
Retrospective Theses and Dissertations

1973

Parametric Studies Involving Community Noise Exposure Around Airports

Eldon T. Day
University of Central Florida

 Part of the [Engineering Commons](#)

Find similar works at: <https://stars.library.ucf.edu/rtd>

University of Central Florida Libraries <http://library.ucf.edu>

This Masters Thesis (Open Access) is brought to you for free and open access by STARS. It has been accepted for inclusion in Retrospective Theses and Dissertations by an authorized administrator of STARS. For more information, please contact STARS@ucf.edu.

STARS Citation

Day, Eldon T., "Parametric Studies Involving Community Noise Exposure Around Airports" (1973).
Retrospective Theses and Dissertations. 50.

<https://stars.library.ucf.edu/rtd/50>

PARAMETRIC STUDIES INVOLVING COMMUNITY
NOISE EXPOSURE AROUND AIRPORTS

BY

ELDON T. DAY
B.S.E., Florida Technological University, 1972

RESEARCH REPORT

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Engineering
in the Graduate Studies Program of
Florida Technological University

Orlando, Florida
1973

ABSTRACT

This report uses a computer program to study the effects of the following parameters on noise exposure forecast contours:

1. Aircraft mix
2. Aircraft track
3. Number of operations
4. Time of day
5. Aircraft thrust

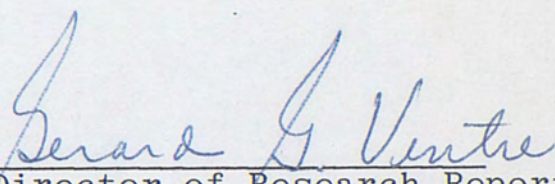
Approved: 
Director of Research Report

TABLE OF CONTENTS

Chapter		
I.	INTRODUCTION	1
II.	NEF CONTOURS	2
III.	COMPUTER PROGRAM	5
IV.	PARAMETRIC ANALYSIS	7
V.	CONCLUSION	13
VI.	APPENDIX A: HYPOTHETICAL AIRPORT COMMUNITY . .	15
VII.	APPENDIX B: NEF CONTOUR PLOTS	17

LIST OF TABLES

Table		Page
1	Lengths and Areas of NEF 30 and NEF 40 Contours	11
2	Comparison of NEF Contour Data with Baseline Run	12

NOMENCLATURE

<u>Quantity</u>	<u>Units</u>	<u>Description</u>
Sound Pressure Level	Decibels (dB)	Measures atmospheric pressure change
Sound Level (A-Weighted)	dB(A)	Measures loudness as perceived by the human ear
Perceived Noise Level (PNL)	PNdB	Computed measure of annoyance
Effective Perceived Noise Level (EPNL)	EPNdB	Modifies PNL to account for pure tones and duration of exposure
Noise Exposure Forecast (NEF)	NEF No.	Cumulative measure of exposure to discrete noise events during a 24 hour period

CHAPTER I

INTRODUCTION

In recent years, noise around airports and its effect on the surrounding community has become a major concern of city planners and zoning boards. Through the use of a computer program designed to calculate noise exposure forecast contours, this report will look at the effect of various parameters on the size and shape of these (NEF) contours.

Five parameters have been studied. This report looks into the effects of:

1. Aircraft Mix: How much does the new quieter aircraft reduce the size of NEF contours?
2. Number of Operations: If the number of operations increase, how do the contours grow?
3. Thrust: Do thrust cutbacks appreciably reduce the contours?
4. Track: Can aircraft be routed to avoid heavily populated areas?
5. Time of Day: How do nighttime flights affect the contours?

CHAPTER II

NEF CONTOURS

The noise exposure forecast contour is a tool to predict the present and future impact of aircraft noise on the surrounding community. NEF* contours consider⁽¹⁾:

1. Aircraft EPNdB
2. Time of day and number of operations
3. Aircraft track and profile

EPNdB curves for each aircraft are derived from taking noise level readings at various positions about the aircraft (as specified by the FAA). The Perceived Noise Level* (in units of PNdB)* is a measure of noisiness and is dependent upon amplitude and frequency. EPNdB* modifies PNdB to include the effects of:

1. Pure tone, and
2. Duration of noise exposure

The following statements can be made concerning NEF contours⁽²⁾:

1. In general, NEF values decrease as distance from the airport increases.

*See Nomenclature, page iii

2. There are three regions of interest:
 - a. A NEF value less than 30 should produce little annoyance due to aircraft noise.
 - b. A NEF value greater than 40 could produce considerable annoyance.
 - c. A NEF value between 30 and 40 is an intermediate range. It could annoy some people but not others, according to individual differences.
3. If the number of operations are doubled, holding all other variables constant, the NEF value at any given point will increase by 3.
4. A specific change in EPNdB for each aircraft, holding all other variables constant, will change the NEF value at any given position by the corresponding amount.

The effect of aircraft noise on a community is hard to determine. In general, as the noise exposure increases, the following reactions take place⁽³⁾:

Exposure → Annoyance → Complaint → Protest

There are psychological/sociological factors that prevent this mechanism from showing a true picture of the effect of noise on a community. The two most common levels of response are annoyance and complaint.

Factors affecting annoyance by aircraft noise intrusion are (4):

1. Fear of aircraft crashing.
2. General attitude about noise.
3. General attitude about residential environment.
4. Beliefs about the preventability of aircraft noise.
5. Belief in the importance and value of airports and air traffic.
6. Belief in the possible effects of noise on health.

The following factors help to determine whether there will be complaints due to aircraft noise (5):

1. Knowledge of where to complain and to whom.
2. Belief in the effectiveness of complaint.
3. Level of annoyance.
4. Effectiveness of local organization.
5. Influence of other major problems, personal or local.

As complicated as the mechanism of community reaction to noise is, airports and air traffic has in the last 15 years become the major cause of noise complaints.

CHAPTER III

COMPUTER PROGRAM

The computer program was developed by the Department of Transportation to compute NEF contours for airports. It was designed to be used on the CDC 6400 computer system. This program was modified to run on the IBM 360 computer facilities at FTU. Besides NEF contours, the program can also calculate EPNdB levels for a given set of grid coordinates, and provide a listing of all flights, the noise level generated by each flight, and the cumulative noise exposure at specified points on the ground⁽⁶⁾.

The program can accommodate a maximum of 50 runways with a maximum of 75 flights on all runways (e.g., 75 flights on 1 runway; 25 flights on 3 runways; 15 flights on 5 runways). The program can be changed to accommodate more flights and runways⁽⁶⁾. A flight is defined as any aircraft type flying a given flight path. The program has at present 6 types of aircraft:

1. B-747
2. DC-10/L1011
3. B-707, DC-8, B-720
4. B-727

5. B-737

6. DC-9

More aircraft types can be added or deleted.

A trial run was made and compared to a hypothetical problem in reference (2) to verify the program modifications.

CHAPTER IV

PARAMETRIC ANALYSIS

Baseline data is as follows:

Airport configuration:

- Length: 12,000 ft.
- Distance to touchdown point: 1,000 ft
- Start of take-off roll: 100 ft

The flight tracks are straight except in run 10. The approach profile is the same for all aircraft. It consist of a 3° glide slope with an 11,000 ft. ground roll after touchdown. There are two take-off profiles.

Profile A is as follows:

- Ground Roll: 3,400 ft.
- Initial Climb:
 - Length: 1,600 ft.
 - Angle: 2.87°
- Final Climb:
 - Length: 200,000 ft.
 - Angle 9.27°

Profile B is as follows:

Ground Roll:	4,000 ft.
Initial Climb:	
Length:	3,000 ft.
Angle:	3.05°
Final Climb:	
Length:	200,000 ft
Angle:	8.75°

There are six flights as follows:

<u>FLIGHT</u>	<u>AIRCRAFT TYPE</u>	<u>PROFILE</u>	<u>THRUST</u>	<u>DAY OPERATIONS</u>	<u>NIGHT OPERATIONS</u>
<u>TAKEOFFS</u>					
1	DC-8	B	100%	6	3
2	DC-9	A	100%	19	3
3	B-727	A	100%	25	4
<u>APPROACHES</u>					
4	DC-8		42.7%	7	2
5	DC-9		44.5%	21	1
6	B-727		51.3%	24	5

The DC-8 is a large turbofan transport; the DC-9 is two-engine turbofan transport aircraft; and the B-727 is a three engine turbofan transportation aircraft.

The five parameters under study are:

1. Mix
2. Number of operations
3. Thrust
4. Track
5. Time of day

Eleven runs were made. Runs 1 through 5 involve mix of aircraft types; runs 6 and 7 maintain baseline mix, but change the number of operations; run 8 maintains mix and number of operations, but changes approach thrust levels; run 9 and 10 change flight tracks; run 11 changes all operations to daytime operations.

