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UNLIMITED

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BR 73763

LEVEL III



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ROYAL AIRCRAFT ESTABLISHMENT ✓

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⑨ Technical Report 79052 ✓

⑪ May 1979

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⑥ CONTRIBUTIONS TO THE UK MICROWAVE
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Volume 3.

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by

⑩ J.M. Jones

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Procurement Executive, Ministry of Defence
Farnborough, Hants

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Fig 6.1

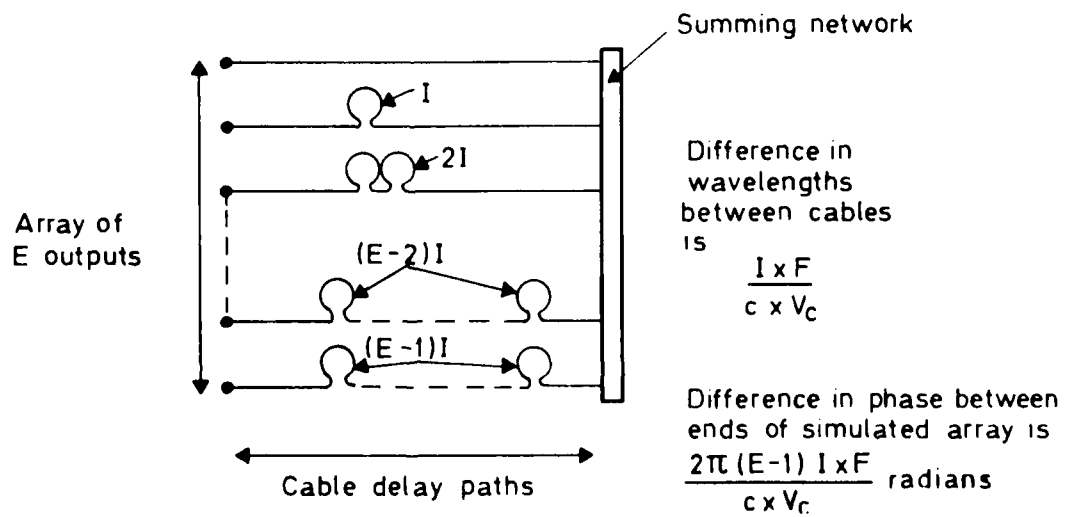
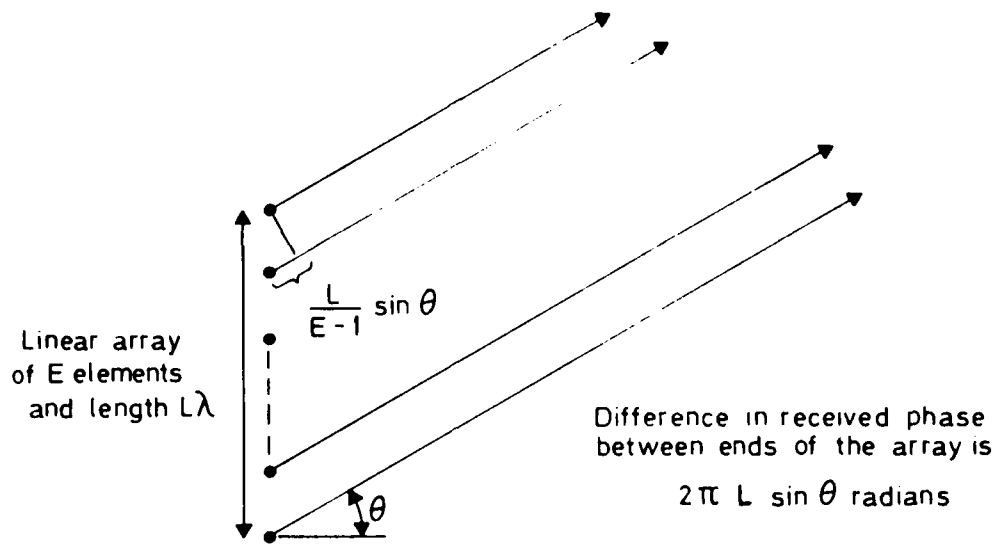


Fig 6.1 Comparison of Doppler antenna and cable transmission simulation

Fig 6.2

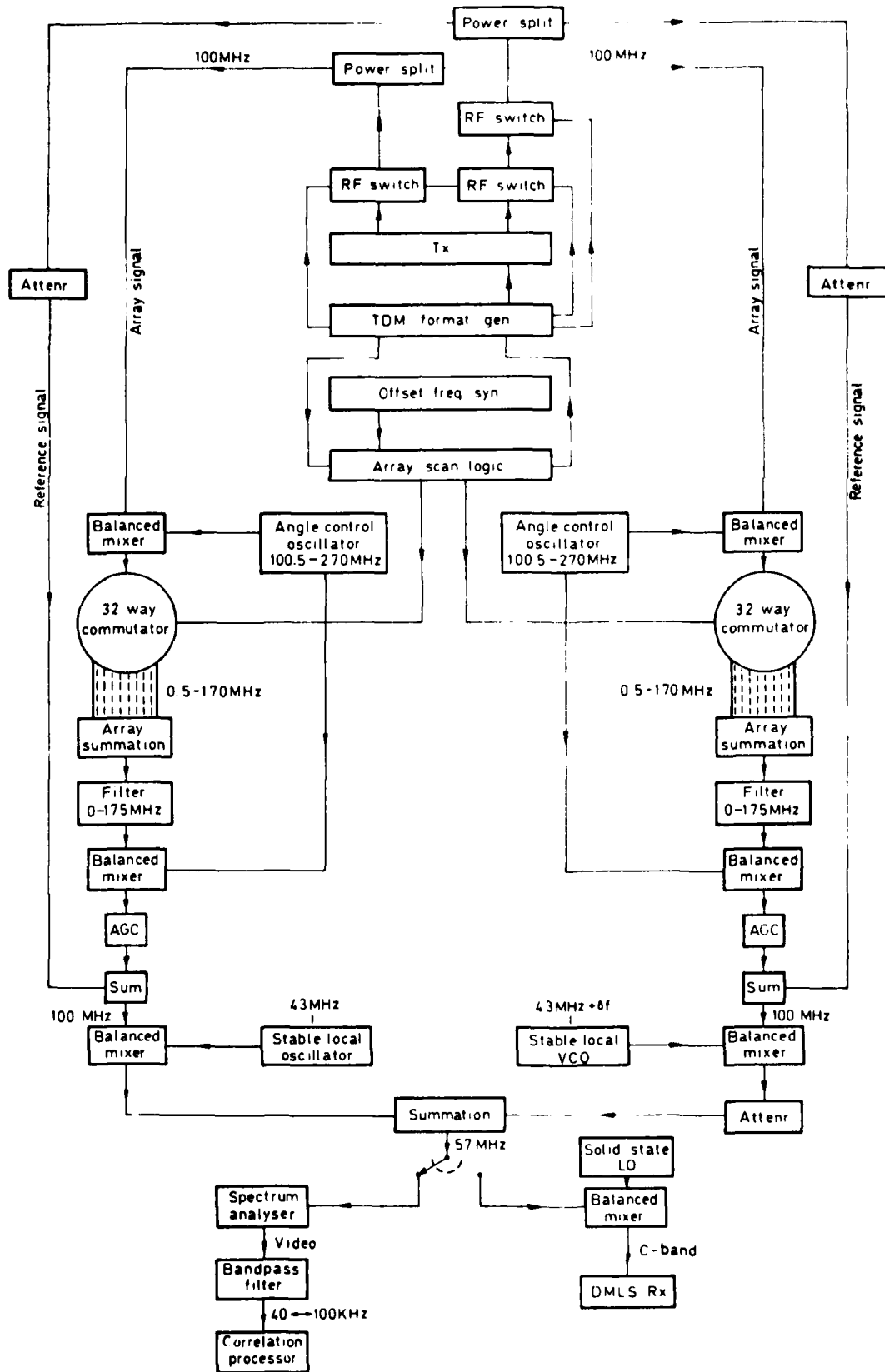


Fig 6.2 Simulator block diagram

Fig 6.3

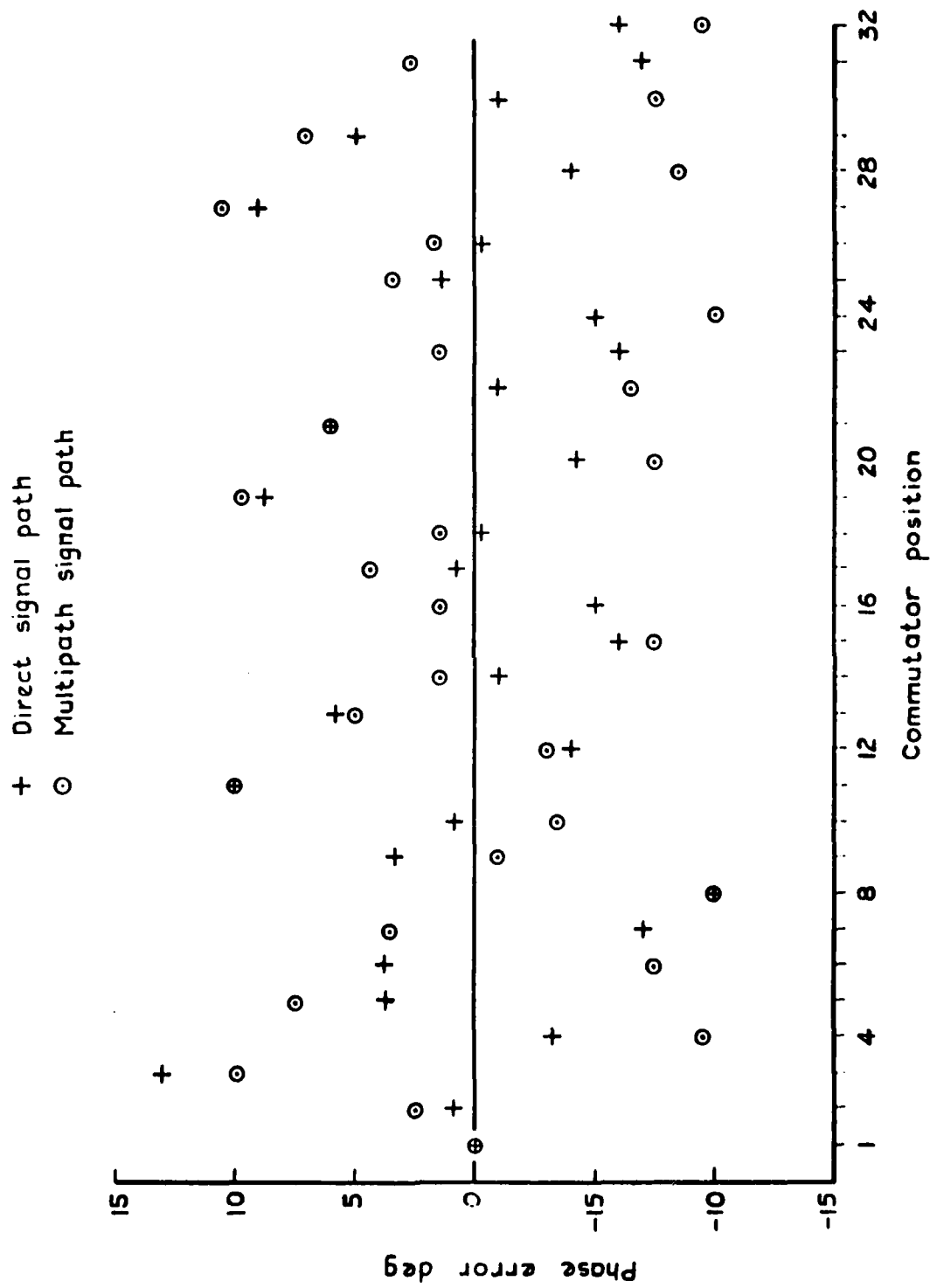


Fig 6.3 Simulator array phase errors at 170 MHz

IF bandwidth: 300 Hz
 Spectrum width: 100 kHz/division
 Amplitude: 10 dB/division

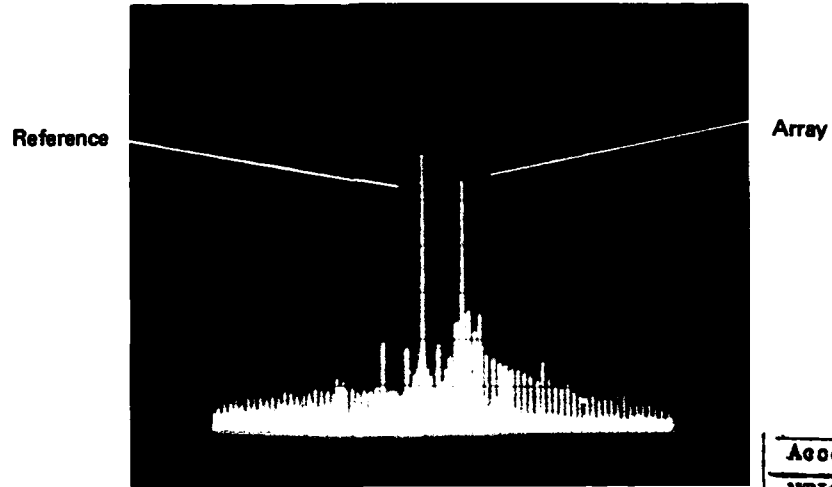


Fig 6.4 Simulator output spectrum – no multipath

Accession For	
NTIS COM&I	<input checked="" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/ _____	
Availability Codes	
Dist	Avail and/or special
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IF bandwidth: 300 Hz
 Spectrum width: 10 kHz/division
 Amplitude: 10 dB/division

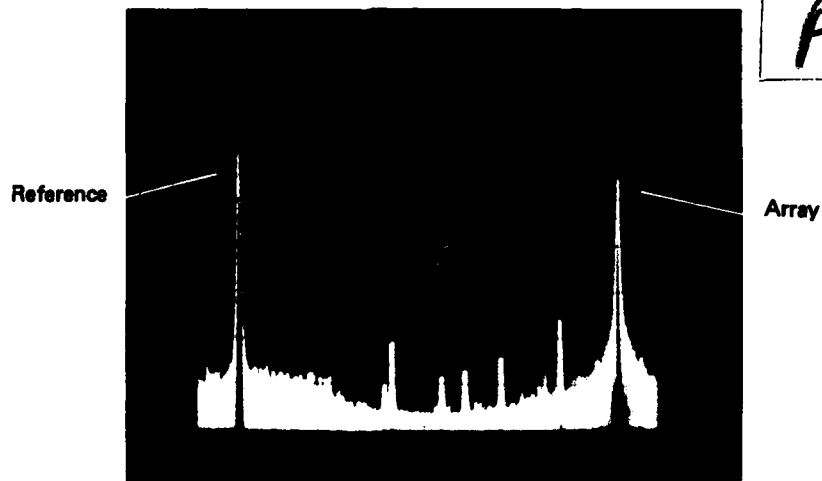


Fig 6.5 Simulator output spectrum – no multipath, expanded frequency scale

Figs 6.6 & 6.7

IF bandwidth: 300 Hz
Spectrum width: 10 kHz/division
Amplitude: 10 dB/division

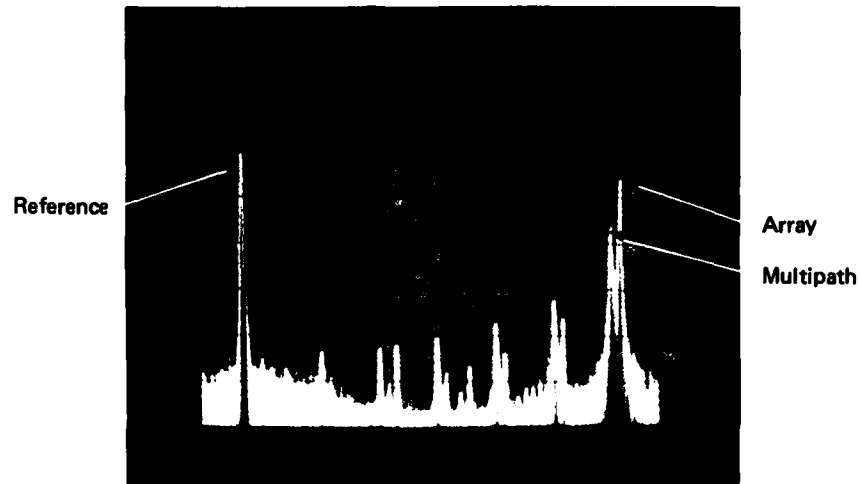


Fig 6.6 Simulator output spectrum with multipath signal

IF bandwidth: 300 Hz
Spectrum width: 2 kHz/division
Amplitude: 10 dB/division
Multipath -5° with respect to wanted signal

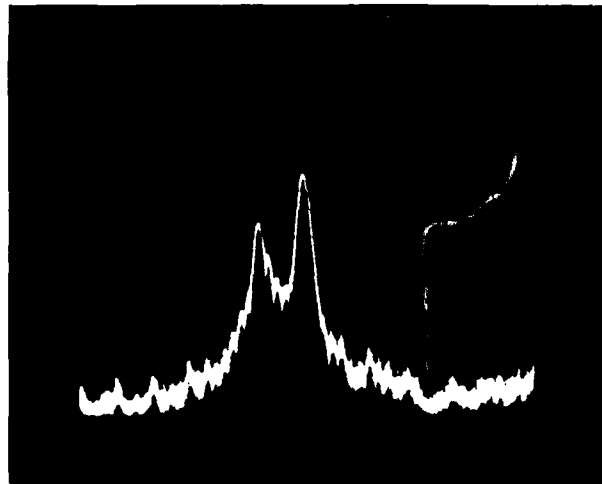


Fig 6.7 Simulator output spectrum with multipath signal. Expansion of Fig 6.6 around array signal

IF bandwidth: 300 Hz
Spectrum width: 2 kHz/division
Amplitude: 10 dB/division

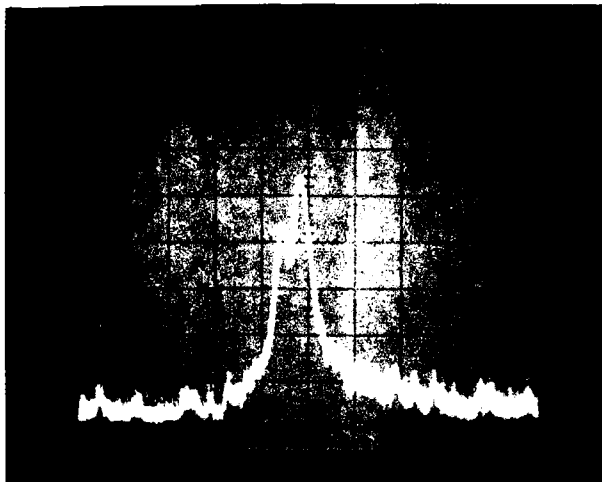


Fig 6.8 Expanded simulator output spectrum, multipath at -2 degrees separation

IF bandwidth: 300 Hz
Spectrum width: 2 kHz/division
Amplitude: 10 dB/division

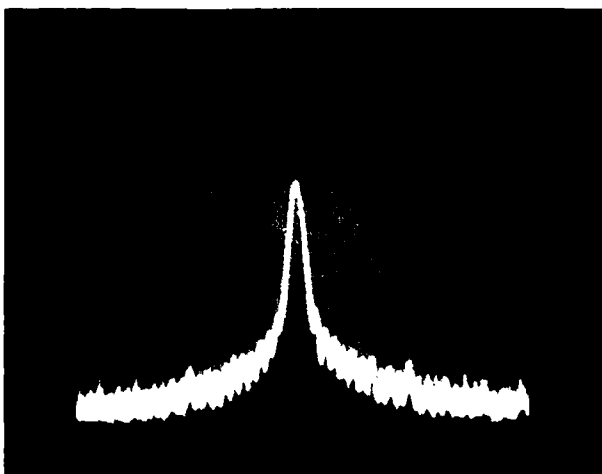


Fig 6.9 Expanded simulator array signal, no multipath

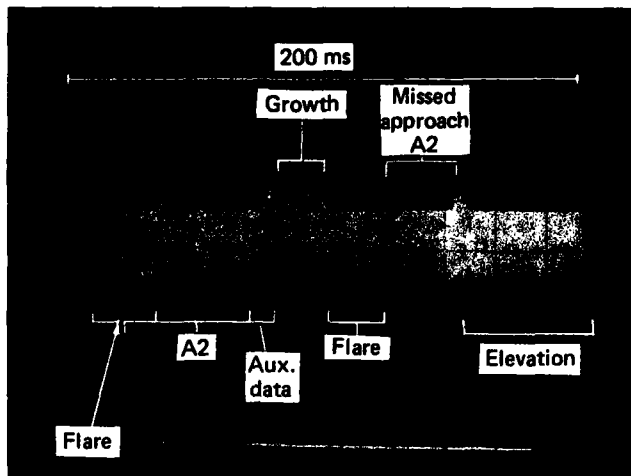


Fig 6.10 Receiver video output for a 200ms frame containing azimuth, elevation, missed approach azimuth flare and auxiliary data signals

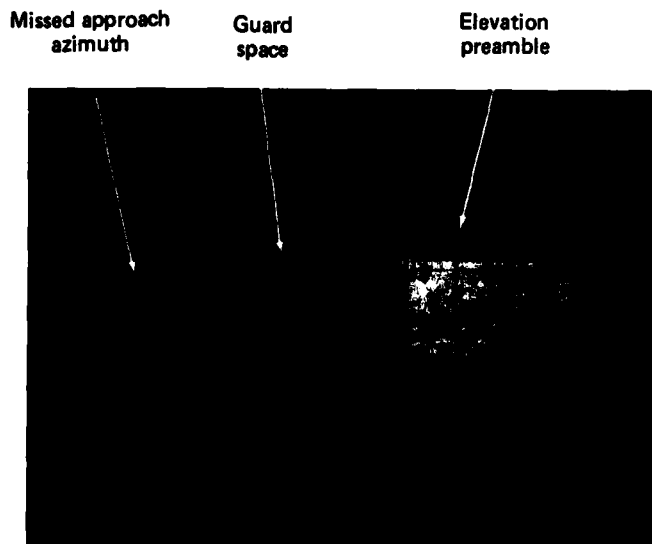


Fig 6.11 Part of Fig 6.10, expanded time scale

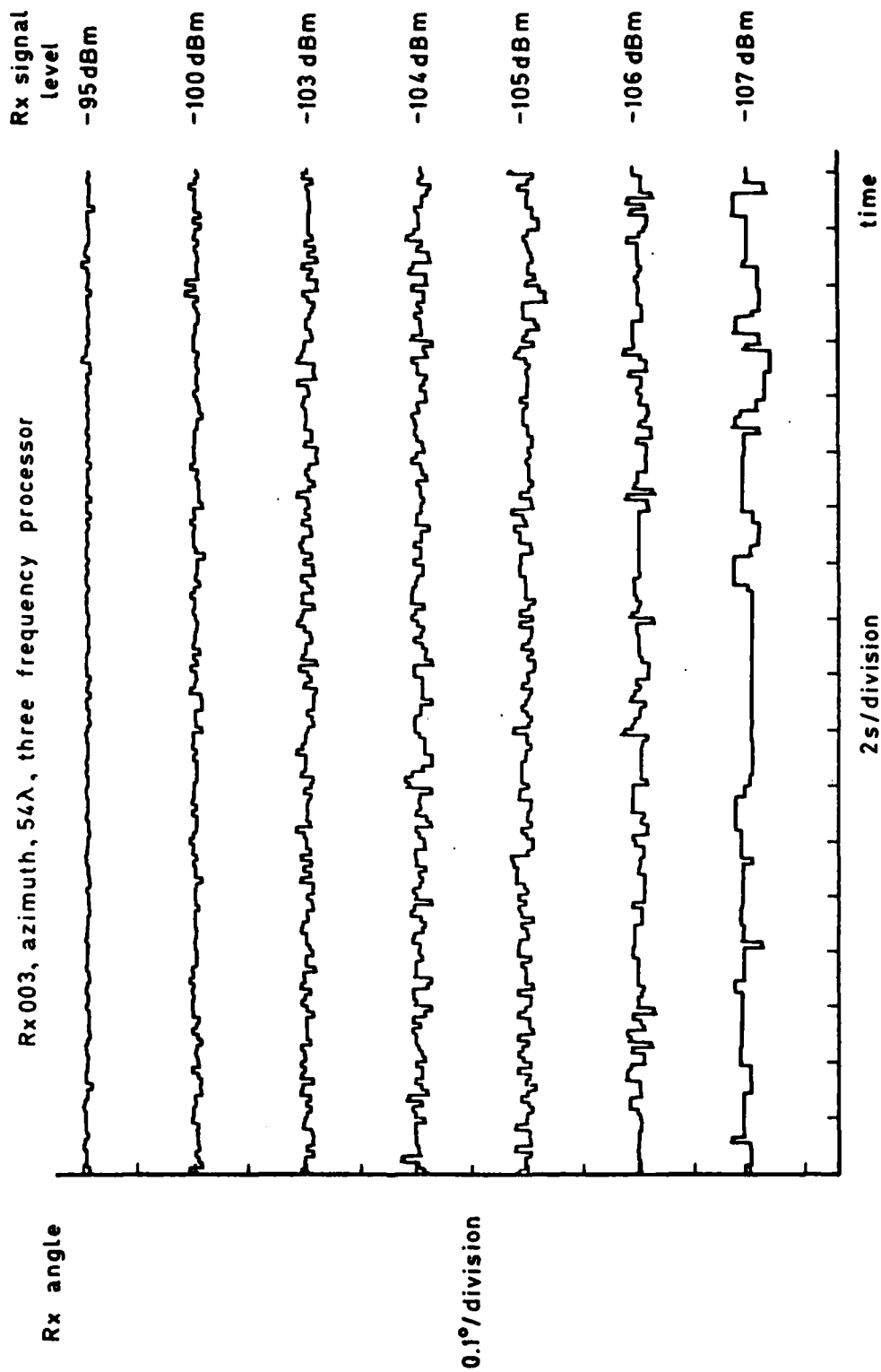


Fig 6.12a

Fig 6.12a Azimuth angle noise as function of signal level (full system)

Fig 6.12b

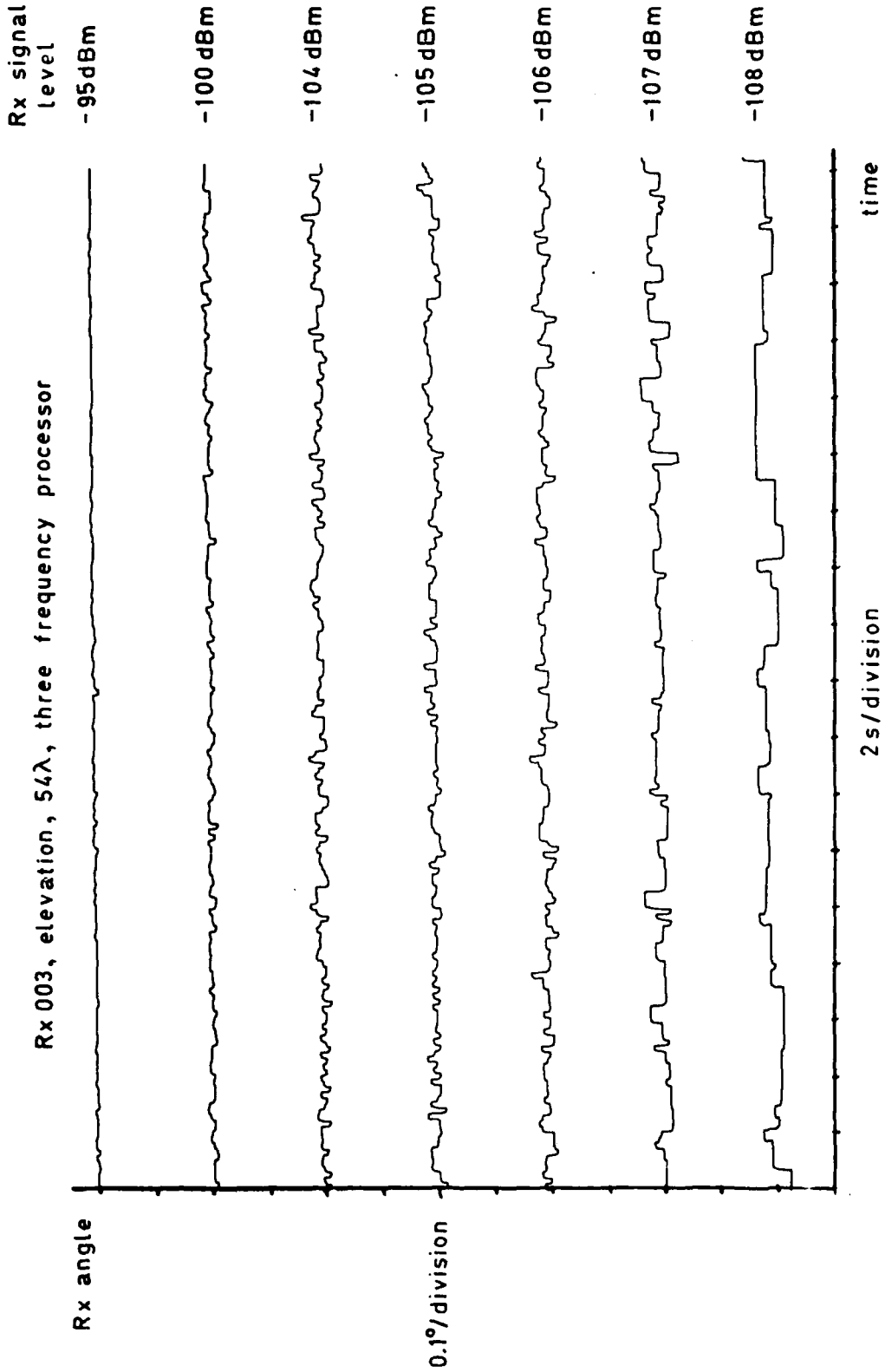


Fig 6.12b Elevation angle noise as function of signal level (full system)

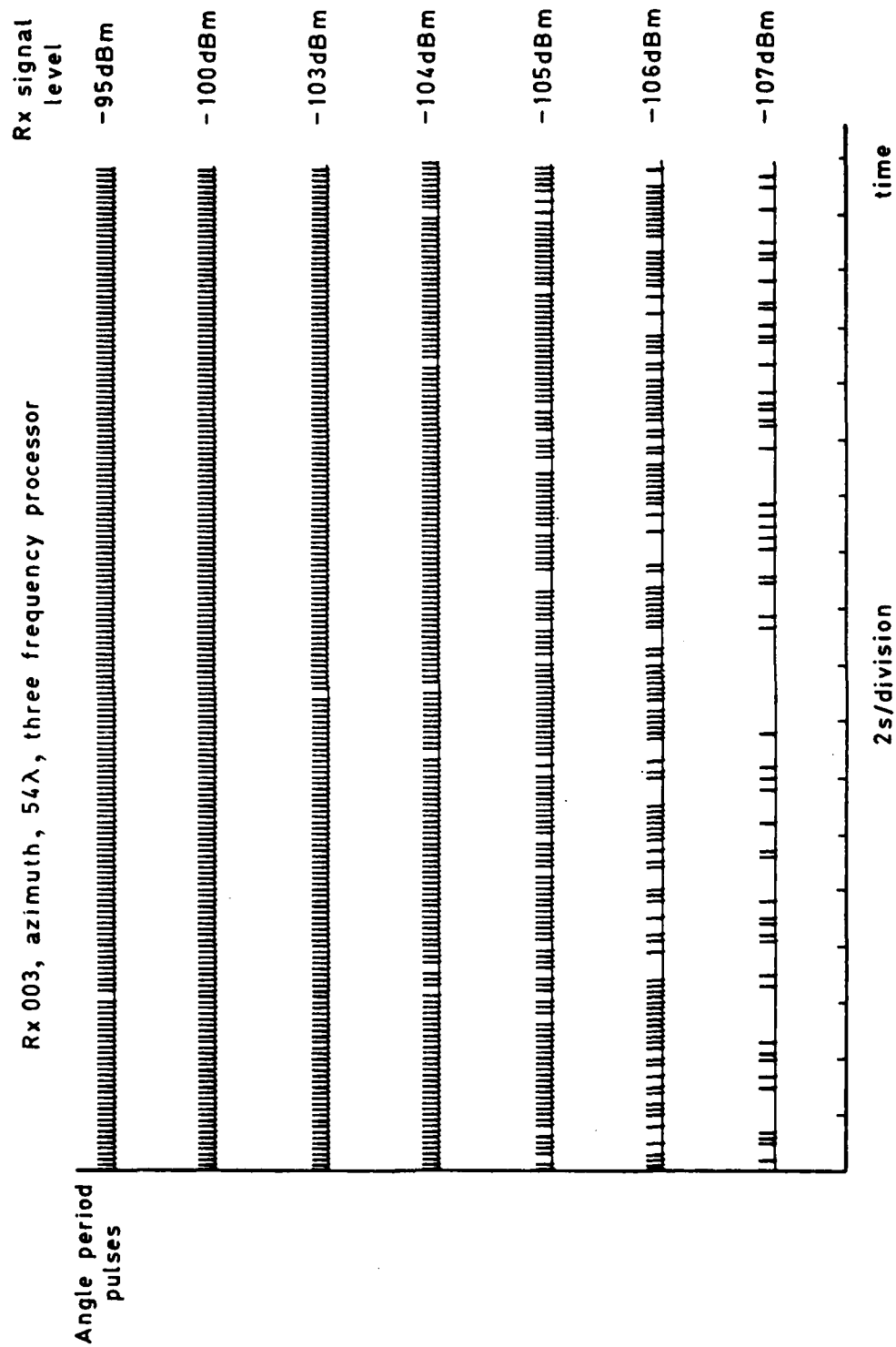


Fig 6.13a

Fig 6.13a Azimuth function identity decode success

Fig 6.13b

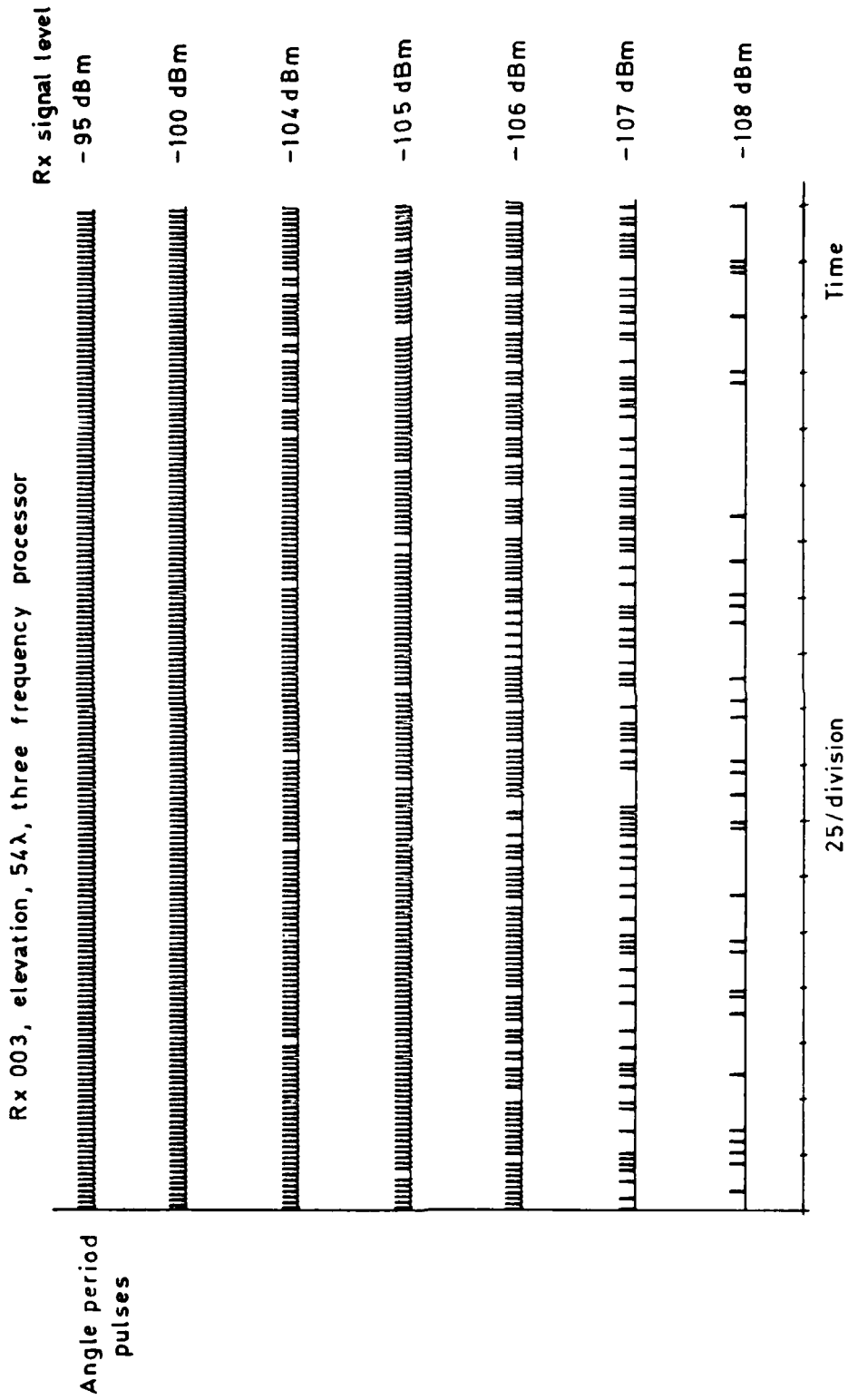


Fig 6.13b Elevation function identity decode success

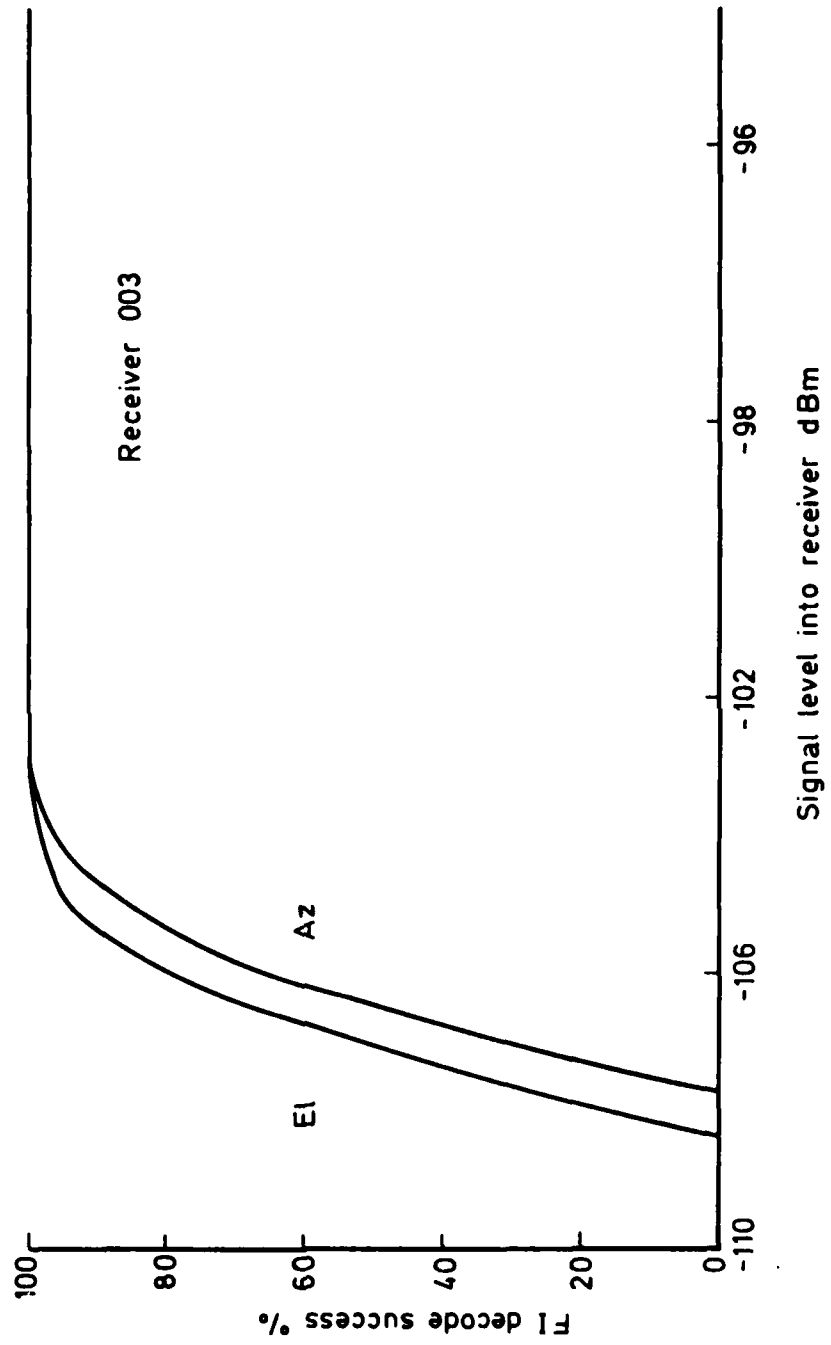


Fig 6.14

Receiver performance at low signal level

Fig 6.15

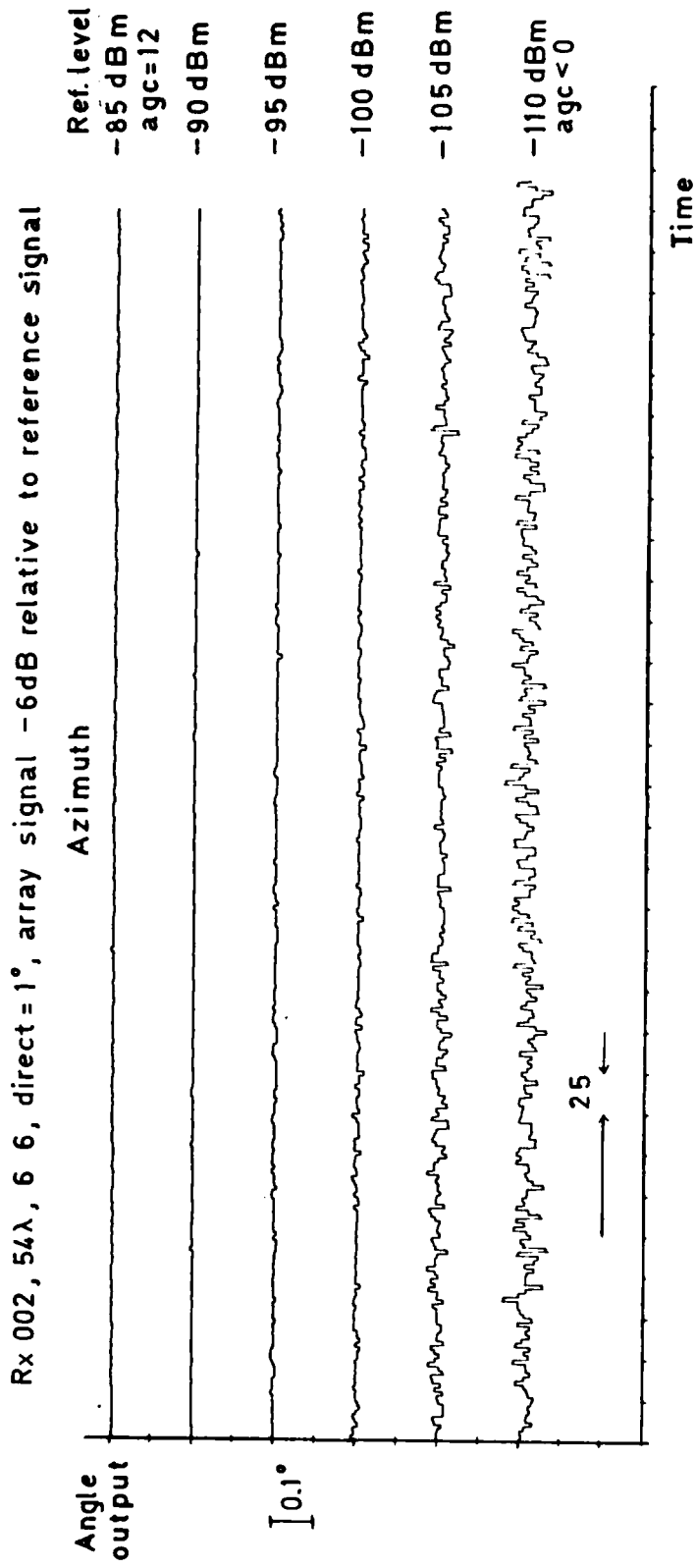


Fig 6.15 Azimuth receiver noise as a function signal input level (F1 preamble hard wired)

Rx 003, 54λ , BI-DIR, I/P signals ≈ -95 dB m

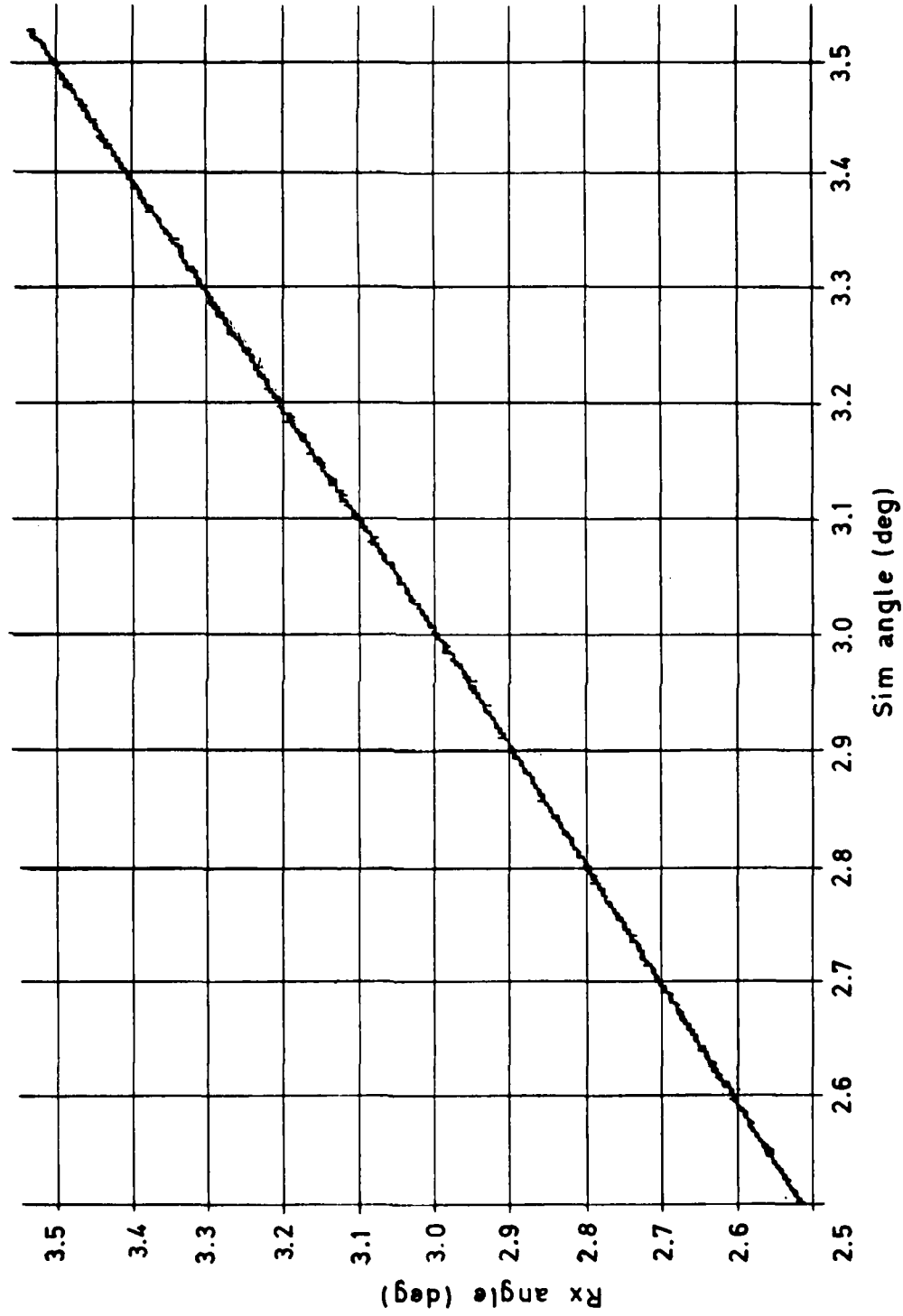


Fig 6.16

Fig 6.16 Azimuth angle output as a function of simulator angle

Fig 6.17a

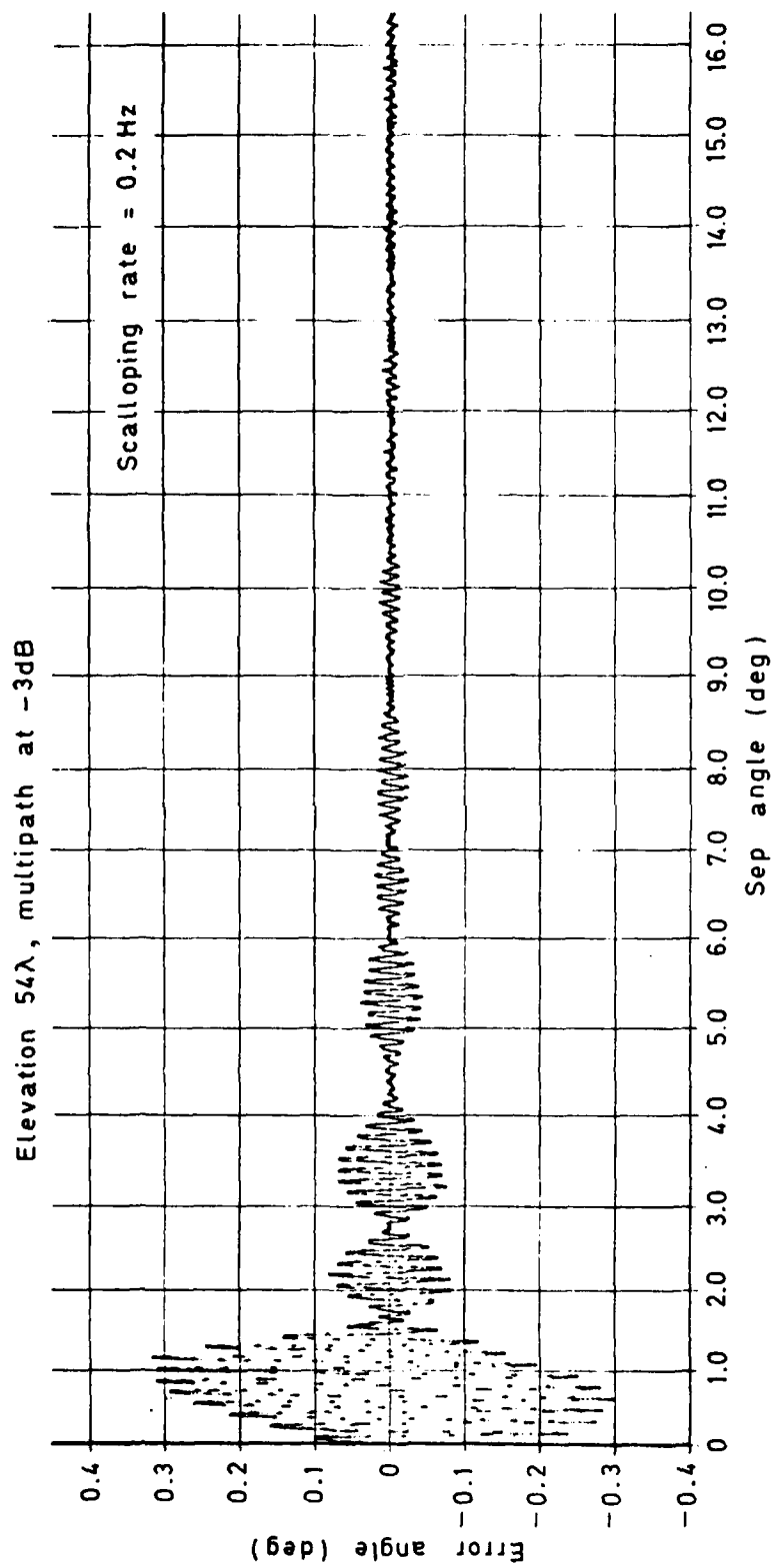


Fig 6.17a Elevation error as a function of separation angle — single frequency processor

Elevation, 54λ , image multipath signal -1dB relative to direct signal
Scalloping rate = 0.2Hz

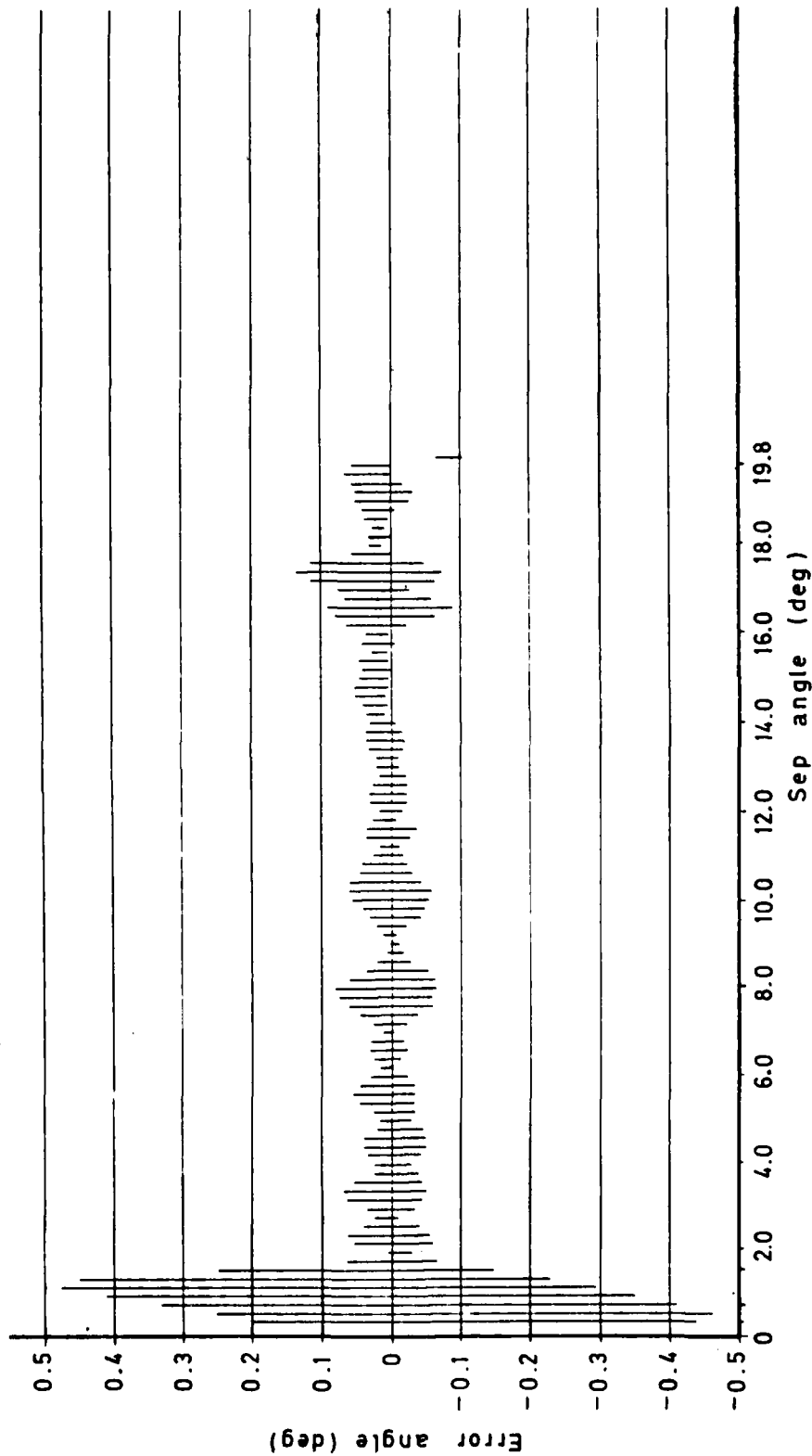


Fig 6.17b

Fig 6.17b Elevation error as a function of separation angle - Taylor taper processor

Fig 6.17c

Rx 001, elevation, 54λ , direct = $+1^\circ$, multipath signal -0.9dB relative to direct
No multipath reference, scalloping rate = 0.2Hz

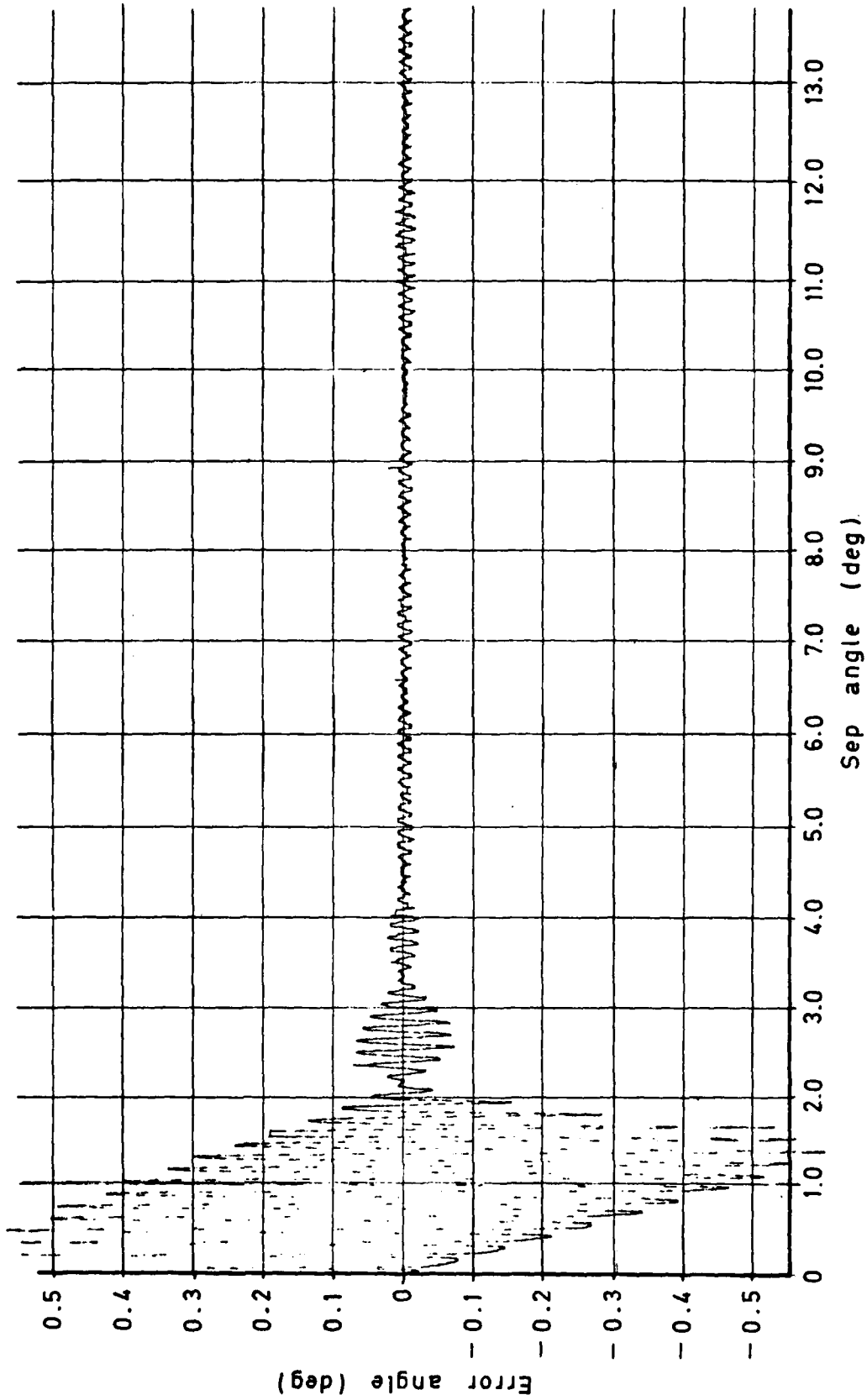


Fig 6.17c Elevation error as a function of separation angle - three frequency processor

Rx 003, elevation, 54λ , direct = $+3^\circ$, multipath signal -3dB relative to direct
No multipath reference, scalloping rate = 0.2Hz

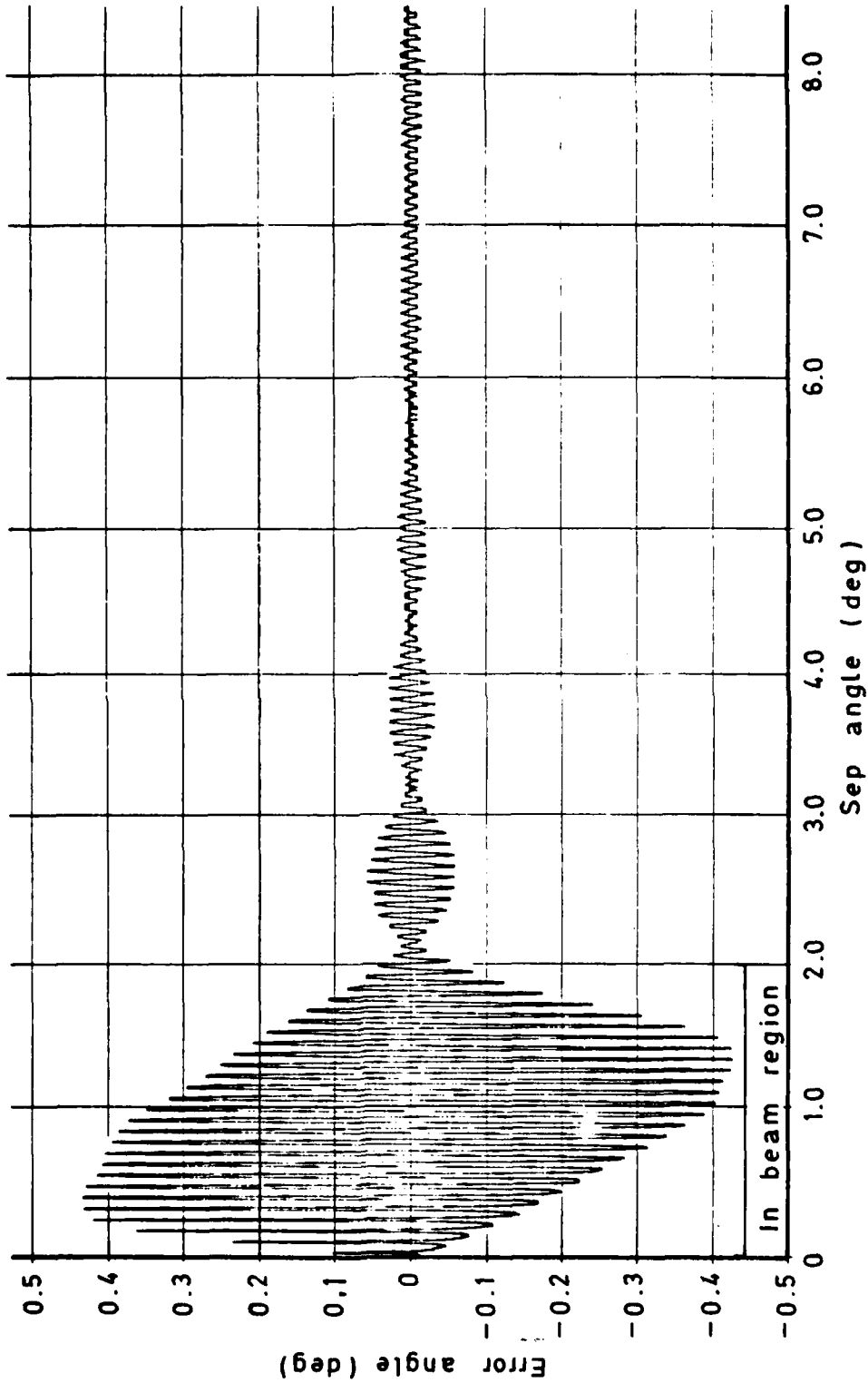


Fig 6.18a Elevation error as a function of separation angle - three frequency processor - 54λ

Fig 6.18b

Rx 003, elevation, 40λ , direct = $+3^\circ$, multipath signal - 3dB relative to direct
no multipath reference, scalloping rate = 0.2 Hz

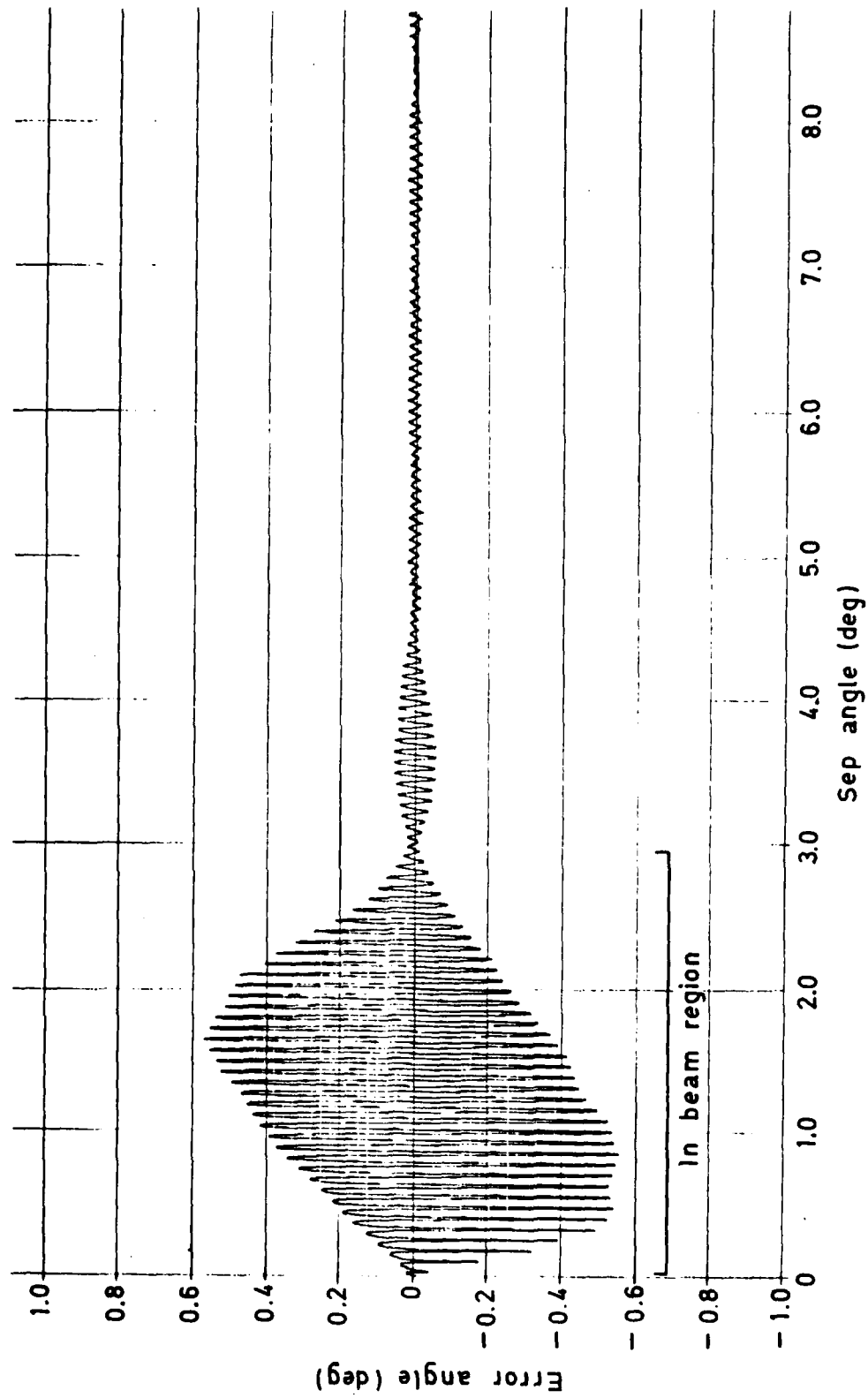


Fig 6.18b Elevation angle as a function of separation angle - three frequency processor - 40λ

Rx 003, elevation, 30λ , direct = $+3^\circ$, multipath signal -3dB relative to direct no multipath reference, scalloping rate = 0.2 Hz

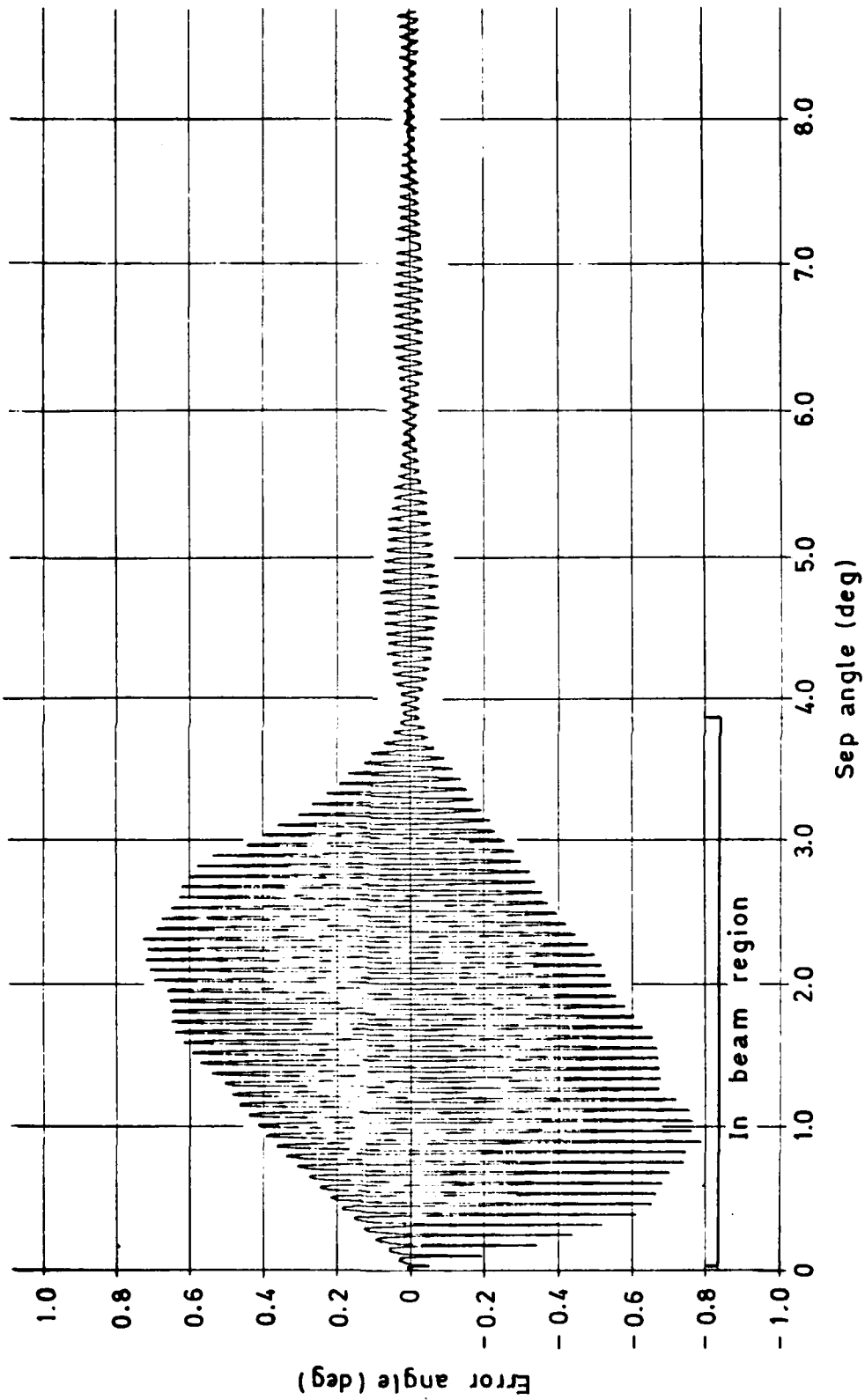


Fig 6.18c

Fig 6.18c Elevation error as a function of separation angle — three frequency processor — 30λ

Fig 6.19

Rx003, elevation, 27λ , direct = $+3^\circ$, multipath signal -3 dB relative to direct
no multipath reference, scalloping rate = 0.2 Hz

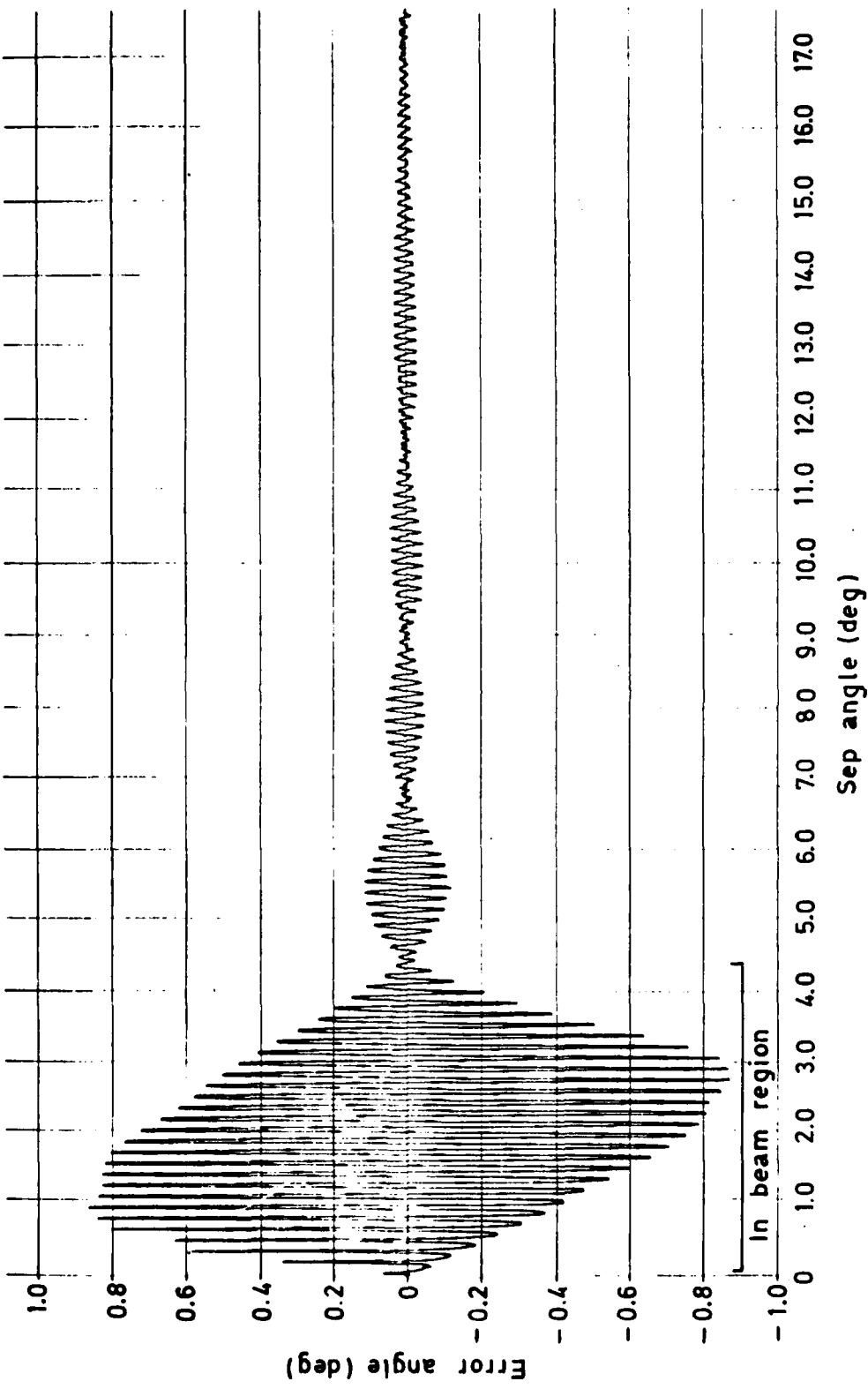


Fig 6.19 Elevation error as a function of separation angle - three frequency processor - 27λ

Rx 003, azimuth, 54λ , UNI-DIR., direct = $+1^\circ$, multipath signal -3dB relative to direct
No multipath reference, scalloping rate = 0.2Hz

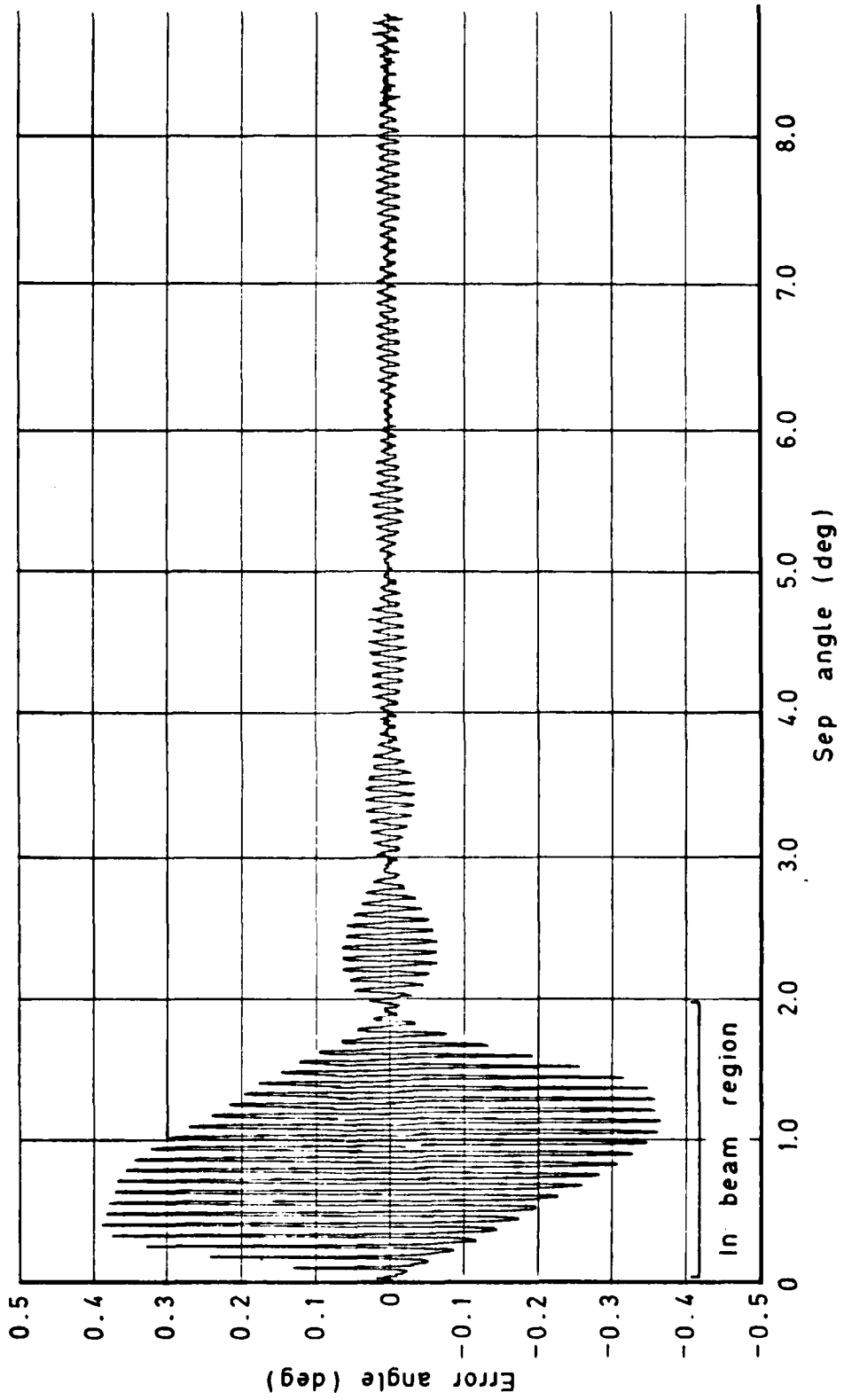


Fig 6.20a

Fig 6.20a Azimuth error as a function of separation angle - three frequency processor - 54λ

Fig 6.20b

Rx003, azimuth, 27λ , direct = $+1^\circ$, multipath signal -3dB relative to direct
Scalloping rate = 0.2Hz

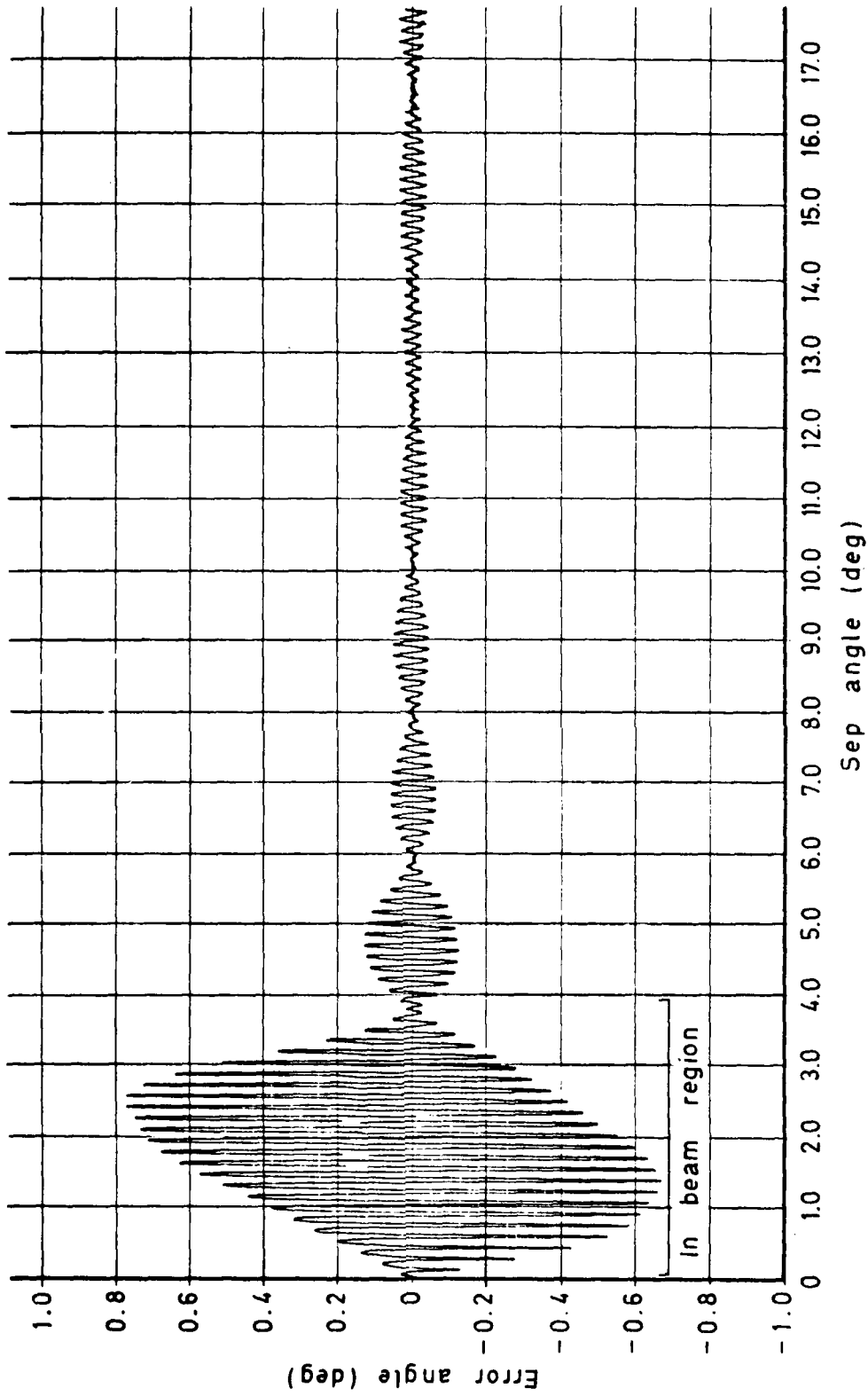


Fig 6.20b Azimuth error as a function of separation angle -- three frequency processor -- 27λ

Rx003, azimuth, 20λ , direct = $+1^\circ$, multipath signal -3dB relative to direct
No multipath reference, scalloping rate = 0.2Hz

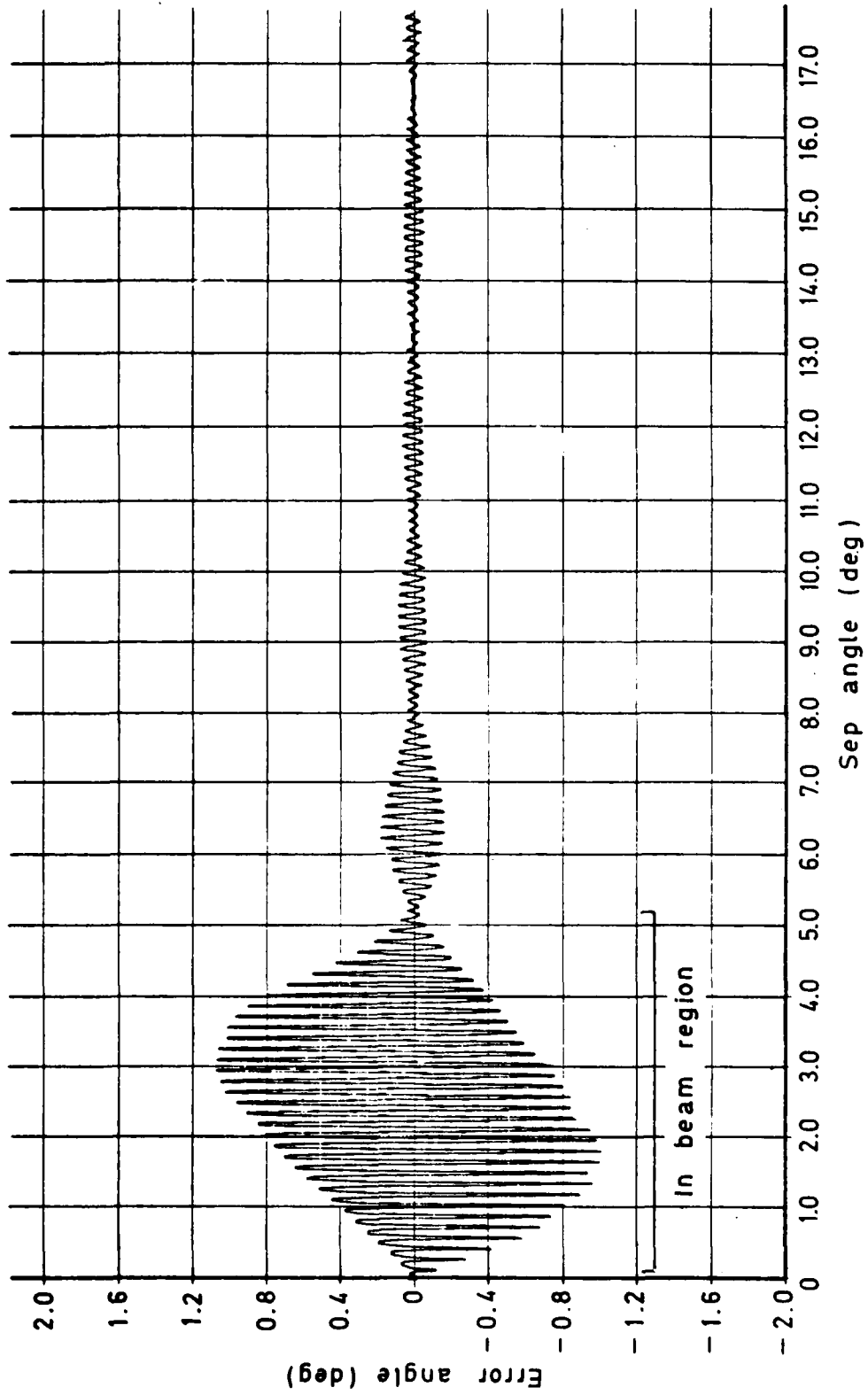


Fig 6.20c

Fig 6.20c Azimuth error as a function of separation angle - three frequency processor - 20λ

Fig 6.20d

Rx 003, azimuth, 15λ , direct = $+1^\circ$, multipath signal -3dB relative to direct
No multipath reference, scalloping rate = 0.2Hz

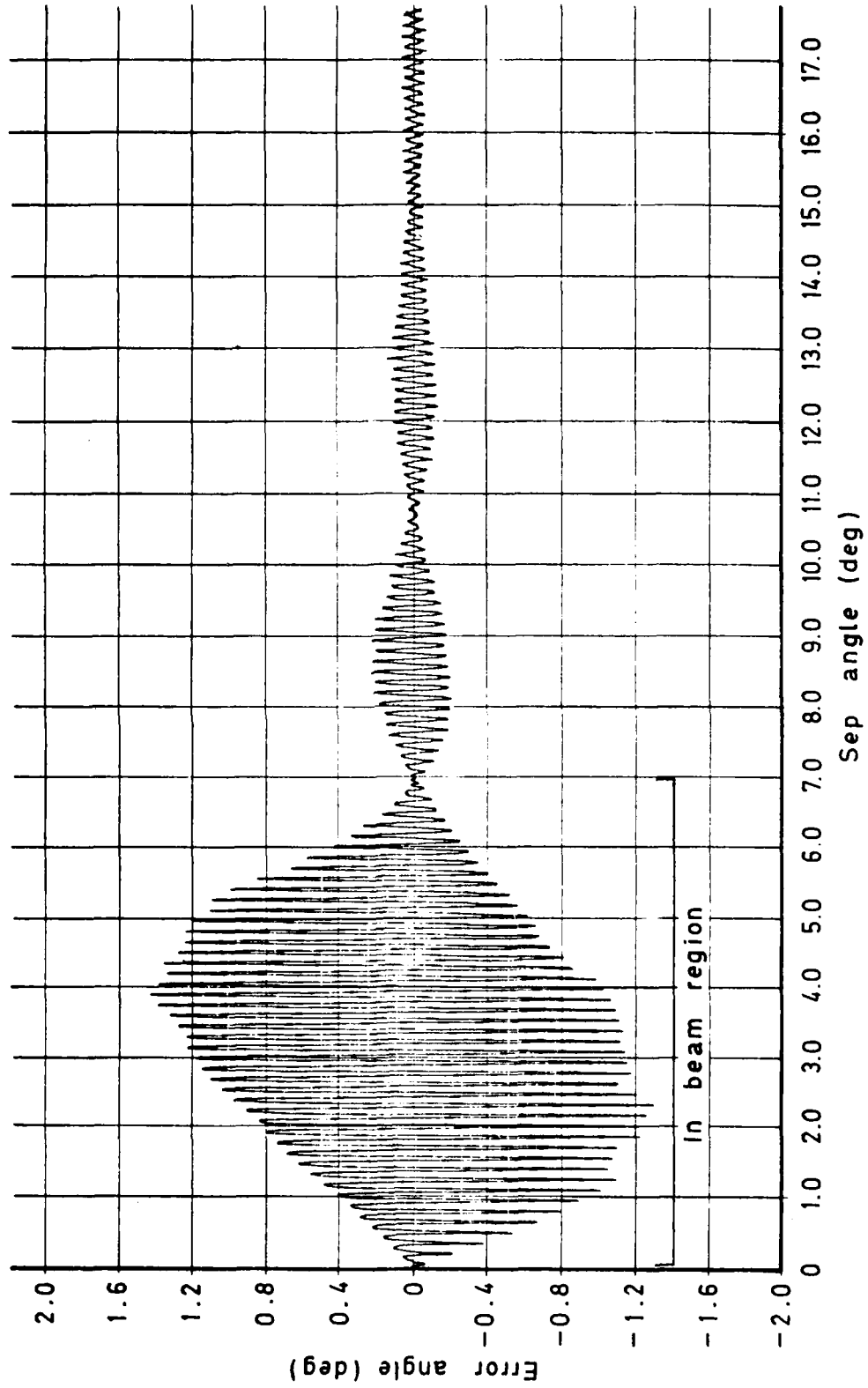
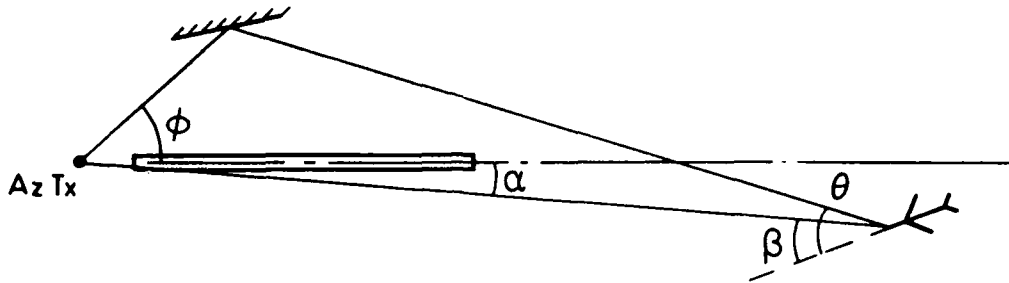


Fig 6.20d Azimuth error as a function of separation angle - three frequency processor - 15λ

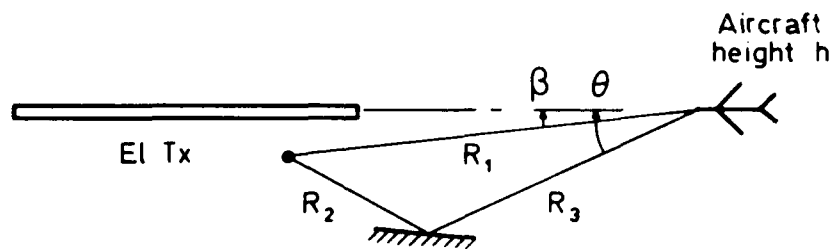


Direct signal code angle = α

Multipath code angle = ϕ

$$\text{Differential fading rate} = \frac{v}{\lambda} (\cos \beta - \cos \theta)$$

a Azimuth systems



$$\text{Direct signal code angle} = \alpha = \tan^{-1} \frac{h}{R_1}$$

$$\text{Multipath code angle} = \phi = \tan^{-1} \frac{h}{R_2 + R_3}$$

$$\text{Differential fading rate} = \frac{v}{\lambda} (\cos \beta - \cos \theta)$$

b Elevation system

Fig 6.21 Typical multipath geometries

Fig 6.22

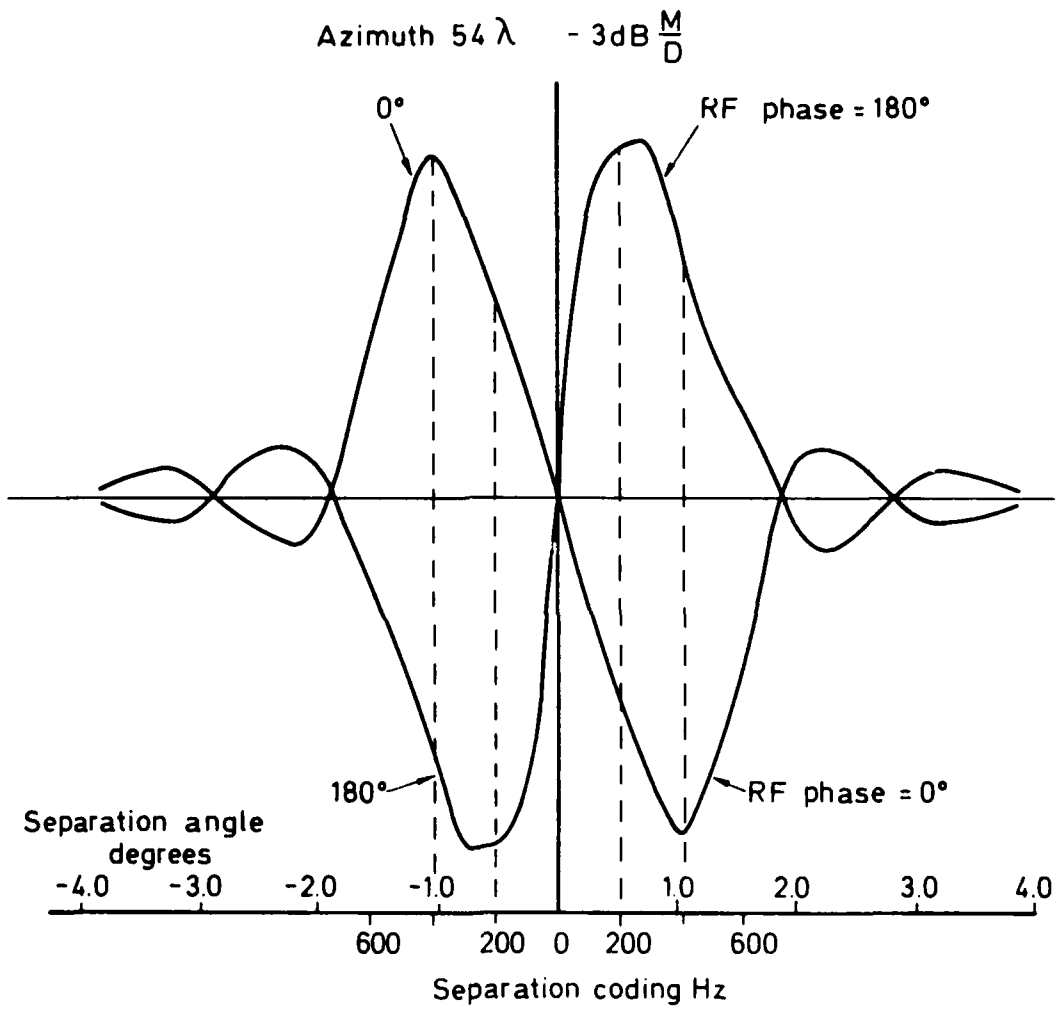


Fig 6.22 Multipath curves, worst case phase

Rx003, azimuth, 54λ , UNI-DIR., multipath signal -3dB relative to direct
Direct = $+1^\circ$, multipath = $+10^\circ$, rate of change of scalloping = 0.65Hz/s

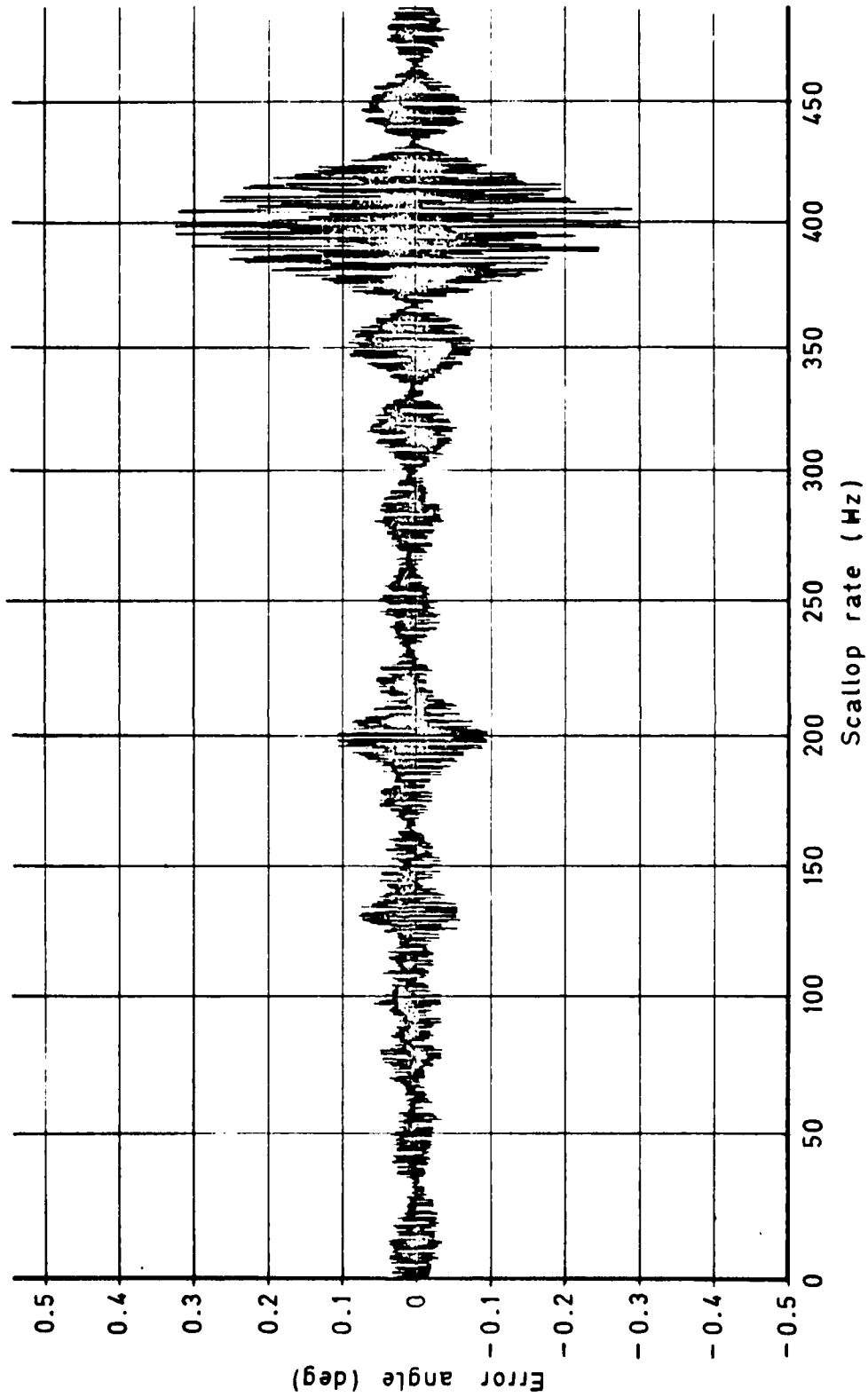


Fig 6.23a

Fig 6.23a Azimuth error as a function of scalloping rate — 54λ , unidirectional scan

Fig 6.23b

Rx 003, azimuth, 54λ , BI-DIR., multipath signal -3dB relative to direct
Direct = $+1^\circ$, multipath = $+5^\circ$, rate of change of scalloping = 0.65Hz/s

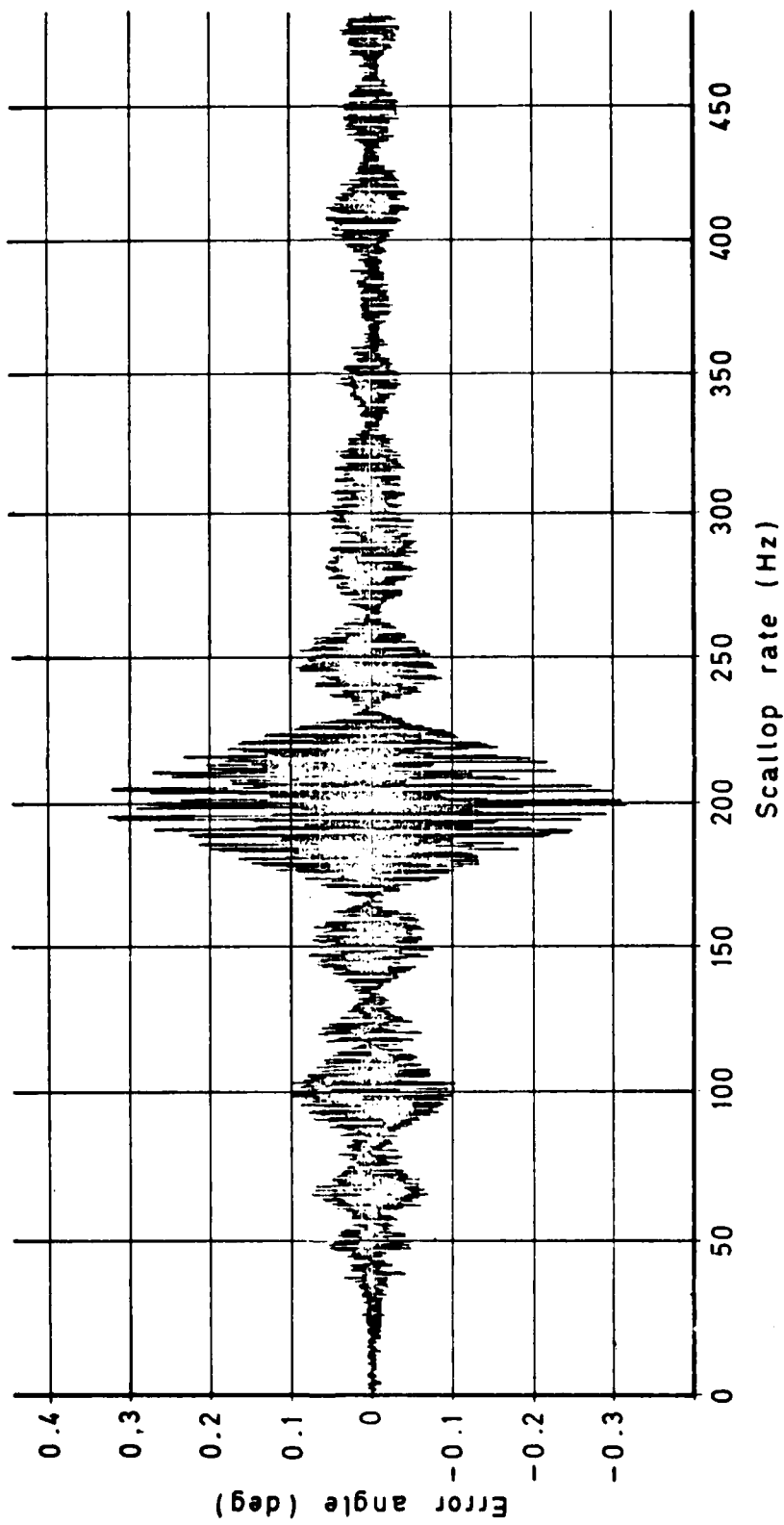


Fig 6.23b Azimuth error as a function of scalloping rate - 54λ , bidirectional scan

Rx 001, azimuth, 54λ , $6^+ 6^-$, multipath signal -3dB relative to direct
Direct = $+1^\circ$, multipath = $+5^\circ$, rate of change of scalloping = 0.65Hz/s

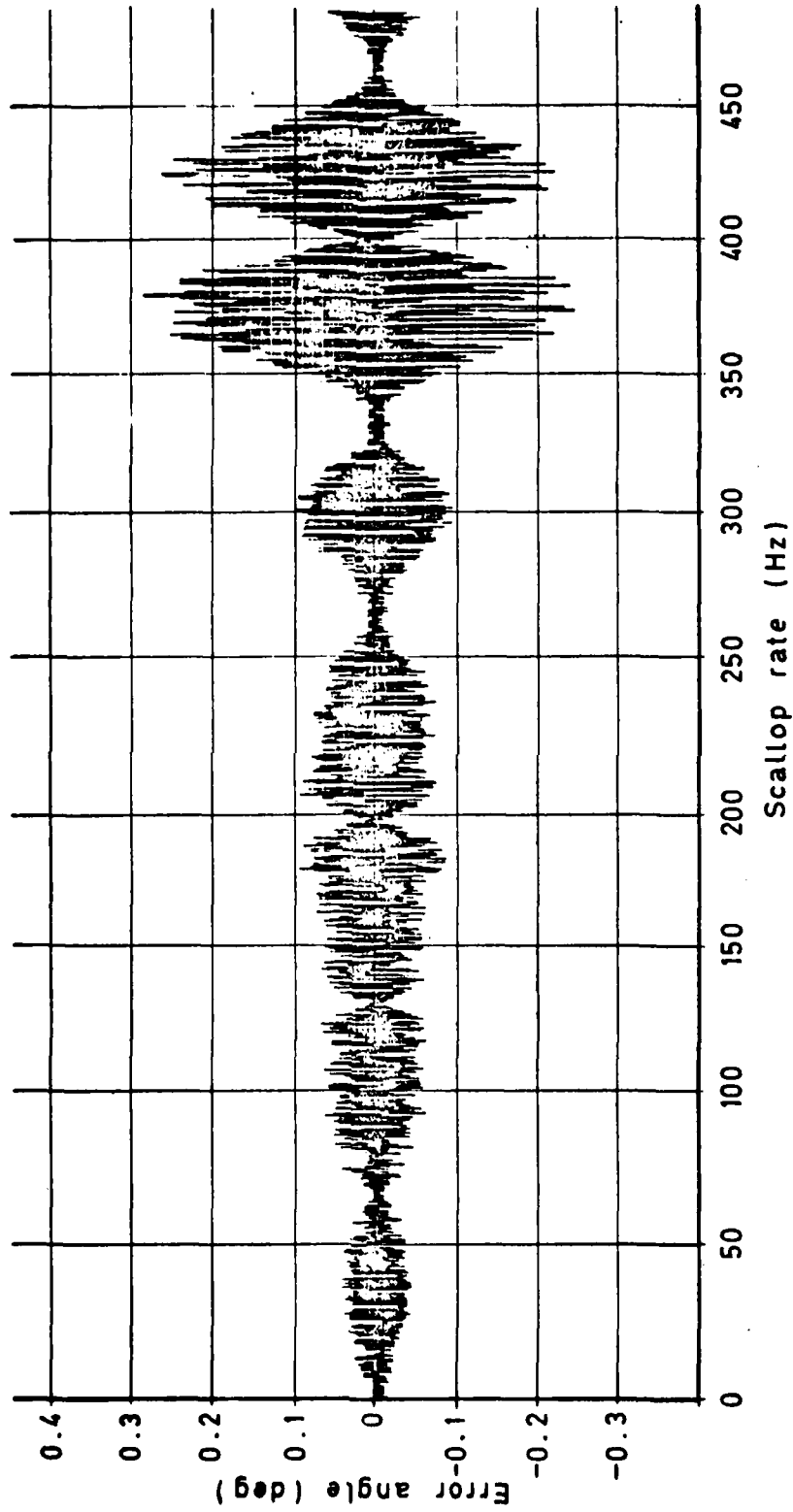


Fig 6.23c Azimuth error as a function of scalloping rate - 54λ , block scan ($6^+ 6^-$)

Fig 6.24

Rx 003, azimuth, 54λ , $6^+ 6^-$, multipath signal -3dB relative to direct
Direct = $+1^\circ$, multipath = $+5^\circ$, rate of change of scalloping = 0.65Hz/s

