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Atmospheric optical measurements in western Florida, Flight 112, Part IV. Sky radiances (red)

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Author
Boileau, Almerian R

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Visibility Laboratory
University of California
Scripps Institution of Oceanography
San Diego 52, California

ATMOSPHERIC OPTICAL MEASUREMENTS IN WESTERN FLORIDA,

FLIGHT 112, Part IV, SKY RADIANCES   (Red)

Almerian R. Boileau

November 1960

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Approved:

[signature: Seibert Q. Duntley]

Seibert Q. Duntley, Director
Visibility Laboratory

Approved for Distribution:

[signature: Roger Revelle]

Roger Revelle, Director
Scripps Institution of Oceanography

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Atmospheric Optical Measurements in Western Florida,

Flight 112, Part IV, Sky Radiances (Red)*

by

Almerian R. Boileau

INTRODUCTION AND SUMMARY

The Visibility Laboratory of the University of California, La Jolla
Campus, is engaged in an on-going research program studying the trans-
mission of optical images through the atmosphere. In connection with
this work several data gathering flights were made in Florida, in the
vicinity of Eglin Air Force Base, in the spring of 1957. Flight 112,
during which data in this report were measured, was one of these flights.

Part I of this report, SIO Reference 60-22 of April 1960, presented
data as a catalogue of recorded optical measurements less the sky lum-
inance and radiance distribution.

Part II of the report, SIO Reference 60-32 of June 1960 presented
sky luminance data in graph form showing the sky luminance distribution
as it varied with altitude, zenith angle, and azimuth with respect to
the sun. Similarly, Part III of this report, SIO Reference 60-55 of
November 1960, presented sky radiance distribution as measured by a blue
light sensitive filter-phototube combination.

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This part of the report, Part IV, presents the sky radiance distribution as measured by a red light sensitive filter-phototube combination, and shows how it varied with altitude, zenith angle, and azimuth.

PROCEDURE

U. S. Air Force XB-29 No. 4224725 took off from Eglin Air Force Base, Florida, at 0917 Eastern Standard Time, 16 May 1957, to begin Flight 112. The airplane carried optical and meteorological instruments from the Visibility Laboratory of the University of California, La Jolla Campus. Two of the optical instruments were sky scanning telephotometers by which the sky luminance and radiance distributions were recorded. The airplane arrived at 20 000 feet altitude preparatory to data gathering at 1010.

Recording Schedule. Sky radiance distribution data were recorded as follows:

Eastern Standard Time	Altitude	Headings
1010-1036	20 000 feet	000°
1057-1108	10 000 feet	175°
1119-1127	1 000 feet	180°
1200-1204	Eglin Air Force Base B-29 on runway	185°

Flight Pattern. The flight pattern was north and south between Eglin Air Force and Crestview Florida, as shown in Fig. 1. immediately following this page. However, the sky distribution data were recorded in the northern part of the flight path in the vicinity of Crestview in order that the terrain over which data were recorded would be consistently of the same type.

Weather. The day was clear and warm. During ascent haze layers were observed at 1500, 3000, 7000, 10 000, 12 000, and 14 000 feet altitudes. These layers were observable only when seen edge-on; they could not
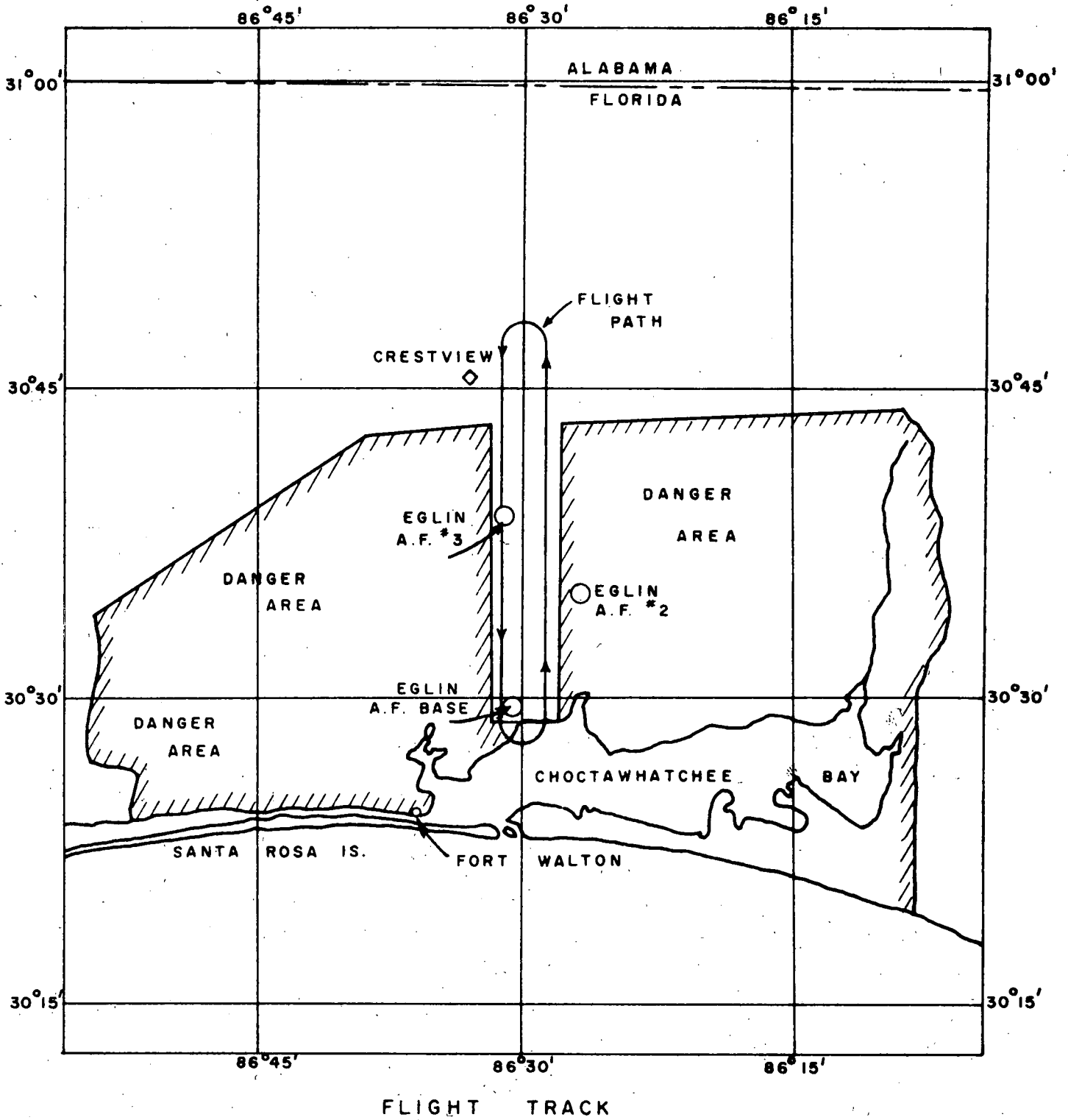
FLIGHT   TRACK

FIGURE 1
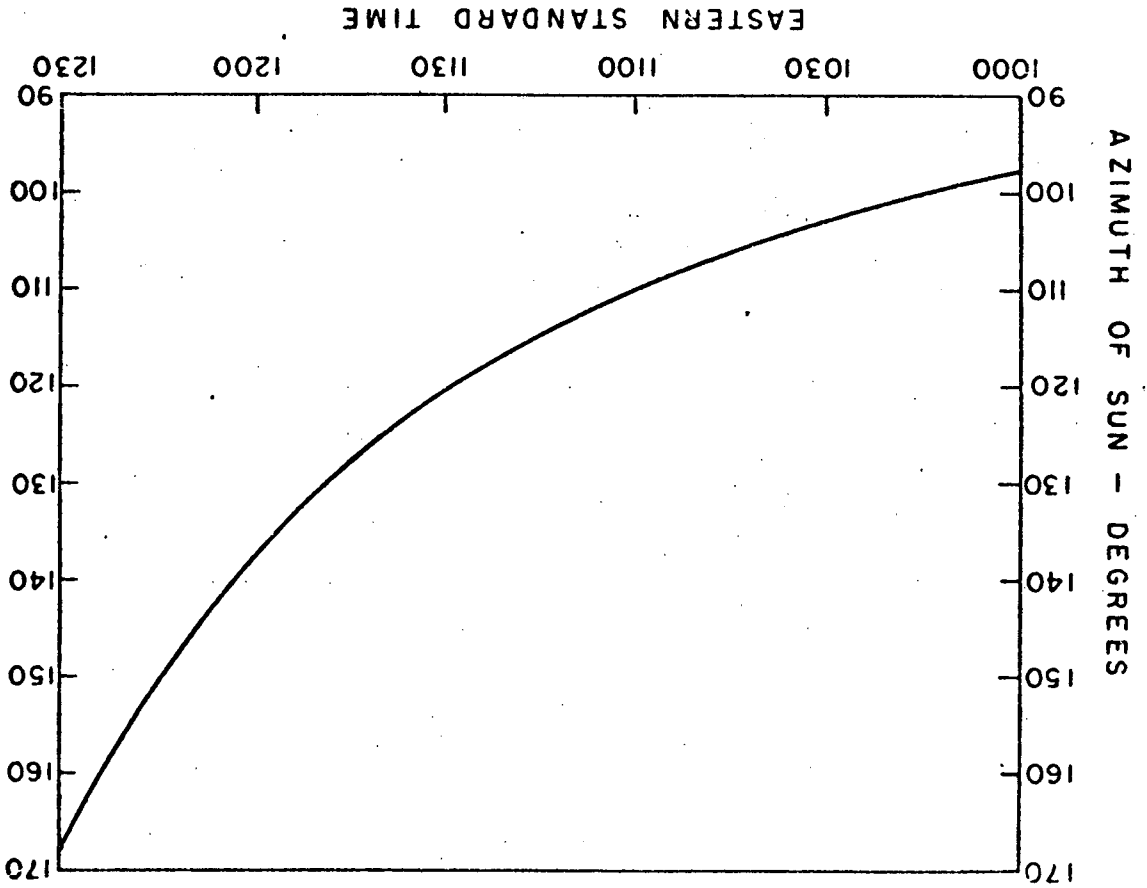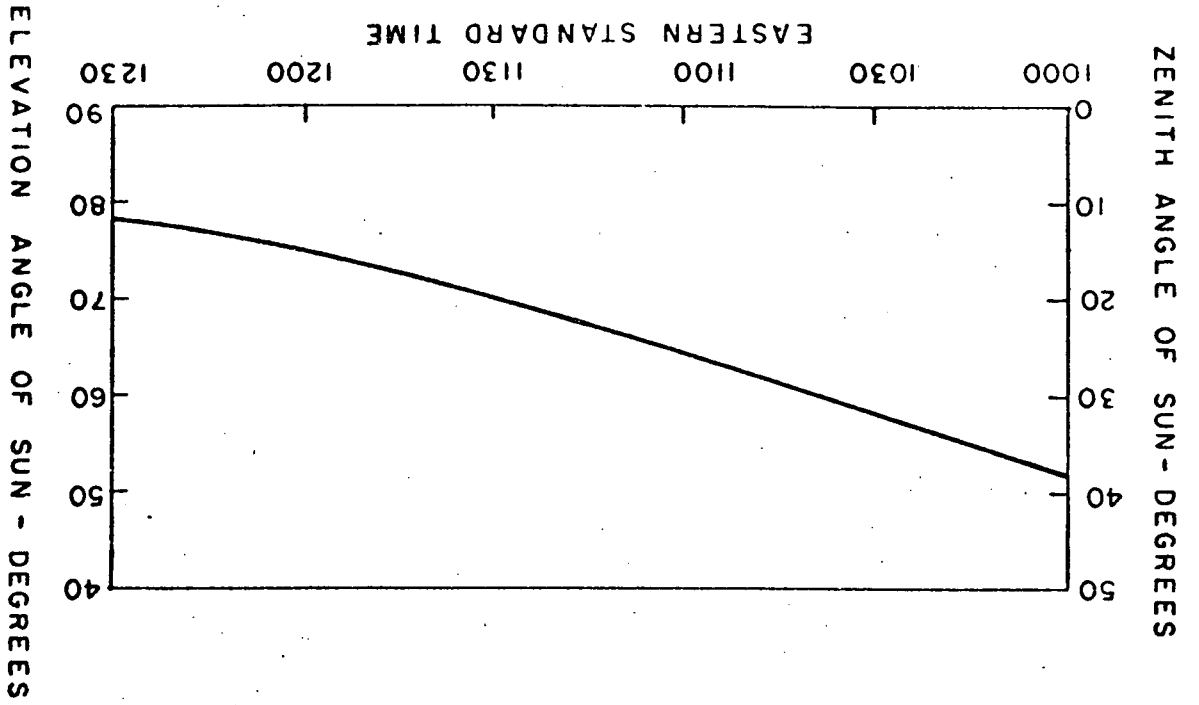FLIGHT 112
16 MAY 1957
CRESTVIEW, FLORIDA

be determined by an observer looking in either an upward or downward direction. At some distance from the flight pattern a few widely scattered altostratus and altocumulus clouds could be seen apparently at the altitude of some of the haze layers. Color prints showing the sky and terrain are included in Part I of this report.[1]

Position of Sun. The azimuth and zenith angle of the sun computed for 30° 40' N. Lat. and 86° 30' W. Long., the approximate location of Crestview, are shown in Fig. 2, immediately following this page. These angles are plotted for the period 1000 to 1230 Eastern Standard Time. The ordinates on the lower graph are shown as zenith angles on the left and elevation angles on the right, these angles being complementary.

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1. "Atmospheric Optical Measurements in Western Florida, Flight 112, Part I," A. R. Boileau, SIO Reference 60-22, April 1960.

ANGLES OF SUN DURING FLIGHT 112
COMPUTED FOR LAT 30-40 N.
LONG 86-30 W.

CRESTVIEW, FLORIDA
MAY 16, 1957
FLIGHT 112
FIGURE 2

EASTERN STANDARD TIME

ELEVATION ANGLE OF SUN - DEGREES

ZENITH ANGLE OF SUN - DEGREES

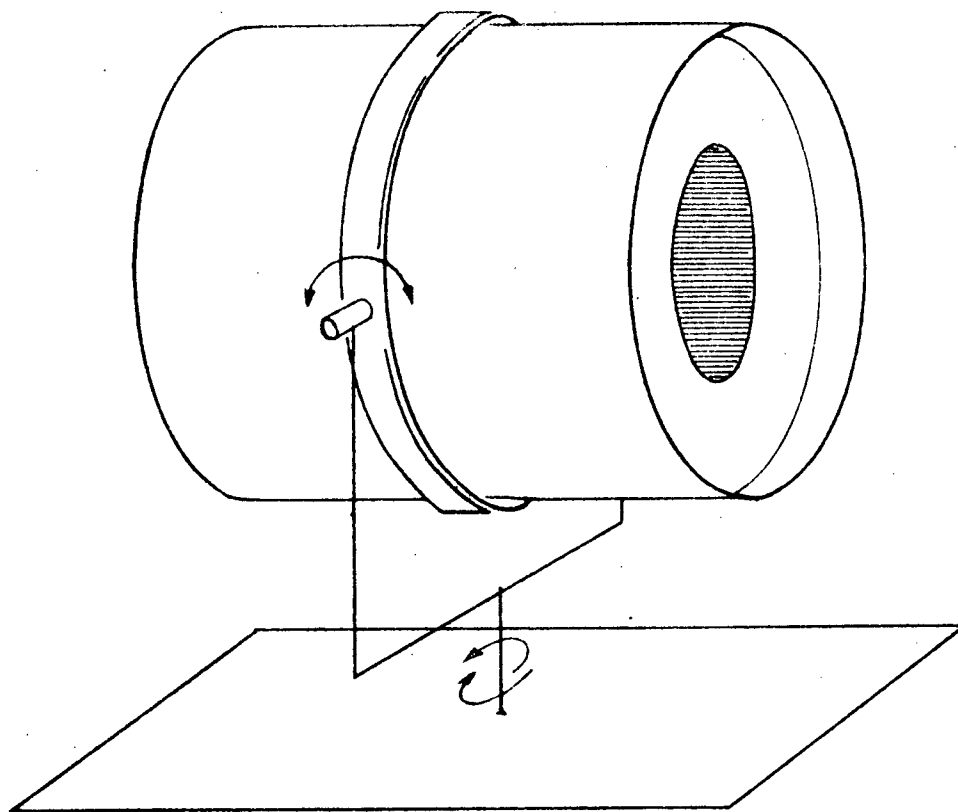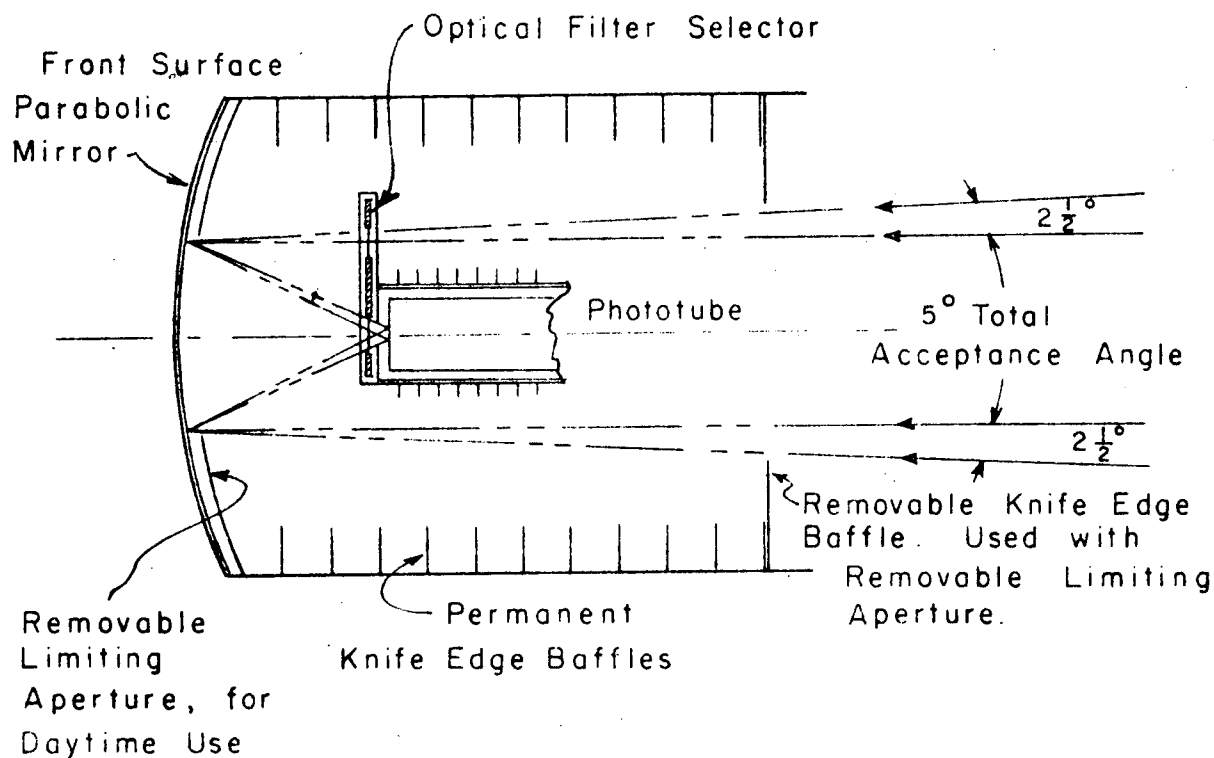EASTERN STANDARD TIME

AZIMUTH OF SUN - DEGREES

SIO Ref. 60-35

INSTRUMENTATION

Sky Scanning telephotometers. Two sky scanning telephotometers were carried by the XB-29, one mounted in the forward upper gun turret position and one in a retracting mount in the rearmost lower gun turret position. The telephotometers were operated from the control position in the pressurized after compartment of the XB-29. Once started, both telephotometers continued their scanning operation until completion, at which time they automatically stopped and remained stopped until restarted.

The sky scanning telephotometers are shown schematically in Fig. 3 immediately following this page. The optical unit, shown at the top of the Figure, consists of a cylindrical shell with a 13" parabolic front surface mirror mounted on one end of the shell and an end-on multiplier phototube mounted with its light-sensitive surface at the focus of the mirror. A field stop in front of the light-sensitive surface limits the incoming rays to those contained in a 5° circular cone.

The optical units of the sky scanning telephotometers were designed for use in both high and low light levels. For high light level or day time use the sensitivity of the photometer is reduced by the mirror limiting aperture. The flux incident on the phototube is further reduced by the use of neutral density filters. Internal scattering is kept to a minimum by the removable front knife-edge baffle and the permanent knife-edge baffles throughout the inside length of the cylindrical shell and on the outside of the phototube housing.

Optical Filter Selector

Front Surface
Parabolic
Mirror

Phototube

$2\frac{1}{2}°$

5° Total
Acceptance Angle

$2\frac{1}{2}°$

Removable Knife Edge
Baffle. Used with
Removable Limiting
Aperture.

Removable
Limiting
Aperture, for
Daytime Use

Permanent
Knife Edge Baffles

SKY SCANNING TELEPHOTOMETER

Figure 3

In front of the field stop there is an optical filter selector mechanism which by being operable from the control position permits any one of four optical filters to be interposed in the flux path. The relative spectral sensitivities of the four filter and phototube combinations are shown in Fig. 4 immediately following this page. -

The data presented in this part of the report are the data as seen by the "Red" filter - phototube combination.

Scanning Patterns. The scanning patterns of the two sky scanning telephotometers are such that the optical units scan in elevation with a change of azimuth occurring between elevation scans in the case of the upper scanner and simultaneously with elevation scans in the case of the lower scanner.

The upper scanning telephotometer starts from 2 1/2° below the horizontal, scans upward through the zenith and continues downward to 2 1/2° below the horizontal 180° from the starting azimuth. At the conclusion of an elevation scan the scanner shifts 10° in azimuth and starts a return scan. It makes eighteen elevation scans, thereby completing the upper sky in 90 seconds. At the end of the eighteen elevation scan it reverses its azimuth drive and again scans the upper sky, in reverse, in 90 seconds. A change of optical filters during the time of reversal permits two complete upper sky measurements to be completed in three minutes.

The scanning pattern of the lower sky scanning telephotometer is similar to the scanning pattern of the upper sky scanning telephotometer in that it starts from 2 1/2° above the horizontal, scans downward through the nadir and continues upward to 2 1/2° above the
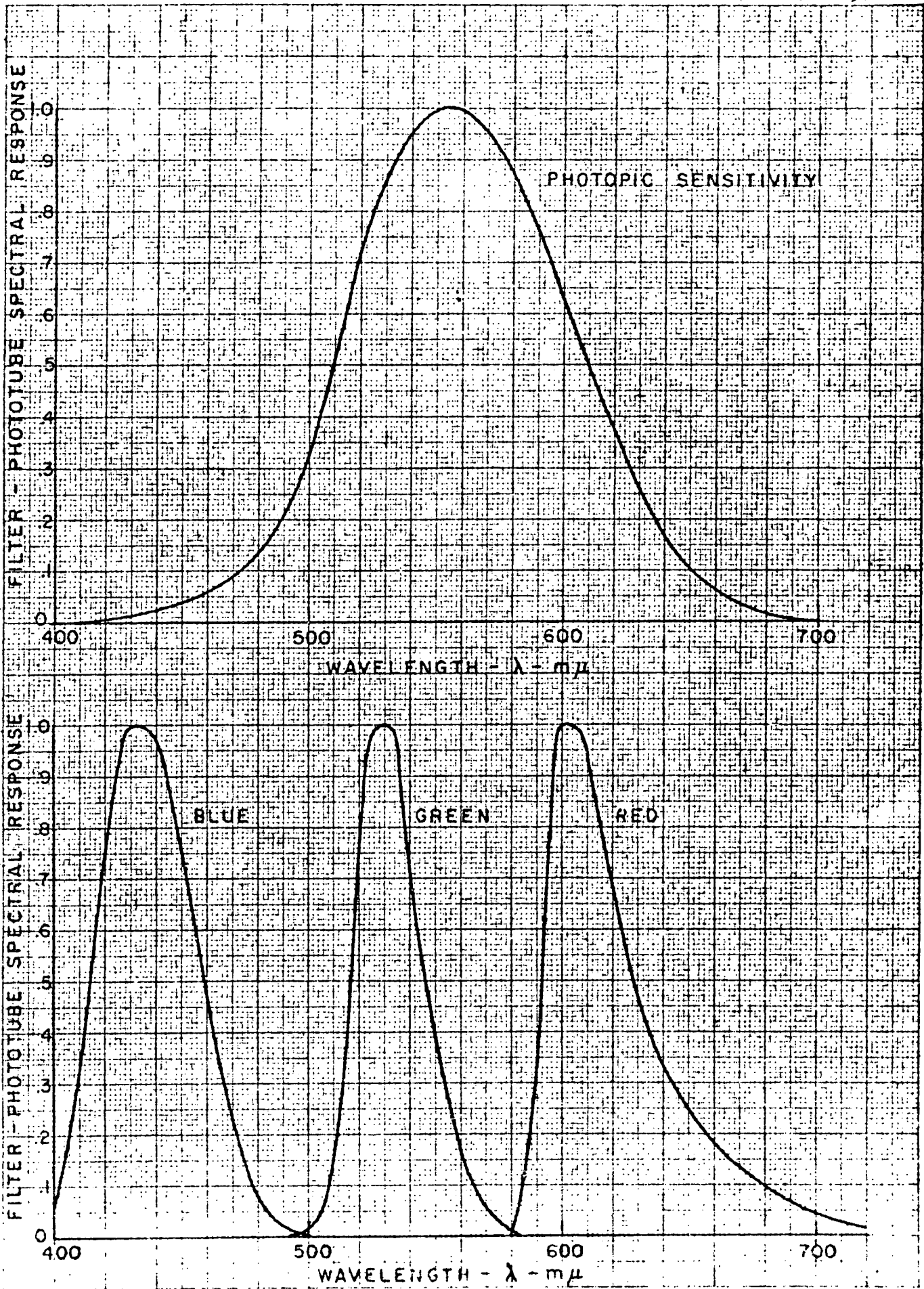
Figure 4

REDUCTION OF DATA

Method of Recording. Data were recorded during Flight 112 on Sanborn
Recorder strip charts. The data were continuous traces representing
the value of sky radiance as the scanners operated through their cycles.
The angular positions in elevation of the scanners, that is, their
zenith angle positions, were indicated by a marking stylus which was
activated by a microswitch in contact with a protractor type cam. The
data recording stylus and the zenith angle marking stylus recorded
continuously and simultaneously so that zenith angle indications and
corresponding sky radiance data were synchronized. Because the scanners
always started from and stopped in the same azimuthal positions, the
azimuth of each elevation scan was easily determined by counting the
number of elevation scans.

Handling of Data. The strip chart data were read directly onto IBM
cards by the use of computer peripheral equipment. Through the operation
of a Burroughs No. 220 computer at the U. S. Navy Electronics Labor-
atory, San Diego, California, which was programmed to correct for the
nonlinearities of the airborne electronic recording equipment, the
data points were converted into tables of equivalent radiance values.
These radiance values were plotted against azimuth values on semi-
logarithmic paper, the azimuth being with reference to geographical
north. The azimuthal scale marked off along the linear coordinates
of the graph paper was then shifted to cause the azimuthal scale to
indicate azimuth with reference to the sun. The last step was to re-
plot radiance values for selected zenith angles against altitude on
semi-logarithmic graph paper. Continuous curves were then drawn
through those points.

horizontal. It differs from the scanning pattern of the upper sky scanning telephotometer in that it rotates in azimuth at a constant rate, changing 10° in azimuth with each elevation scan. At the conclusion of eighteen elevation scans in a little less than 90 seconds it automatically reverses and retraces its pattern. A change of optical filters during the time of reversal permits two lower sky measurements to be completed in the same manner as but in slightly less time than the upper sky measurements.

PRESENTATION OF DATA

Notation. The notation in this report follows the notation for the various radiometric and photometric optical quantities discussed in detail elsewhere.[2] The general symbol for radiance is N. The particular symbol for the radiance of a path of sight when neither the path length is specified nor the source of radiance identified is N (z,θ,∅), the parenthetic symbols indicating that the photometer is at altitude z and that the path of sight is as specified by the zenith angle θ and the azimuth ∅. The zenith angle varies from 0° for looking vertically upward to 180° for looking vertically downward. The azimuth ∅ in this report is with reference to the sun.

Organization of data. The data are presented as a series of semi logarithmic plots in which the linear ordinate values represent altitudes and the logarithmic abscissa values represent radiances. Each Figure consists of four sheets (with the exception of Fig. 6 which has five sheets) and presents radiance data for one azimuth as a group of curves, each curve representing radiance for one specific zenith angle. The Figures are arranged in order of increasing azimuth in increments of 20° starting with an azimuth of 0° and ending with an azimuth of 340°.

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2. "Image Transmission by the Troposphere I", S. Q. Duntley, A. R. Boileau and R. W. Preisendorfer, JOSA 47, 499-506, (1957).

As stated above each Figure, with two exceptions, consists of four sheets. These sheets present data as follows:

Sheet a - zenith angles of $0°$, $15°$, $30°$, $45°$, and $60°$.

Sheet b - zenith angles of $75°$, $80°$, $85°$, and $90°$.

Sheet c - zenith angles of $90°$, $95°$, $100°$, and $105°$.

Sheet d - zenith angles of $120°$, $135°$, $150°$, $165°$, and $180°$.

To differentiate between the data plots for the different zenith angles five distinctive types of lines are used. These lines are illustrated in Fig. 5 immediately following this page.

