FINAL REPORT ON PRELIMINARY FIELD TESTS OF K-BAND SCANNING-BEAM TECHNIQUE OF ELEVATION ANGLE MEASUREMENT

REPORT NO. 8284-1
Contract FAA/BRD-172
December 1961

FEDERAL AVIATION AGENCY

Bureau of Research and Development

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by

F H Battle, Jr

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ABSTRACT

Several series of tests have been made to evaluate the static performance of a technique of elevation-angle measurement based on airborne decoding of a narrow, scanning, K_u-band radio beam The tests were made over airport terrain, since the technique is intended for use in an all-weather instrument landing system. Time-shared measurements using three scanning beams and a single airborne receiver are proposed as a full-scale landing guidance system. However, one or two scanning beams, especially for vertical angle measurements, can provide useful guidance for landings.

The feasibility and accuracy of low-angle elevation measurements were investigated by these basic types of tests (1) static and dynamic lobing, showing the magnitude of the effects of ground reflections on propagation of the scanning beam, (2) static and dynamic beamshape, showing the distortion of the received signal envelope caused by reflections, and (3) receiver angle readings, showing the overall static accuracy of the experimental system. Each type of test was made at various distances and azimuths from the scanning antenna, and under varying conditions of ground moisture, vegetation, equipment installation and adjustments The resulting data are plotted as functions of elevation angle.

Optimum conditions were found to include tall grass and low installation of the scanning antenna. Factors of no appreciable significance include direction of scan, distance, relative azimuth, and ground moisture. It is concluded that the technique is feasible, and seems accurate enough for the intended application. The overall system error, under stationary conditions, tends to be about 0 02 degree.

I INTRODUCTION

A technique of angle measurement, using a narrow scanning radio beam, has been developed by Airborne Instruments Laboratory (AIL) for potential application in an advanced all-weather landing system. Although the overall system concept calls for the use of three scanning beams--for the separate measurements of two elevation angles and one azimuth angle--a substantial part of the required capability of all-weather landings would be provided by the two elevation measurements alone. Furthermore, as one of the advantages claimed for the system, all of the angles would be measured by the same basic technique, a demonstration of satisfactory performance in measuring one elevation angle (under critical conditions) should therefore suffice to prove the feasibility of the system

A series of field tests has been conducted under the sponsorship of the Federal Aviation Agency, Bureau of Research and Development, to ascertain the precision with which this technique can measure elevation angles above typical airport terrain Experimental "breadboard" equipment previously designed by AIL was installed and operated at MacArthur Airport, Islip, Long Island, New York This equipment produced a single rapidly scanning, narrow beam on K_u-band (16,000 Mc), which was received and decoded at low elevation angles over the airport surface. Since the main cause of errors was expected to be partial reflection of the beam from the ground, and since this should be largely confined to very low angles, all tests were made with the receiving equipment ground-based, no flight tests were included.

This report describes the tests that were conducted, the equipment used, and the results obtained The operational significance of the performance that has been demonstrated is best judged in relation to the intended application. In the following section, therefore, the proposed application of this angle-measurement technique in an all-weather landing system is described.

II. DESCRIPTION OF ANGLE-MEASUREMENT TECHNIQUE

A SYSTEM APPLICATION

The full-scale system concept requires one vertically scanning beam originating near the runway threshold, and another originating about 3000 feet down the runway, the necessary antennas are to be placed a few hundred feet to one side The two elevation angles relative to these sites will define the aircraft's vertical position and distance-to-go. A third beam may be scanned horizontally from a centerline location beyond the stop end of the runway to provide an accurate measurement of horizontal deviation Each beam is 0 5 degree wide in its direction of scan, and is fan-shaped to cover a 20-degree sector, also each beam is scanned through 20 degrees, so that all three can be received in succession within a pyramidic volume of the approach airspace, which is 20 degrees square (Figure 1)

The scan angle from each site is continuously encoded on the beam itself, so that the angular position of an aircraft intercepting the beam is found by decoding the beam signal The angle reference data on the beam are thus broadcast ground-to-air, and any number of airborne equipments can receive and interpret the signals directly In this respect, the technique is similar to the standard ILS and unlike GCA or any radar systems, furthermore, no DME or other airborne transmitter is necessary.

The equipment at each ground site will comprise an 8-foot pillbox antenna, driven at a speed of 10 scans per second, and three racks of encoding, transmitting, and automatic monitoring equipment. The scanners will be synchronized so that only one signal is broadcast at a time (Figure 2).

A single receiver in the aircraft receives all three beams on a time-sharing basis, and provides three corresponding outputs Each output can be used to actuate the pilot's instruments, path computer, and autopilot approach coupler The ground sites are so chosen on the airport that the measured angles are directly usable without coordinate conversion (though height and distance can be computed, if desired). One elevation angle defines the glide path, a second elevation angle varies in proportion to height and sink rate during flareout, and the azimuth angle defines deviation from the runway centerline

The operational use of the full system is illustrated in Figures 3, 4, and 5. As shown in Figure 3, an aircraft turning onto final approach at any point within 10 degrees of the extended runway centerline, and up to 20 degrees elevation, immediately receives all signals to be used for landing guidance. The wide-sector localizer (azimuth) angle measurement allows a smooth and accurate turn-on, preferably by reference to computed steering commands from a flight director. Similarly, the desired glide angle, once intercepted, can be maintained within suitably close tolerances by simply "homing" the aircraft toward the elevation scanner near the runway threshold--that is, this measured angle is required to have zero rate of change The use of angle rate as the primary error signal enhances the stability of glide control, since no fixed path need be sought and "bracketed" after a minor disturbance In the event of an excessive deviation from the intended glide angle, however, an error signal based on angle displacement can be added automatically to avoid the need for new power settings and trim

The elevation angle measured from the flareout scanner, half a mile beyond the runway threshold, represents stand-by information during the initial glide. This measurement is visually and automatically monitored--first to confirm its quality, and second to detect the need for flareout initiation. When flareout initiation is scheduled for any particular distance-to-go, the flareout trigger is provided by a specific relationship of the two measured elevation angles; most simply, a pitch-up signal is made to occur upon the attainment of a preselected flareout elevation angle

Just before flareout, the true ground speed can be computed from a continuous automatic comparison of the two elevation angles. In one form of flare controller, the speed provides a basis for accurate dead-reckoning of distance-to-go during the flareout. In a simpler form of controller, any deviation from an acceptable range of speeds would actuate a wave-off alarm

During the flareout maneuver, as shown in Figure 4, alignment with the runway is maintained, and the rate of descent is decreased to the low value required for touchdown With the initial glide accomplished and flareout initiated, the forward elevation measurement is relinquished, and the vertical maneuver is completed by reference to the rear elevation angle and to distance-to-go

As implied earlier, various means can be devised to use these basic positional data for the control of landings. In sophisticated applications to high-performance aircraft, or for landings on short runways, it would be desirable to take advantage of the performance capabilities of the aircraft so as to land near the runway threshold. For this purpose, a flareout path computer in the aircraft could provide a reference trajectory much shorter than the simple exponential path that is usually proposed, certainly the aircraft is capable of more efficient maneuvers. In cases where the added complication is warranted, any desired trajectory could be computed, and appropriate signals coupled to the autopilot and instruments, the attitude gyro signals could be used in conjunction with height and distance, derived by conversion of the scanning-beam angular measurements to rectangular coordinates

For conservation of runway length, it is also desirable to establish the initial glide toward, or just inside, the runway threshold. One advantage of scanning-beam guidance for the glide slope would be the ability to site the scanner near the threshold at all locations, thereby allowing simple homing on the signal source, and maximum utilization of the runway.

Although the scanning-beam data might be converted to rectangular coordinates for the more stringent applications of the technique, some computer simulation work has indicated that the angular form is directly usable. An attractive possibility is the addition of a flareout and landing capability to the present ILS system by installation of a single scanner for measurement of the rear elevation angle (as it is shown in Figures 3, 4, and 5) This method would not exploit the full capabilities of scanning-beam guidance, such as runway conservation, but would be immediately useful

In this method, a controlled transition between the flareout trigger value of the rear elevation angle and a preselected touchdown value of this angle is enforced For example, the measured angle and its rate of change can be decreased exponentially, by proper pitch control of the aircraft, in response to signals representing deviations from a prescribed ratio of the angle and its rate The simple exponential controller can be replaced by a terminal controller that also operates on angle rate, according to a slightly more complicated relationship As another alternative, control can be based on a prescribed program of height and distance-to-go, which are computed from the measured elevation angle and, knowing the ground speed, from elapsed time after flareout initiation

However the flareout is controlled, it will begin soon enough to ensure reaching the terminal glide angle desired for touchdown with several seconds yet to go. This status depends on a conservative maneuver that is compatible with the control characteristics of each aircraft, for which the point of flareout initiation must be appropriately chosen. The terminal glide to runway contact can be maintained, as shown in Figure 5, by holding a constant angle as measured from the flareout scanner. Since this angular origin is only about 5 feet above the runway level, touchdown will inevitably occur in front of the scanner if the airborne antenna for the scanning-beam receiver is more than 5 feet above the wheels (Even if the antenna is lower than this, a constant pitch attitude can be held until touchdown, after bypassing of the scanner site causes the guidance signal to drop out) The nominal (gust-free) touchdown point can be precomputed for the chosen final glide angle and the existing antenna height, allowing for typical dispersion of touchdown, the moment of contact is thus predictable within 1 or 2 seconds of elapsed time from flareout initiation, and a decrab maneuver can be scheduled on this basis After touchdown is accomplished, the localizer scanning-beam signal provides steering information for control during the deceleration roll.

B IMPLEMENTED TECHNIQUE

The preliminary field tests at MacArthur Airport were intended only to demonstrate the capabilities of the angle-measurement technique under static (ground-based) conditions For this purpose, a single elevation-scanning antenna was installed, and simplified receivers (not providing for time-shared reception of several beams) were operated at surveyed locations above the airport surface

The transmitting and receiving electronic equipment, together with suitable test instruments, were installed in trucks to facilitate changes in test locations and methods Tests of beamshape and basic propagation effects were usually made with the scanning antenna (or a horn at the same location) connected to a receiver, and with a transmitter at various locations on the field, uncoded pulse transmissions were used for these tests Static tests of system performance, using coded transmissions and angle-decoding and tracking receivers, were then made by transmitting from scanning antenna to receiver in the normal manner.

More detailed descriptions of these test facilities are included in Appendix A.

C GROUND-BASED EQUIPMENT

The ground-based equipment used for the field tests comprised an experimental implementation of only one of the three ground sites required for a full-scale system. Detailed descriptions of the components are included in Appendix B.

The scanning antenna is shown in Figure 6. An 8-foot parabolic pillbox array is driven by a counterbalanced linkage assembly so as to nod through a 40-degree sector at an adjustable rate of 5 to 10 scans per second (using both upward and downward scans). The central 20 degrees of this sector, in which the speed is nearly constant, is used for radio signal transmission The turn-around time between successive scans is twice the active scan time, and would allow similar transmissions from two additional scanners while the first is silent.

The instantaneous tilt angle of the scanning antenna is determined by photoelectrically reading an engraved scale fixed to the side of the pillbox The scale is marked at 0.01-degree increments of scan angle, and 2000 marks are tallied in a digital counter as the 20-degree sector is traversed. At every instant during the scan, therefore, the stored count is proportional to the angle. During the antenna turn-around after each scan, an automatic check is made to confirm that 2000 marks were counted, otherwise, an alarm is triggered

Figure 7 shows the experimental angle-data encoder (as repackaged after the field tests). The encoder continuously samples the instantaneous value of the stored antenna count, which it uses to control the elapsed time between the transmission of successive pulses by the RF transmitter. The pulse spacing is thus varied so as to represent the scan angle in accordance with the code illustrated in Figure 8. A continuous stream of pulses is always produced, but during each scan of the antenna through the 20-degree sector, the pulse spacing varies at a uniform rate of 4.00 μsec per degree--from 16 μsec at zero degrees to 96 μsec at 20 degrees The quantity that varies linearly with scan angle is the pulse interval (which is directly measured by the airborne receiver), and the pulse rate therefore varies nonlinearly between limits of 10.417 kc and 62.500 kc.

The pulse modulator used in the field tests was of the hard-tube type The modulator and associated power supply were designed with adequate bandwidth and regulation to pulse a klystron transmitter at high (and variable) PRF, maintaining amplitude and frequency variations within acceptable limits The modulator and klystron (or, for some tests, the front section of a receiver) were mounted in a small box attached to the scanner assembly, and the output radio signals were conducted to the feed point on the scanning pillbox through waveguide An air-gap coupling between two flanges of the waveguide served the function of a rotary joint.

A more detailed description of the ground-based equipment is included in Appendix B

Figure 9 is a plan drawing of a section of MacArthur Airport, showing the sites that were used for the tests. The scanning antenna was installed on a concrete slab at the scanner site designated at the left edge of the drawing. For a few of the early tests, the azimuthal centerline of the antenna was aligned with site 1, for most tests, however, the antenna centerline coincided with the test radial through sites 5, 2, etc. An elevation profile of this radial is given in Figure 10, and a profile of the radial through site 1 in Figure 11. Figure 12 is a profile of the test line parallel to Runway 10, through sites 1, 11, 12, 13, and 14.

Except for the scanning antenna (and the attached data pickoff and transmitter or receiver units), the equipment was mounted in trucks The truck containing the ground-based encoder was parked beside the scanner, and a second truck pulled a trailer-mounted tower to various test sites on the airport.

D. ANGLE-DECODING EQUIPMENT

Two models of the angle-decoding and tracking receiver were used during the test period Most of the tests were made with receiver Model A, a breadboard model incorporating all of the essential circuit functions except automatic calibration control Autocalibration was provided, together with some circuit changes, in breadboard Model B. In Model A, provisions were included for manual calibration of the angle-decoding and tracking circuits against an internally generated pulse train with a crystal-controlled pulse spacing. The receiver was manually calibrated before each test run, and was rechecked upon completion of the run.

Each model of the receiver was split into two units, exclusive of power supplies. The front end, containing the RF mixer, klystron local oscillator, and IF preamplifier, was packaged separately, so that it could be raised to various heights on the test tower Its output was connected by coaxial cable to the main unit, which contained the IF amplifier proper and all other circuit elements. The measured elevation angle was represented by the DC output voltage of the receiver, using a scale factor of 1.00 volt per degree.

The memory-reference (center-of-gravity) tracking technique inherently provides hold-over of the output voltage from each scan to the next, so that the angular data are continuously present at the output The tracking circuit could be adjusted to provide any fraction of the full correction increment, in response to an error detected upon the passage of a scanning beam, an adjustment resulting in less than full scan-to-scan corrections affords smoothing of the output, at the expense of dynamic tracking capability Although only static tracking tests were made, a high correction factor (between 0.7 and unity) was maintained. No external damping was applied when test results were chart-recorded; however, an estimated average was taken of voltmeter output readings that fluctuated 0.01 or 0.02 degree, as often happened

A more detailed description of the receiver functions is included in Appendix B.

III. DESCRIPTIONS AND RESULTS OF TESTS

A. BEAMSHAPE AND PROPAGATION EFFECTS

Four types of measurements were made to investigate beamshape and propagation effects over the typical airport surface at MacArthur Airport These were

1. Static Lobing--field intensity versus geometric (optical) elevation angle from transmitter to receiver, using broad-beam (20-degree) horns at each site to virtually eliminate effects of antenna directivity.
2. Dynamic Lobing--field intensity versus instantaneous scanner elevation angle, the intensity being measured when the peak of the scanning beam strikes a probe fixed at various heights in turn.
3. Static Beamshape--field intensity versus geometric elevation angle, with the directional beam stationary at a nominal elevation angle
4. Dynamic Beamshape--the intensity envelope received as the scanning directional beam passes entirely over a probe at a fixed height

1. Test Objectives and Procedures

In all cases, the scanner site near the southwest corner of the airport (Figure 9) served as one end of the transmission path. Except for static lobing tests, the directional antenna of the scanner was used for transmission or reception at that site. (Since reciprocity applies to all propagation measurements, the direction of transmission was chosen as most convenient for each type of test) At the field end of the path, a broad horn antenna was invariably used to probe the signal field, the 20-degree vertical half-power beamwidth of this horn should be typical for airborne installation, and is not believed to have suppressed any reflection effects (For Static Lobing tests, such horns were used at both ends of the path) At each field site, the probe horn was raised on a pole to various heights, painted markings on the pole provided 1-foot calibration intervals, and estimated fractions of a foot were sometimes recorded. [illegible] attempted.

At the beginning of the field-test program, all prospective test sites and radials were included in an elevation survey, using the top surface of the concrete slab supporting the scanning antenna as a height datum (Figures 10, 11, and 12). However, the heights of the probe antenna on the pole--as recorded during each test run--are only indirectly related to the same datum plane. Furthermore, for an evaluation of the low-angle performance of the scanning-beam technique, the average ground plane of the airport should determine the zero reference for elevation angle measurements. Accordingly, the angle of greatest interest cannot be computed directly from the heights and distances recorded on the data sheets.

Table I (on page 41) allows direct conversion of the recorded height, in feet, to elevation angle, in degrees. The tabulated angle is the geometric angle between the pole-mounted horn and a plane parallel to the average ground plane, at the height of the center of the scanning antenna This is the "geometric angle" shown in Figure 13 The conversions in Table I are based on. (1) the assumption of a "ground-parallel" plane for each test radial, (2) the height of the ground at each test site relative to that plane, as indicated in Figures 10 and 11, and (3) allowance for the 18 inches by which the foot of the pole was raised above the ground onto its trailer mounting. As an example, the tabulated angle corresponding to a height on the pole of 38 feet at site 5 (1500 feet from the base scanner) is 1.24 degrees, this was obtained by deducting, from 38 feet, the 5 5 feet by which the zero mark on the pole underlies ground parallel at site 5 (Figure 10), then dividing by 1500 feet, and then converting radians to degrees.

For a few tests, the scanning antenna (or horn) was elevated above its normal position, in such cases, the additional height should be subtracted from that of the pole-mounted probe antenna before using Table I.

In all tests of beamshape and propagation effects, the relative signal strengths were measured with an AIL Type 03060 piston attenuator in the 60-Mc IF channel of the receiver. The geometric elevation angle to the pole-mounted horn antenna could be computed as described above

The nominal scan angle, being the mechanical tilt of the pillbox antenna array, was read from the photoelectric pickoff scale attached to the array This scale carries engraved marks at 0.02-degree intervals of antenna tilt, each mark being nearly 0 01 degree wide. By either visual or photoelectric counting of both edges of the marks, the relative tilt angle can be determined within 0 01 degree at all times The absolute tilt angle was determined by the initial adjustment of the pickoff aperture relative to the scale, using a spirit level to maintain the pillbox antenna plumb.

For dynamic tests, the instantaneous tilt angle of the rapidly scanning antenna was correlated with the signal strength variations (resulting from the changes in scan angle) by reference to the Angle Increment Counter section of the Encoder (Appendix A) The Encoder includes a sensing matrix controlled by toggle switches in such a way that a trigger can be obtained from the counter as the scan angle passes through any selected 0 01-degree increment. This trigger intensified an oscilloscope trace, so that the signal amplitude being displayed on the scope at the instant the trigger occurred was very accurately associated with the selected scan angle. The attenuator normalized the amplitude of the intensified portion of the displayed signal, for various selected angles in turn, and the corresponding changes in attenuation were recorded to represent relative amplitude as a function of scan angle.

Static Lobing tests were made with a horn antenna substituted for and mounted within a few feet of the scanner, at the exact height of the center of the pillbox aperture (or at a measured deviation from this height, in some cases). Relative signal strength was then recorded as the probe horn antenna was moved to successive calibrated heights on the pole.

The Static Lobing measurements were independent of the characteristics of the scanning-beam technique, except for the K_u-band operating frequency, therefore, they cannot provide direct criteria of performance. They do, however, provide indications of the isolated effects of the terrain itself--in particular, the effective coefficients of reflection for various stretches of intervening ground and various conditions of measurement

The tabulated data from 21 Static Lobing tests are included in Appendix D. Plots of the data from specific tests are also included and will be discussed.

Dynamic Lobing tests were made with the scanning antenna operating. With the probe antenna held at various heights on the pole, the relative signal strength was measured at the peak of the amplitude envelope that was received as the scanning beam passed over the probe Since an entire test run of this type required only 1 or 2 minutes, it was assumed that the transmission power remained constant; the variations in peak-of-beam signal amplitude should therefore be attributable to ground lobing, as modified by the variable illumination of the ground during the scan.

The Dynamic Lobing tests were made with the energy confined in the directional radiation pattern that characterizes the system, and should therefore allow predictions of the effects of reflections on system performance. However, an absolute correlation of these lobe structures with performance would be difficult, and a more direct measure of their effect is afforded by other tests (Dynamic Beamshape), the chief reason for Dynamic Lobing measurements was, therefore, to obtain a relative check on propagation conditions, from day to day and from site to site These tests were also more convenient than Static Lobing tests to intersperse with others, because the same antennas and test setup could be used

Static Beamshape tests were made by fixing the scanner tilt at a low angle, and probing the vertical field pattern with the pole-mounted horn Only a few tests of this type were made, because the static beamshape, as distorted by reflections resulting from constant illumination of the ground, is not at all similar to the apparent or "dynamic" beamshape encountered in normal system operation A scanning beam continuously varies the distribution of energy illuminating the ground, and reception normally occurs at a point that is practically stationary during each complete scan. In contrast, the Static Beamshape was measured with a fixed beam and a moving probe, the resulting patterns are of academic interest only.

The Dynamic Beamshape tests were made with the probe transmitting from various heights on the pole, using the angle-selector switches on the Encoder, as described earlier, to identify angles within the received beam envelope and to measure the corresponding normalized amplitudes By this method, data describing the complete beam envelope were recorded within 1 or 2 minutes, and the short-term stability of the transmitted signal seemed adequate to ensure good precision of measurements. (In some of the early tests, however, the precision suffered because of low signal-to-noise ratio, this was later improved.)

The bulk of the investigation of propagation effects consisted of Dynamic Beamshape tests, of which nearly 200 were made, the tabulated data are included in Appendix D. The scanning-beam receiver is designed to determine the center-of-gravity angle within the amplitude envelope received during each scan, these measurements of dynamic beamshape should therefore allow predictions of the errors in angle measurement caused by ground reflections alone--that is, independent of angle-decoding and tracking errors.

The azimuthal antenna pattern of the scanning array was shaped by the addition of "flaps" adjacent to the vertical edges of the pillbox aperture These flaps were arbitrarily chosen to provide some confinement of energy in the horizontal plane, and thus to reduce reflections from nearby structures Although the azimuthal pattern used for the test program was not necessarily optimum (and could easily by changed), an approximate measurement of it was made For this purpose, the probe horn antenna was fixed near the top of the test pole, which was kept near the scanner to maintain a high elevation angle (clear of ground reflections). The pole was first towed past the scanner along a short circular arc, with the probe always facing inward. To obtain a greater range of azimuth angles, it was then towed past along a surveyed line, and compensations for distance and attitude of the probe horn were computed (Table II). In each case, the peak-of-beam amplitude of the scanning beam was measured as the probe arrived at previously surveyed azimuth angles.

2. Test Results

A wide variety of Static Lobing patterns has been obtained at the various test sites, depending on the conditions of measurement Figure 14 shows one of the more conventional results, in comparison with a curve computed for the geometric situation and coefficients of reflection giving the best match The comparison indicates that the coefficient of reflection during this particular test was about 0 85 at the angle of the first null, and that the fixed horn was about 5 5 feet above the equivalent idealized ground plane shown in Figure 11, the fixed horn in this case was at the normal height of the center of the scanner. From Figure 11, it is apparent that our choice of an arbitrary ground-parallel plane as an angular reference did not correspond very well with propagational behavior under the conditions of this test. However, as the following discussion will show, slight changes in test conditions can cause radical changes in the lobing structure, we therefore chose to retain our arbitrary reference, which was based on the actual ground contours

Figures 14, 15, and 16 show how the lobing pattern changes for different heights of the fixed radiator The changes in spacing between peaks and nulls are as predicted by theory However, the changes in amplitude were greater than expected, the effective coefficient of reflection evidently increases as the position of the radiator (or scanner) is raised Since horizontal polarization is used, the reflection coefficient produced by an ideal smooth plane should decrease very slightly, rather than increase. The surface of the airport itself did not seem rough, and, in any case, Rayleigh's criterion would lead one to expect a contrary result. Later tests indicate that grass was responsible, as discussed in the following paragraphs.

It was found that no consistent lobing pattern could be obtained at a given test site over a long period. Figure 17 shows the mean lobe structure prevailing at one site, as determined from eight tests in a five-week period, it also shows the test result least similar to this mean At certain times, also, the lobing was found to be practically nonexistent.

At least when the grass is long, the influence of surface moisture from rainfall on propagation effects seems negligible (see the plots in Figure 18). These measurements were made just before and after a heavy rain shower. Before the shower, no rain had fallen for more than a week, and only a light sprinkle had fallen when the first test was completed. The second test was made a few hours later, after the ground was thoroughly wet.

The effect of grass is confirmed by Figure 19. It is believed that grass of the height normally found on airports interposes a significant degree of screening above the actual surface Since only angles of near-grazing incidence are involved in the various tests (and in the system application), even a sparse stand of grass a few inches high has considerable effect This hypothesis is consistent with the previously noted effects of elevation, within the limits of our tests, the lower a radiation source is placed, the more grass must be penetrated by energy reflected from the ground--hence the more attenuation of reflections.

Unfortunately, this cause of the variable results of our several types of tests was confirmed rather late in the measurement program, and no exact record had been kept of the airport's grass-cutting schedule. Furthermore, it is difficult to conduct controlled experiments to determine the exact effects of grass--partly because it grows slowly, and partly because its quantitative measurement is not readily achieved.

The Dynamic Lobing tests, as mentioned before, should afford better indications of the effects of reflections on system performance than Static Lobing tests provide. However, no exact correlation with overall system performance has been discovered, but rather a qualitative dependence of system errors on the strength of lobing is apparent.

A typical Dynamic Lobing pattern is shown in Figure 20. The amplitude variation is much less than that of the static lobing pattern in Figure 14, though the two measurements were made one day apart over the same test range.

Variations in Dynamic Lobing from day to day are illustrated by Figure 21, which is a composite plot of three individual patterns and their mean, taken over a one-month period. (Test No 218 was made with short grass) Although there is considerable variation among the results, a definite lobing structure is evident in the mean plot.

The Dynamic Lobing measurements plotted in Figure 22 were obtained in a three-day period along a single test radial, but at different distances from the scanner site. The amplitude of variations in signal intensity increases with distance, however, an aircraft following the more distant portion of a normal approach path would be high enough in elevation angle to avoid the worst fluctuations--those shown in the plots for 3900 feet and 3000 feet.

When the directional beam is held stationary at various low angles, its shape is distorted by reflections, as illustrated by the Static Beamshape plots in Figures 23 through 26. This form of distortion, however, is not directly detectable in the system application Instead of fixed illumination of the ground and a varying geometric angle, an airborne receiver sees varying illumination of the ground from a fixed geometric point--which is evidently a more stable situation.

Figures 27 through 31 are plots of the dynamic beamshape detected by the receiver as the beam scans past, Figure 32 is a set of similar plots for a different test site. The angle-decoding and tracking circuits of the receiver are designed to find the center of gravity--that is, the centroid of energy distribution--within the portion of such an envelope that contains a specified amount of energy and that has maximum amplitude. In other words, the receiver discards the low-level skirts of the beam envelope--say below the 3-db points--but integrates the central portion (at full received amplitude) in a differential circuit that determines the center of gravity of that central portion.

By graphical analysis of typical Dynamic Beamshape plots, it was found that the center-of-gravity angle defined above was nearly the same as the median angle between 3-db points--which is easily determined by inspection of each plot. The difference between this median angle of the received beam envelope and the geometric angle to the test probe can be interpreted as the probable system error due to ground reflections (though this is not well confirmed by later tests using the receiver) Accordingly, the 3-db median angle errors were determined graphically from several series of plots such as Figure 32 The results are shown in Figure 33 (based on Table III).

Comparison of Figure 33 with the Dynamic Lobing patterns in Figure 22 proves disappointing, insofar as any exact correlation is concerned. At various distances, the average magnitude of angular shift in the beam center is roughly proportional to the strength of lobing, as would be expected. Considering the different spans of time required for the two types of measurements, it is perhaps too much to expect a point-for-point correlation.

Figure 34 represents a further attempt to interpret the results of our propagation measurements more quantitatively. The lower plot from Figure 33 is reproduced, together with receiver errors theoretically predicted for the same test range. An electronic computer was programmed to calculate the shift in center of gravity of the beam as a function of receiver height, using assumptions as noted in Figure 34 The dashed line shows the result for a point source at the center of the scanning array, whereas the solid line represents a combination of sources better simulating the actual distributed source Again, no convincing correlation is apparent, however, this comparison indicates that the receiver errors will theoretically be less than might be predicted from Figure 33--a possibility that is further supported by the results of subsequent receiver tests

The approximate azimuth pattern of the scanning beam is plotted in Figure 35 (Table II) As stated earlier, no attempt was made to optimize this pattern, its exact shape is not considered critical for ground-based testing. The half-power beamwidth is between 20 and 25 degrees, and provides adequate long-range coverage. The pattern of an operational scanner should be asymmetrical (such as cosecant-squared), so that the signal intensity throughout the touchdown zone over the runway is sufficient and reasonably constant.

B. RECEIVER ANGLE READINGS

The field measurements of receiver angle readings were actually tests of overall system performance--though only in the lowest (and most critical) range of elevation angles, and only with the receiver stationary The receiver tests depended on reception of the scanning beam at distances and angles typical of the proposed landing-system application. Under these conditions, the measured error is the net effect of errors from various sources, such as angle pickoff at the scanner, encoding, ground lobing, noise, and receiver calibration

As stated earlier, two breadboard models of the AIL angle-decoding receiver were used in the test program. The Model A receiver, lacking automatic calibration control, was useful in testing the consistency of system performance in all respects except stability of the receiver calibration. The Model B receiver was electrically identical with the proposed flyable model, and the absolute accuracy of its angle readings was therefore of interest

1 <u>Test Procedures</u>

Most of the receiver tests were made at the same surveyed test sites that were used for the beamshape and propagation measurements. Figure 36 is a block diagram of the equipment setup used at each site

The platform on which the receiver antenna and front end were raised on the test pole was equipped with a switch, so positioned that it was actuated by studs placed at 1-foot intervals of height In addition, the pole was painted in 1-foot bands, alternately orange and white, to allow accurate determination of receiver height and subsequent calculation of the actual elevation angle

Before each test, about 15 minutes was allowed for receiver warmup, and various receiver waveforms and voltages were checked. For tests with the Model A receiver, calibration adjustments were made before each series of tests. One part of the calibration procedure was to substitute DC voltages, representing exactly zero and 4 degrees in turn, for the output signal from the pulse-spacing decoder, and to adjust the tracking circuit so that the identical voltages were obtained from the angle memory. The procedure was completed by introducing a simulated beam signal at the second detector, and adjusting the decoder to obtain correct angle readings at the receiver output. The simulated signal was a periodic burst of pulses with a crystal-controlled spacing of either 16 or 32 µsec (for zero or 4 degrees), as selected, each burst was amplitude modulated to resemble a received beam signal Using the 16-µsec pulse spacing, the reference voltage of the decoder was adjusted to produce a zero angle reading Using the 32-µsec spacing, the decoder scale factor (sawtooth slope) was then adjusted to produce a 4-degree reading. Several repetitions of these adjustments were necessary because their effects were interactive The accuracy of the resulting initial calibration was held within 0 01 degree, and any larger errors found during a series of tests were recorded on the data sheets.

The Model B breadboard receiver, which had automatic calibration control, was not generally recalibrated before individual test series, though frequent checks were made of its calibration. (Separate laboratory power-supply units provided positive and negative voltages to the receiver, and minor adjustments were made whenever necessary to maintain balance between these voltages. In the multiple power supply designed especially for the receiver, such adjustments are obviated by the use of a common reference for voltage regulation) Some tests were made with this model before a proper adjustment of the autocalibration circuits was achieved, and in these cases the calibration errors were recorded In the final two weeks of testing, however, the automatic calibration control was usually effective and accurate.

Approximate measurements of signal-to-noise ratio were occasionally made. The receiving antenna was raised to the top of the pole, and the receiver IF gain was set to produce a 2-cm oscilloscope deflection on noise alone. The attenuation then required to reduce the peak-signal deflection to 2 cm was measured with the 60-Mc attenuator (Figure 36), and was recorded as signal-to-noise ratio.

Receiver angle rea i ngs at each site were determined at 1-foot increments of height on the pole, generally starting at the maximum height of 38 feet. The manually recorded data were read from the Fluke voltmeter, after a voltage null was obtained in each case Sometimes the angle readings were simultaneously recorded by the Brush pen recorder.

2. Test Results

The original data obtained in all receiver tests are listed, separately for the two models of the receiver, in Appendix D Plots of individual test results are presented in cases that are considered significant--either as typifying a set of results, or as showing the effects of some special test condition These plots show receiver angle reading (original data) versus angle above ground parallel, since one-to-one correspondence of these angles is lacking, they must be correlated by means of the "heading" data for each test, using Figure 13 and Table I. (Figure 13 and Table I are discussed on page 14)

As indicated in Figure 13, the geometric angle (angle above ground parallel) did not, in general, correspond with the angle encoded on the scanning beam At some field locations the test receiver could be lowered below the ground-parallel plane, to allow measurements at such depressed elevations, the zero-degree limit of the transmitted data sector was set at an arbitrary "sub-zero" angle. Ideally, therefore, the receiver angle reading should be the sum of the geometric elevation and the sub-zero angle.

Results obtained with the Model A breadboard receiver are shown in Figures 37 through 59. The sub-zero angle is indicated by a dot on the zero-degree ordinate of each graph, a 45-degree line through this point would represent the ideal receiver reading as a function of actual elevation.

Two shortcomings of the Model A receiver are apparent in many of the test results (1) a considerable "bias" error was frequently present throughout an individual run, causing a fixed deviation of the angle readings from the expected absolute values, and (2) a slow drift in receiver calibration tended to occur during the several minutes required to complete a run Although most of the drift error was definitely attributed to temperature variations, the cause of the bias error was never established with certainty, it was intermittently present, and appeared as a discrepancy between the effect of actual beam reception and the effect of operation with the synthetic signals used for receiver calibration.

The provision for automatic calibration control in the Model B breadboard was anticipated, during the initial system design, as a requirement to guard specifically against bias and drift errors. Since the autocalibration feature has proven effective, adjustments of the test data obtained with the Model A breadboard so as to simulate the autocalibration function would allow a more valid assessment of system capabilities. The manual calibration checks showed how each set of results should be adjusted, and such adjustments are implied by the dashed reference lines in Figures 37 through 59. (However, no adjustments have been applied to the plots themselves, the actual receiver readings are shown in every case) In each case, the slope of the reference line differs from 45 degrees to compensate for the measured calibration drift, which autocalibration would have prevented. The reference line is also displaced to compensate for the bias error, which must be ascribed to intermittent malfunctioning of the Model A receiver. Deviations of the actual readings from the dashed line are therefore equivalent to the errors expected with autocalibration and a properly functioning receiver--at least insofar as the variation of error as a function of elevation is concerned.

Figures 37, 38, and 39 show examples of the results obtained with the Model A receiver at various distances from the scanner, as the RF section was lowered, in 1-foot steps, from a height of about 38 feet The effects of reflections at angles below 1/2 degree are apparent, in particular, Figure 38 shows a strong effect of reflections at site 2, even at an elevation as high as 0.8 degree Although these results are typical, the data were not generally repeatable from day to day However, good agreement was obtained between test runs made on the same day at a given site, errors of observation are therefore ruled out as a major source of inconsistency. As in the case of lobing and other propagation measurements, it was concluded that the results were very sensitive to the condition of the terrain.

Figure 40 shows another example of the receiver readings obtained at a distance of 1500 feet (site 5) under typical test conditions The effect of raising the scanning antenna only 16 inches above its normal position is shown in Figure 41, a slight but noticeable roughness in angular gradient is introduced--presumably by the stronger ground lobing illustrated by Figure 15, as compared with Figure 14.

While the scanner was still elevated as for Figure 41, the grass on the intervening ground was cut, and the test at site 5 was then repeated, the results are shown in Figure 42 The strongest ground reflections, which occur at low angles, had evidently been subdued by the screening effect of the grass (Figure 41), but caused significant errors below 0 3 degree when the grass was shortened (Figure 42)

On the following day, the scanner was lowered to its normal position, and the test at site 5 was again repeated Figure 43 shows that the low-angle readings became less erratic when the center of radiation was lowered, however, with shorter grass, the linearity of angle readings above 0 2 degree is slightly worse than it was originally (Figure 40).

Figure 44 shows low-angle readings obtained at an extremely long range (3580 feet, site 10), with the scanner elevated and the grass on part of the ground freshly mowed (The test pole was not high enough to reach the angular region that will normally be of operational interest at this range.) As a crude test of the ability of artificial ground screening (or "fences") to reduce reflection errors, a single automobile was later parked where it would block part of the scanner radiation from some of the intervening ground (on the test radial just beside the ILS Glide Slope--Figure 9). A definite tendency toward reduction of the errors is noticeable in Figure 45

Some control over the shape of the received beam envelope is afforded, at low angles where ground reflections cause distortion, by variation of the angular limit of beam transmission For example, if transmission ceased during the downward scan (and resumed during the upward scan) just as the nose of the beam passed the aircraft, only half of the normal beam envelope would be received Several series of tests were made to ascertain what angular limit should be imposed on the lower edge of the scan sector in order to offset the effects of reflections as much as possible Two sets of the results are shown in Figures 46 and 47 It can be seen that setting the lower scan limit above the ground-parallel plane introduces more distortion at low angles than it prevents, furthermore, the errors at slightly higher angles tend to increase, but never decrease However, these tests indicate that severe degradation of accuracy can be prevented at very low angles by limiting the scan at about 0 1 degree below ground parallel

Figures 48 and 49 show the effects of alternate directions of scan on the receiver readings. Theoretically, center-of-gravity tracking (and similar methods that average the angular information received throughout each passage of the scanning beam over the aircraft) is equally accurate for either direction of the scan. In contrast, techniques that conduct a sequential sampling of the received information in search of an instantaneously correct answer, such as beam-skirt or notch triggering techniques, are dependent on the sequence in which ground reflections and side lobes occur relative to the main lobe of the beam, such techniques are best limited to downward scans, so that the strongest ground-lobe interference occurs after an answer has been obtained from the main lobe

The virtual immunity of center-of-gravity tracking from dependence on the direction of scan, even in the extreme low-angle region, is well illustrated by Figures 48 and 49 During these tests, the scanning beam was transmitted during alternate (and both) directions of scan, just long enough in each case to allow the receiver reading to be observed, this procedure was repeated at each elevation angle in turn In general, the dependence of the readings on direction of scan amounts to less than ± 0.02 degree (Tests have shown that this small discrepancy was caused by slight unbalance in the tracking circuits)

The angle readings obtained as the receiver was brought into the near field of the scanning antenna are shown in Figures 50 through 53. The square of the aperture divided by the wavelength (a^2/λ) is about 1000 feet, in an operational situation, with the scanner several hundred feet off the runway, operation within this distance should rarely be required. Nevertheless, exceptionally good results were obtained in these tests, even at the 500-foot range (see also Figure 60).

Measurements with the Model A receiver at the offset sites on the runway-parallel line (Figures 9 and 12) are plotted in Figures 54 through 59. Although the receiver was displaced up to 37 degrees from the horizontal centerline of the scanner, the results are not markedly different from those obtained at like distances on the centerline. These readings are plotted against the offset geometric angle, which is the elevation angle measured from the virtual origin shown in Figure 9, relative to the elevation (at each offset site) of an assumed ground-parallel plane. The ground-parallel plane slopes downward from the center of the scanner toward all sites--at a depression angle of 0.17 degree, except 0.18 degree toward site 1--and the average ground level along the runway-parallel line is taken as 4.5 feet below the ground-parallel plane These assumptions represent an arbitrary but approximately correct idealization of the actual test area at MacArthur Airport. The scale factor used for the "offset geometric angle" corresponds to the angular coding on the scanning beam, the "sub-zero angle" indicated on each plot represents, as before, the angle value that ideally should have been decoded at zero geometric angle.

Many of the tests that have been discussed were repeated with the Model B receiver As expected, the results were similar except for a general improvement in absolute accuracy of the angle readings For example, Figures 60 through 64 show the results of another series of tests at distances of 500 feet to 3000 feet, on the main test radial (Note that the origin and scale factor in Figure 60 differ from those in the other plots) In these cases, the scan sector and encoding reference were adjusted so that zero angle should have been read at ground parallel, hence, there was no sub-zero angle, and the dashed reference lines on the plots represent ideal readings. The lower scan limit was deliberately set well below ground level (0.32 degree below zero code), and the lower extremes of these plots show the full effects of reflections, these errors could be reduced by optimizing the scan limit, as shown in Figures 46 and 47 The absolute accuracy of all angle readings above 0.5 degree in these tests was better than ±0 02 degree, except in the region below 1 degree at 500 feet

As stated previously, the Model B breadboard receiver did not always perform perfectly Some operational experience was needed to determine the proper adjustments of various time constants gains, and other circuit parameters (which are subject to further changes based on flight tests). Furthermore, the ground-based equipment was known to produce some errors in the encoded angle data, because of imperfect adjustments of the encoder and the scanner (Several ground-based automatic monitoring devices are being developed for use in operational installations) One such source of errors is the alignment of the mechanical axis of scan. If the scanning axis is tilted slightly off horizontal, no detectable errors are produced directly in front of the scanner, but appreciable changes in the absolute angle readings can result at the edges of the azimuthal pattern

Figure 65 shows a case in which the scanning axis was tilted about 0 17 degree (Test No. 288), as well as the angle readings obtained after the tilt was corrected (Test No 297) The tilt angle, reduced by the ratio of the offset distance (631 feet) to the projected distance from the virtual origin to each site on the runway-parallel, appears as a constant error in the angle readings, at site 1, the error due to tilt was 0 12 degree, as shown by the two plots in Figure 65. The remaining constant error that is evident in the plot of Test No 297 is unexplained--presumably arising within the receiver.

Figures 66 through 70 are plots of angle readings obtained at other positions on the runway-parallel before the scanner tilt was corrected. In each case, the fixed error attributable to scanner tilt is indicated by displacement of the dashed reference line above a 45-degree line through the origin; therefore, the reference line represents ideal readings under the known test conditions

A possible operational situation was simulated by these tests along the runway-parallel line, assuming that this line might have been the centerline of a runway. Within the range of distances used for the tests, utilization of the guidance signals would be for flareout control. If an aircraft were executing a typical flareout from an initial 3-degree glide toward a point 3000 feet in front of the scanner, it would be expected to arrive over the test locations at about the elevations indicated successively in Figures 65 through 70. (Calculation of these elevations was based on an exponential decrease of the measured scanning-beam angle from 1 5 degrees, at flare initiation, toward 0 5 degree, as a terminal touchdown condition, using a 10-second time constant) Although these test results do not represent optimized performance of the measurement technique, it is apparent that the errors are not large in the portion of each plot that is operationally significant. It should be noted that the angular rates to be encountered by an approaching aircraft cannot be derived from these plots, which show the variations in angle readings obtained along a vertical line over each site, rather than along a line of flight across all sites

Comparisons of the plots of angle readings that have been discussed indicate considerable variations in the errors that were found at particular test locations. The scope of this test program did not allow enough repetitions of the various tests to obtain good statistical samples However, the largest number of receiver tests at any one location occurred at site 5, 1500 feet in front of the scanner. Figure 71 shows the mean, RMS, and extreme errors in all receiver angle readings obtained with the Model B receiver at this location (excluding Tests No. 268 and 270, during which the receiver was known to be miscalibrated). No adjustments were made to the data from which these curves were derived, the errors from the individual test runs are listed in Table IV (The original and adjusted data from Tests No. 268 and 270 are also shown in Table IV, but were not used for Figure 71)

As shown in Figure 71, the mean error in receiver angle readings at site 5 barely exceeds 0 01 degree down to an elevation angle of 0.5 degree, and the largest errors measured in the six tests were ±0 03 degree in the region above 0 5 degree

Figure 72 allows a comparison of the mean errors in receiver angle readings at site 5 with the errors due to propagation effects alone, as measured four months earlier. A definite correlation is evident below 0.5 degree, at higher angles, any correlation might be hidden by the 0.01-degree precision of the beamshape measurements--as indicated by the vertical bar through each plotted point. (The plot of half-power median angle errors is based on single measurements, each recorded to the nearest 0.01 degree whereas the receiver error plot is based on six sets of readings recorded with 0 01-degree precision)

The errors in angle readings obtained in all 14 tests with the Model B receiver on the main test radial at MacArthur Airport are represented statistically in Figure 73 These data include the six tests used for Figure 71, plus two tests each at sites 2, 4, and 10, plus Tests No 268 and 270, adjusted for known calibration errors. Table V lists the data not included in Table IV, as well as the mean and RMS deviation as plotted.

The mean error derived from these 14 combined tests is less than 0 01 degree at all angles above 0.2 degree. However, the significance of this result may well be questioned, since the mean of data taken at greatly different distances provides no measure of the perturbations that would occur moment by moment during an approach maneuver, and since the RMS dispersion, as plotted, is based on a limited sample. The dynamic responses of the guidance receiver, the flight control system, and the aircraft can be satisfactorily established only by flight tests

IV. CONCLUSIONS

The following conclusions can be made from the various types of tests that were made during this program.

A. STATIC LOBING

The results of the Static Lobing tests, using essentially nondirectional antennas over typical airport terrain, indicate that

1. A distinct lobing structure caused by ground reflections is nearly always present. The pattern of amplitude versus elevation of the resultant signal is a long-term (daily or weekly) variable
2. Grass of even moderate density causes significant attenuation of the ground reflections
3. The effects of surface moisture are negligible when grass is present on most of the reflecting terrain
4. The scanning antenna should be installed as low as possible to reduce the lobing amplitude

It should be noted that no tests were made with snow or ice on the ground, the above conclusions might not be supported by such tests.

B. DYNAMIC LOBING

The Dynamic Lobing tests measured the variations in the resultant peak-of-beam signal as a function of elevation angle, with most of the primary radiation vertically confined in a narrow beam The results of these tests confirm that

1. The narrow beam reduces the amplitude of the lobing pattern caused by ground reflections. This pattern, also, is a long-term variable.

2. At a given elevation angle, the effect of ground reflections tends to increase in proportion to distance (at least up to 4000 feet).

C BEAMSHAPE

The direct effects of ground reflections on the scanning-beam envelope, as received at various elevation angles, were observed in the Static and Dynamic Beamshape tests The results show that

1. The static field pattern of the directional beam, held at a low fixed angle, is distorted by ground reflections. However, the perturbations in the dynamic beam envelope, as received at the same angle, are considerably less severe.
2. The center of gravity of the dynamic beam envelope--that is, the centroid of energy distribution--oscillates about the free-space angular position, as a range of low elevation angles is traversed Good correlation of the measured data with results predicted by simple theoretical models could not be obtained
3. The AIL center-of-gravity tracking method minimizes the errors resulting from ground reflections (Errors in angle readings computed for a theoretical model of the center-of-gravity tracking technique are much smaller than the errors implied by the measured variations in half-power median angle of the beam envelope--Figure 34 See also conclusion 6 under Receiver Readings)

D. RECEIVER READINGS

The overall static performance of the measurement technique, as implemented with experimental equipment, was indicated by the receiver angle readings. These tests at low elevation angles showed that.

1 Reflections from the ground cause detectable errors in the angle readings up to at least 1.0 degree of elevation, above 0.5 degree, these errors rarely exceed 0.03 degree.

2. Grass causes a significant reduction of the low-angle errors, and surface moisture (not frozen) has little or no effect with grass present.

3 Errors caused by reflections can be minimized, under normal conditions, by (a) installation of the scanner as low as possible, (b) use of artificial fences or vegetation, and (c) restraint of signal transmission at scan angles below ground level.

4 The accuracy of center-of-gravity tracking is essentially independent of the direction of scan

5. Operation within the near field of the scanner, as close as 500 feet ($a^2/2\lambda$), causes no significant degradation of accuracy. As the distance increases, the errors in angle readings (at the low angles investigated) do not increase greatly, but vary more rapidly as the receiver height is varied over a fixed point on the ground

6. Errors in receiver angle readings at low angles show a fair correlation with propagational distortion of the scanning-beam envelope, but are generally smaller than the propagational errors (Figure 72).

7. Angle readings taken to one side of a properly installed scanner are the same as though taken on the azimuthal centerline.

8. The automatic calibration control circuitry in the receiver substantially eliminates errors due to calibration drift

9. The mean error in static angle readings obtained with a properly adjusted receiver is about 0 01 degree. At the angles and ranges of greatest operational interest, the peak errors are generally less than 0 03 degree

E GENERAL

The K-band scanning-beam technique of elevation-angle measurement that has been tested under this program was specifically designed for application in an aircraft landing system. Several peculiarities of that application affected the choice of components and operating parameters. Any conclusions regarding the potential merits of the technique should therefore relate its demonstrated performance to the intended conditions of use

The series of static, ground-based tests reported here has confirmed the basic feasibility of this technique of elevation angle measurement, and has furnished a preliminary indication of the accuracy to be expected The results are promising enough to justify a program of flight testing, during which the dynamic accuracy of the measurement technique and its compatibility with flight-control and display instrumentation systems can be determined

Conclusions regarding the operational suitability of the technique for landing-system application should be based largely on future flight testing. However, the program of ground-based tests has indicated no incompatibility of this technique with its intended application.

TABLE I

ELEVATION ANGLES RELATIVE TO GROUND PARALLEL OVER TEST RADIALS FROM SCANNER MOUNTED AT NORMAL HEIGHT

Site No	1	5	2	4	6	10	7
Distance in Feet	1100	1500	2000	2500	2990	3560	3900
Height on Pole in Feet				Elevation Angle in Degrees			
38	1 71	1 [illegible]	0 95	0 77	0 65	0 58	0 49
37	1 66	1 20	0 92	0 74	0 63	0 56	0 48
36	1 61	1 17	0 89	0 72	0 62	0 55	0 46
35	1 55	1 13	0 87	0 70	0 60	0 53	0 45
34	1 50	1 09	0 84	0 68	0 58	0 51	0 43
33	1 45	1 05	0 8[illegible]	0 65	0 56	0 50	0 42
32	1 39	1 01	0 78	0 63	0 54	0 48	0 40
31	1 34	0 98	0 75	0 61	0 5[illegible]	0 [illegible]	0 39
30	1 29	0 94	0 7[illegible]	0 58	0 50	0 45	0 3[illegible]
29	1 24	0 90	0 69	0 56	0 43	0 43	0 36
28	1 19	0 86	0 66	0 54	0 46	0 42	0 34
27	1 14	0 82	0 64	0 52	0 44	0 40	0 33
26	1 08	0 79	0 61	0 49	0 42	0 39	0 31
25	1 03	0 75	0 58	0 47	0 40	0 37	0 30
24	0 98	0 71	0 55	0 45	0 39	0 35	0 28
23	0 93	0 67	0 52	0 42	0 37	0 34	0 27
22	0 88	0 63	0 49	0 40	0 35	0 32	0 26
21	0 82	0 59	0 46	0 38	0 33	0 31	0 24
20	0 77	0 56	0 44	0 36	0 31	0 29	0 23
19	0 72	0 52	0 41	0 33	0 29	0 27	0 21
18	0 67	0 48	0 38	0 31	0 27	0 26	0 20
17	0 61	0 44	0 35	0 29	0 25	0 24	0 18
16	0 56	0 40	0 32	0 26	0 23	0 23	0 17
15	0 51	0 36	0 29	0 24	0 21	0 21	0 15
14	0 46	0 33	0 26	0 22	0 19	0 19	0 14
13	0 40	0 29	0 24	0 20	0 17	0 18	0 12
12	0 35	0 25	0 21	0 17	0 15	0 16	0 10
11	0 30	0 21	0 18	0 15	0 14	0 15	0 09
10	0 25	0 17	0 15	0 13	0 12	0 13	0 08
9	0 19	0 14	0 12	0 10	0 10	0 1[illegible]	0 06
8	0 14	0 10	0 09	0 08	0 08	0 [illegible]0	0 05
7	0 09	0 06	0 06	0 06	0 06	0 06	0 03
6	0 04	0 02	0 04	0 03	0 04	0 [illegible]	0 02
5	-0 02	-0 02	0 01	0 01	0 02	0 05	0 01
4	-0 07	-0 06	-0 02	0 0[illegible]	0 00	0 03	-0 01
3	-0 12	-0 10	-0 05	-0 03	-0 02	0 02	-0 02
2	-0 17	-0 13	-0 06	-0 06	-0 04	0 00	-0 04

TABLE II

REDUCTION OF AZIMUTHAL PATTERN DATA FROM TEST NO 221

Azimuth in Degrees*	Distance in Feet**	Range Ratio in db	Relative Signal in db as Recorded in Each Run 1*	2*	3*	4*	Normalized Average in db	Attitude Correction in db ††	Compensated Pattern in db
50.0	403	3 5		14 0		20 4	-18 2	1.5	-13.2
47.5	385	3 0			20 2	19.5	-18 7	1 4	-14.3
45 0	370	2 7		14 9	19 6	20.1	-18 2	1 4	-14 1
42 5	356	2 3			17 0	19 5	-20 2	1.3	-16 6
40 0	344	2 0		11 6	17 2	17.1	-21 1	1.2	-17 9
37 5	333	1 8			16.4	16 3	-22.2	1 1	-19 3
35 0	323	1 5	26 9	14 2	19 2	18 7	-18 6	1 1	-16 0
32 5	315	1 3			23.9	24 1	-14 5	1 0	-12.2
30.0	307	1 1	31.8	19 7	25 0	25 6	-12 9	0 9	-10 9
27 5	301	0 9			26.4	26 4	-12.1	0 8	-10.4
25 0	295	0 7	33.3	20 9	27 4	27 0	-11 2	0 8	- 9.8
22.5	290	0.6			27 6	27 3	-11 1	0.7	- 9.8
20.0	286	0 4	33.5	20.4	27.3	27 1	-11 3	0.6	-10 3
17 5	282	0 3			26.7	26.5	-11 9	0.5	-11.1
15.0	279	0 2	32 9	21 0	27 4	27 4	-11 2	0.5	-10 5
0.0	272	0	44.3	32 2	38 5		0	0	0
-15 0	285	0 4	37 4	25.8	31 0		- 6.9	0 5	- 6.0
-30.0	325	1 5	32 8	19 9	26 3		-12 0	0.9	- 9 6

TABLE II (cont)

Azimuth in Degrees*	Distance in Feet**	Range Ratio in db	Relative Signal in db as Recorded in Each Run 1*	2*	3*	4*	Normalized Average in db	Attitude Correction in db ††	Compensated Pattern in db
-40	367	2 6	22 0	8.6	16 1		-22 8	1 2	-19 0
-45	402	3 5	22.7		16 2		-22 0	1.5	-17.0
-45 †	402			9 5		19.2			

* Original data.

** Measurements were made at surveyed angles on a slightly skew line past the scanner, broadside and end-point distances were measured, other distances were computed.

† Probe horn facing scanner to find required attitude compensation

†† Assumed linear at 0 03 db/degree, based on runs 3 and 4 at -45 degrees.

TABLE III

REDUCTION OF DYNAMIC BEAMSHAPE DATA TO OBTAIN ERRORS IN HALF-POWER MEDIAN ANGLES

Site No.	Test No	Probe Geometric Angle	3-db Median Angle	Error in Degrees	Site No	Test No	Probe Geometric Angle	3-db Median Angle	Error in Degrees
1	22	1.21	1.21	0.0	2	159	0.92	0.93	0.01
	23	1.10	1.10	0.0		160	0.84	0.87	0.03
	24	1.00	0.99	-0.01		161	0.72	0.74	0.02
	25	0.90	0.90	0.0		162	0.61	0.60	-0.01
	26	0.79	0.78	-0.01		163	0.49	0.49	0.0
	27	0.69	0.69	0.0		164	0.38	0.40	0.02
	28	0.58	0.56	-0.02		165	0.35	0.37	0.02
	29	0.48	0.49	0.01		166	0.32	0.35	0.03
	30	0.37	0.40	0.03		167	0.29	0.33	0.04
	31	0.27	0.24	-0.03		168	0.26	0.27	0.01
	32	0.16	0.21	0.05		169	0.15	0.12	-0.03
	33	0.11	0.20	0.09		170	0.04	-0.03	-0.07
	35	-0.05	-0.20	-0.15					
	36	-0.15	-0.21	-0.06					

TABLE III (cont)

Site No	Test No	Probe Geometric Angle	3-db Median Angle	Error in Degrees	Site No	Test No	Probe Geometric Angle	3-db Median Angle	Error in Degrees
5	172	1 20	1 21	0 01	4	186	0 77	0 79	0.02
	173	1 09	1 09	0		187	0 68	0 67	-0 01
	174	0 94	0 94	0		188	0 58	0.58	0
	175	0 79	0 79	0		189	0 49	0.48	-0 01
	176	0 63	0 64	0 01		190	0.40	0 39	-0 01
	177	0 48	0 49	0 01		191	0 40	0.43	0 03
	178	0 36	0 39	0.03		192	0.38	0 43	0 05
	179	0 33	0 34	0 01		193	0 36	0 39	0.03
	180	0 29	0 28	-0.01		194	0 33	0 37	0.04
	181	0 25	0 26	0 01		195	0 31	0 35	0 04
	182	0 21	0 24	0 03		196	0.31	0 35	0.04
	183	0 17	0 17	0		197	0.22	0 27	0 05
	184	0.02	-0 12	-0 14		198	0 13	0 08	-0 05
						199	0 03	-0.10	-0 13
6	89	0.65	0 69	0 04	7	114	0 49	0.49	0
	90	0 62	0 63	0 01		115	0 48	0.49	0 01
	91	0 58	0 52	-0 06		116	0.46	0 47	0 01
	92	0 54	0 53	-0 01		117	0 45	0.46	0 01
	93	0 50	0 46	-0 04		118	0 43	0 45	0 02

TABLE III (cont)

Site No	Test No	Probe Geometric Angle	3-db Median Angle	Error in Degrees
6 (cont)	94	0 48	0 48	0
	95	0 46	0.47	0.01
	96	0 44	0 45	0.01
	97	0 42	0 45	0 03
	98	0 40	0.47	0 07
	99	0.39	0 44	0 05
	100	0 35	0.34	-0.01
	101	0 31	0 26	-0.05
	102	0 29	0 33	0 04
	103	0 27	0.31	0 04
	104	0.25	0 29	0 04
	105	0 23	0 29	0 06
	106	0 21	0.25	0 04
	107	0 19	0 21	0.02
	108	0.15	0 12	-0 03
	109	0 12	0 13	0 01
	110	0 10	0 09	-0.01
	111	0 08	0	-0 08
	112	0 04	-0 14	-0.18
	113	0	-0 17	-0.17
7 (cont)	119	0.42	0 42	0
	120	0 40	0 43	0.03
	121	0 39	0 40	0.01
	122	0.37	0.42	0 05
	123	0.34	0 38	0.04
	124	0.31	0 35	0.04
	125	0.28	0.35	0 07
	126	0 27	0.33	0 05
	127	0 26	0.28	0.02
	128	0.23	0 20	-0.01
	129	0 20	0 17	-0 03
	130	0 17	0 17	0
	131	0 15	0 23	0 08
	132	0 14	0 13	-0 01
	133	0 10	-0 13	-0.21
	134	0 08	-0 12	-0.20
	135	0.05	-0 13	-0 18
	136	0 02	-0.16	-0 18
	137	-0.01	-0.15	-0 14

TABLE IV

ERRORS IN READINGS OF RECEIVER MODEL B AT SITE 5
(Errors in Hundredths of a Degree)

Test No. / Elevation in Degrees	273	274	277	278	279	295	(273 - 295) Mean	(273 - 295) RMS Deviation	268	270	268 (Adjusted)	270 (Adjusted)	(6 Tests Adjusted) Mean	(6 Tests Adjusted) RMS Deviation
1.20	-1	2	1	2	0	0.0	0 7	1 1	-4	-2	-2	-1	0 1	-.3
1 17	-1	2	0	1	0	-0 5	0 3	1 0	-5	-4	-3	-1	-0.3	1.4
1 13	-1	2	1	1	0	0 0	0 5	1 1	-4	-4	-2	0	0 1	1 2
1 09	-1	2	1	1	0	0 5	0 6	0.9	-4	-4	-2	0	0 2	1 1
1 05	-1	2	1	1	1	1 0	0 8	0.9	-4	-4	-2	0	0 4	1.2
1 01	-1	2	1	1	1	1 0	0 8	0 9	-3	-4	-1	0	0 5	1.0
0 98	-1	-1	0	0	0	1 0	0 2	0 7	-4	-4	-2	-2	-0 4	1 0
0 94	0	2	1	0	1	1 0	0 8	0 7	-3	-4	-1	-2	0 3	
0 90	0	2	1	0	0	1 0	0 7	0 7	-3	-4	-1	-1	0 3	
0.86	0	3	1	0	-1	1 5	0 8	1 1	-2	-3	0	0	0 6	
0 82	0	2	2	0	1	2 0	1 2	0 9	-2	-4	0	0	0 9	0.9
0 79	-2	2	1	-1	0	1.0	0 2	1.4	-3	-4	-1	-1	-0 1	1.3
0 75	-2	1	1	-1	-1	1.0	-0 2	1 2	-3	-4	-1	-2	-0 5	
0 71	-2	3	1	-1	-1	1.0	0 2	1.7	-2	-4	0	-2	-0 1	
0 67	-2	2	1	-1	0	1.0	0.2	1 4	-2	-4	0	-1	0.0	
0.63	-2	2	1	-1	0	0 5	0 1	1 3	-2	-5	0	-1	-0 1	
0 59	-1	2	1	-1	0	0 0	0 2	1 1	-2	-5	0	0	0 1	

TABLE IV (cont)

Test No	273	274	277	278	279	295	(273 - 295) Mean	(273 - 295) RMS Deviation	268	270	268 (Adjusted)	270 (Adjusted)	(8 Tests Adjusted) Mean	(8 Tests Adjusted) RMS Deviation
Elevation in Degrees														
0 56	-1	1	0	-2	-1	-1 0	-0 7	0 9	-3	-6	-1	0	-0 6	
0 52	-1	1	1	-2	-1	-2.0	-0 7	1.2	-3	-6	-1	-1	-0.8	
0.48	-1	1	1	-2	-1	-3.5	-0 9	1 6	-2	-5	0	-1	-0 8	
0 44	0	1	1	-2	-2	-4 5	-1 1	2 0	-1	-4	1	-2	-0 9	1.9
0 40	2	2	3	-1	-3	-6 0	-0.5	3 2	1	-3	3	0	0 0	3.0
0 36	2	3	4	1	-5	-8 5	-0 6	4 6	1	-3	3	3	-0 3	
0 33	0	3	3	0	-7	-10 5	-1 9	5 0	0	-4	2	4	-0 9	
0 29	0	4	1	1	-7	-10 5	-1 9	5 1	0	-2	2	6	-0 4	
0.25	2	6	2	3	-5	-7 0	0 2	4 6	3	-1	5	5	1 4	
0 21	3	7	6	4	-2	-6 0	2 0	4 6	4	-2	6	4	2.8	
0 17	2	5	4	2	-3	-7 0	0.5	4 2	4	0	6	1	1 2	
0 14	-2	-1	-2	-4	-9	-11.0	-4 8	3.8	-1	-8	1	-2	-3 8	
0 10	-7	-3	-5	-9	-12	-16 0	-8 7	4 3	-5	-10	-3	-6	-7 6	
0 06	-10	-4	-5	-10	-12	-16 0			-7	-12	-5	-6		
0 02	-9	-4	-4	-10	-9	-18 0			-6	-9	-4	-6		
-0 02	-6													

TABLE V

ERRORS IN READINGS OF RECEIVER MODEL B

AT VARIOUS DISTANCES

(Errors* in Hundredths of a Degree)

Site	2	2	4	4	10	10	5, 2, 4, 10	
Test No	275	280	276	281	283	287	(14 Tests**)	
Elevation in Degrees							Mean	RMS Deviation
0 92	2	1 5					0 6	1 1
0 89	2	1 5					0 6	1 1
0 87	2	1 0					0 8	1 1
0 84	1	1 0					0 8	0 9
0 81	1	1 0					0 9	1 0
0 78	1	1 0					0 1	1 2
0 75	2	-1 0	1	1			0 1	1 3
0 72	2	1 0	1	1			0 3	1 3
0 69	1	1 0	1	1			0.3	1 3
0 66	1	0.0	1	1			0.3	1 1
0 64	0	-1 0	1	2			0 1	1 2
0 61	1	-1.0	2	1			0 3	1.1
0 58	1	-1 0	2	2			0 4	1 1
0 55	1	-2.0	3	0	-2	2	-0 2	1 5
0 52	1	-2 0	1	-1	-1	2	-0 4	1 2
0.49	1	-2.0	2	-1	-4	4	-0 5	2 1
0 46	2	0.0	2	-1	-2	1	-0 4	1 7
0 44	1	-3 0	2	-2	0	-1	-0.8	1 8
0 41	1	-4 0	4	-1	0	-2	-0 2	2 6
0 38	3	-4.0	6	0	0	-1	0.4	3 4
0.35	3	-2 0	4	-1	-2	-3	0 1	3 9
0 32	4	-1 0	5	0	-3	-3	-0 3	4 3
0 29	4	-1 0	5	1	-3	-5	-0 2	4 5
0 26	5	0.0	6	-1	-5	-2	0 9	4 3

TABLE V (cont)

Site*	2	2	4	4	10	10	5, 2, 4, 10	
Test No.	275	280	276	281	283	287	(14 Tests**)	
Elevation in Degrees							Mean	RMS Deviation
0.24	4	-2 0	4	0 0	-14	-1	0 1	5 3
0 21	0	-3.0	3	-1 0	-15	-19	-0 9	7.5
0 18	-2	-7.0	-4	-11.0	-10	-25	-3.3	
0 15	-5	-13.0	-7	-15.0			-4 8	
0.12	-6	-13 5	-8	-15 0			-7 3	
0 09	-7	-15.5	-6	-12 0			-8 5	
0 06	-7	-14.5	-4	-12 5				
0 04	-6	-13.0		-13 0				
0 01		-11.0		-13 0				

* Errors for Sites 5, 4, and 10 derived by interpolation between angles actually recorded.

