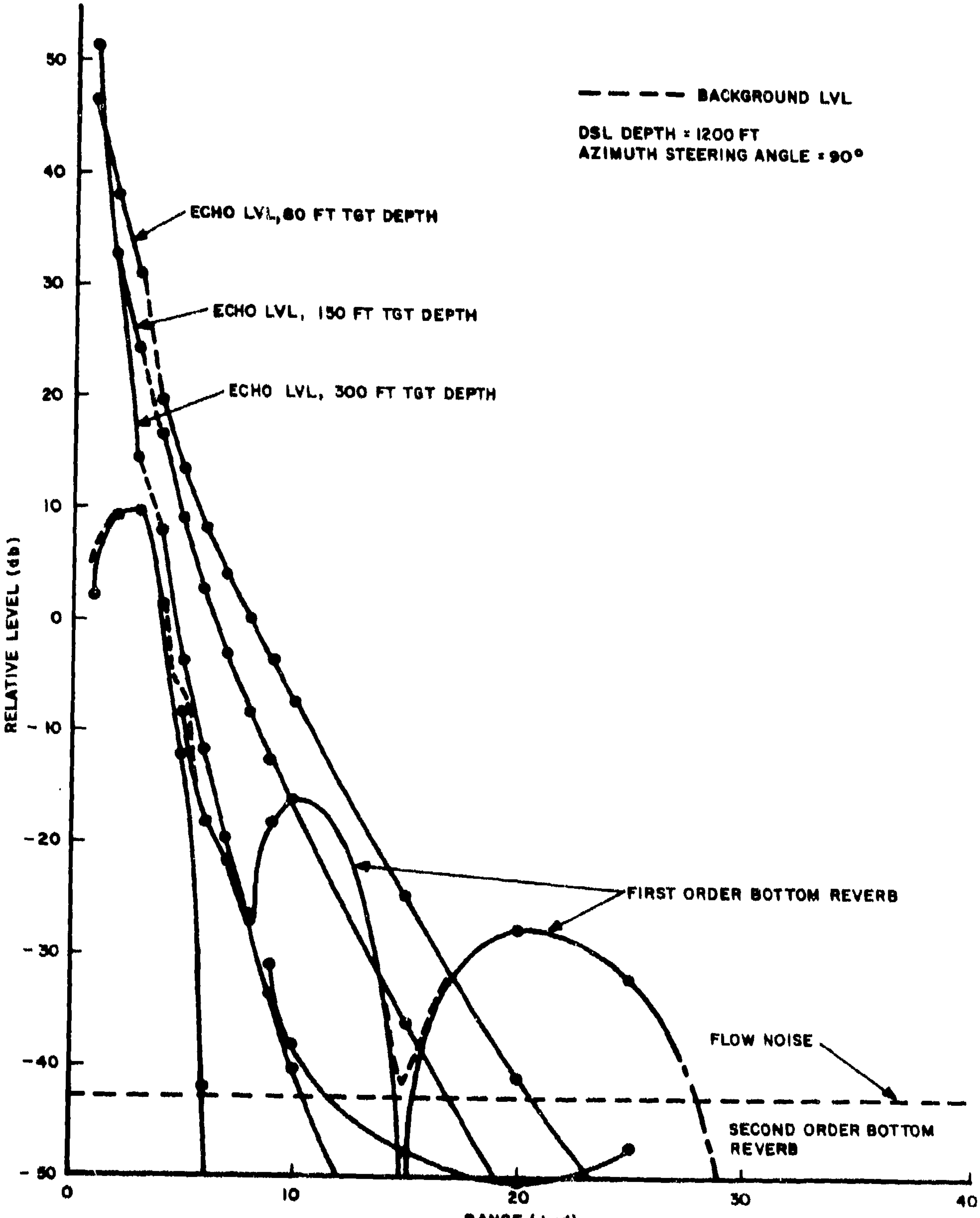


Figure 11. RELATIVE LEVELS VS RANGE

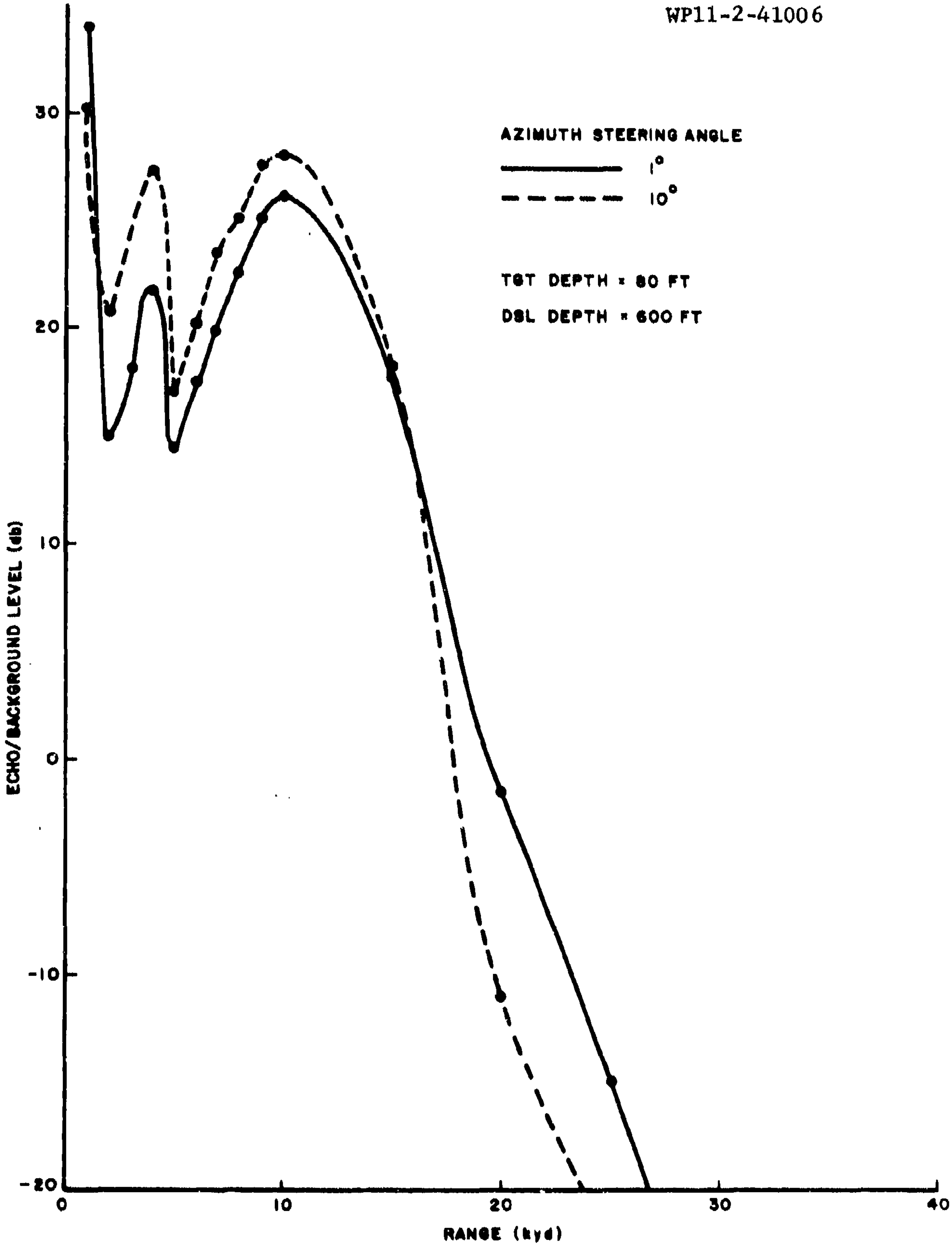


Figure 12. ECHO/BACKGROUND LEVEL VS RANGE

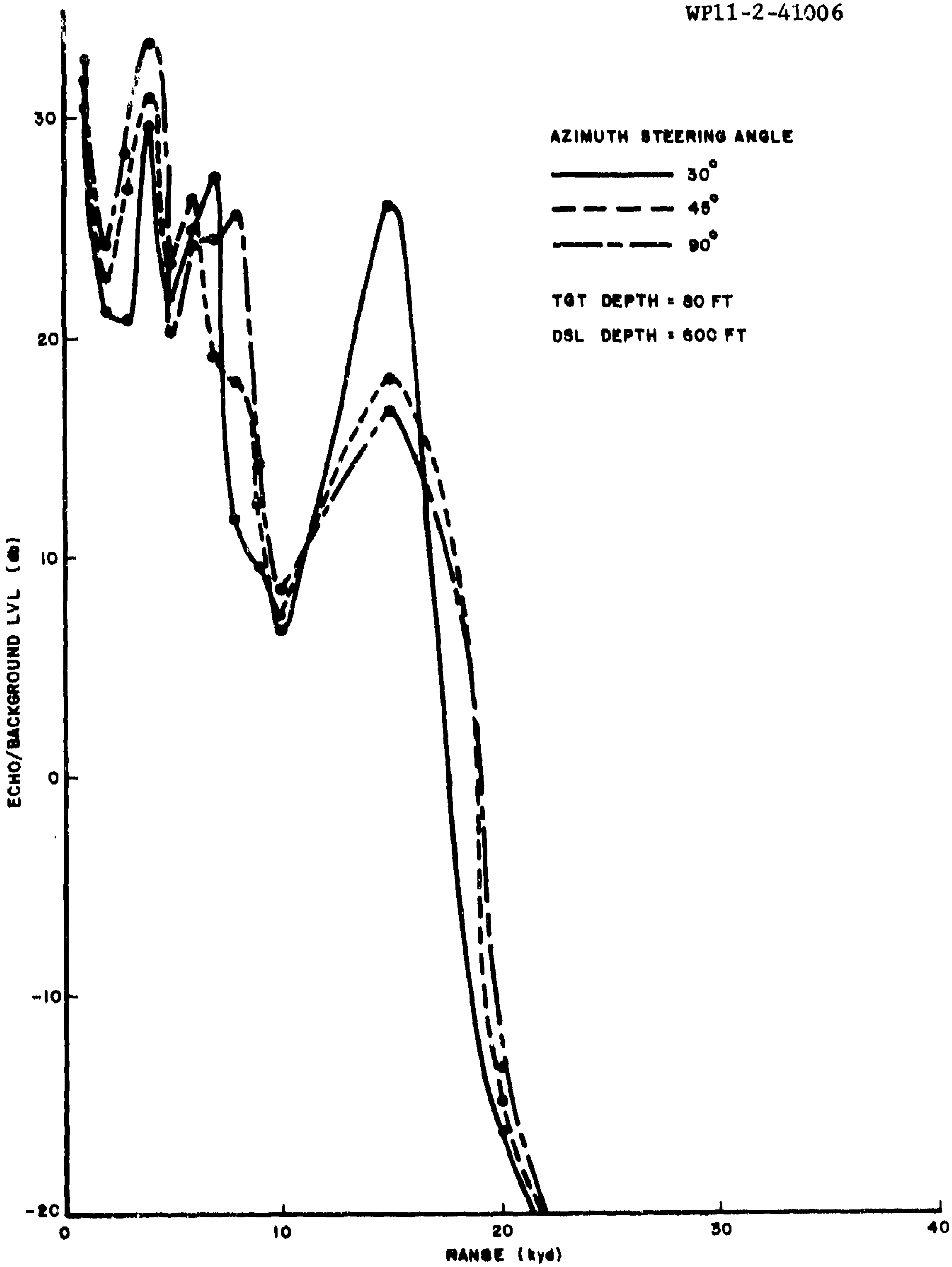


Figure 13. ECHO/BACKGROUND LEVEL VS RANGE

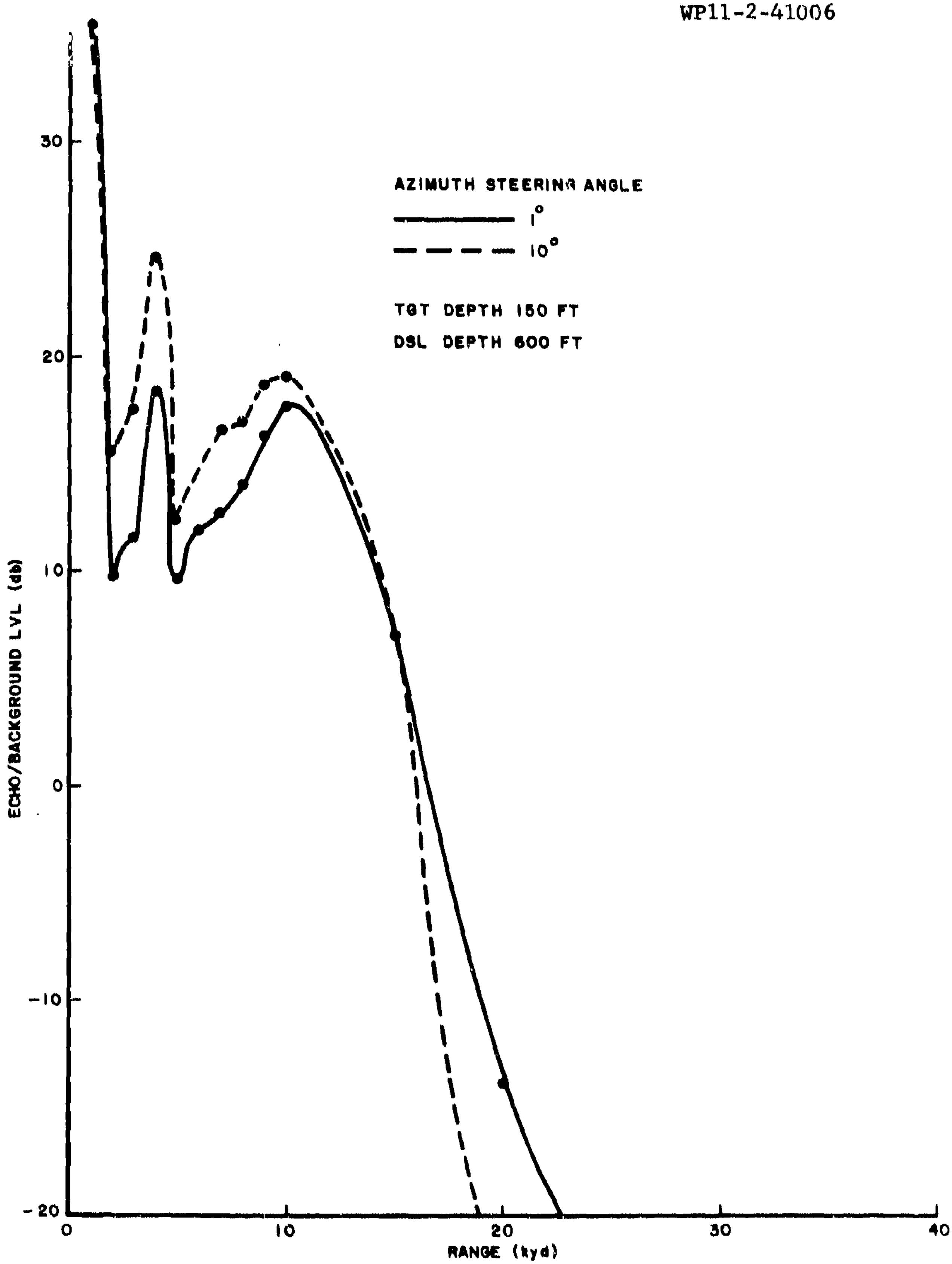