A run by run description is as follows:

Run Base	24% DC-8, 38% DC-0, 38% B-727
1	40% DC-8
2	80% DC-8
3	20% DC-10 and L-1011
4	40% DC-10 and L-1011
5	80% DC-10 and L-1011
6	Double number of operations
7	Quadruple number of operations
8	100% thrust on approach
9	Take-off to North, approach from North
10	Turn West on take-off, approach from Southeast
11	No night operations

On runs 3 to 5, the additional flights are as follows:

Flight	Aircraft Type	Profile	Thrust
7	DC-10/L-1011 Take-off	B	100%
8	DC-10/L-1011 Approach		40%

On run 10 the flight profiles remain unchanged, but on take-off after initial climb the plane enters a 60° turn West. The turn has a radius of 2,000 ft. On approach, 15,000 ft. from touchdown, the plane makes a 60° turn from the Southeast to due North. The radius of the turn is 2,000 ft.

The results of the runs are plotted in the Appendix. They are also tabulated in Table 1 and Table 2. From Table 2, comparing runs 1 through 5, it is seen that the new quiet jets (DC-10 and L-1011) have a drastic effect on contour size. They reduced the 30 contour by as much as 34% in length and 57% in area. The size of the aircraft does not affect the contour size nearly as much as shown in runs 1 and 2. Runs 6 and 7 show that the number of operations must be increased significantly before it causes a large change in the contour sizes. Run 8 show that thrust level has a tremendous effect on contour size. Run 11 shows that nighttime operations has the largest single effect on noise annoyance around airports.

The plots of runs 9 and 10 show the possibility of changing flight tracks to avoid heavily populated areas.

TABLE 1

LENGTHS AND AREAS OF NEF 30 AND NEF 40 CONTOURS

RUN NO.	<u>30 CONTOUR</u>				<u>40 CONTOUR</u>			
	+Length	-Length	Total	Area	+Length	-Length	Total	Area
B	42,500	39,017	81,517	14.24	19,095	16,595	35,690	2.39
1	41,840	43,795	85,635	14.80	19,741	19,795	39,536	2.8
2	40,100	51,061	91,161	15.43	21,012	24,012	24,034	3.56
3	39,345	36,410	75,755	11.12	18,342	15,015	33,357	2.09
4	36,031	33,352	69,383	10.02	17,522	13,319	30,841	1.81
5	29,300	24,550	53,850	6.14	15,761	8,456	24,217	1.19
6	56,350	49,406	105,756	25.08	23,699	21,760	44,459	3.05
7	75,702	62,650	138,352	44.94	30,151	28,037	58,188	6.91
8	42,470	102,085	144,555	34.37	19,105	43,181	62,286	6.22
9	59,450	1,850	61,300	13.21	30,665	800	31,465	2.41
10	20,645	20,703	41,348	20.35	13,048	15,969	29,017	2.67
11	26,210	24,102	50,312	5.07	12,653	8,429	21,082	0.79

UNITS: Length in feet

Area in square miles

TABLE 2

COMPARISON OF NEF CONTOUR DATA WITH BASELINE RUN

<u>Run No.</u>	<u>30 CONTOUR</u>		<u>40 CONTOUR</u>	
	<u>% of Base</u> Length	Area	<u>% of Base</u> Length	Area
B	100	100	100	100
1	105	104	111	117
2	112	108	126	149
3	93	78	93.5	87.5
4	85	70.5	86.5	76
5	66	43	68	50
6	130	176	125	127.5
7	170	315	163	289
8	177.5	241	174.5	260
9	75	92.5	88	101
10	--	143	--	112
11	55	35.6	59	33

CHAPTER V

CONCLUSION

The movement to quieter aircraft, combined with thrust cut-backs on take-off and approach, plus limits on nighttime operations have the largest effects on the reduction of the noise problem caused by aircraft traffic around airports. Airport officials can alter flight tracks to avoid populated areas. But airport areas are noisy; therefore, the best utilization of noise level contours will be in planning the development of land around airports.

FOOTNOTES

¹Dickerson, David O., Transportation Noise Pollution: Control and Abatement, NASA Contract NGT 47-003-028, Hampton, Virginia: NASA Langley Research Center and Old Dominion University, 1970.

²Ibid, p. 65.

³Ibid, p. 28.

⁴Ibid, p. 29.

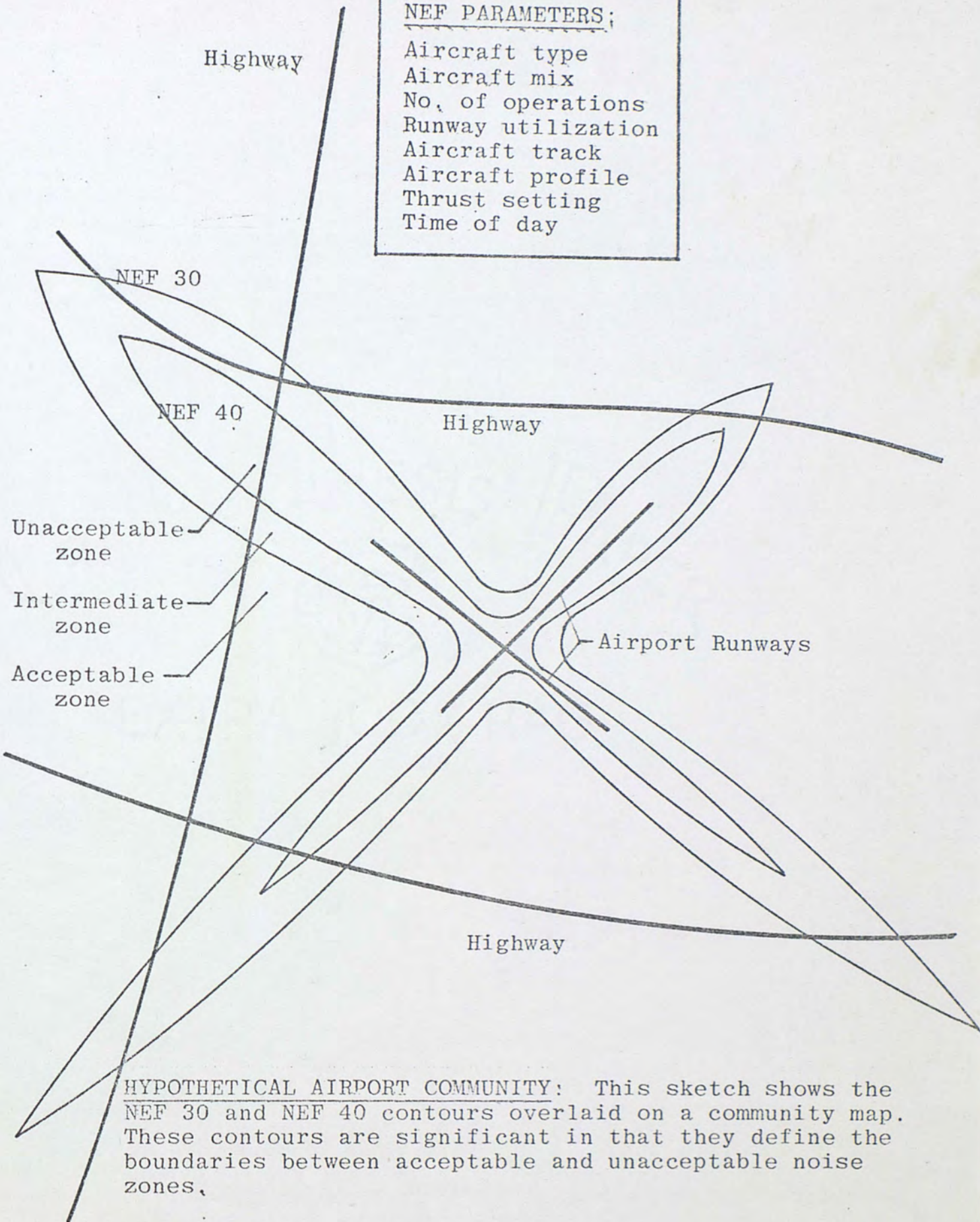
⁵Ibid, p. 30.

⁶Safeer, Harvey B. and Williams, Louis J., Airport Noise Exposure Contour Model User Manual, Report No. OST-ONA 72-3, Washington, D. C.: Department of Transportation, 1972.

APPENDIX A

HYPOTHETICAL AIRPORT COMMUNITY

NEF PARAMETERS;
 Aircraft type
 Aircraft mix
 No. of operations
 Runway utilization
 Aircraft track
 Aircraft profile
 Thrust setting
 Time of day



HYPOTHETICAL AIRPORT COMMUNITY: This sketch shows the NEF 30 and NEF 40 contours overlaid on a community map. These contours are significant in that they define the boundaries between acceptable and unacceptable noise zones.