** Including all tests listed in Table IV for Site 5

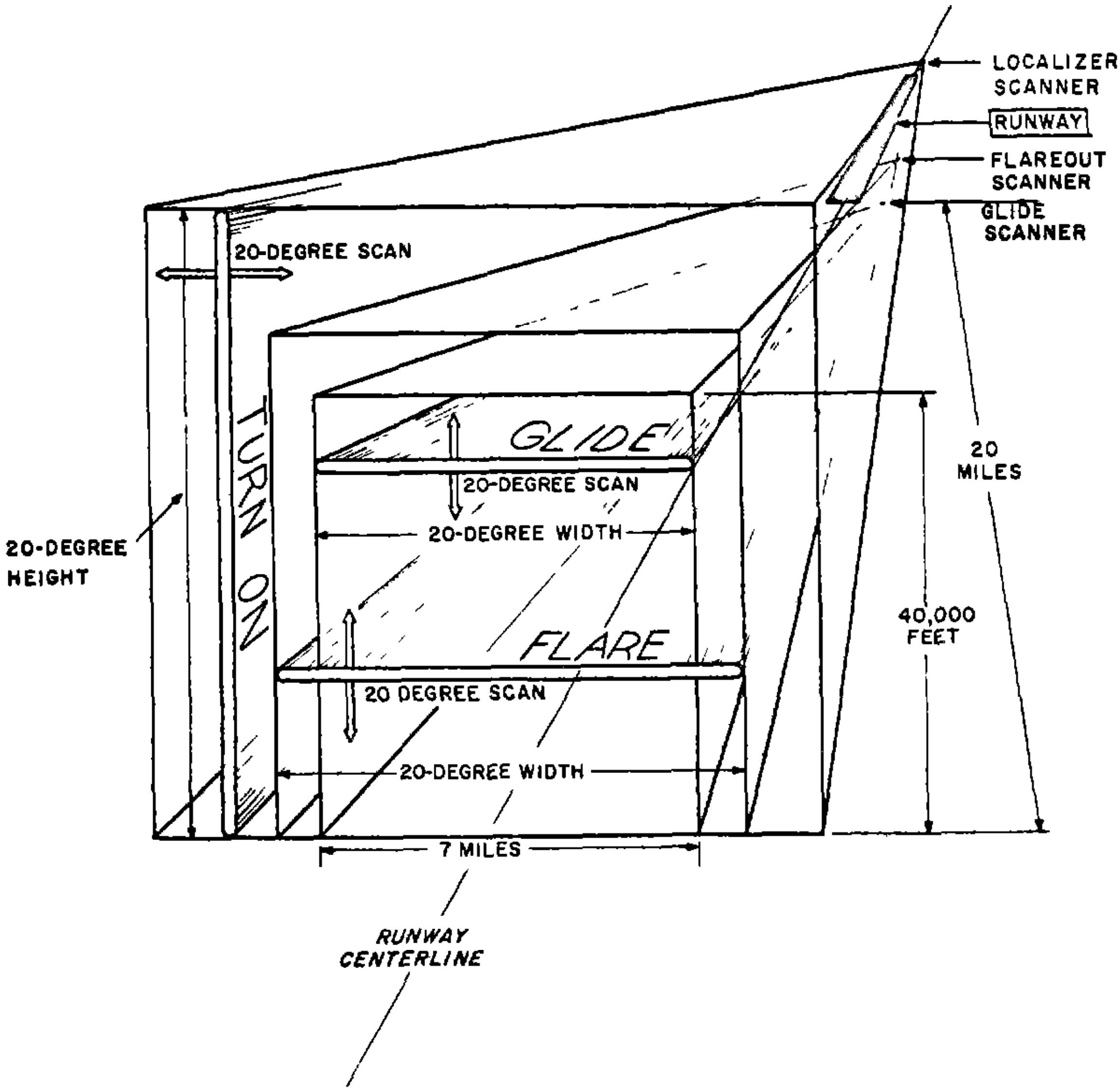

FIGURE 1. VOLUMETRIC COVERAGE OF PROPOSED LANDING SYSTEM USING THREE SCANNING BEAMS

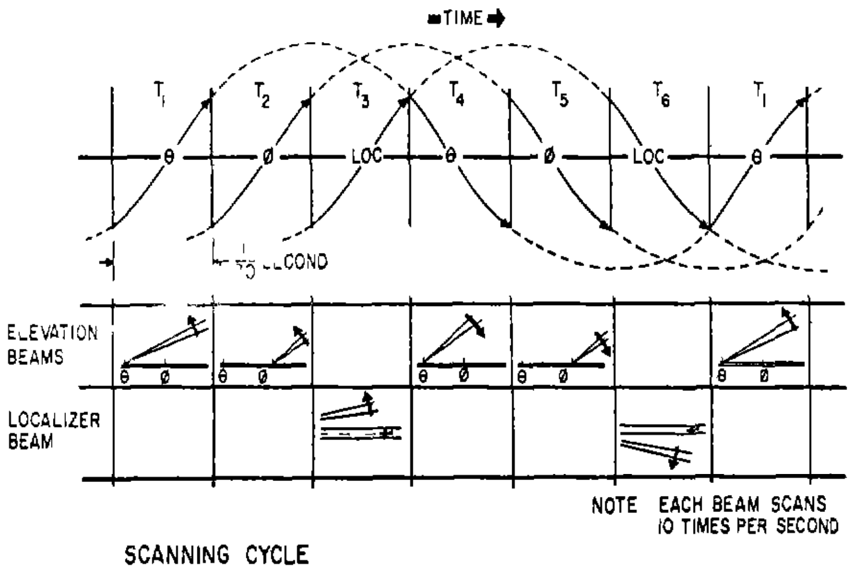

FIGURE 2. PROPOSED TRANSMISSION SEQUENCE FOR THREE SCANNING BEAMS

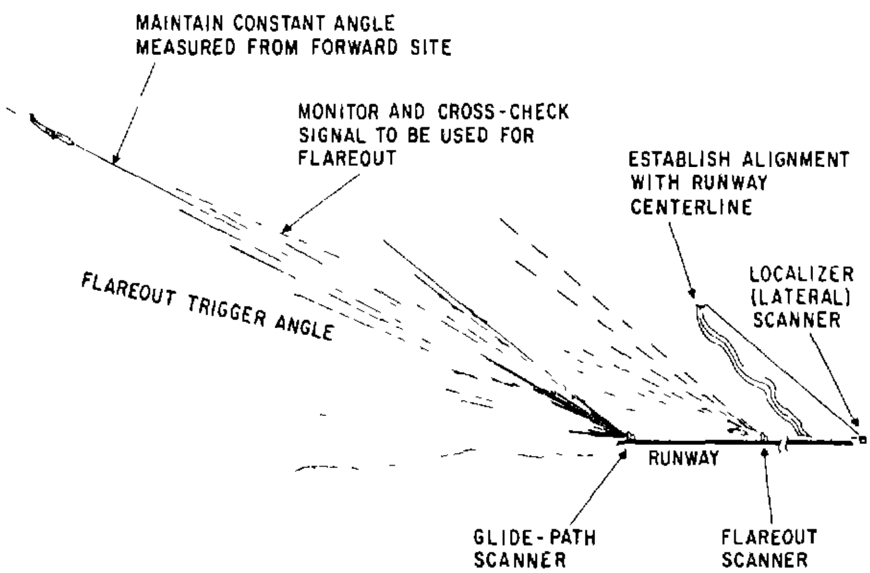

FIGURE 3 USE OF PROPOSED SYSTEM DURING INITIAL GLIDE

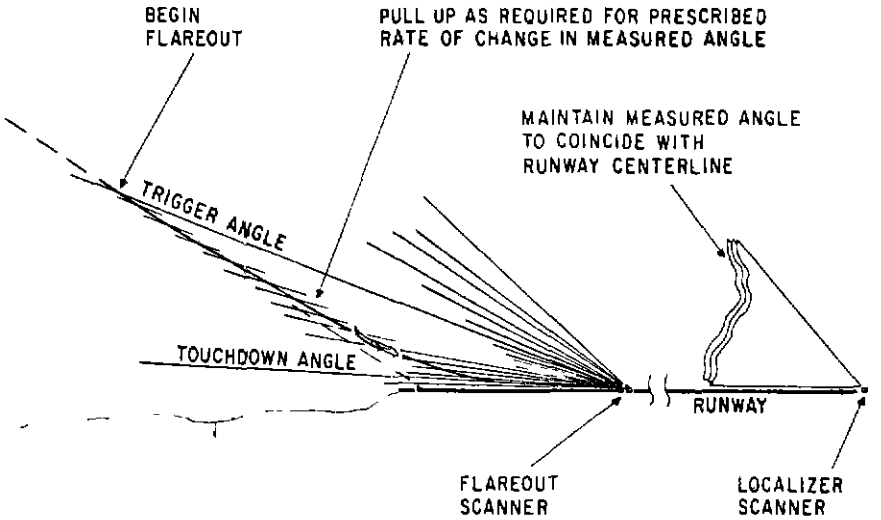

FIGURE 4. USE OF ANGULAR GUIDANCE DURING FLAREOUT

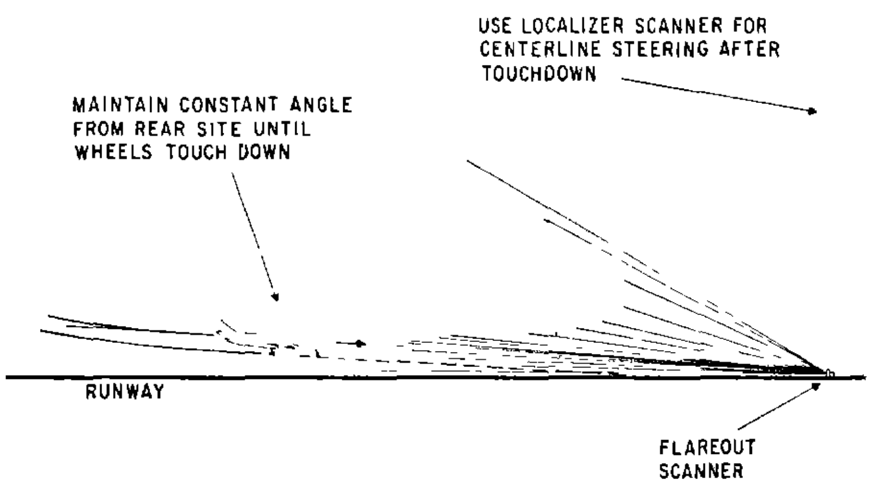

FIGURE 5. USE OF ANGULAR GUIDANCE FOR TOUCHDOWN

FIGURE 6   EXPERIMENTAL SCANNING ANTENNA

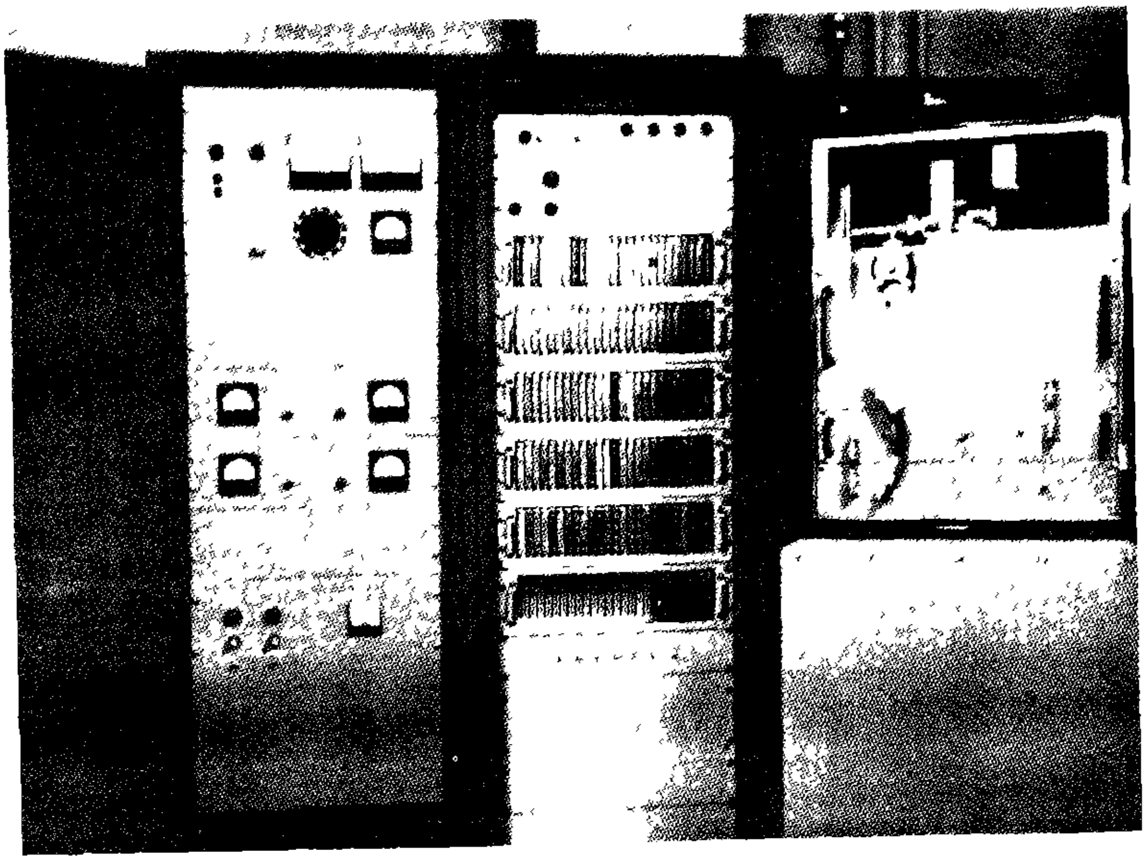

FIGURE 7. EXPERIMENTAL GROUND-BASED ELECTRONIC PACKAGE

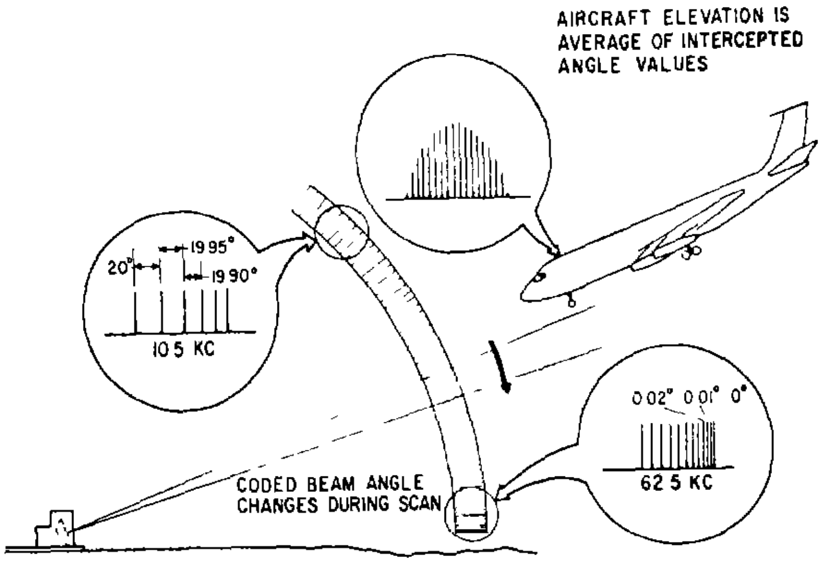

FIGURE 8. ANGLE-DATA TRANSMISSION AND RECEPTION

SITE	DISTANCE FROM VIRTUAL ORIGIN IN FEET
1	878
11	1875
12	2910
13	3930
14	4940

SITE	RADIAL DISTANCE FROM SCANNER IN FEET
1	1100
3	1100
5	1500
2	2000
4	2500
6	2990
10	3580
7	3900
11	2000
12	3000
13	4000
14	5000

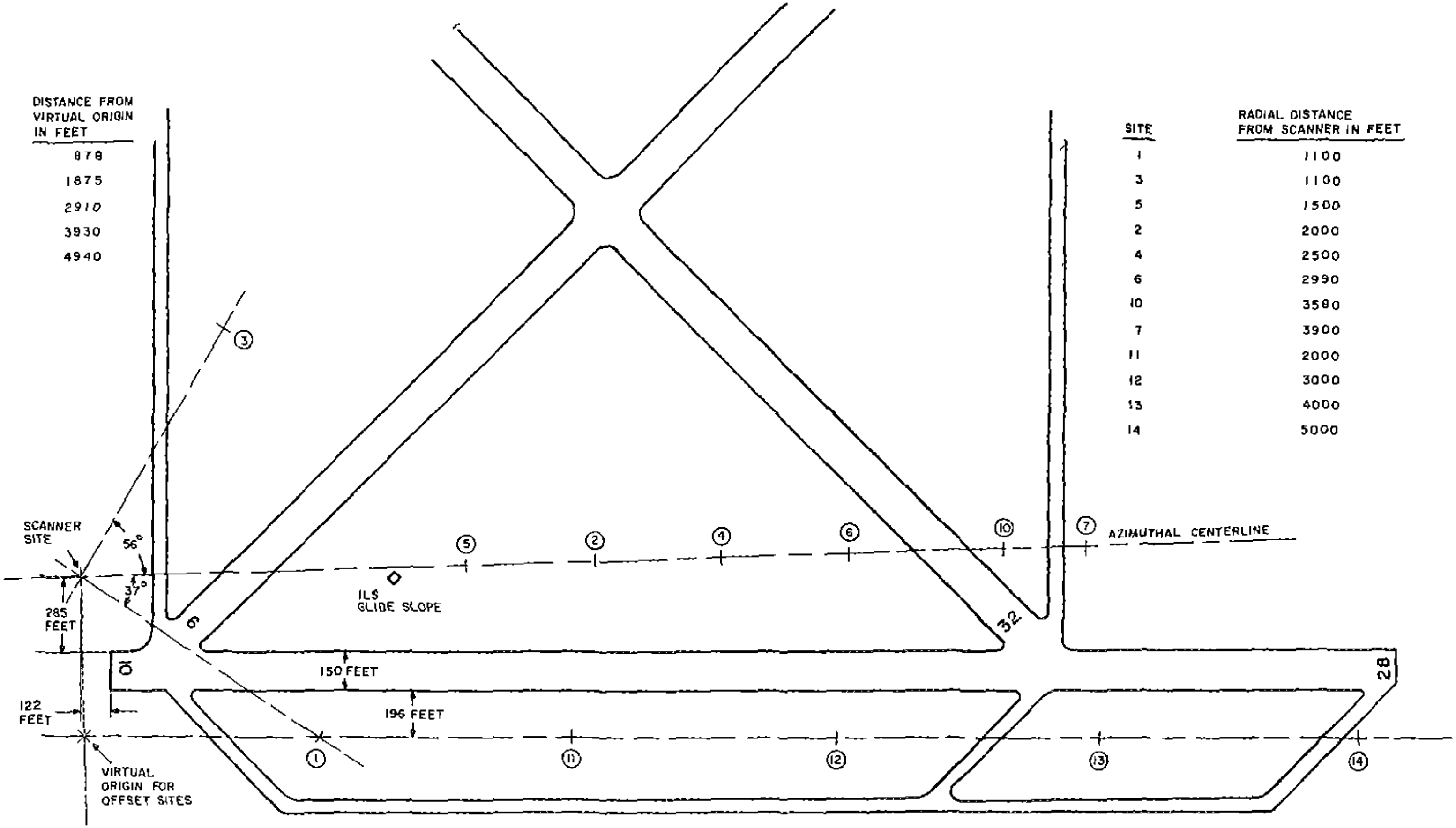

FIGURE 9 LOCATIONS OF TEST SITES AT MAC ARTHUR AIRPORT

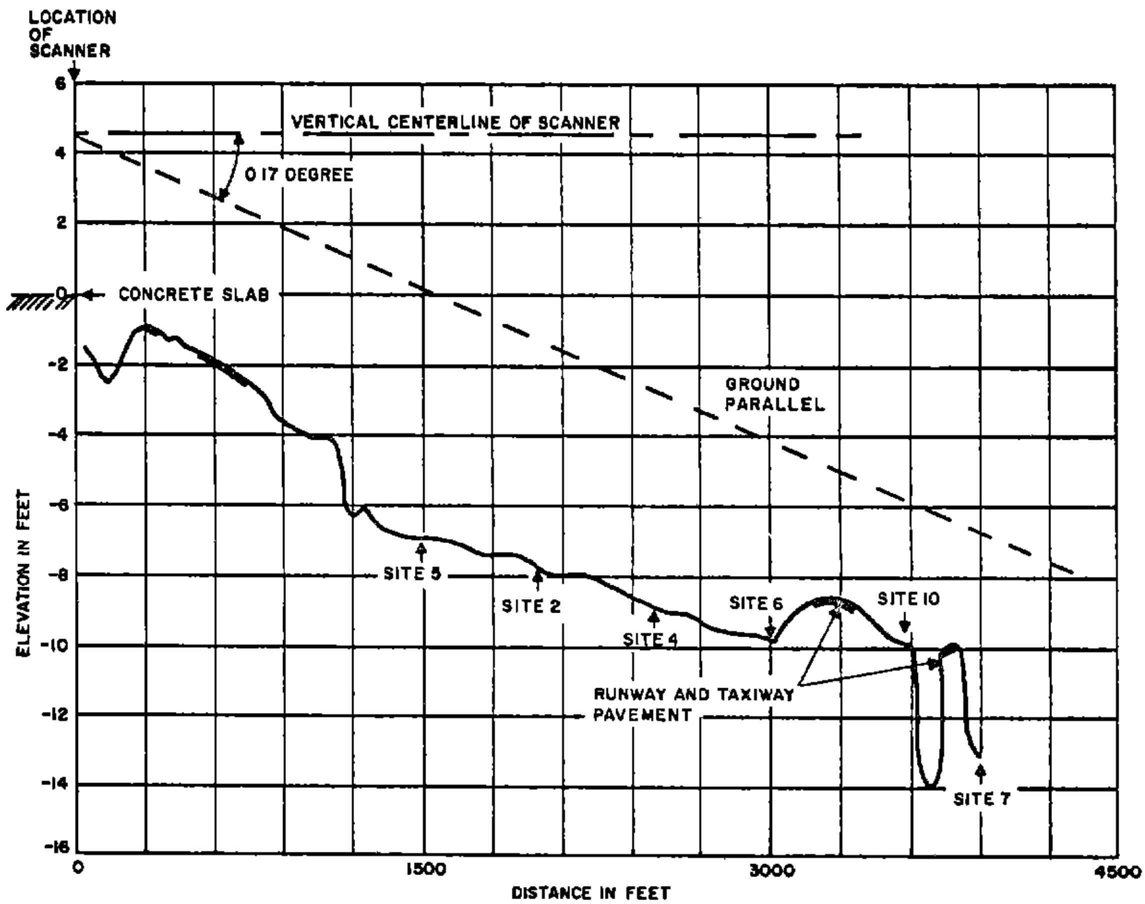

FIGURE 10. ELEVATION PROFILE OF MAIN TEST RADIAL

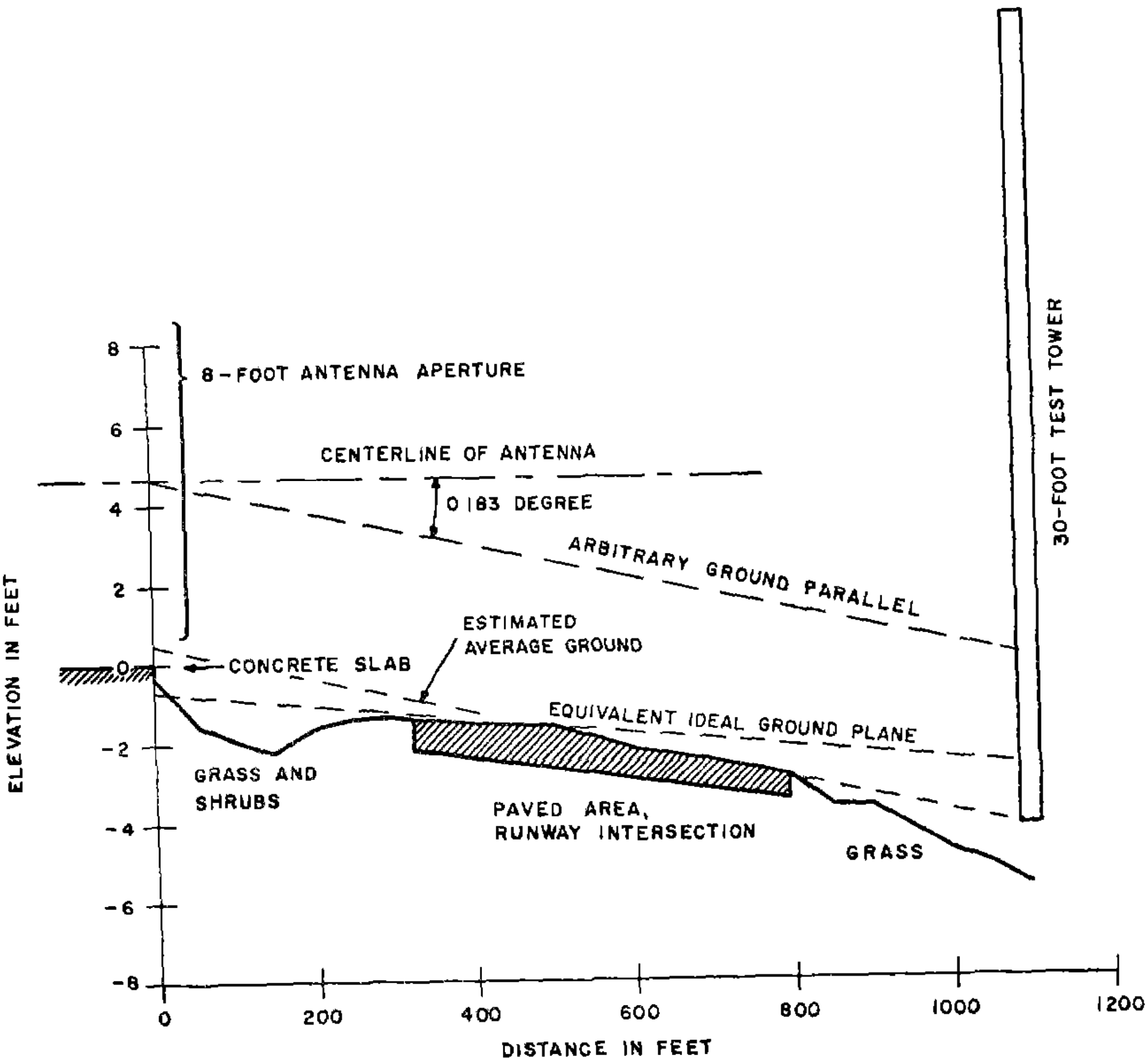

FIGURE 11. ELEVATION PROFILE OF TEST RADIAL TO SITE 1

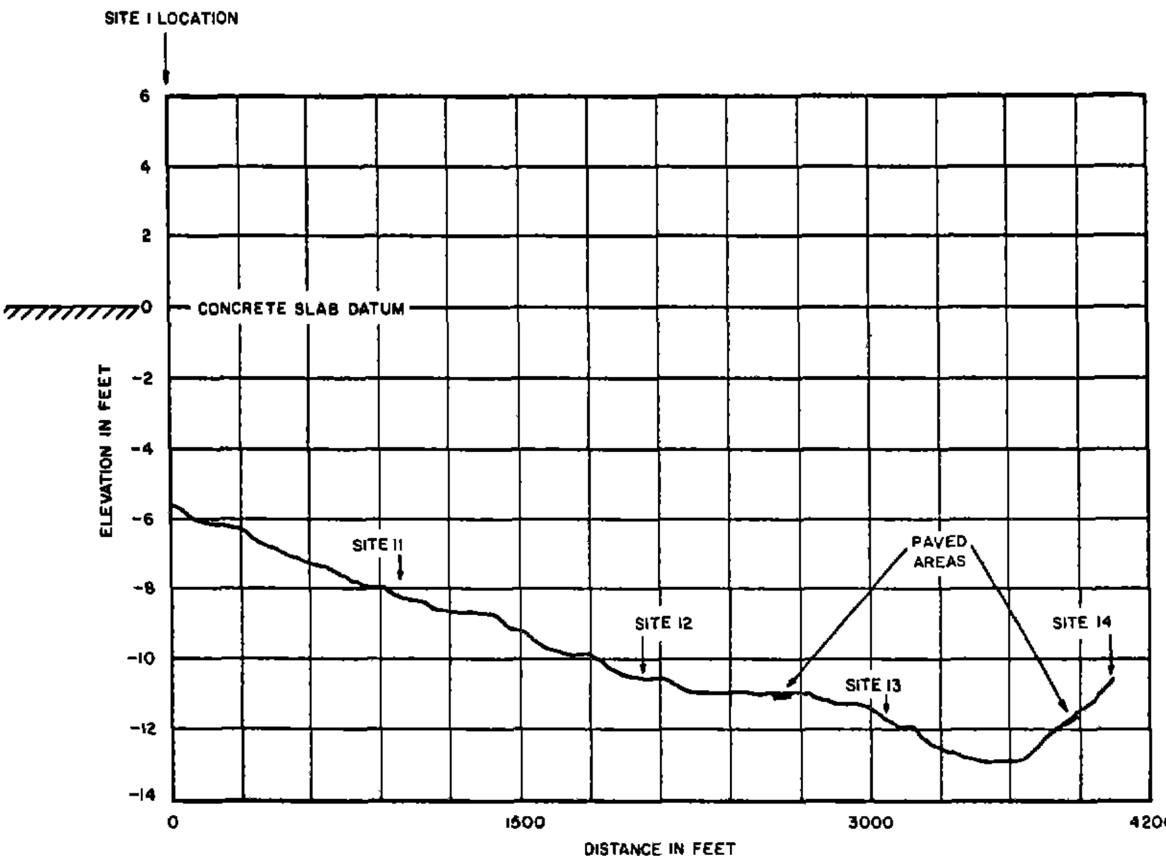

FIGURE 12. ELEVATION PROFILE OF RUNWAY-PARALLEL TEST RANGE

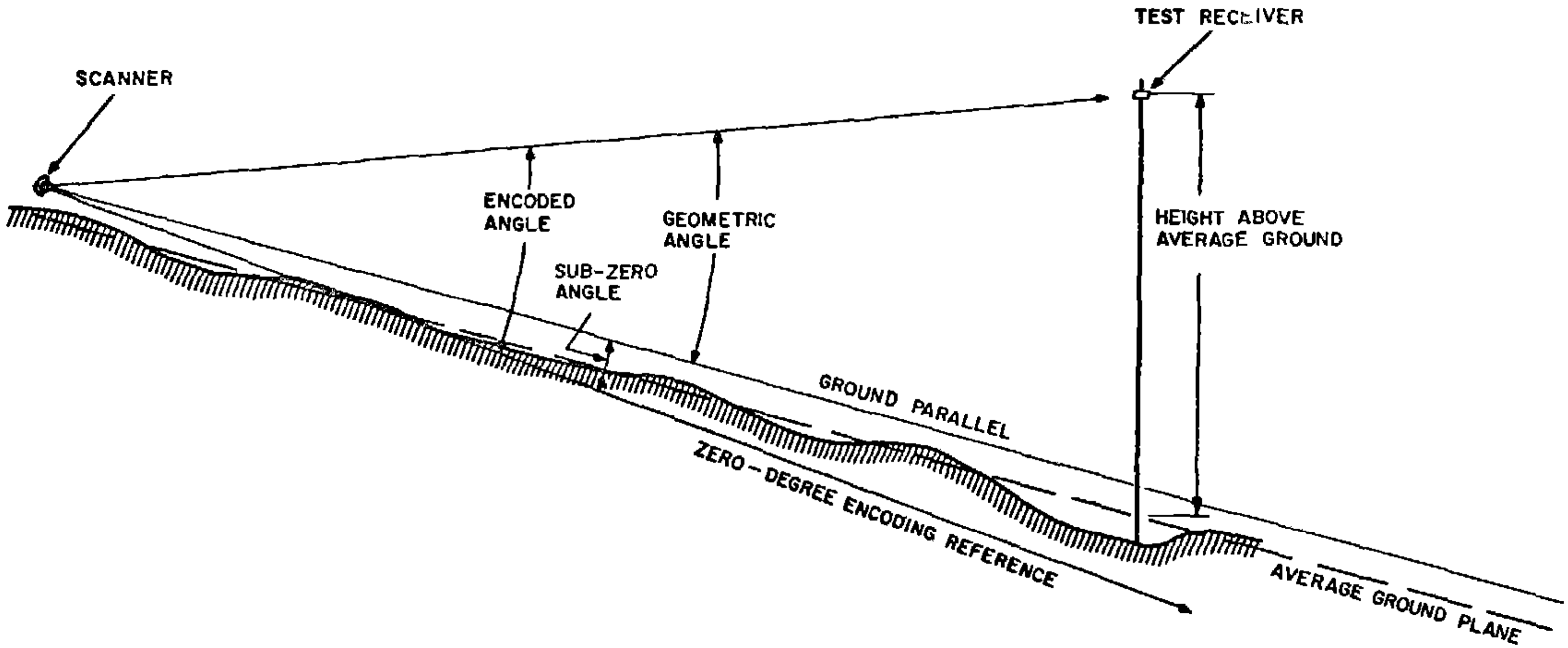

FIGURE 13. FIELD-TEST GEOMETRY

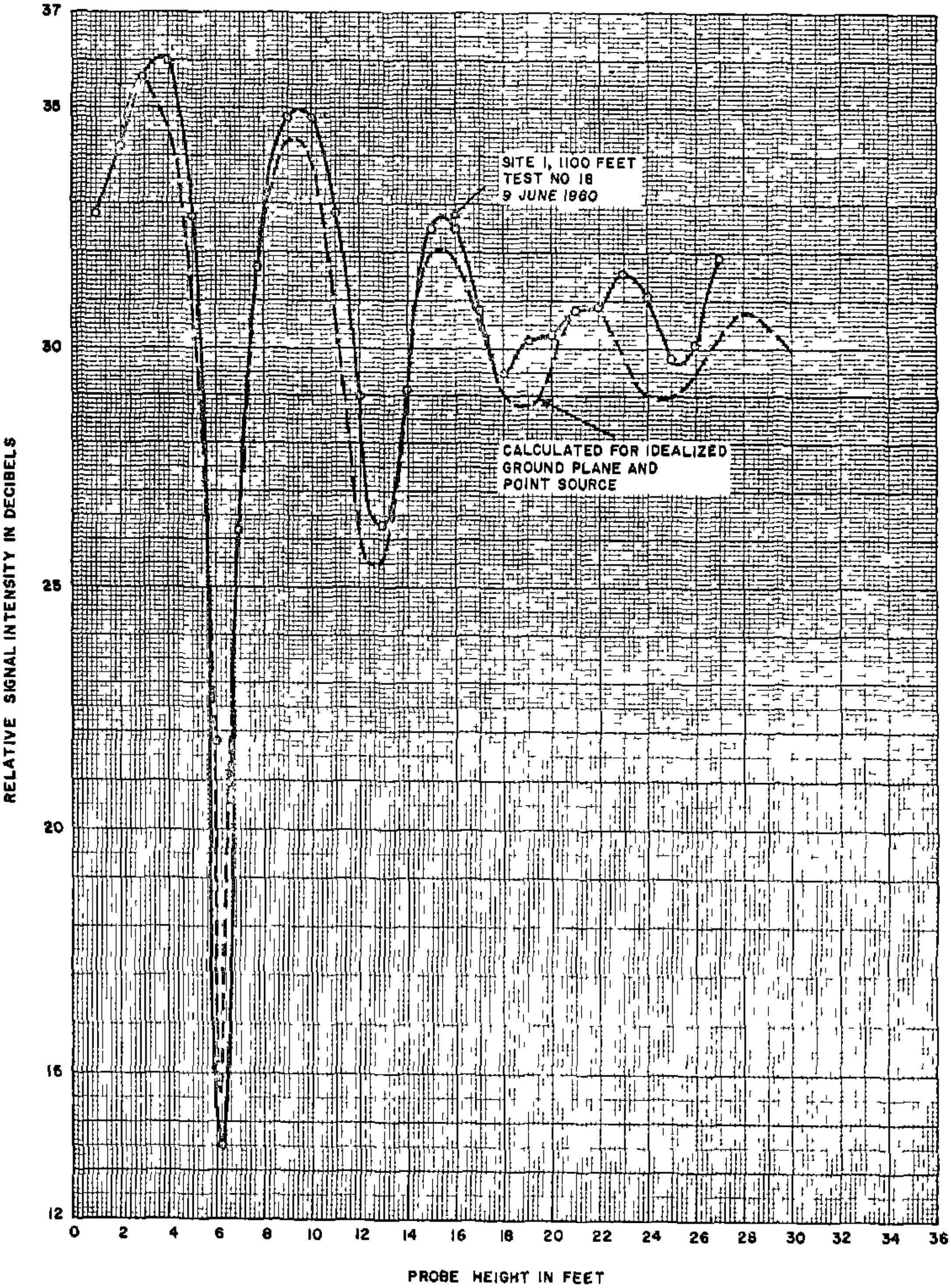

FIGURE 14. STATIC LOBING FROM TEST RADIATOR 4 FEET ABOVE AVERAGE GROUND LINE

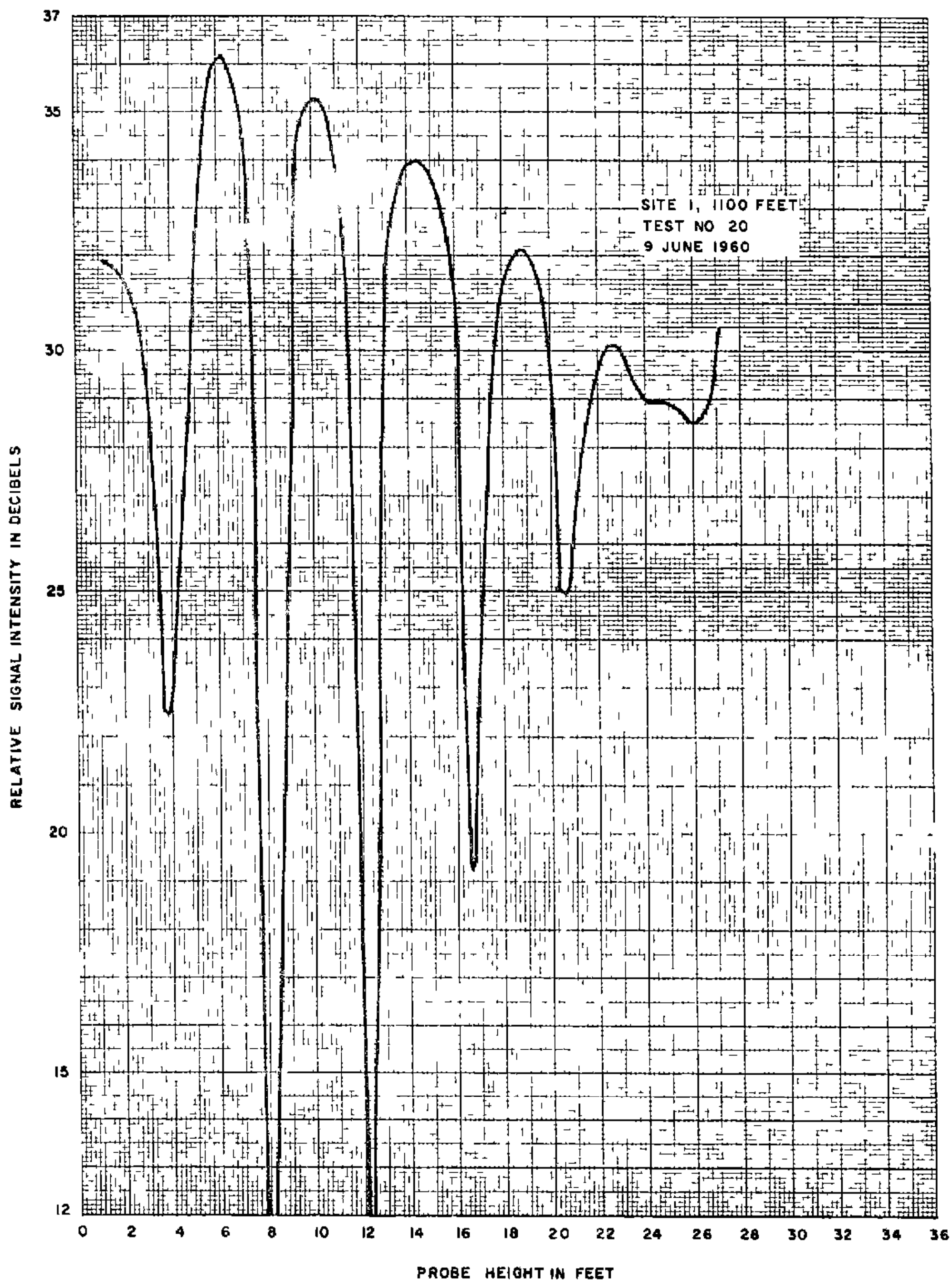

FIGURE 15. STATIC LOBING FROM TEST RADIATOR 7 FEET ABOVE AVERAGE GROUND LINE

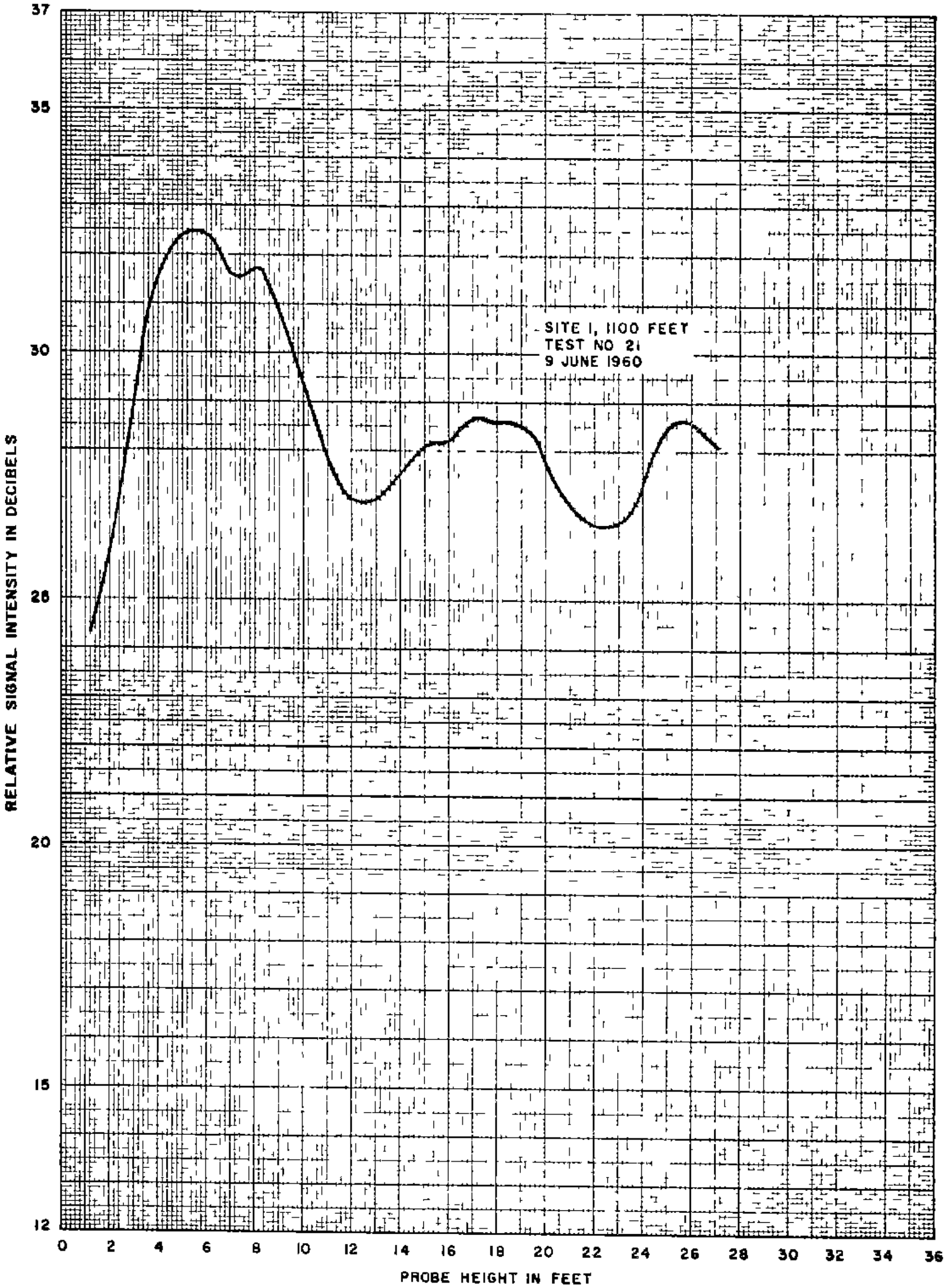

FIGURE 16. STATIC LOBING FROM TEST RADIATOR 1 FOOT ABOVE AVERAGE GROUND LINE

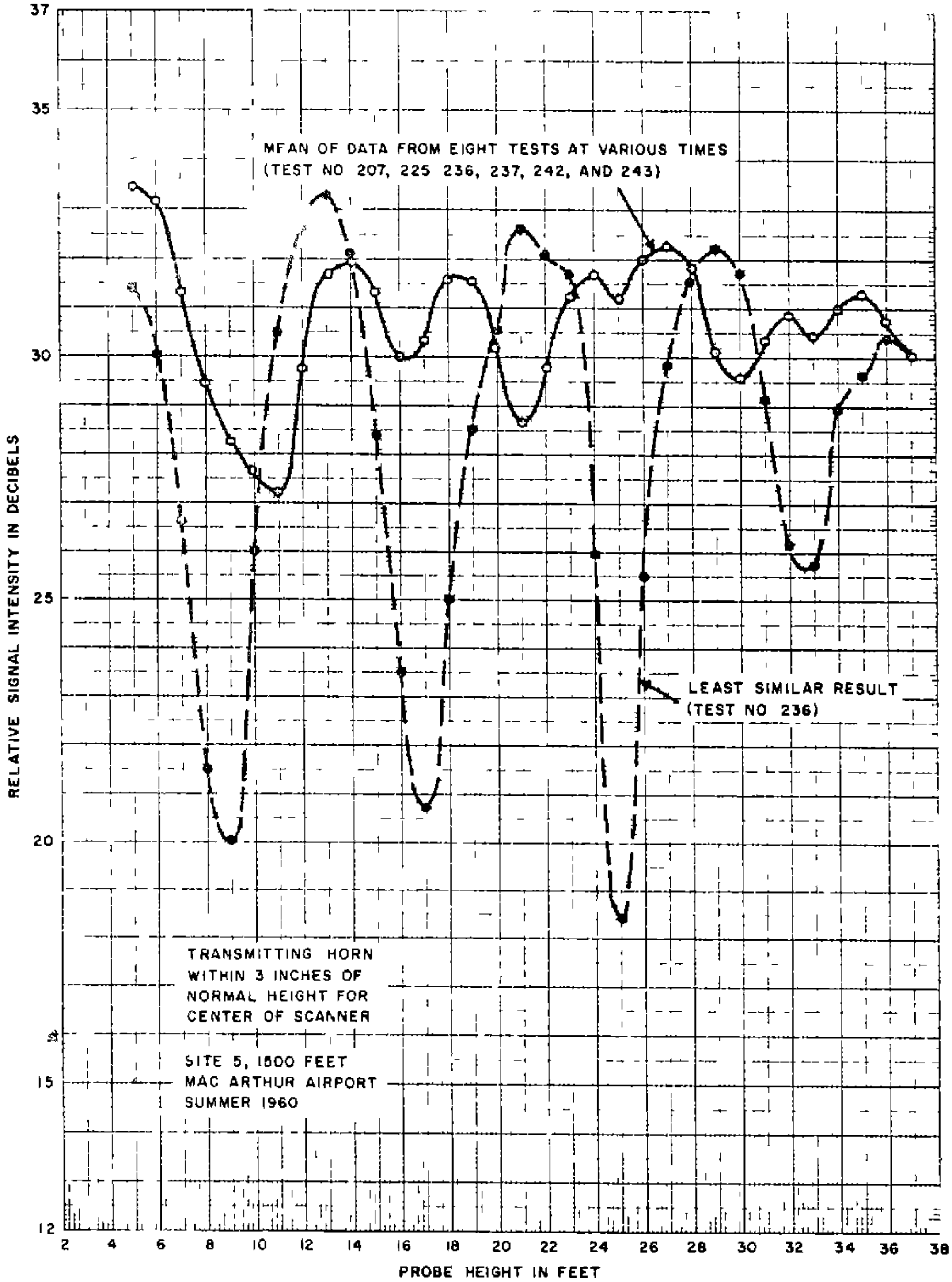

FIGURE 17. STATIC LOBING PATTERNS (COMPOSITE DATA)

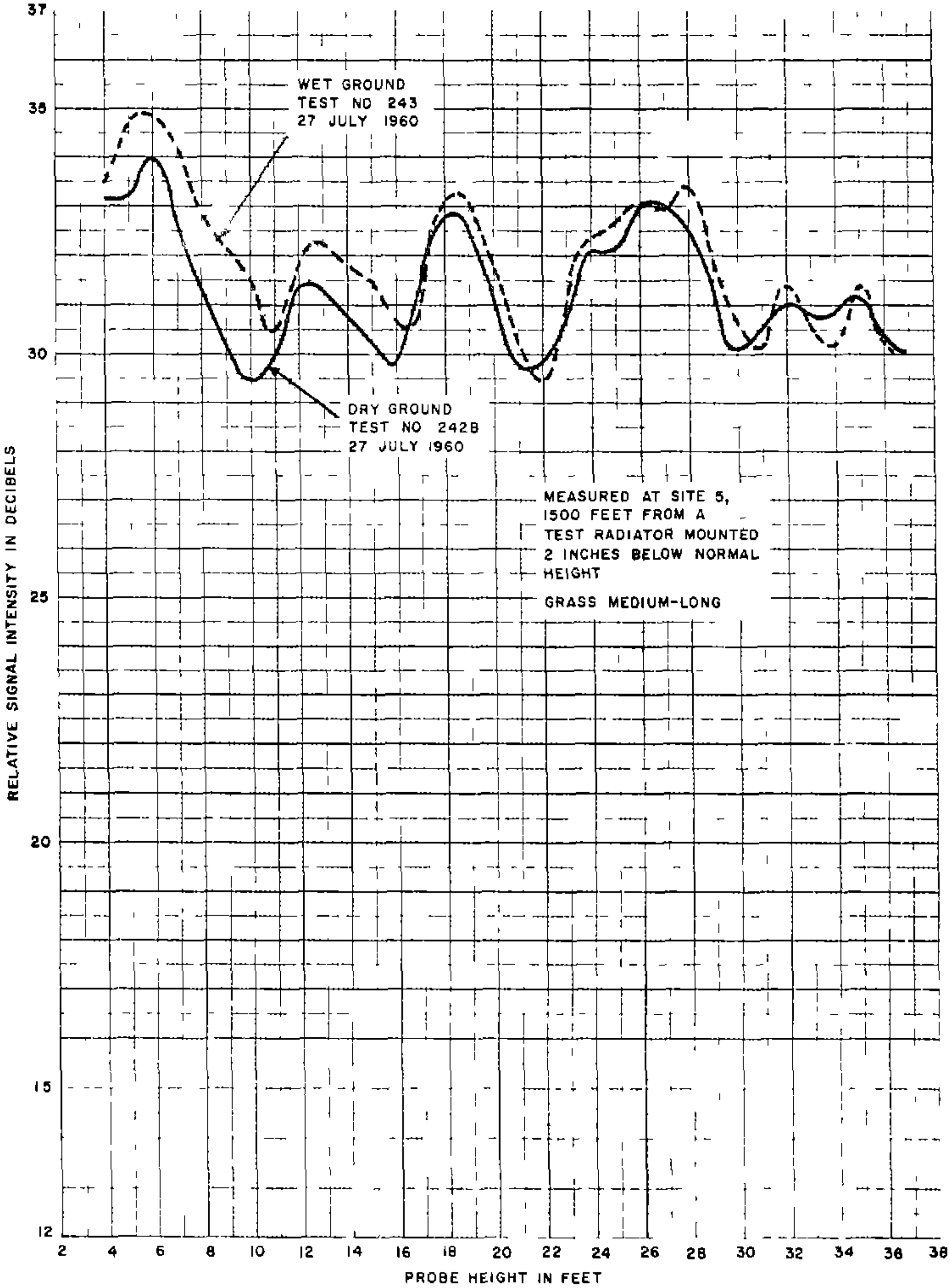

FIGURE 18   EFFECT OF MOISTURE ON STATIC LOBING PATTERN

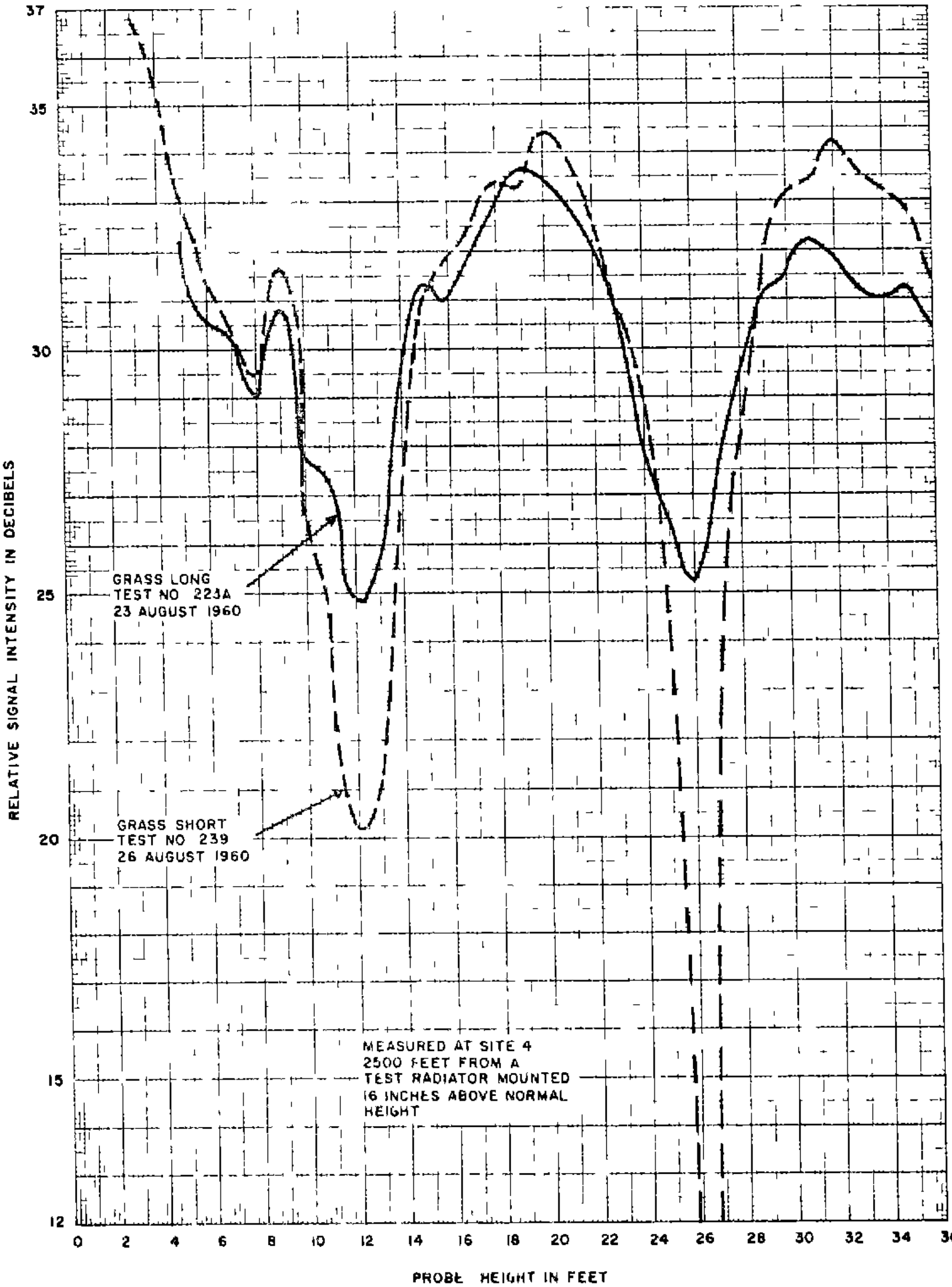

FIGURE 19 EFFECT OF GRASS ON STATIC LOBING PATTERN

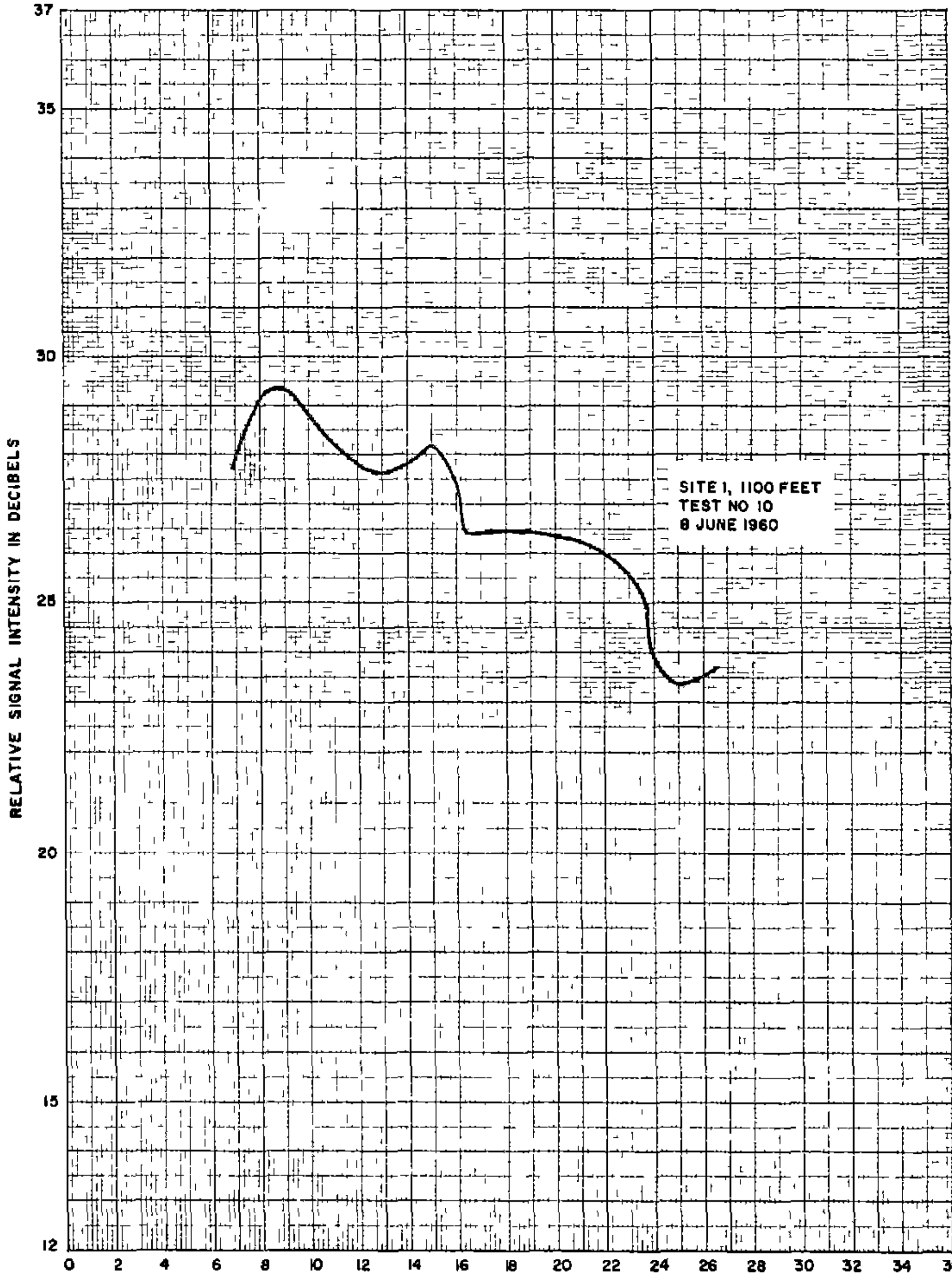

FIGURE 20 EFFECT OF DYNAMIC LOBING ON PEAK-OF-BEAM AMPLITUDE OF INTERCEPTED SCANNING BEAM

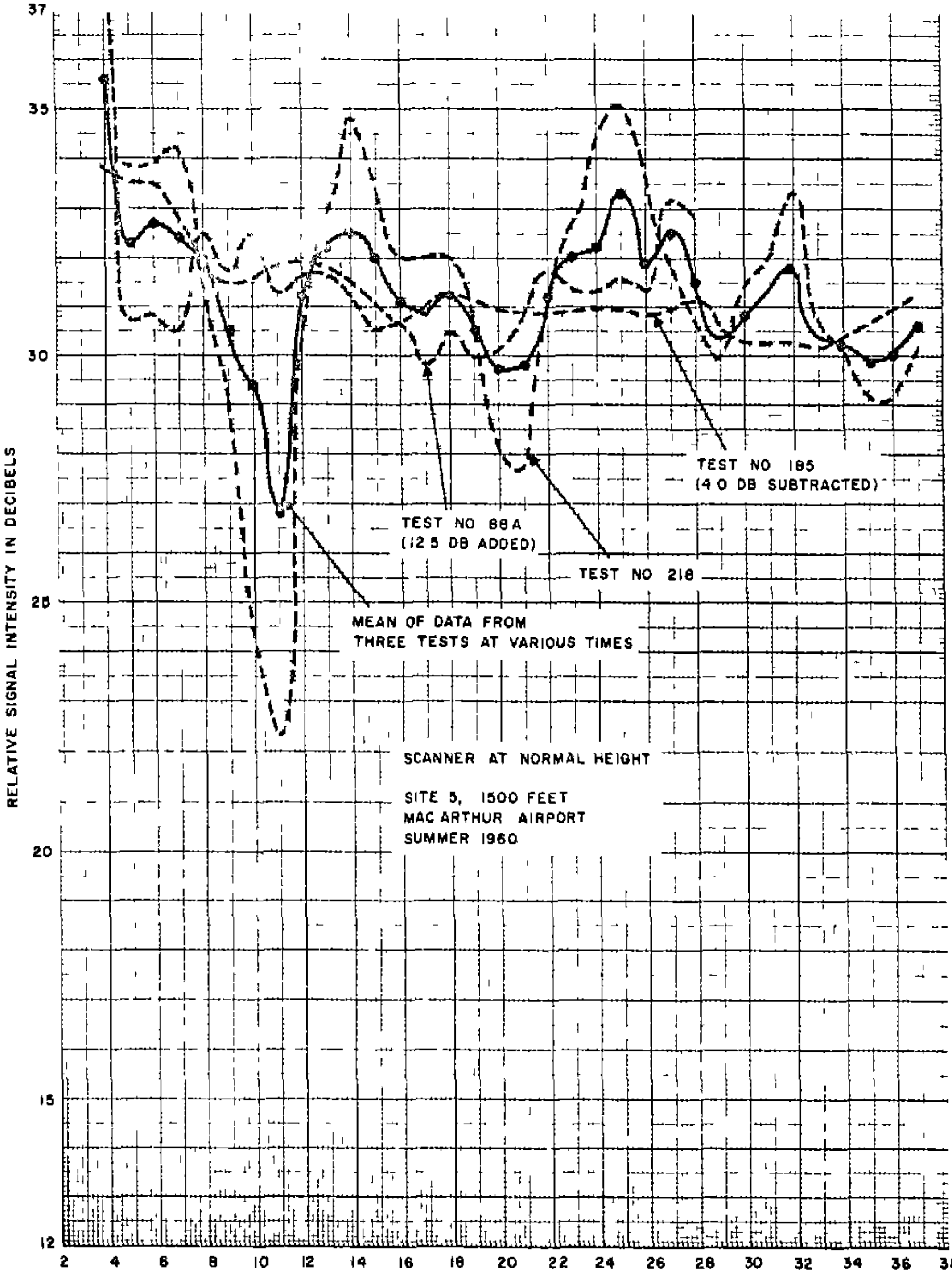

FIGURE 21. DYNAMIC LOBING PATTERNS (COMPOSITE DATA)

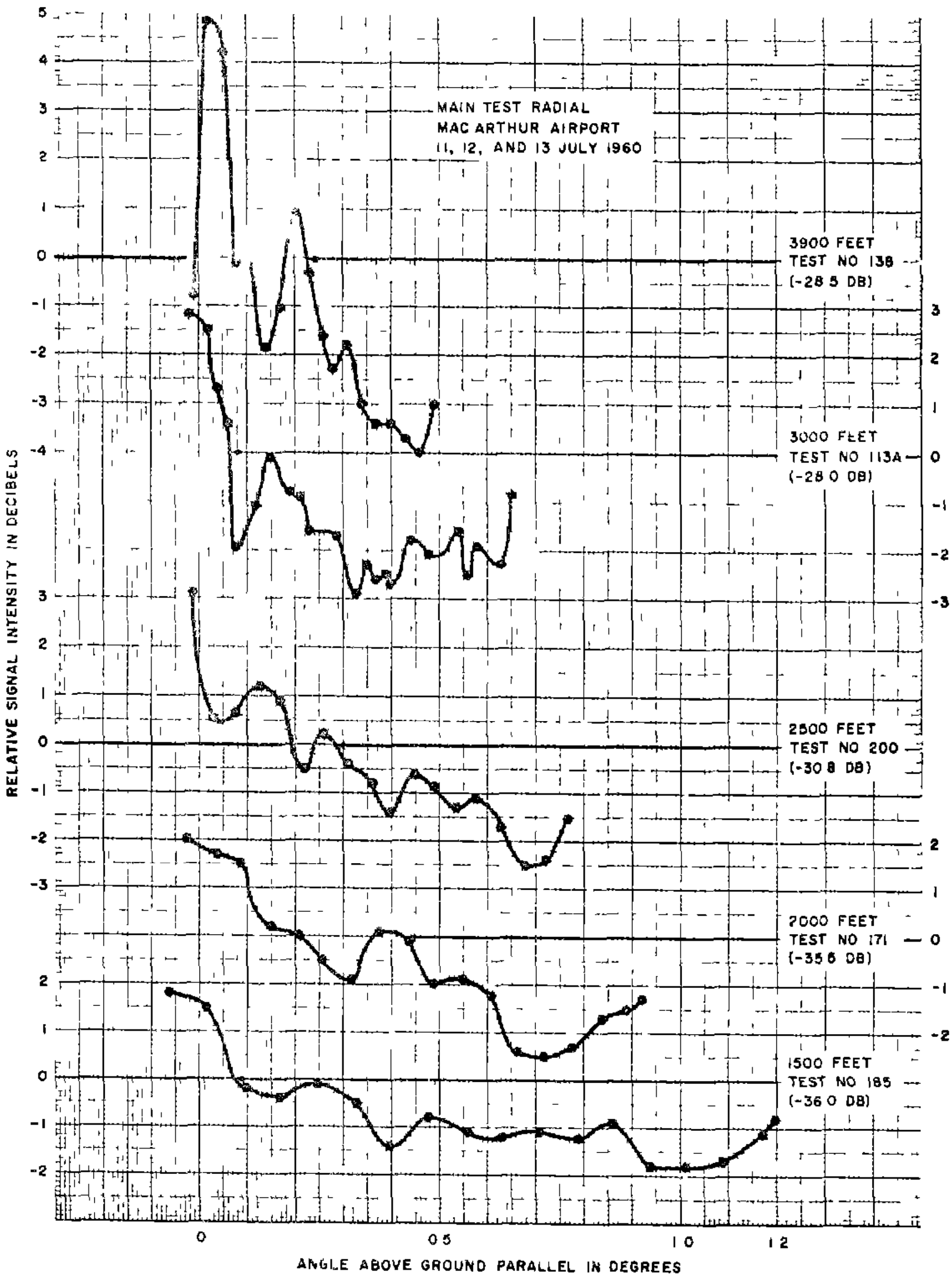

FIGURE 22. DYNAMIC LOBING AT VARIOUS DISTANCES

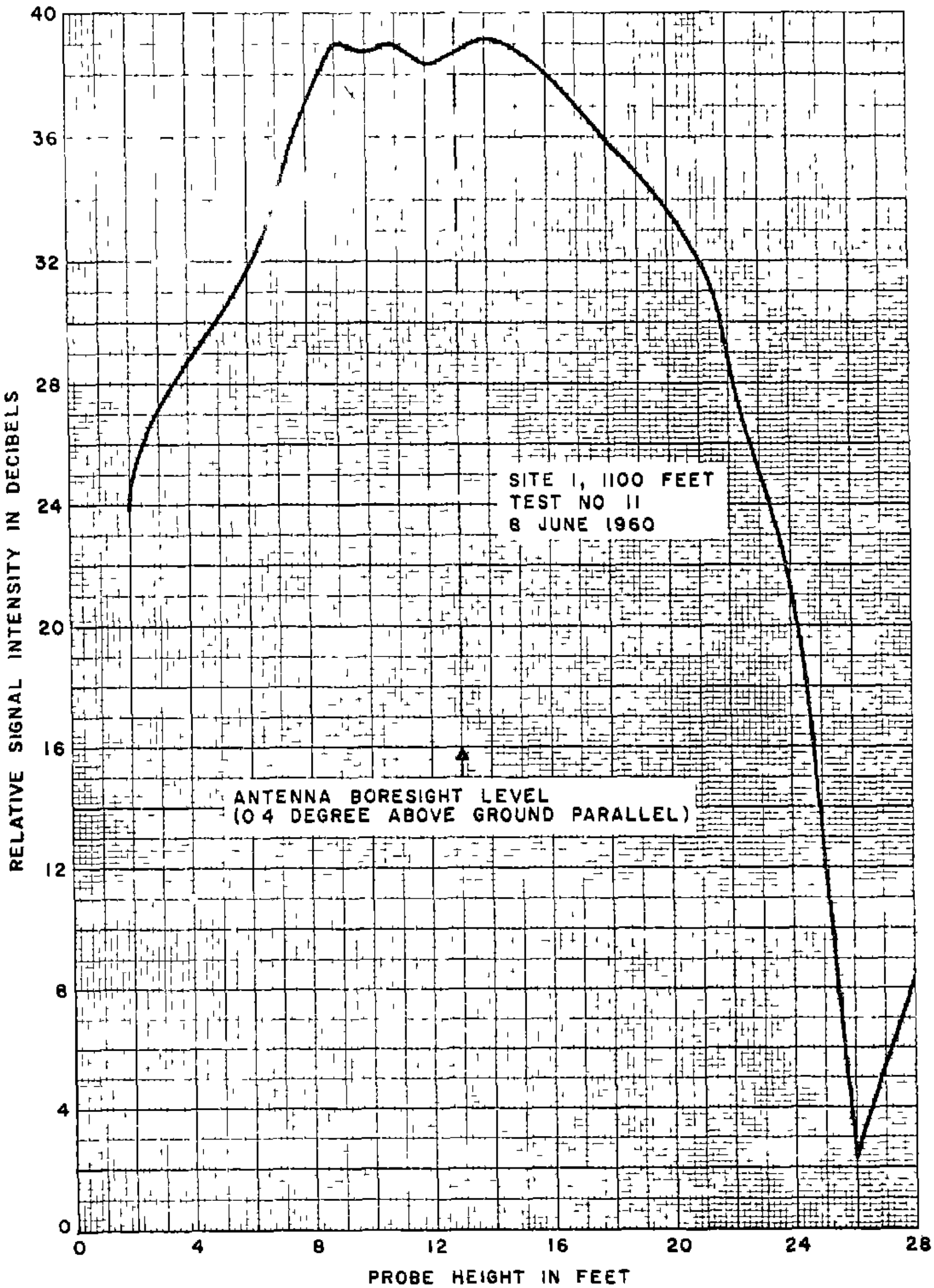

FIGURE 23. STATIC BEAMSHAPE PATTERN (TEST NO. 11)

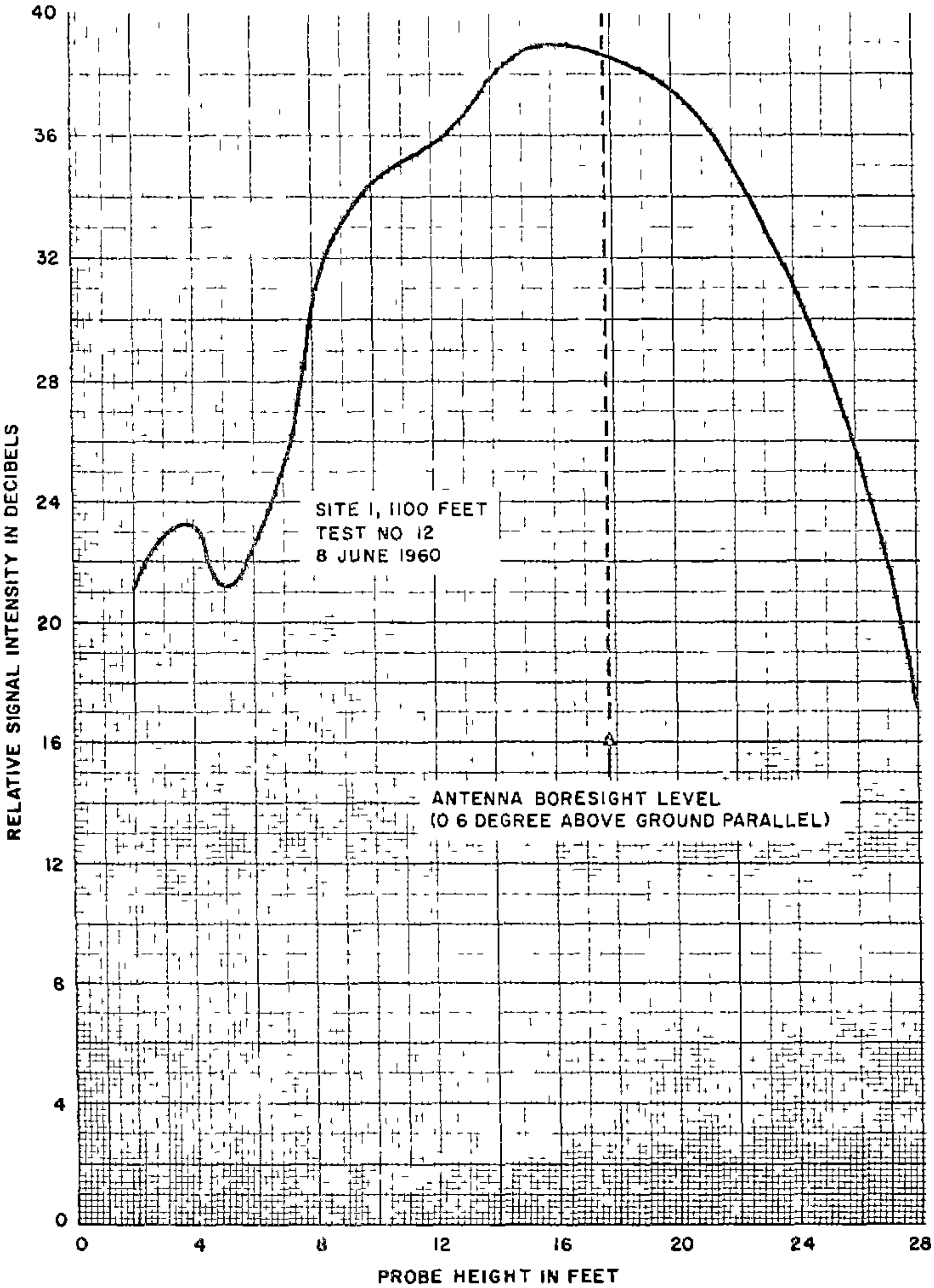

FIGURE 24 STATIC BEAMSHAPE PATTERN (TEST NO 12)