Figure 14. ECHO/BACKGROUND LEVEL VS RANGE

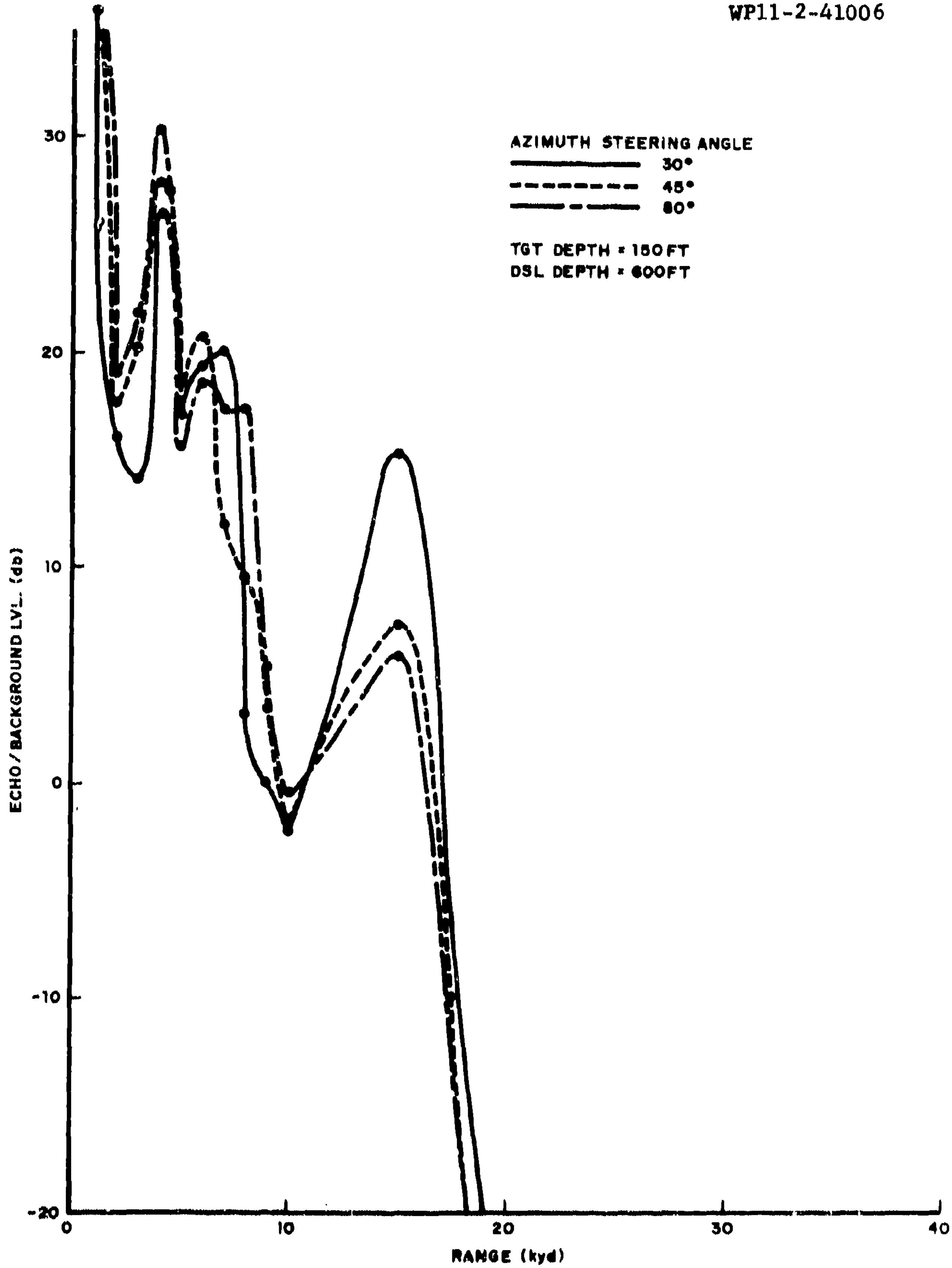


Figure 15. ECHO/BACKGROUND LEVEL VS RANGE

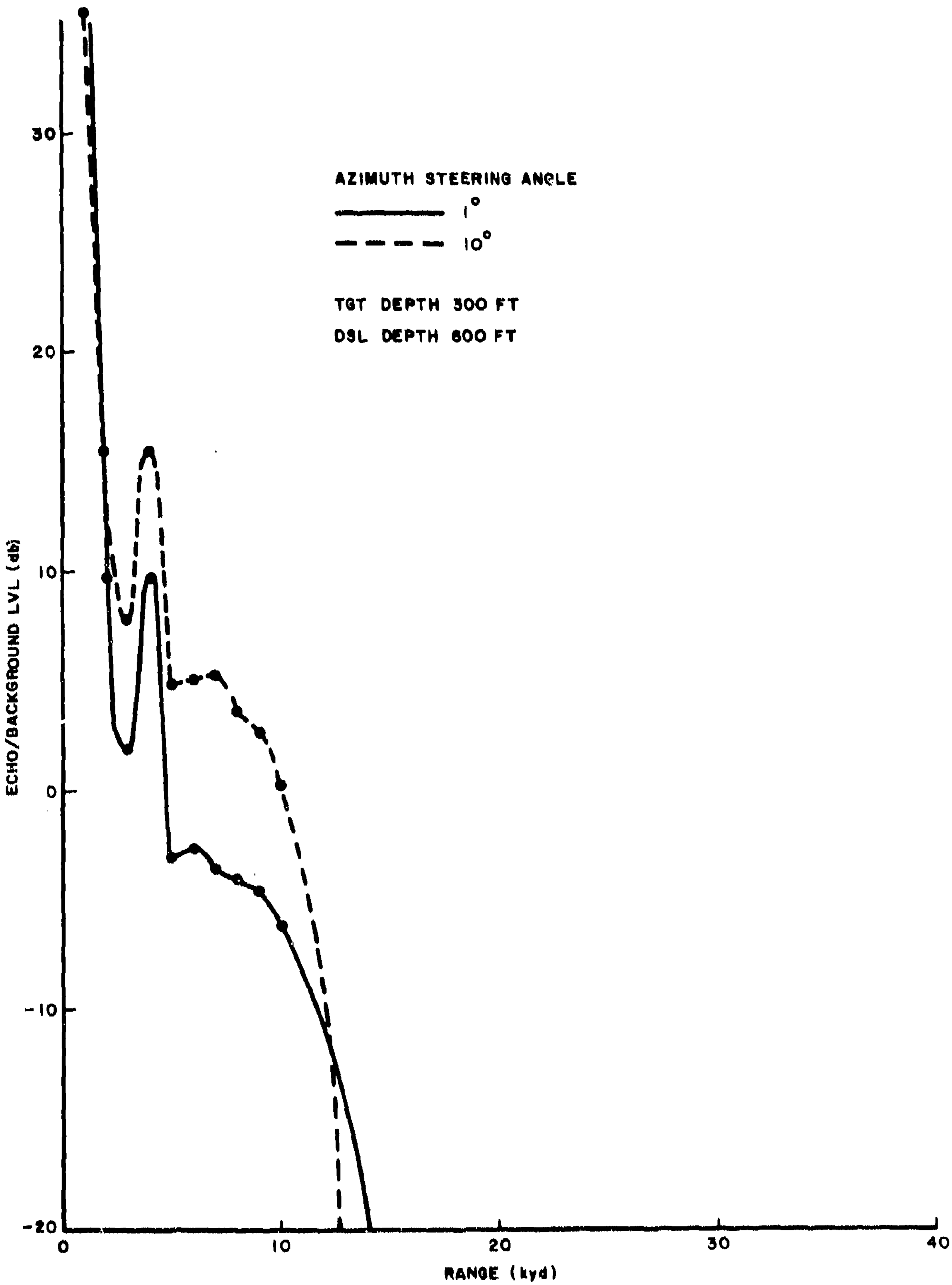


Figure 16. ECHO/BACKGROUND LEVEL VS RANGE

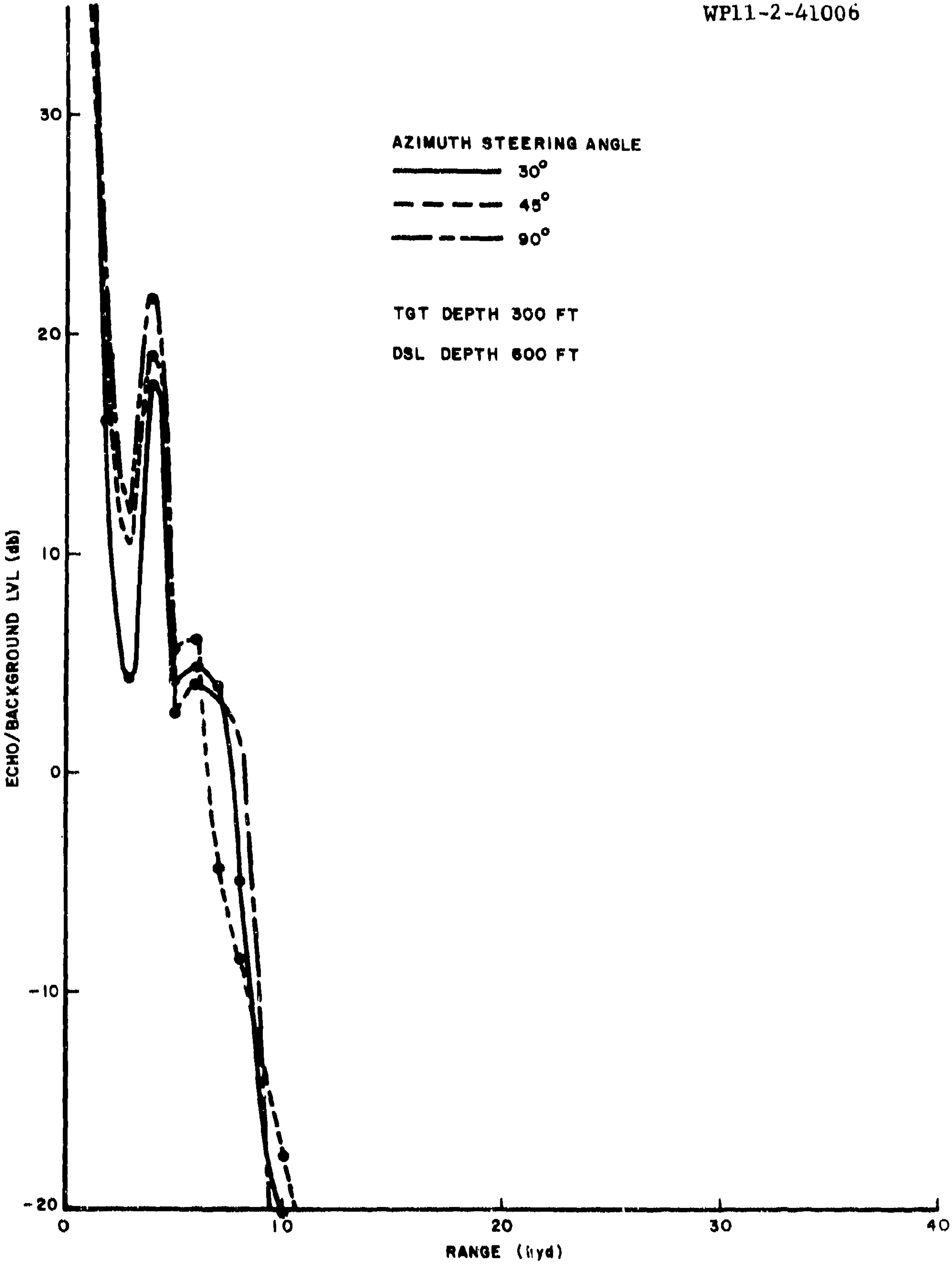


Figure 17. ECHO/BACKGROUND LEVEL VS RANGE

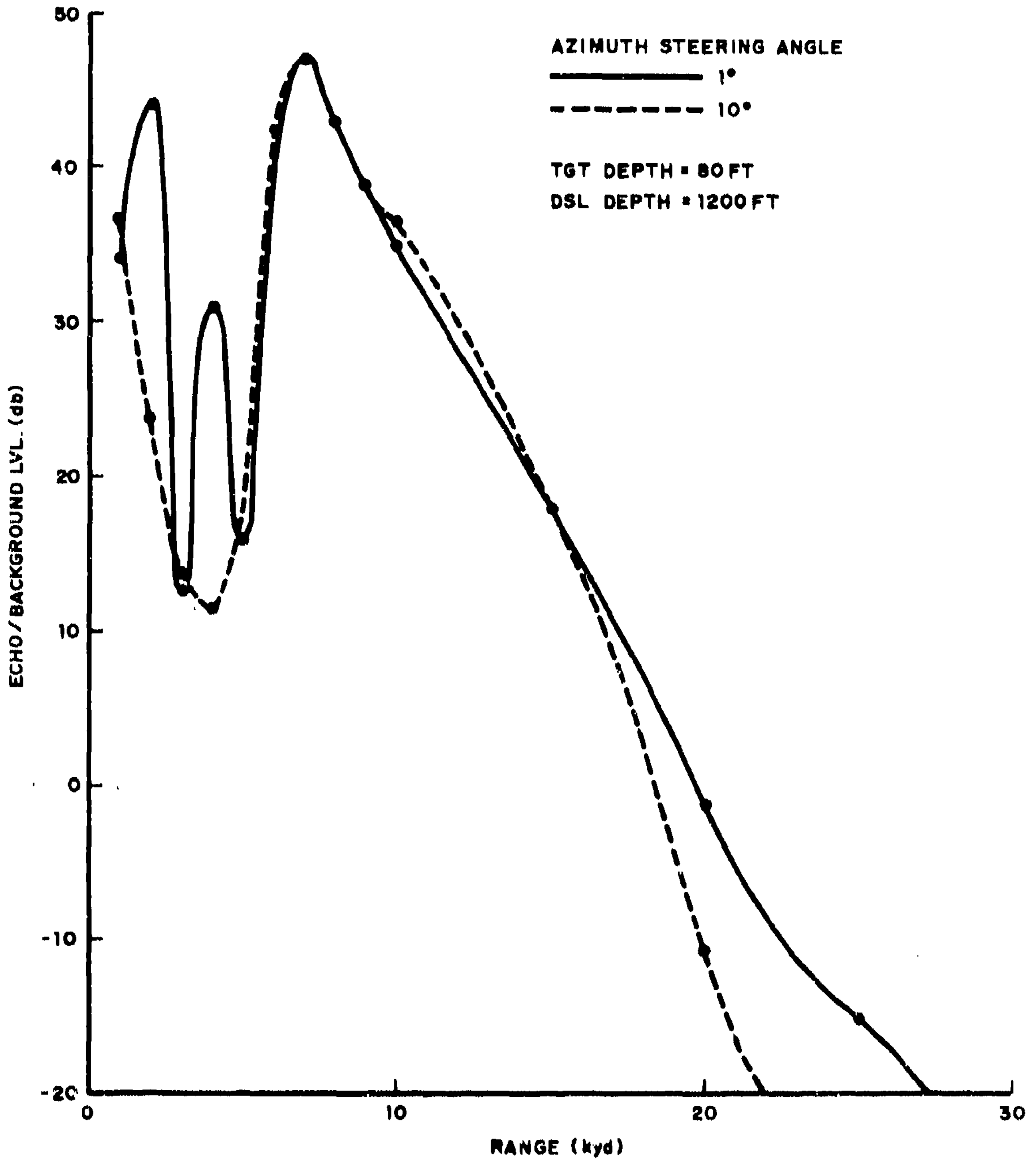


