NASA CR 152055

(NASA-CR-152055) TEST DATA REPORT, LOW SPEED WIND TUNNEL TESTS OF A FULL SCALE LIFT/CRUISE-FAN INLET, WITH ENGINE, AT HIGH ANGLES OF ATTACK (Boeing Commercial Airplane Co., Seattle) 165 p HC A08/MF A01 CSCL 01A G3/02 N78-19049 Unclas 08587

TEST DATA REPORT, LOW SPEED WIND TUNNEL TESTS OF A FULL SCALE LIFT/CRUISE - FAN INLET, WITH ENGINE, AT HIGH ANGLES OF ATTACK

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January 1978

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Prepared under Contract No. NAS2-9640 by

The Boeing Commercial Airplane Company
Seattle, Washington 98125

for

AMES RESEARCH CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

1. Report No	2 Government Accession No	3 Recipient's Catalog No.
NASA CR 152055		

4. Title and Subtitle
Test Data Report, Low Speed Wind Tunnel Tests of a Full Scale Lift/Cruise-Fan Inlet, with Engine, at High Angles of Attack

5 Report Date
Jan 1978

6. Performing Organization Code

7 Author(s)
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8 Performing Organization Report No
T6-6145

9. Performing Organization Name and Address
Boeing Commercial Airplane Company
P. O. Box 3707
Seattle, Washington 98124

10 Work Unit No

11. Contract or Grant No
NAS2-9640

12 Sponsoring Agency Name and Address
National Aeronautical and Space
Administration Washington D.C. Zip 20546

13. Type of Report and Period Covered
Contractor Report

14 Sponsoring Agency Code

15 Supplementary Notes

16 Abstract

A low speed wind tunnel test of a fixed lip inlet with engine, was performed at NASA-Ames Research Center. The inlet was close coupled to a Hamilton Standard 1.4 meter, variable pitch fan driven by a Lycoming T55-L-11A engine. Tests were conducted with various combinations of inlet angle-of-attack (0-120°), freestream velocities (0-82 m/sec), and fan airflows (70-165 kg/sec-M^2). Data were recorded to define the inlet airflow separation boundaries, performance characteristics and fan blade stresses. The report includes descriptions of the test model, installation, instrumentation, test, data reduction and final data.

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17. Key Words (Suggested by Author(s))
High Angle-of-Attack
Low Speed Inlet Test
Variable Pitch Fan
High Bypass Ratio Fan Inlet

18 Distribution Statement

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21 No of Pages	22 Price*
Unclassified	Unclassified		

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-C-168 (Rev. 10-75)

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REFERENCES

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2. Syberg, J.; "Test Planning and Coordination Lift/Cruise Fan Inlet Test Program" Boeing Document D180-20725-1 dated July 1977.

3. Syberg, J; "Low Speed Tests of a High Bypass Ratio Propulsion System with an Asymetric Inlet Designed for a Tilt Nacelle VSTOL Airplane" Boeing Document D180-22888-1, November 1977, (NASA CR-152072 dated January 1978).

SUMMARY

A low speed wind tunnel test of a fixed lip inlet operating at high angles-of-attack was performed in the NASA-Ames Research Center (NASA-ARC) 12.2 X 24.4 meter wind tunnel (40 X 80 WT). The purpose of the test was to demonstrate total pressure recovery and distortion levels which result in acceptable fan/core engine stall margins and blade stress levels. These characteristics would be demonstrated when operating at combinations of high angles-of-attack, freestream velocities and engine airflows. The inlet was designed and built by Boeing, was asymmetric, with a contraction ratio varying from 1.30 (leeward) to 1.76 (windward). It was matched to a Hamilton Standard 1.4 meter (55") fan driven by a Lycoming T55-L-11A gas turbine engine. The test model (nacelle) was mounted on its side on a turntable, approximately 3.8 meters (12.6') above the wind tunnel floor.

The nacelle contained approximately 225 parameters measured/recorded by a Boeing supplied data system. Measurements were also made of the nacelle lift, drag, and side forces and the pitch, yaw and rolling moments. Key operational and monitoring parameters were also recorded in real time on magnetic tape recording systems. The model performance data were reduced on site into a semi-final form for test progress analysis and the tape recorded data were available for, if needed, historical analysis.

Tests were first run to define the inlet airflow separation boundaries as a function of angle-of-attack. An airflow and tunnel velocity was set and the model slowly pitched until separation occurred within the inlet. Data were recorded at discrete points approaching the separated conditions as defined by monitoring the dynamic pressure activity at the windward side of the fan face. Data were also recorded later defining the angle-of-attack and airflow hysteresis (attached/ separated/re-attached) characteristics. Following definition of the operating placard, tests were run at fixed angles of attack and velocity with varying airflow to define in detail the inlet performance characteristics.