APPENDIX B

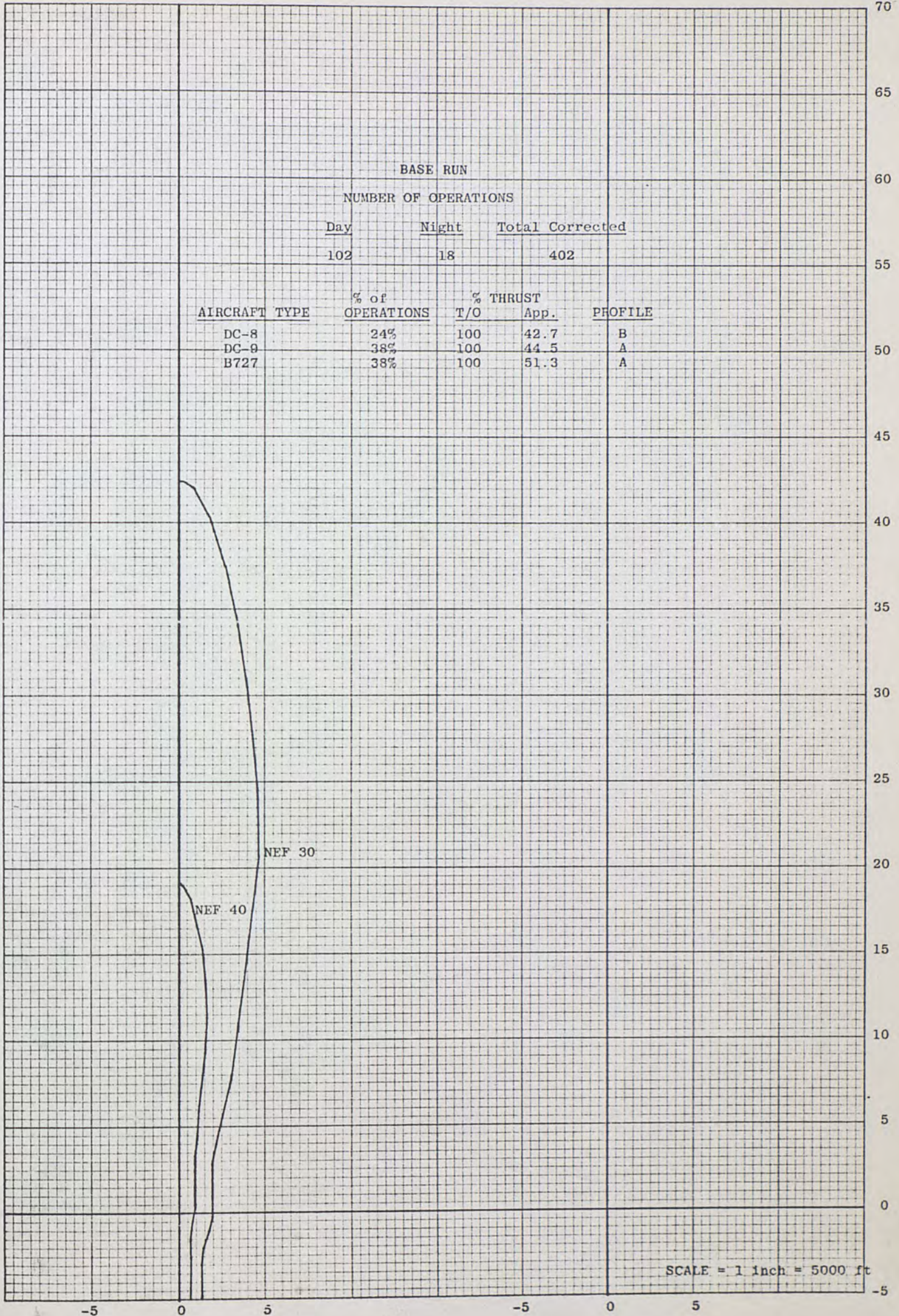
NEF CONTOUR PLOTS

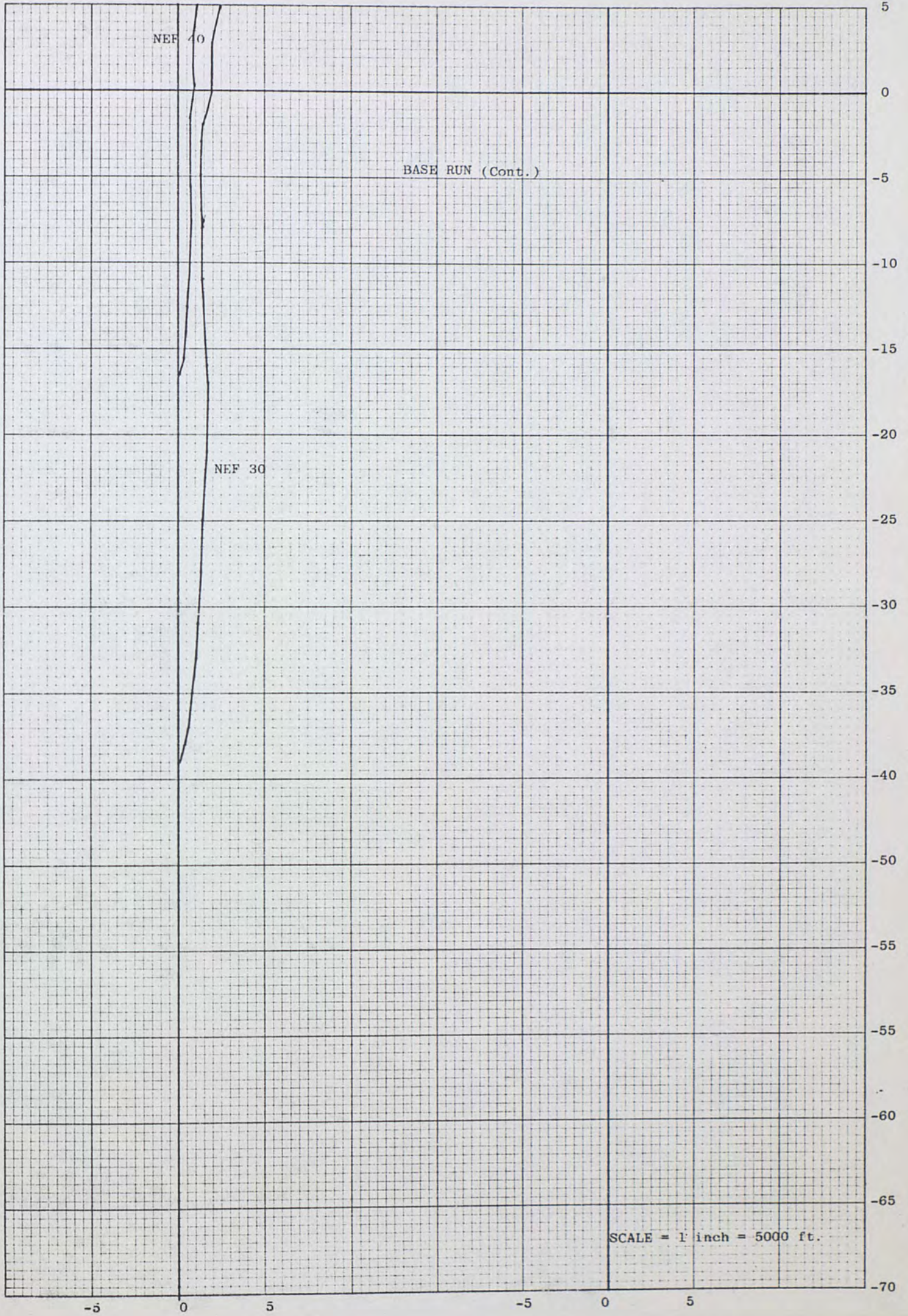
BASE RUN

NUMBER OF OPERATIONS

Day	Night	Total Corrected
102	18	402

AIRCRAFT TYPE	% of OPERATIONS	% THRUST		PROFILE
		T/O	App.	
DC-8	24%	100	42.7	B
DC-9	38%	100	44.5	A
B727	38%	100	51.3	A





RUN 1

MODIFIES BASE RUN AS FOLLOWS:

Increase DC-8 operations to 40% of total

RUN 2

MODIFIES BASE RUN AS FOLLOWS:

Increase DC-8 operations to 80% of total

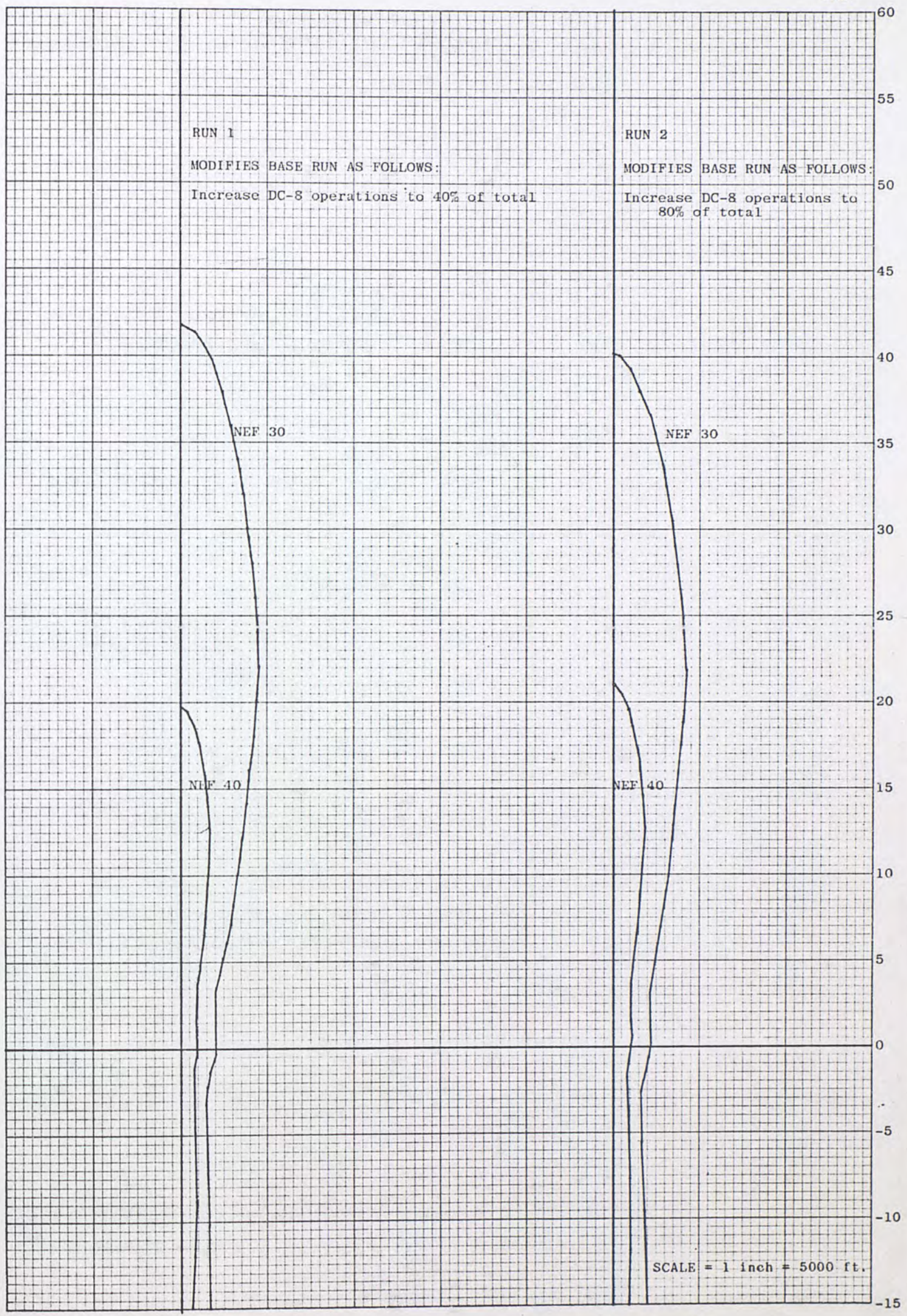
NEF 30

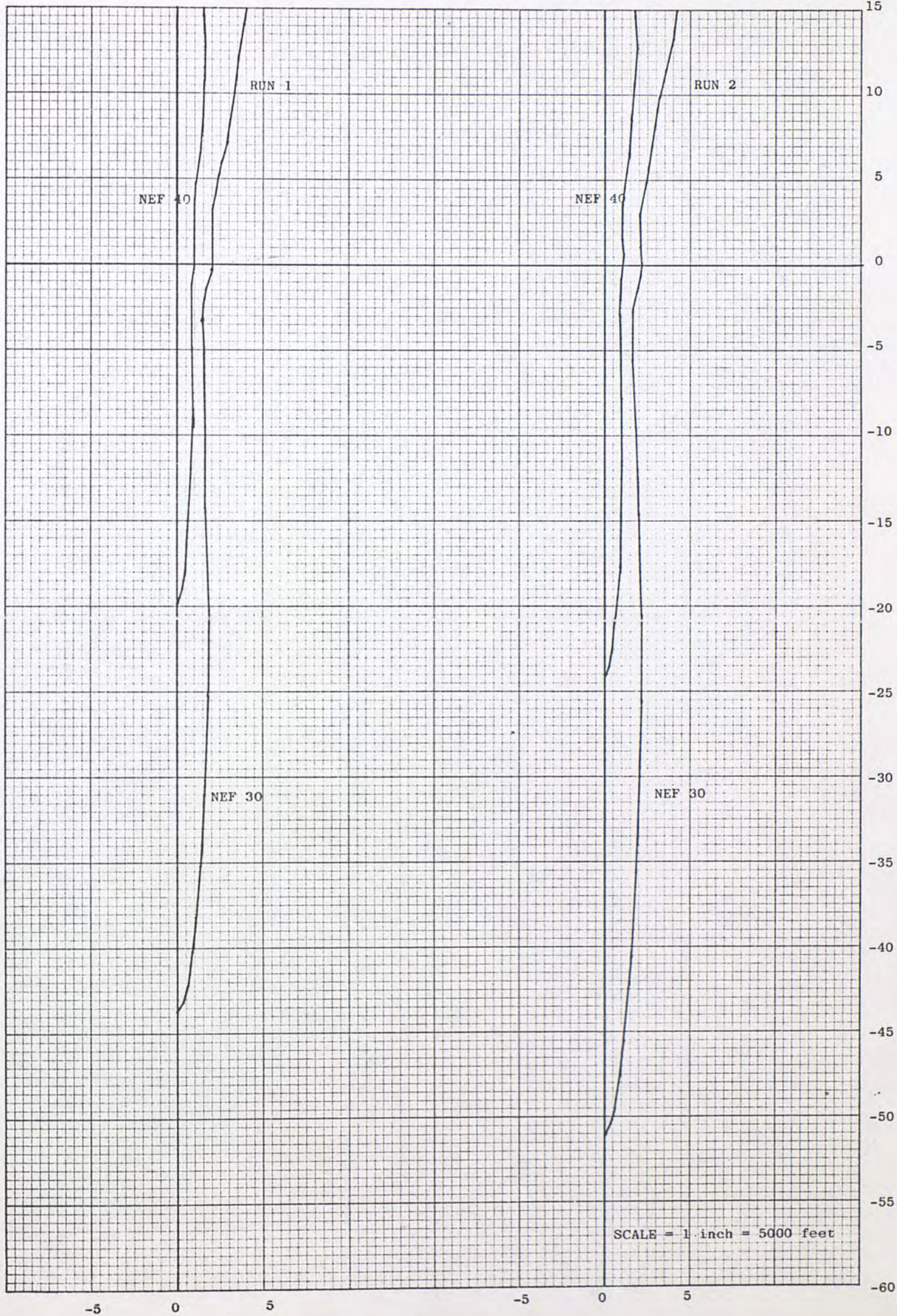
NEF 30

NEF 40

NEF 40

SCALE = 1 inch = 5000 ft.