Figure 18. ECHO/BACKGROUND LEVEL VS RANGE

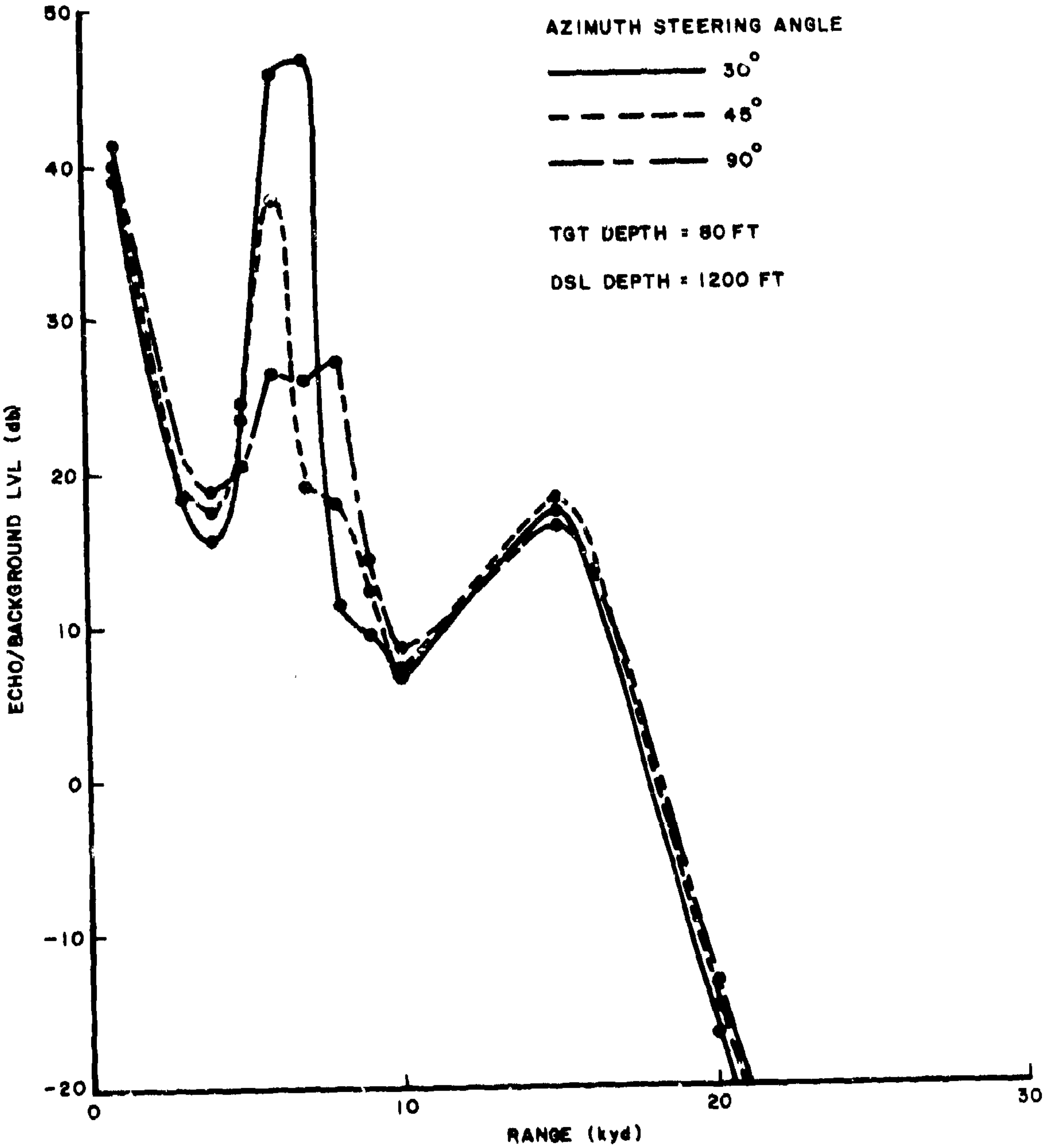


Figure 19. ECHO/BACKGROUND LEVEL VS RANGE

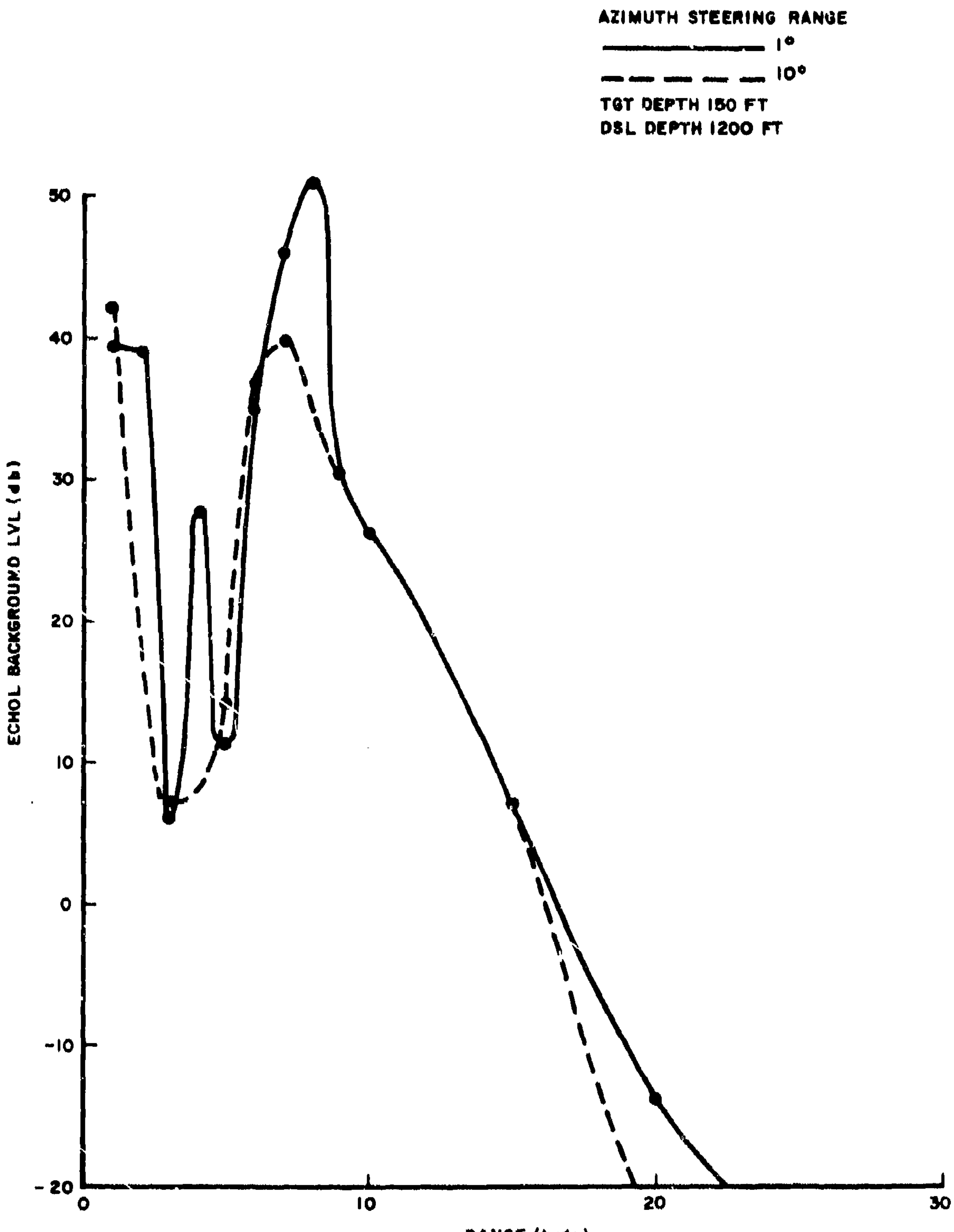


Figure 20. ECHO/BACKGROUND LEVEL VS RANGE

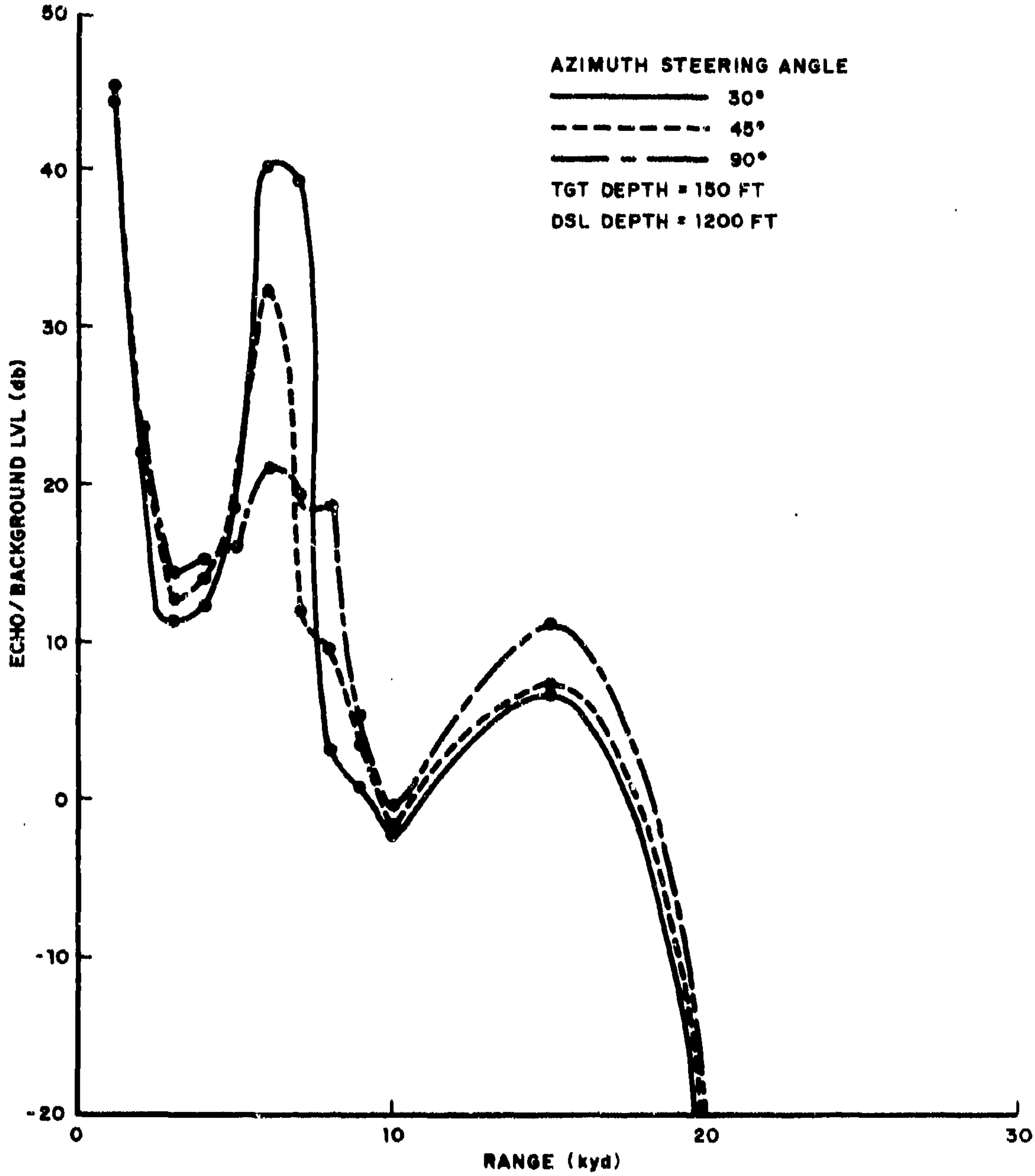


Figure 21. ECHO/BACKGROUND LEVEL VS RANGE