In the cases of the first and last data Figures, azimuths of $0°$ and $340°$, respectively, five sheets comprise each Figure. This is because the radiance values for some of the zenith angles at these azimuths exceed the scale of radiance values printed on the master plotting sheet within which almost all of the data fell. The additional sheets are designated as sheet "aa" of the Figure and carry the warning "NOTE CHANGE OF SCALE" near the bottom of the sheet. The scale for these sheets is greater by a factor of 10.
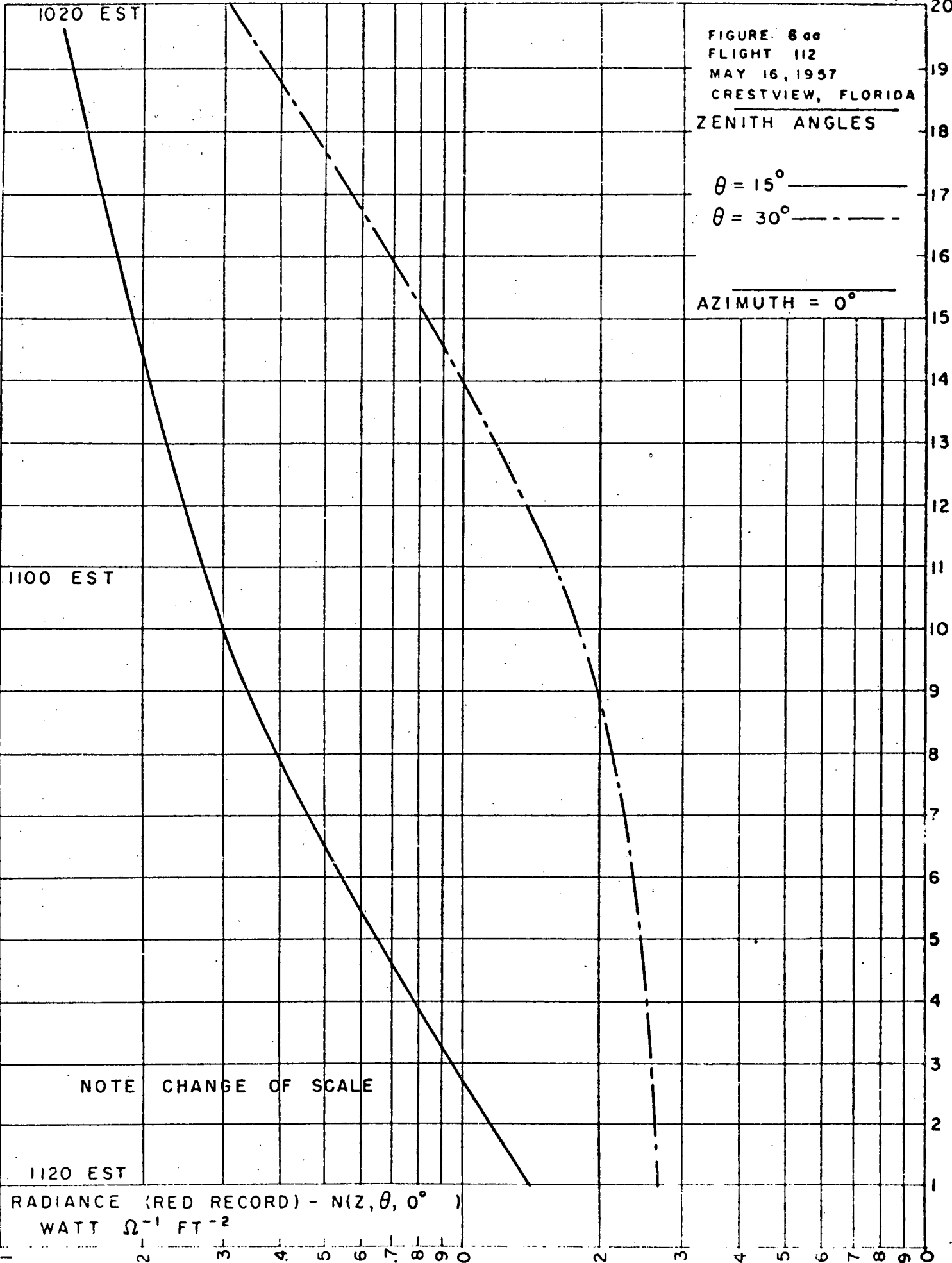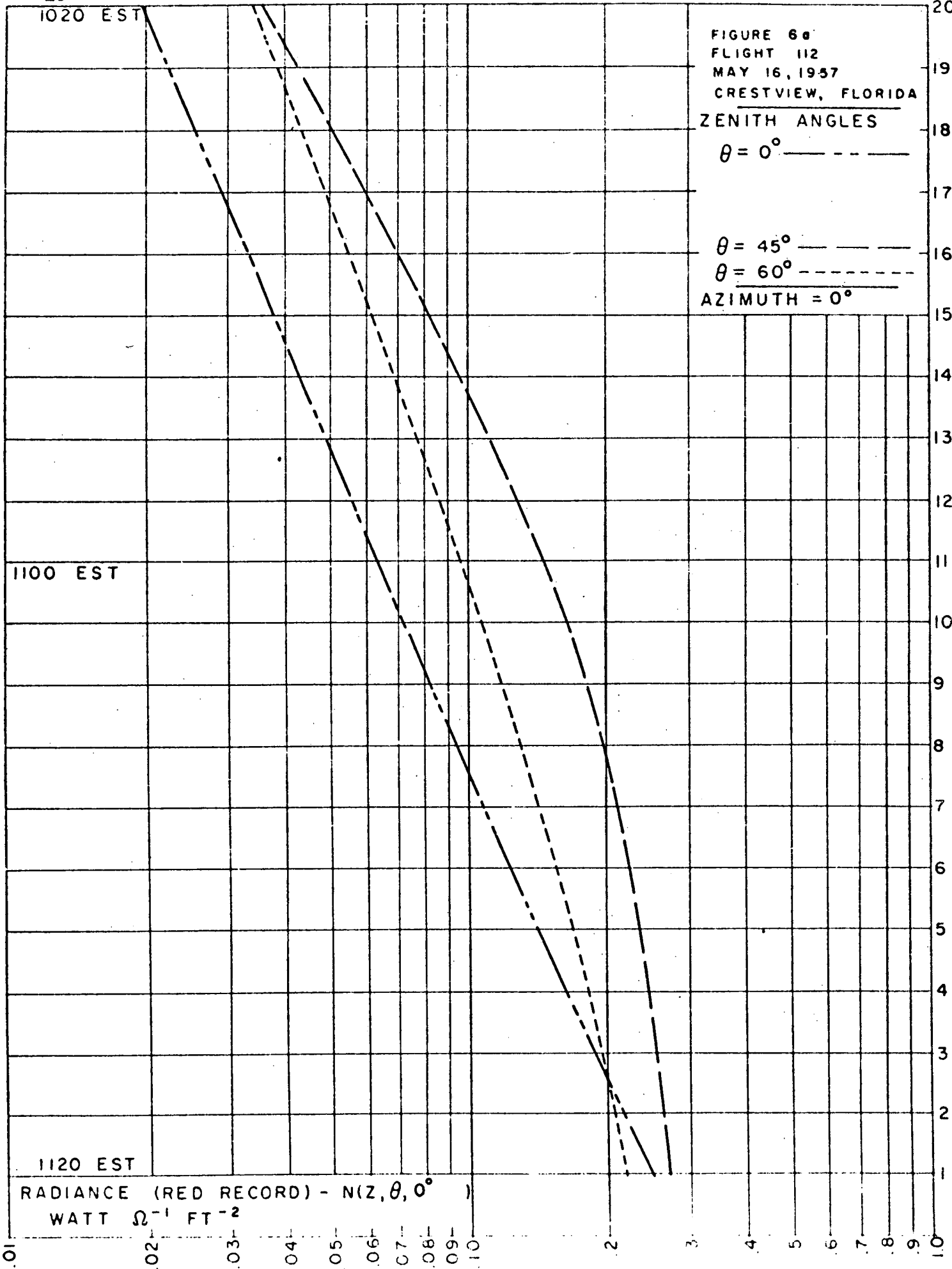
TYPE OF LINE

ZENITH ANGLE θ

0°
15°
30°
45°
60°
75°
80°
85°
90°
95°
100°
105°
120°
135°
150°
165°
180°

SHEET A
SHEET B
SHEET C
SHEET D
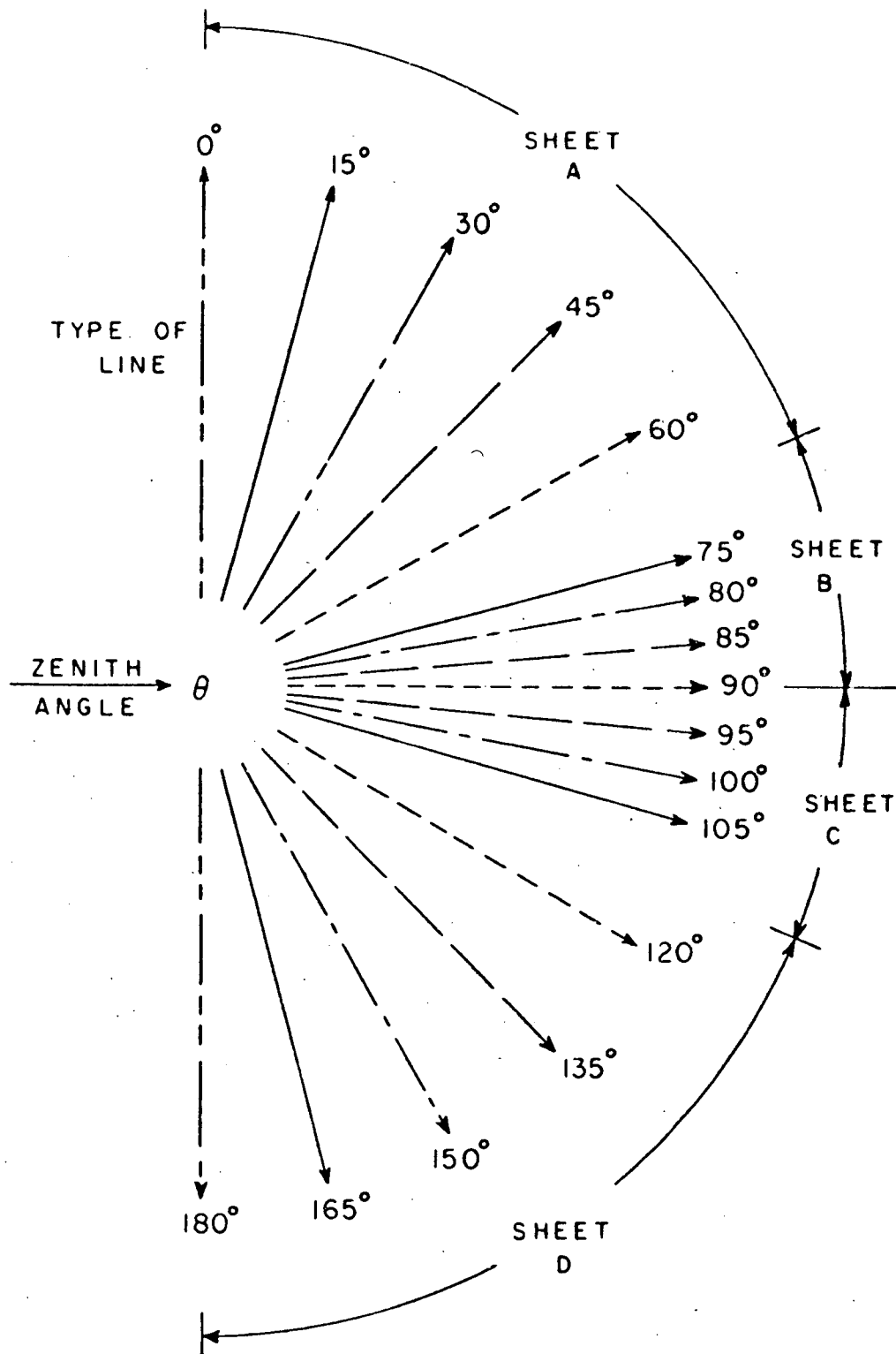
LINES USED FOR SKY RADIANCE PLOTS.

FIGURE 5
FLIGHT 112
MAY 16, 1957
CRESTVIEW FLORIDA

INDEX OF GRAPHS

FIGURE 6 aa
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 15°$ ————
$\theta = 30°$ —·——·—

AZIMUTH = 0°

1020 EST

1100 EST

NOTE CHANGE OF SCALE

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 0°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 6a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ ___ __ __ ___
$\theta = 45°$ ___ __ ___
$\theta = 60°$ __ __ __ __ __
AZIMUTH = 0°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 0°)$
WATT Ω^{-1} FT^{-2}

SIO Ref. 60-56

FIGURE 6b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ — — —
$\theta = 85°$ —·—·—
$\theta = 90°$ - - - - -

AZIMUTH = 0°

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

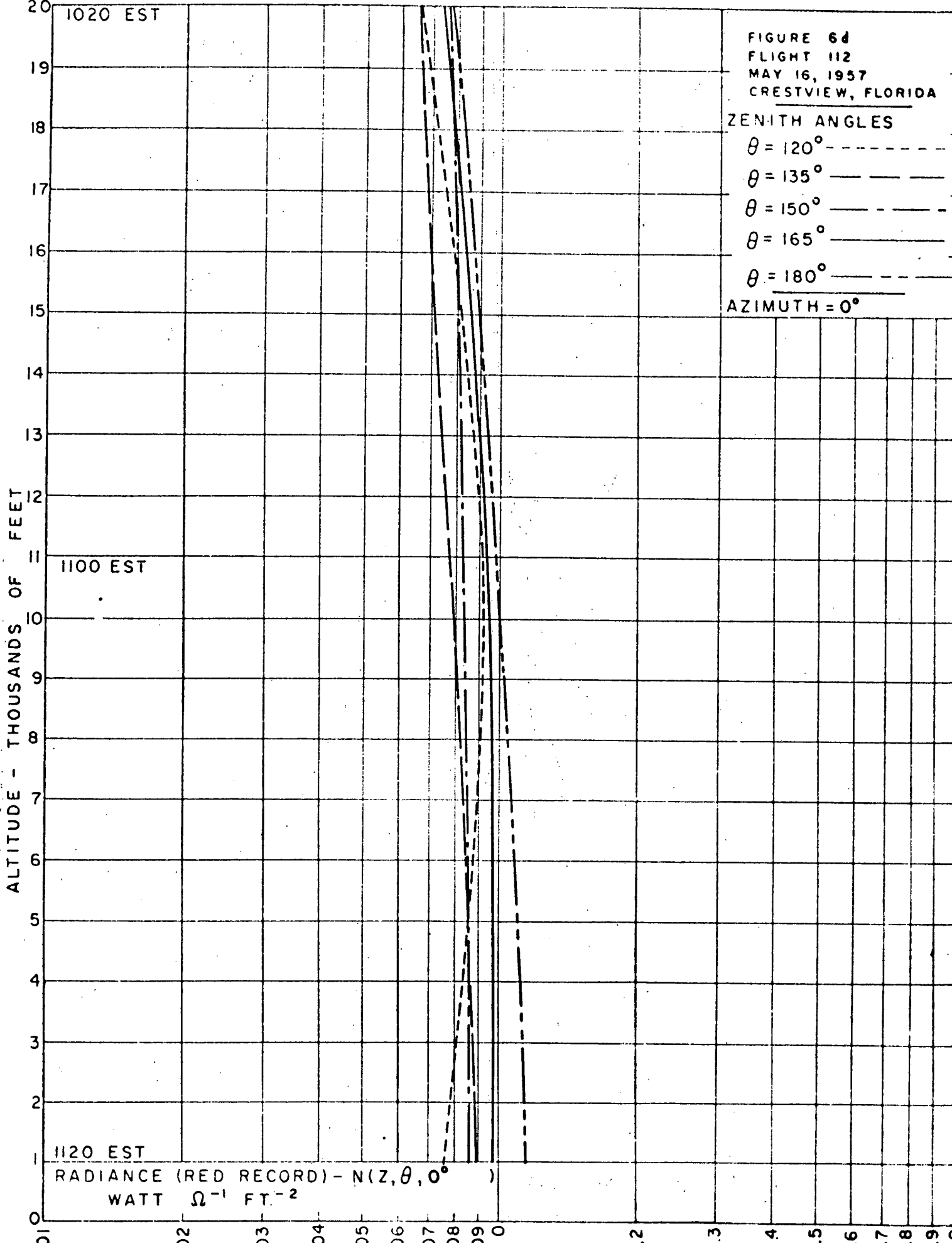RADIANCE (RED RECORD) - $N(Z, \theta, 0°)$
WATT Ω^{-1} FT^{-2}

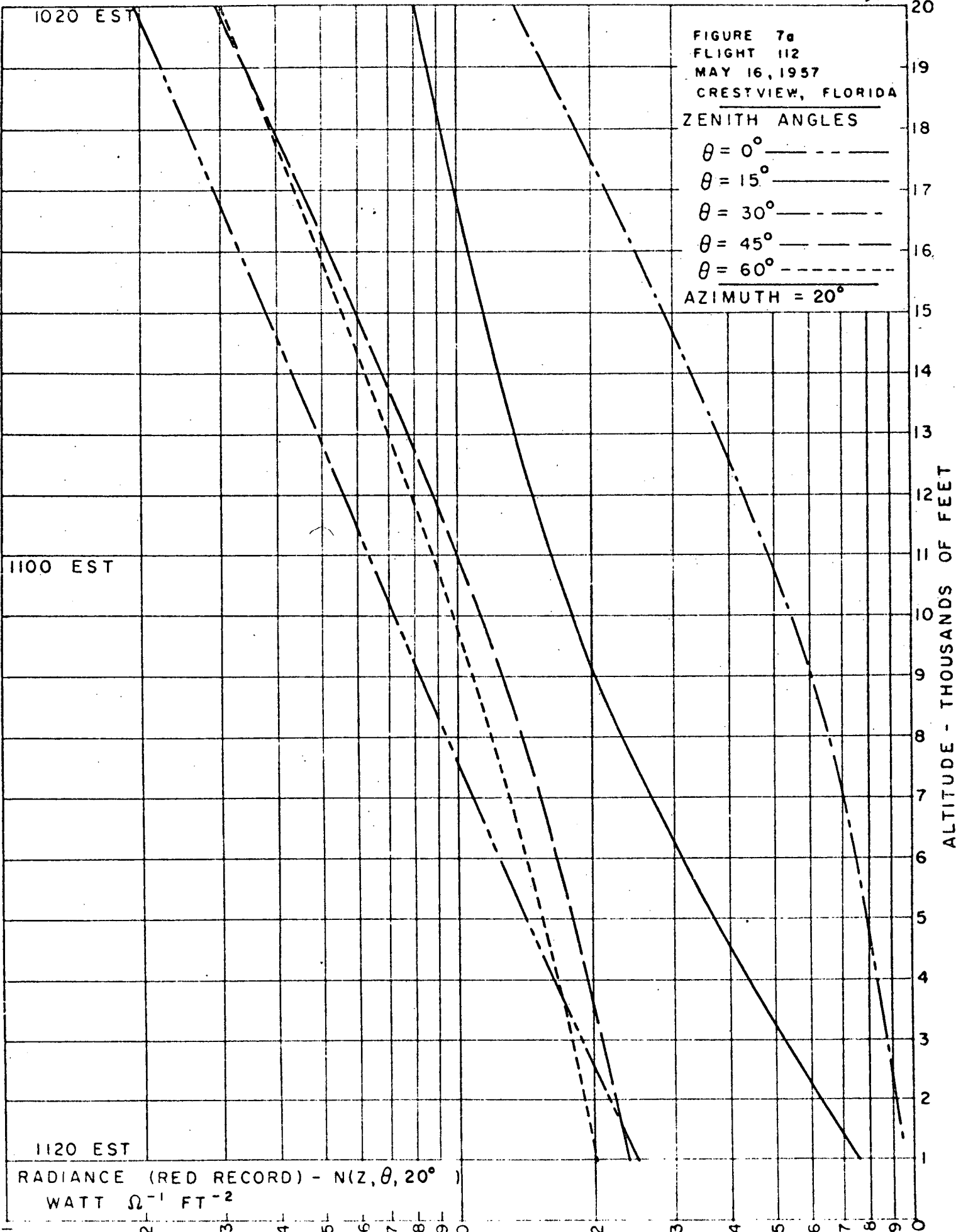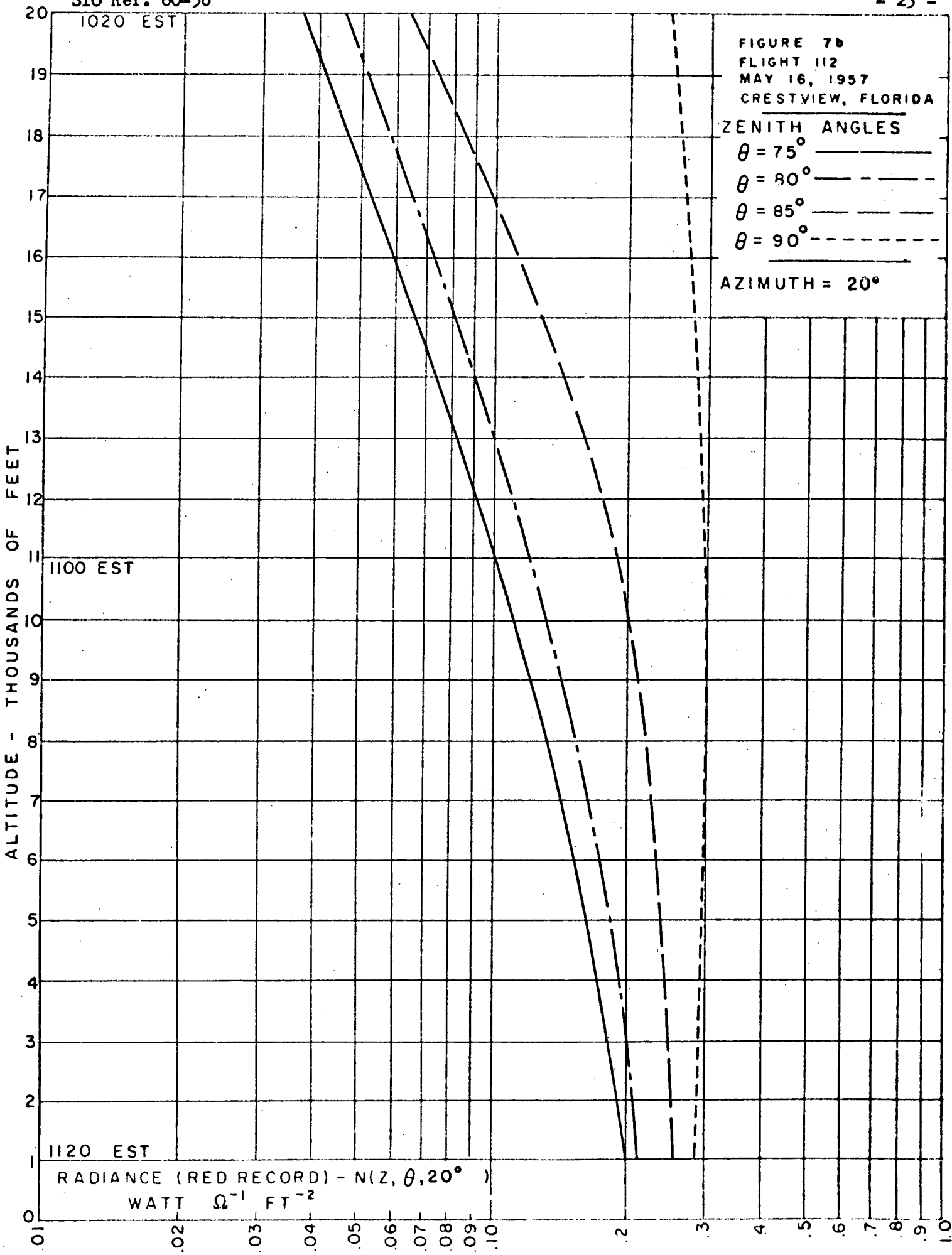1020 EST

FIGURE 6c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 90°$ -------
$\theta = 95°$ ———
$\theta = 100°$ ——·——
$\theta = 105°$ ———

AZIMUTH = 0°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 0°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET
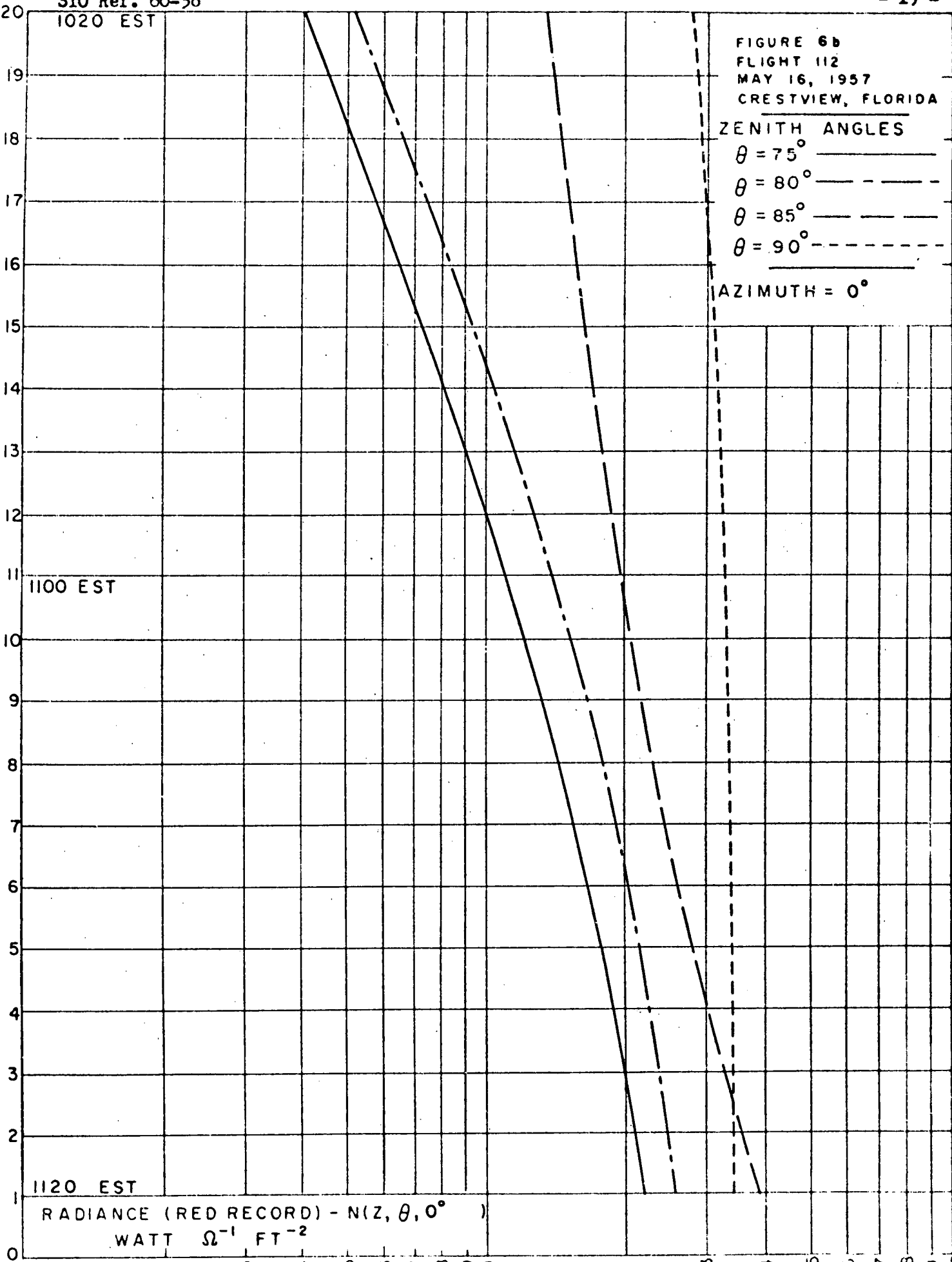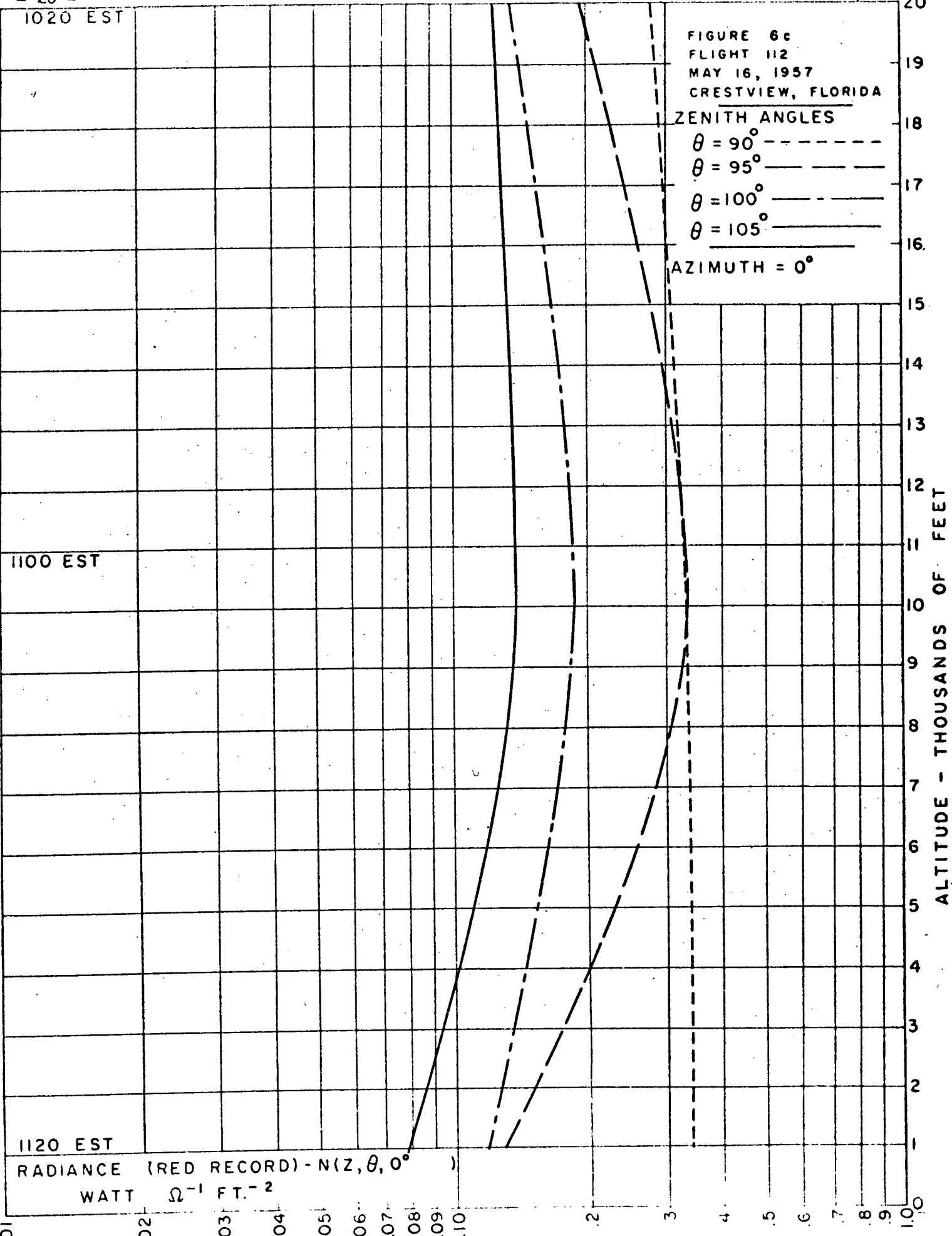
FIGURE 6d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 120°$ — — — — —
$\theta = 135°$ —— —— ——
$\theta = 150°$ —·— ·— ·—
$\theta = 165°$ ————
$\theta = 180°$ —— · ——
AZIMUTH = 0°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) — N(Z,θ,0°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE – THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 20°)

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 7a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

θ = 0° — — —
θ = 15° ————
θ = 30° —·—·—
θ = 45° —— ——
θ = 60° – – – –

AZIMUTH = 20°

FIGURE 7b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ——————
$\theta = 80°$ — — — —
$\theta = 85°$ —— —— ——
$\theta = 90°$ - - - - -

AZIMUTH = 20°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 20°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 7c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ --------
$\theta = 95°$ ———
$\theta = 100°$ —·—·—
$\theta = 105°$ ———

AZIMUTH = 20°

1020 EST

1100 EST

1120 EST
RADIANCE (RED RECORD) - N(Z, θ, 20°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE – THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z,θ, 20°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 7d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ - - - - - -