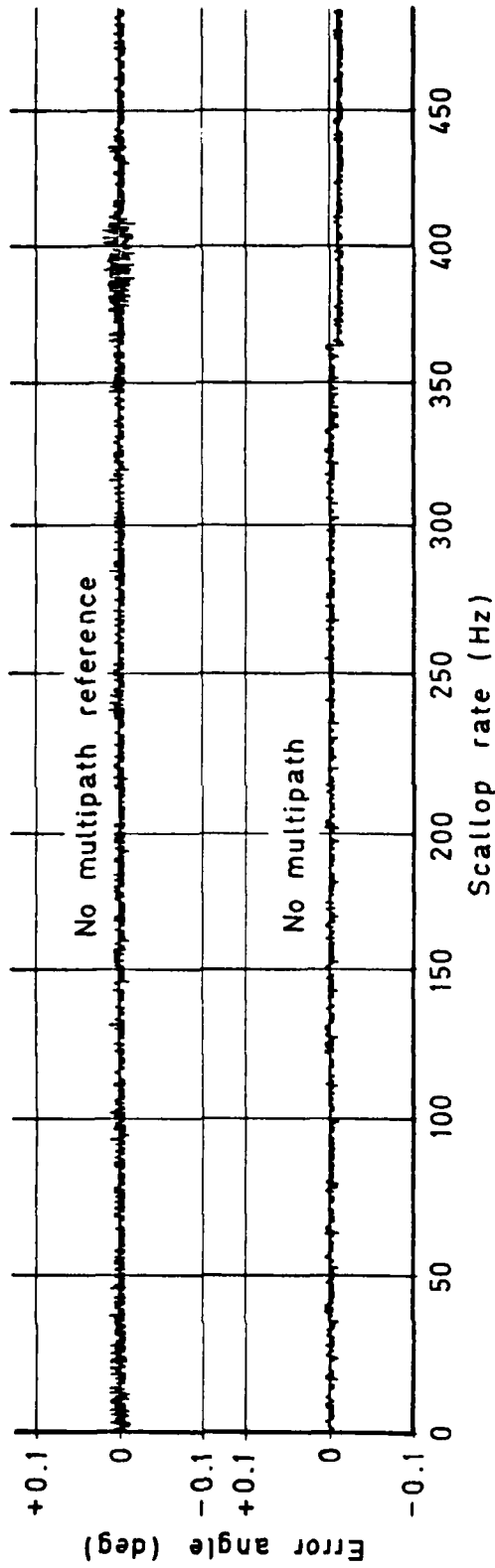


Fig 6.24 Azimuth error as a function of scalloping rate — 54λ , block scan

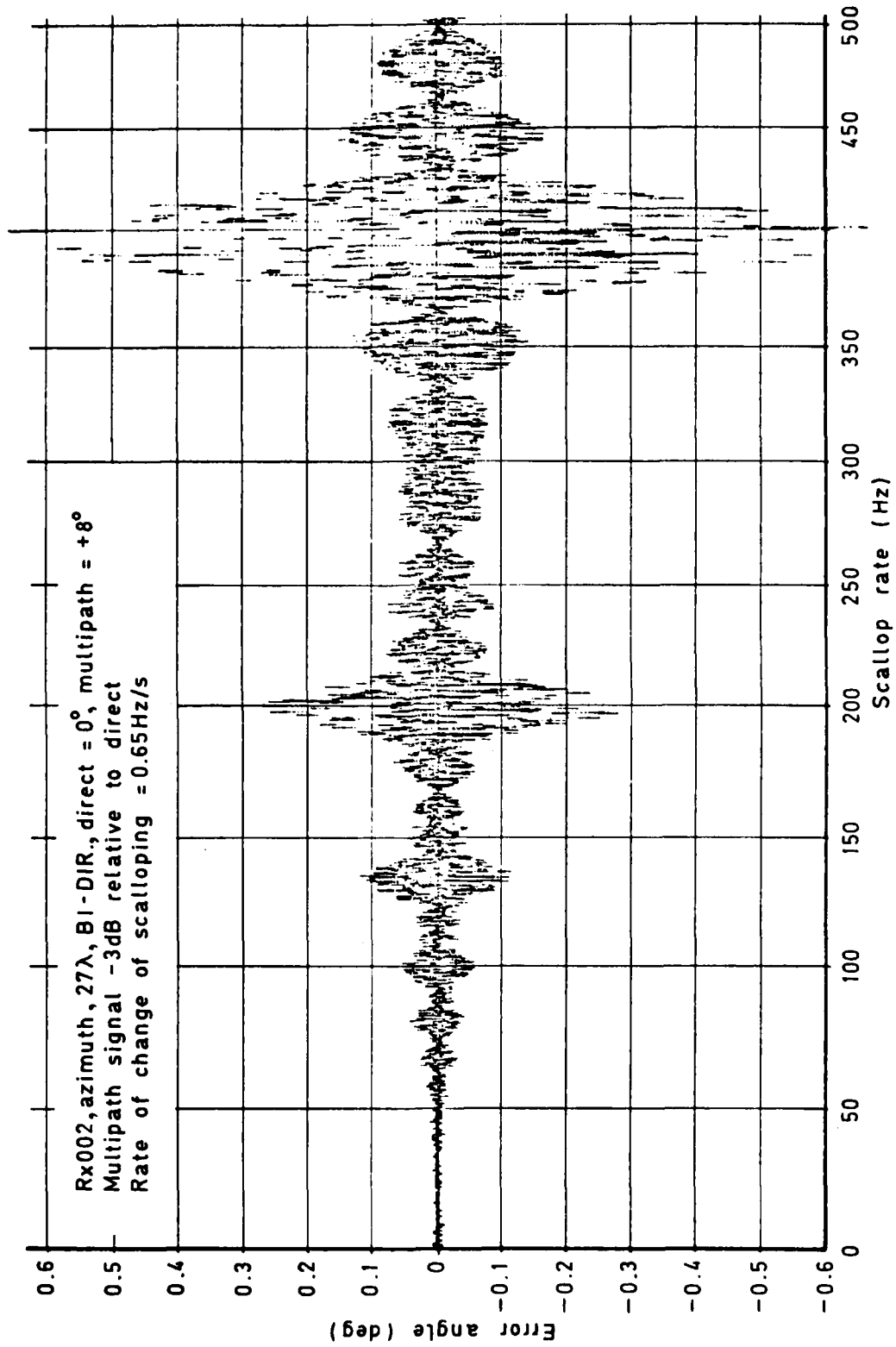


Fig 6.25a

Fig 6.25a Azimuth error as a function of scalloping rate - 27λ , bidirectional scan

Fig 6.25b

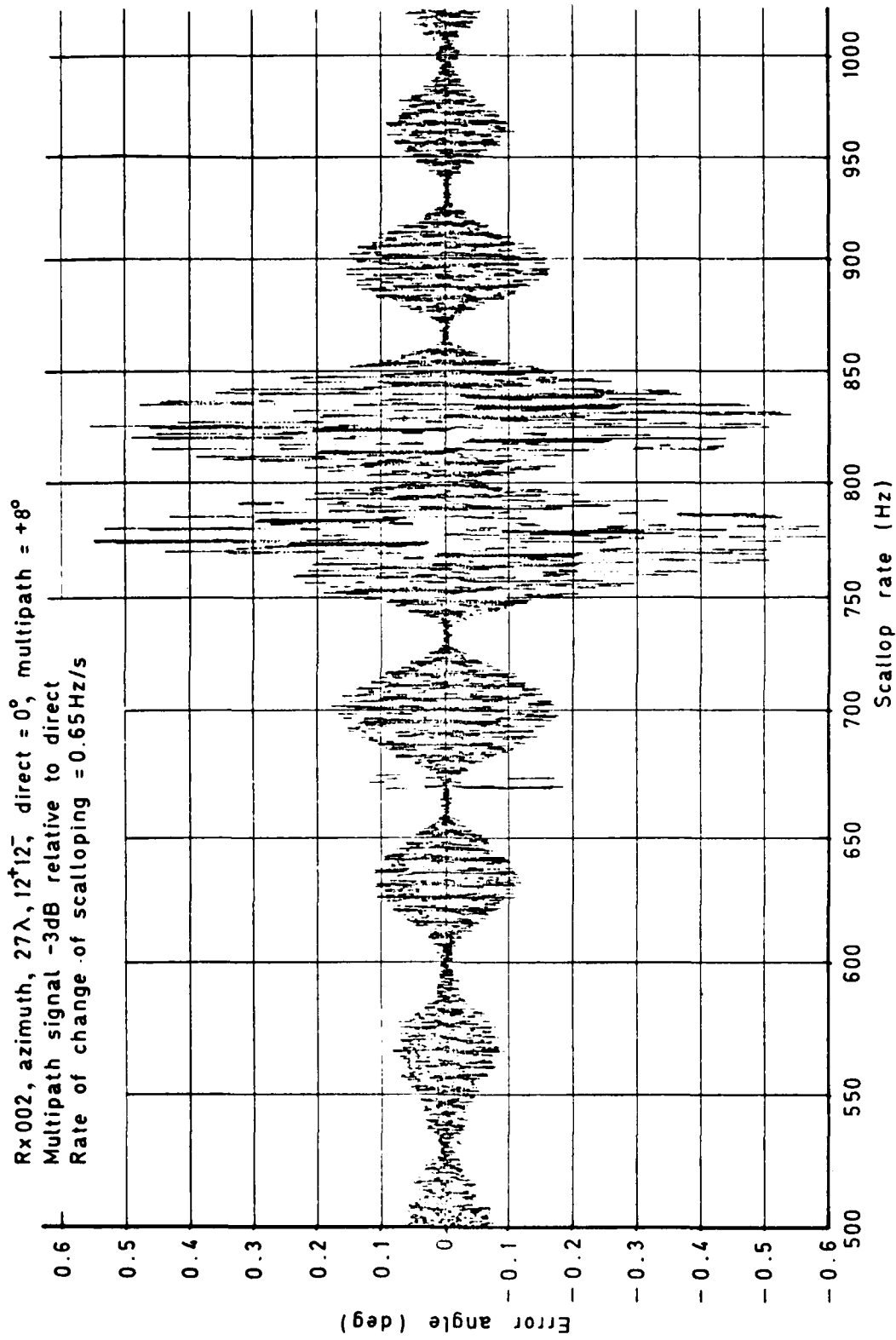


Fig 6.25b Azimuth error as a function of scalloping rate - 27λ , block scan ($12^\circ 12'$)

Rx 003, azimuth, 54λ , $6^+ 6^-$, multipath signal -3dB relative to direct
Direct = $+1^\circ$, multipath = $+5^\circ$, rate of change of scalloping = 26Hz/s

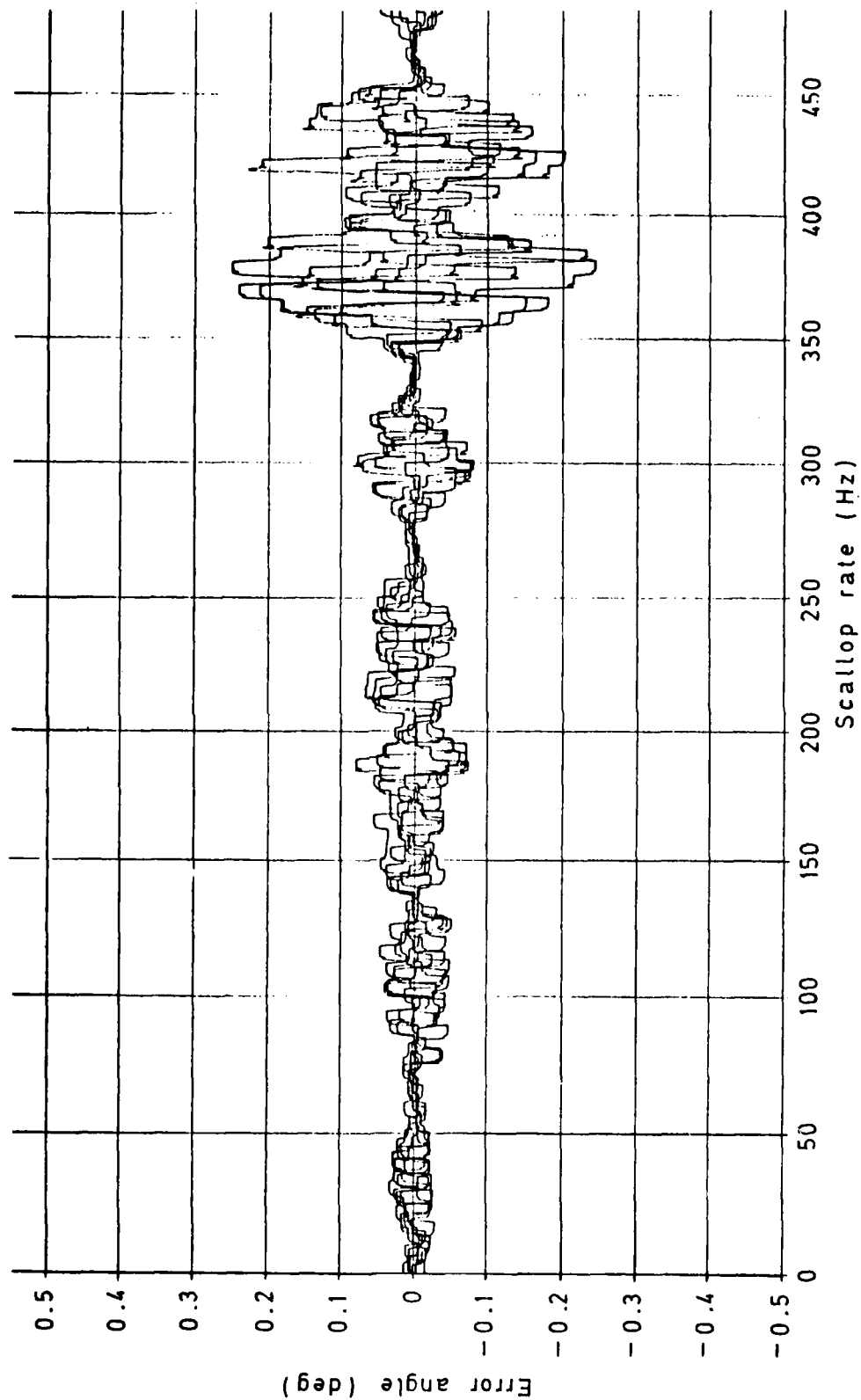


Fig 6.26

Fig 6.26 Azimuth error as a function of scalloping rate - 54λ , $6^+ 6^-$ scan, high rate of change

Fig 6.27a

Rx 001, elevation, 54λ , 20° to 20° , multipath signal -3dB relative to direct
Direct = $+3^{\circ}$, multipath = $+2^{\circ}$, rate of change of scalloping = 0.65Hz/s

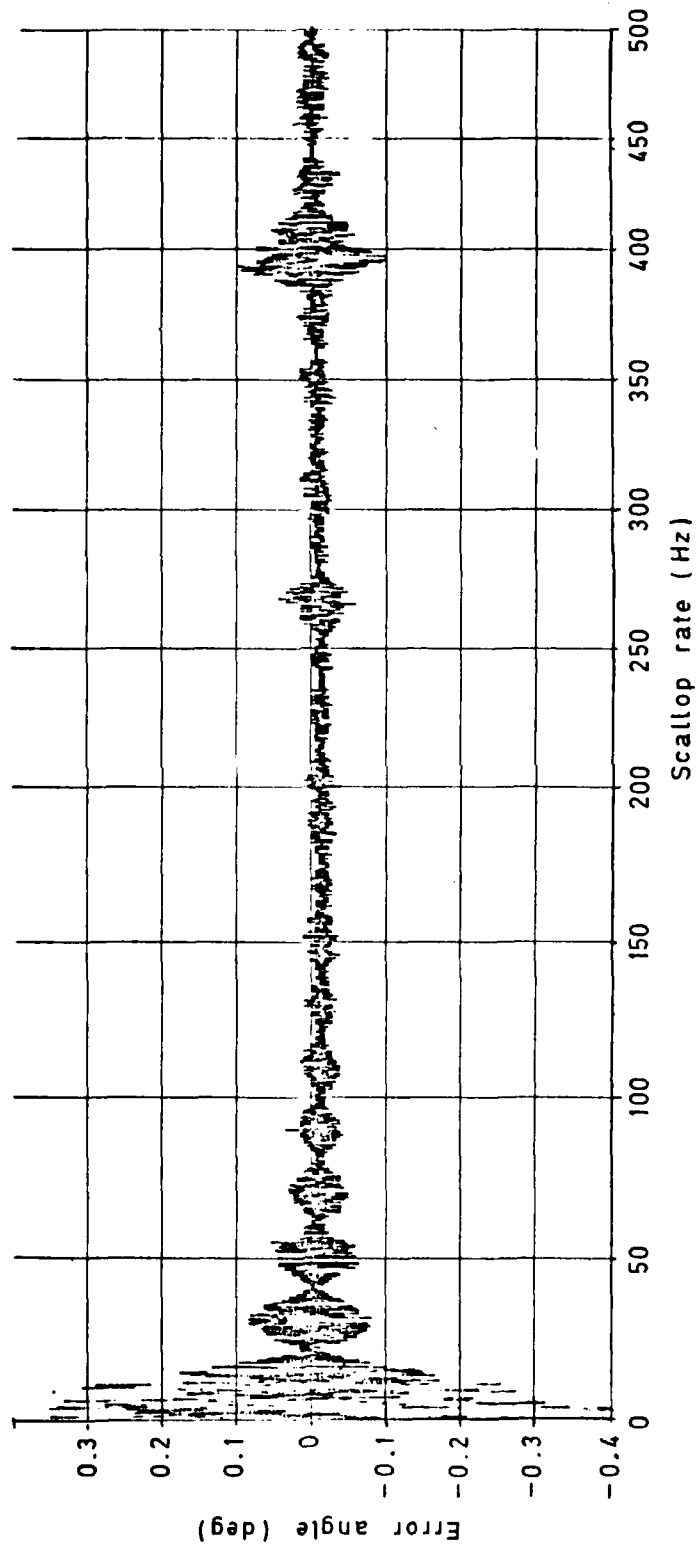


Fig 6.27a Elevation error as a function of scalloping rate - 54λ , block scan (20° to 20°)

Rx 001, elevation, 54λ , $20^+ 20^-$, multipath signal level -3dB relative to direct
Direct = $+3^\circ$, multipath = $+2^\circ$, rate of change of scalloping = 0.65Hz/s

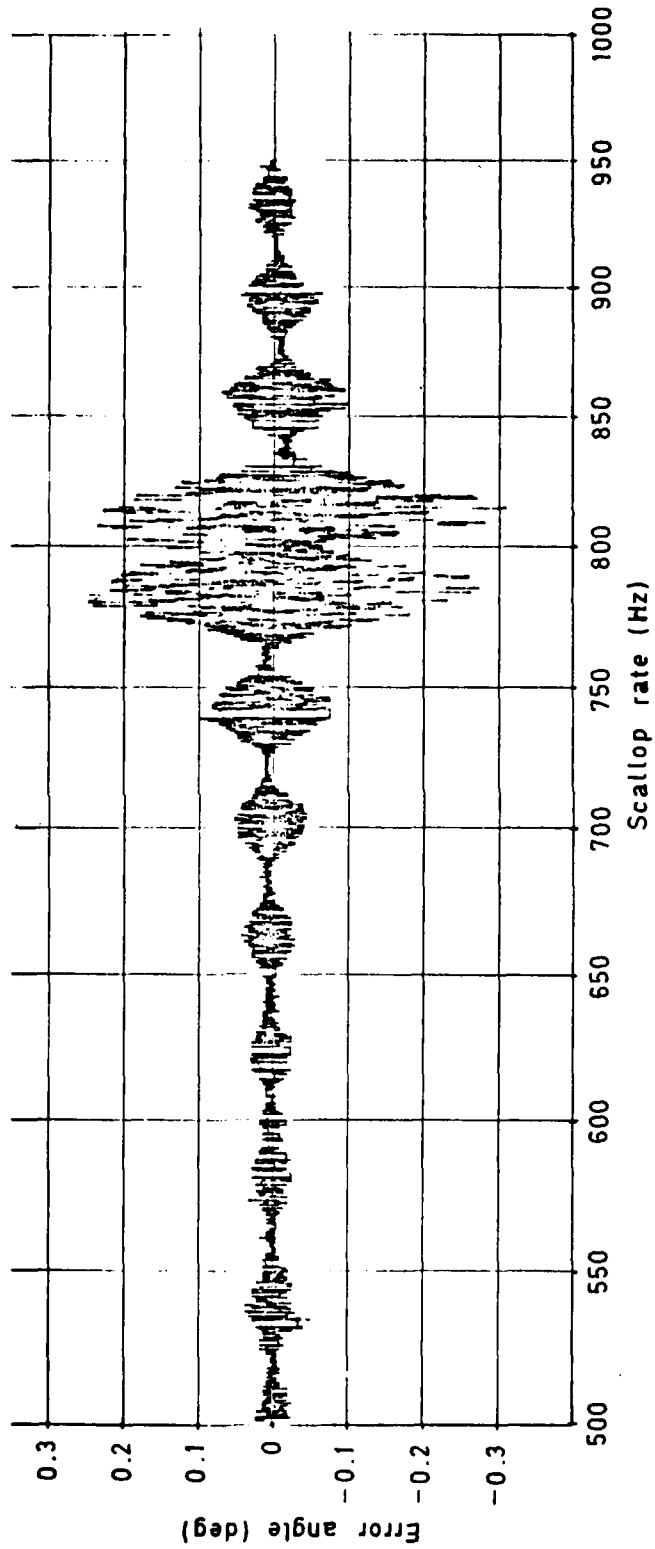


Fig 6.27b

Fig 6.27b Elevation error as a function of scalloping rate - 54λ , block scan ($20^+ -$)

Fig 6.28a

Rx001, elevation, 54λ , $20^+ 20^-$, multipath signal level -3dB relative to direct
Direct = $+3^\circ$, multipath = $+2^\circ$, rate of change of scalloping = 0.65 Hz/s
No multipath reference

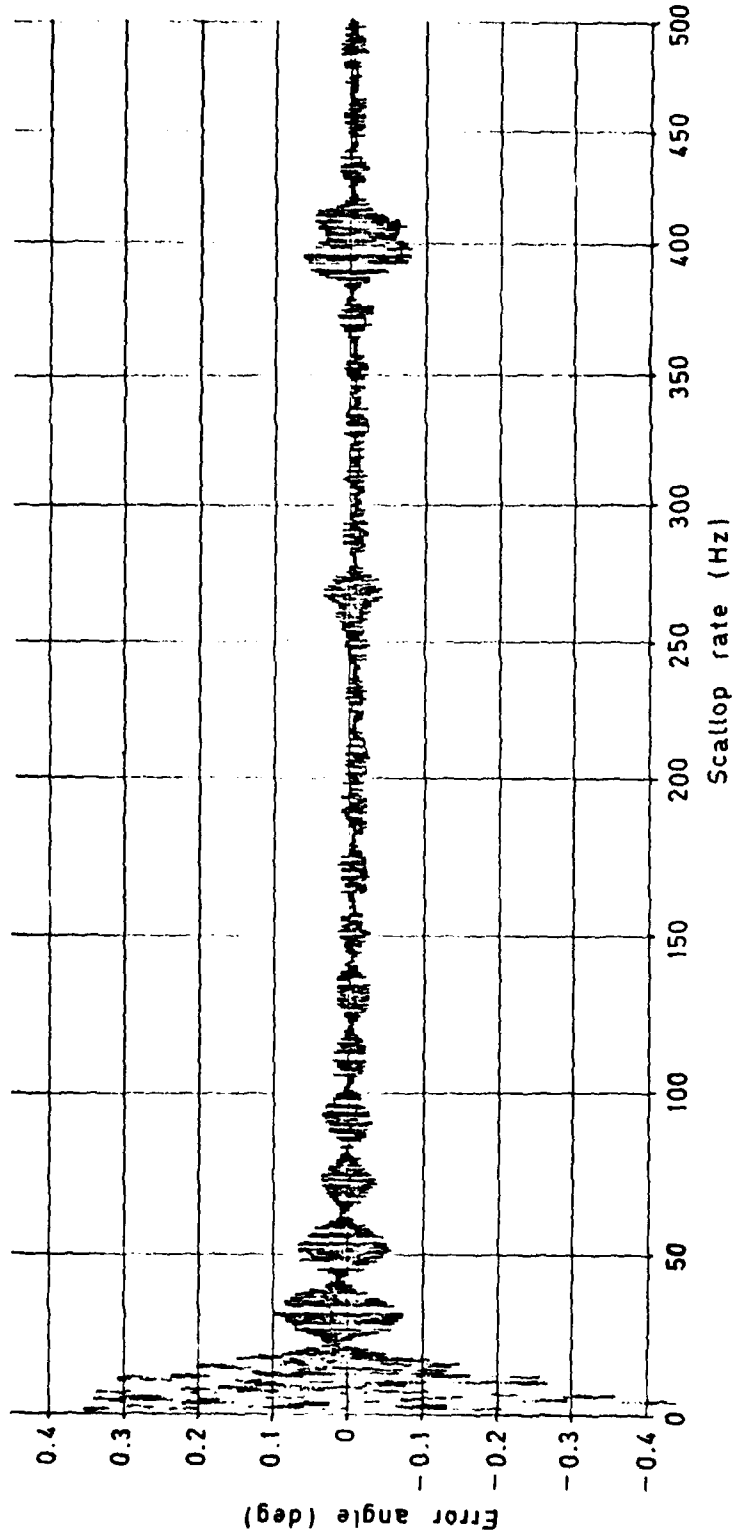


Fig 6.28a Elevation error as a function of scalloping rate - 54λ , block scan ($20^+ -$),
no multipath reference

Rx 001, elevation, 54λ , $20^+ 20^-$, multipath signal -3dB relative to direct
Direct = $+3^\circ$, multipath = $+2^\circ$, rate of change of scalloping = 0.65 Hz/s
No multipath reference

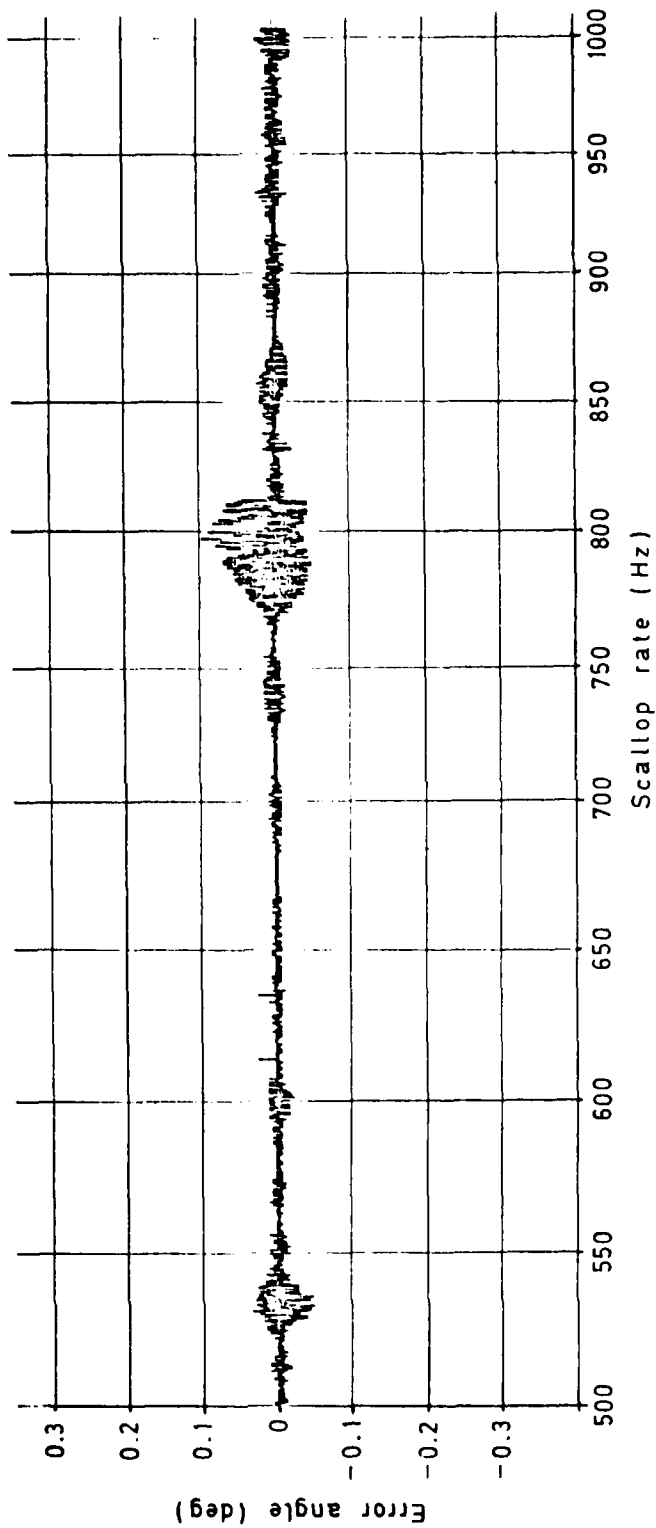


Fig 6.28b

Fig 6.28b Elevation error as a function of scalloping rate - 54λ , block scan ($20^+ 20^-$), no multipath reference

Fig 6.29

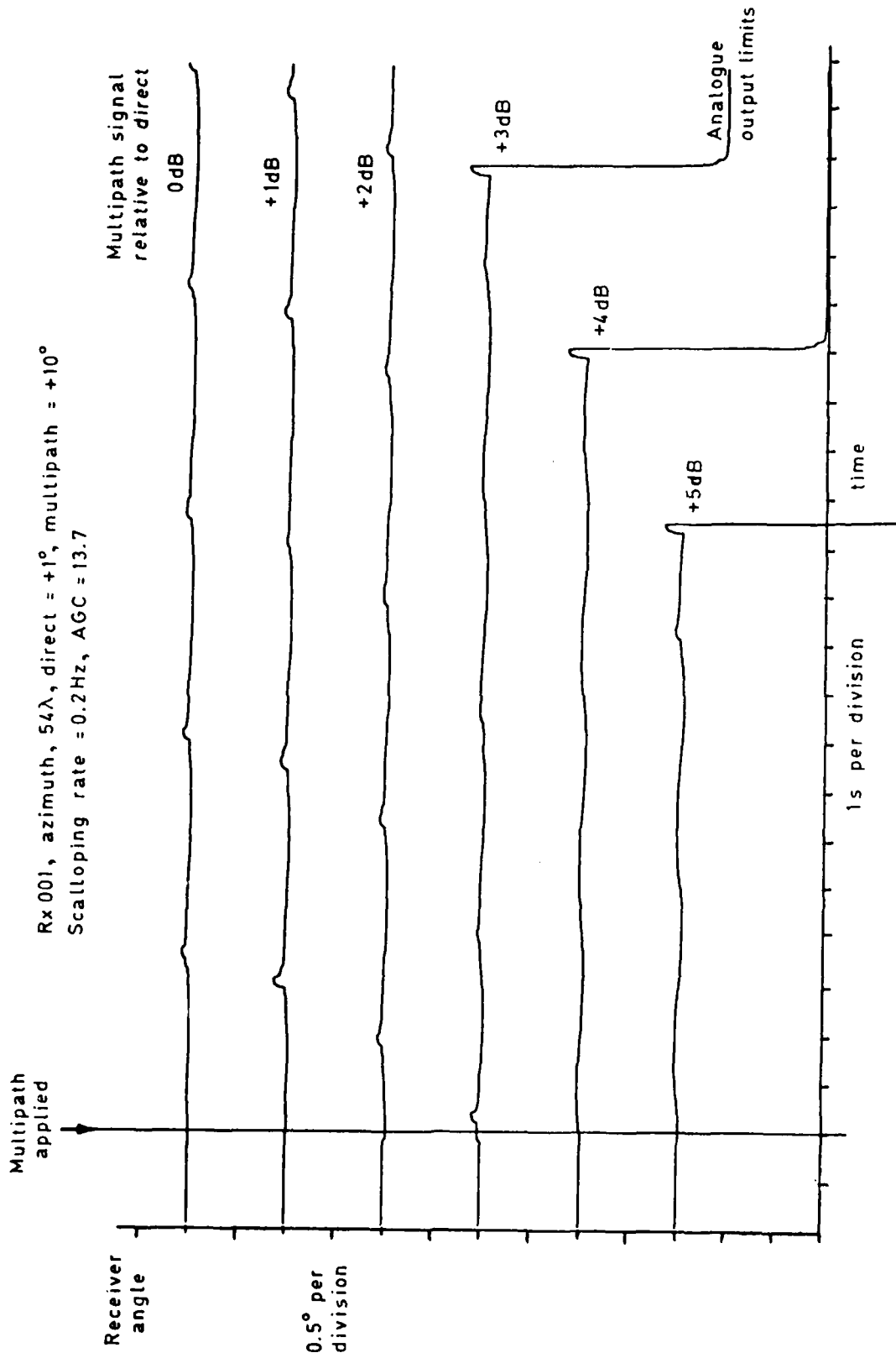


Fig 6.29 Multipath acquisition as a function of relative signal level — low scallop rate

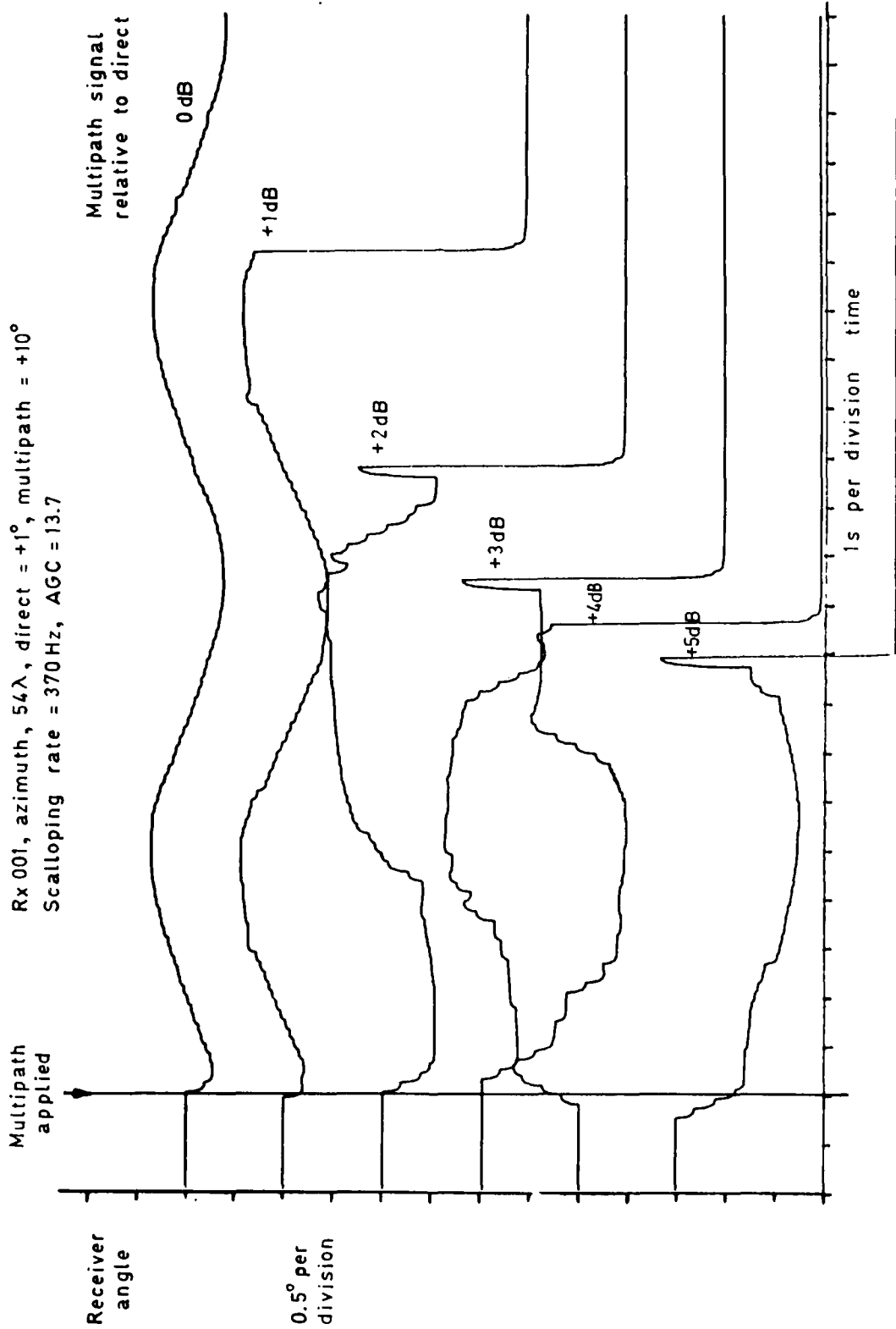


Fig 6.30

Fig 6.30 Multipath acquisition as a function of relative signal level — high scallop rate

Fig 6.31

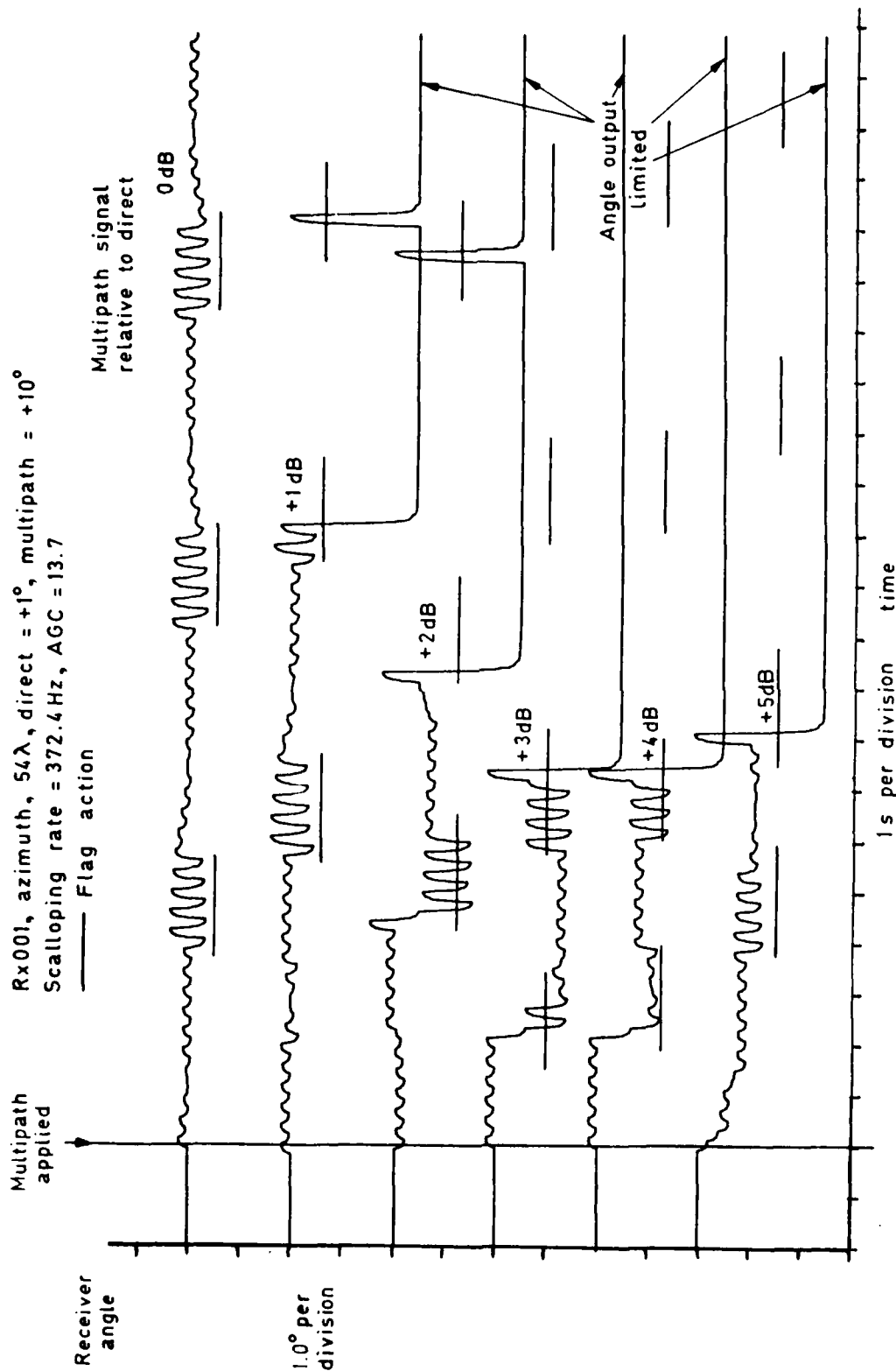


Fig 6.31 Multipath acquisition as a function of relative signal level — high scallop rate

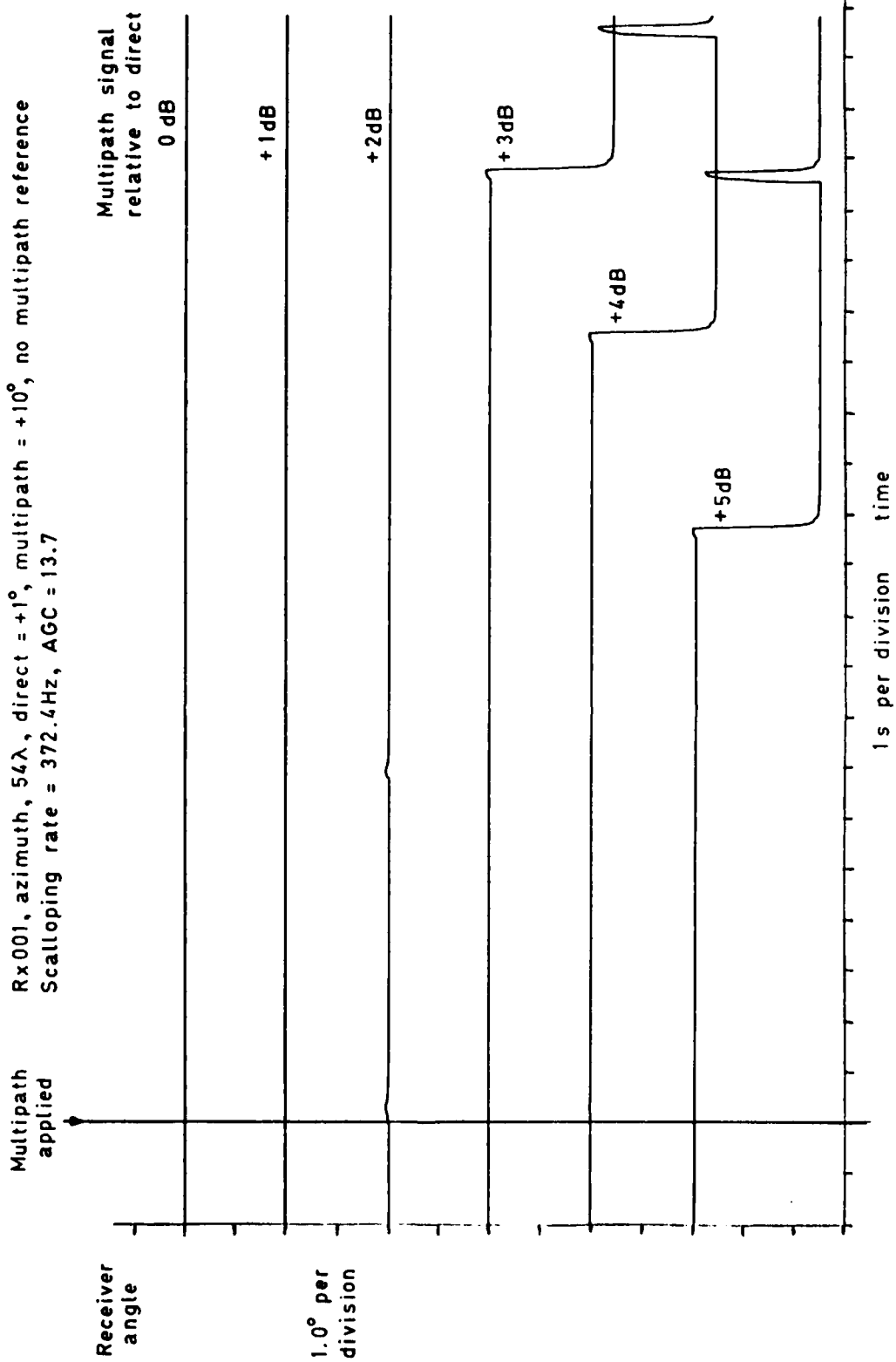


Fig 6.32

Fig 6.32 Multipath acquisition as a function of relative signal level — high scallop rate, no multipath reference

Fig 6.33

Rx.001, azimuth, 54λ , direct = $+1^\circ$, multipath = $+10^\circ$
Scalloping rate = 0.2Hz, AGC = 13.7

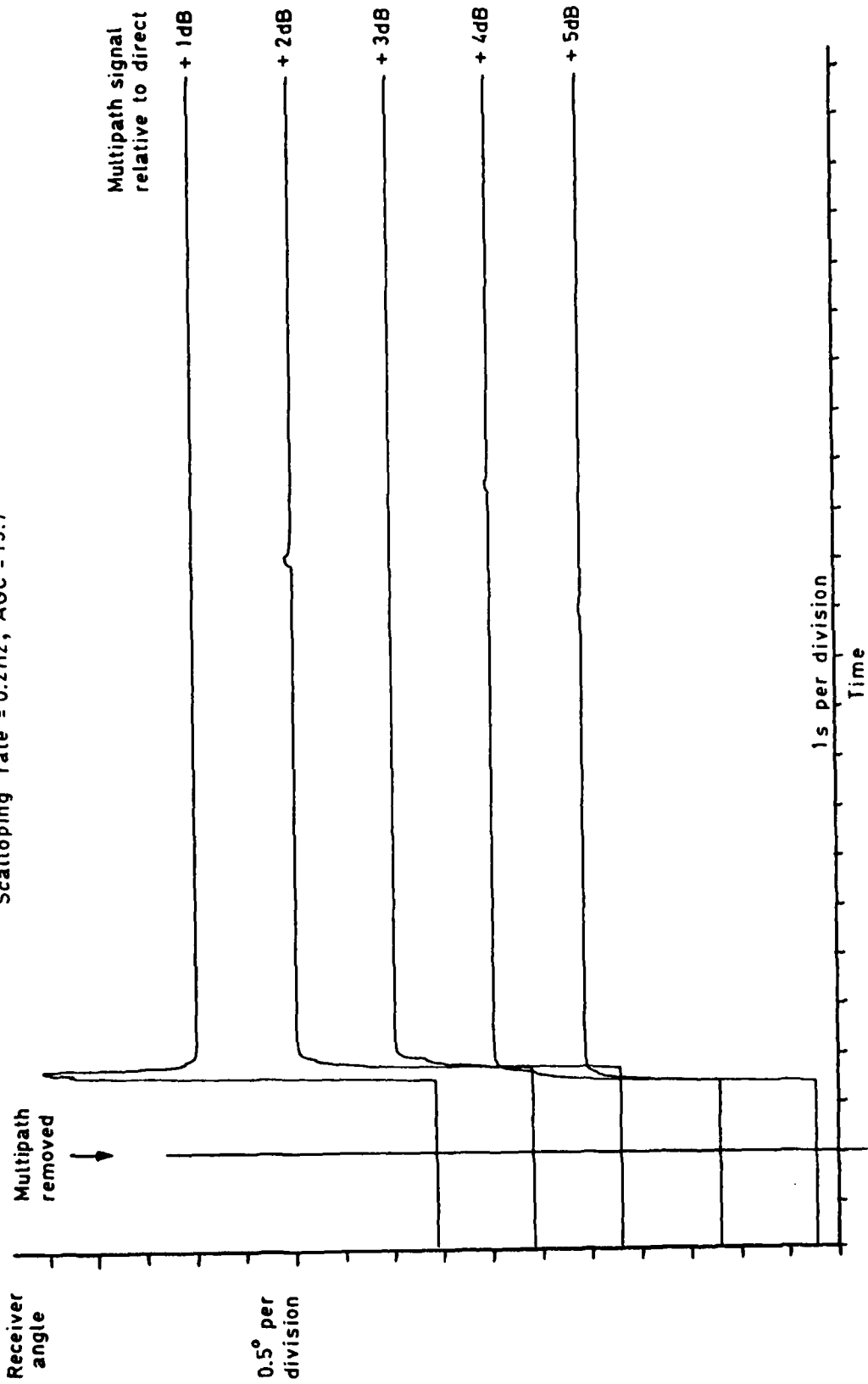


Fig 6.33 Signal reacquisition as a function of relative multipath level

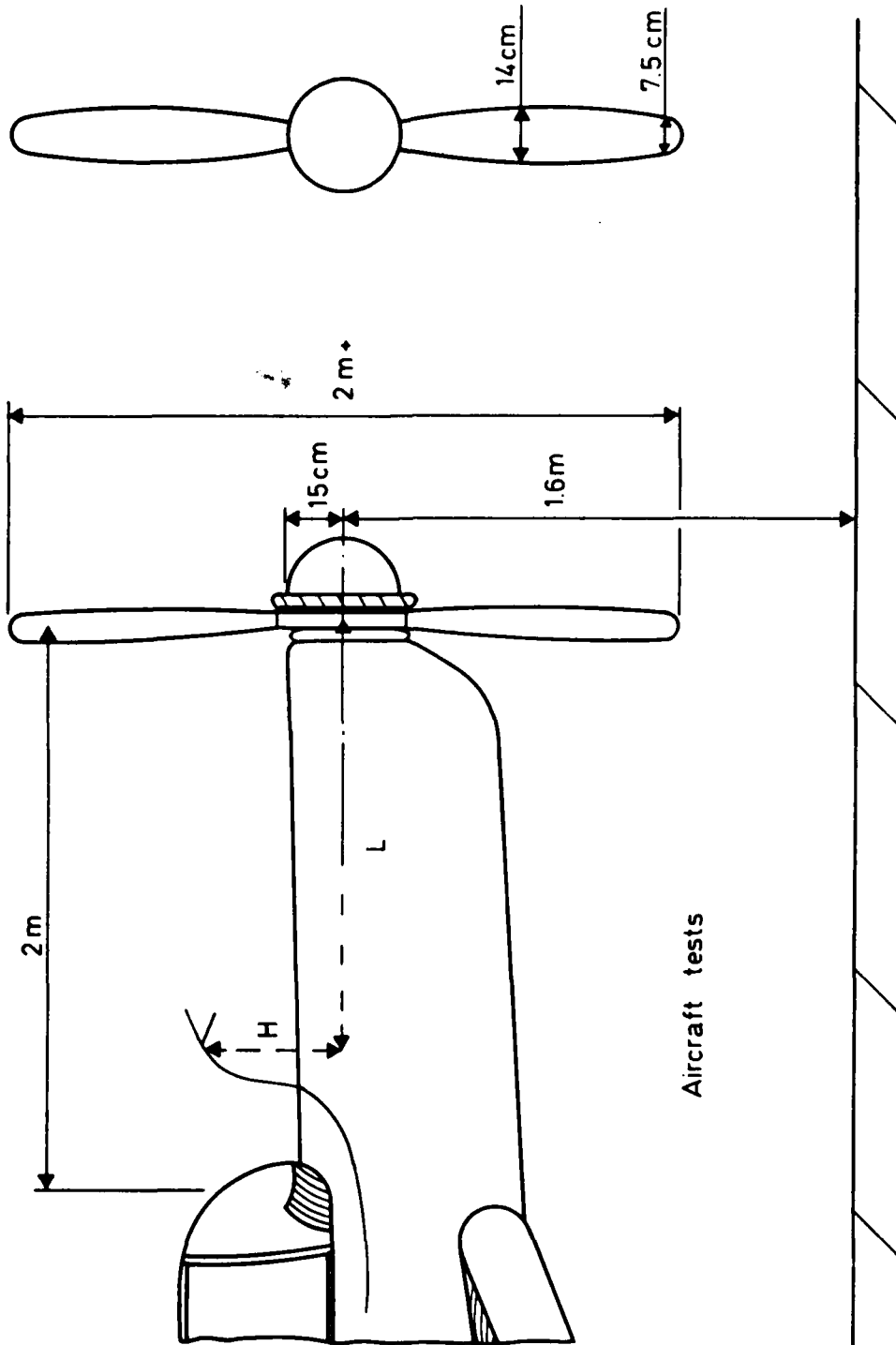


Fig 6.34

Fig 6.34 Geometry of aircraft propeller tests

Fig 6.35

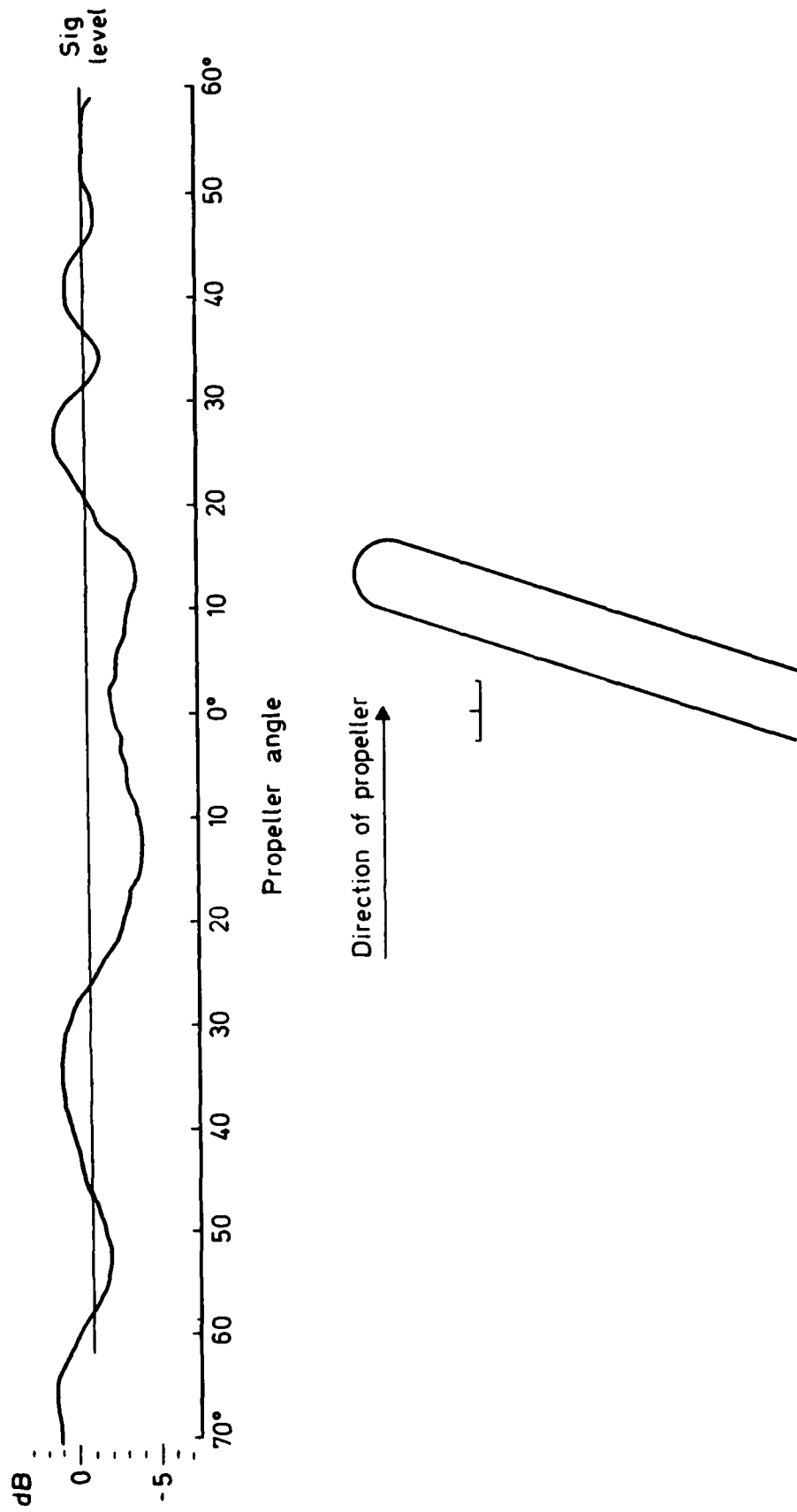


Fig 6.35 Aircraft propeller effects — monopole antenna, $L = 28.3\lambda$, $H = 10\lambda$

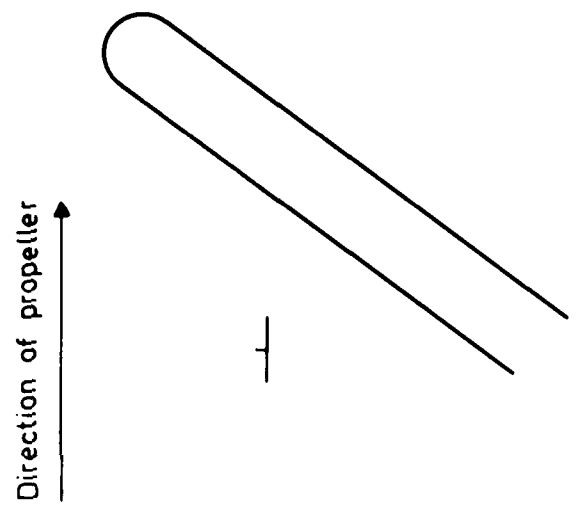
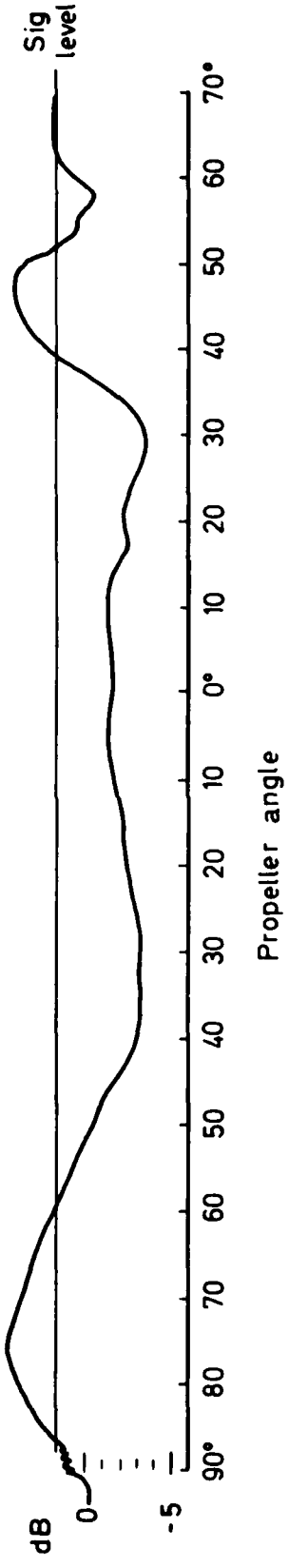


Fig 6.36 Aircraft propeller effects — monopole antenna, $L = 28.3\lambda$, $H = 5\lambda$

Fig 6.37

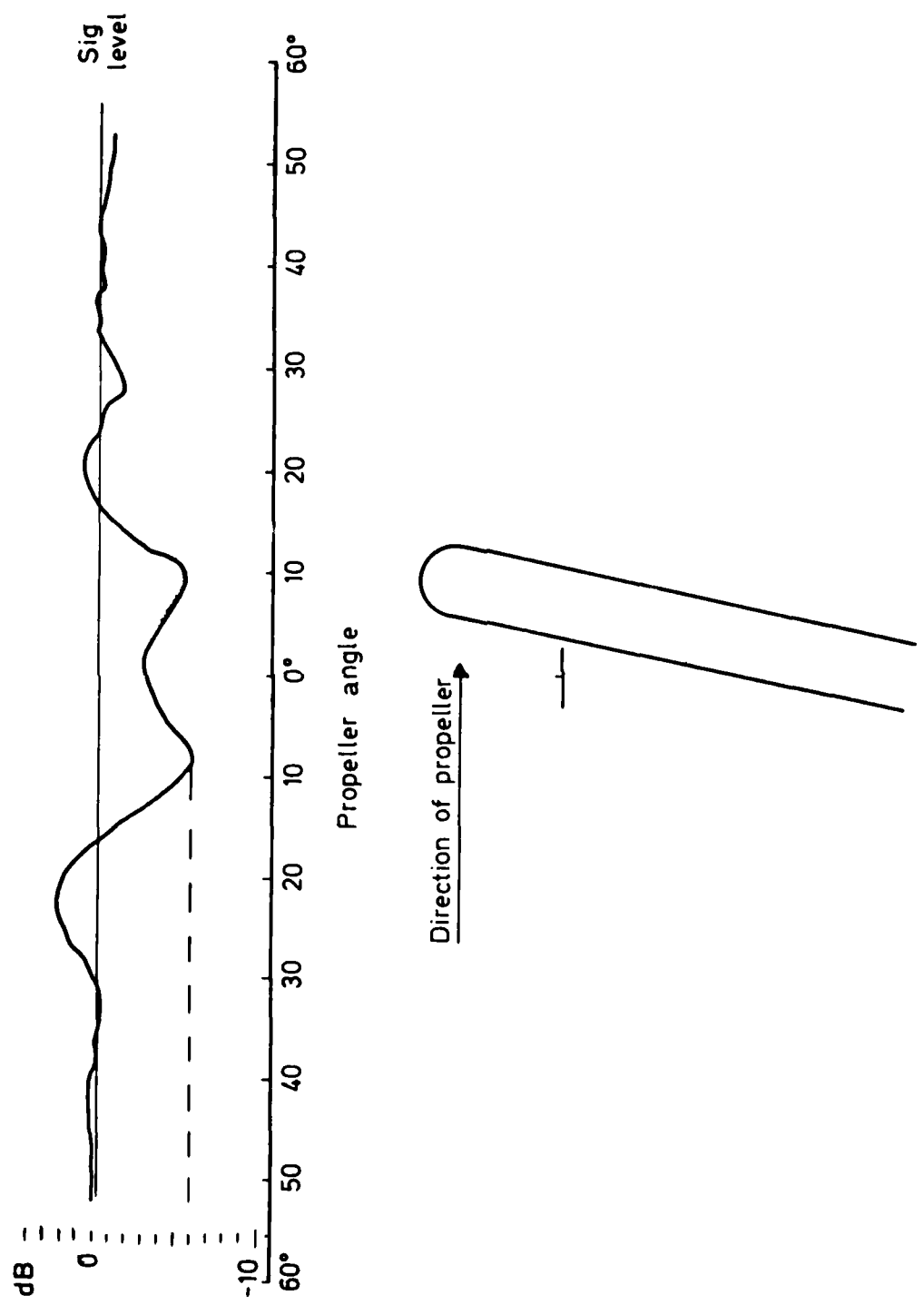


Fig 6.37 Aircraft propeller effects — monopole antenna, $L = 16.6\lambda$, $H = 10\lambda$

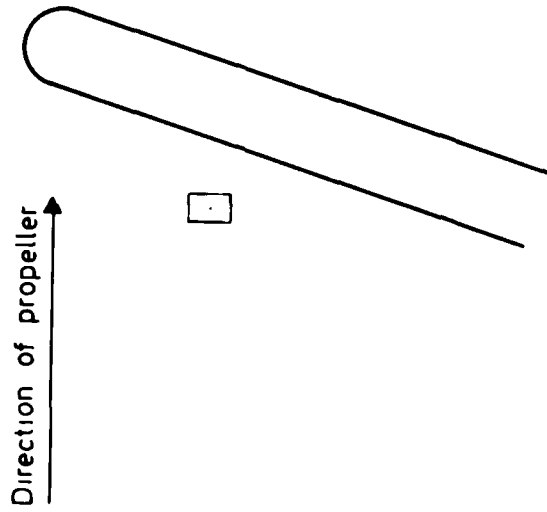
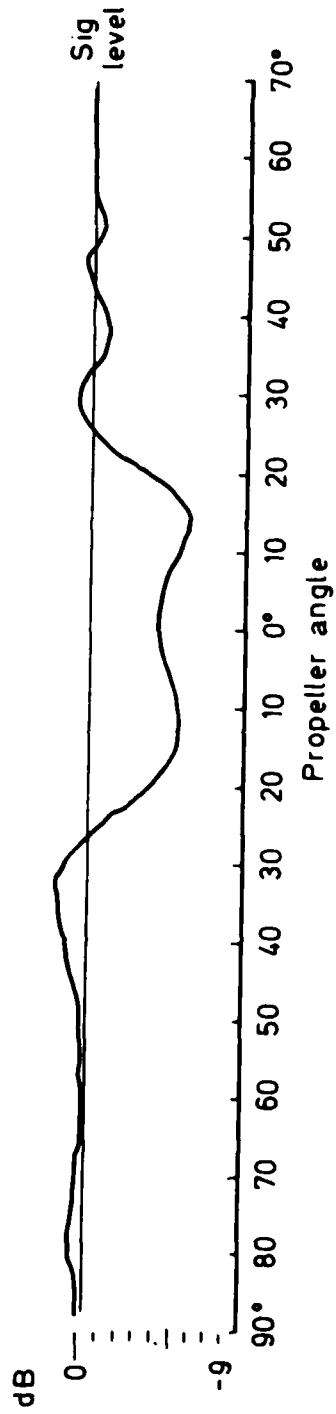
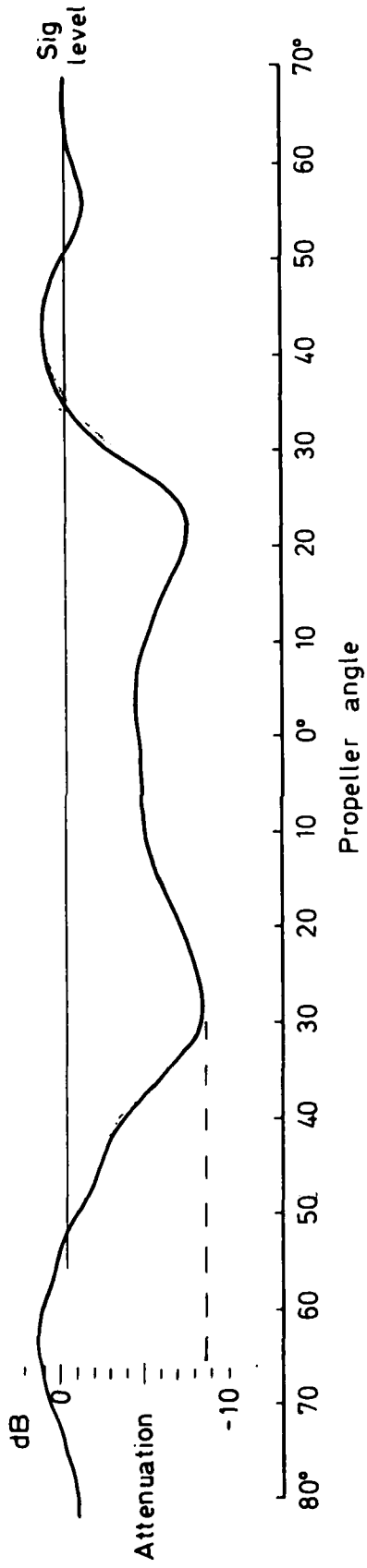


Fig 6.38 Aircraft propeller effects - small horn antenna, $L = 16.6\lambda$, $H = 10\lambda$

Fig 6.39



Direction of propeller →

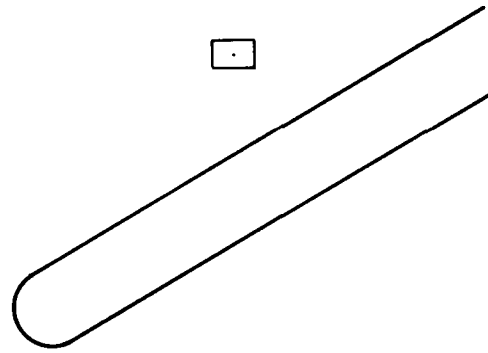


Fig 6.39 Aircraft propeller effects - small horn antenna, $L = 16.6\lambda$, $H = 5\lambda$

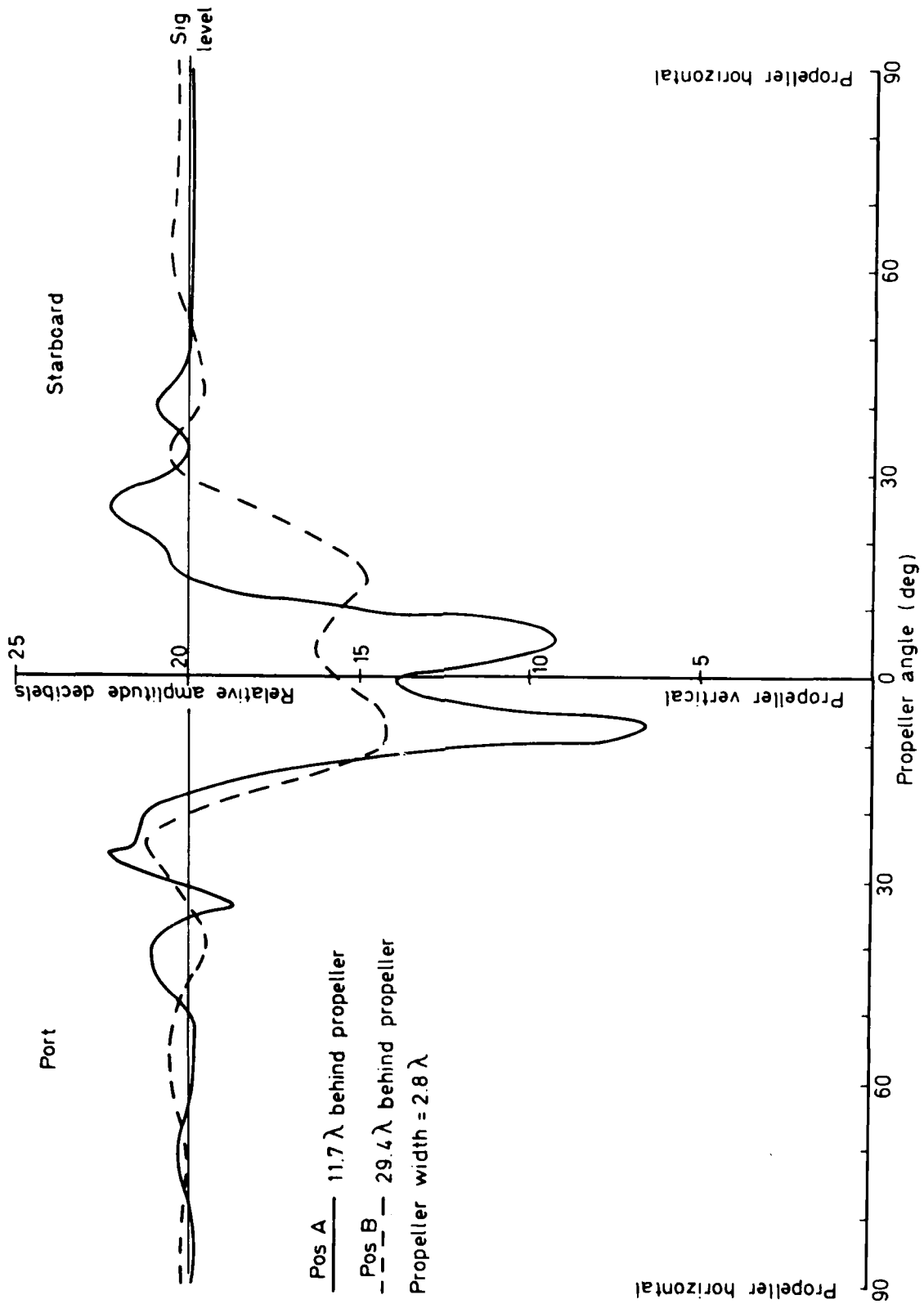


Fig 6.40

Fig 6.40 Aircraft propeller effects — FAA data

Fig 6.41

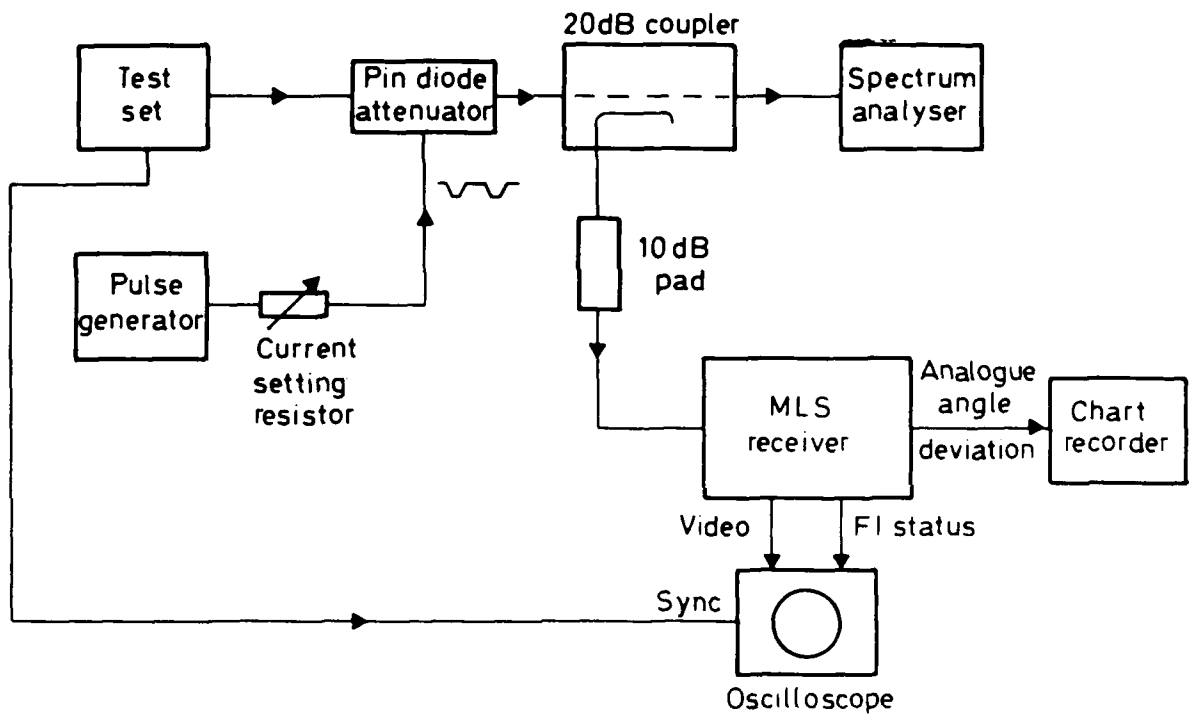


Fig 6.41 Experimental arrangement for propeller modulation simulation

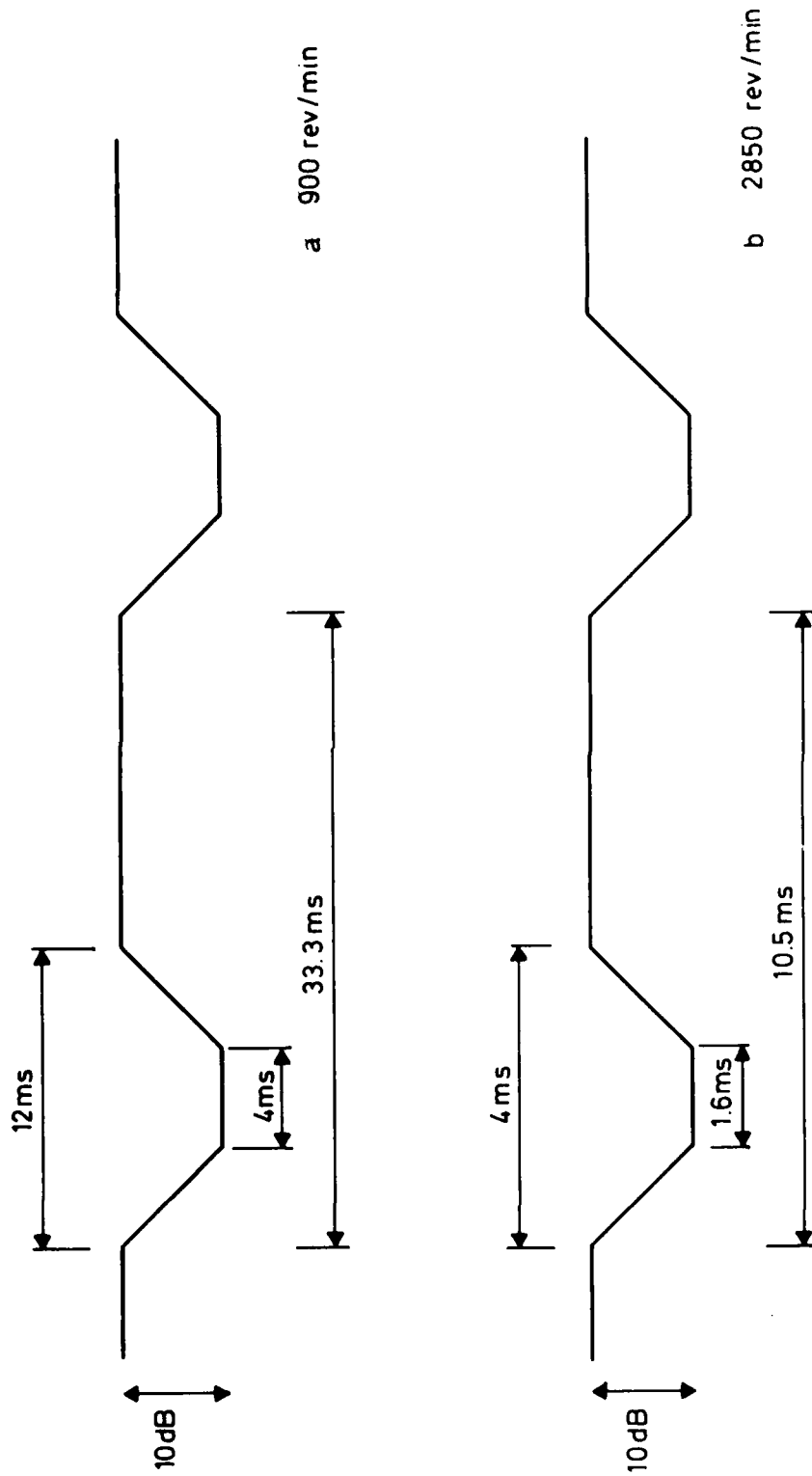


Fig 6.42 Propeller modulation waveforms – simulated two blade propeller

Fig 6.43

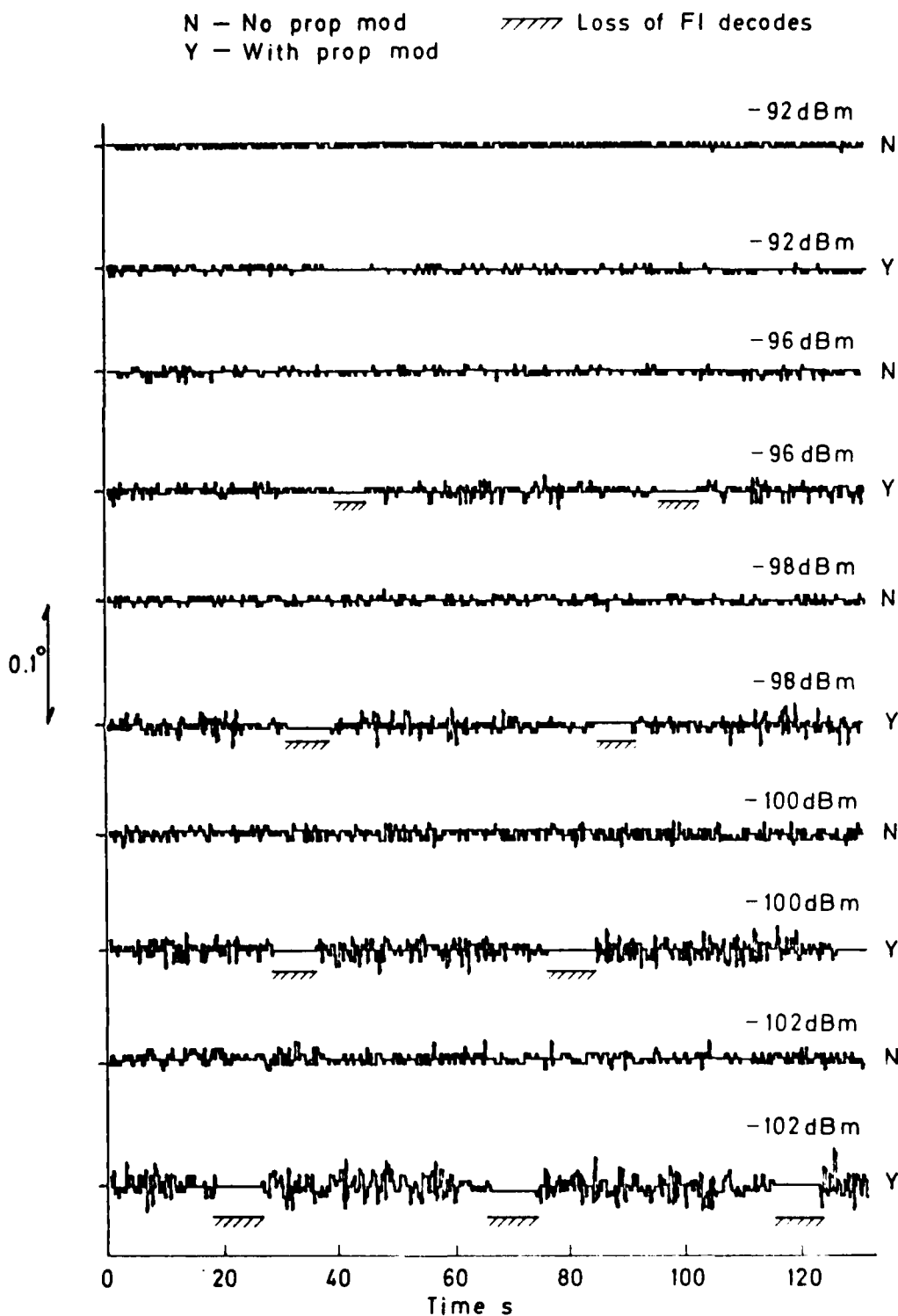


Fig 6.43 Typical effects of propeller modulation with max attenuation of -10 dB

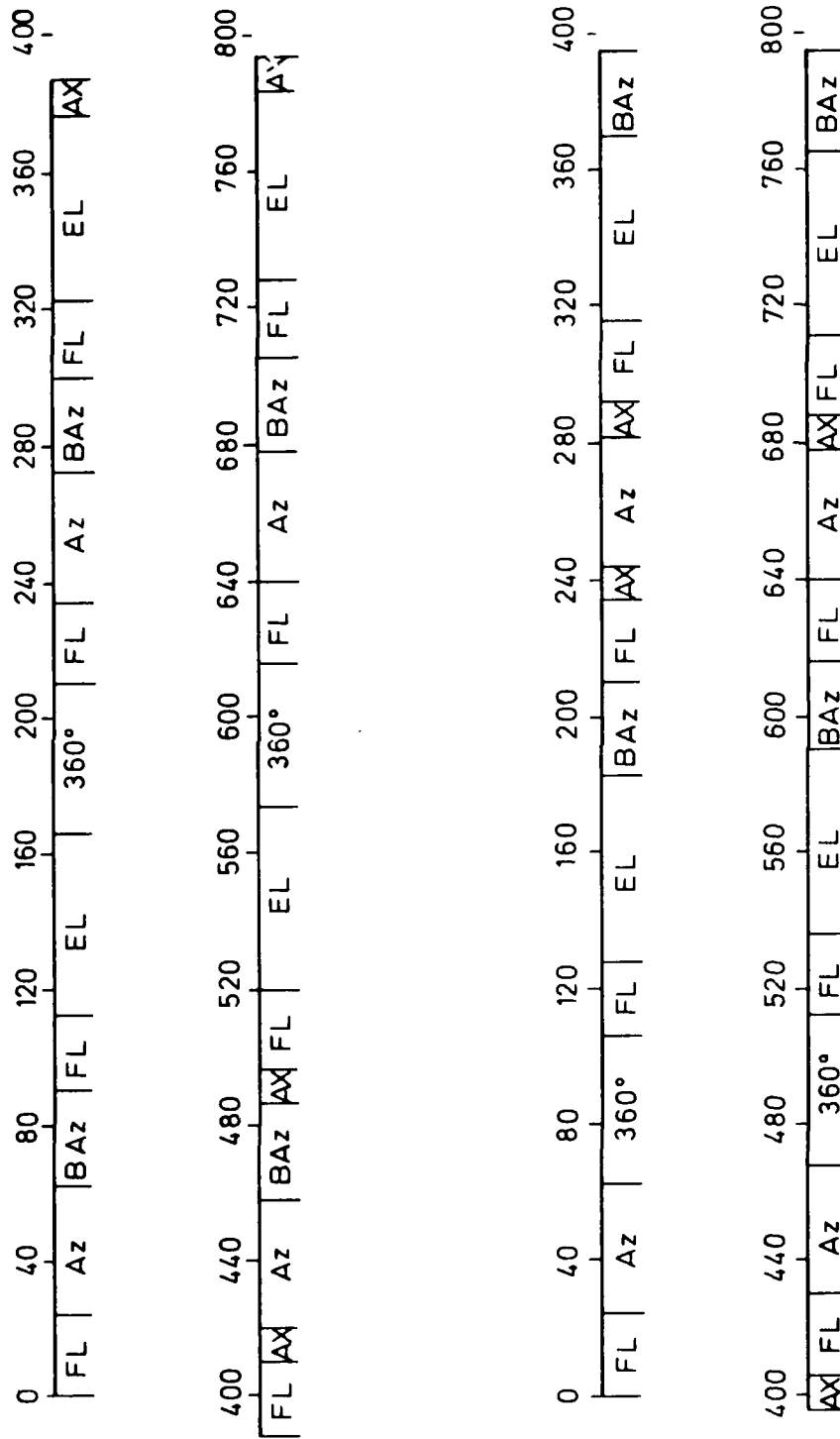


Fig 6.44

Fig 6.44 Typical DMLS formats with 360° azimuth and jitter

Fig 7.1

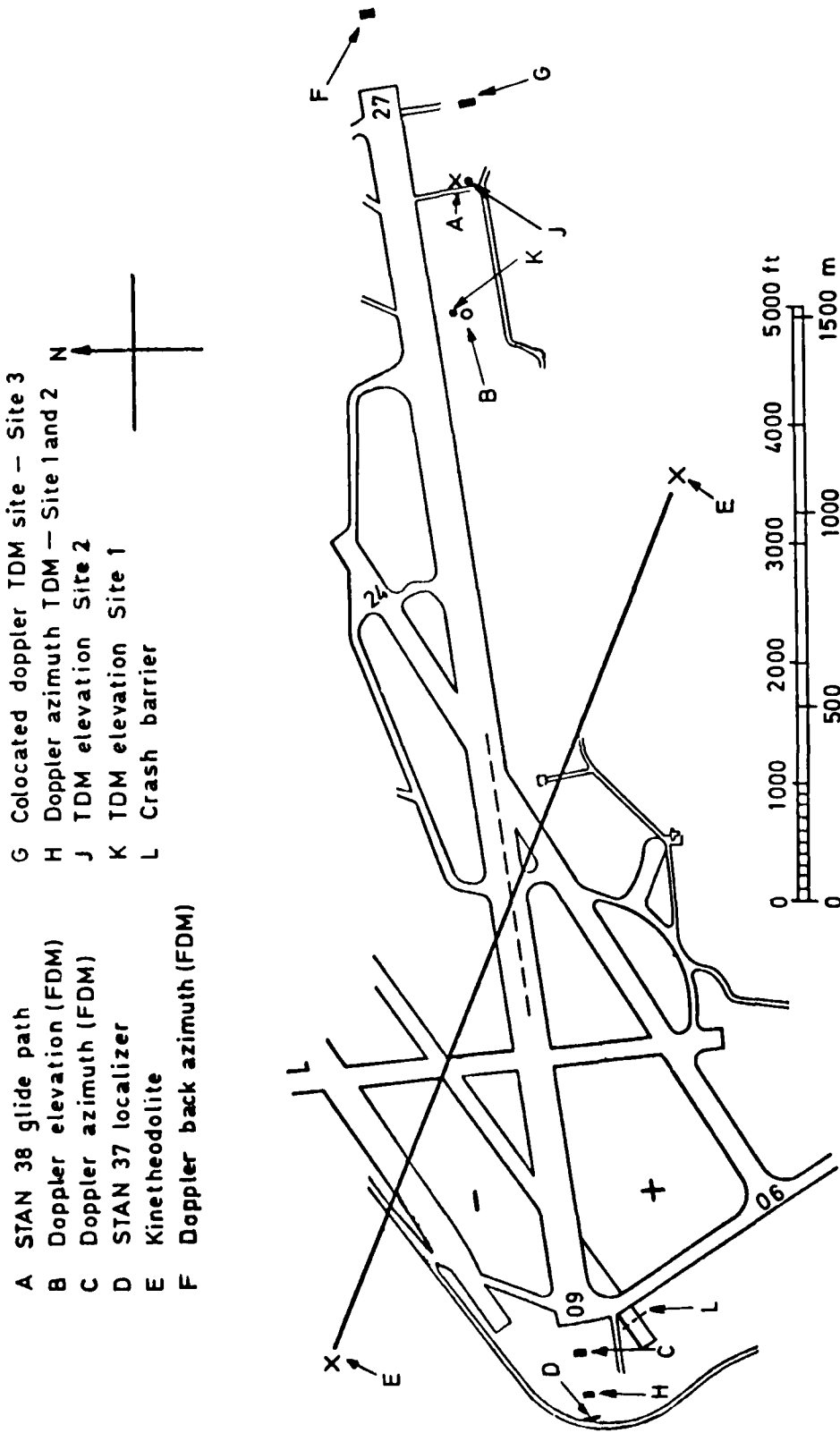


Fig 7.1 TDM equipment positions - Bedford airfield

TR 79052

CLYDE S. P. 3-14-75 20:05/75

RECEIVED

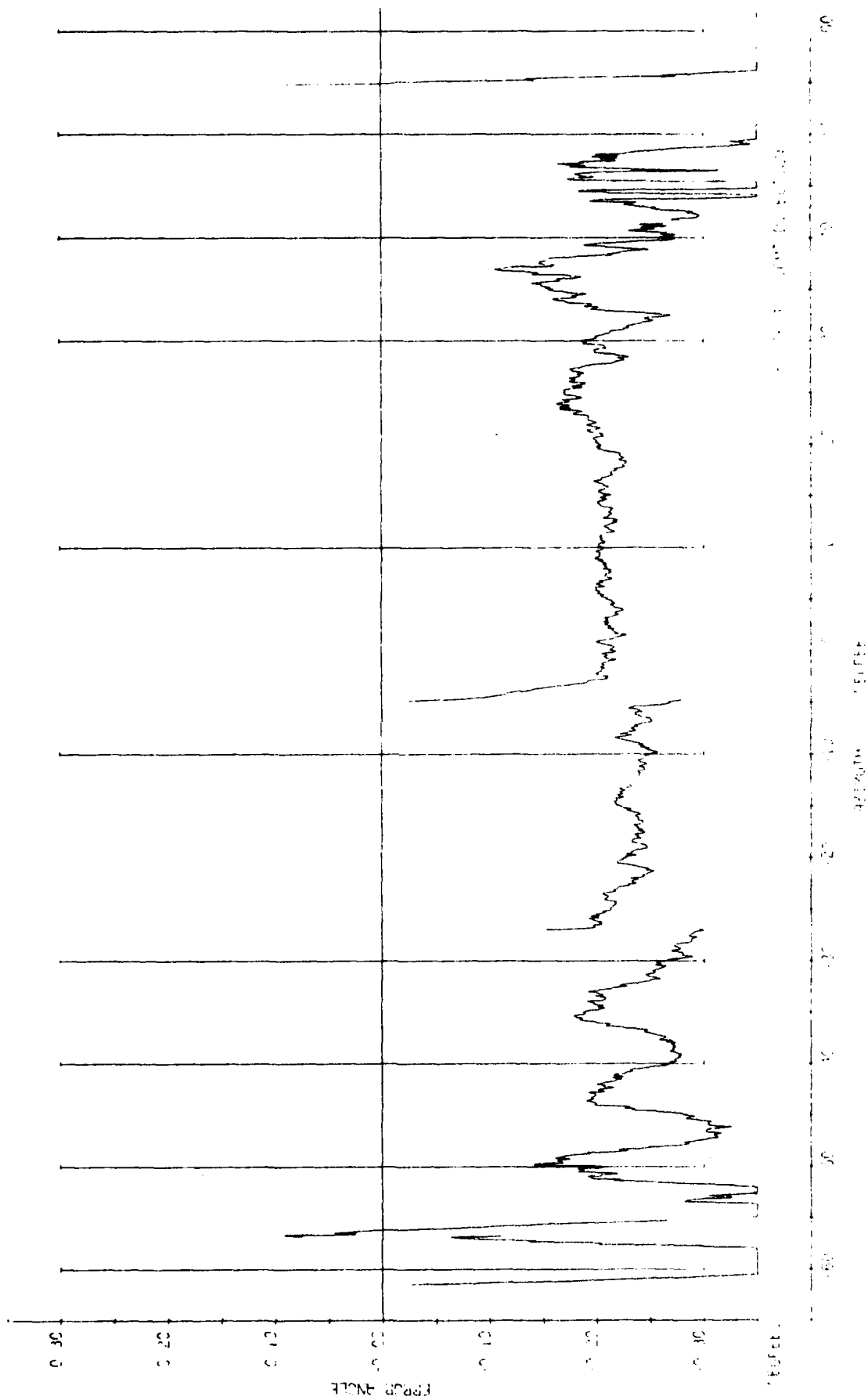


Fig 7.2

Fig 7.2 Azimuth part orbit at 4.4 n mile and 1900 ft (Site 3)

Fig 7.3

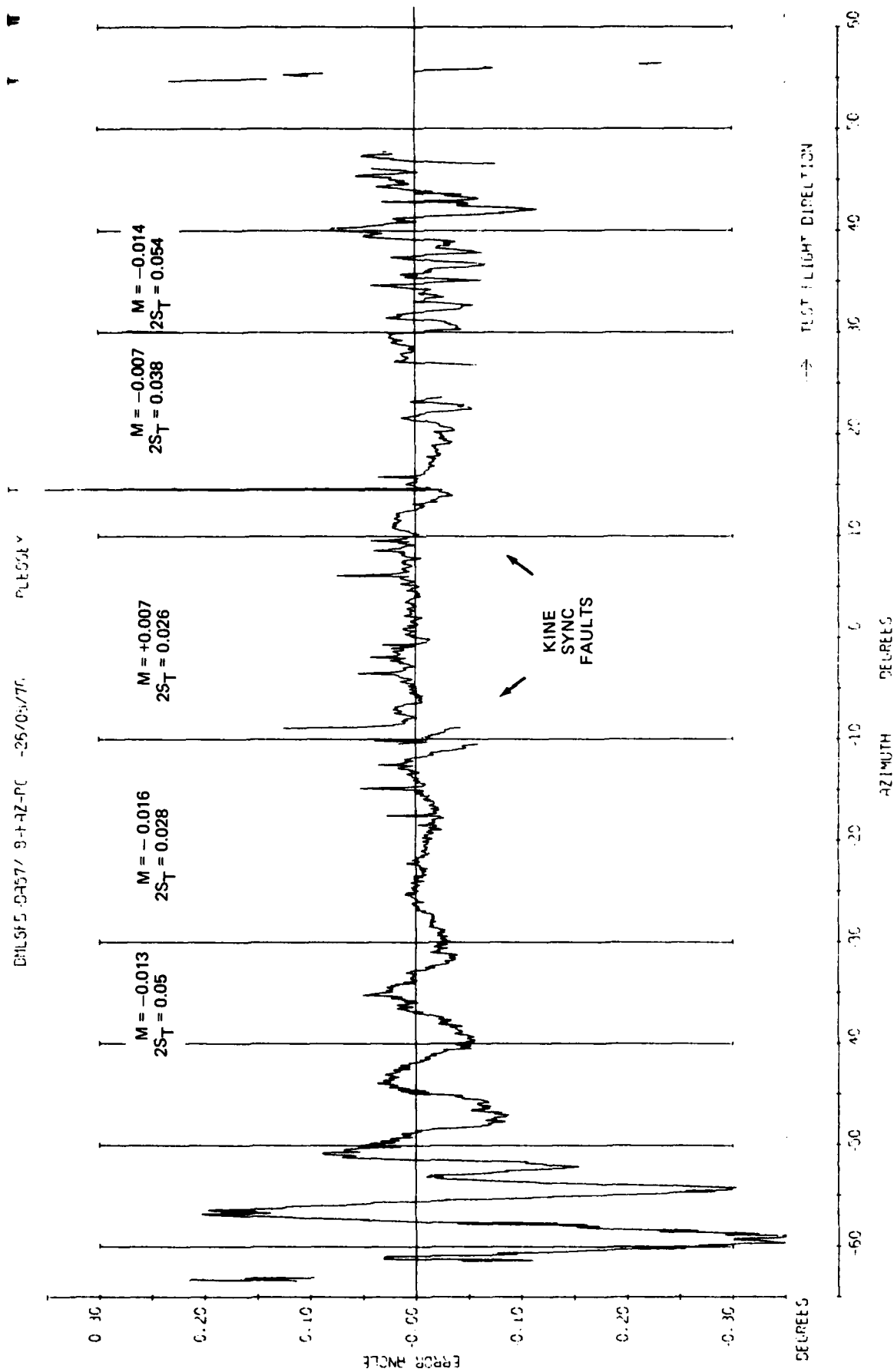
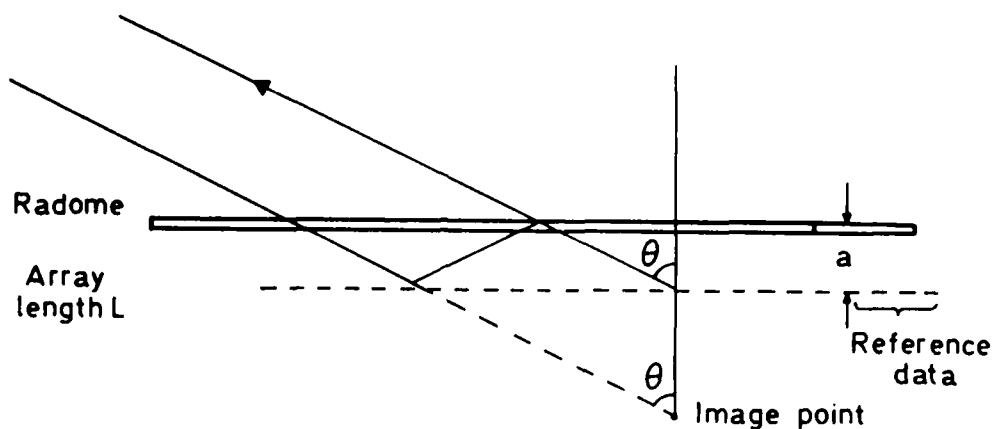


Fig 7.3 Azimuth part orbit at 5.8 n mile and 2000 ft (Site 3)

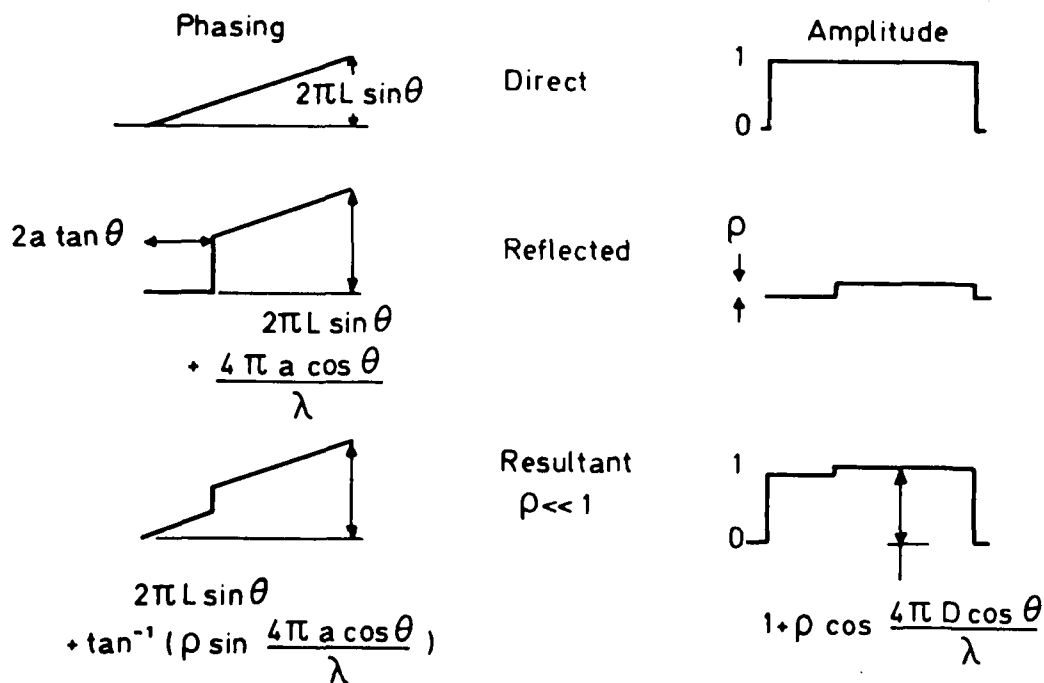


Effective image length $L - 2a \tan \theta$

Delay of reflected signal $\frac{2a \cos \theta 2\pi}{\lambda}$ radians

Relative level of reflected signal is ρ

Received signals



Error maxima occur at $\frac{4\pi a \cos \theta}{\lambda} = (2n+1) \frac{\pi}{2}$

Fig 7.4 Effect of radome mismatch

Fig 7.5a

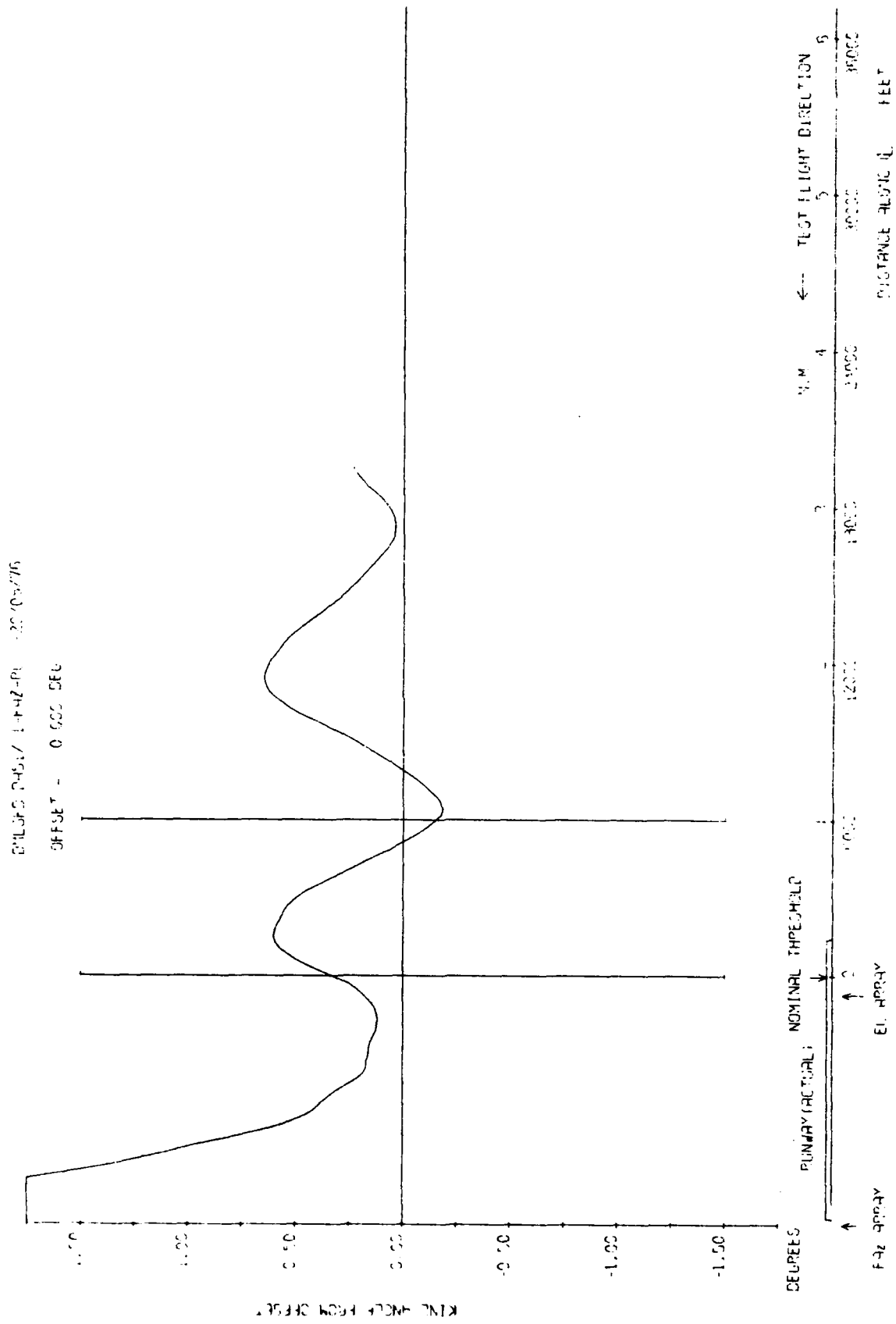


Fig 7.5a Azimuth 3 degree approach to low overshoot

TR 79082

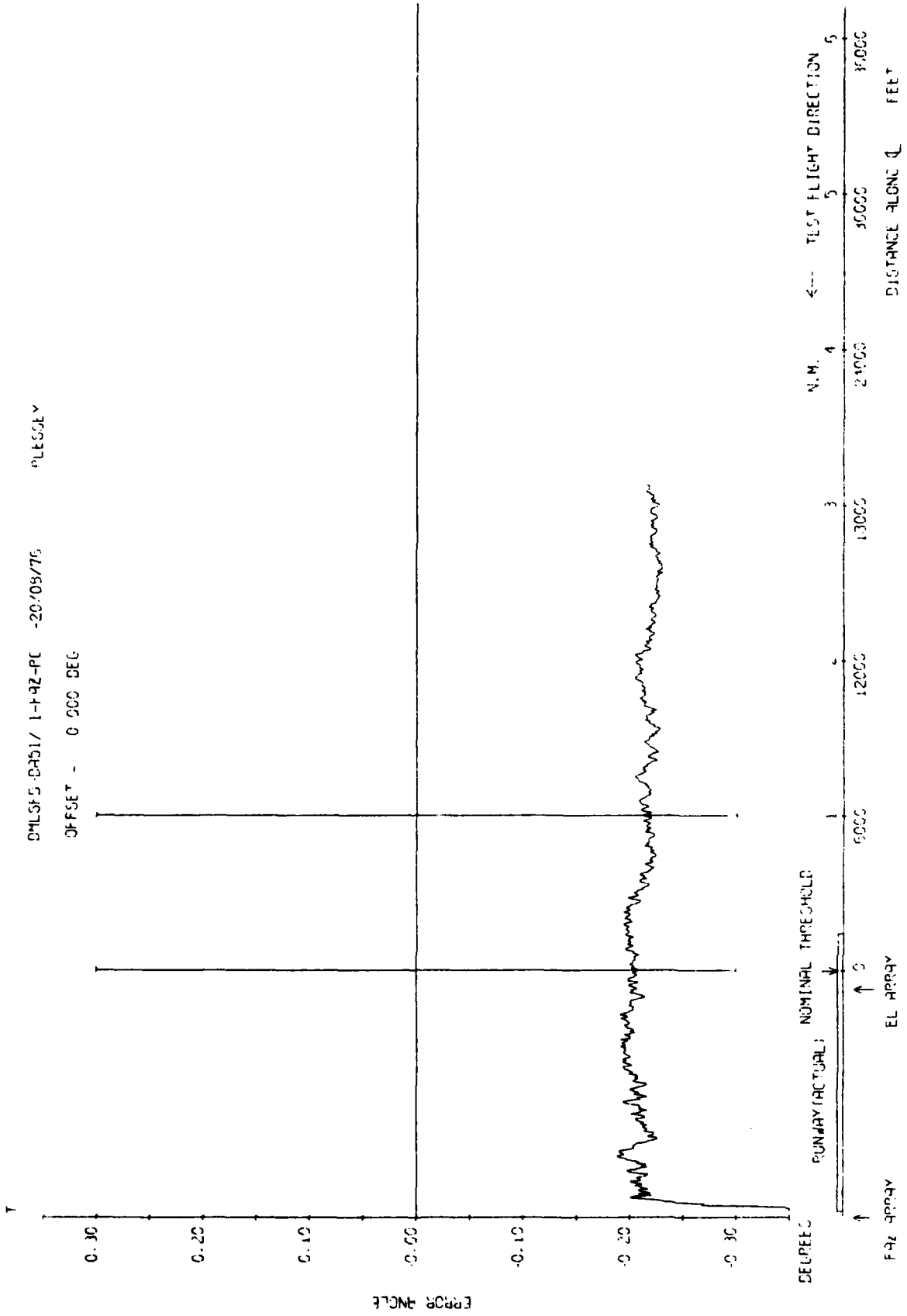


Fig 7.5b

Fig 7.5b Azimuth 3 degree approach to low overshoot

Fig 7.5c

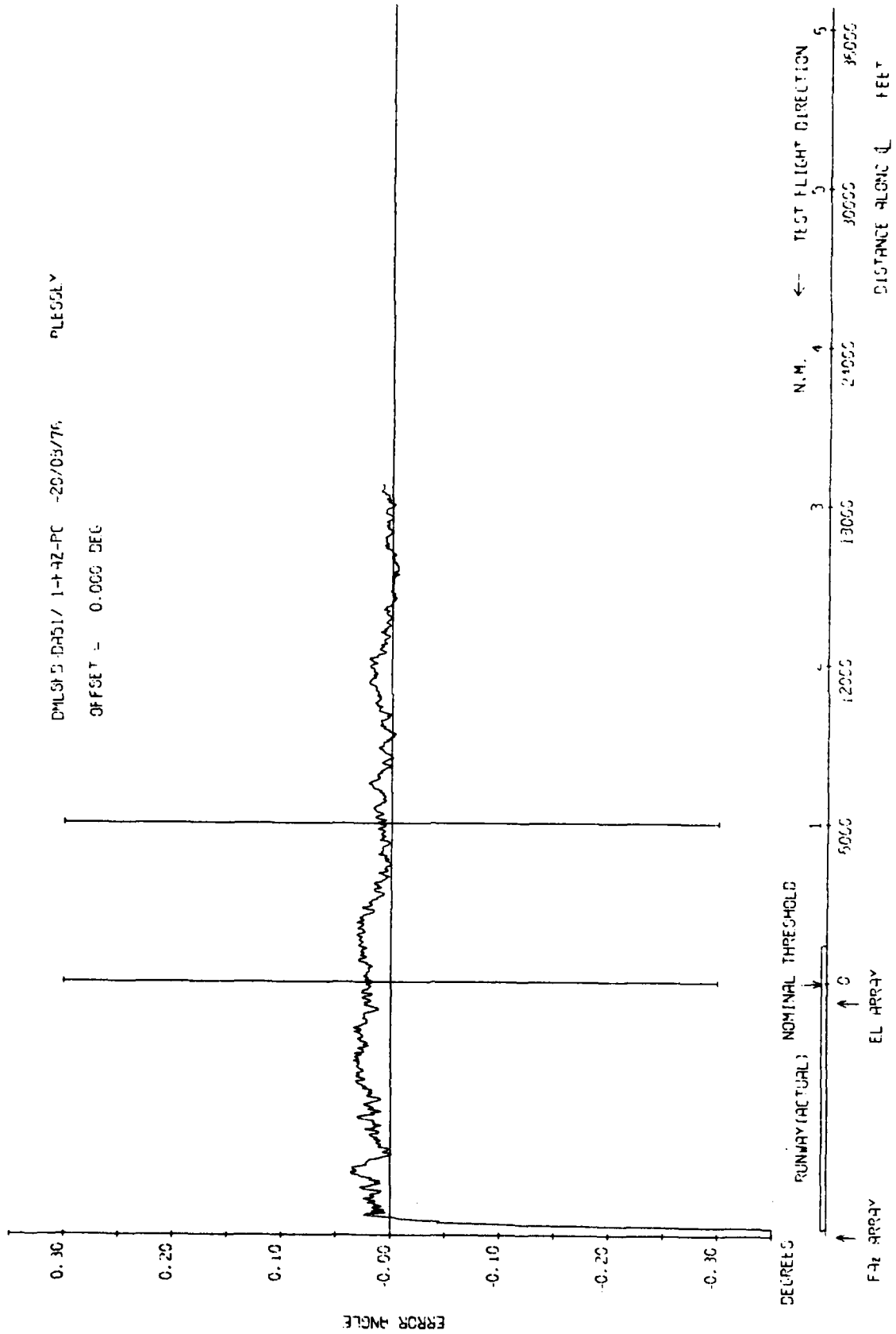


Fig 7.5c Azimuth 3 degree approach to low overshoot (bias removed)