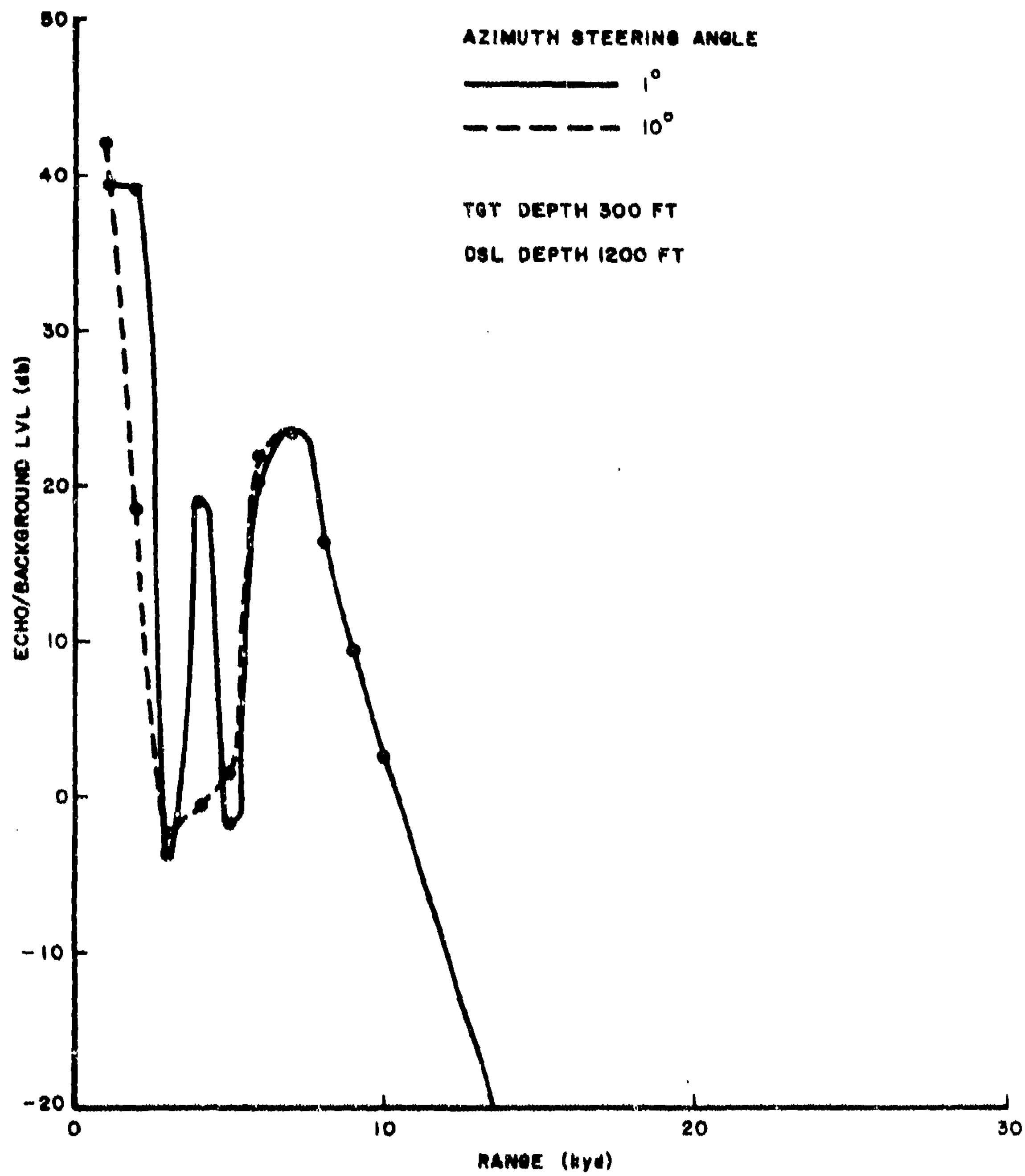


Figure 22. ECHO/BACKGROUND LEVEL VS RANGE

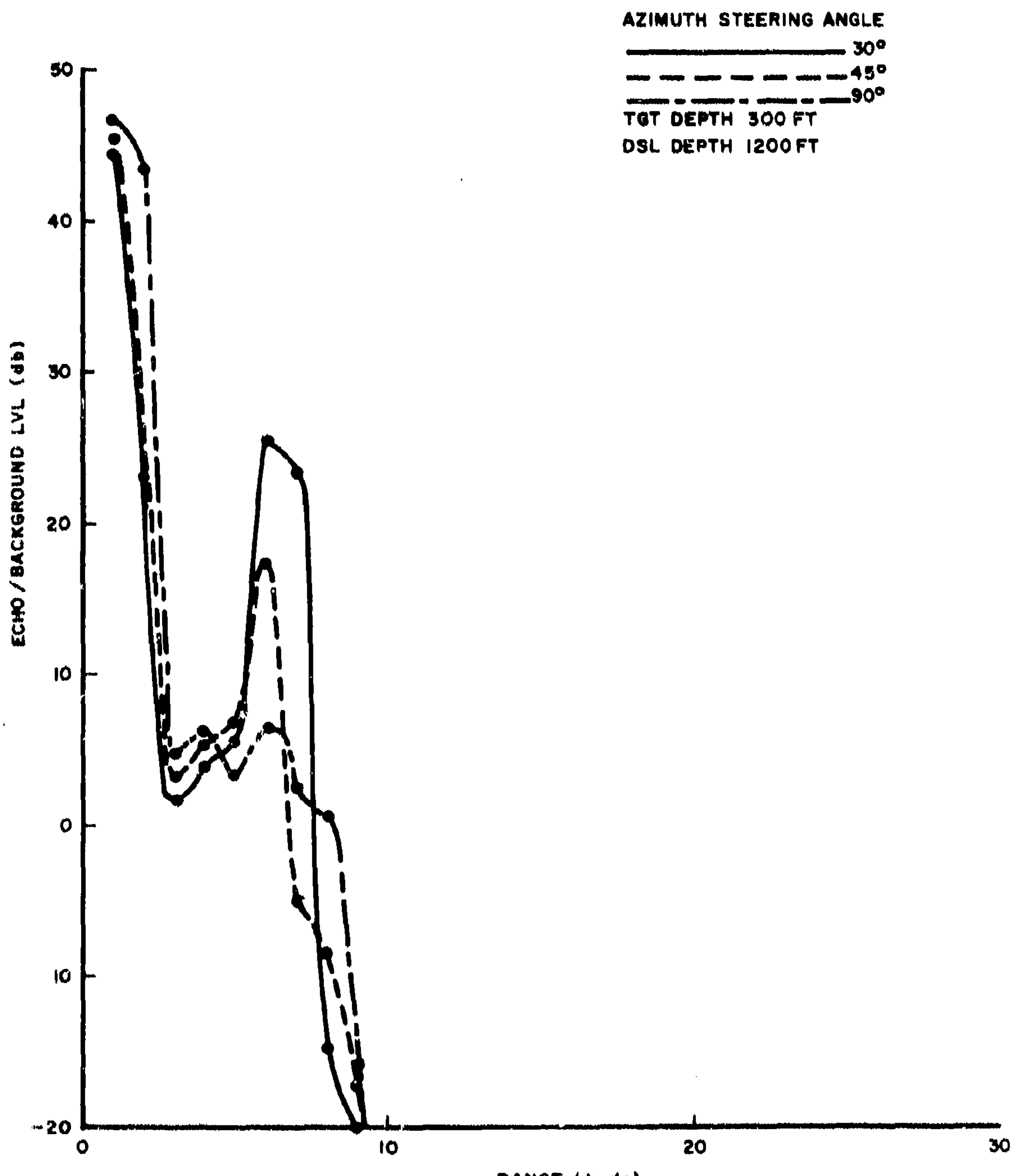


Figure 23. ECHO/BACKGROUND LEVEL VS RANGE

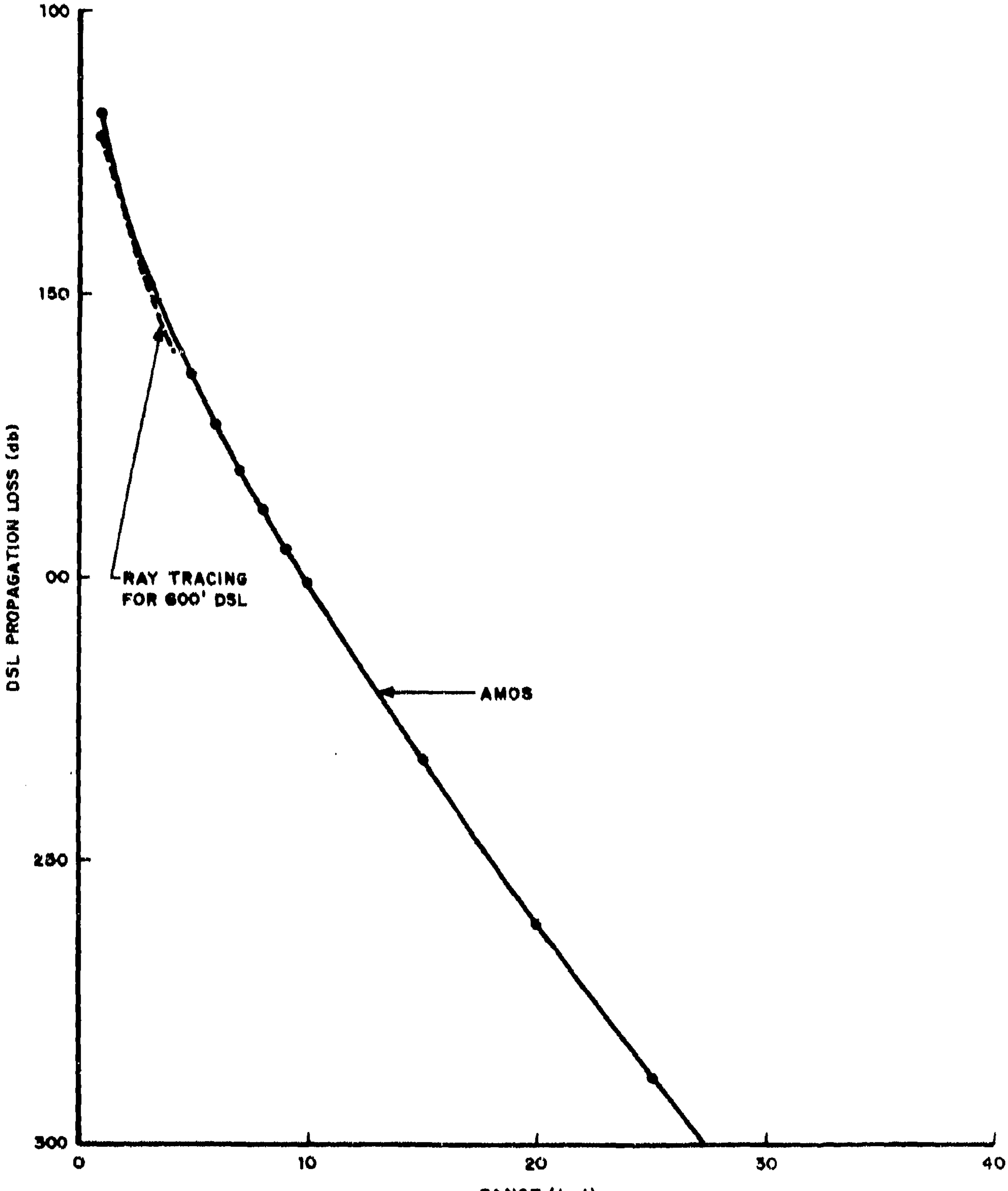
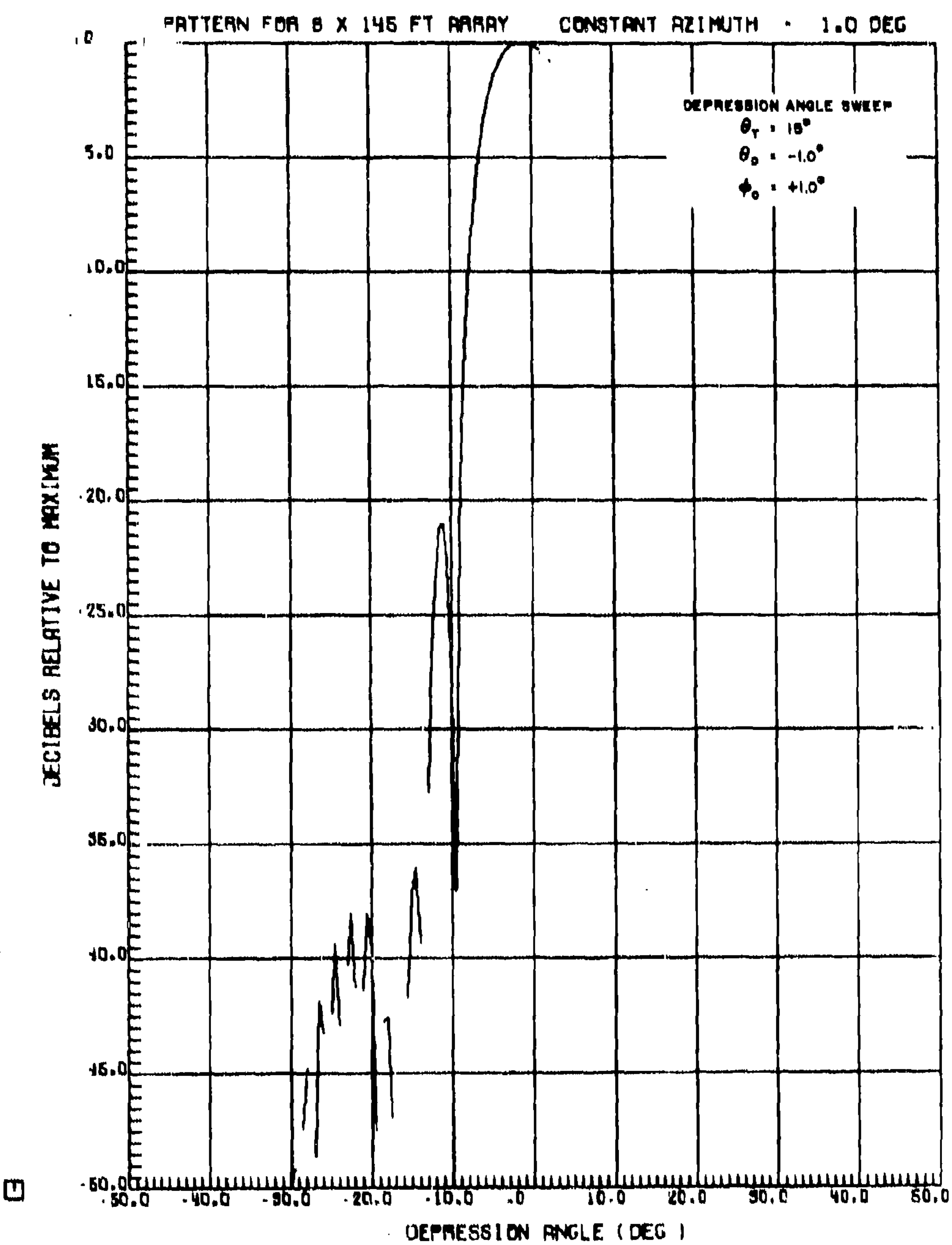
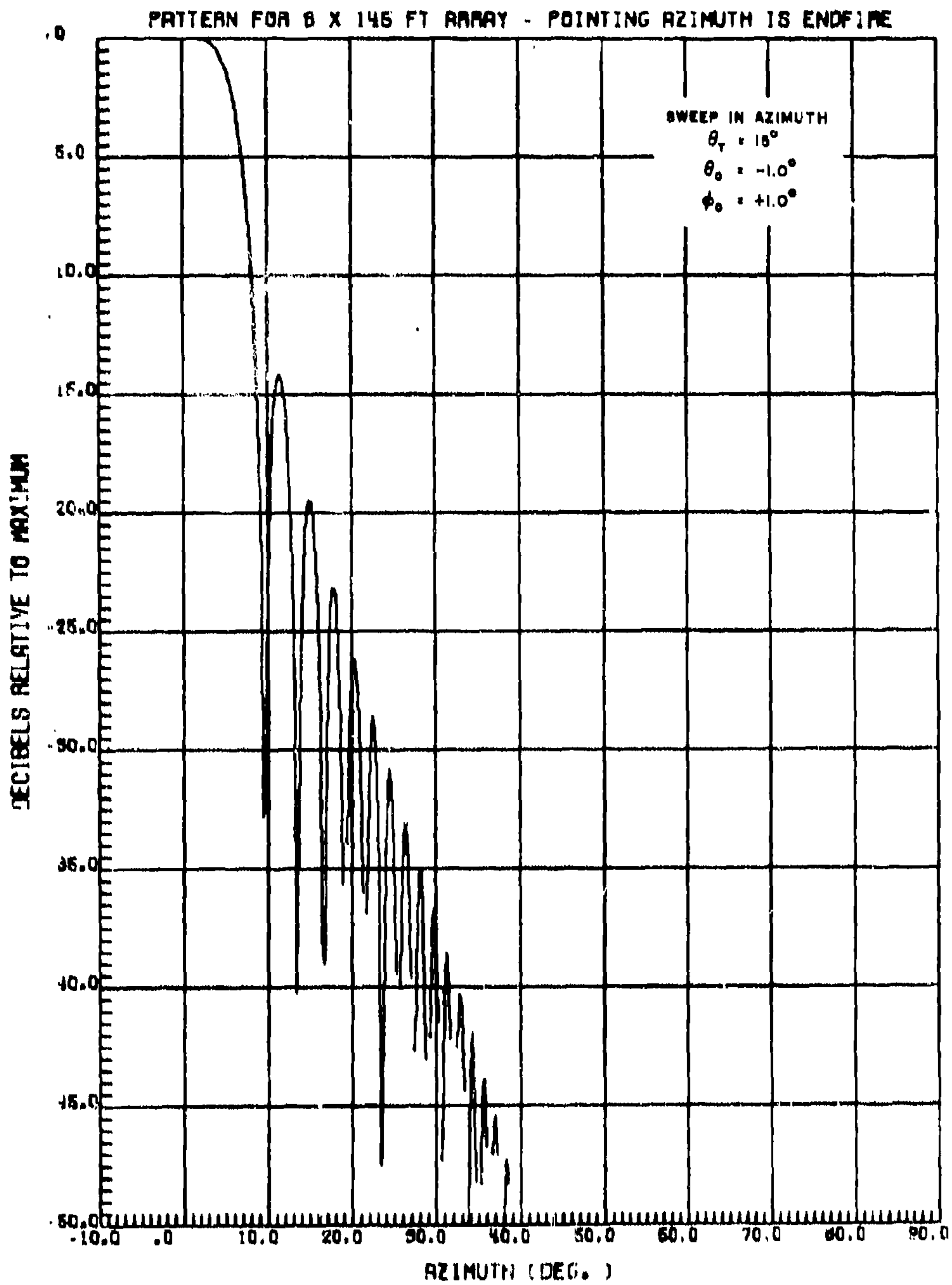


