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UH-1H AIDAPS TEST BED PROGRAM. VOLUME II.

James Provenzano, et al

Hamilton Standard

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USAAVSCOM TECHNICAL REPORT 72-18

UH-1H AIDAPS TEST BED PROGRAM

VOLUME II OF II

BY

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AUGUST 1972

U.S. ARMY AVIATION SYSTEMS COMMAND
ST. LOUIS, MISSOURI 63166

CONTRACT DAAJ01-70-C-0827 (P3L)
HAMILTON STANDARD DIVISION OF UNITED AIRCRAFT CORP.
WINDSOR LOCKS, CONNECTICUT

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VOLUME II OF II
FIGURES & TABLES
AUGUST 31, 1972

FINAL TECHNICAL REPORT

— SUBMITTED TO —

THE U.S. ARMY
AVIATION SYSTEMS COMMAND

ST. LOUIS, MISSOURI

— IN ACCORDANCE WITH —

CONTRACT NO. DAA J01—70—C—0827 (P3L)

UH-1H AIDAPS TEST BED PROGRAM

Details of illustrations in
this document may be better
studied on microfiche

Hamilton Standard
DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT · U.S.A.

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SECTION 2

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UH-1 TEST BED PROGRAM

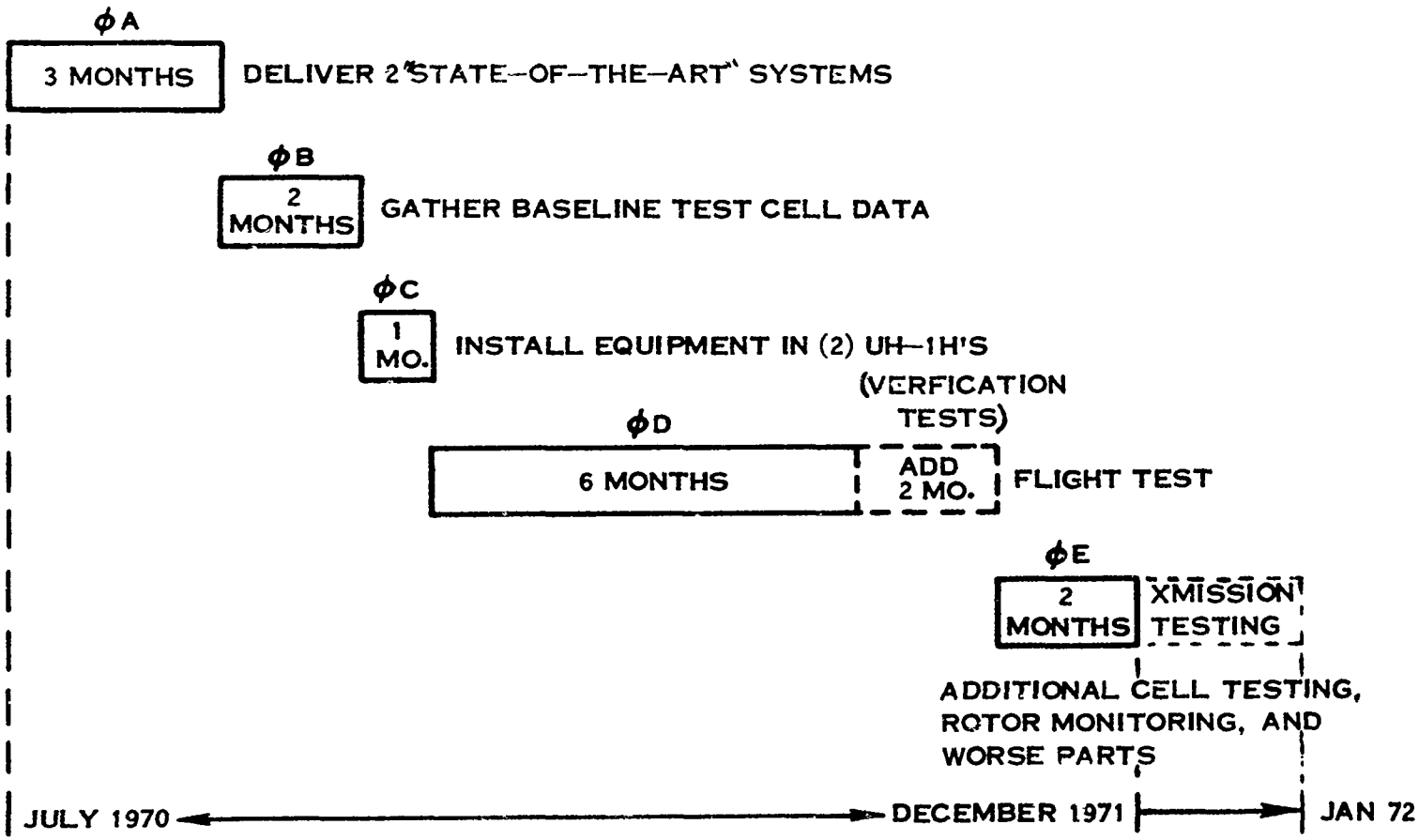
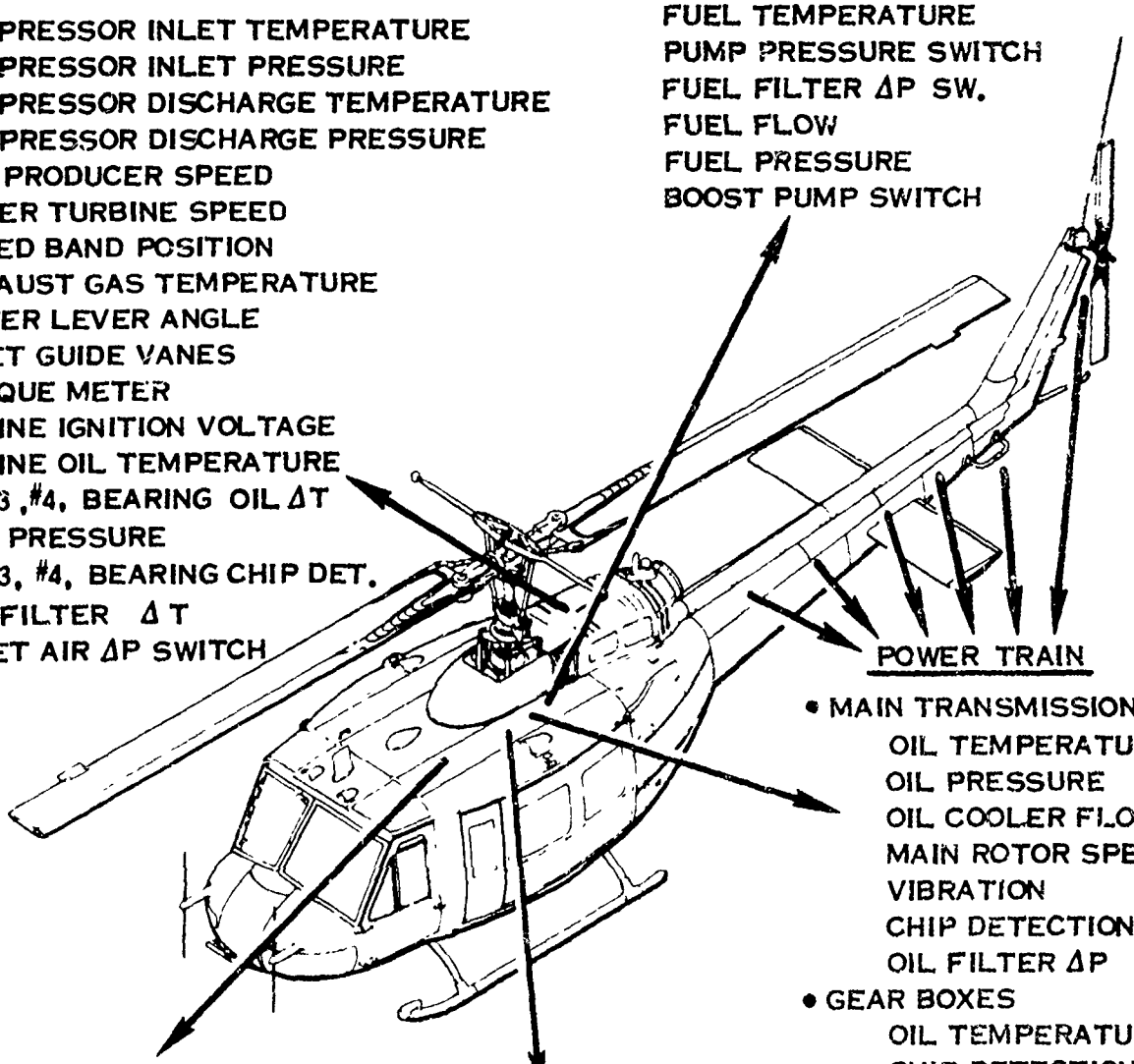


FIGURE 2–2

TEST-BED PARAMETERS



PROPULSION

COMPRESSOR INLET TEMPERATURE
COMPRESSOR INLET PRESSURE
COMPRESSOR DISCHARGE TEMPERATURE
COMPRESSOR DISCHARGE PRESSURE
GAS PRODUCER SPEED
POWER TURBINE SPEED
BLEED BAND POSITION
EXHAUST GAS TEMPERATURE
POWER LEVER ANGLE
INLET GUIDE VANES
TORQUE METER
ENGINE IGNITION VOLTAGE
ENGINE OIL TEMPERATURE
#2, #3, #4, BEARING OIL ΔT
OIL PRESSURE
#2, #3, #4, BEARING CHIP DET.
OIL FILTER ΔT
INLET AIR ΔP SWITCH

FUEL SYSTEM

FUEL TEMPERATURE
PUMP PRESSURE SWITCH
FUEL FILTER ΔP SW.
FUEL FLOW
FUEL PRESSURE
BOOST PUMP SWITCH

POWER TRAIN

- MAIN TRANSMISSION
  - OIL TEMPERATURE
  - OIL PRESSURE
  - OIL COOLER FLOW
  - MAIN ROTOR SPEED
  - VIBRATION
  - CHIP DETECTION
  - OIL FILTER ΔP
- GEAR BOXES
  - OIL TEMPERATURE
  - CHIP DETECTION
  - VIBRATION
- HANGER BEARING
  - VIBRATION

ELECTRICAL SYSTEM

28 VDC ESSENTIAL BUS
115 VAC ESSENTIAL BUS
26 VAC INSTRUMENT BUS
START BATT VOLTAGE

HYDRAULIC SYSTEM

SUPPLY PRESSURE
PUMP BYPASS FLOW
PUMP BYPASS ΔT
FILTER ΔT

AIRCRAFT FLIGHT MODE

TOTAL PRESSURE
STATIC PRESSURE
COLLECTIVE PITCH
HI/LO RPM WARNING
OVERSPEED GOVERNOR SWITCH

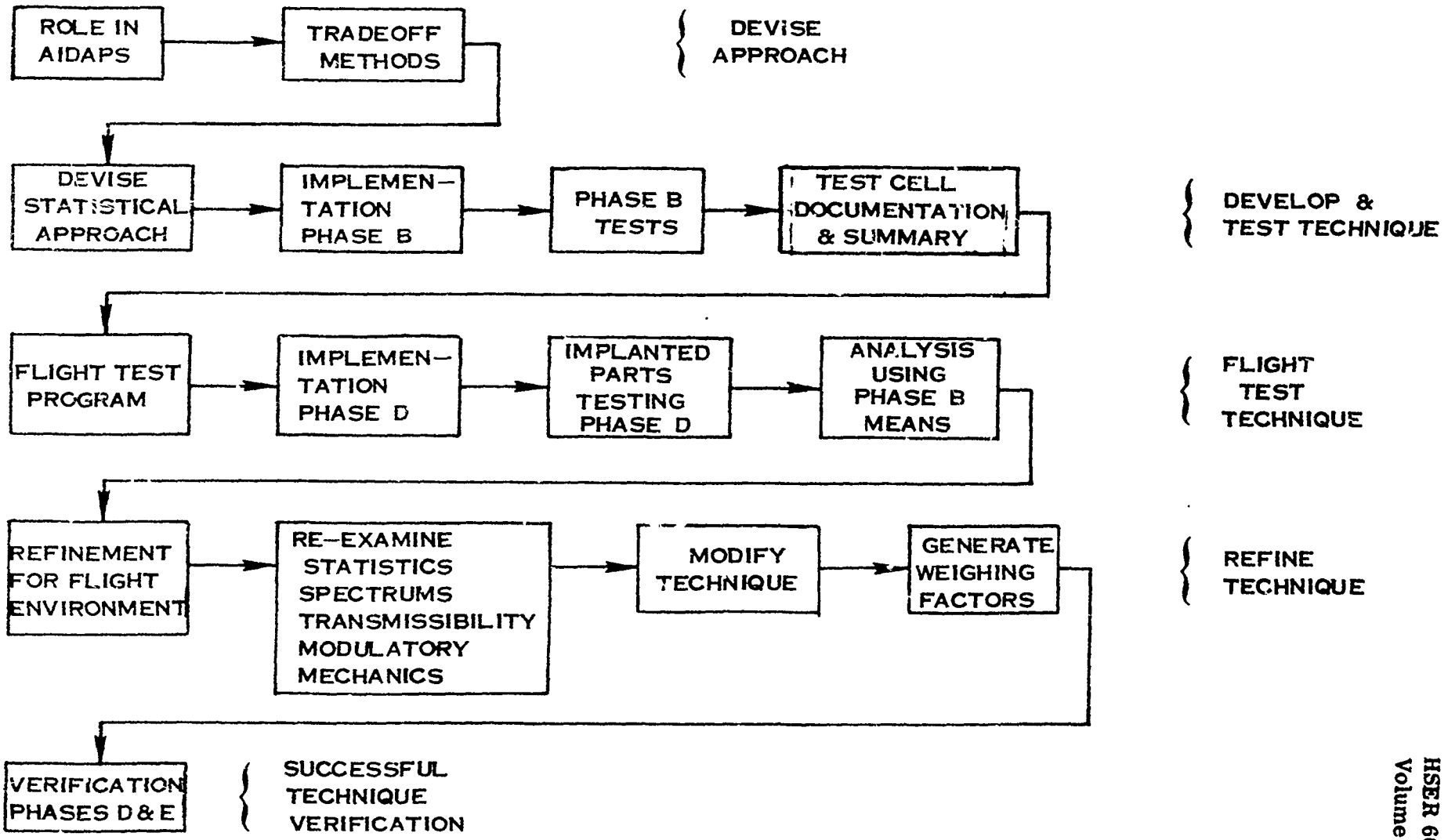


FIGURE 2-3. HAMILTON STANDARD VIBRATION TECHNIQUE DEVELOPMENT

SECTION 3

THE PROGRAM

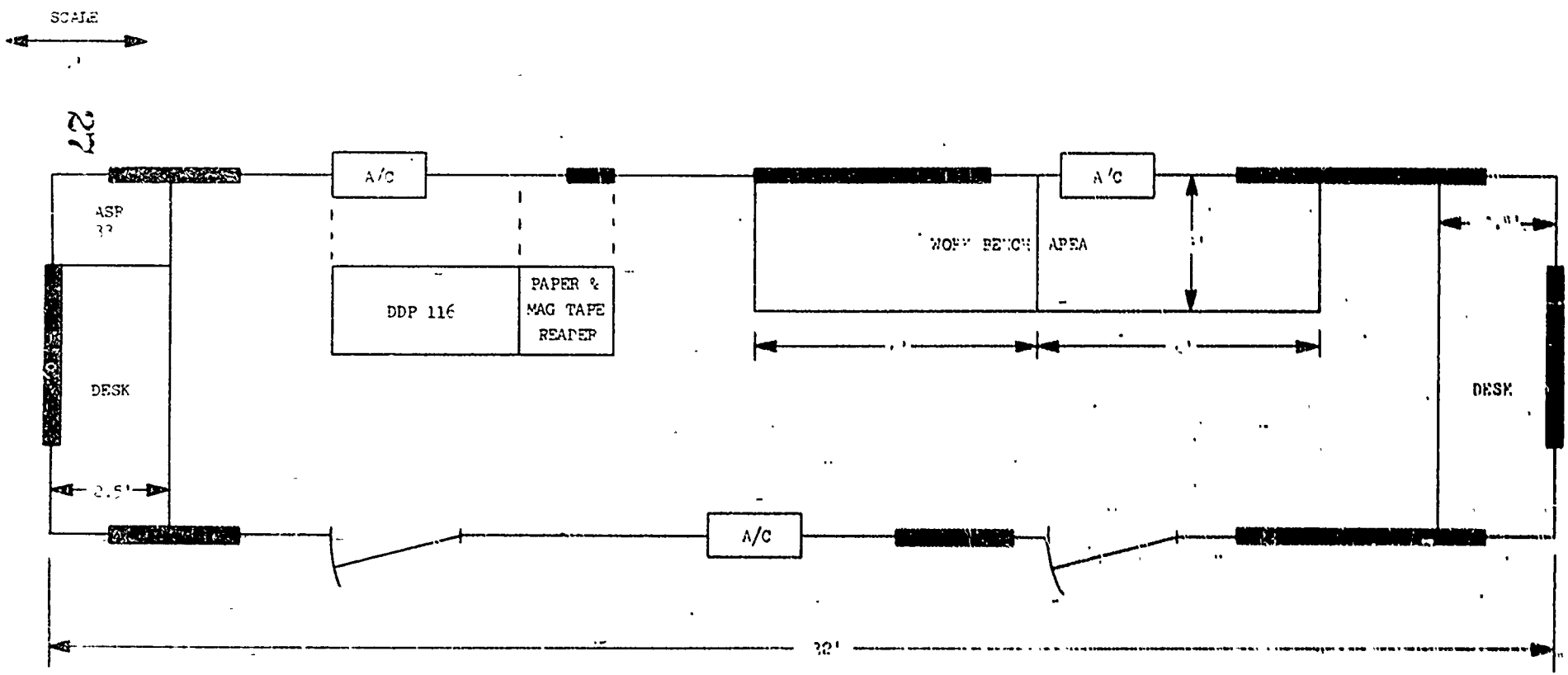


FIGURE 3–1 FLOOR PLAN–MC–36 MOBILE OFFICE (VAN)

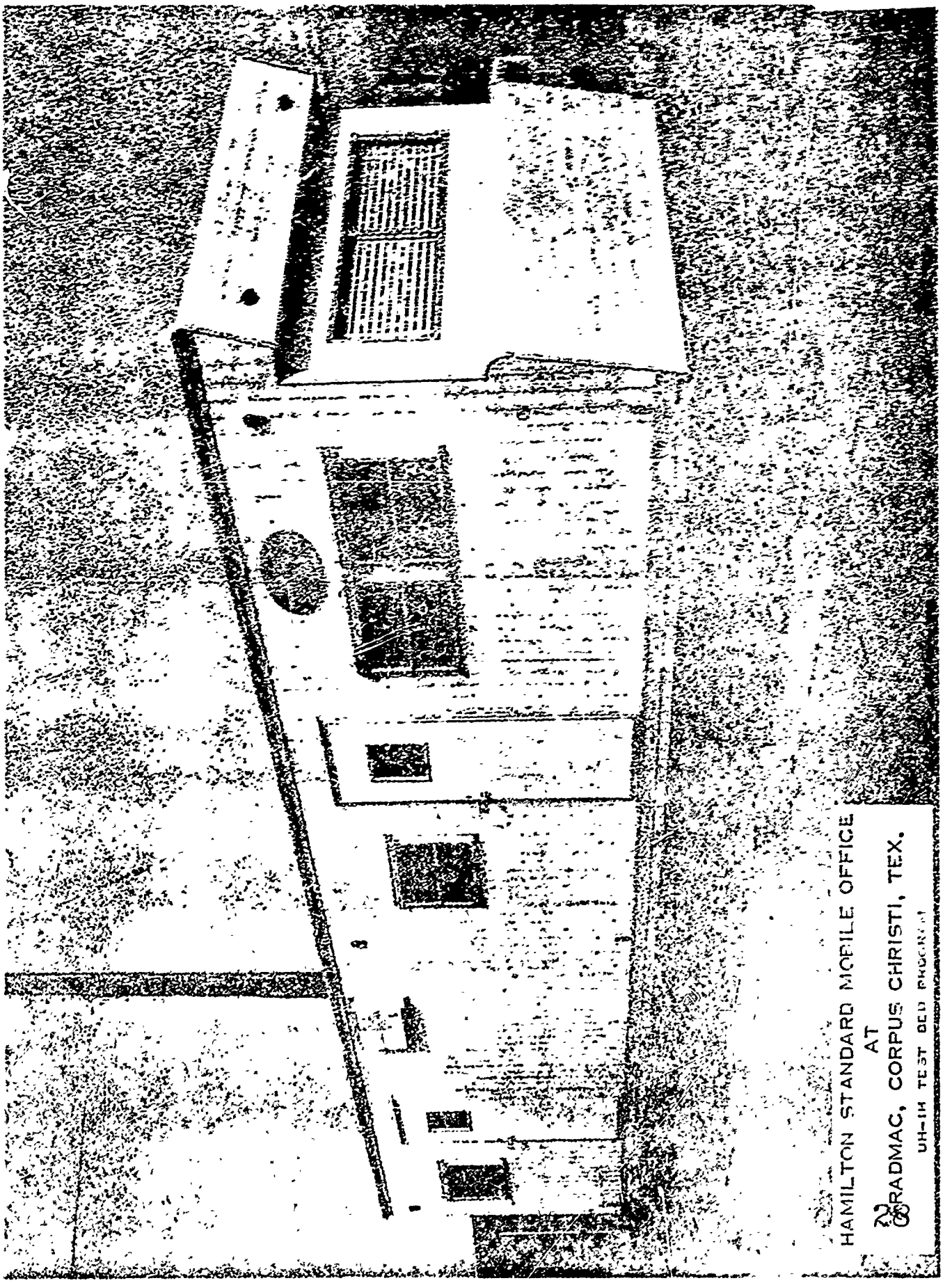

HAMILTON STANDARD MOBILE OFFICE
AT
CRADMAC, CORPUS CHRISTI, TEX.
UH-1H TEST BED PROGRAM

FIGURE 3-1 A

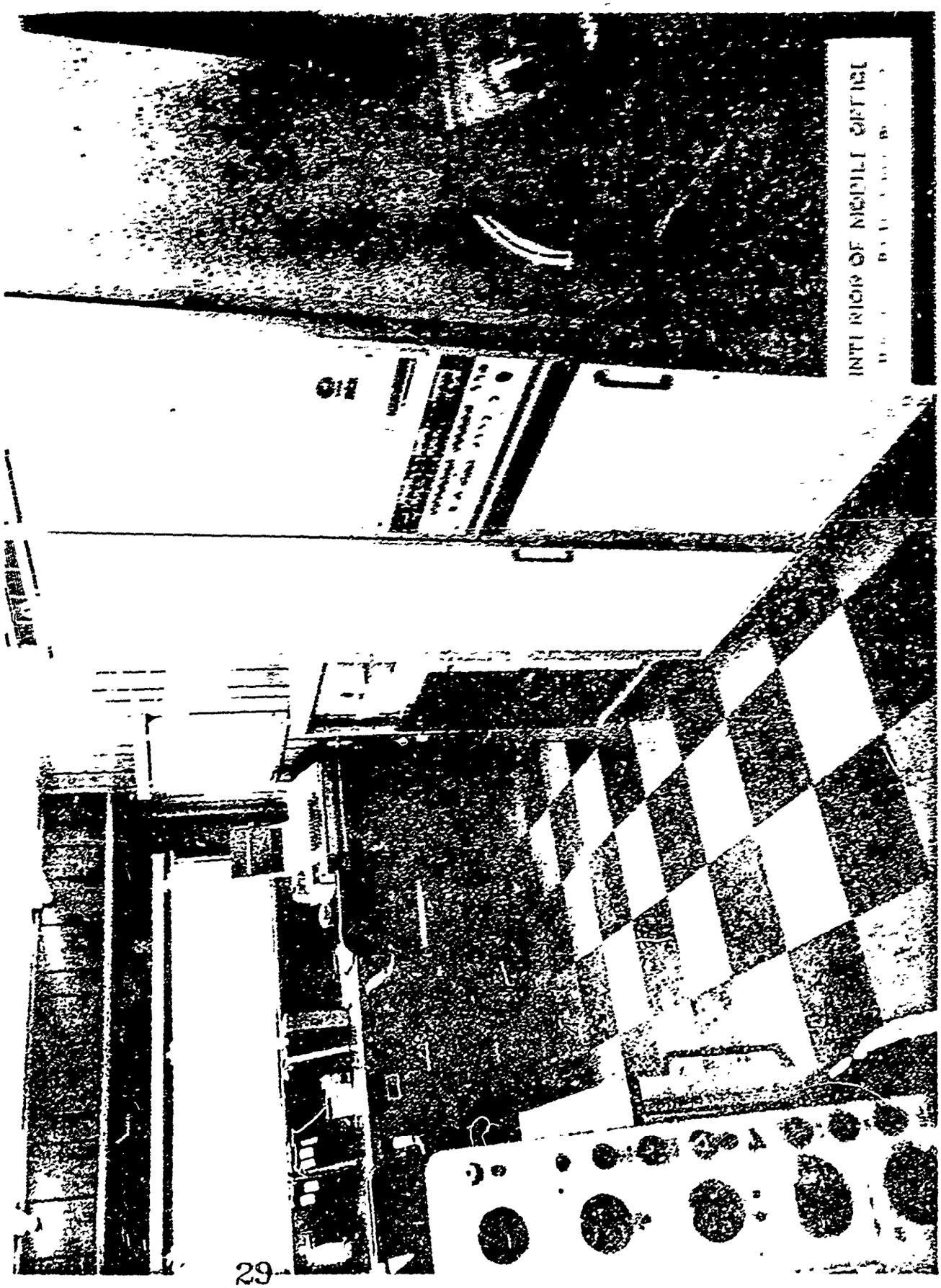


FIGURE 3-1 B

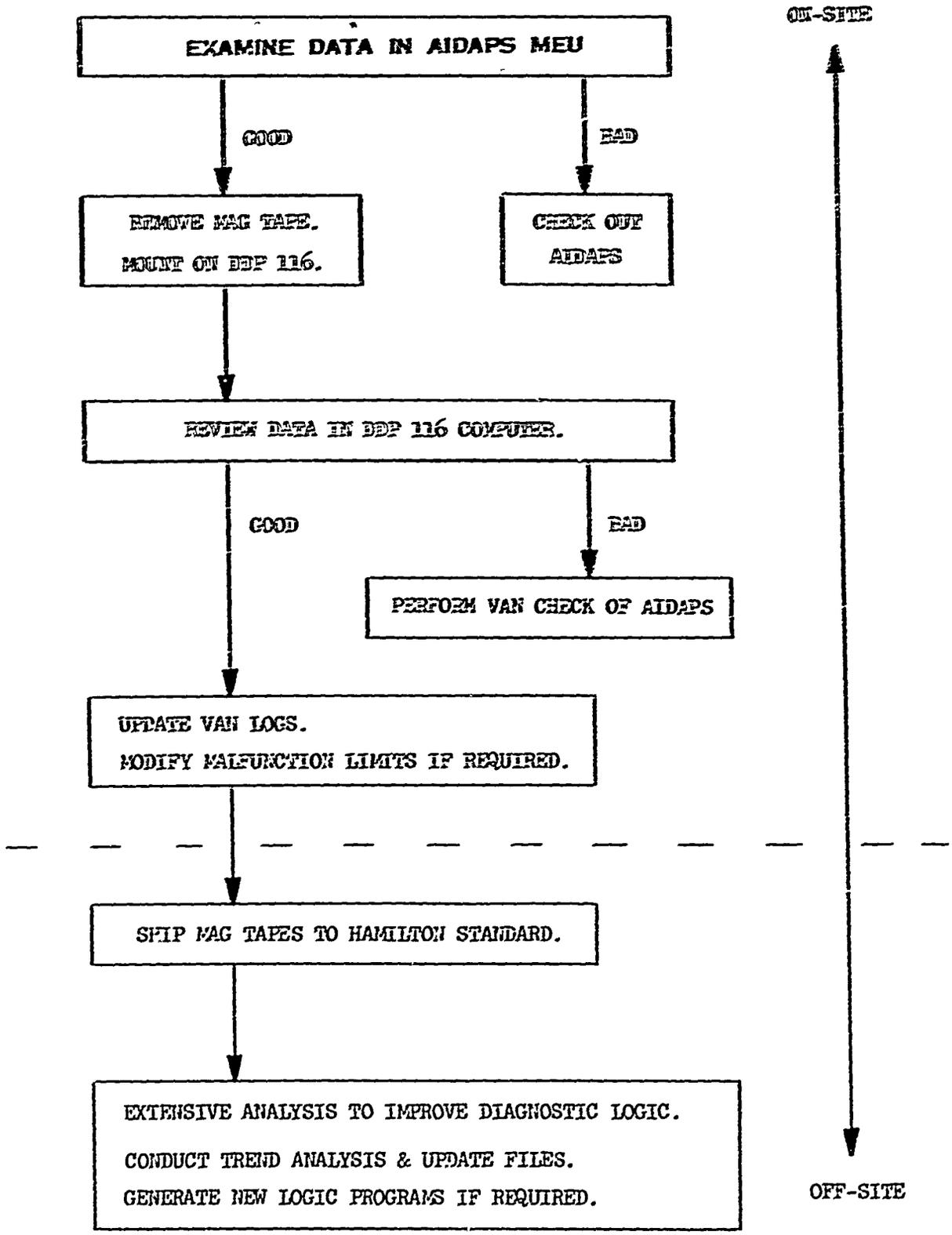


FIGURE 3-2 DATA ANALYSIS FLOW CHART

TABLE 3.1

REQUIRED OPERATION FOR DEGRADED ENGINE COMPONENTS

Degraded Comp.	#2 Bearing	#3/4 Bearing	N_1 Nozzle	N_2 Nozzle	N_1 & N_2 Nozzle	Rich Fuel Cont.	N_1 Rotor Balance	N_2 Rotor Balance	Worn Compressor
No. Required	2	2	2	1	1	1	1	1	1
Engine Condition									
Start Up	Yes		Yes	Yes	Yes	Yes			Yes
Idle									
Military	2 Min	2 Min	3 Min	3Min	3Min		2 Min	2Min	3 Min
Autorotation			2 Min	2 Min	2 Min				
Accel/Decel			Yes	Yes	Yes	Yes			Yes
75% Power									
Normal Power	2 Min		2 Min	2 Min	2 Min		2 Min	2 Min	
90% Power									
Wave Off			Yes	Yes	Yes	Yes			
Shut Down									

TABLE 3-2

Tail Boom Sensor Drawings

HS Item No.	Drawing No.	Title
	Bell Dwg.	
54,56,104	205-040-003	Driveshaft Inst. Tail Rotor, Long Boom
" " "	11x4856	Installation-Vibration Pickup-Shaft Hanger Bearings
" " "	11x4844	Bracket, Mounting-Vibration Pickup-Shaft Hanger Bearings
	Bell Dwg Pg 2	
59	204-040-003	Gear Box Assy, 42° Tail Rotor Drive
"	11x4848	Inst. Velocity Pickup & Accelerometer-42° Gear Box
"	11x 4837	Bracket Mounting, Vibration Pickup-42° Gear Box
	Bell Dwg Pg 2	
61	204-040-003	Gear Box Assy, 42° Tail Rotor Drive
"	11x4848	Inst. Velocity Pickup & Accelerometer-42° Gear Box
"	11x4843	Accelerometer Mounting Adapter-42° Gear Box
58	SK79730-110	42° Gear Box ΔT
90,91	SK79730-150	Elec. Inst. All Existing Aircraft Sensors
	Bell Dwg.	
64 & 66	204-040-012	Gear Box Assy, Tail Rotor Drive
" "	11x4847	Inst, Velocity Pickups-90° Gear Box
" "	11x4836	Bracket, Mounting, Vibration Pickup-90° Gear Box
63	SK79730-140	90° Gear Box ΔT

TABLE 3-3

Engine Sensor Drawings & Photographs

HS Item No.	Photo/Drawing No.	Title
1,9,17	Photo E6	----
2	Photo E4	----
"	PSK-15920	Manifold, Lubrication Pressure-Assy of (Rework)
3	Photo E15	----
5,6	Photo E13	----
" "	PSK16937	Isolation Tee Assy
10	Photo E4	----
11	Photo E15	----
"	1-160-645-01	Bracket, Chip Detector
12	Photo E10	----
13	Photo E1	----
14,4	Photo E14	----
18	Photo E5	----
19	SK79730-180	Power Lever Angle Installation
"	SK79730-181	Bracket, Shaft Clamp
"	SK79730-182	Clamp, Synchro Shaft
"	SK79730-183	Bracket, Synchro Mtg.
"	SK79730-184	Platform, Synchro, Mtg.
15	Photo E3	----

TABLE 3-3

(CONTINUED)

BI Item No.	Photo/Drawing No.	Title
16	Photo E2	----
20,122	SK79730-100	Flowmeter, Fuel Flow to Filter
" "	SK79730-101	Bushing, Reducer-Screw Thd to Flare Tube Connection
" "	SK79730-102	Tube Assy, Fuel Flowmeter
21,22, 36	SK79730-150 Note 5	Electrical Inst. All Existing Aircraft Sensors
23,37, 120,121	SK79730-150	Electrical Inst. All Existing Aircraft Sensors
8,30,32,24	Photo E11	----
26	Photo E9	----
29	Photo E8	----
31	Photo E7	----
34	SK79730-200	Bleed Band Switch
"	SK79730-201	Bracket, Bleed Band Switch
119	SK79730-190	Installation, Inlet Guide Vane
	SK79730-191	Bracket, Synchro Mtg, IGV
	SK79730-192	Plate, Synchro Mtg, IGV
	SK79730-193	Shaft, Extender
	SK79730-194	Bracket, Synchro Mtg, IGV
52	11x4857	Installation-Vibration Pickup-Shaft Hanger Bearing
"	11x4845	Adapter-Vibration Pickup-Shaft Hanger Bearing
7	Photo E12	----

TABLE 3-3

(CONTINUED)

Miscellaneous Engine Photographs

Photo No.		
E16	-	View of Engine Toward Front Firewall
E17	-	Engine Harnessing
E18	-	Engine Harnessing
E19	-	Side View of Engine

TABLE 3-4

Transmission and Hydraulics Sensor Drawings

HS Item No.	Drawing No.	Title
38,39,40,43 102,69	SK79730-150	Electrical Inst, All Existing Aircraft Sensors
51	SK79730-20	XMSN. Ext. Oil Filter Δ P
"	SK79730-21	Elbow, Special, Neg Pressure Line
"	SK79730-22	Elbow, Special, Pos Pressure Line
"	SK79730-23	Bracket, Δ P Transducer Support
101	SK79730-60	XMSN. Oil Cooler Flow
"	SK79730-61	Upper Tube, XMSN Oil Cooler Flow
"	SK79730-62	Lower Tube, XMSN. Oil Cooler Flow
103	SK79730-70	XMSN. Internal Oil Filter Δ P
"	SK79730-71	Bracket, Int. Oil Filter
70	SK79730-90	Hydraulic Supply Pressure
71	SK79730-130	Thermocouple, All Fluid Temp
72	SK79730-30	Hydraulic Filter Δ P
"	SK79730-31	Bracket, Hydraulic Filter Δ P
107	SK79730-80	Hydraulic Pump Case Leakage
108	SK79730-130	Thermocouple, All Fluid Temp.
All XMSN Vib. Items	Bell Dwg. 205-040-001	Transmission Assy, Mechanical
" "	11x4855	Vibration Pickups
45 & 125	11x4850	Inst. Velocity Pickup & Acc.-Input Drive
" "	11x4839	Bracket, Mounting-Acc. & Velocity Pickup Transmission Input

TABLE 3-4

(CONTINUED)

HS Item No.	Drawing No.	Title
47 & 123	11x4849	Inst. Velocity Pickups-Upper Mast Bearing
" "	11x4838	Bracket, Mounting-Vibration Pickup, Main Mast Bearing
49 & 126	11x4853	Inst. Velocity Pickup & Accelerometer-Transmission Tail Rotor Drive
" "	11x4841	Bracket, Mounting-Accel & Velocity Pickup Transmission-Tail Rotor Drive
129	11x4854	Inst. Velocity Pickup-Transmission
"	11x4842	Bracket, Mounting, Velocity Pickup Transmission
127	11x4851	Inst. Accelerometer, Transmission-Sun Gear
"	11x4840	Bracket, Mounting-Accelerometer Planetary Gears-Transmission
128	11x4852	Inst. Accelerometer Transmission-Acc. Drive Gear Mesh
"	11x4840	Bracket, Mounting-Accelerometer Planetary Gears-Transmission

TABLE 3-5

Instrument Panel Sensor Drawings

HS Item No.	Drawing No.	Title
77	SK79730-40	Total Pressure (Airspeed)
78	SK79730-50	Static Pressure (Altitude)
"	SK79730-51	Assy, Tube, Static Pressure
87,41,112,113	SK79730-150	Electrical Inst, All Existing Aircraft Sensors
109,110,111	SK79730-150 Note 5	Electrical Inst, All Existing Aircraft Sensors
80	SK79730-120	Collective Pitch Synchro

TABLE 3-6

Electronic and Instrumentation Equipment Drawings

Drawing No.	Title
SK79850-1	Electronic Equipment, Installation UH-1
SK79850-2	Bracket, Support Rack
SK79850-3	Bracket, Mounting, Data Entry Panel
SK79850-4	Bracket, Mounting, Connector, Recorder
SK79850-5	Bracket, Mounting, Recorder
SK79850-6	Connector Mounting Plate MEU
SK79850-7	Equipment Mounting Deck, Main
SK79850-8	Equipment Mounting Deck, Left
SK79850-9	Equipment Mounting Deck, Right
SK79850-10	Equipment Weights and Location

TABLE 3.7

FLIGHT SEQUENCE #	LINE REPLACEABLE UNITS FLOWN
1	#2 BEARING (ENGINE) 42° GEARBOX INPUT (BALL)
2	#3 BEARING (ENGINE) 42° GEARBOX INPUT (ROLLER)
3	#4 BEARING (ENGINE) 90° GEARBOX INPUT (BALL)
4	#1 NOZZLE (ENGINE) 90° GEARBOX INPUT ROLLER
5	COMPRESSOR (ENGINE) 90° GEARBOX OUTPUT (BALL)
6	N_2 TURBINE (ENGINE) 90° GEARBOX OUTPUT (ROLLER)
7	MAIN MAST BEARING (TRANSMISSION)
8	TAIL ROTOR QUILL (ROLLER) (TRANSMISSION)
9	INPUT QUILL (TRANSMISSION)
10	#2 NOZZLE (ENGINE) 42° GEARBOX INPUT (BALL)
11	#4 BEARING (ENGINE) 42° GEARBOX INPUT (ROLLER)
12	SET #1 GOOD BASELINE LRU's (ENGINE, TRANSMISSION PARTS, 42" 90" GEARBOX)
13	SET #2 GOOD BASELINE LRU's
14	SET #3 GOOD BASELINE LRU's
15	SET #4 GOOD BASELINE LRU's
16	#2 BEARING (ENGINE) 90° GEARBOX INPUT (BALL)
17	#3 BEARING (ENGINE) 90° GEARBOX INPUT (ROLLER)
18	COMPRESSOR (ENGINE) 90° GEARBOX OUTPUT (BALL)

TABLE 3.7 CONTINUED

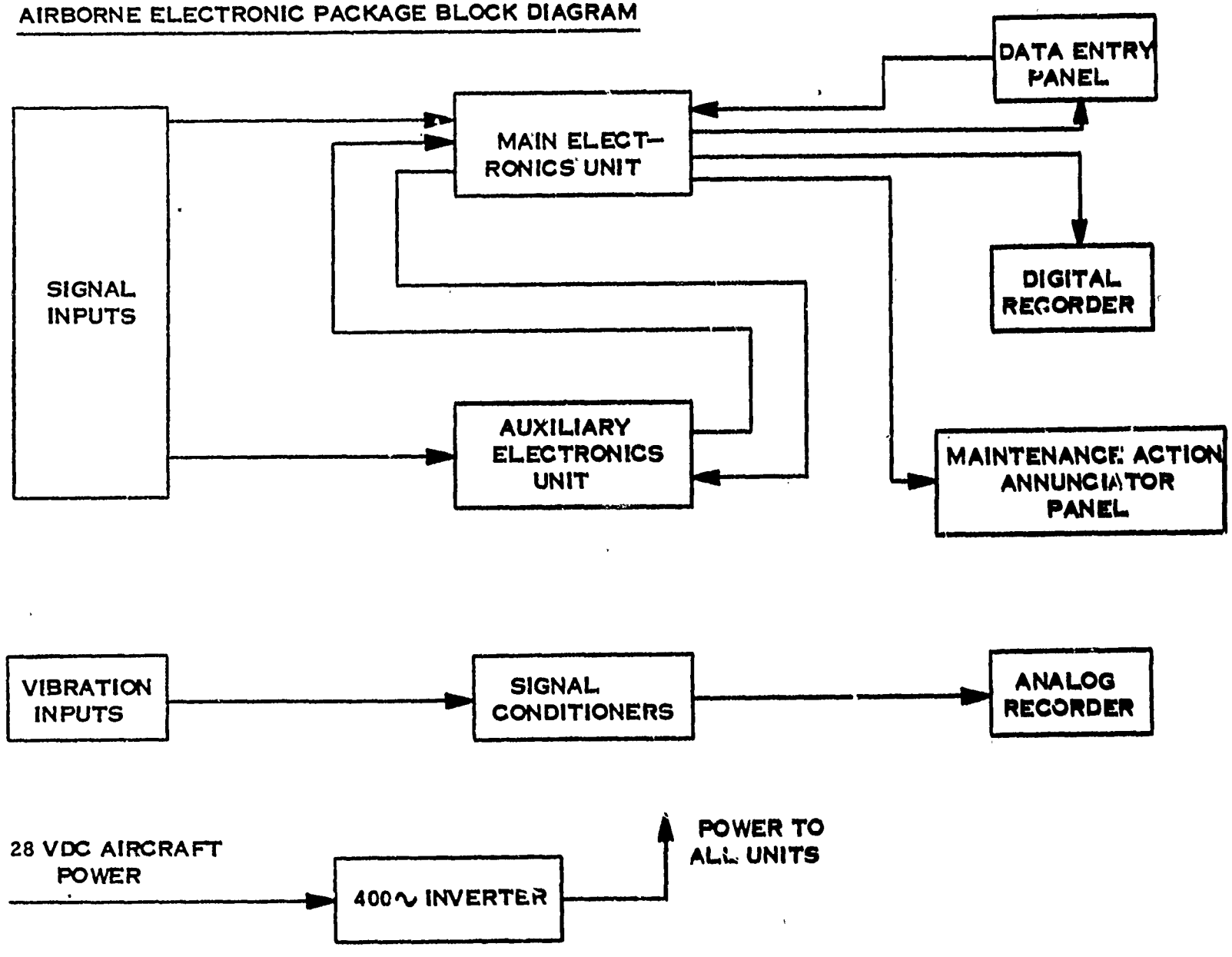
FLIGHT SEQUENCE #	LINE REPLACEABLE UNITS FLOWN
19	FUEL CONTROL (ENGINE) 90° GEARBOX OUTPUT (ROLLER)
20	N_2 TURBINE (ENGINE)
21	#2 NOZZLE (ENGINE)
22	#1 NOZZLE (ENGINE)
23	FUEL CONTROL (ENGINE)
24	MAIN MAST BEARING (TRANSMISSION)
25	TAIL ROTOR QUILL (BALL) (TRANSMISSION)
26	TAIL ROTOR QUILL (ROLLER) (TRANSMISSION)
27	INPUT QUILL (TRANSMISSION)
28	TAIL ROTOR QUILL (BALL) (TRANSMISSION)

SECTION 4

AIRBORNE HARDWARE

FIGURE 4–1

AIRBORNE ELECTRONIC PACKAGE BLOCK DIAGRAM



UH-1 AIDAPS SYSTEM

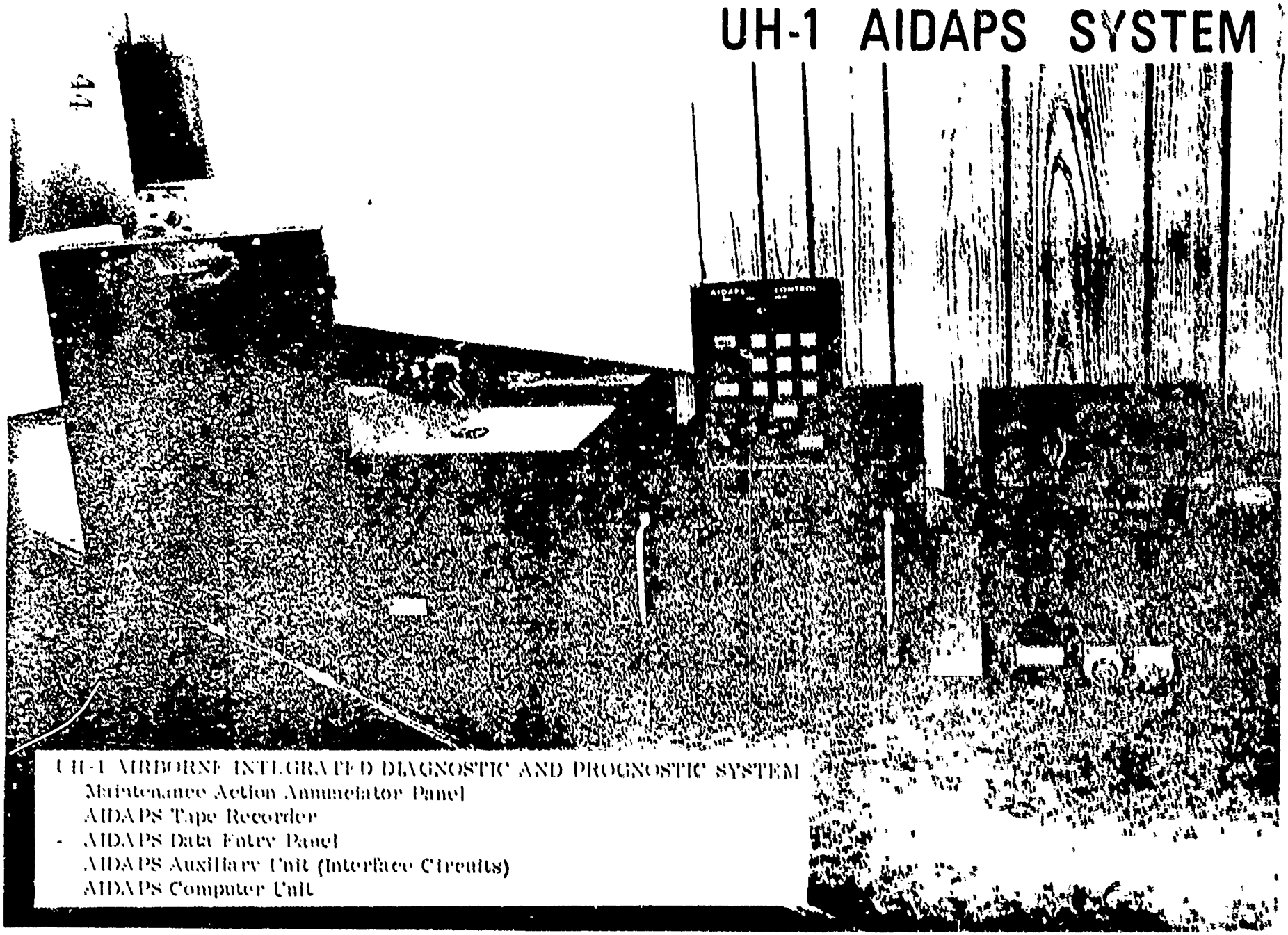


FIGURE 4-2

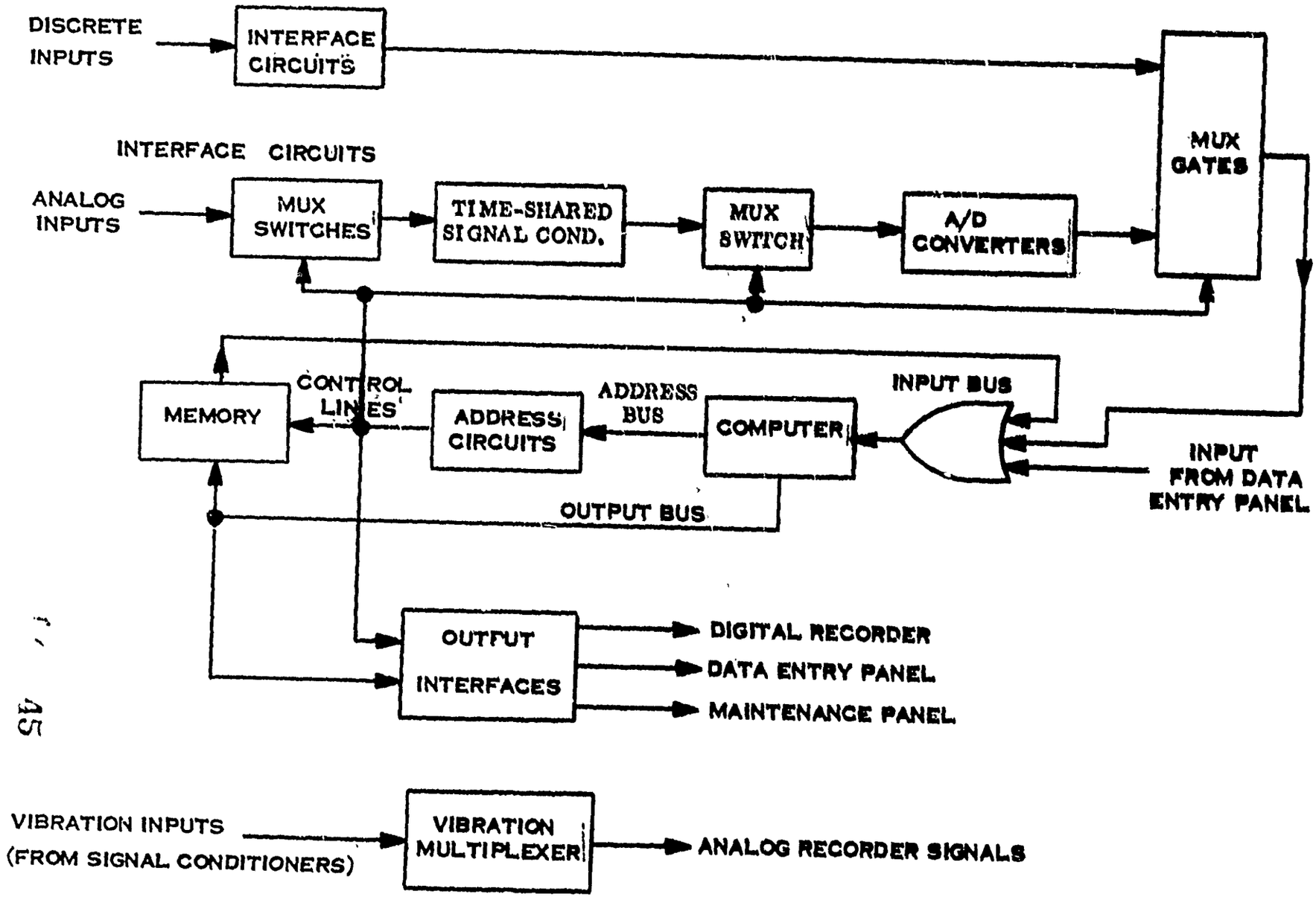


FIGURE 4–3 ELECTRONICS BLOCK DIAGRAM

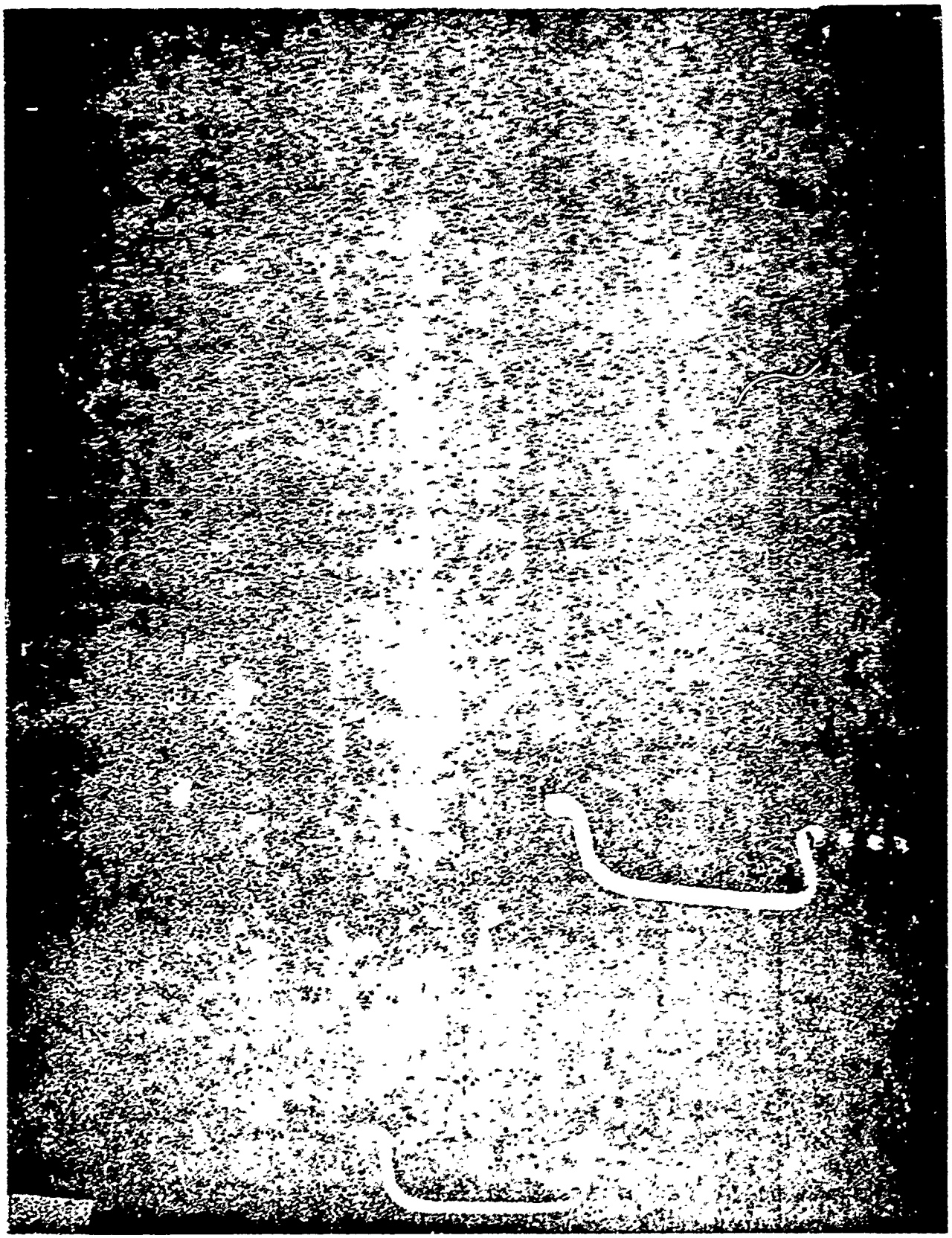


FIGURE 4-4

Reproduced from best available copy.

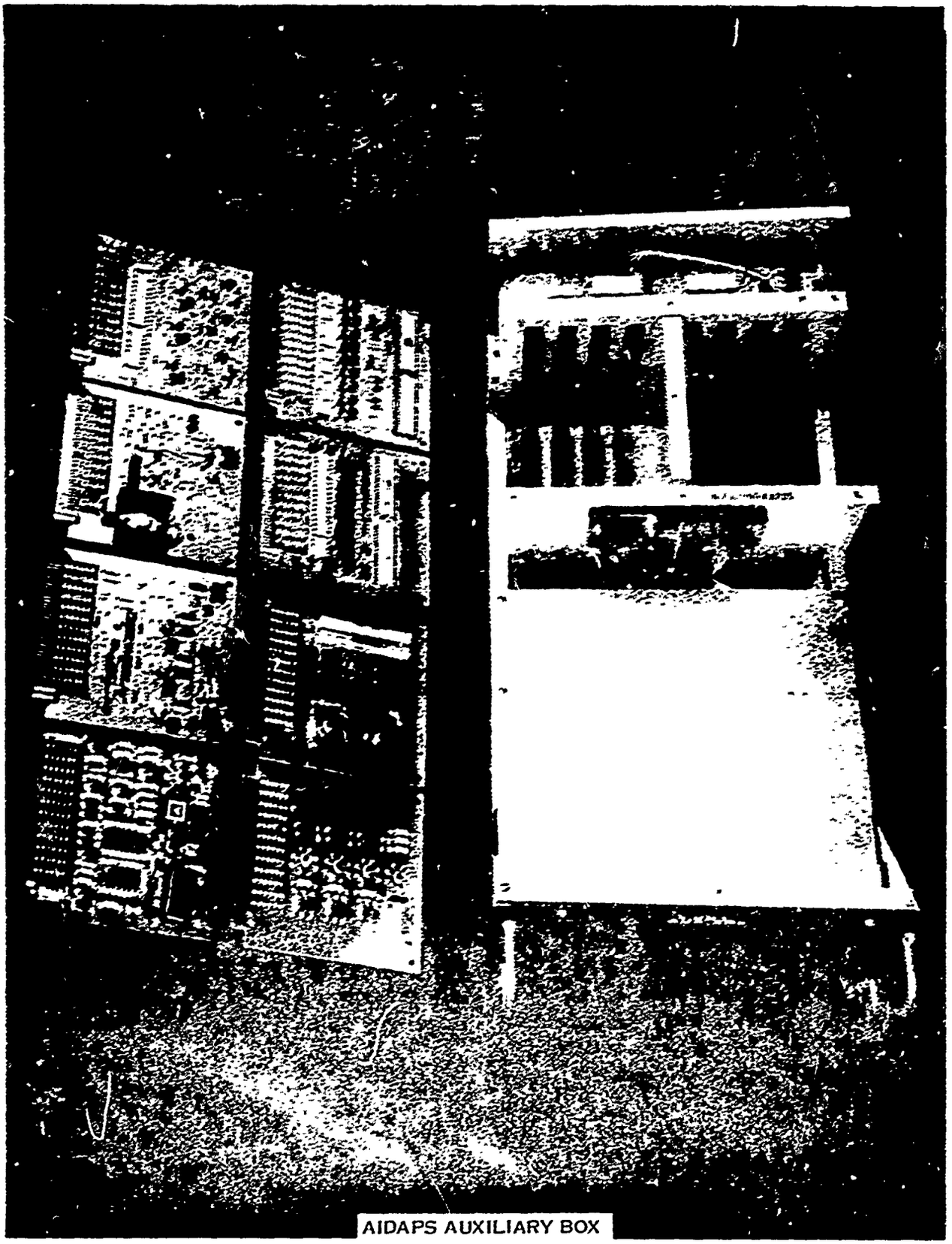


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FIGURE 4-5

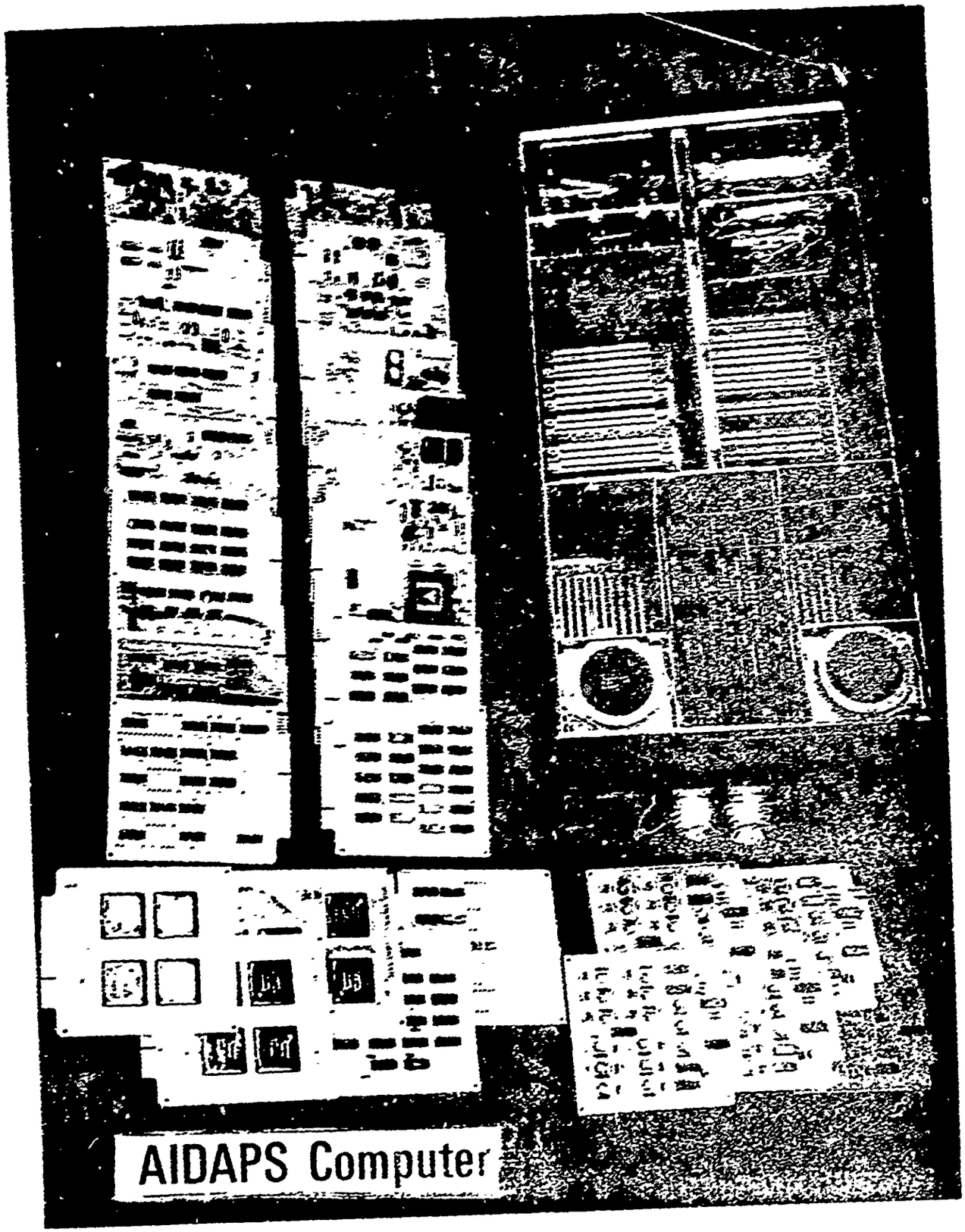


FIGURE 4-

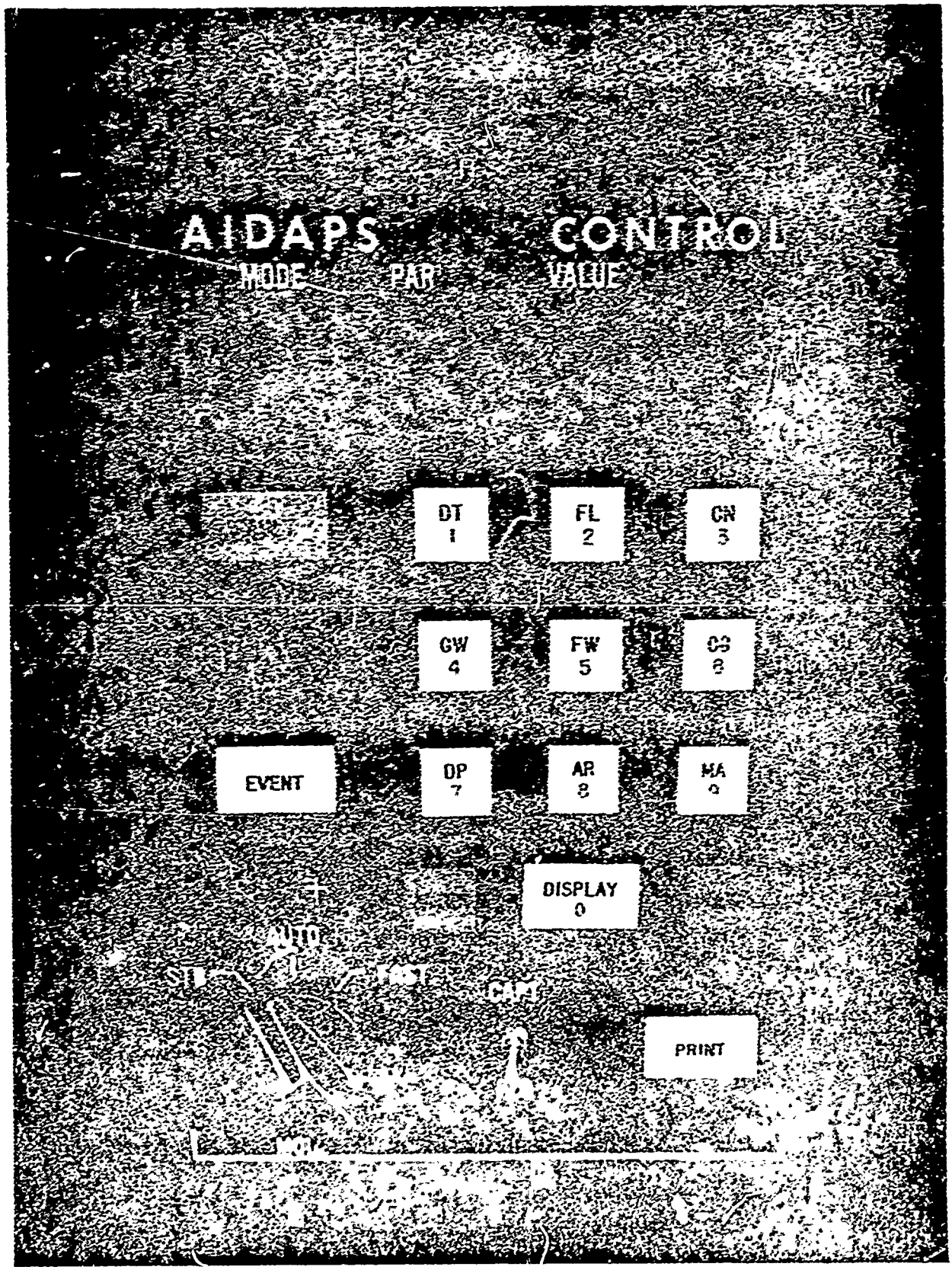

AIDAPS CONTROL
MODE
PAR
VALUE
DT
1
FL
2
CN
3
GW
4
FW
5
EVENT
DP
7
AR
8
DISPLAY
0
PRINT

FIGURE 4-7

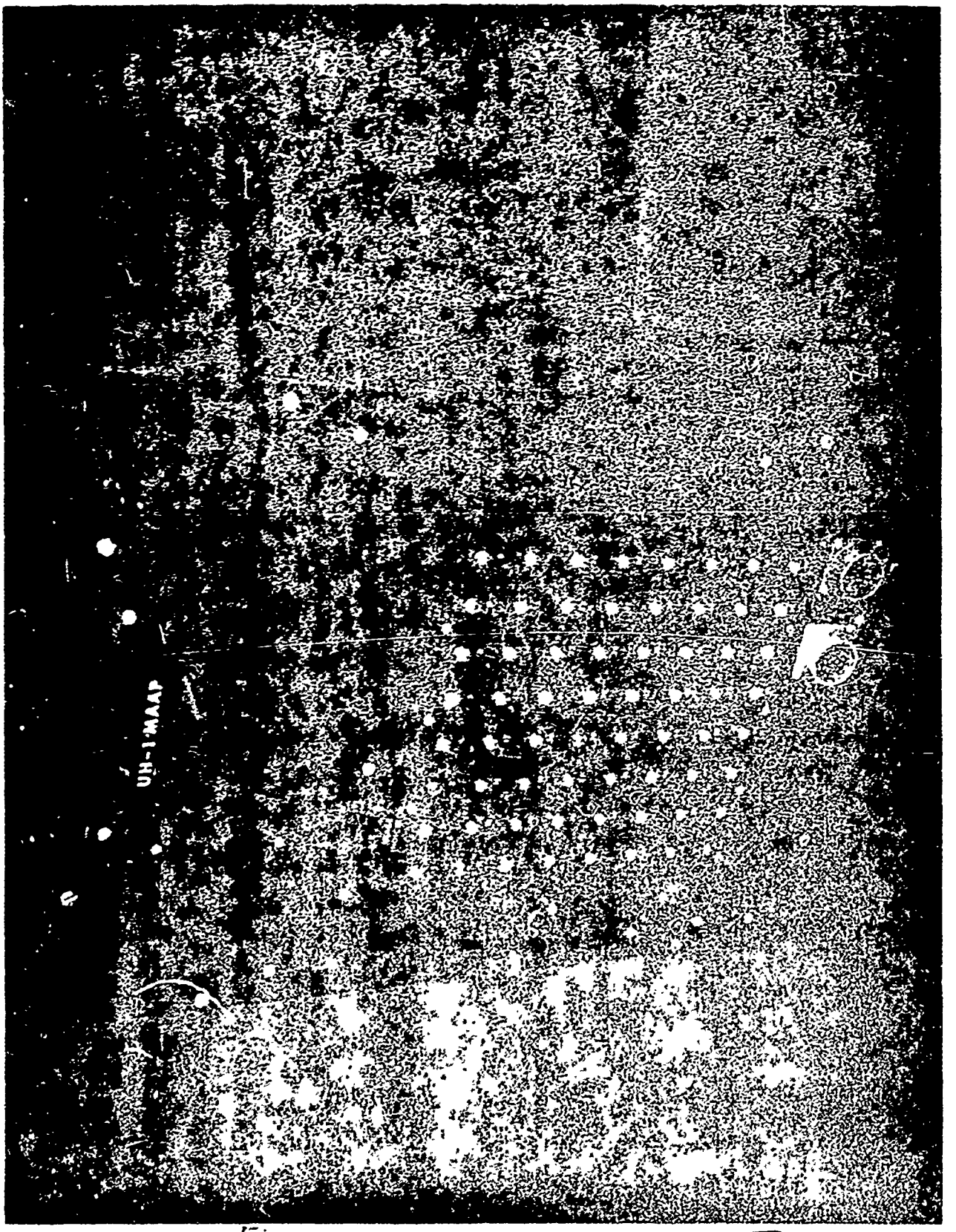


FIGURE 4-8

Reproduced from best available copy.

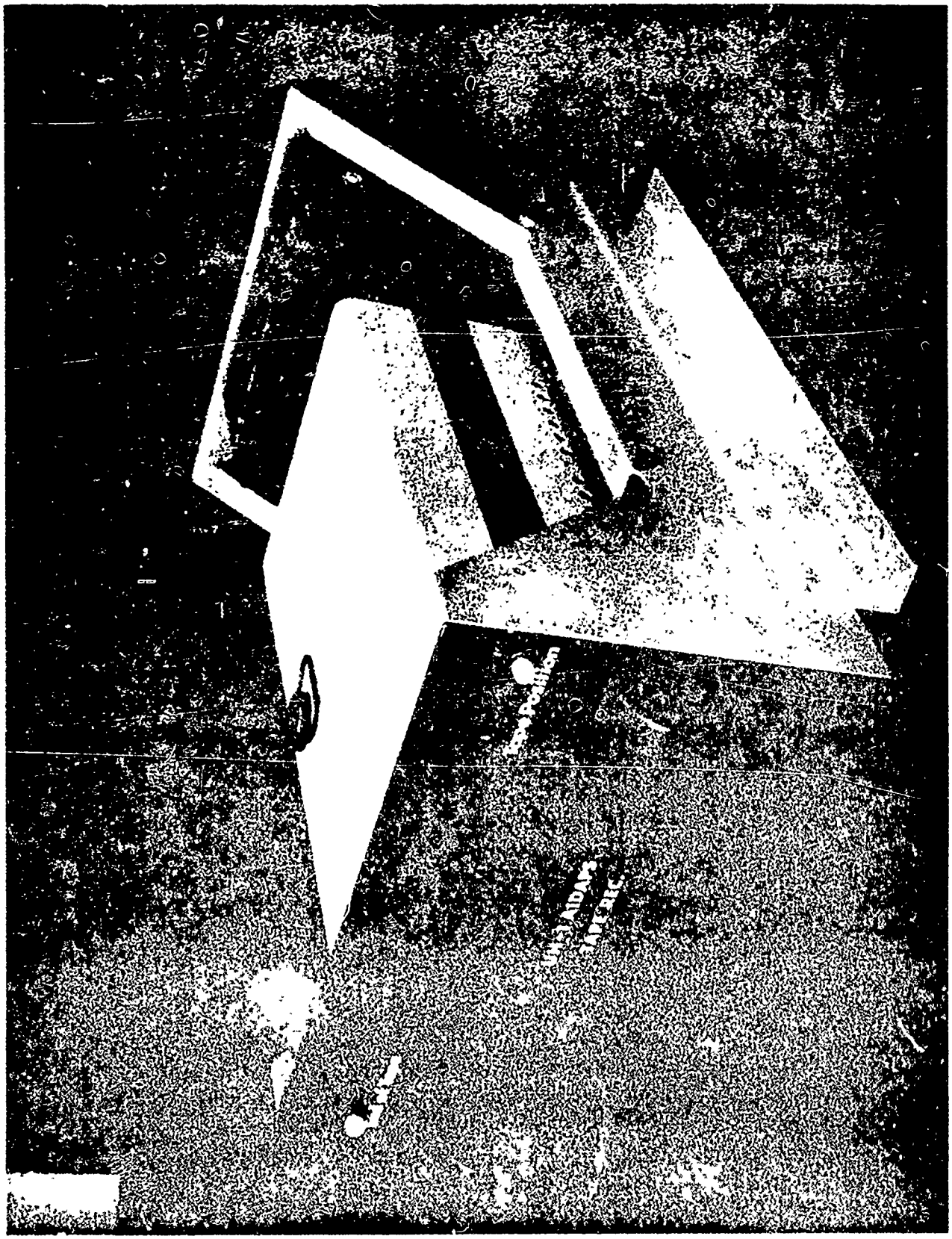


FIGURE 4-9

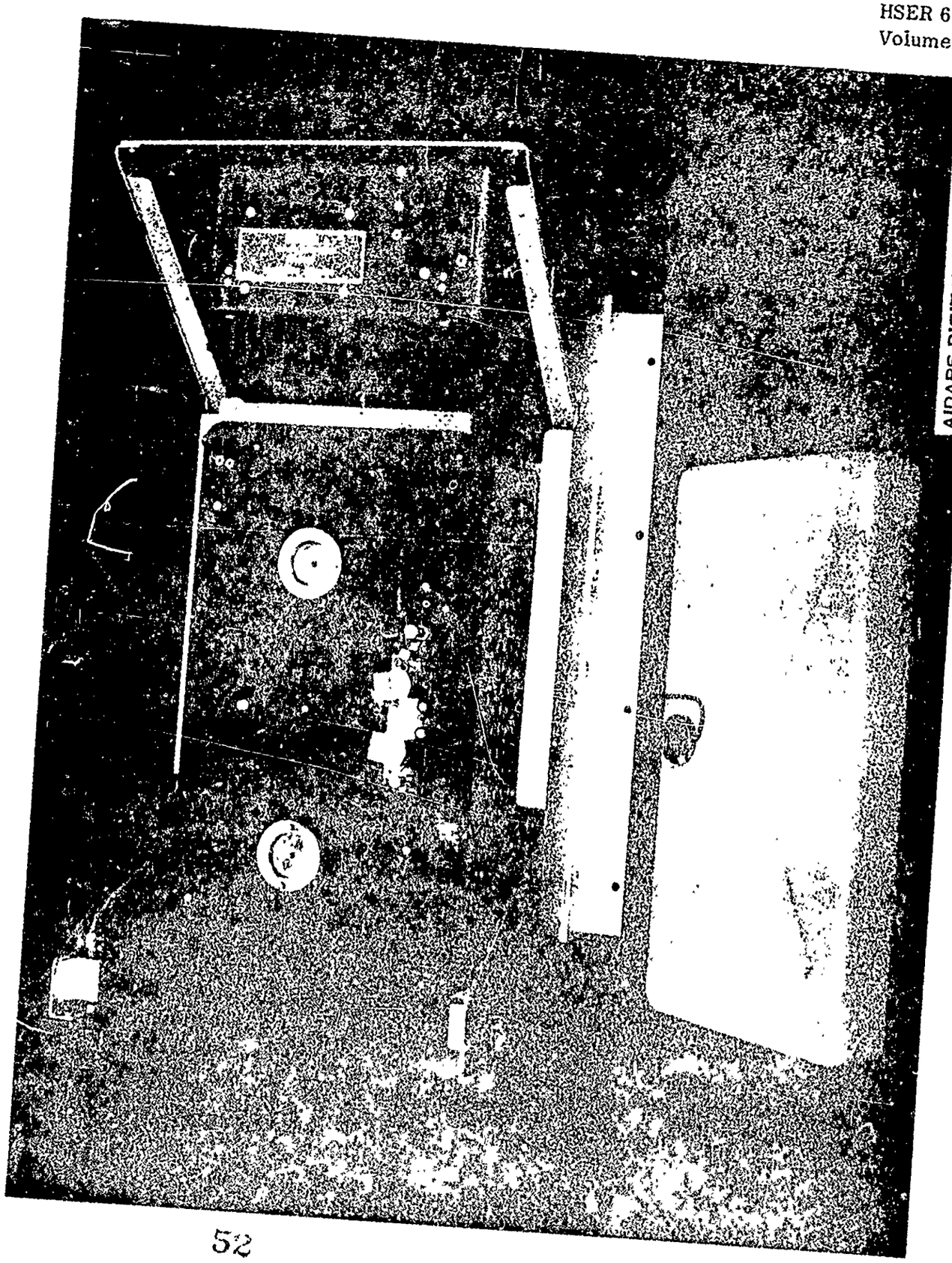


FIGURE 4-10

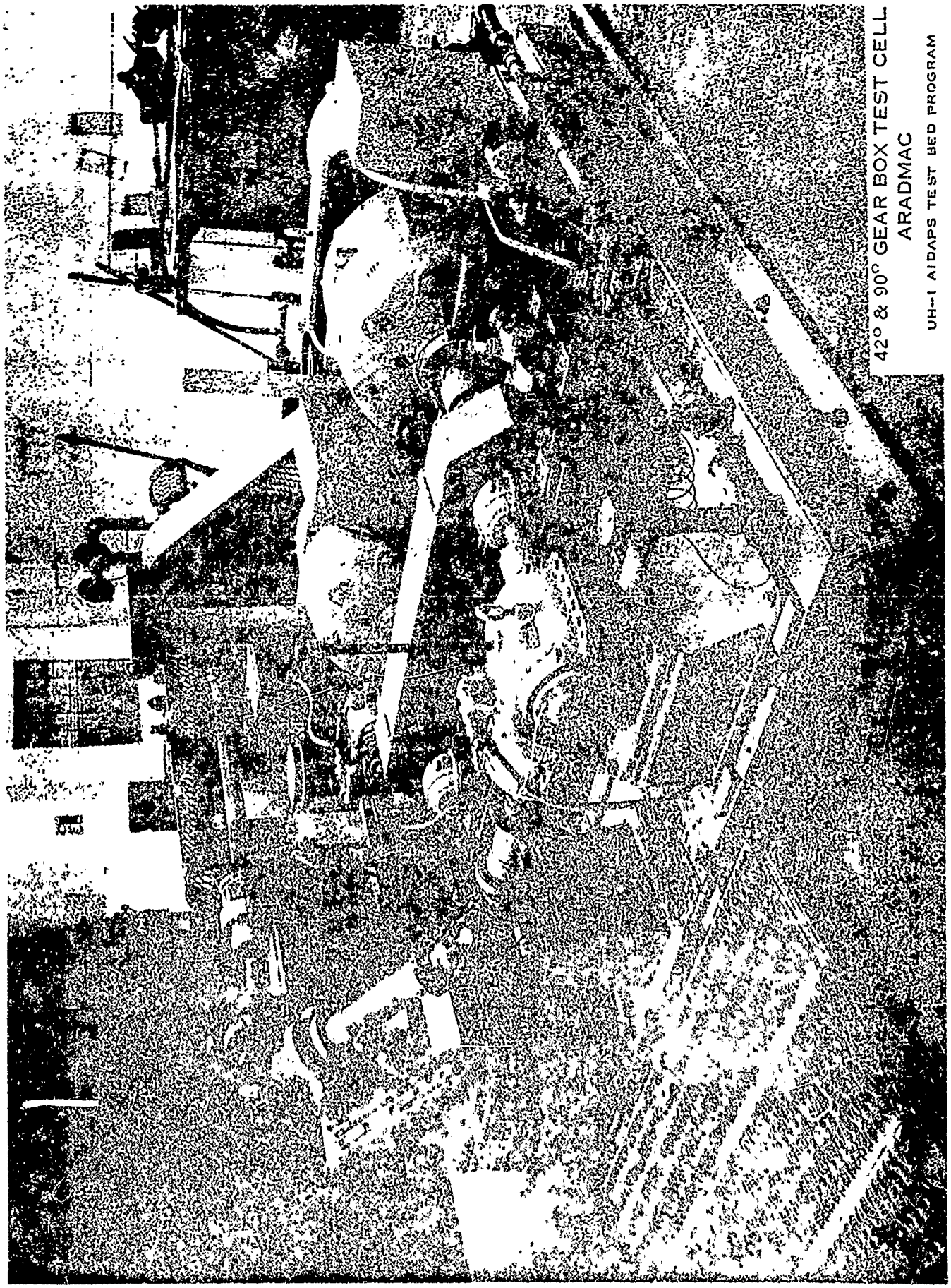
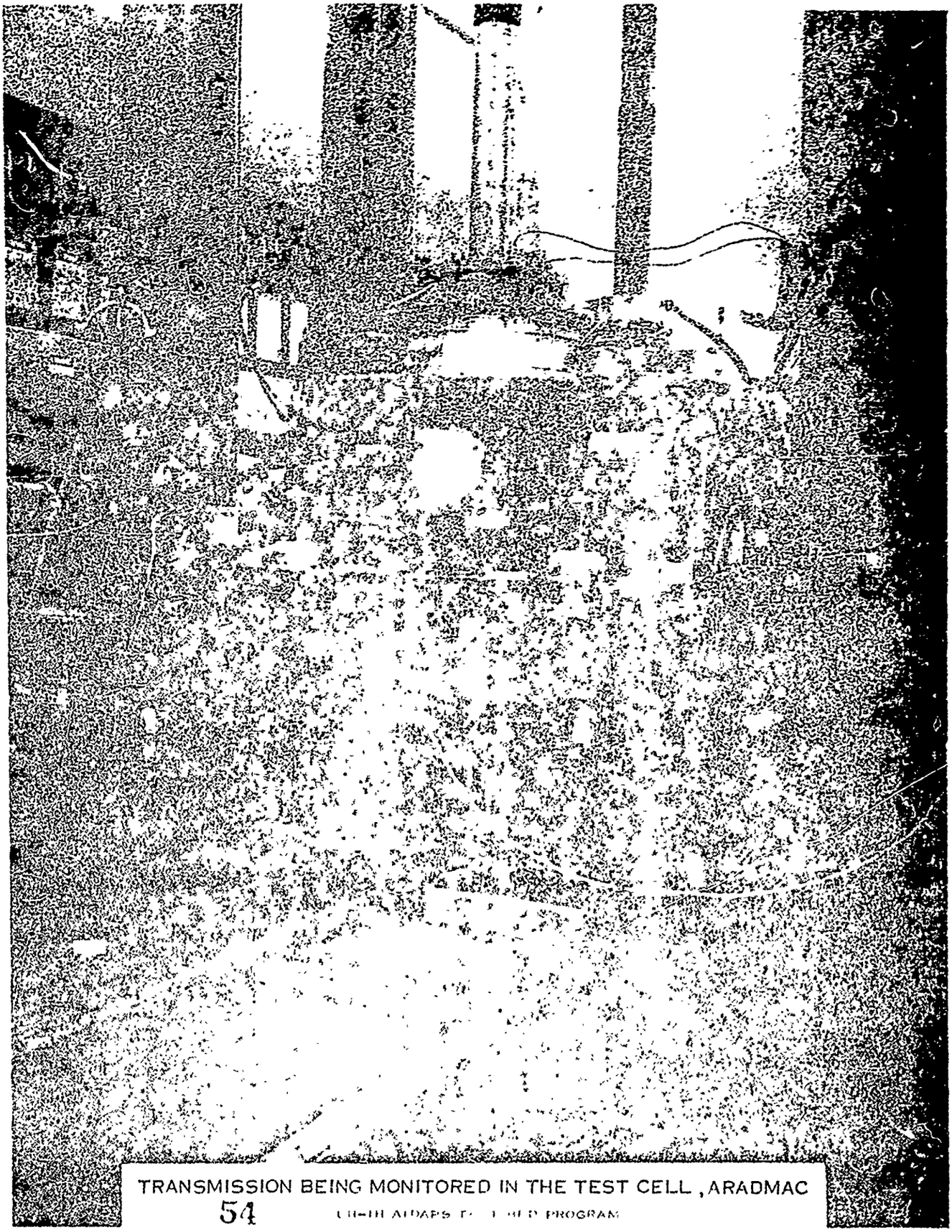
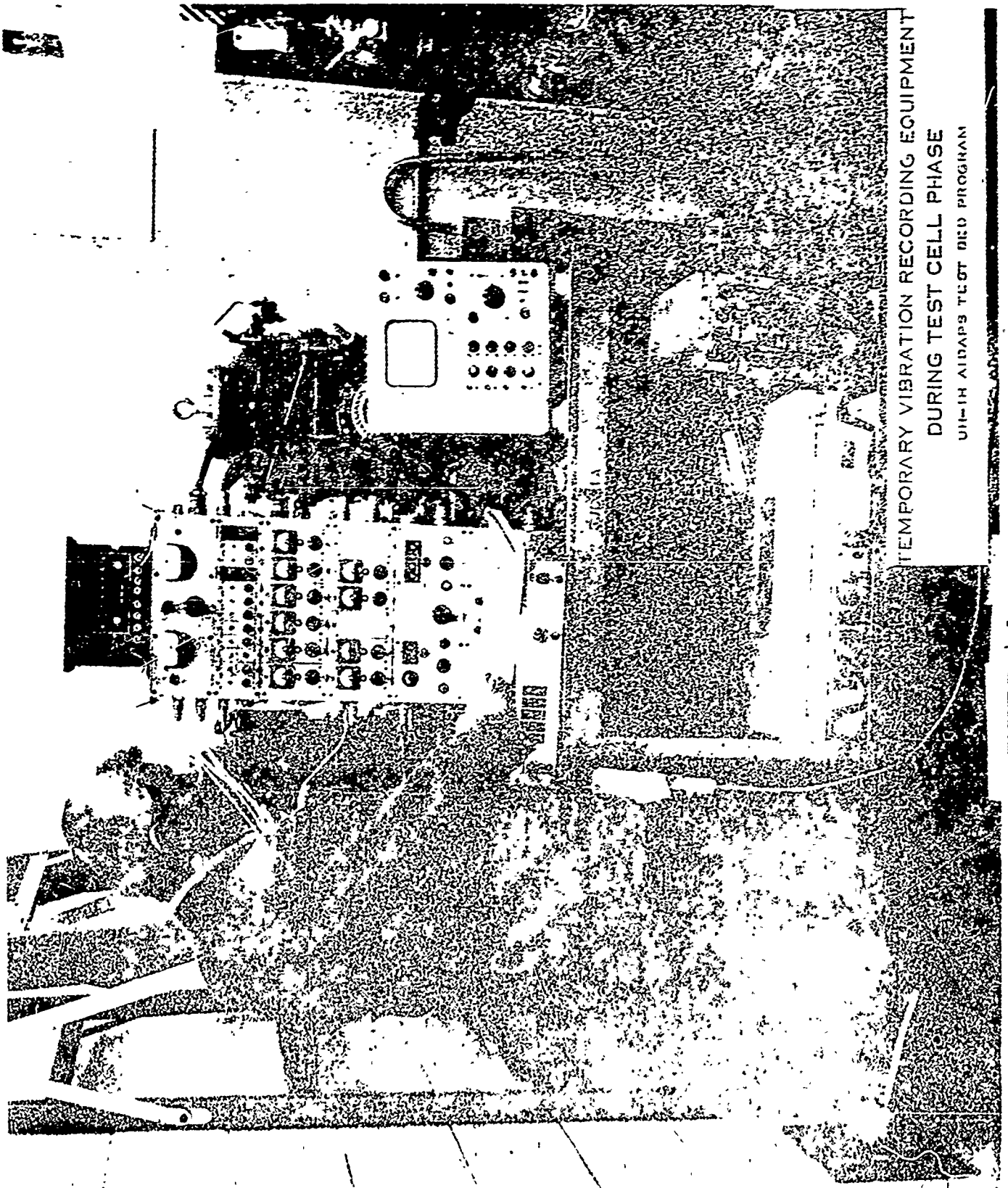


FIGURE 4-11



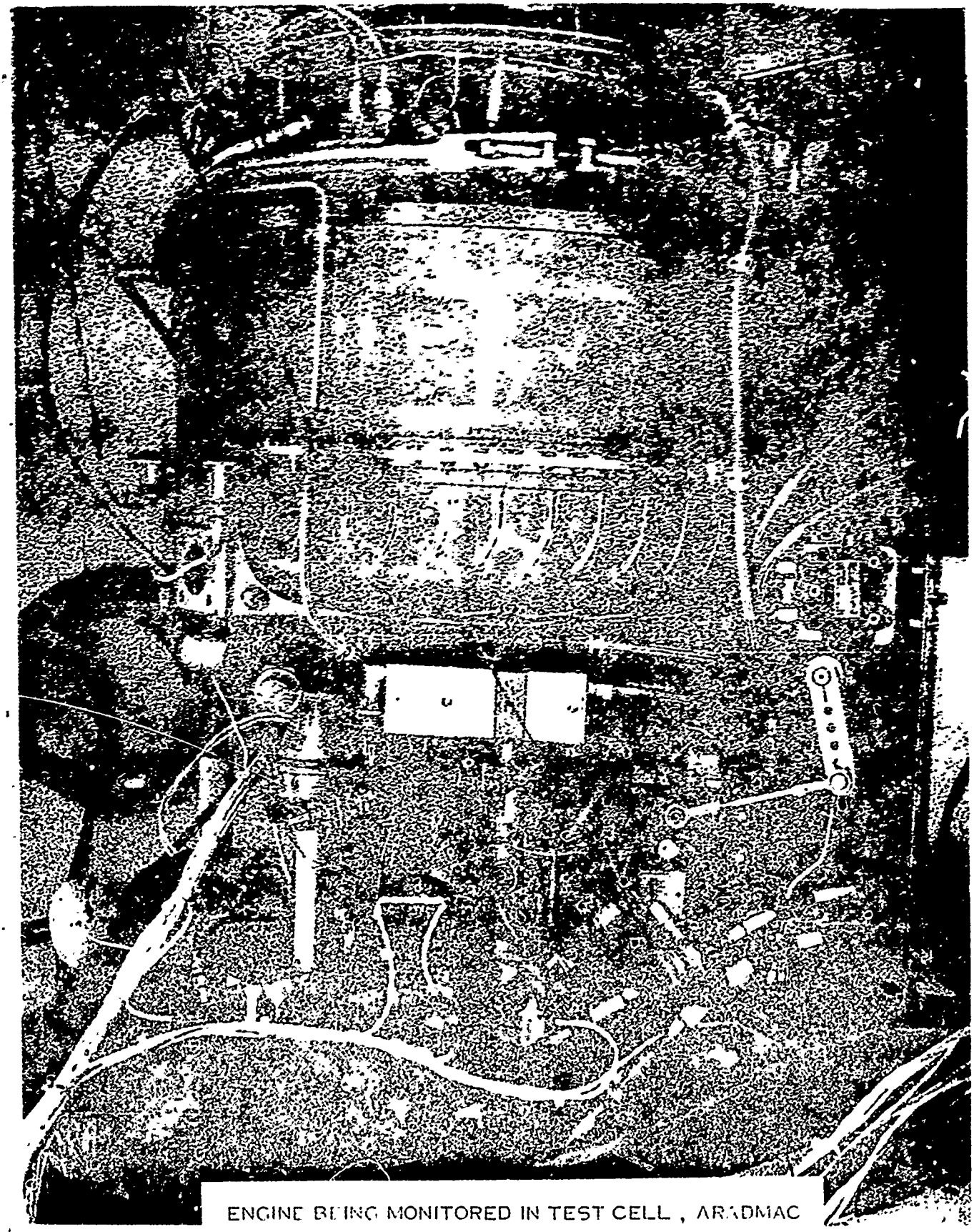
TRANSMISSION BEING MONITORED IN THE TEST CELL, ARADMAC

FIGURE 4-12



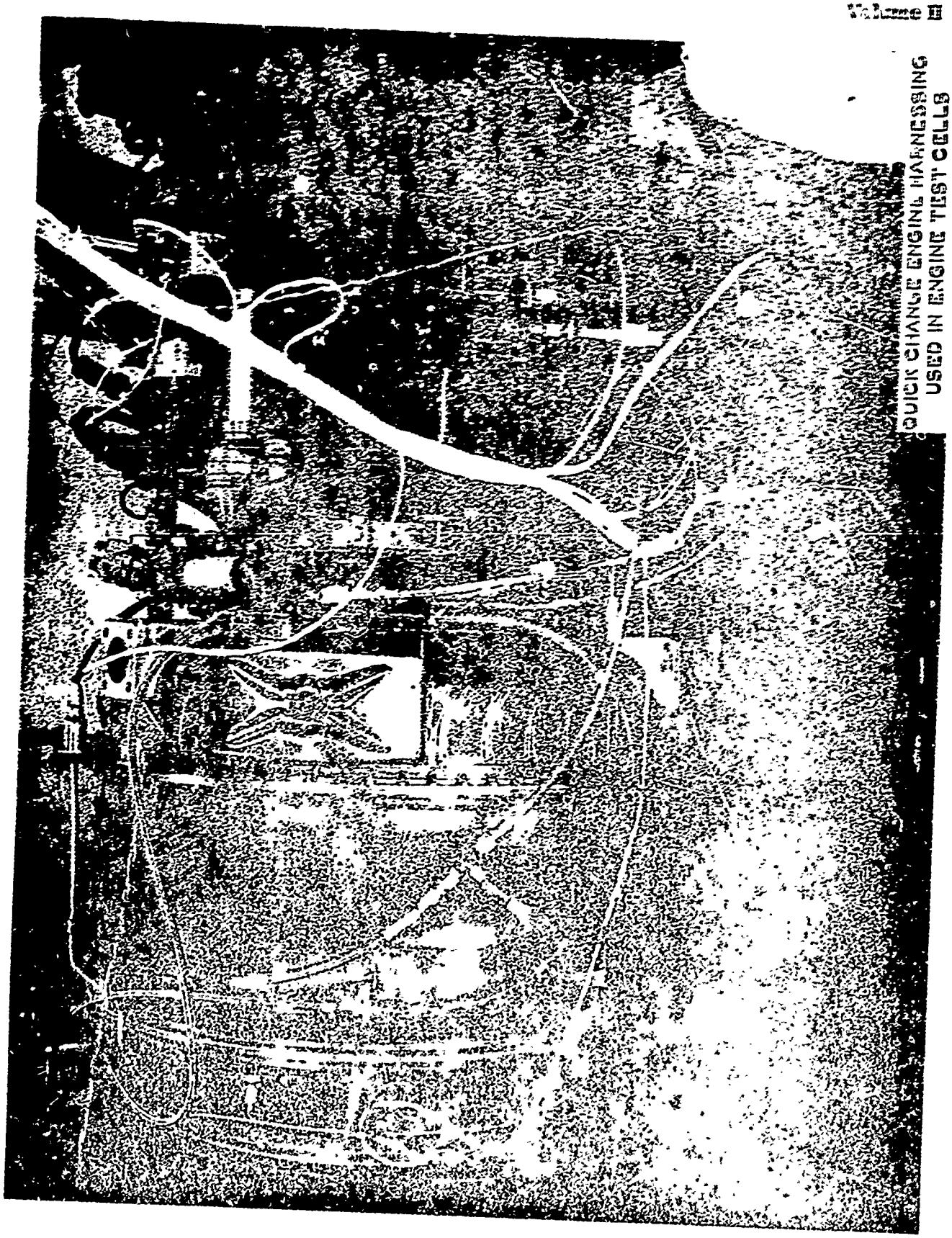
TEMPORARY VIBRATION RECORDING EQUIPMENT
DURING TEST CELL PHASE
UH-1H AIRAPS TEST BED PROGRAM

FIGURE 4-1.



ENGINE BEING MONITORED IN TEST CELL , ARADMAC

FIGURE 4-14



QUICK CHANGE ENGINE HARNESSING
USED IN ENGINE TEST CELLS

FIGURE 4-15

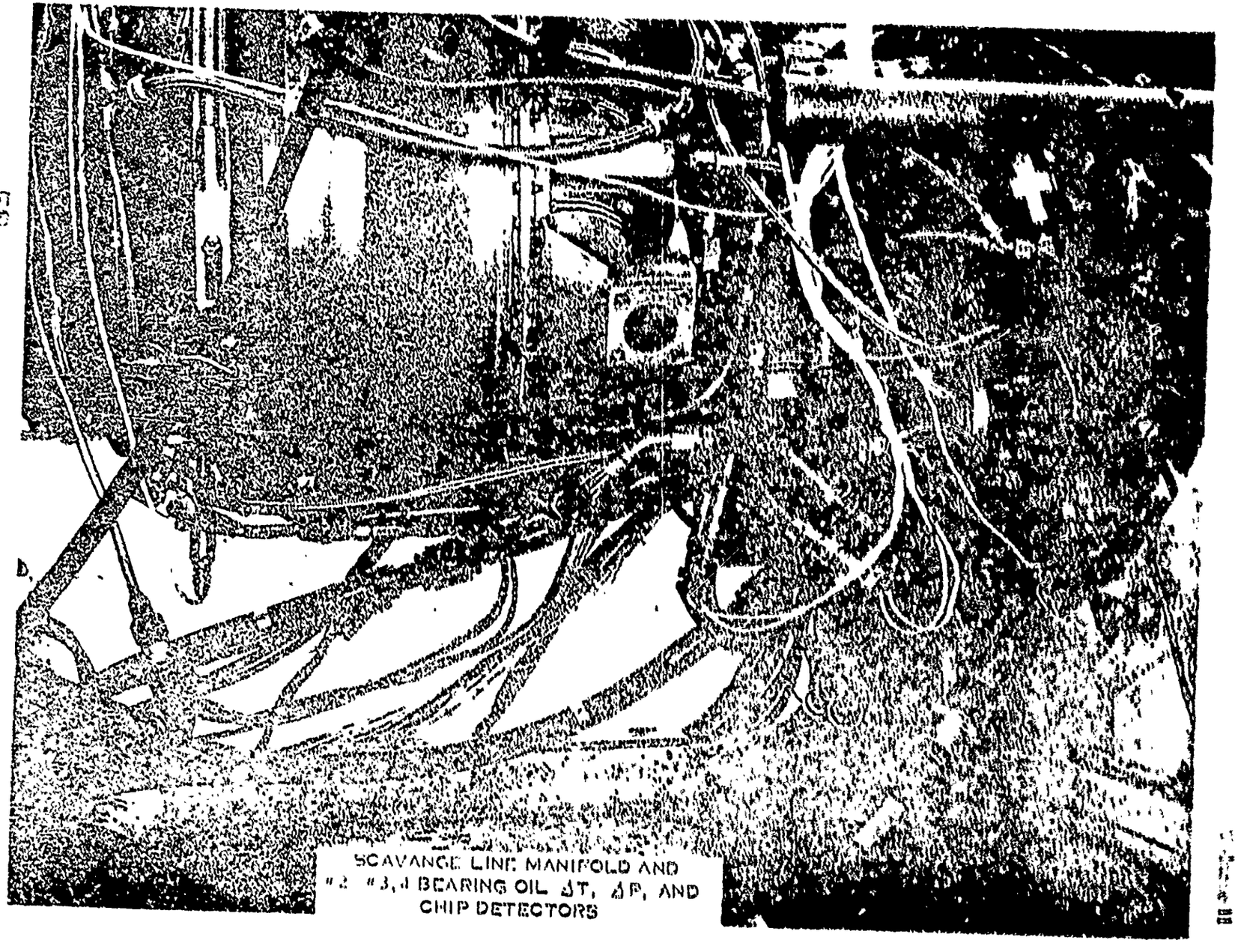
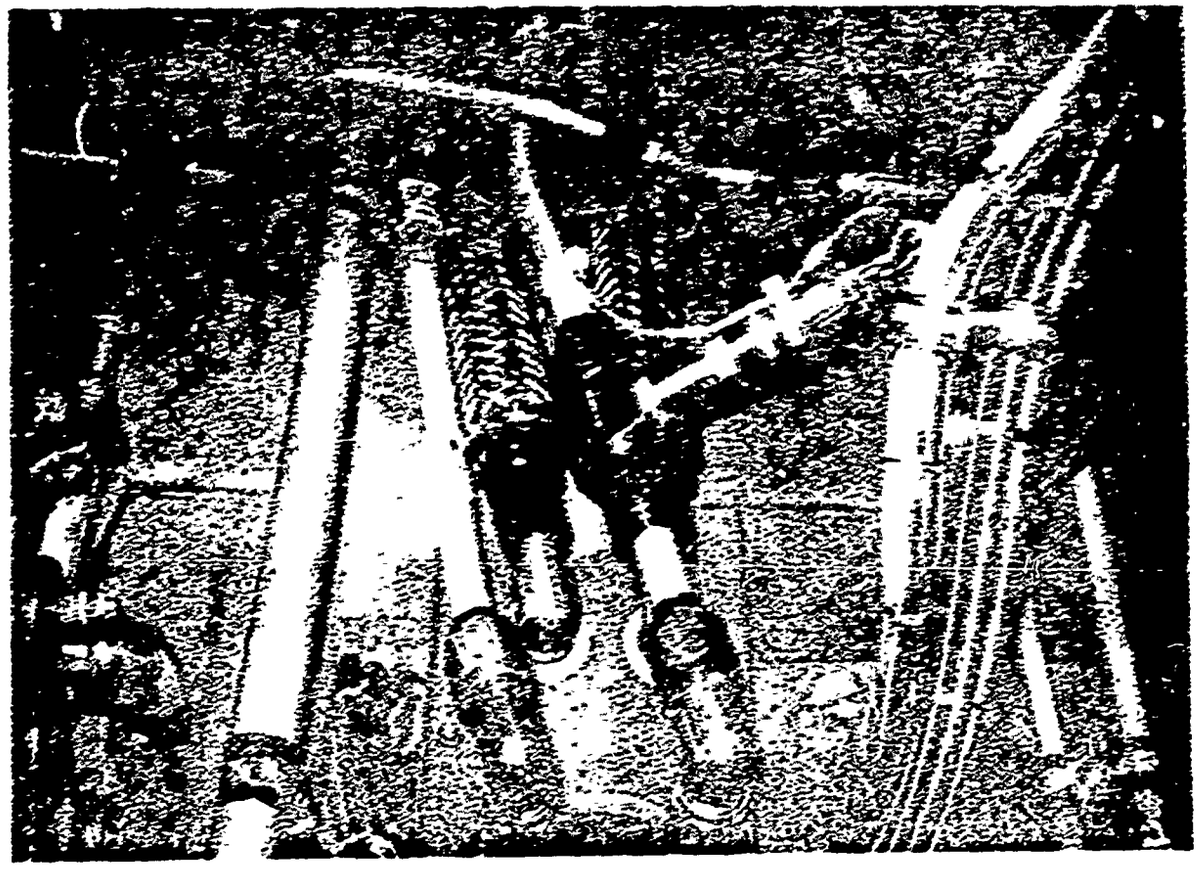
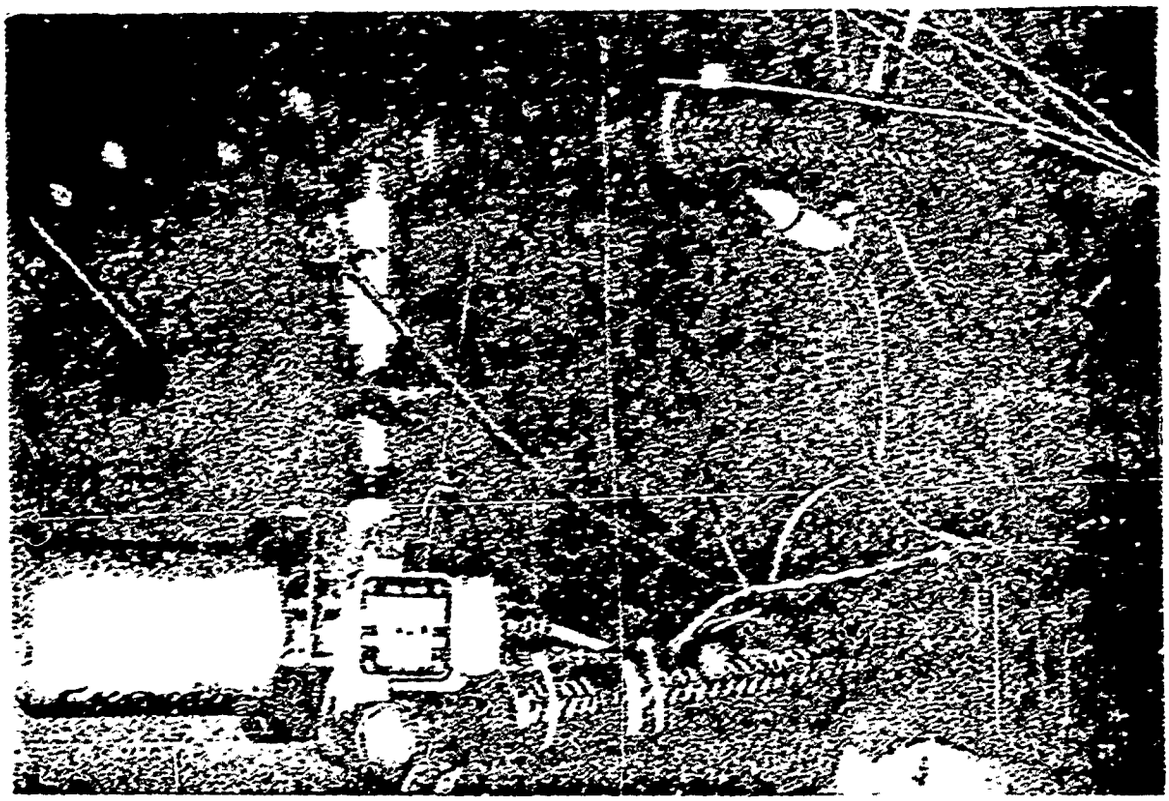

SCAVANGE LINE MANIFOLD AND
#2 #3,4 BEARING OIL ΔT, ΔP, AND
CHIP DETECTORS

FIGURE 4-16



TRANSMISSION OIL COOLER FLOWMETER INSTALLATION
ON THE UH-1H AIRCRAFT
UH-1H AIDAPS TEST BED PROGRAM

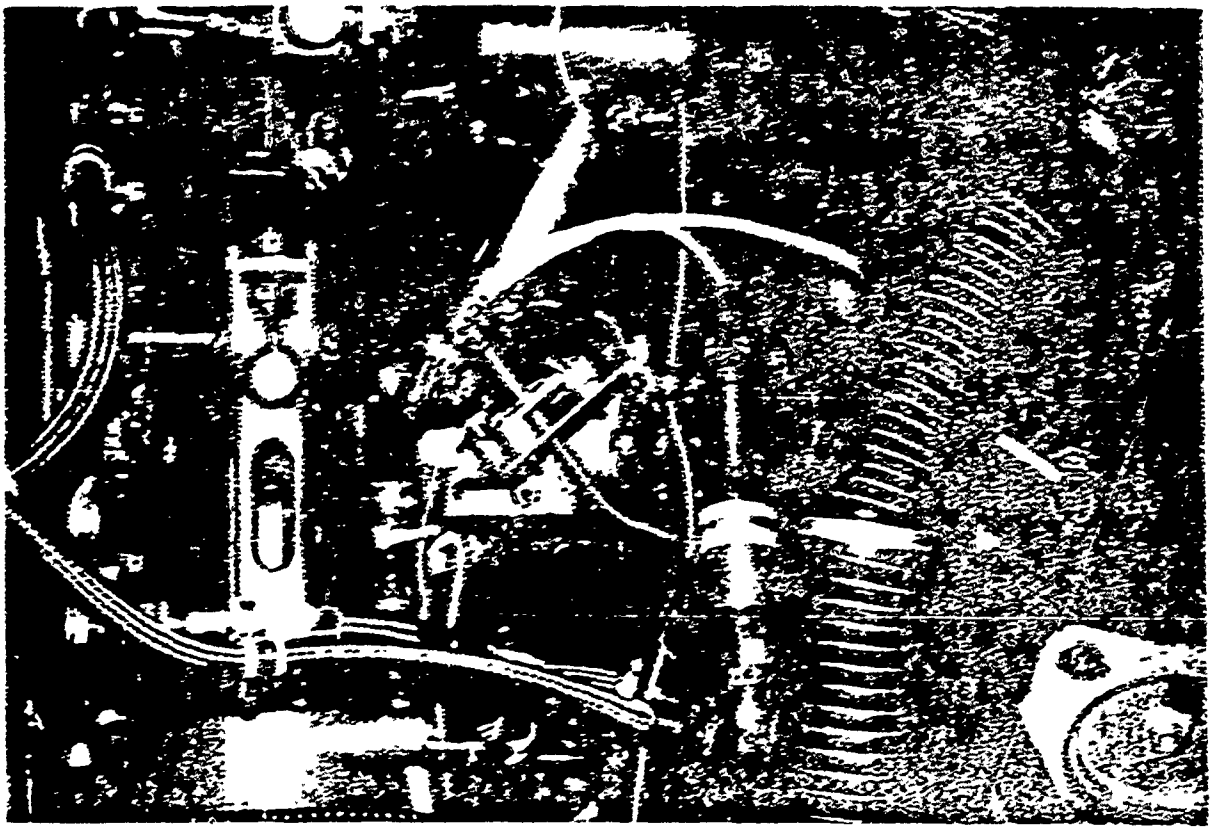
FIGURE 4-17



FUEL FLOW AND TEMPERATURE SENSOR INSTALLATION
THE UH–1H AIRCRAFT

UH–1H AIDAPS TEST BED PROGRAM

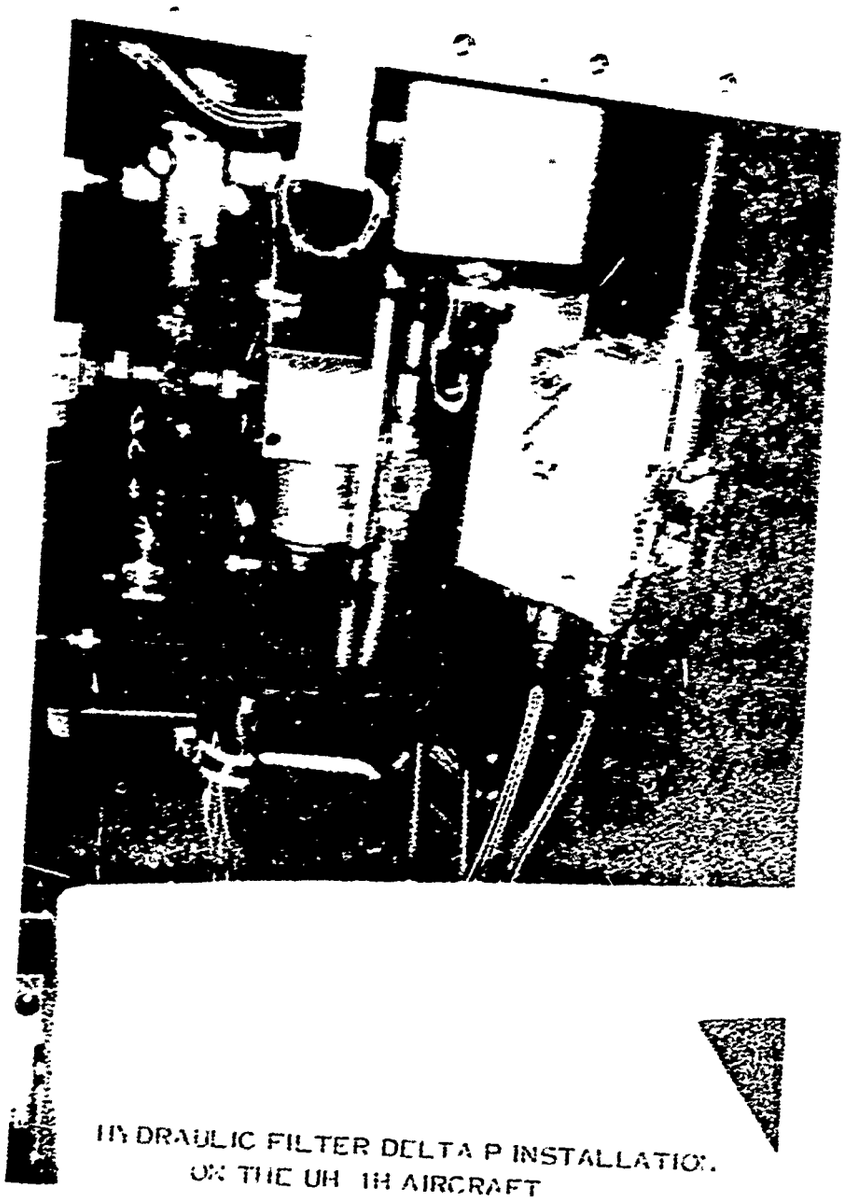
FIGURE L-18



AIRCRAFT INSTALLATION OF THE I.G.V. SYNCHRO
FOR THE LI3 ENGINE

UH-1H AIDAPS TEST BED PROGRAM

FIGURE 4-19

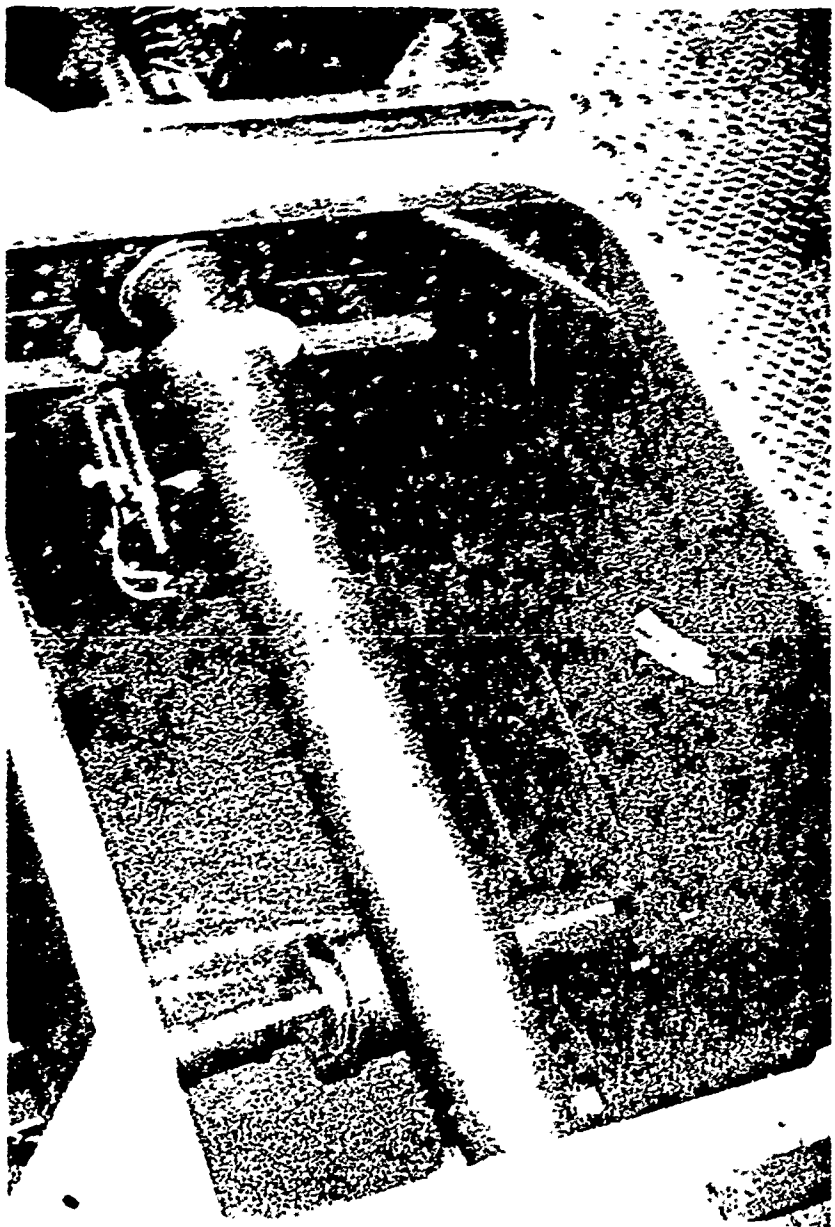


HYDRAULIC FILTER DELTA P INSTALLATION
ON THE UH 1H AIRCRAFT

FIGURE 4-20

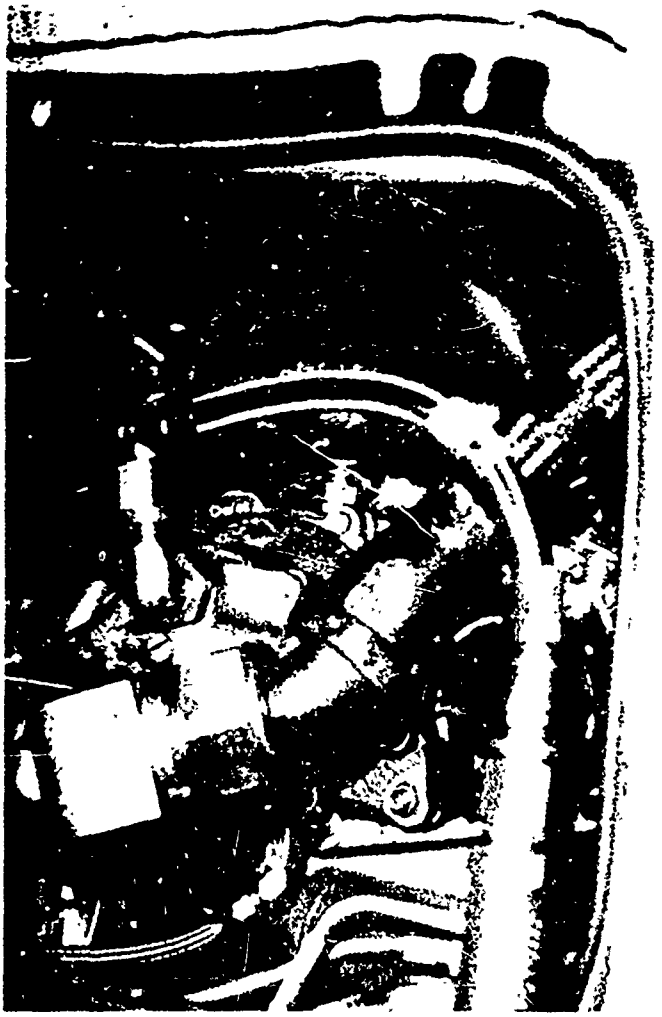
BLEED BAND SWITCH ON THE
L13 ENGINE

FIGURE 4-21



COLLECTIVE PITCH SYNCHRO INSTALLATION
ON THE UH-1H AIRCRAFT

FIGURE 4-22



HYDRAULIC BYPASS TEMPERATURE AND FLOW METER
INSTALLATION ON THE UH 1H AIRCRAFT

FIGURE 4-23

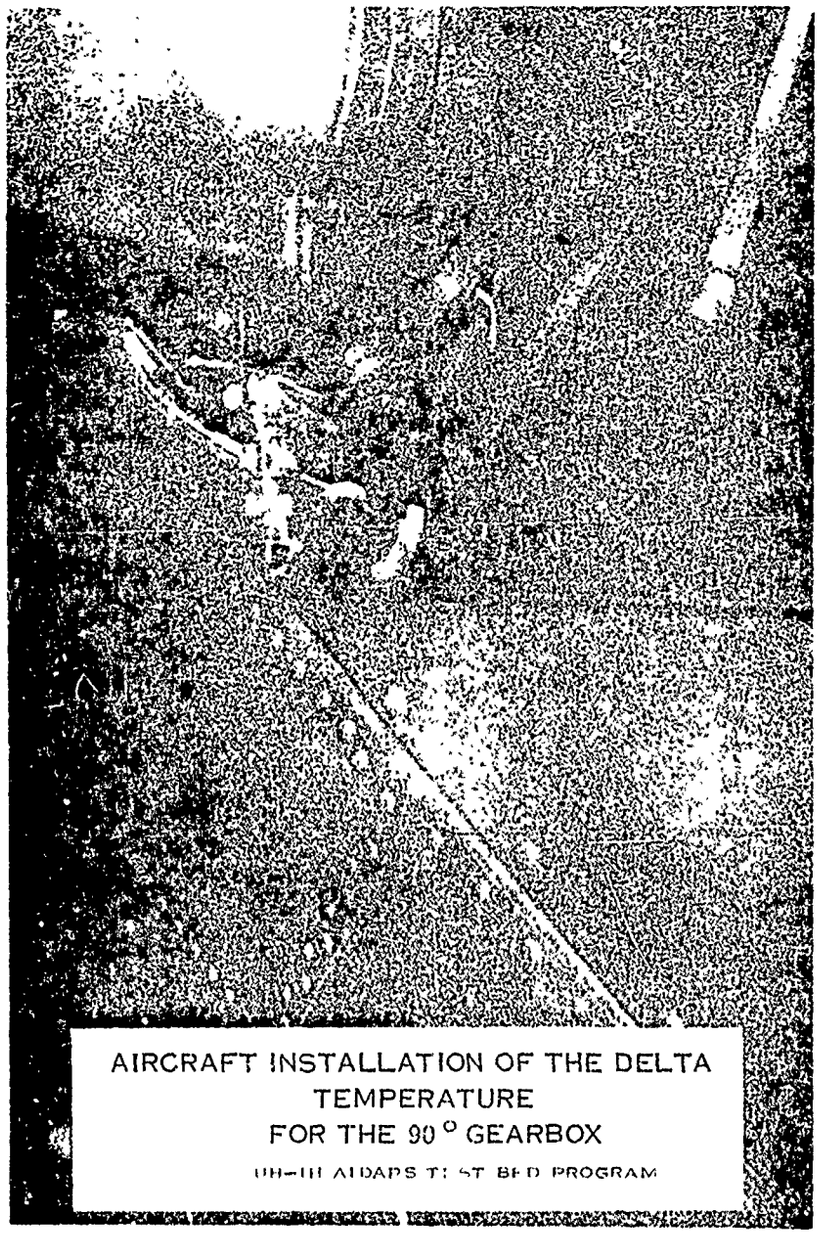
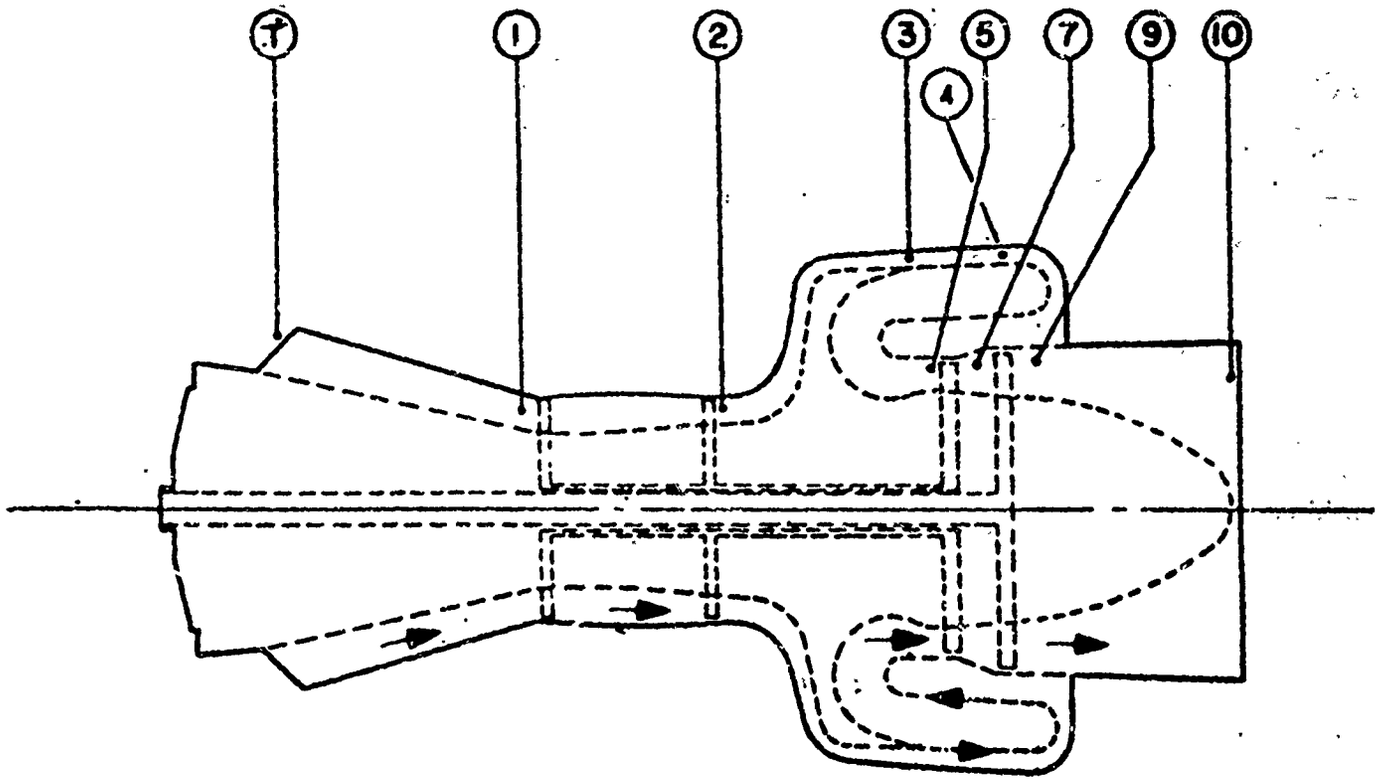

AIRCRAFT INSTALLATION OF THE DELTA
TEMPERATURE
FOR THE 90° GEARBOX

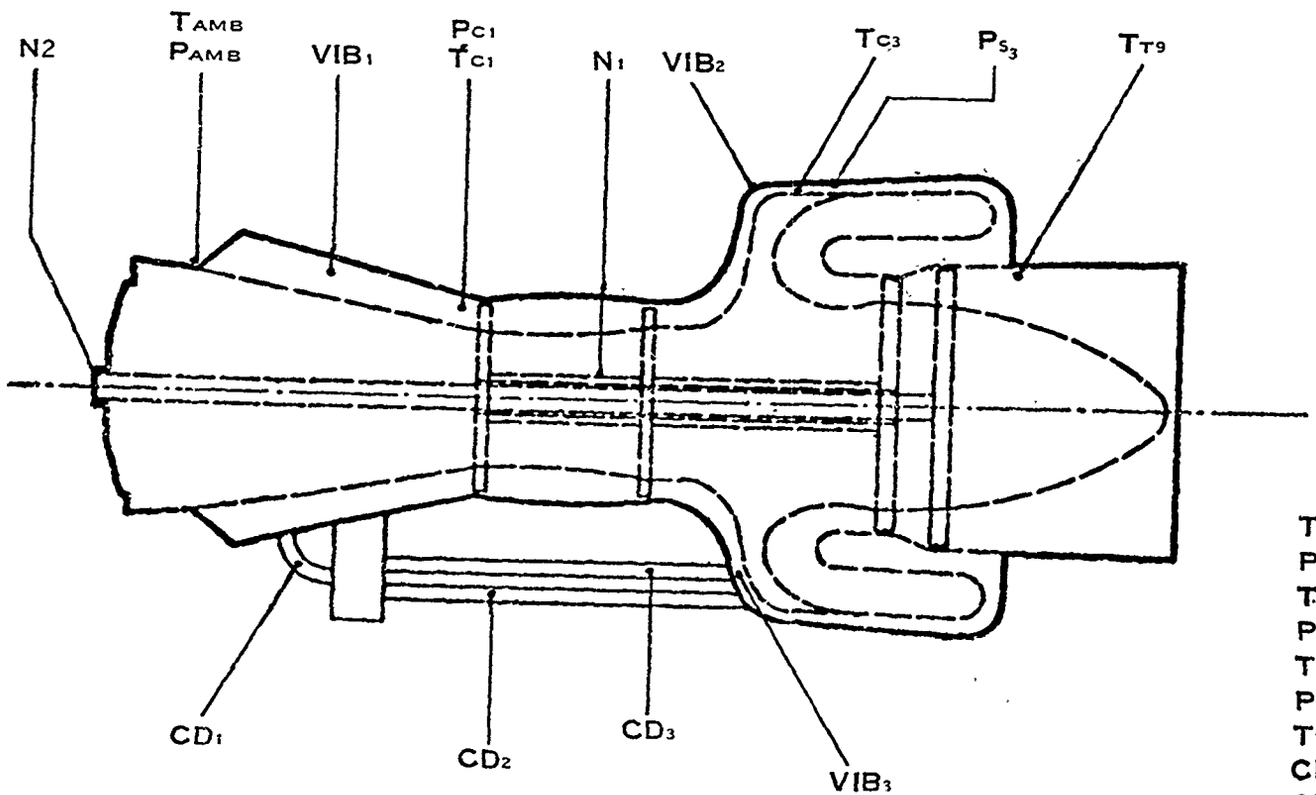
FIGURE 4-24



(T) ENGINE INLET
(1) AXIAL COMPRESSOR ENTRANCE
(2) CENTRIFUGAL COMPRESSOR ENTRANCE
(3) COMPRESSOR DIFFUSER EXIT
(4) COMBUSTOR STATIC PORT
(5) GAS PRODUCER TURBINE ENTRANCE
(7) POWER TURBINE ENTRANCE
(9) EXHAUST DIFFUSER ENTRANCE
(10) EXHAUST DIFFUSER EXIT