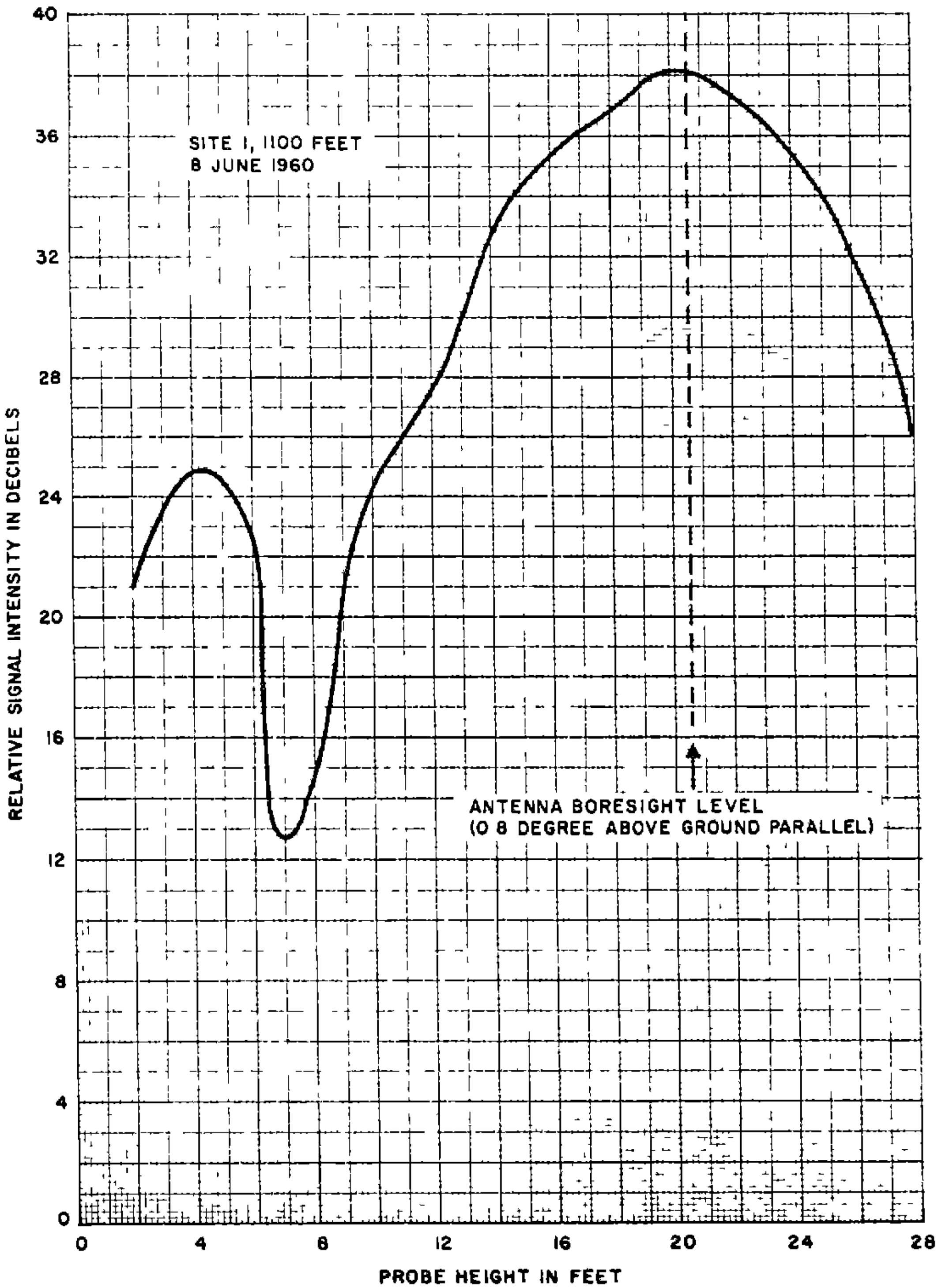

FIGURE 25. STATIC BEAMSHAPE PATTERN (TEST NO. 13)

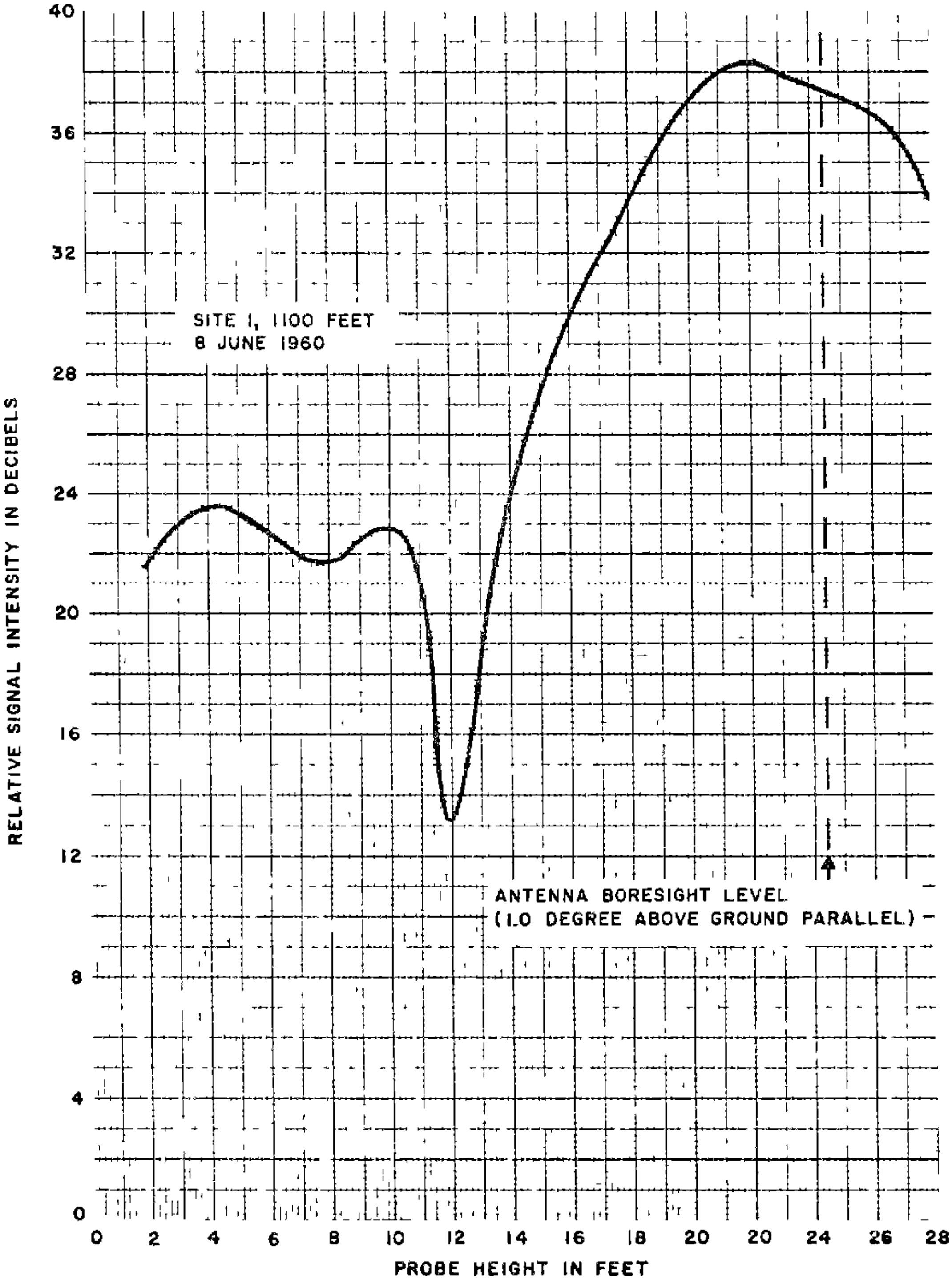

FIGURE 26. STATIC BEAMSHAPE PATTERN (TEST NO. 14)

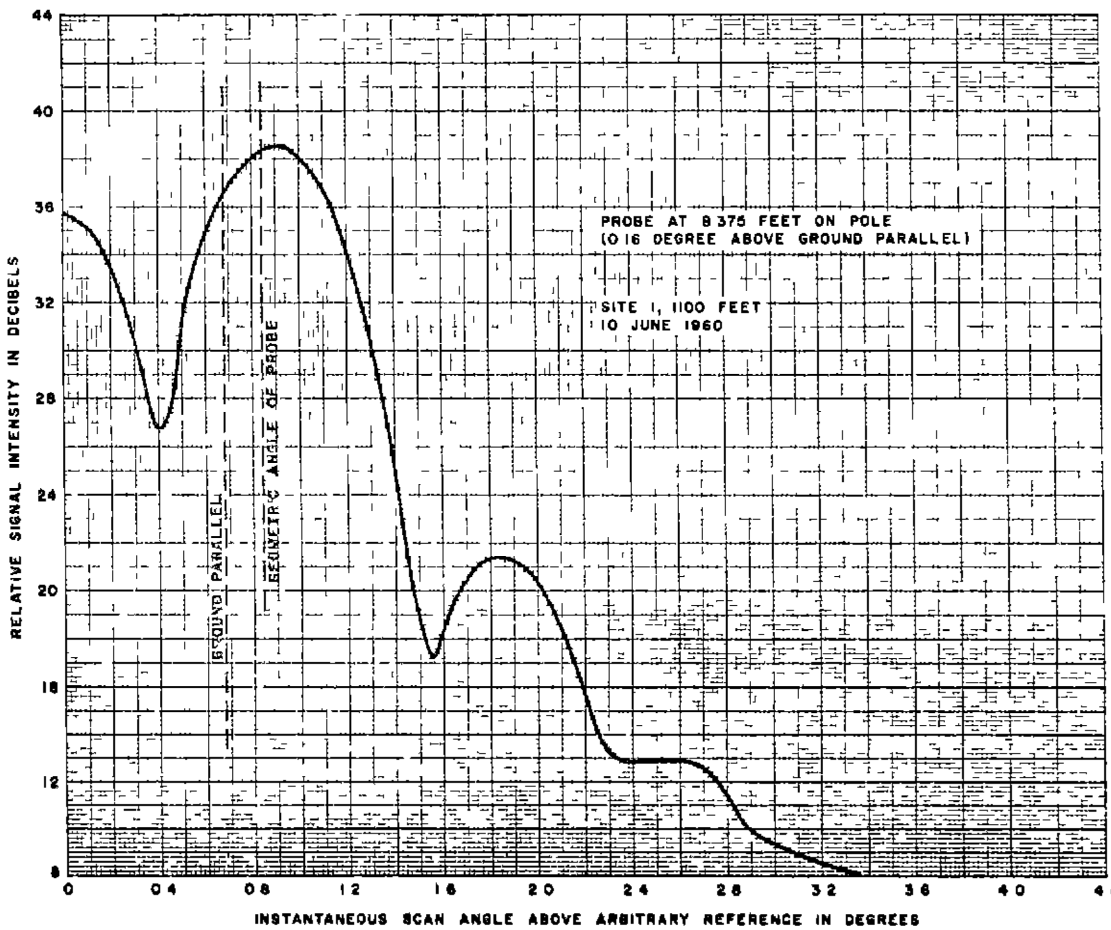

FIGURE 27. DYNAMIC ENVELOPE OF SCANNING BEAM (TEST NO. 32)

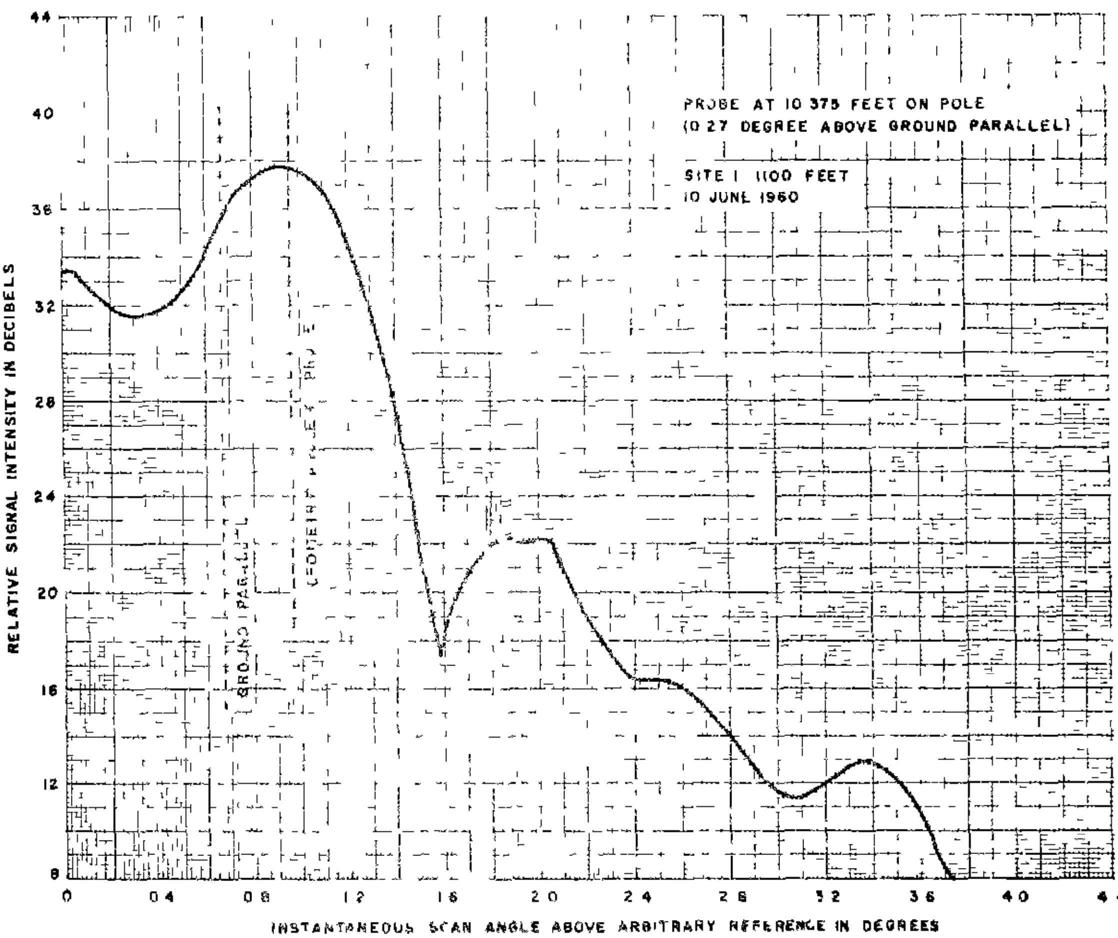

FIGURE 28 DYNAMIC ENVELOPE OF SCANNING BEAM (TEST NO 31)

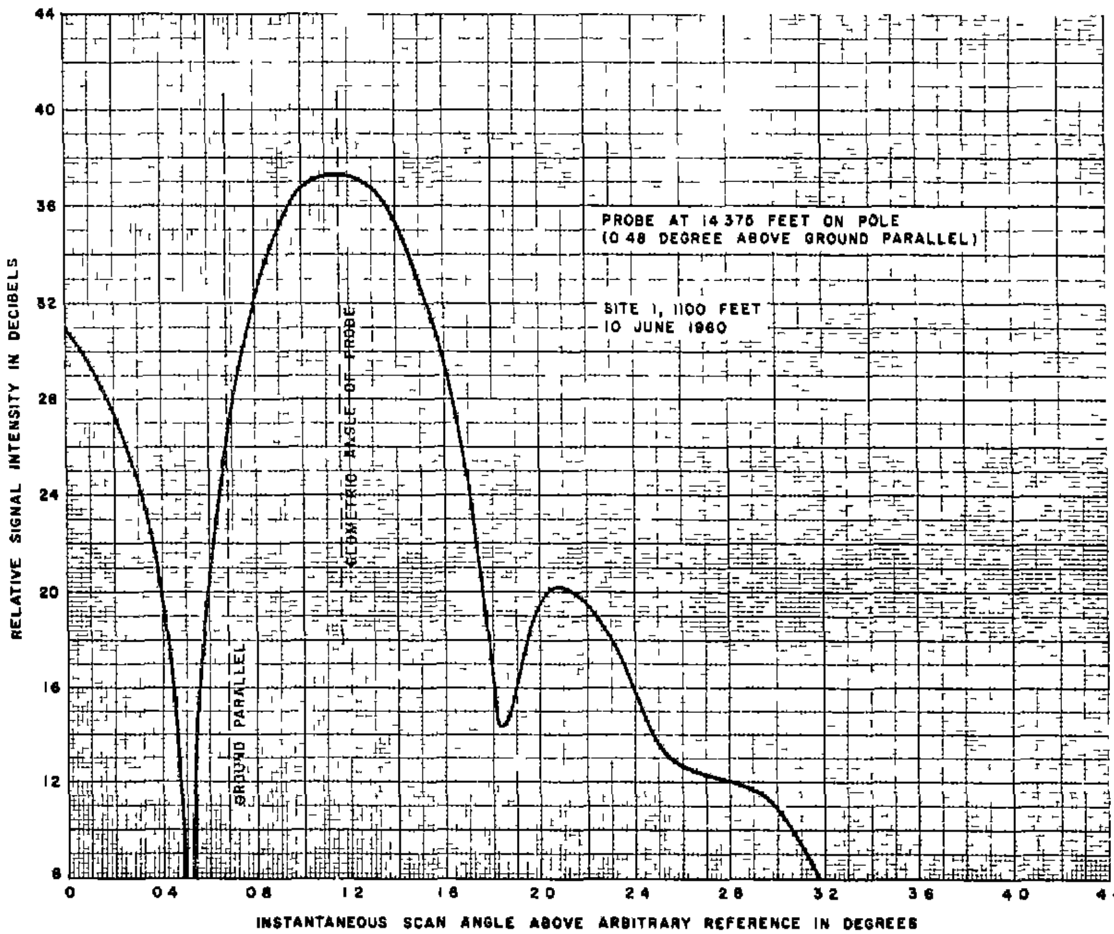

FIGURE 29. DYNAMIC ENVELOPE OF SCANNING BEAM (TEST NO. 29)

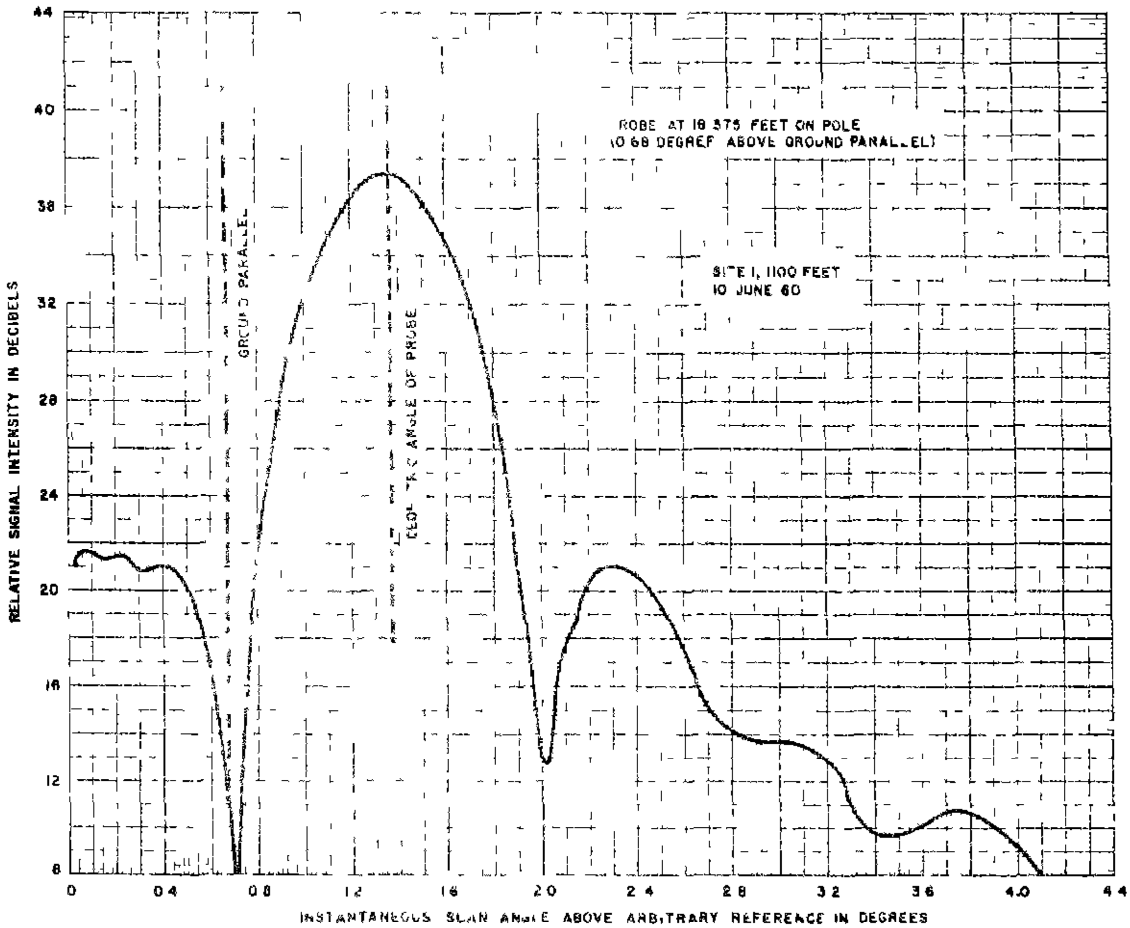

FIGURE 30 DYNAMIC INDICATIONS OF SCANNING BEAM (TEST NO 27)

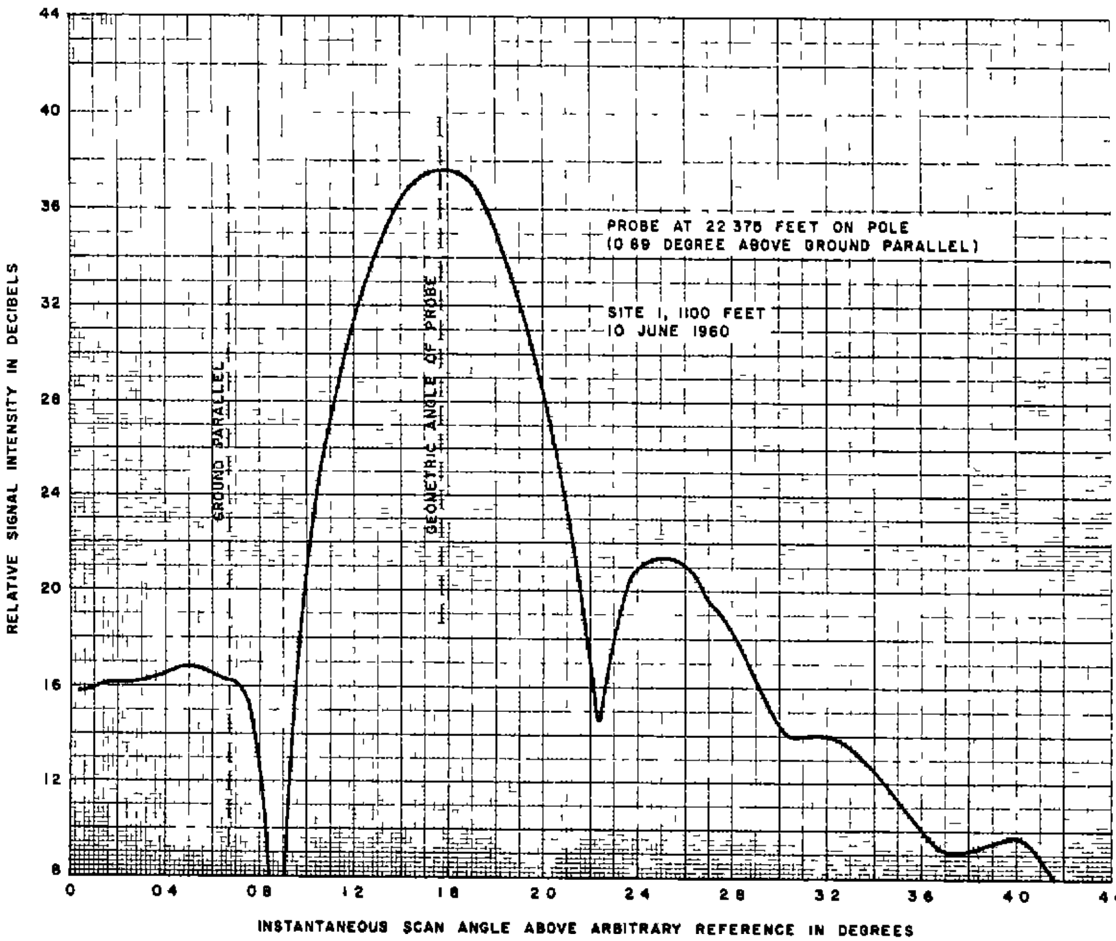

FIGURE 31. DYNAMIC ENVELOPE OF SCANNING BEAM (TEST NO. 25)

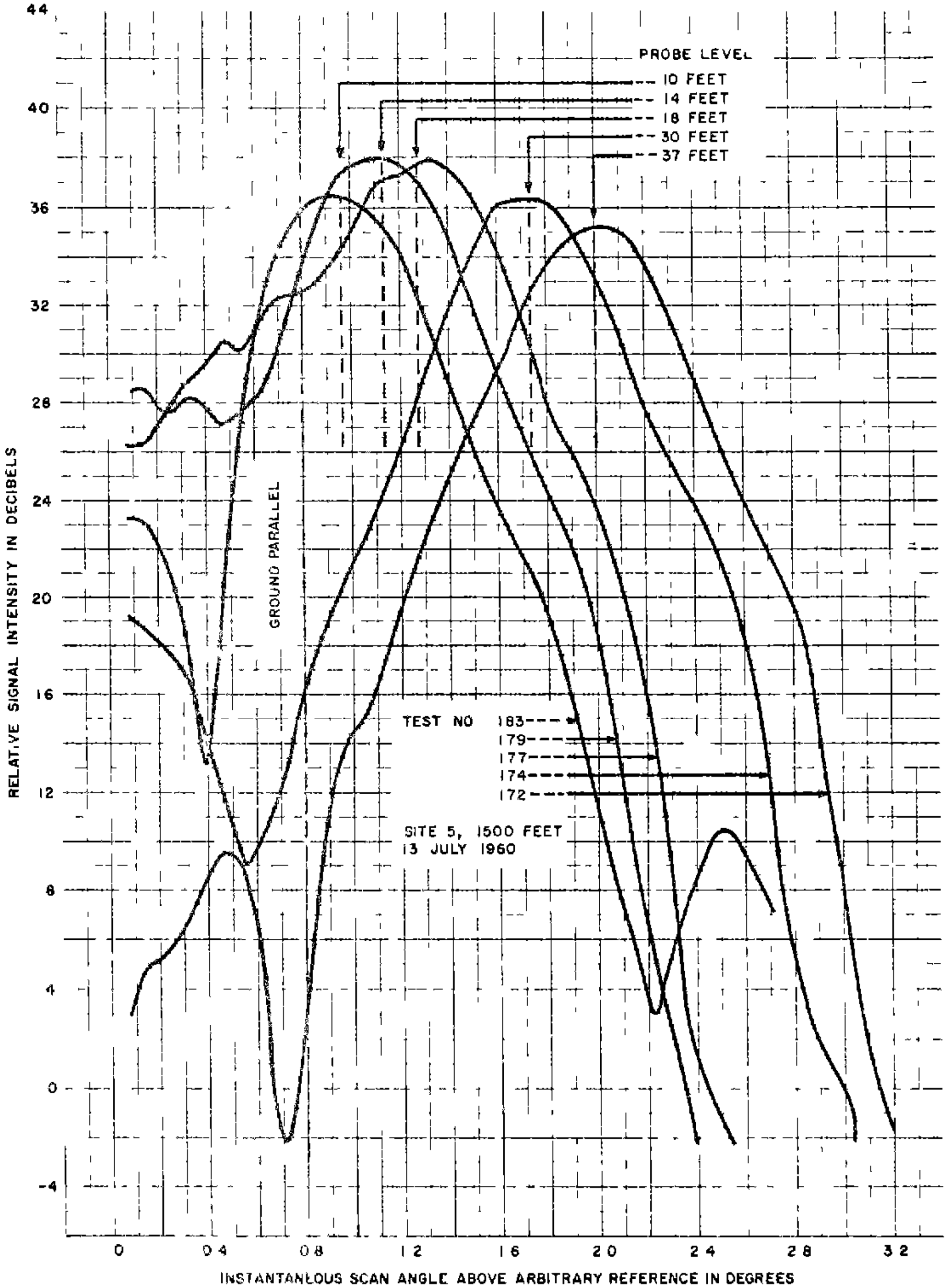

FIGURE 32. VARIATIONS IN DYNAMIC ENVELOPE OF SCANNING BEAM AT LOW ANGLES

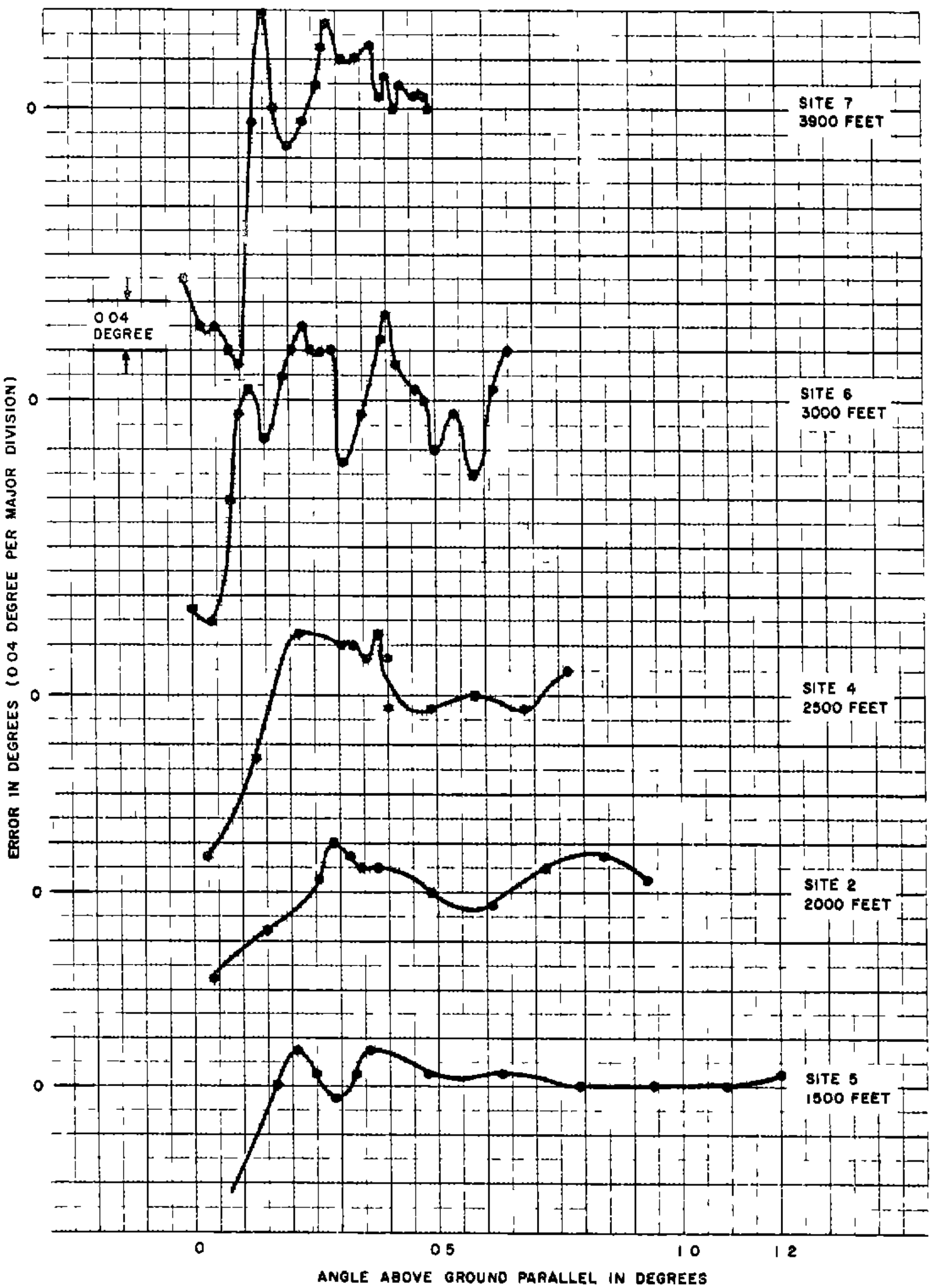

FIGURE 33. HALF-POWER MEDIAN ANGLE ERRORS FROM DYNAMIC BEAMSHAPE TESTS

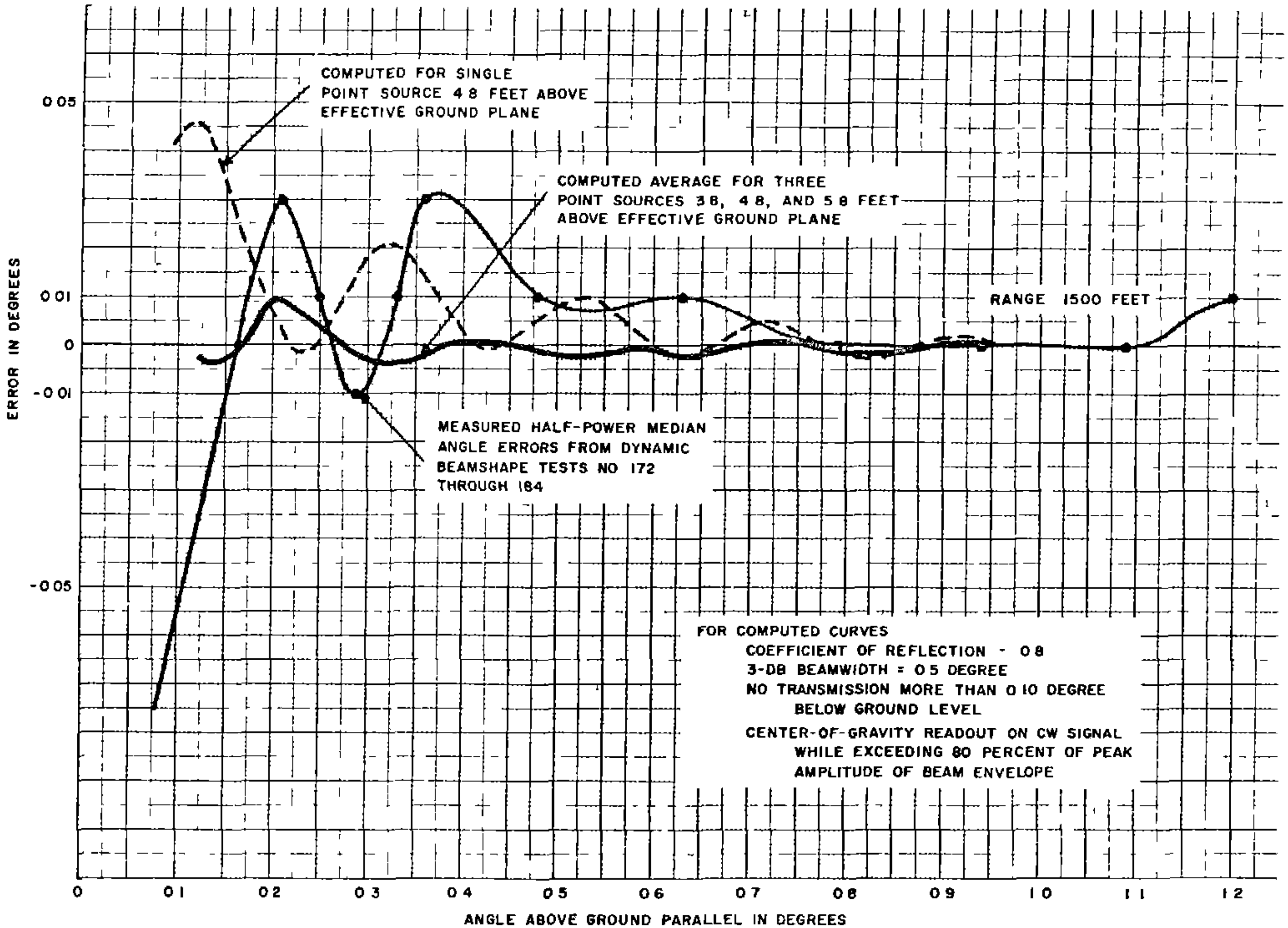

FIGURE 34. THEORETICAL AND MEASURED PROPAGATION ERRORS IN ELEVATION ANGLE

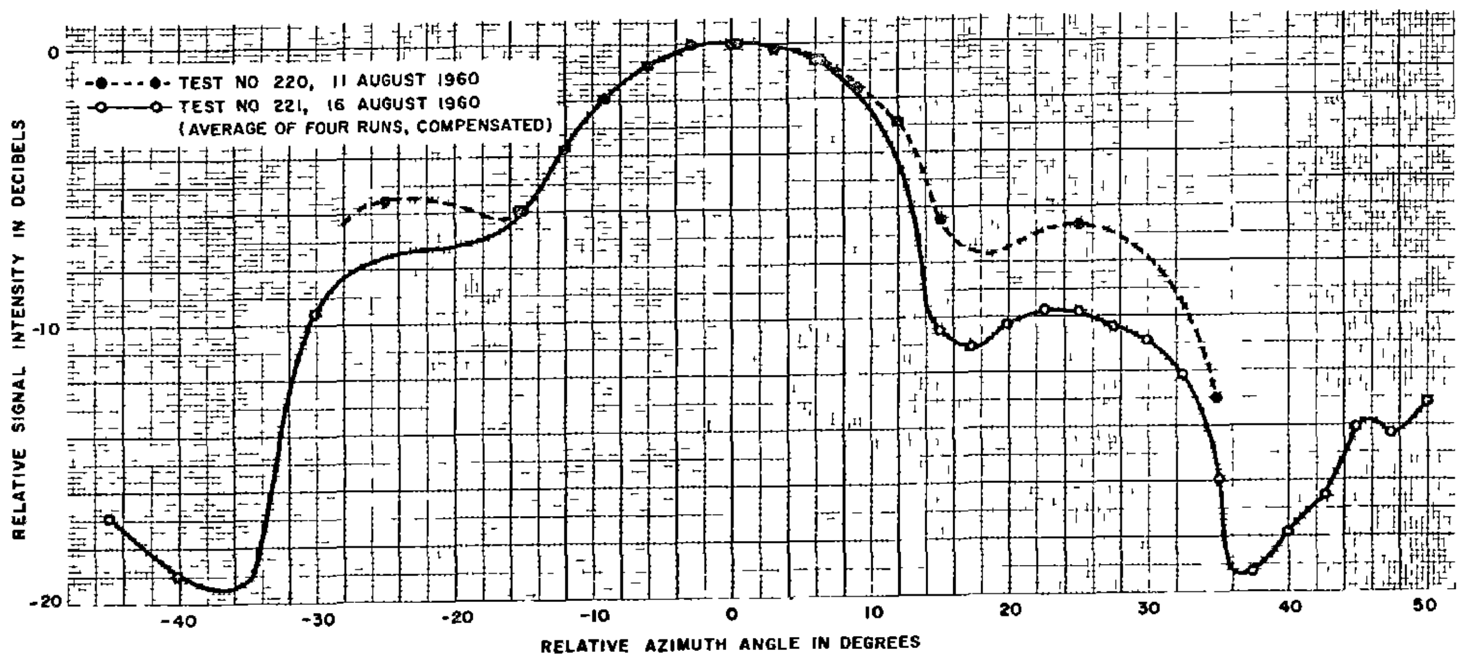

FIGURE 35. AZIMUTH PATTERN OF SCANNING ANTENNA

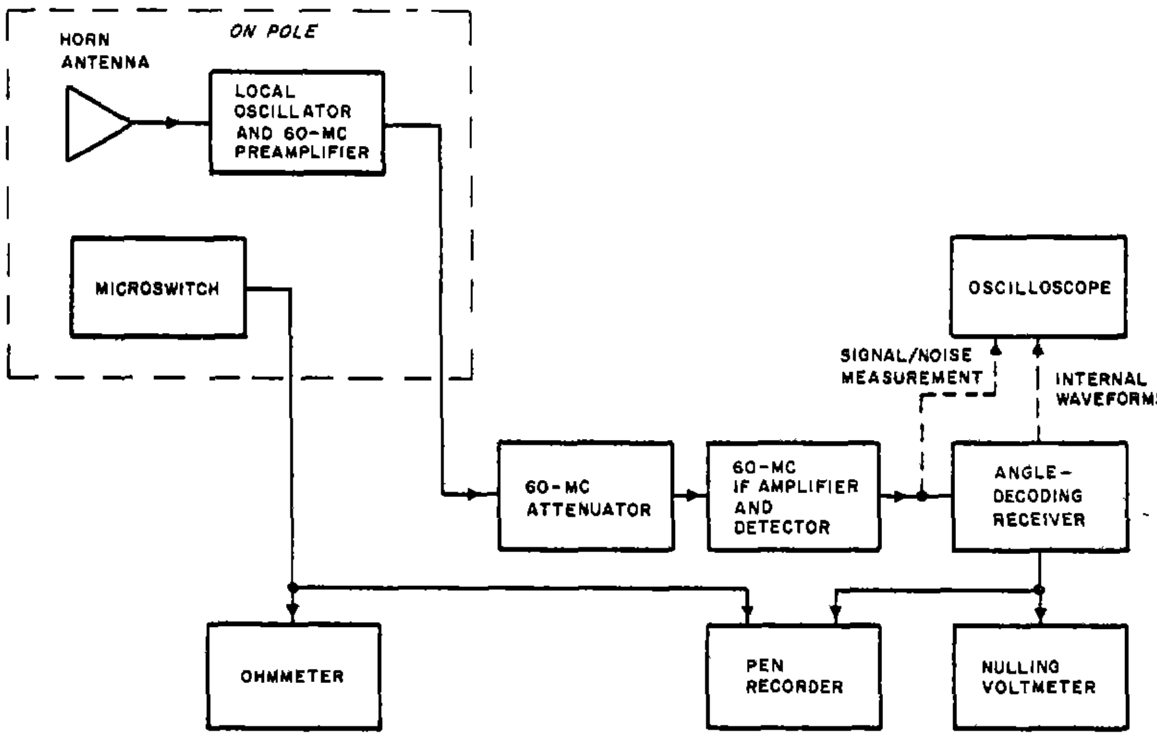

FIGURE 36 EQUIPMENT SETUP AT RECEIVER TEST STATION

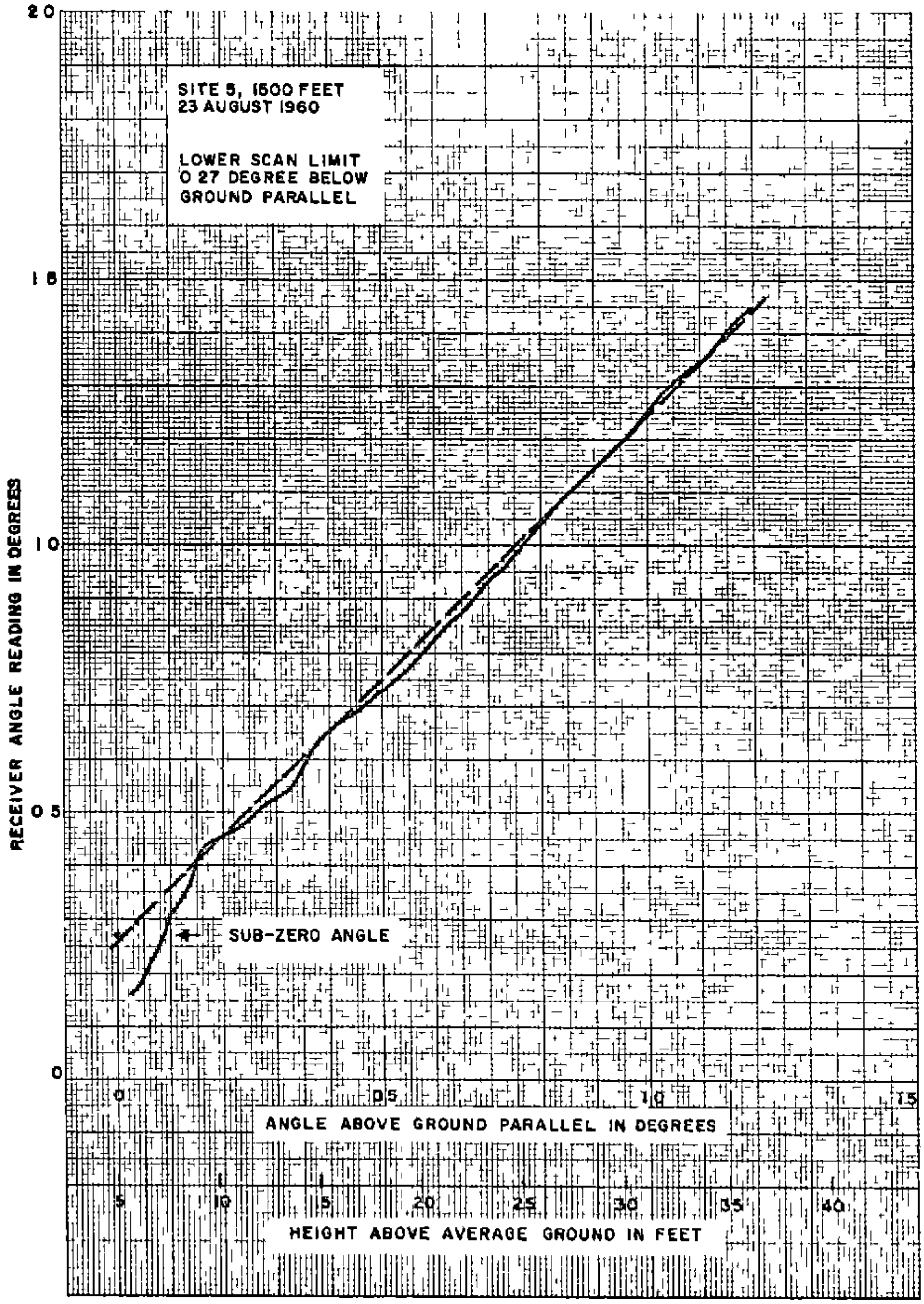

FIGURE 37 RECEIVER READINGS AT 1500 FEET (TEST NO. 226)

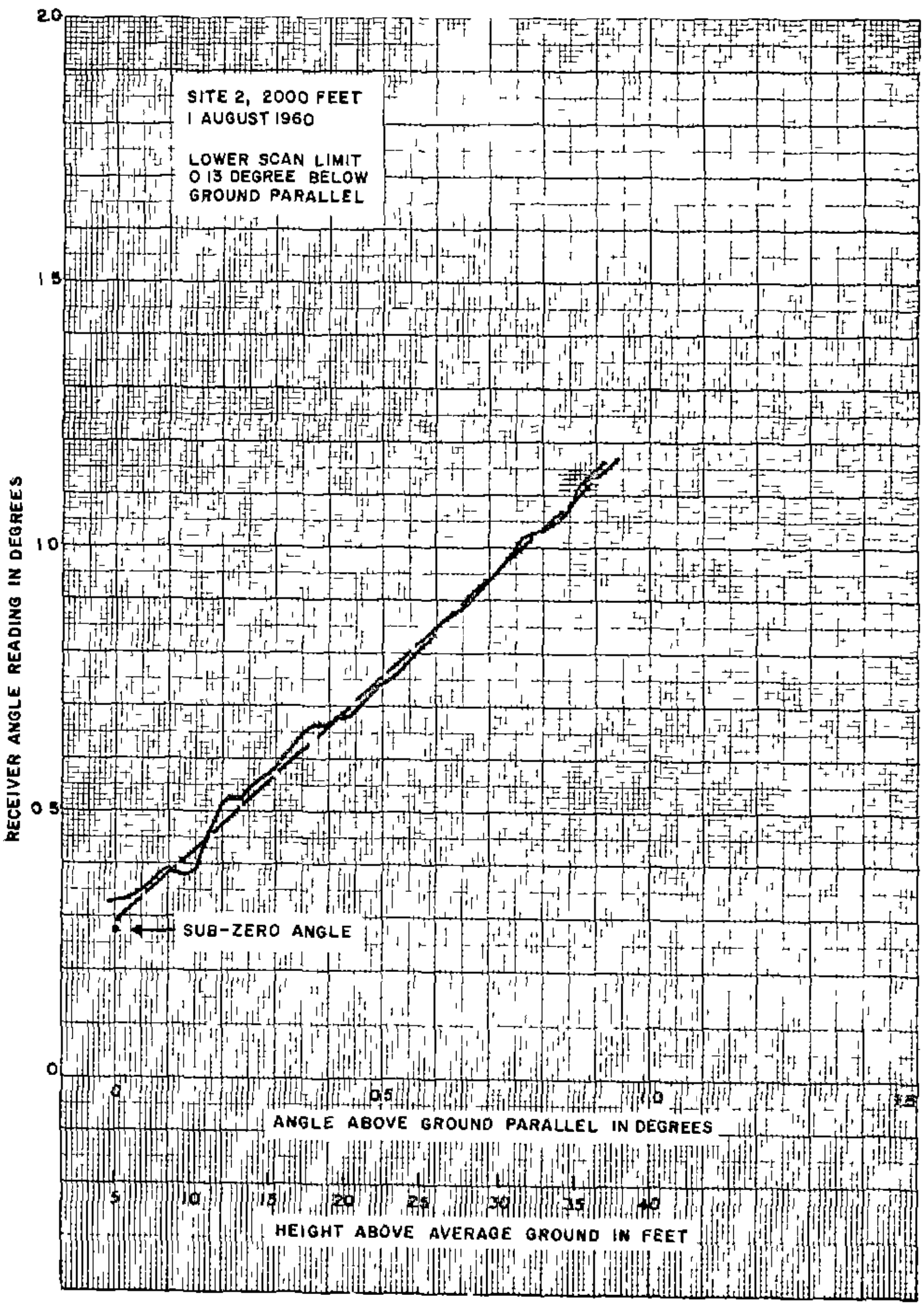

FIGURE 38 RECEIVER READINGS AT 2000 FEET (TEST NO. 216)

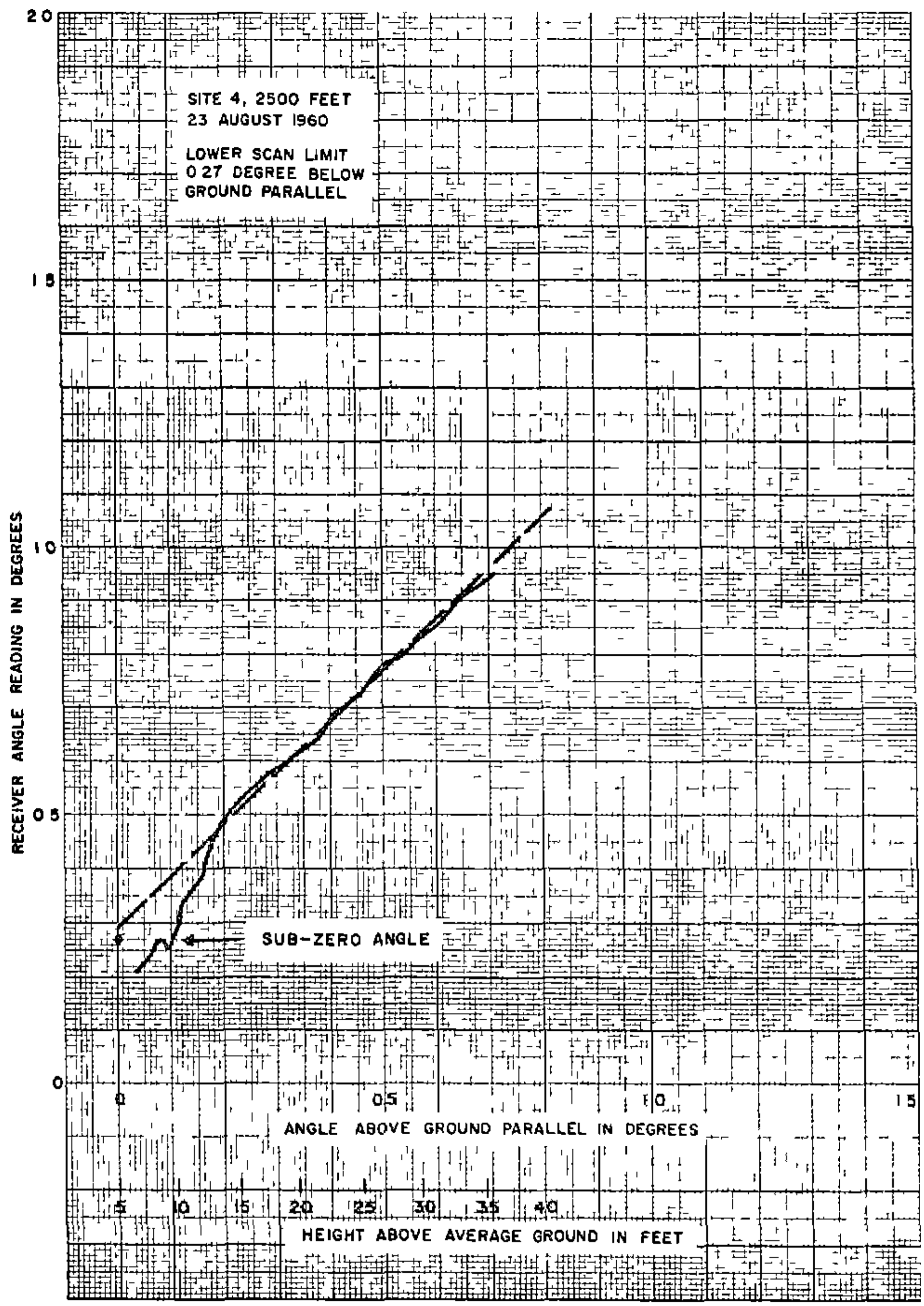

FIGURE 39. RECEIVER READINGS AT 2500 FEET (TEST NO 224)

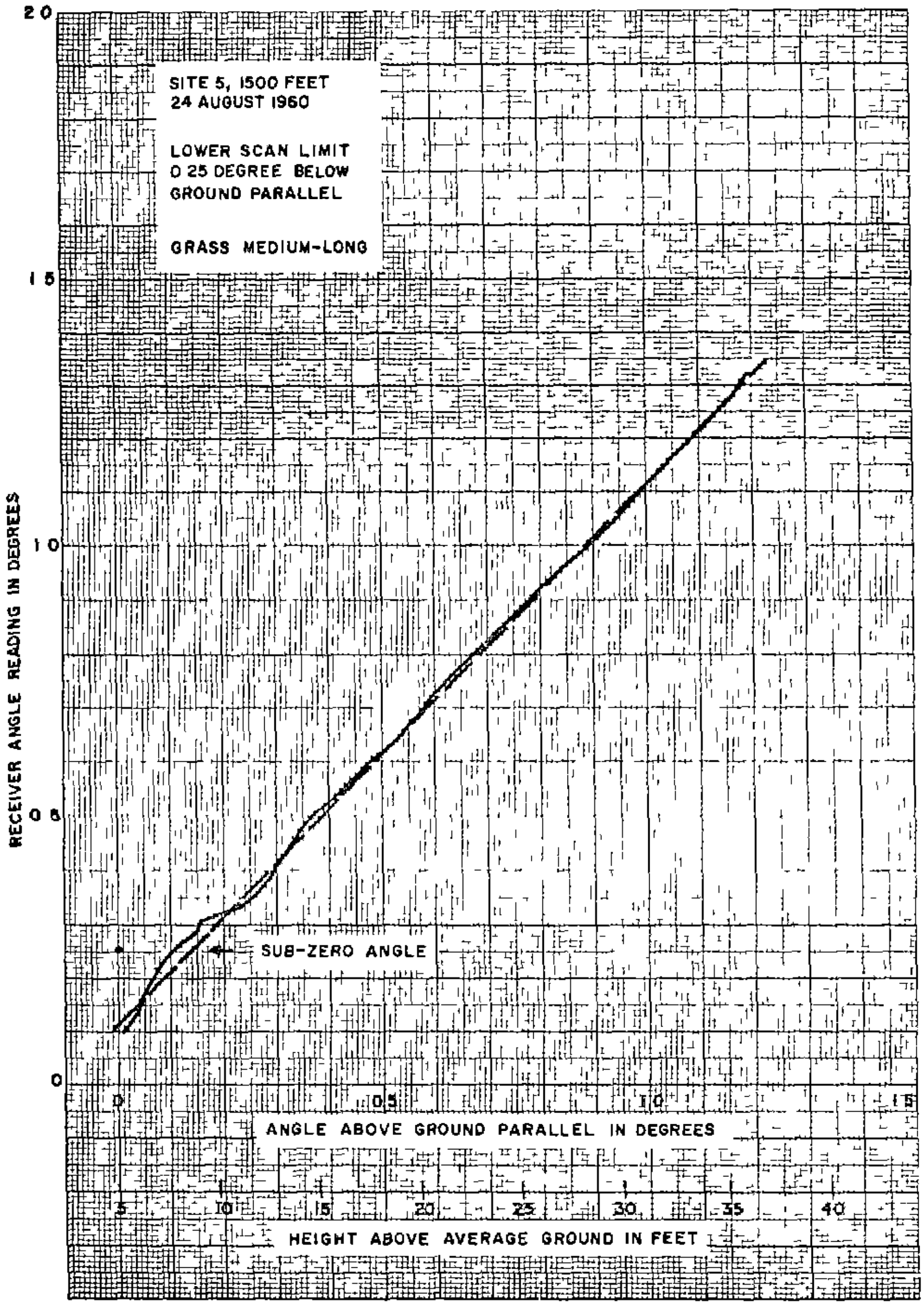

FIGURE 40 RECEIVER READINGS WITH NORMAL SCANNER HEIGHT (TEST NO. 229)

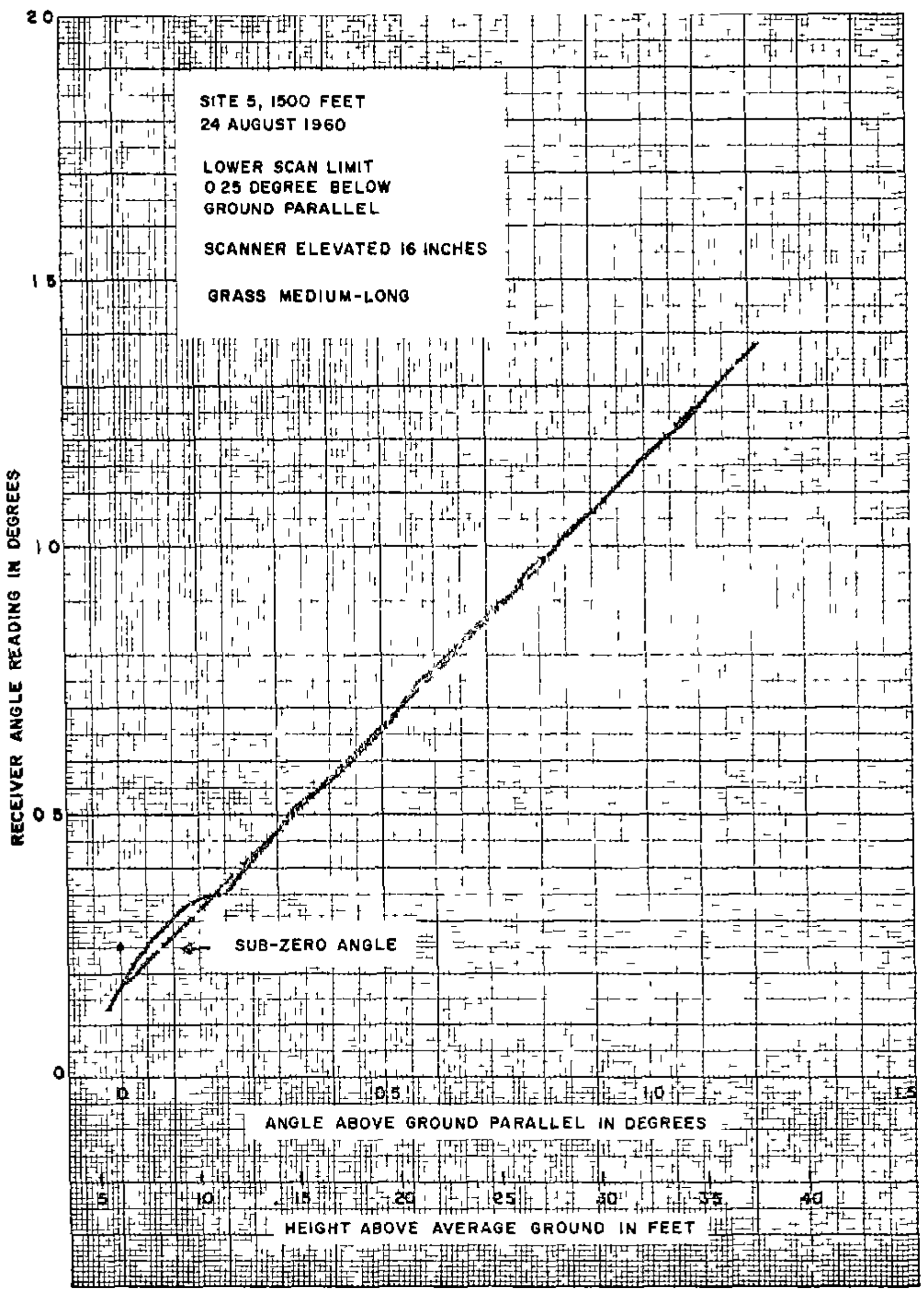

FIGURE 41. RECEIVER READINGS WITH ELEVATED SCANNER AND LONG GRASS (TEST NO 231)

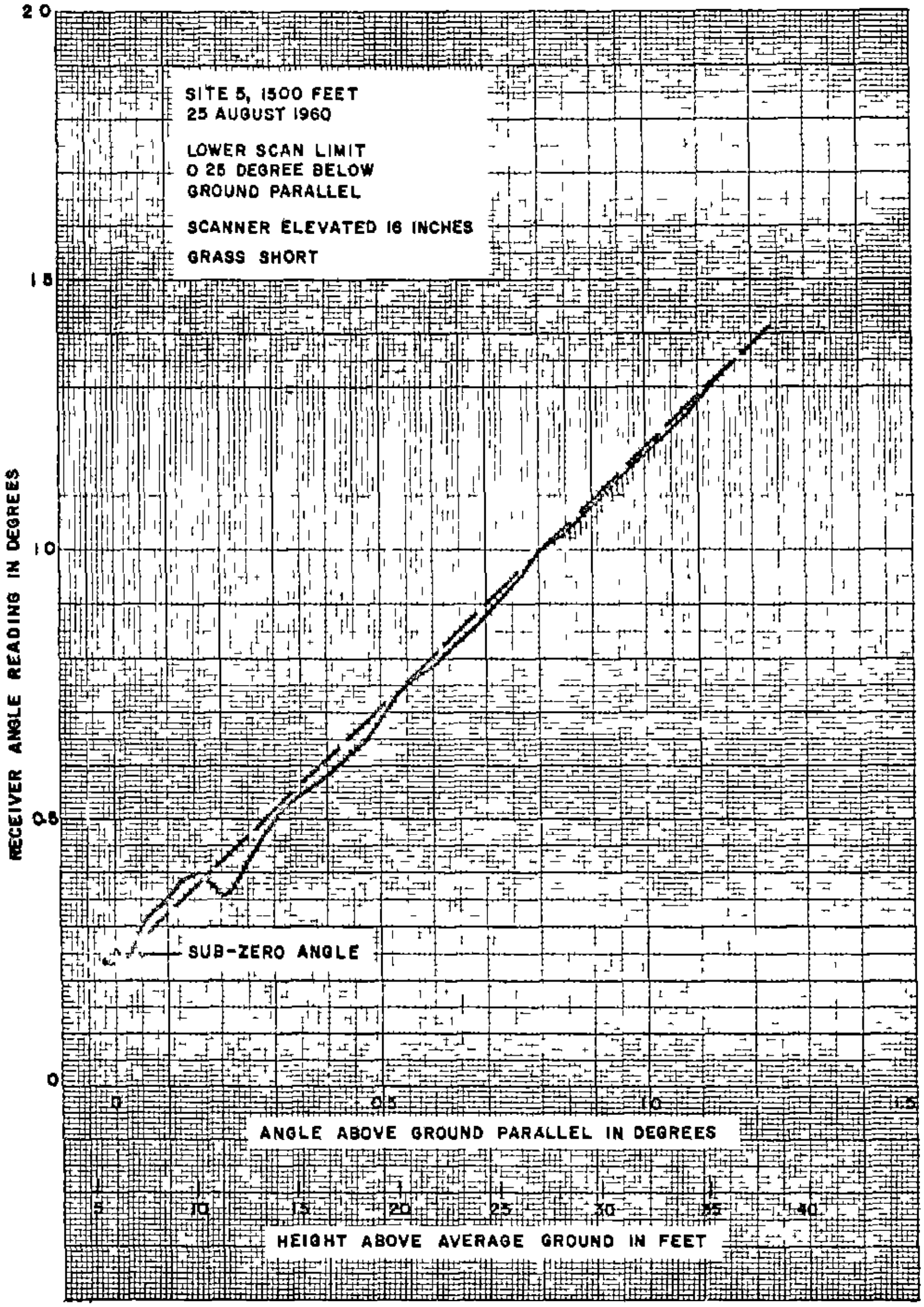

FIGURE 42. RECEIVER READINGS WITH ELEVATED SCANNER AND SHORT GRASS (TEST NO. 232)

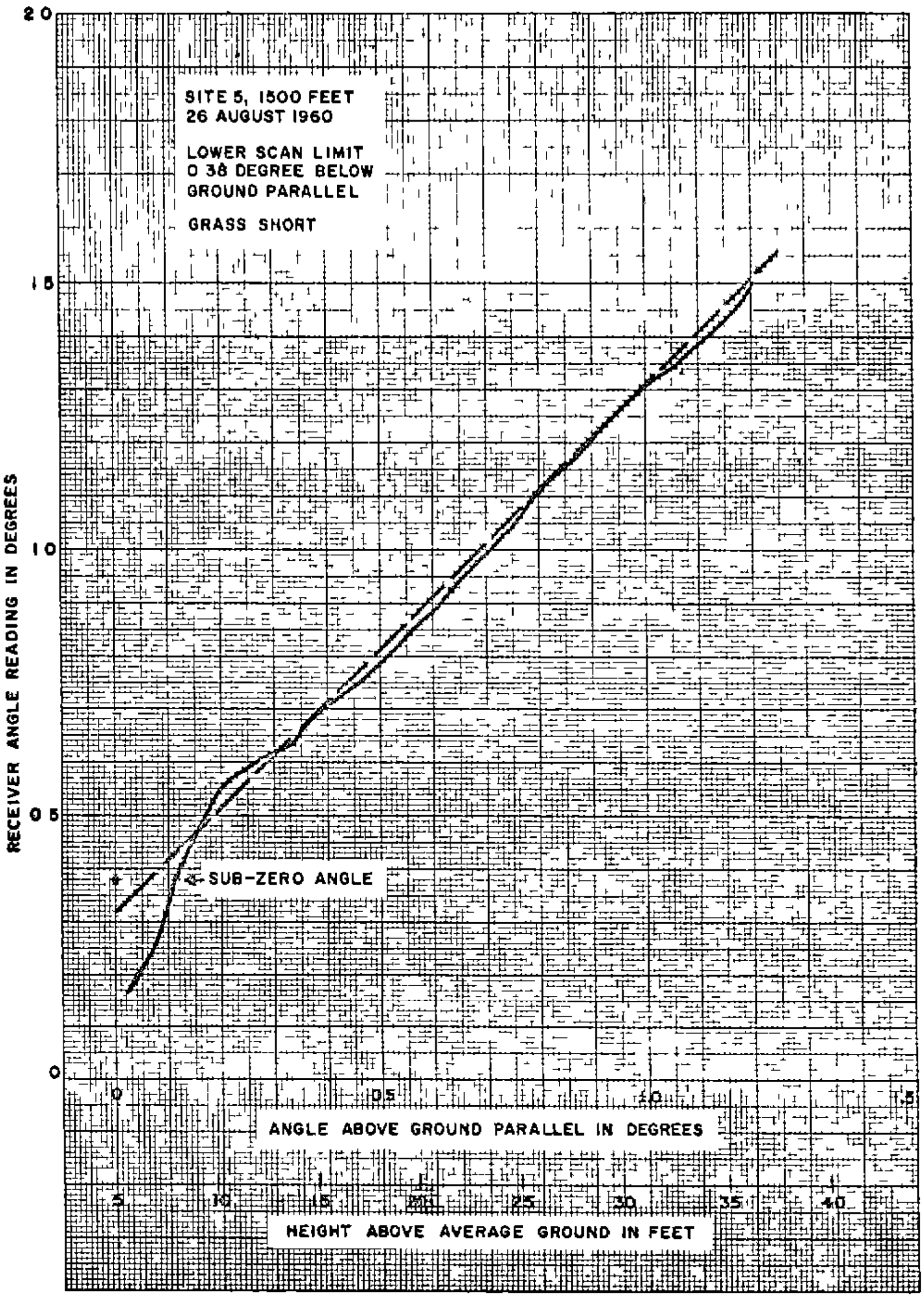

FIGURE 43 RECEIVER READINGS WITH SHORT GRASS (TEST NO. 233)

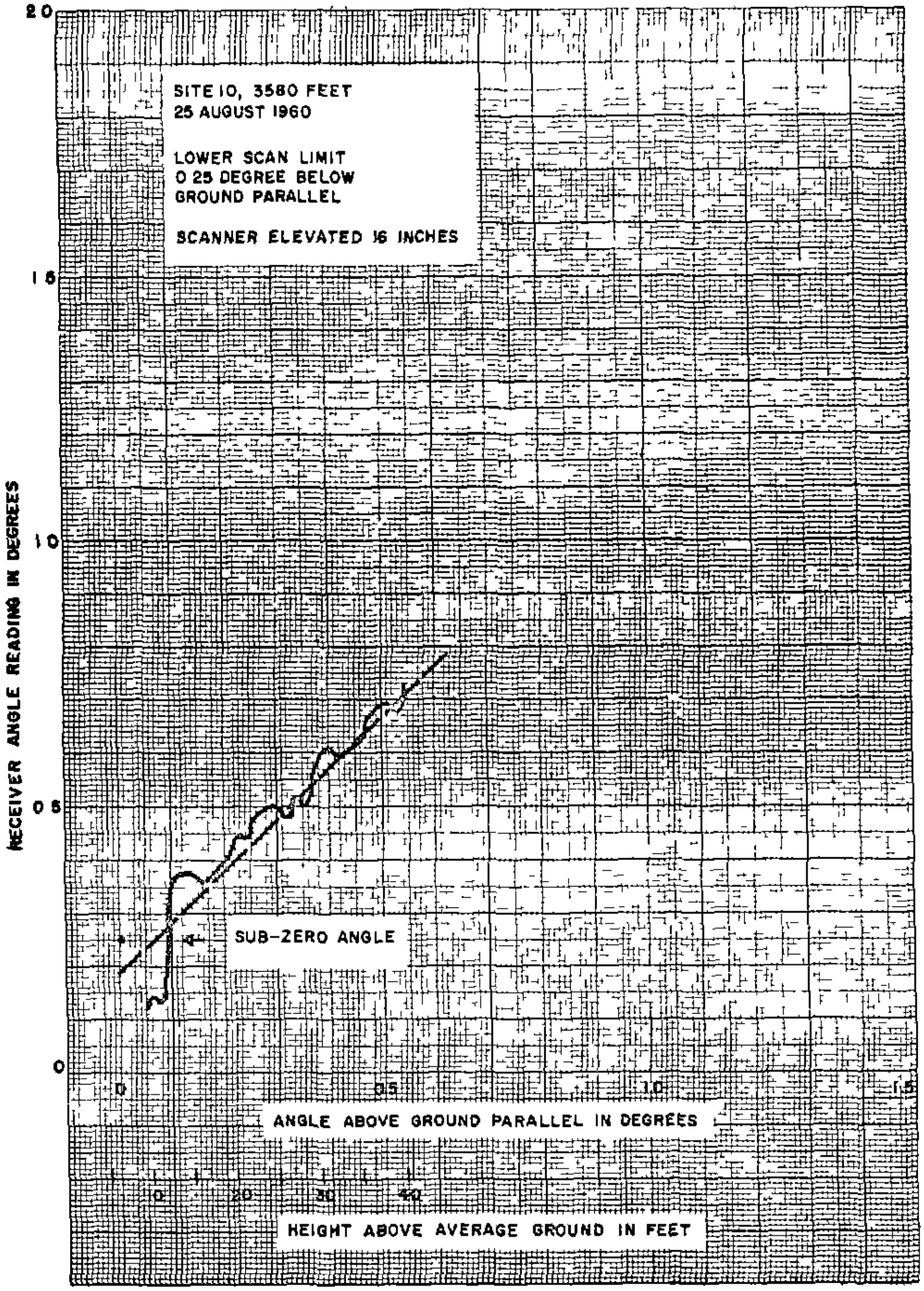

FIGURE 44. RECEIVER READINGS AT 3580 FEET (TEST NO. 240)