Figure 24. DSL PROPAGATION LOSS VS RANGE



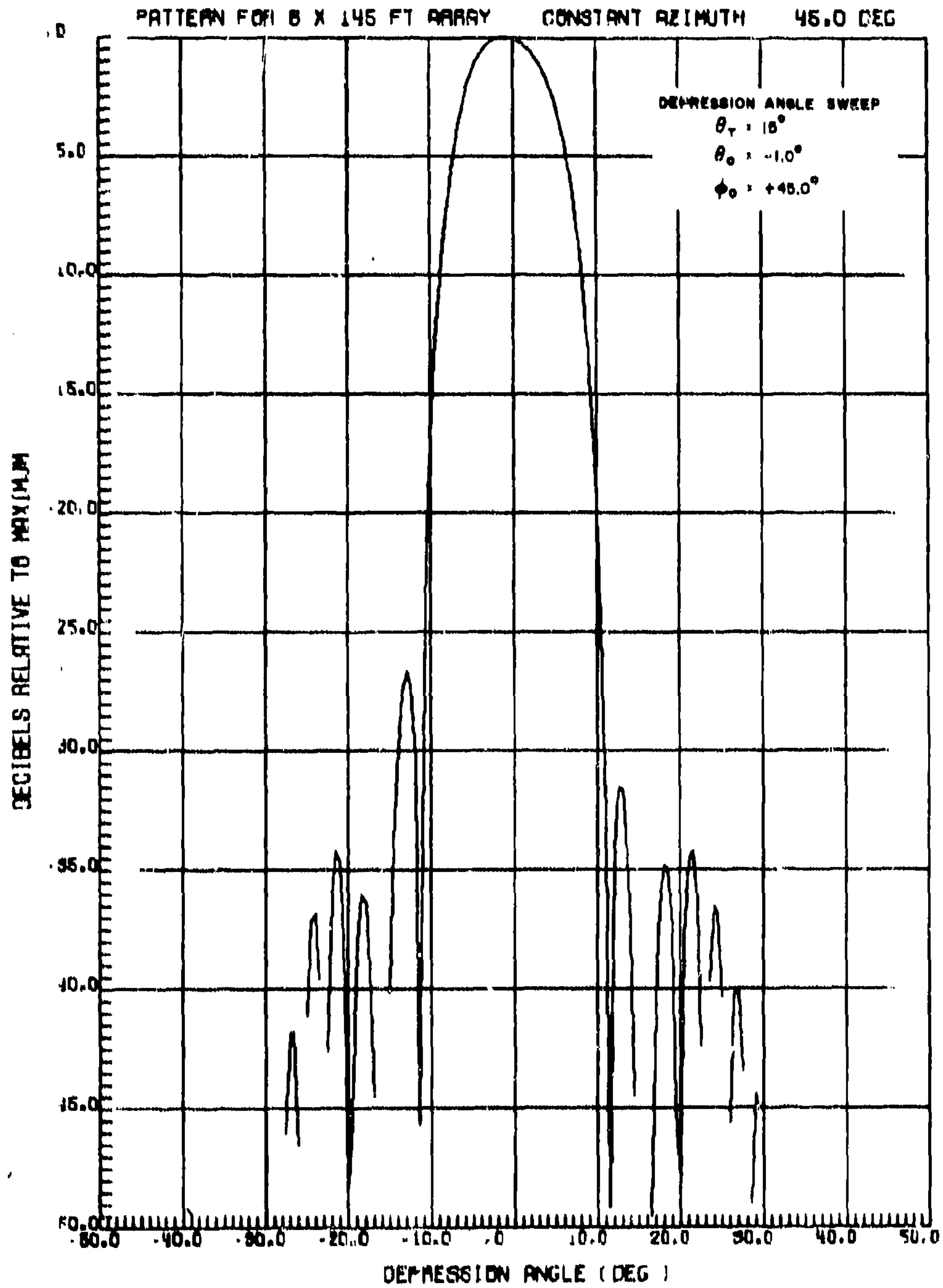
PATTERN FOR 8 X 145 FT ARRAY CONSTANT AZIMUTH · 1.0 DEG
DEPRESSION ANGLE SWEEP
θ_T = 15°
θ_0 = -1.0°
ϕ_0 = +1.0°
DECIBELS RELATIVE TO MAXIMUM
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
-50.0
-50.0
-40.0
-30.0
-20.0
-10.0
.0
10.0
20.0
30.0
40.0
50.0
DEPRESSION ANGLE (DEG)

FIGURE 25



PATTERN FOR 8 X 145 FT ARRAY - POINTING AZIMUTH IS ENDFIRE
SWEEP IN AZIMUTH
θT = 15°
θo = -1.0°
φo = +1.0°
DECIBELS RELATIVE TO MAXIMUM
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
-10.0
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
AZIMUTH (DEG.)

FIGURE 26



PATTERN FOR 8 X 145 FT ARRAY CONSTANT AZIMUTH 45.0 DEG
DEPRESSION ANGLE SWEEP
θ_T = 15°
θ_0 = -1.0°
ϕ_0 = +45.0°
DECIBELS RELATIVE TO MAXIMUM
DEPRESSION ANGLE (DEG)

FIGURE 27

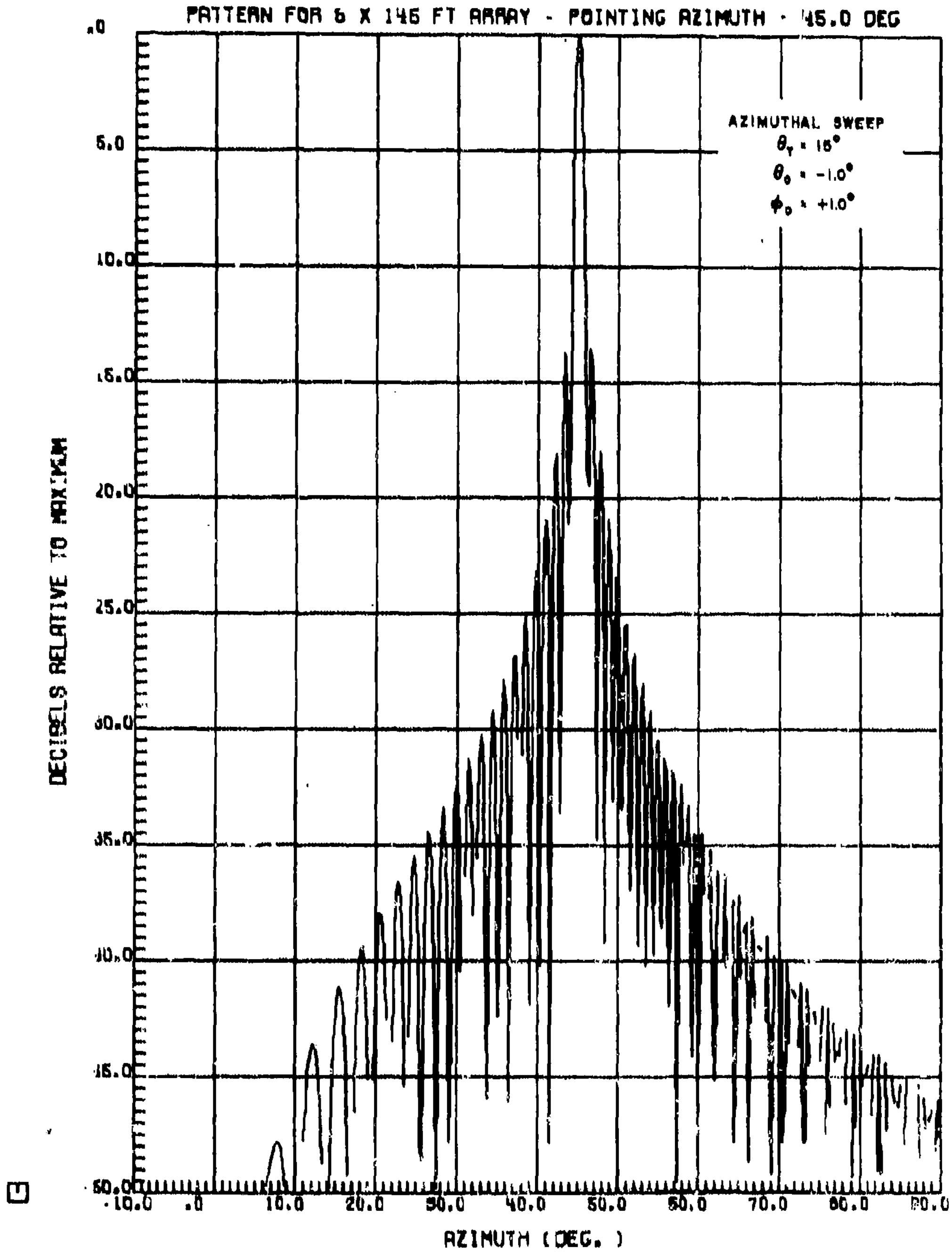

PATTERN FOR 6 X 146 FT ARRAY - POINTING AZIMUTH - 45.0 DEG
AZIMUTHAL SWEEP
θ_T = 15°
θ_0 = -1.0°
ϕ_0 = +1.0°
DECIBELS RELATIVE TO MAXIMUM
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
-10.0
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
AZIMUTH (DEG.)

FIGURE 28

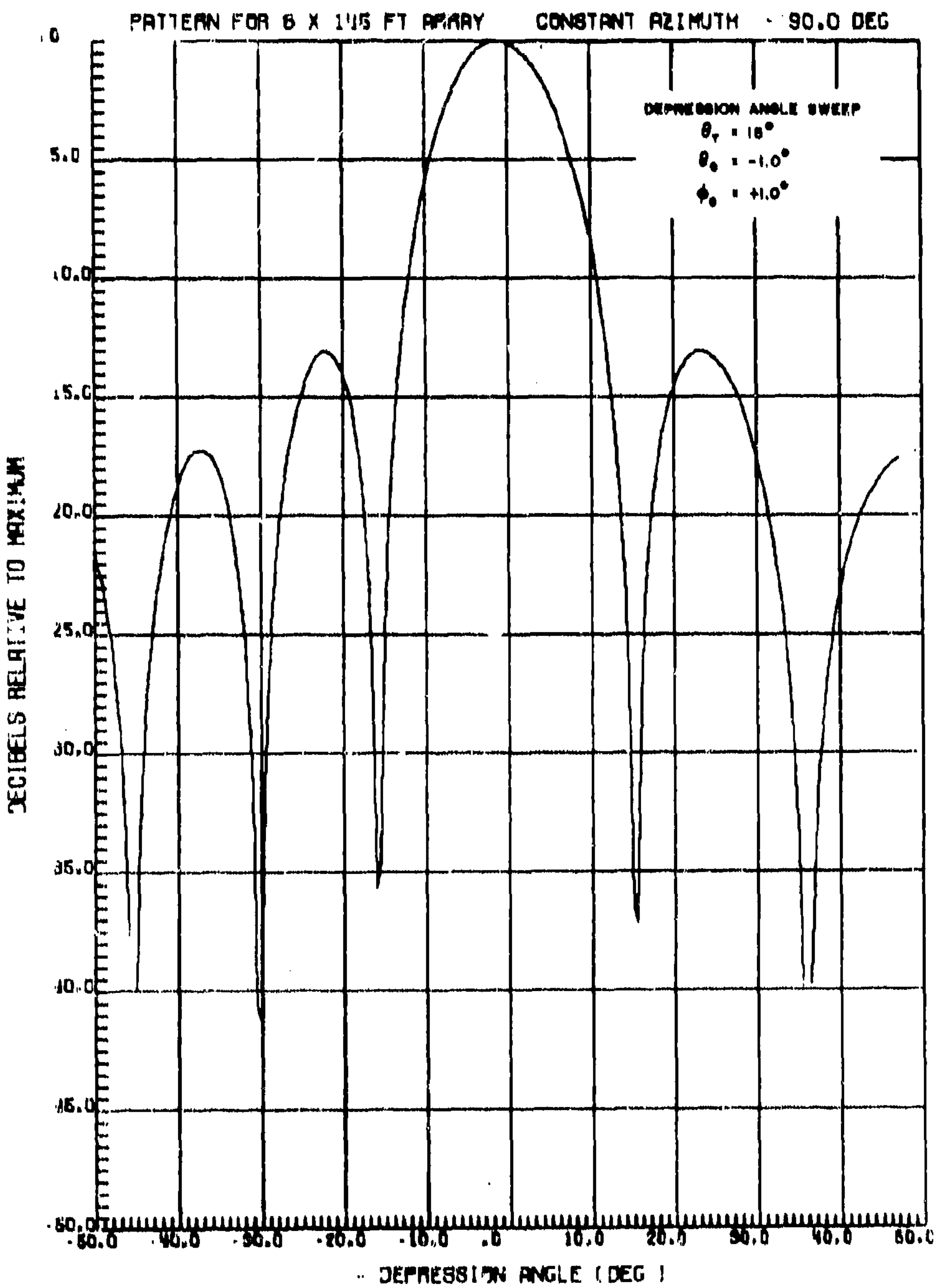

CONSTANT AZIMUTH 90.0 DEG
DEPRESSION ANGLE SWEEP
θe = -1.0°
φe = +1.0°
DECIBELS RELATIVE TO MAXIMUM
DEPRESSION ANGLE (DEG)
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
-50.0
-40.0
-30.0
-20.0
-10.0
10.0
20.0
30.0
40.0
50.0