TR 79062

DMLSF5-DH52/ 1-H Z-PC -23705/76

OFFSET = 0.00 DEG

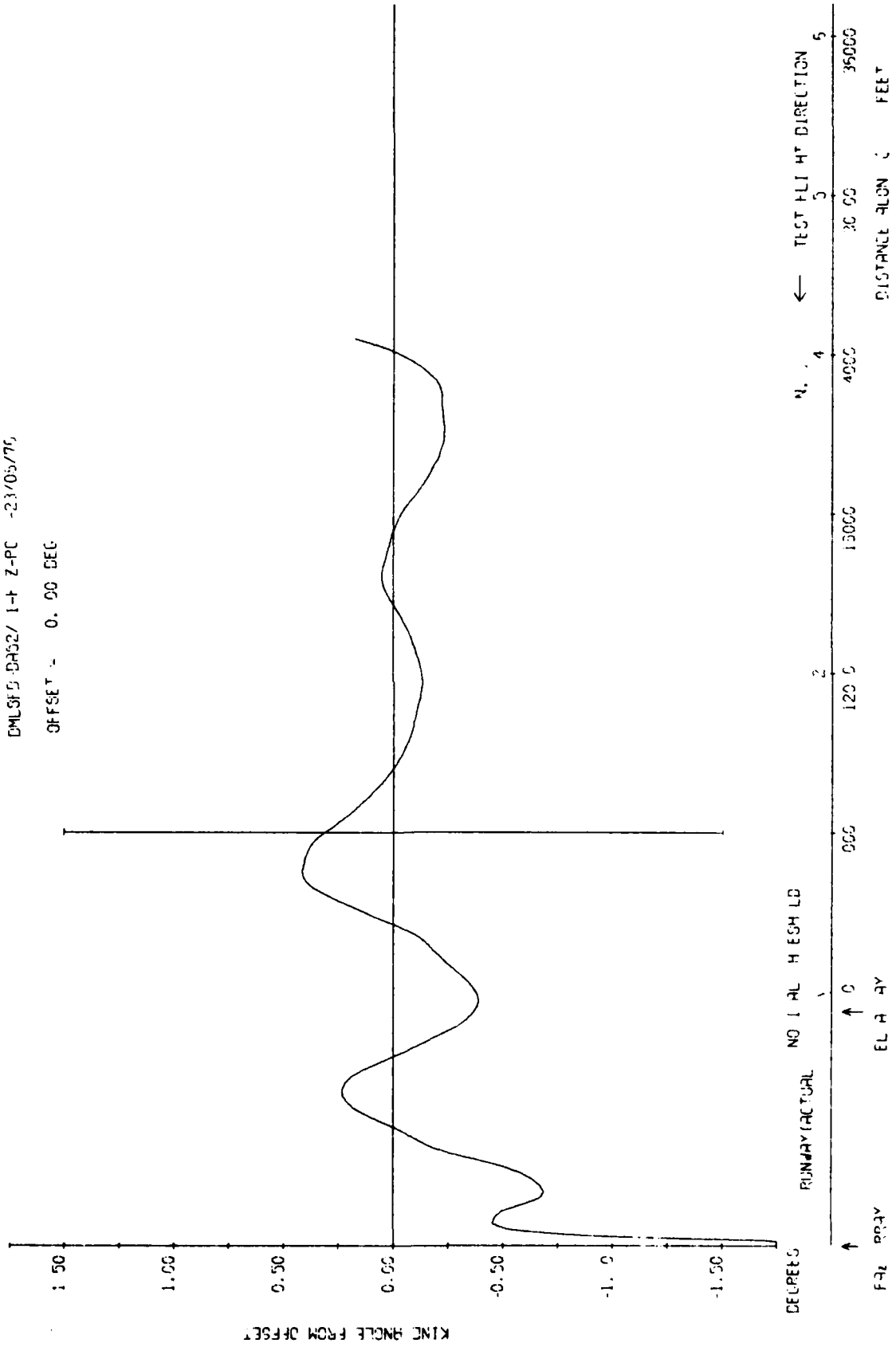


Fig 7.6a

Fig 7.6a Azimuth 3 degree approach to low overshoot

Fig 7.6b

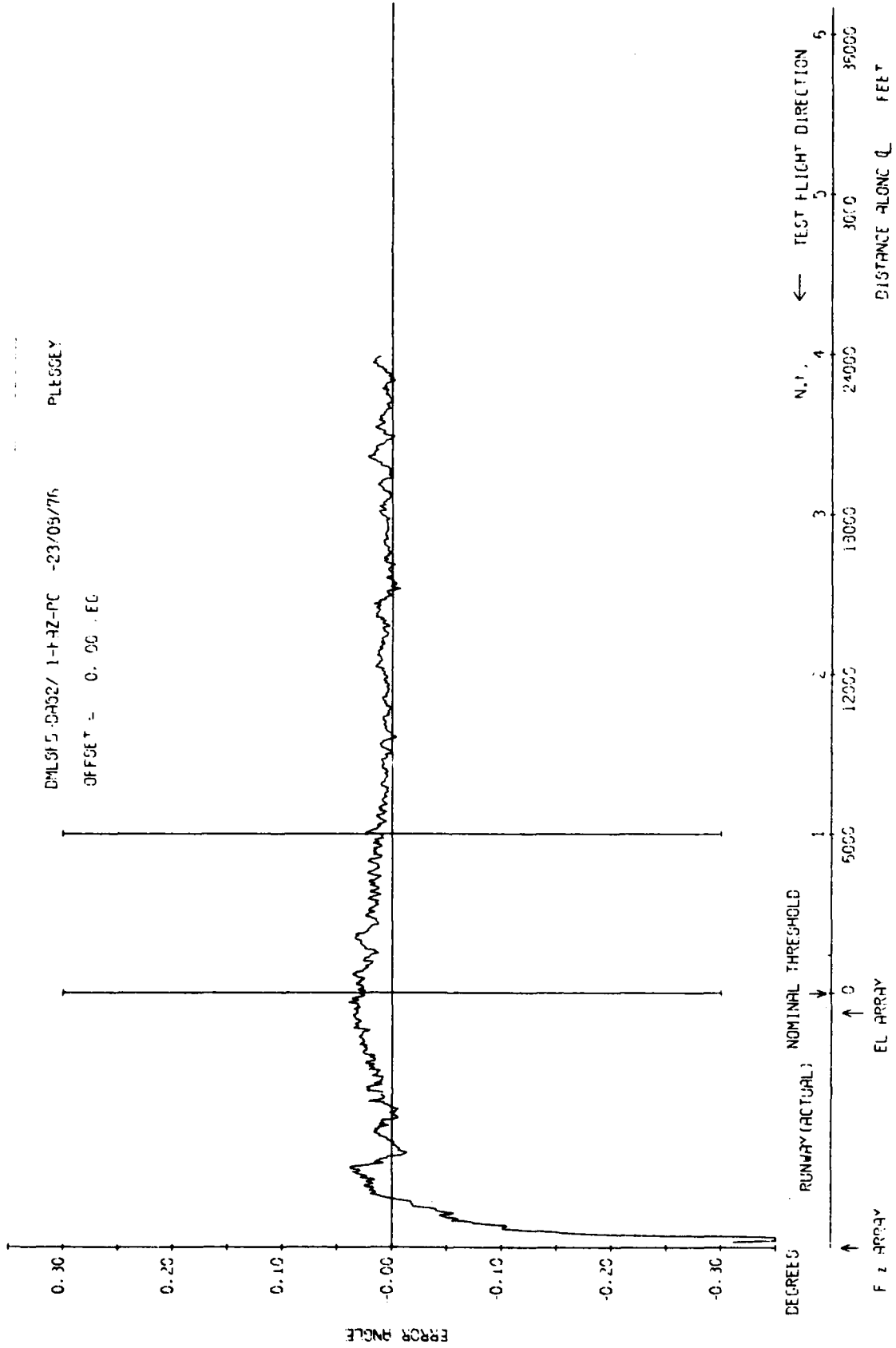


Fig 7.6b Azimuth 3 degree approach to low overshoot

TR 79082

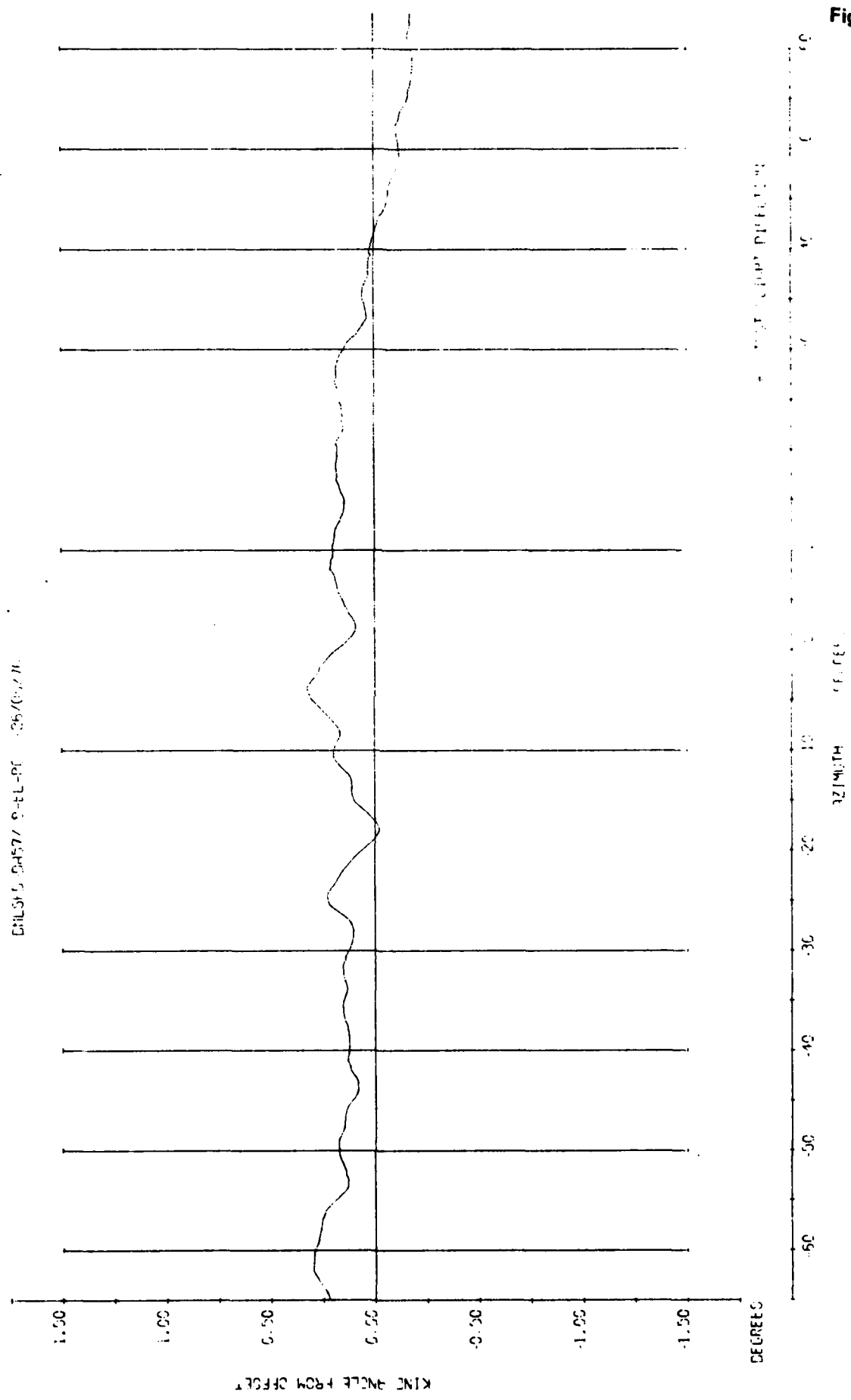


Fig 7.7a

Fig 7.7a Elevation orbit at 5.8 n mile and 2000 ft

Fig 7.7b

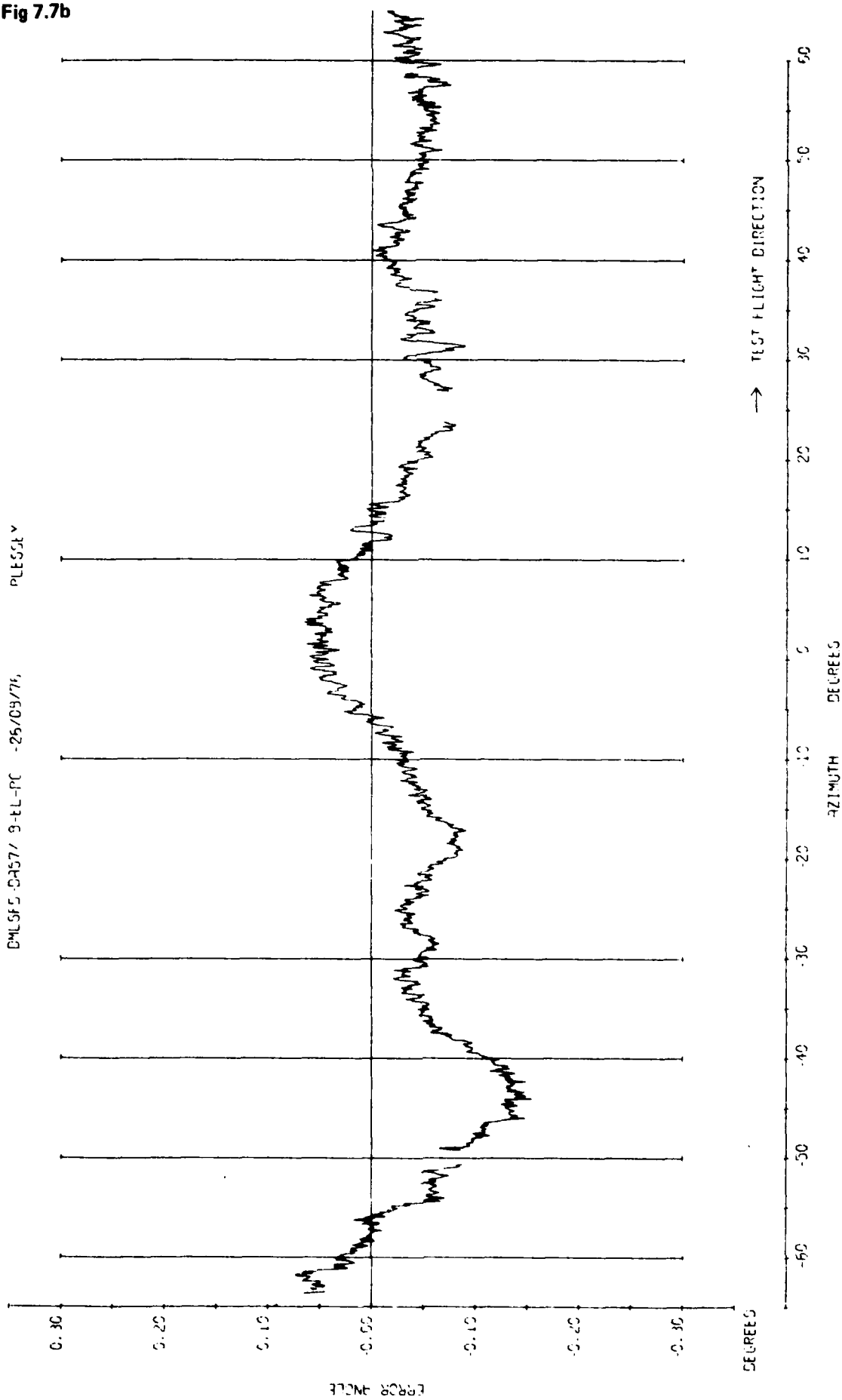


Fig 7.7b Elevation orbit at 5.8 n mile and 2000 ft

TR 79062

ORBITAL DATA 5-EL-PT 25/03/76

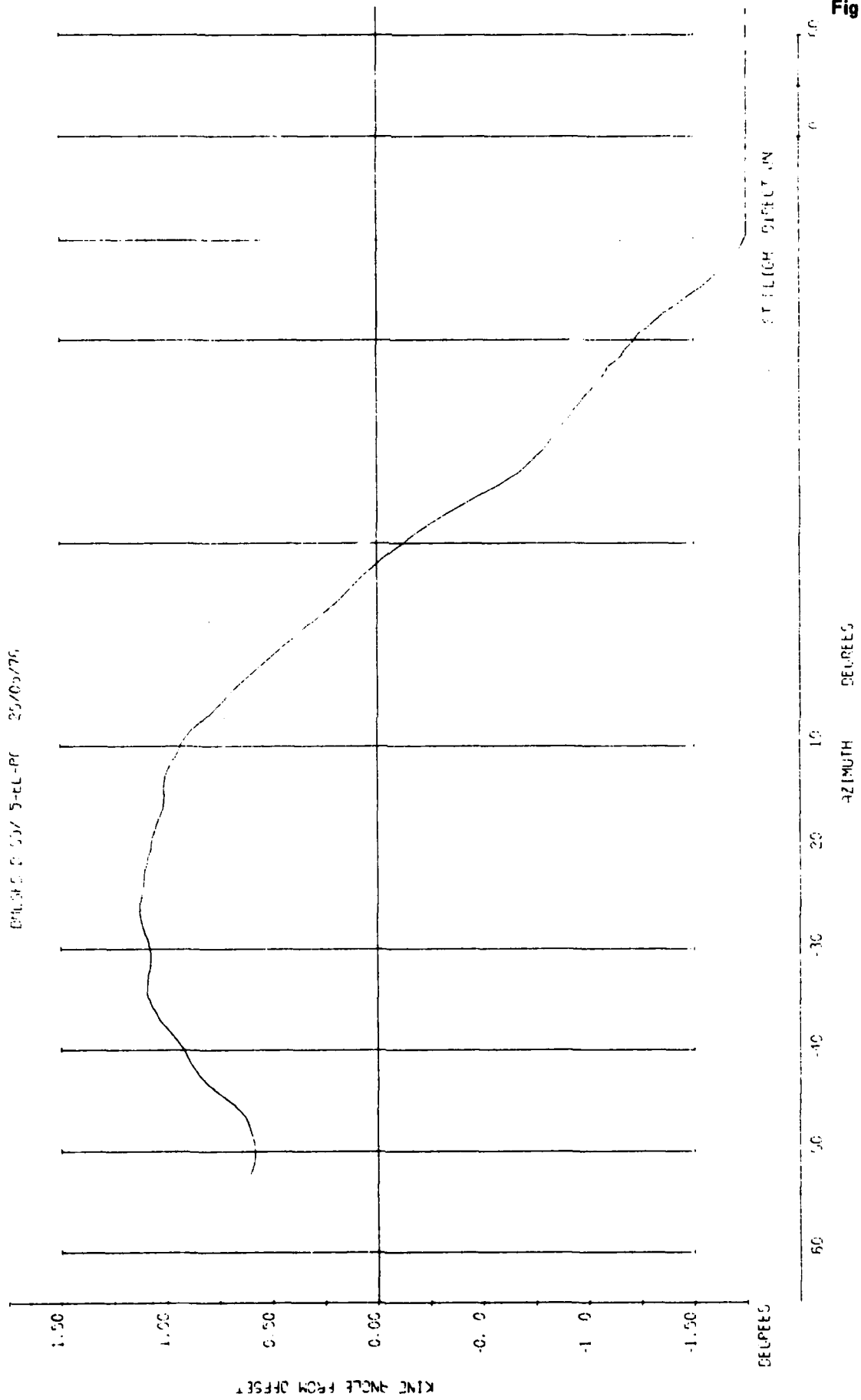


Fig 7.8a

Fig 7.8a Elevation orbit at 3.4 n mile and 3900 ft

Fig 7.8b

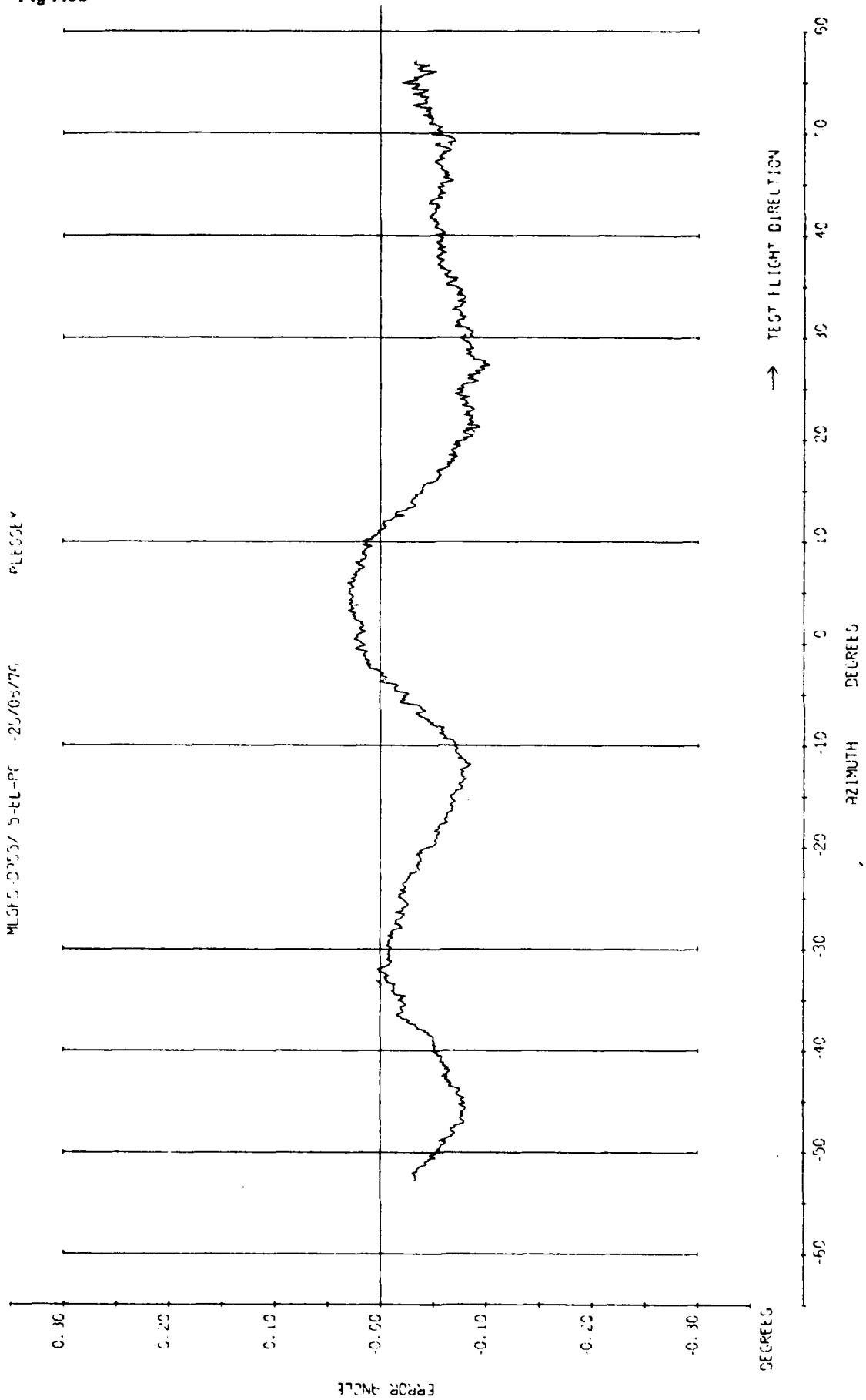
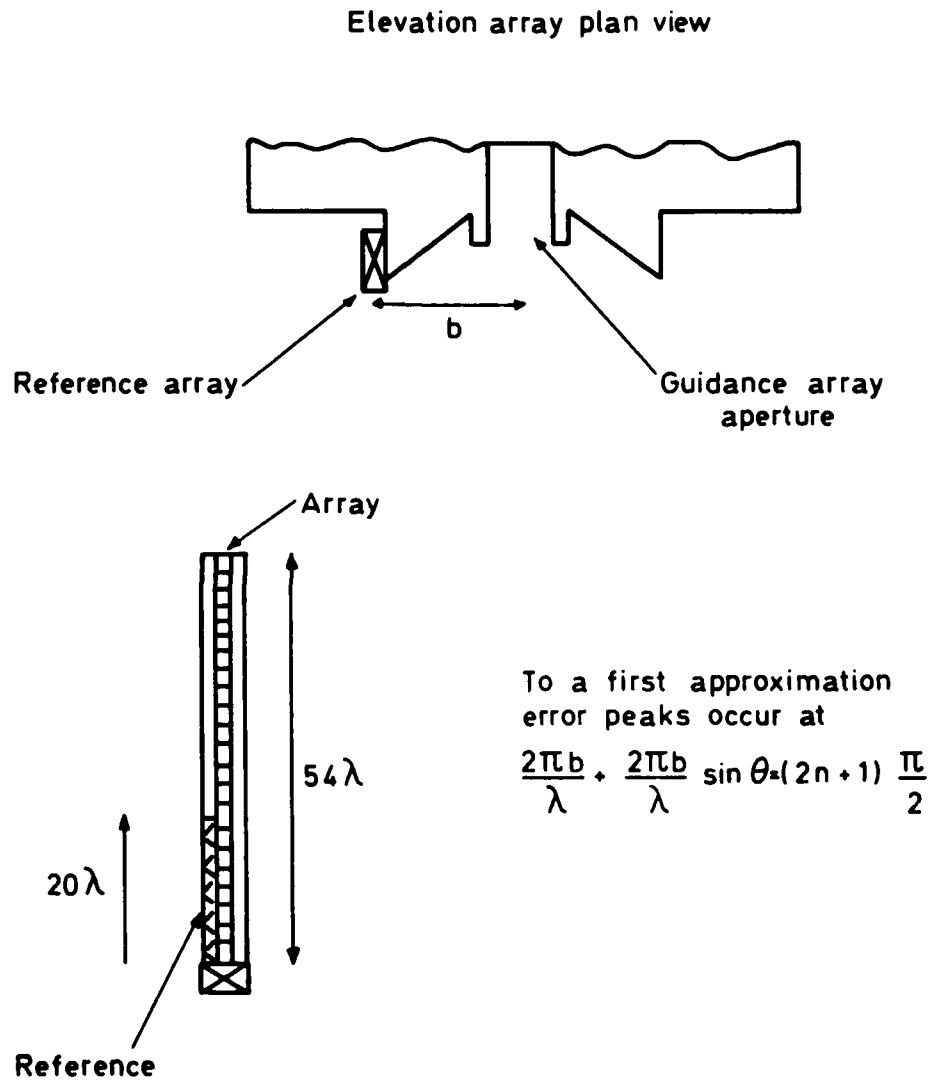


Fig 7.8b Elevation orbit at 3.4 n mile and 3900 ft



TR 79052

Fig 7.9 Geometry of elevation antenna

Fig 7.10a

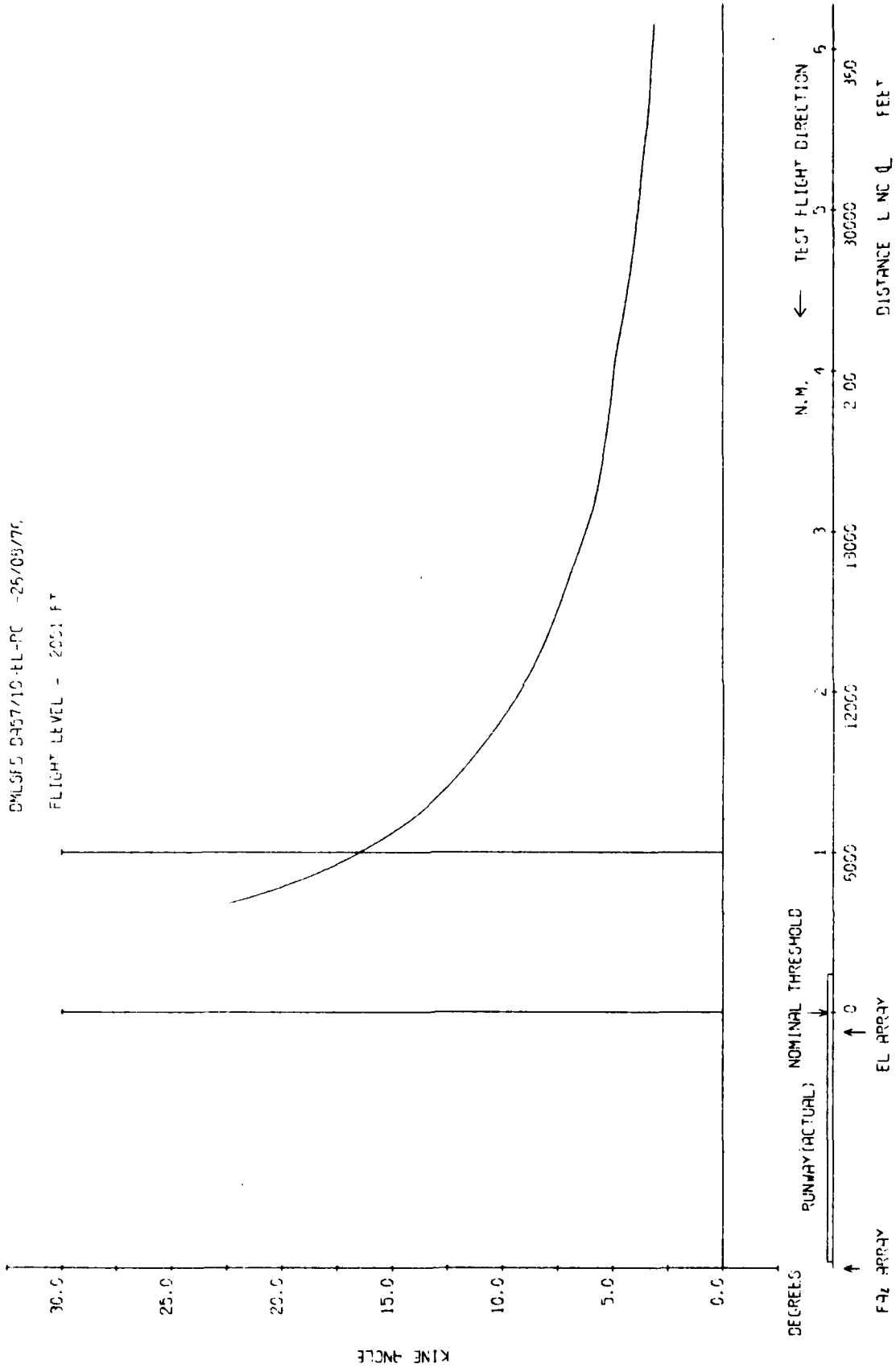


Fig 7.10a Elevation radial at 2051 ft and zero azimuth

TR 75062

DNLSFD-DR57/10-EL-PC -26/08/76 PLESSEY
FLIGHT LEVEL = 2051 FT

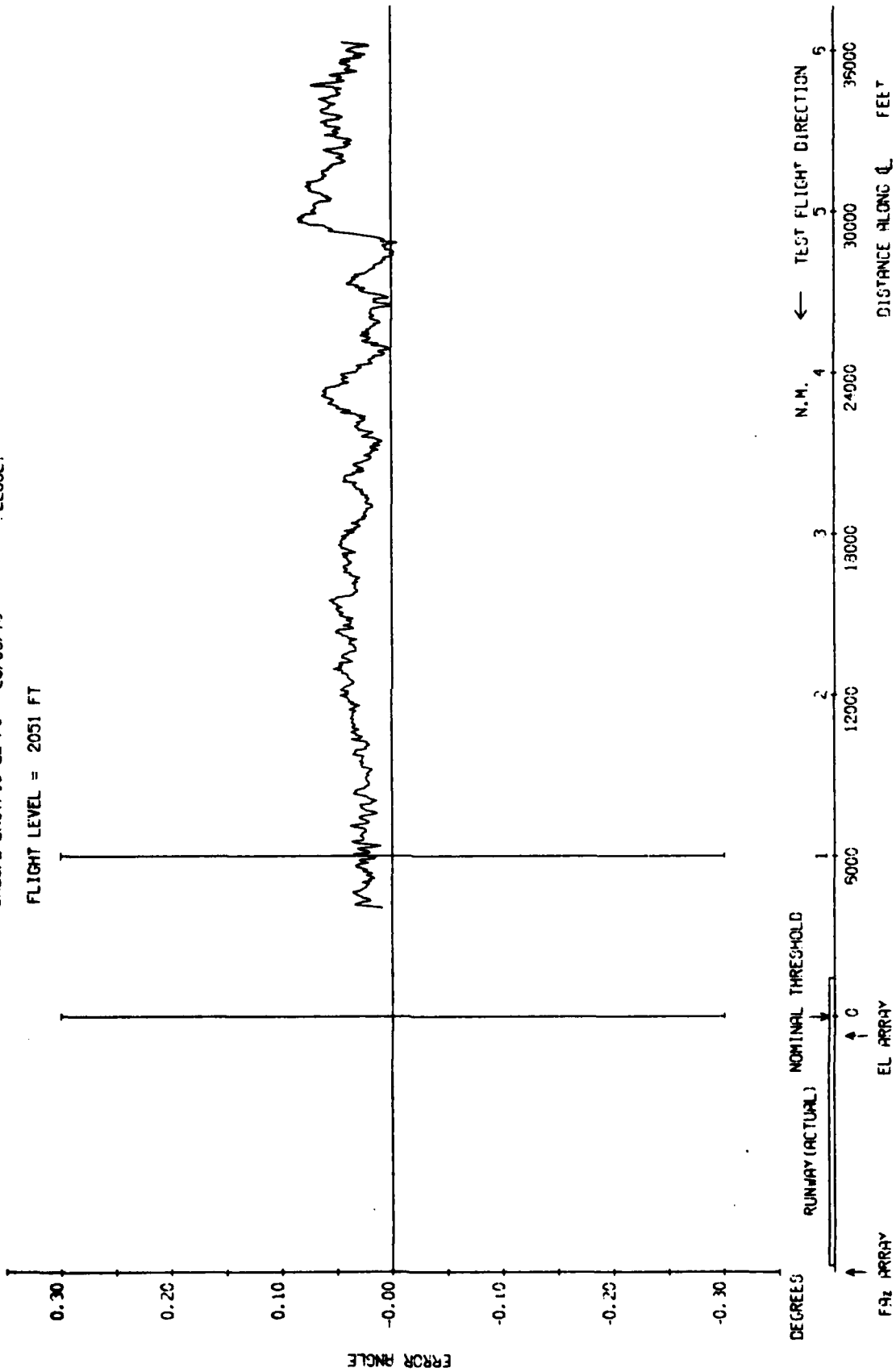


Fig 7.10b

Fig 7.10b Elevation radial at 2051 ft and zero azimuth

Fig 7.11a

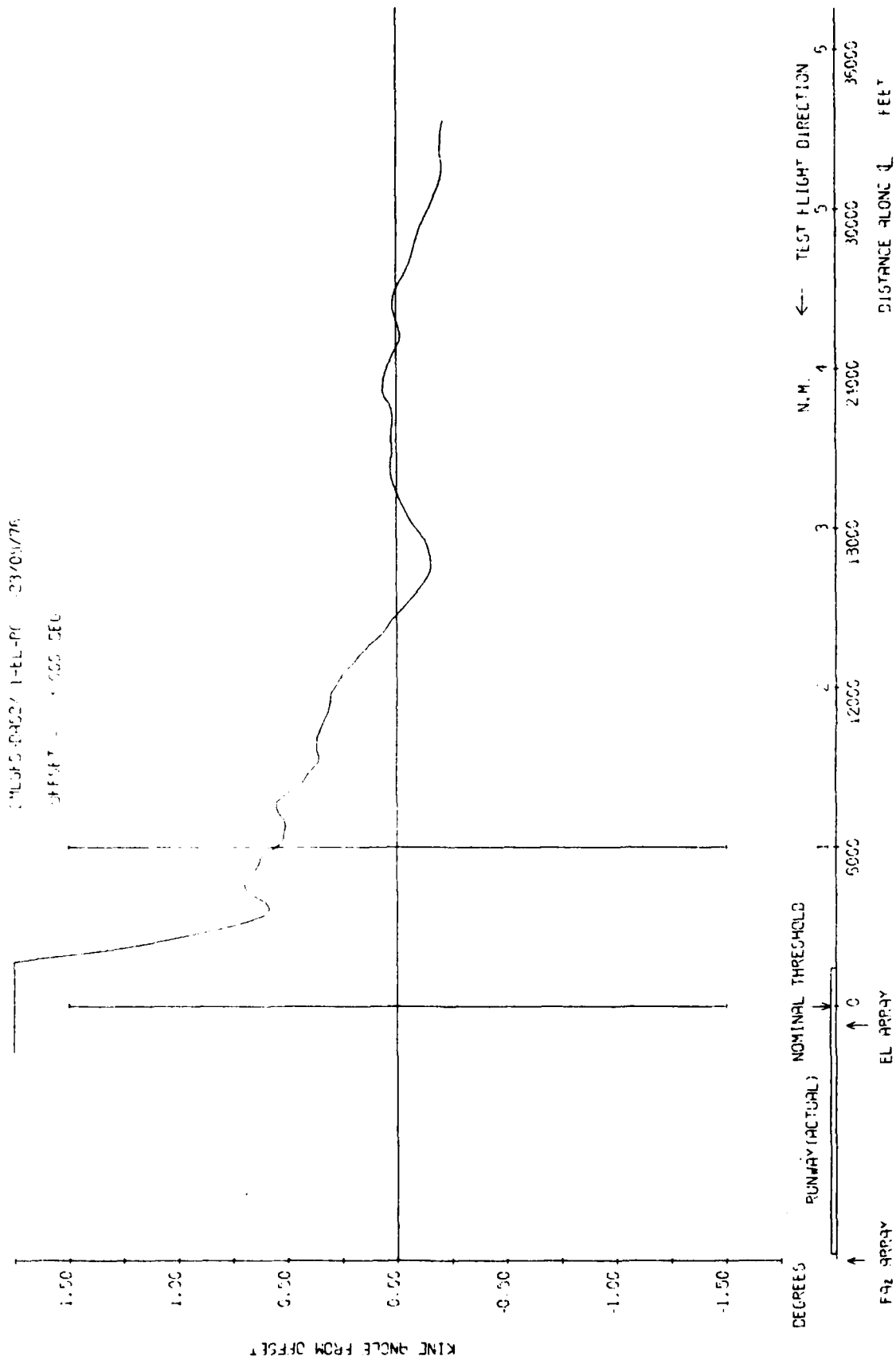


Fig 7.11a Elevation 3 degree approach to low overshoot

TR 79082

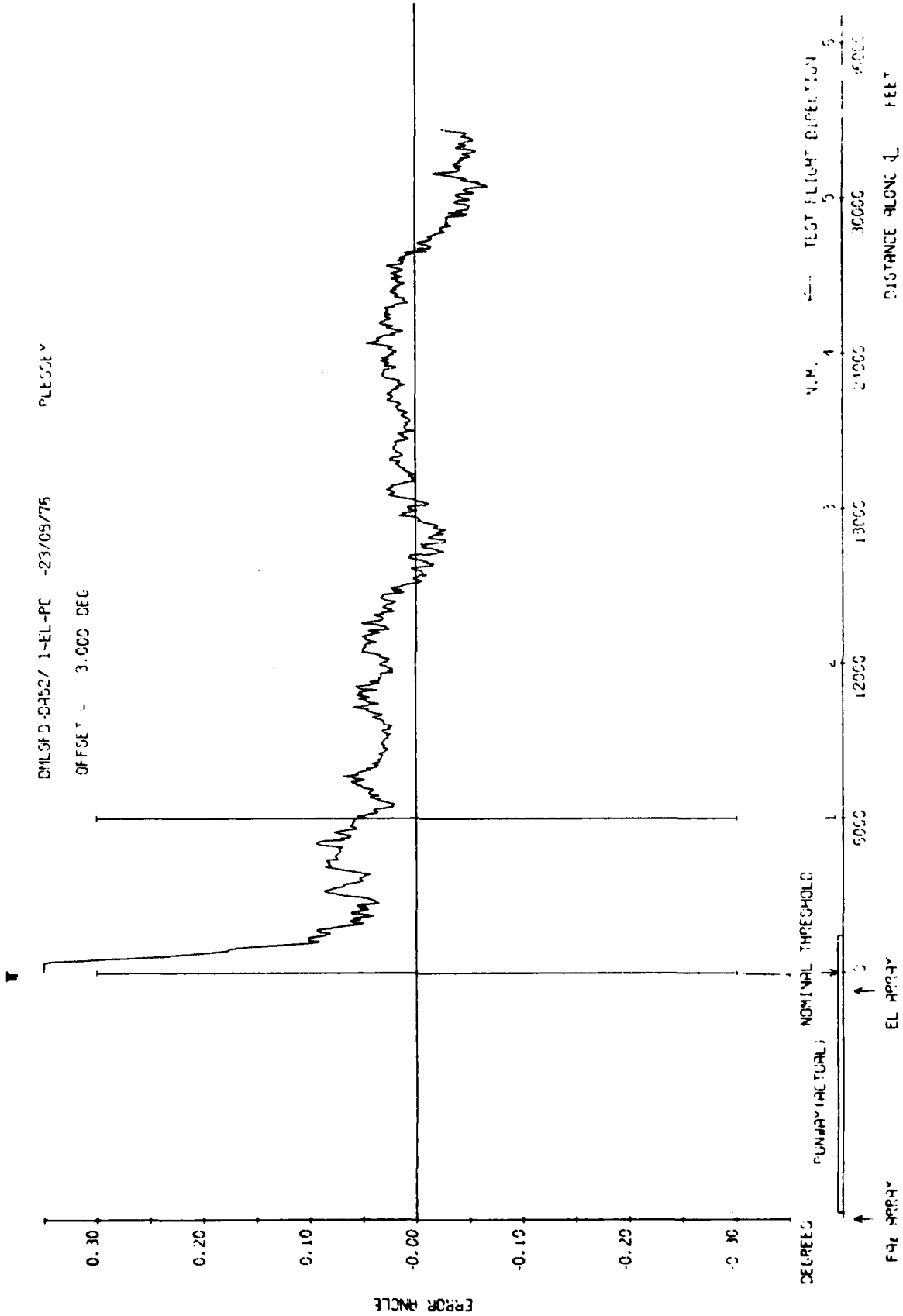


Fig 7.11b

Fig 7.11b Elevation 3 degree approach to low overshoot

Fig 7.12

CP 315 05237 5-42 P 13410 76 PLEESLY

2.1 DEGREE ELEVATION FROM AZIMUTH

T T

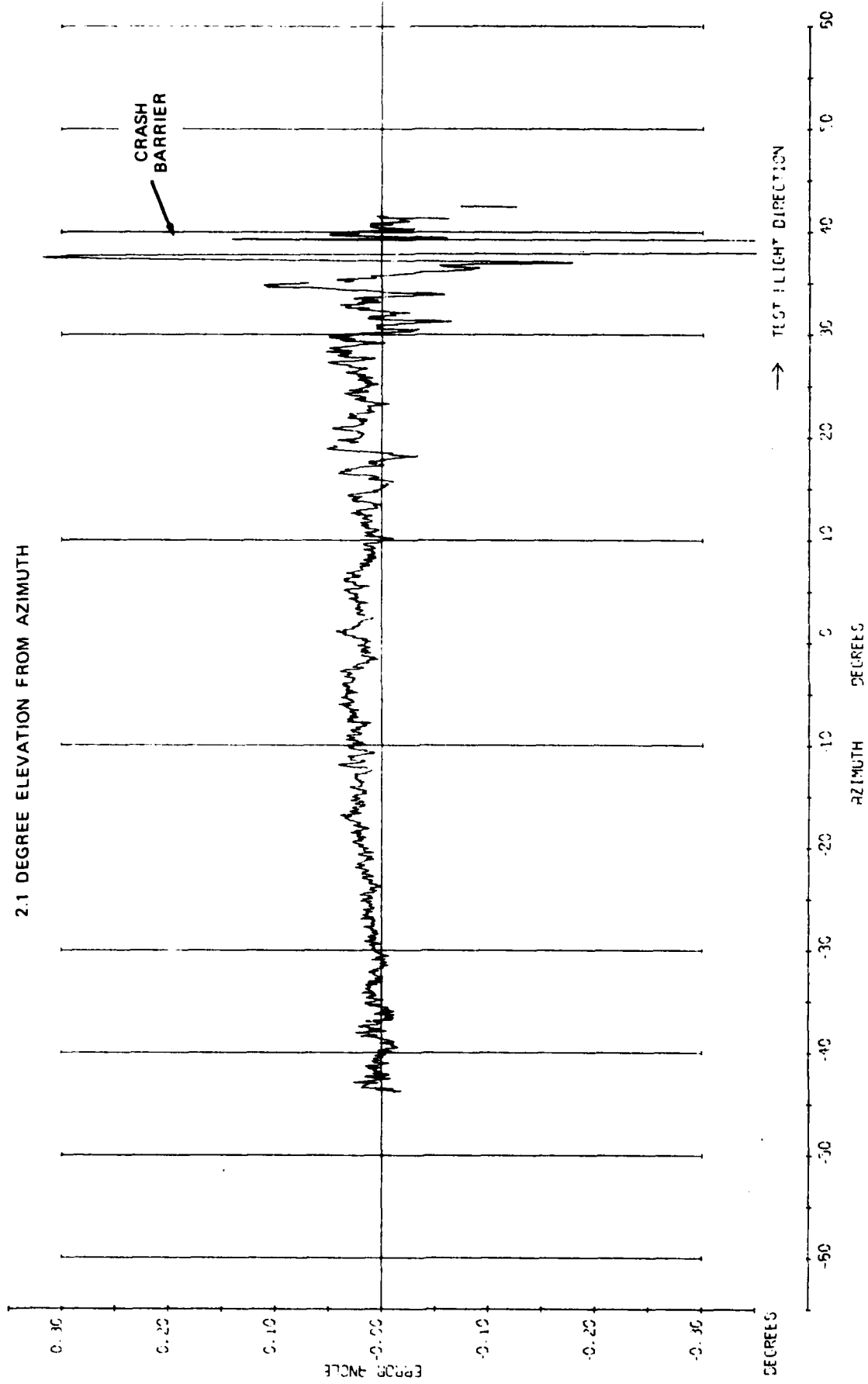


Fig 7.12 Azimuth part orbit at 8.8 n mile and 1950 ft height

TR 79082

DMLSF0-0828/ 4-FRZ-PC -13/10/76 PLESSEY

2.5 DEGREE ELEVATION FROM AZIMUTH

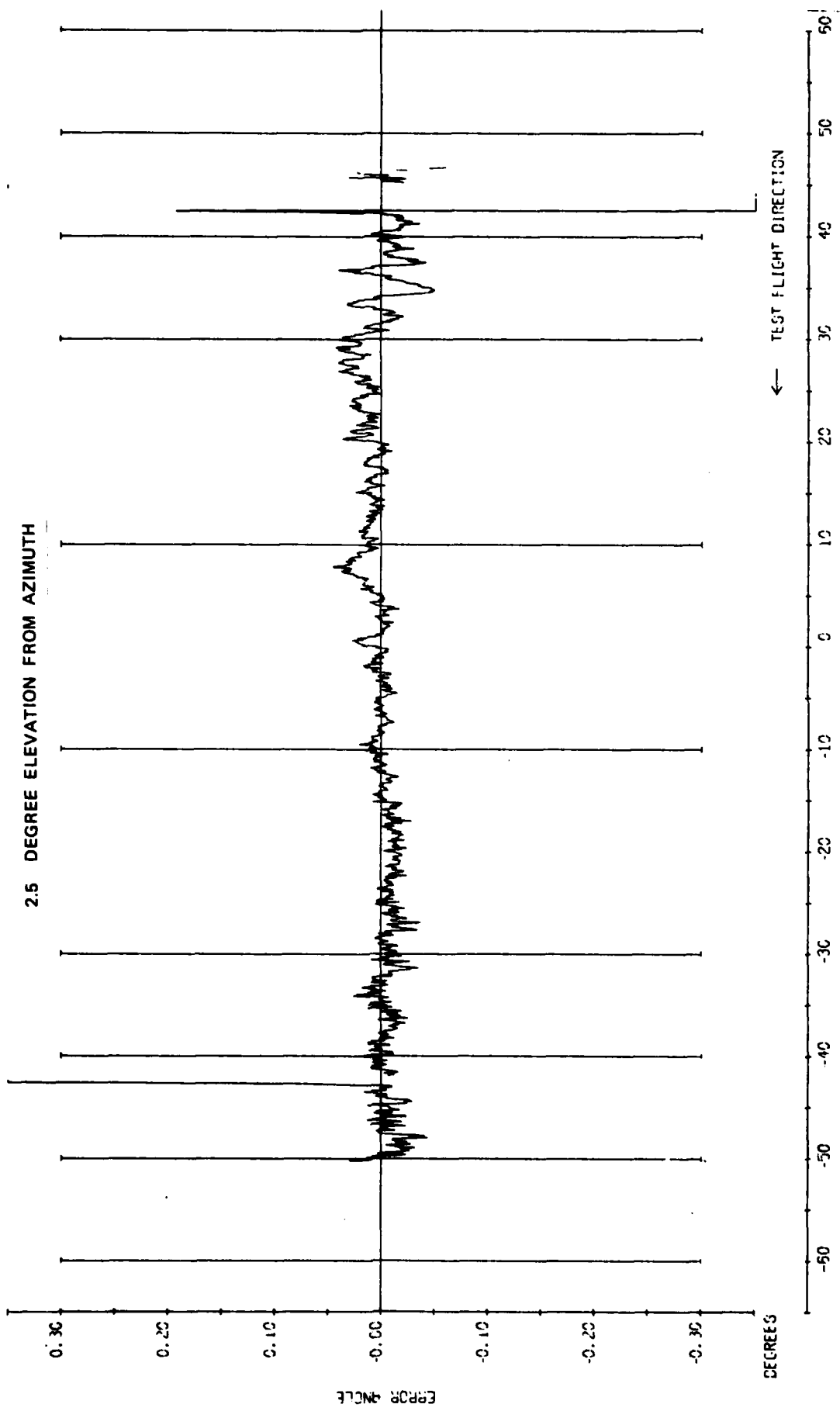


Fig 7.13

Fig 7.13 Azimuth part orbit at 7.5 n mile and 1950 ft height

Fig 7.14

DHLJ'S 0023/ 2-F-HZ-PC -13/10/76 PLESSLY

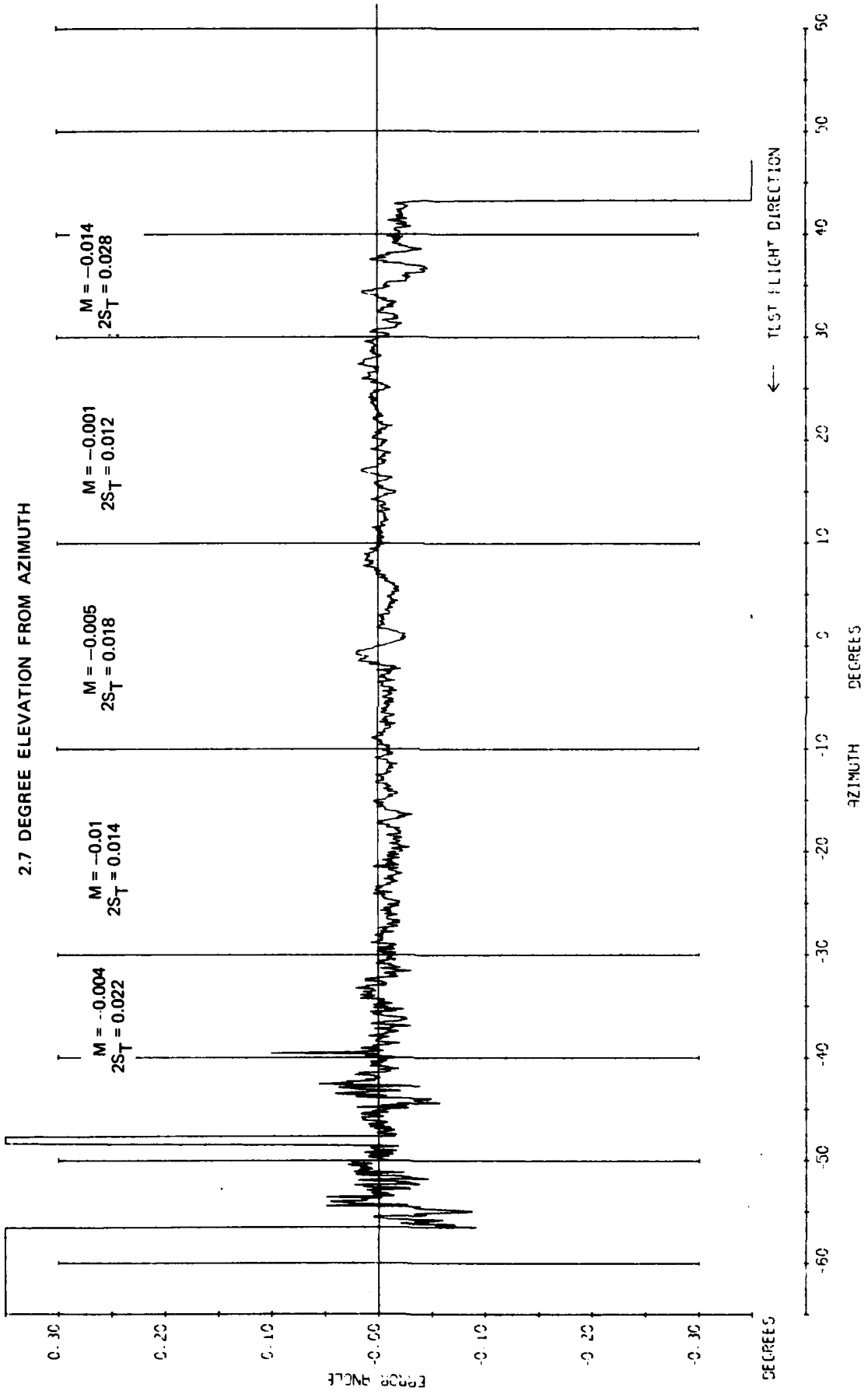


Fig 7.14 Azimuth part orbit at 6.8 n mile and 1930 ft height

TR 79062

U. S. ORBIT 3 FZ-PC -13/12/76

PLESM

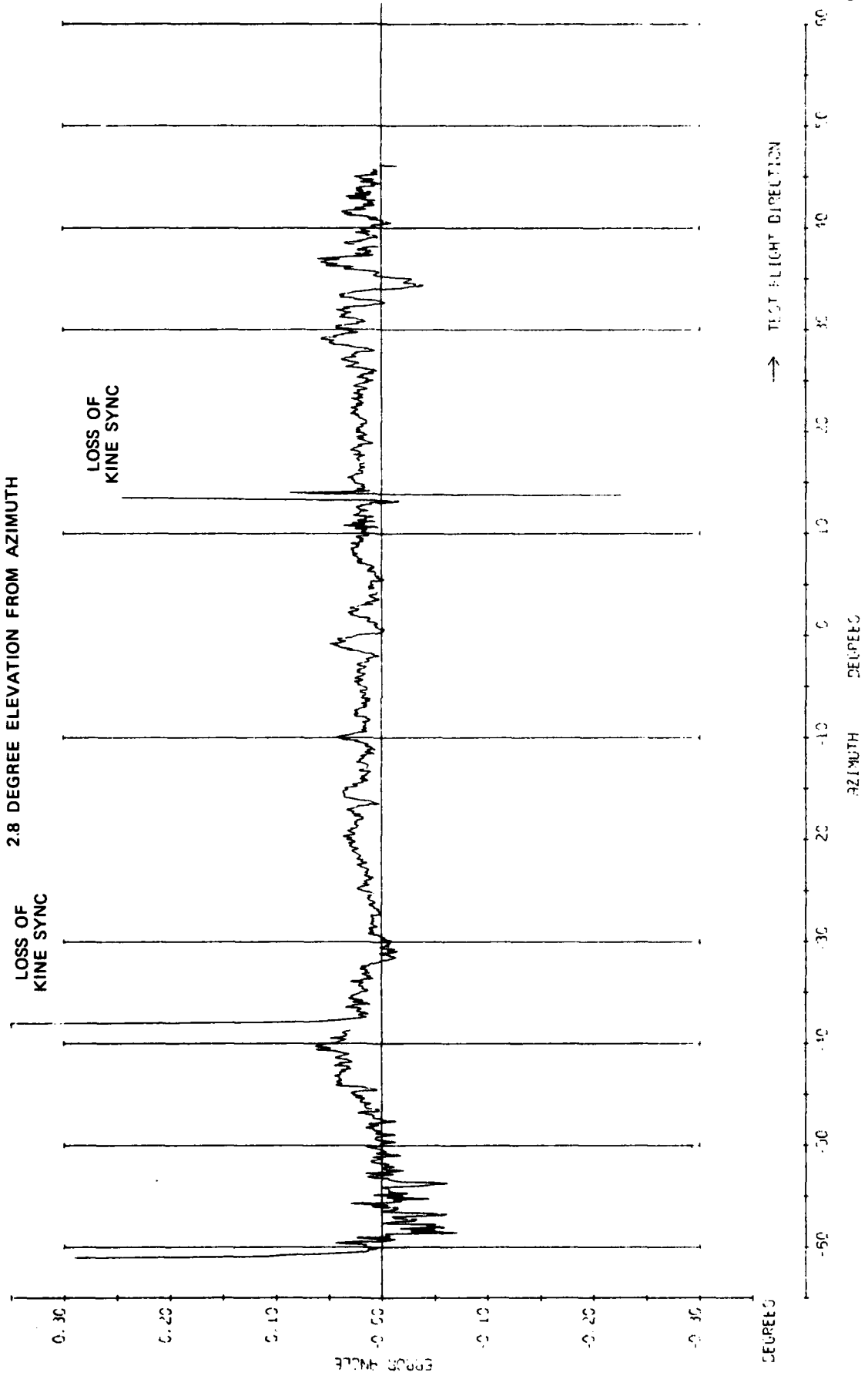


Fig 7.15

Fig 7.15 Azimuth part orbit at 6.6 n mile and 1950 ft height

Fig 7.16c

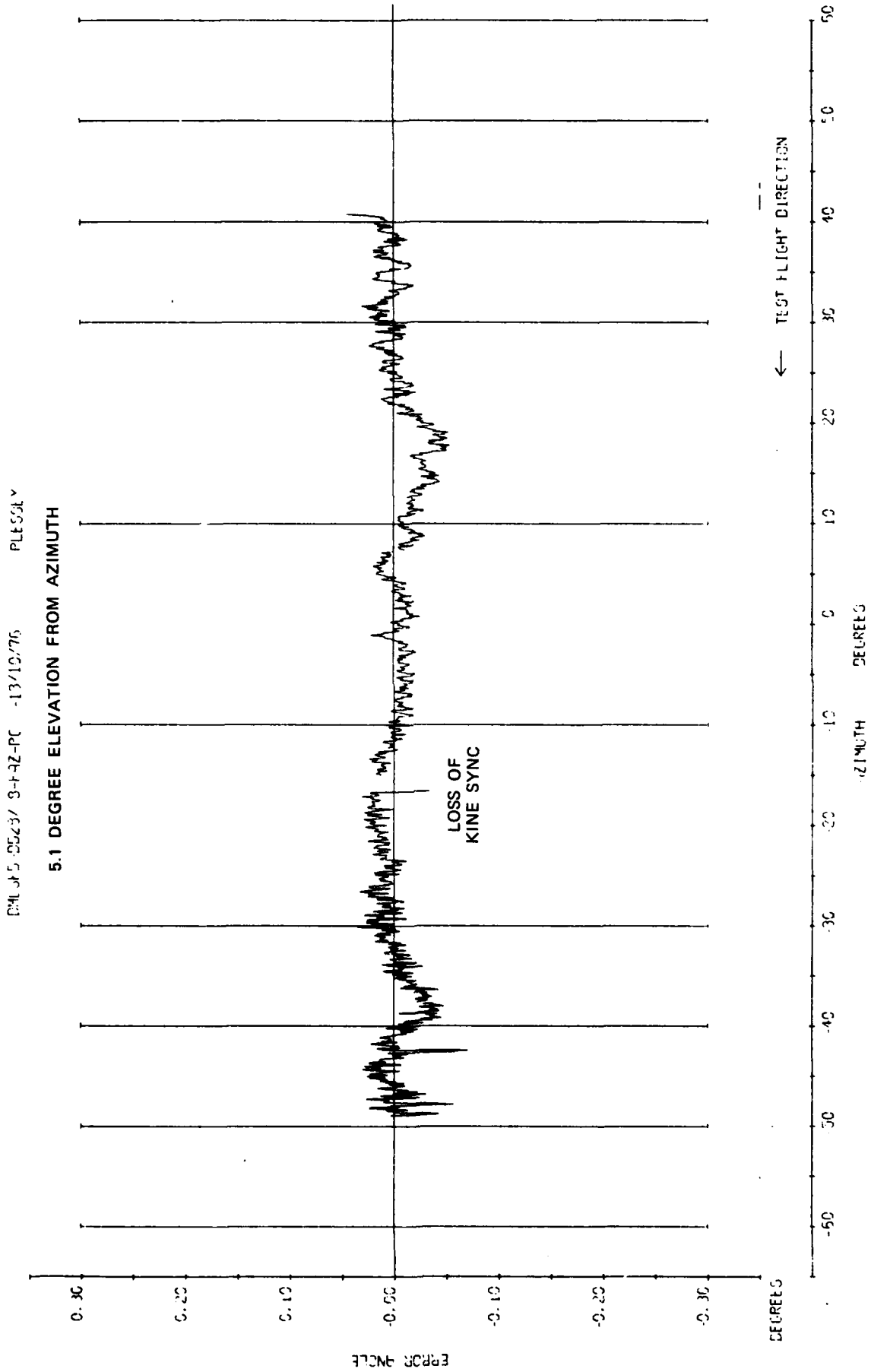


Fig 7.16c Azimuth part orbit at 7.5 n mile and 4020 ft height

TR 79082

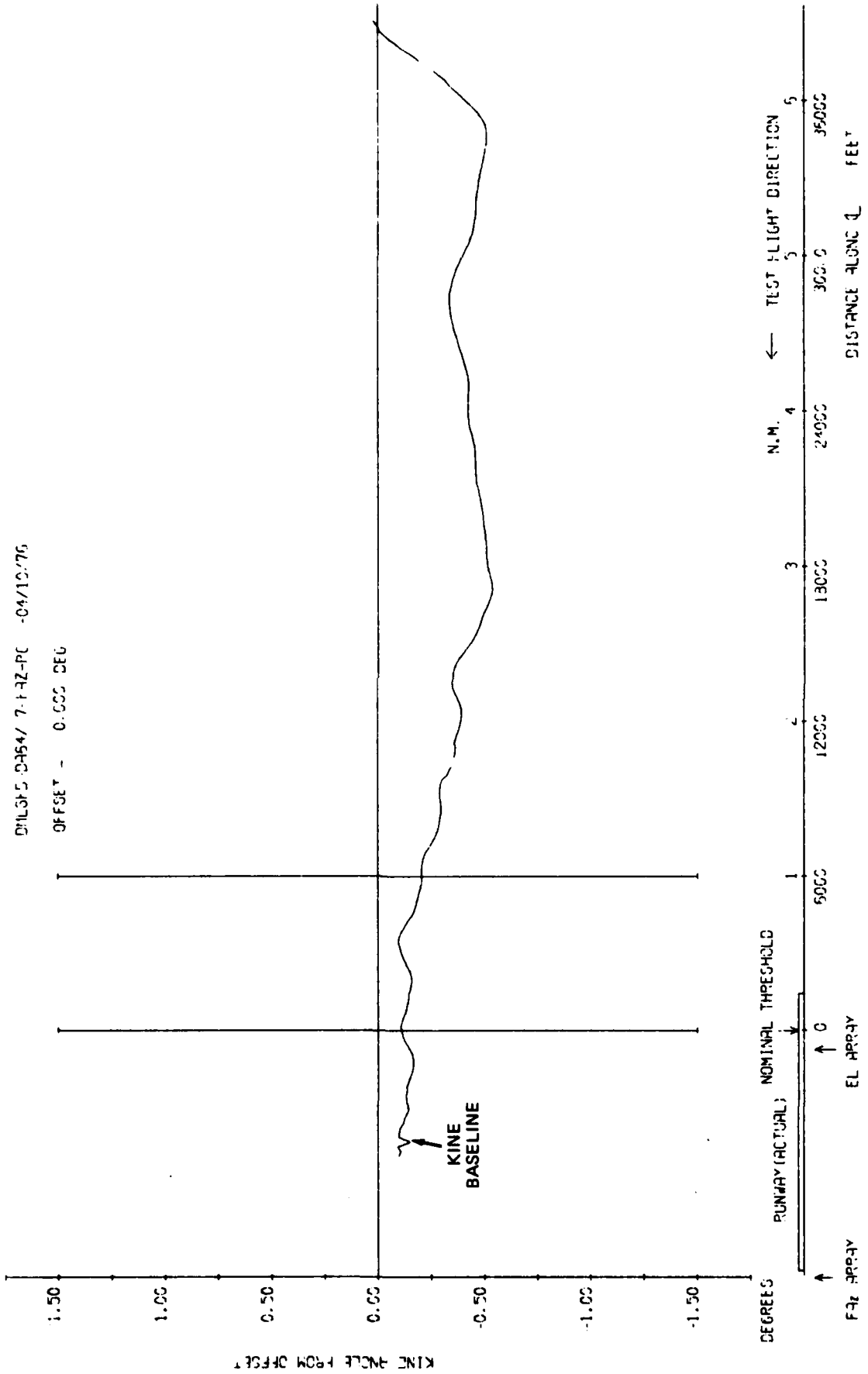


Fig 7.17a

Fig 7.17a Azimuth 3 degree approach to low overshoot

Fig 7.17b

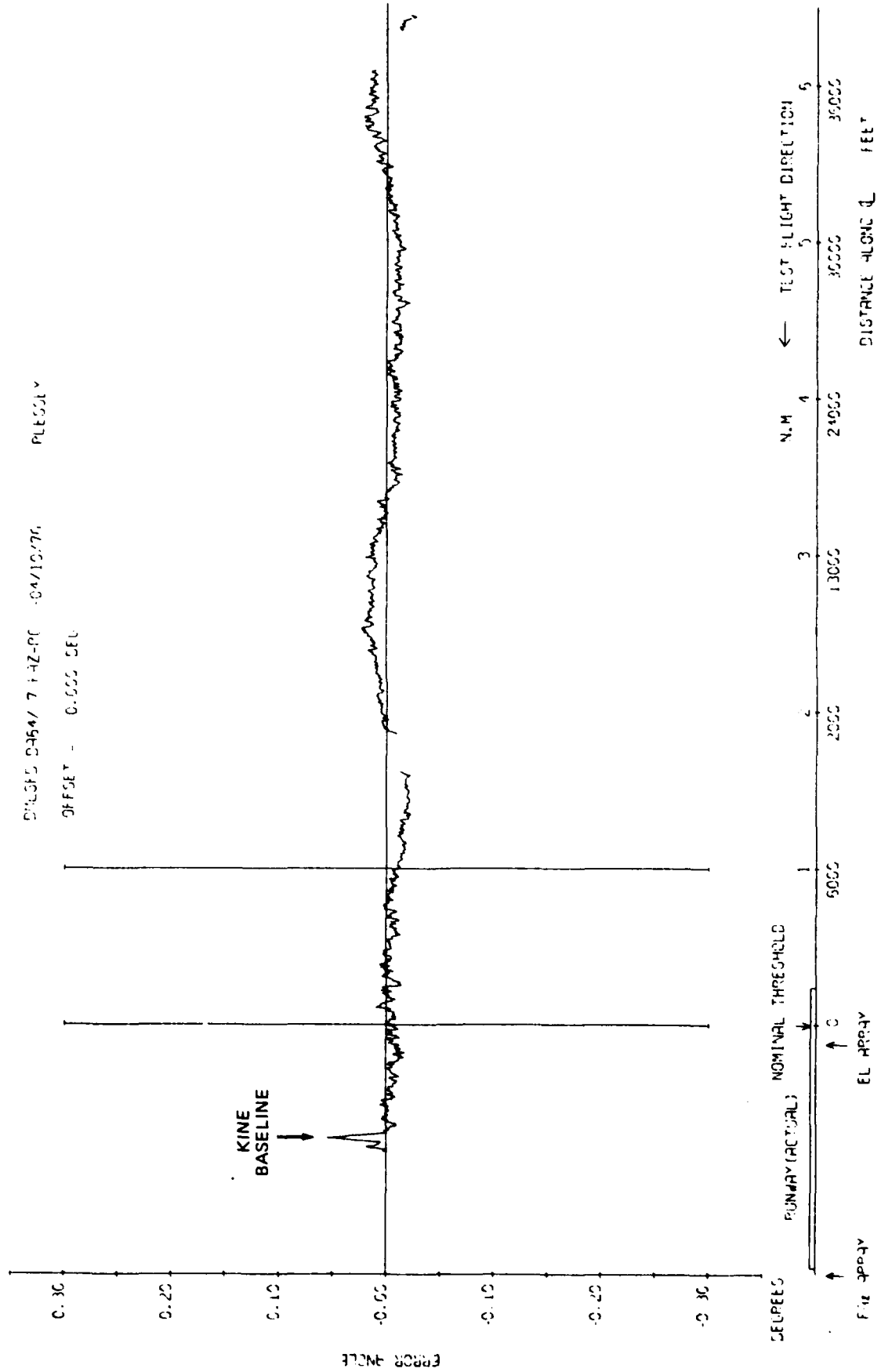


Fig 7.17b Azimuth 3 degree approach to low overshoot

TR 79082

DWLSFD-DB28/ 1-FRZ-PC -13/10/76

OFFSET = 0.000 DEG

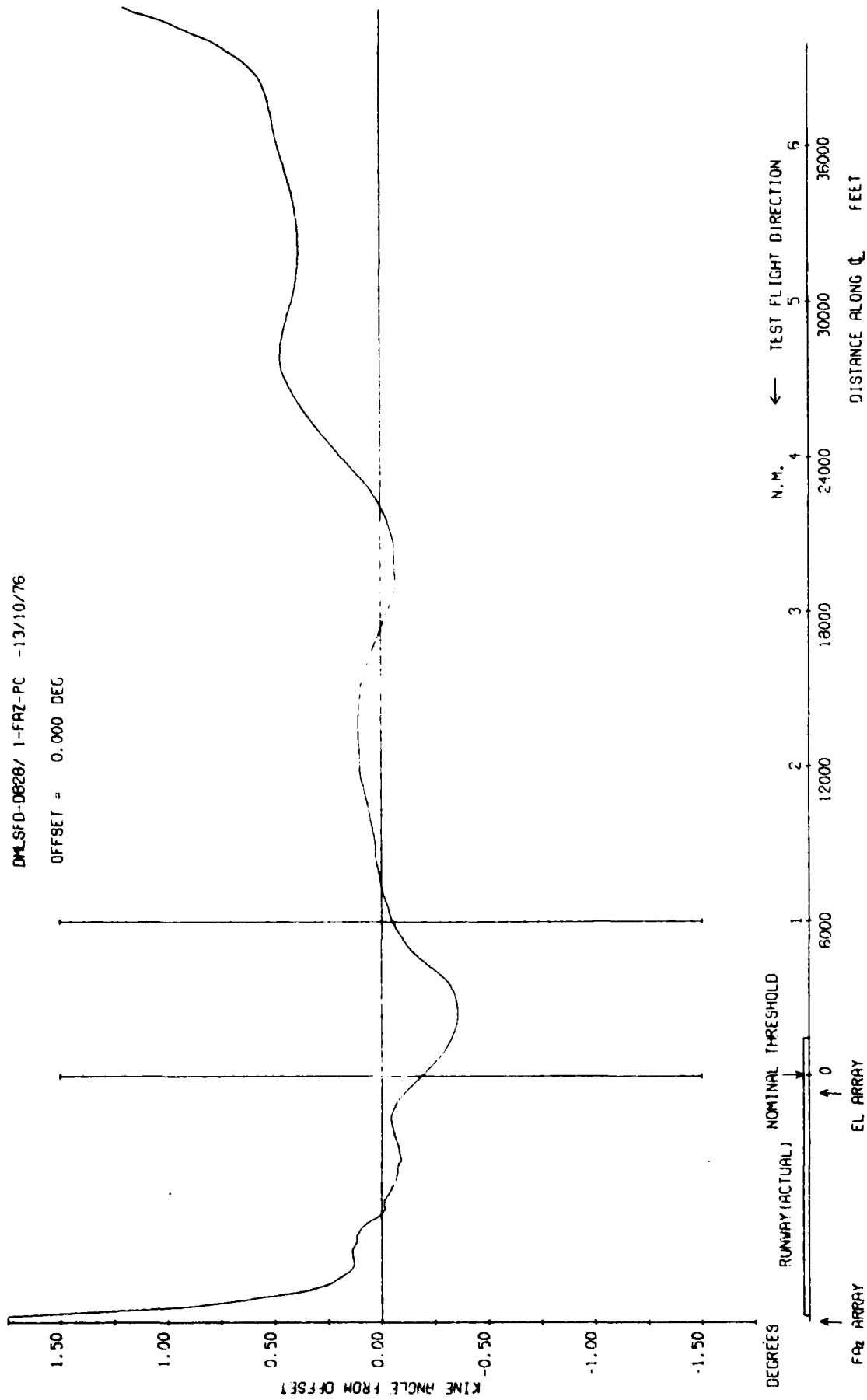


Fig 7.18a

Fig 7.18a Azimuth 3 degree approach to low overshoot

Fig 7.18b

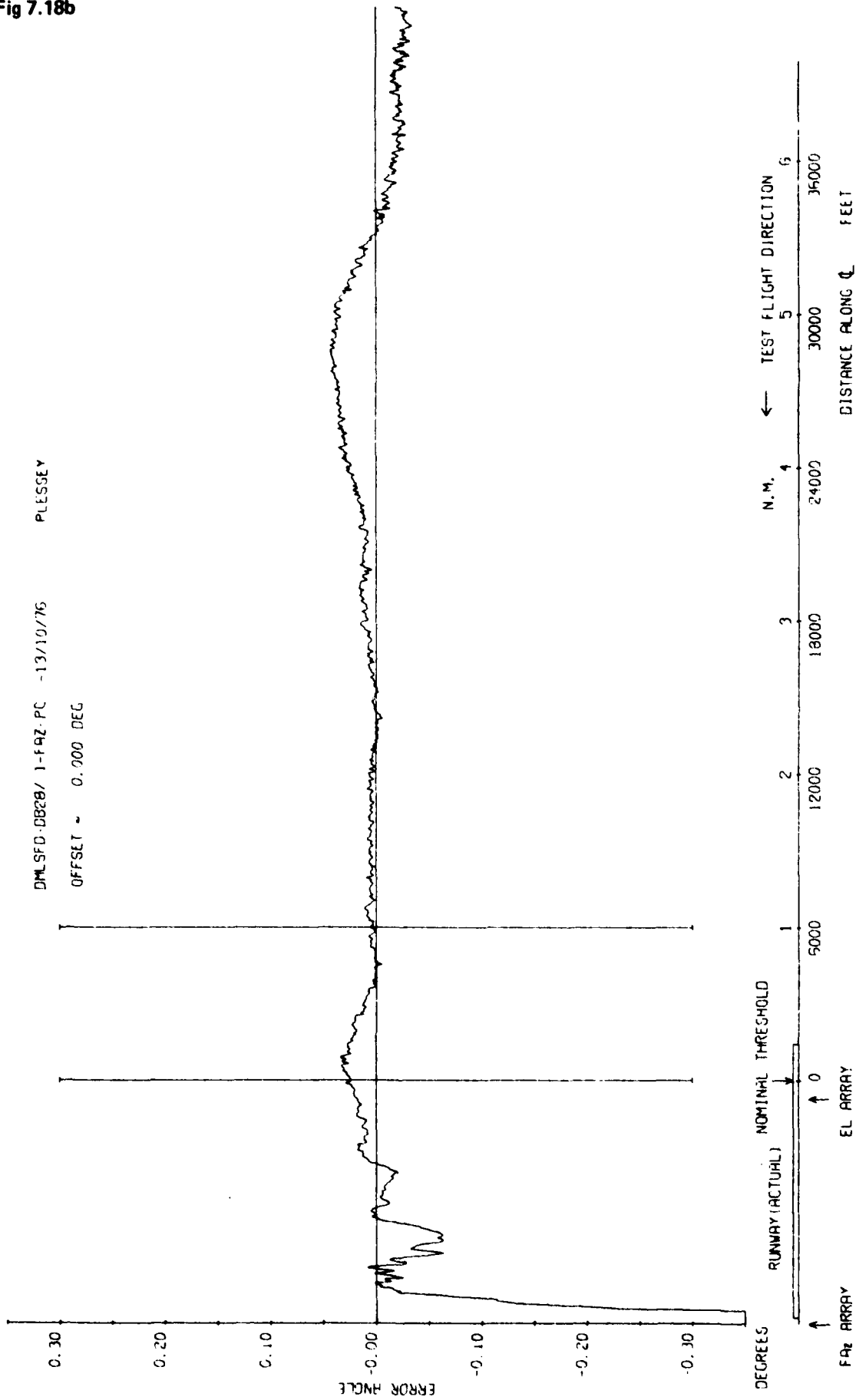


Fig 7.18b Azimuth 3 degree approach to low overshoot

DML JCS DE-2/J 5-44Z-PC -13/10/76

OFFSET - 0.000 DEG

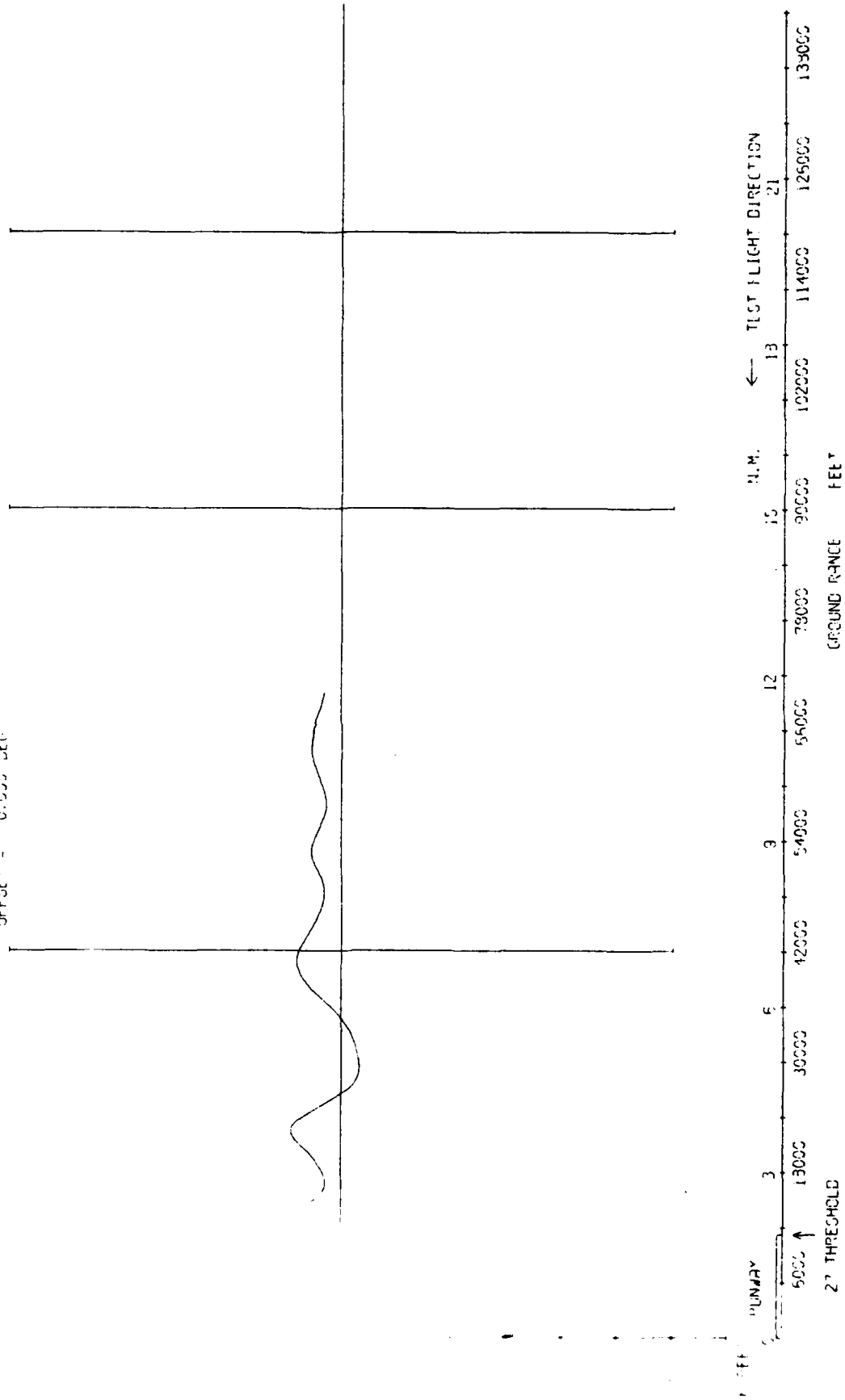


Fig 7.19a

Fig 7.19a Azimuth radial at 5000 ft

Fig 7.19b

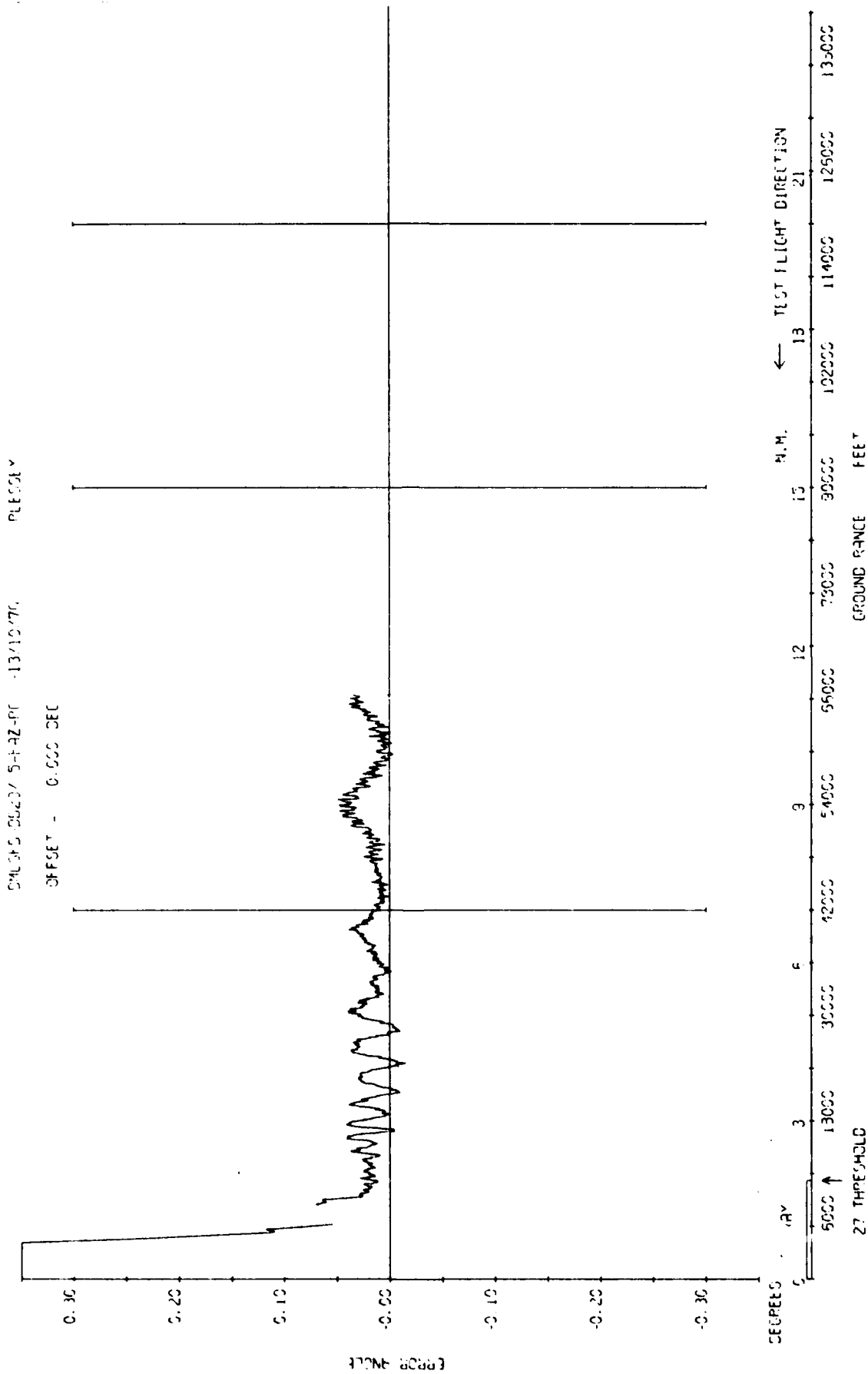
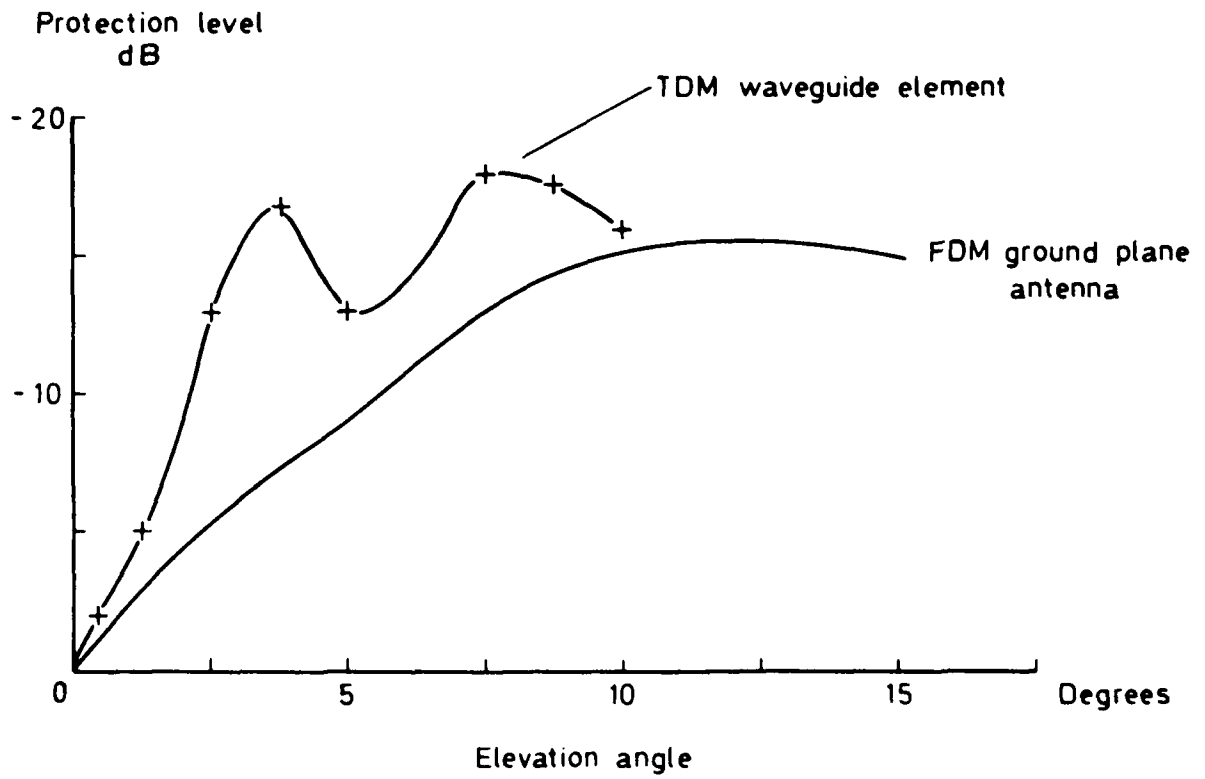