FIGURE 4–25 T53 ENGINE STATION DIAGRAM UH–1H

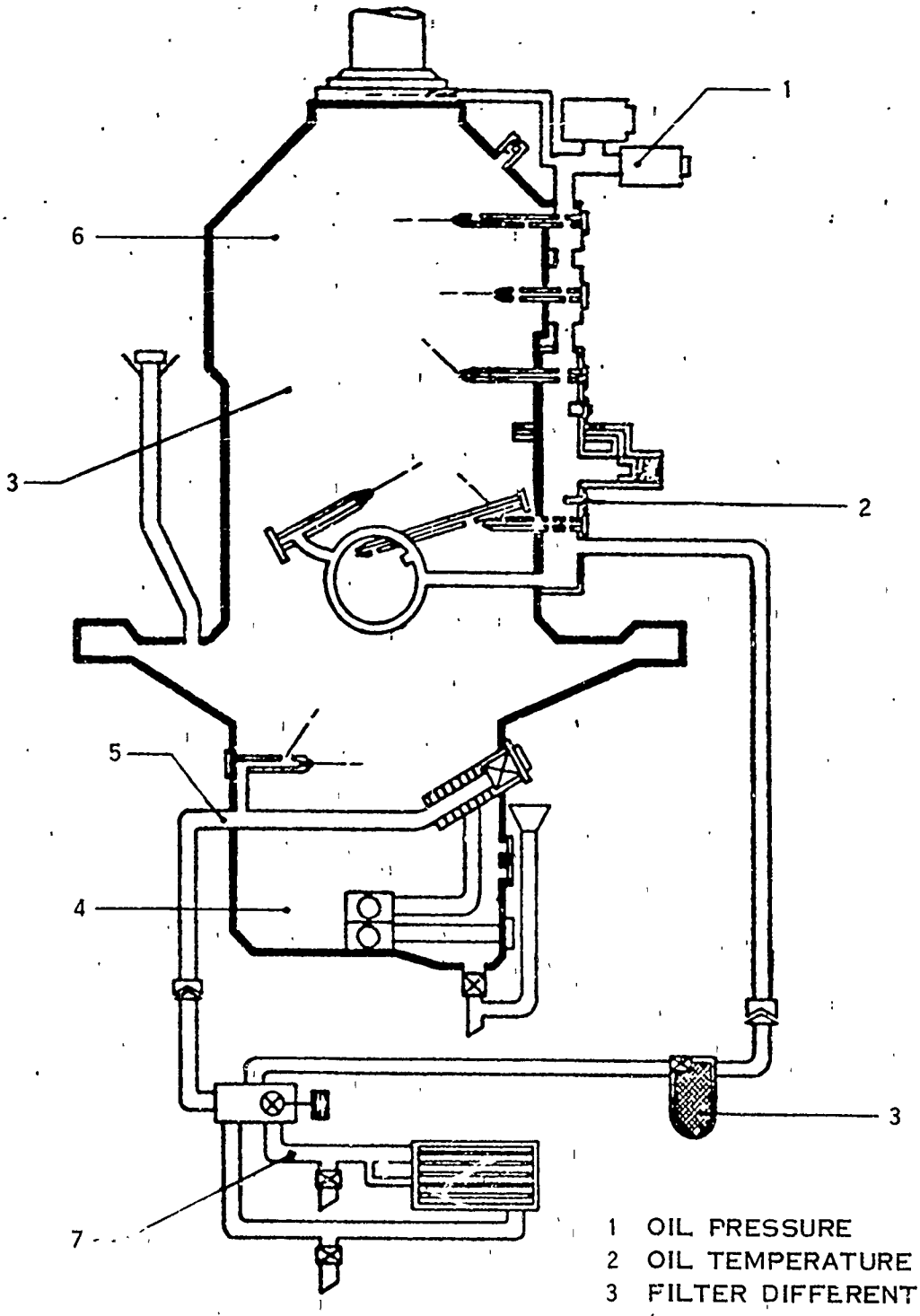
T53 PRIMARY ENGINE SENSORS UH-1H



T_{AMB}	AMBIENT TEMPERATURE
P_{AMB}	AMBIENT PRESSURE
T_{C1}	COMPRESSOR INLET TEMP.
P_{C1}	COMPRESSOR INLET PRESS.
T_{C3}	COMPRESSOR DISCHARGE TEMP.
P_{S3}	COMPRESSOR DISCHARGE PRESS.
T_{T9}	EXHAUST GAS TOTAL TEMP.
CD_1	FWD ENGINE COMPONENTS
CD_2	NO. 2 BEARING SCAVENGE LINE
CD_3	POWER TURBINE BEARING
N_1	GAS PRODUCER SPEED
N_2	POWER TURBINE SPEED
VIB_1	VIBRATION FWD.
VIB_2	VIBRATION AFT.
VIB_3	VIBRATION 3/4 SCAVANGE LINE

FIGURE 4–26

TRANSMISSION SENSORS UH-1H



1 OIL PRESSURE
2 OIL TEMPERATURE IN
3 FILTER DIFFERENTIAL (EXTERNAL & INTERNAL)
4 CHIP DETECTOR
5 OIL TEMPERATURE OUT
6 VIBRATION
7 OIL COOLER FLOW

FIGURE 4–27

42° GEARBOX SENSORS UH-1H

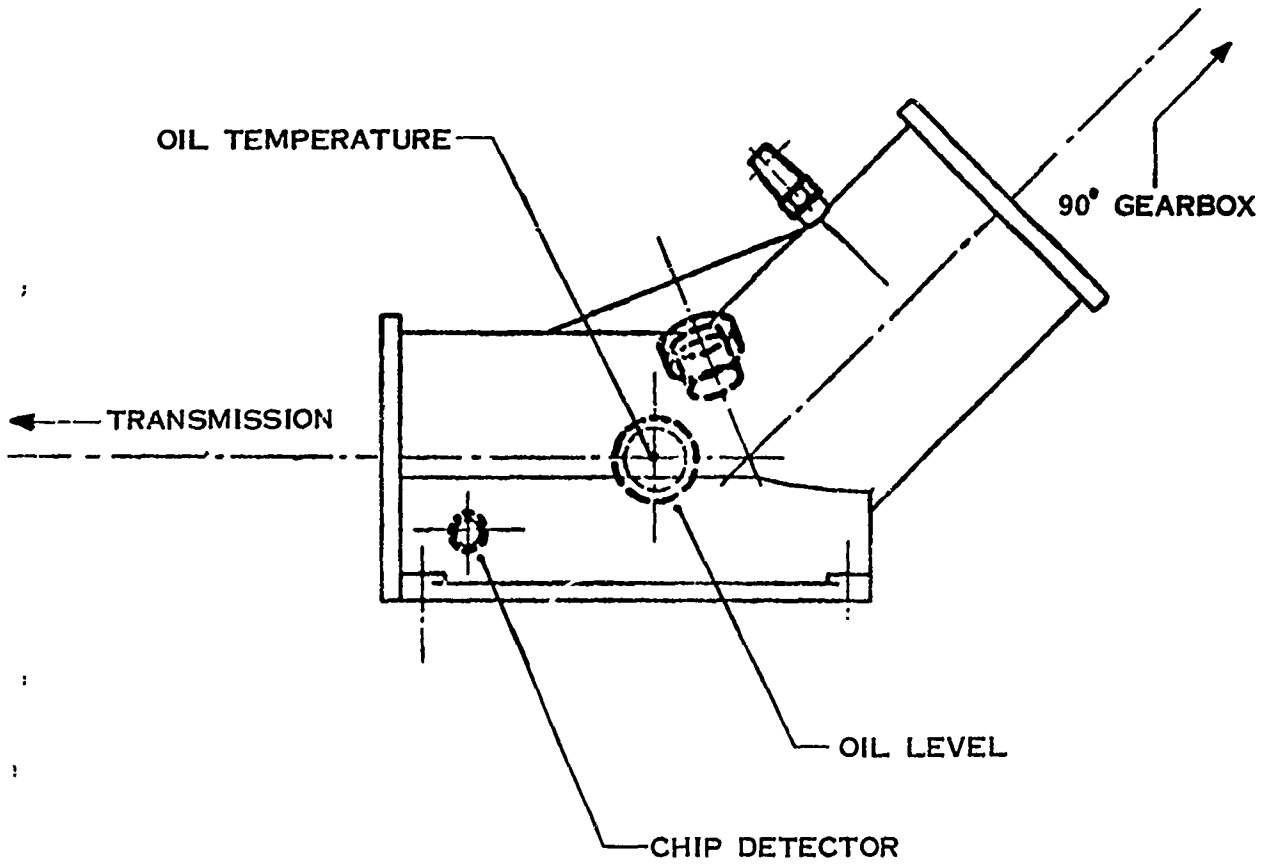


FIGURE 4–28

90° GEARBOX SENSORS UH-1H

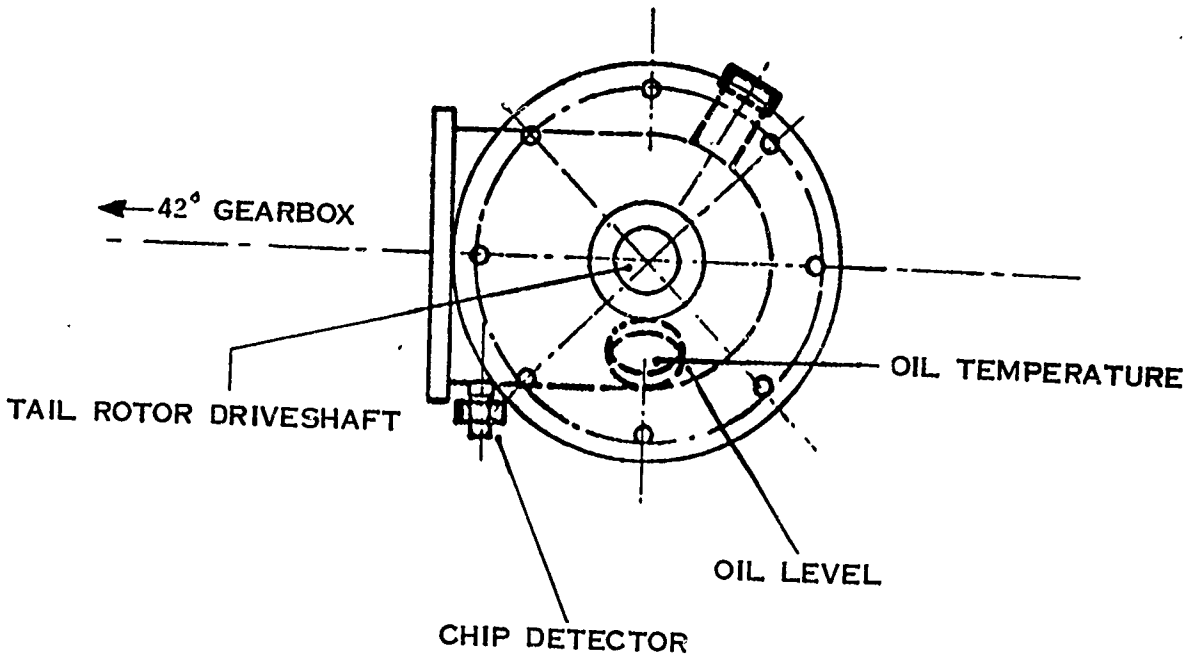


FIGURE 4–29

PARAMETER	PARAMETER	SENSOR TYPE	RANGE	VENDOR	MODEL	ACCURACY
1	Eng. #2 Bearing oil scavenge pressure	Pressure Switch	Open spsig: close spsig	Custom Components	7G315	±1 psig
2	Eng. #2 bearing oil Temp	Iron constanin thermocouple	0 to 300°F	ALD	---	±6°F
3	Eng #2 bearing chip detector	Chip Detector	Open 2K short	ALD	---	---
4	Compressor FOD. #2 bearing	Velocity Pickup	.100 inches peak to peak	CEC	4-125-0001	±5.4
5	EGT (Average)	Chromel-alumel thermocouple	32°F to 1400°F	Existing	---	±6°F
6	EGT (Individual) a thru i	Chromel-alumel thermocouple	32°F to 1700°F	Existing	---	±6°F
7	#3 and #4 Bearing	Velocity Pickup	.100 inches peak to peak	CEC	4-125-0001	±5.4
8	Compressor FOD	Accelerometer	100 g's	CEC	4-231-0001	±3.2
9	Eng. 3/4 bearing oil scavenge pressure	Pressure Switch	Open spsig:close spsig	Custom Components	7G315	±1psig
10	Eng #3/4 bearing oil Temp	Iron Constantin thermocouple	0 to 300°F	ALD	---	±6°F
11	Eng. #3/4 bearing chip detector	Chip Detector	Open 2K short	ALD	---	---
12	Eng. Accessory G. B. chip detector	Chip Detector	Open 2K short	ALD	---	---
13	Compressor Discharge Pressure (P_3)	Strain Gage Pressure Sensor	0 to 100 psi	Taber	Series 185	±.343 psi
14	Compressor Discharge Temp. (T_3)	Chromel-Alumel Thermocouple	32°F to 600°F	ALD	---	±6°F
15	Engine Inlet Pressure (P_1)	Strain Gage Pressure Sensor	0 to 30 psi	Taber	Series 187	±.338 psi
16	Engine Inlet Temp. (T_1)	Platinum Resistance Probe	0 to 164°F	ALD	---	±2.6°F
17	Gas Generator Speed (N_1)	Tachometer	25 to 110	Existing	---	---
18	Power Turbine Speed (N_2)	Tachometer	25 to 110	Existing	---	---
19	Power Lever Angle (PLA)	Synchro	Min/Max	Harowe	8CX-200-A-1 7	±11.2 min.
20	Fuel Flow (W_F)	Turbine Flow Meter	.167 to 2.5 gal min	Cox	AN8-4	± 27.
21	Left Fuel Boost Pump Flow Sev.	Flow Switch	Open 60pph:close 60pph	Existing	---	---
22	Right Fuel Boost Pump Flow Sev.	Flow Switch	Open 60pph:close 60pph	Existing	---	---
23	Fuel Pressure	Synchro Transmitter	0 to 30 psi	Existing	---	---
24	Engine Driven Fuel Pump Press. Sev.	Pressure Switch	Open 45psid:close 45 psid	Hydroelectric Co.	40210	±3.5 psid
26	Eng. Fuel Filter P Sev.	Pressure Switch	open 11psid:close 11psid	Westport Dev.	CG12529	±1 psid
29	Eng. Lube Oil Temp.	Resistance Bulb	0 to 350°F	Existing	---	---
30	Eng. Lube Oil Pressure	Variable Reluctance Press. Sen.	0 to 100 psi	Existing	---	---
31	Eng. Oil Filter P Sev.	Pressure Switch	open 11psid:close 11psid	Westport Dev.	CG12529	±1psid
32	Torque	Variable Reluctance Press. Sen.	0 to 1650 ft. lbs.	Existing	---	---
34	Bleed Band Position	Switch	Open/Closed	Microswitch	---	---
36	Battery Voltage at Start	DC Voltage	0 to 35 VDC	---	---	---
37	Engine Ignition Excites	Switch	On/Off	Existing	---	---
38	XMSN Oil Pressure Switch	Pressure Switch	open 30psi:close 30psi	Existing	---	---
39	XMSN Oil Pressure	Vauable Reluctance Press. Sen.	0 to 100 psi	Existing	---	---
40	XMSN Oil Temp. Sev.	Temp. Switch	open 110°C:close 110°C	Existing	---	---
41	XMSN Oil Temp.	Resistance Bulk	0 to 350°F	Existing	---	---
43	XMSN Oil Sump Chip Detector	Chip Detector	Open/2K short	Existing	---	---
45	Input Quill Ball Bearing	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5
47	Main Mast Bearing - Axial	Velocity Pickup	.200 inches peak to peak	M. B. Electronics	Type 14V	±9
49	Sump Input & Tailrotor Quill Bearings	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5
51	XMSN Ext. Oil Flt. P	Variable Reluctance Press. Sen.	Open 15psi:close 15psi	Dynasciences	P7D ±25 psid	±1 psid
58	42°G. B. 0.1 Temp. (T)	Chromel-Alumel Thermocouple	0 to 160°F	HSD	---	±6°F
59	Input Output Quill Bearings	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5
61	Gearmesh - 42° G.B.	Accelerometer	±100 g's	Columbia	1111-1	±5.2
63	90° G.B. Oil Temp. (T)	Chromel-Alumel Thermocouple	0 to 160°F	HSD	---	±6°F
64	Input Quill Bearings & Gearmesh	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5
66	Output Quill Bearings	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5

TABLE . . 4—1 SENSOR CHARACTERISTICS

PARAMETER *	PARAMETER	SENSOR TYPE	RANGE	VENDOR	MODEL *	ACCURACY
69	Hydraulic Pressure Switch	Pressure Switch	open 500psi:close 300psi	Existing	---	---
70	Hydraulic Supply Pressure	Variable Reluctance Press. Sen.	0 to 1500 psig	Dynasciences	P3D ±1500 psid	±10.6 psig
71	Hydraulic Supply Temp.	Chromel-Alumel Thermocouple	32 to 160°F	HSD	---	±6°F
72	Hydraulic Filter P	Variable Reluctance Press. Sen.	open 60psid:close 60 psid	Dynasciences	P7D ±100 psid	±2 psid
77	Total Pressure (P_T)	Strain Gage Pressure Sensor	0 to 35 psia	Statham	PA872-35	±.15 psia
78	Static Pressure (P_S)	Strain Gage Pressure Sensor	0 to 35 psia	Statham	PA872-35	±.15 psia
80	Collective Pitch Stick Position	Synchro	Up/Down	Harowe	8CX-200-A-1/7	±11.6 min.
87	Overspeed Governor Switch	Switch	Auto/Emergency	Existing	---	---
90	42° G. B. Chip Detector	Chip Detector	open/2K short	Existing	---	---
91	90° G. B. Chip Detector	Chip Detector	Open/2K short	Existing	---	---
101	XMSN Oil Cooler Flow	Turbine Flowmeter	0.5 to 15 gpm	Cox	AN10	±.2%
102	Main Rotor RPM (Nr)	Tachometer	25 to 110%	Existing	---	---
103	XMSN Int. Oil Flt. P	Variable Reluctance Press. Sen.	open 20psid:close 20psid	Dynasciences	P7D ±50 psid	±1 psid
107	Hydraulic Pump Case Leakage Flow	Turbine Flowmeter	0.05 to 0.5 gpm	Cox	LF0-1	±.5%
108	Hydraulic Pump Case Leakage Flow (T)	Chromel-Alumel Thermocouple	0 to 50°F	HSD	---	±6°F
109	28 VDC Essential Buss	DC Voltage	0 to 35 VDC	---	---	---
110	115 VAC Essential Buss	AC Voltage	0 to 130 VAC	---	---	---
111	26 VAC Instrument Buss	AC Voltage	0 to 35 VAC	---	---	---
112	Hi/Lo RPM Warning Light	Switch	On/Off	---	---	---
113	Hi/Lo RPM Warning Audio	Switch	On/Off	---	---	---
119	IGV Angle	Synchro	Open/Closed	Harowe	8CX-200-A-1/7	±11.6 min.
120	Inlet Air Filter P Switch	Pressure Switch	open 8 H_2O: closed 8 H_2O	Existing	---	---
121	Engine Oil Pressure Switch	Pressure Switch	open 25 psig: closed 25 psig	Existing	---	---
122	Fuel Temp.	Chromel-Alumel Thermocouple	32°F to +160°F	HSD	---	±6°F
123	Main Mast Bearing - radial	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5%
125	Input Quill Gearmesh	Accelerometer	±100 g's	Columbia	1111-1	±5.2%
127	Tail Rotor Quill Gearmesh	Accelerometer	±100 g's	Columbia	1111-1	±5.2%
129	Hyd. Pump and Tach. Quill Bearings	Velocity Pickup	.140 inches peak to peak	M. B. Electronics	Type 11	±5.5%

TABLE 4-1 CONTINUED

TABLE 4.2

CHRONOLOGICAL LISTING OF HARDWARE PROBLEMS

DATE	PROBLEM	CORRECTIVE ACTION
1/1/71 thru 1/15/71	Misc. Aircraft Wiring Discrepancies after completion of installation (Phase C)	Corrected Wiring errors
1/20/71	Hyd. By-pass flow readings erractic	Defective flowmeter; returned to manufacturer for repair under warrantee
2/17/71 and 2/18/71	Malfunction of DDP Hb ground based computer	Contacted Honeywell Rep. who repaired multiply and divide P.C. card
2/24/71	Recorder problem - tape not moving in cassette	Repaired defective cassette.
3/1/71	MEU unit #1 - Error in thermocouple readings	Replaced defective filtering capacitors
3/12/71	Fuel flow signal scattered (A/C 011)	Replaced flowmeter and modified adapter
	Note: On A/C 011, Misc. repairs to engine harnessing were necessary due to removing & replacing of engines with discrepant parts.	
4/13/71	MEU Unit #1 - power supply problem, 5V power supply failed.	Replaced power transistor in regulator circuit.
4/20/71	A/C #011 - Fuel temp. inoperative	Found broken wire on thermocouple due to engine change, replaced thermocouple

TABLE 4.2 (CONTINUED)

DATE	PROBLEM	CORRECTIVE ACTION
5/25/71	MEU Unit #1 hydraulic pump bypass readout inoperative	Replaced operational amplifier in signal conditioning circuitry
6/10/71	MEU #1, foreign matter in electronics units due to aircraft landing on beach	MEU #1 disassembled, cleaned, reassembled, and tested
6/21/71	A/C #1011, T_1 probe dammaged on installation	replaced T_1 probe
7/8/71	A/C 1011, Hydraulic supply pressure transducer failed	Replaced transducer
7/20/71	MAAP failed to operate correctly	Found broken wire in MEU #1 replaced broken wire
7/30/71	A/C #1011, #2 bearing $\Delta\tau$ thermocouple intermittent	repaired thermocouple
8/9/71	MEU #1, +28 volt supply failed due to broken connector on engine harness on A/C #1011	Replaced connector and repaired +28V supply.
8/10/71	A/C #1011, EGT (average) readout incorrect	Found engine EGT harness to be shorted. Repaired harness
8/16/71	A/C #1011, PLA signal not present	Replaced PLA sensor.
8/18/71	A/C #1011, W_f signal intermittent	Replaced W_f sensor
8/25/71	A/C #1011, T_3 probe intermittent	Replaced T_3 probe

Thru 8/31/71

TABLE 4.2 (CONTINUED)

DATE	PROBLEM	CORRECTIVE ACTION
9/14/71	Electrical connector on DC drift and cold junction compensation P.C. card was discovered to be broken	Connector replaced
9/14/71	Multiplexing circuit in AUX box defective	Replaced P.C. card

SECTION 5

DATA ACQUISITION AND PROCESSING

FIGURE 5-1

AIDAPS DATA COLLECTION AND ON SITE REVIEW

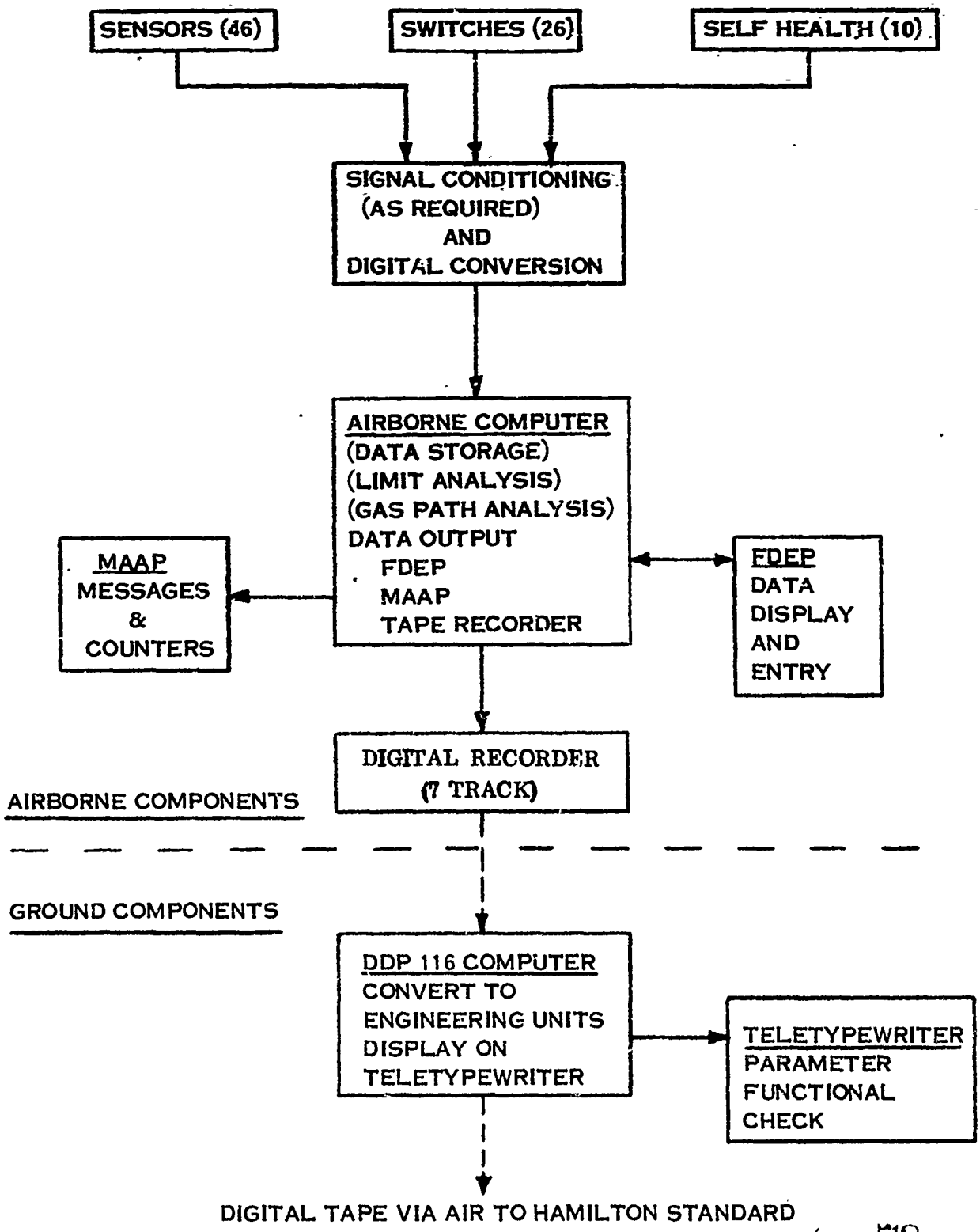


TABLE 5–1 AIDAPS PARAMETER DEFINITION

ENGINE PARAMETERS (GAS PATH)

NAME	SYMBOL	OPERATING RANGE	SAMPLES/ FRAMES	LIMIT VALUE
Gas Producer Speed	N_1	20000 to 26000 RPM	4	N/A
Power Turbine Speed	N_2	6000 to 6600 RPM	4	
Fuel Flow	WF	200 to 900 PPH	4	
Power Turbine Torque	Q2	200 to 1600 ft. lbs.	4	
Compressor Discharge Pressure	PS3	40 to 110 psi	4	
Compressor Discharge Temperature	T_{T3}	300 to 650°F	4	
Compressor Inlet Temperature	T_{T1}	0 to 120°F	2	
Aircraft Total Pressure	P_T	8 to 18 psi	2	
Average Exhaust Gas Temperature	T_{T9}	700 to 1100°F	4	N/A

ENGINE PARAMETERS (MECHANICAL)

Exhaust Gas Ring Temperatures	EGT 1-12	500 to 1100°F	1 each	+200/-400°F
Aircraft Static Pressure	PS	8 to 16 psia	1	N/A
Compressor Inlet Static Pressure	PS1	8 to 16 psia	1	N/A
Engine Oil Temperature	EOT	Amb to 300°F	2	>250°F/150°F
Engine Oil Pressure	EOP	Amb to 100 psi	2	< 27 psia
Fuel Temperature	T Fuel		1	
Bearing 2 Differential Temperature	B2ΔT	Amb to 300°F	1	>220°F/190°F
Bearing 3 & 4 Differential Temperature	B3ΔT	Amb to 300°F	1	>220°F/190°F
Power Lever Angle	PLA	0 to 100%	4	N/A
Collective Pitch Angle	CPA	0 to 100%	4	N/A
Inlet Guide Vane Angle	IGV	0 to 100%	4	N/A
Fuel Pressure	P Fuel		4	< 4 psi
Accessory Gearbox Chip Detector	ACGCD		2	
Bearing 2 Chip Detector	B2CD		2	
Bearing 3 & 4 Chip Detector	B3CD		2	
Fuel Filter Differential Pressure Switch	FFΔP		2	>11 psi
Right Fuel Pump Flow Switch	RBP SW		2	
Left Fuel Pump Flow Switch	LBP SW		2	
Inlet Air Filter Differential Pressure	Inlet Filter Δ P		2	
Engine Driven Fuel Pump Pressure Switch	Fuel Pump ΔP		2	
Oil Pressure Switch	EOP SW		2	
Oil Filter Differential Pressure Switch	EOF ΔP		2	>11 psi
Bearing 3 & 4 Pressure Switch	B3P		2	>8 psi
Bearing 2 Pressure Switch	B2P		2	>8 psi
Bleed Band Position Switch	BBP SW		2	
Transmission Oil Temperature	TOT	0 to 300°F	2	>230°F
Transmission Oil Pressure	TOP	0 to 100 psi	2	< 29 psi/>70 psi
Oil Cooler Flow	OCF	.05 to 15 gpm	2	>12 gpm
Oil Temperature Switch	TOT SW		2	
Oil Pressure Switch	TOP SW		2	
Internal Oil Filter Differential Pressure Switch	TIOF ΔP		2	> 20 psi
External Oil Filter Differential Pressure Switch	TEOF ΔP		2	> 15 psi
Oil Sample Chip Detector	TOCD		2	

TABLE 5–1 (CONT'D) AIDAPS PARAMETER DEFINITION

NAME	SYMBOL	OPERATING RANGE	SAMPLES/ FRAMES	LIMIT VALUE
HYDRAULIC SYSTEM PARAMETERS				
Supply Pressure (high Switch)	HSP	0 to 1200 psi	2	< 500/>1150 psi
Supply Temperature	HST		2	N/A
Pump Bypass Flow	H.P. WF	.1 to 2. gpm	2	> 0.45 gpm
Pump Temperature Rise	Pump ΔT		2	> 50°F
Supply Pressure Switch (Low)	HSP SW		2	
Filter Differential Pressure Switch	HYD FILT ΔP		2	>60 psi
GEARBOX PARAMETERS				
42° Differential Temperature	G42ΔT	0 to 200°F	2	>130°F
42° Chip Detector	G42CD		2	
90° Differential Temperature	G90ΔT		2	>130°F
90° Chip Detector	G90CD			
ANCILLARY PARAMETERS				
Rotor Speed	NR	280 to 350 RPM	4	>335/<295 rpm
Rotor Audio Alarm	Audio Alarm		2	
Rotor Light Alarm	Light Alarm		2	
Overspeed Governor Switch Position	Gov. SW.		2	
Ignition Exciter Switch Position	Ig. Ex. SW		2	
Starting Battery Voltage	SBV	15 to 30V	1	<21V
115 VAC Essential Bus Voltage	ACEB	100 to 130V	1	>120/<110V
26 VAC Instrument Bus Voltage	ACIB	24 to 28V	1	>26.6/<25.4V
28 VDC Essential Bus Voltage	DCEB	24 to 30V	1	>29/<26V

FIGURE 5-2 COMPRESSOR PRESSURE FOR INITIAL STEADY STATE TEST

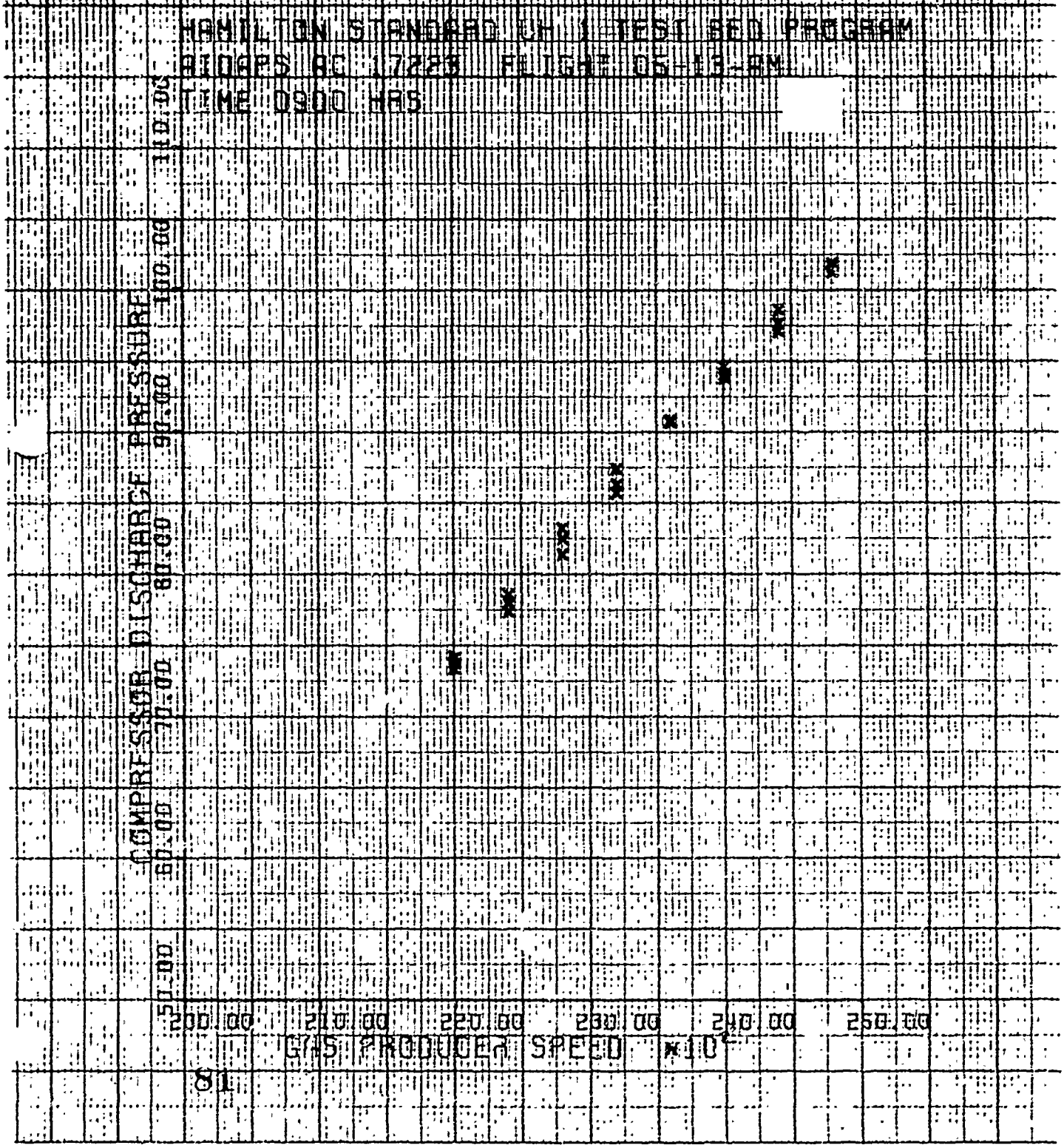


FIGURE 5–3 COMPRESSOR TEMPERATURE FOR INITIAL STEADY STATE TEST

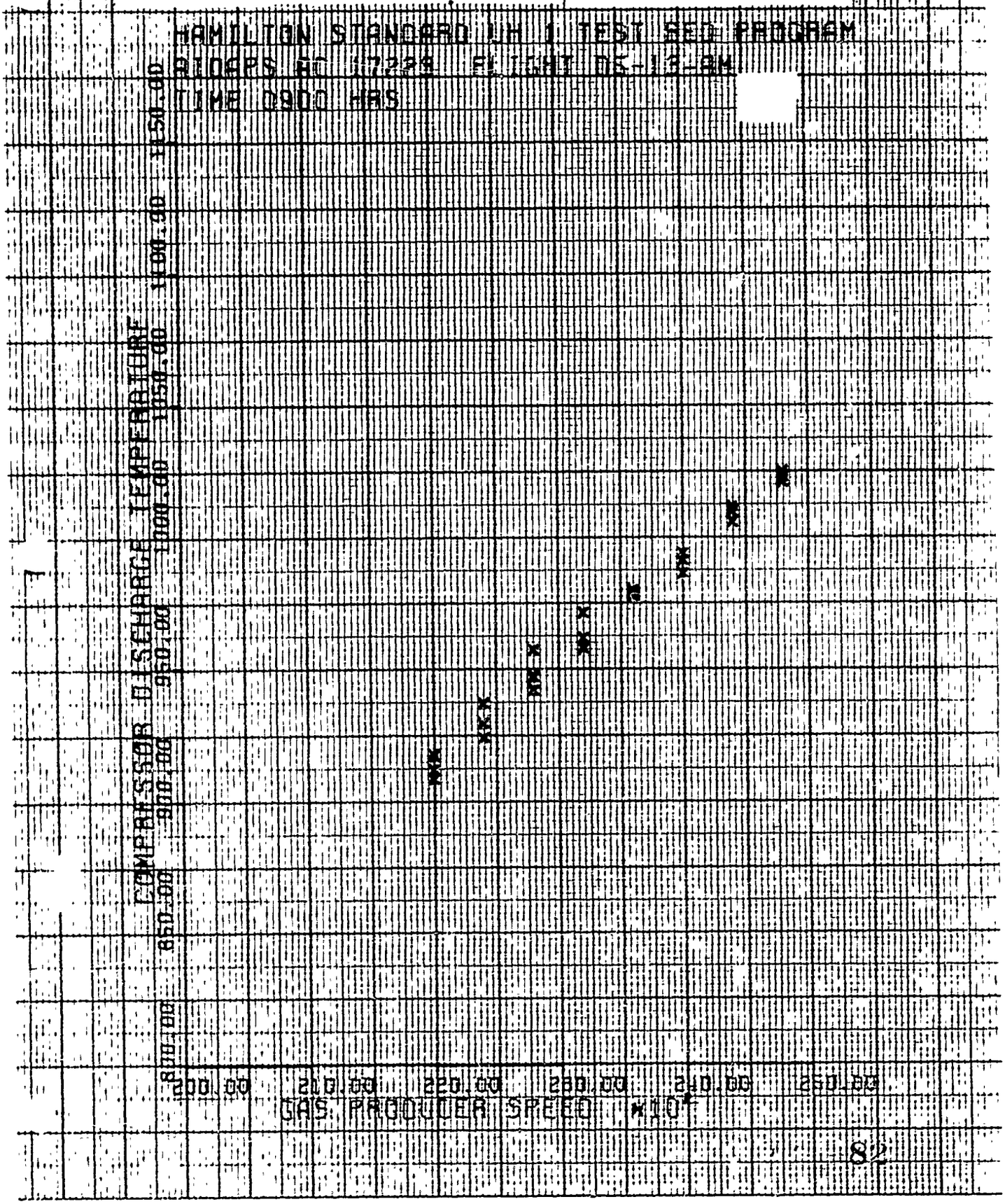


FIGURE 5-4 FUEL FLOW FOR INITIAL STEADY STATE TEST.

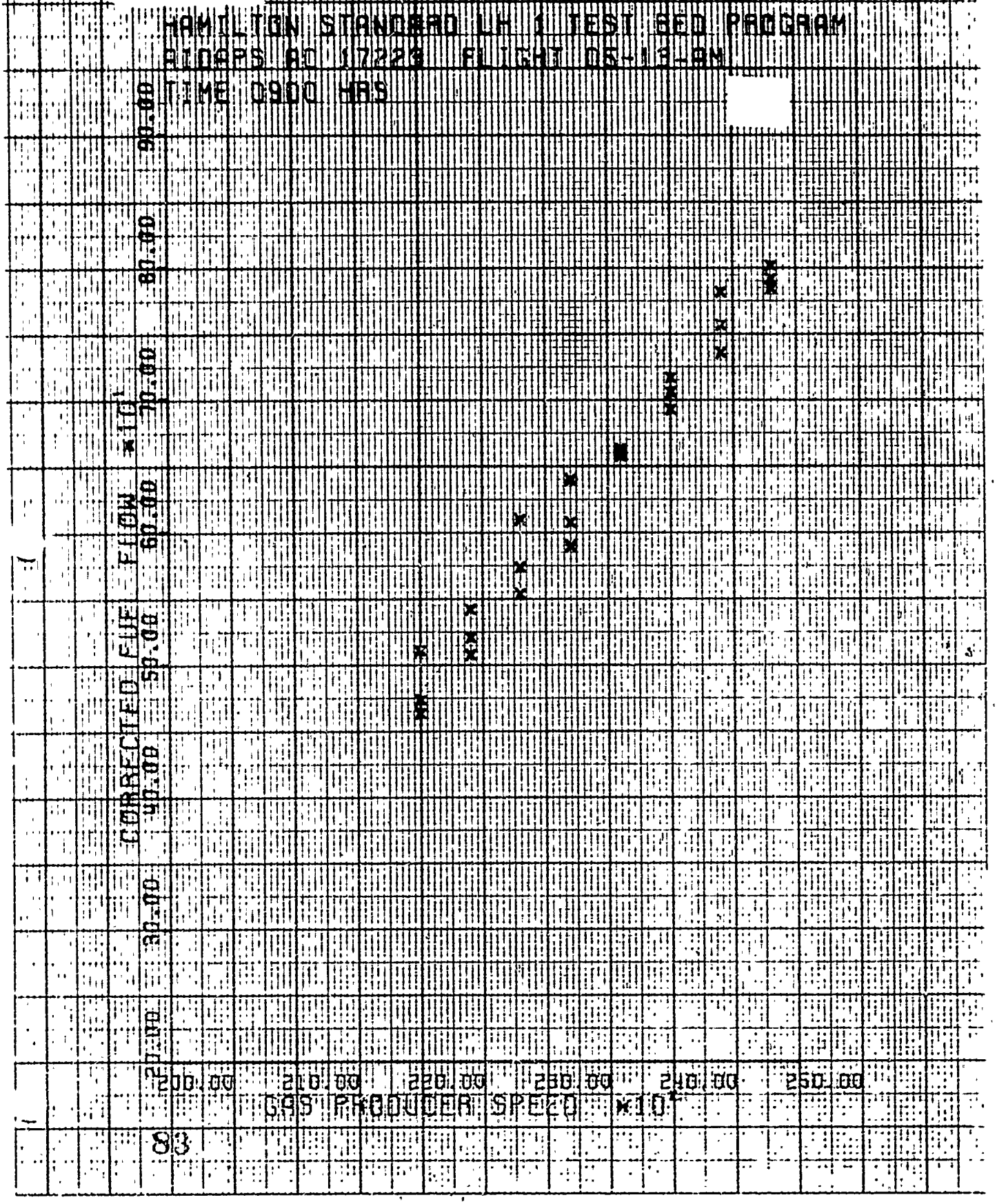


FIGURE 5–5 HORSEPOWER FOR INITIAL STEADY STATE TEST

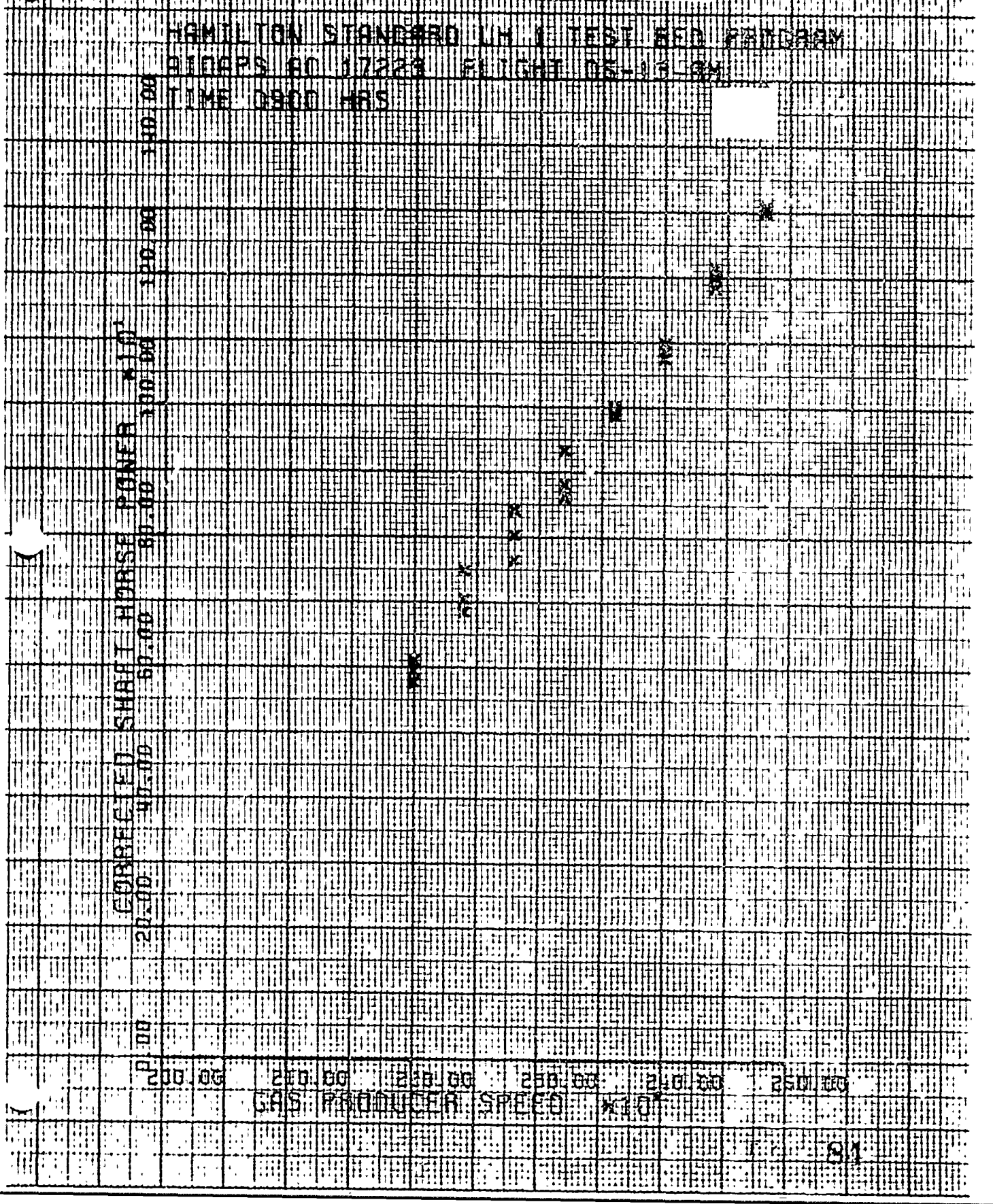


FIGURE 5-6 EXHAUST GAS TEMPERATURE FOR INITIAL STEADY STATE TEST

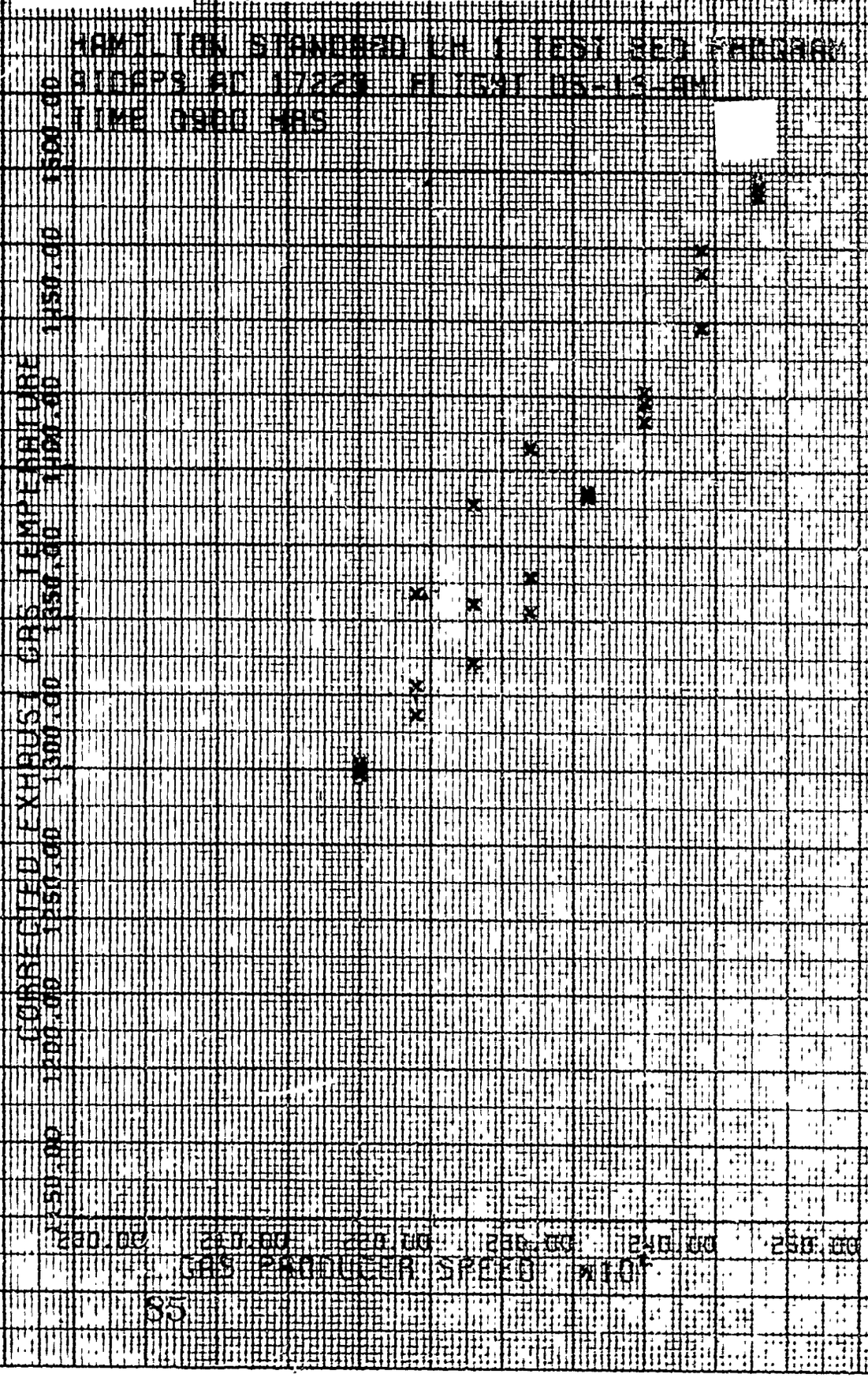


FIGURE 5-7 COMPRESSOR PRESSURE FOR FINAL STEADY STATE TEST

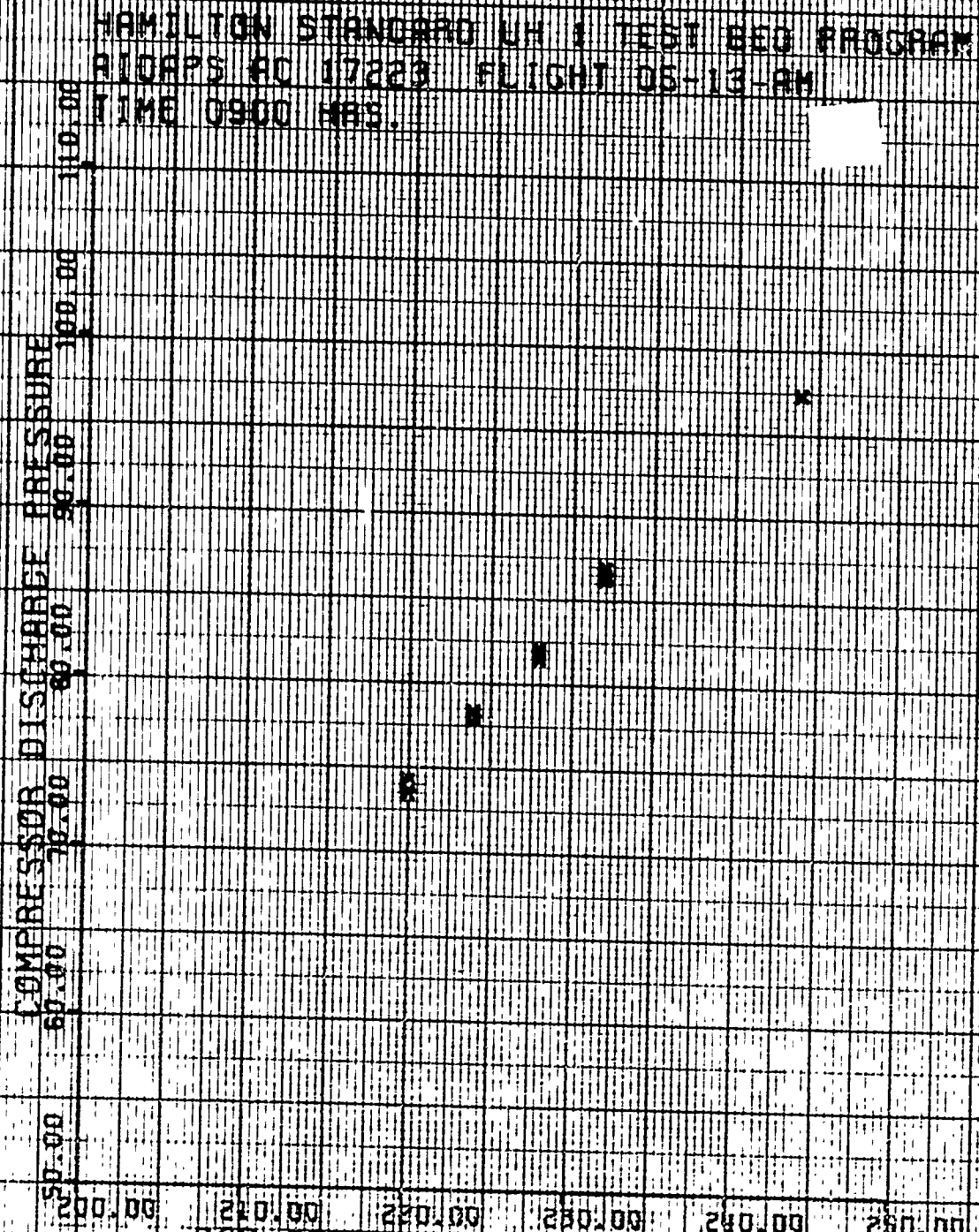


FIGURE 5-8 COMPRESSOR TEMPERATURE FOR FINAL STEADY STATE TEST

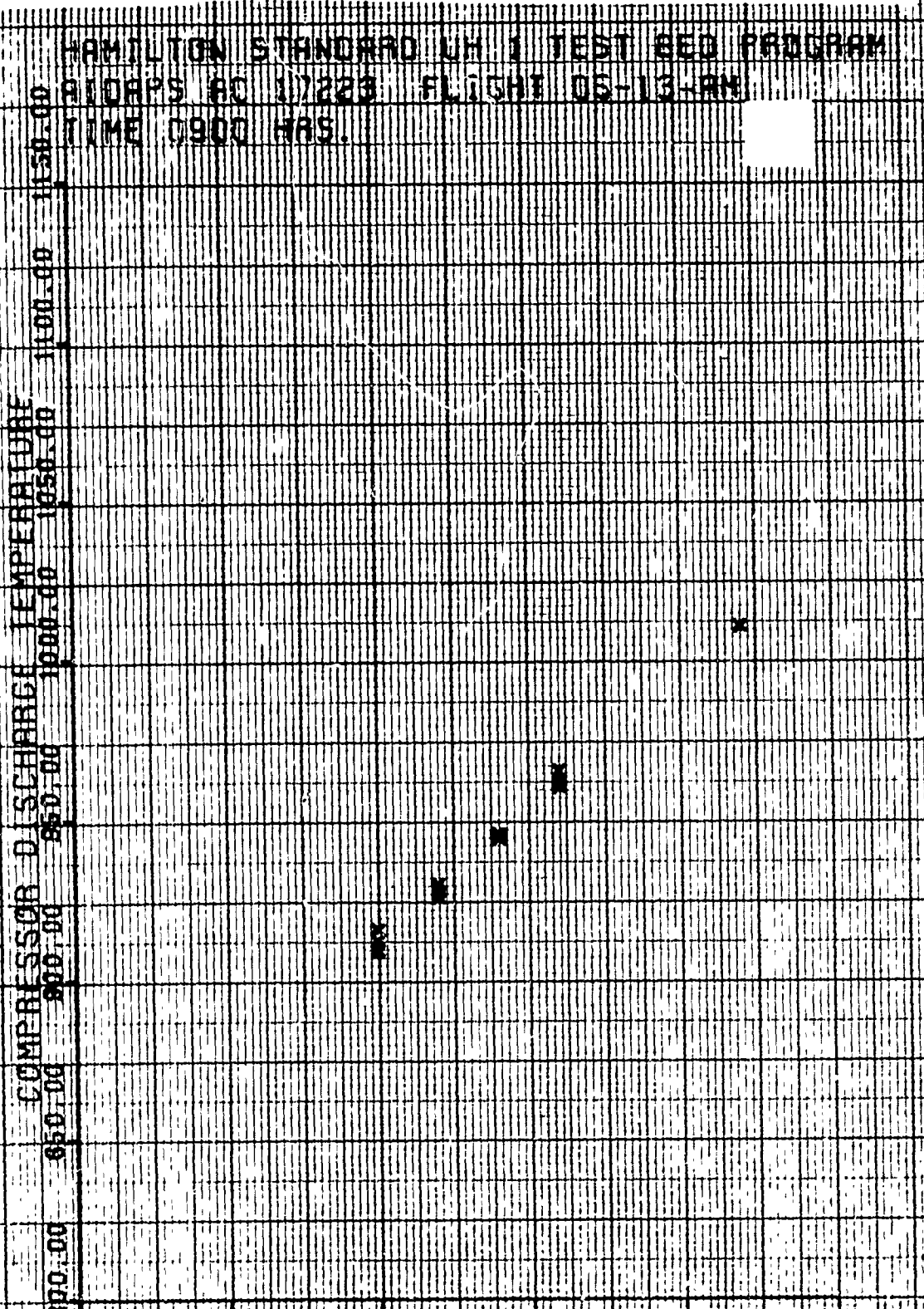


FIGURE 5-9 FUEL FLOW FOR FINAL STEADY STATE TEST

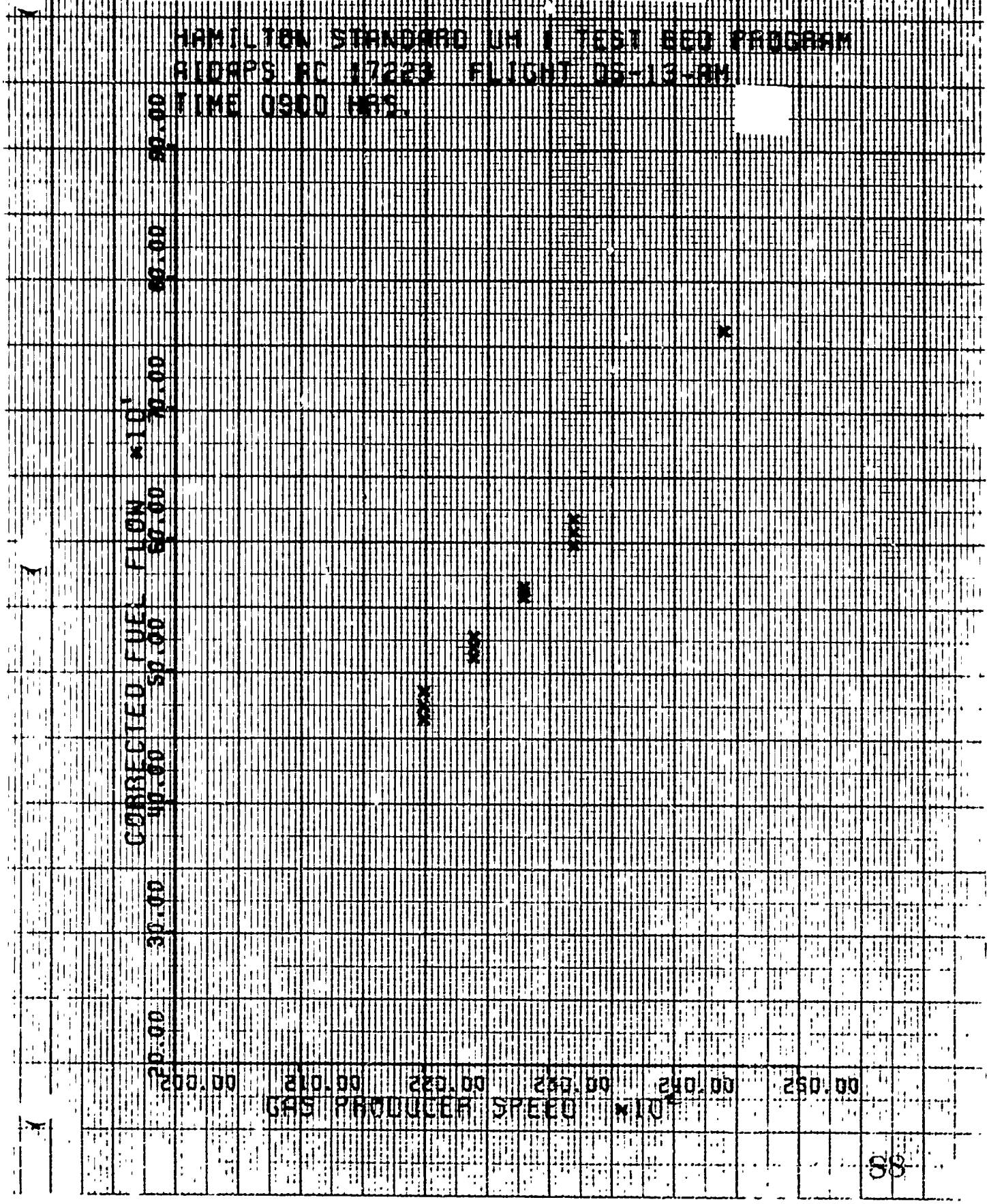


FIGURE 5-10 HORSEPOWER FOR FINAL STEADY STATE TEST

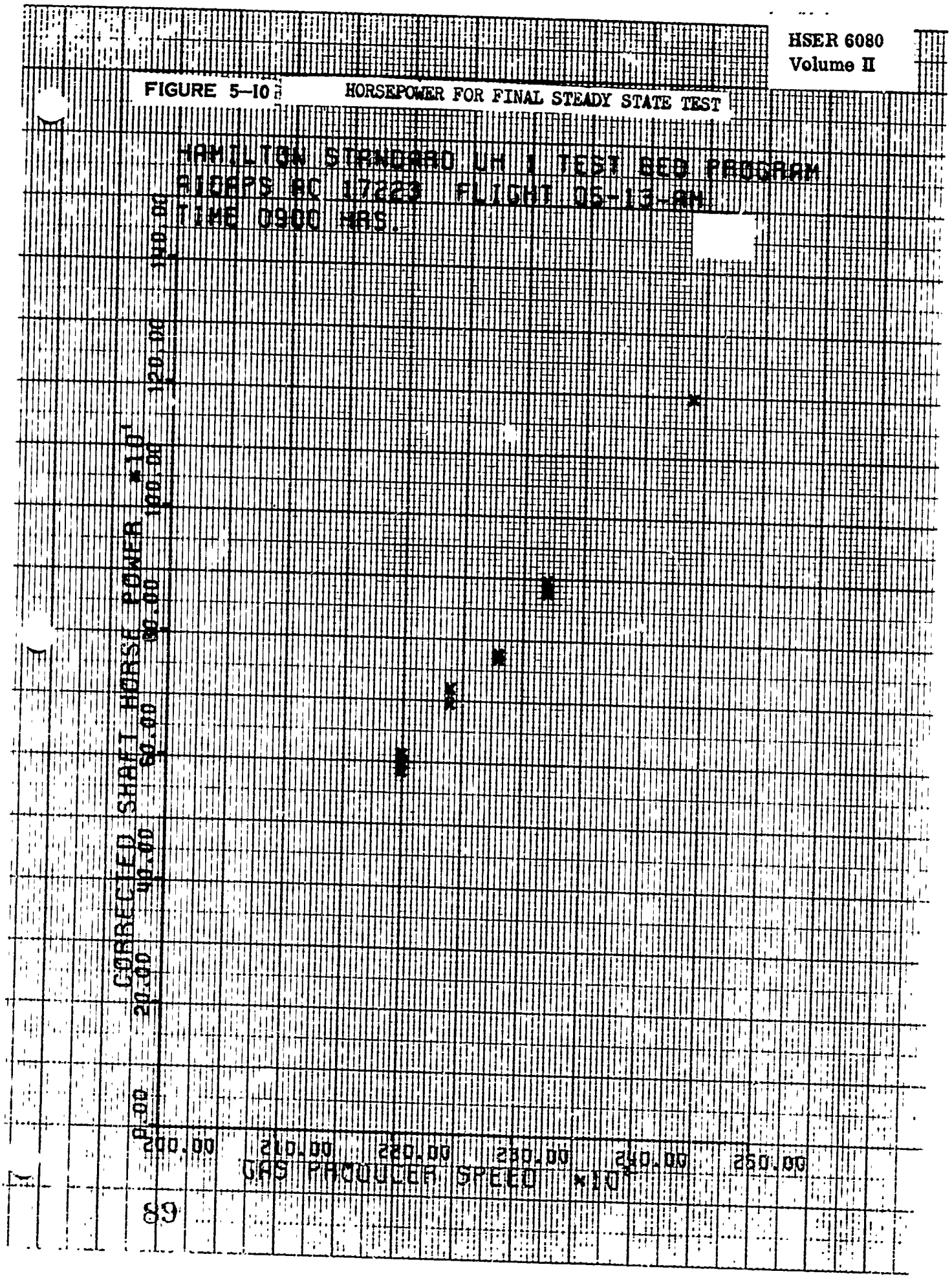


FIGURE 5—II EXHAUST GAS TEMPERATURE FOR FINAL STEADY STATE TEST

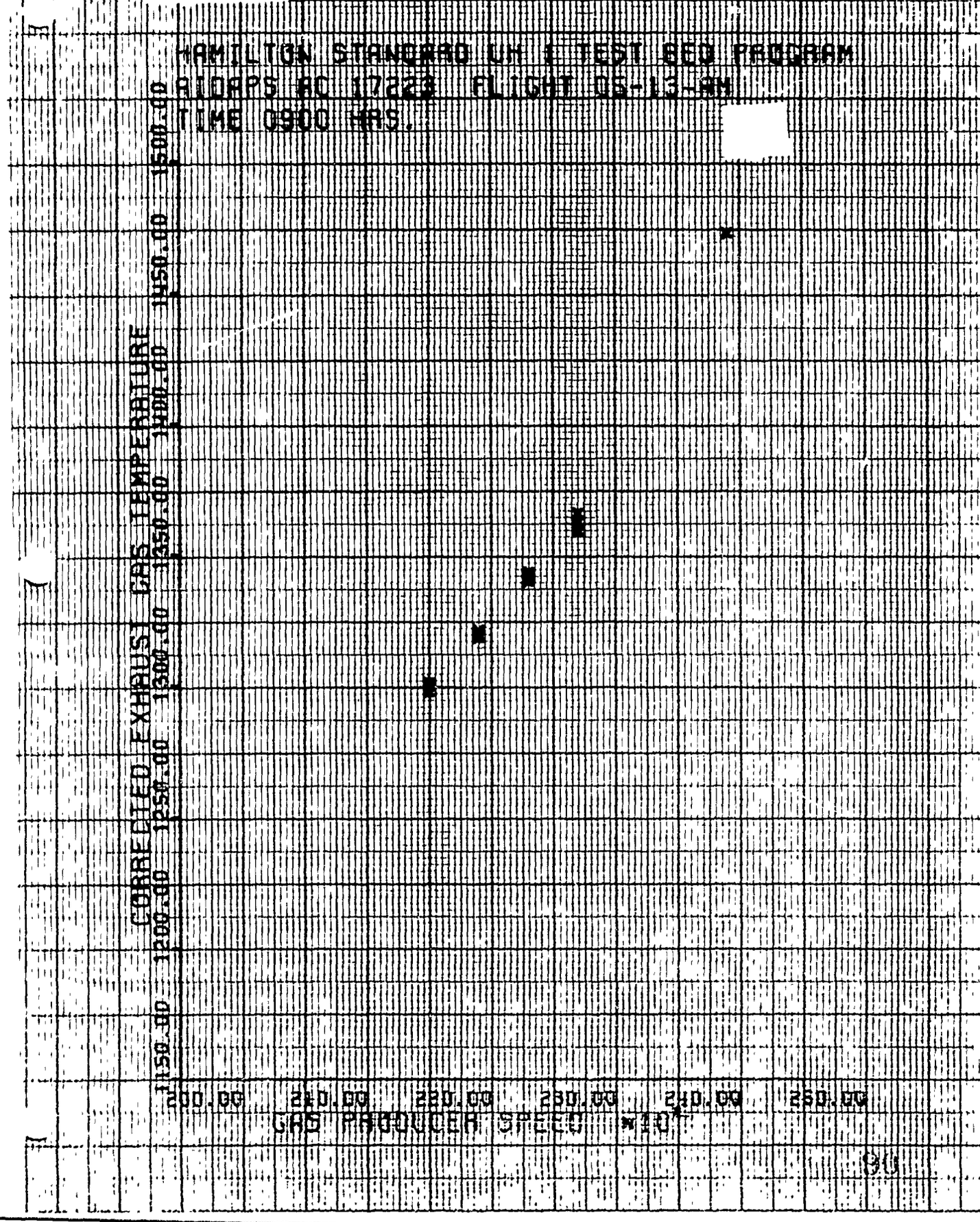


FIGURE 5–12 GAS PRODUCER SPEED BASELINES FOR FLIGHT TEST ENGINES

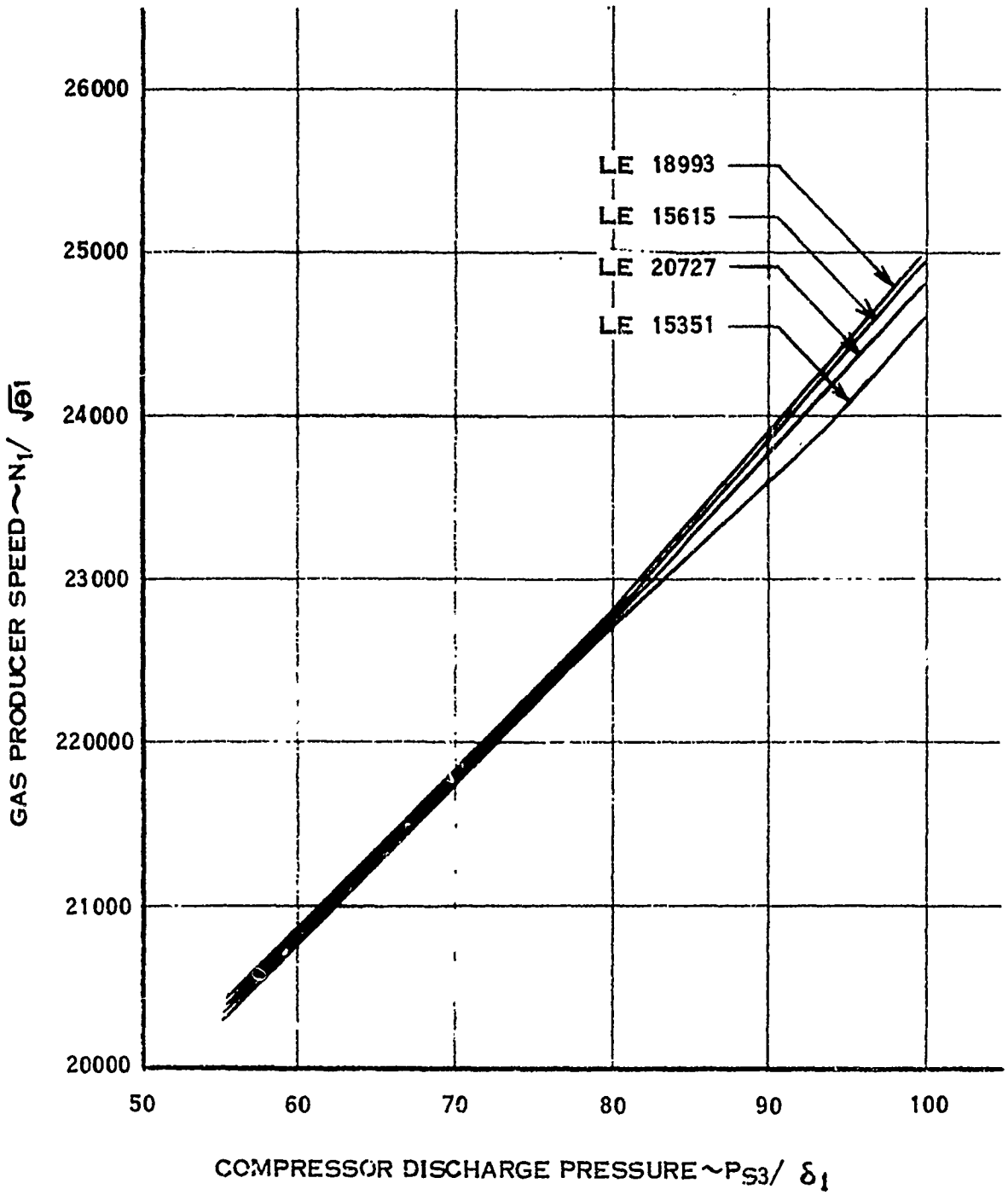


FIGURE 5–13 COMPRESSOR TEMPERATURE BASELINES FOR FLIGHT TEST ENGINES

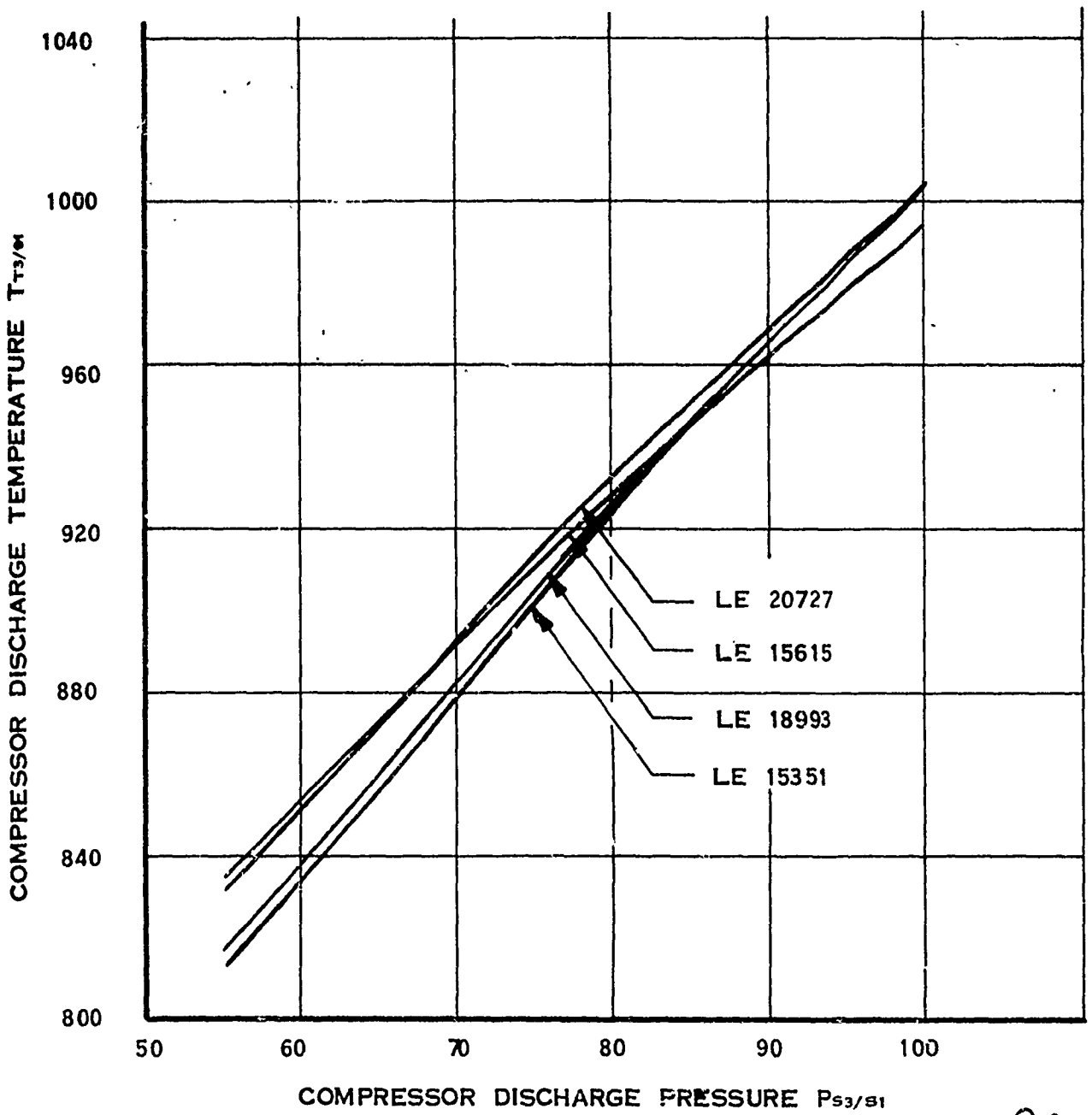


FIGURE 5-14 FUEL FLOW BASELINES FOR FLIGHT TEST ENGINES

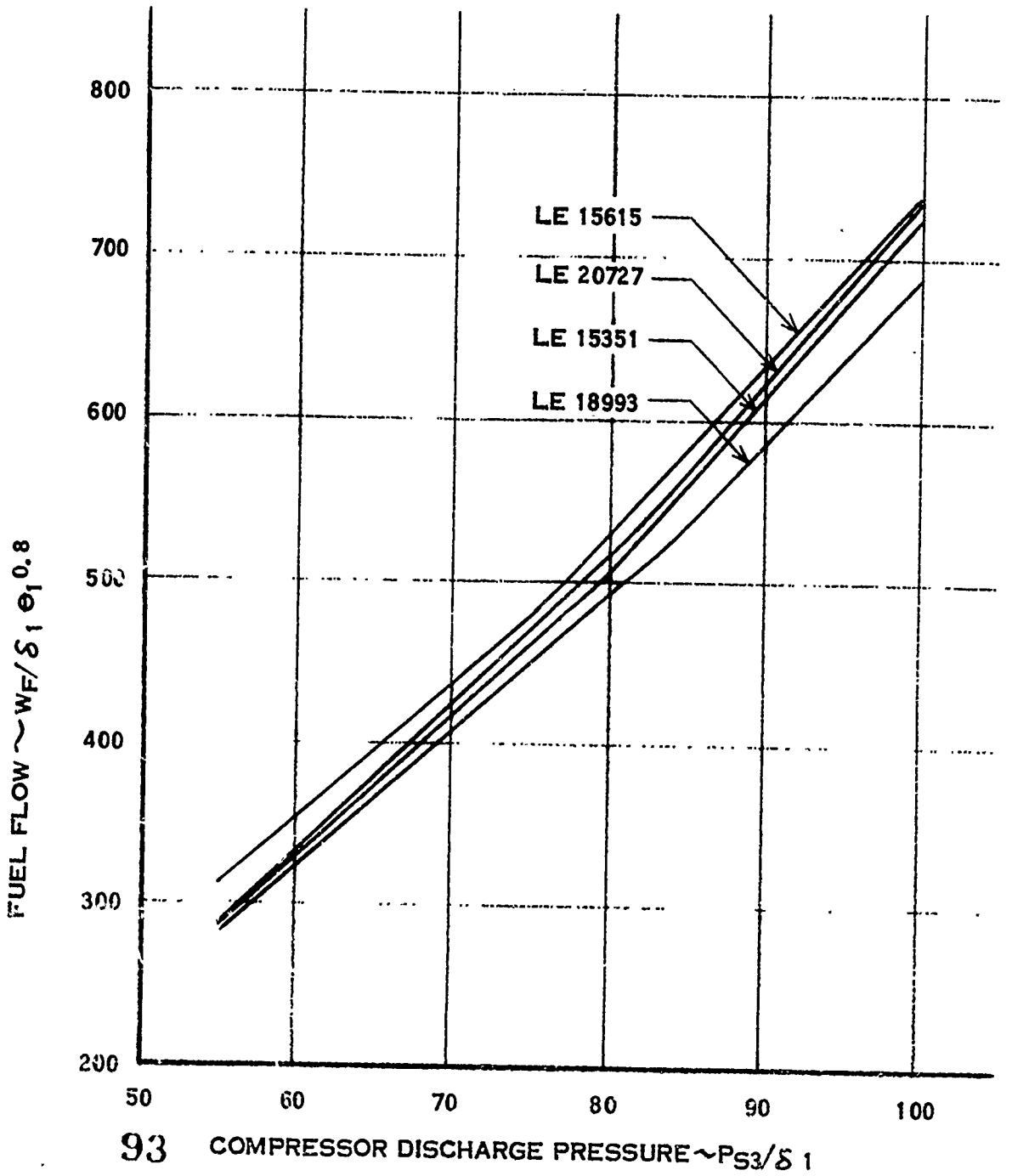


FIGURE 5–15 SHAFT HORSEPOWER BASELINES FOR FLIGHT TEST ENGINES

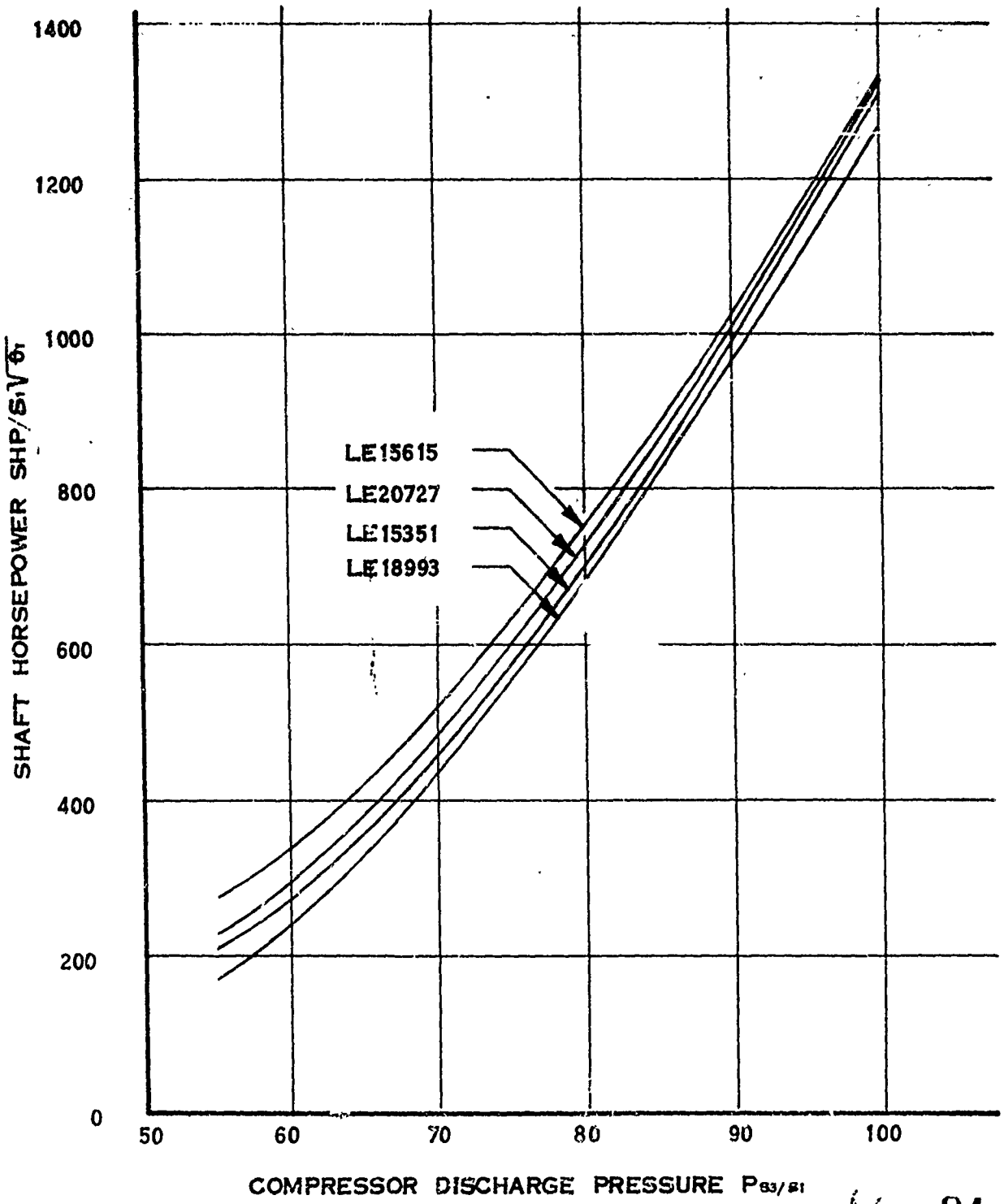


FIGURE 5–16 EXHAUST GAS TEMPERATURE BASELINES FOR FLIGHT TEST ENGINES

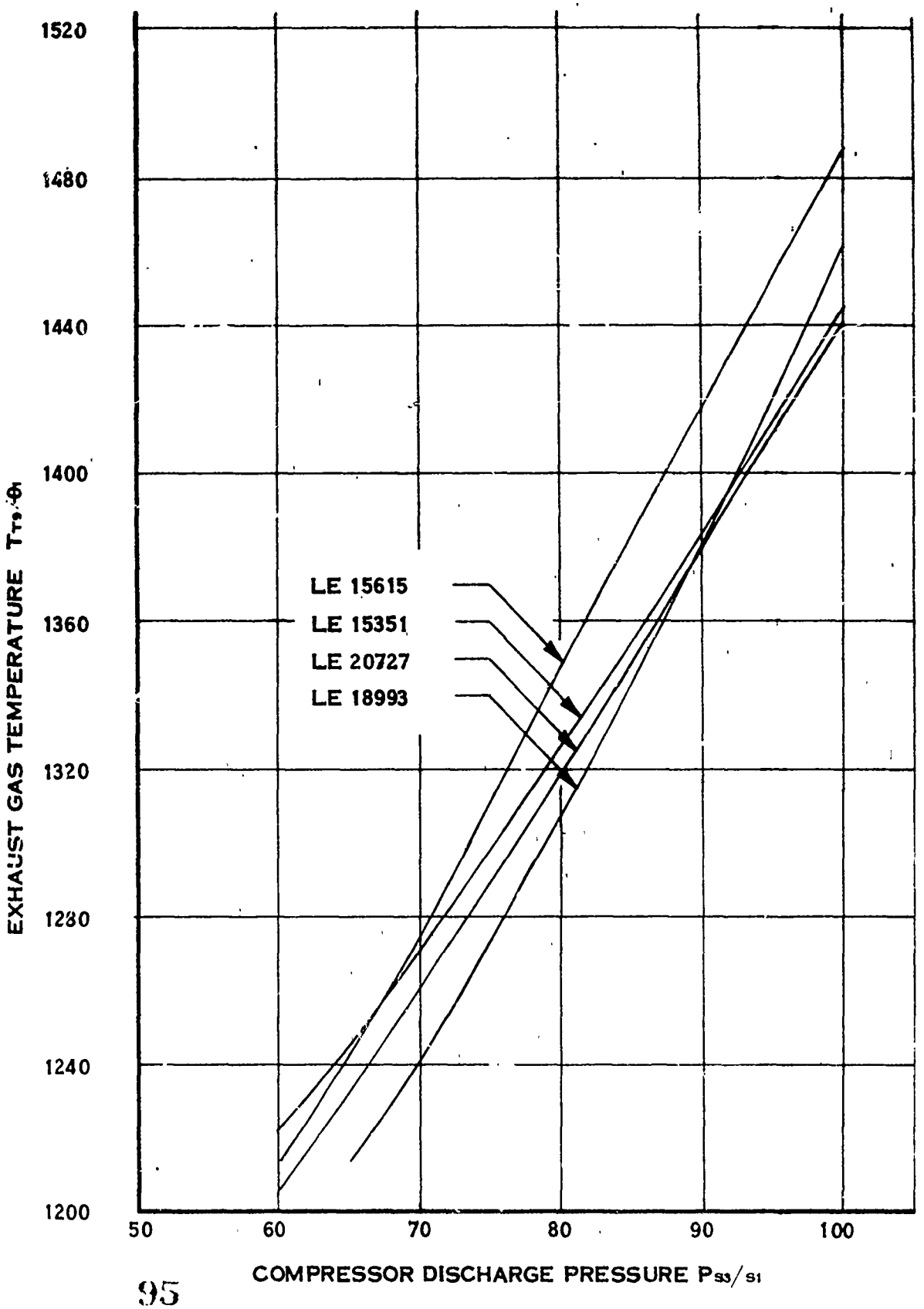


FIGURE 5-17 GAS PRODUCER SPEED BASELINE FOR VERIFICATION ENGINES

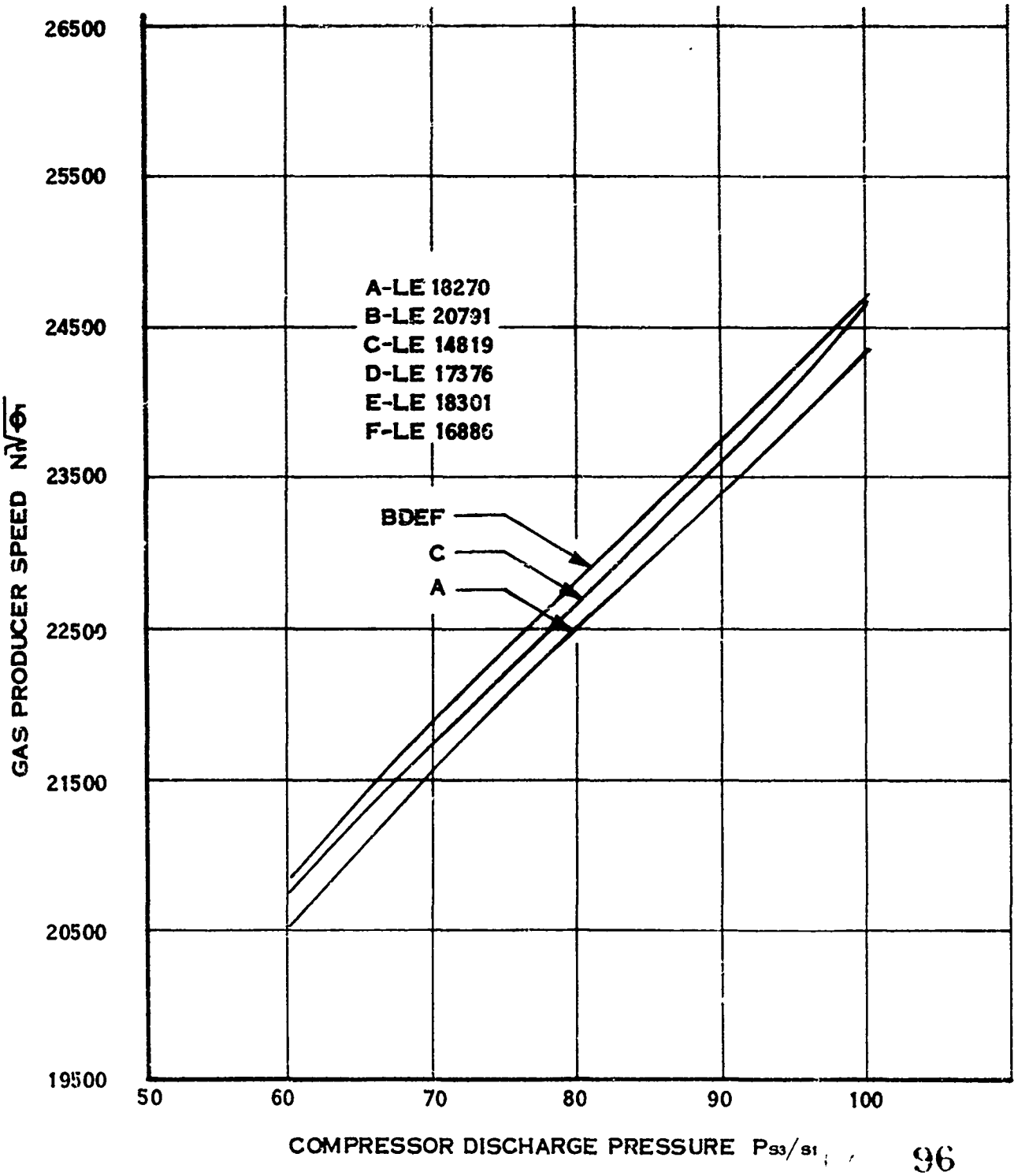


FIGURE 5–13 COMPRESSOR TEMPERATURE BASELINES FOR VERIFICATION ENGINES

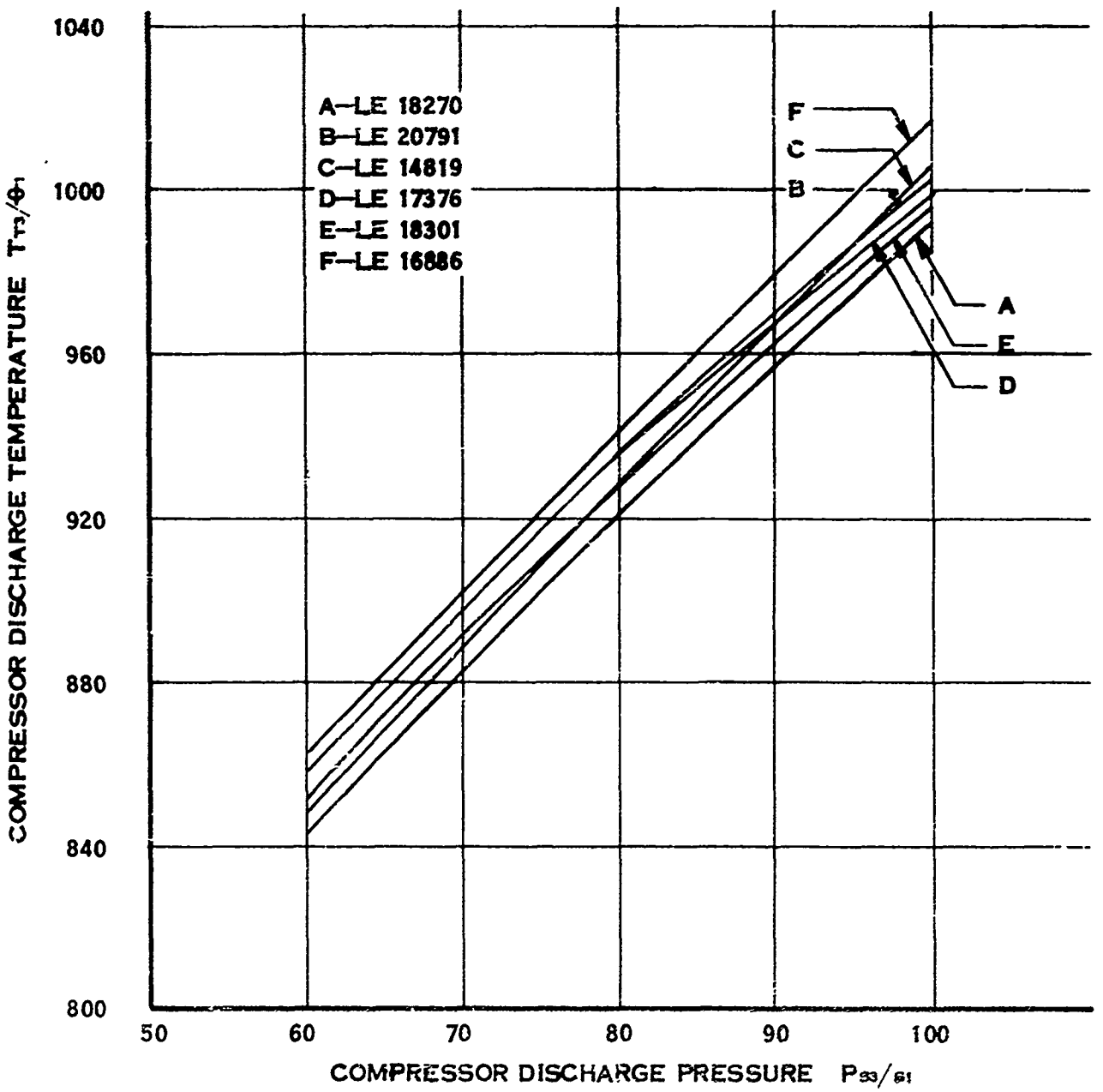


FIGURE 5-19 FUEL FLOW BASELINES FOR VERIFICATION ENGINES

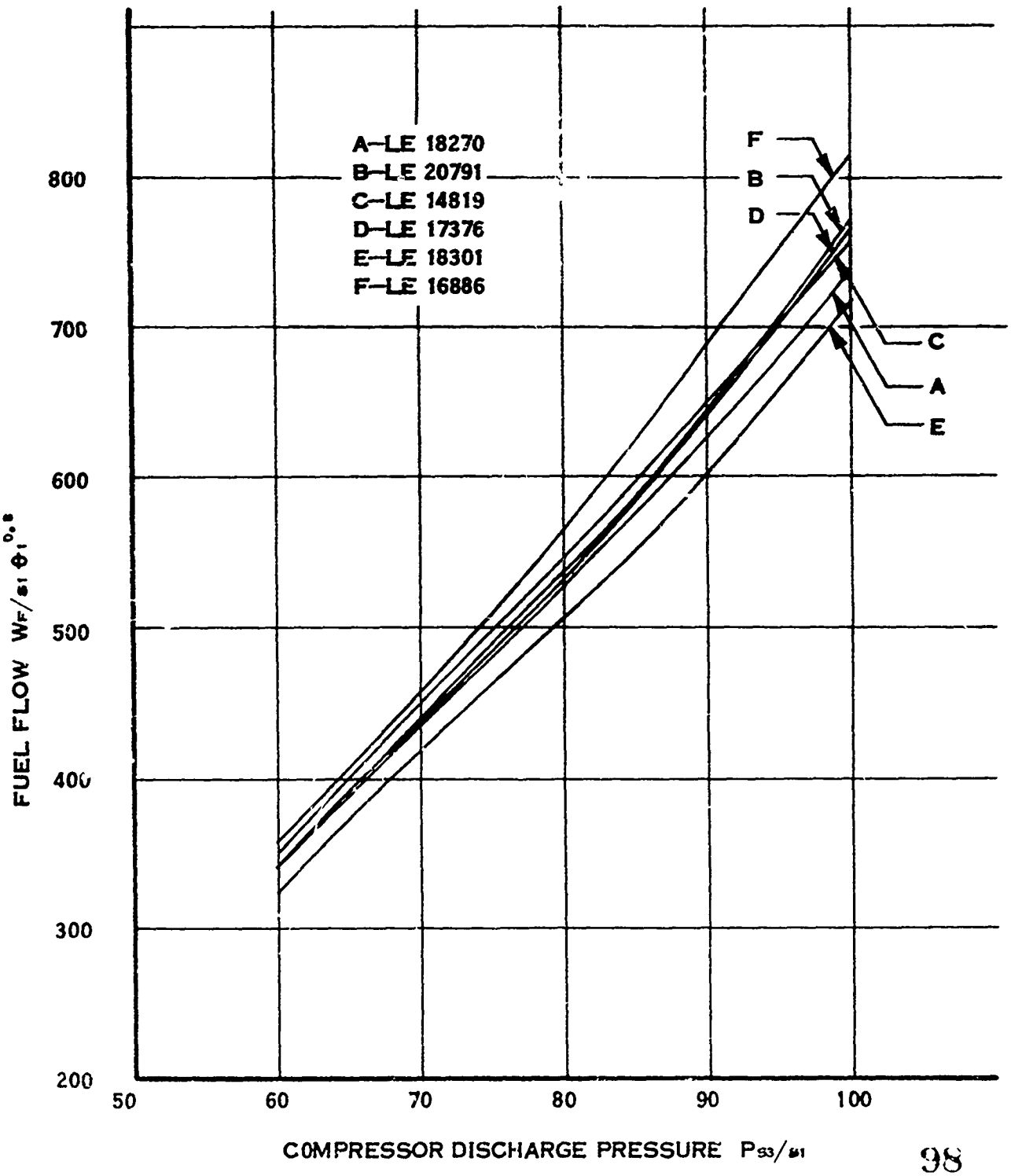


FIGURE 5–20 SHAFT HORSEPOWER BASELINES FOR VERIFICATION ENGINES

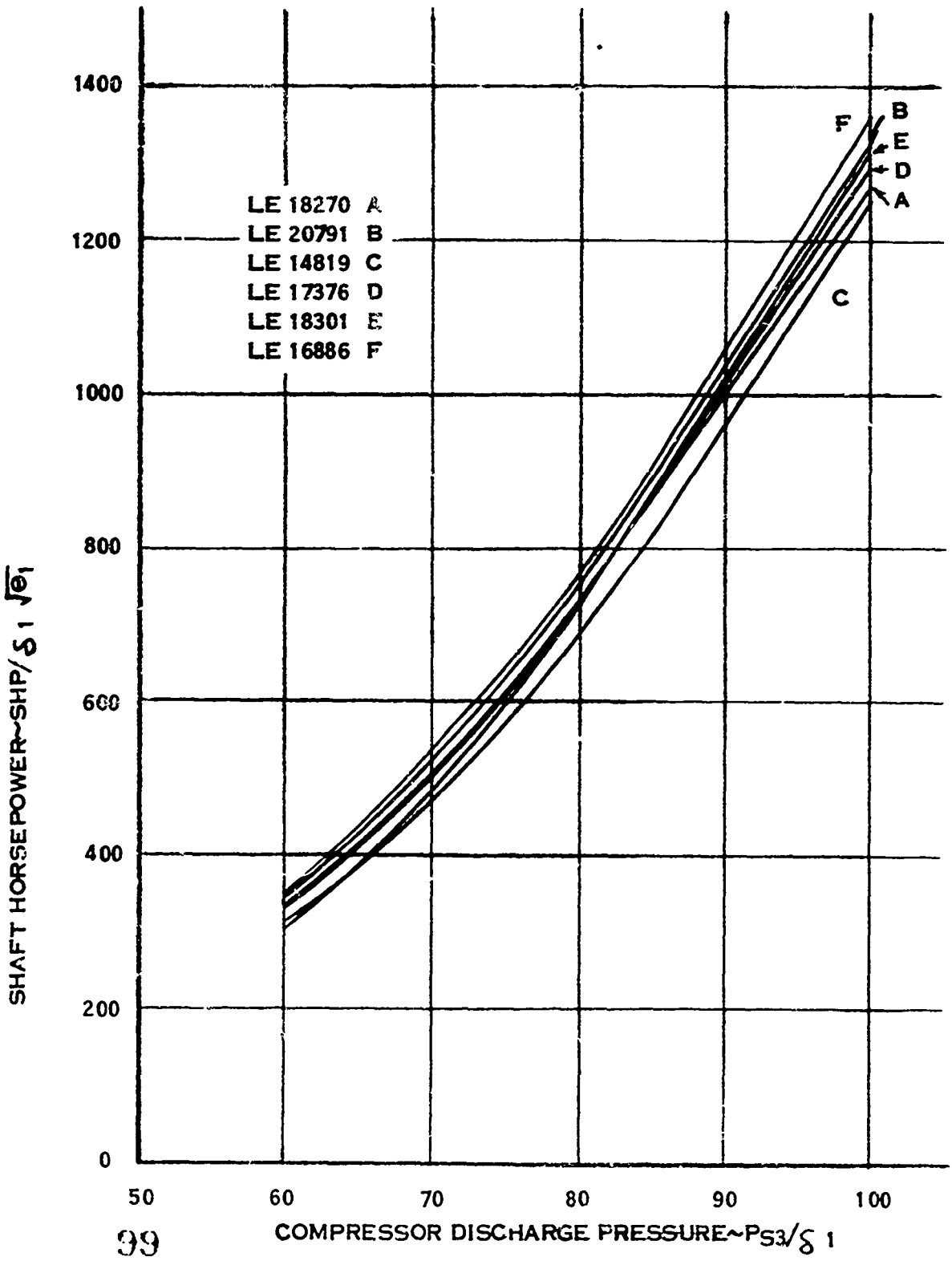


FIGURE 21 EXHAUST GAS TEMPERATURE BASELINES FOR VERIFICATION ENGINES

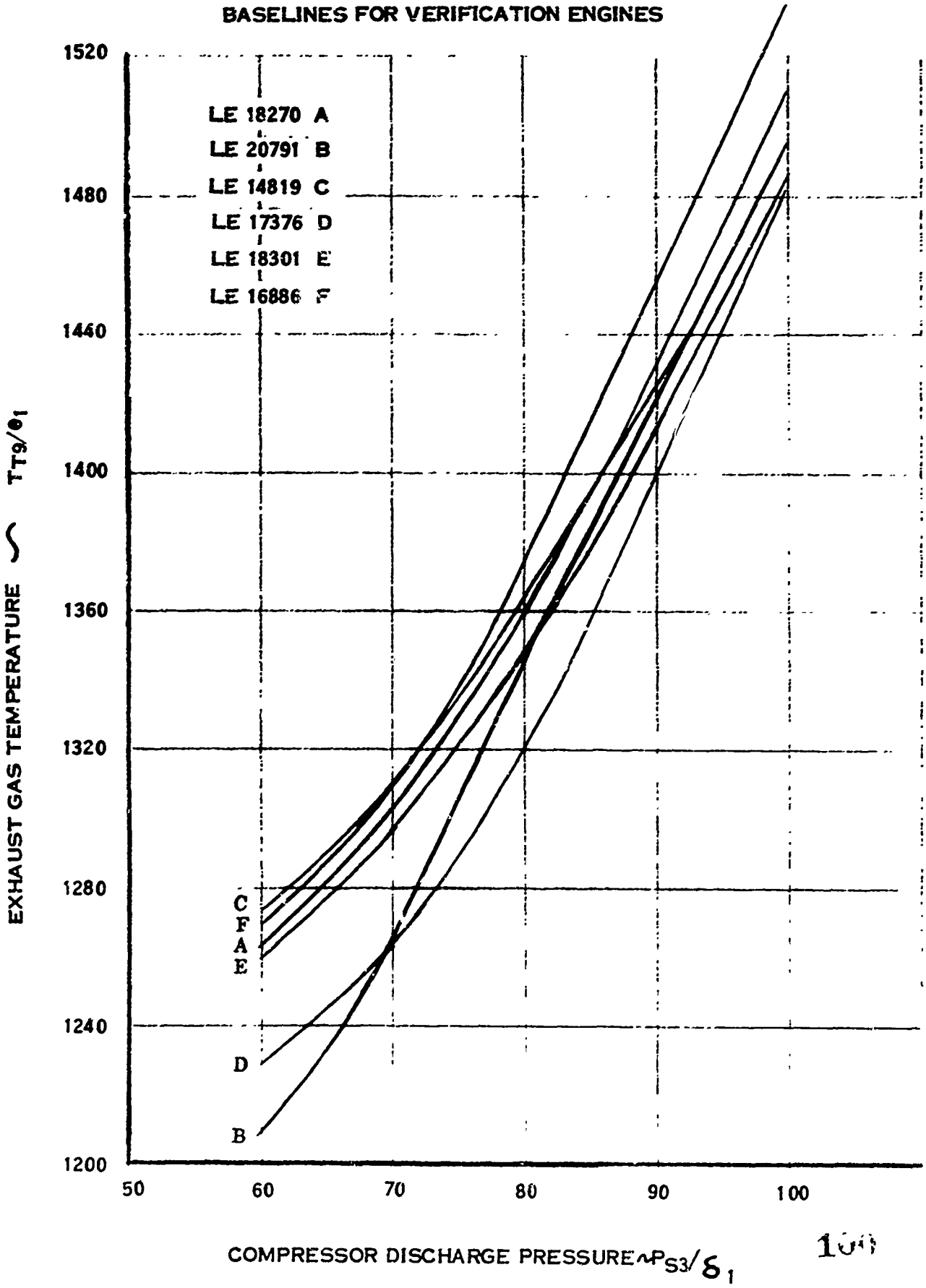


FIGURE 5-22 AIDAPS BASELINE VARIATION ANALYSIS

ANALYSIS APPROACH	ΔN_1	ΔT_{T3}	ΔW_F	ΔSHP	ΔT_{T9}	$\Delta T_{\hat{T}5}$	ΔW_A	$\Delta \eta_C$	ΔA_5	$\Delta \eta_T$	ΔA_N
I	±0.22	±0.54	±3.68	±4.67	±1.43	±1.69	±6.13	±1.24	±5.38	±2.09	±6.00
II	±0.71	±0.96	±5.33	±5.60	±2.02	±2.36	±9.04	±2.24	±7.71	±3.13	±8.25
III	±0.89	±1.28	±4.59	±5.33	±3.00	±3.21	±9.82	±2.99	±7.90	±4.42	±8.18

(CALCULATED ON ROOT-SUM-SQUARE BASIS.)

APPROACH	BASELINE DATA FROM
I	PHASE D ENGINES
II	DEMONSTRATION ENGINES
III	NOMINAL ENGINE BAND

FIGURE 5-23 AIDAPS FLIGHT PROFILE

1. 3 MINUTE HOVER: AMBIENT PRESSURE _____
AMBIENT TEMPERATURE _____

2. MAINTAIN CONSTANT I.A.S. AND ALTITUDE DURING RUNS AT 100 N_2

$\%N_{1c}$	TIME (MIN)	TEMP (°C)	N_1 (% IND)	IAS (KNOTS)	ALT (FT)	TORQUE (PSI)
83 TO 87	5					
87 TO 91	10					
91 TO 95	10					
95 TO 100	5					

3. VIBRATION DATA PROFILE

TIME OF DAY	MANEUVER	N_1	TORQUE (PSI)	ALT (FT)	IAS (KNOTS)
	GROUND RUN (FULL POWER)				
	HOVER				
	NORMAL CLIMB (500 FPM/80 KTS)				
	LOW POWER LEVEL FLIGHT (75 KTS)				
	MEDIUM POWER LEVEL FLIGHT (95 KTS)				
	HIGH POWER LEVEL FLIGHT (115 KTS)				
	NORMAL DESCENT (500 FPM/80 KTS)				

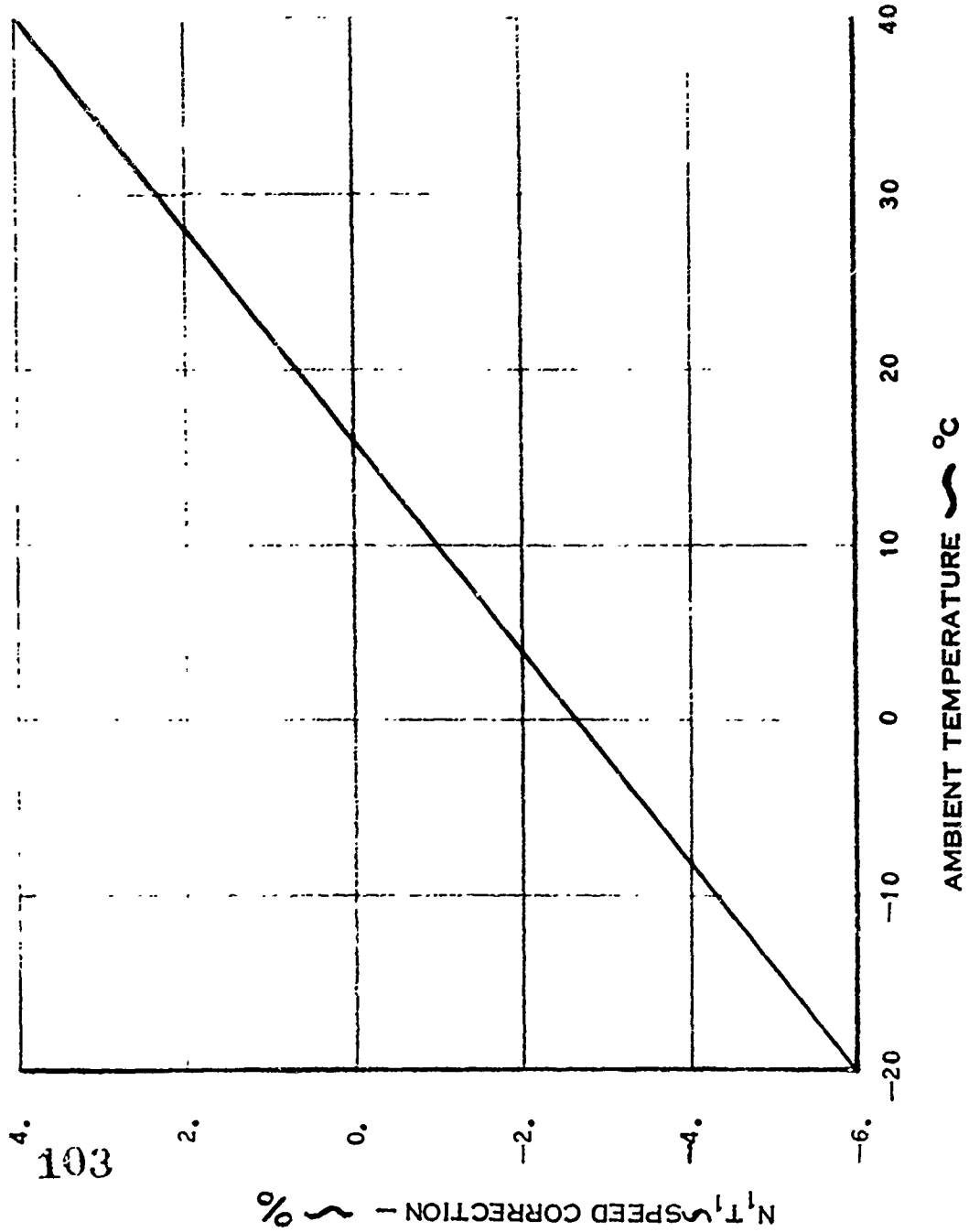
4. REPEAT VIBRATION PROFILE 3 ABOVE.

5. REPEAT PROFILE 2 ABOVE.

NOTES
1. BLANKS TO BE COMPLETED BY CREW DURING FLIGHT.
2. CALCULATE $\%N_{1c}$ AS FOLLOWS.
$\%N_{1c} = \%N_1$ IND + N_1T_1 FROM ATTACHED CURVE

FIGURE 5–23 (CONTINUED)

AMBIENT TEMPERATURE CORRECTION TO INDICATED N_1 RPM



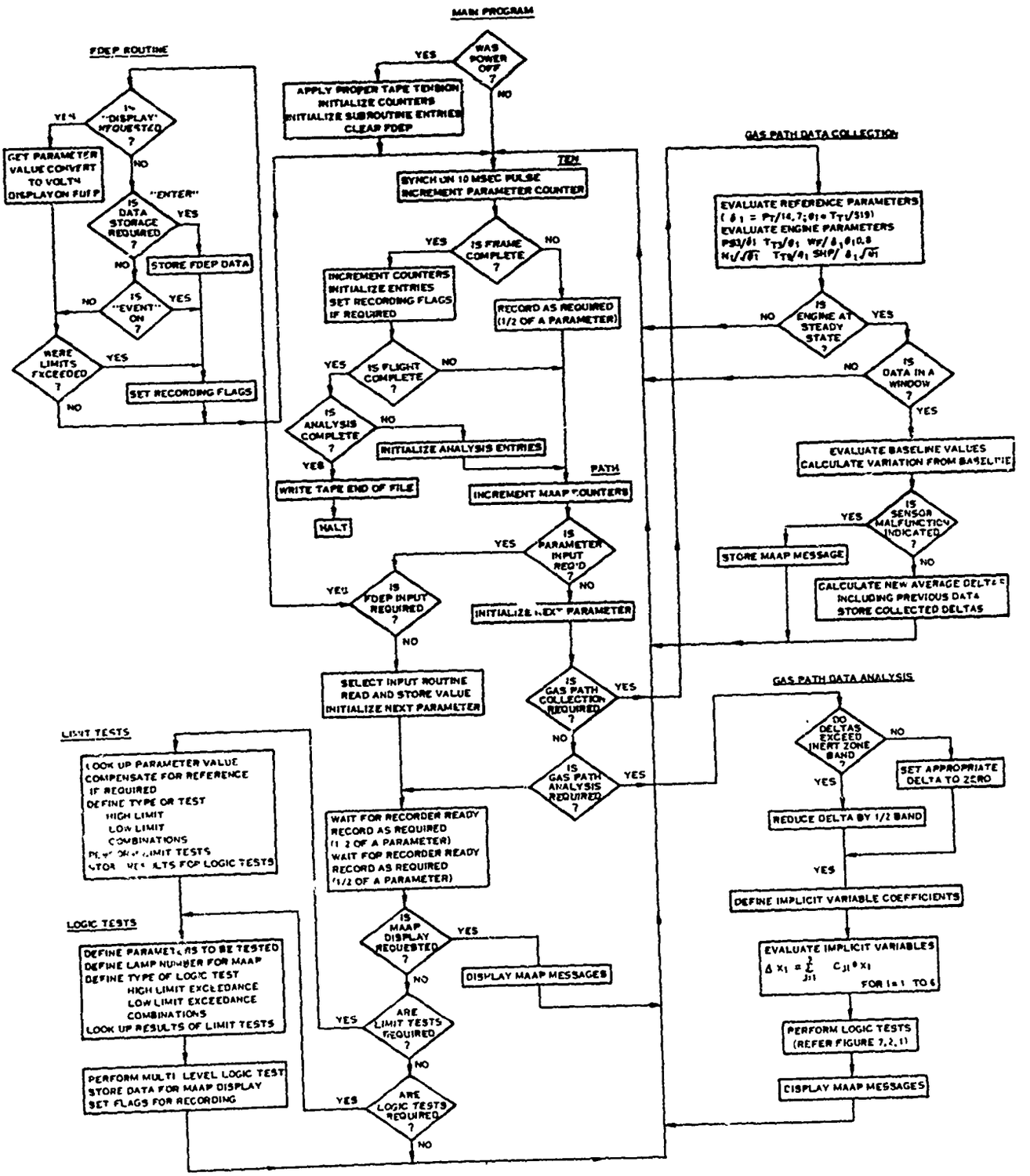


FIGURE 3-24 AIDAPS AIRBORNE PROGRAM FLOW DIAGRAM

FIGURE 5-25

AIDAPS ON-SITE DATA REVIEW LISTING

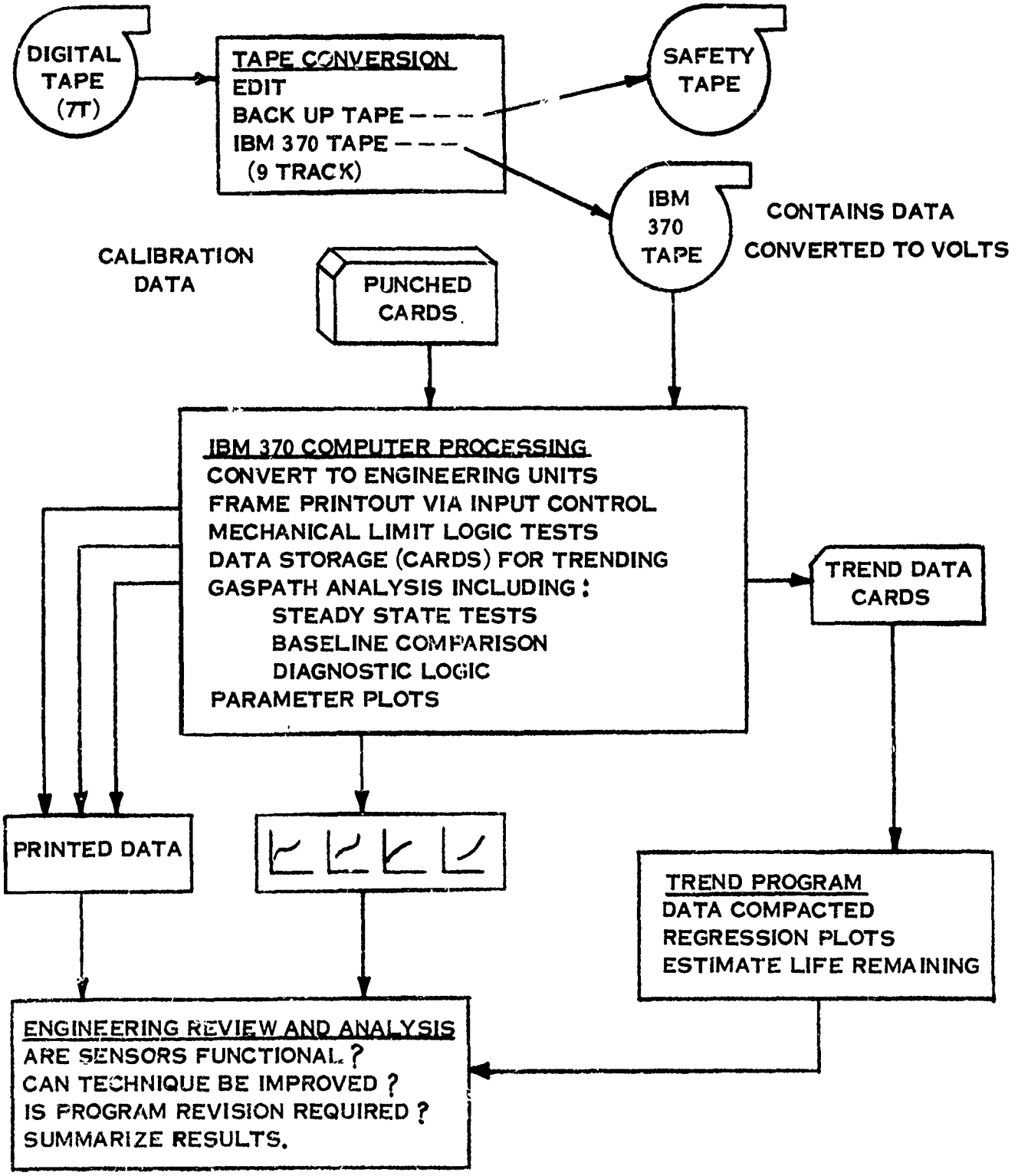
AIDAPS RECORD NUMBER 000731 STANDARD RECORD

TIME	03283				
SYNCH	01021	01021	01021	01021	FRAME IDENTIFIERS
N1	092.21	092.21	092.21	092.34	
N2	100.33	100.49	100.16	100.33	
NP	101.99	102.50	101.99	102.16	
PS3	066.64	066.49	066.84	066.94	
TT3	0439.6	0437.5	0439.9	0442.3	
EGT	0874.8	0872.4	0875.7	0869.2	
TT9	0910.5	0900.7	0891.8	0954.2	RING PATTERN
	0912.9	0944.5	0917.7	0921.0	
	0910.5	0973.6	0933.9	0943.6	
WF	0544.4	0526.5	0540.7	0529.5	
02	0368.6	0380.6	0366.2	0383.0	
PEF	25.951	26.143	25.983	26.143	Q2 SENSOR REFERENCE
PT PS	13.654	13.654	13.063		
P1	13.154				
TT1	082.53	082.61			
DCJSG	-04.461	02.544			
LRIFT	-04.526	-03.581	-04.551	-04.531	COMPUTER HEALTH
OCH	08.384	08.384			
PP WF	0.1647	0.1186			
F TOP	082.20	082.08	049.09	048.57	2 EOP/2 TOP
PEF	26.015	26.111	26.047	25.887	OIL SENSOR REFERENCE
HSP	0990.0	1055.4	PRESSURE SEN		PRESSURE SENSOR REF.
REF	10.025	10.141			B2DT/B3DT
B2 3T	245.06	233.72			
G4 9T	047.88	001.80			G42DT/G90DT
HT FT	095.89	064.69			HST/T FUEL
HP DT	034.70	039.41			
H TOT	100.19	100.00	115.88	116.85	2 EOT/2 TOT
ACEB	113.48				
ACIB	26.108				
DC SB	27.952	26.427			DCEB/SBV
DG 4	01021.	00959.	00126.		PACKED SWITCHES
7 11	01021.	00959.	00126.		
PLA S	00.054	00.054	00.054	00.054	
PLA C	-04.196	-04.196	-04.191	-04.206	
LGV S	00.844	00.844	00.819	00.829	SINE θ
LGV C	-04.081	-04.076	-04.086	-04.096	COSINE θ
HP S	01.404	01.349	01.369	01.384	
FP C	03.984	04.004	03.989	03.994	
CPA S	01.194	01.189	01.184	01.199	
CPA C	-04.041	-04.041	-04.041	-04.051	

NOTE: PLA, IGV, FP, CPA are each proportional to angle θ.

