6 00167 7765

Nacelle Aerodynamic and Inertial Loads (NAIL) Project

AUG 1983
RECEIVED
NASA STI FACILITY
ACCESS DEPT.

ORIGINAL PAGE IS
OF POOR QUALITY

AUG 1983
PUBLICLY RELEASED
ON

(NASA-CR-165760 NACELLE AERODYNAMIC AND INERTIAL LOADS (NAIL) PROJECT Test Report, Oct. 1979 - Nov. 1980 (Boeing Commercial Airplane Co., Seattle) 352 p HC A16/MF A01 CSCL 01C G3/05

N83-30402

Unclas
12625

ERRATA

p. viii, line 6	change to Wing Upper Surface
p. 2, lines 1 through 4	delete; add "During the IPSA portion of the NAIL program, surface static pressures were measured as follows on both the inboard and outboard engine installations: • Internal and external inlet surfaces • Engine core cowling • Pylon • Neighboring upper and lower wing surfaces A data base at these locations was acquired at Mach numbers 0.77, 0.80, 0.86, and 0.91 through three test flights."
p. 3, line 7	change NASI to NASI
p. 6, line 11	change 499 to 557 and 322 to 380
p. 9, line 26	change $(W_A\sqrt{\theta_{T_2}/\delta_{T_2}})$ to $W_A\sqrt{\theta_{T_2}}/\delta_{T_2}$
p. 10, insert	∞ free stream value α angle of attack θ_{T_2} total temperature ratio at engine face, T_{T_2}/T_{SLS} ρ air density, slug/ft^3 θ circumferential position, degrees δ_{T_2} total pressure ratio at engine face, P_{T_2}/P_{SLS}
p. 10, line 20	add SUBSCRIPTS after T_2 and before f
p. 10, line 22	change "pylon-core cowl intersection" to "pylon-fan cowl intersection"
pp. 11 & 12, line 1	change "pylon-fan cowl intersection" to "pylon-core cowl intersection"
p. 16, figure 5	at top of photograph, obliterated callouts are WBL 809, 834, and 870, reading left to right
p. 16, figure 6	callouts reading from top to bottom in lower left-hand corner are Inboard aileron Trailing-edge flaps

p. 25, figure 9	in table for outboard engine (No. 4) change the Point T NAC STA value from 216.12 to 206.10
	delete "Side View" from over bulleted items
	in upper right hand corner, change "2°" callout to "2-deg pitch-up"
p. 28, line 2	change to "...up to 2 deg relative to the WRP (fig. 9)."
p. 28, line 10	change to "...WLT for each engine using distances given in figure 9."
p. 28, line 17	add after "...or WBL 834 outboard."—"This reference nacelle station is labeled NAC STA in figure 9."
p. 29, table 4	in table, change 301.07 cm (118.53 in) to 301.056 cm (118.526 in)
	under r_{EXT}/L_k (first part of table) change values to
	0.2869 0.2859 0.2829 0.2812 0.2799 0.2781 0.2765 0.2747 0.2730 0.2708 0.2696 0.2662 0.2638
	and in second column r_{EXT}/L_k change 0.2329 to 0.2330
p. 35, table 7	change callout M to G (upper left-hand corner)
	change C_m = 206.080 cm (81.134 in) to C_g = 206.080 cm (81.134 in)
	X,Y = 0 @ m to X,Y = 0 at G
	change first line of table to
	X/C_g Y/C_g $\pm Z/C_g$
p. 36, table 8	in INBOARD and OUTBOARD tables interchange Y/C_n and Z/C_n headings

p. 37, table 9	in INBOARD and OUTBOARD tables interchange Y/C_n and Z/C_n headings
p. 38a, b, table 10	replace with two new pages
p. 39, table 11	delete 0.2750 and 0.4750 under WBL 445, UPPER and close up
p. 41, table 13	change NAC WL 180 to NAC WL 155 and change NAC WL 155 to NAC WL 180
p. 53, figure 21	change title to Accelerometer Installation (Thrust Link)
p. 61, figure 33	line 14, add "Surge valve bleed position" in second column
p. 69, line 8	change M_C and V_C to read M_D and V_D
p. 73, table 19	replace
p. 88, line 22	change 10 ft/s to 5 ft/s

APPENDIX A

A-6, table A-2	delete Engine 4 callout and boxed data
A-26, table A-22, line 4	change CONDITION 117, 1.5g to CONDITION 117, 1.6g
A-28, table A-24, line 4	change CONDITION 121, 1.5g to CONDITION 121, 1.6g
A-85, figure A-56	replace
A-87, figure A-58	replace
A-89, figure A-51	replace
A-97, figure A-68	replace
A-98, figure A-69	replace

APPENDIX B

B-10, figure B-1	delete data point at 1.25 on 090-deg plot
	delete data point between 1.25 and 1.50 on 150-deg plot
B-11, figure B-1	delete data points between 1.25 and 1.75

B-12, figure B-1	delete data points between 1.25 and 1.75
B-13, figure B-1	delete data points between 1.00 and 1.50
B-29, figure B-2	delete data points between 1.25 and 1.75
B-30, figure B-2	delete data points between 1.25 and 1.50 on 090-deg plot
	delete data points between 1.25 and 1.50 on 150-deg plot
B-31, figure B-2	delete data points between 1.50 and 1.75
B-32, figure B-2	delete data points between 1.00 and 1.75
B-33, figure B-2	delete data points between 1.00 and 1.75
B-49, figure B-3	delete data points between 1.25 and 1.75
B-50, figure B-3	delete data point at 1.25
B-51, figure B-3	delete data points between 1.00 and 1.50
B-52, figure B-3	delete data points between 1.25 and 1.75
B-53, figure B-3	delete data points between 1.00 and 1.75
B-54, figure B-3	delete data points between 1.00 and 1.75
B-85 through B-87, figure B-5	delete local Mach = 0.0 data points
B-89, figure B-5	replace graph
B-91, figure B-5	WBL 870, replace graph
B-101 through B-103, figure B-5	delete local Mach = 0.0 data points
B-106, figure B-5	WBL 870, replace graph
B-116 through B-118, figure B-7	delete local Mach = 0.0 data points
B-121, figure B-7	WBL 870, replace graph
B-135, figure B-8	WBL 870, replace graph

MICROFICHE

Replaced entirely

NASA-CR-165760

NACELLE AERODYNAMIC AND INERTIAL LOADS (NAIL) PROJECT

TEST REPORT

Contract NAS1-15325
MAY 1981

BOEING COMMERCIAL AIRPLANE COMPANY

FOREWORD

This document constitutes the test report of work conducted under NASA contract NAS1-15325 from October 1979 through November 1980. The contract was managed by the NASA Energy Efficient Transport Office (EETPO), headed by Mr. R. V. Hood—a part of the Aircraft Energy Efficiency (ACEE) program organization at the Langley Research Center. Mr. D. B. Middleton and Mr. K. W. Heising were the technical monitors for the contract. The work was performed within the Vice-President-Engineering and the Vice-President-Flight Operations organizations of the Boeing Commercial Airplane Company. Key contractor personnel responsible for the contract work were:

G. W. Hanks Program Manager	F. J. Davenport Structures Technology
R. L. Martin Project Manager	F. W. McIlroy Flight Test Instrumentation
K. H. Dickenson Structures Technology	C. D. Beard Flight Test Instrumentation
W. R. Lambert Propulsion Technology	E. L. Wallace Flight Test Analysis
W. F. Wilson Flight Test Operations	R. D. LaBounty Industrial Engineering Flight Test Support
B. W. Farquhar Propulsion Technology	B. G. Skelton Flight Test and Crew Training Support

Results of the total program, including analysis of the test data contained in this report, will be provided in a separate NASA contractor report.

The test effort was conducted in cooperation with the Pratt and Whitney Aircraft Company, who were supported by the NASA Lewis Research Center under Contract NAS3-20632.

PRECEDING PAGE BLANK NOT FILMED

Principal measurements and calculations used during these studies were in customary units.

CONTENTS

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
1.0	SUMMARY	1
2.0	INTRODUCTION	3
2.1	Objectives	3
2.2	Background	4
2.3	Approach	5
3.0	SYMBOLS AND ABBREVIATIONS	7
4.0	TEST DESCRIPTION AND RESULTS	13
4.1	Test Description	13
4.1.1	Test Vehicle	13
4.1.1.1	Flight Loads	13
4.1.1.2	Installed Propulsion System Aerodynamics	13
4.1.2	Instrumentation	32
4.1.2.1	Flight Loads	32
4.1.2.2	Installed Propulsion System Aerodynamics	62
4.1.3	Test Conditions and Procedures	65
4.1.3.1	Flight Loads	65
4.1.3.2	Installed Propulsion System Aerodynamics	71
4.1.4	Test Data Format	72
4.2	Test Results	75
4.2.1	Aerodynamic and Inertial Loads	75
4.2.1.1	Aerodynamic Loads	75
4.2.1.2	Inertial Loads	88
4.2.2	Installed Propulsion System Aerodynamics	89
5.0	REFERENCES	91
APPENDIX A	Aerodynamic and Inertial Loads	A-1
APPENDIX B	Installed Propulsion System Aerodynamics	B-1
MICROFICHE	Pressure Coefficient and Mach Number Tables	2
	Pressure Coefficient Plots	80
	Local Mach Number Plots	220

TABLES

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
1	Wing Coordinates	18
2	Engine 3 Pylon Coordinates	26
3	Engine 4 Pylon Coordinates	27
4	Engines 3 and 4 Core Cowl Coordinates	29
5	Engines 3 and 4 Inlet Coordinates	30
6	Engines 3 and 4 Fan Cowl Coordinates	33
7	Engines 3 and 4 Pylon-Fan Cowl Intersection	35
8	Engine 3 Wing-Pylon Intersection	36
9	Engine 4 Wing-Pylon Intersection	37
10	Pylon-Core Cowl Intersection	38
11	Wing Pressure Orifice Locations	39
12	Engine 3 Pylon Pressure Orifice Locations	40
13	Engine 4 Pylon Pressure Orifice Locations	41
14	Engine 3 Inlet Pressure Orifice Locations	42
15	Engine 4 Inlet Pressure Orifice Locations	43
16	Engines 3 and 4 Core Cowl Pressure Orifice Locations	44
17	Lateral Offset of Wing Pressure Belt Pressure Orifices From Wing Buttock Line	66
18	Test Conditions Flown	70
19	Inboard Aileron	73
20	Pressure Coefficient	76
21	Summary of Measurements of Engine Performance	77
22	Engine Fuel-Flow Data	78
23	Measurements for Engine Clearance	79
24	Measurements of Turbine-Case Temperature	80
25	Engine 3 A-Flange Resultants	83
A-1	Engine 3 Pressure Port Locations	A-3
A-2	Pressure Corrections for Instrumentation Problems	A-6
A-3	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 101 (612K)	A-7
A-4	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 101 (538K)	A-8
A-5	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 101 (647K)	A-9

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
A-6	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 118 . .	A-10
A-7	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 102 . .	A-11
A-8	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 103 . .	A-12
A-9	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 104 . .	A-13
A-10	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 105 . .	A-14
A-11	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 106 . .	A-15
A-12	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 107 . .	A-16
A-13	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 108 . .	A-17
A-14	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 109 . .	A-18
A-15	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 110 . .	A-19
A-16	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 111 . .	A-20
A-17	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 112 . .	A-21
A-18	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 113 . .	A-22
A-19	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 114 . .	A-23
A-20	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 115 . .	A-24
A-21	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 116 . .	A-25
A-22	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 117 . .	A-26
A-23	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 120 . .	A-27
A-24	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 121 . .	A-28
A-25	Fourier-Bessel Coefficients for Engine 3 Pressures, Condition 123 . .	A-29
B-1	Summary of Selected Test Condition Averages	B-3
B-2	Tabulated Data for Test 273-09, Condition 1.00.137.001	B-4

FIGURES

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
1	RA001 Test Airplane	14
2	Inboard Engine Buildup	14
3	Inboard Inlet Removal	15
4	Inboard Engine Removal	15
5	Pressure Orifice Configuration	16
6	Upper Wing Surface	16
7	747 Elastic Wing Twist	23
8	Wing Coordinate System	24
9	Nacelle Coordinate System	25
10	Inboard Engine Pressure Taps	45
11	Inboard Inlet Pressure Taps	45
12	Pressure Transducer	47
13	Pressure Transducer Installation	47
14	Pressure Transducer Box	48
15	Cowl Door Pressure Taps	48
16	Outboard Engine Pressure Taps	49
17	Inertial Data Sensors	49
18	Q-FLEX Accelerometer	50
19	Rate Gyro	50
20	Accelerometer and Rate Gyro	51
21	Accelerometer Installation (Thrust Link)	53
22	Clearance Monitoring System	53
23	Laser Generator Boxes	54
24	Fan Video Camera Installation	56
25	Turbine Video Camera Installation	56
26	Fan Laser Probe	57
27	Turbine Laser Probe	58
28	Turbine Laser Probe Installed	58
29	Laser Proximity Probe Locations	59
30	Laser System Video Monitors and Controls	60
31	Laser Video Tape Recorder	60
32	Nitrogen System	61
33	Expanded Engine Performance	61

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
34	Typical Cross-Section of Wing Pressure Belt	64
35	Acceptance Flight Profile	68
36	View of Pressure Ports	70
37	Airborne Data Analysis and Monitoring System	74
38	Test Airplane Interior View	74
39	Sign Convention for Steady-State Loads, Engine 3	82
40	Inlet Pitching Moment Time History, 538 000 lb Gross Weight Takeoff	84
41	Inlet Airload Moment Time History, 647 000 lb Gross Weight Takeoff	86
42	Airload Moment Time History, Stall Warning Maneuver, Flaps 10	87
A-1	Pressure Data Coordinate Conventions	A-30
A-2	Engine No. 3 Inlet Pressures, Condition 101, 612K GW Takeoff (Flaps 20)	A-31
A-3	Engine No. 3 Cowl Pressures, Condition 101, 612K GW Takeoff (Flaps 20)	A-32
A-4	Engine No. 3 Inlet Pressures, Condition 101, 538K GW Takeoff (Flaps 10)	A-33
A-5	Engine No. 3 Cowl Pressures, Condition 101, 538K GW Takeoff (Flaps 10)	A-34
A-6	Engine No. 3 Inlet Pressures, Condition 101, 647K GW Takeoff (Flaps 10)	A-35
A-7	Engine No. 3 Cowl Pressures, Condition 101, 647K GW Takeoff (Flaps 10)	A-36
A-8	Engine No. 3 Inlet Pressures, Condition 118, 780K GW Simulated Takeoff (FLaps 10)	A-37
A-9	Engine No. 3 Cowl Pressures, Condition 118, 780K GW Simulated Takeoff (Flaps 10)	A-38
A-10	Engine No. 3 Inlet Pressures, Condition 102, Low Climb	A-39
A-11	Engine No. 3 Cowl Pressures, Condition 102, Low Climb	A-40
A-12	Engine No. 3 Inlet Pressures, Condition 103, Mid Climb	A-41
A-13	Engine No. 3 Cowl Pressures, Condition 103, Mid Climb	A-42
A-14	Engine No. 3 Inlet Pressures, Condition 104, High M Cruise	A-43
A-15	Engine No. 3 Cowl Pressures, Condition 104, High M Cruise	A-44
A-16	Engine No. 3 Inlet Pressures, Condition 105, Low M Cruise	A-45
A-17	Engine No. 3 Cowl Pressures, Condition 105, Low M Cruise	A-46

FIGURES (Continued)

ORIGINAL PAGE IS OF POOR QUALITY

		Page
A-18	Engine No. 3 Inlet Pressures, Condition 106, Maximum M	A-47
A-19	Engine No. 3 Cowl Pressures, Condition 106, Maximum M	A-48
A-20	Engine No. 3 Inlet Pressures, Condition 107, Inflight Relight	A-49
A-21	Engine No. 3 Cowl Pressures, Condition 107, Inflight Relight	A-50
A-22	Engine No. 3 Inlet Pressures, Condition 108, Maximum q	A-51
A-23	Engine No. 3 Cowl Pressures, Condition 108, Maximum q	A-52
A-24	Engine No. 3 Inlet Pressures, Condition 109, Stall Warning (Flaps Up)	A-53
A-25	Engine No. 3 Cowl Pressures, Condition 109, Stall Warning (Flaps Up)	A-54
A-26	Engine No. 3 Inlet Pressures, Condition 110, Stall Warning (Flaps 10)	A-55
A-27	Engine No. 3 Cowl Pressures, Condition 110, Stall Warning (Flaps 10)	A-56
A-28	Engine No. 3 Inlet Pressures, Condition 111, Stall Warning (Flaps 30)	A-57
A-29	Engine No. 3 Cowl Pressures, Contition 111, Stall Warning (Flaps 30)	A-58
A-30	Engine No. 3 Inlet Pressures, Condition 112, Idle Descent	A-59
A-31	Engine No. 3 Cowl Pressures, Condition 112, Idle Descent	A-60
A-32	Engine No. 3 Inlet Pressures, Condition 113, Approach	A-61
A-33	Engine No. 3 Cowl Pressures, Condition 113, Approach	A-62
A-34	Engine No. 3 Inlet Pressures, Condition 114, Touch and Go	A-63
A-35	Engine No. 3 Cowl Pressures, Condition 114, Touch and Go	A-64
A-36	Engine No. 3 Inlet Pressures, Condition 115, Thrust Reverse	A-65
A-37	Engine No. 3 Cowl Pressures, Condition 115, Thrust Reverse	A-66
A-38	Engine No. 3 Inlet Pressures, Condition 116, 2.0g Left Turn (Flaps Up)	A-67
A-39	Engine No. 3 Cowl Pressures, Condition 116, 2.0g Left Turn (Flaps Up)	A-68
A-40	Engine No. 3 Inlet Pressures, Condition 117, 1.6 Left Turn (Flaps 30)	A-69
A-41	Engine No. 3 Cowl Pressures, Condition 117, 1.6 Left Turn (Flaps 30)	A-70
A-42	Engine No. 3 Inlet Pressures, Condition 120, 2.0g Right Turn (Flaps Up)	A-71

FIGURES (Continued)

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
A-43	Engine No. 3 Cowl Pressures, Condition 120, 2.0g Right Turn (Flaps Up)	A-72
A-44	Engine No. 3 Inlet Pressures, Condition 121, 1.6g Right Turn (Flaps 30)	A-73
A-45	Engine No. 3 Cowl Pressures, Condition 121, 1.6g Right Turn (Flaps 30)	A-74
A-46	Engine No. 3 Inlet Pressures, Condition 123, Airplane Stall	A-75
A-47	Engine No. 3 Cowl Pressures, Condition 123, Airplane Stall	A-76
A-48	Engine No. 4 Inlet Pressures, Condition 101, 612K Gross Weight Takeoff	A-77
A-49	Engine No. 4 Inlet Pressures, Condition 101, 538K Gross Weight Takeoff	A-78
A-50	Engine No. 4 Inlet Pressures, Condition 101, 647K Gross Weight Takeoff	A-79
A-51	Engine No. 4 Inlet Pressures, Condition 118, 780K Gross Weight Simulated Takeoff	A-80
A-52	Engine No. 4 Inlet Pressures, Condition 102, Low Climb	A-81
A-53	Engine No. 4 Inlet Pressures, Condition 103, Mid Climb	A-82
A-54	Engine No. 4 Inlet Pressures, Condition 104, High M Cruise	A-83
A-55	Engine No. 4 Inlet Pressures, Condition 105, Low M Cruise	A-84
A-56	Engine No. 4 Inlet Pressures, Condition 106, Maximum M	A-85
A-57	Engine No. 4 Inlet Pressures, Condition 107, Inflight Relight	A-86
A-58	Engine No. 4 Inlet Pressures, Condition 108, Maximum q	A-87
A-59	Engine No. 4 Inlet Pressures, Condition 109, Stall Warning (Flaps Up)	A-88
A-60	Engine No. 4 Inlet Pressures, Condition 110, Stall Warning (Flaps 10)	A-89
A-61	Engine No. 4 Inlet Pressures, Condition 111, Stall Warning (Flaps 30)	A-90
A-62	Engine No. 4 Inlet Pressures, Condition 112, Idle Descent	A-91
A-63	Engine No. 4 Inlet Pressures, Condition 113, Approach	A-92
A-64	Engine No. 4 Inlet Pressures, Condition 114, Touch and Go	A-93
A-65	Engine No. 4 Inlet Pressures, Condition 115, Thrust Reverse	A-94
A-66	Engine No. 4 Inlet Pressures, Condition 116, 2.0g Left Turn (Flaps Up)	A-95
A-67	Engine No. 4 Inlet Pressures, Condition 117, 1.6g Left Turn (Flaps 30)	A-96

ORIGINAL PAGE IS
OF POOR QUALITY

		Page
A-68	Engine No. 4 Inlet Pressures, Condition 120, 2.0g Right Turn (Flaps Up)	A-97
A-69	Engine No. 4 Inlet Pressures, Condition 121, 1.6g Right Turn (Flaps Up)	A-98
A-70	Engine No. 4 Inlet Pressures, Condition 123, Airplane Stall	A-99
A-71	Airplane Center-of-Gravity Accelerations, Mild Gust	A-100
A-72	Engine No. 3 Wing/Strut Accelerations, Mild Gust	A-101
A-73	Engine No. 4 Wing/Strut Accelerations, Mild Gust	A-102
A-74	Engine Angular Rates, Mild Gust	A-103
A-75	Engine No. 3 Accelerations, Mild Gust	A-104
A-76	Engine No. 4 Accelerations, Mild Gust	A-105
A-77	Airplane Center-of-Gravity Normal Acceleration, Hard Landing	A-106
A-78	Airplane Center-of-Gravity Angular Rates, Hard Landing	A-107
A-79	Engine No. 3 Wing/Strut Accelerations, Hard Landing	A-108
A-80	Engine No. 4 Wing/Strut Accelerations, Hard Landing	A-109
A-81	Engine Angular Rates, Hard Landing	A-110
A-82	Engine No. 3 Accelerations, Hard Landing	A-111
A-83	Engine No. 4 Accelerations, Hard Landing	A-112
B-1	Sample of Pressure Coefficient Data (Test 273-12, Condition 1.00.137.001.1)	B-5
B-2	Sample of Pressure Coefficient Data (Test 273-12, Condition 1.00.137.002)	B-25
B-3	Sample of Pressure Coefficient Data (Test 273-12, Condition 1.00.137.003)	B-45
B-4	Sample of Pressure Coefficient Data (Test 273-12, Condition 1.00.137.004)	B-66
B-5	Sample of Local Mach Number Data (Test 273-12, Condition 1.00.137.001.1)	B-81
B-6	Sample of Local Mach Number Data (Test 273-12, Condition 1.00.137.002)	B-97
B-7	Sample of Local Mach Number Data (Test 273-12, Condition 1.00.137.003)	B-112
B-8	Sample of Local Mach Number Data (Test 273-15, Condition 1.00.137.004)	B-127

1.0 SUMMARY

The Nacelle Aerodynamics and Inertial Loads (NAIL) program comprised a series of test flights that produced an in-flight measured data base of the aerodynamic and inertial loads imposed on right-hand inboard and outboard JT9D engines installed on the Boeing 747 RA001 test bed aircraft. Wing and engine installed performance data were also obtained. In this report the aerodynamic and inertial loads portion of the test program is referred to as the flight loads, and the wing and engine installed performance portion is referred to as the installed propulsion system aerodynamics (IPSA).

During the flight loads portion of the test program, surface static pressures were measured on the:

- Internal and external surfaces of the inboard inlet
- External surface of the fan cowl doors of the inboard nacelle
- External surface of the fan exhaust sleeve of the inboard nacelle
- Internal and external surfaces of the outboard inlet

Linear accelerations and pitch and yaw rates were also measured on both inboard and outboard nacelle and pylon installations.

The following measurements were made simultaneously with the surface static pressure measurements:

- Engine clearance changes on both inboard and outboard engines
- Turbine case temperature on the inboard engine
- Engine performance on both inboard and outboard engines

The resulting data were correlated with the flight loads. These measurements–

- Duplicated a portion of the airplane flight acceptance test profile
- Demonstrated the effects of variations in takeoff gross weight
- Illustrated the effects of high-g maneuvers

During the IPSA portion of the NAIL program, surface static pressures were measured on the nacelle, pylon, and neighboring wing surfaces on engines 3 and 4 (inboard and outboard). A data base was acquired at Mach numbers 0.77, 0.80, 0.86, and 0.91 through three flights of the RA001.

Pressure coefficient and local Mach number distributions were plotted for each row of pressure orifices. A geometrical description of the surfaces and pressure orifice locations on the nacelle, pylon, and wing is provided. The IPSA data base, derived from a full-scale flight vehicle, should assist in verification and development of analytical models and eventually provide the ability to predict wing-mounted propulsion system performance.

2.0 INTRODUCTION

The test program recommended in the feasibility study (ref. 1) describes a flight test in which flight loads and engine clearance changes can be measured simultaneously on the 747/JT9D engine installation. NASA-Langley and NASA-Lewis Research Centers authorized and jointly funded this program under separate contracts for Boeing Commercial Airplane Company (BCAC) and Pratt & Whitney Aircraft (P&WA). The BCAC effort, Nacelle Aerodynamic and Inertial Loads (NAIL) project, was funded by NASA-Langley under Task 4.3 of contract NAS1-15325. The P&WA effort was funded by NASA-Lewis under Task V, JT9D Engine Diagnostic Flight Loads Test program, contract NAS3-20632. Subsequently, the BCAC contract was revised to include the installed propulsion system aerodynamics (IPSA) effort. The successful completion of this joint test program was only possible through the continuous and extensive coordination between BCAC and P&WA and the excellent cooperation of the NASA-Langley and NASA-Lewis Research Centers. This document reports the BCAC effort during the test program and represents early release of flight test data.

The testing was conducted on the Boeing-owned 747 RA001 test bed airplane during the concurrent 767/JT9D-7R4 engine development program. Following a functional check flight conducted from Boeing Field International (BFI) on 3 October 1980, the airplane and test personnel were ferried to Valley Industrial Park (GSG) near Glasgow, Montana, on 7 October 1980. The combined NAIL and 767/JT9D-7R4 test flights were conducted at the Glasgow remote test site, and the airplane was returned to Seattle on 26 October 1980.

2.1 OBJECTIVES

Objectives of the NAIL flight test program were to:

- Measure flight loads (aerodynamic and inertial) typical of acceptance test and revenue service
- Explore the effects of gross weight, sink rate, pitch rate, and various maneuvers on nacelle loads
- Measure simultaneously engine clearance closures and engine performance changes

- Provide a data base for designing improved propulsion systems (performance retention)

- Provide a data base of pressures measured on wing, pylon, and nacelle surfaces of both inboard and outboard propulsion installations of commercial transport-sized aircraft and to gather information on airflow patterns surrounding the powerplant installations using static pressure surveys

2.2 BACKGROUND

Since introduction of the jet engine into commercial transport service, historical data have indicated that deterioration of engine specific fuel consumption (SFC) occurs over the life of installed engines. Until recent shortages in fuel and the resulting high fuel costs, increases in fuel consumption were considered to be a nuisance rather than a technical problem requiring a solution. Motivated by fuel shortages and costs, the NASA Engine Component Improvement (ECI) program (part of the NASA Aircraft Energy Efficiency program) was made responsible for determining the cause of and potential solutions to installed engine SFC deterioration. As part of the ECI program, BCAC assisted P&WA under their NASA-Lewis contract NAS3-20632 during evaluation of the problem. It was found that the SFC of engines increased from 0.5% to 6% from the time of removal from the acceptance test stand followed by installation and operation on the airplane for a given period of time. Measurement of rotor blades at the outer diameter and inspection of the inner surface of engine cases indicated that definite interference occurred between the blades and the case. This interference resulted in increased clearance and gas flow leakage between the blades and the outside case. The study found that 87% of the increase in SFC was due to flight loads occurring within the first 50 flight cycles.

Factors contributing significantly to engine performance losses are divided into engine loads and flight loads, as follows:

- Engine loads (those loads not related to the flight environment)
  - Internal engine pressures
  - Thermal loads due to temperature differentials
  - Thrust loads—fore and aft
  - Centrifugal loads

- Flight loads (those loads imposed by the flight environment)
  - Aerodynamic pressures
  - Inertial forces

A finite element model analysis using these factors predicted a 1% increase in SFC at sea level due to the aircraft acceptance flight test.

Aircraft fuel consumption is proportional to aircraft drag. Thus to reduce fuel consumption, drag should be minimized. Most mechanisms of drag production are understood and are predictable to some degree, with the exception of a component termed "interference drag." This drag results from disruption of the flow over the wing caused by the wing-mounted propulsion system in the vicinity of the propulsion system. This interruption interferes with the wing performance. Current techniques for estimating and minimizing interference drag rely heavily on comprehensive test programs that independently vary a set of parameters believed to significantly influence interference. Current analytical technology is sufficiently advanced so that transonic potential flows around arbitrary three-dimensional bodies can be accurately predicted. However, the development of analytical techniques depends extensively on experimental results for comparison of the predicted results. Development of analytical techniques to model the physics of flow about propulsion systems installed near wings has been initiated and some of the techniques are nearing completion. However, the comprehensive data base to which these predictions could be compared is lacking.

2.3 APPROACH

Recommendations and conclusions of previous studies prescribed a feasible cost-effective approach to the NASA-funded NAIL/JT9D Flight Loads flight test program. This joint program involved BCAC and P&WA, funded by NASA-Langley and by NASA-Lewis, respectively.

A 15-hour flight test program covering portions of the acceptance flight profile, variations in takeoff and landing conditions, and high-g turns was chosen to measure simultaneously the flight loads (cause) and engine clearance changes (effect) associated with engine performance deterioration. The flight test program used the Boeing-owned 747 RA001 aircraft.

Aerodynamic loads were measured by 252 static pressure ports on the inboard nacelle (engine 3) and 45 static pressure ports on the outboard nacelle (engine 4).

Inertial loads were measured by six accelerometers and two rate gyros on both the inboard and outboard engines. The pylon and strut interface of both engines was equipped with an additional six accelerometers. The resulting engine clearance changes were measured by laser proximity probes on the fan of both engines and on the high-pressure turbine of the inboard engine. The expanded engine performance instrumentation and 20 high-pressure turbine thermocouples provided additional data on the inboard engine for resolving clearance and performance changes.

The IPSA pressure data were obtained in the neighborhood of both engines by a total of 499 static pressure orifices; 322 of these were arranged in rows above and below the wing and on each side of both pylons and core cowls. The remaining data, on both inlets and fan cowls, were acquired from part of the aerodynamic loads instrumentation.

ORIGINAL PAGE IS
OF POOR QUALITY

3.0 SYMBOLS AND ABBREVIATIONS

A_n	Fourier-Bessel coefficient for nth cosine harmonic
AC	axial acceleration
ACCEL	acceleration
ADAMS	airborne data analysis and monitor system
A-flange	engine fr[illegible] flange at nacelle station 100
A_x	acceleration in x-direction
A_y	acceleration in y-direction
A_z	acceleration in z-direction
B_n	Fourier-Bessel coefficient for nth sine harmonic
BCAC	Boeing Commercial Airplane Company
BFI	Boeing Field International, Seattle, Washington
CG	center of gravity
C_p	pressure coefficient
deg	degrees
ECI	engine component improvement program
EPR	engine pressure ratio
E3	engine position 3
E4	engine position 4
ft	feet
FLTRD	filtered
FS	front spar
FT	flight test
F_x	force in the x-direction
F_y	force in the y-direction
F_z	force in the z-direction
g	acceleration of gravity
GSG	Valley Industrial Park, northeastern Montana

GW	airplane gross weight
H_p	pressure altitude
HPC IGV POS	high-pressure compressor inlet guide vane position
HPT	high-pressure turbine
HWLDG	heavyweight landing
Hz	hertz (cycles per second)
IGDA	interactive graphics data analysis
in	inch
in-kip	1000 inch-pounds
INLET STA	inlet station, value increases moving aft along inlet centerline
IPSA	installed propulsion system aerodynamics
IRIG	inter-range instrumentation group master clock
kn, KTS	knots
kcas	knots calibrated airspeed, indicated airspeed corrected for position error (calibrated airspeed equals true airspeed in standard atmosphere at sea level)
LAST	final formated tape produced by the flight test data system
lb	pound
LH	left hand
lbm	pounds mass
M	Mach number, ratio of true airspeed to the velocity of sound
M_c	design cruise Mach number
M_x	moment about the x-axis
M_y	moment about the y-axis
M_z	moment about the z-axis
min	minutes
NAC BL	nacelle buttock line, value increases moving outboard in the nacelle coordinate system

NAC STA	nacelle station, value increases moving aft in the nacelle coordinate system
NAC WL	nacelle waterline, value increases moving up in the nacelle coordinate system
NAIL	nacelle aerodynamics and inertial loads
NASA	National Aeronautics and Space Administration
NASTRAN	NASA structural analysis
N1	low-pressure rotor speed
N2	high-pressure rotor speed
OCLK	clock position
P	pressure
PC	pressure coefficient
POS	position
PSI (lb/in^2)	pounds per square inch
P_S	static pressure
PS3	low-pressure compressor discharge static pressure
PS4	high-pressure compressor discharge static pressure
P_T	total pressure
PT2.5	fan stream total pressure at exit guide vane
PT3	low-pressure compressor discharge total pressure
PT7	low-pressure turbine discharge total pressure
PWR LVR ANG	power lever angle
P&WA	Pratt & Whitney Aircraft
q,Q	dynamic pressure, $\frac{1}{2} \rho V^2$
RA001	Boeing-owned 747-100 research aircraft 1
RH	right hand
rms	root mean square
RWA	referred engine airflow, $\left(W_A\sqrt{\theta_{T_2}/\delta_{T_2}}\right)$
sec	seconds
S	arc length along surface from highlight
S_{nom}	nominal arc length along surface

ORIGINAL PAGE IS
OF POOR QUALITY

SFC	specific fuel consumption
SLS	sea level standard
TO	takeoff
TR	thrust reverse
T_T	total temperature
TT3	low-pressure compressor discharge total temperature
TT4.5	high-pressure compressor discharge total temperature
TT6	high-pressure turbine discharge total temperature
TT7	low-pressure turbine discharge total temperature
V	true airspeed, feet per second
V_C	design cruise speed
V_S	stalling speed or the minimum steady flight speed at which airplane is controllable
WA	engine airflow
WBL	wing buttock line, value increases by moving outboard
W_f	fuel flow rate
WFS	wing front spar
WRP	wing reference plane
WUT	windup turn, a level turn produced by increasing the angle of bank at a prescribed rate
	free stream value
	angle of attack
T_2	total temperature ratio at engine face, T_{T_2}/T_{SLS}
	air density, slug/ft^3
	circumferential position, degrees
T_2	total pressure ratio at engine face, P_{T_2}/P_{SLS}
f	fan cowl
g	pylon-core cowl intersection
h	highlight
i	inlet
k	core cowl
l	engine 4 wing-pylon intersection

m	pylon-fan cowl intersection
n	engine 3 wing-pylon intersection
s	pylon (strut)
w	wing

4.0 TEST DESCRIPTION AND RESULTS

4.1 TEST DESCRIPTION

The Boeing-owned 747 RA001 test bed aircraft (fig. 1) was the basis of the Nacelle Aerodynamic and Inertial Load (NAIL) flight test program, which comprised two basic studies and data collection systems divided into the flight loads and installed propulsion system aerodynamics (IPSA) programs. Where necessary, discussion of the flight loads and IPSA portions are separated for clarity. However, airplane and performance data were used by both programs, and some of the flight loads pressure data were used by the IPSA program.

4.1.1 Test Vehicle

4.1.1.1 Flight Loads

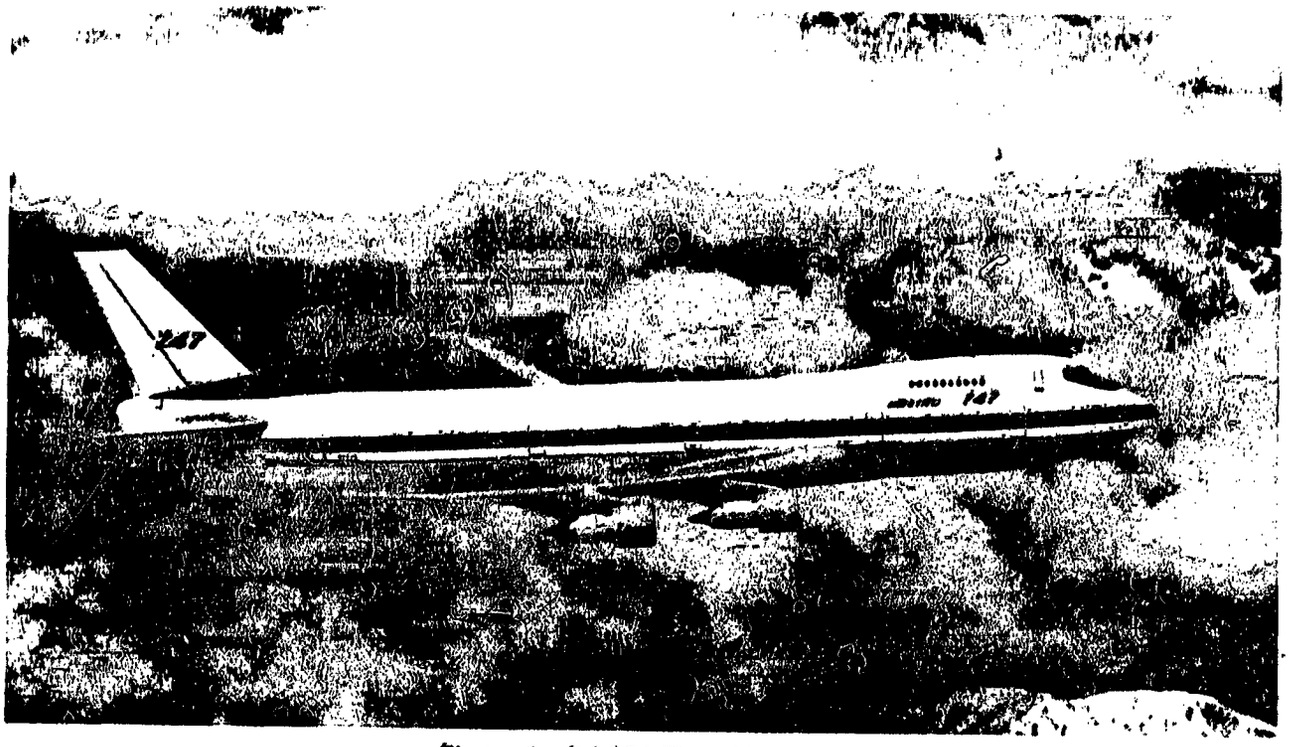
The NAIL program required fabrication and installation effort to provide the means to collect, control, and maintain the quality and quantity of data obtained. The flight loads portion of the program required instrumentation of the inboard and outboard engines (i.e., positions 3 and 4). Highest emphasis was placed on engine 3, which is shown on the wing during the buildup period (fig. 2).

Likewise, during the postflight test phase, refurbishment was necessary to prepare the aircraft for the next program. Inlet 3 (fig. 3) was removed followed by engine 3 (fig. 4), which was shipped to Pratt and Whitney Aircraft (P&WA) for further static testing followed by an analytical teardown and refurbishment.

4.1.1.2 Installed Propulsion System Aerodynamics

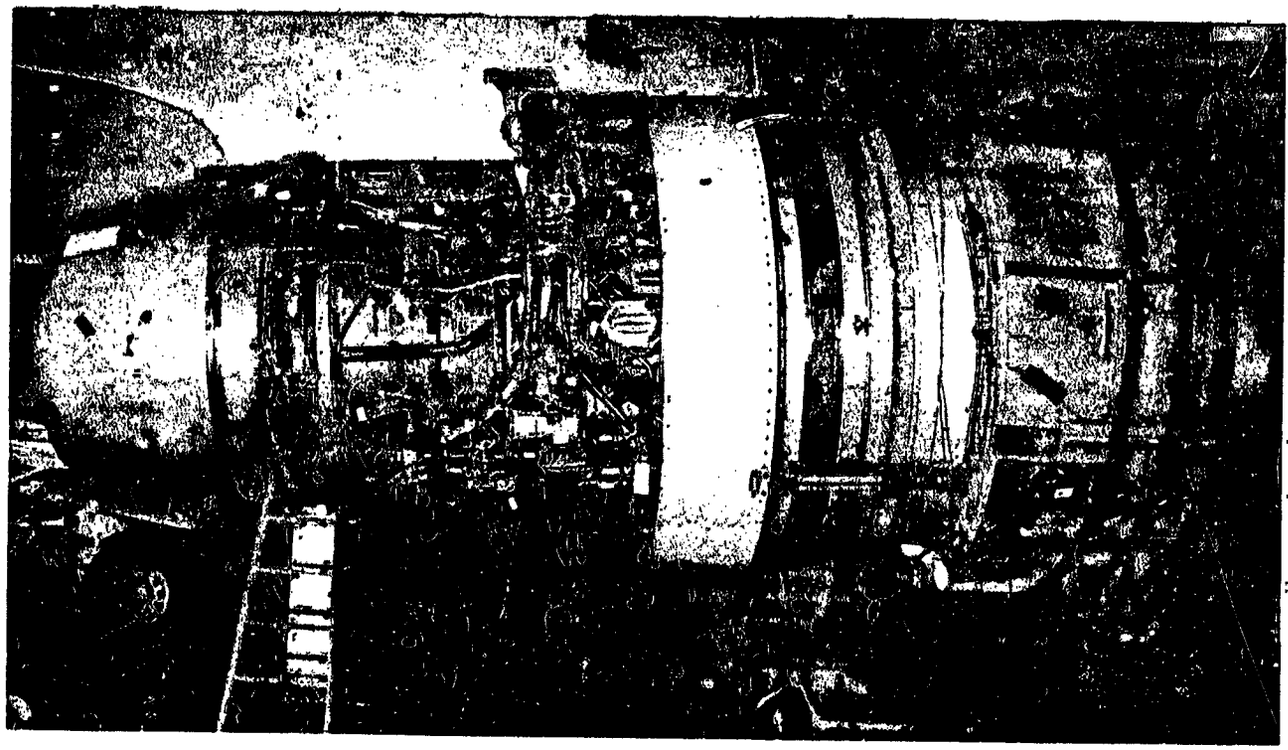
Description of the basic B-747 test vehicle pertinent to the IPSA program requires a geometrical definition of the fan inlet, fan cowl, pylon, and core cowl for an inboard and an outboard engine installation and requires neighboring wing geometry for each engine. This description is provided by defining the local geometry with relative positions and contours of pressure orifice rows and wing-pylon, pylon-nacelle intersections. Figures 5 and 6 describe the location and nomenclature for the pressure orifice rows.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



125200-1

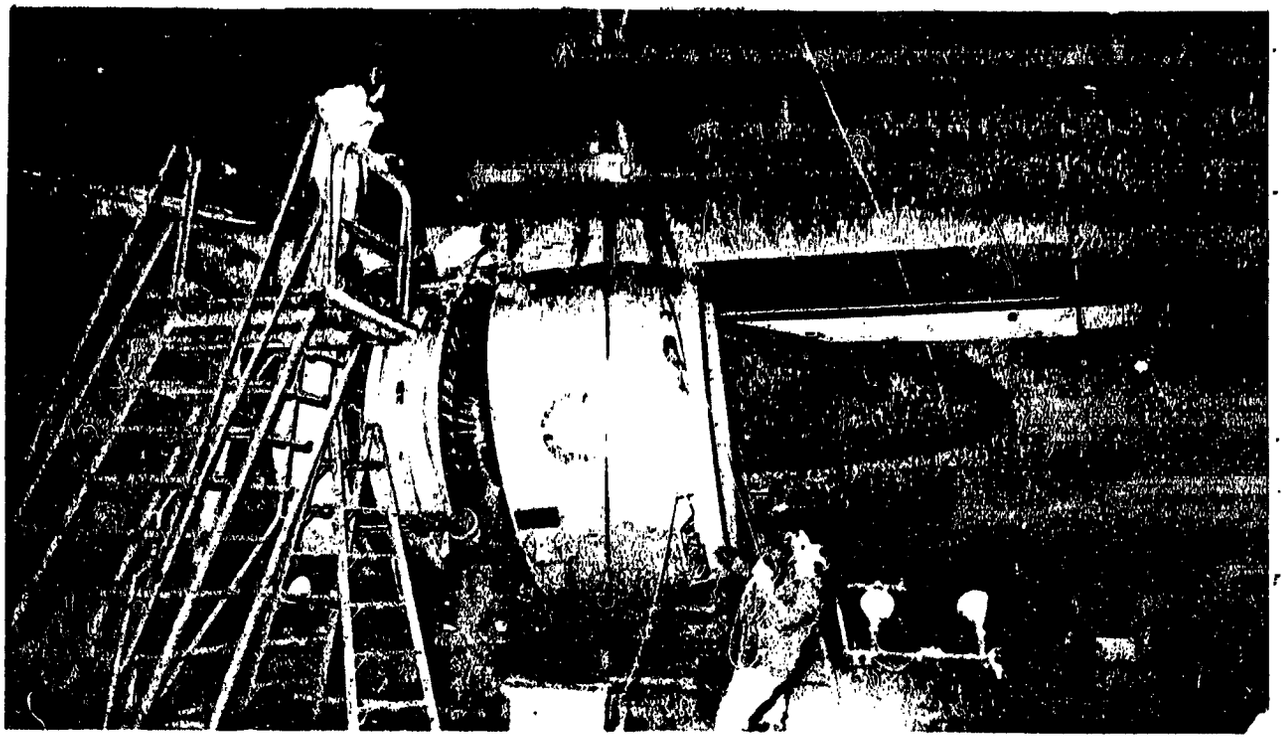
Figure 1. RA001 Test Airplane



125200-2

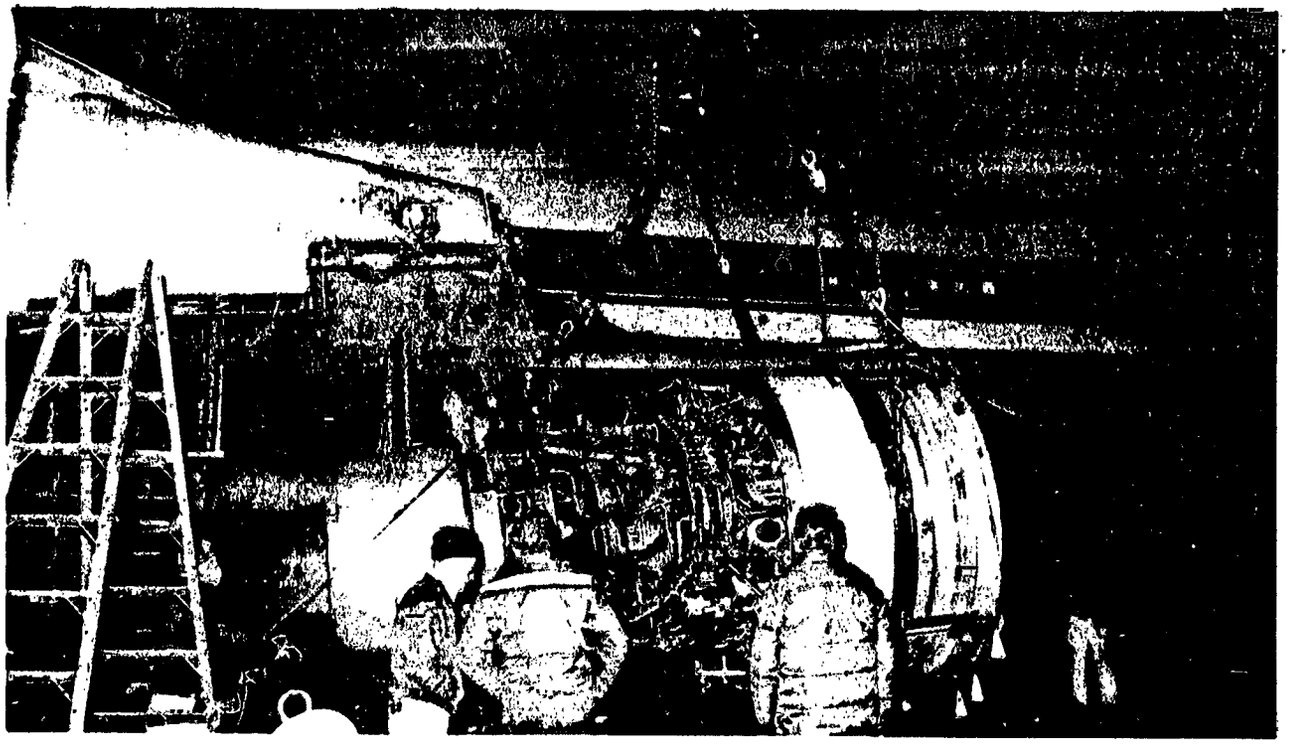
Figure 2. Inboard Engine Buildup

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



125209-3

Figure 3. Inboard Inlet Removal



125209-4

Figure 4. Inboard Engine Removal

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

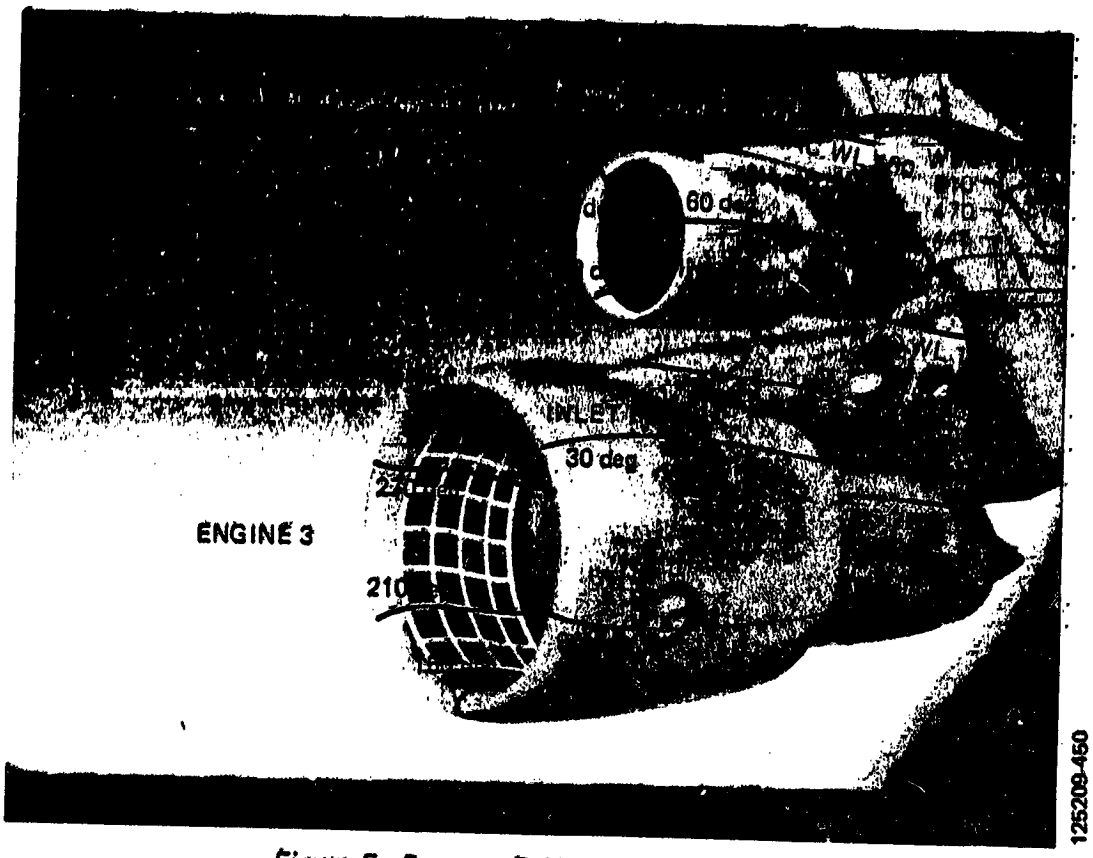


Figure 5. Pressure Orifice Configuration

Figure 6. Upper Wing Surface

Wing Geometry—Coordinates defining the wing cross-sectional profiles (table 1) are measured along and perpendicular to the wing reference plane (WRP). The WRP is an untwisted plane with 7-deg dihedral and +2-deg angle of incidence to the aircraft body centerline. The coordinates given in table 1 orient the wing profiles as they are in the no-load or jig position, so that the wing leading edges are not necessarily on WRP. See figure 7 for a plot of the jig wing twist. The in-flight wing twist, measured at 50% chord, varies with airplane Mach number and gross weight. In figure 7, the elastic wing twist is plotted for a Mach number of 0.86 at two representative airplane gross weights.

The spanwise location of each wing cross-sectional profile is denoted by a wing buttock line (WBL), which defines a plane perpendicular to the WRP (fig. 8). The relative fore and aft location of the wing cross-sectional profile at each WBL due to wing sweep is also shown in figure 8. Here, the leading-edge sweep angle is identified inboard and outboard of WBL 470 (inboard engine) and WBL 834 (outboard engine).

The leading-edge sweep angle is measured in the WRP relative to a line that is perpendicular to each WBL (470 and 834) and passes through the intersection of the WBL plane and the projection of the wing leading edge in the WRP (fig. 8). The wing leading-edge sweep is constant between WBL 445 and 834. However, it changes outboard of WBL 834 (outboard engine).

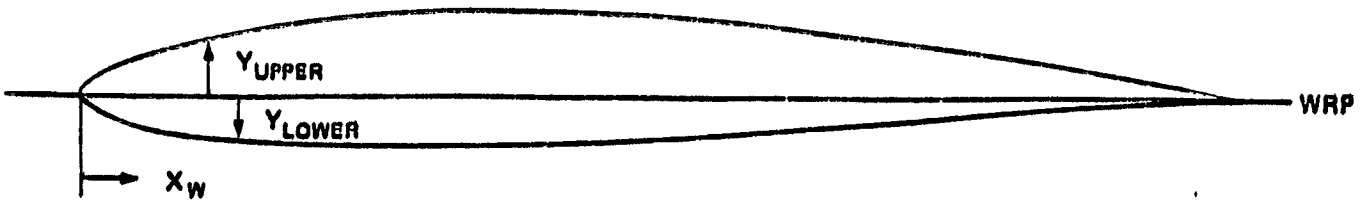
Also at WBL 834, a fairing extends from the outboard strut over the wing leading edge. Fairing coordinates given in table 1 are along the intersection of the WBL 834 plane and the fairing surface.

Engine Nacelle and Pylon Geometry—Coordinates defining engine nacelle and pylon geometry are given in a second coordinate system, the nacelle, which is shown in relation to the WRP in figures 8 and 9.

Pylon cross-sectional coordinates (tables 2 and 3) are measured along and perpendicular to the nacelle buttock line (NAC BL) 0.0, which defines a plane perpendicular to the WRP that is toed inboard 2-deg relative to the WBL plane (fig. 8). Depending on engine location, the origin of this 2-deg toe-in is at the intersection of the WBL 470/834 plane and the WRP at the projection of the WBL 470/834 wing profile leading edge. These profile leading edges are labeled T (figs. 8 and 9). A side view of the pylon and engine nacelle (fig. 9) shows that the pylon coordinates (tables 2 and 3) are contained in nacelle

ORIGINAL PAGE IS
OF POOR QUALITY

Table 1. Wing Coordinates



$X_W = 0$ @ WING LEADING EDGE

WBL 445 C_W = 989.78 cm (389.68 in)

$\frac{X_W}{C_W}$	$\frac{Y_{UPPER}}{C_W}$	$\frac{Y_{LOWER}}{C_W}$
0.00	-0.00206	0.00206
0.01	0.00901	0.00695
0.02	0.01414	0.00837
0.03	0.01791	0.00965
0.05	0.02333	0.01196
0.10	0.03198	0.01665
0.15	0.03790	0.02058
0.20	0.04234	0.02393
0.25	0.04550	0.02682
0.30	0.04783	0.02910
0.35	0.04953	0.03067
0.40	0.05032	0.03103
0.45	0.05002	0.03064
0.50	0.04902	0.02951
0.55	0.04712	0.02761
0.60	0.04401	0.02533
0.65	0.03996	0.02269
0.70	0.03493	0.01987
0.75	0.02915	0.01691
0.80	0.02338	0.01398
1.00	0.0	0.0

125209-24-168

ORIGINAL PAGE IS
OF POOR QUALITY

Table 1. Wing Coordinates (Continued)

WBL 510 C_W = 892.44 cm (351.35 in)		
$\frac{X_W}{C_W}$	$\frac{Y_{UPPER}}{C_W}$	$\frac{Y_{LOWER}}{C_W}$
0.00	-0.00126	0.00126
0.01	0.00928	0.00678
0.02	0.01429	0.00694
0.03	0.01796	0.00797
0.05	0.02331	0.00988
0.10	0.03210	0.01386
0.15	0.03828	0.01742
0.20	0.04289	0.02063
0.25	0.04622	0.02362
0.30	0.04870	0.02624
0.35	0.05060	0.02820
0.40	0.05180	0.02909
0.45	0.05208	0.02912
0.50	0.05154	0.02840
0.55	0.05023	0.02687
0.60	0.04779	0.02488
0.65	0.04429	0.02251
0.70	0.03999	0.01983
0.75	0.03488	0.01636
0.80	0.02877	0.01265
1.00	0.0	0.0

125209-24-169

ORIGINAL PAGE IS
OF POOR QUALITY

Table 1. Wing Coordinates (Continued)

WBL 470	C_W = 952cm (374.94 in)
X_W/C_W	Y_{UPPER}/C_W
0.00	-0.00171
0.10	0.03190
0.20	0.04246
0.30	0.04803
0.40	0.05078
0.50	0.04990
0.60	0.04539
0.70	0.03669
0.80	0.02528
1.00	0.0

WBL 834	C_W = 619.49cm (243.89 in)
X_W/C_W	Y_{UPPER}/C_W
0.00	0.0
0.10	0.03801
0.20	0.04797
0.30	0.05289
0.40	0.05551
0.50	0.05416
0.60	0.04937
0.70	0.04125
0.80	0.03009
1.00	0.0

FAIRING	
-0.128	-0.029
-0.087	-0.015
-0.028	0.005
0.037	0.015

125209-24-170

ORIGINAL PAGE IS
OF POOR QUALITY

Table 1. Wing Coordinates (Continued)

WBL 809 C_W = 640.29 cm (252.08 in)

$\frac{X_W}{C_W}$	$\frac{Y_{UPPER}}{C_W}$	$\frac{Y_{LOWER}}{C_W}$
0.00	0.0	0.0
0.01	0.01135	0.00464
0.02	0.01674	0.00536
0.03	0.02142	0.00599
0.05	0.02701	0.00722
0.10	0.03705	0.01043
0.15	0.04296	0.01377
0.20	0.04717	0.01706
0.25	0.05014	0.02011
0.30	0.05228	0.02269
0.35	0.05371	0.02440
0.40	0.05458	0.02511
0.45	0.05470	0.02491
0.50	0.05387	0.02400
0.55	0.05201	0.02249
0.60	0.04919	0.02023
0.65	0.04554	0.01817
0.70	0.04114	0.01558
0.75	0.03598	0.01297
0.80	0.03003	0.01037
1.00	0.0	0.0

125209-24-171

ORIGINAL PAGE IS
OF POOR QUALITY

Table 1. Wing Coordinates (Concluded)

WBL 870 C_W = 596.93 cm (235.01 in)		
$\frac{X_W}{C_W}$	$\frac{Y_{UPPER}}{C_W}$	$\frac{Y_{LOWER}}{C_W}$
0.00	-0.00140	0.00140
0.01	0.01034	0.00617
0.02	0.01591	0.00689
0.03	0.02008	0.00753
0.05	0.02723	0.00881
0.10	0.03685	0.01204
0.15	0.04298	0.01528
0.20	0.04715	0.01842
0.25	0.05017	0.02128
0.30	0.05234	0.02366
0.35	0.05383	0.02511
0.40	0.05476	0.02557
0.45	0.05498	0.02519
0.50	0.05417	0.02404
0.55	0.05238	0.02238
0.60	0.04966	0.02025
0.65	0.04608	0.01774
0.70	0.04183	0.01499
0.75	0.03685	0.01226
0.80	0.03093	0.00963
1.00	0.00140	-0.00140

125009-24-172

ORIGINAL PAGE IS
OF POOR QUALITY

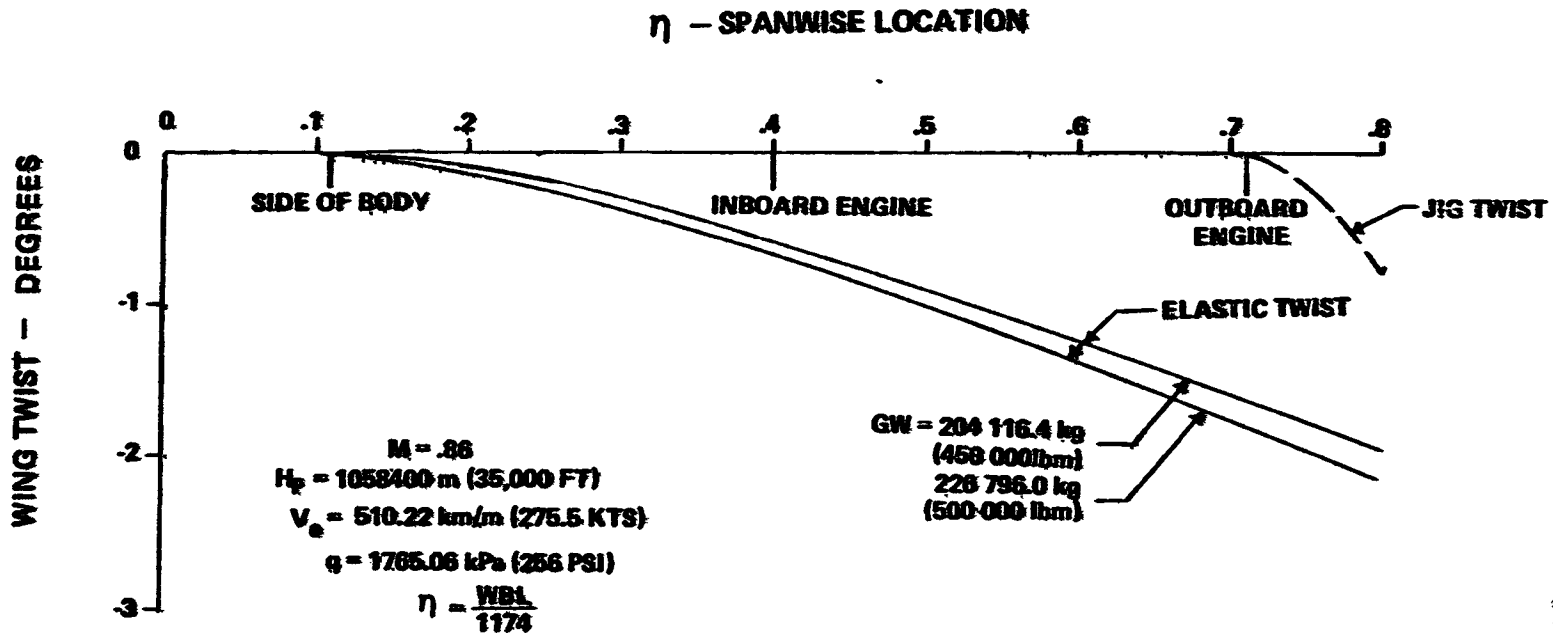
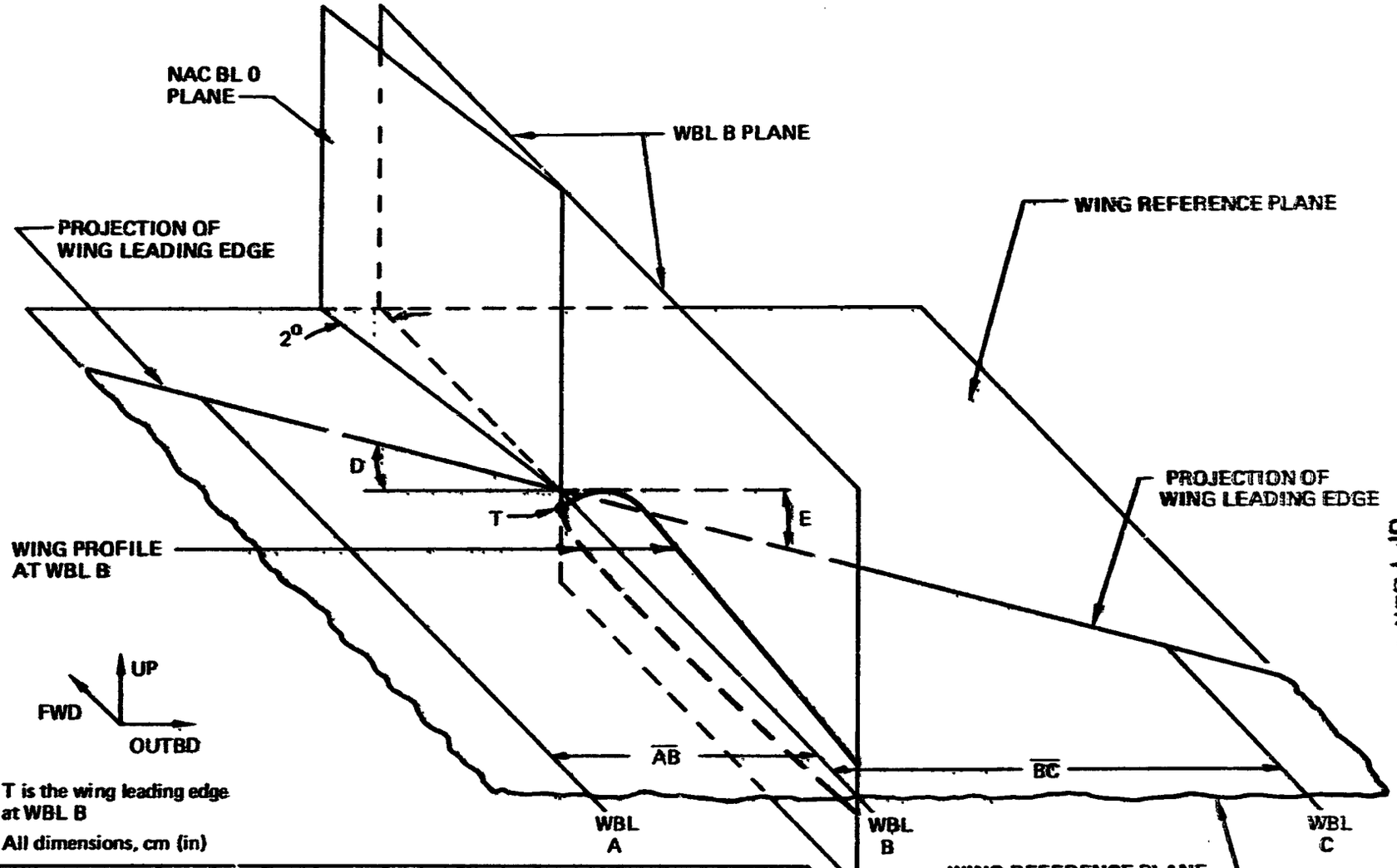


Figure 7. 747 Elastic Wing Twist

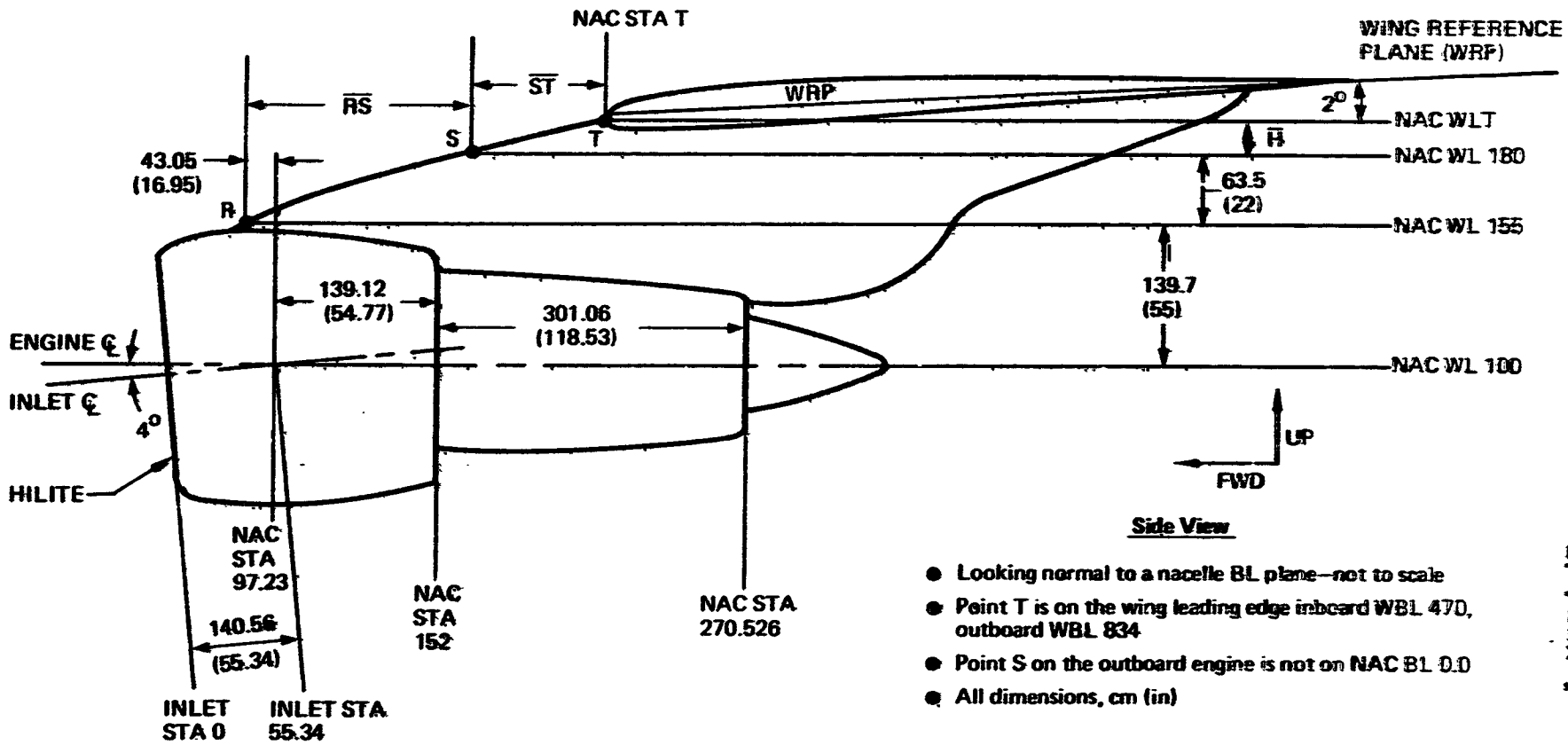


- T is the wing leading edge at WBL B
- All dimensions, cm (in)

Engine	A	B	C	$\overline{AB}$	$\overline{BC}$	D	E	$\overline{\text{WBL 470 WBL 834}}$
Inboard (No. 3)	445	470	510	63.5 (25.0)	101.6 (40.0)	42.30°	42.30°	924.56 (364.00)
Outboard (No. 4)	809	834	870	63.5 (25.0)	91.44 (36.0)	42.30°	39.66°	

Figure 8. Wing Coordinate System

ORIGINAL PAGE IS OF POOR QUALITY



Engine	$\overline{RS}$	$\overline{ST}$	$\overline{R_1}$	T
Inboard (No. 3)	242.11 (95.32)	102.92 (40.52)	32.66 (12.86)	NAC STA 216.12 NAC WL 192.86 NAC BL 0.0
Outboard (No. 4)	225.45 (88.76)	94.13 (37.06)	22.86 (9.00)	NAC STA 216.10 NAC WL 189.00 NAC BL 0.0

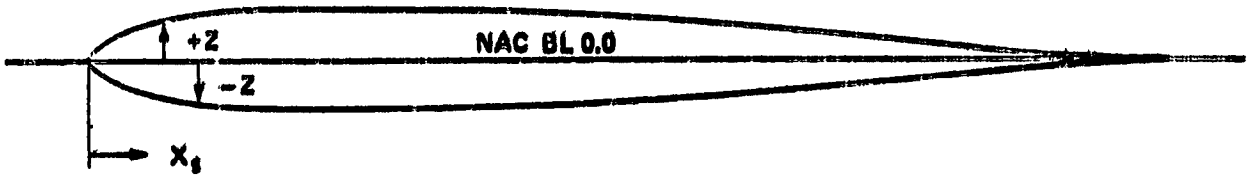
Figure 9. Nacelle Coordinate System

ORIGINAL PAGE IS OF POOR QUALITY

126384-463

ORIGINAL PAGE IS
OF POOR QUALITY

Table 2. Engine 3 Pylon Coordinates



NAC WL 155 C_s = 735.43cm (289.54 in)

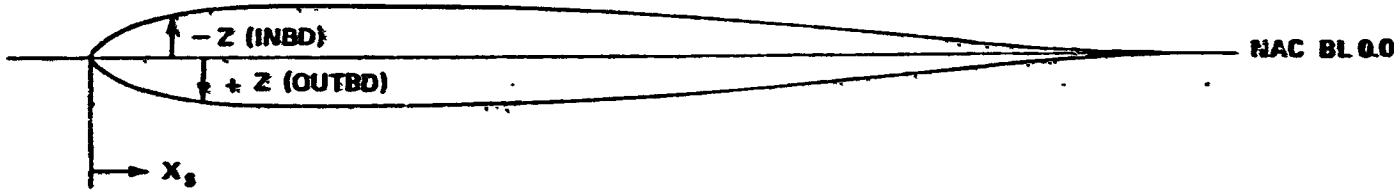
$\frac{X_s}{C_s}$	$\frac{\pm Z}{C_s}$
0.0	0.0
0.0163	0.01160
0.0336	0.01596
0.0508	0.01889
0.0681	0.02110
0.1199	0.02549
0.2063	0.03046
0.3099	0.03447
0.3962	0.03658
0.4826	0.03768
0.5344	0.03786
0.5689	0.03782
0.6725	0.03271
0.7589	0.02601
0.8970	0.01140
1.0	0.0

NAC WL 180 C_s = 722.91cm (284.61 in)

$\frac{X_s}{C_s}$	$\frac{\pm Z}{C_s}$
0.0	0.0
0.0155	0.01511
0.0330	0.02161
0.0506	0.02582
0.0857	0.03380
0.1033	0.03672
0.1209	0.03926
0.1560	0.04343
0.2087	0.04778
0.2614	0.05036
0.2966	0.05109
0.3493	0.05119
0.4722	0.05036
0.5074	0.04887
0.6479	0.03738
0.7886	0.02245
1.0	0.0

125309-24-173

Table 3. Engine 4 Pylon Coordinates



NAC WL 155 C_s = 684.30cm (269.41 in)

$\frac{X_s}{C_s}$	$\frac{\pm Z}{C_s}$
0.0	0.0
0.0361	0.01715
0.0546	0.02030
0.0732	0.02268
0.1289	0.02739
0.2217	0.03274
0.3330	0.03704
0.4258	0.03931
0.5186	0.04050
0.6300	0.03890
0.6671	0.03815
0.7228	0.03062
0.8156	0.02153
0.8898	0.01344
1.0	0.0

NAC WL 180 C_s = 608.46cm (239.55 in)

$\frac{X_s}{C_s}$	$\frac{+Z}{C_s}$	$\frac{-Z}{C_s}$
0.0	-0.01536	0.01536
0.0458	0.02150	0.03515
0.0666	0.02818	0.03707
0.0875	0.03323	0.03903
0.1084	0.03720	0.04099
0.1501	0.04396	0.04513
0.1710	0.04671	0.04721
0.2754	0.05677	0.05677
0.3380	0.05982	0.05982
0.3797	0.06070	0.06070
0.5884	0.04959	0.04959
0.6302	0.04483	0.04483
0.8180	0.02204	0.02204
0.96[illegible]2	0.00434	0.00434
0.9999	0.0	0.0

ORIGINAL PAGE IS
OF POOR QUALITY

125209-24-174

water line (NAC WL) planes, which are perpendicular to the NAC BL 0.0 plane and pitched up to 2 deg relative to the WRP.

The proper orientation of each NAC WL plane containing the coordinates in tables 2 and 3 is achieved by first locating the reference NAC WL T plane (fig. 9) which passes through the wing leading edge at WBL 470/834. The leading-edge point may be located relative to the WRP by using coordinates given in table 1. This reference NAC WL corresponds to NAC WL 192.86 for the inboard engine and NAC WL 189.00 for the outboard engine. Coordinates defining the pylon cross-sectional profile are given for both engine pylons at NAC WL 155 and NAC WL 180. These NAC WLs can be located from the reference NAC WL for each engine (fig. 9).

Each nacelle coordinate system is an isolated coordinate system. To provide for the proper position of each engine NAC WL relative to the other, the reference NAC WL plane must be positioned to account for the difference in elevation between the inboard and outboard engine installations due to WRP dihedral.

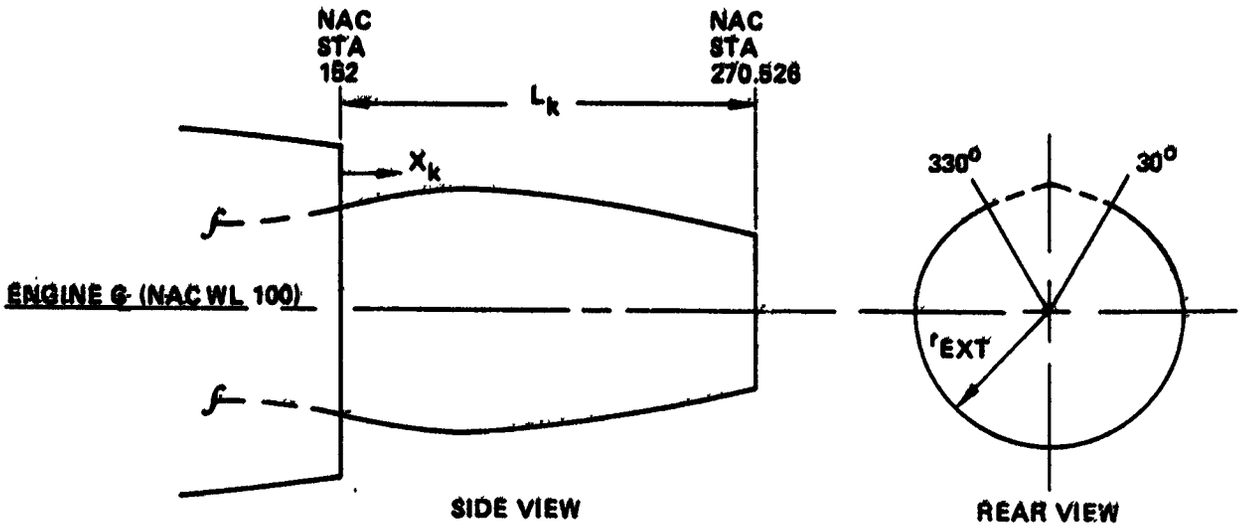
The fore and aft positions of NAC WL 155 and 180 profiles on each pylon are found by locating a reference nacelle station (NAC STA) passing through the wing leading-edge point at WBL 470 (inboard) or WBL 834 (outboard). Lines representing NAC STA are perpendicular to the intersection of a NAC WL plane and NAC BL 0.0 plane; distances between NAC STA are measured parallel to the intersection. At point T, the NAC STA reference for the inboard pylon is 216.12; for the outboard pylon, 206.10 (fig. 9).

The outboard pylon pressure port row at NAC WL 180 has an unsymmetric profile (table 3). The contour of the fairing at WBL 834 shifts the pylon leading edge to the inboard side of NAC BL 0.0.

The inlet, fan cowl, and core cowl surface geometries are the same on both engines. Each engine centerline is coincident with NAC WL 100. The core cowl is a body of revolution between 30 and 330 deg (table 4). This cowl is defined by radii measured from NAC WL 100 at points between NAC STA 152 and NAC STA 270.526. The inlet and fan cowl profiles are given along constant inlet angles measured about the inlet centerline, which lies in the NAC BL 0.0 plane, pitched down (drooped) 4 deg relative to the engine centerline at NAC STA 97.23 (fig. 9). The fan inlet cross-sectional profile coordinates (table 5) are measured along and perpendicular to the inlet axis for five circumferential

ORIGINAL PAGE IS
OF POOR QUALITY

Table 4. Engines 3 and 4 Core Cowl Coordinates



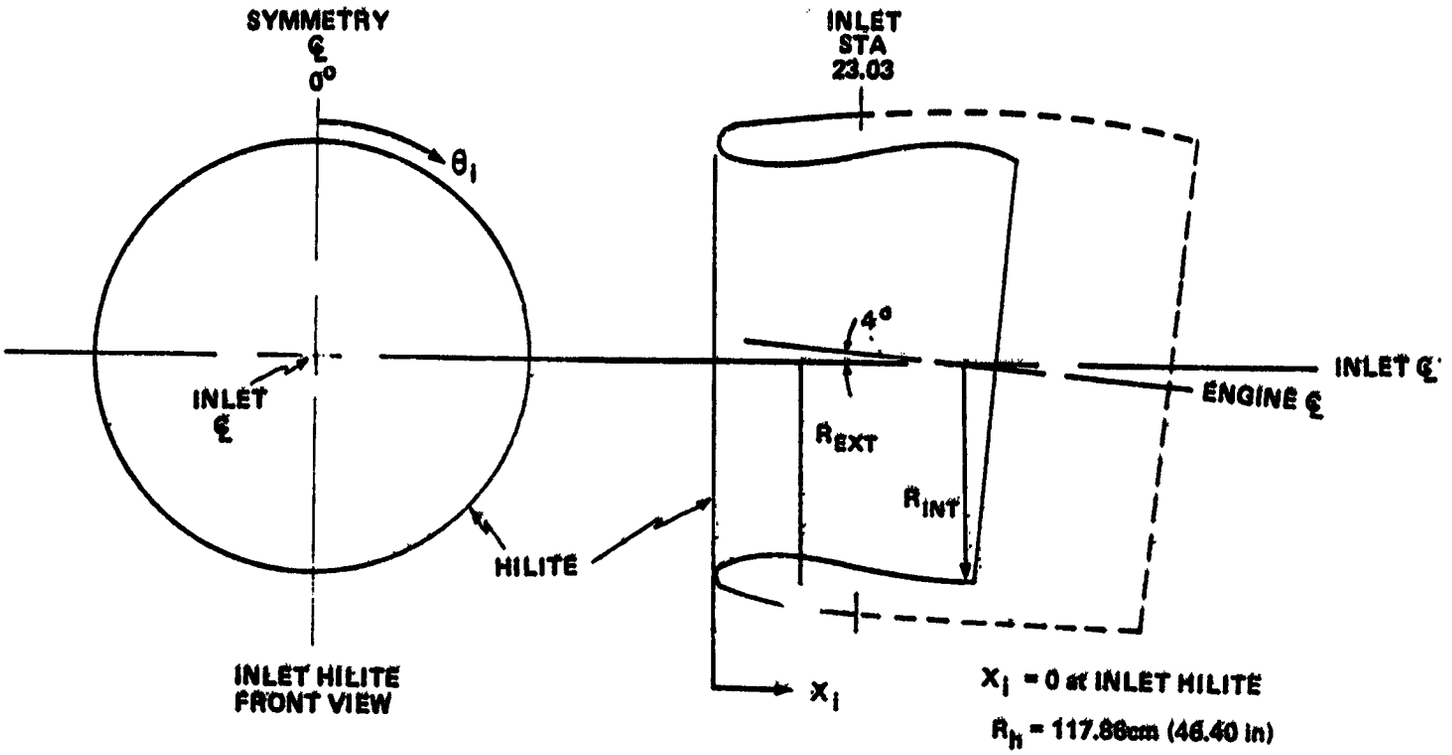
X_k = 0 at NAC STA 152, L_k = 301.07 cm (118.53 in)

X_k/L_k	r_{EXT}/L_k	X_k/L_k	r_{EXT}/L_k
0.0	0.2867	0.6834	0.2602
0.0338	0.2858	0.6918	0.2592
0.1519	0.2829	0.7003	0.2582
0.2362	0.2811	0.7425	0.2528
0.2953	0.2799	0.7762	0.2481
0.3797	0.2782	0.8100	0.2429
0.4472	0.2764	0.8353	0.2388
0.4978	0.2746	0.8690	0.2329
0.5315	0.2708	0.9028	0.2257
0.5653	0.2696	0.9196	0.2216
0.5822	0.2697	0.9534	0.2158
0.6243	0.2696	0.9956	0.2080
0.6497	0.2638	1.0000	0.2070

125209-26-179

ORIGINAL PAGE IS
OF POOR QUALITY

Table 5. Engines 3 and 4 Inlet Coordinates



$\theta_i = 30$

X_i/R_h	R_{EXT}/R_h	R_{INT}/R_h
0.2661		0.8957
0.1853		0.8991
0.1196		0.9094
0.0776		0.9217
0.0302		0.9461
0.0037		0.9786
0.0	1.0000	1.0000
0.0069	1.0158	
0.0248	1.0303	
0.0647	1.0493	
0.1379	1.0714	
0.2185	1.0877	
0.3448	1.1061	
0.4963	1.1200	

$\theta_i = 60$

X_i/R_h	R_{EXT}/R_h	R_{INT}/R_h
1.2874		1.0000
1.1222		1.0072
0.7813		0.9546
0.5563		0.9158
0.4019		0.8998
0.2661		0.8957
0.1196		0.9094
0.0302		0.9461
0.0	1.0000	1.0000
0.0647	1.0493	
0.1379	1.0714	
0.3448	1.1061	
0.4963	1.1200	

125208-24-175

Table 5. Engines 3 and 4 Inlet Coordinates (Concluded)

$\theta_i = 90$

X_i / R_h	R_{EXT} / R_h	R_{INT} / R_h
0.2651		0.8957
0.1853		0.8991
0.1196		0.9094
0.0776		0.9217
0.0302		0.9461
0.0037		0.9786
0.0	1.0000	1.0000
0.0069	1.0158	
0.0248	1.0303	
0.0647	1.0493	
0.1379	1.0714	
0.2155	1.0877	
0.3448	1.1061	
0.4963	1.1200	

$\theta_i = 150$

X_i / R_h	R_{EXT} / R_h	R_{INT} / R_h
0.2651		0.8957
0.1853		0.9004
0.1196		0.9126
0.0776		0.9261
0.0302		0.9518
0.0037		0.9829
0.0	1.0000	1.0000
0.0069	1.0158	
0.0248	1.0303	
0.0647	1.0493	
0.1379	1.0714	
0.2155	1.0877	
0.3448	1.1061	
0.4963	1.1200	

$\theta_i = 180$

X_i / R_h	R_{EXT} / R_h	R_{INT} / R_h
1.1822		1.0044
1.1222		1.0072
0.7813		0.9546
0.5563		0.9158
0.4019		0.8998
0.2651		0.8957
0.1196		0.9126
0.0302		0.9518
0.0	1.0000	1.0000
0.0647	1.0493	
0.1379	1.0714	
0.3448	1.1061	
0.4963	1.1200	

ORIGINAL PAGE IS
OF POOR QUALITY

125209-24-176

angles measured about the inlet centerline. At these same inlet angles, the fan cowl cross-sectional profiles are defined relative to the engine centerline. Coordinates in table 6 give the angle about the engine centerline for each point with the distance to the surface measured along and perpendicular to NAC WL 100.

Pylon-fan cowl, pylon-core cowl, and wing-pylon intersections are defined along axes of the nacelle coordinate system (tables 7 through 10). These tables include the information necessary to locate these intersections. The pylon-core cowl intersection is separated into three sections between NAC STA 220 and 270.526 to define a pylon-core cowl fairing surface (table 10).

The pressure orifice positions on the defined profiles are given in tables 11 through 16. A pressure orifice is found in the profile plane at the intersection of the aircraft surface and a line normal to the X direction at the nondimensional position given by X/C or X/L.

4.1.2 Instrumentation

The NAIL program was an ambitious undertaking in terms of number of measurements obtained. There were 693 pressure measurements, 30 accelerometers, 7 rate gyros, 12 blade clearance measurements, and 20 thermocouples for required test data. Numerous thermocouples were used to provide temperature information on heat-sensitive instrumentation. Finally, expanded engine performance data were provided by an additional 68 measurement channels. The quantity and quality of the data obtained were excellent.