Fig 7.19b Azimuth radial at 5000 ft



TR 79052

Fig 7.20 Azimuth antenna ground reflection attenuation factors

Fig 7.21a

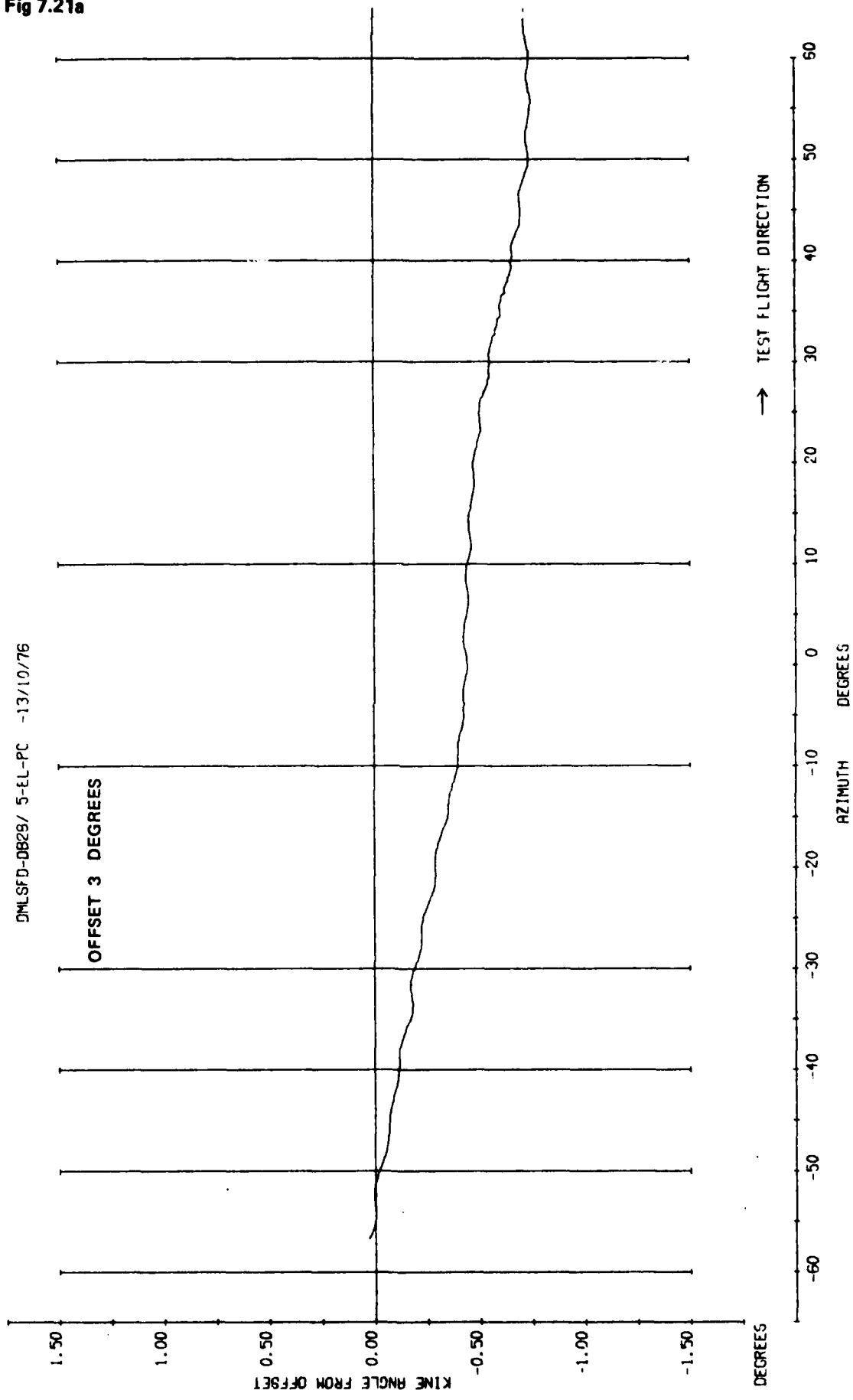


Fig 7.21a Elevation part orbit at 2.6 degrees elevation

TR 79062

DELJFS 0543/ S-CL-FC -13/10/76 PLESSEY

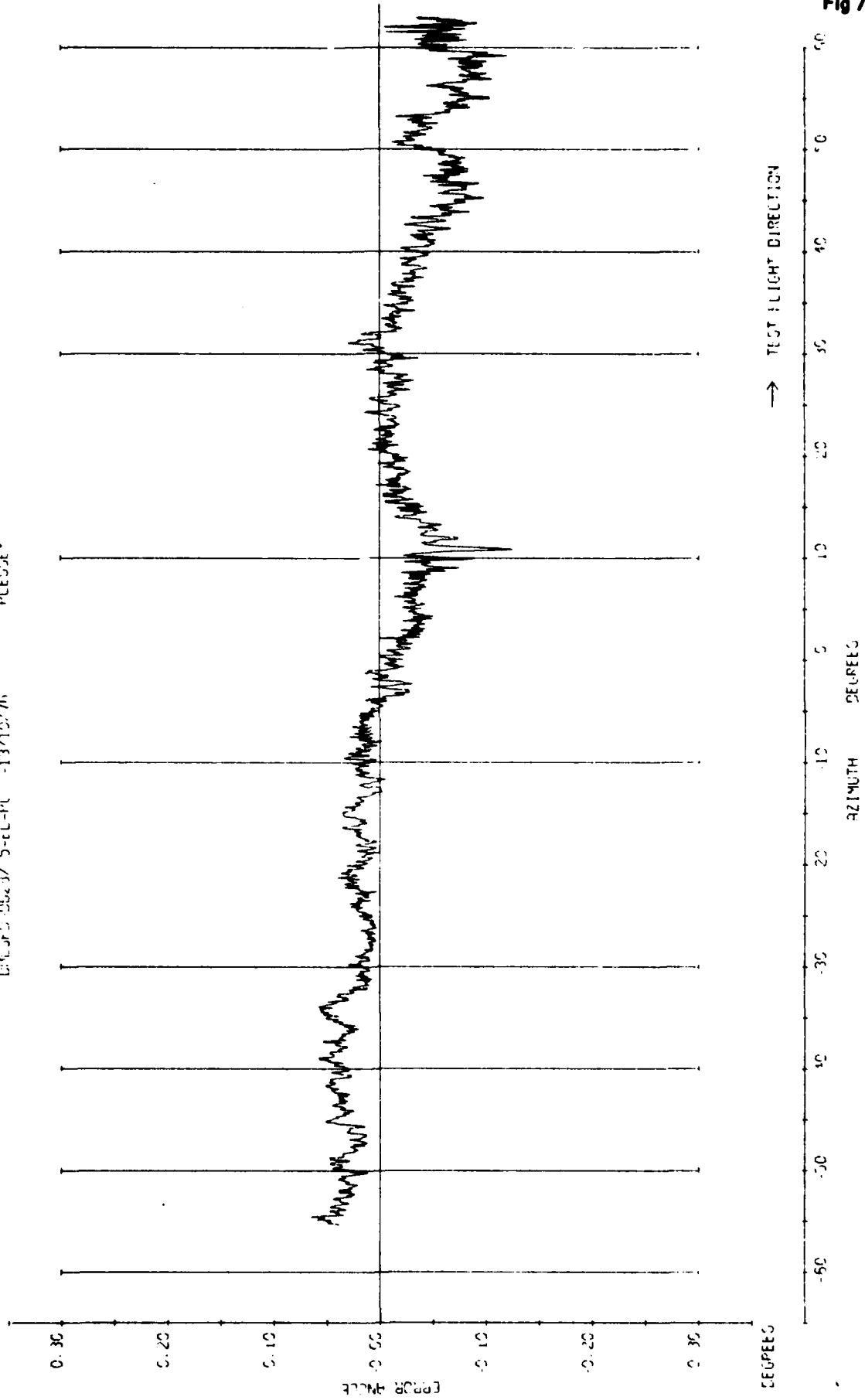


Fig 7.21b

Fig 7.21b Elevation part orbit at 2.6 degrees elevation

Fig 7.22a

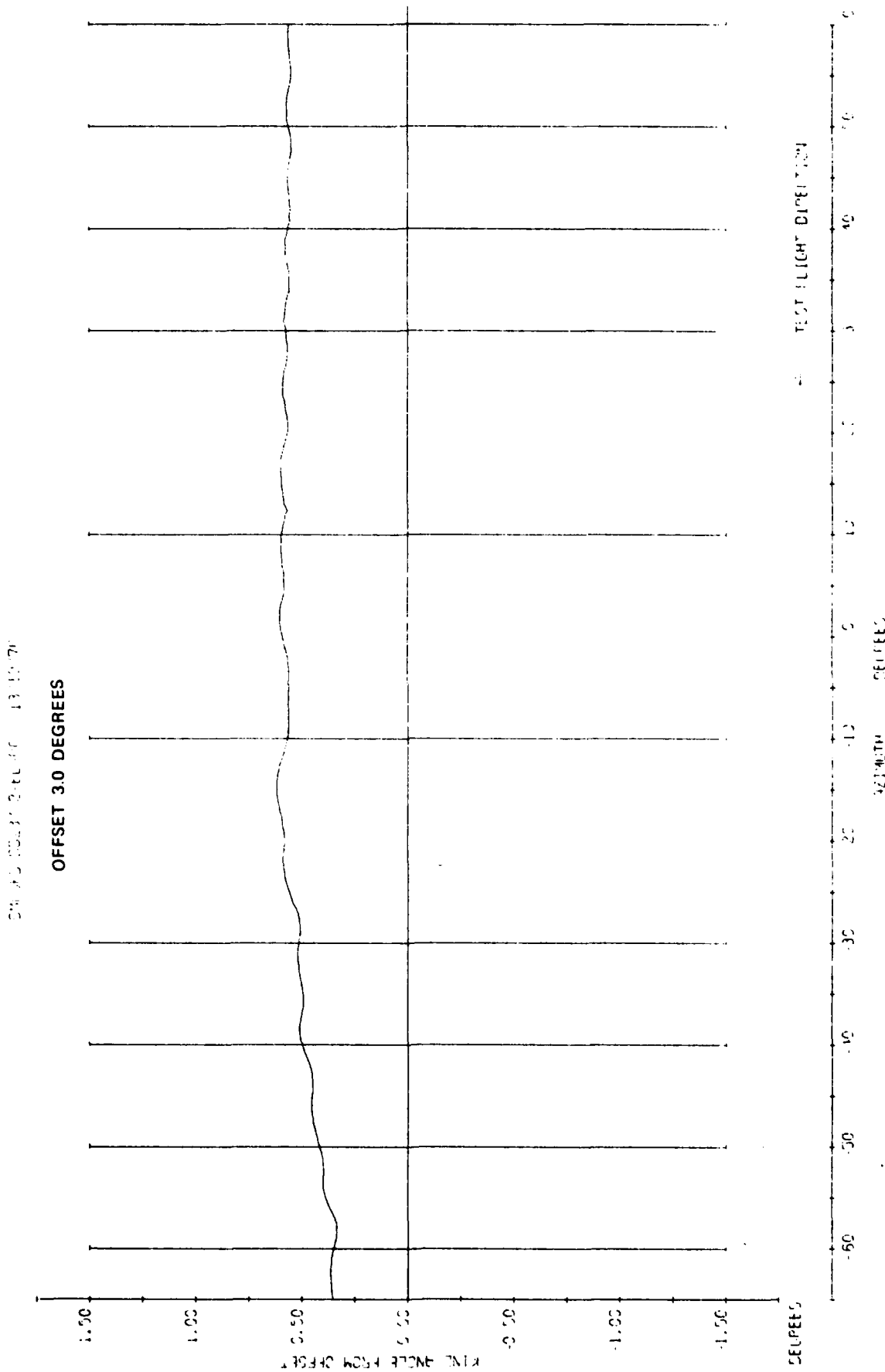


Fig 7.22a Elevation part orbit at 3.5 degrees elevation

TR 79052

1341076

085087

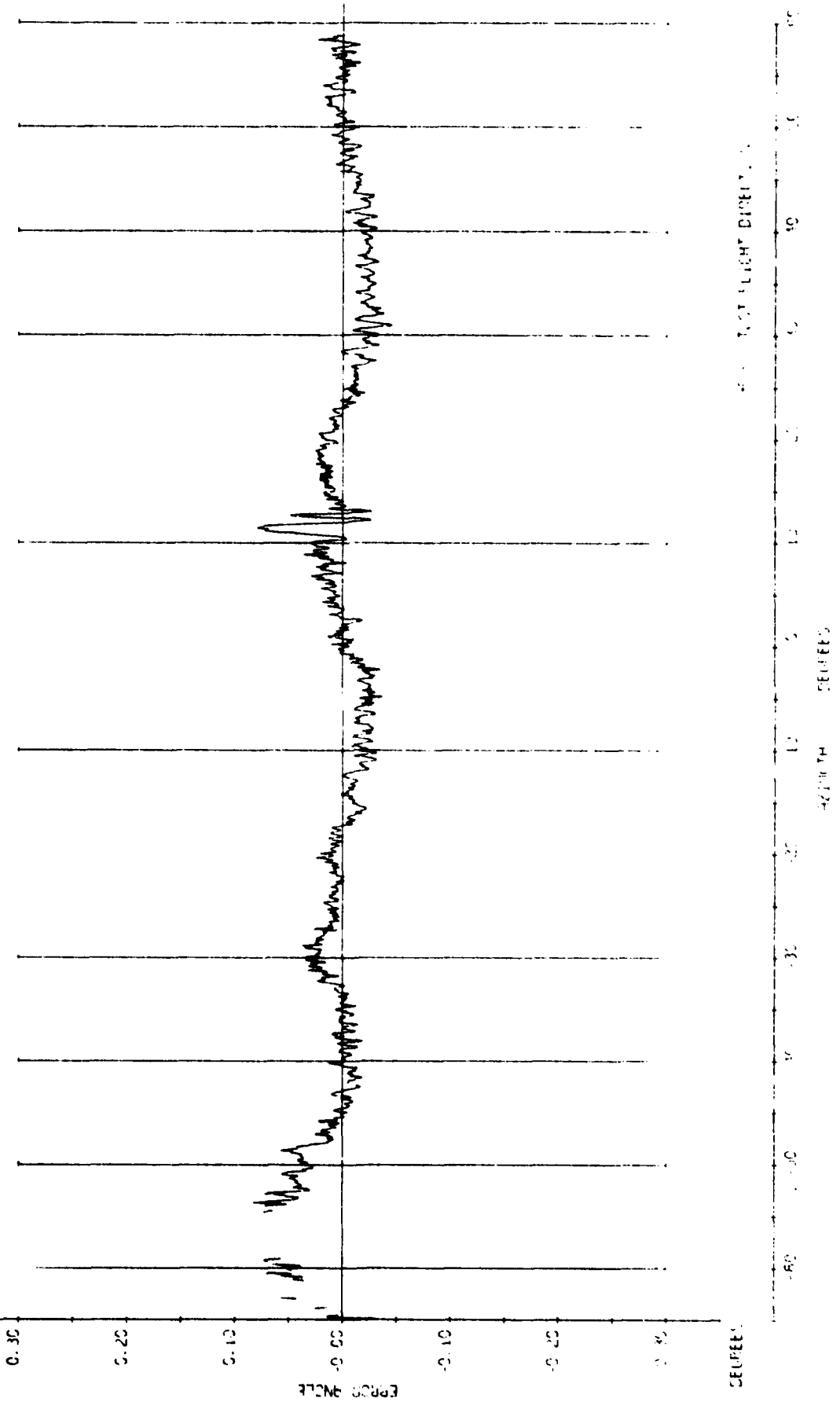


Fig 7.22b

Fig 7.22b Elevation part orbit at 3.5 degrees elevation

Fig 7.23a

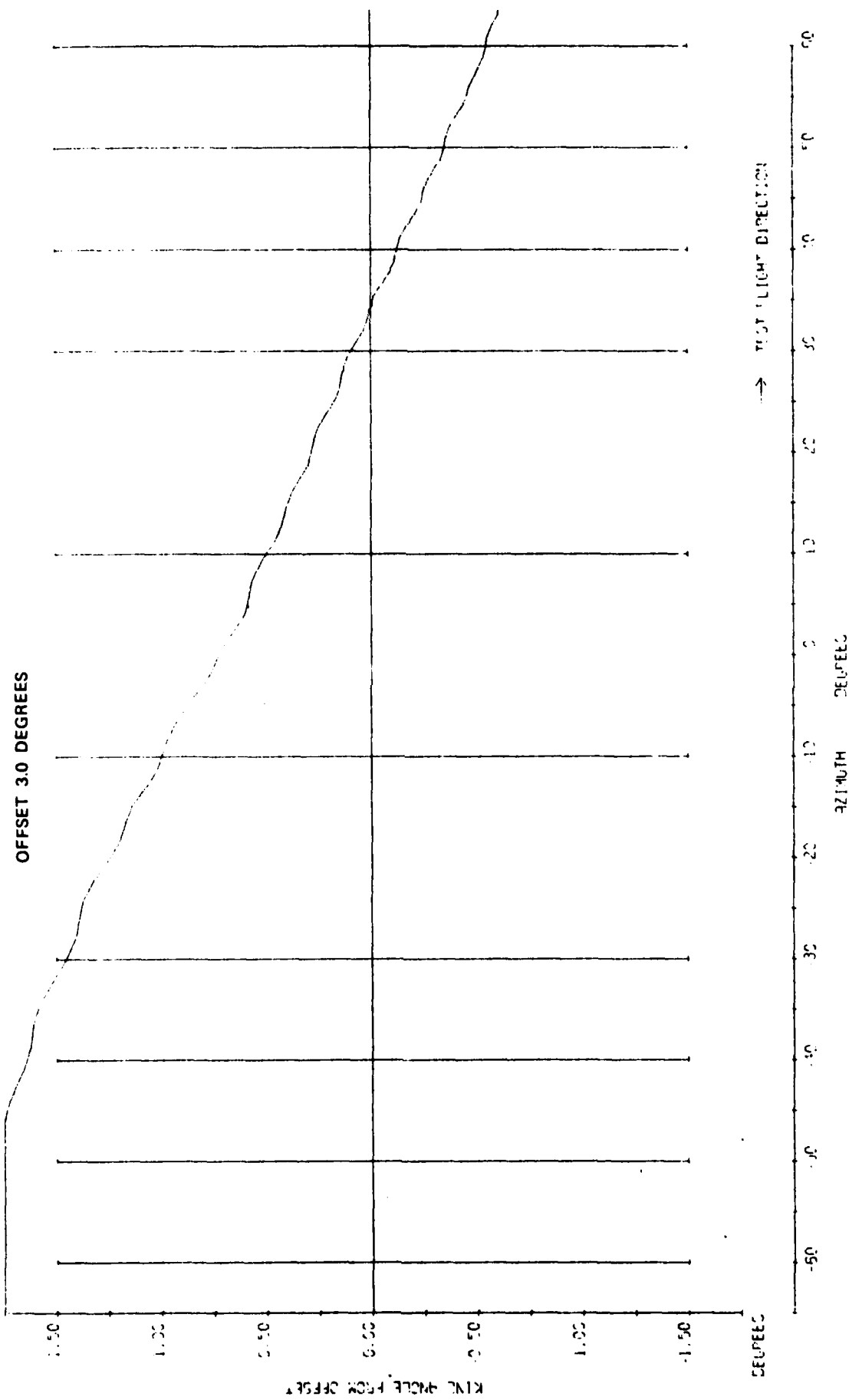


Fig 7.23a Elevation part orbit at 3.75 degrees elevation

EM-115-0563/ 3-EL-PC -13/10/76 PLESLEY

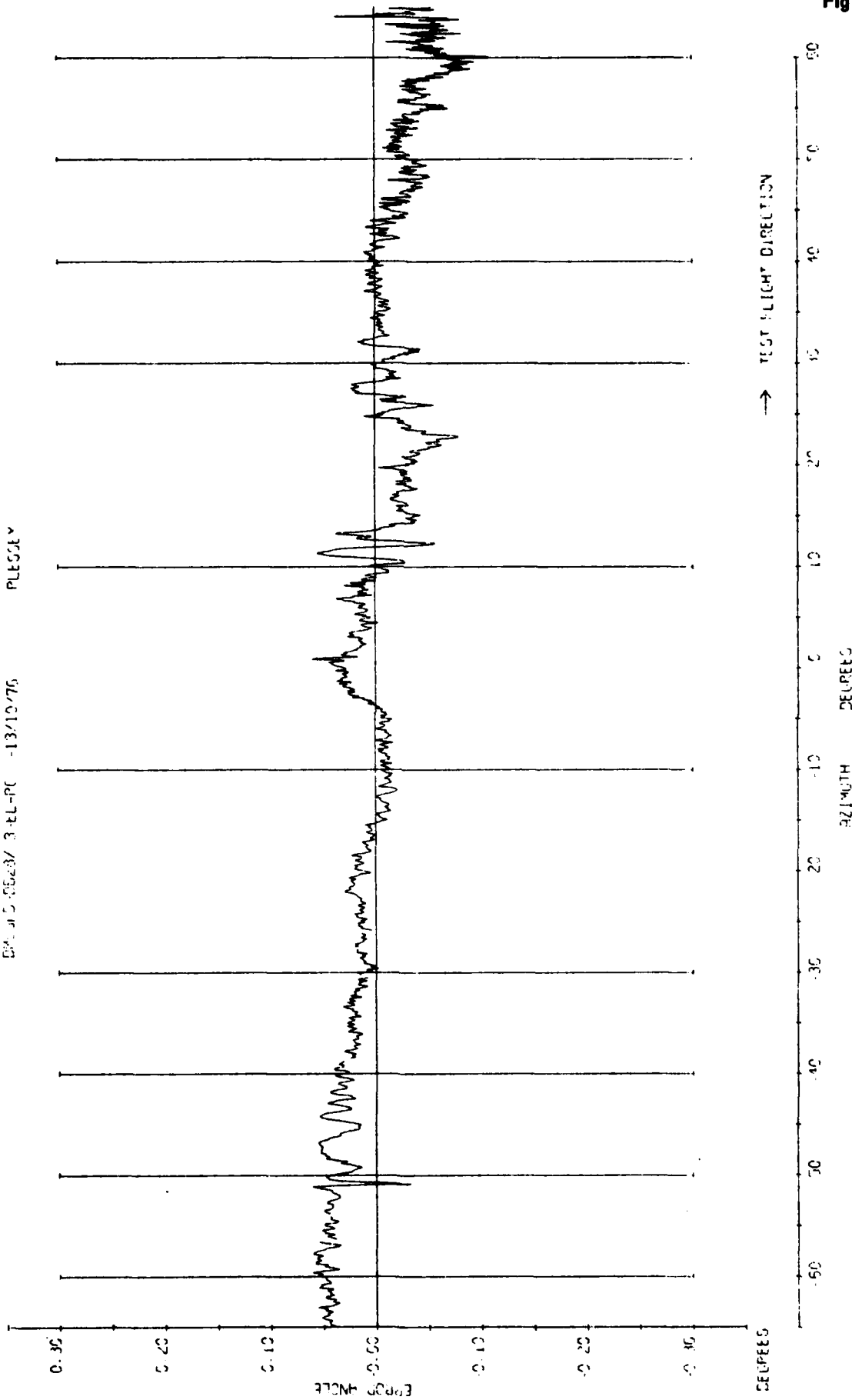


Fig 7.23b

Fig 7.23b Elevation part orbit at 3.75 degrees elevation

Fig 7.24a

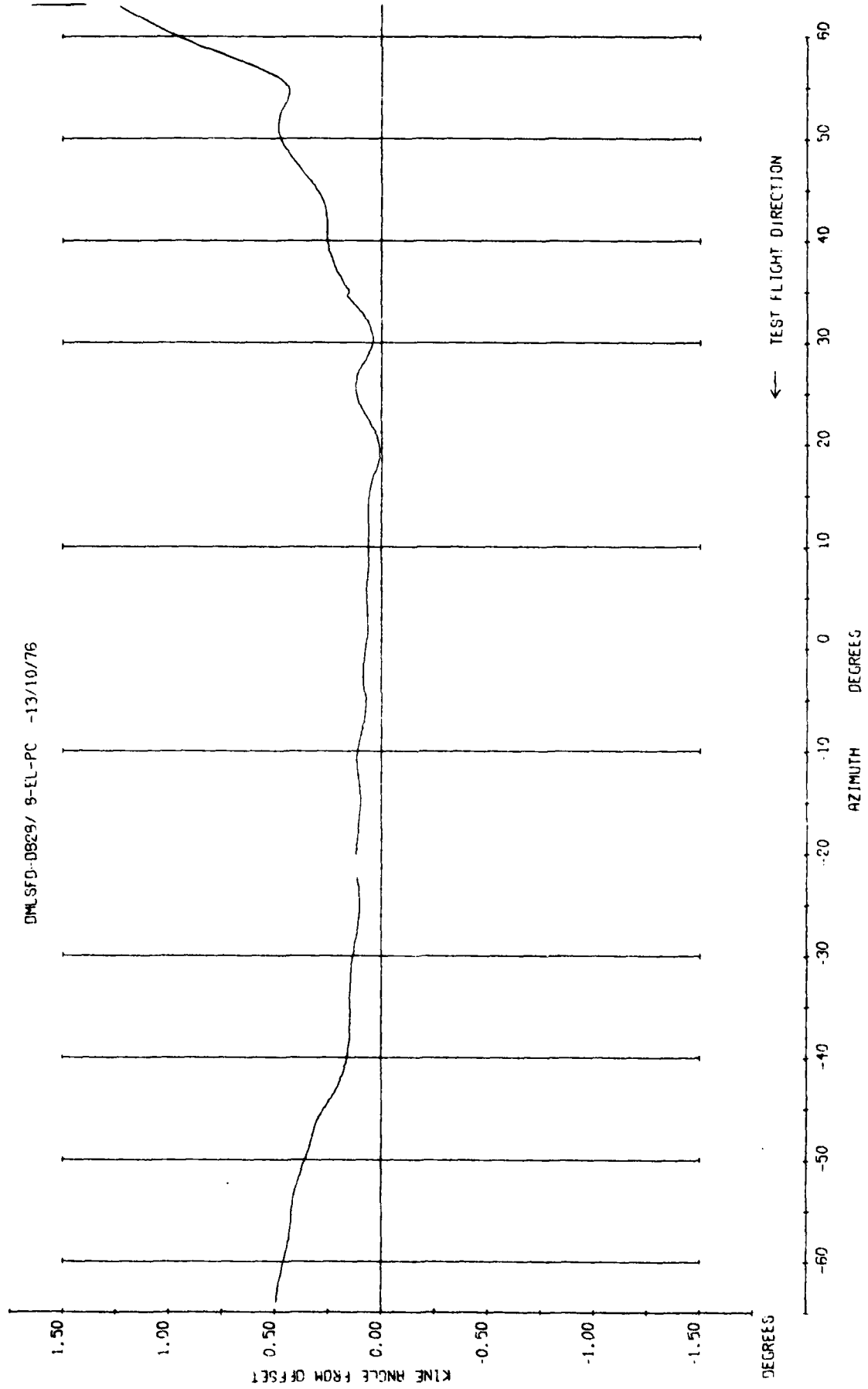


Fig 7.24a Elevation part orbit at 6.5 degrees elevation

TR 79082

DML SFD-0528/ 8-EL-PC -13/10/76 PLESSEY

ELEVATION ANGLE = 6.5°

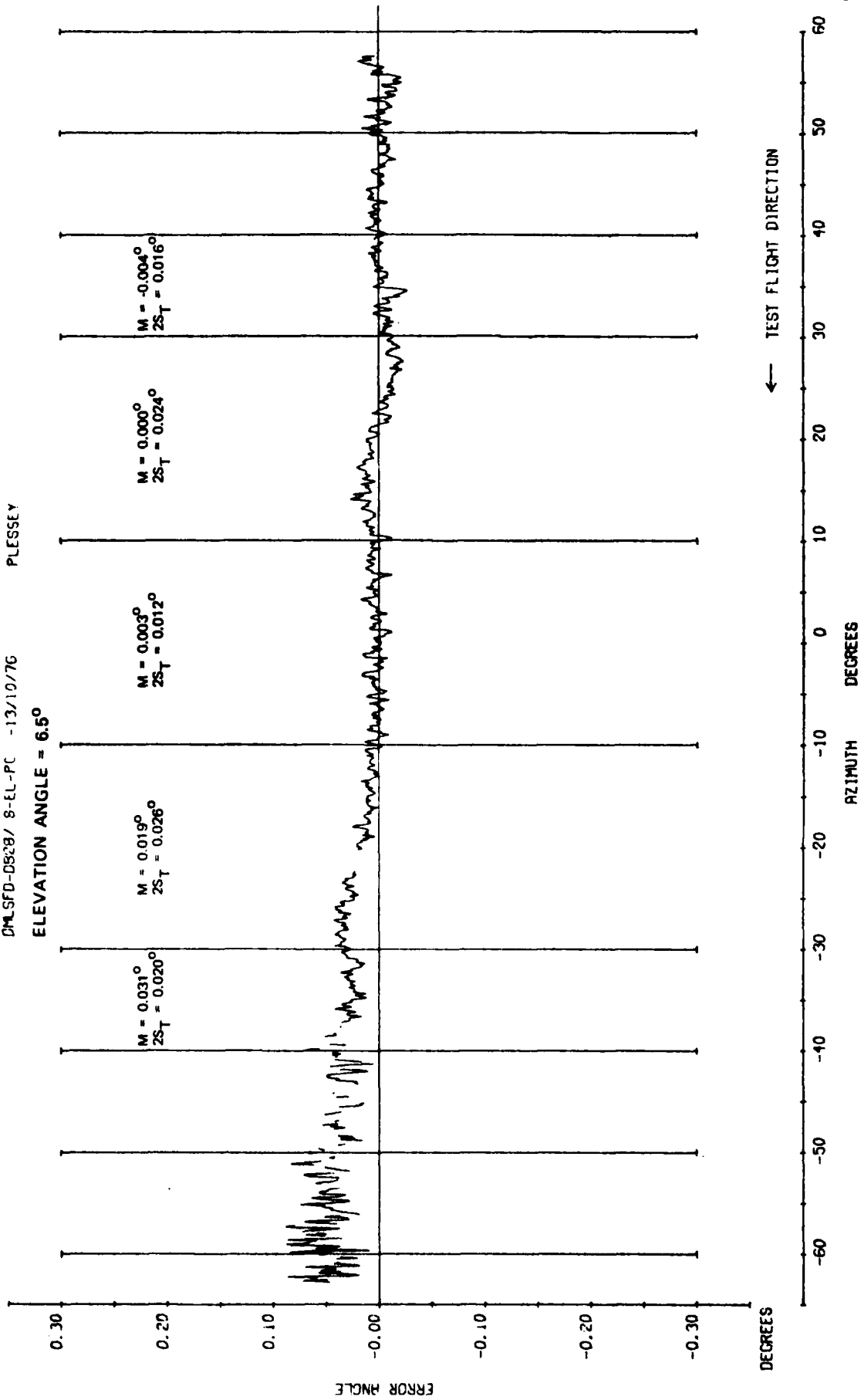


Fig 7.24b

Fig 7.24b Elevation part orbit at 6.5 degrees elevation

Fig 7.25a

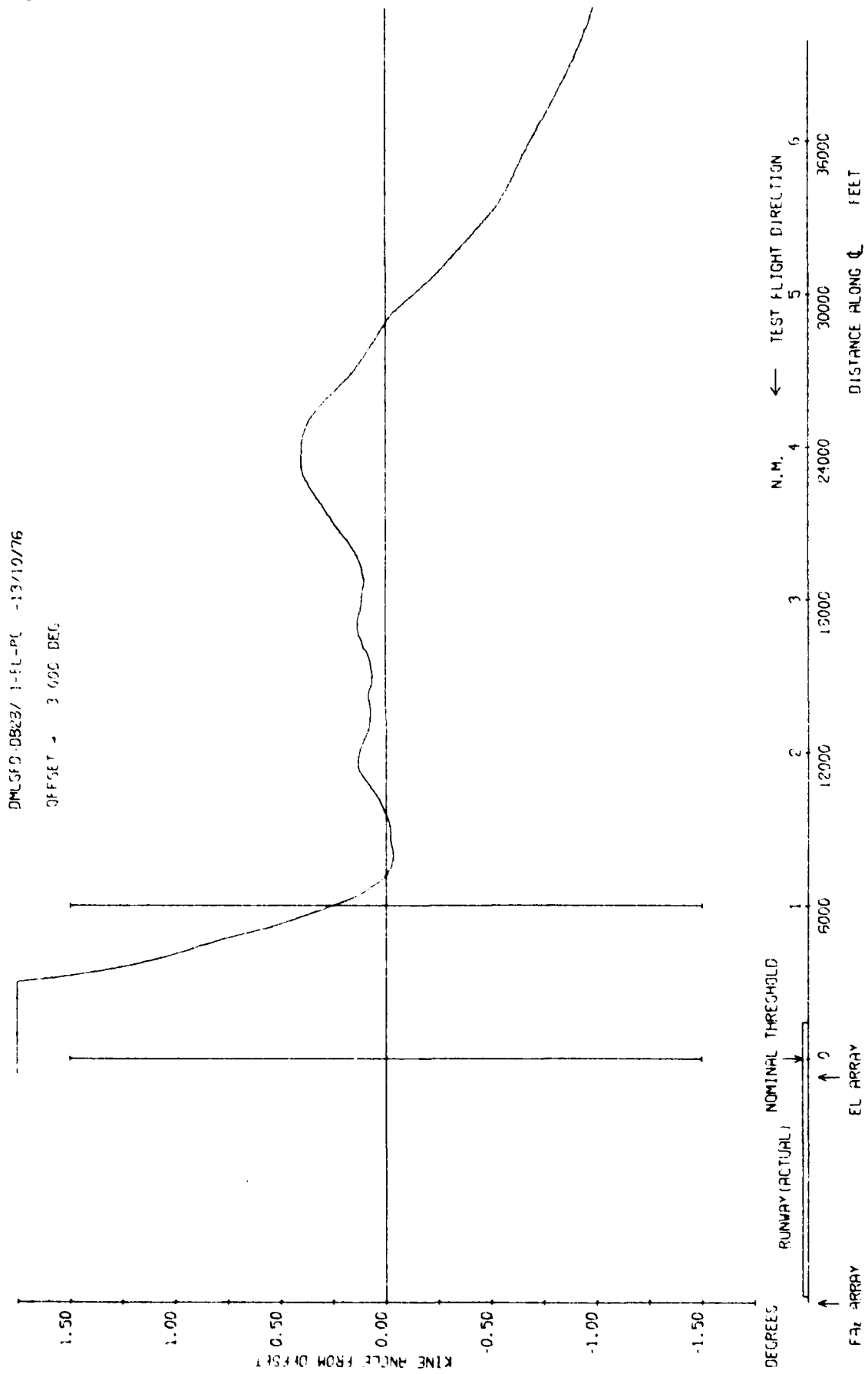


Fig 7.25a Elevation 3 degree approach

TR 79052

DMLSFD DB29/ 1-EL-PC -13/10/76 PLESSEY
OFFSET = 3.000 DEG

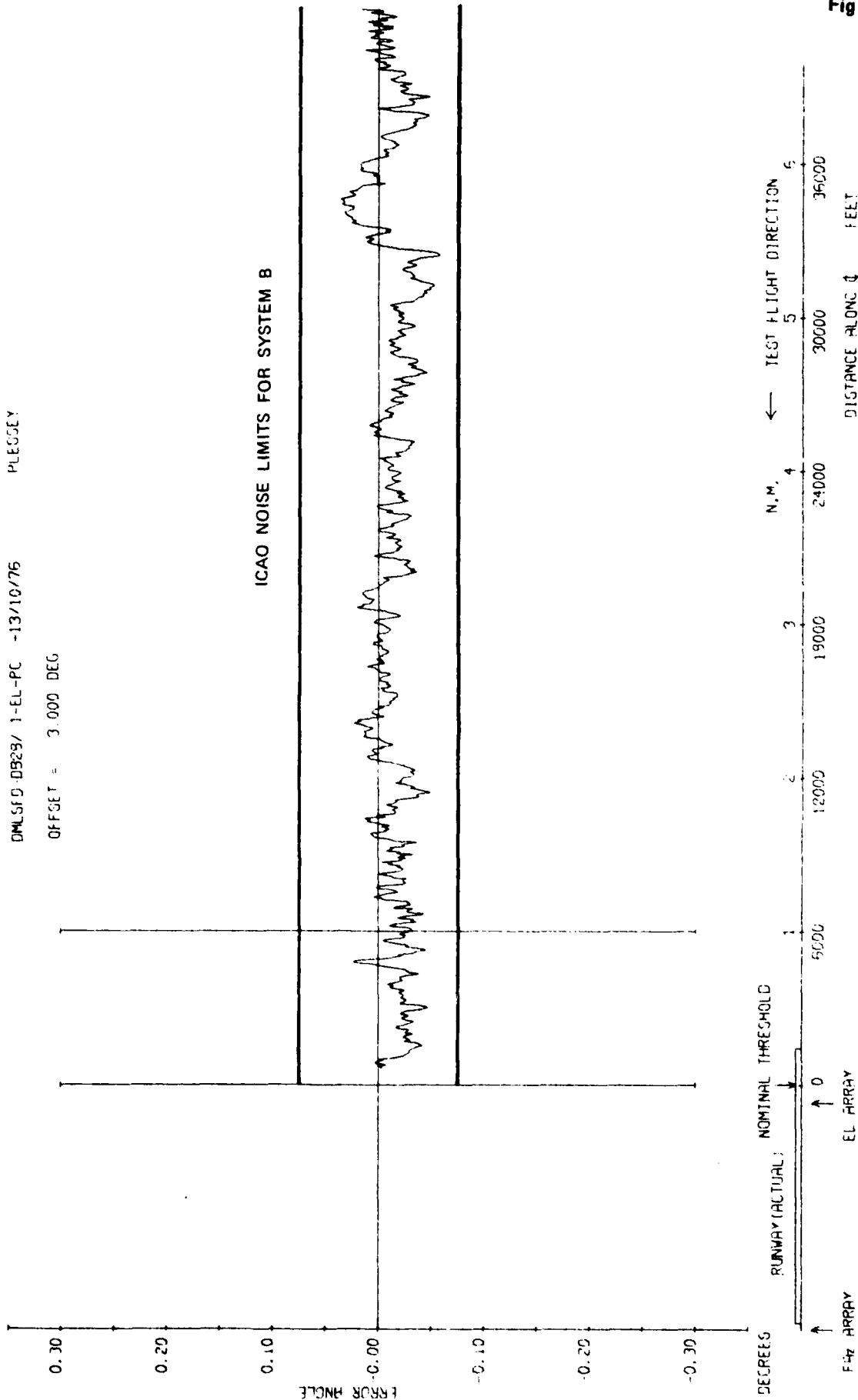


Fig 7.25b

Fig 7.25b Elevation 3 degree approach

Fig 7.26a

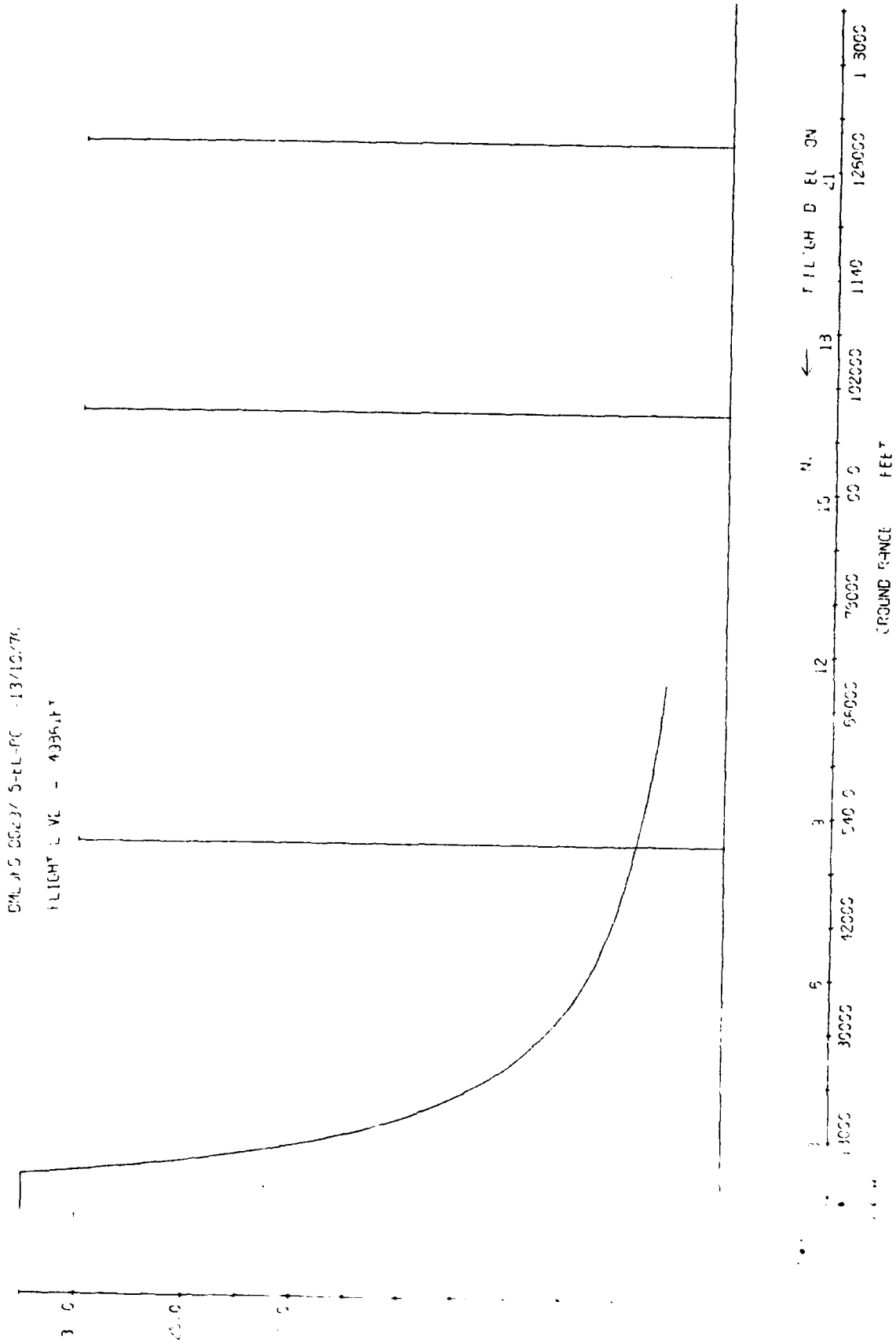


Fig 7.26a Elevation radial at 5000 ft

AD-A085 480

ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND)
CONTRIBUTIONS TO THE UK MICROWAVE LANDING SYSTEM RESEARCH AND D--ETC(U)
MAY 79 J M JONES

F/6 17/7

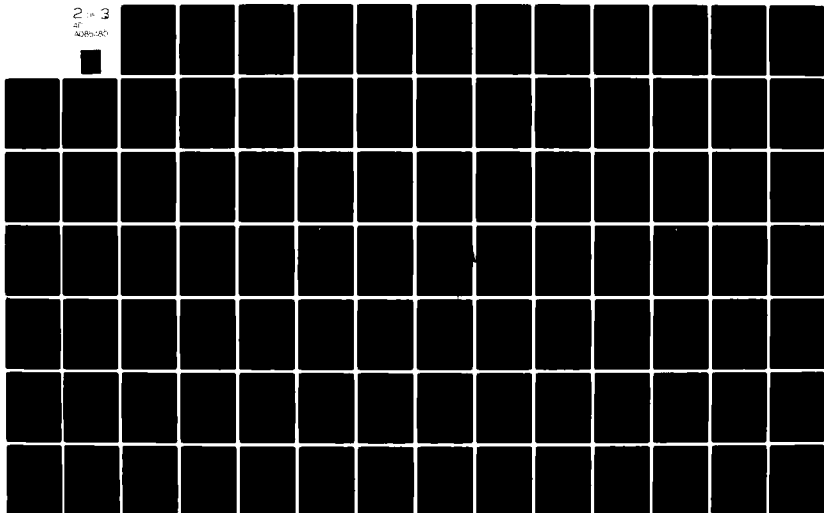
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2 of 3
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TR 79062