The model occupied the wind tunnel for five weeks, three of which were required to repair the wind tunnel after a drive motor failure. Tests were done on a single shift basis and covered angle-of-attack ranges from 0 to 120 degrees, freestream velocities of 0 - 82 meters/sec (160 kts) and fan airflows of 70 - 165 kg/sec-M^2 (14 - 34 lb/sec-ft^2). Approximately 240 data conditions were recorded during 20 hours of engine operation. Included in the report are detailed descriptions of the model, installation, instrumentation and test procedures. Also included are the test, engine and instrumentation logs along with the final model performance and blade stress data.

INTRODUCTION

During the first part of 1976, The Boeing Aerospace Company, Military Airplane Development was awarded, by NASA-Ames Research Center, an inlet design contract in support of a multi-mission VSTOL airplane; contract NAS2-9215. The performance of a Boeing fixed lip inlet would be demonstrated on a Hamilton-Standard Q-Fan (TM) demonstrator/T-55 engine operating in a severe "angle-of-attack" environment provided by the 40 X 80 WT. Boeing was the prime contractor responsible for the inlet and nacelle design, fabrication and assembly, installation, wind tunnel test and data analysis. The responsibility for supplying the core engine/fan system along with its operation during test was sub-contracted to Hamilton-Standard (HS).

The main objective would be to demonstrate that a fixed lip inlet can provide adequate pressure recovery and distortion levels that result in acceptable core engine/fan stall margins and fan blade stress levels at combinations of large nacelle tilt angles, freestream velocities and engine airflow levels.

Initial testing in the wind tunnel began in July 1976. After several days of testing, a gear failure in the fan gearbox temporarily ended testing. The test was resumed, after gearbox repairs, in September of 1976. Again after several days of testing the same gear failed and severly damaged the core engine. The test was again stopped without acquiring enough data to meet the original objectives. Details of these tests were reported in Reference 1.

In June 1977, a new contract, NAS2-9640, was issued as a follow-on to complete the initially planned test series. The HS gearbox was analyzed, redesigned, remanufactured and verification tested to assure structural integrity. Testing was be resumed in the fall of 1977.

FACILITY

Testing was performed in the NASA-ARC Wind Tunnel. The Wind Tunnel has a closed 12.2 by 24.4 meter (40' X 80') test section with semi-circular sides of 6.1 meters (20') radii, and a closed circuit air return passage. The general arrangement is shown in Figure 1. Air is driven in the wind tunnel by six 12.2 meter (40') diameter fans which are powered by six, 6,000 horsepower electric motors. The tunnel operates with a stagnation pressure equal to atmospheric. The stagnation temperature varies from ambient upwards, due to the entrained products of combustion and the heat from the tunnel drive system.

INSTALLATION

A schematic of the test model, installed in the wind tunnel, is shown in Figure 2. The main wind tunnel model support struts were removed and the semi-span turntable installed for mounting the nacelle. The nacelle was bolted atop a Boeing designed pylon-strut which in turn was bolted to the turntable. This entire assembly was mounted "on balance" for measuring the model forces. A large fairing was designed and built to fit around the strut and turntable and mounted "off balance" to provide shielding from the Wind Tunnel air forces. The centerline of the nacelle was 3.84 meters (12.6') above the Wind Tunnel floor and located on the vertical centerplane of symmetry in the Wind Tunnel.

The center of the installation, or center of rotation, was at tunnel station 261.5. A model alignment check was done after installation and the model was determined to be 0.2° nose down at 0° angle of attack. No correction was made for this slight deviation from the horizontal.

The rotation of the semi-span turntable is in the horizontal plane (normal inlet yaw) and since the inlet was asymmetric the inlet was installed on its side, i.e., the 90° position on the inlet lip was up in the wind tunnel. This exposed the windward designed side of the inlet to the tunnel flow at angles of attack. Figure 3 shows the model installed in the wind tunnel.

The peripheral support equipment, other than the instrumentation systems, were mainly hydraulic and lubrication supply systems for the variable pitch fan. One high pressure pump, reservoir and cooler were located on the first floor, with a gear box lubrication supply and scavenging pump (2) located on the second floor. The high pressure pump supplied fluid for the fan blade pitch change and control system and the engine power lever position. The lube and scavenge pumps supplied and scavenged the fan gear box of lubrication oil. Fuel for the engine (JP-5) was supplied from the facility system.