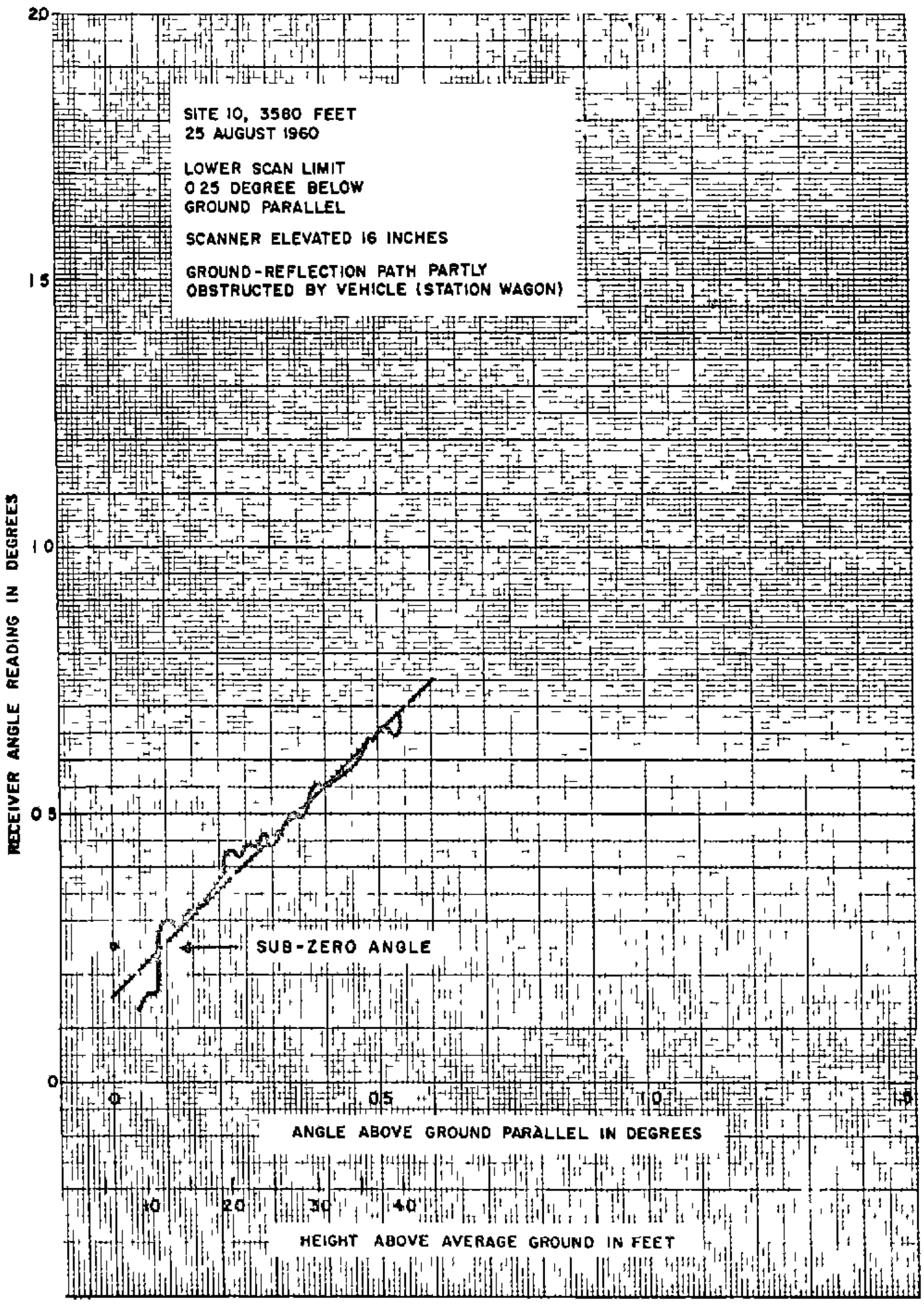

FIGURE 45. RECEIVER READINGS WITH OBSTRUCTED PATH (TEST NO. 241)

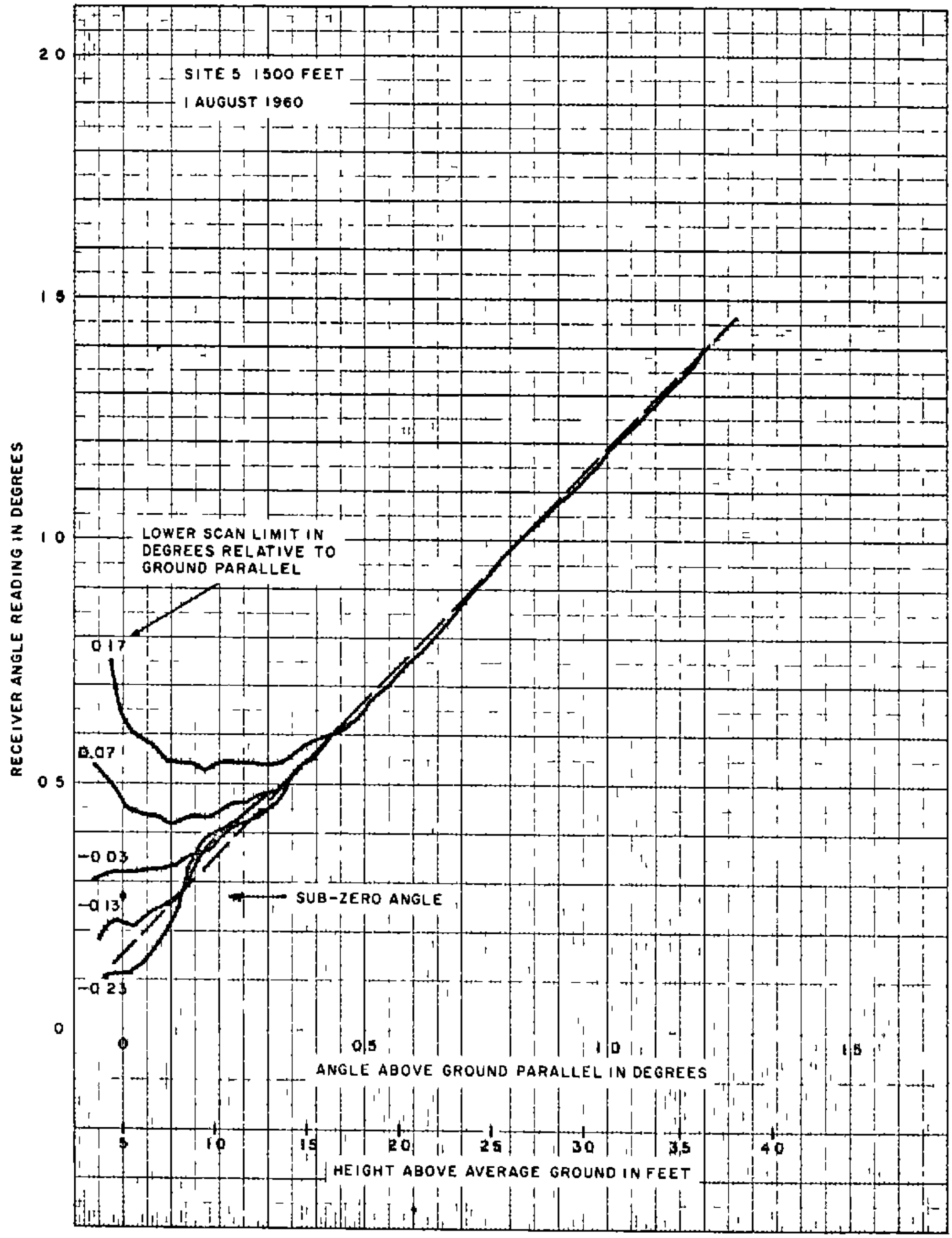

FIGURE 46. EFFECTS OF VARYING LOWER SCAN LIMIT (TEST NO 215)

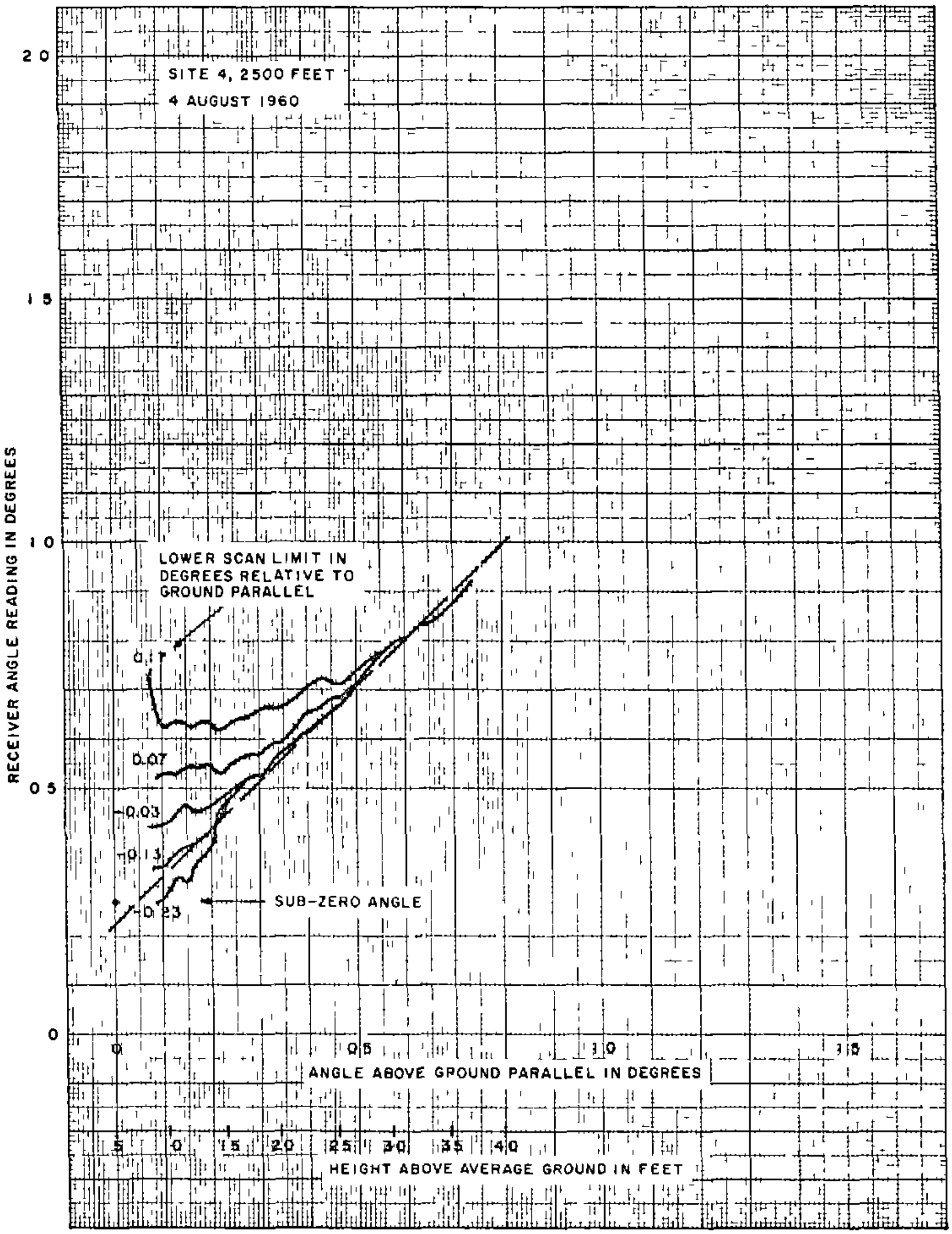

FIGURE 47. EFFECTS OF VARYING LOWER SCAN LIMIT (TEST NO. 217)

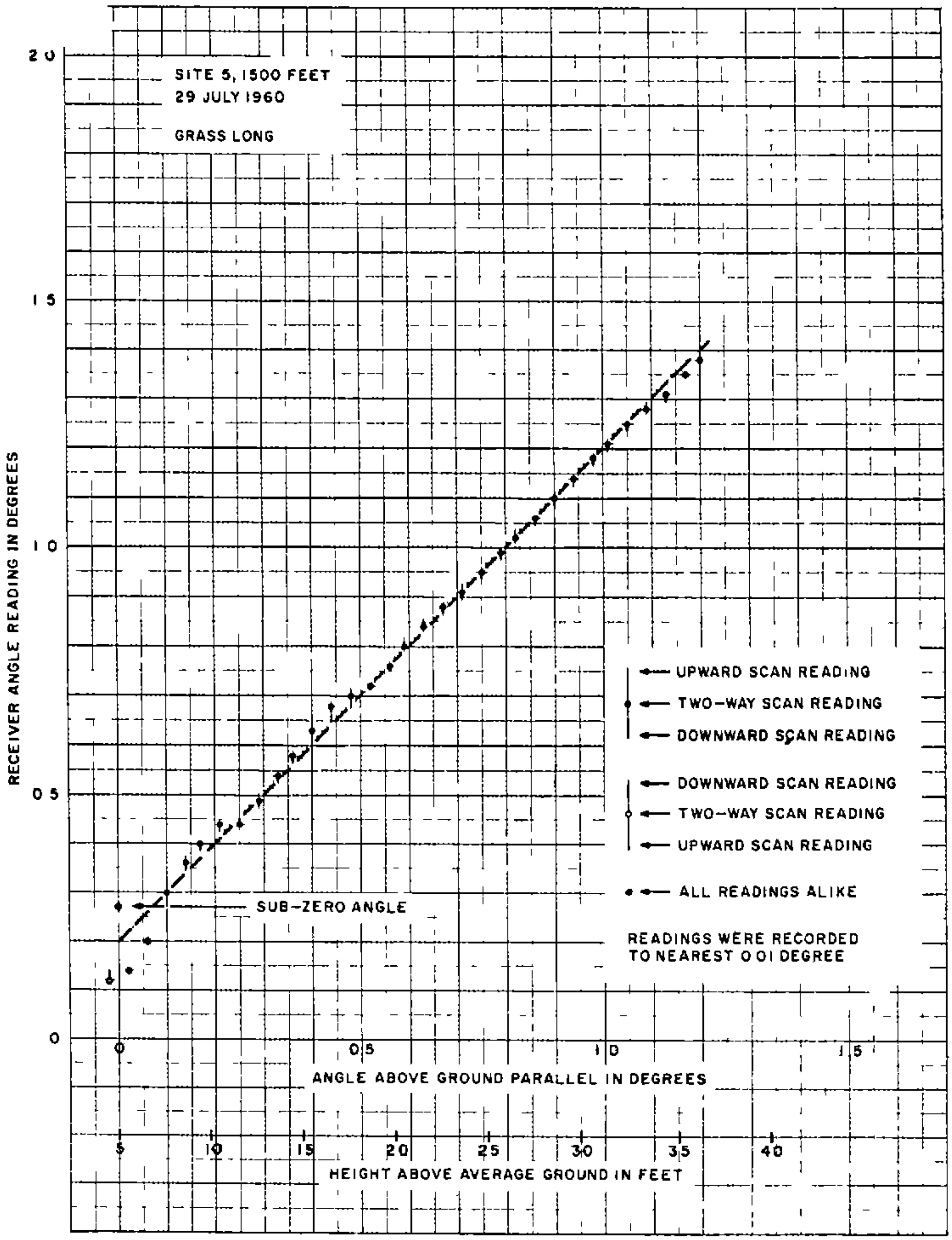

FIGURE 48. EFFECTS OF DIRECTION OF SCAN ON RECEIVER READINGS (TEST NO 214)

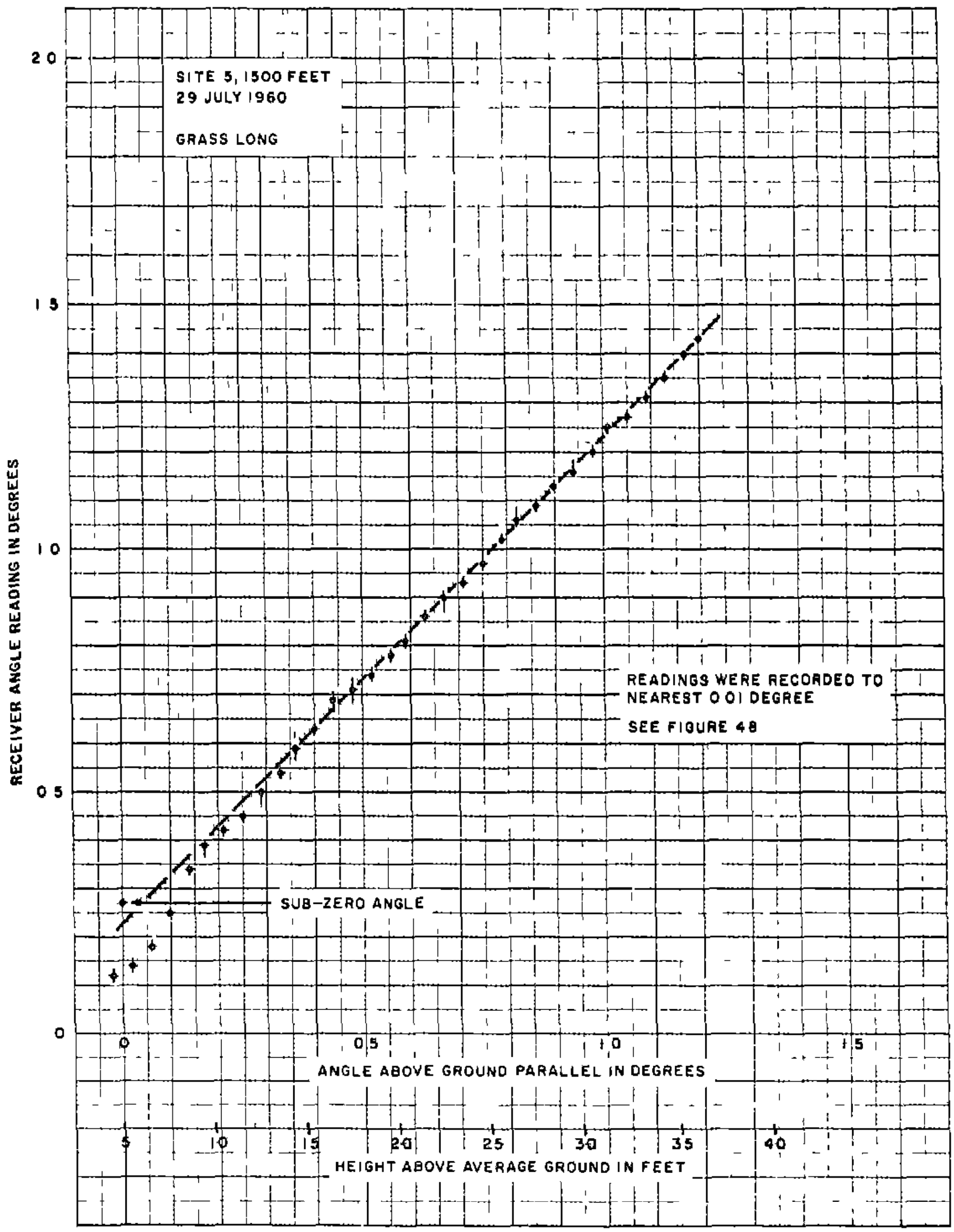

FIGURE 49. EFFECTS OF DIRECTION OF SCAN ON RECEIVER READINGS (TEST NO. 214A)

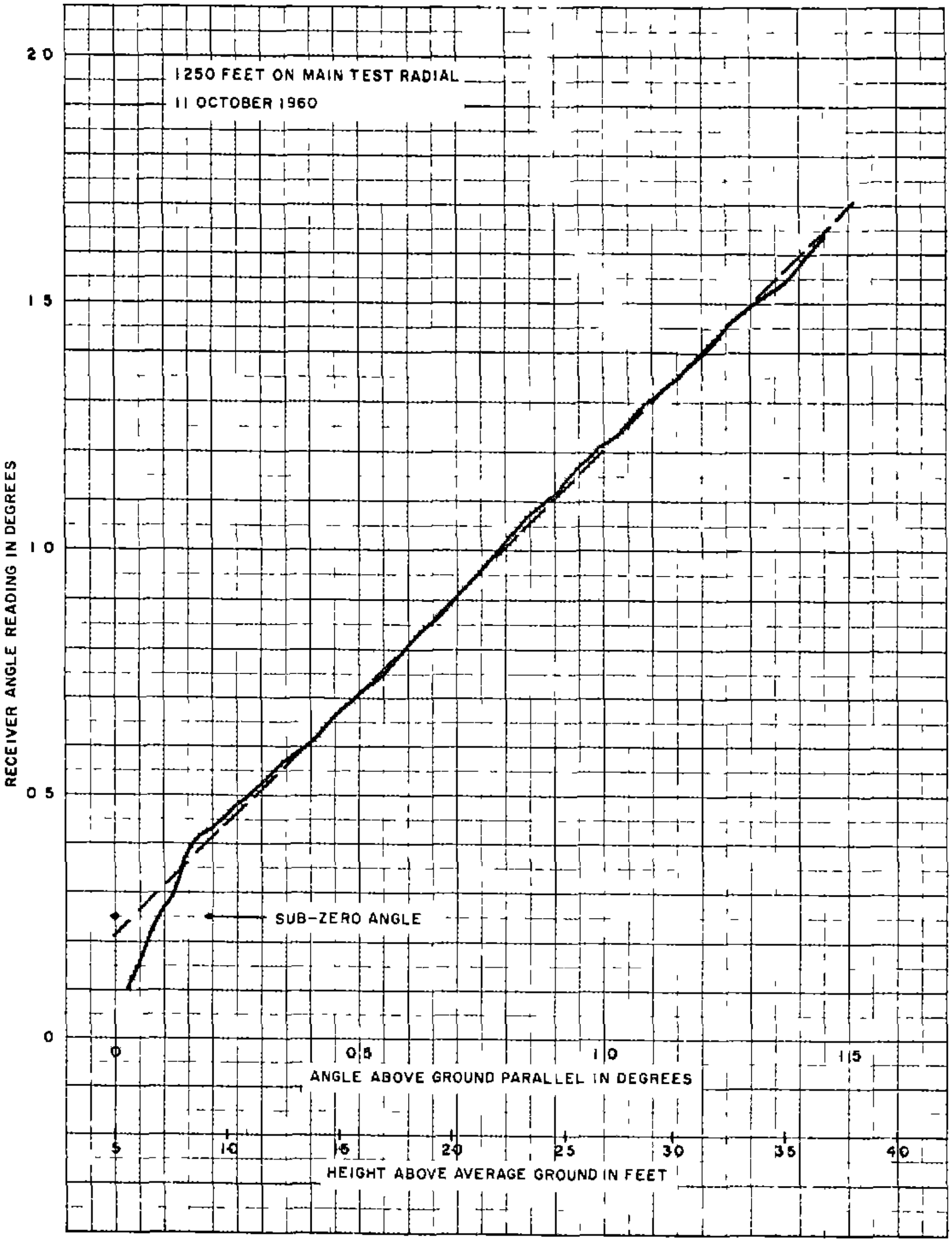

FIGURE 50. RECEIVER READINGS AT 1250 FEET (TEST NO. 257)

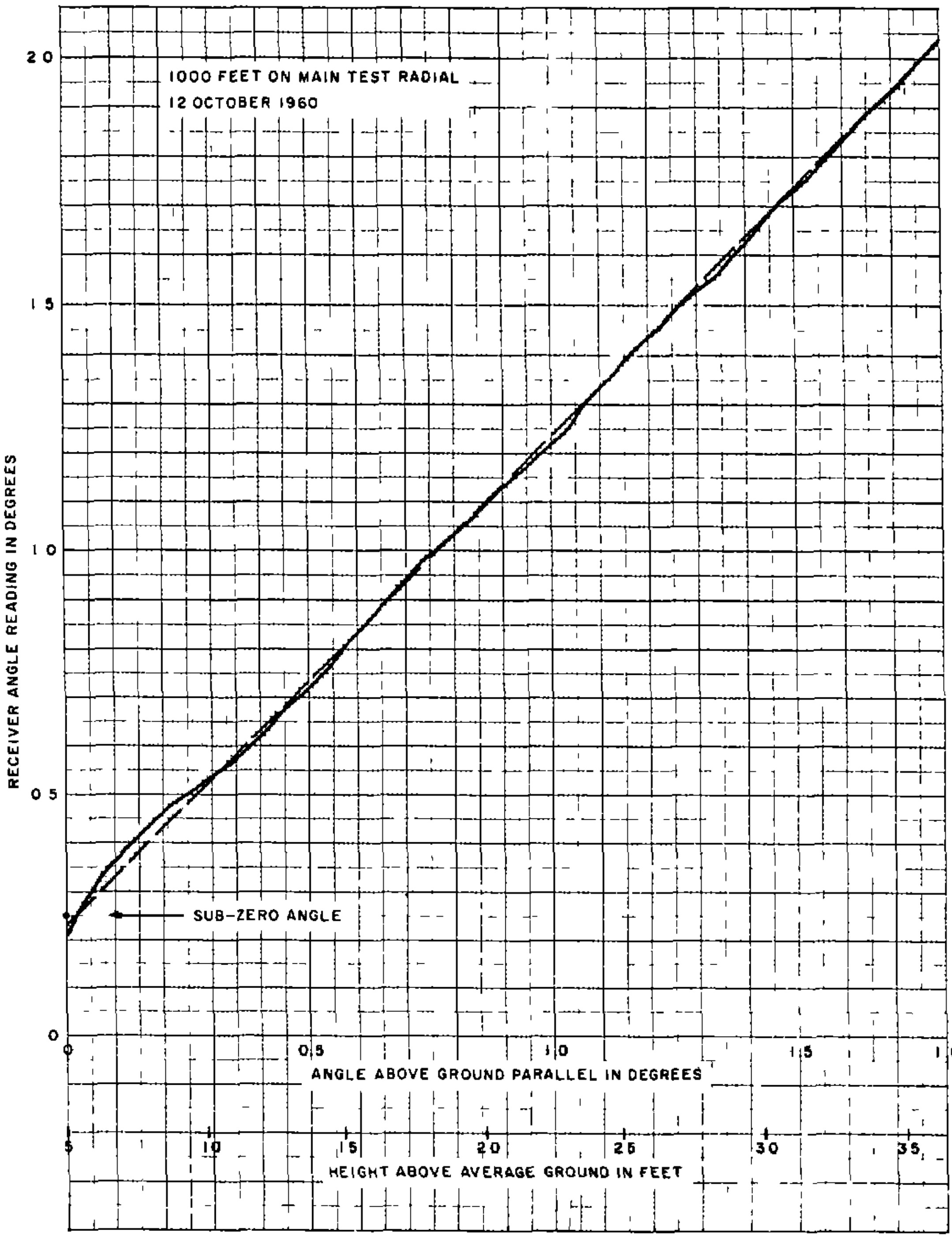

FIGURE 51 RECEIVER READINGS AT 1000 FEET (TEST NO. 258)

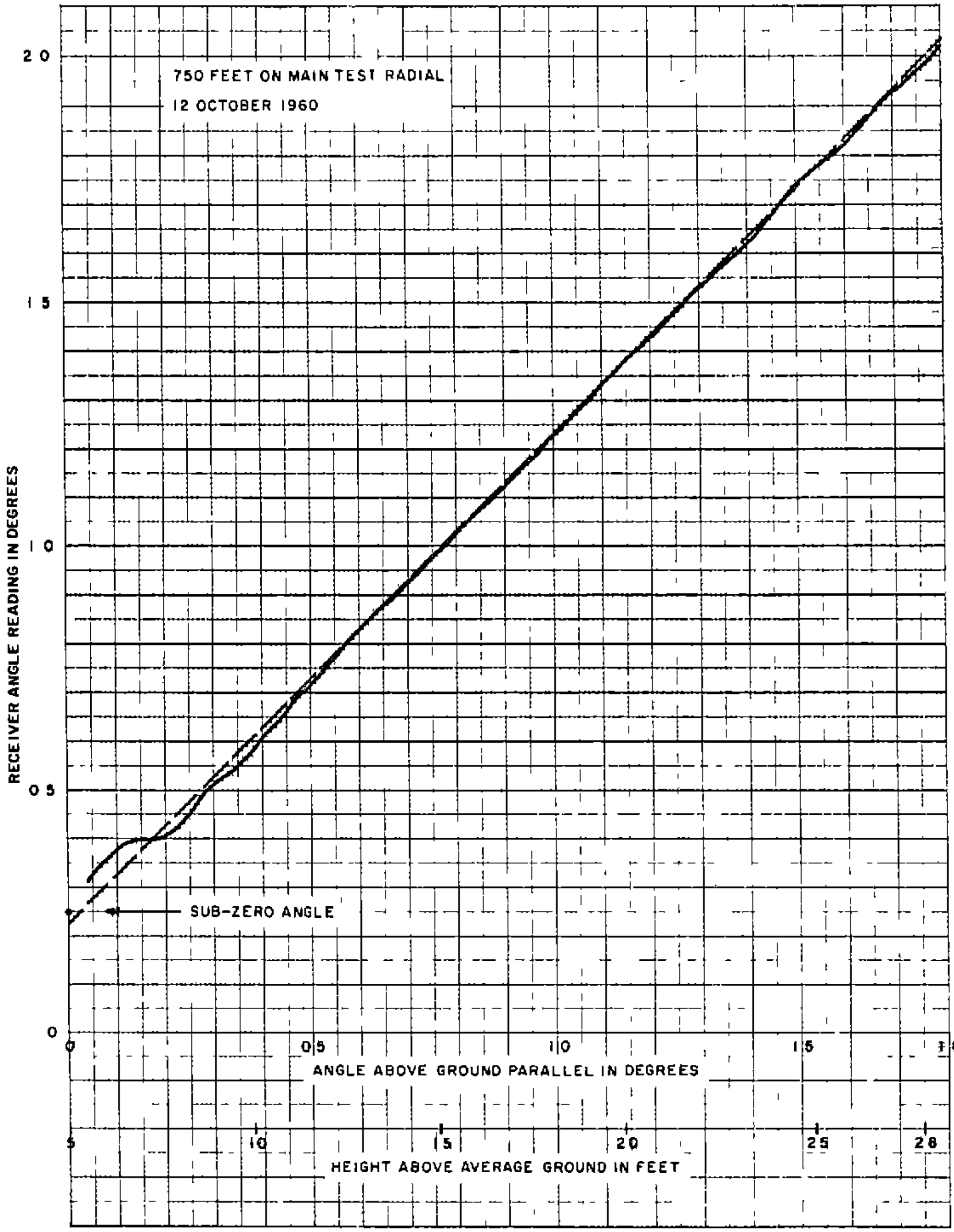

FIGURE 52 RECEIVER READINGS AT 750 FEET (TEST NO. 259)

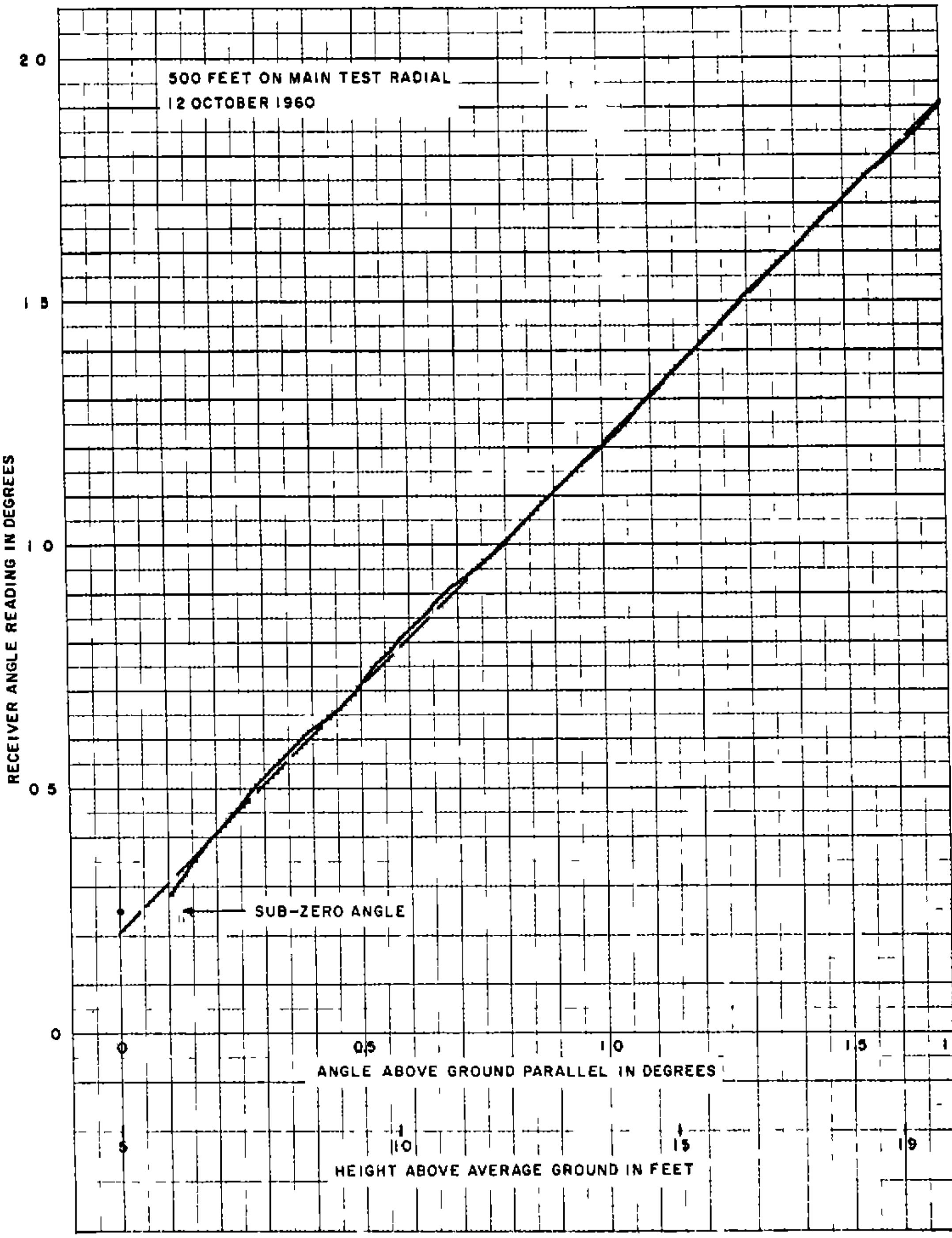

FIGURE 53. RECEIVER READINGS AT 500 FEET (TEST NO 260)

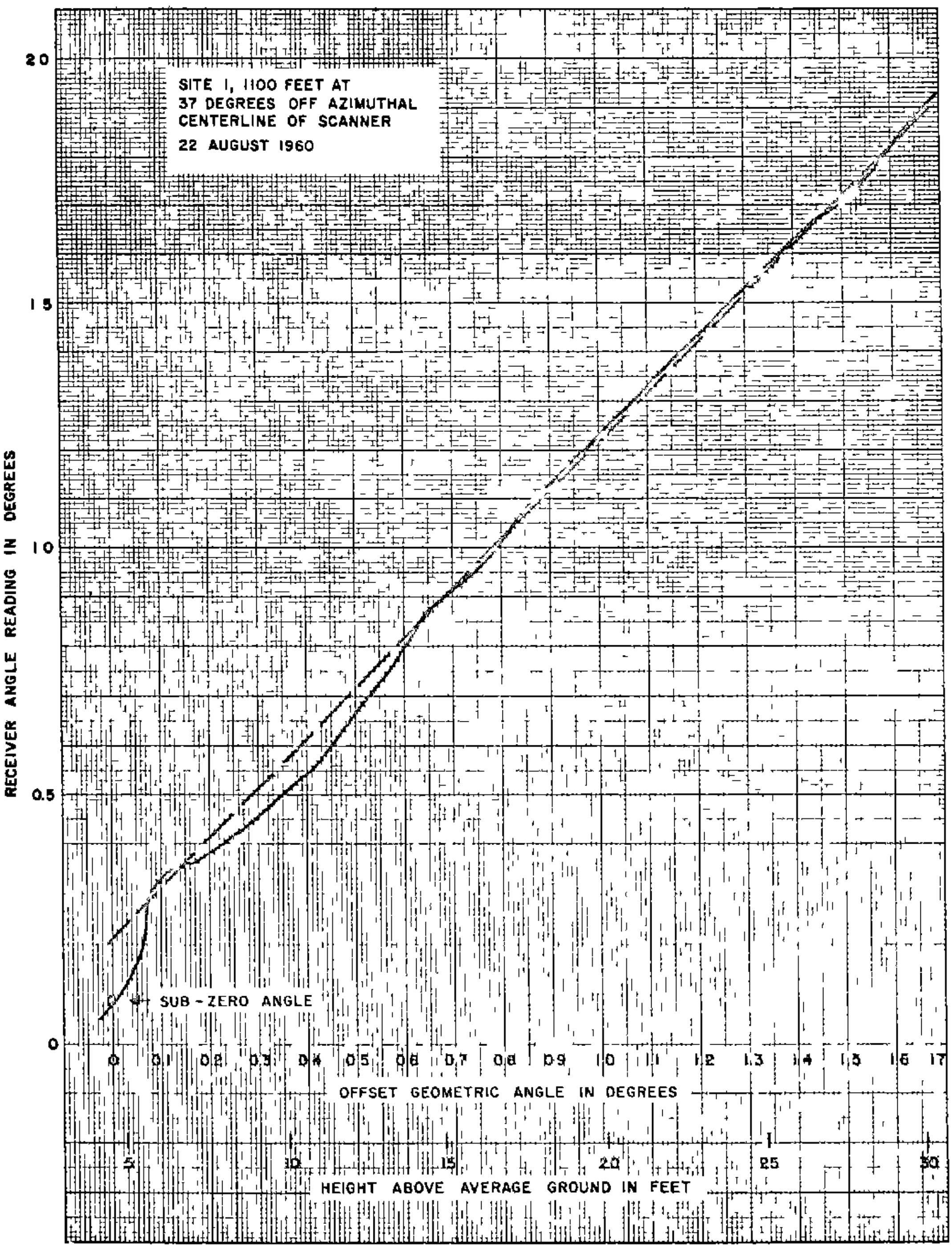

FIGURE 54 RECEIVER READINGS AT 37-DEGREE AZIMUTH (TEST NO. 222A)

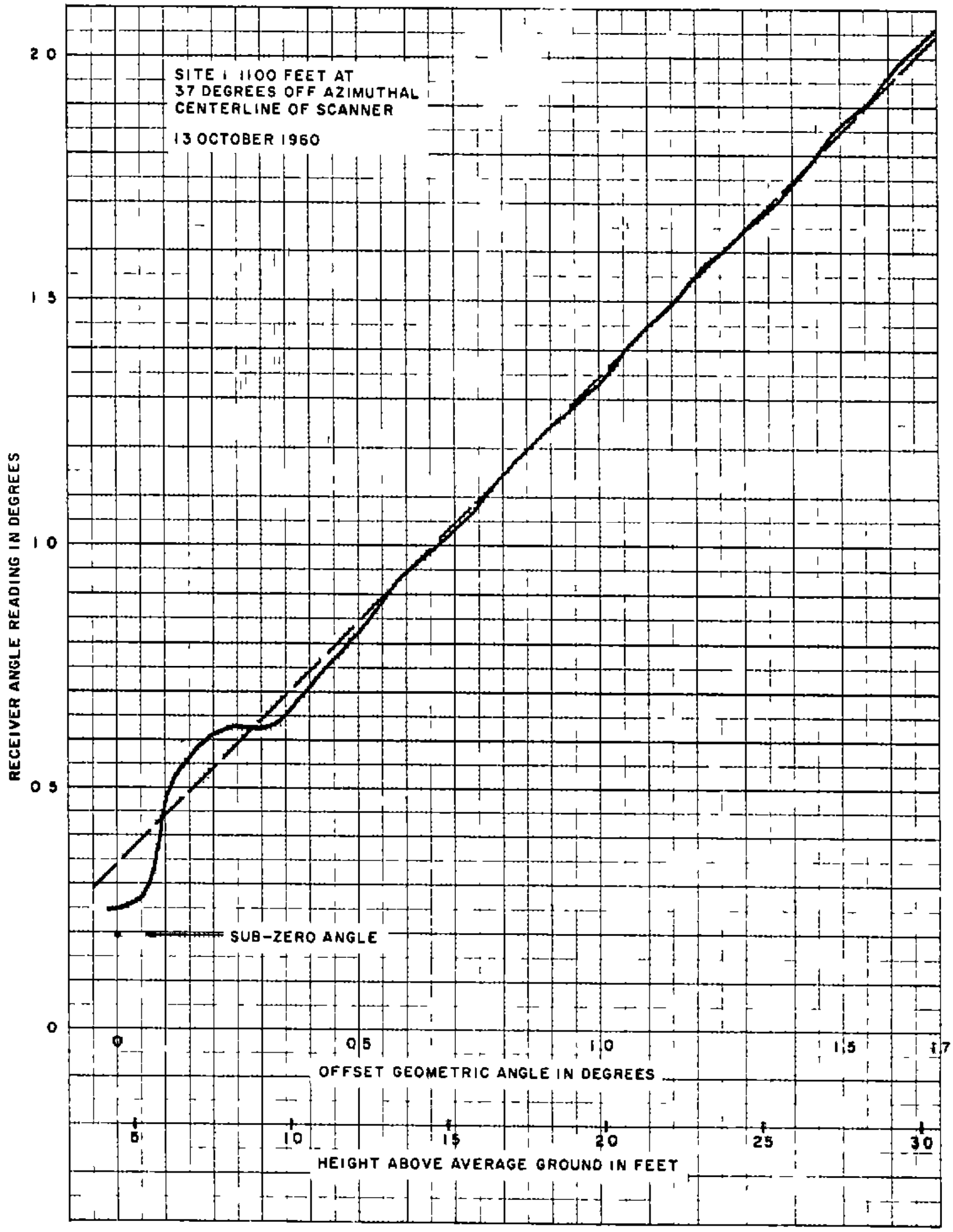

FIGURE 55. RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO. 261)

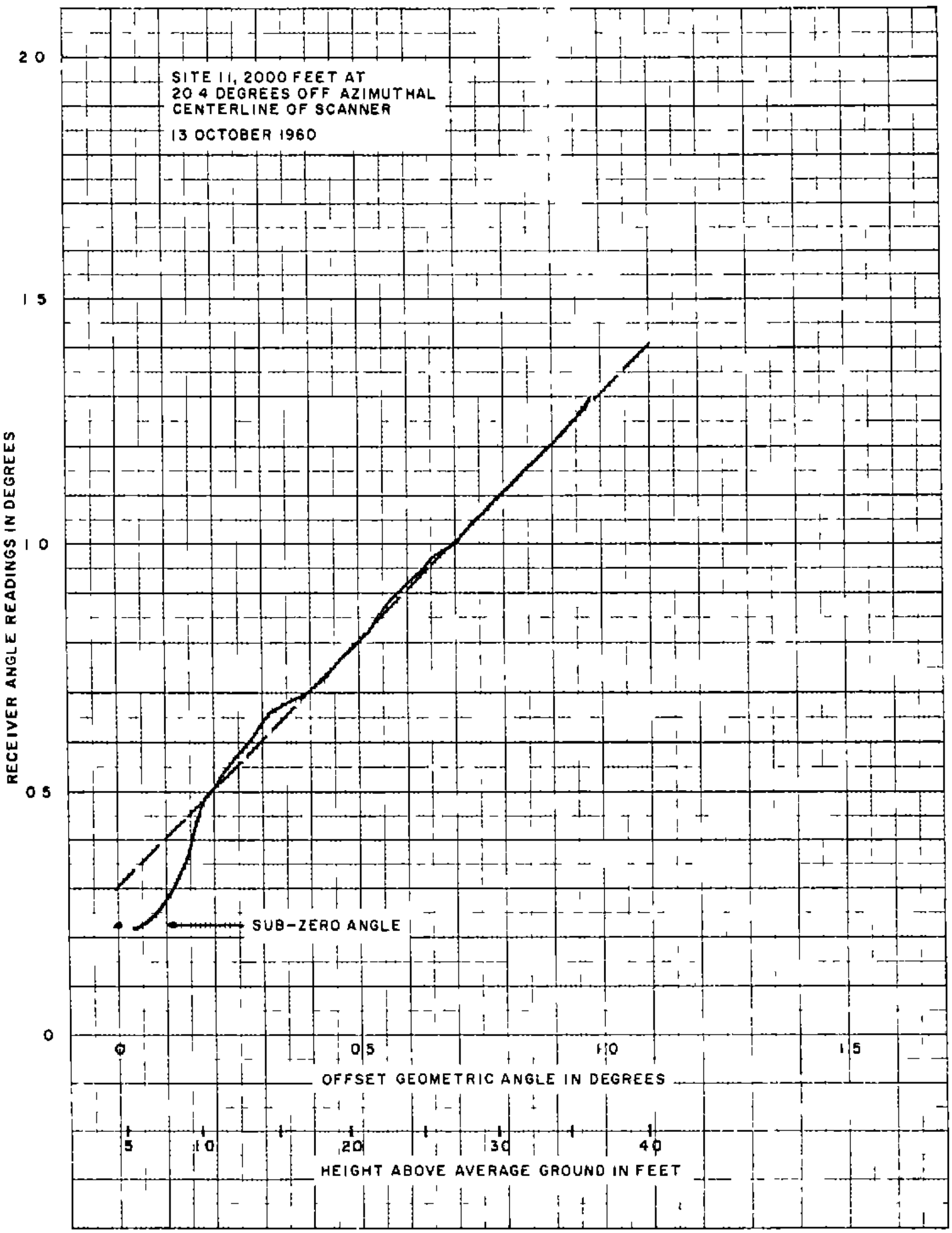

FIGURE 56 RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO 262)

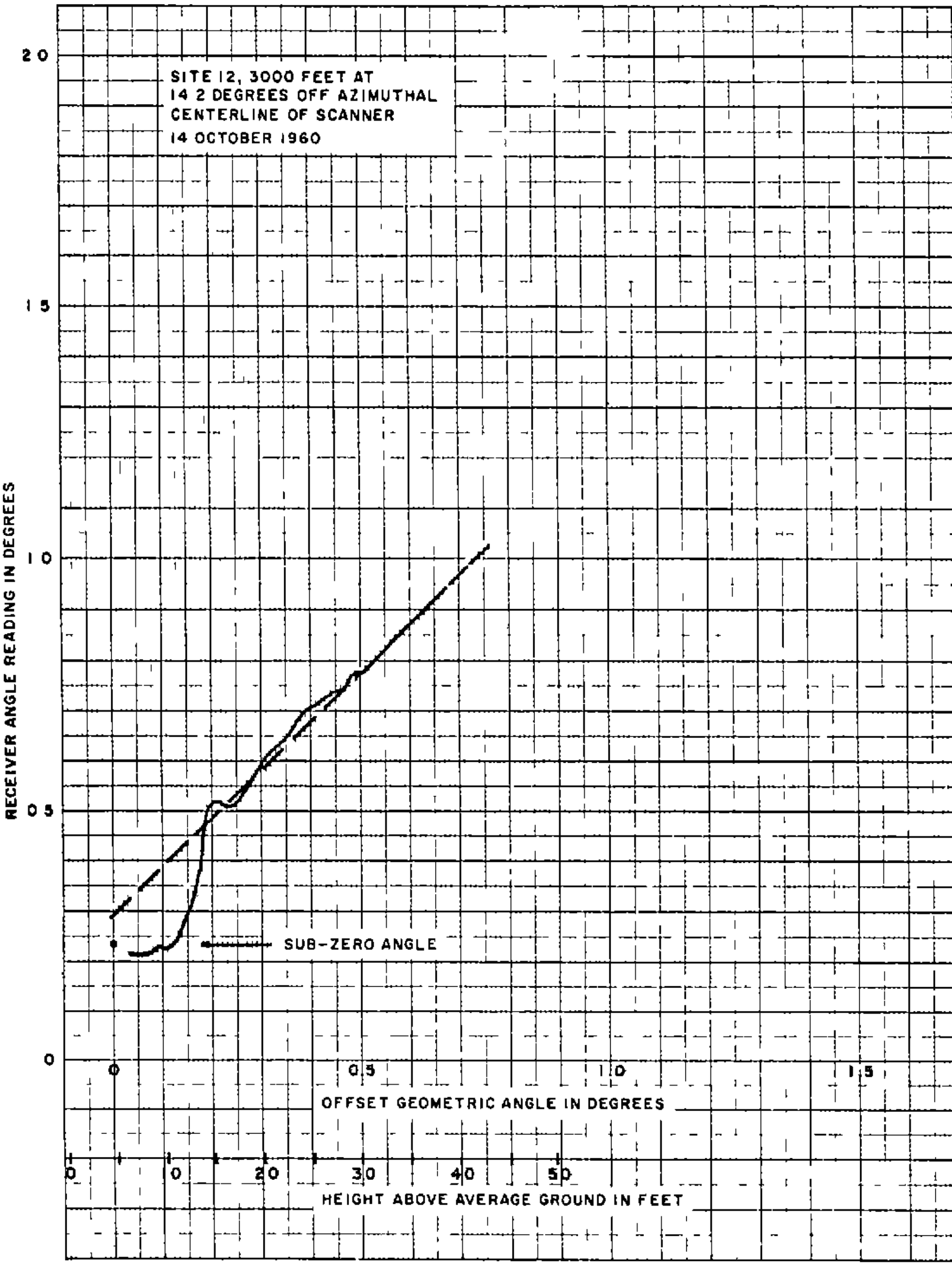

FIGURE 57. RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO. 263)

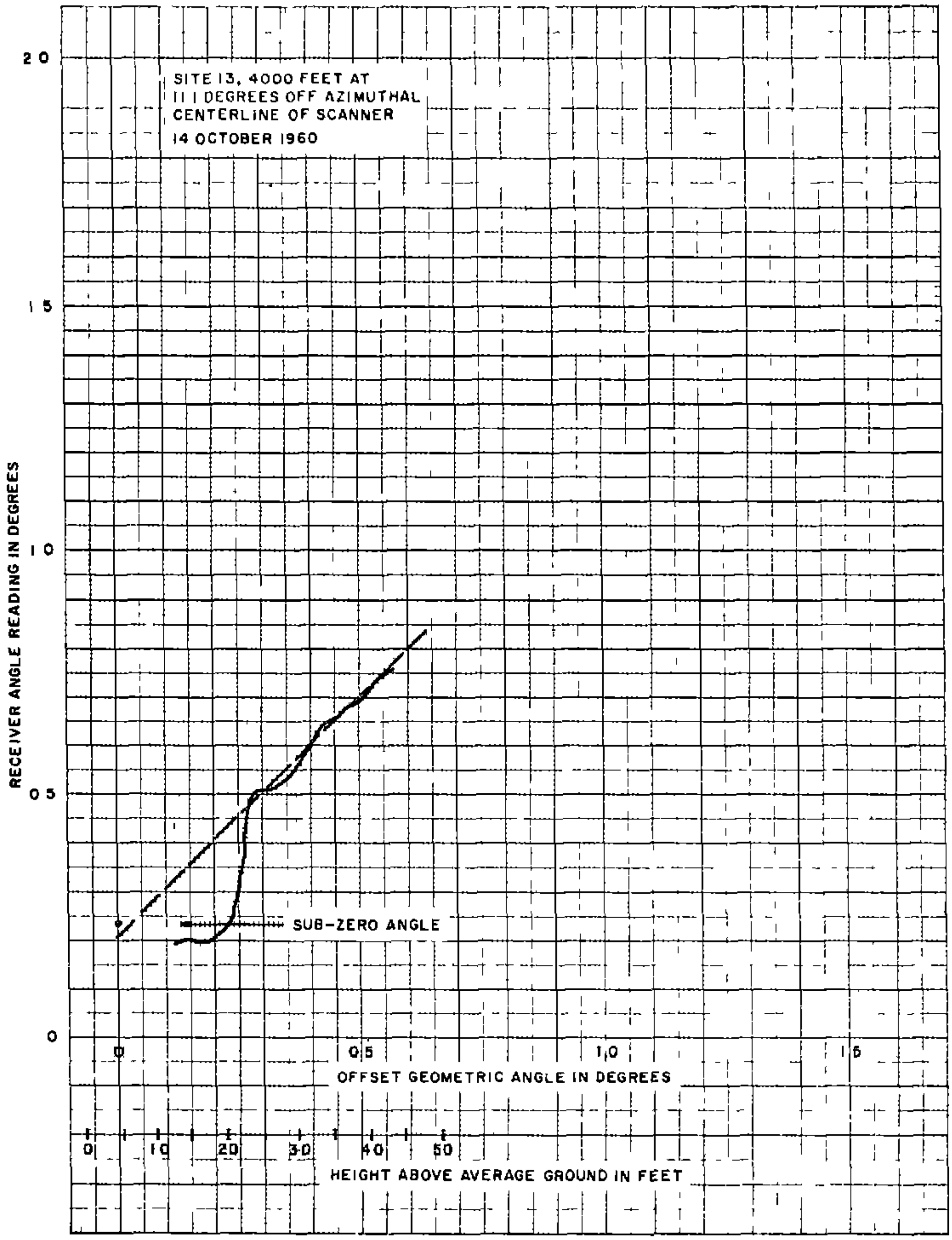

FIGURE 58. RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO. 265)

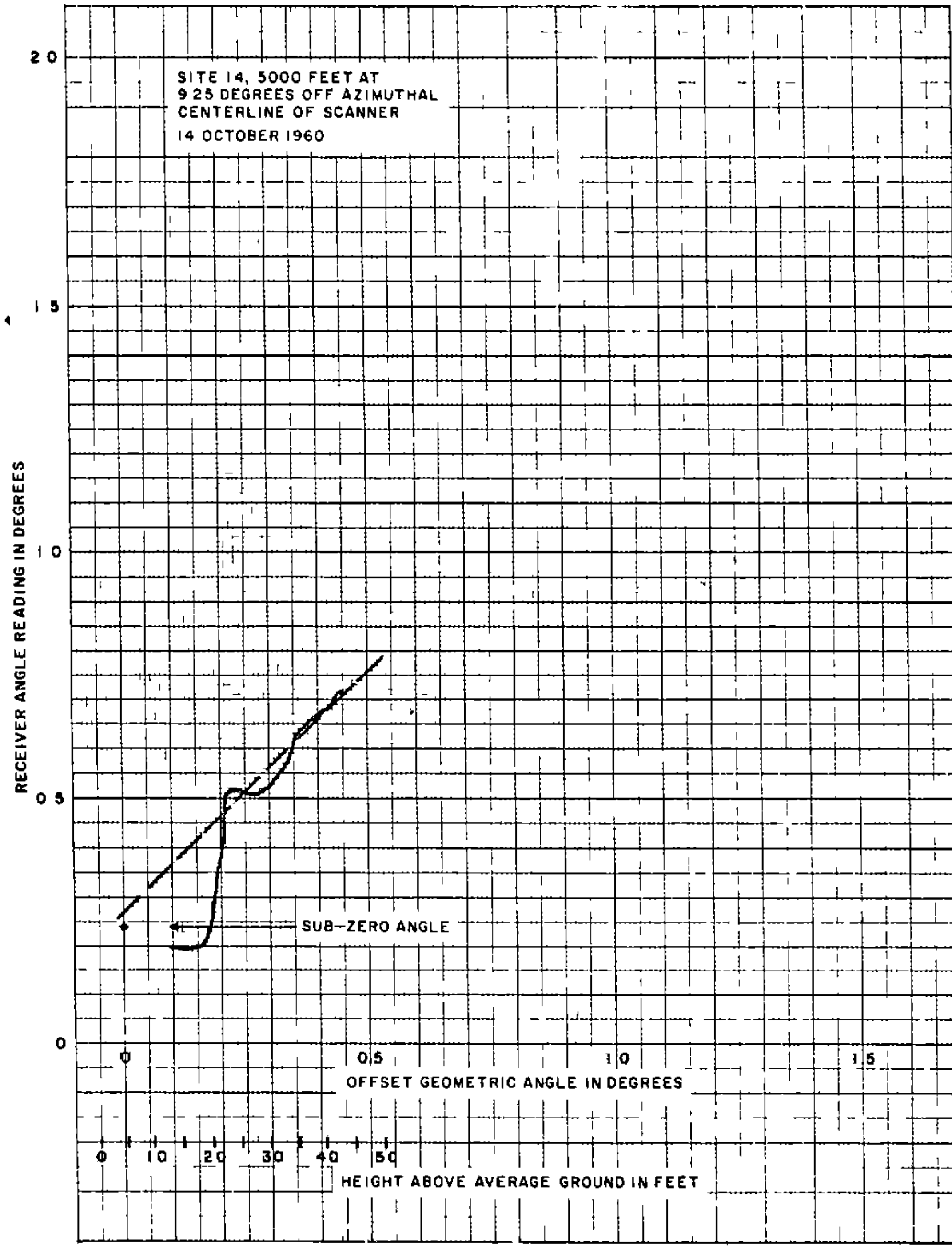

FIGURE 59 RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO. 264)

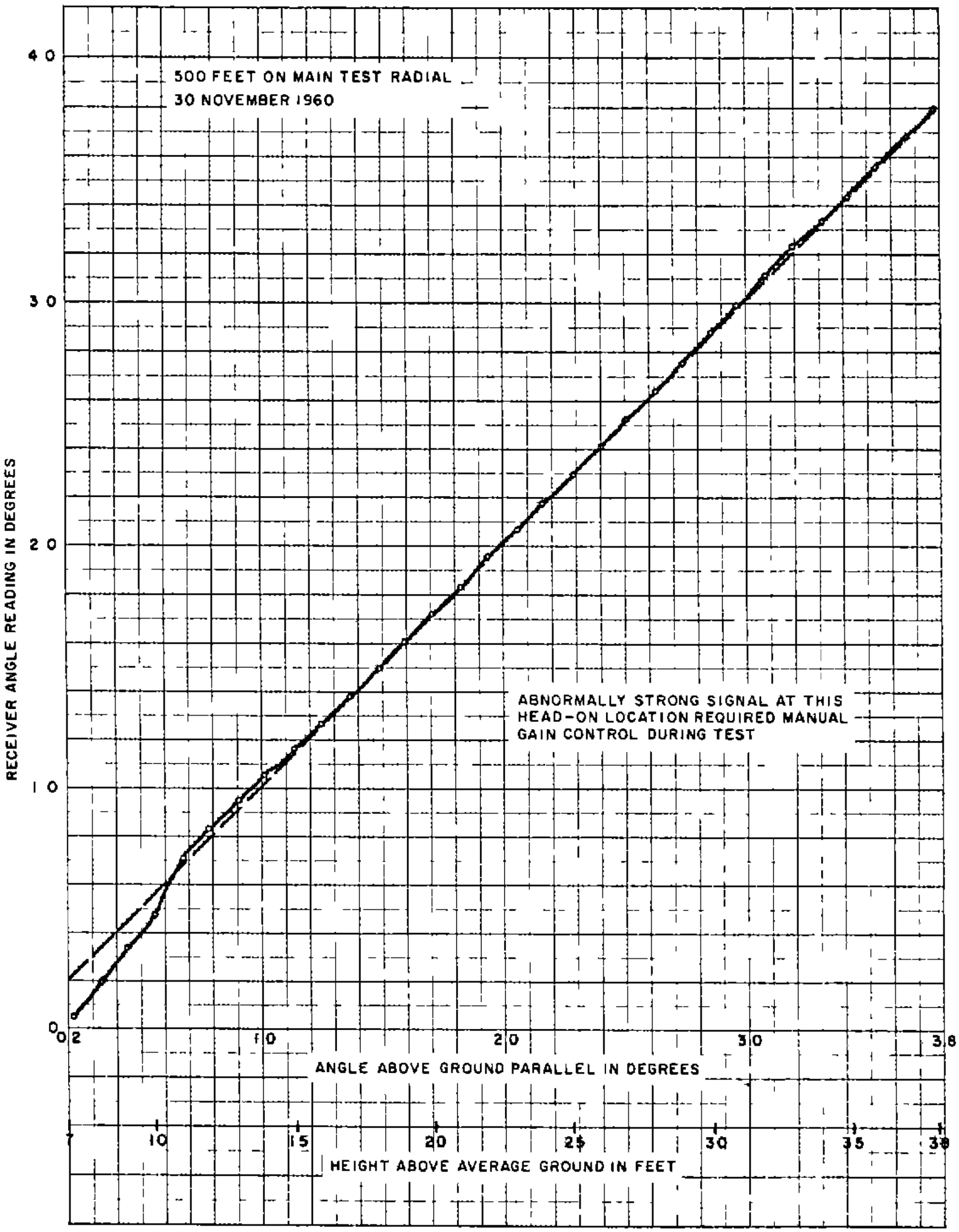

FIGURE 60. MODEL B RECEIVER READINGS AT 500 FEET (TEST NO. 294)

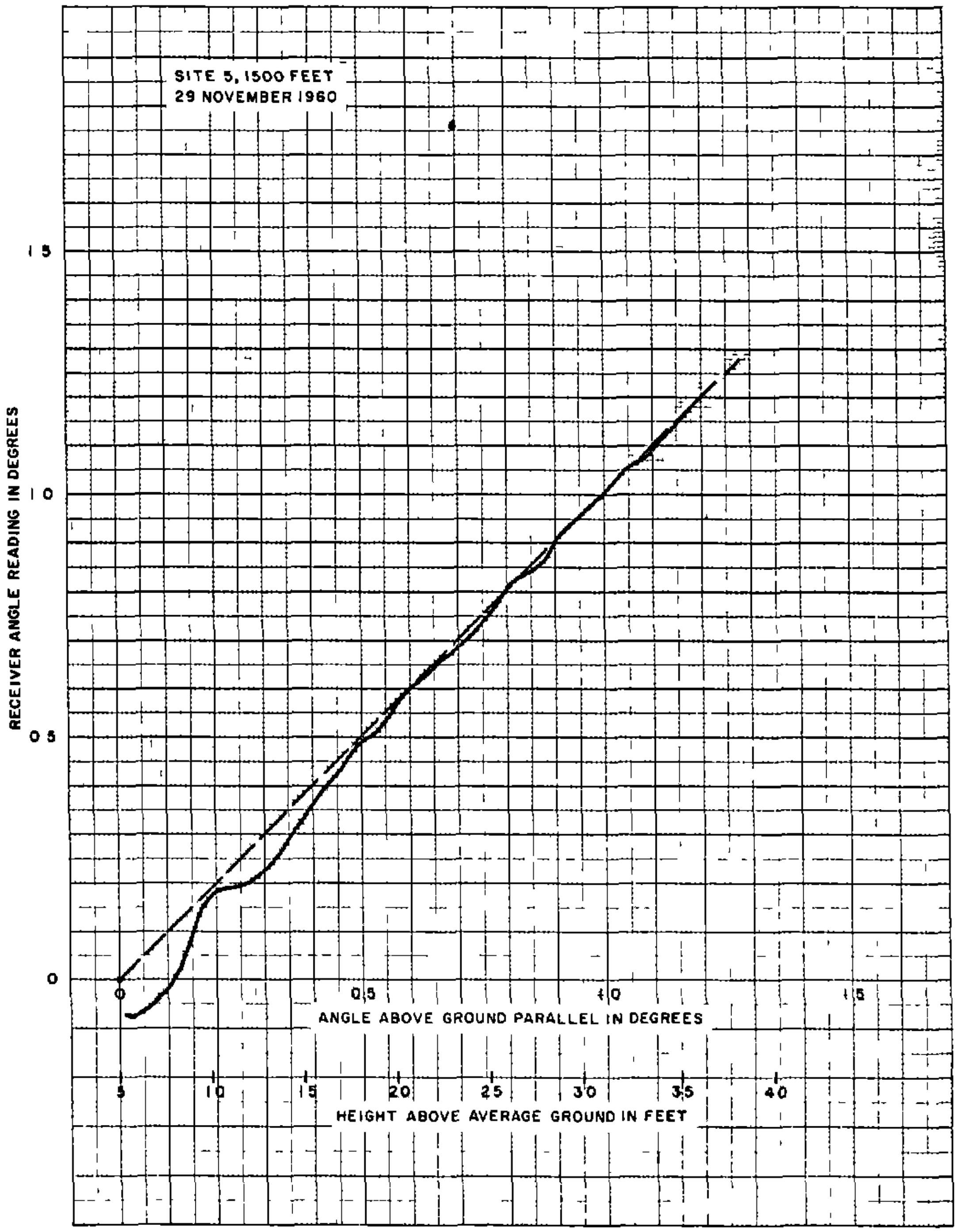

FIGURE 61. MODEL B RECEIVER READINGS AT 1500 FEET (TEST NO 279)

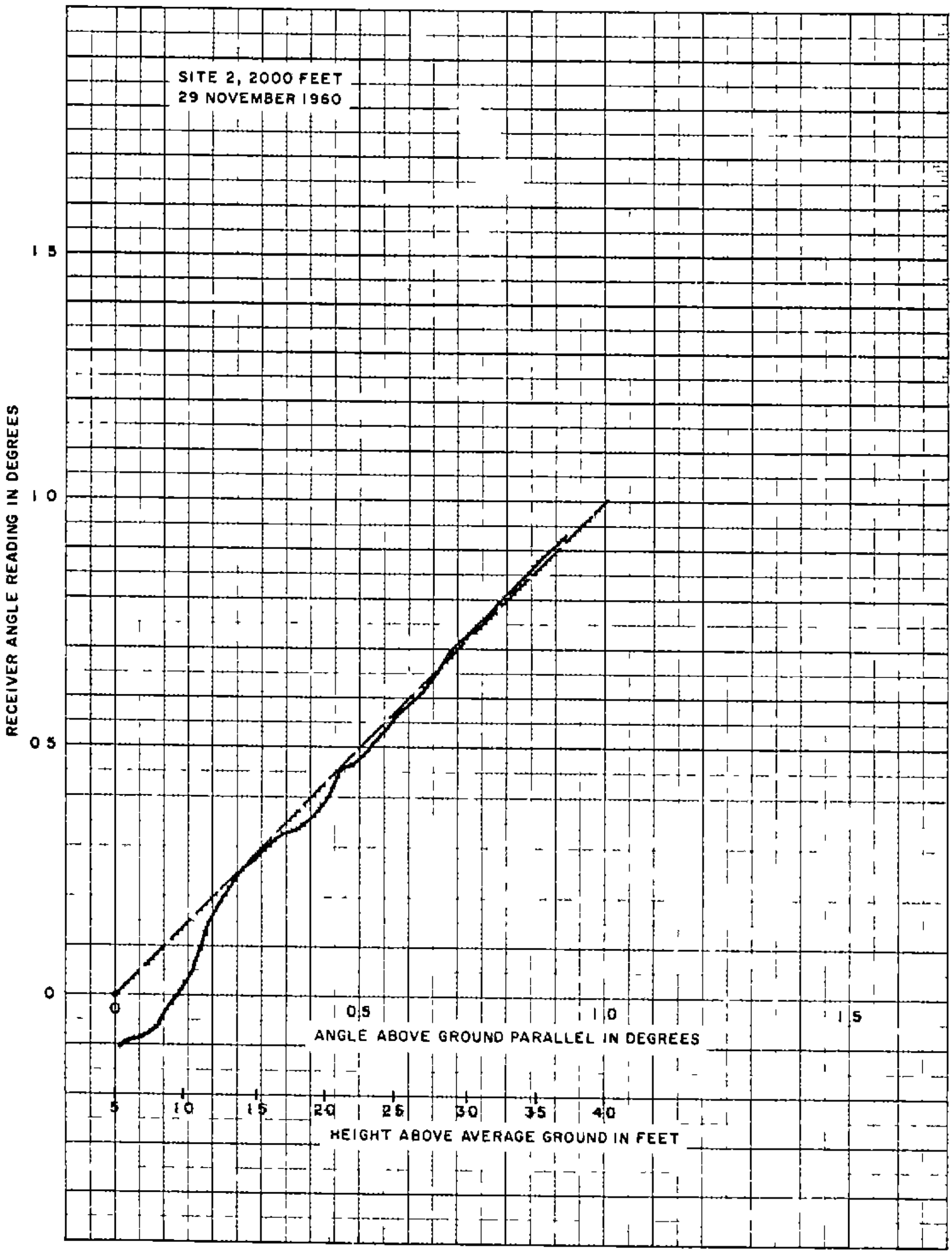

FIGURE 62. MODEL B RECEIVER READINGS AT 2000 FEET (TEST NO. 280)

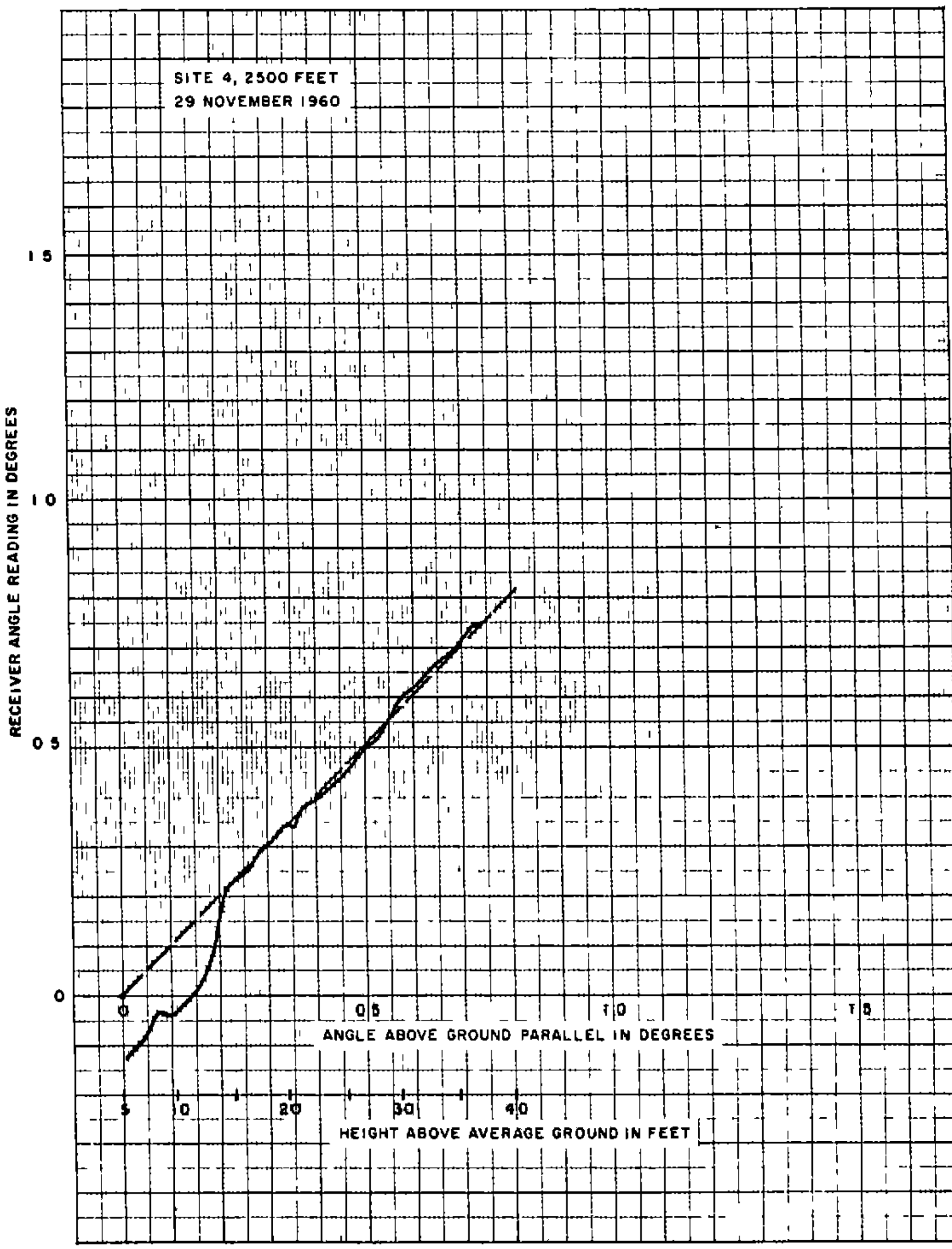

FIGURE 63. MODEL B RECEIVER READINGS AT 2500 FEET (TEST NO. 281)