$\theta = 135°$ ⎯ ⎯ ⎯

$\theta = 150°$ ⎯ · ⎯ · ⎯

$\theta = 165°$ ⎯⎯⎯⎯

$\theta = 180°$ ⎯ ·· ⎯

AZIMUTH = 20°
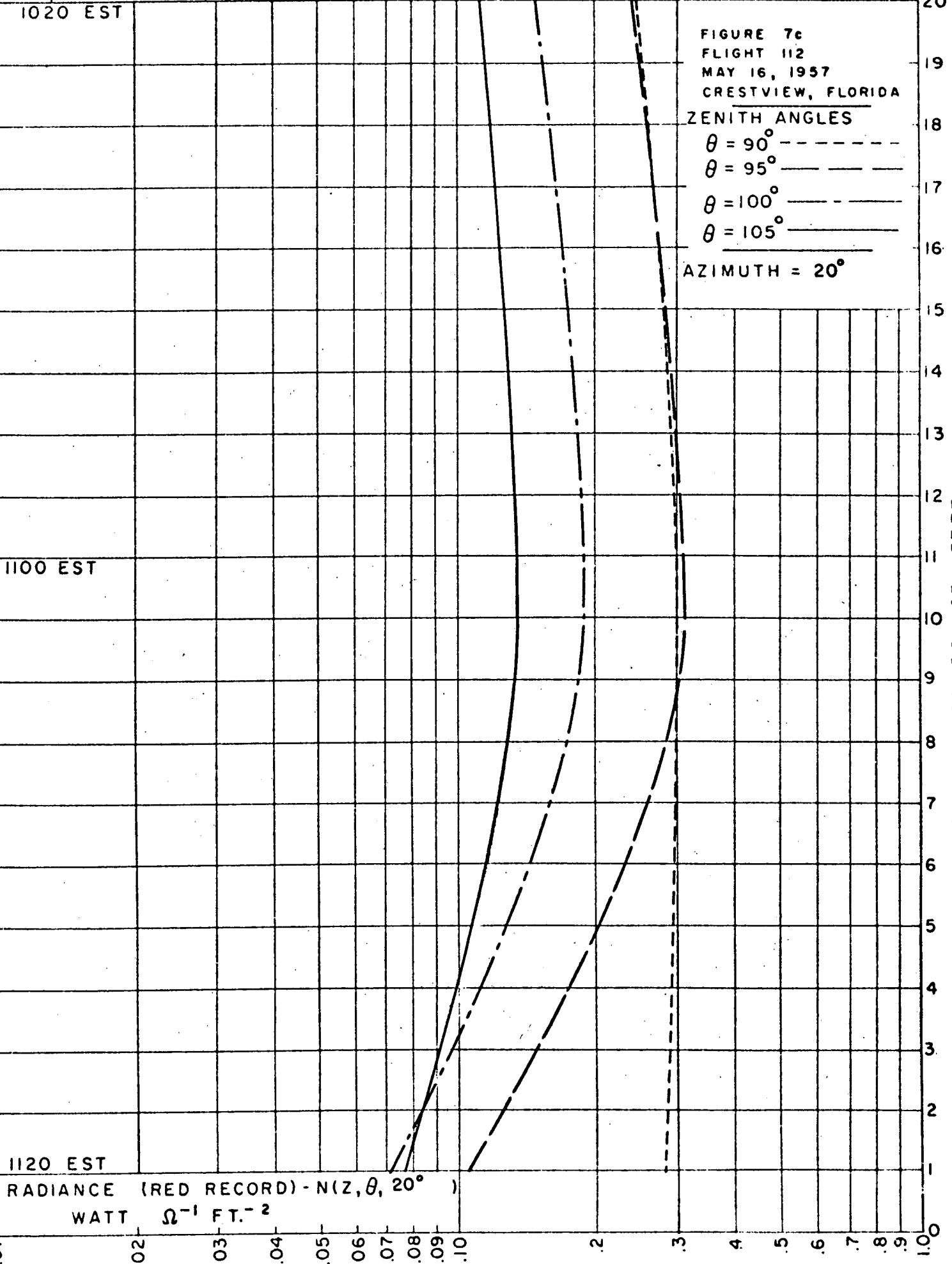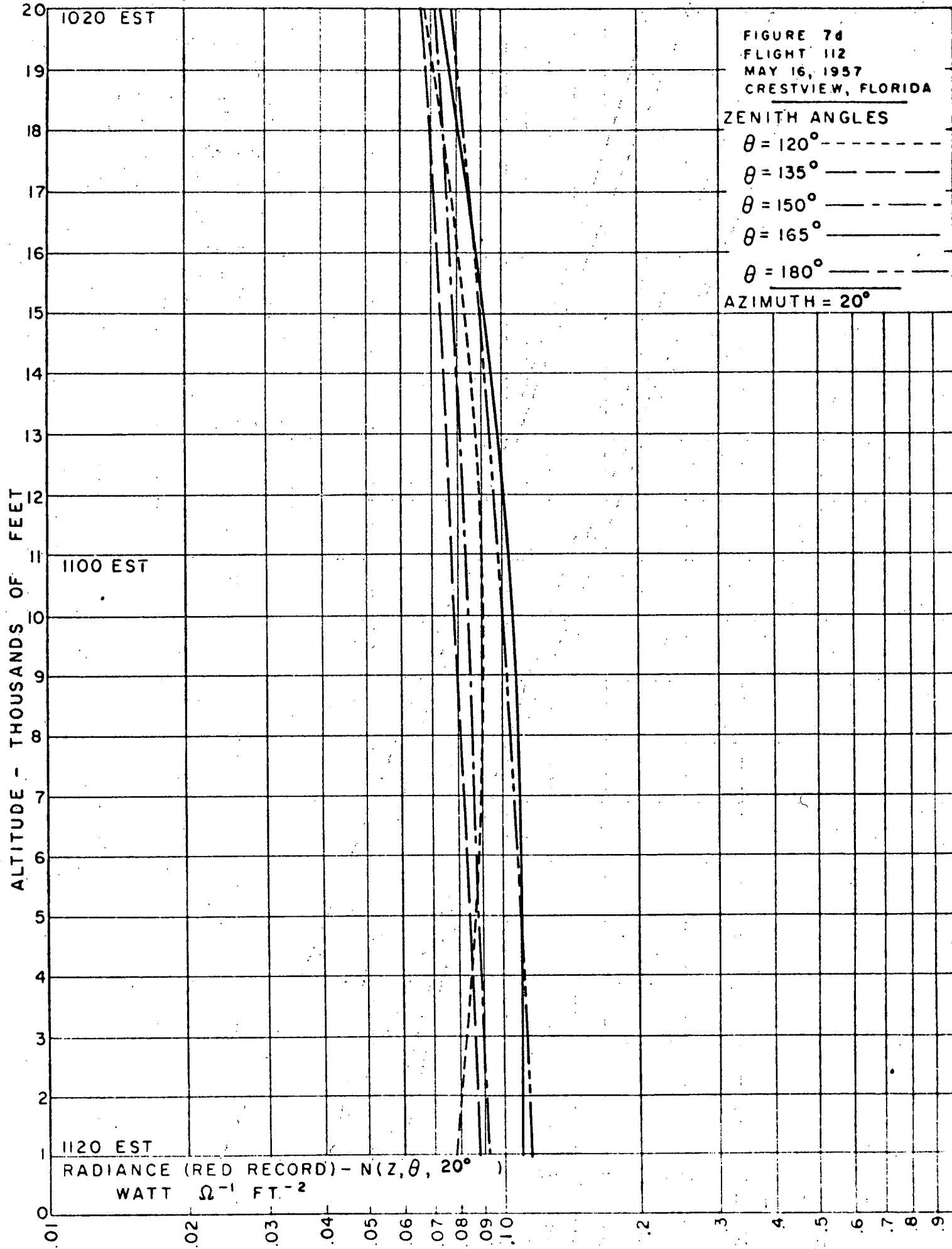
1020 EST

1100 EST

1120 EST

FIGURE 8a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ —— · —— ·

$\theta = 15°$ ————

$\theta = 30°$ —— · —— ·

$\theta = 45°$ —— —— ——

$\theta = 60°$ - - - - - - -

AZIMUTH = 40°

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z,θ,40°)
WATT Ω^{-1} FT^{-2}

SIO Ref. 60-56

1020 EST

FIGURE 8b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ — — —
$\theta = 85°$ —— ——
$\theta = 90°$ - - - - -

AZIMUTH = 40°

1100 EST

1120 EST

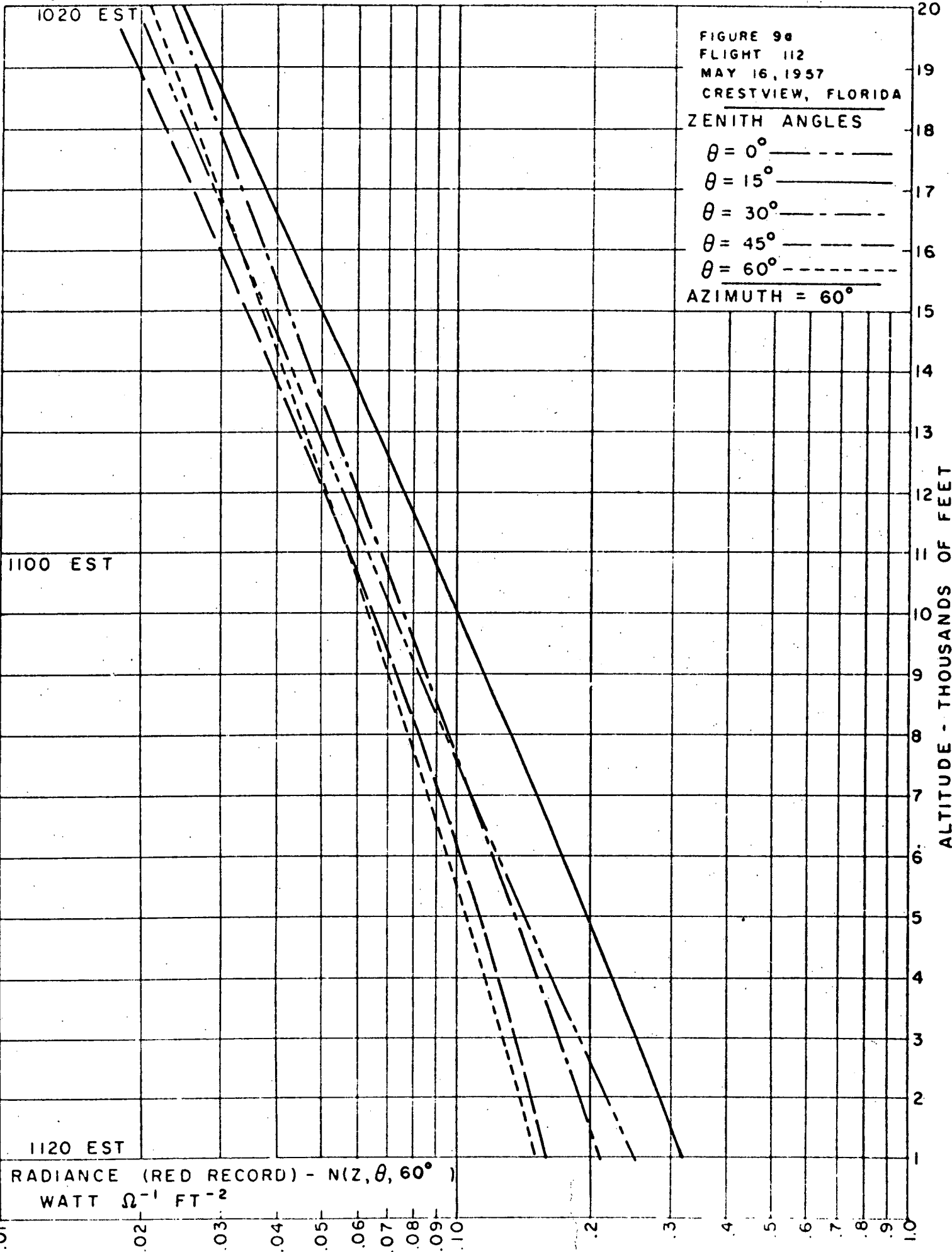RADIANCE (RED RECORD) - N(Z, θ, 40°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 8c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ - - - - -
$\theta = 95°$ ————
$\theta = 100°$ —·—·—
$\theta = 105°$ ————

AZIMUTH = 40°

1020 EST
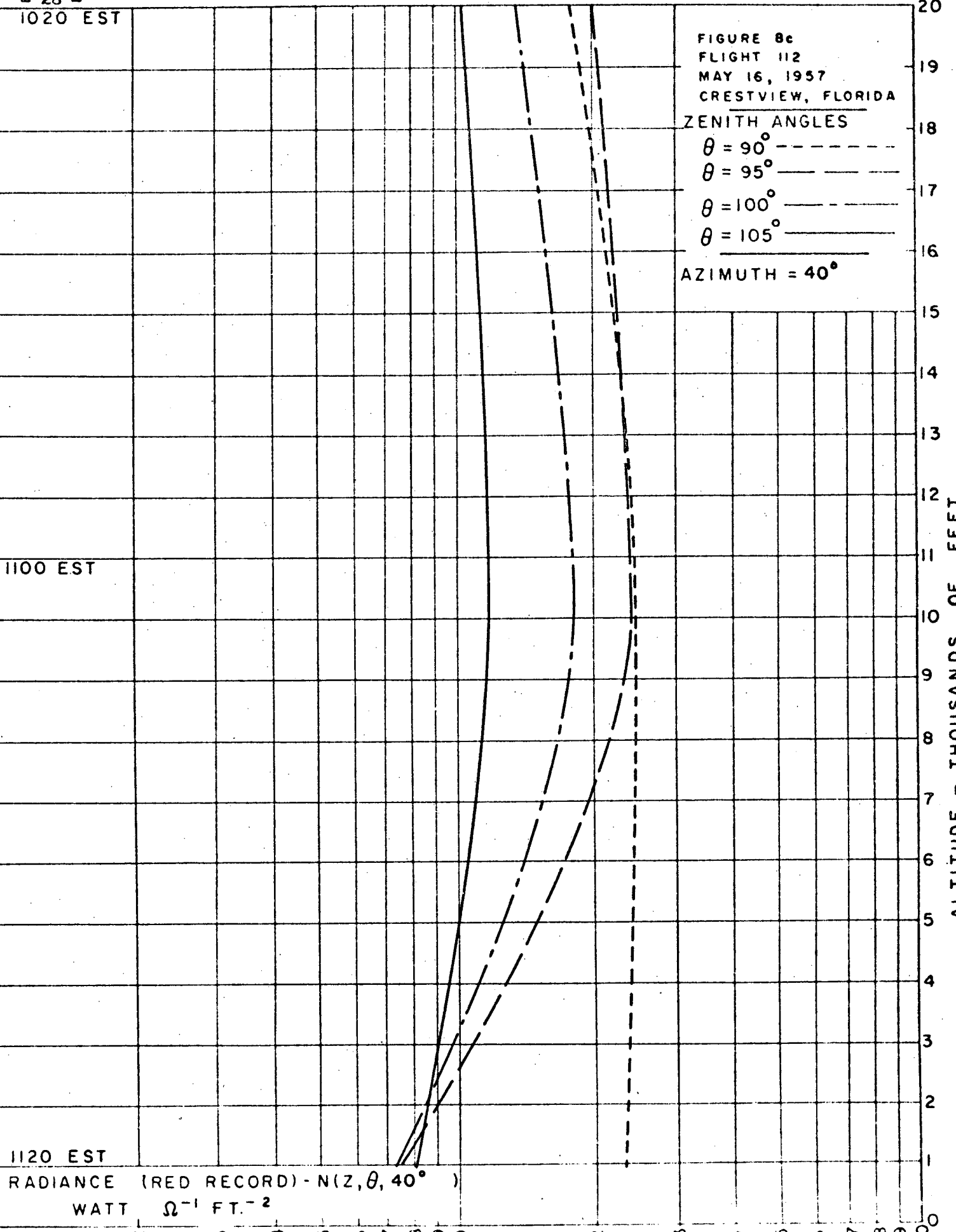
1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 40°)$
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 8d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 120°$ --------
$\theta = 135°$ — — —
$\theta = 150°$ —·—·—
$\theta = 165°$ ————
$\theta = 180°$ —— —
AZIMUTH = 40°

1020 EST

1100 EST

1120 EST

ALTITUDE – THOUSANDS OF FEET

RADIANCE (RED RECORD) – N(Z,θ,40°)
WATT Ω^{-1} FT.$^{-2}$

FIGURE 9a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ ————— ·

$\theta = 15°$ —————

$\theta = 30°$ ————— ·

$\theta = 45°$ —————

$\theta = 60°$ - - - - - -

AZIMUTH = 60°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 60°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET
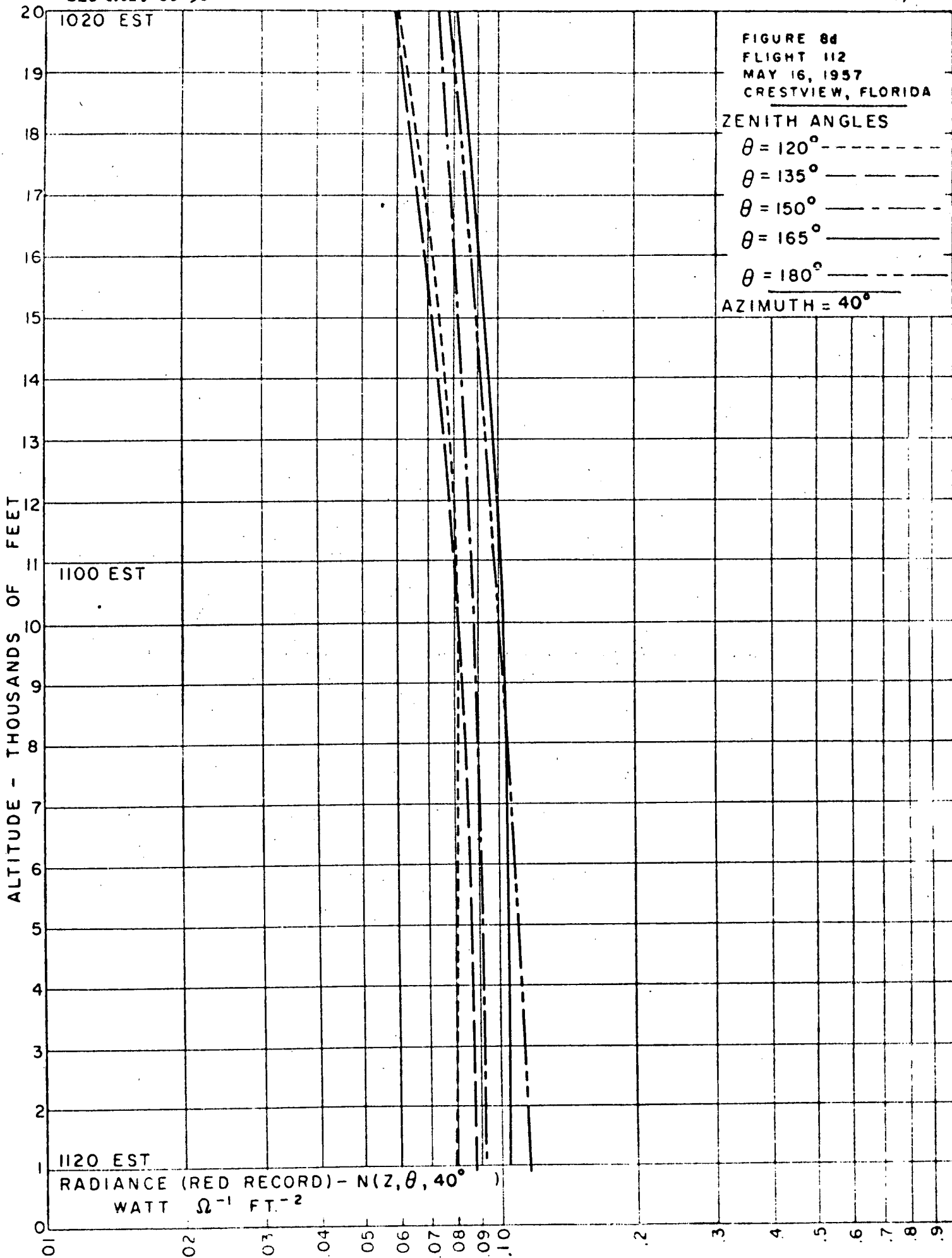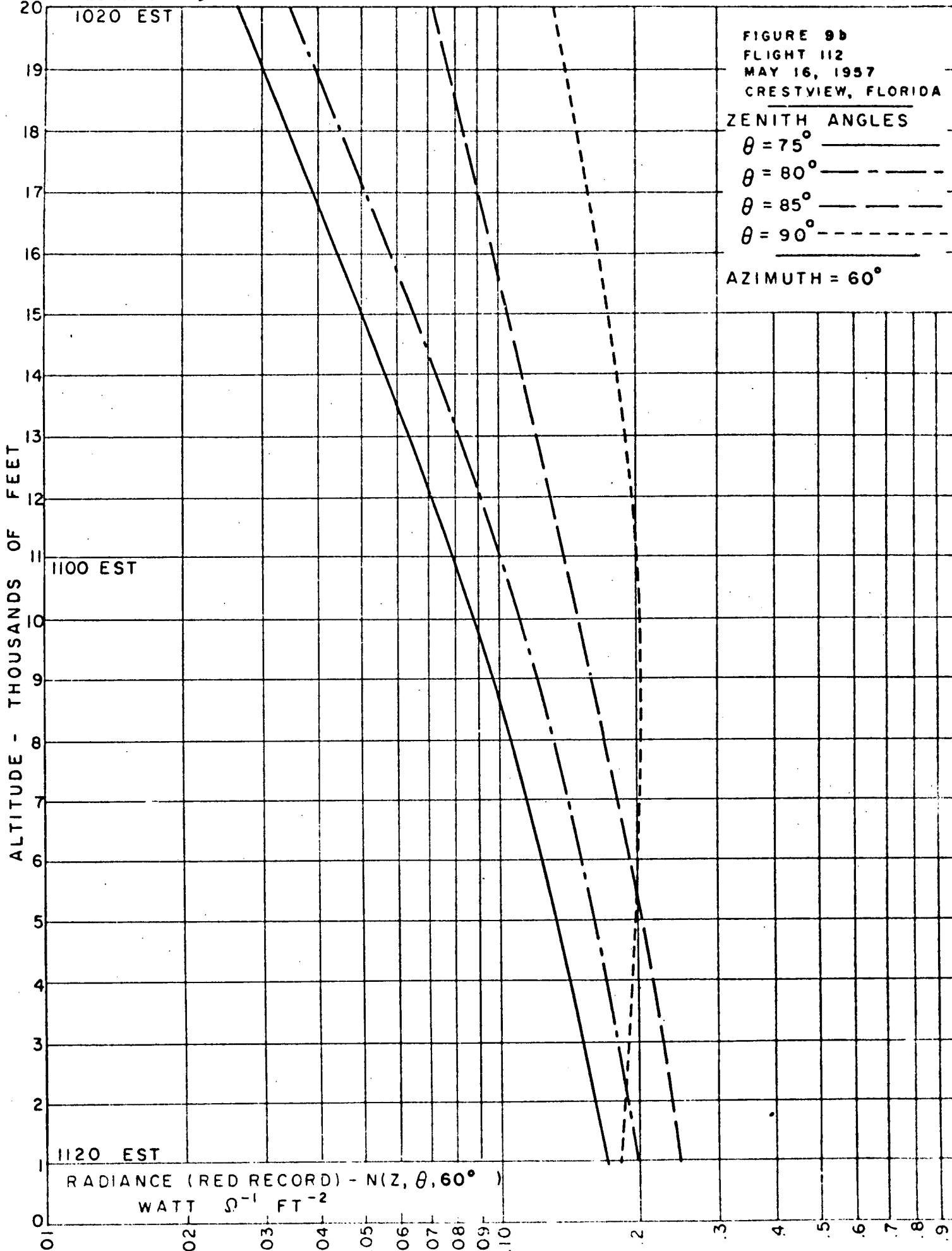
FIGURE 9b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ — · — · —
$\theta = 85°$ — — — —
$\theta = 90°$ - - - - -

AZIMUTH = 60°

1020 EST

1100 EST

1120 EST

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z, θ, 60°)
WATT Ω^{-1} FT^{-2}

1020 EST

1100 EST

1120 EST

FIGURE 9c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 90°$ --------
$\theta = 95°$ — —
$\theta = 100°$ —·—·—
$\theta = 105°$ ————

AZIMUTH = 60°

ALTITUDE – THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z, θ, 60°)

WATT Ω^{-1} FT.$^{-2}$

FIGURE 9d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
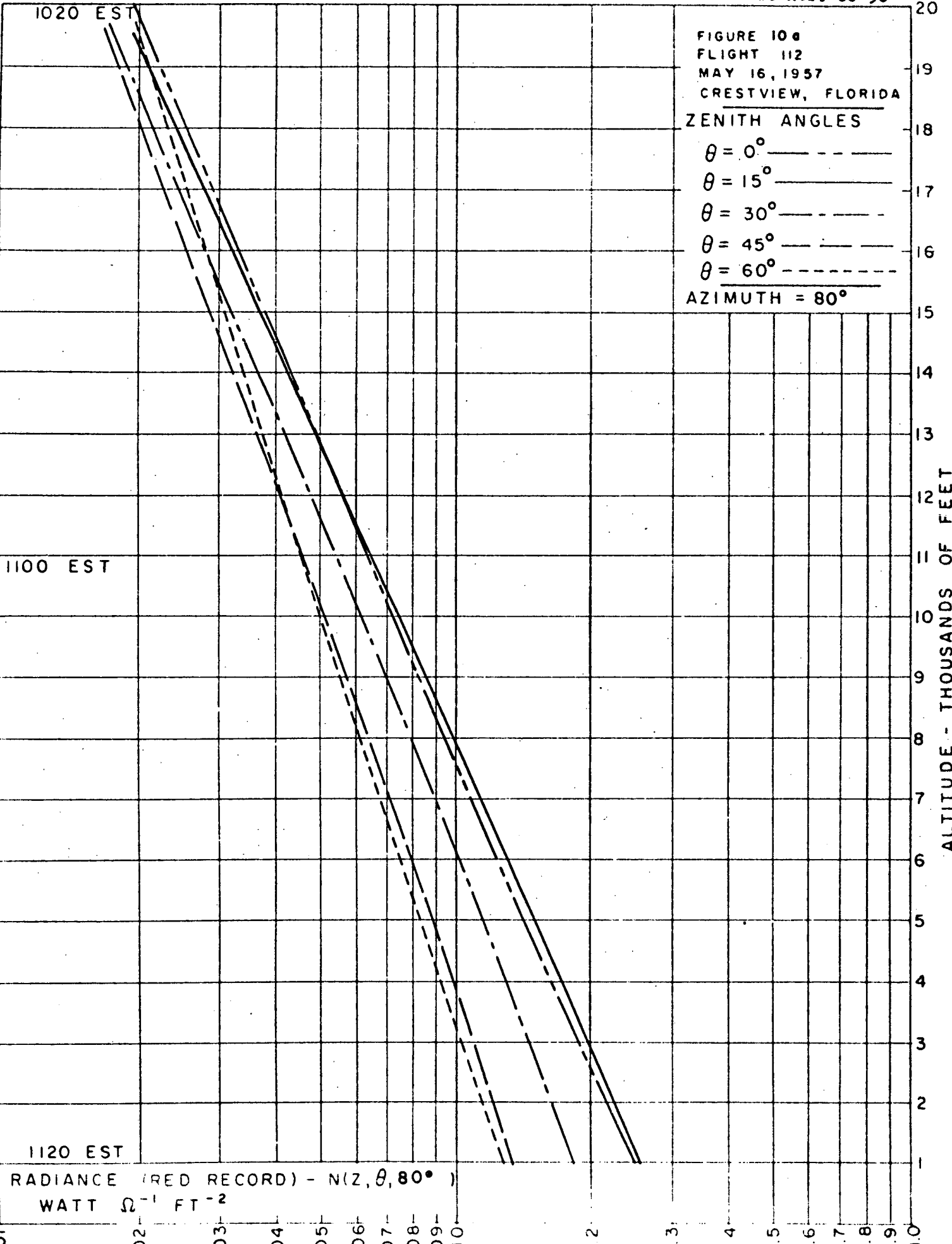
ZENITH ANGLES
$\theta = 120°$ ------
$\theta = 135°$ ——
$\theta = 150°$ —·—
$\theta = 165°$ ——
$\theta = 180°$ —·—
AZIMUTH = 60°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 60°)
WATT Ω^{-1} FT^{-2}

ALTITUDE -- THOUSANDS OF FEET

FIGURE 10 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ ———— — —
$\theta = 15°$ ————
$\theta = 30°$ ——— · ——— ·
$\theta = 45°$ ——— · ———
$\theta = 60°$ — — — — —
AZIMUTH = 80°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 80°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 10 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ——————
$\theta = 80°$ —— —— ——
$\theta = 85°$ ——— ———
$\theta = 90°$ - - - - - -

AZIMUTH = 80°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 80°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

1020 EST

FIGURE 10c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90°$ -------
$\theta = 95°$ —— ——
$\theta = 100°$ —— · ——
$\theta = 105°$ ————

AZIMUTH = 80°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z,θ,80°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 10 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 120°$ -------
$\theta = 135°$ — — —
$\theta = 150°$ — · — ·
$\theta = 165°$ ————
$\dot\theta = 180°$ — — —
AZIMUTH = 80°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 80°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56
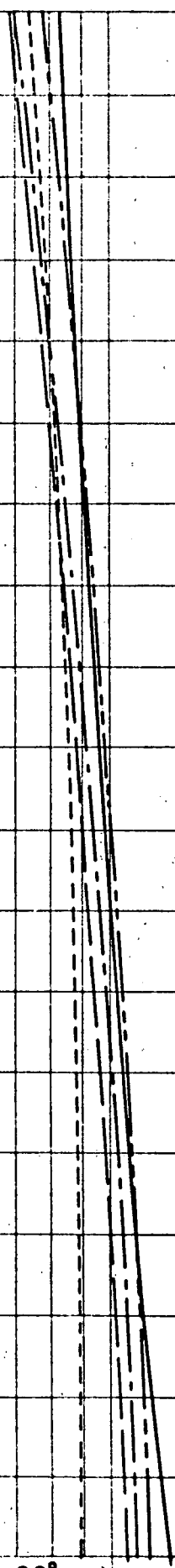
FIGURE 11a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ ———— — —
$\theta = 15°$ ————————
$\theta = 30°$ —— · —— ·
$\theta = 45°$ —— —— ——
$\theta = 60°$ — — — — —

AZIMUTH = 100°

1020 EST

1100 EST

1120 EST

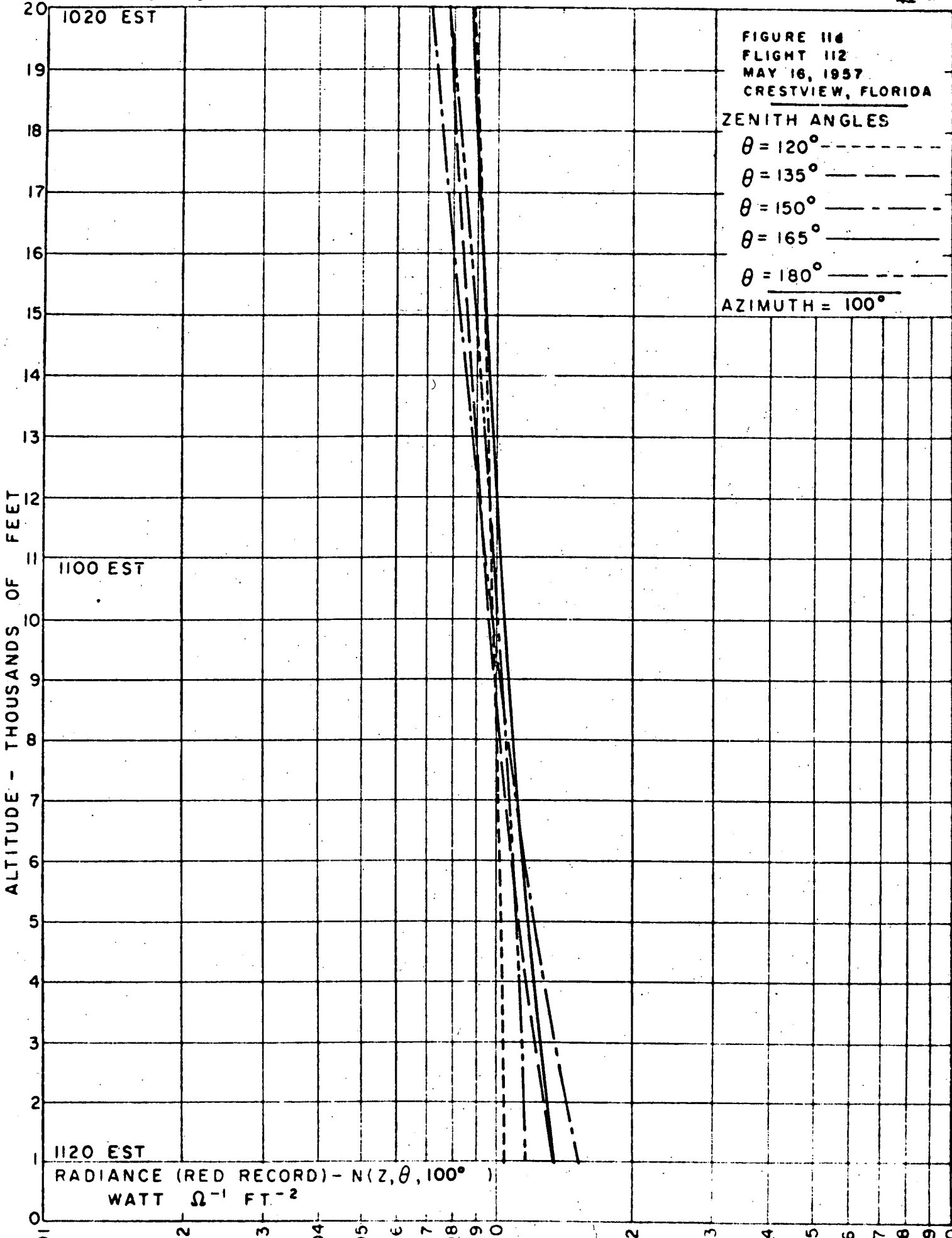RADIANCE (RED RECORD) - N(Z, θ, 100°)