The onboard fire system consisted of manifolded nozzles within the core engine cowling attached to two high pressure nitrogen bottles. In the event of an external engine fire the cavity inside the cowling would be filled with inert gas (N_2). More detailed information regarding the installation support equipment may be found in the Plan of Test, Reference 2.

MODEL

The test model, or nacelle, consisted of an inlet, a variable pitch fan, a gas turbine core engine, and the appropriate fairings, nozzles etc.

The inlet has a 1.469 meter (57.826") highlight diameter, a 1.2 meter (47.236") throat diameter and a 1.397 meter (55") fan face diameter. The inlet contours are asymmetric with the windward side (180°) having a higher contraction ratio than the leeward side (0°). The contraction ratio varies from 1.76 at 180° to 1.30 at 0°. At a given inlet station, both the internal and external contours are circular in cross section with offset centers. The inlet cowl was made of fiberglass.

The Hamilton-Standard Q-Fan (TM) demonstrator is a 1.397 meter (55"), 13 bladed, variable pitch fan which utilizes a Lycoming T55-L-11A, 3750 hp gas turbine as the core engine. The fan has 17:1 bypass ratio and is driven through a 4.75:1 gear reduction to a maximum speed of 3365 rpm. The fan system used a .645 meter (25.4") diameter "semi-elliptical" nose dome fairing. The fan exit nozzle was a simple, round, constant area, aluminum nozzle with an exit area of 1.064 sq. meters (1649 square inches). The core engine exit nozzle supplied with the engine, had an exit area of .254 sq. meters (394 square inches). A schematic of the inlet and nacelle showing the major components and station designations is shown in Figure 4.

INSTRUMENTATION

The test model instrumentation was divided into three groups: 1) Model performance, 2) Fan/engine operation and health and 3) Wind Tunnel condition. A brief description of each group follows:

Model Performance

INLET: The inlet contained 45 cowl surface static pressure ports, Figure 5, and seven fan face total pressure rakes (70 total pressures, 7 statics and 3 flush mounted total pressure transducers,) Figure 6. These rakes are also shown in the photograph, Figure 7. One flush mounted Kulite was located near the inlet throat at 180° in the cowl wall.

FAN DUCT: The fan duct had two rakes located just ahead of the fan nozzle exit, Figure 8. The rakes each contained 10 total pressures, 3 total temperature probes, one Prandtl-type static probe (two flush surface statics were also on the core engine cowling) and are shown in Figure 9.

CORE ENGINE: The core engine compressor face was instrumented with eight,6 probe total pressure rakes (44 total pressures and 4 flush mounted transducers), and 8 static pressure ports, Figure 10. Three total pressures and one static were located at 0° on the core compressor inlet lip, Figure 11.

Engine performance was determined by measuring N1, N2, and power shaft torque. The engine nozzle contained four static pressures, Figure 12.

Fan Engine Operation and Health Monitoring

INLET: Inlet performance was monitored on-line through use of one X-Y and two X-YY plotters. The X-Y plotter was used to monitor the fan face radial total pressure profile at 180° (rake No. 4). The two X-YY plotters were used for monitoring RMS peak-to-peak pressure dynamics versus model angle-of-attack or airflow; one plotter for two of the fan face/inlet Kulites and the other for two of the compressor face Kulites. All eight of the Kulites (PDF1-3; PDC1-4; PDS) were also visually monitored on RMS meters. Three of the seven fan face total pressure rakes were strain gaged near the root to monitor stress levels during testing.

FAN: Fan operation and health was monitored basically by RPM, blade angle, blade stress (5 blades were strain gaged) and vibration. In addition, the gearbox lube oil pressure, temperature and flow rate were displayed along with other key temperatures and vibrations. Several (6) proximeter probes, located in the fan gear box, were used to monitor spacial displacement of the sun and ring gears.

CORE ENGINE: The engine system contained all the normal monitor and control parameters, N1, N2, TT7, oil pressures, level and temperatures (various locations), vibration pickups, power lever angle and fuel supply pressures. In addition engine external structure and cowl cavity temperatures were displayed on panel meters.

The various temperature sensors, vibration pickups and proximeter probe locations used in monitoring the nacelle system operation are shown schematically in Figure 13.

Wind Tunnel

The Wind Tunnel instrumentation consisted of measuring the total pressure, dynamic pressure, and the total temperature. In addition the model lift, drag and side forces, pitch, yaw and rolling moments were measured by the facility balance system.