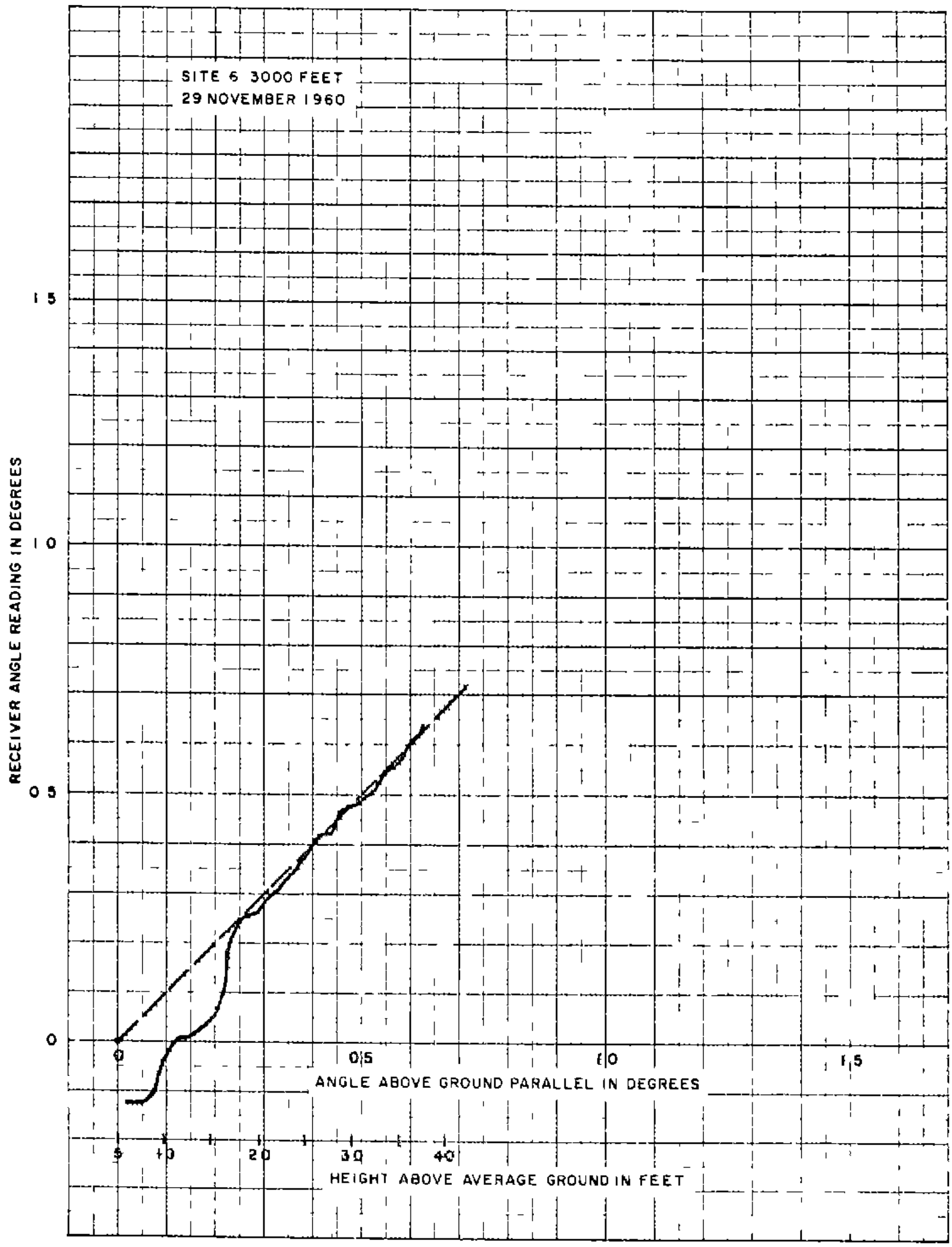

FIGURE 64 MODEL B RECEIVER READINGS AT 3000 FEET (TEST NO 282)

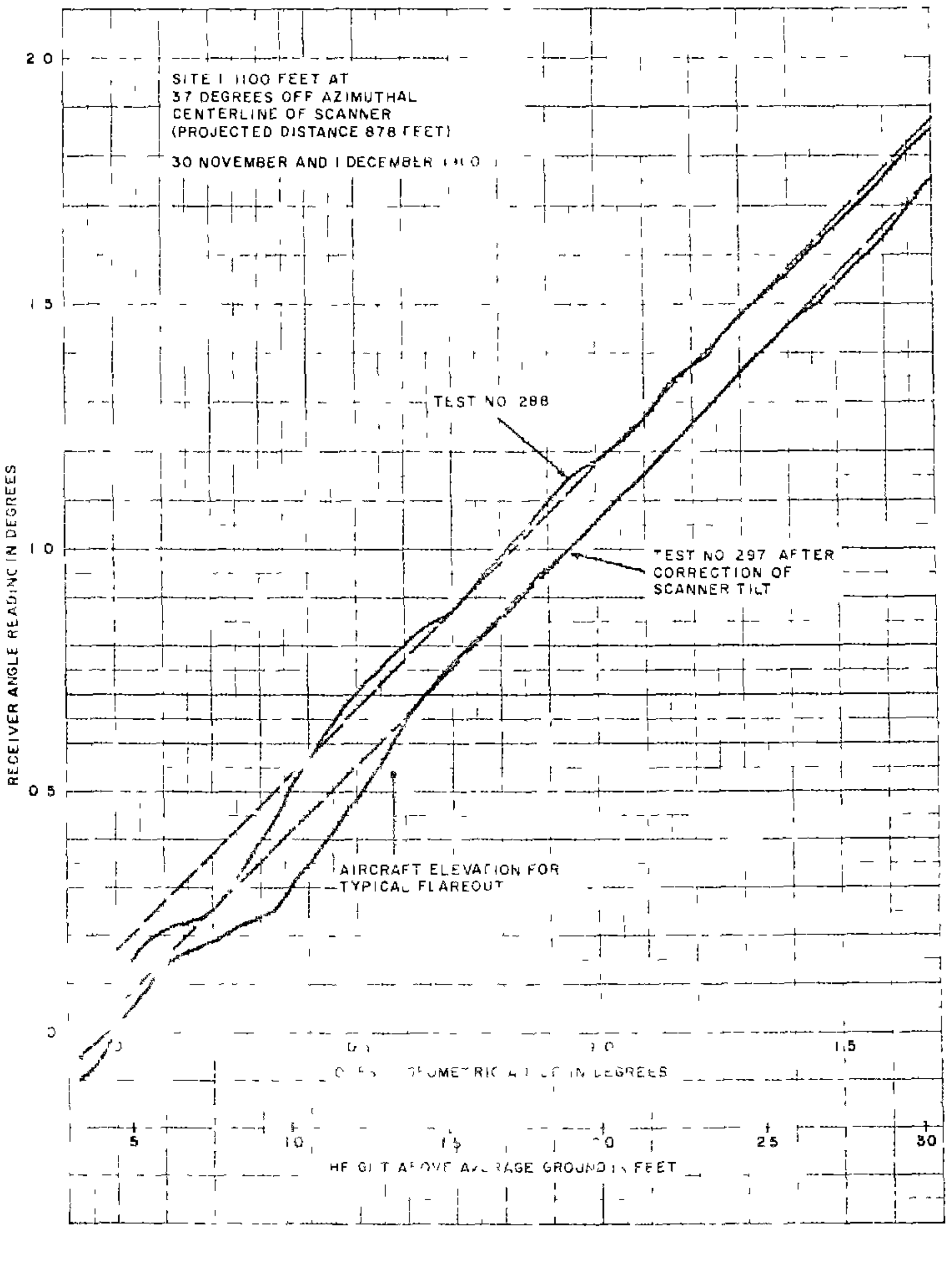

FIGURE 65 ... READINGS ON ... PARALLEL
(TESTS NO 288 AND 297)

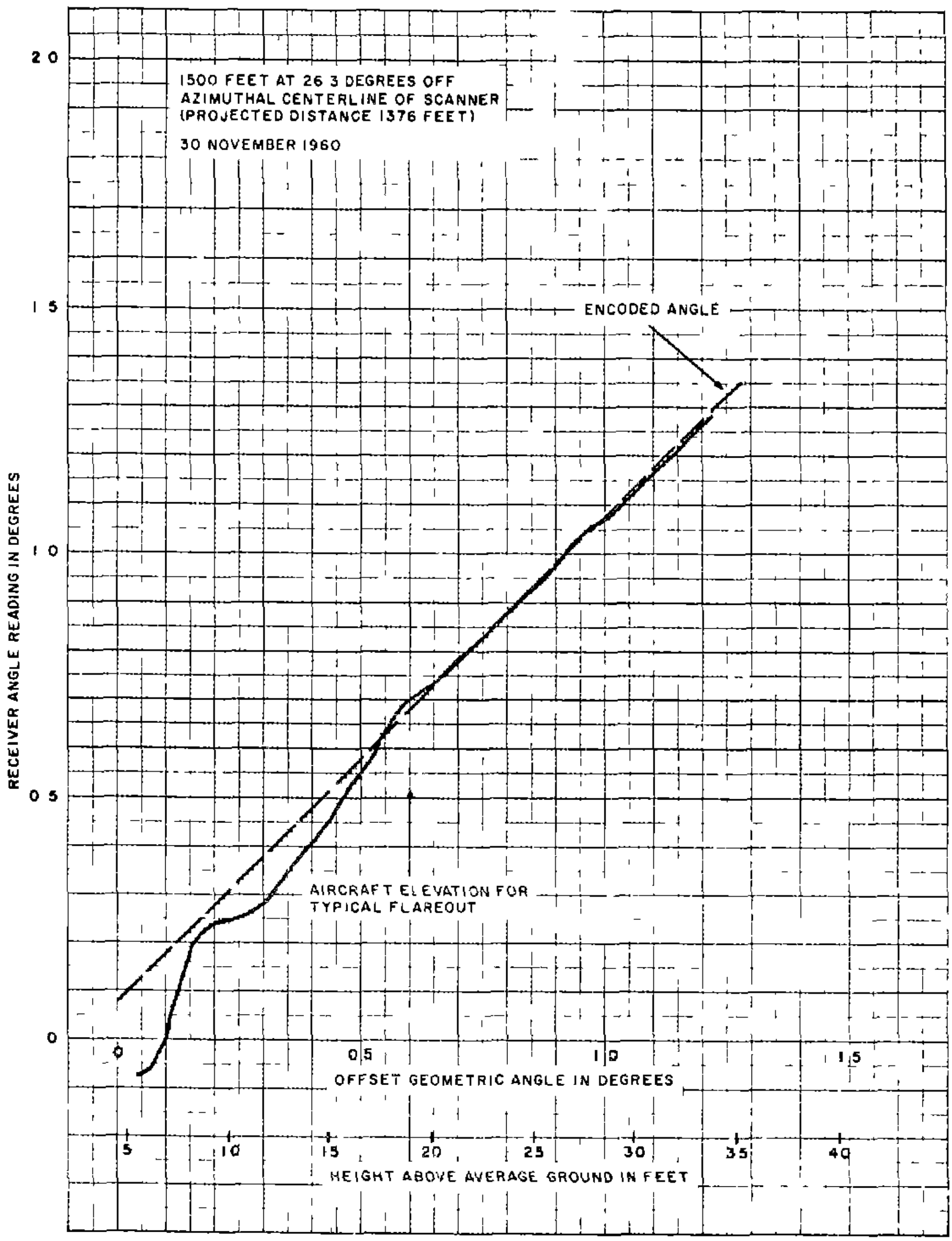

FIGURE 66 MODEL B RECEIVER READINGS ON RUNWAY-PARALLEL (TESTS NO 289)

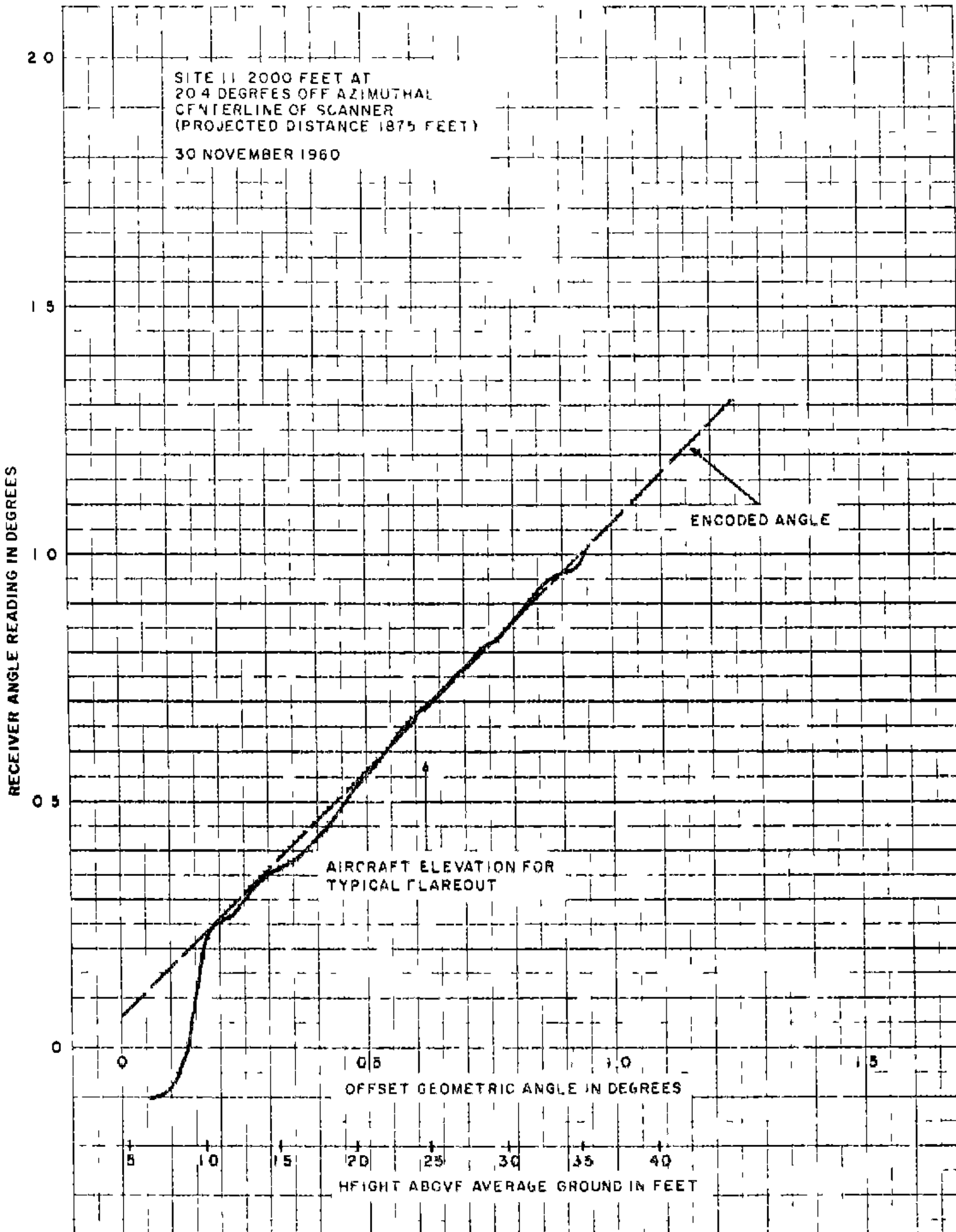

FIGURE 67 MODEL B RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO. 290)

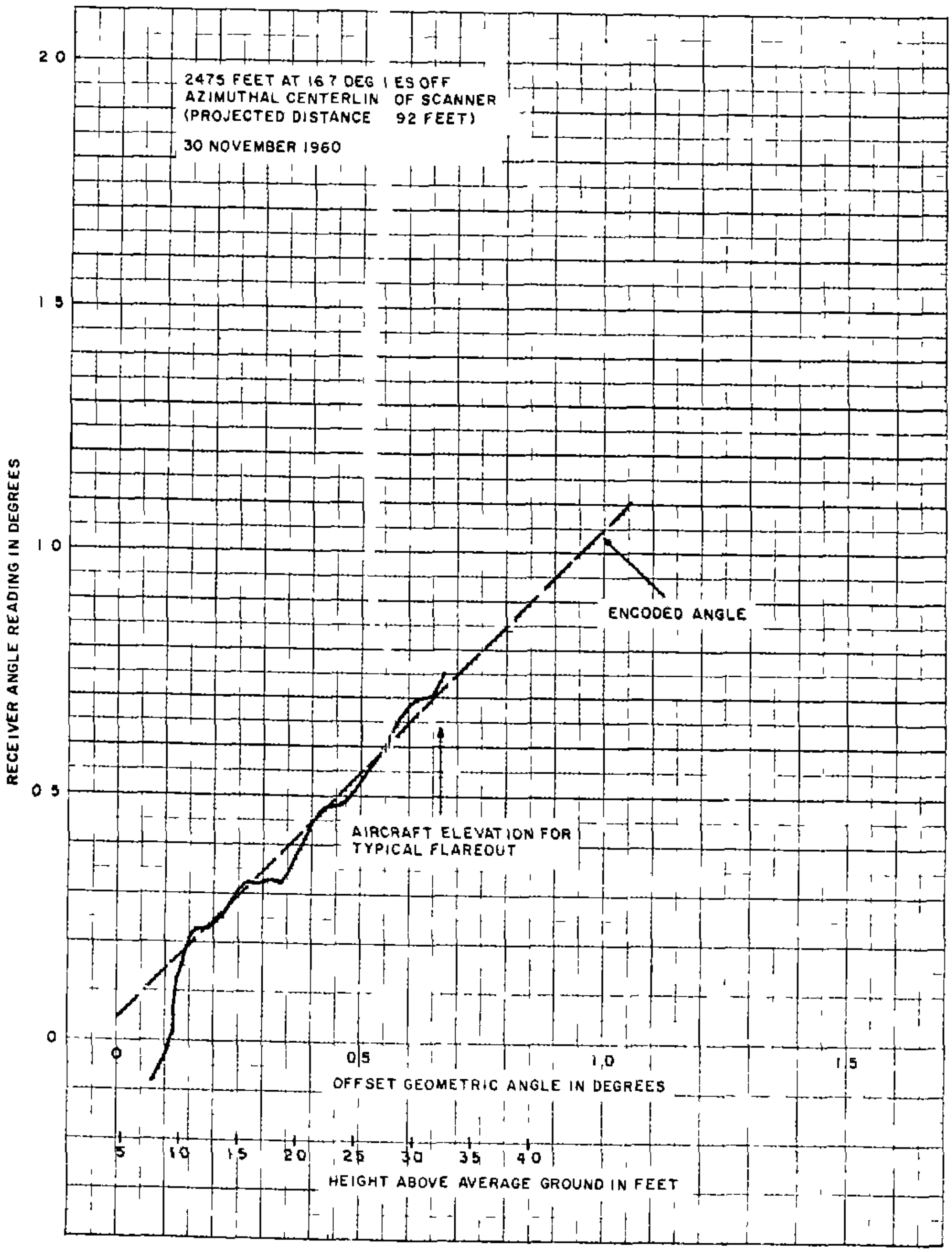

FIGURE 68 MODEL B RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO 291)

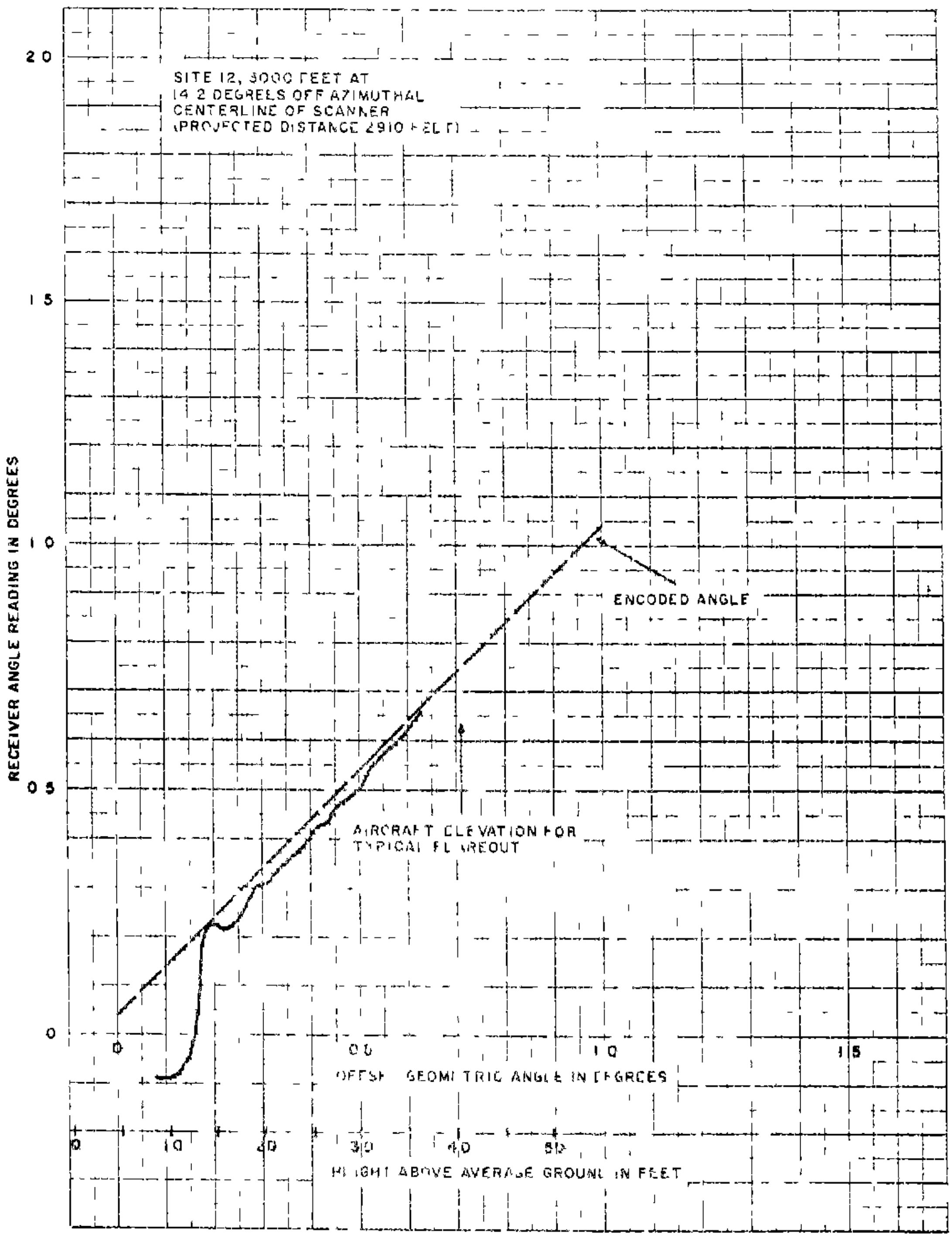

FIGURE 69 MODEL B RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO)

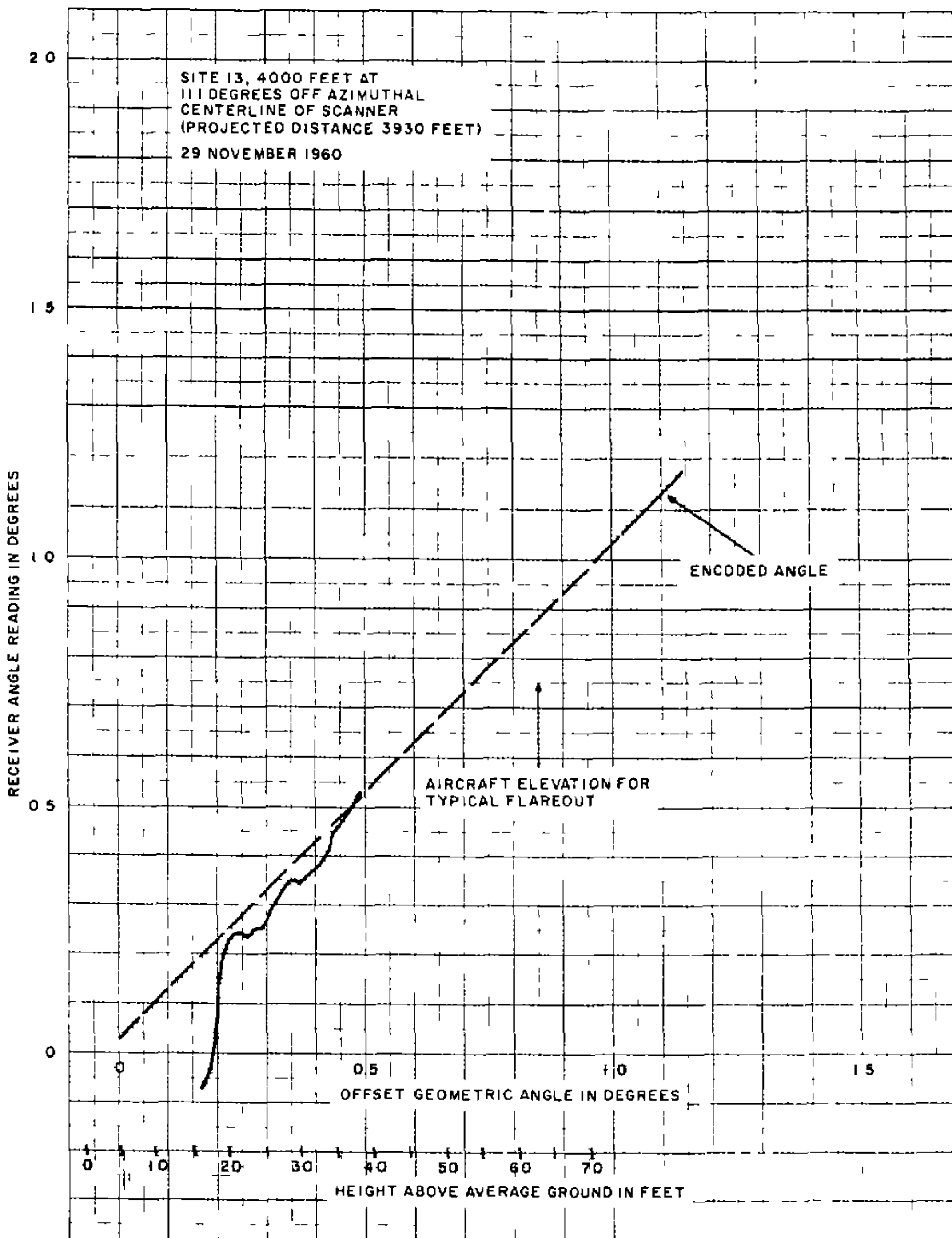

FIGURE 70 MODEL B RECEIVER READINGS ON RUNWAY-PARALLEL (TEST NO 286)

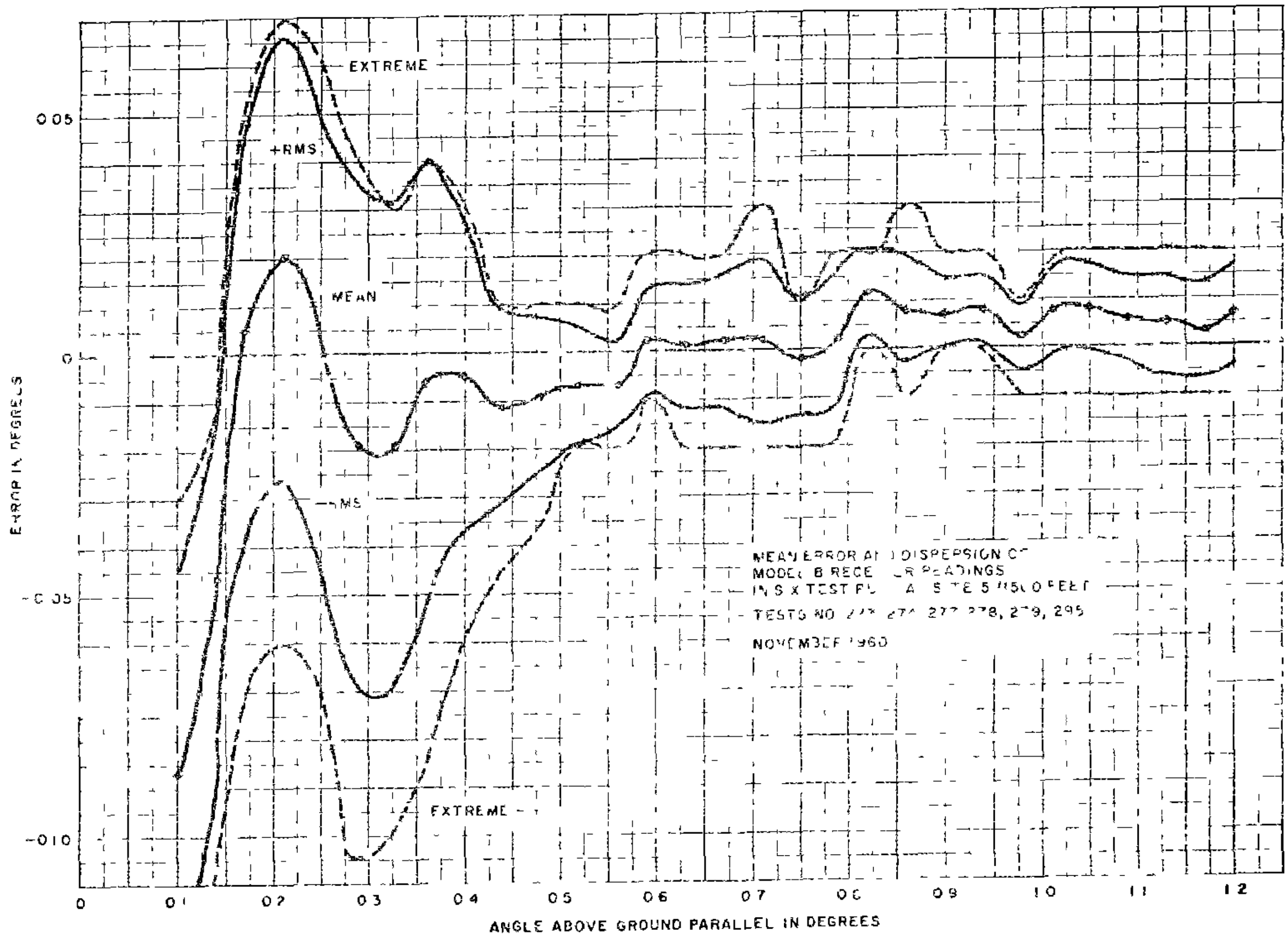

FIGURE 71. MEAN ERROR IN MODEL B RECEIVER READINGS AT SITE 5

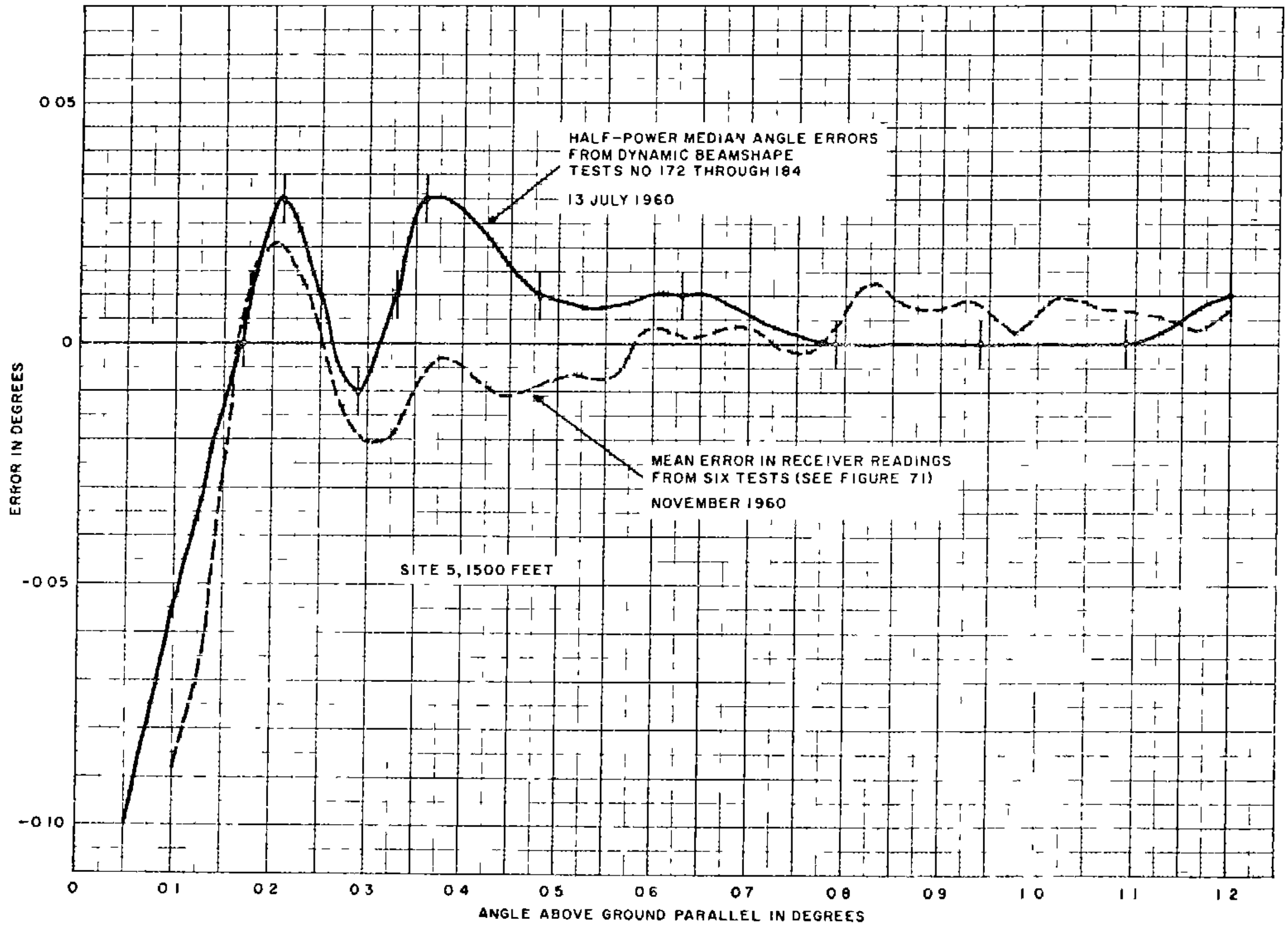

FIGURE 72. MEASURED PROPAGATION ERRORS AND RECEIVER READING ERRORS AT SITE 5

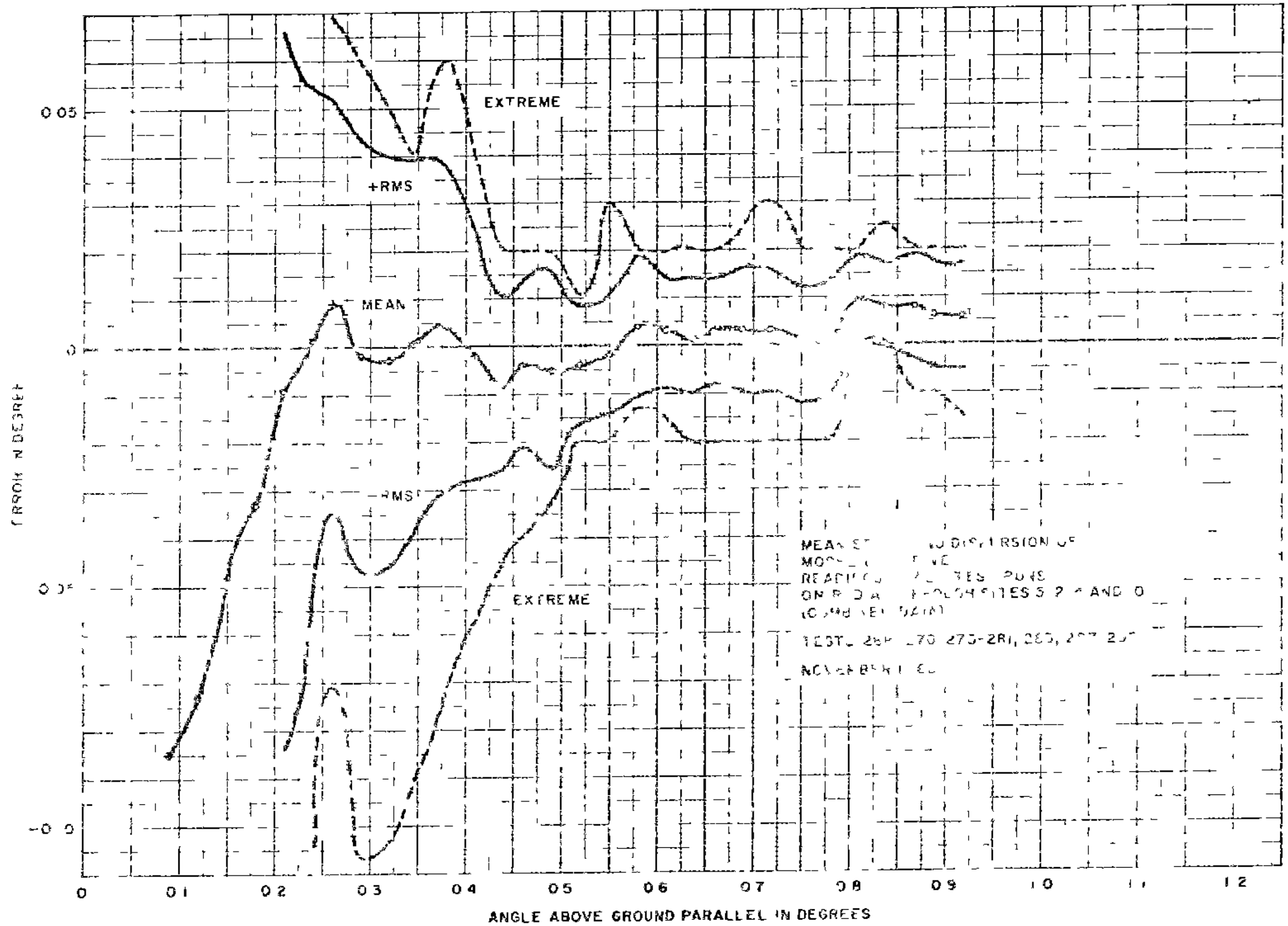

FIGURE 73 MEAN ERROR IN ALL MODEL B RECEIVER READINGS ON MAIN TEST RADIAL

APPENDIX A

TEST EQUIPMENT

The following types of commercial test equipment were used

1. Piston attenuator, 60-Mc, AIL Type 03060,
2. Oscilloscope, Tektronix Model 545A (Models 535 and 545 have insufficient trigger delay),
3. Oscilloscope recording camera (Polaroid), DuMont Model 297,
4. Counter, Hewlett-Packard Model 523B with EPUT modification,
5. Pulse generator, General Applied Science Labs Model PSG-1,
6. Voltmeter, DC differential, Fluke Model 801,
7. Pen recorder, Brush Mark II,
8. Pen recorder, Texas Instruments Recti-Riter,
9. Horn antenna, K_u-band, FXR Type Y638A

The following special devices were used for test purposes

1. Mixer, local oscillator, and IF preamplifier of angle-decoding receiver,
2. IF amplifiers, LEL Models IF60-D and IF16.5-22,
3. Transmitter, K_u-band klystron with pulse modulator,
4. Angle Selector Panel of AIL landing-system Encoder

APPENDIX B

DETAILED DESCRIPTION OF EQUIPMENT

The general characteristics of the ground-based and airborne equipment were discussed in Section II. The more complicated of the electronic units are described in more detail below.

ANGLE-DATA ENCODER

The Encoder generates pulses to modulate the landing system transmitter. It accepts the continuously changing angular position information from the antenna's angle data pick-off, and produces a train of pulses, the spacing between any two of which defines the antenna's angular position.

The Encoder differs from many pulse-position modulation systems in two respects:

1. Instead of producing pairs of pulses, the second of which "slides" relative to the first, the Encoder generates a train of single pulses with a continuously varying PRF, in which any interval defines the instantaneous angle. The latter type of code requires more sophisticated equipment for its generation, but it provides a higher data rate and more precise information, especially at [illegible] (which correspond to narrow spacings).

2. The input information from the antenna's angle data pick-off is in digital form. Furthermore, this information is continuously and rapidly changing. Thus, changes in angular position must continue to be sensed and accounted for during the time in which each pulse interval is being generated.

The Encoder has a high resolution--one part in 2000--and correspondingly high accuracy. The high resolution is based in part on digital counting techniques, just as in most high-resolution pulse interval generating systems However, the system is unique in incorporating a combination of digital and analog timing, with the analog-timing circuit acting as an "interpolator " This greatly reduces the frequency of the necessary digital counting, giving a considerably more reliable device

The Encoder's input information is derived from the Angle Data Pick-off unit mounted on the antenna A steel scale, ruled in one-hundredth-of-an-inch divisions, is mounted on the scanning antenna, and moves with it A photocell pickup senses the difference between the black marking and the background color of the scale. Thus, as the scale moves, it produces a pulse each time a scale division passes under the photocell The radius to the scale is so chosen that a movement of one-hundredth of an inch along the scale indicates an antenna rotation of 0 02 degree Leading and trailing edges of the pulses are then used to give a count pulse for every 0 01 degree of antenna motion

The interval between Encoder output pulses varies from 16 to 96 μsec as the antenna scans through 20 degrees, with the pick-off sensing each 0.01-degree change. A simple calculation shows that a unit change in the antenna count must cause a 0 04-μsec change in the interval.

Figure B-1 is a block diagram of the Angle-Data Encoder.

The angle increment counter accepts and counts antenna pick-off pulses to derive a number representing the angular position of the antenna. Since the antenna moves in an oscillating manner, the angle value will oscillate, and a bidirectional counter is required The direction of counting is changed by a limit-switch signal for each reversal of antenna rotation

Generation of the pulse interval begins at the initial interval generator, which produces a fixed interval corresponding to the minimum pulse spacing required for encoding. This interval is generated by counting a fixed number of pulses from a reference oscillator. A signal produced at the end of the initial interval then opens a logic circuit, gating pulses from the reference oscillator to the variable interval counter.

By the same process of counting pulses from the reference oscillator, the variable interval counter generates an interval that corresponds to the eight most significant digits of the number in the angle increment counter. The number from which the variable interval counter generates its portion of the interval is gated into this counter from the angle increment counter at either of two instants during the initial interval. The guard pulse circuit ensures that the read-in will not take place at an instant when the count is changing.

Since the reference oscillator is crystal-controlled to a frequency of 3.125 Mc, the coarse interval (the sum of the initial and variable intervals) is determined as an integral number of increments of 0.32 μsec. The end of the complete timing interval is reached by adding a small increment onto the coarse interval; this increment is generated by the interpolator, and is proportional to the sum of the three least significant binary digits of the number in the angle increment counter.

The output pulse of the interpolator signals the end of the full interval. This pulse is reconstituted to a standard length and used to modulate the transmitter.

A timing diagram would show that the number supplied to the interpolator must be derived by adding the interpolation value for the previous interval to the three bits currently in the angle increment counter. A three-bit binary adder performs this addition continuously, and once per cycle the output of the adder is transmitted to the interpolation counter. This counter holds the results of the addition until the time of generation of the interpolation interval, and it provides storage for antenna pick-off pulses that are received during the generation of the coarse interval. This latter function updates the encoder on changes in angle that occur during the generation of the coarse interval.

The interpolation counter will receive and correctly store antenna pick-off pulses up to the point where the capacity of the counter is exceeded and an overflow occurs. This overflow represents a change required in the coarse interval of one count* from the reference oscillator, and it is accounted for by changing the length of the variable interval by one count. The interval must be increased by one count if the angle increment counter is counting forward, or decreased by one count if it is counting backward. Logic circuits are incorporated to make these changes when the interpolation-counter overflow line is energized.

A similar overflow may occur when adding interpolation values together. In this case, an overflow still represents a change of a unit count from the reference oscillator, but only in a positive direction. The change is incorporated by stretching the initial interval by one count when the output of the adder indicates an overflow.

ANGLE-DECODING RECEIVER

The K-band Angle-Decoding Receiver has been designed, from its inception, with the ultimate system application in

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* The timing of the system is such that an overflow of more than one count can never occur within the interval between two output pulses.

mind This approach has had much influence on the choice of techniques and components--usually on the side of conservatism--and it affords convincing proof of the feasibility of certain proposed features that would be necessary in an operationally useful system

For example, a superheterodyne rather than a crystal-video front end was adopted immediately Although this choice was helpful in terms of receiver sensitivity and rejection of interference, it was not dictated by a dearth of high-power magnetrons (which are available), nor by the radio environment (which is relatively quiet at K_u-band). A primary consideration was the great likelihood of its eventual requirement in the routine use of the proposed landing system, for frequency channelization as well as reliability.

Similarly, automatic calibration control was incorporated in an early version (Model B) of the receiver, though short-term stability that was good enough for a test program could probably have been achieved without this complication Again, a future operational requirement affected the choice An analog format had been chosen for angle-data encoding, and analog circuits for decoding and tracking, in order to allow relatively simple (and hence reliable) airborne equipment, however, it is doubtful that the necessary system accuracy could be maintained by these techniques, in routine airline or military service, without autocalibration

As a final example of this design philosophy, the feasibility of the circuits to be used for switching the receiver functions among two or three scanning-beam signals in sequence has been shown by the successful use of similar circuits for switching between autocalibration and normal beam signals

To ensure compatibility of the interim circuit design with the expanded functions of future models, the

Model A and Model B breadboard receivers were based on block diagrams of the full-scale version, as shown in Figures B-2A through B-2D Those functions not incorporated in the Model B are cross-hatched in the diagrams

A description of the four major sections of the proposed full-scale receiver follows, this description applies to corresponding elements of the Model B receiver used in this test program.

The front end is of conventional design The decoder section recovers the angle reference data and produces a voltage proportional to the beam angle at the instant each pulse is received, it also decodes beam identity, and accordingly switches certain circuits in the receiver The tracker section compares the decoded angle voltage during each beam passage with the output voltage representing the aircraft's angular position, and adjusts the output voltage as required. The calibrator section continually tests the performance of the decoder and tracker, whenever no beam is actually being decoded and tracked.

Detailed descriptions of various video circuit functions will follow a discussion of the general characteristics and design goals for this receiver.

The major design goal is to obtain angular measurements that are consistent, from scan to scan, within 0 01 degree, and accurate in absolute value within 0.05 degree. Obtaining performance of this quality in a relatively uncomplicated airborne equipment is facilitated by some peculiarities of the application (1) performance can be permitted to fall short of the goals except when the aircraft is actually about to land--that is, except at low elevation angles, near the center of the azimuth sector and at close range, (2) optimum conditions will prevail just when best performance is required--high signal-noise ratio and high pulse data rate, (3) the critical circuits are used only intermittently--about 6 percent of the time, during beam passages--and can be automatically monitored and servoed when not in use, and (4) the pulse rates are high enough to permit integration of many individual measurements to obtain the output values.

DECODER-TRACKER

The decoder-tracker section has three major functions: (1) recovery of angle reference data, (2) discrimination against unwanted signals (reflections, noise, and interference), and (3) recognition of beam identity (and right-left sensing on the localizer beam).

The reader is referred throughout this discussion to the functional block diagram of the receiver (Figures B-2A through B-2D).

Since the defruit gate and search gate depend for their operation on signals generated during the angle data recovery and tracking process, let us bypass these gates for the moment and assume that data pulses (but no identity pulses) are emerging from the video gate.

DECODER

In Figure B-3, the data pulses (which are all of the same amplitude, having passed through the video quartizer) trigger the simultaneous beginning of the retrace gate and the read gate. The early portion of the retrace gate is prevented from reaching the linear sweep generator by the presence of the read gate in the retrace inhibit logic. However, as soon as the read gate ends, the retrace signal gates on a low impedance discharge path within the linear sweep circuit, reducing the output of that circuit to zero, and holding it there until the retrace gate ends.* The linear sweep then begins at a rate of 0 25 volt/μsec When the next pulse arrives, the read gate that it triggers stops the rise of the sweep voltage and holds the level that has been attained for 4 μsec. This voltage (which is an analog of pulse spacing, since the sweep voltage increases at a constant, known rate) is used by the tracker during the read interval

ANGLE TRACKER

In the angle tracker section, the pulse-spacing analog voltages from all the pulses within one passage of a beam are compared, one by one, with the angle data established by previous passages of that particular beam An error signal is thus developed that is used to update the angle data stored in the angle memory

The angle tracker uses a technique known as center-of-gravity tracking, in which angle information is derived by averaging all the spacings in an entire beam passage, rather than by considering a small number of pulses at the nominal center of the beam. The averaging process inherent in this technique minimizes random errors and frees the output from the granularity of any digital encoding scheme.

The tracking comparator is the heart of the center-of-gravity tracker To this circuit are fed the pulse-spacing analog voltages from the linear sweep generator, the

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* As the figure shows, the sweep is actually retraced to a small voltage below zero This ensures operation on the linear portion of the sweep when zero voltage is reached. Note that zero voltage is equivalent to 18 μsec, the pulse spacing used to represent zero degrees in the encoding scheme (During the tests, and earlier in this report, 16 μsec was taken as zero degrees)

angle memory voltage, and non-quantized video pulses These three signals are shown in Figure B-4 in slightly idealized form for clarity * An abnormally large error is represented

The comparator output is the difference between each spacing-analog voltage and the angle memory voltage, multiplied by the amplitude of the non-quantized video pulse This can be seen by examining the waveforms at times t_1, t_2, and t_3 At t_1, the difference between the spacing-analog and memory voltages is substantial, but the video pulse is small, so that the output is small

At time t_2, on the other hand, the voltage difference has decreased to about half of its former value, but since the video pulses are now quite large, the output pulse is large

At time t_3, the video pulse is still fairly large but the voltage difference has become nearly zero, reducing the output

Finally, it should be noted that as the voltage difference changes polarity, the output pulses also change polarity

These pulses are fed to the differential error integrator, which integrates over the entire beam and produces an output as shown The steady-state condition that is finally reached at [illegible] integration period is an output voltage that is proportional to the error, the difference between the angle data stored in the memory and the angle represented by the pulse spacing at the center of energy of the beam

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* For instance, in the representation of the non-quantized video pulses, no attempt has been made to show the small difference in pulse spacing that would exist between pulses in the leading and trailing edges of the beam envelope.

That this is true is easily seen if we visualize what would have happened had there been no error. In that case, Figure B-4A would, of course, be unchanged but, in Figure B-4B, half of the spacing-analog voltages would be more negative and half more positive than the angle memory voltage This, in turn, would make the envelope of positive pulses at the comparator output the mirror image of the envelope of negative pulses. The positive and negative areas would then be equal, and the residual charge at the end of the integration process would be zero

The error voltage developed at the output of the integrator drives a constant-current generator. During the sample interval, the current from this generator flows through the input matrix to the proper memory, correcting it to the new angle value.

At the end of the sample interval, the constant-current generator is disconnected from the memory, which retains the new angle value, and a discharge pulse returns the differential error integrator output to zero, preparatory to the next determination of angle.

DISCRIMINATOR GATES

In discussing the search and defruit gates, we assume as an initial condition that the search gate is open, and that the value in the angle memory is greatly different from the angle of the beam about to be received This is the condition that could prevail if no beams had been received for a long time.

With the search gate open, all the data pulses plus some extraneous pulses (noise, interference, and reflections) pass to the video gate and thence to the decoder and threshold circuitry

Most of the extraneous p[illegible] w[illegible] not pass through the threshold gate (which rejects all [illegible]lses below a given level), but some will--along with the data pulses The decoding and tracking circuits will [illegible]refore correct the angle memory to a [illegible] that [illegible] error because of the extraneous pulses (L[illegible]mitation of the error depends on the much higher pulse rate, at least [illegible]0 kc, from the scanning beam signal than from interfering sig[illegible] is normally encountered)

On the next pass of that same beam, the first pulse will again pass through the search gate, triggering a retrace gate and starting a linear sweep The outputs of the linear sweep generator and the angle memory are connected to the defruit discriminator This discriminator opens the defruit gate when the sweep voltage comes within, say, 1 volt of the angle memory voltage Since the linear sweep rises at 0 25 volt/µsec, the discriminator will open the gate 4 µsec before the pulse is expected If the next pulse arrives with about the same spacing as detected in the last beam (as approximately represented by the memory voltage) it, and the subsequent pulses, will pass through the defruit gate as well as the search gate

When the memory is tracking correctly, all of the data pulses will thus be passing through the defruit gate, and will flow to the tracked-beam detector [illegible] the tracked-beam detector receives [illegible] number of pulses (which, having passed through the defruit gate, indicate that the gate is tracking, it closes the search gate, effectively blocking all but the very few extraneous pulses that nearly coincide with beam pulses The resultant increase in accuracy of the data in the angle memory tends to further reinforce the tracking condition

There are two other conditions under which the search gate is closed The retrace gate (nominally 17 µsec long) is fed back from its genera r to close the search gate for the first 17 μsec after each pulse, this blocks all identity pulses (which occur 10, 12, or 14 μsec after each data pulse) from reaching the decoder. Furthermore, the autocalibrate gate signal closes the search gate during the calibration cycle, this prevents stray pulses from interfering with the calibration process

IDENTITY CODING

The glide-path beam and the localizer beam are distinguished from the flareout beam and from each other by the presence of identity pulses 10, 12, or 14 μsec after each data pulse * Decoding of this identity information is required so that the proper angle memory voltage is selected for use in the defruit discriminator and in the tracking and calibrator circuits. The receiver AGC level is set by the flareout beam, and tracking corrections must be applied to the proper memory circuits

All received pul are applied directly to the identity decoder, which is a passive delay line with short-term (millisecond) integrator networks fed from the taps at 10, 12, and 14 μsec, respectively When a beam from either the glide-path scanner or the localizer scanner is received, the identity pairs with one of these spacings build up a voltage on one of the two identity gate input lines. Immediately after each beam has been tracked, both gates are turned on by the discharge gate generator, which also applies a transient that triggers the scan-sequence counter. Either one or neither of the counter's output lines are energized

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* A pulse at t + 10 μsec identifies the glide-path beam A pulse at 12 μsec indicates that the angle being received is to the right of the centerline, and a pulse at 14 μsec indicates that it is to the left of the centerline. The flareout beam is identified by the absence of identity pulses.

(three possible states), depending on whether either one or neither of the identity gates [illegible] transient when the reset trigger is received. At this time the right left sensing signal passes to the R-L sensing switch

The counting cycle is [illegible] each beam (corresponding to the scan sequence established on the ground) so that, after each beam is received, the scan sequence counter immediately performs all [illegible] functions required for proper interpretation of the next beam

AGC CIRCUITRY

The receiver incorporates a novel AGC system to minimize the dependence of measurements on the shapes of scanning beams Although the signal strength may vary during an approach by nearly 60 db, the beamwidths seen by the decoding and tracking circuits should be limited to those between 3- and 15-db down points (about 0.5 to 0 9 degree) to avoid any side lobes and shoulders that may occur

The AGC level is determined during the presence of the flareout beam, the strength of which can be taken as an average for the three beams The differential error integrator, in addition to its main output, produces a voltage proportional to the energy in the entire beam This signal, as derived from the flareout beam, is held in the AGC [illegible] and [illegible] the IF gain

At low angles (close to the ground), it is desirable to set the tracking threshold level [illegible] high, since lobes and shoulders caused by reflections are most likely to be encountered close to the ground. This is accomplished by thresholding on a [illegible] pulse count, taking advantage of the fact that the coding scheme provides a greater pulse density at low elevation angles By establishing a threshold level such that a constant number of pulses from each beam passes the threshold gate, the threshold control and quantizer limits the portion of the beam considered by the tracking circuits to the high-amplitude region of the beam envelope. Note, however, that this higher threshold does not reduce the amount of information provided to the tracking circuits A constant number of pulses give a constant number of angle determinations, even though the threshold level varies.

AUTOCALIBRATOR

The autocalibrator section generates pulses of a standard spacing, and a comparison voltage exactly equivalent to this spacing, for continual monitoring and calibration of the decoder and tracker circuits These circuits are calibrated after each beam, the effects of any drift or nonlinearity in the sweep voltage are thus minimized

During the calibrate period, the following events take place

1 The video gate is switched, allowing a simulated beam (a train of pulses from the calibrate section) to enter the decoding and tracking circuits At the same time, the voltage gate is switched, feeding the calibration reference voltage to the comparator

2. The simulated beam is decoded and, because the calibration reference voltage was chosen to correspond exactly to the spacing the voltage developed at the output of the error integrator is proportional to the error in the decoding and tracking process

3 The error voltage causes the constant-current generator to produce a current that is fed to either the width or slope servo integrator

4 The output of the width servo integrator controls the width of the retrace gate Since the end of the retrace gate triggers the beginning of the linear sweep, controlling the width of this gate controls the starting time of the sweep, and therefore controls the voltage attained for a given spacing.

5 The output of the slope sensor integrator controls the charging voltage applied to the linear sweep circuit, and thus controls the slope of the sweep itself.

The two types of calibration are performed alternately, one after each beam passage. Width is calibrated for the minimum pulse spacing, 18 μsec, and slope is calibrated for a pulse spacing of 63 μsec. In addition to being convenient spacings at which to check the width and slope, 18 μsec and 63 μsec correspond to angles that are important operationally. An 18-μsec spacing corresponds to zero degrees on the flareout beam, and it is at low elevation angles that this beam is actually used. A 63-μsec spacing corresponds to only 1-1/4 degrees right or left of centerline on the azimuth beam--which is used for centerline alignment--and to 2-1/2 degrees, a commonly used glide angle, on the glide-path beam.

GATING AND TIMING FUNCTIONS

The entire decoding-tracking process is started by the skirt detector, a pulse-to-pulse (100 μsec) integrator that builds up an effective triggering level from the first few pulses in the leading skirt of the beam as it starts to scan past the aircraft. No useful information is sacrificed in this process; these pulses would not have been tracked because they are necessarily below the threshold level established by the threshold control.

The output of the skirt detector triggers the beam-delay multivibrator, as shown in Figure B-5. The on time of the beam-delay multivibrator is made large enough that an entire beam has passed and been tracked before a sample gate is generated. The sample gate activates the memory input matrix, and during the sample gate period the output of the constant-current generator flows to the proper angle memory, correcting it to the latest decoded angle value

The end of the sample gate initiates the discharge gate, which dumps the charge stored in the differential error integrator preparatory to the next integration The discharge signal also resets the scan sequence counter for the next beam The end of the discharge gate then generates the auto-calibrate gate, which

1. Switches the calibration sequence flip-flop, so that alternate calibration modes (width and slope) will be used after alternate beams.
2. Switches the video gate, allowing a train of pulses from the proper calibration reference oscillator to enter the decoding-tracking circuits
3. Switches the voltage gate, applying the proper calibration reference voltage to the comparator.
4 Closes the search gate to block noise and interference
5 Disables the threshold circuitry

To prevent the calibrate beam itself from generating another cycle of calibration, the beginning of the autocalibrate gate starts another and longer gate signal, the calibration inhibit This signal holds the calibration inhibit logic closed for a period of time during and immediately after each calibration beam Thus, the discharge gate generated by the calibrate beam cannot reach the autocalibrate gate generator, and calibration beams are prevented from regenerating themselves

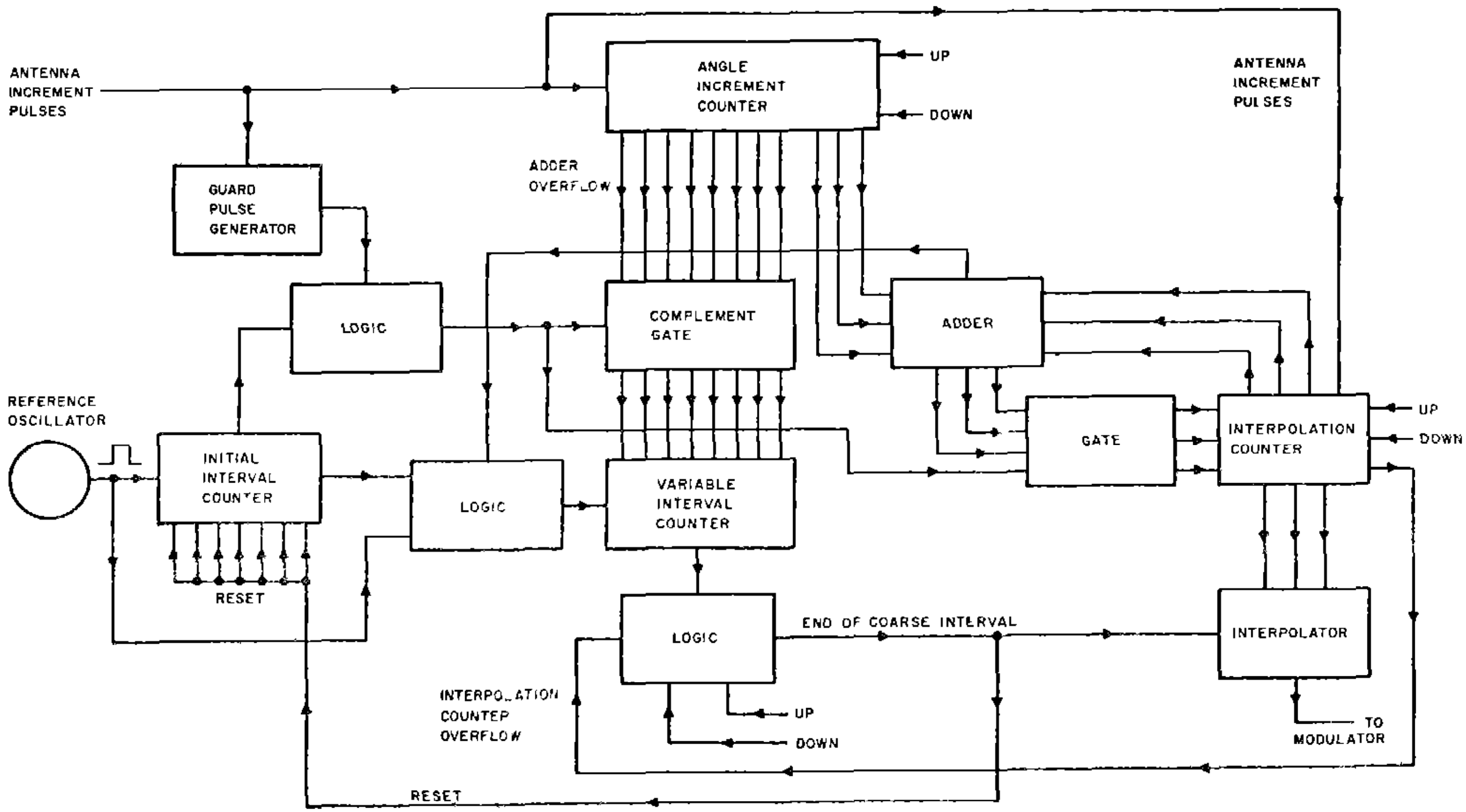
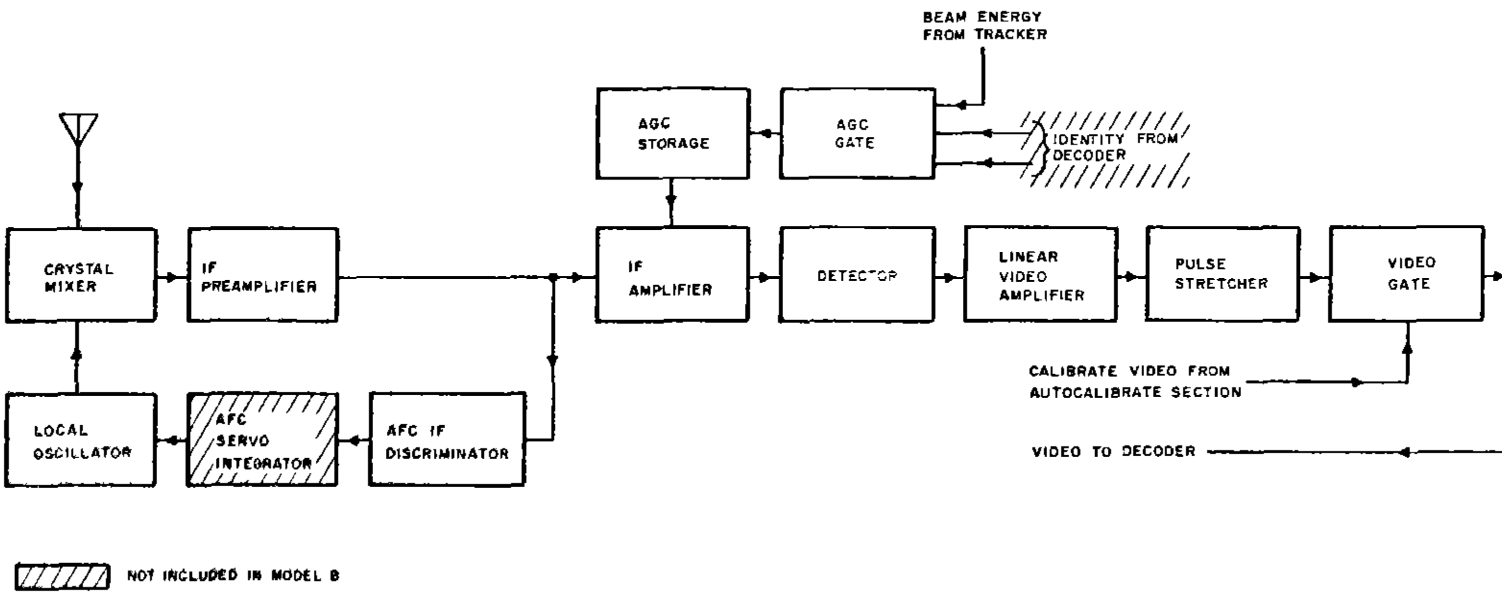
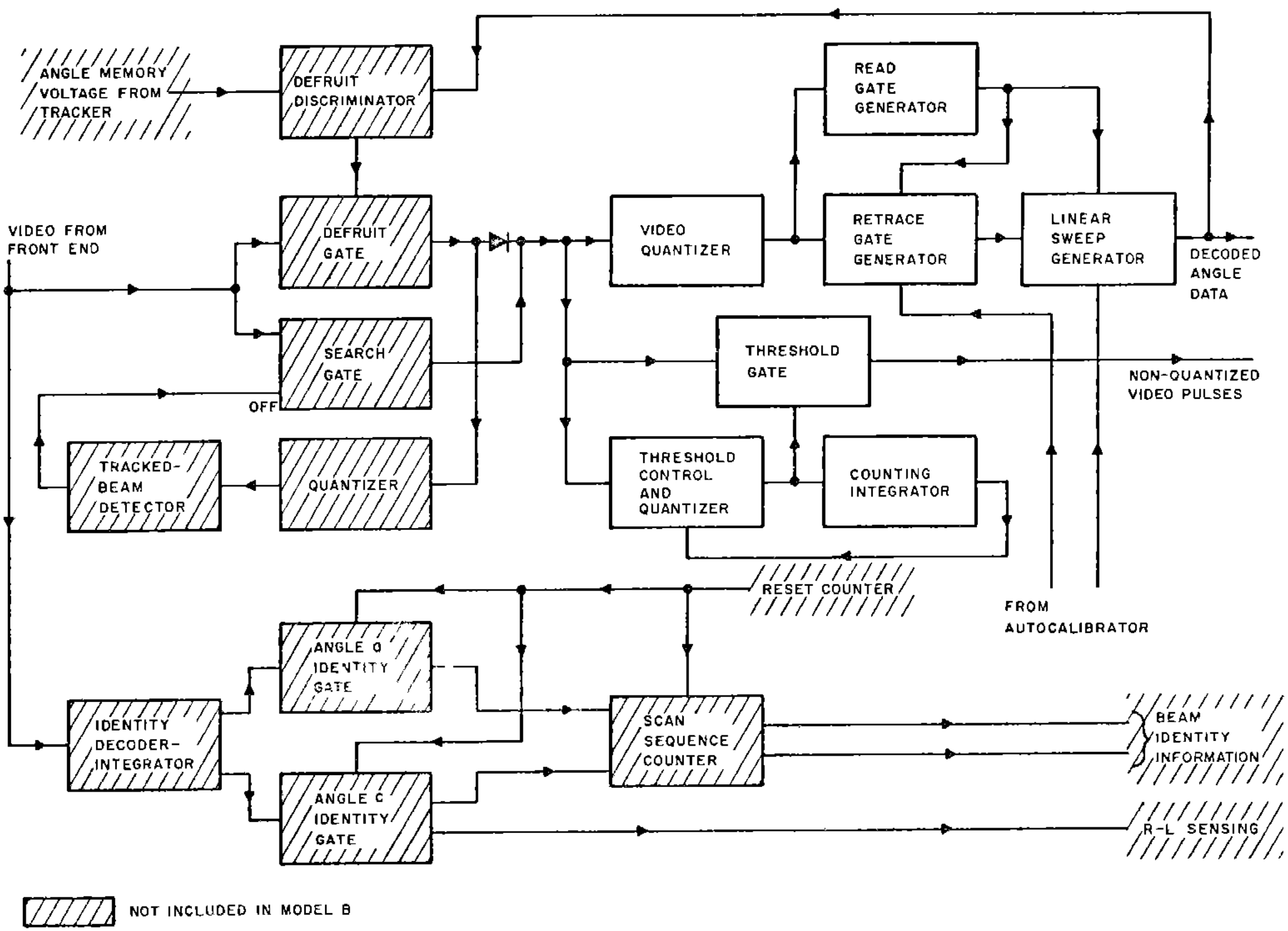