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET
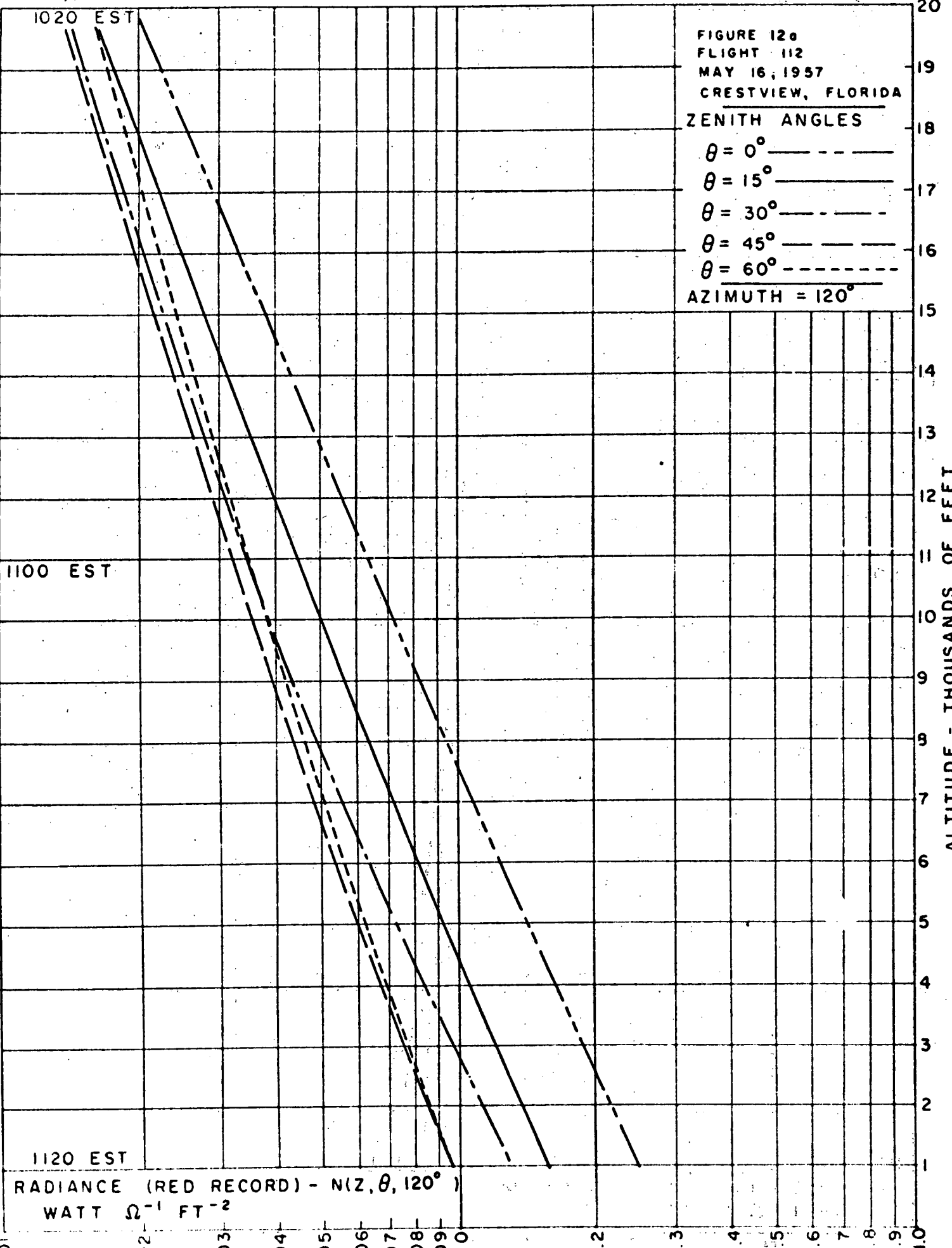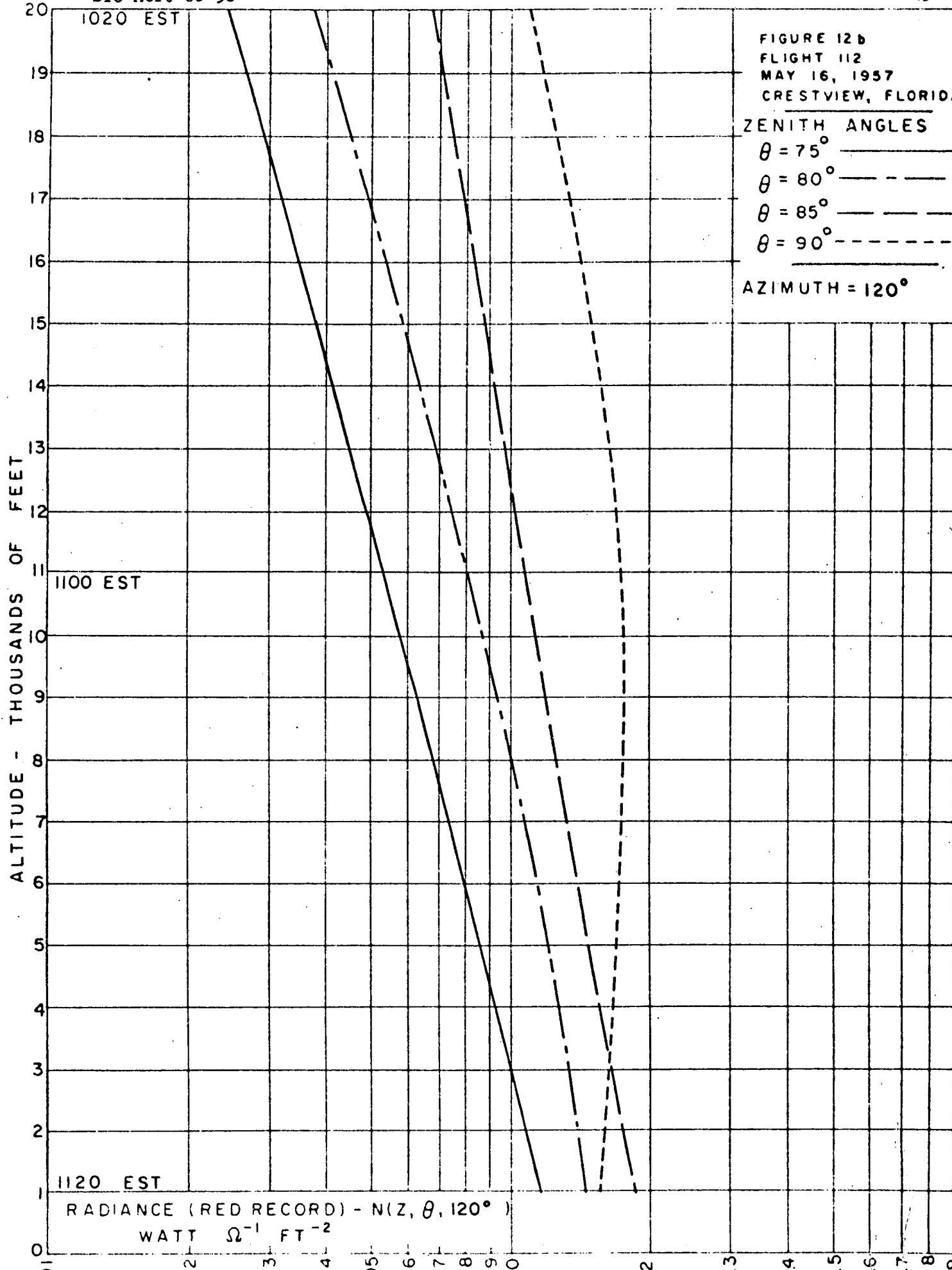
SIO Ref. 60-56

FIGURE 11b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 75°$
$\theta = 80°$
$\theta = 85°$
$\theta = 90°$

AZIMUTH = 100°

1020 EST

1100 EST

1120 EST

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z, θ, 100°)
WATT Ω^{-1} FT^{-2}
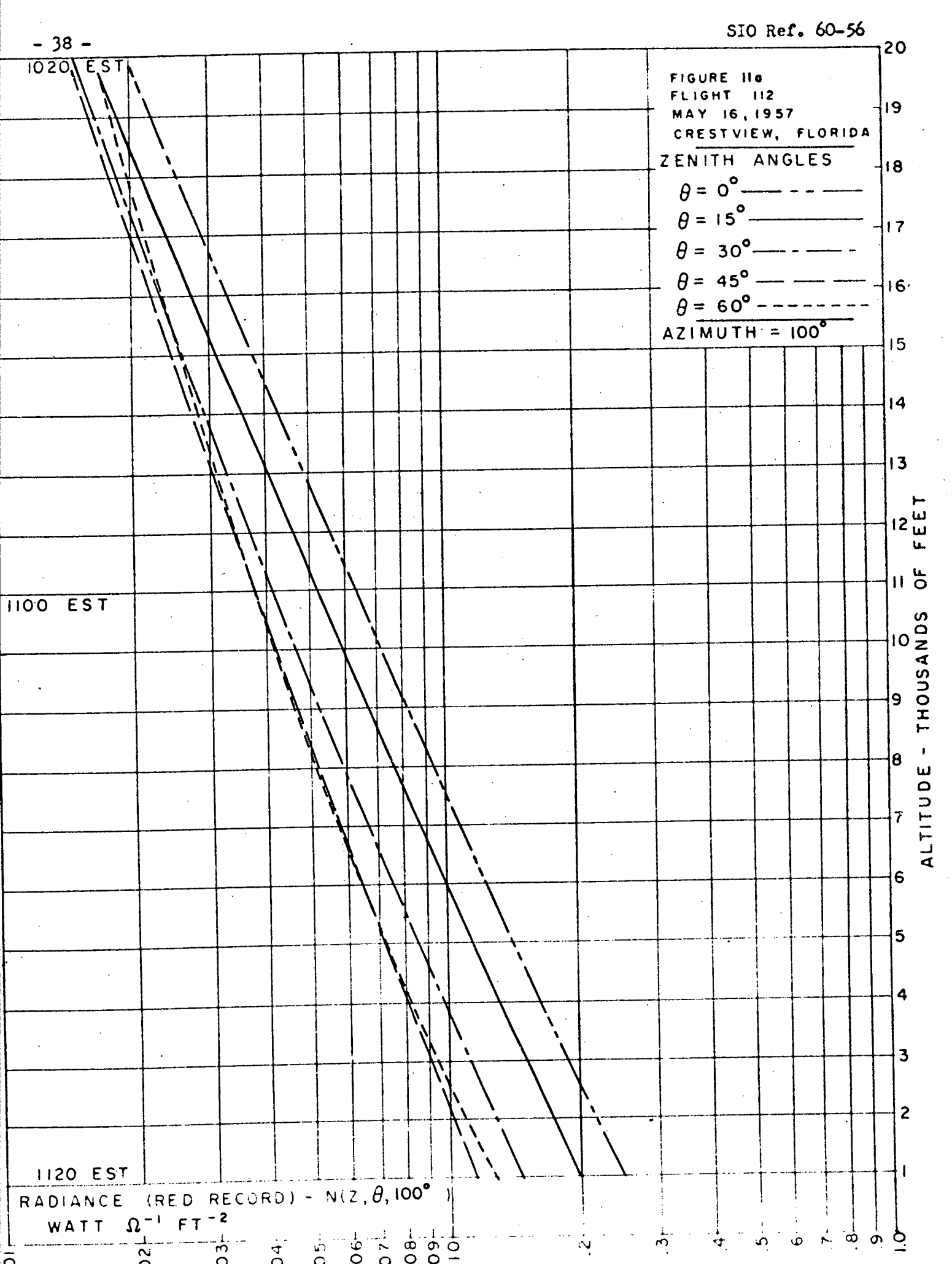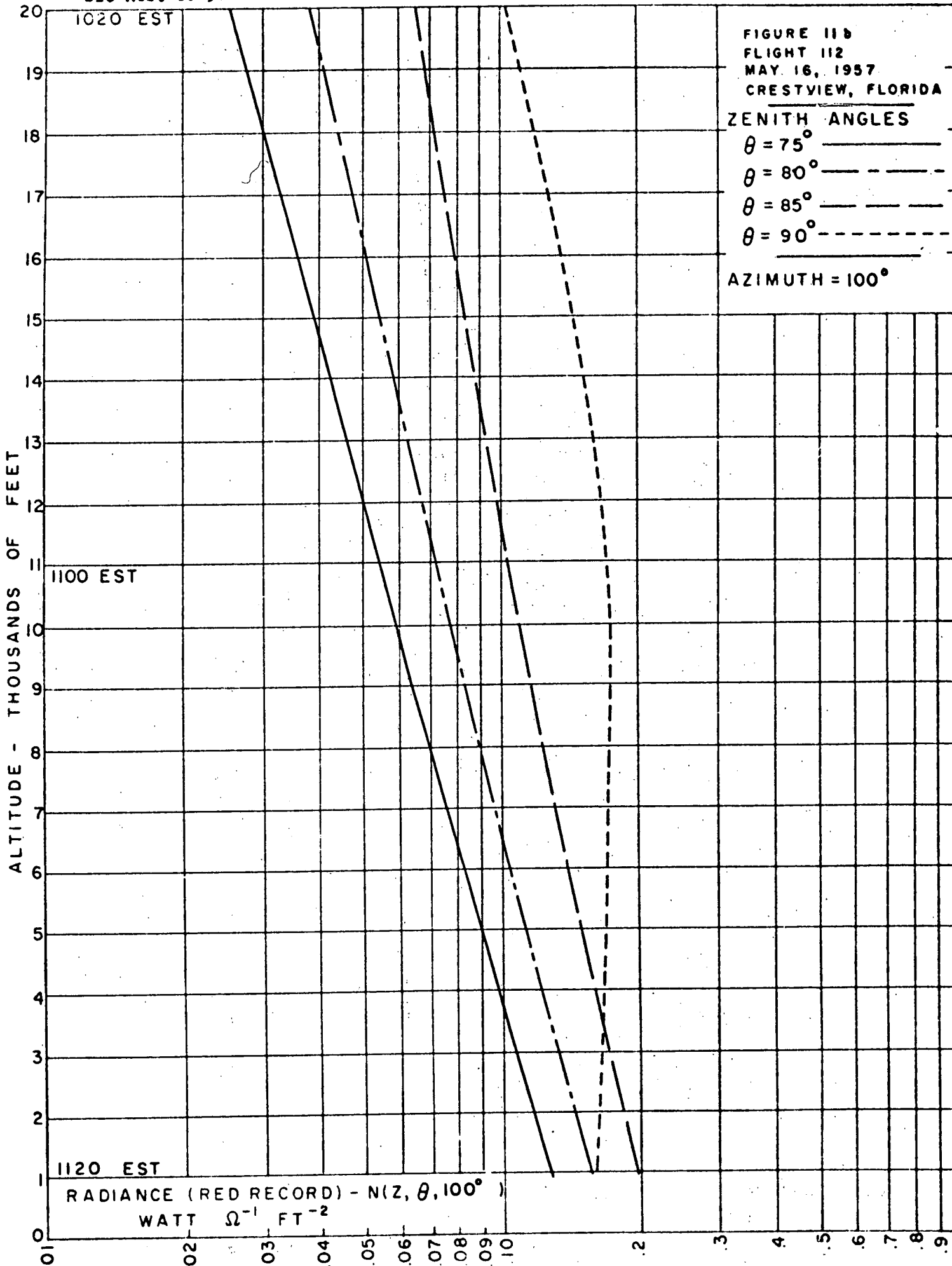
FIGURE 11c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 90°$ - - - - -
$\theta = 95°$ — — —
$\theta = 100°$ — · — ·
$\theta = 105°$ ———

AZIMUTH = 100°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD)- $N(Z,\theta,100°)$
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 11d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ ----------

$\theta = 135°$ ————

$\theta = 150°$ —·—·—

$\theta = 165°$ ————

$\theta = 180°$ —·· —··

AZIMUTH = 100°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) $- N(Z, \theta, 100°)$

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 12a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 0°$
$\theta = 15°$
$\theta = 30°$
$\theta = 45°$
$\theta = 60°$
AZIMUTH = 120°

SIO Ref. 60-56

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

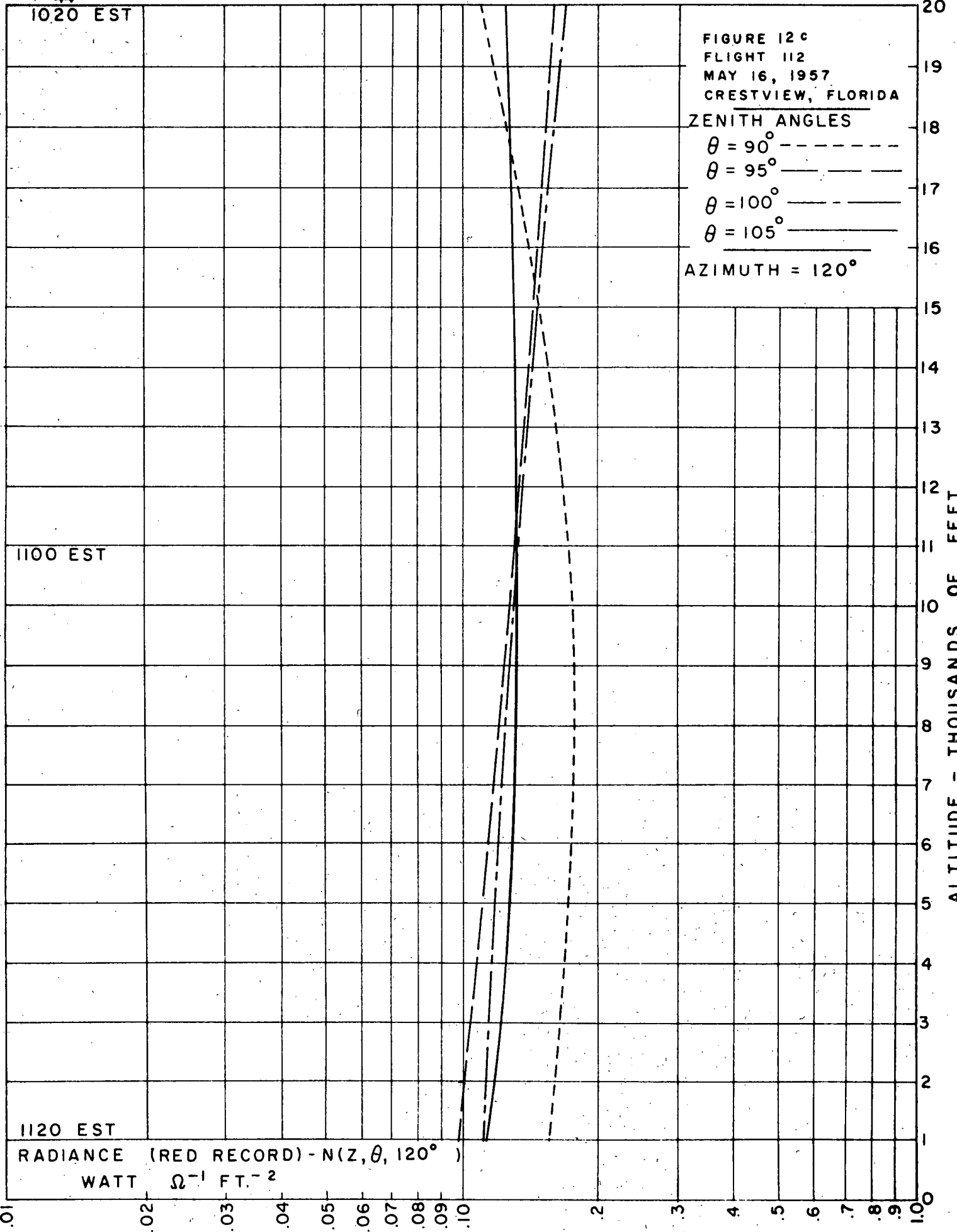RADIANCE (RED RECORD) - N(Z, θ, 120°)
WATT Ω^{-1} FT^{-2}

1020 EST

FIGURE 12 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ————

$\theta = 80°$ ——— —

$\theta = 85°$ ——— ———

$\theta = 90°$ ----------

AZIMUTH = 120°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 120°)

WATT Ω^{-1} FT^{-2}

1020 EST

FIGURE 12 c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ ----
$\theta = 95°$ —— —— ——
$\theta = 100°$ —— · —— ·
$\theta = 105°$ ————

AZIMUTH = 120°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 120°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

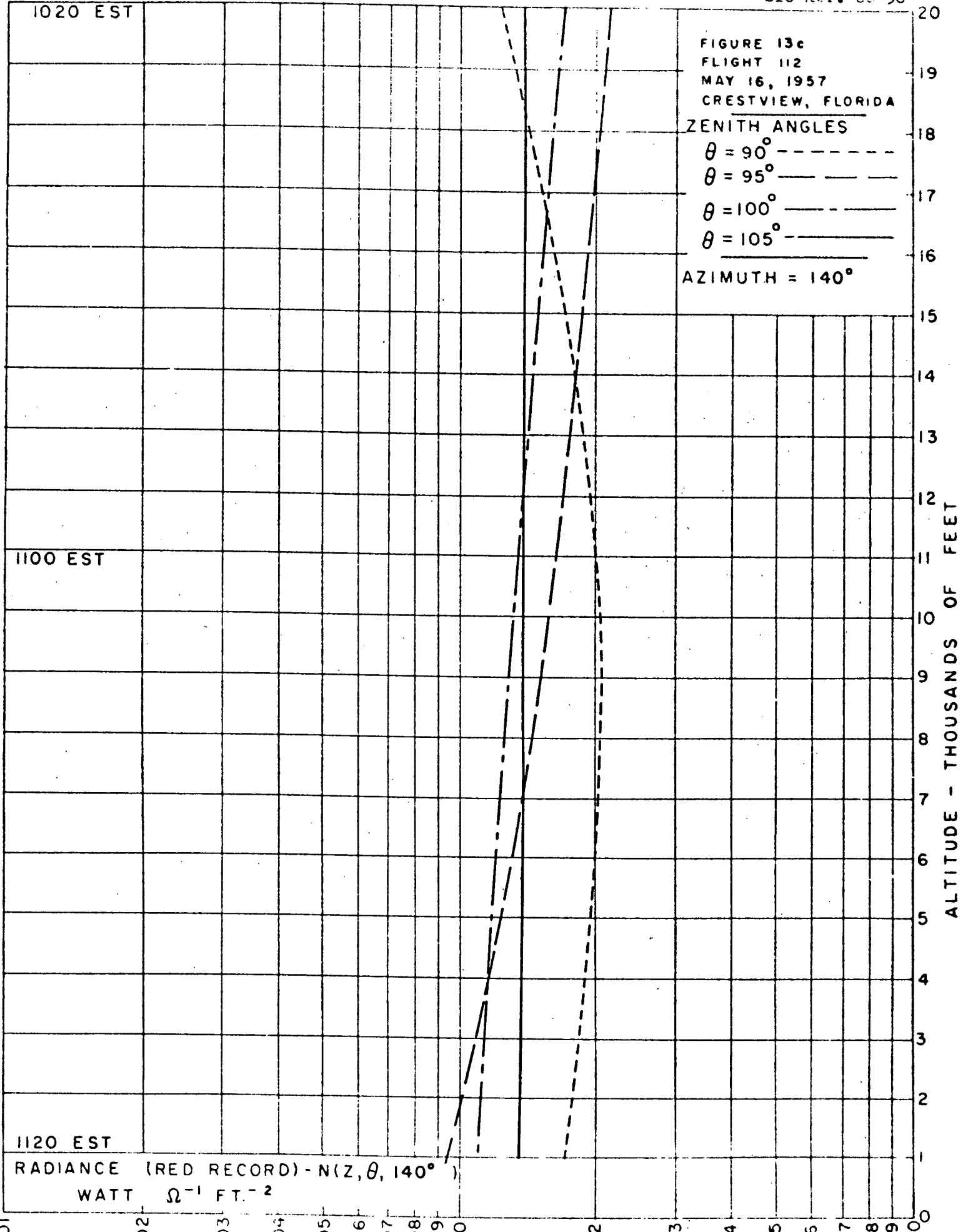FIGURE 12d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 120°$ -------
$\theta = 135°$ -- -- --
$\theta = 150°$ -- · -- ·
$\theta = 165°$ ————
$\theta = 180°$ —— · ——
AZIMUTH = 120°

1020 EST
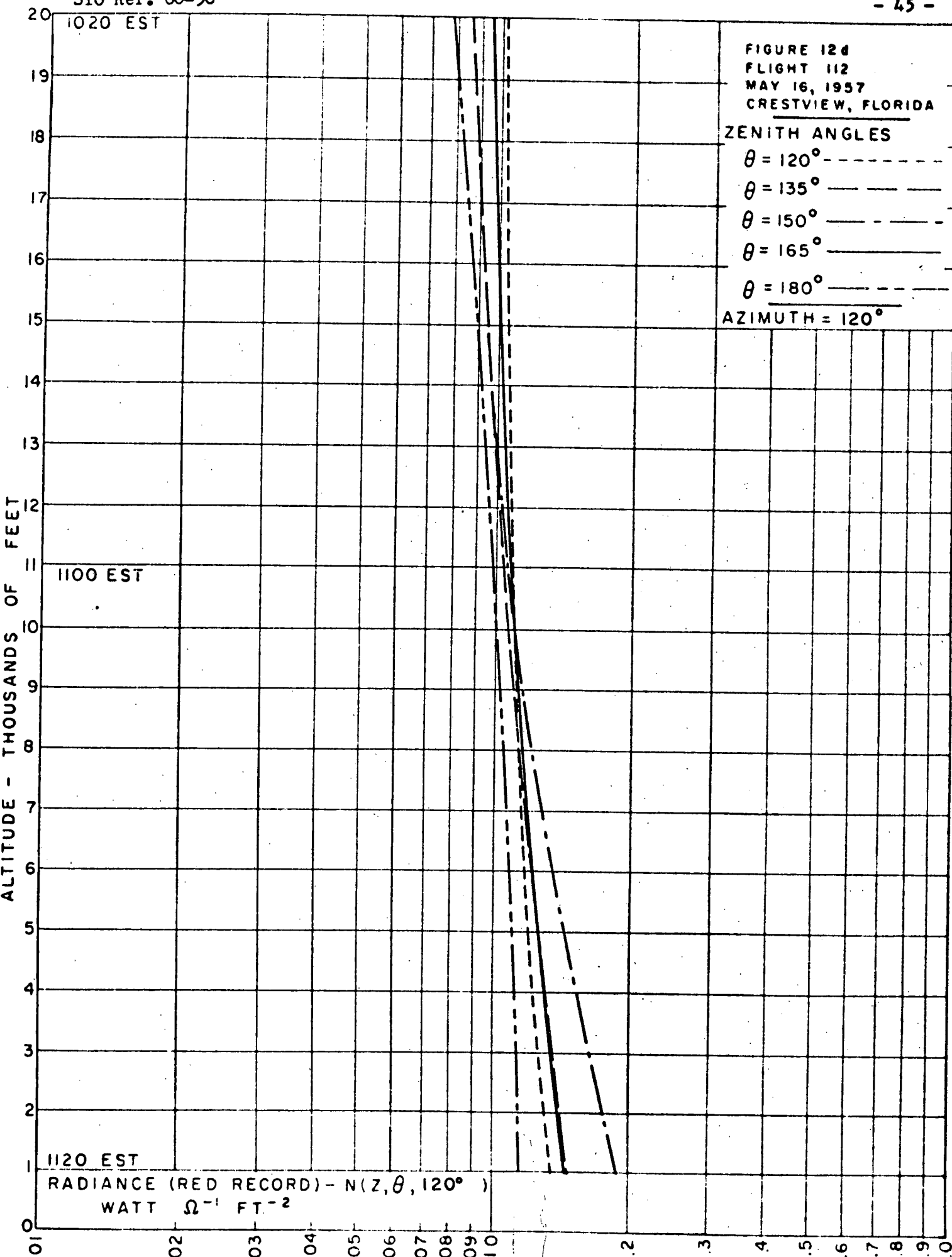
1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 120°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 13a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ —— — —
$\theta = 15°$ ————
$\theta = 30°$ —·—·—
$\theta = 45°$ —— —— ——
$\theta = 60°$ - - - - -

AZIMUTH = 140°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 140°)

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 13b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ————
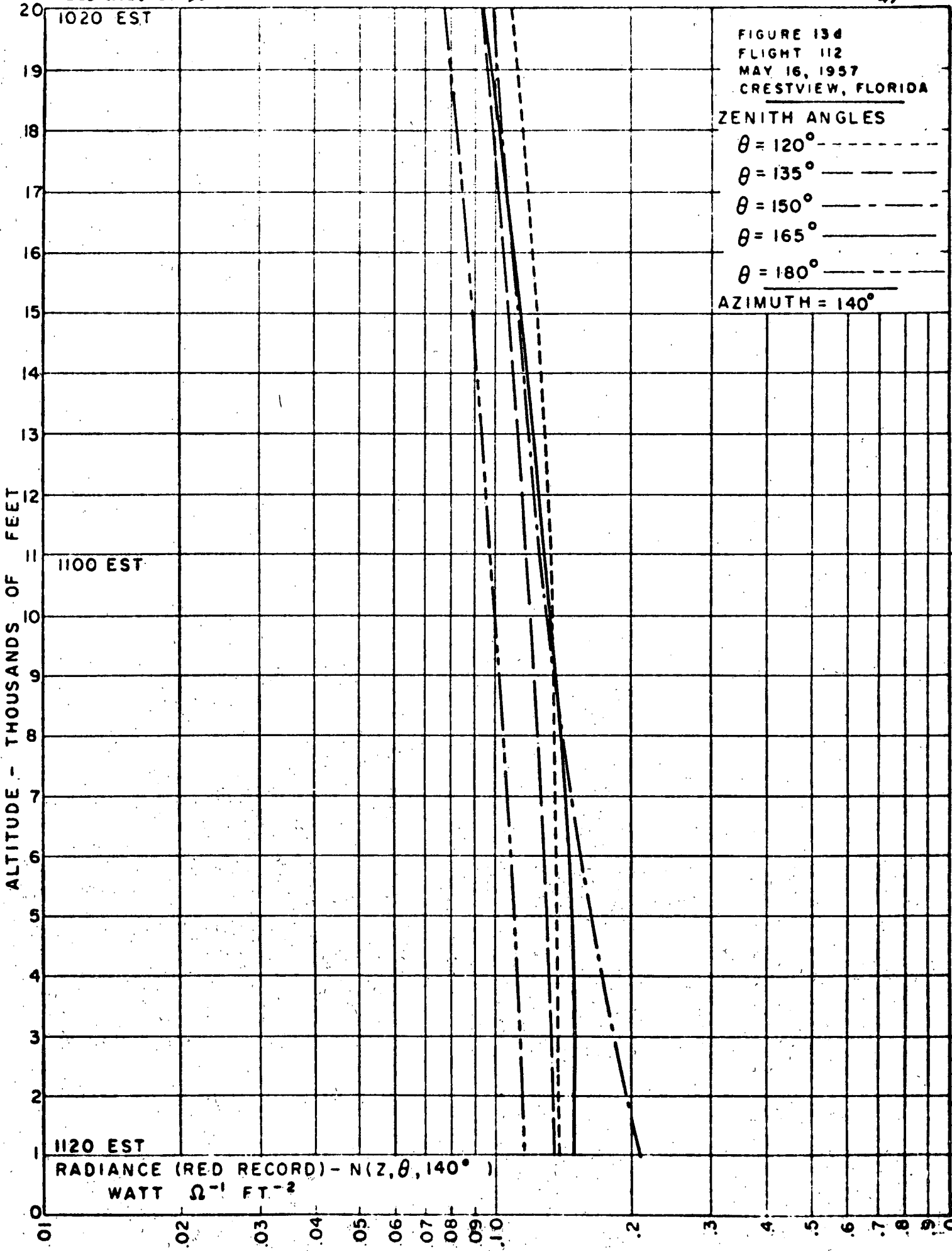$\theta = 80°$ —·—·—
$\theta = 85°$ ———
$\theta = 90°$ - - - -