FIGURE 5–26

AIDAPS REMOTE GROUND ANALYSIS



TYPICAL FRAME DATA

RECORD 205 FILE 1 34 MINUTES, 38 SECONDS FROM START OF FLIGHT
0830 (LE 18301) STN UNKNOWN 215

N1 RPM	W FUEL	PS3	TT9
23685.86	628.71	73.88	943.38
23721.09	550.75	73.88	944.24
23721.89	539.90	73.83	946.79
23650.71	559.18	73.93	949.34

N2 RPM	NR RPM	TT3	TORQUE
6544.45	327.36	514.13	678.53
6544.45	326.85	514.72	684.27
6544.45	327.36	511.77	676.50
6544.45	327.88	514.43	671.15

1	931.64	TT1	DCJC	-4.475	EOT	90.00	HYD SUP P
2	981.56	57.62	CJC	-4.440		90.00	
3	959.68	57.62	DRFT	-3.585	TOT	121.00	HYD SUP T
4	902.17		SGRF	9.980		121.00	FUEL TEMP
5	1021.74	PT	ACER	112.79	EOP	93.39	BRG 2 DT
6	911.08	11.88	ACIR	26.00		92.63	BRG 3+4 DT
7	891.64	11.87	UCER	26.78	TOP	55.53	42 GBOX DT
8	987.65		SBV	26.98		56.30	90 GBOX DT
9	973.85	PS/PS1	PLA	98.31	CPA	61.98	IGV
10	1084.33	11.49		98.32		61.92	
11	907.03	11.09		98.74		61.92	
12	971.84			98.60		61.88	

761.04	OIL FLOW	3596.11
431.86		3623.75
122.38	HYD FLOW	0.114
62.04		0.639
53.48	PUMP DT	38.47
154.42		35.35
48.51	DCDRFT	-4.52
38.22		-4.52
93.55	FUEL PRES	21.46
93.85		21.81
93.85		23.01
94.12		21.57

	SLOT 1	SLOT 2	MALFUNCTION
ACC. GEARBOX CHIP	1	1	0
NO. 2 BEARING CHIP	1	1	0
42 DEGREE GEARBOX CHIP	1	1	0
OVERSPEED GOV. SWITCH POSITION	1	1	0
RPM WARNING LIGHT	1	1	0
RIGHT FUEL PUMP FLOW	0	0	1
HYD. PRESSURE	0	0	1
TRANSMISSION OIL TEMPERATURE	0	0	1
IGNITION EXCITER	0	0	1
ENG. DRIVER FUEL PUMP PRESSURE	0	0	1
ENGINE OIL FILTER DP	0	0	1
NO. 2 BEARING PRESSURE	1	1	0
TRANS. INT. OIL FILTER DP	1	1	0
BLEED BAND POSITION	1	1	0

	SLOT 1	SLOT 2	MALFUNCTION
NO. 3 & 4 BEARING CHIP	1	1	0
90 DEGREE GEARBOX CHIP	1	1	0
TRANS. OIL SUMP CHIP	1	1	0
RPM WARNING AUDIO	1	1	0
FUEL FILTER DP	0	0	1
LEFT FUEL PUMP FLOW	0	0	1
INLET AIR FILTER DP	0	0	1
TRANSMISSION OIL PRESSURE	0	0	1
ENGINE OIL PRESSURE	0	0	1
NO. 3 & 4 BEARING PRESSURE	1	1	0
HYD. FILTER DP	1	1	0
TRANS. EXT. OIL FILTER DP	1	1	0

AVERAGED DATA

EGT AVER	FUEL FLOW	TT3	N1	PS3	TT1	TORQUE	PUMP DT	TGT
945.9387	539.8984	513.7646	23712.3750	73.8804	57.6182	677.6113	36.9093	121.0000
N2	EOP	HSP	NR	DCF	PT	EOT	TOP	P9 FLOW
6544.4531	93.0104	596.4541	327.3630	3609.9316	11.8762	90.0000	55.9187	0.3768

CORRECTED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CR	Q2C	TT9C	SHPC
976.3640	91.4472	23744.0039	6553.1797	669.6990	1409.6919	838.7295	1403.8445	1071.9453

CORRECTED FILTERED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CR	Q2C	TT9C	SHPC
976.3640	91.4472	23744.0039	6553.1797	669.6990	1409.6919	838.7295	1403.8445	1071.9453

CORRECTED TT9 PATTERN

1395.355	1445.405	1423.474	1365.806	1485.696	1374.740	1355.247	1451.513	1437.677	1548.450	1370.679	1435.657

FIGURE 5–27 TYPICAL FRAME DATA
RECORD 205 ON 7/30/71

RECORD 206 FILE 1 34 MINUTES, 40 SECONDS FROM START OF FLIGHT
(LE 18301) 5TH UNKNOWN 215

N1 RPM	W FUEL	PS3	TT9
23827.49	534.66	73.88	945.94
23615.69	542.57	73.99	944.24
23685.86	537.26	73.93	945.94
23721.09	596.74	73.99	949.34

N2 RPM	NR RPM	TT3	TORQUE
6544.45	327.38	513.54	676.61
6544.45	327.38	510.59	659.66
6544.45	326.43	514.43	675.53
6544.45	327.36	513.84	675.03

1	931.64	TT1	DCJC	-4.475	EGT	0.00	HYD SUP P	734.71	OIL FLOW	3623.75
2	980.75	57.54	CJC	-4.430		90.00		573.51		3651.83
3	958.87	57.62	DRFT	-3.545	TOT	121.00	HYD SUP T	121.46	HYD FLOW	0.122
4	932.17		SGRF	9.960		121.00	FUEL TEMP	59.33		0.197
5	1023.36	PT	ACFR	112.53	FOP	94.12	BRG 2 DT	63.17	PUMP DT	35.63
6	911.89	11.38	ACIR	26.00		93.95	BRG 3+4 DT	153.52		41.36
7	991.64	11.38	DCFR	26.71	TOP	57.22	42 GBOX DT	42.54	DCDRFT	-4.52
8	988.66		SBV	27.16		56.60	90 GBOX DT	33.08		-4.50
9	974.67	PS/PS1	PLA	98.45	CPA	61.98	IGV	93.83	FUEL PRES	21.65
10	1083.52	11.49		98.59		61.98		93.63		21.98
11	909.65	11.38		98.45		61.94		93.83		22.04
12	974.27			98.46		62.11		93.84		22.34

	SLOT 1	SLOT 2	MALFUNCTION
ACC. GEARBOX CHIP	1	1	0
NO. 2 BEARING CHIP	1	1	0
42 DEGREE GEARBOX CHIP	1	1	0
OVERSPEED GOV. SWITCH POSITION	1	1	0
RPM WARNING LIGHT	1	1	0
RIGHT FUEL PUMP FLOW	0	0	1
HYD. PRESSURE	0	0	1
TRANSMISSION OIL TEMPERATURE	0	0	1
IGNITION EXCITER	0	0	1
ENG. DRIVER FUEL PUMP PRESSURE	0	0	1
ENGINE OIL FILTER DP	0	0	1
NO. 2 BEARING PRESSURE	1	1	0
TRANS. INT. OIL FILTER DP	1	1	0
BLEED BAND POSITION	1	1	0

	SLOT 1	SLOT 2	MALFUNCTION
NO. 3 & 4 BEARING CHIP	1	1	0
90 DEGREE GEARBOX CHIP	1	1	0
TRANS. OIL SUMP CHIP	1	1	0
RPM WARNING AUDIO	1	1	0
FUEL FILTER DP	0	0	1
LEFT FUEL PUMP FLOW	0	0	1
INLET AIR FILTER DP	0	0	1
TRANSMISSION OIL PRESSURE	0	0	1
ENGINE OIL PRESSURE	0	0	1
NO. 3 & 4 BEARING PRESSURE	1	1	0
HYD. FILTER DP	1	1	0
TRANS. EXT. OIL FILTER DP	1	1	0

AVERAGED DATA

EGT AVER	FUEL FLOW	TT3	N1	PS3	TT1	TORQUE	PUMP DT	TOT
945.3645	534.6394	513.0999	23712.5156	73.9465	57.5774	671.7078	38.4985	121.0000
N2	EGP	HSP	NR	DCF	PT	EGT	TOP	PB FLOW
6544.4531	94.0377	554.1128	327.3638	3637.7871	11.8841	90.0000	56.9089	0.1594

CORRECTED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CP	Q2C	TT9C	SHPC
375.7744	91.4677	23745.0820	6553.4375	662.7727	1410.2300	830.8650	1404.3867	1061.9119

CORRECTED FILTERED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CP	Q2C	TT9C	SHPC
375.7744	91.4677	23745.0820	6553.4375	662.7727	1410.2300	835.8311	1404.3867	1068.2590

CORRECTED TT9 PATTERN

1345.465 1444.706 1422.774 1365.914 1487.441 1375.661 1355.354 1452.441 1438.694 1547.763 1372.412 1438.208

FIGURE 5-28 TYPICAL FRAME DATA

RECORD 206 ON 7/30/71

RECORD 208 FILE 1 34 MINUTES, 50 SECONDS FROM START OF FLIGHT
(LE 18301) CTR UNKNOWN 215

N1 RPM	W FUEL	PS3	TT9
23721.09	589.26	73.[illegible]	946.73
23650.71	546.15	73.99	945.09
23721.09	570.93	73.88	942.53
23756.44	535.06	73.99	949.34

N2 RPM	N3 RPM	TT9	TORQUE
6544.45	326.45	511.77	672.13
6544.45	326.33	508.82	685.31
6544.45	327.36	513.54	674.31
6544.45	327.36	512.95	676.72

1	931.54	TT1	DCJC	-4.475	EGT	90.00	HYD SUP P	608.10	OIL FLOW	3651.83
2	982.37	57.37	CJC	-4.440		90.00		763.87		3596.11
3	961.30	57.45	DREF	-3.560	TOT	121.00	HYD SUP T	121.17	HYD FLOW	0.639
4	912.17		SGRE	9.940		121.00	FUEL TEMP	60.23		0.179
5	1024.18	P1	ACE3	112.79	EDP	93.77	BRG 2 DT	65.87	PUMP DT	35.63
6	912.70	11.38	ACIA	26.00		94.46	BRG 3+4 DT	159.10		41.36
7	890.83	11.48	DCEA	26.68	TCP	56.02	42 GBOX DT	42.54	DCOREF	-4.52
8	959.46		SRV	27.16		56.33	90 GBOX DT	30.06		-4.50
9	972.23	PS/PS1	PLA	98.50	CPA	61.94	IGV	93.55	FUEL PRES	21.81
10	1078.48	11.49		98.73		61.94		93.82		22.05
11	907.03	11.50		98.45		61.98		93.83		21.70
12	974.27			98.46		62.02		93.57		21.99

	SLOT 1	SLOT 2	MALFUNCTION
ACC. GEARBOX CHIP	1	1	0
NO. 2 BEARING CHIP	1	1	0
42 DEGREE GEARBOX CHIP	1	1	0
OVERSPEED GOV. SWITCH POSITION	1	1	0
RPM WARNING LIGHT	1	1	0
RIGHT FUEL PUMP FLOW	0	0	1
HYD. PRESSURE	0	0	1
TRANSMISSION OIL TEMPERATURE	0	0	1
IGNITION EXCITER	0	0	1
ENG. DRIVER FUEL PUMP PRESSURE	0	0	1
ENGINE OIL FILTER DP	0	0	1
NO. 2 BEARING PRESSURE	1	1	0
TRANS. INT. OIL FILTER DP	1	1	0
BLEED BAND POSITION	1	1	0

	SLOT 1	SLOT 2	MALFUNCTION
NO. 3 & 4 BEARING CHIP	1	1	0
90 DEGREE GEARBOX CHIP	1	1	0
TRANS. OIL SUMP CHIP	1	1	0
RPM WARNING AUDIO	1	1	0
FUEL FILTER DP	0	0	1
LEFT FUEL PUMP FLOW	0	0	1
INLET AIR FILTER DP	0	0	1
TRANSMISSION OIL PRESSURE	0	0	1
ENGINE OIL PRESSURE	0	0	1
NO. 3 & 4 BEARING PRESSURE	1	1	0
HYD. FILTER DP	1	1	0
TRANS.-EXT. OIL FILTER DP	1	1	0

AVERAGED DATA

EGT AVER	FUEL FLOW	TT3	N1	PS3	TT1	TORQUE	PUMP DT	TOT
545.9387	546.1750	511.7703	23712.3291	73.9200	57.4139	677.1157	38.4985	121.0000
N2	CDP	HSP	NR	DCF	PT	ECT	TDP	PB FLOW
6544.4531	94.1195	685.9319	326.9758	3623.9688	11.8841	90.0000	56.1770	0.4094

CORRECTED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CR	Q2C	TT9C	SHPC
974.7493	91.4350	23749.6445	6554.4766	677.2444	1410.2485	837.5542	1404.4167	1070.5640

CORRECTED FILTERED DATA

TT3C	PS3C	N1C	N2C	WFC	TT9CR	Q2C	TT9C	SHPC
974.7493	91.4350	23749.6445	6554.4766	677.2444	1410.2485	837.5542	1404.4167	1070.5640

CORRECTED TT9 PATTERN

1395.206 1444.735 1425.661 1364.345 1408.726 1376.909 1354.969 1452.900 1436.616 1543.396 1371.221 1438.663

FIGURE 5-29 TYPICAL FRAME DATA

RECORD 208 ON 7/30/71

FIGURE 5–30
AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5–1"

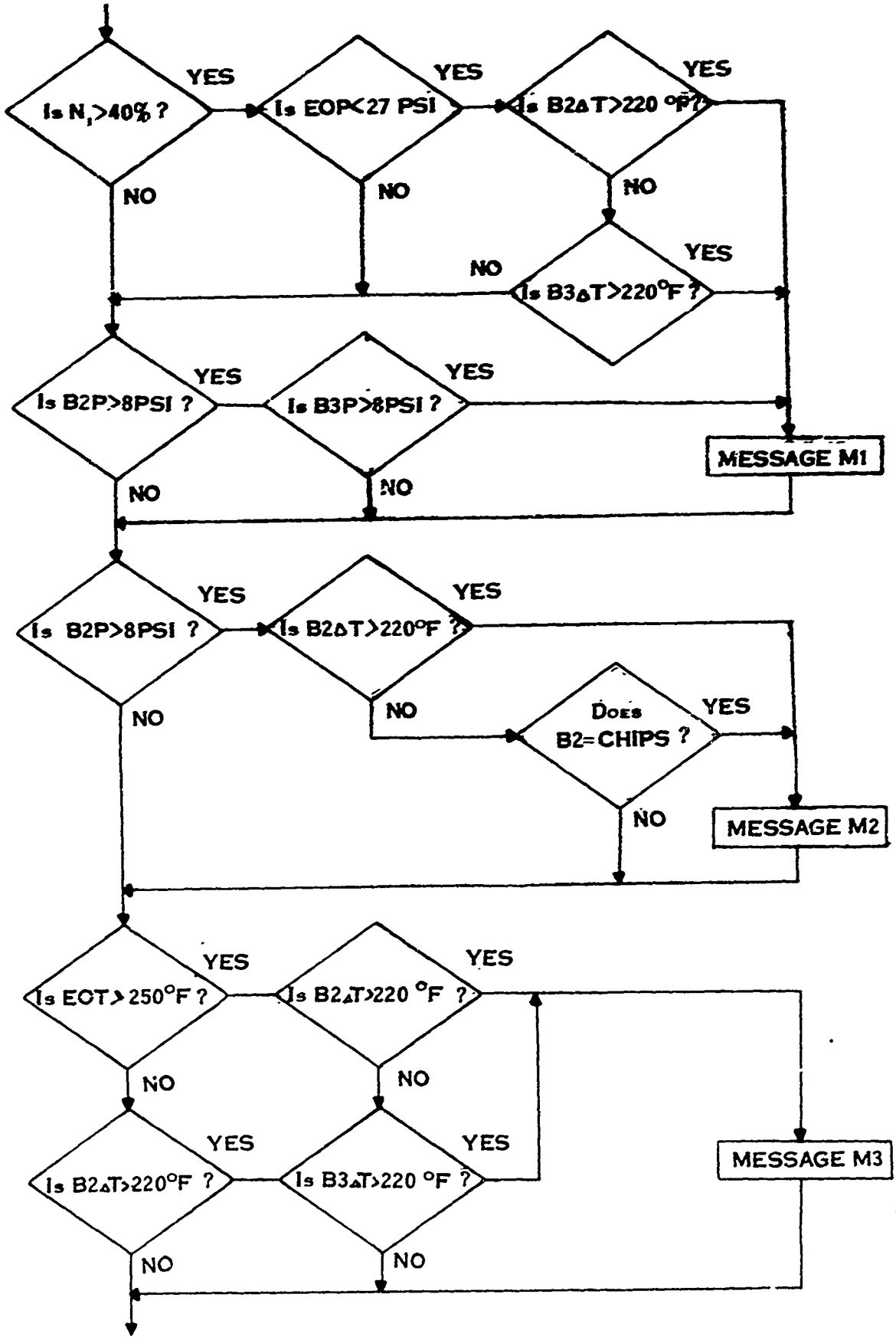


FIGURE 5-31

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5-1"

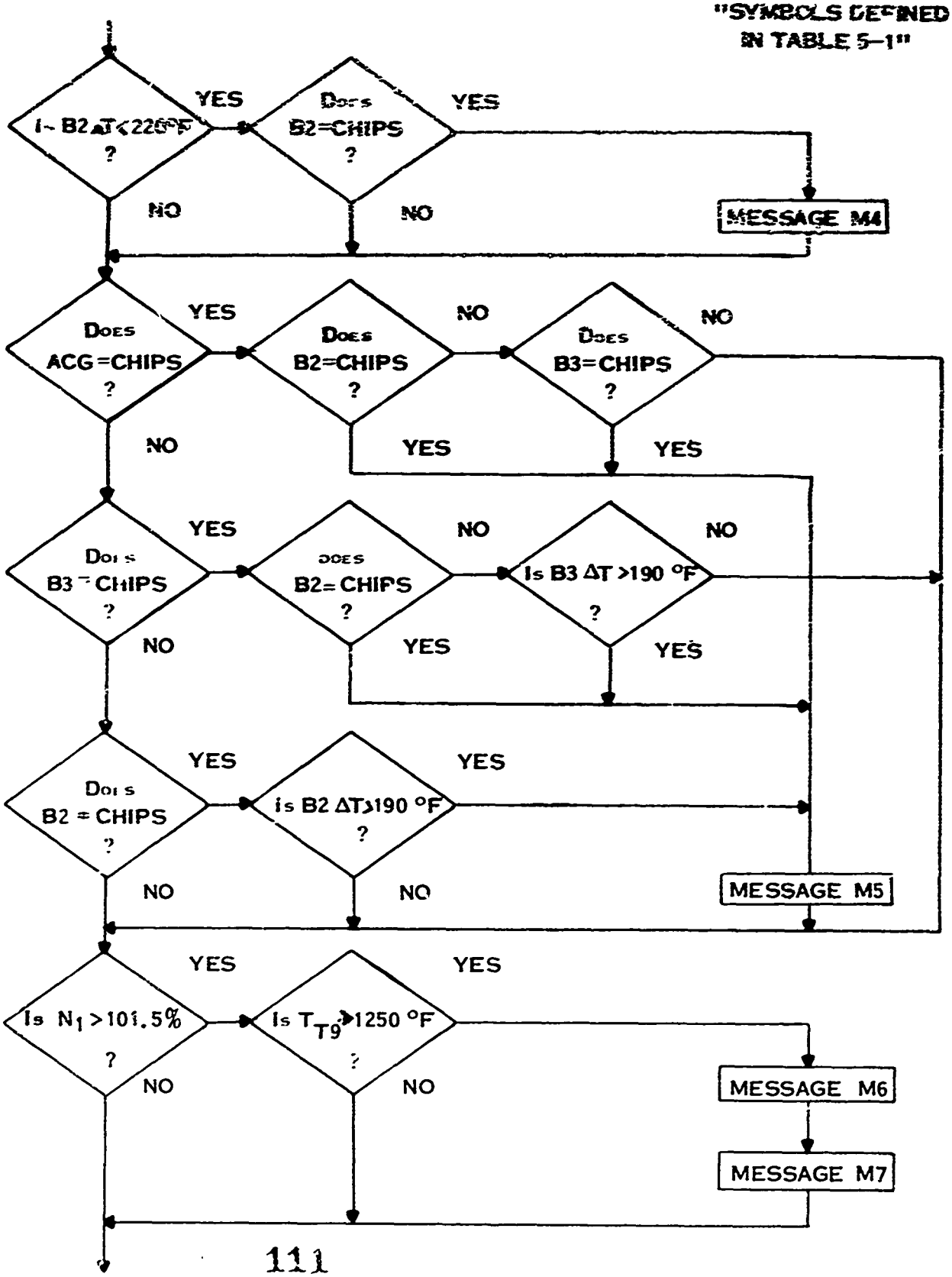


FIGURE 5-32

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5-1"

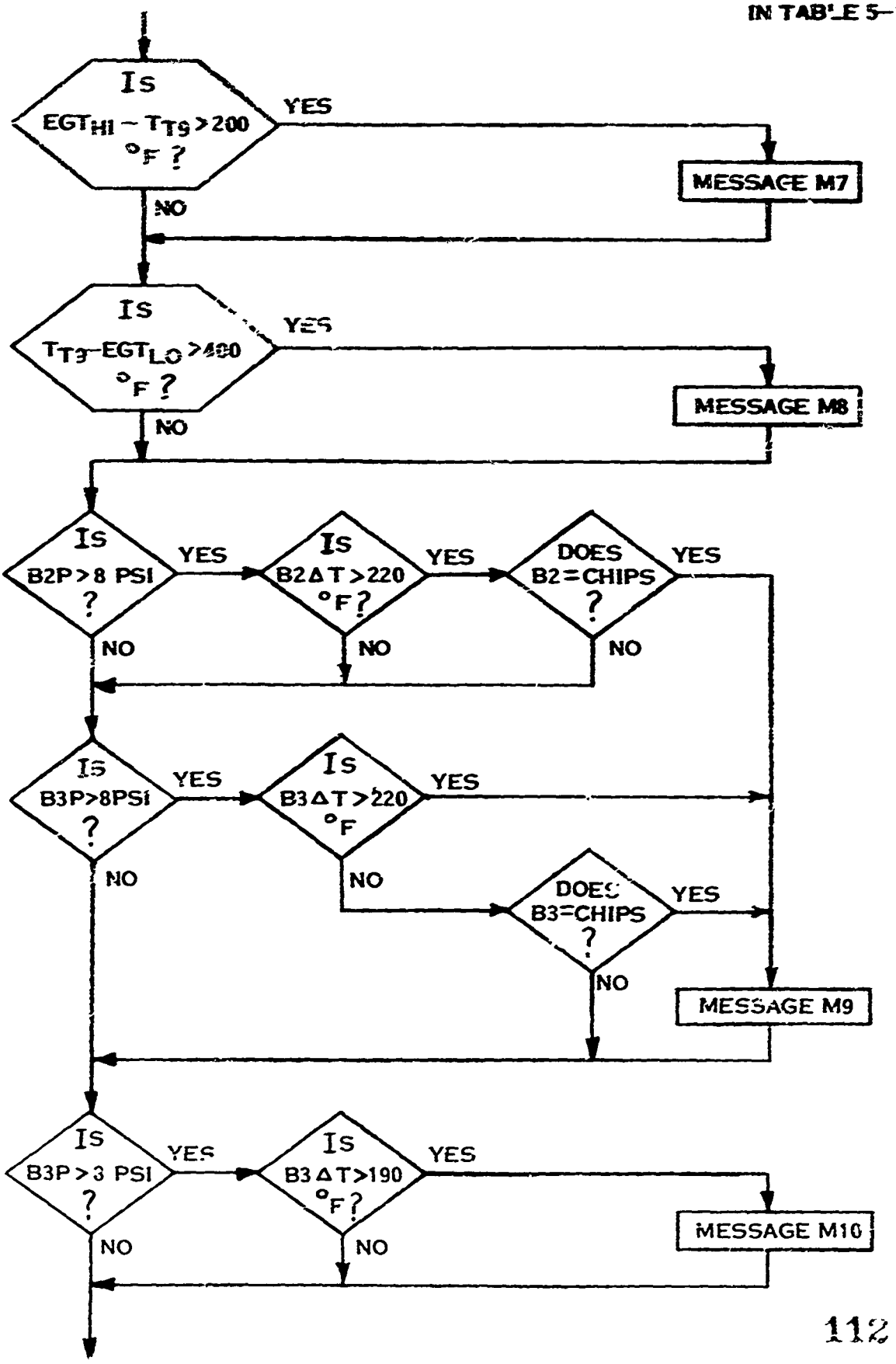


FIGURE 5-33

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5-1"

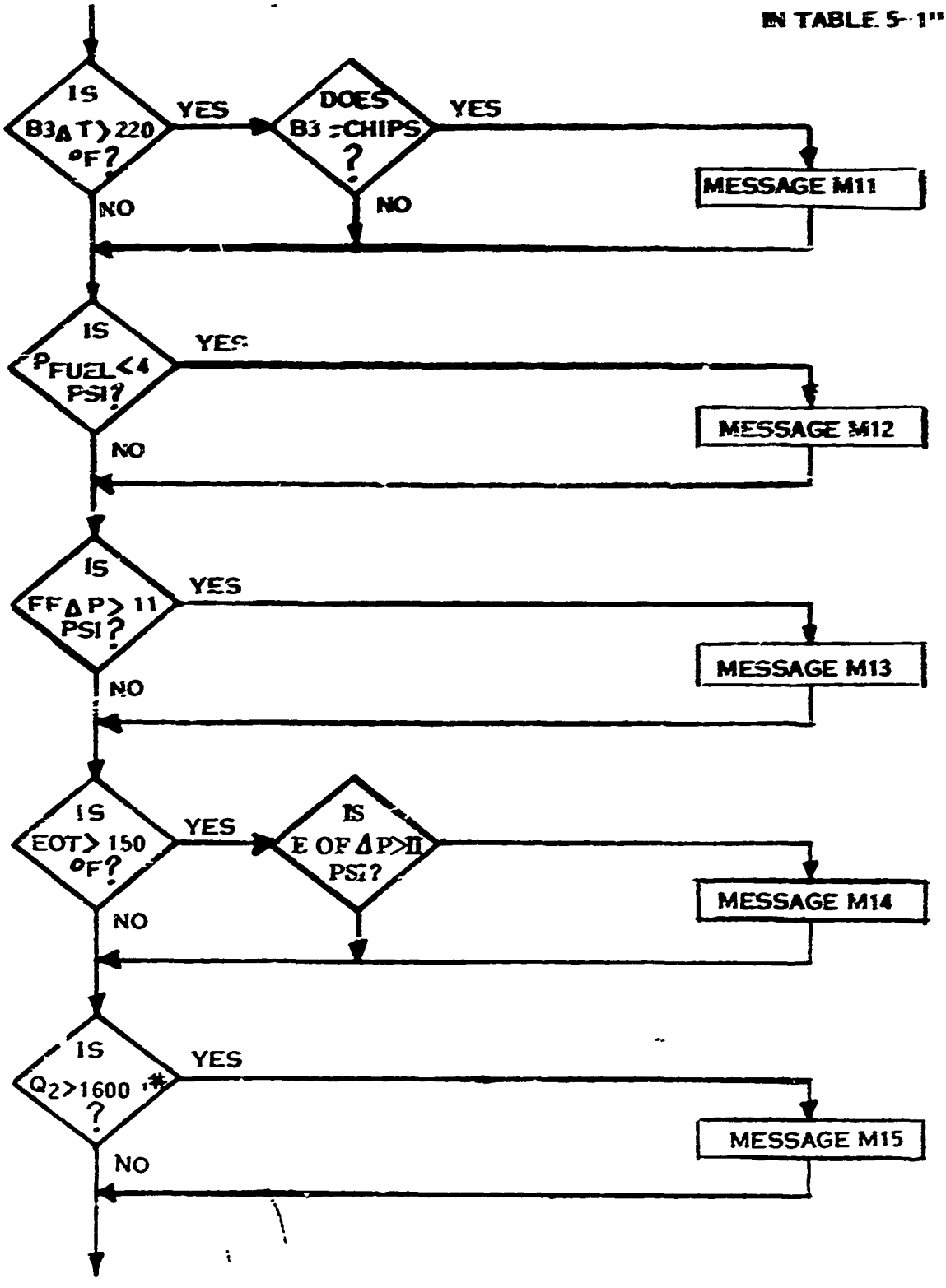


FIGURE 5 .4

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5-1"

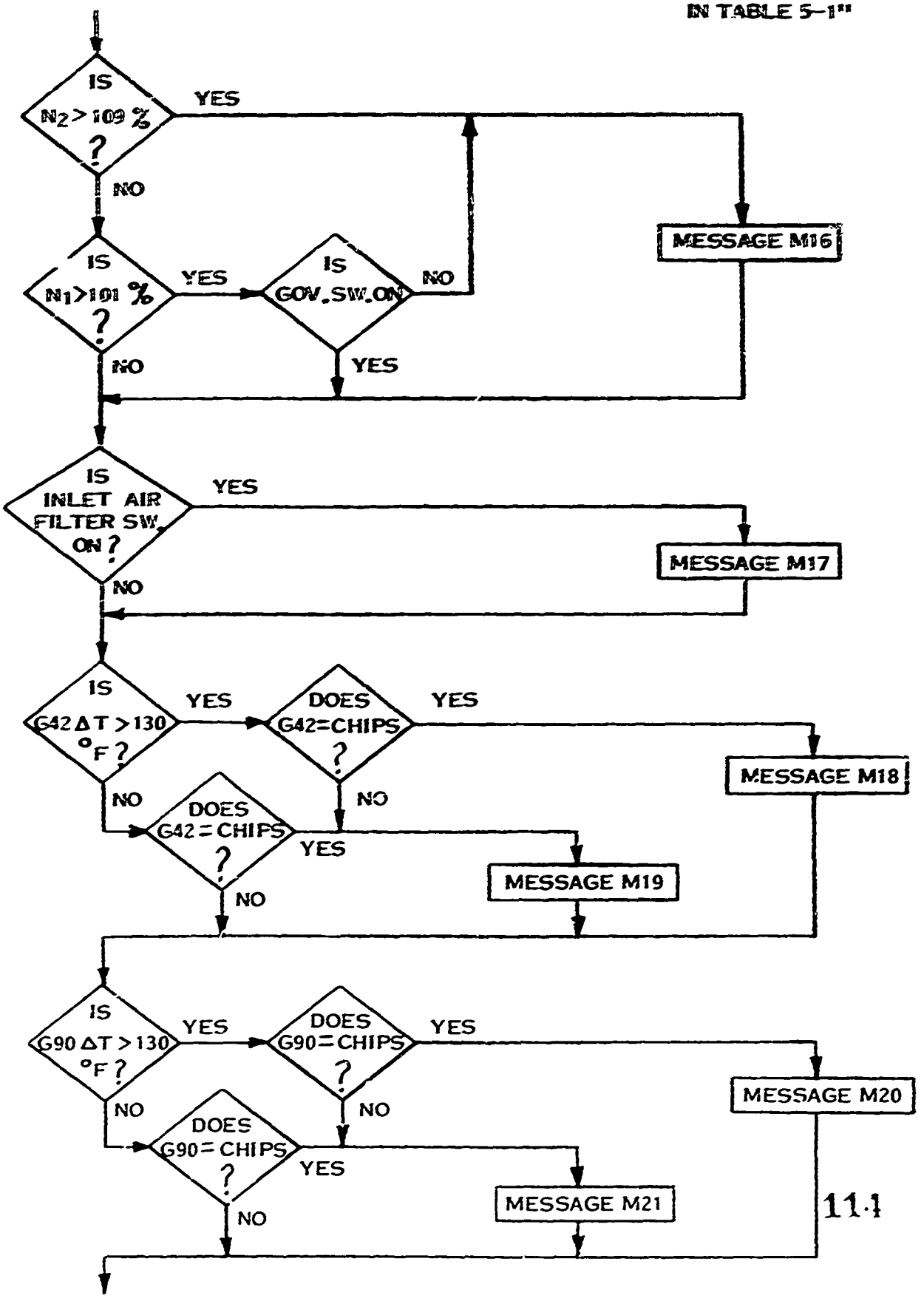
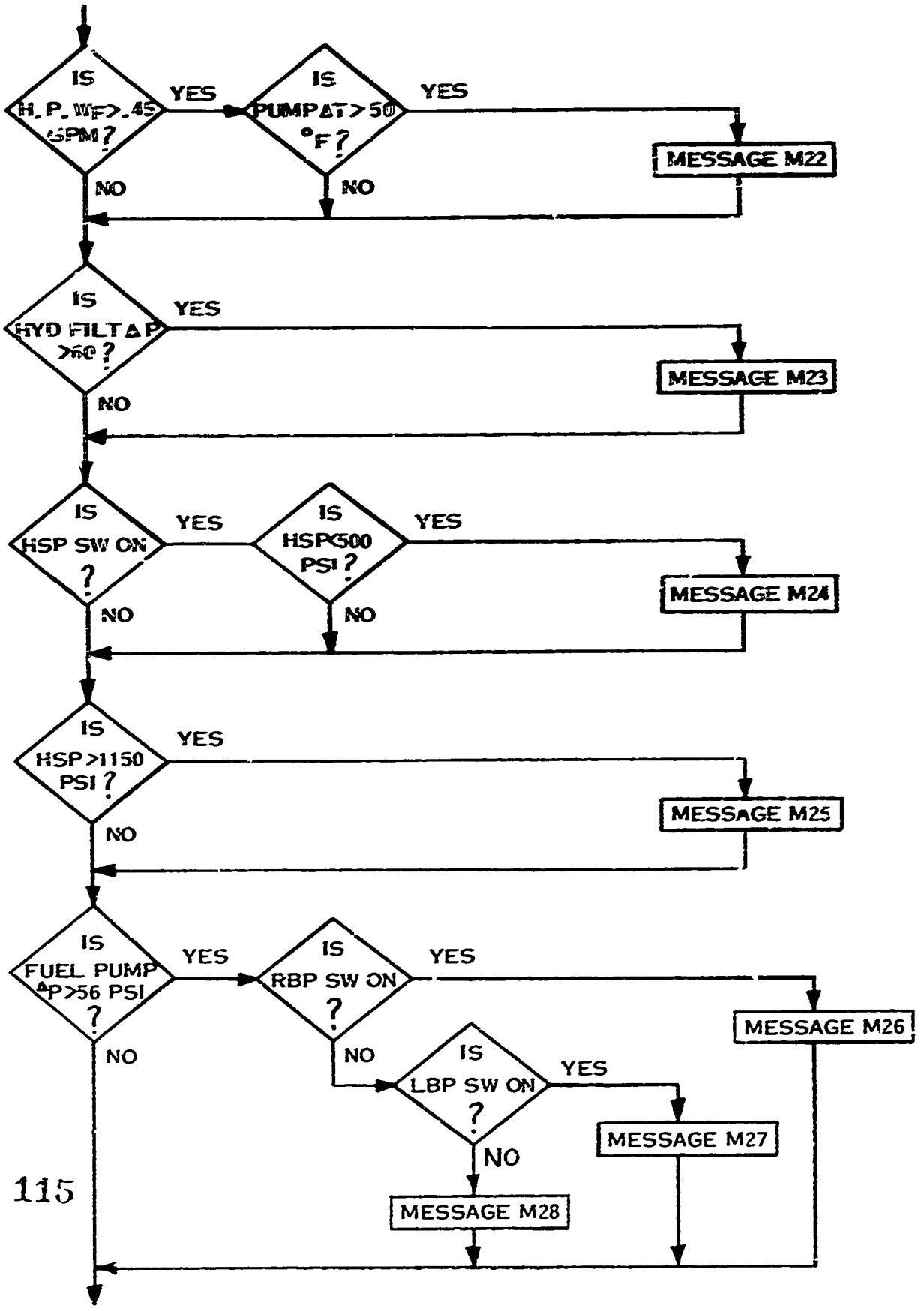


FIGURE 5-35

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5-1"



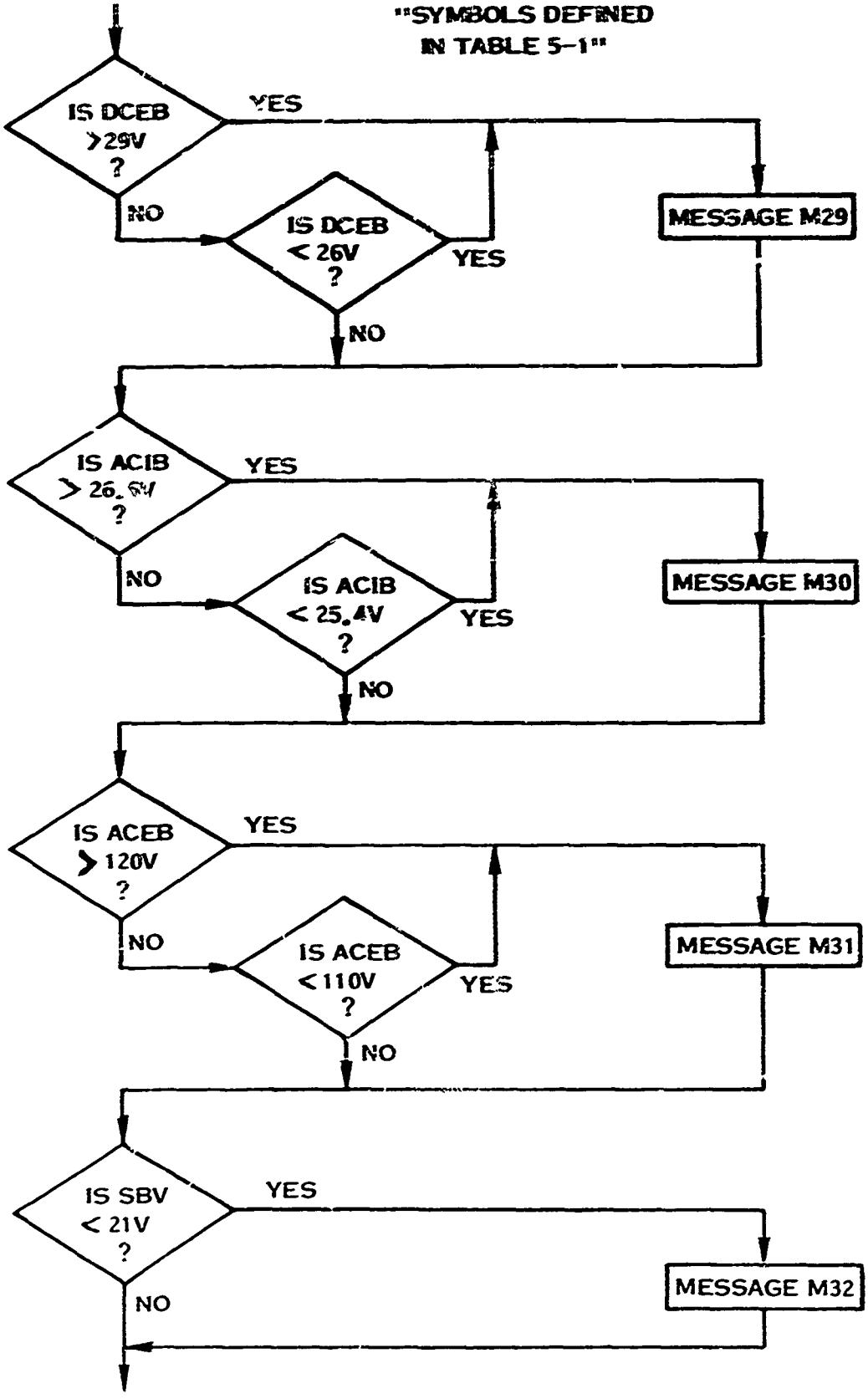


FIGURE 5–36 AIDAPS MECHANICAL DIAGNOSTIC LOGIC

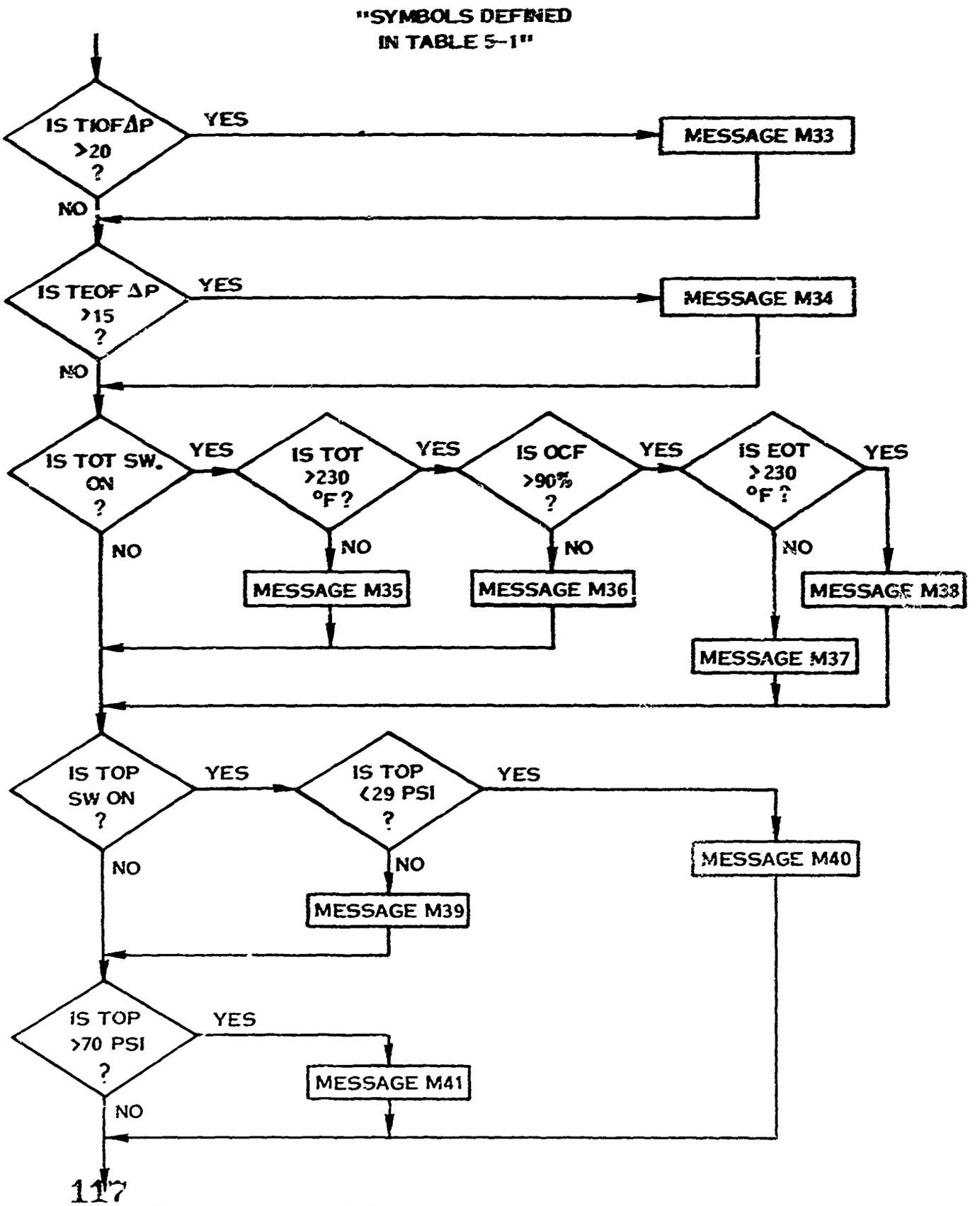
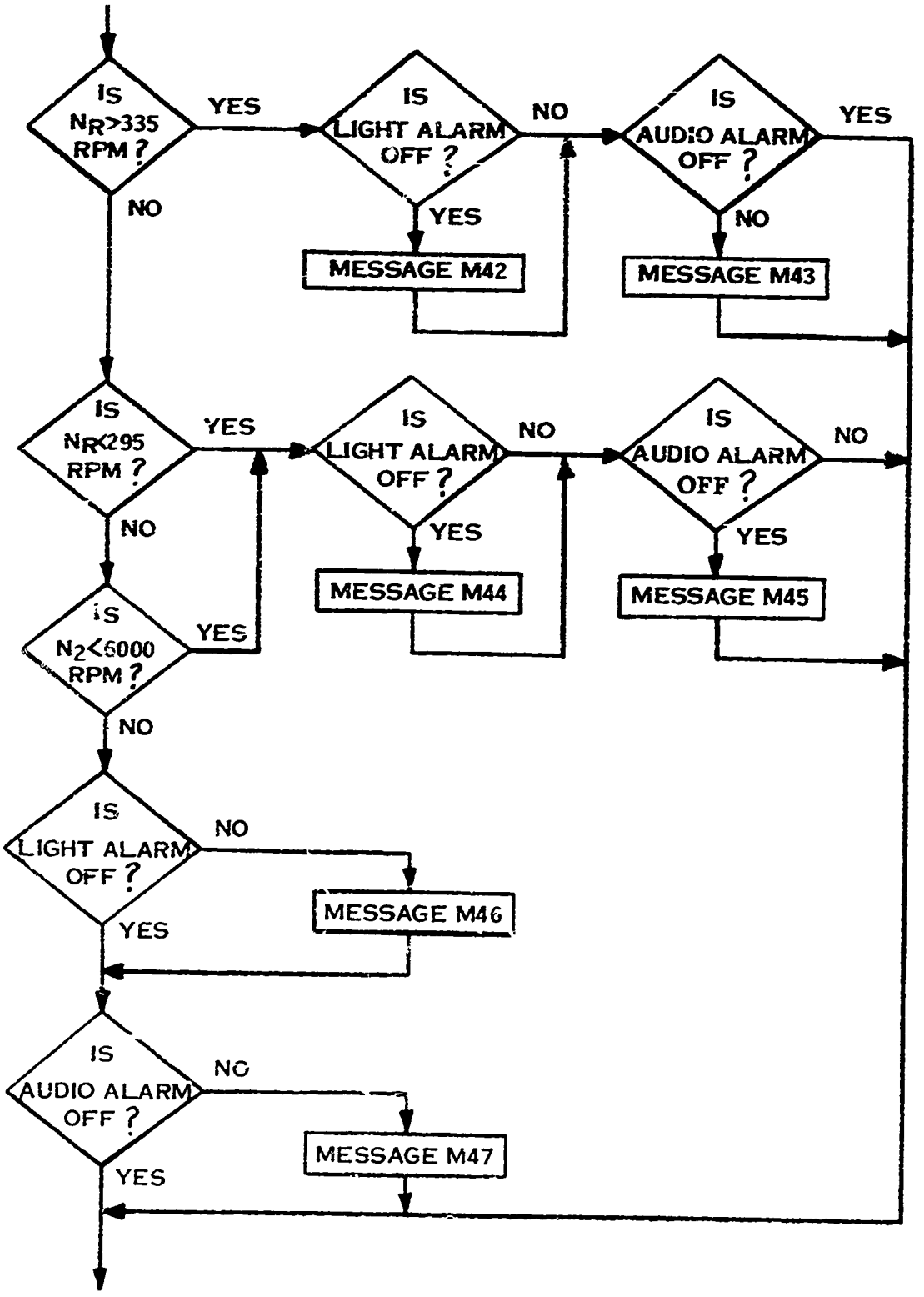


FIGURE 5-37 AIDAPS MECHANICAL DIAGNOSTIC LOGIC

FIGURE 5–38

AIDAPS MECHANICAL DIAGNOSTIC LOGIC

"SYMBOLS DEFINED IN TABLE 5–1"



END OF MECHANICAL LOGIC.

FIGURE 5-39 AIDAPS Maintenance Action Messages

Mechanical Diagnostic Actions

M1	Adjust Oil Pump Pressure
M2	Inspect Compressor Rear Bearing Seal
M3	Inspect Lubrication System
M4	Inspect Bearing 2 Oil Strainer
M5	Perform Oil Contamination Inspection
M6	Perform N_1 Topping Check
M7	Perform Internal (Hot End) Inspection
M8	Replace EGT Harness
M9	Replace Combustor/Turbine Assembly
M10	Inspect Power Turbine Rotor Assembly
M11	Inspect Bearing 3 and 4 Oil Strainer
M12	Replace Faulty Fuel Pump
M13	Replace Fuel Control Servo Filter
M14	Clean Engine Oil Filter
M15	Perform Overtorque Inspection
M16	Perform Overspeed Inspection
M17	Clean Inlet Air Filter
M18	Replace 42 Degree Gearbox
M19	Inspect 42 Degree Gearbox
M20	Replace 90 Degree Gearbox
M21	Inspect 90 Degree Gearbox
M22	Replace Worn Hydraulic Pump
M23	Clean Hydraulic Oil Filter
M24	Hydraulic Supply Pressure Is Low. Improper Operation of Pressure Relief Valve, Shutoff Valve or Broken Line.

FIGURE 5-39 (CONTINUED)

M25 Hydraulic Supply Pressire Is High. Pressure Relief Valve Did Not Open or Pressure Control Is Inoperative.

M26 Inspect Right Boost Fuel Pump and Pressure Switch.

M27 Inspect Left Boost Fuel Pump and Pressure Switch.

M28 Replace Fuel Pump Pressure Switch.

M29 Malfunction of 28 VDC Essential Bus.

M30 Malfunction of 26 VAC Instrument Bus.

M31 Malfunction of 115 VAC Essential Bus.

M32 Replace or Recharge Starting Battery.

M33 Clean Transmission Internal Oil Filter.

M34 Clean Transmission External Oil Filter.

M35 Replace Transmission Oil Temperature Switch.

M36 Replace Transmission Oil Cooler Thermal Valve or Adjust Setting to Increase Oil Flow.

M37 Clear Obstructions in Oil Cooler.

M38 Check Oil Cooler Fan Operation.

M39 Replace Transmission Oil Pressure Switch.

M40 Transmission Pressure Is Low. Inspect Pressure, Relief Valve, Transmission Pump, or for Broken Line.

M41 Transmission Pressure Is High. Pressure Relief Valve Did Not Open.

M42 Rotor Light Alarm Did Not Function During Overspeed.

M43 Rotor Audio Alarm Is On Improperly During Overspeed.

M44 Rotor Light Alarm Did Not Function During Underspeed.

M45 Rotor Audio Alarm Did Not Function During Underspeed.

M46 Rotor Light Alarm Is On Without Cause.

M47 Rotor Audio Alarm Is On Without Cause.

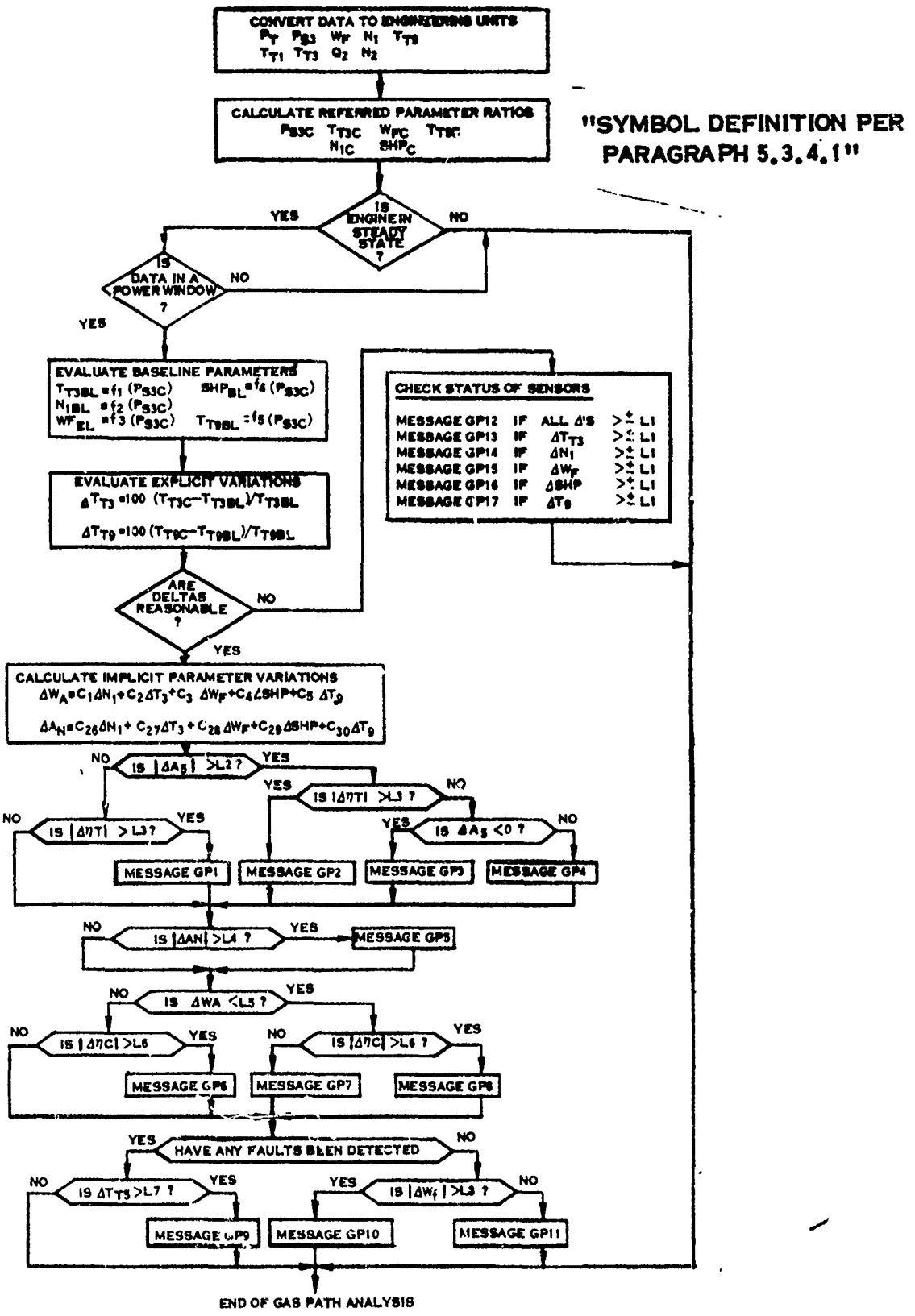
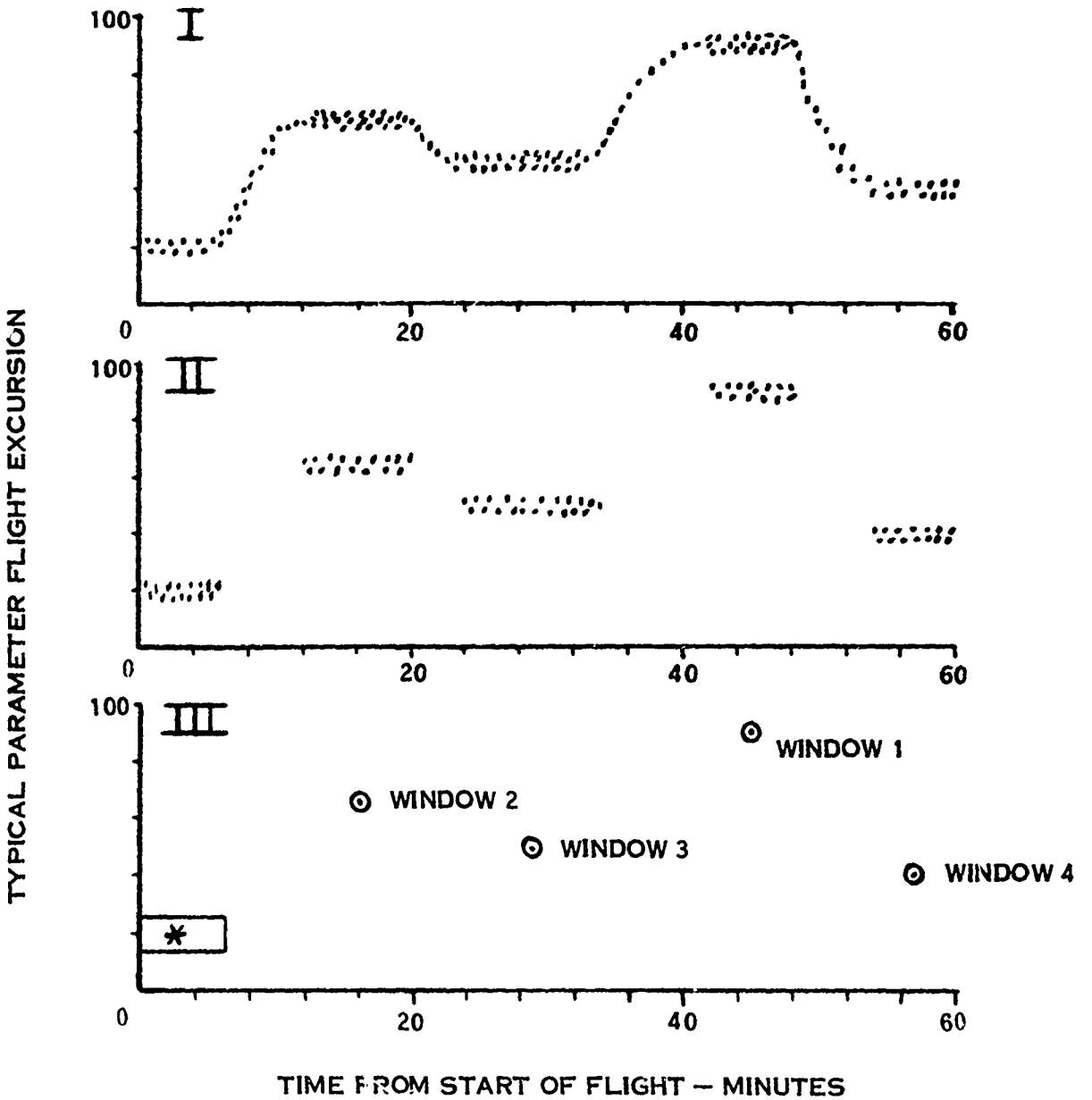


FIGURE 5-40 AIDAPS GAS PATH ANALYSIS FLOW DIAGRAM



I : TOTAL FLIGHT DATA

II : STEADY STATE DATA

III : EFFECTIVE DATA FOR FLIGHT

* : DATA IN THIS ZONE WAS BELOW DESIRED POWER WINDOWS

FIGURE 5–41 FLIGHT DATA COLLECTION & COMPRESSION

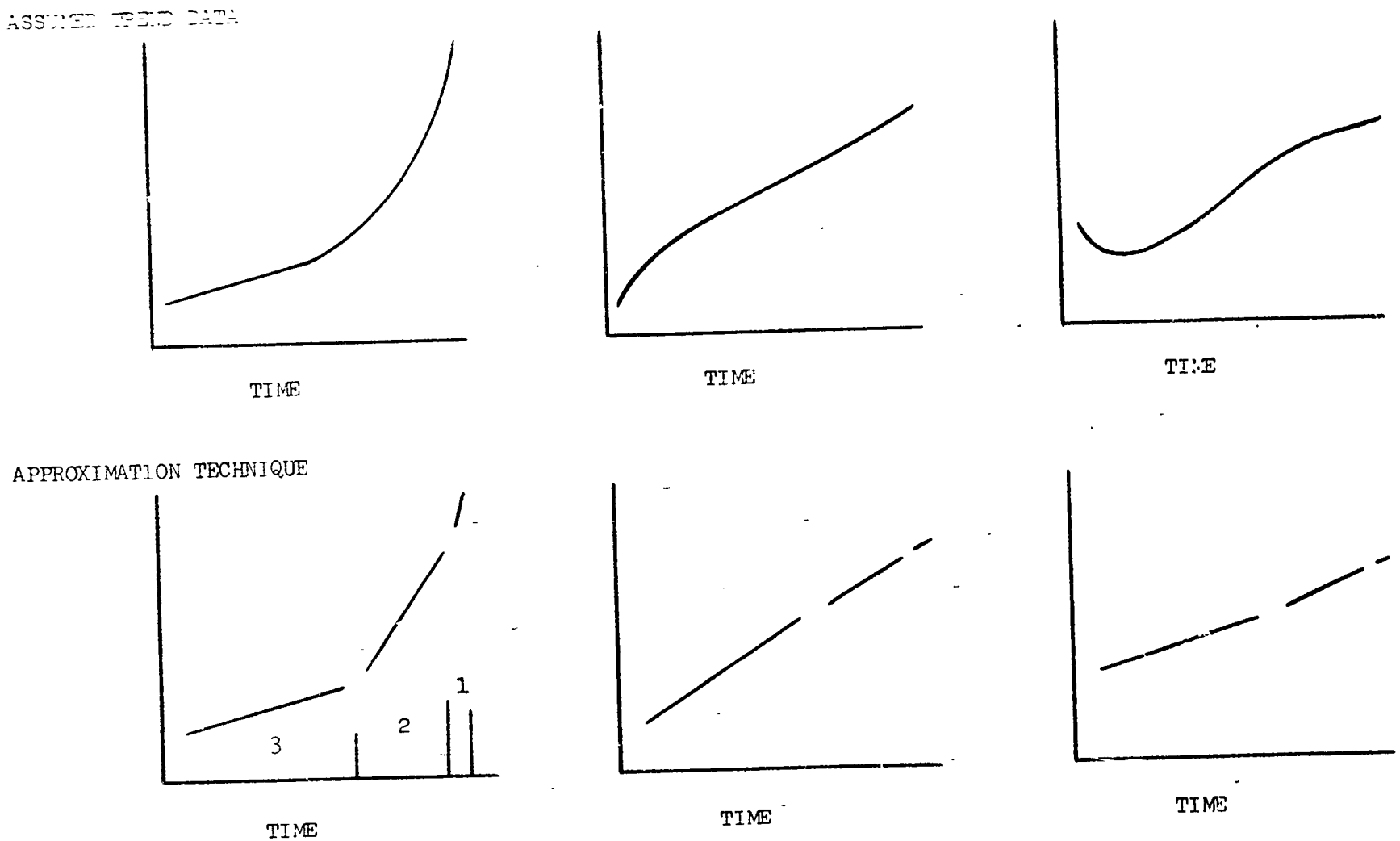


FIGURE 5-42 EXAMPLE OF CURVE FITTING TECHNIQUE

FIGURE 5-43

AIDAPS TREND ANALYSIS LOGIC FLOW

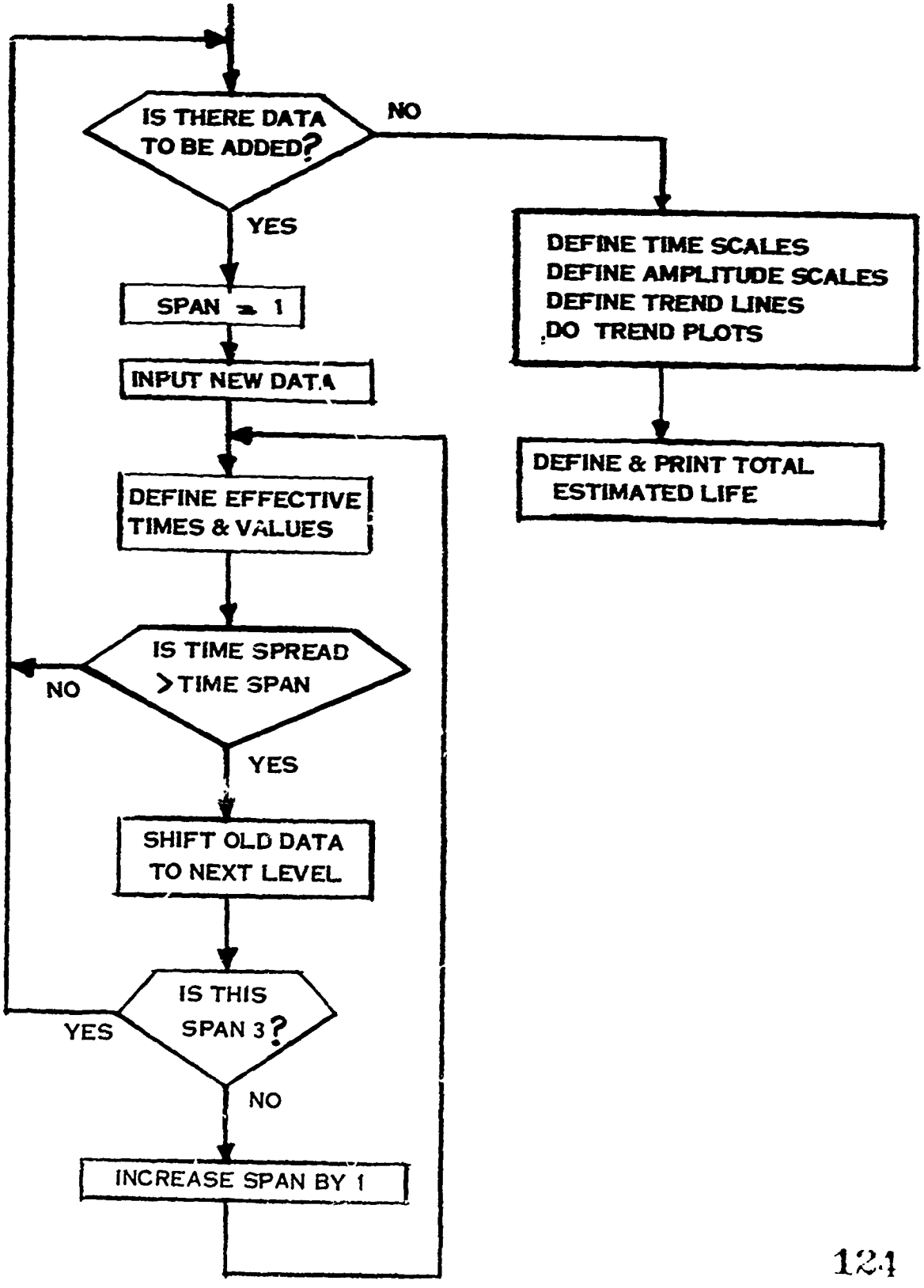


FIGURE 5-44

DERIVATION OF TREND LINE EQUATIONS

A. Definition of data to be utilized in Trend Line is as follows:

1) flights occurred at times $T_1, T_2, T_3, \ldots T_i$;

2) average parameter value for each condition of interest is $Y_1, Y_2, Y_3, \ldots Y_i$; and

3) number of data frames included in each average parameter value is $N_1, N_2, N_3, \ldots N_i$.

B. Form of desired Trend Line equation is:

$$Y \text{ average} = a_o + a_1 T$$

where constants a_o and a_1 must be evaluated from available data.

C. Definition of intermediate equations:

1) $\sum N = N_1 + N_2 + N_3 + \ldots N_i$

2) $\sum Y = Y_1 + Y_2 + Y_3 + \ldots Y_i$

3) $\sum T = T_1 + T_2 + T_3 + \ldots T_i$

4) $\sum YT = Y_1 T_1 + Y_2 T_2 + Y_3 T_3 + \ldots Y_i T_i$

5) $\sum T^2 = T_1^2 + T_2^2 + T_3^2 + \ldots T_i^2$

D. Normal equations for defining the coefficients a_o and a_1 by Least Squares technique are

1) $\sum Y = a_o \sum N + a_1 \sum T$; and

2) $\sum YT = a_o \sum T + a_1 \sum T^2$

E. Resultant coefficients obtain by solving equations in D above are:

1) $a_o = \dfrac{\sum Y \cdot \sum T^2 - \sum T \cdot \sum YT}{\sum N \cdot \sum T^2 \quad \sum T \cdot \sum T}$; and

2) $a_1 = \dfrac{\sum N \cdot \sum YT - \sum T \cdot \sum Y}{\sum N \cdot \sum T^2 \quad \sum T \cdot \sum T}$

F. The average Trend Line is thus defined as:

1) $Y \text{ average} = a_o + a_1 T$

and the effective life indicated by the parameter may be obtained by equating the Trend Line to the malfunction limit.

2) $Y \text{ average} = a_o + a_1 T = \text{Limit}$

or the time at which the limit is reached is;

3) $T = (\text{Limit} - a_o)/a_1$

TABLE 5.2

GAS PATH DIAGNOSTIC ACTIONS

GP1	INSPECT N_1 TURBINE ROTOR
GP2	REPLACE N_1 TURBINE ASSEMBLY
GP3	REPLACE COKED N_1 TURBINE NOZZLES
GP4	REPLACE ERODED N_1 TURBINE NOZZLES
GP5	REPLACE N_2 TURBINE ASSEMBLY
GP6	WARNING: COMPRESSOR EFFICIENCY IS DETERIORATING.
GP7	WARNING: COMPRESSOR PUMPING CAPACITY IS DETERIORATING. CHECK IGV AND BLEEDBAND OPERATION
GP8	BAD COMPRESSOR. CHECK FOR VISUAL DAMAGE, IMPROPER IGV OPERATION, EXCESSIVE AIR BLEED OR REPLACE COMPRESSOR
GP9	PERFORM INTERNAL (HOT END) INSPECTION
GP10	INSPECT BURNER NOZZLES, LINER AND DIFFUSER FOR WEAR, OR CLOGGING
GP11	ENGINE PASSED ALL TESTS, NO PROBLEMS DETECTED
GP12	REPLACE OR CALIBRATE P_{S3}, P_T & T_{T1} SENSORS
GP13	REPLACE OR CALIBRATE T_{T3}, SENSOR
GP14	REPLACE OR CALIBRATE N_1, SENSOR
GP15	REPLACE OR CALIBRATE W_F SENSOR
GP16	REPLACE OR CALIBRATE Q_Z & N_Z SENSORS
GP17	REPLACE OR CALIBRATE T_{T9} SENSORS

TABLE 5.3 AIDAPS TREND PARAMETERS

GAS PATH PARAMETERS

SYMBOL	DEFINITION	LIMITS (NOTE 1) LOWER	UPPER	UNITS
D TT3	VARIATION OF T_{T3}/θ_1	-25	25	%
D N1	VARIATION OF $N_1/\sqrt{\theta_1}$	-25	25	"
D WF	VARIATION OF $WF/\delta_1\theta_1^{.8}$	-25	25	"
D SHP	VARIATION OF $SHP/\delta_1\sqrt{\theta_1}$	-25	25	"
D T_{T9}	VARIATION OF T_{T9}/θ_1	-25	25	"
D TT5	VARIATION OF $TT5/\theta_1$	NA	10	"
D WAIR	VARIATION OF $WA/\delta_1\sqrt{\theta_1}$	- 6	NA	"
D ETA C	VARIATION OF COMP. EFFICIENCY	- 6	NA	"
D NTA	VARIATION OF N_1 TURBINE AREA	- 6	6	"
D ETA N1	VARIATION OF N_1 TURBINE EFFICIENCY	- 6	NA	"
D ETA PT	VARIATION OF N_2 TURBINE EFFICIENCY	- 6	6	"

MECHANICAL PARAMETERS

SYMBOL	DEFINITION	LIMITS (NOTE 2) LOWER	UPPER	UNITS
SB VOLTS	START BATTERY VOLTAGE	21	NA	VOLTS
EOP	ENGINE OIL PRESSURE	27	NA	PSI
EOT	ENGINE OIL TEMPERATURE	NA	250	°F
FUEL P	FUEL PRESSURE	4	NA	PSI
HYD P	HYDRAULIC PRESSURE	500	1150	PSI
42 GB DT	42 DEG. GEARBOX TEMPERATURE RISE	NA	130	°F
90 GB DT	90 DEG. GEARBOX TEMPERATURE RISE	NA	130	°F
BRG 2 DT	BEARING 2 TEMPERATURE RISE	NA	220	°F
HYD FLOW	HYDRAULIC PUMP LEAKAGE FLOW	NA	0.45	GPM
PUMP DT	HYDRAULIC PUMP TEMPERATURE RISE	NA	50	°F
OC FLOW	TRANSMISSION OIL COOLER FLOW	250	4960	PPH
TOP	TRANSMISSION OIL PRESSURE	29	70	PSI
TOT	TRANSMISSION OIL TEMPERATURE	NA	230	°F
BRG 3 DT	BEARING 3 & 4 TEMPERATURE RISE	NA	220	°F
ACEB 115	AC ESSENTIAL BUS VOLTAGE	110	120	VOLTS
ACIB 26	AC INSTRUMENT BUS VOLTAGE	25.4	26.6	VOLTS
DCEB 28	DC ESSENTIAL BUS VOLTAGE	26	29	VOLTS

NA INDICATES NO APPLICABLE LIMIT

NOTE 1: GAS PATH LIMITS DERIVED BY HAMILTON STANDARD

NOTE 2: MECHANICAL LIMITS EXTRACTED FROM GOVERNMENT DATA

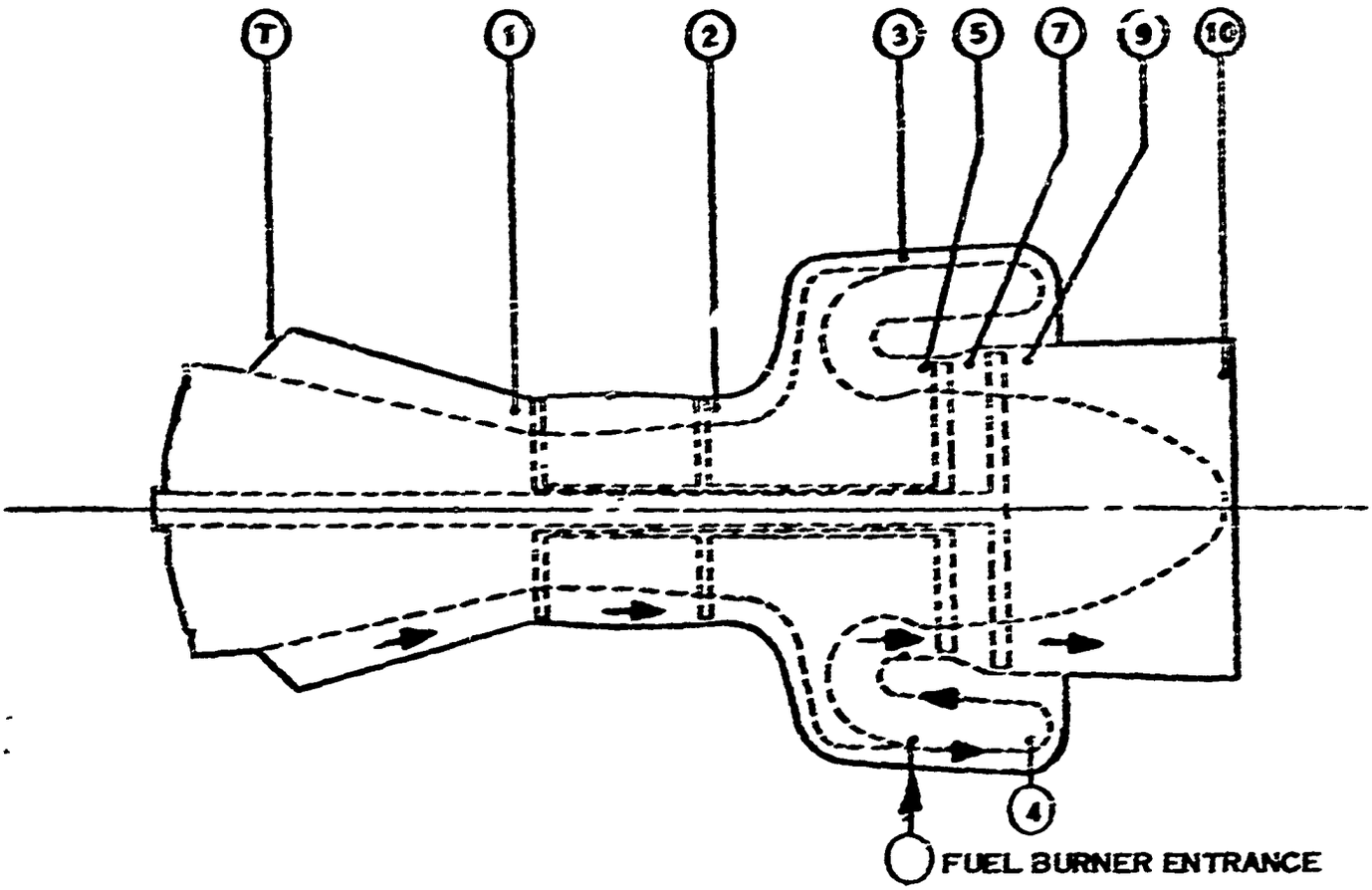
SECTION 6

SIGNATURE DEFINITION

AND

ANALYSIS OF FLIGHT DATA

T53 ENGINE STATION DIAGRAM UH-1H



(T) ENGINE INLET
(1) AXIAL COMPRESSOR ENTRANCE
(2) CONTRIFUGAL COMPRESSOR ENTRANCE
(3) COMPRESSOR DIFFUSER EXIT
(4) FUEL BURNER EXIT
(5) GAS PRODUCER TURBINE ENTRANCE
(7) POWER TURBINE ENTRANCE
(9) EXHAUST DIFFUSER ENTRANCE
(10) EXHAUST DIFFUSER EXIT

FIGURE 6–1 T53–L13 ENGINE SCHEMATIC

SIMPLIFIED FLOW DIAGRAM
T53L13 ENGINE GAS PATH ANALYSIS

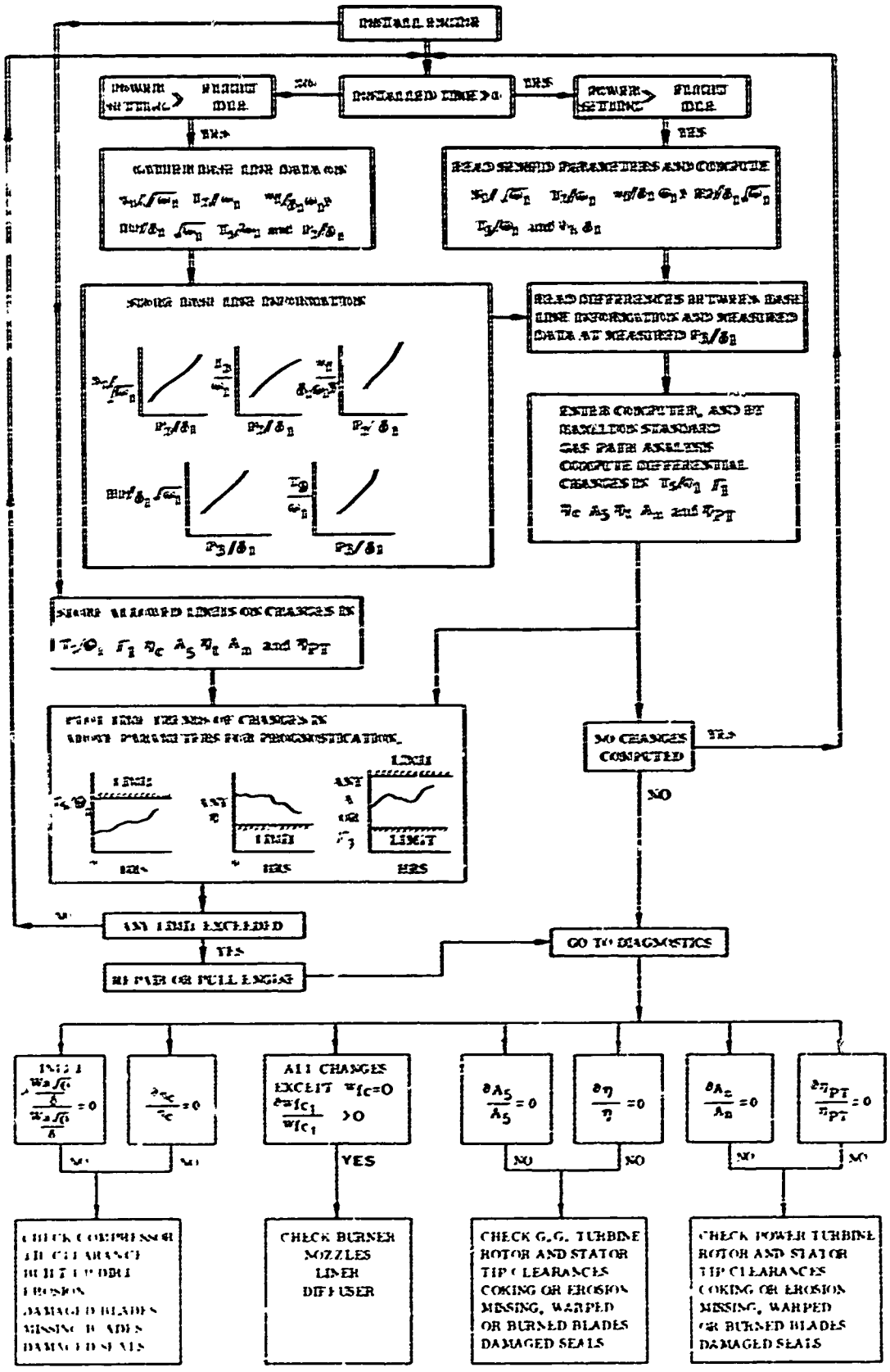

YES
NO
YES
YES
YES
NO
YES
NO
NO
NO
NO
NO
NO
YES
NO
NO
NO
NO
NO
NO

FIGURE 6-3 AIDAPS GAS PATH ANALYSIS SUMMARY FOR SIGNATURE DEFINITIONS

CONSIDERATIONS: DIAGNOSTICS OBTAINED WITH DETERIORATIONS OF LESS THAN 5%

INSERTED COMPONENT	BASELINE = f (P_{s3}/δ_1) WITH NOISE REJECTION	BASELINE = f (P_{s3}/δ_1) WITHOUT NOISE REJECTION	BASELINE = f ($N_1/\sqrt{\theta_1}$) WITH NOISE REJECTION	BASELINE = f ($N_1/\sqrt{\theta_1}$) WITHOUT NOISE REJECTION	ANALYSIS OF TEST CELL DATA
Bearing 2 (LE 15615)	No Gas Path Fault (Correct Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_1 Nozzles Degraded Compressor (Wrong Diagnostic)	Degraded Compressor Degraded N_1 Nozzles (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
Bearing 3 (LE 20727)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
Bearing 4 (LE 15351)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine Degraded Compressor (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
N_1 Nozzles (LE 15615)	No Gas Path Fault (Possible Diagnostic)	Degrade N_2 Turbine (Wrong Diagnostic)	Degraded N_2 Turbine Degraded N_1 Nozzles (Wrong Diagnostic)	Degraded N_2 Turbine Degraded N_1 Nozzles (Wrong Diagnostic)	No Gas Path Fault (Possible Diagnostic)
N_2 Nozzles (LE 18993)	Degraded N_2 Turbine Degraded Compressor Degraded N_1 Turbine (Isolated Primary Fault)	Degraded N_2 Turbine Degraded Compressor (Isolated Primary Fault)	Degraded N_2 Turbine (Correct Diagnostic)	Degraded N_2 Turbine Degraded Compressor (Isolated Primary Fault)	Degraded Compressor Degraded N_1 Turbine Degraded N_2 Turbine (Wrong Diagnostic)
N_2 Nozzles (LE 20727)	No Gas Path Fault (Possible Diagnostic)	Degraded N_2 Turbine (Correct Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)
N_2 Turbine (LE 15351)	Not Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine (Isolated Primary Fault)	No Gas Path Fault (Possible Diagnostic)
Compressor (LE 15615) (Note 1)	Degraded N_2 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine Degraded Compressor (Wrong Diagnostic)	Degraded Compressor Degraded N_1 Nozzle Degraded N_2 Turbine (Isolated Primary Fault)

Possible Diagnostic Indicates Part Deterioration May Not Be Sufficient To Warrant Removal.

Note 1: Compressor Data Was Obtained Before Final Data Acquisition Technique Was Established.

		EXPLICIT PARAMETERS					IMPLICIT PARAMETERS					
	BEARING #2	ΔN_1	ΔT_3	ΔW_f	ΔSHP	ΔT_9	ΔT_5	ΔW_A	$\Delta \eta C$	ΔA_5	$\Delta \eta T$	ΔA_N
P_{S3}/δ_1	NO DEADBAND	.03	−.39	−3.29	−4.74	−.57	−.96	−1.64	.91	−2.22	−1.51	.15
	WITH DEADBAND	0.	−.02	−.74	−3.28	−.21	−.60	.59	.05	.14	−.51	1.70
	BEARING #2	ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND	−.73	−.82	−4.95	−5.78	−.07	−.57	−4.87	1.36	−4.24	−2.66	−1.90
	WITH DEADBAND	−.13	−.52	−3.20	−4.38	0.	−.42	−2.86	1.11	−3.06	−2.17	−.85
	N_1 NOZZLES	ΔN_1										
P_{S3}/δ_1	NO DEADBAND	−.07	−.41	−.85	−3.11	−1.19	−1.71	2.83	.95	1.58	−.21	2.97
	WITH DEADBAND	0.	−.04	0.	−1.65	−.83	−1.09	2.41	.09	1.80	.52	2.42
	N_1 NOZZLES	ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND	−.14	−.52	−.73	−2.94	−1.93	−2.48	4.25	1.10	3.12	.54	4.14
	WITH DEADBAND	0.	−.22	0.	−1.54	−1.73	−2.04	4.37	.51	3.30	1.14	3.74
	TEST CELL N_1 NOZZLES	ΔN_1										
P_{S3}/δ_1	NO DEADBAND	0.	0.	−.5	3.5	.5	1.10	−2.97	0.	−2.27	0.	−3.83
	WITH DEADBAND	0.	0.	0.	2.04	.14	.45	−1.01	0.	−.69	.21	−1.64
		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND											
	WITH DEADBAND											

FIGURE 6–4 AIDAPS GASPATH ENGINE DATA LE 15615

EXPLICIT PARAMETERS

	COMPRESSOR	ΔN_1	ΔT_3	ΔW_f	ΔSHP	ΔT_9
P_{S3}/δ_1	NO DEADBAND	−.52	−.32	−4.26	−9.10	0.
	WITH DEADBAND	−.23	0.	−1.71	−7.64	0.

	COMPRESSOR	ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND	1.63	.08	−2.35	−4.25	1.14
	WITH DEADBAND	1.03	0.	−.60	−2.75	.84

	TEST CELL COMPRESSOR	ΔN_1				
P_{S3}/δ_1	NO DEADBAND	1.27	1.25	1.60	1.00	2.60
	WITH DEADBAND	.98	.88	0.	0.	2.24

		ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND					
	WITH DEADBAND					

		ΔN_1				
P_{S3}/δ_1	NO DEADBAND					
	WITH DEADBAND					

		ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND					
	WITH DEADBAND					

IMPLICIT PARAMETERS

ΔT_5	ΔW_A	$\Delta \eta_C$	ΔA_5	$\Delta \eta_T$	ΔA_N
−.88	−.69	.74	−3.47	−2.90	1.13
−.90	1.16	0.	−.49	−1.61	3.23

.88	−3.42	1.04	−5.85	−3.67	−1.68
.51	−1.22	.78	−2.78	−2.41	−.11

3.05	−8.69	−2.91	−2.43	.10	−2.78
2.62	−8.62	−2.05	−3.70	−.67	−3.48

FIGURE 6–4 (CONTINUED) AIDAPS GASPATH ENGINE DATA LE 15615 (CONTINUED)

		EXPLICIT PARAMETERS					IMPLICIT PARAMETERS					
	N_2 NOZZLES	ΔN_1	ΔT_3	ΔW_f	ΔSHP	ΔT_9	ΔT_5	ΔW_A	$\Delta \eta C$	ΔA_5	$\Delta \eta T$	ΔA_N
P_{S3}/δ_1	NO DEADBAND	.46	.57	1.57	10.98	1.17	2.84	−5.94	−1.33	−2.32	2.04	−7.56
	WITH DEADBAND	.17	.20	0.	9.52	.81	2.33	−5.67	−.47	−3.45	1.19	−7.91
	N_2 NOZZLES	ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND	−1.25	.17	.52	6.87	.22	1.26	−2.76	−1.34	.22	2.52	−4.50
	WITH DEADBAND	−.65	0.	0.	5.37	.02	.83	−2.20	−.49	−.48	1.51	−3.78
	TEST CELL N_2 NOZZLES	ΔN_1										
P_{S3}/δ_1	NO DEADBAND	2.5	3.0	14.0	22.0	3.5	6.04	−5.78	−6.98	7.50	8.21	−3.65
	WITH DEADBAND	2.21	2.63	11.45	20.54	3.14	5.68	−6.82	−6.11	5.13	7.21	−5.20
		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND											
	WITH DEADBAND											
		ΔN_1										
P_{S3}/δ_1	NO DEADBAND											
	WITH DEADBAND											
		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND											
	WITH DEADBAND											

FIGURE 6–5 AIDAPS GASPATH ENGINE DATA LE 18993

EXPLICIT PARAMETERS

BEARING #3		ΔN_1	ΔT_5	ΔW_f	ΔSHP	ΔT_9
P_{S3}/δ_1	NO DEADBAND	−.08	−.65	.97	−3.13	.26
	WITH DEADBAND	0.	−.26	0.	−1.67	0.

IMPLICIT PARAMETERS

ΔT_5	ΔW_A	$\Delta \eta_C$	ΔA_5	$\Delta \eta_T$	ΔA_N
−.65	2.09	1.46	1.32	−1.89	3.03
−.37	.57	.60	.31	−.80	1.18

BEARING #3		ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND	−.11	.02	1.81	−1.57	−.25
	WITH DEADBAND	0.	0.	.06	−.07	−.05

−.75	3.46	−.13	3.20	.42	3.71
−.07	.22	0.	.18	.05	.20

N_2 NOZZLES		ΔN_1				
P_{S3}/δ_1	NO DEADBAND	−.28	−.73	1.39	−1.49	−.05
	WITH DEADBAND	0.	−.36	0.	−.03	0.

−.82	3.52	1.70	2.01	−1.40	2.88
−.17	.01	.84	−.08	−.70	.04

N_2 NOZZLES		ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND	1.07	−.37	2.84	1.66	.67
	WITH DEADBAND	.47	−.07	1.09	.16	.47

.32	2.29	1.67	.77	−1.65	1.34
.29	.60	.52	−.02	−.86	.52

		ΔN_1				
P_{S3}/δ_1	NO DEADBAND					
	WITH DEADBAND					

		ΔP_{S3}				
$N_1/\sqrt{\theta_1}$	NO DEADBAND					
	WITH DEADBAND					

FIGURE 6–6 AIDAPS GASPATH ENGINE DATA LE 20727

		EXPLICIT PARAMETERS					IMPLICIT PARAMETERS					
BEARING #4		ΔN_1	ΔT_3	ΔW_f	ΔSHP	ΔT_9	ΔT_5	ΔW_A	$\Delta \eta_C$	ΔA_5	$\Delta \eta_T$	ΔA_N
P_{S3}/δ_1	NO DEADBAND	−.10	.58	−2.06	1.19	−.55	.21	−1.58	−1.35	−1.78	1.58	−2.57
	WITH DEADBAND	0.	.21	0.	0.	−.19	−.09	.42	−.49	.38	.61	.28
BEARING #4		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND	.74	.86	−2.98	4.40	−1.05	.47	−2.79	−1.44	−3.55	2.39	−5.21
	WITH DEADBAND	.14	.56	−1.23	2.90	−.85	.04	−.68	−1.20	−.74	2.17	−2.28
POWER TURBINE		ΔN_1										
P_{S3}/δ_1	NO DEADBAND	0.	.29	0.	−.91	−.85	−.85	2.20	−.67	1.75	1.30	1.92
	WITH DEADBAND	0.	0.	0.	0.	−.49	−.48	1.09	0.	.85	.52	.75
POWER TURBINE		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND	.25	.41	.42	−.78	−1.41	−1.39	4.09	−.76	2.97	1.99	3.19
	WITH DEADBAND	0.	.11	0.	0.	−1.21	−1.15	2.69	−.26	2.13	1.50	1.84
		ΔN_1										
P_{S3}/δ_1	NO DEADBAND											
	WITH DEADBAND											
		ΔP_{S3}										
$N_1/\sqrt{\theta_1}$	NO DEADBAND											
	WITH DEADBAND											