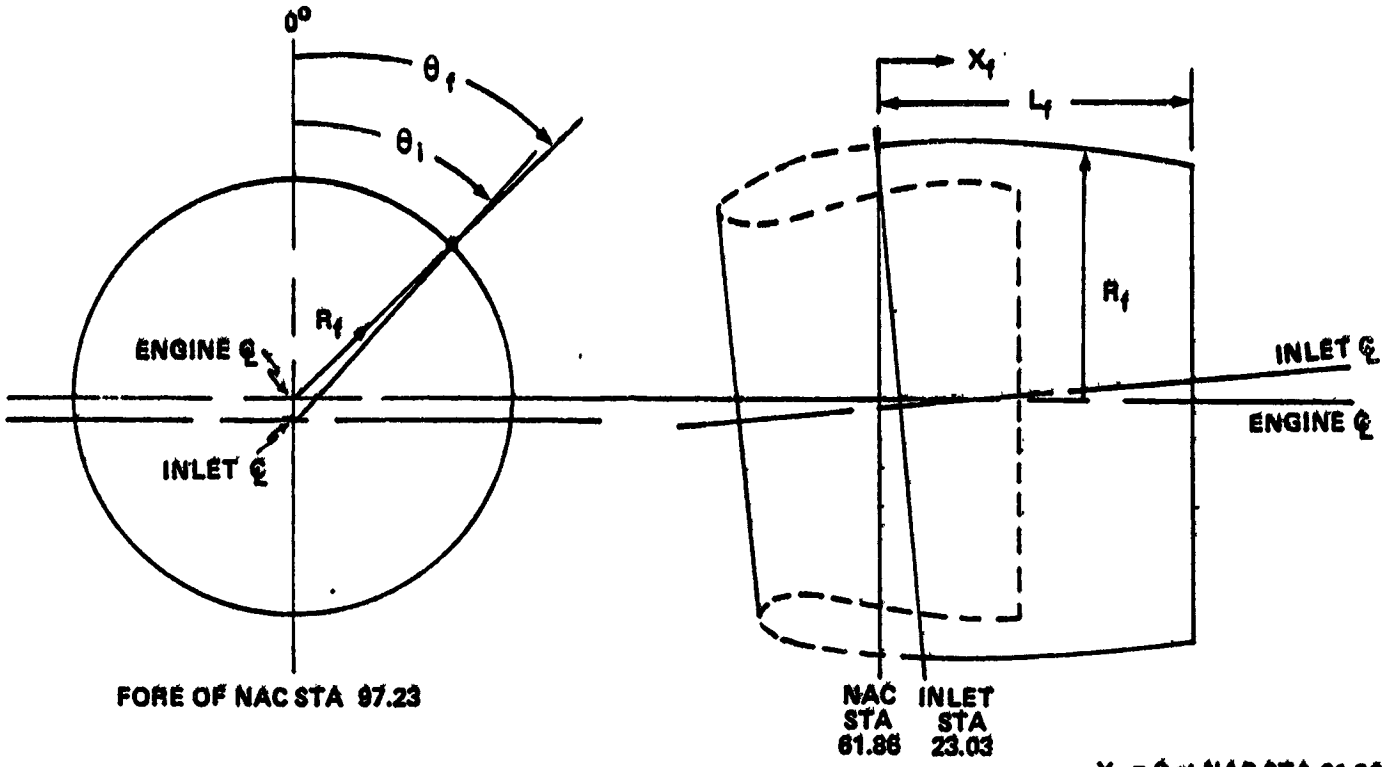
Instrumentation placed on or near the numbers 3 and 4 engine and pylon was designed to further the understanding of the flight loads (cause) and engine clearance changes (effect) associated with engine deterioration and to provide information on the flight environment of the engine and wing interface.

4.1.2.1 Flight Loads

Pressure Instrumentation—Most of the pressure instrumentation was placed on the inlet of engine 3 (figs. 10 and 11). It was believed that the inboard engine was subject to higher angles of attack than the outboard engine because wing bending reduced the incidence of the outboard nacelle and because the outboard nacelle was less affected by upflow induced by the wing flaps. Therefore, the inboard nacelle sustained greater loads and was chosen for a more detailed survey using 252 pressure taps.

ORIGINAL PAGE IS
OF POOR QUALITY

Table 6. Engines 3 and 4 Fan Cowl Coordinates



X_f = 0 at NAC STA 61.86
L_f = 228.96cm (90.14 in)

$\theta_i = 30$

θ_f	$\frac{X_f}{L_f}$	$\frac{R_f}{L_f}$
31.356	0.0	0.5640
30.928	0.1126	0.5663
30.568	0.2123	0.5732
29.975	0.3821	0.5771
29.261	0.5851	0.5675
28.483	0.7892	0.5447
28.168	0.8669	0.5358
27.579	1.0000	0.5148

$\theta_i = 60$

θ_f	$\frac{X_f}{L_f}$	$\frac{R_f}{L_f}$
62.262	0.0147	0.5641
61.634	0.1126	0.5727
60.020	0.2123	0.5781
60.001	0.3821	0.5802
58.843	1.0000	0.5148

ORIGINAL PAGE IS
OF POOR QUALITY

Table 6. Engines 3 and 4 Fan Cowl Coordinates (Concluded)

$\theta_i = 90$

θ_f	$\frac{X_f}{L_f}$	$\frac{R_f}{L_f}$
92.483	0.0349	0.5771
91.929	0.1125	0.5816
91.234	0.2123	0.5846
90.071	0.3821	0.5835
88.642	0.5851	0.5685
87.080	0.7892	0.5446
86.449	0.8669	0.5358
85.265	1.0000	0.5148

$\theta_i = 150$

θ_f	$\frac{X_f}{L_f}$	$\frac{R_f}{L_f}$
151.141	0.0697	0.5973
150.997	0.1125	0.5974
150.665	0.2123	0.5957
150.096	0.3821	0.5865
149.383	0.5851	0.5687
148.603	0.7892	0.5446
148.289	0.8669	0.5358
147.700	1.0000	0.5148

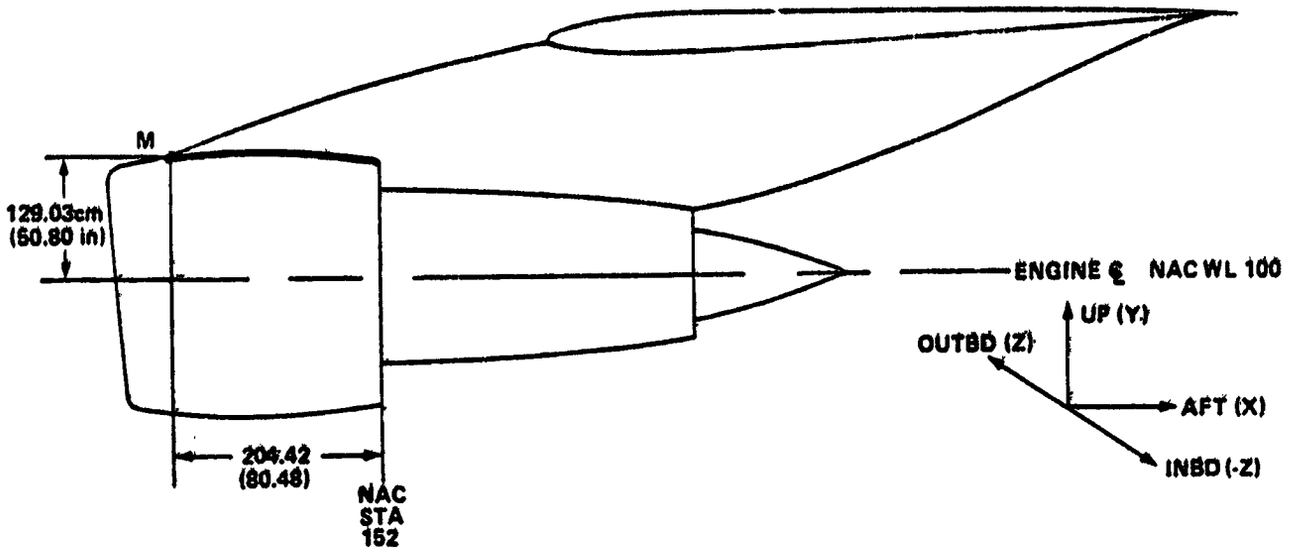
$\theta_i = 180$

θ_f	$\frac{X_f}{L_f}$	$\frac{R_f}{L_f}$
180.000	0.0771	0.6001
180.000	0.1125	0.6000
180.000	0.2123	0.5975
180.000	0.3821	0.5867
180.000	1.0000	0.5148

125209-26-178

ORIGINAL PAGE IS
OF POOR QUALITY

Table 7. Engines 3 and 4 Pylon-Fan Cowl Intersection



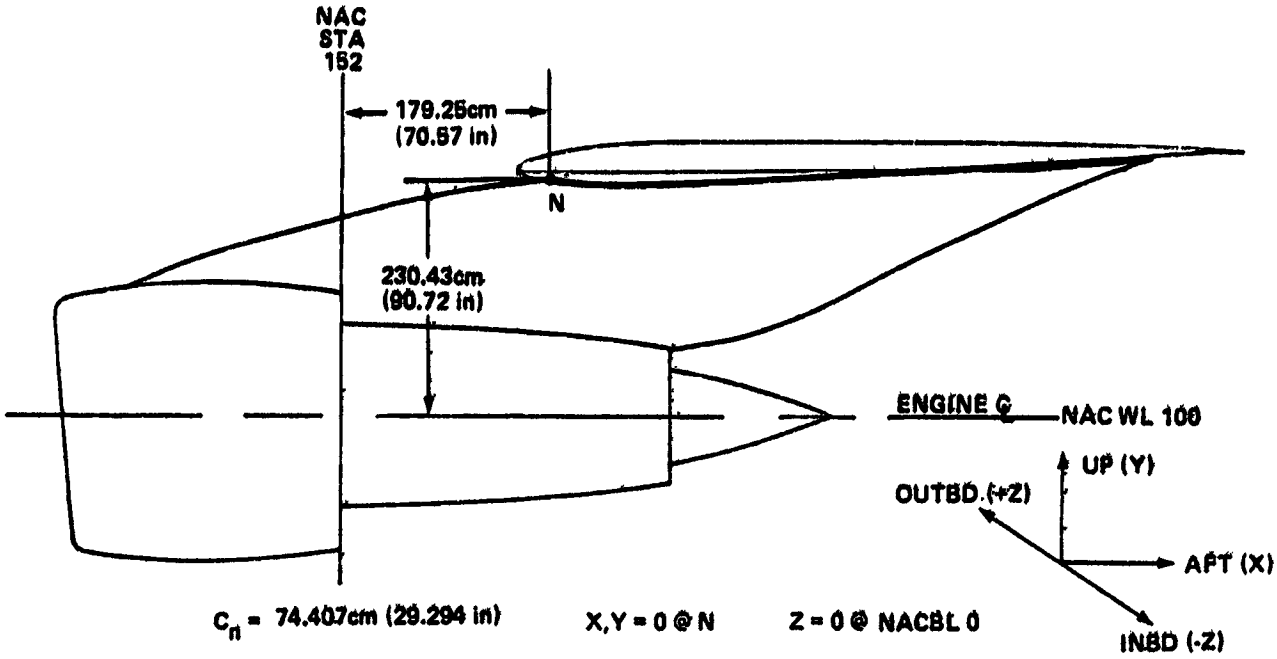
C_m = 206.080 cm (81.134 in) X, Y = 0 @ m Z = 0 @ NAC BL 0

X/C_m	Y/C_m	$\pm Z/C_m$
0.0	0.0	0.0
0.1661	0.00801	0.0620
0.2894	0.00900	0.0779
0.4127	0.00579	0.0886
0.5359	-0.00345	0.0959
0.6715	-0.02305	0.1019
0.8437	-0.04055	0.1071
0.9919	-0.06471	0.1090

125209-26-181

ORIGINAL PAGE IS
OF POOR QUALITY

Table 8. Engine 3 Wing-Pylon Intersection



OUTBOARD

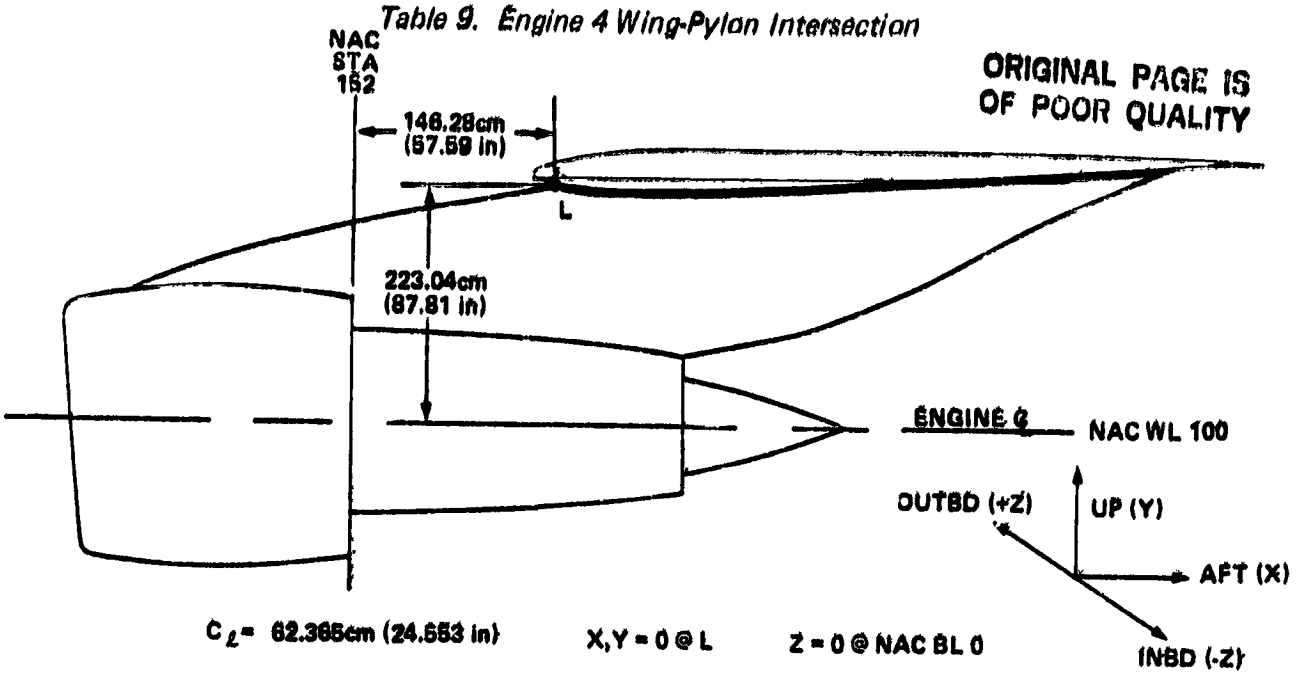
X/C_n	Y/C_n	Z/C_n
0.0000	-0.0751	0.0000
0.0075	-0.0297	0.0051
0.0553	0.0703	0.0133
0.1167	0.1369	0.0167
0.2195	0.2123	0.0181
0.3304	0.2762	0.0171
0.4909	0.3451	0.0133
0.6923	0.4117	0.0068
1.0077	0.4813	-0.0038
1.8171	0.5456	-0.0324
4.5412	0.4772	-0.0922
5.3294	0.4120	-0.0802
6.1500	0.3400	-0.0485
6.9789	0.2748	0.0024
8.0122	0.2014	0.0830
8.9316	0.1369	0.1648
9.5572	0.0679	0.2284
10.0000	0.0000	0.2745

INBOARD

X/C_n	Y/C_n	Z/C_n
0.0000	-0.0751	0.0000
0.0109	-0.1375	-0.0089
0.0536	-0.2048	-0.0205
0.1403	-0.2751	-0.0348
0.2823	-0.3458	-0.0509
0.4909	-0.4120	-0.0690
0.8462	-0.4793	-0.0915
1.7044	-0.5318	-0.1260
3.5137	-0.5179	-0.1526
4.2818	-0.4803	-0.1417
5.2533	-0.4100	-0.1048
6.0623	-0.3441	-0.0608
6.9789	-0.2758	0.0048
8.0122	-0.2038	0.0884
8.9316	-0.1379	0.1703
9.5572	-0.0690	0.2311
10.000	0.0000	0.2745

126209-26-182

Table 9. Engine 4 Wing-Pylon Intersection



ORIGINAL PAGE IS OF POOR QUALITY

CUTBOARD

X/C_ℓ	Y/C_ℓ	Z/C_ℓ
0.0000	-0.0411	0.0000
0.0049	0.0000	0.0024
0.0468	0.0856	0.0065
0.1275	0.1654	0.0086
0.2366	0.2342	0.0094
0.4411	0.3275	0.0081
0.6920	0.4114	0.0049
1.0048	0.4891	-0.0004
1.5318	0.5747	-0.0118
2.5910	0.6337	-0.0391
3.5804	0.5967	-0.0546
4.0138	0.5653	-0.0509
4.8597	0.4883	-0.0216
5.6588	0.4077	-0.0209
6.4273	0.3340	0.0863
7.3498	0.2484	0.1682
8.2727	0.1637	0.2501
9.1952	0.0786	0.3319
10.0000	0.0045	0.4036

INBOARD

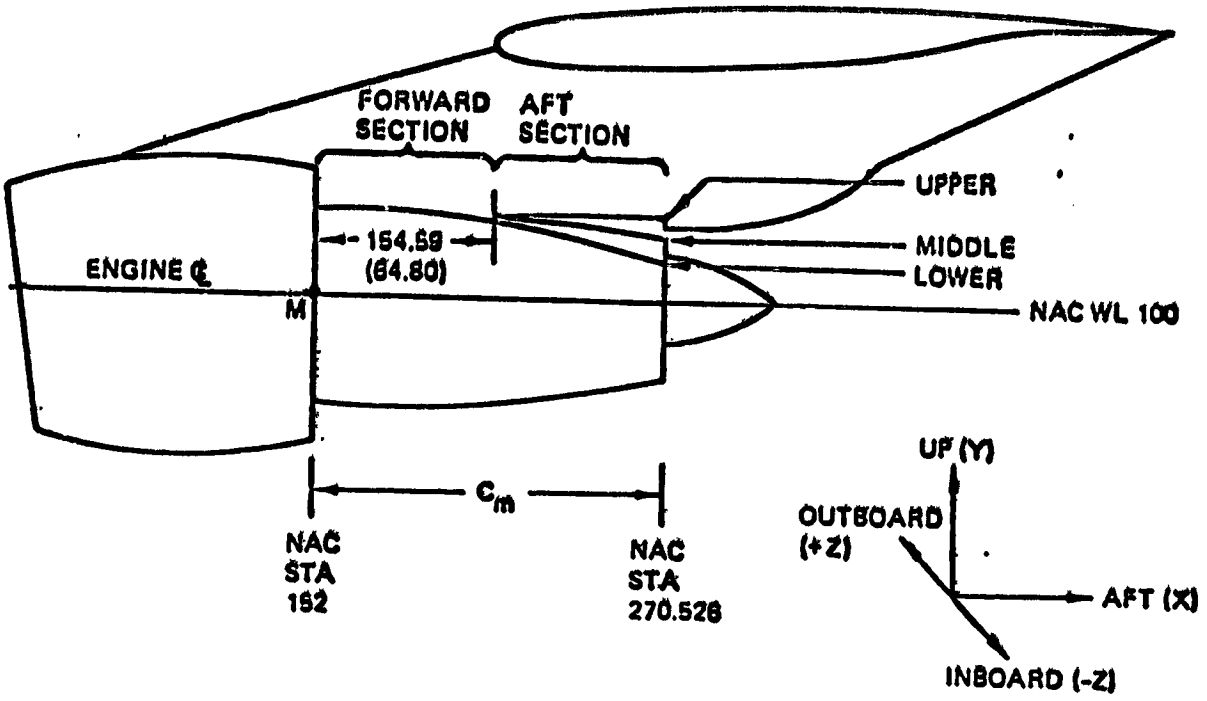
X/C_ℓ	Y/C_ℓ	Z/C_ℓ
0.0000	-0.0411	0.0000
0.0053	-0.0819	-0.0029
0.0525	-0.1637	-0.0090
0.1592	-0.2484	-0.0171
0.3063	-0.3234	-0.0261
0.5441	-0.4085	-0.0383
0.8590	-0.4863	-0.0521
1.4096	-0.5698	-0.0729
2.5093	-0.6256	-0.0949
3.8724	-0.5735	-0.0644
4.9143	-0.4863	-0.0069
5.6588	-0.4134	0.0452
6.5813	-0.3258	0.1197
7.5038	-0.2391	0.1959
8.2727	-0.1686	0.2598
9.1952	-0.0823	0.3364
9.9943	-0.0053	0.4032

125209-26-183

Table 10: Pylon-Core Cowl Intersection (To Be Submitted in Final Report)

ORIGINAL PAGE IS
OF POOR QUALITY

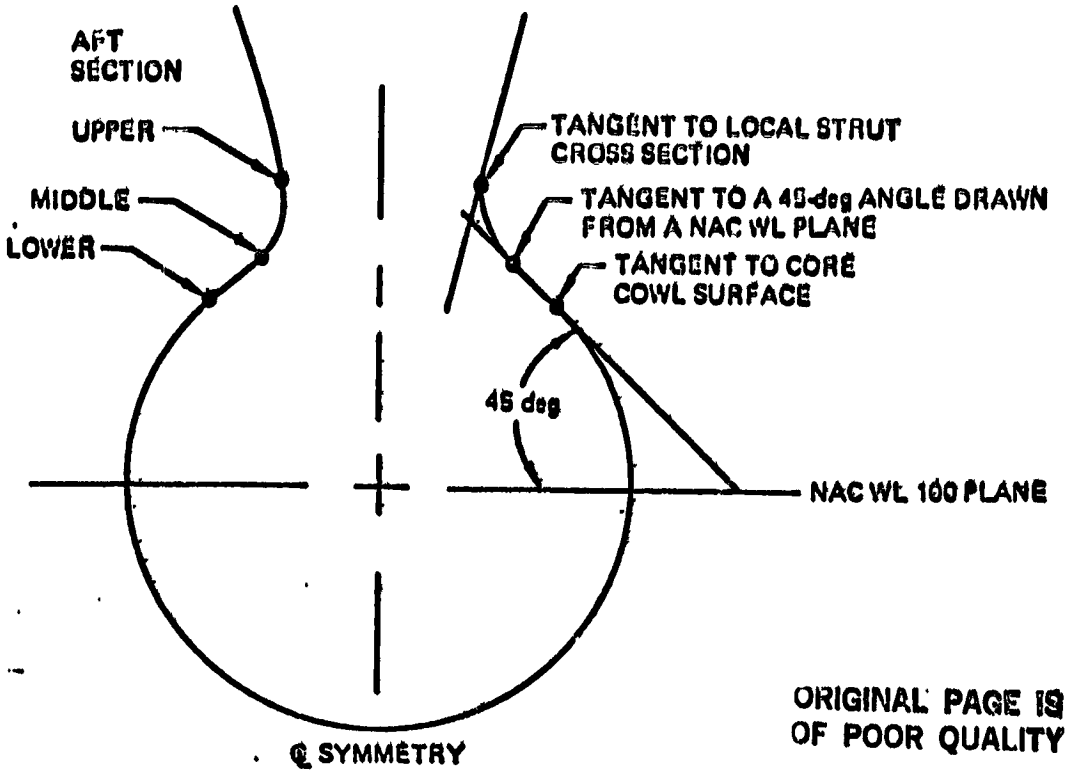
Table 10. Pylon-Core Cowl Intersection



C_m = 301.056 cm (118.526 in) X, Y = 0 at M Z = 0 at NAC BL 0

FORWARD SECTION		
X_m/C_m	Y_m/C_m	$\pm Z_m/C_m$
0.0000	0.2797	0.0636
0.0377	0.2788	0.0638
0.0697	0.2780	0.0640
0.1336	0.2773	0.0643
0.1976	0.2771	0.0647
0.2296	0.2771	0.0649
0.2935	0.2771	0.0651
0.3575	0.2770	0.0653
0.3894	0.2769	0.0653
0.4454	0.2764	0.0653
0.4909	0.2754	0.0650
0.5402	0.2738	0.0631

Table 10. Pylon-Core Cowl Intersection (Concluded)



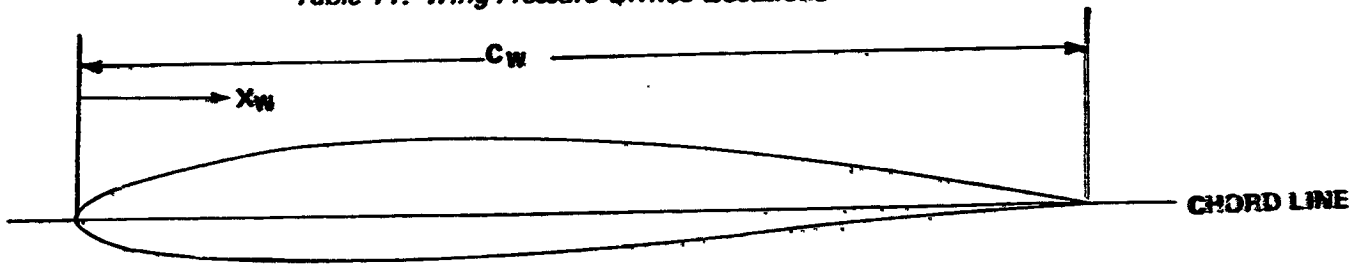
ORIGINAL PAGE IS OF POOR QUALITY

TYPICAL CROSS SECTION IN AFT SECTION OF STRUT-CORE COWL INTERSECTION

C_m = 301.056 cm (118.526 in) X, Y = 0 at M Z = 0 at NAC BL 0

AFT SECTION						
UPPER			MIDDLE		LOWER	
X_m/C_m	Y_m/C_m	$\pm Z_m/C_m$	Y_m/C_m	$\pm Z_m/C_m$	Y_m/C_m	$\pm Z_m/C_m$
0.5737	0.2775	0.0621	0.2724	0.0639	0.2685	0.0709
0.6189	0.2834	0.0604	0.2696	0.0657	0.2618	0.0782
0.6581	0.2895	0.0582	0.2652	0.0672	0.2551	0.0827
0.7003	0.2955	0.0555	0.2594	0.0683	0.2484	0.0849
0.7159	0.2972	0.0543	0.2574	0.0681	0.2459	0.0861
0.7333	0.2980	0.0534	0.2550	0.0676	0.2432	0.0854
0.7425	0.2985	0.0532	0.2540	0.0672	0.2418	0.0852
0.7846	0.2939	0.0495	0.2460	0.0641	0.2348	0.0837
0.8268	0.2887	0.0458	0.2415	0.0597	0.2284	0.0807
0.8690	0.2786	0.0475	0.2349	0.0540	0.2218	0.0756
0.9112	0.2663	0.0394	0.2278	0.0473	0.2151	0.0690
0.9534	0.2542	0.0300	0.2194	0.0405	0.2082	0.0611
0.9956	0.2410	0.0247	0.2109	0.0337	0.2012	0.0528
1.0000	0.2394	0.0240	0.2096	0.0332	0.2013	0.0485

Table 11. Wing Pressure Orifice Locations

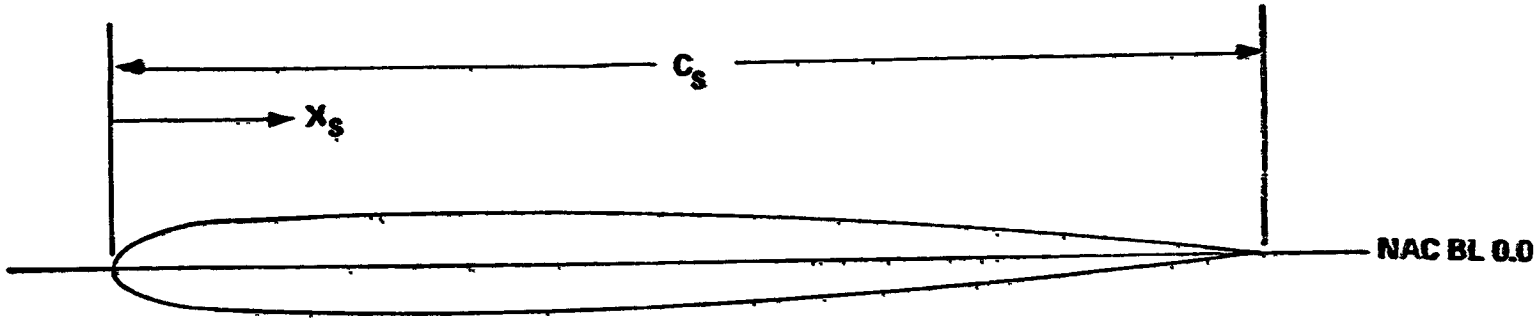


X MEASURED ALONG CHORD LINE
X_W/C_W TOLERANCE ±0.0005

WBL 445		WBL 470	WBL 510		WBL 809		WBL 834	WBL 870	
X_W/C_W		X_W/C_W	X_W/C_W		X_W/C_W		X_W/C_W	X_W/C_W	
UPPER	LOWER	UPPER	UPPER	LOWER	UPPER	LOWER	UPPER	UPPER	LOWER
FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH
0.0100	0.0099	0.1090	0.0100	0.0100	0.0100	0.0100	0.1200	0.0100	0.0089
0.0200	0.0223		0.0200	0.0207	0.0190	0.0165		0.0200	0.0189
0.0300	0.0300	BELT	0.0300	0.0309	0.0300	0.0300	BELT	0.0300	0.0284
0.0500	0.0487	0.2000	0.0500	0.0500	0.0500	0.0500	0.2405	0.0500	0.0489
0.0750	0.1000	0.3000	0.0750	0.1000	0.0750	0.1015	0.3000	0.0734	0.0723
0.1000	0.1500	0.4000	0.1000	0.1472	0.1000	0.1500	0.4000	0.1000	0.1000
0.1500		0.5000	0.1500		0.1500		0.5000	0.1500	0.1500
BELT	BELT	0.6000	BELT	BELT	BELT	BELT	0.6000	BELT	BELT
0.2000	0.1950		0.2000	0.1972	0.2000	0.2000		0.2000	0.2043
0.2250	0.2453		0.2250	0.2472	0.2250	0.2500		0.2250	0.2543
0.2500	0.2953		0.2500	0.2972	0.2466	0.3000		0.2500	0.3043
0.2750	0.3453		0.2750	0.3472	0.3000	0.3500		0.3000	0.3543
0.3043	0.3953		0.3000	0.3972	0.3500	0.4000		0.3500	0.4043
0.3543	0.4454		0.3500	0.4472	0.4000	0.4500		0.4000	0.4543
0.4037	0.4954		0.4000	0.4972	0.4500	0.5000		0.4500	0.5043
0.4538	0.5455		0.4500	0.5472	0.5000	0.5500		0.4750	0.5543
0.4750	0.5955		0.4750	0.5972	0.5250	0.6000		0.5000	0.6043
0.5060	0.6455		0.5000	0.6472	0.5500	0.6500		0.5250	0.6543
0.5250			0.5200		0.6000			0.5500	
0.5554			0.5500		0.6500			0.6000	
0.6049			0.6000		0.7000			0.6500	
0.6551			0.6500		0.7500			0.7000	
0.7049			0.7000		0.8000				
0.7552									
0.8049									

ORIGINAL PAGE IS
OF POOR QUALITY

Table 12. Engine 3 Pylon Pressure Orifice Locations



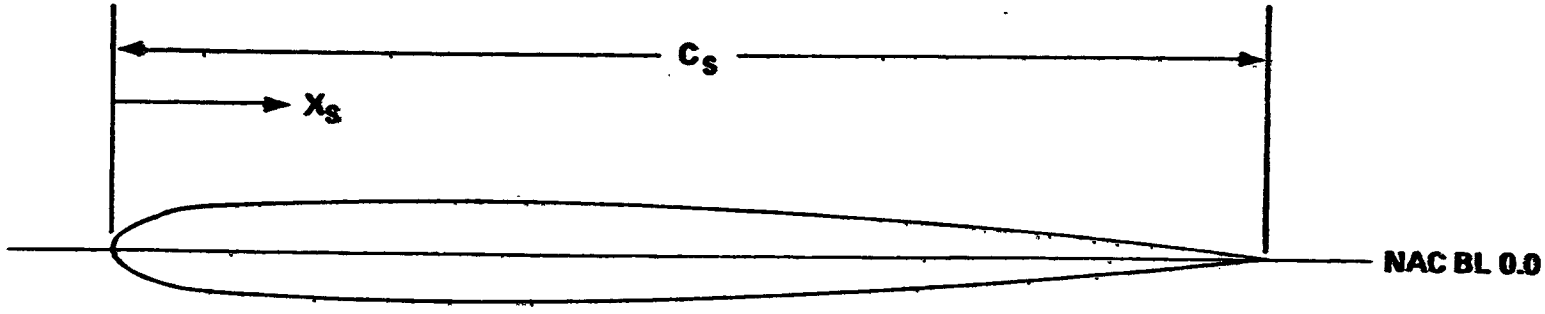
X MEASURED ALONG NAC BL 0.0

X_S/C_S TOLERANCE ±0.0005

NAC WL 155	NAC WL 180
X_S / C_S	X_S / C_S
INBD AND OUTBD	INBD AND OUTBD
0.0163	0.0169
0.0349	0.0330
0.0508	0.0506
0.0750	0.0752
0.1234	0.9898
0.2146	0.1279
0.3043	0.1600
0.3938	0.2136
0.4865	0.2614
0.5392	0.2966
0.5724	0.3493
0.6207	0.4757
0.6725	0.6514
0.7589	0.7885
0.8279	
0.9005	

ORIGINAL PAGE IS
OF POOR QUALITY

Table 13. Engine 4 Pylon Pressure Orifice Locations



X MEASURED ALONG NAC BL 0.0

X_S/C_S TOLERANCE ±0.0005

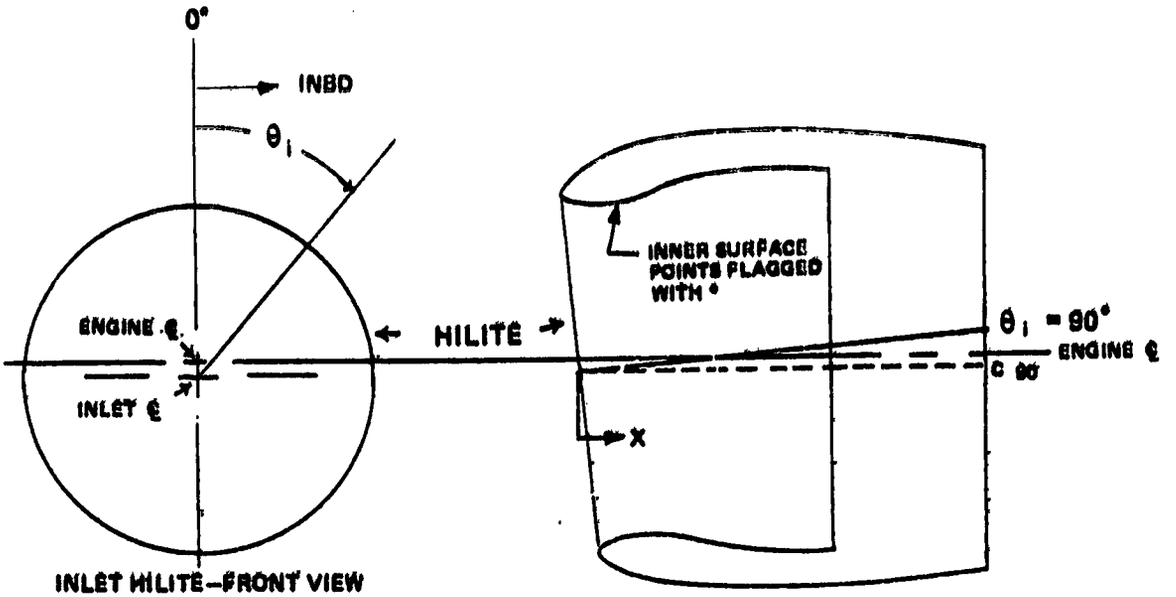
NAC WL 180	NAC WL 155
X_S / C_S	X_S / C_S
INBD AND OUTBD	INBD AND OUTBD
0.0175	0.0474
0.0375	0.0666
0.0546	0.0875
0.0896	0.1092
0.1326	0.1460
0.2306	0.1793
0.3321	0.2169
0.4295	0.2837
0.5229	0.3371
0.5762	0.3785
0.6237	0.4423
0.6671	0.5991
0.7228	0.8158
0.8156	0.9641
0.8898	
0.9677	

ORIGINAL PAGE IS OF POOR QUALITY

12B209-27-188

ORIGINAL PAGE IS
OF POOR QUALITY

Table 14. Engine 3 Inlet Pressure Orifice Locations



INLET HILITE–FRONT VIEW
$C_{30} = C_{330} = 286.46$ cm (112.78 in)
$C_{90} = C_{270} = 279.32$ cm (109.97 in.)
$C_{150} = C_{210} = 272.21$ cm (107.17 in.)

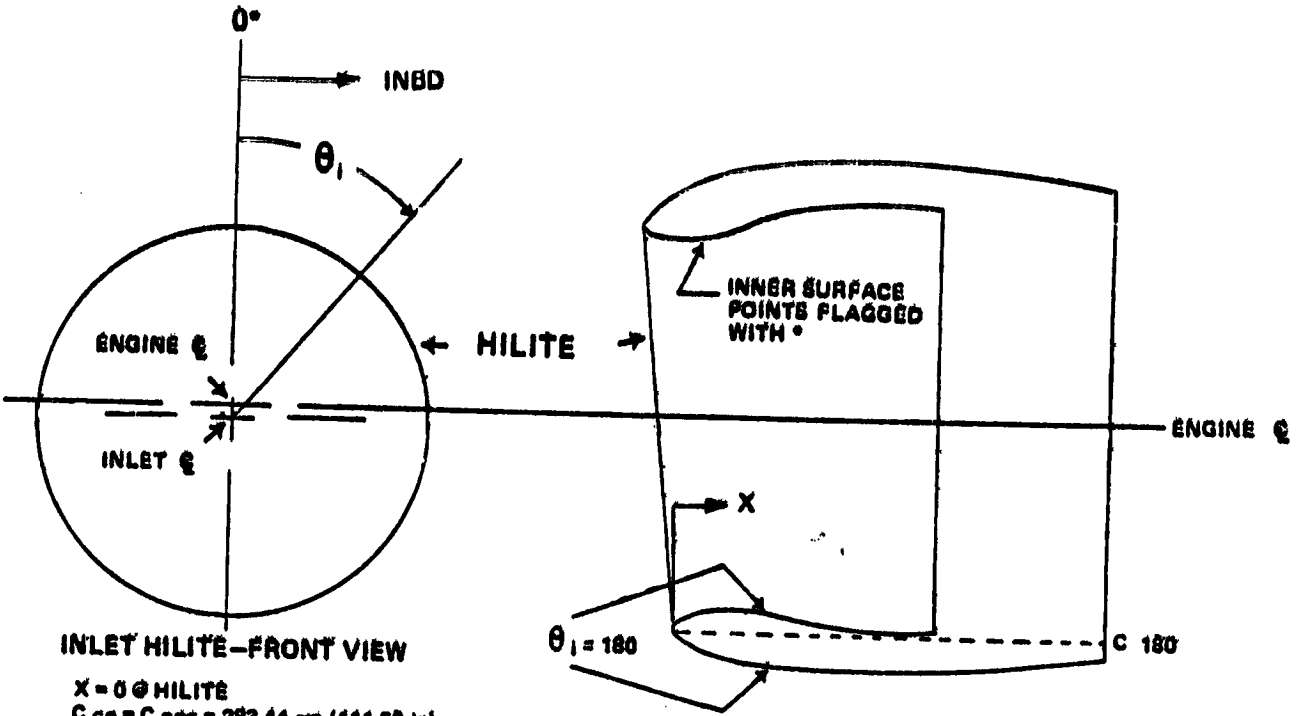
X = 0 @ HILITE
X/C TOLERANCE ±0.003

$\theta_i = 30°$	$\theta_i = 90°$	$\theta_i = 150°$	$\theta_i = 210°$	$\theta_i = 270°$	$\theta_i = 330°$
X/C	X/C	X/C	X/C	X/C	X/C
0.079*	0.077*	0.080*	0.080*	0.081*	0.079*
0.051*	0.053*	0.050*	0.050*	0.055*	0.051*
0.034*	0.033*	0.034*	0.034*	0.037*	0.034*
0.014*	0.014*	0.014*	0.014*	0.014*	0.014*
0.002*	0.002*	0.002*	0.002*	0.002*	0.002*
0.000	0.000	0.000	0.000	0.000	0.000
0.004	0.004	0.005	0.005	0.004	0.004
0.010	0.011	0.012	0.012	0.011	0.010
0.025	0.028	0.030	0.030	0.028	0.026
0.056	0.061	0.063	0.062	0.062	0.056
0.086	0.091	0.095	0.095	0.090	0.086
0.122	0.128	0.146	0.146	0.128	0.122
0.168	0.174	0.183	0.181	0.172	0.178
0.212	0.227	0.227	0.224	0.218	0.214
0.261	0.277	0.277	0.275	0.267	0.262
0.336	0.348	0.345	0.343	0.339	0.337
0.457	0.463	0.458	0.455	0.453	0.454
0.572	0.576	0.571	0.569	0.567	0.570
0.645	0.647	0.639	0.639	0.639	0.645
0.718	0719	0.710	0.708	0.711	0.718
0.824	0.824	0.813	0.810	0.816	0.827
0.994	0.997	0.994	0.991	0.990	0.994

125209-27-187

ORIGINAL PAGE IS
OF POOR QUALITY

Table 15. Engine 4 Inlet Pressure Orifice Locations



INLET HILITE–FRONT VIEW

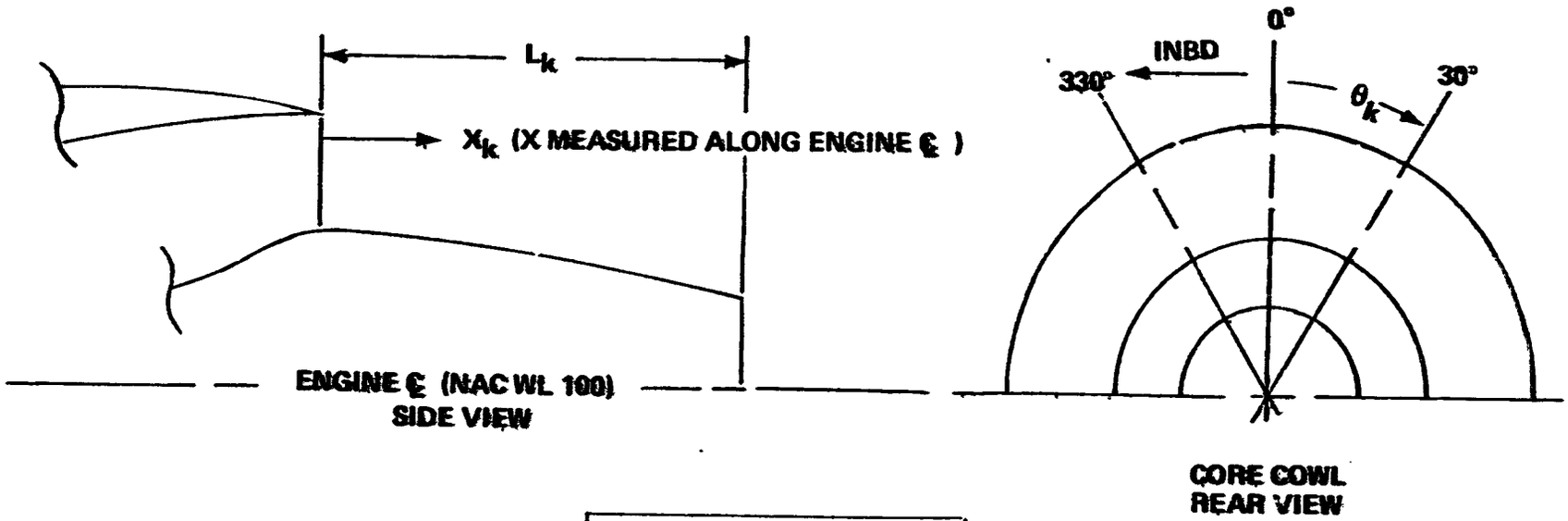
X = 0 @ HILITE
$C_{60} = C_{300}$ = 283.44 cm (111.59 in)
C_{180} = 271.11 cm (106.74 in)

X/C TOLERANCE ±0.003

θ_i = 60°	θ_i = 180°	θ_i = 300°
X / C	X / C	X / C
0.441*	0.426*	0.424*
0.322*	0.318*	0.322*
0.232*	0.244*	0.228*
0.167*	0.178*	0.164*
0.104*	0.107*	0.101*
0.050*	0.052*	0.048*
0.021*	0.021*	0.021*
0.000	0.000	0.000
0.026	0.064	0.027
0.060	0.098	0.057
0.125	0.135	0.125
0.170	0.178	0.171
0.263	0.272	0.264
0.327	0.345	0.330
0.432	0.455	0.434

125209-27-188

Table 16. Engine 3 and 4 Core Cowl Pressure Orifice Locations

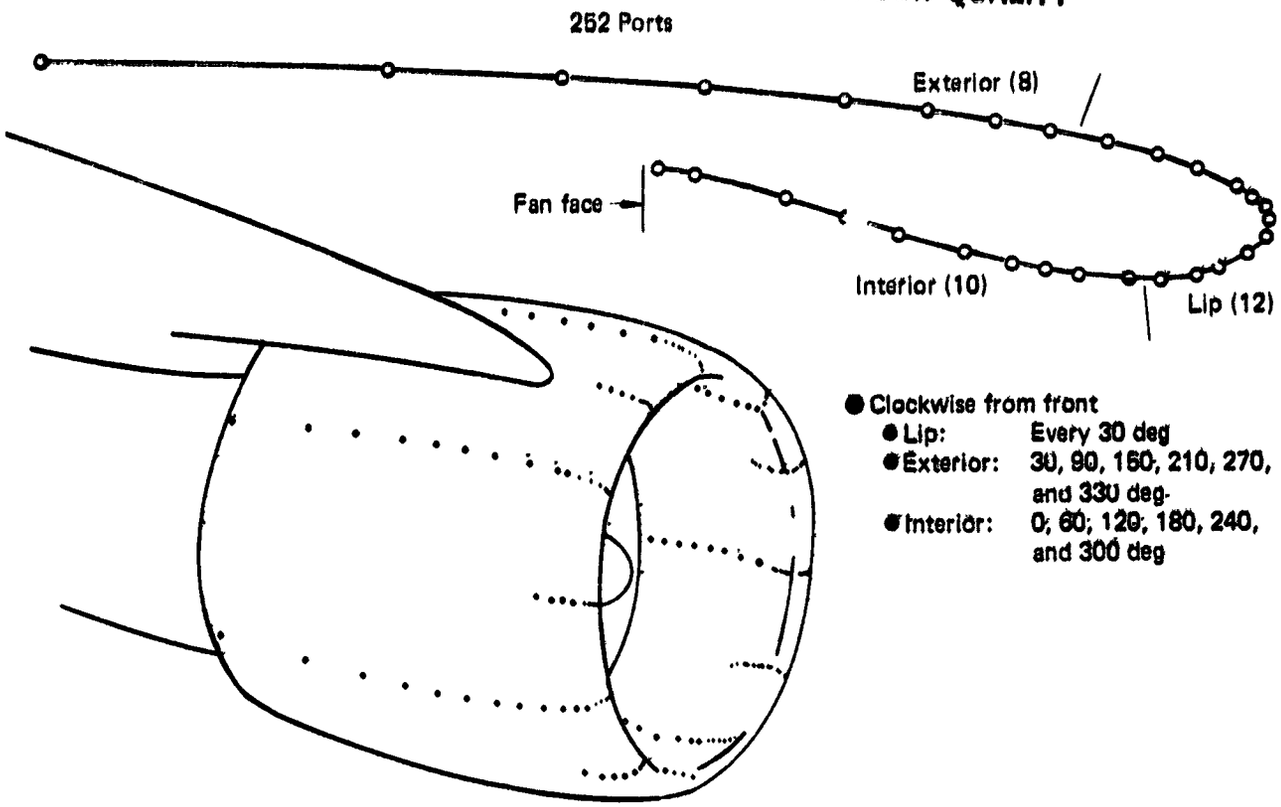


θ_k = 30° AND 330°	
X_k/L_k ±0.0007	
0.0363	0.6817
0.1552	0.6918
0.2405	0.7024
0.2928	0.7410
0.3797	0.7745
0.4472	0.8085
0.4995	0.8380
0.5315	0.8672
0.5703	0.9010
0.5822	0.9205
0.6277	0.9545
0.6497	0.9947

ORIGINAL PAGE IS
OF POOR QUALITY

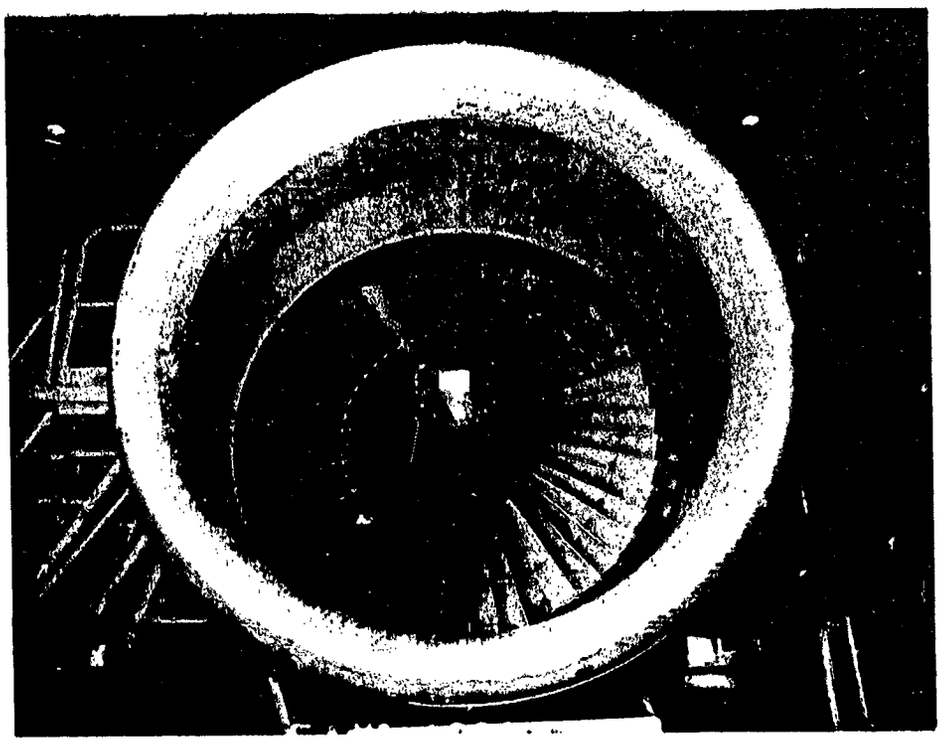
125209-27-189

ORIGINAL PAGE IS
OF POOR QUALITY



125209-5

Figure 10. Inboard Engine Pressure Taps



125209-6

Figure 11. Inboard Inlet Pressure Taps

The greatest deviations from ambient pressure and most rapid variations of pressure with distance occur near the inlet lip. Contribution of the lip area to the overall force and moment is very large. Because of this contribution, 144 taps in 12 rows, 30 deg apart, were located in the lip area. Aft of the lip, 60-deg circumferential spacing of the rows provided adequate definition.

Each pressure tap was connected to an Endevco pressure transducer (fig. 12) by approximately 8 ft of 0.061-in inside diameter copper tubing to ensure that lag effects were equalized. The transducers were mounted in temperature controlled boxes in groups of 22 (figs. 13 and 14). Each transducer measured differential pressure between the tap and a reference pressure.

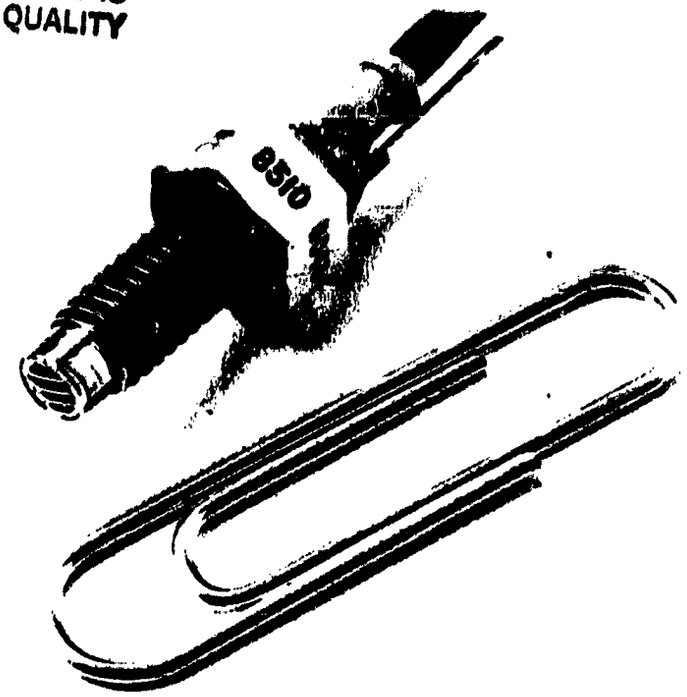
Further pressure measurements were obtained on the fan cowl doors of engine 3 (fig. 15). The arrangement was two rows of pressure taps, one on each side of both cowl doors, 30 deg from the top. Each pressure tap was connected to its individual transducer by copper tubing except at the hinges of the fan cowl doors, where a small section of copper tubing was replaced by a piece of flexible clear polymer. This flexible section enabled the doors to function throughout the test program.

The pressure instrumentation on engine 4 was designed to substantiate a finding of the feasibility study (ref. 1), which suggested that engine deterioration was independent of position. Therefore, engine 4 inlet was instrumented with three rows of 15 pressure taps each spaced 120 deg apart (fig. 16) for a total of 45 measurements. These measurements were sufficient to indicate relative load levels between inboard and outboard inlets.

Inertial Loads Instrumentation—Instrumentation for inertial loads consisted of accelerometers and rate gyros located on the engine and pylon (fig. 17) and the aircraft center of gravity. Linear accelerations were measured by Q-FLEX accelerometers (fig. 18). These instruments were used on both test engines and at their fore and aft wing and pylon interface. For angular accelerations two axes of a three-axis Northrop rate gyro mounted on the two test engines (figs. 19 and 20) were used.

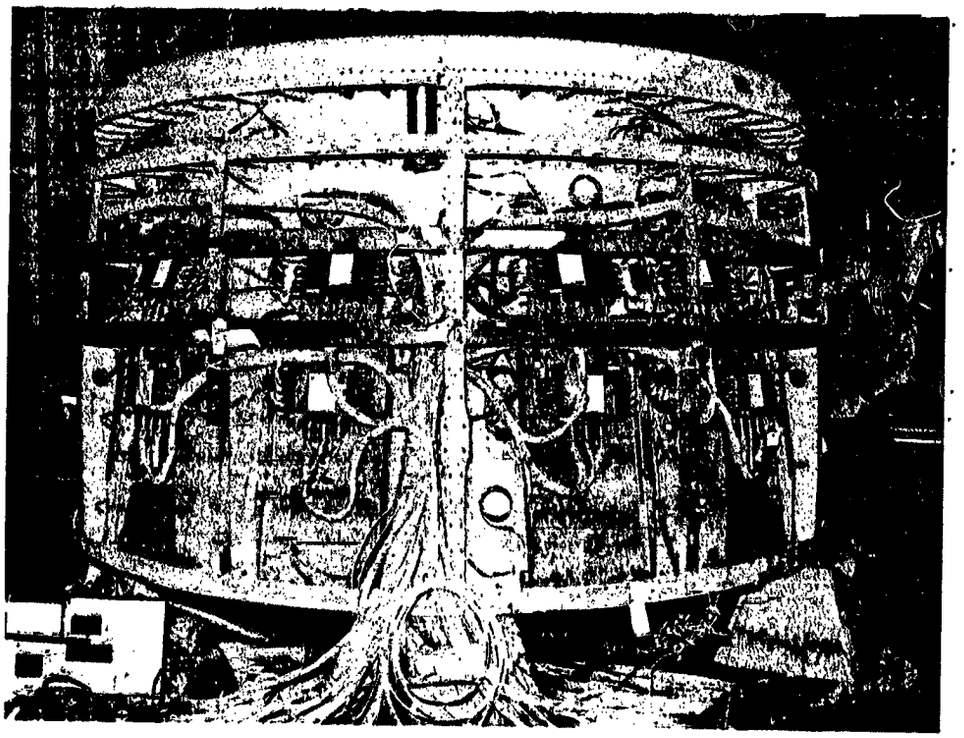
Location of accelerometers and rate gyros is referenced by clock position, looking aft. Accelerometers were placed on the engines so that lateral accelerations were measured in the lateral direction at NAC STA 46 at 3 o'clock and at NAC STA 100 at 6 o'clock. Vertical accelerations were measured at NAC STA 46 at 6 o'clock, NAC STA 100 at

ORIGINAL PAGE IS
OF POOR QUALITY



126209-7

Figure 12. Pressure Transducer



126209-8

Figure 13. Pressure Transducer Installation

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

Figure 14. Pressure Transducer Box

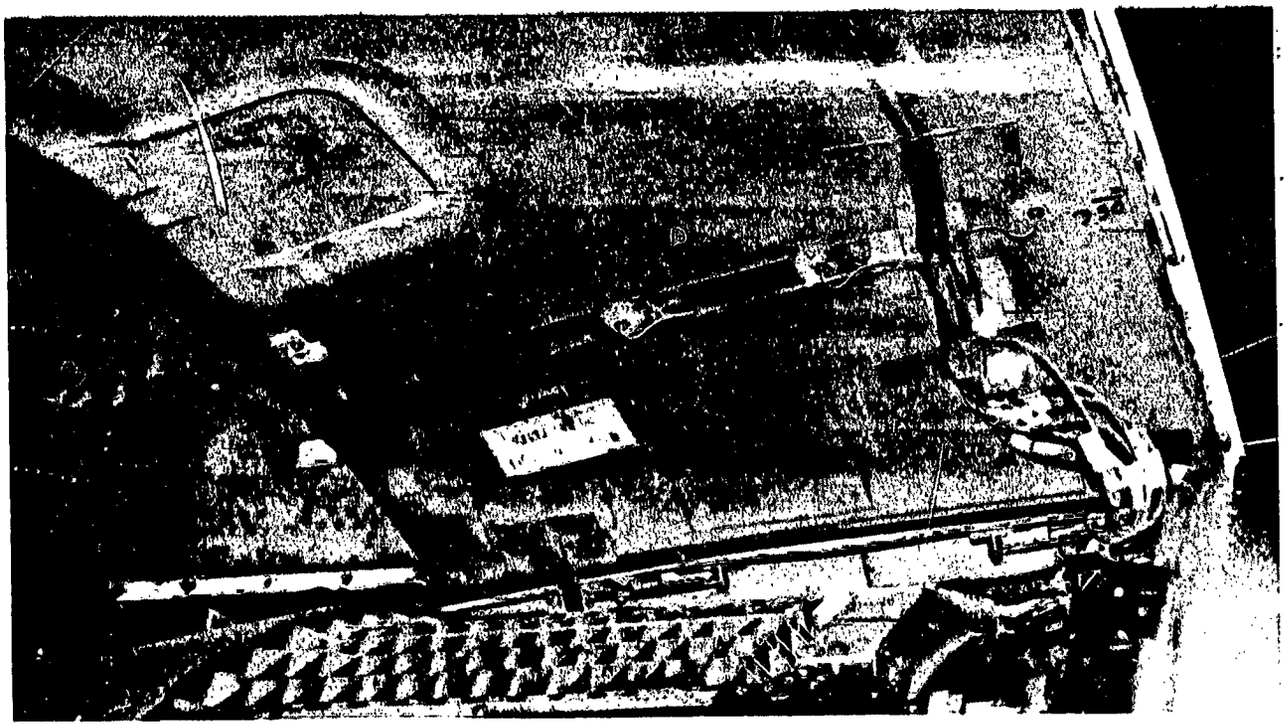
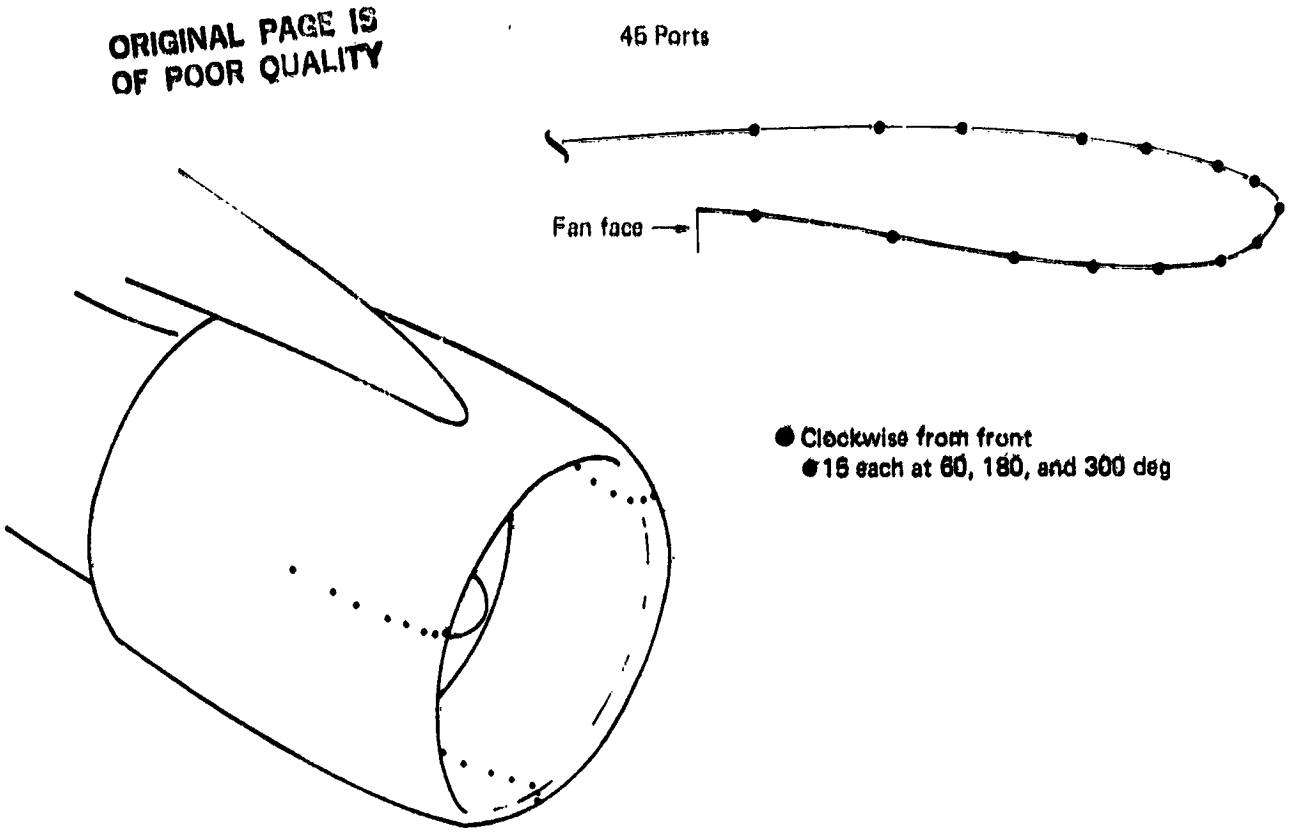


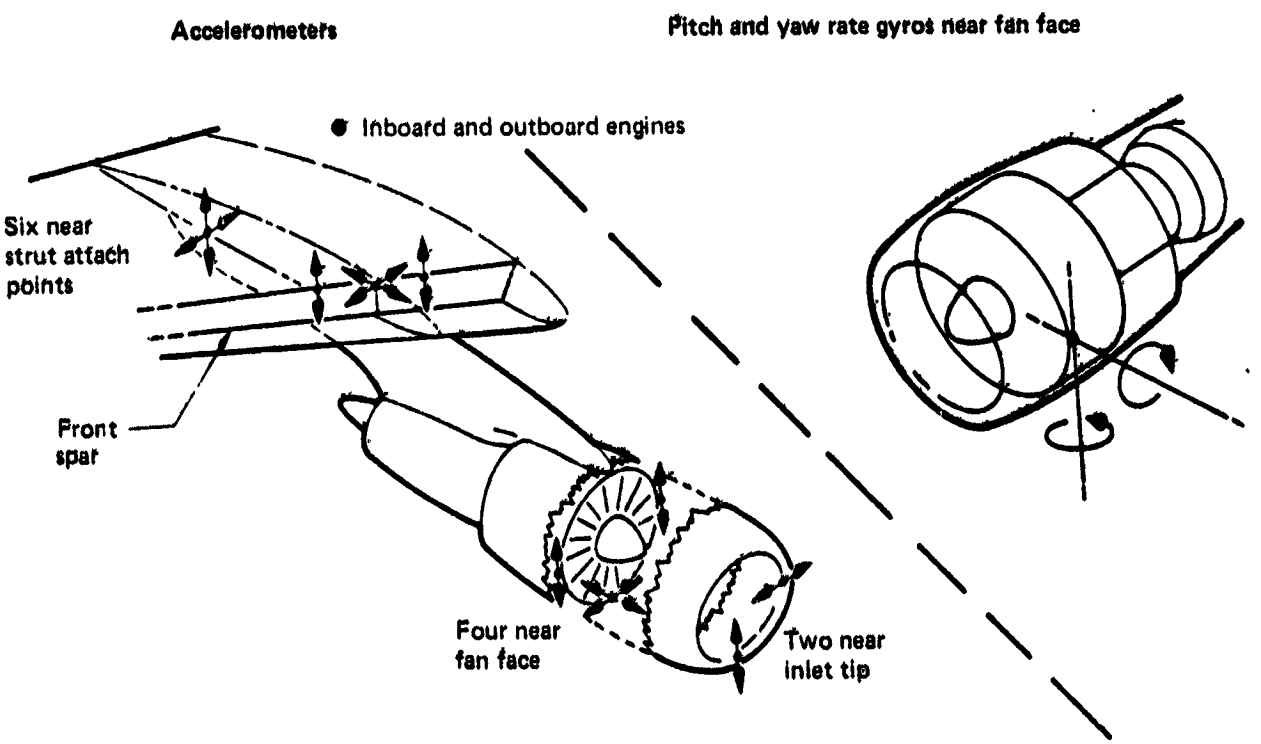
Figure 15. Cowl Door Pressure Taps

ORIGINAL PAGE IS
OF POOR QUALITY



125209-12

Figure 16. Outboard Engine Pressure Taps



125209-11

Figure 17. Inertial Data Sensors

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

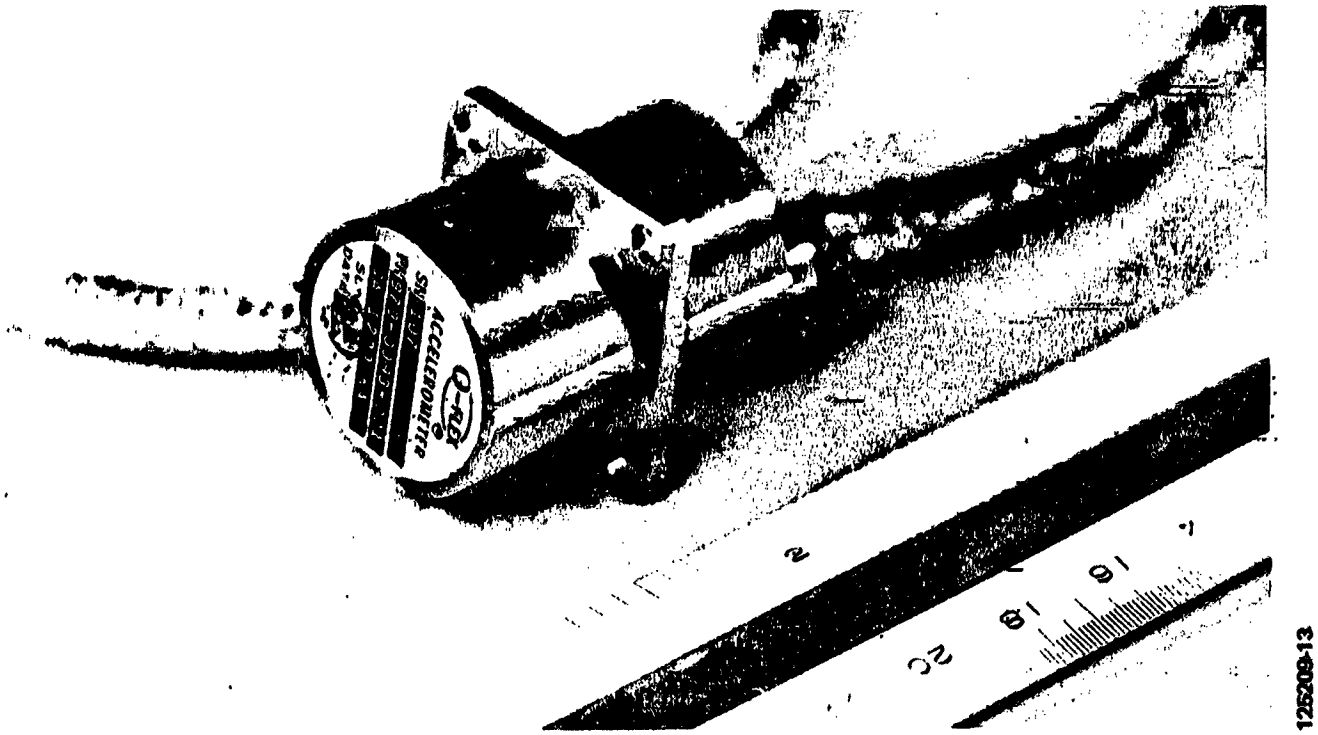


Figure 18. Q-FLEX Accelerometer

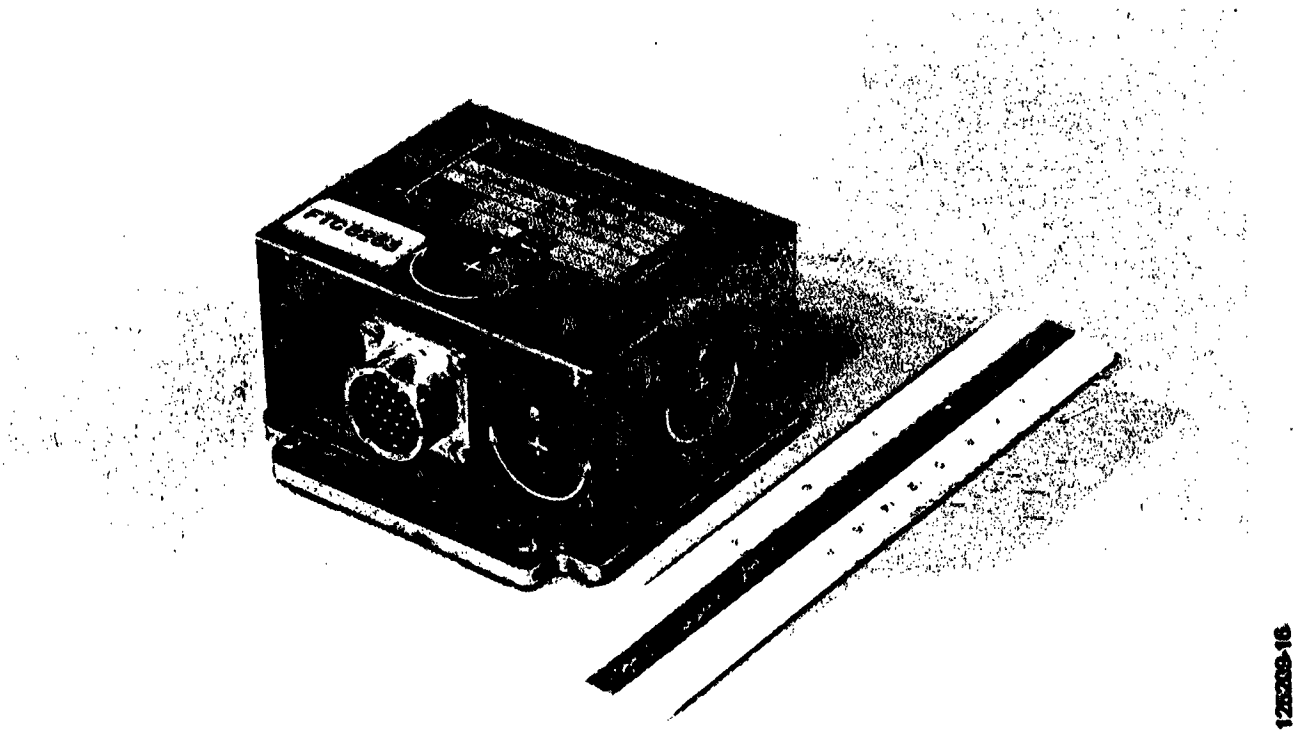
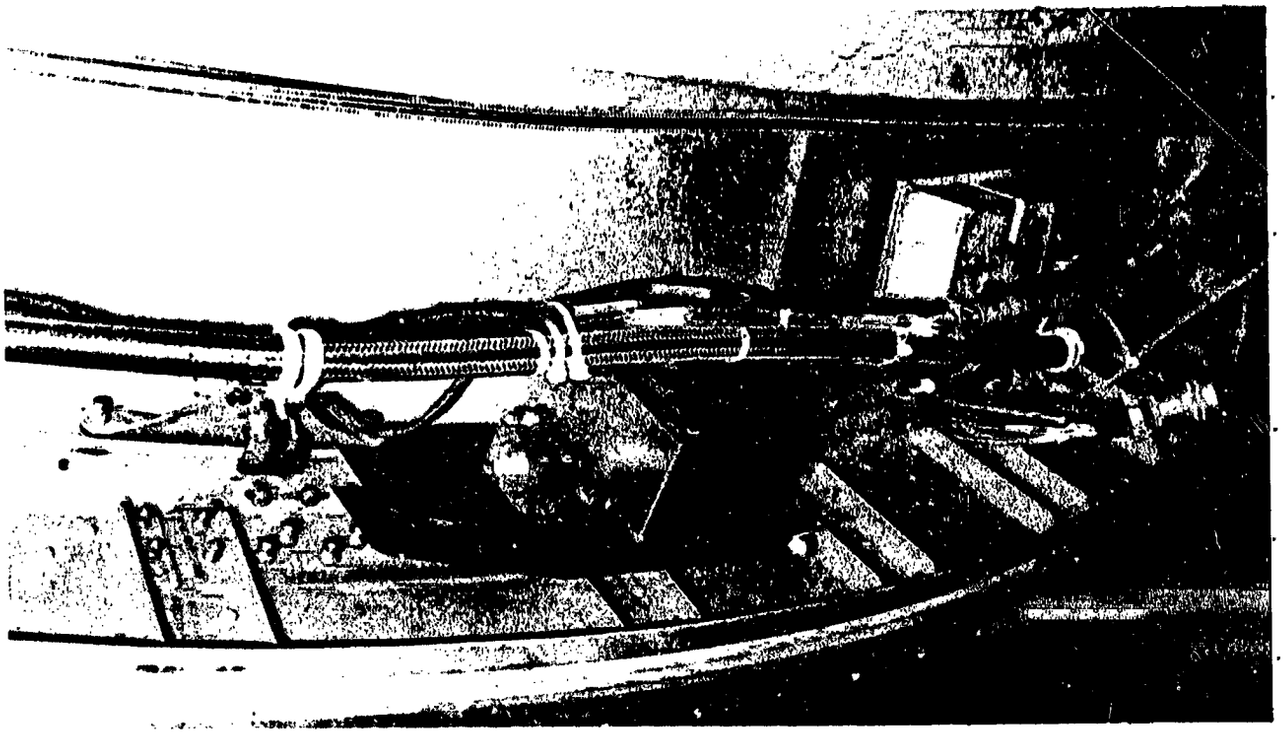


Figure 19. Rate Gyro

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



126208-17

Figure 20. Accelerometer and Rate Gyro

the lateral direction at NAC STA 46 at 3 o'clock and at NAC STA 100 at 6 o'clock. Vertical accelerations were measured at NAC STA 46 at 6 o'clock, NAC STA 100 at 3 o'clock, and NAC STA 100 at 9 o'clock, and longitudinal acceleration was at NAC STA 100 at 6 o'clock. Rate gyros were placed at NAC STA 100 at 3 o'clock and were used to measure pitch and yaw rate. A total of six accelerometers and one rate gyro per engine permitted calculation of the translational and angular accelerations at the engine center of gravity.

Accelerations were also measured at the pylon/wing interfaces. The lateral accelerations were measured at the wing front spar and the rear thrust link attach point (fig. 21). The vertical accelerations were measured inboard and outboard of the front spar attach point and on the rear thrust link attach point. In the longitudinal direction, accelerations were measured only at the front spar. Each interface had a total of six linear accelerometers.

Basic airplane information was also recorded, including pitch, yaw, and roll angles, along with side-slip and angle of attack. Angular accelerations about all three axes were measured at the aircraft center of gravity.

Clearance Measurement System—Engine clearance change measurements were made by P&WA simultaneously with flight load application. Measurements were made on the fan and first-stage high-pressure turbine on the inboard engine and the fan stage of the outboard engine by a laser proximity system for each stage. Each clearance monitoring system consisted of: (1) the laser assembly (four lasers per box), (2) the input fiber optic assembly, (3) video camera assembly, (4) laser probe assembly (four probes per stage), (5) video monitor, and (6) video tape recorder (fig. 22).

In accordance with the interface agreement between the two companies, P&WA provided all clearance monitoring system components and made the necessary engine preparations. Operation and maintenance of the system during testing were also the responsibility of P&WA. P&WA provided to BCAC the equipment necessary for installation in the airplane during the layup period prior to testing.

Laser assemblies were installed in a rack inside the airplane cabin (fig. 23). Four laser assemblies of four laser generators per box were installed in the rack, which provided one spare box to facilitate changeover in flight should a laser generator malfunction.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

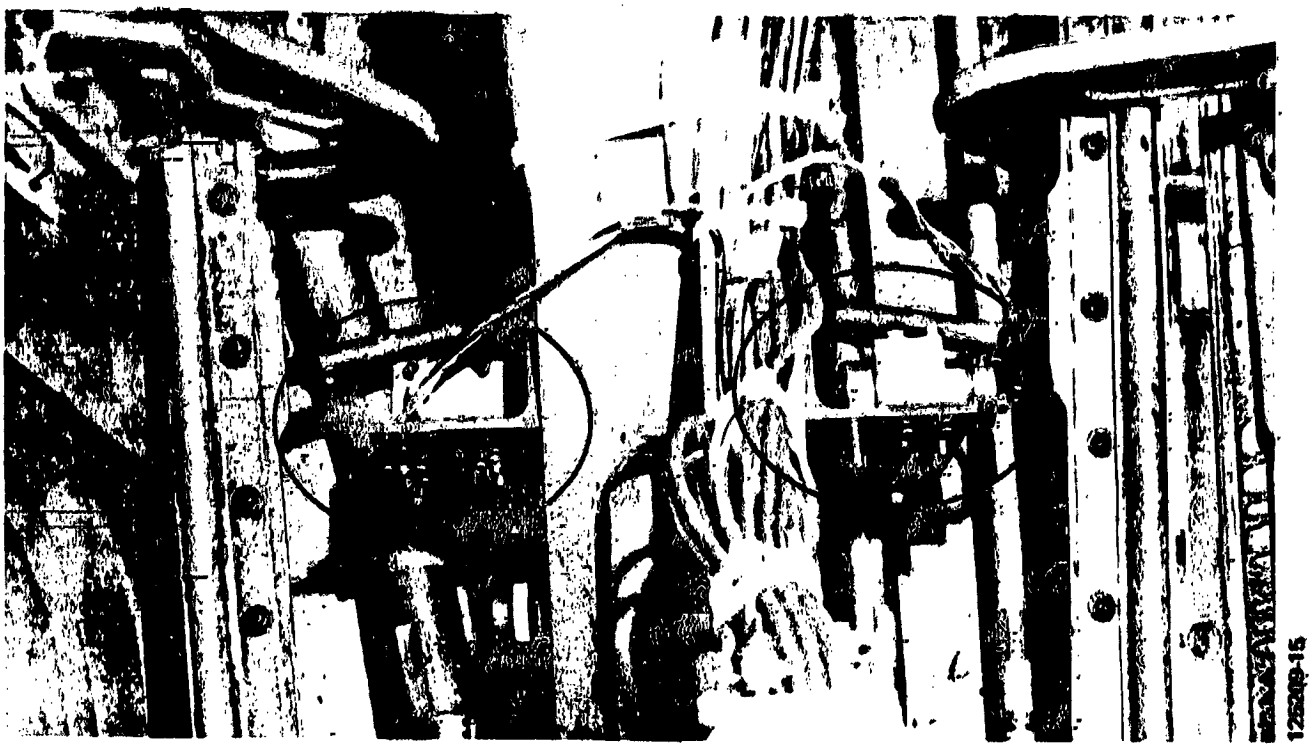


Figure 21. Acceleron Installation (Thrust Link)

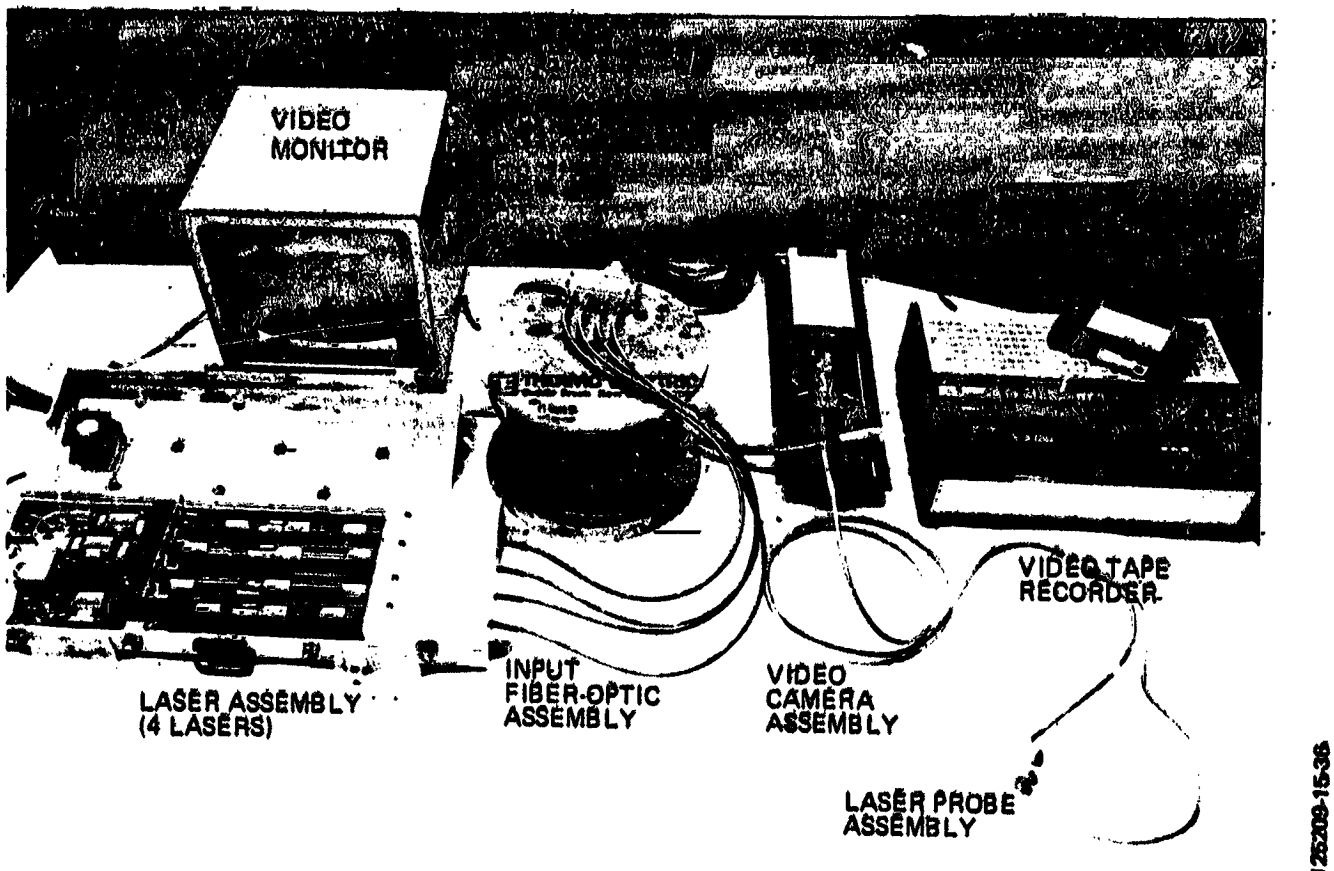
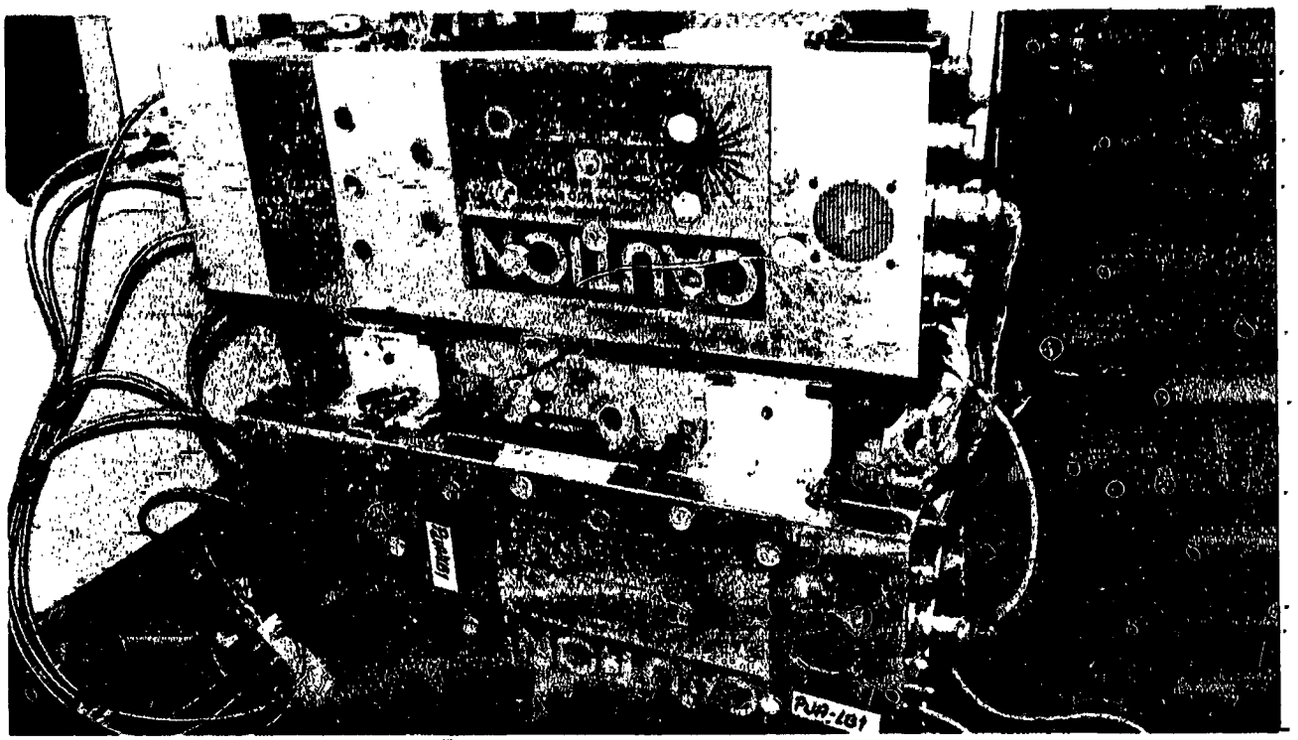


Figure 22. Clearance Monitoring System

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



125209-18

Figure 23. Laser Generator Boxes

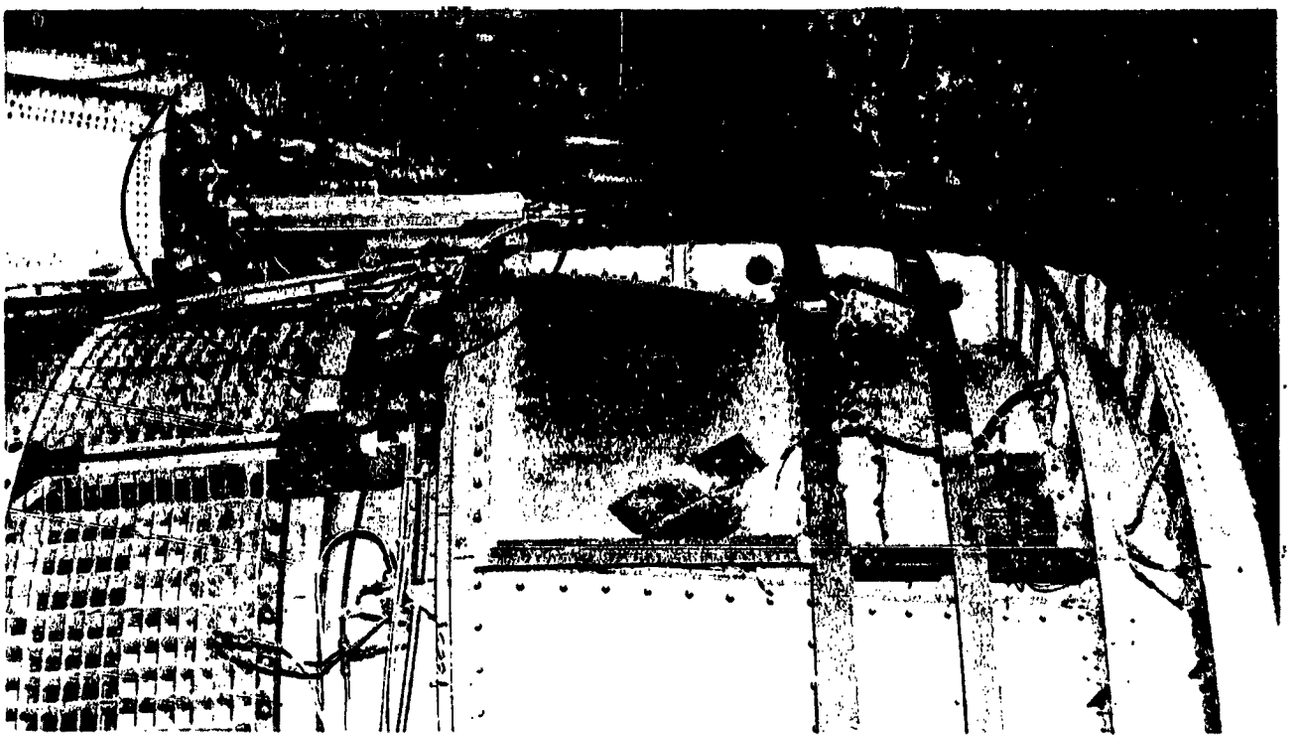
Video cameras were installed in the "dog house" (fig. 24) for the fans on the inboard and outboard engines and in the "kneecap" (fig. 25) of the wing and pylon intersection for the turbine of the inboard engine. The input fiber optic leads were divided in the camera box installation into four separate leads and routed to each laser probe assembly. A fan laser probe assembly is shown in figure 26 and a turbine laser probe assembly is shown in figures 27 and 28. The fan and turbine probe radial locations, which are essentially 90 deg apart, are shown in figure 29.