Data Systems

The various test parameters were recorded on several data systems. Model performance data on a Boeing steady state data acquisition system, wind tunnel and force information on the facility data system, fan operation and health on a HS tape recording system and select, representative parameters for system diagnostic studies, should they be needed, on a Boeing tape recording system. Engine operational parameters were also hand recorded on the engine logs.

The steady-state data acquisition system, Figure 14, consisted of the various sensors, signal conditioners and a Hewlett-Packard (HP) 3052A automatic digital data system. The HP 3052A contained a 40 channel scanner, digital voltmeter, programmable calculator/controller, line printer and a paper tape punch. Data were recorded on magnetic tape (casettes), punched paper tape and a line printout.

The various wind tunnel condition parameters and force balance data were recorded on the facility data system. These values were continuously displayed on-line and output on punched paper tape for each test condition.

The two tape recording systems were utilized for recording real-time data defining and/or monitoring critical operational/conditional parameters. Table 1 lists the various parameters recorded and their recording location. The HS system was used to record the fan blade strain gages (stress) and enough peripheral information to define operating conditions. This data was then used in developing the "Blade Stress Report" contained in Appendix A. These tapes were retained and stored by HS. A tape log of the contents of these tapes is also contained in the "Blade Stress Report". The main purpose of the Boeing tape recording system was to provide a real time record of the transient flow conditions within the fan and core engine. This data could then be used in analyzing any failure or anomalies which might occur during testing. The data, as of yet, has not been required for any analysis. The tapes remain stored at NASA-ARC. Tape logs of their identification, content and calibrations are contained in Appendix B.

A complete schematic of the data acquisition and monitoring system is shown in Figure 15.

DATA REDUCTION

The punched paper tapes from the Boeing steady-state data acquisition system and the wind tunnel data system were input to the NASA IBM 360 computer system. The data were calibrated, combined and then calculated for on-site, "short-turn-around" data. The original data tapes were then returned to Seattle for final editing, reprocessing, conversion to Standard International (S.I.) units and plotting. This data has been reproduced and is contained on microfiche as Appendix C.

The data were processed in Seattle with program PN026. The following pages list the basic equations and constants. Item numbers refer to the printout location shown in the "Data Sheet Format", Figure 16.

1. Test Number - Boeing Test Identification 2593. NASA-ARC Test 513

2. W/T inputs - V0 - Wind Tunnel Velocity - KTS; Alpha - Nacelle angle-of-attack-Degrees; Q-Dynamic pressure, PSF; PT0-Tunnel Total pressure psia; TT0 - Tunnel Total Temperature - °R; Tunnel Static pressure, psia P0 = PT0 - QPSF/144

3. Barometric Pressure - Reference pressure, psia: All recorded pressures were referenced to barometric PACTUAL = PBAR $\pm$ S/V reading.

4. Inlet corrected Airflow, lbs/sec

   WK1 = WK1A * 12.98

4a. $WK1A = 46.315*CDT/PTFA$, $lb/sec\text{-}ft^2$

CDT was obtained from model scale data where the inlet airflow was calibrated as a function of the average inlet throat static pressure PAV

PAV = (PC13 + PC33 + PC37 + PC38)/4PTO

PAV vs CDT - Table 2

PTFA = item 6

5. Inlet Airflow, lb/sec

$$W1 = WK1 * \delta_T / \sqrt{\theta_T}$$

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where

$$\theta_T = TT0/518.688$$

$$\delta_T = PT0/14.696$$

6. Fan face average total pressure recovery, area weighted.

PTFA = PTFAV/PTO

6a. $$PTFAV = 1/1869.12 \sum_{n=1}^{10} PTFR_n \, (A_n) \quad \text{psia}$$

$$PTFR = 1/7 \sum_{n=1}^{7} PTFX_n$$

6b. PTFXn = Individual fan face total pressures, number x,

An = Area Weighting factor

n	A-in^2	PTF-X
1	93.462	1, 11, 21, 31, 41, 51, 61
2	93.462	2, 12, 22, 32, 42, 52, 62
3	280.362	3, 13, 23, 33, 43, 53, 63
4	280.362	4, 14, 24, 34, 44, 54, 64
5	280.362	5, 15, 25, 35, 45, 55, 65
6	280.362	6, 16, 26, 36, 46, 56, 66
7	280,362	7, 17, 27, 37, 47, 57, 67
8	93.462	8, 18, 28, 38, 48, 58, 68
9	93.462	9, 19, 29, 39, 49, 59, 69
10	93,462	10, 20, 30, 40, 50, 60, 70