AZIMUTH = 140°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 140°)
WATT Ω^{-1} FT^{-2}
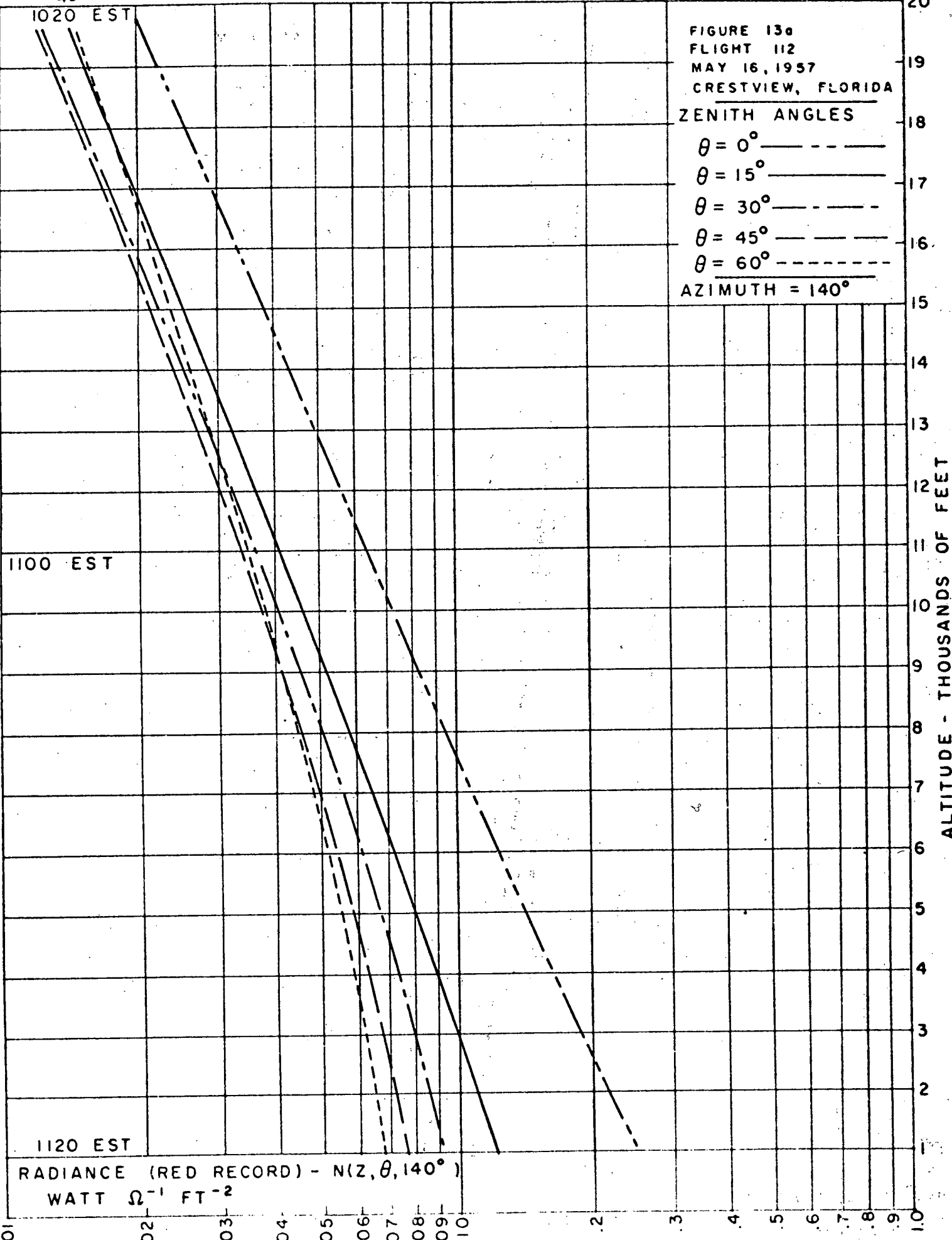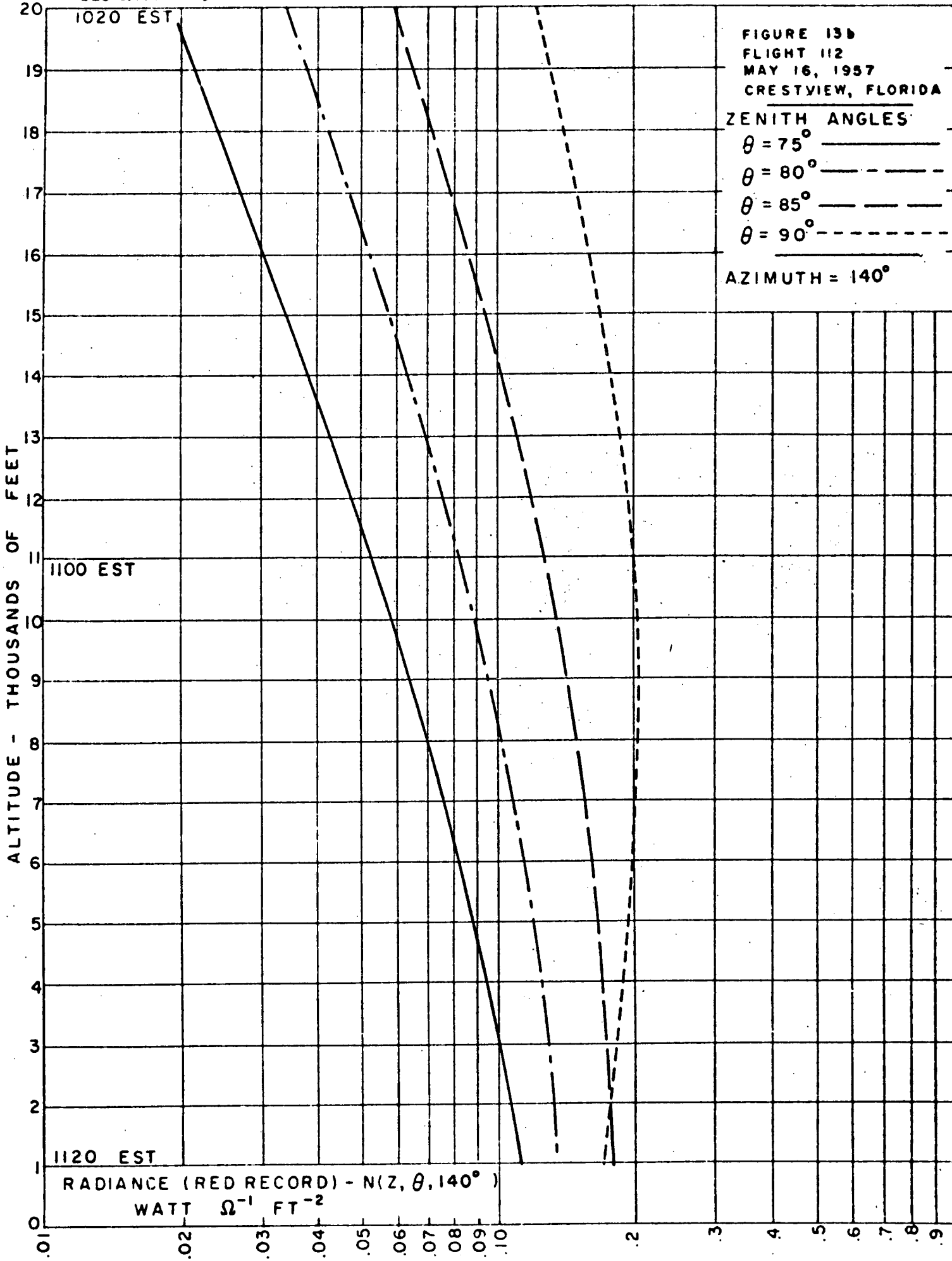
ALTITUDE - THOUSANDS OF FEET

FIGURE 13c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ ------
$\theta = 95°$ —— —
$\theta = 100°$ —·—·—
$\theta = 105°$ ————
AZIMUTH = 140°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 140°)$
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

Figure caption / legend:

1020 EST

FIGURE 13d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ ------
$\theta = 135°$ —— ——
$\theta = 150°$ —— · ——
$\theta = 165°$ ————
$\theta = 180°$ —— —

AZIMUTH = 140°

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 140°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET
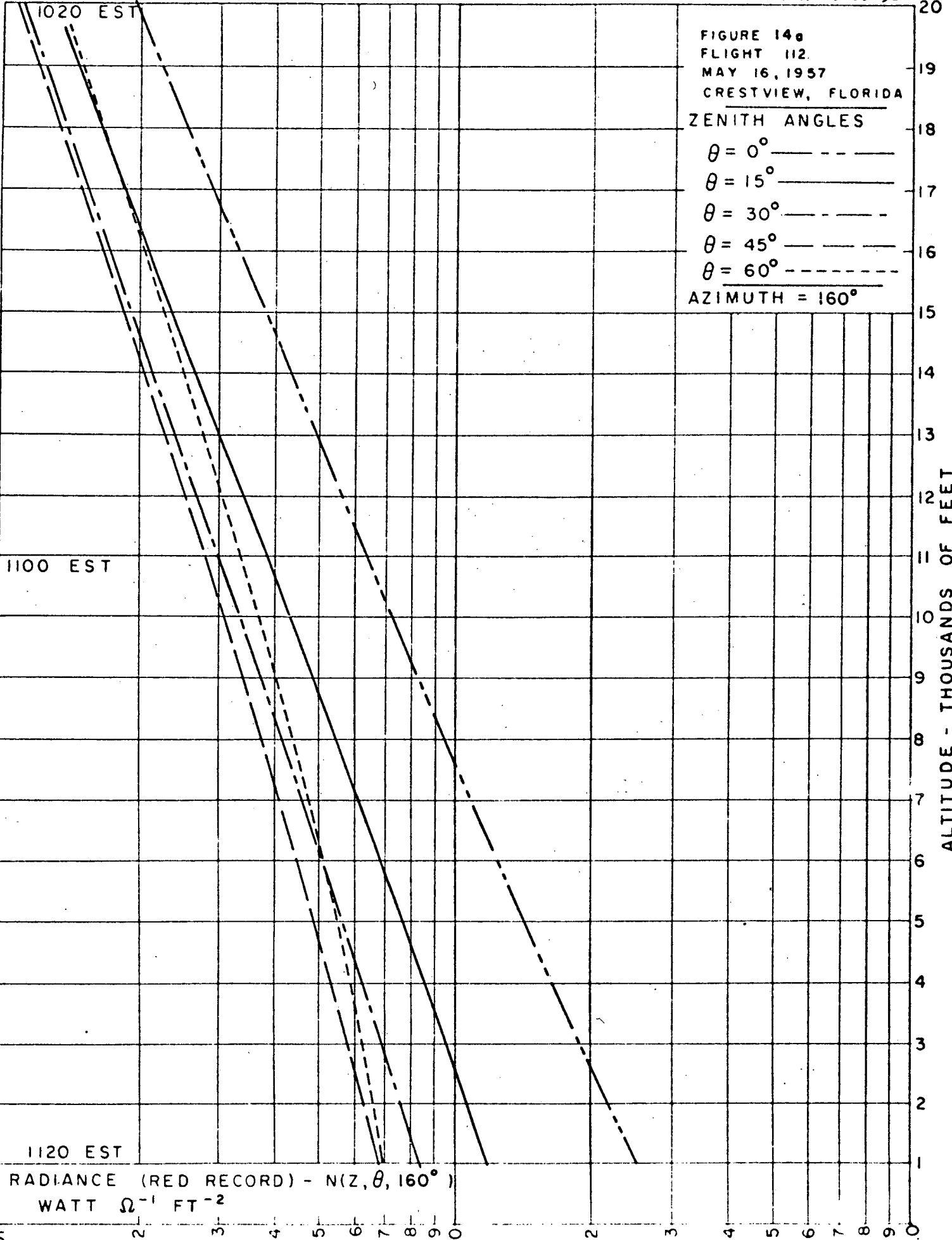
FIGURE 14a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ — - - —
$\theta = 15°$ ————
$\theta = 30°$ —·—·—
$\theta = 45°$ — — —
$\theta = 60°$ - - - - -
AZIMUTH = 160°

1020 EST
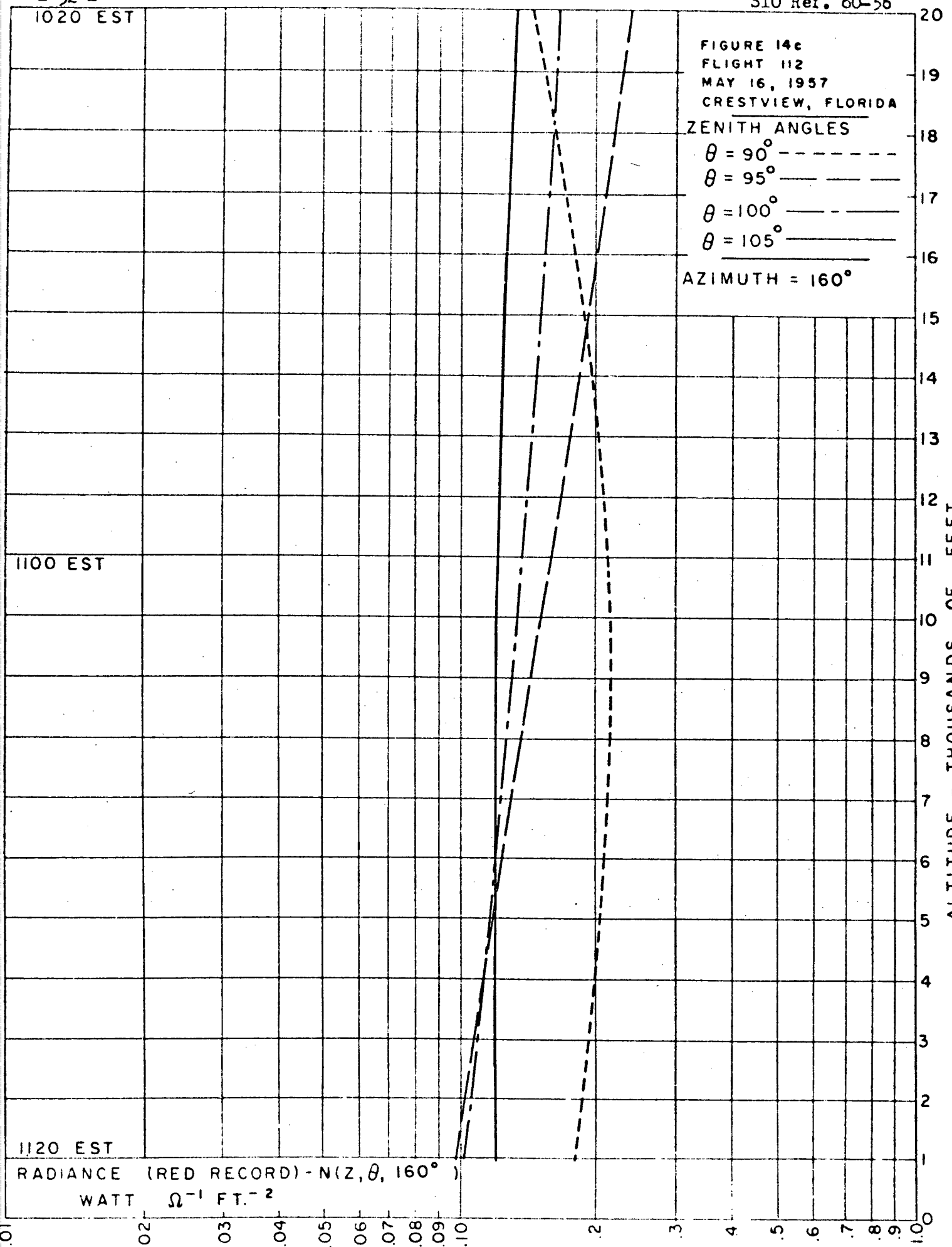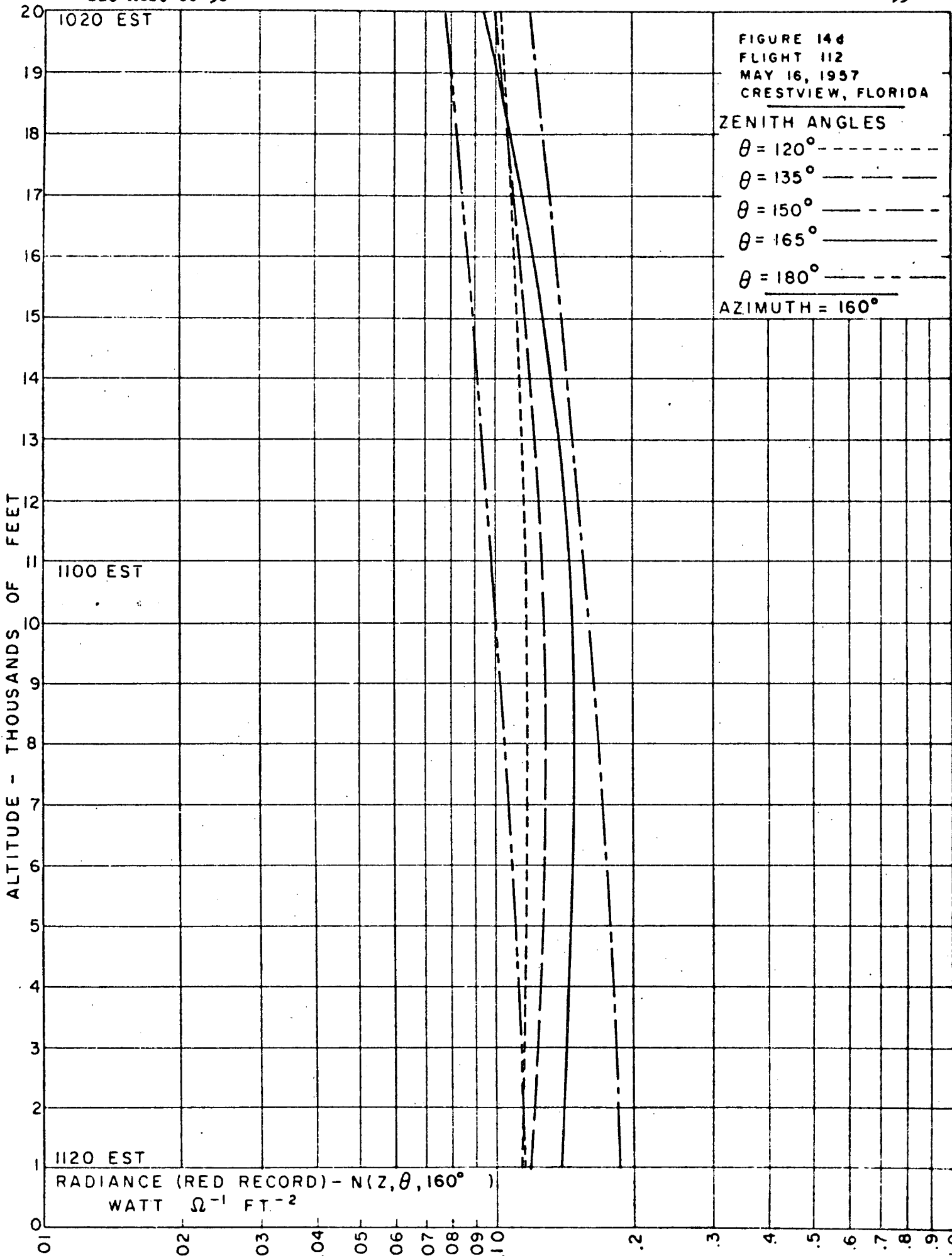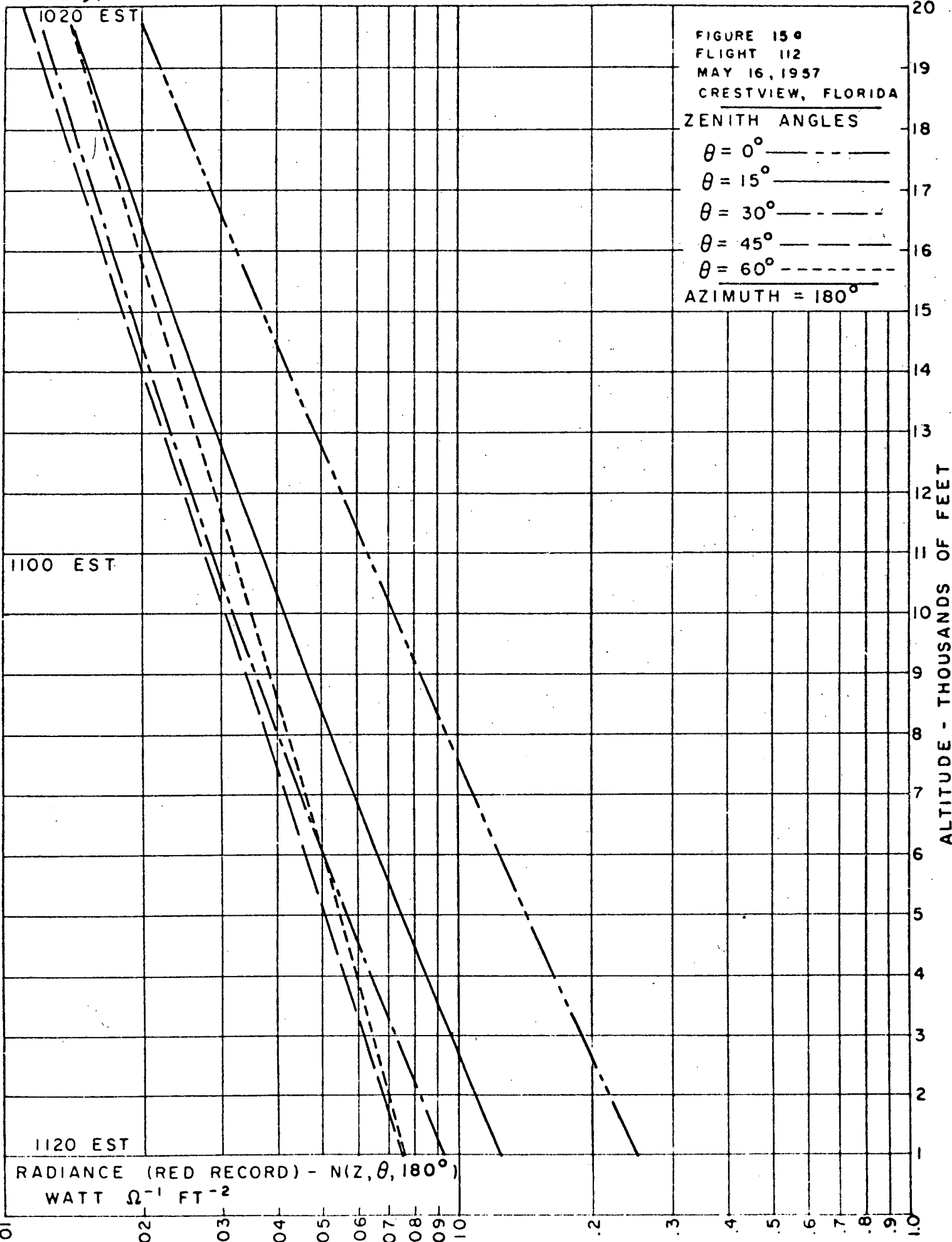
1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 160°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 14 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ————
$\theta = 80°$ — — —
$\theta = 85°$ —— ——
$\theta = 90°$ -------

AZIMUTH = 160°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 160°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

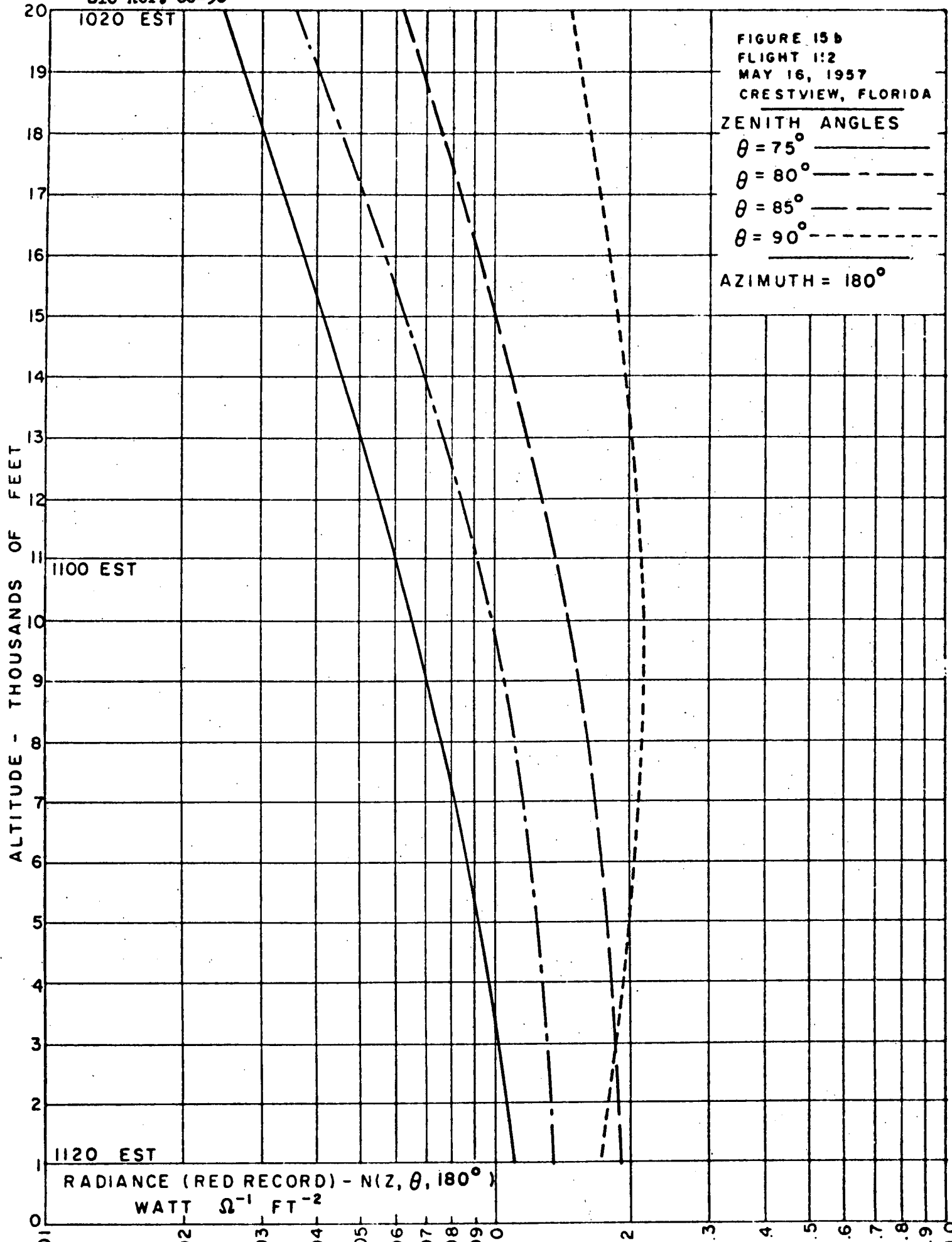1120 EST

FIGURE 14c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90°$ — — — —
$\theta = 95°$ — — —
$\theta = 100°$ — · — ·
$\theta = 105°$ ————

AZIMUTH = 160°

RADIANCE (RED RECORD) - N(Z, θ, 160°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 14d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 120°$ ------
$\theta = 135°$ —— · ——
$\theta = 150°$ —— · ——
$\theta = 165°$ ————
$\theta = 180°$ —— ---
AZIMUTH = 160°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) — $N(Z, \theta, 160°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 15 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ ———— — — —
$\theta = 15°$ ————————
$\theta = 30°$ —— · —— · ——
$\theta = 45°$ ——— ———
$\theta = 60°$ — — — — —

AZIMUTH = 180°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 180°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

1020 EST

1100 EST

1120 EST

FIGURE 15 b
FLIGHT 1:2
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ —·—·—
$\theta = 85°$ — — —
$\theta = 90°$ - - - - -

AZIMUTH = 180°

ALTITUDE - THOUSANDS OF FEET

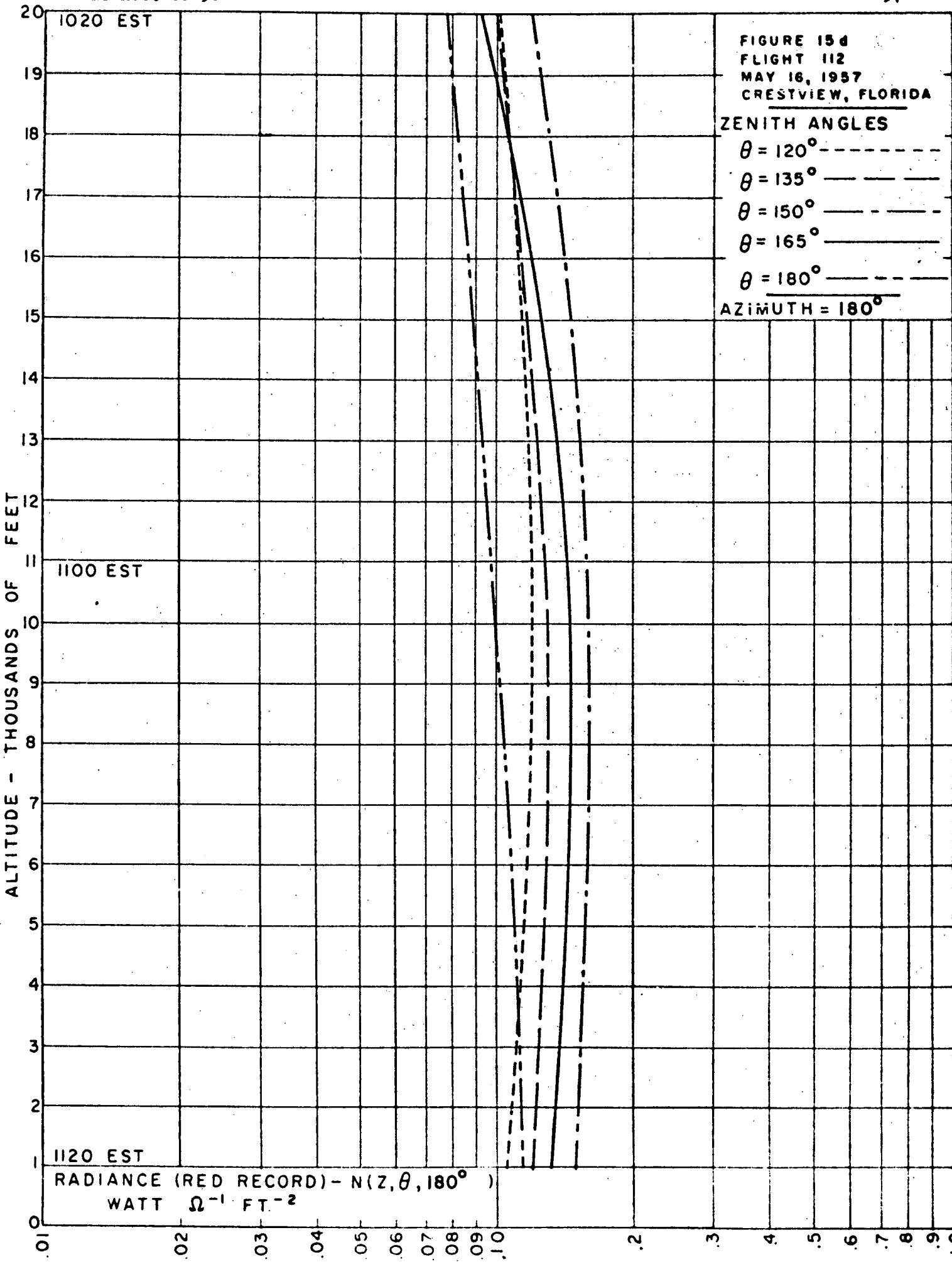RADIANCE (RED RECORD) - N(Z, θ, 180°)
WATT Ω^{-1} FT^{-2}