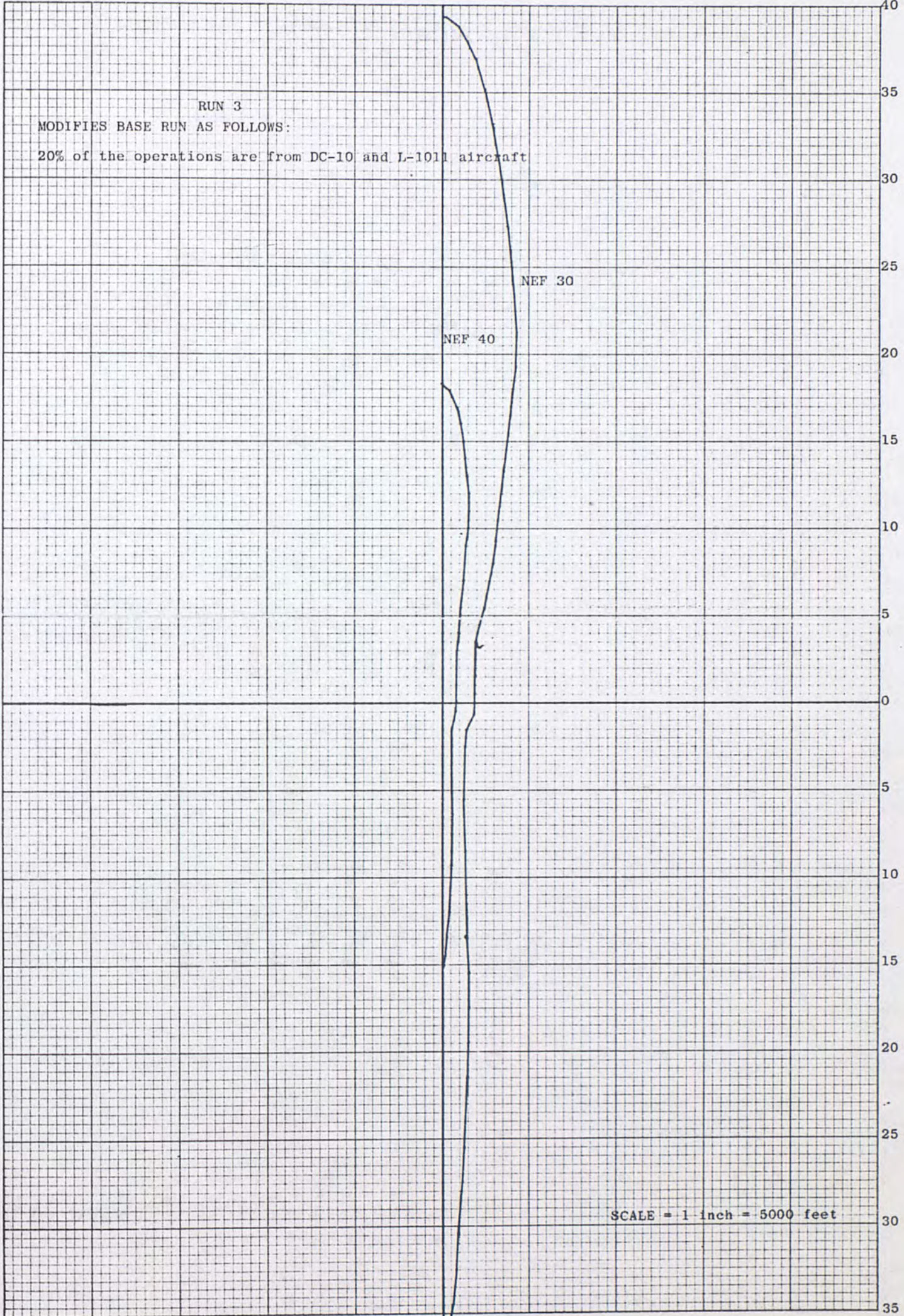


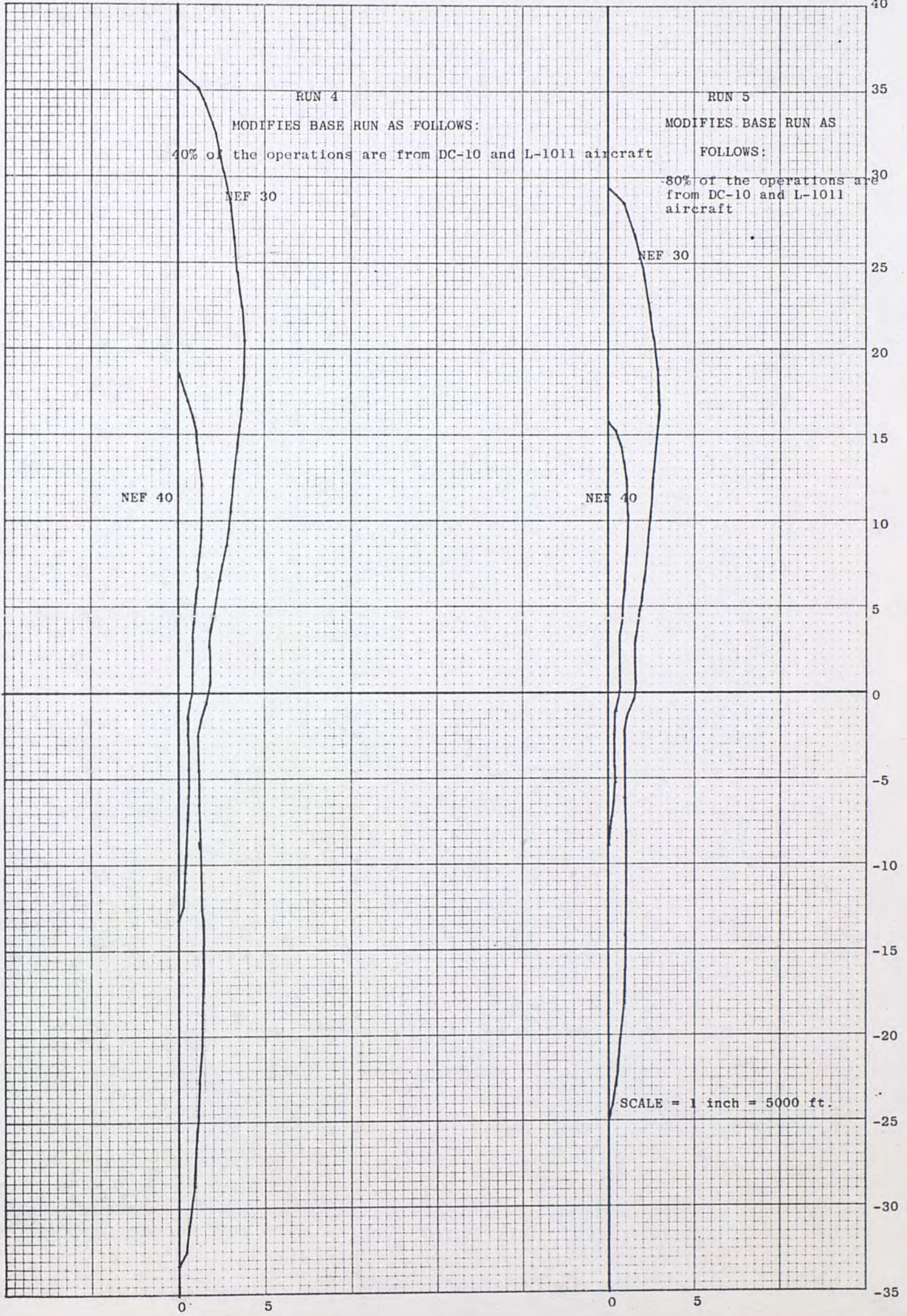


RUN 3
MODIFIES BASE RUN AS FOLLOWS:
20% of the operations are from DC-10 and L-1011 aircraft

NEF 30
NEF 40

SCALE = 1 inch = 5000 feet





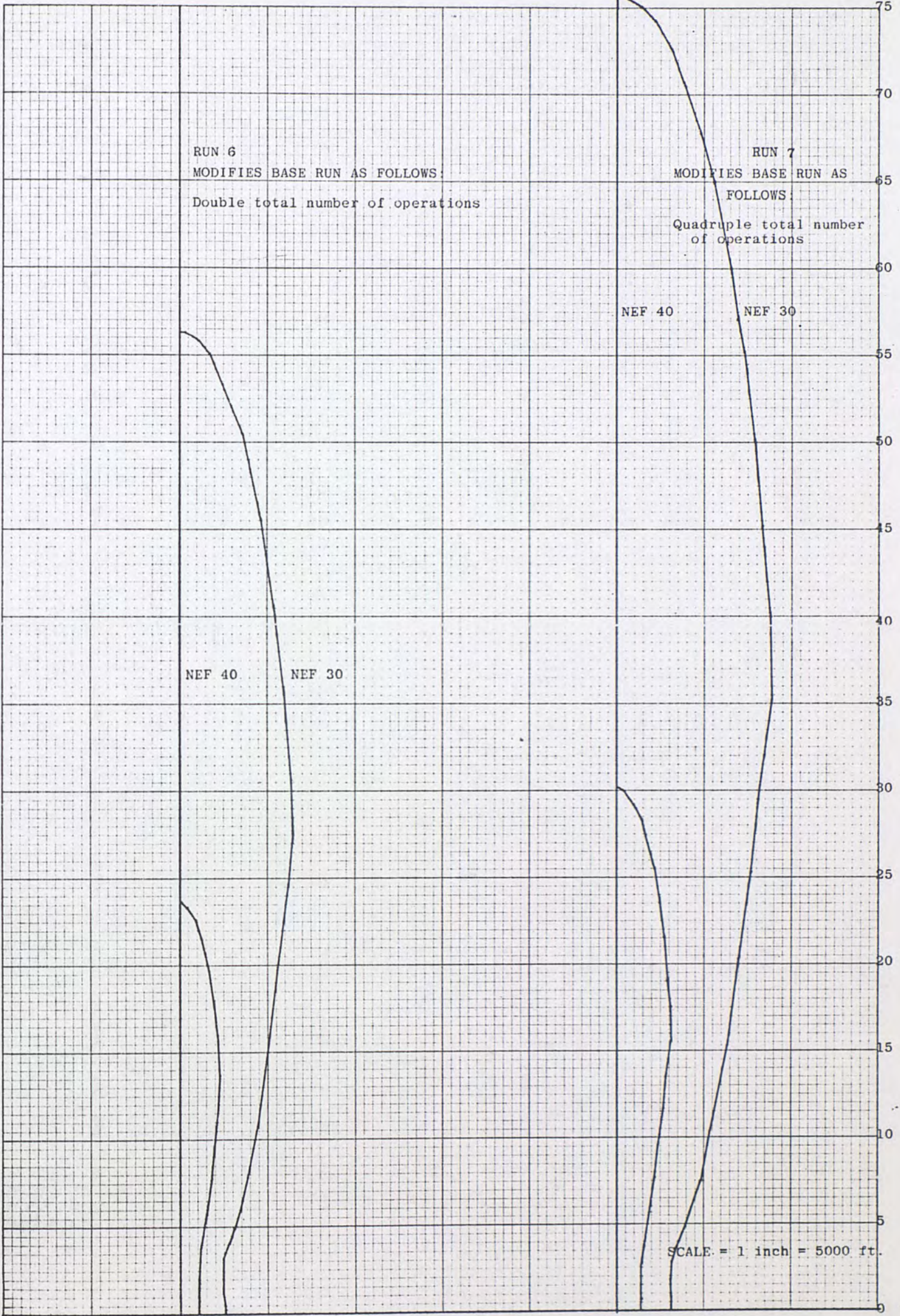
RUN 6
MODIFIES BASE RUN AS FOLLOWS:
Double total number of operations