DRG JLS 0823/ 5-EL-PC -13/12/76 PLE55A
FLIGHT LEVEL - 43361 FT

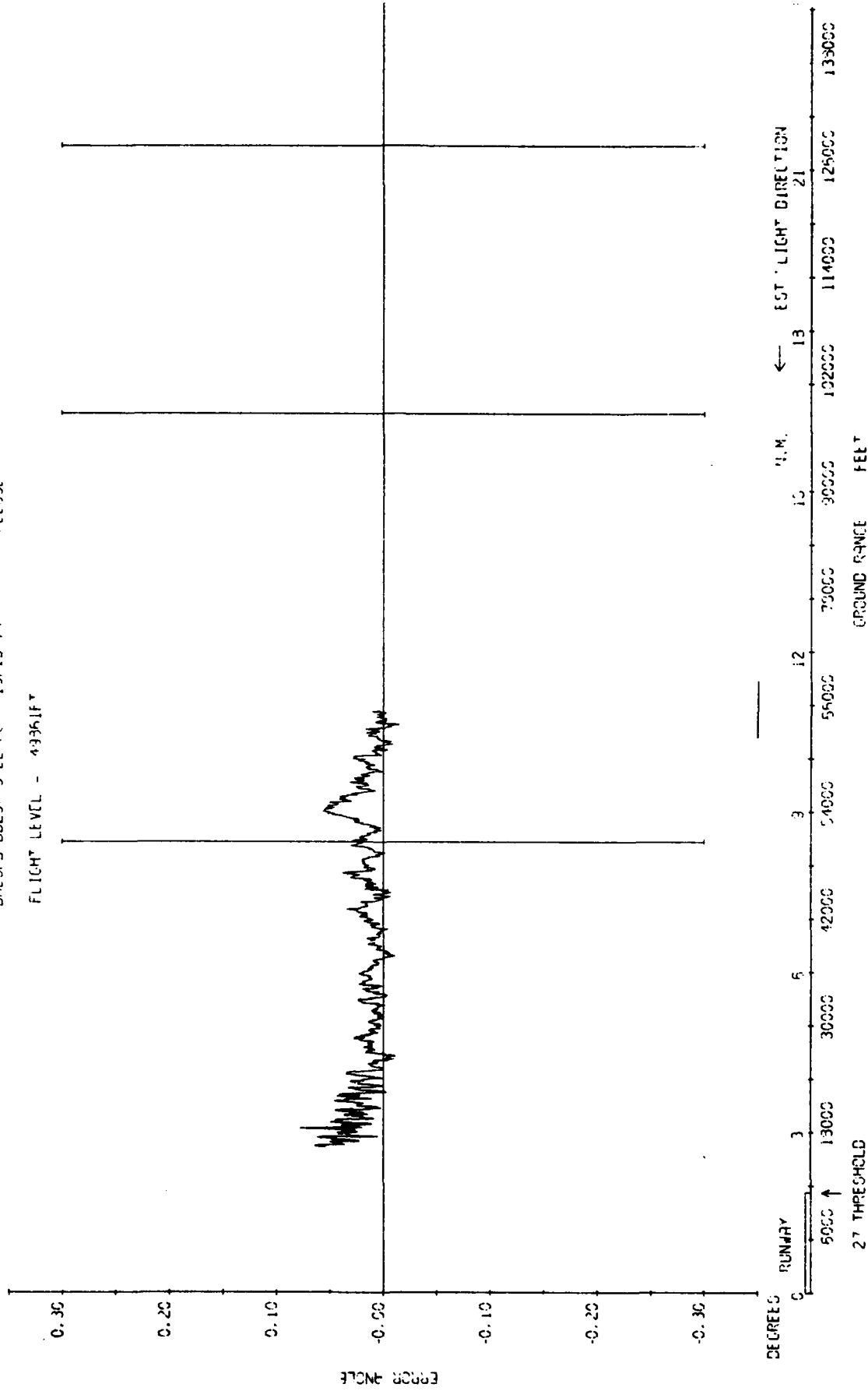


Fig 7.26b

Fig 7.26b Elevation radial at 5000 ft

Fig 7.27a

DMLSFD-0A73/ 3-EL-PC -03/03/77

FLIGHT LEVEL = 2044 FT

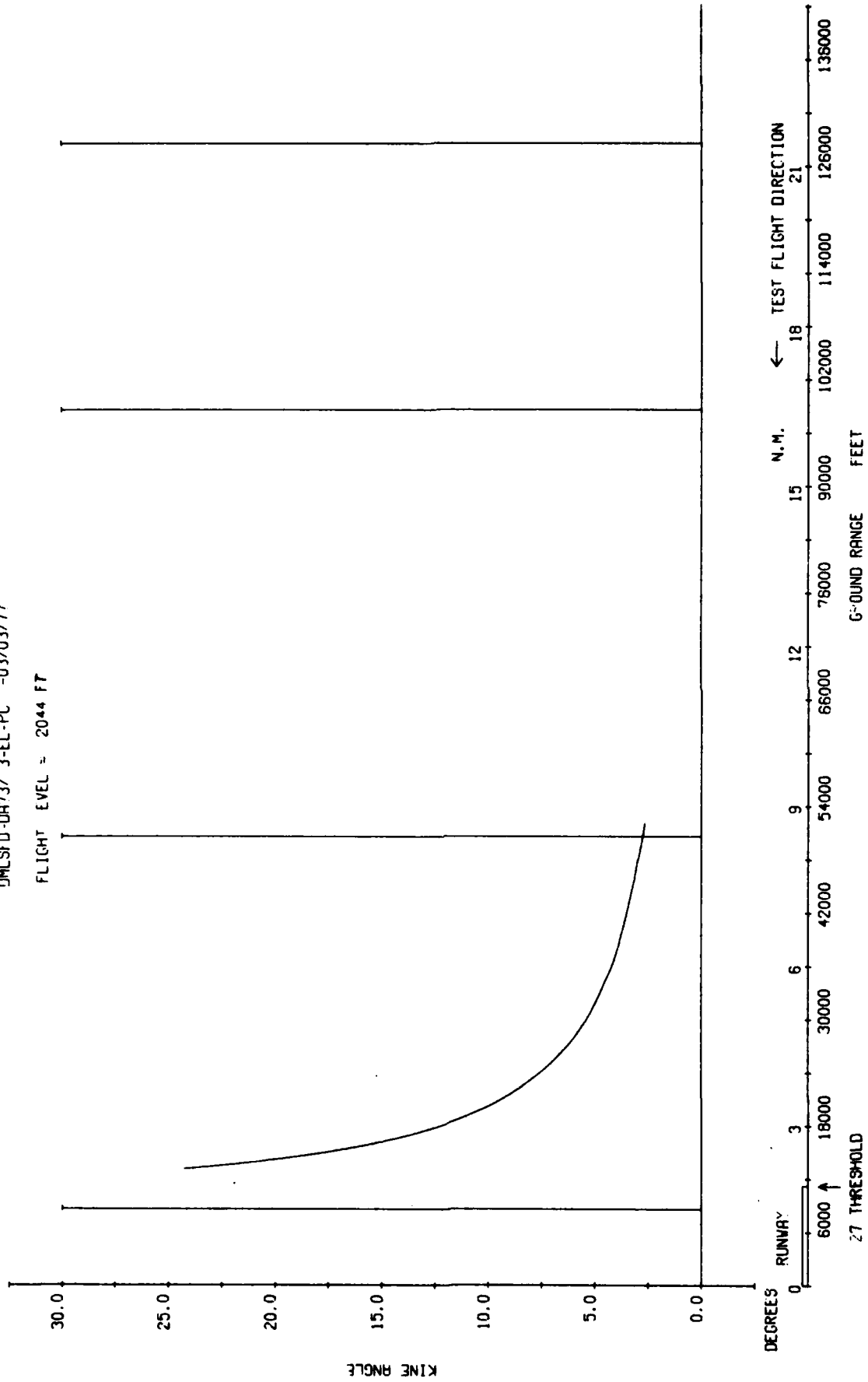


Fig 7.27a Elevation 54λ, constant height radial at 2044 ft

TR 79052

DMLSFD-DA / 3-EL-PC -03/03/77
FLIGHT LEVEL = 2044 FT

PLESSEY

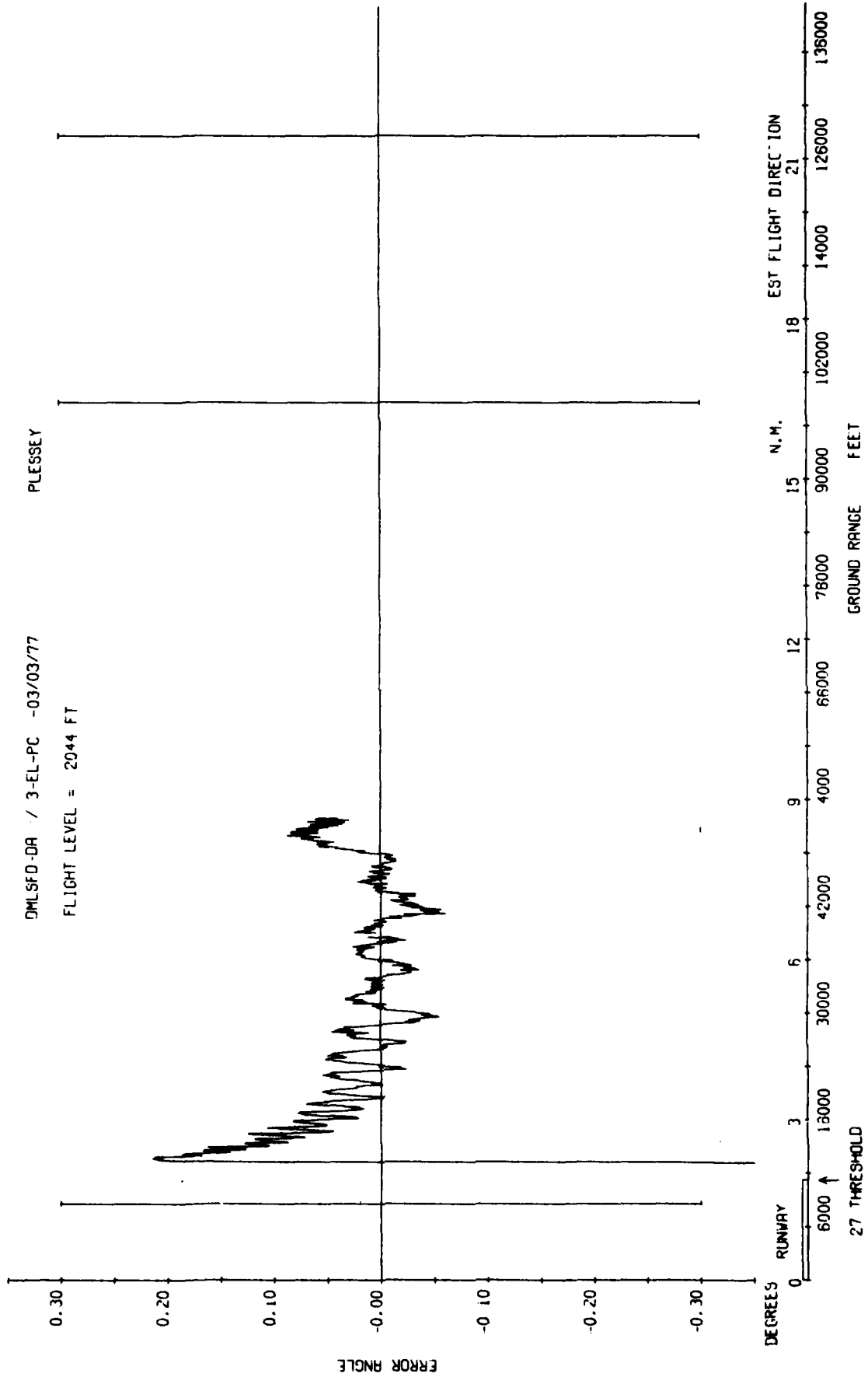


Fig 7.27b Elevation 54, constant height radial at 2044 ft

Fig 7.28

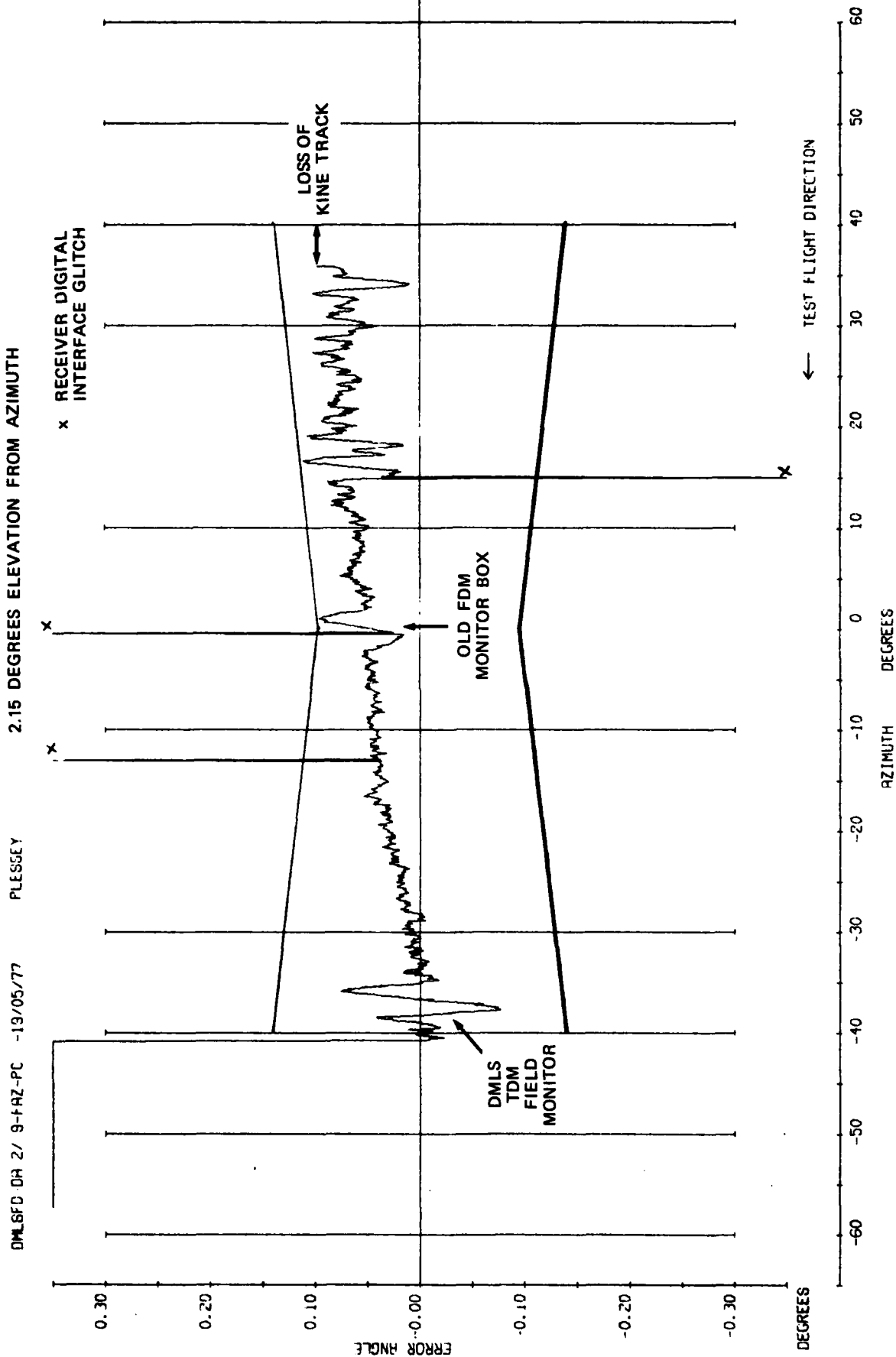


Fig 7.28 Azimuth 54λ, part orbit at 6.8 n mile and height 1540 ft

TR 79062

DMLSFD-DR 3/ 4-FRZ-PC -20/05/77

PLESSEY

2.2 DEGREES ELEVATION FROM AZIMUTH

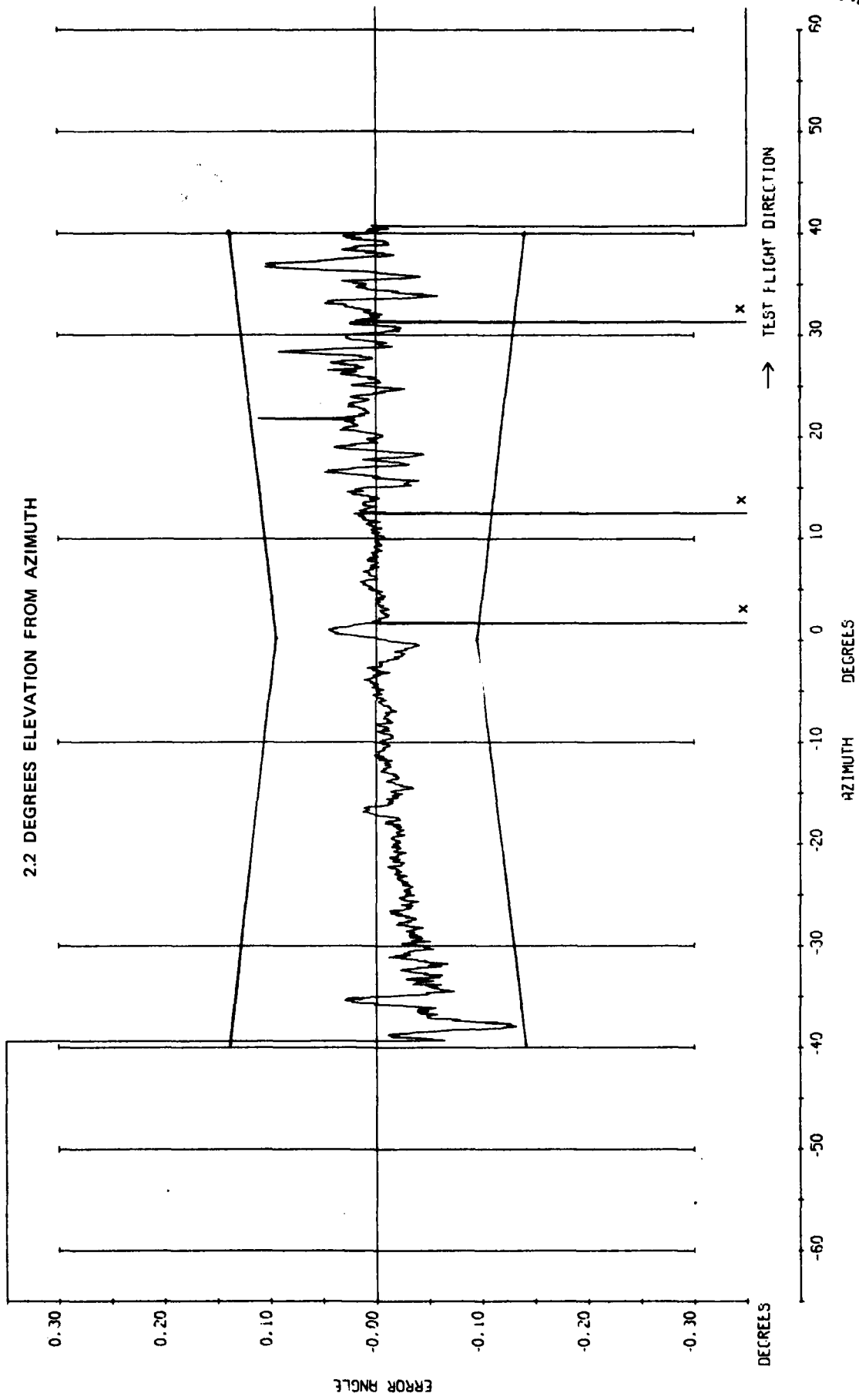


Fig 7.29

Fig 7.29 Azimuth 54λ, part orbit at 6.7 n mile and height 1554 ft

Fig 7.30

DMLSTD-DR10/ 3-F4Z-PC -27/05/77 PLESSEY
6.1 DEGREES ELEVATION FROM AZIMUTH

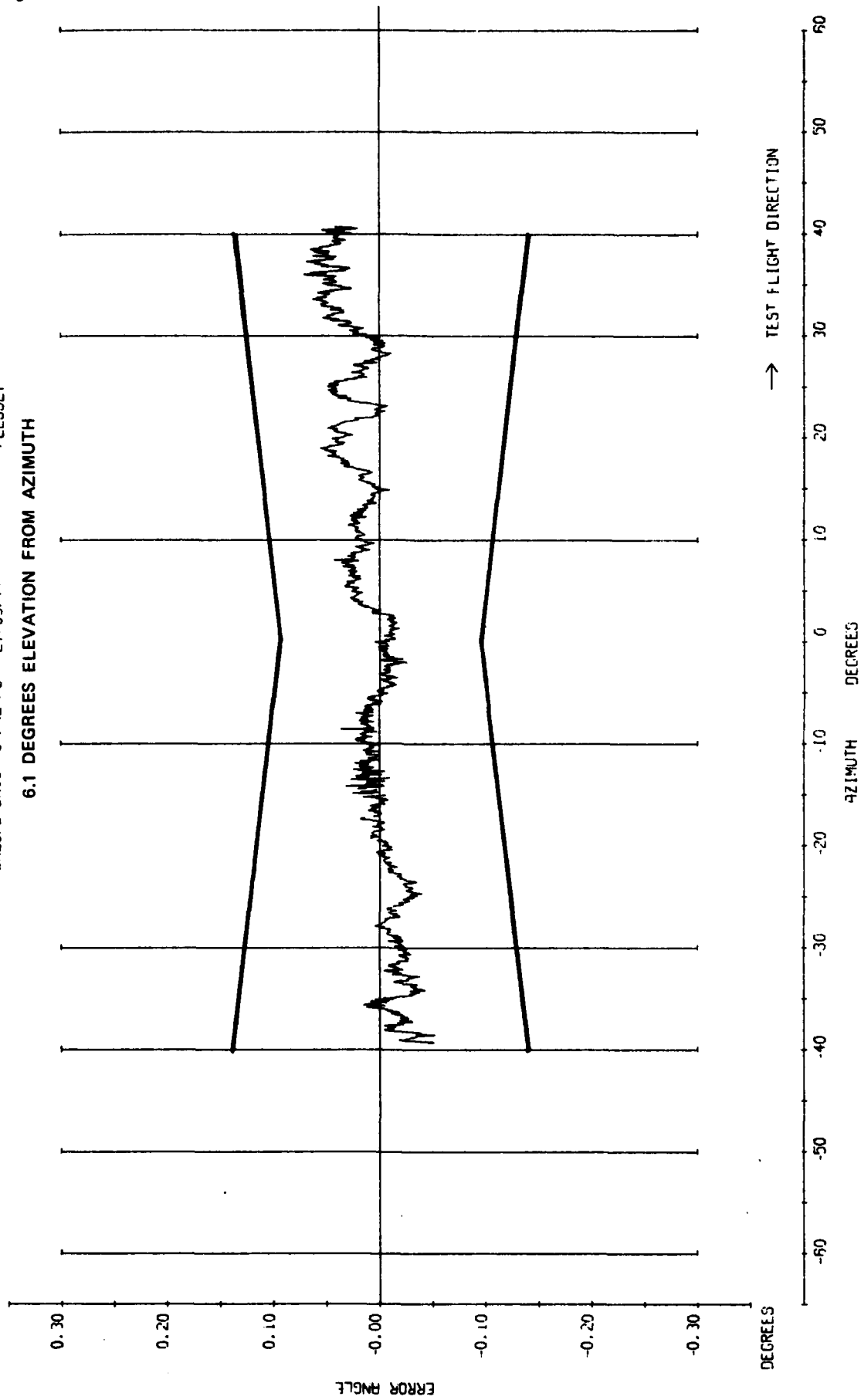


Fig 7.30 Azimuth 54λ, part orbit at 6.4 n mile height 4088 ft

DMLESD-DH10/ 4-FHZ-PC -27/05/77 PLESSEY

9.36 DEGREES ELEVATION FROM AZIMUTH

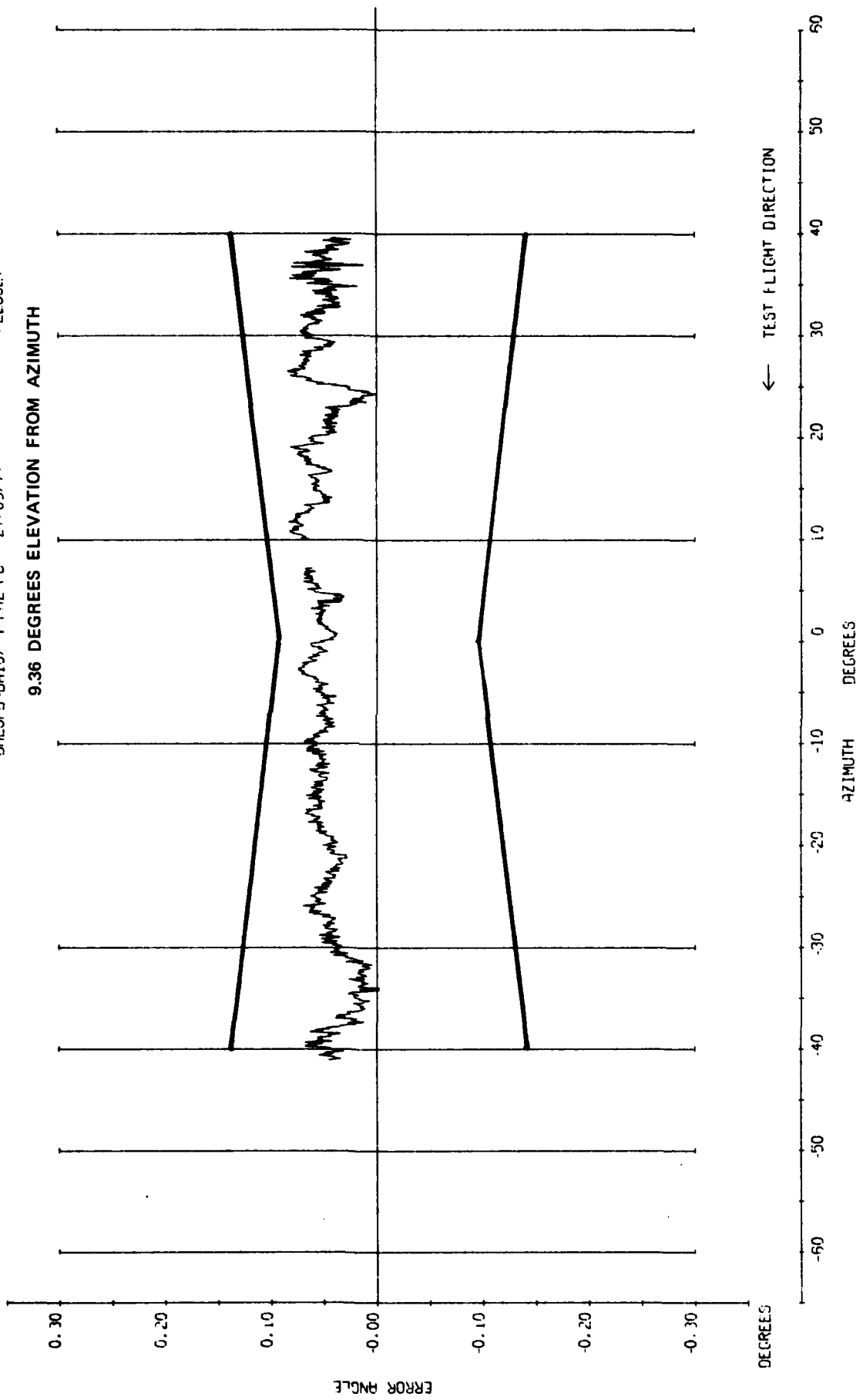


Fig 7.31

Fig 7.31 Azimuth part orbit at 6.5 n mile height 6498 ft

Fig 7.32

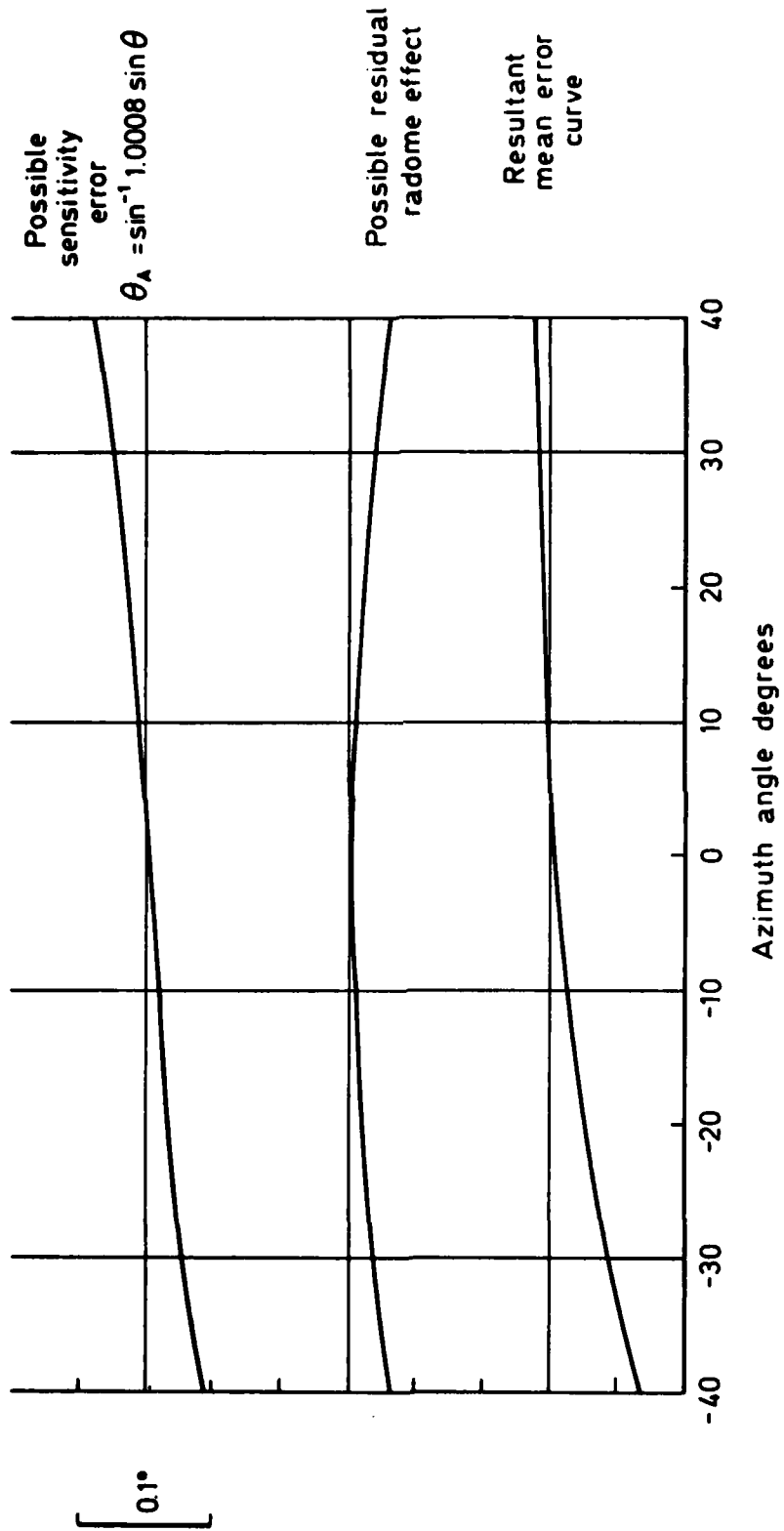


Fig 7.32 Probable source of orbital bias

TR 79082

DMLSFD-DA10/ 5-F4Z-PC -27/05/77

OFFSET = -35,000 DEG

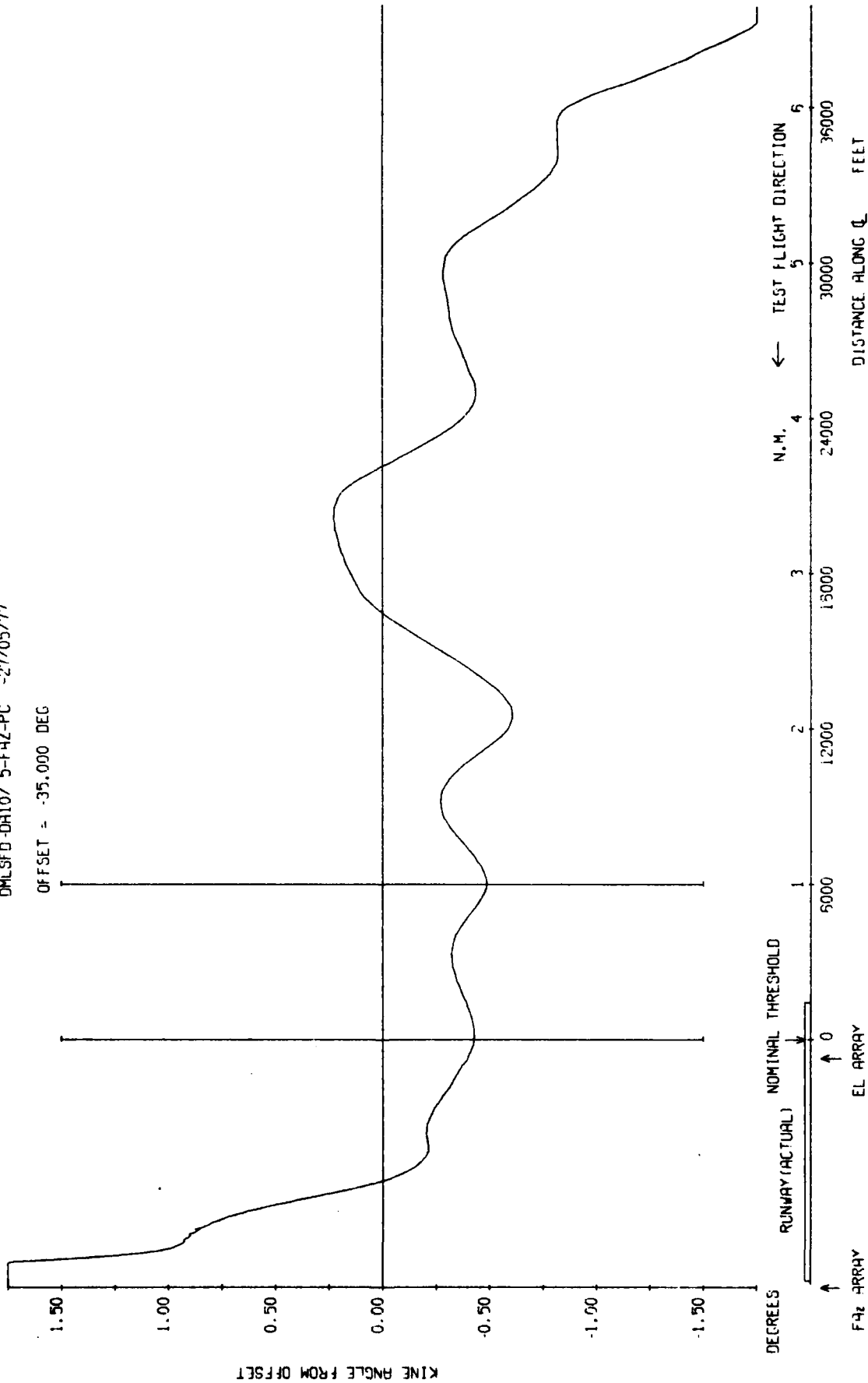


Fig 7.33a

Fig 7.33a Azimuth 54λ, constant height radial at 2000 ft and -35 degrees

Fig 7.33b

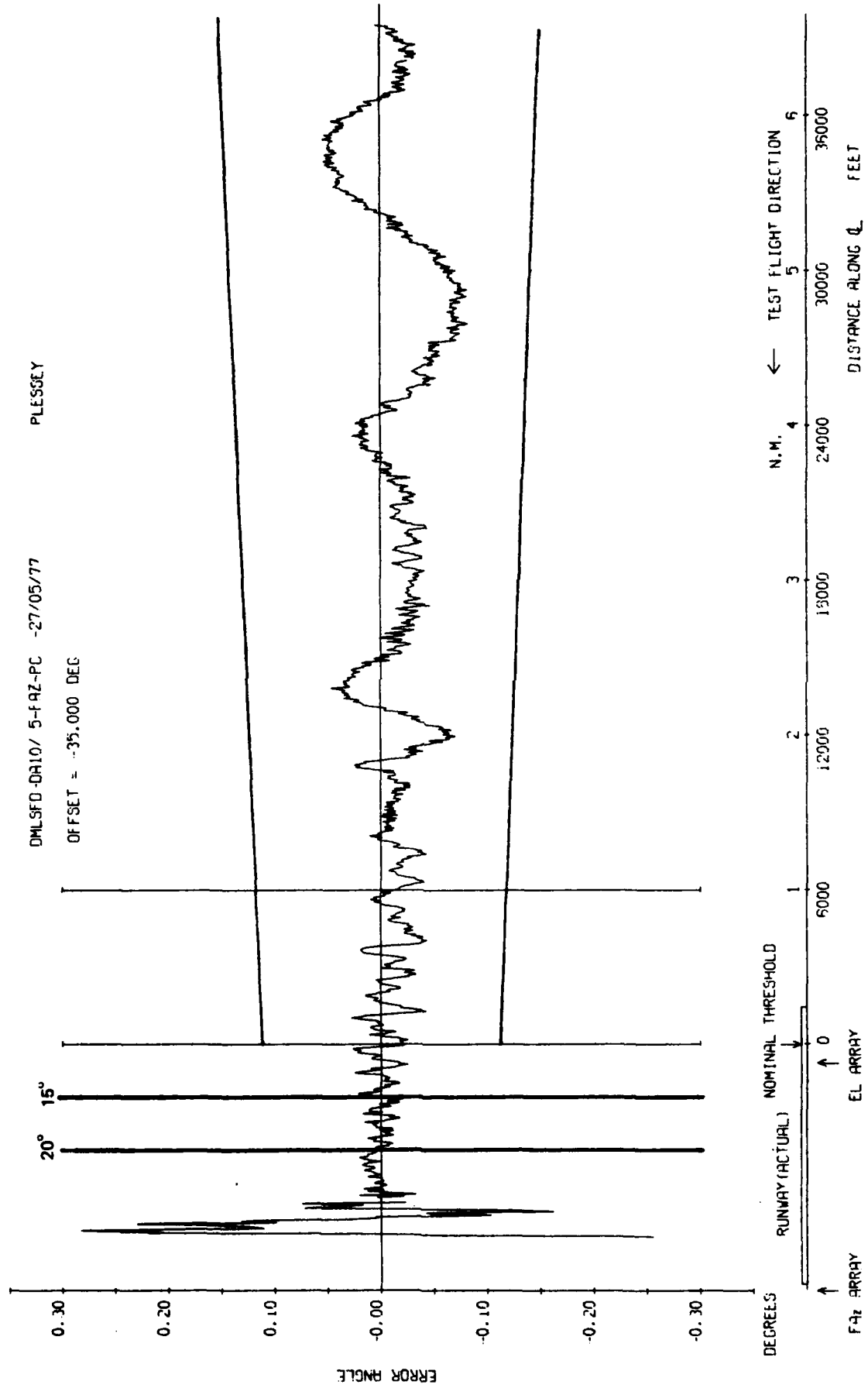


Fig 7.33b Azimuth 54°, constant height radial at 2000 ft and -35 degrees

TR 79052

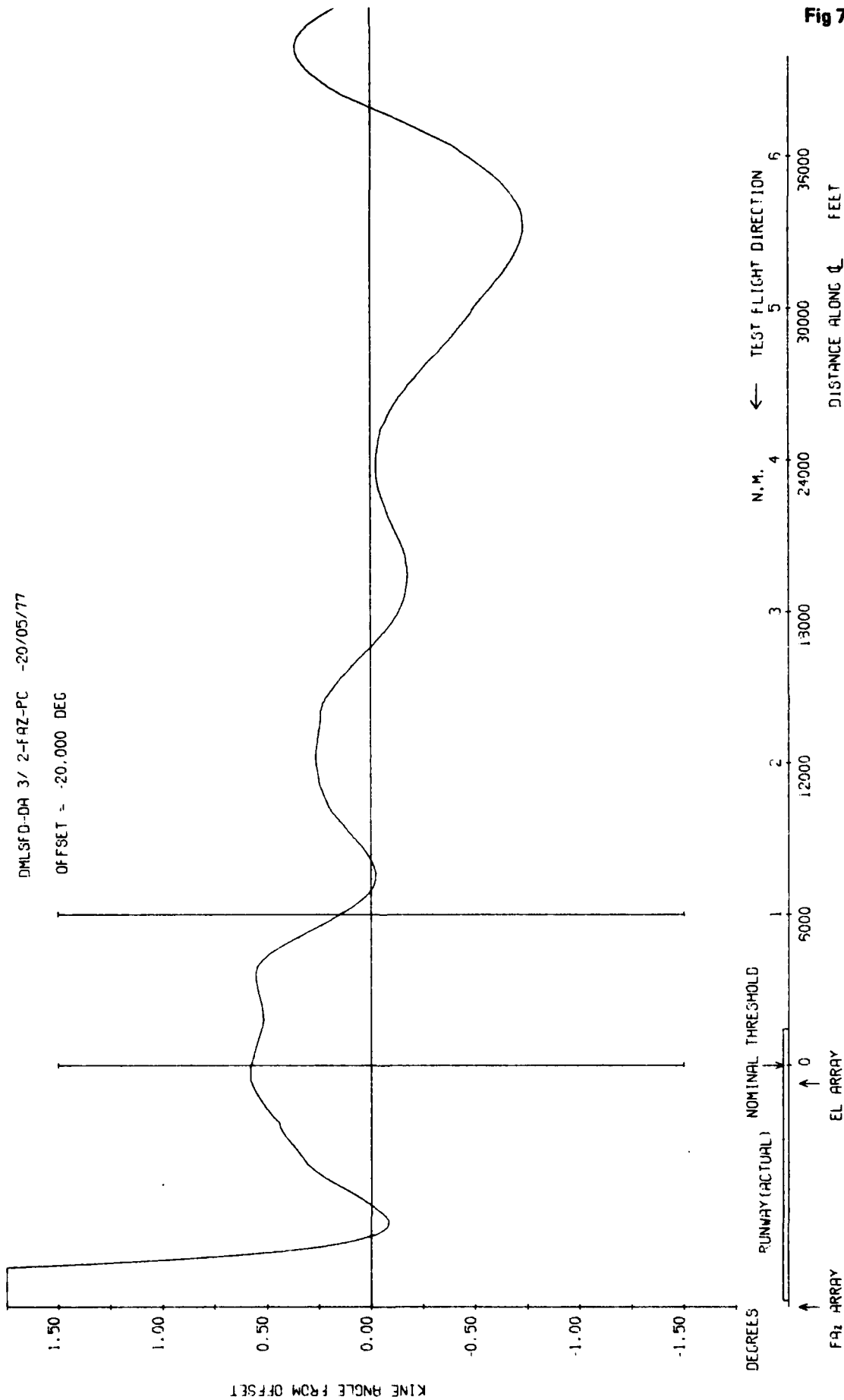


Fig 7.34a

Fig 7.34a Azimuth 54, constant height radial at 2000 ft and -20 degrees

Fig 7.34b

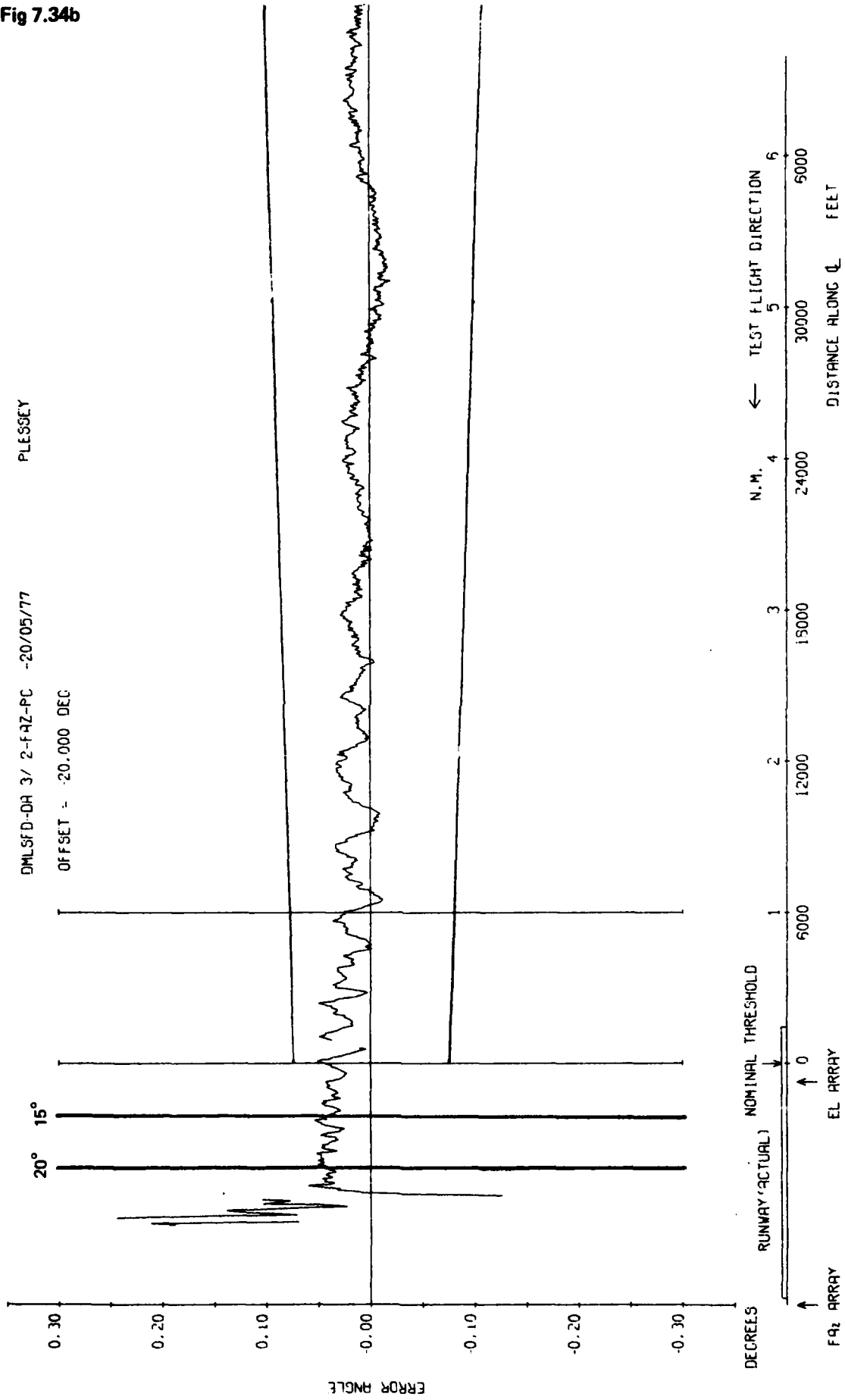


Fig 7.34b Azimuth 54λ, constant height radial at 2000 ft and -20 degrees

TR 79062

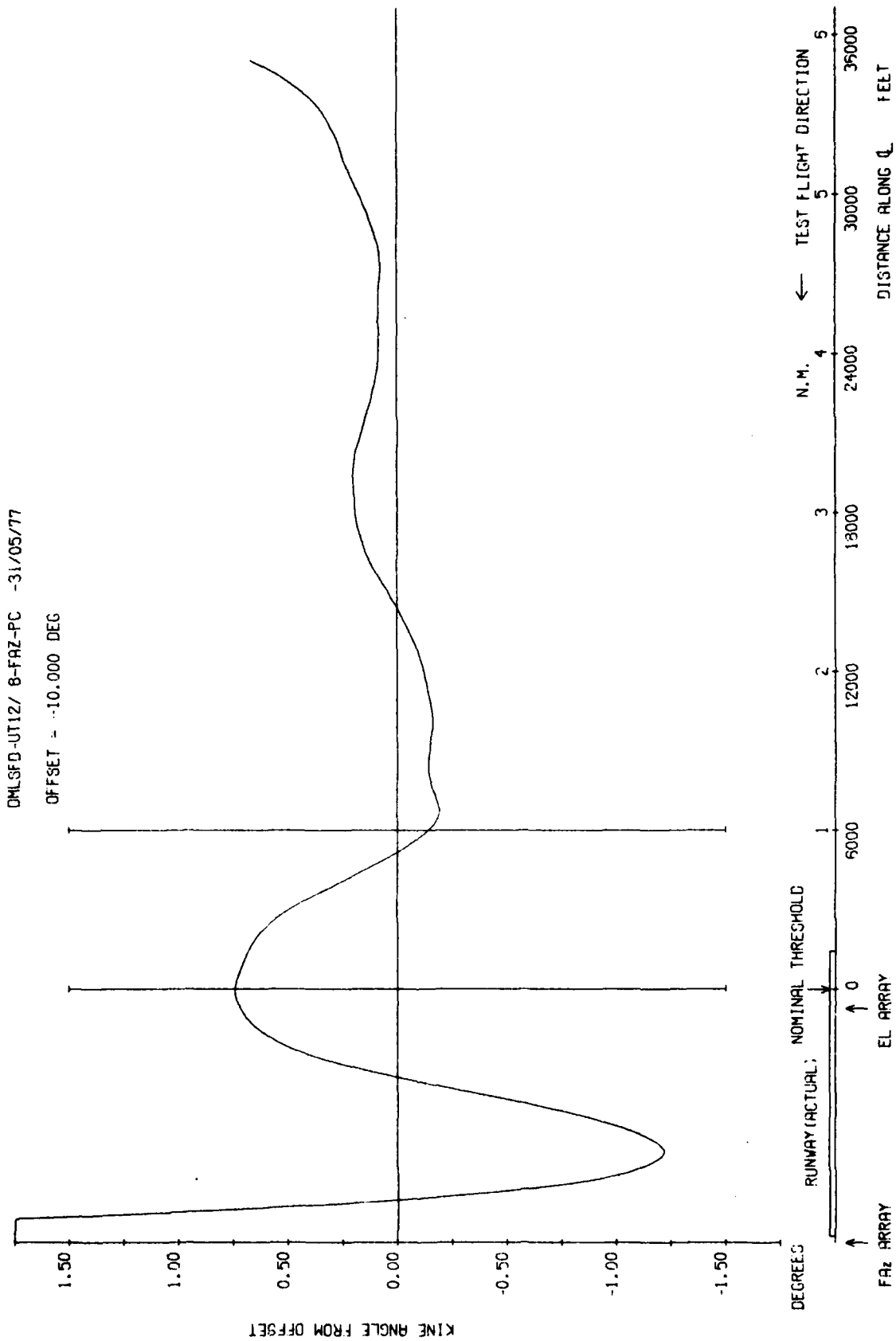


Fig 7.35a

Fig 7.35a Azimuth 54, constant height radial at 2000 ft and -10 degrees

TR 79082

DMLST-D-UT12/ 3-FAZ-PC -31/05/77

OFFSET = 0.000 DEG

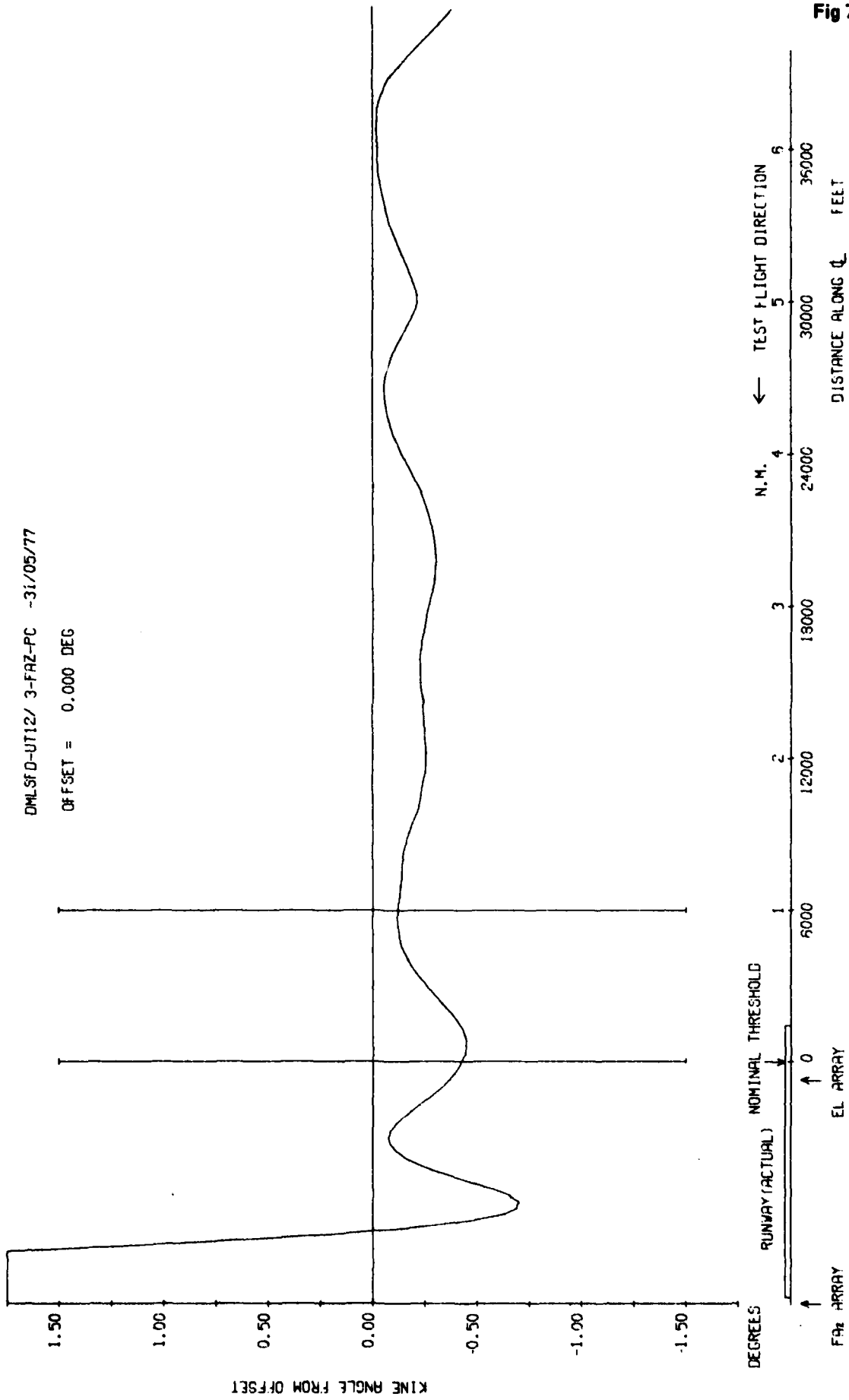


Fig 7.36a

Fig 7.36a Azimuth 54λ, constant height radial at 2000 ft on centre line

Fig 7.36b

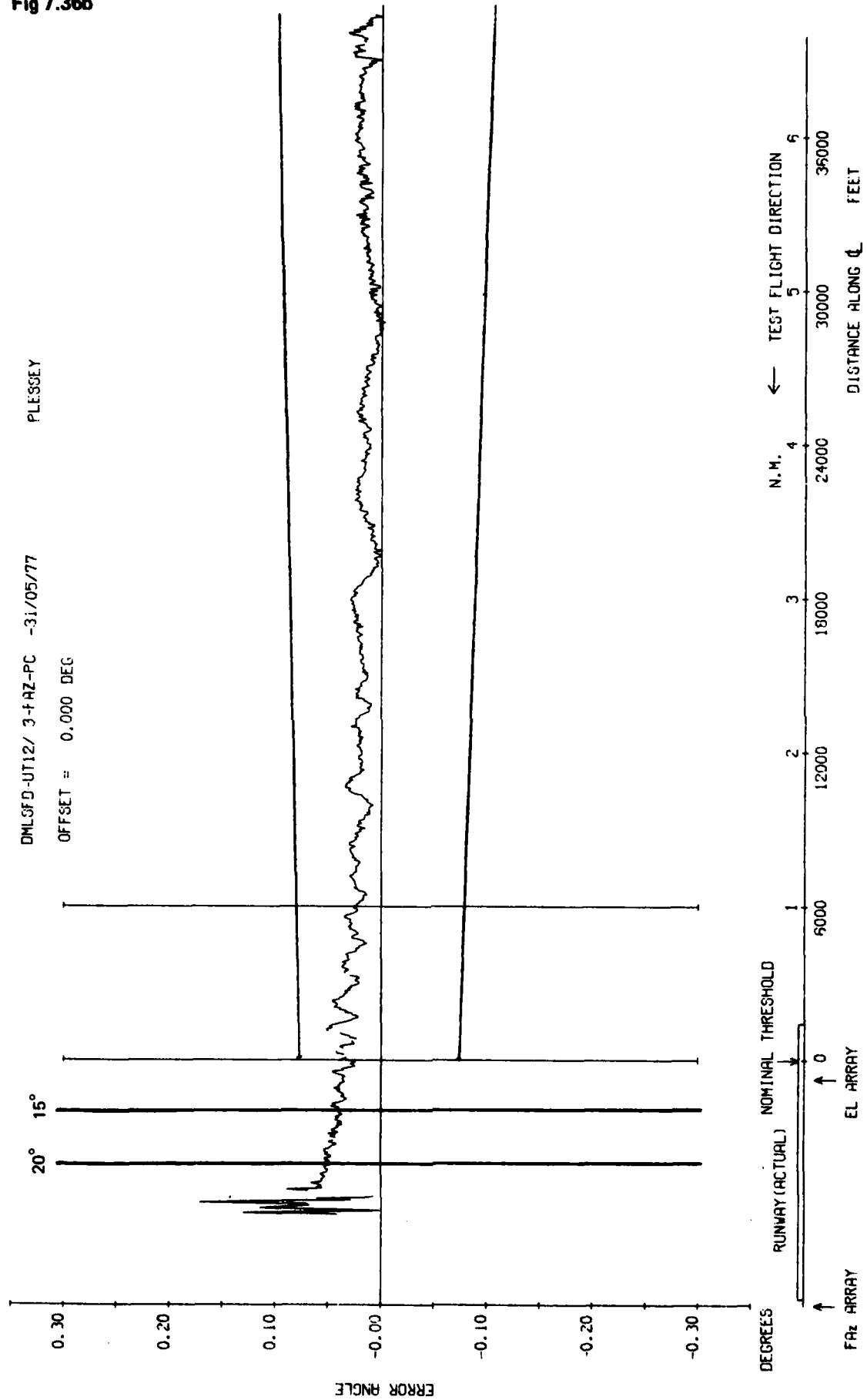


Fig 7.36b Azimuth 54, constant height radial at 2000 ft on centre line

TR 79062

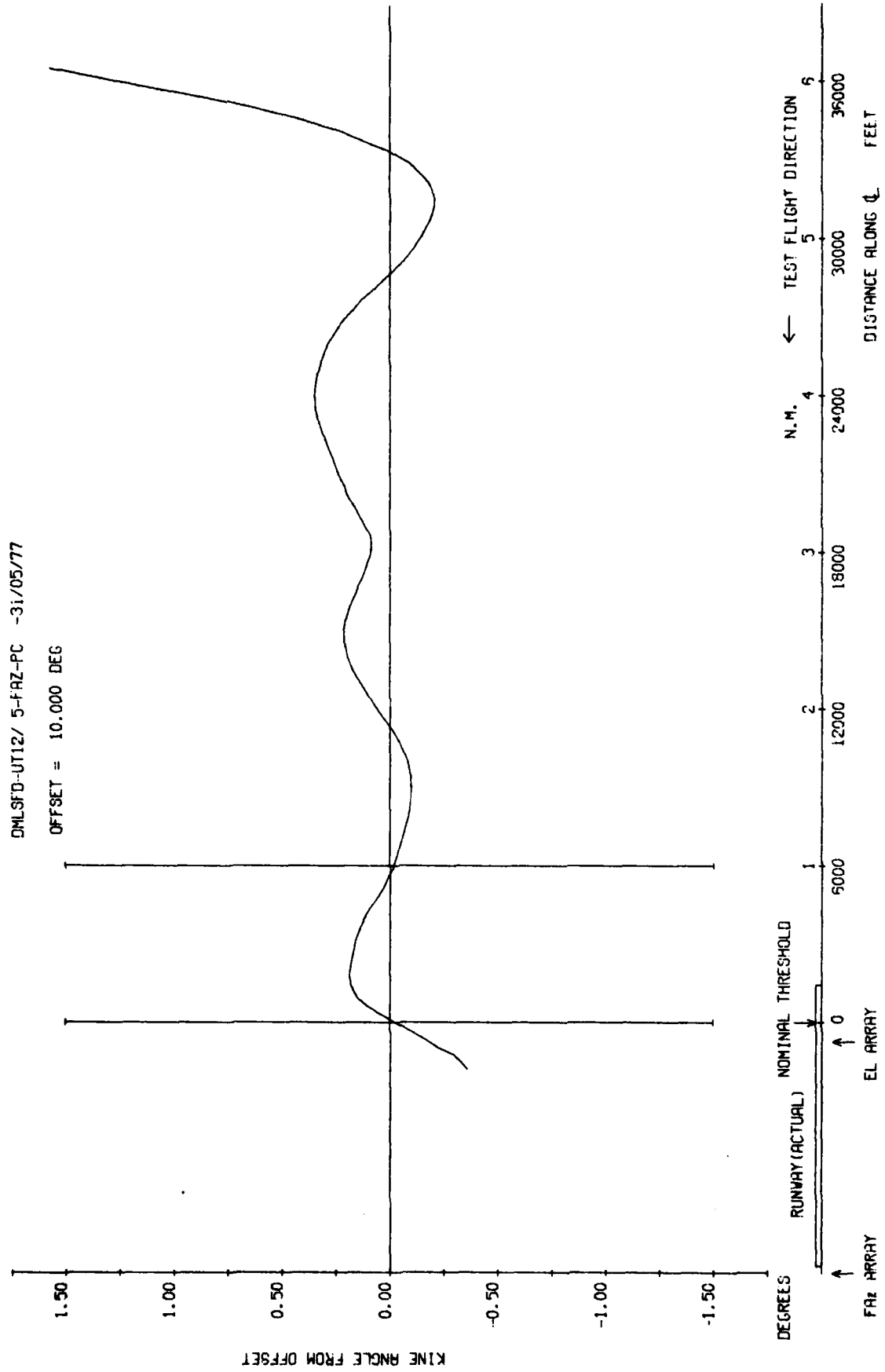


Fig 7.37a

Fig 7.37a Azimuth 54, constant height radial at 2000 ft and +10 degrees

Fig 7.37b

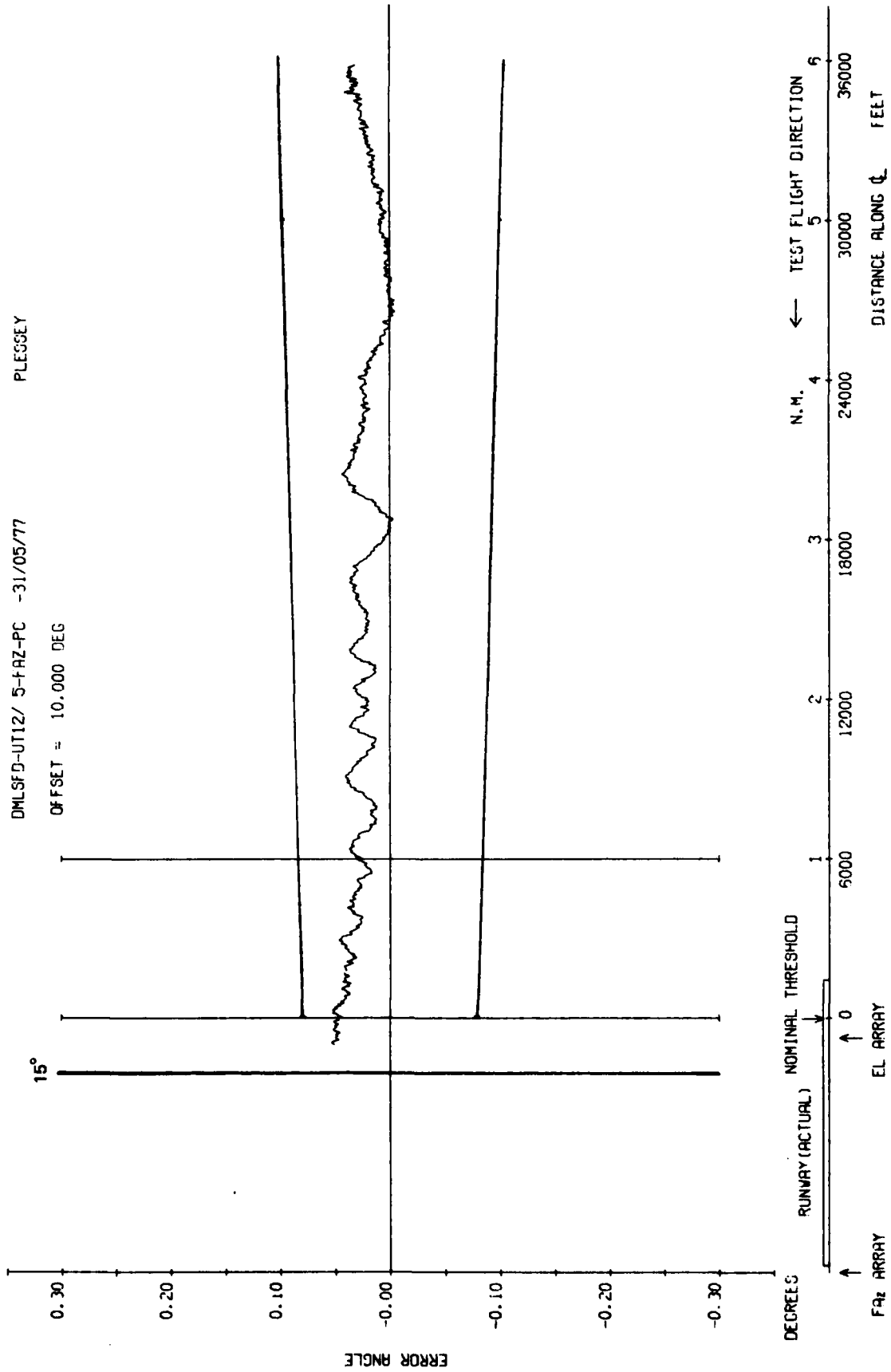


Fig 7.37b Azimuth 54λ, constant height radial at 2000 ft and +10 degrees

TR 79082

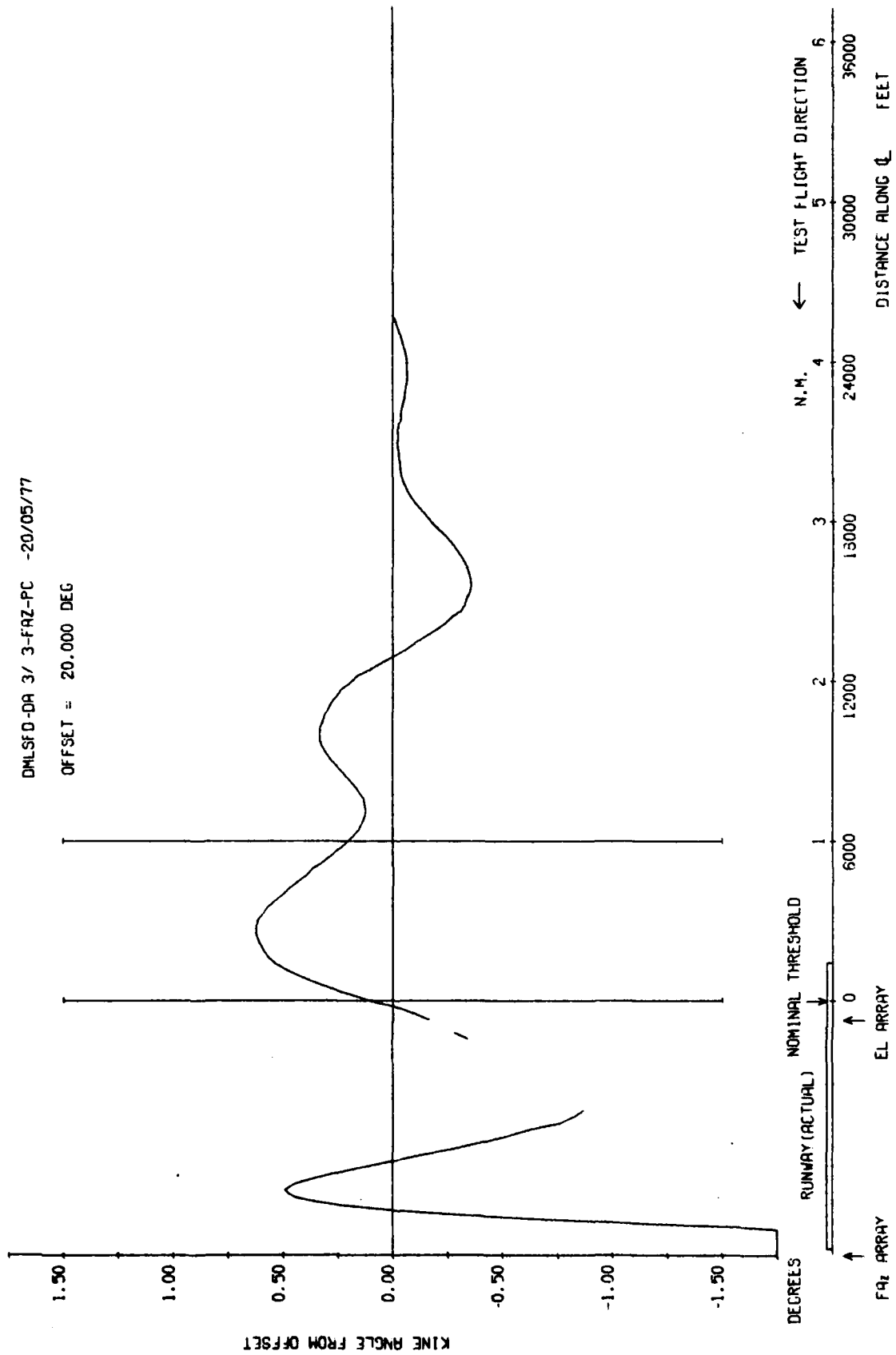


Fig 7.38a

Fig 7.38a Azimuth 54λ, constant height radial at 2000 ft and +20 degrees

Fig 7.38b

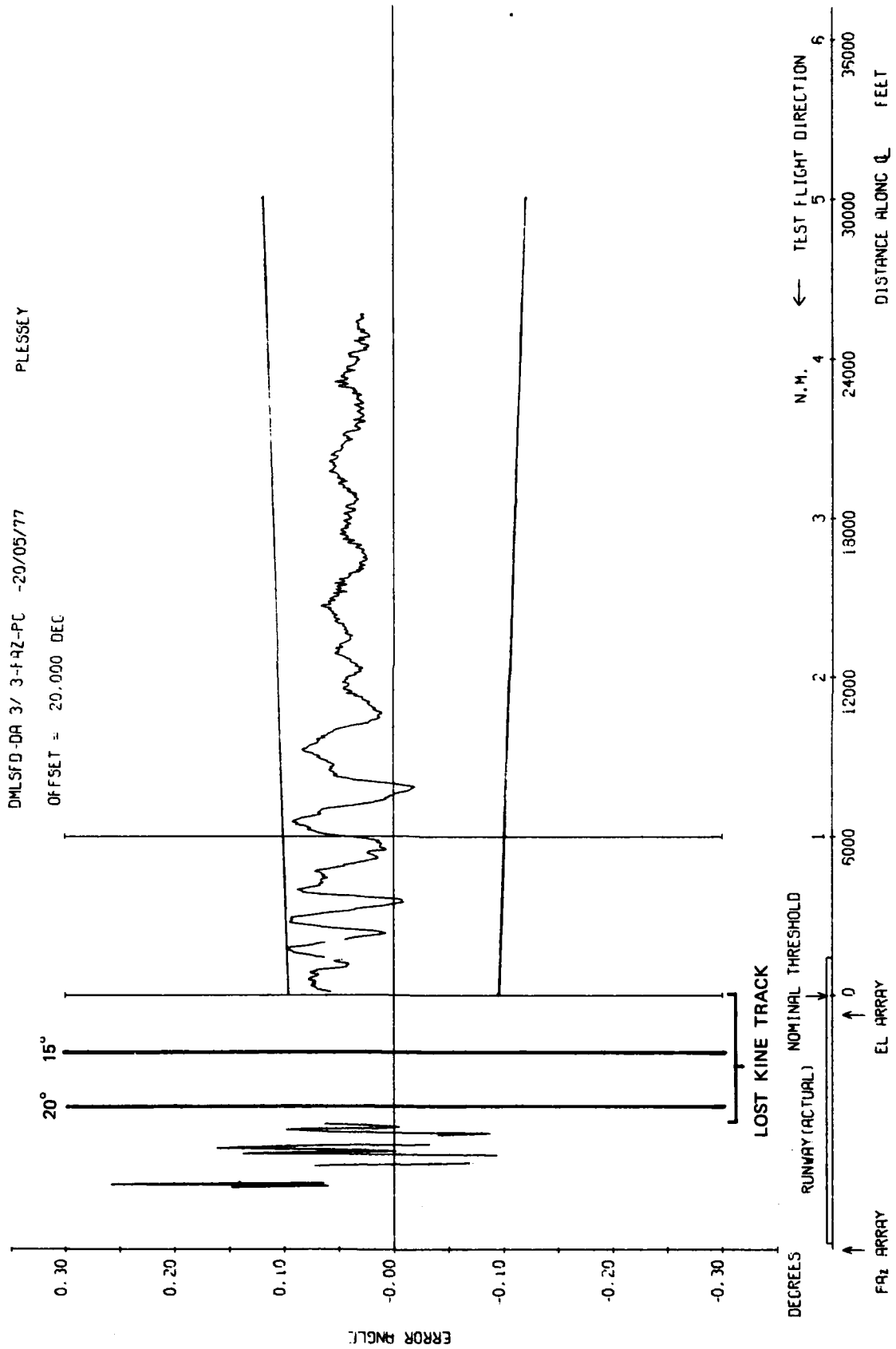


Fig 7.38b Azimuth 54, constant height radial at 2000 ft and +20 degrees

TR 79082

DMUSFD-DA 3/ 7-FAZ-PC -20/05/77

OFFSET = 30.000 DEC

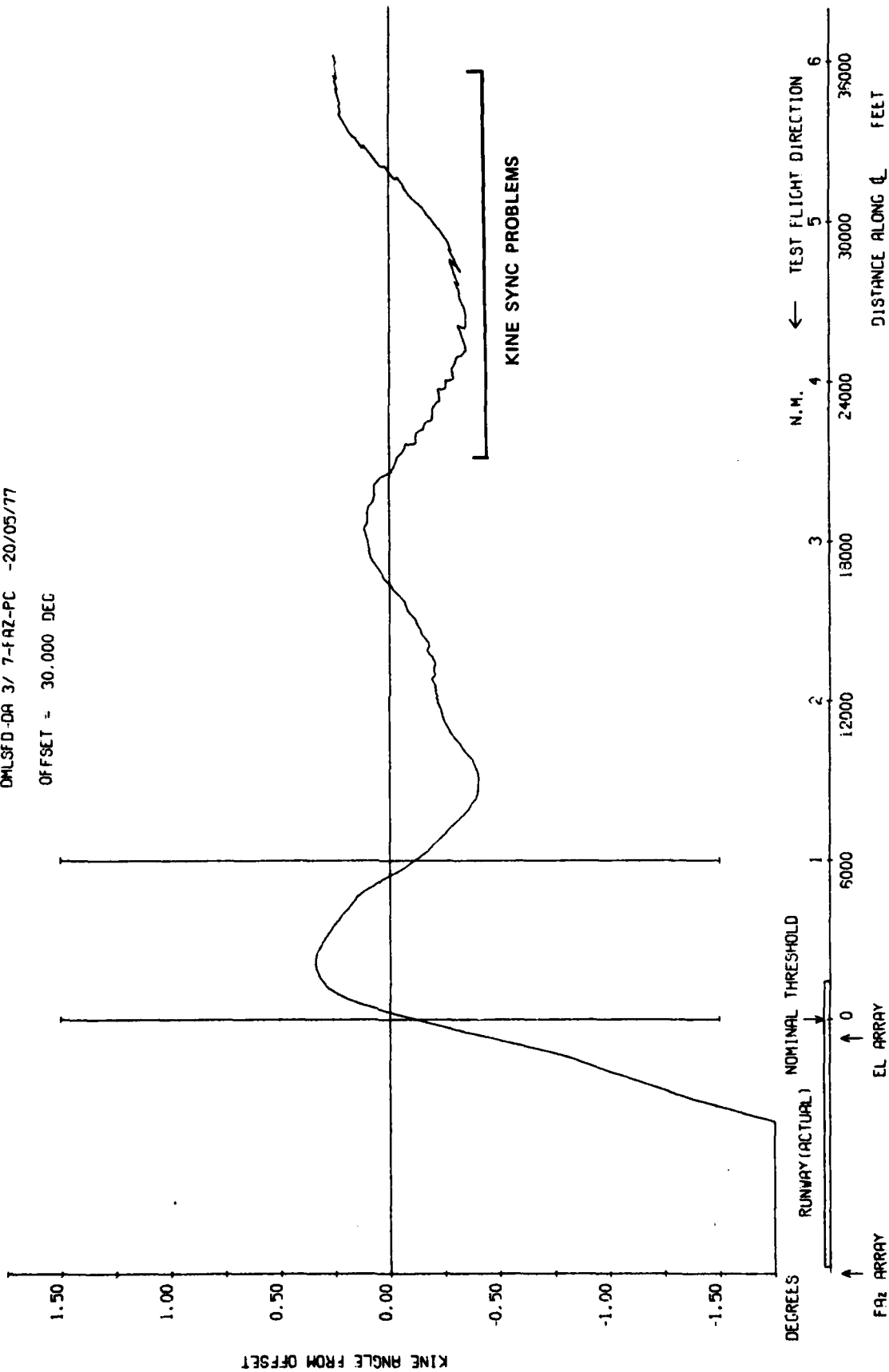


Fig 7.39a

Fig 7.39a Azimuth 54λ, constant height radial at 2000 ft and +30 degrees

Fig 7.39b

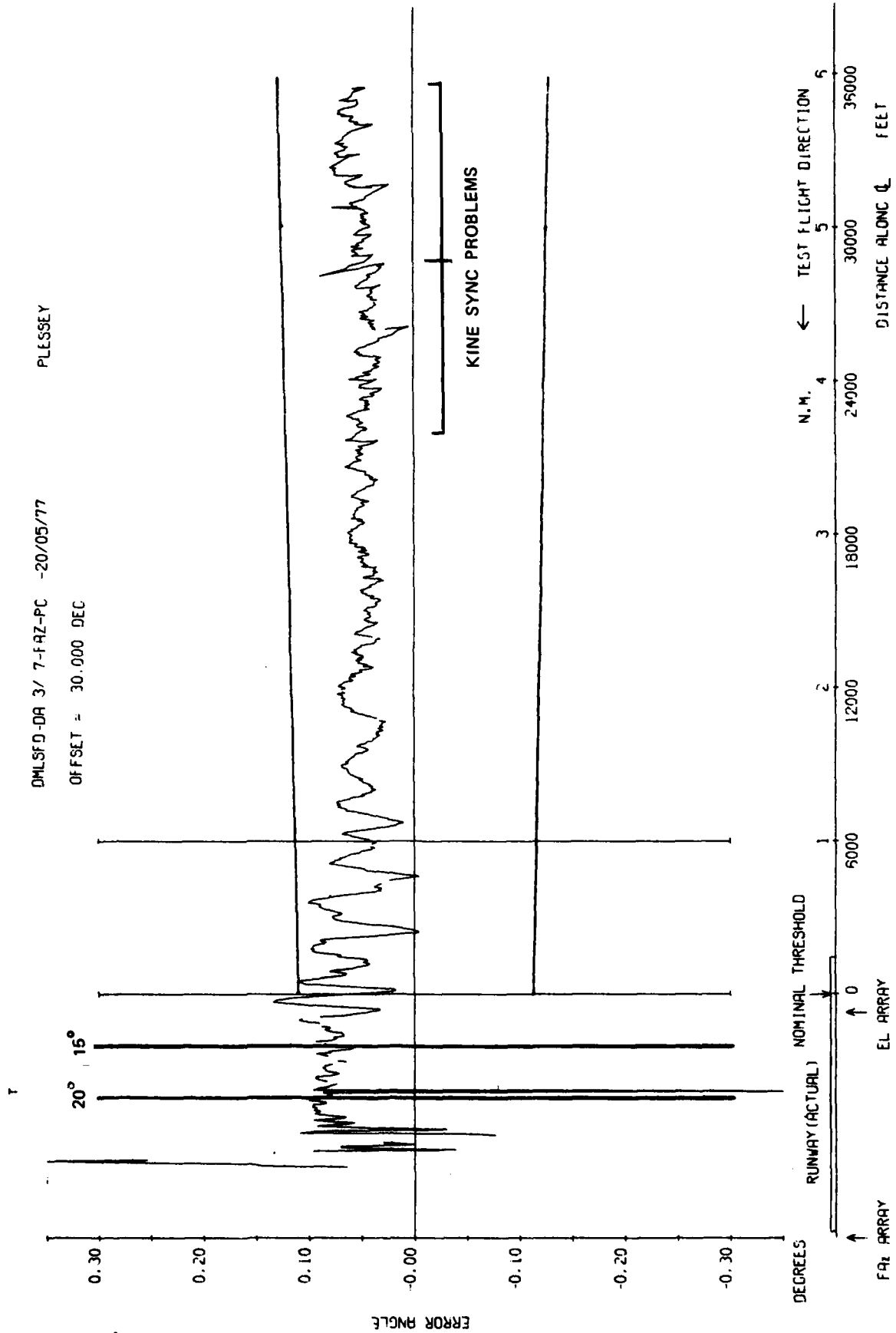


Fig 7.39b Azimuth 54λ, constant height radial at 2000 ft and +30 degrees

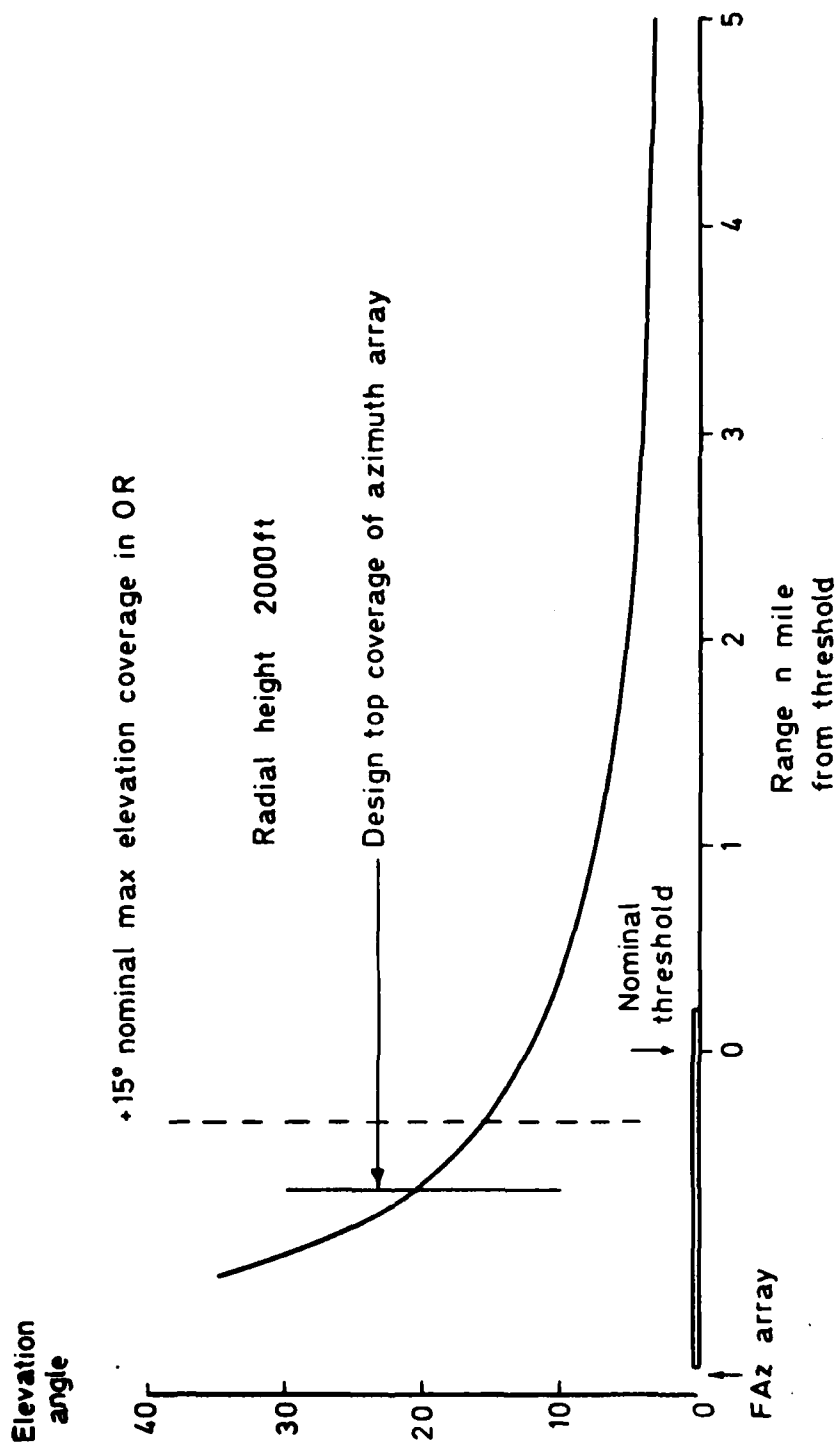


Fig 7.40

Fig 7.40 Elevation from azimuth array as function of range for radial flights

Fig 7.41a

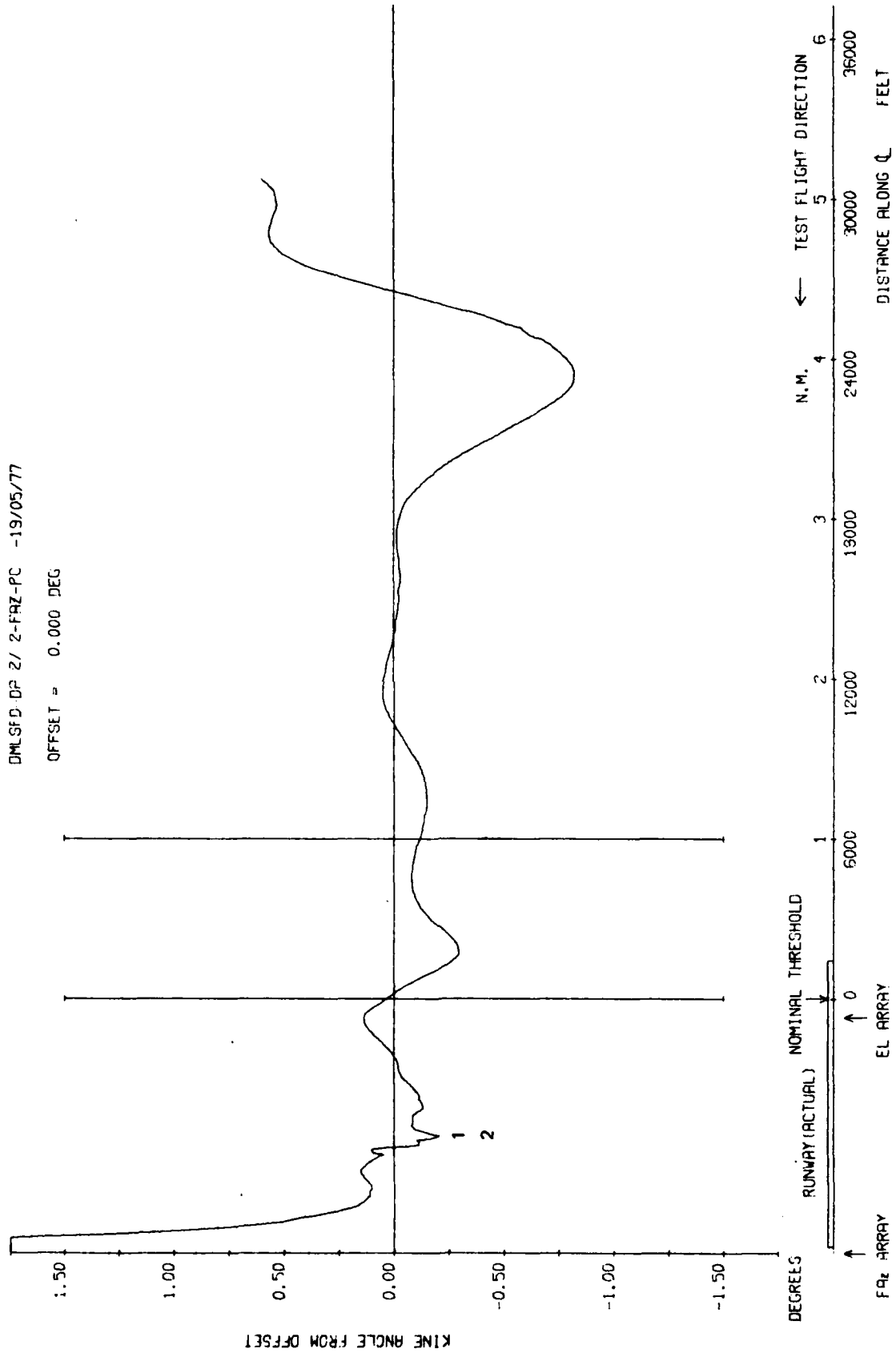


Fig 7.41a Azimuth 54, 3 degree approach to touch and go

TR 79052

DMLSFD-DR 2/ 2-FRZ-PC -19/05/77

OFFSET = 0.000 DEG 54λ

PLESSEY

x RECEIVER DIGITAL
INTERFACE GLITCH

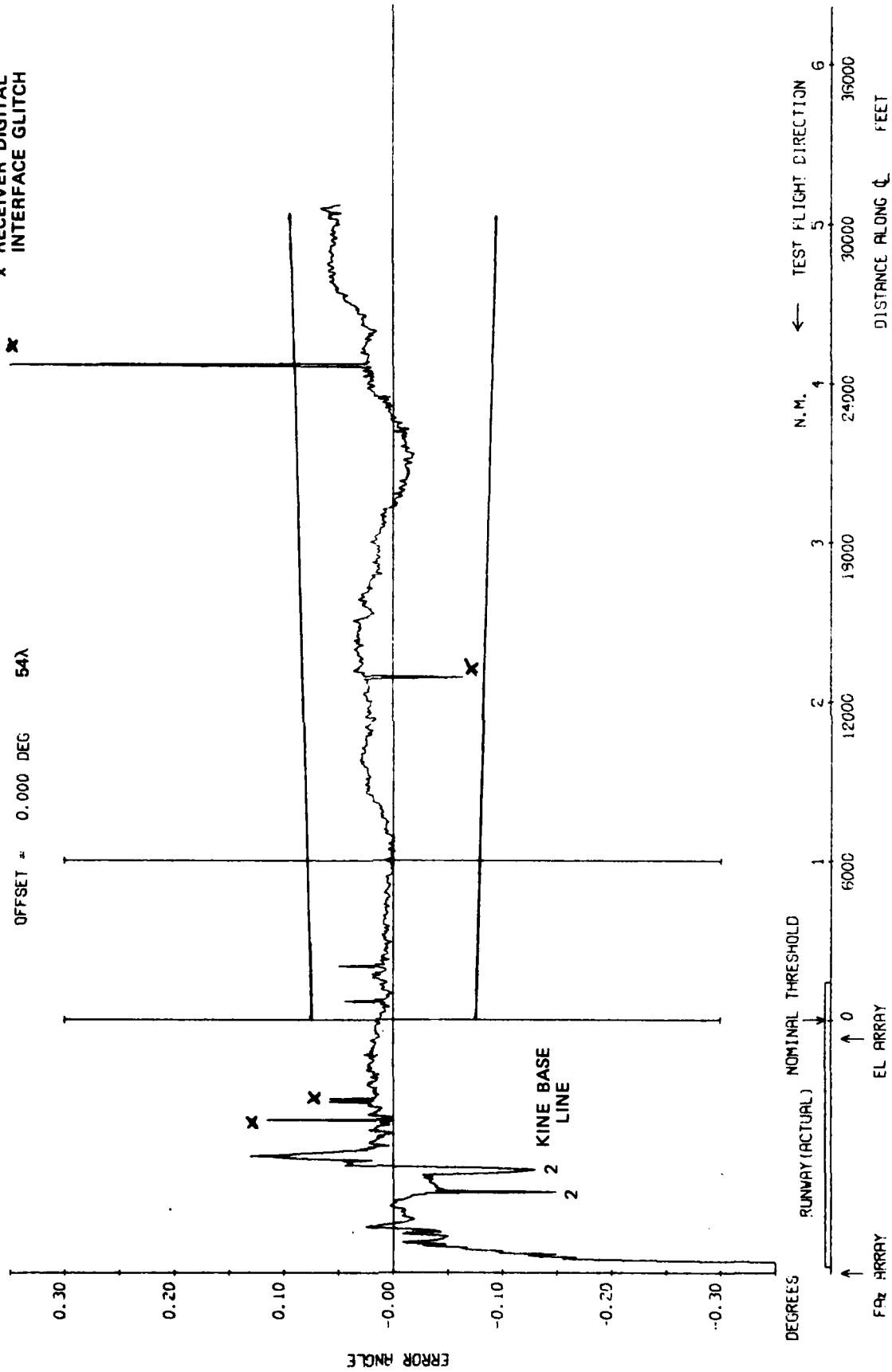


Fig 7.41c Azimuth 54λ, 3 degree approach to touch and go

Fig 7.41c

Fig 7.42a

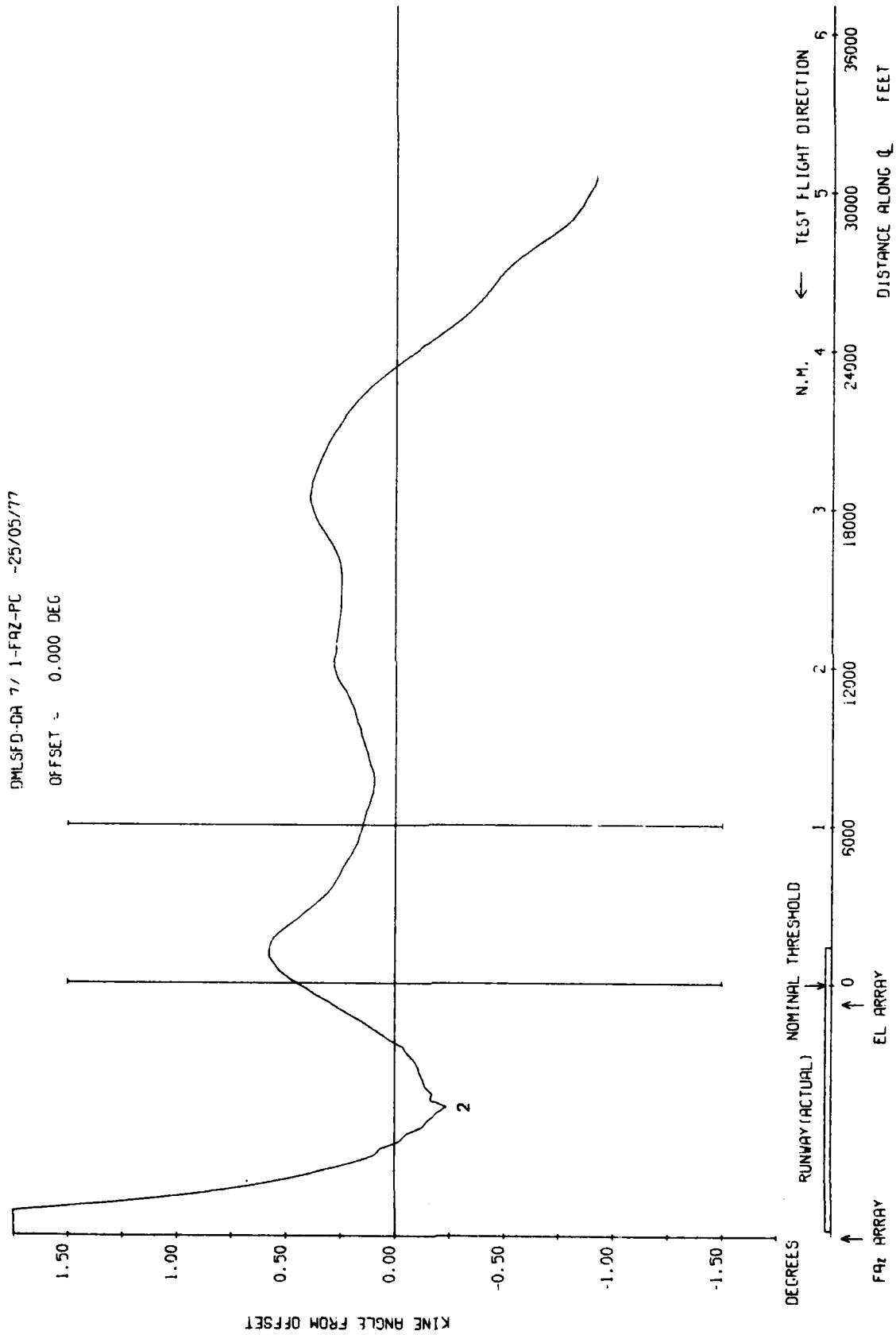


Fig 7.42a Azimuth 54λ, 3 degree approach to 300 ft overshoot

TR 79062

DMLSF:DR 7/ 1-FAZ-PC -25/05/77 PLESSEY

OFFSET = 0.000 DEG

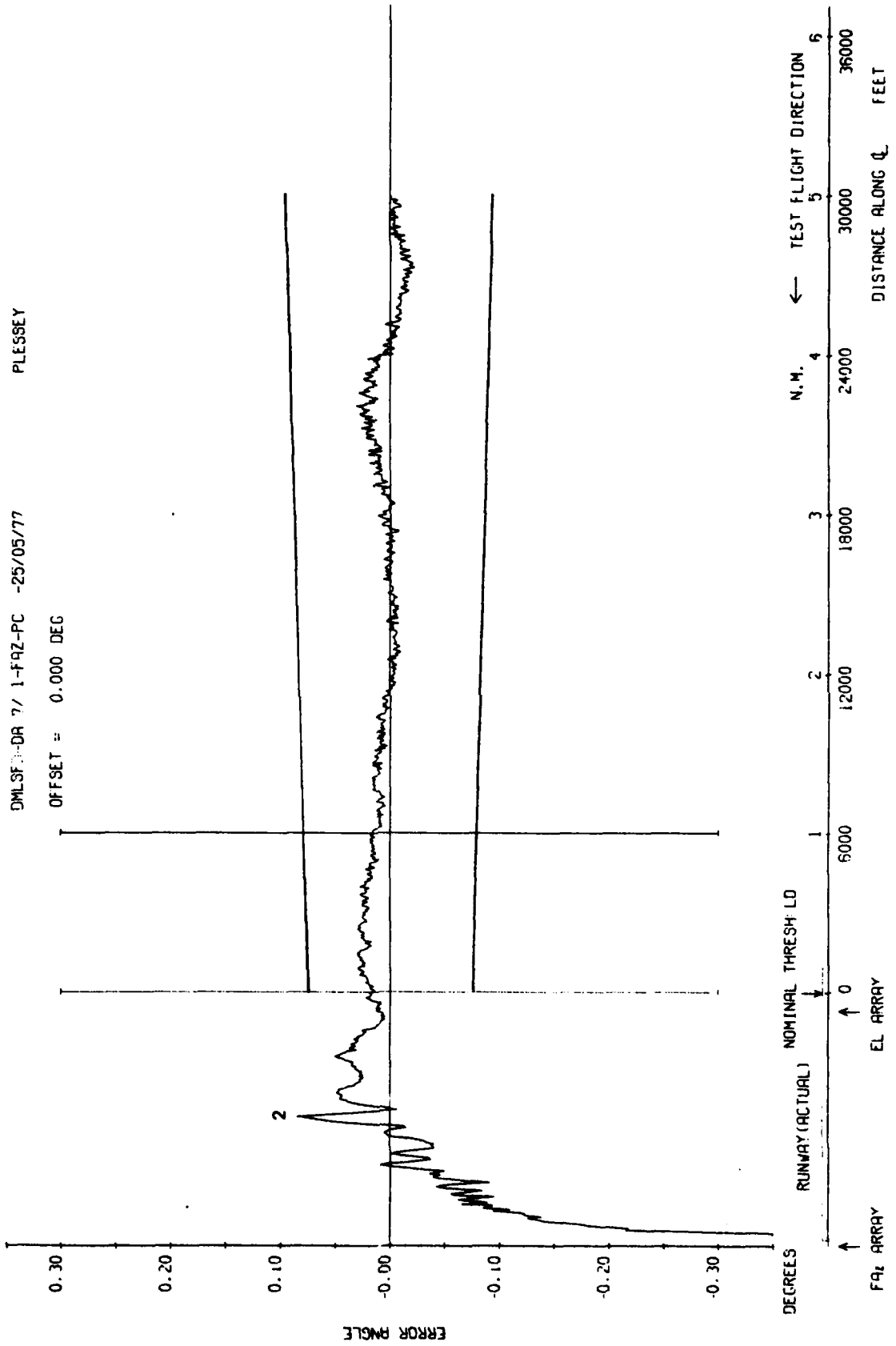


Fig 7.42c

Fig 7.42c Azimuth 54λ, 3 degree approach to 300 ft overshoot

Fig 7.43a

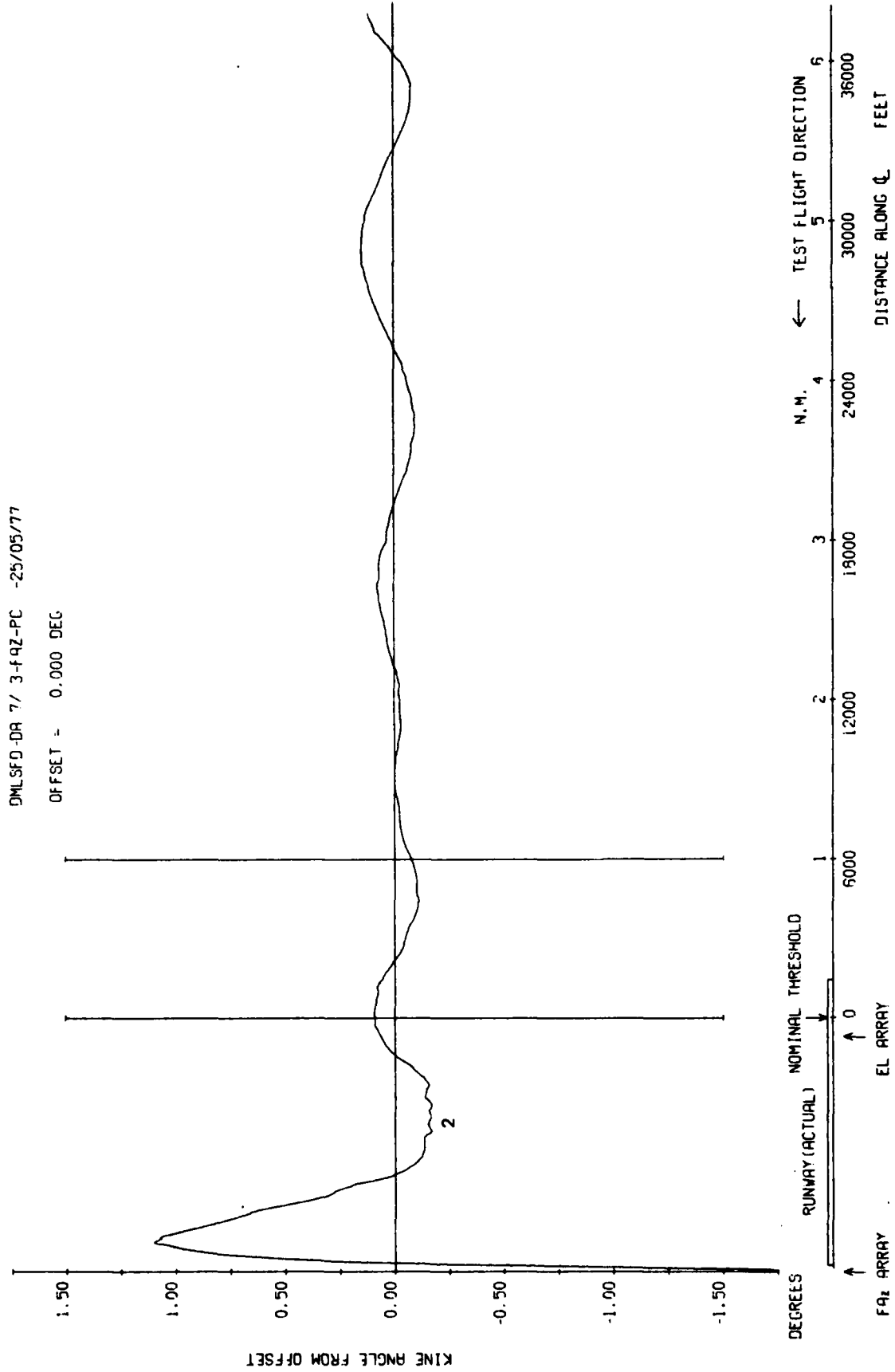


Fig 7.43a Azimuth 54, 1.5 degree approach to 300 ft overshoot

TR 79062

DMLSFD-DA 7/ 3-FRZ-PC -25/05/77 PLESSEY

OFFSET = 0.000 DEG

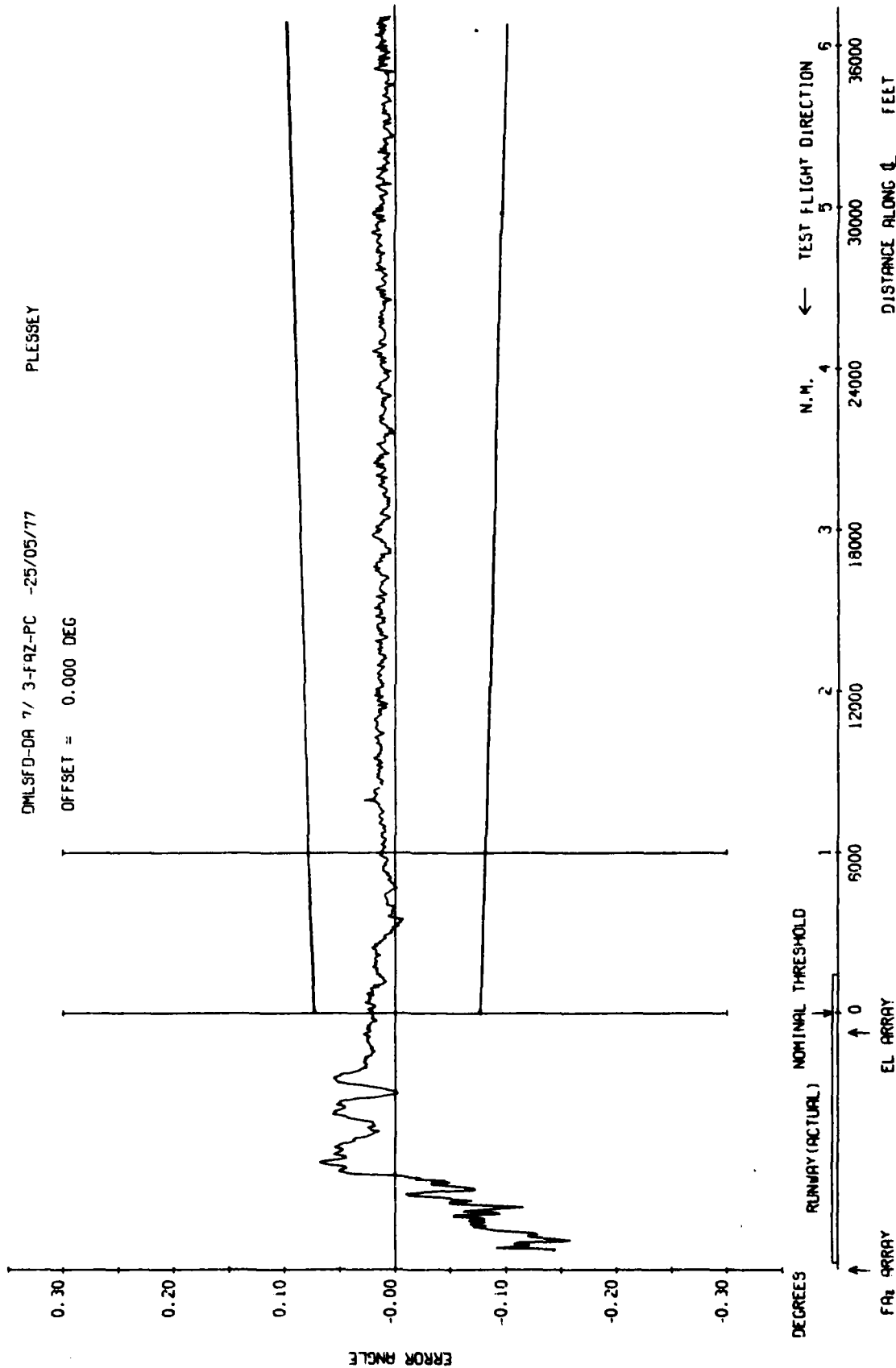


Fig 7.43c

Fig 7.43c Azimuth 54, 1.5 degree approach to 300 ft overshoot

Fig 7.44a

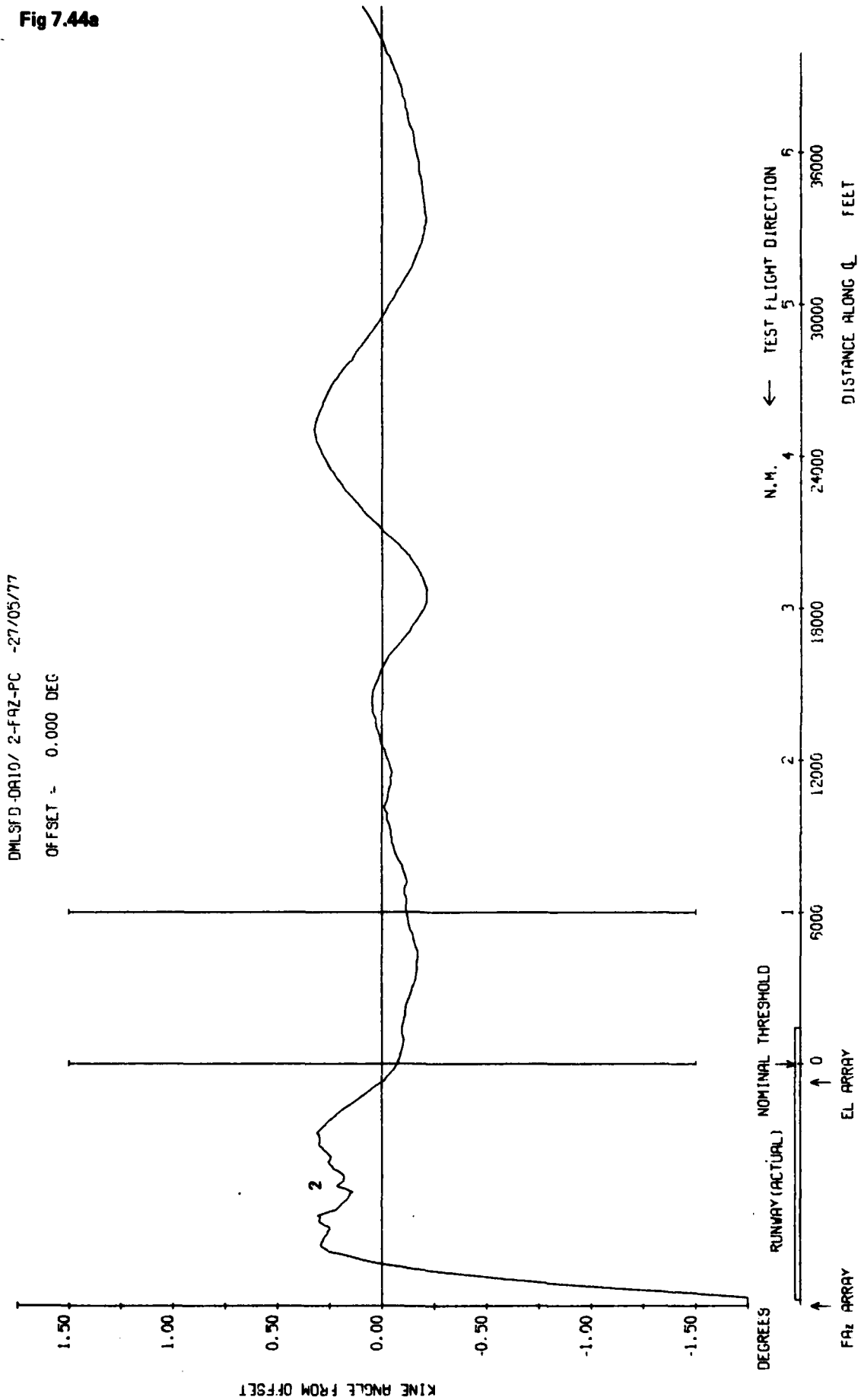


Fig 7.44a Azimuth 54λ, 3 degree approach to 300 ft overshoot

TR 79062

DMLSFD-DR10/ 2-FRZ-PC -27/05/77 PLESSEY
OFFSET = 0.000 DEG

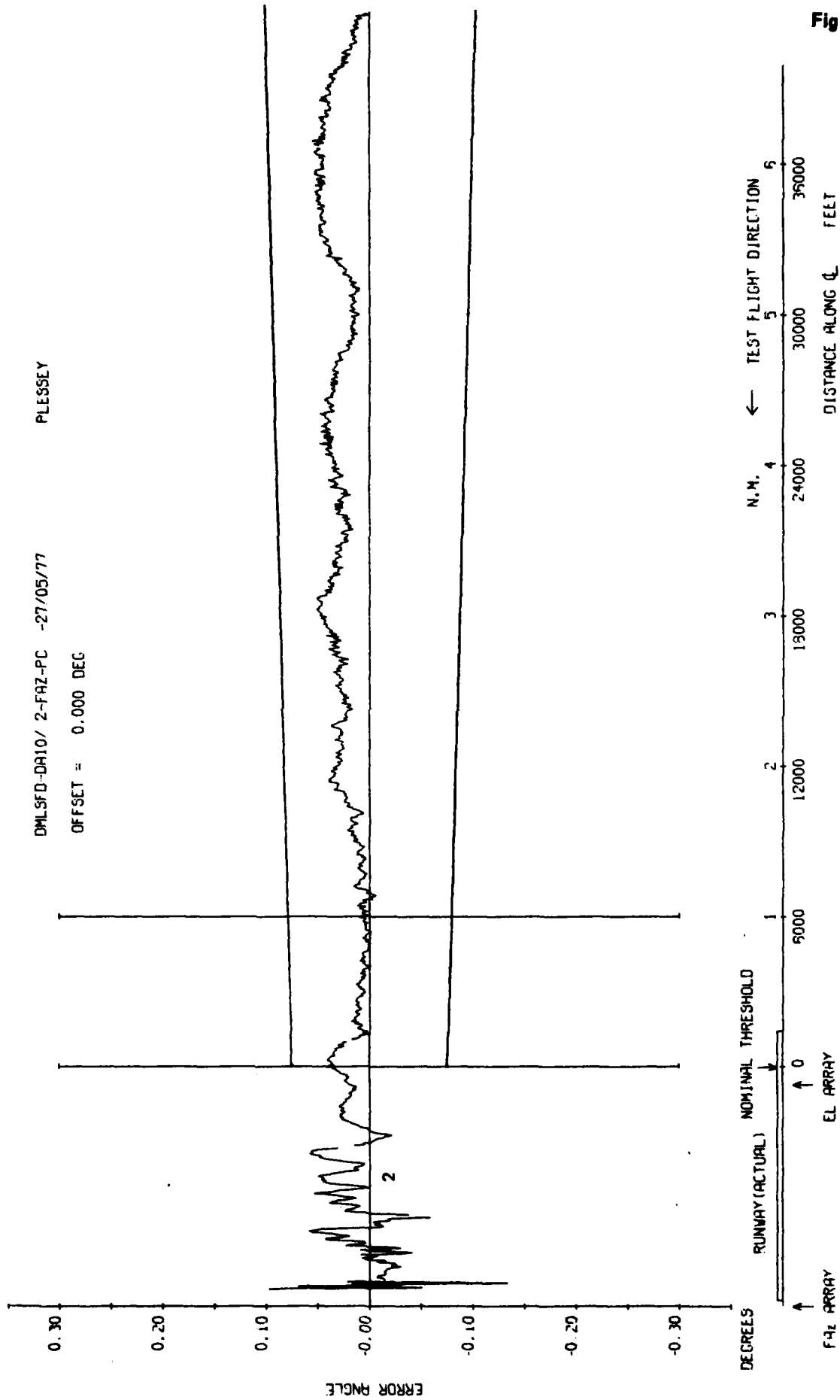


Fig 7.44c

Fig 7.44c Azimuth 54λ, 3 degree approach to 300 ft overshoot

Fig 7.45a

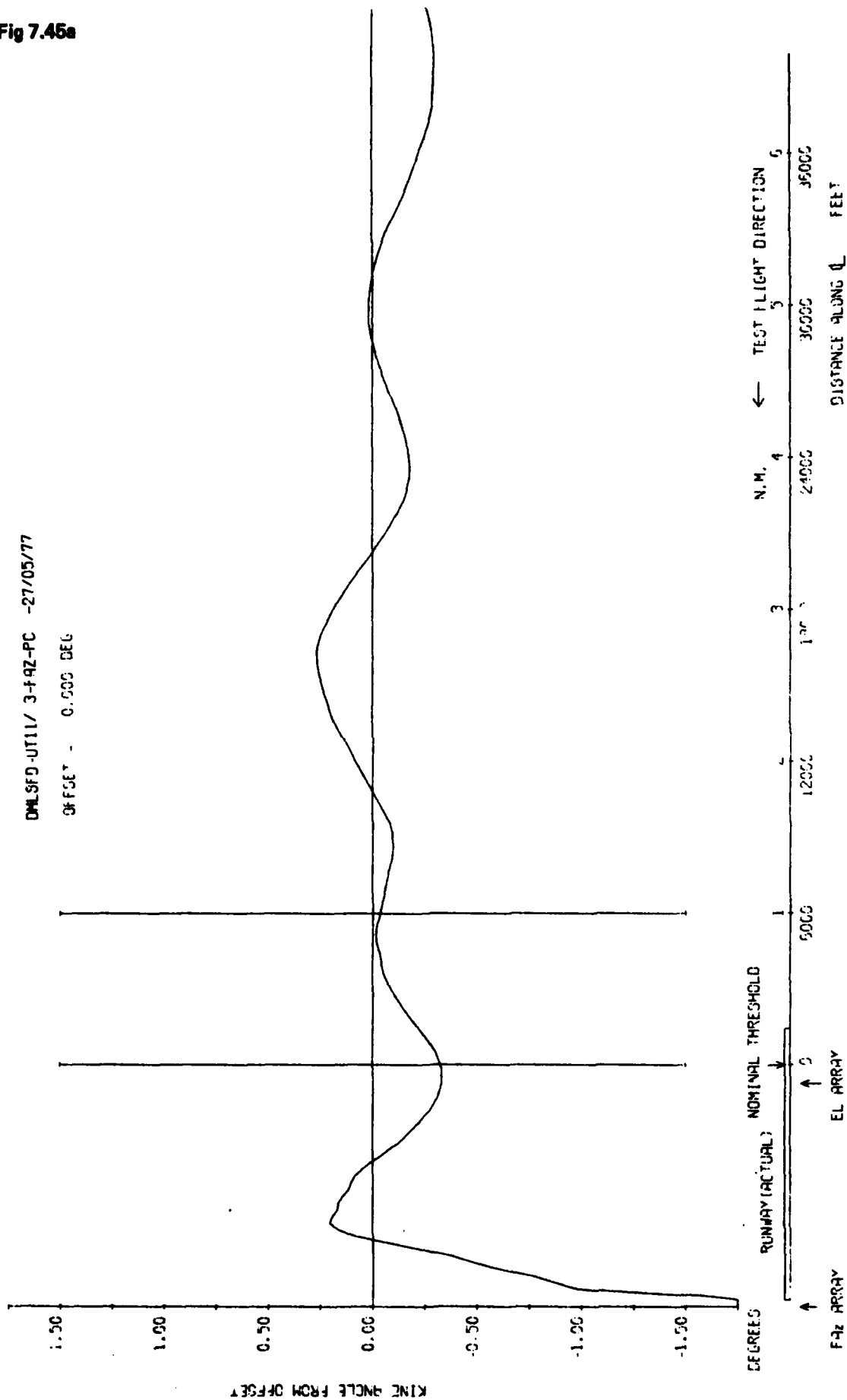


Fig 7.45a Azimuth 54λ, 3 degree approach to 300 ft overshoot

TR 79052

DML3FD-UT11/ 3+4Z-PC -27/05/77 PLESSEY

OFFSET = 0.000 DEG

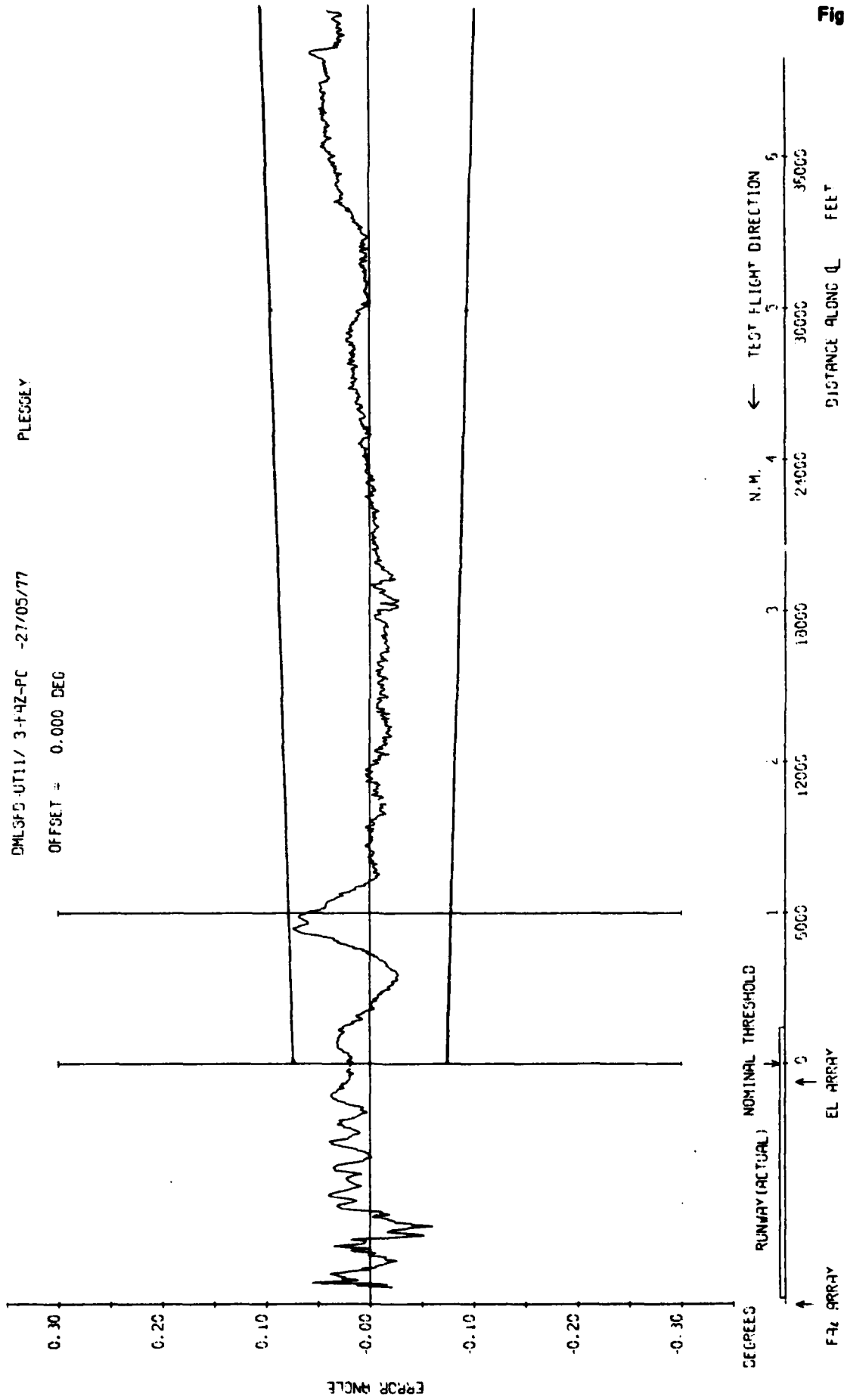


Fig 7.45c

Fig 7.45c Azimuth 54, 3 degree approach to 300 ft overshoot

Fig 7.46a

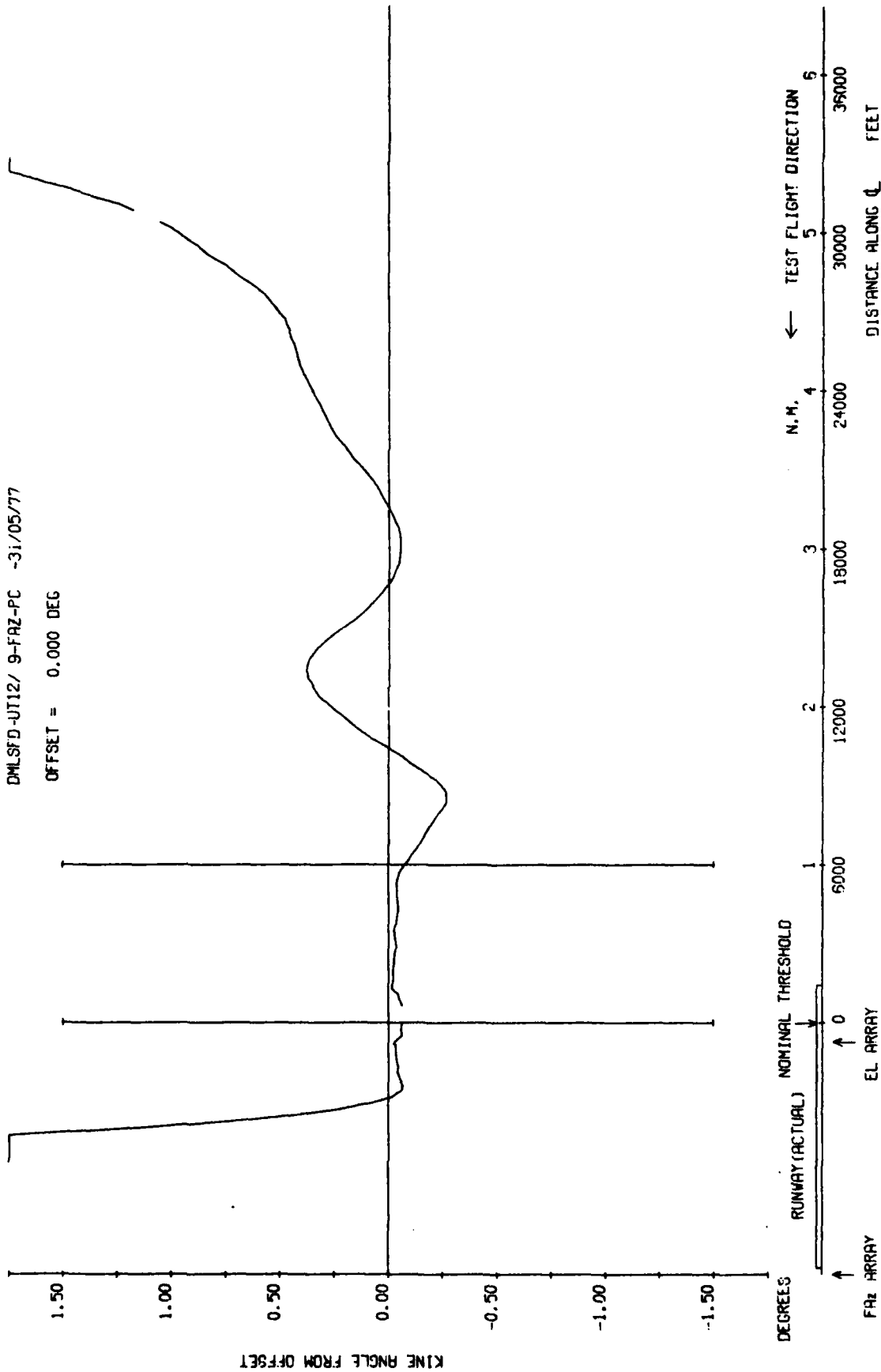


Fig 7.46a Azimuth 54, 3 degree approach to 50 ft overshoot

TR 79062

DMLSFD-UT12/ 9-FRZ-PC -31/05/77 PLESSEY

OFFSET = 0.000 DEG

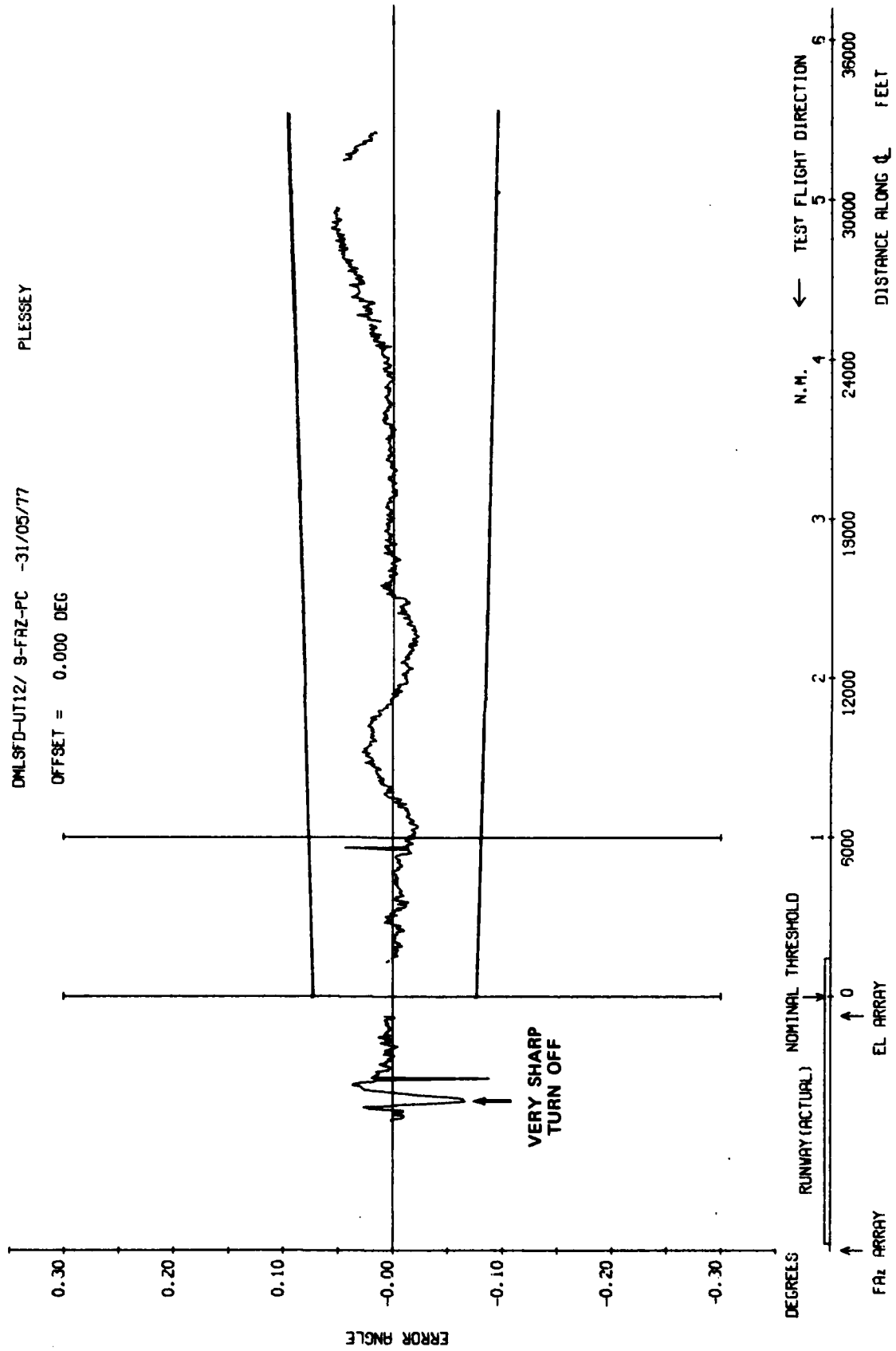


Fig 7.46c

Fig 7.46c Azimuth 54λ, 3 degree approach to 50 ft overshoot

Fig 7.47a

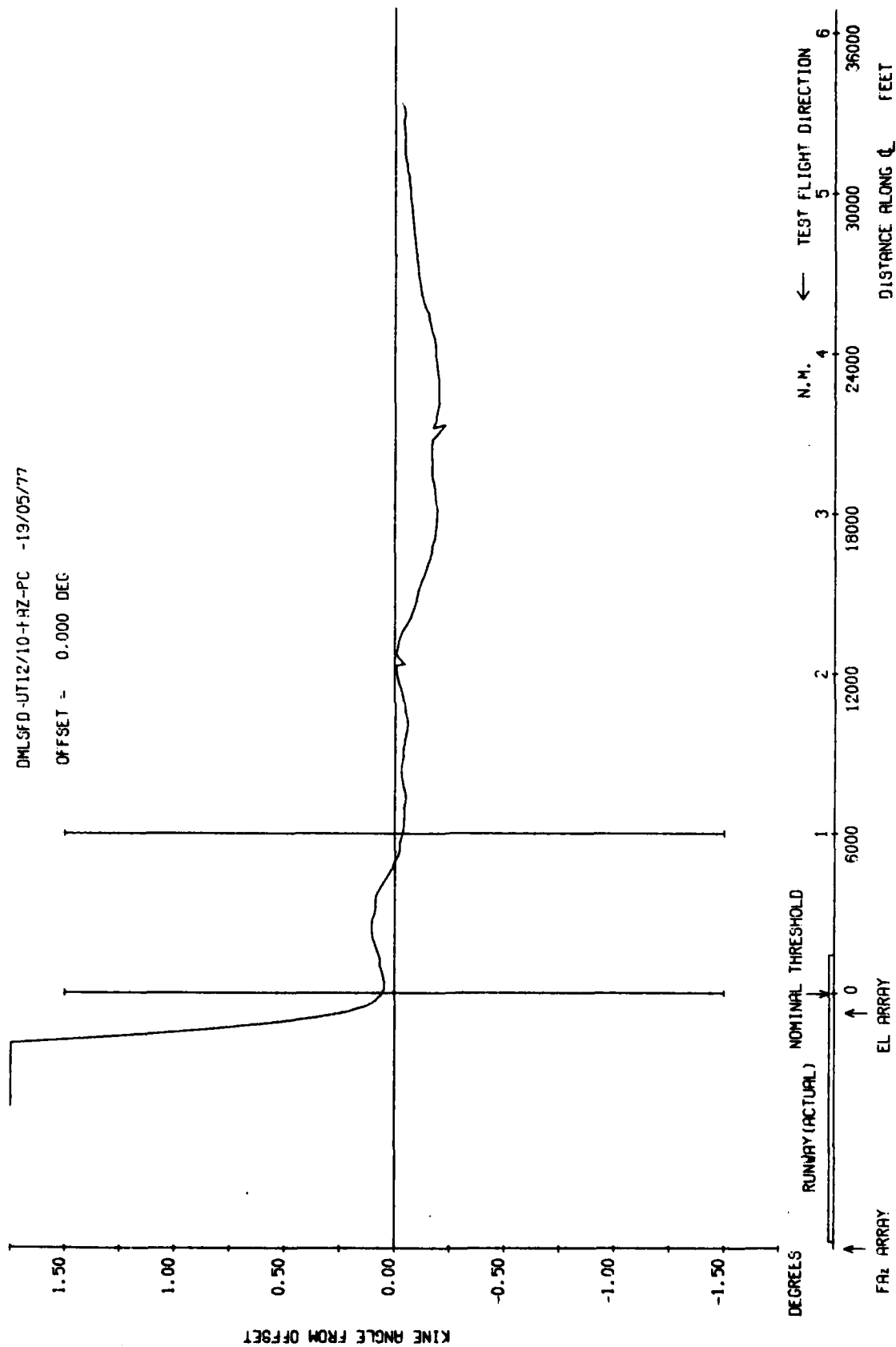


Fig 7.47a Azimuth 54, 3 degree approach to 50 ft overshoot

TR 79052

DMLSPD UT12/10-FR-PC -19/05/77
PLESLEY
OFFSET - 0.000 DEG

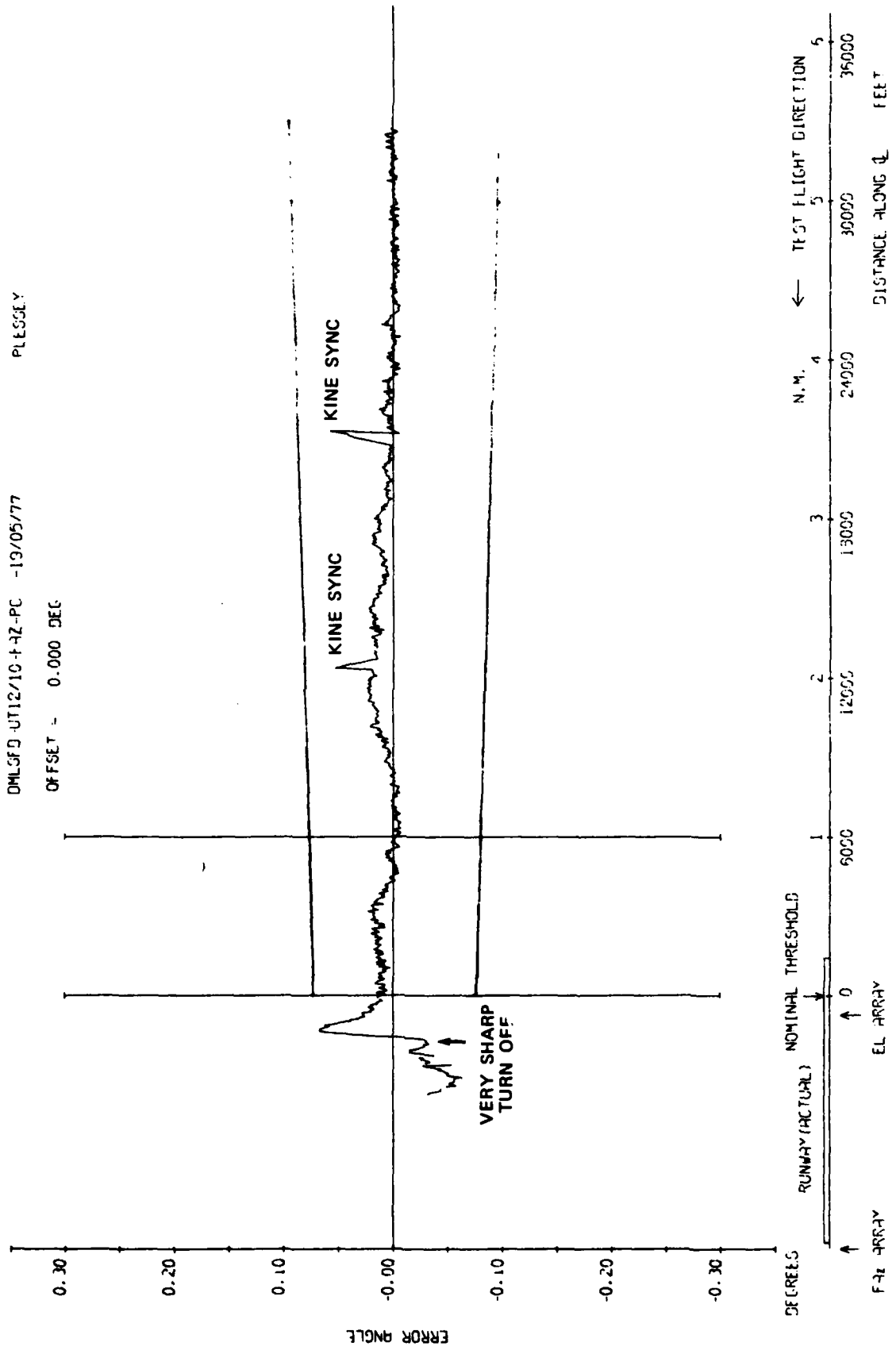


Fig 7.47c

Fig 7.47c Azimuth 54λ, 3 degree approach to 50 ft overshoot

Fig 7.48a

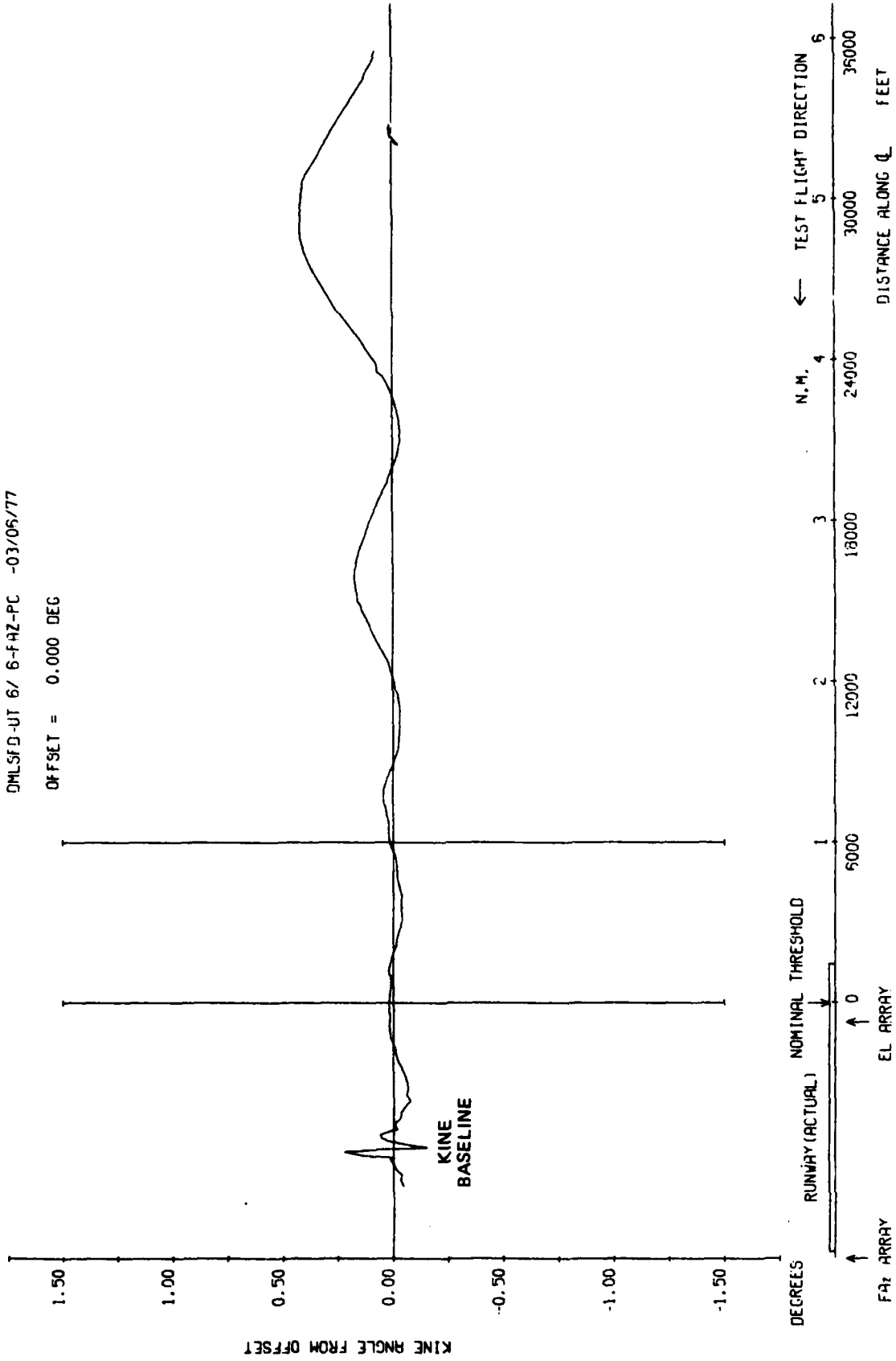


Fig 7.48a Azimuth 54, 3 degree approach to 50 ft overshoot

TR 79062

DMLSFD-UT 6/ 6-FRZ-PC -03/06/77
PLESSEY
OFFSET = 0.000 DEG

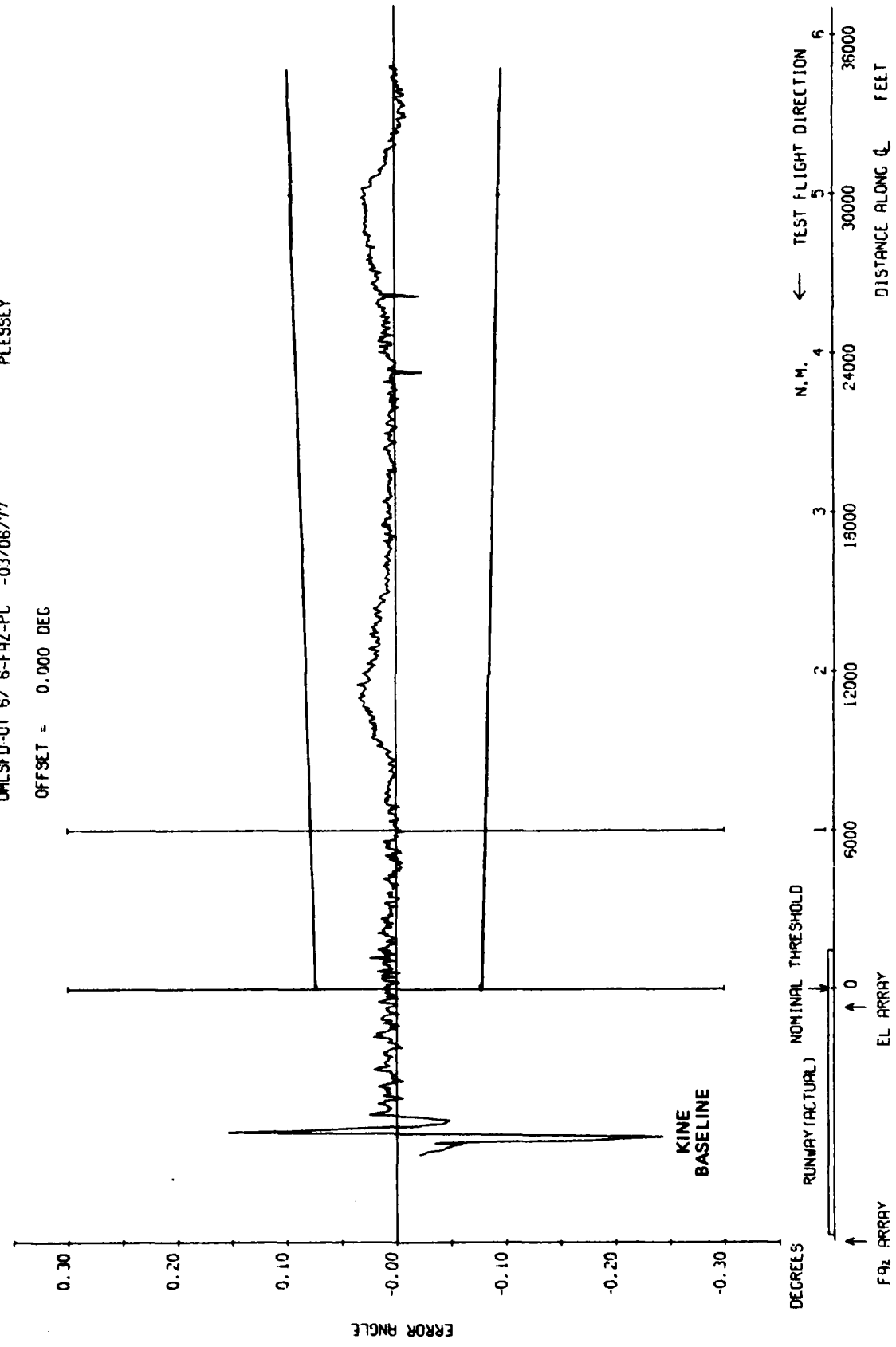


Fig 7.48c

Fig 7.48c Azimuth 54λ, 3 degree approach to 50 ft overshoot

Fig 7.49a

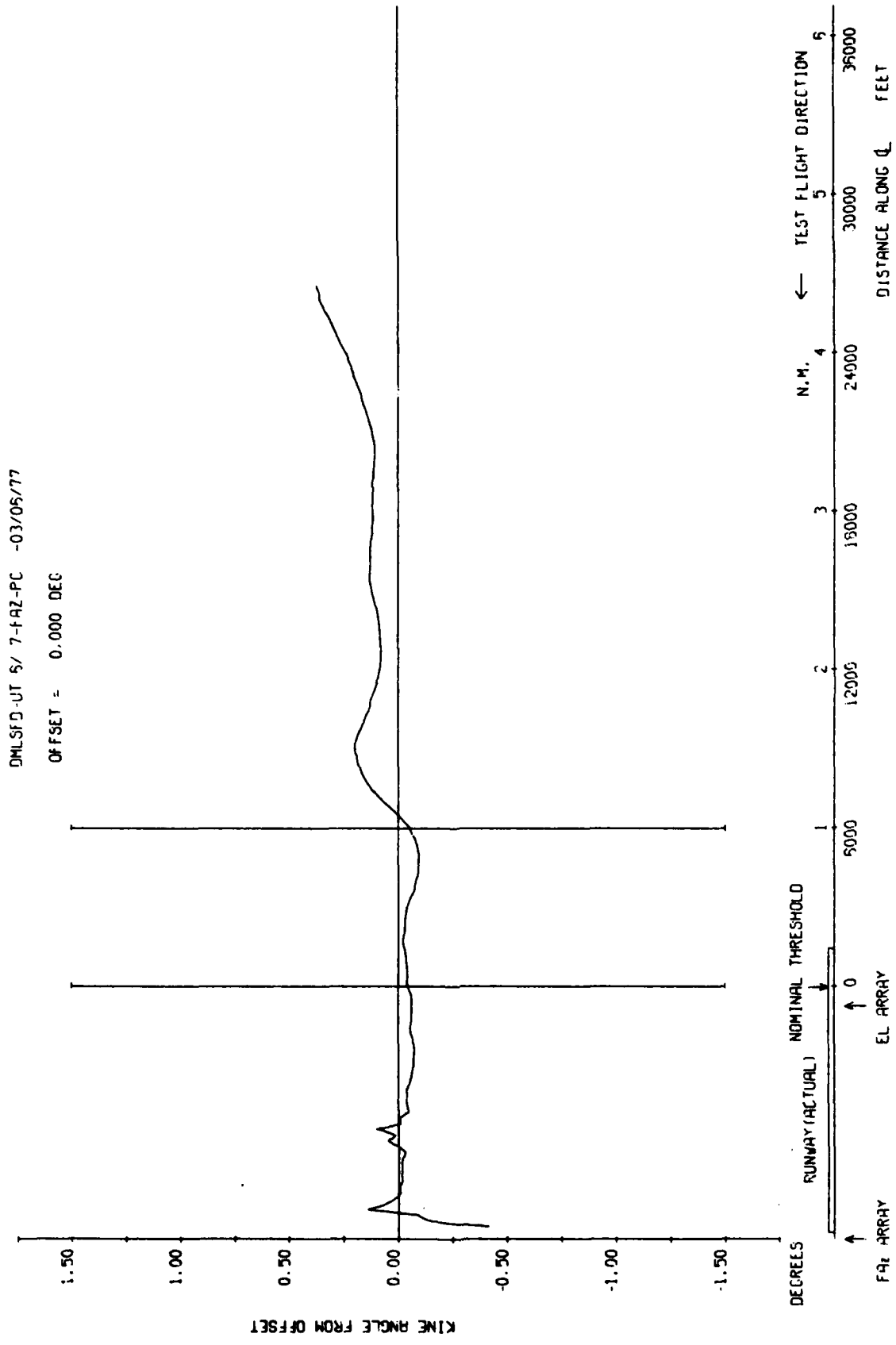


Fig 7.49a Azimuth 54λ, 3 degree approach to 50 ft overshoot

TR 79052

DMLSFD-UT 6/ 7-FAZ-PC -03/06/77 PLESSEY

OFFSET = 0.000 DEC

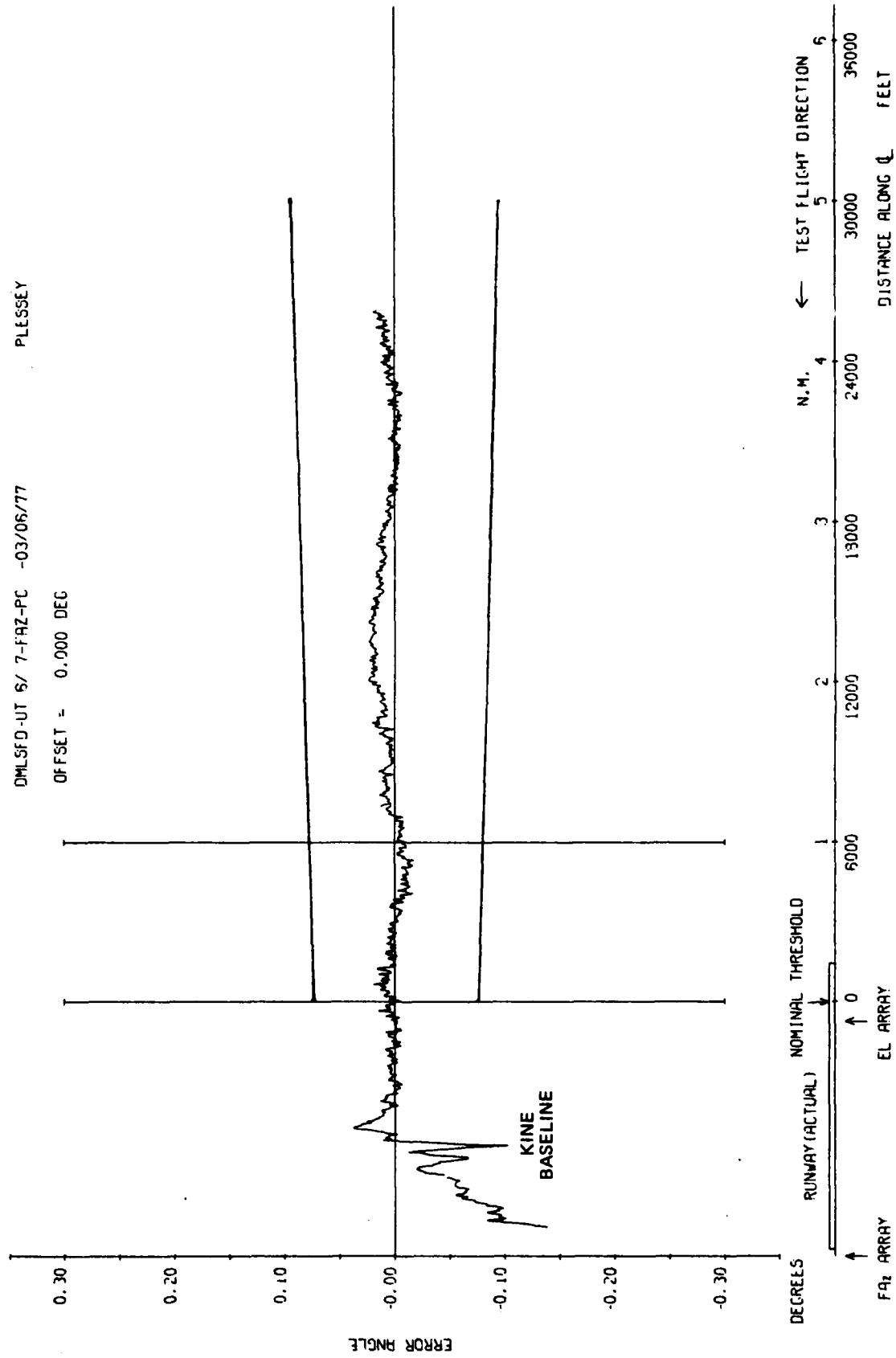


Fig 7.49c

Fig 7.49c Azimuth 54λ, 3 degree approach to 50 ft overshoot

Fig 7.50

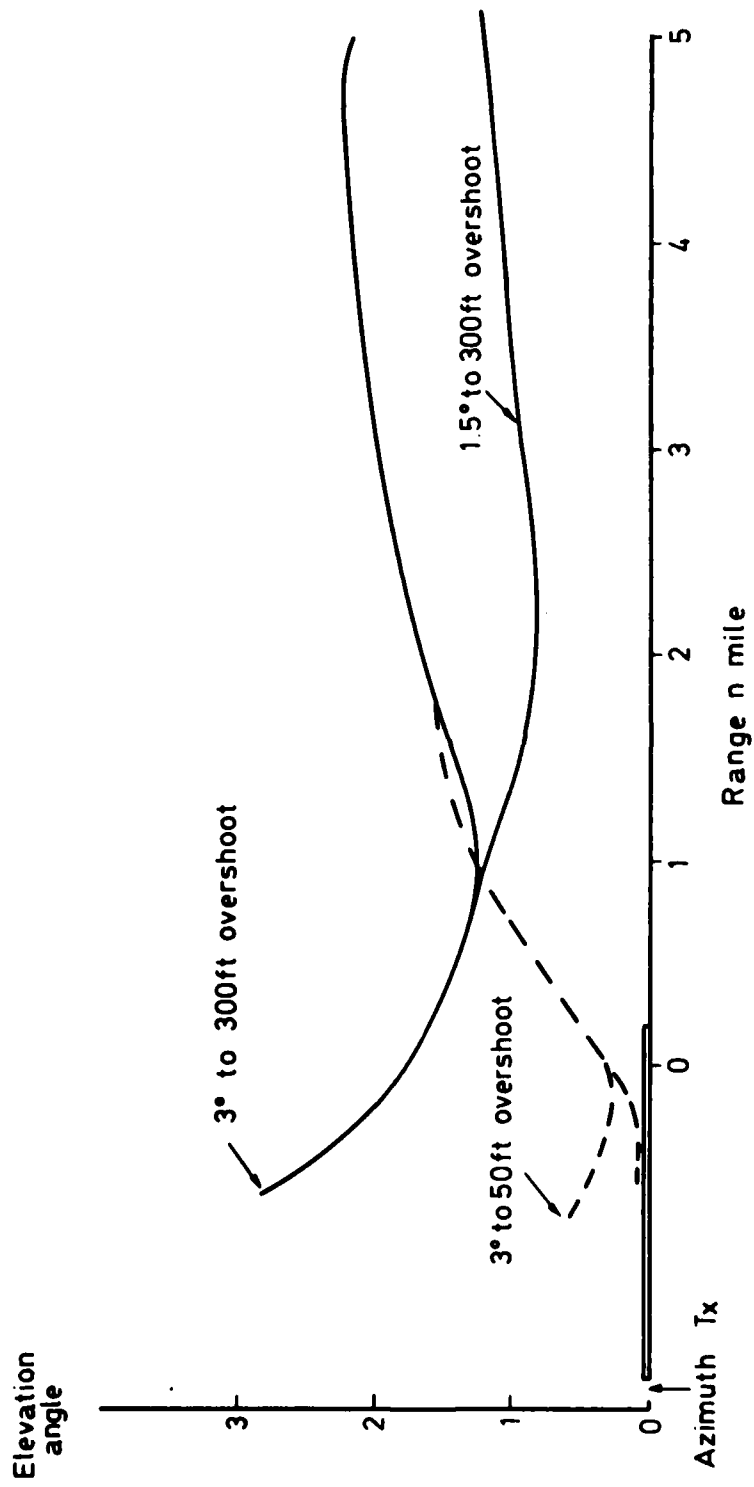


Fig 7.50 Elevation profiles referenced to azimuth site

TR 79062

DMLSFD-DR 2/ 9-EL-PC -19/05/77

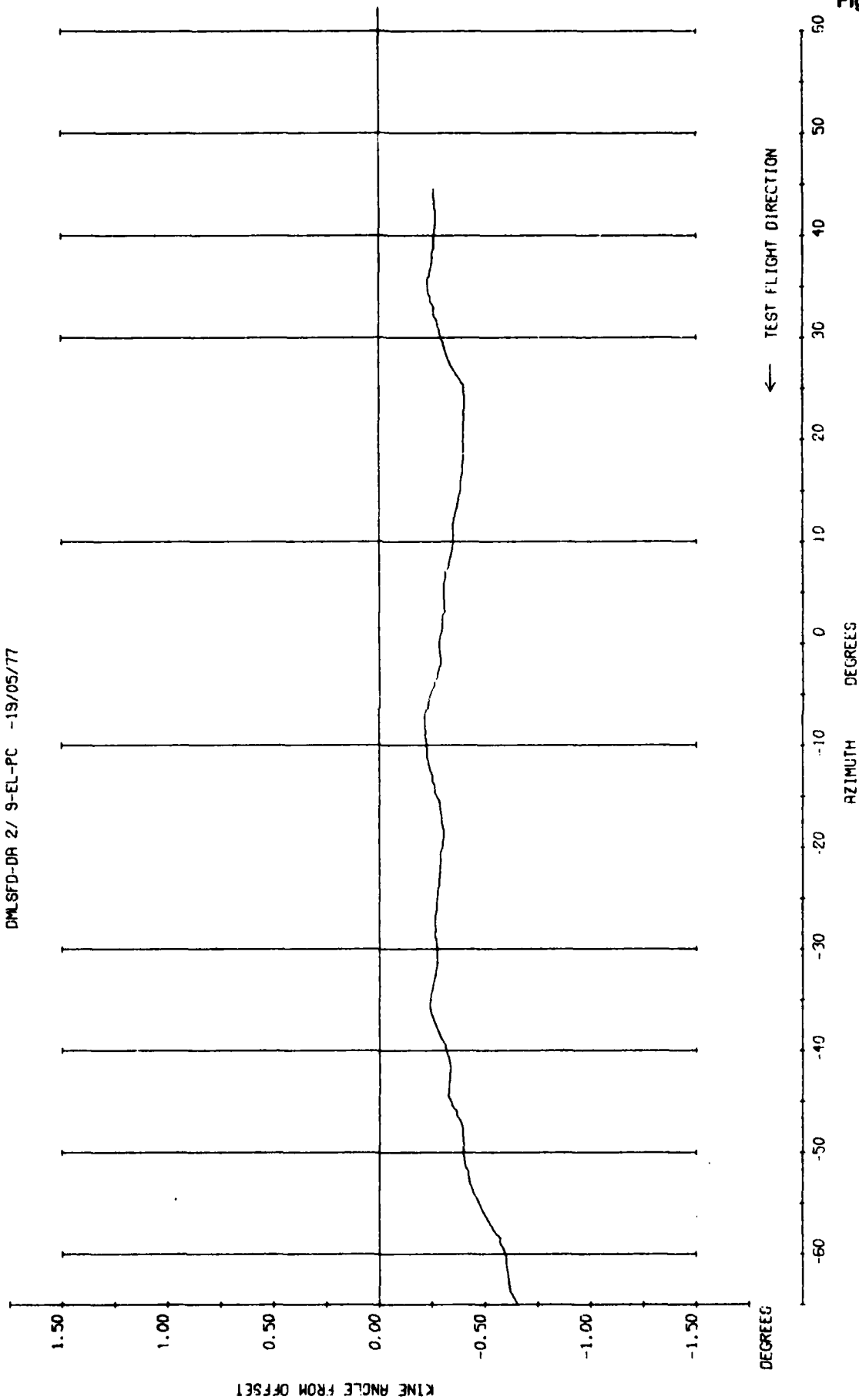


Fig 7.51a

Fig 7.51a Elevation 54λ part orbit, 3 degrees nominal

Fig 7.51b

DMLSFD-DR 2/ 9-EL-PC -19/05/77 PLESSEY

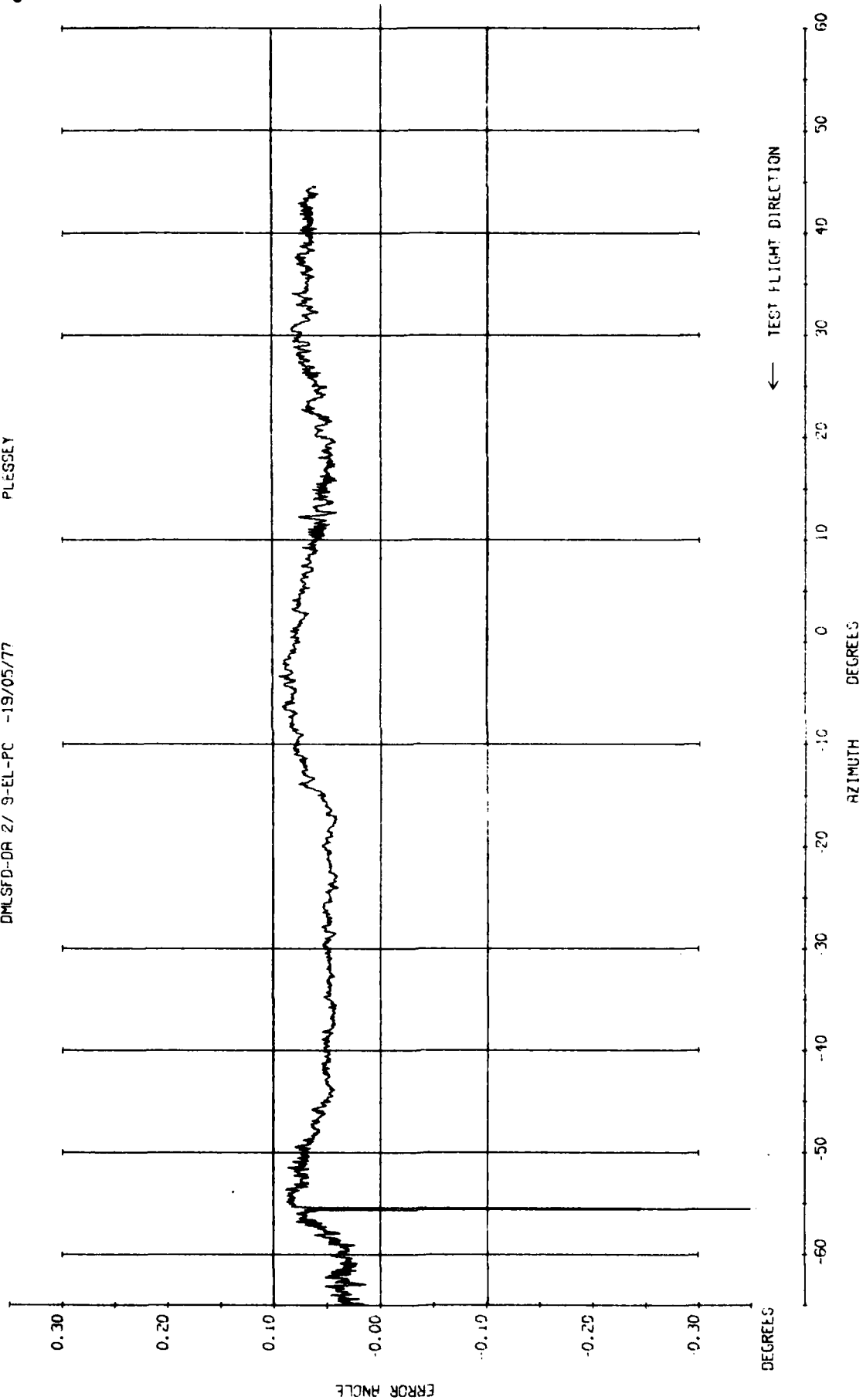


Fig 7.51b Elevation 54λ, part orbit, 3 degrees nominal

TR 79062

DMLSD-DA 3/ 4 EL-PC -20/05/77

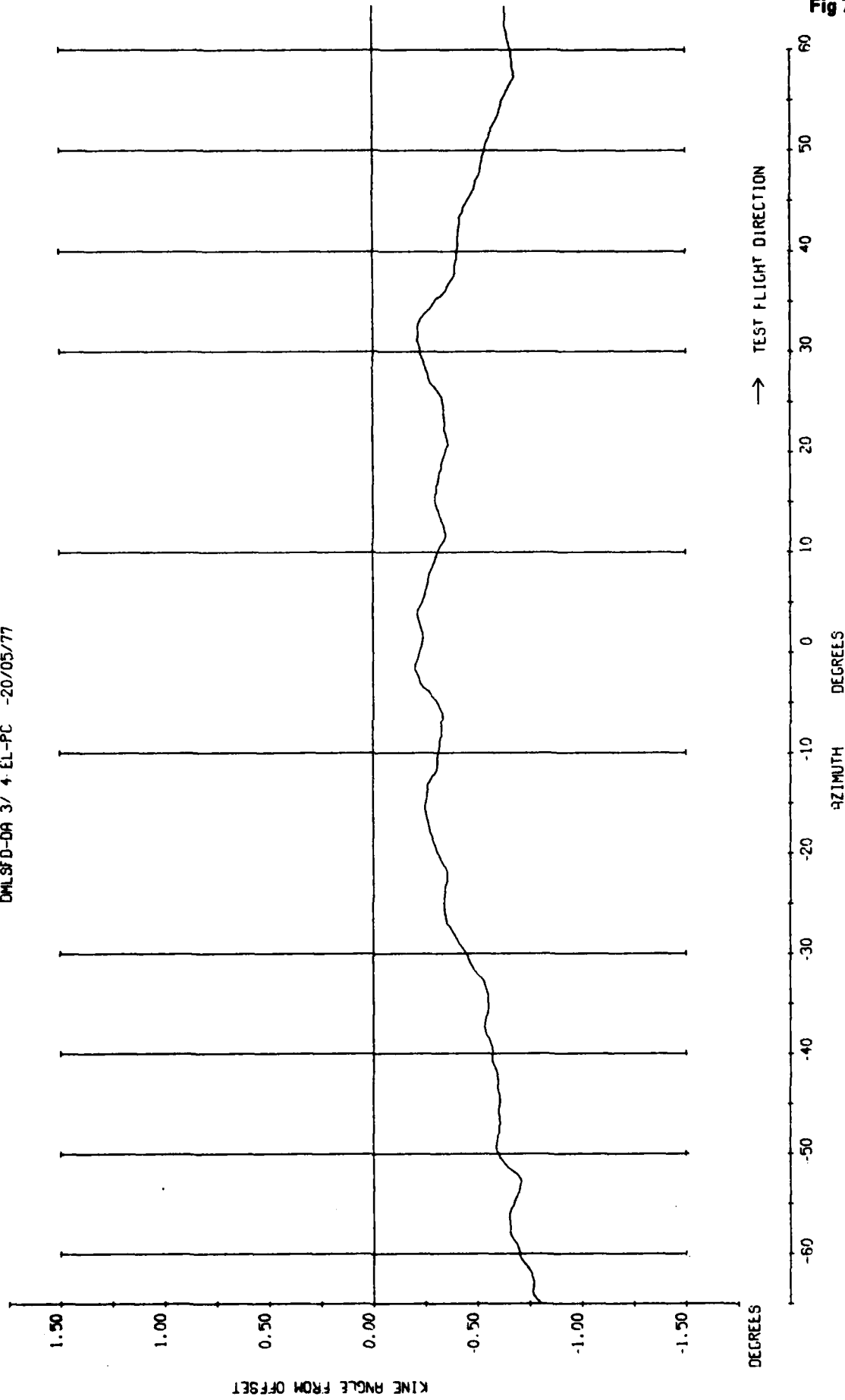


Fig 7.52a

Fig 7.52a Elevation 54λ, part orbit, 3 degrees nominal

Fig 7.52b

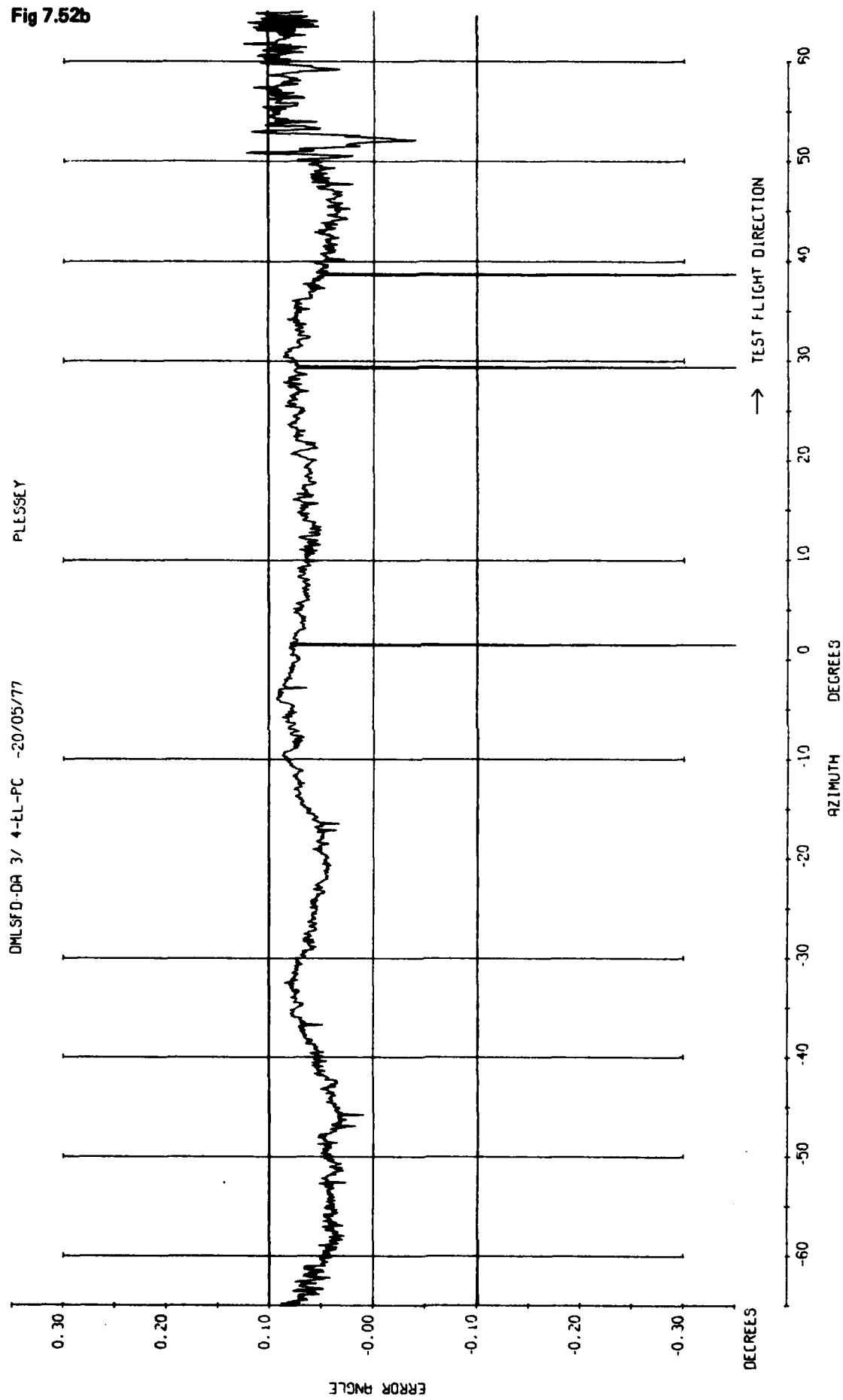


Fig 7.52b Elevation 54λ, part orbit, 3 degrees nominal

TR 75062

DMLSF0-DRI10/ 3-EL-PC -27/05/77

OFFSET 10 DEGREES

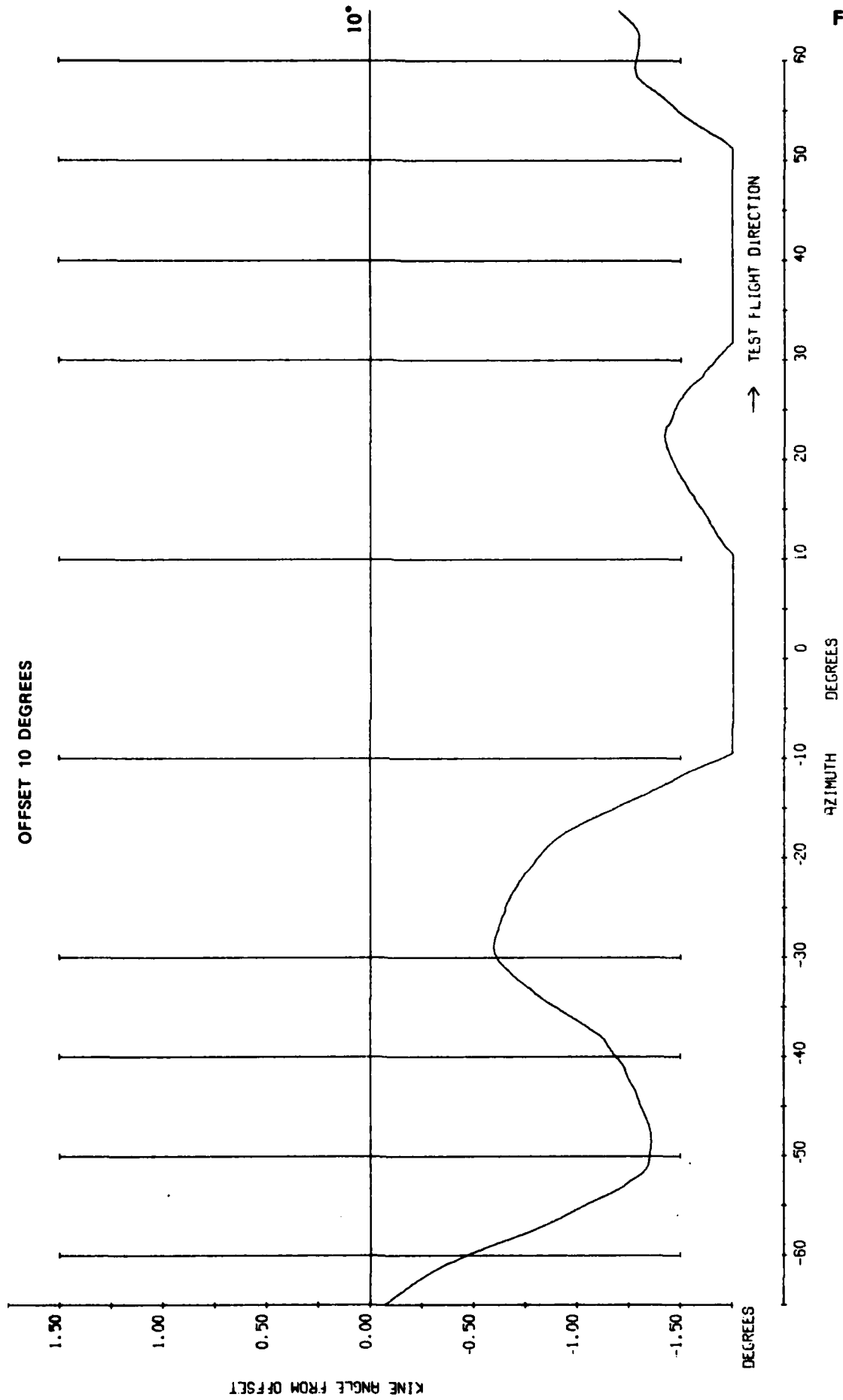


Fig 7.53a

Fig 7.53a Elevation part orbit, 10 degrees nominal

Fig 7.53b

PLESSEY

DMLSFD-DALD/ 3-EL-PC -27/05/77

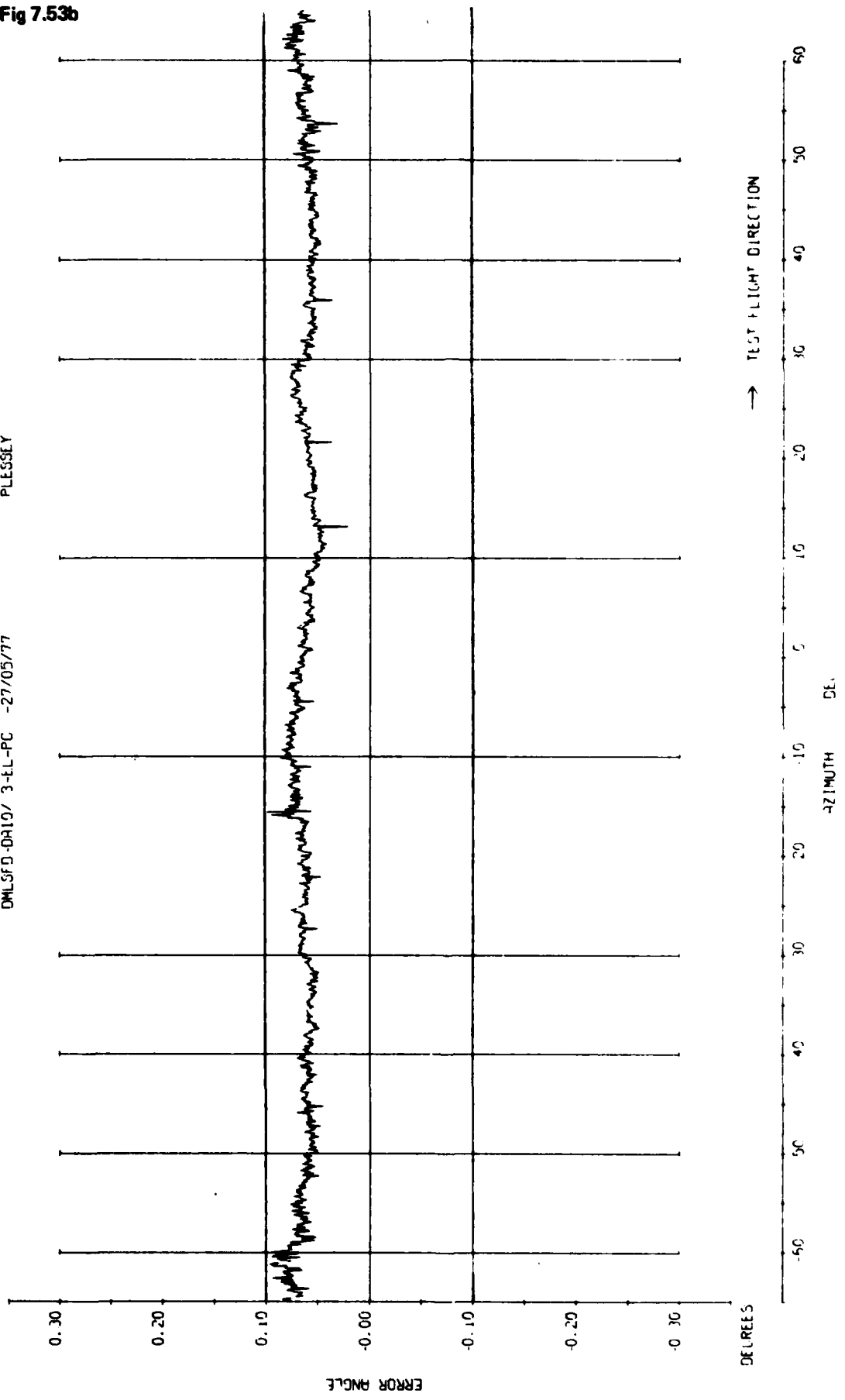


Fig 7.53b Elevation part 1 degrees nominal

TR 79082

DML5FD-0A10/ 4-EL-PC -27/05/77

OFFSET 10 DEGREES

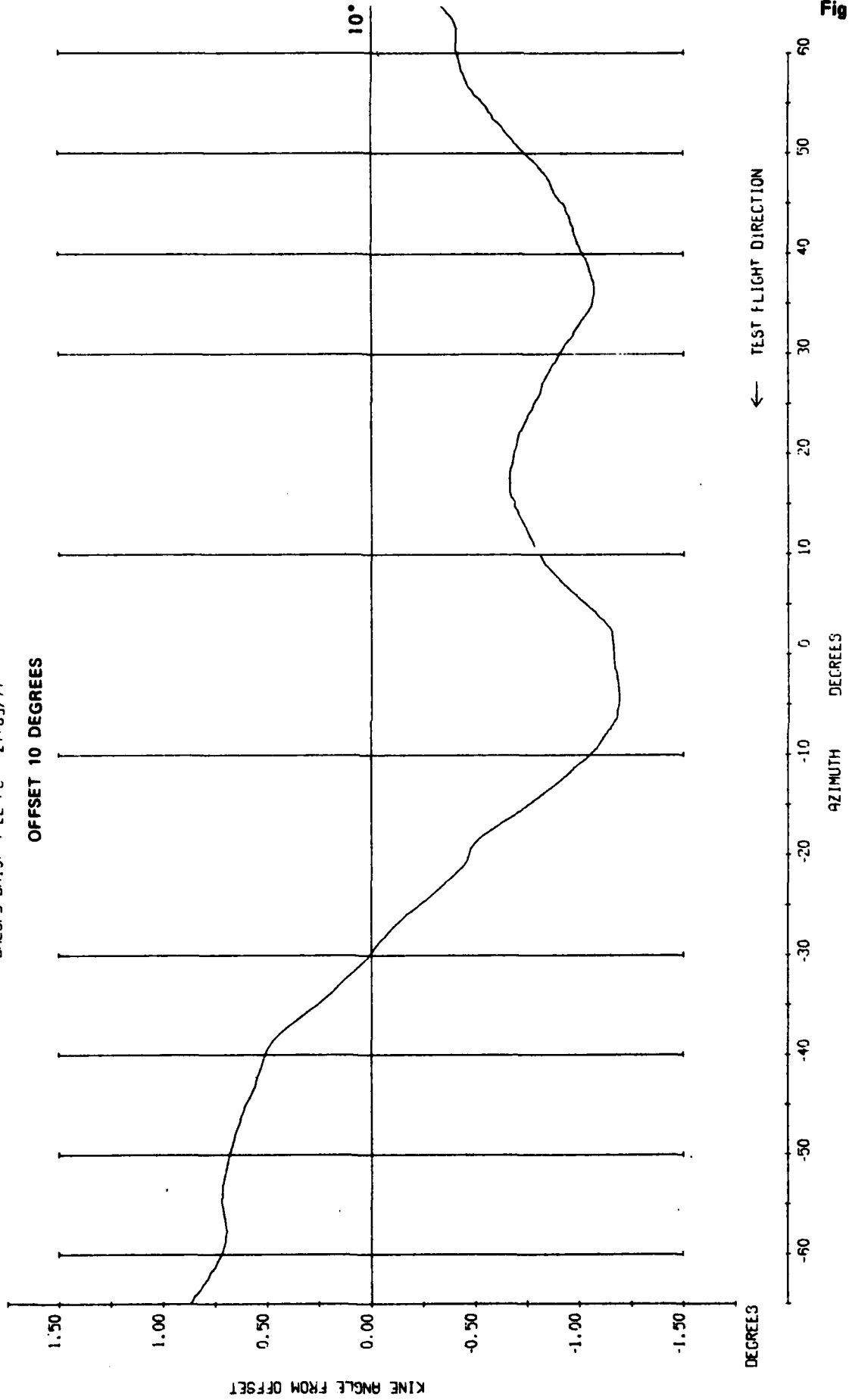


Fig 7.54a

Fig 7.54a Elevation part orbit, 10 degrees nominal

Fig 7.54b

PLESSEY

OMLSFD-OR10/ 4-EL-PC -27/05/77

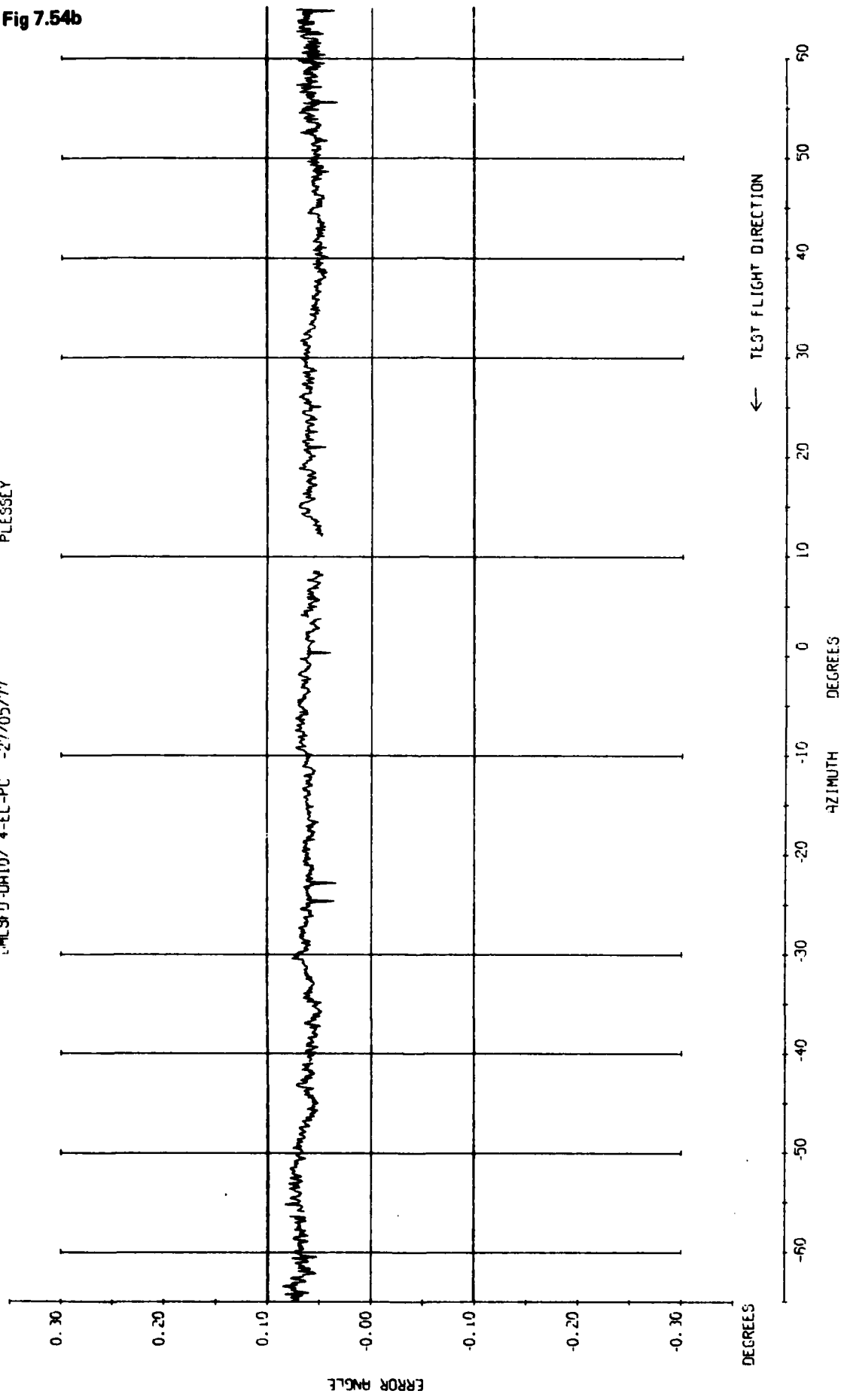


Fig 7.54b Elevation part orbit, 10 degrees nominal

TR 79052

DMLSFD-DA14/ 6-EL-PC -19/07/77
OFFSET 3 DEGREES

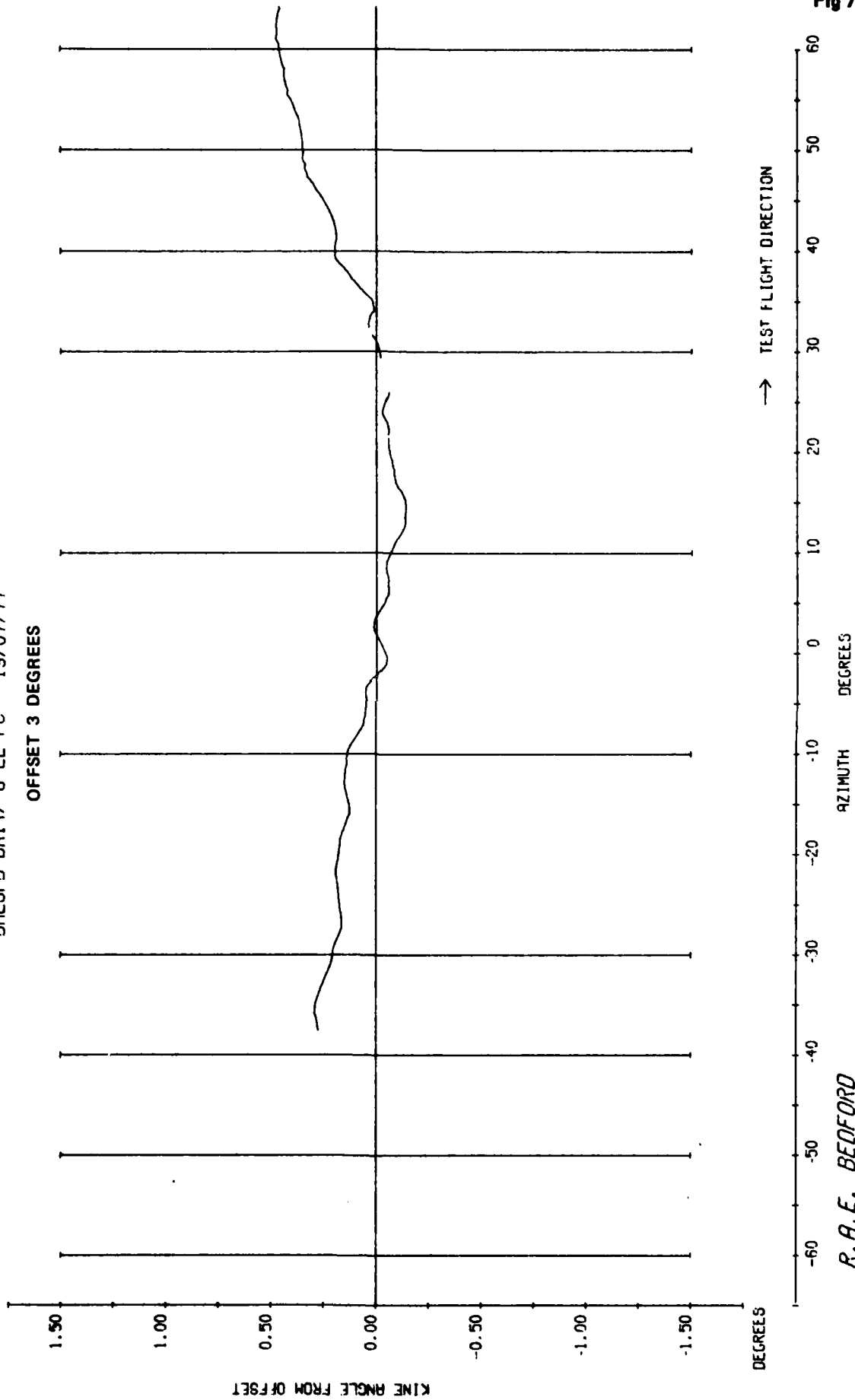


Fig 7.55a

Fig 7.55a Elevation part orbit, 3 degrees nominal. Range 4.6 n mile.
Height 1550 ft

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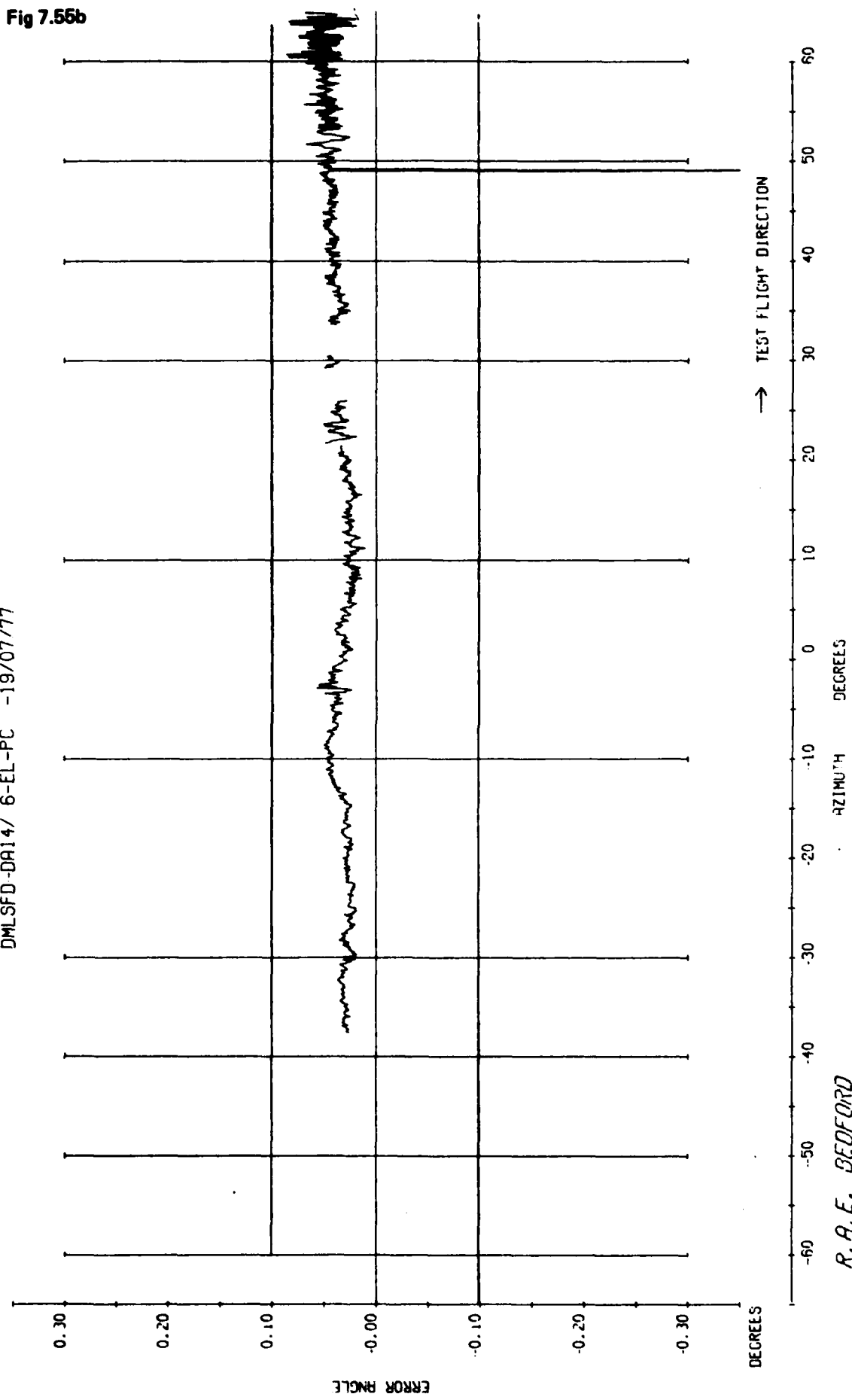