FIGURE 15c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90^{\circ}$ ----
$\theta = 95^{\circ}$ —— ——
$\theta = 100^{\circ}$ —— · ——
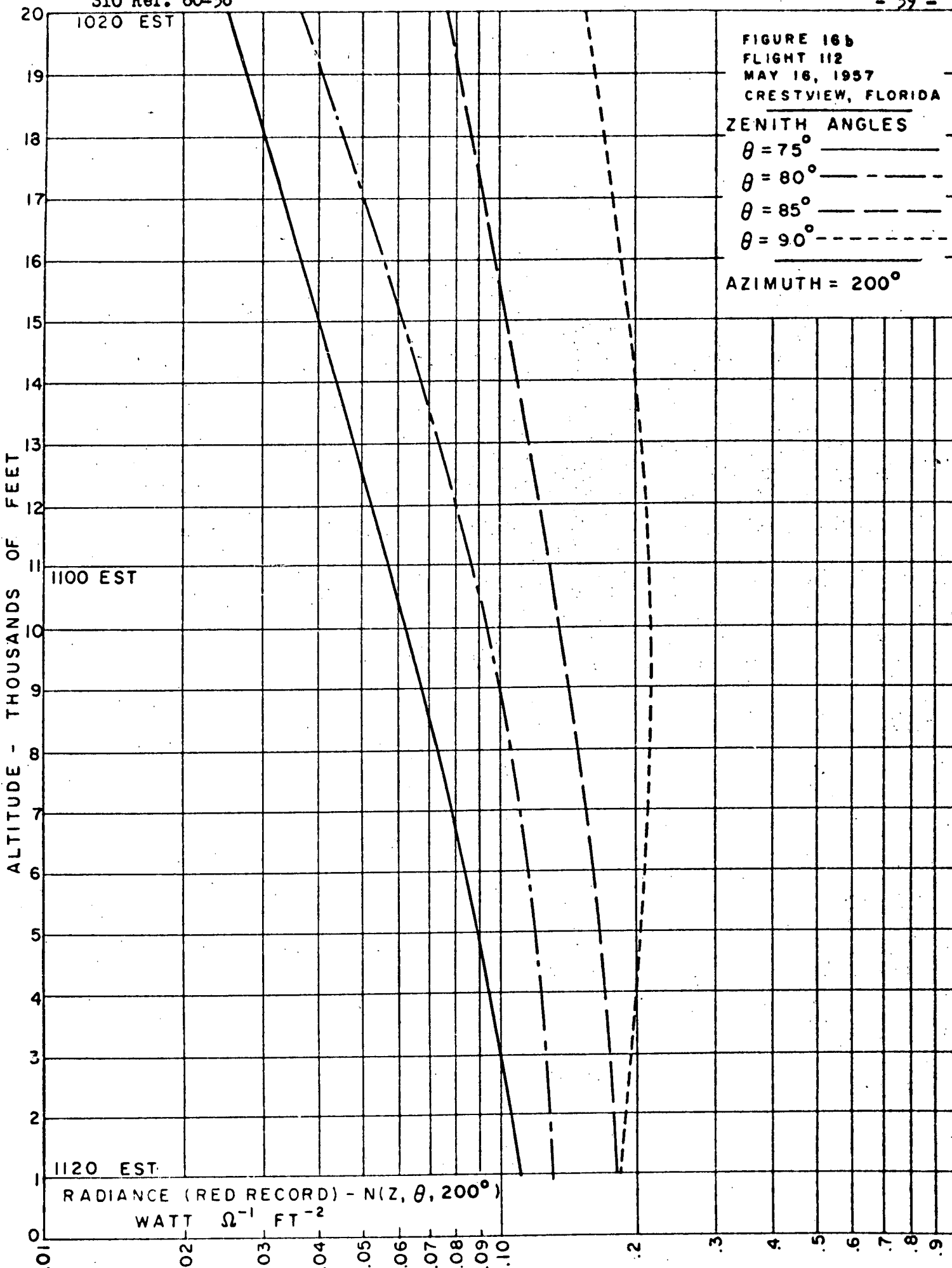$\theta = 105^{\circ}$ ————

AZIMUTH = 180°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 180^{\circ})$

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 15 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 120°$ ----
$\theta = 135°$ ---
$\theta = 150°$ ---
$\theta = 165°$ ---
$\theta = 180°$ ---
AZIMUTH = 180°

1020 EST

1100 EST

1120 EST

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - $N(Z, \theta, 180°)$
WATT Ω^{-1} FT.$^{-2}$

SIO Ref. 60-56
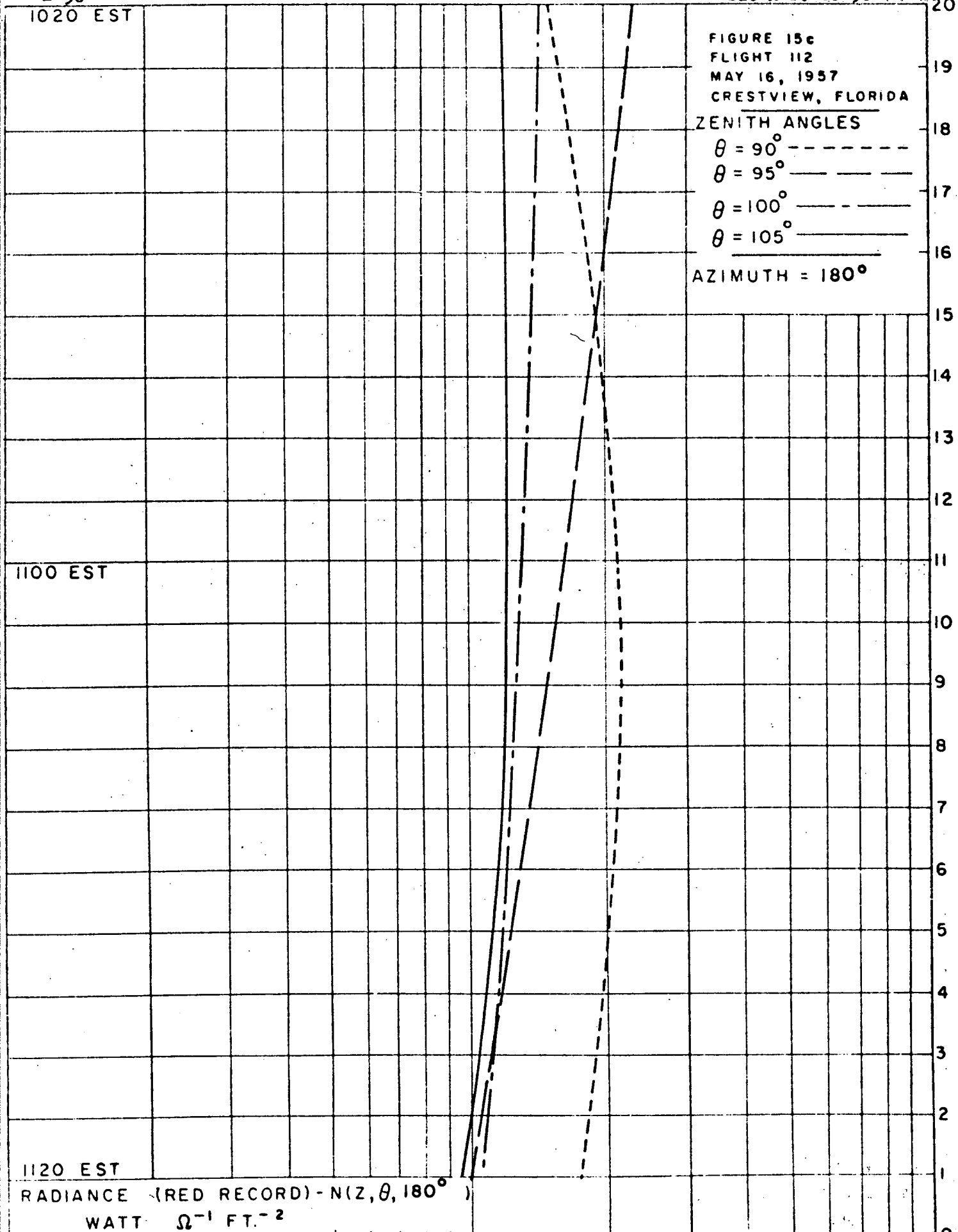
FIGURE 16 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ — — —
$\theta = 15°$ ————
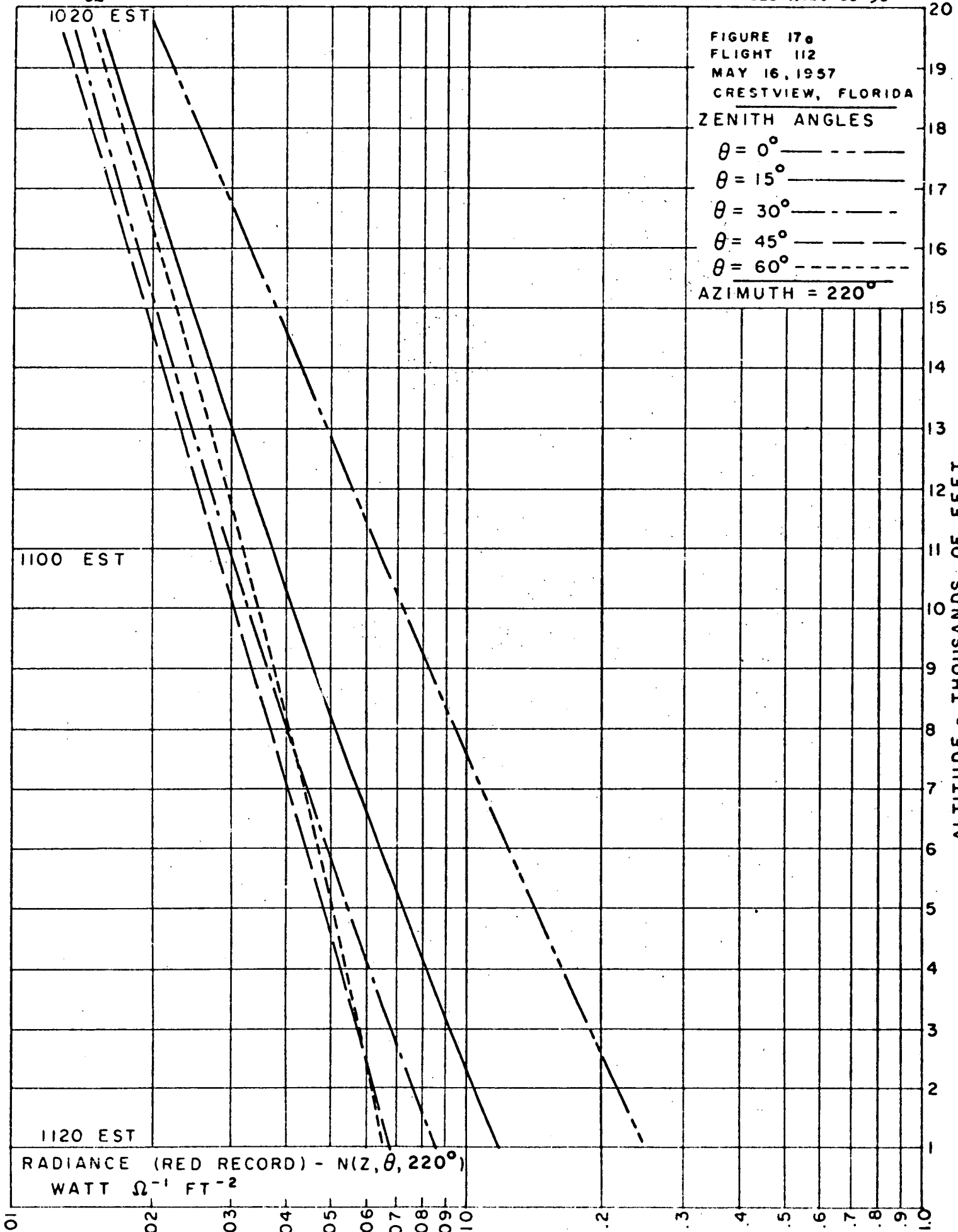$\theta = 30°$ —·—·—
$\theta = 45°$ — — —
$\theta = 60°$ - - - - -

AZIMUTH = 200°

1020 EST
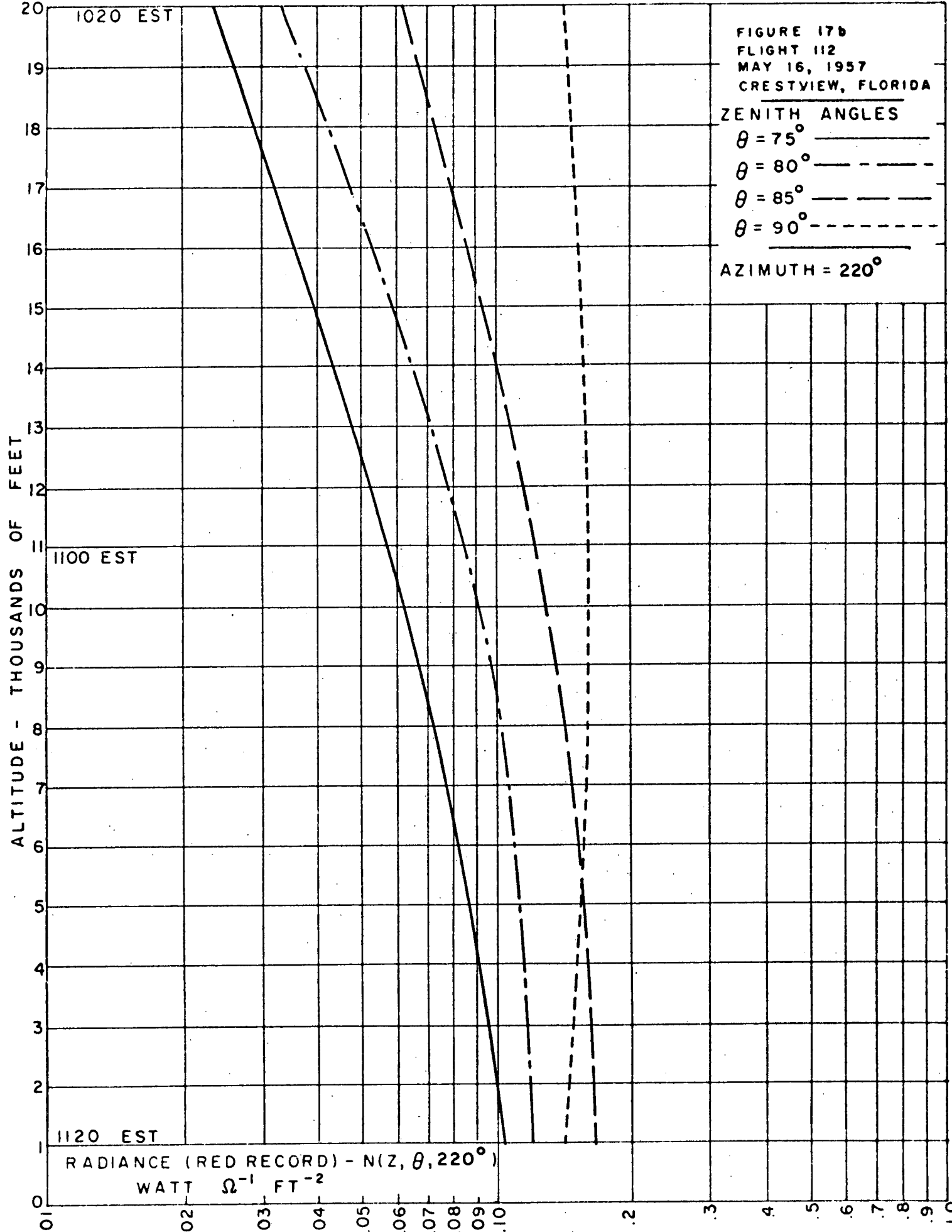
1100 EST

1120 EST
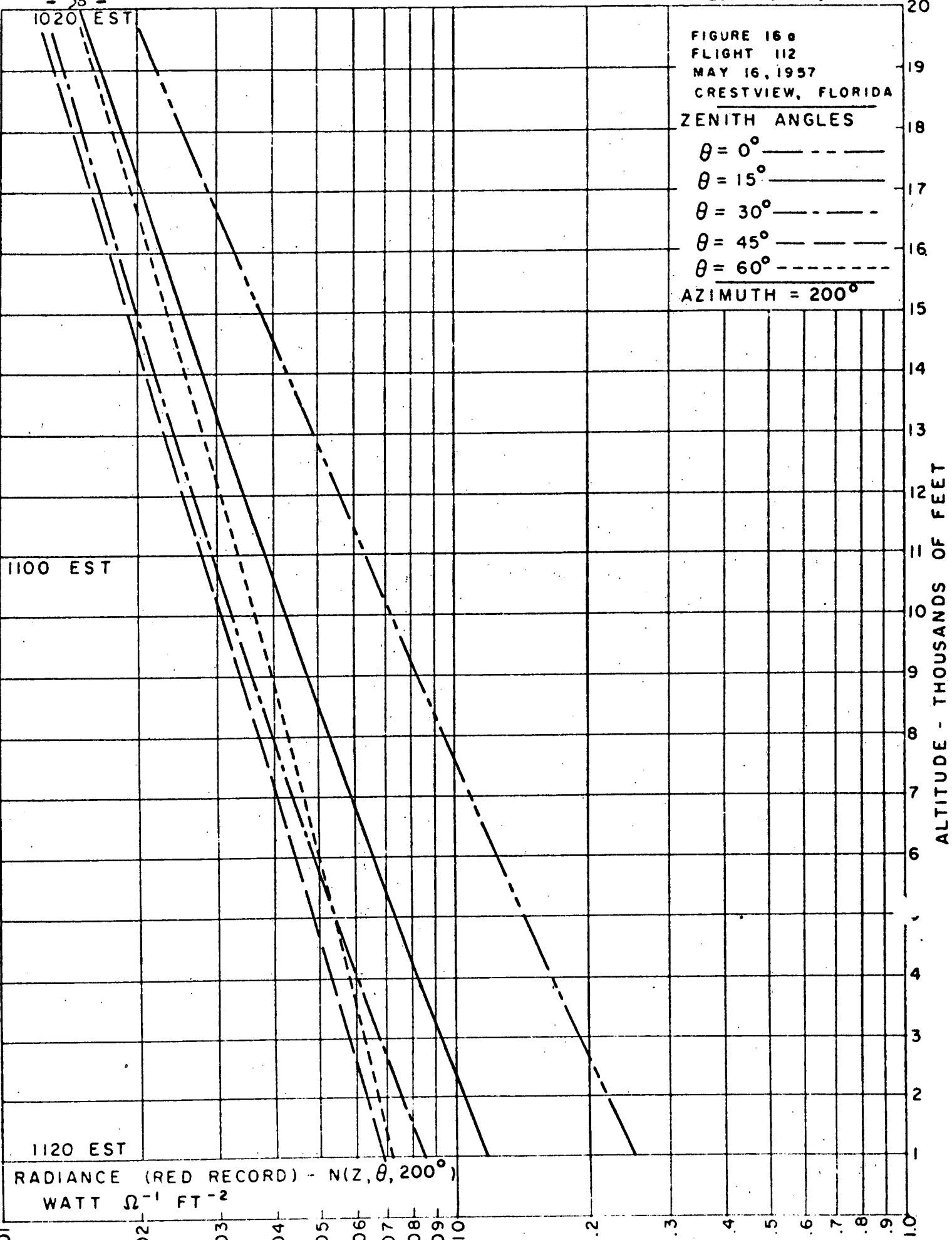
RADIANCE (RED RECORD) - $N(Z, \theta, 200°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 200°)
WATT Ω^{-1} FT^{-2}

FIGURE 16b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ———
$\theta = 80°$ — · —
$\theta = 85°$ — —
$\theta = 90°$ - - -

AZIMUTH = 200°

1020 EST

1100 EST

1120 EST

FIGURE 16 c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90°$ --- --- ---
$\theta = 95°$ ——— ———
$\theta = 100°$ —·—·—
$\theta = 105°$ ————

AZIMUTH = 200°

RADIANCE (RED RECORD) - N(Z, θ, 200°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 16 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 120°$ —————
$\theta = 135°$ —————
$\theta = 150°$ —————
$\theta = 165°$ —————
$\theta = 180°$ —————
AZIMUTH = 200°

1020 EST

1100 EST

1120 EST
RADIANCE (RED RECORD) = N($\bar{z}$, θ, 200°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 17a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ —— - - ——
$\theta = 15°$ ——————
$\theta = 30°$ —— - · —— -
$\theta = 45°$ —— —— ——
$\theta = 60°$ - - - - - - -
AZIMUTH = 220°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 220°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 17b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ —·—·—
$\theta = 85°$ —— ——
$\theta = 90°$ ------

AZIMUTH = 220°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 220°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

FIGURE 17c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90°$ ----

$\theta = 95°$ ——

$\theta =100°$ —·—

$\theta =105°$ ——

AZIMUTH = 220°

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z, θ, 220°)

WATT Ω^{-1} FT.$^{-2}$

1020 EST

FIGURE 17 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 120°$ -------
$\theta = 135°$ — — —
$\theta = 150°$ — · — ·
$\theta = 165°$ ————
$\theta = 180°$ —— · ——
AZIMUTH = 220°

1100 EST

ALTITUDE - THOUSANDS OF FEET

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 220°)$
WATT Ω^{-1} FT.$^{-2}$

SIO Ref. 60-56

FIGURE 18 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ —————

$\theta = 15°$ —————

$\theta = 30°$ —·—·—

$\theta = 45°$ — — —

$\theta = 60°$ - - - -

AZIMUTH = 240°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 240°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET
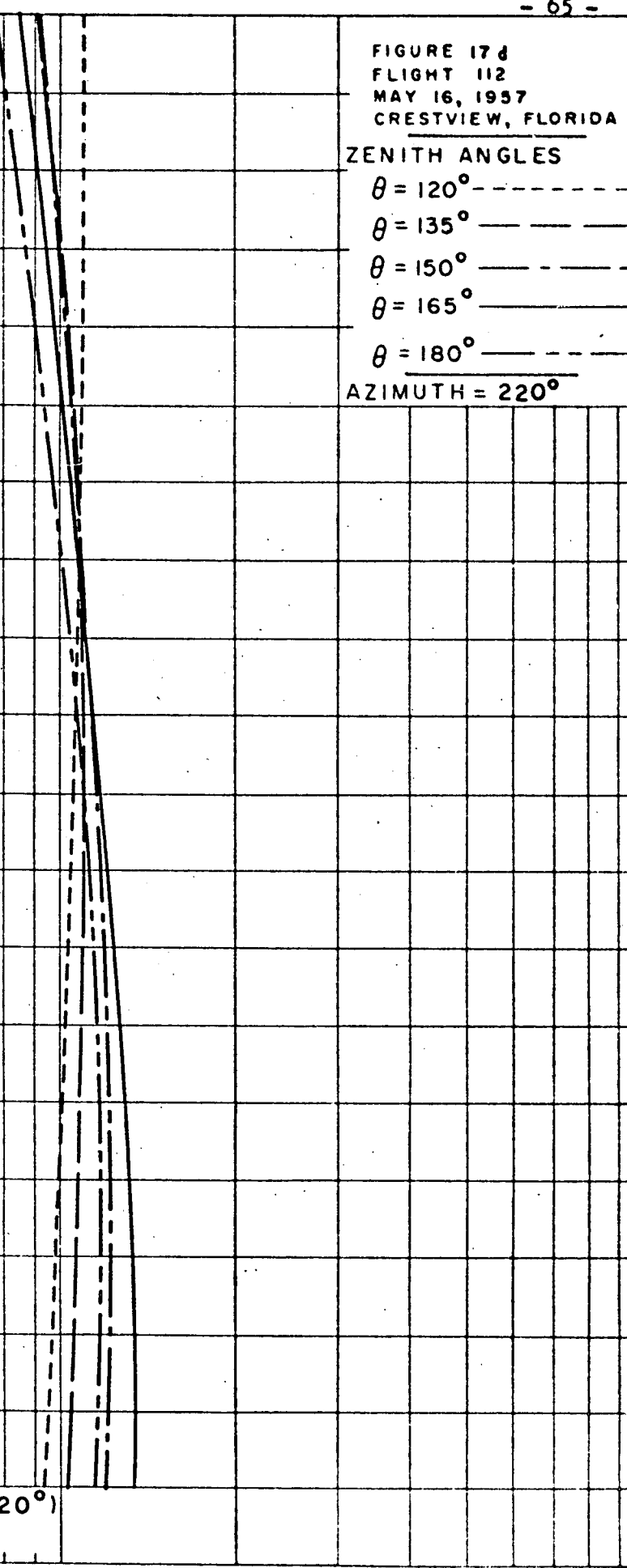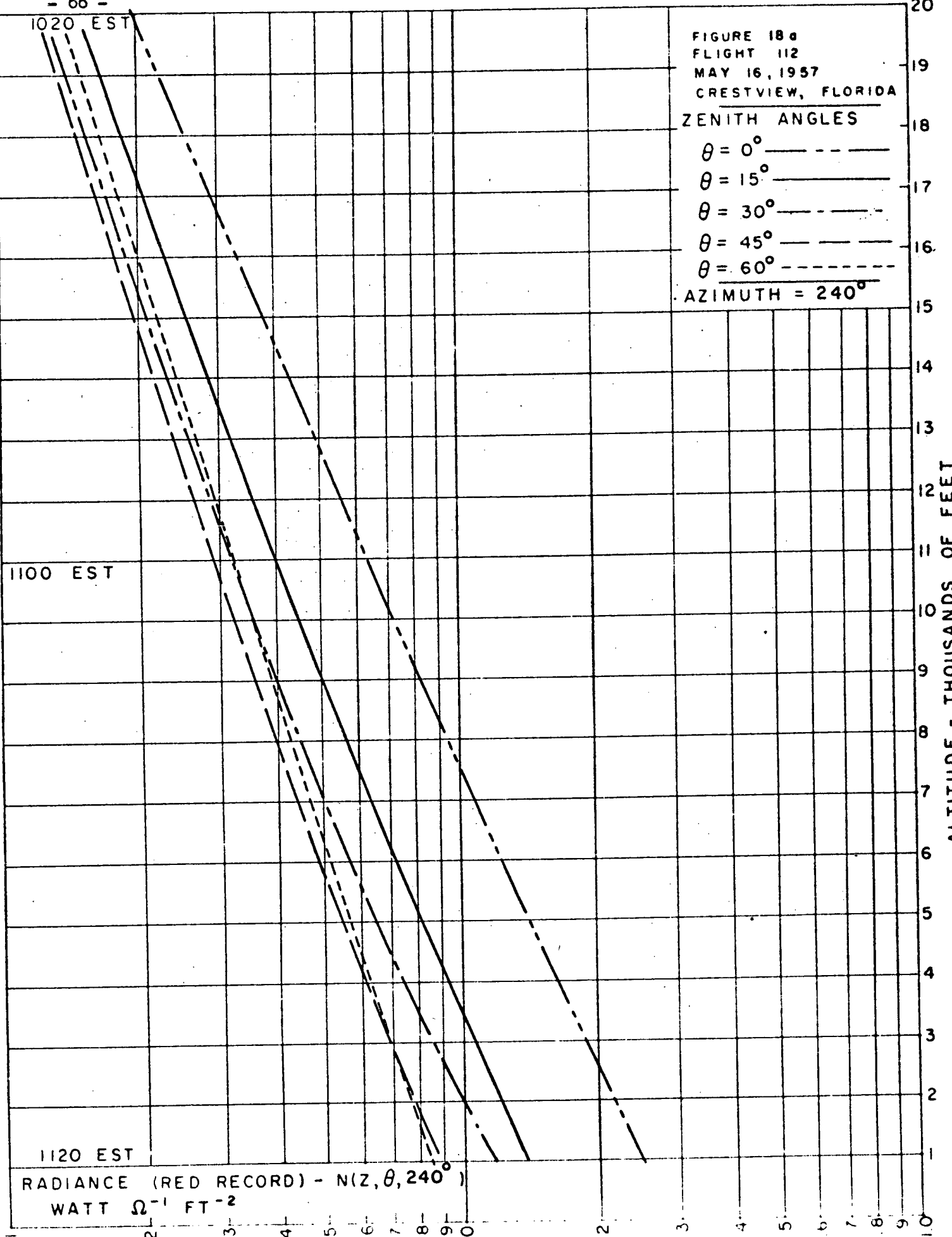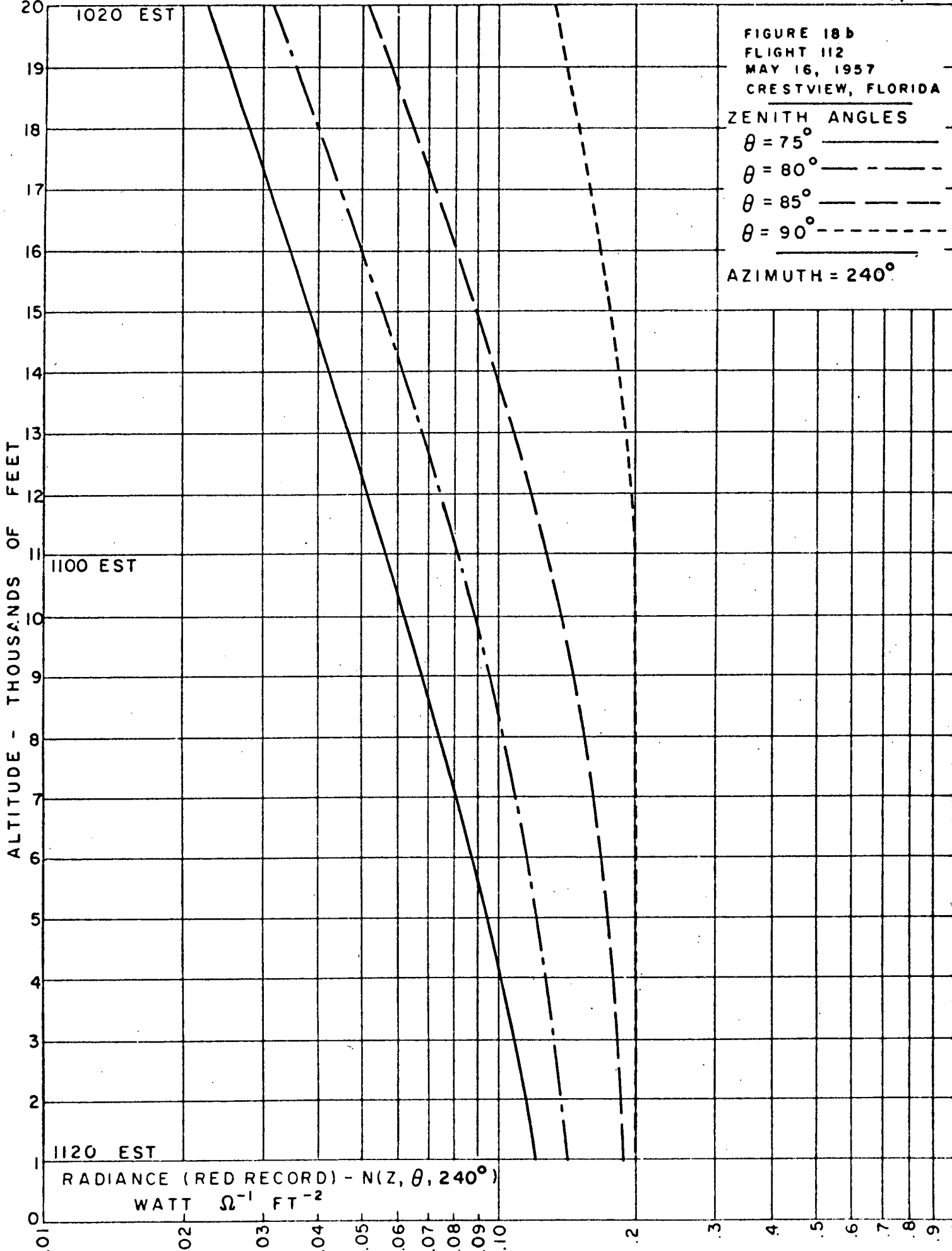
SIO Ref. 60-56