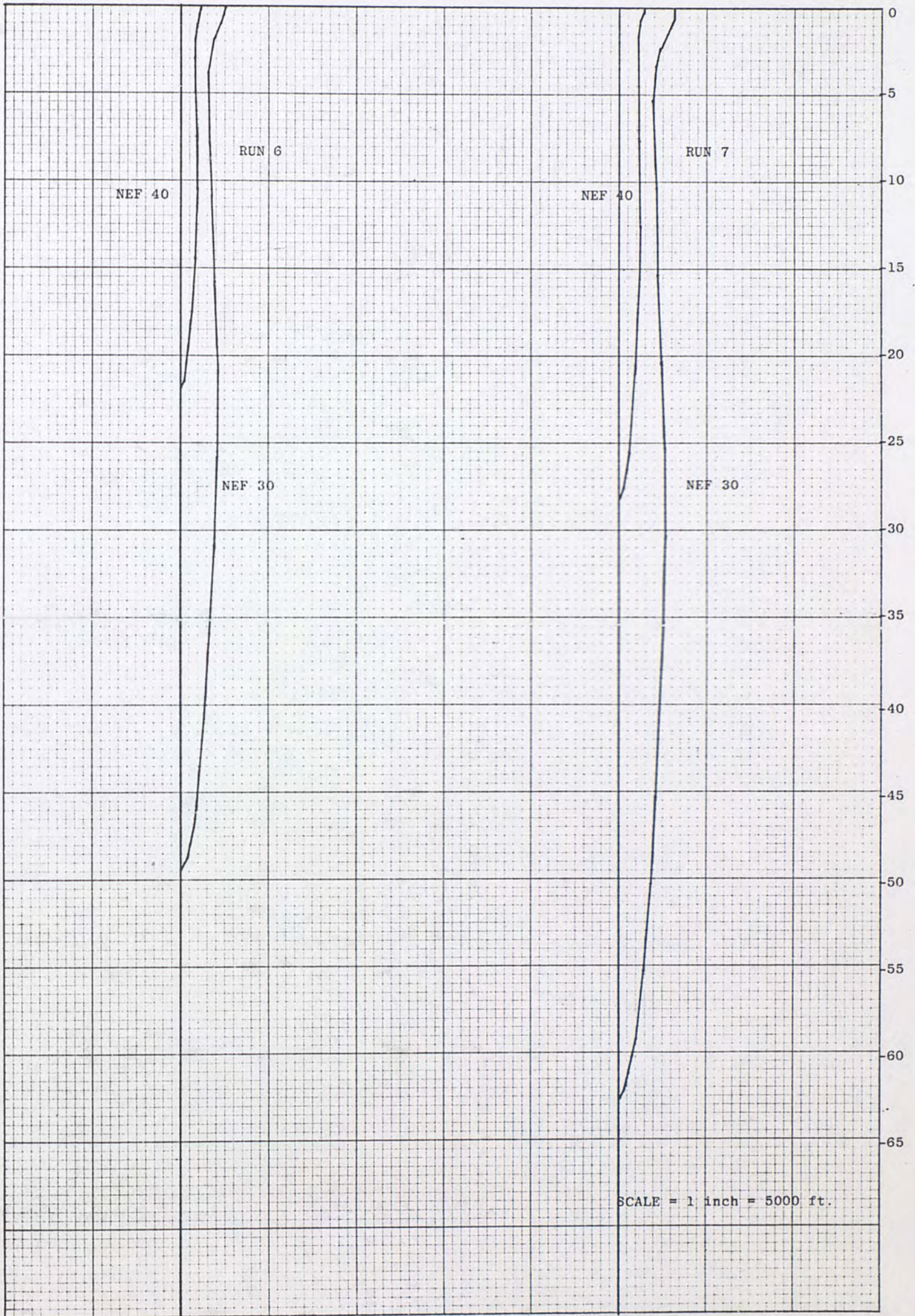
RUN 7
MODIFIES BASE RUN AS FOLLOWS:
Quadruple total number of operations