Reflected light from the engine blades was transmitted back through the probe and through the coherent output fiber optic to the video camera. At the video camera the reflected light was converted to a video signal and transmitted through a cable to the airplane cabin. In the cabin, clearance values were read on the video monitors (fig. 30) and were recorded on a video tape recorder (fig. 31).

In addition to the aforementioned components to the laser system, a gaseous nitrogen system was required to cool and purge the high-pressure turbine laser probes. BCAC provided the system, which was located in the forward cargo hold (fig. 32). Components of the gaseous nitrogen system included storage racks for 56 nitrogen bottles, the nitrogen bottles, the high-pressure manifolds and regulators, control valves, pressure sensors, probe temperature sensors and readout, tubing, and the flow-controlling orifice that is built into the high-pressure turbine probes. The system was configured to provide nitrogen for approximately 13 hours of operation without resupply.

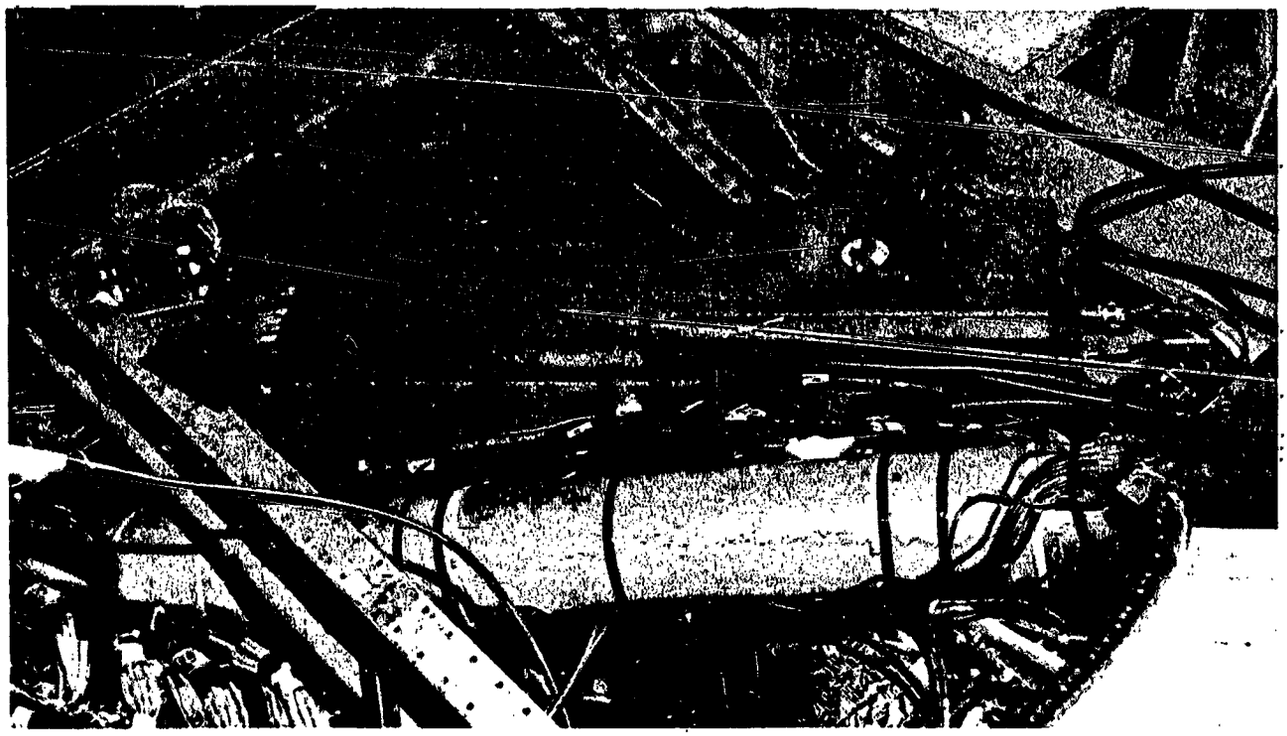
Expanded Engine Performance—Expanded engine performance data (fig. 33) were required for the P&WA effort to correlate measured engine clearance changes or closures with performance losses. Primary emphasis was on engine 3, which had complete instrumentation (fig. 33). Minimum instrumentation to define engine speed and engine airflow and power level was provided for engine 4. Instrumentation for engine 3 was typical of that used for a performance engine test program and was compatible with that used during the pre- and postprogram base engine calibrations at the P&WA Middletown test facility. To better correlate data, the Boeing-owned flight high- and low-rotor speed tachometers (N2 and N1, respectively) and the fuel flow meter were calibrated by P&WA and were used during the pre- and postcalibration at P&WA. The tachometers and flow meter were used on this engine throughout the entire NAIL program.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



12S309-19

Figure 24. Fan Video Camera Installation



12S309-20

Figure 25. Turbine Video Camera Installation

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

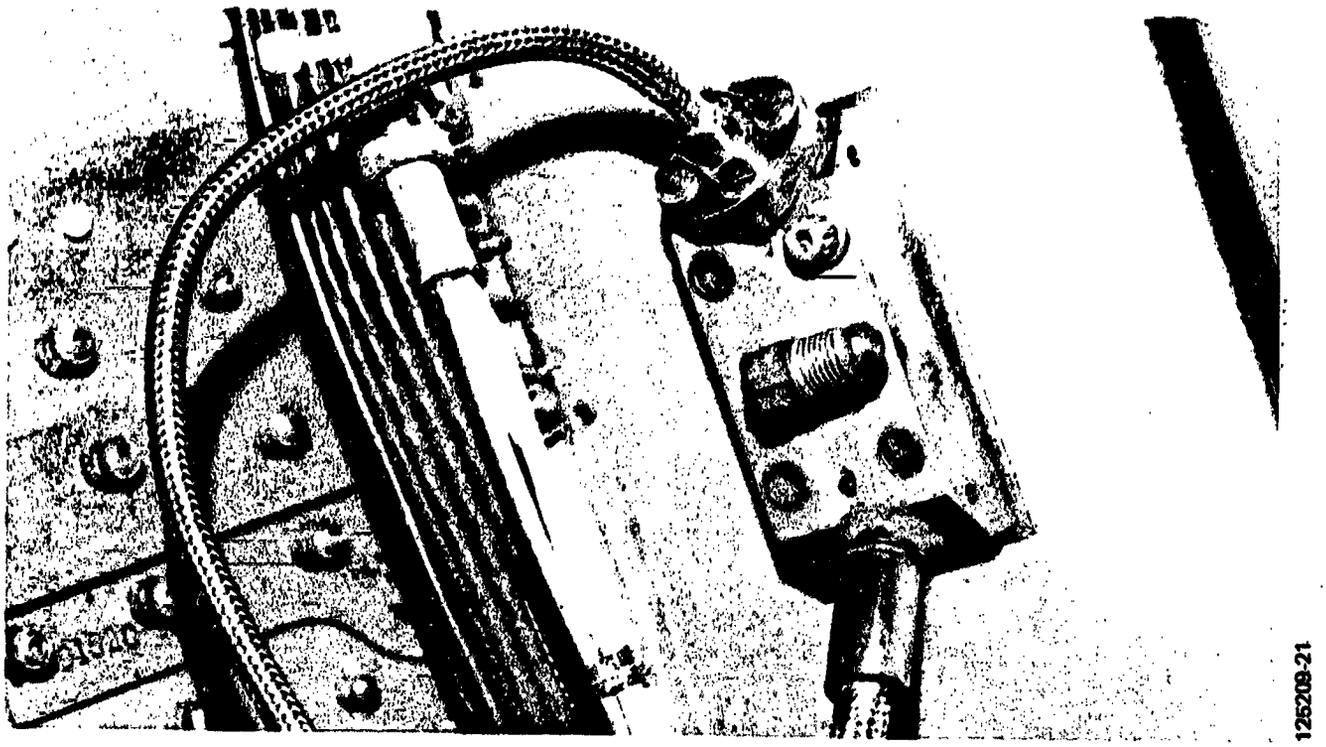


Figure 26. Fan Laser Probe

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

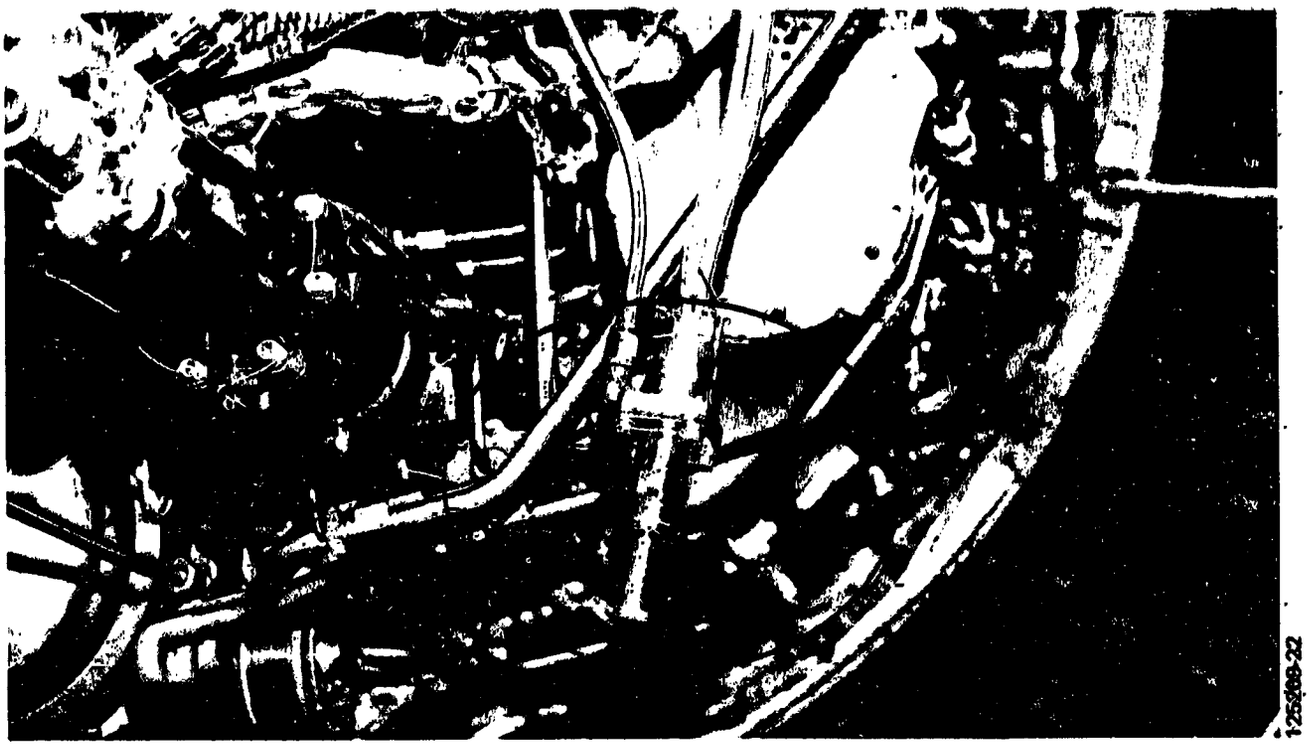


Figure 27. Turbine Laser Probe

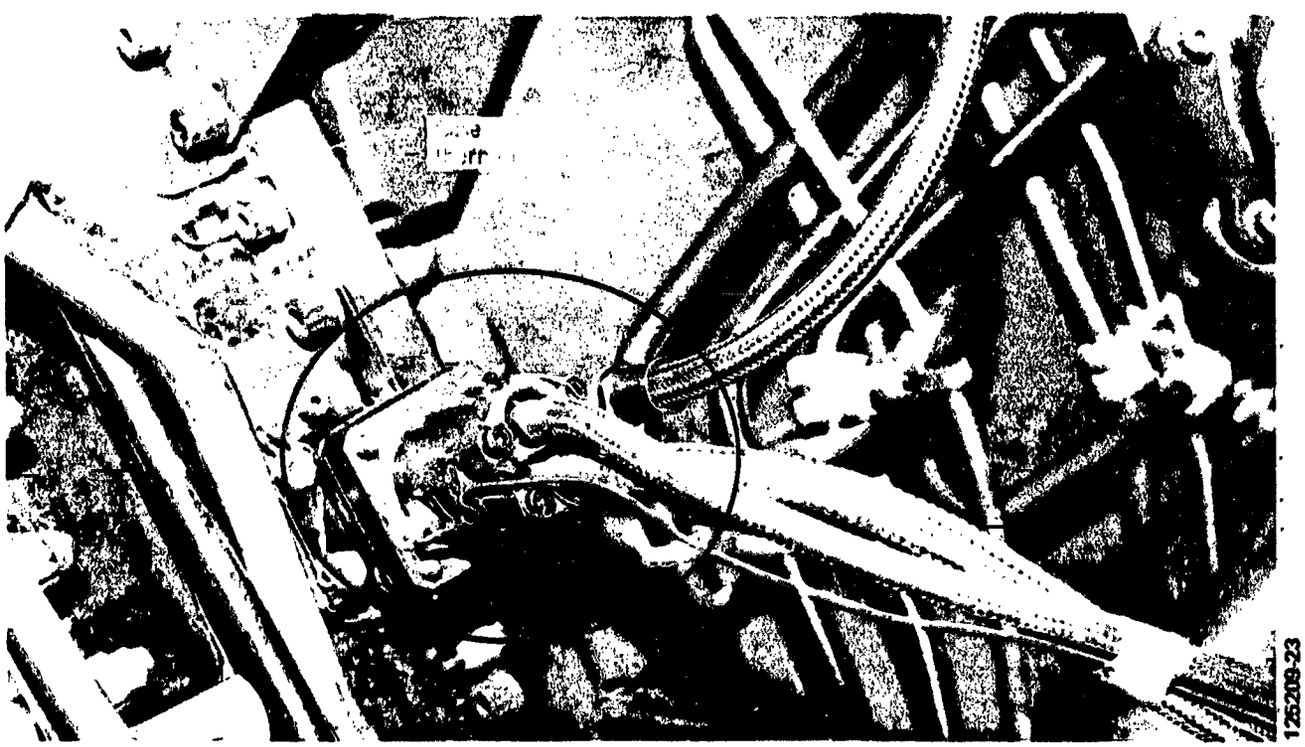


Figure 28. Turbine Laser Probe Installed

ORIGINAL PAGE IS
OF POOR QUALITY

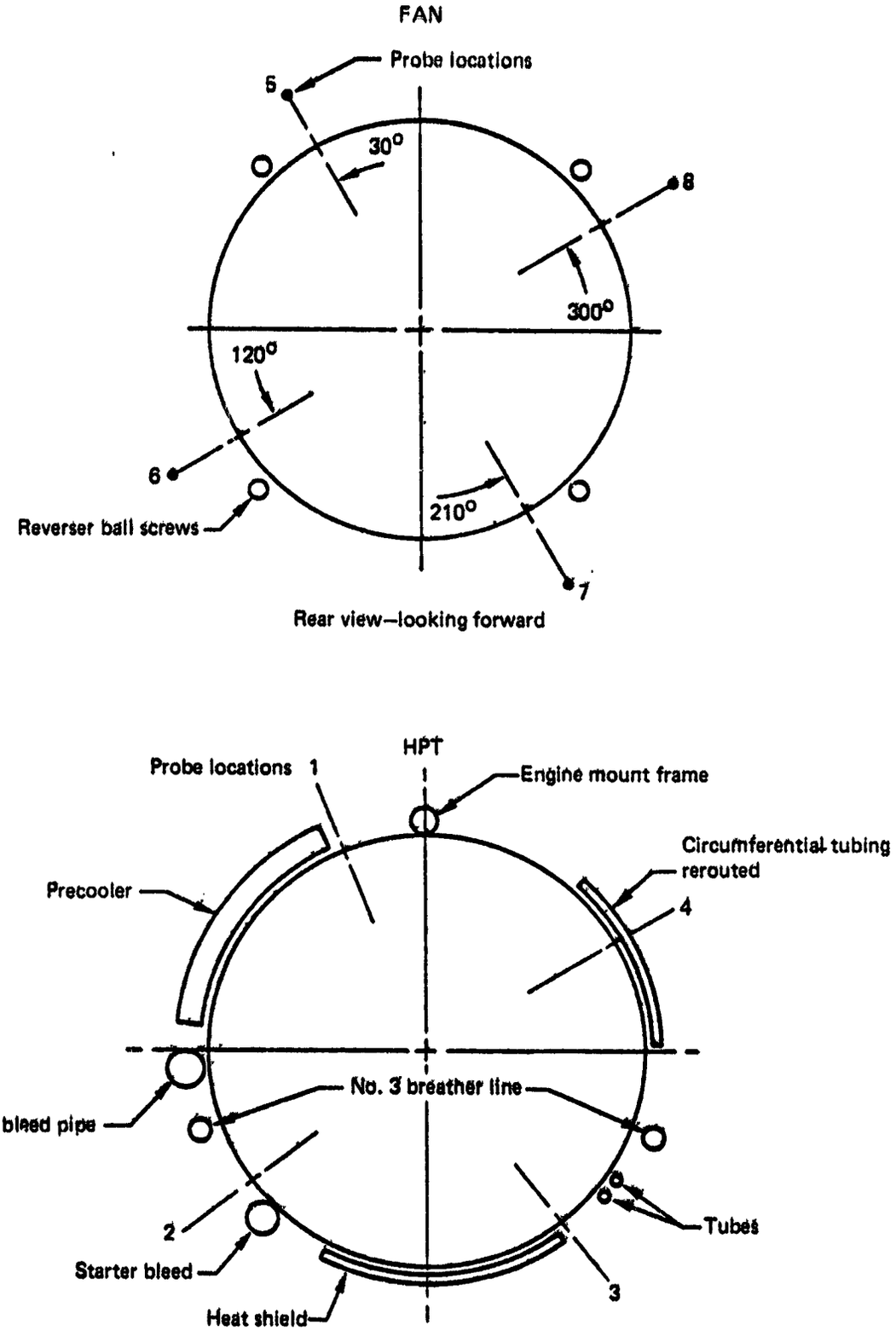


Figure 29. Laser Proximity Probe Locations

125209-106

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

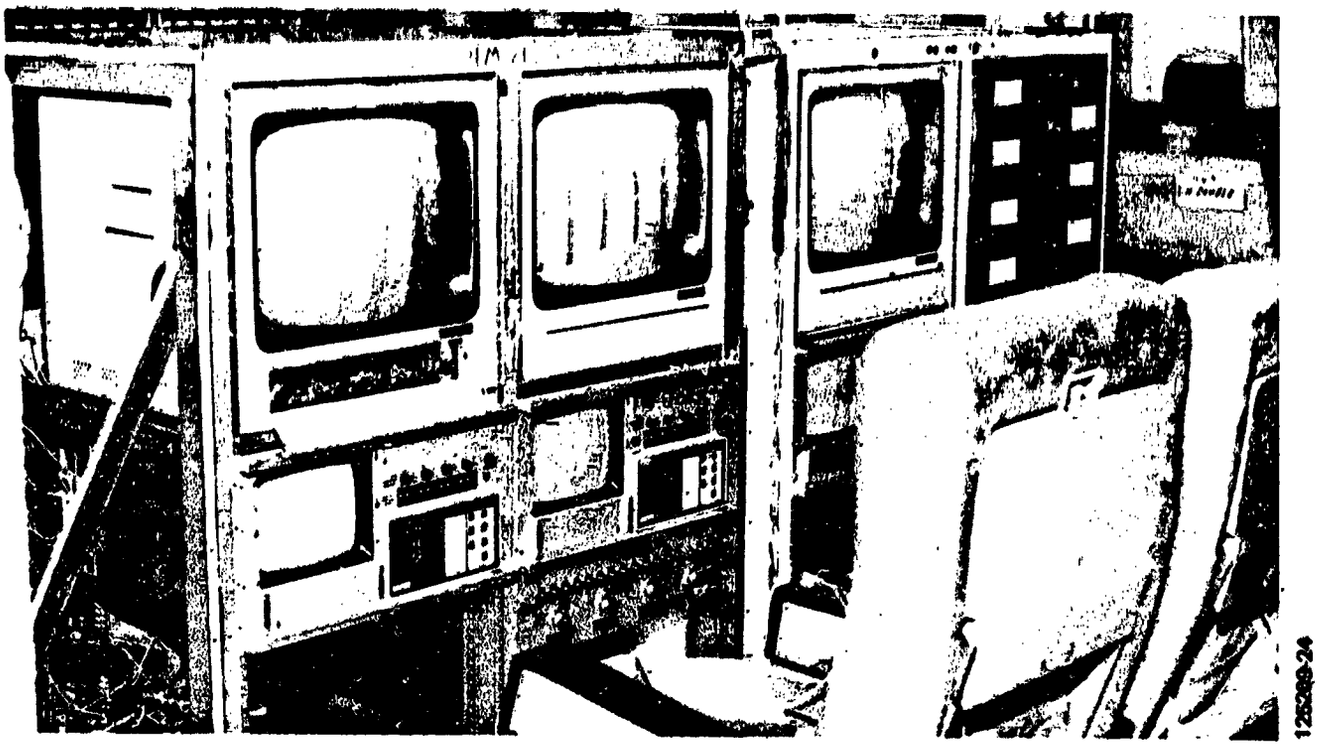


Figure 30. Laser System Video Monitors and Controls

Figure 31. Laser Video Tape Recorder

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

126209-36

Figure 32. Nitrogen System

N2	High-pressure (H.P.) rotor speed
N1	Low-pressure (L.P.) rotor speed
TT7	L.P. turbine discharge total temperature
TT4.5	H.P. compressor discharge total temperature
TT3	L.P. compressor discharge total temperature
TT6	H.P. turbine discharge total temperature
PT7	L.P. turbine discharge total pressure
PT3	L.P. compressor discharge total pressure
PT2.5	Fan stream total pressure at exit guide vane
PS3	L.P. compressor discharge static pressure
PS4	H.P. compressor discharge static pressure
HPC IGV POS	H.P. compressor inlet guide vane position
PWR LVR ANG	Power lever angle
Surge bleed valve POS	
Pylon valve POS	Pylon airbleed shut-off valve position
Air control valve, HPC	Pressure regulator
W_f	Fuel flow rate (computed)
Elapsed fuel	Total fuel burned

126209-20-103

Figure 33. Expanded Engine Performance

4.1.2.2 Installed Propulsion System Aerodynamics

Instrumentation—Selection of the pressure measurement system used for this program was guided by the need to obtain pressure measurements on the wing, pylon, and core cowl only during quasi-steady-state airplane operating conditions. Accordingly, in these areas, a 24-port scanivalve pressure sampling system, which samples 12 ports per second, was compatible with the normal time frame for maintaining quasi-steady-state airplane operating conditions. The option of using individual transducers for each measurement, as on the inlet and fan cowl, thereby allowing a simultaneous sampling of each pressure, was not overlooked. Not enough transducers could be purchased from appropriate manufacturers in the time frame available to complete the test program.

A Gould Statham Model PM 131TC ($\pm$17.2 kPa [$\pm$2.5 lb/in^{2}a]) differential-pressure transducer was used in all scanivalve modules. Specifications for the transducer were as follows: combined nonlinearity and hysteresis of less than $\pm$0.75% full scale, thermal sensitivity shift less than 0.01%/°F from -65°F to +250°F (-54°C to +121°C), and thermal zero shift less than 0.01% full scale/°F from -65°F to +250°F (-54°C to +121°C). The natural frequency of the transducer diaphragm was 3500 Hz. The transducer output resulting from an acceleration stimulus applied perpendicular to the plane of the diaphragm was 0.2% of full scale per g for vibration frequencies to approximately 20% of the diaphragm natural frequency. Above the natural frequency, the response increased in accordance with the behavior of an undamped single-degree-of-freedom system.

Each scanivalve transducer housing was fitted with a thermostatically controlled heater jacket, which maintained a 10°C (50°F) operating environment for the transducer given ambient temperatures below 10°C (50°F). The heater system, however, did not maintain a 10°C (50°F) environment if the ambient temperatures were above 10°C (50°F). This condition seemed likely to occur only in the scanivalve assemblies mounted in the engine pylon where engine bleed air ducts transfer heat into the pylon bays. To monitor the temperature at each scanivalve location, a thermocouple was installed on each scanivalve assembly.

The impact of airplane- or engine-induced vibration on the installed pressure transducers was assessed during the ferry flight to the remote test site. It was assumed that the highest vibration levels would be encountered in scanivalve installation in the engine pylon. Piezoelectric accelerometers were bonded onto the installed scanivalve assembly

and g-levels were measured in a direction perpendicular to the plane of the transducer diaphragm during cruise conditions approximating the required test conditions. The highest measured acceleration level was approximately 0.9g rms at 230 Hz that would produce an output of 0.18% of full scale, based on the transducer acceleration sensitivity.

Other sources of measurement error involved signal gain, analog-to-digital conversion stability, and sampling speed. Testing transducers showed nonlinearity and hysteresis to be ±0.82% at worst and ±0.30% on an average. Based on pre- and postflight system calibrations and monitored in-flight operating conditions, the analog-to-digital conversion error was ±2%. Scanivalve sampling speed was found to be significant only in shock areas. A 6.9 kPa (1 lb/in^2) pressure drop between the first 12 ports and the last 12 ports introduced a ±1% error. The accuracy of measured pressures was estimated to be ±3% in low-pressure gradient areas and ±4% in shock areas.

Static pressure orifices were installed on the pylon and core cowl of inboard and outboard engines 3 and 4 and on the wing in the vicinity of both engines. Three rows of surface-static pressures on the upper surface of the wing and two rows on the lower surface were installed near both engines, (figs. 5 and 6). Two rows of surface static pressures on each side of the engine pylon were installed on engines 3 and 4 (fig. 6). Finally, two rows of surface static pressures were installed on each side of the engine core cowl of engines 3 and 4 (fig. 6).

Surface-static pressure orifices were installed flush to the local wing, pylon, and core cowl surface except for the wing-pressure orifices, which were located over or aft of the wing fuel tanks. In these areas, pressure belts were bonded to the wing surface and faired into the surface (fig. 34). The location of the transition from flush orifices to pressure belt orifices is documented for each wing pressure measurement row (see table 1).

To improve the accuracy of actually locating a position of the pressure orifice on the wing, pylon, or core cowl, computer-generated surface-profile templates marked with the desired orifice location were used in regions experiencing large changes in surface curvature. The actual location of installed pressure orifices deviated in some cases from the desired location because of interference with, for example, structural members and anti-icing ducts. Actual locations were checked again after installation. Orifice positions tabulated in tables 11 to 16 represent the actual installed pressure orifice position plus or minus the tolerance indicated with each group of coordinates.

ORIGINAL PAGE IS
OF POOR QUALITY

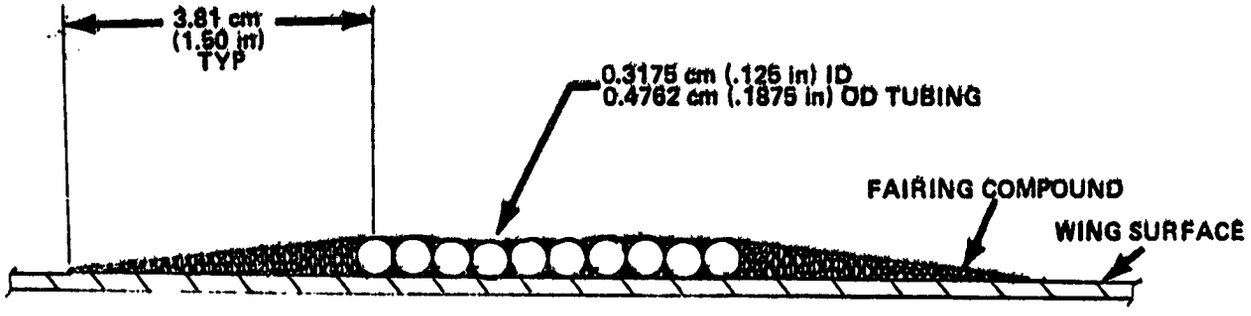


Figure 34. Typical Cross-Section of Wing Pressure Belt

125209-27-190

Orifice positions on the engine 3 fan inlet and cowl did not deviate from the angular position of the profile. Engine 4 fan inlet and cowl orifices deviated from the angular position of the profiles a maximum of ±2 deg. The other significant deviation occurred on both engines 3 and 4 NAC WL 155 and 180 pressure orifice rows. The NAC WL values were within ±1.78 cm (0.7 in).

Additional clarification of locations for those pressure orifices located in the upper and lower surface wing pressure belts is necessary. For belt-located pressure orifices, one pressure orifice was allocated to one belt tube. Because the belt tubes were arranged laterally to provide a low profile, the orifice locations gradually deviated laterally due to tube width, resulting in increasing orifice distance from the start of the pressure belt. Table 17 presents the manner and amount of deviation for each pressure belt orifice at a given WBL.

4.1.3 Test Conditions and Procedures

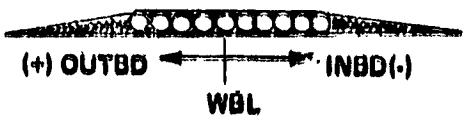
4.1.3.1 Flight Loads

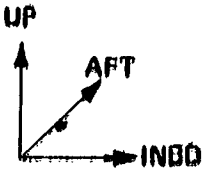
Testing for performance degradation was accomplished in several well defined stages. Such testing was necessary to measure engine clearance changes resulting from various flight maneuvers. Once the installation and fabrication on the test bed aircraft was completed, an engine ground calibration was performed prior to the functional check flight. This calibration enabled comparison with the test stand calibrations by P&WA and provided a data base line for the flight test program.

It was suspected that the first 1% loss in performance due to engine clearance changes occurred during the production flight test acceptance profile (fig. 35). Therefore, this profile was chosen as the basis of the first test flight and was followed by a second ground calibration. Subsequent flights contained high-g turns and variations in takeoff gross weight. Under the test plan, each series of tests required a ground calibration after the particular series. Using these calibrations, performance deterioration was determined for each series of tests. The final ground calibration was performed after completing all flight testing. In all, five ground calibrations were conducted during the NAIL flight test program.

ORIGINAL PAGE IS
OF POOR QUALITY

Table 17. Lateral Offset of Wing Pressure Belt Pressure Orifices From Wing Buttock Line





WBL 445				WBL 510			
UPPER SURFACE		LOWER SURFACE		UPPER SURFACE		LOWER SURFACE	
X_W/C_W	OFFSET X 0.1588 cm (1/16")	X_W/C_W	OFFSET X 0.1588 cm (1/16")	X_W/C_W	OFFSET X 0.1588 cm (1/16")	X_W/C_W	OFFSET X 0.1588 cm (1/16")
0.2000	0	0.1950	0	0.2000	0	0.1972	0
0.2250	-3	0.2453	-3	0.2250	-3	0.2472	-3
0.2500	-6	0.2953	-6	0.2500	-6	0.2972	-6
0.2750	-9	0.3453	-9	0.2750	-9	0.3472	-9
0.3043	-12	0.3953	-12	0.3000	-12	0.3972	-12
0.3543	-15	0.4454	-15	0.3500	-15	0.4472	-15
0.4037	-18	0.4954	-18	0.4000	-18	0.4972	3
0.4538	-21	0.5455	3	0.4500	-21	0.5472	6
0.4750	-24	0.5955	6	0.4750	3	0.5972	9
0.5060	-27	0.6455	9	0.5000	6	0.6472	12
0.5250	3			0.5250	9		
0.5554	6			0.5500	12		
0.6049	9			0.6000	15		
0.6551	12			0.6500	18		
0.7049	15			0.7000	21		
0.7552	18						
0.8049	21						

WBL 470	
UPPER SURFACE	
X_W/C_W	OFFSET X 0.1588 cm (1/16")
0.2000	0
0.3000	-3
0.4000	-6
0.5000	3
0.6000	6

125209-27-191

ORIGINAL PAGE IS
OF POOR QUALITY

Table 17. Lateral Offset of Wing Pressure Belt Pressure Orifices From Wing Buttock Line (Concluded)

WBL 809				WBL 870			
UPPER SURFACE		LOWER SURFACE		UPPER SURFACE		LOWER SURFACE	
X_w/C_w	OFFSET X 0.1588 cm (1/16")	X_w/C_w	OFFSET X 0.1588 cm (1/16")	X_w/C_w	OFFSET X 0.1588 cm (1/16")	X_w/C_w	OFFSET X 0.1588 cm (1/16")
0.2000	0	0.2000	0	0.2000	0	0.2043	0
0.2250	-3	0.2500	-3	0.2250	-3	0.2543	-3
0.2466	-6	0.3000	-6	0.2500	-6	0.3043	-6
0.3000	-9	0.3500	-9	0.3000	-9	0.3543	-9
0.3500	-12	0.4000	-12	0.3500	-12	0.4043	-12
0.4000	-15	0.4500	-15	0.4000	-15	0.4543	-15
0.4500	-18	0.5000	-18	0.4500	-18	0.5043	3
0.5000	-21	0.5500	3	0.4750	-21	0.5543	6
0.5250	3	0.6000	6	0.5000	3	0.6043	9
0.5500	6	0.6500	9	0.5250	6	0.6543	12
0.6000	9			0.5500	9		
0.6500	12			0.6000	12		
0.7000	15			0.6500	15		
0.7500	18			0.7000	15		
0.8000	21						

WBL 834	
UPPER SURFACE	
X_w/C_w	OFFSET X 0.1588 cm (1/16")
0.2405	0
0.3000	-3
0.4000	-6
0.5000	3
0.6000	6

ORIGINAL PAGE IS
OF POOR QUALITY

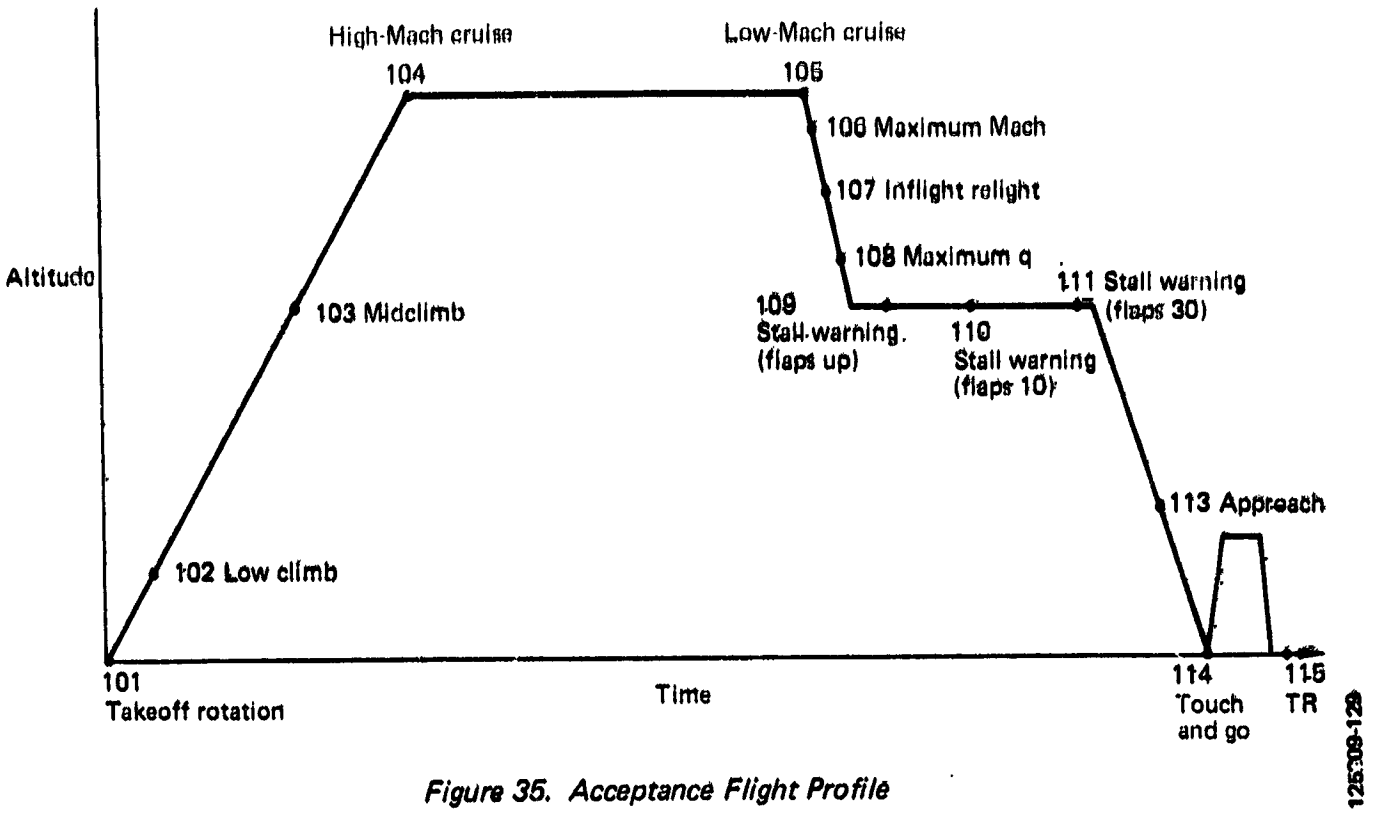


Figure 35. Acceptance Flight Profile

The final test conditions (table 18) of the NAIL program resulted from compromise and various flight restrictions. Originally NAIL was to be a standalone flight program. However, the flight test was conducted concurrently with the 767/JT9D-7R4 test program, which imposed certain flight restrictions on RA001. The most notable restrictions were to remain within the 767 design cruise speed and Mach number (V_C and M_C) limits of 360 kcas and M = 0.86 until the completion of all JT9D-7R4 test conditions and to limit nacelle loads to 80% of the design limit. Upon completion of the JT9D-7R4 program, the 767 design envelope V_C and M_C limits of 420 kcas and M = 0.91 were applied to the NAIL program.

Several restrictions were imposed on the NAIL program—not because of the NAIL flight test profile but because of inclement weather (i.e., rain, snow, hail, fog, high wind, and wide variations in temperature). Moisture caused problems for the RA001 in that only engine 1 had thermal anti-ice protection. Therefore, no flights were conducted into known or suspected icing conditions. The pressure instrumentation (fig. 36) was not to be exposed to visible moisture to ensure that water did not enter the lines and freeze.

Use of laser probes for detection of engine clearance changes dictated adherence to three conditions: that the nitrogen purge and cooling system operate whenever engine 3 was used, that nitrogen cooling be required for the camera environmental housings when ambient ground conditions dictated, and that the aircraft heading prevent sunlight from entering the inlet and interfering with laser readings.

Because a functional check flight and a ferry flight to the remote test site were required prior to any NAIL data collection effort, it was necessary to restrict the level of power to prevent performance losses in the analytically built engine 3. Therefore, all flights prior to the first data flight were limited to an engine pressure ratio (EPR) of 1.18 with no bleeds during takeoff and maintained a locked throttle climb to 10 000 ft at which time normal operation resumed.

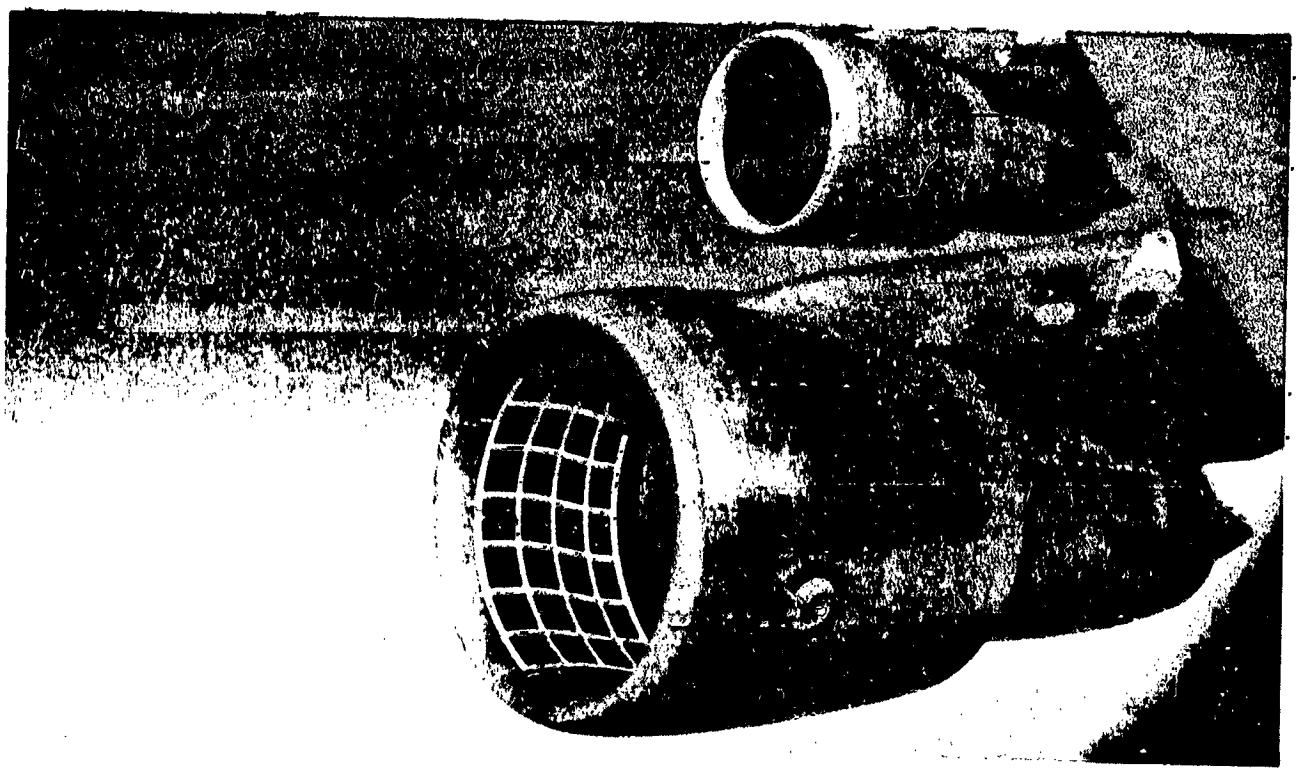
As a result of the concurrent testing programs, data were taken over approximately 33 hours of flight time instead of over the initially planned 15-hour maximum. The increased flight time resulted in a substantially larger quantity of data to survey and select from for analysis and provided additional conditions for analysis. The result of this concurrent testing was that additional data were obtained, yet flight hours charged to the NASA program were considerably fewer than planned.

ORIGINAL PAGE IS
OF POOR QUALITY

Table 18. Test Conditions Flown

Test condition	Test no.	Event time	Pressure altitude, ft	M
101 612K gross weight takeoff (flaps 20)	273-7	6:41:44	2 653	0.250
101 638K gross weight takeoff (flaps 10)	273-10	9:44:10	2 667	0.239
101 647K gross weight takeoff (flaps 10)	273-11	10:13:52	2 634	0.254
118 780K gross weight simulated takeoff (flaps 10)	273-15	8:13:18	3 646	0.296
102 Low climb	273-10	9:46:00	5 861	0.367
103 Mid climb	273-7	7:28:44	17 187	0.699
104 High M cruise	273-7	7:49:26	35 481	0.859
105 Low M cruise	273-7	7:56:40	35 612	0.772
106 Max M	273-15	12:09:27	36 978	0.906
107 Inflight relight	273-7	8:12:53	27 859	0.721
108 Maximum q	273-16	11:39:00	24 513	0.836
109 Stall warning (flaps up)	273-7	8:18:58	16 964	0.391
110 Stall warning (flaps 10)	273-7	8:22:26	16 239	0.347
111 Stall warning (flaps 30)	273-7	8:24:52	17 049	0.270
112 Idle descent	273-7	8:28:56	8 450	0.439
113 Approach	273-7	8:34:27	6 003	0.265
114 Touch and go	273-7	8:40:36	2 561	0.263
115 Thrust reverse	273-7	8:46:00	2 561	0.179
116 2.0g left turn (flaps up)	273-10	13:33:58	8 397	0.487
117 1.6g left turn (flaps 30)	273-10	13:41:07	8 202	0.260
120 2.0g right turn (flaps up)	273-15	11:04:03	8 240	0.476
121 1.6g right turn (flaps 30)	273-15	11:07:25	8 278	0.266
123 Airplane stall	273-10	13:26:17	9 000	0.207

126208-20-107



126208-28

Figure 36. View of Pressure Ports

4.1.3.2 Installed Propulsion System Aerodynamics

Four test conditions were flown during the IPSA program. The test conditions included level flight at M = 0.77, 0.80, and 0.86 and at M = 0.91, a condition that required the airplane to be put into a shallow dive. The test conditions flown at M = 0.77, 0.86, and 0.91 satisfied the contract commitment and were coincident with flight load conditions. All test conditions were flown at a representative cruise altitude.

Preflight and postflight calibrations of the pressure measuring system were performed for each test flight. During a test flight, seven flight condition parameters were monitored online with a multichannel pen recorder. These parameters included flight Mach number, ambient total temperature, angle of attack, heading, pressure altitude, sideslip, and inboard aileron position. These parameters were used collectively to determine the stability of the airplane prior to and during the recording of measured pressure data. In each parameter, the deviations allowed for approximately a 30-sec period during which measured data were recorded; these deviations are:

Mach number	± 0.001
Ambient total temperature	$\pm 0.1^{\circ}C$
Angle of attack	± 0.25 deg
Heading	± 0.2 deg
Pressure altitude	± 3.048m (± 10 ft)
Sideslip	± 0.25 deg
Aileron position	± 1 deg

All test conditions were flown with the airplane autopilot engaged and in the altitude hold mode.

Because all measured pressure data were acquired during cruise conditions, no wing leading- or trailing-edge devices that would alter the basic wing geometry described in table 1 were deployed with the exception of the inboard aileron. In cruise, the inboard aileron provided small amounts of roll control and was combined with various amounts of midspan spoiler deployment for larger rolling moment inputs. During data recordings, some small aileron deflections, well below those levels causing limited spoiler deployment, were required to maintain level flight. Accordingly, this small amount of inboard aileron deflection effectively changed the local wing camber at WBLs 445, 470, and 510.

For reference, the geometrical arrangement of the inboard aileron at WBLs of 445 and 510 including the wing line location is presented in table 19. The outboard aileron was locked out during cruise and therefore was an inactive control surface at 0-deg deflection.

4.1.4 Test Data Format

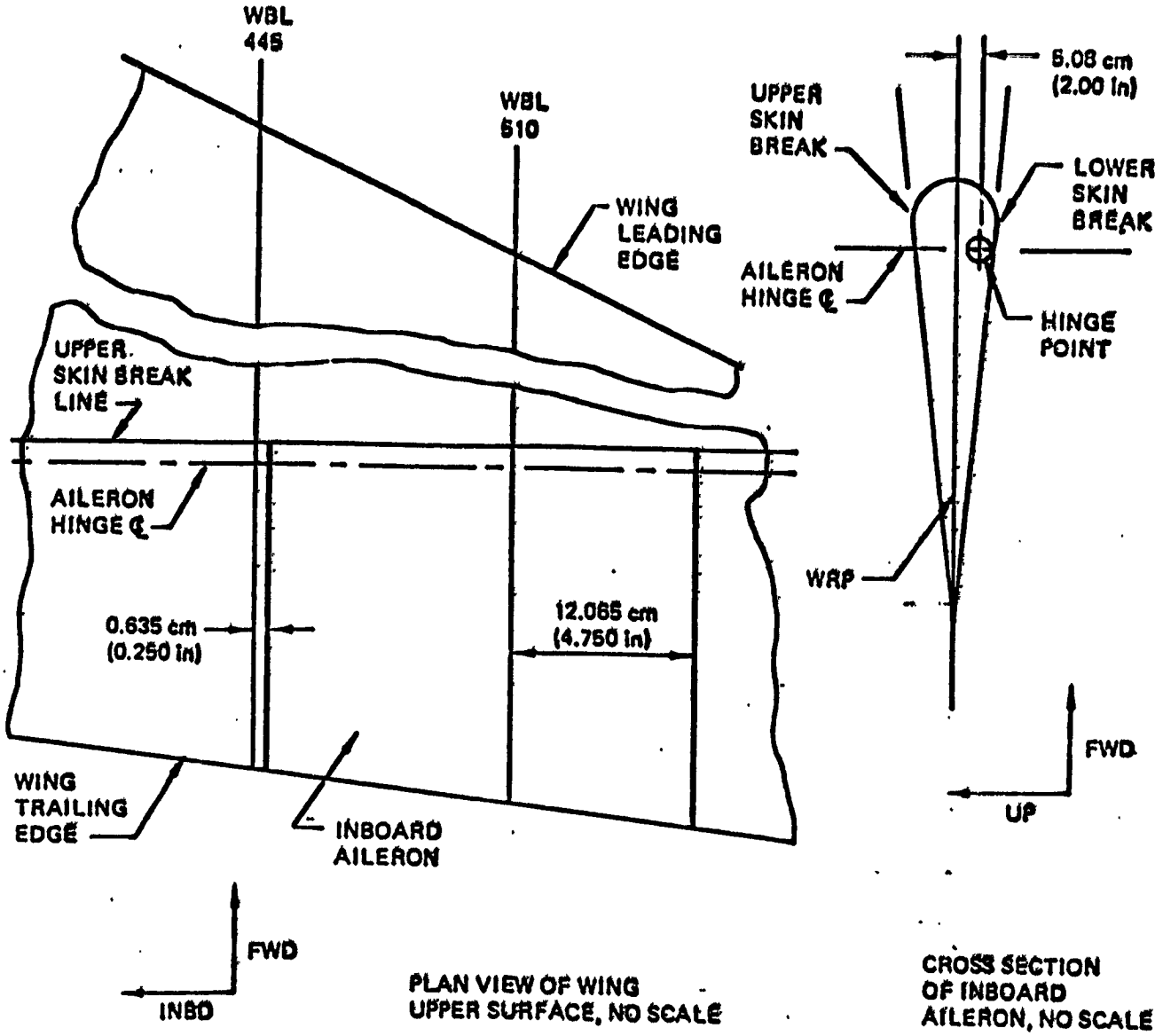
The data collected during the NAIL program required careful use of the airborne data analysis and monitor system (ADAMS) and of the final data system. Of particular concern was the ability to assess real-time data quality for flight decisions, because 1023 channels of measurements were being made during the combined test program and no ground-based analysis system was available at the remote site. It was necessary to send the flight tape to Seattle shortly after completion of the day's testing. This requirement did not allow rerunning the tape on the ADAMS. Therefore, essentially all decisions were based upon real-time data obtained from the ADAMS during flight. Further development of the onboard ADAMS and the combined use of the final data system in conjunction with the flight test interactive graphics data analysis (IGDA) site aided in coping with this problem.

The basic ADAMS (fig. 37) could not handle the volume of data required by the JT9D-7R4 and NAIL programs. The expanded data handling capabilities of the analysis groups doubled that of the basic system by using a second ADAMS on the RA001. The quantity of data collected during the program required system modification in order to minimize testing and preflight delays. These modifications to the onboard flight test system (fig. 38) provided adequate remote-base support to the flight test program. Several hardware and software changes to the basic ADAMS were implemented to accomplish this support.

Two other significant hardware changes were made to the basic ADAMS. First, a fixed head disk for program and measurement information storage was used. The fixed head disk eliminated loading of information through Cartrifiles each time the system was brought online. This improvement was vital because activating the system required 1 to 2 min rather than 15 min as projected, based on the number of measurements required. A 15-min delay was unacceptable in terms of cost, if the system should malfunction once airborne. Further, rapid selection of preselected data sources was also a requirement in view of the quantity of data being measured and the concurrent test program to permit

ORIGINAL PAGE IS
OF POOR QUALITY

Table 19. Inboard Aileron



DISTANCE MEASURED IN WRP, cm (in)	WBL	
	445	510
Leading edge to aileron hinge centerline	830.78 (327.08)	680.54 (267.93)
Leading edge to upper surface skin break line	827.58 (325.82)	677.34 (266.67)
Leading edge to lower surface skin break line	828.47 (326.17)	677.77 (266.84)

ORIGINAL PAGE IS
OF POOR QUALITY

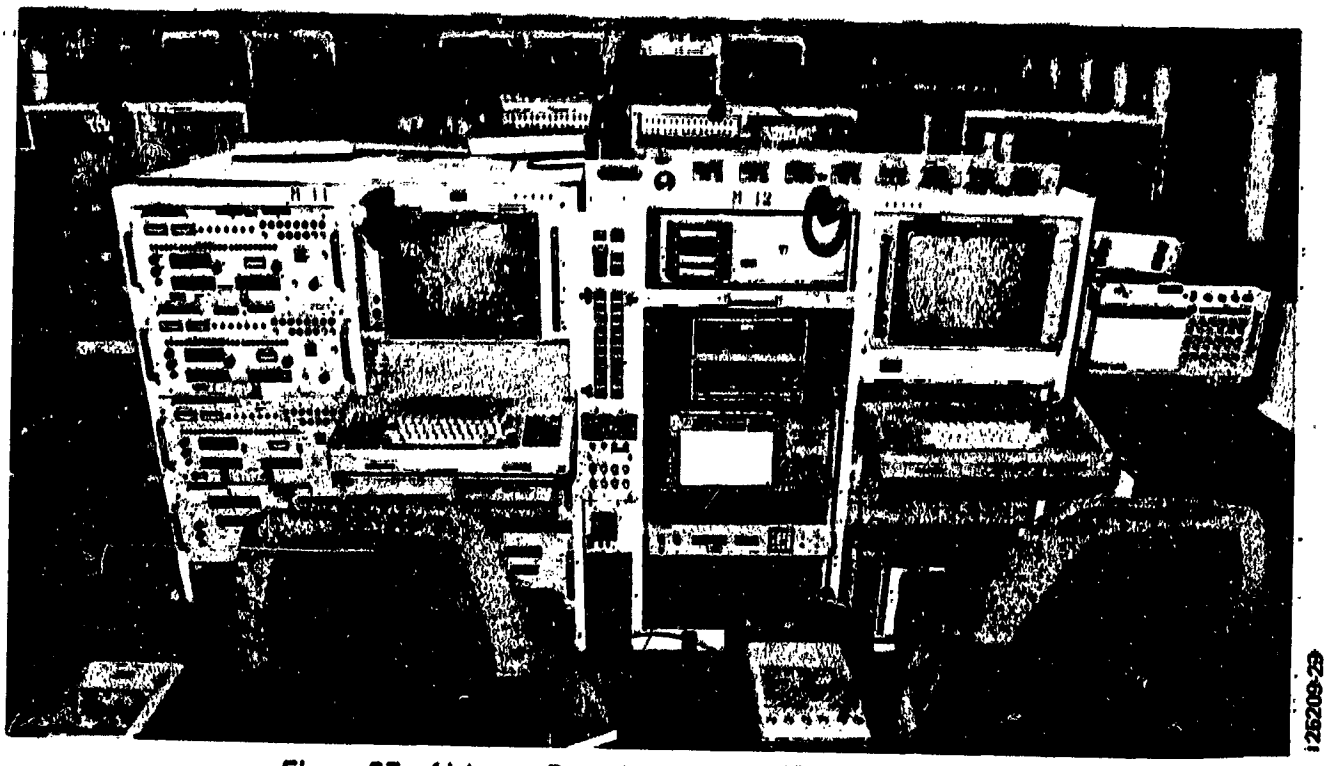


Figure 37. Airborne Data Analysis and Monitoring System

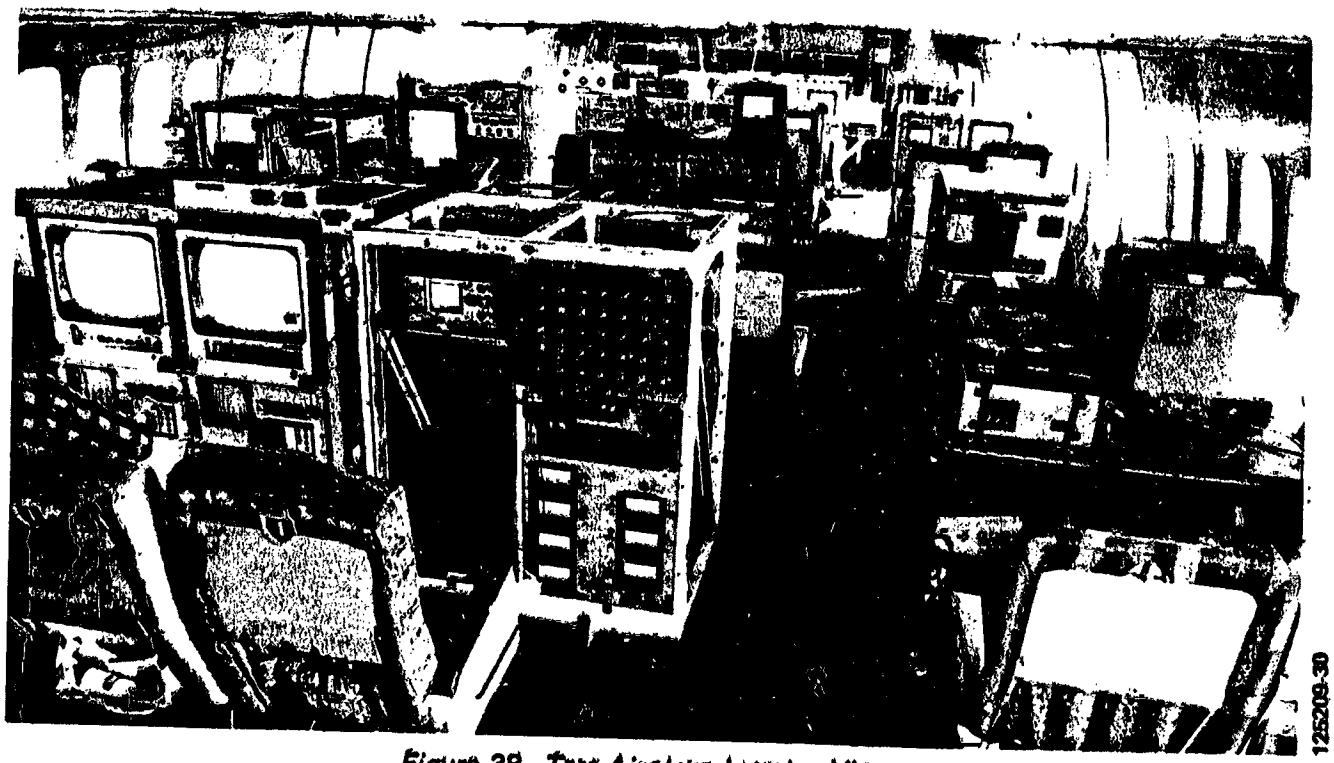


Figure 38. Test Airplane Interior View

the test engineers to track their respective data. Second, a data measurement selector was incorporated into the ADAMS. This was necessary because approximately 1023 measurements were obtained during the flight test. The data measurement selector sent data preselected for output to the digital-to-analog converter.

The original ADAMS software could not support the NAIL program during remote base operation. An onboard pressure coefficient (PC) program was lacking, and thus development of an interim program that satisfied the needs of analysis was necessary. The PC program was developed to use the Brush recorder as a quasigraphics system and to use the line printer for summary outputs. The program could calculate pressure coefficients for up to 16 measurement groups with a maximum of 20 pressure ports each. The output of the program was displayed on the Brush recorder while a summary table of port differential pressures and pressure coefficient values was printed on the line printer. This information was output either continuously or upon keyboard command for a predetermined time interval. The program provided real-time information for determining data quality and for making decisions on subsequent test conditions.

Data were supplied in the forms of tables, computer-generated graphs, and data files on magnetic tapes. Table 20 is an example of a pressure coefficient data table. Engine performance and fuel flow examples are given in tables 21 and 22. An example of an engine clearance data table is given in table 23. Finally, table 24 is an example of a turbine case temperature table. The magnetic tape data files included all the above examples and basic airplane data for all flight conditions, plus acceleration data for the heavyweight landing.

4.2 TEST RESULTS

4.2.1 Aerodynamic and Inertial Loads

4.2.1.1 Aerodynamic Loads

Pressures were measured at 252 ports in 12 rows nominally 30 deg apart on the inlet and fan cowl of engine 3. The actual spacing varied slightly for some ports because of installation and arrangement requirements. (See Appendix A for details.) Fourteen ports were found to have defective or doubtful transducers, and the indicated pressures of those ports were not used. Pressure data are presented graphically and in tabular form in Appendix A.

Table 20. Pressure Coefficient

AIRPLANE MODEL 747-100 TEST 273-07 PRESSURE COEFFICIENT REQUEST NO 0391.0309
AIRPLANE NUMBER RA001 DATE 10/13/80 TIME 0347

COORDINATION TIME HR-MIN-SEC	CE	ALPHA BEG	Q PSI	PRESS-INLET E3 PT01 240R PS 3211	CP	PRESS-INLET E3 PT02 240R PS 3212	CP	PRESS-INLET E3 PT03 240R PS 3213	CP	PRESS-INLET E3 PT04 240R PS 3214	CP	PRESS-INLET E3 PT05 240R PS 3215	CP	PRESS-INLET E3 PT06 240R PS 3216	CP
			IEC	11.296	IEC	11.152	IEC	10.994	IEC	10.871	IEC	10.629	IEC	10.427	IEC
8-33-20.014		DNA	0.495	11.225	-1.040	11.136	-1.220	10.994	-1.506	10.852	-1.794	10.603	-2.276	10.475	-2.555
8-33-20.064		DNA	0.495	11.182	-1.126	11.152	-1.187	11.064	-1.364	10.852	-1.794	10.638	-2.227	10.512	-2.491
8-33-20.114		DNA	0.495	11.197	-1.098	11.152	-1.188	10.994	-1.506	10.569	-1.717	10.620	-2.252	10.499	-2.534
8-33-20.164		DNA	0.495	11.182	-1.126	11.168	-1.155	11.029	-1.435	10.890	-1.717	10.635	-2.192	10.487	-2.532
8-33-20.214		DNA	0.495	11.254	-0.933	11.184	-1.123	10.994	-1.507	10.909	-1.675	10.655	-2.172	10.487	-2.532
8-33-20.264		DNA	0.495	11.211	-1.069	11.168	-1.155	11.029	-1.436	10.852	-1.795	10.655	-2.172	10.487	-2.532
8-33-20.314		DNA	0.495	11.310	-0.868	11.215	-1.058	11.052	-1.329	10.871	-1.756	10.628	-2.223	10.509	-2.507
8-33-20.364		DNA	0.495	11.239	-1.012	11.152	-1.188	11.039	-1.436	10.871	-1.755	10.621	-2.243	10.437	-2.532
8-33-20.414		DNA	0.495	11.296	-0.897	11.168	-1.155	11.030	-1.436	10.871	-1.756	10.603	-2.273	10.475	-2.553
8-33-20.464		DNA	0.495	11.353	-0.782	11.184	-1.123	10.977	-1.542	10.891	-1.717	10.621	-2.263	10.453	-2.532
8-33-20.514		DNA	0.495	11.268	-0.954	11.184	-1.123	10.995	-1.507	10.871	-1.756	10.621	-2.252	10.530	-2.507
8-33-20.564		DNA	0.495	11.225	-1.040	11.200	-1.091	10.995	-1.507	10.833	-1.833	10.621	-2.252	10.509	-2.507
8-33-20.614		DNA	0.495	11.240	-1.011	11.152	-1.188	11.012	-1.471	10.833	-1.833	10.638	-2.227	10.475	-2.507
8-33-20.664		DNA	0.495	11.226	-1.040	11.088	-1.318	11.030	-1.436	10.852	-1.795	10.621	-2.263	10.530	-2.507
8-33-20.714		DNA	0.495	11.240	-1.012	11.137	-1.221	11.012	-1.472	10.872	-1.755	10.638	-2.223	10.475	-2.553
8-33-20.764		DNA	0.494	11.226	-1.041	11.137	-1.221	11.012	-1.472	10.852	-1.795	10.621	-2.254	10.509	-2.528
8-33-20.814		DNA	0.494	11.254	-0.984	11.217	-1.059	11.030	-1.437	10.891	-1.718	10.656	-2.194	10.513	-2.484
8-33-20.864		DNA	0.494	11.211	-1.070	11.137	-1.221	11.013	-1.472	10.872	-1.757	10.621	-2.264	10.513	-2.494
8-33-20.914		DNA	0.494	11.212	-1.070	11.185	-1.124	11.048	-1.401	10.891	-1.718	10.635	-2.229	10.433	-2.574
8-33-20.964		DNA	0.494	11.254	-0.984	11.185	-1.124	11.013	-1.472	10.910	-1.580	10.621	-2.254	10.475	-2.559
8-33-21.014		DNA	0.494	11.269	-0.955	11.201	-1.091	11.013	-1.472	10.872	-1.737	10.604	-2.299	10.476	-2.559
8-33-21.064		DNA	0.494	11.325	-0.840	11.265	-0.962	11.030	-1.437	10.872	-1.757	10.639	-2.229	10.493	-2.534
8-33-21.114		DNA	0.494	11.226	-1.041	11.169	-1.156	11.030	-1.437	10.853	-1.796	10.621	-2.254	10.476	-2.559
8-33-21.164		DNA	0.494	11.311	-0.868	11.137	-1.221	11.048	-1.401	10.891	-1.718	10.604	-2.299	10.551	-2.508
8-33-21.214		DNA	0.494	11.254	-0.983	11.137	-1.221	11.013	-1.472	10.891	-1.776	10.604	-2.299	10.498	-2.533
8-33-21.264		DNA	0.494	11.283	-0.926	11.153	-1.188	10.978	-1.543	10.853	-1.795	10.639	-2.222	10.485	-2.533
8-33-21.314		DNA	0.495	11.297	-0.897	11.153	-1.188	10.960	-1.575	10.891	-1.717	10.622	-2.253	10.498	-2.532
8-33-21.364		DNA	0.495	11.240	-1.012	11.137	-1.220	10.995	-1.507	10.872	-1.756	10.622	-2.262	10.476	-2.557
8-33-21.414		DNA	0.495	11.155	-1.184	11.169	-1.155	11.031	-1.435	10.834	-1.833	10.622	-2.262	10.533	-2.481
8-33-21.464		DNA	0.495	11.212	-1.069	11.153	-1.187	10.960	-1.577	10.911	-1.675	10.655	-2.191	10.476	-2.555
8-33-21.514		DNA	0.495	11.198	-1.097	11.169	-1.155	11.048	-1.399	10.872	-1.755	10.639	-2.225	10.571	-2.505
8-33-21.564		DNA	0.495	11.269	-0.953	11.218	-1.058	11.013	-1.470	10.911	-1.677	10.691	-2.121	10.526	-2.415
8-33-21.614		DNA	0.495	11.226	-1.039	11.186	-1.122	11.048	-1.399	10.949	-1.599	10.674	-2.155	10.563	-2.379
8-33-21.664		DNA	0.495	11.283	-0.925	11.218	-1.057	11.046	-1.364	10.911	-1.677	10.674	-2.156	10.525	-2.455
8-33-21.714		DNA	0.495	11.241	-1.011	11.154	-1.187	11.031	-1.435	10.815	-1.871	10.622	-2.261	10.494	-2.552
8-33-21.764		DNA	0.495	11.284	-0.925	11.170	-1.155	11.031	-1.435	10.753	-1.957	10.518	-2.472	10.370	-2.931
8-33-21.814		DNA	0.495	11.340	-0.810	11.186	-1.123	10.996	-1.505	10.854	-1.794	10.587	-2.332	10.476	-2.555
8-33-21.854		DNA	0.495	11.255	-0.983	11.186	-1.123	11.014	-1.471	10.950	-1.601	10.674	-2.157	10.551	-2.428
8-33-21.914		DNA	0.495	11.213	-1.069	11.186	-1.123	11.031	-1.436	10.950	-1.691	10.709	-2.087	10.563	-2.382
8-33-21.964		DNA	0.495												

CONDITION AVERAGES

CALIBRATED AIRSPEED	145.3 KNOTS	MACH NUMBER	0.245		
PRESSURE ALTITUDE	6072 FEET	FLAP POSITION	30 DEG		
DYNAMIC PRESSURE	0.495 PSI	LANDING GEAR	UP		
NORMAL ACCELERATION	1.043 G	GROSS WEIGHT	0 LBS		

PROGRAM LIBRARY 08/11/80 FR07

CONDITION NO 4.32.915 118
DOCUMENT NO D5-22119-1
PAGE 40

ORIGINAL PAGE IS OF POOR QUALITY

001-22-000121

Table 21. Summary of Measurements of Engine Performance

AIRPLANE MODEL 747-100 TEST 273-15 JT9 ENG PERF SUMMARY REQUEST NO 1316.0101
AIRPLANE NUMBER RA001 DATE 10/31/80 TIME 0515

AIRPLANE DATA

HP FEET	M	V KTS	DELTAM DEG C	TAM DEG C	TT1 DEG C	PS1 IN HG	PT1 IN HG	DELAMB	DELT1	THEA67	THET67	THET91	THET57
24076.	0.681	364.8	2.5	-30.2	-12.7	11.56	14.75	0.3863	0.4930	0.8920	0.9346	NDA	NDA

GAS GENERATOR SUMMARY

ENG STS	FN RFN LBS	SFC RSFC	N1 RN1 RPM	N2 RN2 RPM	T6 RT6 C/K	T7 RT7 C/K	WF RWF LB/HR	WAT RWAT LB/SC	P25PT1 PT2PT1	PS4 PS4PT7	SBV BPR POS/	SVA SGF DEG/	P1A DEG
1	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	NDA	NDA
NDA	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	0.8213	
2	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	NDA	NDA
NDA	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	0.8213	
3	7212.	0.6979	2788.	6644.	628.	488.	5039.	725.	1.335	205.527	1.8	0.4	72.1
NDA	18670.	0.7824	2924.	6988.	979.	749.	10938.	1398.	1.892	12.763	6.37	0.8213	
4	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	NDA	NDA
NDA	NDA	IDU	NDA	NDA	NDA	NDA	IDU	NDA	NDA	NDA	NDA	0.8213	

THRUST CALCULATION DETAIL SUMMARY

ENG	FGF RFGF LBS	FGP RFGP LBS	FRAM RFRAM LBS	WIF WIP LB/SC	P25PAM PRFPA	PT7PAM PRPPA	PTMRP PTBRF	PTMBF	CGF CDF	CGP CDP	AFAN APRI FT2	RT2.5 WBA K/PPS	WFFN WH2O LB/SC	GPRI RPRI
1	NDA	NDA	NDA	NDA	NDA	NDA	NDA		NDA	NDA	20.119	NDA	NDA	NDA
	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	6.641	NDA	7.220	0.9
2	NDA	NDA	NDA	NDA	NDA	NDA	NDA		NDA	NDA	0.0	NDA	NDA	NDA
	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	0.0	NDA	7.220	0.9
3	17697.	3384.	13869.	646.	1.7036	1.3932	1.0162		0.9441	0.9473	20.119	318.	1.395	1.359
	45812.	8760.	35902.	102.	1.6956	1.3709	1.0047	1.0000	0.9698	0.9723	6.641	0.0	7.220	0.0
4	NDA	NDA	NDA	NDA	NDA	NDA	NDA		NDA	NDA	20.102	NDA	NDA	NDA
	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	6.644	NDA	7.220	0.0

ALL VALUES PRINTED ARE CONDITION AVERAGES

PROGRAM LIBRARY 08/11/80 PR07 CONDITION NO 4.08.015.007
DOCUMENT NO D6-22119-1
PAGE NO

ORIGINAL PAGE IS
OF POOR QUALITY

Table 22. Engine Fuel-Flow Data

AIRPLANE MODEL 747-100
AIRPLANE NUMBER RA001

TEST 273-15

ENGINE FUEL FLOW DATA

ENGINE MODEL P&WA JT9D-3/7

REQUEST NO 1316.0101
DATE 10/31/80 TIME 0515

COORDINATION TIME	CB EN	WF LB/HR 0 10	TEST VALUES RWF LB/HR 0 10	SFC LBS/HR/LB -3 15	RSFC -3 10	TIME SEC -3 10	DRWF PCT -1 10	PNTS /LN 0 10	DFFN PCT -1 10	TEST VALUES SWF LB/HR 0 10	ARWF LB/HR 0 10	APSFC LBS/HR/LB -4 10	APRSFC -4 10
11-27-40.086	3	IDU	NDA	NDA	NDA	IDU	NDA	ID	NDA				
11-27-45.086	3	5039	10938	698	782	8080	71	8	72				
AVERAGE	3	5039	10938	698	782	8080	71	8	72	IDU	IDU	IDU	IDU
NO. OF POINTS	3	1	1	1	1	1	1	1	1	0	0	0	0

PROGRAM LIBRARY 08/11/80 PR07

CONDITION NO 4.23.015.007
DOCUMENT NO D3-22119-1
PAGE NO

ORIGINAL PAGE IS
OF POOR QUALITY

Table 23. Measurements for Engine Clearance

AIRPLANE MODEL 747-100 TEST 273-15
AIRPLANE NUMBER RA001

REQUEST NO 1316.0131
DATE 10/31/80 TIME 0515

COORDINATION TIME	E3 CLEARANCE HPT 21.7 DEG	E3 CLEARANCE HPT 128 DEG	E3 CLEARANCE HPT 218 DEG	E3 CLEARANCE HPT 300 DEG	E3 CLEARANCE FAN 30 DEG	E3 CLEARANCE FAN 120 DEG	E3 CLEARANCE FAN 210 DEG	E3 CLEARANCE FAN 300 DEG	E4 CLEARANCE FAN 30 DEG	E4 CLEARANCE FAN 120 DEG	E4 CLEARANCE FAN 210 DEG	E4 CLEARANCE FAN 300 DEG	TEMP M-FLNGE TIP 0 RAD	TEMP M-FLNGE TIP 60 RAD
	MILS	MILS	MILS	MILS	MILS	MILS	MILS	MILS	MILS	MILS	MILS	MILS	DEGF	DEGF
	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	5180	5181
	0.133	0.133	0.133	0.133	0.135	0.135	0.135	0.136	0.162	0.162	0.162	0.162	-0.040	-0.030
	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	0	0
HR MIN SEC	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11-33-00.094	122330	475168	26711	95729	510606	114197	88564	26678	131500	46295	525126	71934	665	MP
11-33-01.094	56532	LP	20544	40145	513694	110081	97832	40017	15408	93633	202843	171755	665	MP
11-33-02.094	67841	517338	81184	71025	522960	149180	118429	57459	-22605	16451	147242	136784	665	MP
11-33-03.094	89431	LP	62683	93670	LP	78185	114310	40017	42119	-56614	133856	34955	668	MP
11-33-04.094	29802	LP	22680	26764	366478	95676	60758	26678	92460	135825	LP	119293	665	MP
11-33-05.094	69898	499853	103795	34999	469427	87445	91653	37964	137664	201687	370677	289812	668	MP
11-33-06.094	46251	429913	45211	29852	515753	79214	117399	50277	LP	238734	LP	282841	668	MP
11-33-07.094	28774	463855	-2067	49409	473544	128682	133877	61564	236291	116098	485998	182041	665	MP
11-33-08.094	103825	589110	45211	102934	LP	106954	136966	87215	116089	161553	88551	290341	665	MP
11-33-09.094	59617	513224	11294	57644	447807	81271	70027	9235	40864	44237	228584	270493	661	MP
AVERAGE	67630	486923	41717	60217	477534	103085	102982	43710	87666	99190	272860	177001	665	NDA
MINIMUM	28774	429913	-2067	26764	366478	78185	60758	9235	-22605	-56614	88551	34955	661	NDA
MAXIMUM	122330	517338	103795	102934	522960	149180	136966	87215	236291	238734	525126	298041	668	NDA
STD DEVIATION	28927	29753	31236	27432	49021	22201	24322	20670	73834	85028	155952	83668	2	NDA
NO. OF POINTS	10	7	10	10	8	10	10	10	9	10	8	10	10	0

PROGRAM LIBRARY 08/11/80 PR07

CONDITION NO 4.98.015.019
DOCUMENT NO D6-22119-1
PAGE NO

ORIGINAL PAGE IS
OF POOR QUALITY

Table 24. Measurements of Turbine Case Temperature

AIRPLANE MODEL 747-100 TEST 273-15
AIRPLANE NUMBER RA001

REQUEST NO 1336.0101
DATE 10/31/80 TIME 0515

COORDINATION TIME	TEMP M-FLNGE TIP 120 RAD	TEMP M-FLNGE TIP 240 RAD	TEMP M-FLNGE TIP 180 RAD	TEMP M-FLNGE TIP 300 RAD	TEMP M-FLNGE ROOT 0 RAD	TEMP M-FLNGE ROOT 60 RAD	TEMP M-FLNGE ROOT 120 RAD	TEMP M-FLNGE ROOT 180 RAD	TEMP M-FLNGE ROOT 240 RAD	TEMP M-FLNGE ROOT 300 RAD	TEMP M-FLNGE ROOT 0 RAD	TEMP M-FLNGE ROOT 120 RAD	TEMP M-FLNGE ROOT 240 RAD	TEMP M-FLNGE TIP 0 RAD
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
	5182	5183	5184	5185	5186	5187	5188	5189	5190	5191	5192	5193	5194	5195
	-0.020	-0.010	-0.000	0.010	0.020	0.030	0.040	0.050	-0.040	-0.030	-0.020	-0.010	-0.000	0.010
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR MIN SEC	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11-31-20.091	652	717	670	689	709	707	707	-1343	717	728	1010	792	794	754
11-31-21.091	655	726	672	691	704	707	711	-1296	715	724	1015	801	803	750
11-31-22.091	655	722	672	689	709	707	711	-1319	717	724	1017	799	801	752
11-31-23.092	650	717	668	689	707	702	707	-1380	717	726	1010	792	794	750
11-31-24.092	652	720	670	687	709	707	709	-1368	709	720	1010	792	797	754
11-31-25.092	652	717	665	691	713	711	713	-1331	715	724	1015	794	794	756
11-31-26.092	650	715	670	689	711	707	707	-1368	715	724	1021	790	797	757
11-31-27.092	652	715	670	687	707	696	709	-1355	717	726	1019	792	797	750
11-31-28.092	655	717	668	691	709	704	707	-1343	717	726	1021	792	799	752
11-31-29.092	650	717	668	687	709	702	707	-1355	715	726	1019	792	794	750
AVERAGE	652	718	669	689	709	705	709	-1346	716	725	1016	794	797	752
MINIMUM	650	715	665	687	704	698	707	-1380	709	720	1010	790	794	750
MAXIMUM	655	726	672	691	713	711	713	-1296	717	728	1021	801	803	754
STD DEVIATION	2	3	2	2	2	3	2	24	3	2	4	3	3	2
NO. OF POINTS	10	10	10	10	10	10	10	10	10	10	10	10	10	10

ORIGINAL PAGE IS OF POOR QUALITY

To compute resultant airloads from the pressure data, a previously developed computer program was used. It approximates the inlet and cowl geometry as a series of conical frustums and adjusts for the tilt of the inlet axis with respect to the nacelle centerline by insertion of wedge-shaped surfaces. This procedure was checked by comparison to a method based on a complete three-dimensional geometry definition. Resultant forces differed by less than 3%, and resultant yaw and pitching moments at the engine face differed by less than 1%. (Rolling moments differed by 3.5% but are not significant loads.)

Figure 39 shows the coordinate system for the resultant loads.

Table 25 gives resultant loads along with key airplane and engine parameters for 23 flight conditions.

Takeoffs—Four takeoffs—one at flaps 20 deg and 612 000 lb gross weight and three at flaps 10 deg and gross weights of 538 000, 647 000, and 780 000 lb (simulated)—were selected for detailed loads analyses. For two takeoffs, time histories of resultant loads were calculated for the purpose of correlating maximum clearance changes, whenever they occurred, with the aerodynamic loads. For the 780 000 lb takeoff, which was simulated by a pullup manuever at 1000 ft above ground level, the analysis was done at the instant the correct airplane lift coefficient was reached.

The flaps 20 deg, 612 000 lb gross weight takeoff was the initial takeoff for the entire test program. Peak load was reached at inter-range instrumentation group master clock (IRIG) time 6:41:44. The pitching moment at the A-flange was 329 000 in-lb.

The 538 000 lb takeoff occurred during test 273-10, and the time history covers the IRIG span of 9:44:00 to 9:44:11. Time histories of A-flange pitching moment and airflow sensor vane angle* during the takeoff rotation are given in figure 40. The direct relationship of load to flow angle is evident. Also note that the maximum moment for this condition (401 000 in-lb) is considerably higher than the maximum for the flaps 20-deg takeoff, table 25.

---

*The airflow sensor vanes are mounted on both sides of the fuselage near the flight deck. The flow angles indicated by the vanes are influenced by flap setting, wing upwash, body crossflow, and other factors and should not be construed as airplane angle of attack.

C-2

ORIGINAL PAGE IS
OF POOR QUALITY

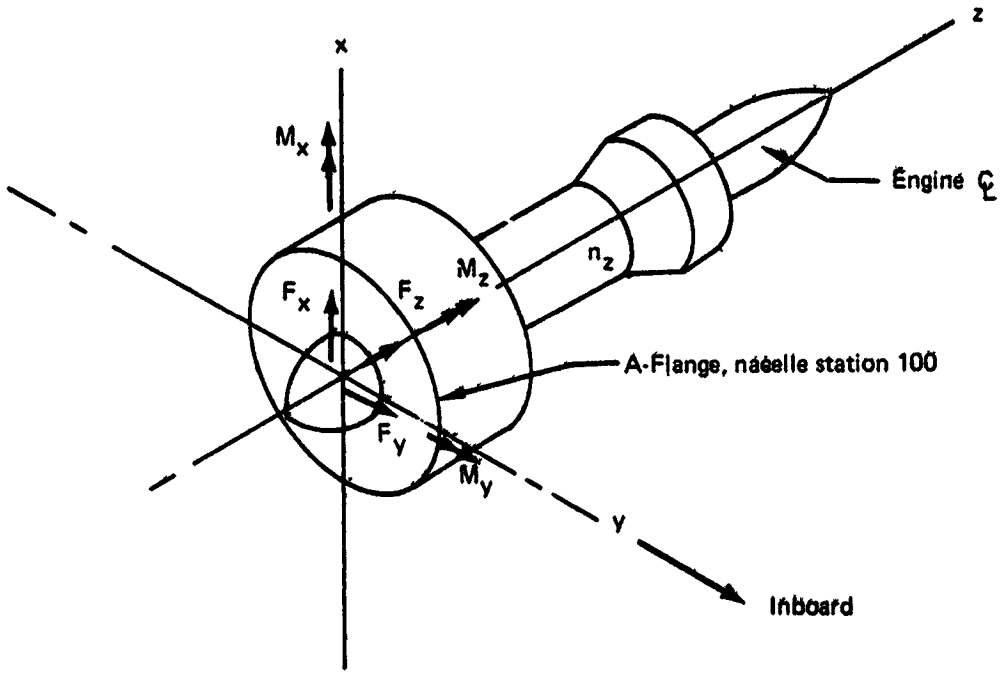


Figure 39. Sign Convention for Steady-State Loads, Engine 3

ORIGINAL PAGE IS
OF POOR QUALITY

Table 26. Engine 3 A-Flange Resultants

Condition	Air-speed, KCAS	Pressure altitude, ft	Mach number	Referred airflow, lb/s	Load factor, g	F_x, lb	F_y, lb	M_x, in-lb	M_y, in-lb
101 612K gross weight takeoff (flaps 20)	157.8	2 553	0.250	1549	1.14	6001	-2754	-147 736	-328 780
101 638K gross weight takeoff (flaps 10)	161.0	2 667	0.239	1527	1.26	7197	-2916	-152 292	-400 756
101 647K gross weight takeoff (flaps 10)	160.1	2 634	0.254	1524	1.17	7921	-3112	-159 326	-424 987
118 780K gross weight simulated takeoff (flaps 10)	183.6	3 646	0.296	1573	1.20	8344	-2757	-134 046	-430 154
102 Low climb	218.8	5 861	0.367	1539		4670	-1067	- 45 361	-206 043
103 Mid climb	290.4	17 187	0.599	1622		4084	- 588	- 25 756	-125 891
104 High M cruise	291.3	35 481	0.859	1633		2469	-1023	- 36 317	- 59 441
105 Low M cruise	258.3	35 512	0.772	1604		3478	-1131	- 42 237	-106 150
106 Max M	299.0	36 978	0.906	1642		302	- 464	- 15 779	+ 19 317
107 Inflight relight	286.7	27 859	0.721	1365		3277	-736	- 25 639	- 84 847
108 Maximum q	357.5	24 513	0.836	1617		-1410	+ 984	29 060	98 411
109 Stall warning (flaps up)	188.4	16 964	0.391	1591		5437	-1384	- 63 775	-243 214
110 Stall warning (flaps 10)	189.2	16 239	0.347	1621		6229	-2142	- 97 024	-304 770
111 Stall warning (flaps 30)	129.3	17 049	0.270	1633		3927	-1292	- 72 893	-220 730
112 Idle descent	249.7	8 450	0.439	748		4130	-1124	- 29 669	- 97 234
113 Approach	157.4	6 003	0.265	1547		3707	-1411	- 71 607	-201 854
114 Touch and go	166.5	2 561	0.263	1589		4388	-2321	-125 622	-241 654
115 Thrust reverse	113.2	2 561	0.179	1369		44	- 10	- 17 298	- 40 963
116 2.0g left turn (flaps up)	277.5	8 397	0.487	1562	1.99	7212	-3459	-133 292	-264 186
117 1.6g left turn (flaps 30)	143.0	8 202	0.260	1539	1.61	5293	-3672	-191 221	-284 557
120 2.0g right turn (flaps up)	272.1	8 240	0.476	1196	2.04	7634	-1629	- 47 455	-239 481
121 1.6g right turn (flaps 30)	151.3	8 278	0.266	1436	1.60	5416	- 359	- 10 105	-282 023
123 Airplane stall	115.7	9 009	0.207	1551		6072	-1613	- 89 181	-366 818

ORIGINAL PAGE IS
OF POOR QUALITY

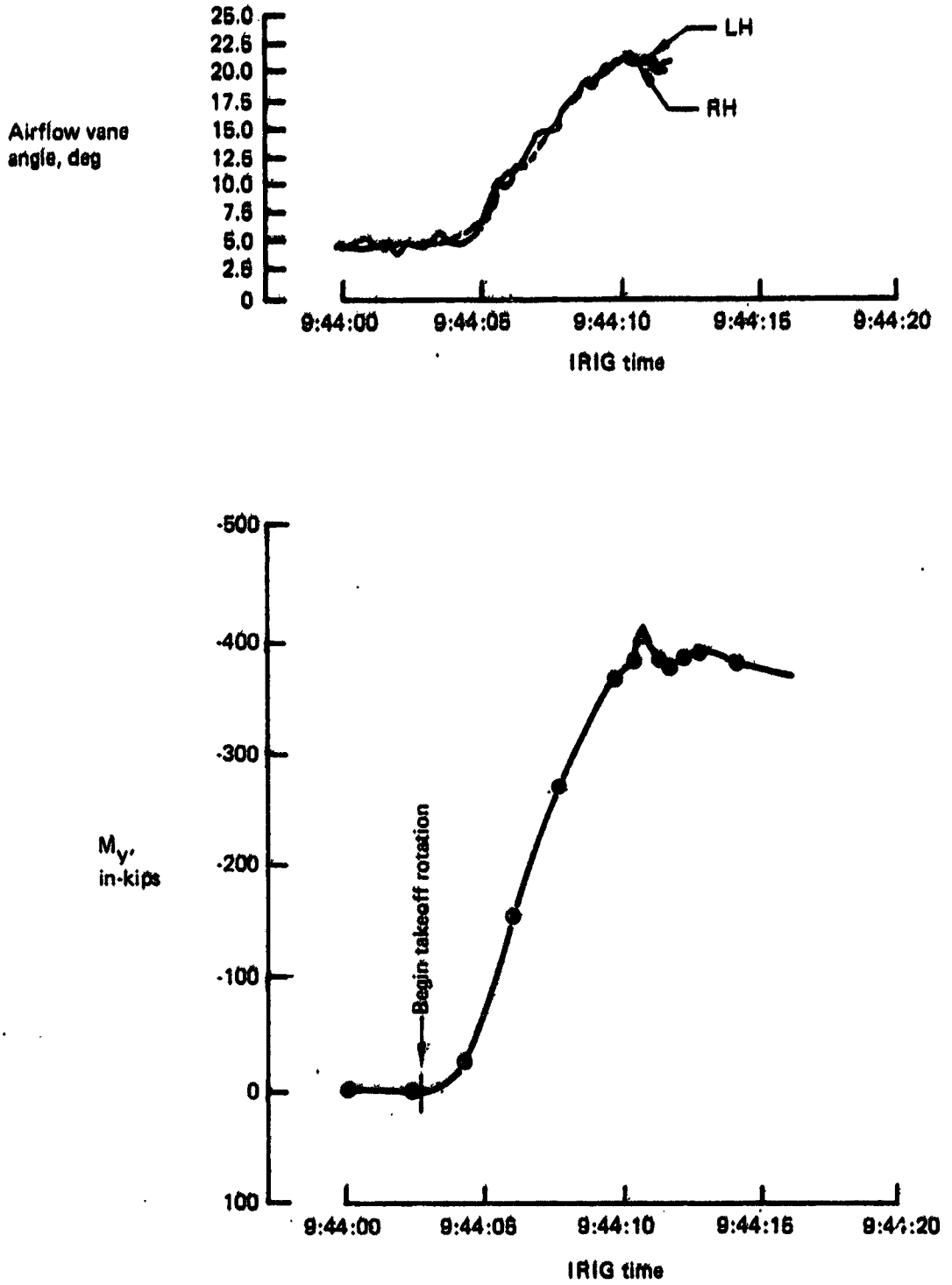


Figure 40. Inlet Pitching Moment Time History, 838 000 lb Gross Weight Takeoff

The 647 000 lb takeoff occurred during test 273-11 between IRIG time 10:13:46 and 10:13:55. The pitching moment time history (fig. 41) shows that the maximum aerodynamic load occurred at IRIG 10:13:52, with a nose-up moment of 425 000 in-lb. The load factor was 1.17g.