FIGURE 29

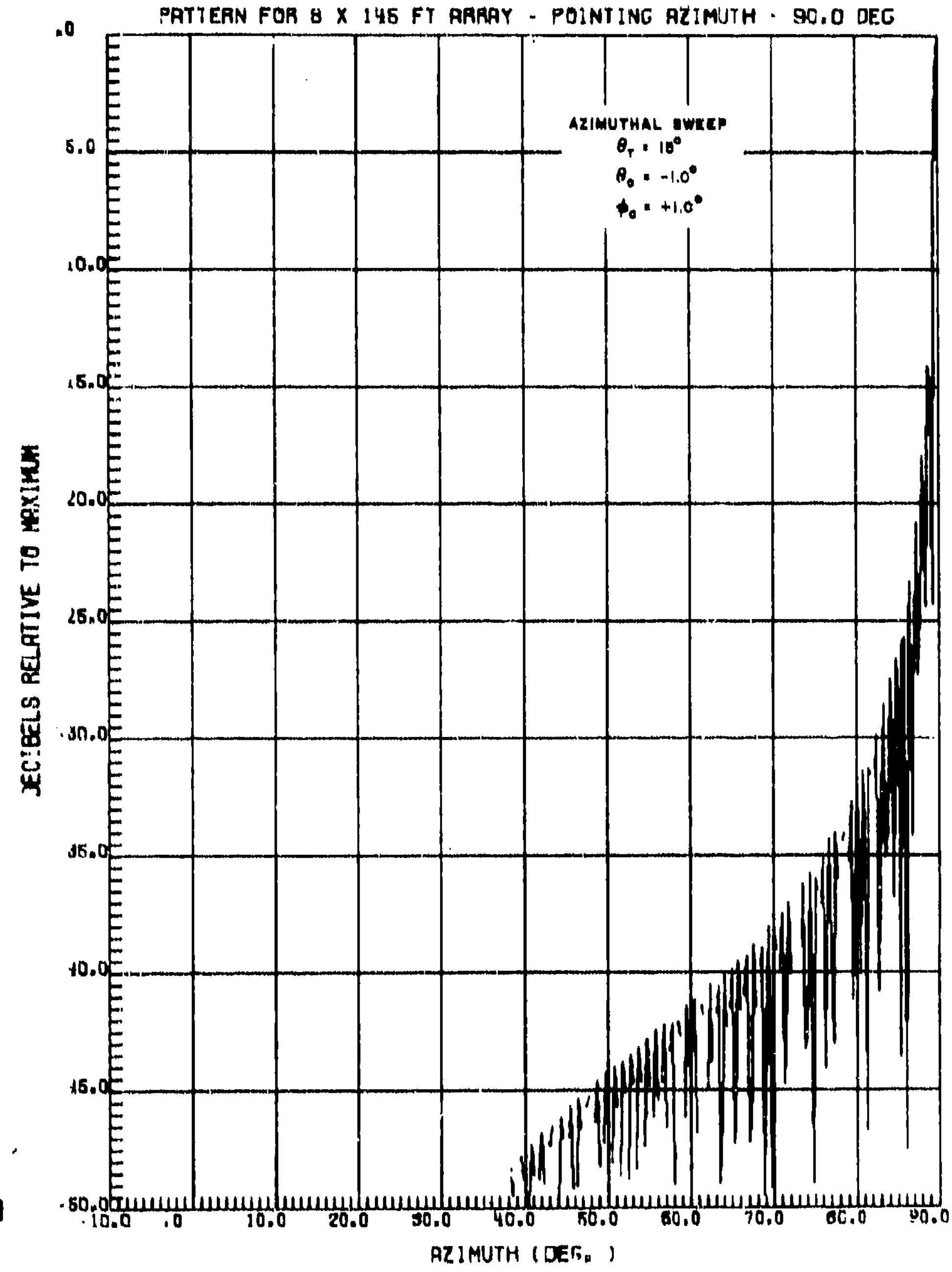

PATTERN FOR 8 X 146 FT ARRAY - POINTING AZIMUTH - 90.0 DEG
AZIMUTHAL SWEEP
θ_T = 18°
θ_o = -1.0°
ϕ_o = +1.0°
DECIBELS RELATIVE TO MAXIMUM
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
-10.0
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
AZIMUTH (DEG.)

FIGURE 30

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	12.2	0.3	12.3	12.3	46.4	34.1
2	—	23.1	23.1	23.1	38.1	15.0
3	—	12.7	12.7	12.7	30.9	18.2
4	—	-1.8	-1.8	-1.8	19.9	21.7
5	-85.8	-0.6	-0.6	-0.6	13.8	14.4
6	-78.7	-9.2	-9.2	-9.2	8.4	17.6
7	-76.1	-15.9	-15.9	-15.9	4.1	20.0
8	-68.8	-22.6	-22.6	-22.6	0.	22.6
9	-63.7	-28.9	-28.9	-28.9	-3.7	25.2
10	-66.3	-34.8	-34.8	-34.2	-7.5	26.7
15	-53.5	-64.8	-53.2	-42.6	-24.8	17.8
20	-42.6	-91.2	-42.6	-39.8	-41.2	-1.4
25	-49.2	-117.8	-49.2	-42.2	-57.1	-14.9
30	-90.1	-143.9	-90.1	-43.0	-72.3	-29.3
35	-79.7	-169.6	-79.7	-43.0	-87.8	-44.8
40	-70.6	-195.0	-70.6	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 1°

TARGET DEPTH = 80 FT
DSL DEPTH = 600 FT

Table 1. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

NOTE: TABLES 1 Thru 30:

BEST AVAILABLE COPY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	9.7	14.9	16.1	16.1	46.4	30.3
2	—	17.4	17.4	17.4	38.1	20.7
3	—	6.7	6.7	6.7	30.9	24.2
4	—	-7.5	-7.5	-7.5	19.9	27.4
5	-82.5	-3.3	-3.3	-3.3	13.8	17.1
6	-76.6	-11.9	-11.9	-11.9	8.4	20.3
7	-74.7	-19.6	-19.6	-19.6	4.1	23.7
8	-74.5	-25.3	-25.3	-25.3	0.	25.3
9	-66.6	-31.6	-31.6	-31.3	-3.7	27.6
10	-60.6	-36.5	-36.5	-35.6	-7.5	28.1
15	-53.1	-66.5	-53.0	-42.6	-24.8	17.8
20	-30.6	-93.9	-30.6	-30.3	-41.2	-10.9
25	-24.0	-120.5	-24.0	-24.0	-57.1	-33.1
30	-87.8	-146.6	-87.8	-43.0	-72.3	-29.3
35	-84.4	-172.3	-84.4	-43.0	-87.8	-44.8
40	-101.1	-197.7	-101.1	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 10°

TARGET DEPTH = 80 FT
DSL DEPTH = 600 FT

Table 2. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	5.2	15.5	15.9	15.9	46.4	30.5
2	—	16.8	16.8	16.8	38.1	21.3
3	—	10.2	10.2	10.2	30.9	20.7
4	—	-9.7	-9.8	-9.8	19.9	29.7
5	-77.6	-8.0	-8.0	-8.0	13.8	21.8
6	-69.9	-16.6	-16.6	-16.6	8.4	25.0
7	-57.1	-23.3	-23.3	-23.3	4.1	27.4
8	-11.7	-30.0	-11.7	-11.7	0.	11.7
9	-13.4	-36.3	-13.4	-13.4	-3.7	9.7
10	-14.3	-42.2	-14.3	-14.3	-7.5	6.8
15	-51.6	-71.2	-51.6	-51.0	-24.8	26.2
20	-24.9	-98.6	-24.9	-24.9	-41.2	-16.3
25	-29.1	-129.6	-29.1	-29.0	-57.1	-28.1
30	-64.0	-151.3	-64.0	-43.6	-72.3	-29.3
35	-63.2	-177.0	-63.2	-43.0	-87.8	-44.8
40	-57.6	-202.4	-57.6	-42.9	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 30°

TARGET DEPTH = 80 FT
DSL DEPTH = 600 FT

Table 3. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	3.7	14.4	14.7	14.7	46.4	31.7
2	–	15.3	15.3	15.3	38.1	22.8
3	–	4.0	4.0	4.0	30.9	26.9
4	–	-11.2	-11.2	-11.2	19.9	31.1
5	-69.2	-9.5	-9.5	-9.5	13.8	23.3
6	-29.8	-18.1	-18.0	-18.0	8.4	26.4
7	-15.6	-24.8	-15.1	-15.1	4.1	19.2
8	-18.1	-31.5	-18.0	-18.0	0.	18.1
9	-16.1	-37.8	-16.1	-16.1	-3.7	12.4
10	-14.7	-43.7	-14.7	-14.7	-7.5	7.2
15	-61.7	-72.7	-61.4	-43.0	-24.8	18.2
20	-26.4	-100.1	-26.4	-26.4	-41.2	-14.8
25	-30.7	-126.7	-30.7	-30.4	-57.1	-26.7
30	-64.4	-152.8	-64.4	-43.0	-72.3	-29.3
35	-63.7	-178.5	-63.7	-43.0	-87.8	-44.8
40	-59.3	-203.9	-58.3	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 45°

TARGET DEPTH = 80 FT
DSL DEPTH = 600 FT

Table 4. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	2.2	13.3	13.6	13.6	46.4	32.8
2	—	13.9	13.9	13.9	38.1	24.2
3	—	2.5	2.5	2.5	30.9	28.4
4	—	-13.7	-13.7	-13.7	19.9	33.6
5	-8.4	-11.0	-6.5	-6.5	13.8	20.3
6	-18.3	-19.6	-15.9	-15.9	8.4	24.3
7	-21.9	-26.3	-20.5	-20.5	4.1	24.6
8	-27.4	-33.0	-25.8	-25.8	0.	25.8
9	-17.9	-39.3	-17.9	-17.9	-3.7	14.2
10	-16.1	-45.2	-16.1	-16.1	-7.5	8.6
15	-47.0	-74.2	-47.0	-41.5	-24.8	16.7
20	-27.8	-101.6	-27.8	-27.7	-41.2	-13.4
25	-32.1	-128.2	-32.1	-29.8	-57.1	-27.3
30	-65.5	-154.3	-65.5	-43.0	-72.3	-29.3
35	-64.5	-180.0	-64.5	-43.0	-87.8	-44.8
40	-59.2	-205.4	-59.2	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 80 FT.
DSL DEPTH = 600 FT.

Table 5. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL DB
1	12.2	0.3	12.3	12.3	51.8	39.5
2	–	23.1	23.1	23.1	32.9	9.8
3	–	12.7	12.7	12.7	24.3	11.6
4	–	-1.8	-1.8	-1.8	16.7	18.5
5	-85.8	-0.6	-0.6	-0.6	9.1	9.7
6	-78.7	-9.2	-9.2	-9.2	2.8	12.0
7	-76.1	-15.9	-15.9	-15.9	-3.1	12.8
8	-68.8	-22.6	-22.6	-22.6	-8.4	14.2
9	-63.7	-28.9	-28.9	-28.9	-12.5	16.4
10	-66.3	-34.8	-34.8	-34.2	-16.5	17.7
15	-53.5	-64.8	-53.2	-42.6	-35.6	7.0
20	-42.6	-91.2	-42.6	-39.8	-53.6	-13.8
25	-49.2	-117.8	-49.2	-42.2	-71.0	-28.8
30	-90.1	-143.9	-90.1	-43.0	-88.3	-45.3
35	-79.7	-169.6	-79.7	-43.0	-105.2	-62.2
40	-70.6	-195.0	-70.6	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR

AZIMUTH STEERING ANGLE = 1°

TARGET DEPTH = 150 FT

DSL DEPTH = 600 FT

Table 6. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	9.7	14.9	16.1	16.1	51.8	35.7
2	–	17.4	17.4	17.4	32.9	15.5
3	–	6.7	6.7	6.7	24.3	17.6
4	–	-7.5	-7.5	-7.5	16.7	24.2
5	-82.5	-3.3	-3.3	-3.3	9.1	12.4
6	-76.6	-11.9	-11.9	-11.9	2.8	14.7
7	-74.7	-19.6	-19.6	-19.6	-3.1	16.5
8	-74.5	-25.3	-25.3	-25.3	-8.4	16.9
9	-66.6	-31.6	-31.6	-31.3	-12.5	18.8
10	-60.6	-36.5	-36.5	-35.6	-16.7	19.1
15	-53.1	-66.5	-53.0	-42.6	-35.6	7.0
20	-30.6	-93.9	-30.6	-30.3	-53.6	-23.3
25	-24.0	-120.5	-24.0	-24.0	-71.0	-47.0
30	-87.8	-146.6	-87.8	-43.0	-88.3	-45.3
35	-84.4	-172.3	-84.4	-43.0	-105.2	-62.2
40	-101.1	-197.7	-101.1	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 10°

TARGET DEPTH = 150 FT
DSL DEPTH = 600 FT

Table 7. **ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY**

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL DB
1	5.2	15.5	15.9	15.9	51.8	35.9
2	—	16.8	16.8	16.8	32.9	16.1
3	—	10.2	10.2	10.2	24.3	14.1
4	—	-9.7	-9.8	-9.8	16.7	26.5
5	-79.6	-8.0	-8.0	-8.0	9.1	17.1
6	-69.9	-16.6	-16.6	-16.6	2.8	19.4
7	-57.1	-23.3	-23.3	-23.3	-3.1	20.2
8	-11.7	-30.0	-11.7	-11.7	-8.4	3.3
9	-13.4	-36.3	-13.4	-13.4	-12.5	0.9
10	-14.3	-42.2	-14.3	-14.3	-16.5	-2.2
15	-51.6	-71.2	-51.6	-51.0	-35.6	15.4
20	-24.9	-98.6	-24.9	-24.9	-53.6	-28.7
25	-29.1	-129.6	-29.1	-29.0	-71.0	-42.6
30	-64.0	-151.3	-64.0	-43.6	-88.0	-45.3
35	-63.2	-177.0	-63.2	-43.0	-105.2	-62.2
40	-57.6	-202.4	-57.6	-42.9	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 30°