7. Fan face total pressure distortion

DISF = (PTFXMAX - PTFXMIN)/PTFAV

8. Fan duct airflow, lbs/sec

$$WF = \sum_{n=1}^{20} \frac{A_i \, P_{TM_n}}{\sqrt{518.688}\sqrt{\theta_F}} \left\{ \frac{2g\,\gamma}{R(\gamma-1)} \left[\left(\frac{PM}{PTM_n}\right)^{\frac{2}{\gamma}} - \left(\frac{PM_n}{PTM_n}\right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

$\gamma = 1.4015$

$g = 32.1741$ ft/sec^2

$R = 53.35$ ft-lb/lb°R

8a. PTM = Fan duct nozzle total pressure

8b. PM = Fan duct nozzle static pressure:

$$\text{for } 1 \leq n \leq 10 = (PM2-PM)\left(\frac{R_n - 18.61}{10.65}\right) + PM2, \; R_n = \underset{18.91}{\overset{28.73}{\uparrow}}$$

$$\text{for } 11 \leq n \leq 20 = (PM4-PM3)\left(\frac{R_n - 18.61}{10.65}\right) + PM4$$

$A_i = f(PTM_n)$

n	A_i - in^2	Radius
1,11	117.1	28.73
2,12	110.5	27.4
3,13	99.8	26.16
4,14	90.7	24.98
5,15	82.5	23.86
6,16	75.	22.79
7,17	68.4	21.77
8,18	63.5	20.78
9,19	58.5	19.83
10,20	60.2	18.91

8c. $$F = \left(\frac{1}{6} \sum_{n=1}^{6} TTM_n\right)/518.688$$

TTM = fan duct nozzle total temperature

9. Fan duct corrected airflow, lbs/sec

$$WKF = WF * \sqrt{\theta_F} / \delta_F$$

where δ_F = PTMAV/14.696

9a. $$PTMAV = .992 \left[\frac{1}{1649} \sum_{n=1}^{10} \left(\frac{PTM_n + PTM_{n+10}}{2} \right) A_n \right] \quad \text{psia}$$

A_n = two times the values shown in A_i (8b) table, for values $1 \leq N \leq 10$

10. Core engine compressor face airflow, lb/sec

$$WE = \sum_{n=1}^{8} WER_n$$

$$WER = \frac{16.96 * PTCAR_n}{\sqrt{TTC}} \left\{ \frac{2g\ \gamma}{R(\gamma - 1)} \left[\left(\frac{PSC_n}{PTCAR_n} \right)^{\frac{2}{\gamma}} - \left(\frac{PSC_n}{PTCAR_n} \right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

PTCAR = The individual core engine rake average pressure.

10a. TTC = Core engine compressor face total temperature, °R

10b. PSC_n = Core engine compressor face static pressure aligned with each core engine rake arm.

11. Core engine compressor face corrected airflow.

$$WKE = WE * \sqrt{\theta_E} / \delta_E$$

θ_E = TTC/518.688

δ_E = PTCAV/14.696

11. Continued

PTCAV = Area weighted average total pressure at the compressor face, psia

$$= \sum_{n=1}^{48} \frac{PTC_n}{48}$$

11a. PTC = Individual total pressures (48) at the core engine compressor face

12. Area weighted average total pressure recovery, core engine compressor face.

PTCA = PTCAV/PTO

13. Core engine compressor face total pressure distortion

DISC = (PTCMAX - PTCMIN)/PTCAV

14. Core engine horsepower

$EP = 2\pi * ET * N2/33000$

14a. where ET = Core engine torque (Table 2)

N2 = Power turbine speed

15. Corrected core engine nozzle thrust - table look-up (Table 2), lb_f FKN vs. corrected engine horsepower (CP)

$$CP = EP/(\sqrt{\theta_E} * \delta_E)$$

16. Core engine nozzle thrust, lb_f

$$FN = FKN * \delta_E$$

17. Core engine nozzle exit velocity, ft/sec

VN = FN * (g/WE) + FF

where FF is a table look-up (Table 2)
FF vs. KN1
KN1 = Corrected compressor speed, N1.