NEF 40 NEF 30

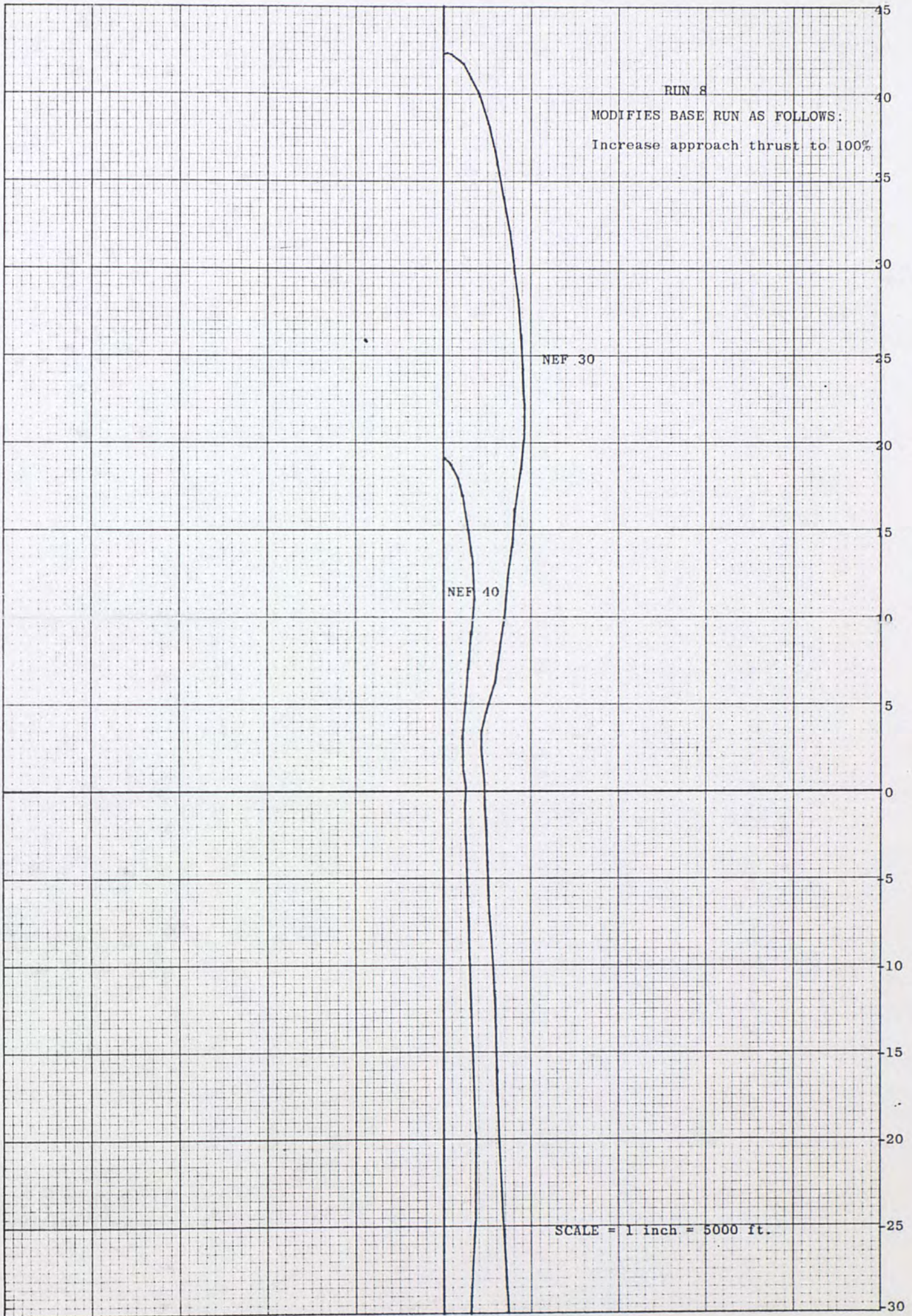
NEF 40 NEF 30

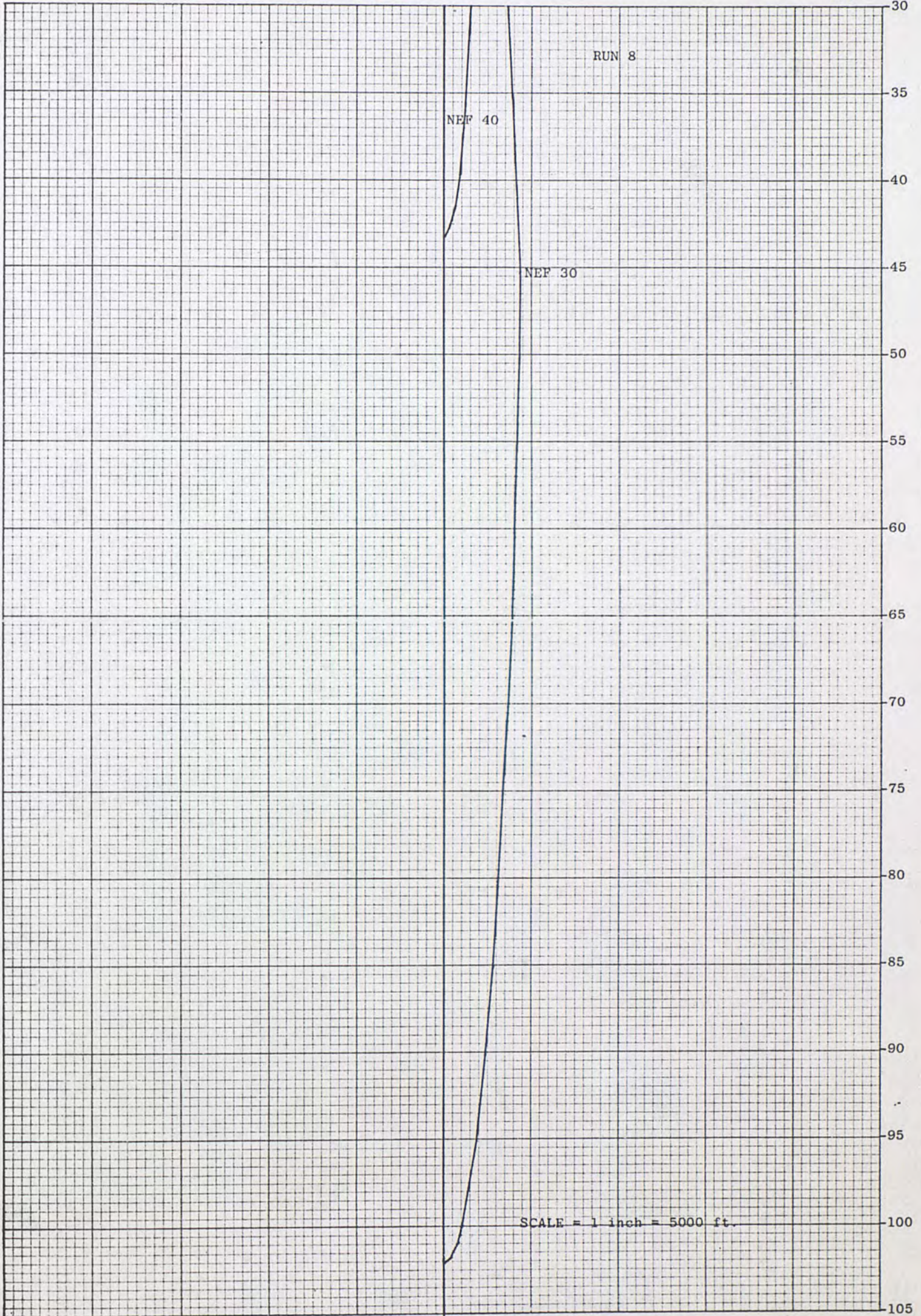
SCALE = 1 inch = 5000 ft.

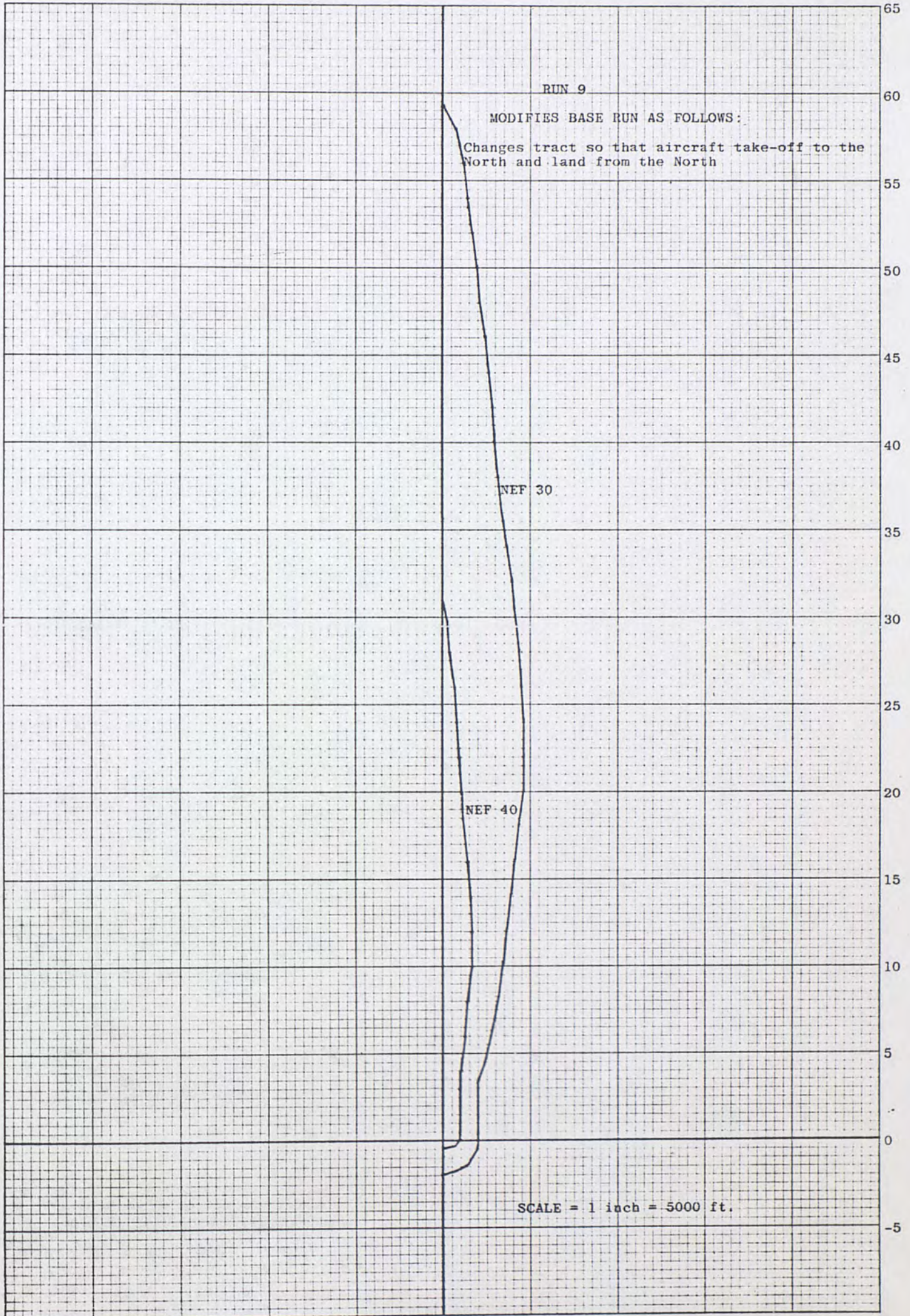




SCALE = 1 inch = 5000 ft.