TARGET DEPTH = 160 FT
DSL DEPTH = 600 FT

Table 8. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

Range KYDS	Surf. & Bottom Reverb DB	DSL Reverb DB	Total Reverb DB	Bkgrnd Lvl DB	Echo Level DB	Echo/Background Lvl DB
1	3.7	14.4	14.7	14.7	51.8	37.1
2	—	15.3	15.3	15.3	32.9	17.6
3	—	4.0	4.0	4.0	24.3	20.3
4	—	-11.2	-11.2	-11.2	16.7	[illegible]
5	-69.2	-9.5	-9.5	-9.5	9.1	18.6
6	-29.8	-18.1	-18.0	-18.0	2.8	20.8
7	-15.6	-24.8	-15.1	-15.1	-3.1	12.0
8	-18.1	-31.5	-18.0	-18.0	-8.4	9.7
9	-16.1	-37.8	-16.1	-16.1	-12.5	3.6
10	-14.7	-43.7	-14.7	-14.7	-16.5	-1.8
15	-61.7	-72.7	-61.4	-43.0	-35.6	-7.4
20	-26.4	-100.1	-26.4	-26.4	-53.6	-27.2
25	-30.7	-126.7	-30.7	-30.4	-71.0	-40.6
30	-64.4	-152.8	-64.4	-43.0	-88.3	-45.3
35	-63.7	-179.5	-63.7	-43.0	-105.2	-62.2
40	-59.3	-203.9	-58.3	-43.0	-109.4	-66.4

Flow Noise at 25 KTS = -43.0 DB RE 1 μBAR
Azimuth Steering Angle = 45°

Target Depth = 150 FT
DSL Depth = 600 FT

Table 9. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	2.2	13.3	13.6	13.6	57.9	38.2
2	—	13.9	13.9	13.9	32.9	19.0
3	—	2.5	2.5	2.5	24.3	21.8
4	—	-13.7	-13.7	-13.7	16.7	30.4
5	-8.4	-11.0	-6.5	-6.5	9.1	15.6
6	-18.3	-19.6	-15.9	-15.9	2.8	18.7
7	-21.9	-26.3	-20.5	-20.5	-3.1	17.4
8	-27.4	-33.0	-25.8	-25.8	-8.4	17.4
9	-17.9	-39.3	-17.9	-17.9	-12.5	5.4
10	-16.1	-45.2	-16.1	-16.1	-16.5	-0.4
15	-47.0	-74.2	-47.0	-41.5	-35.6	5.9
20	-27.8	-101.6	-27.8	-27.7	-53.6	-25.8
25	-32.1	-129.2	-32.1	-29.8	-71.0	-41.2
30	-65.5	-154.3	-65.5	-43.0	-88.3	-45.3
35	-64.5	-180.0	-64.5	-43.0	-105.2	-62.2
40	-59.2	-205.4	-59.2	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 150 FT
DSL DEPTH = 600 FT

Table 10. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	12.2	-0.3	12.3	12.3	51.8	39.5
2	—	23.1	23.1	23.5	32.9	9.4
3	—	12.7	12.7	12.7	14.5	1.8
4	—	-1.8	-1.8	-1.9	8.0	9.9
5	-85.8	-0.6	-0.6	-0.6	-3.7	-3.1
6	-78.7	-9.2	-9.2	-9.2	-11.8	-2.6
7	-76.1	-15.9	-15.9	-15.9	-19.4	-3.5
8	-68.8	-22.6	-22.6	-22.6	-26.6	-4.0
9	-63.7	-28.9	-28.9	-28.9	-33.5	-4.6
10	-66.3	-34.8	-34.8	-34.2	-40.3	-6.1
15	-53.5	-64.8	-53.2	-42.6	-71.8	-29.2
20	-42.6	-91.2	-42.6	-39.8	-91.4	-51.6
25	-49.2	-117.8	-49.2	-42.2	-108.9	-66.7
30	-90.1	-143.9	-90.1	-43.0	-126.1	-83.1
35	-79.7	-169.6	-79.7	-43.0	-143.0	-100.0
40	-70.6	-195.0	-70.6	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 1°

TARGET DEPTH = 300 FT
DSL DEPTH = 600 FT

Table 11. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	9.7	14.9	16.1	16.1	51.8	35.7
2	—	17.4	17.4	17.4	32.9	15.5
3	—	6.7	6.7	6.7	14.5	7.8
4	—	-7.5	-7.5	-7.5	8.0	15.5
5	-82.5	-3.3	-3.3	-3.3	-3.7	-0.1
6	-76.6	-11.9	-11.9	-11.9	-11.8	0.1
7	-74.7	-19.6	-19.6	-19.6	-19.4	0.2
8	-74.5	-25.3	-25.3	-25.3	-26.6	-1.3
9	-66.6	-31.6	-31.6	-31.3	-33.5	-2.2
10	-60.6	-36.5	-36.5	-35.6	-40.3	-4.7
15	-53.1	-66.5	-53.0	-42.6	-71.8	-29.2
20	-30.6	-93.9	-30.6	-30.3	-91.4	-61.1
25	-24.0	-120.5	-24.0	-24.0	-108.9	-84.9
30	-87.8	-146.6	-87.8	-43.0	-1[illegible].6	-93.1
35	-84.4	-172.3	-84.4	-43.0	-143.0	-100.0
40	-101.1	-197.7	-101.1	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 10°

TARGET DEPTH = 300 FT
DSL DEPTH = 600 FT

Table 12. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	5.2	15.5	15.9	15.9	51.8	45.8
2	—	16.8	16.8	16.8	32.9	16.1
3	—	10.2	10.2	10.2	14.5	4.3
4	—	-9.7	-9.8	-9.8	8.0	17.8
5	-79.6	-8.0	-8.0	-8.0	-3.7	4.3
6	-69.9	-16.6	-16.6	-16.6	-11.8	-4.8
7	-57.1	-23.3	-23.3	-23.3	-19.4	3.9
8	-11.7	-30.0	-11.7	-11.7	-26.6	-14.9
9	-13.4	-36.3	-13.4	-13.4	-33.5	-20.1
10	-14.3	-42.2	-14.3	-14.3	-40.3	-26.6
15	-51.6	-71.2	-51.6	-51.0	-71.8	-20.8
20	-24.9	-98.6	-24.9	-24.9	-91.4	-66.5
25	-29.1	-129.6	-29.1	-29.0	-108.9	-79.9
30	-64.0	-151.3	-64.0	-43.6	-126.1	-83.1
35	-63.2	-177.0	-63.2	-43.0	-143.0	-100.0
40	-59.6	-202.4	-57.6	-42.9	-159.6	116.7

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 30°

TARGET DEPTH = 300 FT
DSL DEPTH = 600 FT

Table 13. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAYS

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL DB
1	3.7	14.4	14.7	14.7	51.8	37.1
2	–	15.3	15.3	15.3	32.9	17.6
3	–	4.0	4.0	4.0	14.5	10.5
4	–	-11.2	-11.2	-11.2	8.0	19.2
5	-69.2	-9.5	-9.5	-9.5	-3.7	5.8
6	-29.8	-18.1	-18.0	-18.0	-11.8	6.2
7	-15.6	-24.8	-15.1	-15.1	-19.4	-4.3
8	-18.1	-31.5	-18.0	-18.0	-26.6	-8.5
9	-16.1	-37.9	-16.1	-16.1	-33.5	-17.4
10	-14.7	-43.7	-14.7	-14.7	-40.3	-25.6
15	-61.7	-72.7	-61.4	-43.0	-71.8	-28.8
20	-26.4	-100.1	-26.4	-26.4	-91.4	-65.0
25	-30.7	-126.7	-30.7	-30.4	-108.9	-78.5
30	-64.4	-152.8	-64.4	-43.0	-126.1	-83.1
35	-63.7	-178.5	-63.7	-43.0	-143.0	-100.6
40	-58.3	-203.9	-58.3	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 45°

TARGET DEPTH = 300 FT
DSL DEPTH = 600 FT

Table 14. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	2.2	13.3	13.6	13.6	51.9	38.3
2	—	13.9	13.9	13.9	32.9	19.0
3	—	2.5	2.5	2.5	14.5	12.0
4	—	-13.7	-13.7	-13.7	8.0	21.7
5	-8.4	-11.0	-6.5	-6.5	-3.7	2.8
6	-18.3	-19.6	-15.9	-15.9	-11.8	4.1
7	-21.9	-26.3	-20.5	-20.5	-19.4	1.1
8	-27.4	-33.0	-25.8	-25.8	-26.6	-0.8
9	-17.9	-39.3	-17.9	-17.9	-33.5	-15.6
10	-16.1	-45.2	-16.1	-16.1	-40.3	-24.2
15	-47.0	-74.2	-47.0	-41.5	-71.8	-30.3
20	-27.8	-101.6	-27.8	-27.7	-91.4	-63.6
25	-32.1	-129.2	-32.1	-29.8	-108.9	-79.1
30	-65.5	-154.3	-65.5	-43.0	-126.1	-83.1
35	-64.5	-180.0	-64.5	-43.0	-143.0	-100.0
40	-59.2	-205.4	-59.2	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 300 FT
DSL DEPTH = 600 FT

Table 15. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB. DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	12.2	-55.0	12.2	12.2	46.4	34.2
2	–	-6.3	-6.3	-6.3	38.1	44.4
3	–	18.2	18.2	18.2	30.9	12.7
4	–	11.1	11.1	-11.1	19.9	31.0
5	-85.8	-2.1	-2.1	-2.1	13.8	15.9
6	-78.7	-32.5	-32.5	-32.2	8.4	40.6
7	-76.1	–	-76.1	-43.0	4.1	47.1
8	-68.8	–	-68.8	-43.0	0.0	43.0
9	-63.7	–	-63.7	-43.0	-3.7	39.3
10	-66.3	–	-66.3	-42.0	-7.5	35.5
15	-53.5	–	-53.5	-42.7	-24.8	17.9
20	-42.6	–	-42.6	-39.8	-41.2	-1.4
25	-49.2	–	-49.2	-42.1	-57.1	-15.0
30	-90.1	–	-90.1	-43.0	-72.3	-29.3
35	-79.7	–	-79.7	-43.0	-87.8	-44.8
40	-70.6	–	-70.6	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 1°

TARGET DEPTH = 80 FT
DSL DEPTH = 1200 FT

Table 16. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

Range KYDS	Surf. & Bottom Reverb DB	DSL Reverb DB	Total Reverb DB	Bkgrnd Lvl DB	Echo Level DB	Echo/Background Lvl. DB
1	9.7	-34.7	9.7	9.7	46.4	36.7
2	—	14.3	14.3	14.3	38.1	23.8
3	—	17.1	17.1	17.1	30.9	13.8
4	—	8.5	8.5	8.5	19.9	11.4
5	-82.5	-5.1	-5.1	-5.1	13.8	18.9
6	-76.6	-34.4	-34.4	-33.8	8.4	42.2
7	-74.7	—	-74.7	-43.0	4.1	47.1
8	-74.5	—	-74.5	-43.0	0.0	43.0
9	-66.6	—	-66.6	-43.0	-3.7	39.3
10	-60.6	—	-60.6	-43.0	-7.5	36.5
15	-53.1	—	-53.1	-42.6	-24.8	17.8
20	-30.6	—	-20.6	-30.4	-41.2	-10.8
25	-24.0	—	-24.0	-24.0	-57.1	-33.1
30	-87.8	—	-87.9	-43.0	-72.3	-29.3
35	-84.4	—	-84.4	-43.0	-87.8	-44.8
40	-101.1	—	-101.1	-43.0	-102.6	-59.6

Flow Noise at 25 KTS = -43.0 DB RE 1 μBAR
Azimuth Steering Angle = 10°

Target Depth = 80 FT
DSL Depth = 1200 FT

Table 17. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB. DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	5.2	3.2	7.3	7.3	46.4	39.1
2	—	10.8	10.8	10.8	38.1	27.3
3	—	12.7	12.7	12.7	30.9	18.2
4	—	1.1	1.1	1.1	19.9	18.8
5	-29.6	-9.4	-9.4	-9.4	13.8	23.2
6	-69.9	-39.0	-39.0	-37.5	9.4	45.9
7	-57.1	—	-57.1	-42.8	4.1	46.9
8	-11.7	—	-11.7	-11.7	0.0	11.7
9	-13.4	—	-13.4	-13.4	-3.7	9.7
10	-14.3	—	-14.3	-14.3	-7.5	6.8
15	-51.6	—	-51.6	-42.4	-24.8	17.6
20	-24.9	—	-24.9	-24.9	-41.2	-16.3
25	-29.1	—	-29.0	-28.8	-57.1	-28.3
30	-64.0	—	-64.0	-43.0	-72.3	-29.3
35	-63.2	—	-63.2	-43.0	-87.8	-44.8
40	-57.6	—	-57.6	-42.8	-102.6	-59.8

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
A... ... STEERING ANGLE : 30°

TARGET DEPTH : 80 FT
DSL DEPTH : 1200 FT

Table 18. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	3.7	3.0	6.4	6.4	46.4	40.0
2	—	9.7	9.7	9.7	38.1	28.4
3	—	11.4	11.4	11.4	30.9	19.5
4	—	2.6	2.6	2.6	19.9	17.3
5	-69.2	-10.6	-10.6	-10.6	13.8	24.4
6	-29.8	-40.5	-29.9	-29.5	8.4	37.9
7	-15.6	—	-15.1	-15.1	4.1	19.2
8	-18.1	—	-18.1	-18.1	0.0	18.1
9	-16.1	—	-16.1	-16.1	-3.7	12.4
10	-14.7	—	-14.7	-14.7	-7.5	-7.8
15	-61.7	—	-61.7	-43.0	-24.8	18.2
20	-26.4	—	-26.4	-26.4	-41.2	-14.8
25	-30.7	—	-30.7	-30.5	-57.1	-26.6
30	-64.4	—	-64.4	-43.0	-72.3	-29.3
35	-63.7	—	-63.7	-43.0	-87.8	-44.8
40	-58.3	—	-58.3	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 45°