1020 EST

FIGURE 18 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ————

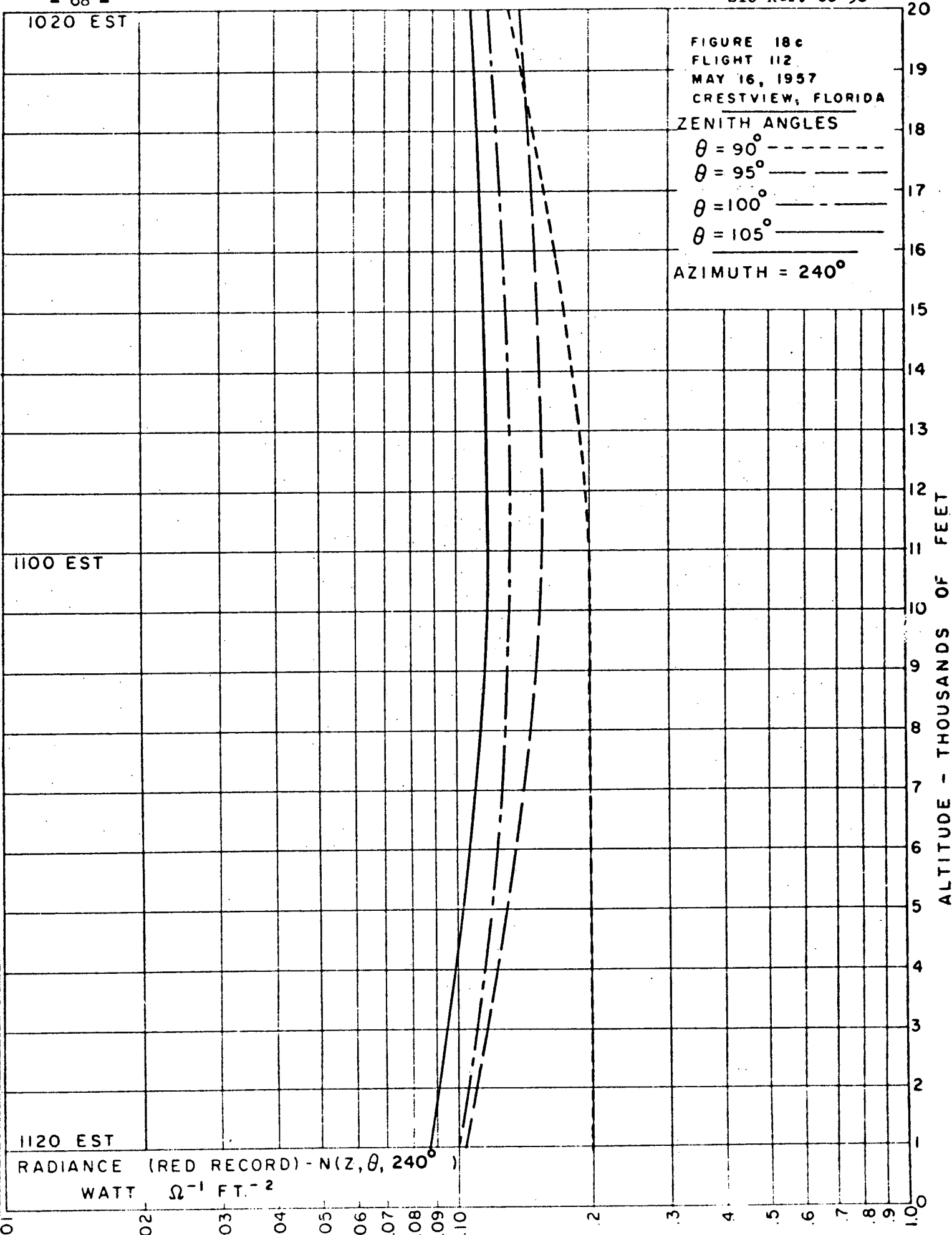$\theta = 80°$ — — —

$\theta = 85°$ —— ——

$\theta = 90°$ - - - - -

AZIMUTH = 240°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 240°)
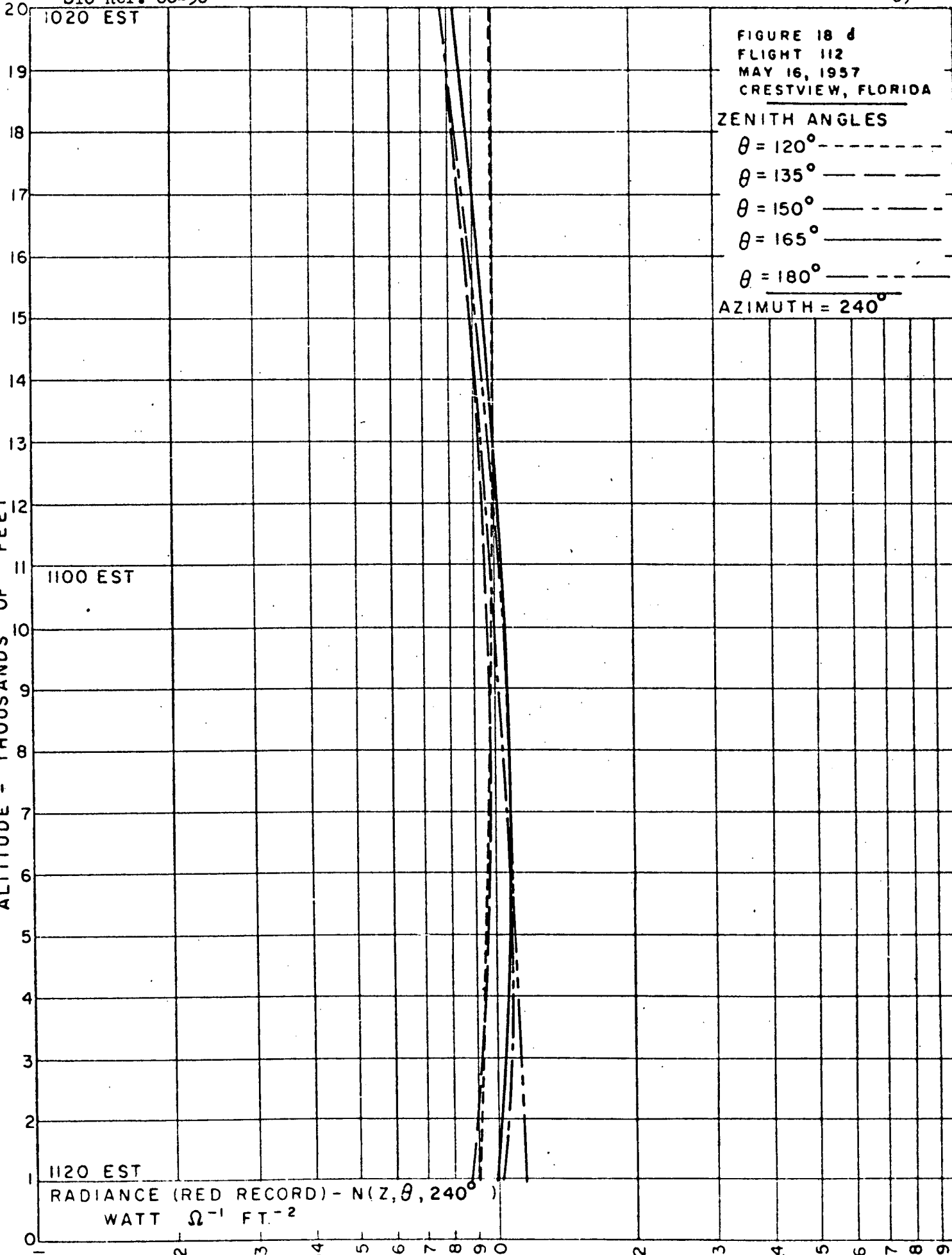
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

FIGURE 18c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 90^\circ$ ----------

$\theta = 95^\circ$ ————

$\theta = 100^\circ$ —·——·——

$\theta = 105^\circ$ ————

AZIMUTH = 240°

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - $N(Z, \theta, 240^\circ)$

WATT Ω^{-1} FT.$^{-2}$

FIGURE 18 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 120°$ - - - - - - -
$\theta = 135°$ — — —
$\theta = 150°$ — · — · —
$\theta = 165°$ ————
$\theta = 180°$ — · — ·
AZIMUTH = 240°

1020 EST

1100 EST

1120 EST
RADIANCE (RED RECORD) - N(Z,θ,240°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 19a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ ———— — —————

$\theta = 15°$ ————————

$\theta = 30°$ ——— · — · —

$\theta = 45°$ ———— ————

$\theta = 60°$ — — — — — — —

AZIMUTH = 260°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 260°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 19b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ——————
$\theta = 80°$ —·—·—·—
$\theta = 85°$ ——— ———
$\theta = 90°$ - - - - - - -

AZIMUTH = 260°

1020 EST

1100 EST

1120 EST

ALTITUDE — THOUSANDS OF FEET

RADIANCE (RED RECORD) — N(Z, θ, 260°)
WATT Ω^{-1} FT^{-2}

SIO Ref. 60-56

1020 EST

FIGURE 19 c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ ------
$\theta = 95°$ —— —— ——
$\theta = 100°$ —— · —— ·
$\theta = 105°$ ————
AZIMUTH = 260°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 260°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

1020 EST

1100 EST

1120 EST

FIGURE 19 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ ————
$\theta = 135°$ ————
$\theta = 150°$ ————
$\theta = 165°$ ————
$\theta = 180°$ ————

AZIMUTH = 260°
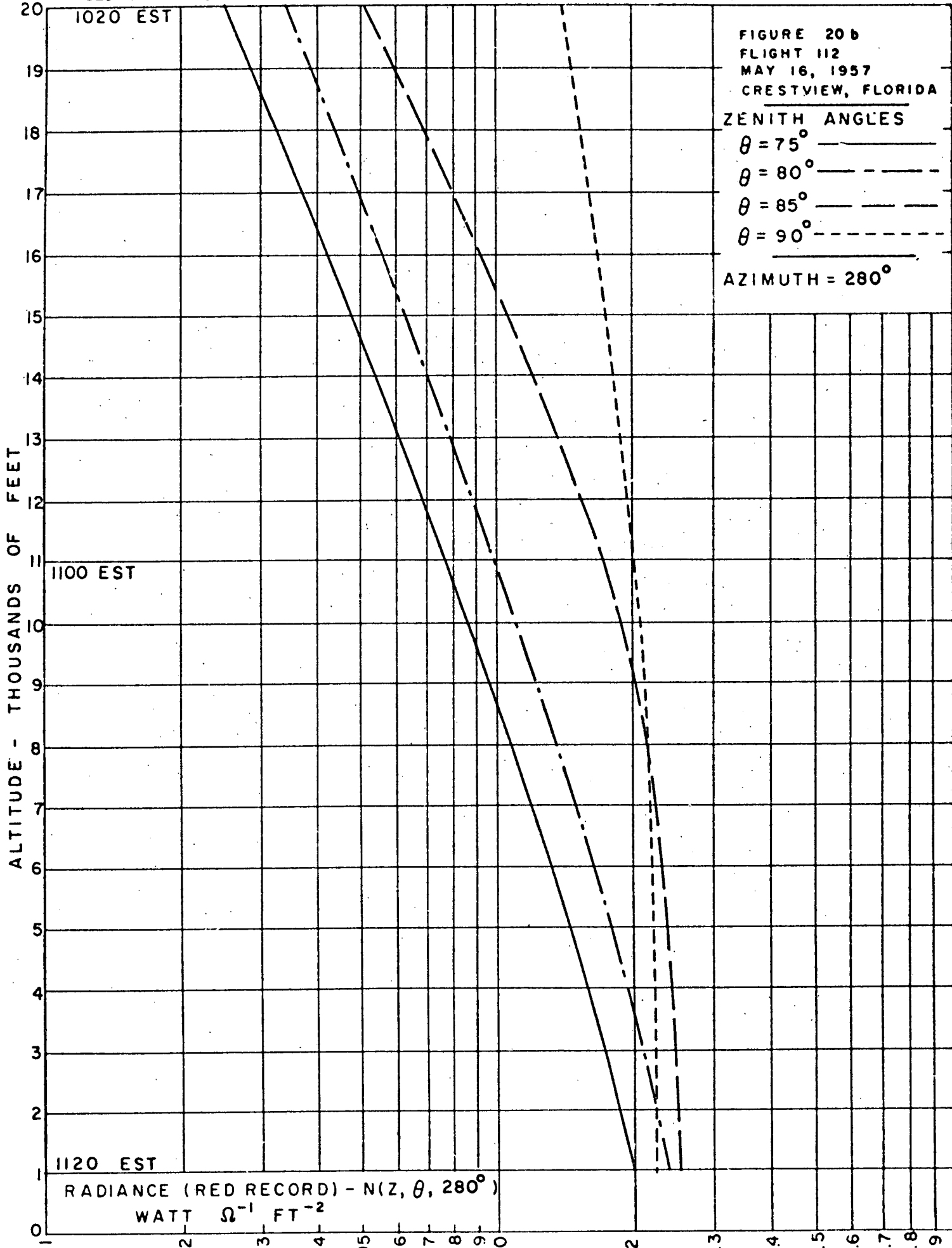
ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - $N(Z, \theta, 260°)$
WATT Ω^{-1} FT^{-2}

1020 EST

1100 EST

1120 EST

FIGURE 20a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 0°$ — — —
$\theta = 15°$ ———
$\theta = 30°$ — · — · —
$\theta = 45°$ — — —
$\theta = 60°$ - - - - -

AZIMUTH = 280°

ALTITUDE - THOUSANDS OF FEET
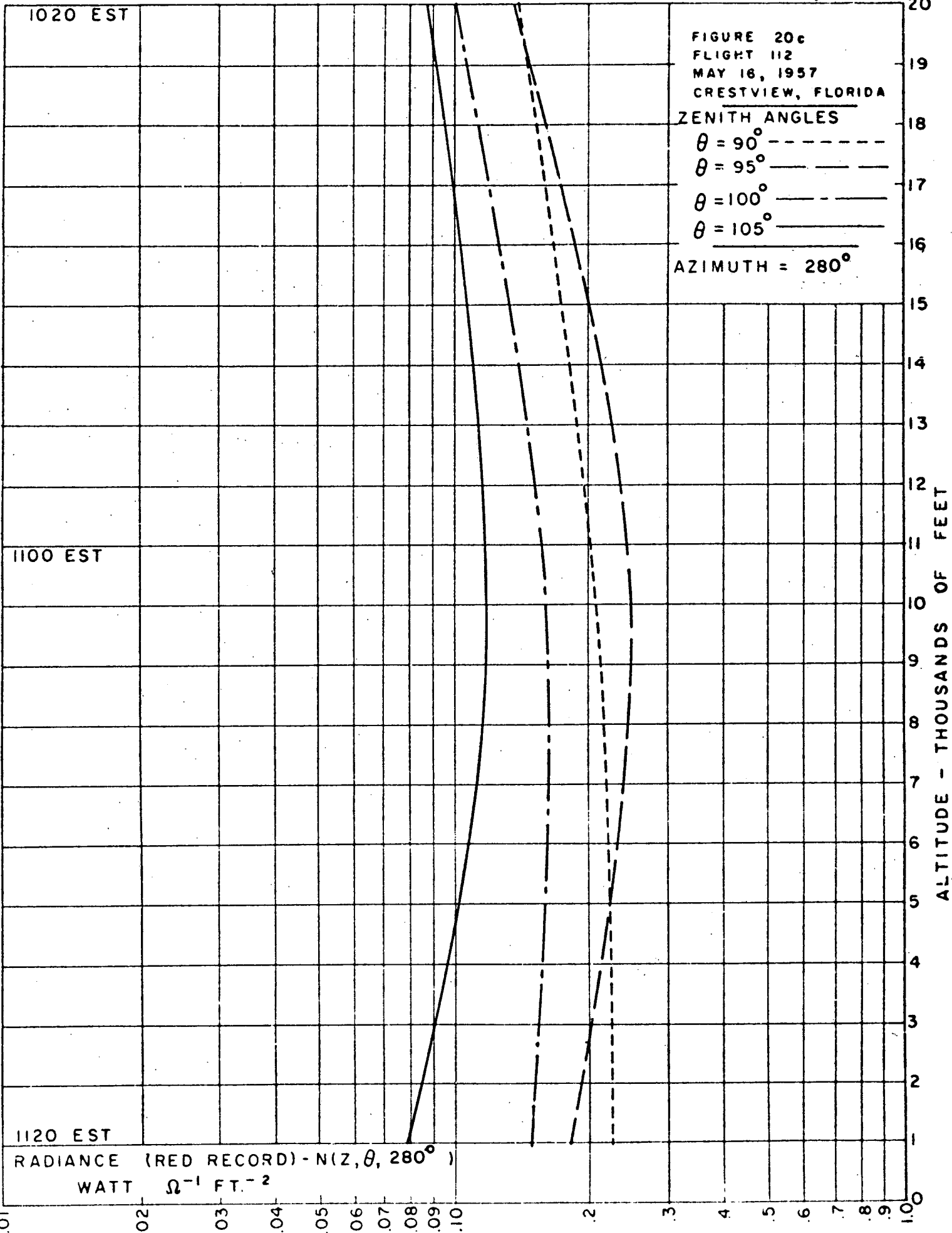
RADIANCE (RED RECORD) - N(Z, θ, 280°)
WATT Ω^{-1} FT^{-2}

1020 EST
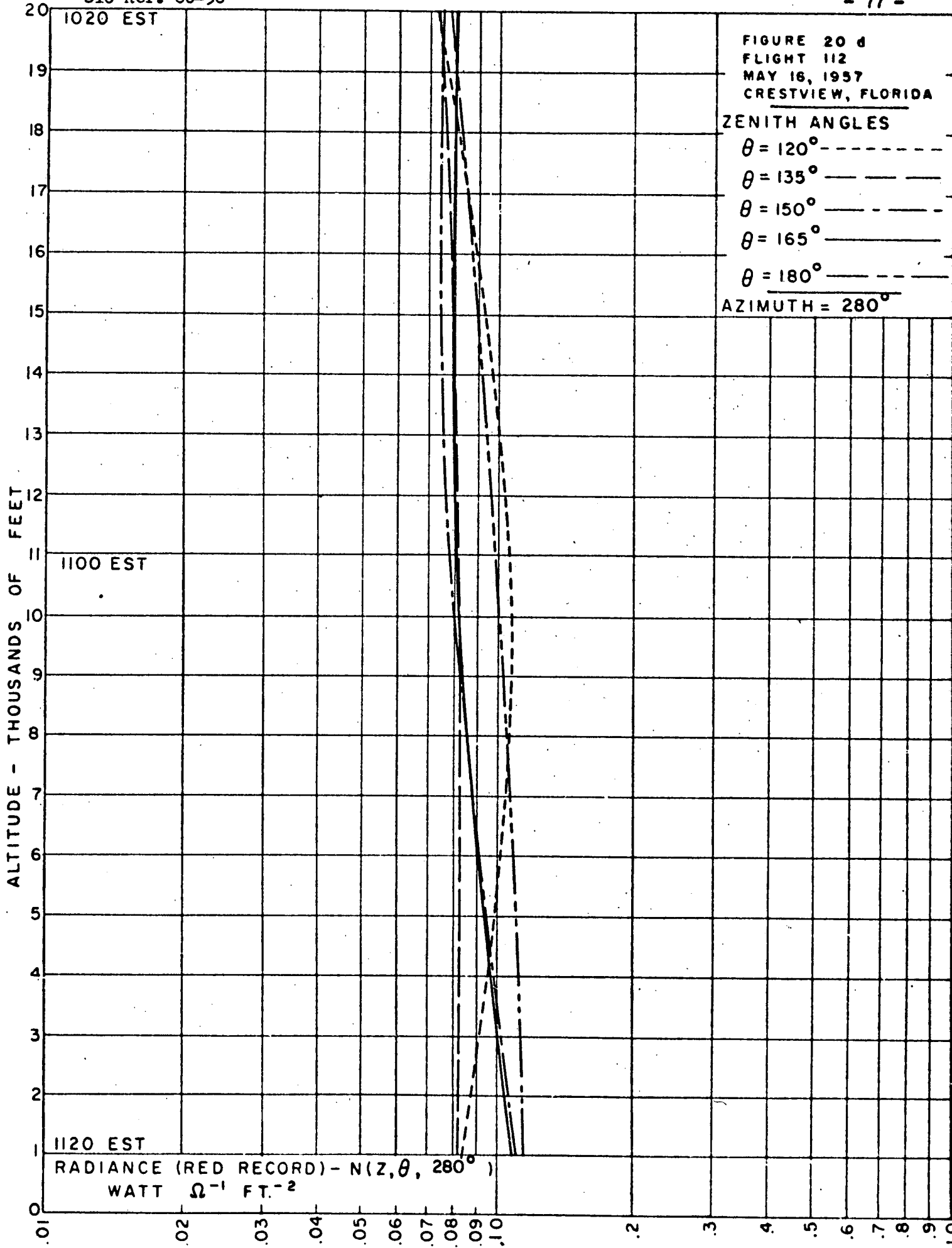
1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 280°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 20 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ———
$\theta = 80°$ —·—
$\theta = 85°$ — —
$\theta = 90°$ -----
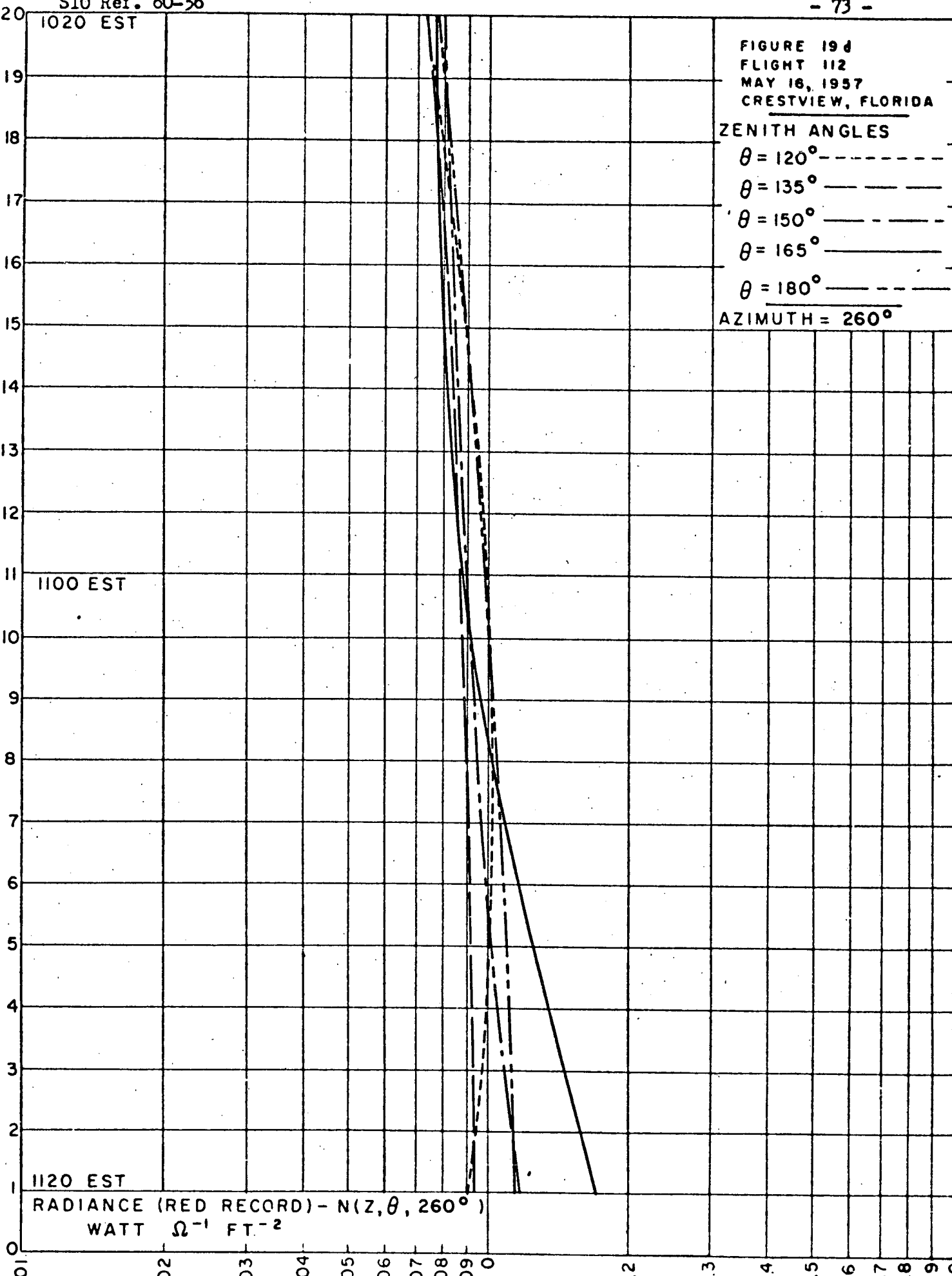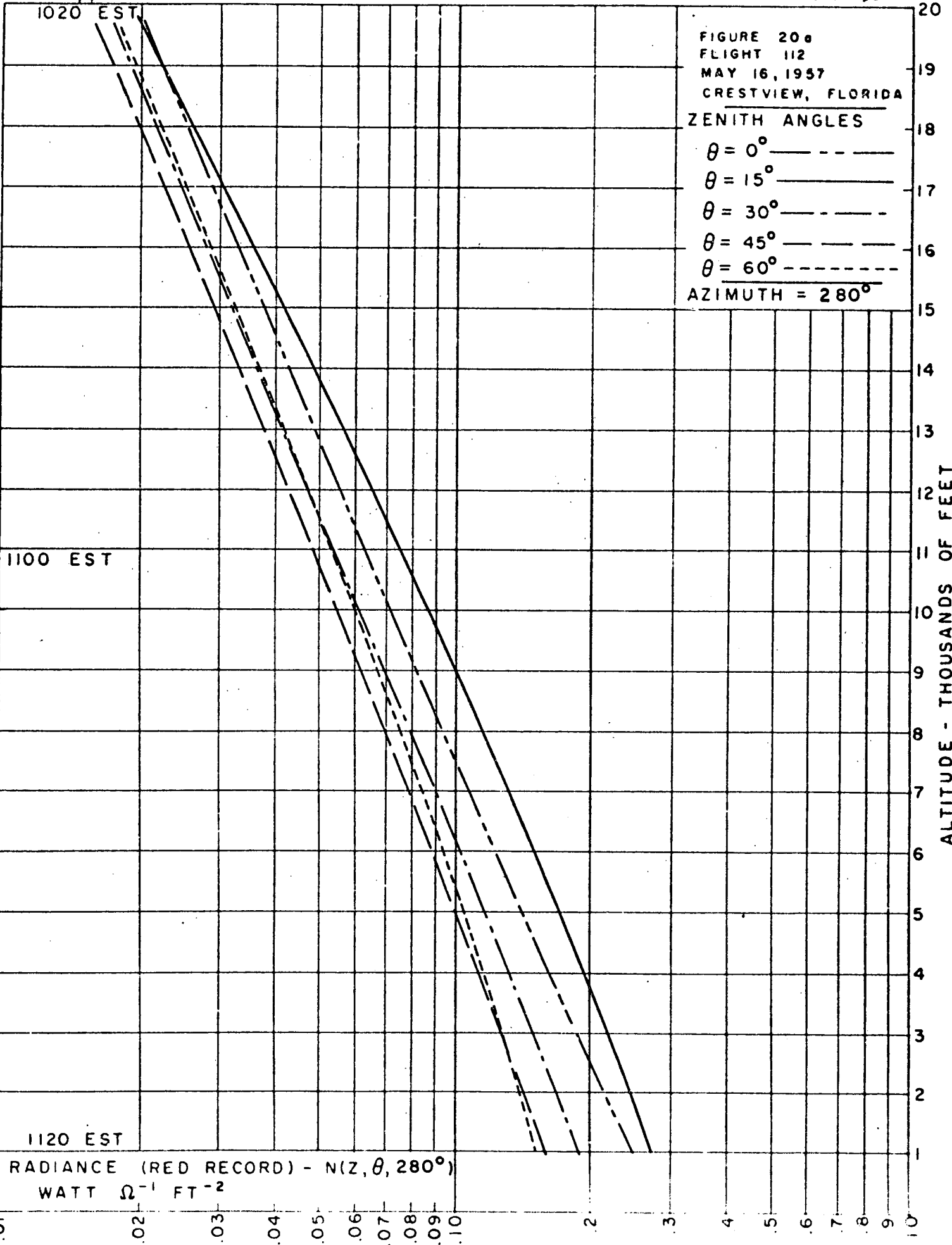
AZIMUTH = 280°

FIGURE 20c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ ------
$\theta = 95°$ ——
$\theta = 100°$ — · —
$\theta = 105°$ ——

AZIMUTH = 280°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 280°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

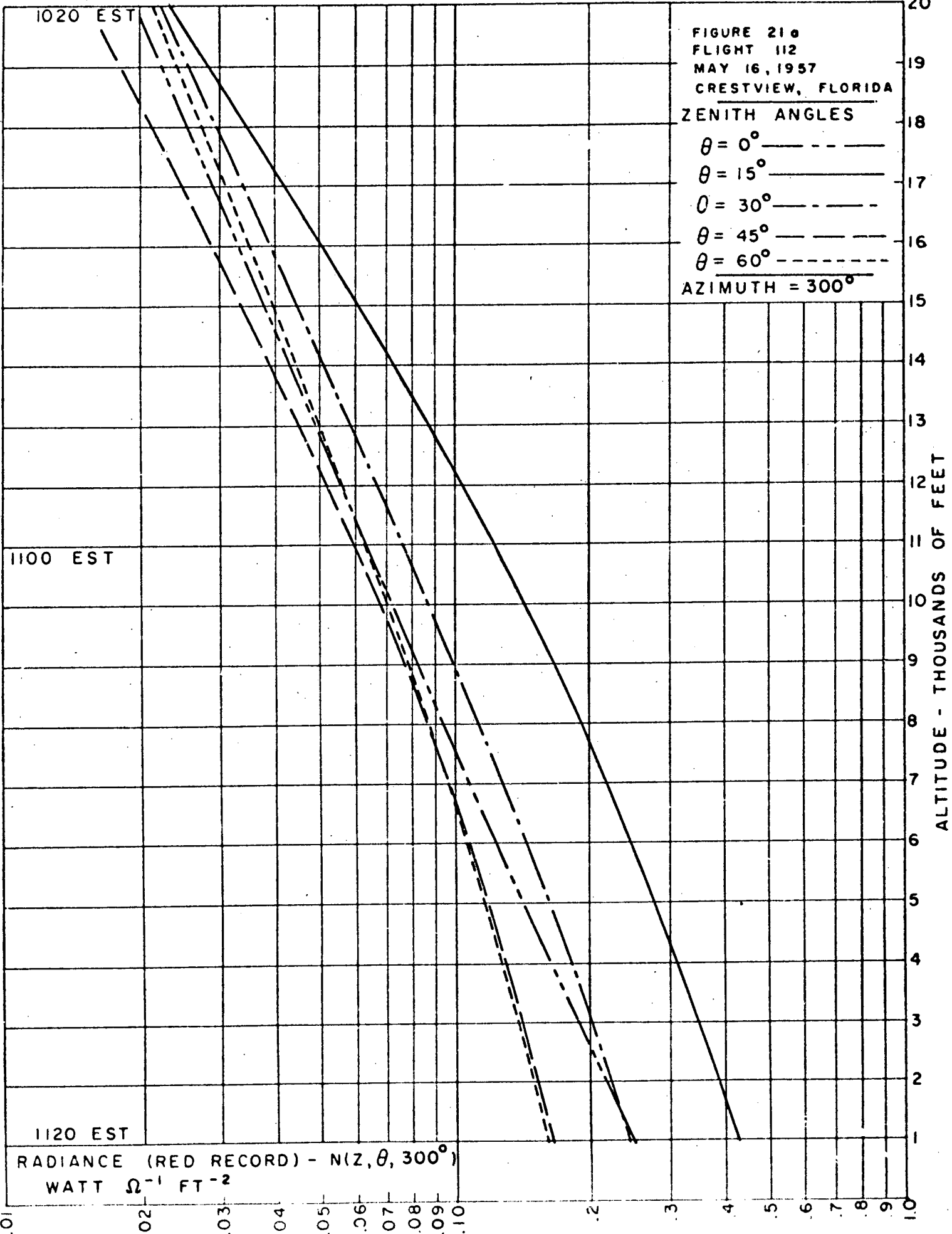FIGURE 20 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
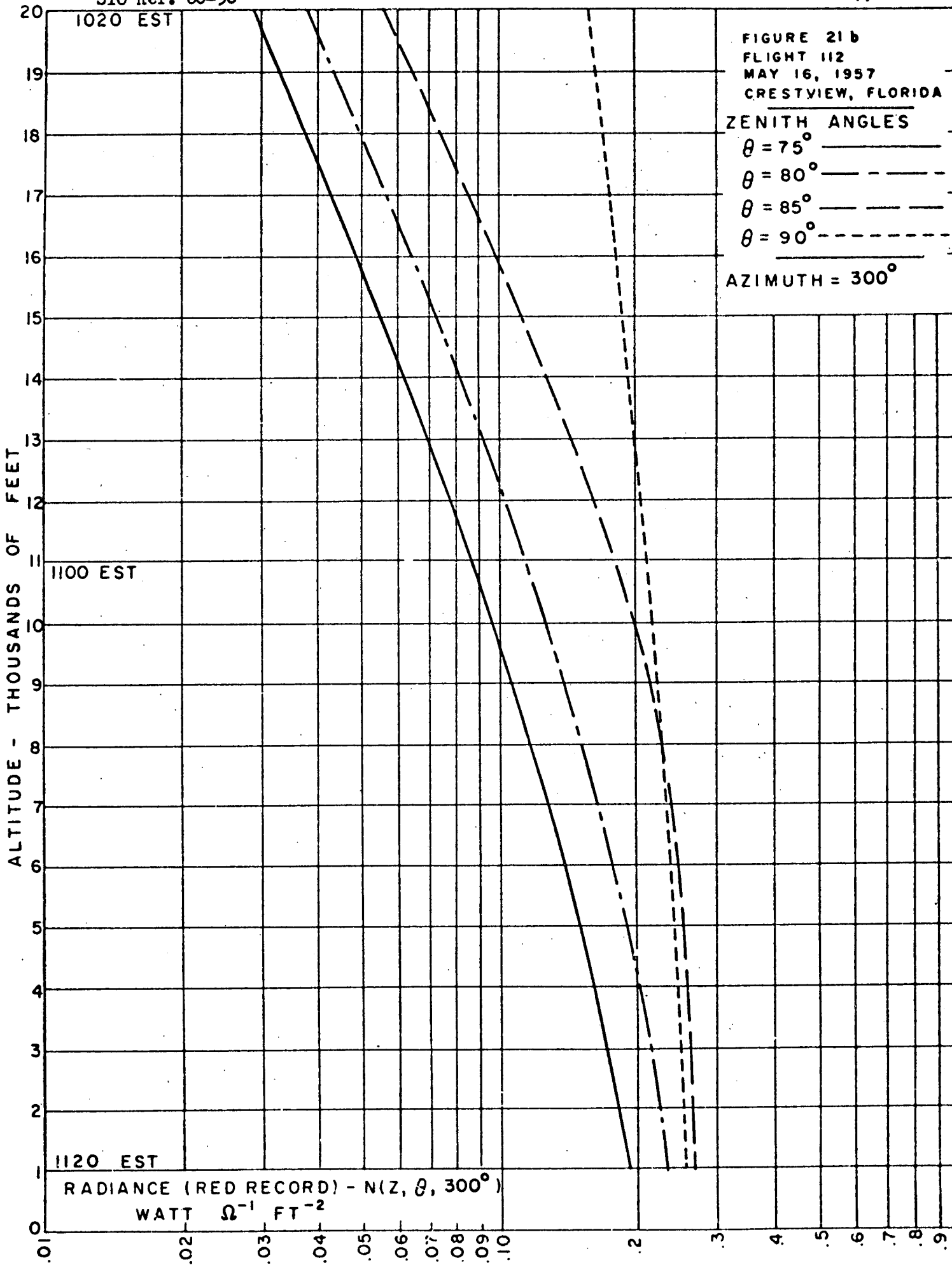$\theta = 120°$ - - - - - -
$\theta = 135°$ —— —— ——
$\theta = 150°$ —— · —— ·
$\theta = 165°$ ————
$\theta = 180°$ —— · · ——
AZIMUTH = 280°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 280°)$
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 21 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ —— - —
$\theta = 15°$ ————
$0 = 30°$ —— · —— ·
$\theta = 45°$ —— —— ——
$\theta = 60°$ - - - - -
AZIMUTH = 300°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 300°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