18. Calculated inlet airflow, lb/sec

$$W2 = \sum_{n=1}^{70} \frac{A*PTF_n}{\sqrt{TTO}} \left\{ \frac{2g\,\gamma}{R(\gamma-1)} \left[\left(\frac{PPA}{PTF_n}\right)^{\frac{2}{\gamma}} - \left(\frac{PPA}{PTF_n}\right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

18. Continued

$A = A_n/7$ (from the A_n table used in the calculation of PTFAV)

PPA = Interpolated average static pressure for each fan face total pressure probe.

$$= \frac{(PCz - PPy) * (RA - 13.797)}{13.703} + PPy \qquad RA \quad \begin{matrix} 27.228 \\ \uparrow \\ 13.237 \end{matrix}$$

18a. PC = Inlet cowl compressor face static pressure

18b. PP = Fan face rake prandtl static pressure

N	z	y
$1 \leq n \leq 10$	39	1
$11 \leq n \leq 20$	40	2
$21 \leq n \leq 30$	41	3
$31 \leq n \leq 40$	42	4
$41 \leq n \leq 50$	43	5
$51 \leq n \leq 60$	44	6
$61 \leq n \leq 70$	45	7

19. Calculated inlet corrected airflow, lb/sec

$$WK2 = W2 * \sqrt{\theta_T} / \delta_T$$

20. Total fan face airflow (calculated), lb/sec

$$W3 = WF + WE$$

21. Fan pressure ratio

$$FPR = PTMAV/PTFAV$$

22. Fan duct exit velocity, ft/sec

$$VM = \left\{ 2gR \left(\frac{\gamma}{\gamma-1}\right) * TTMAV \left[1 - \left(\frac{PMAV}{PTMAV}\right)^{\frac{\gamma-1}{\gamma}} \right] \right\}^{1/2}$$

TTMAV = Average fan duct nozzle total temperature

$$TTMAV = \frac{1}{6} \sum_{n=1}^{6} TTM_n$$

PMAV = Average fan duct nozzle static pressure.

$$1/4 \sum_{n=1}^{4} PM_n$$

23. Corrected compressor speed, rpm

$$KN1 = N1/\sqrt{\theta_E}$$

24. Corrected power turbine speed, rpm

$$KN2 = N2/\sqrt{\theta_E}$$

25. Fan inlet cowl surface Mach number

$$MC_n = \left\{ \frac{2}{\gamma - 1} \left[\left(\frac{PTO}{PC_n} \right)^{\frac{\gamma - 1}{\gamma}} - 1 \right] \right\}^{1/2} \qquad n = PC1 \text{ thru } 45$$

26. Force Balance (reference Figure 17)

FX = Nacelle drag force, lb_f QX = Nacelle roll moment, ft. lb_f

FY = Nacelle lift force, lb_f QY = Nacelle yaw moment, ft. lb_f

FZ = Nacelle side force, lb_f QZ = Nacelle pitching moment, ft.

FXY = Resultant nacelle axial force = $(FX*FX+FY*FY)^{1/2}$, lb_f

27. Fan blade angle b - degrees 43°-170°

28. Core engine power lever angle - degrees 0-100°

29. Fan and compressor face. Kulite pressures - RMS PSI/PTO

30. Steady state data acquisition system measured tunnel total and static pressure and total temperature (for use as a backup)

Note: Individual pressure measurements tabulated on data sheets (items 6b, 8a, 8b, 10b, 11a, 18a, 18b, 25a,) are ratioed to PTO.

31. Core engine exhaust gas temperature °R.

In addition to the Max minus Min-over-average distortion for the core engine, an "Allison Distortion Index" was calculated from the compressor face total pressure data. This data were output on a separate page. The index is calculated using the following procedure. First the rake average total pressure for each of the eight rake arms are calculated. Next the rake average pressures for 12 imaginary arms are calculated. These pressure have the following relationship to the actual recorded pressures.

Imaginary Rake No. (A) = 5/6 of the average of Actual Rake No. (B) + 1/6 of the average of Actual Rake No. (C)

Rake No. (A)	Rake No. (B)	Rake No. (C)
1 (30 deg)	8	1
3 (90 deg)	7	6
4 (120 deg)	6	7
6 (180 deg)	5	4
7 (210 deg)	4	5
9 (270 deg)	3	2
10 (300 deg)	2	3
12 (360 deg)	1	8

Imaginary Rake No. (A') = 1/2 [Average of Actual Rake No. (B') + Average of Actual Rake No. (C')]

Rake No. (A')	Rake No. (B')	Rake No. (C')
2 (60 deg)	7	8
5 (150 deg)	5	6
8 (240 deg)	3	4
11 (330 deg)	1	2

From these rake average pressures, the twelve contiguous 120 degree sector average pressures are calculated. The minimum 120 degree sector is then located from this array.