FIGURE B-1 BLOCK DIAGRAM OF ANGLE-DATA ENCODER



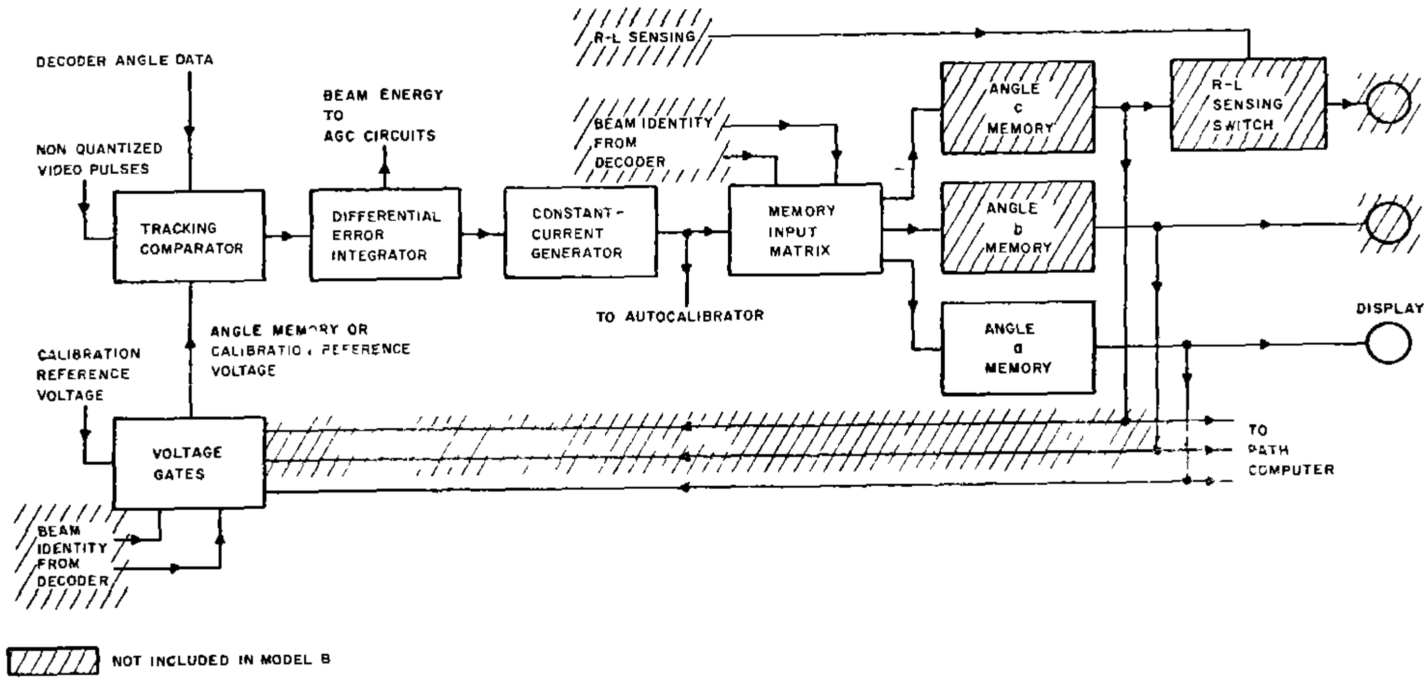
A. FRONT END

FIGURE B-2. BLOCK DIAGRAM OF ANGLE-DECODING RECEIVER
(SHEET 1 OF 4)



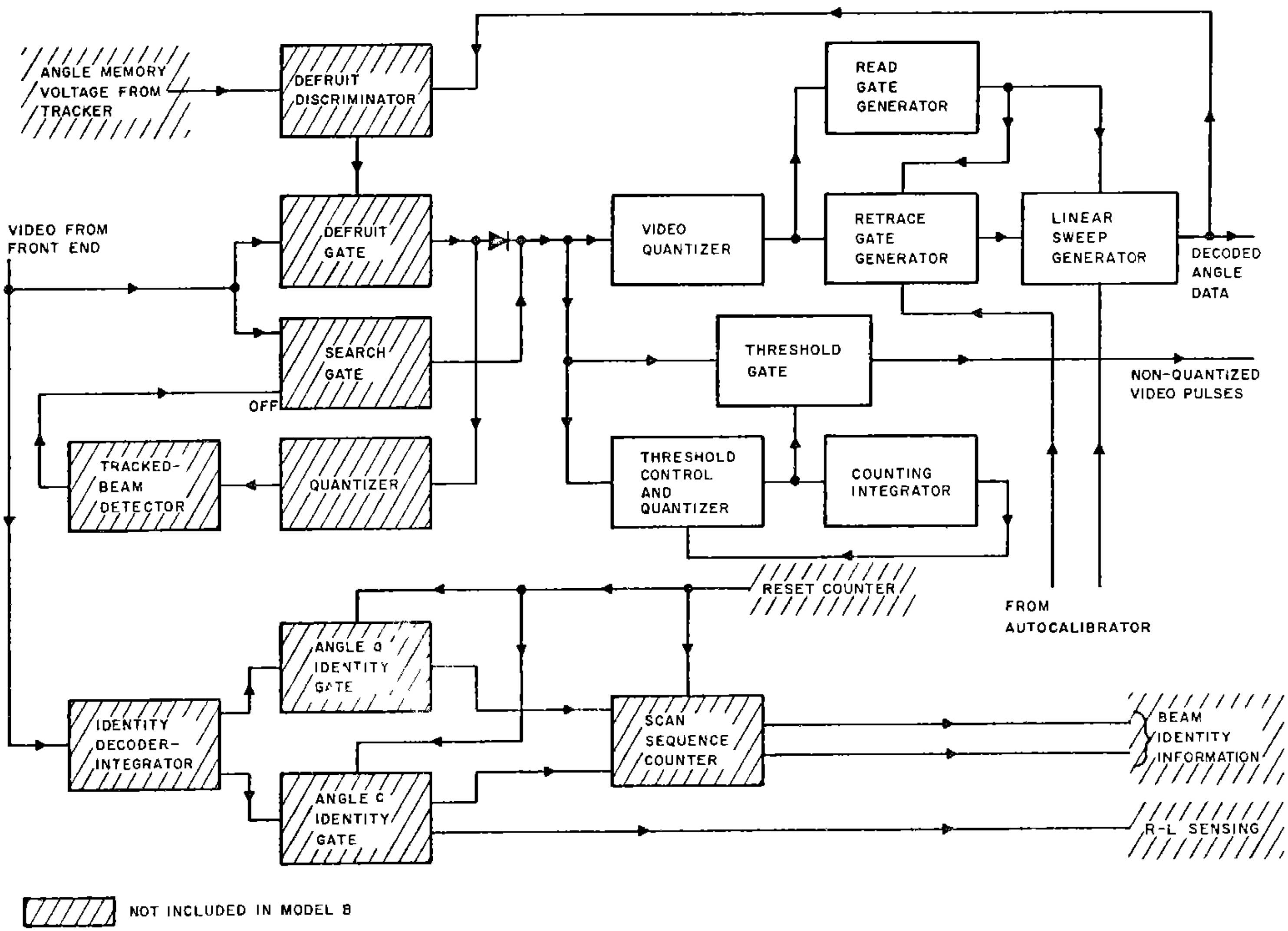
B DECODER

FIGURE B-2
SHEET 2 OF 4



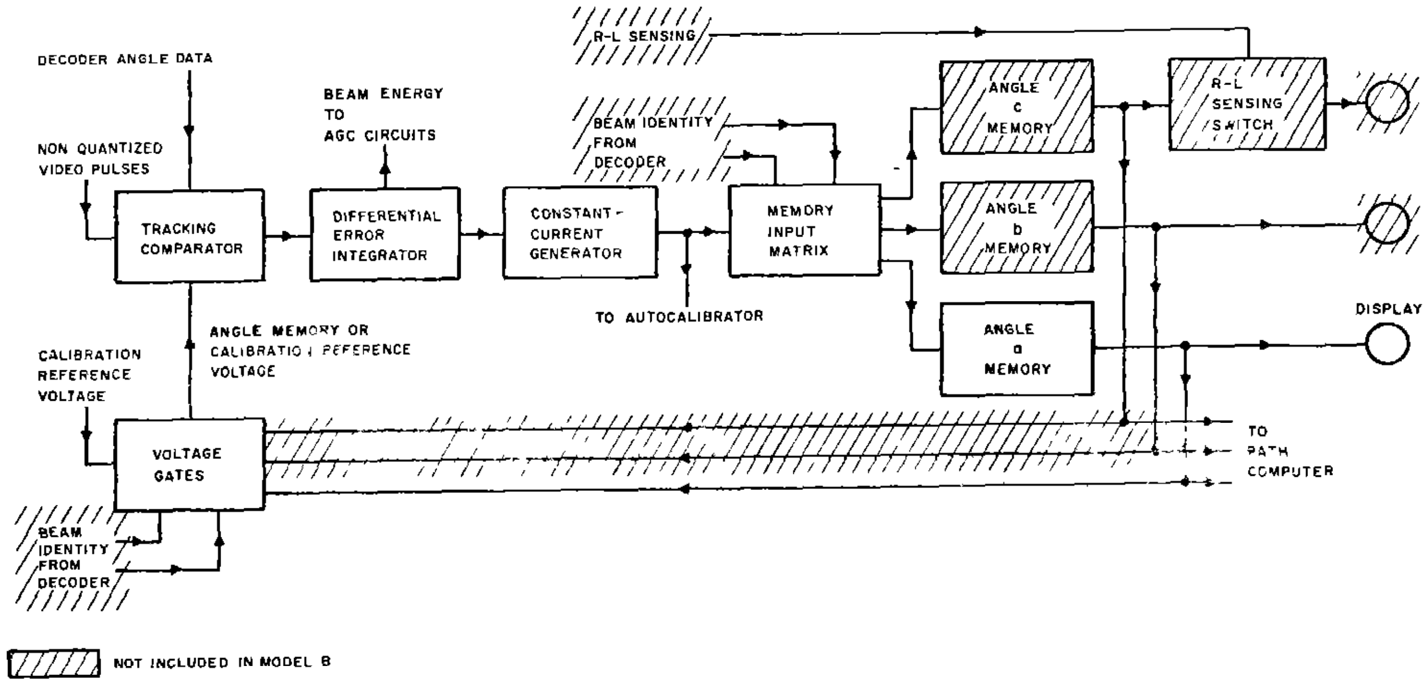
C ANGLE TRACKER

FIGURE B-2
SHEET 3 OF 4



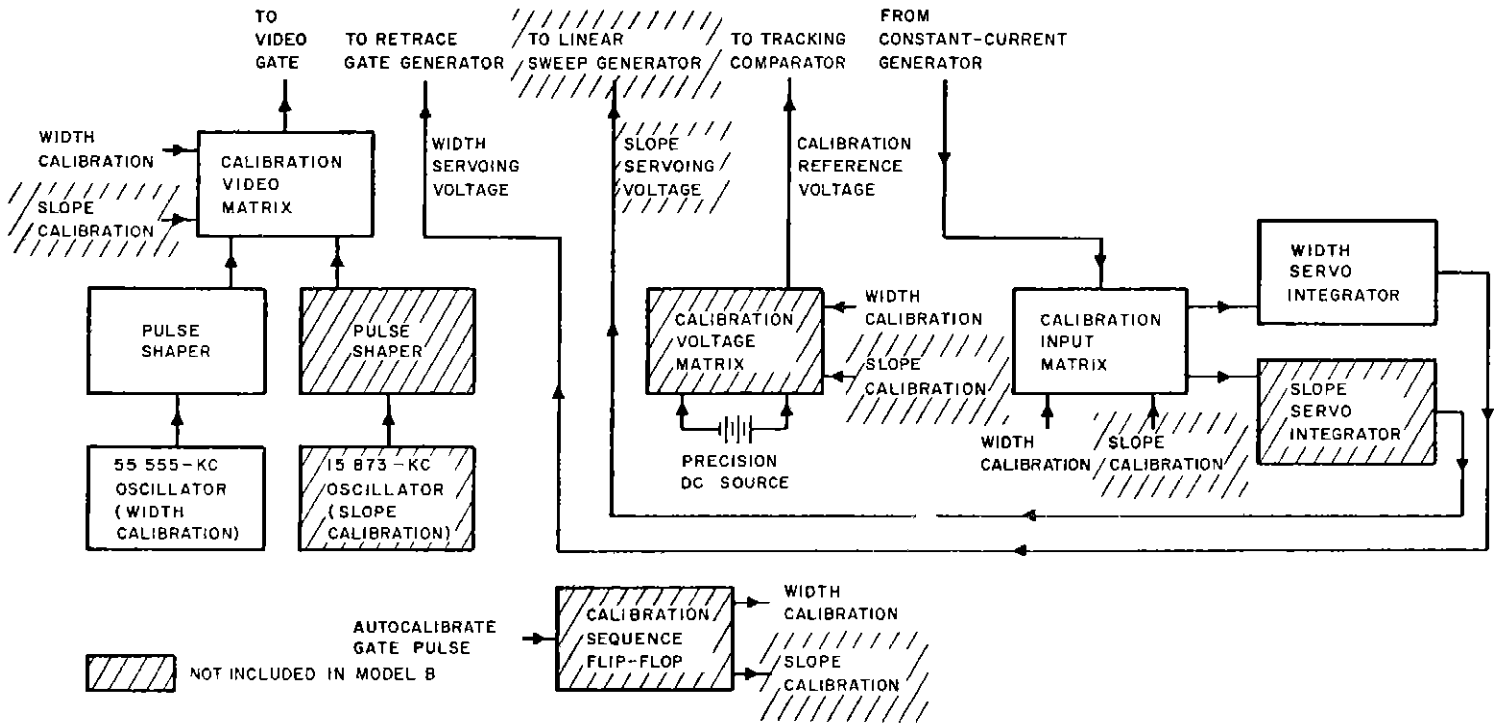
B DECODER

FIGURE B-2
SHEET 2 OF 4



C ANGLE TRACKER

FIGURE B-2
SHEET 3 OF 4



D AUTOCALIBRATOR

FIGURE B-2
SHEET 4 OF 4

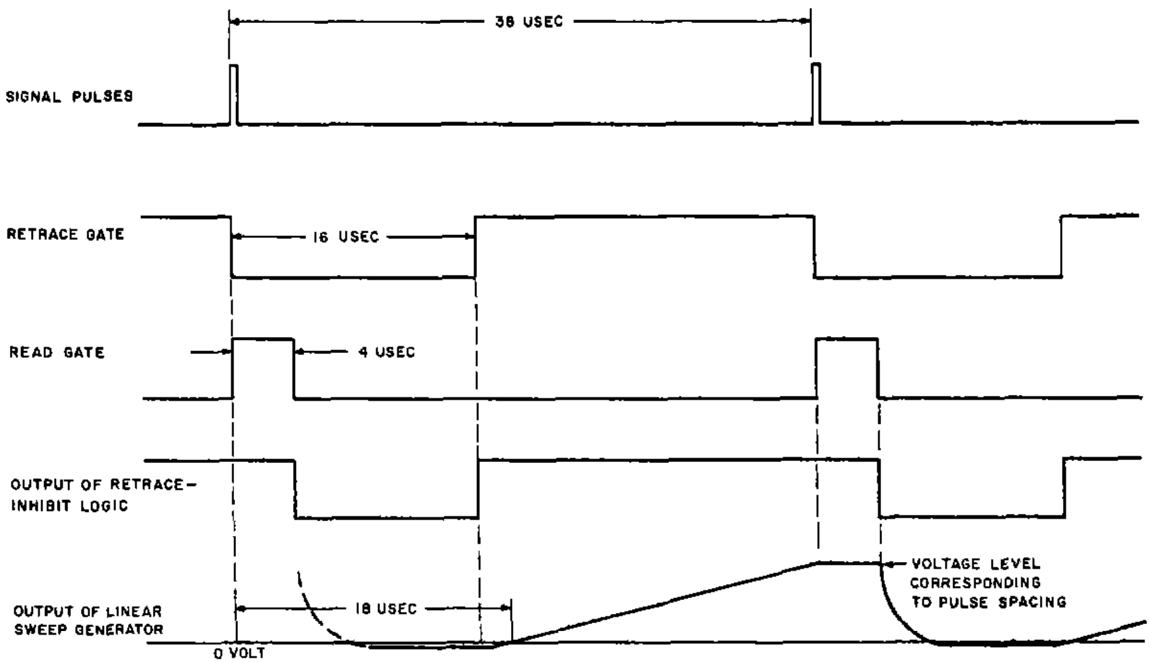


FIGURE B-3 ANGLE-DECODING WAVEFORMS

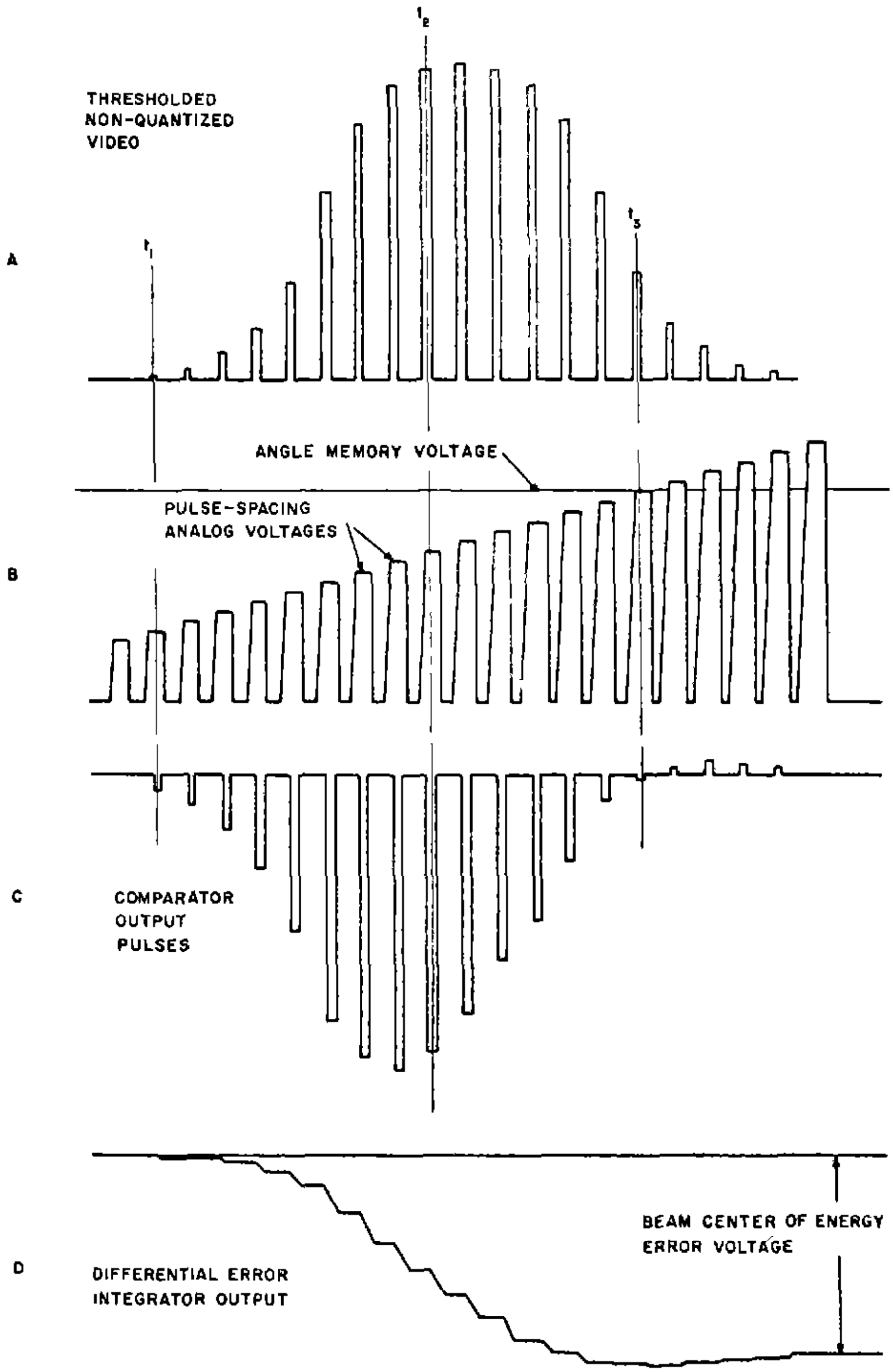


FIGURE B-4 CENTER-OF-GRAVITY TRACKING WAVEFORMS

APPENDIX C
PROPOSED OFFICIAL TESTS

In general, the tests we propose to be officially witnessed by FAA engineers are chosen from among the many types of tests developed by AIL to most efficiently demonstrate the validity and repeatability of the results contained in this report In this light, such "basic research" as Dynamic Lobing and Static Beamshape tests (see paragraph A of Section III) are not included Furthermore, since the autocalibration feature of the receiver has been found to be a reliable way to improve the accuracy of angle measurement by a substantial amount, and since the system has never been claimed to be operational without autocalibration, all tests should be conducted with the autocalibrate circuitry in operation

Briefly, we propose to perform three different tests at each one of a group of checkpoints (to be specified by the FAA) within the coverage of the system. The checkpoints should be chosen to include evaluation of the effects of (a) range,and (b) offsets from the centerline of the scanning antenna With these factors in mind, checkpoints are suggested that are at ranges between 500 and 4000 feet, and on lines 22 degrees and 45 degrees from the centerline of the scanner's azimuth coverage.

At each one of the chosen checkpoints, we propose to perform three tests (a) Static Lobing, (b) Dynamic Beamshape, and (c) Received Angle.

STATIC LOBING TEST

This test (described in Section III) should be performed first at each checkpoint. The test is quick and easy to perform, and provides an excellent qualitative evaluation of the terrain between the scanner and the checkpoint The depth of the nulls is an indication of the strength of reflections of the 16-kMc signal taking place along the overall path. This information will aid in interpreting the Received Angle data to be taken later at the same point.

DYNAMIC BEAMSHAPE TEST

The time required to set up and run a Dynamic Beamshape test is not negligible, but this type of test represents a significant part of the AIL measurement program.

The receiver determines the angle at the center of gravity of the dynamic envelope (excluding skirts and side lobes, insofar as this is possible) Thus, if the central portion of the dynamic envelope is distorted by reflections from terrain, an error is generated. Furthermore, this error theoretically cannot be reduced by improvements in encoding or decoding techniques Thus, we may consider the Dynamic Beamshape test to indicate the irreducible minimum system error of the AIL technique

This interpretation should be applied cautiously, however As is discussed in the body of this report, attempts to correlate Dynamic Beamshape errors with overall system errors were many times disappointing, but we still believe that a demonstration of the technique of this test is important and should be included in the official tests.

RECEIVED-ANGLE TEST

Evidently, the receiver should interpret the transmitted signal for a determination of overall system error By using proper equipment and techniques, however, much more than overall system error can be determined during this test It is suggested that both the angle memory and integrated signal strength outputs of the AIL receiver be monitored on a chart recorder running at a relatively fast speed, perhaps 1/2 inch per second. The pulses of integrated signal strength voltage will mark each beam passage, and their spacing will show which beams are upward scans and which are downward scans The angle memory voltage can then be examined to determine if differences exist in the information received from a downward scan compared with that from an upward scan If desired, the transmitter can also transmit on downward scans only or on upward scans only.

It is further suggested that, as the receiving antenna is raised and lowered to intercept different angles, it be held stationary at each position for 5 or 10 seconds. A large number of beam passages will then be recorded at each position, and the recording can later be examined for a statistical determination of system reliability.

APPENDIX D
ORIGINAL DATA

Notes

A. Zero-degree count not recorded on data sheet, but known to have been 68.

B. Downward scan only.

C Operating frequency recorded as 16,000 Mc.

D Operating frequency recorded as 16,100 Mc

E. Signal-to-noise ratio recorded as 45 to 50 db.

F. Zero-degree count not recorded on data sheet, but known to have been 79.

G. Upward scan only

H Signal-to-noise ratio recorded as 30 to 35 db.

I. Signal-to-noise ratio recorded as 35 to 40 db

J. Operating frequency recorded as 16,098 Mc

K Signal-to-noise ratio recorded as 25 to 30 db

L. Signal-to-noise ratio recorded as 50 to 55 db.

M Operating frequency 16,098 Mc, signal-to-noise ratio 30 to 40 db

N. Signal-to-noise ratio recorded as 40 to 45 db

O. Operating frequency recorded as 16,090 Mc

P Operating frequency recorded as 16,095 Mc

Q. Operating frequency 16,095 Mc, signal-to-noise ratio 40 to 50 db.

R. Operating frequency 16,095 Mc, signal-to-noise ratio 30 to 40 db.

S. Operating frequency 16,095 Mc, signal-to-noise ratio 50 to 55 db.

T. Operating frequency 16,093 Mc, signal-to-noise ratio 40 to 50 db

a. Receiver calibration checked continually during test.

b. Temporary site, about 1350 feet (paced) from scanner at 45 degrees, best fit of data is for 1400 feet.

Notes

d. Scanner elevated about 16 5 inches above normal height

e Grass recently mowed on test radial.

f. Ground reflections p rtly suppressed by obstruction on test radial.

g Temporary site at 0 degrees, 1750 feet from scanner (between sites 5 and 2)

h Temporary site at 0 degrees, 2250 feet from scanner (between sites 2 and 4)

i Temporary site at 0 degrees, 2750 feet from scanner (between sites 4 and 6).

j. Temporary site at 0 degrees, 1250 feet from scanner (in line with site 5)

m Temporary site at 0 degrees, 1000 feet from scanner (in line with site 5)

n. Temporary site at 0 degrees, 750 feet from scanner (in line with site 5).

p Temporary site at 0 degrees, 500 feet from scanner (in line with site 5).

q Temporary site at 28 3 degrees, 1510 feet from scanner (1376 feet from virtual origin).

r Temporary site at 16.7 degrees, 2475 feet from scanner (2392 feet from virtual origin)

t Receiver not properly calibrated.

u AGC became unstable at heights below 15 feet

v. Angle readings from scanning beam with various fixed PRF's found too high except at 0 degrees.

w. Primary power to receiver interrupted during test, after 23- and 12-foot readings

x. AGC inoperative, gain controlled during test to maintain constant integrated beam energy.

TEST DATA ON STATIC BEAMSHAPE
FIELD STRENGTH VERSUS PROBE HEIGHT WITH STATIONARY BEAM

TEST NO	11	12	3	14	15	16
DATE (1960)	6/8	6/8	/8	6/8	6/8	6/8
HOUR	1650	1705	1715	1725		1750
SITE NO	1	1	1	1	1	1
REL AZ DEG	0		0	0	0	0
SCAN EL DEG	0.68	.85	0.62	1.35	1.48	1.65
PROBE HT, FT	DB	DB	DB	DB	DB	DB
28	7.1	11.4	6.2	23.4	35.0	32.0
27	5.7					
[illegible]	24	25.6	32.5	36.7	36.1	31.7
25	13.1					
24	30.8	36.2	33.5	31.6	34.7	28.2
23	25.5					
22	28.4	34.4	37.4	38.3	33.7	22.8
21	32.1					
20	33.8	37.5	38.1	37.2	27.8	15.6
19	35.1					
18	35.9	38.4	36.7	33.8	22.2	11.2
17	37.2					
16	38.2	38.8	35.4	30.1	17.1	22.4
15	39.6					
14	39.2	31.9	32.8	23.5	18.4	21.3
13	38.8			18.2		
12	38.6	35.5	21.5	13.5	22.5	21.5
11	39.2			31.2		
10	31.0	34.4	24.3	23.0	24.9	23.3
9	34.2		30.8			
8	31.7	30.3	14.6	21.8	22.4	16.3
7	34.9	25.1	12.7			
6	31.9	2.5	23.5	22.8	17.6	13.4
5	36.2	21.2				
4	28.8	23.2	24.9	23.1	26.6	11.6
3	27.4					
2	23.9	20.7	21.0	21.6	15.8	13.1
1						

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TEST DATA ON STATIC LOBING
FIELD STRENGTH VERSUS PROBE HEIGHT WITH HORN RADIATOR

TEST NO	17	18	19	20	21	207A	207B	208A	208B	223	223A	223B	225	230	232	233
DATE (1960)	6/19	6/19	6/14	6/14	6/14	7/21	7/21	7/21	7/21	8/23	8/23	8/2[illegible]	8/23	8/24	8/24	[illegible]
HOUR	1420	1450	1515	1530	1545	1500	1500	1545	1545							
SITE NO	1	1	1	1	1	5	5	5	5	4	4	4	5	5	5	5
HORN HT FT	4.66	4.66	4.66	2.46	1.92	4.75	4.75	6.66	6.66	4.5	5.4	6.6	4.5	5.9	4.6	4.20
NOTES																
37	—	—				30.0	29.5	29.1	30	30	30.0	30.6	30	30	30	30
36						31.0	31.5	29.5	29.0	29.2	31.5	28.6	31.4	31.0	30.4	31.6
35						31.2	31.1	26.1	27.3	24.5	31.2	27.7	32.9	31.0	29.6	31.9
34						30.6	30.6	27.8	28.4	28.5	31.0	27.3	32.7	30.5	28.1	31.1
33						30.7	30.0	30.4	31.7	27.8	31.2	26.1	32.9	26.2	23.7	31.0
32						31.7	30.8	30.8	32.0	27.2	31.9	27.1	32.4	24.5	[illegible]	[illegible]
31						30.3	29.8	29.8	30.6	27.5	32.2	30.6	31.6	28.1	[illegible]	30.1
30						27.6	27.3	28.5	29.4	26.8	31.5	31.4	30	31.3	30.1	27.4
29						27.2	26.0	28.4	19.5	29.8	31.1	31.8	32.5	22.7	32.2	29.4
28	31.3	31.4	32.1	30.6	28.2	29.8	28.8	28.3	29.0	30.8	29.4	31.7	35.1	32.1	31.5	31.2
27	29.1	30.1	30.8	28.5	28.6	30.3	30.0	28.4	30.0	32.8	27.2	31.7	36.2	32.2	29.5	33.3
26	29.3	29.8	30.2	28.8	28.5	29.7	30.2	30.8	31.9	34.1	25.2	29.8	32.0	30.4	15.5	31.4
25	30.9	31.1	31.4	29.0	27.6	31.6	31.4	31.0	31.7	34.4	26.6	29.2	32.0	27.6	15.4	34.5
24	31.4	31.6	32.1	30.0	26.5	31.8	31.4	28.8	29.8	34.4	28.1	31.6	34.3	23.6	25.9	34.1
23	31.0	30.1	31.7	29.4	26.5	30.3	30.5	26.5	26.6	33.1	30.5	22.2	34.3	32.0	30.7	31.9
22	31.1	30.8	31.3	27.3	26.8	29.8	28.8	28.1	29.2	34.3	32.1	26.9	31.8	33.1	32.1	27.2
21	30.2	30.5	30.1	27.4	27.6	27.3	28.0	28.3	28.9	34.3	32.9	29.2	28.6	30	32.6	33.0
20	27.8	31.2	30.6	32.1	28.5	28.9	28.9		31.8	33.1	33.5	31.8	31.6	30	30.5	33.5
19	29.6	29.5	30.3	31.6	28.6	31.0	30.0		30.1	32.0	33.6	32.2	33.5	29.4	28.5	31.6
18	30.2	30.8	31.5	24.6	28.7	31.1	30.4		24.9	30.3	33.6	33.0	34.5	24.9	25.0	33.2
17	31.9	32.5	32.9	27.6	28.3	27.8	27.4		31.9	27.7	31.9	33.1	34.9	29.1	30.7	34.4
16	32.2	33.5	33.1	33.5	28.2	28.3	28.1		31.4	28.2	31.0	33.1	35.3	22.0	23.2	35.[illegible]
15	28.7	29.2	29.9	34.0	21.6	30.1	29.2		28.3	28.2	31.3	33.7	30.2	22.1	28.4	[illegible]
14	25.6	26.3	26.6	28.8	27.1	31.0	29.7		25.9	28.8	29.0	32.1	35.1	31.6	32.2	33.4
13	28.4	29.0	29.4	18.4	27.0	30.2	30.1		32.1	30.1	23.5	28.8	33.2	33.3	33.3	31.9
12	32.2	32.8	33.5	33.2	27.7	28.4	27.3		32.1	32.2	24.9	25.4	29.9	33.3	32.6	26.4
11	34.1	34.8	33.0	35.0	24.3	27.8	26.7	33.2		34.4	21.4	24.8	21.8	31.8	30.5	17.6
10	34.5	34.8	35.8	31.7	30.4	21.8	27.0	32.2		34.6	21.8	25.8	23.9	28.3	26.0	26.4
9	31.5	34.7	32.8	14.9	31.7	29.2	28.9	30.2		36.1	30.8	28.8	15.2	23.8	26.0	[illegible]
8	25.9	26.2	21.9	32.4	31.6	30.9	30.8	22.2		34.3	29.4	25.1	27.2	26.3	21.5	32.6
7	22.1	21.8	21.4	36.2	32.4	32.1	31.9	25.0		33.1	30.2	24.8	21.3	24.7	26.6	31.1
6	32.4	32.7	32.2	34.1	32.4	34.0	33.2	30.3		35.3	30.6	29.7	30.1	33.0	30.0	33.2
5	35.2	36.0	36.1	23.2	31.7	33.4	33.4	33.2		35.8	32.2	31.4	32.1	33.0	31.4	35.5
4	35.0	35.7	36.1	28.2	29.5	30.9	31.4	32.1						33.6	31.1	31.6
3	33.2	34.2	35.3	31.5	26.7										31.3	33.1
2	31.5	32.8	33.5	31.9	24.3											
1																

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TEST DATA ON STATIC LOBING
FIELD STRENGTH VERSUS PROBE HEIGHT WITH HORN RADIATOR

TEST NO	238	239	242B	242B	243
DATE (1960)	8/26	8/26	7/27	7/27	7/27
HOUR			1000	1100	1330
SITE NO	2	4	5	5	5
HORN HT, FT	5.9	5.9	4.4	4.4	4.4
NOTES					
37	30	30	30	30	30
36	29.2	31.5	29.5	30.4	30.2
35	27.8	32.8	30.2	31.2	31.4
34	24.8	33.2	30.2	30.8	31.2
33	19.0	33.5	30.2	30.8	31.6
32	19.3	34.2	30.4	31.0	31.4
31	23.9	33.4	29.4	30.5	30.2
30	26.0	33.1	28.7	30.1	30.7
29	28.4	31.4	29.6	31.3	32.0
28	29.1	28.1	31.8	32.5	33.4
27	29.8	22.0	31.8	33	32.9
26	29.0	11.7	31.8	33	33.1
25	21.6	24.8	31.1	32.1	32.6
24	22.1	29.1	30.9	32.1	32.3
23	23.6	30.8	29.6	30.7	31.0
22	16.7	32.7	28.3	29.8	24.5
21	12.6	33.9	28.6	29.8	30.6
20	22.9	34.4	30.0	31.2	32.0
19	26.5	33.2	31.4	32.5	33.1
18	28.8	33.4	31.4	32.8	32.9
17	30.0	32.5	30.1	31.5	30.9
16	30.0	31.8	28.4	29.8	30.1
15	29.0	30.8	29.3	30.2	31.5
14	27.2	27.1	30.3	30.9	31.8
13	25.3	21.4	30.3	31.3	32.2
12	23.0	20.2	30	31.3	31.6
11	17.8	24.5	29.1	29.9	30.5
10	11.5	27.2	28.3	29.5	31.5
9	20.8	31.6	29.1	30.1	32.2
8	24.1	29.0	29.2	31.3	32.8
7	27.0	30.5	30.7	32.5	34.2
6	27.9	31.5	32.9	34	34.8
5	27.9	33.0	32.9	33.2	34.7
4	28.7	35.5	31.8	33.2	33.5
3	28.8	36.8			
2					
1					

TEST DATA ON DYNAMIC LOBING

PEAK-OF-BEAM FIELD STRENGTH VERSUS PROBE HEIGHT WITH SCANNING BEAM

TEST NO	16	72B	33B	38	138	148	158	171	183	206	209	218
DATE (1960)	6/18	7/7	7/1	7/11	7/13	7/12	7/12	7/13	7/13	7/13	7/22	8/8
HOUR	1566	1331										
SITE NO	1	2	5	6	7	8	9	2	5	4	1	5
REL AZ DEG	[illegible]	0	0	0	0	1.5	0.75	0	0	0	0	0
NOTES		[illegible]	M	G	G	[illegible]	G	G	S	T		
38				27.1	25.5	24.8	26.4			30.3	32.5	
37				25.7				34.2	35.2		32.5	30
36				25.7	24.5	29.7	26.2	34.0	34.9	28.4	32.5	34.1
35				25.9							32.5	29.1
34				26.1	24.8	36.8	27.1	33.8	34.3	28.3	32.5	30.1
33				25.5							32.5	30.6
32				26.4	25.1	31.5	26.1	33.2	34.2	29.1	32.5	33.3
31				26.6								32.0
30				25.8	25.1	30.6	28.1	33.0	34.2	29.7		31.4
29				25.9								29.9
28		26.3	25.5	26.2	25.5	31.2	29.1	33.1	35.1	29.5		30.7
27	35.7	26.7	22.4	26.2								31.8
26		18.8	22.8	25.7	26.7	30.0	28.5	34.3	34.8	29.9		33.5
25	35.4	19.6	23.3	25.3								35.1
24		18.8	23.4	25.5	26.2	28.9	28.3	34.6	34.9	30.2		34.4
23	37.7	18.9	23.5	25.4								32.6
22		19.2	23.7	25.7	26.9	27.4	27.7	34.5	34.8	29.4		31.1
21	38.2	18.3	24.1	25.1								27.7
20		17.6	24.0	25.5	28.2	26.8	27.9	30.4	34.9	30.0		28.1
19	38.5	17.5	23.2	26.3								31.6
18		18.0	24.4	26.4	29.4	26.4	27.7	35.6	35.2	30.4		32.6
17	38.4	17.3	23.6	26.4								32.0
16		18.1	23.1	26.4	27.5	26.2	27.9	34.6	34.6	31.0		32.0
15	40.1	18.6	23.8	27.1								33.4
14		18.7	23.9	27.2	26.6	24.1	27.3	35.0	35.5	30.3		34.8
13	39.7	19.1	24.1	27.7								32.8
12		19.1	23.4	21.9	28.4	24.8	27.7	35.5	35.9	31.7		30.0
11	40.3	18.7	22.1	27.5								32.3
10		26.0	23.1	26.9	28.4	21.7	27.6	35.7	35.6	32.0		24.2
9	41.4	19.2	24.1	26.4								29.3
8		26.0	24.6	26.0	32.7	21.3	26.6	37.0	35.8	31.4		31.6
7	39.7	18.0	24.9	28.[illegible]								34.2
6		18.3	25.6	24.3	33.4	20.9	26.0	37.2	37.5	31.3		33.9
5		22.2	25.7	30.5								33.9
4		24.8	35.4	30.8	27.7	23.6	25.0	37.5	37.8	33.9		
3		25.0	24.8	30.8								
2		22.6	23.6									
1												

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	1		2				3				4					
DATE (1960)	6/[illegible]		6/[illegible]				6/[illegible]				6/[illegible]					
HOUR											1150					
SITE NO	1		1				1				1					
REL AZ DEG	0		0				0				0					
O-DEG COUNT	66															
PROBE HT FT	37		37				37				37					
NOTES			A				A				A					
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	1.12	16.2	.02	12.9	2.12	26.1	.14	7.3	2.34	1.2	1164	8.2	263	11.2		
	1.16	16.6	.16	12.0	2.16	24.4	.22	16.1	3.42	1.9	1180	9.3	2[illegible]	[illegible]		
	1.20	16.6	.18	11.0	2.20	22.9	.30	12.3	[illegible]	4.9	1172	11.6	112	3[illegible]		
	1.24	17.3	.26	10.4	2.24	21.3	.38	14.3	4.08	3.2	1152	12.7	134	34.0		
	1.28	18.2	.34	9.2	2.28	18.7	.46	[illegible]	4.16	7.5	1136	12.6	176	38.5		
	1.32	19.5	.42	9.1	2.32	11.3	1.04	11.1	4.24	7.1	1120	11.9	168	35.0		
	1.36	21.0	.50	7.0	2.36	15.5	1.12	17.5	4.32	3.7	1104	16.7	160	36.3		
	1.40	[illegible]	.58	4.3	2.40	15.3	1.20	18.1	4.40	4.1	1088	16.1	152	34		
	[illegible]	23.2	.66	3.7	2.44	14.1	1.28	[illegible]	4.48	2.0	10[illegible]	11.3	144	31.6		
	1.48	[illegible]	.74	3.1	2.48	14.7	1.36	[illegible]			1024	12.4	[illegible]	[illegible]		
	1.52	26.1	.82	11.4	2.52	13.2	1.44	27.5			992	14	[illegible]	[illegible]		
	1.56	27.0	.90	13.1	2.56	13.2	1.52	29.1			960	13.4	12[illegible]	[illegible]		
	1.60	27.7	.98	16.2	2.60	14.3	1.60	31.0			928	[illegible]	[illegible]	[illegible]		
	1.64	29.1	1.06	1.4	2.66	14.2	1.68	31.6			896	13.3	[illegible]	14.4		
	1.68	29.3	1.10	17.1	2.70	13.2	1.76	32.6			864	11.9	4	[illegible]		
	1.72	29.2	1.14	18.2	2.74	12.2	1.84	33.0			832	[illegible]	[illegible]	[illegible]		
	1.76	30.1	1.18	18.3	2.78	11.8	1.92	34.6			800	14.4	[illegible]	17.0		
	1.80	30.0	1.22	18.0	2.82	10.0	2.0	36.3			768	[illegible]	12	16.6		
	1.84	30.1	1.26	19.3	2.86	2.1	[illegible]	23.5			736	6.7	[illegible]	[illegible]		
	1.88	29.9	1.30	20.5	2.90	1.7	[illegible]	20.3			704	7.3	56	14.1		
	1.92	29.1	1.34	21.8	2.94	6.3	2.24	13.4			672	2.7	48	14.2		
	1.96	29.4	1.36	23.8	2.98	5.9	2.32	15.1			640	6.7	40	15.1		
	2.00	28.9	1.40	24.2	3.02	4.7	2.40	14.7			608	5.8	32	18.0		
	2.04	25.3	1.44	26.8	3.06	3.6	2.48	[illegible]			576	2.9	24	18.4		
	2.08	27.3	1.48	21.2	3.10	3.2	2.56	14.3			544	[illegible]	[illegible]	1[illegible]		
	2.12	26.1	1.52	27.3	3.14	3.2	2.64	14.1			512	6.7	8	[illegible]		
	2.16	24.1	1.56	30.0	3.18	3.3	2.72	13.2			496	3.3	4	2[illegible]		
	2.20	23.5	1.60	29.9	3.22	4.6	2.80	1.7			18[illegible]	6.7	2	26.1		
	2.24	21.7	1.64	31.0	3.26	5.2	2.88	4.6			448	16.1				
	2.28	20.1	1.68	31.3	3.34	7.2	2.96	1.3			416	13.4				
	2.32	18.1	1.72	31.2	3.42	7.5	3.04	6.2			384	13.8				
	2.36	15.9	1.76	31.3	3.50	7.3	3.12	3.6			352	14.4				
	2.40	14.1	1.80	31.8	3.58	5.9	3.20	4.9			320	16.5				
	2.44	15.9	1.84	31.3	3.66	3.4	3.28	2.3			288	22.9				
	2.48	13.4	1.88	31.2	3.74	2.5	3.36	7.8			256	18.0				
	2.52	13.4	1.92	31.1	3.82	2.2	3.44	8.6			248	17.1				
			1.96	30.1			3.52	7.3			2[illegible]	23.1				
			2.00	29.3			3.60	6.7			23[illegible]	2[illegible]				
			2.04	25.1			3.68	4.3			224	32.2				
			2.08	2[illegible]			3.76	2.3			216	35.0				

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	5				6						7					
DATE (1960)	6/7				6/8						6/8					
HOUR	1600				1??						1310					
SITE NO	1				1						1					
REL AZ DEG	0				0						0					
0-DEG COUNT																
PROBE HT FT	14				27						35					
NOTES	A.B.C				A.B.E						A.B.E					
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	628	8.4	104	40.2	.04	18.3	2.56	18.7	5.60	-2.0	.4	10.5	2.56	21.6	5.76	5.6
	612	6.4	96	38.6	.16	18.2	2.64	20.1			.20	12.6	2.64	22.1	5.84	6.5
	578	0	88	36.9	.48	14.7	2.72	20.2			.36	14.5	2.72	21.2	5.92	7.9
	582	6.2	80	34.1	.64	17.1	2.80	20.6			.52	17.5	2.80	20.2	6.00	8.2
	548	0	72	31.2	.80	13.5	2.88	20.2			.68	19.2	2.88	18.3	6.08	8.3
	532	0	64	27.5	.96	13.0	2.96	11.0			.88	17.6	2.16	6.6	6.16	8.4
	536	0	56	11.7	1.12	2.1	3.04	11.6			.76	13.1	3.04	14.8	6.24	7.7
	520	0	48	0	1.20	17.5	3.12	14.8			1.04	13.7	3.08	12.1		
	504	.4	40	26.1	1.28	24.4	3.20	12.0			1.12	22.9	3.16	12.4		
	488	0	32	25.2	1.32	26.6	3.28	11.5			1.20	28.1	3.08	3.8		
	412	0	24	24.0	1.36	28.7	3.36	12.3			1.28	31.4	3.16	14.4		
	456	5.6	16	31.1	1.40	30.5	3.44	12.1			1.32	32.3	3.24	4.1		
	440	6.3	8	31.8	1.44	32.6	3.52	12.6			1.36	33.4	3.32	3.8		
	424	6.8	4	33.5	1.48	33.1	3.60	12.3			1.40	34.4	3.40	3.1		
	408	6	2	33.5	1.52	34.7	3.68	11.9			1.44	35.6	3.48	12.8		
	392	5.2			1.56	35.1	3.76	11.6			1.48	36.4	3.56	2.5		
	376	11.8			1.60	31.7	3.84	11.5			1.52	36.8	3.64	2.8		
	360	14.3			1.64	36.6	3.92	11.4			1.56	31.4	3.72	2.4		
	344	14.7			1.68	36.9	4.0	11.9			1.60	31.5	3.80	3.5		
	328	15.1			1.72	32.6	4.08	11.6			1.64	31.1	3.88	12.1		
	312	13.2			1.76	31.6	4.12	11.8			1.68	31.3	4.00	2.4		
	216	13.9			1.80	31.1	4.2	11.1			1.72	31.3	4.14	1.3		
	280	16.0			1.84	31.1	4.28	10.2			1.76	31.1	4.22	1.0		
	264	15.6			1.88	32.3	4.36	3.8			1.80	31.3	4.30	7.0		
	248	13.6			1.92	36.5	4.44	6.3			1.84	36.7	4.38	3.1		
	232	16.9			1.96	35.8	4.48	5.1			1.88	36.5	4.46	1.0		
	216	22.0			2.00	35.7	4.56	3.5			1.92	35.0	4.54	0		
	200	24.0			2.04	34.6	4.64	0			1.96	34.9	4.62	0		
	284	23.8			2.08	35.6	4.72	-2.0			2.00	33.5	4.70	2.1		
	192	22.5			2.12	32.4	4.80	-2.1			2.04	32.2	4.78	4.5		
	184	19.5			2.16	31.1	4.88	0			2.08	30.7	4.86	6.7		
	176	21.1			2.20	30.0	4.96	2.8			2.12	28.5	4.44	7.2		
	168	26.7			2.24	27.8	5.04	3.9			2.16	26.1	5.12	8.0		
	160	31.5			2.28	25.6	5.12	5.0			2.20	24.1	5.20	8.6		
	152	34.9			2.32	23.3	5.20	5.0			2.24	20.7	5.28	7.7		
	144	31.6			2.36	19.8	5.28	4.0			2.28	17.5	5.36	6.3		
	136	38.9			2.40	16.5	5.36	3.0			2.32	14.2	5.44	4.9		
	128	40.3			2.44	15.6	5.44	0.8			2.36	15.0	5.52	4.9		
	120	39.9			2.48	5.7	5.52	-0.6			2.40	17.5	5.60	3.2		
	112	40.1			2.52	17.2	5.60	-2.1			2.48	20.8	5.68	4.8		

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	8				9						22					
DATE (1960)	6/18				6/18						6/16					
HOUR	1435				1432						1216					
SITE NO	1				1						2					
REL AZ DEG	6				6						6					
0-DEG COUNT											65					
PROBE HT FT	23				21						21					
NOTES	Run				Run						[illegible]					
	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB
	.16	26.4	2.16	22.0	.08	22.2	.40	33.8	.6	2.1	.16	12.5	[illegible]	13.1	[illegible]	
	.32	17.9	2.24	22.0	.64	16.9	.48	33.3	.68	4.8	.32	13.7	2.56	[illegible]	2.76	[illegible]
	.48	19.1	72	21.0	.68	17.6	2.56	22.1	.76	[illegible]	.56	17.3	2.64	18	2.92	[illegible]
	.64	17.2	80	19.3	.76	17.3	.64	32.5	.84	5.8	.72	11.6	2.72	26.4	[illegible]	[illegible]
	.80	16.1	88	17.1	.84	18.6	.72	17.4	[illegible]	7	.88	17.1	2.8	[illegible]	[illegible]	[illegible]
	.88	2	96	14.7	.48	19.3	.80	17.7	6.00	[illegible]	1.04	12.3	2.88	31.3	[illegible]	5.3
	.96	12.9	3.04	13.5	.64	18.5	.88	13.4	.08	3.6	1.12	10.3	2.96	30.8	6.24	6
	1.04	24.6	12	13.1	.80	6.6	.96	13.8	.16	4.0	1.20	8.7	3.04	9.4	[illegible]	[illegible]
	1.12	29.3	20	13.6	.88	16.5	3.04	14.8			1.28	12.8	3.12	[illegible]	[illegible]	[illegible]
	1.16	31.8	28	13.3	.96	23.9	.12	15.5			1.36	24.1	[illegible]	16.1	[illegible]	[illegible]
	1.20	33.3	36	14.0	1.00	28.7	.20	15.1			1.40	33.5	3.28	14.1	[illegible]	[illegible]
	1.24	34.7	44	13.5	.04	30.4	.28	15.2			1.44	[illegible]	3.36	[illegible]	[illegible]	[illegible]
	1.28	35.7	52	12.6	.08	32.4	.36	14.3			1.48	29.5	3.44	[illegible]	[illegible]	[illegible]
	1.32	36.6	60	12.1	.12	34.0	.44	14.4			1.52	32.1	3.52	[illegible]	[illegible]	[illegible]
	1.36	37.3	68	12.1	.16	35.8	3.52	12.5			1.56	32.5	3.60	[illegible]	[illegible]	[illegible]
	1.40	37.6	76	12.2	.20	36.8	.60	13.0			1.60	34.3	3.68	[illegible]	[illegible]	[illegible]
	1.44	37.8	84	12.8	.24	32.5	3.68	12.5			1.64	[illegible]	3.76	[illegible]	[illegible]	[illegible]
	1.48	38.3	92	12.9	1.28	38.1	.76	13.5			[illegible]	36.1	3.84	[illegible]	[illegible]	[illegible]
	1.52	38.3	4.00	12.6	.32	39.1	3.84	13.1			1.72	36.7	3.92	[illegible]	7.76	3.2
	1.56	38.5	4.08	12.0	.36	34.6	.92	13.0			1.76	31.3	4.00	[illegible]	7.84	3.6
	1.60	38.4	16	10.3	.40	39.7	4.00	12.6			1.80	37.8	[illegible]	[illegible]	[illegible]	3.1
	1.64	38.6	24	9.2	.44	39.4	.08	11.4			1.84	31.1	[illegible]	1.9	[illegible]	4
	1.68	38.1	32	6.1	.48	39.6	.16	8.8			1.88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.72	38.0	4.40	4.1	.52	31.8	.24	[illegible]			1.92	[illegible]	[illegible]	[illegible]	[illegible]	7.3
	1.76	37.6	4.48	1.6	.56	[illegible]	.32	[illegible]			[illegible]	31.6	[illegible]	[illegible]	[illegible]	[illegible]
	1.80	36.7	4.56	0	1.60	37.3	.40	0			2.00	31.6	[illegible]	[illegible]	[illegible]	
	1.84	36.4	4.64	0	.64	39.1	4.48	0			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.88	34.8	4.72	0.3	.68	38.3	.56	6.6			2.08	36.9	[illegible]	4.1	[illegible]	2.1
	1.92	34.3	4.80	1.8	.72	38.1	.64	2.8			2.12	36.1	4.72	3.6	8.00	2.7
	1.96	32.3	4.88	3.5	1.76	37.2	.72	5.4			2.16	35.2	4.80	0.3	8.08	[illegible]
	2.00	31.1	4.96	4.3	.80	36.5	.80	7.7			2.20	33.8	4.88	2	8.16	11.0
	2.04	28.8	5.04	4.3	.84	34.7	.88	8.5			2.24	32.0	4.96	0.5	8.24	7.1
	2.08	26.3	5.12	3.9	1.88	33.0	.96	7.6			2.28	31.4	5.04	2.1	8.32	8.5
	2.12	23.4			1.92	31.5	5.04	6.0			2.32	30.0	5.12	4.4	8.40	8.6
	2.16	21.0			.96	29.6	5.12	2.2			2.36	27.2	5.20	5.3	8.48	7.9
	2.20	17.8			2.00	26.8	.20	0			2.40	24.4	5.28	5.8	8.56	8.4
	2.24	16.6			2.08	20.7	.28	0			2.44	22	5.36	5.5	8.64	9
	2.32	19.4			.16	17.4	.36	0			2.48	19.0	5.44	4.2	8.72	10.0
	2.40	22.1			.24	20.1	.44	0			2.52	16.8	5.52	3.1	8.80	11.1
	2.48	23.0			.32	22.8	5.52	0			2.54	15.8	5.60	.2	8.88	16

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	23				24				25					26		
DATE (1960)	6/10				6/16				6/16					6/16		
HOUR	0935				1035				1052					1110		
SITE NO	1				1				1					1		
REL AZ DEG	0				0				0					0		
0-DEG COUNT																
PROBE HT FT	25				23				21					17		
NOTES	BDL				BDL				BDE					BDE		
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	[illegible]	17.9	2.64	19.6	.91	12.4	[illegible]	13.6	[illegible]	13.8	3.24	19.1	.24	1.1	2.88	11.8
	.24	13.8	2.1	20.3	[illegible]	11.7	2.3	14.4	.8	15.8	3.26	14.6	.08	7.7	3.04	11.1
	.40	4.7	[illegible]	21.1	.24	12.1	2.40	16.1	.16	16.0	2.36	21	.16	1.0	3.26	11.4
	.12	[illegible]	[illegible]	20.1	.28	11.1	2.48	19.2	.3	16.1	3.52	11.1	.24	0	3.52	8.1
	.64	13.1	2.96	18.5	.16	12.6	2.56	20.3	.40	16.7	3.68	9.1	.32	[illegible]	3.84	8.0
	.56	1.7	3.04	16.6	.32	12.9	2.64	20.4	.24	16.3	3.84	9.1	.40	6.8	4.16	3.8
	.96	1.44	3.12	15.6	.48	13.5	2.72	19.6	.72	16.1	4.00	9.6	.48	[illegible]	4.32	0
	1.12	[illegible]	3.20	13.4	.64	17.3	2.88	17.0	.80	12.0	[illegible]	8.0	.56	8.4	4.48	0
	[illegible]	34.7	2.36	13.1	.72	12.5	3.04	13.3	.88	3.9	4.32	4.4	.64	2.8	4.80	3.4
	[illegible]	[illegible]	3.44	13.6	.76	16.7	3.20	12.5	.96	16.1	4.48	1.2	.72	0	4.96	3.7
	[illegible]	[illegible]	3.52	13.4	.80	16.0	3.36	13.1	1.04	22.9	4.64	1.3	.80	4.8	5.12	0.1
	1.40	[illegible]	3.60	12.2	.84	14.1	3.52	13.2	1.12	27.6	4.80	3.7	.88	16.5	5.28	0
	1.44	32.4	[illegible]	11.2	.88	14.1	3.68	10.2	1.20	31.4	4.96	4.9	.96	23.1	5.44	0
	1.48	[illegible]	3.84	9.2	.16	7.5	3.84	10.1	1.28	33.1	5.12	3.8	1.04	27.5	5.60	0
	[illegible]	[illegible]	4.00	8.8	1.04	12.4	4.00	10.3	1.36	35.3	5.44	0.5	1.13	30.7	5.76	1.5
	1.56	[illegible]	[illegible]	9.2	1.12	31.0	4.16	10.1	1.10	36.3	5.76	3.5	1.20	34.3	6.08	3.0
	[illegible]	[illegible]	[illegible]	1.4	[illegible]	[illegible]	[illegible]	7.1	1.14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	.49	1.24	[illegible]	1.48	[illegible]	1.48	31.3	6.40	2.6	1.28	34.1	6.72	0
	[illegible]	27.1	[illegible]	0	1.28	34.8	4.64	0	[illegible]	[illegible]	6.72	2.3	1.32	34.4	7.04	2.3
	[illegible]	31.3	4.1	[illegible]	1.32	31.6	4.80	1.8	1.56	31.4	1.04	2.0	1.36	[illegible]	7.36	1.6
	[illegible]	32.2	[illegible]	0	1.36	32.1	5.12	6.7	1.60	31.3	1.12	.29	1.40	[illegible]	7.52	1.9
	[illegible]	[illegible]	4.8	0	1.40	33.6	5.44	2.4	1.64	31.3	7.20	5.1	1.44	35.9	7.68	1.2
	1.32	37.3	4.16	0.4	1.44	34.1	5.60	0	1.68	31.5	7.28	7.8	1.48	35.1	7.84	7.4
	1.88	31.0	[illegible]	2.8	1.48	35.4	5.76	1.1	1.72	31.4	7.36	9.6	1.52	35.3	8.00	5.1
	1.92	36.3	5.28	1.8	1.52	35.7	6.08	4.6	1.76	36.3	7.44	9.9	1.56	35.4	8.32	8.1
	1.96	33.6	5.44	0	1.56	36.1	6.40	4.8	1.80	35.5	7.52	11.2	1.60	35.2	8.64	9.7
	2.00	34.8	5.71	0	1.60	36.4	6.72	7.5	1.84	34.4	7.60	12.1	1.64	34.6	8.96	9.9
	2.04	34.8	6.08	0	1.64	36.4	7.04	5.1	1.92	32.2	7.68	11.6	1.68	33.8	9.28	8.3
	[illegible]	33.6			1.68	36.7	7.20	5.7	2.00	24.8	7.84	9.9	1.16	32.1	9.60	8.2
	[illegible]	32.3			1.72	36.6	7.52	11.2	2.08	24.9	8.00	7.8	1.84	29.1	9.92	8.1
	2.16	31.4			1.76	36.5	7.68	11.9	2.16	18.5	8.16	7.7	1.92	26.2	10.24	8.0
	2.20	29.5			1.80	36.1	7.84	11.4	2.24	14.4	8.32	8.0	2.00	21.1	10.56	6.1
	2.24	27.8			1.84	35.7	8.16	7.2	2.32	18.2	8.48	9.4	2.08	14.3	10.88	6.2
	[illegible]	25.7			1.88	35.0	8.32	7.6	2.40	20.9	8.64	10.8	2.16	14.4	11.20	7.1
	2.32	23.1			1.92	33.9	8.64	10.7	2.48	21.3	8.96	10.6	2.24	17.6	11.52	5.2
	2.36	19.4			1.96	32.8	8.96	11.6	2.56	21.2	9.28	10.6	2.32	18.9		
	2.40	16.1			2.00	31.9	9.29	11.0	2.64	21.0	9.60	10.6	2.40	19.1		
	2.44	14.0			2.08	28.8			2.72	19.3	9.92	8.7	2.48	18.8		
	2.48	14.0			2.16	25.4			2.80	18.6			2.56	18.3		
	2.52	15.9			2.24	19.2			2.88	16.7			2.72	14.6		

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

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TEST NO	27						28						29			
DATE (1960)	6/16						6/						6/			
HOUR	1130						1131						1?21			
SITE NO	1						1						1			
REL AZ DEG	0						0									
O-DEG COUNT																
PROBE HT FT	11						12						13			
NOTES	ADE						ADE						A.D.			
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.04	36.1	2.88	13.2	10.76	.6	.01	21.7	2.96	15.6	10.56	3.3	.01	30.0	[illegible]	7.5
	.08	36.5	3.04	13.6	10.56	3.4	.02	21.8	2.72	15.7	10.48	12.1	.02	30.1	2.31	6.5
	.16	31.3	3.20	12.9	1.08	5.6	.04	21.6	2.88	16.5	11.21	10.0	.04	30.5	3.32	7.7
	.24	31.2	3.36	9.8	1.64	1.7	.13	26.4	3.04	16.4	11.52	9.7	.08	30.0	3.68	2.1
	.32	26.6	3.5	9.6	11.2	7.3	.16	17.1	3.20	14.2	11.84	9.7	.16	28.2	3.84	4.4
	.40	26.8	3.68	10.3	11.52	6.1	.24	13.4	3.36	12.5	12.16	5.6	.24	26.4	4.00	0
	.48	26.5	3.84	10.4	11.84	2.5	.32	15.1	3.52	11.3	12.48	1.4	.32	24.4	4.16	0
	.56	18.4	4.0	9.2	12.16	4.7	.40	15.1	3.68	11.8	12.80	6.6	.40	17.1	4.48	2.3
	.64	13.5	4.16	6.4	12.48	0	.48	16.8	3.84	10.0	13.12	10.1	.48	12.0	4.64	0
	.72	7.8	4.32	3.6	12.80	1.0	.56	11.1	4.00	6.4	13.44	7.7	.52	3.9	4.80	0
	.80	19.9	4.48	5.1	13.12	4.8	.64	22.1	4.16	3.4	13.16	1.3	.56	12.1	5.12	0
	.88	35.1	4.64	6.7	13.44	5.1	.72	26.0	4.32	3.7	14.08	6.4	.64	32.5	5.44	1
	.96	36.1	4.80	6.6	13.76	6.8	.80	30.2	4.48	2.2	14.40	8.8	.72	38.4	5.76	0
	1.04	32.5	1.16	2.6	14.08	6.8	.88	33.4	4.64	6.6	14.72	5.7	.80	3.2	6.08	0
	1.12	34.7	5.12	0	14.40	6.8	.96	36.0	4.80	10.0	15.04	7.3	.88	34.1	6.24	3.6
	1.20	36.1	5.28	0	14.72	4.0	1.04	36.0	4.96	6.1	15.36	6.1	.12	35.3	[illegible]	4.1
	1.28	37.2	5.44	3.0	15.04	0.2	1.08	37.4	5.12	[illegible]	15.68	2.1	1.0	38.0	[illegible]	[illegible]
	1.32	37.1	5.60	3.4			1.12	39.[illegible]	5.28	1.3	16.0	2	1.1	36.8	[illegible]	[illegible]
	1.36	37.[illegible]	5.76	3.3			1.16	38.2	5.44	6.[illegible]	16.[illegible]	1.8	1.04	31.0	[illegible]	4.1
	1.40	37.3	5.92	3.3			1.20	38.2	5.60	1.3	16.64	2.1	1.08	34.1	1.28	8.0
	1.44	33.3	6.08	3.6			1.24	35.4	5.76	[illegible]	16.96	2.1	1.12	37.0	1.36	7.6
	1.48	37.0	6.40	7.4			1.28	38.4	5.92	1.4	11.20	5.6	1.16	31.1	1.52	3.3
	1.52	36.1	6.56	8.1			1.32	38.4	6.08	8.1	12.[illegible]	5.8	1.20	31.1	1.68	3
	1.56	36.0	6.72	7.2			1.36	38.4	6.24	7.6	17.60	4.0	[illegible]	[illegible]	1.84	2
	1.60	34.7	6.88	6.1			1.40	37.8	6.40	1.8	17.92	0	1.32	34.9	[illegible]	3
	1.68	32.5	7.04	7.4			1.44	32.2	6.56	1.2	18.24	2.0	1.32	32.5	8.16	1.4
	1.76	29.9	7.20	10.3			1.48	36.5	6.72	8.8	18.56	.8	1.36	35.8	8.32	2.5
	1.84	26.5	7.36	12.1			1.52	36.2	7.04	14.4	18.88	0	1.44	34.7	8.48	1.6
	1.92	26.0	7.52	11.7			1.60	35.5	7.20	15.4			1.52	33.1	8.64	1.6
	2.00	22.8	7.68	9.6			1.68	30.2	7.36	15.2			1.60	22.0	8.80	1.6
	2.04	12.7	7.84	7.3			1.76	26.1	7.52	15.1			1.68	25.4	8.96	1.8
	2.08	15.7	8.00	7.8			1.84	20.4	7.68	13.3			1.76	19.2	9.12	7.3
	2.16	18.7	8.16	1.6			1.92	16.8	8.00	11.7			1.84	19.[illegible]	9.28	6.2
	2.24	20.6	8.32	11.5			2.00	20.1	8.32	13.6			1.92	16.4	9.60	3.7
	2.32	20.9	8.48	11.7			2.08	22.2	8.64	13.6			2.00	19.3	9.92	6.7
	2.40	20.7	8.64	12.2			2.16	23.0	8.96	13.2			2.08	20.1	10.24	5.0
	2.48	19.9	8.96	12.2			2.24	22.1	9.28	12.4			2.24	19.0	10.56	6.2
	2.56	18.2	9.28	8.3			2.32	22.0	9.60	12.4			2.40	16.2	10.88	7.9
	2.64	16.7	9.60	8.9			2.40	21.4	9.92	13.1			2.56	12.8	11.20	5.1
	2.72	14.8	9.92	8.3			2.48	19.8	10.24	11.4			2.88	11.7	11.52	3.6

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	29 CONT'D		30						31					
DATE (1960)			/10						[illegible]					
HOUR			[illegible]						[illegible]					
SITE NO			1						1					
REL AZ DEG			[illegible]						0					
0-DEG COUNT														
PROBE HT FT			11						9					
NOTES			ADE						ADE					
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	11.54	2.1	.11	30.1	2.40	11.0	[illegible]	[illegible]	[illegible]	32.0	3.36	12.0	[illegible]	5.7
	[illegible]	0	[illegible]	31.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.1	3.52	[illegible]	[illegible]	[illegible]
	[illegible]	0	[illegible]	32.6	[illegible]	11.3	[illegible]	[illegible]	[illegible]	[illegible]	3.68	8.5	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	30.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.84	7.2	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	2.72	2.3	[illegible]	[illegible]	.16	[illegible]	4.00	6.8	11.43	[illegible]
	[illegible]	[illegible]	.24	31.3	2.88	[illegible]	[illegible]	[illegible]	.24	31.6	4.16	4.0	18.56	0
	13.44	1.2	.32	24.8	3.20	1.3	[illegible]	6.1	.32	31.5	4.32	6.5	19.20	0
	[illegible]	1.6	.40	21.4	3.32	9.2	[illegible]	1.6	.40	31.5	4.48	6.6	19.53	0
	[illegible]	1.0	.48	23.1	3.84	3.4	11.68	2.6	.48	32.1	4.80	6.4	19.64	0.1
	14.12	6.9	.56	22.7	4.00	7.2	11.84	7.5	.56	32.1	5.12	8.0	19.76	1.2
	15.04	2.7	.64	26.4	4.16	4.9	12.00	1.9	.64	31.8	5.44	8.1	19.80	3.4
	15.36	3.0	.72	30.1	4.32	7.5	12.16	3.6	.72	36.3	5.76	10.0	19.84	3.8
	15.68	0	.80	3.9	4.48	8.2	12.32	5.6	.80	36.2	6.08	10.7		
	16.00	0	.84	32.4	4.64	1.0	12.48	6.5	.84	31.6	6.40	8.6		
	16.64	0	.88	33.8	4.80	3.2	12.64	7.4	.88	31.1	6.56	7.8		
	17.28	0	.92	34.4	4.96	6.5	[illegible]	7.6	.92	32.6	6.72	13.1		
			.96	34.1	5.12	0	13.45	5.9	.96	32.5	6.88	13.4		
			1.00	34.9	5.28	0	[illegible]	8.3	1.00	31.2	7.04	15.8		
			1.04	34.9	5.44	4.1	[illegible]	[illegible]	1.04	31.4	7.20	13.4		
			1.08	34.9	5.60	7.1	15.36	0	1.08	31.0	7.36	14.2		
			1.12	35.1	5.76	8.5	16.00	0	1.12	36.3	7.68	13.2		
			1.16	34.6	5.93	9.9	16.32	3.0	1.20	34.6	8.00	14.2		
			1.20	34.3	6.08	10.8	16.64	3.0	1.28	32.4	8.32	14.0		
			1.24	34.2	6.24	9.8	16.96	1.0	1.36	29.5	8.46	11.7		
			1.28	34.0	6.40	8.5	17.28	2.1	1.44	23.8	9.29	11.4		
			1.32	33.0	6.56	9.2	17.60	0	1.52	20.8	9.60	12.2		
			1.36	31.9	6.72	10.6	17.92	0	1.60	17.4	9.92	11.2		
			1.44	28.5	6.88	12.0	18.24	0	1.68	20.1	10.24	10.6		
			[illegible]	25.6	7.04	11.2	18.27	0	1.76	21.5	10.51	10.9		
			1.60	20.0	7.20	11.4			1.84	22.1	10.88	9.4		
			1.68	9.2	7.36	9.3			1.92	22.1	11.20	7.6		
			1.72	7.3	7.69	7.5			2.00	21.9	11.52	8.7		
			1.76	11.8	8.00	11.8			2.08	20.9	11.84	7.5		
			1.84	17.0	8.32	13.2			2.24	18.5	12.16	2.2		
			1.92	18.6	8.64	12.7			2.40	16.2	12.48	7.4		
			2.00	18.3	8.96	11.7			2.56	16.1	12.80	9.6		
			2.08	18.1	9.28	16.3			2.72	14.9	13.12	9.6		
			2.16	16.8	7.60	10.3			2.88	12.7	13.45	10.0		
			2.24	15.5	9.92	7.3			3.04	11.2	14.08	8.9		
			2.32	13.2	10.24	2.7			3.20	11.4	14.72	6.1		