FIGURE 6–7 AIDAPS GASPATH ENGINE DATA LE 15351

FIGURE 6–8 NUMBER OF GOOD DATA FRAMES ON TYPICAL TREND FLIGHTS

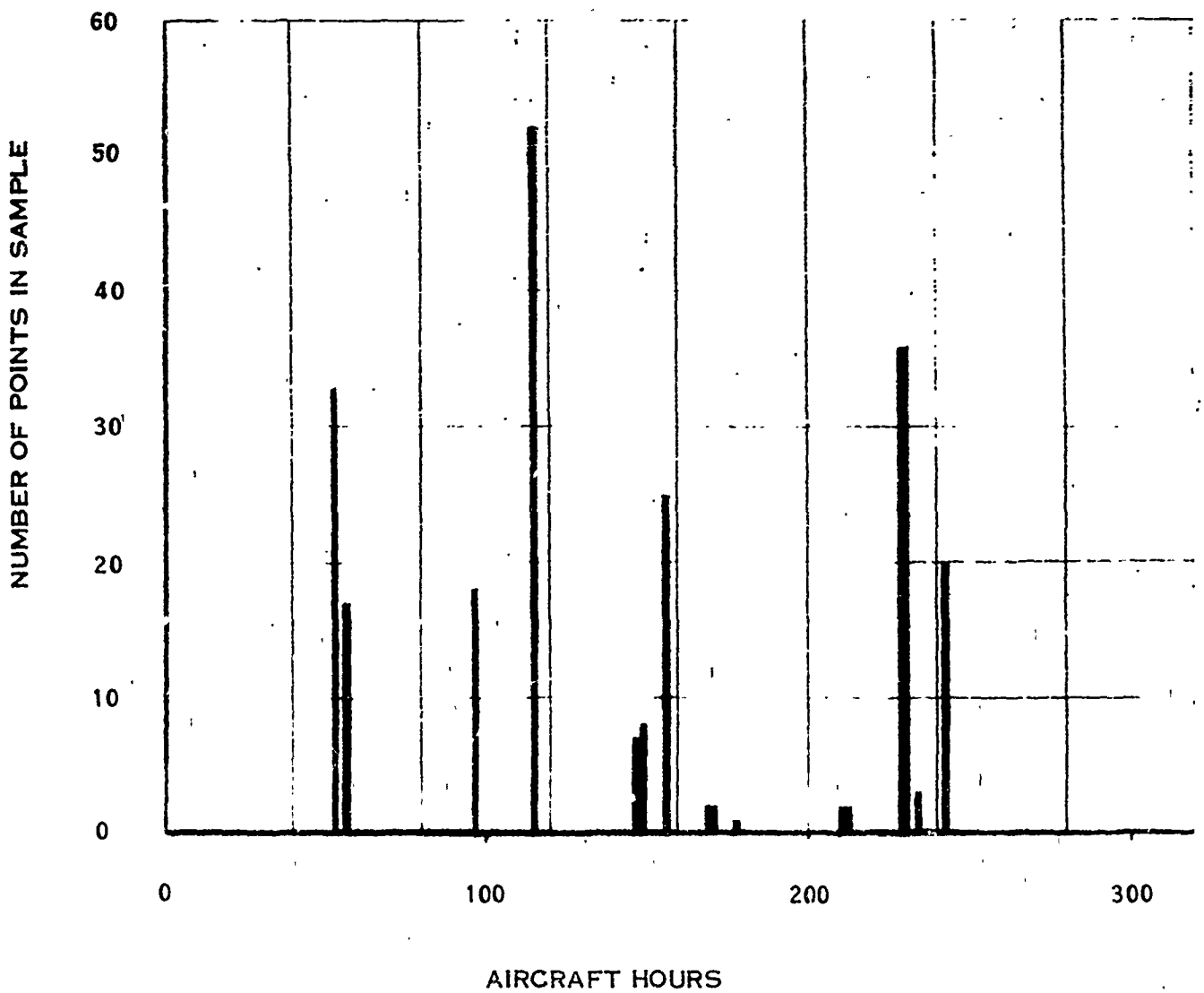


FIGURE 6–9 TREND OF FUEL FLOW

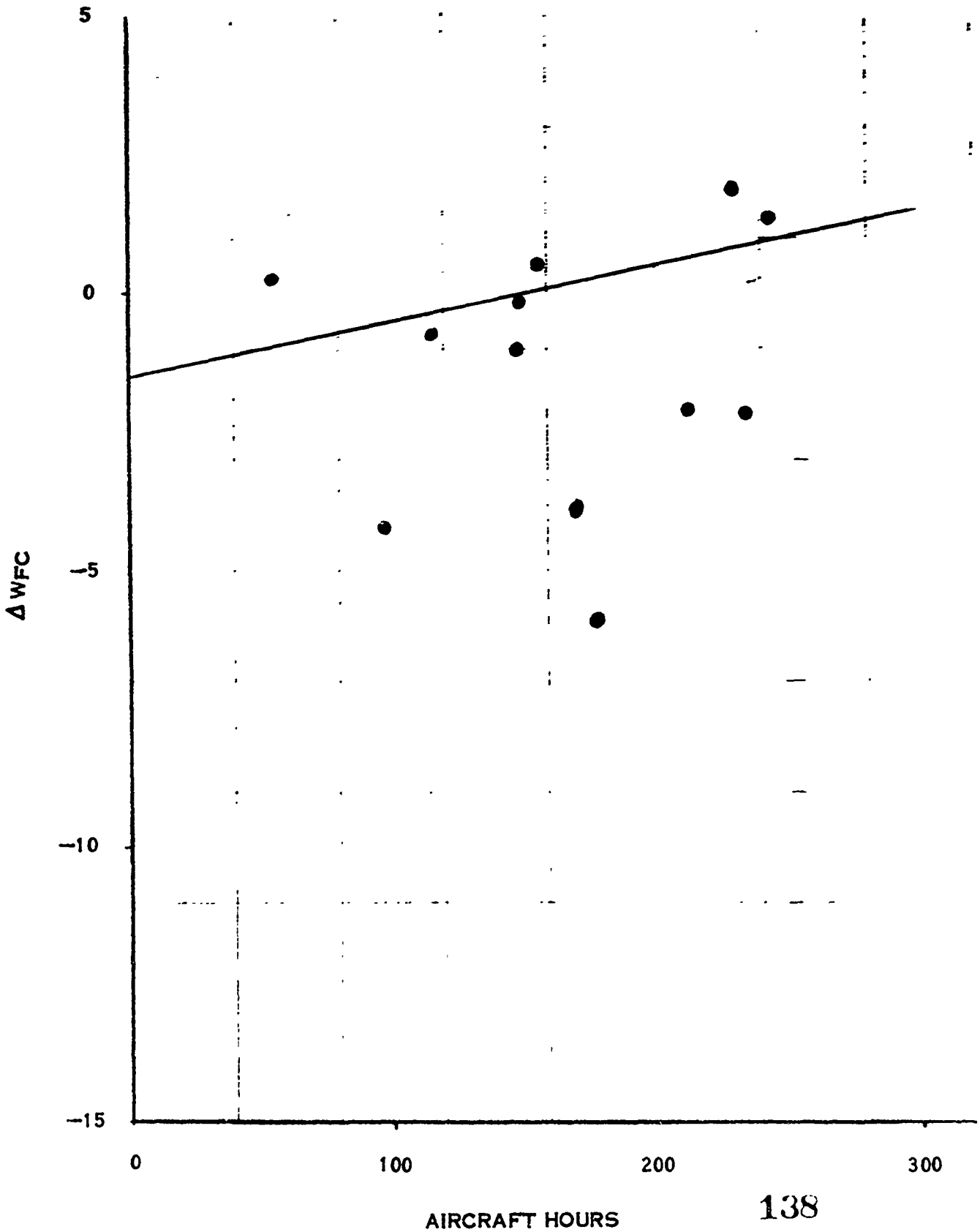


FIGURE 6-10 TREND OF SHIFT HORSEPOWER

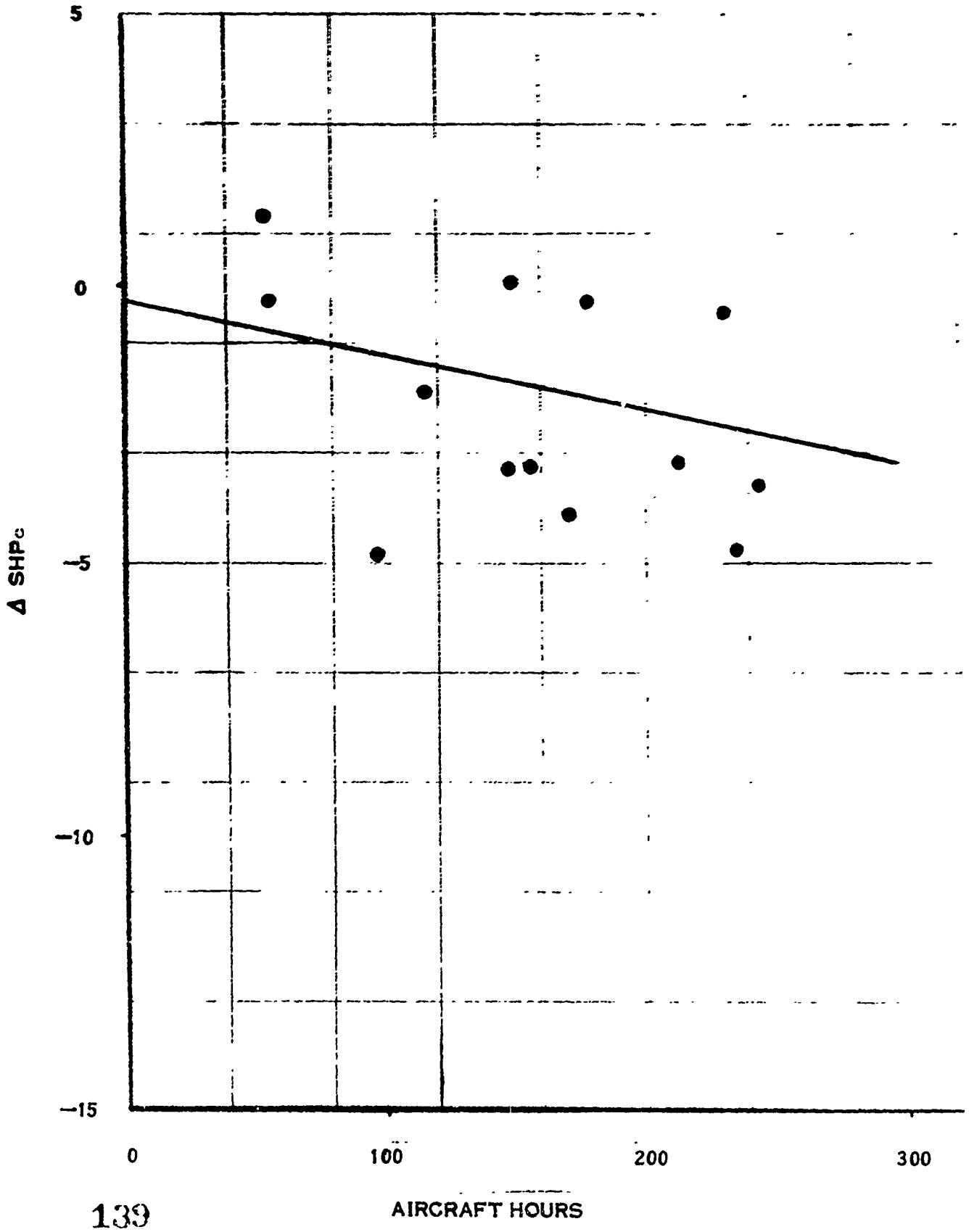


FIGURE 6-11 TREND OF EXHAUST GAS TEMPERATURE

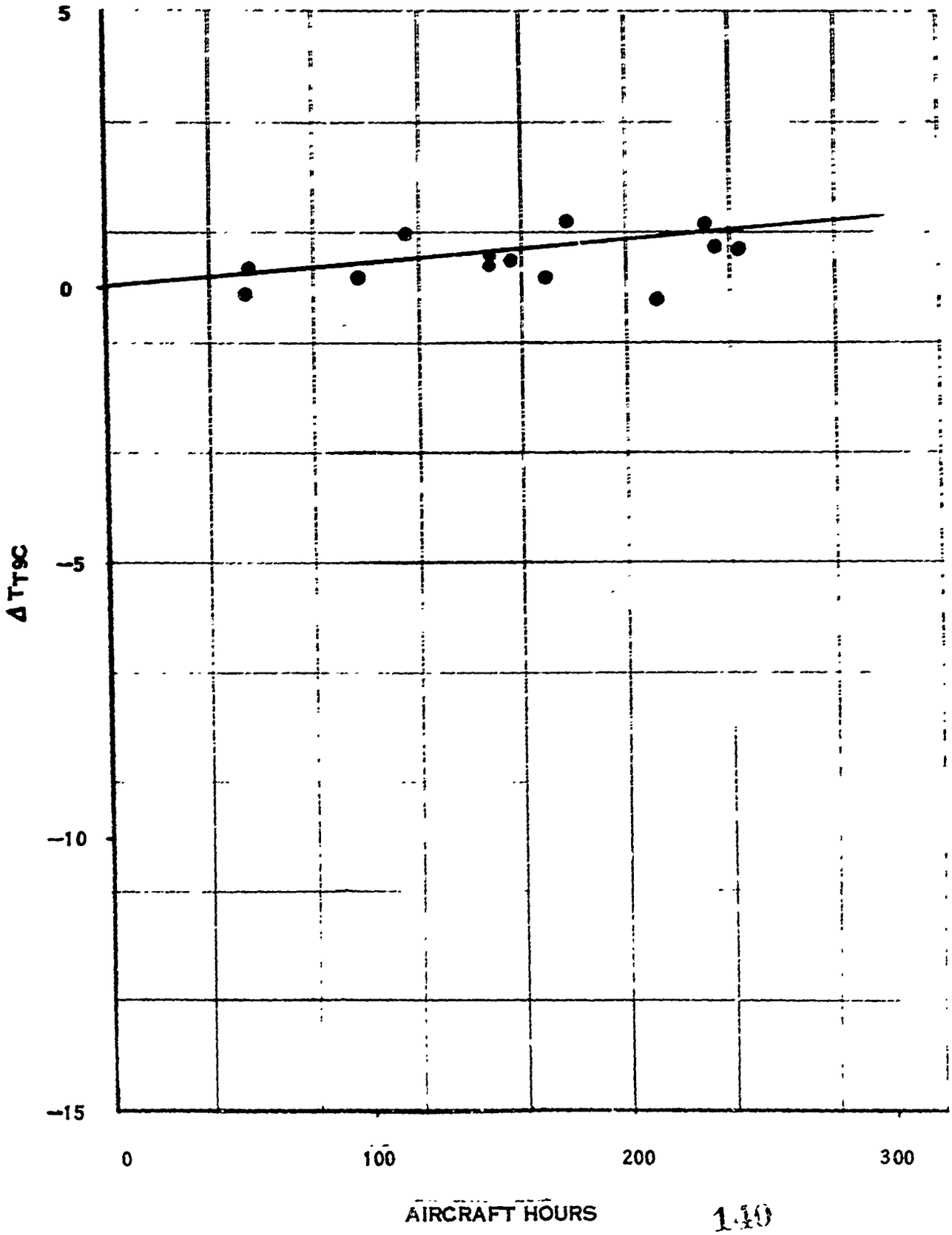


FIGURE 6-12 TREND OF COMPRESSOR TEMPERATURE

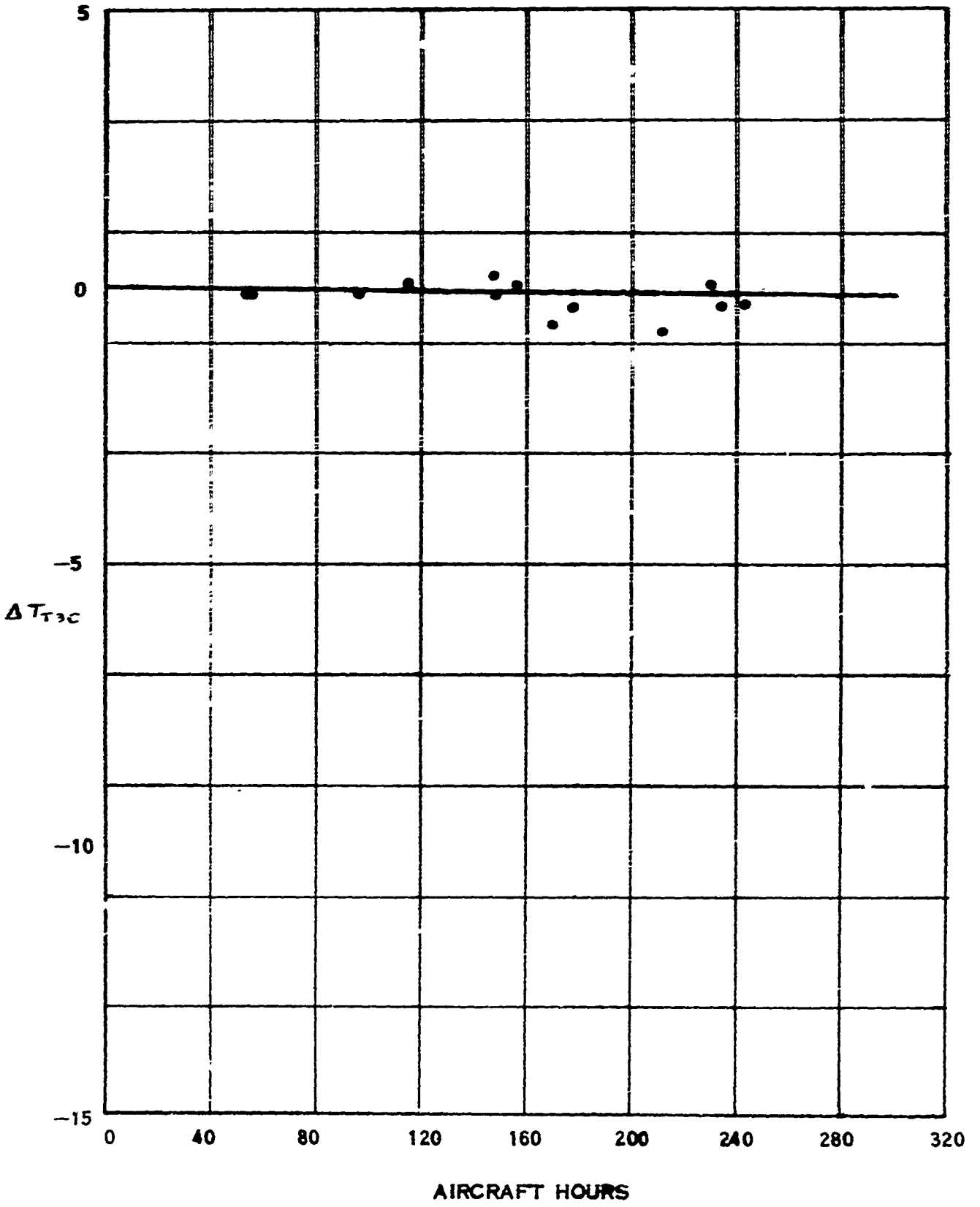


FIGURE 6-13 TREND OF GAS PRODUCER SPEED

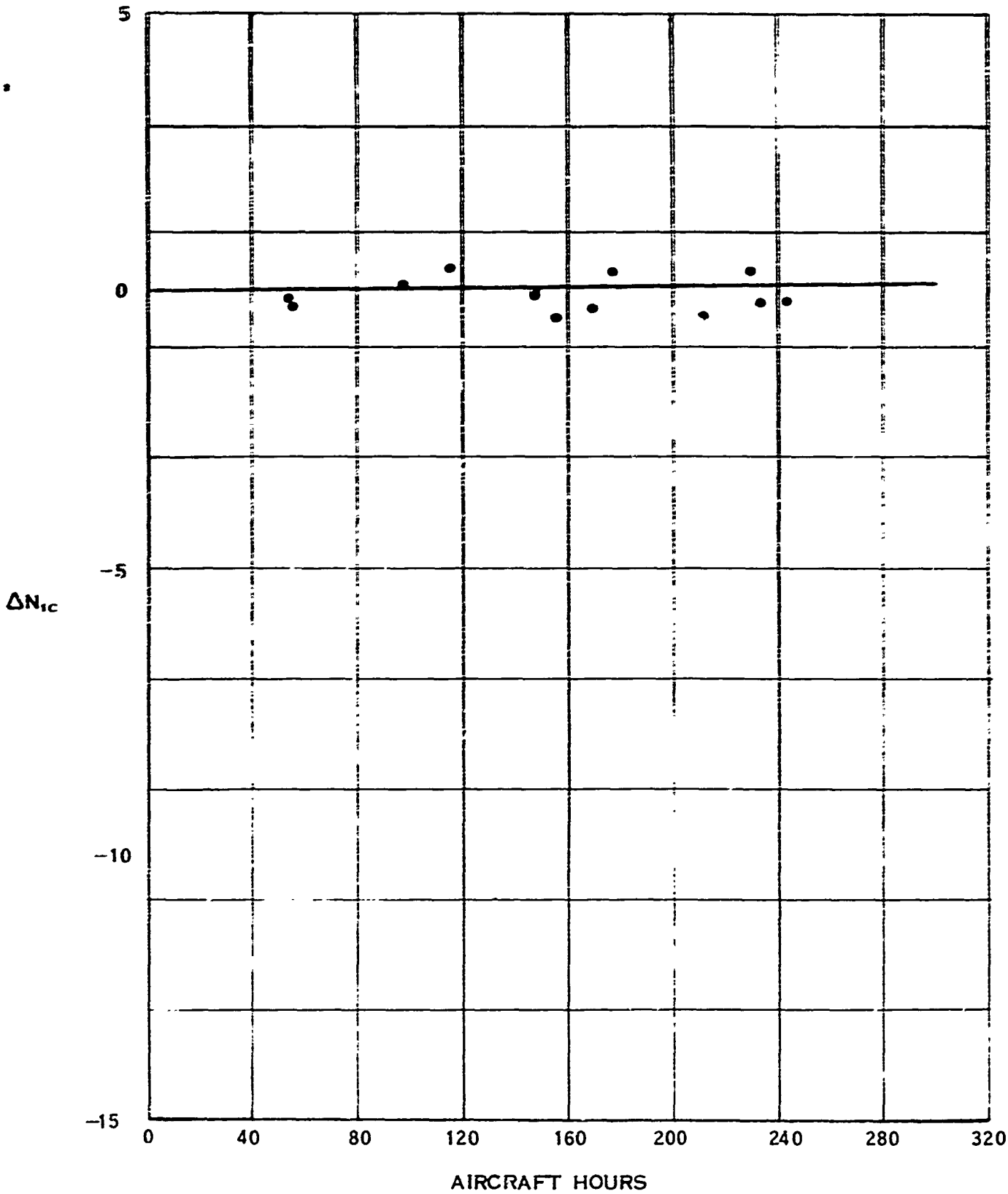


FIGURE 6-14 TREND OF TURBINE INLET TEMPERATURE

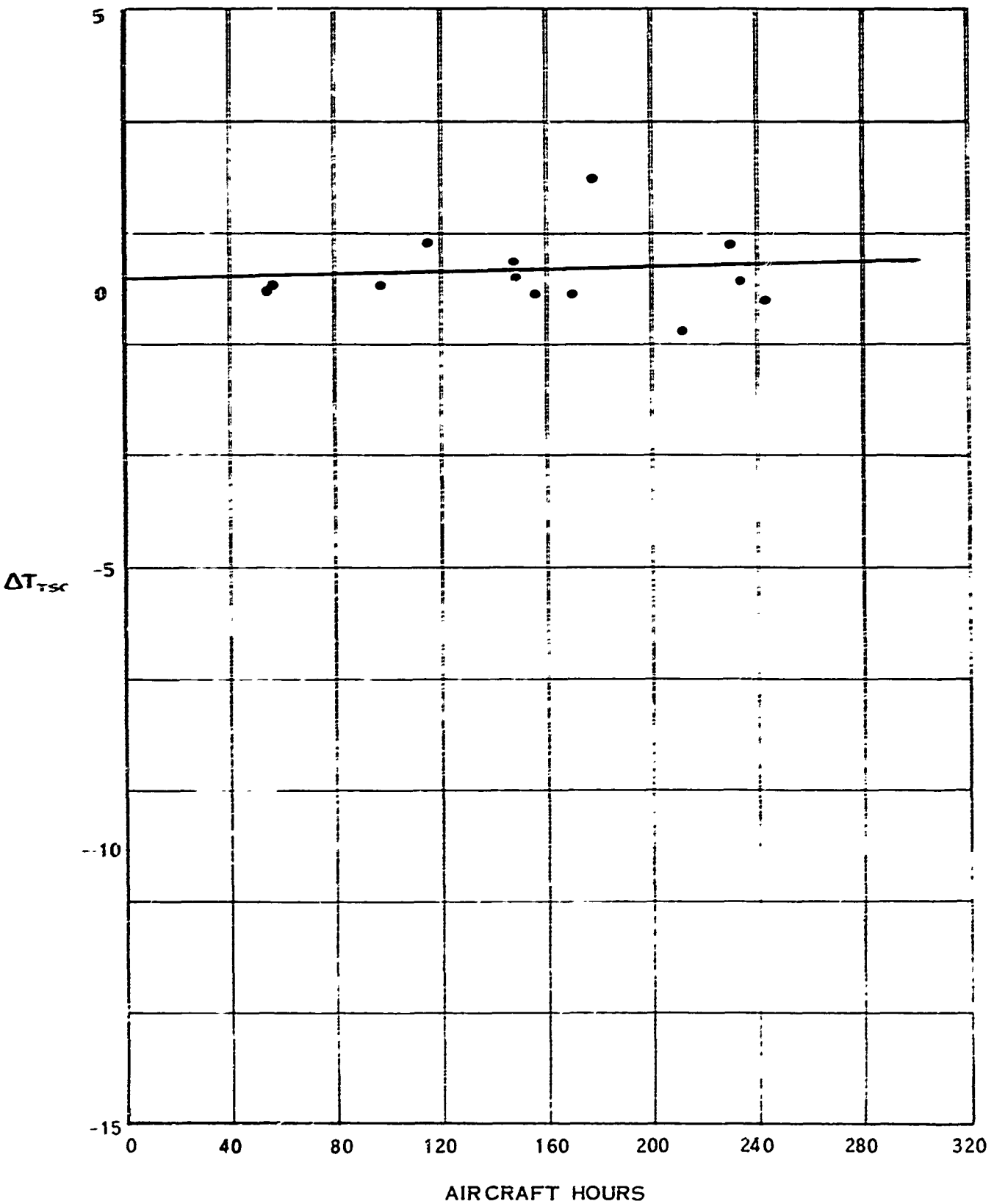


FIGURE 6-15 TREND OF GAS PRODUCER TURBINE AREA

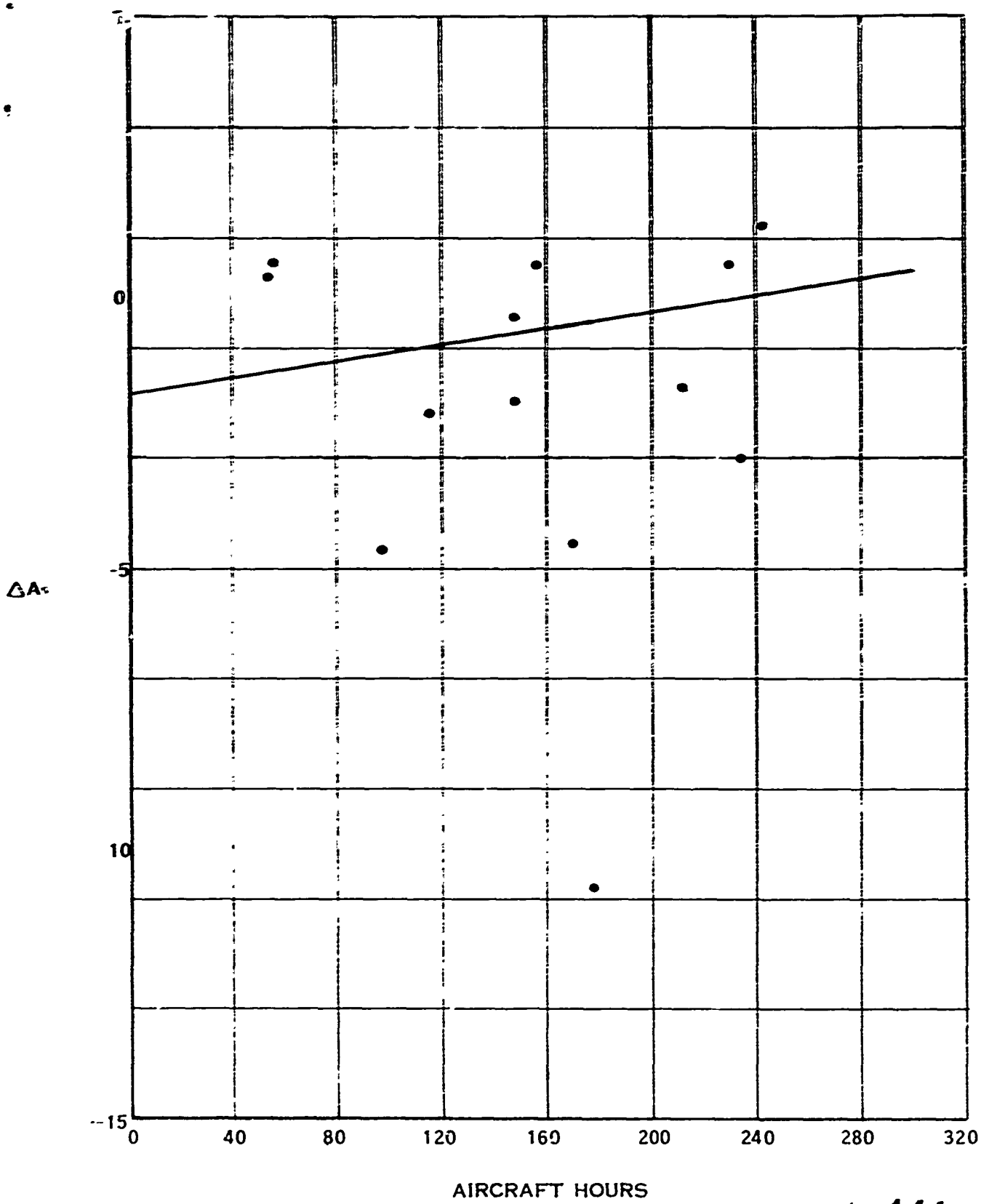


FIGURE 6-15 TREND OF GAS PRODUCER TURBINE EFFICIENCY

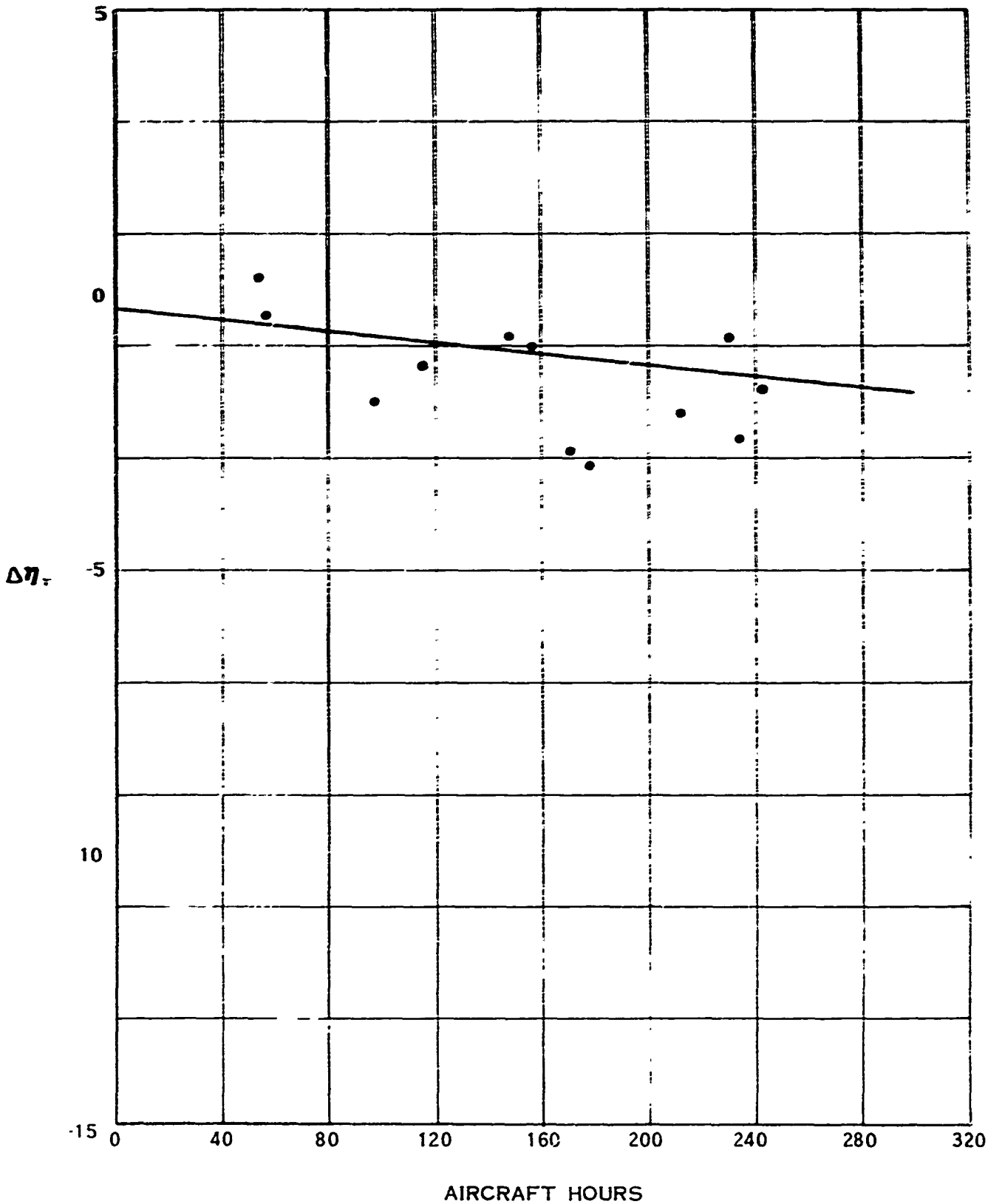


FIGURE 6-17 TREND OF POWER TURBINE AREA

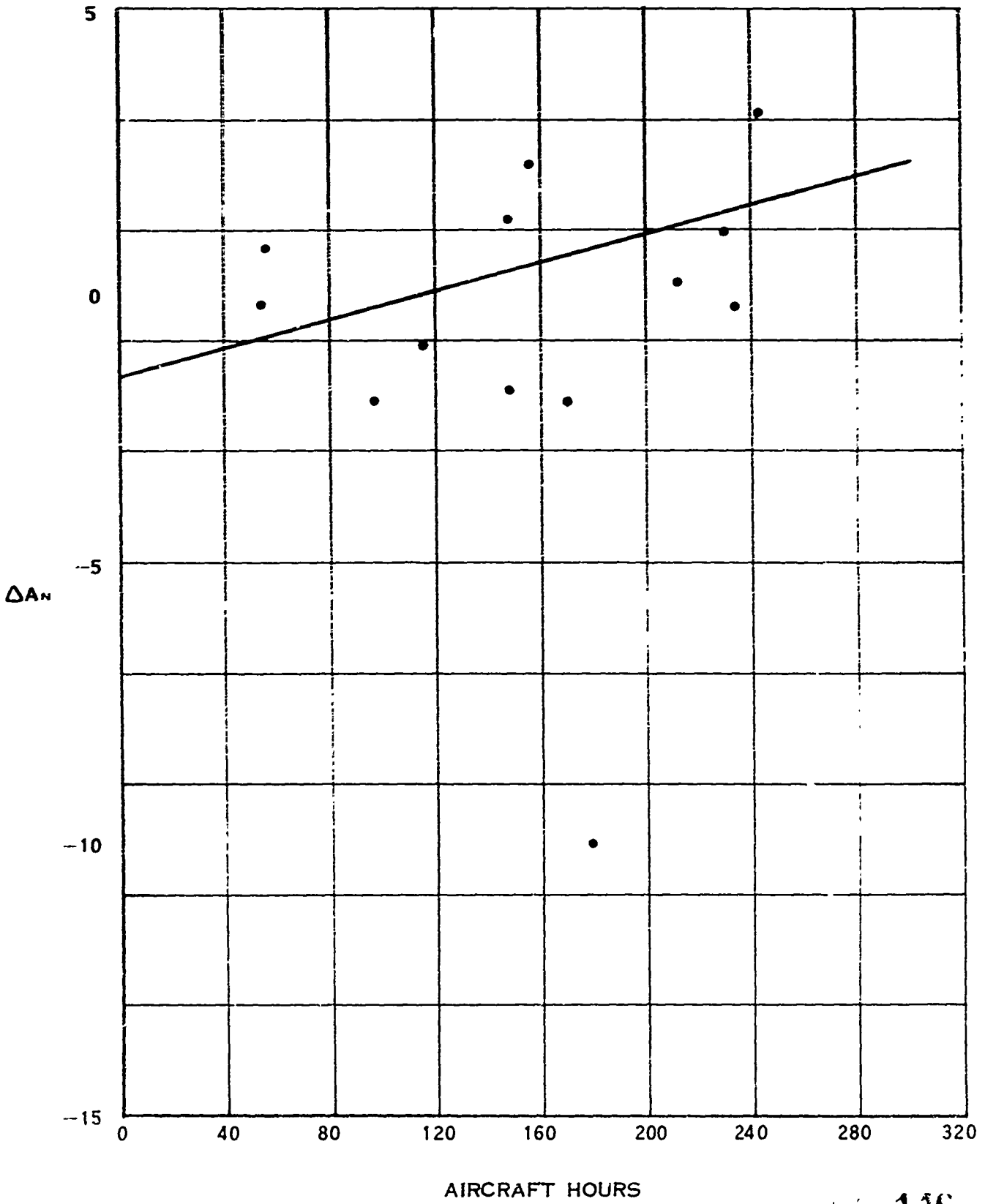


FIGURE 6-18 TREND OF START BATTERY VOLTAGE

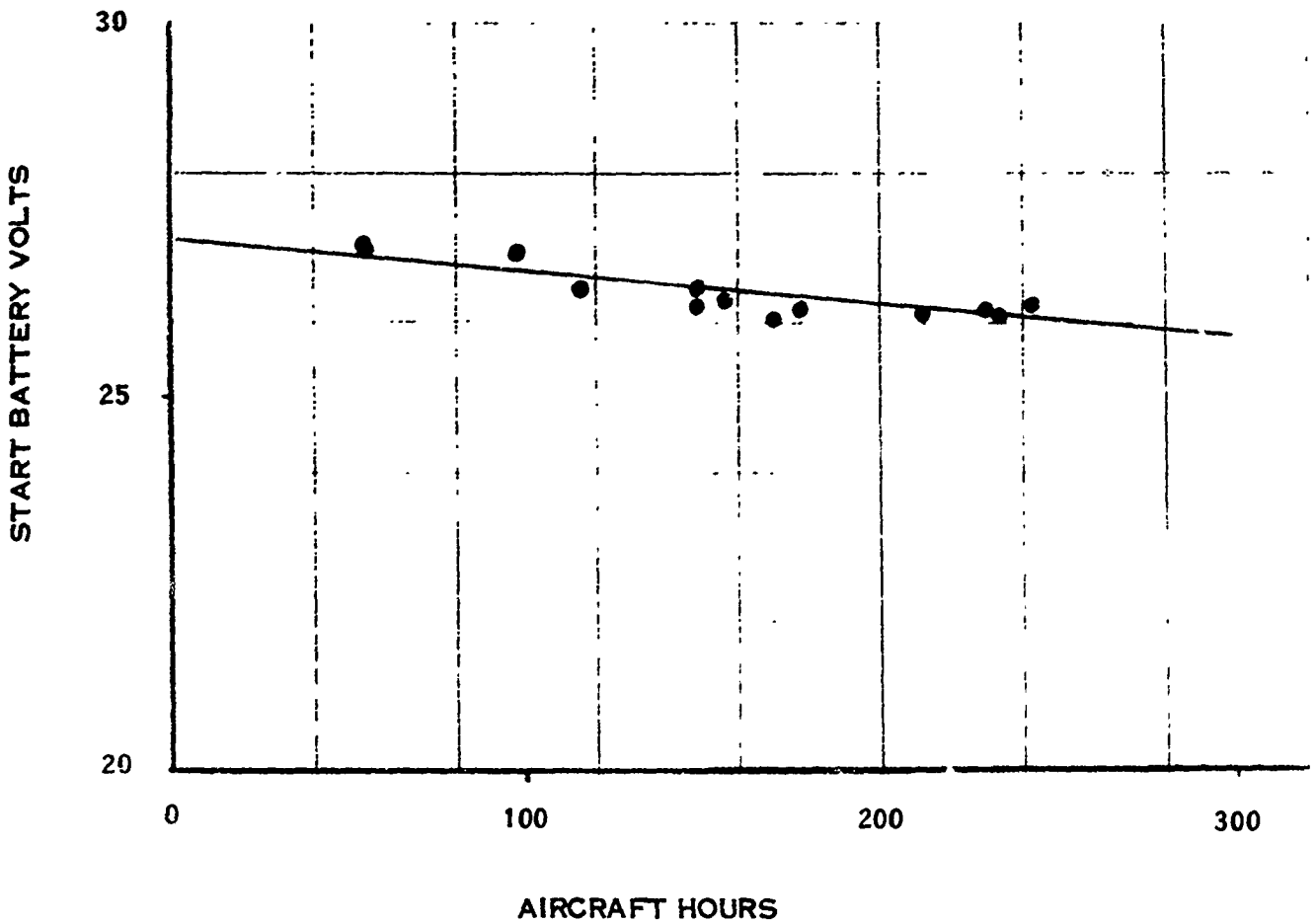


FIGURE 6–19 TREND OF AC ESSENTIAL BUS VOLTAGE

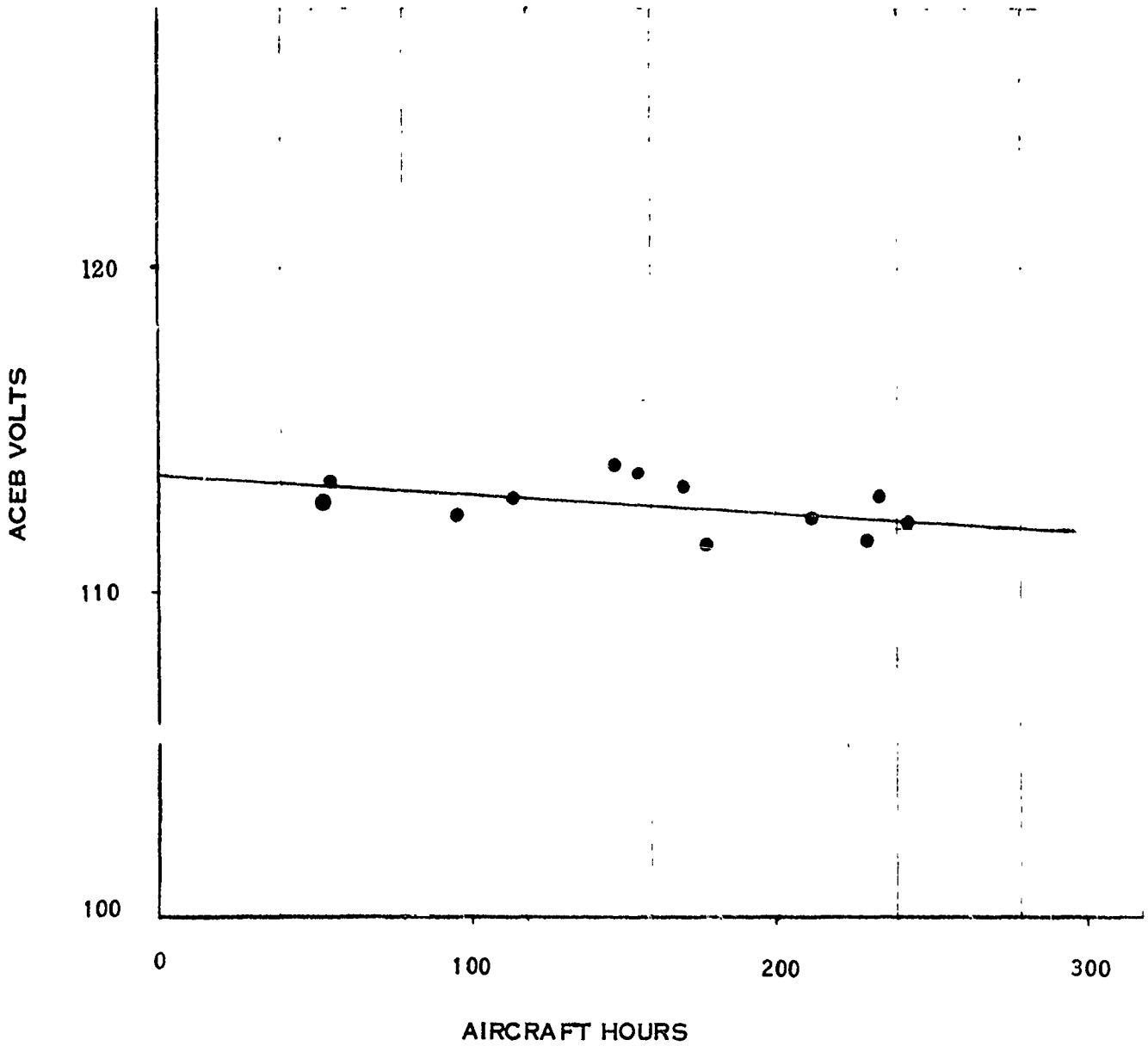


FIGURE 6–20 TREND OF AC INSTRUMENT BUS VOLTAGE

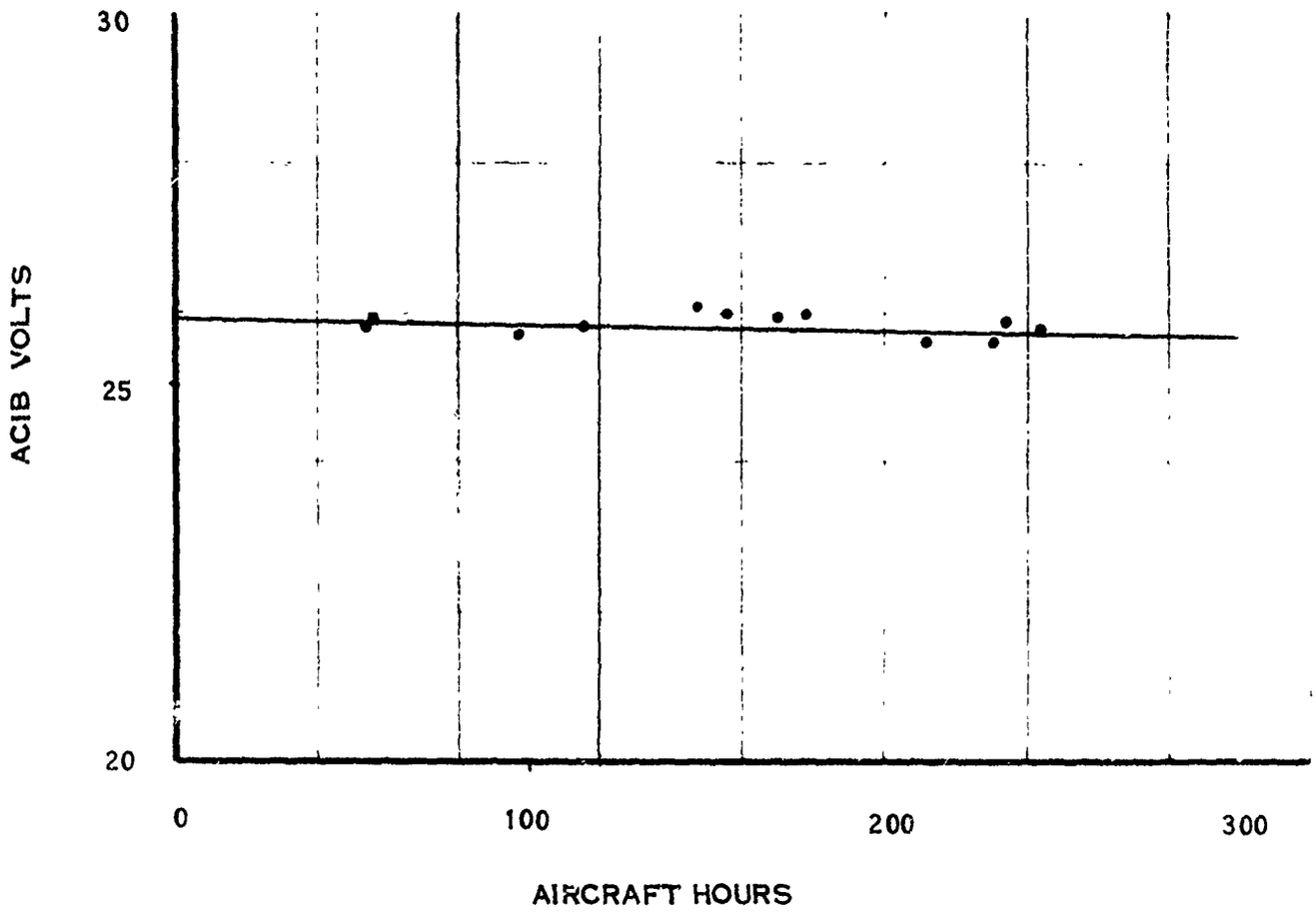


FIGURE 6–21 TREND OF DC ESSENTIAL BUS VOLTAGE

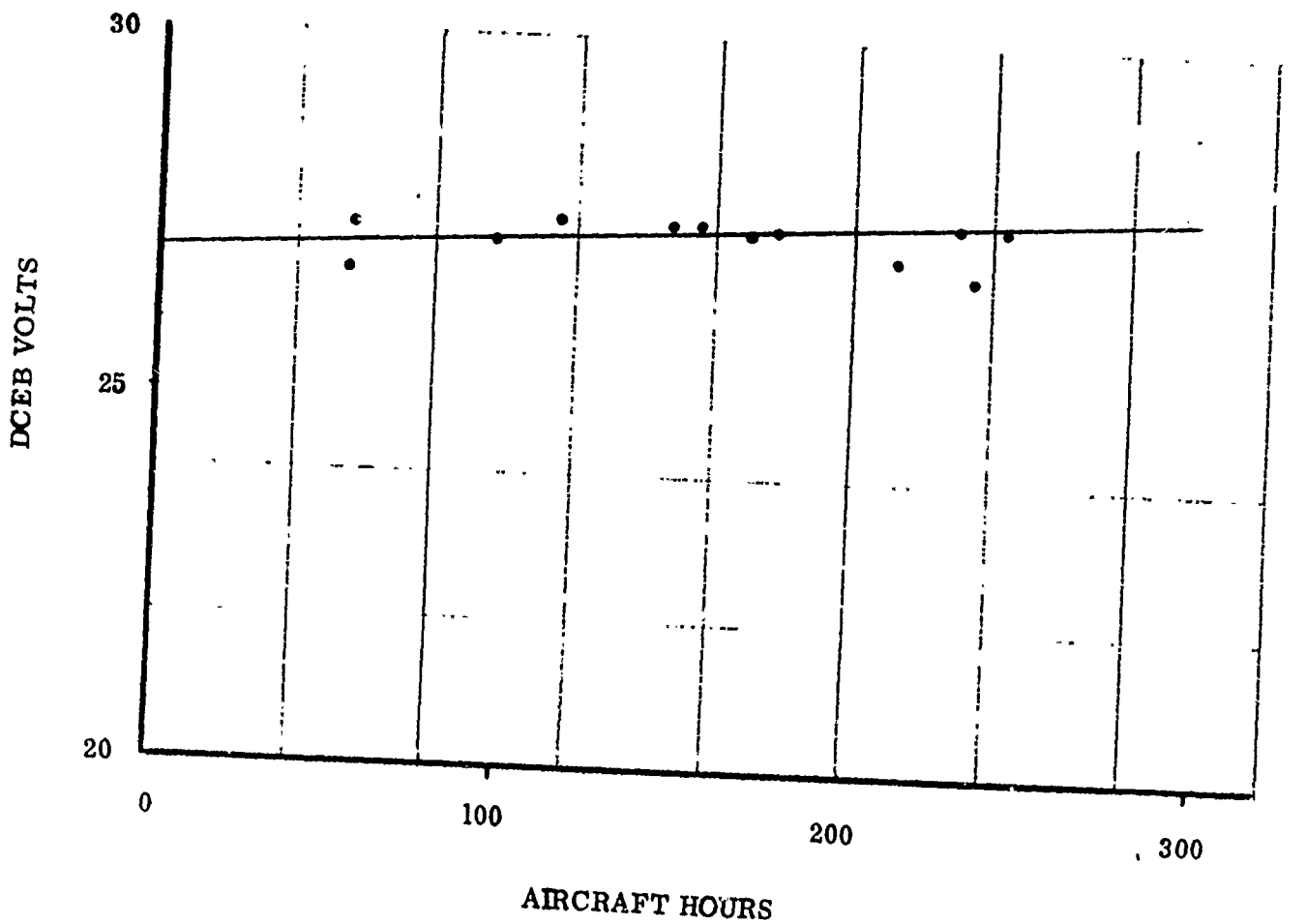


FIGURE 6–22 TREND OF HYDRAULIC PUMP LEAKAGE FLOW

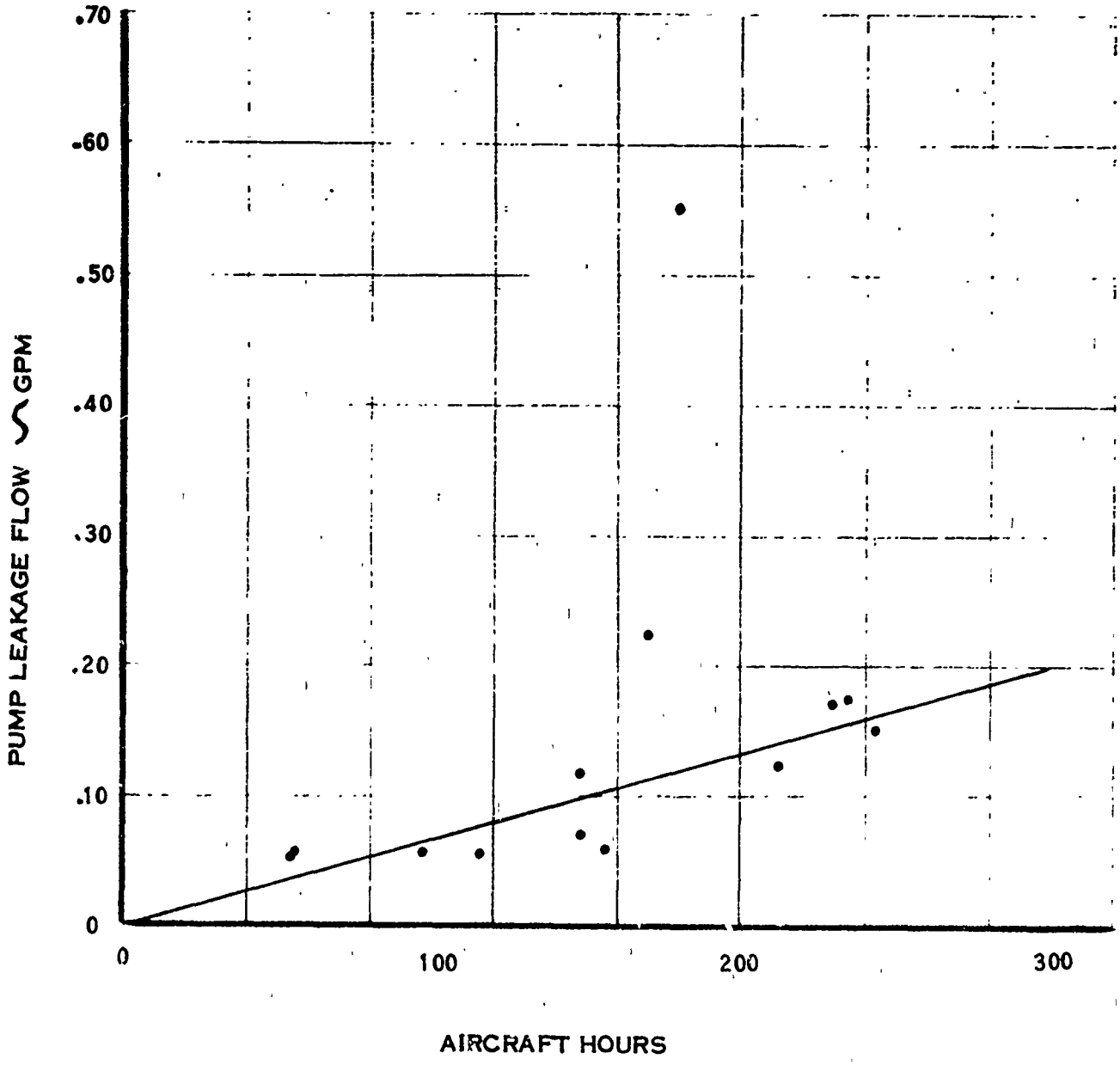


FIGURE 6–23 TREND OF HYDRAULIC PUMP TEMPERATURE RISE

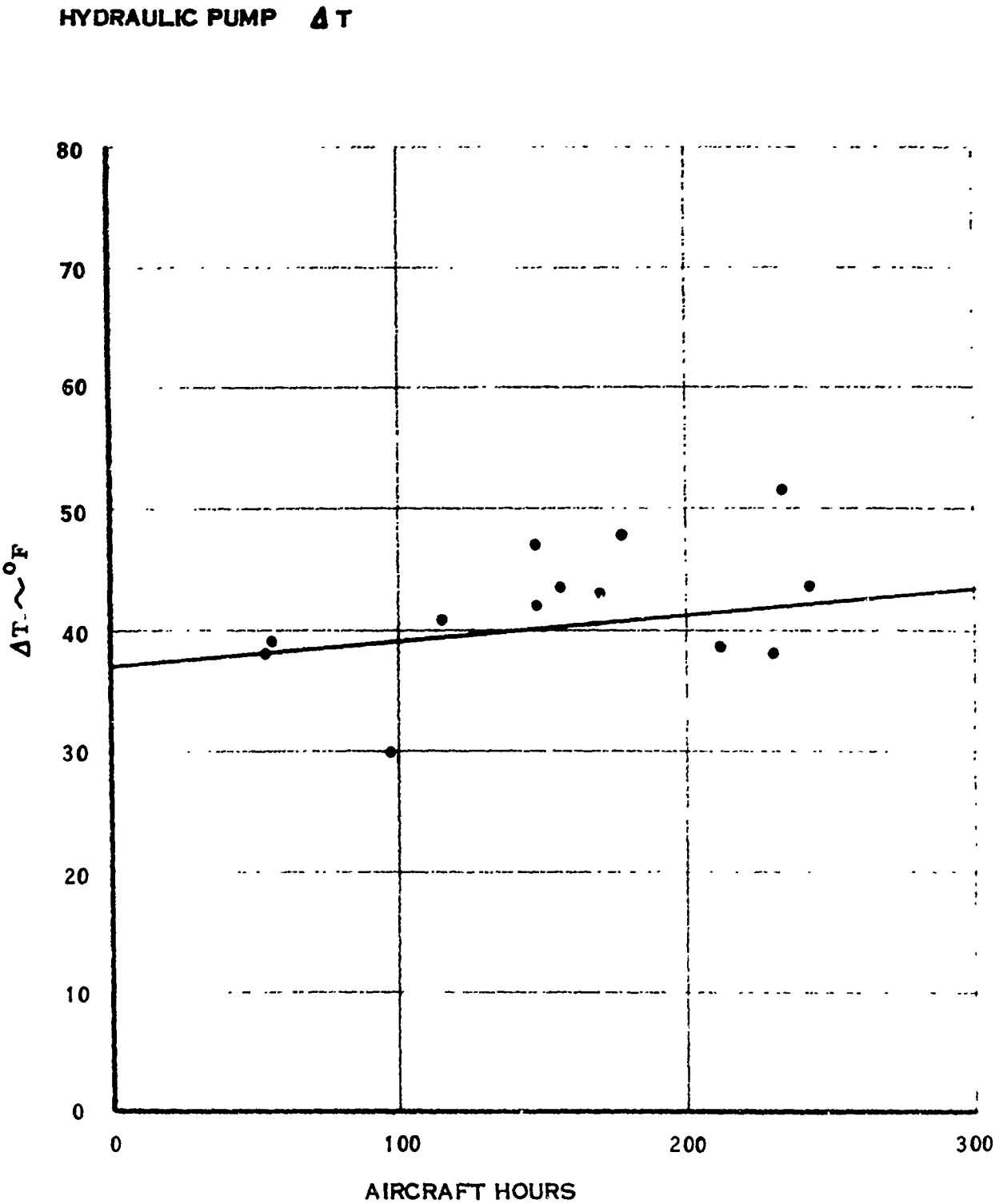


FIGURE 6-24 TREND OF HYDRAULIC SUPPLY PRESSURE

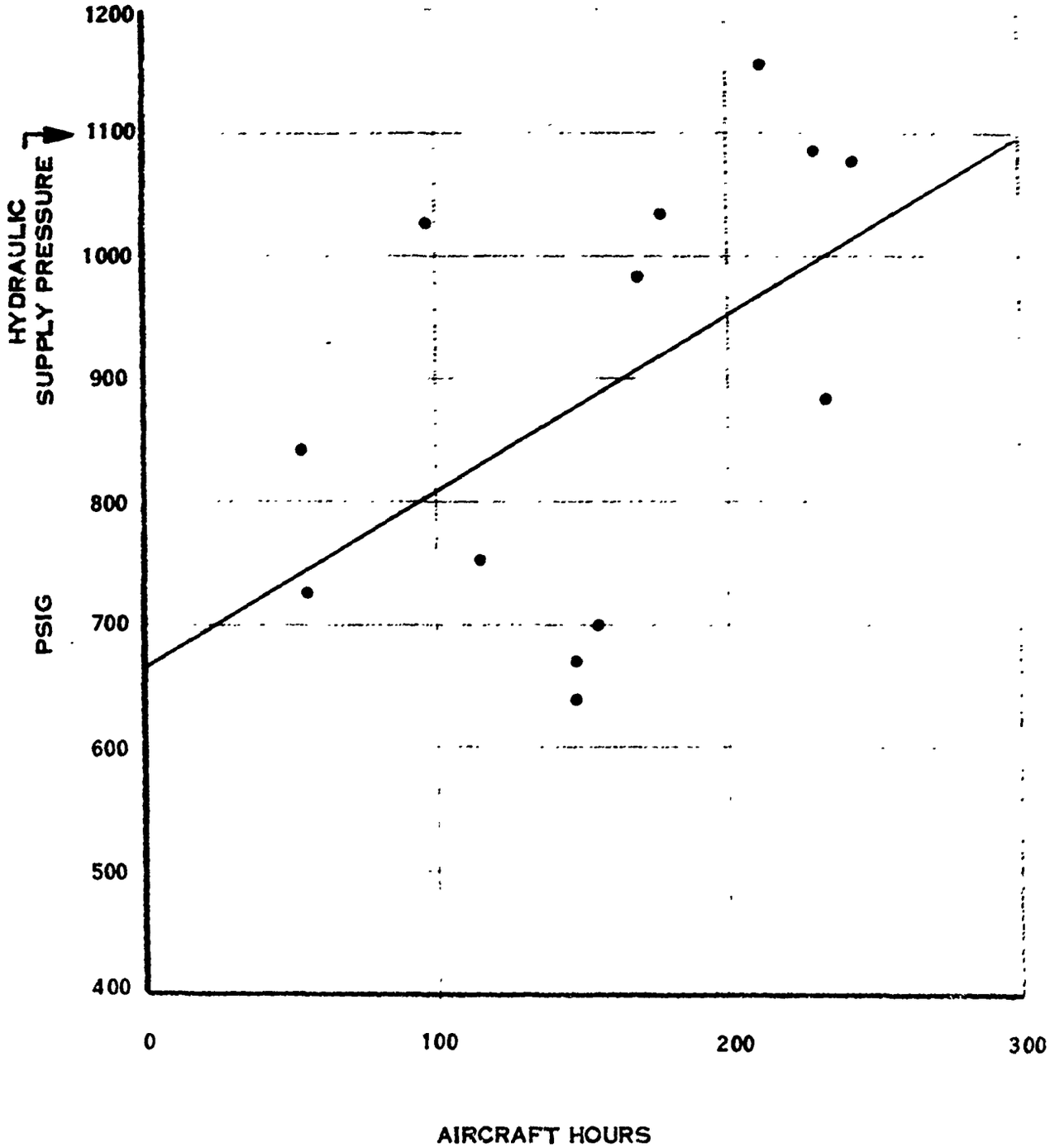


FIGURE 6–25 TREND OF FUEL PRESSURE

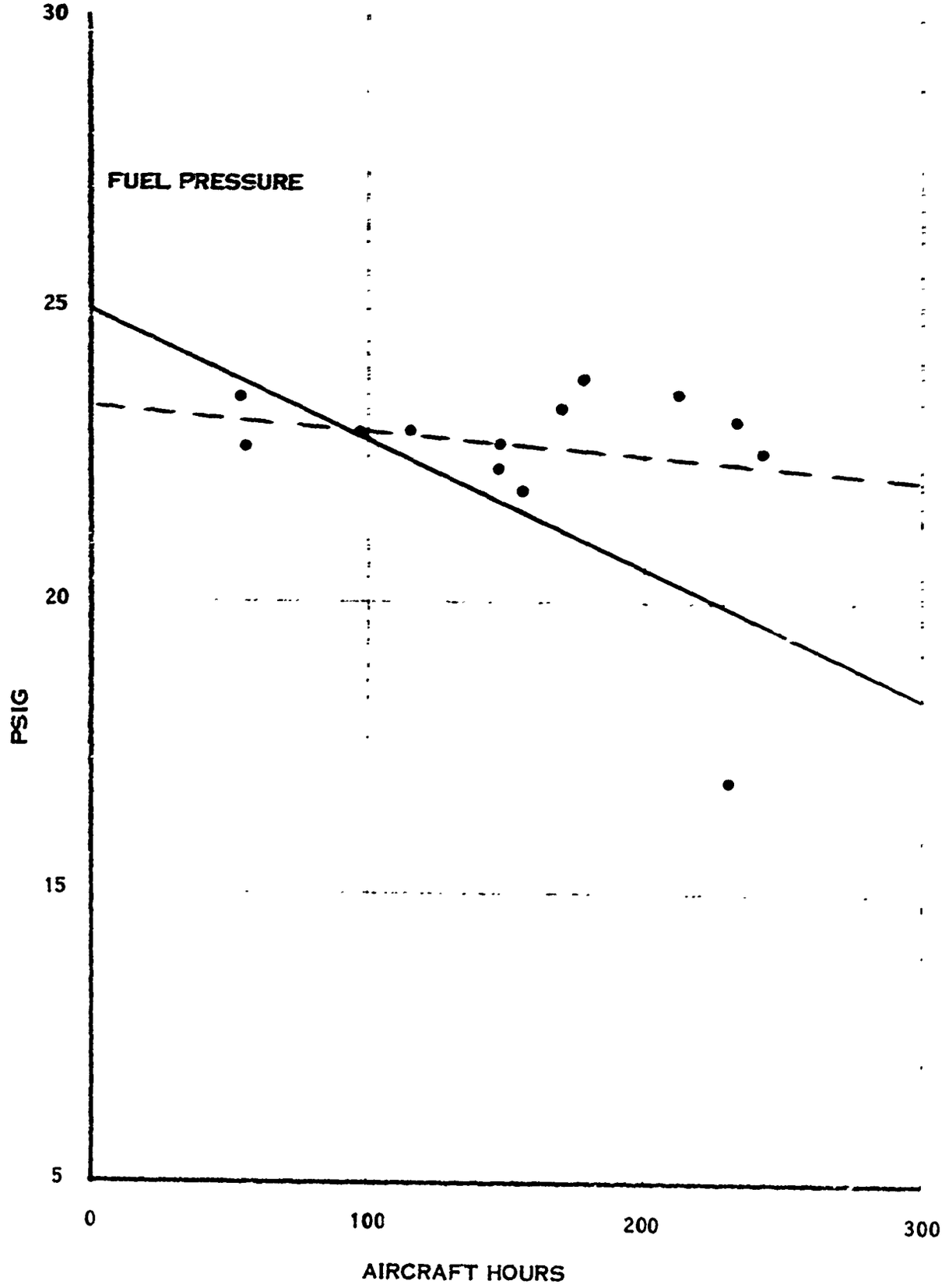


FIGURE 6-26 TREND OF TRANSMISSION OIL COOLER FLOW

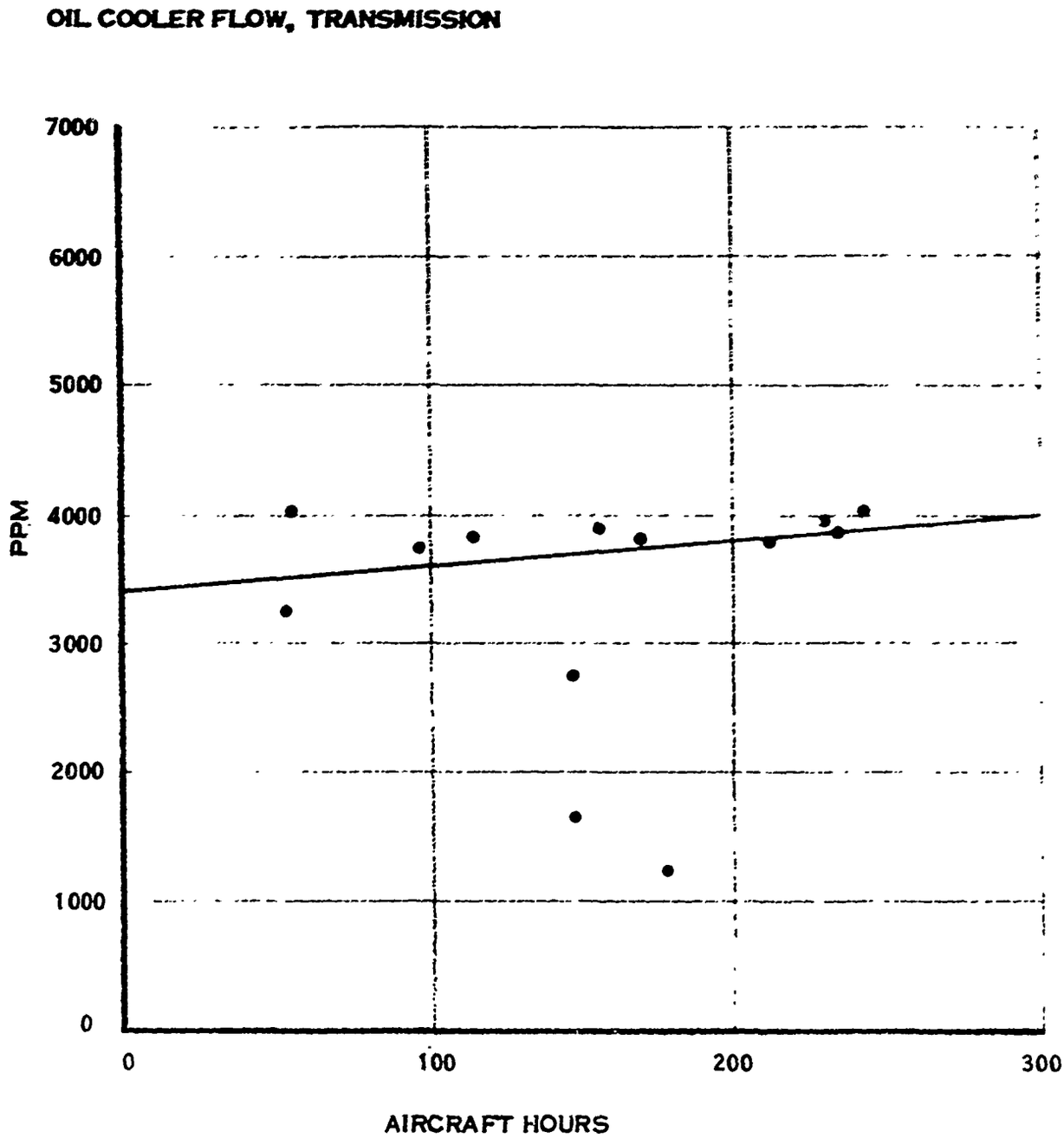


FIGURE 6-27 TREND OF TRANSMISSION OIL PRESSURE

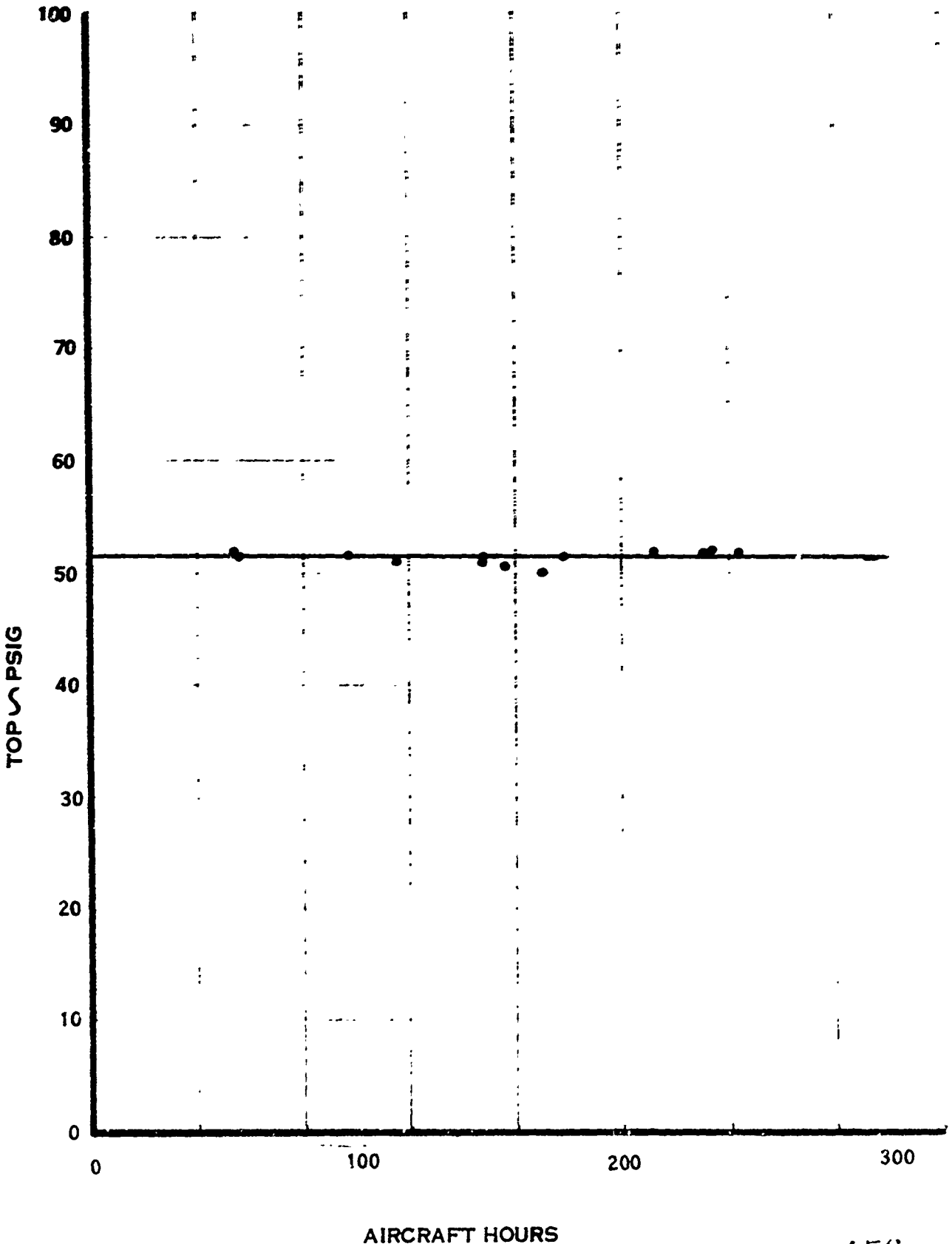


FIGURE 6-28 TREND OF ENGINE OIL PRESSURE

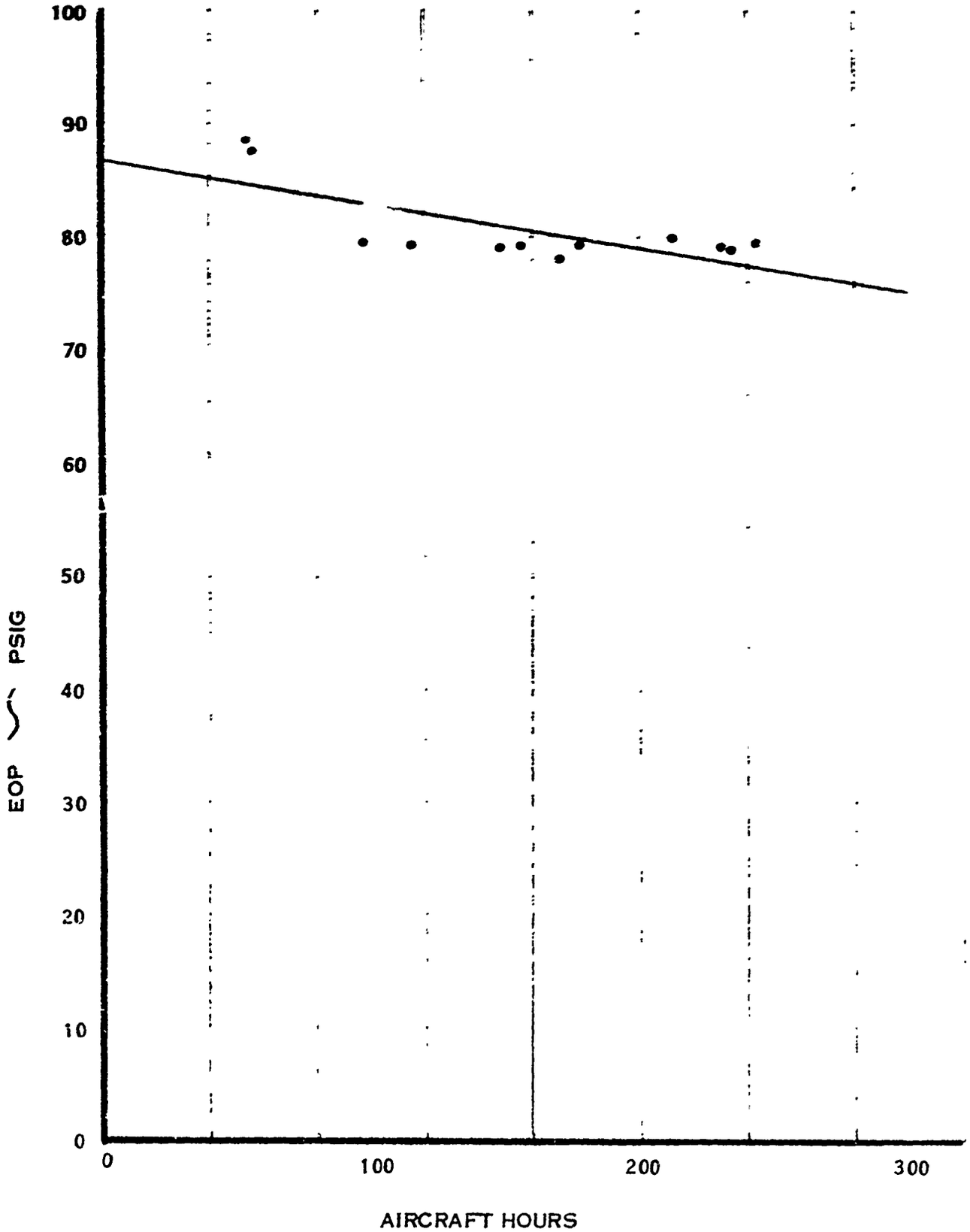


FIGURE 6-29 TREND OF BEARING 2 TEMPERATURE RISE

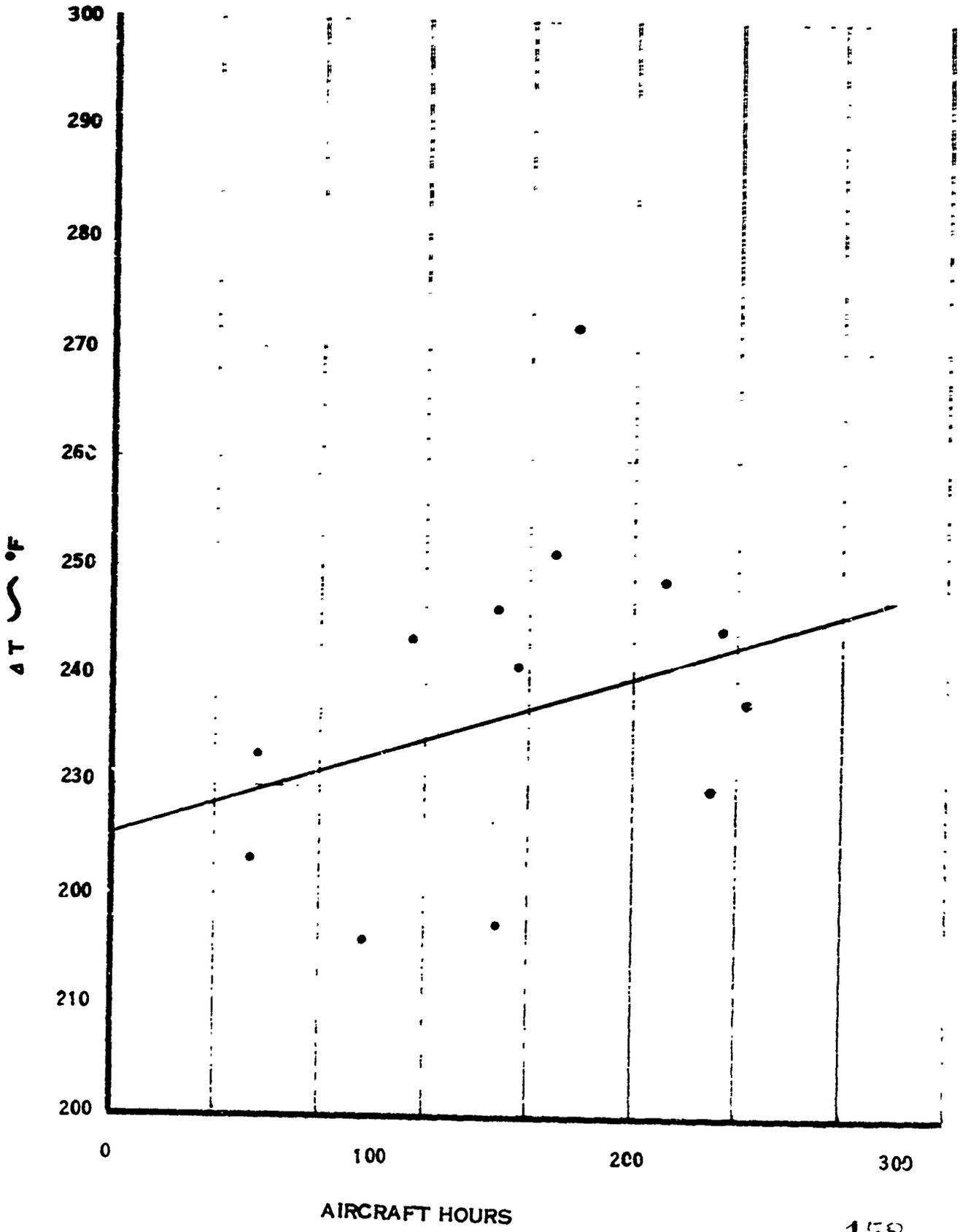


FIGURE 6-36 TREND OF BEARING 3 AND 4 TEMPERATURE RISE

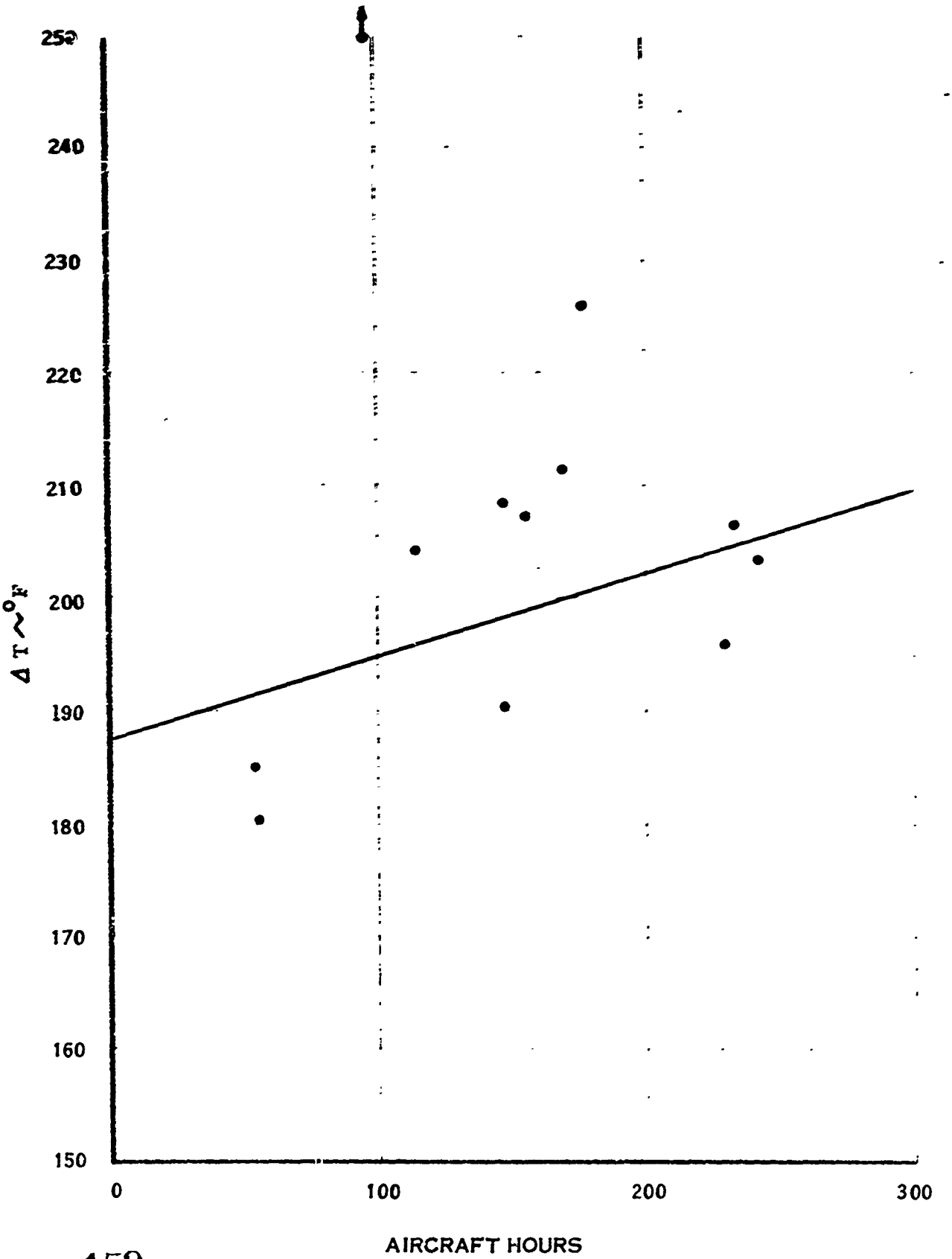


FIGURE 6-31 TREND OF 42° GEARBOX TEMPERATURE DIFFERENTIAL

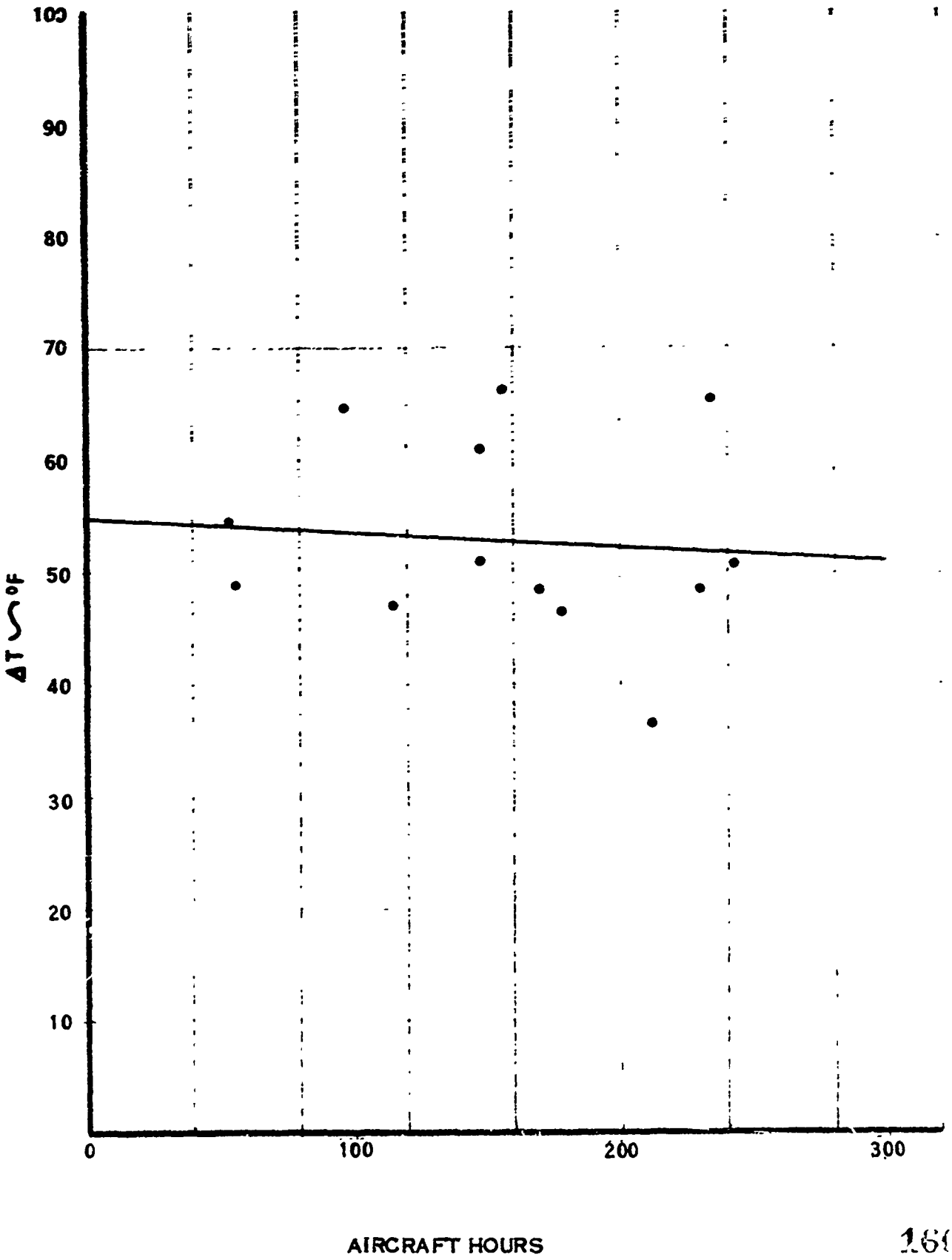
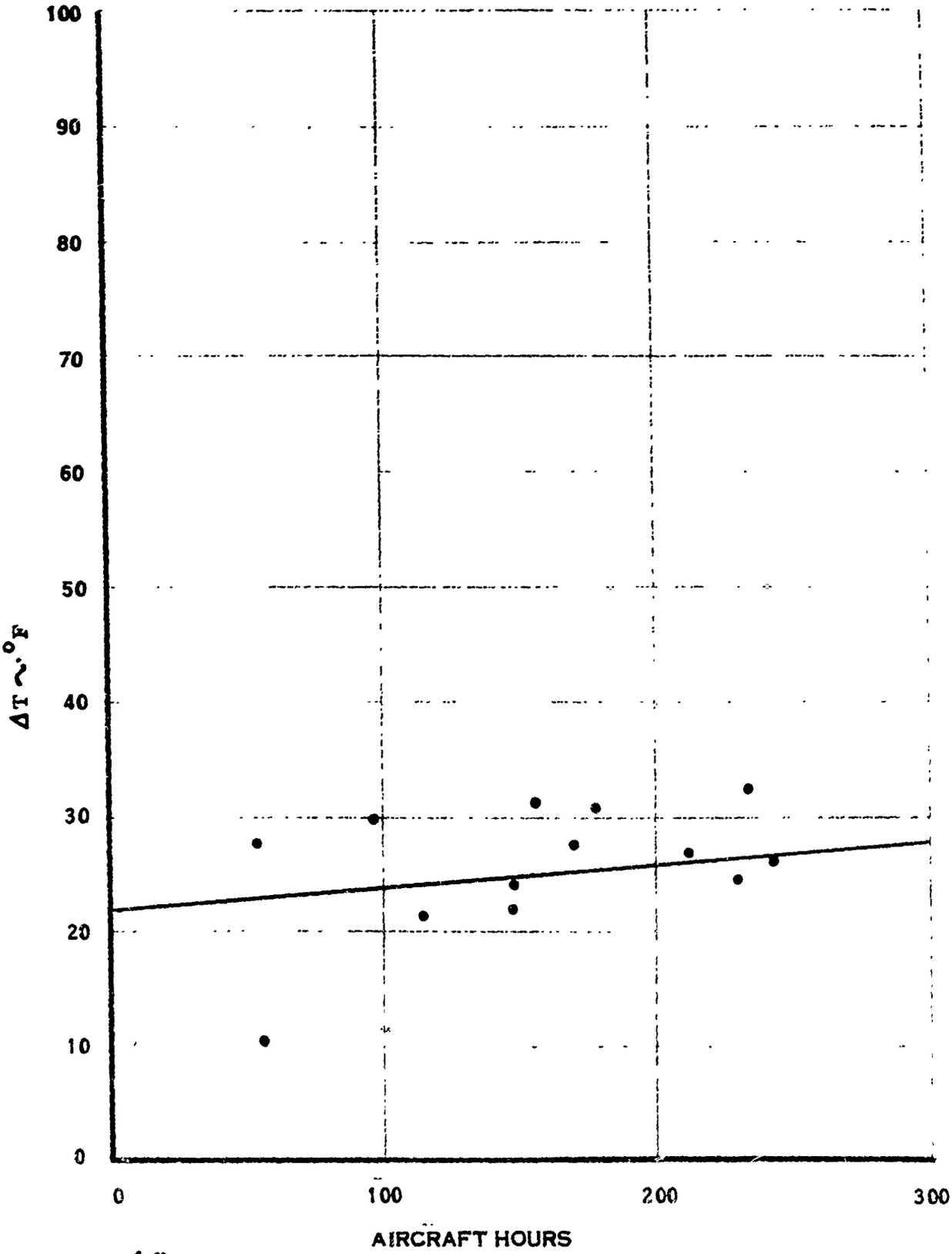


FIGURE 6–32 TREND OF 90° GEARBOX TEMPERATURE DIFFERENTIAL



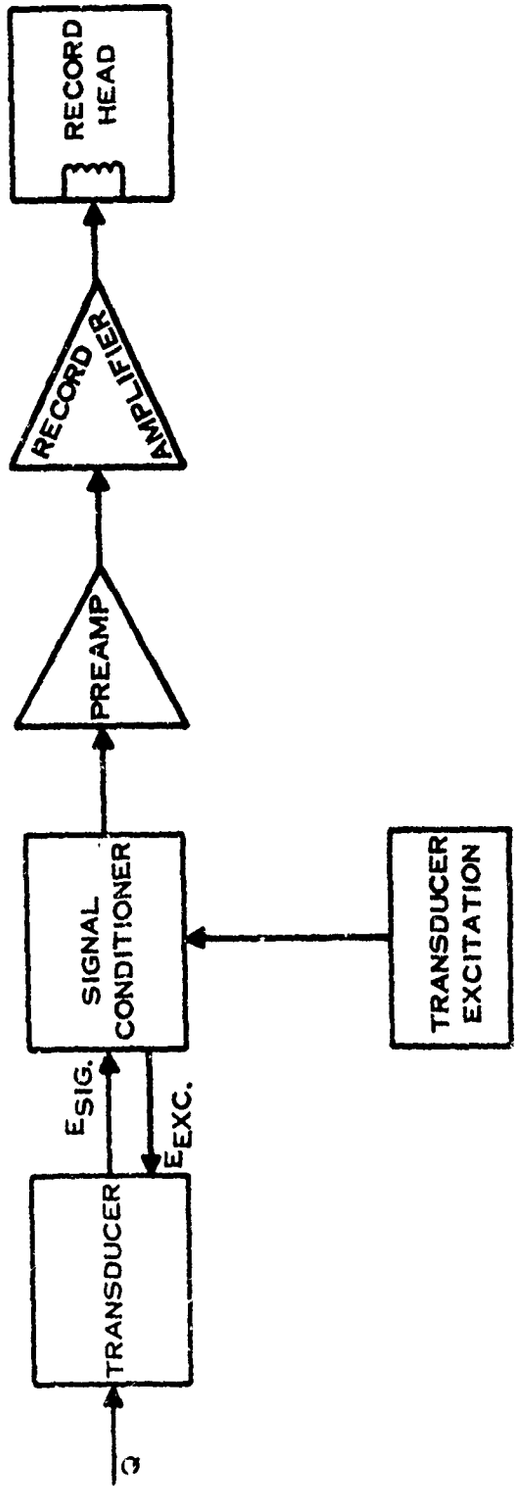


FIGURE 6-33 TAPE RECORD SYSTEM SIGNAL BLOCK DIAGRAM

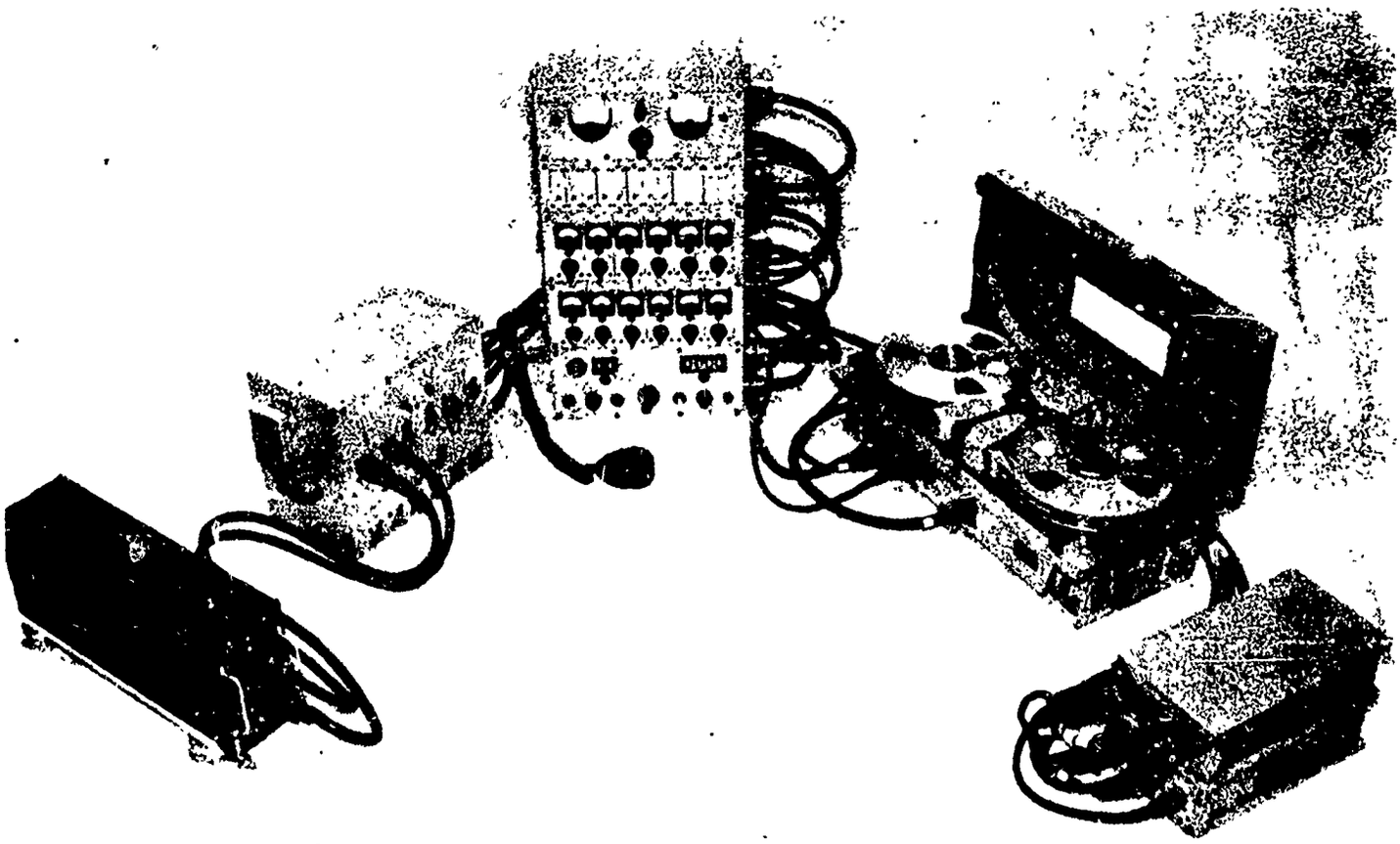


FIGURE 6–34 AR–200 TAPE RECORDING SYSTEM

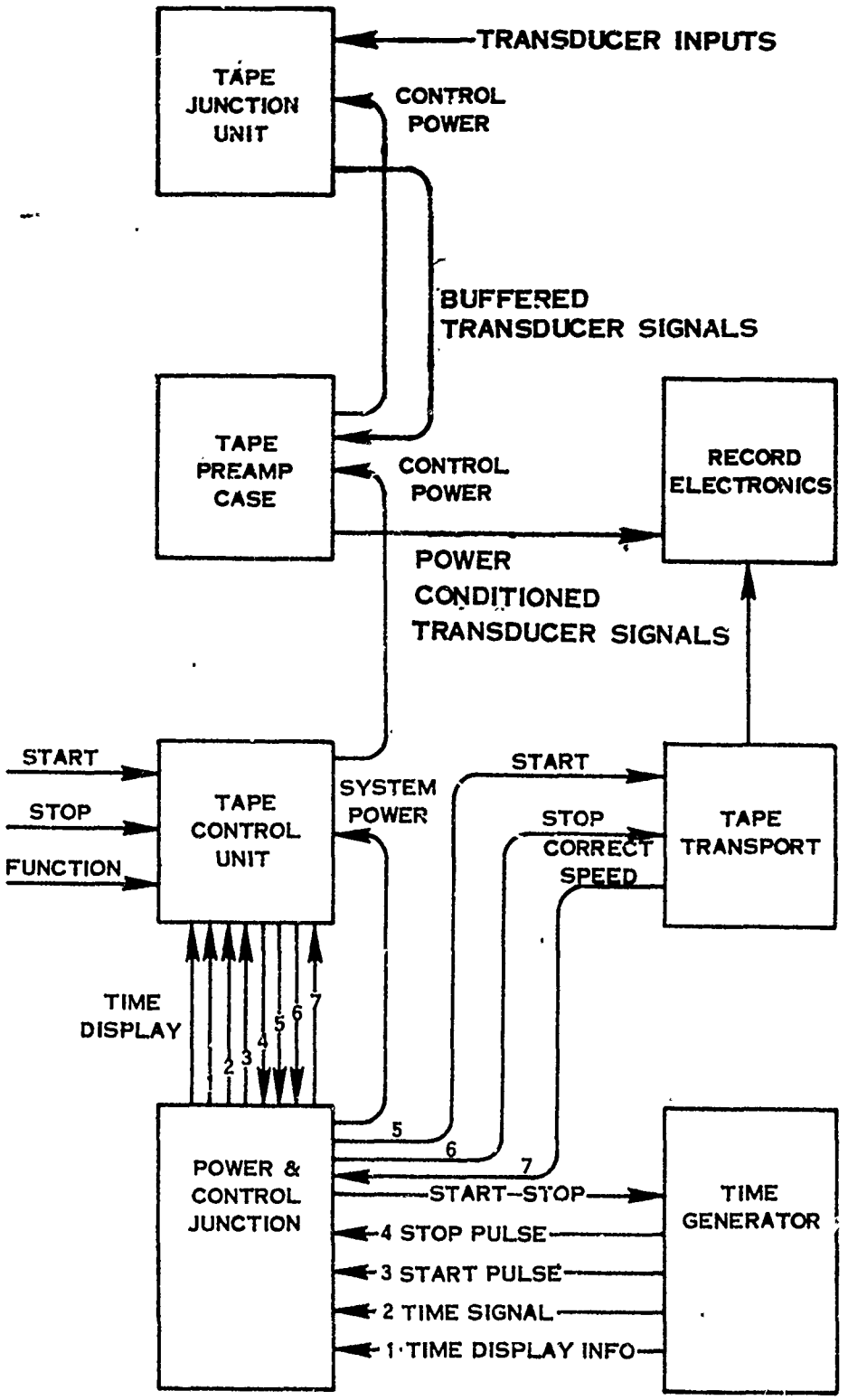


FIGURE 6-35 TAPE RECORD SYSTEM CONTROL BLOCK DIAGRAM – MODEL AR-200

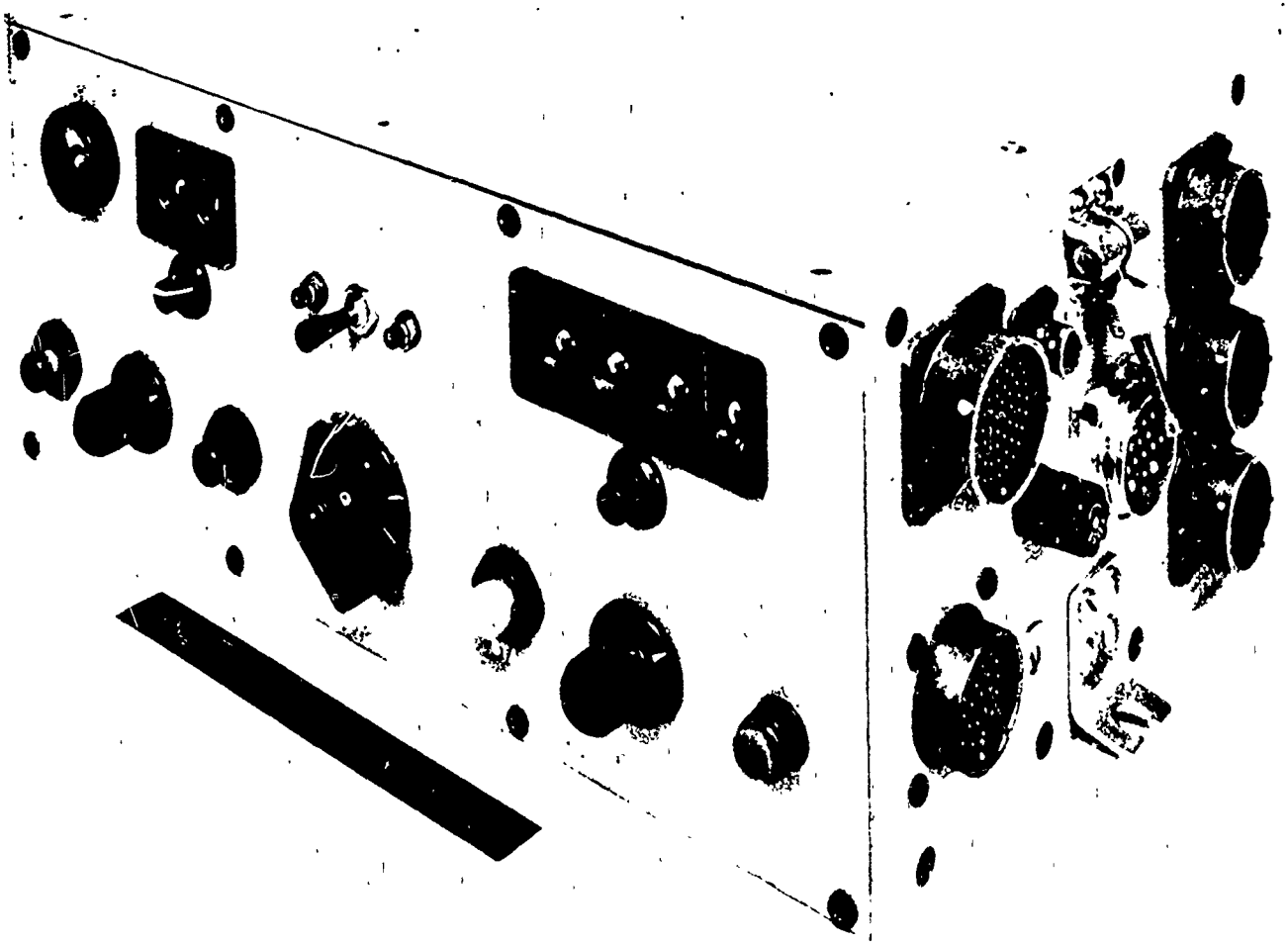


FIGURE 6-36 TAPE CONTROL UNIT

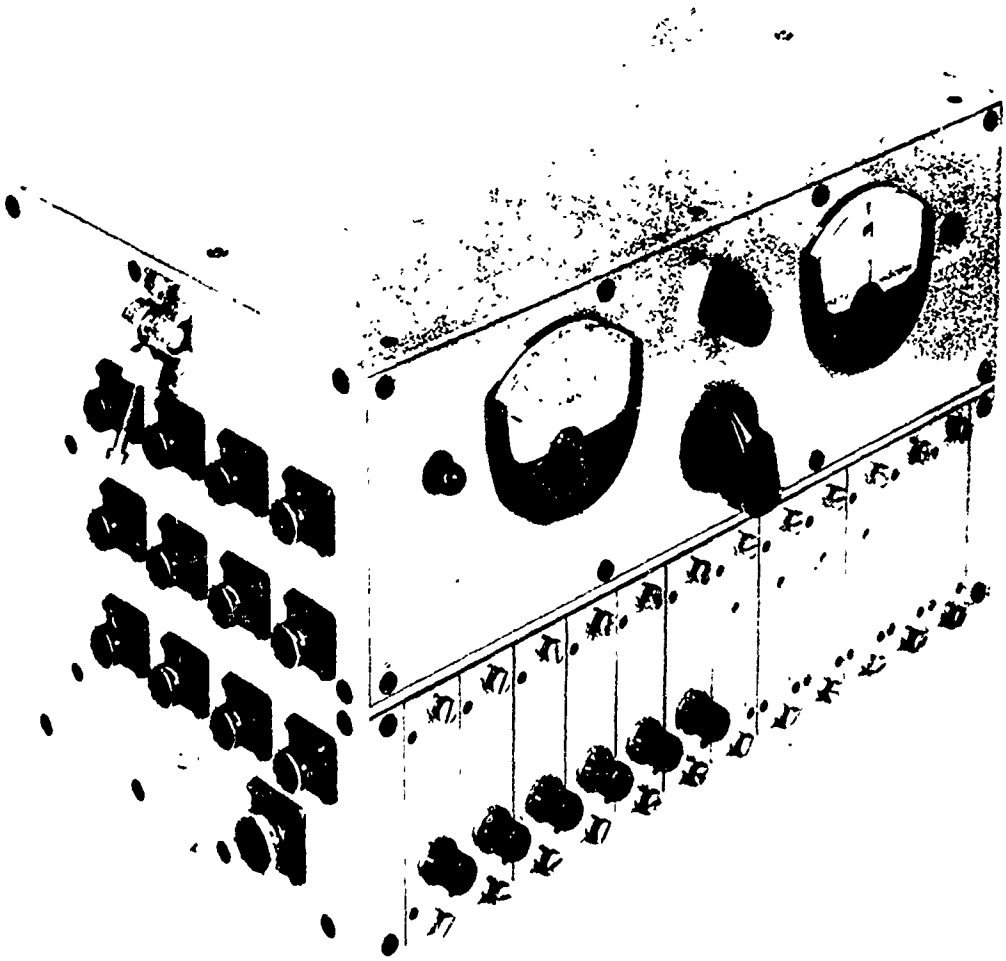


FIGURE 6-37 TAPE JUNCTION UNIT

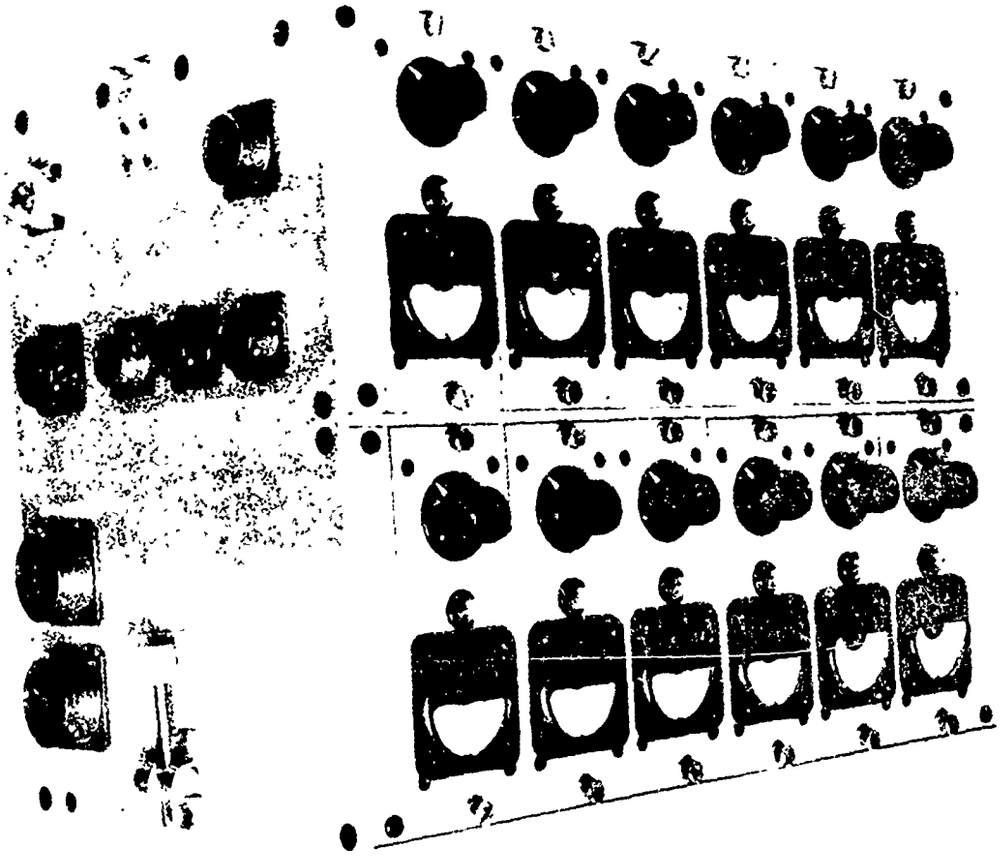


FIGURE 6-38 TAPE PREAMP CASE

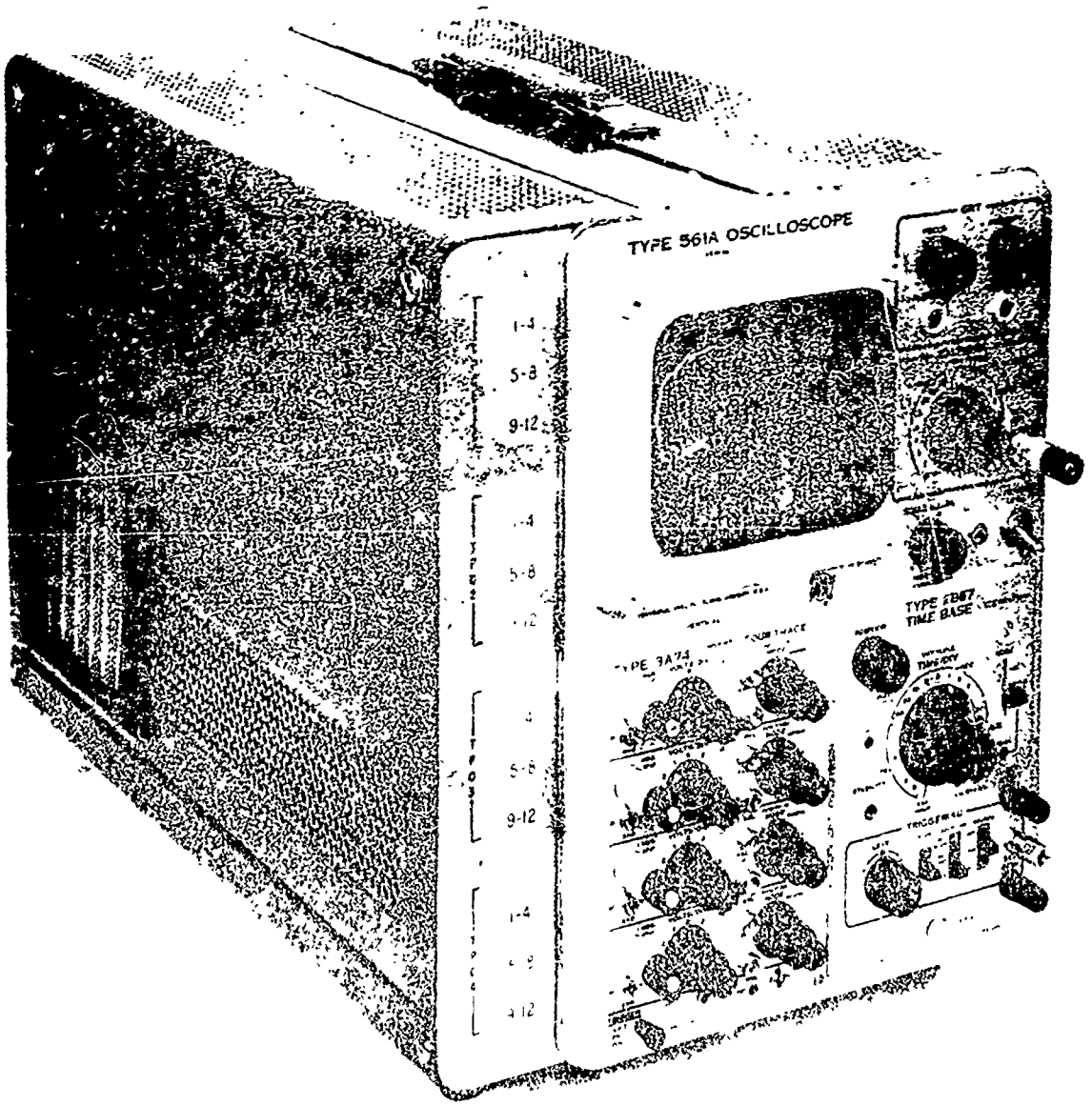


FIGURE [illegible] MONITOR SCOPE

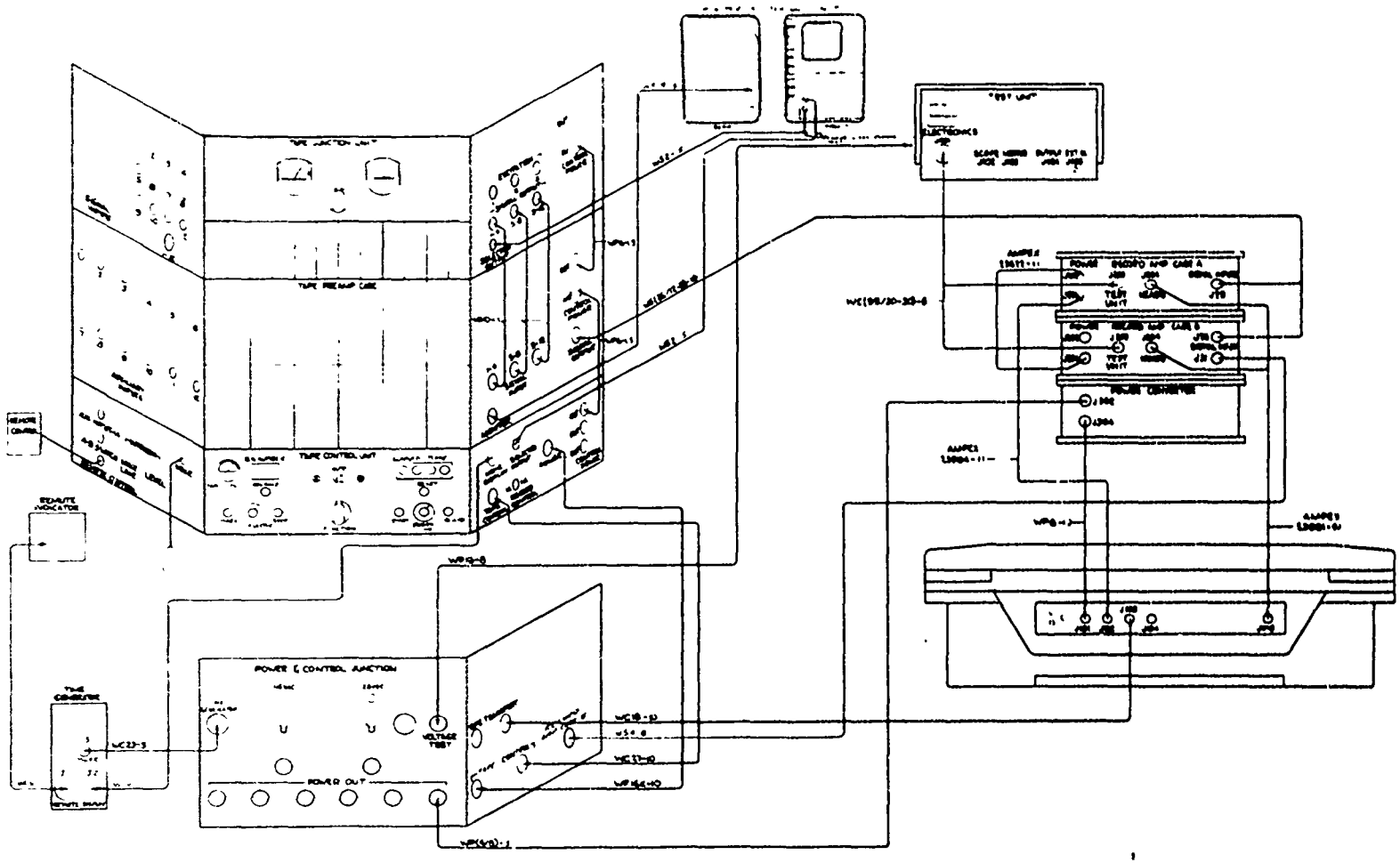


FIGURE 6-40 TAPE RECORD SYSTEM MODEL AR-200
CABLE INTERCONNECTIONS

FIGURE 6-40 TAPE RECORD SYSTEM MODEL AR-200
CABLE INTERCONNECTIONS

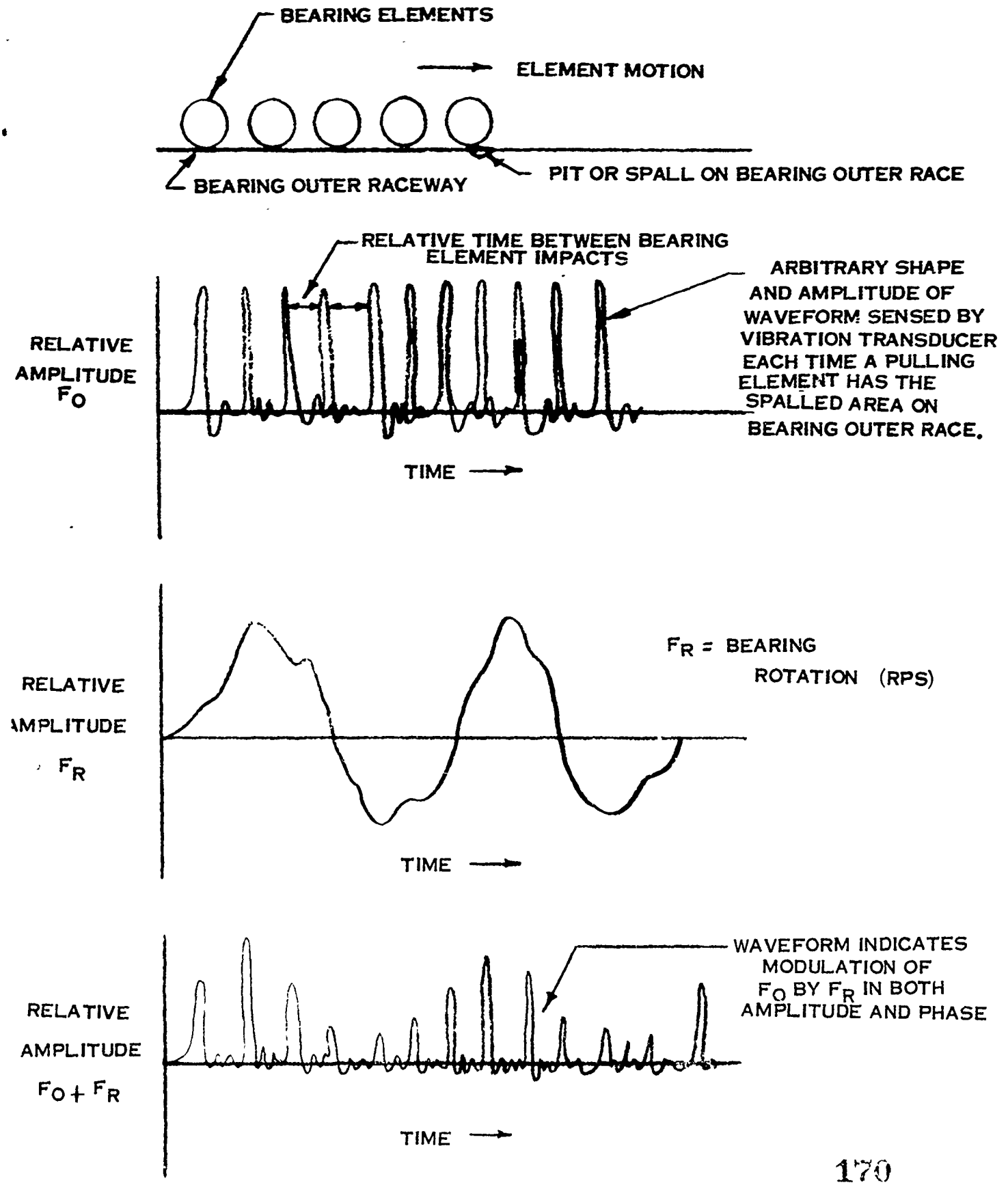


FIGURE 6–41 WAVEFORMS, BEARING PIT FREQUENCIES

42° Gearbox Gearmesh
±72 Hz. Sidebands

Band #	1st Harm.	Band#	2nd Harm.
85	1224	217	3168
90	1296	222	3240
94	1368	227	3312
99	1440	232	3384
104	1512	237	3456
109	1584	242	3528
114	1656	247	3600
119	1728	252	3672
124	1800	257	3744
129	1872	262	3816
134	1944	267	3888
139	2016	271	3960
144	2088	276	4032
149	2160	281	4104
153	2232	286	4176
158	2304	291	4248
163	2376	296	4320
168	2448	301	4392
173	2520	306	4464
178	2592	311	4536
183	2664	316	4608

0-5KC bands

90° Gearbox Gearmesh and Harmonics
±72 Hz Sidebands

Band #	1st Harm.	Band #	2nd Harm.	Band #	3rd Harm.	Band #	4th Harm.
26	360	99	1440	173	2520	247	3600
30	432	104	1512	178	2592	252	3672
35	504	109	1584	183	2664	257	3744
40	576	114	1656	188	2736	262	3816
45	648	119	1728	193	2808	267	3888
50	720	124	1800	198	2880	271	3960
55	792	129	1872	203	2952	276	4032
60	864	134	1944	207	3024	281	4104
65	936	139	2016	212	3096	286	4176
70	1008	144	2088	217	3168	291	4348
75	1080	149	2160	222	3240	296	4320
80	1152	153	2232	227	3312	301	4392
85	1224	158	2304	232	3384	306	4464
89	1296	163	2376	237	3456	311	4536
94	1368	168	2448	242	3528	316	4600
99	1440	173	2520	247	3600	321	4680
104	1512	178	2592	252	3672	325	4752
109	1584	183	2664	257	3744	330	4824
114	1656	188	2736	262	3816	335	4896
119	1728	193	2808	267	3888	340	4968
124	1800	198	2880	271	3960	- -	5040

±28 Hz Sidebands

56	800	129	1880	203	2960	277	4040
58	828	131	1908	205	2988	279	4068
60	856	133	1936	207	3016	281	4096
62	884	135	1964	209	3044	283	4124
63	912	137	1992	211	3072	285	4152
65	940	139	2020	213	3100	286	4180
67	968	141	2048	215	3128	288	4208
69	996	143	2076	217	3156	290	4236
71	1024	145	2104	219	3184	292	4264
73	1052	147	2132	220	3212	294	4292
75	1080	149	2160	222	3240	296	4320
77	1108	151	2188	224	3268	298	4348
78	1136	152	2216	226	3296	300	4376
80	1164	154	2244	228	3324	302	4404
82	1192	156	2272	230	3352	304	4432
84	1220	158	2300	232	3380	306	4460
86	1248	160	2328	234	3408	307	4488
88	1276	162	2356	236	3436	309	4516
90	1304	164	2384	238	3464	311	4544
92	1332	166	2412	239	3492	313	4572
94	1360	168	2440	241	3520	315	4600

0-5KC Bands

FIGURE 6-42

Accessory Drive Gearmesh

±51 Hertz Sidebands

Band #	1st	Band #	2nd
159	2317	--	5144
163	2368		--
166	2419		--
170	2470		--
173	2521		--
177	2572		--
180	2623		--
184	2674		--
187	2725		--
191	2776		--
194	2827		5654
197	2878		--
201	2929		--
204	2980		--
208	3031		--
211	3082		
215	3133		--
218	3184		--
222	3235		--
225	3286		--
229	3337		6164

±69 Hertz Sidebands

Band #	1st	Band #	2nd
147	2137	340	4964
152	2206	--	--
156	2275		--
161	2344		--
166	2413		--
170	2482		--
175	2551		--
180	2620		--
185	2689		--
189	2758		--
194	2827		5654
199	2896		--
203	2965		--
208	3034		--
213	3103		--
218	3172		--
222	3241		--
227	3310		--
232	3379		--
236	2448		--
241	2517		6344

Input Quill Gearmesh

±51 Hertz Sidebands

Band #	1st	Band	2nd
184	2680	--	5870
187	2731		--
191	2782		--
194	2833		--
198	2884		--
201	2935		--
205	2986		--
208	3037		--
212	3088		--
215	3139		--
219	3190		6380
222	3241		--
226	3292		--
229	3343		--
233	3394		--
236	3445		--
240	3496		--
243	3547		--
247	3598		--
250	3649		--
254	3700		6890

±110 Hertz Sidebands

Band #	1st	Band	2nd
144	2090	--	5280
151	2200		5390
159	2310		5500
166	2420		5610
174	2530		5720
181	2640		5830
189	2750		5940
196	2860		6050
204	2970		6160
211	3080		6270
219	3190		6380
226	3300		--
234	3410		--
241	3520		--
249	3630		--
256	3740		--
264	3850		--
271	3960		--
279	4070		--
286	4180		--
294	4290		--

Tail Rotor Gearmesh

±69 Hertz Sidebands

Band #	1st	Band	2nd
82	1182	209	3054
86	1251	214	3123
91	1320	219	3192
96	1389	224	3261
101	1458	228	3330
105	1527	233	3399
110	1596	238	3468
115	1665	243	3537
119	1734	247	3606
124	1803	252	3675
129	1872	257	3744
134	1941	261	3813
138	2010	266	3882
143	2079	271	3951
148	2148	275	4020
152	2217	280	4089
157	2286	285	4158
162	2355	290	4227
166	2424	294	4296
171	2493	299	4365
176	2562	304	4434

±72 Hertz Sidebands

Band #	1st	Band	2nd
80	1152	207	3024
85	1224	212	3096
90	1296	217	3168
94	1368	222	3240
99	1440	227	3312
104	1512	232	3384
109	1584	237	3456
114	1656	242	3528
119	1728	247	3600
124	1800	252	3672
129	1872	257	3744
134	1944	261	3816
139	2016	266	3888
144	2088	271	3960
148	2160	276	4032
153	2232	281	4104
158	2304	286	4176
163	2376	291	4248
168	2448	296	4320
173	2520	301	4392
178	2592	306	4464

FIGURE 6–43A

Upper Planetaries and Harmonics

±5 Hertz Sidebands

Band #	1st Harm.	Band #	2nd Harm.	Band #	3rd	Band #	4th	Band #	5th	Band #	6th	Band #	7th
41	[illegible]	[illegible]	1232	129	[illegible]	[illegible]	[illegible]	217	3155	[illegible]	[illegible]	304	4437
[illegible]	[illegible]	86	1237	129	1876	[illegible]	[illegible]	217	[illegible]	261	3501	304	4442
[illegible]	01	86	1242	130	1883	[illegible]	2514	217	3165	261	[illegible]	305	4447
[illegible]	[illegible]	[illegible]	1247	130	1888	[illegible]	[illegible]	217	3170	[illegible]	3611	305	4452
43	·11	86	1252	130	1893	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	305	[illegible]
43	·1	[illegible]	1257	131	[illegible]	[illegible]	[illegible]	[illegible]	31[illegible]0	[illegible]	3521	306	[illegible]
43	·21	87	1262	131	1903	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
44	·2[illegible]	[illegible]	1267	131	1908	[illegible]	[illegible]	219	3190	263	3631	306	[illegible]
44	·31	[illegible]	[illegible]	132	1913	[illegible]	[illegible]	219	[illegible]	[illegible]	[illegible]	307	[illegible]
44	·3[illegible]	[illegible]	12[illegible]	132	191[illegible]	[illegible]	[illegible]	219	3200	[illegible]	3841	307	4482
45	·41	[illegible]	1282	132	1923	176	[illegible]	220	3205	[illegible]	[illegible]	[illegible]	[illegible]
45	·49	89	[illegible]	133	[illegible]	[illegible]	[illegible]	220	3210	[illegible]	3851	308	4492
[illegible]	·54	89	1292	133	1933	177	[illegible]	220	[illegible]	[illegible]	[illegible]	308	[illegible]
[illegible]	·59	89	[illegible]	133	[illegible]	177	[illegible]	221	3220	[illegible]	[illegible]	308	4502
46	[illegible]	90	1302	134	1943	177	[illegible]	221	[illegible]	[illegible]	[illegible]	309	4507
47	[illegible]	90	[illegible]	134	1948	[illegible]	2589	221	3230	[illegible]	3871	309	4512
[illegible]	[illegible]	91	1312	134	1952	178	2594	222	[illegible]	[illegible]	[illegible]	309	[illegible]
47	[illegible]	91	[illegible]	135	[illegible]	178	[illegible]	222	3240	[illegible]	3881	310	4522
48	·84	91	1322	135	[illegible]	179	[illegible]	223	[illegible]	[illegible]	[illegible]	310	[illegible]
48	·89	92	[illegible]	[illegible]	[illegible]	179	[illegible]	223	[illegible]	[illegible]	3891	310	4532
48	·94	92	1332	136	1972	[illegible]	[illegible]	223	[illegible]	[illegible]	[illegible]	311	[illegible]

±17 Hertz Sidebands

Band #	1st	Band #	2nd	Band #	3rd
121	1810	260	[illegible]		
[illegible]	[illegible]	261	3907		
[illegible]	1844	[illegible]	3924		
128	[illegible]	[illegible]	3941		
129	1878	264	3958		
130	1896	265	3975		
132	1912	267	3992		
133	1929	268	3909		
134	1946	269	[illegible]		
135	[illegible]	270	3943		
136	1980	271	3960		
137	1997	273	3977		
138	2014	274	3994		
140	2031	275	4011		
141	2048	276	4028		
142	2065	277	4045		
143	2082	278	4062		
144	2099	279	4079		
145	2116	281	4096		
147	2133	282	4113		
148	2150	283	4130		

±51 Hertz Sidebands

Band #	1st	Band #	2nd	Band #	3rd
101	1470	237	3450		
105	1521	240	3501		
108	1572	243	3552		
112	1623	247	3603		
115	1674	250	3654		
119	1725	254	3705		
122	1776	257	3756		
126	1827	261	3807		
129	1878	265	3858		
133	1929	268	3909		
136	1980	271	3960		
140	2031	275	4011		
143	2082	278	4062		
147	2133	282	4113		
150	2184	285	4164		
153	2235	289	4215		
157	2286	292	4266		
161	2337	296	4317		
164	2388	299	4368		
168	2439	303	4419		
171	2490	306	4470		

Band #	1st Harm.	Band #	2nd Harm.	Band #	3rd	Band #	4th	Band #	5th	Band #	6th	Band #	7th
33	471	77	1112	121	1743	164	2394	208	3034	259	3774	296	4317
34	488	78	1129	122	1760	166	2411	209	3052	260	3793	297	4334
35	505	79	1146	123	1787	167	2428	211	3069	261	3810	298	4351
37	522	80	1163	124	1804	168	2445	212	3086	262	3827	299	4368
38	539	82	1180	125	1821	169	2462	213	3103	263	3844	300	4385
39	556	83	1197	126	1838	170	2479	214	3120	265	3861	302	4402
40	573	84	1214	128	1855	171	2496	215	3137	266	3878	303	4419
41	590	85	1231	129	1872	173	2513	216	3154	267	3895	304	4436
42	607	86	1248	130	1889	174	2530	218	3171	268	3912	305	4453
44	624	87	1265	131	1906	175	2547	219	3188	269	3929	306	4470
45	641	88	1282	132	1923	176	2564	220	3205	264	3846	307	4487
46	658	90	1299	133	1940	177	2581	221	3222	265	3863	309	4504
47	675	91	1316	135	1957	178	2598	222	3239	264	3880	310	4521
48	692	92	1333	136	1974	179	2615	223	3256	267	3897	311	4538
49	709	93	1350	137	1991	181	2632	224	3273	268	3914	312	4555
51	726	94	1367	138	2008	182	2649	225	3290	269	3931	313	4572
52	743	95	1384	139	2025	183	2666	227	3307	271	3948	314	4589
53	760	97	1401	140	2042	184	2683	228	3324	272	3965	316	4606
54	777	98	1418	142	2059	185	2700	229	3341	273	3982	317	4623
55	794	99	1435	143	2076	186	2717	230	3358	274	3999	318	4640
56	811	100	1452	144	2093	188	2734	231	3375	275	4016	319	4657

Reproduced from best available copy.

FIGURE 6–43B

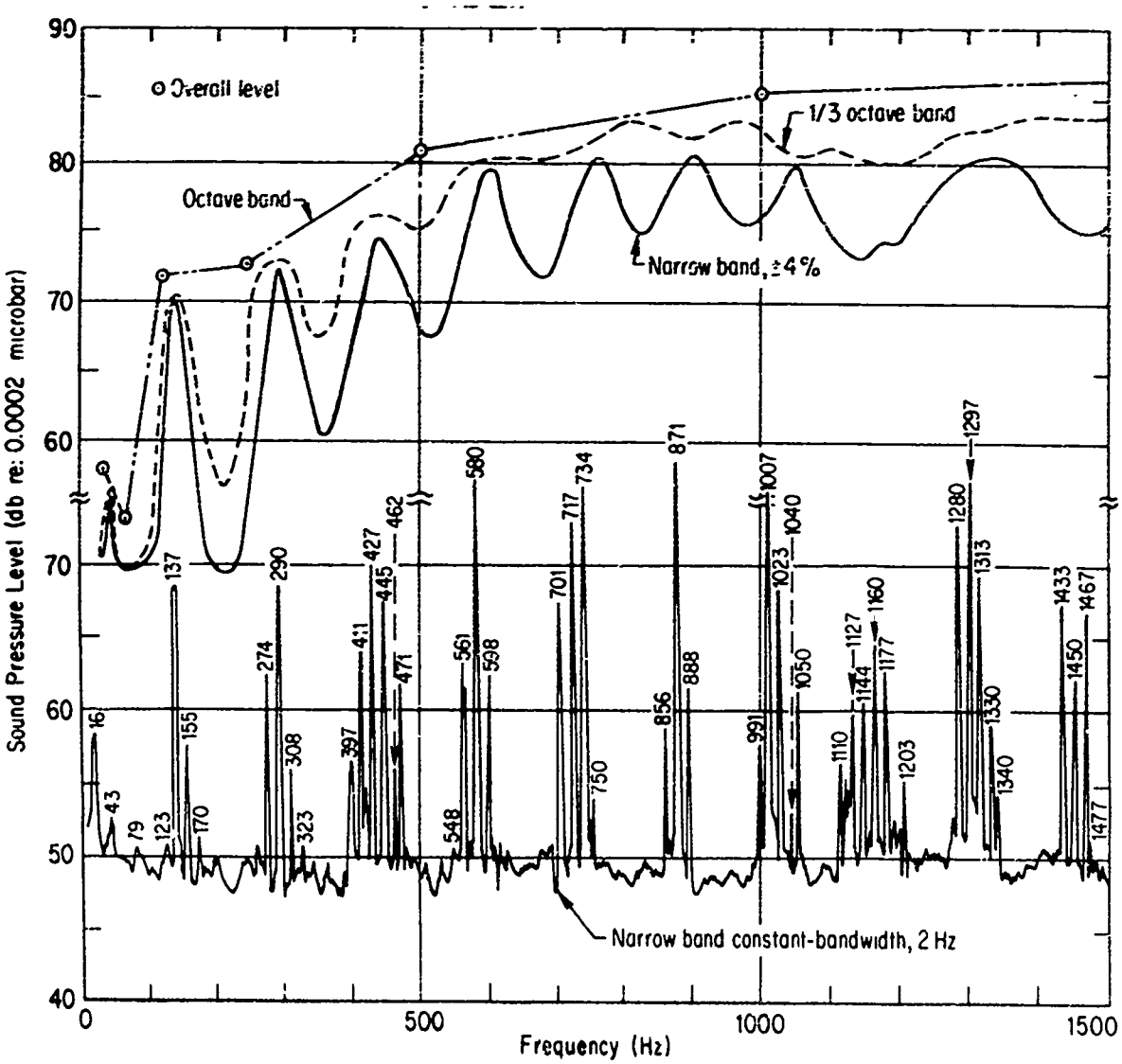

Overall level
1/3 octave band
Octave band
Narrow band, ±4%
Narrow band constant-bandwidth, 2 Hz
Sound Pressure Level (db re: 0.0002 microbar)
Frequency (Hz)
90
80
70
60
70
60
50
40
0
500
1000
1500
16
43
79
123
137
155
170
274
290
308
323
397
411
427
445
462
471
548
561
580
598
701
717
734
750
856
871
888
991
1007
1023
1040
1050
1110
1127
1144
1160
1177
1203
1280
1297
1313
1330
1340
1433
1450
1467
1477

FIGURE 6–44

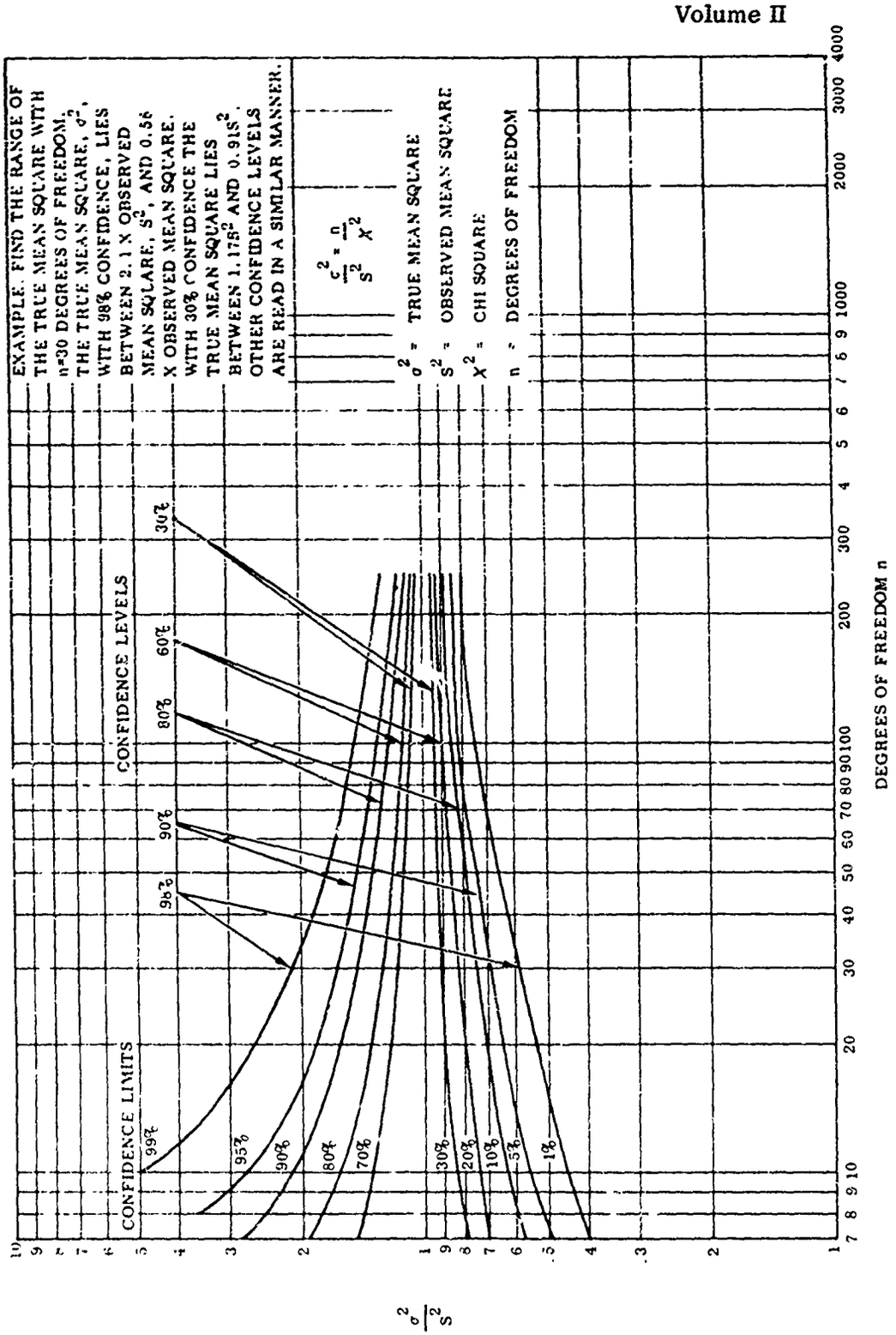


FIGURE 6-45 CHI-SQUARE DISTRIBUTION CHART

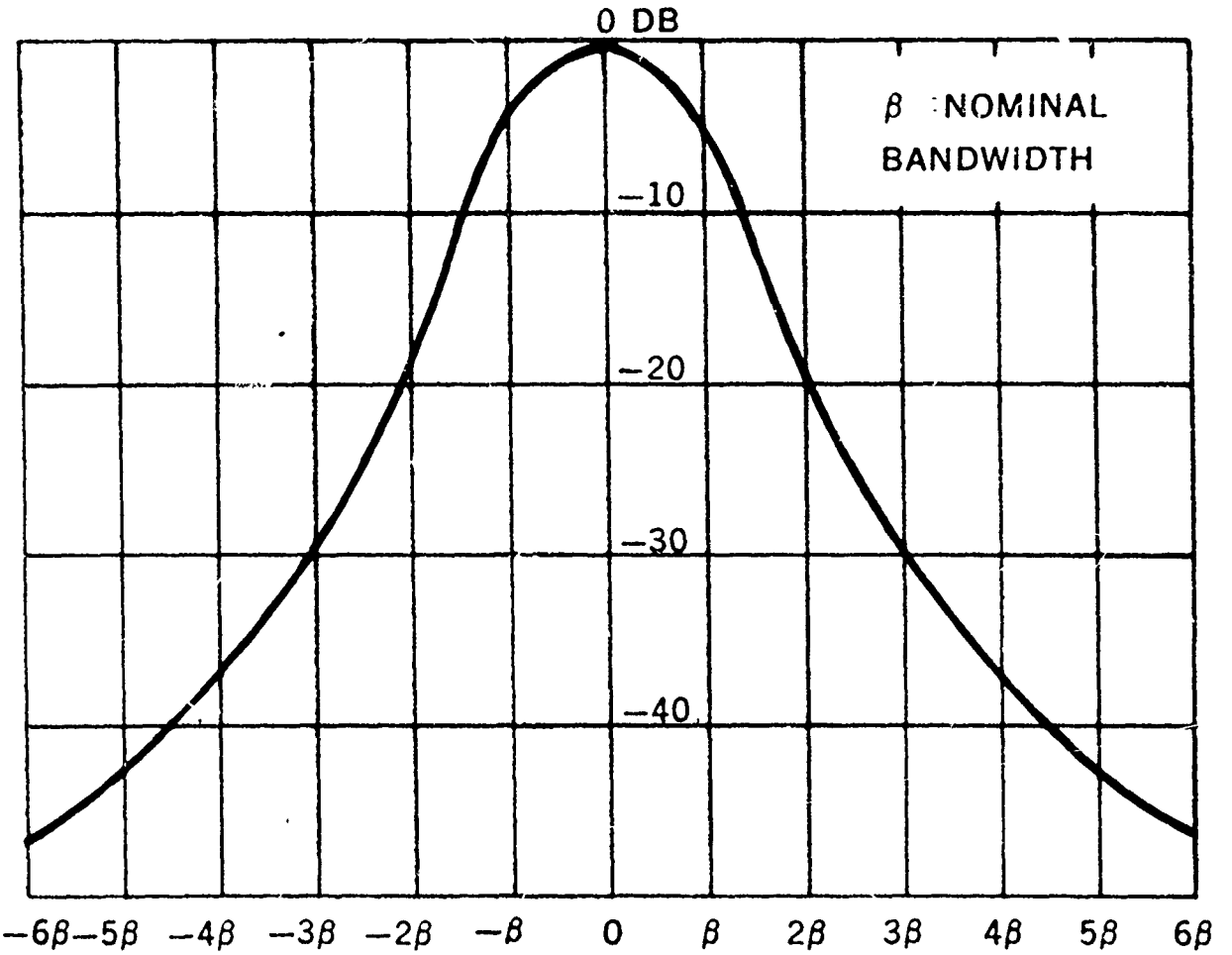
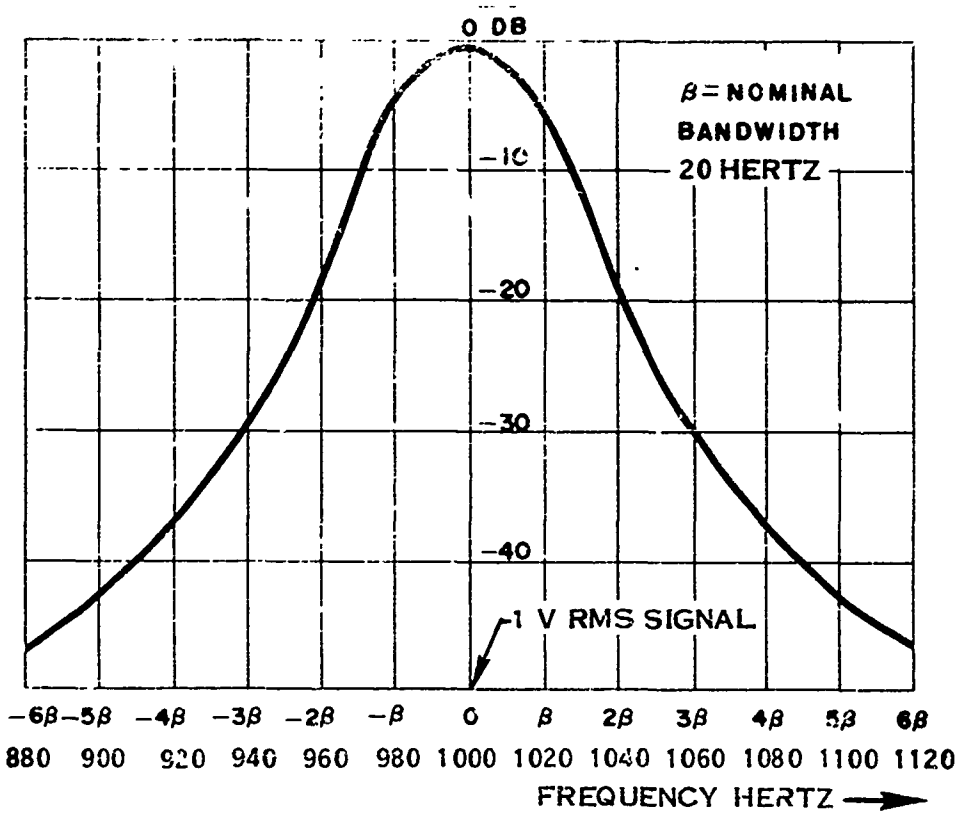
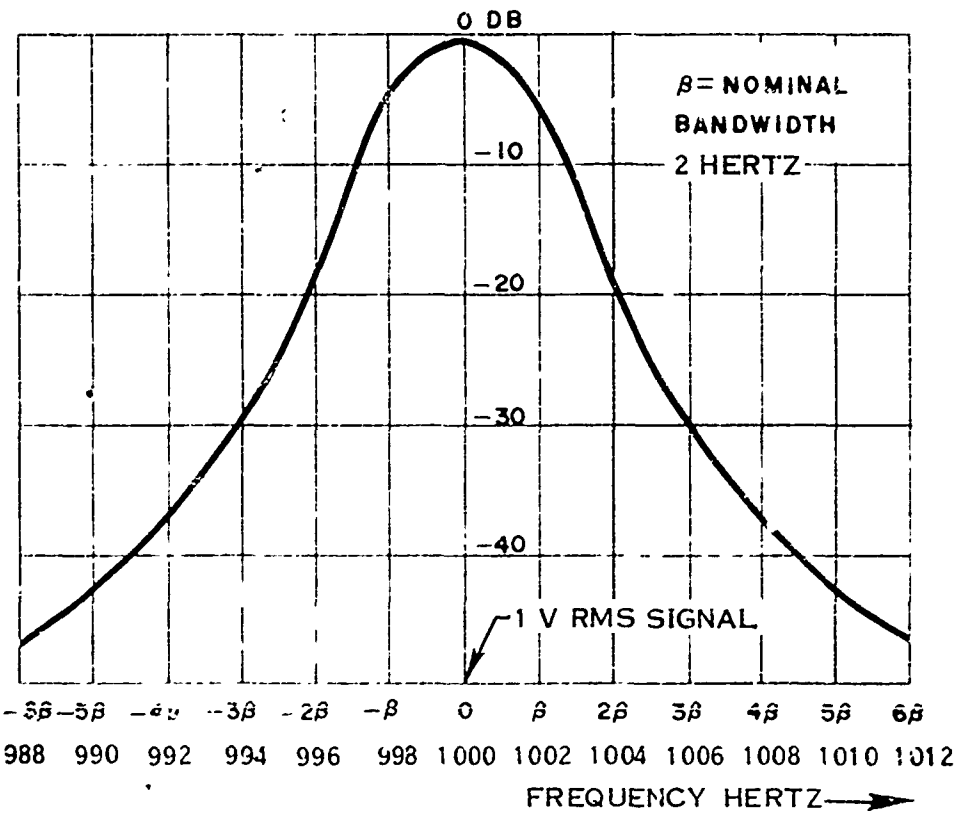


FIGURE 6–46 NORMALIZED SHAPE OF SPECTRAL ANALYSIS FILTER

(DIGITALLY SYNTHESIZED)

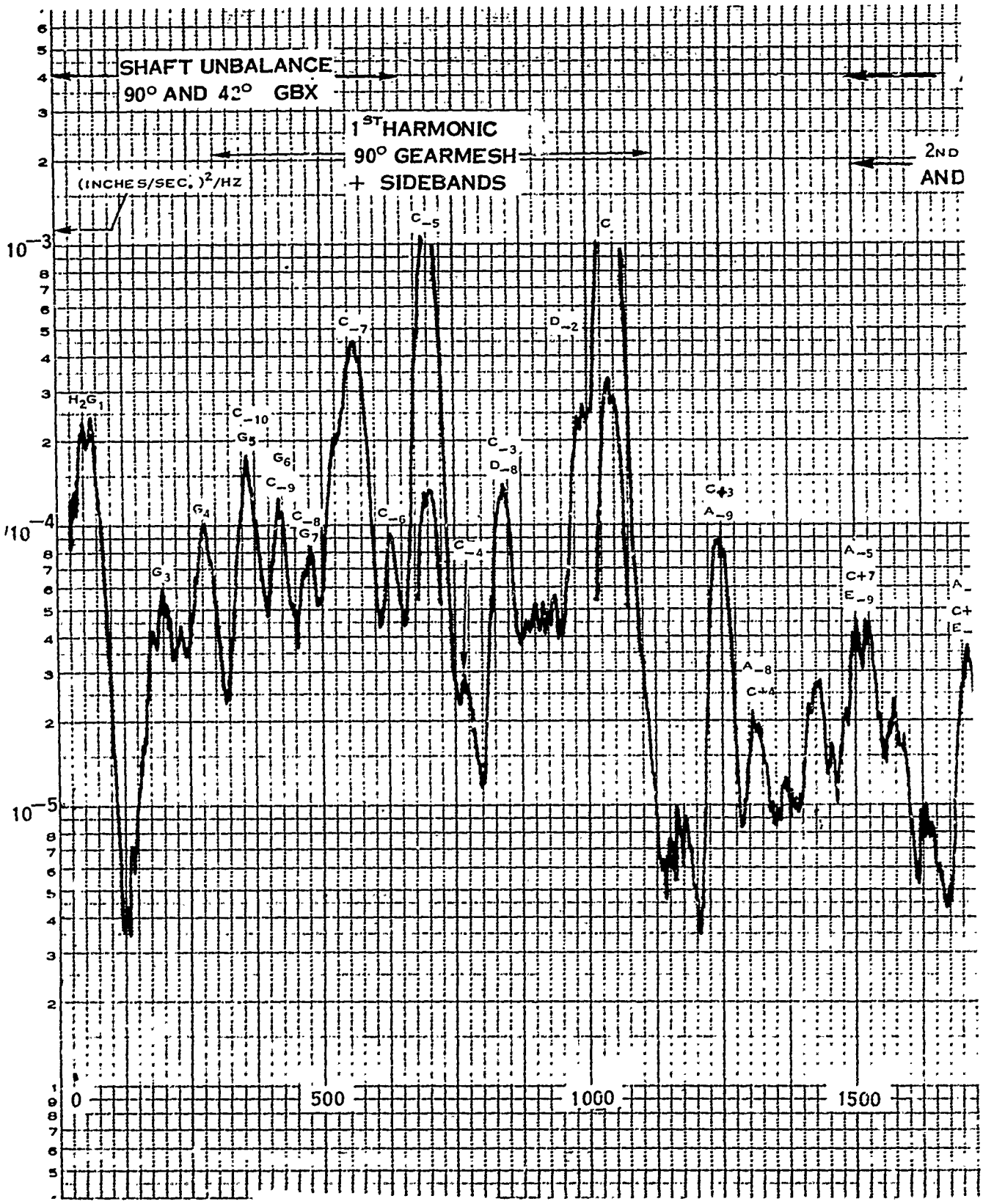


APPROXIMATELY 100 MV RMS OF THE 1 V RMS SIGNAL AT 1000 HZ (−20DB) WILL BE OBSERVED AT 960 HZ DUE TO THE ATTENUATION RATE OF THE FILTER



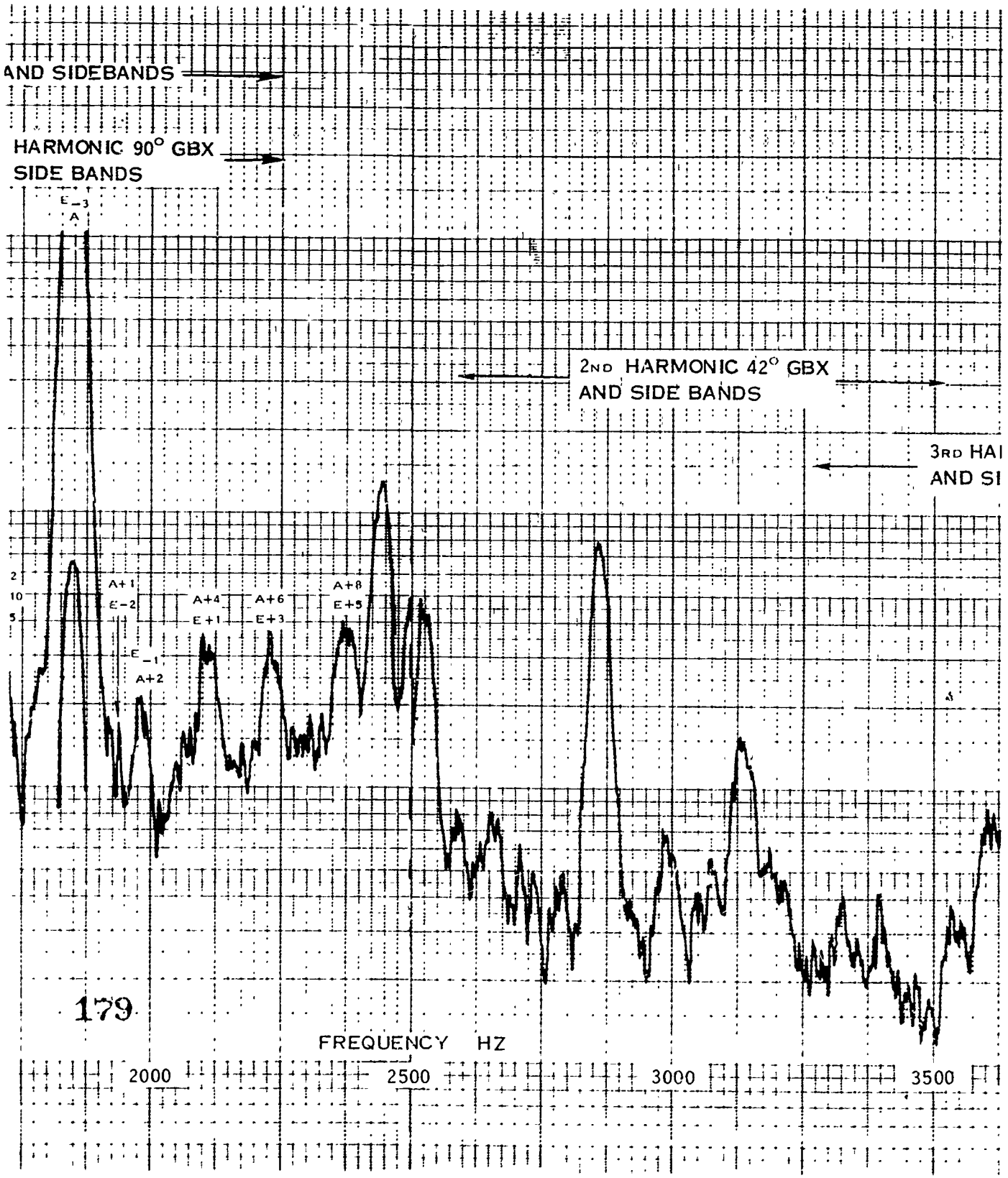
EFFECTIVE ATTENUATION OF THE 2 HZ FILTER IS APPROXIMATELY −60 DB AT 960 HZ

FIGURE 6-47


SHAFT UNBALANCE
90° AND 42° GBX
1ST HARMONIC
90° GEARMESH
+ SIDEBANDS
2ND
AND
(INCHES/SEC.)²/HZ
10⁻³
10⁻⁴
10⁻⁵
0
500
1000
1500
H2G1
G3
G4
C-10
G5
G6
C-9
C-8
G7
C-7
C-6
C-5
C-4
C-3
D-8
D-2
C
C+3
A-9
A-8
C+4
A-5
C+7
E-9
A-
C+
E-

178

6-48A


AND SIDEBANDS
HARMONIC 90° GBX
SIDE BANDS
E−3
A
2ND HARMONIC 42° GBX
AND SIDE BANDS
3RD HA
AND SI
A+1
E−2
A+4
E+1
A+6
E+3
A+8
E+5
E−1
A+2
2
10
5
FREQUENCY HZ
2000
2500
3000
3500