The simulated high gross weight takeoff occurred during test 273-15 at IRIG 8:13:18. The actual gross weight was 696 500 lb. The simulation was achieved by performing a pullup starting at 185 kn and 3646 ft altitude (about 1000 ft above ground) to produce the same airplane lift coefficient that would occur during a 780 000 lb takeoff. (The original intention was to simulate an 820 000 lb-gross weight takeoff. However, insufficient allowance was made for speed reduction due to increasing climb gradient in the pullup maneuver.) The moment at the A-flange was 430 100 in-lb.

Other Cases.--Airloads for conditions other than takeoff were generally of substantially lesser magnitude. However, certain cases were analyzed in greater detail because of possible adverse combinations of aerodynamic loads and thermal transients in the engine. Figure 42 shows a time history of the pitching moment at the engine face, engine airflow, and body vane angle for condition 110 (stall warning 10 deg flaps). The maximum moment (305 000 in-lb) coincided with maximum engine airflow, although the maximum vane angle occurred earlier in the maneuver. The result shows that engine airflow is of comparable importance to angle of attack in determining inlet airloads.

Other cases given special attention were the turns at constant altitude to achieve a specified load factor. Engine clearance changes during these maneuvers were due to a combination of aerodynamic loads, g-loads, and gyroscopic loads. Condition 116, nominally a 2g turn to the left, was run during test 273-10 and achieved a load factor of 1.99 at IRIG 13:33:58. The A-flange moment was 264 200 in-lb. The indicated pitch rate was 4.29 deg/s and the yaw rate was about 2.9 deg/s on both engines. A 2g turn to the right was performed during test 273-15 (condition 120) at IRIG 11:04:03. The moment was 239 500 in-lb, pitch rate was 5.5 deg/s, and yaw rate was 2.8 deg/s. Turns of 1.6g at flaps 30 deg. were performed to the right and to the left. The left turn occurred during test 273-10, IRIG 13:41:07 (condition 117) with a moment of 284 600 in-lb, pitch rate of 6.5 deg/s, and yaw rate of 3.7 deg/s. The right turn occurred during test 273-15 (condition 121) at IRIG 11:07:25 with a moment of 282 000 in-lb, pitch rate of 7 deg/s, and yaw rate of 4.7 deg/s. Finally, an airplane stall occurred during test 273-10. The moment peaked at 367 000 in-lb at IRIG 13:26:16. This relatively high load level resulted from a very high angle of attack.

ORIGINAL PAGE IS
OF POOR QUALITY

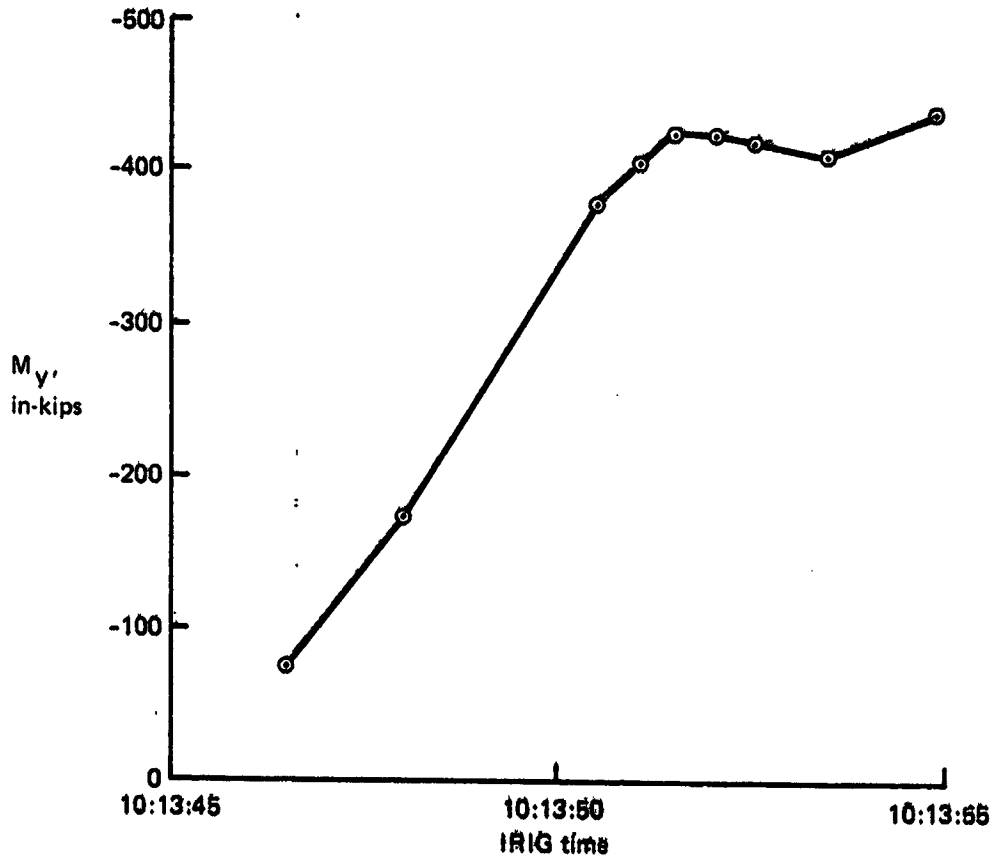
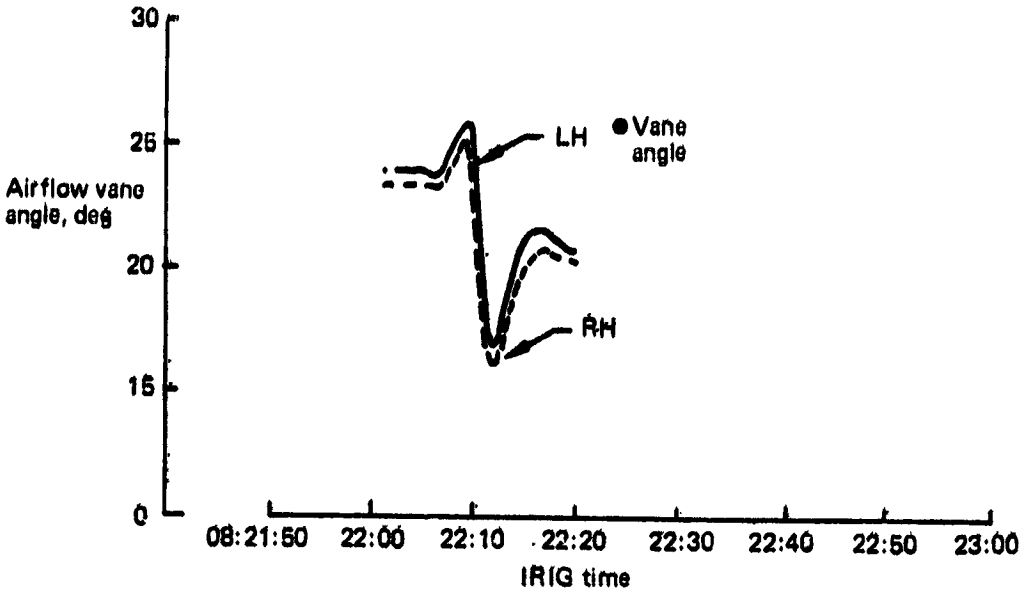


Figure 41. Inlet Airload Moment Time History, 647 000 lb Gross Weight Takeoff

ORIGINAL PAGE IS
OF POOR QUALITY



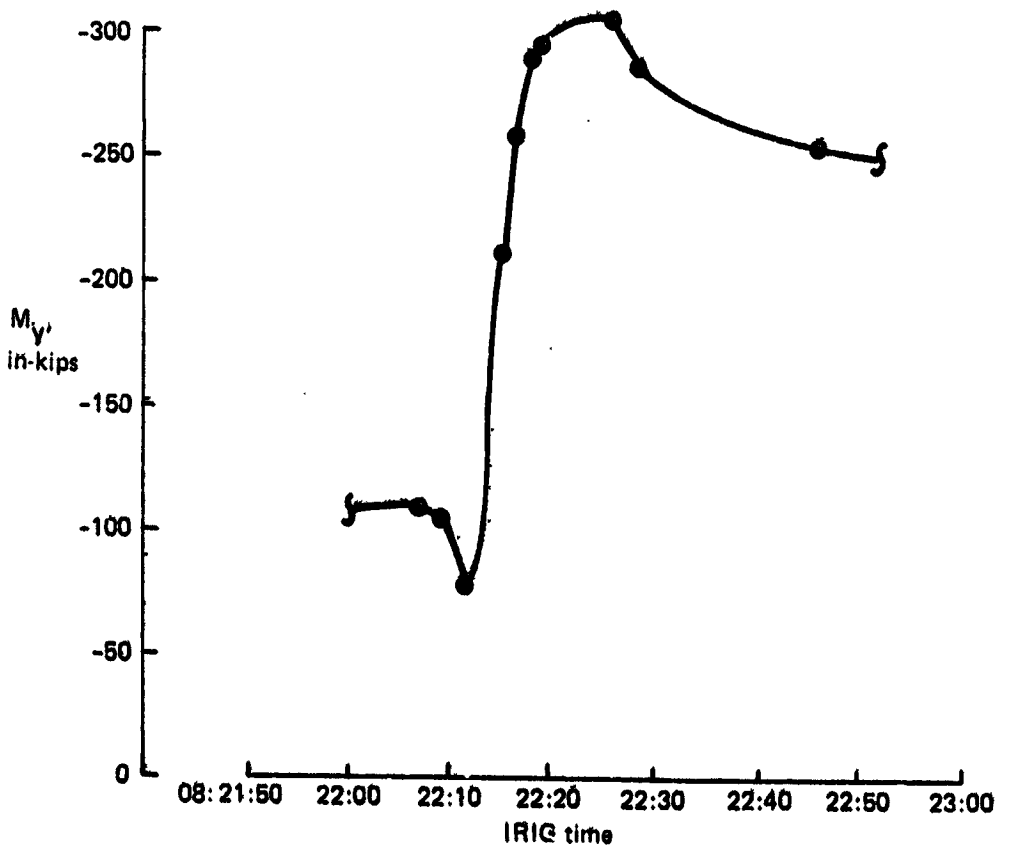


Figure 42. Airload Moment Time History, Stall Warning Maneuver, Flaps 10

125209-33

In this section all loads pertain to engine 3. Preliminary review of the test data indicated that the pressures on engine 4 were very close to the pressures of engine 3, implying that the loads were about equal. Comparison of the aerodynamic loads determined in the NAIL program with the loads predicted in task IIIA of the JT9D diagnostic program (ref. 2), indicate that:

- The most critical loads were higher than predicted because of higher angles of attack than had been expected.

- The cosine law for the circumferential pressure distribution assumed in task IIIA is a only a rough approximation of the actual distribution, especially in the critical region near the highlight.

- The phase angle of the cosine distribution is about 20 deg from the vertical near the highlight and further into the inlet approaches 0 deg.

4.2.1.2 Inertial Loads

Normal accelerations measured during takeoff and flight did not exceed 1.3g except during the high-g turn maneuvers. No significant turbulence was experienced during the NAIL program. The difference between g-loads measured at the airplane center of gravity and those measured on engines 3 and 4 was within the scatter of the data. In other words, the instruments responded only to steady-state accelerations of the whole airplane, experiencing no significant contributions from wing or nacelle flexible modes.

An exception to the steady-state accelerations occurred during a hard landing in test 273-15. The airplane landed at 690 000 lb gross weight with 297 000 lb fuel and a sink rate of approximately 10 ft/s. Touchdown occurred at IRIG 8:20:49. Vertical acceleration at the airplane center of gravity was 1.53g, with peaks of 2g at engine 4 and 1.7g at engine 3. This case was selected for dynamic analysis. Another exception occurred during test 273-10 during which a mild gust was encountered at IRIG 12:11:52. Normal accelerations were 1.08g at the airplane center of gravity and 1.3g at the engines. Details of all these cases are shown in Appendix A.

Pitch rates during takeoffs did not exceed 3 deg/s, the peak value being achieved before reaching the maximum load factor.

4.2.2 Installed Propulsion System Aerodynamics

Surface static pressures were measured on the nacelle and pylon of engine 3 (inboard) and engine 4 (outboard) and on neighboring wing surfaces during three separate test flights over the span of the test period. The initial flight, test 273-09, acquired data at M = 0.77, 0.80, and 0.86 and revealed instrumentation problems, which were partially corrected for a second flight, test 237-12. The third flight, test 273-15, was flown primarily to fulfill the remaining NASA conditions, which included M = 0.91. The M = 0.91 test was not flown until the end of the NAIL program when the speed restriction was removed concerning the other Boeing developmental programs...

Data plots of the measured pressures are presented in Appendix B.

5.0 REFERENCES

1. NASA CR-159717 (PWA-5512-46), Expanded Study of Feasibility of Measuring In-Flight 747/JT9D Loads, Performance, Clearance, and Thermal Data—JT9D Jet Engine Diagnostics Program.

2. D6-34720, Report of Task III A, Short Diagnostics Test Program, Engine Component Improvement Program, JT9D Engine Diagnostics (15 November 1978).

APPENDIX A

1.0 Pressures

The locations of pressure ports on engine 3 are shown in table A-1.

The coordinate system is shown in figure A-1. The arc length from the highlight to the port under considerations is denoted by "s." Positive values signify an external port and negative values signify an internal port.

The θ coordinate is the azimuth angle measured from the top and clockwise looking at the inlet from the front.

A distinction was made between nominal values and actual values of s and θ. The nominal values s_{nom} and θ_{nom} are convenient for the computerized plotting of the data. In practice, installing the pressure taps at the nominal location was not always possible because of structural interferences. Consequently the actual s and θ are also listed. Small discrepancies in actual pressure values resulting from these location shifts were accounted for by interpolation in the pressure integration process. The axial coordinate z (the normal distance from the highlight plane) is also listed.

Several pressure tranducers gave unreliable or obviously erroneous readings. Therefore, pressures were determined by averaging values measured at adjacent ports using suitable weighting for geometric relationships. The ports for which such systematic substitutions were made are listed in table A-2. Pressures that still appeared to be erroneous after this substitution were corrected manually before they were plotted.

A complete description of the pressure distribution function $p(s,\theta)$ at any point on the inlet is required to obtain inlet loads through integration. Because pressure was measured only at the pressure taps, an interpolation scheme was needed to determine the pressure at other locations. In the circumferential direction the Fourier-Bessel formula was used:

$$p(\theta) = A_0 + \Sigma A_n \cos(n\theta) + \Sigma B_n \sin(n\theta)$$

The use of this formula leads to a $p(\theta)$ function that fits every measured point exactly and ensures maximum smoothness in between. In the s-direction a linear interpolation was used between measured points.

The coefficients A_n and B_n for all flight conditions are listed in tables A-3 to A-25. (Note that in the lip area, 12 coefficients are tabulated, because pressures were measured at 12 θ values. Elsewhere, only six coefficients are available, because only six θ values were instrumented.)

The axial pressure distributions for each flight condition and value of θ are shown graphically in figures A-2 to A-47. The pressures are plotted in terms of pressure coefficient versus nominal arc lengths. Each flight condition is covered by two pages, one (inlet pressures) pertaining to the rows of pressure ports that extend all the way into the inlet (i.e., θ = 0 deg, 60 deg) and the other (cowl pressures) pertaining to the rows that extend to the trailing edge of the fan cowl (i.e., θ = 30 deg, 90 deg).

On engine 4, pressure taps were installed at three circumferential locations, θ = 60 deg, 180 deg, and 300 deg. Axial pressure distributions are shown in figures A-48 to A-70. No Fourier-Bessel coefficients were calculated for this engine because no integration was carried out. The pressures were measured mainly for the purpose of comparison with engine 3 pressures. Note that for some of the test conditions the power level of engine 4 was considerably different from engine 3.

2.0 INERTIAL LOADS

Recorded accelerations on inlets and strut-wing intersections are presented in figures A-71 to A-83 for both engines for conditions when dynamically interesting events occurred:

- Mild gust during test 273-10
- Hard landing during test 273-15

The graphs show airplane parameters measured at airplane center of gravity and engine accelerations and angular rates. Engine accelerations were filtered to pass only frequencies below 40 Hz. Pitch and yaw rates were filtered to 5 Hz.

Table A-1. Engine 3 Pressure Port Locations

PORT NO.	NOM S (IN)	ROW NO. 1 NOMINAL THETA= 0. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 2 NOMINAL THETA= 30. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 3 NOMINAL THETA= 60. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 4 NOMINAL THETA= 90. DEG Z (IN)	S (IN)	THETA (DEG)
1	-56.50	55.23	-57.68	1.64				53.60	-56.05	59.30			
2	-51.21	46.95	-49.38	1.54				47.74	-50.15	61.35			
3	-44.21	41.50	-43.80	1.71				42.04	-44.35	58.30			
4	-38.21	36.04	-38.23	1.55				36.25	-38.45	61.42			
5	-32.21	31.12	-33.23	-1.19				31.14	-33.25	58.68			
6	-28.21	25.69	-27.73	1.15				25.81	-27.85	61.19			
7	-24.21	21.22	-23.23	1.23				21.39	-23.[illegible]	58.64			
8	-20.21	18.48	-20.48	1.17				18.65	-20.65	61.10			
9	-17.21	15.78	-17.78	-1.24				15.95	-17.95	59.65			
10	-14.21	11.29	-13.28	1.10				11.50	-13.59	60.69			
11	-11.00	8.49	-10.48	1.23	8.61	-10.60	30.00	8.61	-10.60	60.00	8.51	-10.50	90.00
12	-8.00	5.58	-7.53	1.02	5.55	-7.50	30.00	5.48	-7.43	60.92	5.55	-7.50	90.00
13	-5.50	3.61	-5.48	0.00	3.63	-5.50	30.00	3.66	-5.53	60.00	3.63	-5.50	90.00
14	-3.00	1.41	-3.00	0.00	1.41	-3.00	30.00	1.45	-3.05	60.00	1.41	-3.00	90.00
15	-1.00	.17	-1.00	0.00	.17	-1.00	30.00	.19	-1.05	60.00	.17	-1.00	90.00
16	0.00	0.00	0.00	0.00	0.00	0.00	30.00	0.00	0.00	60.00	0.00	0.00	90.00
17	1.00	.32	1.00	0.00	.32	1.00	30.00	.29	.95	60.00	.32	1.00	90.00
18	2.00	1.16	2.00	0.00	1.11	1.95	30.00	1.11	1.95	60.00	1.16	2.00	90.00
19	4.00	3.01	4.00	0.00	2.96	3.95	30.00	2.96	3.95	60.00	3.01	4.00	90.00
20	6.00	8.17	9.40	-.80	6.42	7.60	30.00	6.42	7.60	60.00	6.62	7.81	90.00
21	9.00	11.72	13.00	.68	9.82	11.08	30.00	9.84	11.10	60.00	9.93	11.19	90.00
22	13.69	15.39	16.70	-.62	13.98	15.28	30.00	13.90	15.20	60.00	14.08	15.38	90.00
23	19.00				18.95	20.28	30.00				19.05	20.38	90.00
24	25.00				23.93	25.28	30.00				24.03	25.38	90.00
25	31.00				29.37	30.73	30.00				29.52	30.88	90.00
26	38.00				37.91	39.29	30.00				37.39	38.76	90.00
27	50.00				51.65	53.[illegible]2	30.00				50.08	51.45	90.00
28	62.00				60.63	62.05	30.00				60.63	62.00	90.00
29	74.26				72.86	74.26	30.00				70.71	72.10	90.00
30	77.00				75.59	77.00	30.00				75.59	77.00	90.00
31	98.13				96.58	98.13	30.00				93.95	95.49	90.00
32	107.94				106.39	107.9[illegible]	30.00				106.39	107.94	90.00

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-1. Engine 3 Pressure Port Locations (Continued)

PORT NO.	NOM S (IN)	ROW NO. 5 NOMINAL THETA=120. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 6 NOMINAL THETA=150. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 7 NOMINAL THETA=180. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 8 NOMINAL THETA=210. DEG Z (IN)	S (IN)	THETA (DEG)
1	-56.50	53.32	-55.77	118.18				51.53	-53.97	178.17			
2	-51.21	47.61	-50.02	121.16				48.92	-51.34	180.99			
3	-44.21	41.97	-44.27	118.11				41.01	-43.30	178.10			
4	-38.21	36.32	-38.52	121.22				35.80	-37.99	181.14			
5	-32.21	31.28	-33.39	118.72				30.97	-33.08	178.68			
6	-28.21	25.85	-27.89	121.01				25.60	-27.64	181.09			
7	-24.21	21.44	-23.45	118.64				21.19	-23.20	178.63			
8	-20.21	18.70	-20.70	121.03				18.45	-20.45	181.21			
9	-17.21	15.95	-17.95	118.62				15.70	-17.70	178.62			
10	-14.21	11.64	-13.64	120.00				11.40	-13.39	180.00			
11	-11.00	8.77	-10.76	120.00	8.63	-10.62	150.00	8.52	-10.51	180.00	8.63	-10.62	210.00
12	-8.00	5.92	-7.88	120.00	5.36	-7.31	150.00	5.43	-7.38	180.00	5.36	-7.31	210.00
13	-5.50	3.63	-5.50	120.00	3.63	-5.50	150.00	3.63	-5.50	180.00	3.69	-5.56	210.00
14	-3.00	1.41	-3.00	120.00	1.41	-3.00	150.00	1.41	-3.00	180.09	1.46	-3.06	210.00
15	-1.00	.17	-1.00	120.00	.18	-1.03	150.00	.17	-1.00	180.00	.20	-1.06	210.00
16	0.00	0.00	0.00	120.00	0.00	0.00	150.00	0.00	0.00	180.00	0.00	0.00	210.00
17	1.00	.32	1.00	120.00	.32	1.00	150.00	.31	.98	180.00	.32	1.00	210.00
18	2.00	1.16	2.00	120.00	1.16	2.00	150.00	1.11	1.95	180.00	1.11	1.95	210.00
19	4.00	3.01	4.00	120.00	3.01	4.00	150.00	2.96	3.95	180.00	2.96	3.95	210.00
20	6.00	7.98	9.20	119.21	6.47	7.65	150.00	6.71	7.90	180.00	6.42	7.60	210.00
21	9.00	11.06	12.33	120.51	9.89	11.15	150.00	9.84	11.10	180.00	9.82	11.08	210.00
22	13.69	14.78	16.08	119.20	15.29	16.60	150.00	14.00	15.30	180.00	15.27	16.58	210.00
23	19.00				19.27	20.60	150.00				19.25	20.58	210.00
24	25.00				23.95	25.30	150.00				23.88	25.23	210.00
25	31.00				29.42	30.78	150.00				29.35	30.71	210.00
26	38.00				36.71	38.08	150.00				36.64	38.01	210.00
27	50.00				48.82	50.19	150.00				48.74	50.11	210.00
28	62.00				60.63	62.00	150.00				60.63	62.00	210.00
29	74.26				68.50	69.88	150.00				68.50	69.88	210.00
30	77.00				75.59	77.00	150.00				75.59	77.00	210.00
31	98.13				91.01	92.53	150.00				91.01	92.53	210.00
32	107.94				106.39	107.94	150.00				106.39	107.94	210.00

126200-20-114 (2 of 3)

Table A-1. Engine 3 Pressure Port Locations (Concluded)

PORT NO.	NOM S (IN)	ROW NO. 9 NOMINAL THETA=240. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 10 NOMINAL THETA=270. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 11 NOMINAL THETA=300. DEG Z (IN)	S (IN)	THETA (DEG)	ROW NO. 12 NOMINAL THETA=330. DEG Z (IN)	S (IN)	THETA (DEG)
1	-56.50	53.34	-55.79	238.18				53.92	-56.37	298.30			
2	-51.21	47.63	-50.04	241.08				48.45	-50.87	301.84			
3	-44.21	41.99	-44.29	238.03				42.65	-44.97	298.24			
4	-38.21	36.34	-38.54	241.22				36.86	-39.07	301.61			
5	-32.21	31.40	-33.51	238.84				31.76	-33.88	298.93			
6	-28.21	25.97	-28.01	241.13				26.39	-26.44	301.18			
7	-24.21	21.50	-23.51	238.80				21.49	-23.50	298.89			
8	-20.21	18.76	-20.76	241.21				18.75	-20.75	301.21			
9	-17.21	16.01	-18.01	238.79				16.00	-18.00	298.89			
10	-14.21	11.54	-13.54	240.69				11.50	-13.50	299.31			
11	-11.00	8.58	-10.57	240.69	8.95	-10.94	270.00	8.51	-10.50	300.00	8.61	-10.60	330.00
12	-8.00	5.65	-7.60	240.68	6.01	-7.97	270.00	5.55	-7.50	300.68	5.55	-7.50	330.00
13	-5.50	3.60	-5.47	240.00	4.05	-5.94	270.00	3.57	-5.44	300.00	3.58	-5.45	330.00
14	-3.00	1.37	-2.94	240.00	1.41	-3.00	270.00	1.41	-3.00	300.00	1.41	-3.00	330.00
15	-1.00	.17	-1.00	240.00	.17	-1.00	270.00	.17	-1.00	300.00	.19	-1.05	330.00
16	0.00	0.00	0.00	240.00	0.00	0.00	270.00	0.00	0.00	300.00	0.00	0.00	330.00
17	1.00	.32	1.00	240.00	.30	.97	270.00	.32	1.00	300.00	.32	1.00	330.00
18	2.00	1.16	2.00	240.00	1.10	1.94	270.00	1.14	1.98	300.00	1.16	2.00	330.00
19	4.00	2.98	3.97	240.00	2.98	3.97	270.00	2.99	3.98	300.00	2.99	3.98	330.00
20	6.00	8.06	9.28	240.57	6.72	7.91	270.00	6.45	7.63	300.00	6.45	7.63	330.00
21	9.00	10.95	12.22	239.22	9.87	11.13	270.00	9.87	11.13	300.00	9.82	11.08	330.00
22	13.69	14.73	16.03	240.63	14.02	15.32	270.00	14.00	15.30	300.00	13.98	15.28	330.00
23	19.00				18.99	20.32	270.00				19.95	21.28	330.00
24	25.00				23.97	25.32	270.00				23.93	25.26	330.00
25	31.00				29.46	30.82	270.00				29.37	30.73	330.00
26	38.00				37.38	38.75	270.00				37.86	39.23	330.00
27	50.00				50.05	51.42	270.00				51.16	52.53	330.00
28	62.00				60.63	62.00	270.00				60.63	62.00	330.00
29	74.26				70.71	72.10	270.00				72.86	74.26	330.00
30	77.00				75.59	77.00	270.00				75.59	77.00	330.00
31	98.13				93.95	95.49	270.00				96.58	98.13	330.00
32	107.94				106.39	107.94	270.00				106.39	107.34	330.00

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-2. Pressure Corrections for Instrumentation Problems

Engine 3

Row No.	θ (deg)	Port No.	Averaged from: Row, port	Row, port	Row, port	Row, port
1	0	None	—	—	—	—
2	30	29	2, 28	2, 30	—	—
3	60	2	3, 1	3, 3	—	—
3	60	11	3, 10	3, 12	2, 11	4, 11
3	60	14	3, 13	3, 15	2, 14	4, 14
4	90	15	4, 14	4, 16	3, 15	5, 15
4	90	29	4, 28	4, 30	—	—
5	120	None	—	—	—	—
6	150	None	—	—	—	—
7	180	12	7, 11	7, 13	6, 12	8, 12
7	180	15	7, 14	7, 16	6, 15	8, 15
7	180	22	7, 21	6, 22	8, 22	(6,23 and 8,23)
8	210	29	8, 28	8, 30	—	—
9	240	18	9, 17	9, 19	8, 18	10, 18
10	270	None	—	—	—	—
11	300	20	10, 20	12, 20	—	—
11	300	21	10, 21	12, 21	—	—
11	300	22	10, 22	12, 22	—	—
12	330	None	—	—	—	—

Engine 4

1	60	None	—	—	—	—
2	180	9	2, 8	2, 10	—	—
3	300	None	—	—	—	—

126309-53-423

Table A-3.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 101, 612K GROSS WEIGHT TAKEOFF (FLAPS 20) TEST 273-7 IRIG 6:4:44.1

ALTITUDE= 2553. FT MACH NUMBER= 0.250 CORRECTED AIRFLOW= 1549. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.2155	.3119	.0146	.0234				-.0430	-.0140			
2	48.789	-1.3906	.2381	-.0004	.0051				-.0210	-.0054			
3	41.907	-1.6120	.2576	-.0260	-.0084				.0032	-.0303			
4	36.019	-1.9477	.2542	-.0061	.0324				-.0476	-.0215			
5	30.118	-2.2990	.2968	.0196	-.0104				-.0643	-.0505			
6	26.166	-2.6569	.3170	.0003	-.0089				-.0507	-.0315			
7	22.196	-2.8691	.3810	-.0294	.0439				-.1621	.0044			
8	18.211	-3.0263	.5413	-.0444	.0125				-.1605	-.0147			
9	15.214	-3.1147	.5896	-.0048	.0364				-.1560	.0239			
10	12.215	-3.8102	1.0192	.1093	-.0320				-.3971	.0037			
11	9.009	-4.2116	1.4903	.0074	.0131	.0029	-.0497	.0968	-.5364	.0359	.0482	-.0644	-.0519
12	6.037	-4.0698	1.5537	.1062	-.0335	-.0354	-.0316	-.0397	-.6884	-.0351	.0737	-.0016	-.0269
13	3.629	-4.3663	1.9624	.6032	-.2771	-.1258	.1087	-.0005	-1.2983	.3021	.3394	-.2346	.0166
14	1.413	-4.3156	2.8146	.1469	-.0137	-.2537	.2514	-.0530	-1.3425	.2629	.1134	-.0742	-.0195
15	.172	-2.9354	3.1801	-.2193	-.0289	.0936	-.1965	.0909	-1.3118	.3535	-.0144	.1506	-.0637
16	0.000	-1.4110	2.1947	-.1535	-.0587	-.0473	.0702	-.0523	-1.0283	.3037	.1385	-.0803	.0319
17	.324	-.0637	.4952	-.0949	-.0129	-.0846	.0261	.0631	-.2368	.1588	-.0456	-.0404	.0421
18	1.156	.3181	-.0823	-.0761	-.0202	.0187	.0133	.0003	.0233	.0945	.0078	.0198	-.0312
19	3.007	.3003	-.3196	-.0635	-.0178	-.0129	-.0023	.0034	.1049	.0440	-.0096	.0056	.0038
20	4.886	.2268	-.3380	-.0372	-.0107	.0039	-.0109	.0037	.1378	.0187	-.0131	.0038	.0137
21	7.782	.1246	-.3177	-.0291	-.0103	-.0066	-.0086	-.0024	.1637	-.0008	.0003	.0117	.0087
22	12.404	.0544	-.2180	.0113	.0082	.0055	.0372	-.0113	.0922	-.0459	-.0126	-.0073	.0285
23	17.679	.0430	-.2266	0.0000					.0863	-.0635	-.0034		
24	23.652	.0145	-.1748	.0135					.0906	-.0537	-.0101		
25	29.638	.0086	-.1570	.0232					.0961	-.0486	.0013		
26	36.633	-.0052	-.1361	.0204					.0918	-.0652	-.0006		
27	48.631	-.0309	-.1192	.0436					.0892	-.0652	.0030		
28	60.627	-.0337	-.0807	.0618					.1378	-.0275	.0052		
29	72.863	-.0060	-.0520	.0595					.1472	-.0155	.0105		
30	75.593	.0000	-.0304	.0592					.1466	-.0251	.0092		
31	96.576	.0293	-.0141	.0662					.1374	-.0283	.0118		
32	106.386	.0511	-.0079	.0888					.1764	-.0088	-.0094		

ORIGINAL PAGE IS OF POOR QUALITY

125209-39

Table A-4.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 101, 538K GROSS WEIGHT TAKEOFF (FLAPS 10) TEST 273-10 IRIG 9:44:10.8

ALTITUDE= 2667. FT MACH NUMBER= 0.239 CORRECTED AIRFLOW= 1527. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.2653	.3071	-.0549	.0249				-.0712	-.0121			
2	48.789	-1.3892	.2962	-.0397	-.0062				-.0425	-.0284			
3	41.907	-1.6332	.2481	-.0563	.0022				-.0177	-.0165			
4	36.019	-1.9373	.2790	-.0019	.0212				-.0430	-.0299			
5	30.118	-2.3164	.3508	.0058	.0195				-.0648	-.0008			
6	26.166	-2.6013	.3550	.0016	.0049				-.0598	-.0293			
7	22.196	-2.8569	.4149	-.0036	.0559				-.1693	.0894			
8	18.211	-2.9484	.5920	-.0211	.0341				-.1532	-.0442			
9	15.214	-3.1305	.7117	.0038	.0340				-.2336	.0324			
10	12.215	-3.8486	1.2550	.1704	-.0939				-.4454	.0724			
11	9.009	-4.1913	1.7501	-.0297	.0027	.0500	-.0423	.0927	-.5449	-.0015	.1030	-.0588	-.0604
12	6.037	-4.0980	1.8066	.1379	-.0313	-.0405	.0238	-.0642	-.6428	-.0799	.1595	-.0347	-.0187
13	3.629	-4.5839	2.6442	.3778	-.2160	-.0388	-.1472	.1628	-1.4150	.4223	.0978	.0032	-.1877
14	1.413	-4.7194	3.7211	-.0555	-.0483	-.1750	.1417	-.0296	-1.4491	.3750	.0895	-.0840	.0324
15	.172	-3.2315	3.6531	-.2892	-.0954	.0708	-.1682	.0591	-1.2313	.2295	.1154	.0828	-.0231
16	0.000	-1.7403	2.7211	-.2188	-.1229	.0127	.0684	-.0513	-1.0410	.2934	.1820	-.1418	.0597
17	.324	-.2774	.7305	-.2459	-.0211	-.1305	-.0225	.0478	-.2813	.2052	.0497	-.0449	.0471
18	1.156	.1644	-.0169	-.1002	-.0148	.0333	.0348	.0127	-.0230	.1370	.0445	-.0250	.0038
19	3.007	.2374	-.3167	-.0641	-.0161	-.0201	.0043	.0064	.0668	.0568	.0037	-.0085	-.0044
20	4.886	.1857	-.3403	-.0080	.0100	.0135	.0184	.0022	.0662	.0201	-.0174	-.0029	.0170
21	7.782	.1008	-.3458	-.0147	-.0081	.0094	.0007	-.0048	.1274	.0085	-.0052	.0030	.0255
22	12.404	.0146	-.2[illegible]1	.0307	.0201	-.0142	.0512	-.0038	.0848	-.0837	-.0187	-.0263	.0154
23	17.679	-.0234	-.2524	.0198					.1302	-.0508	-.0191		
24	23.652	-.0187	-.2366	.0385					.0723	-.0823	-.0073		
25	29.638	-.0355	-.2049	.0750					.1159	-.0452	-.0075		
26	36.633	-.0448	-.1673	.0598					.0879	-.0922	-.0126		
27	48.631	-.0767	-.1374	.0853					.1136	-.0837	-.0170		
28	60.627	-.0714	-.09[illegible]5	.0944					.1330	-.0540	-.0089		
29	72.863	-.0431	-.0759	.0913					.1568	-.0498	.0037		
30	75.593	-.0441	-.0493	.0950					.1554	-.0560	.0057		
31	96.576	-.0207	-.0235	.0940					.1592	-.0487	.0083		
32	106.386	-.0323	-.0260	.0900					.2041	-.0932	-.0229		

ORIGINAL PAGE IS OF POOR QUALITY

128209-40

Table A-5.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 101, 647K GROSS WEIGHT TAKEOFF (FLAPS 10) TEST 273-11 IRIG 10:13:51.8

ALTITUDE= 2634. FT MACH NUMBER= 0.254 CORRECTED AIRFLOW= 1524. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.1682	.3417	-.0027	.0336				-.0683	-.0306			
2	48.789	-1.3738	.3132	-.0032	.0087				-.0804	.0020			
3	41.907	-1.5479	.2544	-.0257	.0001				-.0415	-.0630			
4	36.019	-1.8756	.3278	-.0046	.0356				-.1005	.0162			
5	30.118	-2.1989	.3315	.0338	-.0029				-.0499	-.0336			
6	26.166	-2.5647	.4222	-.0212	-.0037				-.0616	.0096			
7	22.196	-2.7454	.4341	-.0656	.0762				-.1777	.0237			
8	18.211	-2.8934	.6924	-.0494	.0088				-.1678	.0059			
9	15.214	-3.0146	.7777	.0082	.0631				-.2265	.0262			
10	12.215	-3.4489	1.1173	-.1317	.1900				.0202	-.4123			
11	9.009	-4.0966	1.8516	.0094	-.0058	.0341	-.1217	.1208	-.5931	.0463	.0575	-.0637	-.0718
12	6.037	-3.9634	1.9817	.0920	-.0375	-.0713	-.0389	-.0367	-.6658	-.0864	.1003	-.0205	-.0514
13	3.629	-4.5242	2.8427	.4280	-.2135	-.0373	-.1371	.1100	-1.5506	.5411	.1307	.0475	-.2022
14	1.413	-4.4928	3.8458	.0054	-.0559	-.1744	.1488	-.0625	-1.5912	.4465	.0469	-.0513	.0122
15	.172	-3.0392	3.7371	-.2515	-.1036	.0934	-.1493	.0498	-1.3862	.3472	.1555	.0480	.0218
16	0.000	-1.6151	2.6195	-.2755	-.1482	-.0318	.0585	-.0550	-1.0690	.3829	.2037	-.1119	.0742
17	.324	-.2419	.6023	-.2376	-.0421	-.1072	-.0068	.0367	-.2042	.2544	.0197	-.0335	.0541
18	1.156	.1822	-.1747	-.1549	-.0489	.0174	.0197	-.0109	.0344	.1177	.0121	.0189	-.0269
19	3.007	.2296	-.3961	-.0913	-.0161	.0140	-.0115	-.0056	.1356	.0509	.0031	-.0171	-.0155
20	4.886	.1529	-.4372	-.0466	.0226	-.0313	.0223	.0017	.1823	.0319	-.0114	-.0037	.0009
21	7.782	.0798	-.4271	-.0156	-.0120	-.0156	.0051	-.0017	.2035	.0038	-.0135	.0053	.0093
22	12.404	.0170	-.3032	.0271	.0206	-.0062	.0471	-.0110	.0982	-.0764	.0865	.0054	.0256
23	17.679	-.0044	-.2827	.0079					.1186	-.0852	-.0192		
24	23.652	-.0023	-.2548	.0428					.0817	-.0983	-.0133		
25	29.638	-.0136	-.2220	.0561					.0940	-.0673	.0040		
26	36.633	-.0399	-.1883	.0574					.1017	-.1119	-.0104		
27	48.631	-.0703	-.1589	.0924					.1309	-.1000	-.0151		
28	60.627	-.0722	-.1083	.1073					.1557	-.0680	-.0083		
29	72.863	-.0359	-.0866	.1029					.1736	-.0582	.0062		
30	75.593	-.0356	-.0580	.1006					.1781	-.0662	.0043		
31	96.576	-.0390	.0305	.0676					.1499	.0015	-.0245		
32	106.386	.0101	-.0054	-.0060					-.0006	.0013	-.0008		

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-6.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 118, 780K GROSS WEIGHT SIMULATED TAKEOFF (FLAPS 10) TEST 273-15 IRIG 8:13:18

ALTITUDE= 3646. FT MACH NUMBER= 0.296 CORRECTED AIRFLOW= 1573. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.0658	.2357	-.0487	.0043				-.0511	-.0371			
2	48.789	-1.2145	.2617	-.0283	-.0212				-.0360	-.0636			
3	41.907	-1.4520	.2082	-.0414	-.0112				-.0417	-.0414			
4	36.019	-1.7687	.2827	-.0251	.0086				-.0353	-.0570			
5	30.118	-2.1792	.3493	.0394	.0066				-.0464	-.0345			
6	26.166	-2.5309	.3831	-.0135	-.0002				-.0044	-.0521			
7	22.196	-2.7464	.4463	.0118	.0485				-.1839	.0752			
8	18.211	-2.8955	.6903	-.0743	.0268				-.1275	-.0198			
9	15.214	-2.9756	.7710	-.0093	.0225				-.1303	.1602			
10	12.215	-3.7718	1.3369	.0804	-.0733				-.3818	.0373			
11	9.009	-4.2763	2.2764	-.2362	.1502	-.0321	-.0447	.0705	-.5323	.1741	-.0806	.0276	-.0711
12	6.037	-3.9914	2.1040	.0375	.0621	-.1527	.0052	-.0327	-.6146	.0014	.0353	.1024	-.0450
13	3.629	-4.2421	2.7385	.3743	-.1155	-.1397	-.0054	.1165	-1.2524	.3448	.1426	.0312	-.2625
14	1.413	-3.8926	3.4801	.0424	-.0391	-.1942	.1736	-.0619	-1.1541	.2641	.1348	-.1010	.0120
15	.172	-2.2986	3.3849	-.3661	-.0934	.0689	-.1775	.0850	-1.0637	.2980	.0390	.0876	-.0821
16	0.008	-.8760	2.0301	-.3551	-.0981	-.0445	.0584	-.0269	-.6930	.2875	.1214	-.0967	.0406
17	.324	.0981	.0284	-.3467	-.0656	-.1547	.0054	.0433	-.0171	.2260	-.0239	-.0690	.0527
18	1.156	.3123	-.4925	-.2092	-.0520	-.0071	.0173	-.0125	.0906	.1281	.0264	-.0328	.0007
19	3.007	.2976	-.5296	-.0585	.0201	-.0447	-.1132	-.0426	.1920	.1225	.1235	.1170	.0530
20	4.986	.2613	-.4806	-.0273	-.0857	-.1029	-.1067	-.0425	.0631	-.1013	-.0711	-.0195	.0148
21	7.782	.1733	-.3213	.0017	-.1422	-.1659	-.1260	-.0636	.0248	-.2268	-.1764	-.0958	.0105
22	12.404	-.0570	-.3728	.0485	.0482	.0072	.0559	-.0146	.0983	-.1058	-.0547	-.0381	.0082
23	17.679	-.1053	-.3663	.0369					.1068	-.0573	-.0029		
24	23.652	-.0759	-.3300	.0275					.0845	-.0703	-.0138		
25	29.638	-.0945	-.2570	.0934					.1405	-.0360	.0049		
26	36.633	-.1000	-.2098	.0554					.0943	-.0998	-.0078		
27	48.631	-.1313	-.1711	.0995					.1267	-.0816	-.0144		
28	60.627	-.1191	-.1096	.1233					.1778	-.0329	-.0130		
29	72.363	-.0760	-.0836	.1066					.1997	-.0365	.0065		
30	75.593	-.0587	-.0430	.1071					.1978	-.0323	.0033		
31	96.576	-.0097	-.0070	.1204					.1888	-.0189	.0184		
32	106.386	.0649	.0164	.0483					.0842	-.0285	.0834		

ORIGINAL PAGE IS
OF POOR QUALITY

126208-42

Table A-7.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 102, LOW CLIMB TEST 273-10 IRIG 9:45:59

ALTITUDE= 5861. FT MACH NUMBER= 0.367 CORRECTED AIRFLOW= 1539. LB/SEC

RAKE NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.4769	.1437	-.0122	.0169				-.0139	-.0289			
2	48.789	-.6266	.1112	.0180	-.0066				-.0251	-.0048			
3	41.907	-.8567	.1413	-.0007	.0078				.0073	-.0211			
4	36.019	-1.1651	.1434	.0176	.0277				-.0286	.0187			
5	30.118	-1.4941	.2197	.0317	.0086				.0059	.0002			
6	26.166	-1.7984	.1788	.0309	-.0002				.0009	.0099			
7	22.196	-1.9869	.2048	.0167	.0362				-.0754	.0745			
8	18.211	-2.0864	.3633	-.0114	-.0093				-.0231	-.0012			
9	15.214	-2.1862	.3478	.0303	-.0077				-.0273	.0278			
10	12.215	-2.6789	.6373	-.0491	.0397				.0092	-.1341			
11	9.009	-2.9348	.9972	.0176	-.0188	-.0007	-.0286	.0402	-.1414	.0236	.0349	-.0453	-.0276
12	6.037	-2.7238	.9553	.0522	-.0344	-.0124	-.0190	-.0253	-.2150	-.0275	.0447	.0239	-.0455
13	3.629	-2.5197	1.0965	.2600	-.0411	-.0965	-.0155	.0571	-.4138	.0654	.1540	-.0161	-.1140
14	1.413	-1.8334	1.4002	.0872	-.0382	-.1115	.0554	.0105	-.3240	.0564	.0379	-.0319	-.0237
15	.172	-.2441	1.2420	-.1469	-.0211	-.0168	-.0304	.0464	-.3025	.0503	.0761	.0340	-.0416
16	0.000	.7709	.4683	-.1567	-.0014	-.0201	.0245	-.0327	-.1434	.0740	-.0420	-.0416	-.0118
17	.324	.6617	-.5627	-.0656	-.0324	-.1259	-.0043	.0731	.2135	.0730	-.1271	-.0383	.0883
18	1.156	.4569	-.6004	-.0516	-.0014	.0237	.0362	-.0052	.1375	.0184	-.0111	-.0215	-.0205
19	3.007	.2193	-.5074	-.0345	-.0116	-.0127	.0058	.0096	.1016	.0375	-.0148	-.0074	-.0143
20	4.886	.0580	-.4357	-.0455	-.0056	-.0119	-.0054	-.0046	.0777	.0277	.0039	.0041	.0129
21	7.782	-.1167	-.3472	-.0431	-.0473	-.0183	-.0112	-.0143	.1446	.0479	.0161	-.0165	.0236
22	12.404	-.1783	-.2645	.0256	.0278	.0086	.0565	.0119	.0283	-.0730	-.0254	-.0079	.0271
23	17.679	-.1769	-.2411	-.0404					.0547	-.0296	-.0340		
24	23.652	-.1335	-.1965	-.0151					.0442	-.0485	-.0056		
25	29.638	-.1588	-.1558	.0202					.0728	.0062	.0045		
26	36.633	-.1417	-.1204	-.0078					.0325	-.0503	-.0051		
27	48.631	-.1636	-.1027	.0475					.0499	-.0163	-.0110		
28	60.627	-.1510	-.0735	.0813					.0962	.0380	.0130		
29	72.863	-.0964	-.0428	.0536					.1093	.0150	.0165		
30	75.593	-.0662	-.0161	.0535					.0993	.0153	.0089		
31	96.576	.0289	.0173	.0552					.0860	.0291	.0178		
32	106.386	.0719	-.0484	.0149					.0839	-.0268	-.0194		

ORIGINAL PAGE IS OF POOR QUALITY

125209-38

Table A-8.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 103, MID CLIMB

ALTITUDE= 17187. FT MACH NUMBER= 0.599 TEST 273-7 IRIG 7:28:44.5 CORRECTED AIRFLOW= 1622. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	.6780	.1108	.0059	.0149								
2	48.789	.5032	.0590	.0236	.0023				.0127	.0137			
3	41.987	.3252	.0997	-.0257	-.0022				-.0047	-.0228			
4	36.019	.0588	.0927	.0003	.0053				.0282	.0071			
5	30.118	-.2328	.1261	.0025	-.0027				.0018	-.0056			
6	26.166	-.4907	.1085	.0039	-.0075				.0198	-.0209			
7	22.196	-.6346	.1030	-.0117	.0350				.0312	.0044			
8	18.211	-.7180	.1969	-.0174	-.0010				-.0113	.0169			
9	15.214	-.7562	.1969	.0173	.0169				.0090	.0038			
10	12.215	-1.2934	.5224	-.1125	-.0852				.0170	.0015			
11	9.009	-1.1600	.5792	.0223	-.0265	.0158	-.0089	-.0299	-.1978	.1093			
12	6.037	-.8481	.5046	.0587	-.0243	-.0129	-.0224	-.0186	-.0488	.0833	.0255	-.0510	.0041
13	3.629	-.3792	.4566	.1265	-.0311	-.0267	.0093	.0006	-.1231	-.0545	.0378	.0187	-.0301
14	1.413	.5771	.5384	.0537	-.0360	-.0448	.0312	.0041	-.1931	.0280	.1066	-.0140	-.0410
15	.172	1.7740	.2684	-.0535	.0416	-.0852	.0613	.0271	-.1111	.0818	.0134	-.0021	.0162
16	0.000	1.6788	-.3672	-.0554	.0182	.0192	.0071	.0095	-.1053	.0362	.0921	.0298	-.0562
17	.324	.0110	-.8984	-.0712	.0063	-.0324	-.0906	-.0496	.0999	.0377	-.0378	-.0578	-.0409
18	1.156	-.4162	-.8648	-.1387	.0689	-.0402	-.0218	.0626	.3038	.1377	.0829	.0388	-.0085
19	3.007	-.5371	-.5566	-.0896	-.0685	-.0274	.0070	.0162	.1501	.0704	-.0251	-.1029	.0194
20	4.886	-.6477	-.4848	-.0729	-.0162	-.0534	-.0189	.0275	.1893	.0532	.0205	.0216	-.0203
21	7.782	-.7882	-.3256	-.0854	-.0747	-.0805	-.0202	-.0055	.2044	.0348	.0303	-.0069	.0082
22	12.404	-.7108	-.2442	.0819	.1083	.0545	.0461	.0702	.2589	.0855	.0529	-.0477	-.0095
23	17.679	-.5881	-.2682	-.0936					-.0361	-.1537	-.0488	.0288	.0873
24	23.652	-.4693	-.1737	-.0908					-.0470	-.0798	-.0700		
25	29.638	-.4457	-.1227	-.0449					.0466	-.0876	-.0357		
26	36.633	-.3996	-.0850	-.0437					.0423	.0028	.0229		
27	48.631	-.4001	-.1324	.0148					.0010	-.0875	-.0119		
28	60.627	-.3611	-.0910	.1095					-.0068	-.0526	-.0070		
29	72.863	-.1889	.0103	.0018					.1036	.0723	.0298		
30	75.593	-.1745	-.0024	.0436					.2061	.0787	.0104		
31	96.576	.0158	.0303	.0482					.1001	.0328	.0120		
32	106.386	.1827	.0859	-.0388					.0665	.0445	.0106		
									.1799	.0200	.0900		

128209-37

ORIGINAL PAGE IS OF POOR QUALITY

Table A-9.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 104, HIGH-MACH CRUISE TEST 273-7 IRIG 7:49:28.4

ALTITUDE= 35481. FT MACH NUMBER= 0.859 CORRECTED AIRFLOW= 1633. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.2549	.0419	.0049	.0114				.0061	.0254			
2	48.789	1.1642	-.0023	.0186	.0110				-.0114	-.0137			
3	41.907	1.0483	.0513	-.0163	-.0047				.0182	.0302			
4	36.019	.8918	.0273	-.0039	-.0042				-.0038	-.0057			
5	30.118	.7167	.0458	.0023	-.0062				.0107	-.0097			
6	26.166	.5626	.0239	.0037	-.0183				-.0052	.0169			
7	22.196	.4900	.0158	.0004	.0053				-.0235	.0096			
8	18.211	.4549	.0523	-.0074	-.0063				-.0114	.0112			
9	15.214	.4287	.0395	.0293	.0039				-.0329	-.0079			
10	12.215	.0382	.3064	.1780	-.1527				-.3341	.2580			
11	9.009	.2773	.1337	.0211	-.0262	.0119	.0017	-.0383	-.0751	.0155	.0129	-.0179	.0243
12	6.037	.4804	.1123	.0249	-.0100	-.0036	-.0144	-.0116	-.1076	-.0187	.0257	.0223	.0196
13	3.629	.8530	.0988	.0376	-.0107	.0318	-.0041	-.0279	-.1014	-.0030	.01[illegible]	.0209	.0257
14	1.413	1.4538	.1215	.0224	-.0116	-.0146	.0046	.0002	-.0546	-.0093	.01[illegible]	.0140	.0160
15	.172	1.9564	.0396	-.0190	.0409	-.0797	.0590	.0165	-.0316	.0313	.0585	.0092	-.0518
16	0.000	1.4382	-.1428	.0141	.0117	.0211	-.0166	.0015	.0873	.0223	-.0344	-.0481	-.0583
17	.324	-.3311	-.2788	.0267	.0511	.0277	-.0492	-.0537	.2317	.0850	.0886	-.0314	-.1801
18	1.156	-.9313	-.5514	-.0991	.1555	-.1080	-.0617	.1091	.2222	.0609	-.0324	-.1591	.1227
19	3.007	-.8094	-.4139	-.0972	-.0242	-.0545	.0254	.0463	.2622	.0850	-.0455	-.0590	-.0752
20	4.886	-1.0264	-.3695	-.0876	.0092	-.0444	-.0413	-.0307	.1534	.0021	.0169	.0503	.0353
21	7.782	-1.1635	-.2509	-.1111	.0014	-.0907	-.0689	.0001	.2235	.0508	.1334	-.0221	.0061
22	12.404	-1.2955	-.0751	.0725	.1358	.0405	-.0141	.0886	-.0237	-.1513	-.1109	.0556	.0980
23	17.679	-1.3105	-.1838	-.1854					-.0213	-.0582	-.0957		
24	23.652	-1.2673	-.2145	-.3147					.0001	-.1679	-.0881		
25	29.638	-1.0379	-.1499	-.2650					.2674	-.0158	-.0353		
26	36.633	-.6817	-.0123	.0759					.2456	.0626	.0137		
27	48.631	-.4925	-.0247	-.0130					-.1280	-.0901	.0006		
28	60.627	-.4461	-.0324	.1072					.0551	.0689	.0327		
29	72.863	-.2016	.0640	-.0377					.1810	.0890	.0066		
30	75.593	-.1883	.0393	.0269					.0553	.0310	.0156		
31	96.576	.0334	.0490	.0271					.0328	.0412	.0085		
32	106.386	.2275	.1129	-.1250					.1887	-.0485	.1500		

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-10.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 105, LOW-MACH CRUISE TEST 273-7 IRIG 7:58:40.5

ALTITUDE= 35512. FT MACH NUMBER= 0.772 CORRECTED AIRFLOW= 1694. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	.9171	.0449	.0039	.0037				.0046	.0200			
2	48.789	.8477	.0218	.0042	-.0022				-.0081	.0006			
3	41.907	.7400	.0550	-.0111	-.0002				.0072	.0142			
4	36.019	.6045	.0401	.0014	-.0014				-.0098	-.0026			
5	30.118	.4582	.0632	.0027	-.0036				-.0012	-.0079			
6	26.166	.3265	.0611	.0024	-.0154				-.0140	.0095			
7	22.196	.2620	.0726	-.0038	.0102				-.0350	.0127			
8	18.211	.2295	.1205	-.0109	-.0052				-.0219	.0082			
9	15.214	.2010	.1230	.0144	-.0005				-.0279	-.0065			
10	12.215	-.1745	.4389	.1660	-.1618				-.3662	.2785			
11	9.009	.0632	.3366	.0102	-.0131	-.0137	.0077	-.0316	-.0786	-.0062	.0047	-.0157	.0228
12	6.037	.2367	.3029	.0195	-.0094	-.0073	-.0096	-.0043	-.1186	-.0140	.0155	.0136	.0132
13	3.629	.5232	.2954	.0362	-.0208	.0177	-.0158	-.0153	-.1369	.0137	.0250	.0021	.0160
14	1.413	1.0399	.2920	.0233	.0031	-.0148	.0133	.0053	-.0890	.0127	.0038	.0139	.0236
15	.172	1.5024	.0501	-.0284	.0448	-.0643	.0379	.0158	-.0356	.0396	.0494	.0140	-.0397
16	0.000	1.0997	-.3475	-.0058	.0164	.0237	-.0046	.0010	.1311	.0182	-.0255	-.0383	-.0441
17	.324	-.3536	-.7175	-.0192	.0616	.0475	-.1109	-.1144	.3094	.1038	.1578	.0222	-.1247
18	1.156	-.8790	-1.0099	-.1186	.1572	-.0876	-.0250	.0879	.2941	.1185	-.0769	-.1269	.0897
19	3.007	-.6025	-.7697	-.1784	-.0598	-.0141	.0255	.0231	.3111	.0811	.0014	-.0898	-.1181
20	4.886	-.9942	-.8150	-.0477	.0861	-.0501	-.1049	-.0094	.2825	-.0091	-.0249	.0392	.1092
21	7.782	-1.0361	-.6643	-.2448	-.1558	-.1044	-.0465	-.0286	.3231	.1119	.0524	-.0589	-.0293
22	12.404	-.8653	-.3686	.1165	.1926	.0702	.0873	.1195	.1801	-.0132	.0093	.0815	.1545
23	17.679	-.5767	-.1450	-.0564					-.0224	-.1182	-.0755		
24	23.652	-.4315	-.0887	-.0558					.0462	-.0922	-.0531		
25	29.638	-.4207	-.0604	-.0315					.0439	-.0225	-.0020		
26	36.633	-.3731	-.0321	-.0230					.0139	-.0766	.0032		
27	48.631	-.3610	-.0802	.0211					.0104	-.0595	-.0014		
28	60.627	-.2913	-.0479	.0983					.1084	.0542	.0246		
29	72.863	-.1461	.0191	.0054					.1636	.0505	.0053		
30	75.593	-.1149	.0266	.0418					.0954	.0262	.0125		
31	96.576	.0414	.0429	.0412					.0670	.0342	.0112		
32	106.386	.1889	.0771	-.0462					.1792	-.0049	.0881		

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-11.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 106, MAXIMUM MACH NUMBER TEST 273-15 IRIG 12:09:26.5

ALTITUDE= 36978. FT MACH NUMBER= 0.906 CORRECTED AIRFLOW= 1642. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.3536	-.0222	-.0267	.0040				-.0014	.0184			
2	48.789	1.2967	-.0421	.0164	-.0159				-.0325	-.0073			
3	41.907	1.1734	.0202	.0105	-.0133				-.0218	.0094			
4	36.019	.9889	-.0014	.0151	-.0123				-.0463	-.0001			
5	30.118	.8559	-.0532	.0257	-.0236				.0316	.0257			
6	26.166	.7210	-.0271	.0183	.0040				.0143	-.0255			
7	22.196	.6029	-.0451	-.0082	.0058				-.0420	.0378			
8	18.211	.5968	-.0066	-.0109	-.0181				-.0181	-.0055			
9	15.214	.5684	-.0788	.0049	-.0390				-.0377	.0300			
10	12.215	.2214	.0600	.0190	-.0214				-.2217	.0723			
11	9.009	.4075	.0336	-.0065	-.0202	.0075	-.0514	-.0769	-.0738	.0235	.0074	-.0388	.0029
12	6.037	.5861	-.0555	.0265	.0104	-.0087	.0102	.0232	-.1187	.0184	.0320	.1110	.0276
13	3.629	1.0293	-.1053	.0058	.0874	.0068	-.0002	.0103	-.0530	-.1043	-.0358	.0455	-.0633
14	1.413	1.5834	-.0086	.0446	.0225	-.0103	.0266	.0378	-.0515	.0183	.0091	.0293	.0007
15	.172	2.0827	-.0021	-.0719	-.0281	-.1350	.0419	.0136	-.0307	.0177	.0488	-.0237	-.0582
16	0.000	1.5524	-.0303	.0135	.0278	.0405	.0073	.0151	.0701	-.0035	-.0355	-.0054	-.0738
17	.324	-.2614	-.0511	-.0080	.0602	.0557	-.0115	-.0577	.1494	-.0336	-.0129	-.1105	-.2109
18	1.156	-1.0150	.0153	-.1118	.0349	-.0137	-.0228	.0744	.2776	.0952	-.0299	.0204	.0264
19	3.007	-.7401	.1124	-.0576	-.0251	-.1382	-.0980	-.0431	.3233	.0561	.1089	.0337	-.0069
20	4.886	-.8398	.0771	-.0371	-.0372	-.1605	-.1156	-.0908	.0661	-.1335	-.0686	.0253	.0383
21	7.782	-.8966	.1706	-.0075	-.1383	-.1791	-.1457	-.0658	-.0526	-.1317	-.1098	-.1314	.0256
22	12.404	-1.1893	.0641	.0673	.1533	.0073	-.0677	.0678	-.0271	-.1712	-.1212	.0103	.0540
23	17.679	-1.2841	.0264	-.1227					-.0384	-.0220	-.0840		
24	23.652	-1.2159	-.0176	-.3283					-.0079	-.1344	-.0659		
25	29.638	-1.1378	.1100	-.2093					.0583	.0287	-.0354		
26	36.633	-1.1096	.0931	-.1914					-.0587	-.1967	-.0143		
27	48.631	-1.0564	.1249	-.1625					.0078	-.1227	-.0143		
28	60.627	-1.0654	.0032	.1706					.1501	.1234	.0648		
29	72.863	-.6071	.2264	-.0053					.2271	.1528	-.0582		
30	75.593	-.1555	-.0874	.0330					.0350	.0151	-.0077		
31	96.576	.0828	.0024	.0047					.0053	.0336	.0050		
32	106.386	.4009	-.0270	-.0135					.0261	.0358	.0163		

ORIGINAL PAGE IS OF POOR QUALITY

Table A-12.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 107, INFLIGHT RELIGHT — TEST 273-7 IRIG 8:12:53.5

ALTITUDE= 27589. FT — MACH NUMBER= 0.721 — CORRECTED AIRFLOW= 1365. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.3631	.0380	.0039	.0019				-.0043	.0329			
2	48.789	1.3162	.0041	.0109	-.0031				-.0105	-.0021			
3	41.907	1.2166	.0372	-.0145	.0028				.0048	.0259			
4	36.019	1.0936	.0329	.0073	-.0088				-.0196	-.0063			
5	30.118	.9645	.0612	-.0064	-.0066				.0103	.0806			
6	26.166	.8619	.0424	.0008	-.0082				-.0030	.0088			
7	22.196	.8063	.0484	.0070	.0124				-.0212	.0241			
8	18.211	.7905	.0789	-.0102	-.0052				-.0006	.0216			
9	15.214	.7794	.0511	-.0012	-.0145				-.0049	.0027			
10	12.215	.6168	.1895	.0189	.0040				-.0936	.0316			
11	9.009	.7151	.2258	.0281	-.0113	-.0200	-.0139	-.0365	-.0613	.0058	-.0293	-.0163	.0480
12	6.037	.8454	.1754	.0206	-.0129	-.0115	-.0323	-.0163	-.0992	-.0109	-.0069	.0179	.0340
13	3.629	1.1843	.2128	.0099	-.0037	.0446	-.0112	-.0334	-.0852	.0138	-.0011	.0169	.0306
14	1.413	1.6347	.1896	.0082	.0090	-.0006	-.0011	.0081	-.0618	-.0133	.0163	.0212	.0389
15	.172	1.8213	-.0618	-.0114	.0705	-.0621	.0814	.0169	-.0172	.0451	.0572	.0215	-.0666
16	0.000	.9196	+.3745	.0070	.0157	.0507	.0086	.0032	.1391	.0277	.0040	-.0533	-.0682
17	.324	-1.3076	-.6804	-.0025	.1101	.1020	-.1815	-.2560	.1476	.0649	.4912	.1974	-.3191
18	1.156	-2.0476	-1.1553	.0681	.1541	-.0102	-.0032	.0655	.5039	-.0752	-.1052	.0312	.0939
19	3.007	-1.7535	-1.1831	-.0848	.1634	.0011	-.0551	-.0108	.3537	.0234	-.1328	.0203	.1141
20	4.886	-1.7517	-1.1938	-.2272	.1131	-.0551	-.1609	-.0345	.3046	.0345	.0202	.1052	.1874
21	7.782	-1.3295	-.4524	-.0766	-.0435	-.0780	-.0838	-.0596	.3268	.1122	.0985	.0291	.0553
22	12.404	-.9979	-.0342	.0809	.0470	-.0320	.0758	.1901	.0602	-.1275	-.1074	-.0878	.0064
23	17.679	-.8128	-.1238	-.0845					-.0547	-.1213	-.0933		
24	23.652	-.6079	-.0864	-.0977					.0446	-.0822	-.0654		
25	29.616	-.5605	-.0503	-.0710					.0413	-.0079	.0026		
26	36.633	-.4758	-.0348	-.0382					.0079	-.0951	-.0152		
27	48.631	-.4535	-.1103	.0026					-.0005	-.0696	-.0127		
28	60.627	-.3824	-.0706	.1090					.1087	.0696	.0299		
29	72.863	-.2378	-.0014	.0405					.1272	.0527	.0254		
30	75.593	-.1724	.0121	.0367					.0950	.0356	.0140		
31	96.576	.0170	.0371	.0350					.0702	.0352	.0125		
32	106.386	.2043	.0687	-.0558					.2037	-.0131	.1128		

ORIGINAL PAGE IS OF POOR QUALITY

12820B-46

Table A-13.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 108, MAXIMUM Q TEST 273-15 IRIG 11:39:00

ALTITUDE= 24513. FT MACH NUMBER= 0.836 CORRECTED AIRFLOW= 1617. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.8899	-.0321	-.0008	.0023				-.0139	.0240			
2	48.789	1.7625	-.0526	.0163	-.0107				-.0353	-.0006			
3	41.907	1.5806	.0257	.0105	-.0134				.0061	.0248			
4	36.019	1.3198	-.0157	.0296	-.0118				-.0256	.0109			
5	30.118	1.0608	.0282	.0195	-.0139				.0372	.0012			
6	26.166	.8478	-.0859	-.0035	-.0092				.0512	-.0217			
7	22.196	.6978	-.1154	-.0022	-.0006				-.0038	.0369			
8	18.211	.6716	-.0716	-.0269	-.0132				.0456	.0020			
9	15.214	.6181	-.1553	.0290	-.0157				.0188	.0252			
10	12.215	.2119	-.1318	-.0096	-.0492				-.0333	.0494			
11	9.009	.3716	-.1040	.0057	-.0423	-.0089	.0085	-.0703	.0527	.0046	.0008	-.0218	.0121
12	6.037	.6670	-.2269	.0276	-.0396	-.0544	-.0354	-.0230	-.0433	-.0436	-.0026	.0427	.0236
13	3.629	1.3210	-.3184	.0065	.0646	.0212	-.0206	.0192	.0988	-.0532	.0228	.1027	-.0253
14	1.413	2.1955	-.1595	.0216	.0171	-.0542	.0310	-.0001	.0363	-.0188	-.0122	.0005	.0178
15	.172	3.0088	.0276	-.0213	.0440	-.1643	.0979	.0132	-.0901	-.0053	.0594	-.0028	-.0799
16	0.000	2.1532	.1499	.0526	-.0169	.0188	-.0316	.0048	-.0526	.0223	-.0975	-.0622	-.1010
17	.324	-.6420	.2720	-.0005	.0469	-.0342	.0726	-.0677	-.0708	-.0602	.0423	-.0725	-.2500
18	1.156	-1.9168	.7576	.0051	-.0801	-.0802	-.0495	.0725	-.1638	-.0860	-.0562	.0146	-.0984
19	3.007	-1.3882	.7122	-.1679	-.1125	-.1357	-.0211	.0364	-.0017	.1538	.1810	.0910	.0998
20	4.866	-1.6484	.3827	-.1560	-.0565	-.1638	-.1744	-.0989	-.1550	-.0934	-.0683	.1027	.0720
21	7.782	-1.8445	.2838	-.0624	-.1020	-.2404	-.1792	-.0623	-.1063	-.0516	-.1053	-.1297	.0160
22	12.404	-2.1683	.3480	.1604	.2299	-.0167	-.1212	.1516	-.2312	-.2864	-.1721	.0375	.0764
23	17.679	-2.2677	.3113	-.1315					-.2765	-.0835	-.1098		
24	23.652	-2.0116	.3779	-.4290					-.1032	-.1395	-.0678		
25	29.638	-1.5213	.9247	-.2902					.1517	.0487	-.0950		
26	36.633	-.8321	-.0708	-.0487					-.1243	-.1600	-.0105		
27	48.631	-.9501	-.1725	.0283					-.1209	-.1378	-.0484		
28	60.627	-.8591	-.1402	.1940					.0226	-.1144	.0434		
29	72.863	-.5909	-.0854	.0192					.0029	-.0089	.0142		
30	75.593	-.4531	-.0244	.0324					-.0925	.0201	.0105		
31	96.576	-.0787	.0197	.0135					-.0350	.0428	.0040		
32	106.386	.4349	.0013	-.0147					-.0042	.0402	.0127		

ORIGINAL PAGE IS OF POOR QUALITY

1280298-47

Table A-14.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 108, STALL WARNING (FLAPS UP) TEST 273-7 IRIG 8:18:08

ALTITUDE= 16964. FT MACH NUMBER= 0.391 CORRECTED AIRFLOW= 1591. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.2761	.1449	.0074	.0232				.0193	-.0115			
2	48.789	-.3815	.1104	.0125	.0016				.0168	-.0106			
3	41.907	-.5477	.1355	-.0249	.0016				.0350	-.0071			
4	36.019	-.7624	.1355	-.0123	.0143				.0020	-.0032			
5	30.118	-1.0046	.1783	.0013	.0012				.0008	-.0149			
6	26.166	-1.2198	2097	.0046	-.0053				-.0032	-.0037			
7	22.196	-1.3409	.2406	-.0212	.0372				-.0678	.0357			
8	18.211	-1.4340	.3755	-.0173	-.0003				-.0394	-.0097			
9	15.214	-1.4805	.4481	.0043	.0150				-.0488	-.0131			
10	12.215	-1.9974	.8743	.1425	-.0959				-.2966	.1229			
11	9.009	-2.0706	1.1155	-.0328	.0184	.0056	.0052	.0060	-.2052	.0165	.0418	-.0607	.0080
12	6.037	-1.9270	1.1605	.0385	-.0238	-.0015	-.0105	-.0194	-.2761	-.0229	.0654	-.0139	.0065
13	3.629	-1.7872	1.2985	.2175	-.0497	-.0583	.0012	.0314	-.4748	.0701	.1696	-.0255	-.0806
14	1.413	-1.3482	1.5679	.0311	-.0458	-.0750	.0554	-.0107	-.4238	.0671	.0775	-.0217	-.0062
15	.172	-.2912	1.3415	-.1809	-.0366	.0041	-.0443	.0441	-.3556	.1068	.0745	.0118	-.0190
16	0.000	.3666	.4574	-.2650	-.0140	-.0293	.0326	-.0243	-.1314	.1419	.0240	-.0385	.0081
17	.324	.3310	-.6306	-.1817	-.0457	-.1010	-.0295	.0322	.2544	.1515	-.0586	-.0065	.0748
18	1.156	.2489	-.7101	-.1503	-.0268	.0131	.0129	.0046	.1985	.0586	-.0144	-.0031	-.0073
19	3.007	.1350	-.5792	-.0782	-.0041	-.0030	-.0056	-.0051	.1664	.0280	-.0017	-.0066	-.0015
20	4.886	.0475	-.5064	-.0675	-.0127	-.0130	-.0216	.0014	.1487	.0149	-.0051	.0006	.0131
21	7.782	-.0630	-.4155	-.0524	-.0365	-.0341	-.0187	-.0041	.1[illegible]	.0284	.0077	-.0107	.0090
22	12.404	-.1101	-.2738	.0370	.0320	.0187	.0564	.0103	.0513	-.0652	-.0249	.0046	.0355
23	17.679	-.0724	-.2702	-.0162					.0439	-.0710	-.0160		
24	23.652	-.0670	-.2126	-.0014					.0734	-.0380	-.0136		
25	29.638	-.0626	-.1646	.0247					.0694	-.0175	.0127		
26	36.633	-.0539	-.1327	.0263					.0553	-.0436	-.0036		
27	48.631	-.0708	-.1052	.0516					.0627	-.0264	-.0027		
28	60.627	-.0632	-.0616	.0908					.1131	.0123	.0066		
29	72.863	-.0214	-.0144	.0804					.1296	.0136	.0161		
30	75.593	.0011	.0018	.0789					.1128	.0108	.0111		
31	96.576	.0604	.0263	.0869					.1042	.0081	.0149		
32	106.386	.1046	.0396	.0765					.1506	-.0025	.0220		

ORIGINAL PAGE IS OF POOR QUALITY

Table A-15.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 110, STALL WARNING (FLAPS 10) TEST 273-7 IRIG 8:22:26

ALTITUDE= 16239. FT MACH NUMBER= 0.347 CORRECTED AIRFLOW= 1621. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.5287	.1811	.0114	.0348				-.0066	-.0187			
2	48.789	-.6518	.1422	-.0039	.0036				-.0170	-.0175			
3	41.907	-.8205	.1413	-.0018	-.0062				-.0024	-.0198			
4	36.019	-1.0727	.1416	-.0010	.0172				-.0299	-.0012			
5	30.118	-1.3226	.2217	.0357	-.0009				-.0068	-.0186			
6	26.166	-1.5477	.2197	.0416	.0027				.0006	-.0162			
7	22.196	-1.6964	.2865	-.0014	.0324				-.0823	.0126			
8	18.211	-1.7902	.4265	-.0009	-.0049				-.0675	-.0009			
9	15.214	-1.8529	.5494	.0422	.0040				-.0802	-.0290			
10	12.215	-2.4470	.9547	.1486	-.0780				-.2710	.0774			
11	9.009	-2.7601	1.6242	-.1442	.0707	.0247	-.1308	.1222	-.3672	.0517	.0036	-.0529	.0079
12	6.037	-2.6707	1.7576	-.0789	-.0798	.0362	-.0661	-.0199	-.5312	.0901	.0365	-.0917	.0814
13	3.629	-2.5904	1.9187	.2102	-.0604	-.0885	.0272	.0385	-.8151	.2208	.1220	-.0551	-.0994
14	1.413	-2.1722	2.1972	.0358	-.0479	-.1212	.0774	-.0090	-.7195	.0888	.1495	-.1003	.0343
15	.172	-1.0175	1.8996	-.2129	-.0786	.0115	-.0579	.0385	-.5851	.1632	.1481	.0089	-.0108
16	0.000	-.1742	1.0006	-.2864	-.0657	-.0532	-.0014	-.0236	-.3785	.1909	.0679	-.0725	-.0016
17	.324	.1934	-.3084	-.2250	-.0702	-.0936	.0062	.0566	.1357	.1730	-.0924	-.0395	.0584
18	1.156	.2617	-.5329	-.1709	-.0440	.0107	.0066	.0110	.1664	.0652	.0019	-.0025	-.0038
19	3.007	.2037	-.5297	-.0960	.0196	-.0084	.0029	.0225	.1665	.0473	-.0252	-.0082	-.0081
20	4.886	.1045	-.4816	-.0398	.0196	-.0158	-.0384	.0163	.1680	.0197	-.0171	.0148	.0193
21	7.782	.0204	-.4155	-.0385	-.0204	-.0031	-.0120	-.0043	.1767	.0238	-.0007	-.0038	.0287
22	12.404	-.0359	-.2977	.0154	.0261	.0065	.0506	-.0030	.0980	-.0703	-.0274	-.0042	.0380
23	17.679	-.0463	-.2735	-.0068					.0671	-.0532	-.0077		
24	23.652	-.0262	-.2530	.0023					.0849	-.0615	-.0072		
25	29.638	-.0273	-.2017	.0124					.0910	-.0268	.0093		
26	36.633	-.0339	-.1592	.0298					.0921	-.0722	-.0130		
27	48.631	-.0457	-.1215	.0554					.1253	-.0514	-.0184		
28	60.627	-.0423	-.0845	.0937					.1410	-.0168	-.0016		
29	72.863	-.0026	-.0493	.0891					.1654	-.0077	.0139		
30	75.593	.0141	-.0247	.0870					.1515	-.0108	.0078		
31	96.576	.0529	-.0035	.0885					.1438	-.0068	.0132		
32	106.386	.0853	.0043	.0976					.1889	-.0193	.0012		

ORIGINAL PAGE IS OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-16.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 111, STALL WARNING (FLAPS 30) TEST 273-7 IRIG 8:24:51.9
ALTITUDE= 17049. FT MACH NUMBER= 0.270 CORRECTED AIRFLOW= 1633. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.7723	.1489	.0065	.0172				.0104	-.0158			
2	48.789	-.8854	.1294	.0021	.0041				.0167	-.0163			
3	41.907	-1.0550	.1283	-.0229	.0025				.0332	-.0176			
4	36.019	-1.2754	.1268	-.0136	.0220				.0121	.0030			
5	30.118	-1.5261	.1569	.0093	-.0004				.0015	-.0235			
6	26.166	-1.7693	.1576	.0084	-.0011				.0105	-.0106			
7	22.196	-1.9176	.1947	-.0185	.0388				-.0504	.0390			
8	18.211	-2.0237	.3006	-.0118	.0069				-.0305	-.0095			
9	15.214	-2.0874	.3601	.0167	.0242				-.0383	-.0072			
10	12.215	-2.7097	.7711	.2460	-.1419				-.3646	.1958			
11	9.009	-2.9508	1.2136	-.1272	.0586	.0229	-.0494	.0743	-.2676	.0524	.0206	-.0390	-.0170
12	6.037	-2.8361	1.1918	.0207	-.0508	.0019	.0107	-.0492	-.3878	.0281	.0557	-.0651	.0333
13	3.629	-2.9101	1.3854	.2959	-.0906	-.0922	.0162	.0523	-.6970	.2194	.1416	-.0302	-.0987
14	1.413	-2.7349	1.8451	.0510	.0116	-.1108	-.0008	.0393	-.5737	.0610	.0865	-.0417	-.0523
15	.172	-1.7020	1.8956	-.1242	-.0385	.0395	-.1189	.0528	-.5706	.1394	.0194	.0862	-.0611
16	0.000	-.7024	1.2416	-.0694	-.0351	-.0304	.0262	-.0067	-.4445	.0818	.0982	-.0450	.0058
17	.324	.0654	.2537	-.0654	-.0189	-.0528	.0261	.0457	-.0765	.0461	-.0502	-.0605	.0468
18	1.156	.2725	-.0904	-.0529	-.0253	.0073	.0116	-.0035	.0218	.0370	-.0037	.0051	-.0129
19	3.007	.2404	-.2027	-.0441	-.0077	-.0101	-.0061	-.0002	.0571	.0116	.0017	.0005	-.0013
20	4.886	.1794	-.2162	-.0259	.0045	-.0045	.0030	.0063	.0843	.0147	.0049	-.0055	.0045
21	7.782	.1130	-.2035	-.0185	-.0115	-.0097	-.0049	-.0043	.0914	.0033	.0003	.0046	.0060
22	12.404	.0548	-.1410	.0127	.0098	.0035	.0224	-.0077	.0525	-.0258	-.0140	-.0034	.0172
23	17.679	.0547	-.1458	.0089					.0476	-.0438	-.0009		
24	23.652	.0366	-.1261	.0138					.0497	-.0241	-.0073		
25	29.638	.0353	-.1056	.0178					.0483	-.0198	.0013		
26	36.633	.0272	-.0943	.0186					.0473	-.0317	-.0011		
27	48.631	.0099	-.0764	.0346					.0556	-.0302	.0043		
28	60.627	.0082	-.0530	.0458					.0814	-.0104	-.0007		
29	72.863	.0238	-.0311	.0431					.0963	-.0020	.0065		
30	75.593	.0315	-.0185	.0432					.0911	-.0043	.0037		
31	96.576	.0502	-.0112	.0498					.0859	-.0090	.0053		
32	106.386	.0630	.0040	.0581					.1165	-.0092	.0009		

125209-50

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-17.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 112, IDLE DESCENT TEST 273-7 IRIG 8:28:56.4

ALTITUDE= 8450. FT MACH NUMBER= 0.439 CORRECTED AIRFLOW= 748. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.2639	.0157	-.0056	.0040				-.0018	.0333			
2	48.789	1.2300	-.0008	.0083	.0064				-.0127	.0075			
3	41.907	1.1914	.0344	-.0011	-.0006				-.0042	.0228			
4	36.019	1.1364	.0325	-.0003	-.0040				-.0066	.0030			
5	30.118	1.0884	.0452	-.0028	-.0073				.0068	-.0001			
6	26.166	1.0491	.0584	-.0027	-.0121				-.0223	.0184			
7	22.196	1.0409	.0793	.0075	.0013				-.0164	.0022			
8	18.211	1.0443	.0982	-.0020	.0013				-.0205	.0148			
9	15.214	1.0332	.1152	.0205	.0029				-.0583	-.0375			
10	12.215	.9902	.2084	-.0098	.0222				-.0374	.0114			
11	9.009	1.0727	.2381	.0117	-.0105	-.0022	-.0141	-.0435	-.0618	.0112	.0062	.0070	.0192
12	6.037	1.1272	.2314	.0060	-.0151	.0046	-.0157	-.0055	-.0663	.0165	.0044	.0045	.0342
13	3.629	1.2796	.2060	-.0570	-.0197	.0483	-.0082	-.0285	-.0483	.0218	-.0253	-.0069	.0397
14	1.413	1.3977	.0371	-.0280	.0396	.0179	-.0089	-.0027	-.0377	-.0010	-.0011	.0327	.0549
15	.172	.8220	-.6155	-.0603	.0873	-.0680	.0408	.0100	.1446	.0582	.0084	-.0435	-.0833
16	0.000	-.7917	-1.4563	-.0402	.0959	.1351	.0472	.0324	.4827	.0693	-.0261	-.1008	-.1185
17	.324	-2.7683	-2.1818	-.3996	.4196	.5883	-.4559	-.6023	.5912	.5202	.9275	.0958	-.6130
18	1.156	-2.2738	-1.8405	-.2842	.2987	-.0044	.0093	.1758	.3893	.1673	-.0765	-.3055	.0716
19	3.007	-1.4961	-1.0829	-.2399	-.1418	-.0796	.0047	.0159	.3908	.0912	.1020	.0822	.0115
20	4.886	-1.2309	-.7692	-.0790	-.0327	-.1168	-.0335	.0242	.3598	.0495	.0031	.0048	.0536
21	7.782	-.9726	-.4377	-.0430	-.0316	-.0664	-.0135	.0118	.2926	.0420	.0243	-.0441	-.0052
22	12.404	-.8101	-.3539	.0914	.1350	.0401	.0524	.1064	.0405	-.1545	-.0752	.0059	.1011
23	17.679	-.6234	-.3465	-.0879					.0300	-.0801	-.0554		
24	23.652	-.4811	-.2932	-.1119					.0814	-.0802	-.0295		
25	29.638	-.4124	-.2017	-.0459					.0683	-.0027	.0172		
26	36.633	-.3266	-.1404	-.0281					.0447	-.0645	-.0049		
27	48.631	-.2903	-.1410	.0170					.0381	-.0296	-.0048		
28	60.627	-.2335	-.0617	.1045					.1097	.0380	.0168		
29	72.863	-.1294	-.0047	.0323					.1654	.0364	.0054		
30	75.593	-.0965	.0049	.0540					.1102	.0197	.0103		
31	96.576	.0250	.0264	.0528					.0891	.0286	.0161		
32	106.386	.1516	.0701	-.0098					.1761	.0181	.0711		

125209-51

Table A-18.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 113, APPROACH TEST 273-7 IRIG 8:34:27