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	32						33						34			
DATE (1960)	6/10						6/10						6/10			
HOUR	1335						1445						1430			
SITE NO	1						1						1			
REL AZ DEG	0						0						0			
0-DEG COUNT																
PROBE HT FT	7						6						5			
NOTES	B.D.E.						B.D.E.						B.D.E.			
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.01	33.5	3.52	6.1	12.48	0	.01	38.4	3.44		10.24	4.4	.01	31.3	3.84	4.0
	.02	33.5	3.84	0	12.80	1.3	.05	38.4	3.52	[illegible]	10.48	7.3	.02	31.8	4.	2.9
	.04	33.3	4.00	0	13.12	5.5	.08	38.4	3.60	1.0	10.56	6.4	.04	37.4	4.16	.4
	.08	33.3	4.16	0	13.44	6.9	.16	37.7	3.68	0.2	10.88	0	.08	31.1	4.50	5.9
	.16	34.7	4.32	0	13.76	2.9	.24	36	3.84	2	11.20	4.4	.16	38.0	5.12	6.3
	.24	32.5	4.48	0	14.08	0	.32	32.6	4.00	3.3	11.52	3.1	.24	31.4	5.28	0
	.32	29.4	4.64	1.7	14.24	0	.40	25.6	4.16	5.4	11.68	0	.32	31.9	5.44	0
	.36	23.4	4.80	3.1	14.40	.5	.44	21.2	4.32	4.9	11.84	4.0	.40	37.6	5.60	5.7
	.40	26.5	4.96	6.7	14.72	4.7	.48	24.0	4.48	5.0	12.00	4.8	.48	37.5	5.76	10.6
	.44	27.1	5.12	10.1	15.04	3.8	.56	31.7	4.64	4.5	12.16	4.1	.56	37.4	5.92	13.4
	.48	22.7	5.28	11.1	15.36	1.1	.64	35.0	4.80	4.7	12.48	1.3	.64	31.7	6.08	14.1
	.56	33.7	5.44	8.5	16.00	4.7	.72	31.5	4.96	3.6	12.80	0.7	.72	38.1	6.24	4.2
	.64	35.7	5.60	3.3	16.64	0	.80	31.8	5.12	5.8	13.12	0	.80	31.9	6.40	12.9
	.72	37.2	5.76	0	17.28	0	.88	35.1	5.28	7.6	13.44	0	.88	32.0	6.56	3.4
	.80	38.1	5.92	1.6	17.12	0	.96	38.1	5.44	4.1	13.76	3.1	.96	35.4	6.72	14.0
	.88	38.5	6.08	4.7			1.04	36.9	5.60	0	14.08	5.3	1.04	35.5	6.88	13.9
	.96	38.4	6.24	4.5			1.12	35.1	5.76	6.0	14.40	0	1.12	30.1	7.04	12.4
	1.04	37.7	6.40	1.4			1.20	32.2	5.92	11.0	14.72	0	1.20	35.3	7.36	11.4
	1.12	36.1	6.56	3.1			1.28	28.6	6.08	12.6	14.88	2.2	1.28	16.5	7.68	12.2
	1.20	33.8	6.72	8.2			1.36	24.1	6.24	11.3	15.04	0.8	1.32	9.9	8.00	14.5
	1.28	31.1	6.88	10.6			1.44	15.8	6.40	7.0	15.36	0	1.34	5.9	8.32	14.6
	1.36	21.0	7.04	11.4			1.52	5.6	6.56	3.5	16.00	0	1.36	9.4	8.64	13.0
	1.44	22.2	7.20	11.9			1.60	14.4	6.72	7.0	16.64	3.3	1.44	11.4	8.96	11.7
	1.52	17.8	7.36	11.9			1.68	17.3	6.88	5.6	16.00	0	1.52	19.8	9.28	10.1
	1.56	17.0	7.52	10.9			1.76	18.8	7.04	0	16.64	2.9	1.60	20.6	9.60	9.7
	1.60	18.2	7.68	10.5			1.84	18.9	7.20	5.2	17.28	0	1.68	20.0	9.92	8.2
	1.68	20.2	8.00	8.7			1.92	18.5	7.36	7.4	17.92	0	1.76	18.6	10.24	2.3
	1.76	21.0	8.32	6.0			2.00	16.8	7.52	3.2	18.57	0	1.84	16.7	10.56	0
	1.84	21.3	8.64	6.0			2.08	15.0	7.68	0	19.20	2.9	1.92	14.6	10.88	6.5
	1.92	21.0	8.96	6.7			2.16	10.9	7.84	0			2.08	11.6	11.04	7.4
	2.00	20.3	9.28	6.7			2.24	6.6	8.00	5.4			2.24	13.3	11.20	6.3
	2.08	19.1	9.60	6.8			2.32	6.8	8.16	8.1			2.40	14.2	11.52	0.9
	2.16	16.8	9.92	7.6			2.40	6.8	8.32	7.2			2.56	12.4	11.60	0
	2.24	14.5	10.24	10.3			2.48	6.9	8.48	7.4			2.72	10.2	11.68	0
	2.32	12.9	10.40	11.8			2.56	6.4	8.64	6.1			2.88	10.0	11.84	6.9
	2.40	12.9	10.56	12.1			2.72	4.6	8.96	0.2			3.04	10.7	12.00	9.0
	2.56	12.9	10.88	9.0			2.88	4.6	9.28	1.0			3.20	10.7	12.16	9.1
	2.72	12.4	11.20	8.9			3.04	7.8	9.60	0.8			3.36	7.1	12.48	10.4
	2.88	9.8	11.52	8.4			3.20	2.7	9.76	0			3.52	4.3	12.80	11.2
	3.20	8.4	12.16	0			3.36	2.2	9.92	0			3.68	4.6	13.12	7.8

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	34	CONT'D	35						36				37		46	
DATE (1960)			6/16						6/16				7/[illegible]		7/[illegible]	
HOUR			1320						1340				[illegible]		[illegible]	
SITE NO			1						1				[illegible]		[illegible]	
REL AT DEG									[illegible]				[illegible]		[illegible]	
0 DEG COUNT																
PROBE HT FT			3						1				25 2		[illegible]	
NOTES			[illegible]						[illegible]				[illegible]		[illegible]	
	DEG	DB	DEG	DB	DEG	DB	DEG	DL	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	13.28	7.0	.01	30.9	7.04	16.[illegible]	17.92	6.8	[illegible]	34.2	7.36	1.6	.08	10.6	.08	12.4
	13.44	7.7	.02	36.5	7.36	17.4			[illegible]	34.9	7.68	12.8	.16	9.6	.16	11.6
	13.76	9.9	.04	37.1	7.68	13.6			.01	35.6	8.00	17.0	.24	8.9	.24	16.4
	14.08	10.9	.08	38.3	8.00	18.9			.08	36.8	8.32	16.1	.32	6.4	.32	7.4
	14.40	4.2	.16	39.9	8.32	18.8			.16	38.9	8.64	13.3	.40	4.2	.40	3.4
	15.36	2.[illegible]	.24	41.4	8.6[illegible]	12.4			.24	4[illegible]	8.96	14.2	.48	2.3	.48	0.6
	16.00	3.9	.32	43.3	8.96	14.5			.32	4[illegible]	9.28	14.[illegible]	.56	2.8	.56	-1.2
	16.32	6.8	.40	43.0	9.28	15.7			.40	41.7	9.60	12.6	.64	4.3	.64	4.1
	16.64	2.5	.48	43.0	9.60	14.4			.48	41.7	9.92	[illegible]	.72	4.8	.72	8.2
	16.96	5.2	.56	43.0	9.92	14.6			.56	44	10.24	13.7	.80	6.7	.80	12.1
	17.28	0	.64	42.4	10.24	14.7			.64	41.7	10.56	13.0	.88	9.5	.88	15.6
	17.60	2.0	.72	[illegible]	10.56	14.7			.72	39.4	10.88	[illegible]	.96	13.4	.96	19.2
	17.92	2.0	.80	39.8	10.88	14.8			.80	38.0	11.20	10.4	1.04	16.1	1.04	26.7
	18.24	0	.88	37.7	11.20	11.7			.88	36.6	11.52	6.0	1.12	18.1	1.12	22.7
	18.56	0	.96	35.9	11.52	7.1			.96	33.6	11.84	5.8	1.20	21.0	1.20	24.4
	18.88	4.7	1.04	32.1	11.68	6.3			1.04	30.3	12.16	10.3	1.28	22.0	1.28	24.4
	19.20	0	1.12	28.0	11.84	8.3			1.12	26.5	12.48	11.3	1.36	23.3	1.36	25.4
			1.20	24.1	12.16	11.6			1.20	24.1	12.80	11.7	1.44	23.4	1.44	25.4
			1.28	24.3	12.48	13.8			1.28	23.9	13.44	13.4	1.52	23.5	1.52	25.0
			1.44	26	12.80	13.8			1.44	22.1	14.08	12.0	1.60	22.2	1.60	23.9
			1.60	26.4	13.12	13.3			1.60	24.4	14.72	9.9	1.68	21.8	1.68	22.3
			1.76	24.4	13.44	14.1			1.76	23.4	15.36	4.1	1.76	19.7	1.76	19.9
			1.92	22.3	13.76	13.5			1.92	21.0	16.00	7.6	1.84	17.5	1.84	18.1
			2.24	19.9	14.08	12.4			2.24	18.3	16.32	7.7	1.92	15.2	1.92	13.7
			2.56	17.4	14.40	12.1			2.56	11.2	16.64	6.0	2.00	13.0	2.00	13.8
			2.88	16.0	14.72	11.6			2.88	15.0	17.28	3.4	2.08	10.0	2.08	11.2
			3.20	13.1	15.04	7.5			3.20	11.9	17.92	4.4	2.16	9.7	2.16	9.5
			3.52	8.8	15.36	5.5			3.52	7.3	18.36	1.8	2.24	6.3	2.24	6.8
			3.84	9.6	15.68	7.6			3.84	8.8	19.20	4.2	2.32	2.4	2.32	4.2
			4.00	10.1	16.00	9.4			4.16	6.5			2.40	0	2.40	1.2
			4.16	9.2	16.32	4.5			4.32	1.9						
			4.48	7.2	16.64	8.2			4.48	3.6						
			4.80	11.6	16.96	6.0			4.80	8.5						
			5.12	12.5	17.28	3.5			5.12	10.5						
			5.44	12.0	17.60	5.0			5.44	11.9						
			5.76	12.8	17.92	6.2			5.76	10.8						
			5.92	11.8	18.24	2.9			6.08	12.3						
			6.08	15.5	18.56	2.9			6.40	16.6						
			6.40	18.5	18.88	7.4			6.72	16.5						
			6.72	18.4	19.20	7.7			7.04	14.6						

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	41		42		43		44		45		46		41		48	
DATE (1960)	7/6		7/6		7/6		7/6		7/6		7/6		7/6		7/6	
HOUR	1630		1640		1655		17[illegible]		1715		1720		172[illegible]		1725	
SITE NO	2		2		2		2		2		2		2		2	
REL AZ DEG	0		0		[illegible]		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	24.5		22.5		20.5		18.[illegible]		17.[illegible]		16.5		15.5		14.5	
NOTES	E.C.1		E.P.H		E.P.H		E.[illegible]		[illegible]		E.C.1		E.P.H		E.[illegible]	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	15.3	.08	17.4	.08	16.9	.8	[illegible]	.8	15.4	.08	15.2	.8	15.3	.08	16.2
	.16	15.4	.16	16.8	.16	[illegible]	.16	22	.16	16.9	.16	16.6	.16	16.6	.16	16.4
	.24	15.6	.24	11	.24	[illegible]	.24	11.1	.24	12.5	.24	12.1	.24	11	.24	12.6
	.32	13.2	.32	[illegible]	.32	[illegible]	.32	12.1	.32	14.0	.32	13.1	.32	13.8	.32	[illegible]
	.40	15	.40	[illegible]	.40	11.1	.40	[illegible]	.40	12	.40	13.2	.40	13.8	.40	[illegible]
	.48	6.1	.48	[illegible]	.48	11.1	.48	[illegible]	.48	[illegible]	.48	11.1	.48	18.1	.48	13.6
	.56	[illegible]	.56	7.6	.56	11.1	.56	[illegible]	.56	[illegible]	.56	19.4	.56	18.1	.56	14.2
	.64	[illegible]	.64	8.1	.64	18.4	.64	[illegible]	.64	20.8	[illegible]	[illegible]	.64	18.1	.64	19.3
	.72	10.0	.72	13.4	.72	[illegible]	.72	21.4	.72	21.1	.72	[illegible]	.72	19.6	.72	19.1
	.80	14.4	.80	[illegible]	.80	[illegible]	.80	[illegible]	.80	21.1	.80	[illegible]	.80	[illegible]	.80	[illegible]
	.88	18.1	.88	21.1	.88	[illegible]	.88	[illegible]	.88	23.3	.88	[illegible]	.88	[illegible]	.88	[illegible]
	.96	20.3	.96	23.1	.96	[illegible]	.96	24.0	.96	23.1	.96	[illegible]	.96	23.2	.96	23.6
	1.04	22.0	1.04	24.1	1.04	25.4	1.04	25.7	1.04	24.5	1.04	[illegible]	1.04	24.1	1.04	24.4
	1.12	23.2	1.12	25.5	1.12	25.4	1.12	25.9	1.12	24.1	1.12	[illegible]	1.12	24.9	1.12	25.5
	1.20	24.2	1.20	26.4	1.20	25.9	1.20	25.4	1.20	25.9	1.20	[illegible]	1.20	24.8	1.20	25.4
	1.28	24.9	1.28	26.5	1.28	25.8	1.28	25.1	1.28	25.1	1.28	[illegible]	1.28	24.5	1.28	24.7
	1.36	23.5	1.36	25.9	1.36	23.[illegible]	1.36	24.4	1.36	24.5	1.36	[illegible]	1.36	22.1	1.36	23.8
	1.44	21.1	1.44	24.3	1.44	24.0	1.44	23.2	1.44	23.2	1.44	21.3	1.44	22.1	1.44	21.8
	1.52	22.4	1.52	22.9	1.52	23.0	1.52	[illegible]	1.52	[illegible]	1.52	20.5	1.52	[illegible]	1.52	18.1
	1.60	22.3	1.60	21.7	1.60	21.1	1.60	17.1	1.60	14.0	1.60	17.1	1.60	18.1	1.60	16.3
	1.68	20.4	1.68	20.3	1.68	8.4	1.68	16.3	1.6[illegible]		1.68	13.1	1.68	[illegible]	1.68	13.6
	1.76	18.6	1.76	17.5	1.76	16.4	1.76	[illegible]	[illegible]	13.3	1.76	12.2	1.76	13.1	1.76	13.2
	1.84	15.0	1.84	15.6	1.84	11.5	1.84	[illegible]	1.84	12.3	1.84	10.7	1.84	10.1	1.84	10.5
	1.92	12.4	1.92	13.1	1.92	[illegible]	1.92	9.7	1.92	8.8	1.92	8.2	1.92	8.5	1.92	8.1
	2.00	12.1	2.00	11.6	2.00	4.9	2.00	6.7	2.00	1.2	2.00	5.4	2.00	6.5	2.00	4.1
	2.08	9.6	2.08	8.8	2.08	6.6	2.08	2.9	2.08	3.0	2.08	2.6	2.08	3.5	2.08	2.6
	2.16	2.4	2.16	6.1	2.16	2.0	2.16	0	2.16	1.0	2.16	-.1	2.16	2.0	2.16	1.4
	2.24	4.1	2.24	2.9	2.24	-2			2.24	3.3	2.24	1.5	2.24	2.5	2.24	0.8
	2.32	2.1	2.32	0.4					2.32	2.8			2.32	1.2		
	2.40	0.5							2.40	0.5						

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	49		50		51		52		53		54		55		56	
DATE (1960)	7/6		7/6		7/6		7/6		7/6		7/6		7/6		7/6	
HOUR	1140						1		1805		1816		1815		1620	
SITE NO	2		2		2		2		2		2		2		2	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	12.5		11.5		10.5		9.5		8.5		6.5		4.5		2.5	
NOTES	EPI		EPI		EPI		EPII		EPI		EPI		EPI		EPII	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	19.3	.08	18.8	.08	18.4	.08	20.6	.08	21.3	.08	21.6	.08	21.7	.08	21.0
	.16	18.5	.16	18.0	.16	18.7	.16	21.6	.16	22.1	.16	21.6	.16	23.4	.16	22.9
	.24	17.5	.24	18.9	.24	18.3	.24	21.8	.24	23.8	.24	23.1	.24	24.2	.24	23.4
	.32	13.8	.32	17.9	.32	18.0	.32	22.4	.32	24.8	.32	24.4	.32	25.0	.32	24.7
	.40	12.4	.40	11.3	.40	18.7	.40	24.3	.40	25.6	.40	25.8	.40	25.6	.40	26.5
	.48	5.5	.48	11.1	.48	17.8	.48	25.1	.48	26.5	.48	26.8	.48	26.4	.48	26.3
	.56	10.1	.56	18.6	.56	26.9	.56	26.2	.56	27.1	.56	27.6	.56	27.2	.56	26.5
	.64	18.6	.64	21.4	.64	22.8	.64	27.5	.64	28.5	.64	28.0	.64	27.1	.64	26.1
	.72	21.9	.72	22.4	.72	24.9	.72	21.0	.72	22.2	.72	27.6	.72	27.5	.72	25.4
	.80	24.6	.80	25.8	.80	22.1	.80	21.1	.80	24.3	.80	18.2	.80	26.1	.80	25.5
	.88	26.8	.88	27.4	.88	26.6	.88	20.5	.88	24.1	.88	27.2	.88	26.0	.88	24.6
	.96	26.1	.96	26.5	.96	21.8	.96	21.4	.96	29.5	.96	27.5	.96	24.4	.96	23.2
	1.04	31.1	1.04	21.2	1.04	25.9	1.04	18.4	1.04	31.5	1.04	24.4	1.04	23.3	1.04	21.6
	1.12	36.8	1.12	26.5	1.12	24.8	1.12	26.1	1.12	21.1	1.12	22.8	1.12	21.1	1.12	18.4
	1.20	25.0	1.20	25.5	1.20	24.1	1.20	24.8	1.20	26.5	1.20	21.0	1.20	17.6	1.20	16.6
	1.28	23.9	1.28	24.6	1.28	22.2	1.28	33.0	1.28	24.0	1.28	20.7	1.28	17.1	1.28	15.5
	1.36	22.1	1.36	21.1	1.36	14.1	1.36	20.2	1.36	21.9	1.36	18.1	1.36	15.0	1.36	15.0
	1.44	19.9	1.44	18.6	1.44	16.2	1.44	11.6	1.44	19.8	1.44	15.9	1.44	13.4	1.44	12.6
	1.52	16.8	1.52	16.1	1.52	13.6	1.52	10.8	1.52	17.1	1.52	13.2	1.52	11.2	1.52	10.5
	1.60	15.6	1.60	15.0	1.60	13.1	1.60	13.0	1.60	15.6	1.60	10.1	1.60	9.1	1.60	7.1
	1.68	14.2	1.68	13.1	1.68	11.2	1.68	10.1	1.68	13.0	1.68	8.5	1.68	5.3	1.68	4.3
	1.76	12.6	1.76	15.6	1.76	9.6	1.76	7.2	1.76	11.5	1.76	4.3	1.76	2.0	1.76	2.1
	1.84	9.6	1.84	9.2	1.84	6.0	1.84	5.2	1.84	6.1	1.84	2.5	1.84		1.84	0.7
	1.92	6.0	1.92	5.2	1.92	3.6	1.92	2.1	1.92	4.2	1.92	0			1.92	0
	2.00	4.1	2.00	2.3	2.00	1.2	2.00	-1	2.00	1.1						
	2.08	2.3	2.08	1.1	2.08	0	2.08	0	2.08	0						
	2.16	0	2.16	0.1	2.16	0	2.16	0	2.16	0						
			2.24	0	2.24	0	2.24	0	2.24	0						
					2.32	0	2.32	1.4	x2.32	1.7						
					2.40	1.6	2.40	3.5	2.40	2.4						
					2.48	2.9	2.48	4.6	2.48	3.5						
					2.56	2.2	2.56	4.2	2.56	3.7						
					2.64	1.5	2.64	4.0								
					3.12	1.1	3.12	3.0								
					3.20	2.6	2.80	1.4								
					3.28	3.4	2.88	0								
					3.36	2.1										
					3.44	2.6										
					3.52	1.4										

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	57		58		59		60		61		[illegible]		[illegible]		[illegible]	
DATE (1960)	7/1		7/1		7/1		7/1		7/1		7/1		7/1		[illegible]	
HOUR	1110		1140		1130		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
SITE NO	4		4		1		1		4		1		1		1	
REF AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	28.5		26.5		24.5		[illegible]		30.5		32.5		14.5		18.5	
NOTES	EHJ		EHJ		EJA		[illegible]		EHJ		EHJ		EHJ		EHJ	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	8.0	.08	8.8	.08	9.1	.08	11.0	.08	8.8	.8	11.[illegible]	.08	11.1	.08	10.8
	.16	8.3	.16	9.4	.16	11.3	.16	12.2	.16	11.0	.16	11.1	.16	13.6	.16	11.1
	.24	8.3	.24	9.2	.24	1.8	.24	12.3	.24	11.2	.24	12.1	.24	14.1	.24	11.1
	.32	7.2	.32	9.6	.32	11.1	.32	15.5	.32	11.6	.32	14.5	.32	14.6	.32	12.1
	.40	5.5	.40	9.6	.40	13.0	.40	13.5	.40	12.6	.40	13.9	.40	14.2	.40	12.5
	.48	1.0	.48	7.6	.48	11.3	.48	13.4	.48	11.7	.48	13.1	.48	13.5	.48	11.1
	.56	-.2	.56	6.6	.56	11.0	.56	13.2	.56	11.0	.56	12.1	.56	12.9	.56	9.4
	.64	-1.5	.64	7.5	.64	11.5	.64	13.[illegible]	.64	11.1	.64	12.1	.64	[illegible]	.64	9.4
	.72	4.4	.72	9.1	.72	12.8	.72	13.0	.72	11.7	.72	12.[illegible]	.72	13.3	.72	11.4
	.80	9.6	.80	[illegible]	.80	14.1	.80	14.6	.80	12.4	.80	14.6	.80	[illegible]	.80	14.7
	.88	12.2	.88	13.1	.88	15.1	.88	15.3	.88	14.8	.88	15.6	.88	[illegible]	.88	16.4
	.96	13.0	.96	15.8	.96	16.8	.96	16.1	.96	15.8	.96	18.4	.96	19.[illegible]	.96	19.1
	1.04	15.8	1.04	17.2	1.04	11.5	1.04	16.6	1.04	11.5	1.04	18.7	1.04	19.5	1.04	19.8
	1.12	17.1	1.12	17.1	1.12	18.1	1.12	18.6	1.12	17.8	1.12	20.1	1.12	20.4	1.12	19.9
	1.20	19.5	1.20	18.3	1.20	18.5	1.20	18.8	1.20	18.2	1.20	19.8	1.20	21.0	1.20	19.8
	1.28	20.3	1.28	18.9	1.28	18.3	1.28	19.1	1.28	18.0	1.28	19.4	1.28	20.4	1.28	19.5
	1.36	20.0	1.36	18.8	1.36	18.0	1.36	18.3	1.36	17.6	1.36	18.7	1.36	19.3	1.36	18.2
	1.44	19.4	1.44	17.6	1.44	17.5	1.44	17.4	1.44	16.4	1.44	17.1	1.44	17.4	1.44	17.3
	1.52	18.2	1.52	16.8	1.52	15.0	1.52	15.3	1.52	14.3	1.52	14.7	1.52	15.6	1.52	14.5
	1.60	16.6	1.60	14.1	1.60	12.2	1.60	13.1	1.60	11.6	1.60	12.3	1.60	13.4	1.60	12.0
	1.68	15.0	1.68	12.0	1.68	10.3	1.68	11.1	1.68	9.4	1.68	7.7	1.68	11.5	1.68	9.9
	1.76	12.3	1.76	9.3	1.76	3.4	1.76	8.	1.76	6.3	1.76	8.[illegible]	1.76	9.2	1.76	8.6
	1.84	10.1	1.84	1.8	1.84	.7	1.84	5.1	1.84	5.2	1.84	5.1	1.84	7.5	1.84	5.8
	1.92	9.1	1.92	6.6	1.92	4.1	1.92	4.1	1.92	3.3	1.92	3.5	1.92	5.3	1.92	3.1
	2.00	5.4	2.00	4.0	2.00	1.2	2.00	1.0	2.00	0.3	2.00	1.7	2.00	2.7	2.00	1.7
	2.08	4.2	2.08	1.8	2.08	-1.5	2.08	-1.5	2.08	-2.2	2.08	-2.3	2.08	-.8	2.08	-1
	2.16	1.8	2.16	-1.6	2.16	-2.3	2.16	-2.2					2.16	-2	2.16	-2.1
	2.24	-.2	2.24	-2.2												
	2.32	-2.2														

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	65		66		67		68		69		70		71		72	
DATE (1960)	7/1		7/1		7/1		7/1		7/1		7/1		7/1		7/1	
HOUR	1200		1210		1215		1220		1225		1230		1235		1240	
SITE NO	4		4		4		4		4		4		4		4	
REL AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	16.5		14.5		12.5		10.5		8.5		6.5		4.5		2.5	
NOTES	EHJ		EHJ		EHJ		EHJ		EHJ		EIJ		EHJ		EIJ	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	8.8	.08	10.9	.08	11.9	.08	10.0	.08	16.8	.08	16.6	.08	20.3	.08	18.4
	.16	9.4	.16	11.3	.16	12.3	.16	10.8	.16	16.5	.16	18.0	.16	21.6	.16	20.2
	.24	9.2	.24	10.9	.24	11.0	.24	11.1	.24	17.6	.24	20.2	.24	22.7	.24	21.5
	.32	9.2	.32	9.4	.32	10.2	.32	11.6	.32	19.4	.32	21.5	.32	23.4	.32	22.8
	.40	7.5	.40	8.4	.40	9.4	.40	12.3	.40	20.1	.40	21.1	.40	25.5	.40	23.5
	.48	3.2	.48	3.4	.48	8.6	.48	13.6	.48	22.1	.48	22.2	.48	25.1	.48	24.2
	.56	-1	.56	-2	.56	12.4	.56	15.1	.56	22.9	.56	22.1	.56	25.8	.56	24.6
	.64	6.5	.64	8.2	.64	14.4	.64	16.1	.64	24.1	.64	23.2	.64	26.1	.64	24.9
	.72	11.5	.72	13.4	.72	17.3	.72	11.8	.72	24.	.72	22.4	.72	25.6	.72	23.9
	.80	16.7	.80	11.1	.80	19.1	.80	18.8	.80	24.8	.80	23.1	.80	25.1	.80	23.5
	.88	16.8	.88	18.4	.88	20.9	.88	19.5	.88	24.4	.88	22.8	.88	23.8	.88	22.6
	.96	18.5	.96	20.4	.96	21.9	.96	19.0	.96	24.4	.96	22.2	.96	22.8	.96	20.6
	1.04	18.5	1.04	20.2	1.04	21.8	1.04	18.4	1.04	23.3	1.04	20.9	1.04	20.4	1.04	18.5
	1.12	18.5	1.12	20.4	1.12	20.9	1.12	17.9	1.12	22.6	1.12	19.6	1.12	18.1	1.12	11.5
	1.20	18.6	1.20	20.6	1.20	19.4	1.20	17.1	1.20	20.8	1.20	18.3	1.20	16.7	1.20	13.4
	1.28	17.4	1.28	18.1	1.28	18.0	1.28	14.4	1.28	18.2	1.28	15.4	1.28	15.6	1.28	11.1
	1.36	15.4	1.36	17.0	1.36	16.1	1.36	15.1	1.36	16.1	1.36	12.8	1.36	13.1	1.36	10.1
	1.44	13.1	1.44	14.3	1.44	13.0	1.44	10.1	1.44	13.2	1.44	10.4	1.44	12.0	1.44	8.1
	1.52	11.5	1.52	12.6	1.52	9.1	1.52	7.7	1.52	11.0	1.52	7.7	1.52	10.4	1.52	7.2
	1.60	10.0	1.60	10.5	1.60	7.6	1.60	5.2	1.60	9.0	1.60	5.1	1.60	7.0	1.60	4.7
	1.68	7.5	1.68	8.3	1.68	6.5	1.68	3.1	1.68	6.8	1.68	3.3	1.68	4.3	1.68	1.6
	1.76	5.7	1.76	6.3	1.76	5.6	1.76	1.8	1.76	5.0	1.76	1.3	1.76	0.1	1.76	-2
	1.84	3.0	1.84	4.4	1.84	3.5	1.84	0.3	1.84	3.3	1.84	-1.8	1.84	-2		
	1.92	1.1	1.92	1.7	1.92	0.6	1.92	-.4	1.92	0.1						
	2.00	-2	2.00	-0.6	2.00	-1.4	2.00	-2.2	2.00	-2.2						
			2.08	-2	2.08	-2.2			2.08							
									2.16							
									2.24							
									2.32							
									2.40	-.4						
									2.48	-.6						
									2.56	-.4						

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	73		74		75		76		77		78		79		80	
DATE (1960)	7/7		7/7		7/7		7/7		7/7		7/7		7/7		7/7	
HOUR	1430		1440		1445		1450		1455		1500		1505		1508	
SITE NO	5		5		5		5		5		5		5		5	
REL AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	28.5		26.0		24.5		22.5		20.5		18.5		16.5		14.5	
NOTES	E.H.J.		E.J.		E.H.J.		E.J.		E.H.J.		E.J.		E.E.J.		E.J.	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	5.6	.08	6.5	.8	12.1	.08	12.3	.08	11.5	.08	9.5	.08	11.3	.08	15.3
	.16	3.9	.16	4.0	.16	11.4	.16	13.3	.16	11.0	.16	10.3	.16	7.4	.16	15.2
	.24	1.6	.24	0.4	.24	9.7	.24	11.6	.24	10.9	.24	11.0	.24	8.3	.24	13.4
	.32	3.9	.32	2.2	.32	9.6	.32	9.8	.32	9.2	.32	11.4	.32	7.0	.32	14.1
	.40	4.9	.40	-2.2	.40	9.5	.40	8.6	.40	8.0	.40	11.7	.40	8.7	.40	13.4
	.48	6.9	.48	-2.3	.48	8.5	.48	8.9	.48	5.0	.48	13.5	.48	12.8	.48	13.8
	.56	6.7	.56	2.2	.56	9.1	.56	8.1	.56	-2.1	.56	13.8	.56	5.6	.56	14.1
	.64	7.1	.64	2.2	.64	9.5	.64	9.7	.64	-2.1	.64	14.6	.64	14.1	.64	11.1
	.72	7.3	.72	3.9	.72	11.3	.72	10.8	.72	5.9	.72	15.5	.72	14.9	.72	16.9
	.80	9.3	.80	0.0	.80	12.6	.80	11	.80	10.7	.80	17.1	.80	16.2	.80	18.4
	.88	10.5	.88	1.1	.88	13.4	.88	12.1	.88	15.3	.88	18.3	.88	11.7	.88	22.4
	.96	13.3	.96	8.7	.96	14.6	.96	15.4	.96	18.0	.96	19.9	.96	20.5	.96	21.6
	1.04	14.9	1.04	11.7	1.04	15.8	1.04	17.9	1.04	20.3	1.04	22.1	1.04	21.9	1.04	22.3
	1.12	17.0	1.12	14.3	1.12	17.1	1.12	19.5	1.12	22.8	1.12	23.4	1.12	22.0	1.12	23.1
	1.20	18.9	1.20	16.7	1.20	19.1	1.20	21.3	1.20	24.0	1.20	24.0	1.20	22.4	1.20	22.3
	1.28	21.0	1.28	11.8	1.28	22.6	1.28	23.3	1.28	24.3	1.28	23.3	1.28	21.5	1.28	22.2
	1.36	23.4	1.36	19.1	1.36	21.8	1.36	21.9	1.36	23.3	1.36	24.3	1.36	21.2	1.36	20.0
	1.44	25.0	1.44	20.8	1.44	22.6	1.44	24.2	1.44	24.5	1.44	23.7	1.44	19.8	1.44	18.7
	1.52	26.1	1.52	21.7	1.52	23.1	1.52	24.4	1.52	23.6	1.52	22.0	1.52	18.9	1.52	16.3
	1.60	27.2	1.60	21.1	1.60	23.6	1.60	24.0	1.60	22.2	1.60	20	1.60	16.8	1.60	13.8
	1.68	27.0	1.68	21.8	1.68	22.9	1.68	22.8	1.68	[illegible]	1.68	18.5	1.68	14.2	1.68	10.9
	1.76	26.0	1.76	20.8	1.76	21.2	1.76	21.2	1.76	18.5	1.76	16.3	1.76	12.1	1.76	9.0
	1.84	24.1	1.84	19.9	1.84	19.6	1.84	17.3	1.84	13.9	1.84	14.2	1.84	10.6	1.84	7.1
	1.92	23.8	1.92	18.4	1.92	17.1	1.92	17.2	1.92	14.4	1.92	11.4	1.92	8.3	1.92	5.2
	2.00	21.9	2.00	16.3	2.00	15.4	2.00	14.8	2.00	17.1	2.00	9.6	2.00	6.0	2.00	3.1
	2.08	19.2	2.08	13.8	2.08	12.1	2.08	12.5	2.08	9.8	2.08	7.6	2.08	1.2	2.08	-2.2
	2.16	17.6	2.16	12.0	2.16	6.6	2.16	10.6	2.16	7.1	2.16	5.1	2.16	-2.2		
	2.24	15.5	2.24	10.2	2.24	8.1	2.24	8.0	2.24	5.3	2.24	2.0				
	2.32	13.4	2.32	8.2	2.32	6.3	2.32	4.3	2.32	1.8	2.32	-2				
	2.40	11.5	2.40	6.0	2.40	2.6	2.40	-2.2	2.40	2.1						
	2.48	9.3	2.48	3.5	2.48	-2	2.48	-2.2								
	2.56	5.5	2.56	-2												
	2.64	1.1														
	2.72	-2														

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	81		82		83		84		85		86		81		88	
DATE (1960)	7/7		7/7		7/7		7/7		7/7		7/7		7/1		7/7	
HOUR	1510		1512		1514		1516		1520		1525		1530		1533	
SITE NO	5		5		5		5		5		5		5		5	
REL AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	135		125		115		105		85		65		45		35	
NOTES																
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	17.1	.08	16.4	.8	15.0	.08	141	.08	14.8	.08	18.9	.08	21.0	.08	19.1
	.16	174	.16	173	.16	15.6	.16	139	.16	15.3	.16	20.0	.16	22.4	.16	208
	.24	182	.24	176	.24	15.0	.24	132	.24	15.7	.24	22.3	.24	245	.24	229
	.32	189	.32	16.9	.32	146	.32	11.8	.32	16.4	.32	23.7	.32	25.1	.32	23.4
	.40	188	.40	16.0	.40	133	.40	6.6	.40	16.9	.40	248	.40	26.8	.40	24.7
	.48	183	.48	149	.48	12.1	.48	-15	.48	187	.48	2.3	.48	26.8	.48	25.5
	.56	117	.56	15.1	.56	89	.56	10.2	.56	21.2	.56	26.5	.56	26.8	.56	25.1
	.64	11.8	.64	16.0	.64	12.5	.64	161	.64	21.4	.64	27.0	.64	216	.64	25.4
	.72	198	.72	177	.72	16.6	.72	20.5	.72	23.8	.72	27.5	.72	272	.72	24.2
	.80	20.5	.80	193	.80	198	.80	25.0	.80	249	.80	21.2	.80	264	.80	23.5
	.88	218	.88	21.1	.88	21	.88	25.0	.88	25.6	.88	22.8	.88	25.0	.88	21.9
	.96	237	.96	22.1	.96	222	.96	25.0	.96	24.9	.96	24.4	.96	236	.96	19.8
	1.04	242	1.04	225	1.04	22.6	1.04	245	1.04	242	1.04	224	1.04	22.1	1.04	17.4
	1.12	23.6	1.12	224	1.12	220	1.12	23.7	1.12	22.9	1.12	21.2	1.12	20.2	1.12	15.2
	1.20	24.1	1.20	226	1.20	218	1.20	228	1.20	21.2	1.20	19.8	1.20	181	1.20	13.1
	1.28	230	1.28	21.5	1.28	200	1.28	205	1.28	19.2	1.28	18.4	1.28	168	1.28	12.8
	1.36	210	1.36	146	1.36	181	1.36	188	1.36	17.5	1.36	15.1	1.36	14.8	1.36	11.3
	1.44	193	1.44	181	1.44	17.1	1.44	16.4	1.44	15.0	1.44	15.6	1.44	12.6	1.44	10.3
	1.52	116	1.52	16.1	1.52	15.9	1.52	15.0	1.52	12.5	1.52	11.5	1.52	10.1	1.52	8.3
	1.60	15.0	1.60	13.2	1.60	13.5	1.60	12.1	1.60	10.6	1.60	10.0	1.60	7.4	1.60	5.3
	1.68	13.6	1.68	10.8	1.68	11.4	1.68	10.8	1.68	9.1	1.68	6.4	1.68	4.7	1.68	0.8
	1.76	10.9	1.76	8.3	1.76	8.1	1.76	9.5	1.76	7.3	1.76	3.0	1.76	-1.7	1.76	2.01
	1.84	8.4	1.84	6.3	1.84	6.1	1.84	6.9	1.84	4.5	1.84	-1.6	1.84	-2.2		
	1.92	5.9	1.92	5.4	1.92	3.5	1.92	4.0	1.92	0.9	1.92	-2				
	2.00	2.8	2.00	0.3	2.00	0.5	2.00	1.4	2.00	-2.2						
	2.08	0	2.08	-2	2.08	-1.4	2.08	-.5	2.08	-2.2						
	2.16	-2			2.16	-2.2	2.16	-2.0	2.16	-2.2						
									2.24	-2.2						
									2.32	2.2						
									2.40	+0.1						
									2.48	+1.1						
									2.56	+2.3						
									2.64	-1.5						

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

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TEST NO	89		90		91		92		93		94		95		96	
DATE (1960)	7/11		7/11		7/11		7/11		7/11		7/11		7/11		7/11	
HOUR	1310															
SITE NO	6		6		6		6		6		6		6		6	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	38		36		34		32		30		29		28		27	
NOTES	EIO		ENO		EN.		END		EN.O		ENO		ENP		ENP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	08	7.7	.08	15.7	.08	15.0	.08	14.3	.08	18.5	.08	18.2	.8	18.7	.08	20.1
	.16	8.9	.16	14.6	.16	14.5	.16	[illegible]	.16	19.0	.16	20.0	.16	19.1	.16	21.7
	.24	7.7	.24	13.1	.24	15.2	.24	15.6	.24	19.6	.24	20.1	.24	20.2	.24	22.3
	.32	6.4	.32	12.3	.32	14.3	.32	14.7	.32	19.1	.32	21.3	.32	20.2	.32	22.6
	.40	4.5	.40	8.3	.40	10.1	.40	13.0	.40	14.0	.40	19.8	.40	19.1	.40	23.5
	.48	3.1	.48	2.8	.48	5.9	.48	9.7	.48	18.2	.48	19.1	.48	19.1	.48	23.0
	.56	2.6	.56	0.3	.56	3.2	.56	10.1	.56	18.5	.56	20.1	.56	19.9	.56	23.4
	.64	4.0	.64	4.3	.64	6.4	.64	13.1	.64	19.8	.64	20.8	.64	20.7	.64	23.5
	.72	4.3	.72	9.3	.72	16.3	.72	17.8	.72	21.8	.72	22.1	.72	21.9	.72	23.2
	.80	7.6	.80	14.2	.80	17.9	.80	20.3	.80	22.1	.80	23.4	.80	22.9	.80	24.3
	.88	9.7	.88	18.4	.88	20.4	.88	23.1	.88	24.3	.88	25.3	.88	24.5	.88	26.2
	.96	12.4	.96	21.1	.96	23.4	.96	25.1	.96	26.2	.96	26.6	.96	26.1	.96	26.9
	1.04	15.1	1.04	24.0	1.04	25.7	1.04	26.4	1.04	28.4	1.04	28.5	1.04	28.3	1.04	28.7
	1.12	17.5	1.12	26.3	1.12	27.1	1.12	27.9	1.12	29.2	1.12	29.8	1.12	29.4	1.12	29.6
	1.20	20.2	1.20	28.	1.20	28.5	1.20	28.6	1.20	30.2	1.20	30.4	1.20	30.2	1.20	29.9
	1.28	21.3	1.28	28.4	1.28	28.8	1.28	29.1	1.28	30.6	1.28	30.4	1.28	29.8	1.28	30.3
	1.36	22.9	1.36	29.6	1.36	28.5	1.36	29.4	1.36	30.4	1.36	30.0	1.36	29.9	1.36	30.0
	1.44	22.5	1.44	29.8	1.44	[illegible]	1.44	28.8	1.44	29.2	1.44	29.5	1.44	28.1	1.44	29.0
	1.52	22.3	1.52	29.0	1.52	[illegible]	1.52	28.0	1.52	28.6	1.52	28.2	1.52	27.1	1.52	27.0
	1.60	22.1	1.60	28.1	1.60	25.3	1.60	26.5	1.60	26.8	1.60	26.0	1.60	24.4	1.60	24.8
	1.68	21.1	1.68	26.2	1.68	[illegible]	1.68	24.2	1.68	24.4	1.68	23.8	1.68	21.3	1.68	[illegible]
	1.76	19.8	1.76	24.6	1.76	[illegible]	1.76	[illegible]	1.76	[illegible]	1.76	[illegible]	1.76	19.4	1.76	20
	1.84	18.1	1.84	22.0	1.84	18.1	1.84	17.5	1.84	19.3	1.84	19.0	1.84	16.4	1.84	17.6
	1.92	15.6	1.92	19.3	1.92	16.6	1.92	16.6	1.92	17.4	1.92	16.5	1.92	15.9	1.92	12.8
	2.00	13.0	2.00	17.5	2.00	14.6	2.00	15.1	2.00	16.3	2.00	14.9	2.00	14.5	2.00	15.0
	2.08	11.3	2.08	15.8	2.08	12.9	2.08	13.0	2.08	13.9	2.08	13.9	2.08	12.3	2.08	12.8
	2.16	9.0	2.16	14.0	2.16	11.2	2.16	10.4	2.16	11.7	2.16	11.1	2.16	2.8	2.16	9.2
	2.24	7.2	2.24	12.8	2.24	8.8	2.24	8.9	2.24	7.7	2.24	7.3	2.24	2.2	2.24	2.5
	2.32	4.0	2.32	10.5	2.32	5.6	2.32	3.8	2.32	2.3	2.32	1.2	2.32	-2.4	2.32	-2.2
	2.40	-.1	2.40	7.3	2.40	2.3	2.40	6.4	2.40	2.3	2.40	2.2	2.40	—	2.40	—
			2.48	3.7	2.48	0.7	2.48	-2.0	2.48	+0.5	2.48	—	2.48	—	2.48	—
			2.56	1.8	2.56	-3.1	2.56	2.0	2.56	+3.3	2.56	—	2.56	—	2.56	—
			2.64	-1.7	2.64	-3.	2.64	0.5	2.64	6.4	2.64	+0.4	2.64	+0.2	2.64	+2.3
					2.72	-3.1	2.72	2.1	2.72	6.2	2.72	3.7	2.72	3.4	2.72	+4.5
					2.80	-3.1	2.80	4.6	2.80	6.2	2.80	5.0	2.80	5.3	2.80	6.3
					2.88	+2.3	2.88	8.0	2.88	4.7	2.88	5.6	2.88	5.0	2.88	6.1
					2.96	3.6	2.96	4.2	2.96	3.6	2.96	5.2				
											3.04	4.0				

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	97		98		99		100		101		102		103		104	
DATE (1960)	7/11		7/11		7/11		7/11		7/11		7/11		7/11		7/11	
HOUR																
SITE NO	6		6		6		6		6		6		6		6	
REL AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT FT	26		25		24		22		20		19		18		11	
NOTES																
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	19.6	.08	18.0	.08	19.	.08	18.7	.08	17.2	.08	17.1	.08	18.3	.08	19.1
	.16	20.9	.16	19.9	.16	20.3	.16	20.2	.16	18.6	.16	17.7	.16	18.1	.16	19.2
	.24	22.6	.24	20.1	.24	21.0	.24	21.8	.24	19.1	.24	17.8	.24	19.1	.24	19.2
	.32	22.4	.32	21.5	.32	21.9	.32	22.4	.32	19.9	.32	17.8	.32	18.8	.32	18.6
	.40	23.2	.40	22.2	.40	22.6	.40	21.3	.40	19.9	.40	17.5	.40	17.8	.40	16.1
	.48	23.8	.48	22.4	.48	22.4	.48	20.4	.48	18.1	.48	14.5	.48	14.8	.48	13.4
	.56	23.9	.56	21.4	.56	22.0	.56	21.0	.56	16.5	.56	9.0	.56	6.1	.56	-(-)
	.64	23.7	.64	21.5	.64	21.3	.64	20.7	.64	17.3	.64	13.4	.64	14.1	.64	14.4
	.72	24.1	.72	21.5	.72	21.5	.72	22.0	.72	19.4	.72	19.7	.72	21.4	.72	23.
	.80	24.9	.80	22.3	.80	22.5	.80	24.4	.80	22.7	.80	21.8	.80	25.6	.80	25.
	.88	25.6	.88	23.6	.88	25.0	.88	26.1	.88	26.0	.88	26.2	.88	27.7	.88	28.8
	.96	27.4	.96	25.3	.96	26.9	.96	27.8	.96	28.2	.96	28.5	.96	29.5	.96	30.0
	1.04	28.4	1.04	27.1	1.04	28.4	1.04	29.3	1.04	28.1	1.04	28.6	1.04	29.7	1.04	30.1
	1.12	29.6	1.12	21.8	1.12	29.5	1.12	30.0	1.12	29.0	1.12	29.5	1.12	29.5	1.12	30.3
	1.20	30.1	1.20	28.5	1.20	30.1	1.20	29.2	1.20	28.8	1.20	29.2	1.20	29.1	1.20	29.3
	1.28	30.2	1.28	28.8	1.28	30.0	1.28	28.3	1.28	28.0	1.28	27.3	1.28	28.4	1.28	28.2
	1.36	29.7	1.36	28.7	1.36	29.4	1.36	27.8	1.36	26.2	1.36	26.8	1.36	26.8	1.36	26.3
	1.44	28.3	1.44	27.7	1.44	27.6	1.44	25.4	1.44	24.9	1.44	24.4	1.44	24.5	1.44	23.1
	1.52	27.0	1.52	[illegible]	1.52	[illegible]	1.52	23.8	1.52	22.5	1.52	[illegible]	1.52	[illegible]	1.52	21.5
	1.60	25.2	1.60	22.4	1.60	[illegible]	1.60	21.3	1.60	19.8	1.60	20.0	1.60	[illegible]	1.60	19.3
	1.68	21.9	1.68	20.1	1.68	22.1	1.68	19.3	1.68	17.3	1.68	16.8	1.68	16.5	1.68	17.2
	1.76	19.6	1.76	18.3	1.76	18.1	1.76	16.6	1.76	15.3	1.76	15.6	1.76	15.5	1.76	15.5
	1.84	17.3	1.84	16.5	1.84	16.4	1.84	14.9	1.84	13.3	1.84	13.3	1.84	14.3	1.84	14.5
	1.92	15.3	1.92	15.1	1.92	15.0	1.92	12.1	1.92	10.0	1.92	11.4	1.92	12.2	1.92	11.2
	2.00	13.2	2.00	13.1	2.00	12.9	2.00	9.8	2.00	7.9	2.00	9.2	2.00	9.0	2.00	8.7
	2.08	11.2	2.08	10.4	2.08	9.9	2.08	6.7	2.08	4.5	2.08	6.0	2.08	5.8	2.08	6.0
	2.16	7.4	2.16	7.0	2.16	6.3	2.16	3.1	2.16	1.0	2.16	3.1	2.16	2.3	2.16	3.4
	2.24	0.3	2.24	1.0	2.24	3.2	2.24	1.8	2.24	.1	2.24	1.2	2.24	0.2	2.24	1.1
	2.32	2.0	2.32	-0.5	2.32	1.6	2.32	1.4	2.32	-1.3	2.32	-0.6	2.32	-1.1	2.32	-1.4
			2.40	-2.0	2.40	0	2.40	-2			2.40	—	2.40	—	2.40	1.4
			2.48	—	2.48	—									2.48	2.7
															2.56	3.6
															2.64	3.0

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	105		106		107		108		[illegible]		110		111		112	
DATE (1960)	7/11		7/11		7/11		7/11		[illegible]		7/11		7/11		7/11	
HOUR																
SITE NO	6		6		6		6		6		6		6		6	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	16		15		14		12		10		9		8		6	
NOTES	F.N.P		F.N.P		F.N.P		F.L.P		F.N.P		F.N.P		F.N.P		F.F.P	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	19.6	.08	19.2	.8	20.0	.8	17.3	.08	22.4	.08	22.4	.08	23.5	.08	[illegible]
	.16	19.0	.16	19.2	.16	19.5	.16	19.9	.16	19.8	.16	22.1	.16	23.0	.16	27.2
	.24	18.4	.24	18.1	.24	19.2	.24	20.4	.24	[illegible]	.24	22.6	.24	25.4	.24	29.6
	.32	18.1	.32	[illegible]	.32	19.8	.32	22.0	.32	21.5	.32	23.2	.32	26.3	.32	30.2
	.40	17.5	.40	18.5	.40	20.3	.40	23.9	.40	22.7	.40	24.5	.40	21.5	.40	31.1
	.48	15.7	.48	17.6	.48	21.9	.48	25.6	.48	24.5	.48	25.7	.48	28.0	.48	31.9
	.56	13.1	.56	20.8	.56	23.2	.56	26.8	.56	26.4	.56	27.4	.56	28.7	.56	32.1
	.64	17.8	.64	23.7	.64	25.2	.64	28.5	.64	27.8	.64	28.3	.64	29.4	.64	32.7
	.72	22.6	.72	23.9	.72	26.9	.72	30.3	.72	24.1	.72	29.6	.72	29.6	.72	32.8
	.80	25.4	.80	26.0	.80	28.3	.80	31.1	.80	30.0	.80	30.4	.80	30.0	.80	32.3
	.88	28.3	.88	27.0	.88	29.1	.88	31.4	.88	30.6	.88	30.1	.88	30.0	.88	31.4
	.96	29.5	.96	27.1	.96	29.4	.96	31.7	.96	30.5	.96	30.1	.96	29.7	.96	30.4
	1.04	29.9	1.04	27.8	1.04	30.0	1.04	30.8	1.04	30.0	1.04	30.2	1.04	29.4	1.04	[illegible]
	1.12	30.1	1.12	27.6	1.12	29.6	1.12	29.5	1.12	28.9	1.12	29.5	1.12	28.5	1.12	28.0
	1.20	29.1	1.20	26.5	1.20	28.5	1.20	28.2	1.20	27.6	1.20	27.1	1.20	27.0	1.20	26.1
	1.28	28.0	1.28	25.5	1.28	27.2	1.28	26.6	1.28	25.1	1.28	25.1	1.28	25.4	1.28	[illegible]
	1.36	25.6	1.36	24.0	1.36	25.2	1.36	24.3	1.36	22.7	1.36	22.6	1.36	22.3	1.36	21.4
	1.44	23.3	1.44	21.9	1.44	22.8	1.44	21.2	1.44	19.8	1.44	19.4	1.44	19.5	1.44	19.1
	1.52	20.1	1.52	18.9	1.52	19.6	1.52	19.0	1.52	17.3	1.52	16.4	1.52	16.7	1.52	17.0
	1.60	17.7	1.60	15.7	1.60	17.0	1.60	16.7	1.60	15.9	1.60	14.6	1.60	14.1	1.60	14.1
	1.68	15.6	1.68	14.0	1.68	15.6	1.68	15.8	1.68	14.9	1.68	[illegible]	1.68	12.4	1.68	11.6
	1.76	15.0	1.76	13.2	1.76	14.3	1.76	14.1	1.76	13.4	1.76	12.4	1.76	11.0	1.76	8.7
	1.84	13.4	1.84	11.3	1.84	[illegible]	1.84	11.1	1.84	10.9	1.84	10.1	1.84	9.1	1.84	1.0
	1.92	11.2	1.92	4.2	1.92	9.7	1.92	2.2	1.92	7.4	1.92	7.2	1.92	7.2	1.92	-1.2
	2.00	8.1	2.00	2.6	2.00	6.1	2.00	3.8	2.00	3.3	2.00	3.0	2.00	4.7	2.00	-0.4
	2.08	5.4	2.08	2.2	2.08	4.7	2.08	0.6	2.08	-2.0	2.08	-2.0	2.08	1.5	2.08	+0.8
	2.16	2.3	2.16	-0.3	2.16	1.1	2.16	—			2.16	—	2.16	-2.0	2.16	2.7
	2.24	-0.4	2.24	—	2.24	2.0									2.24	4.5
					2.32	0.3									2.32	6.1
					2.40	+3.3									2.40	7.5
					2.48	+5.3									2.48	7.9
					2.56	+6.7										
					2.64	+5.9										
					2.72	4.0										
					2.80	1.7										

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	113		114		115		116		117		118		119		120	
DATE (1960)	7/11		7/12		7/12		7/[illegible]		7/12		7/12		7/12		7/12	
HOUR																
SITE NO	6		7		7		7		7		7		7		7	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	4		38		37		6		35		34		33		32	
NOTES	F.E.P		F.N.P		L.N.P		L.N.P		F.N.P		F.N.P		F.N.P		F.N.P	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	27.5	.8	18.9	.08	21.0	.08	19.3	.08	18.3	.08	20.0	.08	20.6	.08	21.2
	.16	28.7	.16	19.0	.16	21.7	.16	19.7	.16	18.7	.16	19.8	.16	21.1	.16	21.7
	.24	30.7	.24	18.8	.24	21.7	.24	20.4	.24	18.8	.24	19.7	.24	21.0	.24	21.5
	.32	31.6	.32	17.7	.32	21.5	.32	20.8	.32	18.4	.32	17.7	.32	21.0	.32	21.7
	.40	32.5	.40	17.0	.40	22.6	.40	19.9	.40	17.4	.40	17.6	.40	20.4	.40	21.4
	.48	33.6	.48	15.6	.48	19.2	.48	20.2	.48	17.2	.48	17.5	.48	19.5	.48	20.1
	.56	33.1	.56	16.3	.56	21.3	.56	22.2	.56	16.5	.56	17.3	.56	20.1	.56	19.7
	.64	33.8	.64	17.2	.64	21.7	.64	26.1	.64	16.4	.64	18.8	.64	19.9	.64	18.1
	.72	31.0	.72	18.7	.72	21.1	.72	20.8	.72	17.2	.72	17.4	.72	20.8	.72	18.9
	.80	33.2	.80	20.1	.80	21.8	.80	22.0	.80	19.6	.80	20.8	.80	22.6	.80	20.3
	.88	33.4	.88	23.1	.88	24.3	.88	23.4	.88	21.5	.88	23.4	.88	24.5	.88	23.5
	.96	30.9	.96	25.0	.96	26.2	.96	25.3	.96	24.2	.96	20.7	.96	26.3	.96	25.1
	1.04	29.4	1.04	27.0	1.04	28.3	1.04	26.6	1.04	26.2	1.04	27.3	1.04	27.2	1.04	26.1
	1.12	27.5	1.12	28.0	1.12	29.1	1.12	28.0	1.12	26.9	1.12	28.7	1.12	28.4	1.12	27.3
	1.20	24.7	1.30	29.0	1.20	30.1	1.20	28.8	1.20	27.2	1.20	29.6	1.20	29.6	1.20	28.2
	1.28	22.1	1.28	29.4	1.28	31.5	1.28	28.9	1.28	27.2	1.28	22.1	1.28	28.7	1.28	28.1
	1.36	20.3	1.36	29.6	1.36	30.1	1.36	28.1	1.36	27.3	1.36	28.1	1.36	27.1	1.36	27.0
	1.44	19.0	1.44	28.7	1.44	29.5	1.44	27.1	1.44	26.8	1.44	27.3	1.44	26.7	1.44	26.0
	1.52	18.0	1.52	27.4	1.52	28.2	1.52	26.1	1.52	24.8	1.52	25.4	1.52	25.0	1.52	24.1
	1.60	16.1	1.60	25.0	1.60	25.8	1.60	23.4	1.60	23.2	1.60	23.1	1.60	23.0	1.60	22.1
	1.68	12.1	1.68	22.0	1.68	24.1	1.68	19.8	1.68	19.4	1.68	18.7	1.68	20.0	1.68	19.0
	1.76	7.7	1.76	19.3	1.76	20.0	1.76	16.4	1.76	16.0	1.76	17.1	1.76	16.1	1.76	16.3
	1.84	-0.2	1.84	17.1	1.84	17.4	1.84	13.4	1.84	14.5	1.84	14.6	1.84	15.2	1.84	14.3
	1.92	—	1.92	15.1	1.92	[illegible]	1.92	12.8	1.92	13.3	1.92	13.4	1.92	13.6	1.92	13.2
			2.00	13.9	2.00	4.1	2.00	11.3	2.00	11.8	2.00	11.8	2.00	12.5	2.00	11.3
			2.08	12.2	2.08	12.5	2.08	9.5	2.08	9.8	2.08	9.6	2.08	9.4	2.08	7.1
			2.16	10.0	2.16	10.0	2.16	6.1	2.16	6.4	2.16	5.1	2.16	6.3	2.16	5.6
			2.24	5.4	2.24	5.1	2.24	1.2	2.24	2.0	2.24	1.0	2.24	1.0	2.24	1.2
			2.32	1.2	2.32	1.9	2.32	-1.6	2.32	1.1	2.32	-1.4	2.32	-2.0	2.32	-0.9
			2.40	-2.0	2.40	-1.5	2.40	—	2.40	2.-	2.40	2.-	2.40	—	2.40	-2
					2.48	—										

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

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TEST NO	121		122		123		134		125		126		127		128	
DATE (1960)	7/12		7/12		7/12		7/12		7/12		7/12		7/12		7/12	
HOUR																
SITE NO	7		7		7		7		7		7		7		7	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT, FT	31		30		28		26		24		23		22		20	
NOTES	E.N.P		ENP		EN.P		ECP		ENP		ENP		ENP		ENP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	21.0	.08	21.2	.08	23.0	.08	21.5	.08	21.9	.08	21.2	.08	20.4	.08	11.8
	.16	21.6	.16	21.8	.16	23.6	.16	22.5	.16	22.9	.16	22.1	.16	26.1	.16	17.8
	.24	21.9	.24	22.3	.24	24.2	.24	23.1	.24	23.8	.24	22.7	.24	20.4	.24	18.5
	.32	22.0	.32	22.2	.32	24.3	.32	23.0	.32	23.1	.32	22.9	.32	21.2	.32	18.9
	.40	21.5	.40	21.6	.40	24.2	.40	22.1	.40	23.1	.40	22.0	.40	[illegible]	.40	20.5
	.48	20.6	.48	20.6	.48	23.2	.48	20.7	.48	21.8	.48	20.7	.48	[illegible]	.48	21.9
	.56	20.3	.56	19.6	.56	21.9	.56	17.0	.56	18.8	.56	17.8	.56	21.5	.56	23.8
	.64	20.2	.64	19.0	.64	21.0	.64	17.9	.64	14.4	.64	15.1	.64	23.0	.64	26.5
	.72	20.9	.72	20.3	.72	21.6	.72	18.4	.72	18.5	.72	18.9	.72	24.9	.72	28.8
	.80	23.8	.80	22.3	.80	23.1	.80	23.7	.80	23.1	.80	23.5	.80	27.2	.80	30.2
	.88	25.2	.88	24.1	.88	25.8	.88	26.7	.88	26.6	.88	27.0	.88	28.6	.88	30.4
	.96	27.3	.96	26.9	.96	27.9	.96	28.6	.96	28.3	.96	28.4	.96	29.7	.96	31.5
	1.04	28.2	1.04	28.5	1.04	28.4	1.04	29.4	1.04	30.2	1.04	29.8	1.04	30.2	1.04	31.7
	1.12	28.4	1.12	29.3	1.12	28.1	1.12	29.6	1.12	[illegible]	1.12	30.2	1.12	30.1	1.12	31.3
	1.20	28.8	1.20	29.4	1.20	28.6	1.20	29.2	1.20	30.0	1.20	29.1	1.20	29.5	1.20	32.0
	1.28	28.5	1.28	29.2	1.28	28.4	1.28	28.8	1.28	24.3	1.28	28.8	1.28	28.7	1.28	[illegible]
	1.36	28.0	1.36	28.1	1.36	21.6	1.36	[illegible]	1.36	21.8	1.36	[illegible]	1.36	21.1	1.36	[illegible]
	1.44	26.1	1.44	21.0	1.44	26.2	1.44	25.8	1.44	[illegible]	1.44	[illegible]	1.44	[illegible]	1.44	[illegible]
	1.52	25.5	1.52	25.0	1.52	24.3	1.52	23.3	1.52	23.0	1.52	[illegible]	1.52	21.8	1.52	22.1
	1.60	22.6	1.60	22.2	1.60	21.5	1.60	21.1	1.60	19.6	1.60	19.8	1.60	19.1	1.60	19.5
	1.68	19.8	1.68	19.6	1.68	17.4	1.68	19.7	1.68	17.0	1.68	17.0	1.68	16.5	1.68	13.1
	1.76	16.7	1.76	17.2	1.76	16.6	1.76	17.2	1.76	15.6	1.76	15.8	1.76	15.1	1.76	16.6
	1.84	14.6	1.84	14.9	1.84	15.0	1.84	12.3	1.84	14.0	1.84	14.6	1.84	14.0	1.84	14.3
	1.92	13.8	1.92	14.0	1.92	13.4	1.92	12.1	1.92	12.3	1.92	12.5	1.92	12.4	1.92	11.7
	2.00	12.2	2.00	12.2	2.00	11.1	2.00	10.5	2.00	10.2	2.00	10.5	2.00	10.1	2.00	8.9
	2.08	10.1	2.08	9.6	2.08	7.1	2.08	7.3	2.08	7.5	2.08	8.5	2.08	8.0	2.08	7.0
	2.16	6.8	2.16	6.6	2.16	5.2	2.16	4.8	2.16	5.2	2.16	6.3	2.16	5.9	2.16	4.1
	2.24	4.0	2.24	3.1	2.24	4.0	2.24	2.8	2.24	3.1	2.24	4.6	2.24	4.4	2.24	1.8
	2.32	0.5	2.32	2.1	2.32	2.7	2.32	1.8	2.32	2.2	2.32	3.3	2.32	2.3	2.32	2.1
	2.40	-2	2.40	0	2.40	1.2	2.40	0.2	2.40	1.6	2.40	2.6	2.40	2.5	2.40	3.5
			2.48	-2	2.48	-2	2.48	-0.6	2.48	1.9	2.48	3.1	2.48	3.6	2.48	5.1
							2.56	-0.4	2.56	3.6	2.56	5.6	2.56	5.0	2.56	6.3
							2.64	-0.2	2.64	3.7	2.64	5.4	2.64	5.2	2.64	6.2
							2.72	-0.1	2.72	3.6	2.72	4.5	2.72	4.7	2.72	5.0
							2.80	—	2.80	0.8	2.80	2.1	2.80	2.1	2.80	4.0
									2.88	-2	2.88	-1.3	2.88	-0.6	2.88	1.9
											2.96	-2	2.96	-2	2.96	1.1
															3.04	0.1

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	127		132		131		12[illegible]		133		134		135		136	
DATE (1960)	7/12		7/12		7/12		7/12		7/12		7/12		7/12		7/12	
HOUR																
SITE NO	7		7		7		7		7		7		7		7	
REL AZ DEG	0		0		0		0		0		0		0		0	
0 DEG COUNT																
PROBE HT FT	18		16		15		14		12		10		8		6	
NOTES	FEP		ENP		ENP		ENP		ENP		FEP		FEP		FEP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	16.8	.08	16.3	.08	13.[illegible]	.08	24.0	.08	24.1	.08	26.0	.08	25.4	.08	24.7
	.16	15.[illegible]	.16	15.[illegible]	.16	23.1	.16	24.6	.16	26.2	.16	26.0	.16	26.7	.16	26.4
	.24	15.[illegible]	.24	11.7	.24	23.6	.24	24.8	.24	27.[illegible]	.24	25.8	.24	28.0	.24	28.1
	.32	12.[illegible]	.32	[illegible]	.32	2[illegible].1	.32	[illegible]	.32	27.8	.32	27.8	.32	29.4	.32	27.1
	.40	[illegible]	.40	11.1	.40	[illegible]	.40	[illegible]	.40	[illegible]	.40	[illegible]	.40	30.1	.40	31.1
	.48	[illegible]	.48	[illegible]	.48	[illegible]	.48	[illegible]	.48	[illegible]	.48	[illegible]	.48	[illegible]	.48	[illegible]
	.56	[illegible]	.56	[illegible]	.56	[illegible]	.56	[illegible]	.56	[illegible]	.56	31.6	.56	33.1	.56	[illegible]
	.64	21.[illegible]	.64	23.[illegible]	.64	24.4	.64	[illegible]	.64	[illegible]	.64	31.5	.64	32.5	.64	32.9
	.72	24.[illegible]	.72	26.6	.72	23.9	.72	27.0	.72	[illegible]	.72	31.[illegible]	.72	32.6	.72	32.6
	.80	30.9	.80	21.[illegible]	.80	26.5	.80	27.7	.80	27.3	.80	30.4	.80	32.1	.80	32.0
	.88	3[illegible]	.88	27.[illegible]	.88	2[illegible].5	.88	28.0	.88	29.8	.88	30.4	.88	31.2	.88	31.0
	.96	31.9	.96	29.[illegible]	.96	29.2	.96	28.9	.96	29.3	.96	29.[illegible]	.96	30.3	.96	31.3
	1.04	31.3	1.04	29.1	1.04	29.4	1.04	28.9	1.04	29.3	1.04	28.0	1.04	28.4	1.04	27.8
	1.12	30.4	1.12	28.4	1.12	28.9	1.12	28.1	1.12	28.6	1.12	26.[illegible]	1.12	26.8	1.12	24.5
	1.20	29.4	1.20	26.[illegible]	1.20	27.8	1.20	26.1	1.20	26.1	1.20	25.0	1.20	24.[illegible]	1.20	21.1
	1.28	28.1	1.28	24.1	1.28	26.2	1.28	24.1	1.28	24.4	1.28	23.3	1.28	21.5	1.28	17.0
	1.36	25.4	1.36	21.4	1.36	23.3	1.36	21.9	1.36	22.4	1.36	21.6	1.36	20.0	1.36	14.3
	1.44	22.3	1.44	8.1	1.44	19.1	1.44	18.7	1.44	21.0	1.44	19.5	1.44	19.1	1.44	13.6
	1.52	19.4	1.52	15.4	1.52	15.6	1.52	15.0	1.52	16.3	1.52	11.2	1.52	11.6	1.52	12.4
	1.60	12.7	1.60	14.3	1.60	14.2	1.60	17.8	1.60	15.1	1.60	14.4	1.60	15.5	1.60	10.7
	1.68	12.0	1.68	14.[illegible]	1.68	14.5	1.68	11.7	1.68	12.6	1.68	11.6	1.68	13.3	1.68	8.4
	1.76	14.7	1.76	13.6	1.76	14.4	1.76	11.6	1.76	11.5	1.76	8.1	1.76	9.4	1.76	5.4
	1.84	12.1	1.84	11.7	84	12.4	1.84	10.0	1.84	9.5	84	6.0	1.84	4.4	1.84	0
	1.92	10.0	1.92	8.5	1.92	11.0	1.92	8.1	1.92	1.3	1.92	4.2	1.92	-2.2	1.92	-2.2
	2.00	7.1	2.00	5.5	2.00	7.9	2.00	6.0	2.00	4.3	2.00	3.2				
	2.08	3.0	2.08	1.2	2.08	5.5	2.08	3.7	2.08	1.6	2.08	2.1				
	2.16	-0.2	2.16	-2.2	2.16	1.6	2.16	0.2	2.16	-2.2	2.16	2.2				
	2.24	-2.			2.24	-2.2	2.24	-2.0			2.24	2.8				
											2.32	3.6				
											2.40	4.8				
											2.48	6.0				
											2.56	6.6				
											2.64	6.8				
											2.72	6.1				
											2.80	5.4				
											2.88	4.0				
											2.96	3.3				
											3.04	2.8				

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	137		139		140		141		142		143		144		145	
DATE (1960)	7/12		7/12		7/12		7/12		7/12		7/12		7/1[illegible]		7/12	
HOUR																
SITE NO	7		8		8		8		8		8		8		8	
REL AZ DEG	0		15		15		15		15		15		[illegible]		15	
O-DEG COUNT																
PROBE HT, FT	4		38		31		22		2[illegible]		22		18		17	
NOTES	ENP		ENP		ENP				ENP		ENP		ENP		ENP	
	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB	Deg	DB
	.08	22.2	.08	11.0	.08	[illegible]	.08	14.6	.08	18.1	.08	18.[illegible]	.08	[illegible]	.08	16.7
	.16	24.1	.16	9.0	.16	[illegible]	.16	14.3	.16	18.3	.16	14.2	.16	11.3	.16	17.3
	.24	25.6	.24	6.0	.24	[illegible]	.24	14.3	.24	18.1	.24	14.9	.24	13.2	.24	17.1
	.32	26.5	.32	3.6	.32	13	.32	14.1	.32	19.1	.32	16.0	.32	13.8	.32	17.7
	.40	27.8	.40	6.9	.40	[illegible]	.40	[illegible]	.40	20.4	.40	17.2	.40	15.1	.40	18.4
	.48	28.6	.48	6.1	.48	13.1	.48	16.1	.48	21.0	.48	16.7	.48	10.3	.48	18.8
	.56	29.0	.56	7.2	.56	14.3	.56	18.4	.56	21.3	.56	[illegible]	.56	5.1	.56	19.5
	.64	29.1	.64	10.2	.64	14.1	.64	17.4	.64	[illegible]	.64	[illegible]	.64	6.7	.64	[illegible]
	.72	29.8	.72	11.5	.72	16.3	.72	[illegible]	.72	23.0	.72	17.8	.72	14.4	.72	22.2
	.80	29.0	.80	13.6	.80	17.8	.80	23.0	.80	24.0	.80	19.5	.80	19.1	.80	23.1
	.88	28.2	.88	12.3	.88	20.4	.88	24.8	.88	25.9	.88	22.1	.88	22.1	.88	24.2
	.96	26.4	96	11.1	.96	22.5	96	27.0	96	27.2	96	24.3	96	24.[illegible]	.96	24.1
	1.04	24.1	104	19.9	1.04	25.0	104	28.5	1.04	28.4	1.04	25.7	1.04	22.9	1.04	24.7
	1.12	22.2	1.12	22.6	1.12	26.8	112	29.1	112	29.2	112	23	112	26.0	112	24.5
	1.20	19.0	1.20	24.4	1.20	28.8	120	30.5	1.20	21.8	1.20	[illegible]5	1.20	26.0	1.20	23.1
	1.28	16.0	1.28	26.1	1.28	27.4	128	30.5	128	29.8	1.28	27.3	1.28	25.0	1.28	22.0
	1.36	13.2	136	27.1	136	29.1	136	30.1	136	29.1	136	26.2	1.36	23.4	1.36	19.7
	144	12.3	144	28.5	144	29.4	144	29.1	144	28.5	144	24.9	144	21.2	144	16.8
	1.52	11.4	1.52	28.3	1.52	28.8	152	28.4	152	27.0	152	22.6	1.52	16.7	1.52	12.8
	1.60	10.2	1.60	21.6	1.60	28.0	160	26.6	160	24.1	160	19.5	1.60	[illegible]	160	10.9
	1.68	7.8	168	26.5	168	26.1	168	22.6	168	[illegible]	168	[illegible]	168	13.3	168	8.1
	1.76	5.0	1.76	22.2	176	21.2	176	21.5	176	17.0	176	14.2	176	11.5	176	6.5
	1.84	1.1	184	23.1	184	21.5	184	18.0	184	16.1	184	12.4	184	7.7	184	5.5
	1.92	-2.2	192	20.3	192	19.0	192	17.1	192	15.0	192	11.2	192	8.4	192	4.3
			200	17.0	200	16.8	200	14.9	200	13.4	200	9.7	200	7.1	200	6.3
			208	15.1	208	13.2	208	12.5	208	11.3	208	7.5	208	3.9	208	2.2
			216	14.2	216	12.1	216	[illegible]	216	7.1	216	5.1	216	0.4		
			224	12.1	224	10.3	224	0.2	224	4.1	224	3.6	224	-2.1		
			232	9.1	232	7.3	232	2.2	232	1.8	232	0.9				
			240	4.5	240	4.1			240	0.1	240	2.2				
			248	-0.4	248	1.9			248	-2.0						
			256	-2.2	256	-0.3										
					264	2.2										