The average compressor face total pressure (PTCAV) is calculated as the arithmetic average of the original 48 recorded pressures. Since ring number 3 lies close to the radius that separates the outer 40 and inner 60 percent of the total compressor face area the outer 40 percent average total pressure (PTCRPA) is calculated as the arithmetic average of rings 1-3 and inner 60 percent total pressure (PTCRFA) as the arithmetic average of rings 3-6. Radial total pressure distortion is then calculated as

$$KR = PTCRPA - PTCRFA/PTCAV$$

The circumferential total pressure distortion is calculated as

$$KTHETA = PTCAV_{240} - PTCAV_{120}/PTCAV_{360}$$

The composite distortion index is calculated as

$$KCOMP = (KR^2 + KTHETA^2)^{1/2}$$

All of the data were calculated using the formula and definitions in the preceeding pages. All constants, etc. were in English units. The final conversion to SI units was done by a multiplication factor applied to the computed or calibrated English value. These conversion factors are listed in Table 2.

TEST PROCEDURE

Testing was done on second shift, with first shift being utilized for troubleshooting and model maintenance. For safety considerations, due to the previous experiences with the test model, engine running was not permitted before 5:00 p.m. At the beginning of each day's testing and/or run startup the data systems were all check calibrated and adjusted for the proper barometric readings. A wind-off zero was taken on the force measuring system. The following general sequence was then followed:

1. Start Wind Tunnel into the synchronizing mode.
2. Start fan gearbox scavenging pump.
3. Start fan gearbox lubrication pump.
4. Start fan blade and PLA control hydraulic pressure pump.
5. A final inspection of the facility and model test systems was completed.
6. The tape recorders were turned on.
7. The engine was started.
8. The Wind Tunnel access door was closed.
9. The Wind Tunnel was then brought on-line.
10. The engine was left at idle power until the Wind Tunnel speed was within approximately 60% of the end value. The engine/fan system was set at an intermediate-to-high power setting (usually around N_2 = 12000 rpm) and the nacelle was yawed to the desired angle-of-attack. The engine and wind tunnel were then trimmed to the required setting.
11. After 20-40 seconds stabilization time data were recorded on both the wind tunnel and steady-state data systems. (The tape recorders were left on-continuously during testing and each run/condition number was announced on the tape.)
12. The model was then reset to a new angle of-attack and/or the air/flow was changed for the next condition number.

Detailed logs were kept during testing defining the wind tunnel, fan-engine, and data conditions. These logs are included as Appendix D and include "Test Logs", "Engine Logs", and "Tape Record Logs". Detailed information noting the pertinent parameters and any erroneous or peculiar data or conditions are recorded.

TEST RESULTS

The test nacelle was assembled and instrumented in Seattle in July, August, 1977. A functional check of the data systems was also performed at this time. The model was shipped from Seattle, completely ready to install in the wind tunnel. Wind tunnel occupancy began on September 12, 1977, with testing beginning on September 16. After a "static conditions" airflow sweep (full power to idle power) testing were done to define the low airflow inlet separation boundaries with varying angle-of-attack. The airflow (fan rpm, Blade angle) was set a constant value and the nacelle was rotated (increasing alpha) until airflow separation occured within the inlet. This was determined by on-line monitoring of the windward side fan face total pressure profile and the dynamic pressure fluctuations. This was done at nominal tunnel velocities of 20, 38, 46, 54, 64, 72 and 82 meters/sec (40, 75, 90, 105, 125, 140 and 160 kts). These tests were then followed by more definative testing at a fixed angle-of-attack and velocity with varying airflow rates.

On September 23, 1977, testing was interrupted by a failure in one of the tunnel main drive motor/generator sets. The repair took approximately three weeks and testing resumed on October 13, 1977. The test was finished on October 15, 1977. During the latter portion of testing data were recorded with the airflow separated to the inlet lip providing none of the prescribed system limits or stresses were exceded during the time-on-condition. Prior to this, time data had been recorded only up-to-near lip separation. The hysteries characteristics of these separated airflow conditions were evaluated both by increasing/decreasing angle-of-attack and decreasing/increasing rpm (separated/attached). A detailed analysis of the data, inlet performance characteristics and specific test results may be found in Reference 3. Table 3 summarizes the conditions, velocity and angles-of-attack tested and the applicable test run numbers.