ALTITUDE= 6003. FT MACH NUMBER= 0.265 CORRECTED AIRFLOW= 1547. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.9824	.1956	-.0005	.0377				.0323	.0079			
2	48.789	-1.1374	.1467	.0344	-.0106				.0126	-.0205			
3	41.907	-1.3859	.1597	.0027	-.0044				.0085	-.0340			
4	36.019	-1.6508	.1058	-.0010	.0209				-.0416	.0014			
5	30.118	-1.9705	.1965	-.0103	.0259				-.0039	-.0072			
6	26.166	-2.2215	.1914	-.0107	.0505				-.0026	-.0379			
7	22.196	-2.4542	.2377	-.0560	.0693				-.0677	.0342			
8	18.211	-2.5446	.3324	-.0655	.0428				-.0254	-.0005			
9	15.214	-2.6340	.4313	.0031	.0474				-.0440	-.0094			
10	12.215	-3.3275	.6888	.1528	-.0893				-.2860	.1107			
11	9.009	-3.5093	.9368	.0280	.0208	.0073	.0160	.0682	-.2242	.0286	.0178	-.0742	.0011
12	6.037	-3.3979	.9730	.0574	-.0241	-.0245	-.0246	-.0286	-.3091	-.0446	.0490	.0332	-.0329
13	3.629	-3.4562	1.1390	.3777	-.0304	-.1445	.0001	.0676	-.6262	.0849	.2201	-.0430	-.1309
14	1.413	-3.1806	1.6028	.1886	-.0419	-.1369	.0700	.0425	-.5739	.0398	.0322	-.0520	-.0377
15	.172	-1.8572	1.8313	-.0685	-.0721	.0420	-.0675	.0377	-.5706	.0898	.0792	.0221	-.0109
16	0.000	-.5835	1.2262	-.0967	-.0242	-.0557	.0680	-.0406	-.4446	.0886	.0639	-.0541	.0458
17	.324	.2907	.1463	-.0412	-.0102	-.0564	.0496	.0680	-.0287	.0238	-.1331	-.0717	.0519
18	1.156	.4482	-.1466	-.0549	-.0209	.0128	.0175	-.0043	.0704	.0226	.0120	-.0083	-.0055
19	3.007	.3148	-.2369	-.0628	.0133	.0047	-.0160	-.0129	.0733	.0248	-.0106	-.0163	-.0030
20	4.886	.2158	-.2660	-.0366	.0199	-.0109	-.0179	.0122	.0934	.0177	.0119	-.0099	.0052
21	7.782	.1031	-.2219	-.0178	-.0018	-.0010	.0027	-.0089	.1182	.0255	.0090	-.0032	.0330
22	12.404	.0307	-.1557	-.0003	-.0094	-.0168	.0253	-.0137	.0791	-.0214	-.0081	-.0125	.0219
23	17.679	.0104	-.1195	.0002					.0337	-.0242	-.0010		
24	23.652	.0102	-.1318	-.0124					.0608	-.0309	.0060		
25	29.633	-.0077	-.1142	.0066					.0538	-.0103	.0047		
26	36.633	-.0156	-.0937	-.0005					.0584	-.0373	-.0018		
27	43.531	-.0326	-.0628	.0205					.0848	-.0234	-.0107		
28	60.627	-.0421	-.0582	.0439					.0794	.0018	.0006		
29	72.863	-.0145	-.0387	.0376					.0996	.0077	.0125		
30	75.593	-.0033	-.0176	.0346					.0881	.0050	.0064		
31	95.576	.0385	.0027	.0389					.0843	.0135	.0120		
32	106.336	.0624	.0138	.0430					.1090	.0068	.0094		

ORIGINAL PAGE IS
OF POOR QUALITY

128209-82

Table A-19.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 114, TOUCH AND GO — TEST 273-7 IRIG 8:40:36.1

ALTITUDE= 2561. FT — MACH NUMBER= 0.263 — CORRECTED AIRFLOW= 1589. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.2423	.2260	.0114	.0279				-.0107	-.0333			
2	48.789	-1.3951	.2037	-.0097	-.0208				.0329	.0119			
3	41.907	-1.6942	.1932	-.0328	.0024				.0238	-.0334			
4	36.019	-2.0402	.1906	-.0274	.0245				-.0299	-.0086			
5	30.118	-2.4476	.2415	.0093	.0021				-.0347	-.0278			
6	26.166	-2.8186	.2262	-.0131	.0013				-.0269	-.0100			
7	22.196	-3.0504	.2456	-.0416	.0496				-.1412	.0414			
8	18.211	-3.2089	.3867	-.0489	.0161				-.1026	-.0100			
9	15.214	-3.3275	.4329	-.0018	.0256				-.1242	.0195			
10	12.215	-4.0792	.8133	.1193	-.0816				-.3961	-.0184			
11	9.009	-4.4561	1.1894	.0149	-.0103	.0370	-.0282	.1130	-.4808	.0443	.0231	-.0699	-.0425
12	6.037	-4.2609	1.1553	.1054	-.0295	-.0373	-.0288	-.0330	-.5649	-.0569	.0720	.0141	-.0555
13	3.629	-4.4133	1.3605	.5531	-.1202	-.1714	.0267	.0755	-1.0506	.1412	.3128	-.0671	-.1415
14	1.413	-4.1699	1.9831	.2495	-.1083	-.0967	.0295	.0620	-1.1096	.2242	.0029	.0065	-.0853
15	.172	-2.5406	2.2309	.0067	-.0629	.0624	-.1107	.0302	-1.0498	.1358	.0854	.0379	.0034
16	0.000	-1.0088	1.5795	-.0577	-.0346	-.0638	.0689	-.0379	-.8200	.1877	.0942	-.0595	.0450
17	.324	.2451	.2778	-.0891	-.0017	-.0821	.0507	.0776	-.1448	.0740	-.0968	-.0701	.0680
18	1.156	.4916	-.1038	-.0455	-.0347	.0162	.0096	-.0054	.0675	.0471	.0065	.0118	-.0243
19	3.007	.4029	-.2489	-.0520	-.0068	-.0077	-.0012	-.0018	.1200	.0177	-.0027	.0042	.0106
20	4.886	.2880	-.2647	-.0342	-.0017	.0031	-.0072	.0072	.1511	.0174	-.0073	.0011	.0087
21	7.782	.1662	-.2471	-.0338	-.0168	-.0060	-.0052	-.0025	.1581	-.0018	-.0023	.0001	.0094
22	12.404	.0812	-.1616	-.0005	-.0026	.0063	.0304	-.0140	.1069	-.0224	-.0074	-.0052	.0216
23	17.679	.0687	-.1745	-.0089					.0830	-.0557	-.0844		
24	23.652	.0498	-.1405	-.0013					.0842	-.0312	-.0053		
25	29.638	.0385	-.1277	.0085					.0906	-.0263	.0056		
26	36.633	.0293	-.1120	-.0004					.0842	-.0394	.0012		
27	48.631	.0024	-.0984	.0264					.0870	-.0333	.0077		
28	60.627	-.0014	-.0726	.0377					.1203	-.0047	.0050		
29	72.863	-.0031	-.0676	.0552					.0853	-.0163	.0160		
30	75.593	.0366	-.0248	.0326					.1264	-.0006	.0088		
31	96.576	.0766	-.0026	.0407					.1192	-.0805	.0155		
32	106.386	.0970	.0145	.0467					.1501	-.0070	.0075		

ORIGINAL PAGE IS OF POOR QUALITY

Table A-20.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 115, THRUST REVERSE TEST 273-7 IRIG 8:45:59.4

ALTITUDE= 2561. FT MACH NUMBER= 0.179 CORRECTED AIRFLOW= 1369. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.8887	.1066	-.0022	.0199				.0314	-.0311			
2	48.789	-.9857	.0774	.0006	-.0071				.0352	.0045			
3	41.907	-1.1633	.0827	-.0252	-.0001				.0384	-.0216			
4	36.019	-1.3741	.0761	-.0208	.0229				.0107	.0032			
5	30.118	-1.6220	.0934	.0008	-.0007				.0190	-.0087			
6	26.166	-1.8395	.0529	.0016	-.0046				.0258	.0013			
7	22.196	-1.9782	.0370	-.0258	.0338				-.0299	.0252			
8	18.211	-2.0915	.0925	-.0263	.0043				.0127	-.0126			
9	15.214	-2.1436	.0820	.0046	.0089				.0301	.0110			
10	12.215	-2.6567	.2559	.1200	-.0946				-.1692	.1059			
11	9.009	-2.8212	.2523	.0170	.0129	.0199	.0133	.0655	-.0603	.0081	.0323	-.0492	-.0359
12	6.037	-2.8874	.2061	.0406	-.0109	-.0187	-.0063	-.0124	-.0956	-.0364	.0294	.0015	-.0534
13	3.629	-3.1425	.1620	.2891	-.0141	-.1186	.0041	.0694	-.2526	.0409	.1674	-.0072	-.1075
14	1.413	-3.3882	.2734	.1837	-.0277	-.1017	.0409	.0277	-.1944	.0332	.0193	-.0476	-.0226
15	.172	-2.9034	.7084	.0515	-.0238	.0634	-.1167	-.0025	-.2458	-.0327	.0021	.0417	-.0094
16	0.000	-1.9518	.5912	.0260	.0306	-.0032	.0365	-.0097	-.2276	.0424	.1073	.0083	.0185
17	.324	-.3537	.2393	-.0432	.0268	.0278	-.0432	-.0225	-.1267	.0045	.1243	.0322	-.0461
18	1.156	.1747	.0377	-.0082	.0468	-.0226	-.0179	.0279	-.0755	.0403	-.0086	-.0236	.0444
19	3.007	.2859	.0049	-.0047	.0139	-.0079	.0161	.0032	-.0141	.0040	-.0079	-.0070	.0027
20	4.886	.2717	-.0087	-.0343	.0004	-.0165	-.0130	-.0053	-.0123	.0132	-.0083	-.0003	-.0004
21	7.782	.2497	-.0163	-.0184	-.0062	-.0119	-.0070	-.0043	.0022	.0047	-.0092	-.0029	.0070
22	12.404	.2022	-.0070	-.0055	-.0120	.0015	.0038	-.0238	.0092	.0065	-.0030	-.0079	.0020
23	17.679	.1994	-.0038	-.0059					-.0057	-.0022	-.0107		
24	23.652	.1872	.0251	-.0208					-.0105	.0275	-.0179		
25	29.638	.1845	.0306	-.0235					-.0202	.0383	-.0206		
26	36.633	.1844	.0222	-.0265					-.0132	.0369	-.0156		
27	48.631	.1887	.0527	-.0276					-.0193	.0348	-.0237		
28	60.627	.2180	.0465	-.0269					-.0120	.0262	-.0160		
29	72.863	.2228	.0393	-.0226					-.0134	.0159	-.0118		
30	75.593	.2371	.0364	-.0137					-.0058	.0214	-.0180		
31	96.576	.2359	.0204	-.0049					-.0038	.0050	-.0876		
32	106.386	.1980	.0521	-.0227					.0352	-.0529	.0339		

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-21.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 116, 2.0g LEFT TURN (FLAPS UP) TEST 273-10 IRIG 13:33:6

ALTITUDE= 8397. FT MACH NUMBER= 0.487 CORRECTED AIRFLOW= 1562. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	.2640	.1281	-.0134	.0535				-.0577	-.0171			
2	48.789	.1083	.1316	.0054	.0139				-.0881	.0237			
3	41.907	-.1314	.1703	-.0038	.0334				.0009	-.0079			
4	36.019	-.4616	.2072	.0665	.0308				-.0616	.0432			
5	30.118	-.7974	.2692	.0463	.0046				-.0240	-.0289			
6	26.166	-1.0615	.1772	.0530	-.0315				-.0861	-.0051			
7	22.196	-1.2836	.2457	-.0064	.0344				-.1466	-.0005			
8	18.211	-1.3373	.4288	.0104	.0035				-.1260	.0081			
9	15.214	-1.4437	.4468	-.0108	.0011				-.1697	.0187			
10	12.215	-1.8907	.8090	-.0481	.0237				-.2491	-.0981			
11	9.009	-2.1006	1.1932	.0574	-.0505	-.0078	-.0172	.0183	-.4310	.0730	.0054	-.0347	.0137
12	6.037	-1.7958	1.1411	.0290	-.0436	.0105	-.0533	-.0380	-.6473	.0164	.0960	.0155	-.0479
13	3.629	-1.4055	1.2481	.2394	-.0573	-.0825	.0005	.0245	-.8742	.1055	.1507	-.0089	-.1072
14	1.413	-.4567	1.4096	.0424	-.0217	-.1266	.0790	.0091	-.7652	.1282	.0543	-.0026	.0064
15	.172	1.0349	.8838	-.1150	.0223	-.0564	.0014	.0208	-.4907	.2557	.0790	.0144	-.0399
16	0.000	1.3851	-.3968	-.2134	-.0146	.0044	.0223	-.0075	.1711	.2858	-.0536	-.0281	-.0040
17	.324	.2314	-1.7001	-.3180	-.0405	.0519	-.0033	.0109	.7529	.2275	.0250	-.0655	-.0831
18	1.156	-.1510	-1.4350	-.1490	-.0252	.0154	.0117	-.0190	.6857	.1001	-.0286	-.0075	-.0240
19	3.007	-.2599	-1.0382	-.1289	-.0680	-.0148	.0288	.0253	.5103	.0988	.0043	.0393	-.0290
20	4.886	-.4280	-.8477	-.0774	-.0224	-.0718	-.0269	.0273	.4922	.0909	-.0299	.0075	.0311
21	7.782	-.5624	-.6215	-.1040	-.0824	-.0788	-.0345	-.0145	.4556	.0787	.0166	-.0508	.0328
22	12.404	-.5198	-.4570	.0600	.0779	.0358	.1039	.0609	.1916	-.1449	-.0774	-.0086	.0832
23	17.679	-.4640	-.4653	-.0906					.1727	-.0515	-.0647		
24	23.652	-.3679	-.3442	-.0659					.1569	-.0869	-.0147		
25	29.638	-.3657	-.2766	-.0067					.1864	-.0190	.0109		
26	35.633	-.3076	-.1908	-.0317					.1101	-.1000	-.0153		
27	48.631	-.3231	-.1918	.0518					.1152	-.0489	-.0162		
28	60.627	-.2846	-.1157	.1245					.2140	.0527	.0357		
29	72.863	-.1849	-.0673	.0785					.2142	.0154	.0270		
30	75.593	-.1306	-.0104	.0754					.2067	.0324	.0369		
31	96.576	.0415	.0402	.0795					.1766	.0339	.0360		
32	106.386	.1402	-.0935	-.0118					.1704	-.0724	-.0300		

ORIGINAL PAGE IS
OF POOR QUALITY

Table A-22.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 117, 1.5g LEFT TURN (FLAPS 30) TEST 273-10 IRIG 13:41:7.5

ALTITUDE= 8131. FT MACH NUMBER= 0.251 CORRECTED AIRFLOW= 1539. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.9499	.2009	-.0069	.0167				-.0914	-.0072			
2	48.788	-1.0971	.1845	.0061	-.0082				-.0767	-.0112			
3	41.907	-1.2762	.1802	-.0019	.0187				-.0353	-.0058			
4	36.019	-1.5752	.1938	.0270	.0161				-.0802	-.0098			
5	30.118	-1.8452	.2620	.0242	.0232				-.0557	-.0073			
6	26.166	-2.1227	.2305	.0095	-.0023				-.1029	-.0226			
7	22.196	-2.2870	.2815	-.0295	.0540				-.2186	.0540			
8	18.211	-2.3877	.4417	-.0353	.0101				-.2351	-.0313			
9	15.214	-2.4740	.4980	-.0139	.0266				-.2357	-.0004			
10	12.215	-3.0055	.8407	-.0044	.0332				-.3800	-.1120			
11	9.009	-3.3737	1.3271	.0286	-.0589	.0139	-.0876	.0751	-.7391	.0709	.0517	-.0150	-.0724
12	6.037	-3.2616	1.2591	.0868	-.0066	-.0390	-.0319	-.0118	-.8404	-.0467	.0988	-.0083	-.0469
13	3.629	-3.5811	1.7594	.5586	-.2120	-.1460	-.0575	.1209	-1.6501	.2929	.3379	-.0424	-.2434
14	1.413	-3.5744	2.4727	.2308	-.0107	-.2344	.1569	.0073	-1.8790	.4276	.1355	-.0209	-.0992
15	.172	-2.3305	2.5667	-.1501	-.0112	.0807	-.1509	.0823	-1.6187	.4095	.0242	.0848	-.0700
16	0.000	-1.0628	1.6854	-.0412	-.0776	-.0346	.0561	-.0507	-1.1847	.3868	.1195	-.0755	.0428
17	.324	-.0522	.2474	-.0615	-.0162	-.1126	-.0211	.0571	-.2192	.2568	.0439	-.0049	.0406
18	1.156	.2109	-.1608	-.0172	-.0146	.0212	.0027	.0034	.0493	.1584	.0174	.0115	-.0170
19	3.007	.2008	-.3160	-.0277	-.0089	-.0064	-.0210	.0245	.1419	.0751	-.0071	.0007	-.0082
20	4.886	.1311	-.3171	-.0115	-.0059	-.0020	-.0305	.0128	.1516	.0147	-.0304	-.0082	.0216
21	7.782	.0572	-.2791	-.0068	-.0073	.0068	-.0089	-.0086	.1791	-.0029	-.0152	.0005	.0353
22	12.404	-.0267	-.2338	-.0026	.0085	-.0145	.0322	-.0007	.1381	-.0554	-.0089	-.0168	.0193
23	17.679	-.0521	-.2084	-.0074					.1592	-.0419	-.0100		
24	23.652	-.0564	-.1943	-.0009					.1074	-.0752	.0017		
25	29.638	-.0690	-.1714	.0277					.1291	-.0492	-.0039		
26	36.633	-.0740	-.1378	-.0013					.1002	-.0937	-.0049		
27	48.631	-.0984	-.1096	.0386					.1139	-.0810	-.0115		
28	60.627	-.0929	-.0834	.0425					.1354	-.0534	-.0001		
29	72.863	-.0544	-.0701	.0432					.1472	-.0359	.0099		
30	75.593	-.0604	-.0253	.0410					.1498	-.0422	.0122		
31	96.576	-.0267	-.0061	.0412					.1473	-.0349	.0182		
32	106.386	-.0381	-.0232	.0245					.1729	-.0872	-.0109		

125209-56

ORIGINAL PAGE IS OF POOR QUALITY

Table A-23.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 120, 2.0g RIGHT TURN (FLAPS UP) TEST 273-15 IRIG 11:04:04

ALTITUDE= 8218. FT MACH NUMBER= 0.475 CORRECTED AIRFLOW= 1195. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	1.0189	.0574	-.0143	-.0081				-.0477	.0207			
2	48.789	.9301	.0580	.0067	-.0269				-.0531	.0246			
3	41.907	.8245	.0814	.0201	-.0157				-.0630	.0154			
4	36.019	.6528	.0963	.0222	-.0118				-.0736	.0208			
5	30.118	.4968	.1745	.0278	-.0024				-.0204	.0082			
6	26.166	.3763	.1842	.0064	-.0082				-.0338	-.0170			
7	22.196	.2945	.2578	.0171	-.0146				-.0884	.0500			
8	18.211	.2881	.3548	-.0261	-.0145				-.0625	-.0059			
9	15.214	.2679	.3611	.0014	-.0184				-.1074	.0863			
10	12.215	-.0287	.6807	.0408	-.0545				-.1974	.1564			
11	9.089	.0418	.8385	.0075	-.0311	-.0182	-.0352	-.0288	-.1126	.0356	.0158	-.0154	.0430
12	6.037	.1711	.8819	-.0416	-.0589	-.0270	-.0437	.0223	-.1897	.0467	.0535	.0282	.0797
13	3.629	.4775	.9297	-.0015	.0356	-.0248	-.0205	.0332	-.1640	-.0297	.0025	.0629	-.0305
14	1.413	.8816	.9405	-.0767	.0064	-.0405	.0452	-.0175	-.2413	.0808	-.0181	-.0012	.0882
15	.172	1.2911	-.0151	-.2531	.0187	-.0512	.0486	.0406	-.1355	.0813	-.0054	-.0794	-.0632
16	0.000	.5610	-1.6444	-.3972	.0519	.0768	.0871	.0392	.3489	.1662	-.1253	-.1148	-.0870
17	.324	-1.5881	-3.7798	-1.1996	-.2200	.2124	.1101	-.0218	.4010	.1192	.0988	-.1468	-.2990
18	1.156	-1.4182	-2.6185	-.5823	-.3176	-.1735	-.1039	-.0582	.5108	.1713	.0244	.0285	.0805
19	3.007	-.8137	-1.4123	-.1617	-.0560	-.0914	-.0878	-.0101	.3625	.1654	.0833	.1309	.0499
20	4.886	-.7198	-.9921	-.0263	-.0917	-.1783	-.1380	.0052	.2454	-.0146	-.1647	-.0354	.0626
21	7.782	-.6209	-.5972	-.0242	-.1662	-.1967	-.1388	-.0383	.1673	-.1265	-.1772	-.1339	.0141
22	12.404	-.6654	-.5878	.1051	.1304	.0438	.0822	.0563	.0307	-.2138	-.1435	-.0090	.0747
23	17.679	-.5316	-.5479	-.0417					.0357	-.1006	-.0925		
24	23.652	-.4077	-.4497	-.0942					.0824	-.1009	-.0608		
25	29.638	-.3594	-.3111	.0311					.1293	-.0167	.0023		
26	35.633	-.2991	-.2474	-.0048					.0661	-.0913	-.0193		
27	48.631	-.2688	-.2101	.0749					.0867	-.0547	-.0260		
28	60.627	-.2321	-.1065	.1645					.1796	.0523	.0126		
29	72.863	-.1266	-.0513	.1193					.2041	.0082	.0180		
30	75.593	-.0682	.0030	.1279					.1780	.0238	.0107		
31	96.576	.0873	.0415	.1211					.1642	.0335	.0260		
32	106.336	.2636	.0374	.1078					.2229	.0556	.0223		

ORIGINAL PAGE IS OF POOR QUALITY

12B2009-87

Table A-24.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 121, 1.5g RIGHT TURN (FLAPS 30) TEST 273-15 IRIG 11:07:27.4

ALTITUDE= 8221. FT MACH NUMBER= 0.265 CORRECTED AIRFLOW= 1434. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-.6732	.1498	-.0138	-.0183				-.0052	-.0467			
2	48.789	-.7798	.1657	-.0122	-.0023				.0027	.0287			
3	41.907	-.9172	.1715	-.0252	-.0093				.0197	-.0298			
4	36.019	-1.1640	.1943	.0112	.0067				-.0228	.0290			
5	30.118	-1.3924	.2638	.0303	.0076				-.0075	-.0058			
6	26.166	-1.6032	.2932	-.0160	.0173				.0265	-.0227			
7	22.196	-1.7629	.3668	-.0093	.0219				-.0460	.0545			
8	18.211	-1.8378	.5273	-.0407	-.0031				-.0088	.0057			
9	15.214	-1.8989	.6131	-.0243	.0036				-.0028	.0705			
10	12.215	-2.4661	1.0935	.1386	-.1293				-.2706	.2101			
11	9.009	-2.5918	1.4074	-.0293	.0033	.0374	-.0622	.0361	-.1016	.0388	.0606	-.0556	-.0001
12	6.037	-2.5741	1.5408	.0463	-.0525	-.0216	-.0370	-.0111	-.1550	.0030	.0346	.0347	-.0012
13	3.629	-2.6406	1.8284	.2495	.0088	-.1157	-.0440	.0973	-.2868	.0002	.1899	.0714	-.1905
14	1.413	-2.7513	2.7746	-.0998	.0750	-.2075	.1373	-.0770	-.3283	.0994	-.0079	.0005	-.0431
15	.172	-1.8514	2.7858	-.3798	-.1449	.0565	-.1185	.0618	-.3686	.0837	.0444	.0331	-.0387
16	0.000	-.8687	1.7891	-.4421	-.1134	-.0101	.0419	-.0204	-.2554	.0897	.0377	-.0656	-.0056
17	.324	-.0575	.1373	-.3615	-.0979	-.0999	-.0236	.0318	-.0385	.0694	-.0100	-.0394	.0485
18	1.156	.1743	-.3116	-.1799	-.0664	.0055	.0283	-.0032	.0037	.0681	.0092	-.0237	.0205
19	3.007	.2564	-.3128	-.0391	.0195	-.0766	-.1310	-.0366	.0644	.0972	.0925	.0949	.0587
20	4.886	.2585	-.2696	-.0120	-.0865	-.1233	-.1293	-.0438	-.0736	-.0848	-.0862	-.0204	.0171
21	7.782	.2090	-.1840	.0207	-.1320	-.1567	-.1322	-.0603	-.1074	-.2077	-.1956	-.0934	.0151
22	12.404	.0016	-.2832	.0374	.0420	-.0035	.0304	-.0189	.0190	-.0633	-.0455	-.0359	-.0042
23	17.679	-.0482	-.2636	.0404					.0345	-.0193	-.0022		
24	23.652	-.0133	-.2406	.0396					.0429	-.0321	-.0050		
25	29.638	-.0305	-.2103	.0755					.0793	.0108	-.0035		
26	36.633	-.0337	-.1704	.0662					.0650	-.0370	-.0118		
27	48.631	-.0501	-.1357	.0918					.0938	-.0352	-.0176		
28	60.627	-.0445	-.1002	.1110					.1196	-.0030	-.0065		
29	72.863	-.0192	-.0789	.0964					.1432	-.0200	.0047		
30	75.593	-.0090	-.0598	.1103					.1346	-.0020	-.0075		
31	96.576	.0195	-.0460	.1037					.1331	-.0095	-.0020		
32	106.386	.0270	-.0411	.1157					.1931	.0010	-.0059		

9/1

ORIGINAL PAGE IS OF POOR QUALITY

Table A-25.

FOURIER - BESSEL COEFFICIENTS FOR ENGINE NUMBER THREE PRESSURES

P(THETA)=A(0) + SIGMA(A(N)COS(NTHETA) + B(N)SIN(NTHETA))

CONDITION 123, AIRPLANE STALL TEST 273-10 IRIG 13:26:16.8

ALTITUDE= 9000. FT MACH NUMBER= 0.207 CORRECTED AIRFLOW= 1551. LB/SEC

ROW NO.	Z (IN)	A(0) (PSI)	A(1) (PSI)	A(2) (PSI)	A(3) (PSI)	A(4) (PSI)	A(5) (PSI)	A(6) (PSI)	B(1) (PSI)	B(2) (PSI)	B(3) (PSI)	B(4) (PSI)	B(5) (PSI)
1	54.051	-1.1607	.2974	-.0420	.0230				-.0452	-.0130			
2	48.789	-1.2851	.2406	-.0307	.0046				-.0587	-.0168			
3	41.907	-1.4541	.2422	-.0234	.0035				-.0285	-.0417			
4	36.019	-1.7063	.2241	-.0220	.0239				-.0459	.0058			
5	30.118	-1.9749	.3137	.0244	.0158				-.0303	-.0130			
6	26.166	-2.2512	.2665	.0079	-.0059				-.0192	-.0139			
7	22.196	-2.4336	.3446	.0141	.0119				-.0996	.0686			
8	18.211	-2.5427	.5000	-.0067	.0085				-.0623	-.0226			
9	15.214	-2.633[illegible]	.5854	.0341	-.0201				-.0378	.0681			
10	12.215	-3.190[illegible]	.9593	.1327	-.0541				-.1575	-.0330			
11	9.009	-3.5562	1.4117	.1436	-.0893	.0605	-.1062	.1130	-.2487	-.0483	.1296	-.0693	-.0169
12	6.037	-3.6103	1.7308	.0173	.0802	-.0565	-.0455	.0066	-.4056	.0765	-.1304	.2473	-.1731
13	3.629	-4.4217	2.9746	.0351	-.0340	-.2304	.0176	.0660	-1.0458	.4339	.1482	-.0868	-.1083
14	1.413	-4.5505	3.6060	.1008	-.1247	-.1533	.0435	.0110	-.9761	.2162	.2239	-.1410	.0331
15	.172	-3.4679	3.7221	-.1680	-.1958	.1032	-.1498	.0725	-.8680	.1864	.1339	-.0684	.0092
16	0.000	-2.0984	2.6943	-.1430	-.1516	-.0877	.1195	-.0613	-.6834	.1163	.1384	-.0723	-.0031
17	.324	-.5955	1.0157	-.2368	-.0647	-.0402	.0123	.0228	-.3337	.0588	.1155	-.0409	-.0323
18	1.156	-.0488	.1940	-.0660	-.0655	-.0052	.0205	.0045	-.0615	.0269	.0257	.0064	-.0189
19	3.007	.1212	-.1471	-.0427	-.0279	-.0143	.0127	.0063	-.0573	.0359	-.0303	-.0018	-.0082
20	4.886	.1013	-.2110	-.0079	.0173	.0110	.0247	-.0074	-.0169	.0076	-.0474	-.0095	.0281
21	7.782	.0936	-.2154	.0072	-.0008	.0155	.0002	-.0033	.0244	.0119	-.0241	.0034	.0245
22	12.404	.0177	-.1910	.0367	.0256	-.0076	.0305	-.0001	.0183	-.0532	-.0299	-.0069	-.0023
23	17.679	-.0027	-.1839	.0281					.0583	-.0160	-.0230		
24	23.652	.0021	-.1743	.0518					.0291	-.0367	-.0000		
25	29.638	-.0097	-.1536	.0866					.0551	-.0183	-.0156		
26	36.633	-.0230	-.1245	.0826					.0528	-.0575	-.0079		
27	48.631	-.0489	-.1088	.1024					.0825	-.0662	-.0241		
28	60.627	-.0416	-.0903	.1058					.1003	-.0402	-.0161		
29	72.863	-.0311	-.0797	.0962					.1130	-.0511	-.0037		
30	75.593	-.0312	-.0690	.1009					.1109	-.0451	-.0140		
31	96.576	-.0238	-.0578	.0929					.1179	-.0456	-.0063		
32	106.386	-.0262	-.0250	.1190					.1673	-.0641	-.0265		

ORIGINAL PAGE IS OF POOR QUALITY

69-002921

ORIGINAL PAGE IS
OF POOR QUALITY

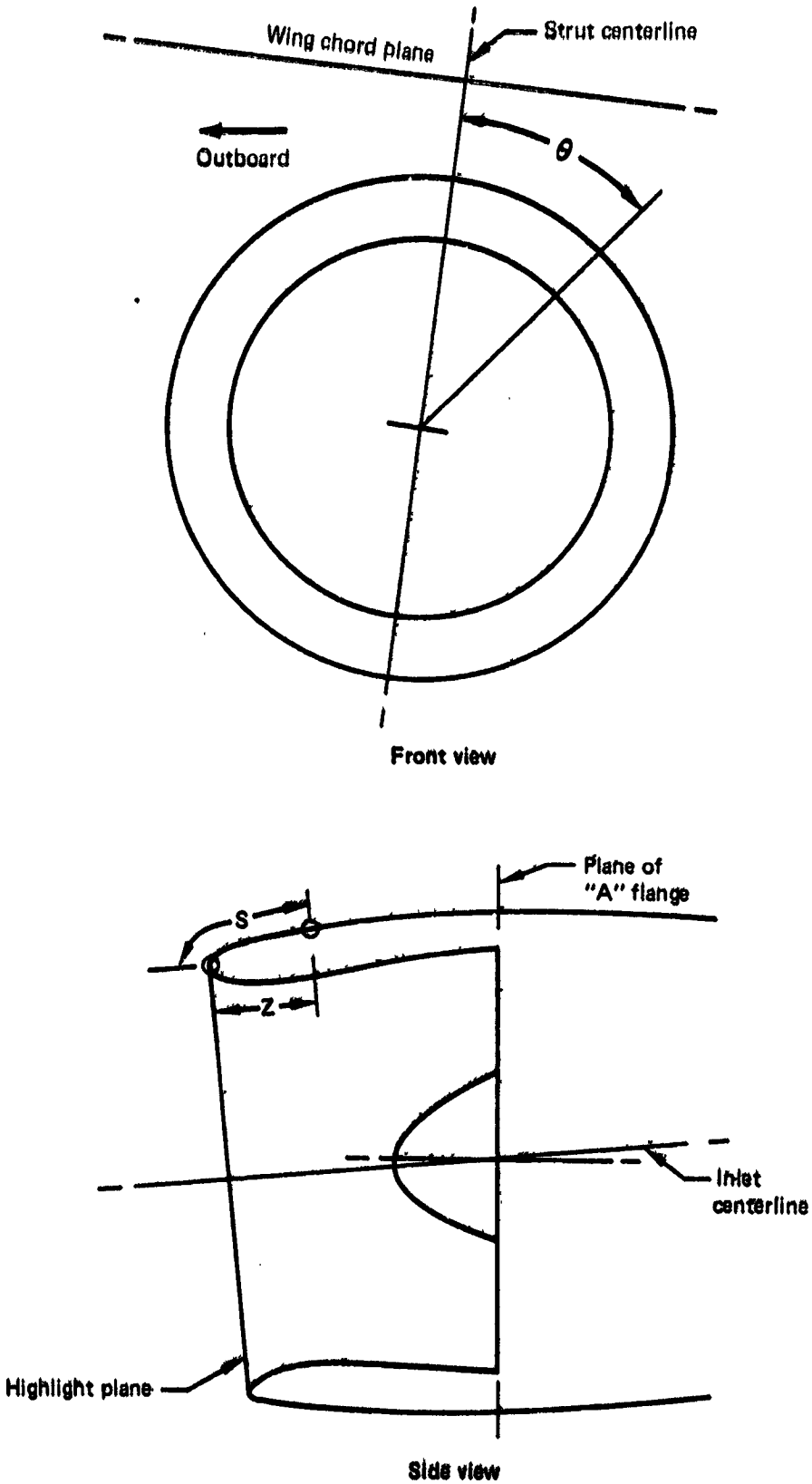


Figure A-1. Pressure Data Coordinate Conventions

ORIGINAL PAGE IS
OF POOR QUALITY

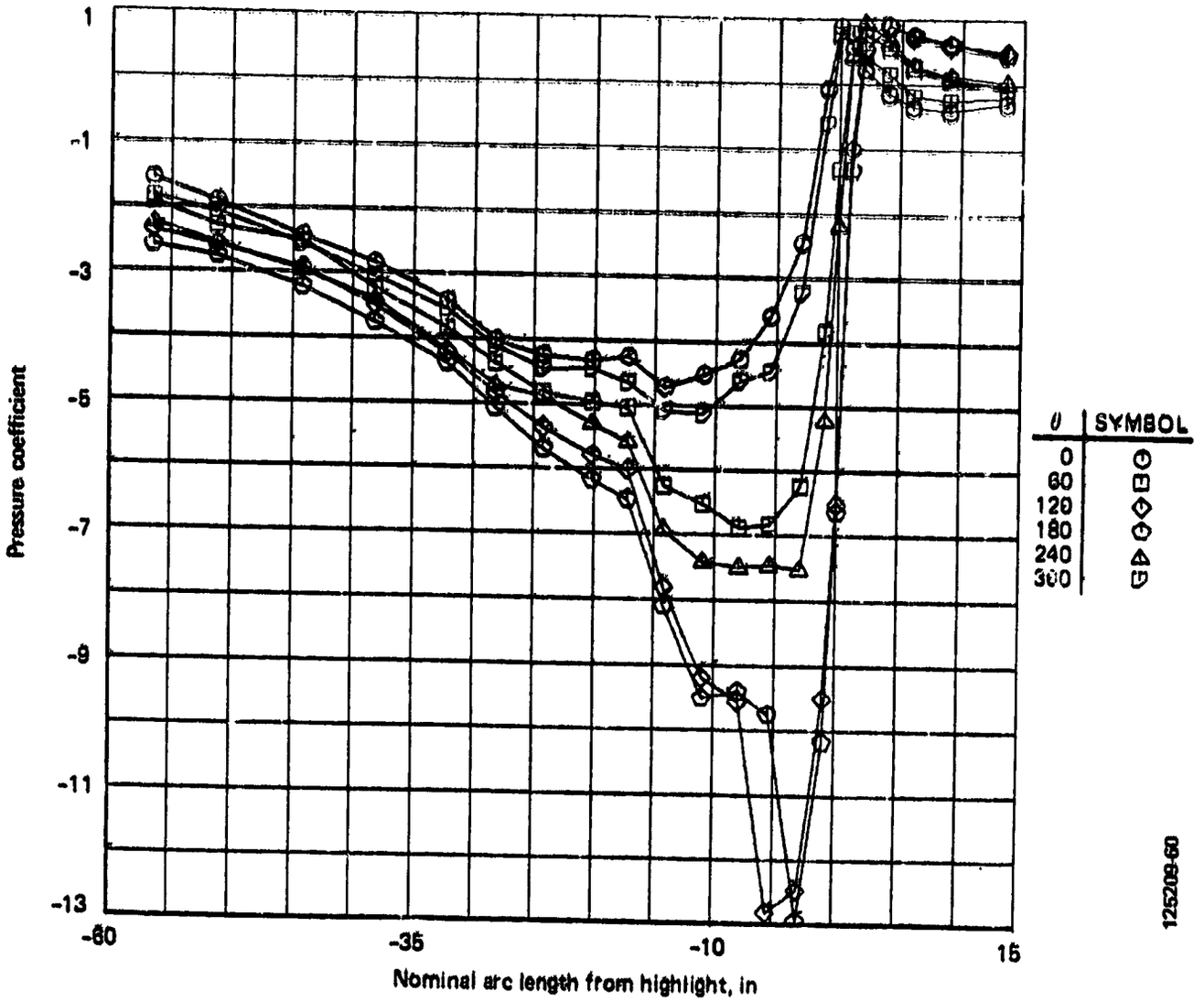


Figure A-2. Engine No. 3 Inlet Pressures, Condition 101, 612K GW Takeoff (Flaps 20)

ORIGINAL PAGE IS
OF POOR QUALITY

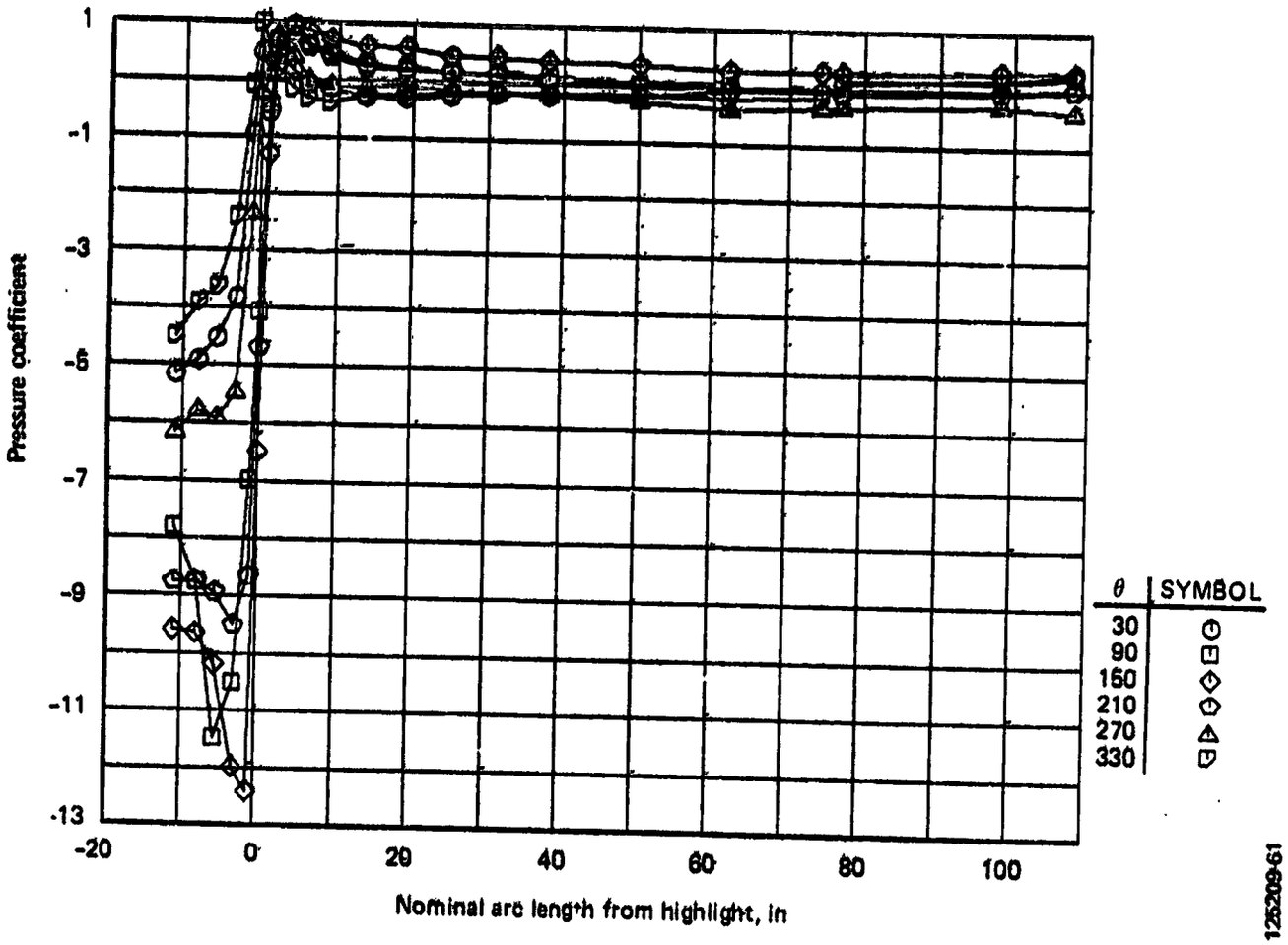


Figure A-3. Engine No. 3 Cowl Pressures, Condition 101, 612K GW Takeoff (Flaps 20)

ORIGINAL PAGE IS
OF POOR QUALITY

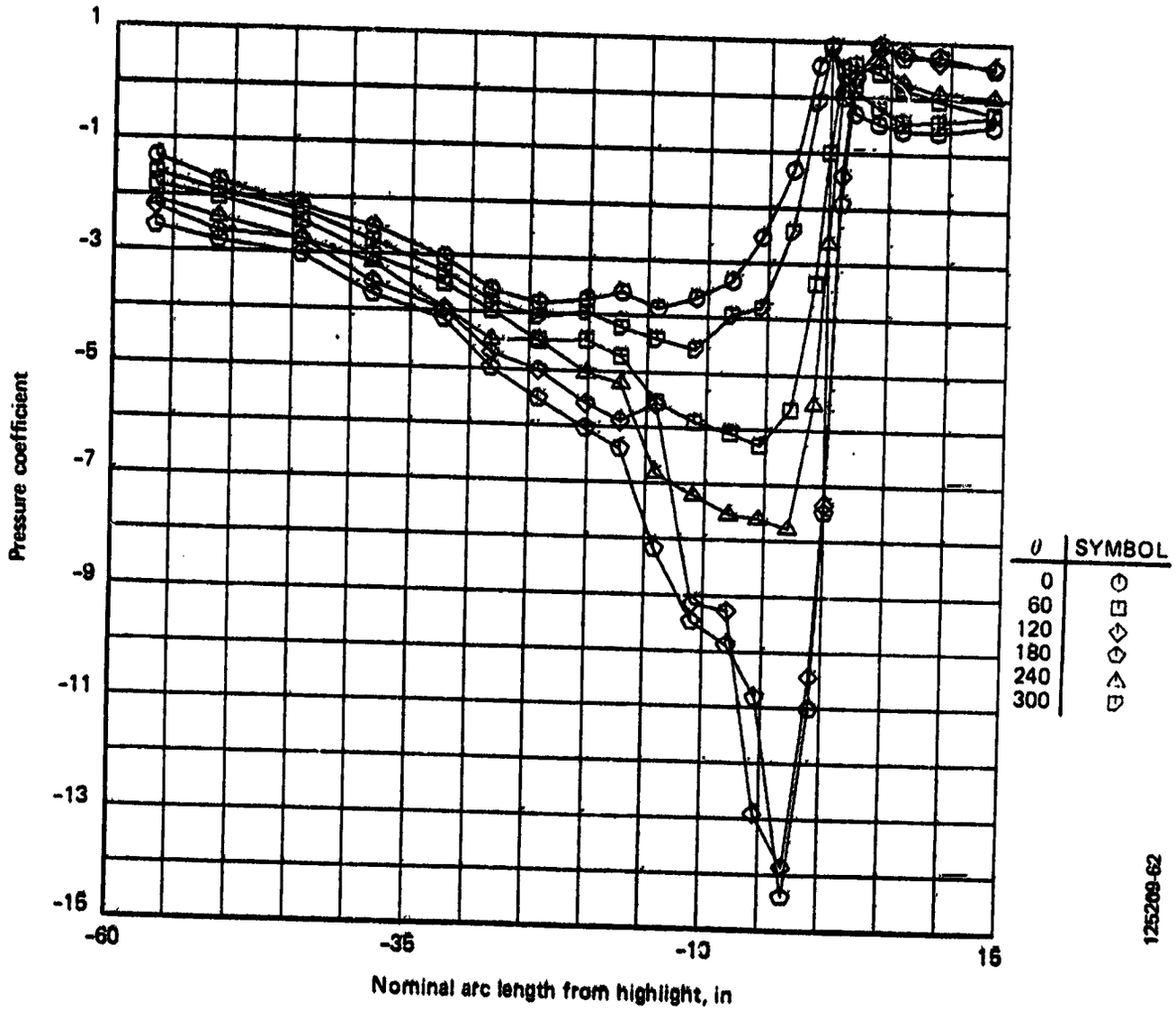


Figure A-4. Engine No. 3 Inlet Pressures, Condition 101, 538K GW Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

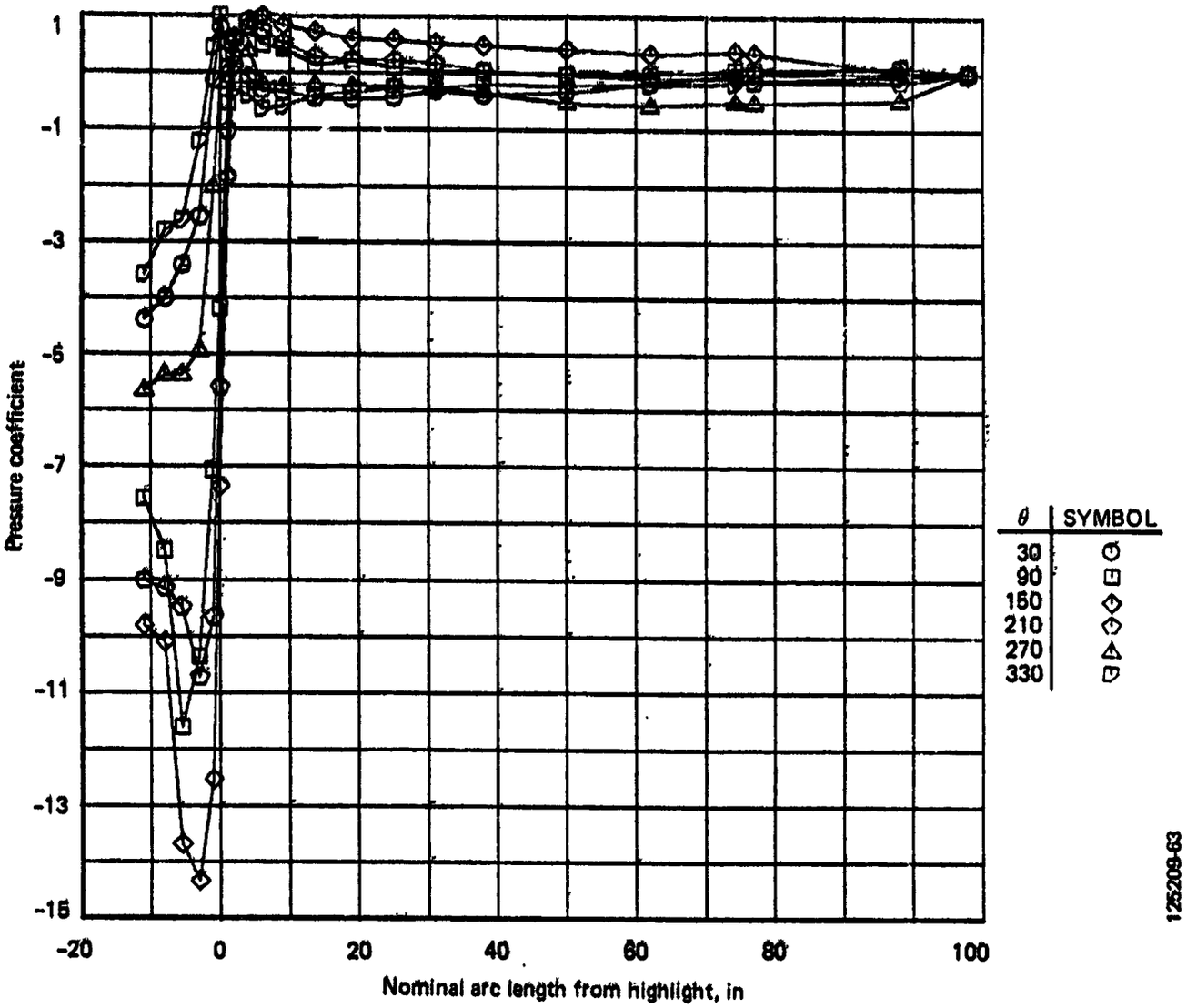


Figure A-5. Engine No. 3 Cowl Pressures, Condition 101, 538K GW Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

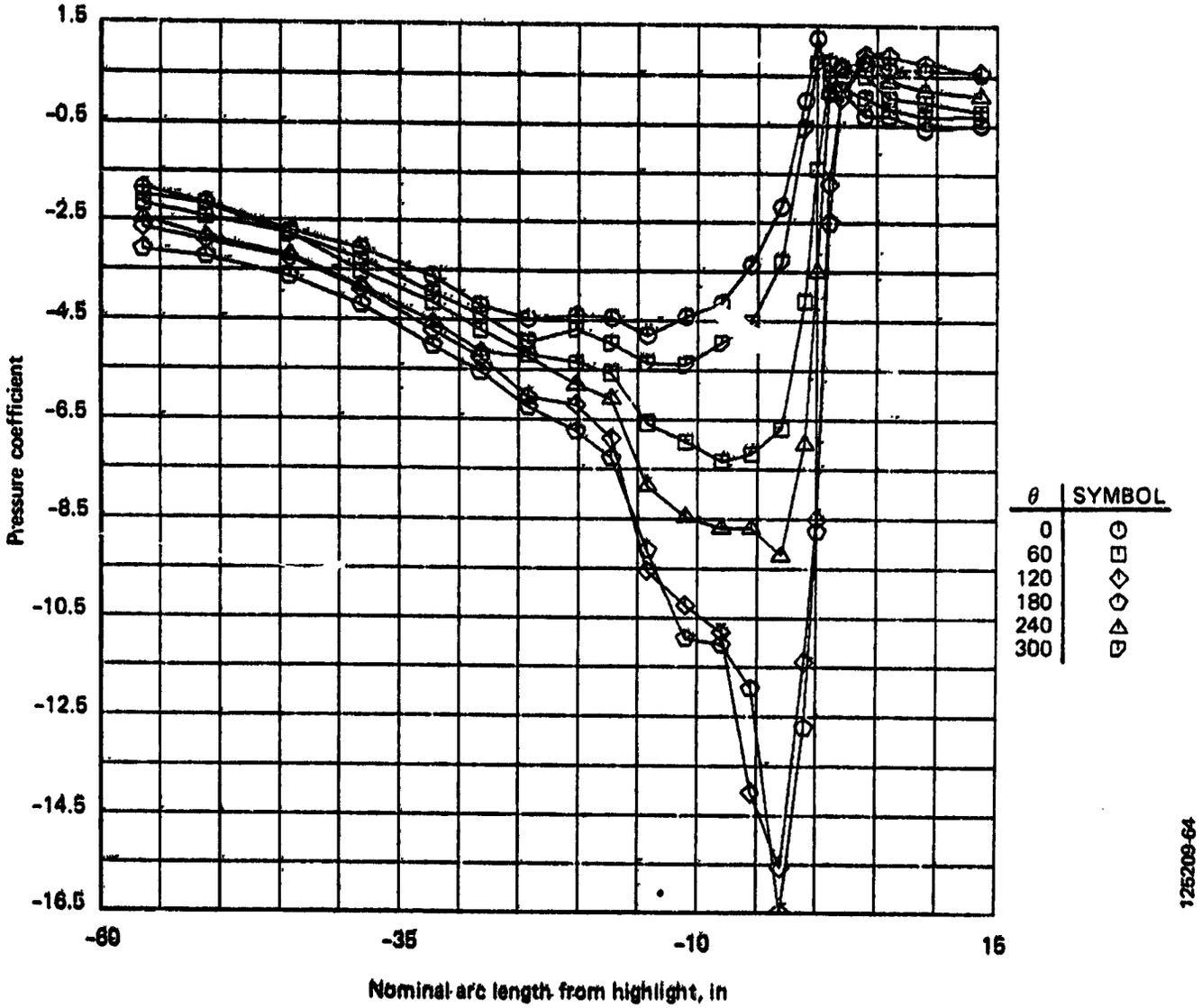


Figure A-6. Engine No. 3 Inlet Pressures, Condition 101, 647K GW Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

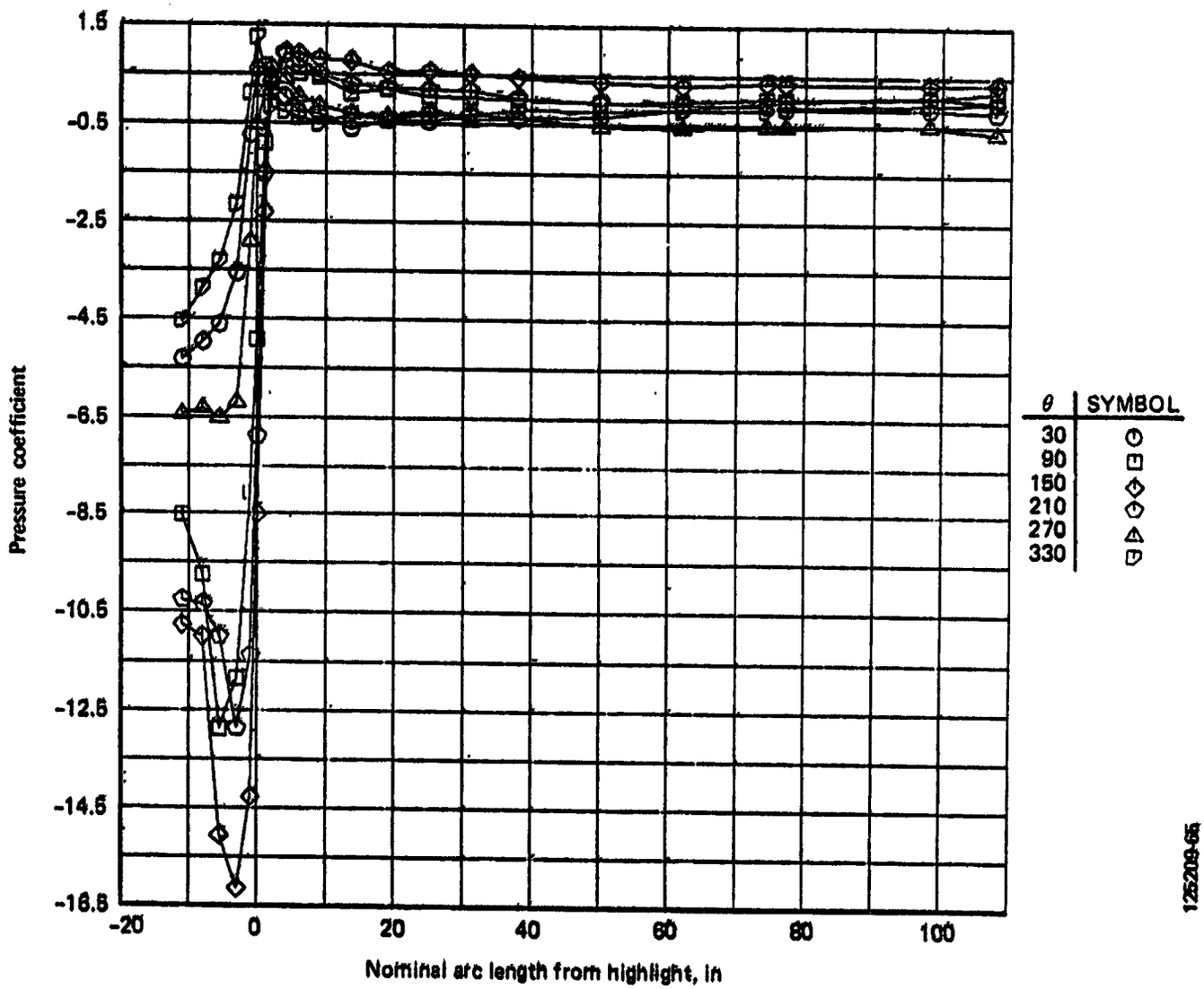


Figure A-7. Engine No. 3 Cowl Pressures, Condition 101, 647K GW Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

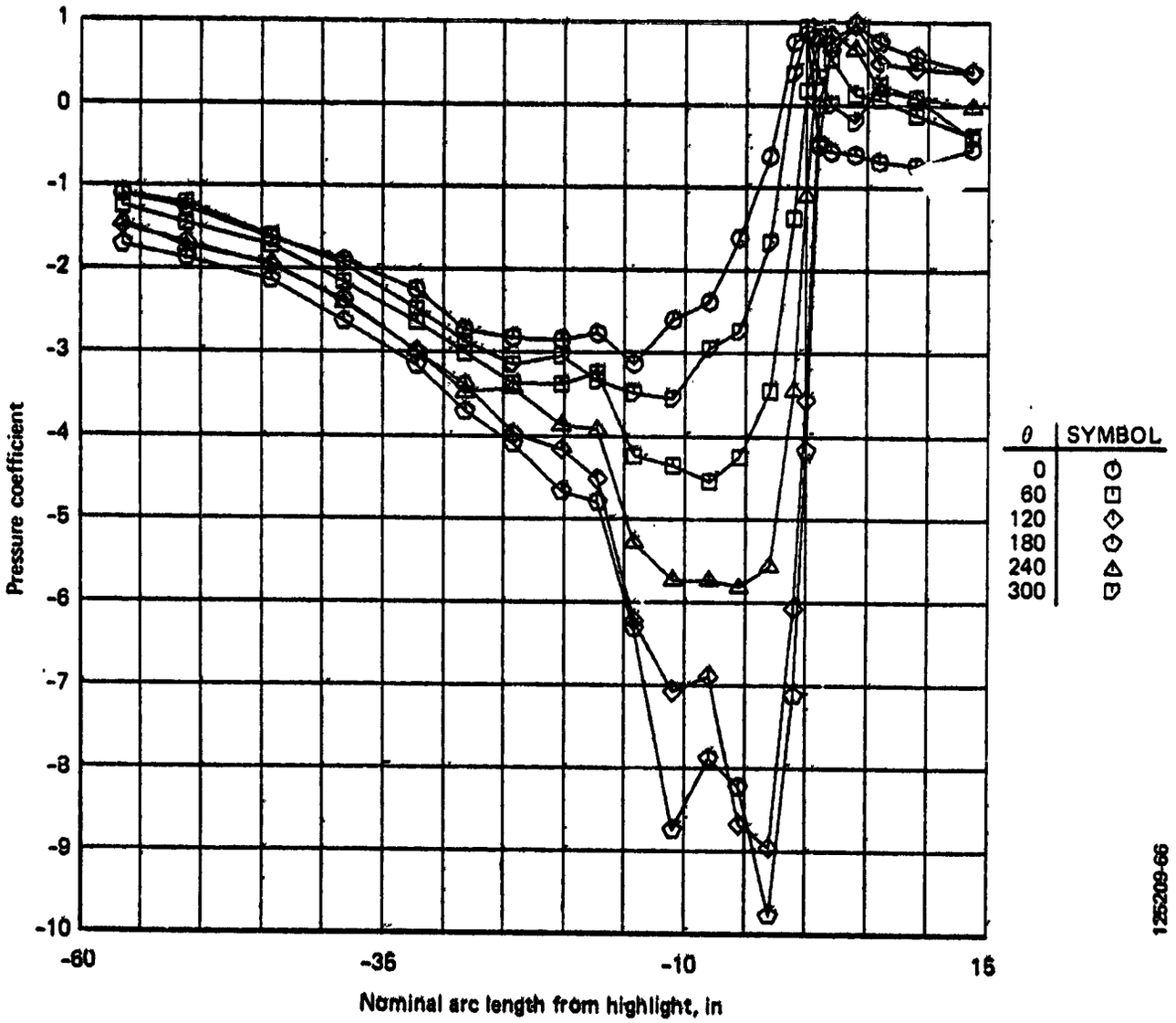


Figure A-8. Engine No. 3 Inlet Pressures, Condition 118, 780K GW Simulated Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

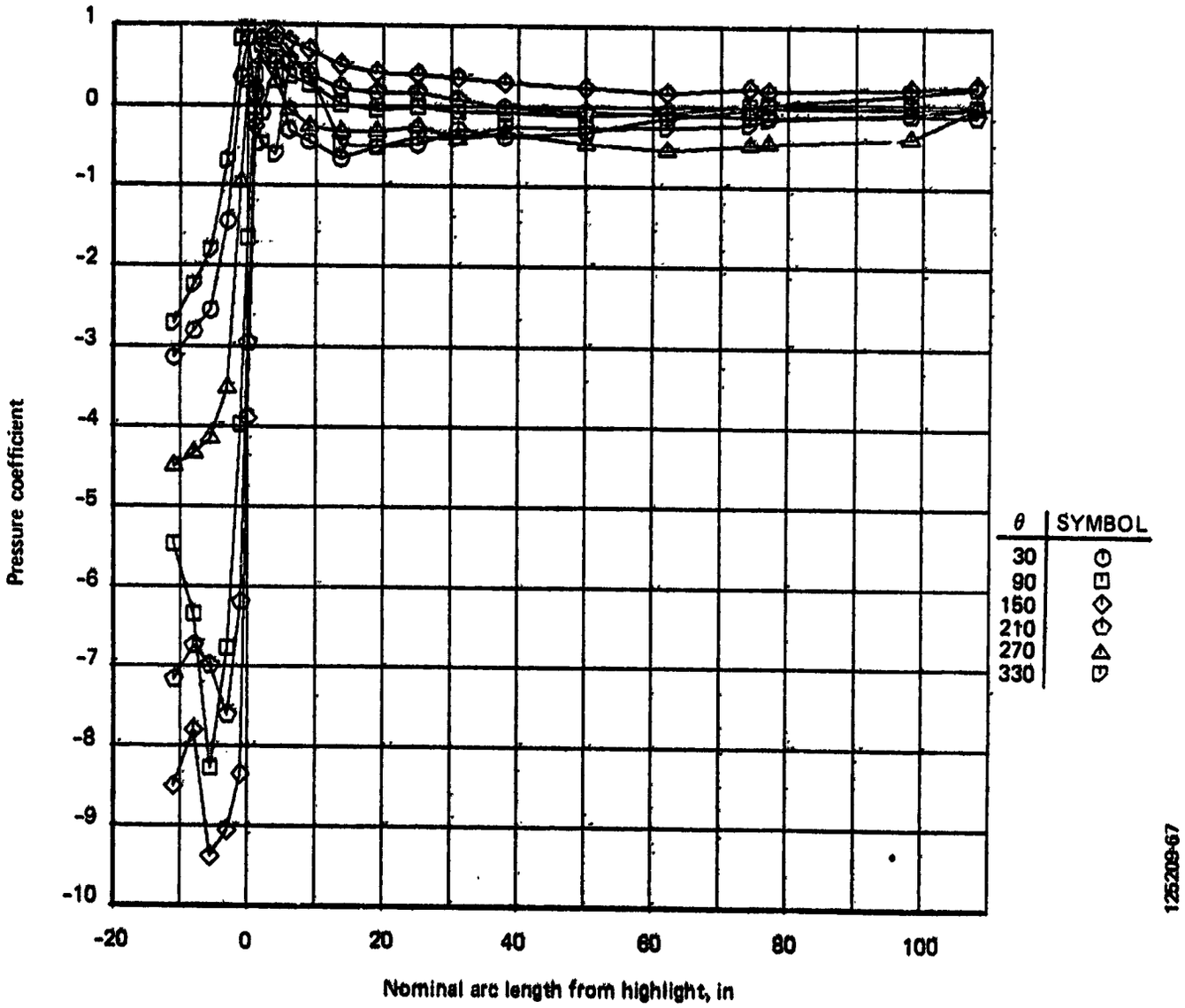


Figure A-9. Engine No. 3 Cowl Pressures, Condition 118, 780K GW Simulated Takeoff (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

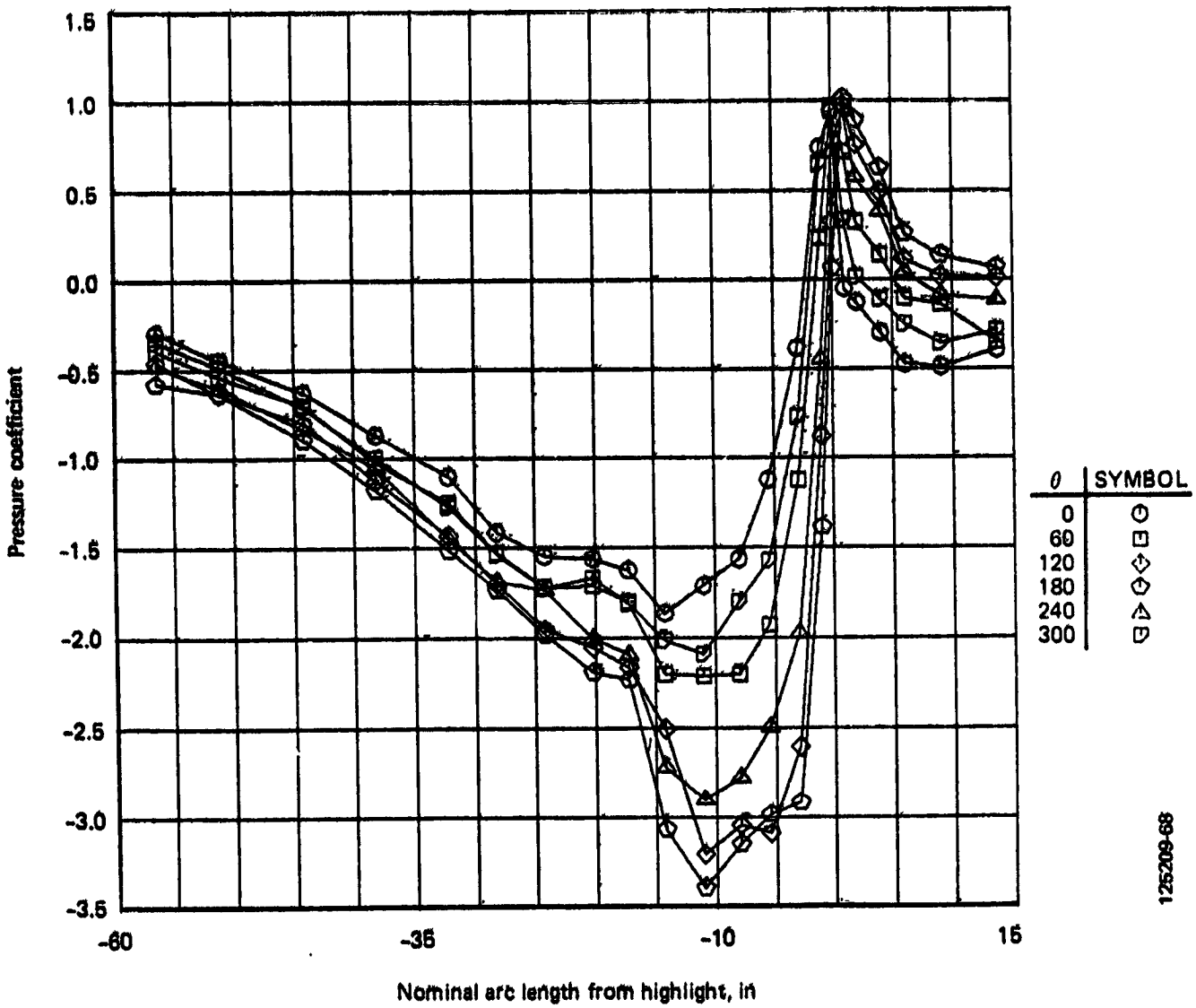


Figure A-10. Engine No. 3 Inlet Pressures, Condition 102, Low Climb

ORIGINAL PAGE IS
OF POOR QUALITY

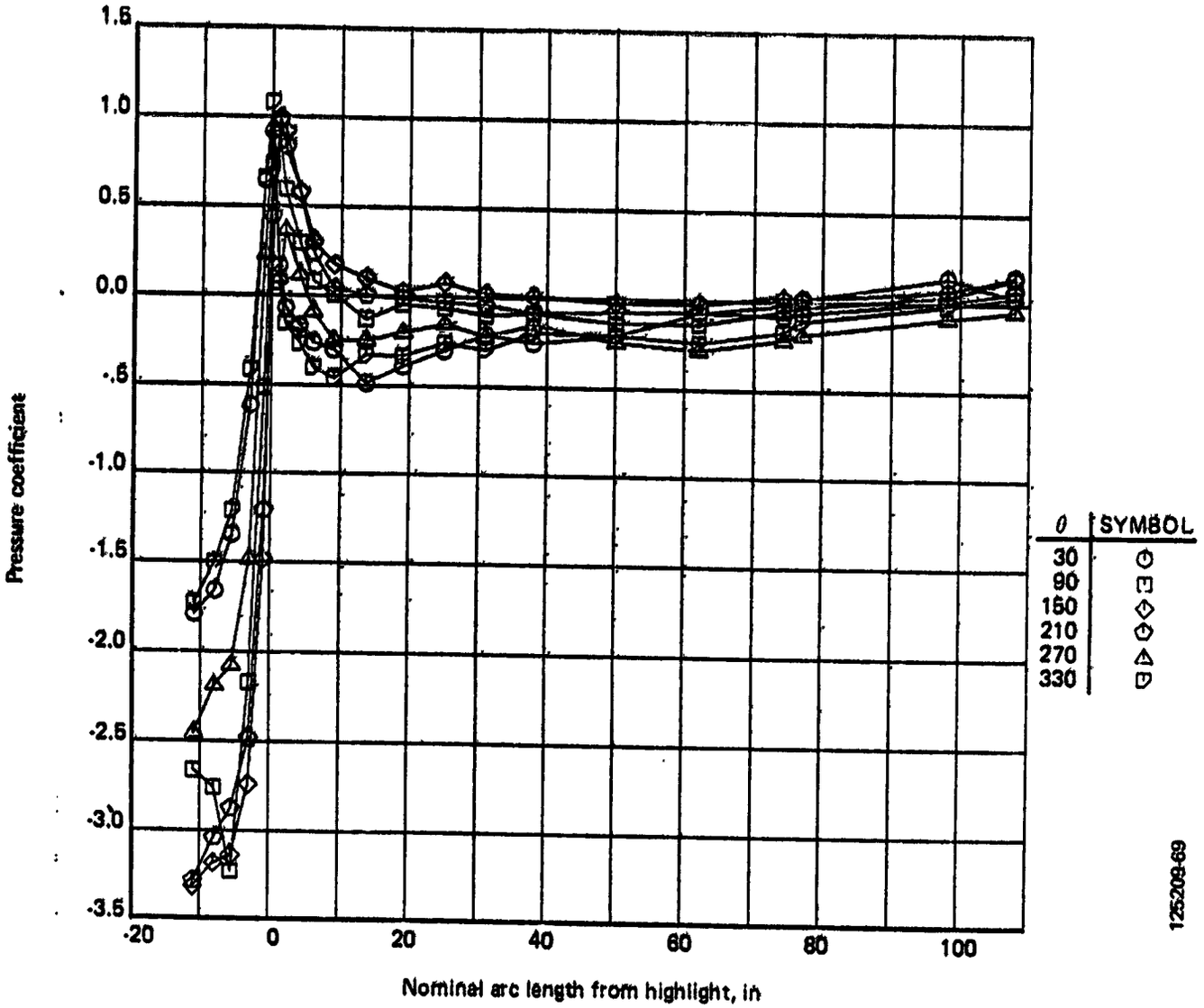


Figure A-11. Engine No. 3 Cowl Pressures, Condition 102, Low Climb

ORIGINAL PAGE IS
OF POOR QUALITY

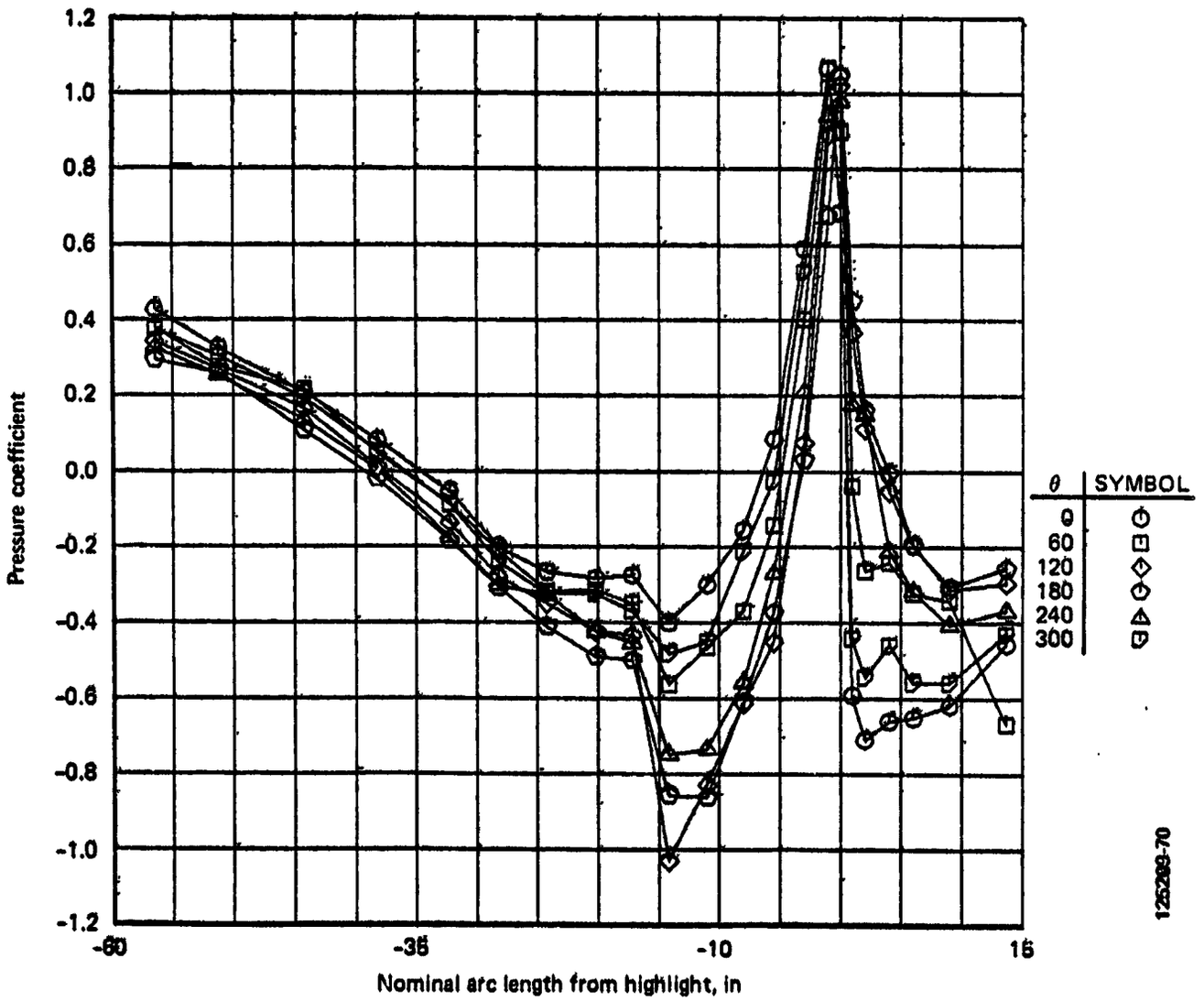


Figure A-12. Engine No. 3 Inlet Pressures, Condition 103, Mid Climb

ORIGINAL PAGE IS
OF POOR QUALITY

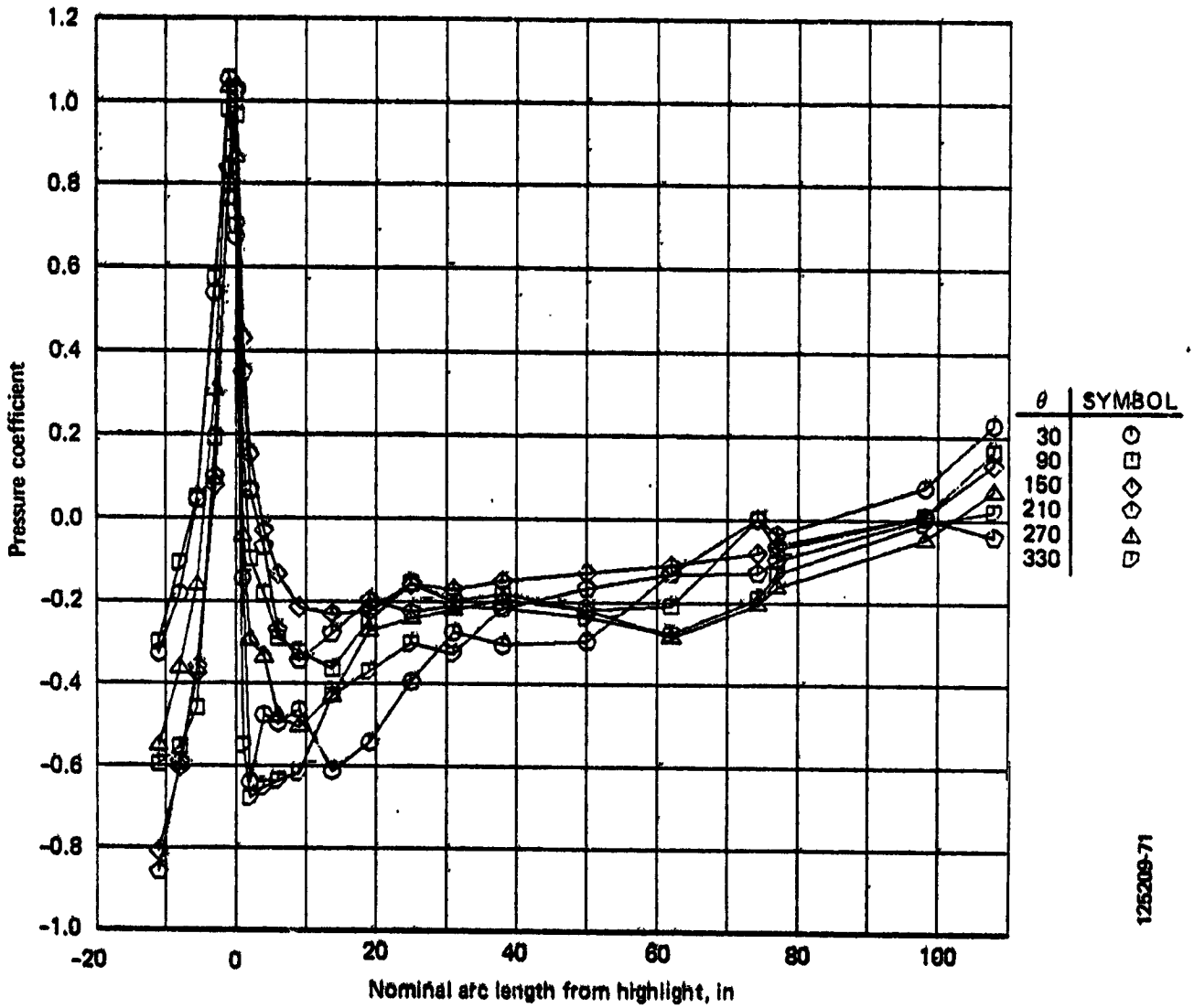


Figure A-13. Engine No. 3 Cowl Pressures, Condition 103, Mid Climb

ORIGINAL PAGE IS
OF POOR QUALITY

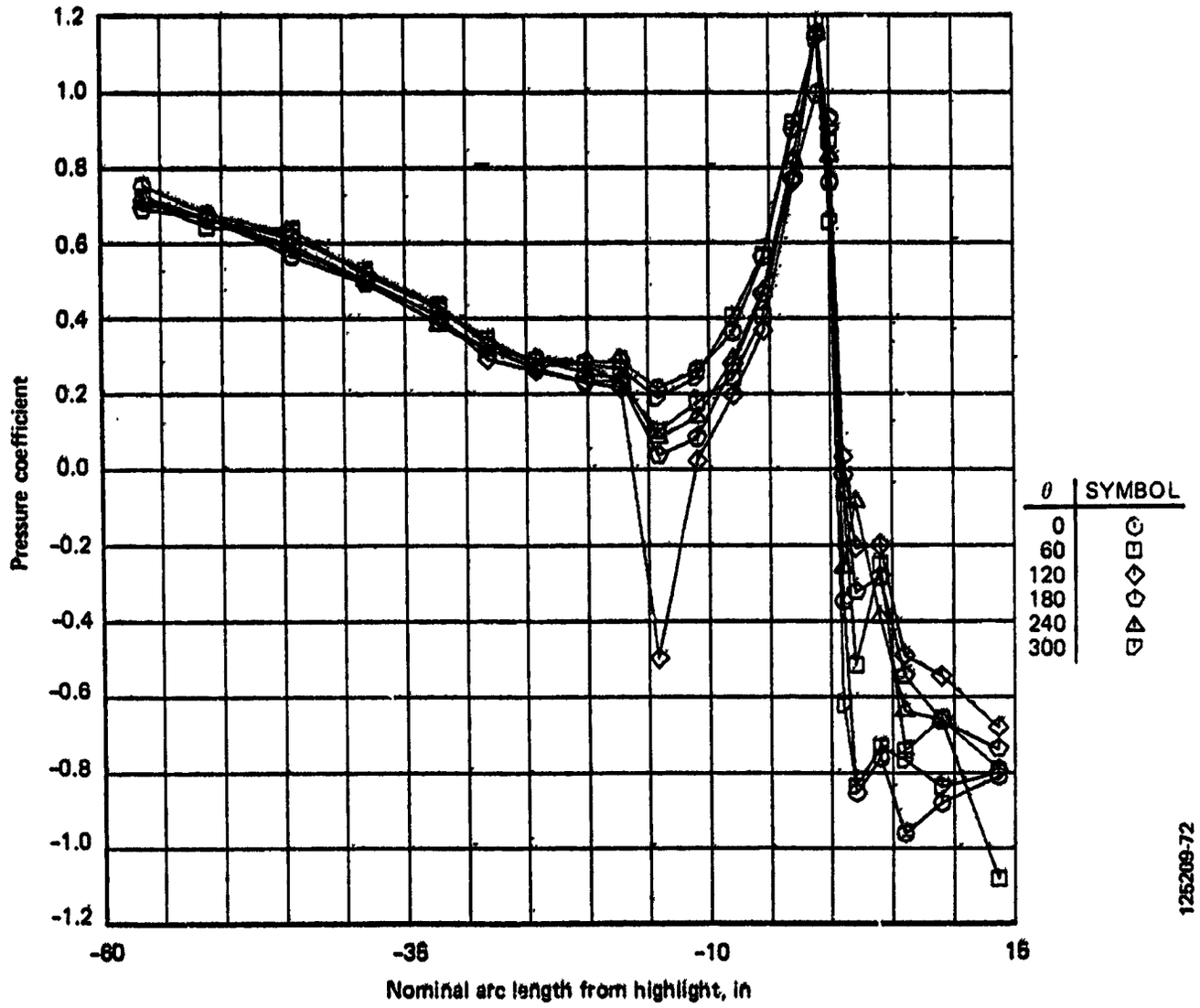


Figure A-14. Engine No. 3 Inlet Pressures, Condition 104, High M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

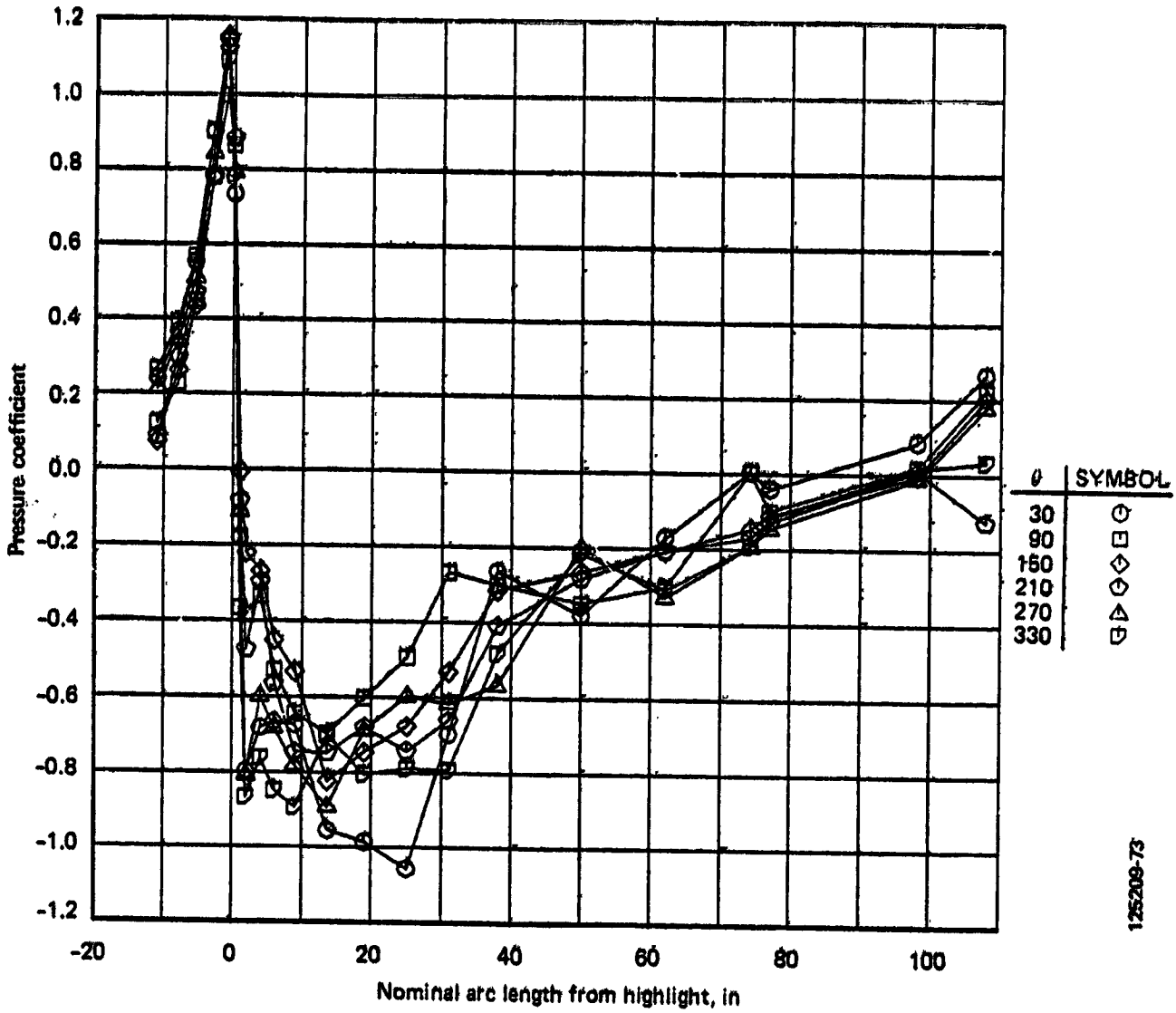


Figure A-15. Engine No. 3 Cowl Pressures, Condition 104, High M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