RUN 9

MODIFIES BASE RUN AS FOLLOWS:

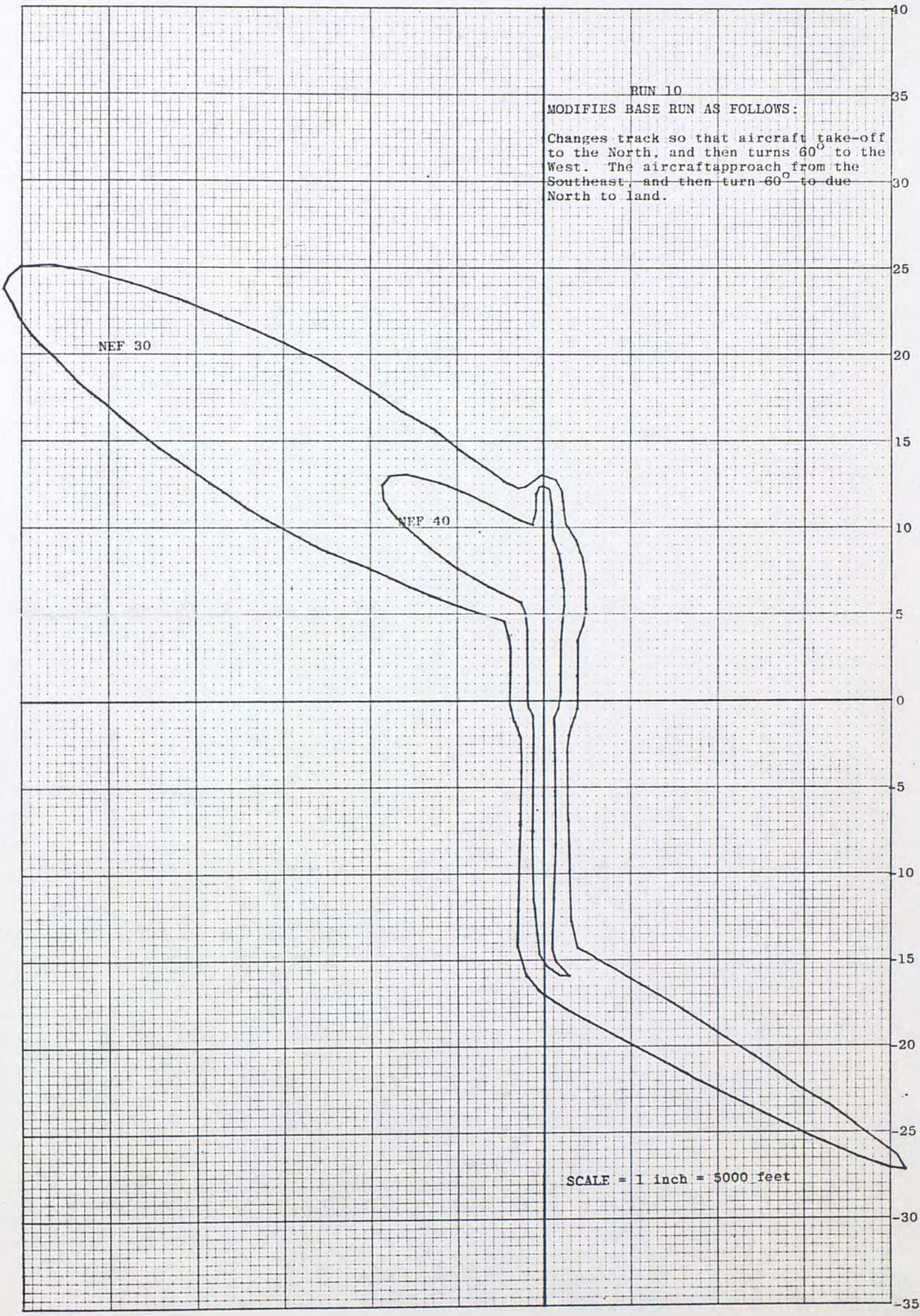
Changes tract so that aircraft take-off to the North and land from the North

NEF 30

NEF 40

SCALE = 1 inch = 5000 ft.

RUN 10
MODIFIES BASE RUN AS FOLLOWS:
Changes track so that aircraft take-off to the North, and then turns 60° to the West. The aircraft approach from the Southeast, and then turn 60° to due North to land.



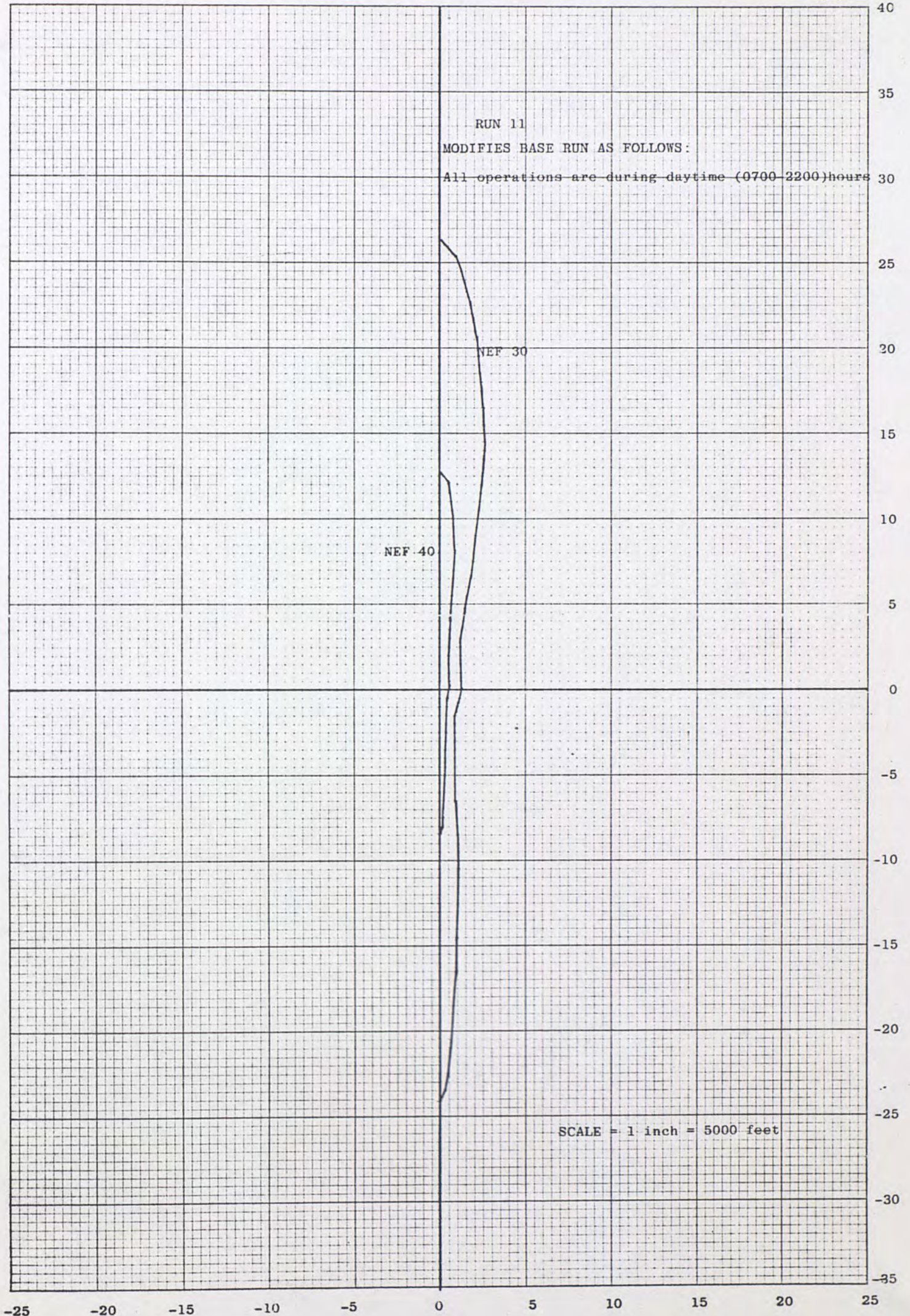
SCALE = 1 inch = 5000 feet

RUN 11
MODIFIES BASE RUN AS FOLLOWS:
~~All operations are during daytime (0700-2200) hours~~

NEF 30

NEF 40

SCALE = 1 inch = 5000 feet



BIBLIOGRAPHY

1. Dickerson, David O., Transportation Noise Pollution: Control and Abatement, NASA Contract NGT 47-003-028, Hampton, Virginia: NASA Langley Research Center and Old Dominion University, 1970.
2. Safeer, Harvey B. and Williams, Louis J., Airport Noise Exposure Contour Model User Manual, Report No. OST-ONA 72-3, Washington, D. C.: Department of Transportation, 1972.