Fig 7.55b

Fig 7.55b Elevation part orbit, 3 degrees nominal

R.A.E. BEDFORD

TR 79082

DMLSFD-DR14/ 7-EL-PC -19/07/77
OFFSET 6.5 DEGREES

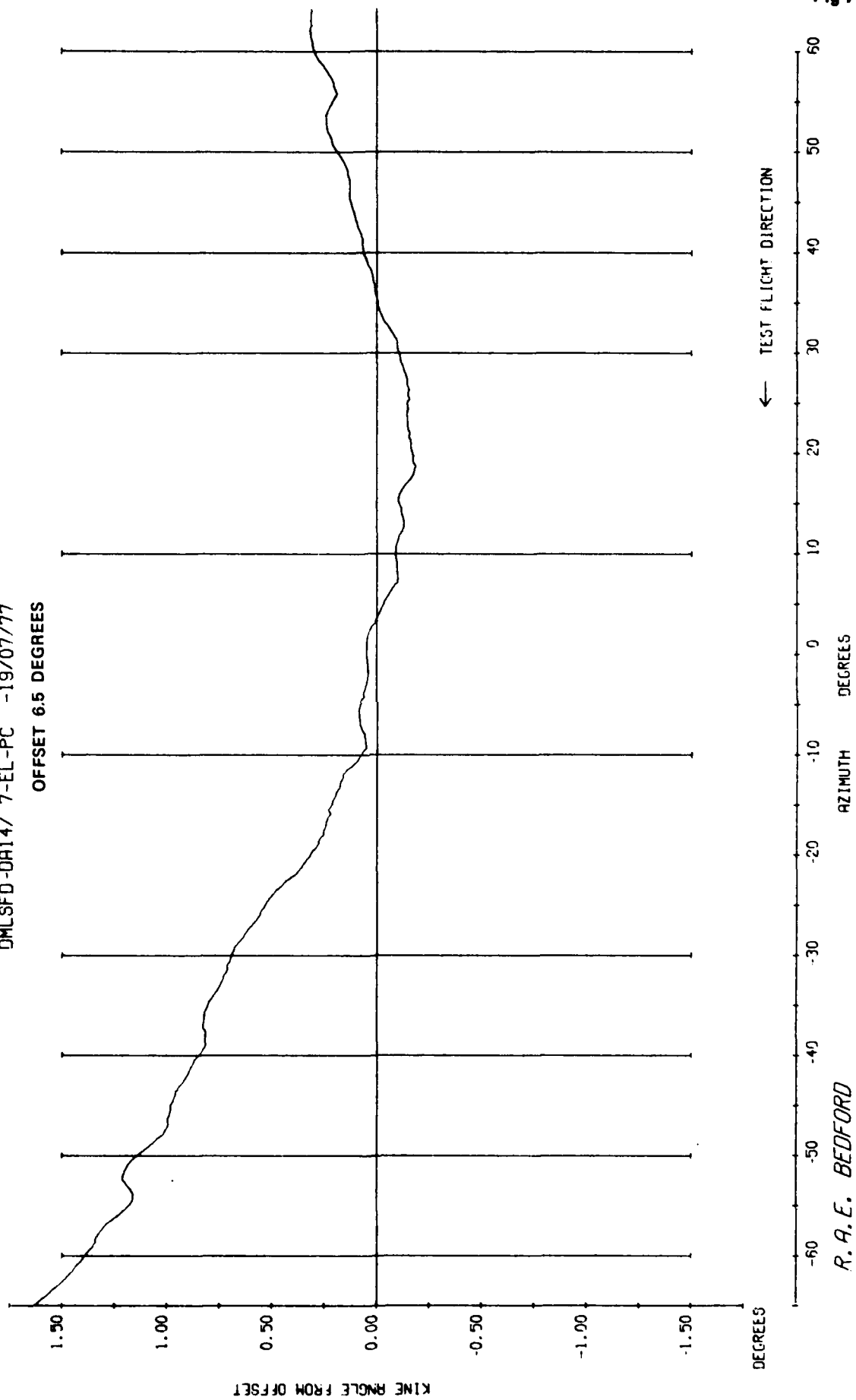
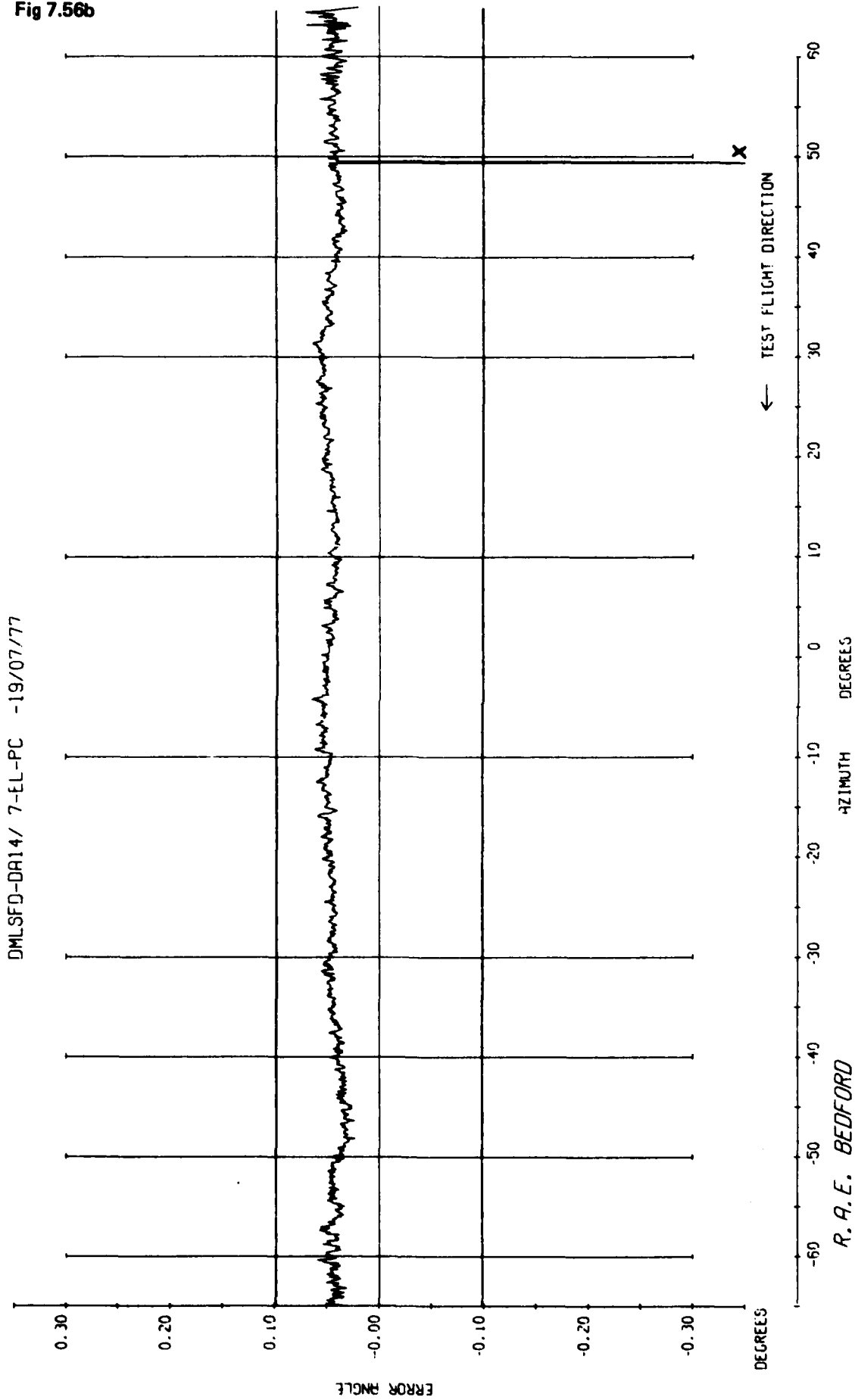


Fig 7.56a

Fig 7.56a Elevation part orbit. Range 4.5 n mile. Height 3060 ft

R. A. E. BEDFORD

Fig 7.56b



R. A. E. BEDFORD

Fig 7.56b Elevation part orbit at 4.5 n mile and 3060 ft

OMLSFD-DR 3/ 2-EL-PC -20/05/77
FLIGHT LEVEL - 1934 FT

-20

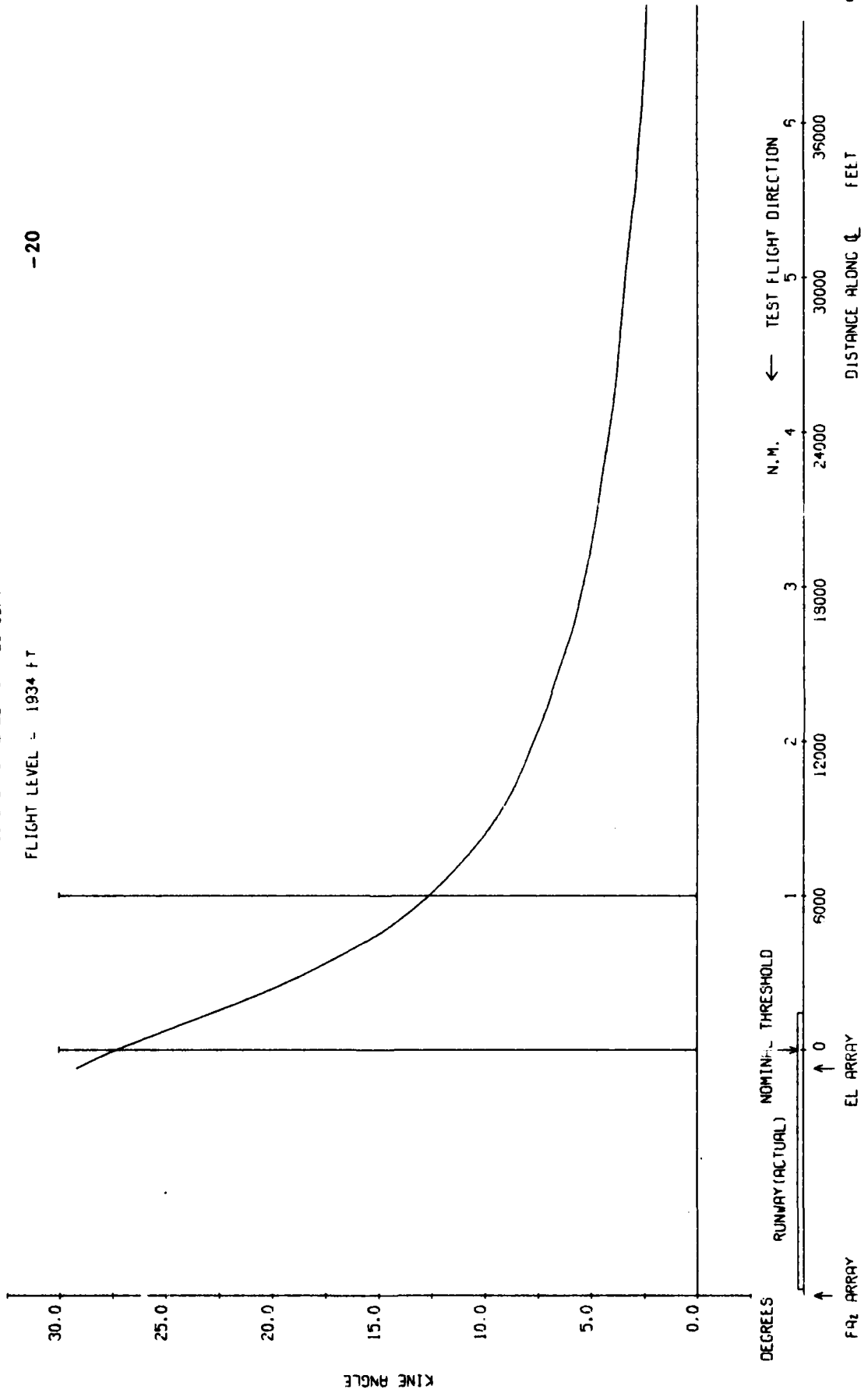


Fig 7.57a

Fig 7.57a Elevation 54λ, constant height radial 1934 ft, - 20 degrees azimuth

Fig 7.57b

DMLSFD-DR 3/ 2-EL-PC -20/05/77 PLESSEY

FLIGHT LEVEL - 1934 FT

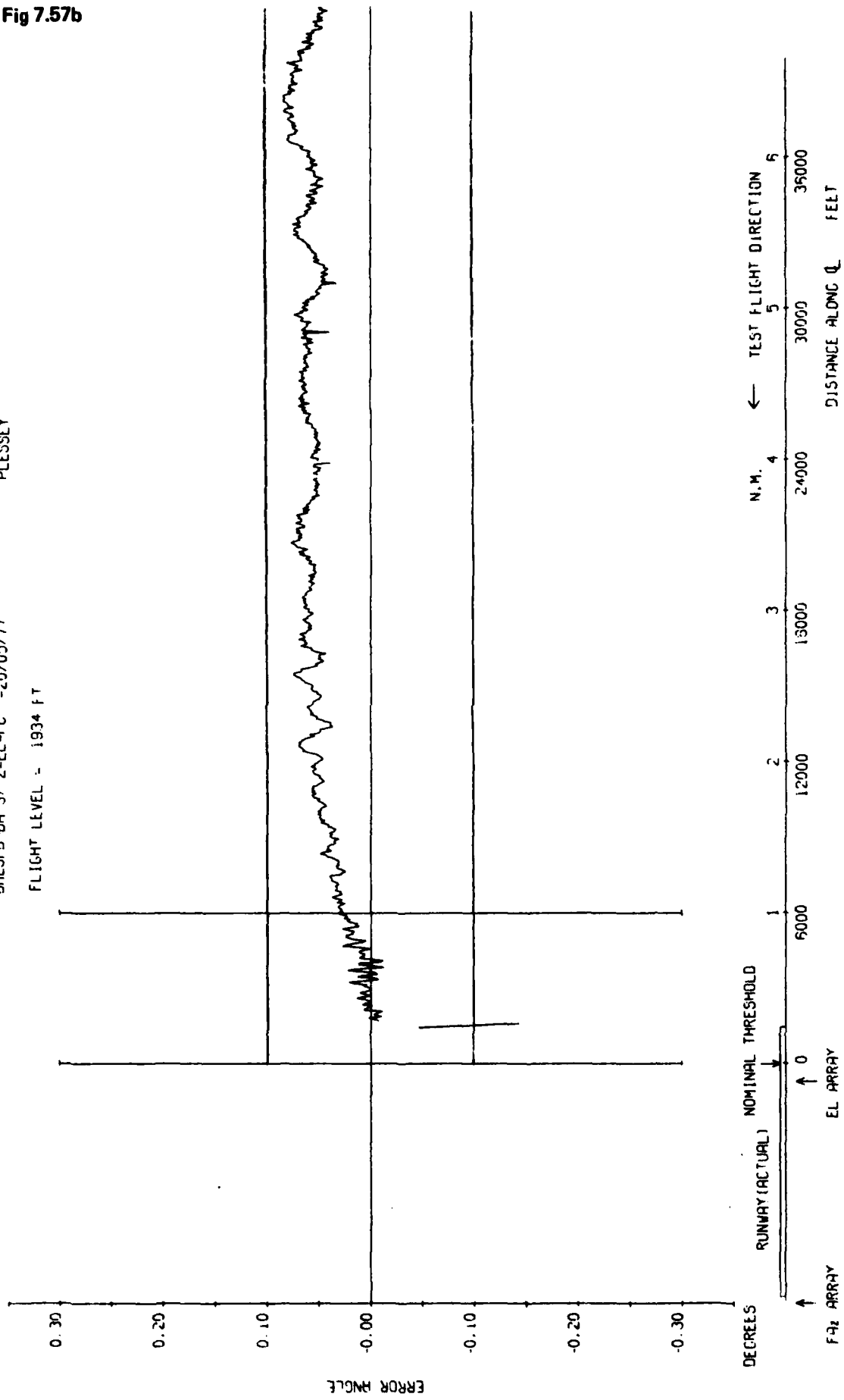


Fig 7.57b Elevation 54λ, constant height radial 1934 ft, - 20 degrees azimuth

TP 79052

DMLSFD-DR12 3-EL-PC -31/05/77
FLIGHT LEVEL - 2048 FT

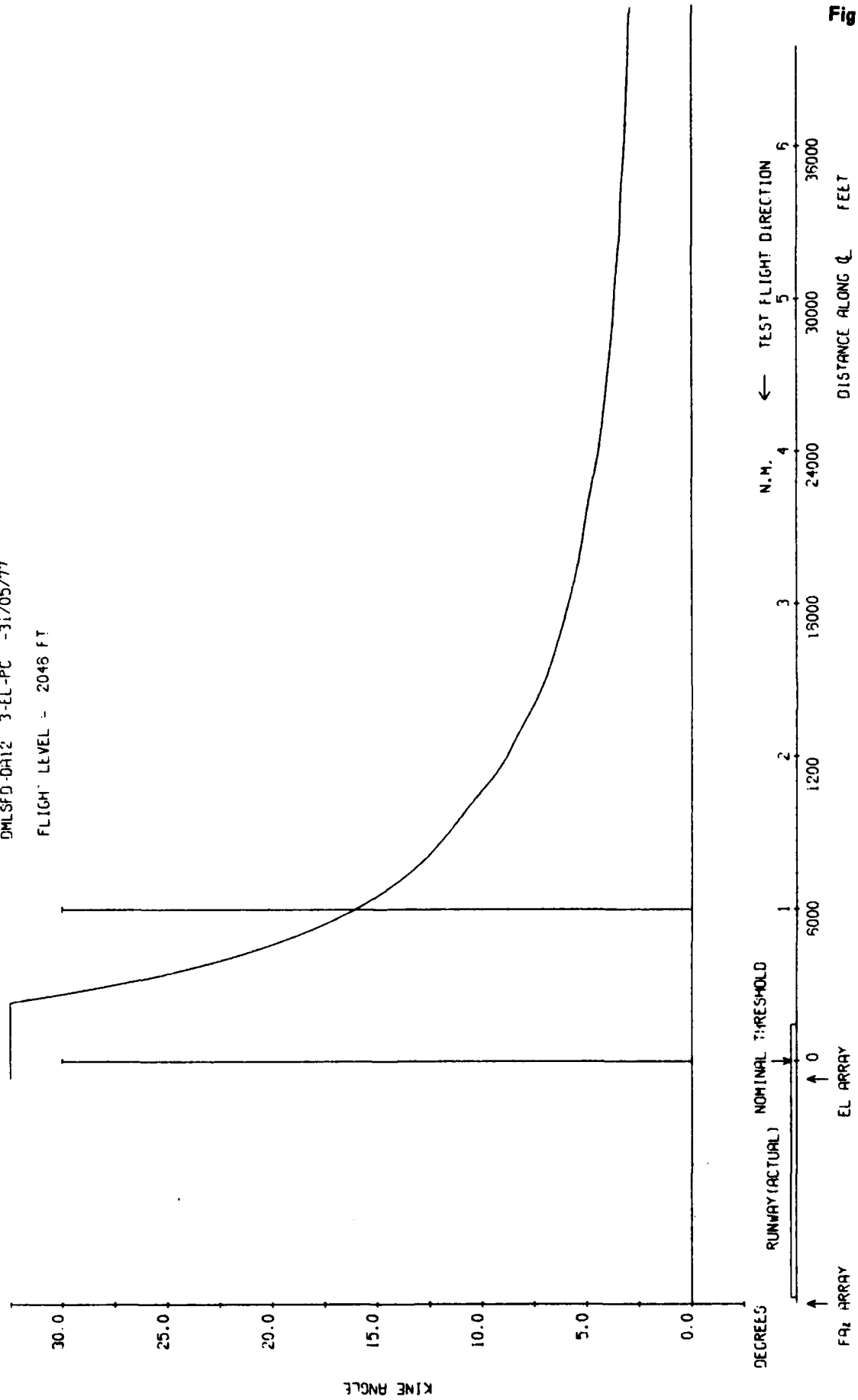


Fig 7.58a

Fig 7.58a Elevation 54λ, constant height radial 2048 ft, 0 degree azimuth

Fig 7.58b

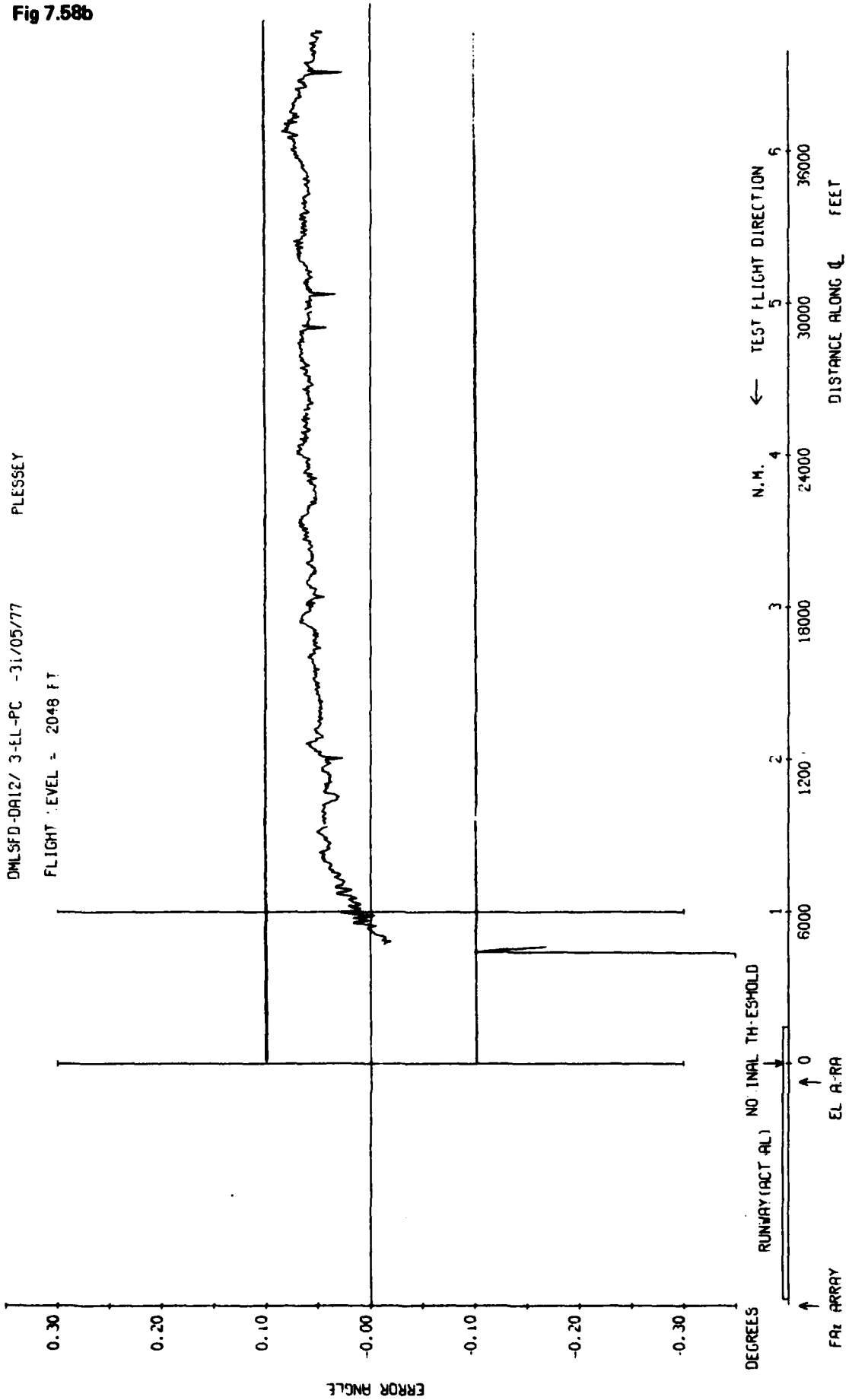


Fig 7.58b Elevation 54λ, constant height radial 2048 ft, 0 degree azimuth

TR 79082

DMLSFD-DR14/ 4-EL-PC -19/07/77

FLIGHT LEVEL = 2038 FT

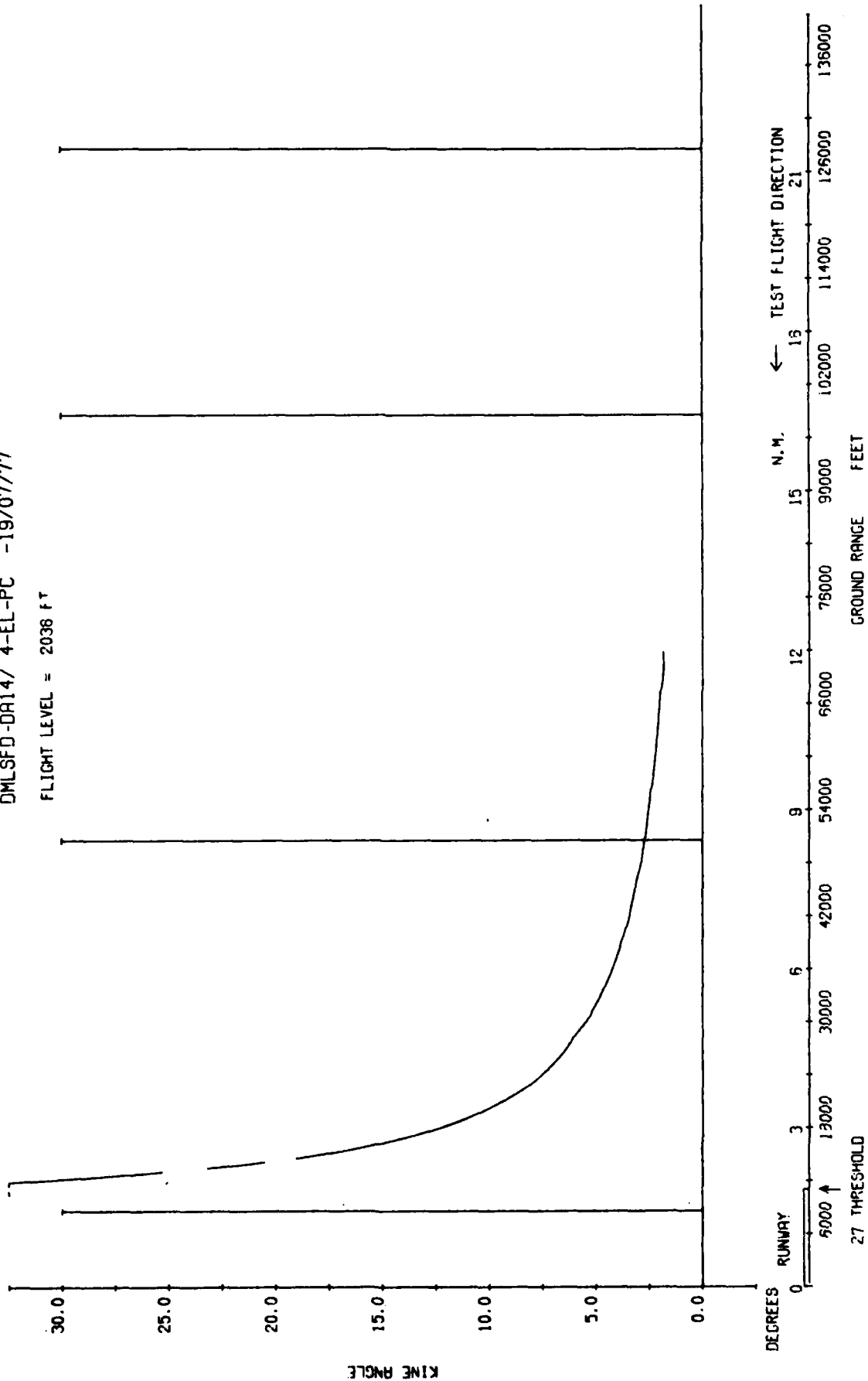
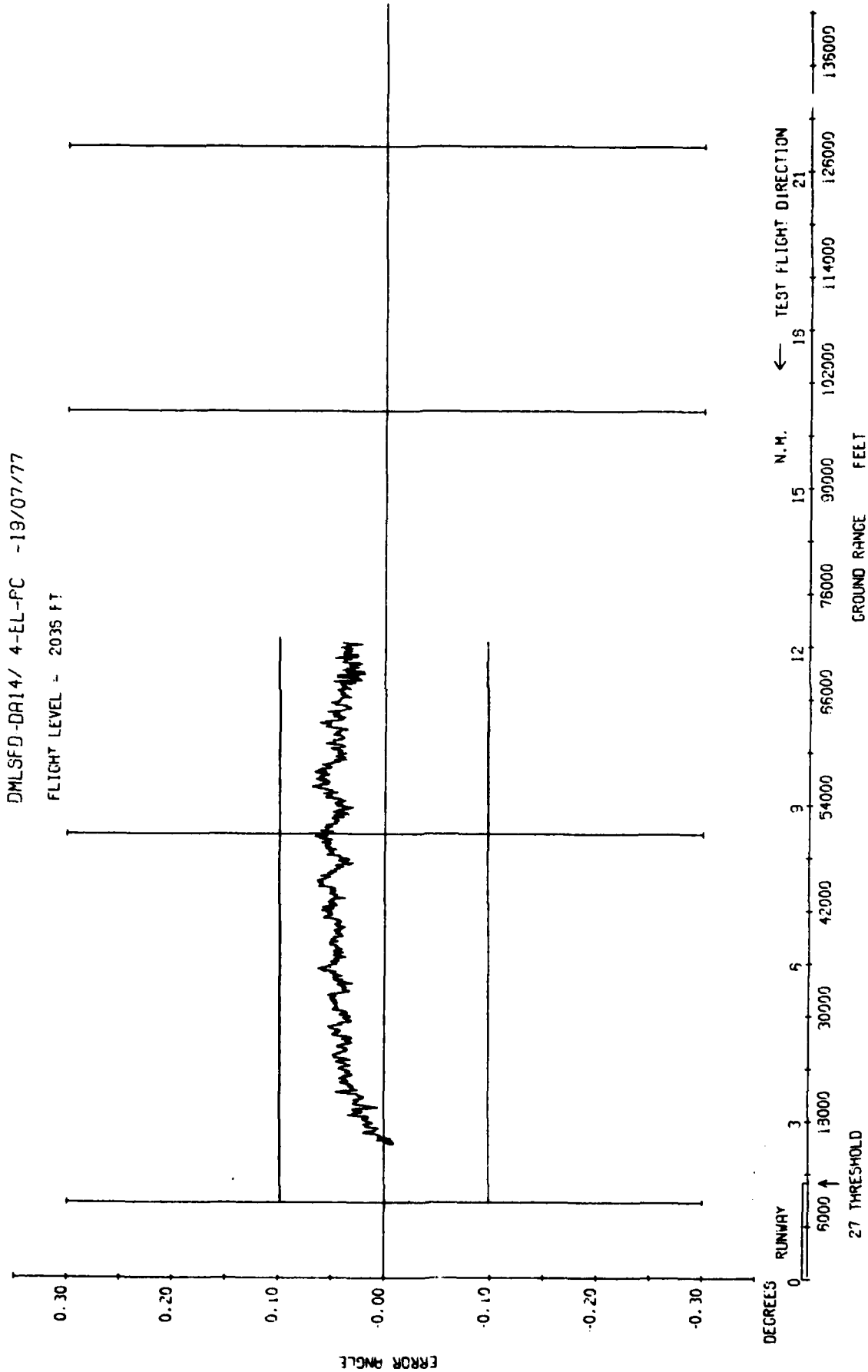


Fig 7.59a

Fig 7.59a Elevation 54λ, constant height radial 2038 ft, 0° degree azimuth

R. A. E. BEDFORD

Fig 7.59b



R. A. E. BEDFORD
Fig 7.59b Elevation 54λ, constant height radial 2036 ft, 0 degree azimuth

OMLSFD-QR 7/ 8-EL-PI 25/05/77

FLIGHT LEVEL = 2023 FT

+10

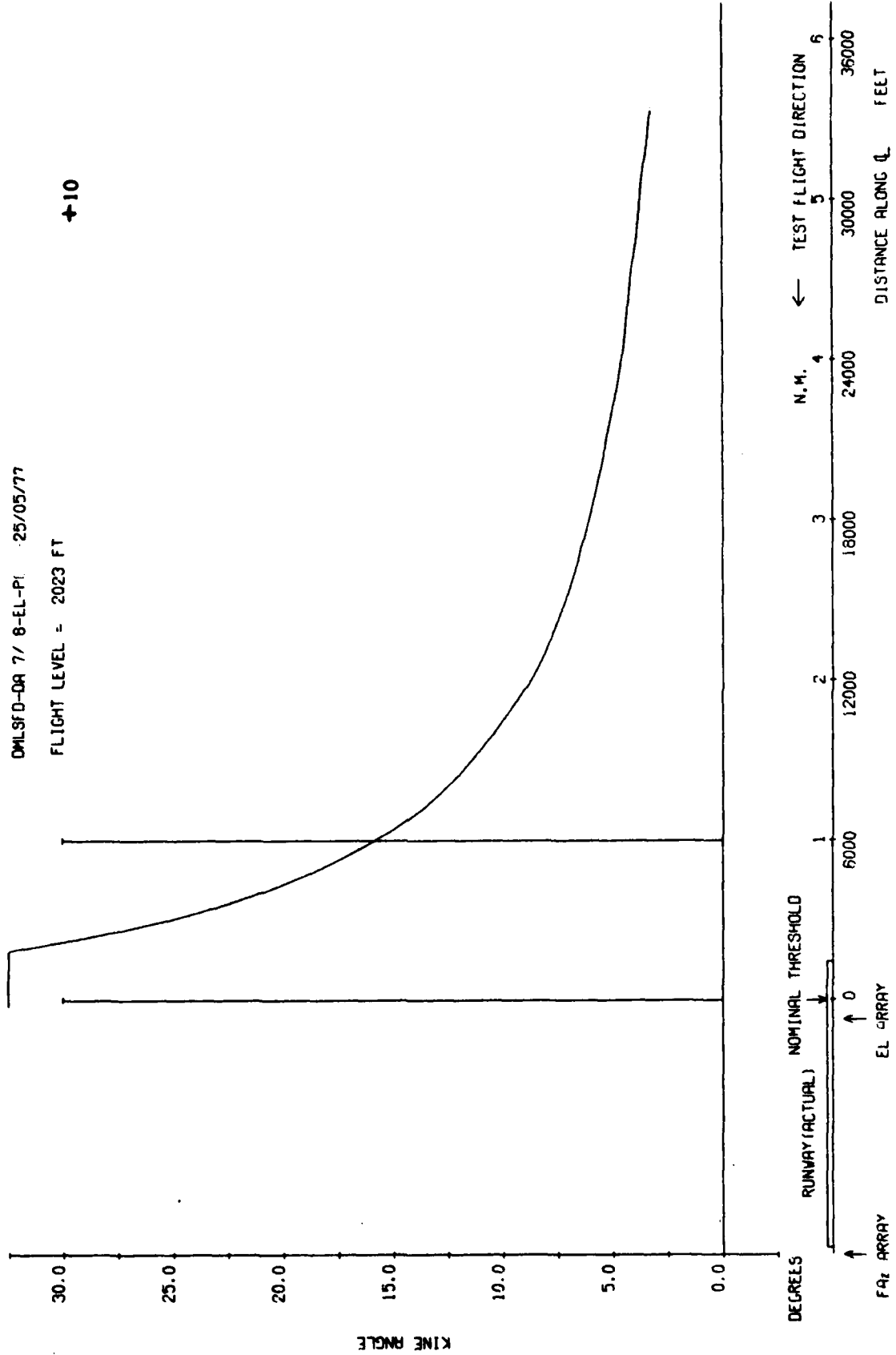


Fig 7.60a

Fig 7.60a Elevation 54λ, constant height radial 2023 ft, +10 degrees azimuth

Fig 7.60b

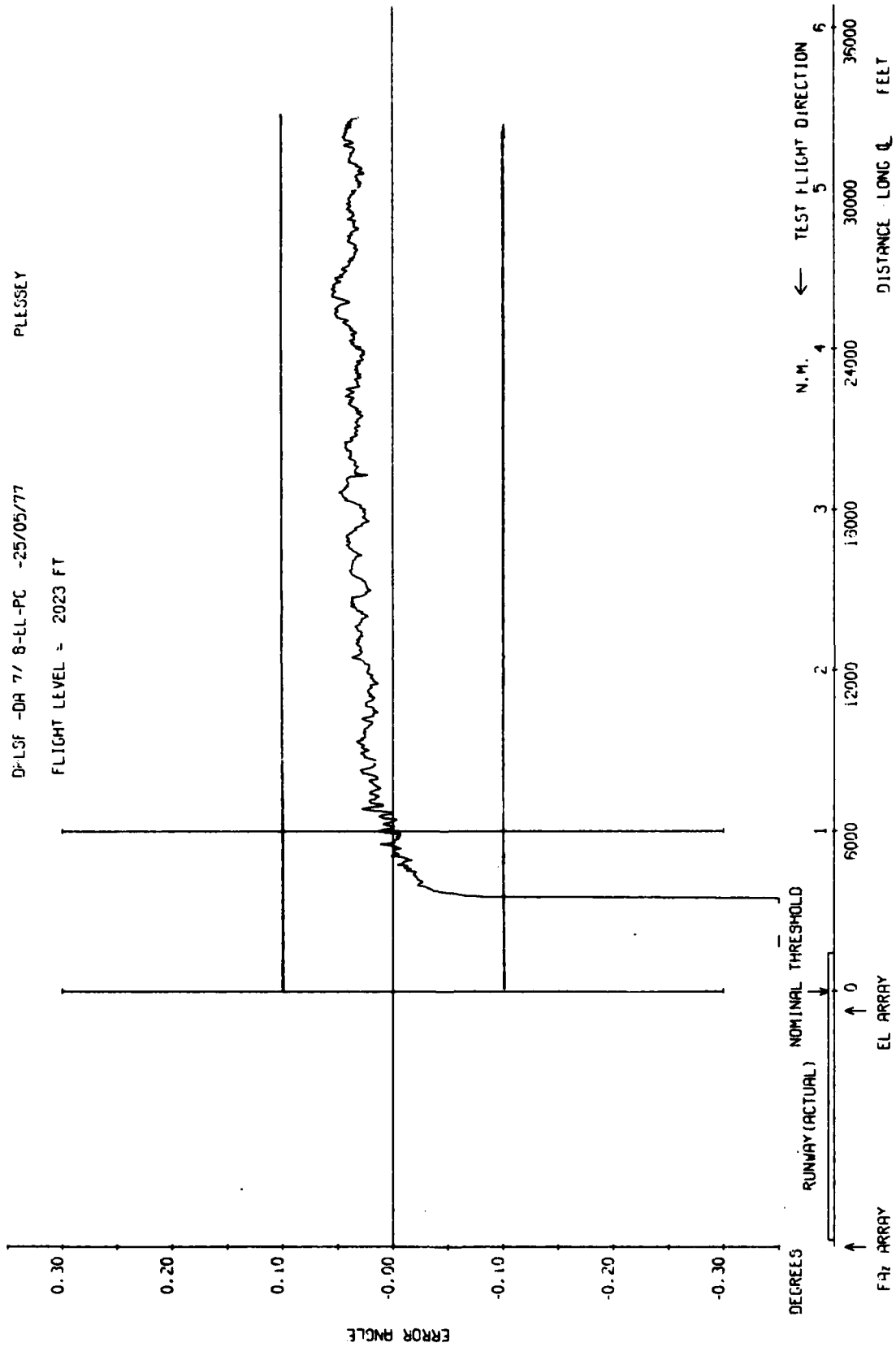


Fig 7.60b Elevation 54λ, constant height radial 2023 ft, +10 degrees azimuth

TR 79062

DMLSFD-DRI14/10-EL-PC -19/07/77
FLIGHT LEVEL = 2041 FT

+20

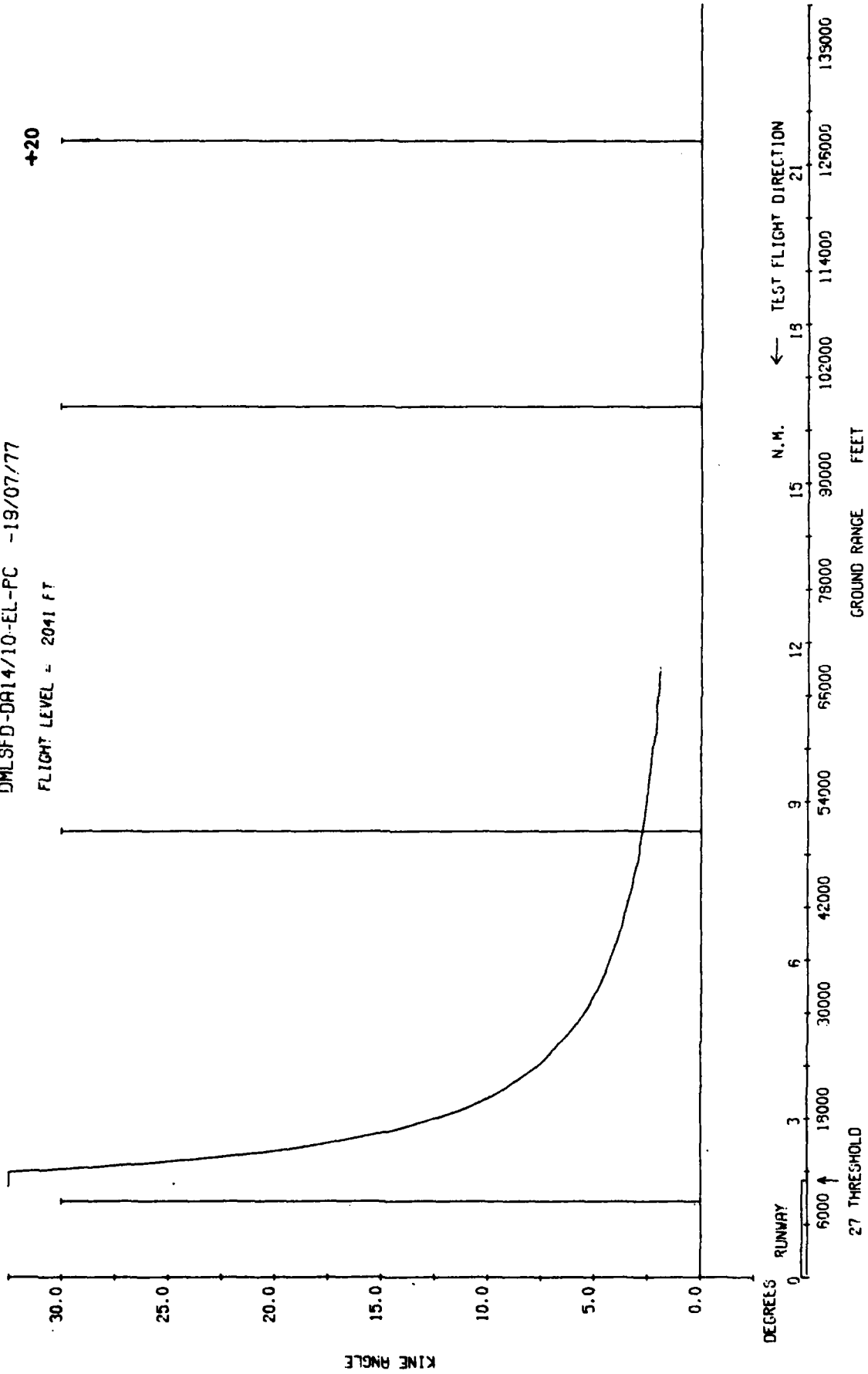
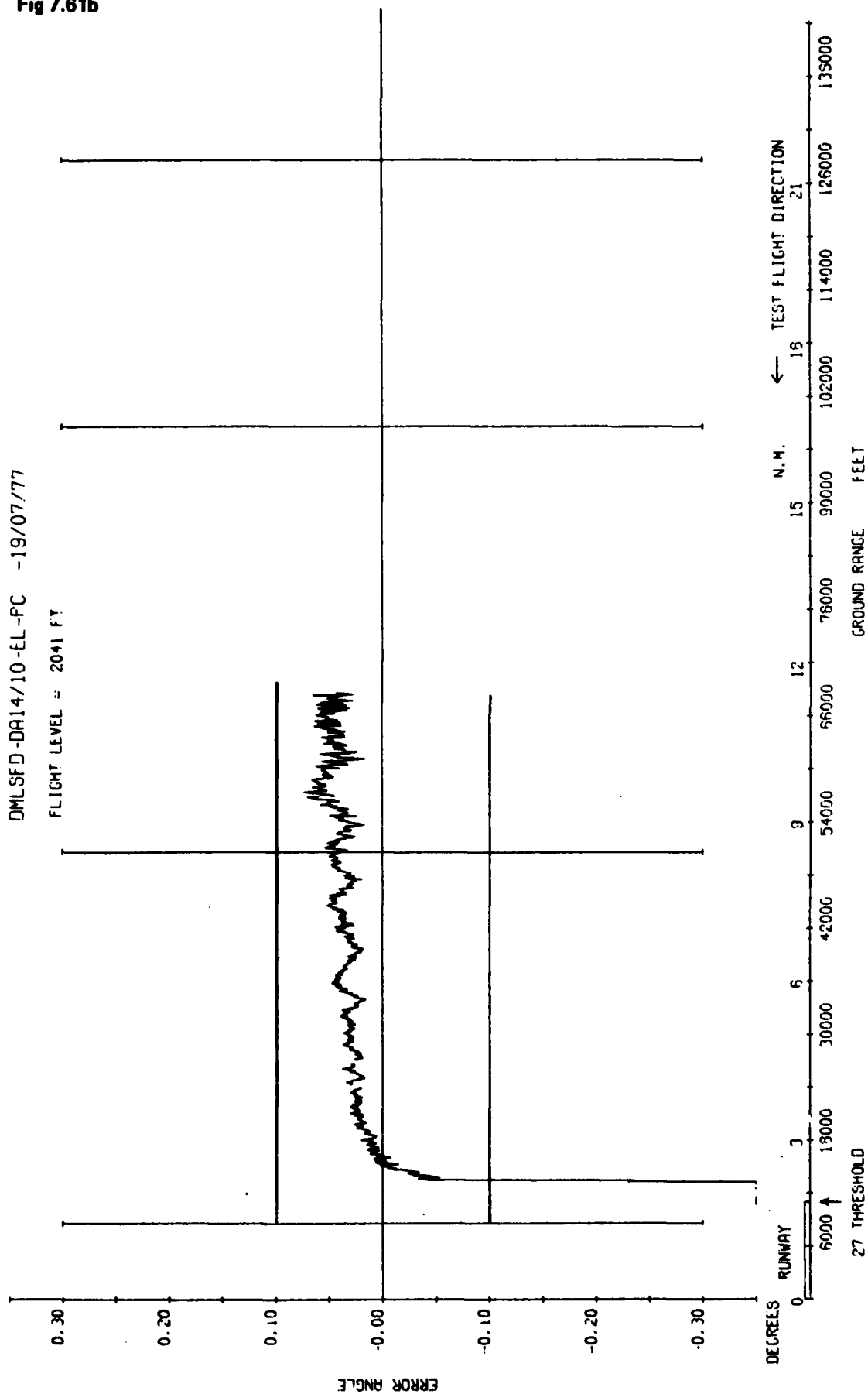


Fig 7.61a

Fig 7.61a Elevation 54λ, constant height radial 2041 ft, +20 degrees azimuth

R. A. E. BEDFORD

Fig 7.61b



R. A. E. BEDFORD Fig 7.61b Elevation 54λ, constant height radial 2041 ft, +20 degrees azimuth

TR 79062

DMLSFD-DA 3/ 7-EL-PC -20/05/77
FLIGHT LEVEL = 2034 FT

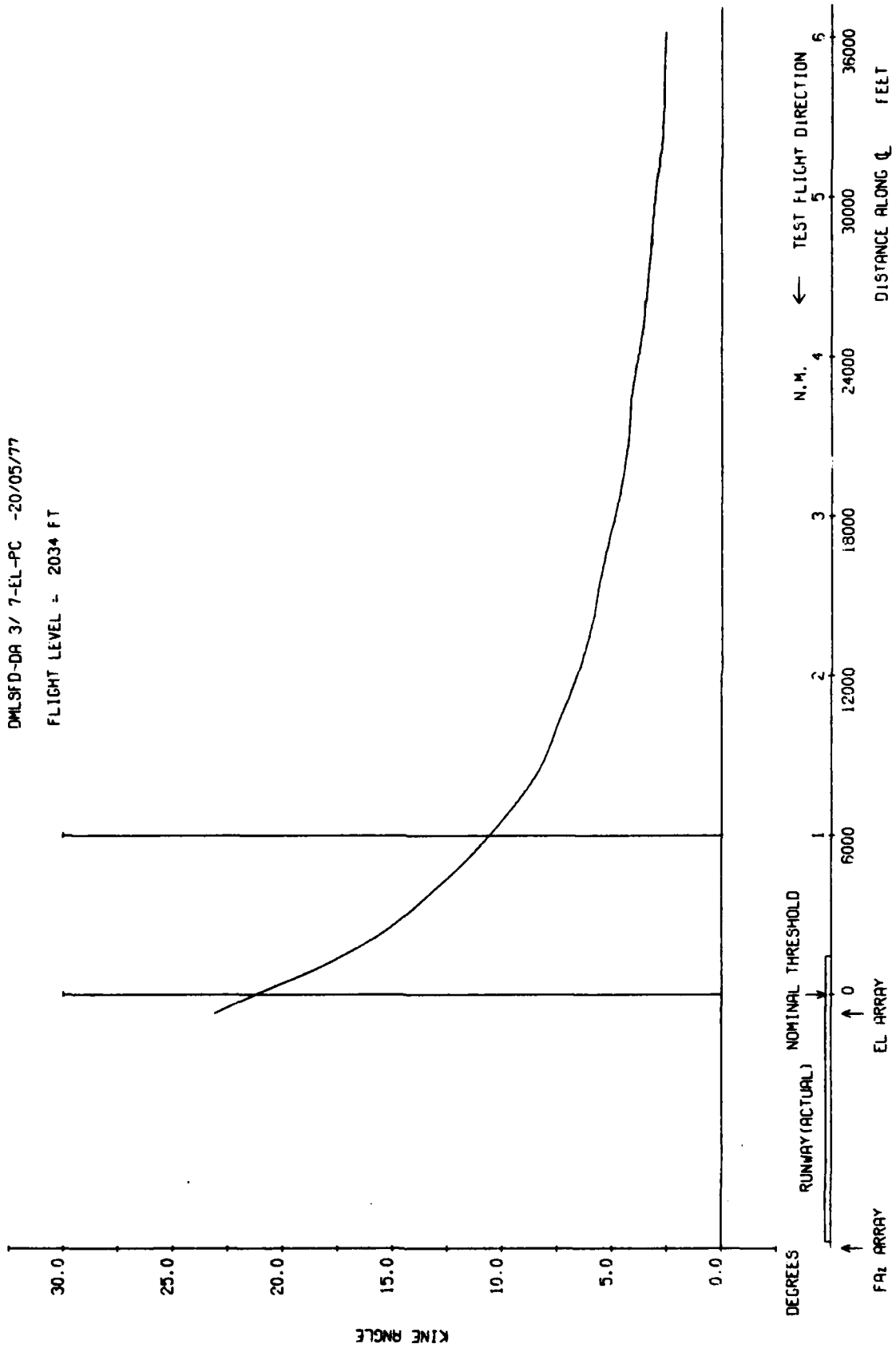


Fig 7.62a

Fig 7.62a Elevation 54λ, constant height radial 2034 ft, +30 degrees azimuth

Fig 7.62b

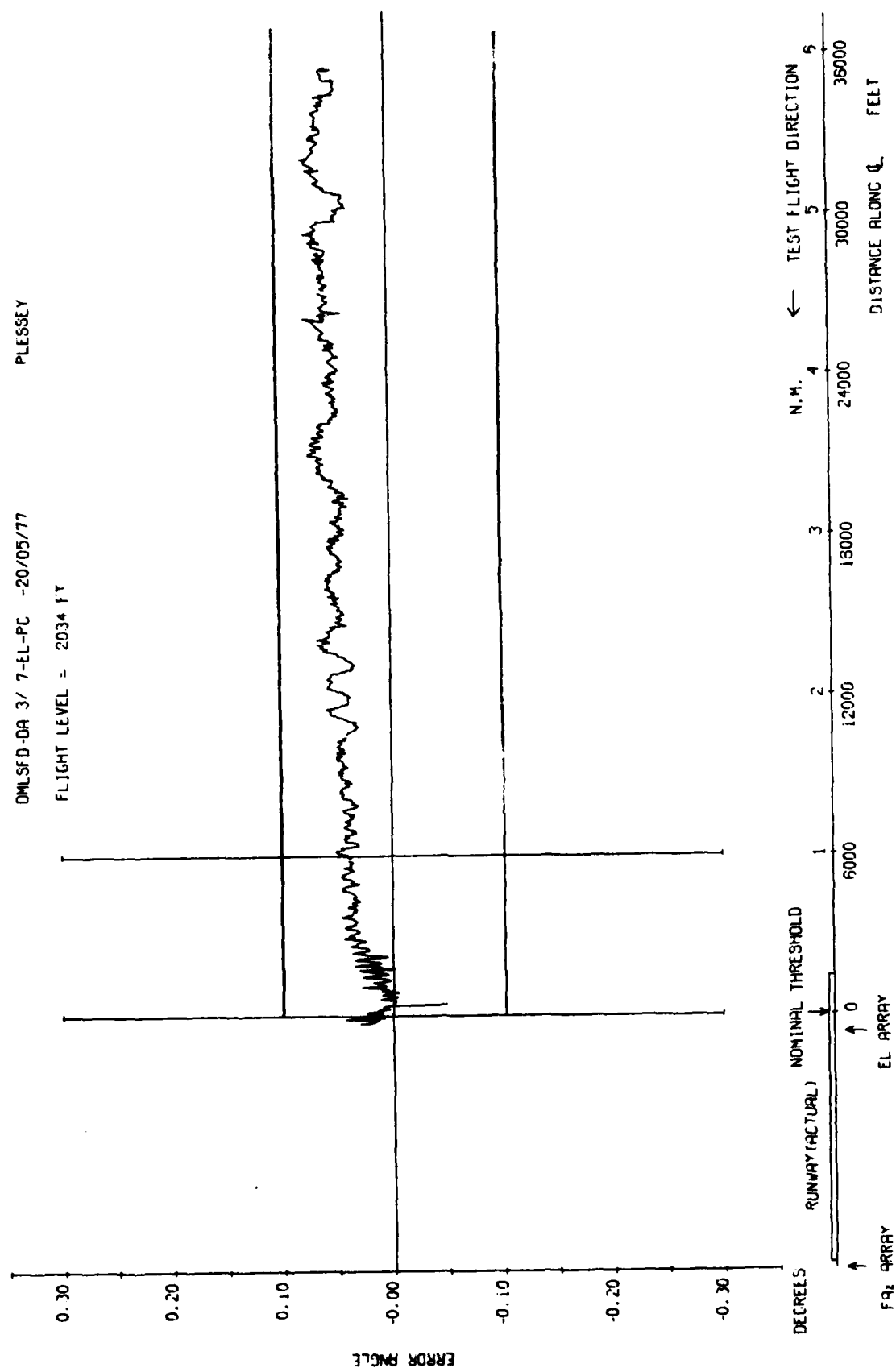


Fig 7.62b Elevation 54λ, constant height radial 2034 ft, +30 degrees azimuth

TR 79052

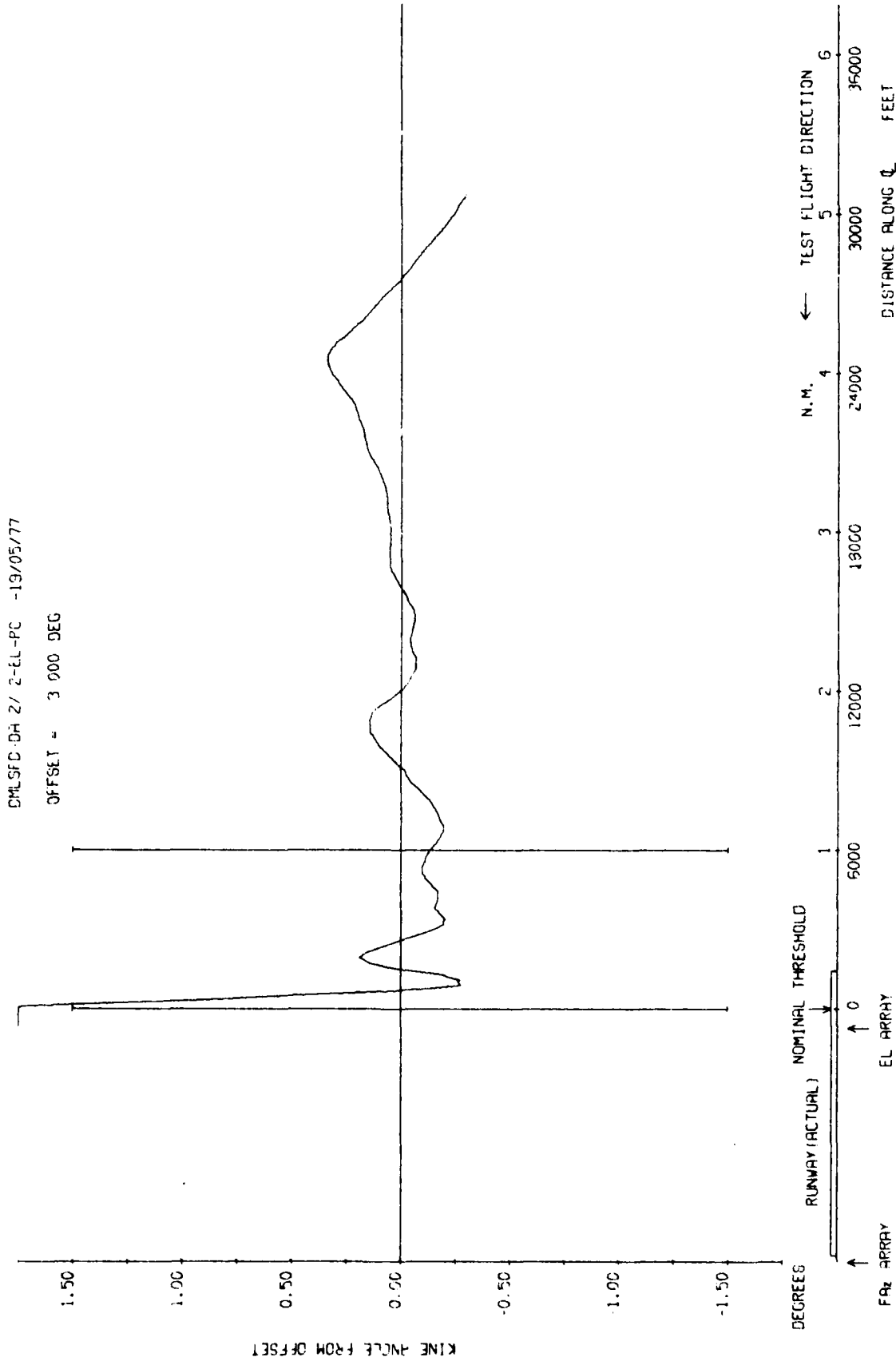


Fig 7.63a

Fig 7.63a Elevation 54λ, 3 degree approach to touch and go

Fig 7.63b

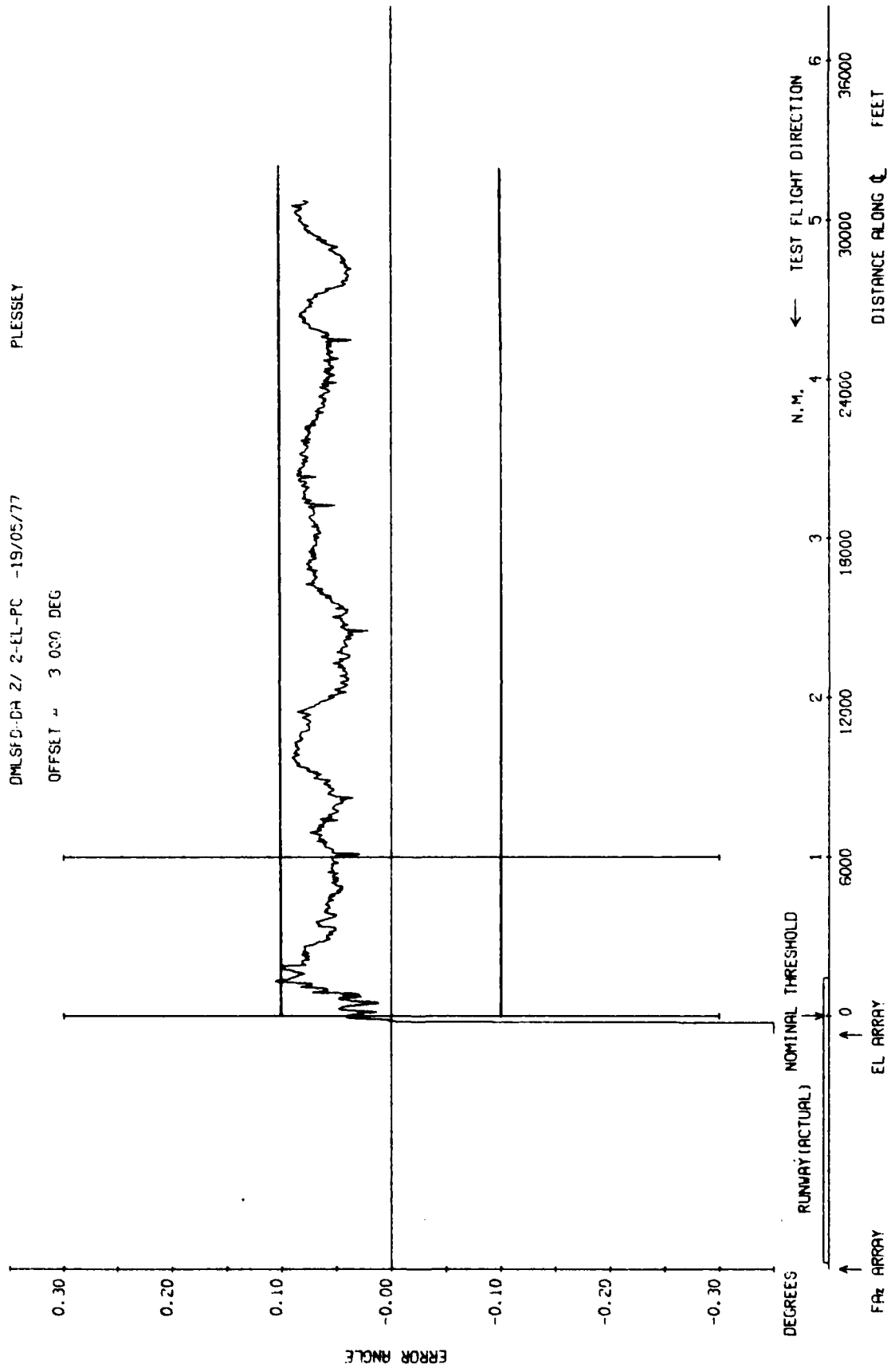


Fig 7.63b Elevation 54λ, 3 degree approach to touch and go

TR 79062

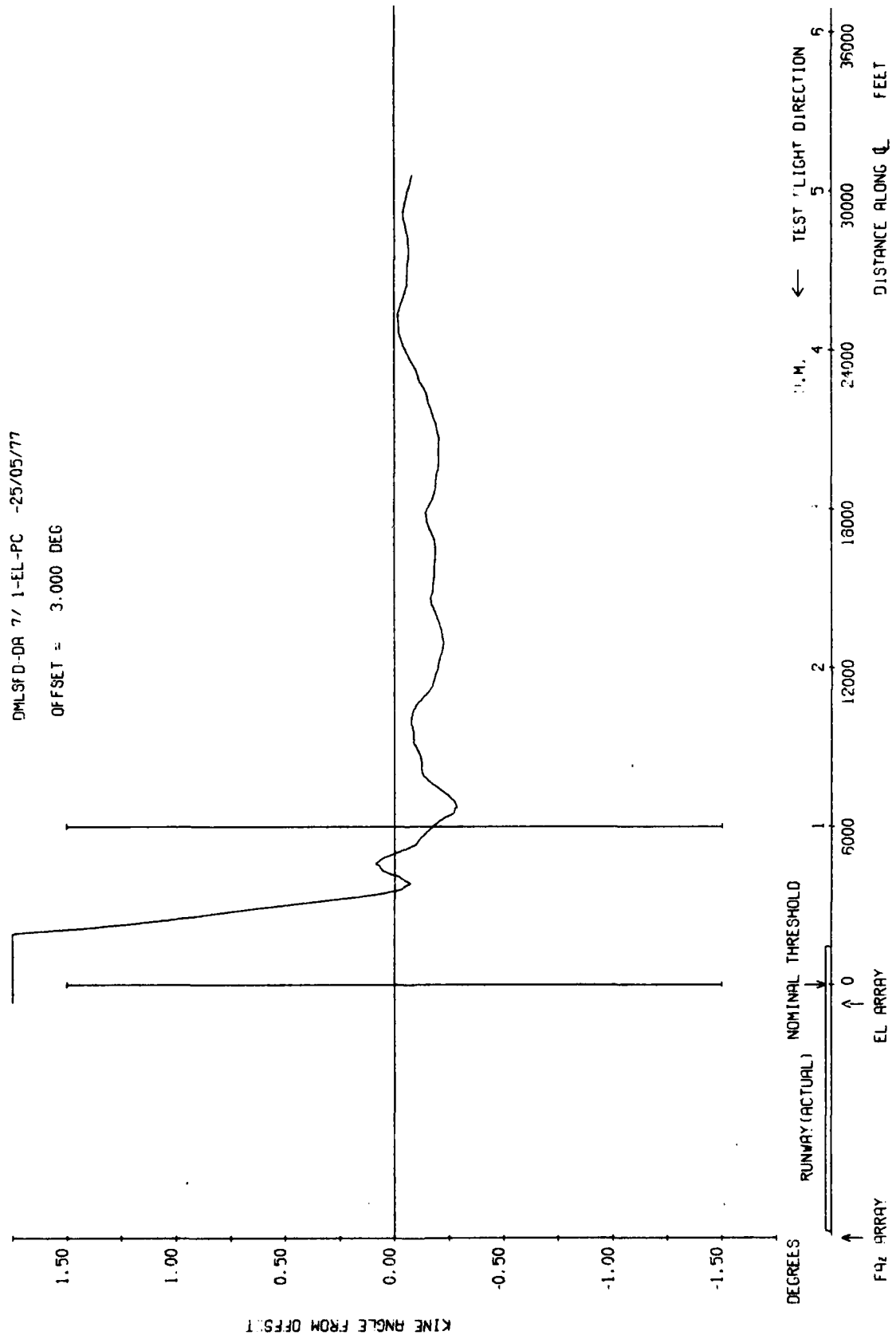


Fig 7.64a

Fig 7.64a Elevation 54λ, 3 degree approach to 300 ft overshoot

Fig 7.64b

DML5FD-DR 7/ 1-EL-PC -25/05/77 PLESSEY

OFFSET = 3.000 DEG

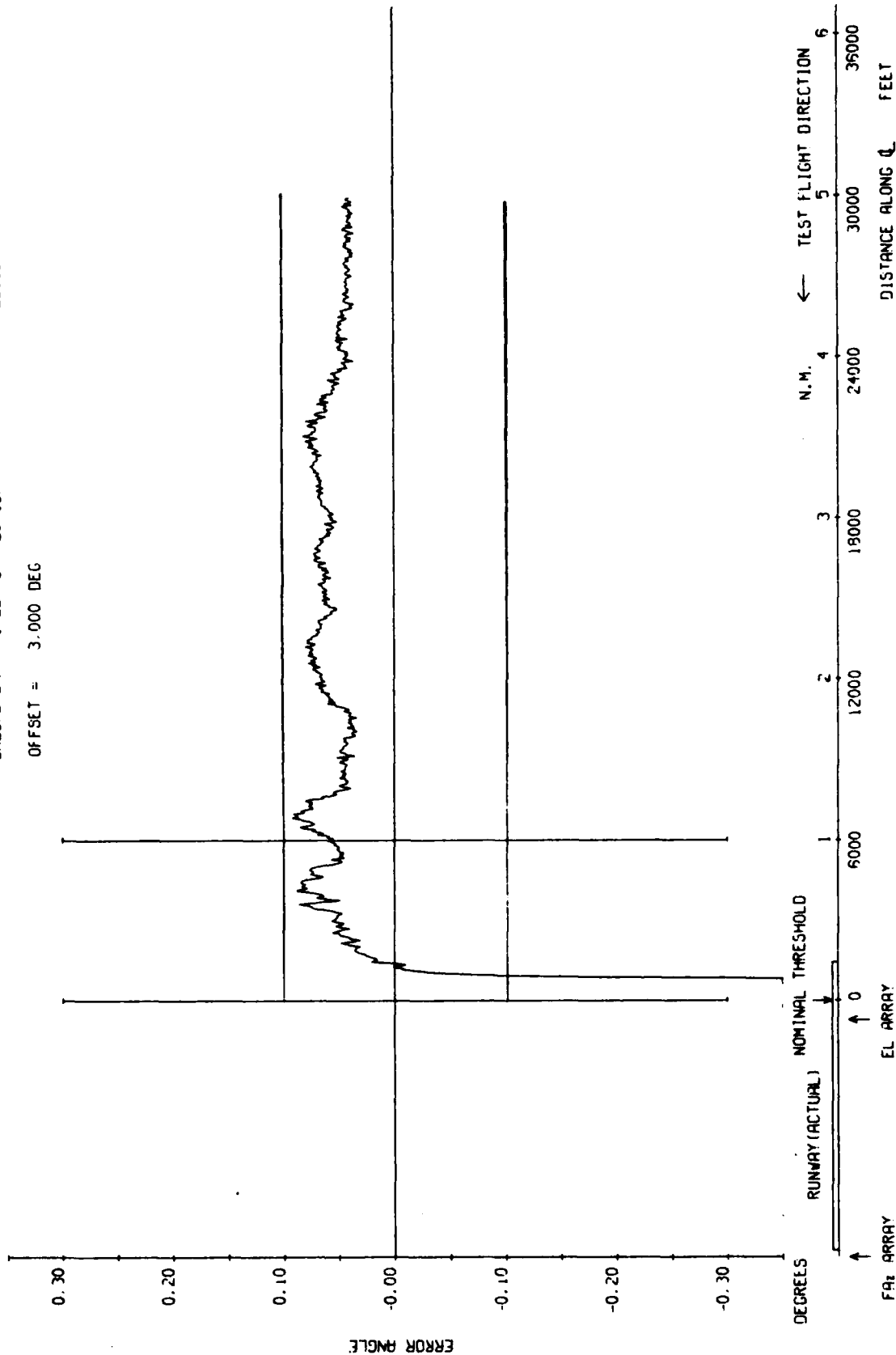


Fig 7.64b Elevation 54λ, 3 degree approach to 300 ft overshoot

TR 79052

DMLSFD-DA 7/ 3--L-PC -25/05/77

OFFSET = 1.500 DEG

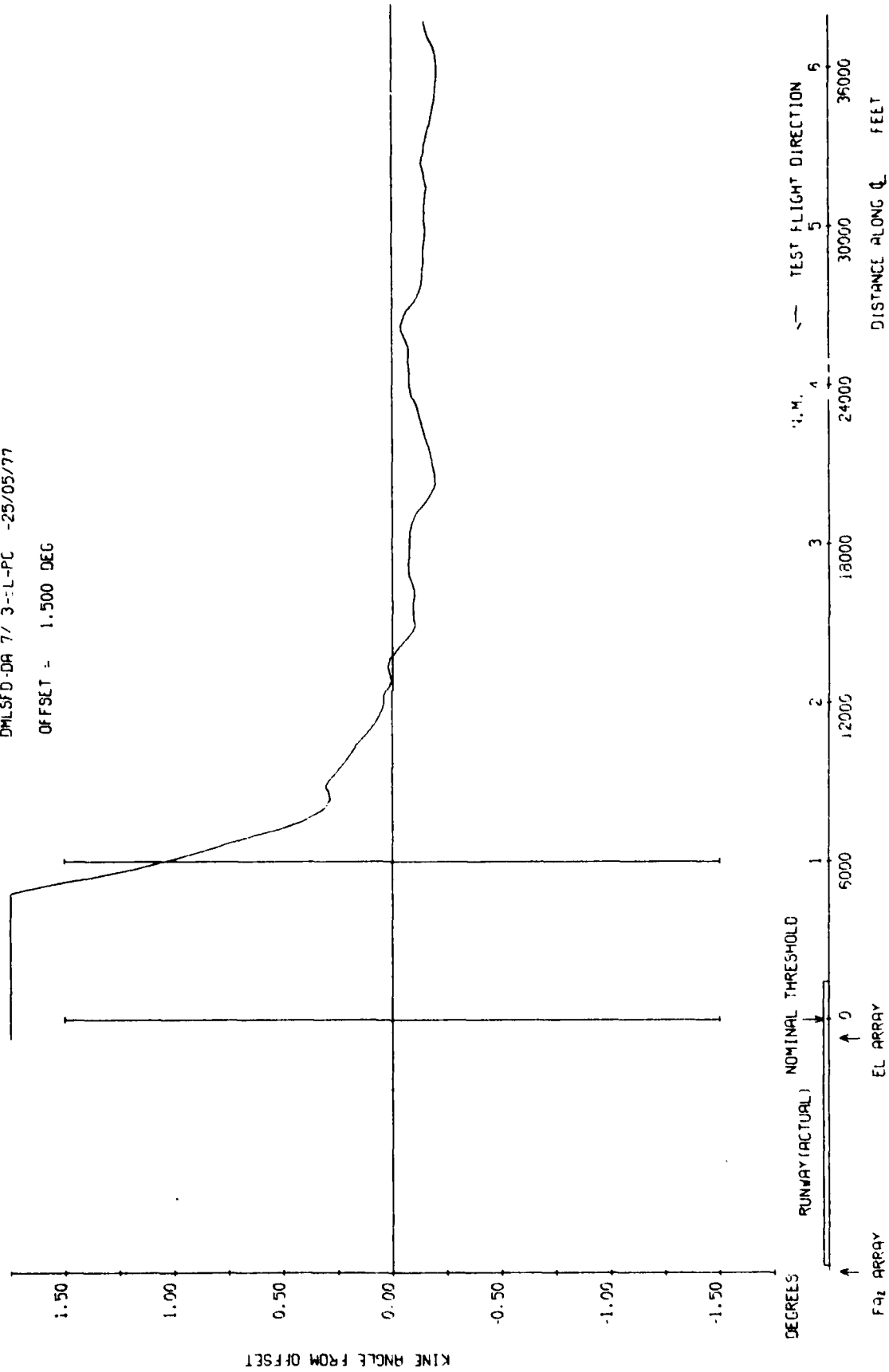


Fig 7.65a

Fig 7.65a Elevation 54λ , 1.5 degree approach to 300 ft overshoot

Fig 7.65b

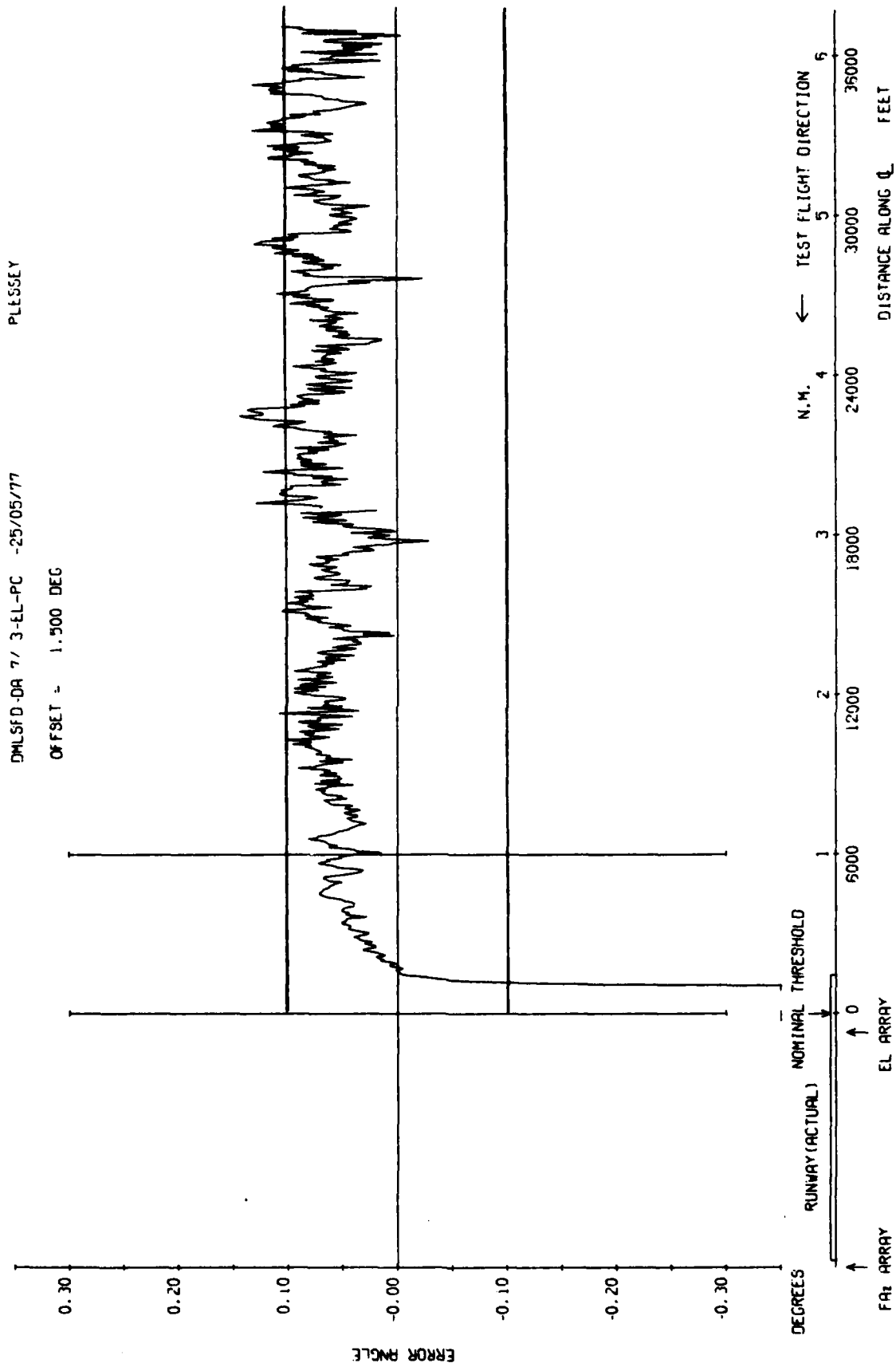


Fig 7.65b Elevation 54λ, 1.5 degree approach to 300 ft overshoot

TR 79062

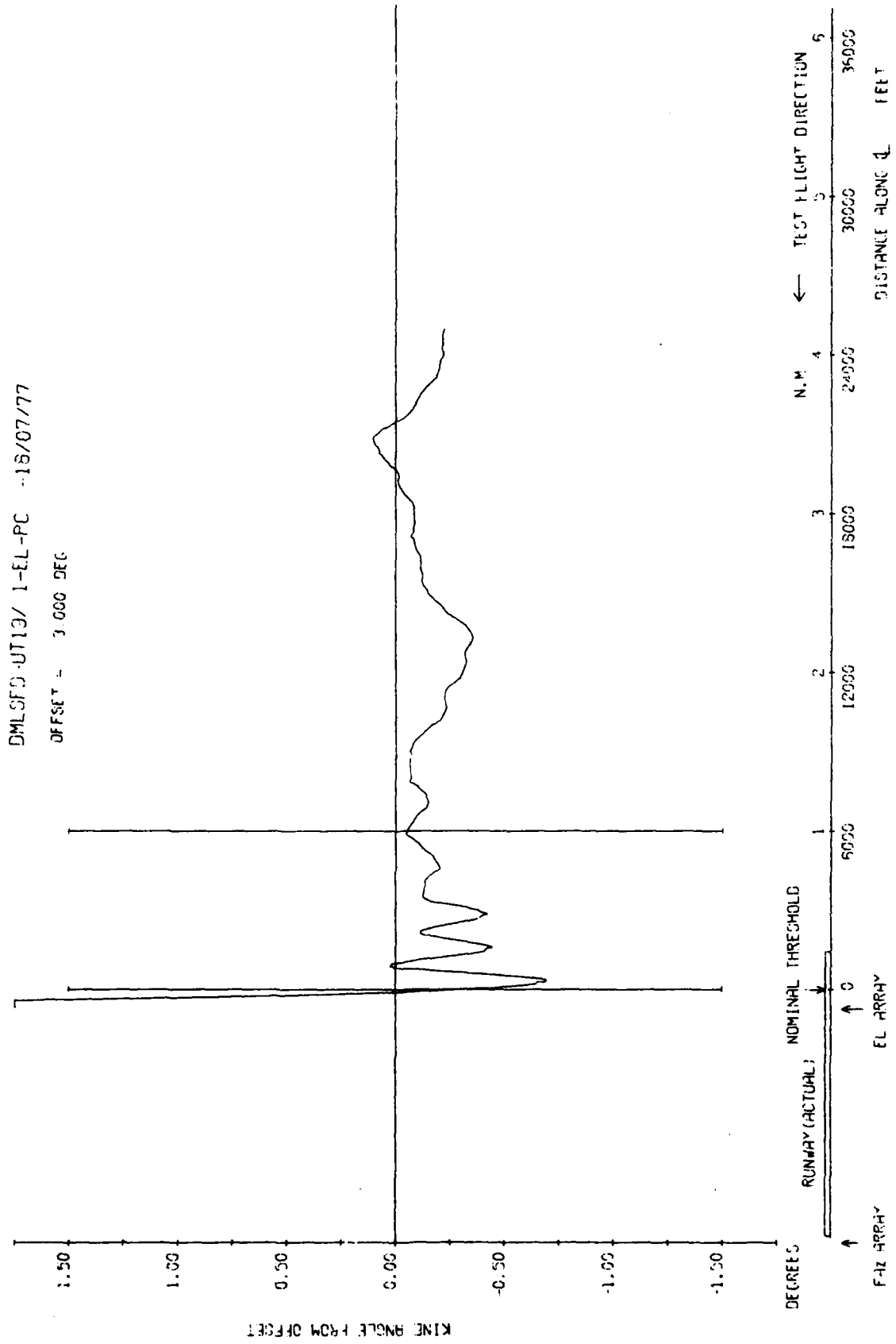


Fig 7.66a

R. A. E. BEDFORD Fig 7.66a Elevation 54λ, 3 degree approach to 50 ft overshoot

Fig 7.66b

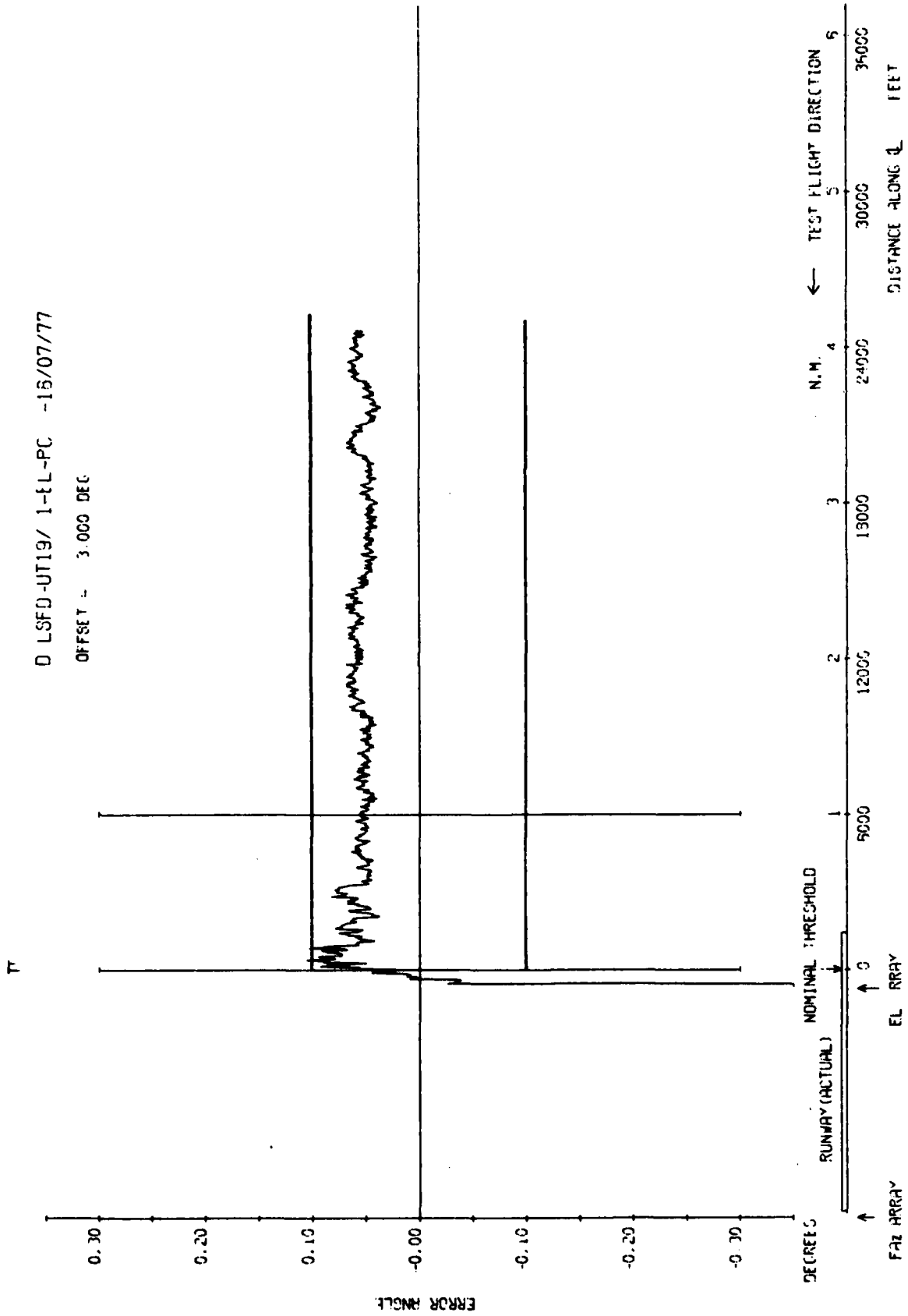


Fig 7.66b Elevation 54λ, 3 degree approach to 50 ft overshoot

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DMLSFD-DA15/ 1-EL-FC -19/07/77
OFFSET = 2.000 DEG

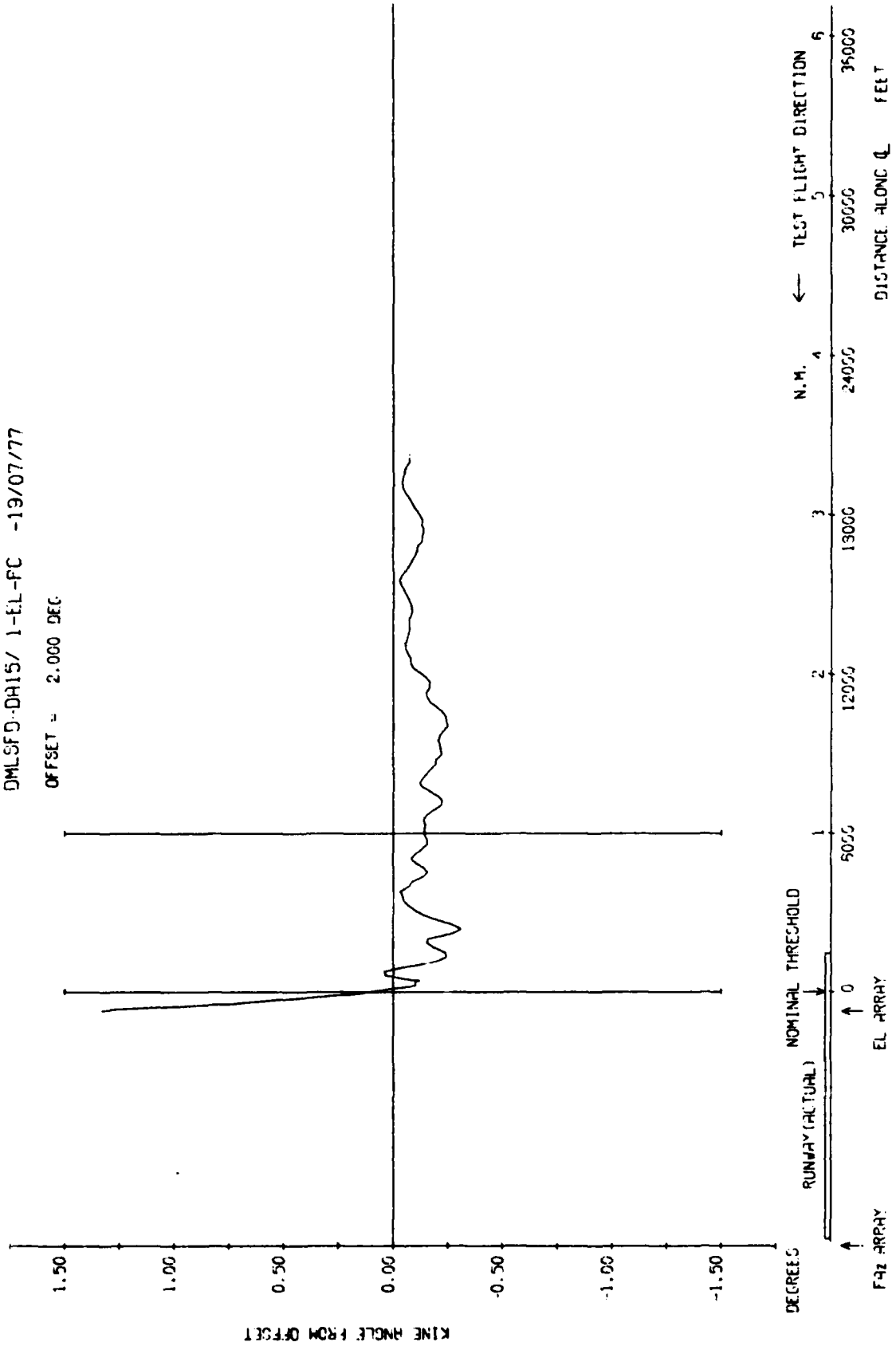


Fig 7.67a

Fig 7.67a Elevation 54λ , 2 degree approach to low overshoot

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Fig 7.67b

DMLSFD-DRI5/ 1-EL-PC -19/07/77

OFFSET = 2.000 DEG

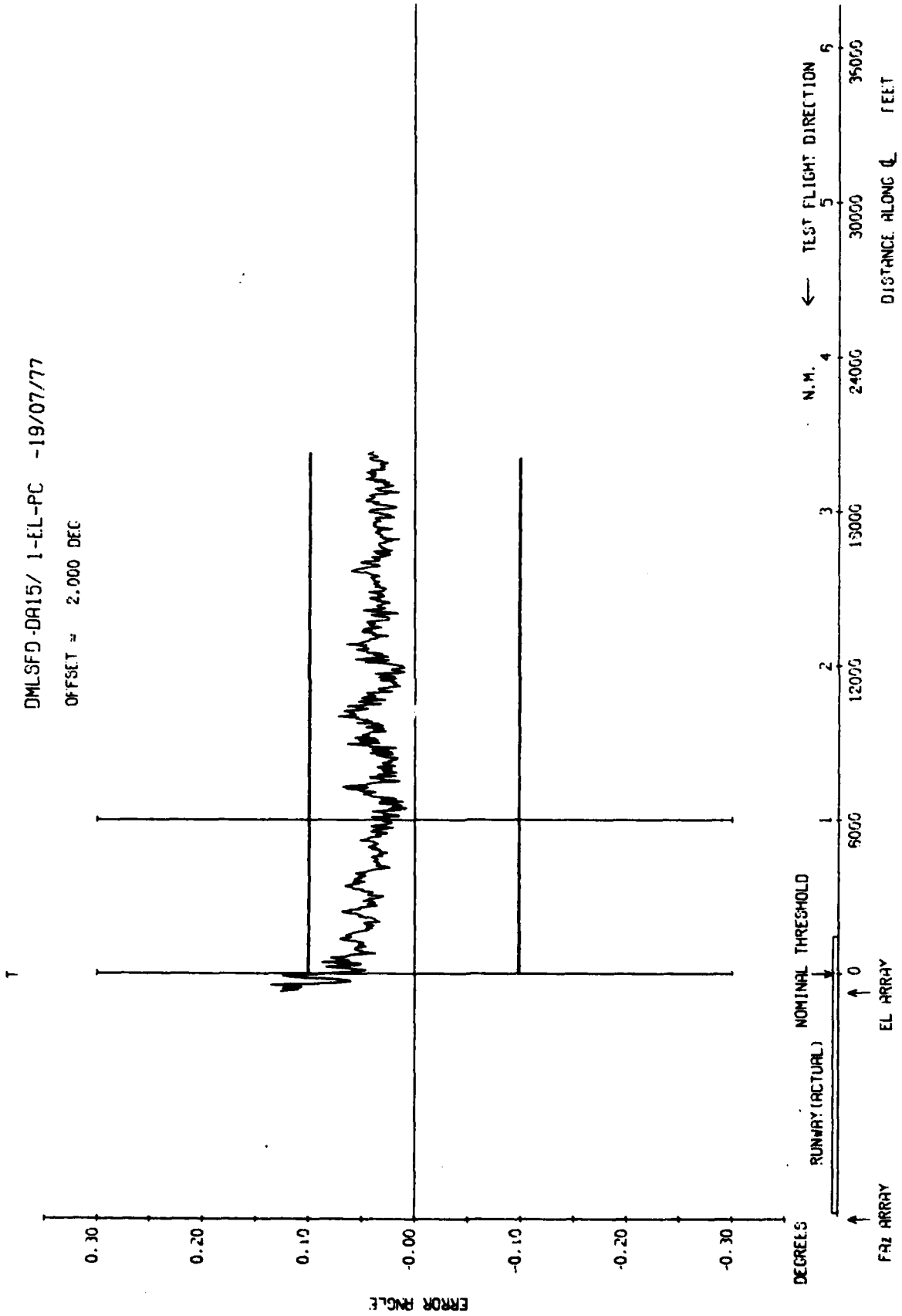


Fig 7.67b Elevation 54λ, 2 degree approach to low overshoot

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TR 79062

DMLSFD-DR15/ 2-EL-PC -19/07/77
OFFSET = 3.000 DEG

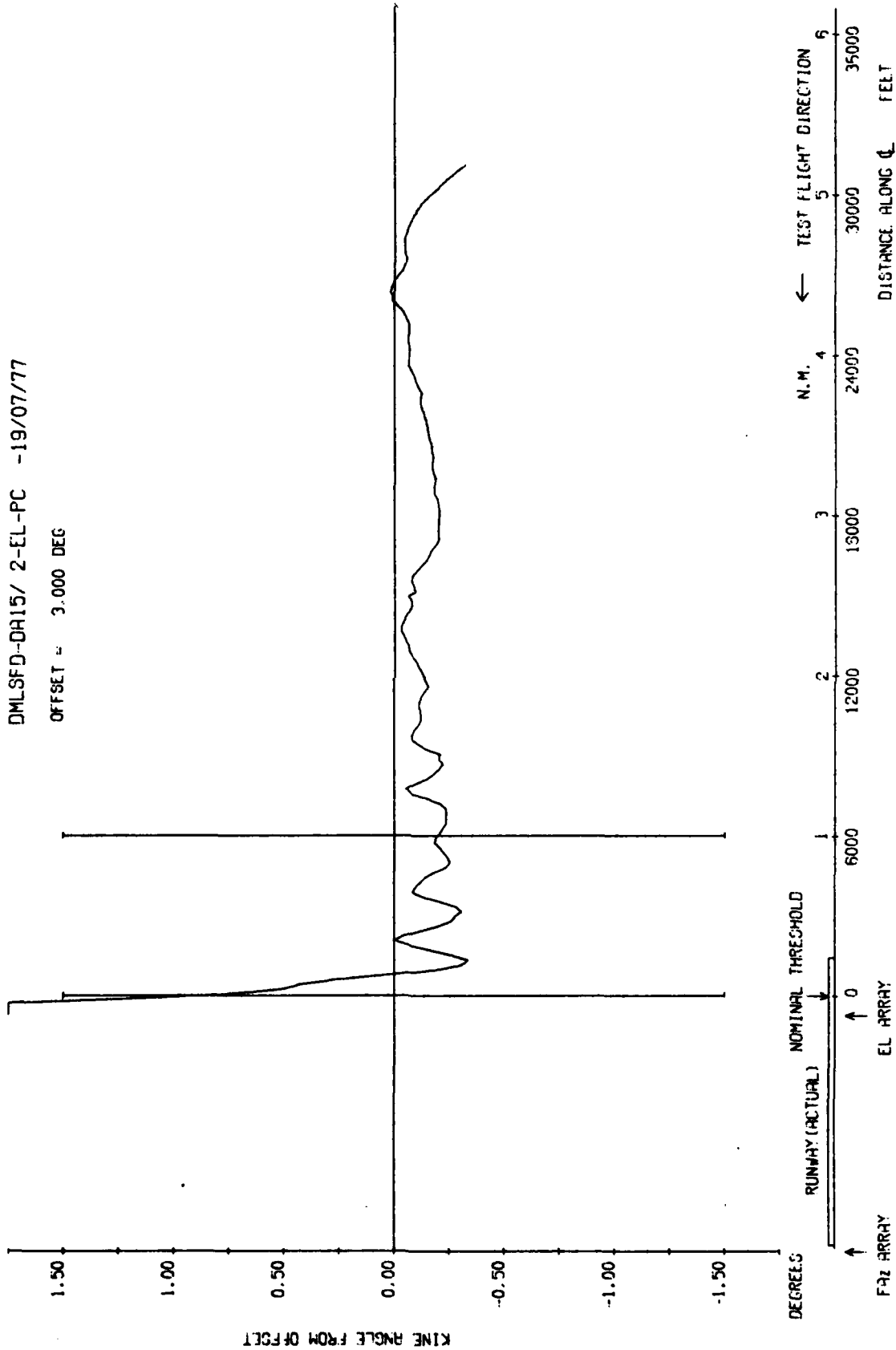
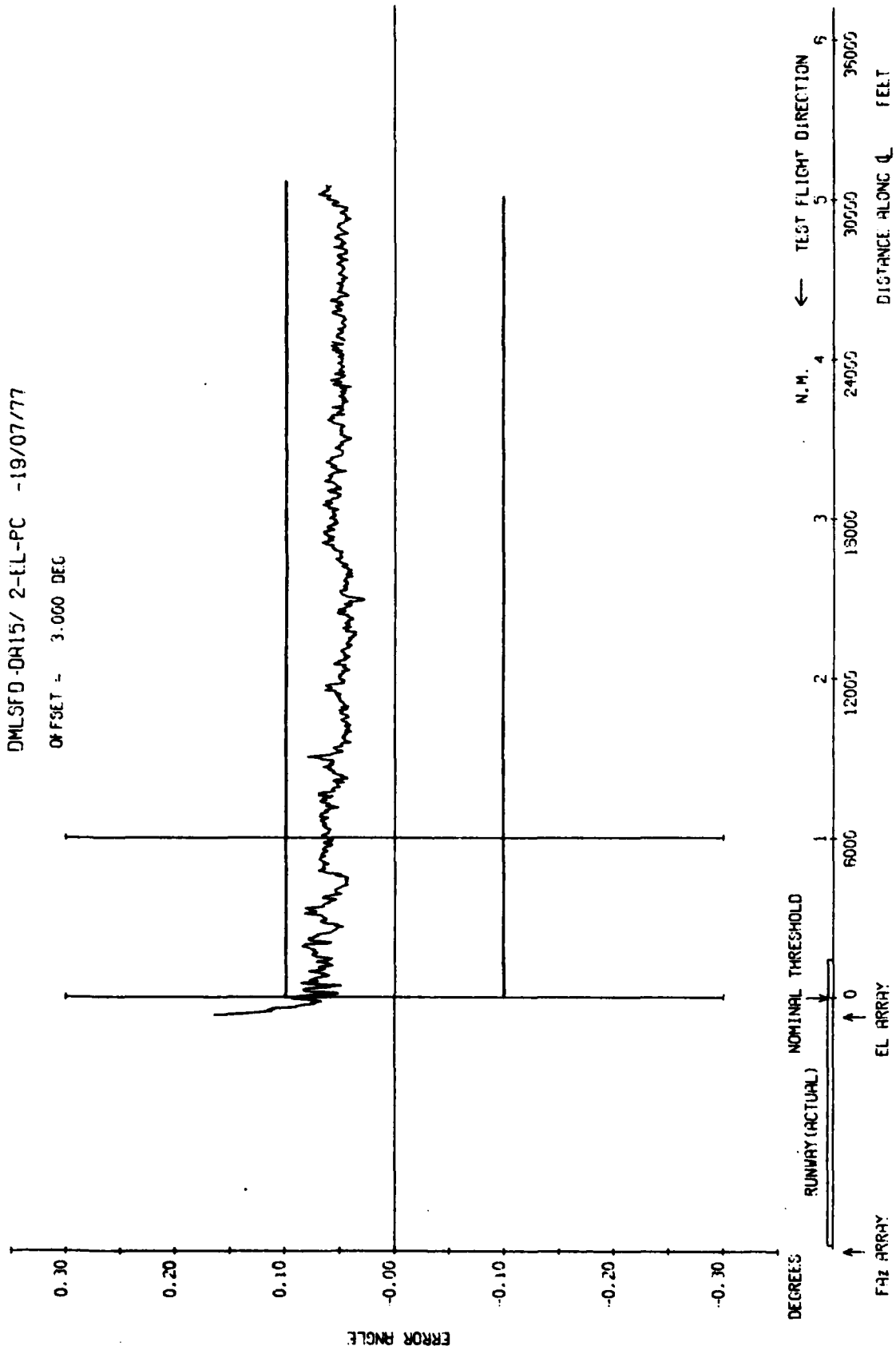


Fig 7.68a

Fig 7.68a Elevation 54λ, 3 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.68b



R. A. E. BEDFORD

Fig 7.68b Elevation 54λ, 3 degree approach to low overshoot

TR 79082

DMLSFD-0A15/ 3-EL-PC -19/07/77

OFFSET = 4.000 DEG

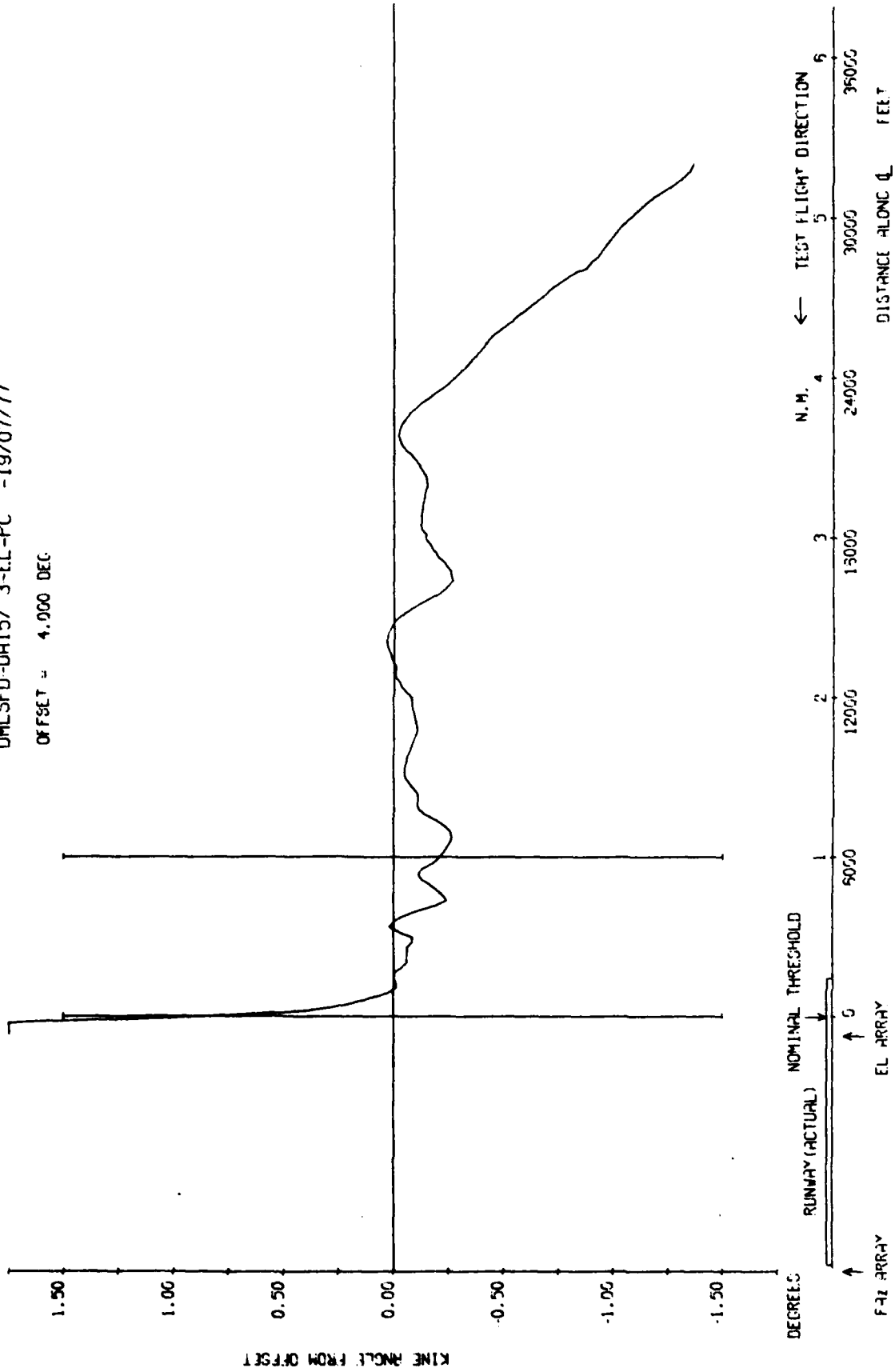


Fig 7.69a

Fig 7.69a Elevation 54λ, 4 degree approach to low overshoot

R. A. E. BEDFORD

TR 79082

DMLSFD-DA15/ 4-EL-FC -19/07/77
OFFSET - 5.000 DEG

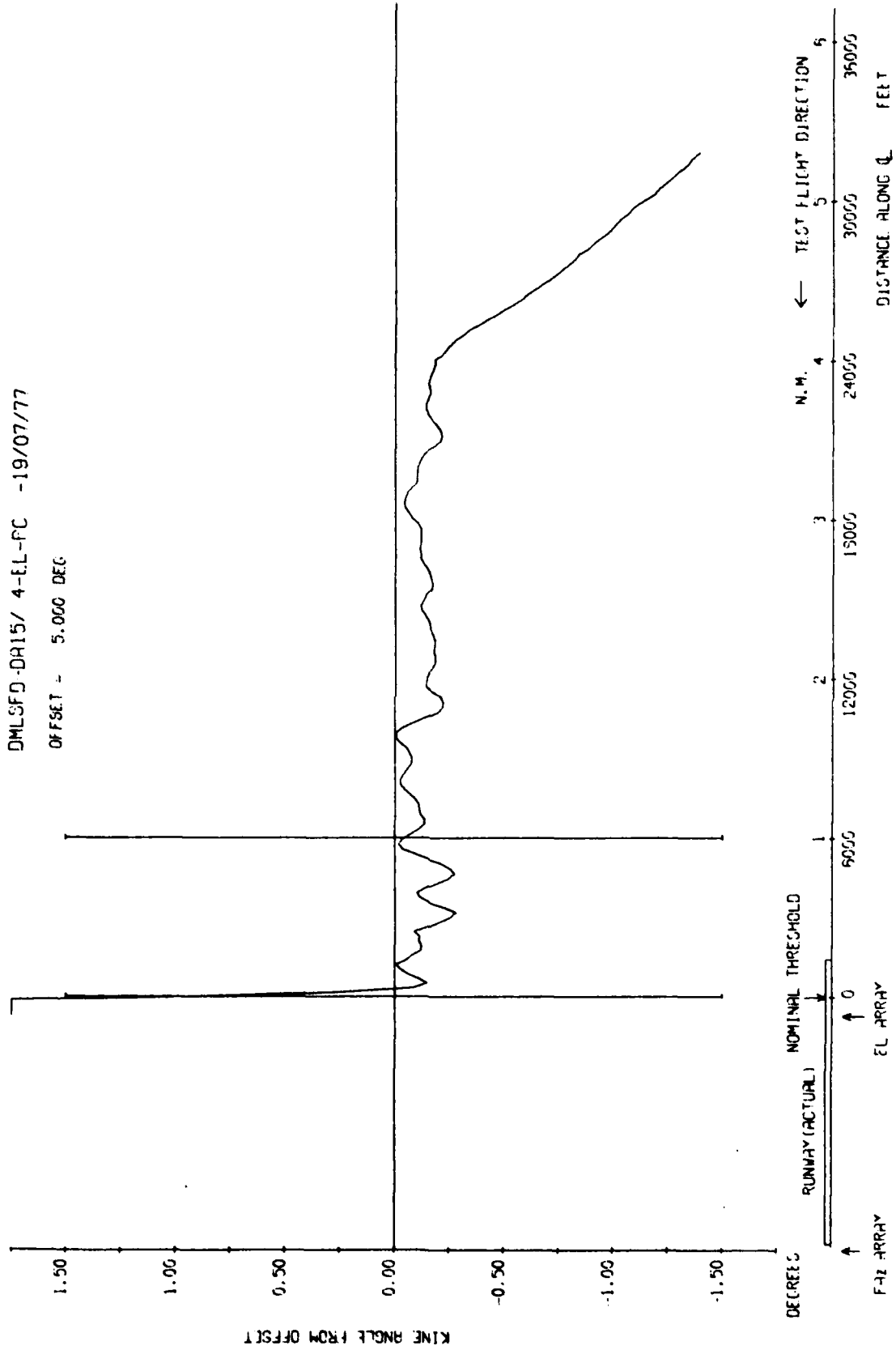


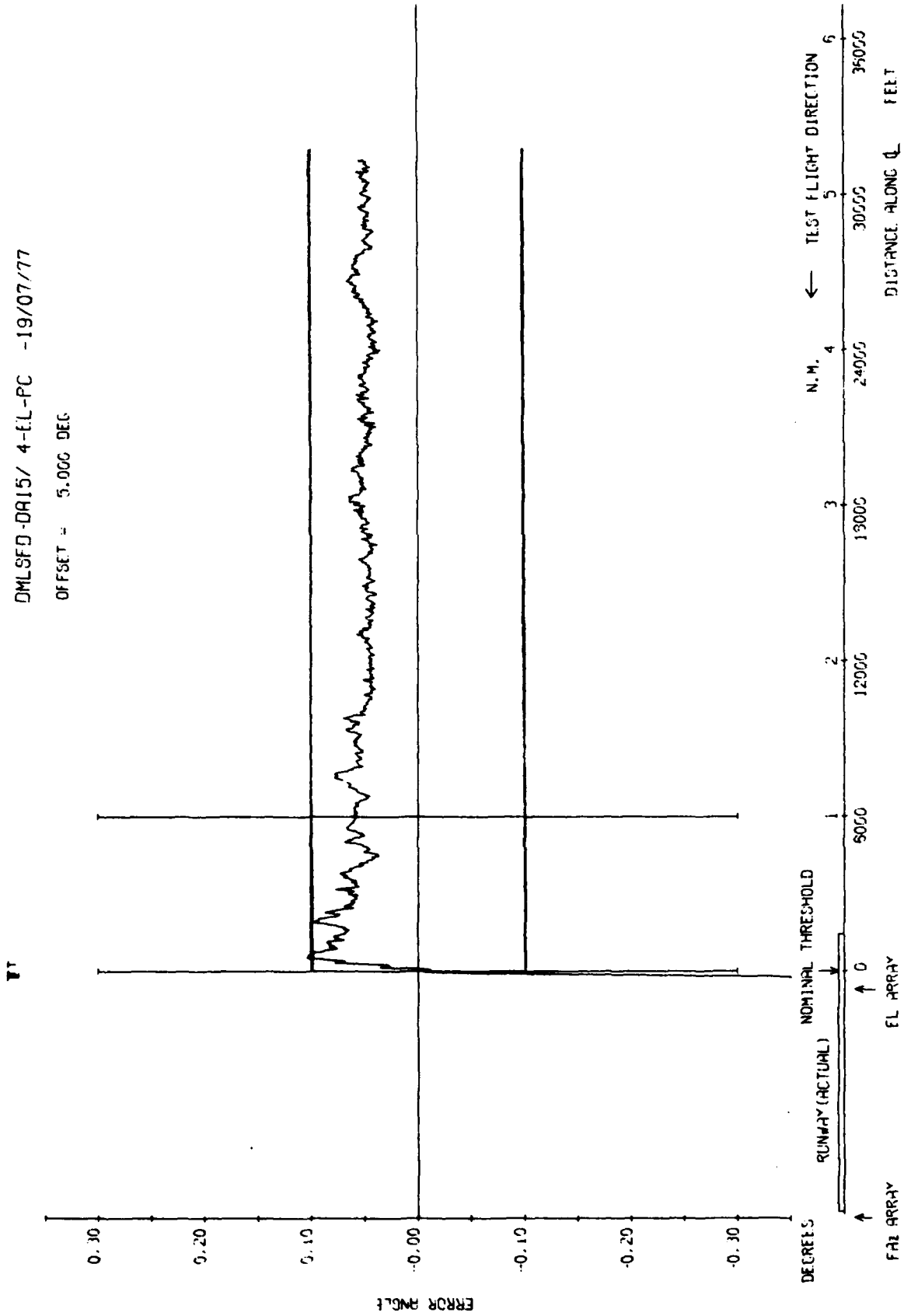
Fig 7.70a

Fig 7.70a Elevation 5A, 5 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.70b