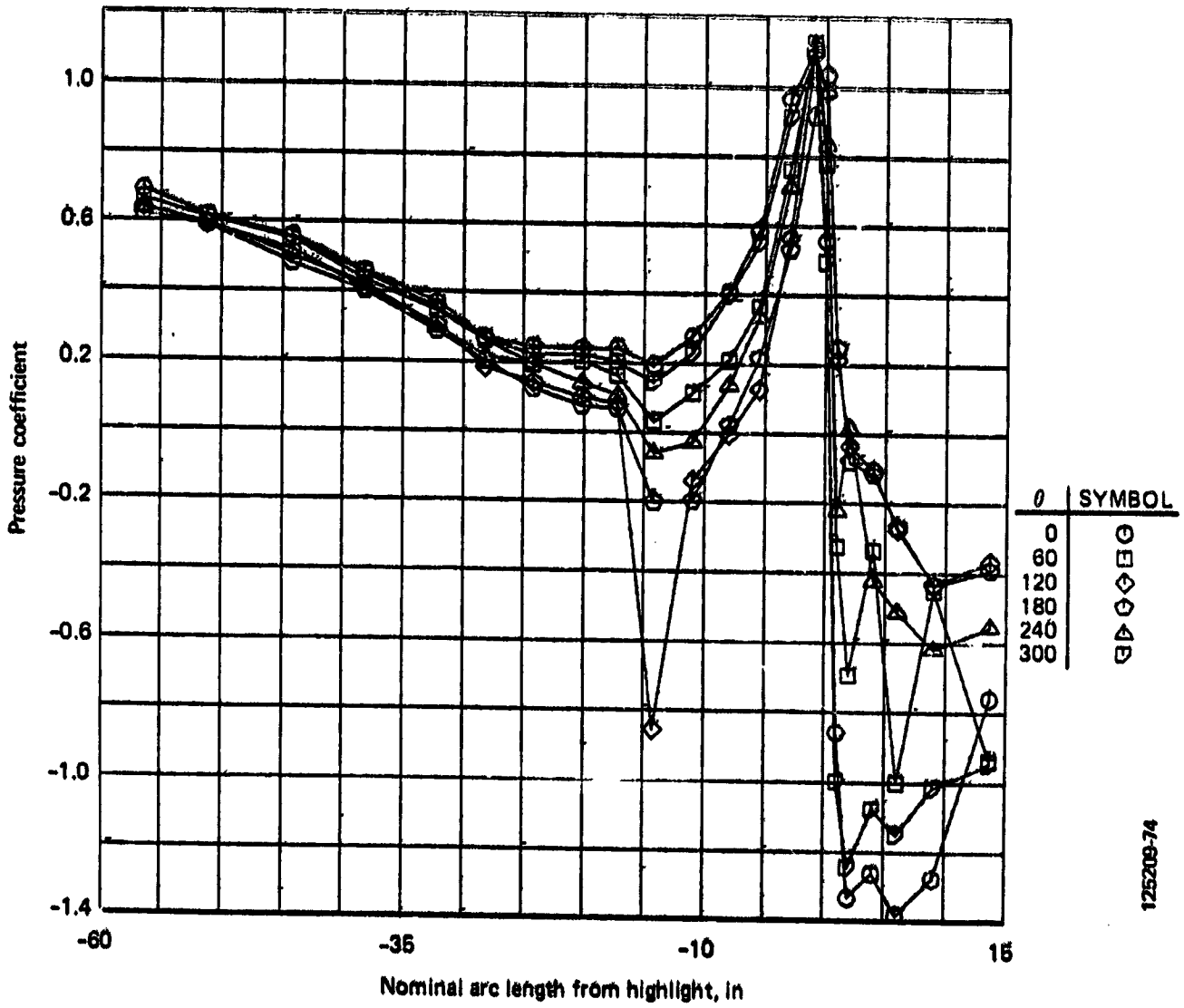


Figure A-16. Engine No. 3 Inlet Pressures, Condition 105, Low M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

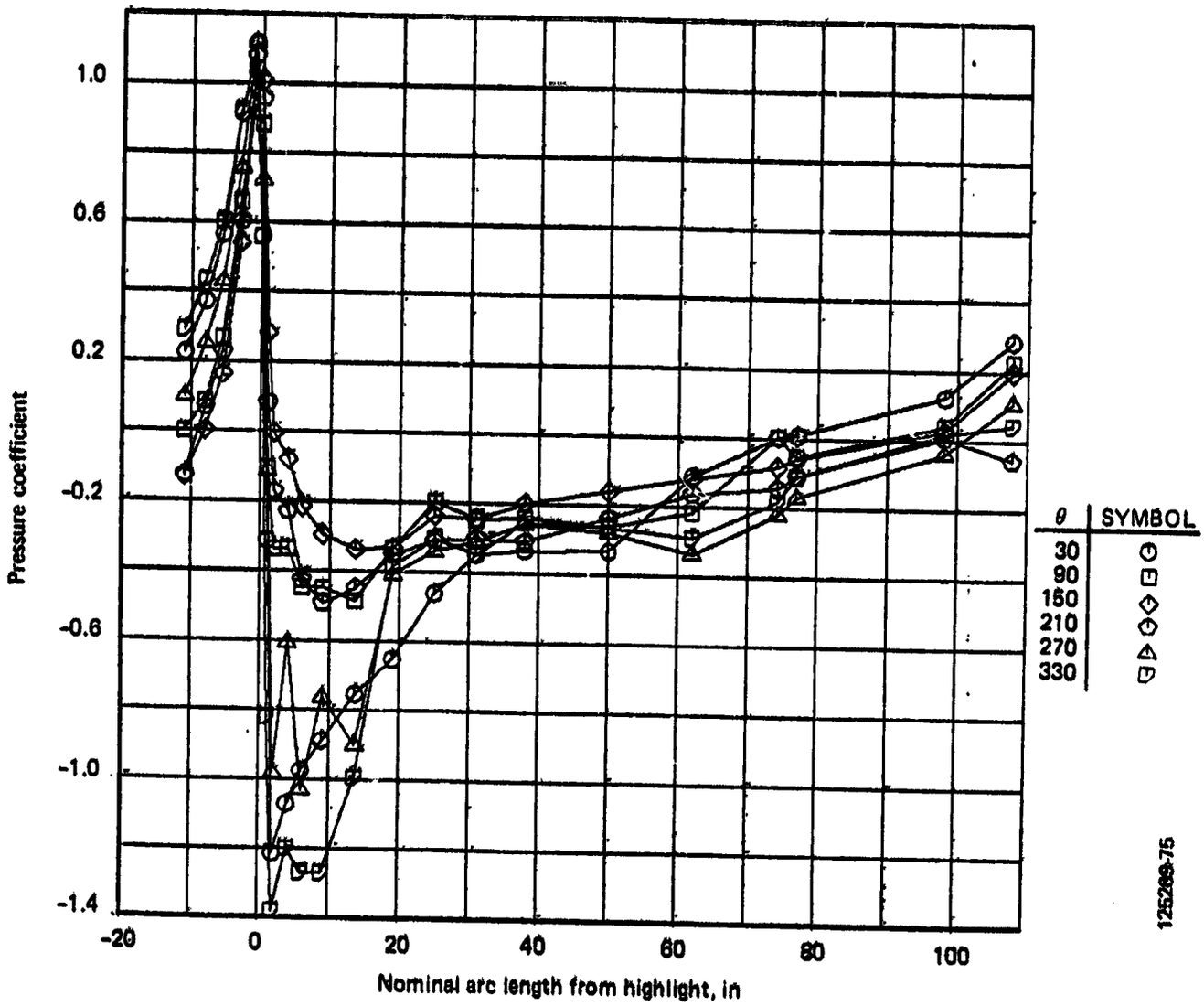


Figure A-17. Engine No. 3 Cowl Pressures, Condition 105, Low M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

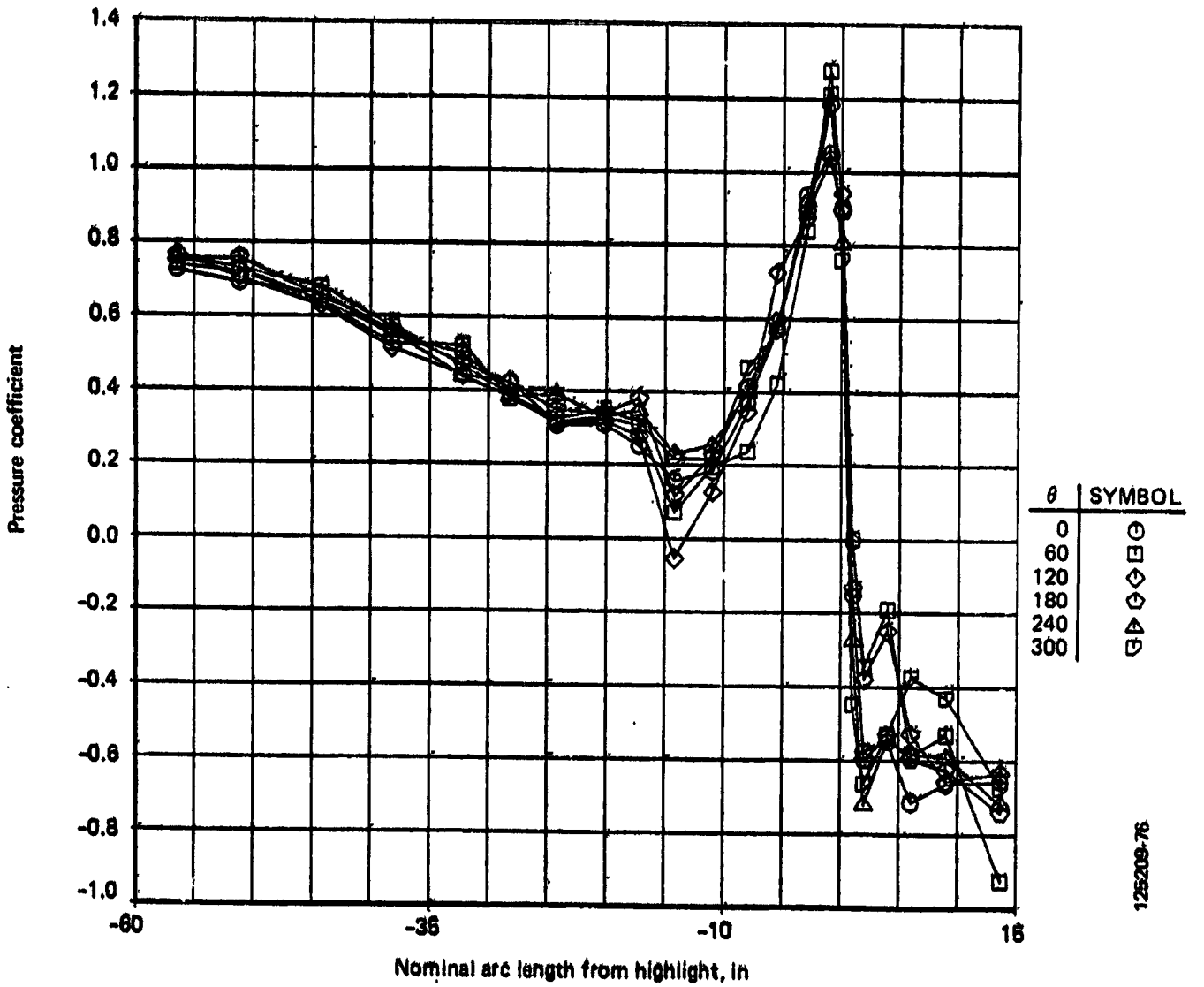


Figure A-18. Engine No. 3 Inlet Pressures, Condition 106, Maximum M

ORIGINAL PAGE IS
OF POOR QUALITY

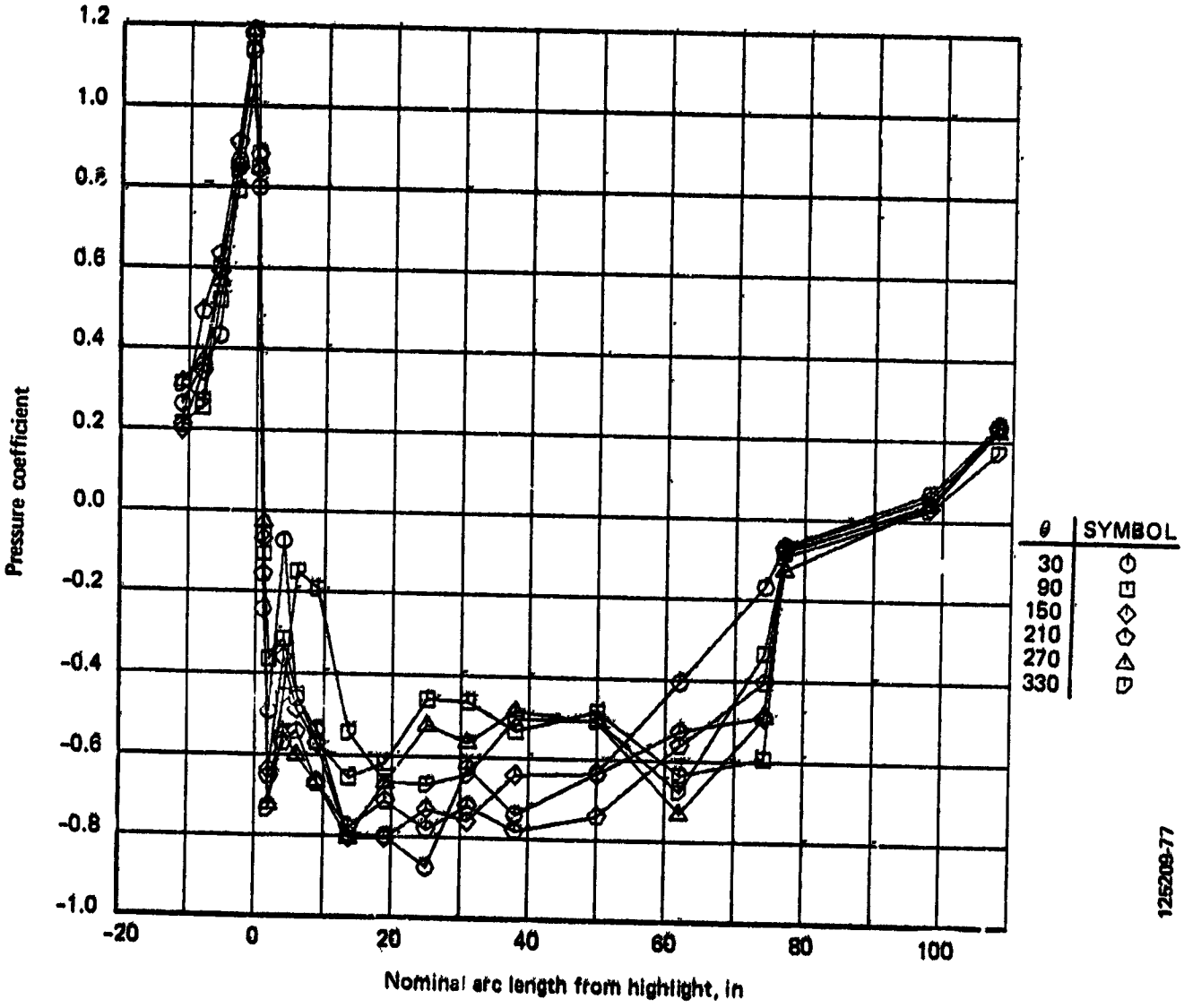


Figure A-19. Engine No. 3 Cowl Pressures, Condition 106, Maximum M

ORIGINAL PAGE IS
OF POOR QUALITY

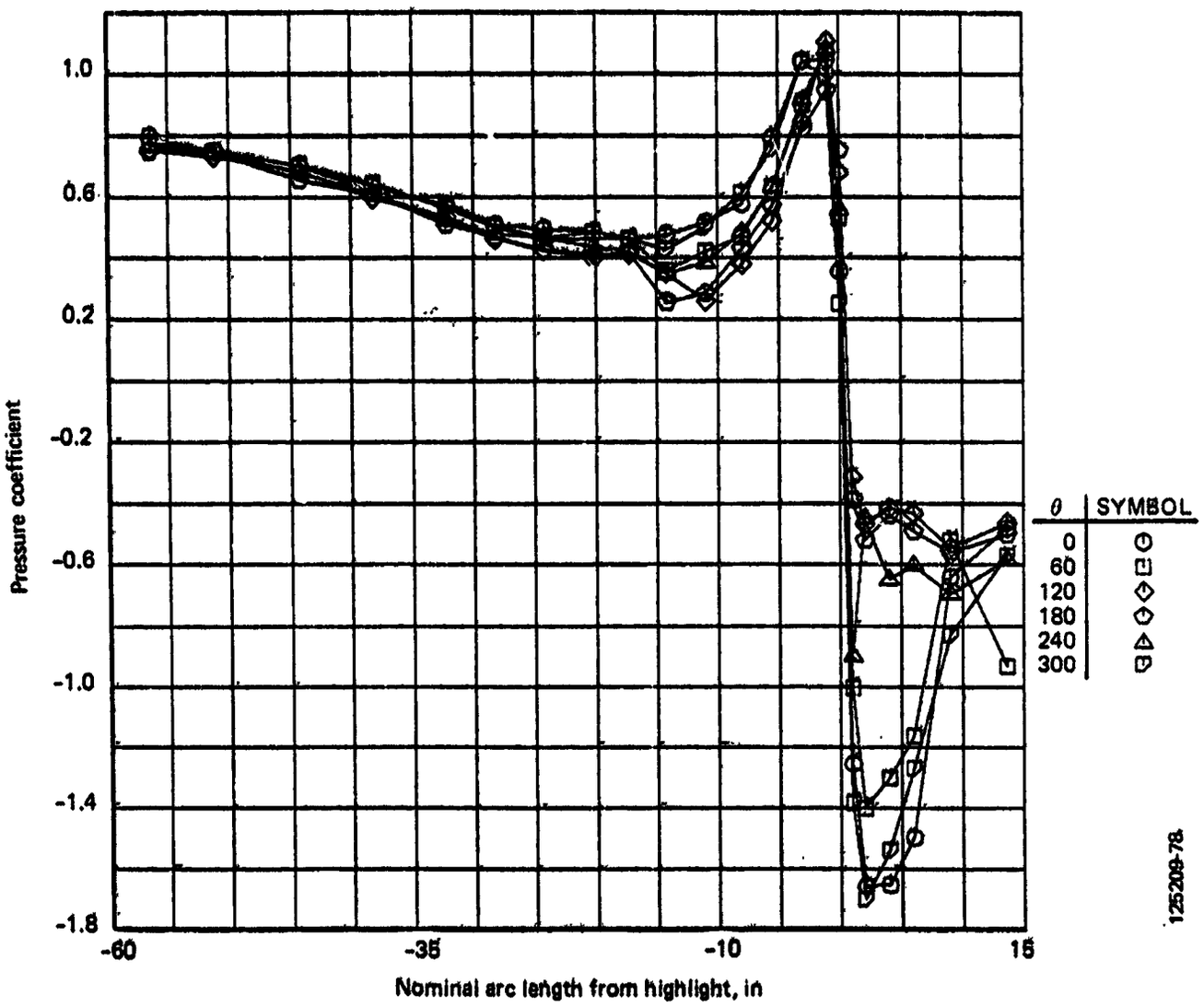


Figure A-20. Engine No. 3 Inlet Pressures, Condition 107, Inflight Relight

ORIGINAL PAGE IS
OF POOR QUALITY

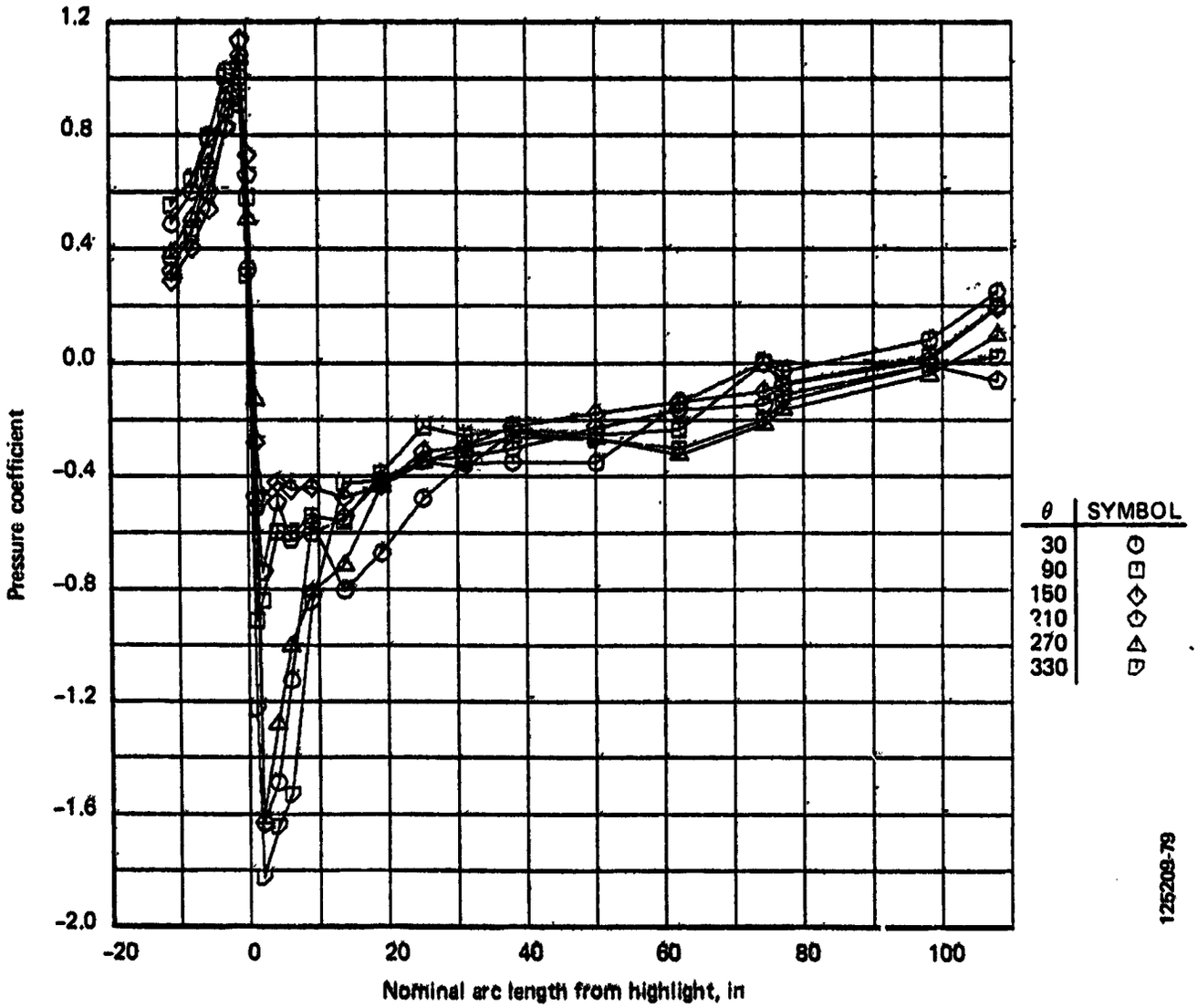


Figure A-21. Engine No. 3 Cowl Pressures, Condition 107, Inflight Relight

ORIGINAL PAGE IS
OF POOR QUALITY

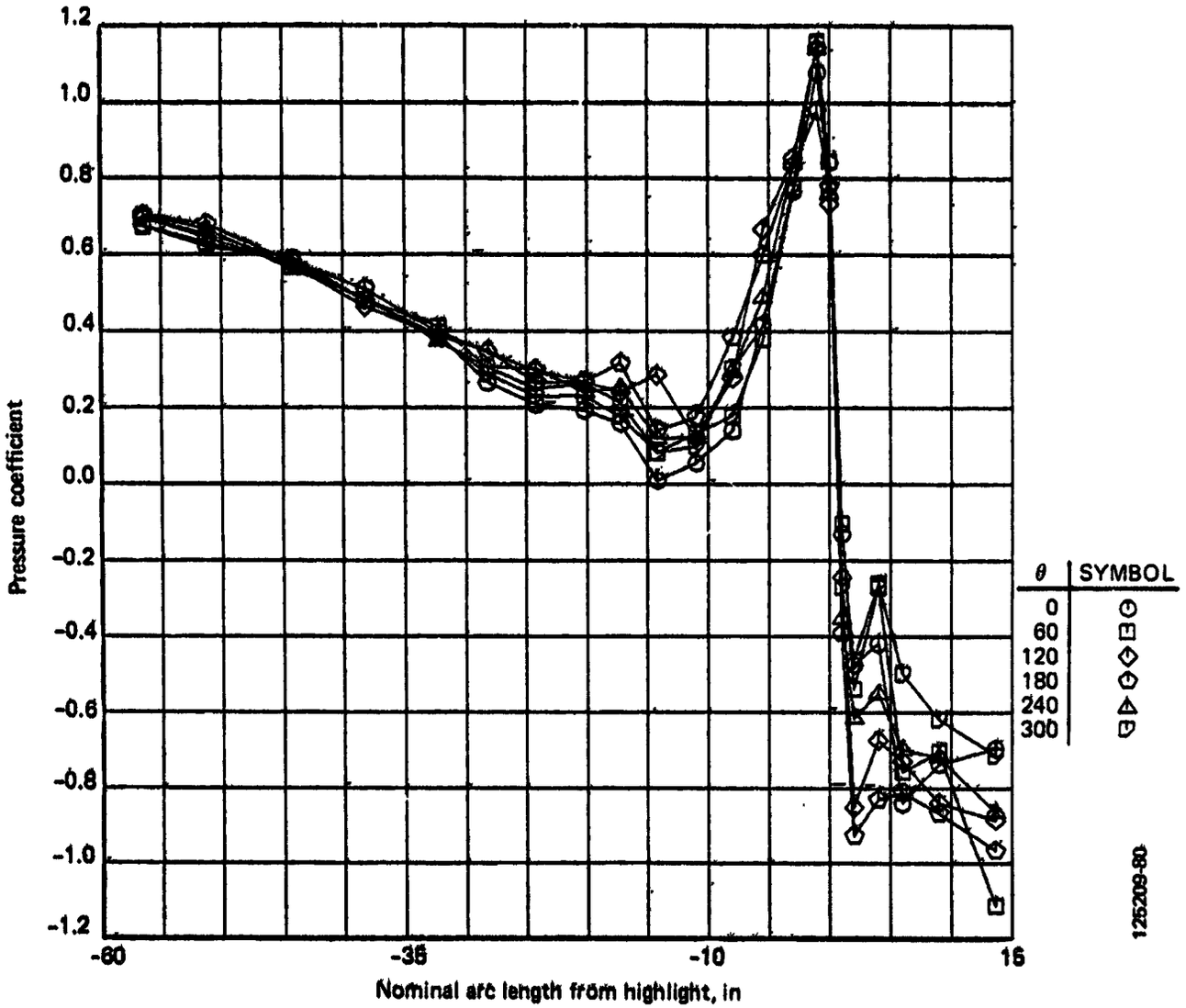


Figure A-22. Engine No. 3 Inlet Pressures, Condition 108, Maximum q

ORIGINAL PAGE IS
OF POOR QUALITY

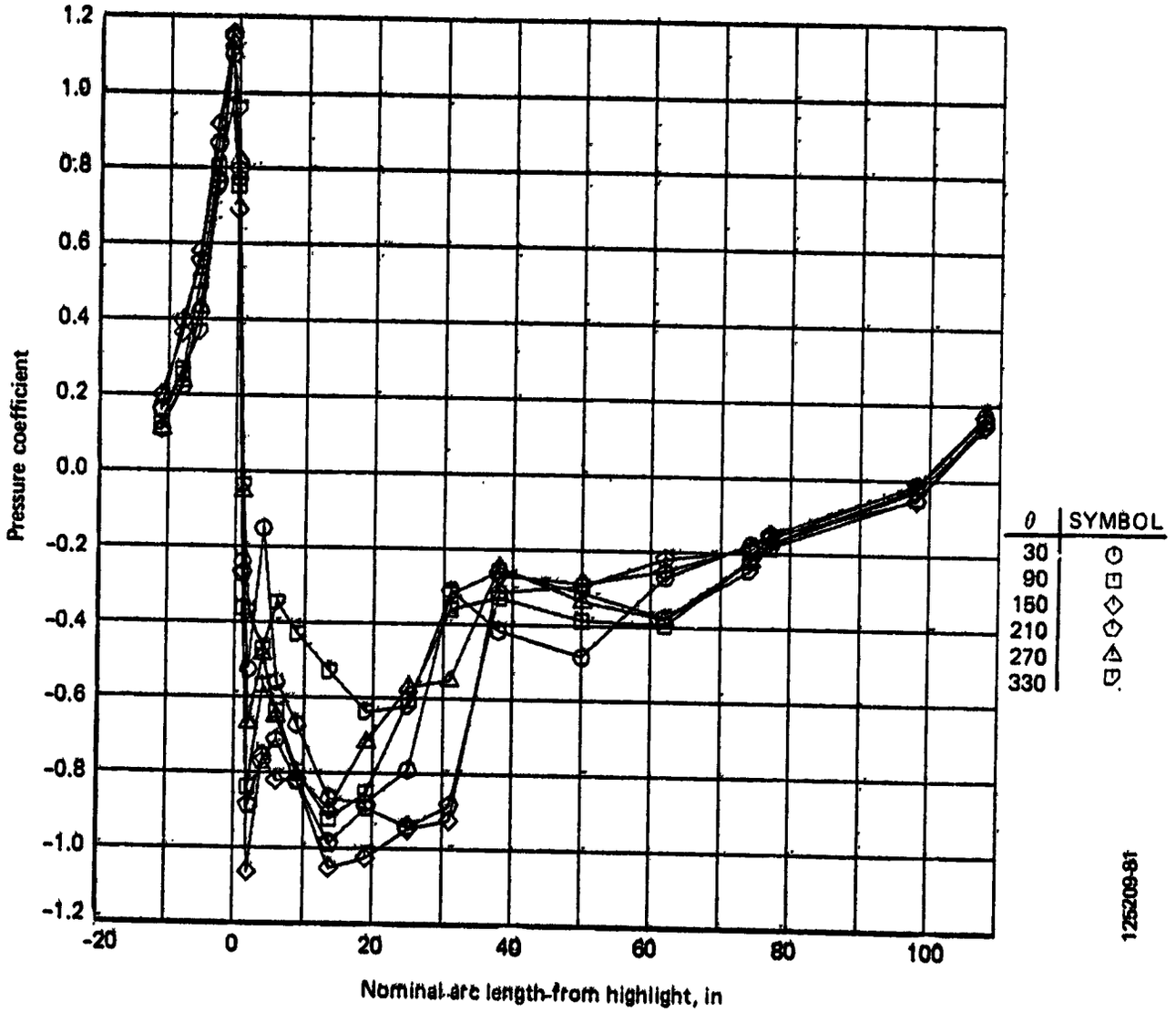


Figure A-23: Engine No. 3 Cowl Pressures, Condition 108, Maximum q

ORIGINAL PAGE IS
OF POOR QUALITY

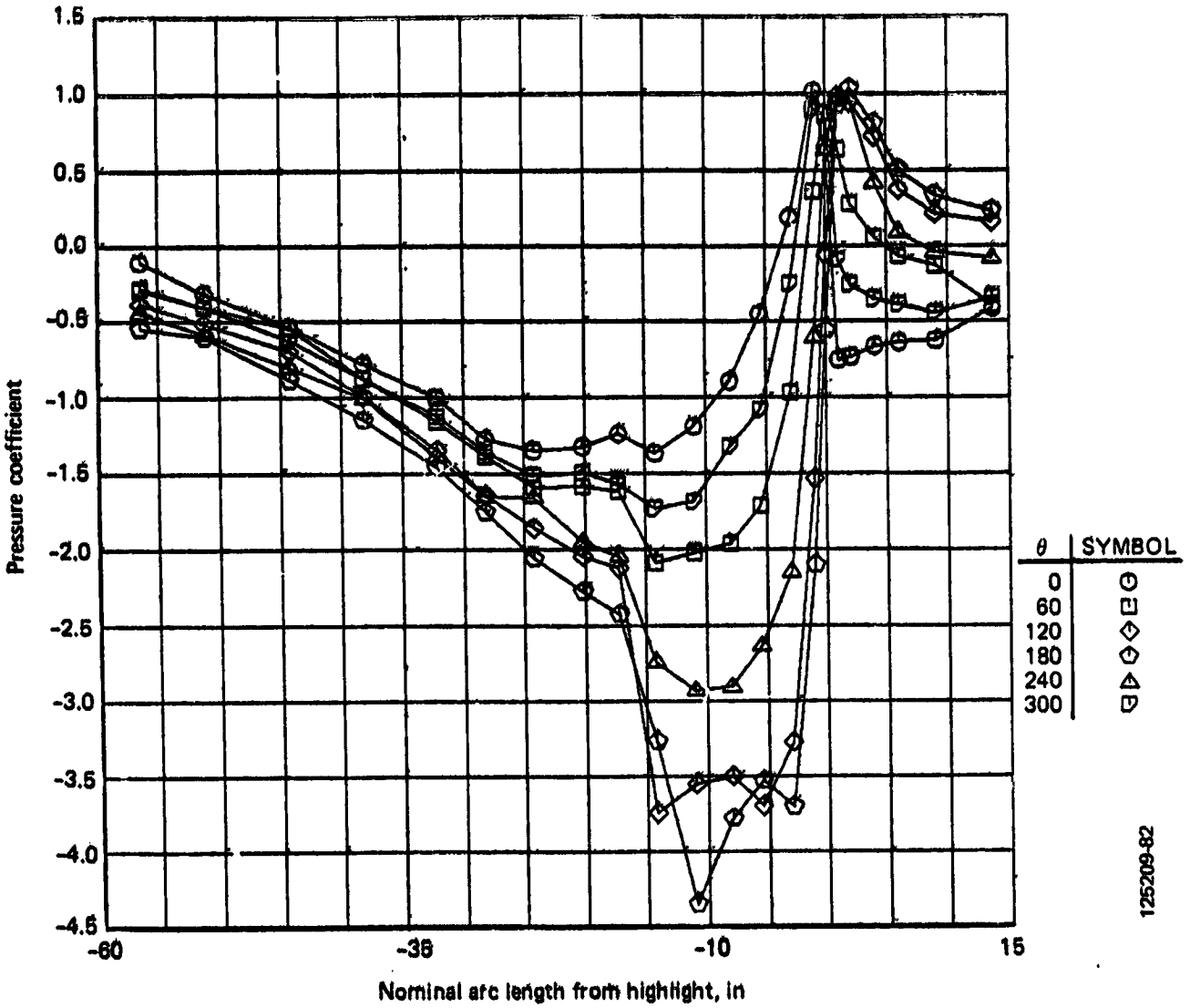


Figure A-24. Engine No. 3 Inlet Pressures, Condition 109, Stall Warning (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

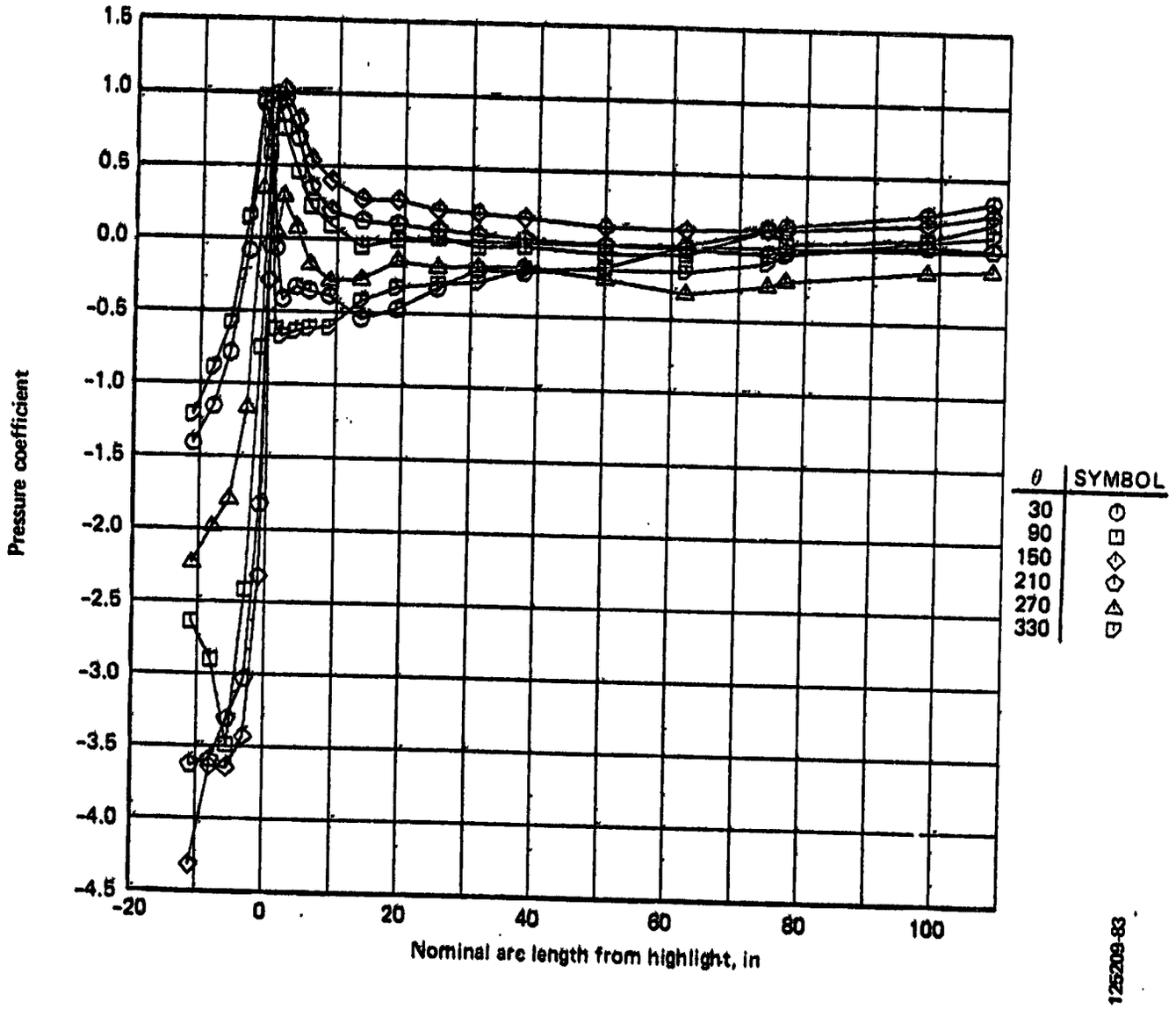


Figure A-25. Engine No. 3 Cowl Pressures, Condition 109, Stall Warning (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

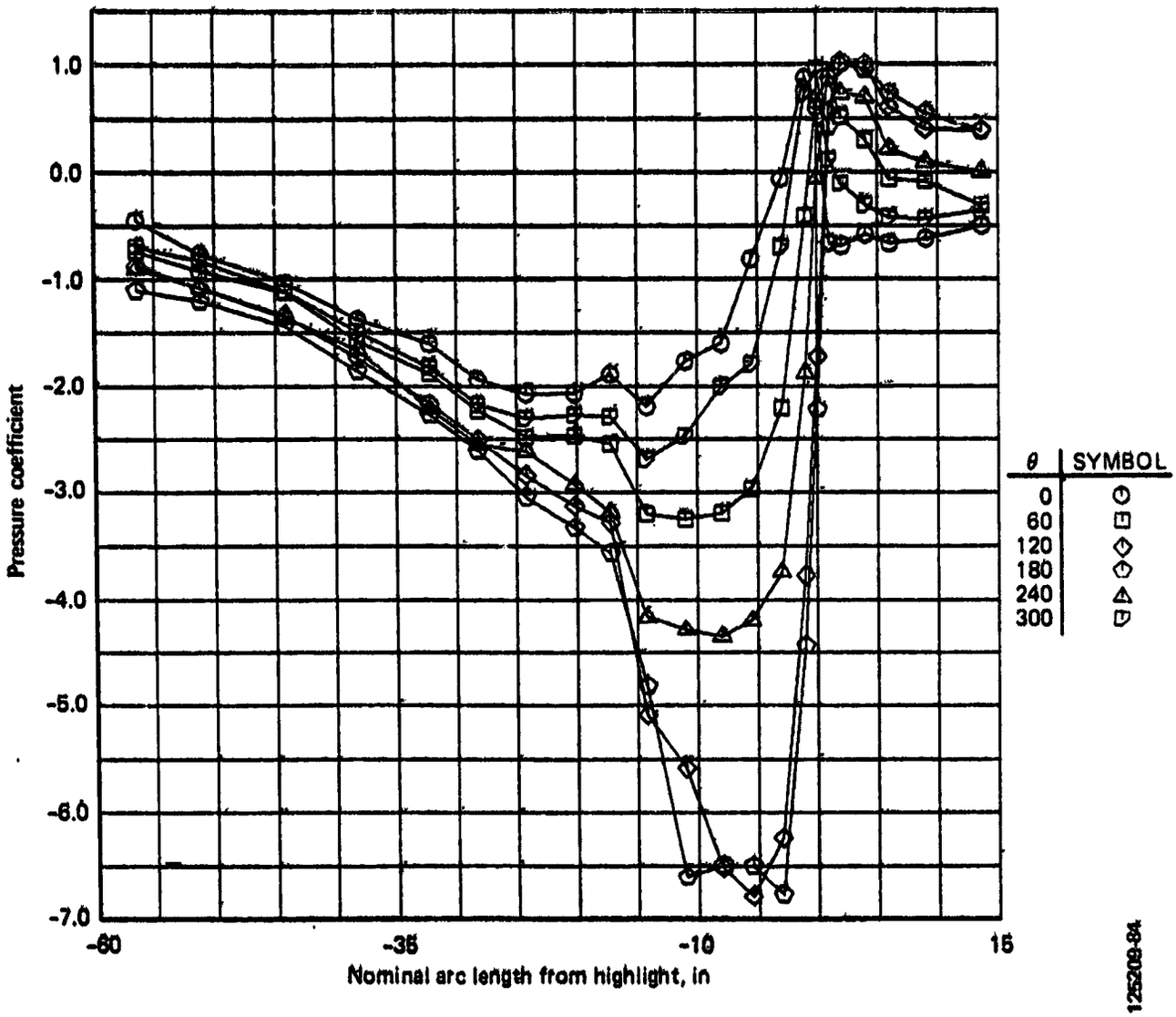


Figure A-26. Engine No. 3 Inlet Pressures, Condition 110, Stall Warning (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

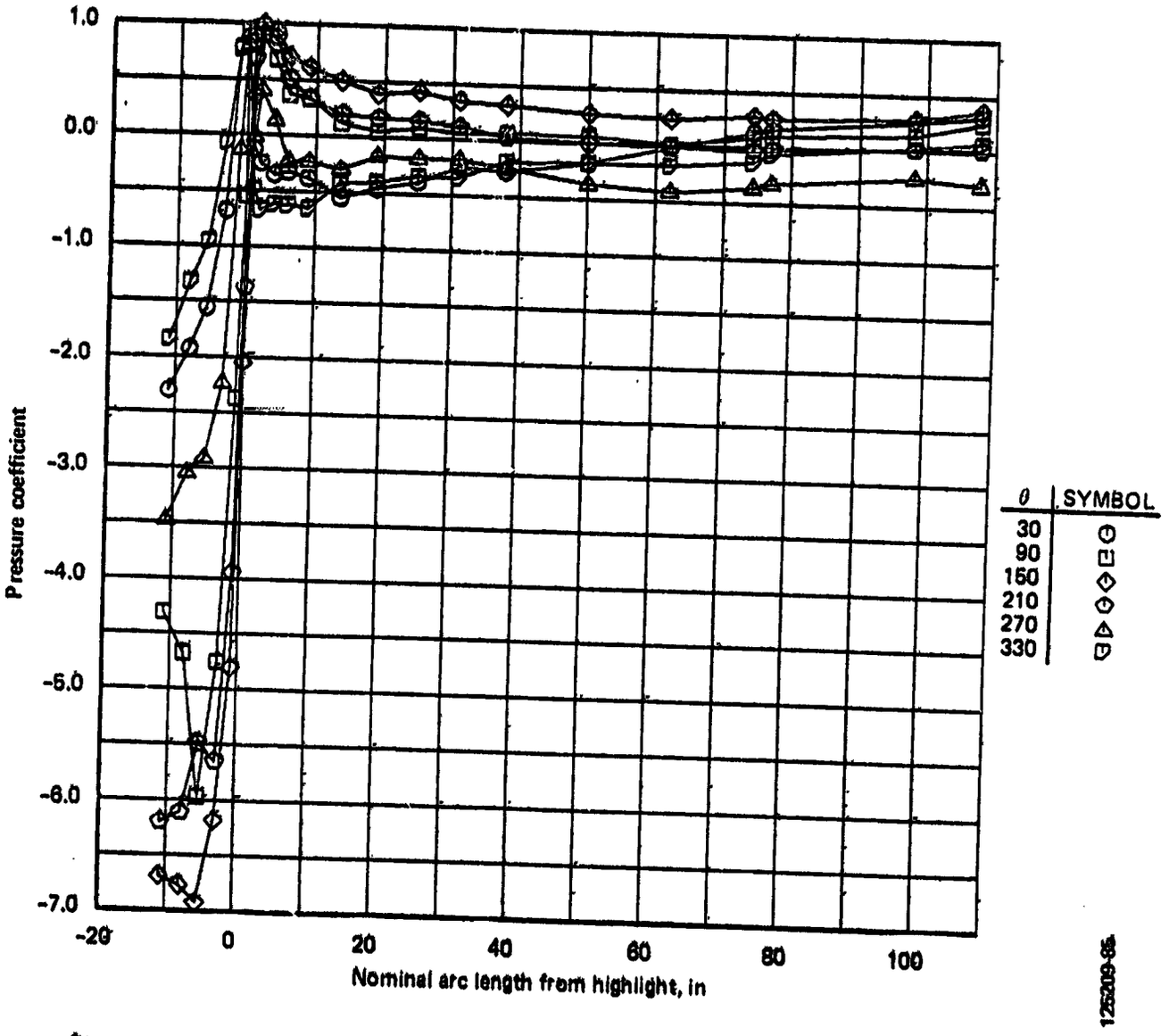


Figure A-27. Engine No. 3 Cowl Pressures, Condition 110, Stall Warning (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

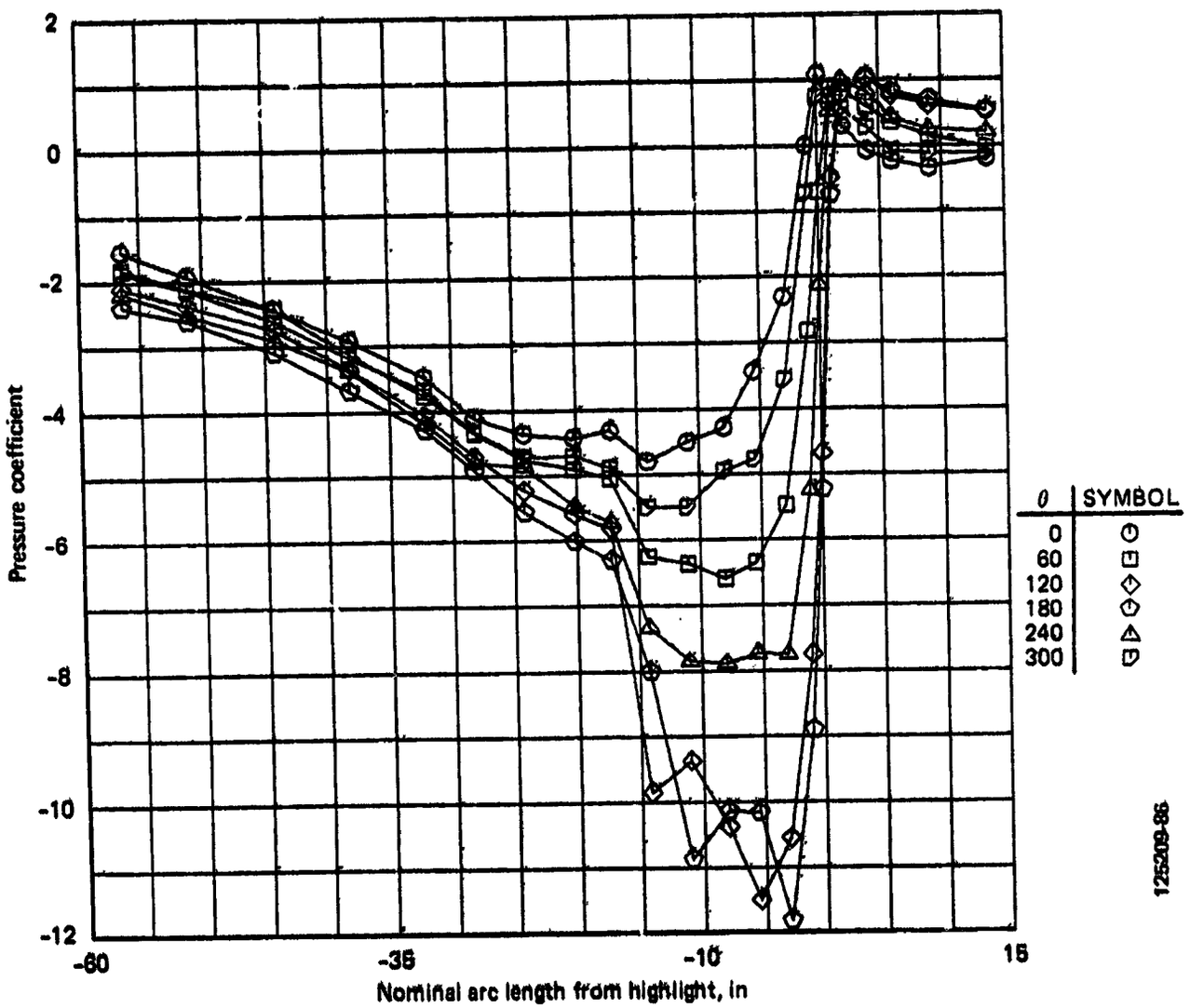


Figure A-28. Engine No. 3 Inlet Pressures, Condition 111, Stall Warning (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

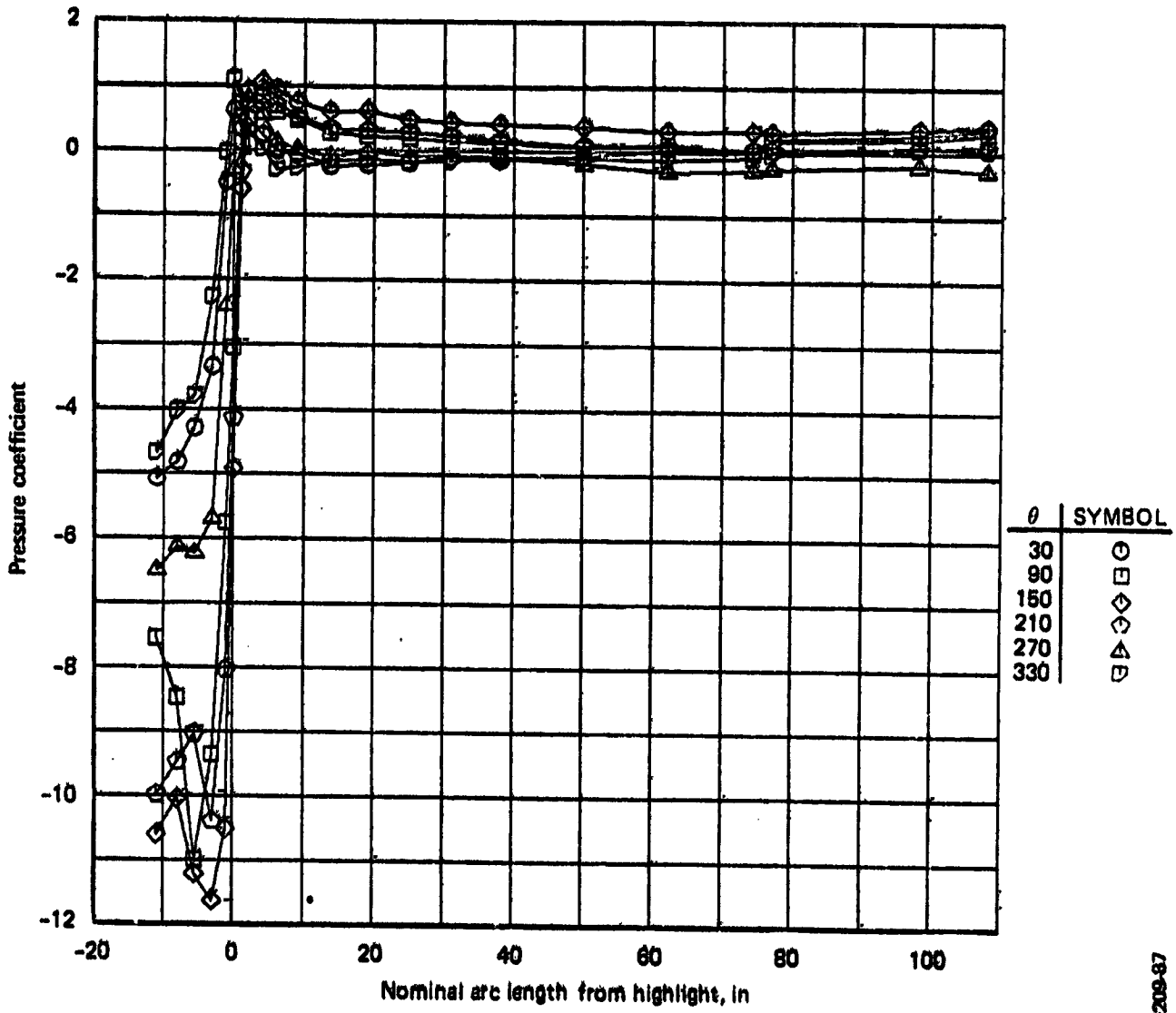


Figure A-29. Engine No. 3 Cowl Pressures, Condition 111, Stall Warning (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

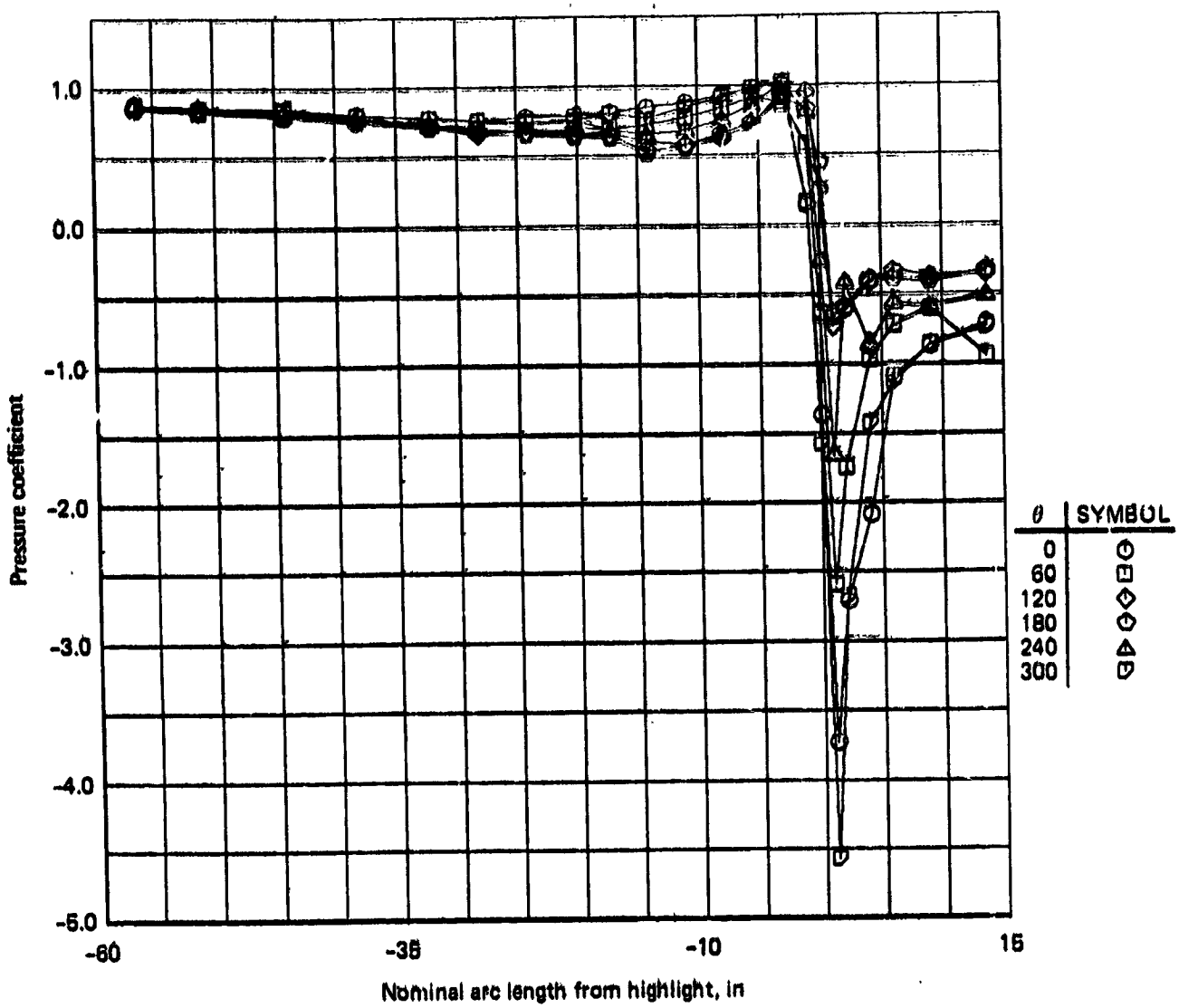


Figure A-30. Engine No. 3 Inlet Pressures, Condition 112, Idle Descent

ORIGINAL PAGE IS
OF POOR QUALITY

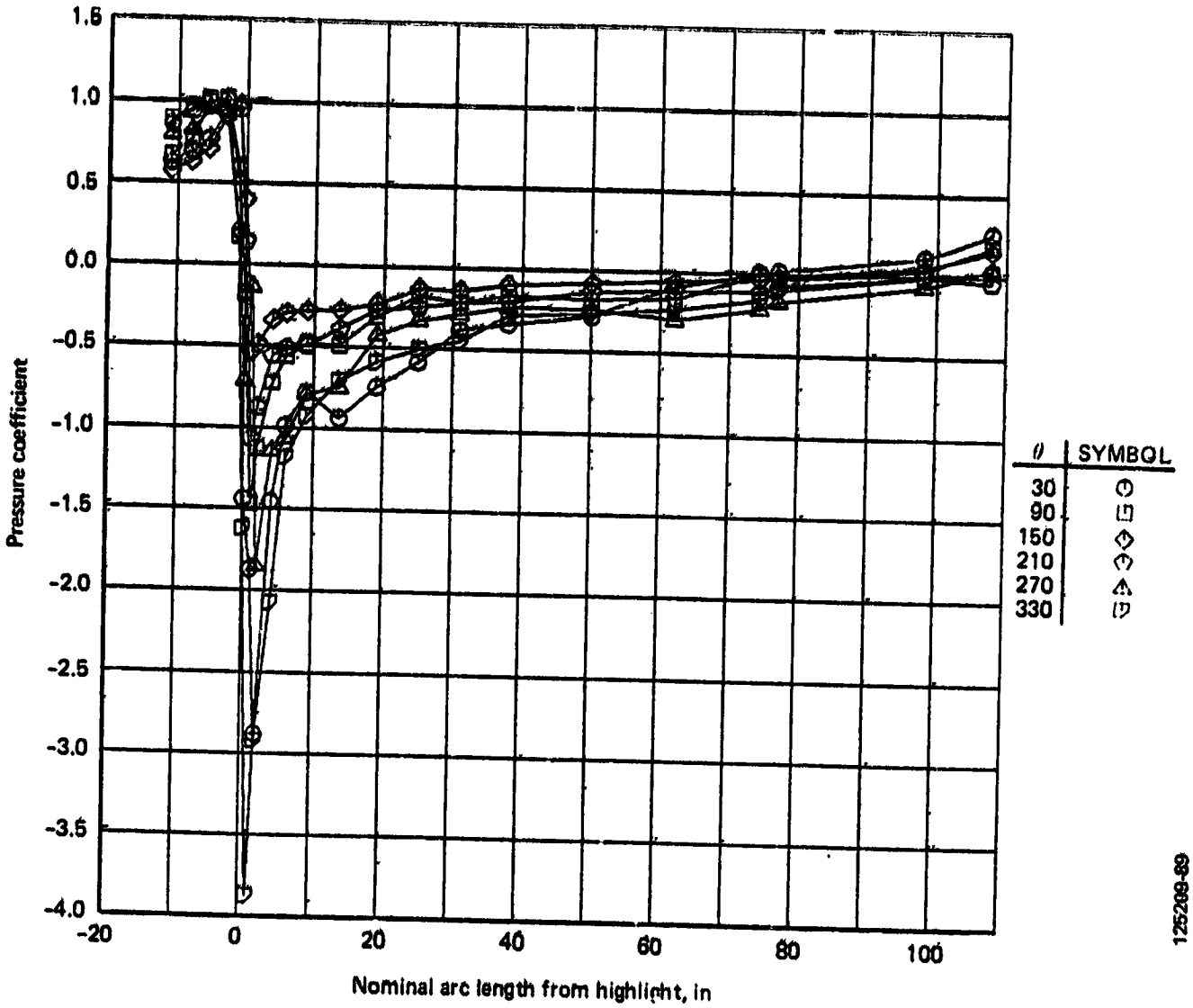


Figure A-31. Engine No. 3 Cowl Pressures, Condition 112, Idle Descent

ORIGINAL PAGE IS
OF POOR QUALITY

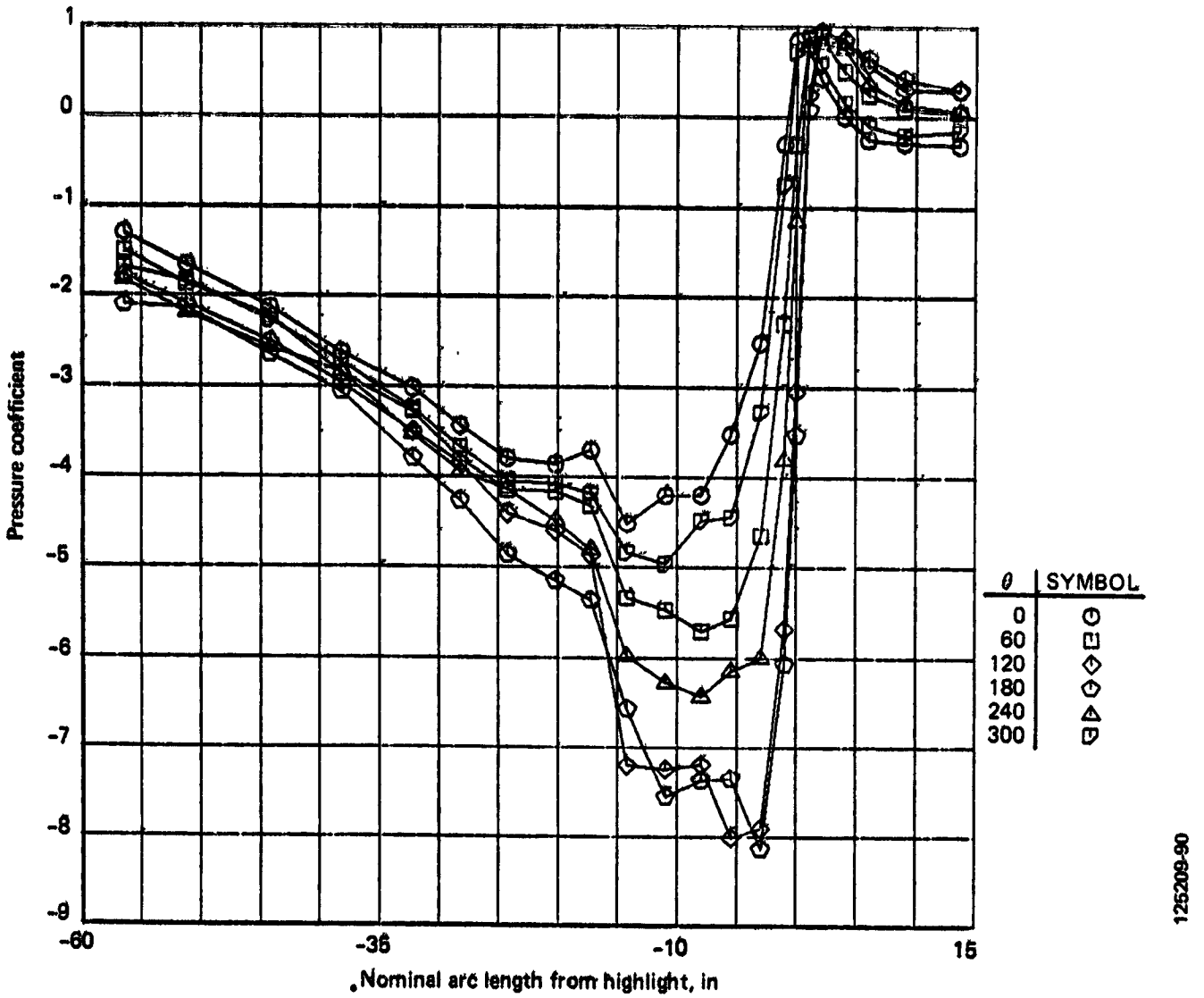


Figure A-32. Engine No. 3 Inlet Pressures, Condition 113, Approach

ORIGINAL PAGE IS
OF POOR QUALITY

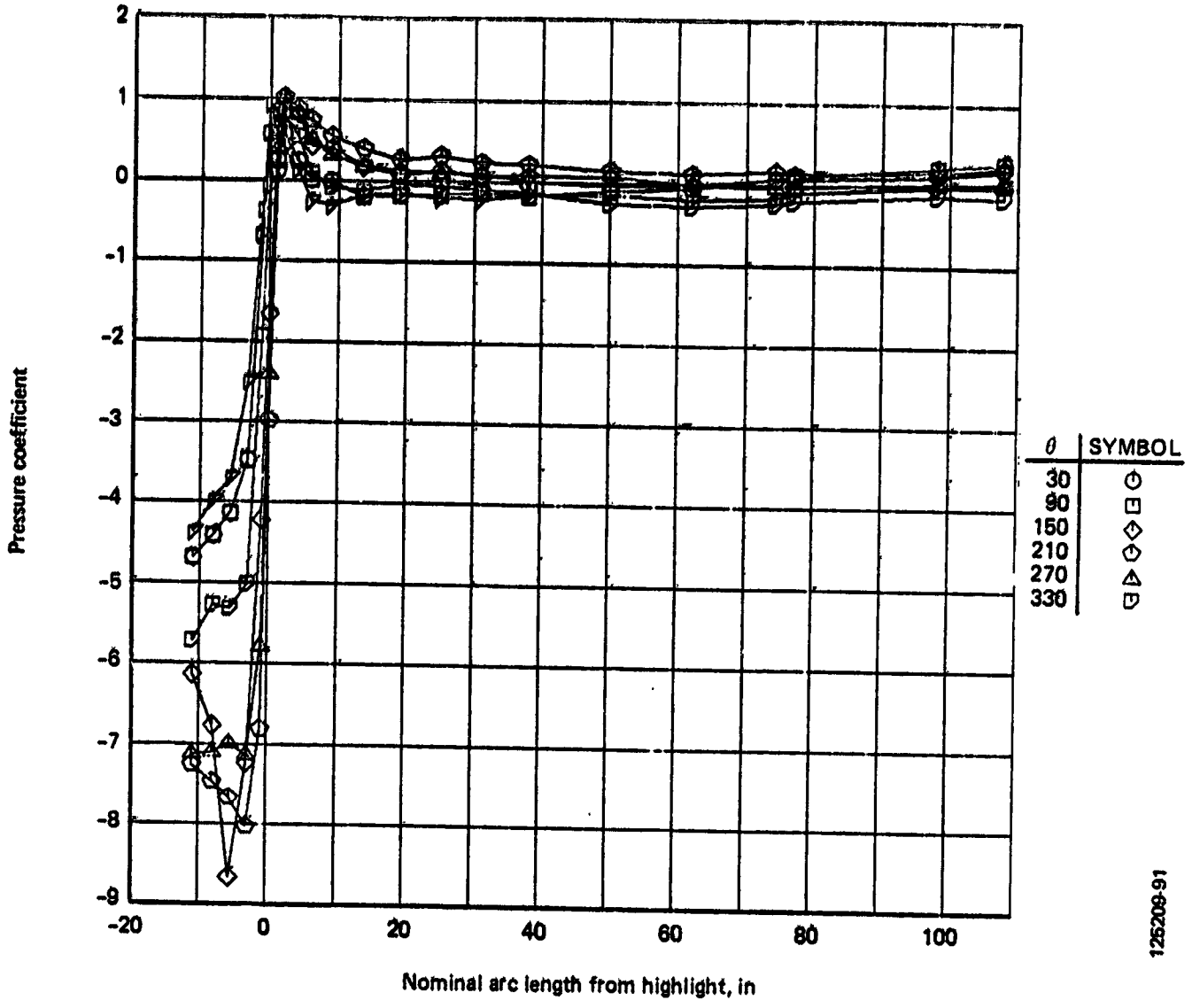


Figure A-33. Engine No. 3 Cowl Pressures, Condition 113, Approach

ORIGINAL PAGE IS
OF POOR QUALITY

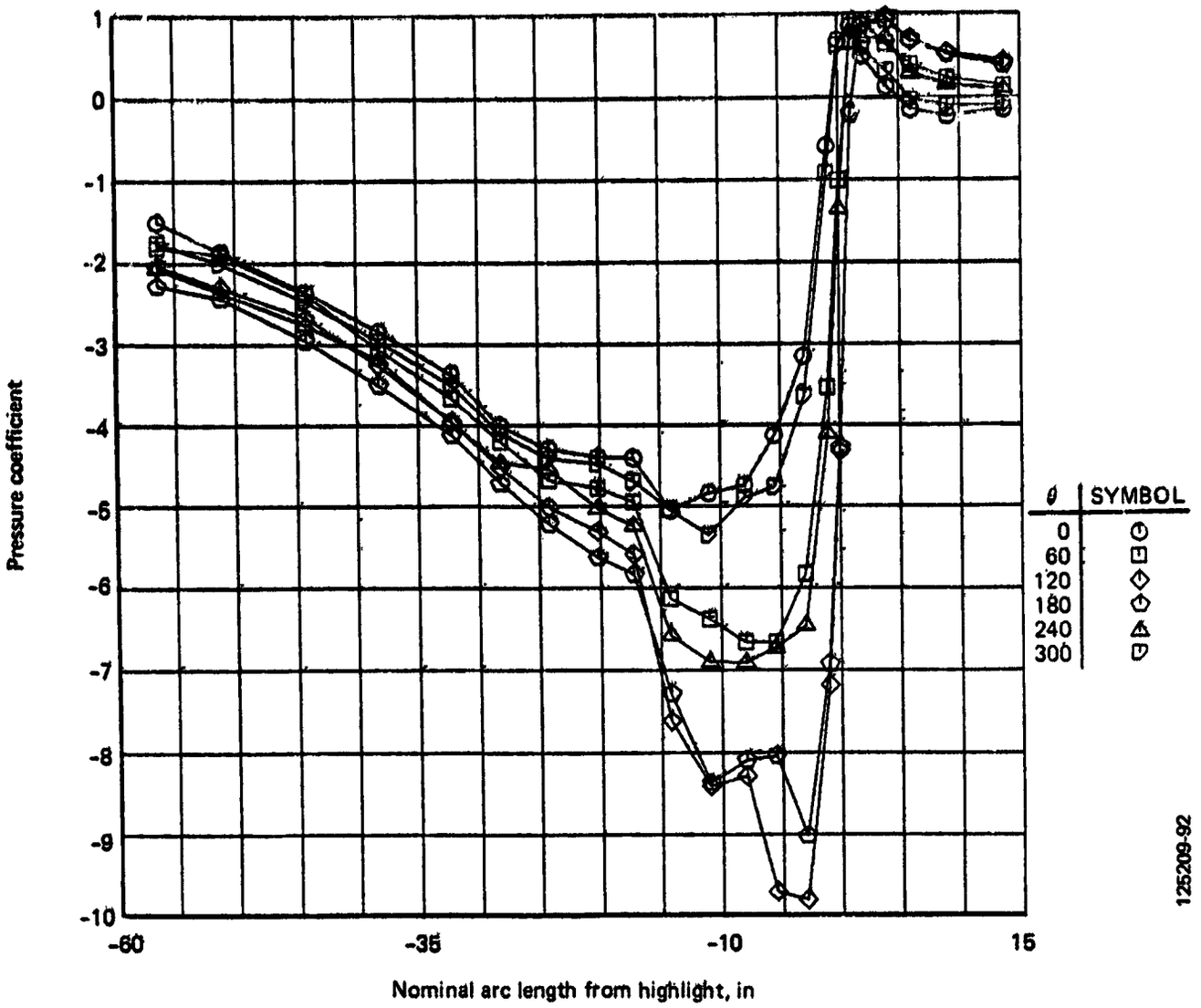


Figure A-34. Engine No. 3 Inlet Pressures, Condition 114, Touch and Go

ORIGINAL PAGE IS
OF POOR QUALITY

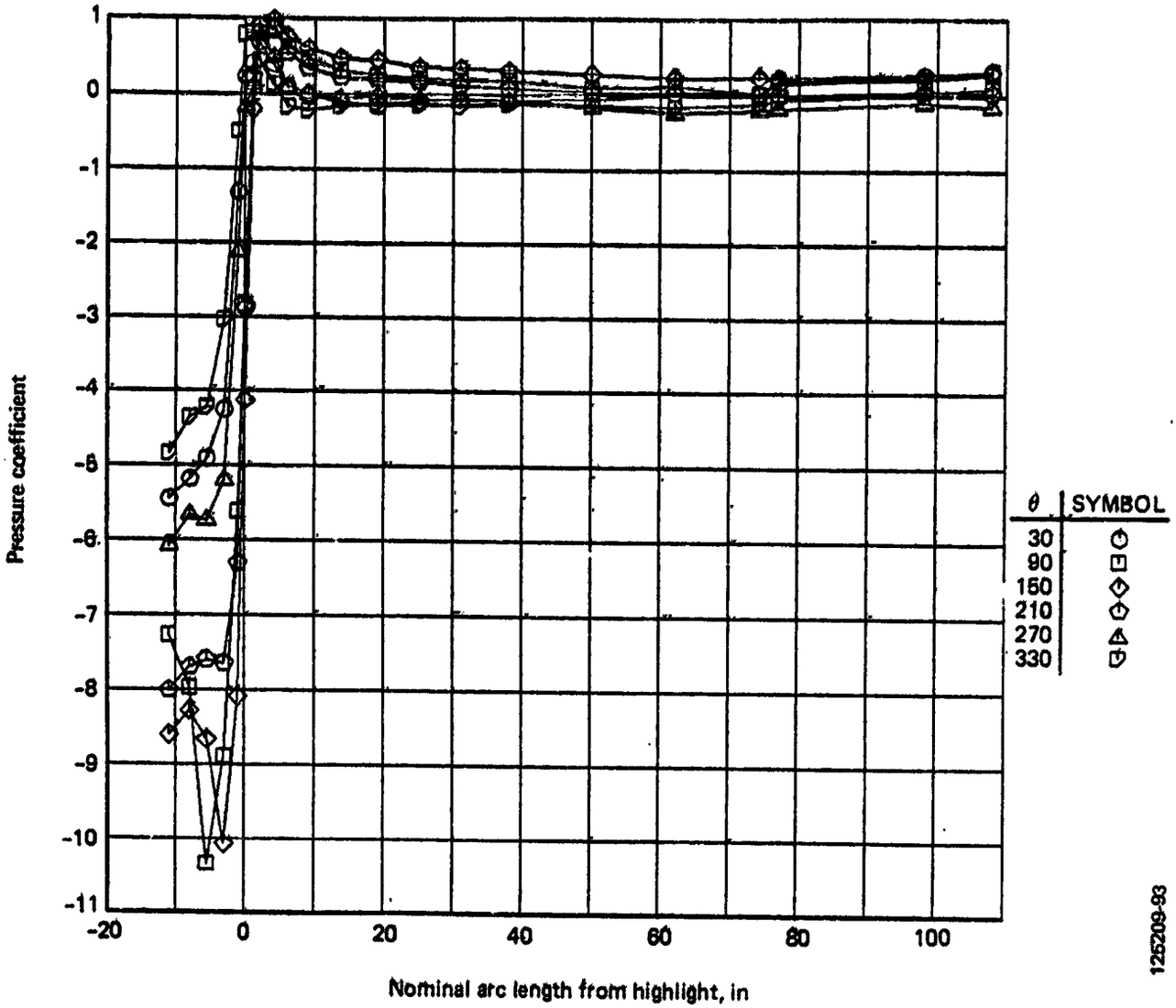


Figure A-35. Engine No. 3 Cowl Pressures, Condition 114, Touch and Go

ORIGINAL PAGE IS
OF POOR QUALITY

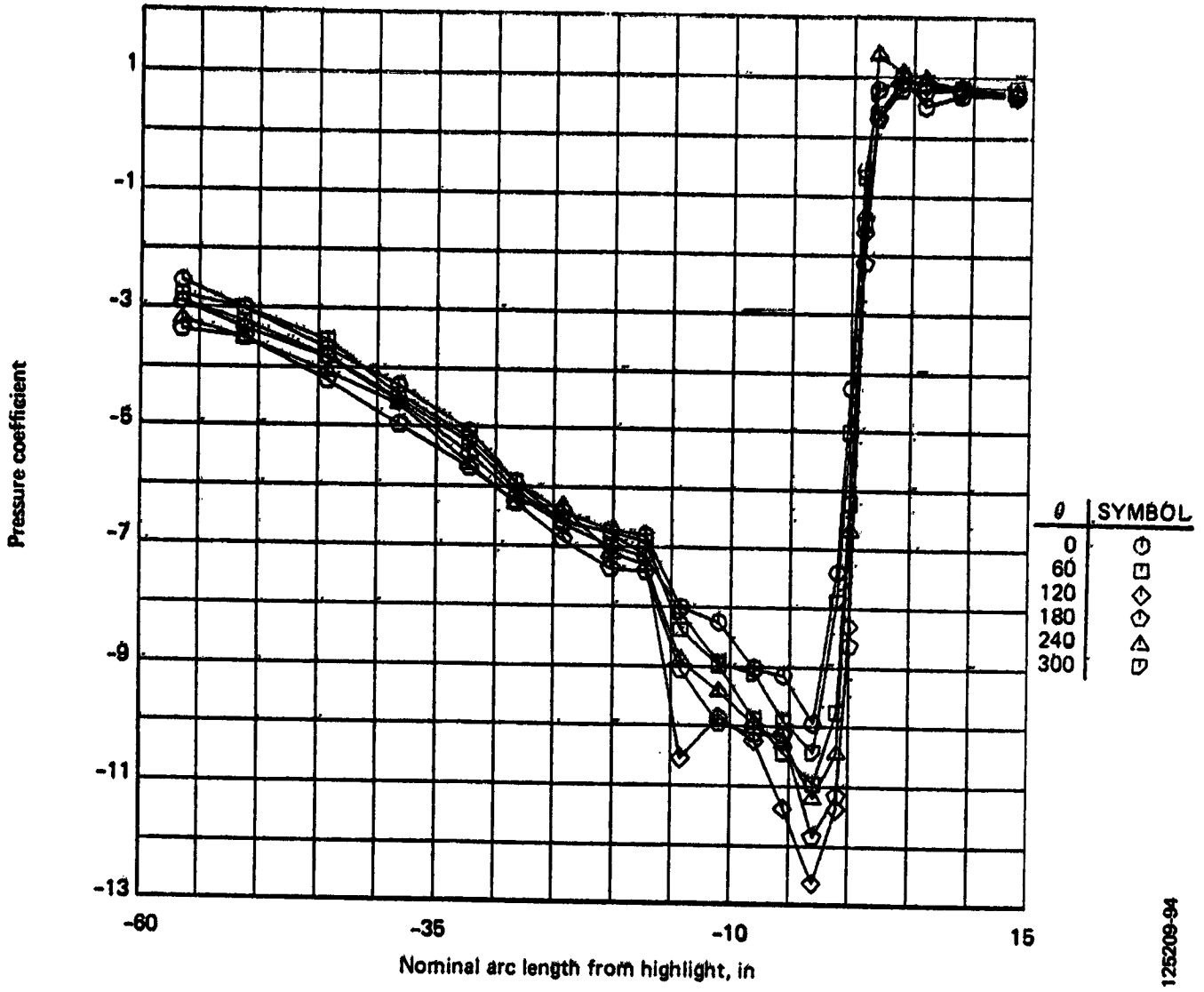


Figure A-36. Engine No. 3 Inlet Pressures, Condition 115, Thrust Reverse

ORIGINAL PAGE IS
OF POOR QUALITY

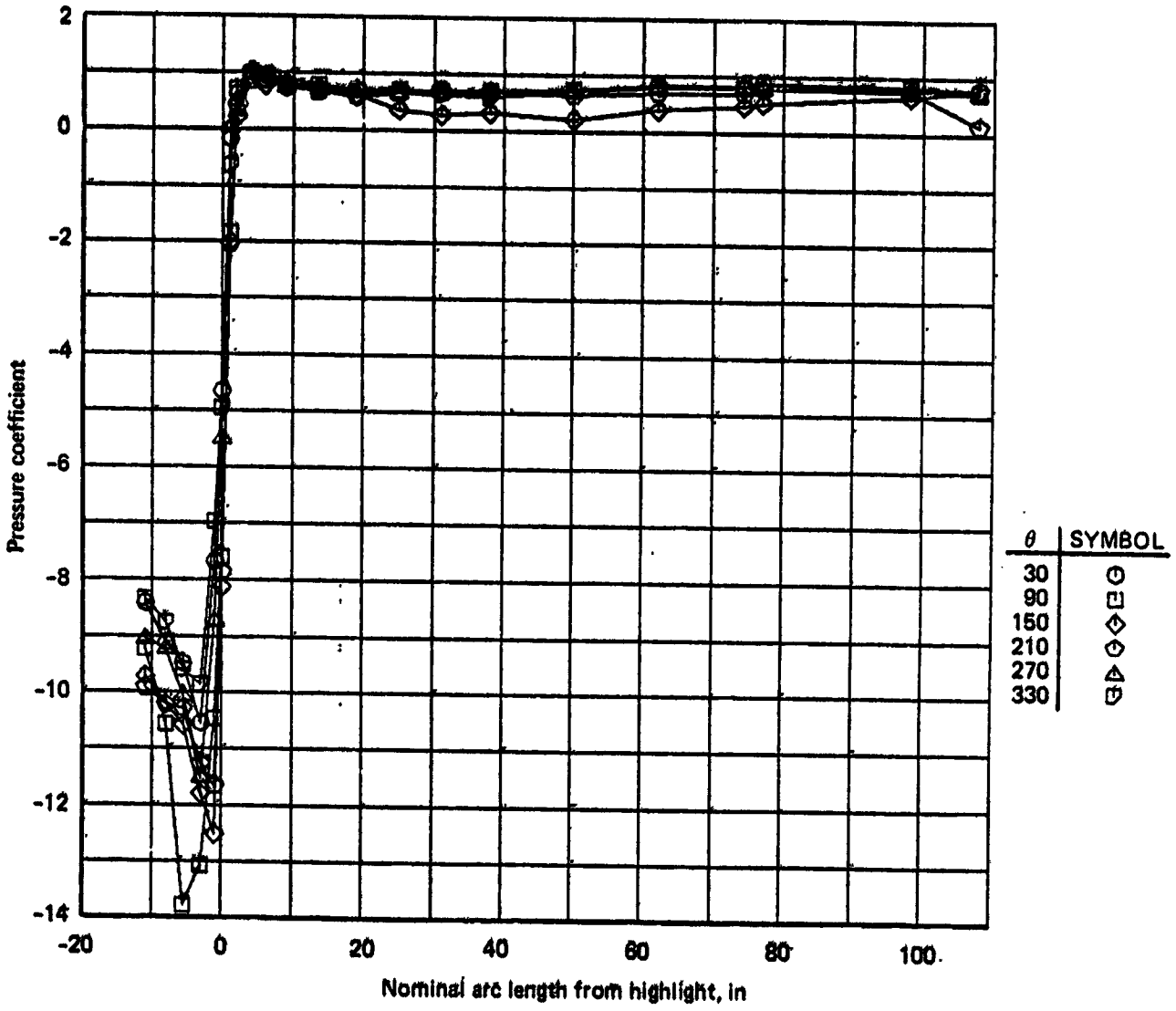


Figure A-37. Engine No. 3 Cowl Pressures, Condition 115, Thrust Reverse

125209-95

ORIGINAL PAGE IS
OF POOR QUALITY

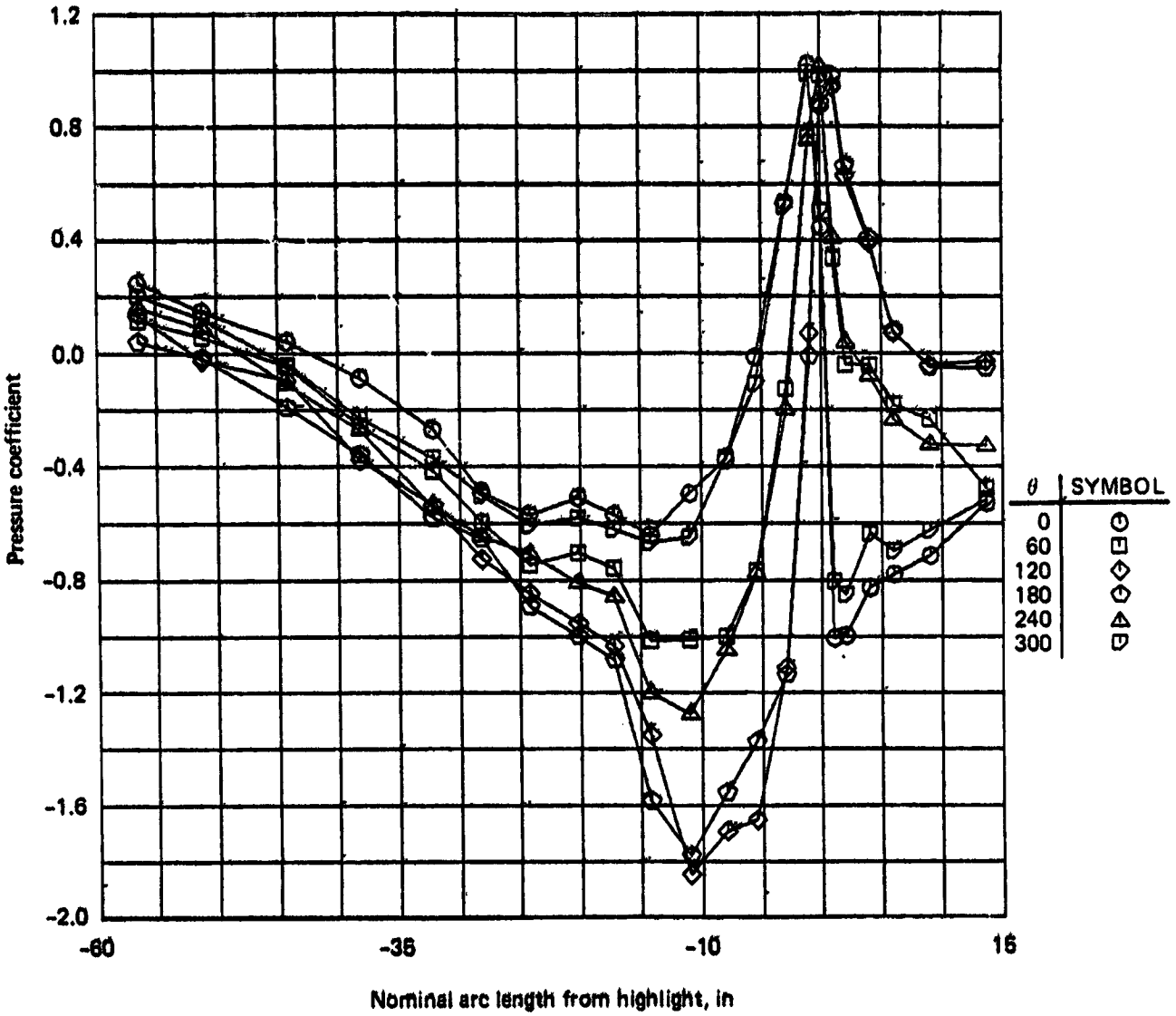


Figure A-38. Engine No. 3 Inlet Pressures, Condition 116, 2.0g Left Turn (Flaps Up)