TARGET DEPTH = 80 FT
DSL DEPTH = 1200 FT

Table 19. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	2.2	2.0	5.0	5.0	46.4	41.4
2	—	9.4	9.4	9.4	38.1	28.7
3	—	9.8	9.8	9.8	30.9	21.1
4	—	1.2	1.2	1.2	19.9	18.7
5	-8.4	-12.4	-6.9	-6.9	13.8	20.7
6	-18.3	-42.0	-18.3	-18.3	8.4	26.7
7	-21.9	—	-21.9	-21.9	4.1	26.0
8	-27.4	—	-27.4	-27.3	0.0	27.3
9	-17.9	—	-17.9	-17.9	-3.7	14.2
10	-16.1	—	-16.1	-16.1	-7.5	8.6
15	-47.0	—	-47.0	-41.5	-24.8	16.7
20	-27.8	—	-27.8	-27.8	-41.2	-13.4
25	-32.1	—	-32.1	-31.8	-57.1	-25.3
30	-65.5	—	-65.5	-43.0	-72.3	-29.3
35	-64.5	—	-64.5	-43.0	-87.8	-44.8
40	-59.2	—	-59.2	-43.0	-102.6	-59.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 80 FT
DSL DEPTH = 1200 FT

Table 20. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

Range KYDS	Surf. & Bottom Reverb DB	DSL Reverb DB	Total Reverb DB	Bkgnd Lvl DB	Echo Level DB	Echo/Background Lvl. DB
1	12.2	-55.0	12.2	12.2	51.8	39.6
2	-	-6.3	-6.3	-6.3	32.9	39.2
3	-	18.2	18.2	18.2	24.3	6.1
4	-	11.1	11.1	11.1	16.7	27.8
5	-85.8	-2.1	-2.1	-2.1	9.1	11.2
6	-78.7	-32.5	-32.5	-32.2	2.8	35.0
7	-76.1	-	-76.1	-43.0	-3.1	46.0
8	-68.8	-	-68.8	-43.0	-8.4	51.0
9	-63.7	-	-63.7	-43.0	-12.5	30.5
10	-66.3	-	-66.3	-43.0	-16.5	26.5
15	-53.5	-	-53.5	-42.7	-35.6	7.1
20	-42.6	-	-42.6	-39.8	-53.6	-13.8
25	-49.2	-	-49.2	-42.1	-71.0	-28.9
30	-90.1	-	-90.1	-43.0	-88.3	-45.3
35	-79.7	-	-79.7	-43.0	-105.2	-62.2
40	-70.6	-	-70.6	-43.0	-109.4	-66.4

Flow Noise at 25 KTS = -43.0 DB re 1 μbar
Azimuth Steering Angle = 1°

Target Depth = 150 FT
DSL Depth = 1200 FT

Table 21. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	9.7	-34.7	9.7	9.7	51.8	42.1
2	—	14.3	14.3	14.3	32.9	18.6
3	—	17.1	17.1	17.1	24.3	7.2
4	—	8.5	8.5	8.5	16.7	8.2
5	-82.5	-5.1	-5.1	-5.1	9.1	14.2
6	-76.6	-34.4	-34.4	-33.8	2.8	36.6
7	-74.7	—	-74.7	-43.0	-3.1	39.9
8	-74.5	—	-74.5	-43.0	-8.4	34.6
9	-66.6	—	-66.6	-43.0	-12.5	30.5
10	-60.6	—	-60.6	-43.0	-16.5	26.5
15	-53.1	—	-53.1	-42.6	-35.6	7.0
20	-30.6	—	-30.6	-30.4	-53.6	-23.2
25	-24.0	—	-24.0	-24.0	-71.0	-47.0
30	-87.8	—	-87.8	-43.0	-88.3	-45.3
35	-84.4	—	-84.4	-43.0	-105.2	-62.2
40	-101.1	—	-101.1	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 µBAR
AZIMUTH STEERING ANGLE = 10°

TARGET DEPTH = 150 FT
DSL DEPTH = 1200 FT

Table 22. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	5.2	3.2	7.3	7.3	51.8	44.5
2	—	10.8	10.9	10.8	32.9	22.1
3	—	12.7	12.7	12.7	24.3	11.6
4	—	4.1	4.1	4.1	16.7	12.6
5	-79.6	-9.4	-9.4	-9.4	9.1	18.5
6	-69.9	-39.0	-39.0	-37.5	2.8	40.3
7	-57.1	—	-57.1	-42.8	-3.1	39.7
8	-11.7	—	-11.7	-11.7	-8.4	3.3
9	-13.4	—	-13.4	-13.4	-12.5	0.9
10	-14.3	—	-14.3	-14.3	-16.5	-2.2
15	-51.6	—	-51.6	-42.4	-35.6	6.8
20	-24.9	—	-24.9	-24.9	-53.6	-28.7
25	-29.1	—	-29.0	-28.8	-71.0	-42.2
30	-64.0	—	-64.0	-43.0	-88.3	-43.5
35	-63.2	—	-63.2	-43.0	-105.2	-6[illegible].8
40	-57.6	—	-57.6	-42.[illegible]	-109.4	-66.4

Flow Noise AT 25 KTS = -43.0 DB RE 1 μBAR
At [illegible] Steering Angle = 30°

TARGET DEPTH = 150 FT
DSL DEPTH = 1200 FT

Table 23. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB. DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	3.7	3.0	6.4	6.4	51.8	45.4
2	—	9.7	9.7	9.7	32.9	23.2
3	—	11.4	11.4	11.4	24.3	12.9
4	—	2.6	2.6	2.6	16.7	14.1
5	-69.2	-10.6	-10.6	-10.6	9.1	19.7
6	-29.9	-40.5	-29.9	-29.5	2.8	32.3
7	-15.6	—	-15.6	-15.1	-3.1	12.0
8	-18.1	—	-18.1	-18.1	-8.4	9.7
9	-16.1	—	-16.1	-16.1	-12.5	3.6
10	-14.7	—	-14.7	-14.7	-16.5	-1.8
15	-61.7	—	-61.7	-43.0	-35.6	7.4
20	-26.4	—	-26.4	-26.4	-53.6	-27.2
25	-30.7	—	-30.7	-30.5	-71.0	-40.5
30	-64.4	—	-64.4	-43.0	-88.3	-45.3
35	-63.7	—	-63.7	-43.0	-105.2	-62.2
40	-58.3	—	-58.3	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 45°

TARGET DEPTH = 150 FT
DSL DEPTH = 1200 FT

Table 24. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL DB
1	2.2	2.0	5.0	5.0	57.8	46.9
2	—	9.4	9.4	9.4	32.9	23.5
3	—	9.8	9.8	9.8	24.3	14.5
4	—	1.2	1.2	1.2	16.7	15.5
5	-8.4	-12.4	-6.9	-6.9	9.1	16.0
6	-18.3	-42.0	-18.3	-18.3	2.8	21.1
7	-21.9	—	-21.9	-21.9	-3.1	18.8
8	-27.4	—	-27.4	-27.3	-8.4	18.9
9	-17.9	—	-17.9	-17.9	-12.5	5.4
10	-16.1	—	-16.1	-16.1	-16.5	-0.4
15	-47.0	—	-47.0	-41.5	-35.6	11.9
20	-27.8	—	-27.8	-27.8	-53.6	-25.8
25	-32.1	—	-32.1	-31.8	-71.0	-39.2
30	-65.5	—	-65.5	-43.0	-88.3	-45.3
35	-64.5	—	-64.5	-43.0	-105.2	-62.2
40	-59.2	—	-59.2	-43.0	-109.4	-66.4

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 150 FT
DSL DEPTH = 1200 FT

Table 25. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	12.2	-55.0	12.2	12.2	51.8	39.6
2	—	-6.3	-6.3	-6.3	32.9	39.2
3	—	18.2	18.2	18.2	14.5	-3.7
4	—	11.1	11.1	-11.1	8.0	19.1
5	-85.8	-2.1	-2.1	-2.1	-3.7	-1.[illegible]
6	-78.7	-32.5	-32.5	-32.3	-11.8	20.9
7	-76.1	—	-76.1	-43.0	-19.4	23.6
8	-68.8	—	-68.8	-43.0	-26.6	16.4
9	-63.7	—	-63.7	-43.0	-33.5	9.5
10	-66.3	—	-66.3	-43.0	-40.3	2.7
15	-53.5	—	-53.5	-42.7	-71.8	-29.1
20	-42.6	—	-42.6	-39.8	-91.4	-51.6
25	-49.2	—	-49.2	-42.1	-108.9	-66.8
30	-90.1	—	-90.1	-43.0	-126.1	-83.1
35	-79.7	—	-79.7	-43.0	-143.0	-100.0
40	-70.6	—	-70.6	-43.0	-159.6	-116.6

FL. NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 1°

TARGET DEPTH = 300 FT
DSL DEPTH = 1200 FT

Table 26. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	9.7	-34.7	9.7	9.7	51.8	42.1
2	—	14.3	14.3	14.[illegible]	32.9	18.6
3	—	17.1	17.1	17.1	14.5	-2.6
4	—	8.5	8.5	8.5	8.0	-0.5
5	-82.5	-5.1	-5.1	-5.1	-3.7	1.4
6	-76.6	-34.4	-34.4	-33.8	-11.8	22.0
7	-74.7	—	-74.7	-43.0	-19.4	23.6
8	-74.5	—	-74.5	-43.0	-26.6	16.4
9	-66.6	—	-66.6	-43.0	-33.5	9.5
10	-60.6	—	-60.6	-43.0	-40.3	2.7
15	-53.1	—	-53.1	-42.6	-71.8	-29.0
20	-30.6	—	-30.6	-30.[illegible]	-91.4	-61.0
25	-24.0	—	-24.0	-24.0	-108.9	-84.9
30	-87.9	—	-87.8	-43.0	-126.1	-93.1
35	-84.4	—	-84.4	-43.0	-143.0	-100.0
40	-101.1	—	-101.1	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 10°

TARGET DEPTH = 300 FT
DSL DEPTH = 1200 FT

Table 27. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	5.2	3.2	7.3	7.3	51.8	44.5
2	—	10.8	10.8	10.8	32.9	22.1
3	—	12.7	12.7	12.7	14.5	1.8
4	—	4.1	4.1	4.1	8.0	3.9
5	-79.6	-9.4	-9.4	-9.4	-3.7	5.7
6	-69.9	-39.0	-39.0	-37.5	-11.8	25.7
7	-57.1	—	-57.1	-42.8	-19.4	23.4
8	-11.7	—	-11.7	-11.7	-26.6	-14.9
9	-13.4	—	-13.4	-13.4	-33.5	-20.1
10	-14.3	—	-14.3	-14.3	-40.3	-26.0
15	-51.6	—	-51.6	-42.[illegible]	-71.8	-28.8
20	-24.9	—	-24.9	[illegible]	-91.4	-66.5
25	-29.1	—	-29.0	-[illegible].8	-108.9	-80.1
30	-64.0	—	-64.0	-43.0	-126.1	-83.1
35	-63.2	—	-63.2	-43.0	-143.0	-100.0
40	-57.6	—	-57.6	-42.8	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 30°

TARGET DEPTH = 300 FT
DSL DEPTH = 1200 FT

Table 28. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL DB
1	3.7	3.0	6.4	6.4	57.8	51.4
2	—	9.7	9.7	9.7	32.9	23.2
3	—	11.4	11.4	11.4	19.5	8.1
4	—	2.6	2.6	2.6	8.0	5.4
5	-69.2	-10.6	-10.6	-10.6	-3.7	6.9
6	-29.8	-40.5	-29.8	-29.5	-11.8	17.7
7	-15.6	—	-15.1	-15.1	-19.4	-4.3
8	-18.1	—	-18.1	-18.1	-26.6	-8.5
9	-16.1	—	-16.1	-16.1	-33.5	-17.4
10	-14.7	—	-14.7	-14.7	-40.3	-25.6
15	-61.7	—	-61.7	-43.0	-71.8	-28.8
20	-26.4	—	-26.4	-26.4	-91.4	-65.0
25	-30.7	—	-30.7	-30.5	-108.9	-78.4
30	-64.4	—	-64.4	-43.0	-126.1	-83.1
35	-63.7	—	-63.7	-43.0	-143.0	-100.0
40	-58.3	—	-58.3	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 45°

TARGET DEPTH = 300 FT
DSL DEPTH = 1200 FT

Table 29. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

RANGE KYDS	SURF. & BOTTOM REVERB DB	DSL REVERB DB	TOTAL REVERB DB	BKGRND LVL DB	ECHO LEVEL DB	ECHO/BACKGROUND LVL. DB
1	2.2	2.0	5.0	5.0	51.8	46.8
2	—	9.4	9.4	9.4	32.9	43.5
3	—	9.8	9.8	9.8	14.5	4.7
4	—	1.2	1.2	1.2	8.0	6.8
5	-8.4	-12.4	-6.9	-6.9	-3.7	3.2
6	-18.3	-42.2	-18.3	-18.3	-11.9	6.[illegible]
7	-21.9	—	-21.9	-21.9	-19.4	2.5
8	-27.4	—	-27.4	-27.3	-26.6	0.7
9	-17.9	—	-17.9	-17.9	-33.5	-15.[illegible]
10	-16.1	—	-16.1	-16.1	-40.3	-24.2
15	-47.0	—	-47.0	-41.5	-71.8	-30.3
20	-27.8	—	-27.8	-27.8	-91.4	-63.6
25	-32.1	—	-32.1	-31.8	-108.9	-77.1
30	-65.5	—	-65.5	-43.0	-126.1	-83.1
35	-64.5	—	-64.5	-43.0	-143.6	-100.0
40	-59.2	—	-59.2	-43.0	-159.6	-116.6

FLOW NOISE AT 25 KTS = -43.0 DB RE 1 μBAR
AZIMUTH STEERING ANGLE = 90°

TARGET DEPTH = 300 FT
DSL DEPTH = 1200 FT

Table 30. ECHO/BACKGROUND LEVELS FOR 8' x 150' ARRAY

REFERENCES

1. A. Novick and R. Seegal, INTERIM REPORT ON SONAR PERFORMANCE (U), TRG-023-TM-66-16, April 1966, CONFIDENTIAL

2. D. F. Gorden and C.L. Allen, SURFACE CHANNEL LOSS CHARTS COMPUTED BY USE OF NORMAL MODES (U); NEL TM-16, July 1963 CONFIDENTIAL

3. G. S. Sprouse, EVOLUTION OF A SONAR PREDICTION MODEL CONSONANT WITH FLEET OPERATIONAL EXPERIENCE (U), NOTS-TP-3957, November 1965, CONFIDENTIAL

4. H. W. Marsh and M. Schulkin, REPORT ON THE STATUS OF PROJECT AMOS, USL Research Report No. 255

5. M. A. Pedersen, "Acoustic Intensity Anomalies Introduced by Constant Velocity Gradients", JASA, 33-465, 1961

6. "Physics of Sound in the Sea", Part 1, Transmission, NDRC Summary Technical Reports, Research Analysis Group, National Research Council.