6-48 B

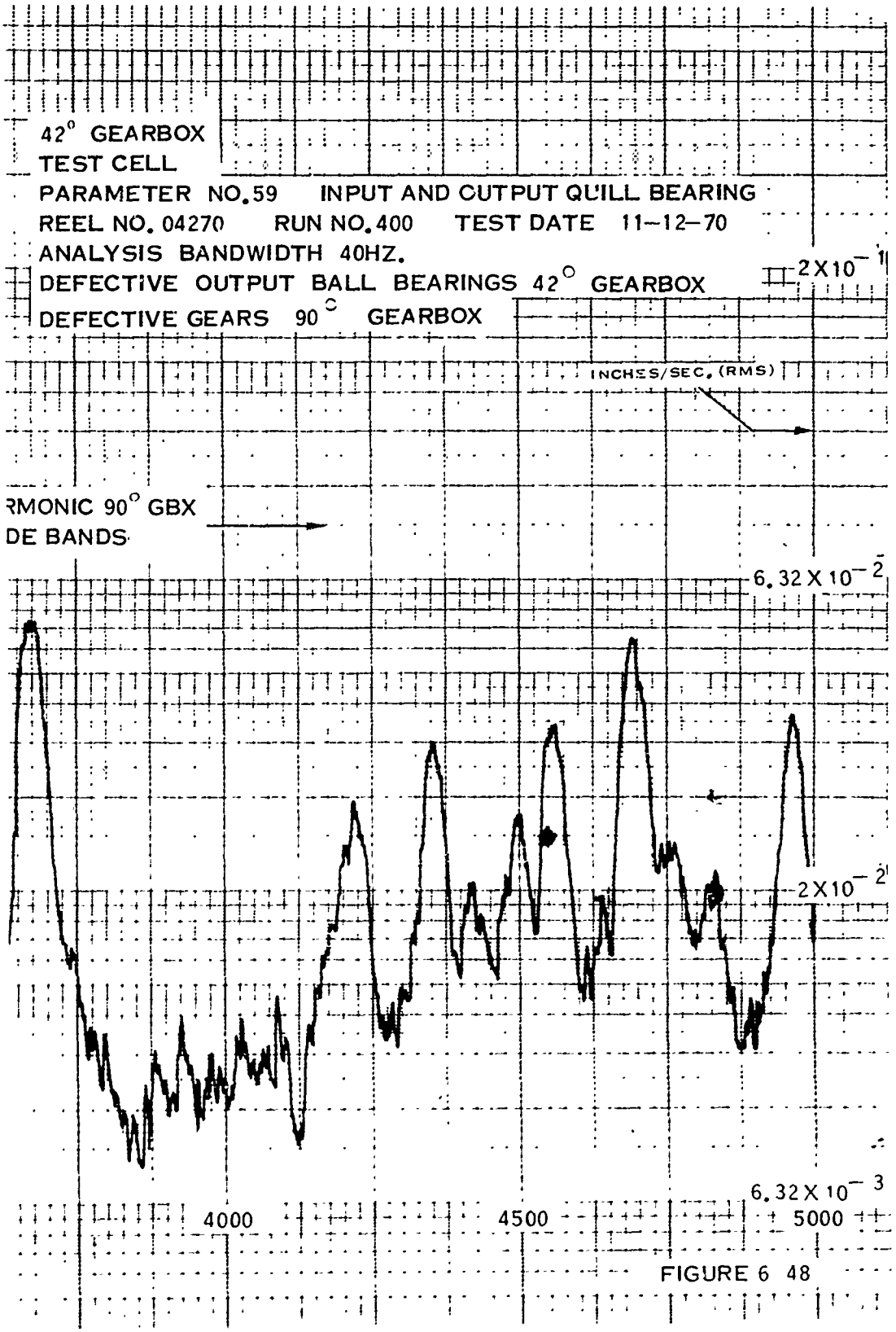
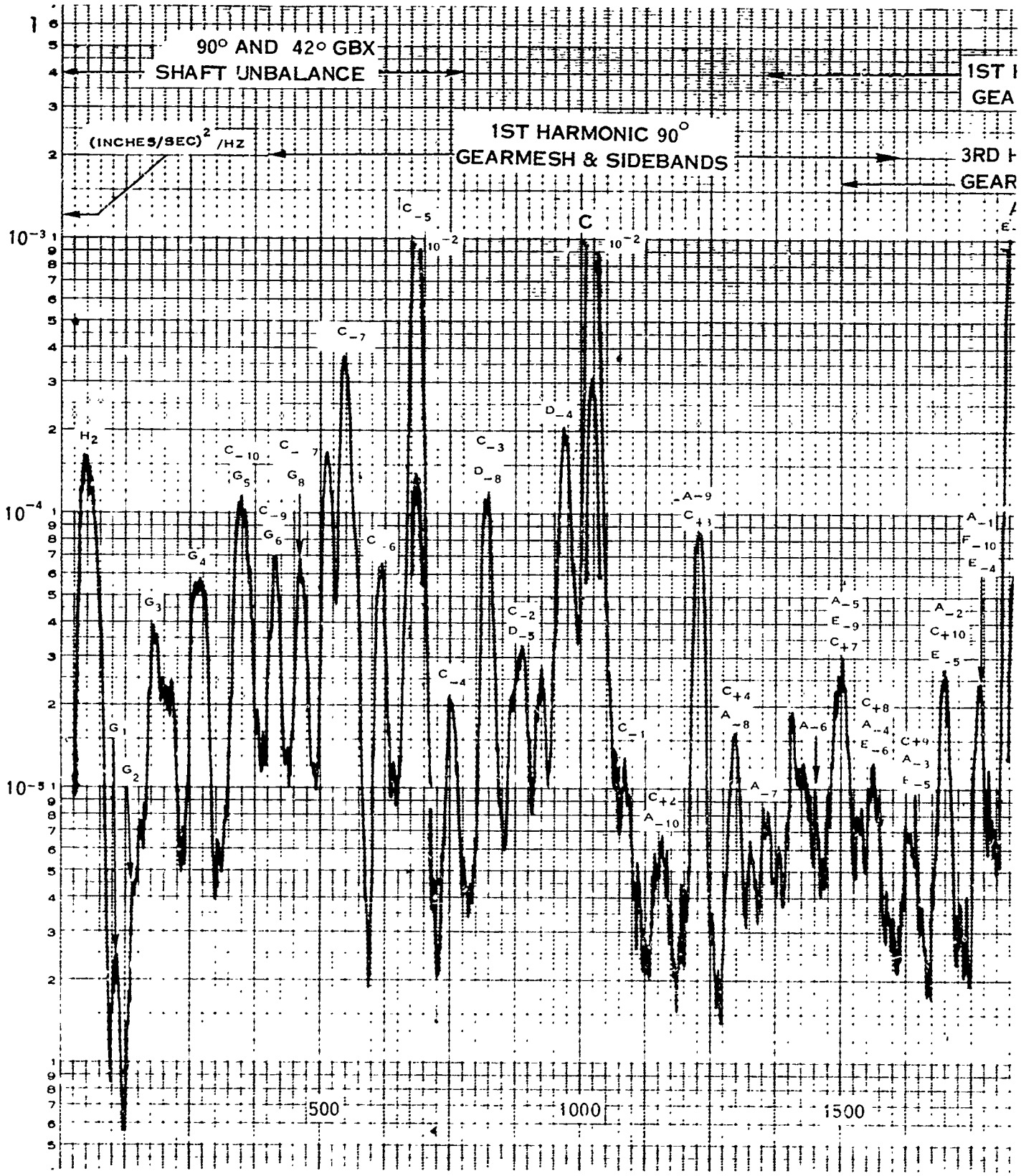
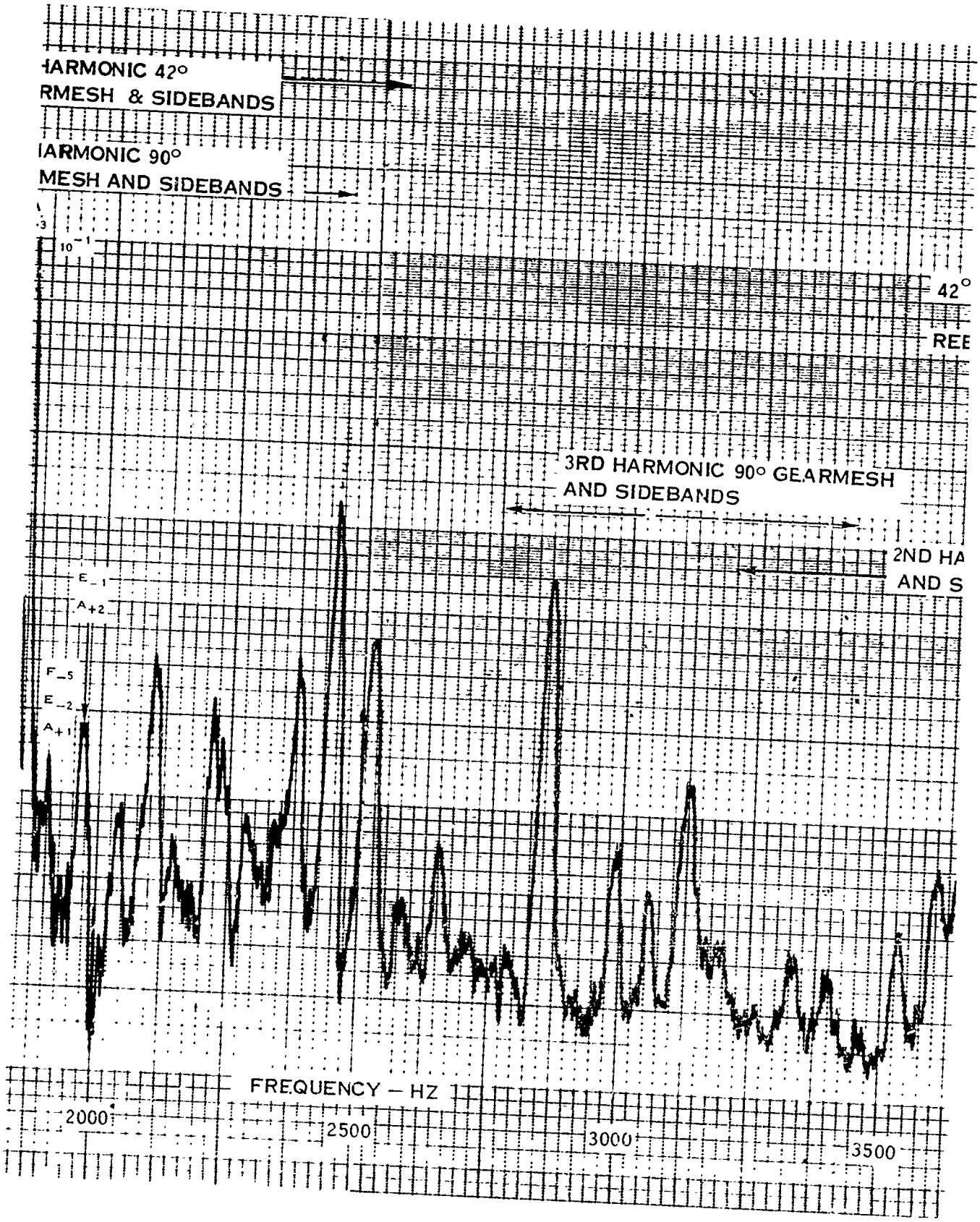


FIGURE 6 48

6-48 C


90° AND 42° GBX
SHAFT UNBALANCE
1ST HARMONIC 90°
GEARMESH & SIDEBANDS
(INCHES/SEC)^2 /HZ
500
1000
1500

6-49A


HARMONIC 42°
RMESH & SIDEBANDS
HARMONIC 90°
MESH AND SIDEBANDS
10^{-1}
42°
REE
3RD HARMONIC 90° GEARMESH
AND SIDEBANDS
2ND HA
AND S
E_{-1}
A_{+2}
F_{-5}
E_{-2}
A_{+1}
FREQUENCY – HZ
2000
2500
3000
3500

182

6-49 B

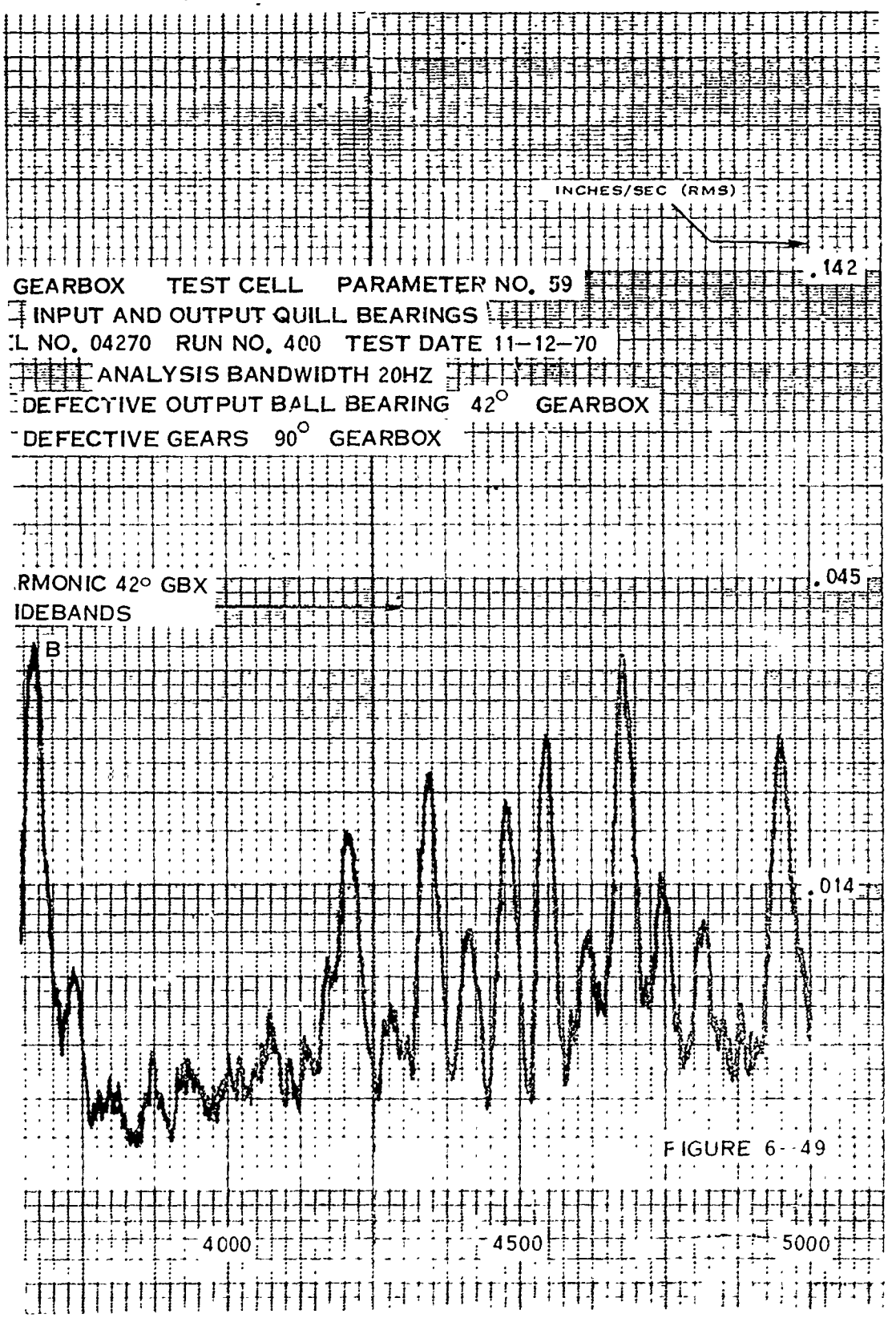
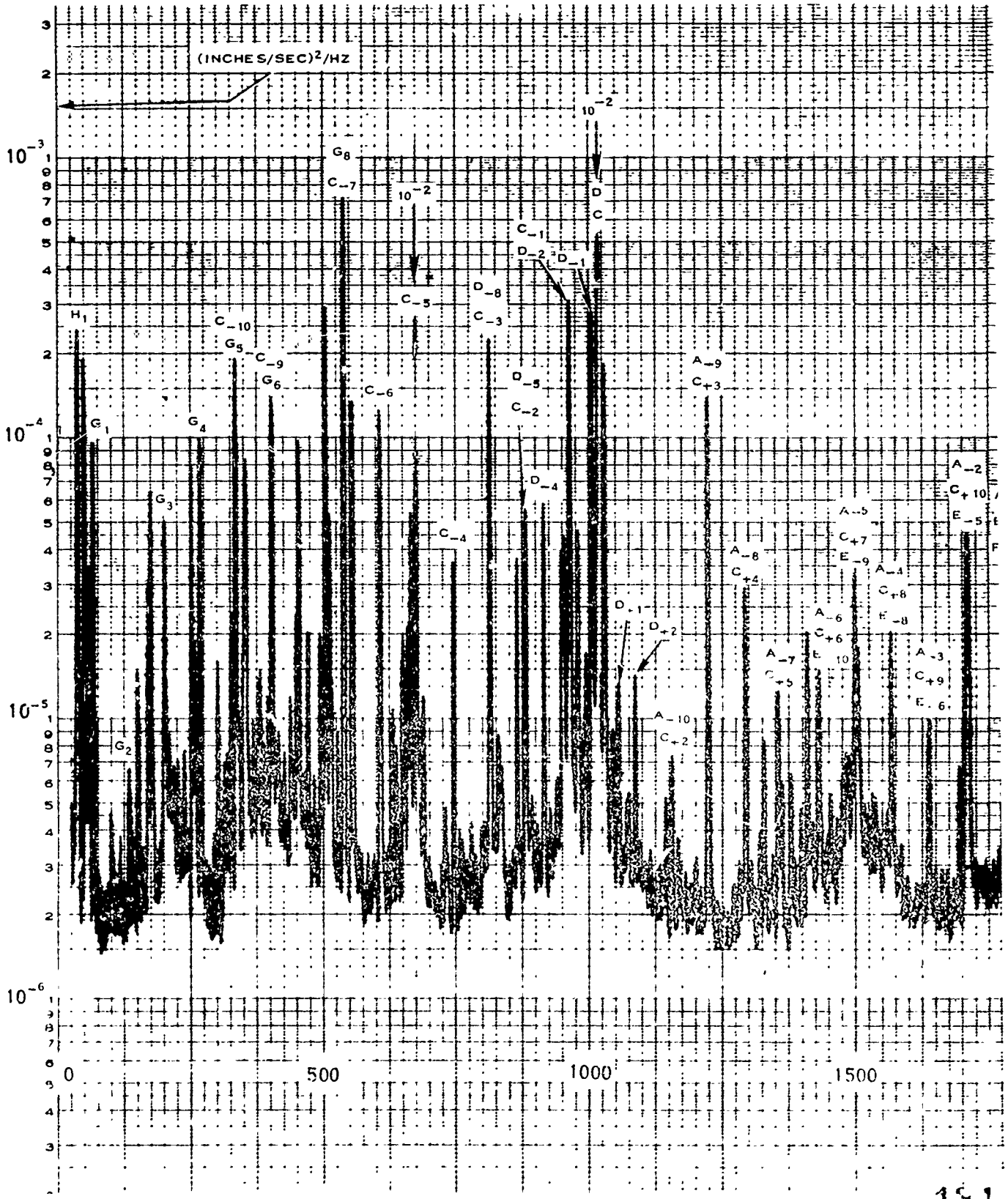
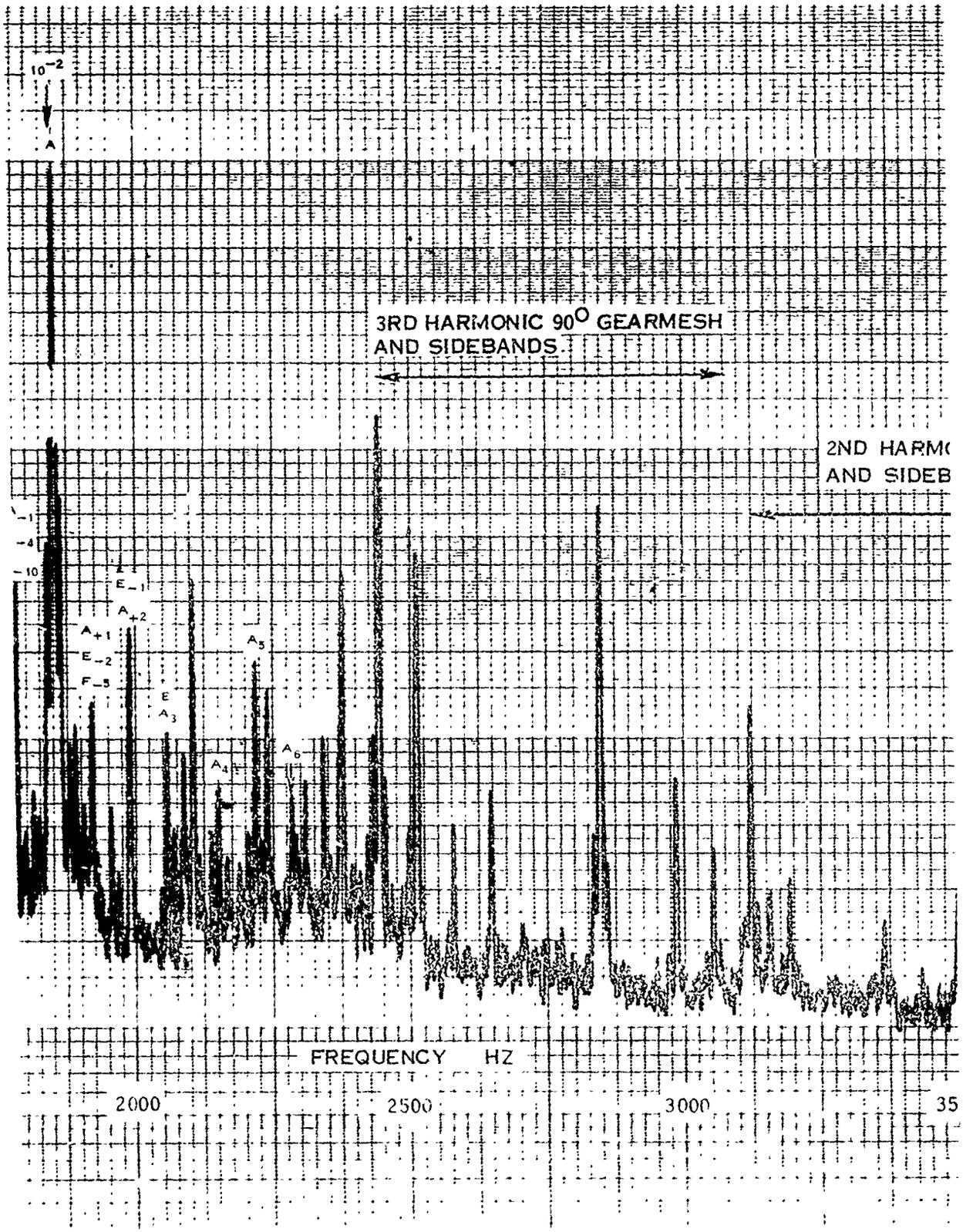


FIGURE 6-49

6-49 C

49 A


(INCHES/SEC)²/HZ
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
0
500
1000
1500
H1
G1
G2
G3
G4
G5
G6
G8
C-10
C-9
C-7
C-6
C-5
C-4
C-3
C-2
C-1
D-8
D-5
D-4
D-2
D-1
D
C
D+1
D+2
A-9
C+3
A-8
C+4
A-7
C+5
A-6
C+6
A-5
C+7
E-9
A-4
C+8
E-8
A-3
C+9
E-6
A-2
C+10
E-5
A-10
C+2
10⁻²


10^-2
A
3RD HARMONIC 90° GEARMESH
AND SIDEBANDS
2ND HARM
AND SIDEB
-1
-4
-10
E-1
A+2
A+1
E-2
F-3
E
A3
A4
A5
A6
FREQUENCY HZ
2000
2500
3000
35

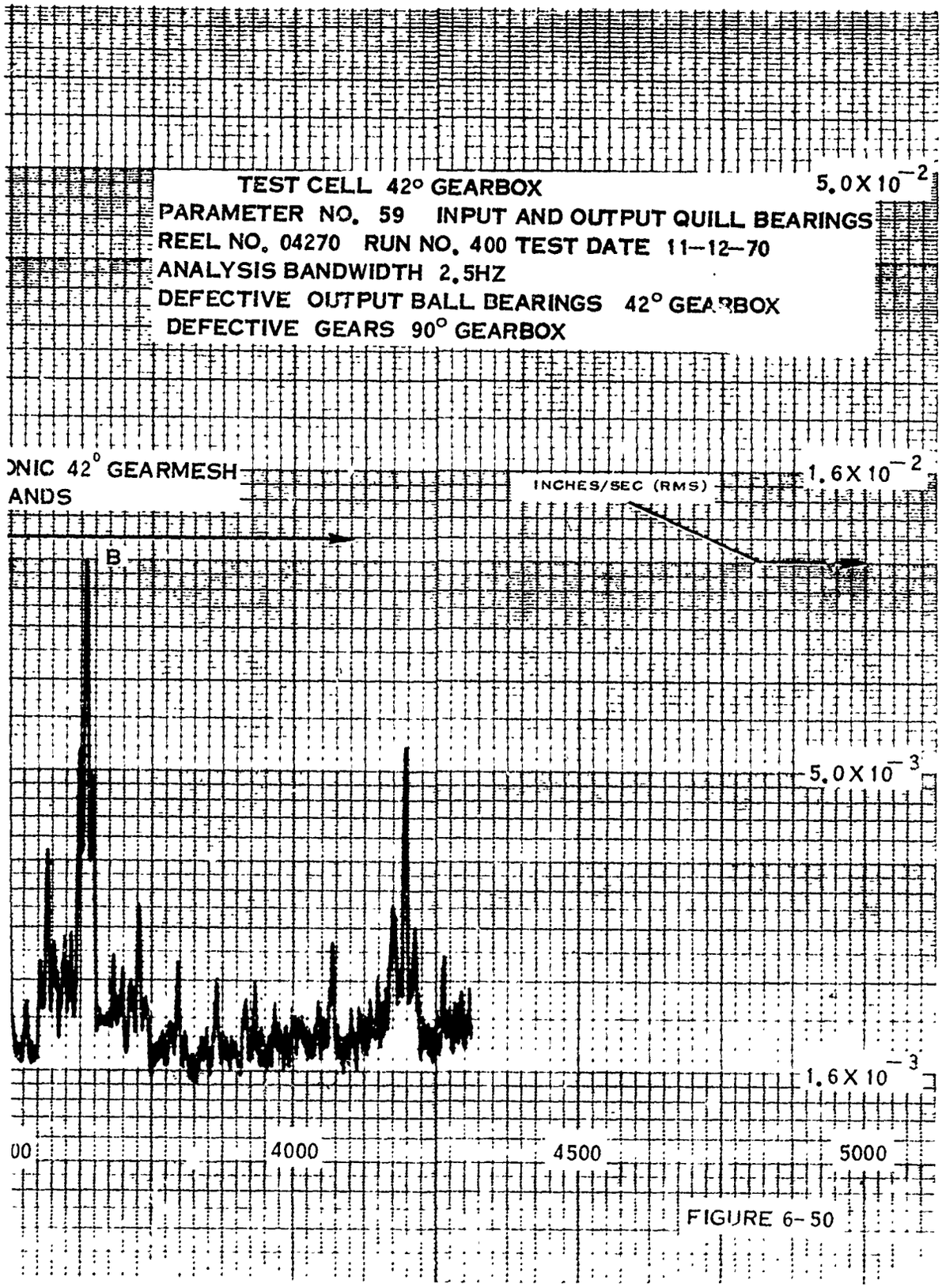
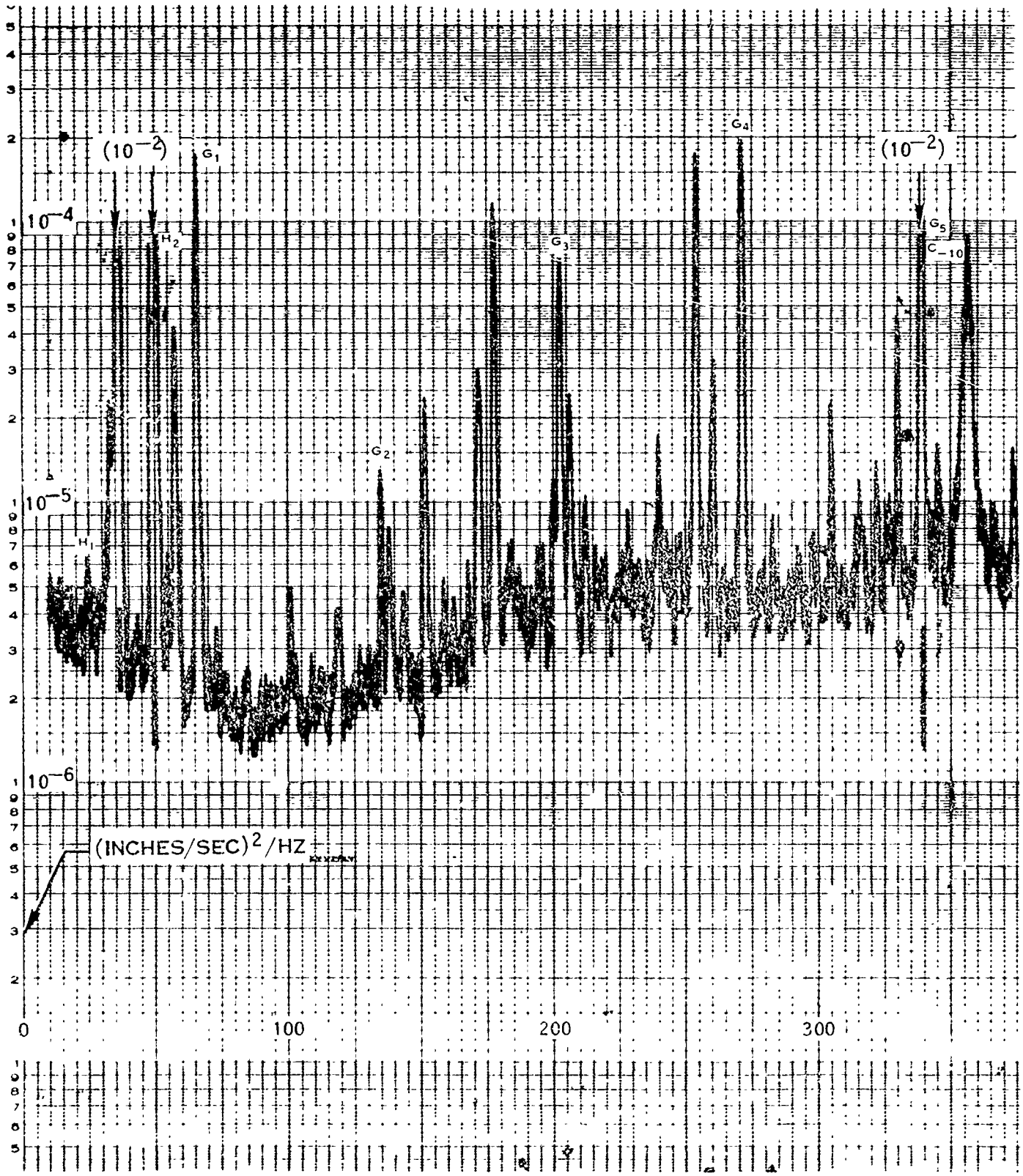
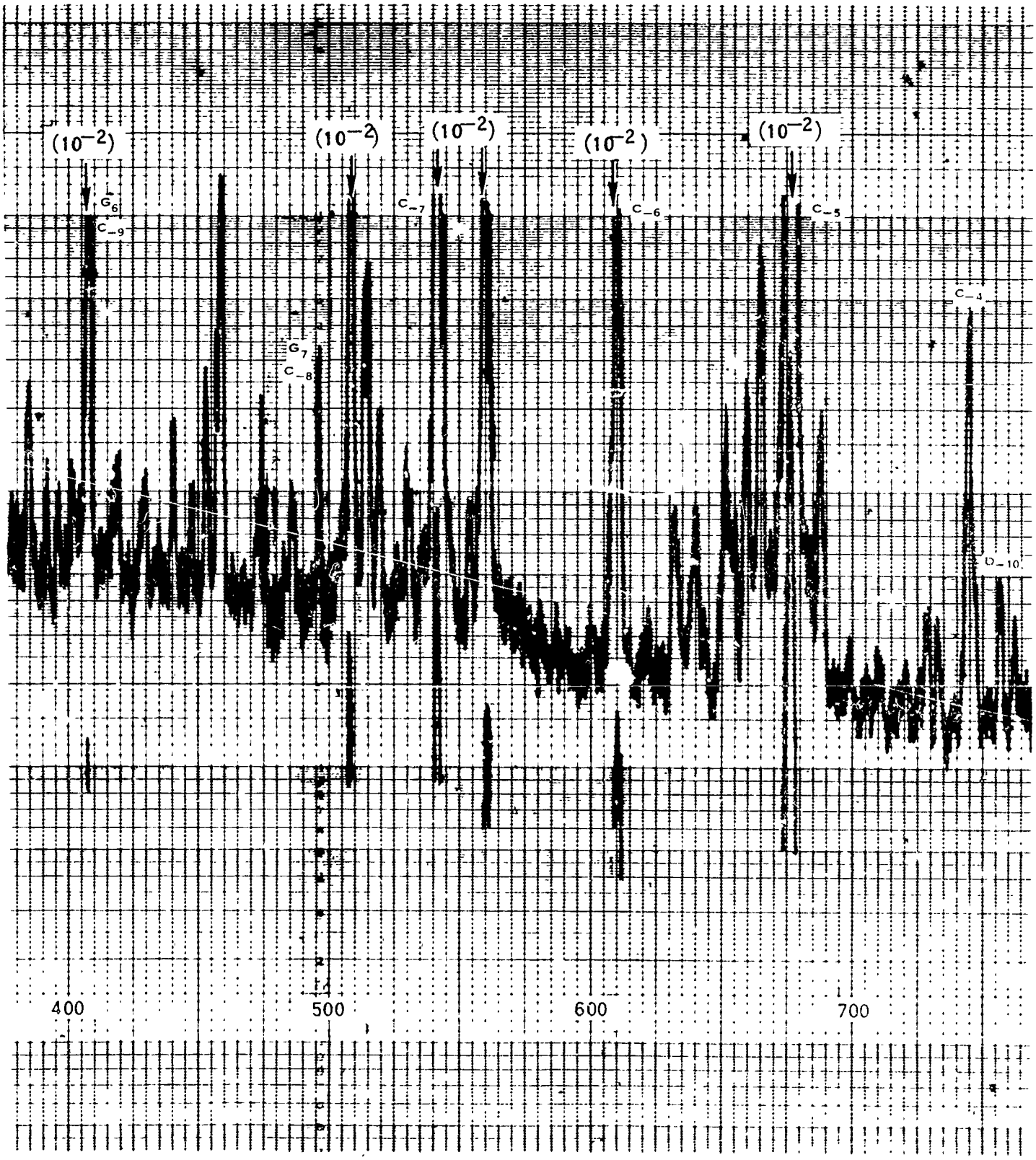

TEST CELL 42° GEARBOX
PARAMETER NO. 59 INPUT AND OUTPUT QUILL BEARINGS
REEL NO. 04270 RUN NO. 400 TEST DATE 11-12-70
ANALYSIS BANDWIDTH 2.5HZ
DEFECTIVE OUTPUT BALL BEARINGS 42° GEARBOX
DEFECTIVE GEARS 90° GEARBOX
5.0X10^-2
ONIC 42° GEARMESH
ANDS
INCHES/SEC (RMS)
1.6X10^-2
B
5.0X10^-3
1.6X10^-3
00
4000
4500
5000

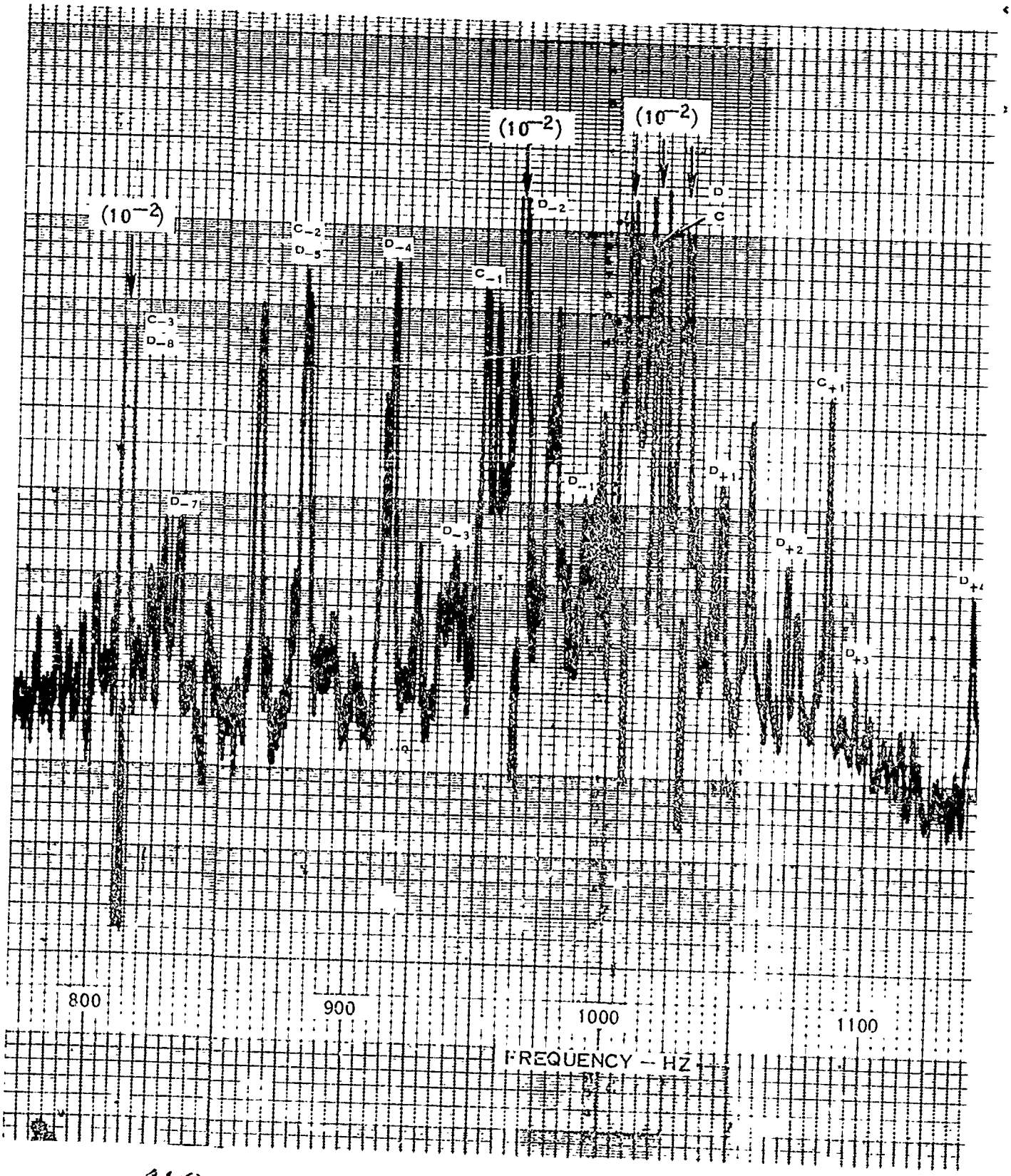
FIGURE 6-50


(10^-2)
G1
H2
10^-4
G3
G4
(10^-2)
G5
C-10
G2
10^-5
H1
10^-6
(INCHES/SEC)^2/HZ
0
100
200
300

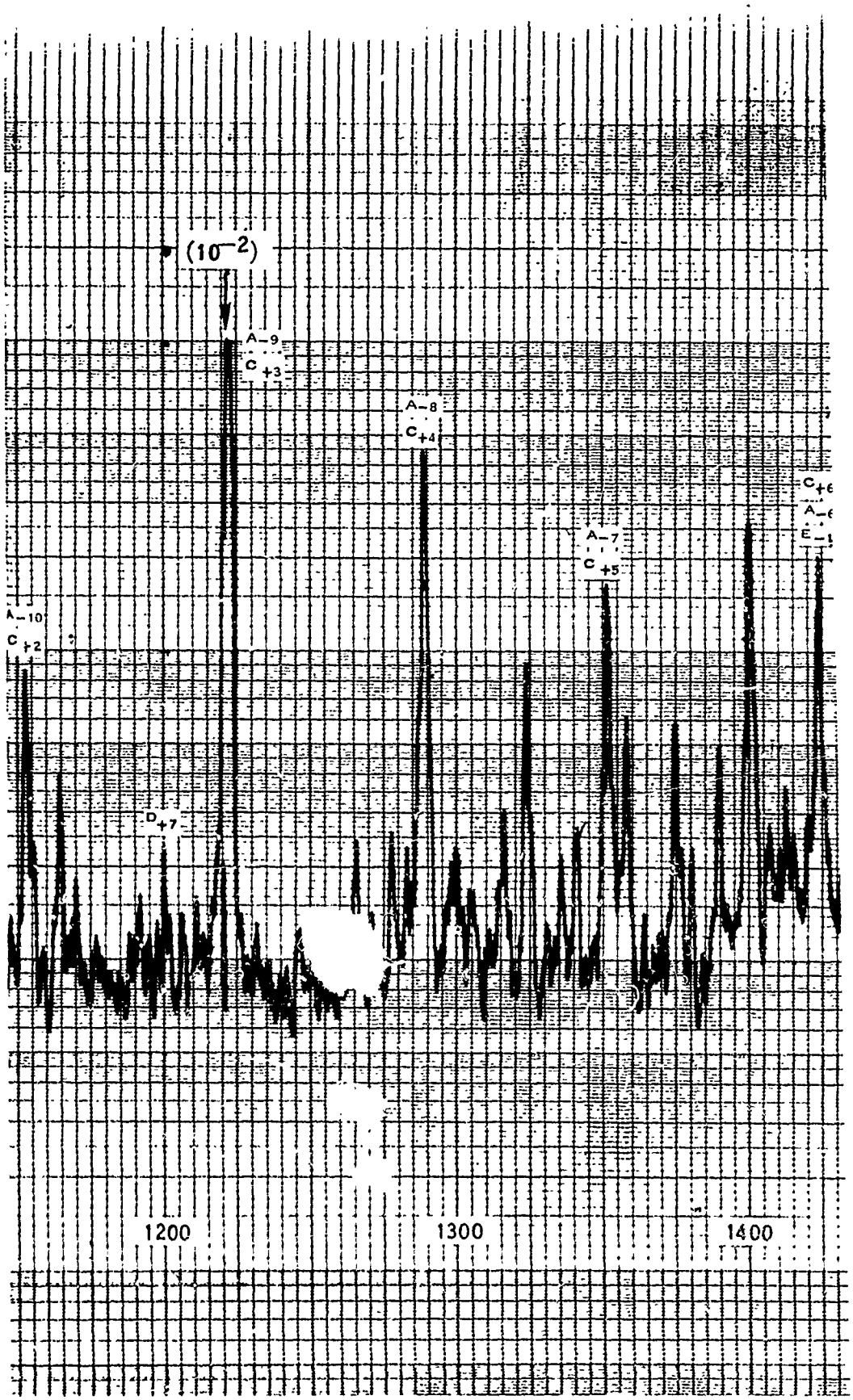
6-51 A



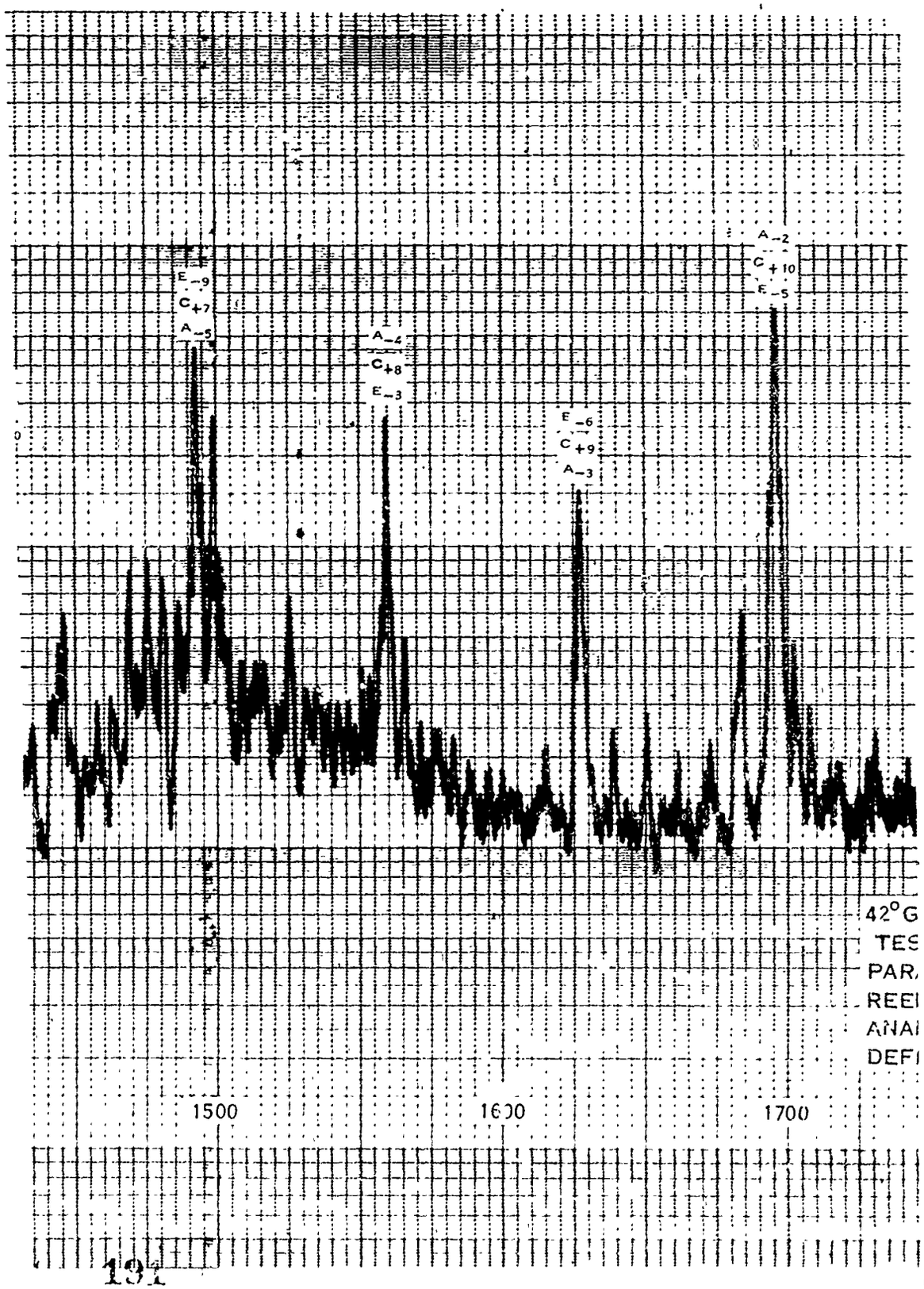
6-51 B


(10⁻²)
(10⁻²)
(10⁻²)
D
C
D−2
C−2
D−5
D−4
C−1
C−3
D−8
C+1
D+1
D−1
D−7
D−3
D+2
D+4
D+3
800
900
1000
1100
FREQUENCY – HZ

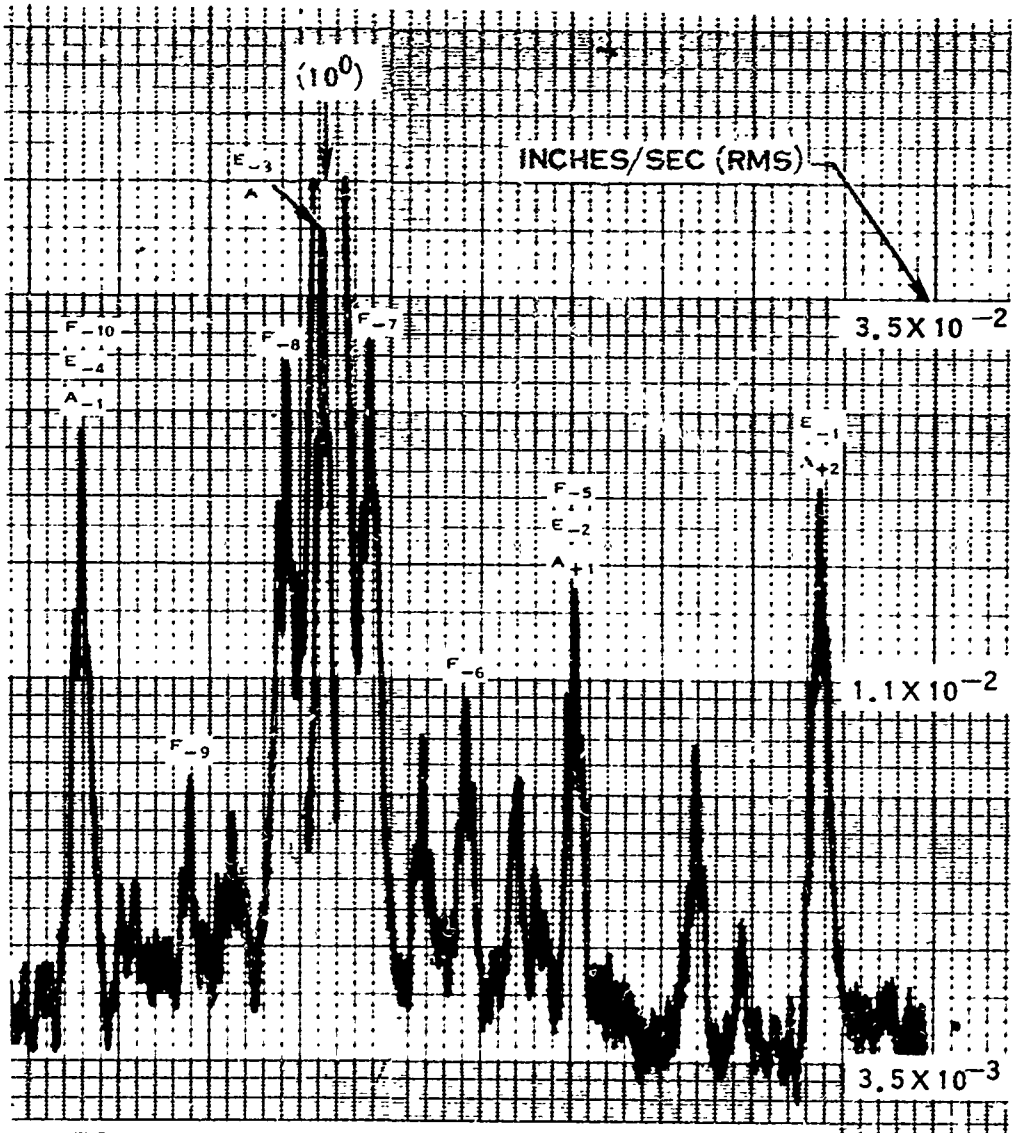
6-51 C



6-51 D


E −9
C +7
A −5
A −4
C +8
E −3
E −6
C +9
A −3
A −2
C +10
E −5
1500
1600
1700
42°G
TES
PAR
REE
ANA
DEF

6-57 E

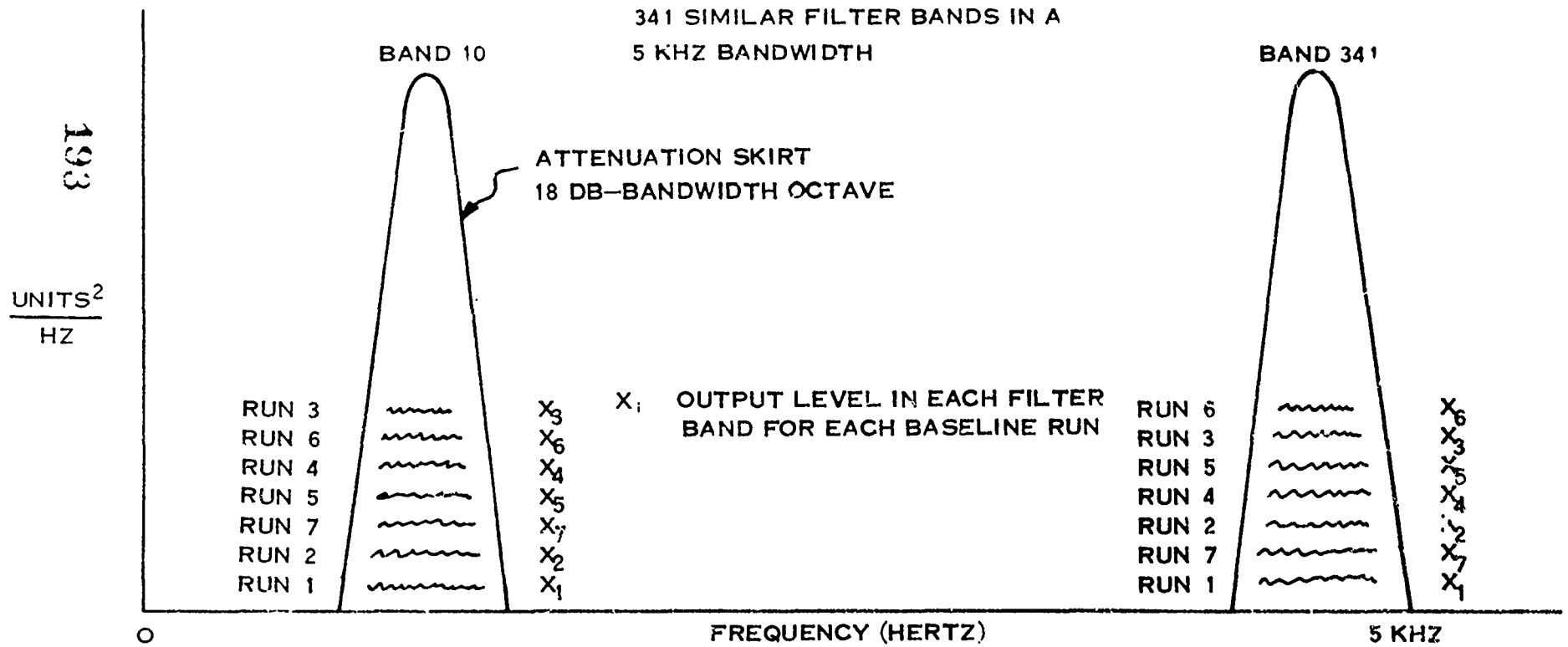


EARBOX
T CELL
AMETER NO. 59 INPUT AND OUTPUT QUILL BEARINGS
NO. 04270 RUN NO. 400 TEST DATE 11-12-70
YSIS BANDWIDTH 1.25 HZ
ECTIVE OUTPUT BALL BEARING

1800 1900 2000

FIGURE 6-51

6-51F



$$\overline{X}\ (\text{ARITHMETIC MEAN}) = \sum_{i=1}^{i=N} \frac{X_i}{N}$$

X_i = VALUE OF EACH SAMPLE

N = NUMBER OF SAMPLES

$$S\ (\text{STANDARD DEVIATION}) = \sqrt{\sum_{i=1}^{i=N} \frac{(X_i - \overline{X})^2}{N-1}}$$

N = NUMBER OF SAMPLES

X_i = VALUE OF EACH SAMPLE

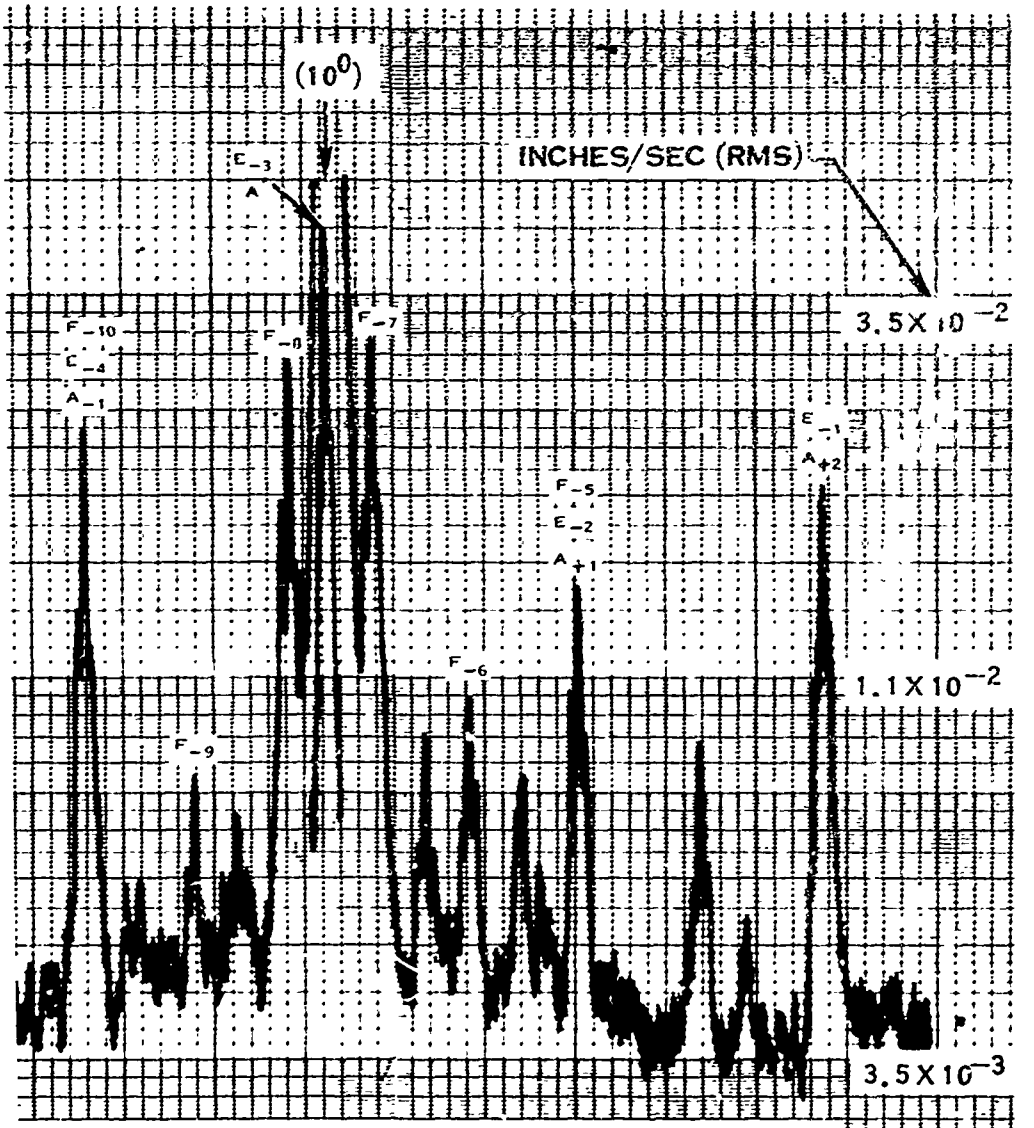
$\overline{X}$ = ARITHMETIC MEAN

$$CV\ (\text{COEFFICIENT OF VARIANCE}) = \frac{S}{\overline{X}} \cdot 100$$

<u>EXAMPLE:</u> FOR 7 BASELINE RUNS ON ONE TRANSDUCER LOCATION, THE MEAN AND STANDARD DEVIATION ARE CALCULATED AS SHOWN 341 TIMES USING 7 DIFFERENT SAMPLES EACH TIME.

FIGURE 6–52 MEAN AND STANDARD DEVIATION GENERATION

HSER 6080
VOLUME IX



EARBOX
T CELL
AMETER NO. 59 INPUT AND OUTPUT QUILL BEARINGS
NO. 04270 RUN NO. 400 TEST DATE 11-12-70
YSIS BANDWIDTH 1.25 HZ
ECTIVE OUTPUT BALL BEARING

1800 1900 2000

FIGURE 6-51

6-51F

MSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= M*4204

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+S	M+2S	M+3S	M+4S
04180	117	2	178A	LE-21173	6	5	3	0	0
04180	138	2	179A	LE-18832	8	3	0	0	0
04180	151	2	181A	LE-14568	218	154	115	0	0
04180	158	2	181A	LE-18107	30	4	0	0	0
02216	174	2	185A	LE-15351	227	114	52	0	0
02216	181	2	186A	LE-18903	104	80	28	0	0
02216	189	2	187A	LE-18257	140	22	4	0	0
02216	196	2	187A	LE-20727	79	46	13	0	0

ITEM= ENGINE
PARAMETER NO. 7
UNITS= IN/SEC.PK
PARAMETER TITLE= NO. 3 AND NO. 4 BEARINGS, DIFFUSOR
NO. OF SPEC. AVGD.= 8

ITEM SPEED= 6600.00 RPM
TRANSMISSION INPUT SPEED= 6600 RPM
TORQUE= 10504 INLB
FREQUENCY RANGE= 5000 HZ
ANALYSIS BW= 21.973 HZ
NO. OF SPEC. COMPARED= 8

PNT FREQ ********** N PER CENT PNT FREQ ********** N PER CENT

ALL ENGINES ARE BASELINE

FIGURE 6-53 " GOOD " COMPARISON SUMMARY

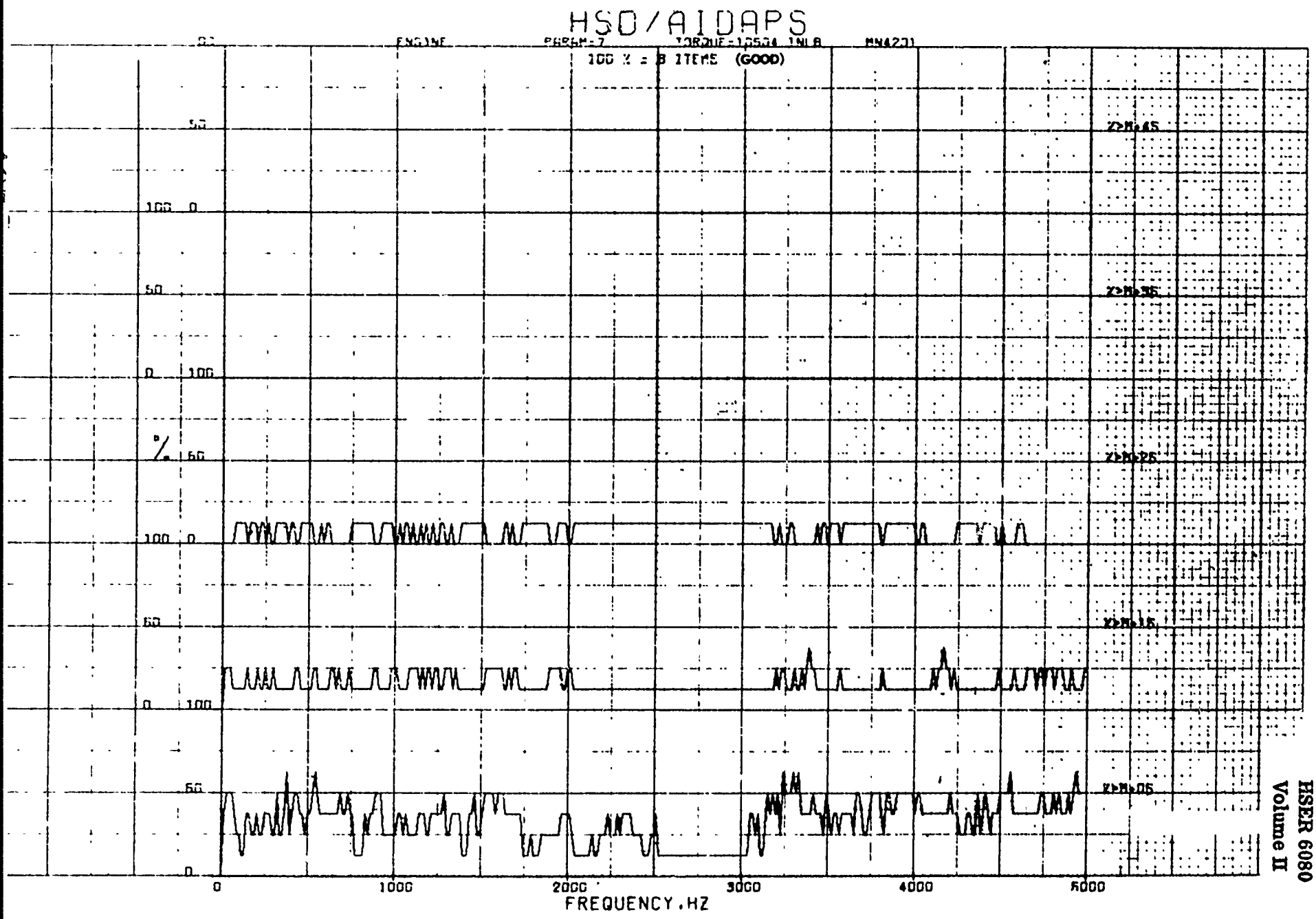

HSO/AIDAPS
100 % = 8 ITEMS (GOOD)
%
0
1000
2000
3000
4000
5000
FREQUENCY,HZ

FIGURE 6–53A

MSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= MN6201

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+S	M+2S	M+3S	M+4S
22187	31	2	16	LE20727	79	27	17	9	6
02724	53	2	45	LE20727	80	24	19	16	14
02724	81	2	69	LE20727	107	34	19	10	7

ITEM= ENGINE
PARAMETER NO. 7
UNITS= IN/SEC,PK
PARAMETER TITLE= NO. 3 AND NO. 4 BEARINGS, DIFFUSOR
NO. OF SPEC. AVGD.= 8

ITEM SPEED= 6000.00 RPM
TRANSMISSION INPUT SPEED= 6600 RPM
TORQUE= 10504 INLB
FREQUENCY RANGE= 5000 HZ
ANALYSIS BW= 21.973 HZ
NO. OF SPEC. COMPARED= 3

PNT FREQ ********** N PER CENT

PNT FREQ ********** N PER CENT

ALL ENGINES HAVE FAULTY NO. 3 BEARINGS

FIGURE 6–54 "BAD" COMPARISON SUMMARY

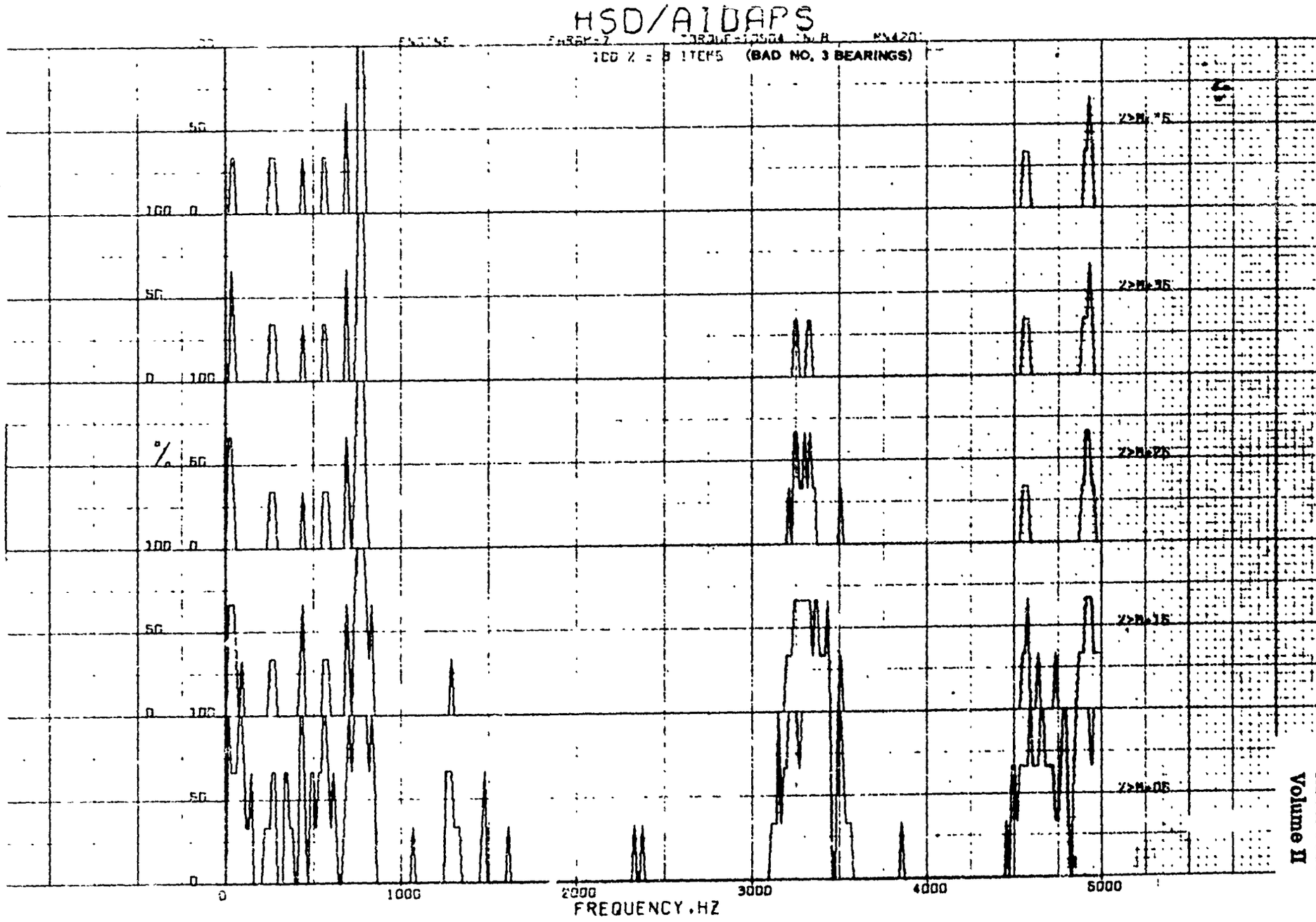

HSD/AIDAPS
100 % = 8 ITEMS (BAD NO. 3 BEARINGS)
%
50
100
0
1000
2000
3000
4000
5000
FREQUENCY,HZ

FIGURE 6–54A

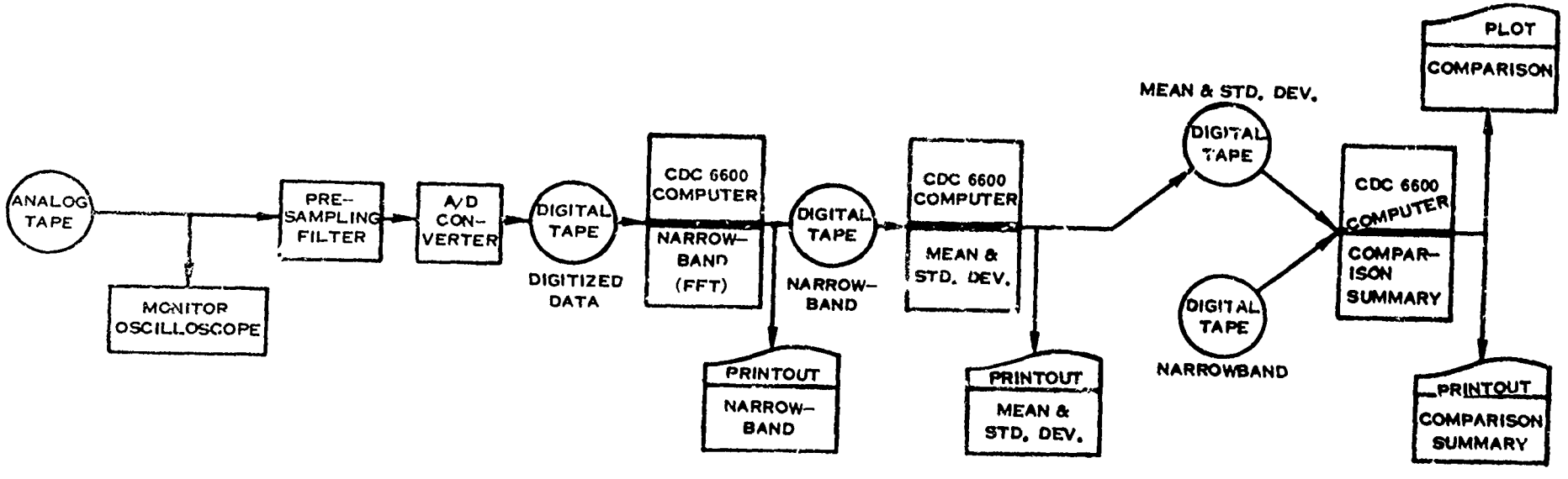


FIGURE 6–55 AIDAPS VIBRATION ANALYSIS... DATA FLOW DIAGRAM

Analysis Range	Anti-Aliasing Filter	Sampling Rate	Data Sample	Number of Frequency Bands	Filter Separation	Effective Bandwidth
5,000 Hz	5,500 Hz	15,000 Hz	2.3 sec.	341	14.64 Hz	21.97 Hz
2,000	2,200	6,000	5.5	341	5.85	8.78
200*	220	600	13.65	85	2.34	3.51

FIGURE 6–56 AIDAPS VIBRATION ANALYSIS PARAMETERS

*NOTE: Performed on very limited amount of data

HAMILTON STANDARD

TEST LOG, MAGNETIC TAPE RECORDING SYSTEM

MASTER PAGE NO 951

TEST TITLE AIDAPS-TRANS & 42° & 90° GBX & TEST ENGINEER DM WP ACB DATE 10 30 70 LOG PAGE No. 1005

Reel No	Run No	TIME	TEST CODE	PREAMP & ATTENUATOR SETTINGS A 1 2 3 4 5 6	B 7 8 9 10 11 12	C 1 2 3 4 5 6	RPM	Torque			NOTES TEST CONDITIONS
0	241	30-33	Use	100 X 1000 X 100 X	100 X -- X X --	2 1 2 2 I	1652	2210			42° ABB-289
2	242	31-48	"			0 5 0 0 R	1604	3640			90° A13-2065
5	243	33-05	"			8 3 8 8 I	1604	1170			42° Pitted & cut balls
7	244	34-40	"			7 6 5 1 G B	1100-1650	1430-2100			90° rusty pitted balls & outer races
	245	05-02-38	"				1652	2210			42° B13-8304
	246	03-52	"				1604	3640			90° B13-6624
	247	05-04	"				1604	1170			42° pitted & cut balls (output quill)
	248	06-18	"				1100-1650	1430-2150			90° rusty balls & outer races (input quill)
	249	09-06-50	STD.	10 X 10 10		2 2 1 X 2 1 2 R 1 I 11/2/70	RPM	Mast	T R	Gen	A12-4214 (-1 Trans)
	250	08-10	F.S.STD.			0 0 8 0 5 0 P 5 R					J411-1 2.3 BRG.
	251	31-50	Use	100 100 100 X 200 1000 50 X -- X 1000 --		8 8 5 5 4 7 M 4 I 3 2 1 5 5 9 0 G B					Input Quill
	252	33-25	"				6600	74	Low	150	
	253	36-33	"	100 100 200 X 200 1000 100 X -- X 1000 --			6400	135	Low	150	
	254	39-15	"				6600	128	High	200	
	255	10-53-53	"	100 100 100 X 200 1000 100 X -- X 1000 --			4500-6600	74	Low	100	
	256	55-20	"				6600	74	Low	150	A12-2655A (-1 Trans)
	257	58-00	"				6400	135	Low	150	13728-3 BRG.
	258	11-00-52	"				6600	128	High	200	Input Quill
	259	12-52-30	"				4500-6600	74	Low	100	
	260	54-10	"				6600	74	Low	150	
	261	57-10	"				6400	135	Low	150	ABU-11153 (-1 Trans.)
	262	59-45	"				6600	128	High	200	6753 1 2.3 BRG.
	263	13-03-130	STD.	10			4500-6600	74	Low	100	Input Quill
	264	04-05	F.S.STD.	10							
0	265	17-55	STD	10							
3	266	18-55	F.S.STD.	10							ABU-11846 (-1 Trans.)
2 7	267	14-09-46	Use	100 100 100 X 200 1000 100 X -- X 1000 --							7510H - 1&2 BRG.
6	268	11-10	"				6600	74	Low	150	Tail Rotor Output
	269	14-10	"	100 100 100 200 200 100 X -- X 1000 --			6400	135	Low	150	Bearing - Ball
	270	16-47	"				6600	128	High	200	
							4500-6600	74	Low	100	

FIGURE 6–57

HAMILTON STANDARD

MASTER DATA LOG MAGNETIC TAPE RECORDING SYSTEM

PAGE No. 902

TEST TITLE _____ HUB DESIGN _____ DATE OF TEST _____ RECORDER NO _____

PURPOSE OF TEST _____ BLADE DESIGN _____ LOCATION OF TEST _____ TAPE SPEED _____

TEST CONFIGURATION _____ ENGINE DESIGN _____ S/N _____ TEST ENGINEER _____ STARTING PAGE NO _____

TEST HARDWARE MODEL NOS _____ ENG PROP GEAR BOX _____ TEST PROGRAM NO _____

Ref No.	MEASUREMENT VARIABLE	TRANSDUCER TYPE	TRANSDUCER MODEL & S/N	TRANSDUCER EXCIT VOLT	TRANSDUCER Sensitivity or Gauge Factor	JUNCTION UNIT CHAN NO	JUNCTION UNIT SIGNAL CONDITIONER	JUNCTION UNIT MODEL & S/N	JUNCTION UNIT NOTES	PREAMP CASE CHAN NO	PREAMP CASE MODULE	PREAMP CASE MODEL & S/N	SUB CARRIER EQUIP CHAN NO	SUB CARRIER EQUIP CENTER FREQ	SUB CARRIER EQUIP MODEL & S/N	RECORD AMP TYPE	RECORD AMP S/N	RECORD AMP NOTES	TAPE TRACK	ZERO ST'D EQUIV	FULL SCALE EQUIV	Chg Ref Leg Bl. Pulse	NOTES
1	input quill ball bearing	MB-11					self gen	44		A-1	AC	70				FM		27 KC	1				
2	hyd pump & tach ball bearing	MB-11						19		2		47				FM			2				
3	main mast bearing-axial	MB-14V						33		3		54				FM			3				
4	offset acc drive gearmesh	Col. 1111-1						15		4		29				FM			4				
5	main mast bearing-radial	MB-14H		See				11		5		22				FM			5		See		
6	input quill gearmesh	Col 1111-1		Below				6		6		41				FM			6		Below		
7	sump & tail rotor bearings	MB-11						35		7		42				FM			7				
8	Sun Gears	Col 1111-1						38		8		26				FM			8				
	rpm	180 teeth					---			9	clipper	X				DIR			9				
	------						---			10	---					--			10				
9	tailrotor quill gearmesh	Col. 1111-1					self gen	9		11	AC	78				FM		27 KC	11				
	time code "B"						---			12	feed thru C	X				DIR			12				
																			13				
									S/N		Sens.	F.S							14				
									2082	B-1	95 m/in/sec	.3121 in/s	A-1										
									2078	2	96 " "	" "	2										
									1849	3	96.5 " "	.311 in/s	3										
			Bracket Set #1							4			4										
		transducer	S/N's and full scales						3089	5	97 " "	309 in/s	5										
									1548	6	36.3 rmsm/pkg	585g	6										
									2079	7	95 m/in/sec	.3121 in/s	7										
									1538	8	33.4 rmsm/pkg	.636 g	8										
								180T @	.65 input speed														
									----	10			10										
									1540	11	39 rmsm/pkg	545 g	11										
									----	12			12										
									2083	C-1	95 m/in/sec	.3121 in/s	B-1										
									2080	2	96 " "	" "	2										
									1850	3	96.5 " "	.311 in/s	3										
			Bracket Set #2							4			4										
		transducer	S/N's and full scales						2056	5	97 m/in/sec	.309 in/s	5										
									1545	6	38.4 rmsm/pkg	.554 g	6										
									2077	7	95 m/in/sec	.3121 in/s	7										
									1549	8	38.9 rmsm/pkg	546 g	8										
								Same as Above		9			9										
									----	10			10										
									1541	11	36.9 rmsm/pkg	.576 g	11										
									----	12			12										

FIGURE 6–58

HS AIDAPS VIBRATION LOG SHEET

NOTE TRANSDUCER SERIAL NUMBERS PER RUN IN TAPE TEST LOGSHEET

DATE	ITEM TESTED	SERIAL NUMBER	TOTAL TIME ON ITEM (Hrs)	TYPE AND DEGREE OF MALFUNCTION-LOCATION	S/N of MALFUNCTION ITEM	TOTAL RUNNING TIME (Hrs)	SHEET # / LOG SHEET #	RUN NUMBER	DISPOSITION OF TOTAL TEST ITEM	ARAMAC TEST LOG NUMBER			REMARKS
10-26-70	42°	B13-2965	1470	Pitted Inner Race and Grooved Pitted Rollers-Input Roller Bra.	0	1/2	02324 / 1607	150-153	Held For Addit. Defective Parts	--	0	-37	RPM sweep end value was 700" ± higher than in any other
10-26-70	90°	A13-2065	833	Fatigue Pitted Outer Race and Pitted Rollers	4428	1/2	02324 / 1607	150-153	Held For Addit. Defective Parts	--	0	-13	RPM sweep were seen Back lash .005--.007
10-26-70	42°	AEB-289	1500	Pitted Inner Race & Rollers	12256	1/2	02324 / 1608	154-157	Hold for Addit. Defective Parts	--	0	-37	--
10-26-70	90°	A13-2772	709	Fatigue Pitted Outer Race	18063	1/2	02324 / 1608	154-157	Hold For Addit. Defective Parts	--	0	-13	--
10-26-70	42°	B13-8304	1500	Rusty Pitted Rollers	101799	1/2	02324 / 1608	158-161	Hold For Addit. Defective Parts	--	0	-37	--
10-26-70	90°	B13-6624	1092	Fatigue Pitted Outer Race & Rollers	2011	1/2	02324 / 1608	158-161	Hold For Addit. Defective Parts	--	0	-13	--
10-26-70	Engine	LE-14566	1471	N.A.	N.A.	--	022167 / 2452	17-	Production Engine	--	0	-13	Control Room Vib. readout indicates power turbine has 3 mils displ. Chg's out-of-proc.
10-27-70	Trans-mission	ABU-11153	1093 / bearing 1090	Rust Pitted Ball & Outer Race Main Mast Bearing	2/N8568	--	02324 / 1608	165	Hold For Addit. Defective Parts	--	0	-5	Most S/N N-9942 Sequ. PD3LL2-38
10-27-70	Trans-mission	ABU-11153	1093	Rust Pitted Rolls & Outer Race Main Mast Bearing	457	--	02324 / 1608	--	Hold For Addit. Defective Parts	--	0	-5	N-9412 PD3LL2-37

FIGURE 6—59

MSU/AIUAPS SPECTRUM ANALYSIS

ITEM: TRANSMISSION
PARAMETER NO. 42
S/N ANU-11153 REEL NO. 02216 RUN NO. 33 TEST LOG SHEET NO. 1403
PARAMETER TITLE: WEST BALL BEARING, RADIAL SPECTRUM NO. 1933

ITEM SPEED: 6600 RPM TRANSMISSION INPUT SPEED: 6600 RPM TORQUE: 74 PRCNT
FREQUENCY RANGE: 2 - 2 HZ ANALYSIS BW: 3.510 HZ

PNT	FREQ	G-PK	IN/SEC-PK	PNT	FREQ	G-PK	IN/SEC-PK
2	2.3438	8.556E-04	2.245E-02	44	100.7813	1.303E-02	7.948E-03
3	4.6875	3.640E-03	4.775E-02	45	103.1250	1.698E-02	1.084E-02
4	7.0313	6.008E-03	5.308E-02	46	105.4688	1.946E-02	1.143E-02
5	9.3750	8.628E-03	5.690E-02	47	107.8125	3.288E-01	1.058E-01
6	11.7188	1.048E-02	5.489E-02	48	110.1563	5.584E-01	3.117E-01
7	14.0625	1.198E-02	5.107E-02	49	112.5000	2.340E-01	1.295E-01
8	16.4063	2.554E-02	9.573E-02	50	114.8438	2.836E-02	1.518E-02
9	18.7500	1.682E-02	5.517E-02	51	117.1875	2.170E-02	1.138E-02
10	21.0938	5.834E-03	1.701E-02	52	119.5313	2.884E-02	1.475E-02
11	23.4375	7.654E-03	2.008E-02	53	121.8750	2.654E-02	1.339E-02
12	25.7813	9.033E-03	2.155E-02	54	124.2188	2.278E-02	1.134E-02
13	28.1250	7.622E-03	1.667E-02	55	126.5625	2.248E-02	1.092E-02
14	30.4688	8.906E-03	1.798E-02	56	128.9063	2.809E-02	1.248E-02
15	32.8125	1.518E-02	2.845E-02	57	131.2500	2.538E-02	1.105E-02
16	35.1563	2.591E-02	4.533E-02	58	133.5938	2.223E-02	1.023E-02
17	37.5000	4.592E-02	7.383E-02	59	135.9375	1.438E-02	6.469E-03
18	39.8438	5.730E-02	8.844E-02	60	138.2813	1.340E-02	6.087E-03
19	42.1875	3.197E-02	4.669E-02	61	140.6250	2.115E-02	9.249E-03
20	44.5313	1.357E-02	1.874E-02	62	142.9688	4.016E-02	1.788E-02
21	46.8750	1.473E-02	1.932E-02	63	145.3125	2.384E-02	1.009E-02
22	49.2188	1.497E-02	1.871E-02	64	147.6563	1.074E-02	4.478E-03
23	51.5625	2.232E-02	2.662E-02	65	150.0000	1.357E-02	4.344E-03
24	53.9063	1.326E-02	1.512E-02	66	152.3438	1.438E-02	5.087E-03
25	56.2500	1.497E-02	1.538E-02	67	154.6875	1.948E-02	7.013E-03
26	58.5938	6.940E-02	7.244E-02	68	157.0313	1.838E-02	6.898E-03
27	60.9375	8.043E-02	8.117E-02	69	159.3750	1.273E-02	4.613E-03
28	63.2813	4.694E-02	4.361E-02	70	161.7188	1.003E-02	3.711E-03
29	65.6250	7.991E-02	7.488E-02	71	164.0625	1.196E-02	4.461E-03
30	67.9688	5.331E-02	4.823E-02	72	166.4063	1.227E-02	4.331E-03
31	70.3125	6.162E-02	5.390E-02	73	168.7500	1.078E-02	3.938E-03
32	72.6563	6.912E-02	5.850E-02	74	171.0938	1.401E-02	5.324E-03
33	75.0000	2.343E-02	1.921E-02	75	173.4375	1.657E-02	6.656E-03
34	77.3438	2.379E-02	1.891E-02	76	175.7812	1.438E-02	5.872E-03
35	79.6875	6.370E-02	4.910E-02	77	178.1250	1.763E-02	6.684E-03
36	82.0313	5.618E-02	4.212E-02	78	180.4688	1.084E-02	3.917E-03
37	84.3750	1.781E-02	1.298E-02	79	182.8125	2.634E-02	9.668E-03
38	86.7188	1.368E-02	9.704E-03	80	185.1563	2.347E-02	7.838E-03
39	89.0625	1.497E-02	1.032E-02	81	187.5000	1.724E-02	5.640E-03
40	91.4063	2.580E-02	1.716E-02	82	189.8438	2.639E-02	7.997E-03
41	93.7500	1.871E-02	1.227E-02	83	192.1875	2.204E-02	7.081E-03
42	95.0938	1.077E-02	6.891E-03	84	194.5313	1.438E-02	4.822E-03
43	98.4375	9.829E-03	6.140E-03	85	196.8750	1.388E-02	4.184E-03

CHARACTERISTIC FREQUENCIES

FR	G-PK	FS	G-PK	FP	G-PK	FB	G-PK	FI	G-PK	FO	G-PK
5.50	3.640E-03	22.00	5.834E-03	2.20	8.556E-04	45.10	1.357E-02	50.50	8.043E-02	47.30	1.473E-02

2FR	G-PK	3FR	G-PK
11.00	1.048E-02	16.50	2.534E-02

FIGURE 6-60 GROUND TEST BASELINE DATA 200 HZ LOW FREQUENCY ANALYSIS

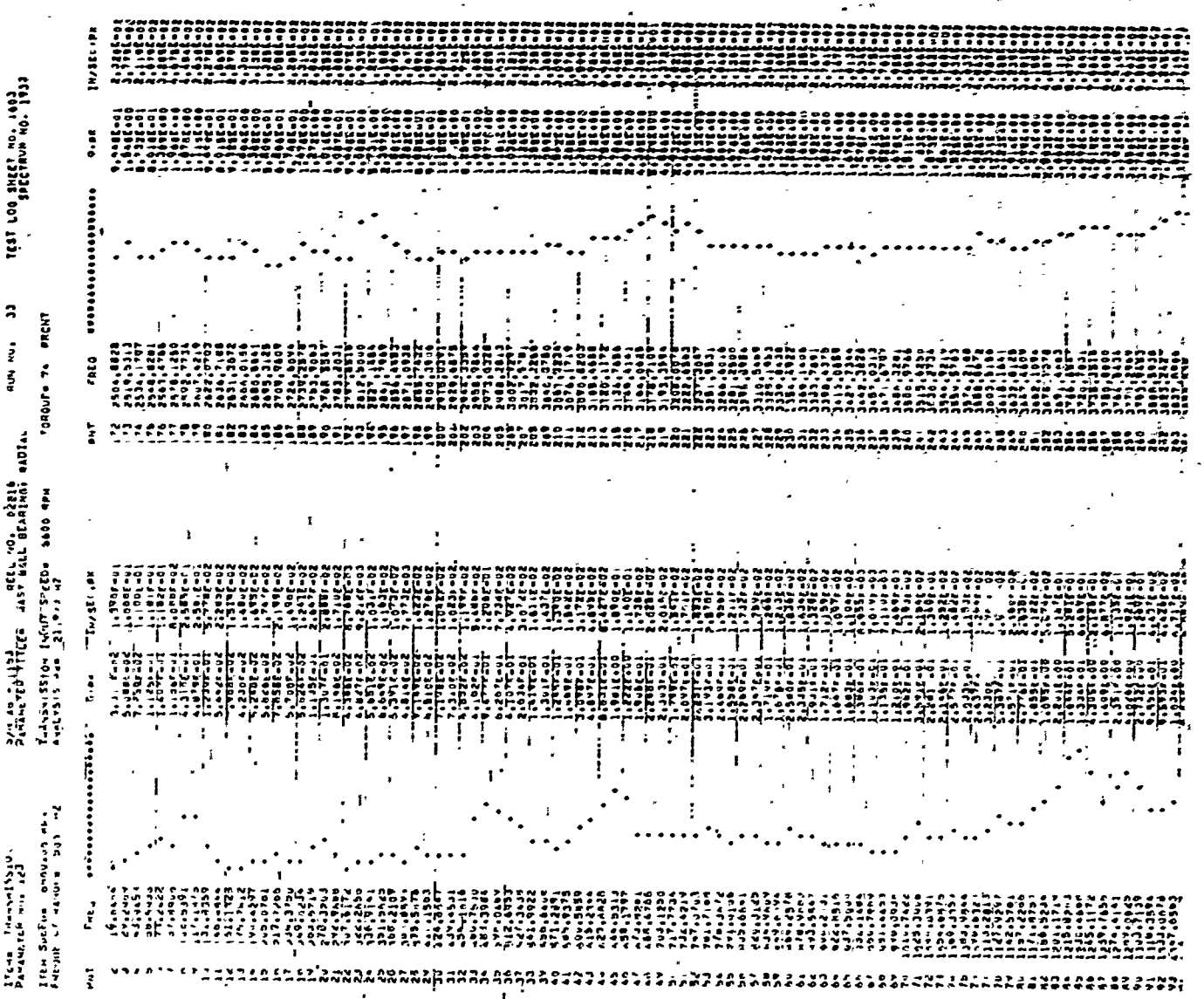
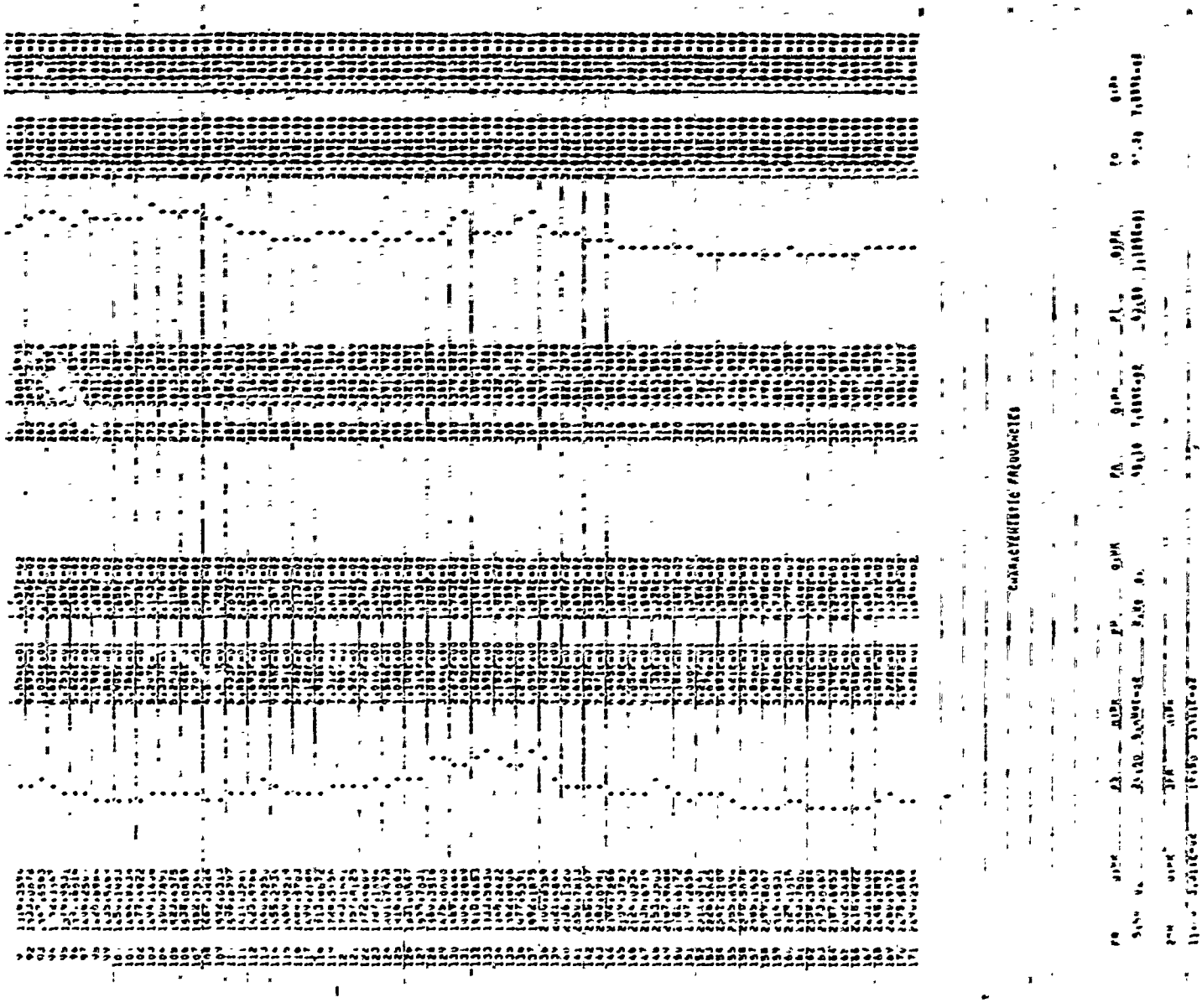


FIGURE G-61A GROUND TEST BASELINE D



E DATA 5000 HZ. HIGH FREQUENCY ANALYSIS

6-64 B

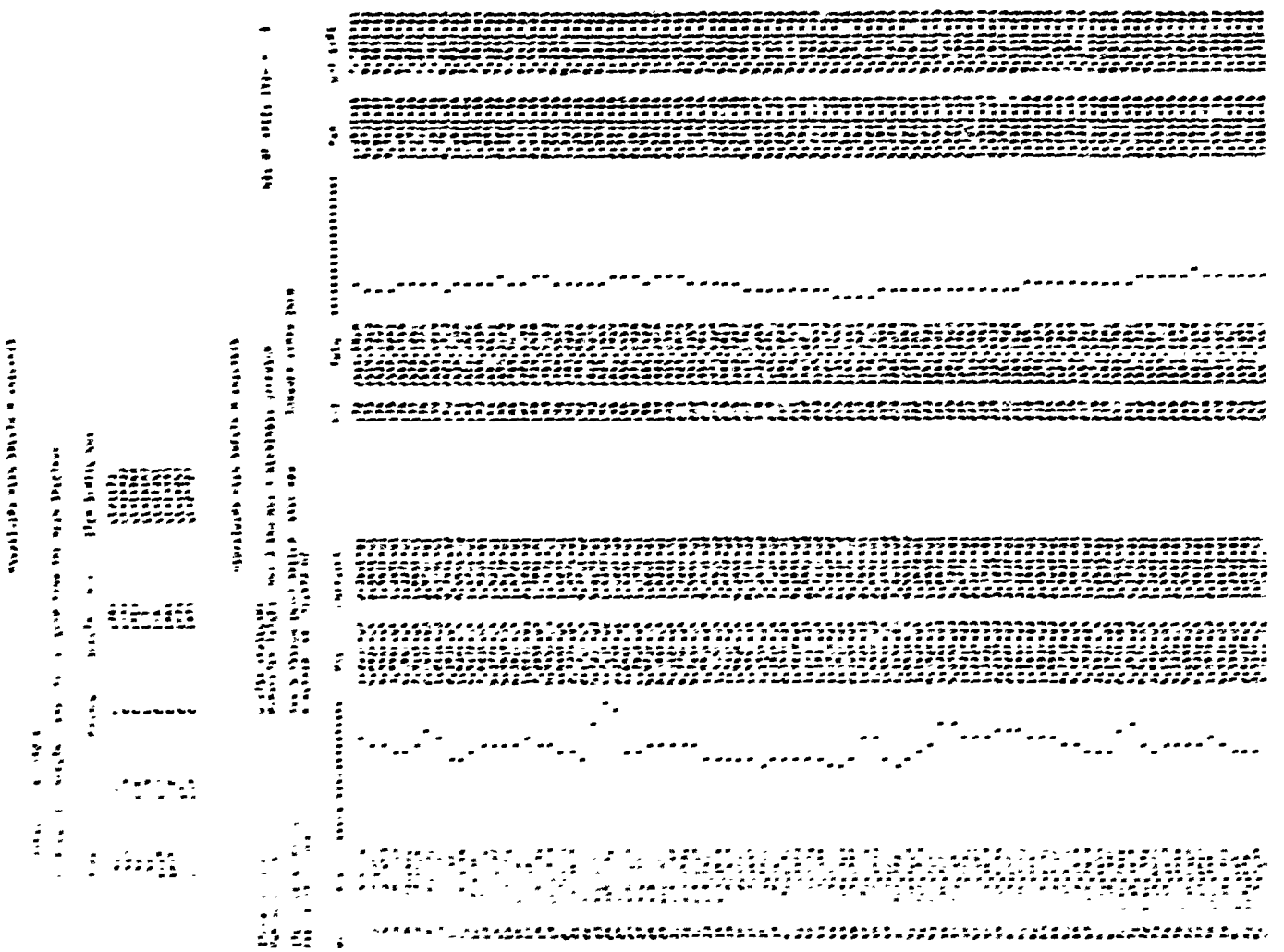


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FIGURE 6 – 62A GROUND TEST M

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TEST MEAN DEVIATION

6-62 B

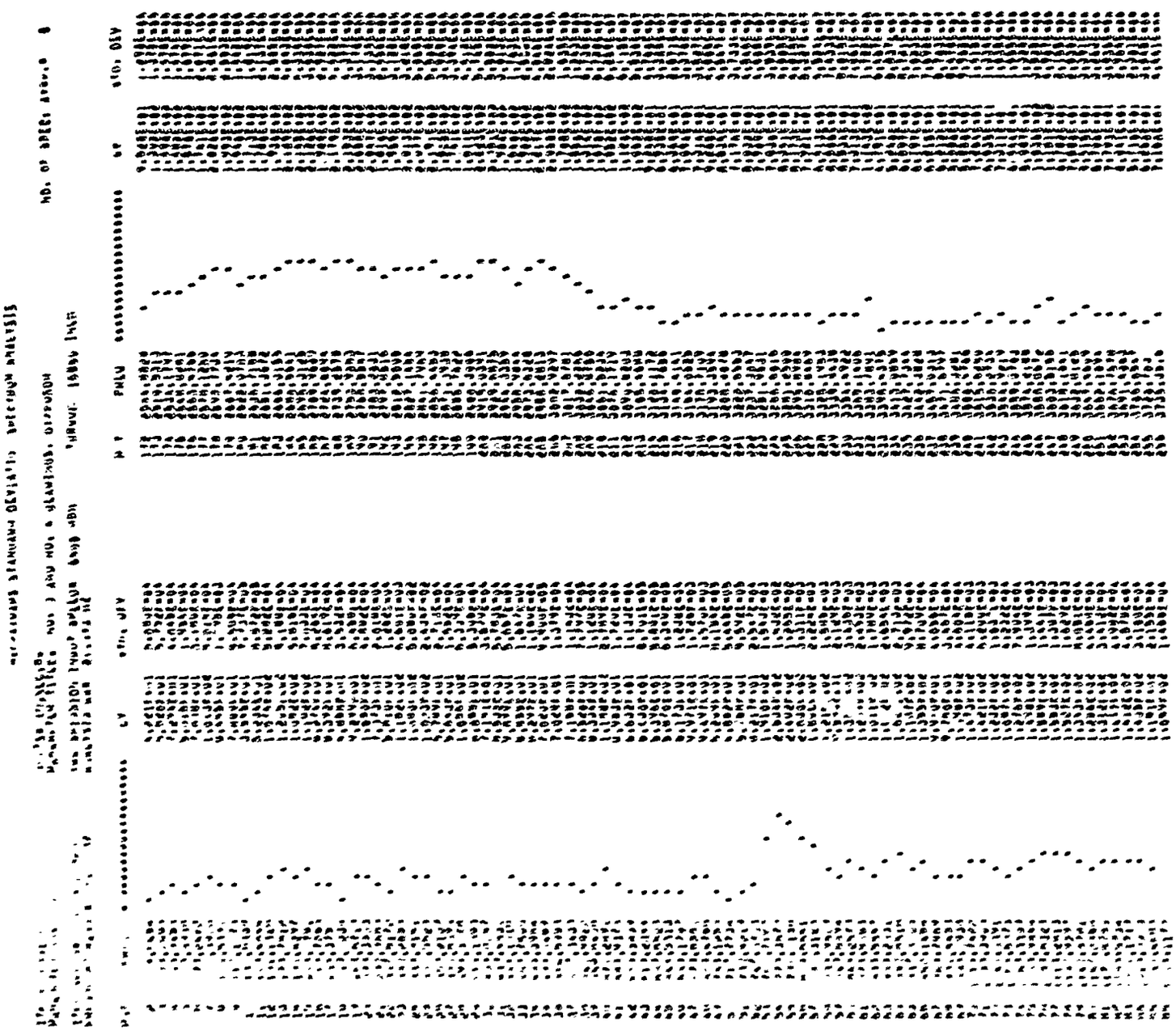

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FIGURE 6–63A GROUND TI

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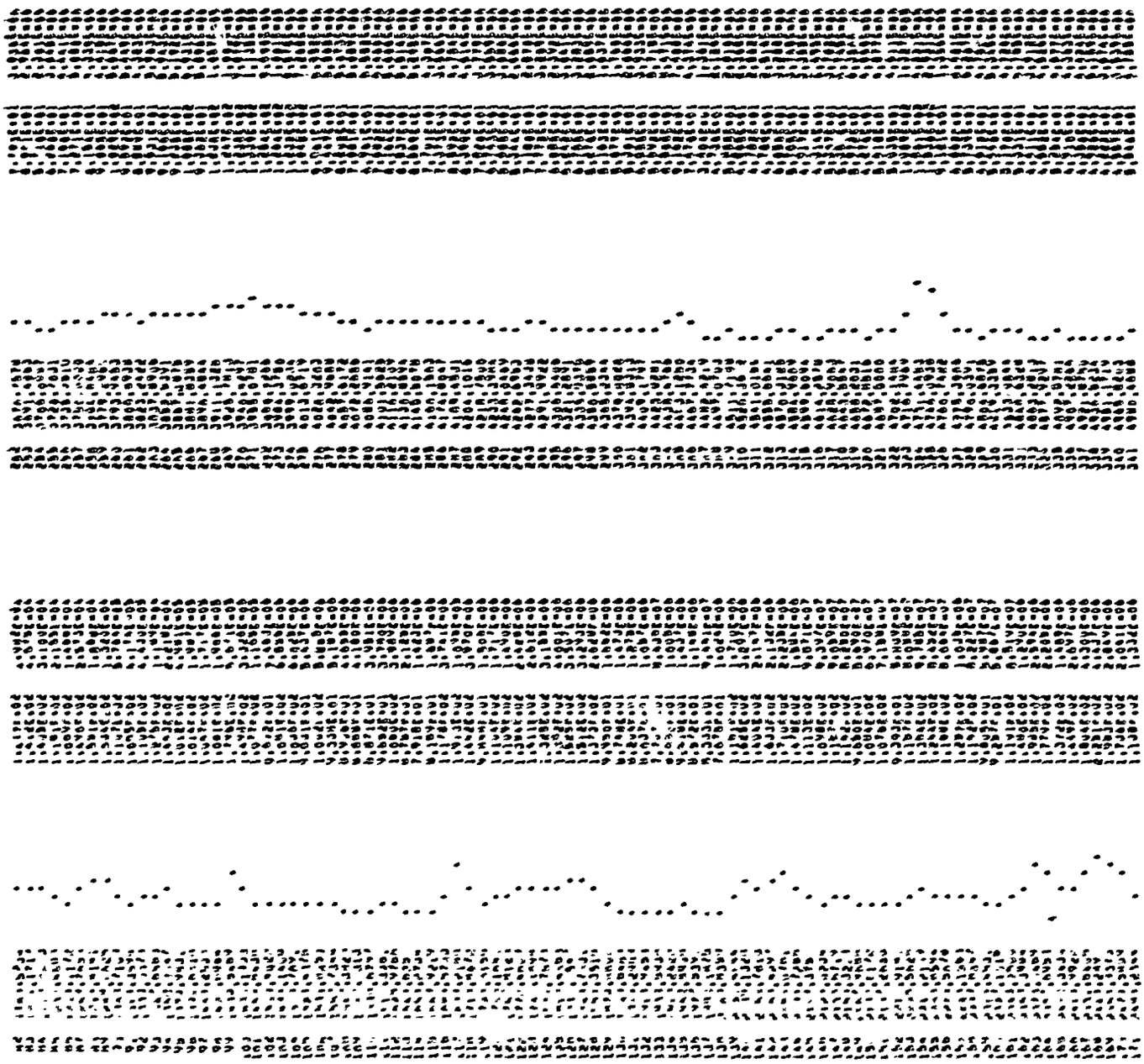


6-63 B

ND TEST STANDARD DEVIATION

HRD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION: [illegible] — DESTRUCTIVE INPUT/OUTPUT BALL BEARINGS

THE FLOOR SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED H	H+8	H+28	H+38	H+48
0327.	314	1	1069	013-8304	107	67	49	39	34
BANDS GREATER THAN H+8		45, 64, 70, 85, 87, 92, 138, 147, 150, 156, 161, 162, 172, 173, 184, 185, 195, 196, 197, 204, 207							
BANDS GREATER THAN H+48		240, 252, 253, 254, 276, 277, 299, 300, 310, 311, 312, 323, 334,							
02216.	351	1	1205	013-8199	69	33	23	20	17
BANDS GREATER THAN H+8		145, 154, 172, 188, 200, 211, 223, 246, 267, 268, 281, 292, 293, 294, 304, 305, 316,							
02216.	355	1	1211	013-2928	69	31	23	20	18
BANDS GREATER THAN H+8		80, 145, 150, 174, 177, 188, 211, 223, 250, 281, 282, 292, 293, 294, 304, 305, 316, 317,							
02216.	359	1	1217	013-8304	90	40	30	27	20
BANDS GREATER THAN H+8		145, 153, 154, 188, 196, 200, 208, 211, 223, 246, 281, 282, 293, 294, 304, 305, 306, 316, 317, 329,							
02216.	363	1	1223	ABU-289	69	45	26	15	12
BANDS GREATER THAN H+8		80, 154, 161, 163, 177, 188, 211, 223, 281, 282, 316, 317,							
0427.	395	1	1271	013-2928	74	40	27	24	20
BANDS GREATER THAN H+8		3, 147, 162, 173, 184, 185, 186, 196, 197, 208, 209, 231, 232, 265, 266, 277, 289, 300, 311, 312,							
0427	399	1	1277	ABU-289	102	63	39	35	26
BANDS GREATER THAN H+8		8/, 93, 116, 139, 147, 148, 149, 162, 172, 173, 174, 175, 184, 185, 197, 208, 209, 230, 239, 255, 266							
BANDS GREATER THAN H+48		289, 300, 301, 312, 324,							

ITEM: 42 DEGREE BEARING — UNITS: IN/SEC,PK
PARAMETER NO. 59 — PARAMETER TITLE: INPUT QUILL AND OUTPUT QUILL BEARINGS — NO. OF SPEC. AVGD.: 11

ITEM SPEED: 4172.00 RPM — TRANSMISSION INPUT SPEED: 6400 RPM — TORQUE: 3640 INLB
FREQUENCY RANGE: 1000 HZ — ANALYSIS BW: 0.709 HZ — NO. OF SPEC. COMPARED: 7

FIGURE 6-64 GROUND TEST FOUR STANDARD DEVIATION COMPARISON SUMMARY

HSU/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION NUMBER -53

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+3	M+2S	M+3S	M+4S
02391	45a	3	1344	ARU-11153	27	9	6	3	2
BANDS GREATER THAN M+4S		34, 37,							
02391	45a	3	1405	A12-4214	25	6	4	1	0
02391	45d	3	1411	A12-2655A	39	19	15	10	7
BANDS GREATER THAN M+4S		4, 43, 44, 51, 52, 57, 125,							

ITEM: TRANSMISSION
PARAMETER NO. 47

UNITS: IN/SEC-PK
PARAMETER TITLE: MAST HALL BEARING, AXIAL

NO. OF SPEC. AVERAGED: 11

ITEM SPEED: 6600.00 RPM
FREQUENCY RANGE: 5000 HZ

TRANSMISSION INPUT SPEED: 6600 RPM
ANALYSIS BWB: 21.973 HZ

TORQUE: 120 PRCNT

NO. OF SPEC. COMPARED: 3

DEFECTIVE SUN GEARD

FIGURE 6-65

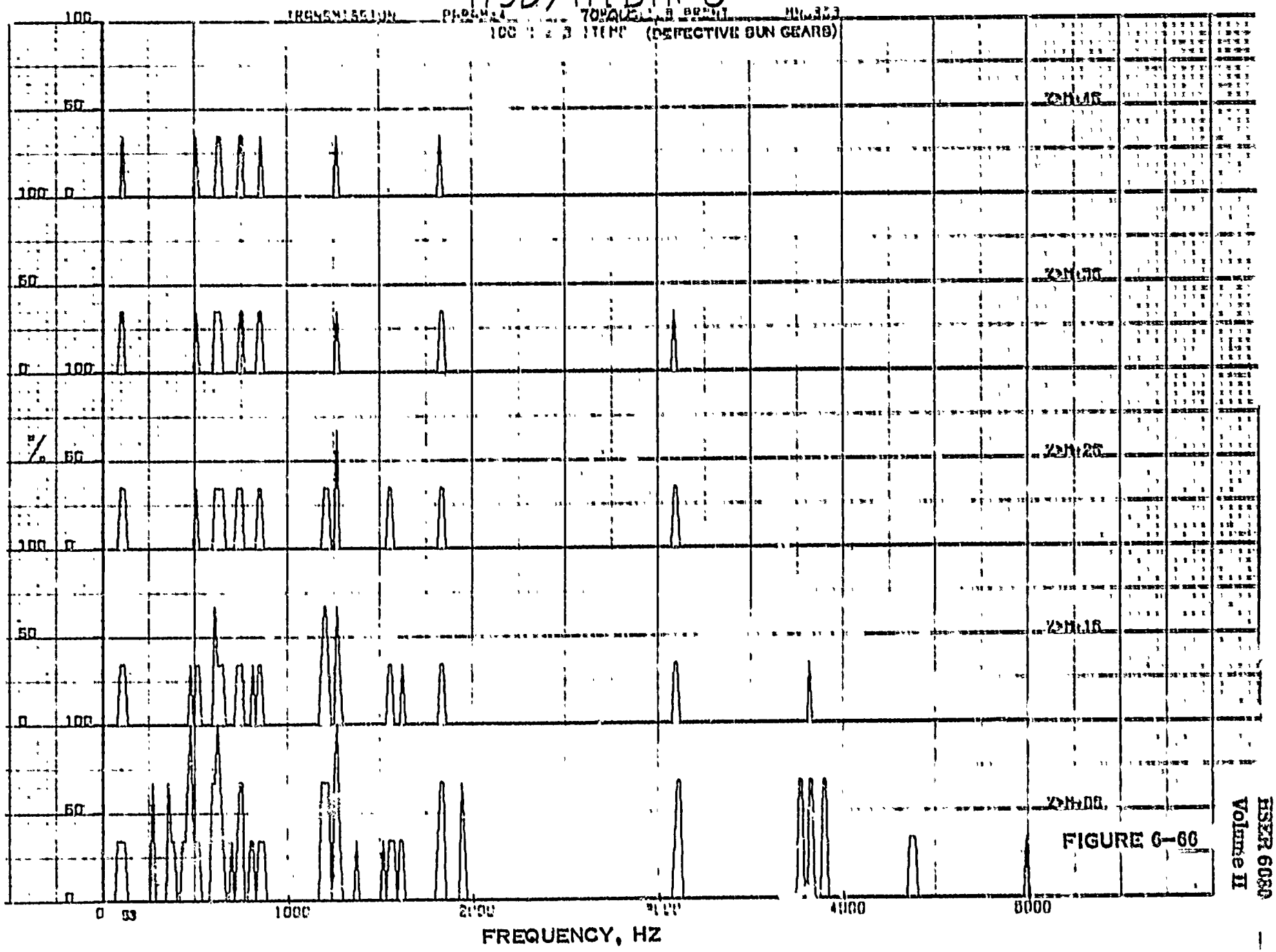
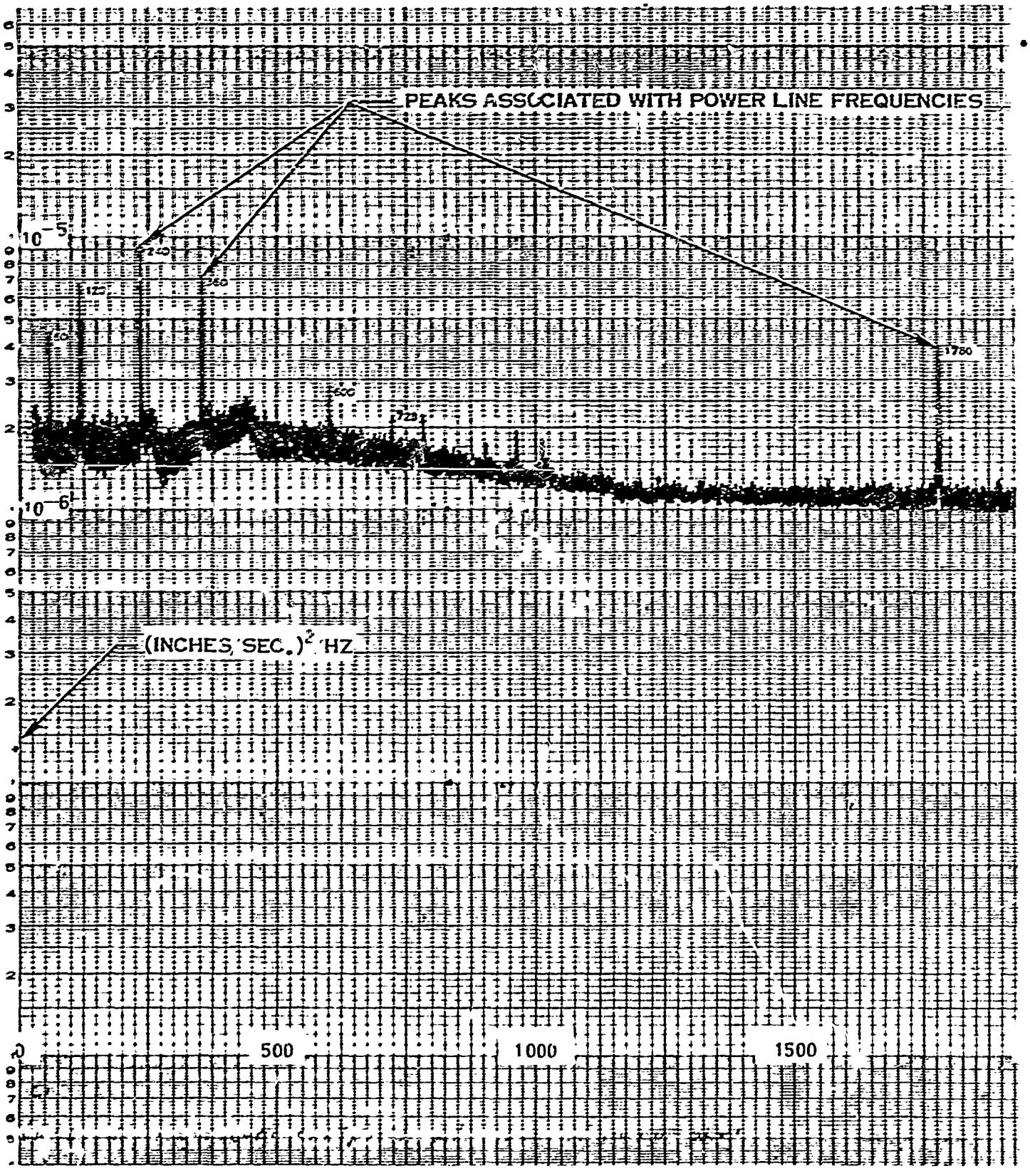
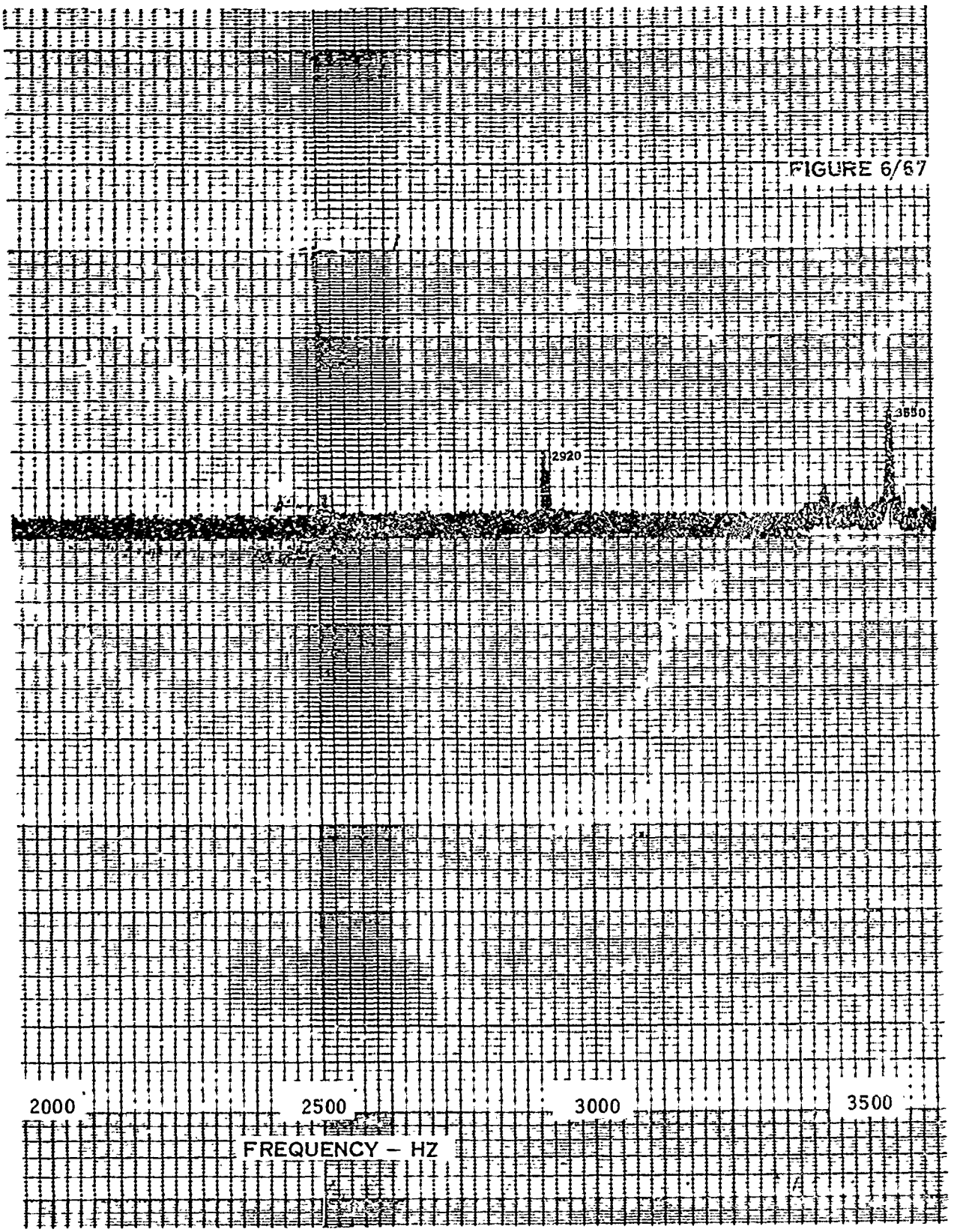

TRANSMISSION
(DEFECTIVE SUN GEARS)
100
50
0
%
0
1000
4000
8000
FREQUENCY, HZ

FIGURE 6-60

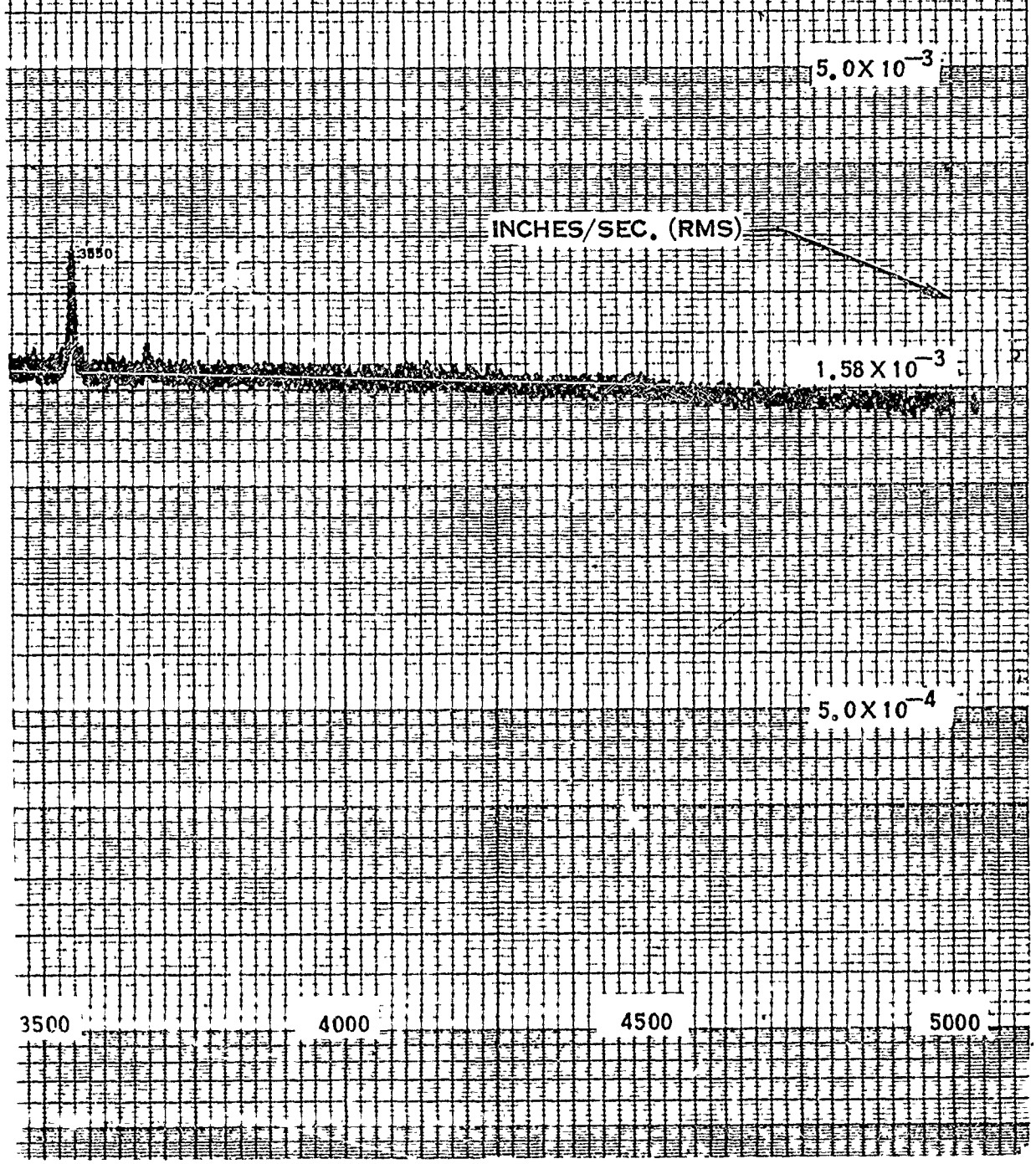

PEAKS ASSOCIATED WITH POWER LINE FREQUENCIES
10^{-5}
10^{-6}
(INCHES/SEC.)^2/HZ
500
1000
1500

6-67-A



6-67 B

URE 6/67 — SPRECTRUM ANALYSIS OF ZERO STANDARDIZE RECORD



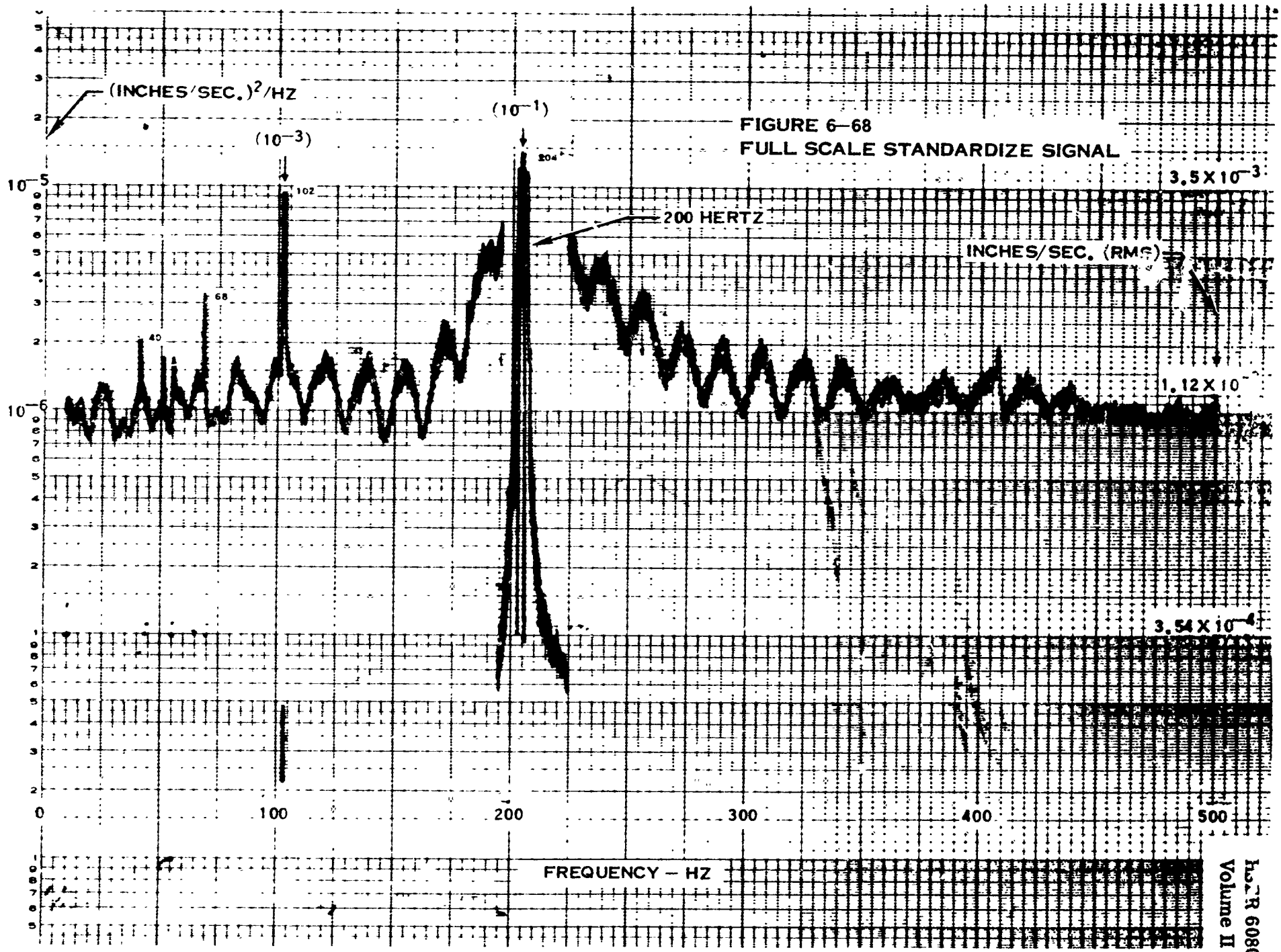


FIGURE 6–68
FULL SCALE STANDARDIZE SIGNAL

AIDAPS - Test Cell Phase Summary -400 rpm ∃ 8660 [illegible] lbs.