DMLSFD-DRI5/ 4-EL-PC -19/07/77
OFFSET = 5.000 DEG



R. A. E. BEDFORD
Fig 7.70b Elevation 54λ, 5 degree approach to low overshoot

Fig 7.71a

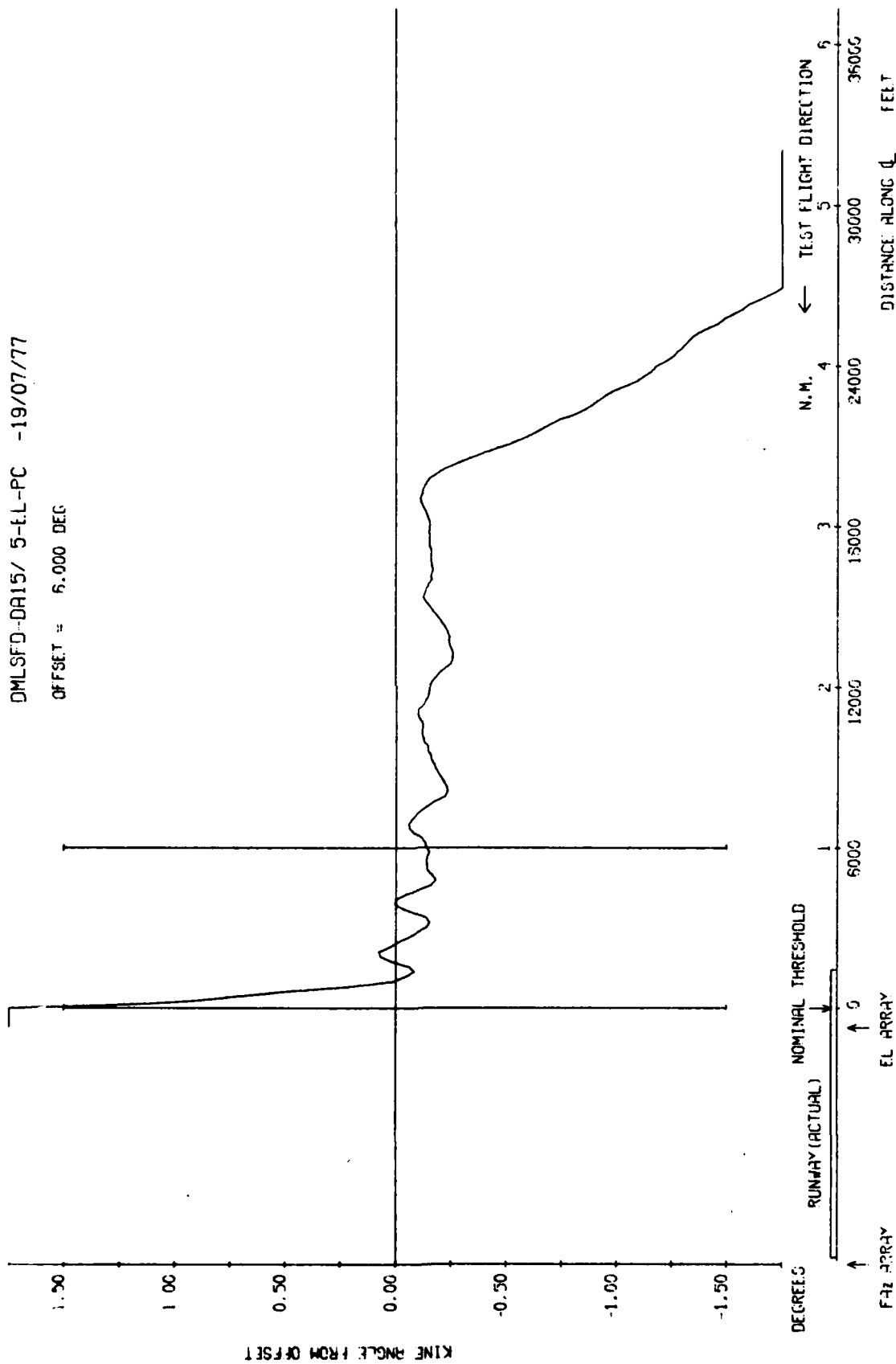


Fig 7.71a Elevation 54λ, 6 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.71b

DMLSFD-DA15/ 5-EL-PC -19/07/77

OFFSET - 6.055 DEG

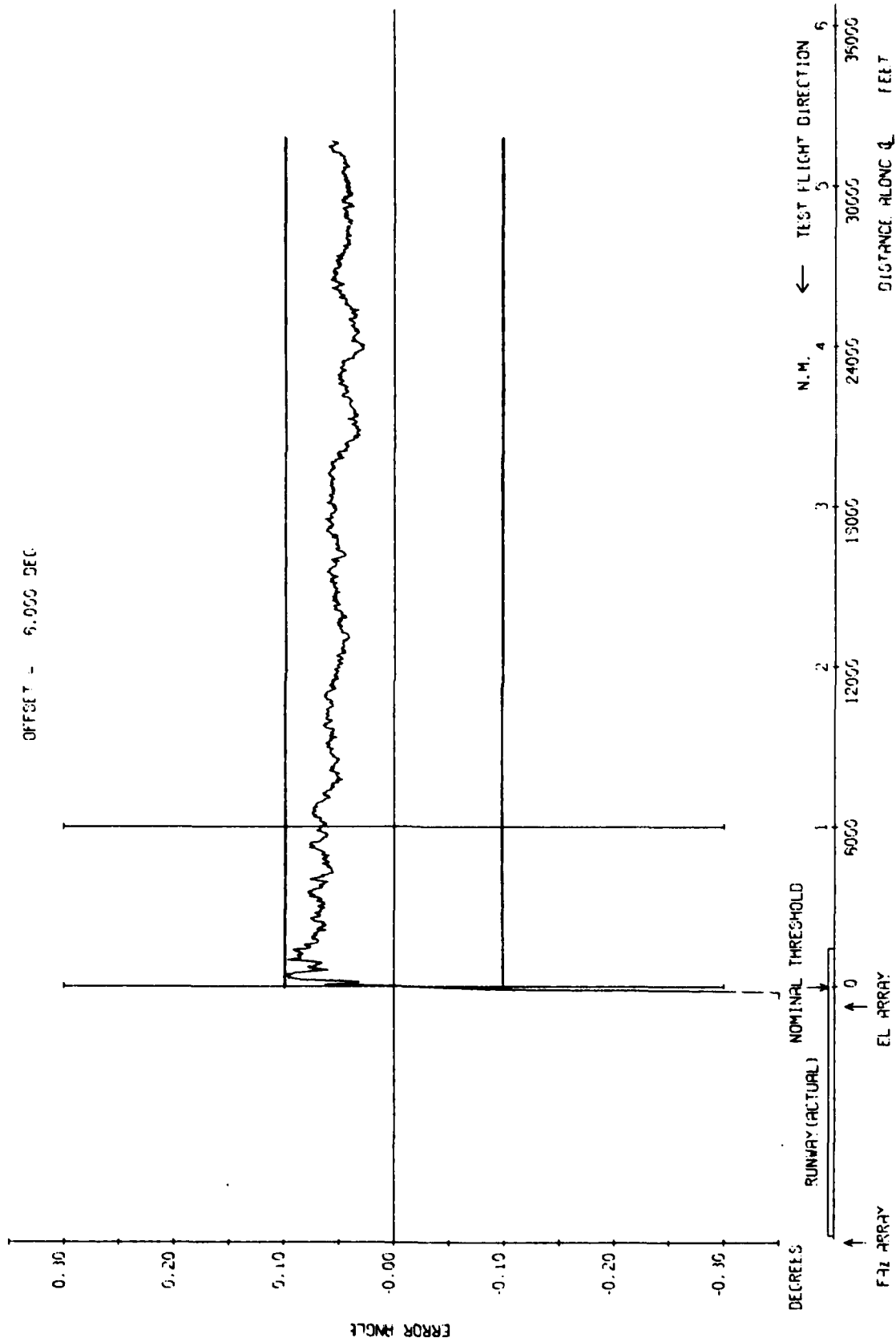


Fig 7.71b Elevation 54), 6 degree approach to low overshoot

R. G. E. BEDFORD

TR 79062

DMLSFD-DA15/ 6-EL-PC -19/07/77

OFFSET = 7.000 DEG

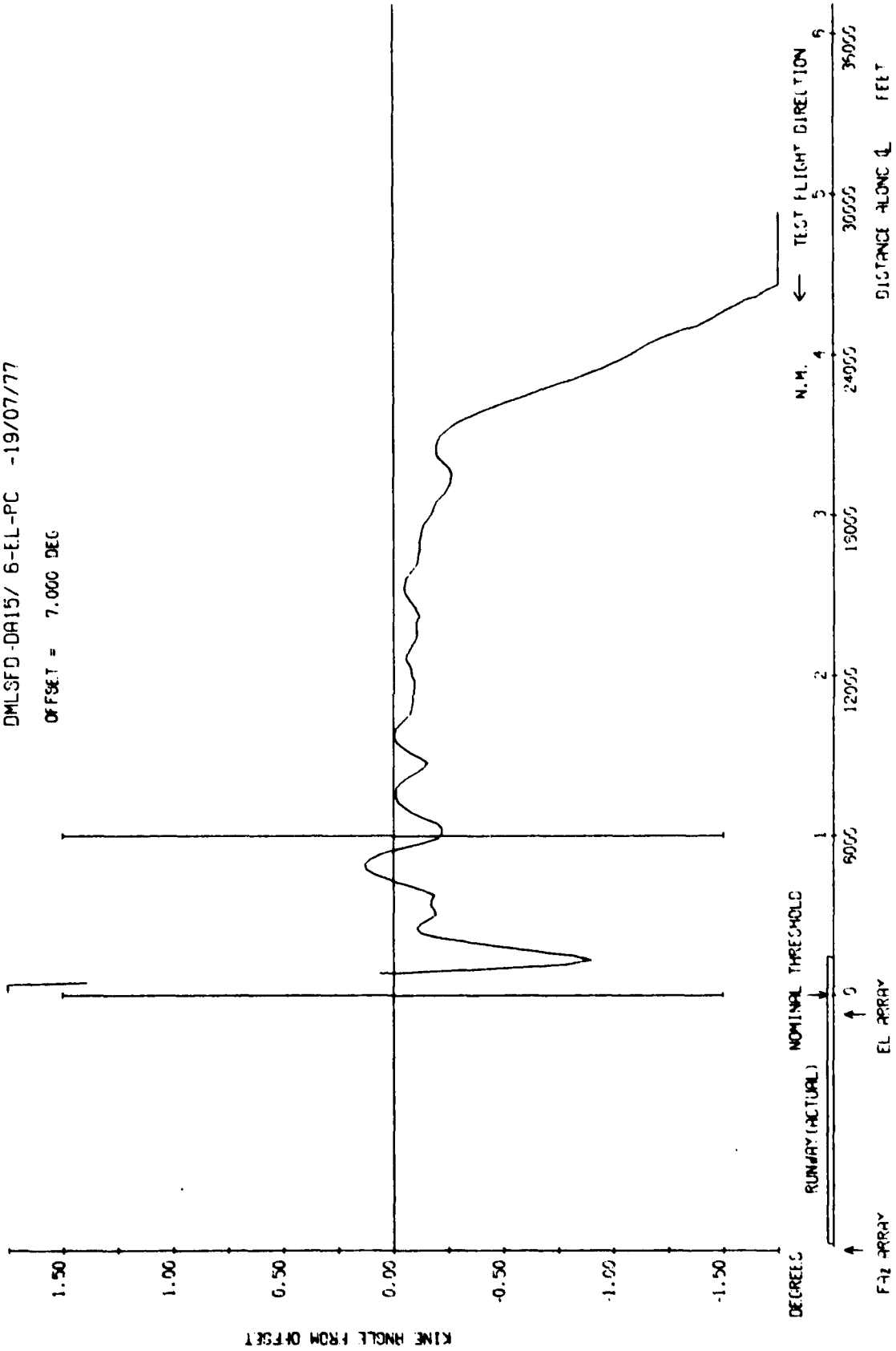


Fig 7.72a

Fig 7.72a Elevation 54λ, 7 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.72b

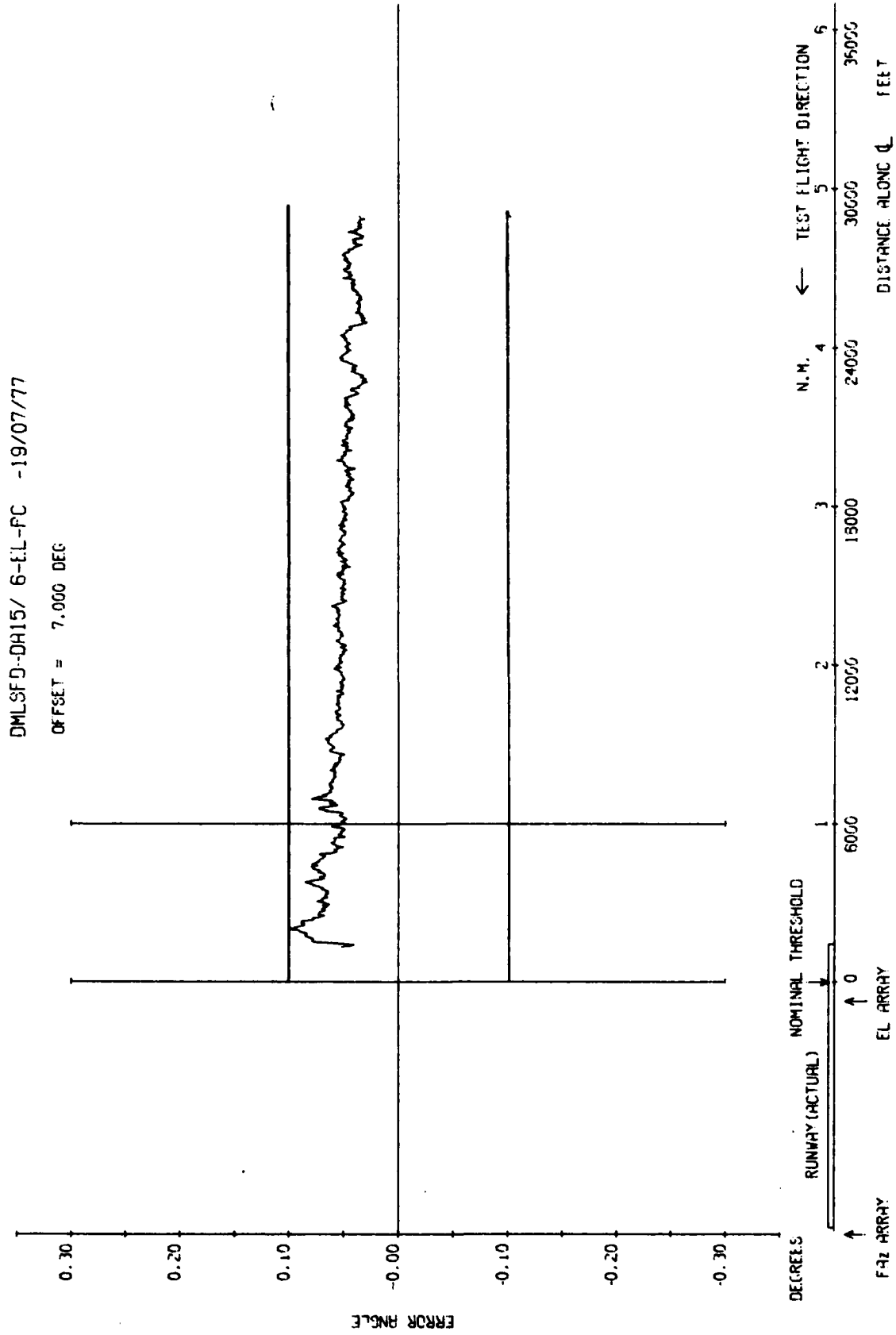


Fig 7.72b Elevation 54λ, 7 degree approach to low overshoot

R. A. E. BEDFORD

TR 79062

DMLSFD-DA15/ 7-EL-PC -19/07/77

OFFSET = 8.000 DEG

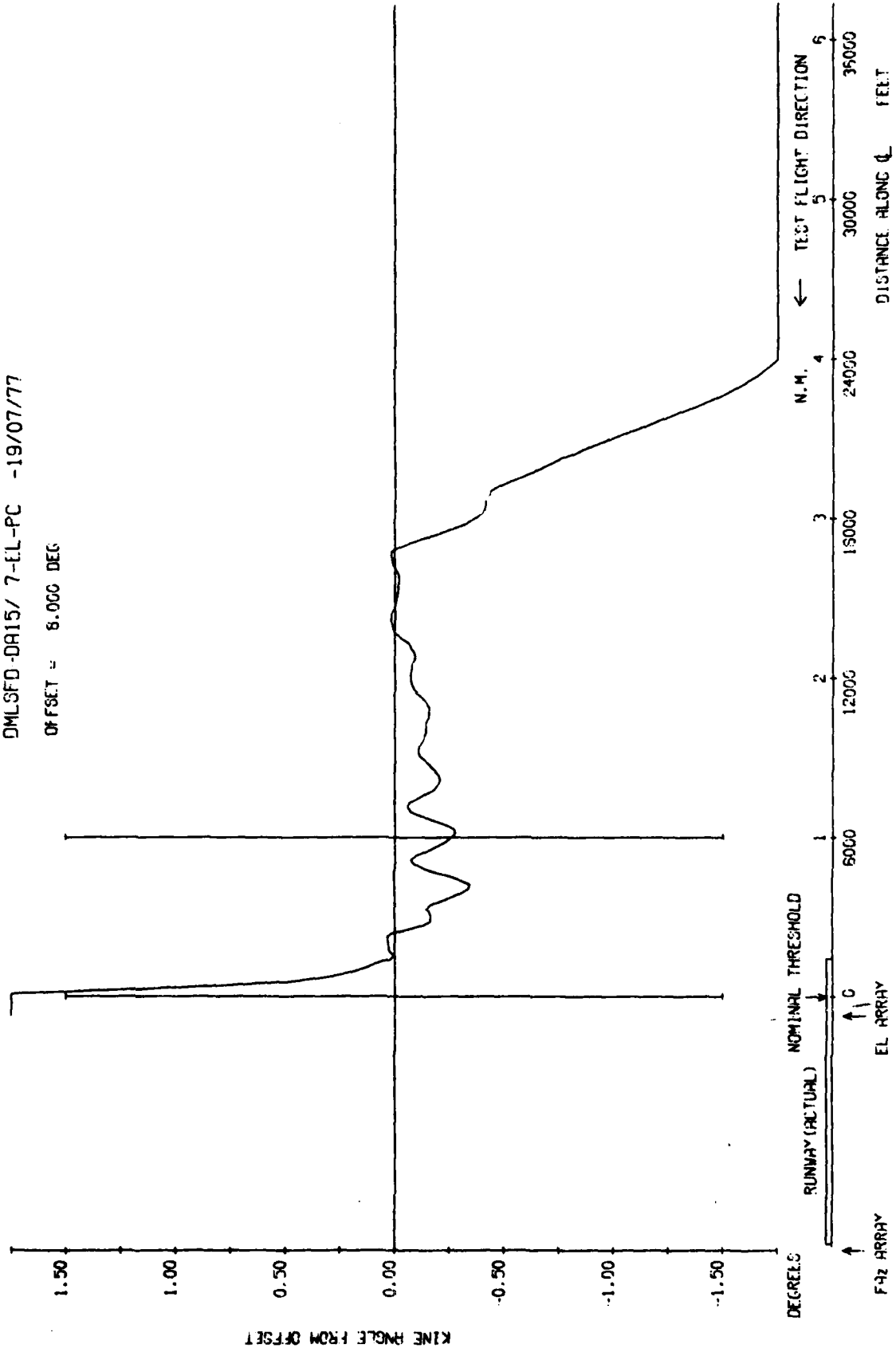


Fig 7.73a

Fig 7.73a Elevation 54), 8 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.73b

DMLSFD-DA15/ 7-EL-PC -19/07/77

OFFSET - 5.000 DEG

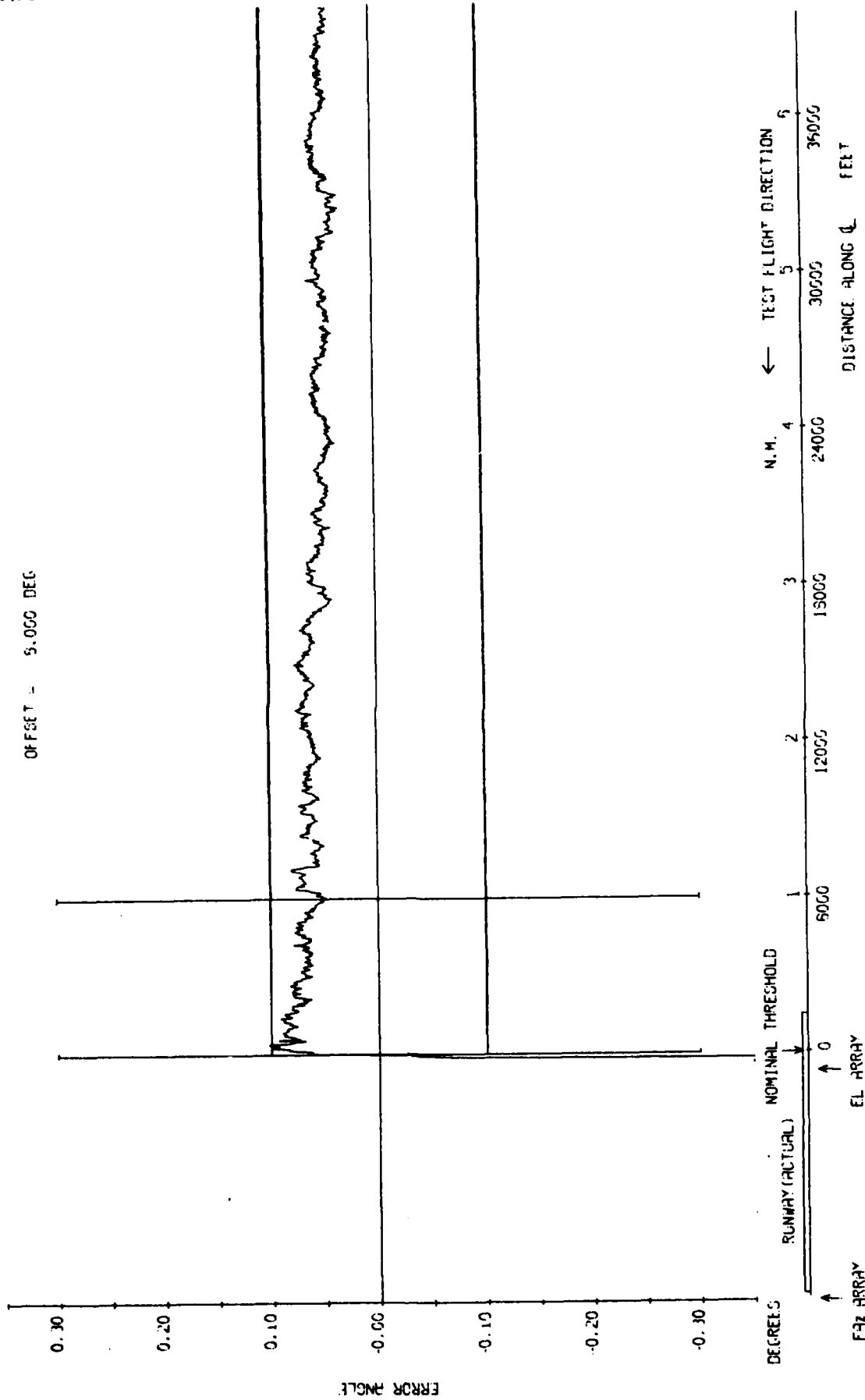


Fig 7.73b Elevation 54λ, 8 degree approach to low overshoot

R. A. E. BEDFORD

TR 79062

DMLSFD -DA15/ 8-LL-FC -19/07/77

OFFSET - 9.000 DEC

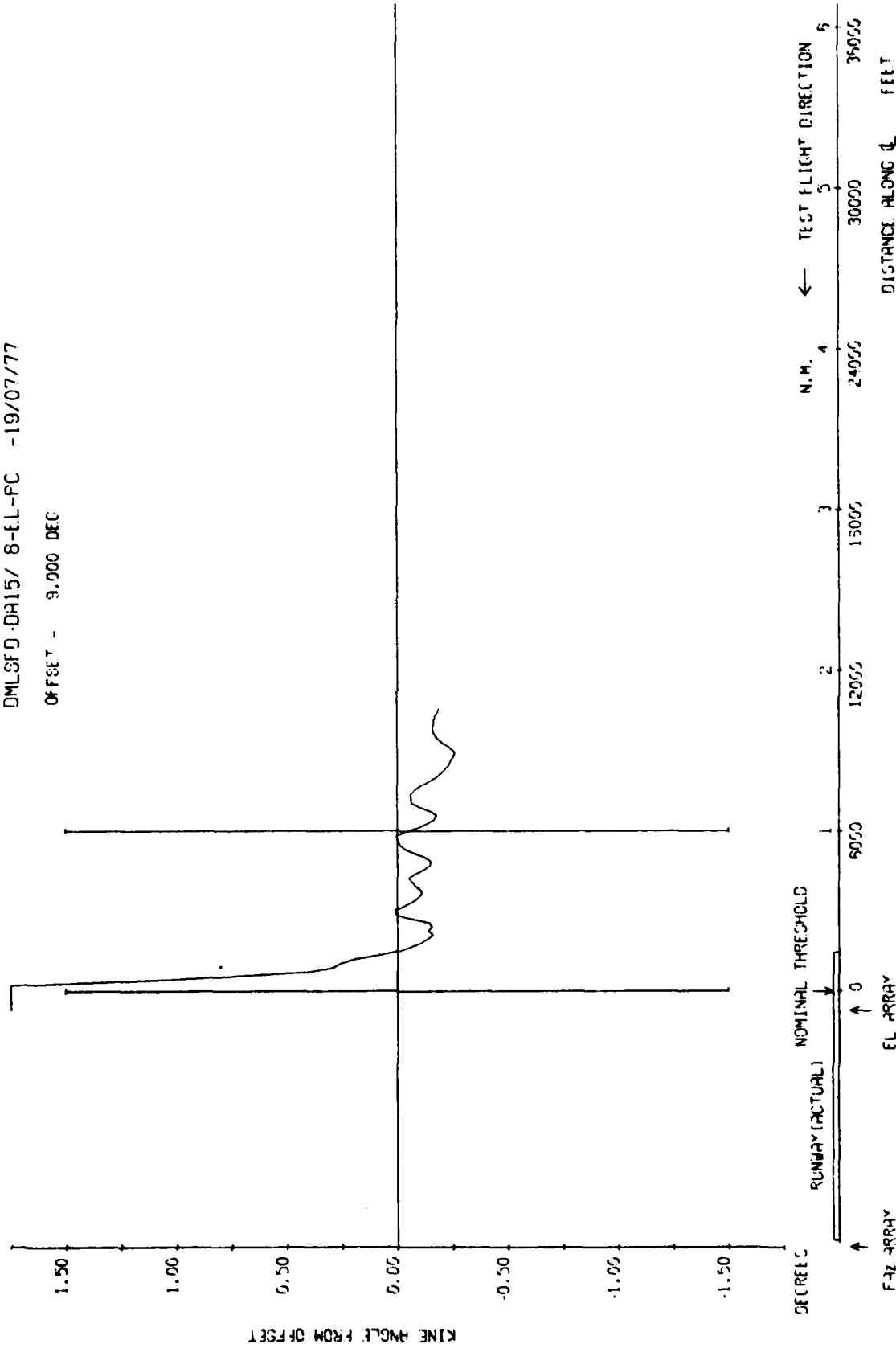


Fig 7.74a

Fig 7.74a Elevation 54, 9 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.74b

DMLSFD-DA15/ 8-EL-PC -19/07/77

OFFSET = 3.000 DEG

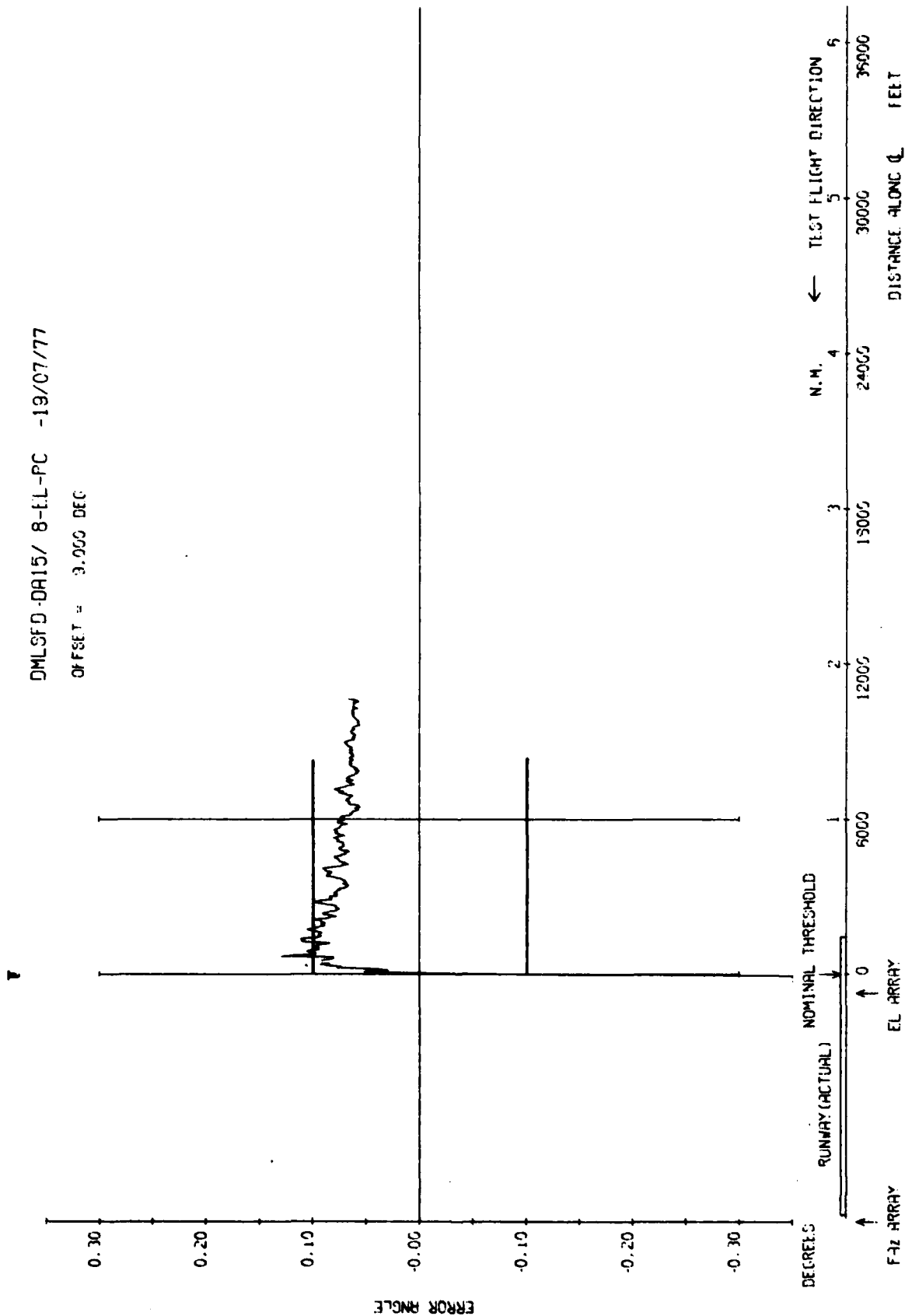


Fig 7.74b Elevation 54λ, 9 degree approach to low overshoot

R. A. E. BEDFORD

TR 79082

DMLSFD-DA15/ 9-EL-PC -19/07/77

OFFSET = 9.300 DEG

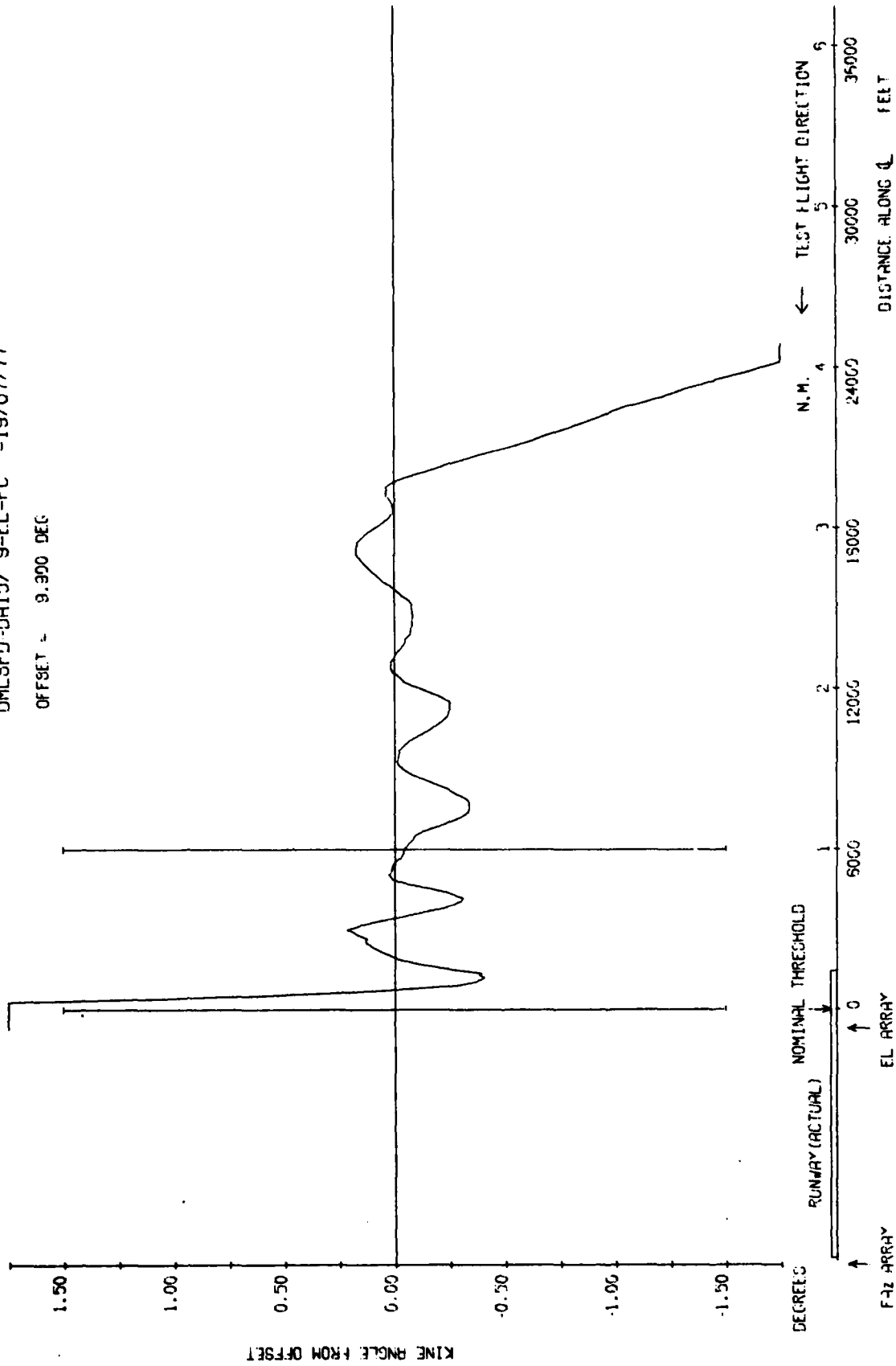


Fig 7.75a

Fig 7.75a Elevation 54λ, 9.9 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.75b

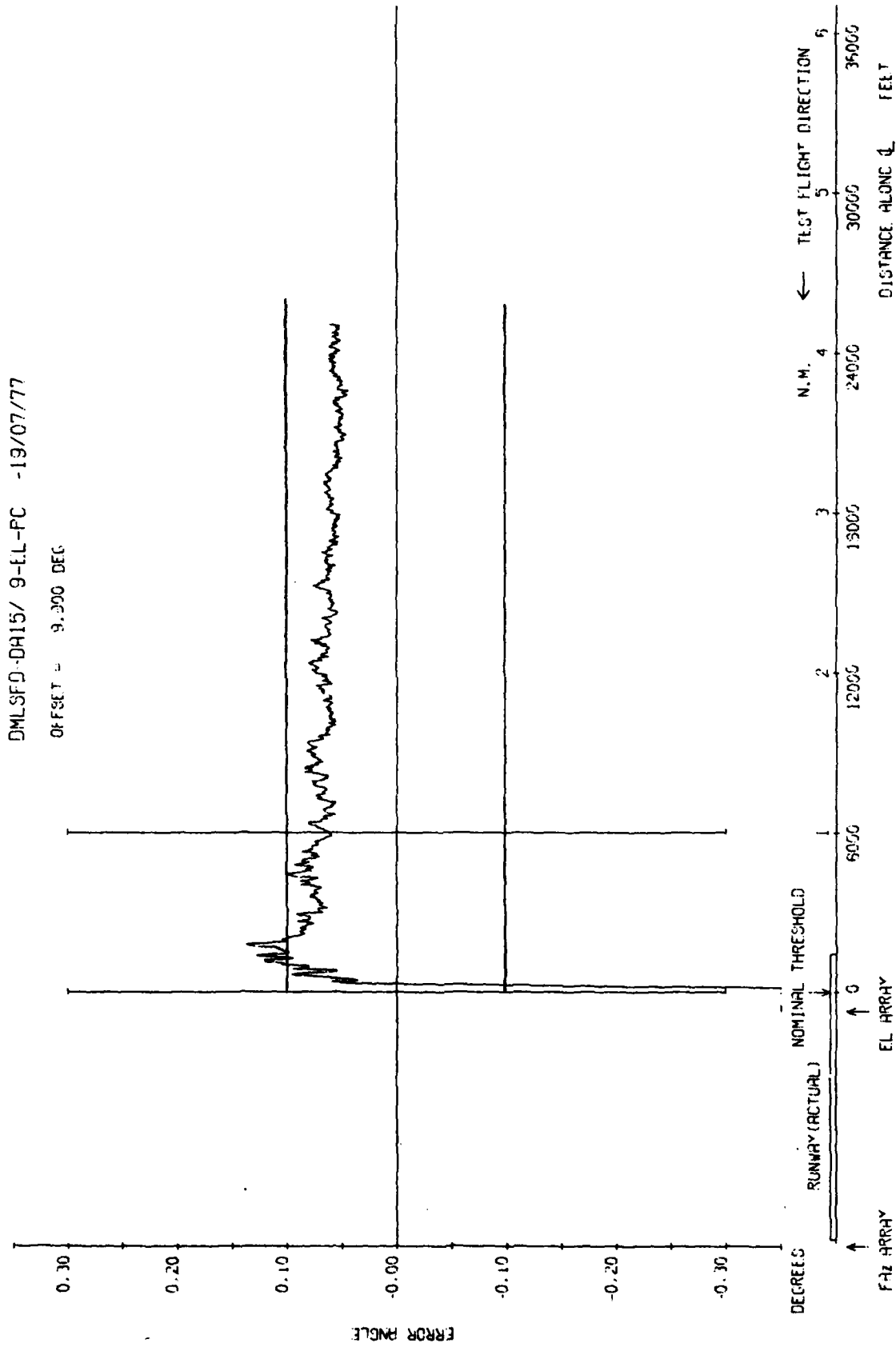
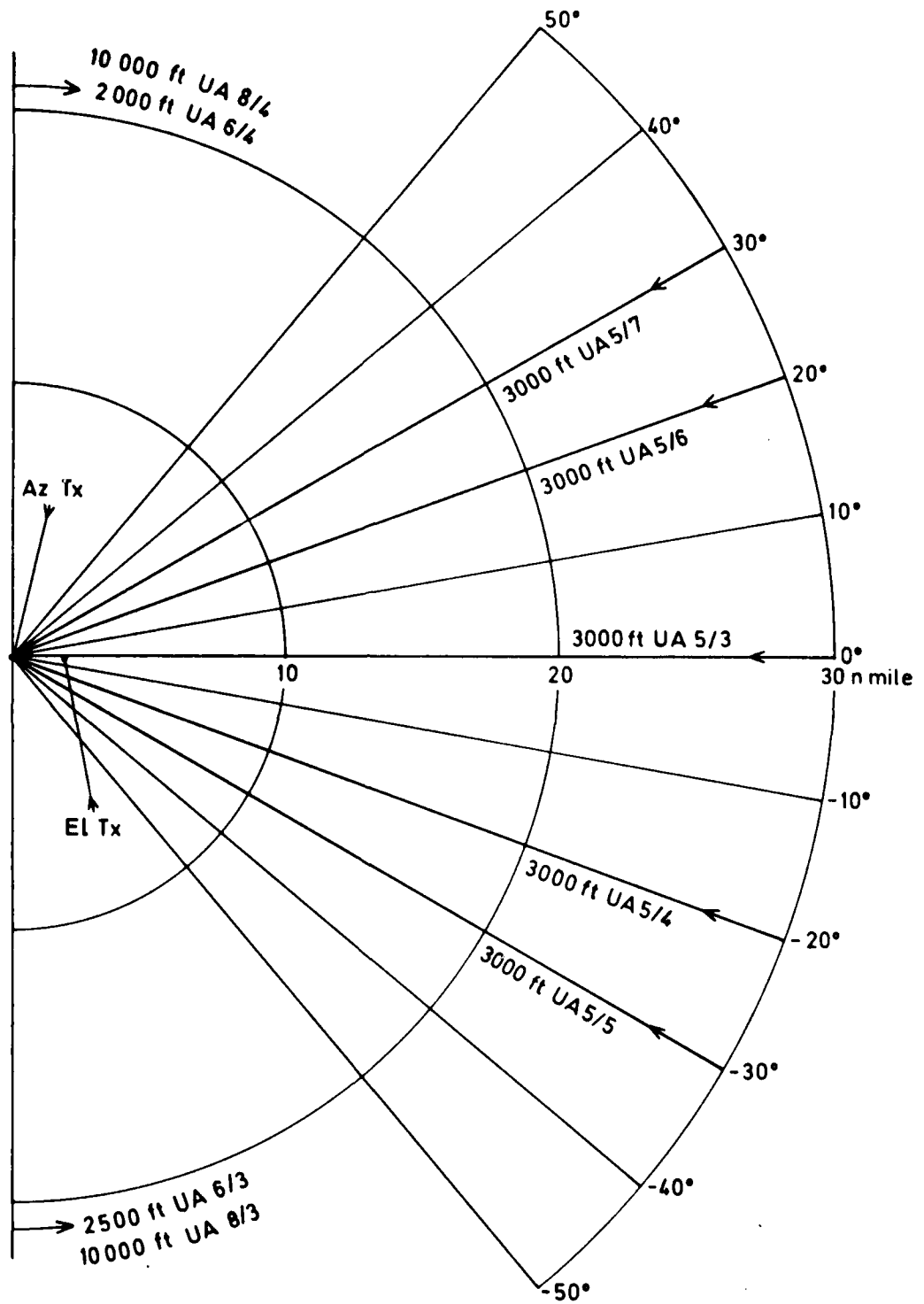


Fig 7.75b Elevation 54λ, 9.9 degree approach to low overshoot

R. A. E. BEDFORD

Fig 7.76



TR 79062

Fig 7.76 Coverage profiles

Fig 7.77a

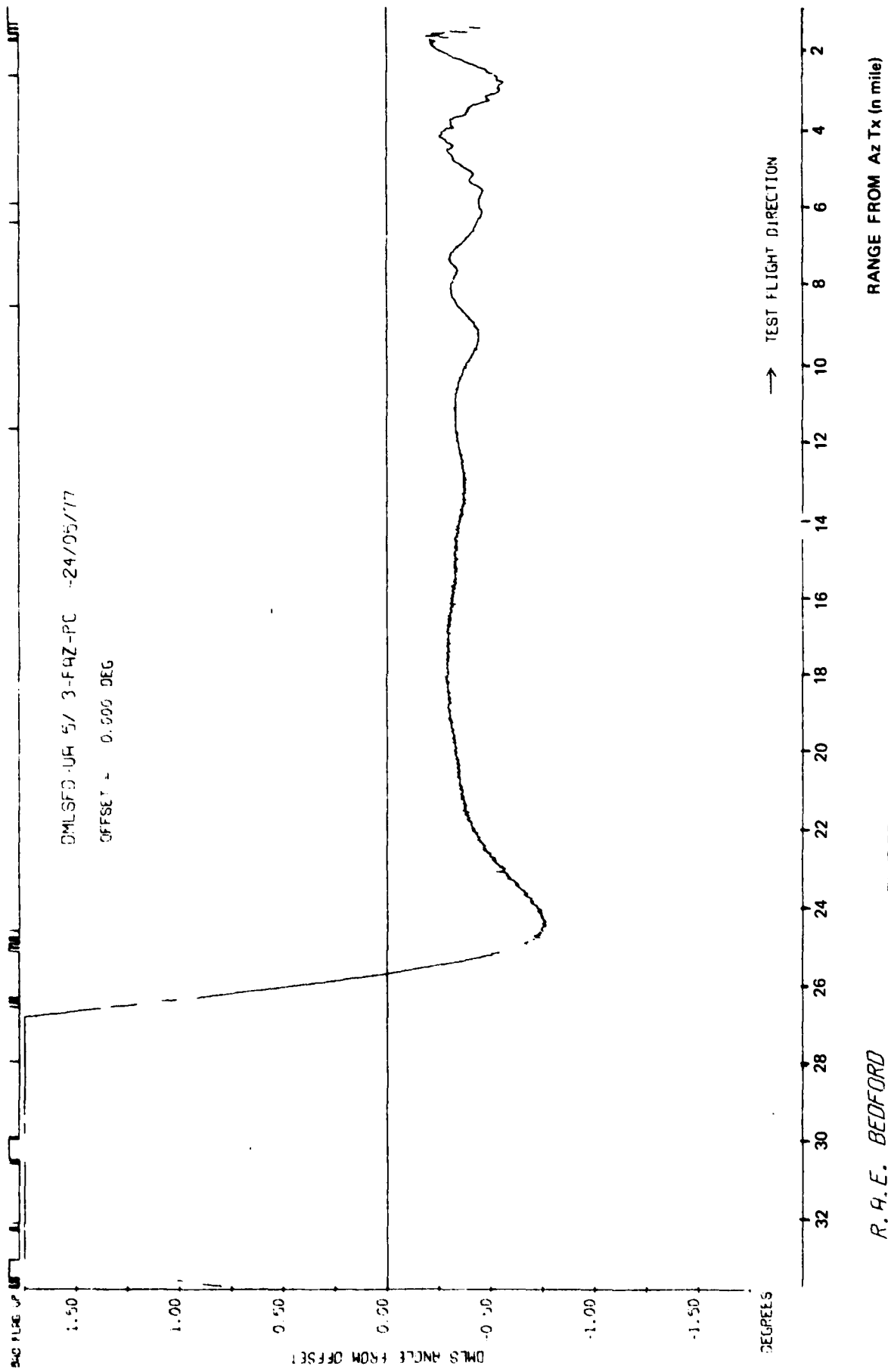


Fig 7.77a Azimuth radial on Q at 3000 ft height

R. A. E. BEDFORD

TR 79052

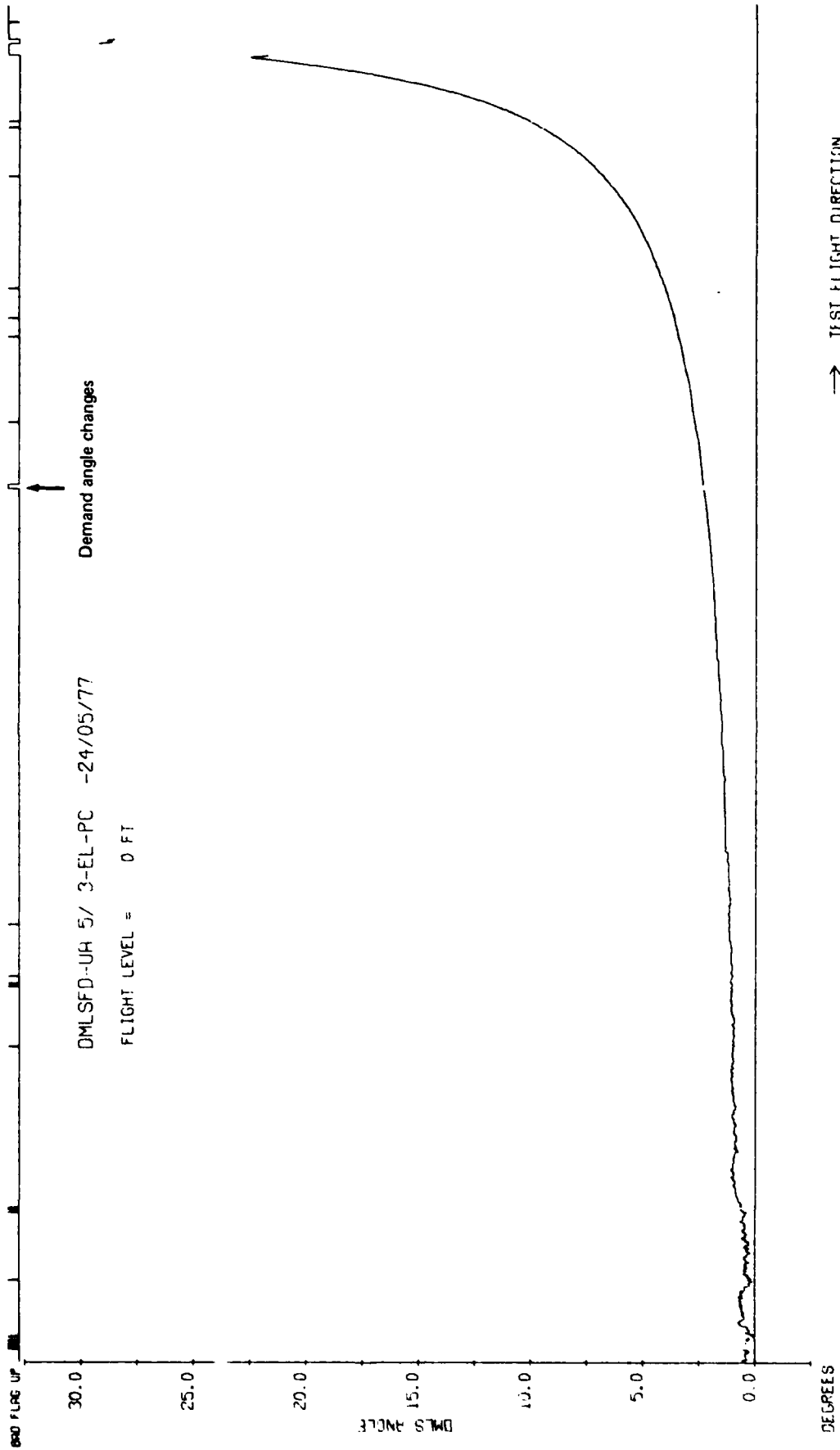


Fig 7.77b

Fig 7.77b Elevation radial on Q_c at 3000 ft

R. A. E. BEDFORD

Fig 7.77c

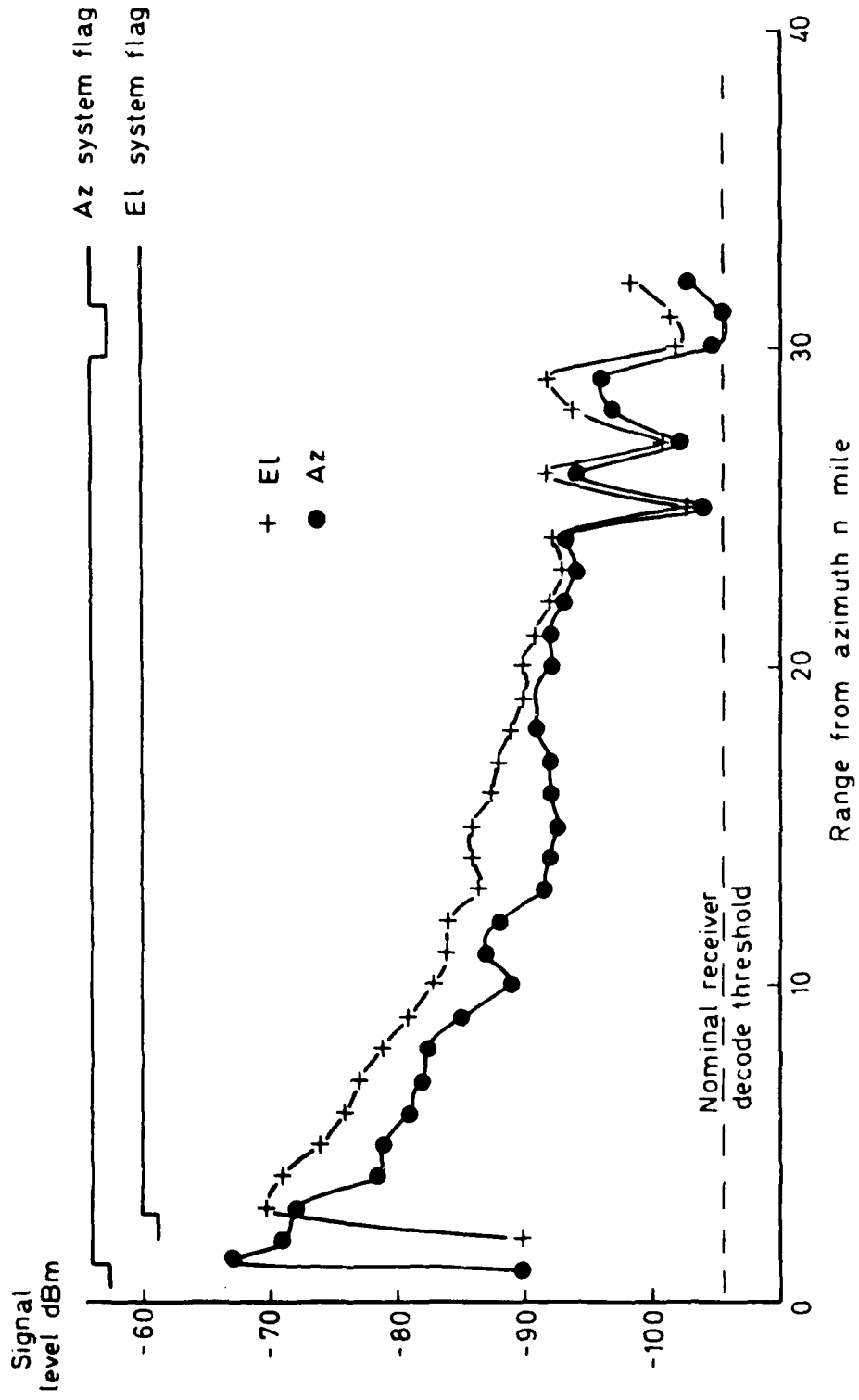


Fig 7.77c Received signal levels for UA05/3

AD-A085 480

ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND) F/6 17/7
CONTRIBUTIONS TO THE UK MICROWAVE LANDING SYSTEM RESEARCH AND D--ETC(U)
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RAE-TR-79052-VOL-3

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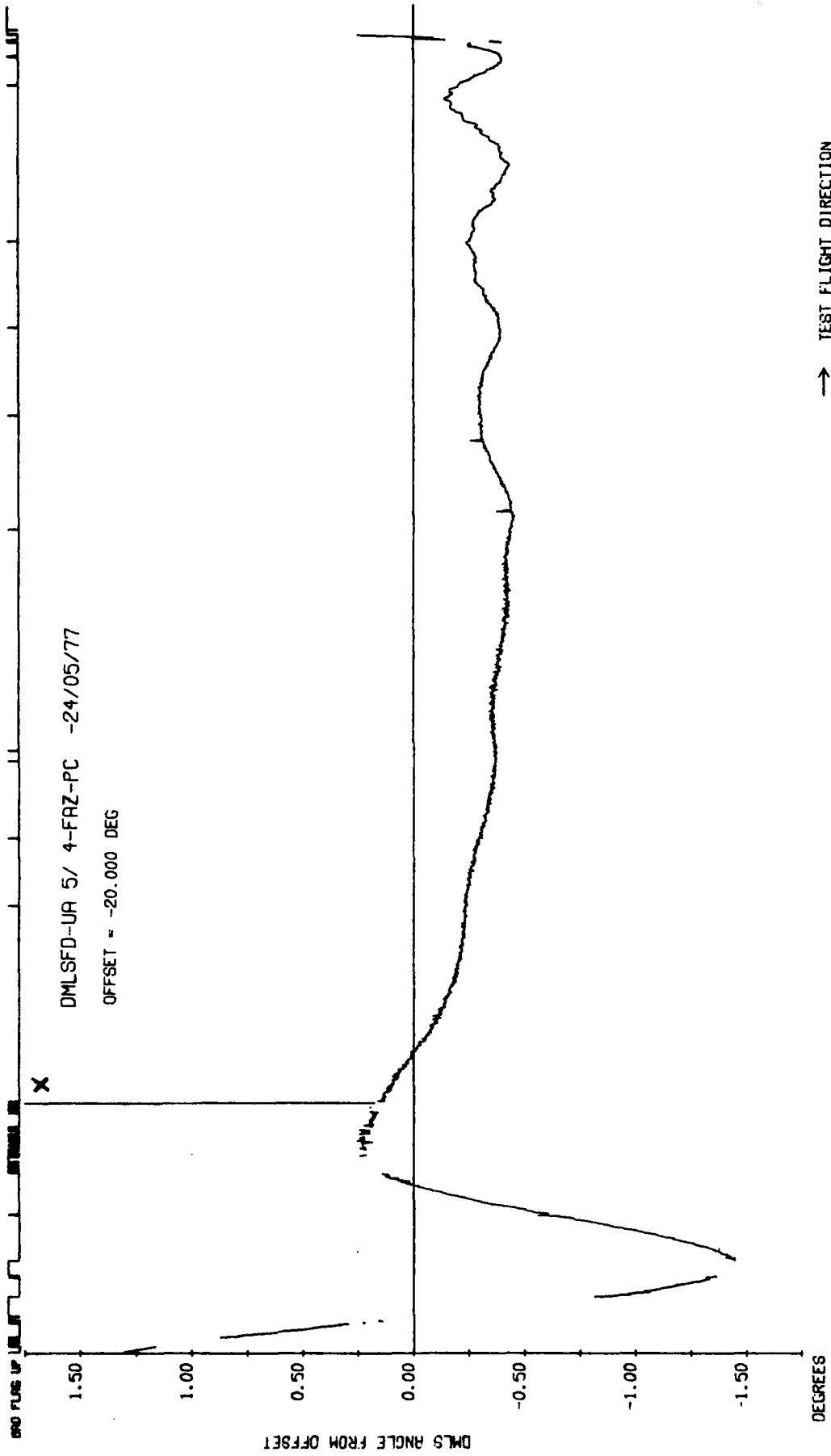
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TR 79052



R. A. E. BEDFORD

Fig 7.78a Azimuth radial at -20 degrees and 3000 ft

Fig 7.78a

Fig 7.78b

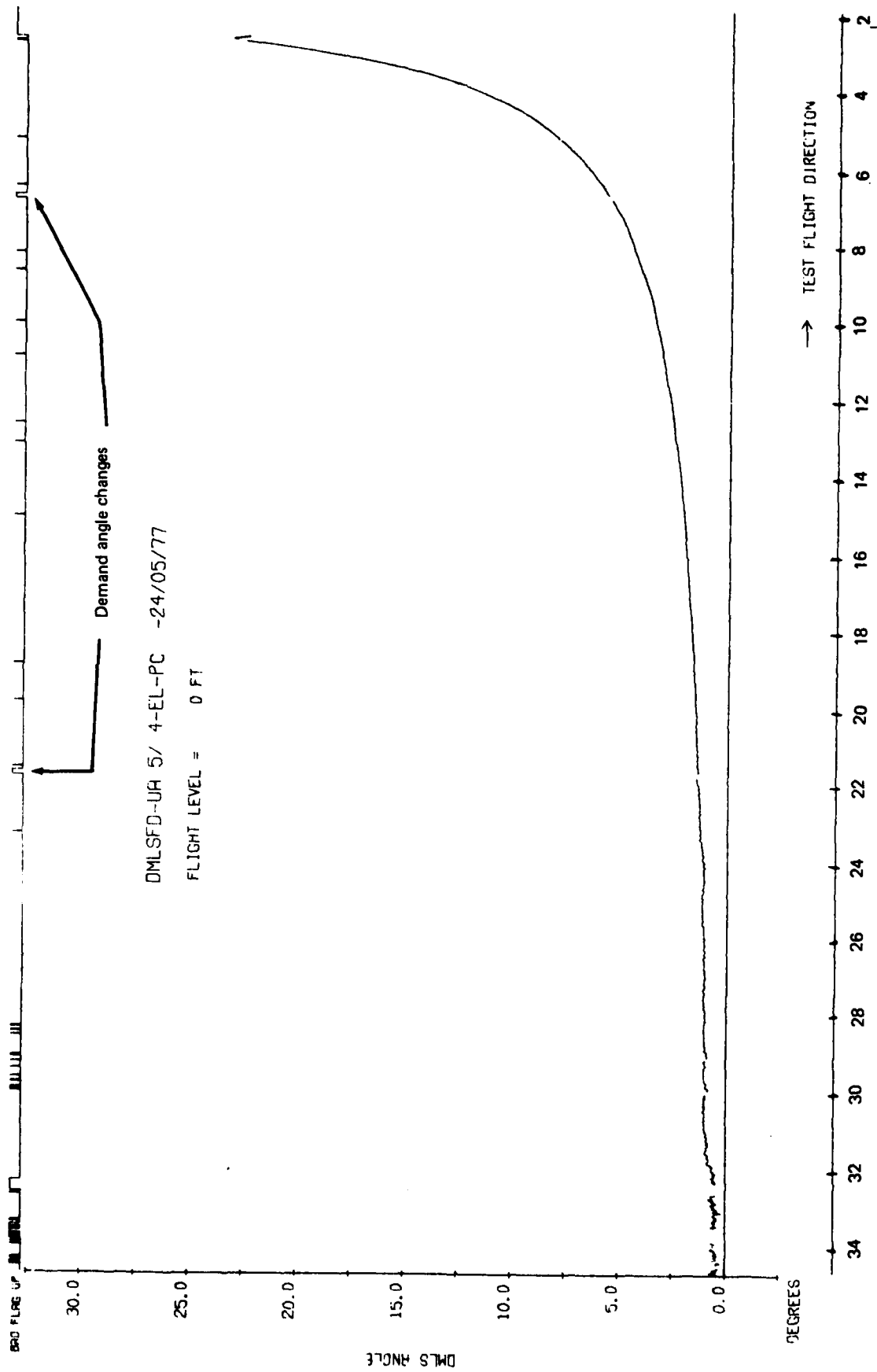


Fig 7.78b Elevation radial at -20 degrees and 3000 ft

R. A. E. BEDFORD

TR 79052

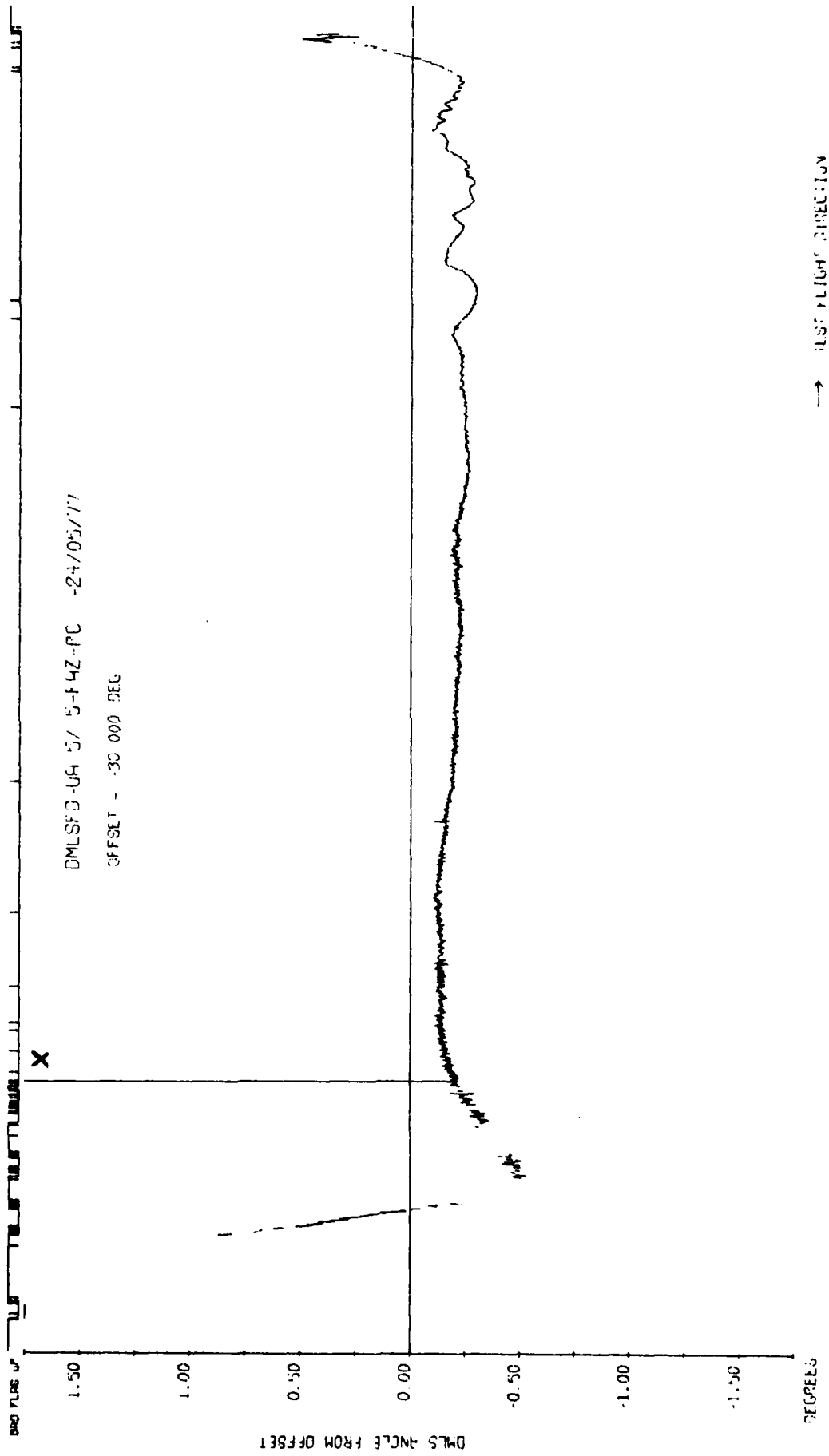


Fig 7.79a

Fig 7.79a Azimuth radial at -30 degrees and 3000 ft

R. H. E. BEJFORD

Fig 7.79b

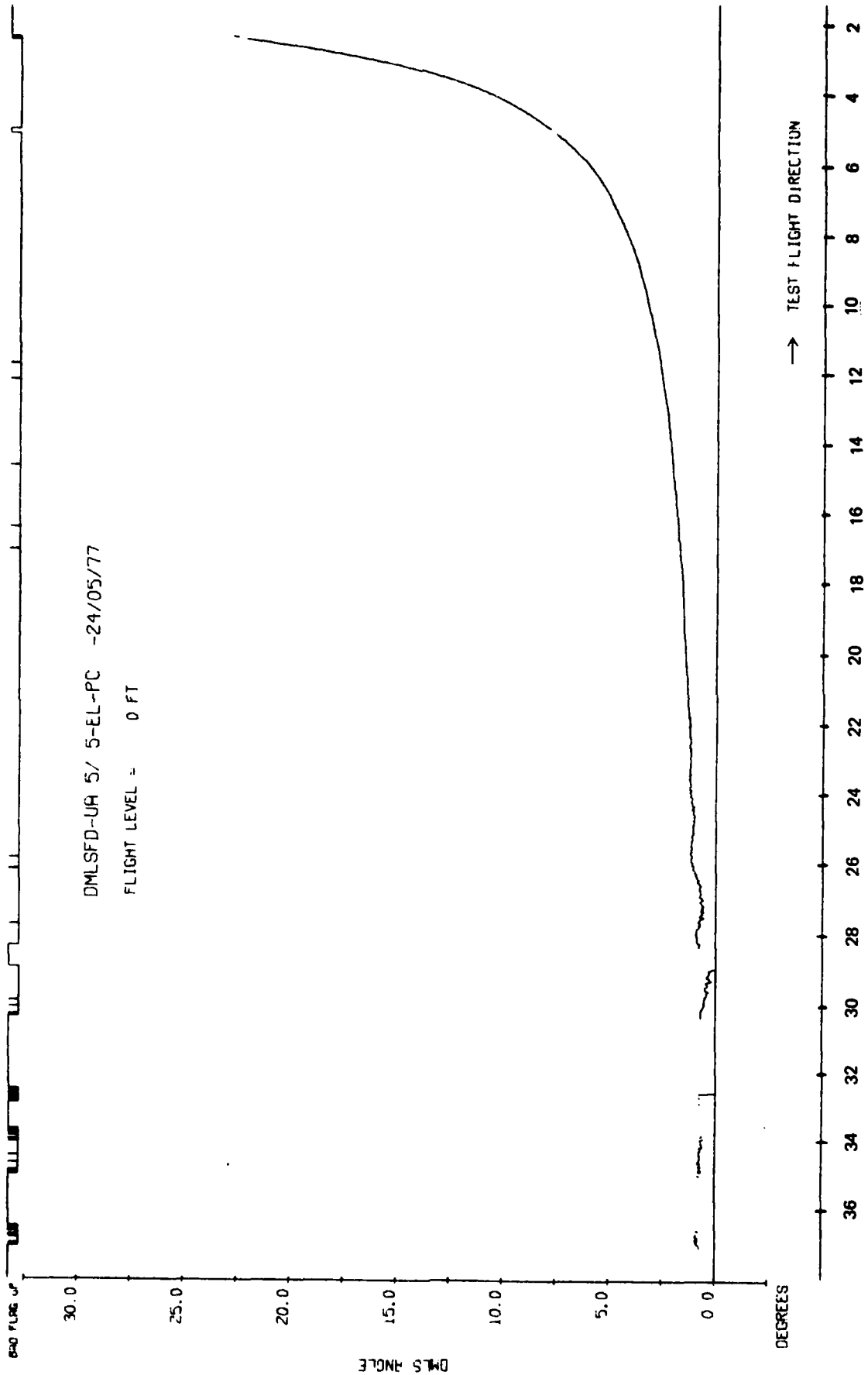


Fig 7.79b Elevation radial at -30 degrees and 3000 ft

R. A. E. BEDFORD

TR 79062

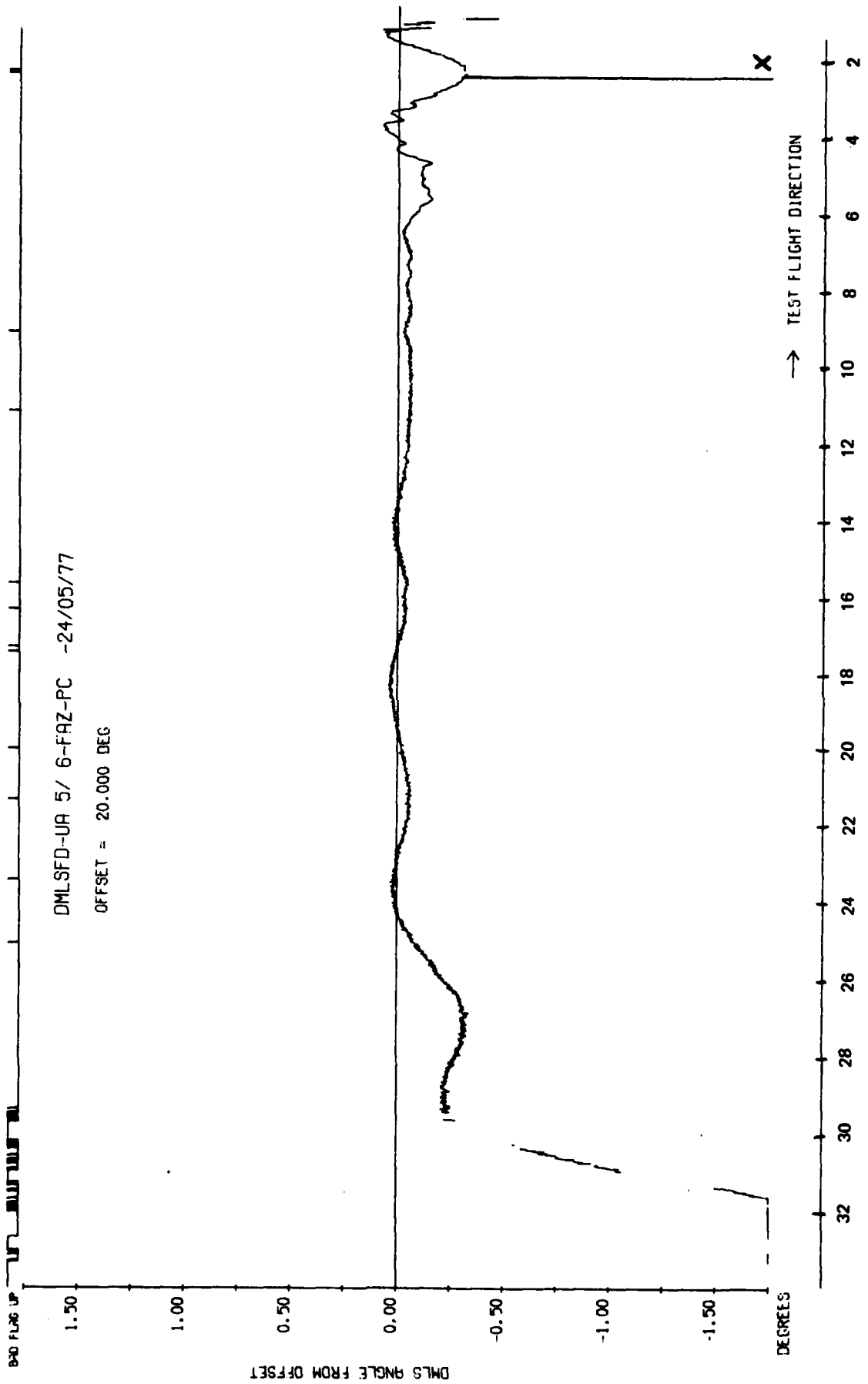


Fig 7.80a

Fig 7.80a Azimuth radial at +20 degrees and 3000 ft

R. A. E. BEDFORD

Fig 7.80b

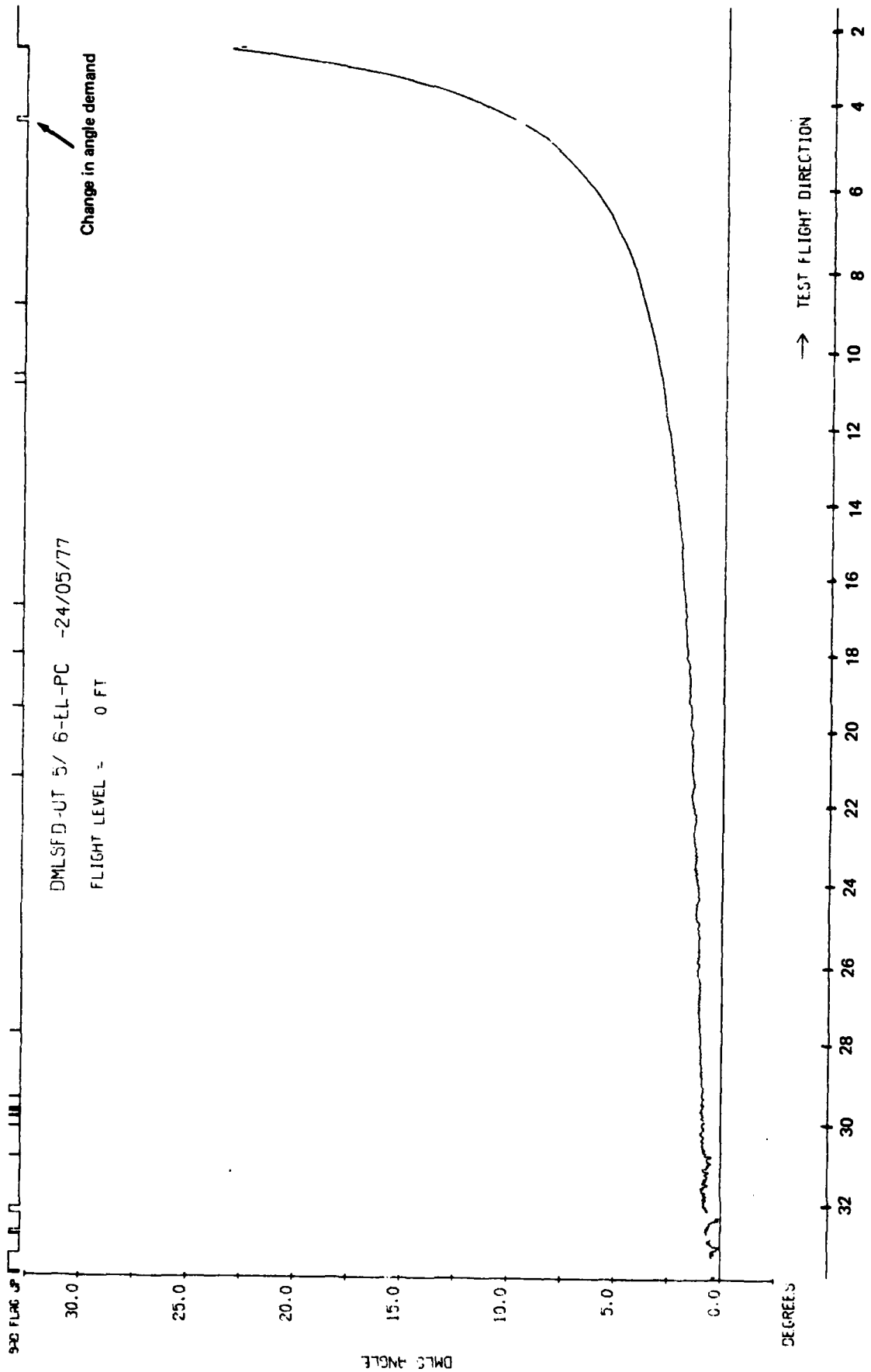
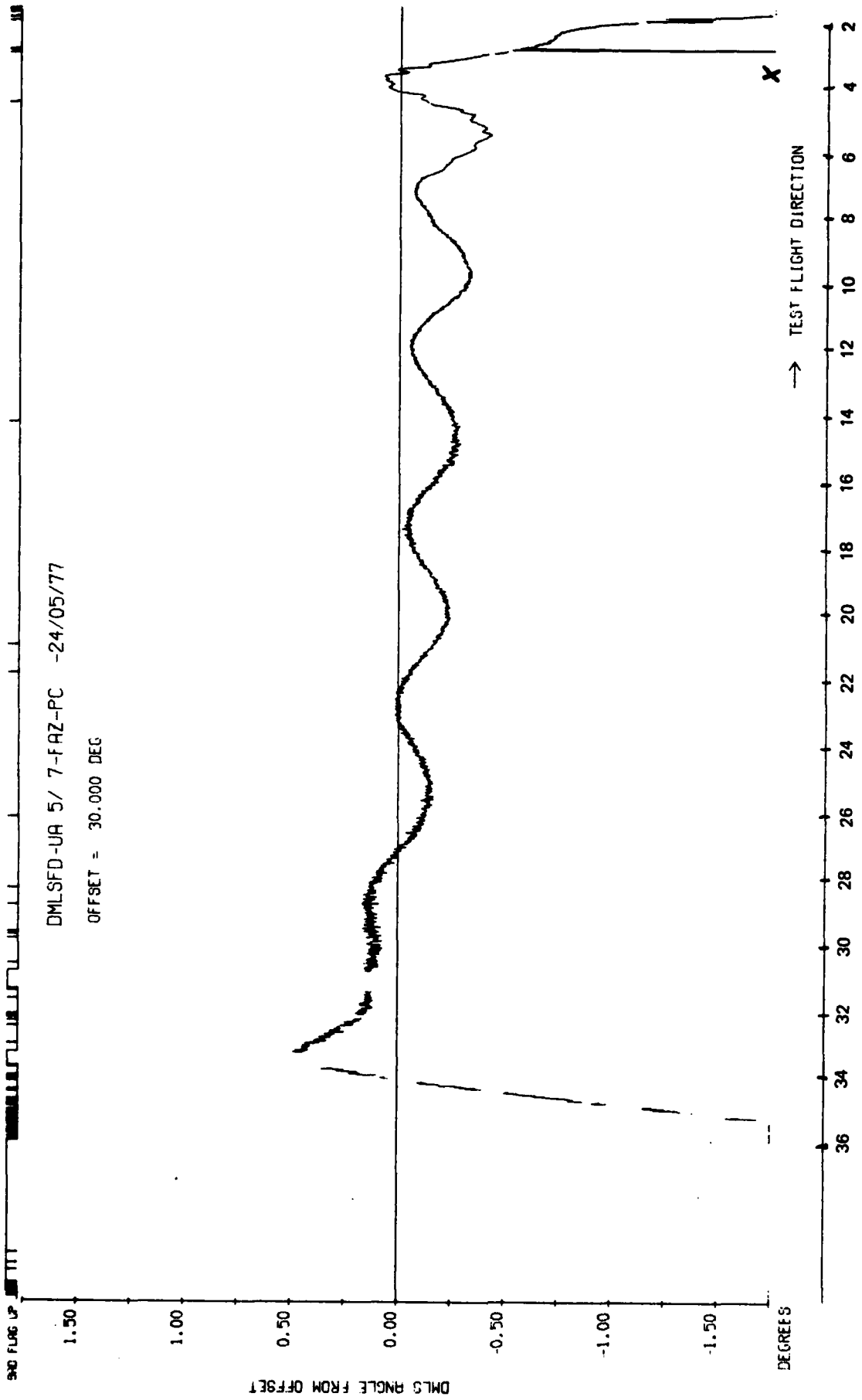


Fig 7.80b Elevation radial at +20 degrees and 3000 ft

R. A. E. BEDFORD

TR 79062



DMLSFD-UA 5/ 7-FAZ-PC -24/05/77
OFFSET = 30.000 DEG

Fig 7.81a

Fig 7.81a Azimuth radial at +30 degrees and 3000 ft

R. A. E. BEDFORD

Fig 7.81b

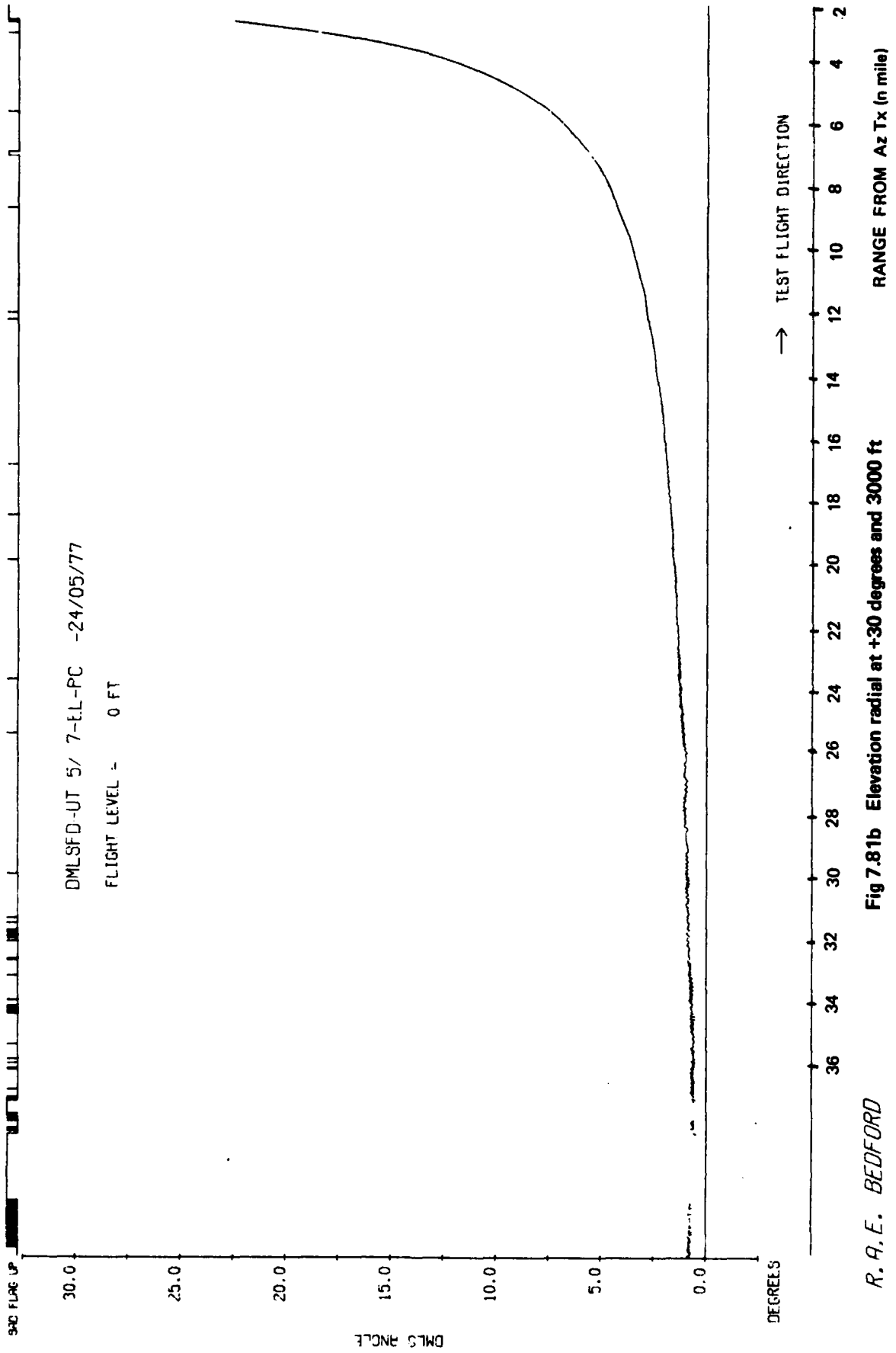


Fig 7.81b Elevation radial at +30 degrees and 3000 ft

R. A. E. BEDFORD

TR 79062

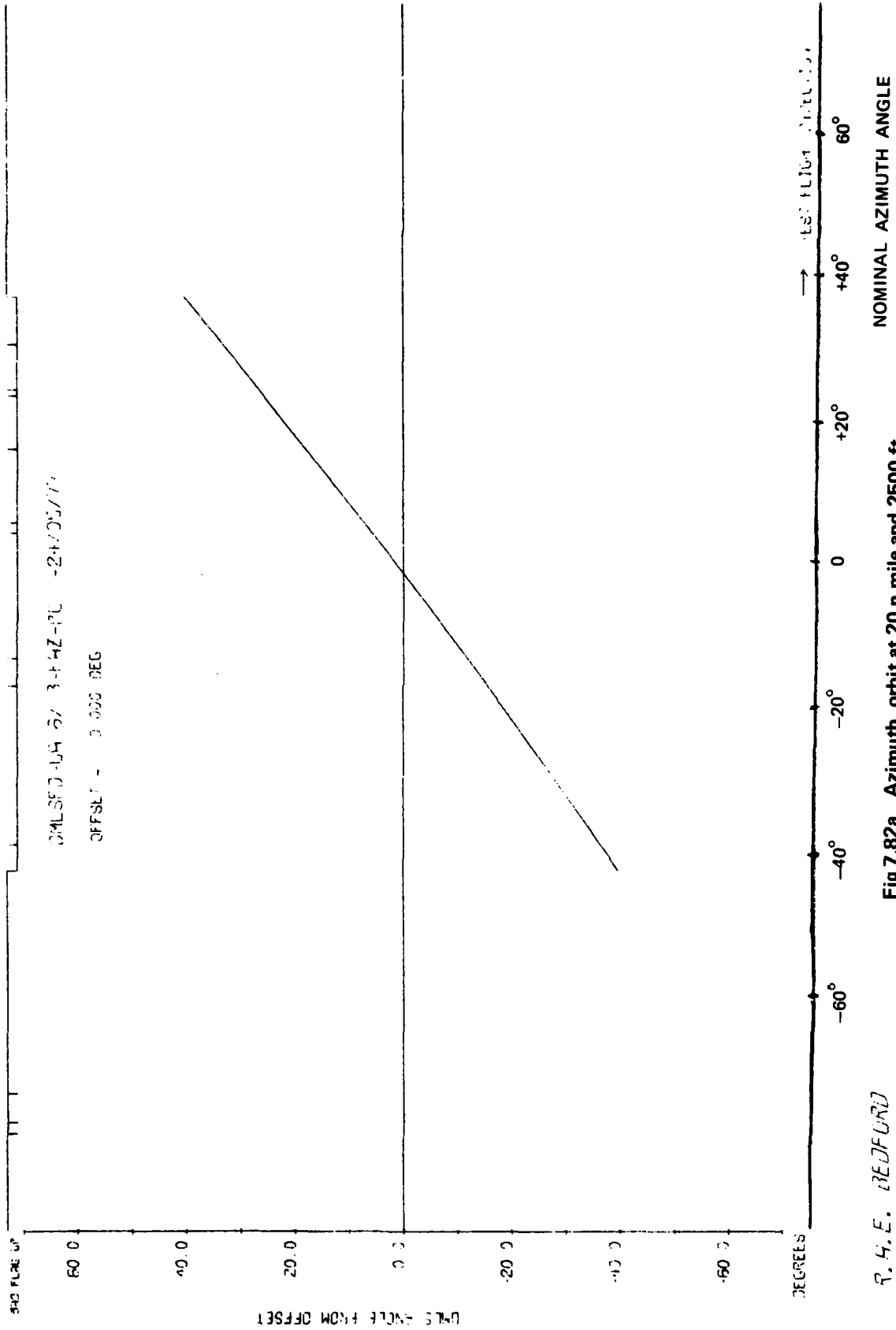


Fig 7.82a

Fig 7.82a Azimuth, orbit at 20 n mile and 2500 ft

R. H. E. BEDFORD

Fig 7.82b

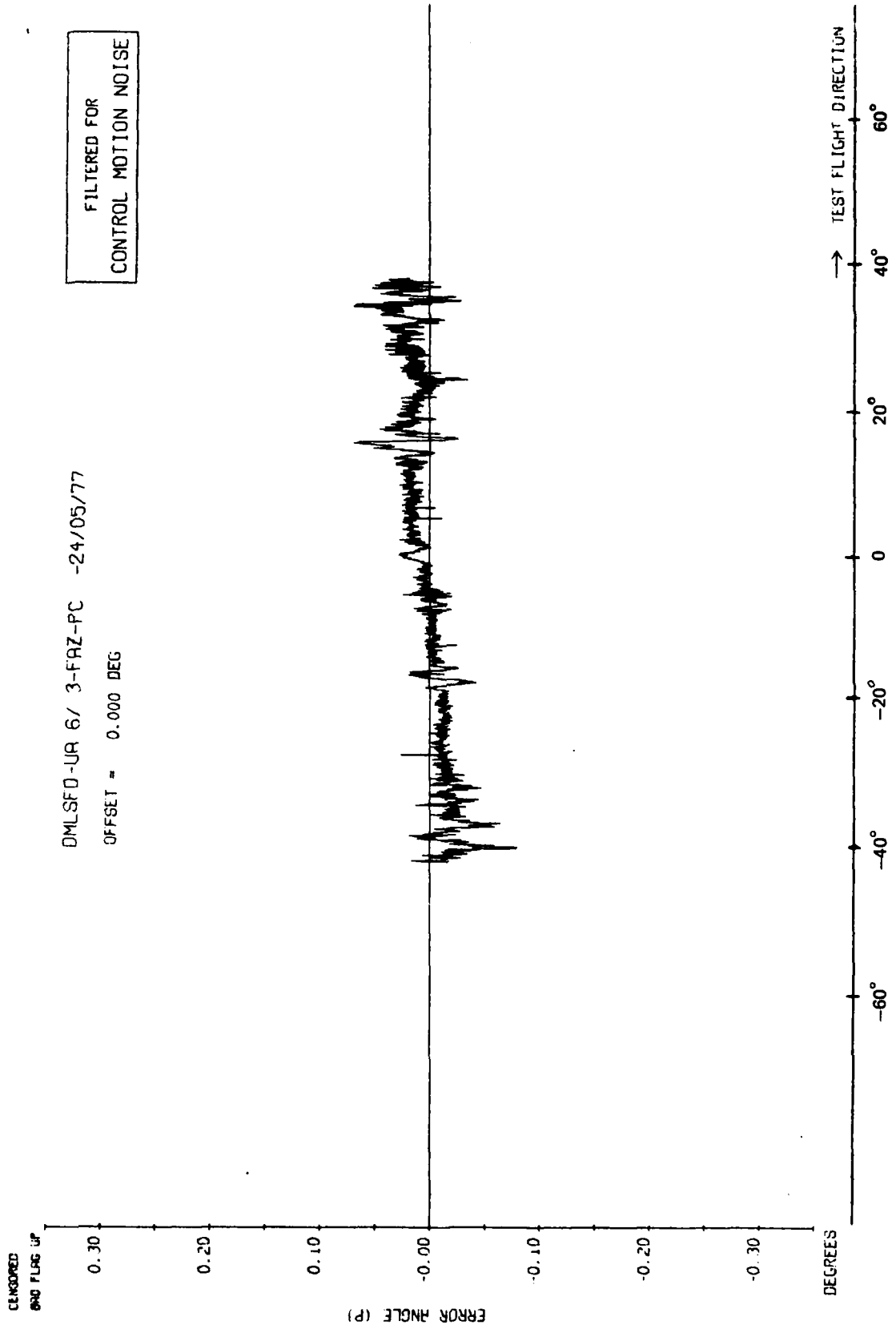


Fig 7.82b Azimuth, orbit at 20 n mile and 2500 ft

R. A. E. BEDFORD

TR 79082

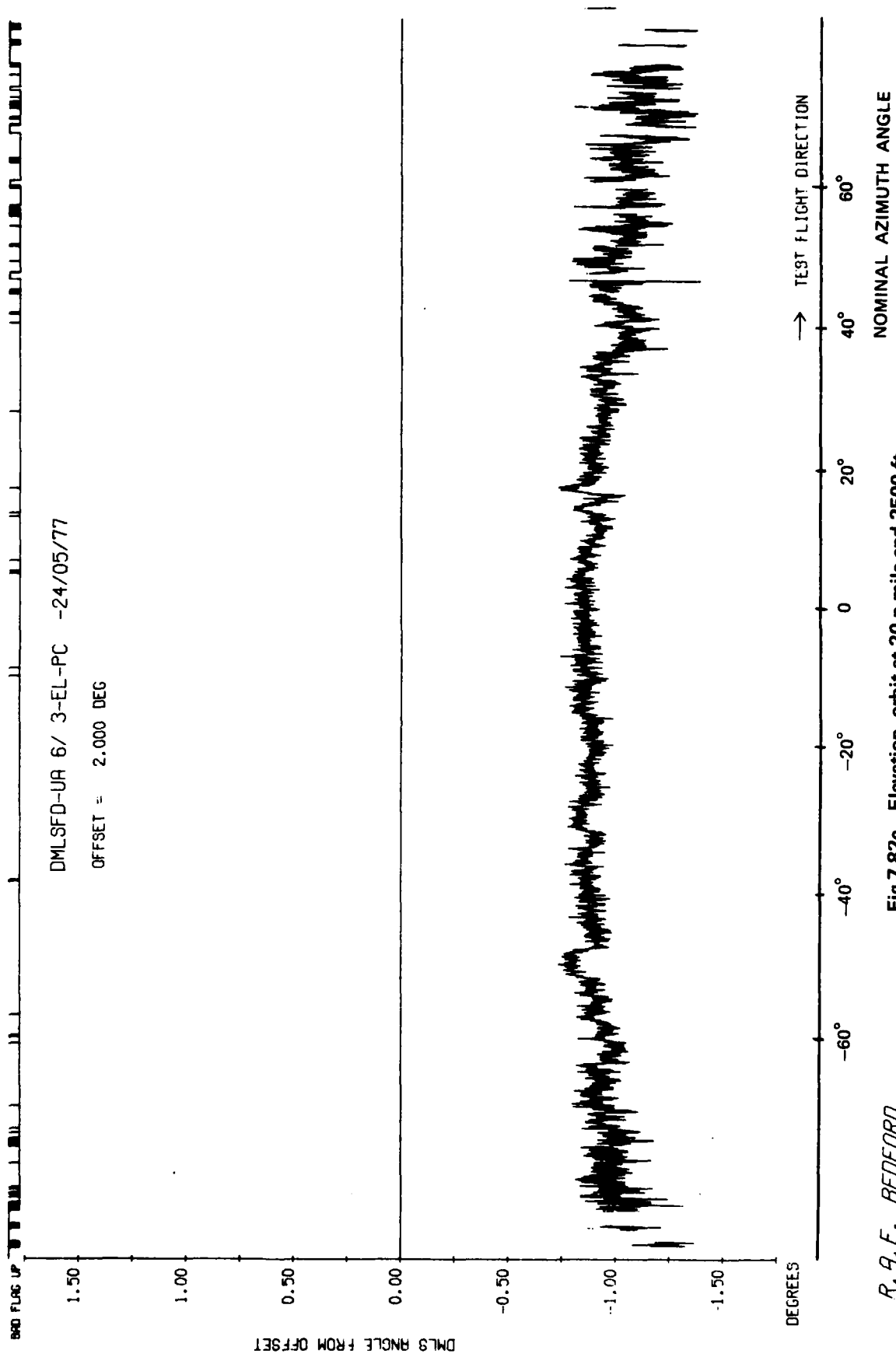


Fig 7.82c

Fig 7.82c Elevation, orbit at 20 n mile and 2500 ft

R. A. E. BEDFORD

TR 79062

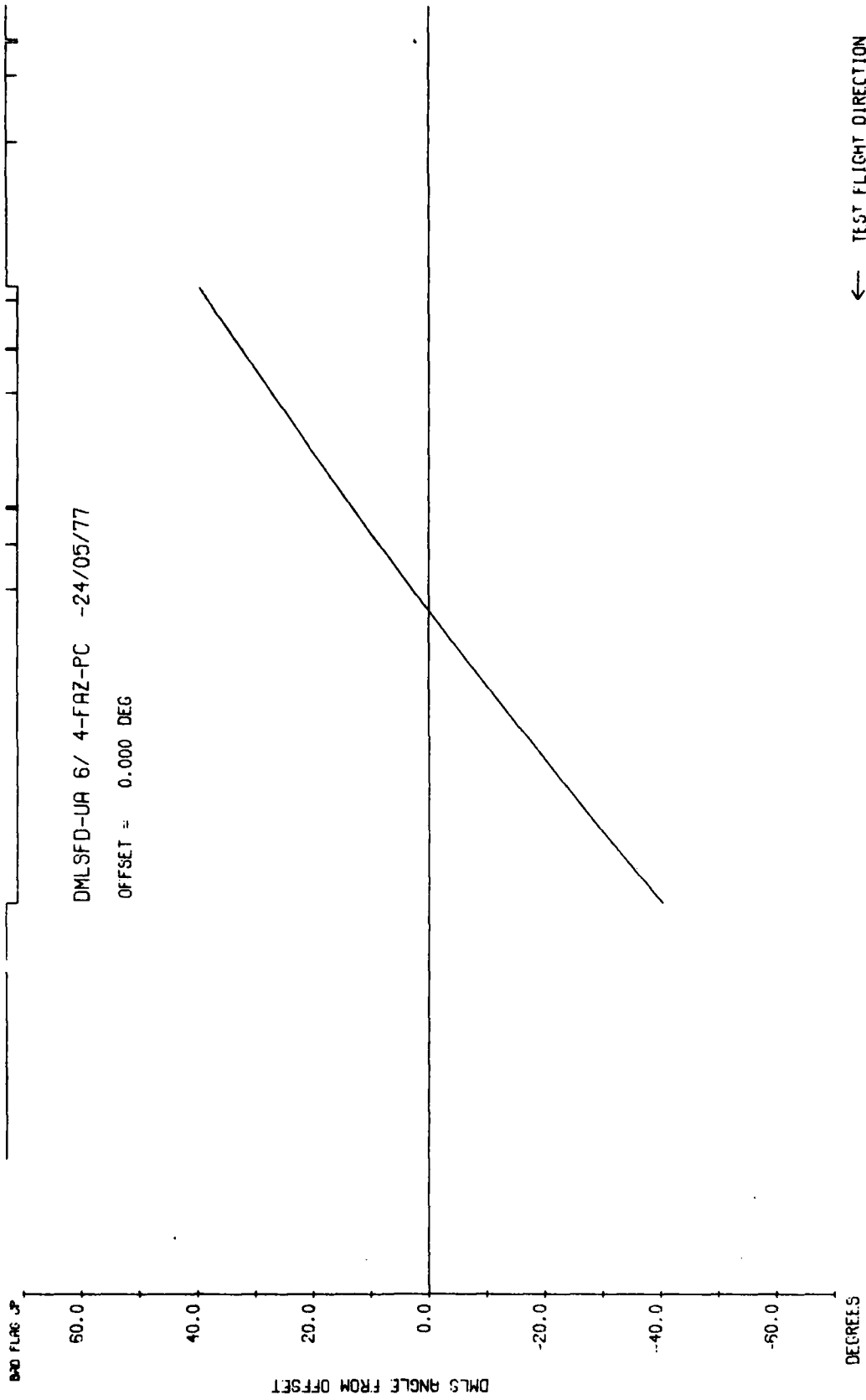
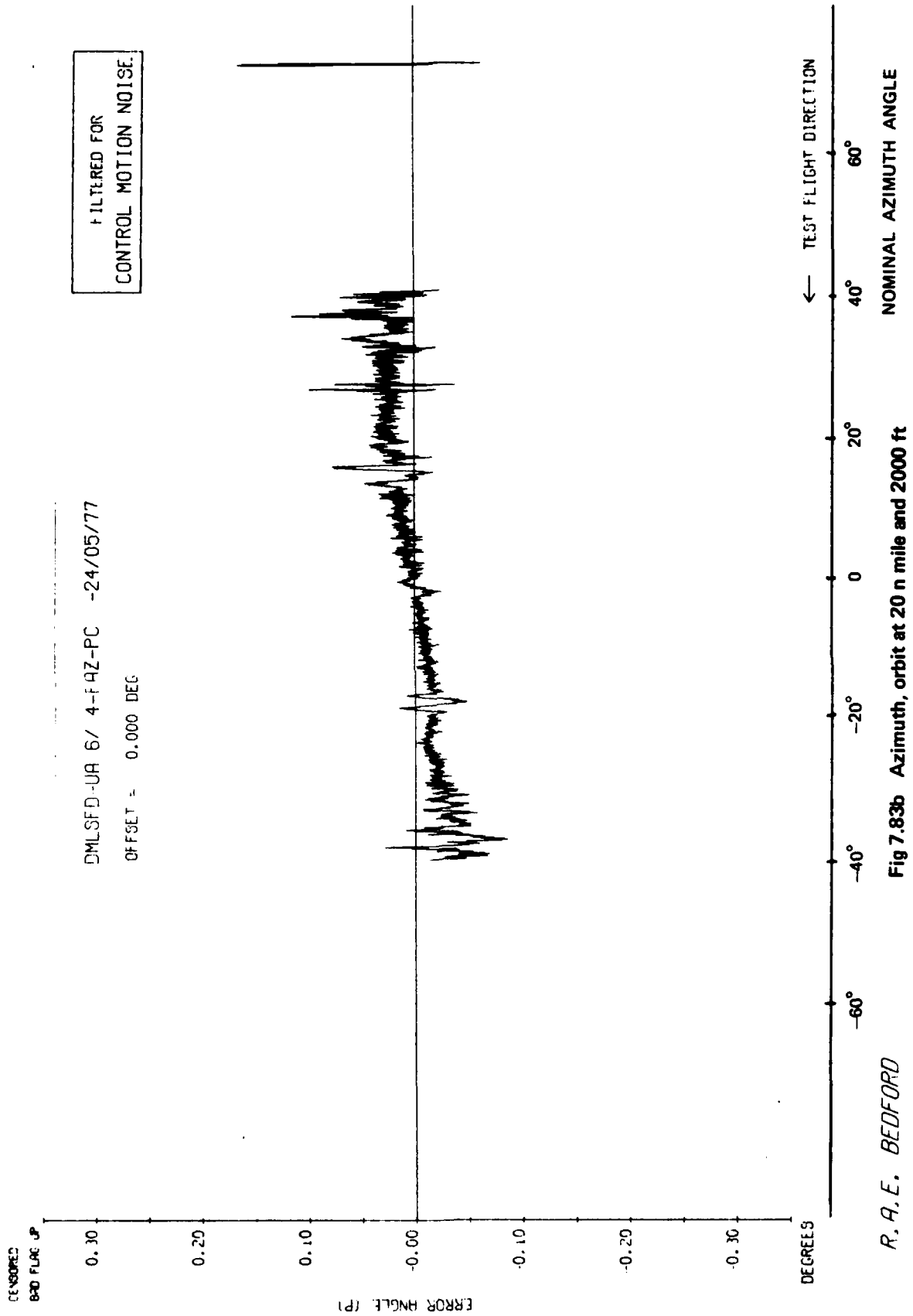