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	146		147		149		150		151		152		153		154	
DATE (1960)	7/10		7/10		7/10		7/1[illegible]		7/12		7/12		7/12		7/12	
HOUR					1500											
SITE NO	8		8		9		9		9		9		9		9	
REL AZ DEG	1.5		1.5		0.25		0.25		0.25		0.25		0.25		0.25	
0-DEG COUNT																
PROBE HT FT	10		6		38		34		30		26		22		18	
NOTES	F.I.P.		F.M.P.		F.N.P.		F.I.P.		L.N.P.		F.N.P.		F.N.P.		F.L.P.	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	15.3	.08	14.6	.08	14.0	.08	[illegible]	.08	16.7	.08	18.6	[illegible]	17.6	8	15.4
	.16	15.7	.16	[illegible]	.16	13.5	.16	14.8	.16	[illegible]	.16	18.7	.16	19.3	.16	16.4
	.24	17.7	.24	17.4	.24	11.9	.24	14.2	.24	[illegible]	.24	19.4	.24	20.2	.24	16.8
	.32	18.4	.32	[illegible]	.32	8.1	.32	12.8	.32	[illegible]	.32	19.4	.32	20.1	.32	16.5
	.40	20.0	.40	20.0	.40	3.5	.40	11.2	.40	16.6	.40	19.6	.40	20.4	.40	17.4
	.48	21.3	.48	20.3	.48	5.8	.48	9.1	.48	16.8	.48	19.4	.48	22.2	.48	12.4
	.56	21.2	.56	20.3	.56	7.3	.56	8.3	.56	17.6	.56	18.9	.56	19.8	.56	4.7
	.64	21.3	.64	20.2	.64	10.6	.64	10.5	.64	17.8	.64	19.6	.64	19.5	.64	2.3
	.72	21.7	.72	19.3	.72	13.6	.72	13.1	.72	18.3	.72	[illegible]	.72	20.5	.72	11.5
	.80	21.6	.80	18.0	.80	15.3	.80	14.7	.80	20.0	.80	21.8	.80	22.2	.80	21.5
	.88	14.7	.88	16.6	.88	11.4	.88	17.7	.88	21.7	.88	23.7	.88	24.6	.88	24.1
	.96	18.1	.96	15.0	.96	19.5	.96	19.8	.96	23.7	.96	25.4	.96	26.4	.96	25.6
	1.14	[illegible]	1.04	13.1	1.04	21.6	1.04	21.9	1.04	25.4	1.04	26.5	1.04	26.2	1.04	26.1
	1.12	13.4	1.12	14.1	1.12	23.6	1.12	23.8	1.12	21.1	1.12	27.8	1.12	21.4	1.12	26.6
	1.20	11.0	1.20	14.1	1.20	25.6	1.20	25.6	1.20	21.8	1.20	28.0	1.20	21.5	1.20	26.4
	1.28	8.8	1.28	14.9	1.28	26.9	1.28	26.9	1.28	28.0	1.28	21.8	1.28	21.1	1.28	25.2
	1.36	6.1	1.36	14.4	1.36	27.9	1.36	21.2	1.36	28.3	1.36	21.2	1.36	22.5	1.36	23.6
	1.44	3.9	1.44	12.8	1.44	27.9	1.44	26.1	1.44	21.3	1.44	25.9	1.44	23.9	1.44	20.4
	1.52	-0.2	.52	10.0	1.52	28.2	1.52	26.4	1.52	26.8	1.52	24.0	1.52	21.6	1.52	18.5
	1.60	-0.4	1.60	8.9	1.60	21.6	1.60	25.8	1.60	25.4	1.60	21.5	1.60	19.2	1.60	15.7
	1.68	-0.5	1.68	6.7	1.68	25.8	1.68	23.9	1.68	23.4	1.68	18.4	1.68	16.9	1.68	13.5
	1.76	0.5	1.76	4.1	1.76	23.8	1.76	21.8	1.76	20.3	1.76	15.4	1.76	14.4	1.76	12.9
	1.84	-0.8	1.84	2.5	1.84	21.8	1.84	19.2	1.84	13.6	1.84	13.1	1.84	12.0	1.84	11.8
	1.92	-2.2	1.92	1.1	1.92	19.2	1.92	16.9	1.92	14.1	1.92	12.1	1.92	10.2	1.92	10.0
			2.00	1.2	2.00	16.8	2.00	15.0	2.00	13.5	2.00	7.4	2.00	7.4	2.00	7.8
					2.08	15.2	2.08	13.4	2.08	10.8	2.08	2.3	2.08	5.1	2.08	5.4
					2.16	13.9	2.16	11.0	2.16	8.0	2.16	[illegible]	2.16	3.0	2.16	2.4
					2.24	12.6	2.24	8.2	2.24	5.0			2.24	2.0	2.24	0.8
					2.32	10.1	2.32	5.5	2.32	0.6			2.32	0.8		
					2.40	6.3	2.40	0.5					2.40	-1		
					2.48	1.4										
					2.56	-2.0										

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	125		126		127		[illegible]		[illegible]		[illegible]		[illegible]		163	
DATE (1960)	7/12		7/12		7/12		7/13		7/[illegible]		7/13		7/12		7/13	
HOUR																
SITE NO	9		9		9		2		2		2		2		2	
REL AZ DEG	0.15		0.75		0.75		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	14		10		6		37		37		30		26		22	
NOTES	ENP		ELP		ENP		EEP		EEP		EEP		EEP		EEP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	13.1	.08	13.6	.08	13.3	.08	[illegible]	.08	8.8	.08	[illegible]	.08	7.5	.08	18.4
	.16	14	.16	14.7	.16	15.1	.16	22.4	.16	18.7	.16	22.4	.16	7.0	.16	24
	.24	15	.24	16.5	.24	19.7	.24	21.1	.24	[illegible]	.24	[illegible]	.24	7.1	.24	16.3
	.32	15.9	.32	18.8	.32	21.9	.32	20.6	.32	19.9	.32	20.8	.32	11	.32	[illegible]
	.40	17.0	.40	20.8	.40	23.2	.40	20.0	.40	[illegible]	.40	20.8	.40	14.2	.40	5.5
	.48	19.2	.48	22.5	.48	24.4	.48	11.4	.48	19.2	.48	21.2	.48	15.7	.48	1.5
	.56	21.2	.56	24.3	.56	25.1	.56	15.5	.56	[illegible]	.56	23	.56	15.1	.56	18.9
	.64	22.7	.64	25.3	.64	25.2	.64	11.4	.64	[illegible]	.64	[illegible]	.64	16.1	.64	21.4
	.72	24.8	.72	26.2	.72	25.7	.72	7.2	.72	18.6	.72	22.0	.72	18.9	.72	22.4
	.80	25.8	.80	26.1	.80	25.8	.80	3.3	.80	19.6	.80	22.0	.80	21.7	.80	25.4
	.88	26.4	.88	26.8	.88	25.3	.88	9.8	.88	20.9	.88	22.0	.88	24.3	.88	21.9
	.96	27.1	.96	26.3	.96	24.3	.96	14.3	.96	23.2	.96	22.1	.96	26.6	.96	23.8
	1.04	26.8	1.04	23.5	1.04	22.5	1.04	17.1	1.04	23.2	1.04	23.9	1.04	29.1	1.04	[illegible]
	1.12	26.1	1.12	24.1	1.12	21.2	1.12	21.4	1.12	24.2	1.12	26.7	1.12	30.9	1.12	33.1
	1.20	24.6	1.20	22.0	1.20	19.7	1.20	24.0	1.20	25.5	1.20	29.1	1.20	32.0	1.20	34.0
	1.28	23.6	1.28	19.4	1.28	17.7	1.28	25.7	1.28	26.8	1.28	31.8	1.28	33.6	1.28	34.0
	1.36	21.2	1.36	16.8	1.36	14.1	1.36	27.8	1.36	29.4	1.36	32.9	1.36	33.9	1.36	33.8
	1.44	17.8	1.44	13.0	1.44	13.1	1.44	29.6	1.44	30.9	1.44	34.5	1.44	33.7	1.44	33.0
	1.52	15.1	1.52	11.0	1.52	13.0	1.52	31.3	1.52	31.9	1.52	34.6	1.52	33.7	1.52	31.8
	1.60	12.0	1.60	10.1	1.60	10.5	1.60	31.9	1.60	32.5	1.60	34.0	1.60	32.0	1.60	30.3
	1.68	10.3	1.68	9.2	1.68	8.6	1.68	32.3	1.68	32.8	1.68	33.1	1.68	30.6	1.68	28.3
	1.76	9.1	1.76	8.1	1.76	7.1	1.76	32.5	1.76	32.2	1.76	32.1	1.76	28.8	1.76	26.0
	1.84	7.8	1.84	5.6	1.84	2.7	1.84	32.0	1.84	31.1	1.84	30.9	1.84	26.8	1.84	24.0
	1.92	6.5	1.92	2.3	1.92	-1.1	1.92	31.2	1.92	29.9	1.92	28.9	1.92	24.2	1.92	21.8
	2.00	3.5	2.00	-2			2.00	29.5	2.00	28.3	2.00	26.3	2.00	22.0	2.00	11.8
	2.08	1.6					2.08	27.8	2.08	26.8	2.08	23.0	2.08	20.5	2.08	15.0
	2.16	-2					2.16	26.0	2.16	23.1	2.16	20.8	2.16	19.1	2.16	11.2
							2.24	23.0	2.24	21.1	2.24	19.0	2.24	17.0	2.24	6.3
							2.32	21.5	2.32	20.5	2.32	16.1	2.32	13.2	2.32	2.8
							2.40	19.0	2.40	18.0	2.40	14.6	2.40	8.1	2.40	-5
							2.48	16.6	2.48	16.0	2.48	9.6	2.48	3.3	2.48	-22+
							2.56	16.0	2.56	13.4	2.56	6.3	2.56	-12		
							2.64	11.4	2.64	7.7	2.64	3.1	2.64	-22+		
							2.72	7.1	2.72	2.4	2.72	3.4				
							2.80	2.1	2.80	-22+	2.80	-22+				
							2.88	1.4								
							2.96	-6								
							3.04	-22+								

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	164		165		166		167		168		169		170		172	
DATE (1960)	2/13		2/13		2/13		2 2		2/13		2/13		2/1		2/13	
HOUR																
SITE NO	2		2		2		5		2		2		2		5	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT																
PROBE HT FT	18		17		16		15		14		10		6		31	
NOTES	F.E.P		F.E.P		F.E.P		F.E.P		F.E.P		F.E.P		F.E.P		F.E.P	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	25.1	.08	24.1	.08	22.0	.08	23.1	.8	23.1	.08	25.7	.08	21.2	.08	2.9
	.16	25.3	.16	25.4	.16	23.6	.16	23.1	.16	22.8	.16	26.6	.16	28.6	.16	4.9
	.24	26.2	.24	26.8	.24	24.1	.24	24.1	.24	24.1	.24	27.2	.24	30.1	.24	5.5
	.32	26.8	.32	27.1	.32	25.1	.32	24.6	.32	23.9	.32	26.9	.32	31.8	.32	6.7
	.40	27.2	.40	21.9	.40	24.9	.40	24.0	.40	23.4	.40	27.5	.40	32.9	.40	8.3
	.48	26.9	.48	27.6	.48	24.3	.48	23.6	.48	22.3	.48	29.3	.48	34.3	.48	9.6
	.56	27.4	.56	21.6	.56	24.0	.56	22.2	.56	22.9	.56	31.1	.56	34.6	.56	8.6
	.64	27.8	.64	21.6	.64	23.8	.64	23.4	.64	24.5	.64	32.5	.64	35.7	.64	3.8
	.72	28.8	.72	28.2	.72	25.8	.72	26.1	.72	27.7	.72	34.1	.72	35.8	.72	2.2
	.80	29.4	.80	30.1	.80	27.6	.80	30.0	.80	30.9	.80	35.5	.80	35.7	.80	2.5
	.88	30.0	.88	31.6	.88	30.0	.88	32.2	.88	32.2	.88	35.1	.88	35.4	.88	10.1
	.96	32.2	.96	33.5	.96	31.9	.96	33.1	.96	33.3	.96	35.6	.96	33.6	.96	13.7
	1.04	33.8	1.04	34.0	1.04	33.1	1.04	34.3	1.04	34.3	1.04	35.4	1.04	32.2	1.04	14.9
	1.12	34.4	1.12	34.6	1.12	33.2	1.12	34.7	1.12	34.3	1.12	34.7	1.12	30.9	1.12	16.9
	1.20	34.4	1.20	35.2	1.20	32.9	1.20	34.2	1.20	34.1	1.20	32.2	1.20	28.6	1.20	19.3
	1.28	33.9	1.28	34.8	1.28	32.4	1.28	33.6	1.28	31.6	1.28	30.2	1.28	26.0	1.28	21.8
	1.36	32.6	1.36	32.0	1.36	30.7	1.36	32.3	1.36	24.9	1.36	21.4	1.36	23.3	1.36	23.5
	1.44	31.6	1.44	31.9	1.44	24.1	1.44	30.4	1.44	28.0	1.44	25.0	1.44	21.2	1.44	25.7
	1.52	29.1	1.52	29.2	1.52	27.4	1.52	27.8	1.52	23.1	1.52	21.1	1.52	19.6	1.52	27.7
	1.60	21.1	1.60	26.9	1.60	25.3	1.60	25.2	1.60	23.8	1.60	19.4	1.60	18.0	1.60	29.1
	1.68	24.5	1.68	24.0	1.68	22.8	1.68	22.4	1.68	22.6	1.68	17.8	1.68	16.5	1.68	31.2
	1.76	22.6	1.76	22.4	1.76	20.2	1.76	20.1	1.76	21.3	1.76	16.2	1.76	13.6	1.76	32.9
	1.84	20.6	1.84	21.1	1.84	18.8	1.84	18.8	1.84	18.0	1.84	14.2	1.84	10.1	1.84	34.1
	1.92	19.3	1.92	20.2	1.92	17.0	1.92	11.0	1.92	15.3	1.92	11.1	1.92	5.0	1.92	34.9
	2.00	17.0	2.00	17.0	2.00	14.0	2.00	13.7	2.00	11.9	2.00	6.5	2.00	-22-	2.00	35.0
	2.08	14.0	2.08	13.3	2.08	10.1	2.08	8.3	2.08	8.1	2.08	2.0			2.08	35.1
	2.16	8.9	2.16	10.0	2.16	6.4	2.16	6.5	2.16	5.4	2.16	-22-			2.16	34.5
	2.24	4.1	2.24	8.0	2.24	6.1	2.24	6.0	2.24	5.0					2.24	33.0
	2.32	2.0	2.32	7.0	2.32	4.4	2.32	4.1	2.32	2.5					2.32	31.4
	2.40	-3	2.40	4.5	2.40	0.5	2.40	-.2	2.40	0.5					2.40	29.6
	2.48	-22-	2.48	-22-	2.48	-22-	2.48	-22-	2.48	0					2.48	26.9
															2.56	25.3
															2.64	23.4
															2.72	21.7
															2.80	19.7
															2.88	16.0
															2.96	11.5
															3.04	4.9
															3.12	1.0
															3.20	-1.7

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	173		174		175		176		177		178		179		180	
DATE (1960)	7/13		7/13		7/13		7/13		7/13		7/13		7/13		7/13	
HOUR																
SITE NO	5		5		5		5		5		5		5		5	
REL AZ DEG	0		0		0		0		0		0		0		0	
0-DEG COUNT																
PROBE HT, FT	34		30		26		22		18		15		14		13	
NOTES	E.L.P		E.L.P		E.L.P		[illegible]		E.L.P		[illegible]		[illegible]		[illegible]	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	16.0	.08	19.2	[illegible]	[illegible]	[illegible]	23.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22.5	[illegible]	[illegible]
	.16	2.1	[illegible]	18.2	.16	13.6	[illegible]	22.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.16	[illegible]
	.24	1.1	.24	17.6	.24	[illegible]	.24	[illegible]	.24	[illegible]	.24	[illegible]	.24	27.6	.24	[illegible]
	.32	12.6	.32	15.7	.32	[illegible]	.32	[illegible]	[illegible]	[illegible]	.32	[illegible]	[illegible]	31.2	.32	[illegible]
	.40	2.8	.40	14.2	.40	[illegible]	.40	[illegible]	.40	29.6	.40	[illegible]	[illegible]	31.9	.40	27.3
	.48	5.4	.48	11.9	.48	15.1	.48	[illegible]	.48	30.5	.48	35.1	.48	31.0	.48	[illegible]
	.56	3.2	.56	9.0	.56	17.1	.56	[illegible]	.56	31.1	.56	25.9	.56	[illegible]	.56	[illegible]
	.64	8.2	.64	10.3	.64	19.2	.64	[illegible]	.64	31.1	.64	[illegible]	[illegible]	24.5	.64	[illegible]
	.72	10.2	.72	2.4	.72	20.8	.72	20.1	.72	32.4	.72	21.7	.72	30.7	.72	32.0
	.80	13.2	.80	[illegible]	.80	[illegible]	.80	31.1	.80	32.5	.80	[illegible]	.80	33.3	.80	33.1
	.88	[illegible]	.88	18.1	.88	23.9	.88	26.2	.88	33.1	.88	33.7	.88	35.7	.88	35.8
	.96	13.4	.96	20.3	.96	25.3	.96	28.4	.96	34.3	.96	36.3	.96	37.3	.96	36.0
	1.04	17.0	1.04	22.4	1.04	27.4	1.04	[illegible]	1.04	35.6	1.04	37.3	1.04	37.8	1.04	36.4
	1.12	19.5	1.12	23.6	1.12	29.5	1.12	32.1	1.12	37.1	1.12	37.7	1.12	37.9	[illegible]	32.1
	1.20	21.8	1.20	26.5	1.20	30.9	1.20	35.0	1.20	37.2	1.20	37.9	1.20	31.7	[illegible]	36.1
	1.28	24.3	1.28	28.1	1.28	33.5	1.28	36.3	1.28	37.1	1.28	37.1	1.28	36.9	[illegible]	34.1
	1.36	25.5	1.36	30.3	1.36	34.9	1.36	36.8	1.36	37.8	1.36	[illegible]	1.36	[illegible]	1.36	33.4
	1.44	27.6	1.44	33.1	1.44	35.9	1.44	37.1	1.44	37.2	1.44	35.3	1.44	34.2	1.44	32.2
	1.52	27.5	1.52	34.5	1.52	36.5	1.52	36.4	1.52	35.9	1.52	33.5	1.52	31.5	1.52	29.5
	1.60	31.2	1.60	36.1	1.60	36.8	1.60	35.3	1.60	31.3	1.60	31.4	[illegible]	29.5	1.60	27.4
	1.68	32.6	1.68	36.2	1.68	36.4	1.68	33.9	1.68	[illegible]	[illegible]	28.8	[illegible]	21.1	[illegible]	24.7
	1.76	33.9	1.76	36.3	1.76	35.6	1.76	32.6	1.76	[illegible]	1.76	[illegible]	[illegible]	25.5	[illegible]	23.3
	1.84	34.6	1.84	36.1	1.84	34.5	1.84	[illegible]	1.84	[illegible]	1.84	24.7	1.84	23.5	[illegible]	[illegible]
	1.92	34.5	1.92	34.6	1.92	32.3	1.92	28.0	1.92	[illegible]	1.92	[illegible]	1.92	21.9	[illegible]	18.6
	2.00	[illegible]	2.00	33.6	2.00	30.4	2.00	[illegible]	2.00	23.5	2.00	[illegible]	2.00	18.0	[illegible]	15.2
	2.08	33.0	2.08	31.0	2.08	21.3	2.08	24.6	2.08	21.3	2.08	16.4	2.08	14.1	2.08	[illegible]
	2.16	31.5	2.16	28.9	2.16	26.0	2.16	22.7	2.16	18.2	2.16	13.0	2.16	8.8	2.16	8.2
	2.24	29.7	2.24	26.8	2.24	24.7	2.24	20.7	2.24	13.9	2.24	6.0	2.24	4.5	2.24	5.5
	2.32	27.6	2.32	25.3	2.32	23.6	2.32	11.6	2.32	6.8	2.32	1.2	2.32	1.6	2.32	-4
	2.40	25.9	2.40	23.8	2.40	21.0	2.40	11.7	2.40	1.5	2.40	-22+	2.40	-22+	2.40	-22+
	2.48	23.8	2.48	22.4	2.48	16.7	2.48	4.8	2.48	-1						
	2.56	22.1	2.56	19.5	2.56	12.1	2.56	3.2	2.56	-22+						
	2.64	19.9	2.64	17.0	2.64	3.1	2.64	2.0								
	2.72	17.1	2.72	10.9	2.72	-22+	2.72	-22+								
	2.80	13.2	2.80	6.3												
	2.88	8.0	2.88	2.3												
	2.96	1.0	2.96	1.0												
	3.04	-22+	3.04	-22+												

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	181		182		183		184		186		182		185		187	
DATE (1960)	7/3		7/3		7/3		7/3		7/3		7/3		7/3		7/3	
HOUR																
SITE NO	5		5		5		5		4		4		4		4	
REL AZ DEG	0		0		0		0		[illegible]		0				0	
O-DEG COUNT																
PROBE HT FT	12		11		10		[illegible]		38		34		30		26	
NOTES	[illegible]		[illegible]		[illegible]		[illegible]		CLP		ENP		ENP		ENP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	20.0	.08	26.6	.08	23.3	.08	30.1	.08	17.3	.08	7.7	.08	13.4	.08	11.5
	.16	27.8	[illegible]	22.0	.16	23.2	.16	32.1	.16	[illegible]	.16	5.6	.16	12.0	.16	17.0
	.24	28.5	.24	26.9	.24	31.4	.24	32.9	.24	[illegible]	.24	-1.2	.24	9.1	.24	17.2
	.32	28.6	.32	32.1	.32	18.7	.32	34.[illegible]	.32	15.[illegible]	.32	[illegible]	.32	8.6	.32	15.9
	.40	27.5	.40	33.5	.40	12.4	.40	31.7	.40	[illegible]	.40	[illegible]	.40	8.3	.40	14.9
	.48	26.4	[illegible]	21.6	.48	20.8	.48	36.7	.48	[illegible]	.48	[illegible]	.48	9.0	.48	14.4
	.56	26.9	[illegible]	25.[illegible]	.56	[illegible]	.56	37.2	.56	[illegible]	.56	[illegible]	.56	10.3	.56	15.6
	.64	28.1	.64	32.8	.64	32.4	.64	31.5	.64	[illegible]	.64	0	.64	11.7	.64	11.5
	.72	32.5	.72	33.6	.72	34.1	.72	37.[illegible]	.72	10.9	.72	5.5	.72	14.7	.72	20.2
	.80	33.6	.80	34.8	.80	36.6	.80	36.6	.80	19.1	.80	8.8	.80	16.4	.80	22.1
	.88	34.8	.88	36.5	.88	36.3	.88	36.1	.88	18.9	.88	13.[illegible]	.88	18.7	.88	23.9
	.96	36.6	.96	37.3	.96	36.1	.96	35.3	.96	18.6	.96	17	.96	21.5	.96	23.6
	1.04	36.5	1.04	37.7	1.04	36.[illegible]	1.04	34.0	1.04	19.2	1.04	20.1	1.04	24.2	1.04	27.1
	1.12	36.8	1.12	37.1	1.12	35.5	1.12	33.0	1.12	17.1	1.12	24	1.12	26.8	1.12	29.3
	1.20	36.0	1.20	36.0	1.20	34.4	1.20	31.1	1.20	22.9	1.20	[illegible]	1.20	28.4	1.20	29.6
	1.28	35.0	1.28	34.5	1.28	32.7	1.28	29.2	1.28	26.1	1.28	28.3	1.28	29.5	1.28	29.8
	1.36	33.5	1.36	32.1	1.36	30.4	1.36	27.0	1.36	28.6	1.36	29.1	1.36	30.2	1.36	29.1
	1.44	31.1	1.44	30.3	1.44	28.0	1.44	23.8	1.44	29.1	1.44	29.5	1.44	30.0	1.44	28.5
	1.52	28.5	1.52	27.7	1.52	25.7	1.52	21.2	1.52	29.8	1.52	29.6	1.52	29.4	1.52	27.5
	1.60	27.0	1.60	26.1	1.60	23.9	1.60	19.5	1.60	30.4	1.60	28.7	1.60	28.0	1.60	25.7
	1.68	24.7	1.68	24.1	1.68	22.1	1.68	17.1	1.68	30.2	1.68	31.2	1.68	26.5	1.68	24.0
	1.76	22.5	1.76	22.[illegible]	1.76	20.6	1.76	15.3	1.76	29	1.76	26.2	1.76	25.0	1.76	21.9
	1.84	20.1	1.84	19.3	1.84	18.0	1.84	9.8	1.84	21.3	1.84	23.5	1.84	22.1	1.84	19.3
	1.92	17.5	1.92	17.0	1.92	14.8	1.92	5.5	1.92	25.4	1.92	2.2	1.92	19.8	1.92	17.0
	2.00	14.2	2.00	12.1	2.00	11.8	2.00	1.3	2.00	23.1	2.00	19.2	2.00	11.6	2.00	15.2
	2.08	9.6	2.08	9.2	2.08	8.7	2.08	2.5	2.08	20.4	2.08	17.[illegible]	2.08	15.4	2.08	13.6
	2.16	7.5	2.16	5.8	2.16	5.3	2.16	3.1	2.16	17.7	2.16	15.4	2.16	13.7	2.16	11.5
	2.24	[illegible]	2.24	3.6	2.24	3.1	2.24	8.6	2.24	[illegible]	2.24	[illegible]	2.24	12.4	2.24	7.2
	2.32	[illegible]	2.32	1.5	2.32	[illegible]	2.32	10.5	2.32	14.5	2.32	1.4	2.32	10.1	2.32	3.3
	2.40	-1.1	2.40	5.0	2.40	8.4	2.40	11.8	2.40	13.3	2.40	8.2	2.40	6.1	2.40	-1.6
	2.48	-4.4	2.48	1.6	2.48	10.3	2.48	11.8	2.48	8.8	2.48	3.[illegible]	2.48	2.5	2.48	2.2+
	2.56	6.1	2.56	8.8	2.56	10.3	2.56	11.9	2.56	4.5	2.56	0	2.56	1.5		
	2.64	3.3	2.64	1.6	2.64	8.5	2.64	11.4	2.64	1.7	2.64	-2.2+	2.64	-1.2		
	2.72	9	2.72	7.0	2.72	7.2	2.72	0.3	2.72	0.2						
	2.80	8.3	2.80	6.6			2.80	9.8	2.80	-2.2-						
	2.88	7.7					2.88	9.6								
	2.96	6.2					2.96	9.3								
	3.04	6.0														

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TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	190		191		12		12		11		11		11		11	
DATE (1960)	2,13		2,3		1/13		1/13		1/13		1/13		1/13		1/13	
HOUR																
SITE NO	4		4		4		4		1		4		4		4	
REL AZ DEG	0		0		0		0		0		0		0		0	
O-DEG COUNT	22		23		21		[illegible]		19		5		12		14	
PROBE HT FT																
NOTES	ENP		ENP		EGP		ELP		ECC		ENP		ENC		ENP	
	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB	DEG	DB
	.08	21.7	.08	21.6	.08	20.8	.08	22.2	.08	20.1	.08	21.0	.08	21.8	.08	22.2
	.16	22.4	.16	21.5	.16	21.3	.16	23.0	.16	21.1	.16	21.0	.16	22.2	.16	22
	.24	23.2	.24	21.8	.24	22.2	.24	24.2	.24	22.5	.24	[illegible]	.24	22.6	.24	21.9
	.32	22.9	.32	22.2	.32	22.3	.32	24.3	.32	23.0	.32	21.5	.32	23.5	.32	21.6
	.40	23.2	.40	22.5	.40	22.8	.40	24.0	.40	22.7	.40	21.1	.40	23.5	.40	19.7
	.48	23.3	.48	22.2	.48	22.4	.48	24.0	.48	21.4	.48	18.4	.48	23.0	.48	16.2
	.56	22.9	.56	22.5	.56	22.2	.56	23.3	.56	20.5	.56	17.7	.56	20.8	.56	14.1
	.64	22.8	.64	23.1	.64	22.2	.64	23.3	.64	21.1	.64	17.5	.64	20.8	.64	20.1
	.72	23.6	.72	24.4	.72	23.4	.72	24.6	.72	24.8	.72	24.2	.72	22.3	.72	24.3
	.80	25.3	.80	25.6	.80	25.3	.80	26.1	.80	25.6	.80	27.9	.80	25.2	.80	27.4
	.88	27.8	.88	27.1	.88	27.0	.88	28.1	.88	27.6	.88	29.4	.88	27.4	.88	29.2
	.96	29.2	.96	29.1	.96	28.1	.96	30.3	.96	30.1	.96	31.5	.96	29.3	.96	30.7
	1.04	30.5	1.04	31.8	1.04	30.4	1.04	30.6	1.04	31.6	1.04	31.7	1.04	30.4	1.04	30.6
	1.12	30.9	1.12	32.8	1.12	31.8	1.12	31.4	1.12	31.5	1.12	32.1	1.12	30.9	1.12	30.1
	1.20	30.1	1.20	32.4	1.20	32.5	1.20	32.0	1.20	31.6	1.20	32.1	1.20	30.9	1.20	29.8
	1.28	30.6	1.28	32.1	1.28	31.8	1.28	31.5	1.28	30.6	1.28	31.1	1.28	30.3	1.28	28.2
	1.36	29.6	1.36	32.3	1.36	30.4	1.36	30.4	1.36	24.9	1.36	30.4	1.36	28.6	1.36	25.9
	1.44	28.4	1.44	30.1	1.44	29.5	1.44	29.2	1.44	28.1	1.44	28.9	1.44	26.8	1.44	23.8
	1.52	26.9	1.52	29.1	1.52	27.6	1.52	27.0	1.52	26.1	1.52	26.2	1.52	25.4	1.52	21.1
	1.60	24.2	1.60	26.1	1.60	25.5	1.60	24.6	1.60	23.2	1.60	23.9	1.60	23.3	1.60	18.7
	1.68	21.6	1.68	24.2	1.68	22.5	1.68	22.1	1.68	21.4	1.68	[illegible]	1.68	20.3	1.68	17.2
	1.76	18.7	1.76	22.5	1.76	19.1	1.76	19.3	1.76	18.8	[illegible]	[illegible]	[illegible]	12.6	1.76	16.0
	1.84	16.4	1.84	20.2	1.84	17.0	1.84	17.2	[illegible]	16.5	1.84	17.4	1.84	16.5	[illegible]	14.5
	1.92	14.9	1.92	18.1	1.92	15.2	1.92	15.4	1.92	14.0	1.92	[illegible]	1.92	14.1	1.92	12.1
	2.00	13.5	2.00	16.0	2.00	14.0	2.00	13.4	2.00	13.1	2.00	13.5	2.00	11.8	2.00	8.9
	2.08	10.9	2.08	14.0	2.08	10.4	2.08	10.5	2.08	10.1	2.08	10.1	2.08	8.9	2.08	6.1
	2.16	6.4	2.16	9.1	2.16	7.2	2.16	6.5	2.16	6.0	2.16	3.1	2.16	5.7	2.16	3.3
	2.24	2.0	2.24	6.3	2.24	4.7	2.24	4.1	2.24	4.2	2.24	5.6	2.24	3.1	2.24	1.1
	2.32	-0.7	2.32	3.8	2.32	3.3	2.32	4.0	2.32	2.5	2.32	4.3	2.32	3.0	2.32	[illegible]
	2.40	-2.2-	2.40	0.1	2.40	1.3	2.40	1.5	2.40	0.3	2.40	0.6	2.40	0.2	2.40	2.9
			2.48	-2.2-	2.48	-2.2-	2.48	-2.2-	2.48	-2.2-	1.48	-2.2-	2.48	-2.2-	2.48	4.5
															2.56	5.0
															2.64	4.4
															2.72	2.1
															2.80	-1.6

TEST DATA ON DYNAMIC BEAMSHAPE
FIXED-PROBE FIELD STRENGTH VERSUS INSTANTANEOUS SCAN ANGLE

TEST NO	198		199	
DATE (1980)	7/13		7/13	
HOUR				
SITE NO	4		4	
REL AZ DEG	0		0	
0-DEG COUNT				
PROBE HT FT	10		6	
NOTES	FNP		FNP	
	Deg	DB	Deg	DB
	08	23.0	08	25.3
	16	23.7	.16	26.4
	24	24.6	.24	27.4
	.32	24.9	.32	28.5
	40	26.5	40	29.6
	.48	27.3	.48	30.1
	56	28.1	56	31.4
	.64	30.3	.64	31.3
	72	31.1	72	31.5
	80	3.4	.80	31.1
	88	31.2	88	30.1
	.96	31.0	96	30.3
	1.04	30.3	1.04	29.0
	1.12	24.8	1.12	21.5
	1.20	28.4	1.20	25.8
	1.28	26.8	1.28	23.6
	1.36	24.9	1.36	21.8
	1.44	21.9	1.44	18.6
	1.52	20.2	1.52	16.0
	1.60	17.4	1.60	14.2
	1.68	13.0	1.68	12.4
	1.76	13.0	1.76	10.5
	1.84	11.0	1.84	7.4
	1.92	8.6	1.92	3.5
	2.00	5.2	2.00	-.5
	2.08	1.2	2.08	-2.2+
	2.16	-2.2+		
	2.24	-1.7		
	2.32	2.2		
	2.40	6.2		
	2.48	7.5		
	2.56	7.1		

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TEST DATA ON RECEIVER MODEL A
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	202A	202B	202C	203	205A	205B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DATE (1960)	[illegible]	[illegible]	2/24	2/24	2/25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HOUR	[illegible]	1100	1130	1145			[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SITE NO	2	2	3	3	5	5	5	5	5	5	5	5	5	5	5	5
REL AZ DEG	0	0	0	0	0		0	0	0	0	0	0	0	0	[illegible]	[illegible]
D-CODE DEG	-0.26	0.26	0.26	0.26	0.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.48	[illegible]	0.41	[illegible]	[illegible]	[illegible]
SCAN LIM DEG	0.44	-0.89	-0.89	0.19	[illegible]	[illegible]	0.002	0.13	0.11	[illegible]				-0.34		
CALIB 0°																
DRIFT 2°																
DEG 4°																
NOTES											GN	N	BN	E	G	
Rcvr Ht. Ft.	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
38																
37	1.52	[illegible]	1.47	1.41	1.93	1.89	1.89		[illegible]	1.14	1.38	1.33	1.37	1.31	1.31	1.28
36											1.3	1.32	1.35		[illegible]	1.35
35	1.45	1.43	1.43	[illegible]	1.82	1.80	1.76		[illegible]	1.25	1.31	1.32	1.32	[illegible]	[illegible]	[illegible]
34											[illegible]	1.23	1.28		1.29	[illegible]
33	1.37	1.31	.38	[illegible]	1.76	1.72	1.69		1.19	[illegible]	1.31	1.27	1.24	[illegible]	1.24	[illegible]
32											1.20	1.2	[illegible]		[illegible]	[illegible]
31	1.3	1.32	1.32	1.3	1.67	1.64	1.6		[illegible]	[illegible]	1.17	[illegible]	1.17	[illegible]	1.1	1.1
30											1.14	1.11	[illegible]		[illegible]	[illegible]
29	[illegible]	1.25	[illegible]	1.34	1.59	1.5	1.4		.82	[illegible]	1.09	1.09	1.0	[illegible]	[illegible]	[illegible]
28											.96	[illegible]	[illegible]		[illegible]	[illegible]
27	[illegible]	[illegible]	1.18	1.18	1.57	1.48	1.4		[illegible]	[illegible]	1.02			1.0	[illegible]	[illegible]
26															19	[illegible]
25	1.11	1.15	1.11	1.1	1.44	1.37	1.38	1.36	[illegible]	[illegible]				.96	.95	[illegible]
24															.92	.91
23	1.09	1.05	1.06	1.06	1.31	1.32	1.32	1.30	[illegible]	[illegible]				.89	.88	[illegible]
22															[illegible]	[illegible]
21	1.05	1.00	.99	1.01	1.19	[illegible]	[illegible]	1.26	[illegible]	[illegible]				[illegible]	.81	[illegible]
20	1.01	.96	.96			[illegible]	[illegible]	1.35	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
19	.97	.11	.94			[illegible]	[illegible]	1.24	[illegible]	[illegible]				.75	[illegible]	[illegible]
18	.95	.91	.91			[illegible]	[illegible]	[illegible]	.12	[illegible]				.71	.71	[illegible]
17	.93	.87	.90			[illegible]	[illegible]	[illegible]	.37					[illegible]	[illegible]	
16	.93	.86	.88			[illegible]	[illegible]	1.41	[illegible]	.38				[illegible]	.63	[illegible]
15	.81	[illegible]	.86			[illegible]	[illegible]	1.21	.3	.34				[illegible]	[illegible]	[illegible]
14	.86	.84	.82			[illegible]		1.21	[illegible]	.33				[illegible]	.54	[illegible]
13	.83	.82	.82			1.04	[illegible]	1.22	[illegible]	.31				.49	[illegible]	[illegible]
12	.80	.80	.80			1.03	[illegible]	1.22	.15	.33				.45	[illegible]	.44
11	.75	.77	.77			1.03	[illegible]		[illegible]	.33				.42	[illegible]	[illegible]
10	.70	.74	.69			[illegible]	[illegible]		.17	.31				.37	[illegible]	[illegible]
9	.62	.66	.62			[illegible]	1.09		.11	.33				.37	.31	[illegible]
8	.57	.58	.52			[illegible]			.12	.3				.32	[illegible]	[illegible]
7	.51	[illegible]	[illegible]			[illegible]			.01	[illegible]				.33	[illegible]	[illegible]
6	.47	.51	.46			[illegible]			.01	.21				.31	[illegible]	[illegible]
5	.43	[illegible]	.42						[illegible]	[illegible]				.31	[illegible]	[illegible]
4	.39															

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TEST DATA ON RECEIVER MODEL A
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	214C	215B	212B	213C	213D	215E	21[illegible]	[illegible]	215A	[illegible]	216A	216B	[illegible]	[illegible]	216F	216F
DATE (1960)	7/29	8/1	8/1	[illegible]	8/1	8/1	[illegible]	[illegible]	8/1	8/1	8/1	8/1	8/1	8/1	8/1	8/1
HOUR	340	1230	103	1030	102	132	12	13	02	132	1330	1330	1330	1330	1330	1330
SITE NO	5	5	5	5	5	5	5	5	5	5	2	2	2	2	2	2
REL AZ DEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O-CODE DEG	-0.44	-0.44	-0.44	0.44	0.44	-0.44	0.44	0.44	-0.44	-0.44	-0.44	-0.44	-0.44	-0.44	0.44	-0.44
SCAN LIM DEG		-0.40	-0.30	0.20	-0.10	0	+0.10	+0.20	+0.30	+0.40	-0.40	0.30	+0.20	+0.10	0	+0.10
CALIB DRIFT DEG 0°		0.04	-0.04	-0.04	-0.04	0.04	-0.04	0.04	0.04	-0.04	+0.05	-0.05	+0.05	+0.05	+0.05	0.05
2°																
4°		0.04	0.04	-0.04	-0.04	-0.04	-0.04	0.04	0.04	-0.04	+0.05	+0.05	0.05	+0.05	+0.05	+0.05
NOTES	B	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Rcvr. Ht., Ft.	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
38																
37	1.38	1.40	1.40	1.40	1.40	1.39	1.38	1.39	1.39	1.39	1.17	1.17	1.16	1.17	1.17	1.17
36	1.35	1.35	1.35	1.35	1.35	1.35	1.36	1.35	1.34	1.35	1.14	1.14	1.14	1.14	1.14	1.14
35	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	[illegible]	1.13	1.12	1.13	1.12	1.12
34	1.28	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.26	1.26	1.06	1.06	1.06	1.10	1.10	1.10
33	1.24	1.23	1.23	1.24	1.23	1.23	1.23	1.24	1.24	1.23	1.05	1.04	1.04	1.04	1.04	1.04
32	1.20	1.19	1.19	[illegible]	1.19	[illegible]	1.19	1.19	1.19	1.18	1.03	1.03	1.03	1.03	1.03	1.02
31	1.17	1.15	1.15	[illegible]	1.15	1.15	1.15	1.15	1.15	1.15	1.00	1.00	1.00	1.00	1.00	1.00
30	1.13	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	.96	.96	.96	[illegible]	.94	.93
29	1.09	1.08	1.08	1.08	1.09	1.09	1.09	1.09	1.09	1.09	.93	.93	.93	.93	.93	.92
28	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	.91	.90	.90	.90	.90	.89
27	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.02	.89	.88	.88	.87	.87	.85
26	.98	.97	.97	.97	.97	.97	.97	.97	[illegible]	1.01	.85	.86	.86	.86	.85	.83
25	.94	.92	.92	.92	.92	.92	.92	.92	.93	.99	.81	.81	.81	.81	.79	.79
24	.90	.88	.88	.88	.88	.89	.88	.86	.89	.99	.79	.79	.79	.79	.75	.78
23	.87	.83	.83	.83	.83	.83	.83	.83	.89	.91	.75	.75	.75	.74	.75	.79
22	.84	.79	.79	.79	.79	.78	.79	.80	.87	.91	.73	.73	.73	.72	.72	.76
21	.80	.75	.75	.75	.75	.75	.74	.79	.87	.91	.70	.70	.69	.68	.69	.74
20	.76	.71	.71	.71	.71	.70	.72	.78	.83	.97	.63	.68	.65	.63	.66	.73
19	.72	.68	.68	.65	.69	.66	.70	.77	.85	.98	.69	.67	[illegible]	[illegible]	.61	.74
18	.62	.63	.63	.63	.63	.62	.63	.76	.85	.94	.70	.66	.60	.61	.65	.71
17	.65	.62	.61	.60	.60	.60	.69	.74	.87	1.03	[illegible]	.65	.60	[illegible]	[illegible]	.72
16	.61	.56	.56	.56	.56	.5		.75	.88	1.00	.64	.60	.56	.59	.62	.73
15	.57	.53	.52	.53	.53			.75	.90	1.10	.59	.57	.55	.56	.64	.72
14	.53	.49	.49	.47	.4			.74	.94	1.14	.56	.55	.53	.56	.63	.71
13	.58	.41	.41	.44	.48			.76	.96		.52	.53	.50	.57	.63	.70
12	.44	.44	.43	.42	.46			.75	.98		.53	.52	.50	.56	.64	.74
11	.43	.41	.41	.40	.45	.54	.64	.74	.91		.50	.46	.48	.54	.63	.73
10	.39	.38	.36	.36	.43	.52	.64	.78			.37	.38	.44	.50	.62	.74
9	.35	.32	.30	.35	.42	.54	.68	.84			.33	.38	.43	.50	.62	.83
8	.30	.21	.26	.33	.42	.54	.74				.30	.38	.43	.50	.65	.87
7	.20	.15	.24	.33	.43	.62	.82				.27	.35	.45	.53	.70	.91
6	.14	.11	.21	.30	.44	.69					.25	.34	.42	.52	.72	.98
5	.13	.11	.22	.32	.52	.77					.25	.33	.42	.52	.76	.96
4		.10	.19	.30	.54						.24	.32	.40	.51	.83	

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TEST DATA ON RECEIVER MODEL A

RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	216G	216H	216I	217A	217B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DATE (1960)	8/1	8/1	8/1	8/4	8/4	8/4	8/4	[illegible]	8/4	8/4	[illegible]	8/4	8/5	8/8	[illegible]	8/8
HOUR	1330	1330	1330	1300	1200	1300	1300	[illegible]	1300	1300	1300	1300	[illegible]	1300	1330	1500
SITE NO	2	2	2	4	4	4	4	4	4	4	4	4	2	2	2	2
REL AZ DEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O-CODE DEG	-0.44	0.44	0.44	-0.44	0.44	0.44	-0.44	[illegible]	-0.44	[illegible]	-0.44	[illegible]	[illegible]	-0.44	[illegible]	[illegible]
SCAN LIM DEG	+0.20	+0.30	+0.10	-0.40	[illegible]	[illegible]	[illegible]	0	-0.10	+0.40	[illegible]	+0.40	[illegible]	[illegible]	[illegible]	[illegible]
CALIB DRIFT DEG 0°	+0.05	+0.05	+0.05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
2°																
4°	+0.05	+0.05	+0.05	+0.14	+0.14	[illegible]	[illegible]	+0.14	[illegible]	+0.14	[illegible]	[illegible]				
NOTES	L	L	L	L	L	L	L	L	L	L	L	L	a	a	a	a
Rcvr. Ht., Ft.	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
38																
37	1.17	1.16	1.12	.92	.92	.92	.92	.92	.92	.93	.92	1.04	1.13	[illegible]	1.15	[illegible]
36	1.15	1.13	1.10	.90	.90	.90	.92	.92	.92	.91	.96	1.03	1.10	1.10	1.10	1.10
35	1.13	1.12	1.08	.88	.88	.88	.88	.88	.88	.90	.96	1.03	1.06	1.06	1.06	[illegible]
34	1.10	1.08	1.08	.86	.86	.86	.86	.86	.86	.89	.96	1.03	1.05	1.05	1.05	1.05
33	1.04	1.04	1.02	.83	.83	.83	.83	.85	.83	.88	.96	1.05	1.02	[illegible]	1.02	[illegible]
32	1.01	1.01	1.02	.82	.82	.82	.82	.84	.84	.89	.96	1.04	.98	.97	.99	.97
31	.98	.99	1.06	.81	.80	.80	.80	.80	.83	.88	.96	1.04	[illegible]	[illegible]	[illegible]	[illegible]
30	.93	.98	1.04	.80	.80	.80	.80	.80	.82	.88	.96	1.04	.96	.96	.96	.96
29	.91	.91	1.02	.78	.78	.78	.78	.78	.82	.89	.96	1.05	.95	.93	.91	.91
28	.90	.95	1.02	.76	.76	.76	.76	.76	.80	.85	.95	1.05	.81	.81	.87	.86
27	.81	.85	1.01	.74	.73	.73	.73	.75	.80	.82	.96	1.07	.83	.85	.84	.84
26	.81	.93	1.01	.70	.70	.70	.70	.72	.80	.86	.95	1.07	.80	.80	.80	.80
25	.83	.92	1.00	.67	.67	.66	.66	.71	.77	.85	.95	1.10	.78	.77	.77	.77
24	.81	[illegible]	1.10	.66	.66	.66	.68	[illegible]	.77	[illegible]	[illegible]	1.10	[illegible]	.72	.72	[illegible]
23	.86	[illegible]	1.02	.64	.63	.63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	.82	[illegible]	1.02	.63	.62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	.83	[illegible]	1.08	.60	.60	.60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.63	[illegible]	[illegible]
20	.80	.92	1.10	[illegible]	.58	.58	.62	.61	[illegible]	[illegible]	.96		[illegible]	.62	.62	[illegible]
19	.80	.92	1.13	.56	.56	.56	.59	.60	.74	.84	[illegible]		.64	.62	.62	.62
18	.80	.94	1.15	.53	.53	.53	.58	.66	.74	[illegible]	.96		.61	.61	.61	.62
17	.80	.91	1.11	.53	.53	.53	.57	.65	.77	[illegible]	.94		.59	.58	.60	.62
16	.82	.96	1.18	.50	.50	.51	.56	.64	.72	.83	.94		.59	.58	.59	.61
15	.83	.98	1.18	.48	.47	.49	.55	.63	.74	.85	.91		.58	.58	.58	.60
14	.81	1.01	1.11	.45	.44	.47	.53	.61	.72	.82	.91		.55	.54	.55	.59
13	.84	.98	1.12	.38	.41	.46	.54	.63	.72	.88	1.01		.51	.51	.52	.58
12	.88	.91	1.10	.35	.39	.45	.54	.62	.73	.90	1.03		.48	.49	.51	.55
11	.90	1.01		.31	.38	.46	.54	.62	.80	.96	1.10		.44	.45	.48	.55
10	.92	1.06		[illegible]	.32	.44	.53	.62	.82	.96	1.10		.21	.40	.45	.53
9	1.00			.27	.34	.43	.53	.62	.83				.31	.38	.45	.54
8	1.03			.27	.34	.42	.52	.75	.90				.28	.34	.42	.53
7	1.10												.26	.35	.44	.54
6	1.16												.24	.32	.42	.54
5													.25	.32		
4																

TEST DATA ON RECEIVER MODEL A
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	217E	219-	21[illegible]	21[illegible]	21[illegible]	222A	222B	224	226	227	228	229	231	232	233	234
DATE (1960)	8/[illegible]	8/[illegible]	8/8	8/8	8/8	8/23	8/23	8/23	8/23	8/24	8/24	8/24	8/24	8/26	8/26	8/26
HOUR	1500	1500	1500	1500	1500											
SITE NO	2	2	2	2	2	1	1	4	5		4	5	5	5	5	4
REL AZ DEG	0	0	0	0	0	37	37	0		45	0	0	0	0	0	0
O-CODE DEG	-0.44	-0.44	0.44	-0.44	-0.44	-0.44	-0.44	-0.44	0.44	0.44	-0.42	0.42	-0.42	-0.42	-0.55	0.42
SCAN LIM DEG	0	+0.1	0.[illegible]	-0.[illegible]	1.4[illegible]											
CALIB DRIFT DEG 0°						0	-0.10	[illegible]	+0.01	0	+0.01	0	+0.01	+0.05	+0.04	0
2°										+0.01	+0.02	+0.02	+0.01	+0.05	-0.04	
4°						+0.01	-0.01	+0.01	+0.01	+0.03	+0.01	-0.01	+0.02	+0.08	+0.04	+0.04
NOTES	a	a	a	a	a					b			d	ae	e	de
Rcvr Ht., Ft	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg
38																
37	1.15	1.15	1.14	1.15	1.14	2.30	2.30		1.45	1.37	.89	1.33	1.32	1.25	1.50	.90
36	1.10	1.10	1.10	1.10	1.12	2.23	2.24	.96	1.42	1.32	.86	1.21	1.29	1.31	1.46	.88
35	1.07	1.07	1.07	1.09	1.11	2.16	2.15	.94	1.37	1.28	.85	1.24	.24	1.27	1.42	.87
34	1.05	1.05	1.05	1.06	1.10	2.09	2.10	.93	1.33	1.22	.81	1.20	1.20	1.23	1.39	.84
33	1.02	1.04	1.01	1.04	1.08	2.03	2.04	.91	1.30	1.56	.79	1.16	1.17	1.19	1.35	.82
32	.99	.99	.98	1.00	1.05	1.96	1.96	.88	1.26	1.52	.76	1.12	1.13	1.15	1.32	.79
31	.96	.96	.96	.99	1.03	1.81	1.89	.86	1.22	1.46	.76	1.08	1.10	1.12	1.29	.76
30	.91	.94	[illegible]	.77	1.05	1.8[illegible]	1.83	.84	1.18	1.4[illegible]	.7[illegible]	1.04	1.0[illegible]	1.08	1.32	.72
29	.91	[illegible]	.92	.10	.99	1.1[illegible]	1.1[illegible]	.82	1.14	1.34	.70	1.00	.03	.04	1.1[illegible]	.70
28	.87	.82	.88	.72	.91	1.6[illegible]	1.6[illegible]	.80	1.10	1.22	.68	.97	.98	1.01	1.1[illegible]	.67
27	.84	.84	.82	[illegible]	1.03	1.62	1.62	.75	1.064	1.23	.6[illegible]	.93	.95	.95	[illegible]	.66
26	.8[illegible]	.80	.83	[illegible]	1.01	1.56	1.57	.71	1.023	1.19	.61	.90	.91	.93	1.10	.64
25	.78	.79	.84	.92	1.02	1.49	1.49	.74	.984	1.12	.61	.87	.88	.90	1.05	.61
24	.73	.76	.82	.92	1.02	1.43	1.43	.72	.938	1.04	.59	.83	.84	.86	1.01	.60
23	.69	.73	.80	.93	1.00	1.36	1.37	.69	.898	1.00	.56	.79	.80	.82	.97	.57
22	.67	.72	.80	.90	1.01	1.30	1.31	.67	.859	.96	.54	.73	.76	.79	.92	.55
21	.66	.70	.79	.87	1.02	1.24	1.24	.64+	.811	.89	.50	.71	.72	.75	.88	.52
20	.66	.72	.81	.91	1.10	1.17	1.16	.63	.778	.82	.50	.67	.67	.71	.85	.51
19	.67	.75	.84	.94		1.09	1.10	.60	.744	.75	.48	.62	.64	.67	.81	.49
18	.67	.74	.83	.96		1.03	1.03	.59	.713	.67	.45	.59	.60	.62	.78	.46
17	.66	.75	.85	.95		.95	.96	.58	.684	.61	.45	.55	.56	.59	.74	.46
16	.65	.74	.83	.93		.89	.88	.55	.652	.57	.43	.52	.53	.55	.71	.44
15	.66	.76	.84	.98		.82	.82	.53	.609	.53	.40	.49	.50	.52	.68	.40
14	.66	.75	.84			.75	.75	.51	.55	.52	.42	.44	.45	.48	.63	.41
13	.67	.76	.86			.66	.67	.47	.52	.49	.40	.39	.41	.41	.61	.41
12	.65	.75	.89			.58	.58	.42	.49	.41	.39	.34	.36	.36	.59	.39
11	.64	.74				.51	.51	.37	.41	.33	.34	.32	.35	.40	.56	.36
10	.63	.78				.46	.47	.35	.44	.15	.31	.31	.33	.39	.51	.30
9	.64	.83				.41	.40	.26	.31	.11	.24	.28	.30	.35	.44	.21
8	.64					.37	.37	.27	.30	.10	.24	.24	.26	.31	.34	.24
7						.35	.34	.23	.21	.09	.20	.18	.20	.24	.23	.22
6						.15	.18	.21	.16		.16	.10	.13	.24	.18	.16
5						.05	.05									
4																

TEST DATA ON RECEIVER MODEL A
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	235	240	241	244	245	246	247	[illegible]	250	251	252	[illegible]	254	[illegible]	256	257
DATE (1960)	8/26	8/25	8/23	8/26	8/26	8/26	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
HOUR				1140	1345	1430	15..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1425	
SITE NO	4	10	10	5	2	4	5	2	5	5		2		4		
REL AZ DEG	0	0	0	0	0	0	0		0	0	0	0	[illegible]	0	0	0
O-CODE DEG	0.55	0.42	0.42	-0.44	0.44	-0.44	0.44	.25	0.30	0.42	-0.42	-1.42	-0.42	0.42	0.42	1.42
SCAN LIM DEG																
CALIB DRIFT DEG 0°	0	+0.01	0		+0.01	0		-0.04	0	0	+0.02	0	+0.01	+0.01	+.01	+0.01
2°																
4°	+0.03	+0.02	+0.01		+0.02	0				0	0	+0.04	+0.01	+0.01	[illegible]	0
NOTES	e	d	d f								g		h		i	j
Rcvr Ht. Ft.	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
38																
37	1.06	.72	.67	1.46	1.17	.98	1.45	1.20	1.33	1.10	1.44	[illegible]	1.07	.97	.57	1.64
36	1.03	.65	.65	1.43	1.14	.95	[illegible]	1.17	[illegible]	1.36	1.21	[illegible]	1.04	.93	.87	1.58
35	1.00	.64	.66	1.39	1.12	.93	[illegible]	1.13	[illegible]	1.32	[illegible]	1.08	1.01	.91	.85	1.53
34	.99	[illegible]	.64	1.35	1.09	.91	1.32	1.09	[illegible]	1.27	1.15	1.05	.99	.89	.82	[illegible]
33	[illegible]	[illegible]	.64	1.31	[illegible]	[illegible]	1.05	1.05	.37	1.24	1.11	1.02	.95	.82	.82	[illegible]
32	.94	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.01	1.32	[illegible]	1.07	.99	[illegible]	[illegible]	[illegible]	[illegible]
31	.92	[illegible]	.57	1.24	.11	.84	1.21	.15	1.293	[illegible]	1.05	.16	.81	.80	.77	[illegible]
30	.11	[illegible]	.57	1.21	.97	.81	1.18	.15	1.26	[illegible]	1.01	.14	.86	[illegible]	.77	.33
29	.88	.51	.56	1.16	.11	.77	1.11	.11	1.22	[illegible]	.18	.91	.84	.71	.73	1.21
28	.81	[illegible]	.32	1.12	.90	.16	1.11	.88	1.18	[illegible]	.94	.81	.52	[illegible]	.70	1.24
27	.83	.31	.33	1.08	.83	.74	1.01	.84	1.14	.92	.11	.84	[illegible]	.14	.67	1.20
26	.83	.56	.52	1.04	.85	.72	1.03	.80	1.11	.97	.83	[illegible]	.11	[illegible]	.67	[illegible]
25	.79	.53	.53	1.00	.83	.70	1.00	.76	1.17	.15	.64	[illegible]	.74	[illegible]	[illegible]	1.11
24	.78	.51	.50	.95	.80	.69	.95	.73	1.13	.1	.81	.77	.72	[illegible]	.66	1.07
23	.75	.47	.46	.91	.78	.66	.91	.69	.11	[illegible]	.78	.74	.70	[illegible]	.62	[illegible]
22	.73	.49	.44	.87	.75	.64	.87	.65	.445	[illegible]	[illegible]	.71	.67	[illegible]	.60	.17
21	.71	.50	.47	.84	.73	.62	.83	.61	.94	.71	.71	.64	.65	[illegible]	[illegible]	.92
20	.69	.48	.44	.81	.70	.59	.80	.58	.87	[illegible]	[illegible]	[illegible]	[illegible]		.56	[illegible]
19	.67	.47	.44	.77	.68	.57	.76	.33	.825	[illegible]		.65	.61	.53	.55	[illegible]
18	.65	.44	.42	.72	.65	.54	.72	.47	.77	[illegible]	[illegible]	.63	.60	.56	.53	.16
17	.64	.44	.43	.69	.62	.53	.69	.46		[illegible]	[illegible]	.61	.59	.54	.52	.72
16	.61	.41	.40	.66	.60	.56	.66	.43		[illegible]	.58	.51	.54	.52	.49	.69
15	.59	.38	.36	.62	.57	.48	.62	.375		.58	[illegible]	.55	.52	.50	.41	.65
14	.59	.36	.33	.58	.54	.48	.59	.34		.55	[illegible]	.52	.50	.47	.44	.61
13	.52	.36	.32	.53	.52	.41	.56	.31		.52	.50	.49	.46	.43	.37	.51
12	.46	.37	.31	.52	.49	.38	.54	.305		.49	.47	.46	.43	.39	.32	[illegible]
11	.39	.37	.29	.50	.45	.30	.52	.295		.44	.42	.44	.41	.32	.30	.48
10	.34	.37	.30	.45	.38	.29	.47	.223		.41	.36	.36	.31	.30	.28	.44
9	.30	.26	.27	.38	.32	.23	.40	.153		.34	.31	.30	.25	.25	.25	[illegible]
8	.31	.14	.17	.28	.27	.24	.30	.105		.27	.24	.22	.23	.26	.21	.30
7	.26	.14	.16	.18	.23	.20	.22	.025		.15	.18	.21	.20	.23	.20	.20
6	.20	.12	.13	.15	.23		.19	0		.10	.15	.23	.20	.19	.16	.10
5																
4																

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TEST DATA ON RECEIVER MODEL A
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	258	259	260	261	262	263	[illegible]	[illegible]
DATE (1960)	10/12	10/12	10/12	10/13	10/13	1/14	[illegible]	[illegible]
HOUR	1035	1108	1155	1500	1605	1009	1106	[illegible]
SITE NO						12	14	15
REL AZ DEG	0	0	0	37	20.4	14.2	9.2	11.1
O-CODE DEG	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	[illegible]	[illegible]
SCAN LIM DEG								
CALIB DRIFT DEG 0°	0	0	0	0	0	+0.02	[illegible]	+0.0[illegible]
CALIB DRIFT DEG 2°								
CALIB DRIFT DEG 4°	0	0	0	0	0	+0.04	+0.02	+0.02
NOTES	m	n	p					
Rcvr Ht., Ft	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg
38								
37	2.10	2.80	4.06	2.46	1.29	.91	.72	.76
36	2.04	2.71	3.94	2.35	1.25	.90	.71	.75
35	1.97	2.64	3.82	2.26	1.22	.88	.69	.74
34	[illegible]	2.56	3.71	2.19	1.19	.86	.68	.72
33	1.88	2.49	3.60	2.14	1.16	.84	.67	.70
32	[illegible]	2.40	3.49	2.09	1.13	.82	.66	.69
31	1.76	[illegible]	3.37	2.03	1.10	.80	.65	.68
30	1.71	[illegible]	3.26	1.97	1.07	.78	.64	.67
29	1.64	[illegible]	3.15	1.89	1.04	.78	.62	.66
28	[illegible]	2.11	3.04	1.83	1.02	.75	.60	.65
27	1.53	[illegible]	2.94	1.75	.98	.74	.57	.64
26	1.48	[illegible]	2.83	[illegible]	.96	.73	.56	[illegible]
25	1.42	1.88	2.71	[illegible]	.92	.71	.54	.59
24	1.37	1.80	2.61	1.56	.90	.70	.52	.57
23	1.31	1.74	2.49	1.49	.86	.67	.52	.55
22	1.25	1.65	2.38	1.43	.82	.64	.51	.53
21	1.19	1.57	2.26	1.35	.79	.63	.51	.52
20	1.13	1.50	2.14	1.29	.76	.61	.51	.51
19	1.08	1.42	2.02	[illegible]	.73	.58	.52	.51
18	1.02	1.35	1.92	1.16	.70	.55	.52	.51
17	.98	1.27	1.80	1.09	.68	.52	.52	.50
16	.91	1.20	1.69	1.02	.67	.51	.43	.38
15	.85	1.13	1.58	.97	.65	.50	.36	.30
14	.79	1.04	1.46	.90	.60	.51	.29	.24
13	.72	.97	1.35	.81	.57	.38	.33	.22
12	.67	.89	1.23	.75	.53	.30	.20	.21
11	.61	.82	1.12	.67	.49	.25	.20	.20
10	.56	.73	1.00	.63	.39	.23	.20	.20
9	.52	.65	.90	.63	.31	.23	.20	.20
8	.48	.56	.79	.59	.26	.22	.20	.20
7	.42	.50	.66	.49	.23	.22	.20	.20
6	.37	.41	.56	.26	.22	.22	.20	.20
5	.30	.39	.43	.25				
4	.18	.33	.29					

TEST DATA ON RECEIVER MODEL B
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	266	267	265	261	270	[illegible]	272	273	274	275	[illegible]	277	278	279	[illegible]	281
DATE (1960)	[illegible]	[illegible]	[illegible]	10/18	10/28	[illegible]	[illegible]	11/4	11/16	11/16	11/16	11/16	[illegible]	11/8	11/29	11/29
HOUR	1410	1430	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1445	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SITE NO	5	5	5	5	5	[illegible]	5	5	5	2	4	5	5	2	2	4
REL AZ DEG	0	0	0	0	0	[illegible]	[illegible]	[illegible]	0	0	[illegible]	0	[illegible]		[illegible]	0
O-CODE DEG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.44	-0.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SCAN LIM DEG																
O ERROR DEG			[illegible]		+0.5				0		0	[illegible]				
HYST P P DEG	[illegible]	[illegible]				[illegible]	[illegible]									
NOTES					t			u	v	w						
Rcvr. Ht., Ft.	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg	Deg
38																
37	1.45	1.40	1.41	1.43	1.55	1.58	1.55	1.43	1.49	1.21	1.02	1.48	1.49	1.205	.935	.75
36	[illegible]	1.37	1.37	1.38	1.52	1.54	1.51	1.40	1.46	1.18	1.00	1.44	1.45	1.17	.905	.73
35	[illegible]	[illegible]	1.34	1.34	1.48	1.50	1.47	1.36	1.42	1.16	.98	1.41	1.41	1.13	.88	.70
34	1.33	[illegible]	1.30	1.30	1.435	1.46	1.43	1.32	1.38	1.12	.95	1.37	1.37	1.085	.85	.69
33	1.28	[illegible]	1.26	[illegible]	1.40	1.42	1.39	1.28	1.34	1.09	.93	1.33	1.33	1.06	[illegible]	.67
32	1.21	1.23	1.23	[illegible]	1.355	1.38	1.35	1.24	1.32	1.06	.92	1.27	1.29	[illegible]	.79	.65
31	1.21	[illegible]	1.19	[illegible]	[illegible]	1.34	1.32	1.21	1.26	1.04	.90	[illegible]	[illegible]	[illegible]	.76	.62
30	1.17	1.15	[illegible]	[illegible]	[illegible]	1.30	1.29	1.18	[illegible]	1.01	.87	1.22	[illegible]	[illegible]	.73	.60
29	1.14	1.12	1.12	1.11	[illegible]	1.26	1.25	1.14	1.19	.97	.86	1.18	1.17	[illegible]	.70	.56
28	1.05	1.08	1.01	1.08	[illegible]	[illegible]	1.21	1.10	1.16	[illegible]	.83	1.14	[illegible]	[illegible]	.66	.53
27		1.04	1.05	1.03	[illegible]	1.19	1.17	1.06	1.11	.91	.80	1.11	[illegible]	[illegible]	.63	.51
26	1.04	1.01	[illegible]	1.00	[illegible]	1.15	[illegible]	1.01	1.08	.89	.78	1.07	1.05	.775	.60	.48
25	1.00	.97	.97	0.955	1.07	1.11	[illegible]	.91	1.03	.86	.76	1.03	1.01	.74	.57	.46
24	.97	.93	.94	0.93	1.03	1.07	[illegible]	.93	1.01	.83	.74	.99	.97	.70	.53	.43
23	.92	.89	.90	0.88	.99	1.02	1.03	.89	.96	.80	.73	.95	.93	.67	.50	.41
22	.88	.84	.86	0.83	.954	.98	.97	.85	.92	.77	.72	.91	.89	.63	.47	.39
21	.83	.82	.82	0.79	.92	.94	.93	.82	.88	.75	.71	.81	.85	.595	.46	.38
20	.79	.78	.78	0.75	.885	.90	.89	.79	.84	.72	.67	.83	.81	.550	.41	.34
19	.73	.75	.74	0.71	.84	.86	.85	[illegible]	.80	.69	.64	.80	.77	.51	.37	.34
18	.71	.71	.71	0.68	.785	[illegible]	.81	.72	.76	.68	.63	.76	.73	.47	.34	.31
17	[illegible]	.68	.68	0.65	.74	.79	.77	.68	.73	.65	.61	.72	.69	.42	.33	.30
16	.64	.65	.66	0.62	.72	.76	.74	.66	.69	.63	.59	.70	.66	.37	.31	.25
15	.58	.62	.62	0.58	.706	.72	.71	.62	.66	.60	.55	.67	.64	.31	.28	.24
14	.55	[illegible]	.58	0.54	.64	.70	.63	.57	.63	.58	.53	.63	[illegible]	.26	.26	.22
13	.54	.55	.54	0.52	.66	.66	.58	.53	.60	.55	.47	.60	.57	.22	.22	.12
12	.54	.53	.53	0.49	.61	.63	.56	.51	.58	.48	.39	.57	.55	.205	.18	.04
11	.53	.50	.50	0.445	.56	.59	.57	.48	.55	.43	.35	.54	.52	.195	.11	0
10	.47	.46	.46	0.42	.495	.54	.52	.43	.49	.37	.32	.48	.46	.14	.02	-.02
9	.41	.39	.38	0.31	.425	.47	.42	.36	.40	.33	.30	.39	.37	.05	-.015	-.035
8	.33	.30	.30	0.25	.35	.38	.24	.27	.34	.29	.30	.32	.28	-0.25	-.065	-.048
7	.29	.24	.24	0.19	.298	.30	.17	.20	.29	.26	.29	.28	.23	-0.55	-.085	-.065
6	.26	.20	.21	0.18	.26	.26	.15	.17	.25	.25	.26	.25	.19	-.107	-.088	-.10
5								.16							-.10	-.12
4																

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TEST DATA ON RECEIVER MODEL B
RECEIVER ANGLE READING VERSUS RECEIVER HEIGHT

TEST NO	282	283	284	285	286	28?	-1?	289	290	291	292	293	294	295	297
DATE (1960)	11/29	11/29	11/29	11/29	11/29	11/	13	11/30	11/30	11/30	11/30	11/30	11/30	2/1	2/1
HOUR	1130	1155	1350	1440	1530	16	35	1050	1130	1154				1000	1130
SITE NO	6	10	14	14	13	10	1		11		12			5	1
REL AZ DEG	0	0	9.2	9.2	11.1	0	37	263	204	16.1	142	0	0	0	31
O-CODE DEG	-0.11	-0.11	0.17	-0.11	-0.17	0.17	0.17	0.17	-0.11	-0.17	-0.11	-0.17	-0.11	0.17	0.11
SCAN LIM DEG															
O ERROR DEG															
HYST P-P DEG															
NOTES							x	9 x		r x	x	B p x	p x		
Rcvr. Ht., Ft	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
38															
37	.64	.55	.42	.43	53	.60	2.18	1.31	1.02	.80	.66	3.91	3.91	1.105	2.06
36	.62	.53	.40	.40	.51	.57	2.13	1.31	.97		.63	3.79	3.79	1.165	1.995
35	.60	.52	.38	.37	.49	.55	2.03	1.28	.96	75	.61	3.68	3.68	1.13	1.925
34	.57	.51	.37	36	.46	.53	1.99	1.24	.94	.70	.59	3.57	3.56	1.095	1.86
33	.55	.47	.35	.35	.44	.53	1.94	1.20	91	70	57	3.45	3.44	1.06	1.80
32	53	.44	34	33	.40	.51	1.84	1.16	.87	.68	.55	3.34	3.33	1.02	1.735
31	.50	.44	.35	.33	.38	.48	1.78	1.12	.83	.65	52	3.23	3.23	.99	1.66
30	.49	45	.35	.35	.37	.44	1.71	1.08	.81	.61	.49	3.11	3.11	.95	1.59
29	.47	.43	33	.34	35	.42	1.65	1.05	.76	58	.48	3.00	2.99	.91	1.53
28	.47	.42	.29	32	.34	.40	1.59	1.01	.75	54	.46	2.89	2.88	.875	1.47
27	.42	.40	.26	28	35	.38	1.53	.96	72	.50	.43	2.77	2.76	.84	1.42
26	.42	.38	.24	.26	33	37	1.47	.92	.67	.48	.42	2.75	2.64	.80	1.35
25	.40	.36	.22	.25	31	.36	1.39	.88	.66	.48	.39		2.52	.76	1.285
24	.38	.33	.22	.24	.28	.32	1.34	84	.63	.46	.37		2.41	.72	1.215
23	.36	.31	21	.24	.25	.31	1.26	.80	.59	.41	.35		2.30	.68	1.15
22	.33	.29	.21	.24	.25	.29	1.20	.76	55	.37	.33		2.18	.635	1.09
21	.31	.29	.21	.24	.23	.26	1.16	.72	.51	32	.31		2.07	.59	1.02
20	.29	.26	.21	24	24	.24	1.10	.79	.47	33	.31		1.96	.55	.96
19	.26	.23	.21	.23	.24	.24	1.02	.64	.43	.32	.27		1.83	.50	.90
18	.26	21	.17	.18	.22	.24	.95	.57	.40	32	.24		1.72	.445	.83
17	.24	.10	.09	.10	.12	23	.88	.51	38	.29	.22		1.61	.395	77
16	.18	.098	-.03	.02	0	.16	.84	.44	.36	.26	22		1.50	34	.69
15	.06	.06	-.11	-.03	-.06	.02	.78	.39	.34	.23	.23		1.38	.215	.60
14	.04	.07	-.13	-.08	-.08	-.05	72	.33	.30	.23	.14		1.27	.225	.50
13	03	.08	-.14			-.07	.63	.29	27	.19	-.01		1.16	.185	.41
12	.01	.08	-.15				.53	.25	.25	.04	-.07		1.06	.18	.33
11	.01	.04	-.15				.42	.25	.15	-.04	-.09		.95	.16	.25
10	0	-.01	-.14				.32	.23	.10	-.025	-.04		.83	.10	.22
9	-.035	-.08	-.14				.24	.15	-.08	-.05	-.04		.71	.03	.18
8	-.09	-.095	-.14				.22	0	-.1	.08	-.09		48	-.06	.15
7	-.12	-.11					.18	-.07	-.07	-.08	-.09		.34	-.1	08
6	-.12	-.11					-.01	-.07	-.075	-.1	-.09		.2	-.16	0
5	.12	-.11	-.14				-.10	-.08	-.14	-.14	-.14		.05		-.05
4															

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