Part Name	Number Tested	Part Number	Part Serial No.	Component Serial Number	Description of Defective Part	4 σ exceedences parameter number #4	#7	#8	Run No.
engine	10	T53-L-13	---	LE-15615	good	0	0	0	--
				LE-14566					--
				LE-21173					119
				LE-18832					140
				LE-14568					153
				LE-18107					160
				LE-15351					175
				LE-18993					183
				LE-18257					191
				LE-20727					194
#2 main bearing	3	1-300-176-01	584	LE-15615	pitted outer race, pitted rollers, .0002 excess end wear	16	10	3	73
			925		pitted outer race, pitted & grooved rollers, .0004 end wear	9	18	2	48
			5724		N.A.	10	--	4	26
#3 main bearing	3	1-300-176-01	2350	LE-20727	pitted rollers, .0002 excess end wear	14	8	28	83
			2967		pitted outer race, .0002 excess end wear	29	3	10	55
			1164		pitted outer race, pitted rollers, .0004 excess end wear	10	7		33
#4 main bearing	3	1-300-015-04	3931	LE-15351	pitted outer race, pitted balls, .0002 excess int. clearence	14	3	2	62
			5257		pitted outer race, pitted balls, .0002 excess int. clearence	28	11	--	40
			984C		corrosive pitted balls, .0004 excess int. clearance	18	10	5	90
compressor	2	1-100-720-18	M42476	LE-15615	extreme damage	16	14	25	148
			M40543		less severe damage	15	13	17	205
power turbine	2	N.A.	3888	LE-20727	N.A.	4	22	24	126
			M63654		N.A.	2	10	20	169
N1 nozzle	2	N.A.	N.A.	LE-18993	N.A.	28	5	4	69
					N.A.	5	5	5	98
N2 nozzle	2	N.A.	N.A.	LE-18993	N.A.	1	2	10	105
					N.A.	41	1	27	133
fuel control	1	N.A.	N.A.	LE-15351	N.A.	0	14	0	112

FIGURE 6—69

AIDAPS - Test Cell Phase Summary 6-00 rpc 3 135% torque

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ exceedances parameter number #45	#125	#47	#123	#49	#126	#129	Run No.
transmission	15	204-040-01[illegible]-1	--	A12-4108	good	0	0	0	0	0	0	0	1A
				B12-1424									11
				A12-2655A									16
				A12-4162									20
				B12-198[illegible]									24
				A12-4214									29
		204-040-01[illegible]-5		ABU-11153									35
		204-040-01[illegible]-5		ABU-11846									42
		204-040-01[illegible]-1		B12-003									51
		204-040-016-1		A12-2653									57
		204-040-01[illegible]-1		A12-1013A									369
		204-040-009-31		A12-[illegible]59B									563
		204-040-009-57		B12-999B									567
		204-040-009-31		B12-621B									571
		204-040-009-31		A12-258B									575
main mast ball bearing	6	204-040-13[illegible]-7	85[illegible]E	ABU-11153	rust pitted balls & outer race	11	6	--	4	3	5	8	166
			457	ABU-11153		6	8	--	7	4	2	6	170
			894C	ABU-11153		8	7	--	14	7	2	6	186
			467L	ABU-11153	rust pits, flaking on balls inner & outer race	6	5	--	17	3	7	2	190
			278K	ABU-11153		7	10	9	19	5	9	4	136
			408R	ABU-11153		4	6	5	15	2	8	3	140
sun gears, upper	3	204-040-330-3	A12-6197	ABU-11153	excessive wear across tip of teeth	9	7	2	10	--	--	--	449
			A12-9059	A12-4214	light metal indentations on all teeth	0	1	0	0	--	--	--	453
			B12-4837	A12-2655A	metal breakout on some teeth, heavy wear	11	7	8	12	--	--	--	457
pinion planetary, upper and lower	4	204-040-108-7	B12-14247 & A12-3406	A12-4214	excessive wear near base of teeth.	7	12	4	8	--	--	--	489
			A12-113 & B12-2603	ABU-11153	metal indentations	17	10	5	6	--	--	--	493
			B12-14028 & B12-4022	A12-2655A	spalling on edge of gear teeth	8	10	2	8	--	--	--	497
			? & ?	ABU-11846	excessive wear on gear teeth	6	8	1	1	--	--	--	501

FIGURE 6—70A

AIDAPS - Test Cell Phase Summary 6400 rpm 1 13% torque

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	# 45	# 125	# 47	# 123	# 49	# 126	# 129	Run No.
						# of exceedances parameter number							
transmission - continued													
input quill ball bearing	10	204-040-346-3	3208	A12-2655A	pitted outer and inner races	5	--	1	1	5	6	--	175
			9689	A12-4214	rusty, pitted balls and outer races	4	2	7	6	16	20	0	182
			1846	ABU-11153	rusty balls and grooved inner race	2	4	1	2	4	5	2	213
			460	ABU-11846	rusty balls and grooved inner race	7	6	--	6	12	10	4	217
			L610	A12-2655A	rusty balls and outer race	7	4	2	4	9	8	12	221
			12350	A12-4214	rusty pitted balls and inner race	1	2	0	0	12	13	6	225
			J411	A12-4214	rusty pitted balls and outer race	2	1	2	4	9	14	7	252
			13728	A12-2655A	pitted inner & outer race	1	1	1	4	4	7	11	256
			6753	ABU-11153	pitted balls inner & outer races	3	1	3	4	6	6	15	260
			K1562	A12-4214	cut balls, pitted outer & inner races	--	--	--	--	8	17	--	332
accessory drive gears	4	204-040-762-1	F12-145	A12-4214	rust pitting on some teeth	--	1	--	--	--	22	--	528
		204-040-763-1	B12-1807	ABU-11153	spalling on gear teeth	--	2	--	--	--	4	--	531
		204-040-762-1	B12-1450	A12-2655A	heavy wear on one end of teeth	--	9	--	--	--	12	--	535
		204-040-763-1	A12-592	ABU-11846	spalling	--	0	--	--	--	11	--	539
tail rotor quill roller bearing	6	204-040-310-1	101485	ABU-11846	rust pitted inner race	--	--	--	--	12	16	--	385
			116550	A12-4214	pitted inner race	--	--	--	--	13	14	--	413
			115840	ABU-11153	pitted inner race	--	--	--	--	0	9	--	417
			133687	A12-2655A	pitted inner race	--	--	--	--	15	11	--	421
			28261	ABU-11846	corrosive pitted inner race & rollers	--	--	--	--	17	4	--	425
			159477	ABU-11846	pitted inner race, groove pitted rollers	--	--	--	--	13	3	--	461
tail rotor quill ball bearing	11	204-040-143-1	7510K	ABU-11846	corrosive pitted & scored balls	7	3	2	3	16	31	14	268
			6234H	A12-2655A	pitted balls and outer races	0	5	2	1	4	6	5	292
			9797G	A12-4214	corrosive pitted balls & outer races	3	3	4	6	7	21	9	296
			7145E	ABU-11153	pitted balls	1	3	1	2	1	11	14	300
			2506D	ABU-11846	pitted & scored balls & outer races	14	0	10	0	13	22	22	304
			7159E	ABU-11153	corrosive pitting on balls, inner & outer races	--	--	--	--	3	6	--	336
			72311	A12-2655A		--	--	--	--	6	7	--	340
			470K	ABU-11846		--	--	--	--	10	12	--	344
			69599	A12-4214		--	--	--	--	38	78	--	373
			38124	ABU-11153	rust pitted balls & outer race	--	--	--	--	3	6	--	377
			44282	A12-2655A		--	--	--	--	12	8	--	381

FIGURE 6-70B

AIDAPS - Test Cell Phase Summary

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ exceedances parameter number							Par No.
						#45	#125	#47	#123	#49	#121	#126	
high time before overhaul	4												
sun gear		204-040-530-3	A12-4348	A12-759	heavy wear	0	6	65	21	16	18	--	69
tail rotor gear		204-040-103-7	A12-2661	A12-759	heavy wear on teeth								89
planetary pinion roller bearing		204-040-725-3	N.A.	A12-759	2 missing rollers								89
upper sun gear		204-040-330-3	A12-7105	D12-621	worn gear teeth	3	38	--	3	25	35	--	93
upper pinion gears		204-040-108-7	N.A.	D12-621	spalled and worn teeth								93
roller bearings		204-040-725-1	N.A.	D12-621	nicked and grooved								91
upper sun gear		204-040-330-3	F12-1832	D12-999	chipped teeth	0	0	--	34	36	17	--	97
input pinion		204-040-700-1	A12-8932	D12-999	rust and pitting on inner race								97
lower sun gear		204-040-329-1	D12-2406	D12-999	heavy wear								97
accessory drive bearing		204-040-135-1	N.A.	D12-999	rough, rusty and pitted								97
bearing		204-040-142-1	N.A.	D12-999	rough, rusty and pitted								97
input pinion		204-040-700-1	A12-649	A12-258	pitting on inboard bearing race	11	6	--	34	20	19	--	100
inner clutch race		204-040-190-7	A12-982	A12-258	excessive pitting								100
sun gear		204-040-336-1	D12-2950	A12-258	obsolete								100

FIGURE 6—70C

4 σ exceedances parameter number

# 45	# 125	# 47	# 123	# 49	# 124	# 129	Run No.
11 8, 67-69, 81, 86, 102, 103, 108-110	6 68, 69, 102, 109, 133, 218	--	4 109, 120, 290, 339	3 1[illegible], 159, 160	5 13, 17, 109, 290, 332	8 7-9, 13, 76, 177, 332, 333	116
6 68, 69, 76, 102, 103, 109	8 68, 69, 109, 133, 215, 219, 245, 246	--	7 120, 133, 134, 297, 298, 339, 340	4 124, 160, 161, 211	2 109, 283	6 76, 86, 177, 178, 333, 334	120
8 67-69, 86, 102, 103, 109, 110	7 68, 109, 110, 133, 215, 245, 246	--	14 64-70, 120, 129, 133, 140, 153-155	7 5-7, 17, 160, 161, 211	2 105, 109	6 19, 20, 177, 178, 333, 334	126
6 67, 68, 102, 103, 109, 110	5 109, 110, 133, 137, 215	--	17 65-71, 120, 129, 140-155	3 160, 161, 321	7 105, 106, 108, 109, 198, 333, 334	2 333, 334	130
7 67-69, 86, 102, 103, 245	10 68, 102, 109, 114, 133, 137, 172, 245, 246, 260	9 58, 62-67, 109, 211	19 58, 59, 61-69, 120, 140, 150-155	5 160, 161, 211, 319, 333	9 105, 108, 109, 120, 177, 178, 283, 290, 333	4 76, 177, 319, 333	136
4 67, 68, 102, 103	6 68, 102, 103, 133, 172, 245	5 109, 124, 128, 129, 211	15 45, 49, 64-69, 75, 76, 124, 128, 129, 140, 149, 152, 153	2	8 102, 103, 105-107, 109, 160, 177	3 76, 177, 133	140
9 40, 80, 84, 107, 120, 140, 205, 206, 253	7 34, 40, 41, 120, 205, 206, 239	2 84, 85	10 67, 84, 100, 101, 121, 205, 206, 289, 290, 291	--	--	--	449
0	1 41	0	0	--	--	--	453
11 7, 8, 14, 120, 121, 164, 177, 178, 205, 206, 253	7 8, 41, 79, 120, 121, 205, 206	8 7, 8, 42, 43, 49, 50, 79, 206	12 41, 42, 49, 50, 79, 120, 121, 164, 205, 206, 289, 290	--	--	--	457

FIGURE 6-70D

4 σ exceedances parameter number

# 45	# 125	# 47	# 123	# 49	# 124	# 129	Run No.
7 3, 4, 120, 205, 206, 253, 254	12 79, 120, 121, 144, 175, 205, 206, 237, 238, 253, 254, 331	4 84, 129, 20[illegible], 249	8 3, 84, 129, 143, 20[illegible], 20[illegible], 252, 335	--	--	--	489
17 7, 8, 14, 24, 25, 73, 76, 79, 80, 84, 107, 120, 126, 205, 206, 253, 254	10 8, 71, 120, 121, 126, 205, 206, 239, 253, 254	5 8, 15, 79, 84, 85	6 7, 79, 205, 20[illegible], 289, 290	--	--	--	493
8 41, 120, 121, 167, 204, 205, 206, 253	10 41, 79, 120, 167, 42, 20[illegible], 204, 205, 206, 247, 248, 330	2	8 120, 121, 205, 206, 210, 252, 289, 328	--	--	--	497
6 4, 80, 81, 84, 91, 176	8 80, 108, 127, 175, 176, 226, 260, 261	1 43	1 176	--	--	--	501
5 124, 133, 265, 269, 270	--	1 265	1 67	9 37, 124, 211, 212, 247	6 37, 38, 124, 247, 327, 328	--	175
4 7-9, 211	2 8, 9	7 8, 9, 256, 264, 265, 296, 297	6 92, 93, 297, 303, 339, 340	16 8, 9, 37, 124, 160, 163, 237, 238, 246, 247, 269, 270, 280-290, 297	20 37, 38, 90-93, 114, 115, 123, 124, 160, 228, 236-238, 246, 247, 289, 296, 297, 301	8 7-9, 81, 86, 333, 334, 342	182
2 76, 109	4 133, 143, 144, 211	1 109	2 297, 339	4 37, 38, 160, 161	6 37, 38, 109, 128, 160	2 177, 333	213
7 86, 129, 133, 177, 178, 183, 270	8 129, 133, 144, 145, 178, 261	--	4 177, 178, 214, 297, 290, 341	18 37, 38, 92, 124, 265, 275, 276, 280, 281, 289, 290, 318	10 38, 92, 93, 124, 275, 276, 280, 281, 289, 290	4 2, 38, 133, 261	217

FIGURE 6-70E

4 σ exceedance parameter number

* 45	* 125	* 4[illegible]	* 123	* 40	* 124	* 129	Run No.
7 102, 107, 124, 133, 141, 225, 270	4 102, 107, 133, 154	2 265, 266	4 102, 107, 270, 280	9 37, 38, 92, 93, 124, 165, 182, 218, 247	8 38, 92, 109, 124, 165, 247, 328, 338	18 2, 37, 38, 63, 211, 212, 216, 217, 236-239	221
1 258	2 41, 123	0	8 90, 92, 101, 209, 287, 294, 309, 339	18 37, 90, 91, 113, 123, 158, 209, 234, 235, 243-245	13 37, 89-93, 113, 123, 234, 235, 243, 244, 316	6 2, 209, 243-245, 252	224
2 123, 258	1 123	2 85, 86	4 252, 294, 304, 339	9 37, 91, 113, 123, 234, 235, 236, 244, 245	14 37, 91, 92, 113, 114, 123, 128, 234, 235, 236, 244, 245, 258, 316	7 2, 244, 245, 276, 276, 281, 287	252
1 123	1 123	1 43	4 210, 214, 304, 307	4 37, 123, 244, 245	7 37, 38, 109, 123, 209, 244, 245	11 2, 37, 38, 123, 141, 196, 198, 209, 210, 244, 245	256
3 7-9	1 133	3 8, 9, 86	4 2, 109, 110, 290	6 8, 9, 37, 184, 160, 161	6 8, 13, 37, 38, 105, 109	15 2, 37, 38, 123, 141, 196, 198, 209, 210, 244, 245	270
--	--	--	--	8 2, 114, 123, 184, 236, 237, 245, 246	17 105, 109, 113, 114, 123, 124, 128, 150, 235-237, 240, 244-246, 259, 341	--	332
--	1 149	--	--	--	22 3, 31, 99, 100, 117, 121-123, 150, 157, 158, 166, 207, 225, 232-234, 240, 242-244, 256	--	328
--	2 62, 128	--	--	--	4 41, 123, 158, 159	--	331
--	9 79, 120, 163-165, 205, 206, 248, 331	--	--	--	18 38, 112, 120, 121, 206, 231, 236-243	--	335
--	8 71, 79, 80, 106, 175, 205, 206, 259	--	--	--	11 80, 105, 107-109, 120, 183, 206, 254, 296, 297	--	339

FIGURE 6-70F

4 σ exceedances parameter number

Run No.	# 45	# 125	# 47	# 123	# 49	# 125	# 129
385	--	--	--	--	18 3, 4, 84, 120, 249, 270, 274, 290, 297, 310-318	16 3, 4, 102, 103, 105, 107-109, 208, 209, 295, 297, 301, 325, 326	--
413	--	--	--	--	13 2, 31, 41, 116, 119, 120, 204, 205, 229, 230, 238-240	14 3, 41, 116, 118, 119, 120, 204, 205, 229, 230, 231, 238-240	--
417	--	--	--	--	8 2, 41, 120, 149, 156, 157, 206, 240	9 3, 40, 41, 47, 50-53, 240	--
421	--	--	--	--	15 2, 31, 32, 41, 50, 119, 120, 181, 102, 204-206, 238-240	11 31, 32, 41, 53, 119, 120, 204, 205, 238-240	--
425	--	--	--	--	17 2-4, 31, 50, 84, 120, 183, 206, 240, 260, 269, 273, 274, 270, 310, 311	4 32, 46, 47, 206	--
461	--	--	--	--	13 3, 4, 84, 120, 102, 183, 240, 260, 269, 273, 270, 309, 310	1 71, 120, 206	--
268	7 80, 81, 85, 86, 123, 128, 176 123, 128, 176	3 127, 128	2 210, 294, 295	3	16 4, 37, 35, 91, 183, 234, 235, 244, 250, 273, 270, 304, 305, 319, 327, 328	31 37-39, 46, 47, 102, 104, 105, 108, 109, 183, 140, 141, 164, 203, 216, 217, 219, 220, 231, 234, 235, 257, 258, 273, 301, 304-306, 319, 319	14 12, 18, 19, 20, 37, 62, 64-67, 132, 176, 244, 245
292	8 13, 14, 124, 133, 153, 167, 211, 269	5 133, 153, 167, 172, 211	2 264, 265	1 300	4 124, 211, 216, 247	6 123, 124, 237, 246, 247, 327	5 2, 8, 211, 216, 246
295	3 105, 123, 258	3 105, 106, 123	4 85, 86, 105, 106	6 2, 105, 106, 210, 234, 294	7 110, 183, 234-236, 244, 245	21 105, 108, 109, 113, 114, 182, 183, 188, 150, 151, 159, 202, 226, 234-236, 240, 244, 245, 254, 258	9 2, 19, 105, 203, 224, 227, 244, 245, 287

FIGURE 6-70G

# 45	# 125	# 4[illegible]	# 123	# 43	# 128	# 129	Par No.
1 109	3 129, 13[illegible], 245	1 109	2 1[illegible], 339	1 1[illegible]0	11 3, 38, 39, 41, 102, 109, 123, 160, 319, 332, 333	14 2, 6, 38-41, 61-65, 177, 282, 283	300
14 7-9, 13, 106-109, 129, 193, 192, 205, 211, 212, 270	6 8, 9, 10[illegible]-10[illegible], 129, 133	10 8, 9, 13, 10[illegible]-10[illegible], 133, 25[illegible], 2[illegible]	8 10-10[illegible], 1[illegible], 5[illegible], 2[illegible], 340, 341	13 4-8, 13, 184, 27[illegible], 2[illegible], 280, 304, 318, 319	22 13, 14, 105-109, 124, 174, 188, 27[illegible], 280, 309, 315-321, 332, 333	22 2, 7-10, 12-14, 16, 17, 61, 62, 64-67, 1[illegible], 133, 281, 273, 27[illegible]	304
"	"	"	"	3 8, 1[illegible]0, 161	6 109, 160, 283, 29[illegible], 333, 334	"	336
"	"	"	"	6 8, 183, 184, 209, 244, 245	7 109, 183, 209, 23[illegible], 244, 245, 324	"	340
"	"	"	"	10 8, 4, 274, 275, 279, 280, 284, 289, 317, 318	12 96, 103-109, 279, 280, 283, 332	"	344
"	"	"	"	18 17, 22-24, 29, 30, 47, 92, 93, 123, 149, 158, 159, 161, 162, 209, 20[illegible], 210, 225, 226, 230, 231, 235, 244, 245, 253, 265-267, 27[illegible]-27[illegible], 285, 287, 290, 309, 304	78 3, 23, 24, 62, 67, 92, 93, 100-103, 105, 109, 113, 115, 116, 123, 128, 138-140, 142, 165, 204-207, 223-236, 242, 244, 245, 253, 254, 260, 275, 286, 287, 290-292, 295, 29[illegible], 300, 301, 307, 311, 312, 321-333, 337, 338, 340-342	"	373
"	"	"	"	3 15, 157, 202	6 105, 107, 108, 157, 326, 327	"	377
"	"	"	"	12 31, 38, 41, 50, 120, 121, 182, 183, 205, 206, 240, 241	8 38, 50, 120, 183, 205, 206, 240, 241	"	381

4 σ exceedances parameter number

FIGURE 6-70H

λ σ correlation parameter number

# 45	# 125	# 4[illegible]	# 181	# 49	# 186	# 189	Run No.
0	6 4[illegible], 4[illegible], 19[illegible], 19[illegible], 2[illegible], 278	65 2[illegible], 10-12, 38-42, 46, 4[illegible], 49-59, [illegible], 115, 116, 136-140, 143, 144, 19[illegible], 197, 221, 229, 244, 2[illegible]1, 2[illegible]7, 278, 281, 284	21 7, 46, 4[illegible], [illegible], 76, 15[illegible], 18[illegible], 18[illegible], 204, 227, 233, 2[illegible]1, 2[illegible]7, 278, 283, 286-290, 31[illegible]	16 29-31, 39, 40, 130, 131, 139, 140, 144, 150, 259, 273, 318, 320, 321	18 29, 40, 103, 106, 116, 130, 131, 139-141, 144, 145, 190, 197, 258, 259, 277, 278	129 "	89
3 17, 242, 243	32 4[illegible], 4[illegible], 97, 98, 139, 140, 146, 147, 153, 154, 157-160, 181, 201, 202, 227, 230, 231, 237, 242, 243, 277, 278, 290, 291, 293, 311, 332, 338, 339	"	3 12-14	85 5-7, 16, 17, 22, 40, 45-47, 78, 130, 131, 139, 140, 205, 259, 260, 277-279, 307, 311, 318, 326	35 2, 16, 17, 23-25, 39-42, 46, 47, 53, 54, 61, 62, 77, 78, 130, 131, 139-141, 145, 197, 222, 258-260, 277, 278, 283, 289, 304, 338	"	93
6 25, 2[illegible], 53, 54, 2, 3, 40-42, 46, 47, 181 119, 220	8	"	34 17, 45-47, 53-57, 60-63, [illegible]-69, 120, 142-149, 156, 195, 220, 224, 225, 230, 239	36 2, 5, 26, 38-41, 45, 60-63, 119-121, 129, 130, 146-150, 154, 155, 157, 169, 170, 173-176, 219, 220, 238, 239, 257	17 2, 39, 50, 51, 53, 54, 60-62, 145, 153, 154, 169, 170, 201, 220, 257	"	97
11 25, 26, 76, 113, 133, 137, 151, 218, 273, 151, 218, 219, 274 253, 273, 274, 330	6	"	14 61, 63-69, 93, 136-138, 273, 274	20 4-7, 22, 26, 117, 118, 137, 138, 170, 234, 235, 273, 274, 289, 303, 316, 320, 321	19 22, 38, 39, 95, 113, 114, 137, 163, 229, 235, 254, 255, 273, 289, 337, 338, 340-342	"	100

FIGURE 6—701

AIDAPS - Test Cell Phase Summary [illegible]

Part Name	Number Tested	Part Number	Part Serial Number	Component Serial Number	Description of Defective Part	# of occurrences Parameter No. #10	#11	Run No.
42° gearbox	11	204-040-001-37	--	B13-4661	[illegible]	[illegible]	[illegible]	[illegible]
		-33		B13-2925				71
		-37		B13-5304				[illegible]
		-37		B13-5199				[illegible]
		-37		ABB-289				110
		-37		B12-7022				203
		-37		B13-[illegible]03				545
		-37		B13-[illegible]				549
		-37		B13-2910				553
		-37		B13-4023				557
		-37		A13-844				
			(I) (O)					
input/output bevel gears	6	204-040-300-9(I)	A13-11597 & A13-2052	B13-2925	reject gears	[illegible]	37	274
		-10(O)	B12-26547 & A13-5905	ABB-289	wear pattern to high on input, worn & scuffed teeth on output	[illegible]	18	278
			CP13-896 & 11583	B13-8304	wear pattern to high & scuffing on input, wear pattern low & scuffing output	30	41	282
			42[illegible]6 & A13-3000	B13-5199	slight scuffing on input, pitting on tooth on output	28	20	286
			A13-747 & 14441	ABB-289	pattern to low on input & output	26	42	328
			B12-8720 & 15427	B13-2925	wear pattern to high on input, pattern to low & scuffing on output	29	32	320
input/output ball bearing	7	204-040-143-1	44282 (O)	B13-8304	rusty pitted balls & outer races	34	66	314
			38948 (O)	B13-5199	corrosive pitting on balls and inner & outer races	17	18	351
			48820 (I)	B13-2925		18	25	355
			37968 (O)	B13-8304		20	30	359
			97978 (I)	ABB-289	corrosive pitted balls and outer races	18	5	363
			71598 (O)	B13-2925	corrosive pitting on balls and inner & outer races	20	39	375
			72311 (O)	ABB-289		20	15	399
input roller bearing	7	204-040-310-1	103524	B13-5199	corrosive pitted rollers & pitted inner race	18	23	147
			155203	B13-2925	groove pitted rollers and pitted inner race	13	18	151
			1225[illegible]	ABB-289	pitted rollers and inner race	20	24	155
			101729	B13-8304	rusty pitted rollers	31	47	159
			5354	B13-2925	grooved rollers & pitted inner race	14	17	187
			13378	ABB-289	grooved & pitted rollers & pitted inner race	11	7	191
			101[illegible]19	B13-5199	grooved rollers & pitted inner race	35	31	310

FIGURE 6-71A

AIDAPS - Test Cell Phase Summary

Part Name	Number Tested	Part Number	Part Serial Number	Component Serial Number	Description of Defective Part	# of exceedances parameter no.		Run No.
high time before overhaul	4					59	61	
input roller bearing		204-040-310-1	9173	B13-2970	pitted race	--	6	103
output roller bearing		204-040-310-1	11329	B13-2970	pitted race			103
output ball bearing		204-040-143-1	47225	A13-854	rough	--	9	107
input roller bearing		204-040-310-1	100050	A13-854	pitted race			107
output ball bearing		204-040-143-1	7940E	B13-5572	rusty balls	--	5	111
output bevel gear		204-040-500-10	N.A.	B13-4023	N.A.	--	3	115
output roller bearing		204-040-310-1	101029	B13-4023	rusty, pitted inner race & rollers			115
input roller bearing		204-040-310-1	115948	B13-4023	pitted race			115
input ball bearing		204-040-143-1	—	B13-4023	rusty balls			115

FIGURE 6-71B

4 σ exceedences/parameter number # 59	# 61	Run No.
22 81, 138, 139, 147, 156, 161, 172, 173, 185, 196, 208, 265, 287-289, 299, 300, 310-312, 333, 334	37	274
14 147, 148, 162, 173, 185, 196, 220, 266, 289, 300, 311, 312, 323, 324	18	278
30 65, 66, 81, 85, 87, 92, 147, 156, 157, 161, 162, 172, 173, 196, 220, 238, 254, 265, 266, 276, 277, 288, 289, 299, 300, 310-312, 328, 334	41	282
28 44, 65, 87, 92, 103, 115, 138, 146, 147, 160, 161, 171-173, 184, 195, 196, 217, 252, 263-266, 286, 298, 308-310	20	286
26 65, 91, 92, 103, 137, 138, 145, 146, 170-172, 193-195, 205, 216, 217, 262, 265, 285, 286, 296, 306-309	42	322
29 138, 146, 147, 150, 160, 161, 171-173, 183-185, 194-196, 205-207, 217, 218, 229, 252, 266, 275, 286, 298, 308-310	32	326

FIGURE 6—71C

4 σ exceedances/parameter number		Run No.
# 59	# 61	
34 65, 66, 78, 85, 87, 92, 138, 147, 150, 154, 161, 162, 172, 173, 184, 185, 195-197, 204, 207, 208, 220-231, 254, 276, 277, 299, 300, 310-312, 323, 334	66 18, 19, 27, 37, 42, 47, 59, 60, 64, 65, 68-70, 77-80, 87-89, 92-121, 124, 125, 134, 135, 138, 139, 142-145, 148, 203, 235, 240, 249, 295	314
17 145, 150, 172, 188, 200, 211, 223, 246, 257, 258, 281, 292-294, 304 305, 316	1[illegible] 106, 109, 127, 164, 165, 169, 183, 188, 197, 211, 226, 235, 239, 240, 253, 323	351
18 80, 141, 150, 176, 177, 188, 211, 223, 258, 281, 282, 292-294, 304, 305, 316, 317	25 70, 97, 118, 142, 165, 169, 174, 188, 207, 216, 221, 235, 239, 240, 253, 254, 267, 277, 286, 300, 305, 323, 324, 332, 333	355
20 150, 153, 154, 188, 196, 200, 208, 211, 223, 246, 281, 282, 293, 294, 304, 305, 306, 316, 317, 329	36 45, 81, 92, 94, 95, 109, 113, 114, 118, 123, 138, 148, 160, 161, 174, 188, 207, 211, 216, 221, 230, 235, 244, 249, 253, 254, 258, 259, 264, 265, 272, 286, 287, 300, 301, 333	359
12 80, 150, 161, 165, 177, 188, 211, 223, 281, 282, 316, 317	5 127, 142, 197, 253, 319	363
20 3, 147, 162, 173, 184-186, 196, 197, 208, 209, 231, 232, 265, 266, 277, 289, 300, 311, 312	32 37, 59, 60, 65, 69, 70, 93, 96, 97, 107, 120, 124, 125, 139, 157, 166, 167, 185, 189, 190, 193, 194, 203, 249, 250, 264, 282, 295, 296, 318, 319, 328	395
26 57, 93, 116, 139, 147-149, 162, 172-175, 184, 185, 197, 208, 209, 220, 239, 255, 266, 289, 300, 301, 312, 324	15 46, 47, 69, 70, 96, 97, 120, 124, 125, 181, 194, 195, 249, 250, 333	399
18 26, 49, 85, 145, 180, 181, 204, 205, 257, 289, 300, 322-325, 335-337	23 7, 54, 55, 59, 100, 103, 130, 135, 144, 157, 188, 201-203, 207, 221, 259-261, 264, 265, 327, 328	147
13 38, 50, 61, 180, 205, 254, 257, 258, 323-326, 338	18 55, 58, 59, 78, 83, 130, 179, 212, 213, 259-261, 285, 294, 295, 308, 309, 333	151

FIGURE 6—71D

4 σ exceedances/parameter number		Run No.
# 59	# 21	
20 7, 8, 37, 38, 60, 61, 73, 180, 203, 204, 216, 228, 255, 287, 299, 300, 322-324, 335	24 53, 54, 58, 59, 87, 101-103, 120, 130, 134, 135, 144, 157, 178, 183, 188, 202, 235, 258-260, 264, 268	155
31 5, 6, 49, 69, 73, 85, 145, 180, 192, 193, 204, 205, 216, 217, 228, 229, 240, 252, 253, 276, 277, 287, 288, 289, 299, 300, 322-325, 336	47 45, 49, 53, 58, 59, 64, 82, 83, 87, 88, 103-106, 111, 115, 116, 120, 130, 135, 139, 150, 151, 157, 178, 179, 183, 202, 207, 211, 212, 216, 221, 226, 240, 258-260, 264-266, 270-272, 307, 308, 341	159
14 15, 154, 155, 166, 167, 178-180, 201-203, 320-322	17 81, 82, 134, 138, 162, 166, 175, 176, 208, 209, 289, 290, 303, 304, 313, 327, 328	187
11 146, 147, 160, 161, 202, 261, 319, 320, 331, 332	7 109, 110, 138, 166, 200, 265, 327	191
35 9, 78, 87, 92, 138, 146, 147, 161, 168, 169, 171-173, 180, 184, 185, 195, 196, 202-204, 207, 208, 266, 275-277, 286-288, 298, 299, 309-311	31 37, 51, 55, 59, 69, 70, 96, 119, 120, 123, 124, 125, 134, 143, 165, 166, 182, 183, 188, 193, 216, 221, 222, 230, 235, 239, 243, 244, 247-249	310
--	6 17, 105, 148, 193, 272, 341	103
--	9 101, 102, 114, 119, 120, 289, 303, 308, 336	107
--	5 36, 100, 101, 303, 341	111
--	3 259, 260, 287	115

FIGURE 6-71E

AIDAPS - Test Cell Phase Summary

~400 rpm & 3040 in. lbs.

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	# of exceedances parameter number 64	66	Run No.
90° gearbox	12	204-040-012-13	--	ABC-915	good	0	0	63
				A13-2065				67
				B13-6624				71
				ABC-142				73
				A13-2772				79
				B13-7694				119
				A13-2179				203
				ABC-332				207
				B13-9443				545
				B13-8329				549
				B13-8420				553
				B13-10061				557
input roller bearings	6	204-040-406-1	30055	ABC-142	pitted roller, fatigue pitted outer race	68	53	147
			4428	A13-2065		47	45	151
			18063	A13-2772		21	19	155
			2011	B13-6624		32	52	159
			15799	A13-2772		2	10	187
			13322	ABC-142		3	18	191
output roller bearing	6	204-040-407-1	2767	ABC-142	fatigue pitted outer race & rollers	16	29	274
			19729	A13-2772	rusty pitted outer race & rollers	8	17	278
			7682	B13-6624	pitted outer race & rusty pitted rollers	27	46	282
			22283	B13-2065	corrosive pitted outer race & rollers	26	28	286
			22032	ABC-142	rust pitted outer race & rollers	44	49	322
			15392	A13-2772	pitted outer race & rust pitted rollers	21	33	326
input ball bearing	6	204-040-143-1	38305	A13-2065	rusty pitted balls & outer races	9	13	195
			25821	B13-6624	rusty pitted balls & outer race	23	53	199
			8647G	ABC-142	flaking & pitted outer races	17	46	234
			8017E	A13-2772	scored & pitted balls	19	28	238
			38124	A13-2065	rusty pitted balls & outer races	16	23	242
			9172D	B13-6624	rusty balls & outer races	6	11	245
output ball bearing	[illegible]	204-040-424-1	1923	B13-6624	rough pitted outer race & balls	34	40	310
			21312	A13-2044	rough, rusty pitted outer race & balls	22	26	314
			J369	ABC-142	fatigue flaking outer race & balls	77	51	351
			6851	B13-6624	rough pitted outer race & balls	46	22	355
			1098C	A13-2065		62	31	359
			6378	A13-2772		80	41	363

FIGURE 6—72A

AIDAPS - Test Cell Phase Summary

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	# of exceedances parameter number #64	#66	Run No.
90° gearbox-continued								
input/output gears	12	204-040-401-[illegible] (O) -0 (I)	(I) (O) B13-12897 & B13-10269	A13-20[illegible]	scuffing on back of input gear, scuffing on output gear	63	46	391
			B13-12073 & A13-2419	B13-[illegible]24	scuffing on back of input gear, scuffing on output gear	84	56	395
			4958 & B13-15073	ABC-142	scuffing on input gear, pitting on output gear	172	53	399
			A13-1437 & E503	A13-2772	scuffing on back of input gear, scuffing on output gear	65	39	403
			3447 & B12-3802	A13-2772	scuffing on input gear, spalling on output	37	[illegible]	411
			SLP741 & 1313G	ABC-142	pitting on input, scuffing on back of output gear	59	39	435
			5039 & 9[illegible]3G	A13-2065	scuffing on input, pitting & scuffing on output gear	44	32	439
			A13-1199 & 400[illegible]	B13-[illegible]24	scuffing on input, scuffing on back of output gear	40	19	443
			11[illegible]4 & A13-1259	ABC-142	pitting on input, heavy wear & spalling on output gear	57	30	471
			10524 & B13-2009	A13-2772	pitted & scuffed input gear, light spalling on output gear	[illegible]	54	475
			5833 & B13-1412[illegible]	A13-2065	pitting on input & output gear	63	49	479
			A13-2040 & A13-20[illegible]4	B13-6824	scuffing on input and pitting on output	48	31	483
high time before overhaul	4	204-040-012-13		B13-10061	output roller bearing	12	10	103
				B13-8420	output ball bearing, input roller bearing	21	26	107
				B13-8329	input & output ball & roller bearings	10	18	111
				B13-9443	nothing	10	9	115

FIGURE 6-72B

AIDAPS - Test Cell Phase Summary

Part Name	Number Tested	Part Name	Defective Part Serial Number	Component Serial Number	Description of Defective Part	# of occurrences parameter number #44	#66	Run No.
high time before overhaul	4							
output roller bearing		204-040-40[illegible]	27[illegible]4	B13-10061	pitted race	12	10	103
output ball bearing		204-040-424-1	21002	B13-8420	rough	21	26	107
input roller bearing		204-040-40[illegible]-1	15013	B13-8420	pitted race			107
output roller bearing		204-040-40[illegible]-1	222[illegible]4	B13-8329	damaged retainer	10	10	111
input roller bearing		204-040-40[illegible]-1	177[illegible]	B13-8329	N.A.			111
input ball bearing		204-040-143-1	[illegible]00	B13-8329	rough			111
output ball bearing		204-040-424-1	[illegible]49	B13-8329	rough			111
no rejections		N.A.	N.A.	B13-9443		10	9	115

FIGURE 6-72C

4 σ exceedances/parameter number		Run No.
# 44	# 66	
20	53	
120, 121, 132, 133, 144, 145, 157, 180, 181, 193, 192, 204, 205, 208, 213, 216, 217, 239-241, 249-254, 258, 260, 261, 263-278, 280-283, 286-290, 292, 293, 299-302, 307, 323-325, 329, 333, 334, 336	3, 28, 29, 45, 64, 73, 75, 76, 78, 91, 109, 121, 132, 133, 136, 144, 145, 153, 154, 160, 161, 167, 180, 181, 185, 192, 193, 204, 229, 239-241, 244, 245, 249-254, 261, 263-264, 270-272, 282, 300, 301, 324, 325	147
47	45	
78, 109, 120-122, 133, 136, 145, 205, 227, 231, 239-241, 248-255, 258, 260, 264-267, 269-277, 281, 301, 302, 333, 339	28, 29, 47-50, 56, 57, 76, 78, 91, 97, 120-122, 133, 136, 144, 145, 180, 181, 228, 235-243, 244-254, 301, 302, 325, 326	151
21	19	
16, 108, 120, 121, 132, 144, 145, 180, 181, 216, 239, 240, 299, 300, 322-324, 333, 339, 340	3, 102, 132, 135, 144, 179, 180, 204, 228, 239, 240, 253, 263, 299, 300, 309, 310, 323, 324	155
32	52	
69, 81, 108, 109, 120, 121, 132, 133, 136, 144, 145, 180, 181, 193, 199, 204, 205, 212, 213, 216, 217, 226, 227, 266, 287, 323-325, 328, 329, 333, 336	3, 49, 65, 66, 69, 73, 91, 100, 102, 132, 133, 144, 145, 162, 180, 181, 192, 193, 198-200, 203-205, 212-214, 216, 221, 224-229, 235-237, 239, 240, 245, 263, 264, 272, 276, 282, 286, 287, 312, 324, 325, 328	159
2	10	
226, 281	75, 143, 144, 167, 178, 179, 202, 203, 283, 324	187
3	18	
107, 108, 214	51, 65, 124, 143, 151, 152, 160, 166, 167, 178, 179, 190, 191, 196, 213, 202, 203, 324	191
16	29	
35, 81, 92, 115, 127, 138, 139, 147, 148, 172, 173, 208, 230, 231, 310, 333	43, 69, 103, 104, 127, 138, 139, 147, 148, 151, 161, 162, 172, 173, 184, 189, 191, 196, 203, 204, 274, 275, 283, 284, 286, 310-318, 334	274
8	17	
35, 81, 115, 138, 139, 148, 173, 212	43, 81, 104, 138, 139, 160, 161, 172-174, 212, 244, 245, 311, 312, 333, 334	278
27	46	
35, 80, 81, 104, 111, 115, 125, 127, 138, 139, 147, 148, 172, 173, 239, 244, 252, 253, 265, 266, 274, 275, 287-289, 333, 334	43, 69, 81, 92, 103, 104, 111, 124, 127, 138, 139, 147, 148, 160, 161, 172, 173, 189, 191, 204, 239, 240, 244, 245, 252, 253, 265, 266, 274-276, 283-285, 287-289, 299-301, 310-312, 333, 334	282
26	28	
7, 20, 44, 92, 111, 114-116, 126, 127, 137, 138, 147, 171-173, 216, 229, 263, 264, 274, 275, 308, 309, 332, 342	43, 44, 69, 77-79, 91, 92, 103, 104, 111, 114, 115, 125-127, 137, 138, 160, 161, 171-173, 263, 308-310, 342	286

FIGURE 6—72D

Part No.	Part	Part No.	Part
322	49 1[illegible], [illegible], 52, 60, 80, 81, 92, 102-106, 116, 111, 124-127, 136-138, 144, 147, 149, 150, 170, 172, 235-241, 250, 253, 262-264, 271-273, 280, 281, 284, 286, 307, 309, 310, 311, 316, 339-342	322	44 7, 81, 79-81, 84-[illegible], 91, 92, 102, 103, 110, 111, 127-129, 136-138, 170-172, 193, 194, 216, 217, 233-241, 243-251, 254, 273, 274, 281, 284, 287, 340-342
326	33 34, 35, 43, 50, 80, 81, 92, 103, 104, 115, 126, 127, 138, 150-152, 159, 171-173, 184, 196, 197, 204, 209, 239, 309, 310, 332-334, 342	326	21 35, 80, 81, 92, 103, 104, 115, 127, 138, 147, 176, 181, 179-181, 217, 218, 309, 332, 333, 342
196	13 28, 47, 75, 110, 180, 143, 152, 179, 272, 284, 286, 309, 320	196	9 115, 119, 120, 202, 223, 224, 237, 249, 308
199	33 13, 28, 61, 65, 75, 108, 111, 132, 143, 144, 152, 153, 160, 161, 167, 178-180, 189, 190, 190-192, 196, 197, 202, 203, 210-218, 219, 219, 223-229, 228, 229, 261, 262, 265, 274, 275, 282-284, 297, 302, 309, 321, 324, 326, 333	199	23 108, 115, 120, 132, 144, 180, 197, 203, 224, 253, 293, 309, 320-325, 329, 332, 333, 338, 339
234	46 4, 43, 57, 92, 93, 103, 104, 115, 126, 137, 138, 139, 147, 148, 160-162, 164, 168, 169, 172, 173, 184, 189, 190, 191, 195, 203-205, 208, 239, 244, 245, 248, 252, 274, 275, 276, 283, 284, 309-311, 333, 334	234	17 35, 92, 115, 127, 134, 147, 161, 172, 173, 204, 208, 230, 231, 239, 244, 299, 333
238	28 4, 14, 43, 57, 58, 69, 80, 81, 92, 103, 104, 126, 127, 138, 160, 161, 164, 167, 171-173, 195, 207, 240, 241, 309-311	238	19 7, 20, 80, 81, 92, 120, 127, 138, 139, 147, 171, 172, 173, 240, 241, 305, 309, 332, 333
242	23 43, 44, 54, 92, 93, 104, 115, 116, 127, 138, 139, 148, 172, 173, 185, 200, 244, 245, 286, 288, 289, 311, 312	242	14 35, 44, 81, 93, 115, 116, 127, 138, 139, 147, 148, 173, 208, 288, 289, 312
246	11 125, 151, 197, 198, 205, 237, 244, 245, 276, 285, 290	246	6 81, 111, 237, 245, 246, 277
310	40 8, 43, 62, 69, 85, 92, 102-104, 111, 124, 126, 127, 138, 141, 171-173, 184, 185, 203, 204, 239, 252, 261, 264-266, 273-276, 282-284, 286-288, 309-311	310	14 80, 81, 85, 86, 111, 124, 126, 127, 138, 139, 147, 171, 172, 173, 208, 234, 241, 243, 252, 253, 255, 260, 264-266, 273-276, 282, 283, 284-288
314	26 8, 23, 24, 37, 43, 44, 59, 92, 93, 111, 116, 127, 138, 139, 148, 172, 173, 184, 203, 265, 266, 275, 310-312	314	22 44, 46, 111, 115, 116, 127, 138, 139, 147, 148, 161, 162, 172, 173, 196, 197, 208, 211, 276, 277, 300, 323

FIGURE 6-72E

# of exceedances/parameter number	Run No.
# 64 77 6, 7, 19, 20, 31-35, 40, 44, 50, 53, 78-80, 83, 84, 87-93, 99-102, 126, 127, 132, 135, 136, 141, 144, 145, 153, 155, 156, 161, 162, 164, 170-172, 175, 176, 185, 187, 188, 193, 194, 197-200, 203, 205, 208, 211-216, 270, 281, 293, 301, 315, 316, 324, 327, 332-334, 339	
45 12, 13, 30-33, 35, 40, 44, 50, 51, 144, 145, 150, 153, 157-159, 162, 176, 193, 194, 199, 203, 207, 208, 212, 214, 217, 219, 264, 270-273, 281, 282, 293, 316, 317, 321, 325, 333, 334, 339, 340	
62 5-7, 18, 19, 30-35, 38-40, 44, 53, 59-60, 74, 76-80, 87, 88, 90, 93, 131, 132, 135, 136, 138, 150, 153, 158, 159, 176, 185, 186, 188, 194, 281, 293, 294, 299, 300-306, 308, 309, 316, 317, 329, 333, 339, 340	
80 5-7, 18, 19, 30-35, 38-40, 44, 45, 49, 50, 53, 57-59, 74-76, 78-80, 83-85, 87-89, 92, 93, 101, 102, 123, 124, 126-129, 131-133, 136-138, 150, 153, 156-158, 161, 162, 167, 170-172, 176, 208, 210, 214-217, 220, 226, 301, 302, 305, 316, 332-335, 339, 340	
63 6-8, 18-21, 27, 30-35, 39, 40, 44, 53, 57, 58, 70, 76-79, 83, 127, 138, 139, 148, 149, 156-158, 161-163, 170-175, 185-187, 192-194, 197, 208, 231-233, 306-308, 312, 313, 324, 325, 338, 339	
85 5-7, 18, 19, 26, 27, 30, 32, 33, 35, 39, 41, 44, 52, 53, 58-60, 70, 81, 83, 93, 138, 139, 147, 148, 154, 157, 161-163, 169, 170, 172-175, 184-188, 192, 193, 196-198, 204, 208, 209, 230-232, 245-247, 277, 278, 288-290, 300, 301, 305, 307-309, 311-313, 317, 321-324, 329, 333-336, 338-340	
172 2-9, 12-36, 38-41, 43-45, 50-52, 54-66, 68-71, 73-84, 86-90, 92-94, 96, 99-104, 111, 124, 125, 127, 135, 136, 138, 139, 142, 156-159, 161-163, 169-175, 184-187, 192-194, 197, 198, 208, 209, 214-220, 224, 227, 231-234, 239-241, 244, 255, 273, 277, 278, 281, 289-291, 300, 305, 308, 309, 312, 313, 321, 322, 324, 325, 329-342	
# 64 61 1, 8, 14, 17, 18, 79, 99, 100, 102, 103, 124, 125, 127, 129, 132, 144, 153, 161, 162, 167, 189, 198, 199-200, 203-205, 207, 211, 212, 216, 312, 330, 244-247, 263, 281, 282, 293, 311, 316, 324, 325, 333, 334, 339, 340	351
82 94, 103, 104, 113, 127, 144, 153, 167, 199, 200, 203, 207, 209, 211, 212, 239, 240, 248, 281, 282, 315, 325	355
31 7-9, 91, 92, 118, 124, 127, 132, 153, 159, 185, 188-190, 196, 199, 200, 215, 216, 249, 250, 270, 281, 282, 293, 294, 316, 323, 324, 334	359
41 7-10, 40, 67, 75, 78-80, 88, 89, 91, 92, 126-128, 132, 167, 170-172, 200, 204, 205, 207, 208, 211, 212, 215, 216, 223, 224, 253-255, 316, 323, 324, 334, 340	363
46 7-10, 66, 67, 104, 105, 125, 127, 128, 152, 153, 156, 157, 160-162, 165, 173, 185, 186, 188, 191, 192, 196, 197, 205, 212-214, 231-233, 252-254, 258, 261, 266, 270, 312, 324, 325, 332, 333	351
54 58, 59, 102-105, 116, 127, 160-162, 172, 173, 184-188, 191, 192, 196, 197, 204, 205, 212, 213, 229-233, 239, 240, 244, 248, 252-255, 258, 260, 261, 263, 265-267, 289, 311, 312, 324, 325, 331-336, 339	395
55 1, 9, 58, 59, 87, 93, 102-104, 116, 127, 151, 152, 162, 170, 173, 184, 185, 188, 191, 192, 196-198, 204, 205, 212-214, 231-233, 239-241, 244, 253-255, 264, 289, 290, 308, 309, 312, 324, 325, 331-336, 339	399

FIGURE 6-72F

# of exceedances/parameter number			Run No.
#64		#54	
66	5-7, 18, 19, 26, 27, 30-35, 37, 40, 44, 45, 52, 53, 57-59, 70, 79, 81-83, 127, 139, 144, 156, 157, 161-163, 170-179, 184-187, 193, 214, 239, 240, 308-310, 312, 313, 324, 325, 332-340, 342	18 9, 30, 41-43, 62, 63, 66, 67, 83, 93, 103, 104, 111, 124, 125, 127, 128, 164-166, 168, 173, 185, 186, 192, 197, 204-206, 212-214, 227, 238, 239-241, 243-248, 252, 253, 308-310, 312, 324, 332, 333, 339, 340	403
37	26, 34, 35, 44, 52, 56, 57, 69, 92, 115, 126, 127, 137, 139, 141, 147, 160-162, 169-173, 184, 194, 307-309, 314, 332, 333, 338-342	22	431
59	5, 6, 25, 26, 34, 35, 44, 52, 53, 57, 65, 69, 80, 81, 83, 91, 92, 103, 137, 138, 145, 146, 157-162, 169-173, 184, 193, 194, 195, 198, 216, 217, 239-241, 249, 250, 285, 306-308, 330, 333, 338-342	39 9, 43, 69, 91, 93, 103, 126-127, 160, 170-172, 197, 205, 209, 210, 238, 239, 240, 245, 246-251, 253, 272-274, 284, 285, 308, 324, 330, 333, 339-342	435
44	2, 25, 26, 34, 35, 41, 52, 53, 57, 58, 69, 70, 80, 83, 92, 103, 104, 111, 115, 124, 126, 127, 137, 138, 146, 147, 151, 170-173, 194, 196, 308-310, 332-334, 338-342	22 9, 83, 43, 59, 91, 92, 103, 104, 111, 124-127, 138, 171-173, 203, 211, 308, 309, 342	439
40	5, 6, 21-23, 25, 26, 35, 44, 52, 53, 57, 69, 70, 80, 81, 92, 115, 124, 127, 138, 139, 147, 148, 160-162, 170-174, 184, 185, 199-200, 309-311, 333	19 43, 92, 103, 104, 111, 115, 126, 127, 138, 172, 173, 211, 212, 231, 309-311, 333, 334	443
37	19-23, 30-32, 39, 52, 53, 56-59, 70, 79, 80, 81, 127, 135, 138, 139, 147, 156, 157, 161, 162, 164, 169-174, 184, 185, 193, 199, 207-209, 216, 219, 220, 308-312, 333-335, 339-342	30 9, 87, 92, 93, 102-104, 124, 127, 160, 172, 173, 185, 191, 196, 203, 204, 207, 208, 211-213, 239, 240, 311, 312, 333-336	471
56	5, 35, 47, 52, 53, 55-59, 69, 70, 71, 79, 81, 83, 92, 93, 104, 115, 116, 127, 138, 139, 147, 148, 159, 157, 160, 161, 162, 164, 184, 186, 193, 230-232, 287-289, 299-301, 310-312, 333-335	44 9, 43, 47, 58, 59, 92, 93, 103, 104, 112, 115, 116, 127, 138, 172, 173, 185, 190, 204, 211-213, 229-232, 239, 241, 242, 244, 249-251, 253, 269, 284, 310-312, 323, 324, 333-335	475
65	5, 6, 21-23, 35, 44, 45, 53, 56-58, 61, 70, 73, 74, 76-81, 124, 126, 127, 138, 139, 147, 148, 156, 157, 161-164, 169-173, 184-186, 193, 196, 197, 200, 230, 300, 301, 311-313, 323, 324, 333-335, 338-340, 342	49 43, 58, 66, 67, 87, 92, 93, 104, 111, 125, 127, 156, 161, 162, 163, 169, 172-174, 185, 186, 191, 192, 196, 197, 209, 212-214, 230, 231, 239-241, 276, 300, 311, 312, 323-326, 328, 329, 333-336, 339	479

FIGURE C-72G

4 σ exceedances/parameter number

# of		# of	Run No.
40	5, 6, 52, 53, 57-59, 70, 81, 93, 114, 115, 127, 128, 138, 139, 14 , 148, 156, 157, 161, 162, 170-173, 185, 186, 193, 200, 230-238, 288, 290, 300, 301, 309, 310, 312, 321, 323, 324, 333, 338	31 58, 59, 87, 104, 115-117, 127, 128, 138, 172, 173, 185, 196, 212, 213, 230-238, 243, 244, 276, 283, 284, 311, 312, 324, 333-336	483
12	6, 16, 17, 19, 60, 68, 107, 108, 213, 214, 223, 224	10 143, 144, 151, 152, 159, 160, 179, 223, 224, 249	103
21	19, 88, 89, 95, 96, 230-232, 234, 237, 239-241, 264-266, 272, 273, 332, 333, 342	26 88, 98, 98, 81, 143, 151, 152, 160, 166, 167, 190, 212, 213, 223, 229-238, 239-241, 309	107
10	6, 80, 81, 89, 114, 115, 231, 239-241	18 50, 85, 109, 143, 152, 160, 179, 190, 236, 237, 239, 240, 248, 249, 264, 272, 295, 296	111
10	107, 224, 226, 227, 231, 239-241, 294, 295	9 212, 239-241, 244, 248, 248, 294, 295	115

FIGURE 6-72H

```
                                   HSD/AIDARS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION: MN4201

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

                                                                  NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED
   TAPE   RUN  CH  ORIG. SPD  SPECTRUM NO.     ITEM SERIAL NO.      M     N=2B    N=3B    N=4B    N=5B
  021048   3  201    4510        2148          LE=14522          113     81      37      27      23
BANDS GREATER THAN N=4S    2: 3: 4: 5: 20: 21: 36: 38: 45: 46: 47: 50: 51: 52: 53:166:220:221:223:283:287
BANDS GREATER THAN N=4B    334:326:

  03488  91  201    4447        3073          LE=14522          106     44      35      34      18
BANDS GREATER THAN N=4S    4: 5: 20: 27: 31: 34: 35: 36: 38: 44: 45: 47: 51:221:222:226:227:228:
BANDS GREATER THAN N=4B

  03450  92  201    4541        2077          LE=14522           96     47      31      22      10
BANDS GREATER THAN N=4S    4: 4: 5: 20: 34: 35: 36: 44: 45: 47: 51: 52: 53:111:220:221:222:227:228:229:
BANDS GREATER THAN N=4B

ITEM: ENGINE                    UNITS: IN/SEC.PK
PARAMETER NO.  2                PARAMETER TITLE: NO. 3 AND NO. 4 BEARINGS, DIFFUSOR          NO. OF SPEC. AVAIL.: 4
ITEM SPEED: 4000.00 RPM         TRANSMISSION INPUT SPEED: 4000 RPM     TORQUE: 18004 IN.LB
FREQUENCY RANGE: 5000 HZ        ANALYSIS BW: 21.973 HZ                          NO. OF SPEC. COMPARED: 8
```

FIGURE 6—73 FOUR STANDARD DEVIATION COMPARISON SUMMARY GOOD FLIGHT DATA AGAINST TEST CELL MEAN

MEAN IDENTIFICATION MNGR01

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

HSD/AIDAPS COMPARISON SUMMARY ANALYSIS

TAPE	RUN	CH	OHIO STD	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED N	N*2	N*2S	N*3S	N*4S
021868	4	102	6510	2106						
BANDS GREATER THAN N*4S			3, 21, 89, 90, 91, 219,		ABU-10527	78	32	18	18	4
03459	24	102	6447	2009						
BANDS GREATER THAN N*4S			3, 4, 24, 80, 90, 91, 120, 188, 219, 220, 276,		ABU-10527	72	39	19	13	11
03459	45	103	6541	2013						
BANDS GREATER THAN N*4S			3, 4, 23, 60, 89, 90, 91, 205, 220,		ABU-10527	72	38	14	9	9

ITEM= TRANSMISSION
PARAMETER NO. 125

UNITS= G-PK
PARAMETER TITLE= INPUT QUILL BEARING H

ITEM SPEED= 6600.00 RPM
FREQUENCY RANGE= 8800 HZ

TRANSMISSION INPUT SPEED= 6600 RPM
ANALYSIS RUN 21,923 HZ

TORQUE= 74 PRCNT

NO. OF SPEC. AVGD= 13

NO. OF SPEC. COMPARED= 3

FIGURE 6–74 FOUR STANDARD DEVIATION COMPARISON SUMMARY GOOD FLIGHT DATA AGAINST TEST CELL MEAN

HSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= MM2301

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	ON	ORIG SPD	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+S	M+2S	M+3S	M+4S
021064	4	109	4510	2154	ABB-1190	92	53	38	32	25
BANDS GREATER THAN M+4S			3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 17, 18, 19, 22, 27, 50, 51, 52, 110, 143, 270							
BANDS GREATER THAN M+3S			271, 272, 275, 276,							
03459	24	109	6447	2057	ABB-1120	88	48	29	23	21
BANDS GREATER THAN M+4S			3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 17, 18, 19, 20, 22, 27, 50, 51, 270, 271, 273							
03459	45	109	6541	2061	ABB-1190	89	50	35	30	23
BANDS GREATER THAN M+4S			3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 17, 18, 19, 27, 49, 52, 99, 100, 143, 265, 274							
BANDS GREATER THAN M+3S			271, 275!							

ITEM= 42 DEGREE GEARBOX — UNITS= G.PK

PARAMETER NO. 61 — PARAMETER TITLE= GEARMESH

ITEM SPEED= 4303.20 RPM — TRANSMISSION INPUT SPEED= 6600 RPM — TORQUE= 2810 INLB — NO. OF SPEC. AVGD.= 10

FREQUENCY RANGE= 5000 HZ — ANALYSIS BW= 21.973 HZ — NO. OF SPEC. COMPARED= 3

FIGURE 6–75 FOUR STANDARD DEVIATION COMPARISON SUMMARY GOOD FLIGHT DATA AGAINST TEST CELL MEAN

MSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= MM3701

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	OK	OHIO SPD.	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+3	M+2S	M+3S	M+4S
021069	5	205	6510	2160	ABC-456	289	262	236	218	191

BANDS GREATER THAN M+4S
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 39, 40, 41, 42, 43, 44, 53, 54
56, 57, 58, 59, 60, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 77, 78, 79
80, 81, 82, 83, 84, 85, 88, 89, 90, 95, 96, 101, 103, 104, 105, 106, 107, 108, 112, 114, 115
125, 128, 129, 152, 153, 154, 156, 159, 160, 161, 162, 165, 166, 174, 175, 176, 187, 188, 189, 190, 195
196, 197, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219
220, 223, 230, 231, 235, 236, 237, 238, 239, 240, 241, 244, 245, 248, 249, 250, 251, 252, 253, 259, 260
261, 262, 263, 264, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 281, 282, 283, 284, 285
286, 287, 288, 291, 292, 293, 294, 295, 296, 297, 298, 305, 306, 307, 310, 311, 312, 319, 321, 322, 336
338, 341,

TAPE	RUN	OK	OHIO SPD.	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+3	M+2S	M+3S	M+4S
03459	31	205	6447	2137	ABC-456	280	260	232	212	196

BANDS GREATER THAN M+4S
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24
25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 39, 40, 41, 42, 43, 44, 52, 53, 54
55, 56, 57, 58, 59, 60, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 77
78, 79, 80, 81, 82, 83, 84, 85, 86, 88, 89, 90, 95, 96, 103, 104, 105, 106, 107, 108, 112
115, 125, 128, 129, 152, 153, 155, 159, 161, 162, 165, 166, 167, 175, 176, 186, 187, 188, 189, 190, 195
196, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 219
220, 223, 230, 231, 235, 236, 237, 238, 239, 240, 241, 243, 244, 247, 248, 249, 250, 251, 252, 253, 259
260, 261, 262, 263, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 281, 282, 283, 284, 285
286, 287, 288, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 305, 309, 310, 311, 312, 320, 321, 322
323, 324, 334, 335, 336, 337, 338,

TAPE	RUN	OK	OHIO SPD.	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+3	M+2S	M+3S	M+4S
03459	52	205	6541	2141	ABC-456	285	259	228	212	194

BANDS GREATER THAN M+4S
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 39, 40, 41, 42, 44, 53, 54, 56
57, 58, 59, 60, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 77, 78, 79
80, 81, 82, 83, 84, 85, 88, 89, 90, 95, 96, 103, 104, 105, 106, 107, 108, 112, 113, 114, 115
127, 128, 129, 152, 153, 156, 159, 160, 161, 162, 165, 166, 174, 175, 176, 188, 189, 194, 196, 197, 199
200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220
230, 231, 233, 235, 236, 237, 238, 239, 240, 241, 243, 244, 245, 248, 249, 250, 251, 252, 253, 254, 258
259, 260, 261, 262, 263, 264, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 281, 282
283, 284, 285, 286, 287, 288, 291, 292, 293, 294, 295, 296, 297, 298, 305, 306, 307, 310, 311, 312, 318
319, 321, 336, 337, 341,

ITEM= 90 DEGREE GEARBOX
PARAMETER NO. 68

UNITS= IN/SEC.PK
PARAMETER TITLE= OUTPUT QUILL BEARINGS

NO. OF SPEC. AVGD.= 11

ITEM SPEED= 1056.00 RPM
FREQUENCY RANGE= 2000 HZ

TRANSMISSION INPUT SPEED= 6600 RPM
ANALYSIS BW= 0.789 HZ

TORQUE= 2210 INLB

NO. OF SPEC. COMPARED= 3

FIGURE 6—76 FOUR STANDARD DEVIATION COMPARISON SUMMARY
GOOD FLIGHT DATA AGAINST TEST CELL MEAN

MSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= MN2102 -23

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

TAPE	RUN	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.	NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED M	M+5	M+2S	M+3S	M+4S
02212	63	1	12?	B13-6623	46	13	1	0	0
02212	67	1	12A	B13-2925	115	55	24	1	0
02212	71	1	13?	B13-8?04	91	17	13	2	0
02212	75	1	13A	B13-5199	246	172	117	14	0
02212	79	1	14?	AB8-289	69	24	7	0	0
012165	119	1	44A	B13-7022	82	54	30	8	0
02574	203	1	1003	B13-8603	79	25	5	0	0
02546	545	1	163A	B13-5572	96	48	24	2	0
02546	549	1	164?	B13-2950	71	21	10	0	0
02546	553	1	164A	B13-4023	68	27	11	1	0
02546	557	1	165?	A13-854	114	63	37	1	0

ITEM: AZ DEGREE GEARBOX
PARAMETER NO. 59

UNITS= IN/SEC,PK
PARAMETER TITLE= INPUT QUILL AND OUTPUT QUILL BEARINGS

NO. OF SPEC. AVGD.= 11

ITEM SPEED= 4172.80 RPM
FREQUENCY RANGE= 2000 HZ

TRANSMISSION INPUT SPEED= 6400 RPM
ANALYSIS BW= 0.789 HZ

TORQUE= 3640 INLB

NO. OF SPEC. COMPARED= 11

ALL RUNS ARE BASELINE

FIGURE 6—77

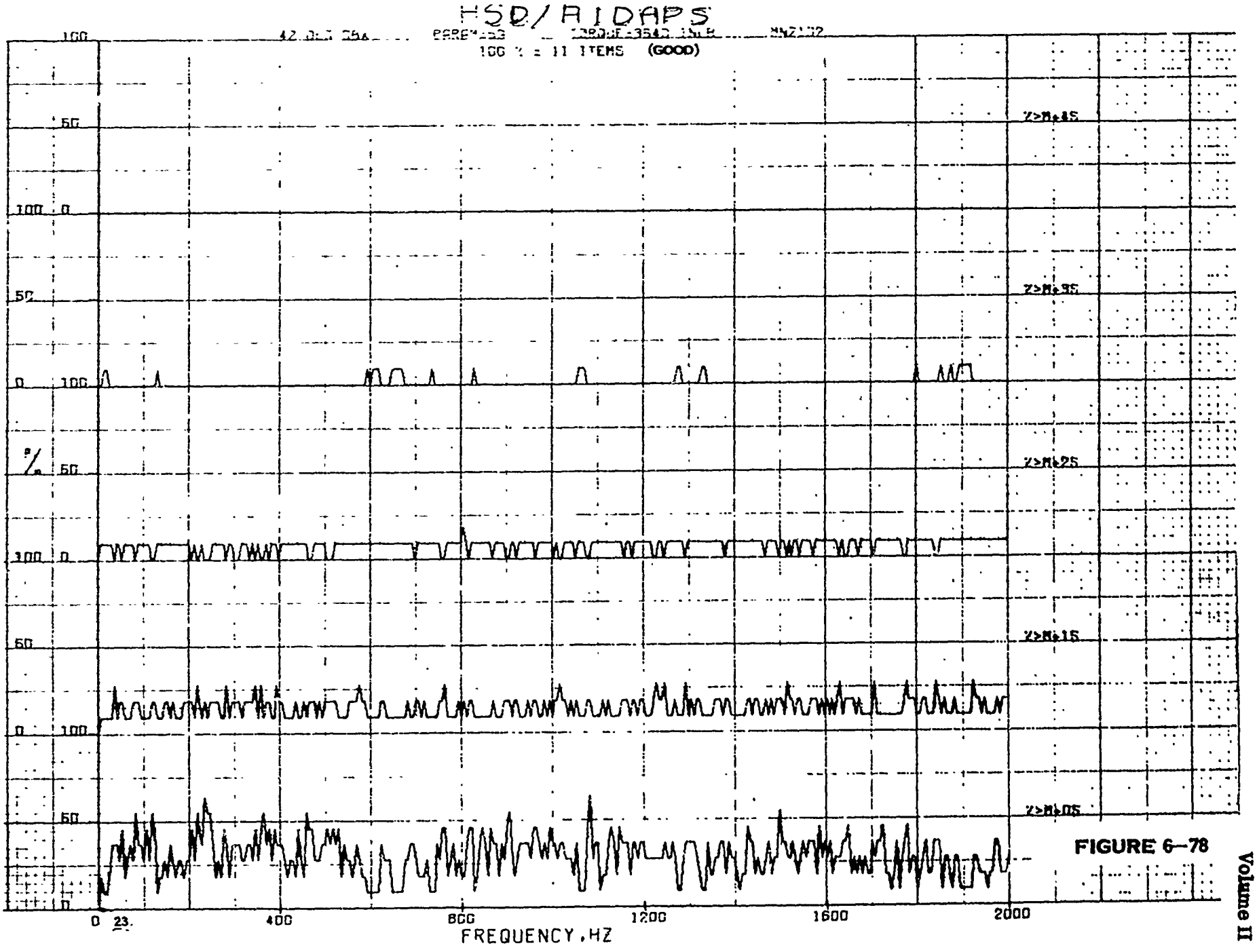

HSD/RIDAPS
100 % = 11 ITEMS (GOOD)
Y>M+4S
Y>M+3S
Y>M+2S
Y>M+1S
Y>M+0S
%
100
50
0
0
23
400
800
1200
1600
2000
FREQUENCY,HZ

FIGURE 6–78

```
                                                    MSD/AIDAPS COMPARISON SUMMARY ANALYSIS
MEAN IDENTIFICATION= MN2102 -26

THE FOLLOWING SPECTRA ARE COMPARED AGAINST THE MEAN SPECTRUM

                                                    NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED
        TAPE        RUN    CHANNEL    SPECTRUM NO.    ITEM SERIAL NO.     M      M+5    M+25    M+35    M+45
        03276       274       1          1030          813-2925          78      44      37      24      22
BANDS GREATER THAN M+45   81,138,139,147,156,161,172,173,185,196,208,265,287,288,289,299,308,310,311,312,333
BANDS GREATER THAN M+45   334,

        03276       278       1          1045          ABB-289           59      31      22      15      14
BANDS GREATER THAN M+45   147,148,162,173,185,196,220,266,289,300,311,312,323,324,

        03276       282       1          1057          813-8304         104      57      43      35      30
BANDS GREATER THAN M+45   65, 66, 81, 85, 87, 92,147,156,157,161,162,172,173,196,220,238,254,265,266,276,277
BANDS GREATER THAN M+45   288,289,299,300,310,311,312,323,334,

        03276       286       1          1057          813-8199         94      57      37      32      28
BANDS GREATER THAN M+45   44, 66, 87, 92,103,115,138,146,147,160,161,171,172,173,184,195,196,217,282,243,244
BANDS GREATER THAN M+45   265,266,286,298,308,309,310,

        022163      322       1          1199          ABB-289           98      61      46      38      34
BANDS GREATER THAN M+45   65, 91, 92,103,137,138,145,146,170,171,172,193,194,195,205,216,217,262,265,283,288
BANDS GREATER THAN M+45   298,306,307,308,309,

        022163      326       1          1199          813-2925          76      48      34      31      29
BANDS GREATER THAN M+45   138,146,147,150,160,161,171,172,173,183,184,185,194,195,196,205,206,207,217,218,229
BANDS GREATER THAN M+45   252,266,275,286,298,308,309,310,

ITEM= 42 DEGREE GEARBOX                UNITS= IN/SEC,PK
PARAMETER NO. =9                       PARAMETER TITLE= INPUT QUILL AND OUTPUT QUILL BEARINGS                NO. OF SPEC. AVGD.= 11

ITEM SPEED= 4172.80 RPM                TRANSMISSION INPUT SPEED= 6400 RPM      TORQUE= 3640 INLB
FREQUENCY RANGE= 2000 HZ               ANALYSIS BW= 0.789 HZ
                                                                                          NO. OF SPEC. COMPARED= 6
                                                                                ALL RUNS ARE BAD GEAR SETS
```

FIGURE 6–79

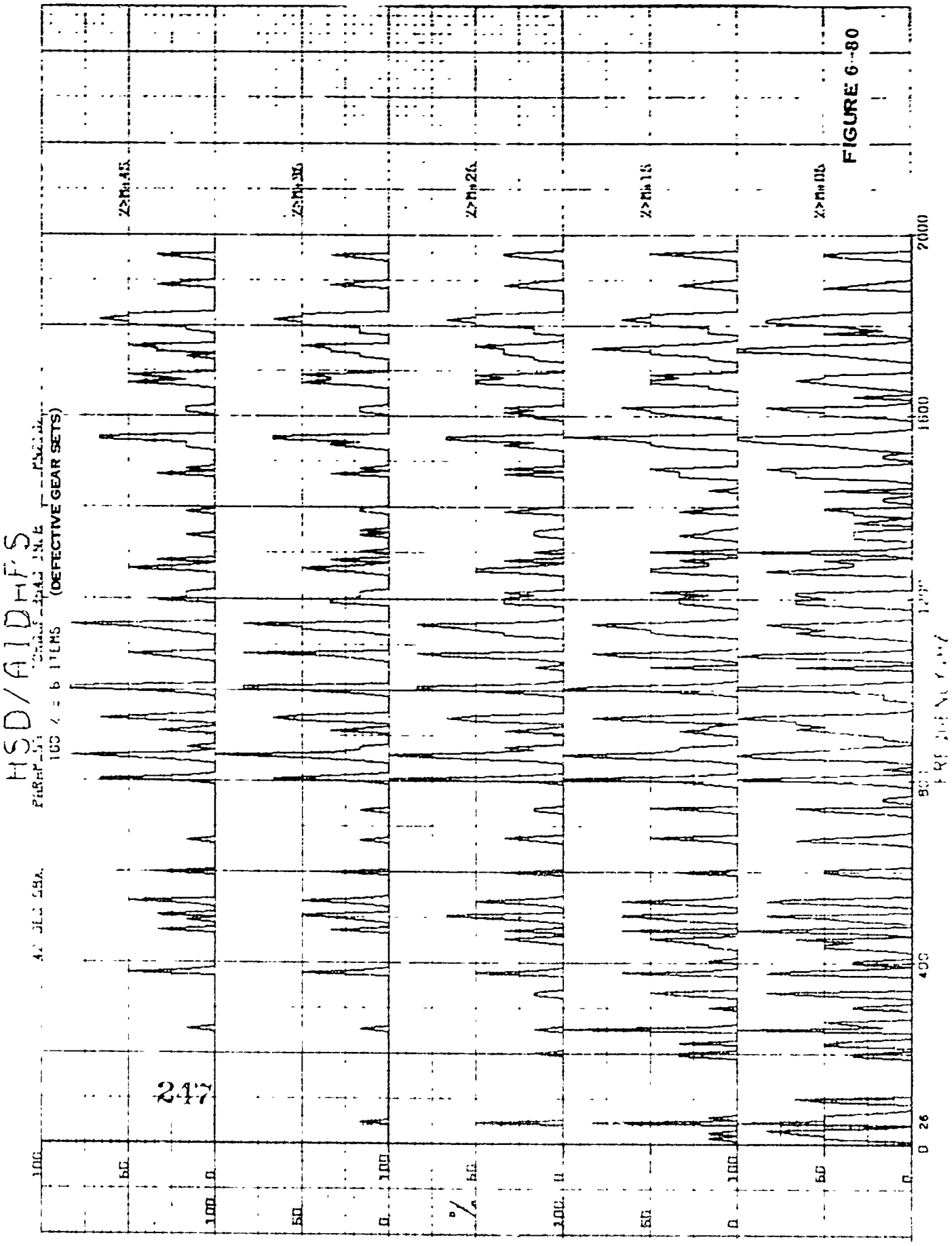

HSD/AIDHFS
(DEFECTIVE GEAR SETS)
Z>M=45
Z>M=35
Z>M=25
Z>M=15
Z>M=05
100
50
0
%
0
400
800
1200
1600
2000

FIGURE 6-80

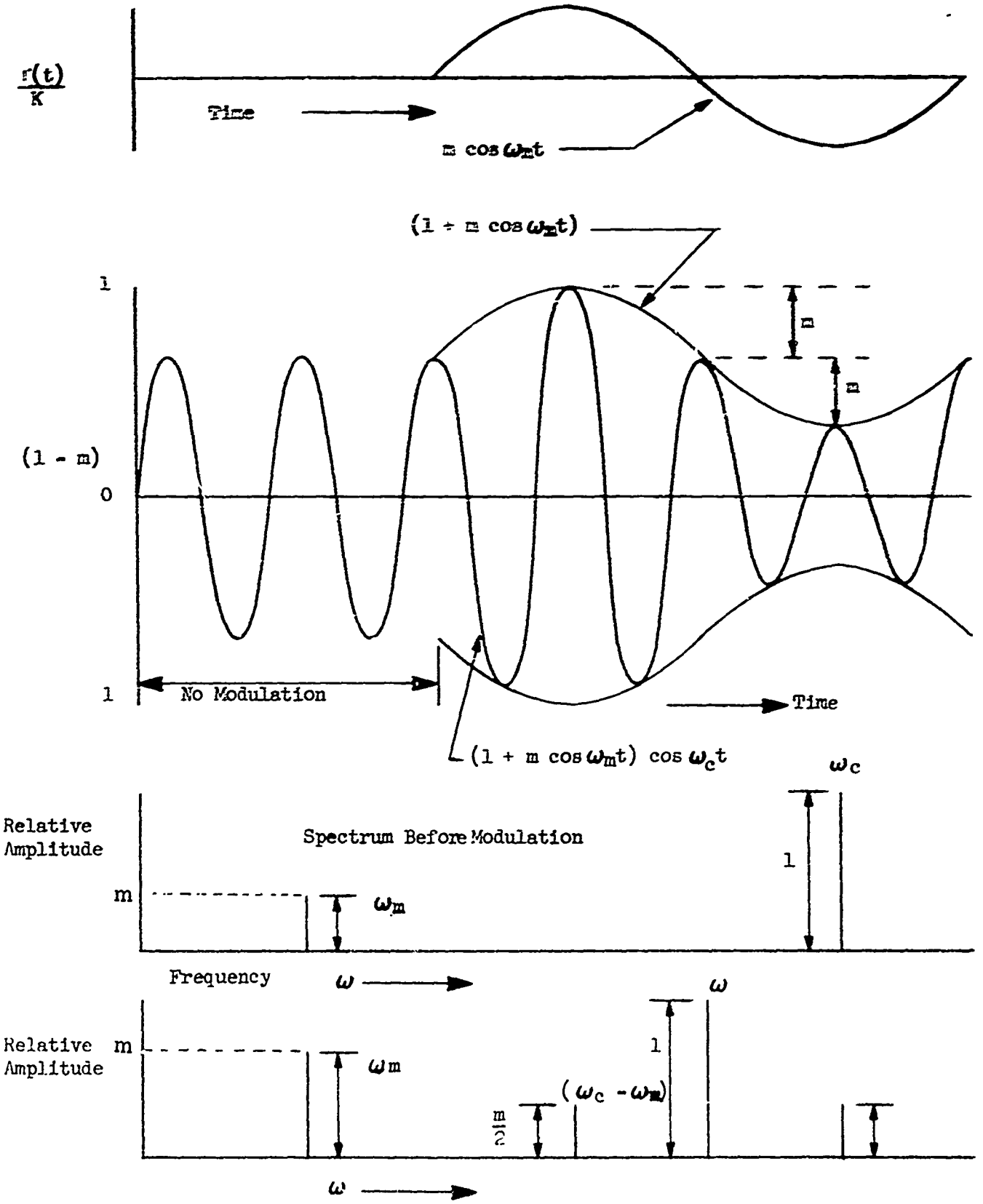


FIGURE 6–81 AMPLITUDE MODULATION AND SPECTRUM

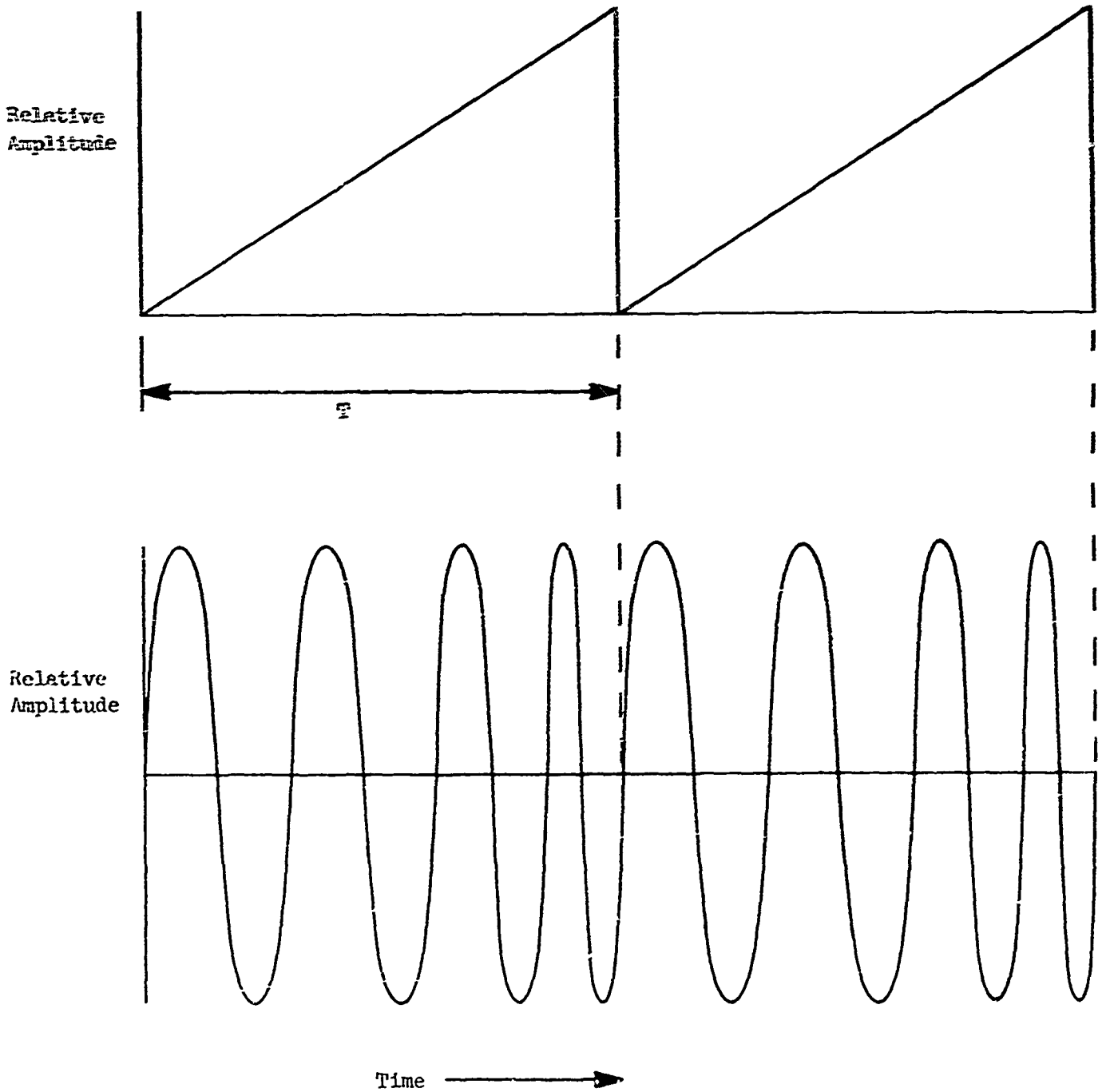
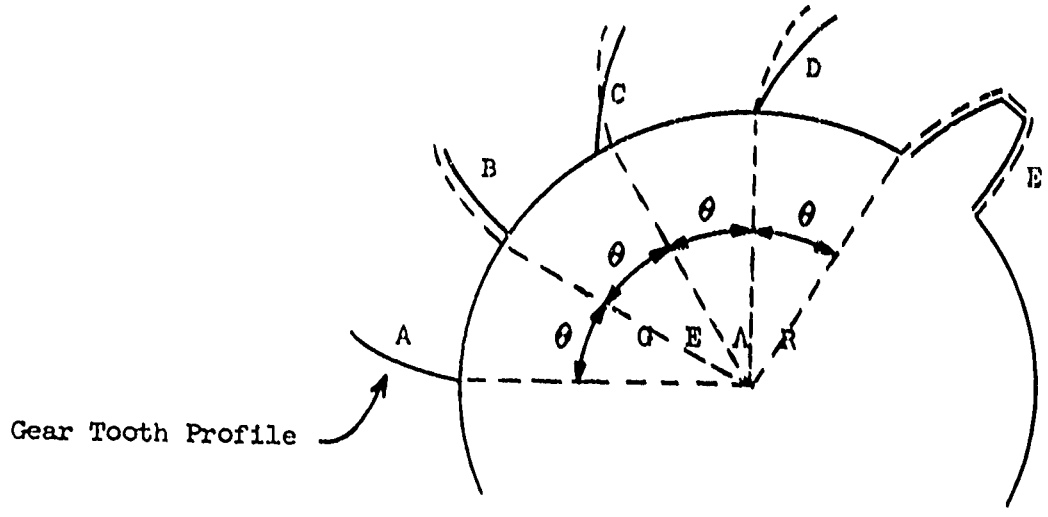


FIGURE 6–82 EXAMPLE OF FREQUENCY MODULATION



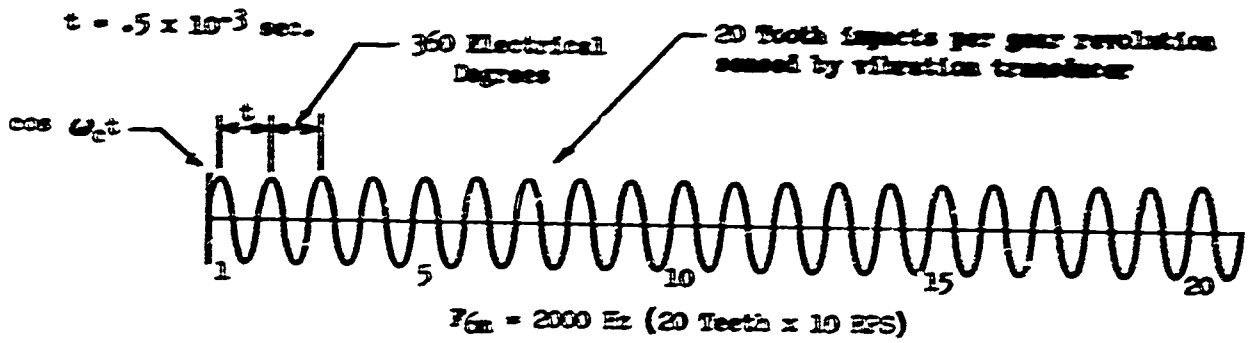
1. The broken line profiles represent theoretically perfect profile positions. The solid lines represent typical inaccuracies resulting from gear manufacture.

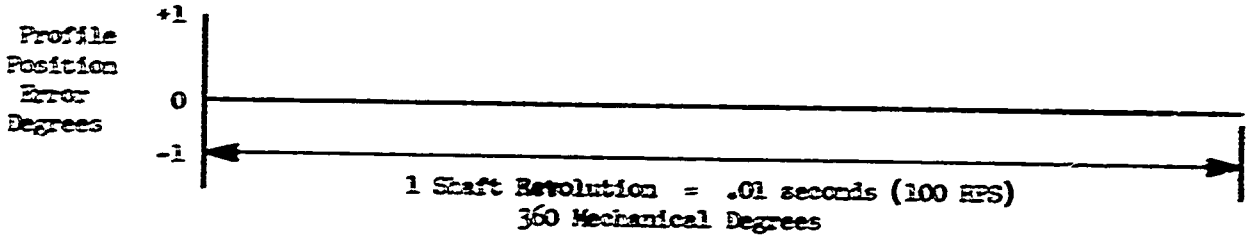
2. Only one profile is drawn for each error example except for the tooth thickness variation example E .

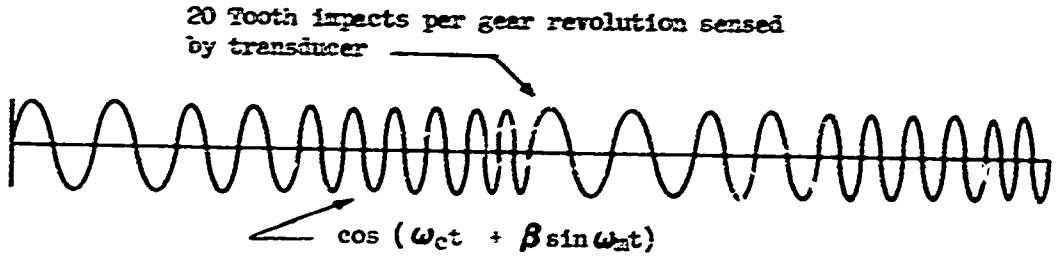
3. Profile error examples:

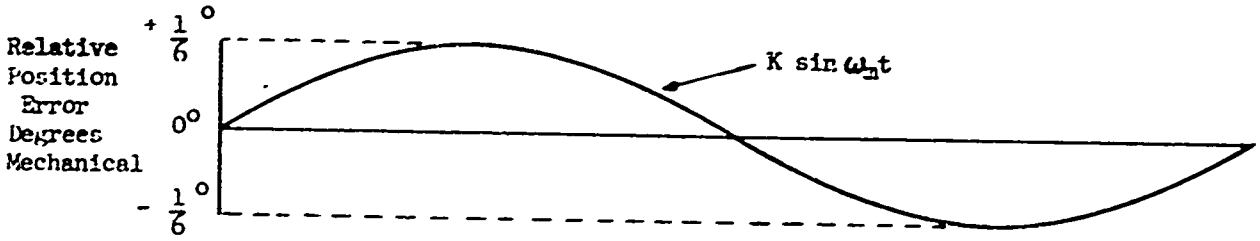
   A. Reference profile perfect form and position.
   B. Profile spacing variation.
   C. Profile deviation from true involute curve.
   D. Profile radial position variation due to runout
   E. Tooth thickness deviation.

FIGURE 6--83 GEAR TOOTH PROFILE POSITION ERRORS









360 Electrical Degrees = $\frac{360}{20}$ = 18 Mechanical Degrees

$\frac{1}{6}$ ° Mechanical error in profile position = 3.3 Electrical Degrees

3.6° Electrical Degrees

$\frac{3.6}{360}$ x 100 = 1% or effective instantaneous peak carrier frequency change of 20 hertz

$$\beta = \frac{\Delta f}{fm} = \frac{20}{100} \approx .2$$

FIGURE 6–84 FREQUENCY MODULATION OF GEARMESH

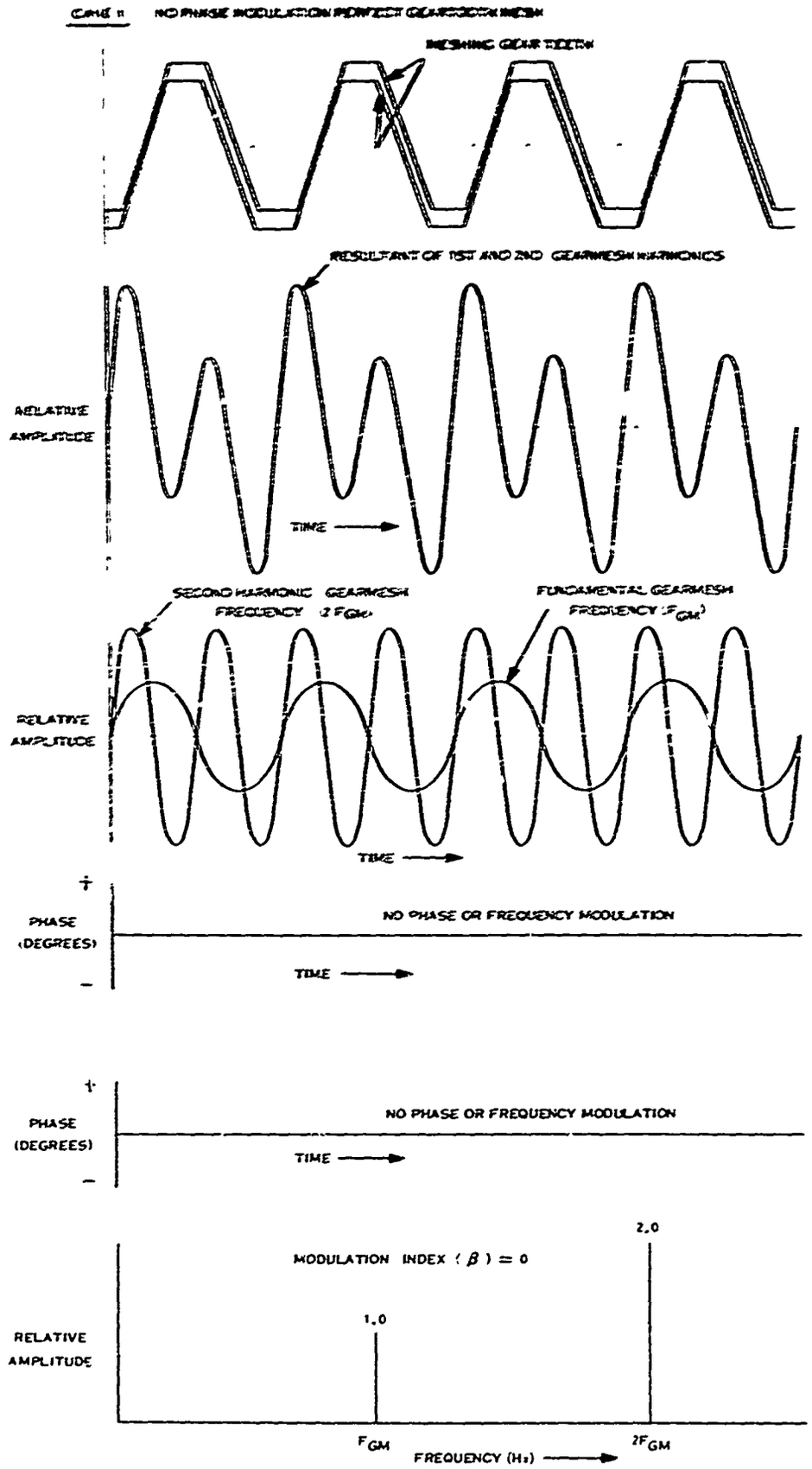

CASE II NO PHASE MODULATION PERFECT GEARTOOTH MESH
MESHING GEAR TEETH
RESULTANT OF 1ST AND 2ND GEARMESH HARMONICS
RELATIVE AMPLITUDE
TIME
SECOND HARMONIC GEARMESH FREQUENCY (2 FGM)
FUNDAMENTAL GEARMESH FREQUENCY (FGM)
RELATIVE AMPLITUDE
TIME
+
PHASE (DEGREES)
NO PHASE OR FREQUENCY MODULATION
TIME
−
+
PHASE (DEGREES)
NO PHASE OR FREQUENCY MODULATION
TIME
−
2.0
MODULATION INDEX (β) = 0
1.0
RELATIVE AMPLITUDE
FGM
2FGM
FREQUENCY (Hz)

FIGURE 6–85

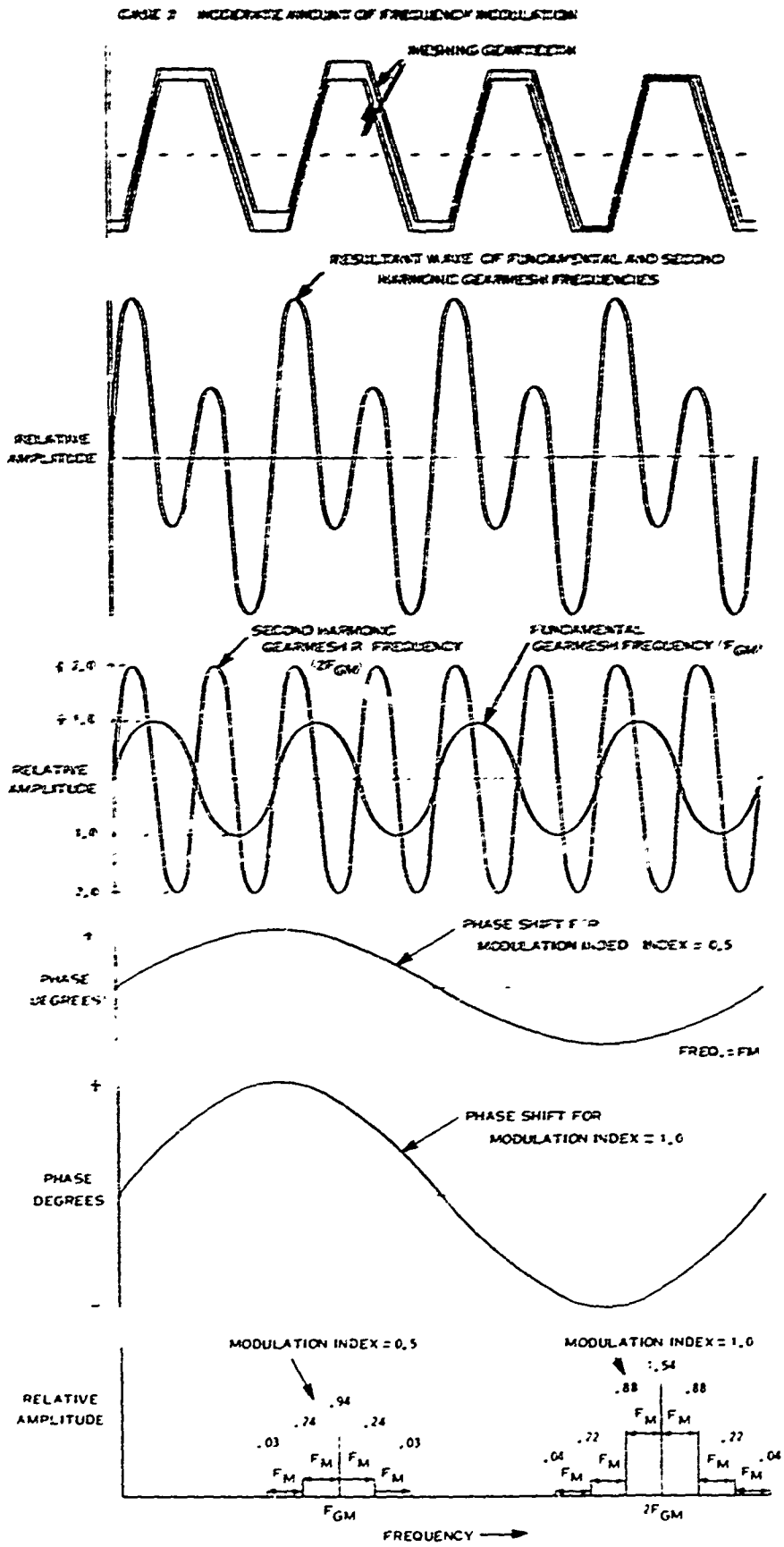

CASE 2 MODERATE AMOUNT OF FREQUENCY MODULATION
MESHING GEARTOOTH
RESULTANT WAVE OF FUNDAMENTAL AND SECOND HARMONIC GEARMESH FREQUENCIES
RELATIVE AMPLITUDE
SECOND HARMONIC GEARMESH FREQUENCY ($2F_{GM}$)
FUNDAMENTAL GEARMESH FREQUENCY (F_{GM})
RELATIVE AMPLITUDE
PHASE SHIFT FOR MODULATION INDEX = 0.5
PHASE (DEGREES)
FREQ. = FM
PHASE SHIFT FOR MODULATION INDEX = 1.0
PHASE DEGREES
MODULATION INDEX = 0.5
MODULATION INDEX = 1.0
RELATIVE AMPLITUDE
.94
.24
.24
.03
.03
F_M
F_{GM}
.54
.88
.88
.22
.22
.04
.04
$2F_{GM}$
FREQUENCY

FIGURE 6–86

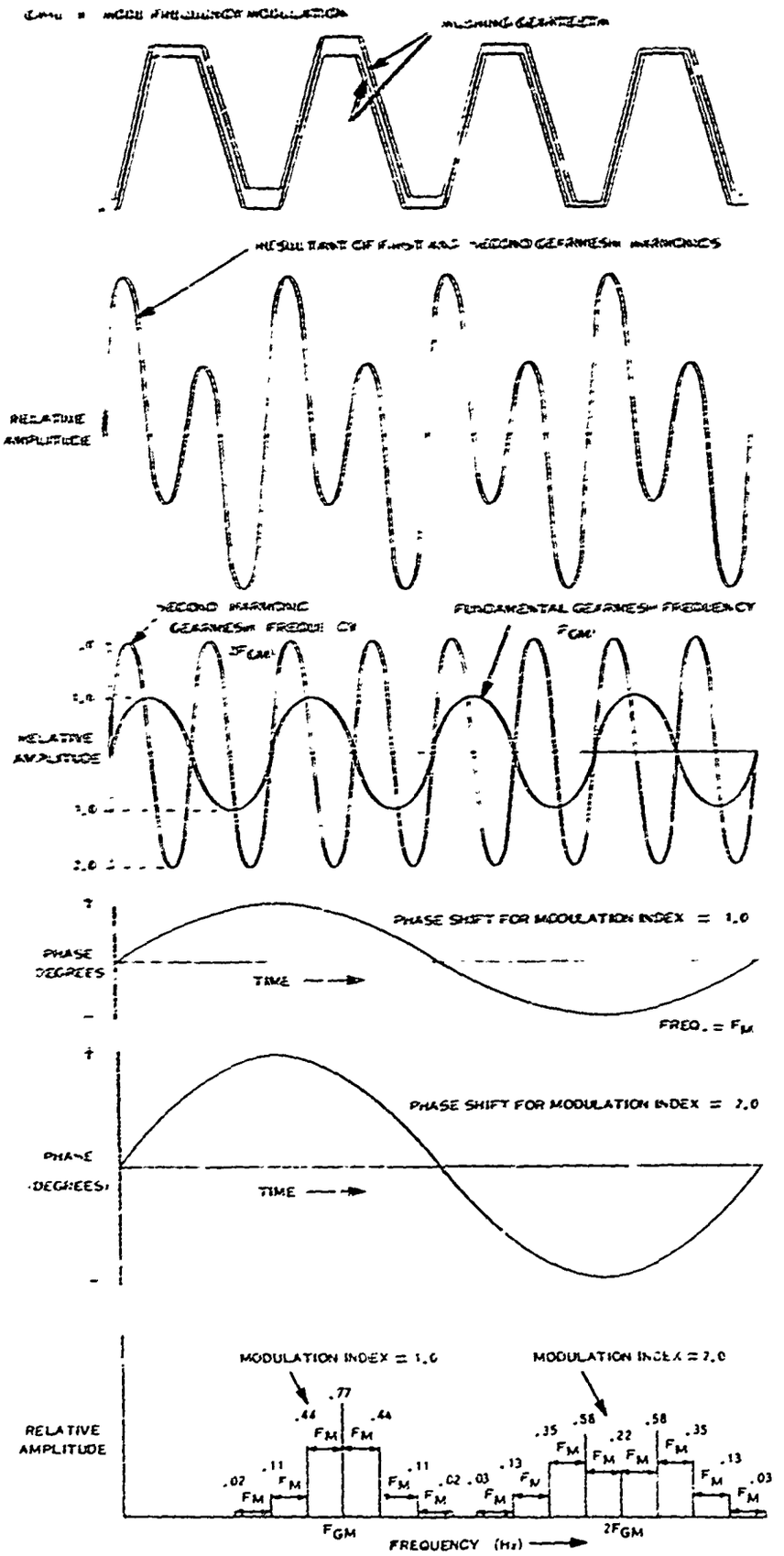
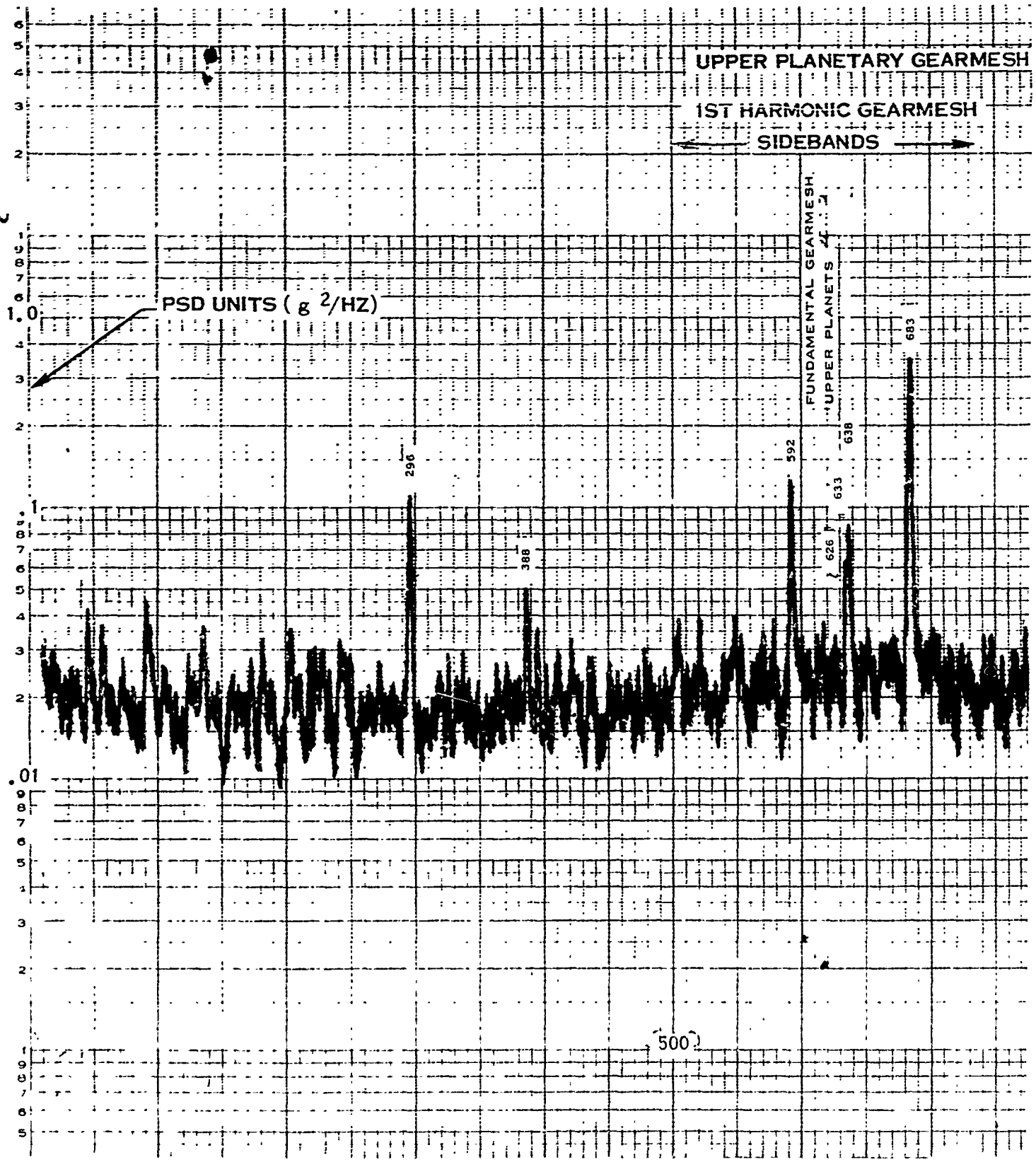

RELATIVE AMPLITUDE
RELATIVE AMPLITUDE
PHASE SHIFT FOR MODULATION INDEX = 1.0
PHASE DEGREES
TIME
FREQ. = F_M
PHASE SHIFT FOR MODULATION INDEX = 2.0
PHASE DEGREES
TIME
MODULATION INDEX = 1.0
MODULATION INDEX = 2.0
RELATIVE AMPLITUDE
.77
.44
.44
.11
.02
.11
.02
.03
.13
.13
.03
.35
.58
.22
.58
.35
F_M
F_{GM}
$2F_{GM}$
FREQUENCY (Hz)

FIGURE 6–87

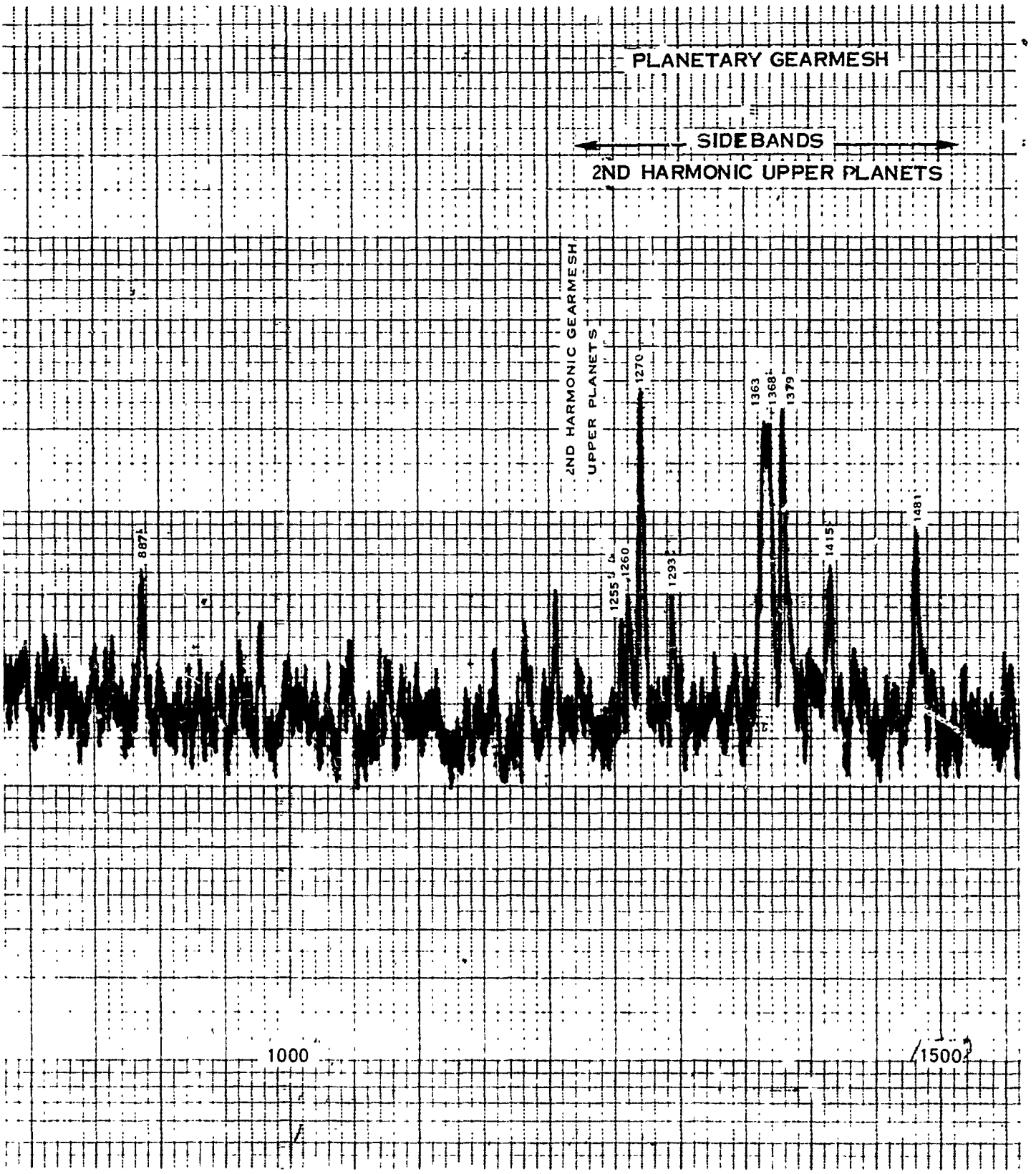
TABLE OF MODULATION INDICES (β) FOR VARIOUS POWER TRAIN GEARMESHES

GEARMESH	FREQ.	n_m	f	β_1	β_2	β_3	β_4	β_5	β_6	β_7
90° Output	1076	28	10.7	.38	.76	--	--	--	--	--
90° Input	1076	72	10.7	.15	.30	--	--	--	--	--
42° Transmission	1936	72	19.4	.27	.54	--	--	--	--	--
Input Quill Bevel	3190	110	31.9	.29	--	--	--	--	--	--
Input Quill Pinion	3190	52	31.9	.61	--	--	--	--	--	--
Accessory Drive Bevel	2827	51	28.3	.55	--	--	--	--	--	--
Accessory Drive Pinion	2827	69	28.3	.41	--	--	--	--	--	--
Tail Rotor Bevel	1870	69	18.7	.27	.54	--	--	--	--	--
Tail Rotor Pinion	1870	72	18.7	.26	.52	--	--	--	--	--
Lower Sun	1980	51	19.8	.39	.78	--	--	--	--	--
Lower Planets	1980	17	19.8	1.16	2.32	--	--	--	--	--
Upper Sun	641	17	6.4	.38	.76	1.14	1.52	1.9	2.28	2.66
Upper Planets	641	5	6.4	1.28	2.56	3.84	5.12	6.4	7.68	8.96
Lower Case Ring Gear	1980	17	19.8	1.16	2.32	--	--	--	--	--
Upper Case Ring Gear	641	5	6.4	1.28	2.56	3.84	5.12	6.4	7.68	8.96

FIGURE 6-88

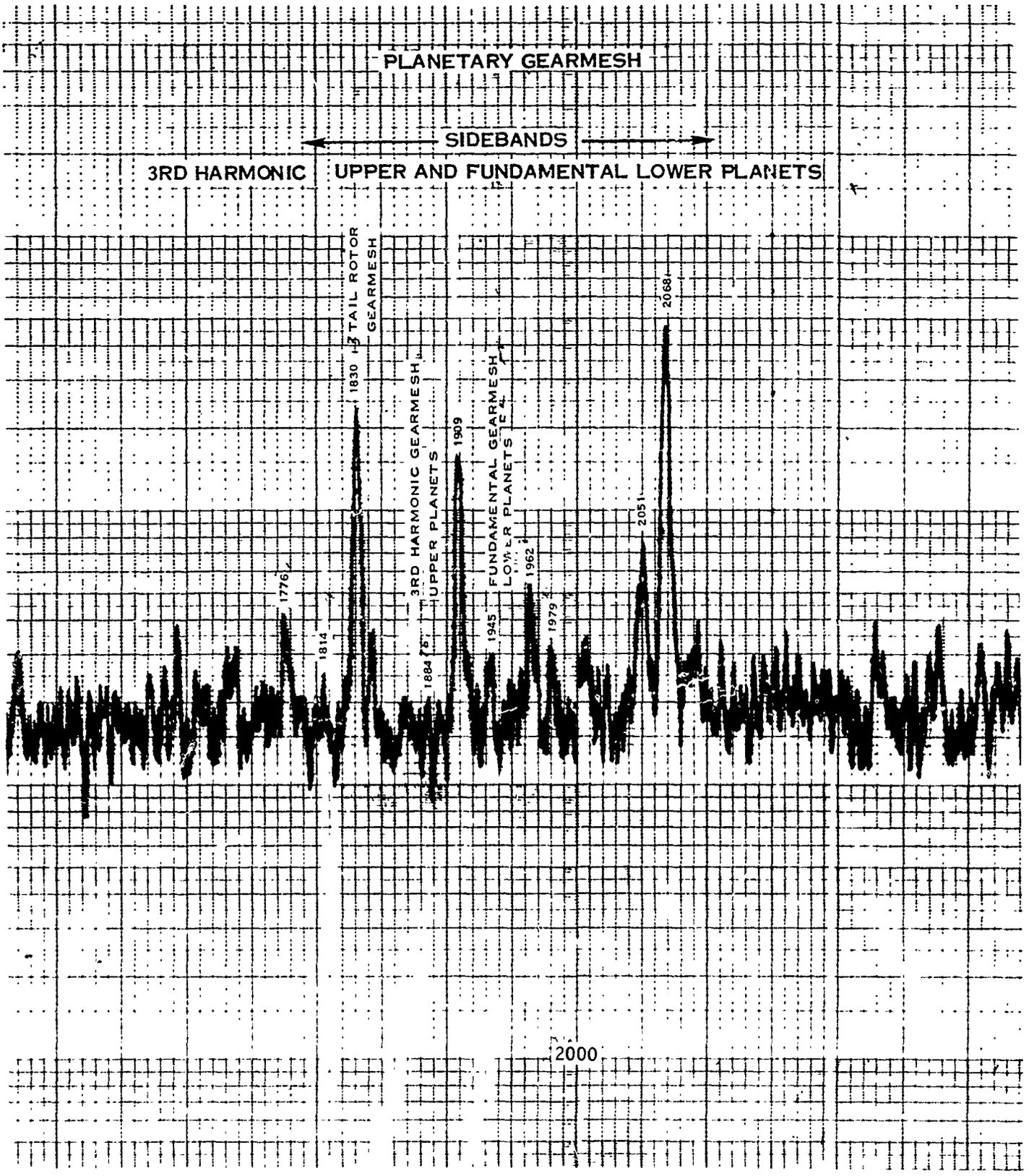

UPPER PLANETARY GEARMESH
1ST HARMONIC GEARMESH
SIDEBANDS
PSD UNITS (g 2/HZ)
FUNDAMENTAL GEARMESH
UPPER PLANETS
296
388
592
626
633
638
683
500
1.0
.01

89 A

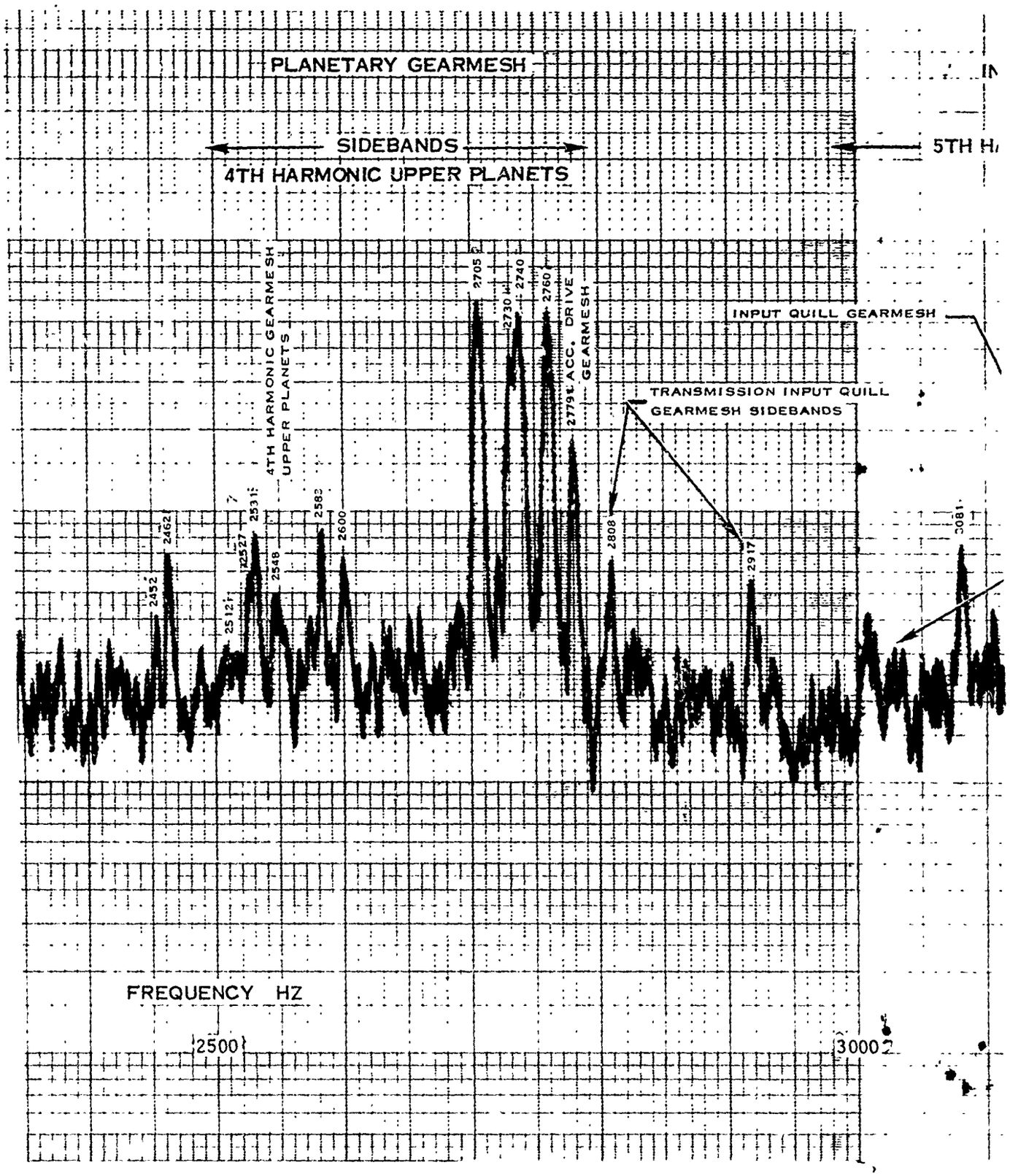

PLANETARY GEARMESH
SIDEBANDS
2ND HARMONIC UPPER PLANETS
2ND HARMONIC GEARMESH
UPPER PLANETS
887
1255
1260
1270
1293
1363
1368
1379
1415
1481
1000
1500

257

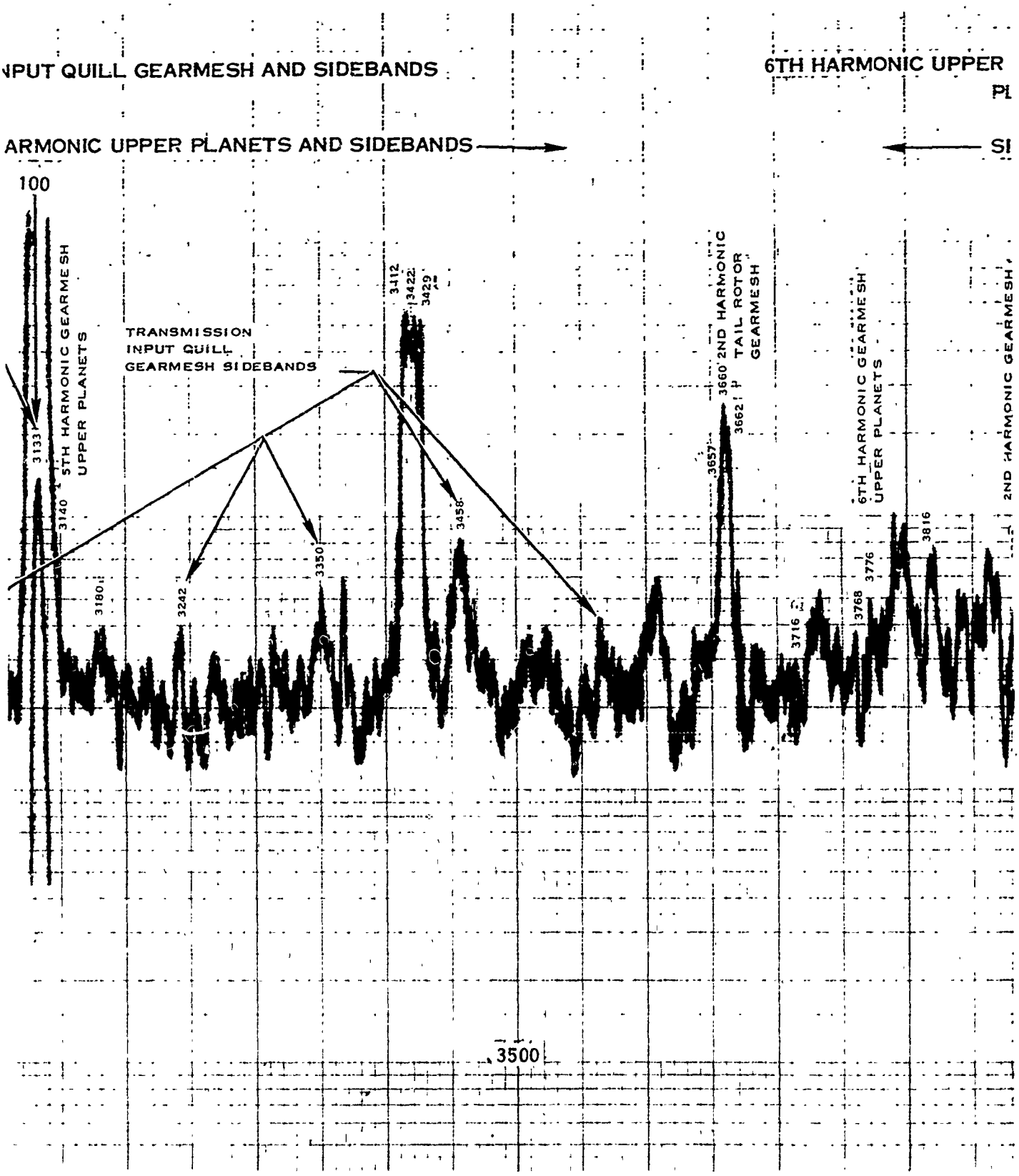
89 13


PLANETARY GEARMESH
SIDEBANDS
3RD HARMONIC
UPPER AND FUNDAMENTAL LOWER PLANETS
TAIL ROTOR
GEARMESH
3RD HARMONIC GEARMESH
UPPER PLANETS
FUNDAMENTAL GEARMESH
LOWER PLANETS
1776
1814
1830
1884
1909
1945
1962
1979
2051
2068
2000

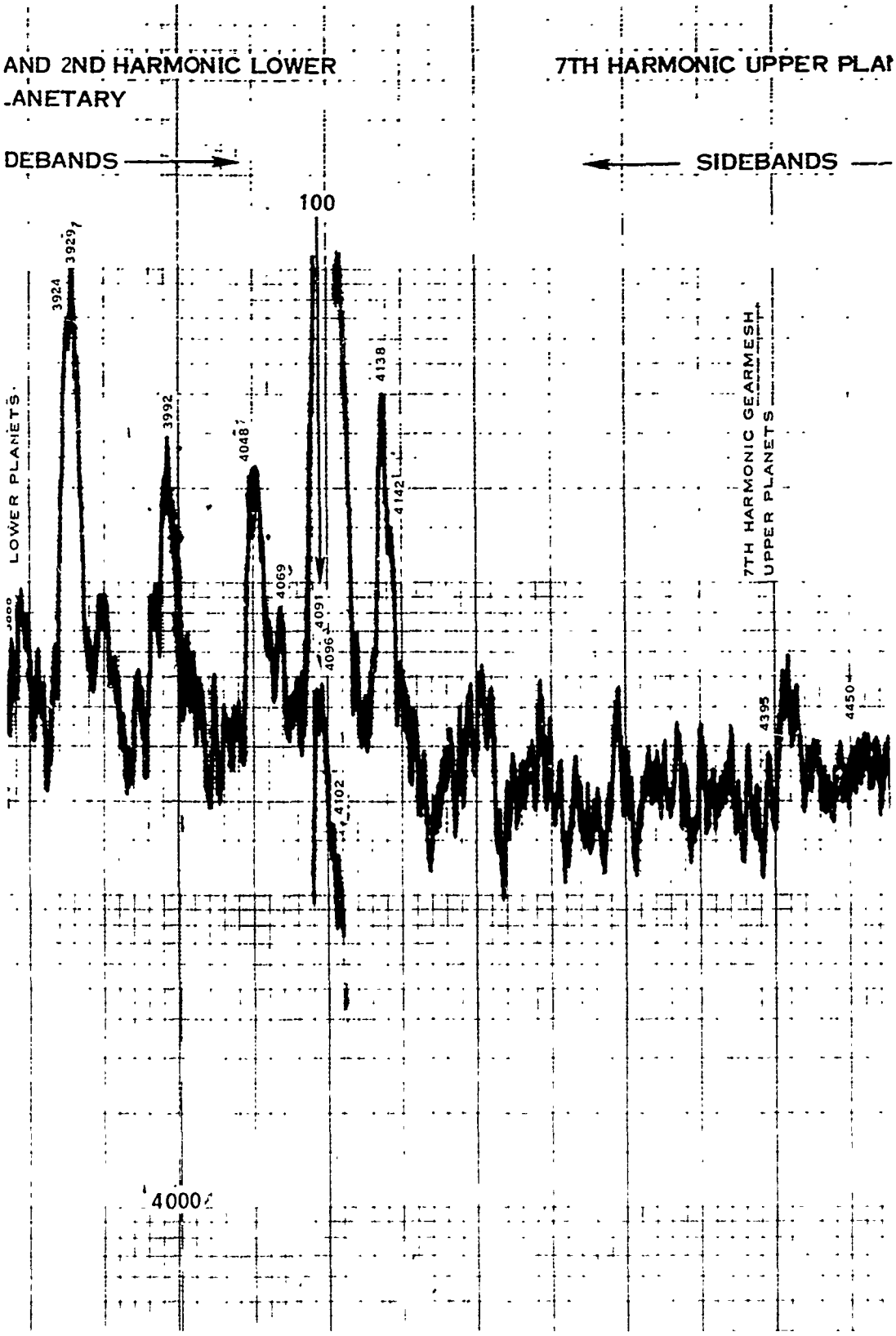
89 C


PLANETARY GEARMESH
SIDEBANDS
4TH HARMONIC UPPER PLANETS
5TH H
4TH HARMONIC GEARMESH
UPPER PLANETS
2452
2462
2512
2527
2531
2548
2582
2600
2705
2730
2740
2760
2791
ACC. DRIVE
GEARMESH
INPUT QUILL GEARMESH
TRANSMISSION INPUT QUILL
GEARMESH SIDEBANDS
2808
2917
3081
FREQUENCY HZ
2500
3000

89 D


NPUT QUILL GEARMESH AND SIDEBANDS
6TH HARMONIC UPPER
PL
ARMONIC UPPER PLANETS AND SIDEBANDS
SI
100
5TH HARMONIC GEARMESH
UPPER PLANETS
TRANSMISSION
INPUT QUILL
GEARMESH SIDEBANDS
2ND HARMONIC
TAIL ROTOR
GEARMESH
6TH HARMONIC GEARMESH
UPPER PLANETS
2ND HARMONIC GEARMESH
3133
3140
3180
3242
3350
3412
3422
3429
3458
3657
3660
3662
3716
3768
3776
3816
3500

89 E


AND 2ND HARMONIC LOWER
ANETARY
7TH HARMONIC UPPER PLAI
DEBANDS
SIDEBANDS
100
3929
3924
3992
4048
4069
4091
4096
4102
4138
4142
4395
4450
LOWER PLANETS
7TH HARMONIC GEARMESH
UPPER PLANETS
4000

89 F

HSER 6080
VOLUME II

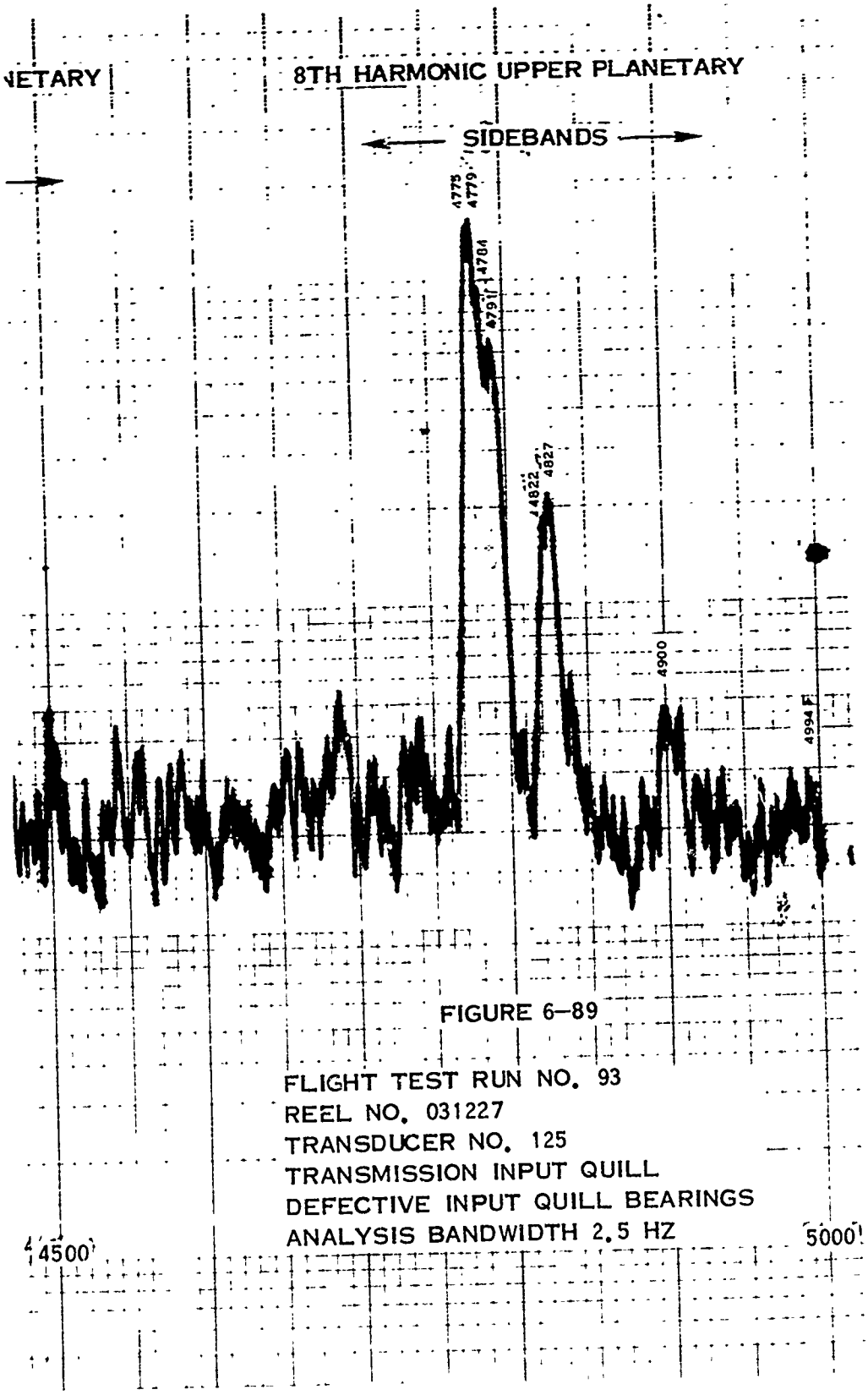


FIGURE 6–89

FLIGHT TEST RUN NO. 93
REEL NO. 031227
TRANSDUCER NO. 125
TRANSMISSION INPUT QUILL
DEFECTIVE INPUT QUILL BEARINGS
ANALYSIS BANDWIDTH 2.5 HZ

FIG 6-89 G

TRANSMISSION

Band No.	Freq. (Hz)	H.P. #129 IPS	Tail Rotor #126 g's	IG #125 g's	MM-RAD #123 IPS	Tail Rotor #42 IPS	MM Axial #47 IPS	IG #45 IPS	
8	102	- -	.74	- -	- -	.15	.07	.074	
16	219	- -	.18	- -	.021	.024	.015	.02[illegible]	
19	263	- -	.80	- -	.015	.335	.022	.04[illegible]	
26	366	- -	.13	- -	- -	.022	.017	.012	
31	439	- -	.29	- -	- -	.051	.027	.015	
36	512	.05	.66	.24	.04	.022	.019	.039	
39	556	.021	.63	.27	.05	.044	.01[illegible]	.011	
45	645	.071	1.51	.67	.66	.143	3.8[illegible]	.103*	Upper sun & planets main mast
50	718	- -	.74	- -	- -	.054	.086	.012	
53	761	.0097	.46	.13	.015	.03	.033	.01	
57	820	.016	.33	.15	.011	.044	.017	.012	
61	879	.027	1.23	.24	.01	.038	.016	.011	
64	922	.015	.41	.14	.012	.019	.015	.01	
70	1010	.018	.62	.20	.012	.048	.01	.01	
72	1040	- -	.62	- -	- -	- -	- -	.014	
76	1098	.078	3.06	.96	.021	.22	.022	.06*	90° G.M. or sideband of tail rotor
85	1230	- -	.84	1.82	.034	.052	.027	.037	
89	1289	.143	1.04	3.4	.065	.055	.057	.091*	2nd harmonic upper main mast planets
95	1376	- -	1.5	- -	- -	.087	.007	.022	
92	1333	.098	.78	.72	.018	.039	.012	.04	
99	1435	- -	.57	.74	.018	.020	.009	.018	
106	1538	- -	- -	.40	.015	.033	.008	.014	
110	1596	.031	.96	.31	.031	.045	.057	.055	
114	1655	.031	1.45	.52	.029	.03	.01	.01[illegible]	
104	1508	- -	- -	- -	- -	.05	.007	.012	
119	1728	.018	1.13	.36	.01	.032	.004	.015	
124	1801	.029	1.8	.46	.016	.038	.01	.021	
129	1875	.102	12.3	2.40	.082	.364	.031	.098*	Tail rotor
133	1933	.031	2.7	2.70	.062	.072	.073	.111*	3rd harmonic upper sun & planets
138	2006	.031	1.7	2.10	.27	.04	.37	.14*	Lower sun lower planets & case ring gear
143	2080	- -	1.34	- -	- -	.013	.022	.022	
147	2138	.017	1.8	.60	.025	.019	.014	.018	
151	2197	.011	.81	.65	.027	.018	.01	.018	
158	2299	.009	.87	.55	.017	.01	.01	.02	
161	2343	.0087	- -	.65	.01[illegible]	.01	.01	.018	
162	2358	- -	1.02	- -	- -	- -	- -	- -	

MEAN VIBRATION VALUES FOR TRANSMISSION AND GEARBOXES FLIGHT TEST (PHASE D)

ALL READINGS ARE MEAN

Band No.	Freq. Hz	[illegible] IPS	[illegible] IPS	[illegible] IPS	
3	11.[illegible]	2.1[illegible]	1.65	- -	
6	29.1	2.82	1.73	.31	
10	52.7	.81	.[illegible]	1.71	
13	70.1	.29	.17	.[illegible]	
16	82	.44	- -	.417	
20	111	.1[illegible]	.1[illegible]	.20	
24	134	.1[illegible]	- -	- -	
25	140	.331	.117	.10	
39	222	.124	.067	.04	
45	275	.232	.109	- -	
49	281	- -	- -	.11[illegible]	
[illegible]	433	- -	- -	.02	
9[illegible]	495	.036	.024	.019	
99	574	.[illegible]7	- -	.025	
103	597	- -	- -	.018	
105	609	.031	.019	.013	
115	668	- -	- -	.018	
120	697	- -	- -	.017	
123	715	.0[illegible]	.0[illegible]	.045	
128	744	.028	.02[illegible]	.013	
132	767	- -	- -	.018	
133	773	.03	.020	- -	
136	791	.022	- -	.019	
137	79[illegible]	.02	.017	- -	
140	814	.02	.018	.025	
14[illegible]	85[illegible]	.024	.018	.044	
1[illegible]2	8[illegible]4	.01[illegible]	- -	.013	
15[illegible]	908	.01[illegible]	.017	.012	
1[illegible]0	931	.026	.018	.029	
1[illegible]4	955	.015	.018	.011	
1[illegible]	9[illegible]	.018	- -	.009	
1[illegible]2	1001	.036	.024	.03	
1[illegible]9	1019	.030	.048	.044	
184	1078	.[illegible]74	.[illegible]59	.149*	90° gear clash
18[illegible]	1094	.026	.025	.014	
1[illegible]9	1101	.029	.030	.02	

STRAIGHT AND LEVEL FLIGHT

FIGURE 6—90A

TRANSMISSION

Band No.	Freq. (Hz)	H.P. #129 IPS	Tail Rotor #126 g's	IQ #125 g's	MM-RAD #123 IPS	Tail Rotor #49 IPS	MM Axial #47 IPS	IQ #45 IPS	
165	2402	.011	.5	.60	.02	.014	.015	.023	
169	2460	.010	.51	.73	.021	.012	.017	.020	
177	2578	.02	.54	1.34	.053	.01	.0395	.069*	4th harmonic upper sun & planets
184	2680	.015	.54	.84	.023	.01	.016	.036	
188	2739	- -	.88	- -	- -	- -	- -	- -	
189	2753	.028	.73	4.2	.045	.012	.049	.114	
191	2783	- -	.93	- -	- -	.01	.02	.026	
194	2827	.048	1.5	2.7	.038	.027	.022	.04*	ACC. Drive gears
198	2885	- -	.7	.88	.022	.01	.015	.019	
201	2929	- -	.7	.86	.015	.011	.014	.023	
204	2973	- -	.71	1.7	.019	.014	.016	.032	
212	3090	.025	.77	1.6	.028	.01	.034	.054	
215	3134	.029	.65	1.5	.045	.008	.039	.043	
219	3193	.13	1.0	22.8	.186	.066	.212	.594*	Input quill gearmesh & 5th
223	3251	- -	.5	1.45	.06	.017	.05	.042	harmonic upper planets
226	3295	.03	.64	1.4	.045	.01	.03	.057	
209	3046	- -	.7	- -	- -	- -	- -	.041	
229	3339	.02	.54	.77	.02	.008	.018	.019	
234	3413	.026	.45	1.5	.02	.007	.02	.033	
237	3457	.032	.54	1.0	.017	.016	.017	.031	
246	3588	.019	.44	.73	.015	.014	.018	.023	
251	3662	.043	1.01	1.02	.018	.037	.025	.02	
256	3735	.22	3.63	2.60	.033	.348	.044	.13*	2nd harmonic tail rotor GM
260	3793	.045	.9	1.3	.046	.067	.064	.049	
265	3867	.064	.58	3.6	.245	.026	.425	.022	
269	3925	.075	.76	4.0	.24	.038	.573	.296*	6th harmonic upper sun & planets
274	3999	.068	.57	7.3	.23	.052	.216	.214*	2nd harmonic lower sun & lower planets
279	4072	- -	.46	6.8	.316	.037	.328	.196	
282	4116	- -	.54	- -	.076	.018	.068	.058	
290	4233	.021	.76	.70	.027	.027	.03	.031	
292	4262	- -	.73	- -	.041	.021	.028	.024	
297	4335	- -	.78	- -	.028	.027	.021	.025	
300	4380	.01	.92	.9	.05	.034	.022	.028	
305	4453	.014	.96	1.0	.023	.047	.019	.031	
310	4526	.014	.89	2.5	.059	.038	.041	.059*	7th harmonic upper sun & planets
314	4585	.013	1.07	1.0	.024	.05	.0136	.028	

ALL READINGS ARE PEAK

Band No. 0--2KHz	Freq. (Hz)	96° GB IQ #64 IPS	96° GB OQ #66 IPS	42° GB I.Q. OQ #32 IPS	
194	1130	.057	.037	.035	
197	1145	.042	.054*	- -	
201	1171	- -	- -	.05	
203	1181	.0137	- -	.012	
204	1189	.0166	.041	.012	
209	1215	.021	.037	.012	
220	1283	- -	- -	.044	
221	1289	- -	- -	.037	
222	1294	.0096	.024	.012	
232	1353	.0115	.032	.02	
234	1365	.011	.034	.041	
236	1376	.0137	.025	.01	
245	1429	- -	- -	.063	
246	1435	.023	.034	.058	
251	1464	.011	.025	.008	
256	1494	- -	- -	.018	
262	1529	- -	- -	.028	
270	1576	.015	.0422	.018	
275	1605	- -	- -	.025	
283	1652	.015	.05	.023	
295	1722	.013	- -	.019	
298	1740	.015	.031	.011	
306	1787	.040	.051	.028	
307	1792	- -	.066	.042	
311	1816	.0305	.036	.013	
316	1845	.017	.024	.012	
319	1863	.012	.021	.037	
321	1875	.014	- -	- -	
332	1939	.06	.05	.714*	420 gear slash
331	1933	.09	- -	.507	
341	1992	.017	- -	.047	
279	1628	- -	- -	.017	

FIGURE 6—90B

TRANSMISSION

Band No.	Freq. (Hz)	H.P. #129 IPS	Tail Rotor #12[illegible] g's	IQ #12[illegible] g's	MM-RAD #12[illegible] IPS	Tail Rotor #1[illegible] IPS	MM Axial #1[illegible] IPS	OQ #1[illegible] IPS
31[illegible]	[illegible]	.013	.[illegible]	.[illegible]	.02	.03[illegible]	.01[illegible]	.02[illegible]
321	[illegible]	.01[illegible]	.[illegible]	.[illegible]	.02	.03[illegible]	.01[illegible]	.02[illegible]
324	[illegible]31	.014	.[illegible]	.[illegible]	.022	.02[illegible]	.01[illegible]	.02[illegible]
330	4820	.01[illegible]	.[illegible]	.[illegible]	.021	.02[illegible]	.01[illegible]	.021
334	48[illegible]	.01[illegible]	.[illegible]	.[illegible]	.01[illegible]	.01[illegible]	.02[illegible]	.02
33[illegible]	4922	.014	.[illegible]	.[illegible]	.01[illegible]	.01	.01[illegible]	.014
339	49[illegible]1	.01[illegible]	.4[illegible]	.[illegible]	.019	.01	.013	.01

H.P. - Hydraulic Pump and Tachometer quill.