125209-96

ORIGINAL PAGE IS
OF POOR QUALITY

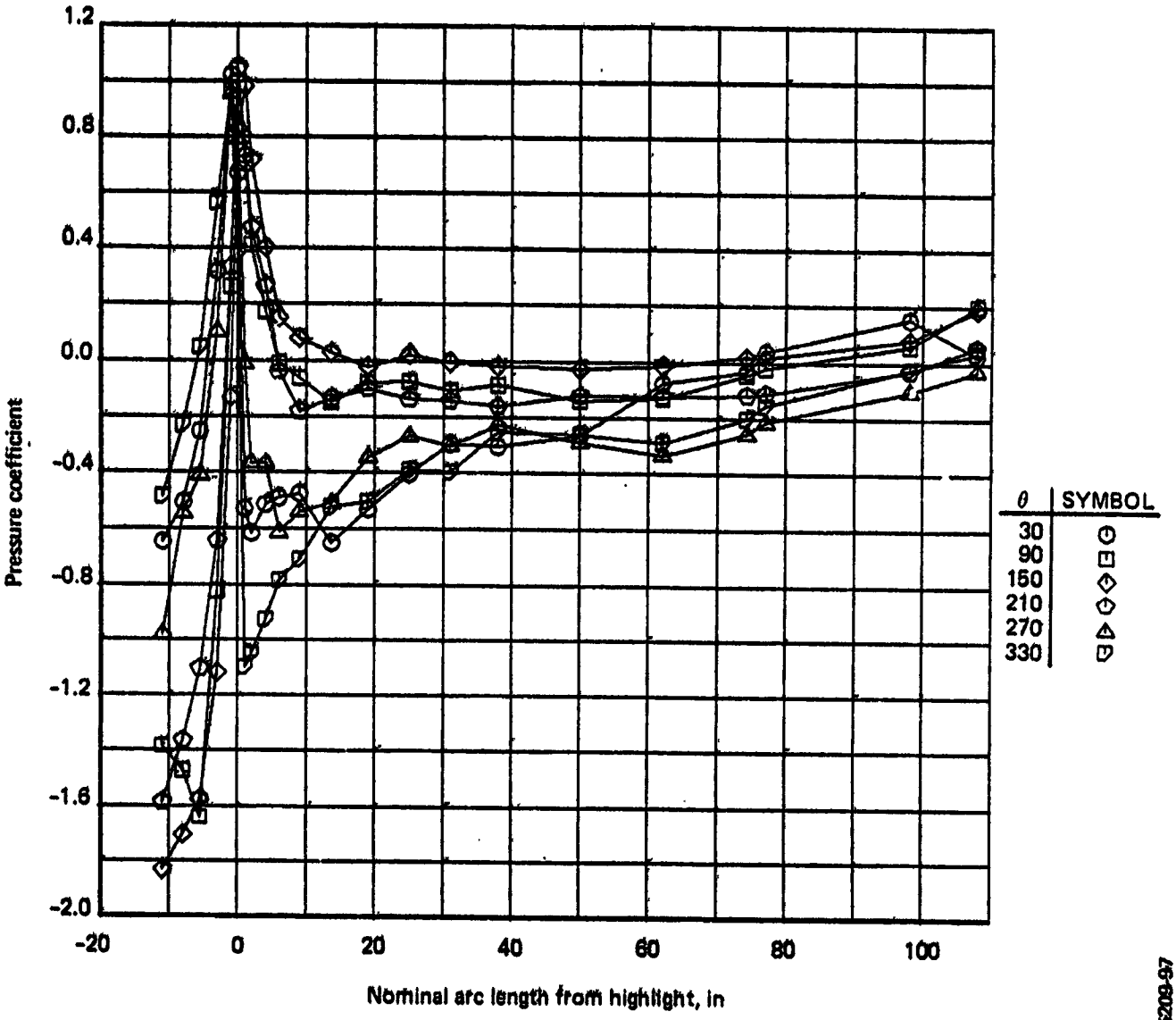


Figure A-39. Engine No. 3 Cowl Pressures, Condition 116, 2.0g Left Turn (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

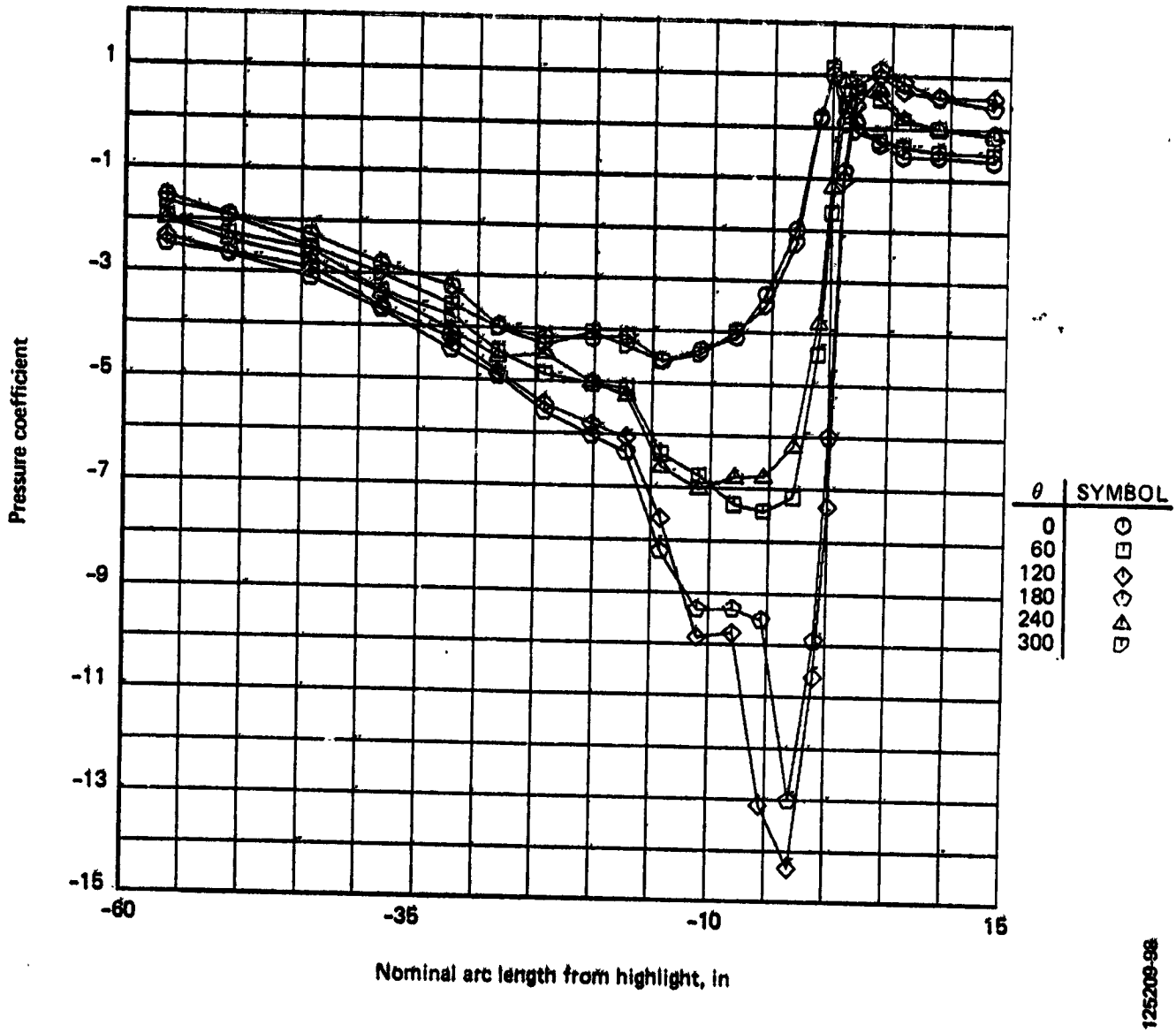


Figure A-40. Engine No. 3 Inlet Pressures, Condition 117, 1.6g Left Turn (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

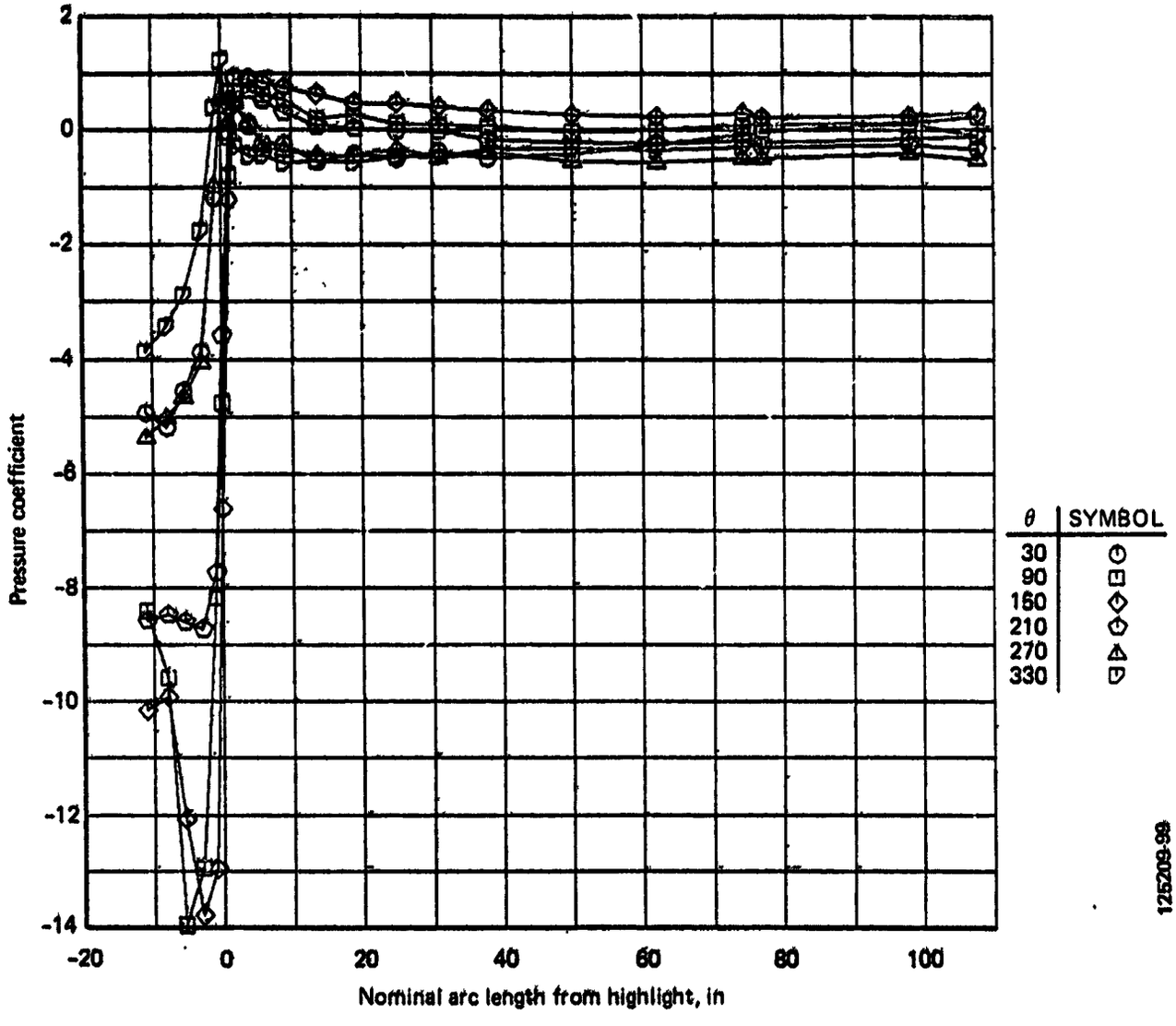


Figure A-41. Engine No. 3 Cowl Pressures, Condition 117, 1.8g Left Turn (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

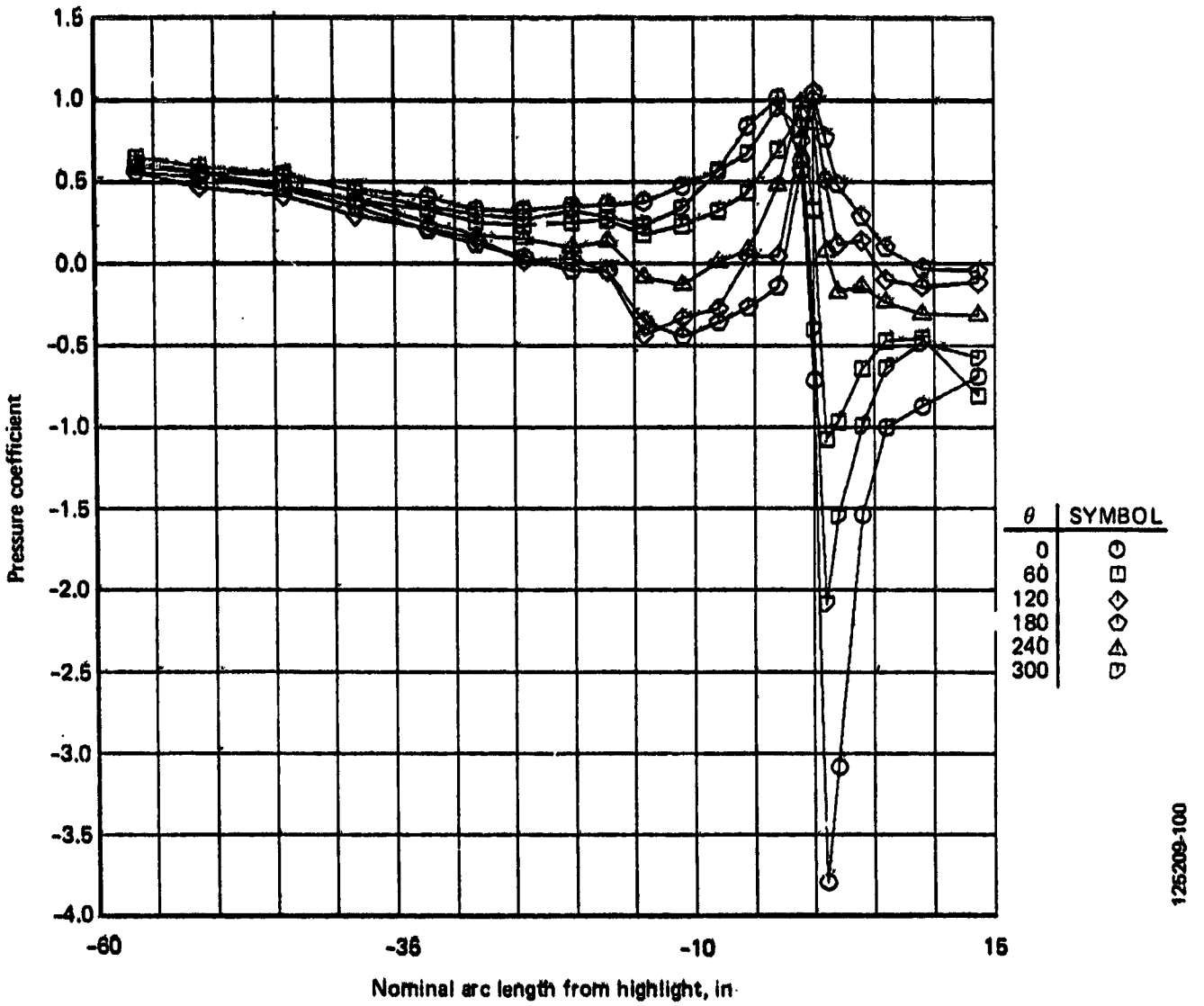


Figure A-42. Engine No. 3 Inlet Pressures, Condition 120, 2.0g Right Turn (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

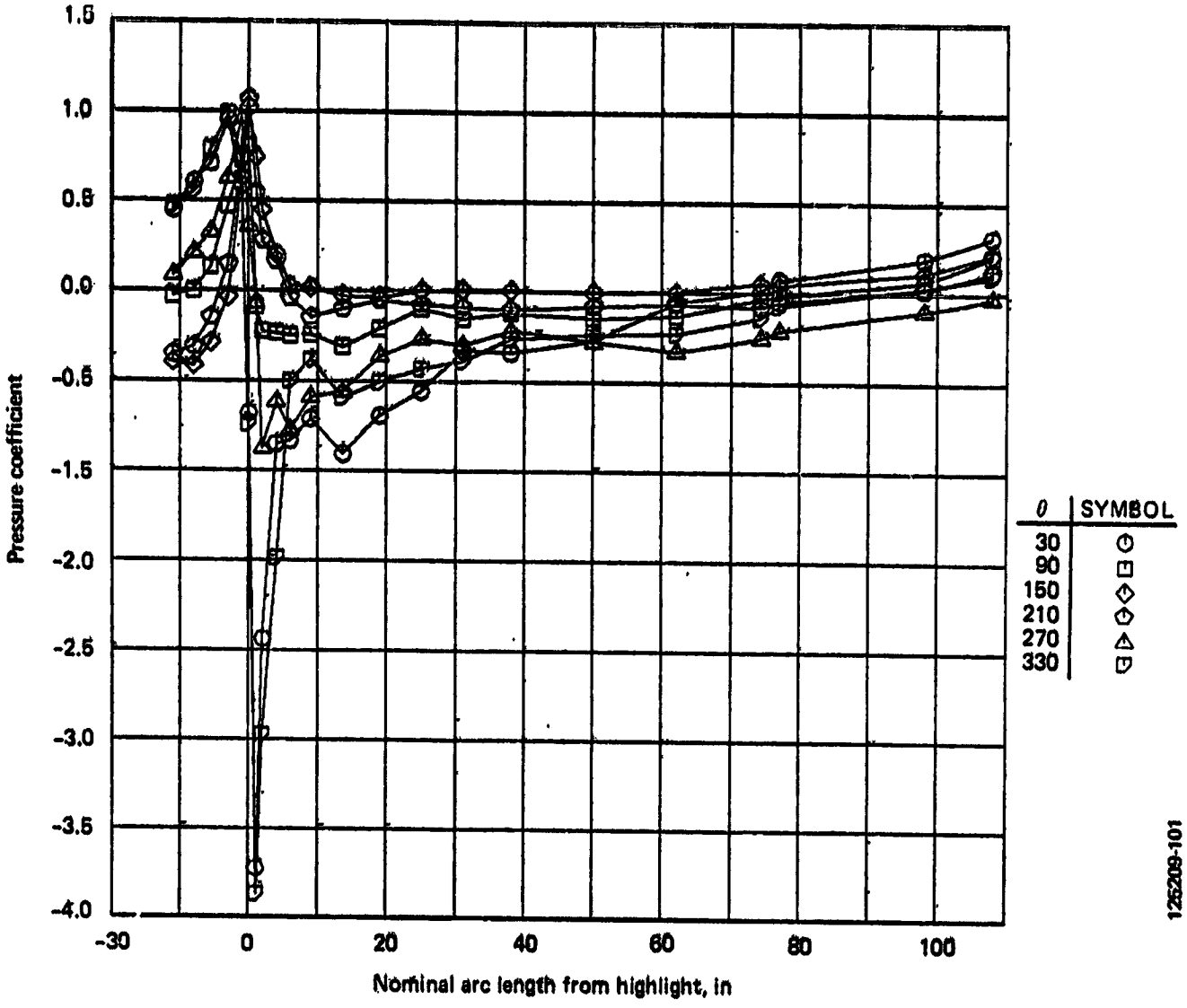


Figure A-43. Engine No. 3 Cowl Pressures, Condition 120, 2.0g Right Turn (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

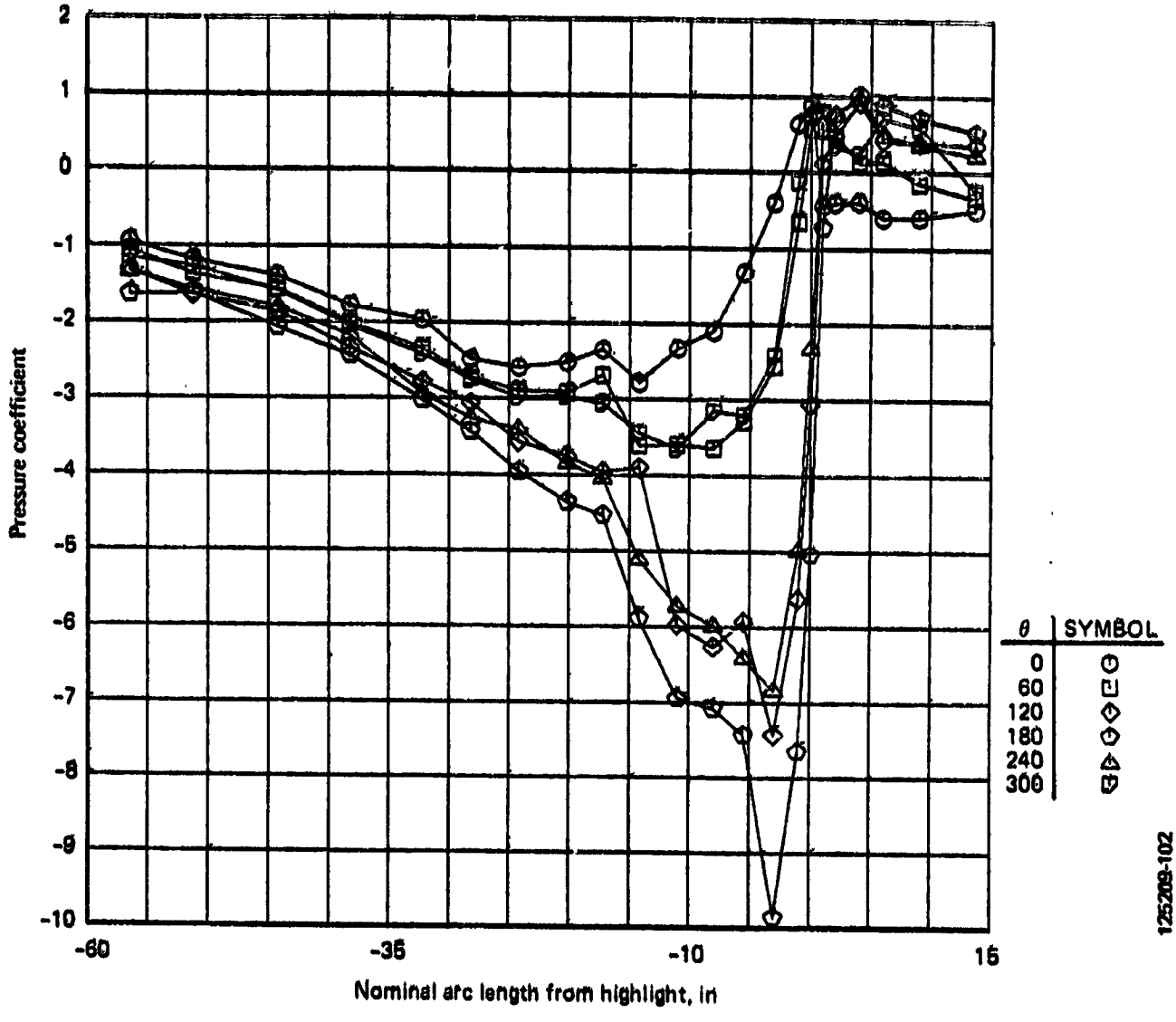


Figure A-44. Engine No. 3 Inlet Pressures, Condition 121, 1.6g Right Turn (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

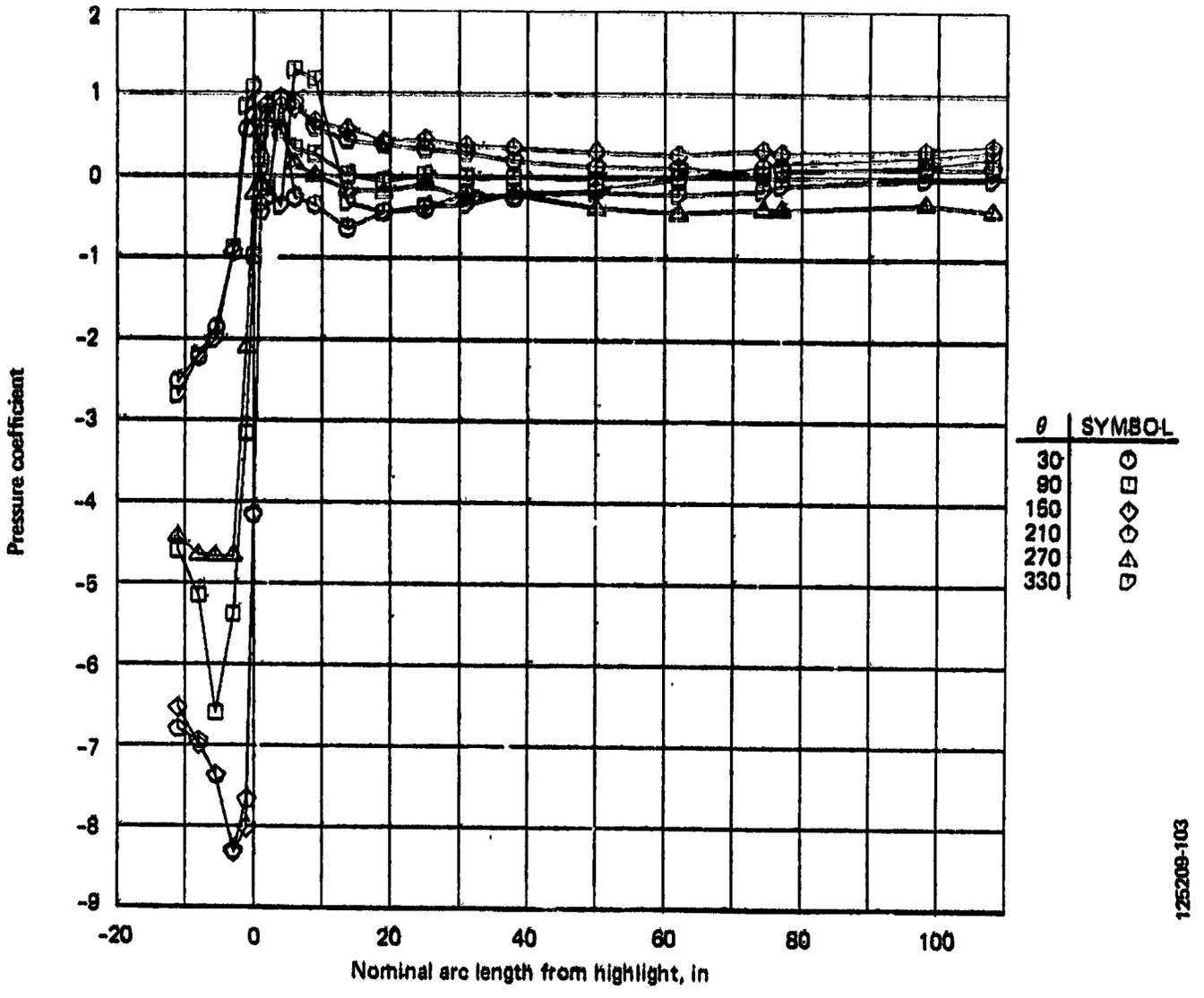


Figure A-45. Engine No. 3 Cowl Pressures, Condition 121, 1.6g Right Turn (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

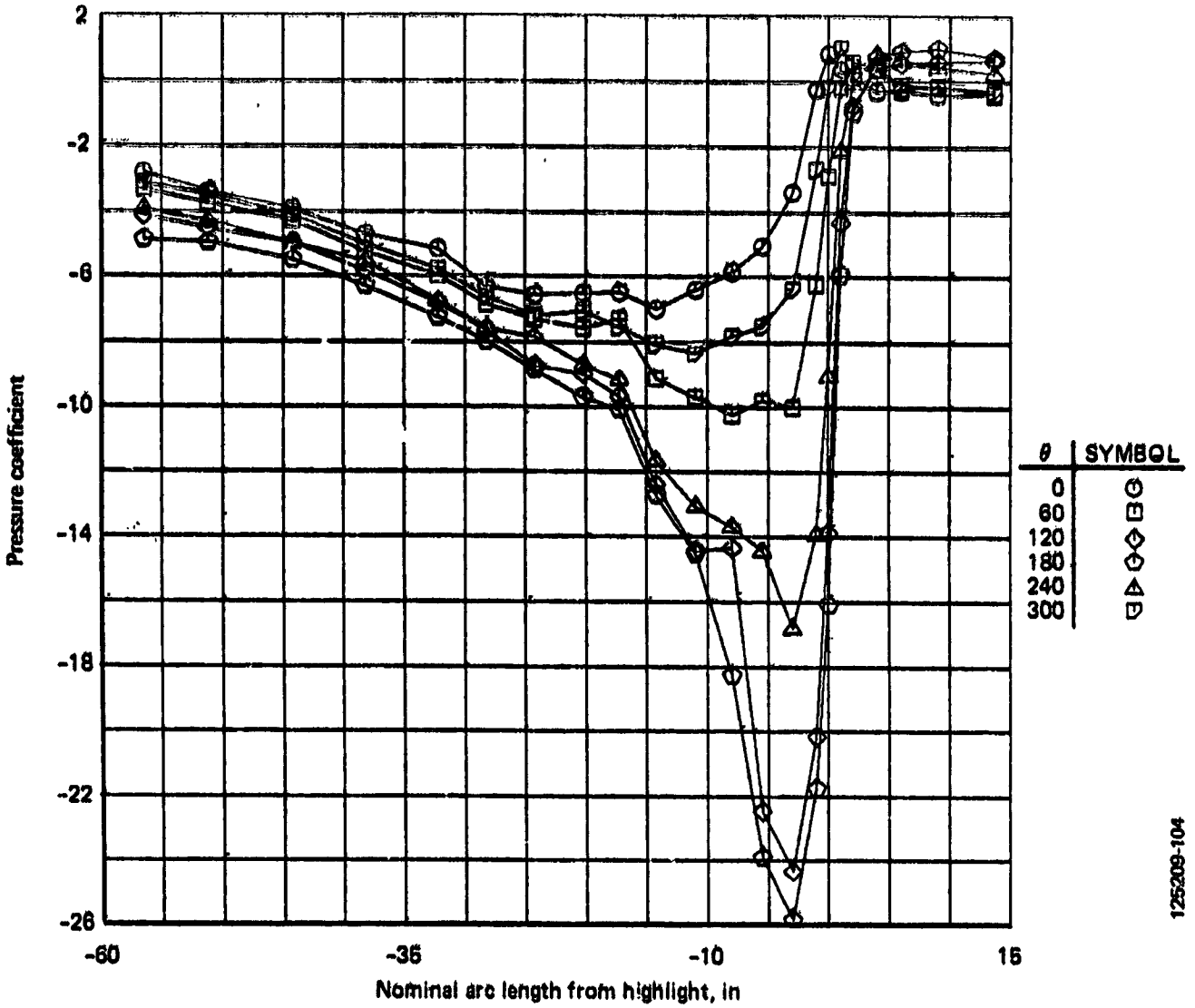


Figure A-46. Enyine No. 3 Inlet Pressures, Condition 123, Airplane Stall

ORIGINAL PAGE IS
OF POOR QUALITY

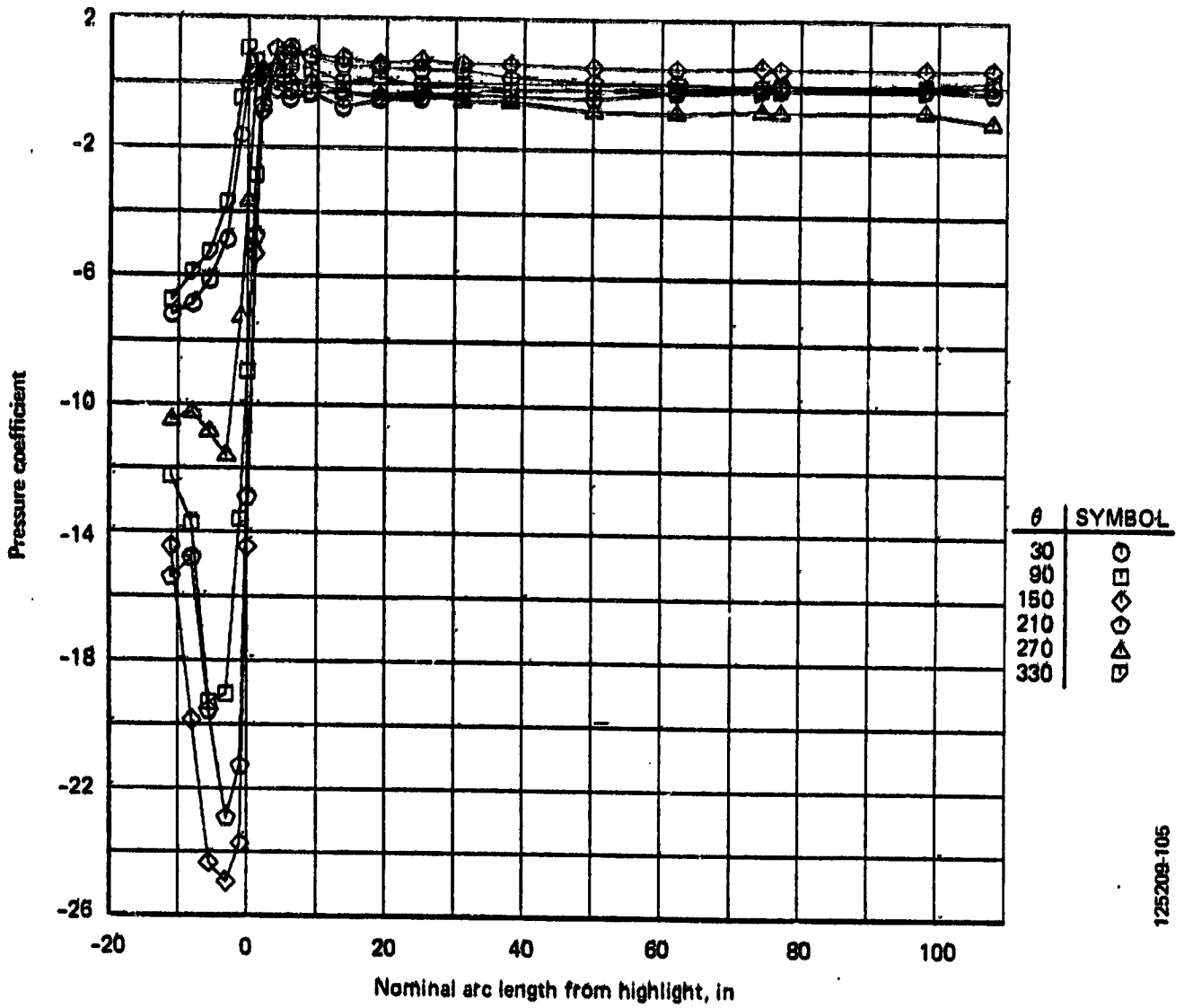


Figure A-47. Engine No. 3 Cowl Pressures, Condition 123, Airplane Stall

ORIGINAL PAGE IS
OF POOR QUALITY

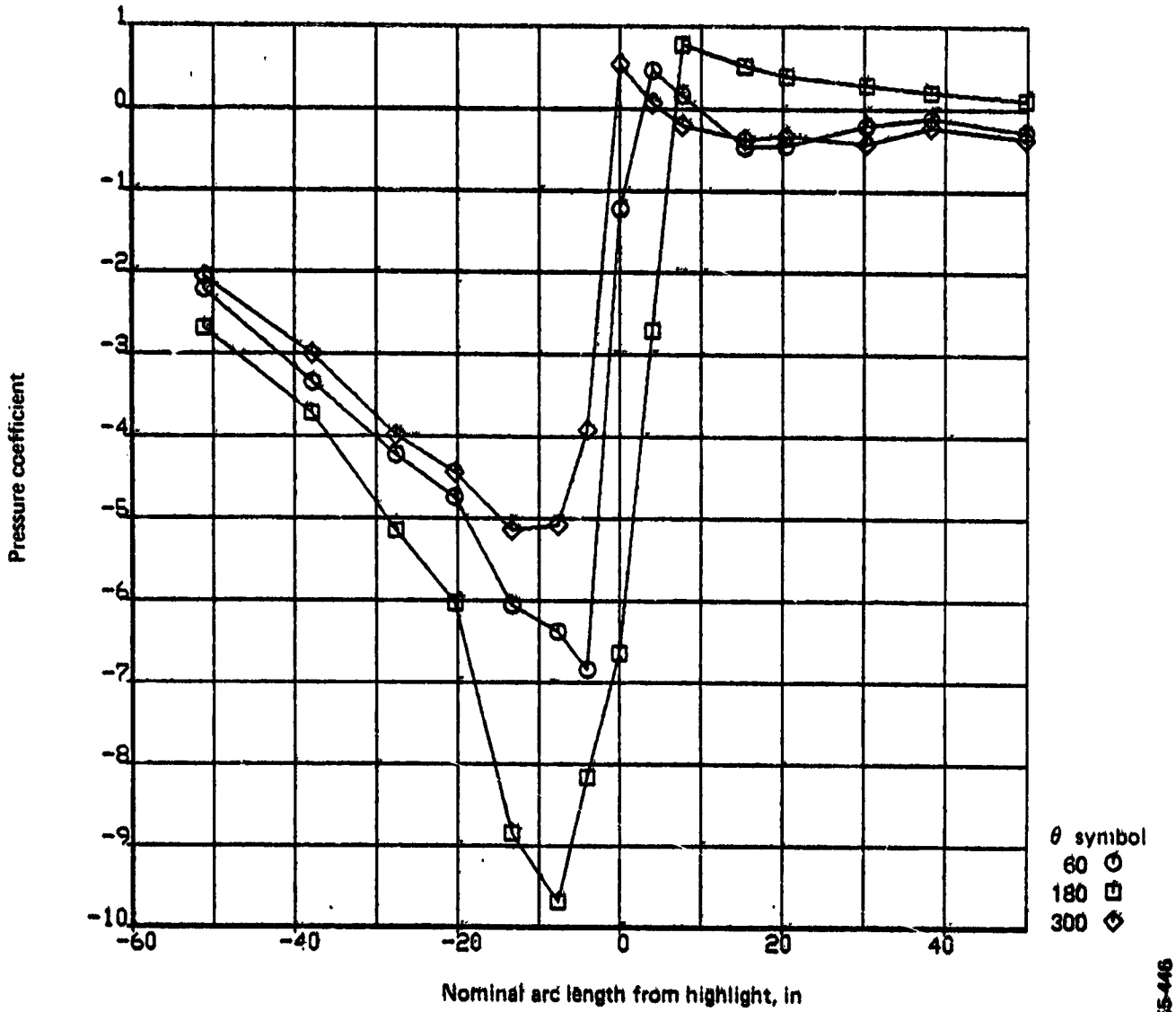


Figure A-48. Engine No. 4 Inlet Pressures, Condition 101, 612K Gross Weight Takeoff

ORIGINAL PAGE IS
OF POOR QUALITY

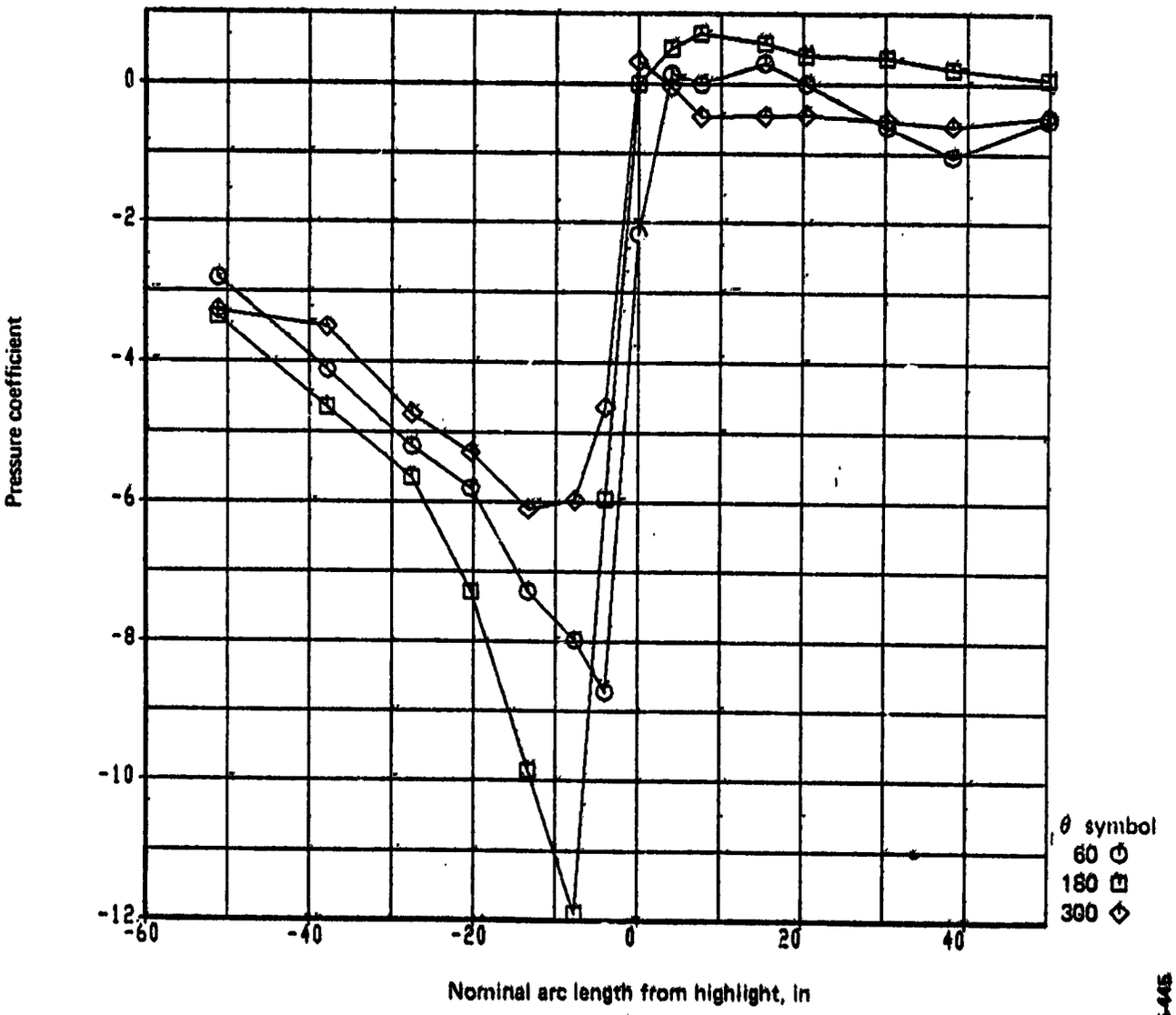


Figure A-49. Engine No. 4 Inlet Pressures, Condition 101, 538K Gross Weight Takeoff

126209-55-445

ORIGINAL PAGE IS
OF POOR QUALITY

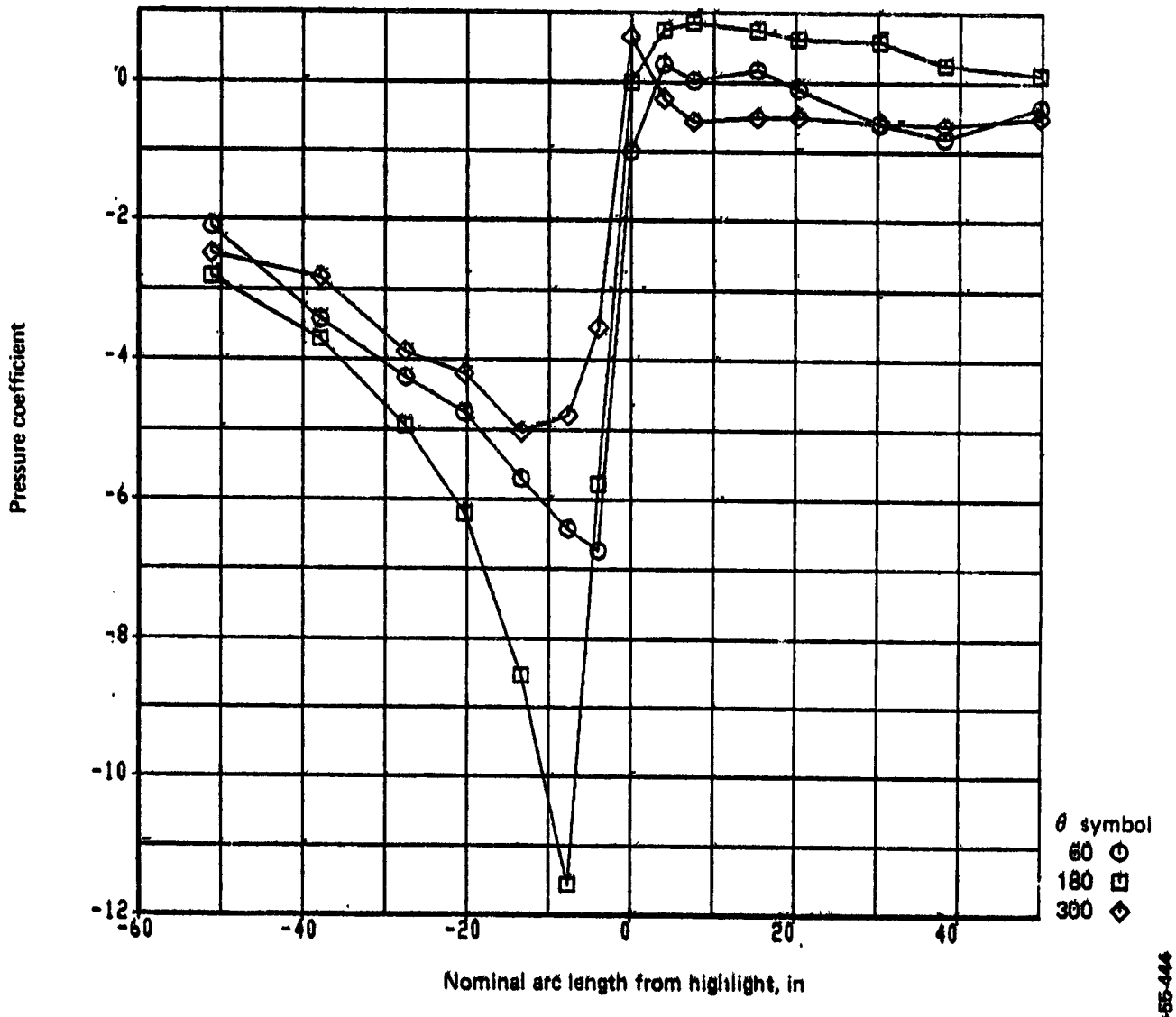
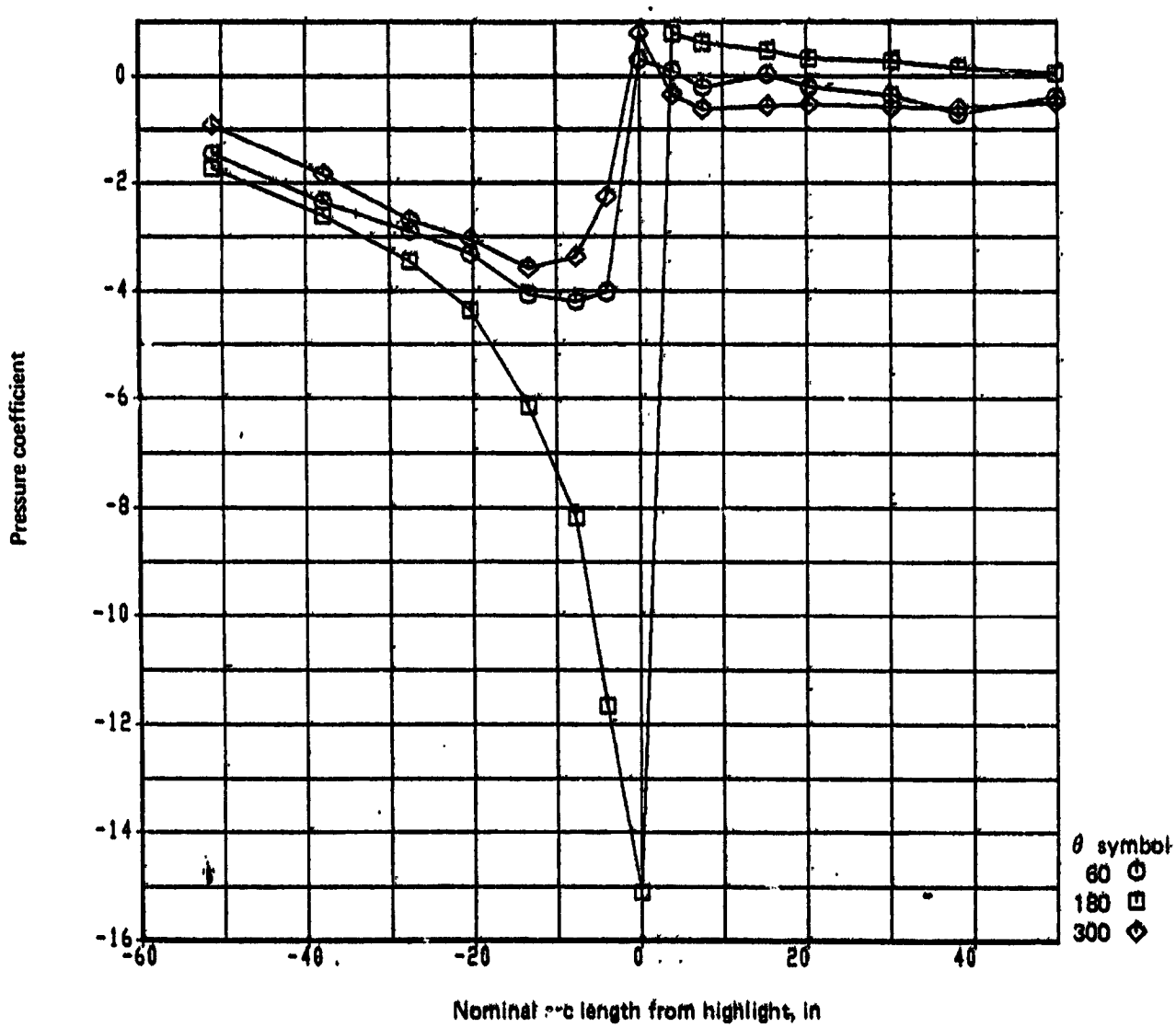


Figure A-50. Engine No. 4 Inlet Pressures, Condition 101, 647K Gross Weight Takeoff

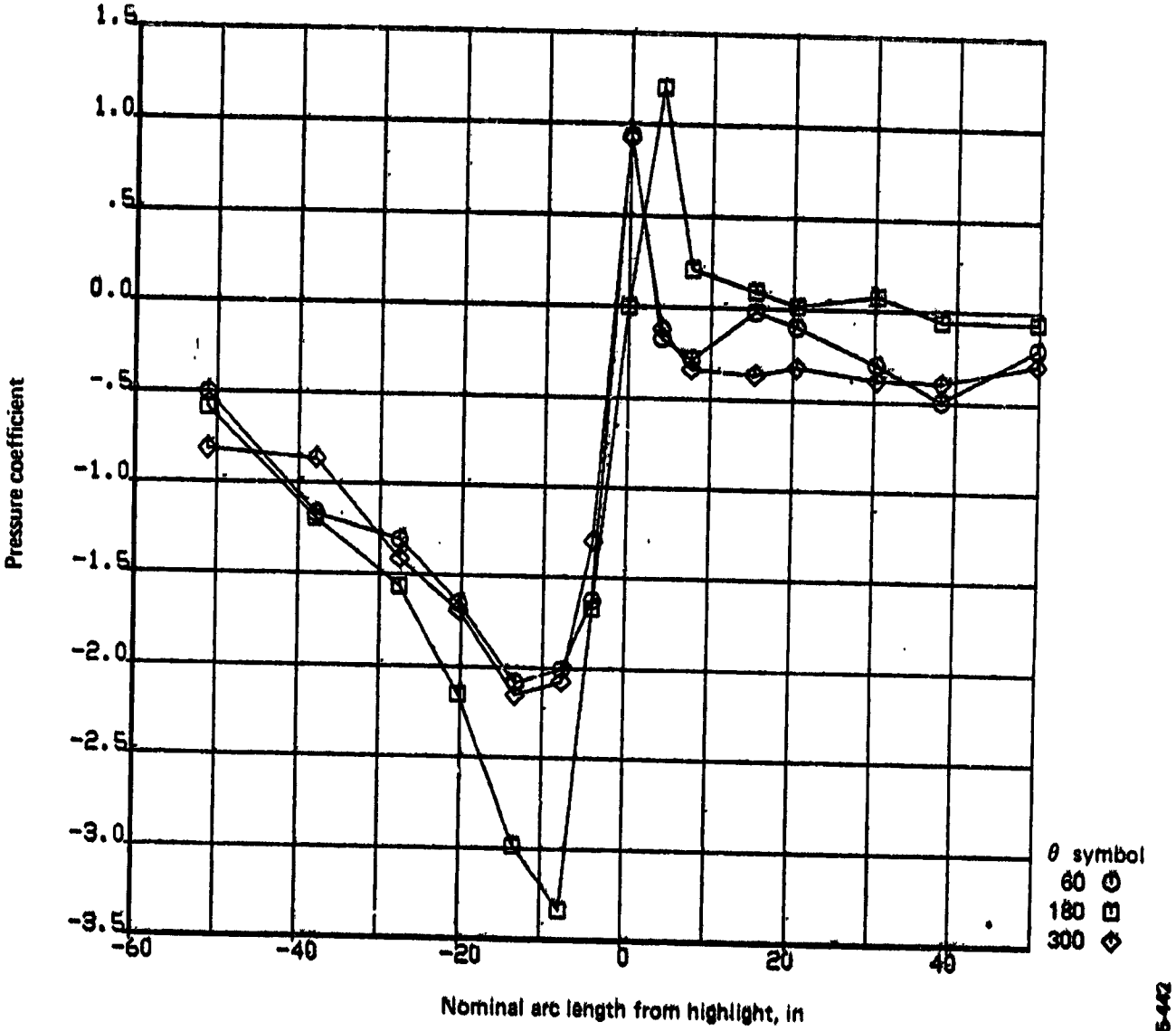
ORIGINAL PAGE IS
OF POOR QUALITY



126009-55-443

Figure A-51. Engine No. 4 Inlet Pressures, Condition 118, 780K Gross Weight Simulated Takeoff

ORIGINAL PAGE IS
OF POOR QUALITY



125209-55-442

Figure A-52. Engine No. 4 Inlet Pressures, Condition 102, Low Climb

ORIGINAL PAGE IS
OF POOR QUALITY

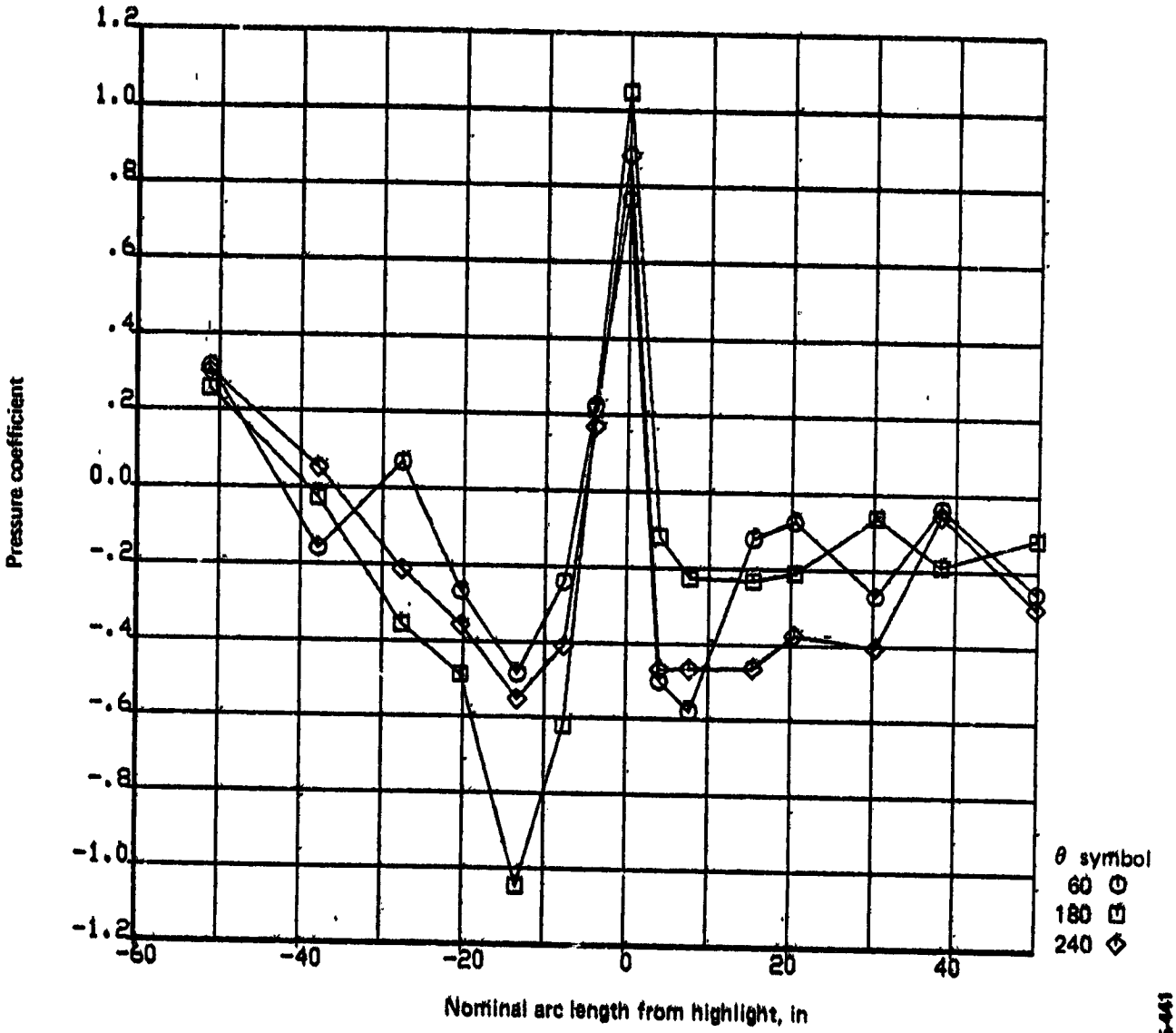


Figure A-53. Engine No. 4 Inlet Pressures, Condition 103, Mid Climb

125289-65-441

ORIGINAL PAGE IS
OF POOR QUALITY

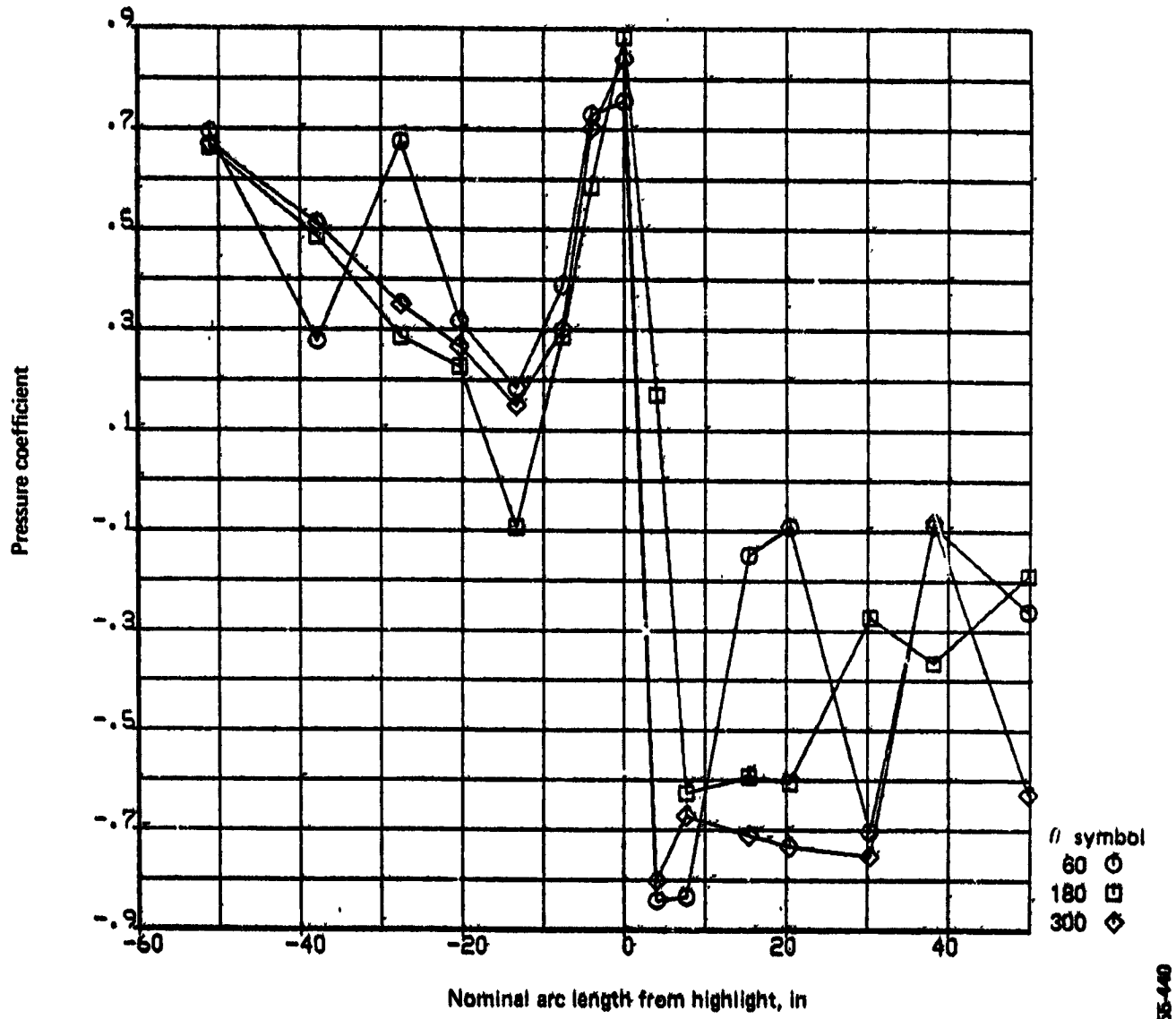


Figure A-54. Engine No. 4 Inlet Pressures, Condition 104, High M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

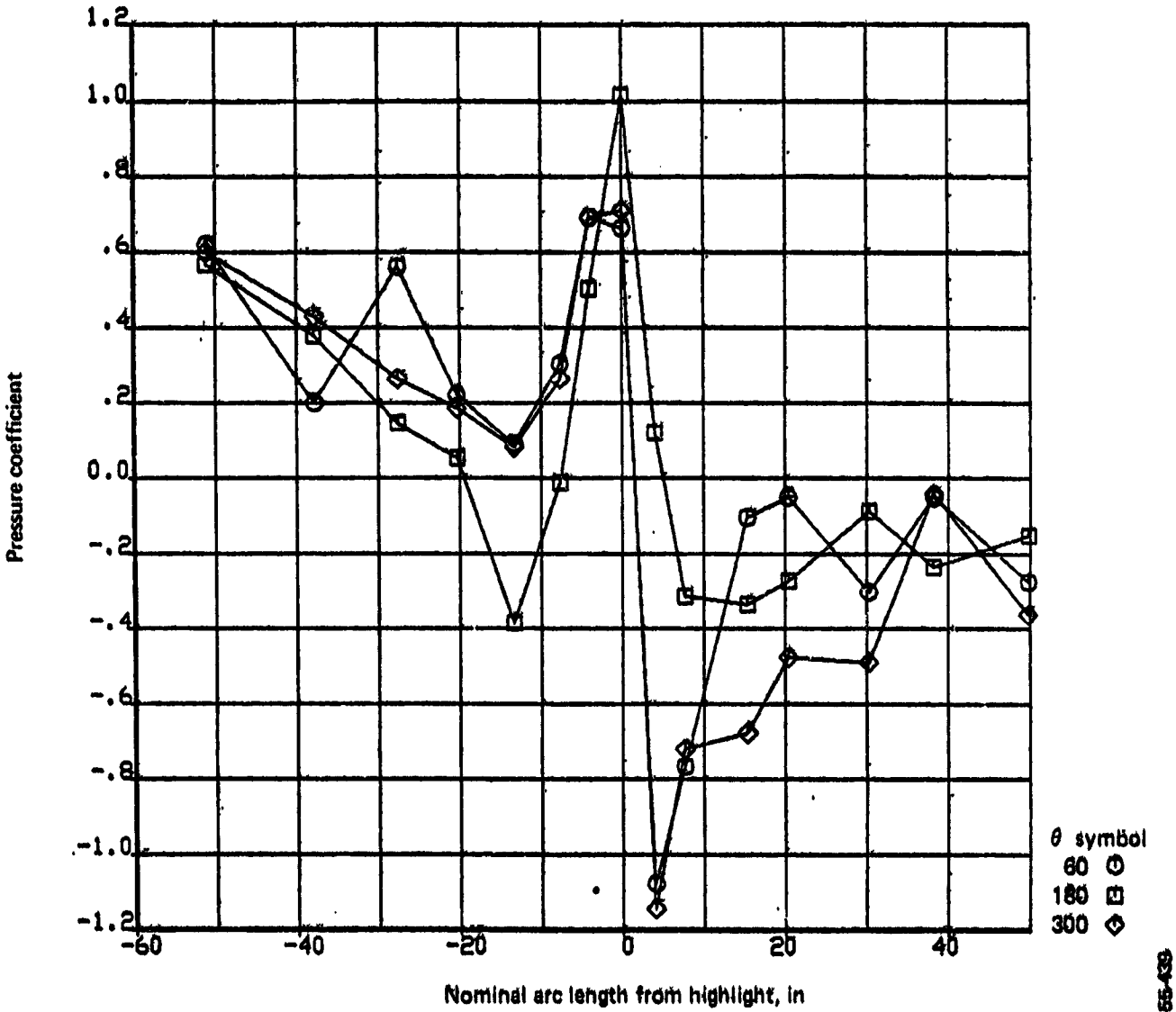


Figure A-55. Engine No. 4 Inlet Pressures, Condition 105, Low M Cruise

ORIGINAL PAGE IS
OF POOR QUALITY

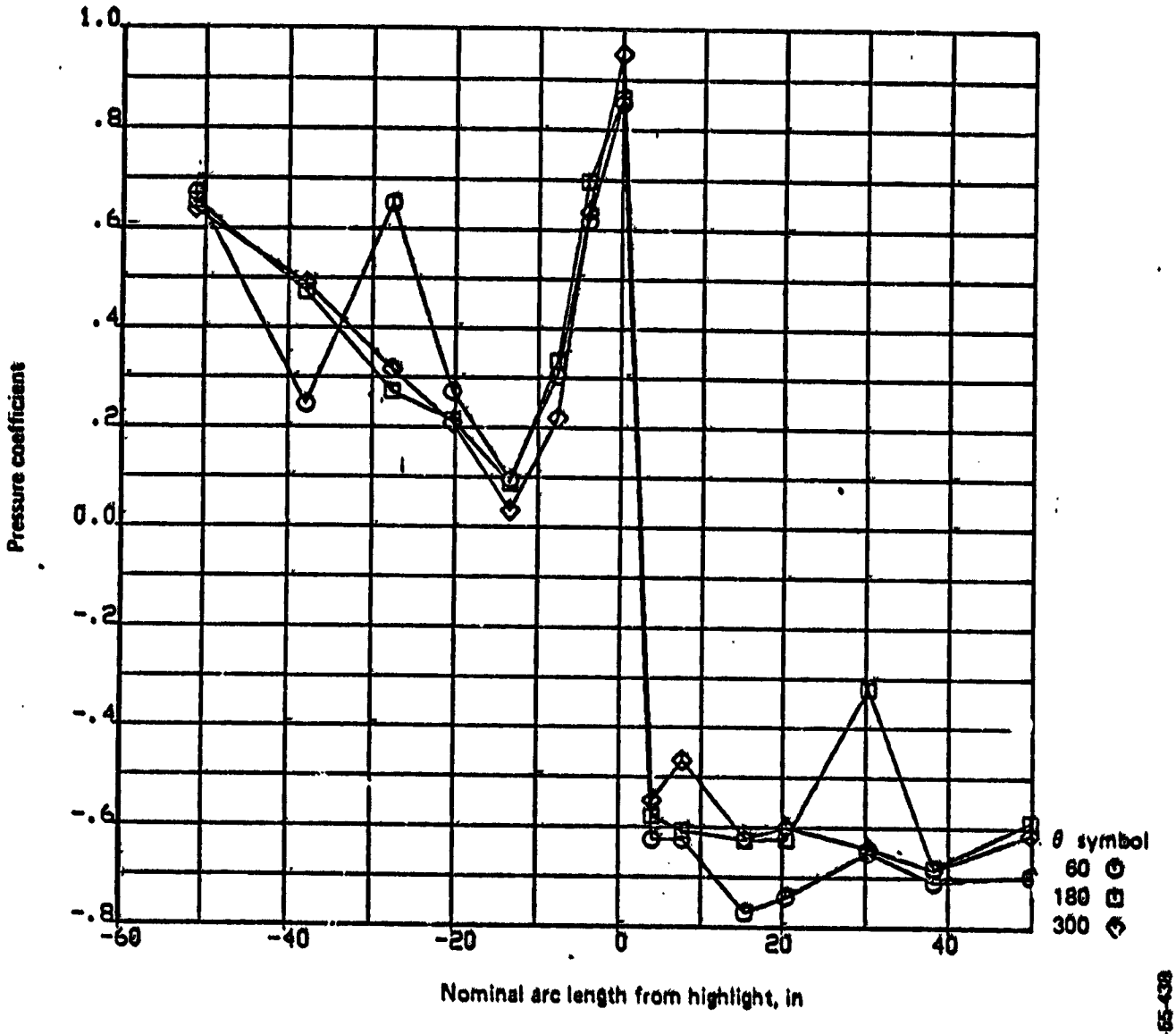


Figure A-56. Engine No. 4 Inlet Pressures, Condition 106, Maximum M

ORIGINAL PAGE IS
OF POOR QUALITY

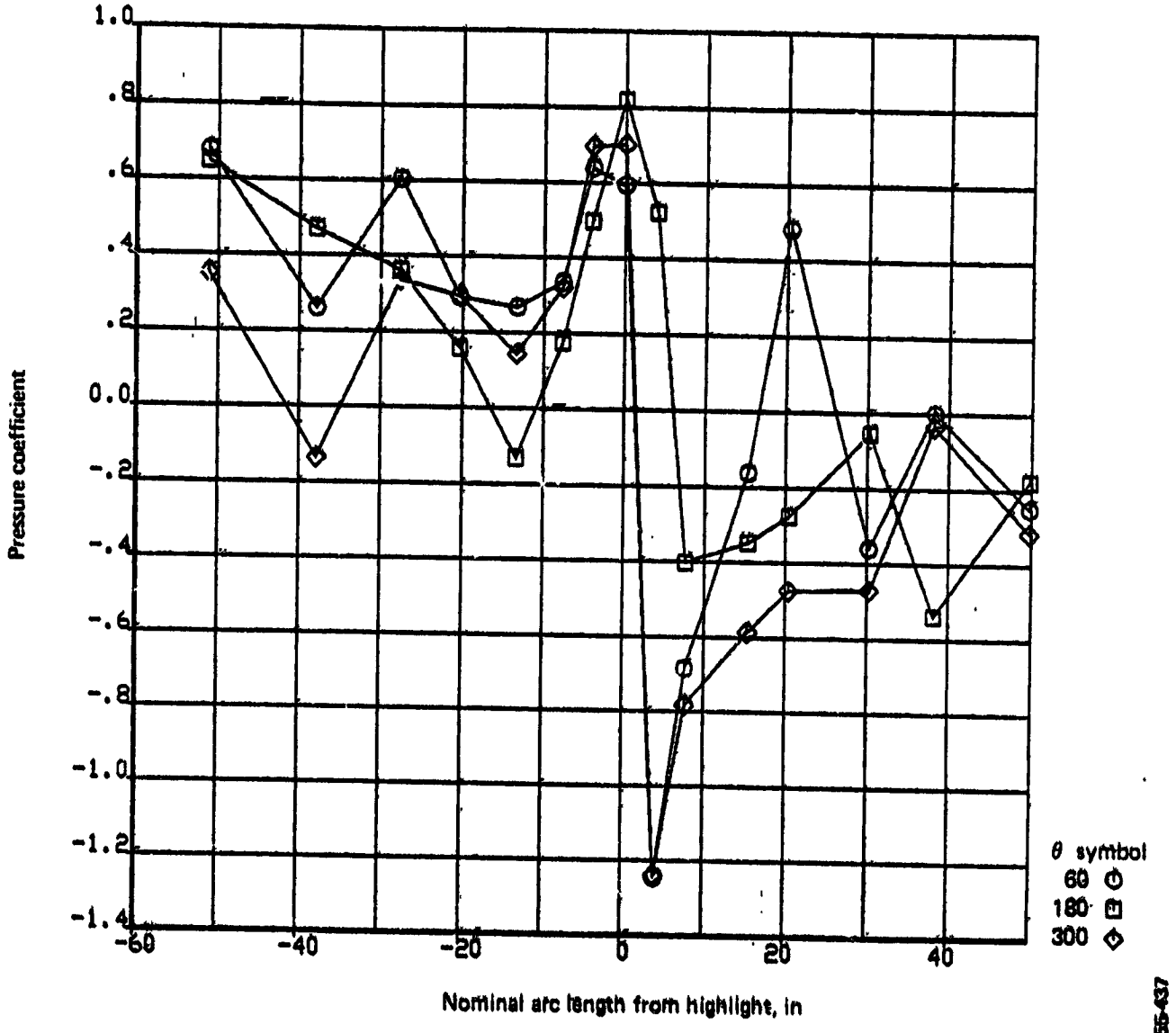


Figure A-57. Engine No. 4 Inlet Pressures, Condition 107, Inflight Relight

125209-55-437

ORIGINAL PAGE IS
OF POOR QUALITY

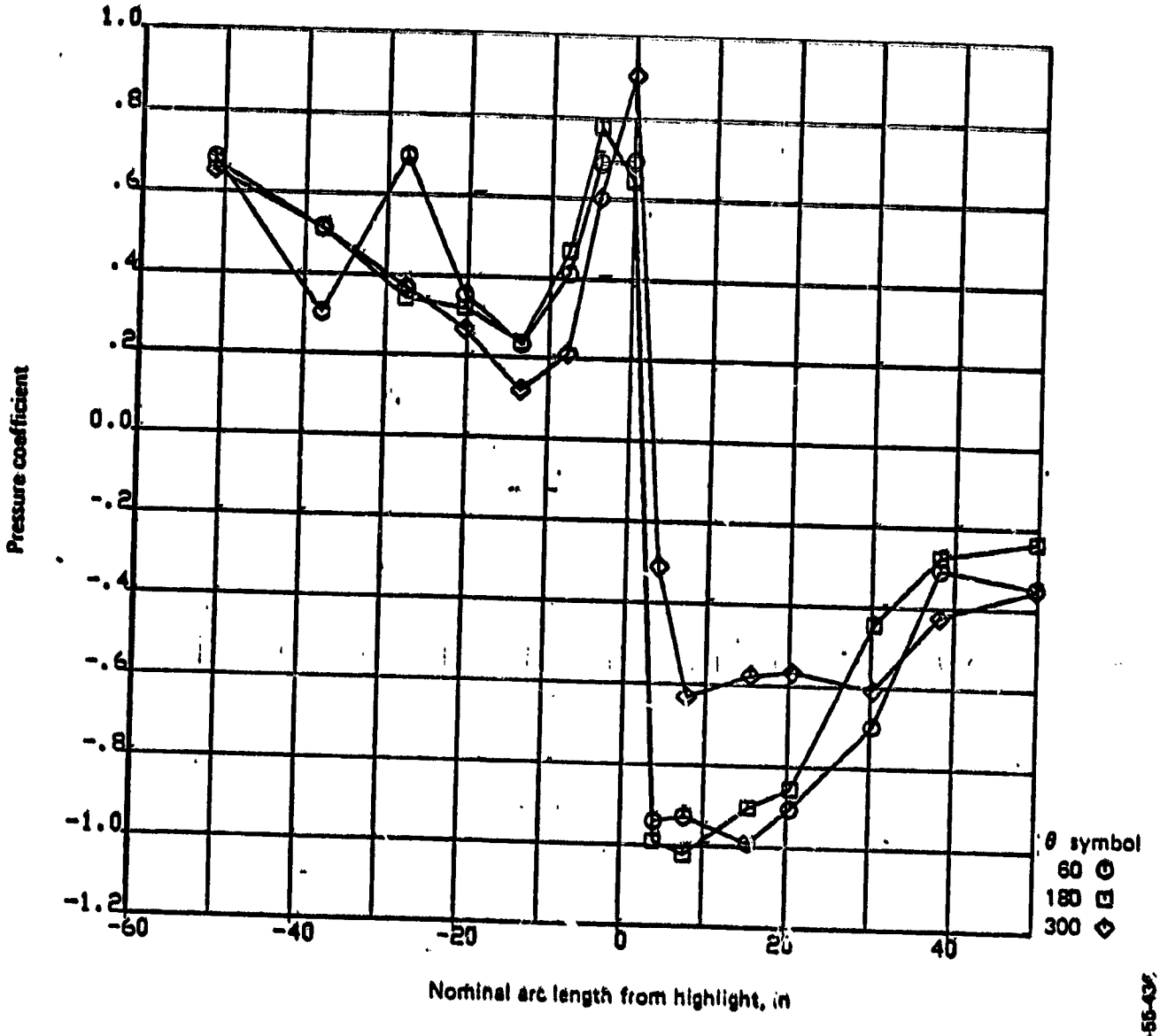


Figure A-58. Engine No. 4 Inlet Pressures, Condition 108, Maximum q

ORIGINAL PAGE IS
OF POOR QUALITY

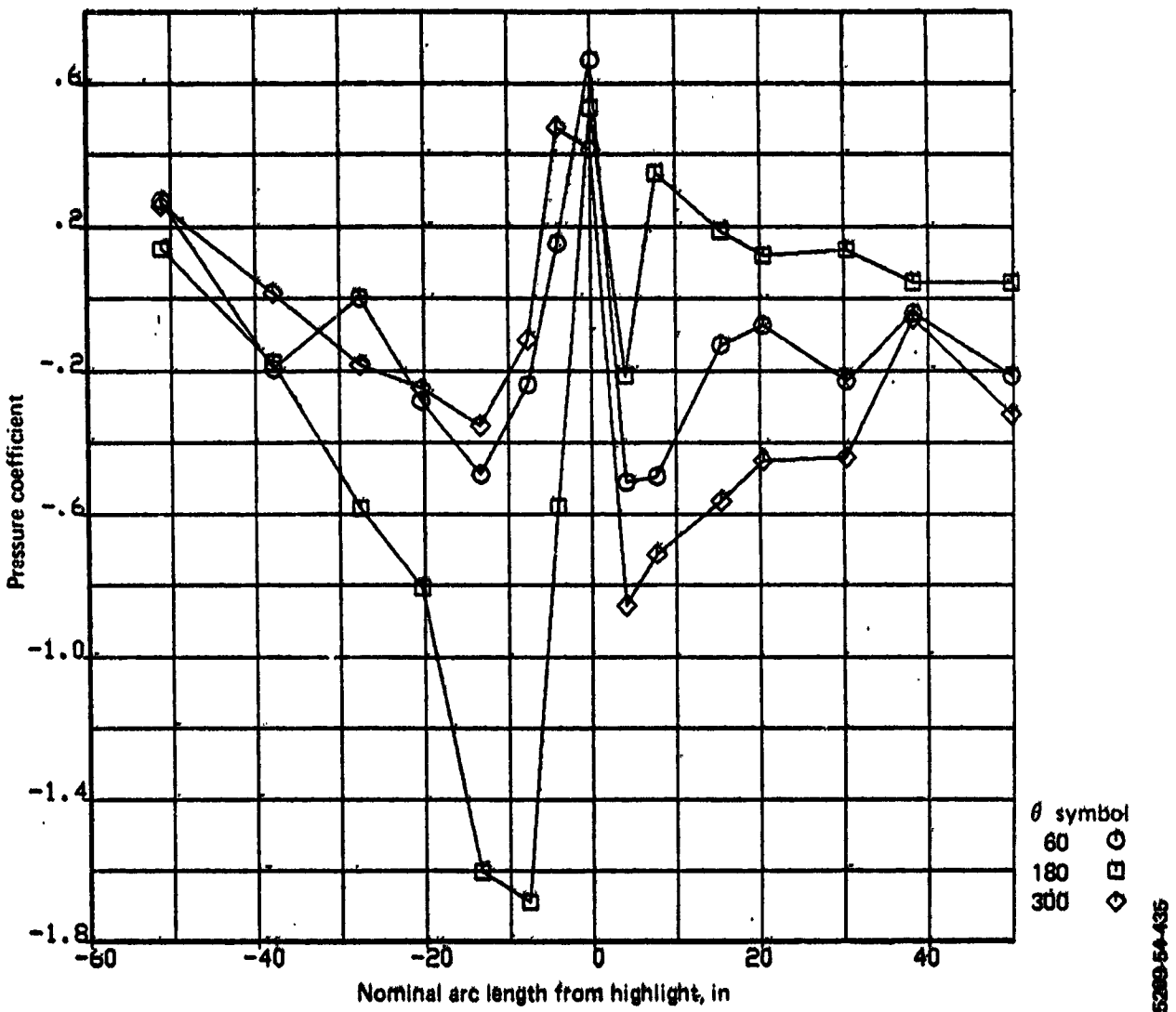


Figure A-59. Engine No. 4 Inlet Pressures, Condition 109, Stall Warning (Flaps Up)

C-3

ORIGINAL PAGE IS
OF POOR QUALITY

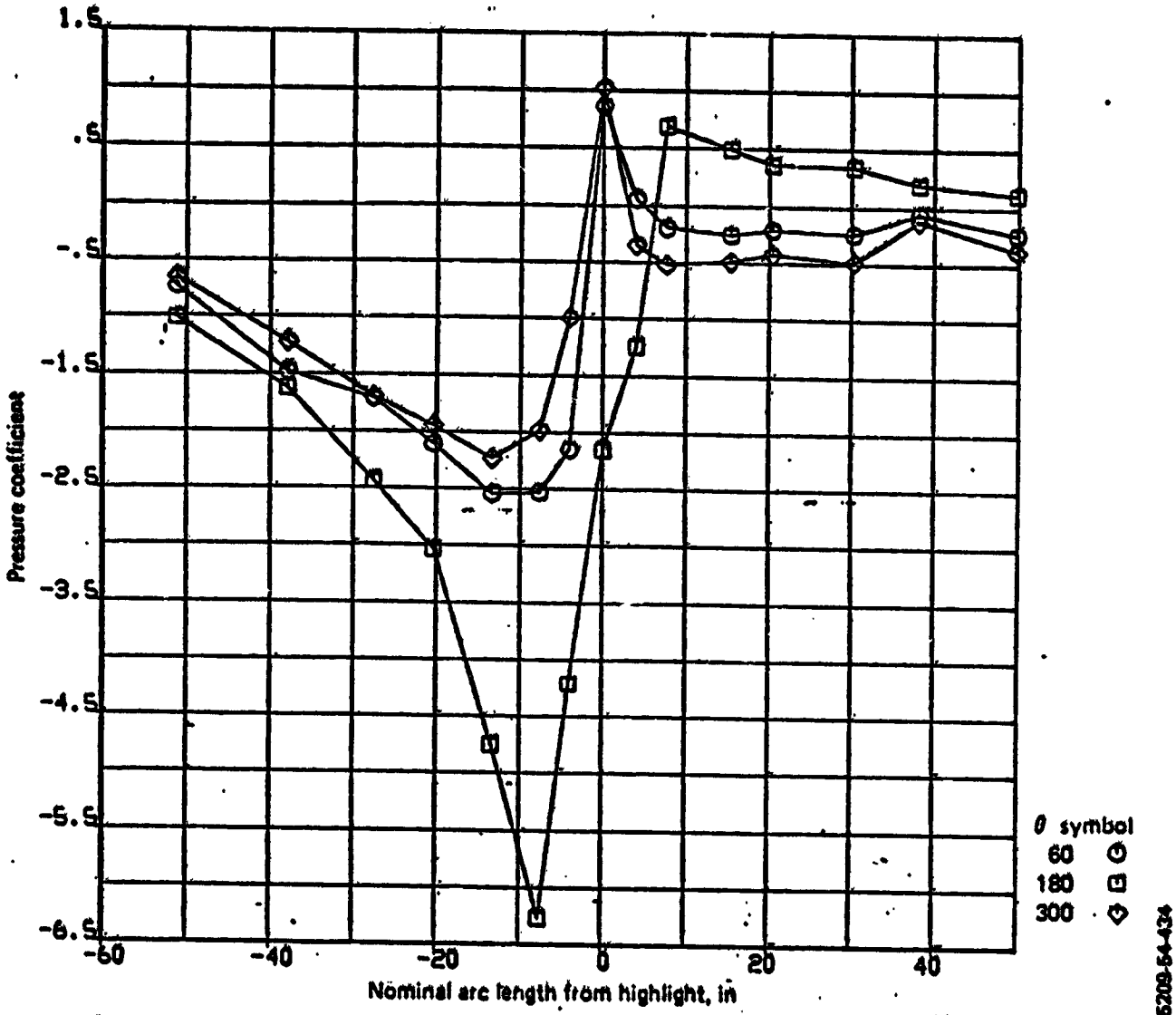


Figure A-60. Engine No. 4 Inlet Pressures, Condition 110, Stall Warning (Flaps 10)

ORIGINAL PAGE IS
OF POOR QUALITY

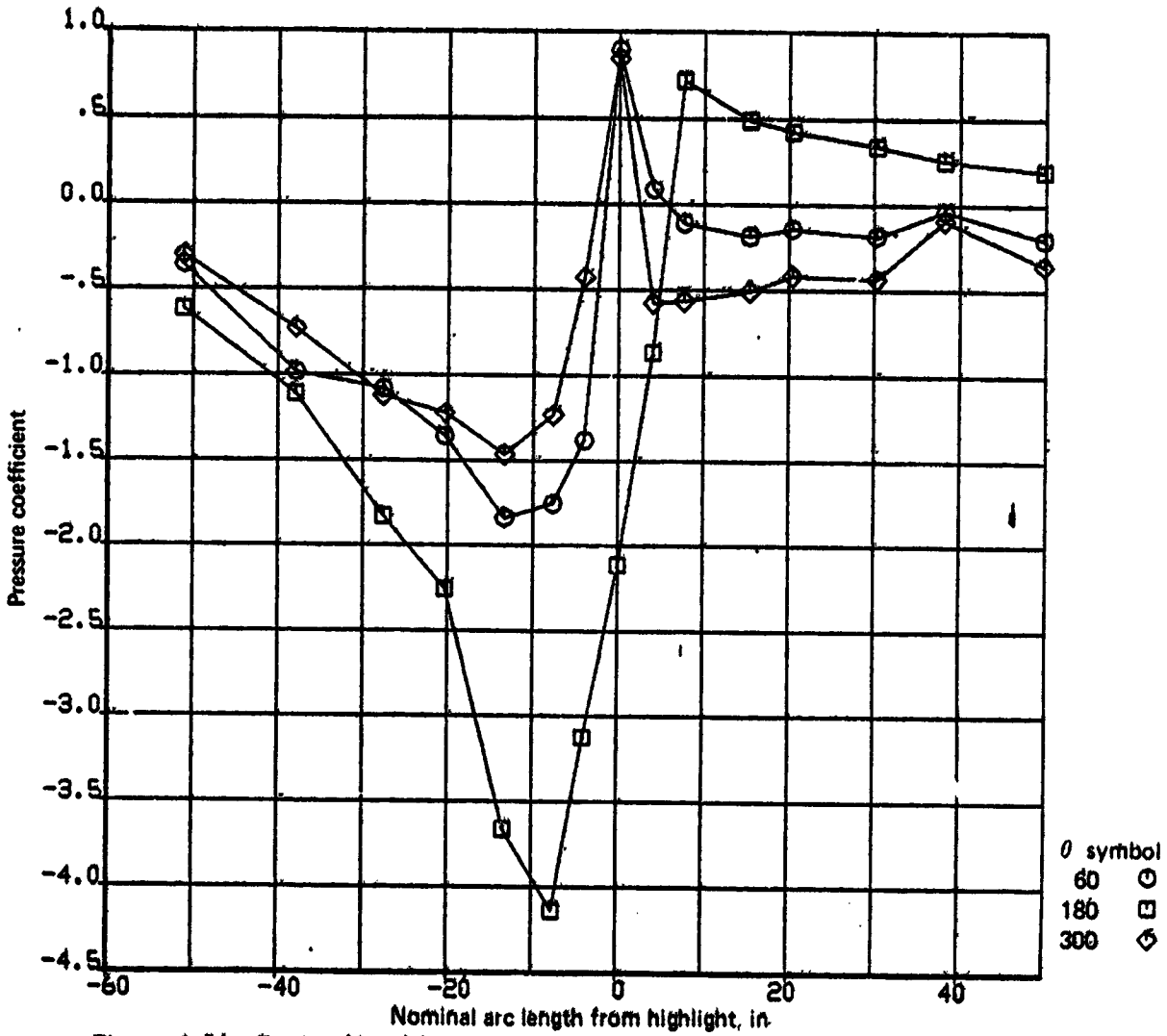


Figure A-61. Engine No. 4 Inlet Pressures, Condition 111, Stall Warning (Flaps 30)