Fig 7.83a

R. A. E. BEDFORD

Fig 7.83a Azimuth, orbit at 20 n mile and 2000 ft

Fig 7.83b



R. A. E. BEDFORD

TR 79062

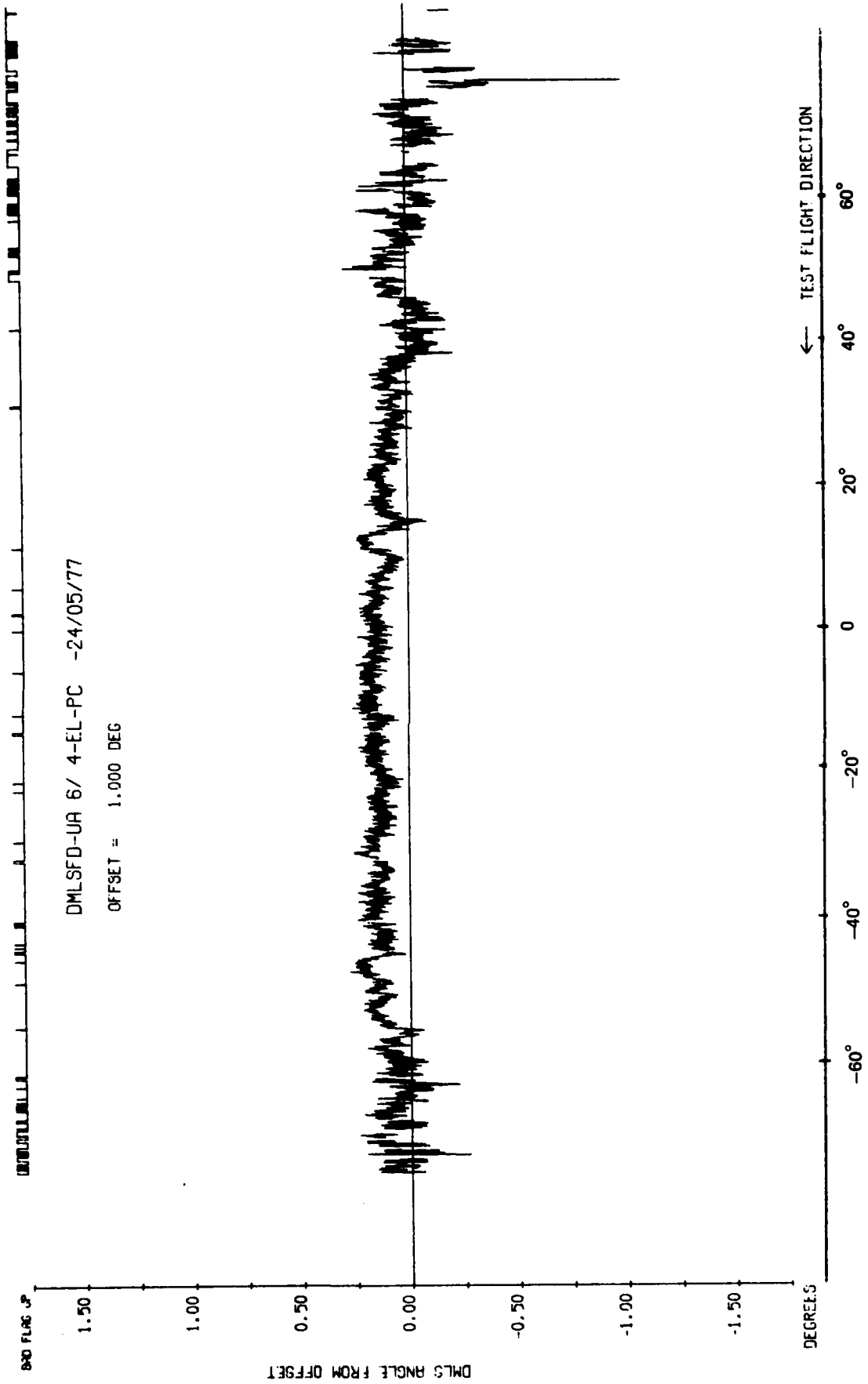


Fig 7.83c

Fig 7.83c Elevation, orbit at 20 n mile and 2000 ft

R. A. E. BEDFORD

TR 79052

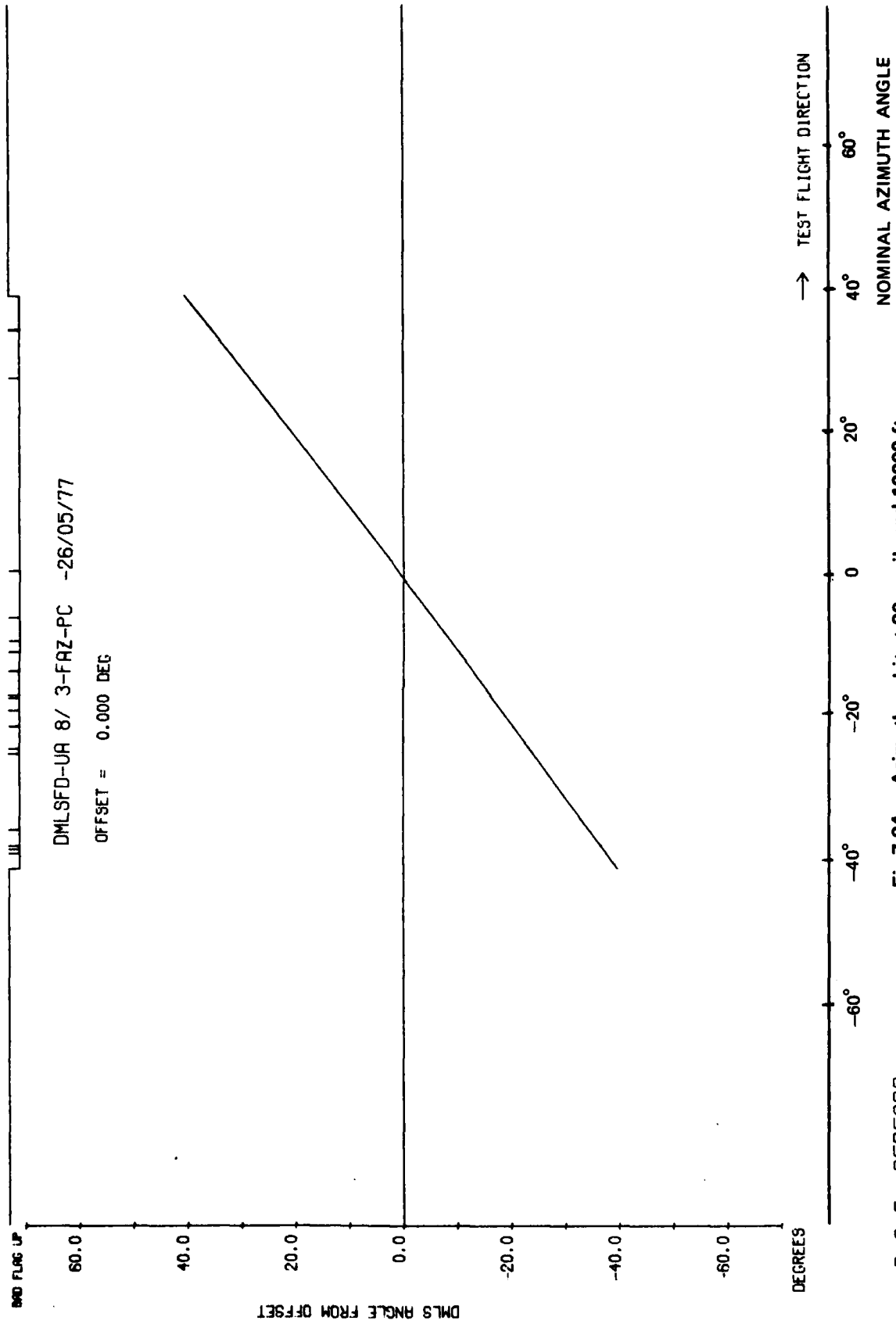


Fig 7.84a

Fig 7.84a Azimuth, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

TR 79062

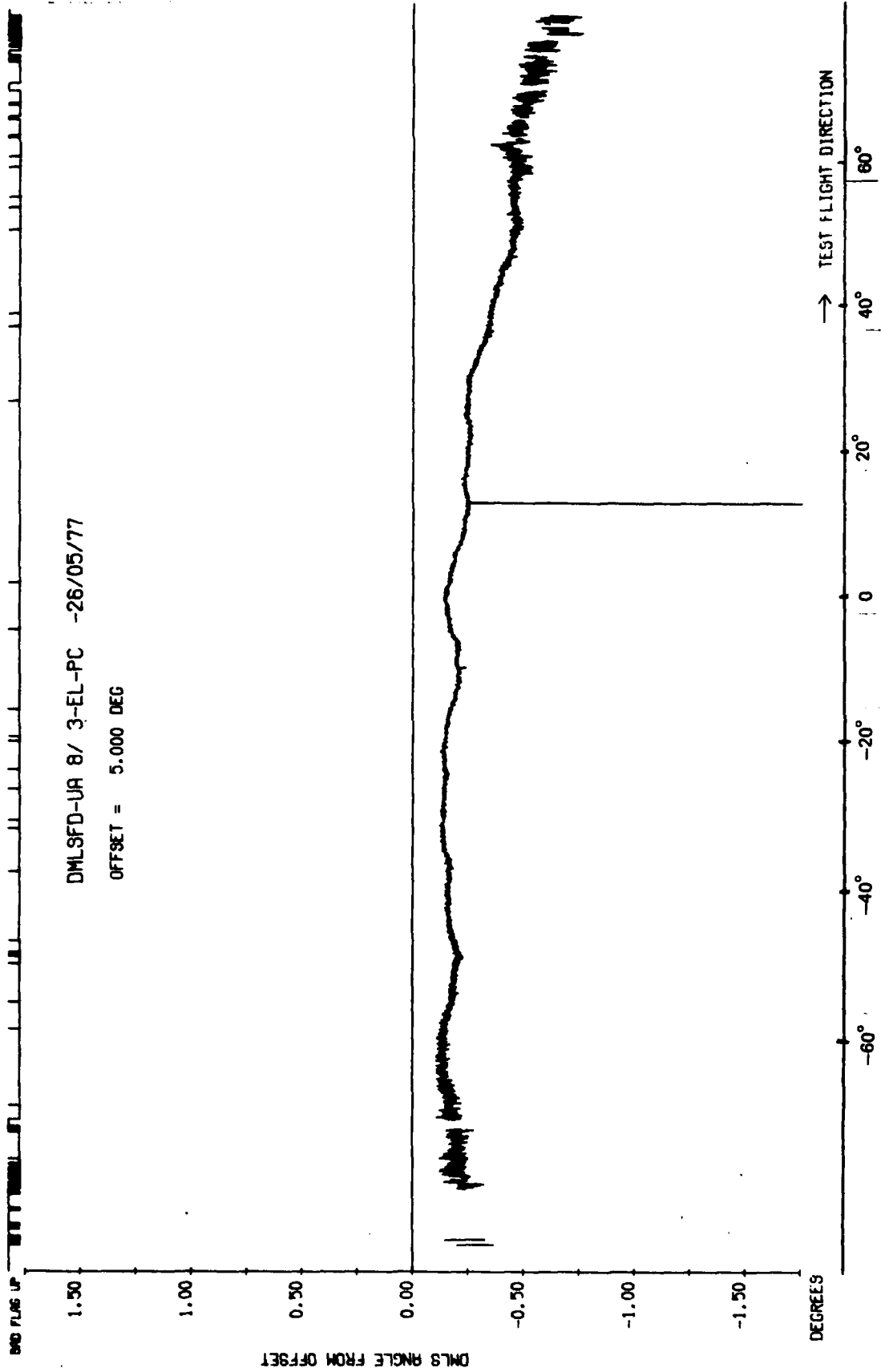


Fig 7.84c Elevation, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

Fig 7.84d

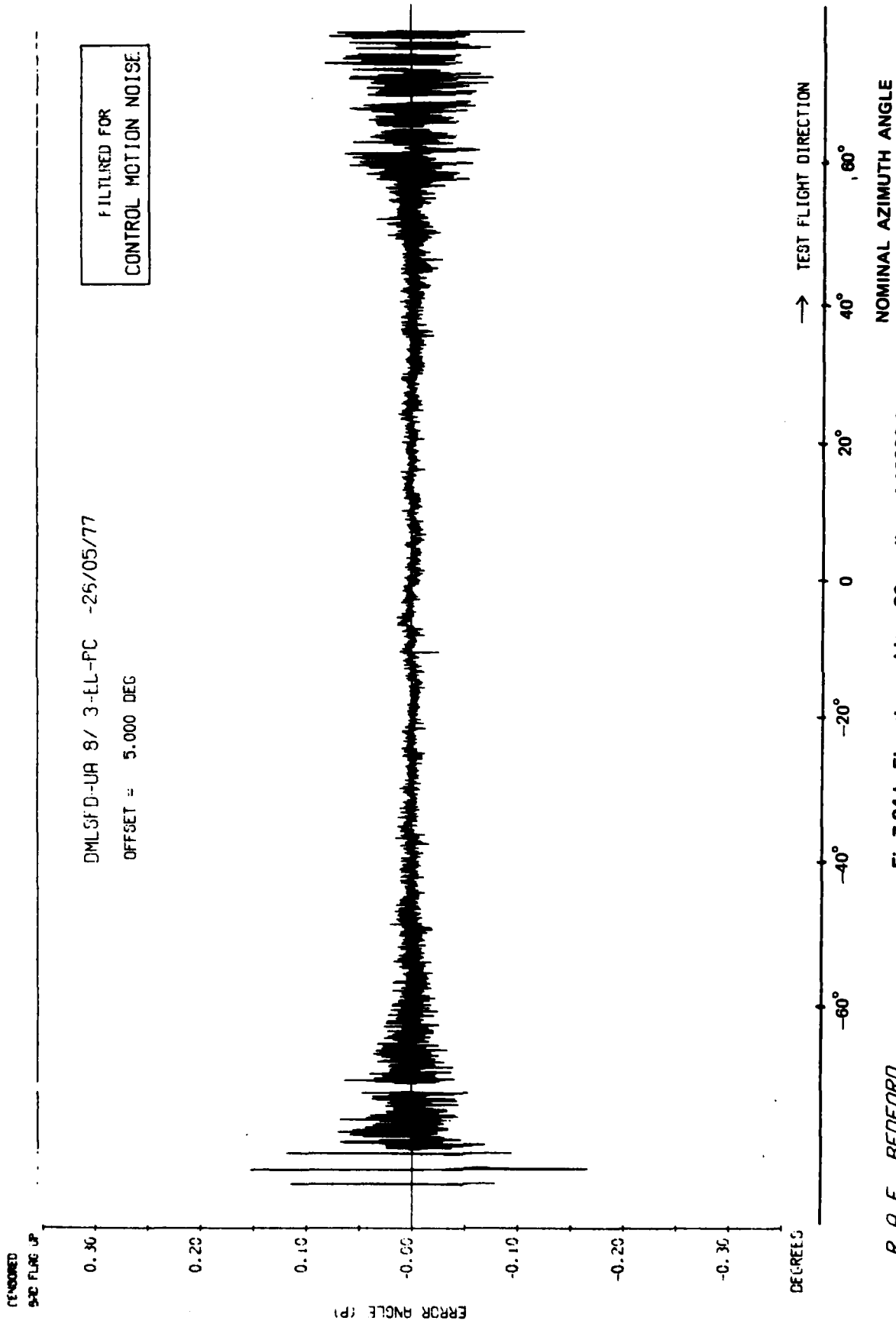


Fig 7.84d Elevation, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

TR 79062

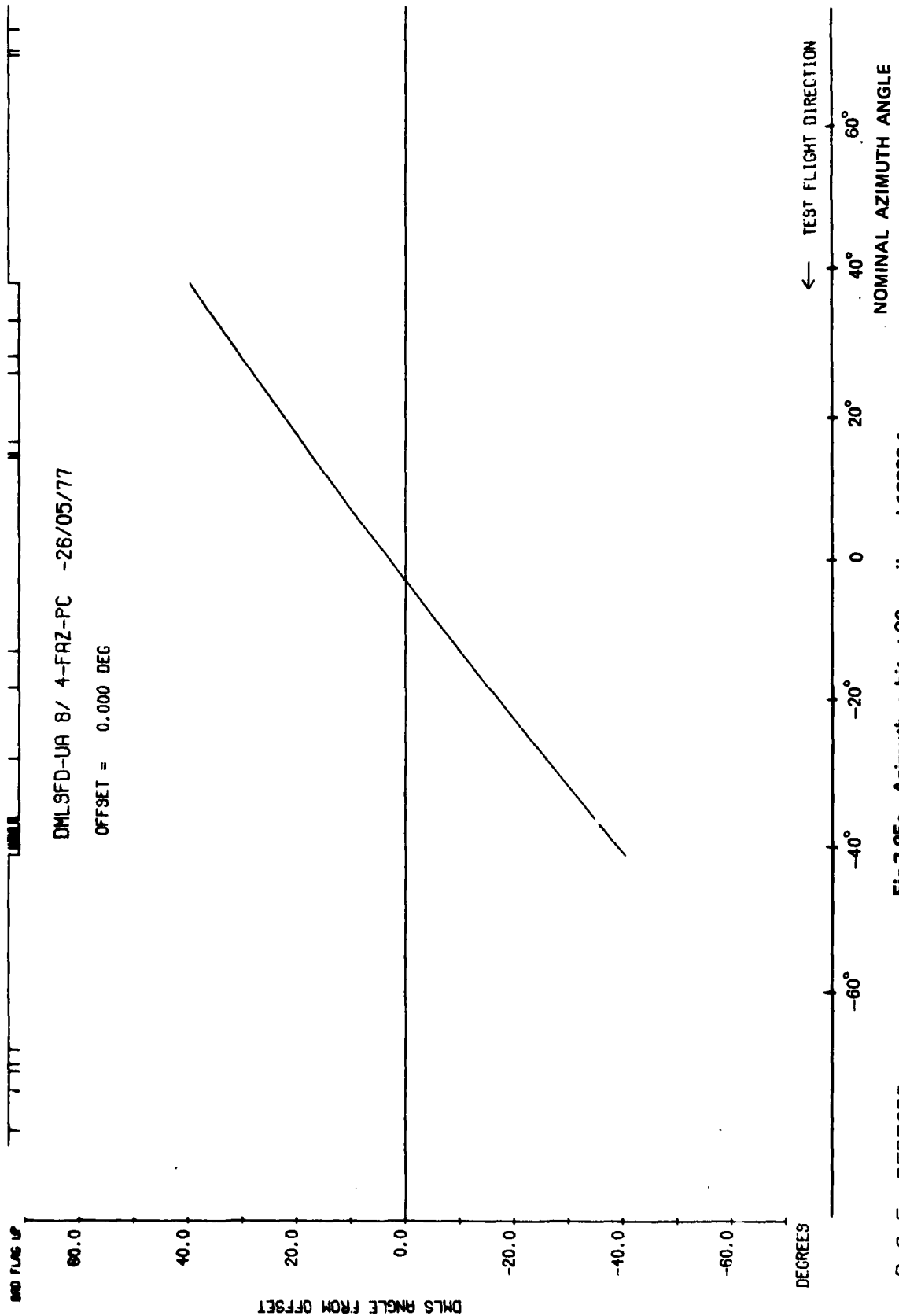


Fig 7.85a

Fig 7.85a Azimuth, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

Fig 7.85b

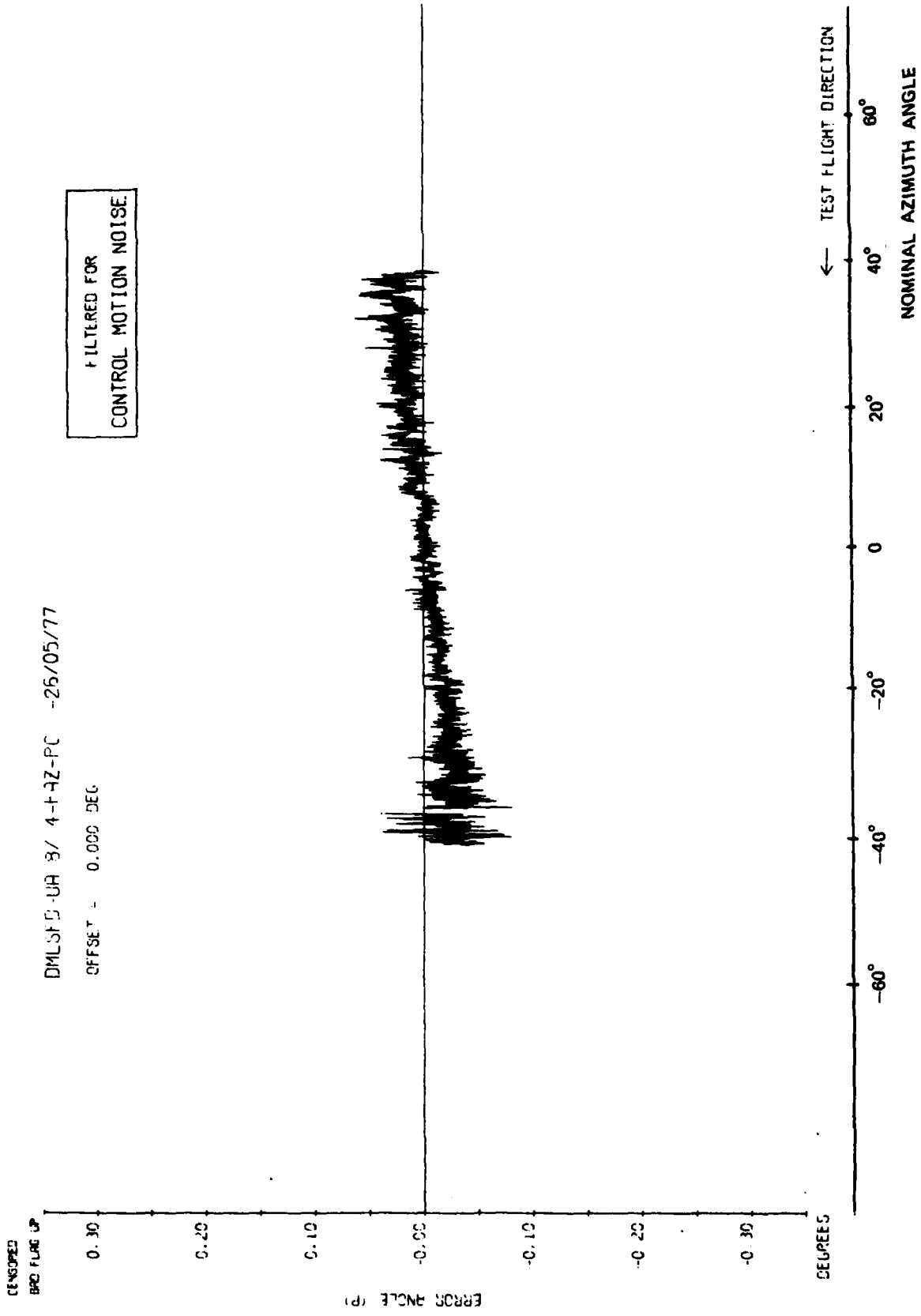


Fig 7.85b Azimuth, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

TR 79062

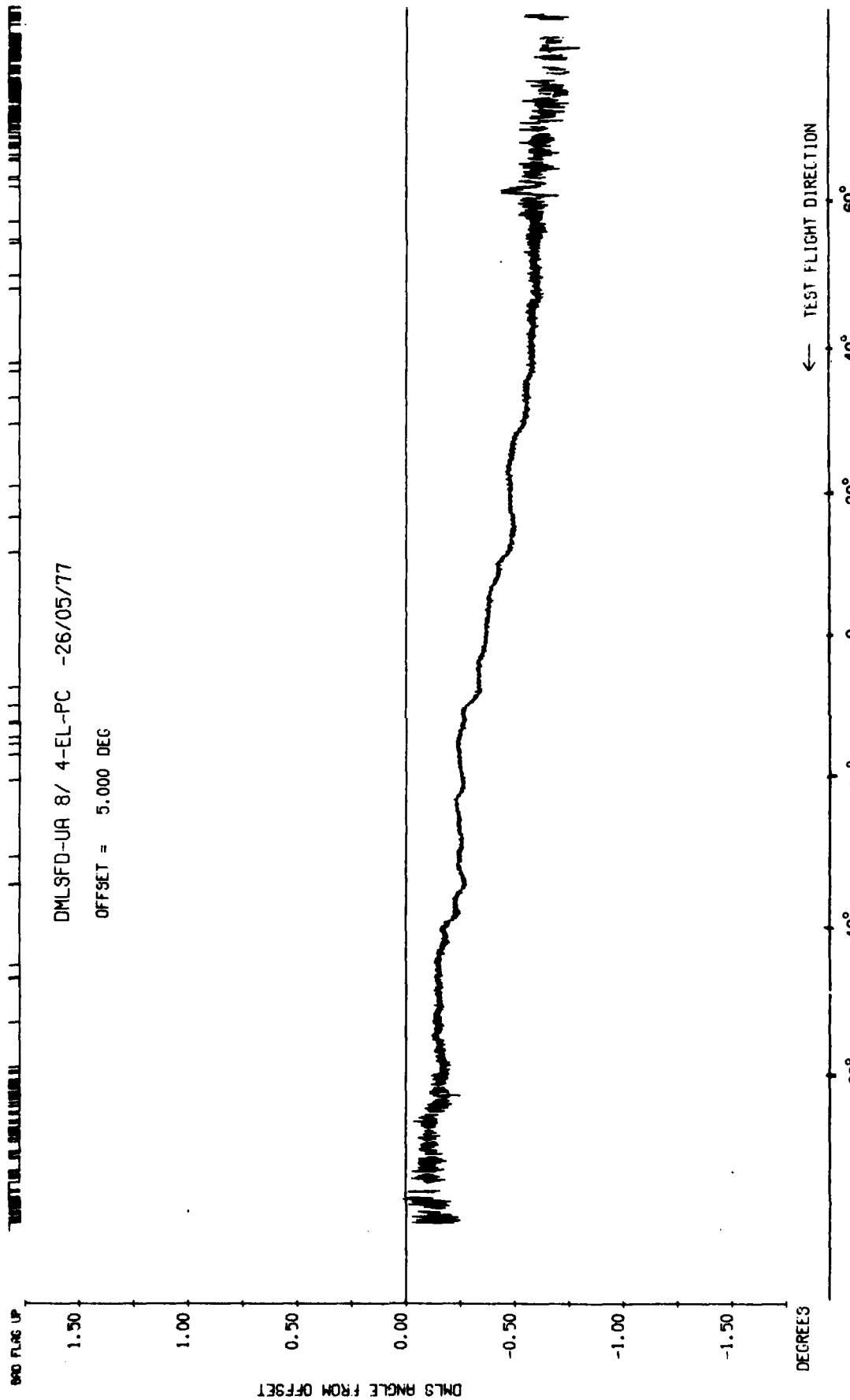


Fig 7.85c

Fig 7.85c Elevation, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

Fig 7.85d

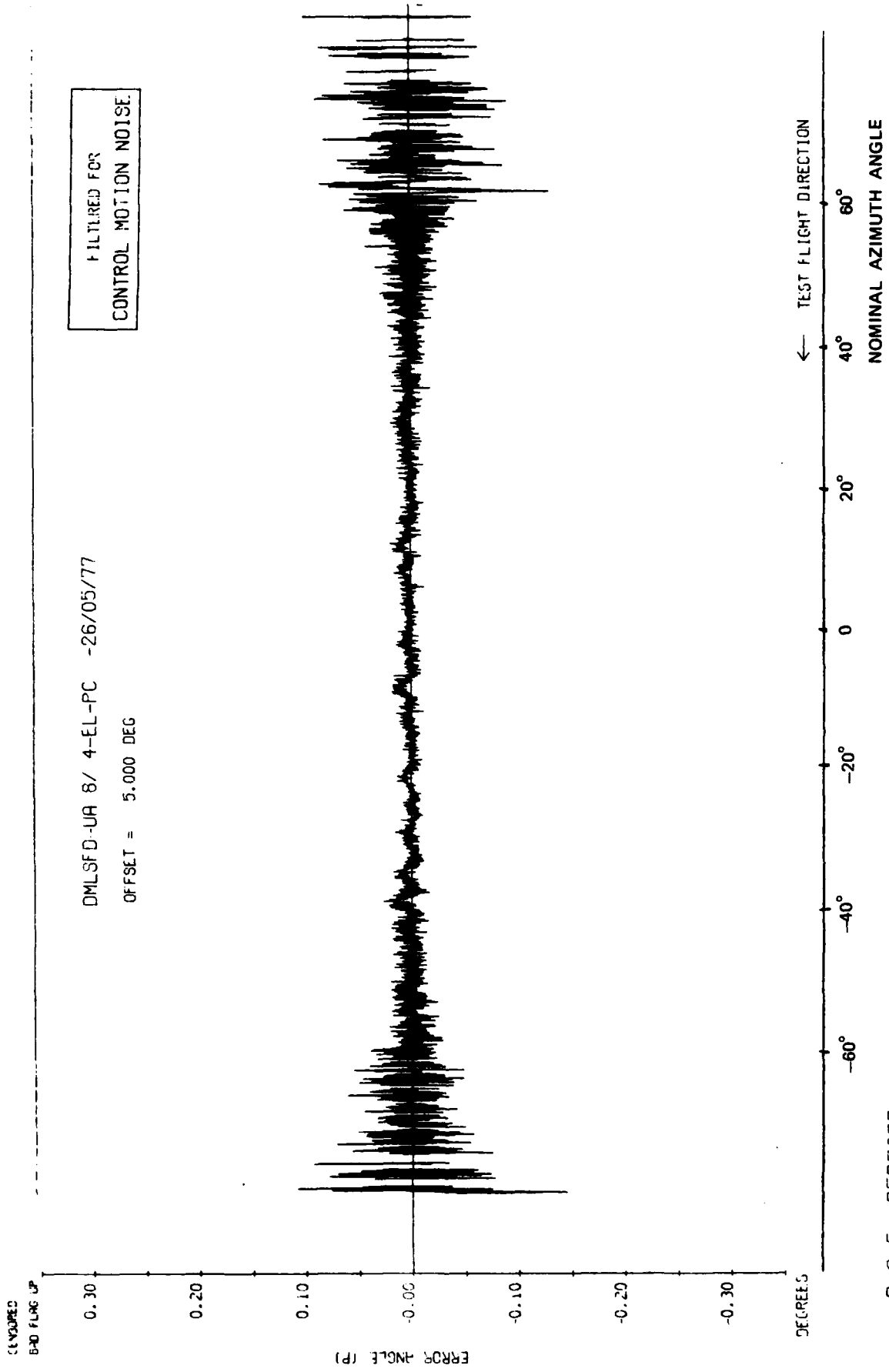


Fig 7.85d Elevation, orbit at 20 n mile and 10000 ft

R. A. E. BEDFORD

TR 79052

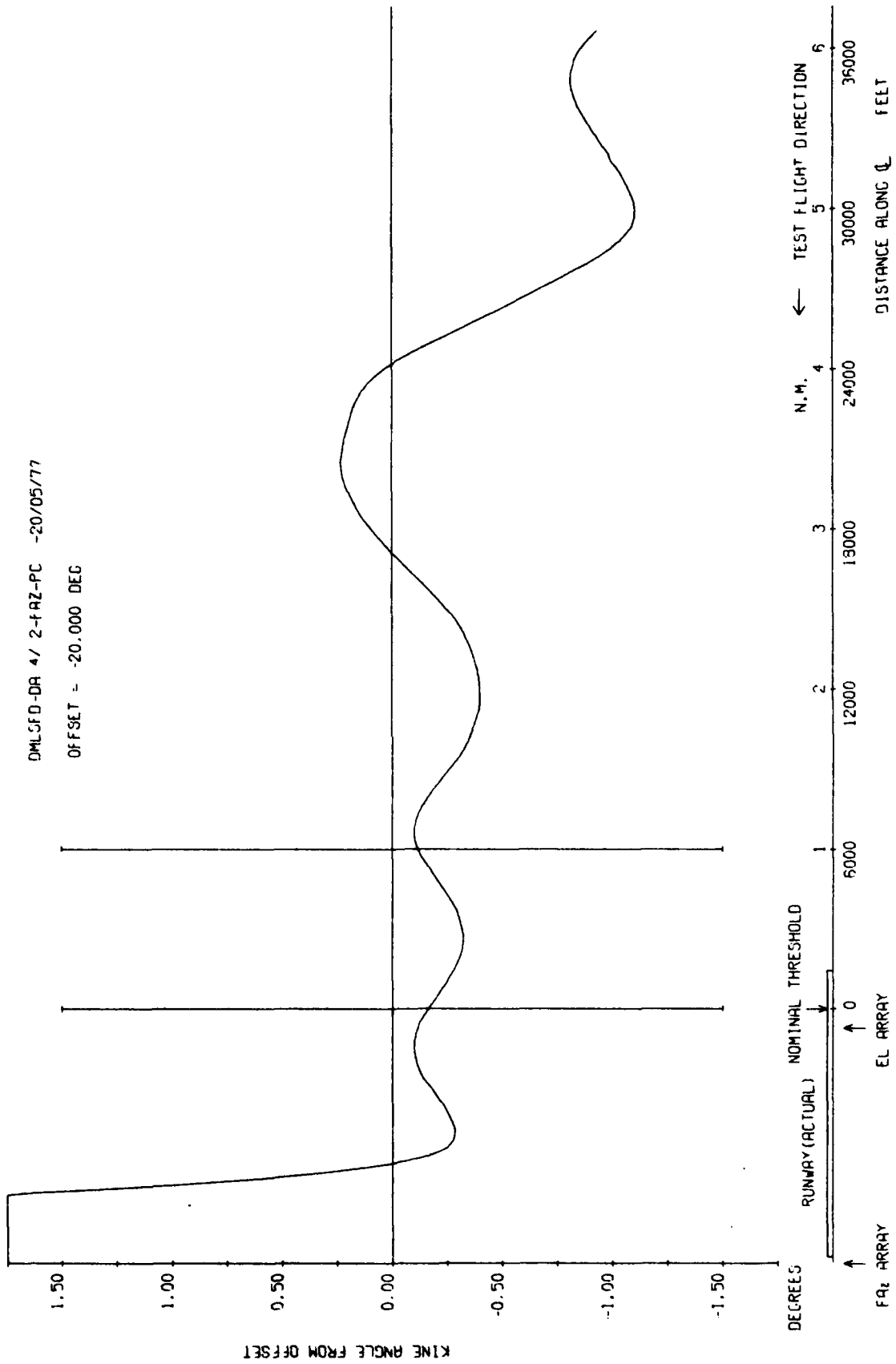


Fig 7.86a Azimuth 27λ , constant height radial at 2000 ft and -20 degrees

Fig 7.86b

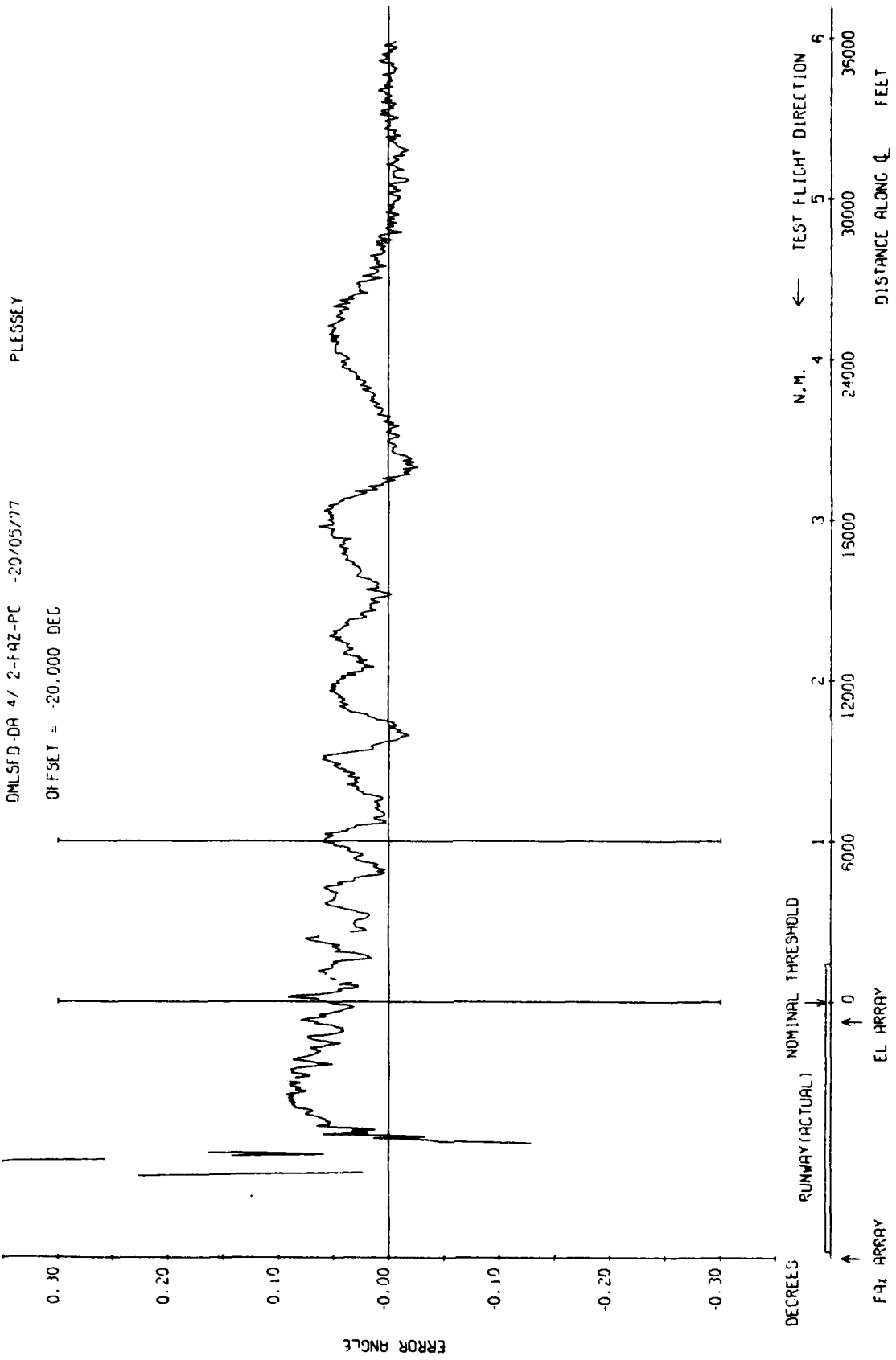


Fig 7.86b Azimuth 27λ, constant height radial at 2000 ft and -20 degrees

TR 79062

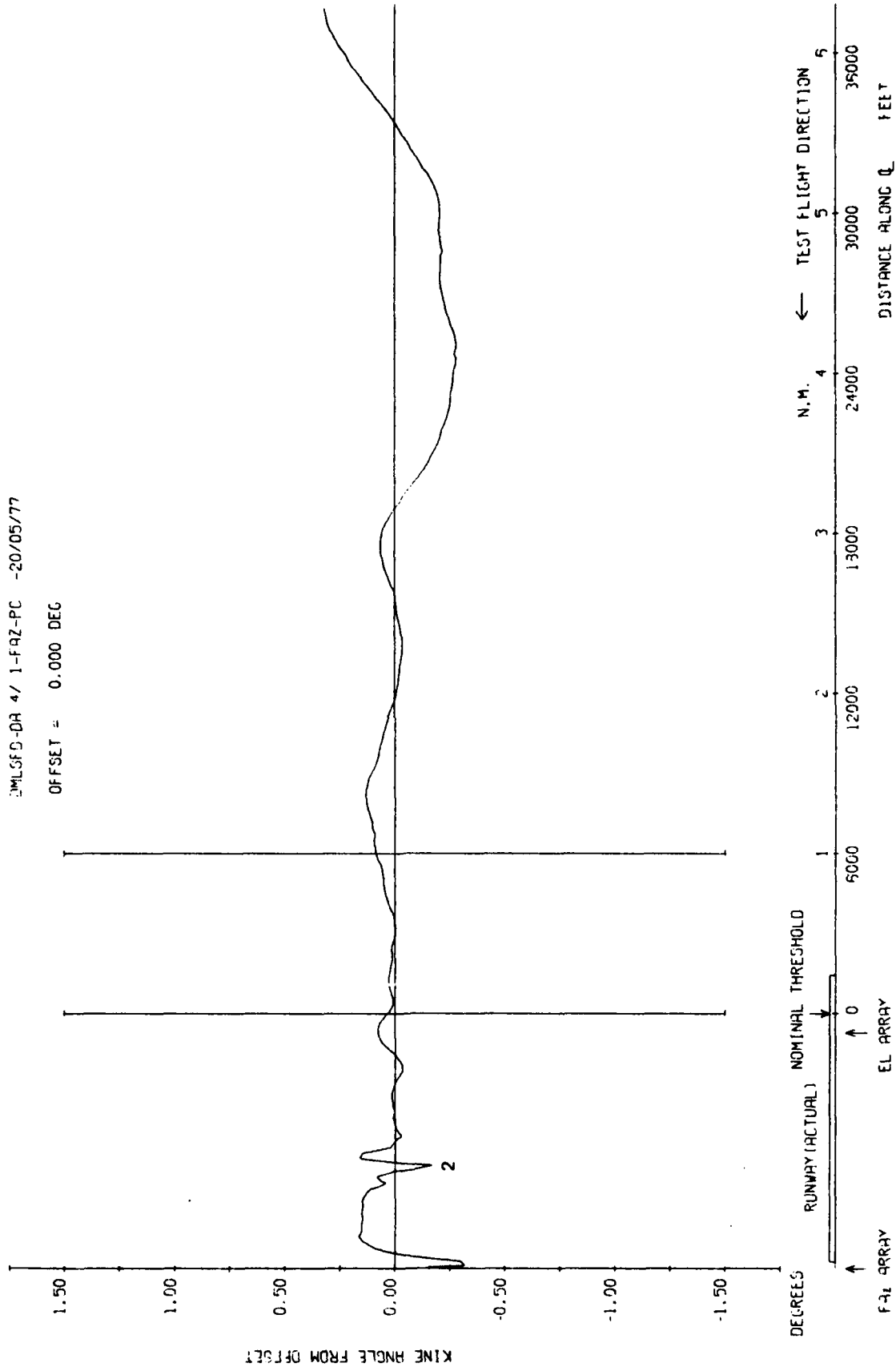


Fig 7.87a

Fig 7.87a Azimuth 27λ, 3 degree approach to low overshoot

Fig 7.87b

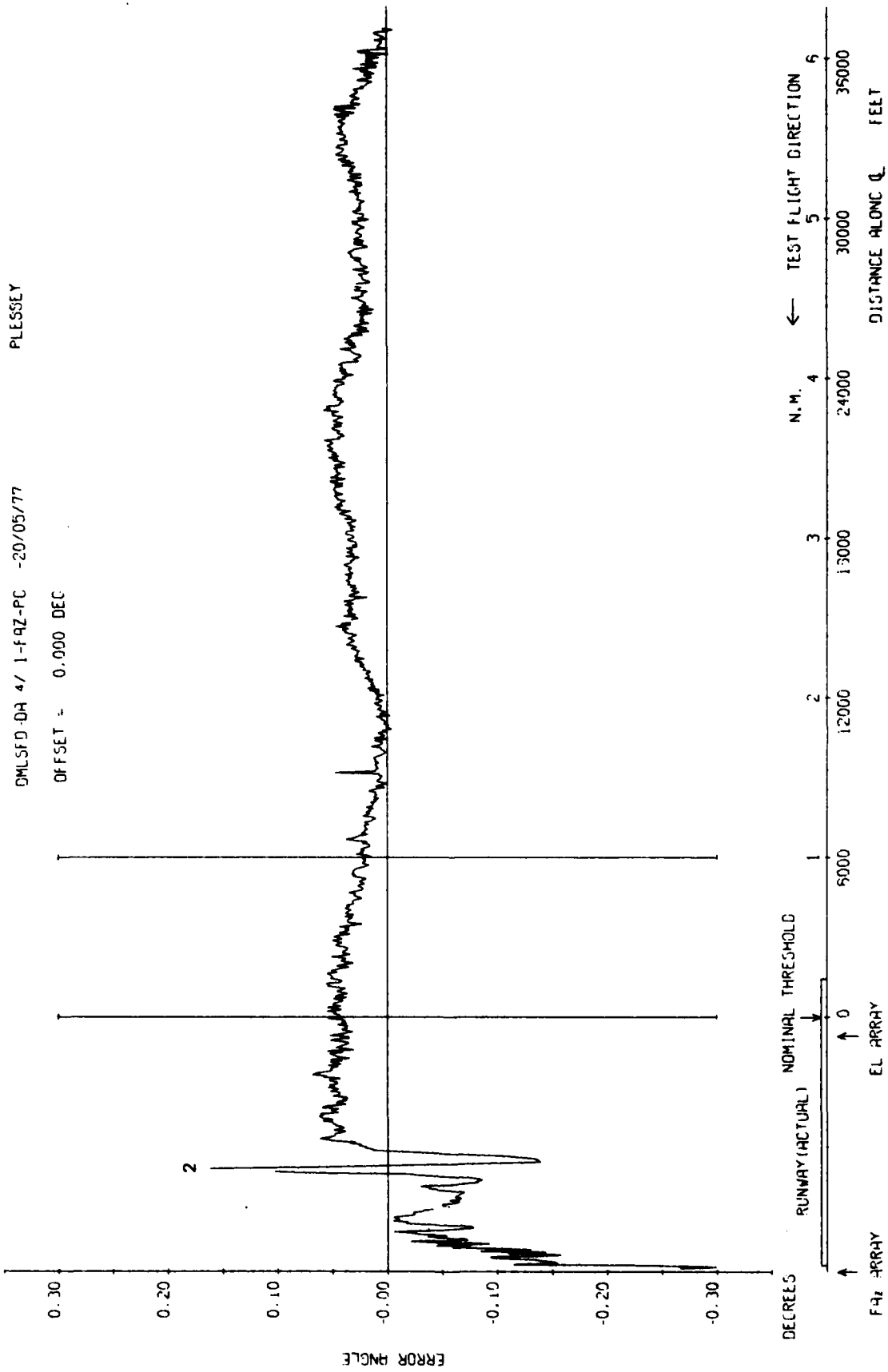


Fig 7.87b Azimuth 27λ, 3 degree approach to low overshoot

TR 79062

DMLSFD-DR 4/ 7-FZ-PC -20/05/77

OFFSET = 0.000 DEG

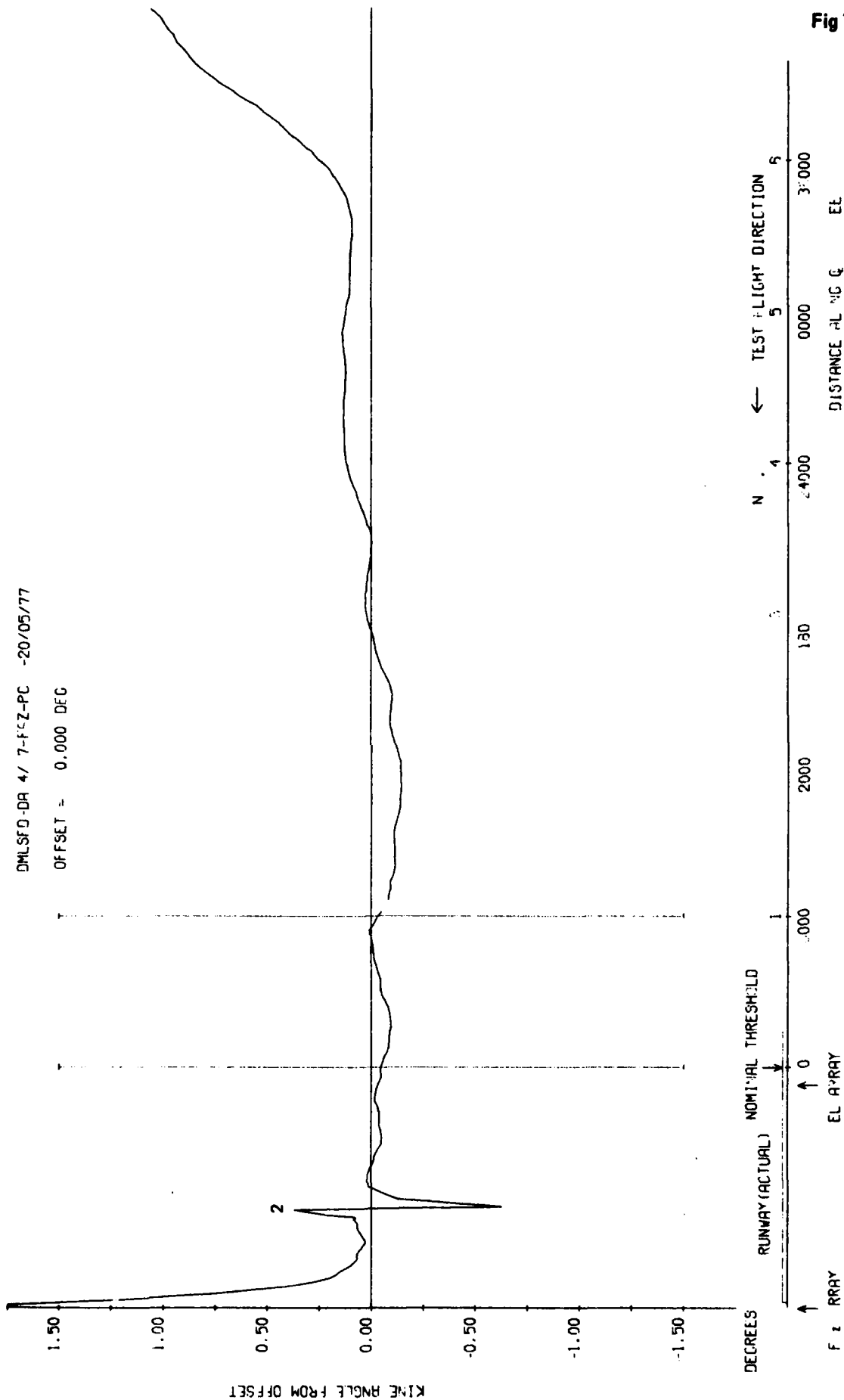


Fig 7.88a

Fig 7.88a Azimuth 27λ, 2 degree approach to low overshoot

Fig 7.88b

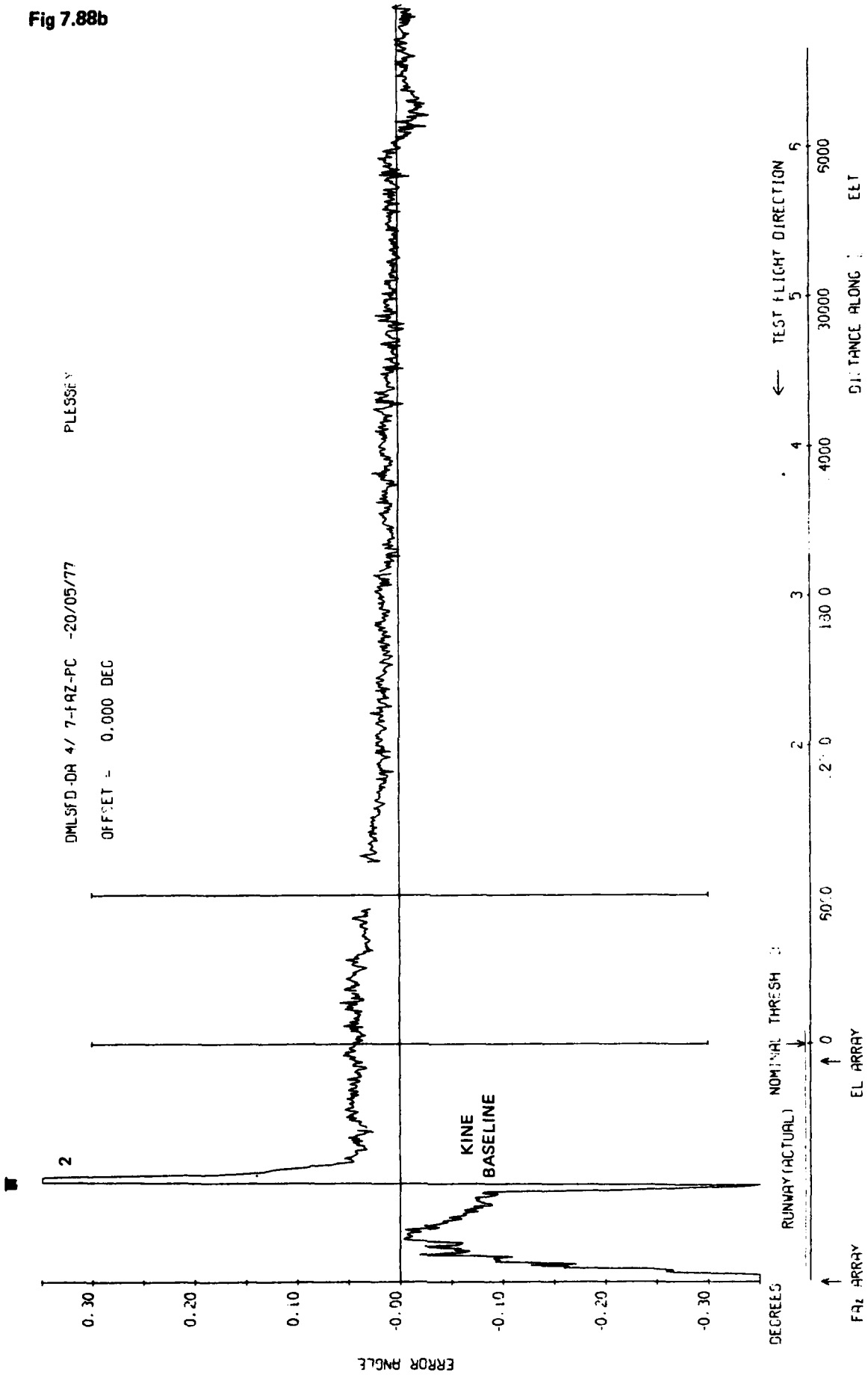


Fig 7.88b Azimuth 27λ, 2 degree approach to low overshoot

TR 79052

DMLSFD-DA 4/ 6-FRZ-PC -20/05/77

OFFSET = 0.000 DEG

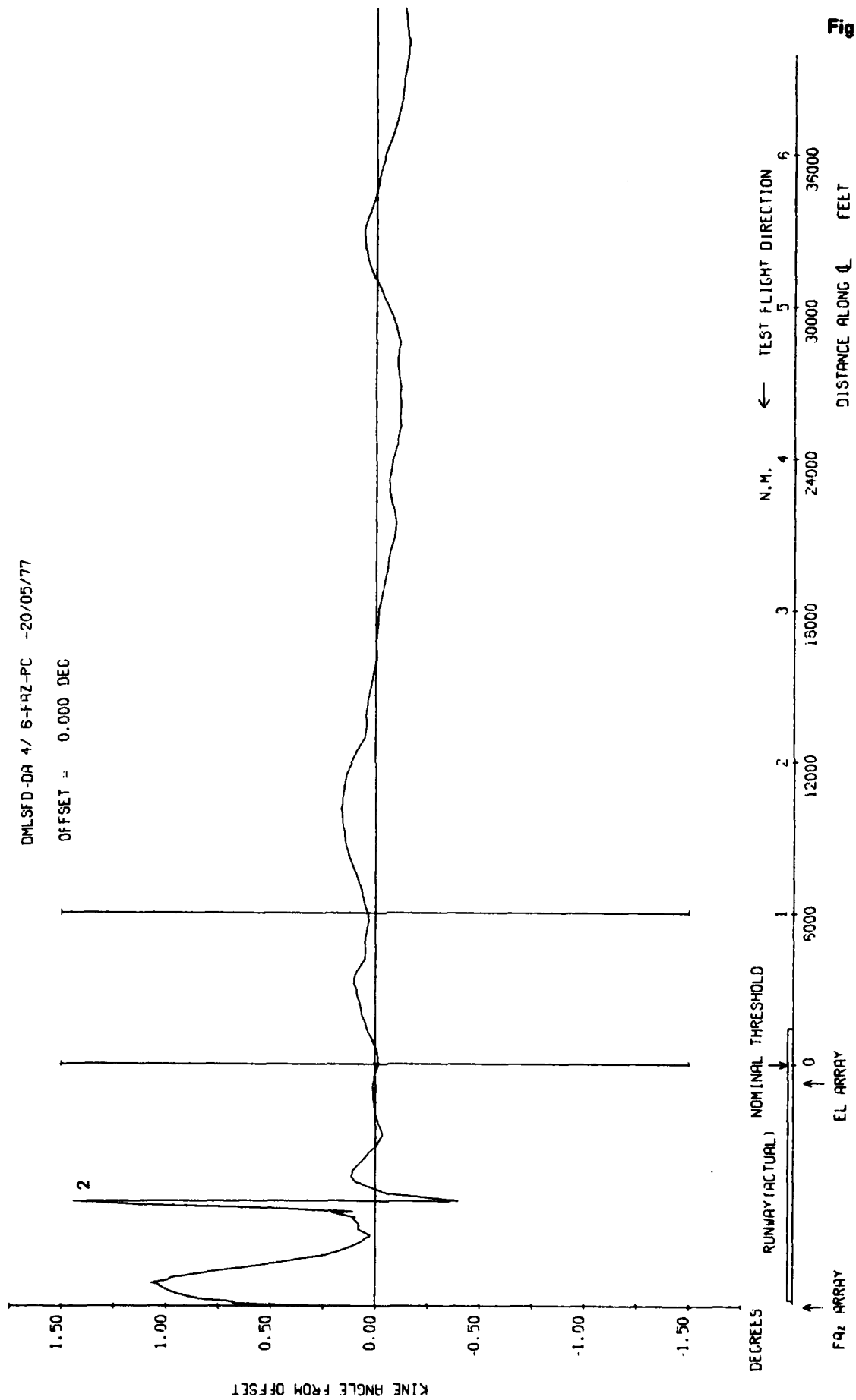


Fig 7.89a

Fig 7.89a Azimuth 1.5 degree approach to low overshoot

Fig 7.89b

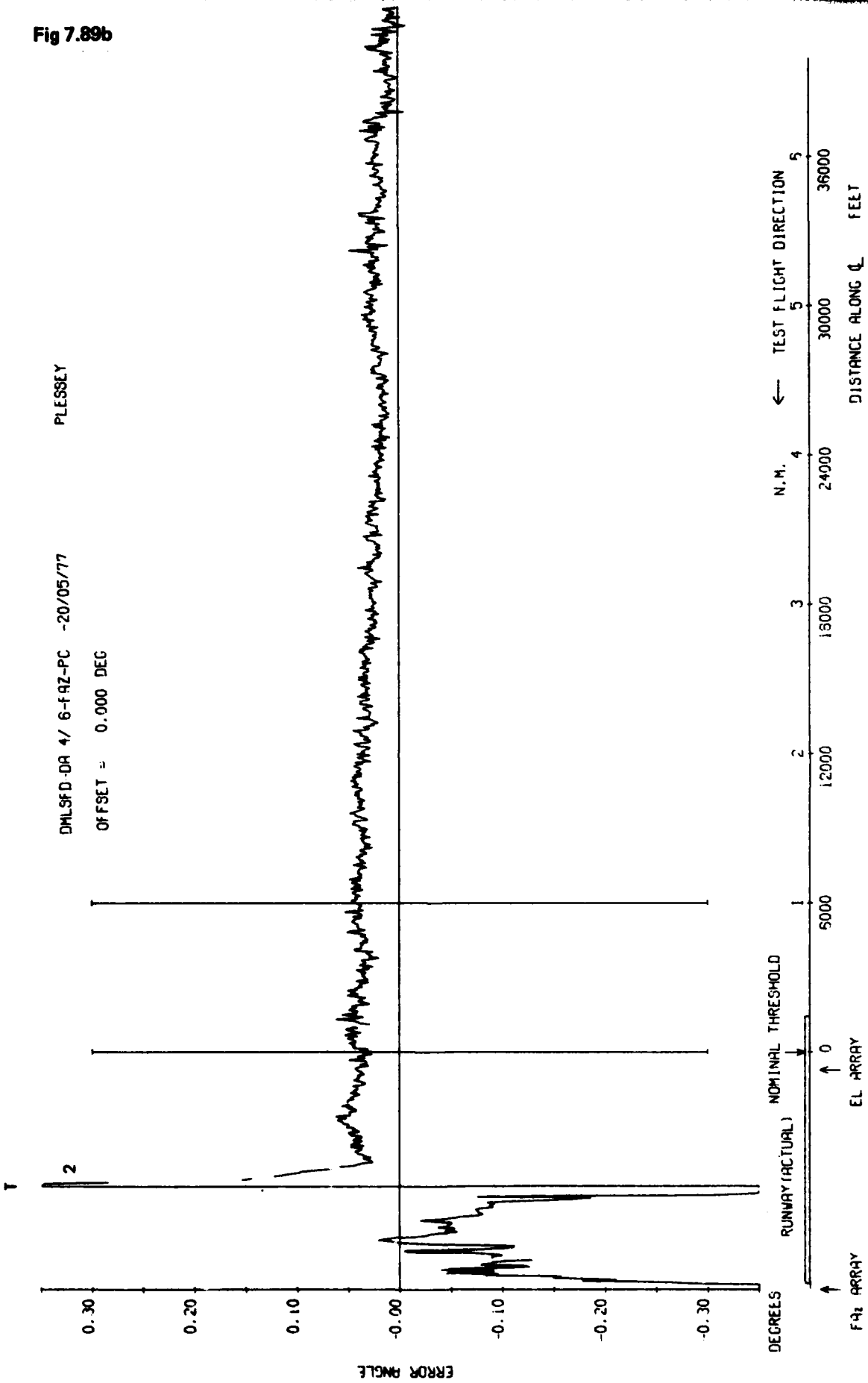


Fig 7.89b Azimuth 1.5 degree approach to low overshoot

TR 79062

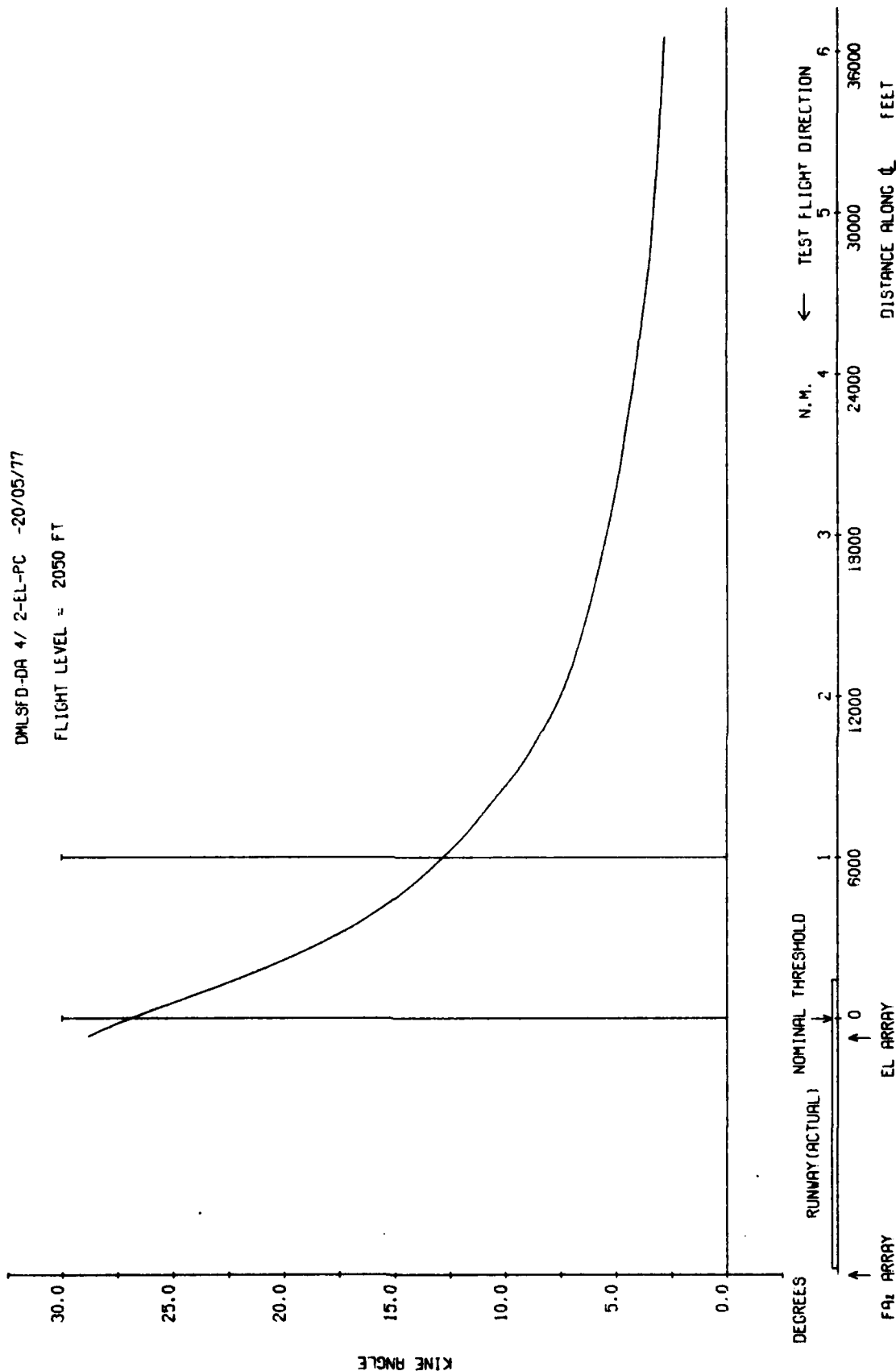


Fig 7.90a Elevation 27λ, constant height radial at 2000 ft and -20 degrees azimuth

Fig 7.90b

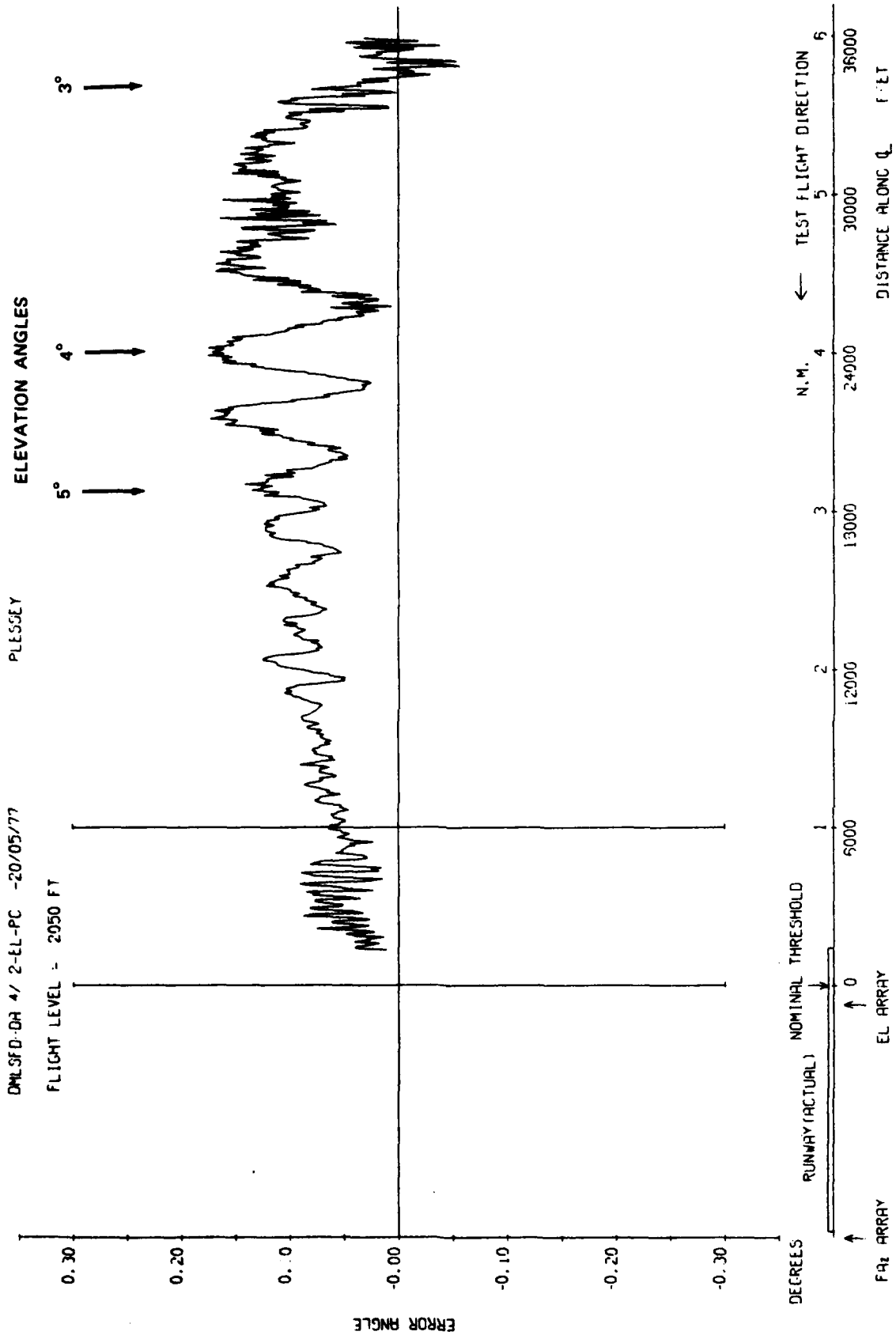


Fig 7.90b Elevation 27λ, constant height radial at 2000 ft and -20 degrees azimuth

TR 79062

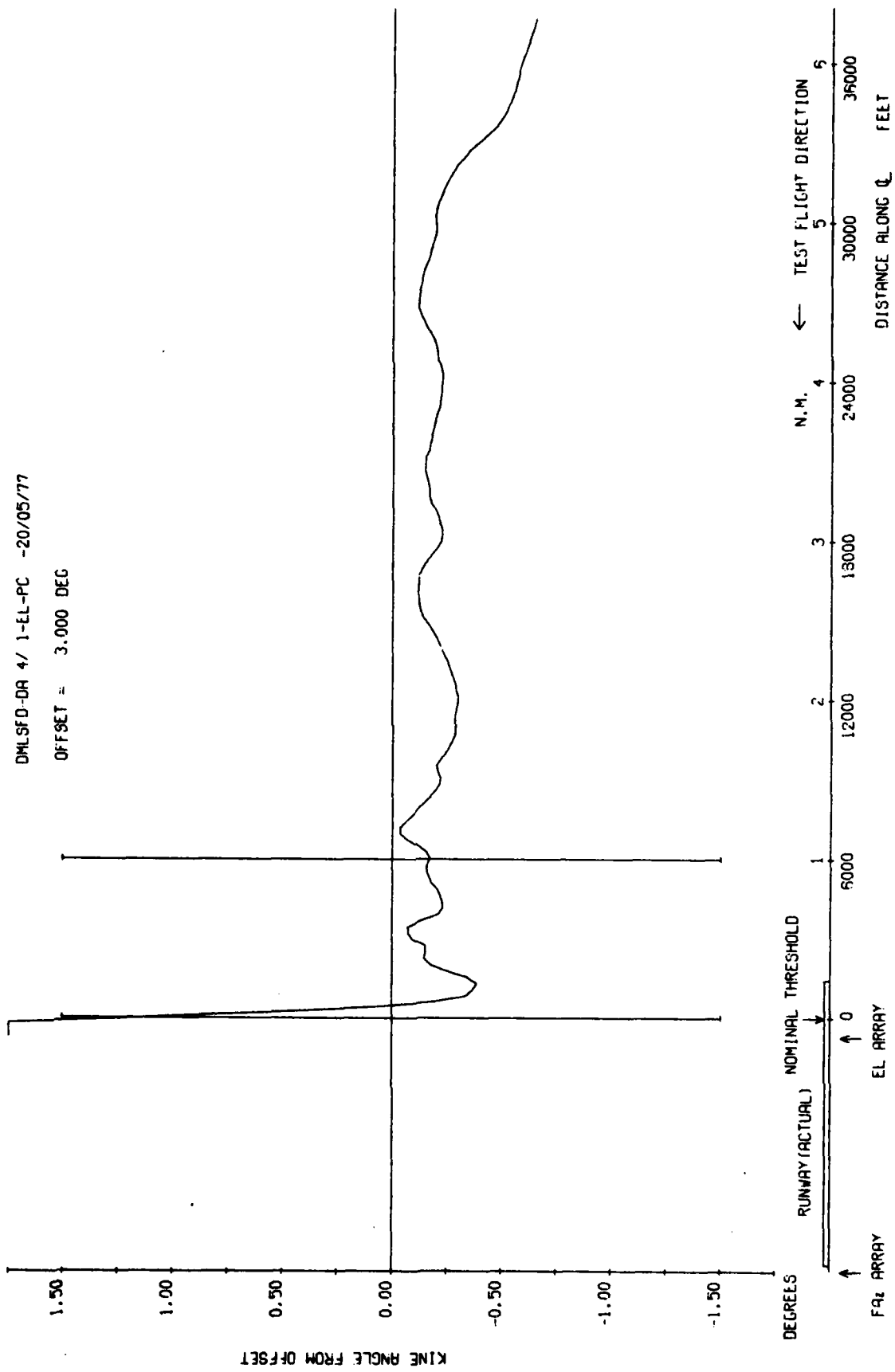


Fig 7.91a

Fig 7.91a Elevation 27λ, 3 degree approach

Fig 7.91b

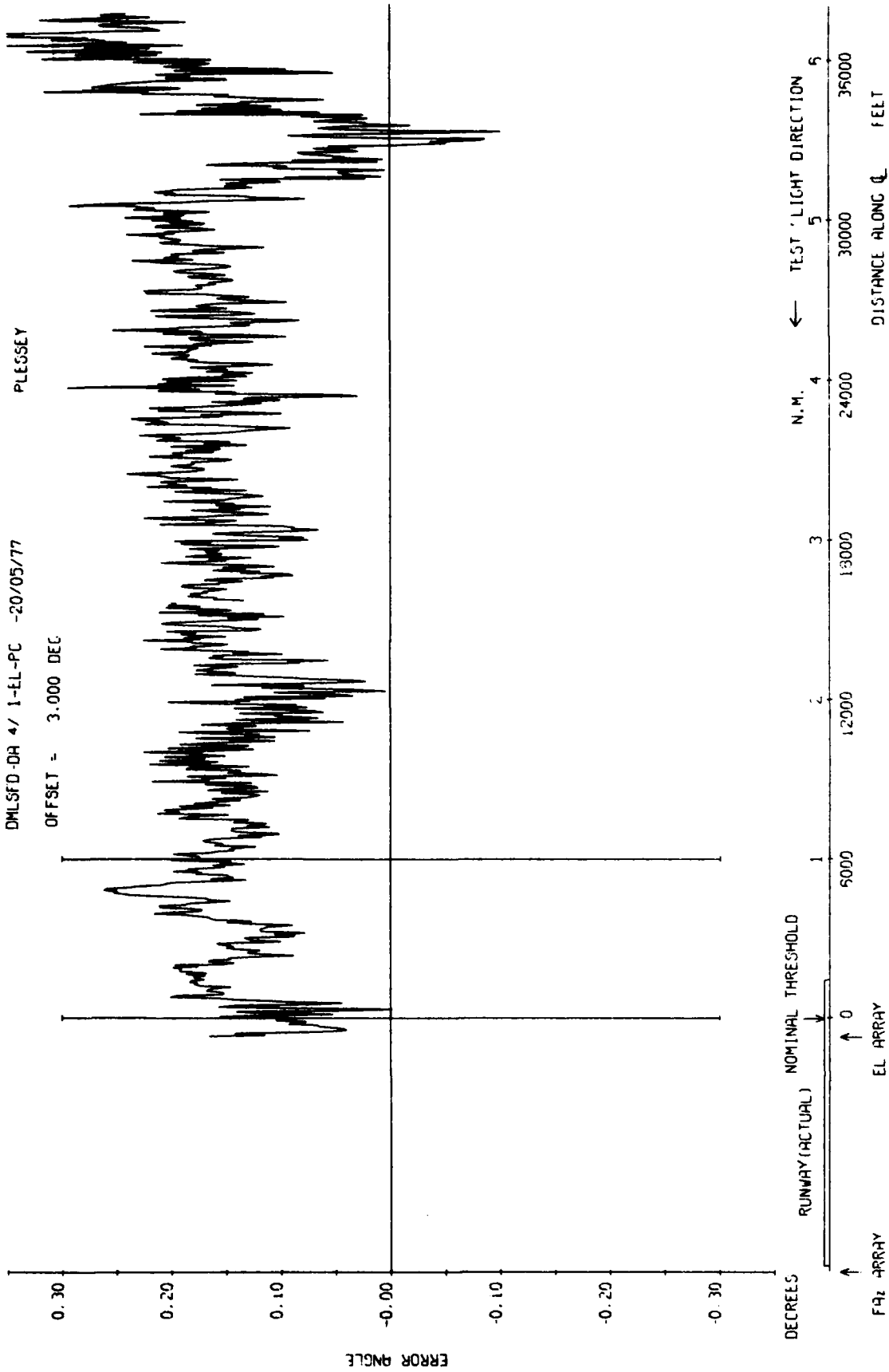


Fig 7.91b Elevation 27λ, 3 degree approach

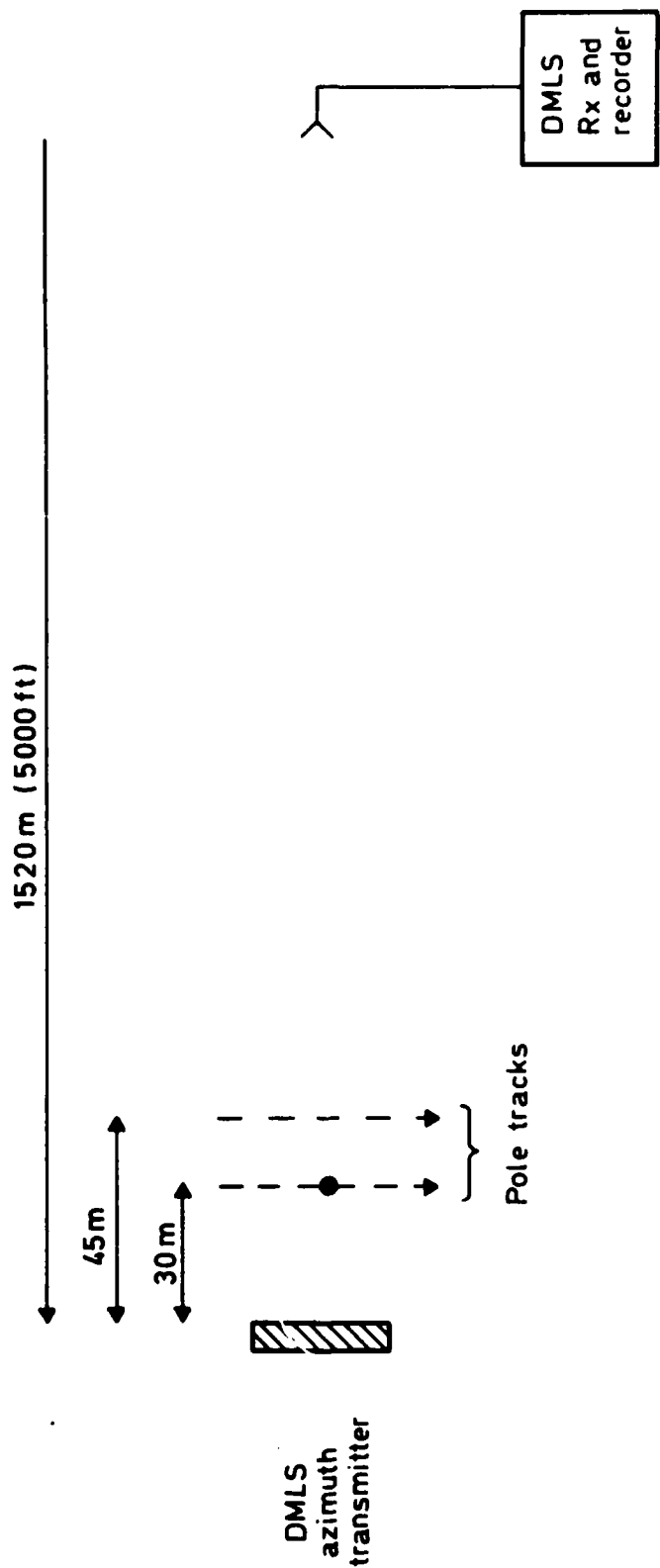


Fig 7.92 Effects of poles - test geometry

Fig 7.93a

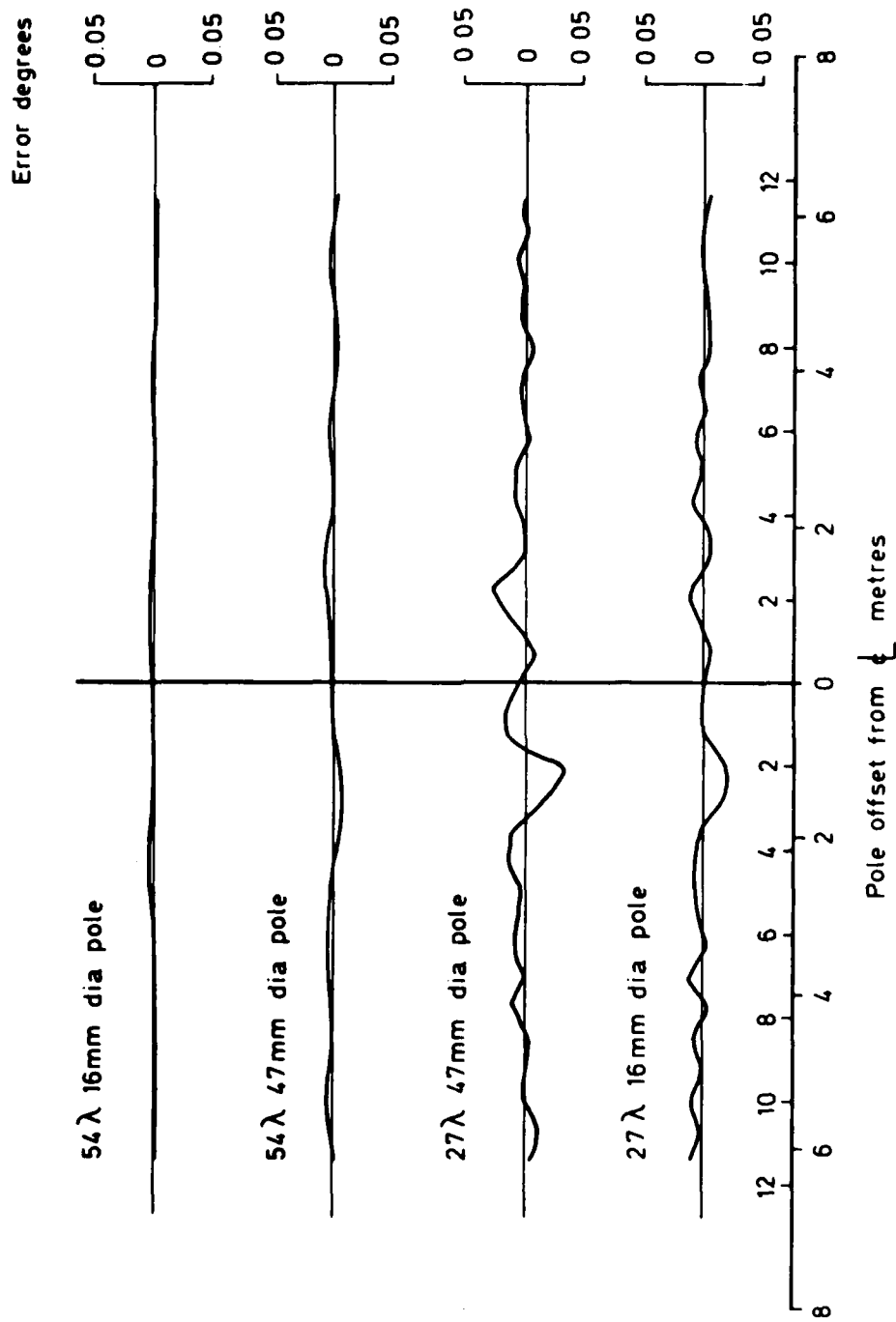


Fig 7.93a Effect of metal poles - range 30 m (100 ft)

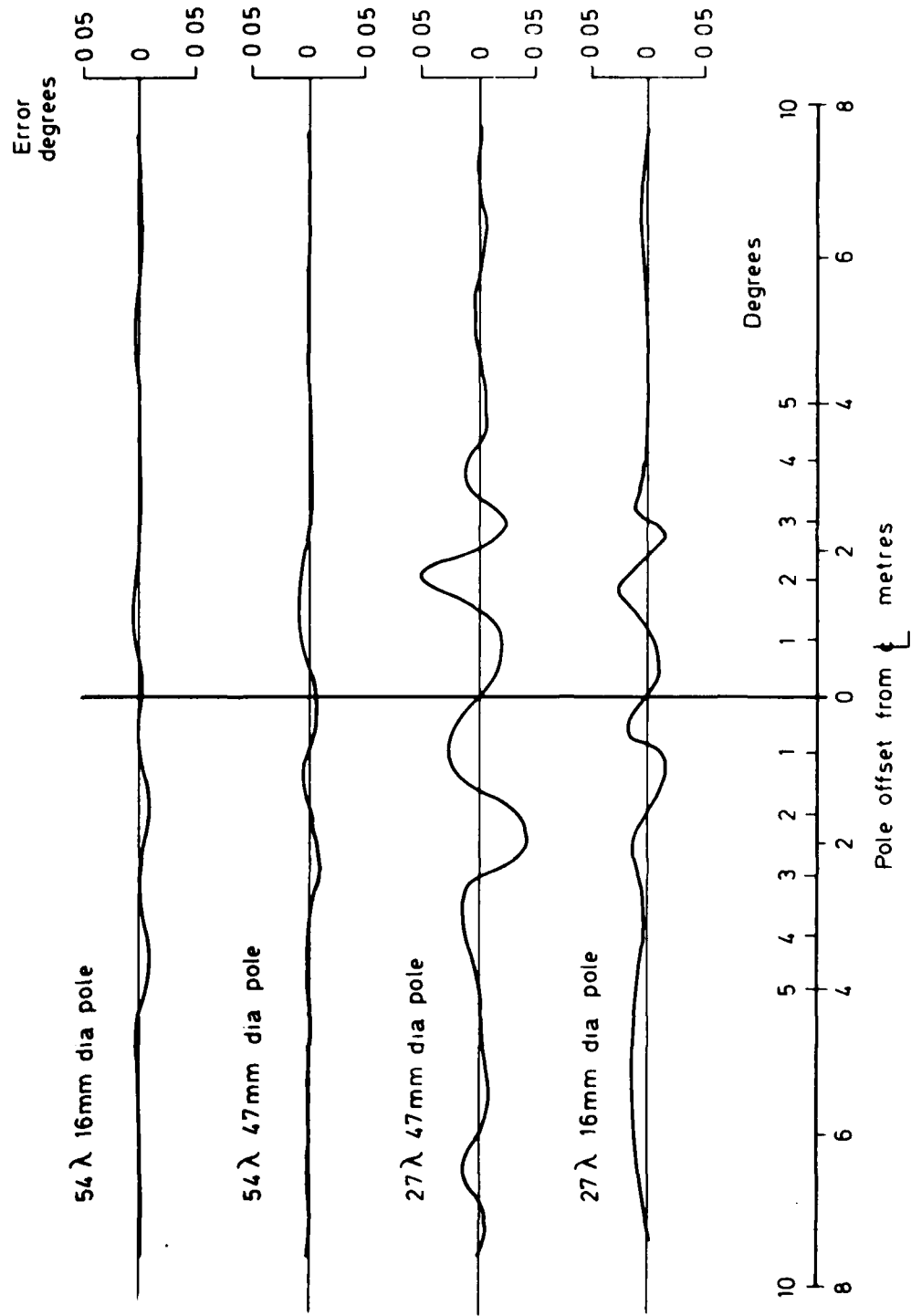
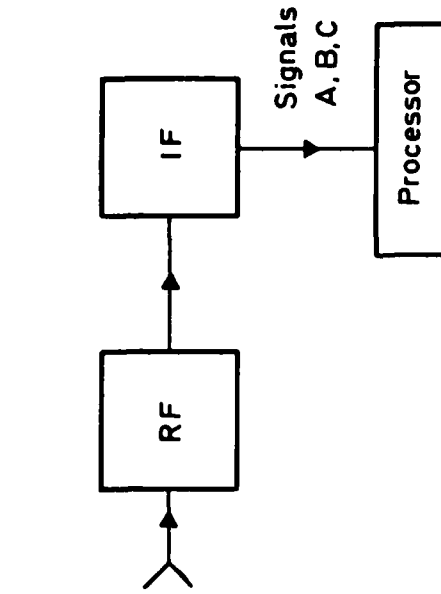


Fig 7.93b Effect of metal poles — range 45 m (150 ft)

Fig 9.1



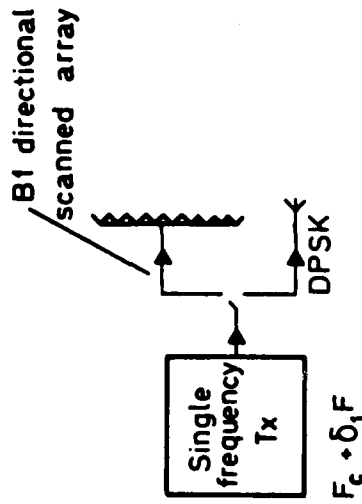
F_D = doppler code

F_C = basic transmitter frequency

$\delta_1 F$ = Tx drift

$\delta_2 F$ = Rx motion doppler shift

$\delta_3 F$ = Rx LO drift



A = DPSK $F_c + \delta_1 F - F_{L0} + \delta_2 F + \delta_3 F$

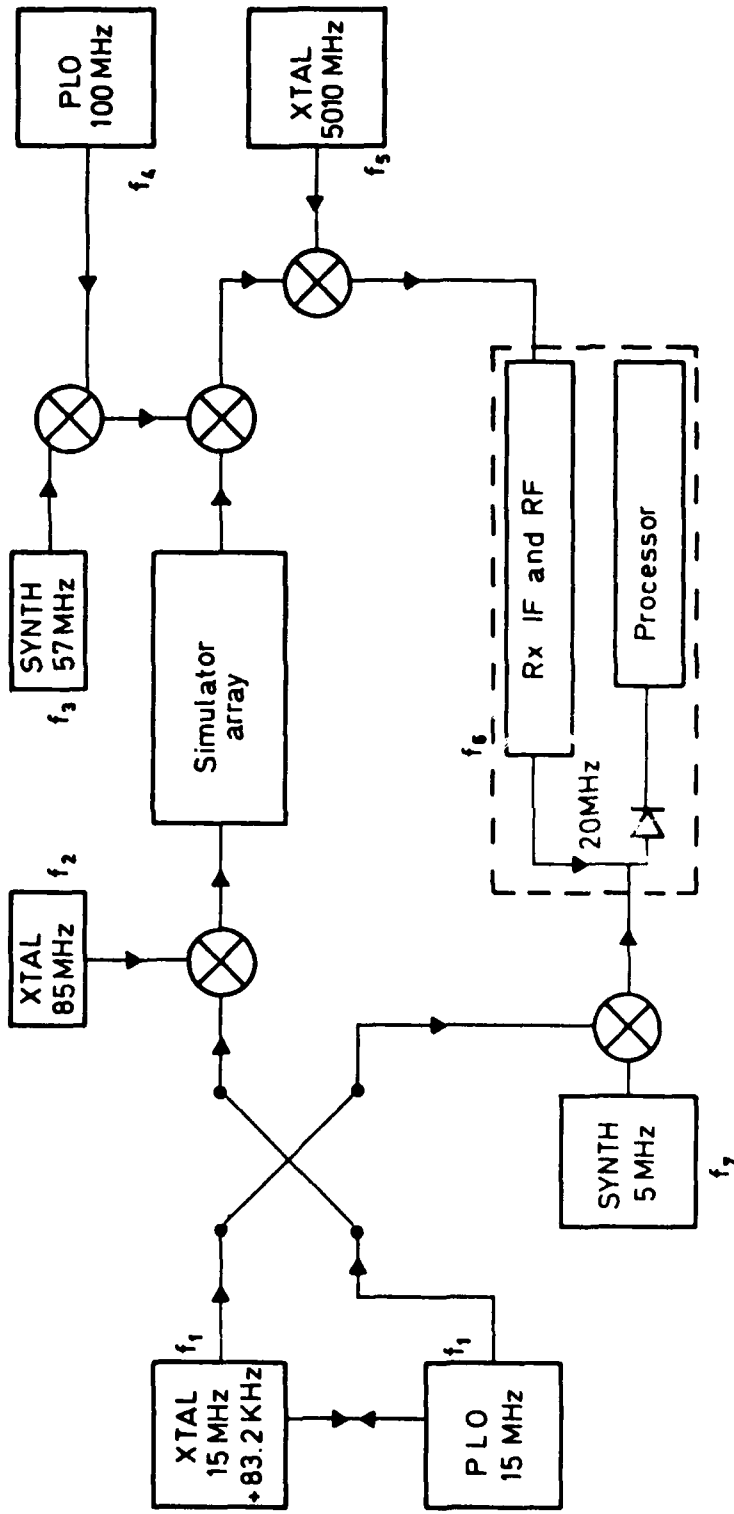
B = odd scans $F_c + \delta_1 F - F_{L0} + \delta_2 F + \delta_3 F + F_D$

C = even scans $F_c + \delta_1 F - F_{L0} + \delta_2 F + \delta_3 F - F_D$

Angle output B - C = $2F_D$

$\delta_1 F + \delta_2 F + \delta_3 F = \pm 25\text{KHz max}$

Fig 9.1 Reference-less DMLS



XTAL = crystal oscillator source

SYNTH = frequency synthesiser

f_1 to f_7 = frequency errors

Fig 9.2

Fig 9.2 Simulation of reference-less system

Fig 9.3

Rx 002, azimuth, 54λ, reference injection at 20MHz IF

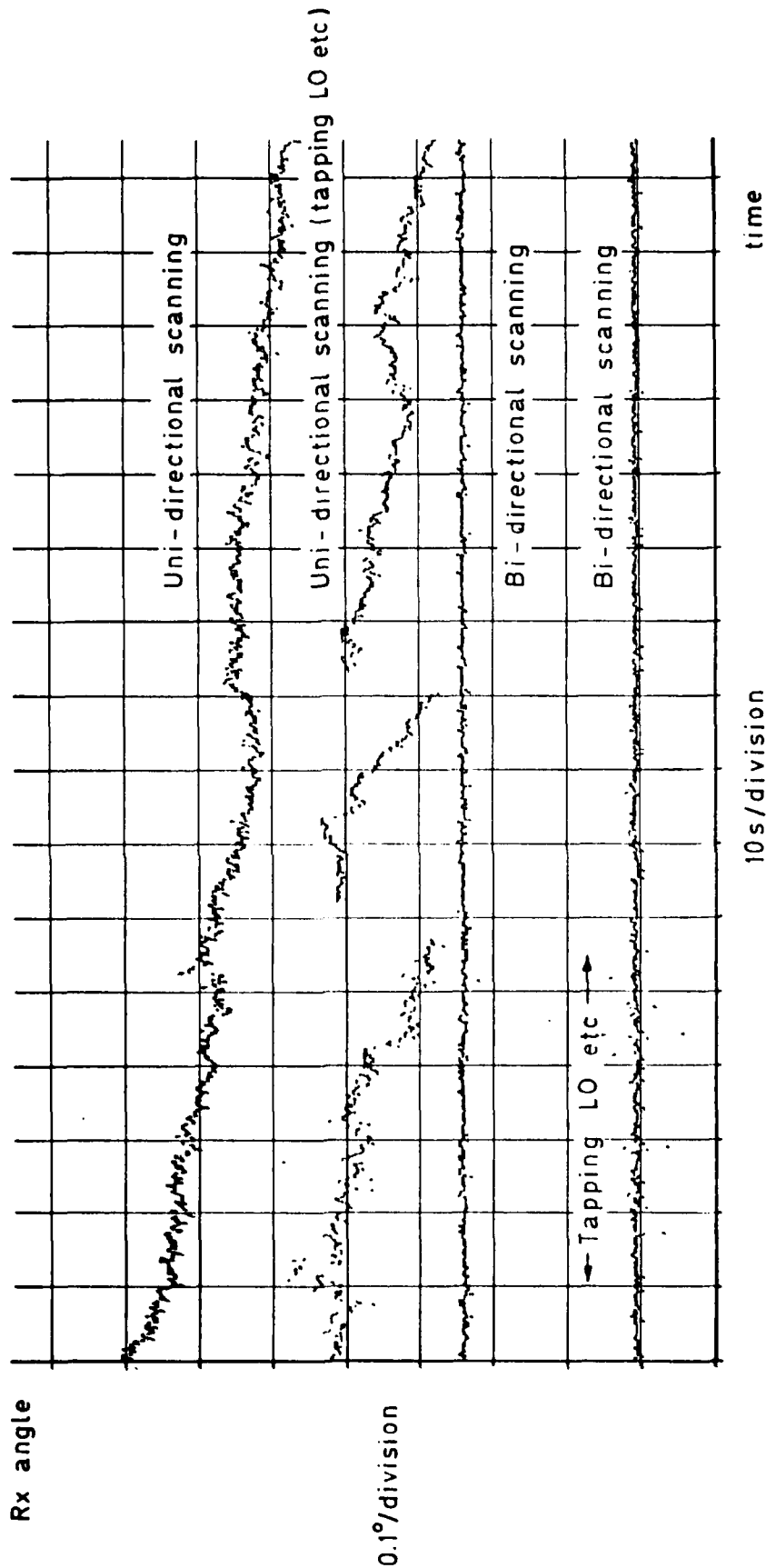


Fig 9.3 Basic angle noise with reference-less transmission

Rx 002, azimuth, 54λ, reference injection at 20MHz IF
Bi-directional scanning AGC = 16.5, direct = +1°
Multipath signal -3dB relative to direct, scalloping rate = 0.2Hz

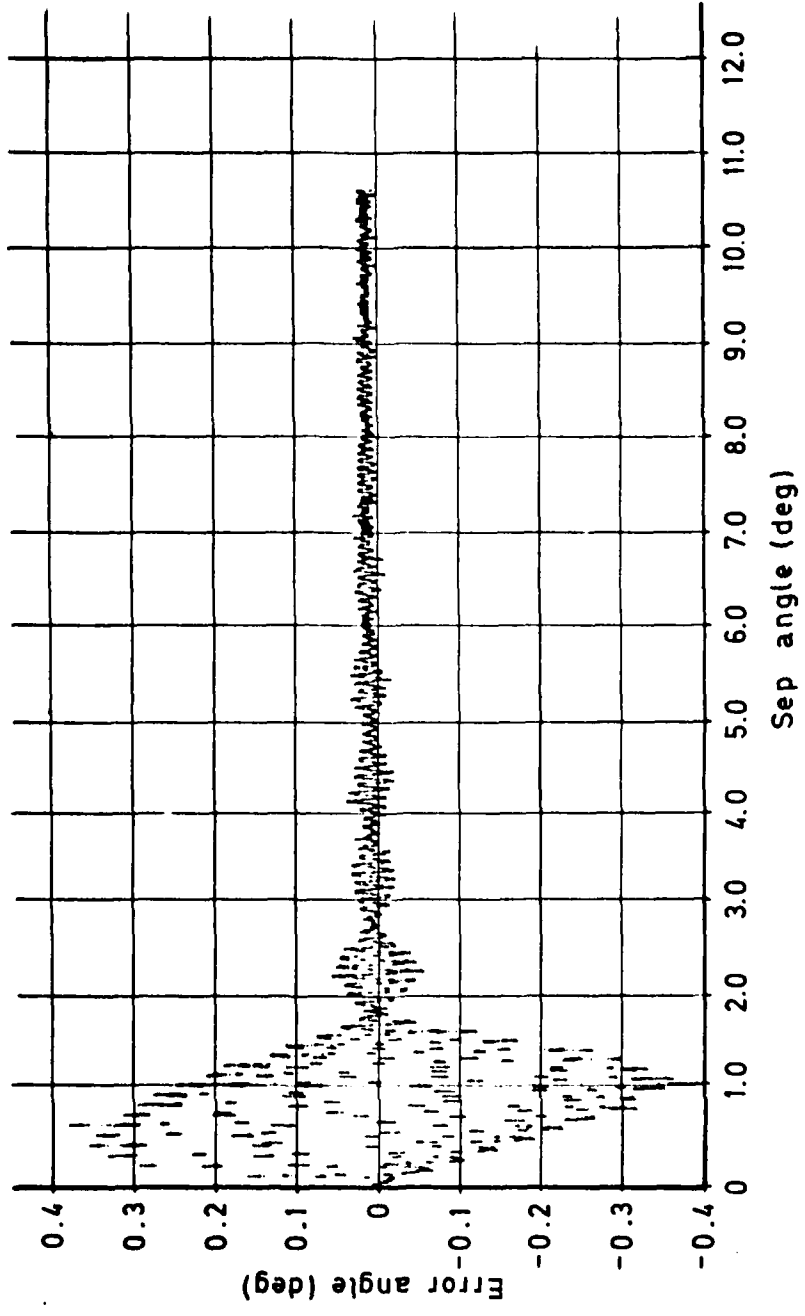


Fig 9.4 Receiver error v separation angle — reference-less transmission

Fig 9.5

Rx 002, azimuth, 54λ , reference injection at 20 MHz IF
Bi-directional scanning, AGC = 16.5, direct = $+1^\circ$
Multipath signal -1dB relative to direct, scalloping rate = 0.2Hz

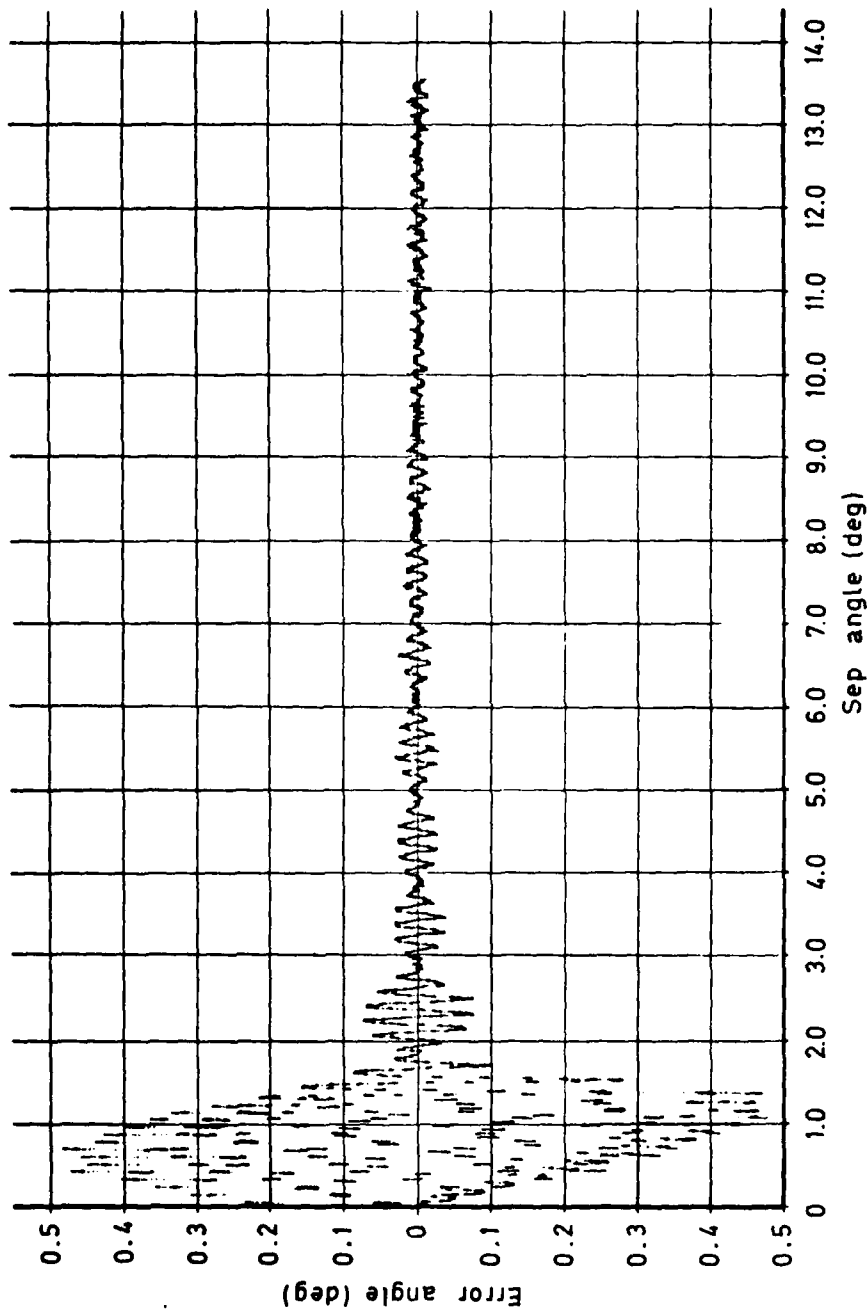


Fig 9.5 Receiver error v separation angle — reference-less transmission

Rx002, azimuth, 54λ, reference injection at 20MHz IF
Bi-directional scanning, multipath signal -1dB relative to direct
Direct = +1°, multipath = +5°

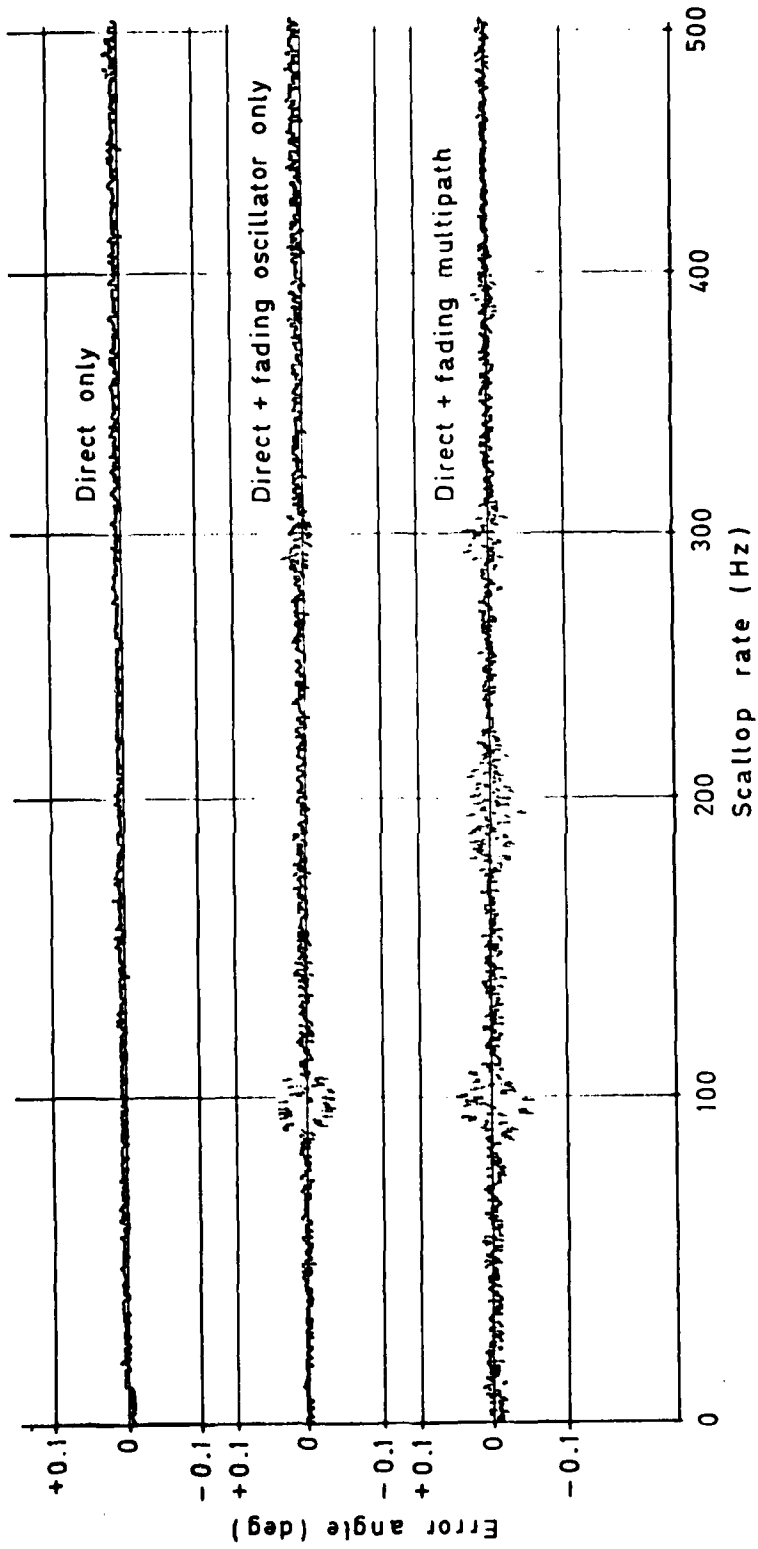


Fig 9.6 Receiver error v scalloping rate - reference-less transmission

Fig 10.1

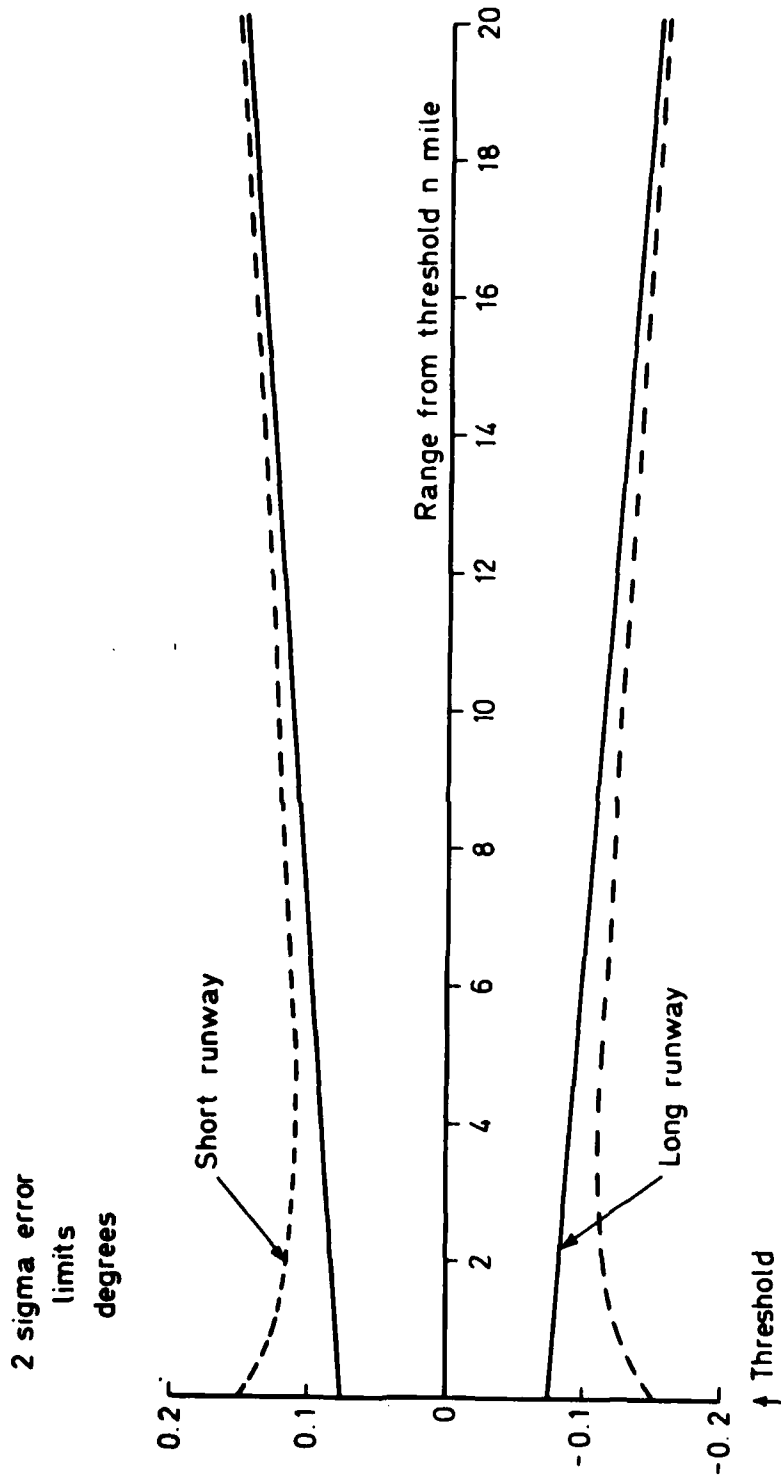


Fig 10.1 Angular error limits for long and short runways