Tail Rotor - Transmission Tail Rotor Shaft System.

Input quill Shaft System

MM Rad. - Main Mast Shaft System (Radial)

MM Axial - Main Mast Shaft System (Axial).

IQ - Input Quill

OQ - Output Quill

I + OQ - Input and Output Quill

GM - Gearmesh

FIGURE 6—90C

42° GB

Band # 0--5KHz	Freq. (Hz)	SM #1 g's	
2	14	1.099	
5	55	.749	
12	141	.107	
14	219	.33[illegible]	
20	278	.371	
25	351	.17[illegible]	
30	424	.095	
35	498	.111	
41	585	.235	
48	659	.208	
50	717	.9[illegible]	
55	791	.25	
60	864	.27	
65	937	.346	
70	1010	.37	
* 75	1083	.86	90°GBX gearmesh
79	1142	.25	
84	1215	.54	
89	1289	.2[illegible]	
94	1362	.20	
99	1435	.42	
104	1508	.211	
109	1582	.155	
114	1655	.3	
119	1728	.29	
124	1801	.88	
129	1875	.74	
*133	1933	7.8	42° gearclash
*138	2006	1.17	2nd harmonic 90
143	2080	.77	
148	2153	1.32	
153	2226	.82	
157	2285	.83	
161	2343	.73	
167	2431	.64	
172	2504	.5[illegible]	

42° GB

Band # 0--5KHz	Freq. (Hz)	SM #1 g's	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1.2[illegible]	
1[illegible]	272[illegible]	.4[illegible]	
192	2[illegible]	.4[illegible]	
1[illegible]	2[illegible]	.910	
202	29[illegible]	.8[illegible]	
20[illegible]	301[illegible]	1.1[illegible]	
211	30[illegible]	.89[illegible]	
21[illegible]	3149	1.64	
221	3[illegible]	.9[illegible]	
22[illegible]	3310	1.2	
231	3369	1.4	
23[illegible]	3442	.76	
241	3515	.91	
24[illegible]	3588	.809	
250	364[illegible]	.88	
25[illegible]	3735	2.21	
261	3808	4.5	
*265	38[illegible]	18.3	2nd harmonic
270	3940	4.6	42° gearclash
275	4013	1.43	
280	408[illegible]	1.12	
284	414[illegible]	.73	
290	4233	.86	
295	430[illegible]	.62	
300	437[illegible]	.68	
305	4483	.89	
310	452[illegible]	.64	
314	4584	1.03	
319	4[illegible]58	.95	
324	4731	.95	
329	4804	.99	
334	46[illegible]	1.14	
339	4951	1.05	

FIGURE 6–90D

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HOVERAIRAPS SPECTRUM ANALYSIS

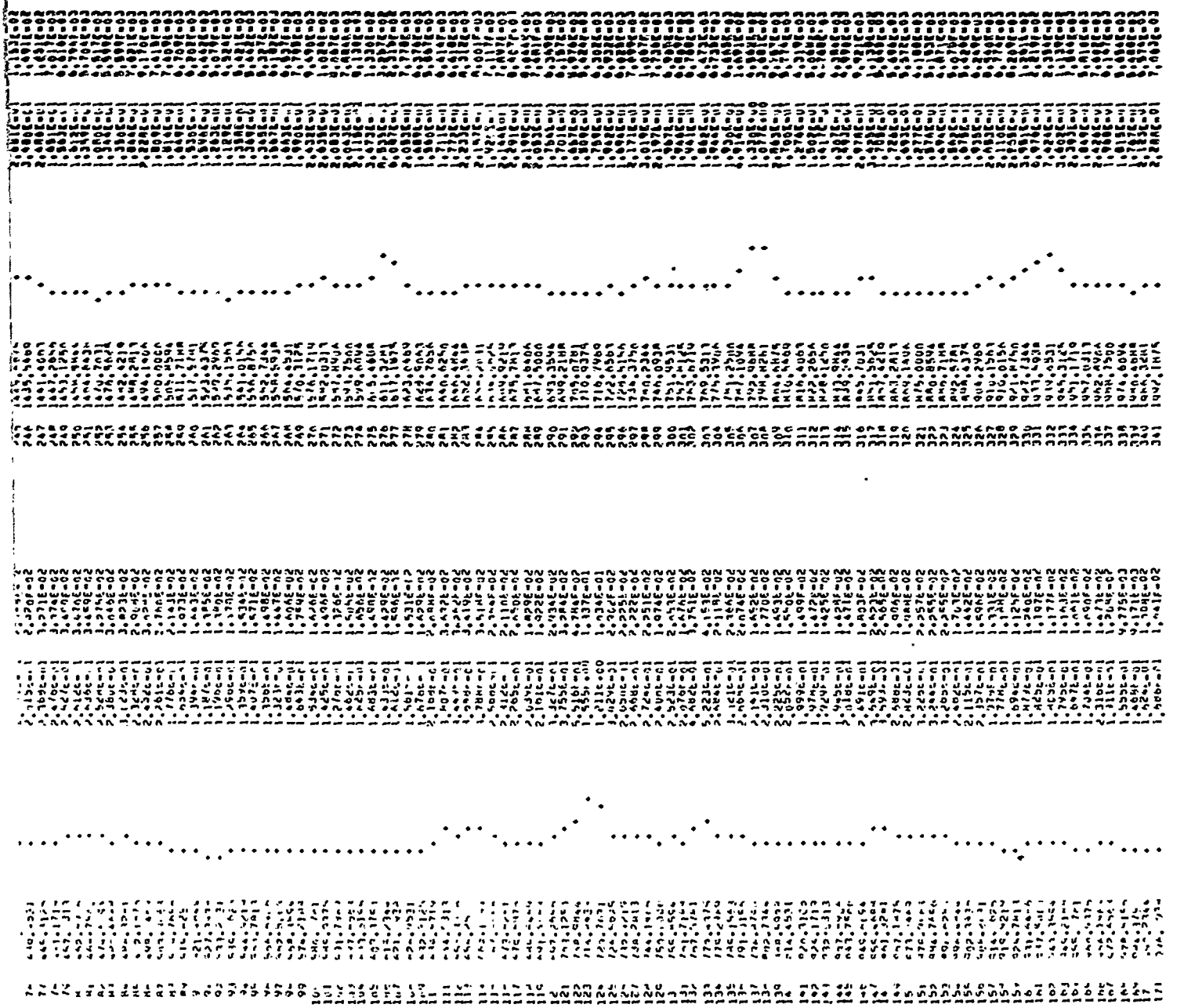
[illegible] NO. 9346A [illegible] NO. 87 TEST LOG SHEET NO. 1610
PARAMETER [illegible] PARAMETER TITLE: TOTAL SHELL HEADINGS AND SPANWISE SPECTRUM NO. 9272

[illegible] TORQUE 3560 PSI
ALT [illegible] A/C NO. 00-1011 A/C SPEED=115.0 KNOTS
[illegible] 0.735 HZ

CHISQUARE [illegible] 23541 NDF 2045

PNT	FREQ		U:PK	IN/SEC:PK	PNT	FREQ		U:PK	IN/SEC:PK
1	[illegible]		1.[illegible]E-01	1.[illegible]E+00	172	1011.4531		3.0276E-01	2.226E-02
2	[illegible]		4.1[illegible]E-01	2.176E+00	173	1017.8125		5.0131E-01	3.625E-02
3	[illegible]		[illegible]	[illegible]	174	1011.6719		4.3[illegible]E-01	2.638E-02
4	[illegible]		1.[illegible]E+00	[illegible]	175	[illegible]		6.1[illegible]E-01	3.934E-02
5	[illegible]		1.[illegible]E+00	[illegible]	176	[illegible]		7.2[illegible]E-01	4.587E-02
6	[illegible]		[illegible]	1.[illegible]E+00	177	1031.2500		3.5[illegible]E-01	2.117E-02
7	[illegible]		[illegible]	1.[illegible]E+00	178	1037.1094		3.4[illegible]E-01	2.033E-02
8	[illegible]		[illegible]	1.[illegible]E+00	179	1042.9688		3.2[illegible]E-01	1.937E-02
9	[illegible]		7.1[illegible]E-01	[illegible]	180	1048.8281		5.4[illegible]E-01	3.195E-02
10	[illegible]		[illegible]	[illegible]	181	1054.6875		4.7[illegible]E-01	2.195E-02
11	[illegible]		[illegible]	1.[illegible]E-01	182	1060.5469		4.0[illegible]E-01	2.365E-02
12	[illegible]		3.7[illegible]E-01	2.[illegible]E-01	183	1066.4063		7.9[illegible]E-01	4.869E-02
13	[illegible]		[illegible]	[illegible]	184	1072.2656		8.1[illegible]E+00	4.684E-01
14	[illegible]		[illegible]	2.[illegible]E-01	185	1078.1250		1.5[illegible]E+01	8.893E-01
15	[illegible]		[illegible]	4.4[illegible]E-01	186	1083.9844		7.5[illegible]E+00	4.269E-01
16	[illegible]		1.952E-01	2.[illegible]E-01	187	1089.8438		7.0[illegible]E-01	3.957E-02
17	[illegible]		2.[illegible]E-01	1.[illegible]E-01	188	1095.7031		3.8[illegible]E-01	2.138E-02
18	[illegible]		3.[illegible]E-01	2.[illegible]E-01	189	1101.5625		5.7[illegible]E-01	3.185E-02
19	[illegible]		3.7[illegible]E-01	1.[illegible]E-01	190	1107.4219		7.0[illegible]E-01	3.929E-02
20	[illegible]		2.[illegible]E-01	1.[illegible]E-01	191	1113.2813		4.2[illegible]E-01	2.351E-02
21	[illegible]		1.17[illegible]E-01	1.[illegible]E-01	192	1119.1406		5.9[illegible]E-[illegible]	3.270E-02
22	[illegible]		4.2[illegible]E-01	2.[illegible]E-01	193	1125.0000		5.6[illegible]E-[illegible]	3.099E-02
23	[illegible]		5.5[illegible]E-01	3.[illegible]E-01	194	1130.8594		1.1[illegible]E+00	6.103E-02
24	[illegible]		[illegible]	[illegible]	195	1136.7188		9.3[illegible]E-01	5.[illegible]E-02
25	[illegible]		7.2[illegible]E-01	3.[illegible]E-01	196	1142.5781		4.6[illegible]E-01	2.[illegible]E-02
26	[illegible]		1.1[illegible]E-01	1.[illegible]E-01	197	1148.4375		7.0[illegible]E-01	3.797E-02
27	[illegible]		2.5[illegible]E-01	1.[illegible]E-01	198	1154.2969		4.2[illegible]E-01	2.243E-02
28	[illegible]		2.2[illegible]E-01	1.[illegible]E-02	199	1160.1563		2.3[illegible]E-01	1.227E-02
29	[illegible]		2.[illegible]E-01	1.[illegible]E-01	200	1165.9156		2.0[illegible]E-01	1.[illegible]E-02
30	[illegible]		2.1[illegible]E-01	7.[illegible]E-02	201	1171.6750		2.2[illegible]E-01	1.184E-02
31	175.7812		5.[illegible]E-02	5.[illegible]E-02	202	1177.3344		2.4[illegible]E-01	1.[illegible]E-02
32	[illegible]		1.[illegible]E-01	4.[illegible]E-02	203	1183.5938		2.9[illegible]E-01	1.[illegible]E-02
33	[illegible]		1.5[illegible]E-01	4.[illegible]E-02	204	1189.4531		3.2[illegible]E-01	1.694E-02
34	[illegible]		1.4[illegible]E-01	5.[illegible]E-02	205	1195.3125		2.2[illegible]E-01	1.134E-02
35	[illegible]		1.3[illegible]E-01	4.[illegible]E-02	206	1201.1719		1.9[illegible]E-01	1.001E-02
36	[illegible]		1.3[illegible]E-01	4.[illegible]E-02	207	1207.0313		1.8[illegible]E-01	9.467E-03
37	[illegible]		1.7[illegible]E-01	5.[illegible]E-02	208	1212.8906		1.8[illegible]E-01	9.617E-03
38	[illegible]		4.7[illegible]E-01	1.[illegible]E-01	209	1218.7500		1.7[illegible]E-01	8.909E-03
39	[illegible]		4.7[illegible]E-01	1.[illegible]E-01	210	1224.6094		1.4[illegible]E-01	7.249E-03
40	[illegible]		2.0[illegible]E-01	5.[illegible]E-02	211	1230.4688		1.1[illegible]E-01	5.988E-03
41	[illegible]		2.1[illegible]E-01	5.[illegible]E-02	212	1236.3281		1.4[illegible]E-01	7.052E-03
42	[illegible]		2.1[illegible]E-01	5.967E-02	213	1242.1875		1.5[illegible]E-01	7.709E-03
43	[illegible]		2.2[illegible]E-01	5.732E-02	214	1247.9469		1.1[illegible]E-01	5.451E-03
44	[illegible]		2.2[illegible]E-01	6.245E-02	215	1253.7063		8.8[illegible]E-02	4.350E-03
45	[illegible]		[illegible]	[illegible]	216	1259.7656		9.7[illegible]E-02	4.770E-03
46	[illegible]		4.3[illegible]E-01	1.[illegible]E-01	217	1265.4250		1.0[illegible]E-01	5.143E-03
47	[illegible]		1.[illegible]E-01	2.[illegible]E-01	218	1271.2844		1.0[illegible]E-01	4.977E-03
48	[illegible]		[illegible]	2.[illegible]E-01	219	1277.1437		4.9[illegible]E-02	4.[illegible]E-03
49	[illegible]		[illegible]	2.[illegible]E-01	220	[illegible]		1.3[illegible]E-01	6.[illegible]E-03
50	[illegible]		4.4[illegible]E-01	2.[illegible]E-01	221	1289.0625		1.1[illegible]E-01	1.[illegible]E-02
51	[illegible]		4.4[illegible]E-01	2.[illegible]E-01	222	1294.9219		2.0[illegible]E-01	9.500E-03
52	[illegible]		7.2[illegible]E-01	1.4[illegible]E-01	223	1300.7813		1.1[illegible]E-01	5.232E-03
53	[illegible]		5.9[illegible]E-01	1.2[illegible]E-01	224	1306.6406		1.0[illegible]E-01	4.767E-03
54	[illegible]		5.0[illegible]E-01	9.4[illegible]E-02	225	1312.5000		1.0[illegible]E-01	5.067E-03
55	[illegible]		4.2[illegible]E-01	8.2[illegible]E-02	226	1318.3594		9.6[illegible]E-02	4.490E-03
56	[illegible]		1.9[illegible]E-01	7.4[illegible]E-02	227	1324.2188		8.7[illegible]E-02	4.[illegible]E-03
57	[illegible]		4.0[illegible]E-01	7.4[illegible]E-02	228	1330.0781		9.9[illegible]E-02	4.[illegible]E-03
58	[illegible]		5.2[illegible]E-01	9.4[illegible]E-02	229	1335.9375		1.2[illegible]E-01	5.[illegible]E-03
59	[illegible]		3.4[illegible]E-01	6.3[illegible]E-02	230	1341.7969		1.1[illegible]E-01	5.3[illegible]E-03
60	145.7031		2.3[illegible]E-01	4.1[illegible]E-02	231	1347.6563		1.6[illegible]E-01	7.316E-03
61	151.5625		2.1[illegible]E-01	3.4[illegible]E-02	232	1353.5156		1.7[illegible]E-01	7.[illegible]E-03
62	[illegible]		1.9[illegible]E-01	3.4[illegible]E-02	233	1359.3750		1.6[illegible]E-01	7.287E-03
63	[illegible]		2.5[illegible]E-01	4.7[illegible]E-02	234	1365.2344		1.7[illegible]E-01	7.767E-03
64	[illegible]		2.5[illegible]E-01	4.2[illegible]E-02	235	1371.0938		1.5[illegible]E-01	6.972E-03
65	[illegible]		2.5[illegible]E-01	4.2[illegible]E-02	236	1376.9531		1.3[illegible]E-01	6.016E-03
66	[illegible]		2.6[illegible]E-01	4.2[illegible]E-02	237	1382.8125		1.2[illegible]E-01	5.436E-03
67	[illegible]		2.5[illegible]E-01	4.6[illegible]E-02	238	1388.6719		1.1[illegible]E-01	5.070E-03
68	[illegible]		2.4[illegible]E-01	4.5[illegible]E-02	239	1394.5313		1.2[illegible]E-01	5.674E-03
69	[illegible]		2.5[illegible]E-01	3.4[illegible]E-02	240	1400.3906		1.2[illegible]E-01	5.664E-03
70	[illegible]		2.4[illegible]E-01	3.9[illegible]E-02	241	1406.2500		1.1[illegible]E-01	6.795E-03
71	[illegible]		2.9[illegible]E-01	4.4[illegible]E-02	242	1412.1094		1.4[illegible]E-01	6.289E-03
72	[illegible]		2.9[illegible]E-01	3.5[illegible]E-02	243	1417.9688		1.3[illegible]E-01	5.844E-03
73	[illegible]		2.4[illegible]E-01	3.4[illegible]E-02	244	1423.8281		1.0[illegible]E-01	4.[illegible]E-03
74	[illegible]		2.5[illegible]E-01	3.1[illegible]E-02	245	1429.6875		2.6[illegible]E-01	1.153E-02
75	[illegible]		2.0[illegible]E-01	2.9[illegible]E-02	246	1435.5469		3.4[illegible]E-01	1.491E-02
76	[illegible]		2.0[illegible]E-01	2.3[illegible]E-02	247	1441.4063		2.4[illegible]E-01	1.[illegible]E-02
77	[illegible]		2.3[illegible]E-01	3.2[illegible]E-02	248	1447.2656		1.4[illegible]E-01	6.[illegible]E-03
78	[illegible]		2.4[illegible]E-01	3.3[illegible]E-02	249	1453.1250		1.5[illegible]E-01	6.610E-03
79	[illegible]		2.5[illegible]E-01	3.4[illegible]E-02	250	1458.9844		1.0[illegible]E-01	4.794E-03
80	[illegible]		2.5[illegible]E-01	3.4[illegible]E-02	251	1464.8438		1.3[illegible]E-01	5.704E-03
81	[illegible]		2.5[illegible]E-01	3.3[illegible]E-02	252	1470.7031		1.0[illegible]E-01	4.917E-03

FIGURE 6—91 FLIGHT TEST BASELINE I
A



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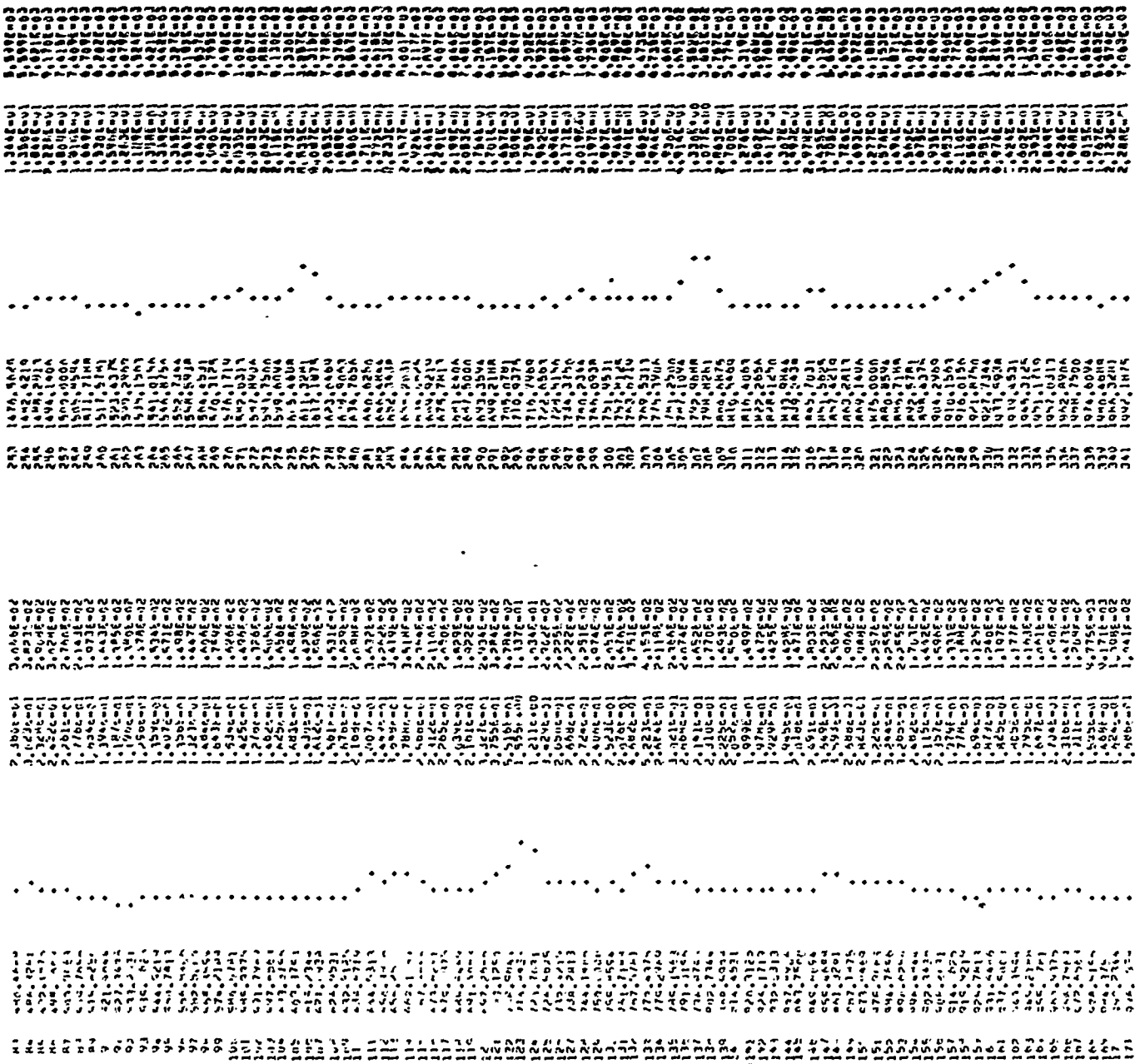
ELINE DATA 2000 HZ. HIGH FREQUENCY ANALYSIS

6-91 B



DATA 2000 HZ. HIGH FREQUENCY ANALYSIS

6-91 C

HSU/AIDAPS MEAN SPECTRUM ANALYSIS

IDENTIFICATIONS PRO 61

THE FOLLOWING SPECTRA WERE USED IN COMPUTING THE MEAN SPECTRUM

TAPE	NO.	CHANNEL	SPECTRUM NO.	ITEM SERIAL NO.
02351	62	1-V	2176	ABW-219
02351	83	1-V	2326	ABW-119W
02356	115	1-V	2691	B13-8J06
02356	114	1-V	2667	ABW-209
02370	127	1-V	2963	B13-319V
02376	136	1-V	2937	B13-2425
02369	187	1-V	3102	B13-1.078
03316	19.	1-V	3264	WWW-492
021.74	1V6	1-V	3270	AWW-364
021.74	1V6	1-V	3270	W13-4122
021.75	6..	1-V	3302	A13-4957
021.75	2..	1-V	3308	A13-2143

HSU/AIDAPS MEAN SPECTRUM ANALYSIS

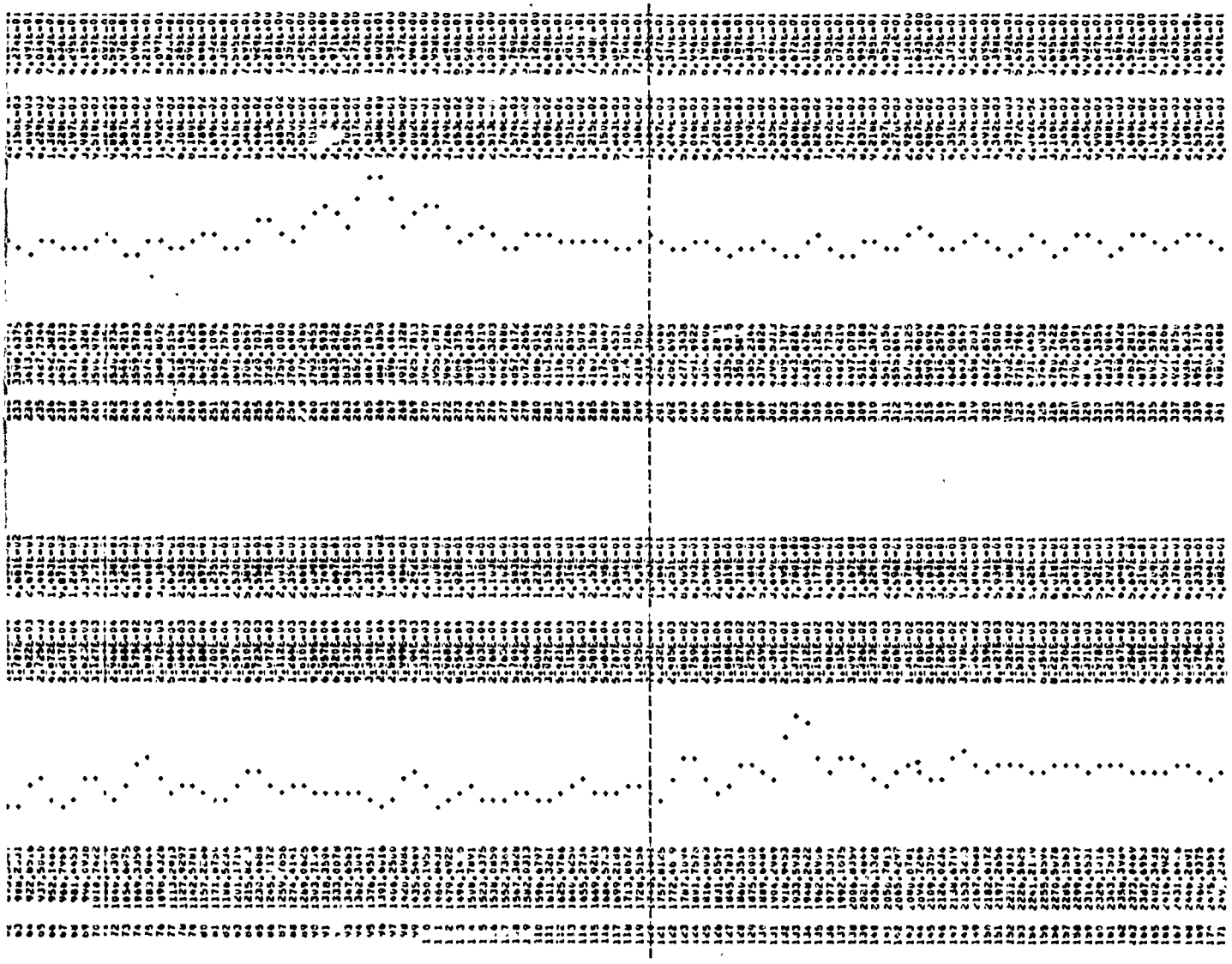
ITEM: 42 DRIVEN GEARBOX — UNITS: G-PK
PARAMETER NO. 61 — PARAMETER TITLE: GEARMESH — NO. OF SPEC. AVERAGED 12

ITEM SPEED: 43.3.2. RPM — TRANSMISSION INPUT SPEED: 6600 RPM — TORQUE: 30.0 PSI
FREQUENCY RANGE: 5.V. HZ — ANALYSIS BW: 21.973 HZ

PNT	FREQ	PSD	UNITS-PK
2	14.6984	2.7505E-02	1.099E-00
3	29.2969	1.9798E-03	2.509E-01
4	43.9953	6.0992E-03	5.561E-01
5	58.5938	1.2678E-02	7.489E-01
6	73.2422	6.3796E-03	4.864E-01
7	87.8906	1.9887E-03	2.879E-01
8	102.5391	7.5018E-04	1.085E-01
9	117.1875	6.7602E-04	1.744E-01
10	131.8359	6.5906E-04	1.875E-01
11	146.4844	2.3935E-03	3.263E-01
12	161.1328	6.2925E-03	6.073E-01
13	175.7812	4.5236E-03	4.523E-01
14	190.4297	2.1744E-03	3.108E-01
15	205.0781	1.9068E-03	2.313E-01
16	219.7266	2.5720E-03	3.261E-01
17	234.3750	1.4555E-03	2.348E-01
18	249.0234	1.9034E-03	2.578E-01
19	263.6719	3.9081E-03	3.688E-01
20	278.3203	3.1224E-03	3.709E-01
21	292.9688	1.4516E-03	2.448E-01
22	307.6172	7.2694E-04	1.787E-01
23	322.2656	5.7602E-04	1.891E-01
24	336.9141	6.5408E-04	1.697E-01
25	351.5625	7.1896E-04	1.774E-01
26	366.2109	6.9336E-04	1.694E-01
27	380.8594	6.1779E-04	1.640E-01
28	395.5078	4.6850E-04	1.422E-01
29	410.1563	2.8065E-04	1.114E-01
30	424.8047	4.5036E-04	9.884E-02
31	439.4531	1.2040E-04	7.012E-02
32	454.1016	1.1315E-04	7.696E-02
33	468.7500	1.2480E-04	7.788E-02
34	483.3984	1.0895E-04	9.149E-02
35	498.0469	2.0468E-04	1.118E-01
36	512.6953	2.5097E-04	1.008E-01
37	527.3438	1.2448E-04	7.685E-02
38	541.9922	1.7286E-04	8.710E-02
39	556.6406	2.8851E-04	1.119E-01
40	571.2891	1.2250E-03	2.162E-01
41	585.9375	1.2656E-03	2.369E-01
42	600.5859	6.8296E-04	1.732E-01
43	615.2344	7.2798E-04	1.789E-01
44	629.8828	5.8777E-04	1.6.7E-01
45	644.5312	9.4208E-04	1.992E-01
46	659.1797	9.5405E-04	2.082E-01
47	673.8281	7.1315E-04	1.789E-01
48	688.4766	5.5043E-04	1.635E-01
49	703.1250	5.1401E-03	4.783E-01
50	717.7734	2.1946E-02	9.592E-01
51	732.4219	7.3548E-03	5.085E-01
52	747.0703	4.5667E-04	1.416E-01
53	761.7188	4.7055E-04	1.327E-01
54	776.3672	6.7426E-04	1.446E-01
55	791.0156	1.5405E-03	2.551E-01
56	805.6641	9.4972E-04	2.421E-01
57	820.3125	6.2161E-04	1.672E-01
58	834.9609	3.2615E-04	1.169E-01
59	849.6094	9.8221E-04	2.566E-01
60	864.2578	1.5772E-03	2.711E-01
61	878.9063	4.5945E-04	1.408E-01
62	893.5547	1.9888E-04	7.666E-02
63	908.2031	1.7076E-04	6.861E-02
64	922.8516	1.9222E-03	2.878E-01
65	937.5000	2.7235E-03	3.461E-01
66	952.1484	4.9772E-04	1.483E-01
67	966.7969	2.2178E-04	9.871E-02
68	981.4453	3.2497E-04	1.296E-01
69	996.0938	2.9234E-03	3.395E-01
70	1010.7422	3.5127E-03	3.736E-01
171	2508.4688	7.3136E-03	9.089E-01
172	2513.8672	9.1161E-03	9.104E-01
173	2519.5313	4.9611E-03	6.889E-01
174	2525.1797	4.6031E-03	4.344E-01
175	2530.8281	5.3961E-03	5.870E-01
176	2536.4766	7.7926E-03	9.847E-01
177	2542.1250	6.7777E-03	9.457E-01
178	2547.7734	4.6456E-03	5.316E-01
179	2553.4219	4.6669E-03	5.560E-01
180	2559.0703	1.7616E-02	6.797E-01
181	2564.7188	2.0534E-02	1.457E-00
182	2570.3672	1.6034E-02	1.160E-01
183	2576.0156	4.4141E-03	3.873E-01
184	2581.6641	3.3281E-03	3.824E-01
185	2587.3125	4.9671E-03	5.194E-01
186	2592.9609	5.0911E-03	5.730E-01
187	2598.6094	4.4444E-03	4.619E-01
188	2604.2578	4.8188E-03	4.292E-01
189	2609.9063	3.8095E-03	4.071E-01
190	2615.5547	4.0311E-03	4.204E-01
191	2621.2031	7.1225E-03	5.578E-01
192	2626.8516	6.1704E-03	9.211E-01
193	2632.5000	4.1280E-03	4.288E-01
194	2638.1484	4.0467E-03	5.957E-01
195	2643.7969	1.0580E-02	9.818E-01
196	2649.4453	1.4955E-02	8.194E-01
197	2655.0938	4.5065E-03	5.272E-01
198	2660.7422	4.5984E-03	5.177E-01
199	2666.3906	1.0945E-02	8.772E-01
200	2671.9391	1.3428E-02	7.681E-01
201	2677.6875	1.0396E-02	6.492E-01
202	2683.3359	1.2720E-03	5.260E-01
203	2688.9844	1.1883E-03	5.347E-01
204	2694.6328	1.1982E-03	5.537E-01
205	2700.2813	3.7918E-02	1.170E-00
206	2705.9297	1.6041E-02	1.190E-00
207	2711.5781	3.1128E-03	5.193E-01
208	2717.2266	3.9236E-03	5.192E-01
209	2722.8750	5.5301E-03	5.092E-01
210	2728.5235	1.8338E-02	6.974E-01
211	2734.1719	1.0695E-02	6.512E-01
212	2739.8203	5.1300E-03	4.748E-01
213	2745.4688	3.7511E-03	4.084E-01
214	2751.1172	1.6421E-02	7.287E-01
215	2756.7656	1.1284E-02	1.401E-00
216	2762.4141	1.1296E-02	1.298E-00
217	2768.0625	5.6504E-03	4.980E-01
218	2773.7109	5.3111E-03	4.353E-01
219	2779.3594	9.8895E-03	9.592E-01
220	2784.9078	2.1475E-02	9.713E-01
221	2790.6563	1.0338E-02	6.748E-01
222	2796.3047	7.0248E-03	5.557E-01
223	2801.9531	7.9296E-03	9.991E-01
224	2807.6016	2.8021E-02	1.142E-00
225	2813.2500	3.0661E-02	1.191E-00
226	2818.8984	6.8671E-03	5.488E-01
227	2824.5469	9.0734E-03	9.281E-01
228	2830.1953	4.0488E-02	9.648E-01
229	2835.8438	1.4386E-02	1.396E-00
230	2841.4922	1.5391E-02	9.424E-01
231	2847.1406	6.4396E-03	9.270E-01
232	2852.7891	1.1966E-03	4.271E-01
233	2858.4375	4.0097E-03	9.971E-01
234	2864.0859	9.2291E-03	9.014E-01
235	2869.7344	1.3098E-02	7.893E-01
236	2875.3828	7.2281E-03	8.748E-01
237	2880.9313	4.1971E-03	9.293E-01
238	2886.5797	3.9084E-03	4.185E-01
239	2892.2281	9.5141E-03	9.497E-01
240	2897.8766		

270

6-92 A



6-92 B

FIGURE 6—92

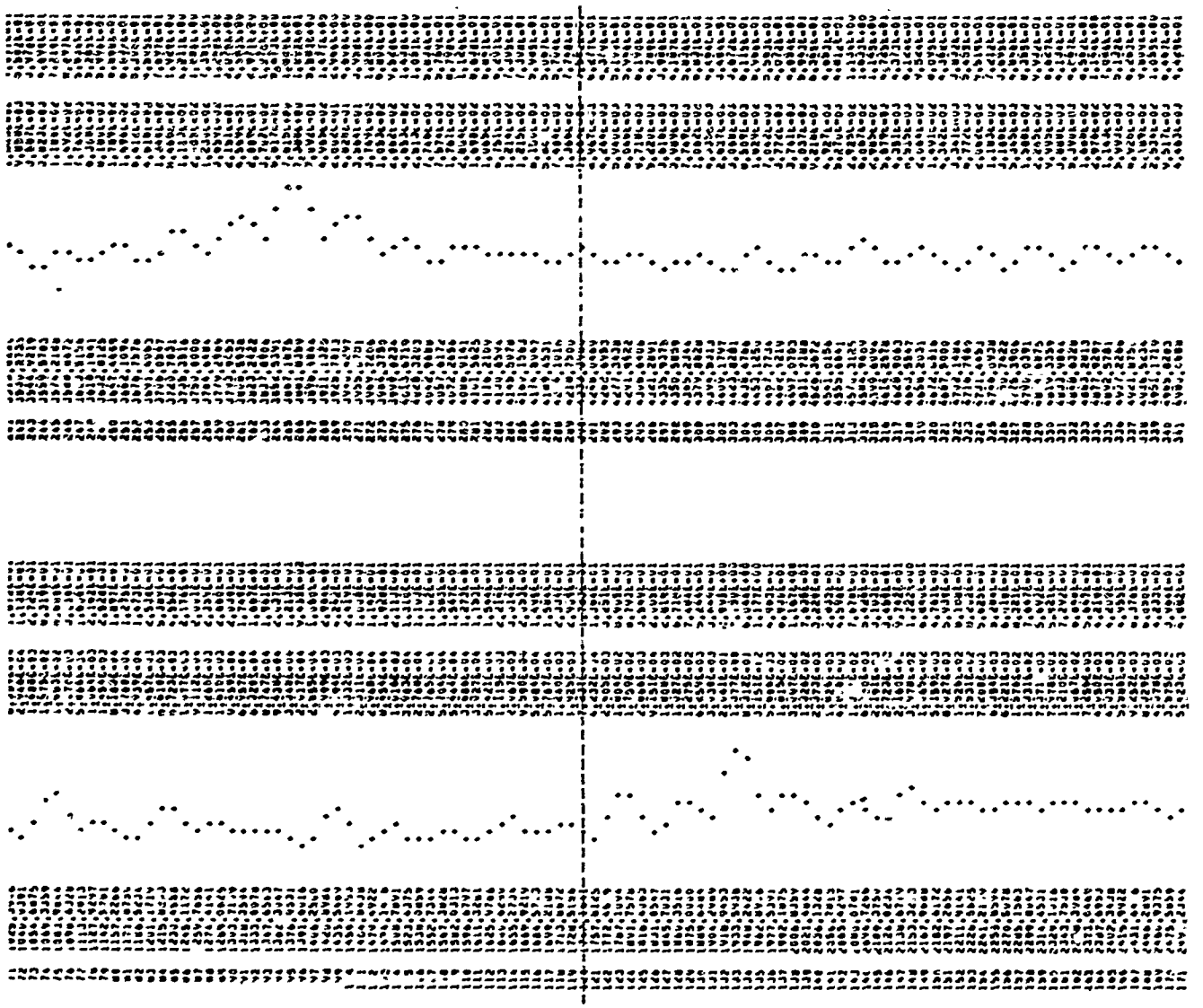


FIGURE 6-92 C

BANDS GREATER THAN M+[illegible] 235,

[illegible]

02371 137 [illegible] 3136 [illegible] [illegible] 33 [illegible] [illegible] 13 10 8 5 [illegible] [illegible]

BANDS GREATER THAN M+[illegible] 64,101,221,[illegible],233,240,241,

[illegible]

BANDS GREATER THAN M+[illegible] 224,[illegible],

BANDS GREATER THAN M+75 230,235,239,

BANDS GREATER THAN M+[illegible] [illegible],[illegible],[illegible],

02371 142 205 3084 80 26 0 [illegible] [illegible] 0 0 0 0 0 0

02371 143 205 [illegible] 71 14 0 2 2 2 1 1 0 0 0

BANDS GREATER THAN M+53 124,

[illegible]

04446 148 205 3100 147 97 33 11 [illegible] [illegible] 0 0 0 0 0

BANDS GREATER THAN M+[illegible] 103,117,135,

[illegible]

BANDS GREATER THAN M+[illegible] 62,

BANDS GREATER THAN M+53 61,124,

02373 [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

BANDS GREATER THAN M+[illegible] 61, 66,136,

BANDS GREATER THAN M+53 84,184,

BANDS GREATER THAN M+[illegible] [illegible],

BANDS GREATER THAN M+73 59, 60,

BANDS GREATER THAN M+93 58,

02373 167 205 3134 101 72 32 18 [illegible] [illegible] 1 0 0 0 0

BANDS GREATER THAN M+53 83,122,

BANDS GREATER THAN M+63 47,

[illegible]

ITEM= [illegible] [illegible]
PARAMETER NO: [illegible]
ITEM SPEED= 1656.60 RPM TRANSMISSION INPUT SPEED= 6600 RPM TORQUE= 30.0 FSI
FREQUENCY RANGE= 2000 HZ ANALYSIS BW= 8.789 HZ NO. OF SPEC. COMPARED= 19

FIGURE 6-93

MSD/AIDAPS COMPARISON SUMMARY ANALYSIS

MEAN IDENTIFICATION= MMA000

THE FOLLOWING CRITERIA ARE CONSIDERED AGAINST [illegible]

NUMBER OF FREQUENCY POINTS WHERE COMPARISON LEVEL IS EXCEEDED

[illegible]

BANDS GREATER THAN M+40 300,

BANDS GREATER THAN M+50 274,

[illegible]

BANDS GREATER THAN M+100 243,

[illegible]	810	203	2807	21	4	1	0	0	0	0	0	0	0	0
[illegible]														
03464	89	200	3018	14	6	2	0	0	0	0	0	0	0	0
02323	67	200	3076	100	38	10	5	3	1	0	0	0	0	0

[illegible]

BANDS GREATER THAN M+50 333,

021760	71	200	2023	127	32	17	3	1	0	0	0	0	0	0
031277	93	200	3737	71	17	7	4	2	1	0	0	0	0	0

BANDS GREATER THAN M+40 200,300,

021277	97	200	2199	63	22	7	4	3	2	2	0	0	0	0

BANDS GREATER THAN M+50 [illegible],

02727	101	200	2700	[illegible]	33	18	14	6	4	3	0	0	0	0

BANDS GREATER THAN M+40 200,300,

BANDS GREATER THAN M+60 [illegible],297,[illegible],

02722	103	200	2700	[illegible]	38	23	11	4	3	2	0	0	0	0

BANDS GREATER THAN M+60 [illegible],[illegible],[illegible],

02356	111	200	2700	100	31	11	6	4	3	2	2	1	1	1

BANDS GREATER THAN M+40 107,

BANDS GREATER THAN M+60 300,

BANDS GREATER THAN M+70 [illegible],

[illegible]	135	200	[illegible]	133	78	32	20	13	6	3	2	1	1	0

BANDS GREATER THAN M+40 178,234,[illegible],[illegible],[illegible],[illegible],[illegible],

BANDS GREATER THAN M+60 [illegible],

AIDAPS - Flight Test Phase Summary — High Speed Level Flight

Part Number	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ Exceedances Parameter #64	4 σ Exceedances Number #64	Run No.
90° gearbox	12	204-040-012-13	--	B13-2[illegible]	good	0	0	62
				[illegible]				83
				A13-1[illegible]				115
				A13-2[illegible]				119
				B13-[illegible]24				129
				A13-20[illegible]				131
				B13-2539				187
				B13-[illegible]433				190
				A13-31[illegible]				194
				B13-3094				198
				B13-5984				200
				B12-3295				203
input ball bearing	2	204-040-143-1	80[illegible]K		rust corrosion ball & races	7	4	75A
			801[illegible]E		grooves on balls	20	13	135
output ball bearing	2	204-040-424-1	E200		rust pitted and grooved balls	3	0	85A
			29745		fatigue pitted balls	3	2	142
input roller bearing	2	204-040-400-1	16805		rust pitted outer race; deep grooved roller	2	0	81A
			2929		rust & pitted outer race; grooved & pitted rollers	3	20	137
output roller bearing	2	204-040-407-1	17522		fatigue pitted outer race & roller	0	0	89
			28418		corrosive pitted outer race and rust pitted rollers	2	2	145

FIGURE 94—A

db exceedances parameter number		Run No.
12 db *64	6 db *66	
7 17, 18, 38, 245-247, 335	4 245, 246, 274, 308	75A
20 18, 38, 45, 47, 63, 80, 81, 90, 179, 180, 189, 277, 319, 334, 335, 338-342	13 101, 175, 224-226, 228, 233-238, 240	135
3 17, 18, 180	0	85A
3 47, 180, 278	2 103, 104	142
2 147, 280	0	81A
3 47, 77, 335	20 84, 85, 101, 221-227, 230, 232, 233, 235-241	137
0	0	89
2 280, 332	2 101, 124	145

FIGURE 6-94B

AIDAPS - FLIGHT TEST PHASE SUMMARY

HIGH SPEED LEVEL FLIGHT

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ Exceedences/Parameter Number #125	#47	#123	#127	#129	Run No.
Transmission	[illegible]	204-040-01[illegible]-1	- -	B12-1[illegible] ABU-1[illegible] ABU-1[illegible] input quill=CP12-42[illegible] tail rotor quill=B12=55524 main mast = [illegible] ABU-1[illegible] input quill=Q12-520 tail rotor quill=F12-6215 main mast = 612J ABU-10527 input quill=Q12-520 tail rotor quill=F12-6277 main mast = 198K ABU-10527 input quill=CP12-7105 tail rotor quill=B12-18628 main mast = 833E ABU-10527 ABU-10527 ABU-10527 ABU-10527 ABU-10527 ABU-10527	good	0	0	0	0	0	62 83 115 119 129 131 187 190 194 198 200 203
Input quill ball bearing	2	204-040-346-3	K-717 CP12-7105**	ABU-10527 ABU-10527	Rusty balls & races	55 3	129 22	27 1	41 31	10 27	93 167
Tail rotor quill ball bearing	1	204-040-143-1	B12-1862B**	ABU-10527		6	3	10	110	25	164
Tail rotor quill roller bearing	1	204-040-310-1	118520	ABU-10527	Rust pitted rollers; cut and rust pitted inner race	2	94	3	32	5	101
Main mast ball bearing	2	204-040-136-7	465 6739	ABU-10527 ABU-10527	Corrosive pitted races and balls	2 1	56 - -	8 26	46 49	4 - -	97 161

** Serial number of the entire quill assembly, not of the implanted defective part.

FIGURE 6—95A

4 σ exceedences/parameter number

#125	#47	#123	#12[illegible]	#129	Run No.
55 13, 21-26, 62, 63, 96-98, 101-105, 124, 125 144-146, 176, 180-182, 191-193 196, 237-240, 282-290, 293, 295, 296, 327, 328, 332-337	129 6-34, 51-75, 77-84, 88, 91-108, 113-127, 131, 144-167, 197, 198, 204, 205, 234, 336-338	2[illegible] 96, 97, 112, 127, 136, 143-146, 185, 191, 192, 197, 237-241, 245, 274, 256, 318, 321, 333-336	41 97-105, 110-113, 127, 252, 257, 274, 279, 283, 284, 286, 314, 315, 317, 318, 321-328, 331-335	10 127, 149, 257, 285-287, 322, 325, 333, 334	93
3 2, 15, 16	22 2, 9, 10, 13, 14, 23-25, 38, 39, 88, 89, 90, 106-108, 117, 155, 156, 194, 306, 307	1 126	31 44, 122, 126, 131, 159, 172-176, 182, 218, 219, 243-247, 227, 249-251, 255, 258-260, 263, 264, 267, 268, 279	27 29, 30, 40, 44, 69, 84, 126, 139, 156, 157, 159, 172, 179-182, 186, 187, 230-232, 251, 254, 255, 258, 259	167
6 2, 15, 16, 42, 43, 281	3 107, 108, 118	10 16, 38, 108, 144, 145, 195-198, 200	110 10, 11, 13, 16, 17, 25, 38, 40-42, 159, 172, 174-176, 178-180, 182-184, 186, 198-200, 203-205, 212, 213, 217-222, 227, 233-249, 252, 253, 255-268, 271-294, 296, 310, 322-328, 330-336, 338-341	25 29-31, 38, 40, 41, 135, 136, 139, 154, 156, 157, 163, 172, 179, 180, 186, 187, 219, 220, 230-232, 246, 259	164
2 25, 127	94 8-32, 55-60, 62-75, 78-84, 92-108, 113, 114, 116-123, 127 147-156, 159, 162, 336, 337	3 127, 145, 336	32 2-29, 51, 74, 75, 127	5 41, 44, 99, 100 127	101

FIGURE 6-95B

4 σ exceedances/parameter number

#125	#47	#123	#126	#129	Run No.
2	56	8	46	4	97
2, 75	12-31, 59, 68-71, 74, 78, 79, 80, 94-98, 101-105, 107, 108, 113, 114, 116-121, 154, 155, 335, 337, 338	22, 23, 75, 76, 127, 144, 145, 321	98-108, 110, 111, 127, 252, 257, 267, 274, 275, 279, 280, 283, 284, 289, 291, 311, 314, 315, 317, 318, 321-328, 330, 332, 334-336, 339-340	127, 128, 149, 257	
1	- -	26	49	- -	161
2		80, 120, 125, 126, 159-172, 182, 186, 187, 191, 196-198, 200	131, 137, 159, 172-176, 182, 186, 221, 222, 227, 242-253, 255-261, 263-268, 272, 276, 278, 279, 282, 284, 290, 291, 322, 324		

FIGURE 6-95C

AIDAPS - Flight Test Phase Summary

High Speed Level Flight

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ exceedances/parameter number	Run No.
420 gearbox	12	204-040-003-3	--	ABB-219 ABB-1130 B13-8304 ABB-289 B13-5199 B13-2925 B13-10078 BBB-492 ABB-564 B13-9122 A13-9857 A13-2148	good	#61 0	62 83 115 119 129 131 187 190 194 198 200 203
input/output ball bearing	2	204-040-143-1	470K (I)	B13-2925	fatigue pitted balls	20 8, 9, 27, 30-32, 50, 51, 217, 168, 169, 183, 218, 247, 264, 272, 273, 299-301	67
			7510H (O)	B13-2925	rust corrosion damage balls & races	15 8, 9, 12, 51, 52, 77, 117, 127, 131, 132, 219, 243, 244, 299, 341	105
input roller bearing	2	204-040-310-1	124631	B13-5199	corrosive pitted inner race and roller	5 34, 45, 122, 127, 166	71
			119953	B13-5199	rust pitted inner race; rust pitted & deep grooved rollers	8 25, 45, 46, 52, 53, 236, 237, 322.	111

FIGURE 6-96

AIDAPS - Flight Test Phase Summary High Speed Level Flight

Part Name	Number Tested	Part Number	Defective Part Serial Number	Component Serial Number	Description of Defective Part	4 σ Exceedances Parameter Number #4	#7	#8	Run No.
engine	12	T53-L-13	--	LE-13669	good	0	0	0	62
				LE-16522					83
				LE-15615					115
				LE-20727					119
				LE-18993					129
				LE-15351					131
				LE-18270					187
				LE-20791					190
				LE-14819					194
				LE-17376					198
				LE-18301					200
				LE-16886					203
#2 main bearing	2	1-300-176-01	1025	LE-15615	pitted outer race; excessive roller end wear	13	2	98	67
			5357	LE-15615	corrosive pitted outer race & roller; excessive roller end wear	14	6	--	135
#3 main bearing	2	1-300-176-01	1164	LE-20727	pitted outer race & rollers; excessive roller end wear	15	3	13	71
			1025	LE-20727	pitted outer race; excessive roller end wear	6	0	42	137
#4 main bearing	2	1-300-015-04	2652	LE-15351	pitted balls & races	0	24	4	75A
			984C	LE-15351	corrosive pitted balls; internal clearance .0004 over max.	6	27	0	105
compressor	2	1-100-720-18	M40543	LE-15c15	compressor F.O.D. (bad); unbalance	5	3	10	85A
			M42476	LE-18993	compressor F.O.D.; unbalance	17	6	4	142
power turbine	2	N.A.	3888	LE-20727	out of balance; bad carbon seals (P5619)	16	5	16	89
			N.A.	LE-15351	rotor warped and out of balance	4	3	7	145
N1 nozzle	2	N.A.	9E128	LE-18993	N.A.	5	7	3	81A
			76-157	LE-15615	N.A.	8	0	5	148
N2 nozzle	2	N.A.	96005	LE18993	N.A.	6	5	0	111
			N.A.	LE-20727	N.A.	11	0	42	153
fuel control	5	N.A.	N.A.	LE16522	out of spec. droop curve	5	9	0	154A
					½ turn lean	5	6	3	155A
					1 turn lean	5	7	2	156
					½ turn rich	8	9	2	157
					1 turn rich	8	9	2	158

FIGURE 6-97A

4 σ Exceedance/parameter number			Run No.
# 1	# 2	# 3	
13 42-44, 51, 52, 123-126, 295-297, 317	2 113, 229	25 2-23, 27-45, 51-54, 57-71, [illegible], 81-85, 88-95, 100, 103, 104, 109, 198, 271, 272, 312, 315-320, 325, 326, 328, 330, 331, 334, 335, 342	57
14 39-46, 83, 110, 112, 113, 199, 298	7 107, 108, 159-161, 199	--	135
15 29, 30, 38, 39, 42-47, 145, 148, 275, 321, 322	3 113, 114, 226	13 94, 95, 105, 107, 108, 176, 178, 180, 218, 223, 226, 291, 109	71
6 28, 29, 201, 305, 327, 328	0	42 55, 56, 61-63, 65, 66, 70, 77, 94, 95, 99, 100, 101, 103, 104, 194, 256, 257, 259, 267, 291, 306, 309, 310, 320, 325-331, 334-342	137
0	24 39-41, 64, 103-108, 112-115, 118-120, 148-151, 164, 223, 312	4 253, 254, 309, 311	75A
6 45, 113, 121, 122, 318, 319	27 39, 40, 62-65, 93, 94, 96-98, 256, 270, 271, 275-279, 281, 283-286, 291, 292, 295	0	105
5 37, 111, 221, 249, 277	3 113, 114, 164	10 29, 30, 220-222, 248-250, 253, 260	85A
17 57, 58, 85, 105, 113, 169, 170, 225, 248, 249, 252, 253, 281, 282, 309-311	6 8, 9, 40-42, 47	4 113, 281, 308, 309	142
16 39-45, 97, 99, 103, 104, 249, 273, 274, 318, 319	5 28, 29, 113, 166, 226	16 200, 267, 300-302, 310, 311, 318-322, 324, 325, 328, 329	89
4 2, 29, 30, 201	3 272-274	7 30, 190, 198, 254, 309-311	145

FIGURE 6-97B

4 σ exceedances parameter number			Run No.
* 4	* 7	* 2	
5 201, 202, 221, 222, 309	7 14, 64, 113, 161, 162, 201, 225	3 193, 276, 291,	81A
8 34, 38, 39, 42, 226, 274, 300, 301	0	5 219, 220, 274, 275, 303	146
6 60, 61, 219, 236, 308, 309	5 2, 40-42, 64	0	111
11 29, 30, 42, 44, 57, 277, 278, 308-311	0	42 30, 56-63, 66, 67, 70, 71, 95, 100, 171, 194, 253, 257-262, 267, 274-276, 281, 291, 309-311, 317, 318, 320, 322, 325, 326, 331, 334, 335	151
5 110, 192, 198, 199, 218	9 47, 52, 53, 56, 158-160, 198, 199	0	154A
5 108, 200, 201, 221, 322	6 160, 161, 162, 200, 201, 339	3 271, 325, 326	155A
5 110, 195, 196, 216, 322	7 157, 158, 195, 196, 216, 217, 339	2 327, 328	156
8 110, 195-197, 215, 236-238	9 157, 158, 195-197, 215, 216, 339, 340	2 327, 328	157
8 109, 110, 198, 199, 218, 219, 235, 236	9 48, 159, 160, 198, 217-219, 332, 339	2 271, 325	158

FIGURE 6-97C

TABLE 6.1

GAS PATH PARAMETERS

Per % Change in / % Change In	$T5/\theta 1$	$N1/\sqrt{\theta 1}$	Pumping Capacity Γ_1	ηc	ηb	A_5	ηt	ηPT
$T5/\theta 1$	1	0	0	0	0	0	0	0
$N_1/\sqrt{\theta 1}$	0	1	0	0	0	0	0	0
Γ_1	C_{11}	C_{21}	C_{31}	C_{41}	0	C_{61}	C_{71}	0
$T3/\theta 1$	C_{12}	C_{22}	C_{32}	C_{42}	0	C_{62}	C_{72}	0
$P3/\delta 1$	C_{13}	C_{23}	C_{33}	C_{43}	0	C_{63}	C_{73}	0
$Wf/\delta 1\theta 1$	C_{14}	C_{24}	C_{34}	C_{44}	1	C_{64}	C_{74}	0
$T7/\theta 1$	C_{15}	C_{25}	C_{35}	C_{45}	0	C_{65}	C_{75}	0
$P7/\delta 1$	C_{16}	C_{26}	C_{36}	C_{46}	0	C_{66}	C_{76}	0
$HP/\delta 1\sqrt{\theta 1}$	C_{17}	C_{27}	C_{37}	C_{47}	0	C_{67}	C_{77}	C_{87}
$T9/\theta 1$	C_{18}	C_{28}	C_{38}	C_{48}	0	C_{68}	C_{78}	C_{88}
$A\eta$	C_{19}	C_{29}	C_{39}	C_{49}	0	C_{69}	C_{79}	C_{89}

TABLE 6.2

T53 L13 FAULT COEFFICIENTS ($N_1/\sqrt{\theta_1}$ = 23400)

MEASURED		COMPRESSOR		GAS GEN. TURBINE		POWER TURBINE		BURNER
		−1%	−1%	+1%	−1%	+1%	−1%	−1%
Δ'S at		$\Delta\Gamma$	$\Delta\eta c$	ΔA_5	$\Delta\eta_{gt}$	ΔAn	$\Delta\eta_{pT}$	$\Delta\eta_b$
$N_1/\sqrt{\theta_1}$ = ¢	$\%\Delta N_1/\sqrt{\theta_1}$	0	0	0	0	0	0	0
	$\%\Delta T3/\theta_1$	-0.27	0.59	-0.15	0.15	-0.12	0	0
	$\%\Delta P3/\delta_1$	-0.84	0.42	-0.46	0.46	-0.38	0	0
	$\%\Delta Wf/\delta_1\theta_1^y$	-1.38	1.92	1.35	2.55	-1.73	0	1.0
	$\%\Delta hP/\delta_1\sqrt{\theta_1}$	-1.79	1.38	1.27	1.57	-2.05	-1.0	0
	$\%\Delta T9/\theta_1$	-0.29	1.14	0.55	1.47	-0.84	0.18	0
P_3/δ_1 = ¢	$\%\Delta N_1/\sqrt{\theta_1}$	0.30	-0.15	0.17	-0.17	0.14	0	0
	$\%\Delta T3/\theta_1$	0	0.45	0	0	0	0	0
	$\%\Delta P3/\delta_1$	0	0	0	0	0	0	0
	$\%\Delta Wf/\delta_1\theta_1^y$	0	1.23	2.10	2.38	-1.10	0	1.0
	$\%\Delta hP/\delta_1\sqrt{\theta_1}$	0	0.21	2.23	0.57	-1.23	+1.0	0
	$\%\Delta T9/\theta_1$	0	1.0	0.61	1.31	-0.71	0.18	0
		0	0					
$\frac{WF}{\delta_1\theta_1^y}$ = ¢	$\%\Delta N_1/\sqrt{\theta_1}$	0.30	-0.42	-0.30	-0.56	0.38	0	-0.22
	$\%\Delta T3/\theta_1$	0	0.21	-0.41	-0.47	0.21	0	-0.20
	$\%\Delta P3/\delta_1$	0	-0.74	-1.27	-1.37	0.66	0	-0.61
	$\%\Delta Wf/\delta_1\theta_1^y$	0	0	0	0	0	0	0
	$\%\Delta hP/\delta_1\sqrt{\theta_1}$	0	-0.38	-0.48	-2.48	0.19	-1.0	-1.30
	$\%\Delta T9/\theta_1$	0	0.74	0.27	0.97	-0.48	0.18	-0.21
$\frac{HP}{\delta_1\sqrt{\theta_1}}$ = ¢	$\%\Delta N_1/\sqrt{\theta_1}$	0.30	-0.19	-0.21	27	0.35	0.17	0
	$\%\Delta T3/\theta_1$	0	0.42	-0.33	09	0.19	0.15	0
	$\%\Delta P3/\delta_1$	0	-0.10	-1.04	27	0.58	0.46	0
	$\%\Delta Wf/\delta_1\theta_1^y$	0	1.06	0.39	1.33	-0.14	0.77	0
	$\%\Delta hP/\delta_1\sqrt{\theta_1}$	0	0	0	0	0	0	0
	$\%\Delta T9/\theta_1$	0	0.97	0.35	1.22	-0.51	0.34	0

TABLE 6-3 AIDAPS GAS PATH ANALYSIS SUMMARY FOR SIGNATURE DEFINITIONS

CONSIDERATIONS: DIAGNOSTICS OBATINED WITH DETERIORATIONS OF LESS THAN 5%

INSERTED COMPONENT	BASELINE = f (P_{a3}/δ_1)		BASELINE = f ($N_1/\sqrt{\theta_1}$)		ANALYSIS OF TEST CELL DATA
	WITH NOISE REJECTION	WITHOUT NOISE REJECTION	WITH NOISE REJECTION	WITHOUT NOISE REJECTION	
Bearing 2 (LE 15615)	No Gas Path Fault (Correct Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_1 Nozzles Degraded Compressor (Wrong Diagnostic)	Degraded Compressor Degraded N_1 Nozzles (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
Bearing 3 (LE 20727)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
Bearing 4 (LE 15351)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine Degraded Compressor (Wrong Diagnostic)	No Gas Path Fault (Correct Diagnostic)
N_1 Nozzles (LE 15615)	No Gas Path Fault (Possible Diagnostic)	Degrade N_2 Turbine (Wrong Diagnostic)	Degraded N_2 Turbine Degraded N_1 Nozzles (Wrong Diagnostic)	Degraded N_2 Turbine Degraded N_1 Nozzles (Wrong Diagnostic)	No Gas Path Fault (Possible Diagnostic)
N_2 Nozzles (LE 18993)	Degraded N_2 Turbine Degraded Compressor Degraded N_1 Turbine (Isolated Primary Fault)	Degraded N_2 Turbine Degraded Compressor (Isolated Primary Fault)	Degraded N_2 Turbine (Correct Diagnostic)	Degraded N_2 Turbine Degraded Compressor (Isolated Primary Fault)	Degraded Compressor Degraded N_1 Turbine Degraded N_2 Turbine (Wrong Diagnostic)
N_2 Nozzles (LE 20727)	No Gas Path Fault (Possible Diagnostic)	Degraded N_2 Turbine (Correct Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)
N_2 Turbine (LE 15351)	Not Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	No Gas Path Fault (Possible Diagnostic)	Degraded N_2 Turbine Degraded N_1 Turbine (Isolated Primary Fault)	No Gas Path Fault (Possible Diagnostic)
Compressor (LE 15615) (Note 1)	Degraded N_2 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine (Wrong Diagnostic)	Degraded N_1 Turbine Degraded Compressor (Wrong Diagnostic)	Degraded Compressor Degraded N_1 Nozzle Degraded N_2 Turbine (Isolated Primary Fault)

Possible Diagnostic Indicates Part Deterioration May Not Be Sufficient To Warrant Removal.

Note 1: Compressor Data Was Obtained Before Final Data Acquisition Technique Was Established.

TABLE 6.4

Possible frequencies associated with pits on the inner, outer races and elements of the 420 gearbox bearing assembly.

	Fi (Hz) Ball	Fi (Hz) Roller	Fo (Hz) Ball	Fo (Hz) Roller	Fb (Hz) Ball	Fb (Hz) Roller
Sideband structure	--	32				
	12	100				
	80	168				
	148	236	6	58	56	27
	216	304	74	126	124	95
	284	372	142	194	192	163
	352	440	210	262	260	231
	420	508	278	330	328	299
Fundamental	488	576	346	398	396	367
Sideband structure	556	664	414	466	464	435
	624	732	482	534	532	503
	692	800	550	602	600	571
	760	868	618	670	668	639
	828	936	686	738	736	707
	896	1004	754	806	804	775
	964	1072	822	874	872	843
	1032	1140	890	942	940	911
	1100	1208	958	1010	1008	979

F_B = 198 Hz for ball, 183 Hz for roller.
F_P = 28.8 Hz.
F_R = 68 Hz.

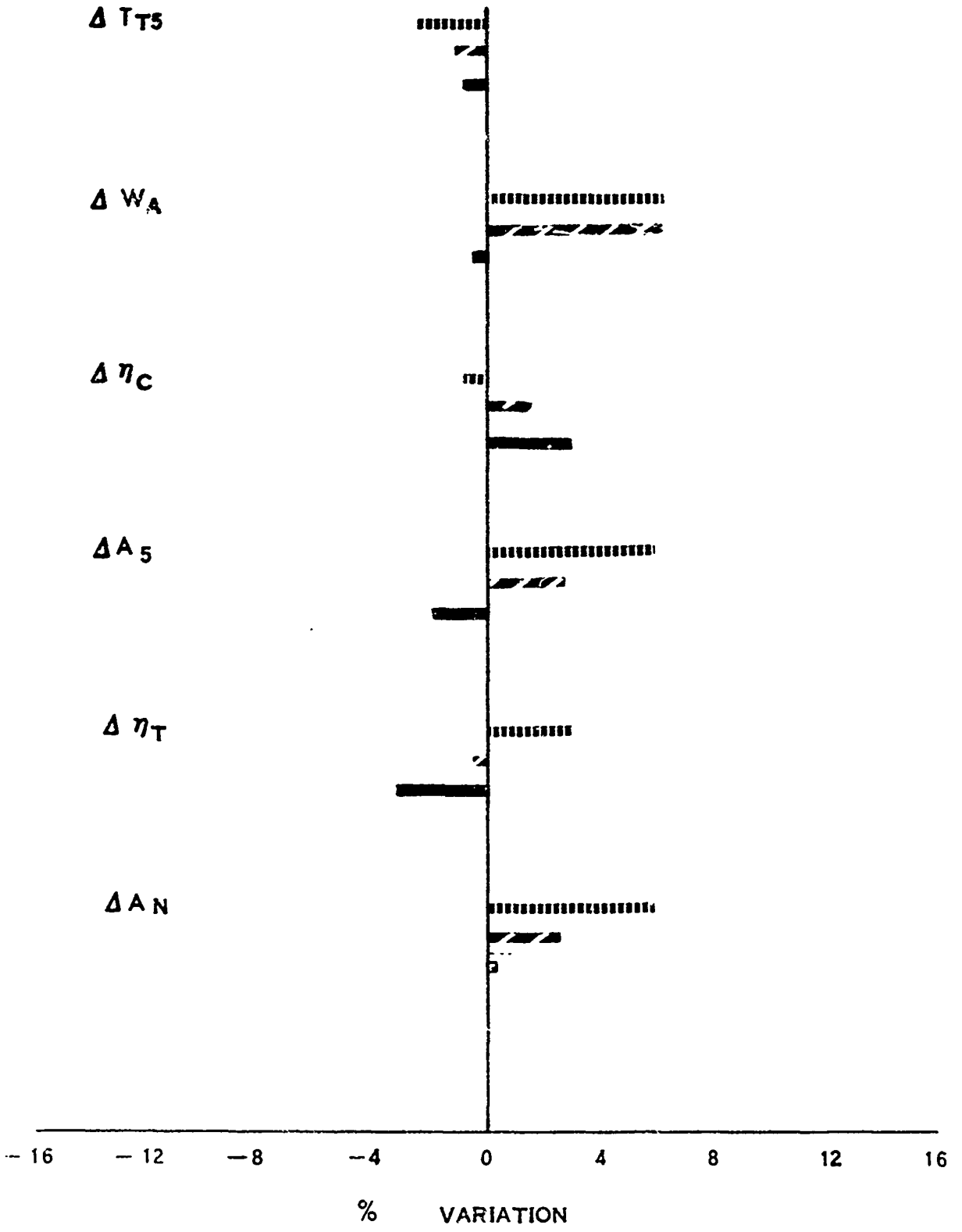
SECTION 7

VERIFICATION TEST ANALYSIS

BAR	DATA DISPLAYED
	FLIGHT TEST - Flight Baseline
	FLIGHT TEST - Average Baseline for 10 AIDAPS Engines
	FLIGHT TEST - Baseline derived from Lycoming Model Spec.
	ARADMAC TEST - ARADMAC Baseline

FIGURE 7-1

DEFINITION OF BASELINE FOR FIGURES 7-2 THROUGH 7-13



ANALYSIS OF VERIFICATION ENGINE LE 18270

FIGURE 7-2

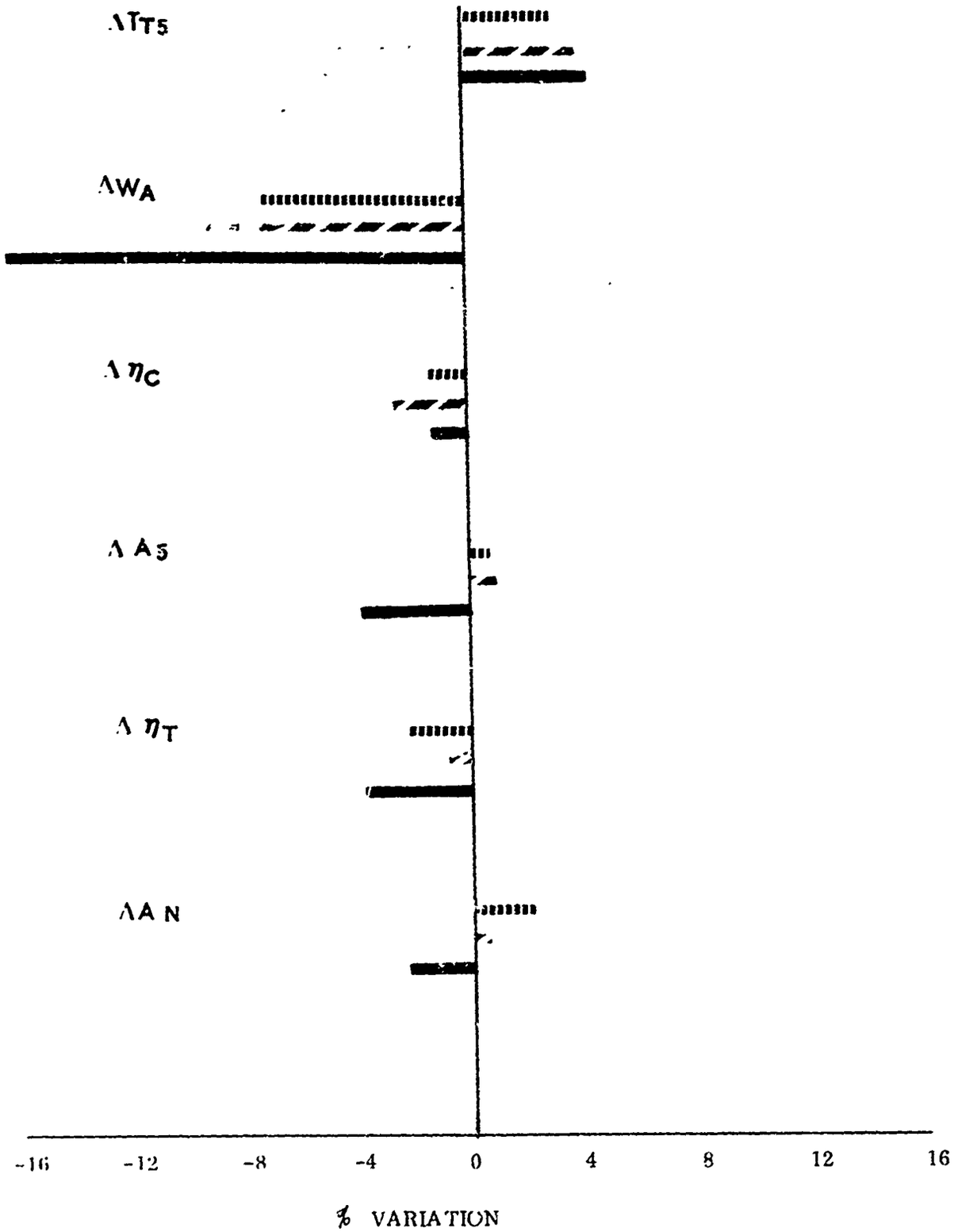


FIGURE 7-3

ANALYSIS OF VERIFICATION ENGINE LE 20791

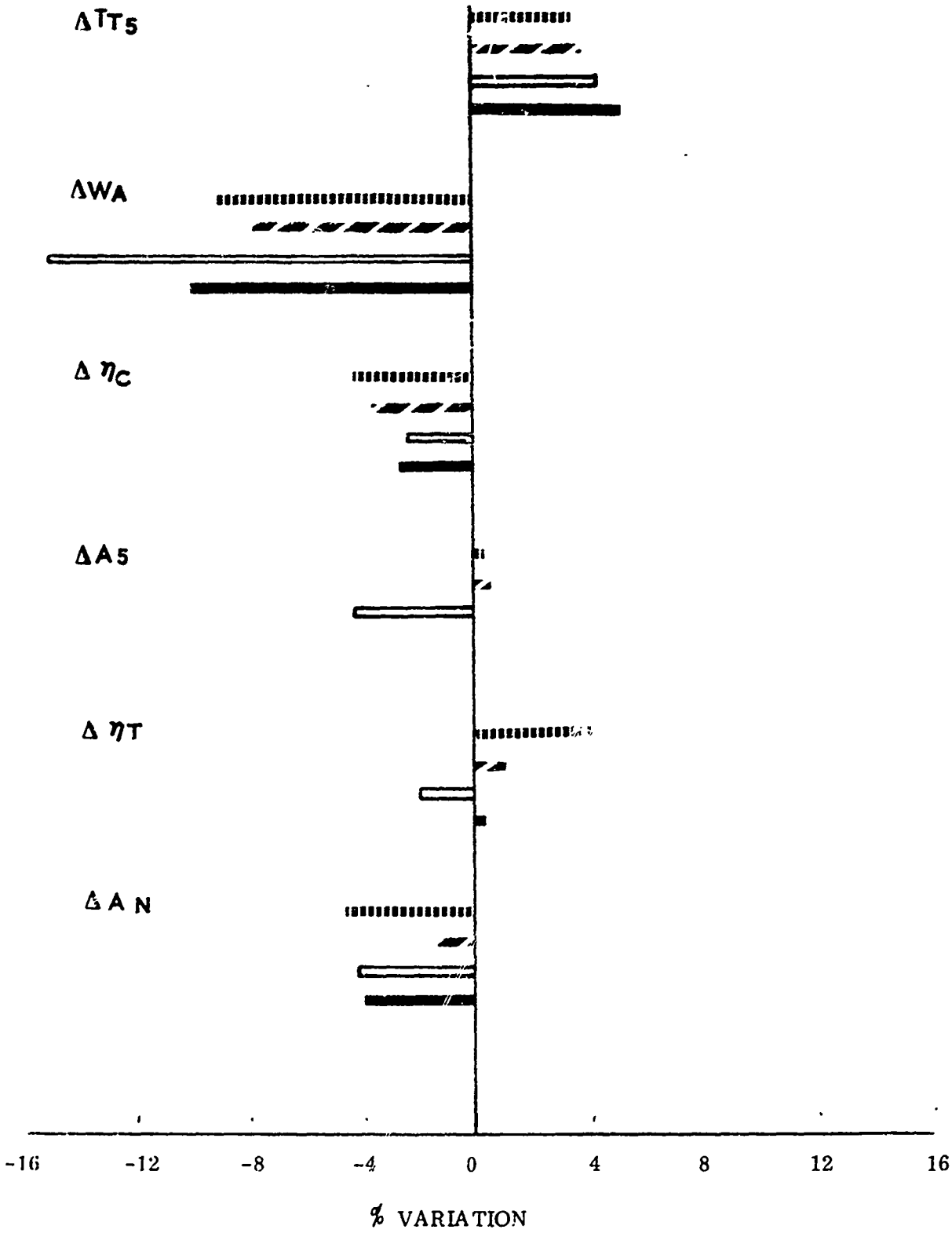


FIGURE 7-4

ANALYSIS OF VERIFICATION ENGINE LE 14819

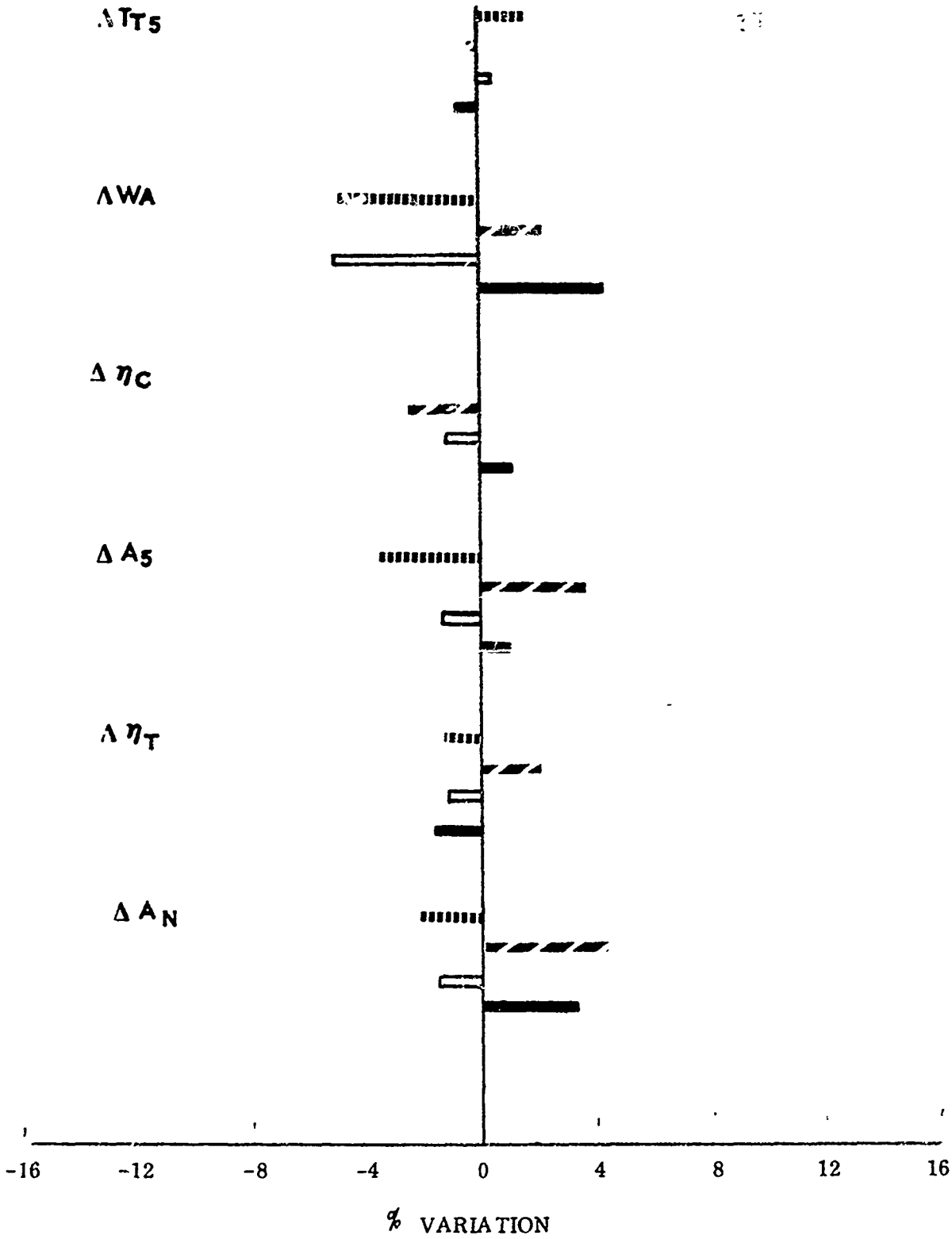


FIGURE 7-5

ANALYSIS OF VERIFICATION ENGINE LE 17376

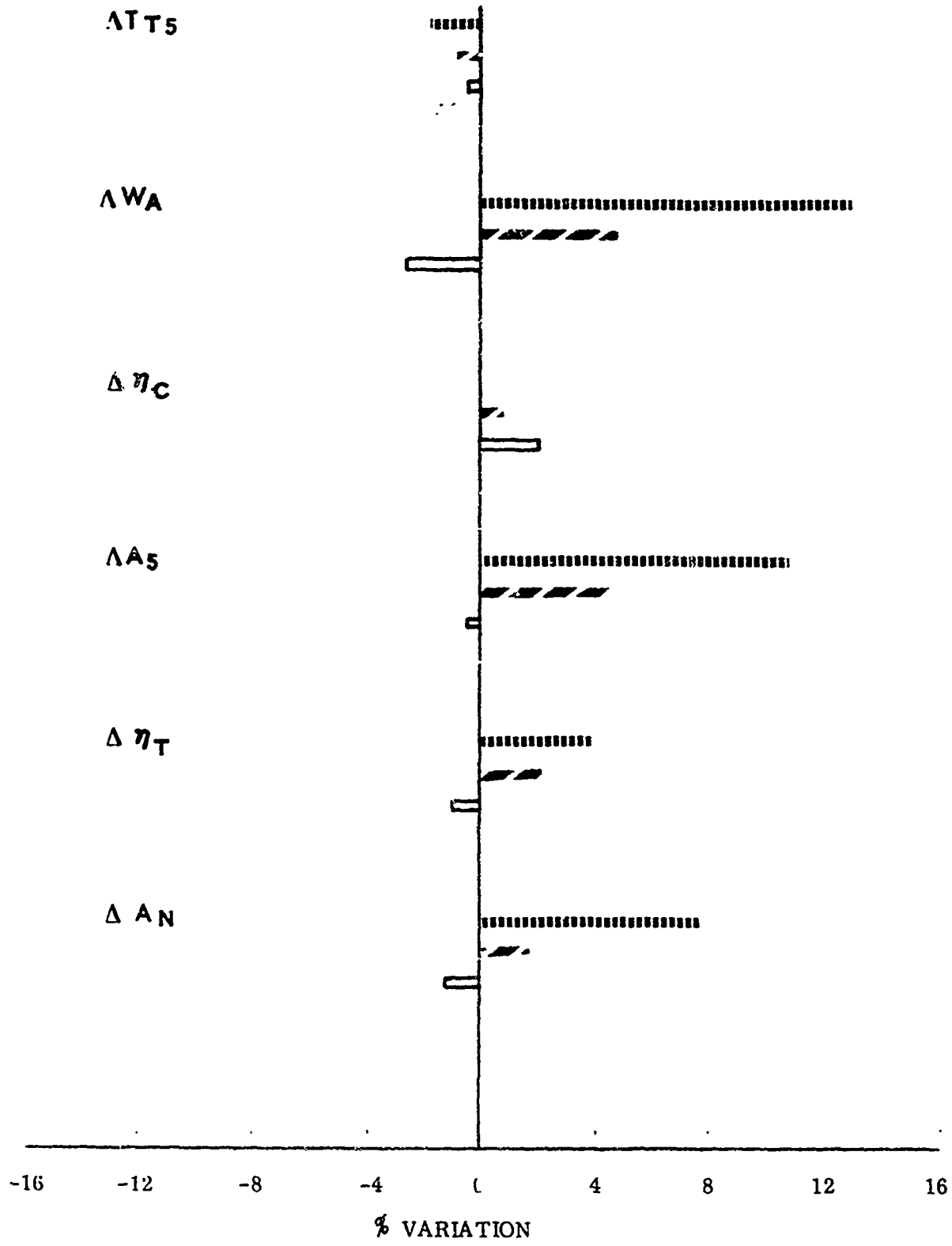


FIGURE 7-6

ANALYSIS OF VERIFICATION ENGINE LE 18301

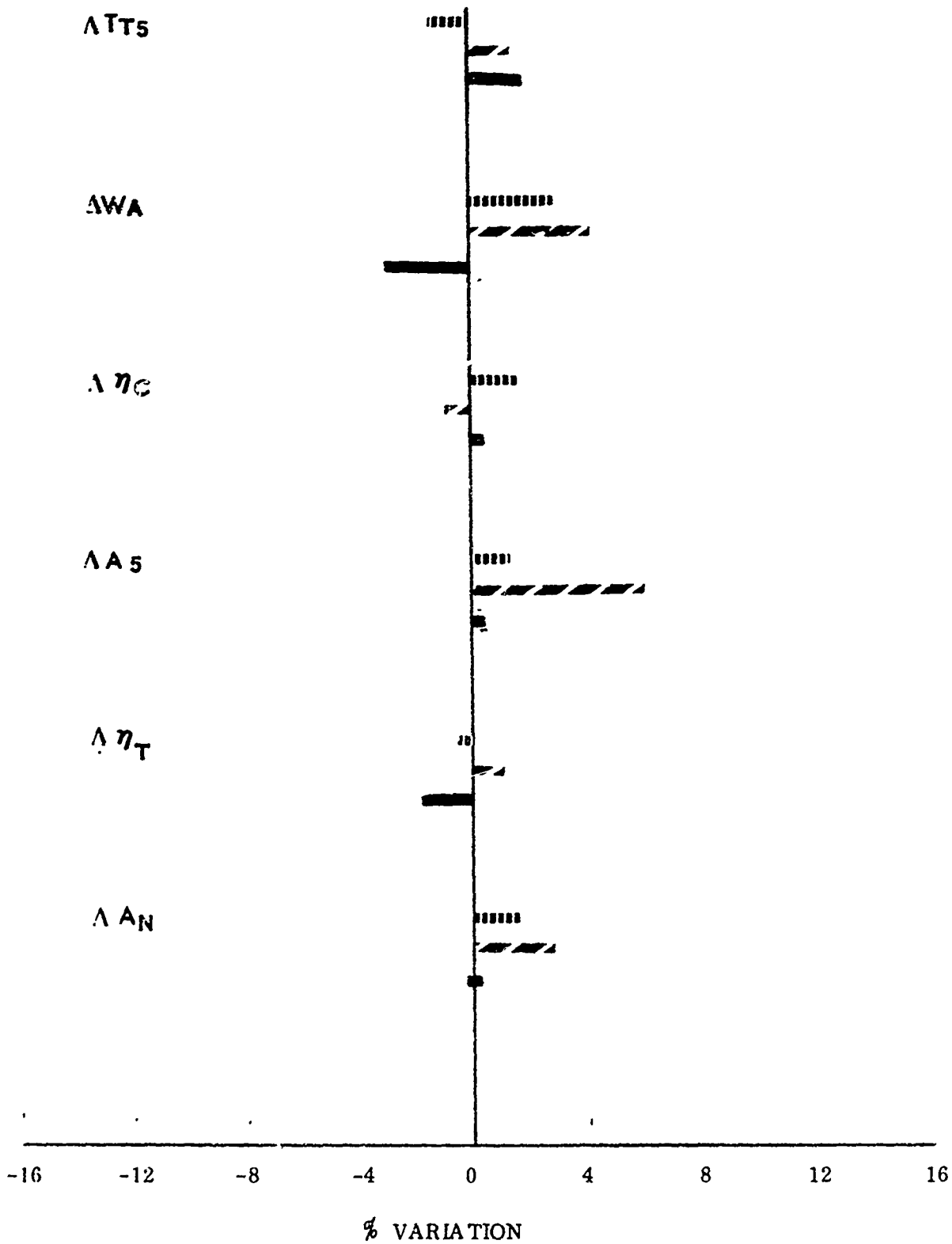


FIGURE 7-7

ANALYSIS OF VERIFICATION ENGINE LE 16886

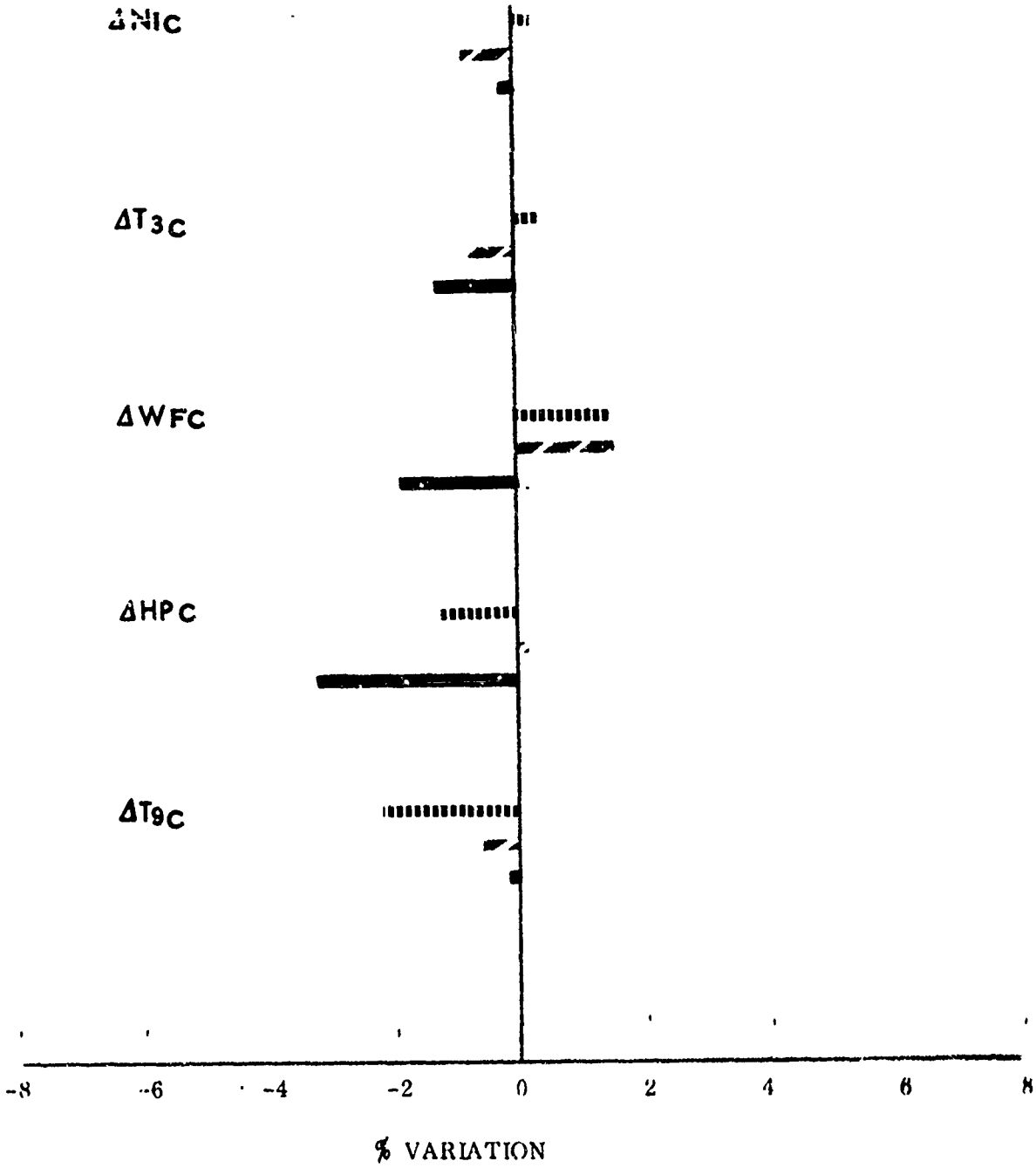


FIGURE 7-8

DATA FOR VERIFICATION ENGINE LE 18270

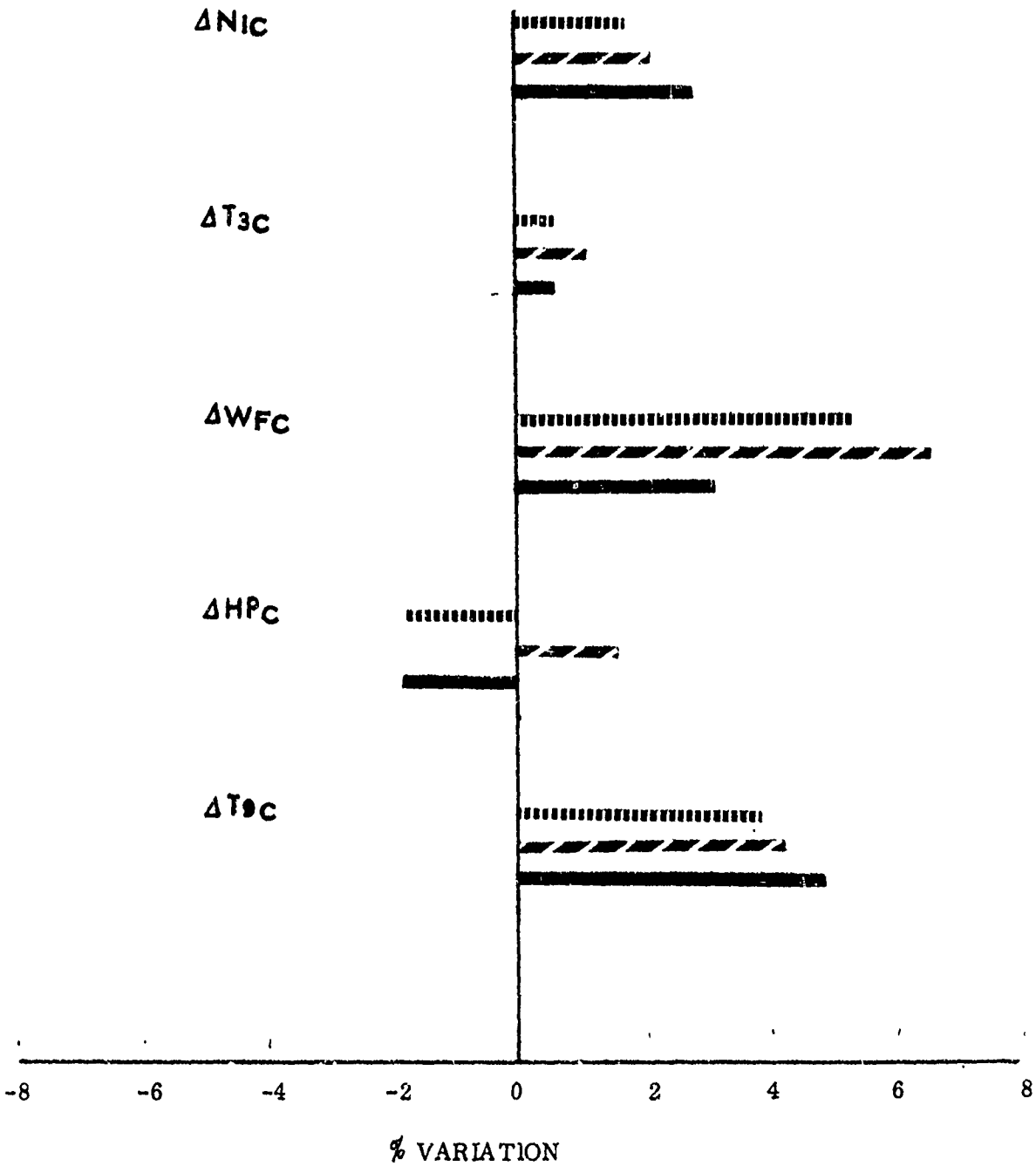


FIGURE 7-9

DATA FOR VERIFICATION ENGINE LE 20791

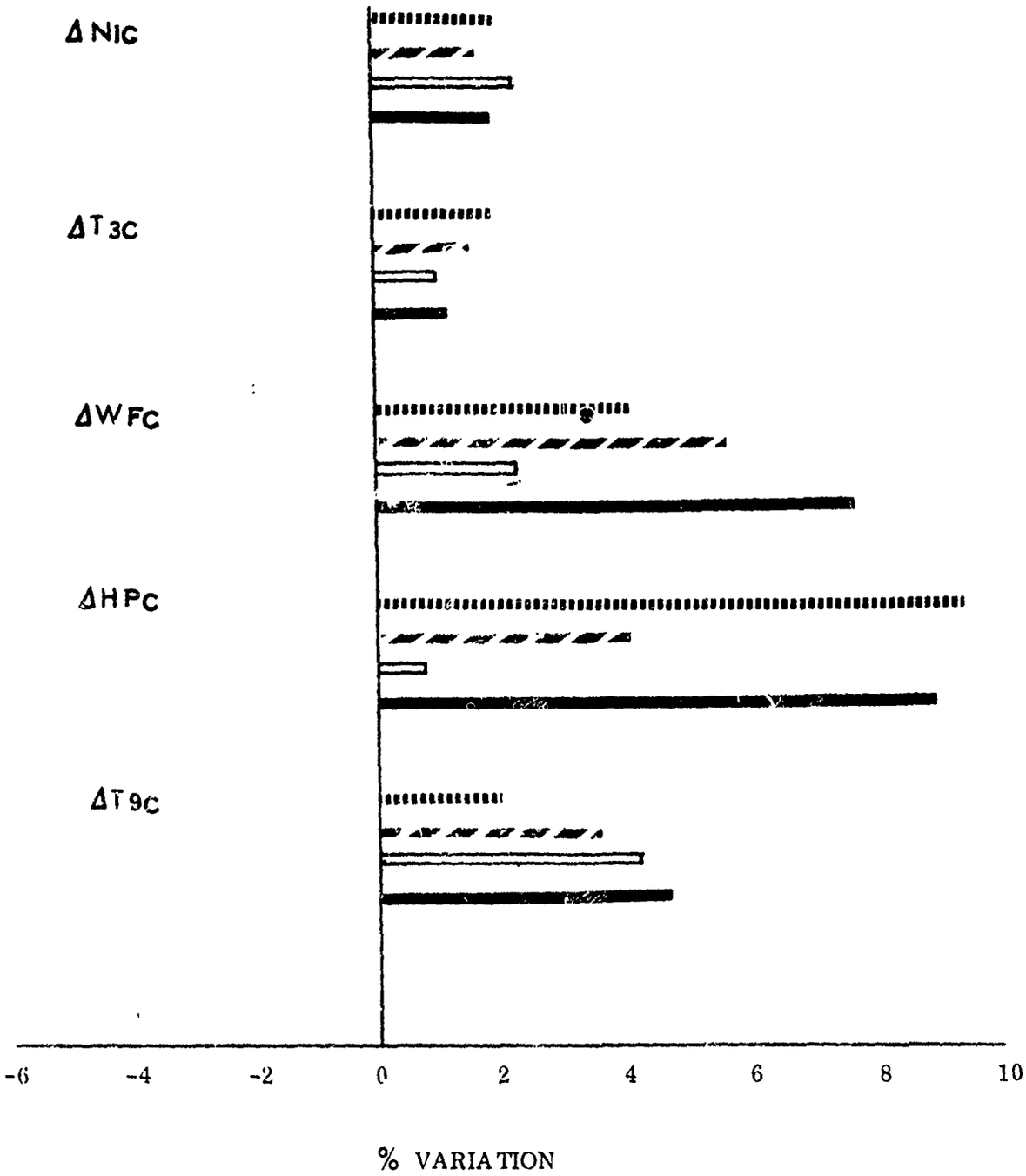


FIGURE 7-10

DATA FOR VERIFICATION ENGINE LE 14819

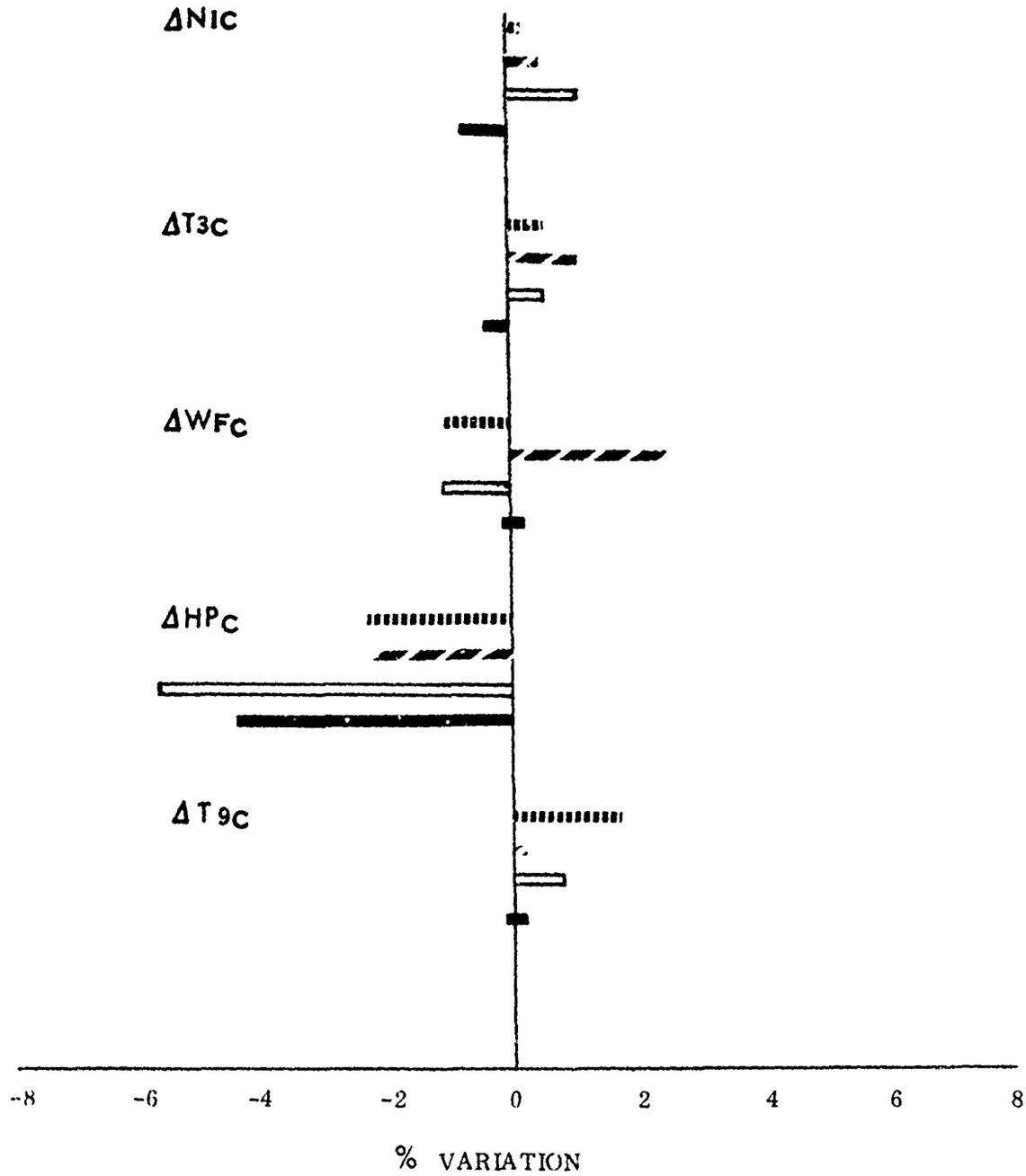


FIGURE 7-11

DATA FOR VERIFICATION ENGINE LE 17376

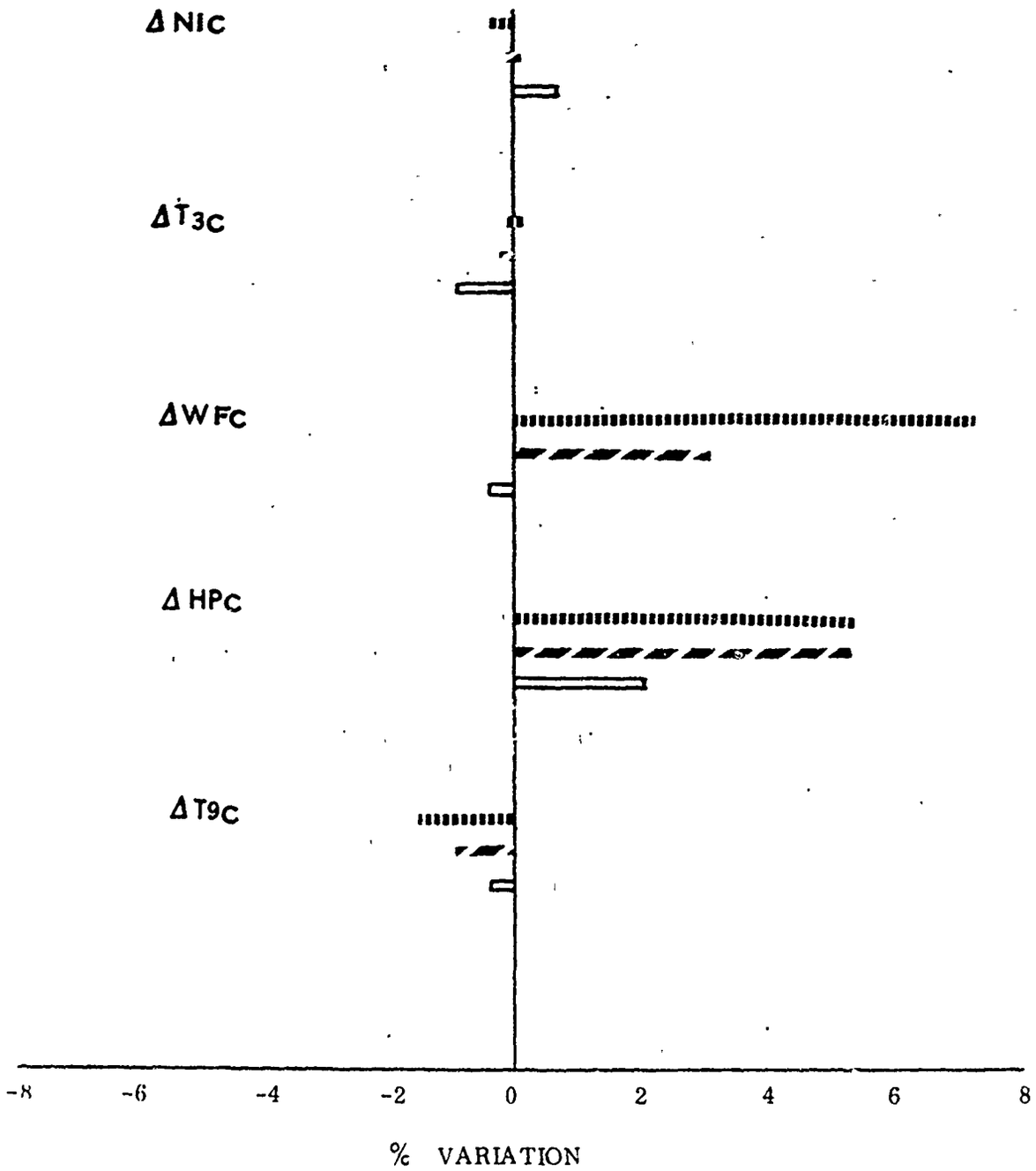


FIGURE 7-12

DATA FOR VERIFICATION ENGINE LE 18301

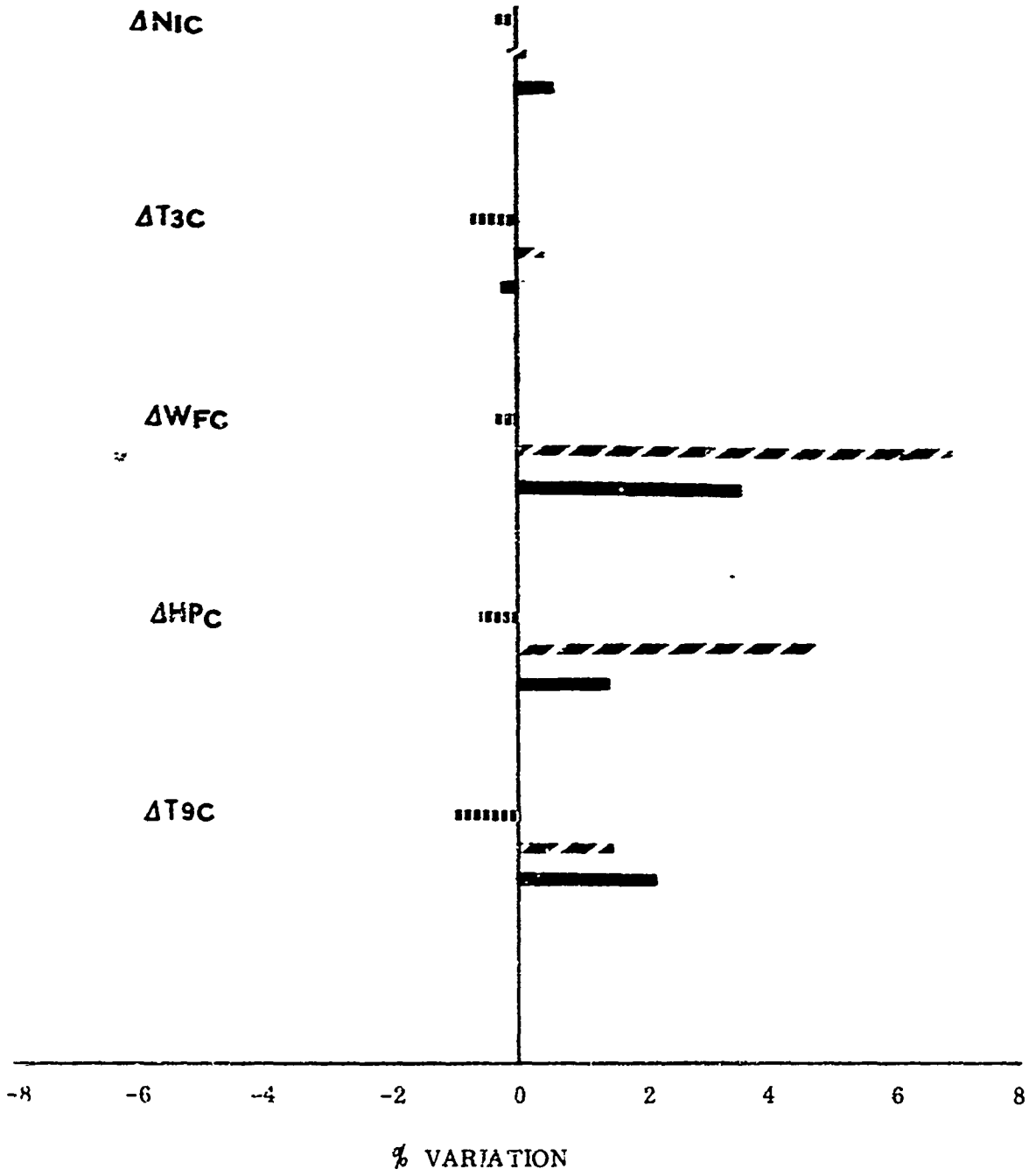


FIGURE 7-13

DATA FOR VERIFICATION ENGINE LE 16886

SECTION 8

CONCLUSIONS

SECTION 9

RECOMMENDATIONS

SECTION 10

PHASE E PROGRAM

Data Item	Freq. - Hz	Amplitude A One Per Rev.
Main Rotor		
1. Pilot's Seat Vertical Acceleration	5.2 - 5.6	.01 - 0.5 g
2. Pilot's Seat Lateral Acceleration	5.2 - 5.6	.01 - 0.5 g
3. Center of Gravity Vertical Acceleration	5.2 - 5.6	.01 - 0.5 g
4. Pylon Lateral Motion	5.2 - 5.6	.004 - 0.2 in.
5. Pylon Fore & Aft Motion	5.2 - 5.6	.004 - 0.2 in.
6. Lift Link Load - Tension	5.2 - 5.6	10 - 500 lb.
7. Main Rotor Azimuth	5.2 - 5.6	0 - 360 deg.
Tail Rotor		
1. 90-degree Tail Rotor Gearbox Vertical Acceleration	26.6 - 28.6	.02 - 1.0 g
2. 90-degree Tail Rotor Gearbox Lateral Acceleration	26.6 - 28.6	.02 - 1.0 g
3. Tail Rotor Azimuth	26.6 - 28.6	0 - 360 deg.