1020 EST

FIGURE 21 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 75°$ ————
$\theta = 80°$ —·—·—
$\theta = 85°$ — — —
$\theta = 90°$ ------

AZIMUTH = 300°

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 300°)

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

STO Ref. SC-96

FIGURE 21c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ --------
$\theta = 95°$ —— ——
$\theta = 100°$ —— · ——
$\theta = 105°$ ————
AZIMUTH = 300°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 300°)
WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

FIGURE 21d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ ----------

$\theta = 135°$ ——————

$\theta = 150°$ —-—-—

$\theta = 165°$ ——————

$\theta = 180°$ —--—--—

AZIMUTH = 300°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 300°)$

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 22 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ _____ - - - - - -
$\theta = 15°$ _____
$\theta = 30°$ _____ - _____
$\theta = 45°$ _____ _____
$\theta = 60°$ - - - - - - -
AZIMUTH = 320°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $\bar{N}(Z, \theta, 320°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

FIGURE 22 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ — — —
$\theta = 85°$ —·—·—
$\theta = 90°$ - - - - -

AZIMUTH = 320°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - $N(Z, \theta, 320°)$
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 320°)

WATT Ω^{-1} FT.$^{-2}$

FIGURE 22 c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 90°$ - - - - -
$\theta = 95°$ — — —
$\theta = 100°$ — · — ·
$\theta = 105°$ ———

AZIMUTH = 320°

ALTITUDE - THOUSANDS OF FEET
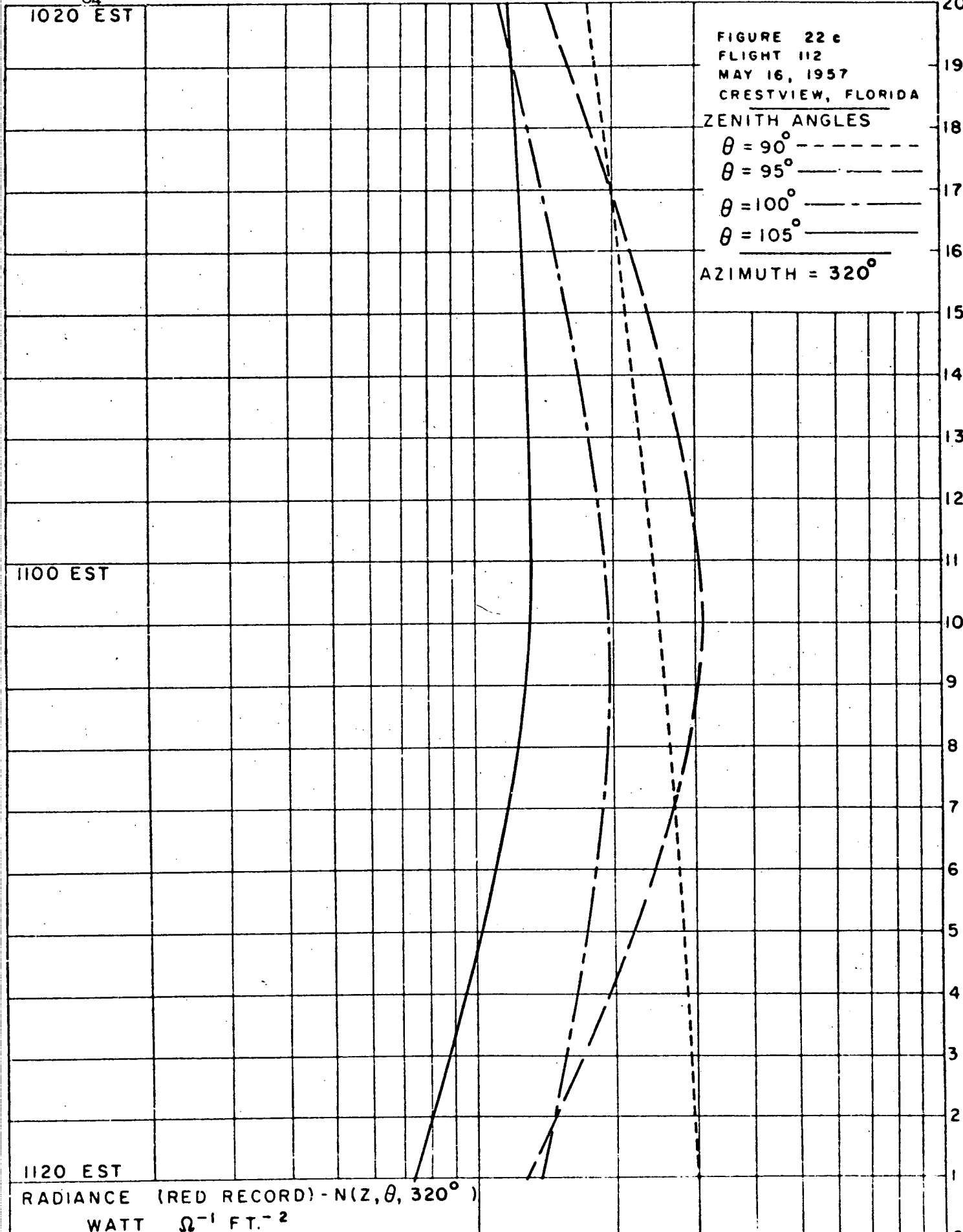
FIGURE 22 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ ---------
$\theta = 135°$ — — —
$\theta = 150°$ —·—·—
$\theta = 165°$ ————
$\theta = 180°$ —— ——

AZIMUTH = 320°
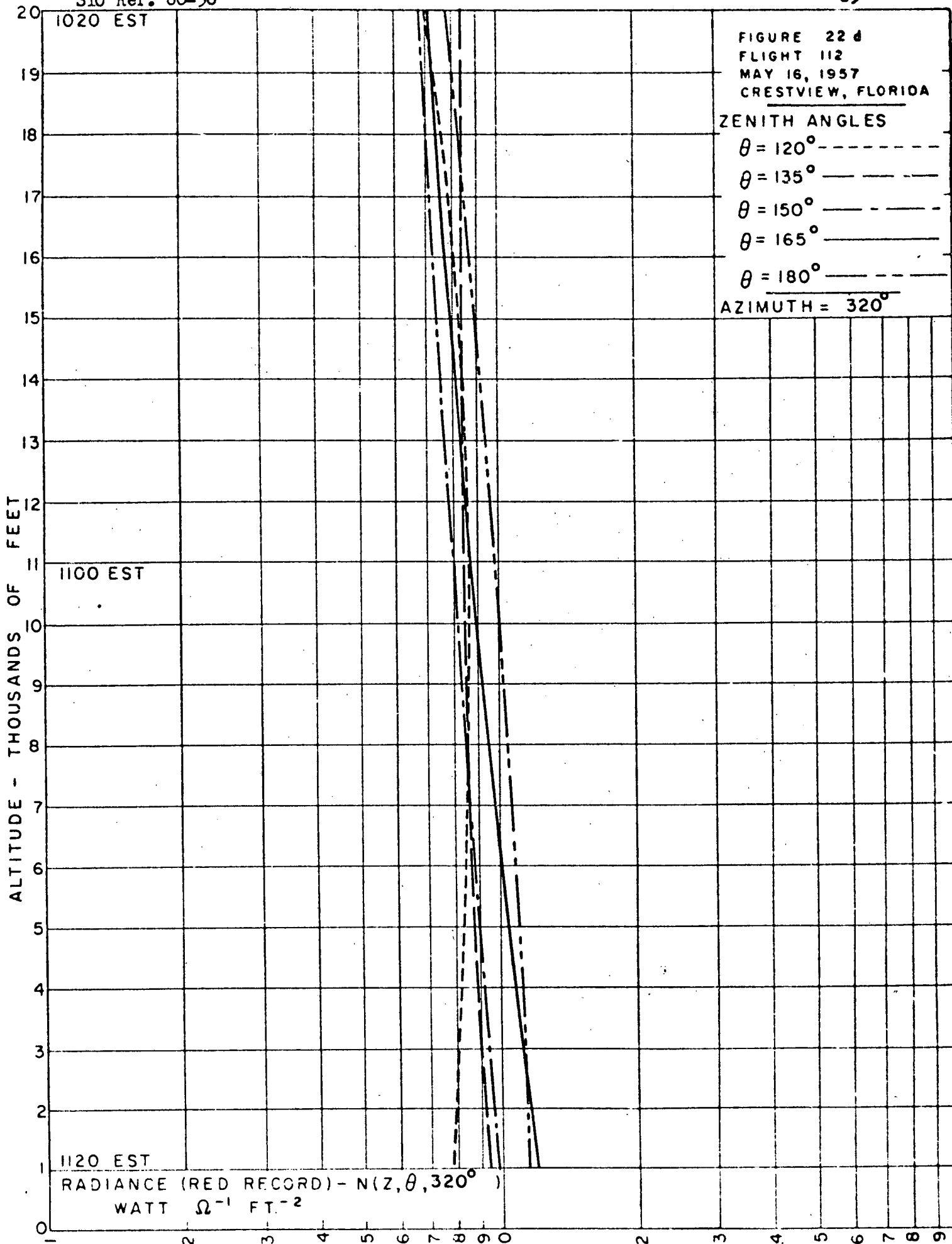
1020 EST

1100 EST

1120 EST

ALTITUDE - THOUSANDS OF FEET

RADIANCE (RED RECORD) - N(Z,θ,320°)

WATT Ω^{-1} FT.$^{-2}$

1020 EST

FIGURE 23 oo
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 15°$ ————————

$\theta = 30°$ —— · —— · —

AZIMUTH = 340°

1100 EST

ALTITUDE - THOUSANDS OF FEET

NOTE CHANGE OF SCALE

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 340°)
WATT Ω^{-1} FT^{-2}

SIO Ref. 60-56
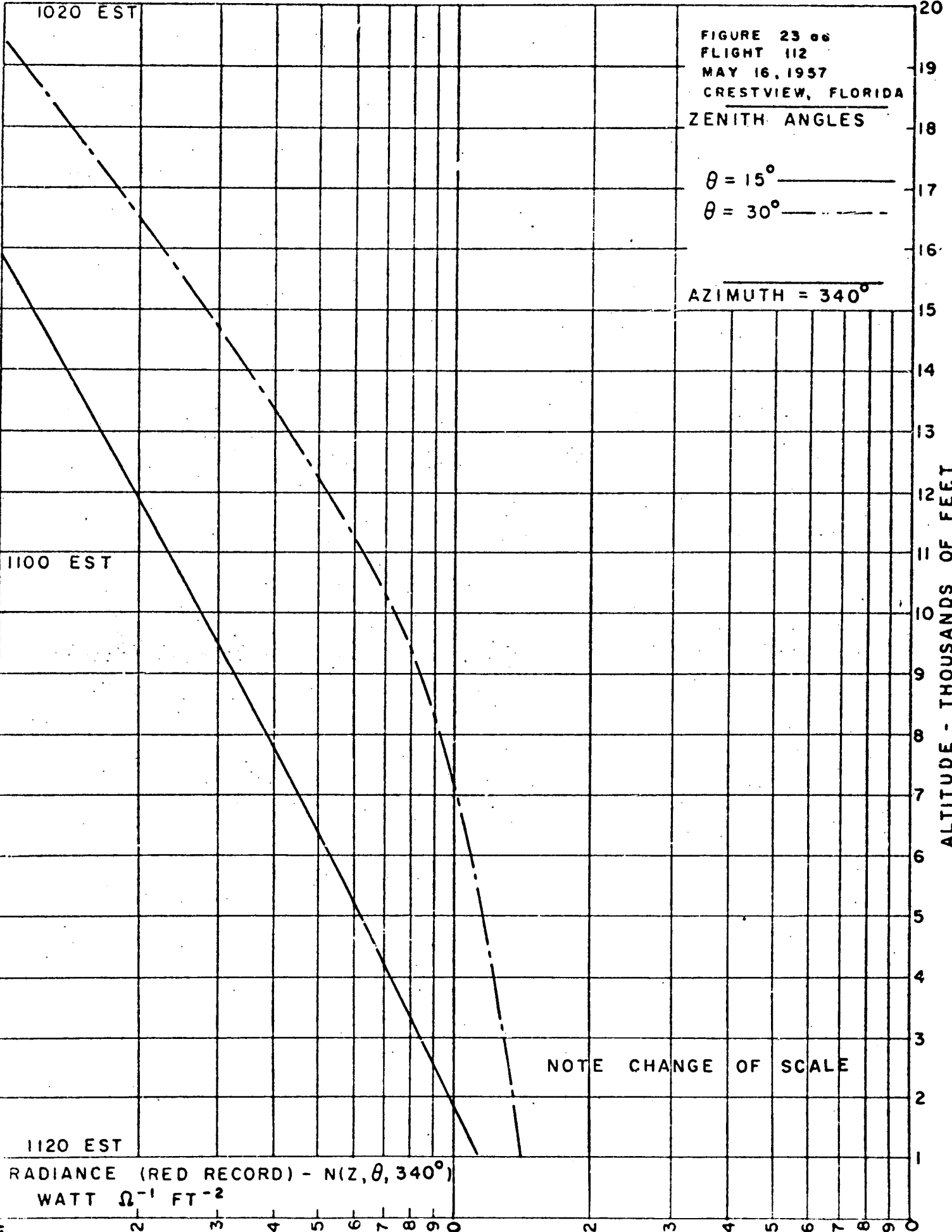
FIGURE 23 a
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA
ZENITH ANGLES
$\theta = 0°$ —— - - ——
$\theta = 15°$ ——————
$\theta = 30°$ —— · —— ·
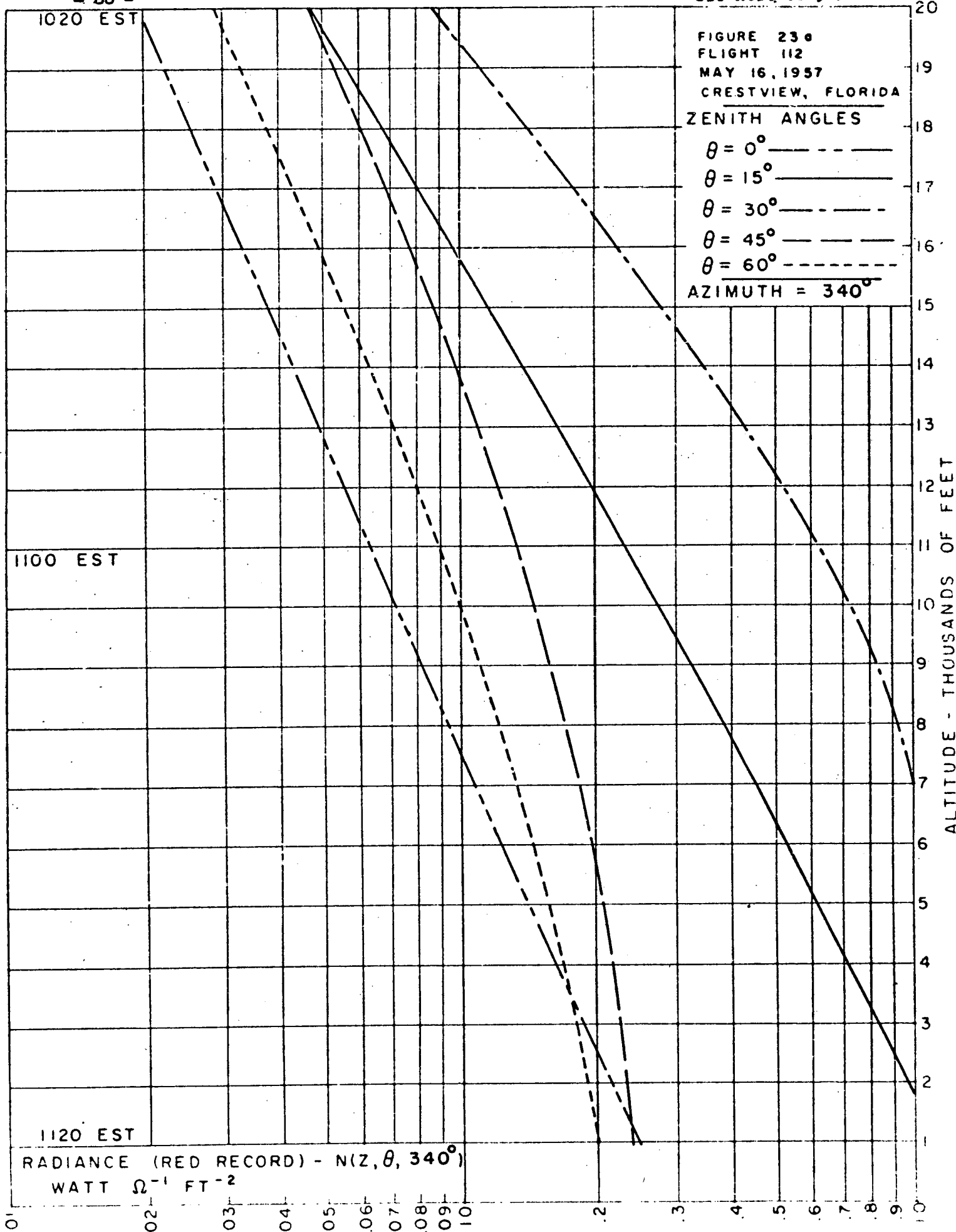$\theta = 45°$ —— —— ——
$\theta = 60°$ - - - - - -
AZIMUTH = 340°

1020 EST

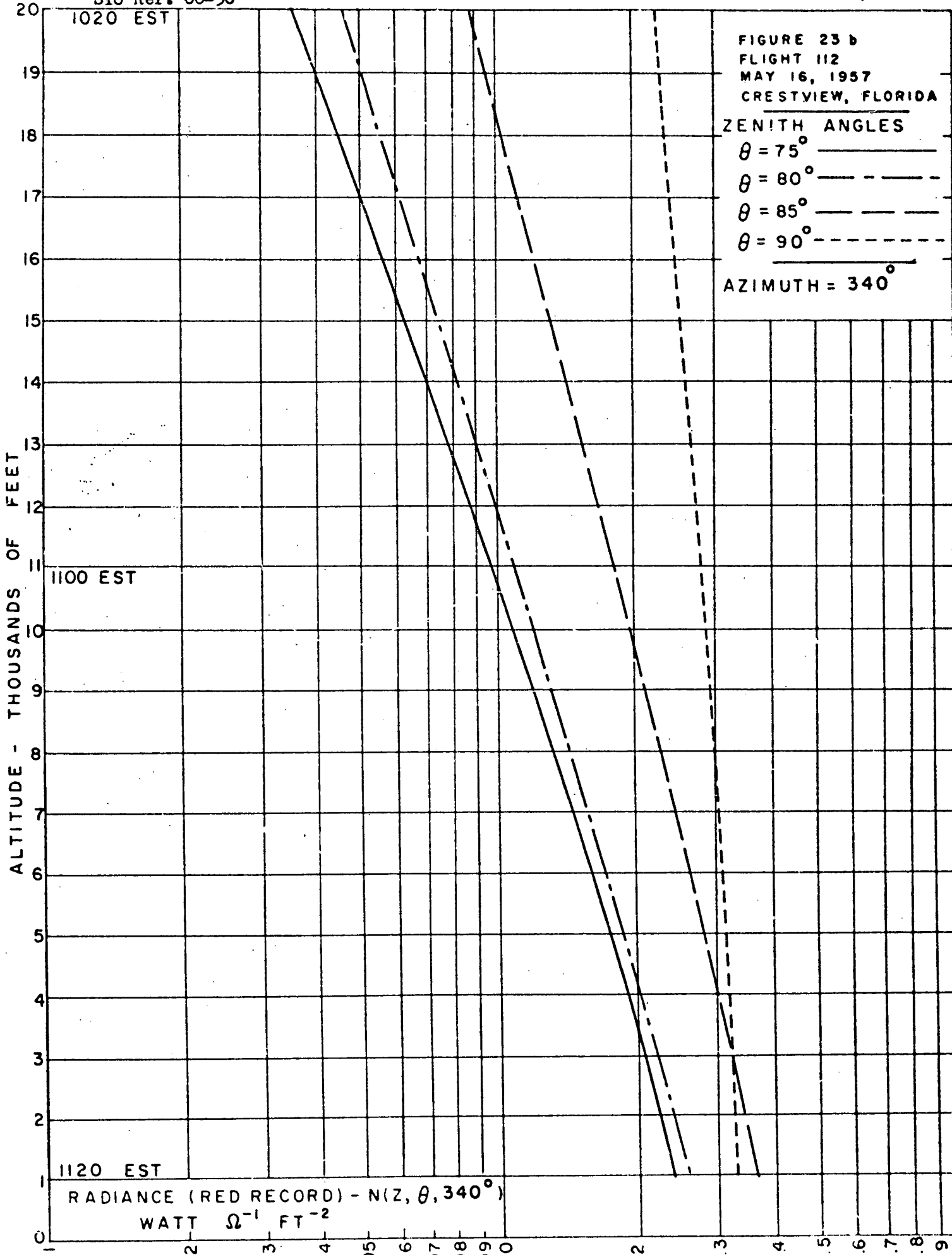1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 340°)
WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 23 b
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 75°$ ————
$\theta = 80°$ — — —
$\theta = 85°$ ———— ————
$\theta = 90°$ - - - - -

AZIMUTH = 340°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 340°)

WATT Ω^{-1} FT^{-2}

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

FIGURE 23 c
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES
$\theta = 90°$ ------
$\theta = 95°$ ————
$\theta = 100°$ —·—·—
$\theta = 105°$ ————

AZIMUTH = 340°

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 340°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET

SIO Ref. 60-56

1020 EST

1100 EST

1120 EST

RADIANCE (RED RECORD) - N(Z, θ, 340°)

WATT Ω^{-1} FT.$^{-2}$

ALTITUDE - THOUSANDS OF FEET
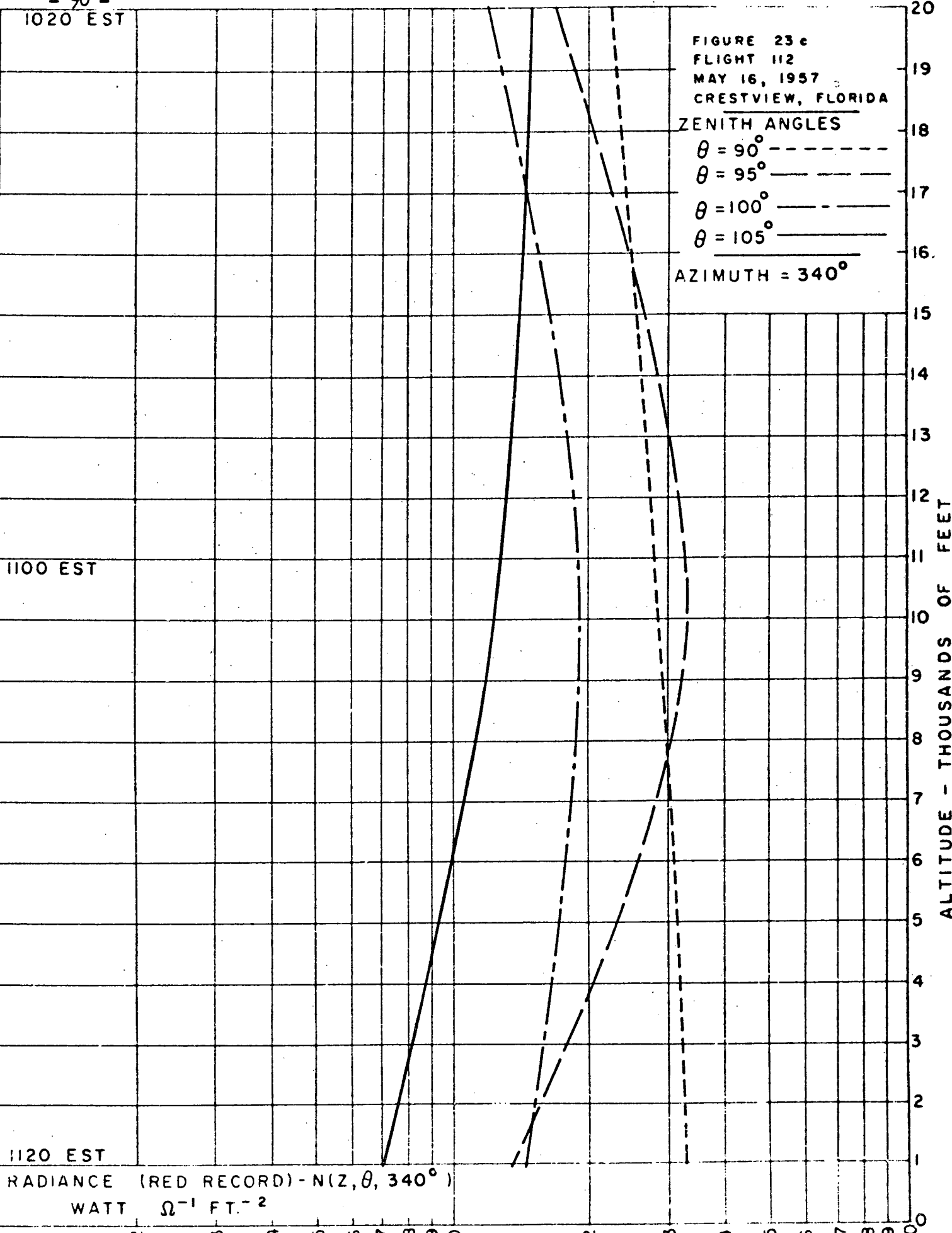
FIGURE 23 d
FLIGHT 112
MAY 16, 1957
CRESTVIEW, FLORIDA

ZENITH ANGLES

$\theta = 120°$ -------
$\theta = 135°$ ———
$\theta = 150°$ —-—-
$\theta = 165°$ ———
$\theta = 180°$ —--—

AZIMUTH = 340°
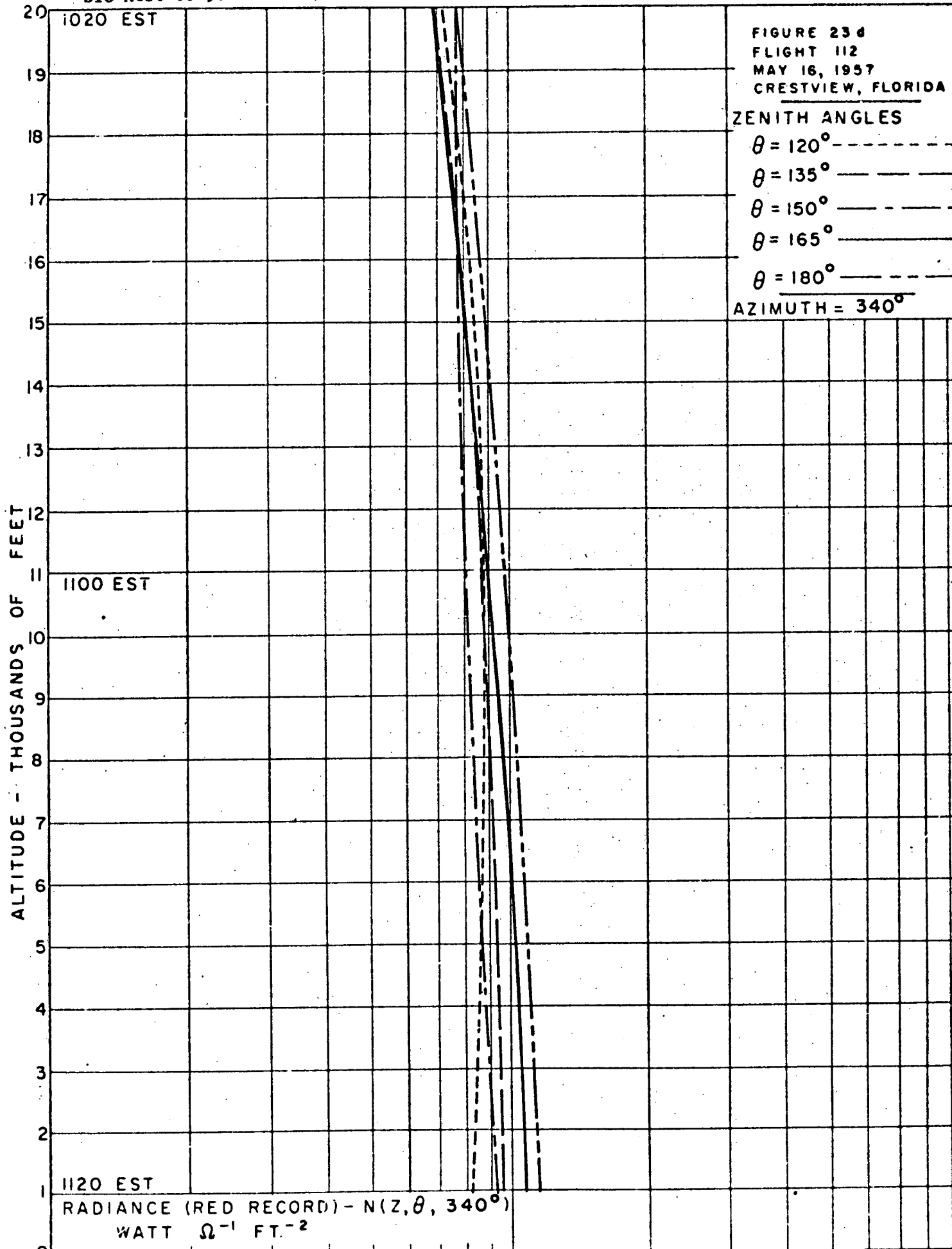
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2. Duntley, S. Q., A. R. Boileau, and R. W. Preisendorfer, "Image Transmission by the Troposphere I," _Journal of the Optical Society of America_, _47_, pp 499-506, (1957).

ACKNOWLEDGEMENTS