125269-54-433

ORIGINAL PAGE IS
OF POOR QUALITY

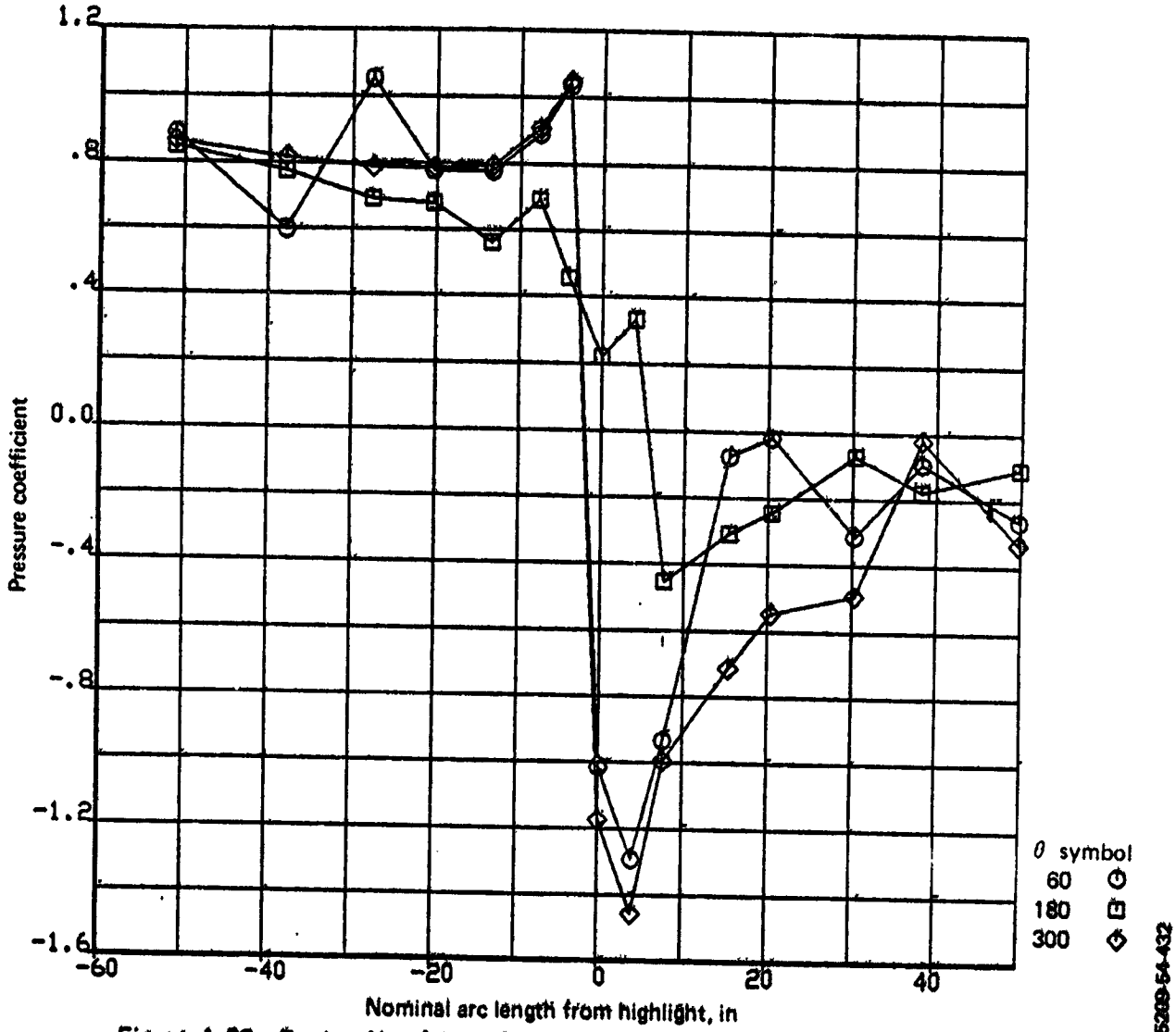


Figure A-62. Engine No. 4 Inlet Pressures, Condition 112, Idle Descent

ORIGINAL PAGE IS
OF POOR QUALITY

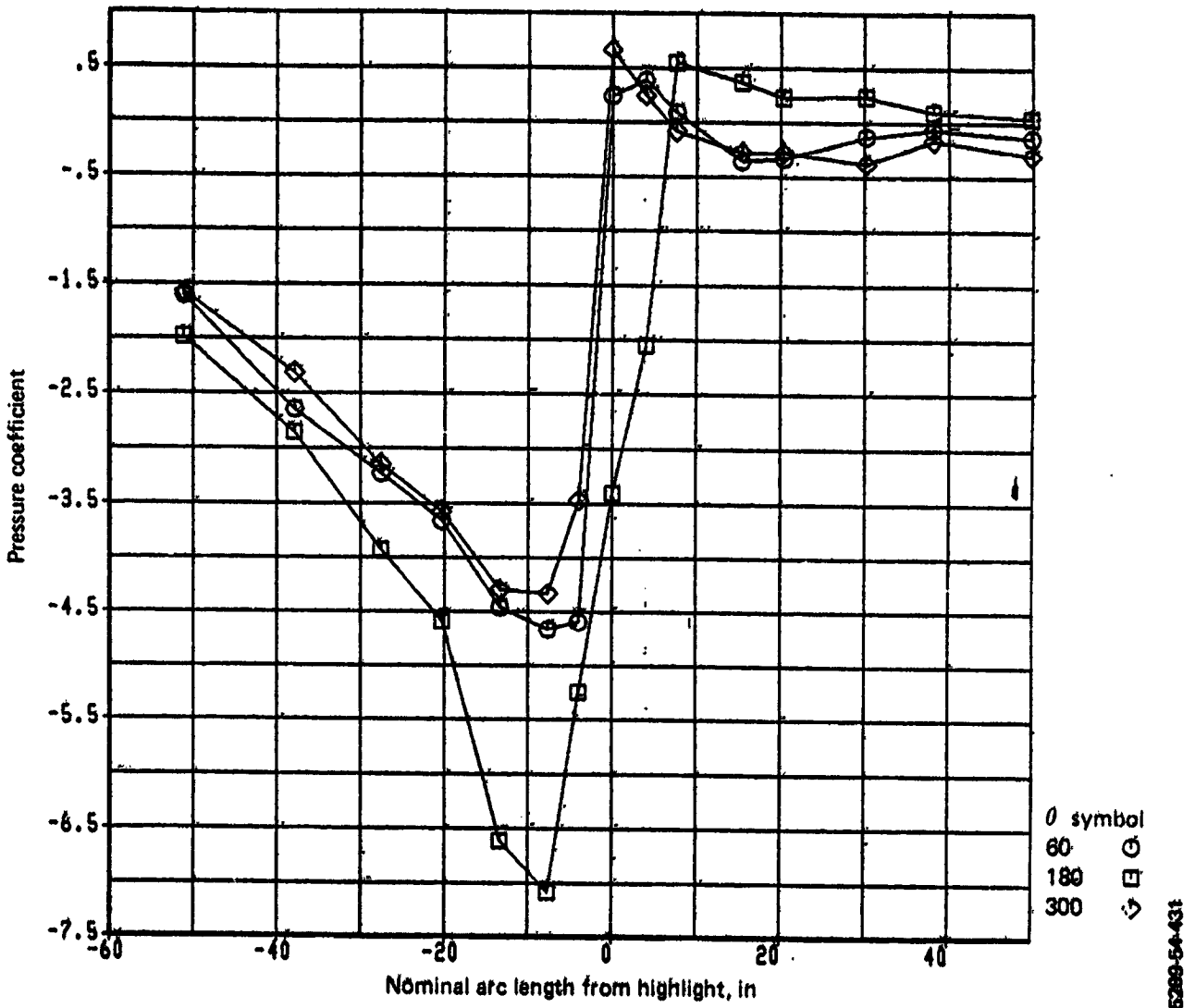


Figure A-63. Engine No. 4 Inlet Pressures, Condition 113, Approach

ORIGINAL PAGE IS
OF POOR QUALITY

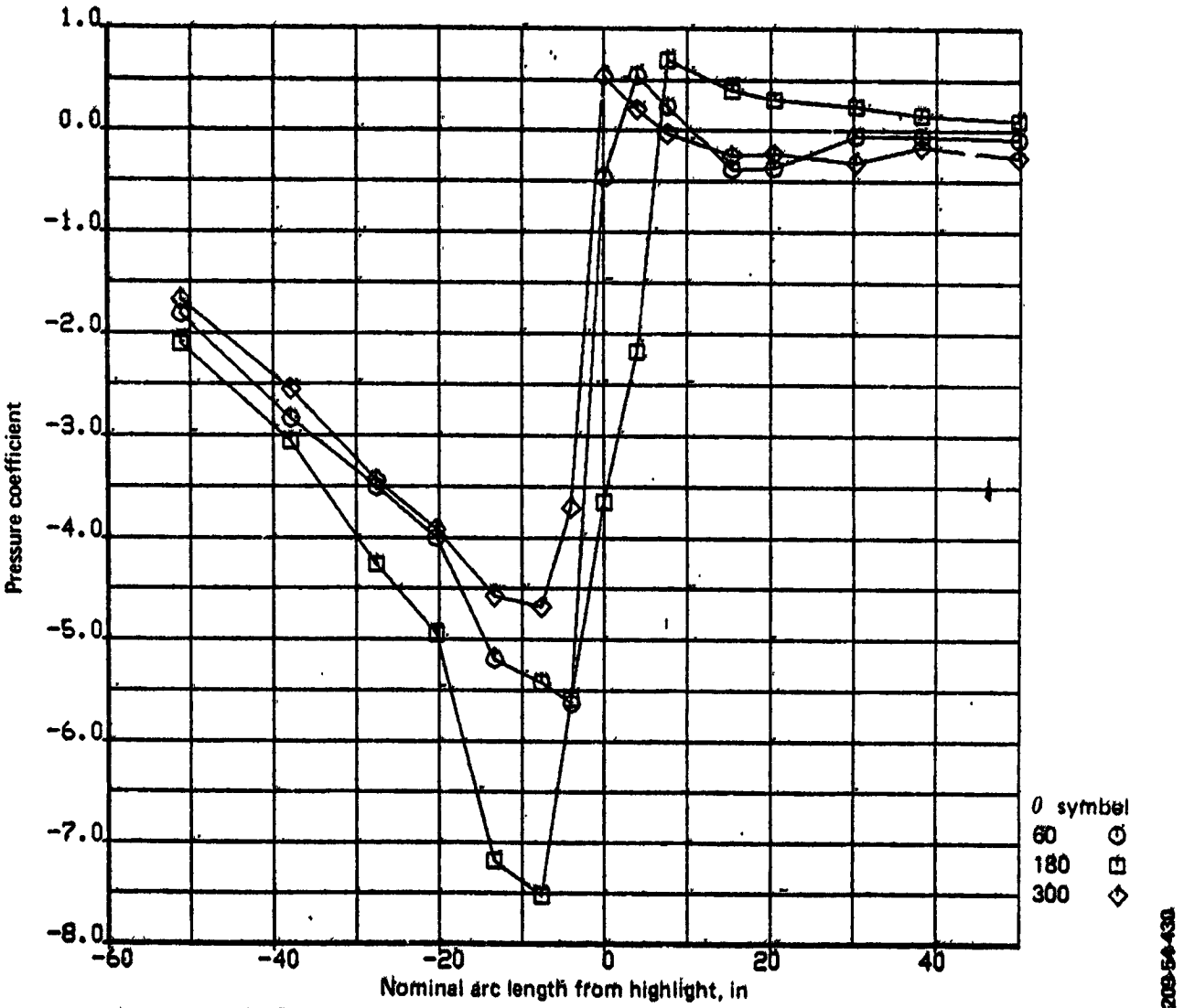


Figure A-64. Engine No. 4 Inlet Pressures, Condition 114, Touch and Go

ORIGINAL PAGE IS
OF POOR QUALITY

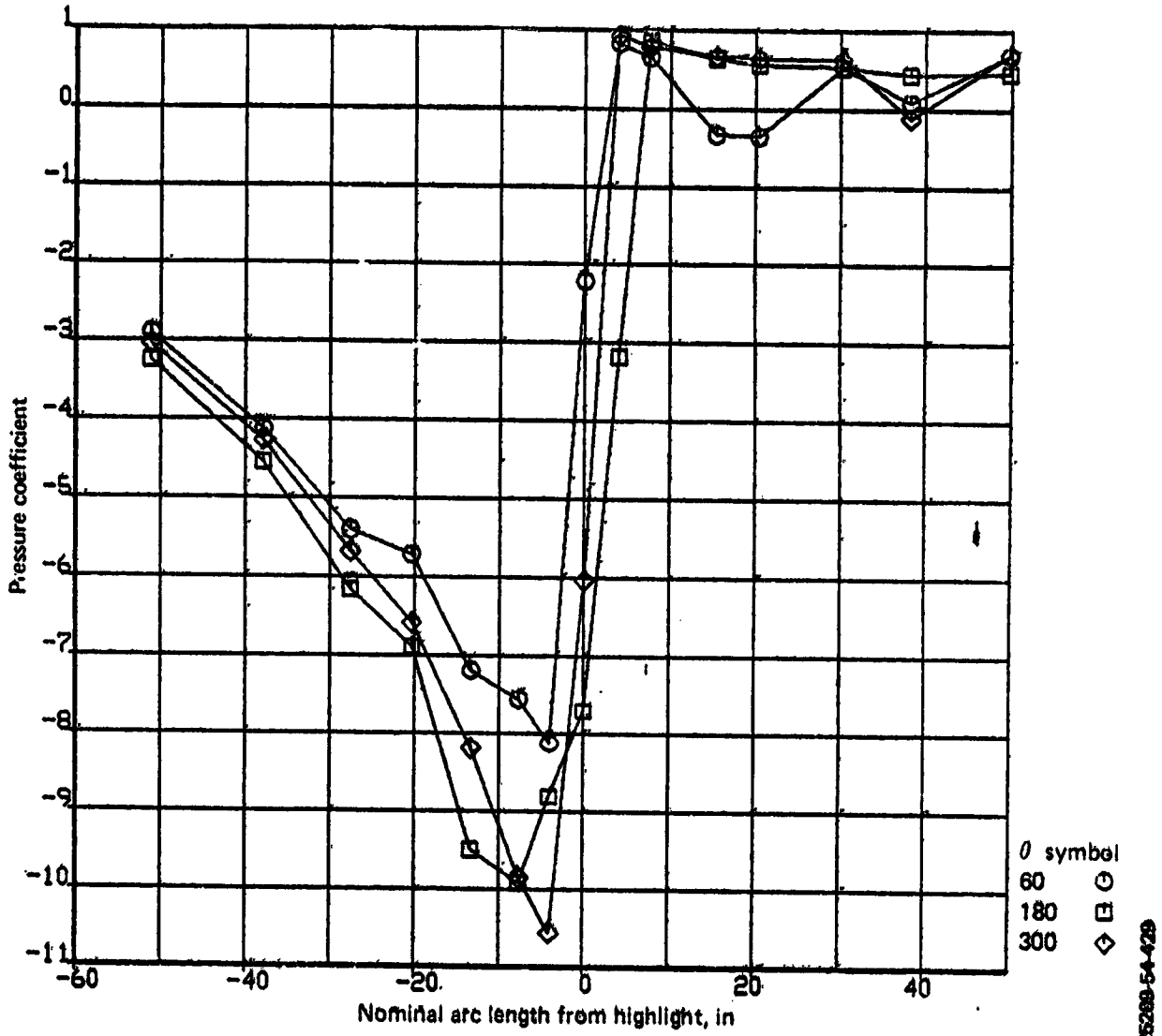


Figure A-65. Engine No. 4 Inlet Pressures, Condition 115, Thrust Reverse

ORIGINAL PAGE IS
OF POOR QUALITY

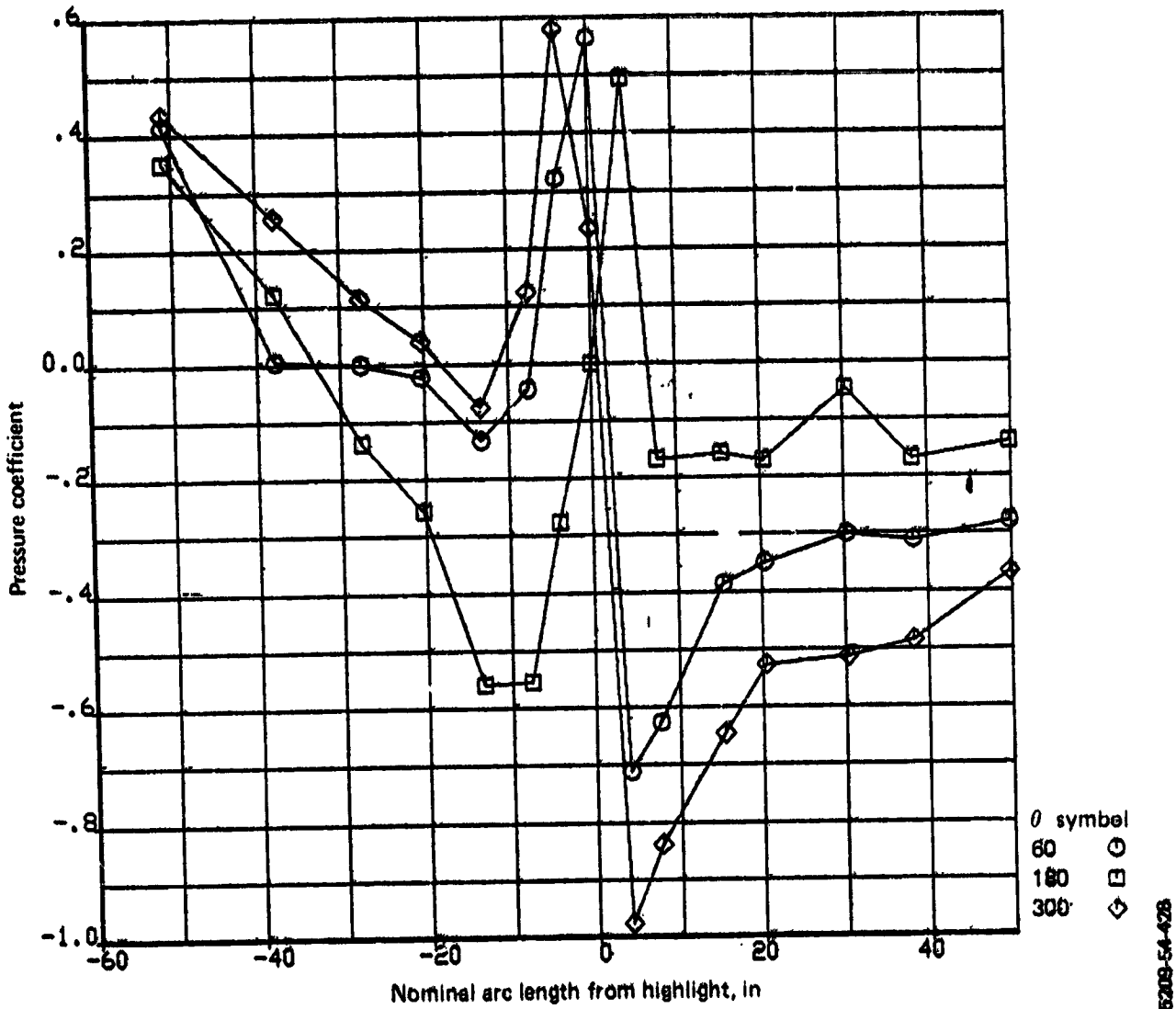


Figure A-66. Engine No. 4 Inlet Pressures, Condition 116, 2.0g Left Turn (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

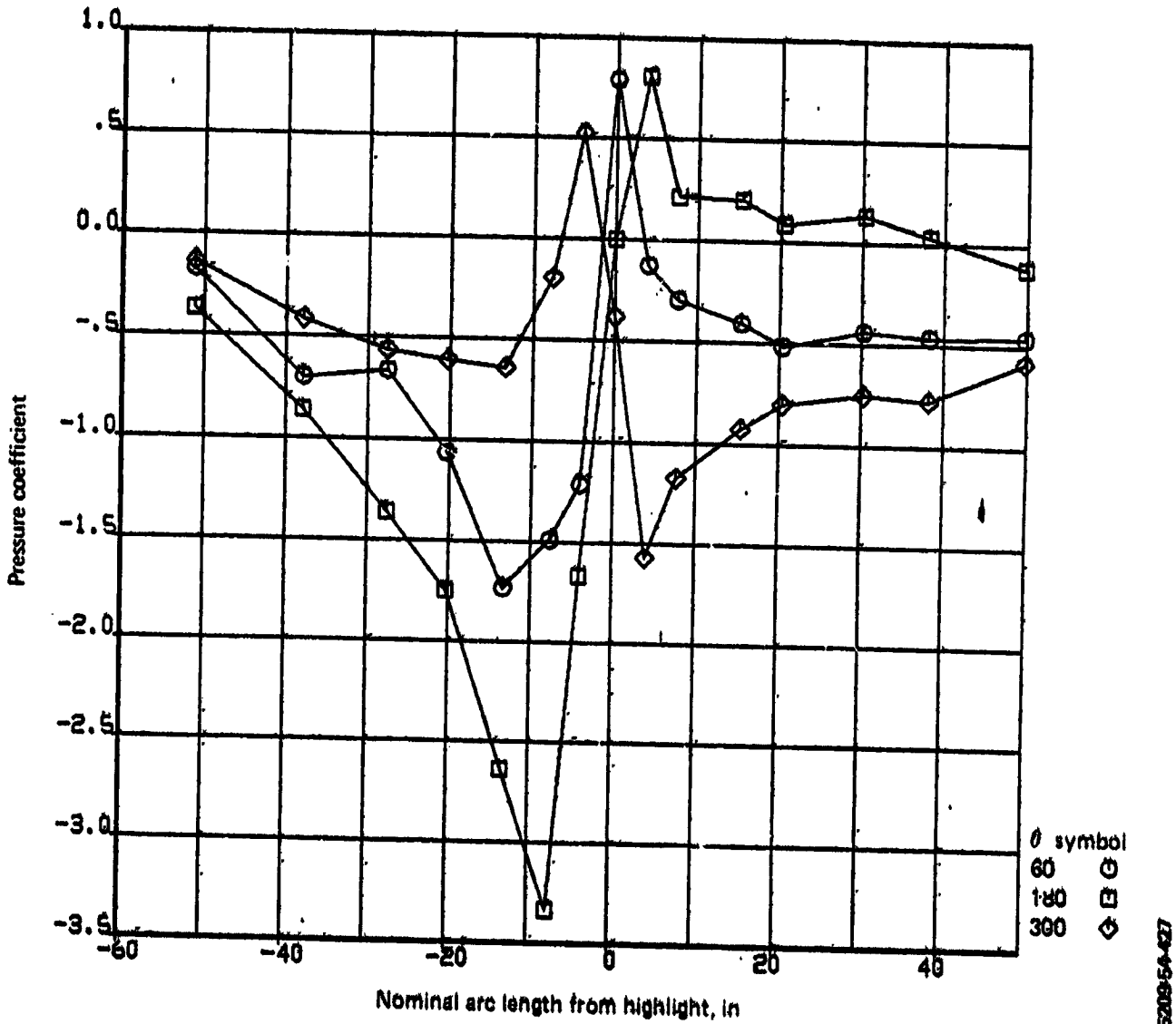


Figure A-67. Engine No. 4 Inlet Pressures, Condition 117, 1.6g Left Turn (Flaps 30)

ORIGINAL PAGE IS
OF POOR QUALITY

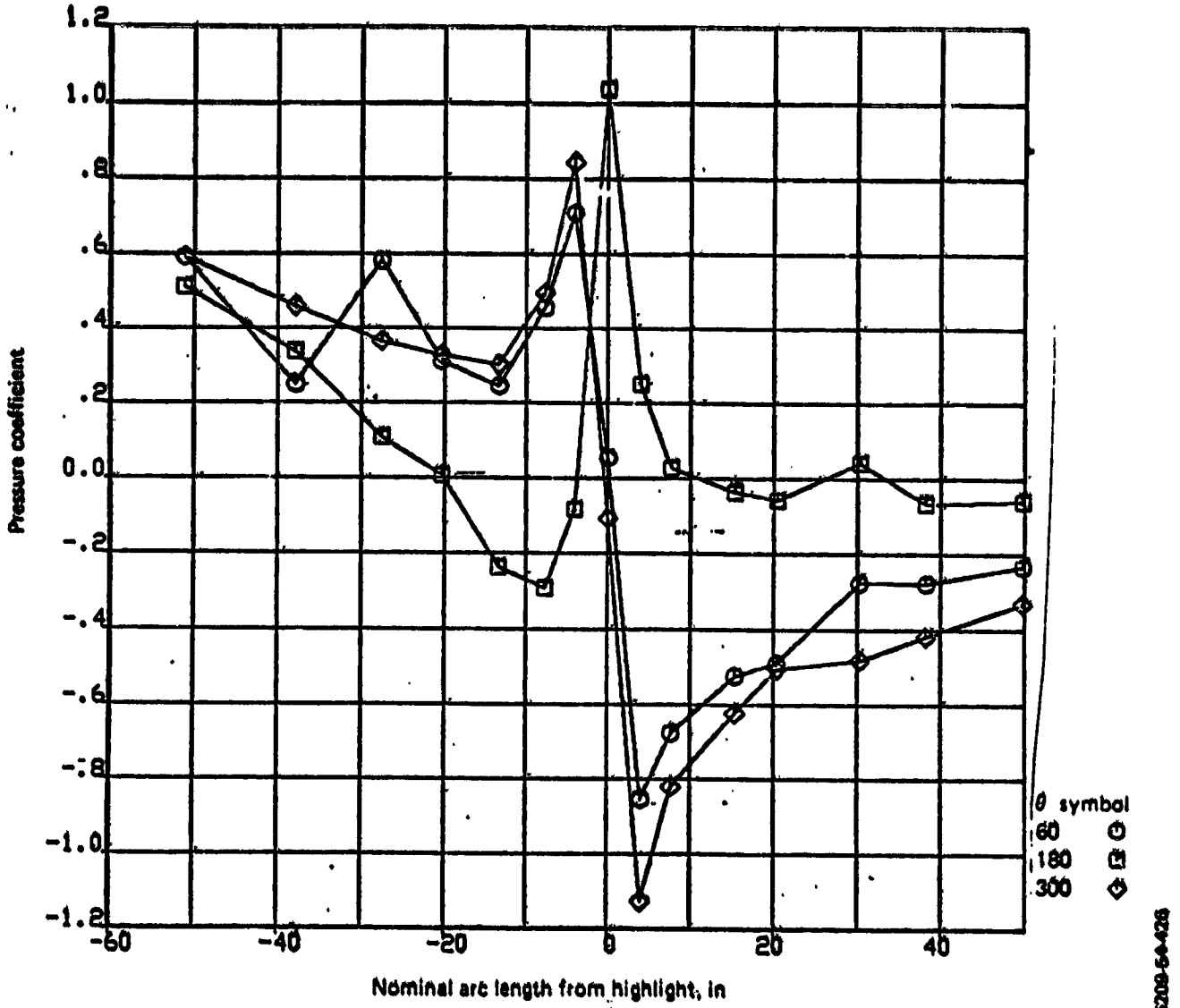


Figure A-68. Engine No. 4 Inlet Pressures, Condition 120, 2.0g Right Turn (Flaps Up)

ORIGINAL PAGE IS
OF POOR QUALITY

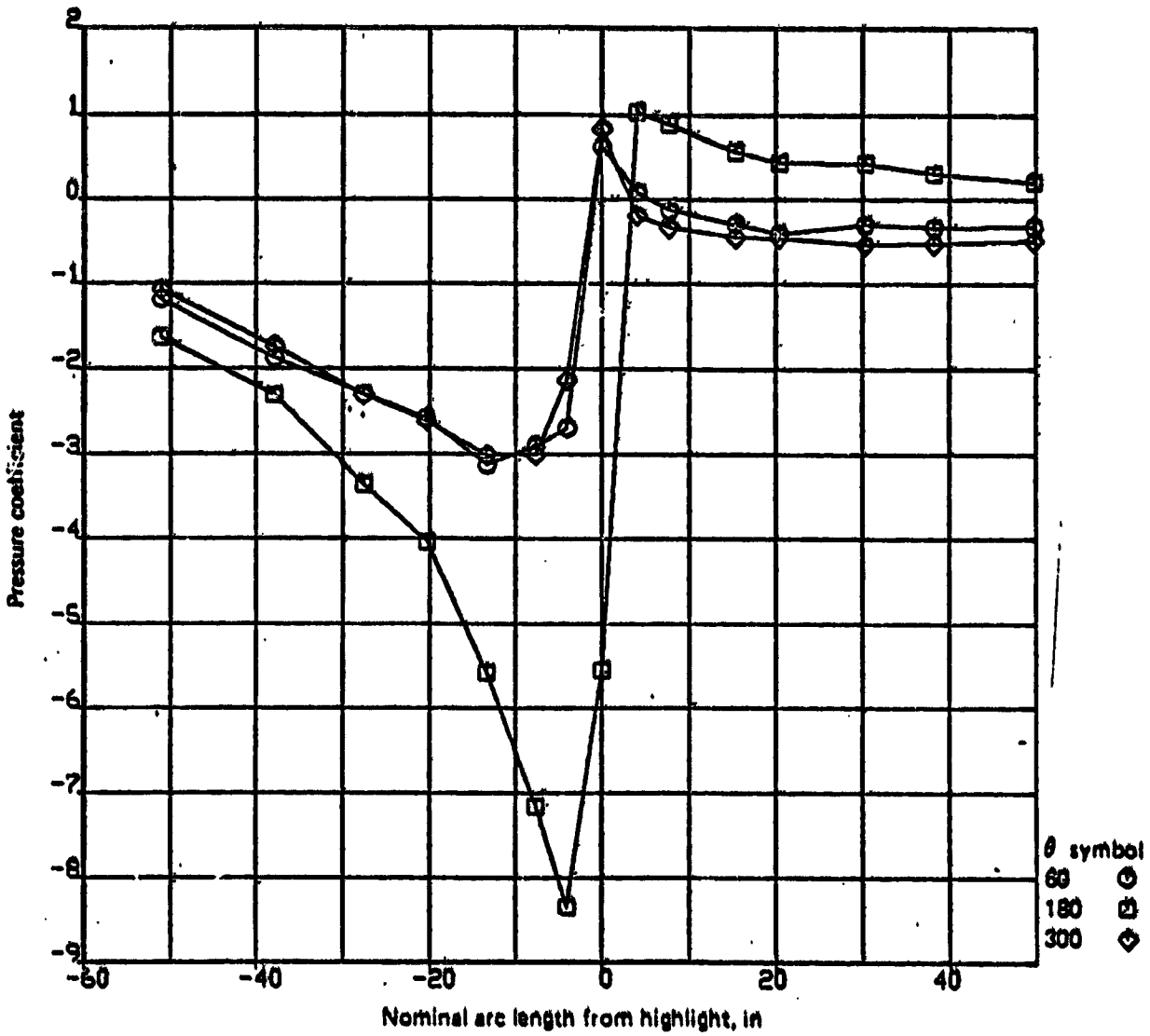


Figure A-69. Engine No. 4 Inlet Pressures, Condition 121, 1.6g Right Turn (Flaps 30)

125209-54-A35

ORIGINAL PAGE IS
OF POOR QUALITY

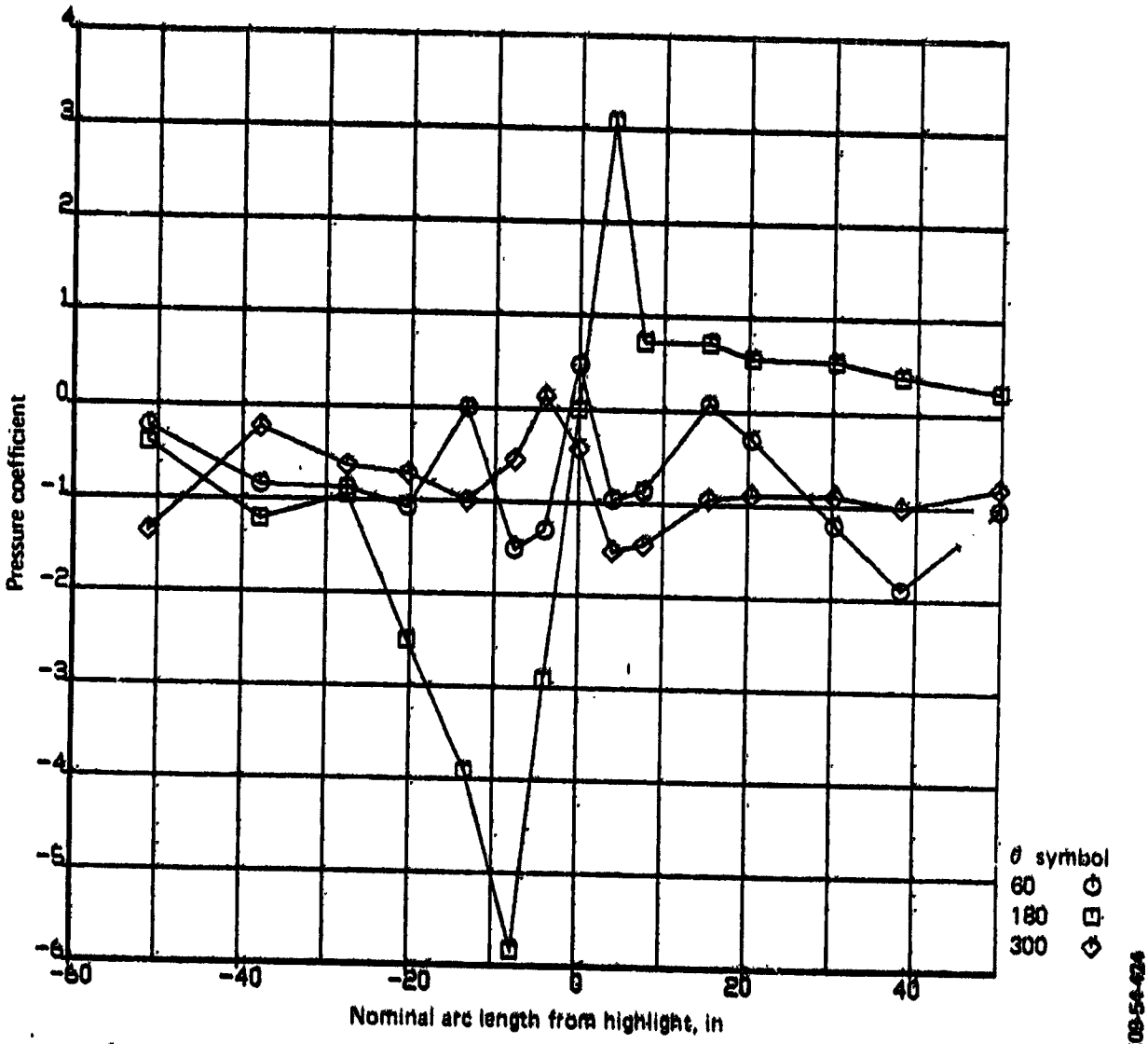
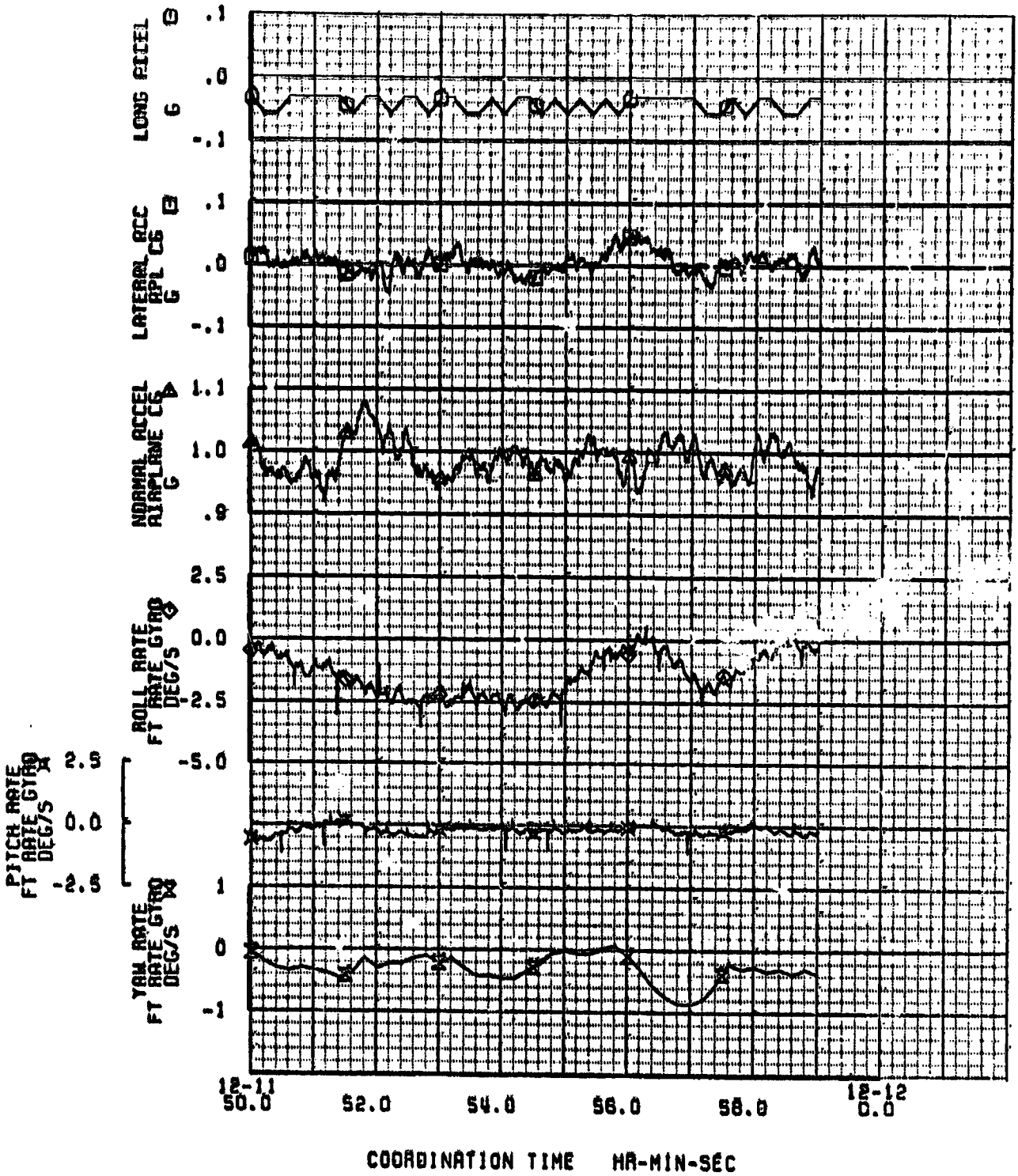


Figure A-70. Engine No. 4 Inlet Pressures, Condition 123, Airplane Stall

ORIGINAL PAGE IS
OF POOR QUALITY



125009-21-115

Figure A-71. Airplane Center-of-Gravity Accelerations, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

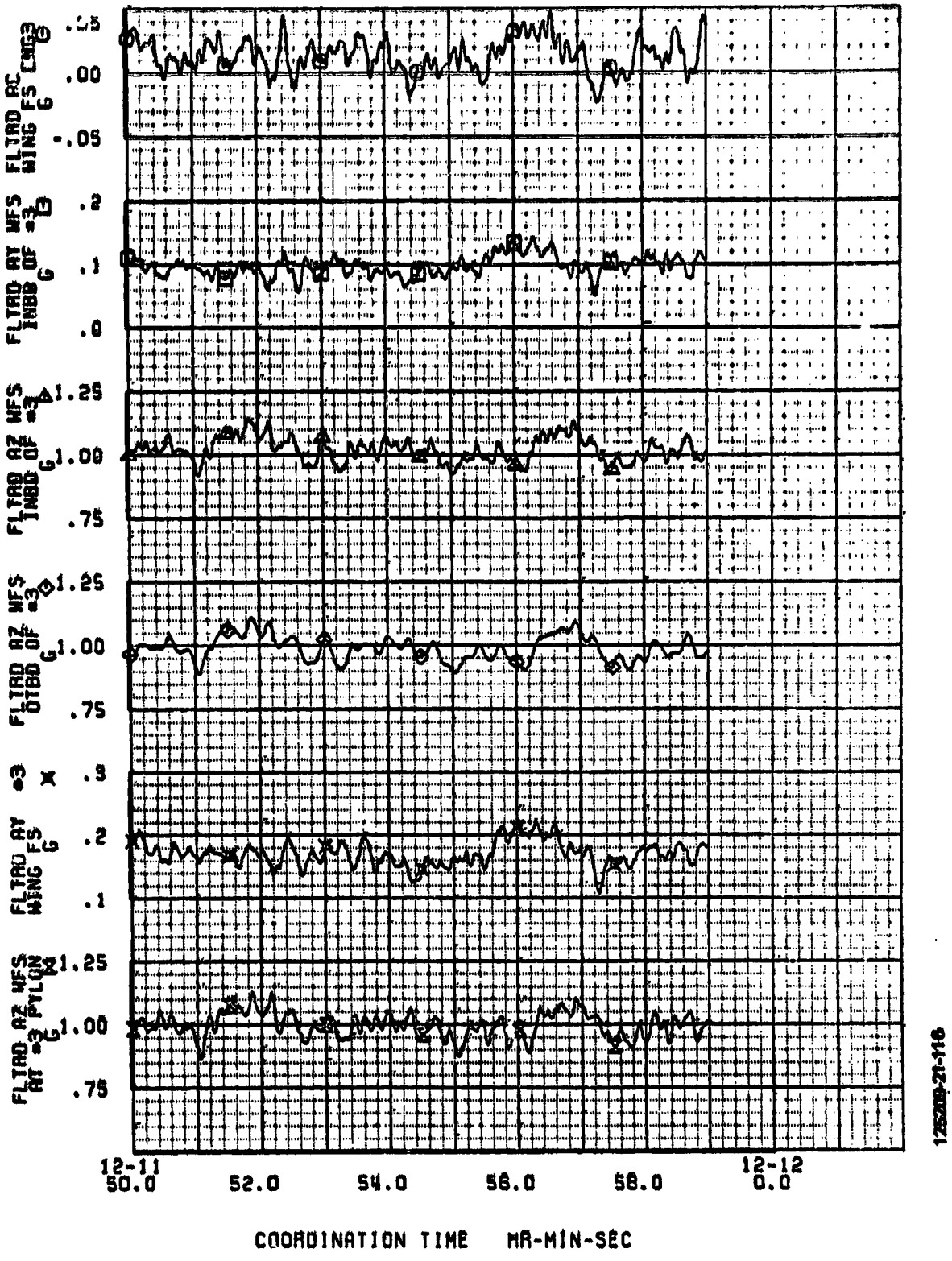


Figure A-72. Engine No. 3 Wing/Strut Accelerations, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

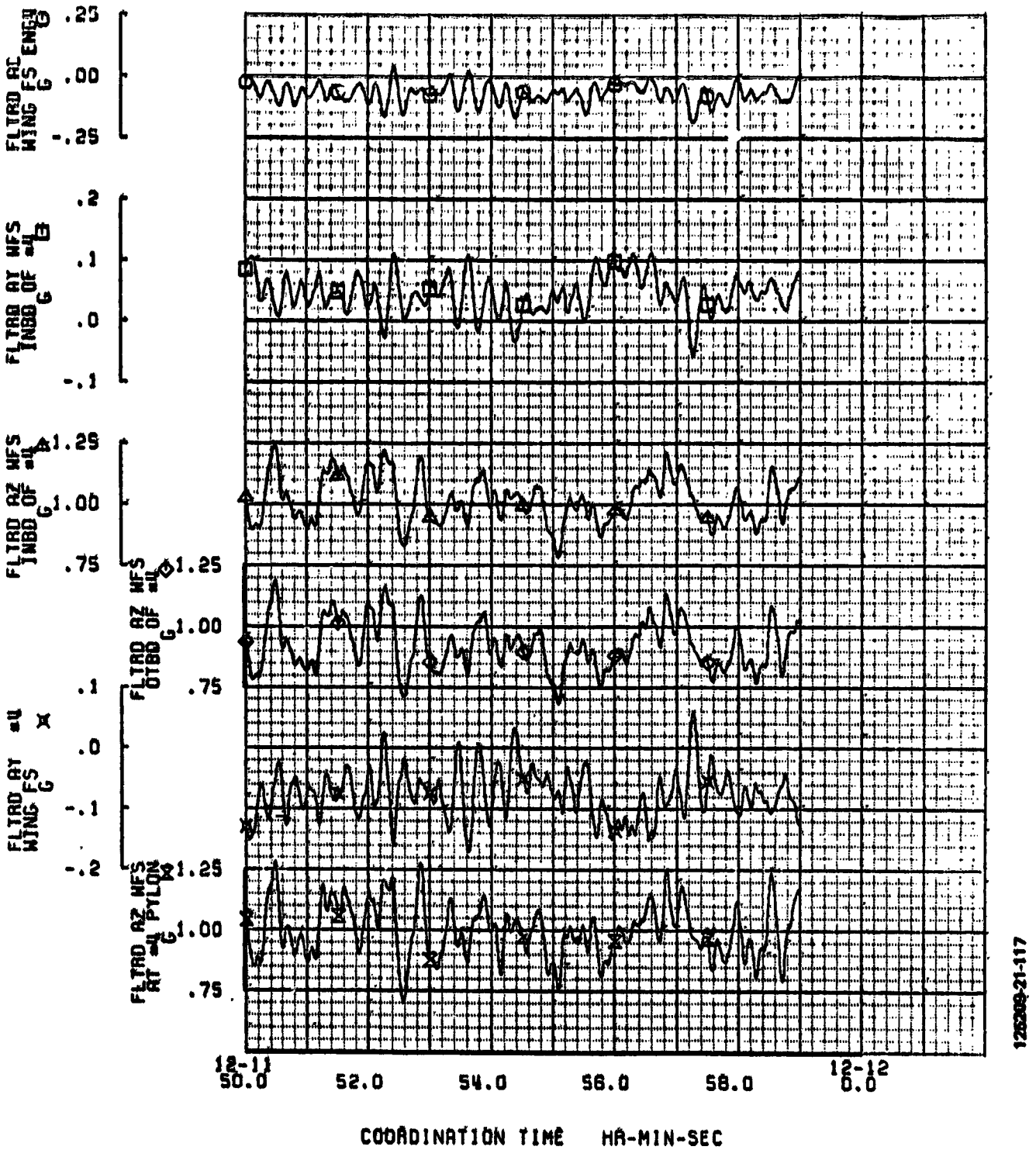


Figure A-73. Engine No. 4 Wing/Strut Accelerations, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

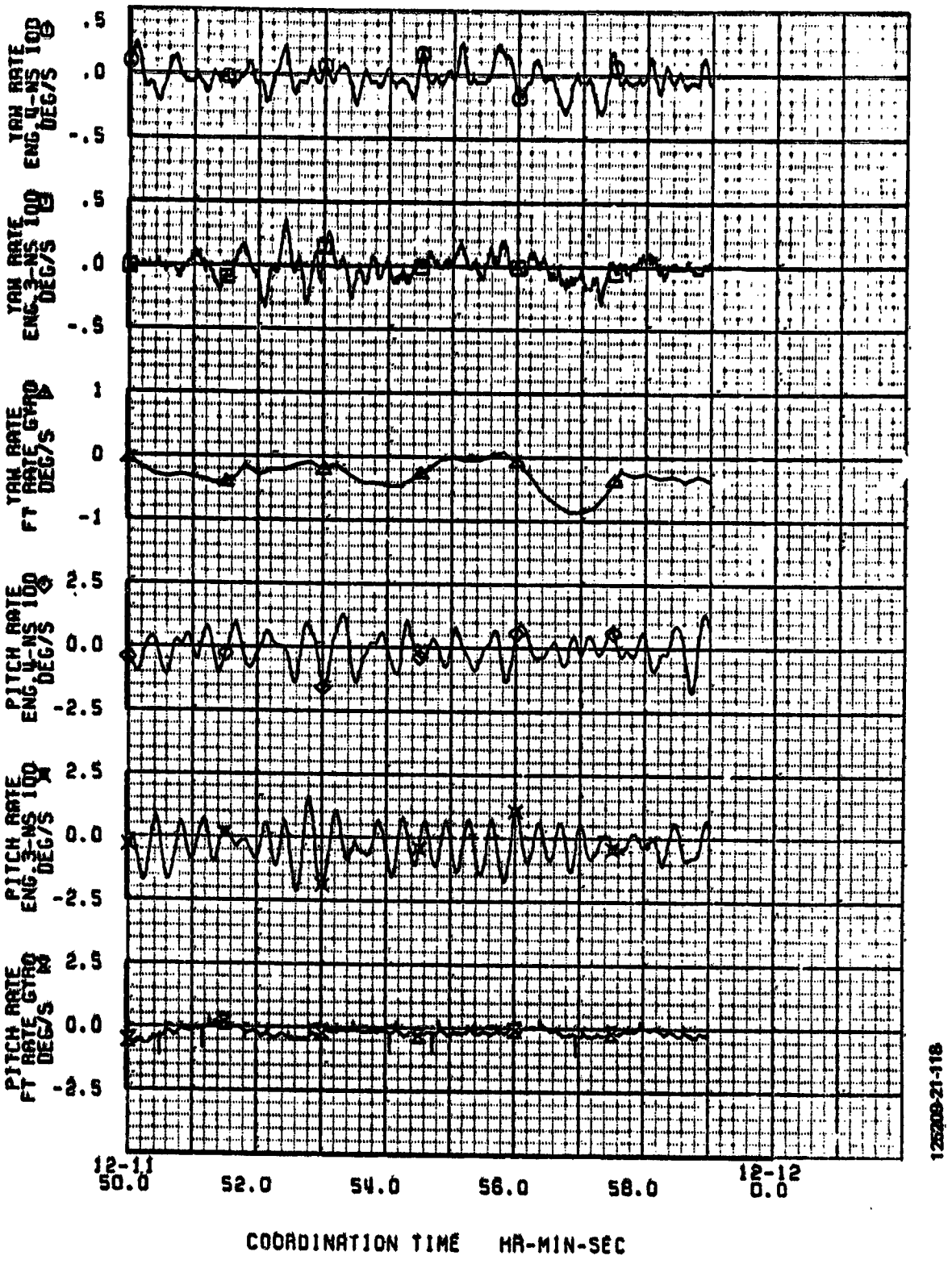


Figure A-74. Engine Angular Rates, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

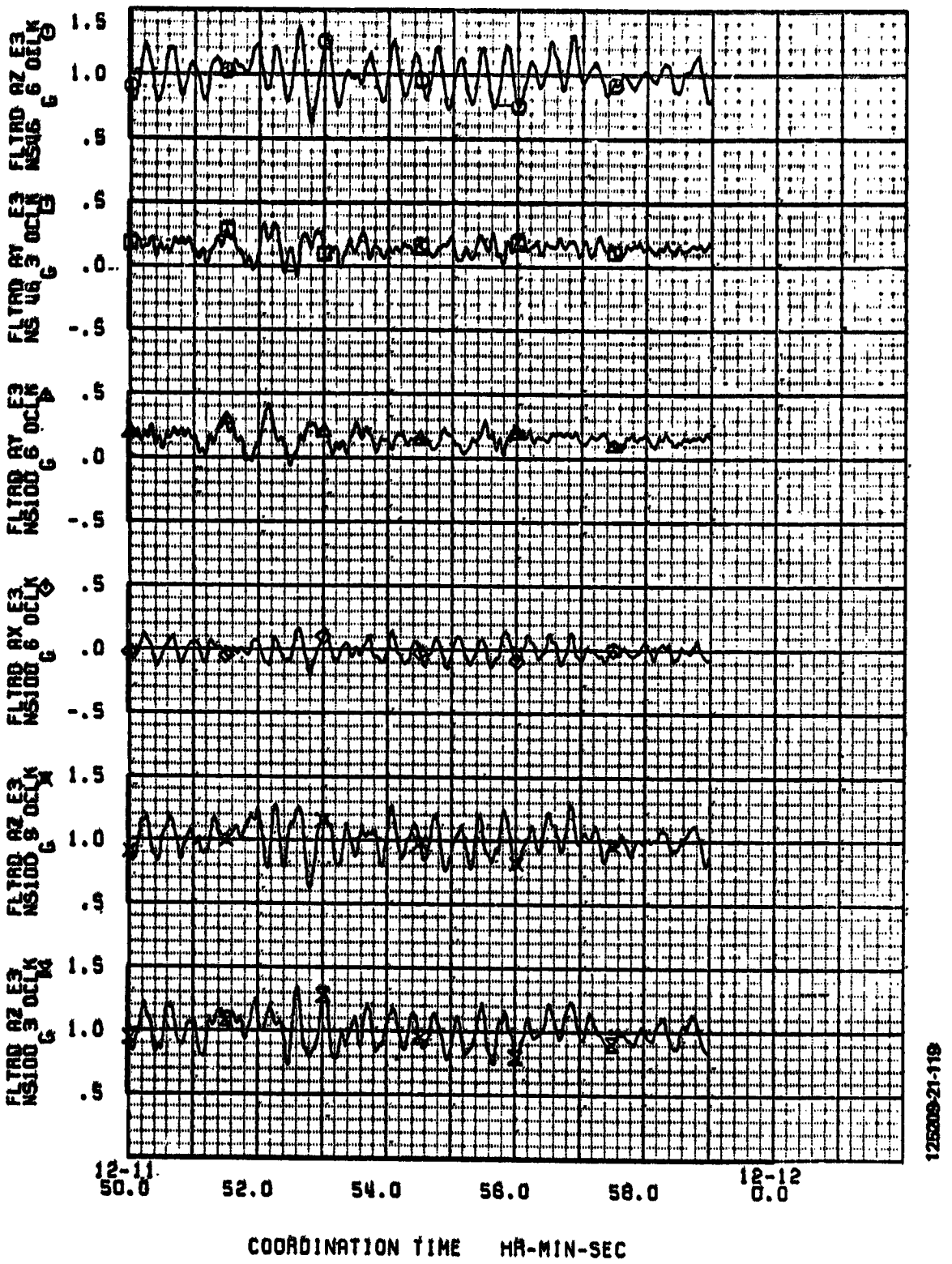


Figure A-75. Engine No. 3 Accelerations, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

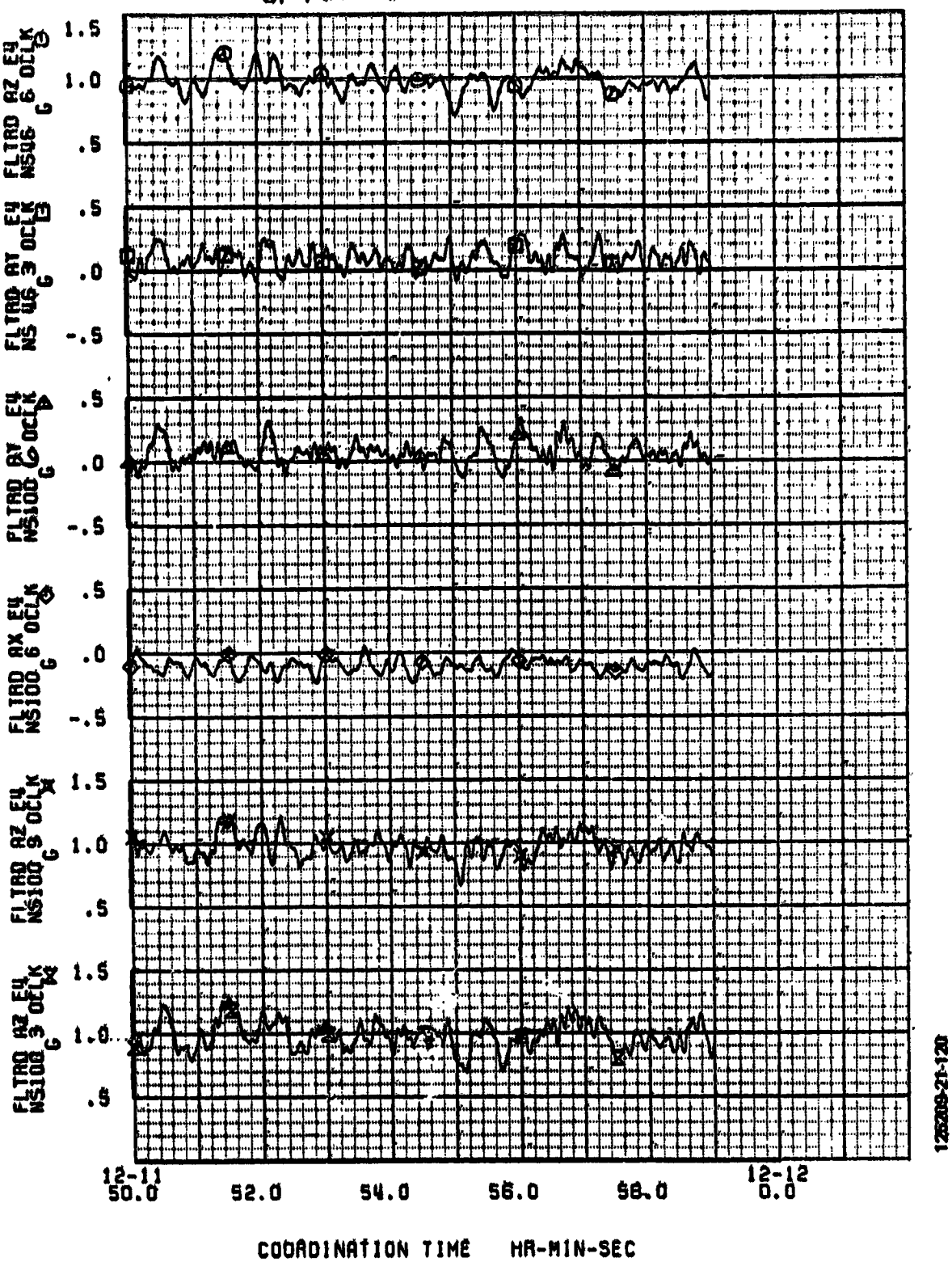


Figure A-76. Engine No. 4 Accelerations, Mild Gust

ORIGINAL PAGE IS
OF POOR QUALITY

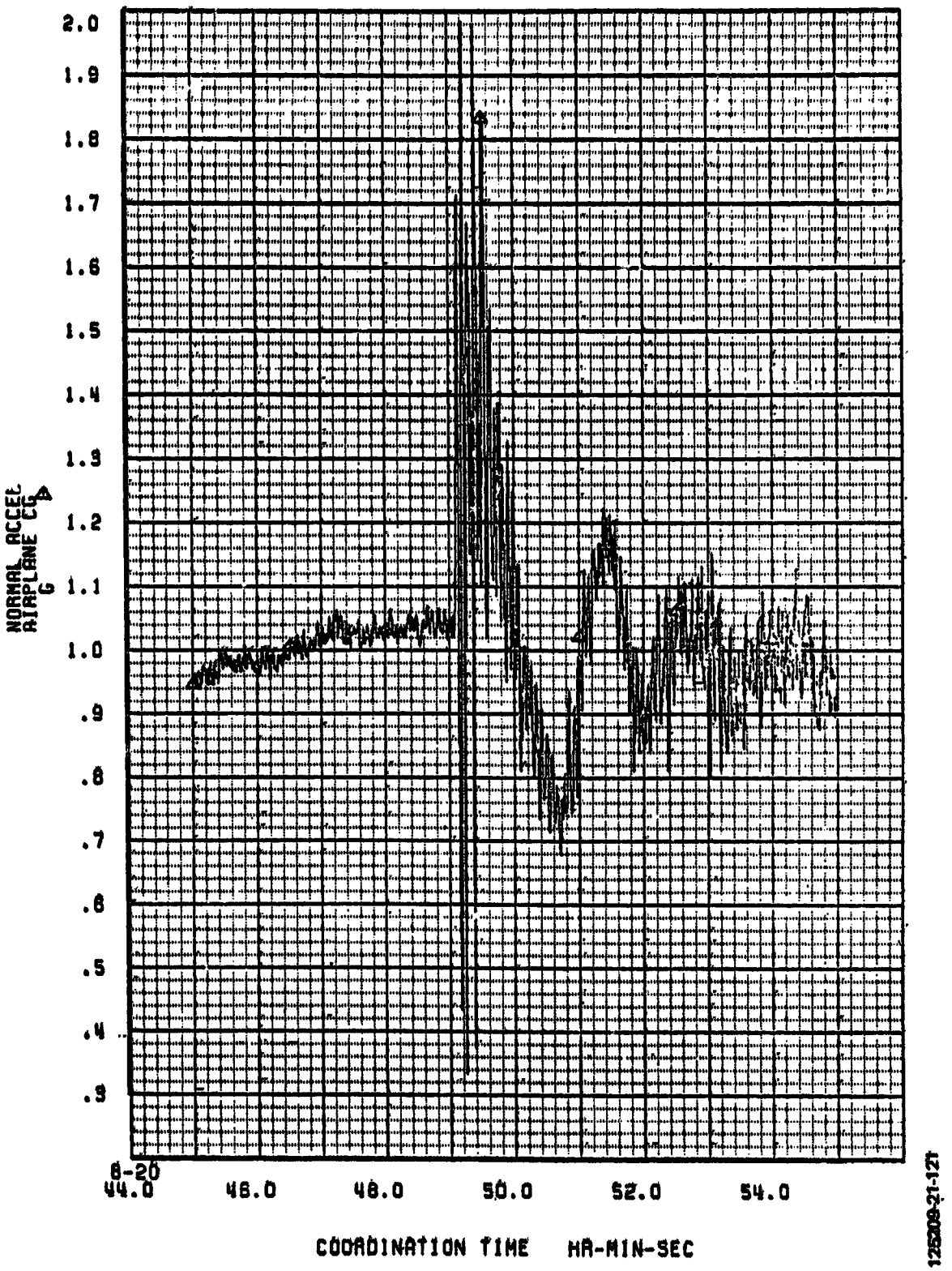


Figure A-77. Airplane Center-of-Gravity Normal Acceleration, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

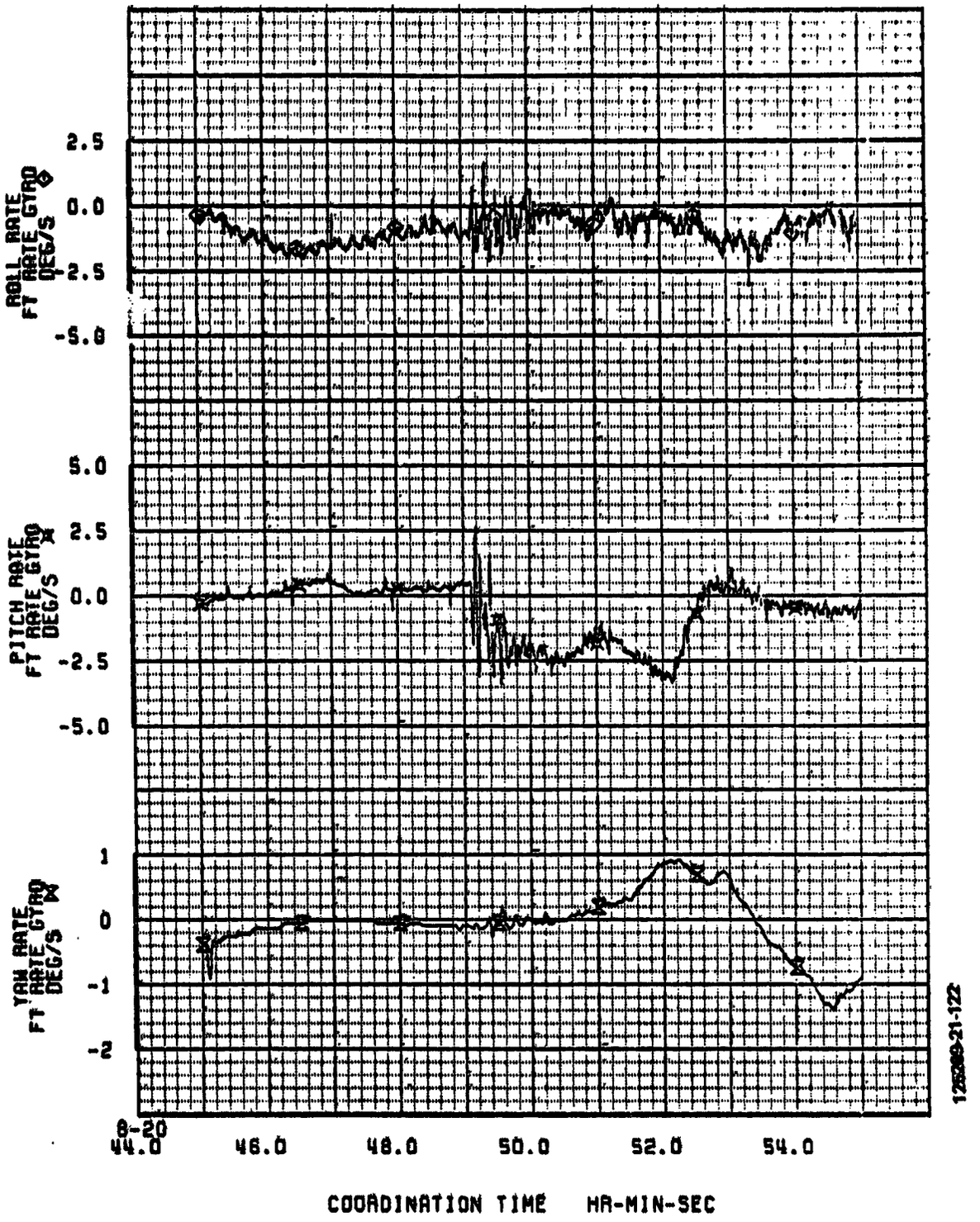


Figure A-78. Airplane Center-of-Gravity Angular Rates, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

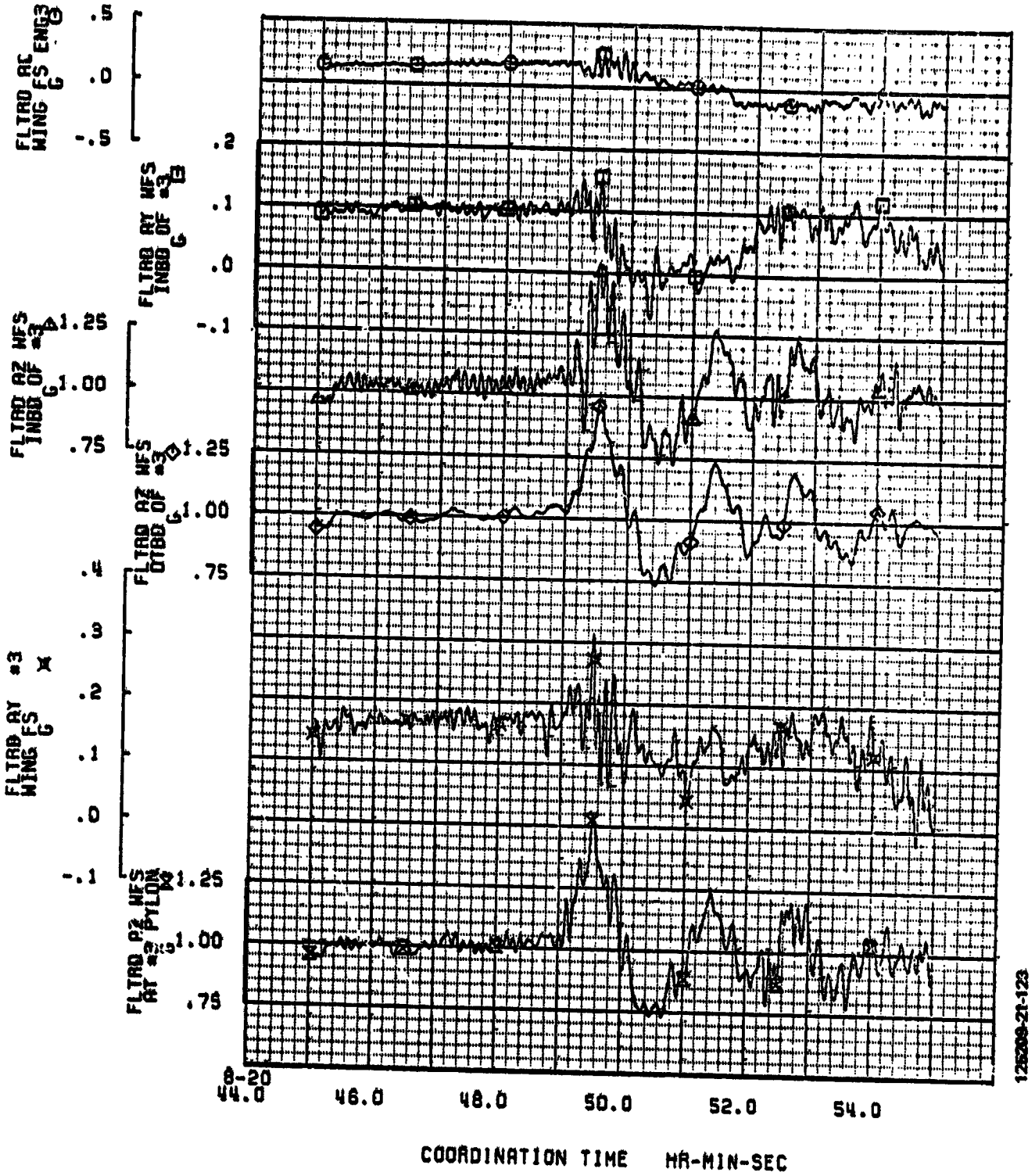


Figure A-79. Engine No. 3 Wing/Strut Accelerations, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

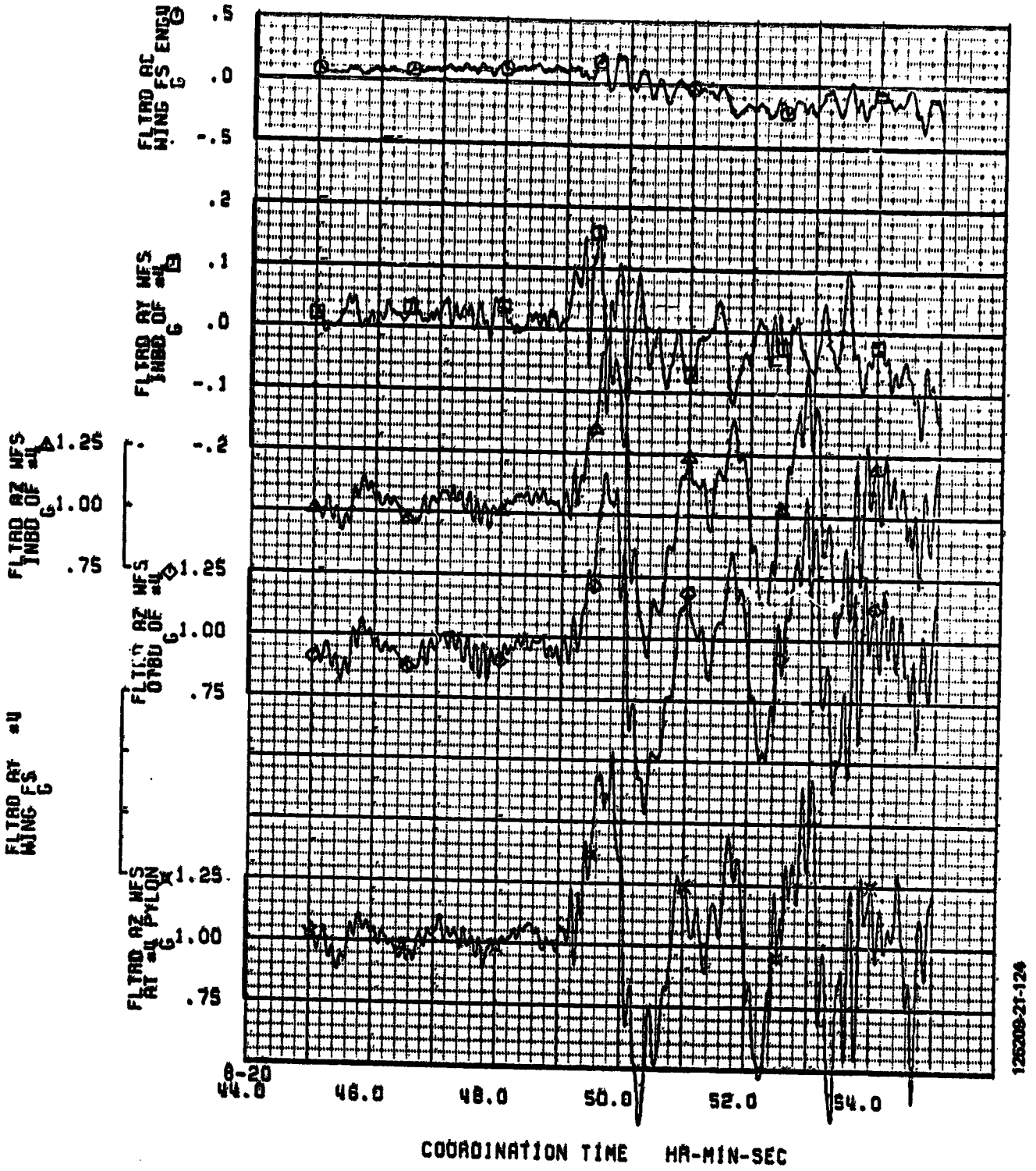


Figure A-80. Engine No. 4 Wing/Strut Accelerations, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

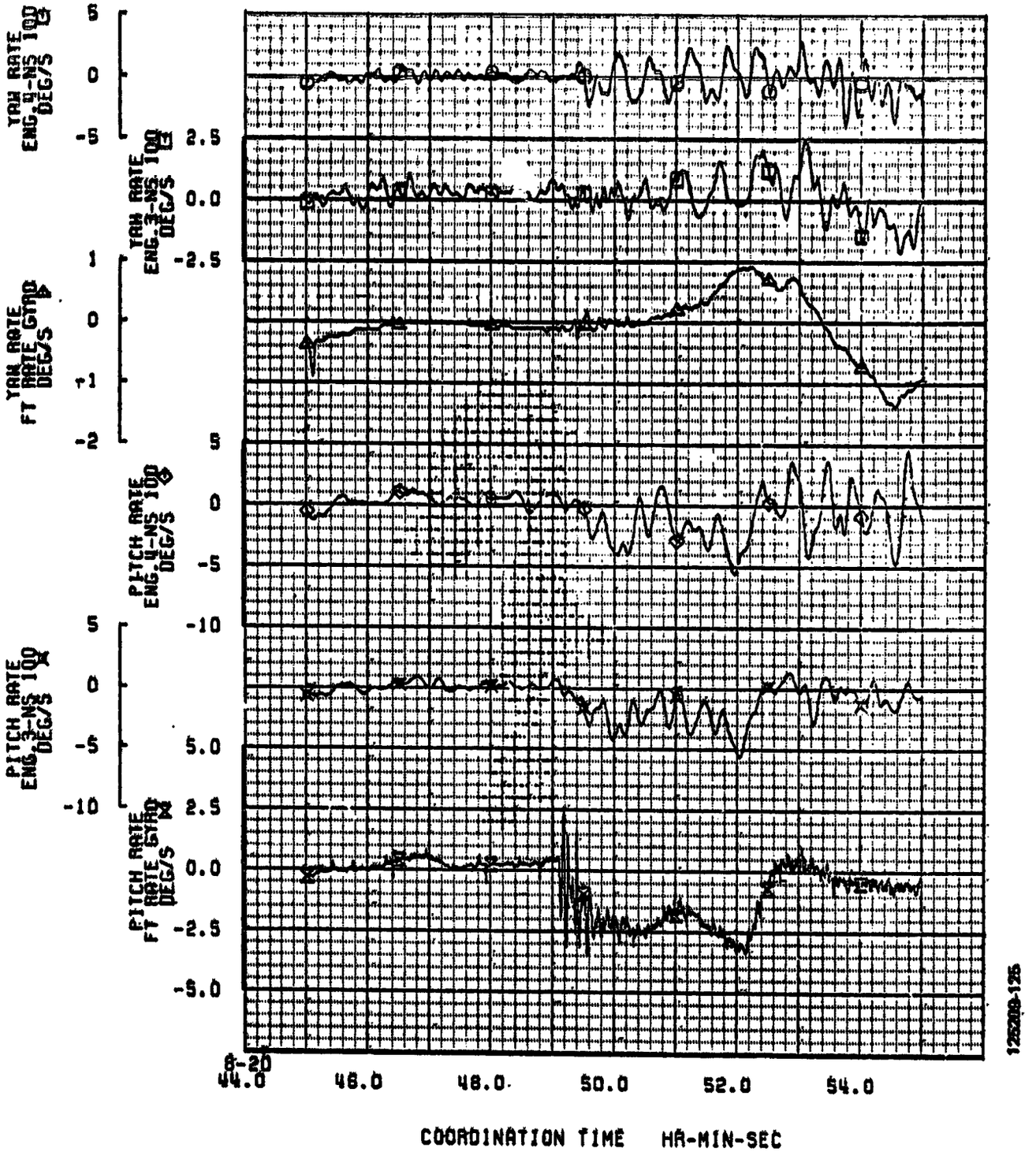


Figure A-81. Engine Angular Rates, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

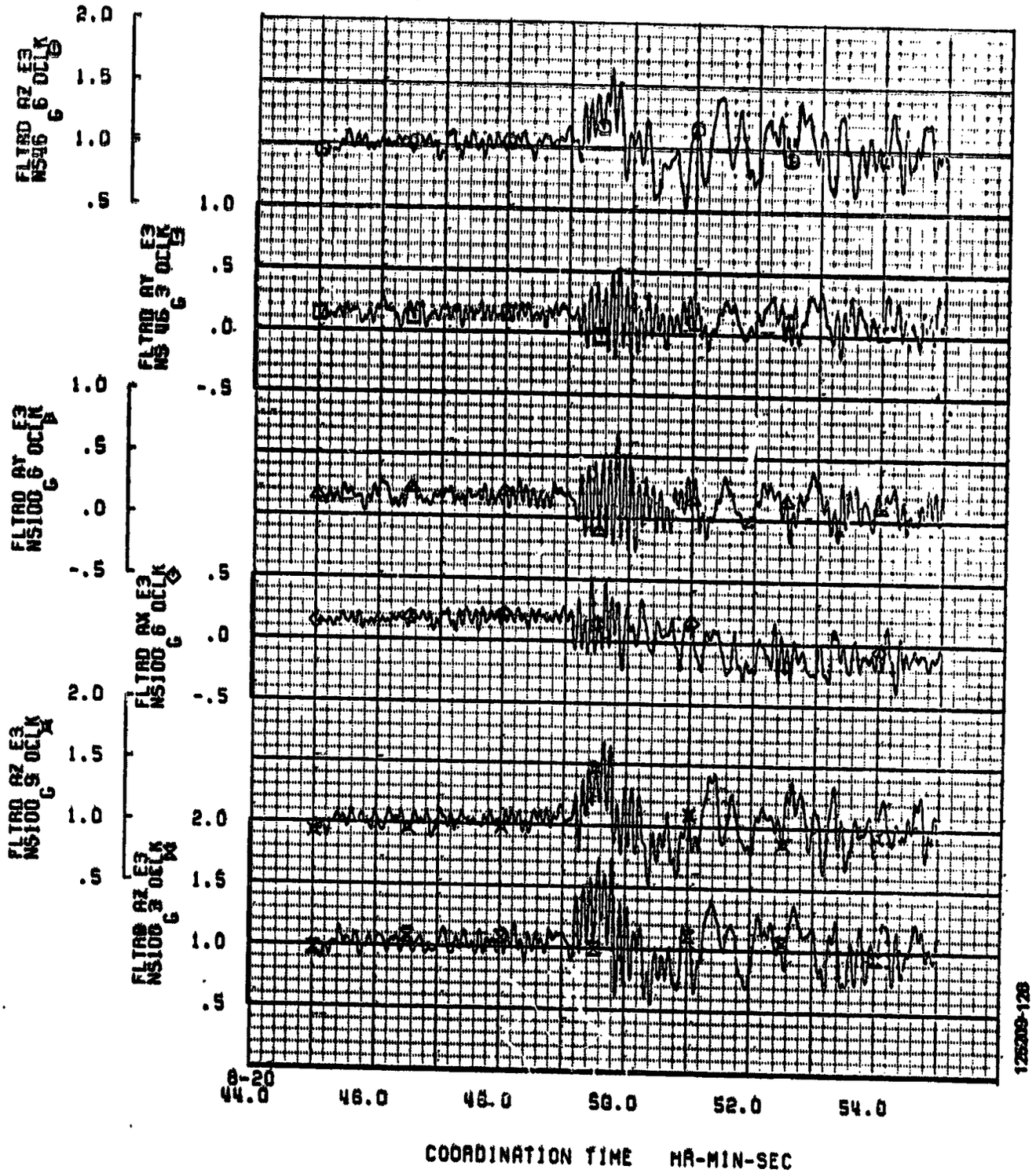


Figure A-82. Engine No. 3 Accelerations, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

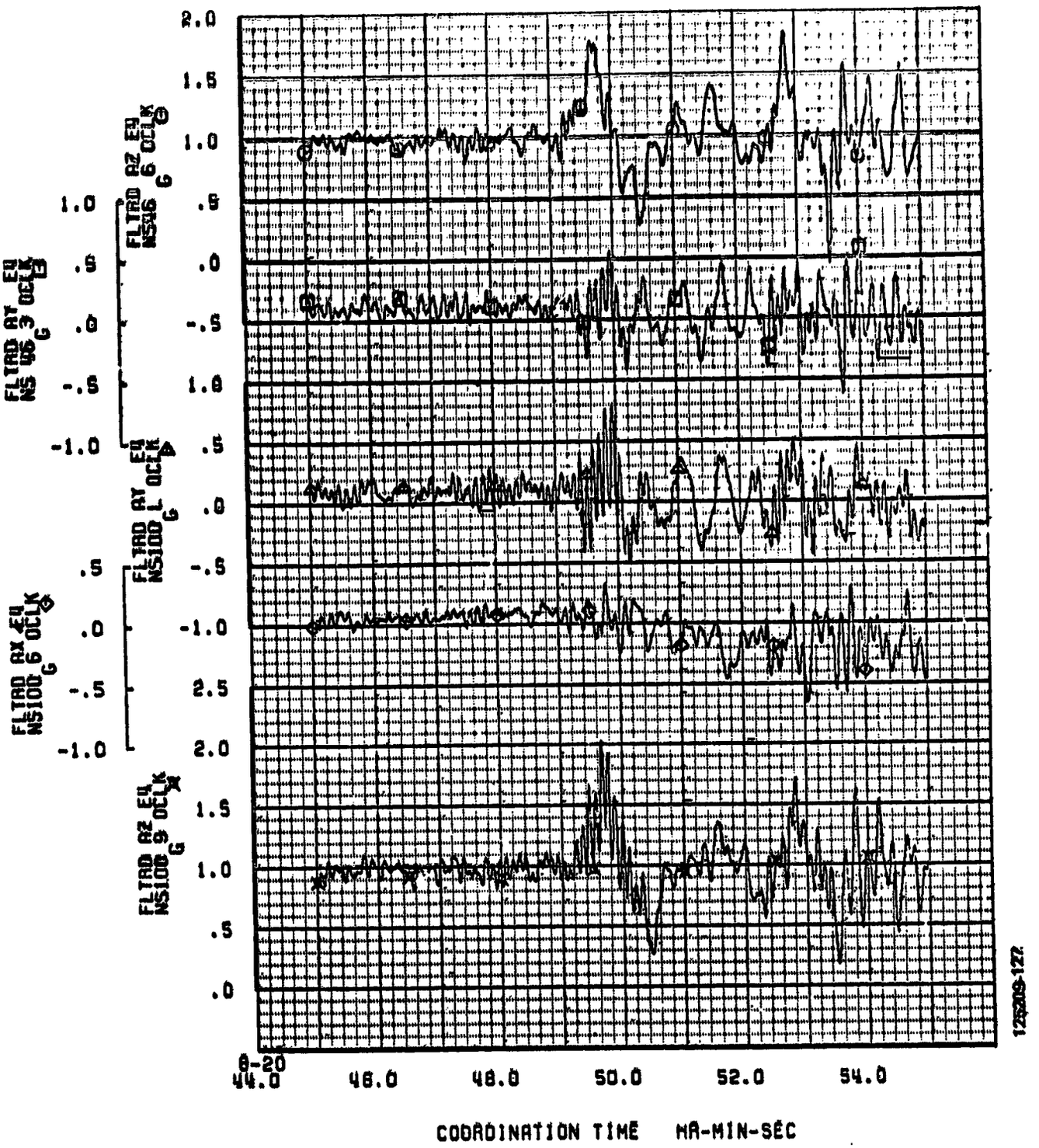


Figure A-83. Engine No. 4 Accelerations, Hard Landing

ORIGINAL PAGE IS
OF POOR QUALITY

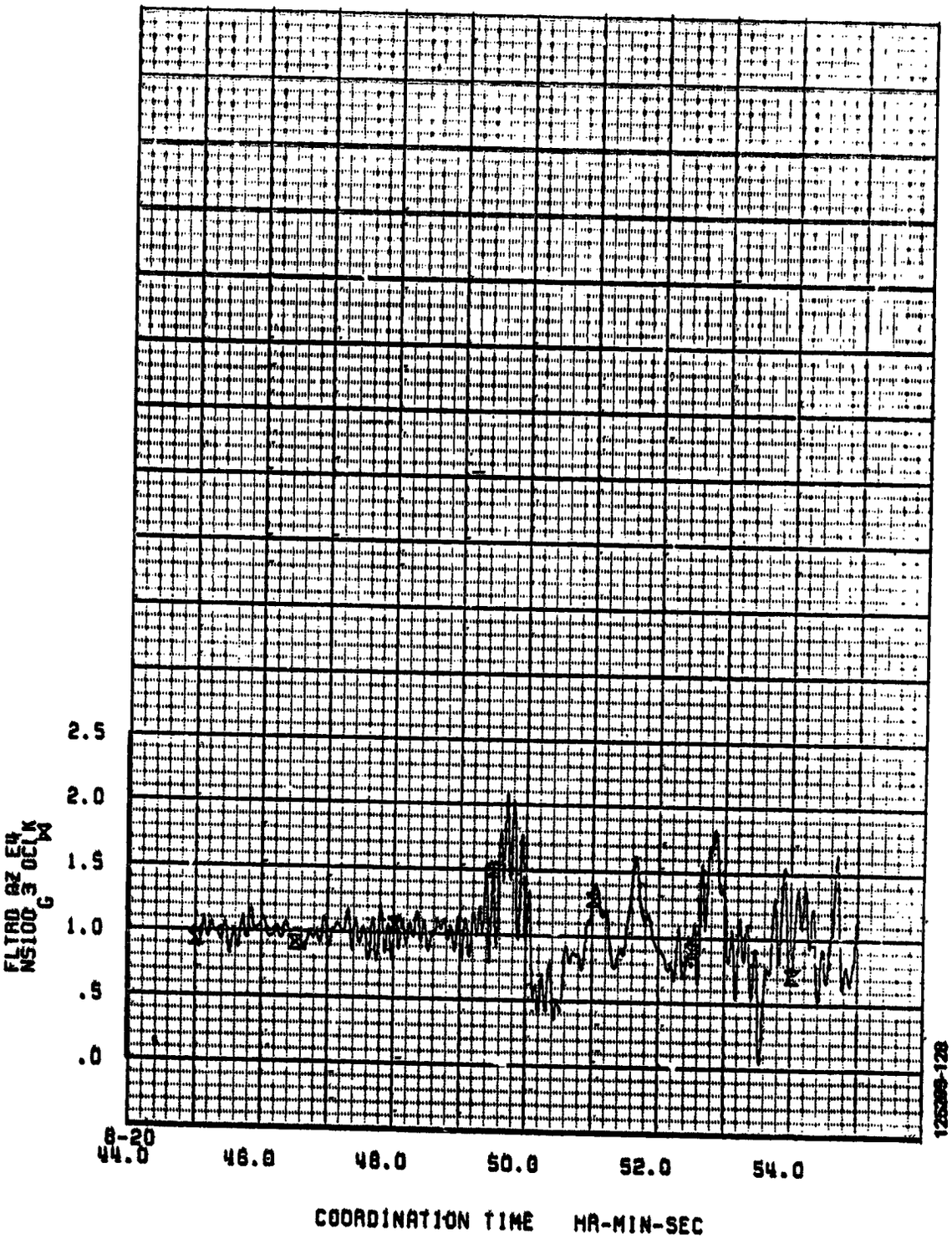


Figure A-83. Engine No. 4 Accelerations, Hard Landing (Concluded)