FIGURE 10-1 ROTOR MONITORING PARAMETERS

TAPE TRACK	PARAMETER	SIGNAL CONDITIONER	AMPLIFIER	TYPE	TRANSDUCER S/N	FS QTY. AHR x 1	AMPLIFIER ATTENUATOR SETTING	FULL SCALE QTY. AT AHR SHOWN	TRANSDUCER SENSITIVITY
1	(Accelerometer) Center of Gravity	Accel. 5.4 Hz S/N #1	DC	Kistler 303B	5859	.0333	5	.165 PK-G's	303 pk mv/pkg
2	(Velocity) 90° G Box Vertical	Accel. 27 Hz S/N #1	DC	MB-11	3065	.104"/sec.	20	200 IPS	20 mv/in./sec.
3	(Displacement) Pylon Motion Lateral	Motion 5.4 Hz S/N #1	DC	Hewlett-Packard 24 DCDT	"X"	.003412"	5	.01707" PK	15.72 volts/.mch
4	(Velocity) 90° G Box Lateral	Accel. 27 Hz S/N #2	DC	MB-11	3060	.104"/sec.	20	2.08 IPS	20 mv/in./sec.
5	(Displacement) Pylon Motion Fore & Aft	Motion 5.4 Hz S/N #2	DC	Hewlett-Packard 24 DCDT	"Y"	.00346"	5	.01705" PK	15.72 volts/inch
6	- -	- -	- -	- -	- -	- -	- -	- -	- -
7	(Acceleration) Pilot's Seat Vertical	Accel. 5.4 Hz S/N #2	DC	Kistler 303B	5856	.03367	5	.165 PK-G's	300 pk mv/pkg
8	(Magnetic Pickup) Tail Rotor Azimuth	- -	Clipper	Electro-Products 3030	- -	- -	- -	- -	- -
9	(Acceleration) Pilot's Seat Lateral	Accel. 5.4 Hz S/N #3	DC	Kistler 303B	5857	.0333	5	.165 PK-G's	303 pk mv/pkg
10	- -	- -	- -	- -	- -	- -	- -	- -	- -
11	(Semiconductor Strain Gage) Lift Link	Strain Gage 5.4 Hz S/N #1	DC	BHC Supplied	01	100	5	900	100 lbs./mv/v
12	Time Generator	-	Feed-thru	1 Hig 3	- -	- -	- -	- -	- -
13	(Magnetic Pickup) Main Rotor Azimuth	- -	Clipper	Electro-Products 3030	- -	- -	- -	- -	- -

FIGURE 10-2 SIGNAL CONDITIONING CHARACTERISTICS

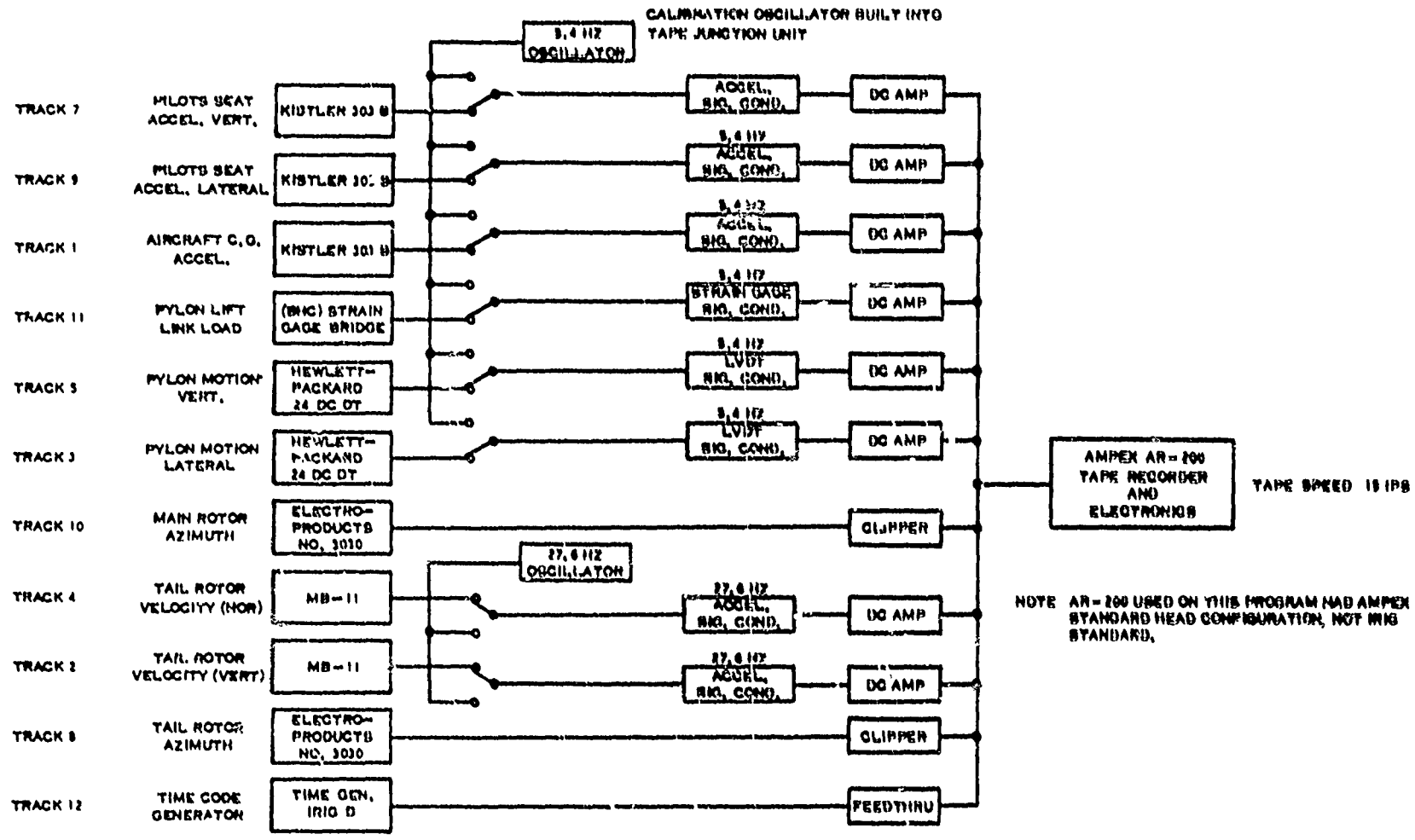


FIGURE 10–3 SIGNAL BLOCK DIAGRAM – ROTOR UNBALANCE PHASE E AIDAPS

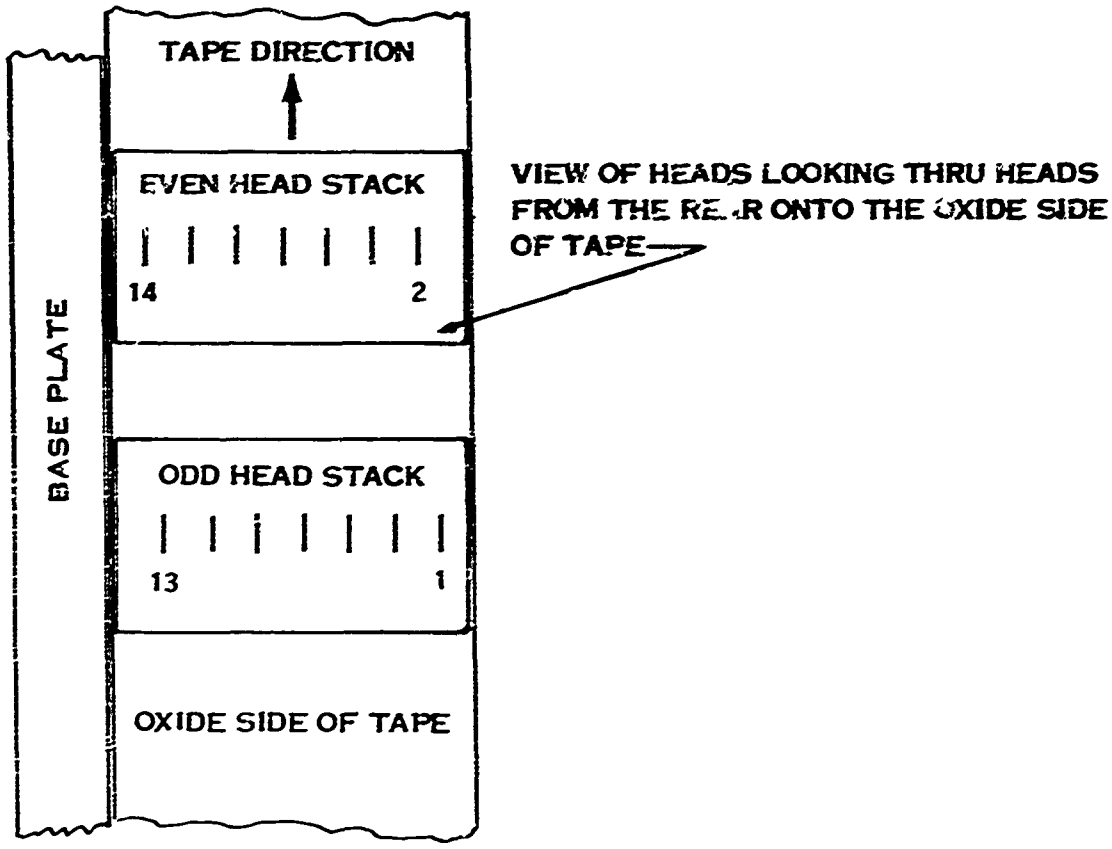


FIGURE 10–4 AMPEX "STANDARD" RECORD HEADS

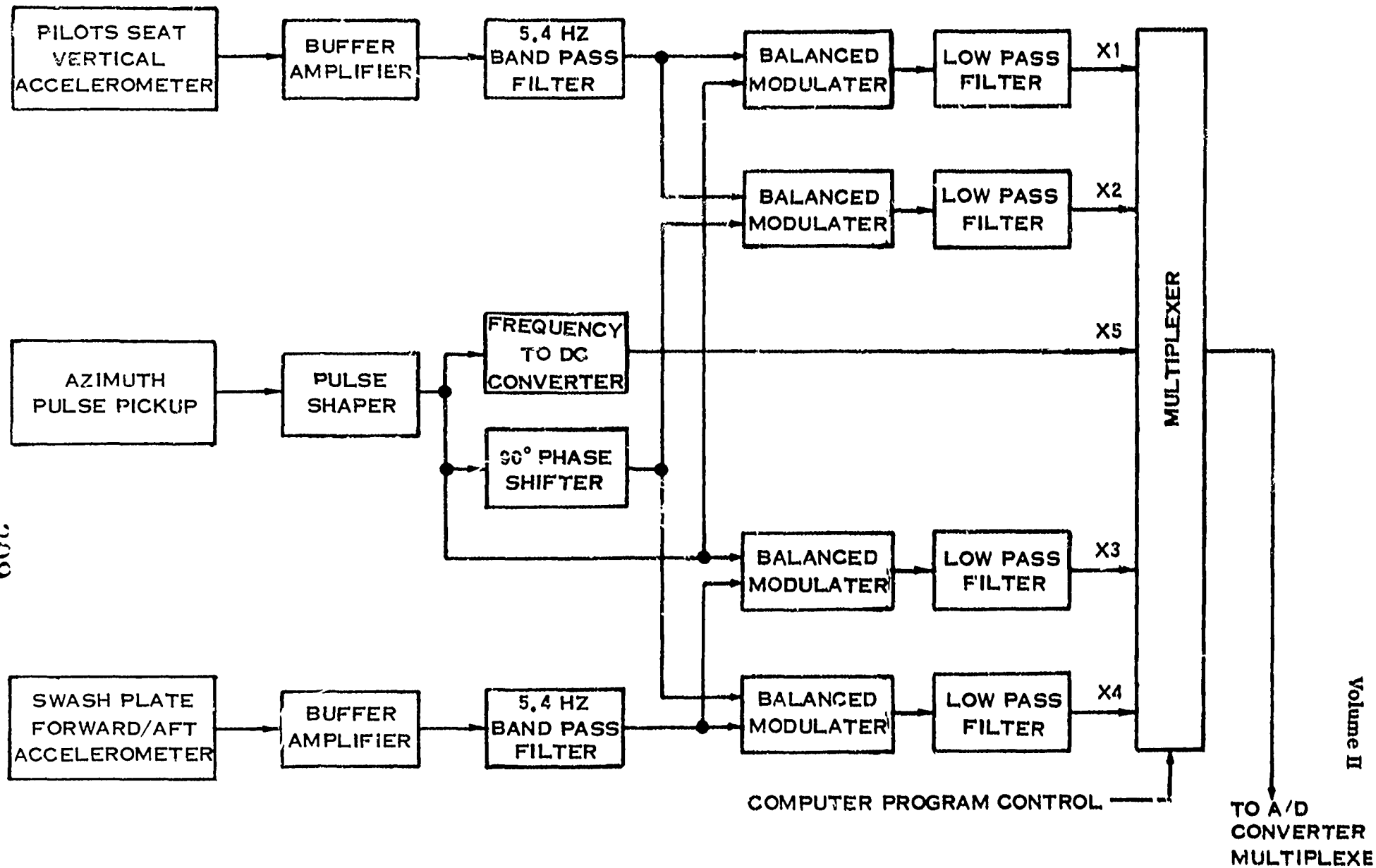


FIGURE 10–5 ROTOR UNBALANCE IMPLEMENTATION BLOCK DIAGRAM

Flight No.	Date	Gas Path Threshold Criteria	Gas Path % Actual Change	Gas Path Conclusion	Vibration Threshold Criteria	Vibration Actual Result	Vibration Conclusion	Transmission Vibration Threshold Criteria	Transmission Vibration Actual Result	Transmission Vibration Conclusion	Chip Series Threshold Criteria	Chip Series Actual Result	Chip Series Conclusion	Chip Series Threshold Criteria	Chip Series Actual Result	Conclusion
1	12-1-71	85 = 5%	11%	Bad N_1, N_2 Nozzle	-	5	↑ NO ENGINE VIBRATION PHENOMENA	[illegible]	-	Good	30	1	Good	8	0	Good
2	12-20-71	85 = -5% 4w = -3%	-[illegible]% Nozzle Area -[illegible]% efficiency	Mildly degraded N_2 Nozzle N_2 Turbine	-	[illegible]		[illegible]	23	Good	30	0	Good	8	0	Good
3	12-3-71		↑ No % actual changes exceeded 50% of respective gas path three-hold criteria ↓	Good	-	0		[illegible]	40	Bad Input Quill	30	15	Marginally Bad	8	67	Bad
4	12-7-71			Good	-	0		[illegible]	51	Input and/or output quill	30	22	Bad	8	96	Bad
5	12-9-71			Good	-	0		[illegible]	19	Good	30	21	Bad	8	62	Bad
6	12-10-71			Good	-	1		[illegible]	4	Good	30	10	Marginally Bad	8	53	Bad
7	12-14-71			Good	-	0		[illegible]	8	Good	30	4	Good	8	18	Bad
8	12-16-71			Good	-	0		[illegible]	6	Good	30	0	Good	8	0	Good

NOTE: ALL FLIGHTS OCCURRED ON SHIP [illegible]

FIGURE 10-6 HAMILTON STANDARD COMPONENT HEALTH RESULTS FROM PHASE E WORSE DEGRADED PARTS FLIGHT TEST ENGINE

FIGURE 10–7 SUMMARY OF CALCULATED PARAMETERS FOR AIDAPS PHASE E TESTS

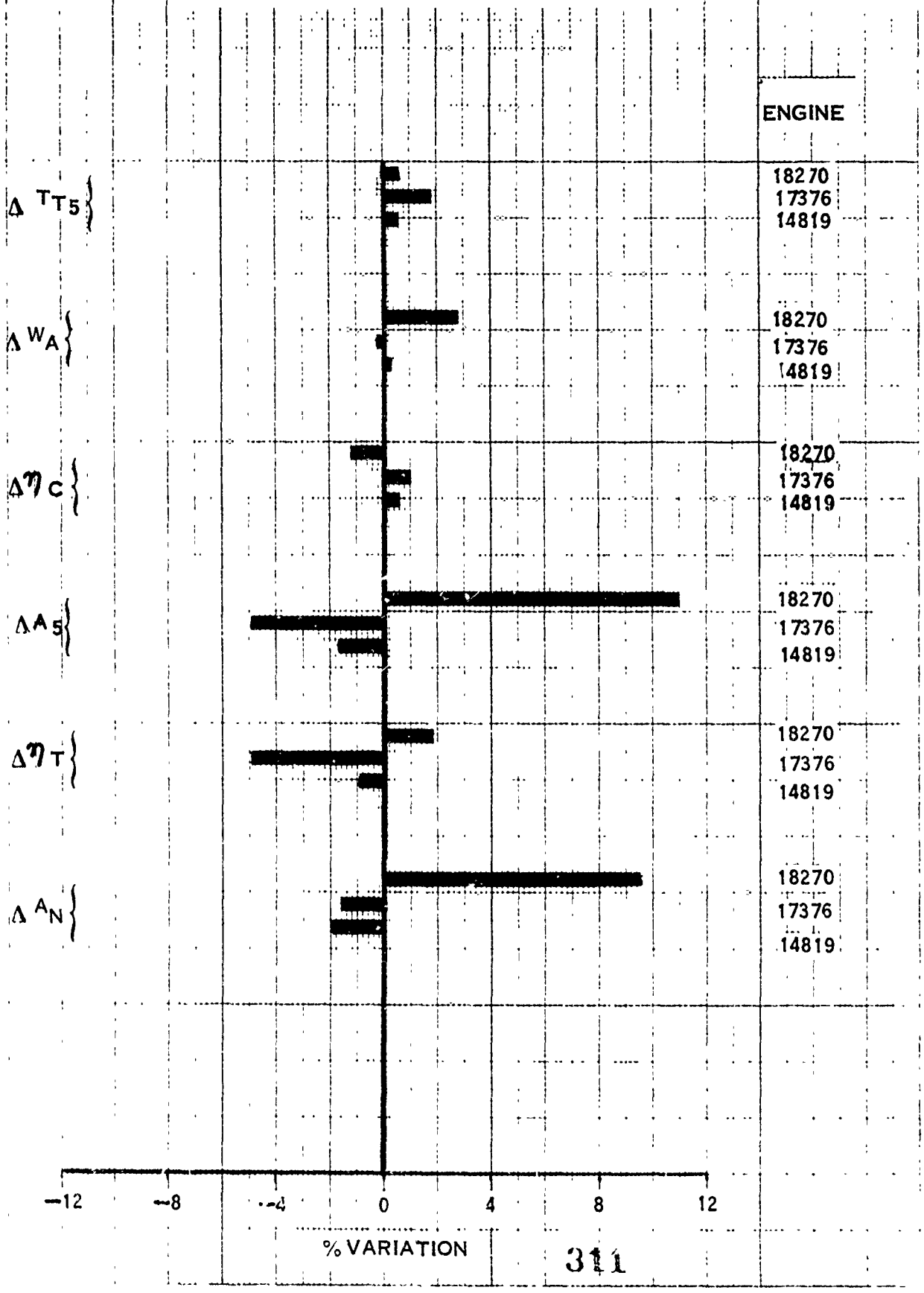


FIGURE 10-8 SUMMARY OF MEASURED PARAMETERS FOR AIDAPS PHSE E TESTS

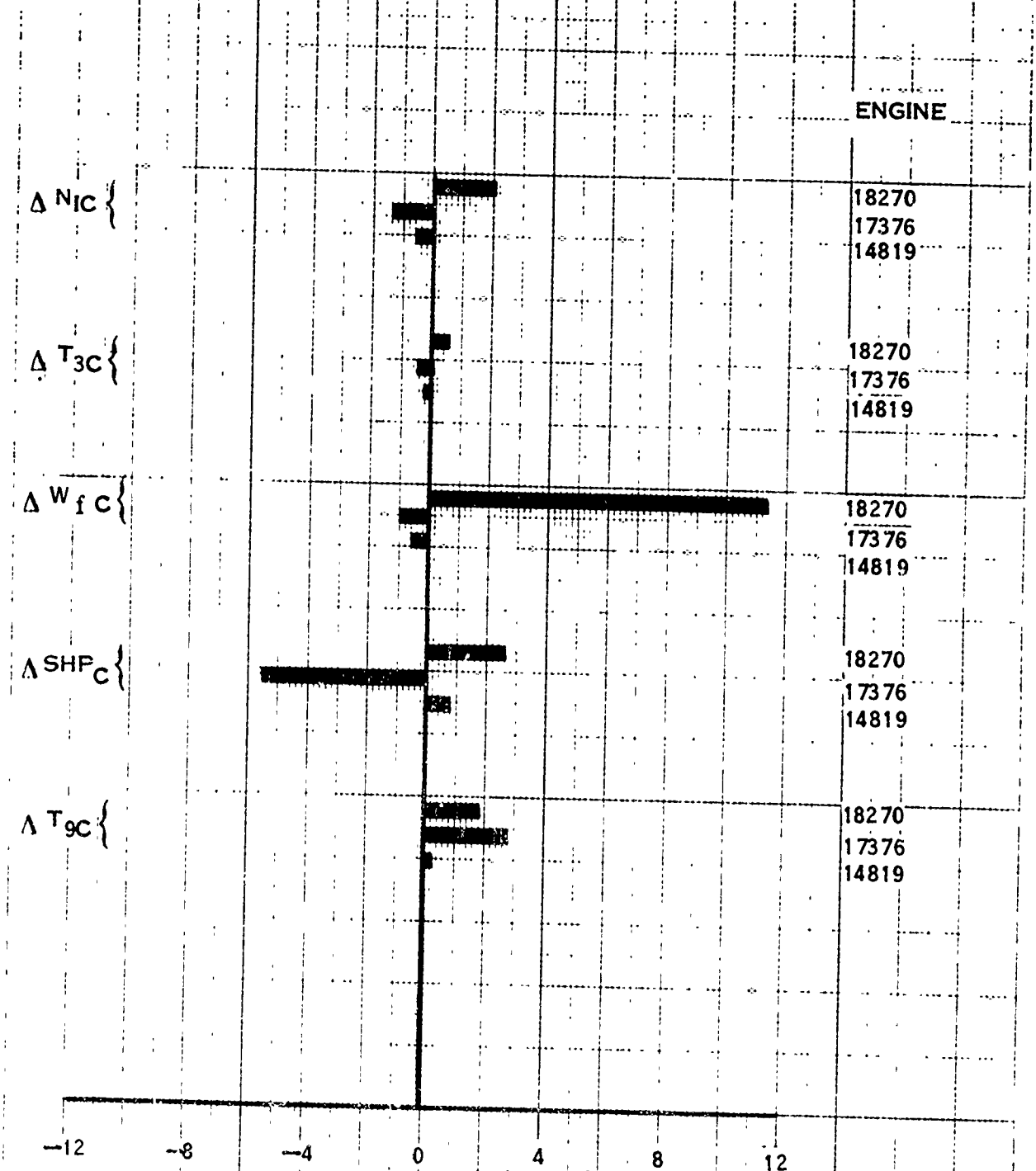


FIGURE 10-9 CALCULATED PARAMETERS FOR LE 18270

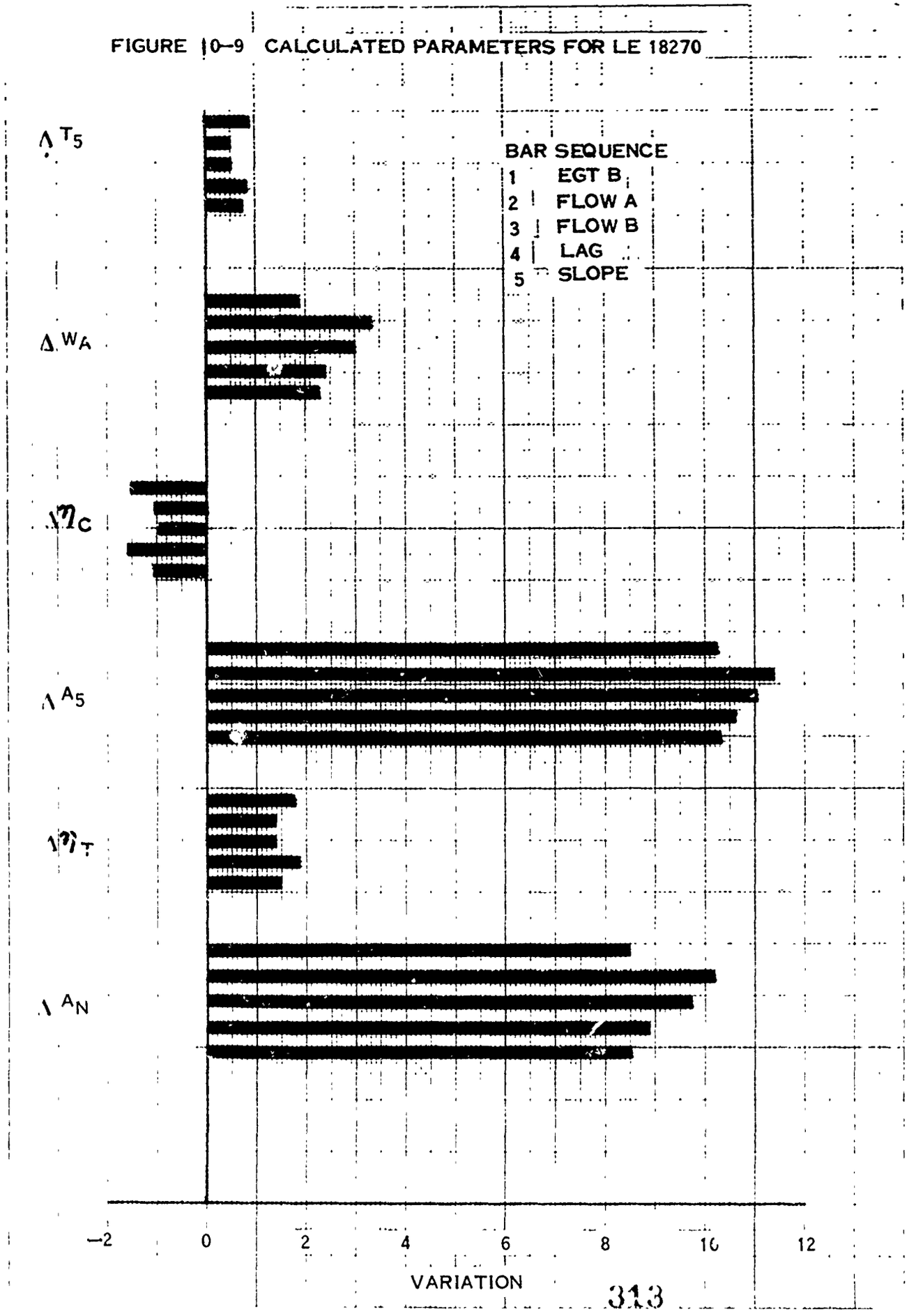


FIGURE 10-10 MEASURED PARAMETERS FOR LE 18270

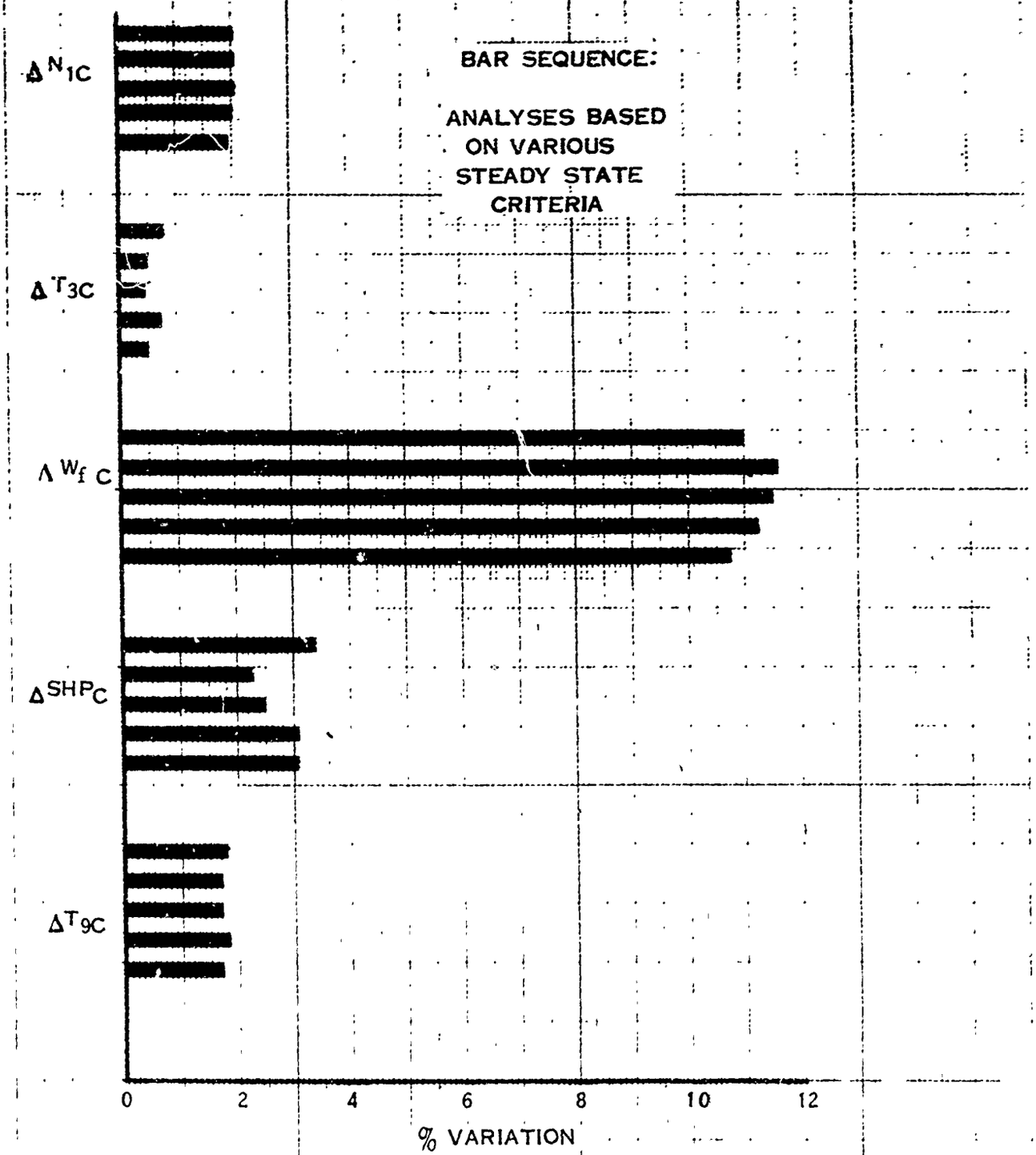


FIGURE 10–11 CALCULATED PARAMETERS FOR LE 17375

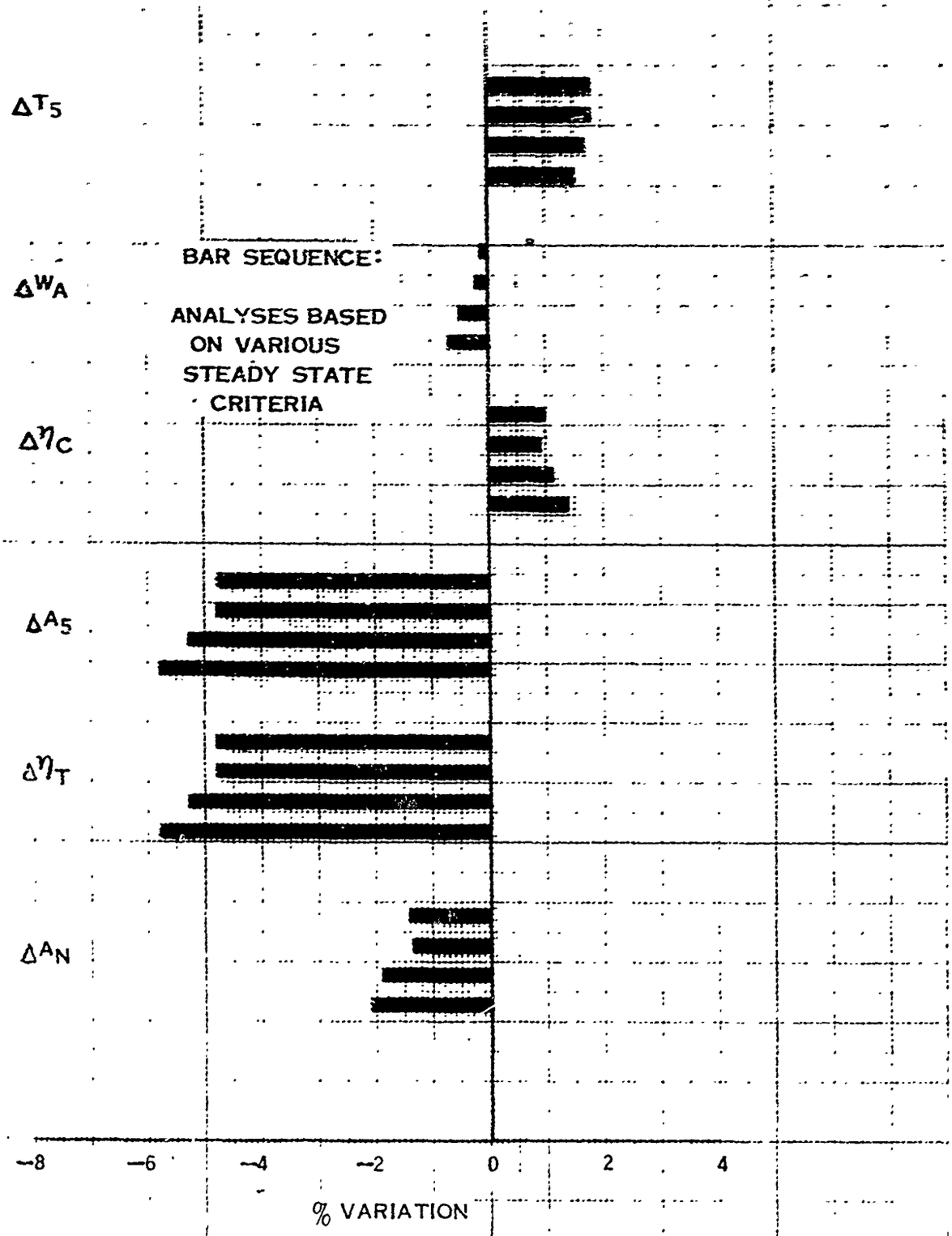


FIGURE 10-12 MEASURED PARAMETERS FOR LE 17376

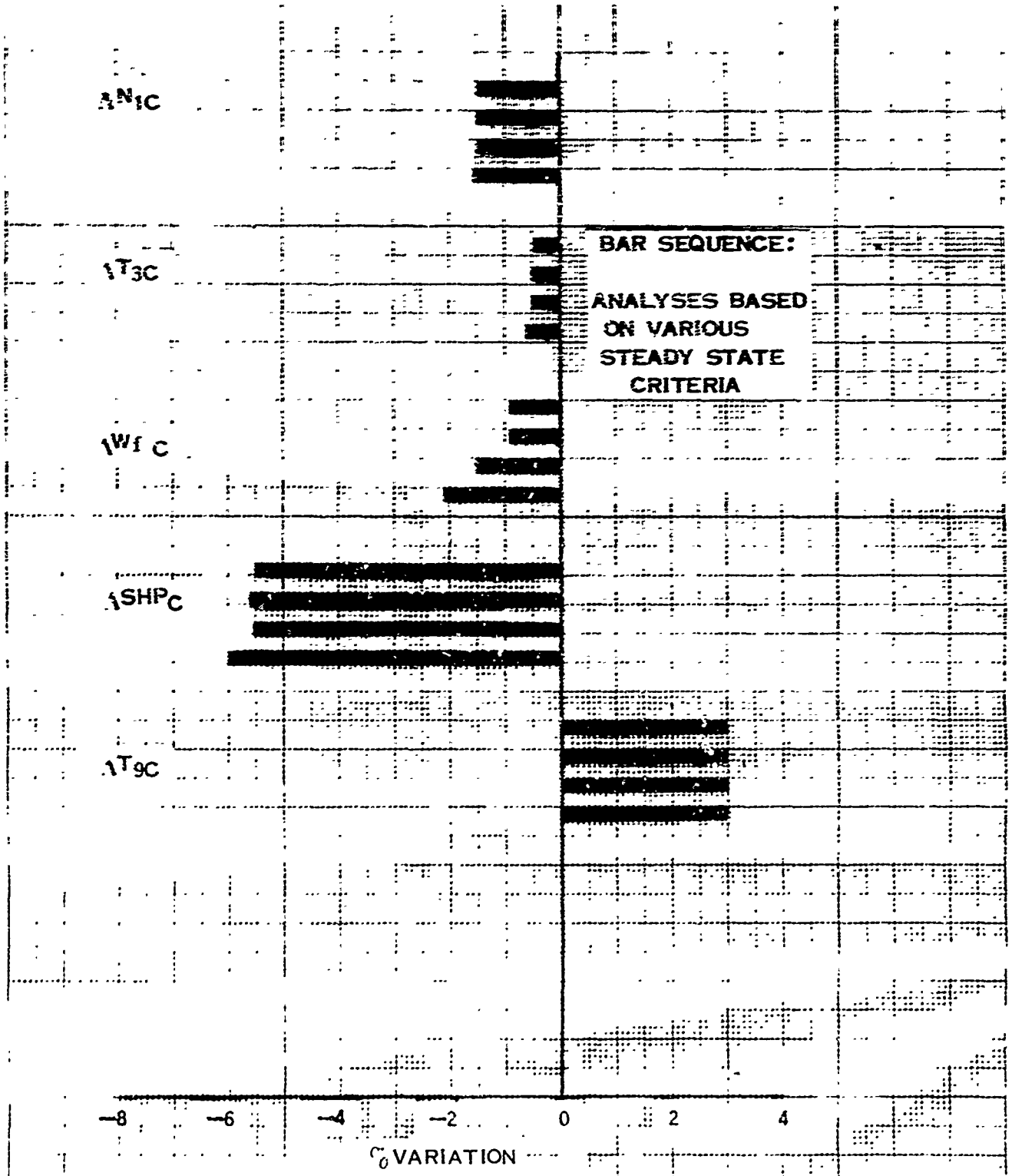


FIGURE 10–13 CALCULATED PARAMETERS FOR LE L4819

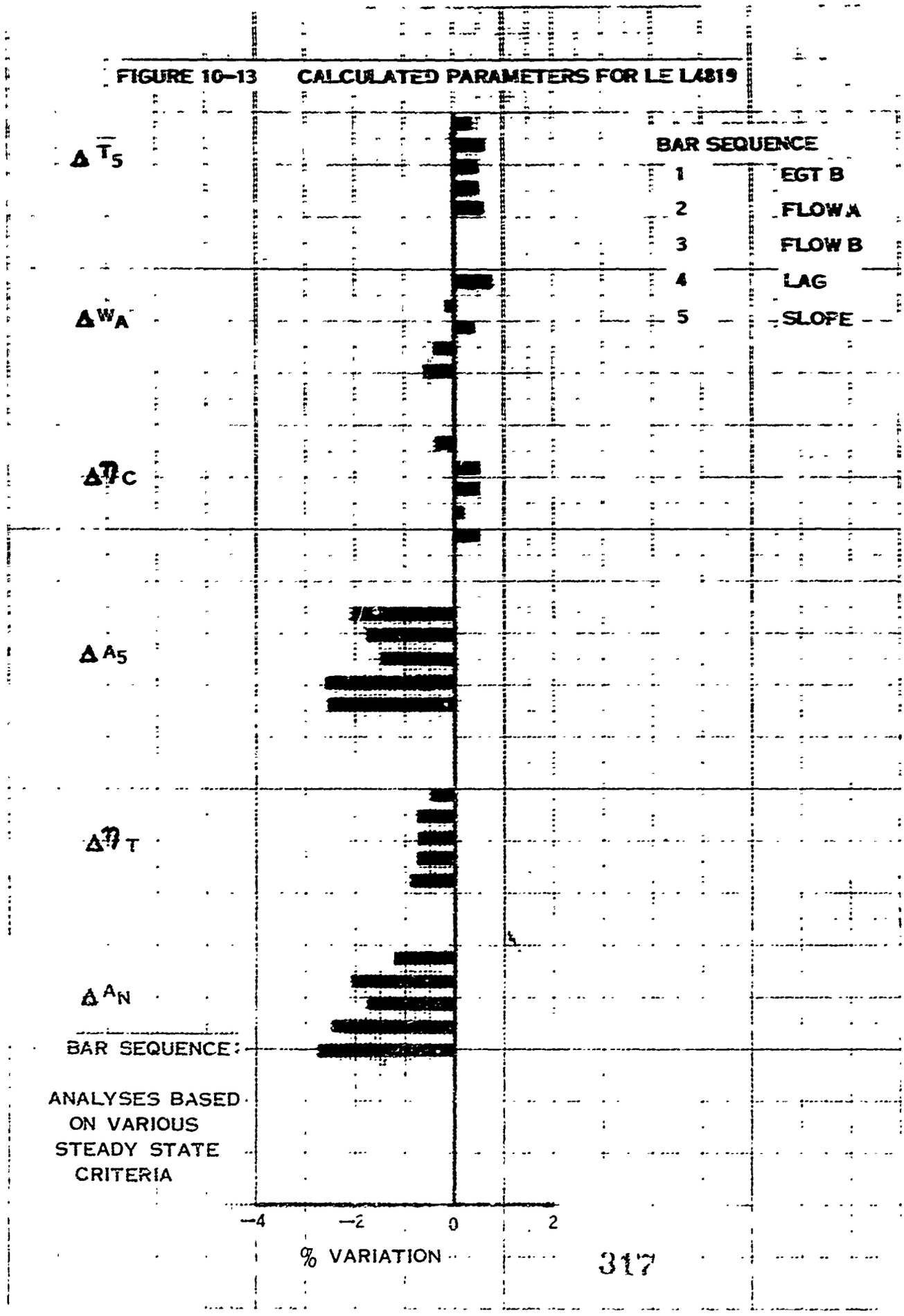


FIGURE 10–14 MEASURED PARAMETERS FOR LE 14519

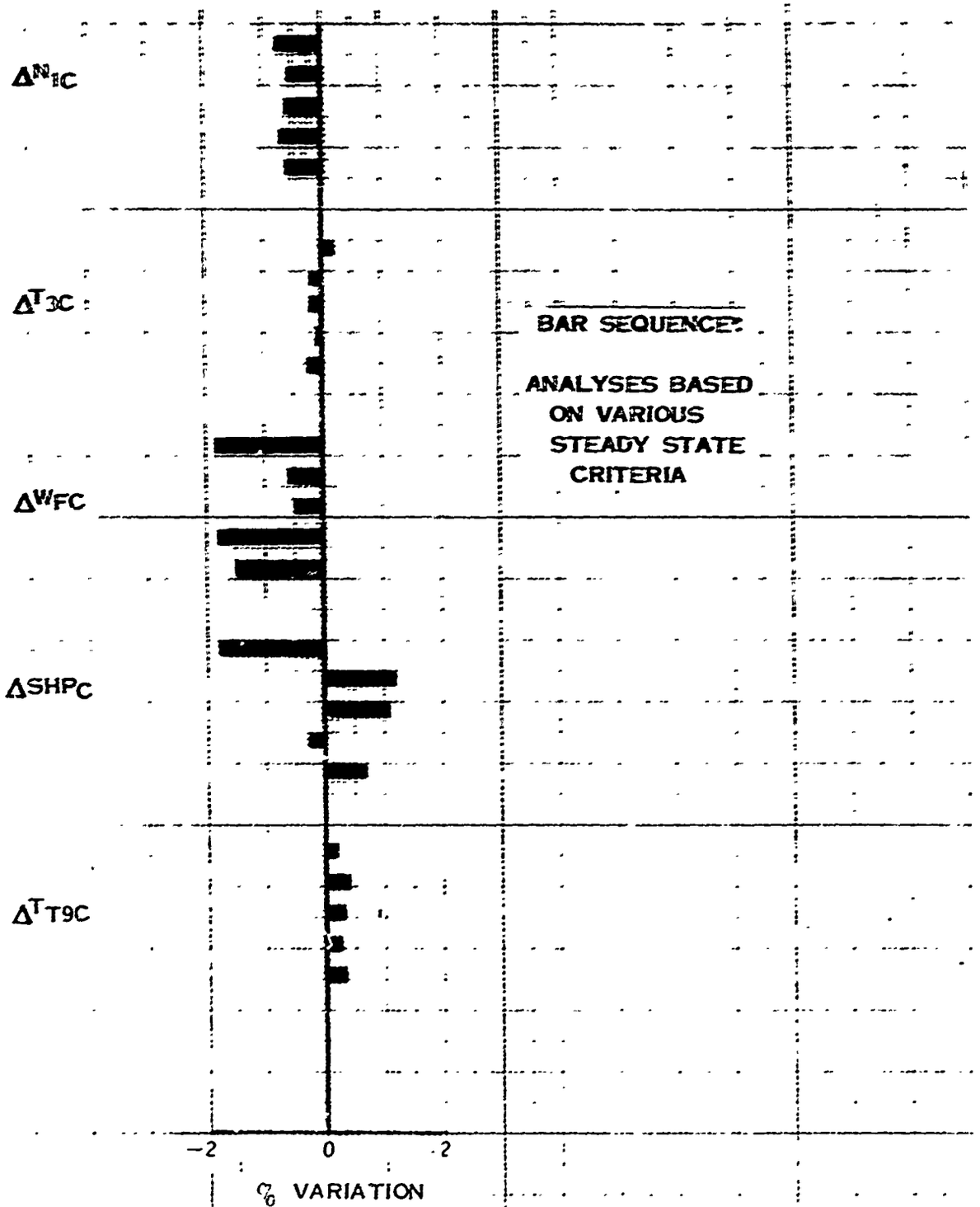
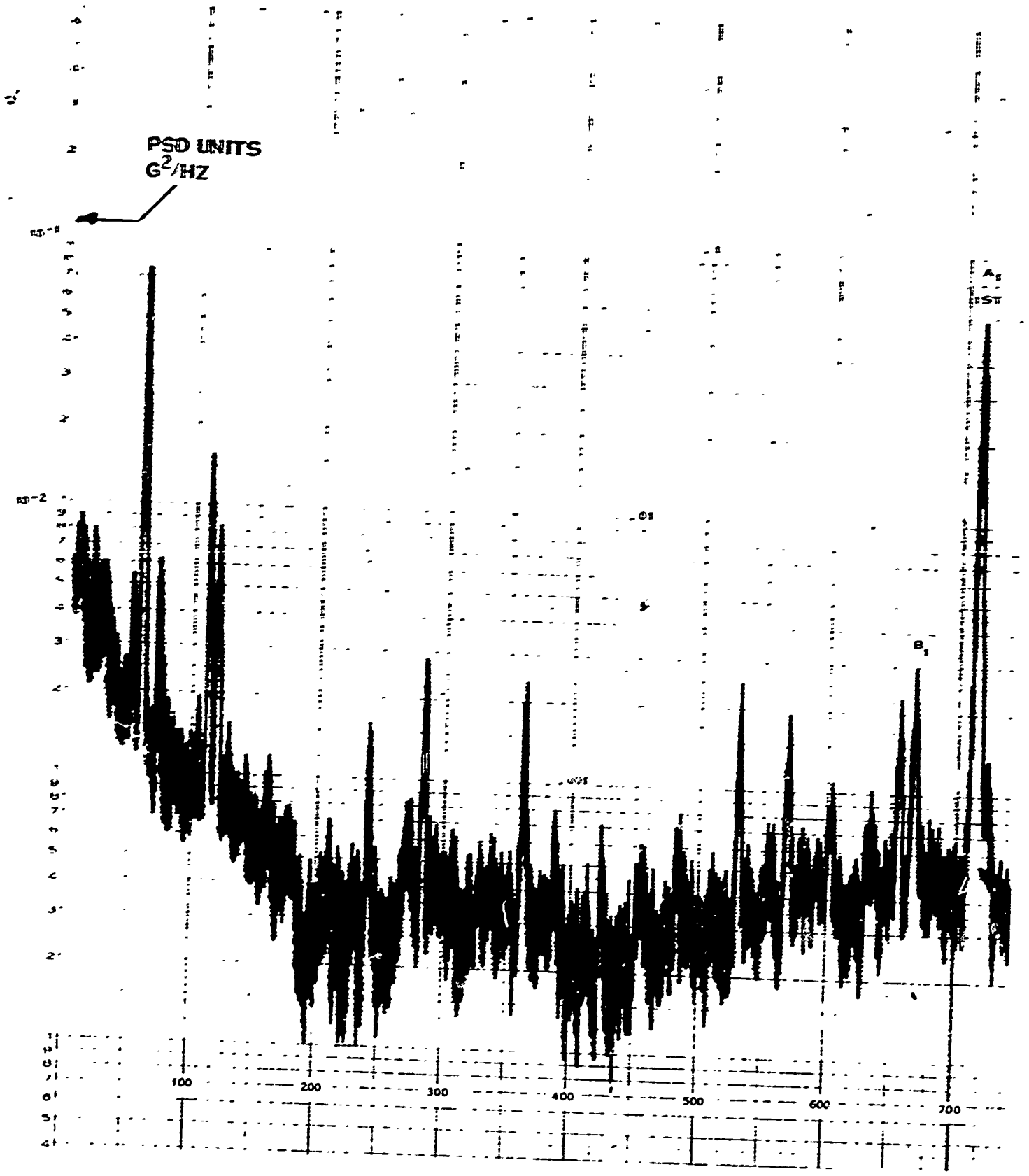


Figure 10-15

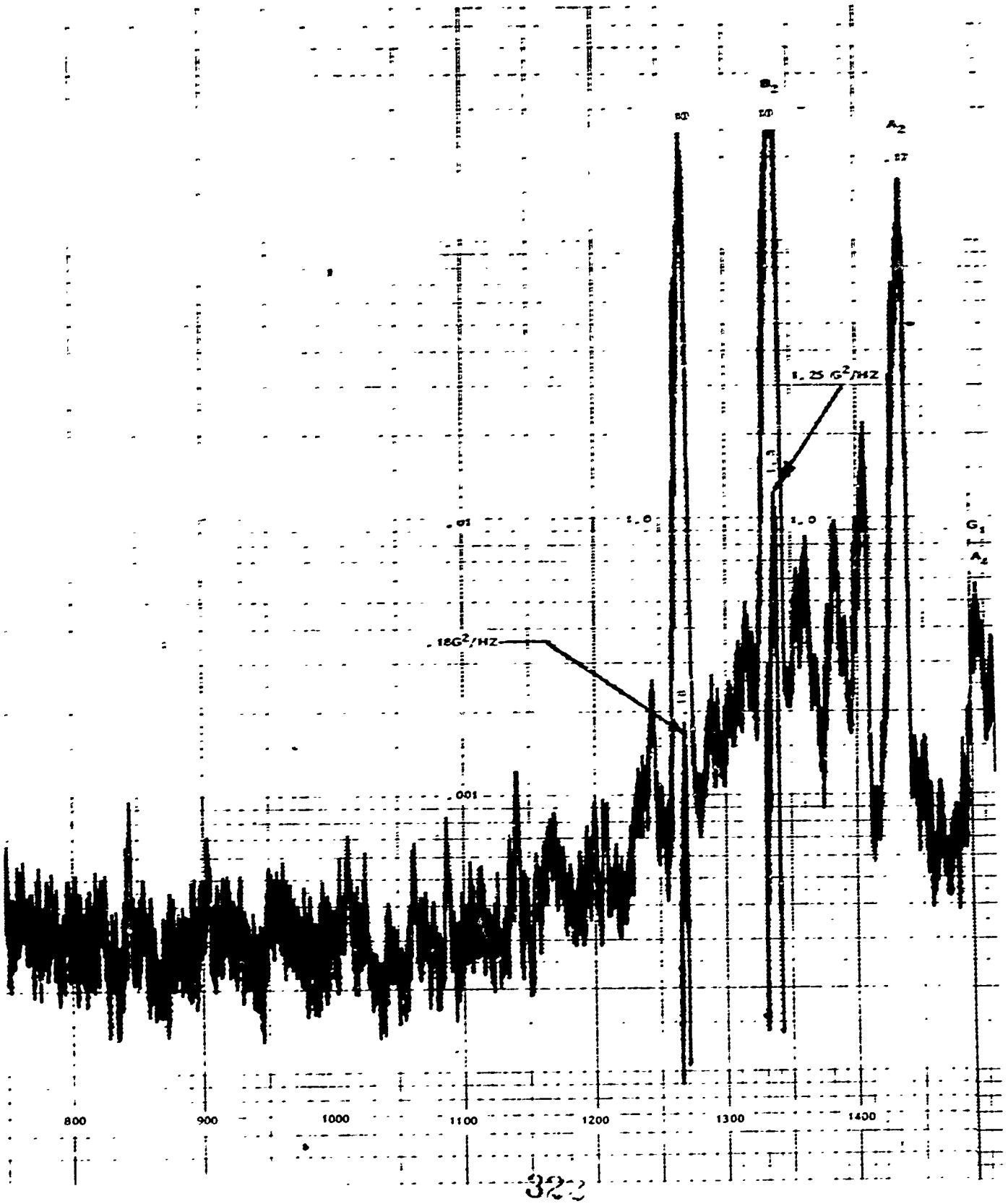
Flight Number	Run Number	#4	#7	#8	#45	#125	#47	#123	#49	#126
1	205	2 105, 106	3 48, 74, 75	8 178, 179, 252, 253, 262, 263, 264, 342	13 77, 103, 104, 105, 209, 239, 240, 287, 288, 312, 313, 335, 336	4 77, 78, 287, 288	4 104, 105, 208, 209	3 105, 209, 240	14 97-100, 103, 105, 112, 143, 162, 208-210, 247	1 274
2	207	3 44, 45, 279	0	0	45 90, 91, 97, 98, 100, 101, 105, 191, 203, 237-240, 246, 285, 286, 312-317, 320-339, 342	4 191, 285, 286, 333	4 104, 105, 207, 208	2 105, 238	12 97-100, 103, 105, 112, 143, 207-209, 312	1 143
3	209	4 46-47, 210	1 210	5 177-179, 204, 222	40 16, 94-96, 98, 102, 103, 141-143, 190, 191, 231, 239-240, 284, 285, 312-314, 317, 321-329, 327-333, 336, 338-341	19 94-96, 141-143, 189-191, 331, 236-238, 281-285, 287	--	12 5-7, 14, 103, 34-37, 102, 205	17 97-100, 102, 103, 112, 117, 122, 126-128, 143, 205, 208, 237, 238	8 117, 122, 127, 132, 136, 142, 146, 147
4	211	0	0	3 180, 181, 319	33 48, 49, 90, 94-98, 101-105, 192, 237-244, 285, 287-289, 312, 314, 315, 323, 335, 336, 338	22 77, 95-98, 144, 145, 192, 239-241, 284-291, 335, 336	--	16 6, 13, 14, 31-38, 49, 50, 104, 105, 240	14 96-100, 105, 112, 143, 144, 207-209, 239, 240	4 55, 116, 117, 143
5	213	1 4[illegible]	0	1 182	11 40, 41, 94-98, 103, 105 209, 313	1 218	6 2, 104, 105, 208, 209, 313	1 105	14 97-100, 103, 105, 112, 143, 144, 208-210, 162, 250	6 55, 116, 123, 142, 143, 250
6	215	2 45, 46	0	3 180, 181, 226	5 66, 77, 78, 105, 313	3 28, 77, 78	5 104, 105, 208, 209, 313	2 28, 105	13 97-100, 105, 112, 129, 130, 143, 144, 208, 209, 247	2 98, 143
7	217	0	0	2 181, 182	15 34, 40-43, 98-101, 103, 105, 210, 313, 314	1 272	4 104, 105, 210, 314	1 105	15 97-100, 103, 105, 125, 130, 112, 143-145, 209-211	4 117, 140, 253, 268
8	219	2 45, 46	0	3 181, 182, 321	13 40-43, 66, 95-98, 103, 210, 315, 316	0	2 105, 210	2 196, 316	10 97-100, 105, 130, 143, 144, 210, 211	2 116, 274

1129	1959	1961	1964	1966
7 73, 104, 109, 207, 311, 312, 313	0	7 33, 44, 77, 101, 108, 329, 330	2 341, 348	--
7 73, 104, 109, 208, 311-313	0	4 33, 44, 210, 214	2 97, 319	--
31 2, 43-45, 103, 136, 137, 140-143, 146, 167, 173, 176-178, 262, 287, 301, 302, 306-309	21 17, 18, 22-24, 27-30, 33, 34, 51, 60, 61, 64-67, 75, 76, 181	29 31, 32, 43, 44, 68, 38, 72, 83, 88, 89, 96, 97, 108, 118, 121, 144, 145, 147, 148, 153, 154, 169, 170, 216, 291	58 95, 96, 161-164, 166-168, 170, 171, 175-178, 190-192, 194-227, 229, 230, 239, 283-285	--
19 45, 104, 109, 138, 140, 141, 142, 159, 160, 173, 176, 239, 287, 291, 292, 299, 310, 308, 310	2 96, 97	16 18, 32, 33, 44, 97, 127, 188, 137, 138, 146, 147, 151, 152, 243, 254, 259	50 150, 157, 159, 169, 171, 319, 173-176, 192-194, 196, 300, 201-203, 205, 207, 210-218, 220-222, 224-227, 230, 240, 276-278, 282-284, 287, 291, 296, 297, 309	--
5 104, 109, 209, 312, 313	3 95-97	24 31-33, 36-39, 41-43, 82, 97, 127-129, 137, 138, 146, 151, 152, 243, 254, 259, 260	40 96, 157, 159, 169, 203, 173-176, 192, 193, 202, 211-213, 215-217, 219, 220-227, 229-231, 280-285, 291, 305, 306, 318	--
4 109, 209, 312, 313	8 69, 95-97, 180, 239-241	24 30, 32-34, 37, 38, 41-44, 67, 72, 73, 96, 97, 106, 121, 143-145, 168, 169, 215, 216	43 95-97, 159-161, 169, 170, 174-176, 192-194, 202, 203, 207-227, 230, 240, 241, 283, 285	--
8 77, 73, 104, 109, 210, 217, 313, 314	3 97, 209, 334	11 32, 33, 38, 41-44, 97, 101, 259, 263	12 98, 161, 168, 174-178, 313, 314, 334, 342	--
8 77, 73, 104, 210, 211, 315-317	4 96-98, 209	15 31-34, 36-38, 41-44, 53, 73, 96, 106	2 97, 318	--

Fig 10-15 A



16 A



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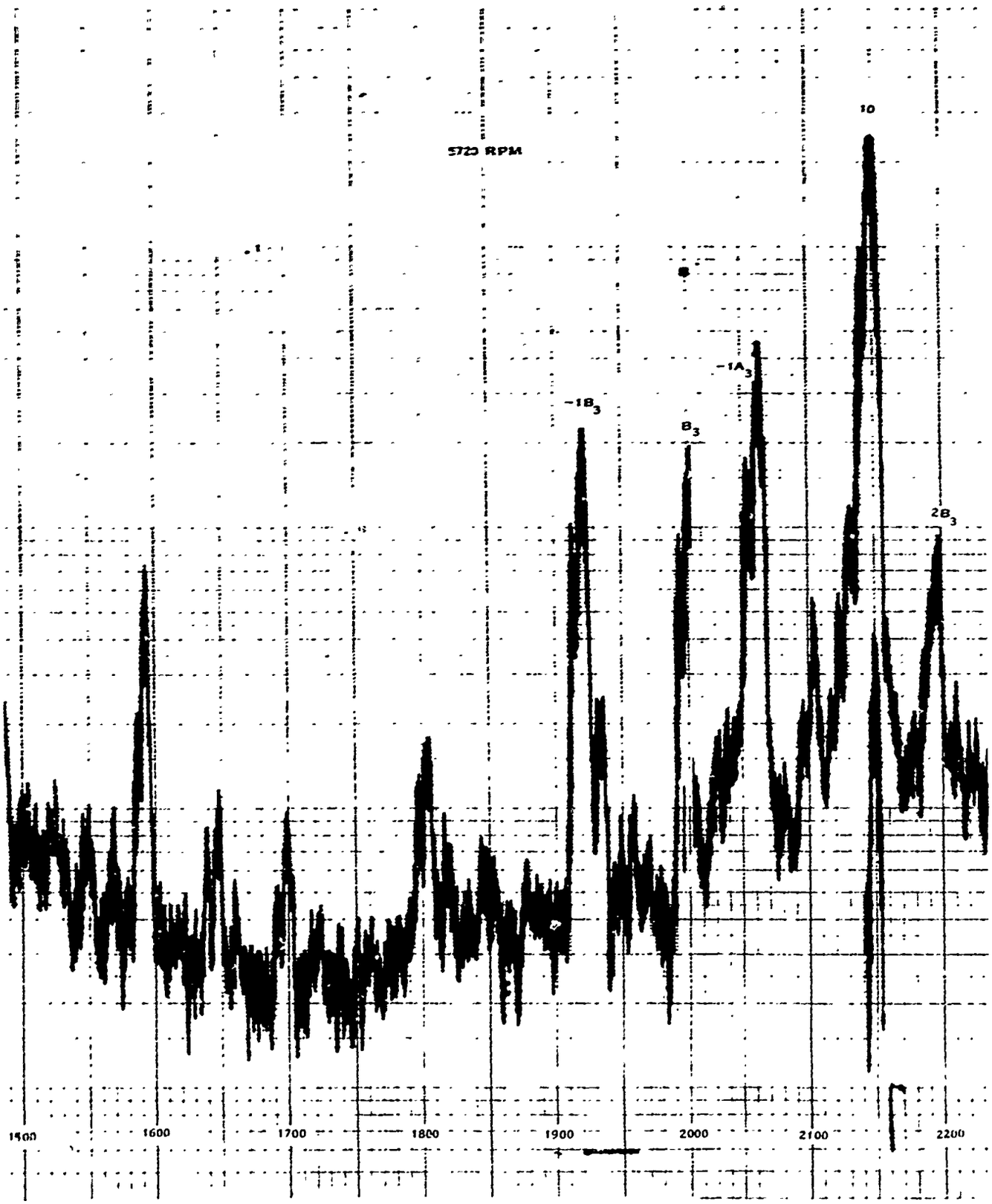
5723 RPM
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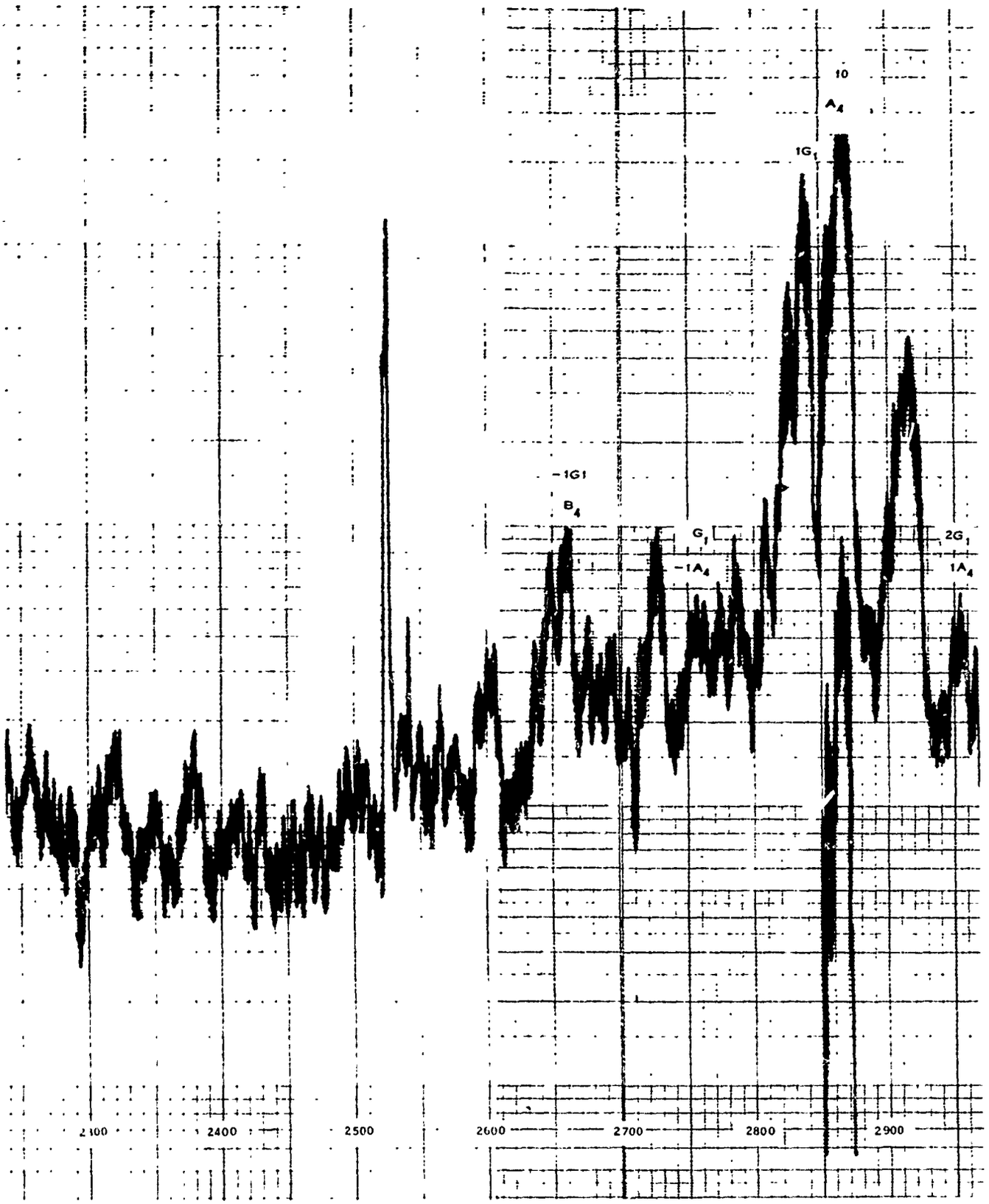
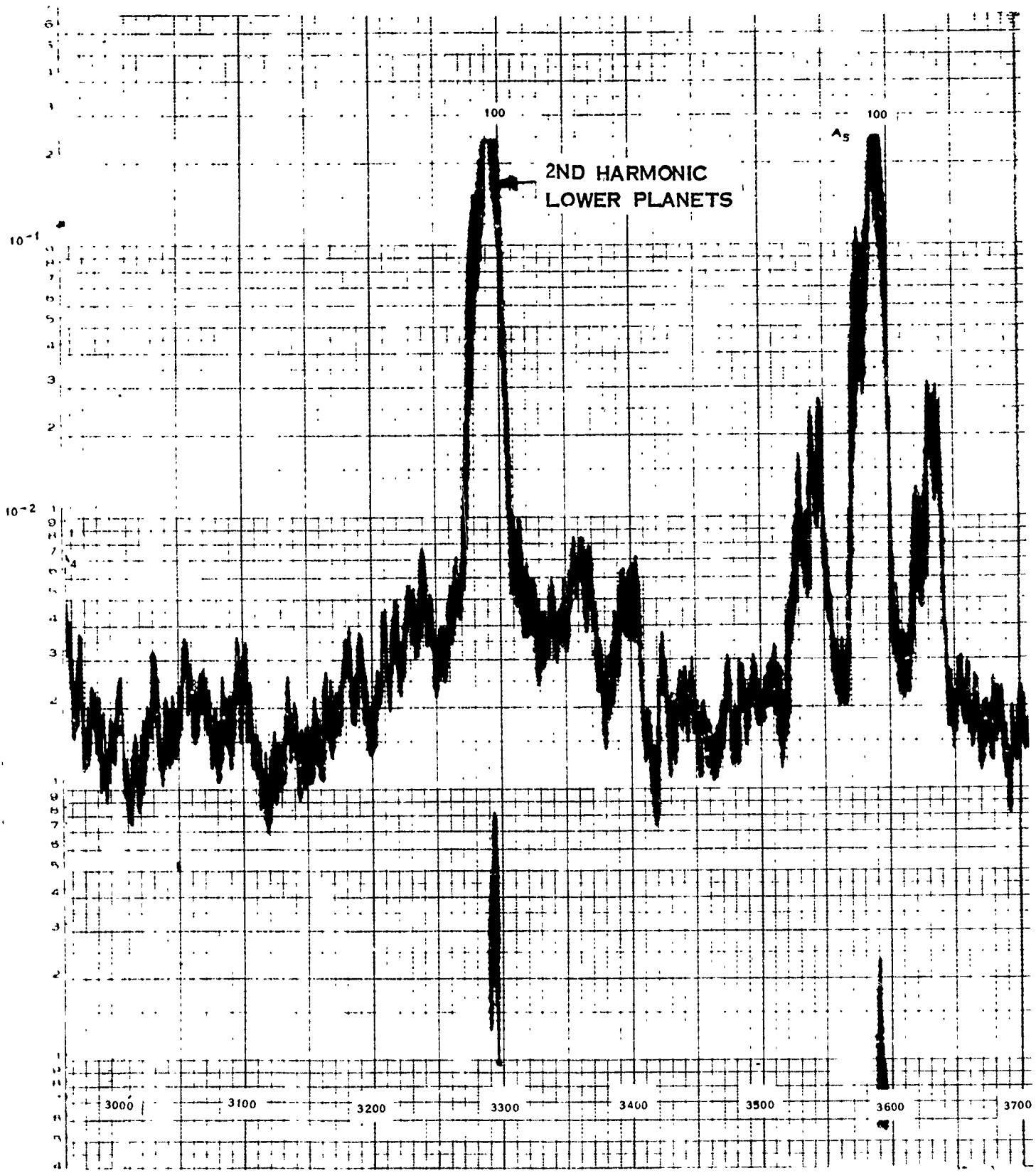
-1A3
-1B3
B3
2B3
1500
1600
1700
1800
1900
2000
2100
2200

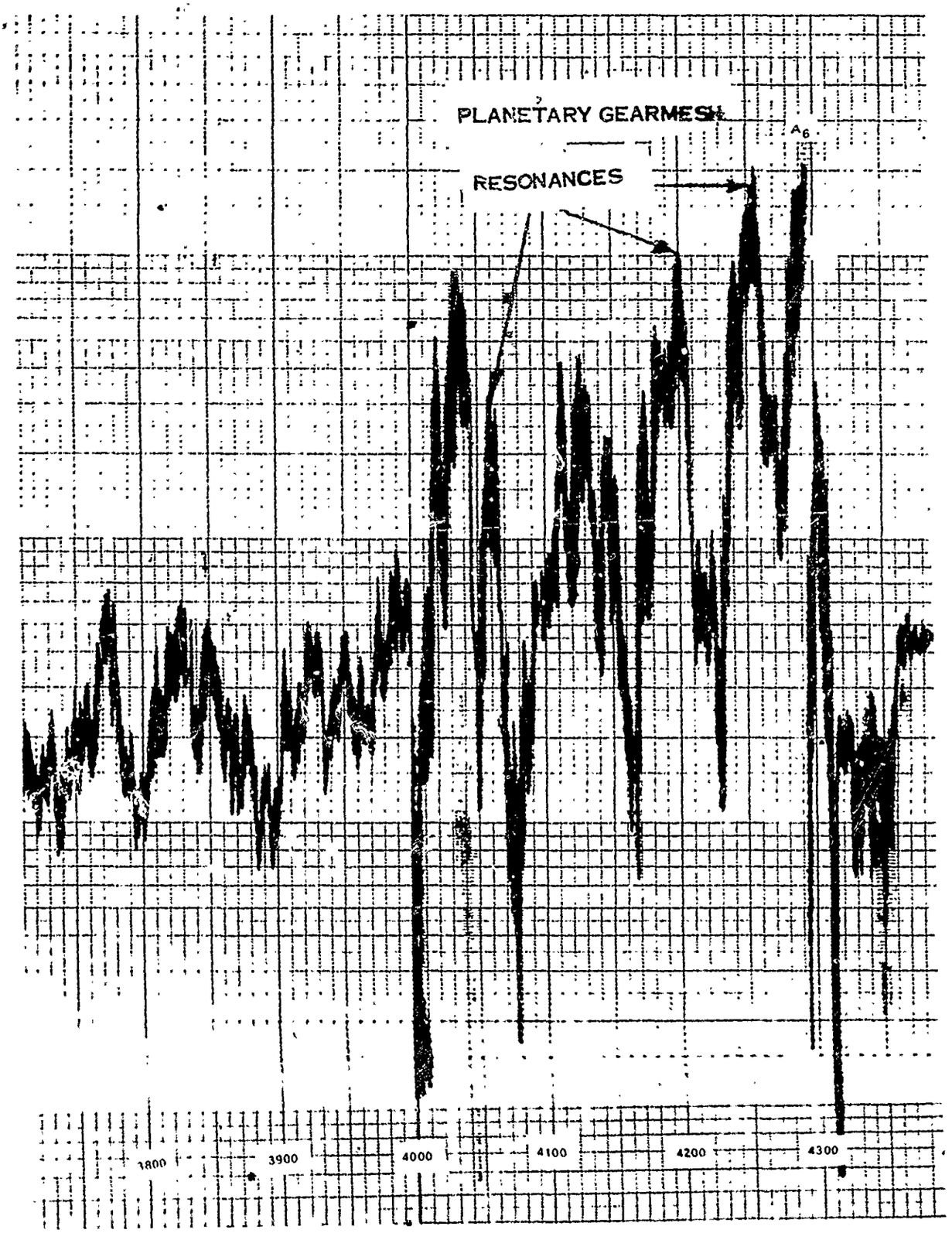
16c


10
A_4
$1G_1$
$-1G1$
B_4
G_1
$-1A_4$
$2G_1$
$1A_4$
2300
2400
2500
2600
2700
2800
2900

16 D


100
100
A_5
2ND HARMONIC
LOWER PLANETS
10^{-1}
10^{-2}
3000
3100
3200
3300
3400
3500
3600
3700

16E


PLANETARY GEARMESH
A_6
RESONANCES
3800
3900
4000
4100
4200
4300

16 F

HSER 6080
VOLUME II

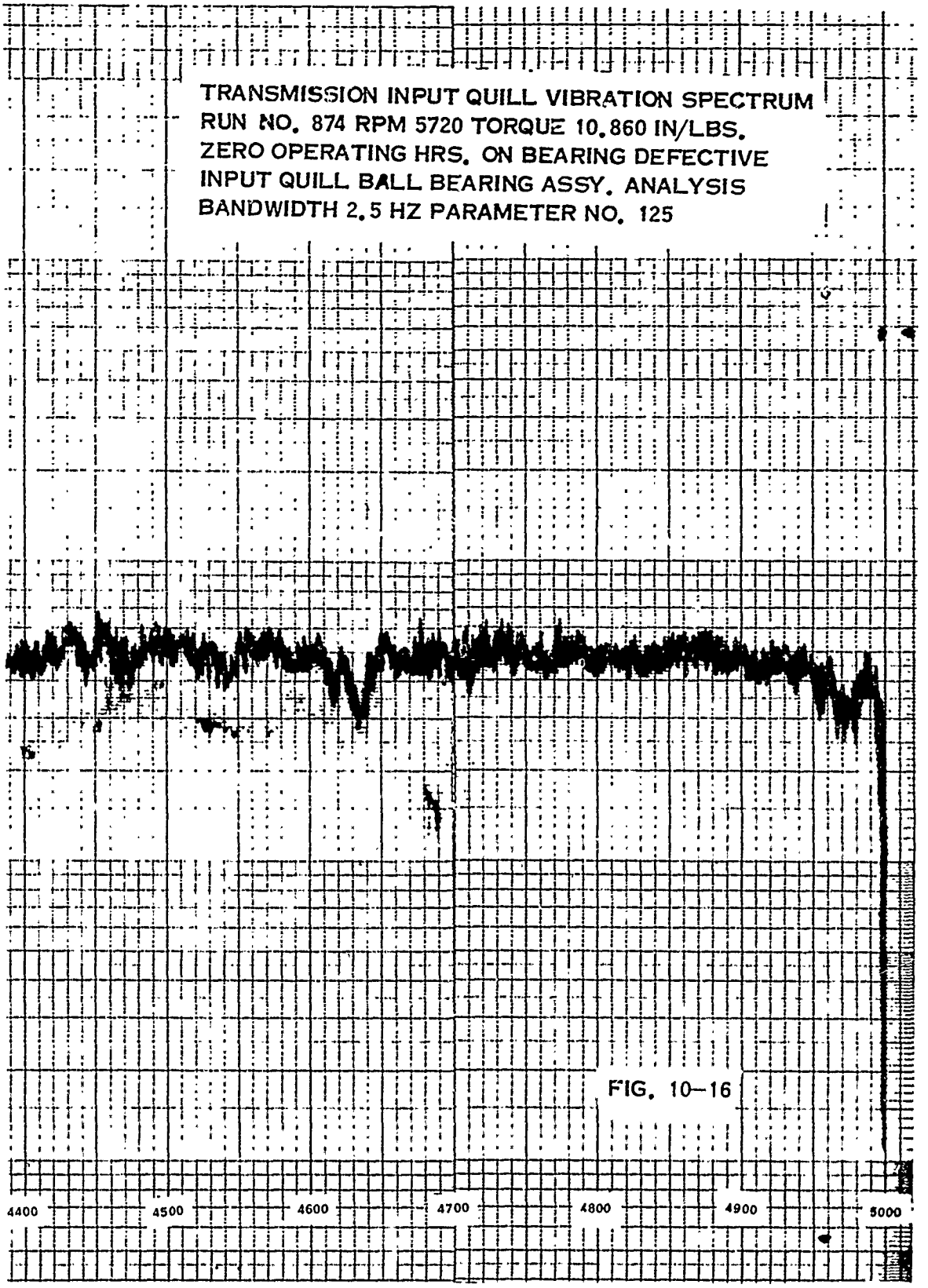


FIG. 10–16

FIG 10-16 G

LISTING OF BEARING AND GEAR FREQUENCIES FOR TRANSMISSION INPUT QUILL ASSEMBLY

m	Fi±mFr	Code	2Fi±mFr	Code	3Fi±mFr	Code	4Fi±mFr	Code	5Fi±mFr	Code	6Fi±mFr	Code	7Fi±mFr	Code
10	1646	+10A1	2352	+10A2	3058	+10A3	3764	+10A4	4470	+10A5	5176	+10A6	-	-
9	1552	+9A1	2258	+9A2	2964	+9A3	3670	+9A4	4376	+9A5	5082	+9A6	-	-
8	1458	+8A1	2164	+8A2	2870	+8A3	3576	+8A4	4282	+8A5	4988	+8A6	-	-
7	1364	+7A1	2070	+7A2	2776	+7A3	3482	+7A4	4188	+7A5	4894	+7A6	-	-
6	1270	+6A1	1976	+6A2	2682	+6A3	3388	+6A4	4094	+6A5	4810	+6A6	-	-
5	1176	+5A1	1882	+5A2	2588	+5A3	3294	+5A4	4000	+5A5	4706	+5A6	-	-
4	1082	+4A1	1788	+4A2	2494	+4A3	3200	+4A4	3906	+4A5	4612	+4A6	-	-
3	988	+3A1	1694	+3A2	2400	+3A3	3106	+3A4	3812	+3A5	4518	+3A6	-	-
2	894	+2A1	1600	+2A2	2306	+2A3	3012	+2A4	3718	+2A5	4424	+2A6	-	-
1	800	+1A1	1506	+1A2	2212	+1A3	2918	+1A4	3624	+1A5	4330	+1A6	-	-
0	706	A1	1412	A2	2118	A3	2824	A4	3530	A5	4236	A6	4942	A7
1	612	-1A1	1318	-1A2	2024	-1A3	2730	-1A4	3436	-1A5	4142	-1A6	4848	-1A7
2	518	-2A1	1224	-2A2	1930	-2A3	2636	-2A4	3342	-2A5	4048	-2A6	4754	-2A7
3	424	-3A1	1130	-3A2	1836	-3A3	2542	-3A4	3248	-3A5	3954	-3A6	4660	-3A7
4	330	-4A1	1036	-4A2	1742	-4A3	2448	-4A4	3154	-4A5	3860	-4A6	4566	-4A7
5	236	-5A1	942	-5A2	1648	-5A3	2354	-5A4	3060	-5A5	3766	-5A6	4472	-5A7
6	142	-6A1	848	-6A2	1554	-6A3	2260	-6A4	2966	-6A5	3672	-6A6	4378	-6A7
7	48	-7A1	754	-7A2	1460	-7A3	2166	-7A4	2872	-7A5	3578	-7A6	4284	-7A7
8	-	-	660	-8A2	1366	-8A3	2072	-8A4	2778	-8A5	3484	-8A6	4190	-8A7
9	-	-	576	-9A2	1272	-9A3	1978	-9A4	2684	-9A5	3390	-9A6	4096	-9A7
10	-	-	482	-10A2	1178	-10A3	1884	-10A4	2590	-10A5	3296	-10A6	4002	-10A7

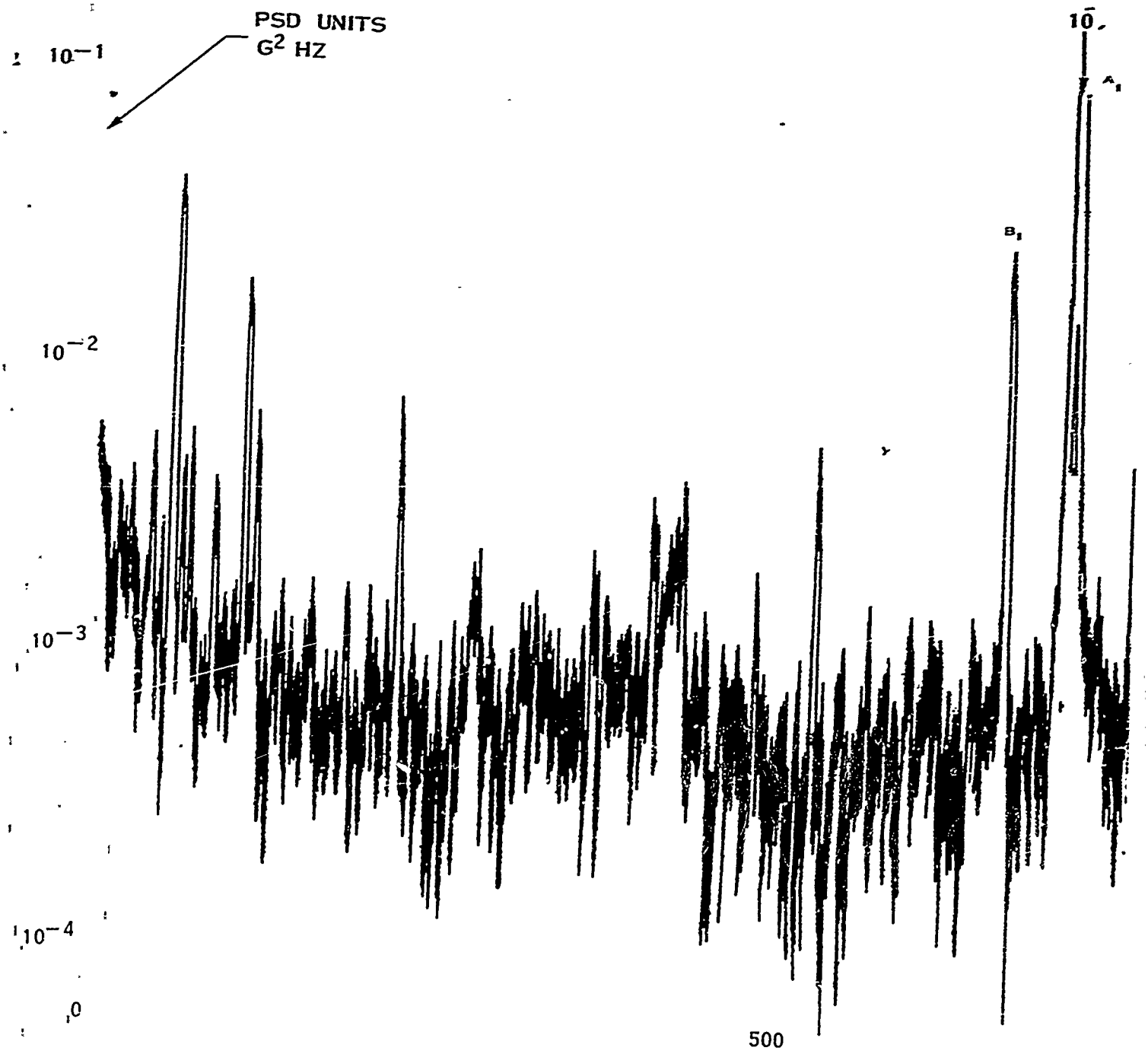
m	Fo±mFr	Code	2Fo±mFr	Code	3Fo±mFr	Code	4Fo±mFr	Code	5Fo±mFr	Code	6Fo±mFr	Code	7Fo±mFr	Code
10	1600	+10B1	2260	+10B2	2920	+10B3	3580	+10B4	4240	+10B5	4900	+10B6	5560	-
9	1506	+9B1	2166	+9B2	2826	+9B3	3486	+9B4	4146	+9B5	4806	+9B6	5466	-
8	1412	+8B1	2072	+8B2	2732	+8B3	3392	+8B4	4052	+8B5	4712	+8B6	5372	-
7	1318	+7B1	1978	+7B2	2638	+7B3	3298	+7B4	3958	+7B5	4618	+7B6	5278	-
6	1224	+6B1	1884	+6B2	2544	+6B3	3204	+6B4	3864	+6B5	4524	+6B6	5184	-
5	1130	+5B1	1790	+5B2	2450	+5B3	3110	+5B4	3770	+5B5	4430	+5B6	5090	-
4	1036	+4B1	1696	+4B2	2356	+4B3	3016	+4B4	3676	+4B5	4336	+4B6	4996	+4B7
3	942	+3B1	1602	+3B2	2262	+3B3	2922	+3B4	3582	+3B5	4242	+3B6	4902	+3B7
2	848	+2B1	1508	+2B2	2168	+2B3	2828	+2B4	3488	+2B5	4148	+2B6	4808	+2B7
1	754	+1B1	1414	+1B2	2074	+1B3	2734	+1B4	3394	+1B5	4054	+1B6	4714	+1B7
0	660	B1	1320	B2	1980	B3	2640	B4	3300	B5	3960	B6	4620	B7
1	556	-1B1	1226	-1B2	1886	-1B3	2546	-1B4	3206	-1B5	3866	-1B6	4526	-1B7
2	472	-2B1	1132	-2B2	1742	-2B3	2452	-2B4	3112	-2B5	3772	-2B6	4432	-2B7
3	378	-3B1	1038	-3B2	1698	-3B3	2358	-3B4	3018	-3B5	3678	-3B6	4338	-3B7
4	284	-4B1	944	-4B2	1604	-4B3	2264	-4B4	2924	-4B5	3584	-4B6	4244	-4B7
5	190	-5B1	850	-5B2	1510	-5B3	2170	-5B4	2830	-5B5	3490	-5B6	4150	-5B7
6	96	-6B1	756	-6B2	1416	-6B3	2076	-6B4	2736	-6B5	3396	-6B6	4056	-6B7
7	2	-7B1	662	-7B2	1322	-7B3	1982	-7B4	2642	-7B5	3302	-7B6	3962	-7B7
8	-	-	568	-8B2	1228	-8B3	1888	-8B4	2548	-8B5	3208	-8B6	3868	-8B7
9	-	-	474	-9B2	1134	-9B3	1794	-9B4	2454	-9B5	3114	-9B6	3774	-9B7
10	-	-	380	-10B2	1040	-10B3	1700	-10B4	2360	-10B5	3020	-10B6	3680	-10B7

Input Quill Gearmesh Gm±mFr	Code
3666	+100H
3572	+90H
3478	+80H
3384	+70H
3290	+60H
3196	+50H
3102	+40H
3008	+30H
2914	+20H
2820	+10H
2726	GM
2632	-10H
2538	-20H
2444	-30H
2350	-40H
2256	-50H
2162	-60H
2068	-70H
1974	-80H
1880	-90H
1786	-100H

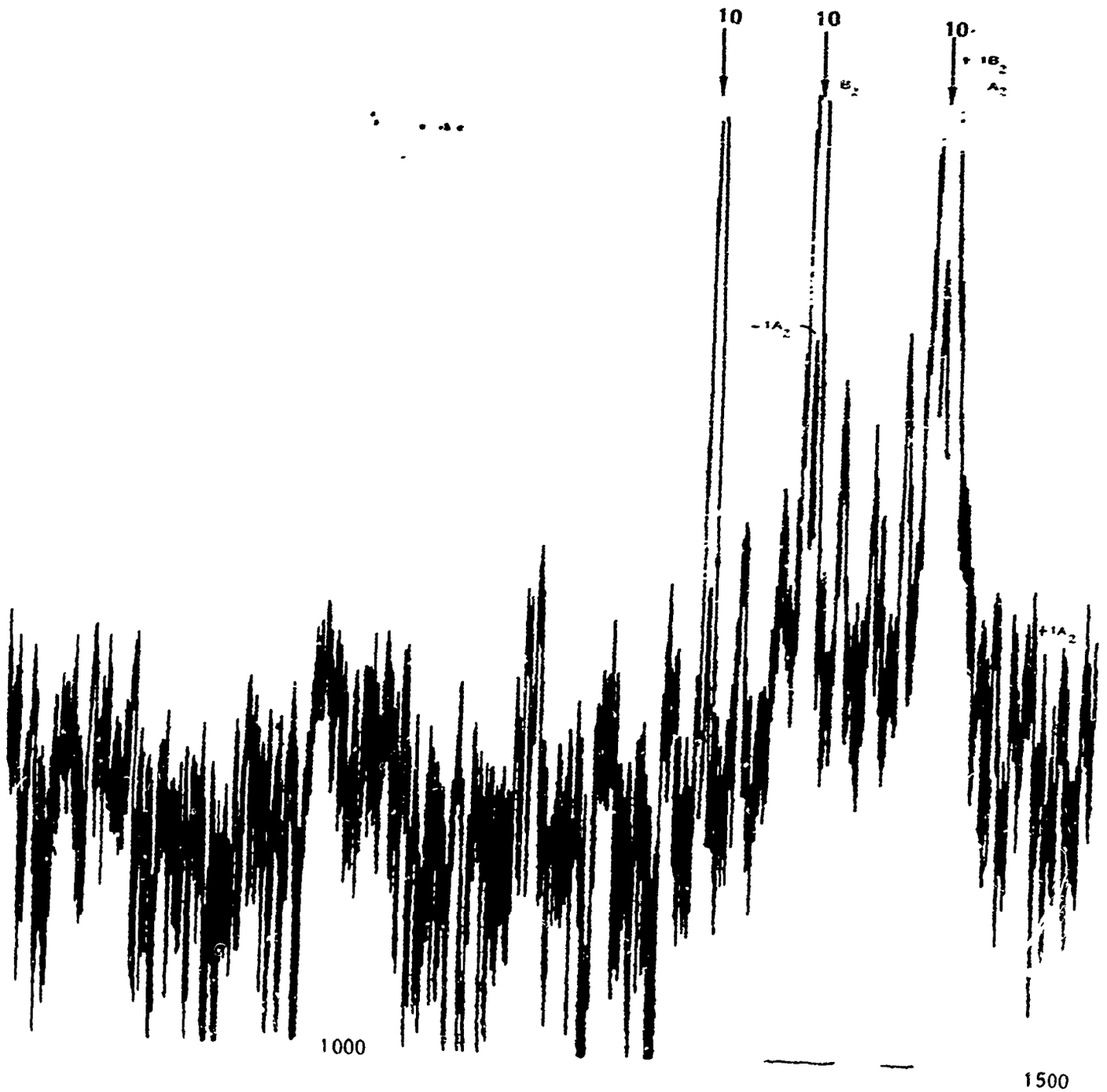
Tabulation of Interfering Sidebands for Fi

+5A1	-10A3
+6A1	-9A3
+7A1	-8A3
+8A1	-7A3
+9A1	-6A3
+10A1	-5A3
+5A3	-1C
+6A3	-9A5
+7A3	-8A5
+8A3	-7A5
+9A3	-6A5
+10A3	-5A5
+10A2	-5A4
+9A2	-6A4
+8A2	-7A4
+7A2	-8A4
+6A2	-9A4
+5A2	-10A4
+5A4	-10A6
+6A4	-9A6
+7A4	-8A6
+8A4	-7A6
+9A4	-6A6
+10A4	-5A6
+5A5	-10A7
+6A5	-9A7
+7A5	-8A7
+8A5	-7A7
+9A5	-6A7
+10A5	-5A7

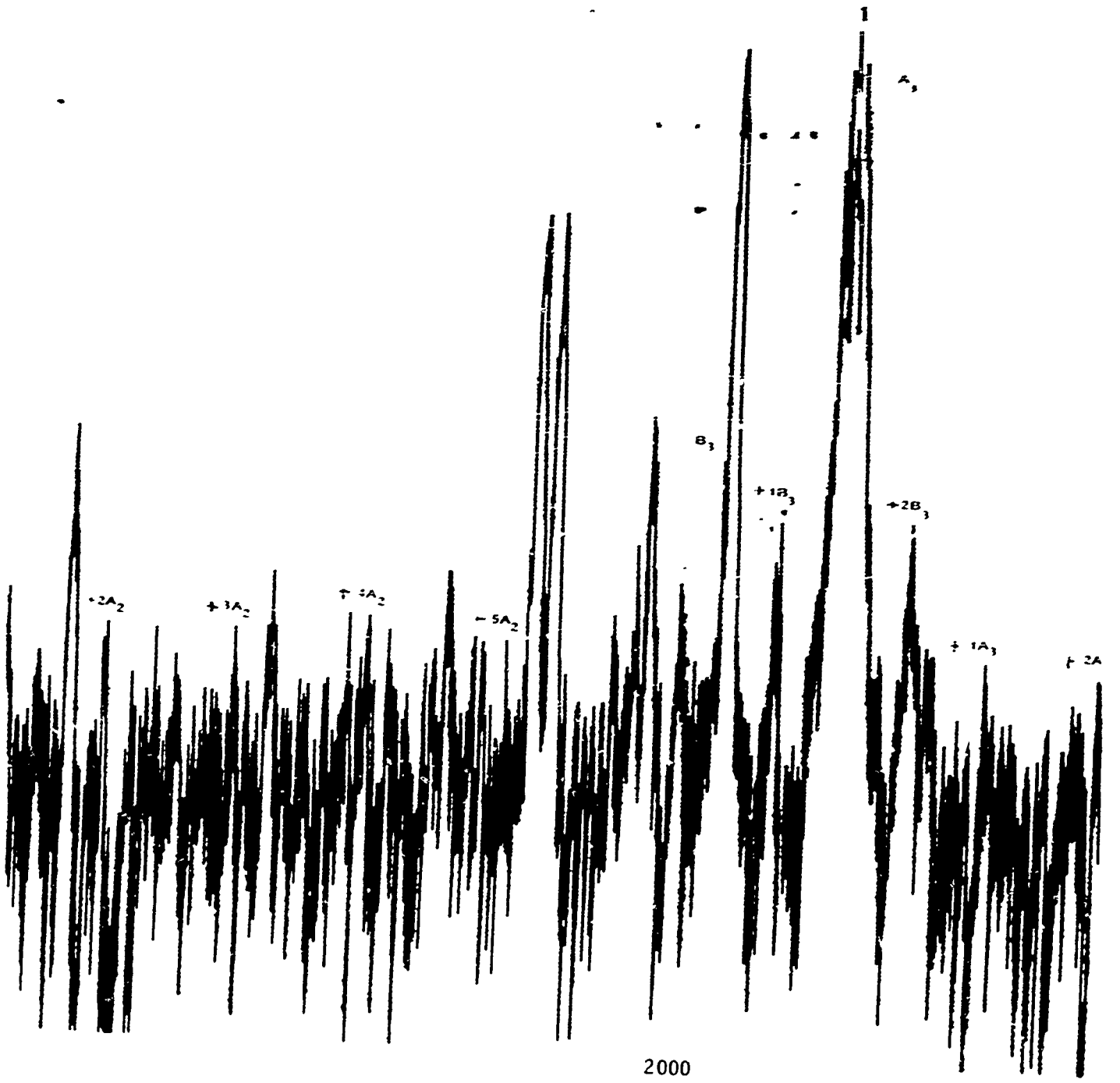
TABLE 10.1



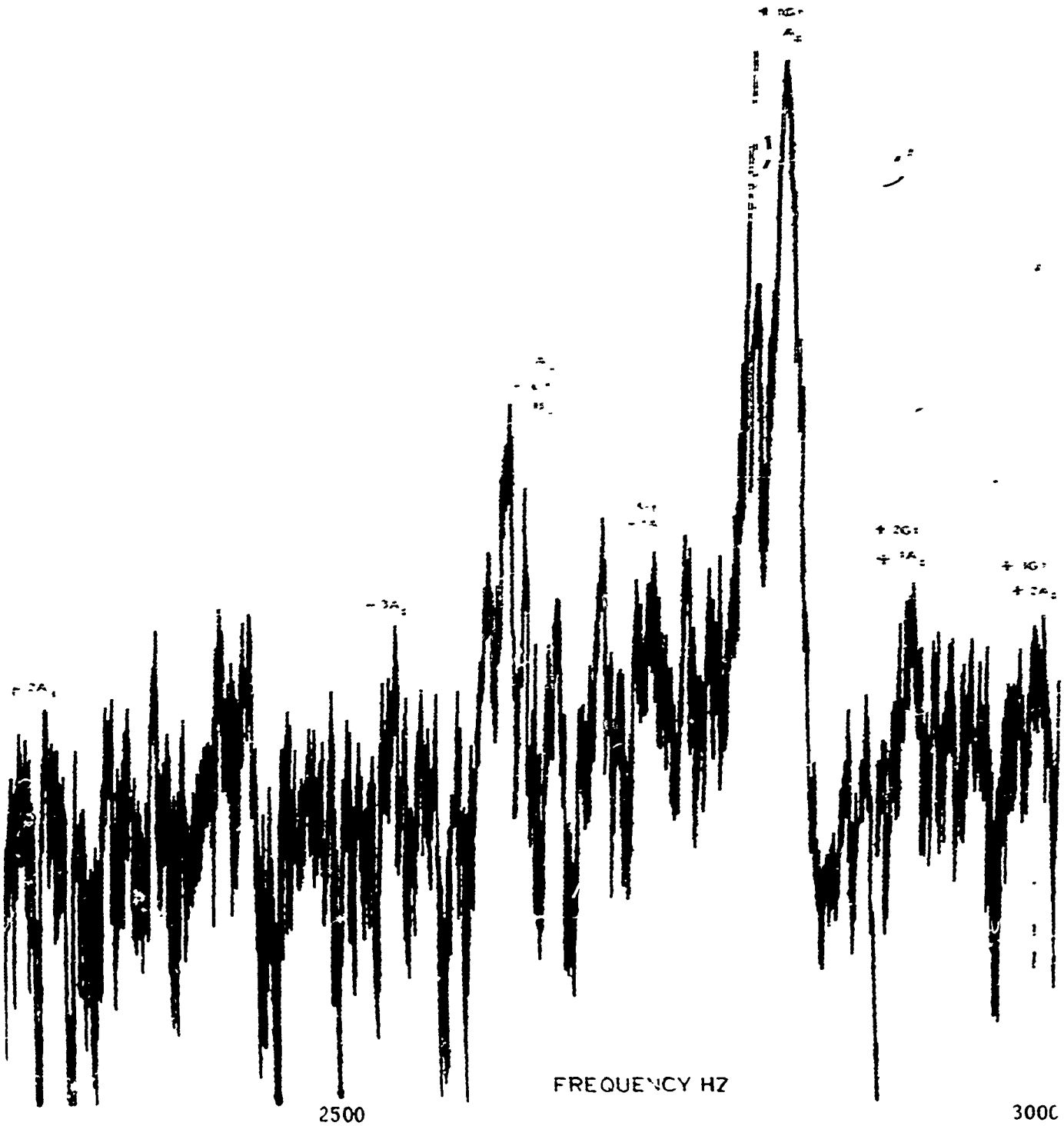
17 A



17 B



17C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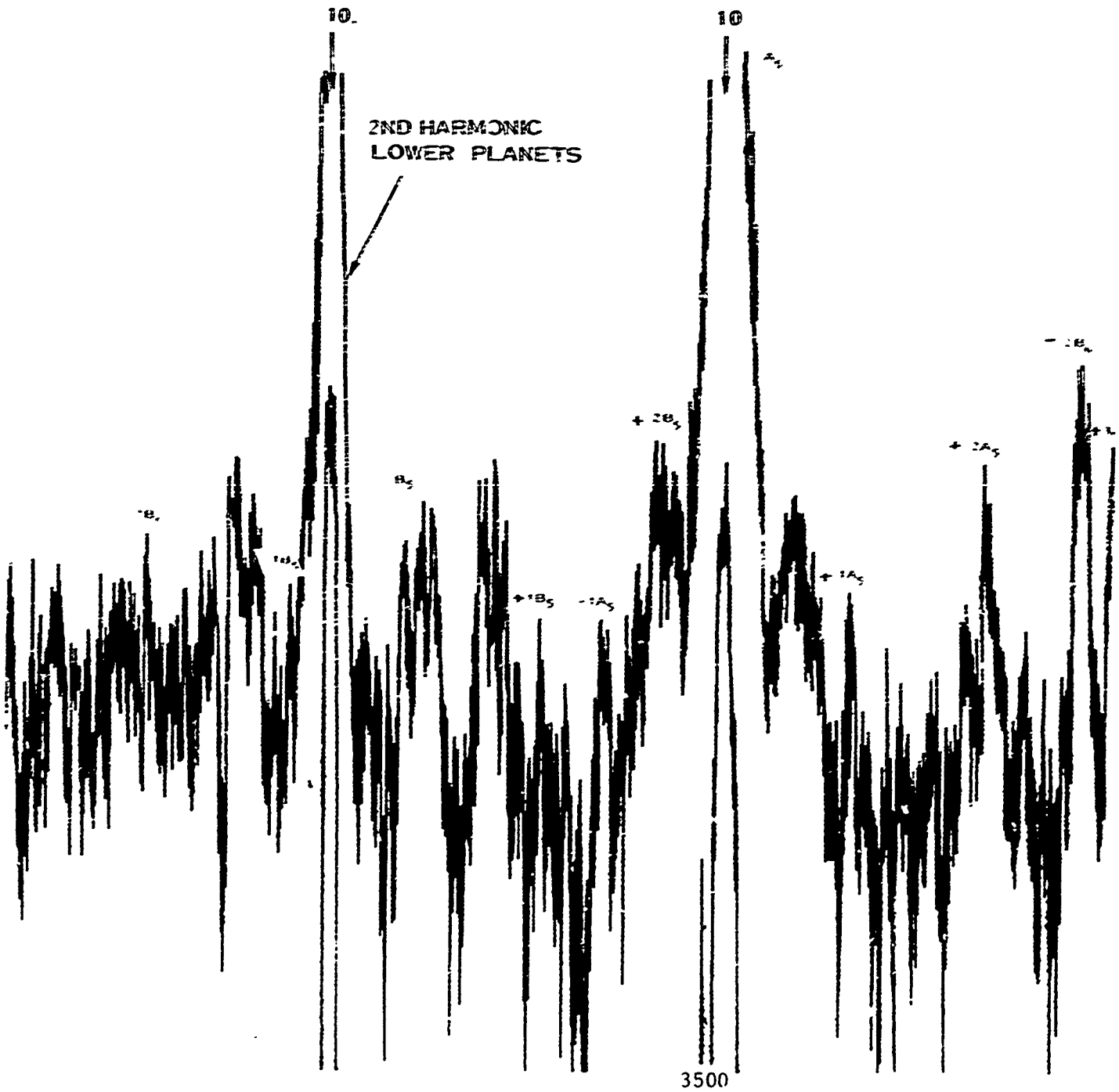
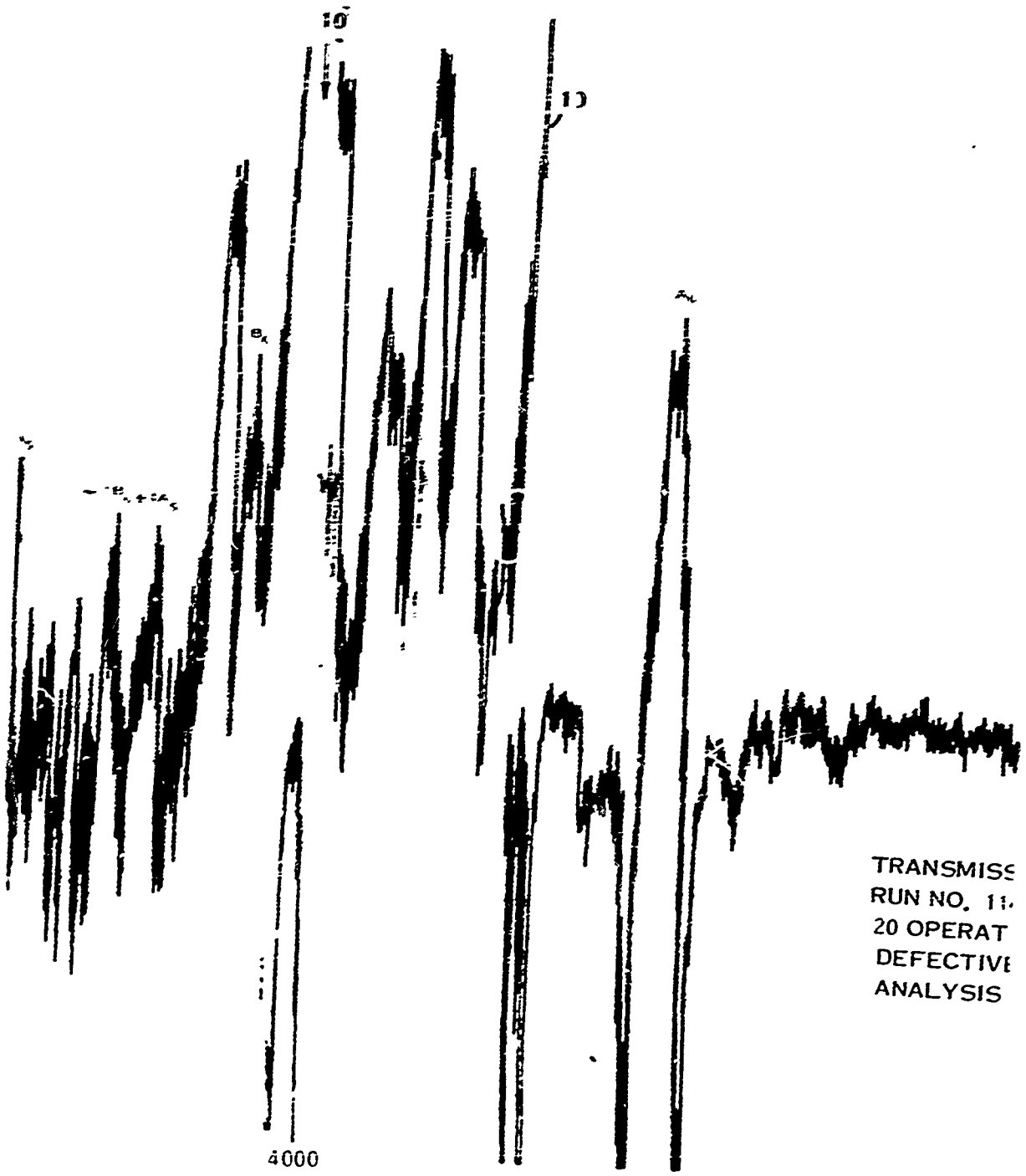
2500
3000



17E



TRANSMISS
RUN NO. 1
20 OPERAT
DEFECTIVE
ANALYSIS

17F

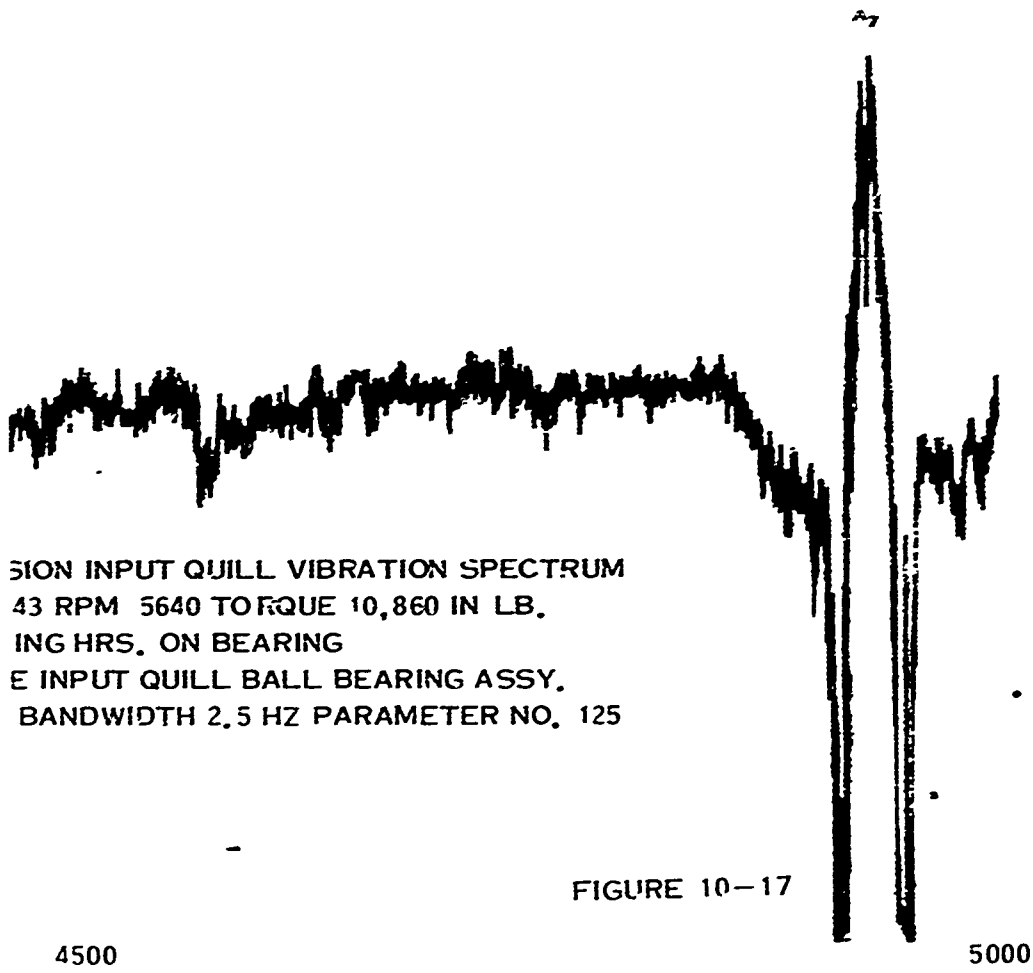


FIGURE 10–17

FIG 10-17 A

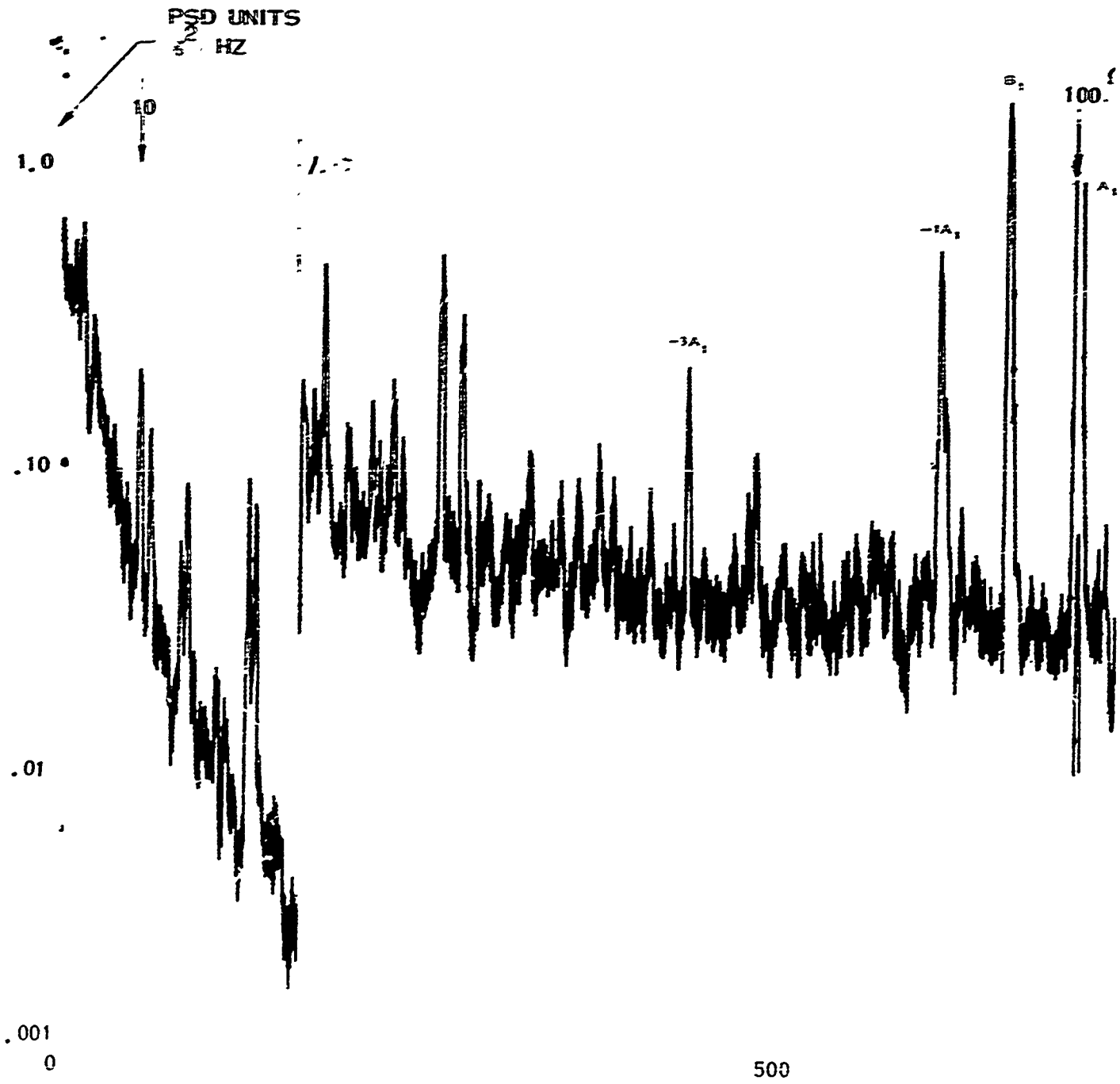
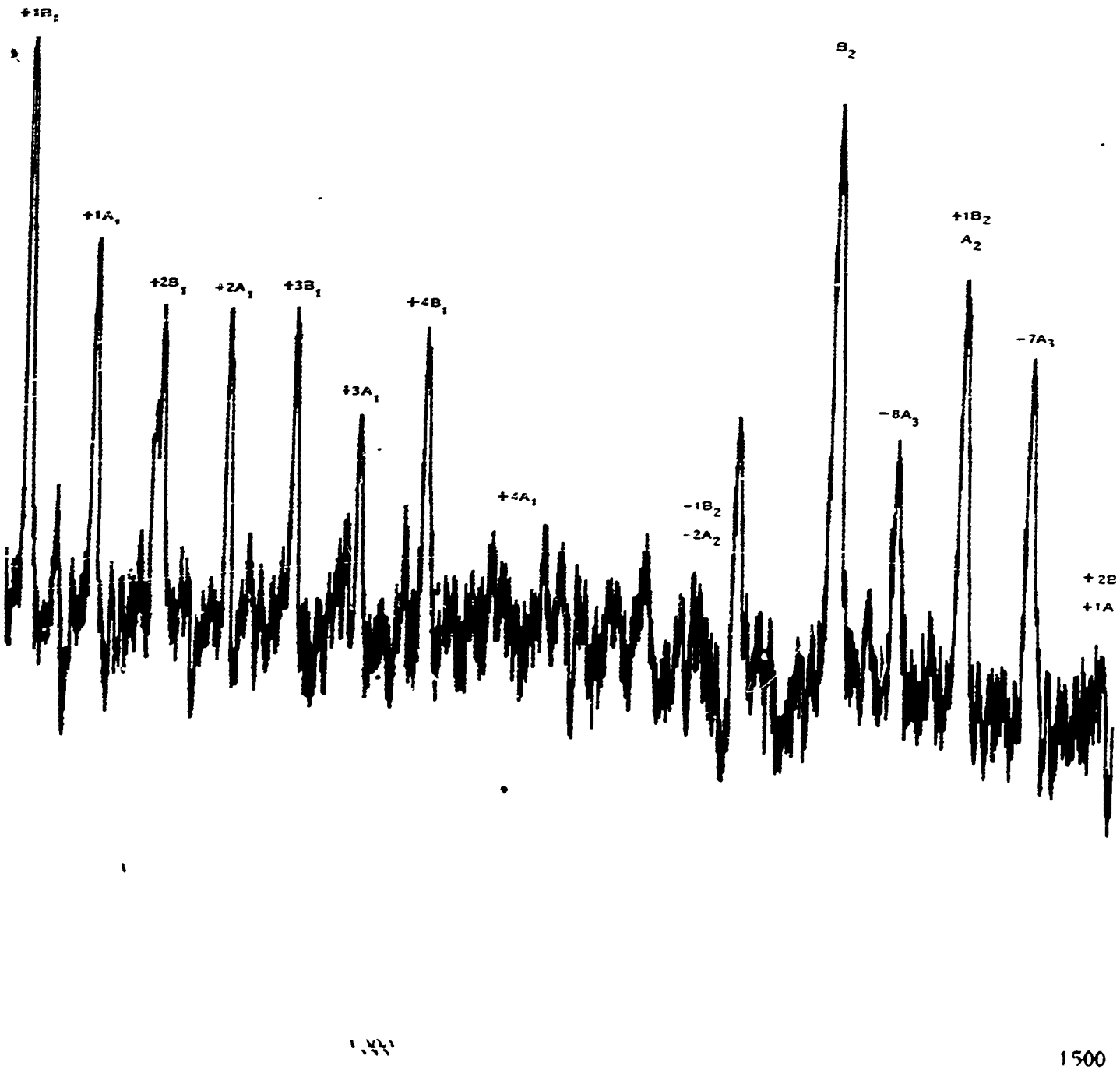
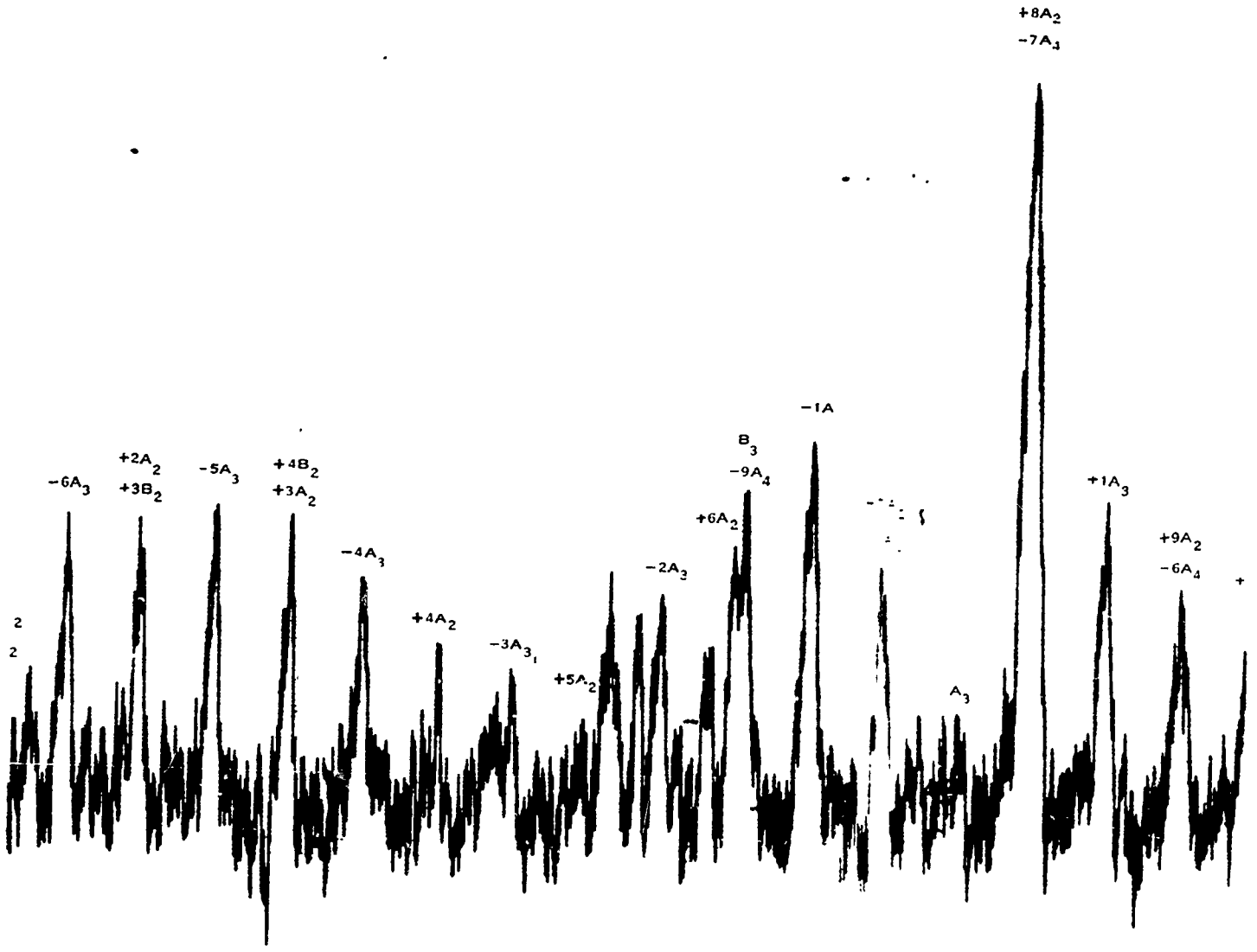


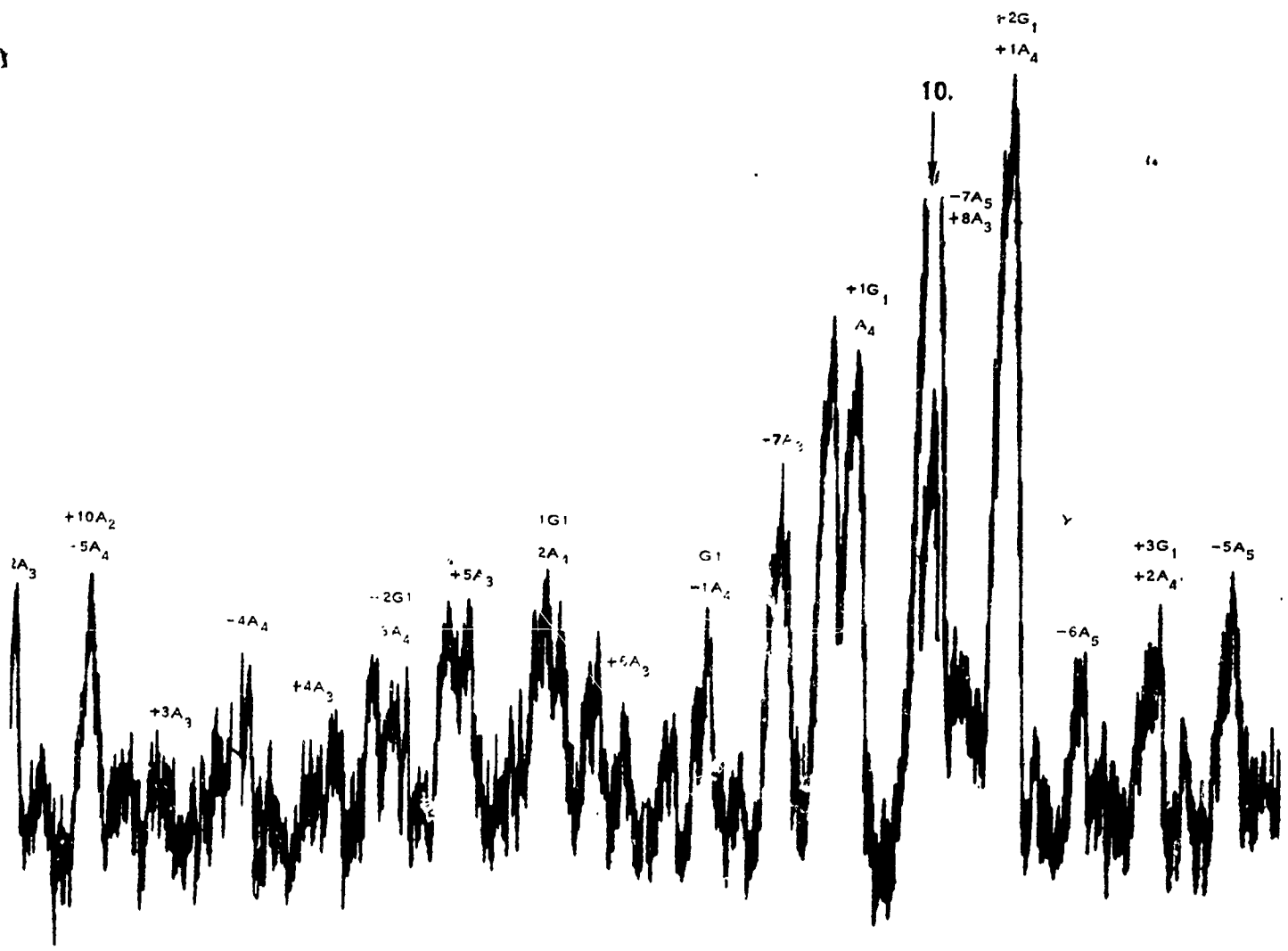
FIG 10-18


+1B1
+1A1
+2B1
+2A1
+3B1
+3A1
+4B1
+4A1
-1B2
-2A2
B2
-8A3
+1B2
A2
-7A3
+2B
+1A
1500

18b


+8A2
-7A4
-1A
B3
-9A4
+6A2
+2A2
+3B2
-6A3
-5A3
+4B2
+3A2
-4A3
+4A2
-3A3
+5A2
-2A3
A3
+1A3
+9A2
-6A4
2000

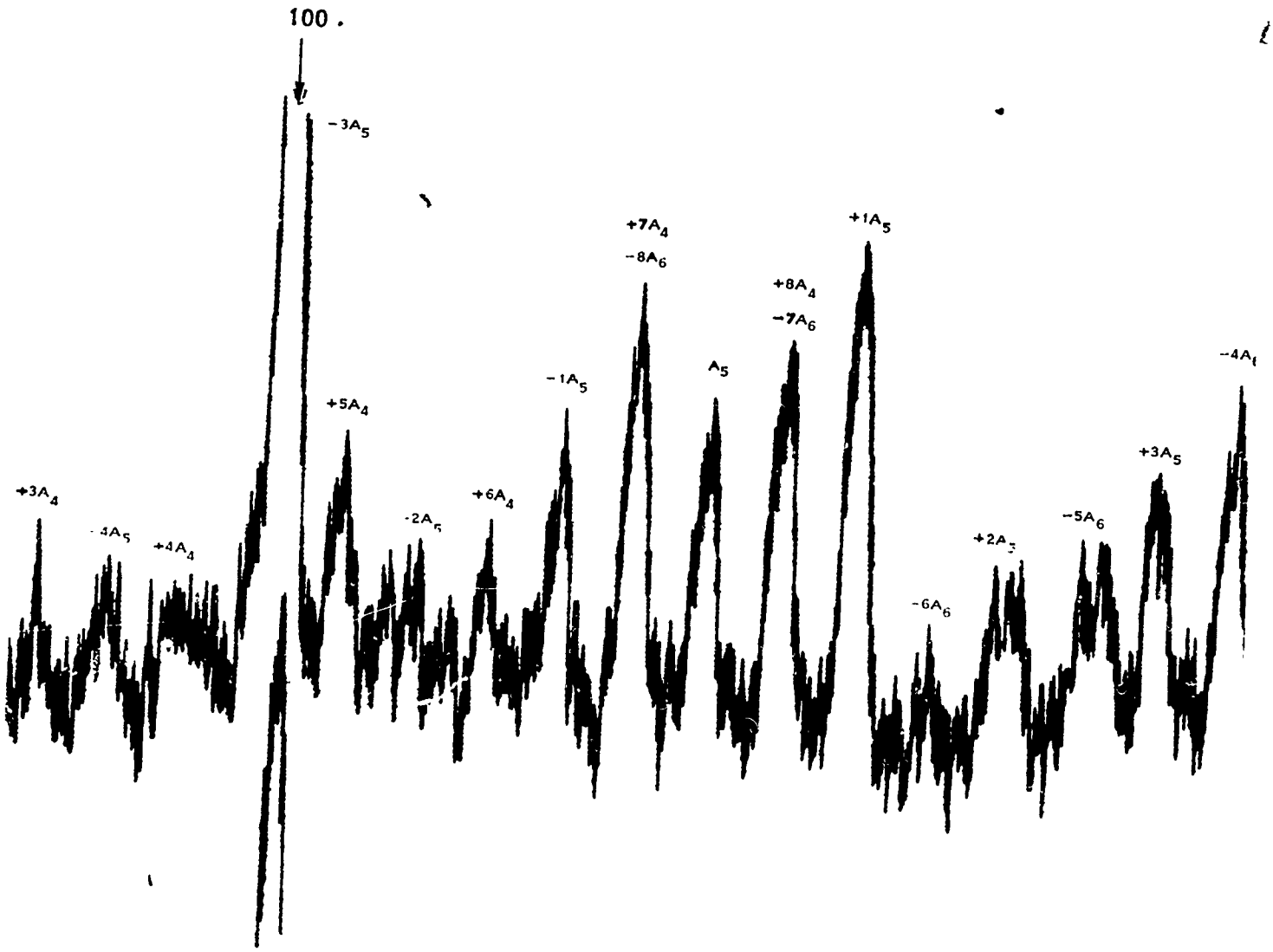
18c



FREQUENCY HZ

2500 3000

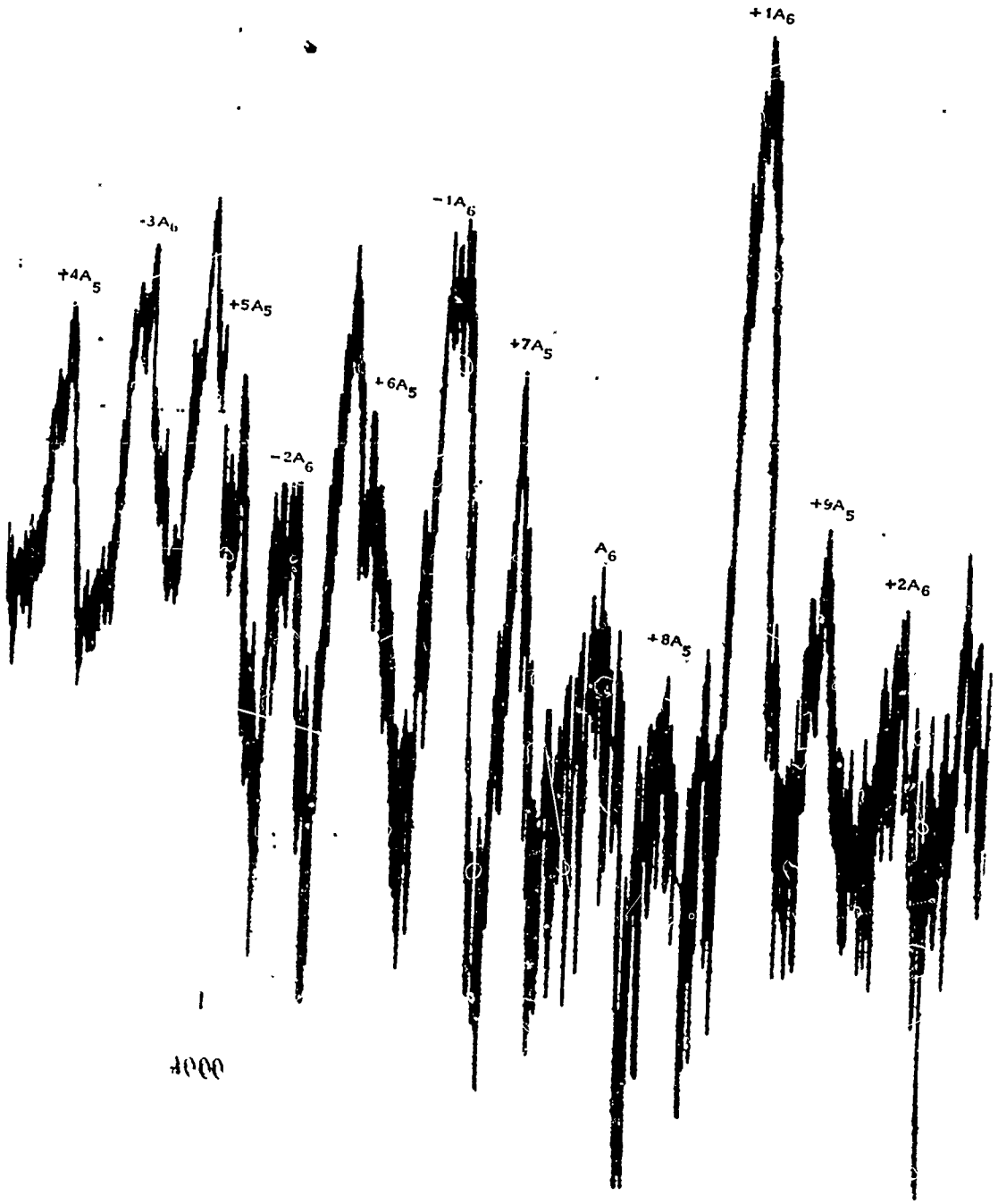
182


100 .
-3A5
+7A4
-8A6
+1A5
+8A4
-7A6
A5
-4A
-1A5
+5A4
+3A5
+3A4
+6A4
-2A5
-5A6
+2A5
-4A5
+4A4
-6A6

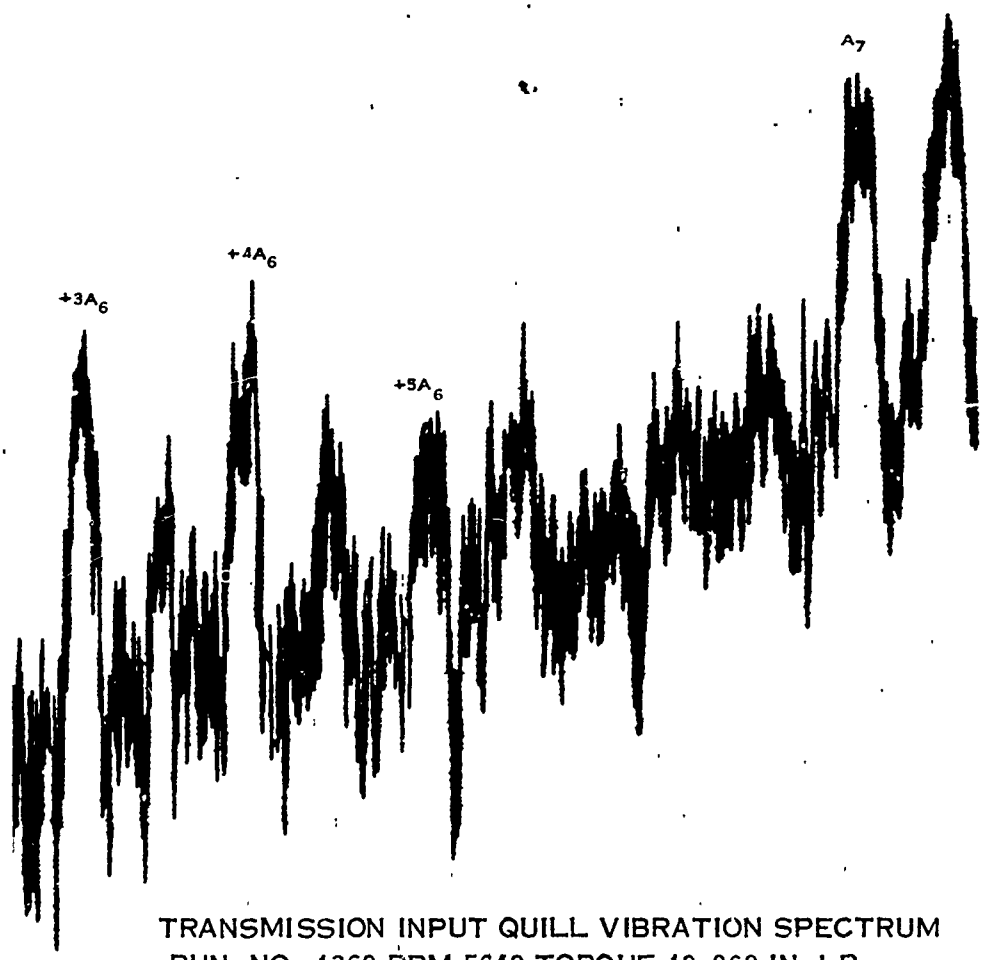
3500

3.10

18e



18



TRANSMISSION INPUT QUILL VIBRATION SPECTRUM
RUN NO. 1360 RPM 5640 TORQUE 10,860 IN-LB.
40 OPERATING HRS ON BEARING
DEFECTIVE INPUT QUILL BALL BEARING ASSY.
ANALYSIS BANDWIDTH 2.5 HZ PARAMETER NO. 125

4500 FIGURE 10-18 5000

18g