TABLE 1
MAGNETIC TAPE/DATA RECORDING CHANNEL ASSIGNMENTS

PARAMETER	TAPE TRACK	
Boeing Tape Recording System		
Fan Face Dynamic Pressure PDF1	1	
Fan Face Dynamic Pressure PDF2	2	
Fan Face Dynamic Pressure PDF3	3	
Cowl Static Dynamic Pressure PDS	4	
Compressor Face Dynamic Pressure PDC1	5	
Compressor face dynamics pressure PDC2	6	(Reels 1-6)
Model Angle of Attack α	6	(Reels 7-11)
Compressor face dynamic pressure PDC3	7	
Compressor face dynamic pressure PDC4	8	
Fan Blade Strain Gage	9	
Fan Blade Strain Gage	10	
Power Turbine Speed N_2	11	
Fan Blade Angle β	12	
Fan Face Pressure Rake Stress	13	
IRIG "B" Time Code	14	
VOICE	EDGE TRACK	
Hamilton Standard Tape Recording System		
Fan Blade Stress #1 Bending	1	
Fan Blade Stress #6 Bending	2	
Fan Blade Stress #7 Bending	3	
Fan Blade Stress #2 Vee	4	
Fan Blade Stress #9 Vee	5	
Fan gear vibration fore &aft	6	
Fan gear vibration lat.	7	
N_2/Sta. MPX #1	8	
Sta. MPX #2	9	
Torque	10	
Fan Blade Angle	11	
Fan Speed - 1P	12	
Voice		
Proximity Probe #1 - Ring gear	1	Multiplexed
" #4 - Ring gear	2	Multiplexed
" #7 - Retaining Nut	3	Multiplexed
" #6 - Sun gear	4	Multiplexed
" #10 - Retaining Nut	5	Multiplexed
Gearbox vibration vertical	7	Multiplexed
Gearbox vibration vertical	9	Multiplexed
Inlet vibration vertical	10	Multiplexed
Inlet vibration horizontal	11	Multiplexed
Proximity probe #9 Sun gear	12	

TABLE 2

LIFT/CRUISE - FAN INLET TEST, DATA REDUCTION TABLES

Inlet Corr. Airflow Vs. Calibration Pressure

PAV	CDT
.55	.961
.60	.937
.65	.904
.70	.860
.75	.806
.80	.739
.85	.654
.90	.546
.925	.478
.950	.390
.975	.250
1.0	0

Engine Torque Vs. Torquemeter Indication

Indication % of 1300 lb-ft	ET inch-lb
10	1550
15	2350
20	3150
25	3900
30	4600
35	5300
40	5900
45	6550
50	7150
55	7750
60	8350
65	9000
70	9650
75	10350
80	11150
85	12000
90	13000
95	14150
100	15450

Corrected Fuel Flow vs. Corr. Engine Speed

$N^1/\sqrt{\theta}$ %18720 RPM	$WF/\delta\theta^{.712}$ lb/hr
55%	340
60	390
65	450
70	520
75	620
80	750
85	940
90	1220
95	1620
100	2120

Corrected Thrust Vs. Corr. Power

EPK hp	FKN lb
0	0
200	30
400	53
600	73
800	91
1000	108
1200	123
1400	138
1600	152
1800	165
2000	178
2200	191
2400	203
2600	215
2800	226
3000	238

S.I. Conversion Constants

From	To	Multiply By
KTS	M/SEC	.5144
FPS	M/SEC	.3048
lb/ft^2	BAR	.0004788
lb/in^2	BAR	.068948
lb/sec	Kg/sec	.45359
°R	°K	.55556
$ft\text{-}lb_f$	Newton-Meters	1.356
lb_f	Newton	4.448
HP	KW	.7457
$lb/sec\text{-}ft^2$	$Kg/Sec\text{-}M^2$	4.8826

TABLE 3 SUMMARY OF TEST CONDITIONS

Run Number	Velocity M/Sec	(KTS)	Angle-of-Attack Degrees	No. of Airflows
3	0	(0)	0	6*
4	20.6	(40)	90 - 120	Const. (1)**
29	"		90	3
30	"		120	9
23	30.9	(60)	75	5
24	"		90	7
25	"		105	7
5	38.6	(75)	70 - 94	Const. (3)
9	"		0	5
38	"		20	3
10	"		60	5
11	"		75	6
13	"		90	12
31	46.3	(90)	70 - 81	Const. (1)
26	"		60	8
27	"		75	9
28	"		90	5
6	54.1	(105)	50 - 95	Const. (4)
12	"		0	5
37	"		20	3
14	"		60	7
15-16	"		75	6
32	64.4	(125)	48 - 84	Const. (5)
17	"		60	8
7	72.1	(140)	40 - 68	Const. (5)
18-19	"		0	9
35	"		20	3
20	"		45	17
36	"		60	5
33	"		70 - 71	Const. (1)
34	82.4	(160)	39 - 63	Const. (4)

* Airflow was usually varied between nominal values of 73.2 kg/sec M^2 (15 lb/sec ft^2) and 166 Kg/sec M^2 - (34 lb/sec ft^2).

** Constant airflow conditions with varying angle of attack
( ) = Number of airflows at which an alpha sweep was done

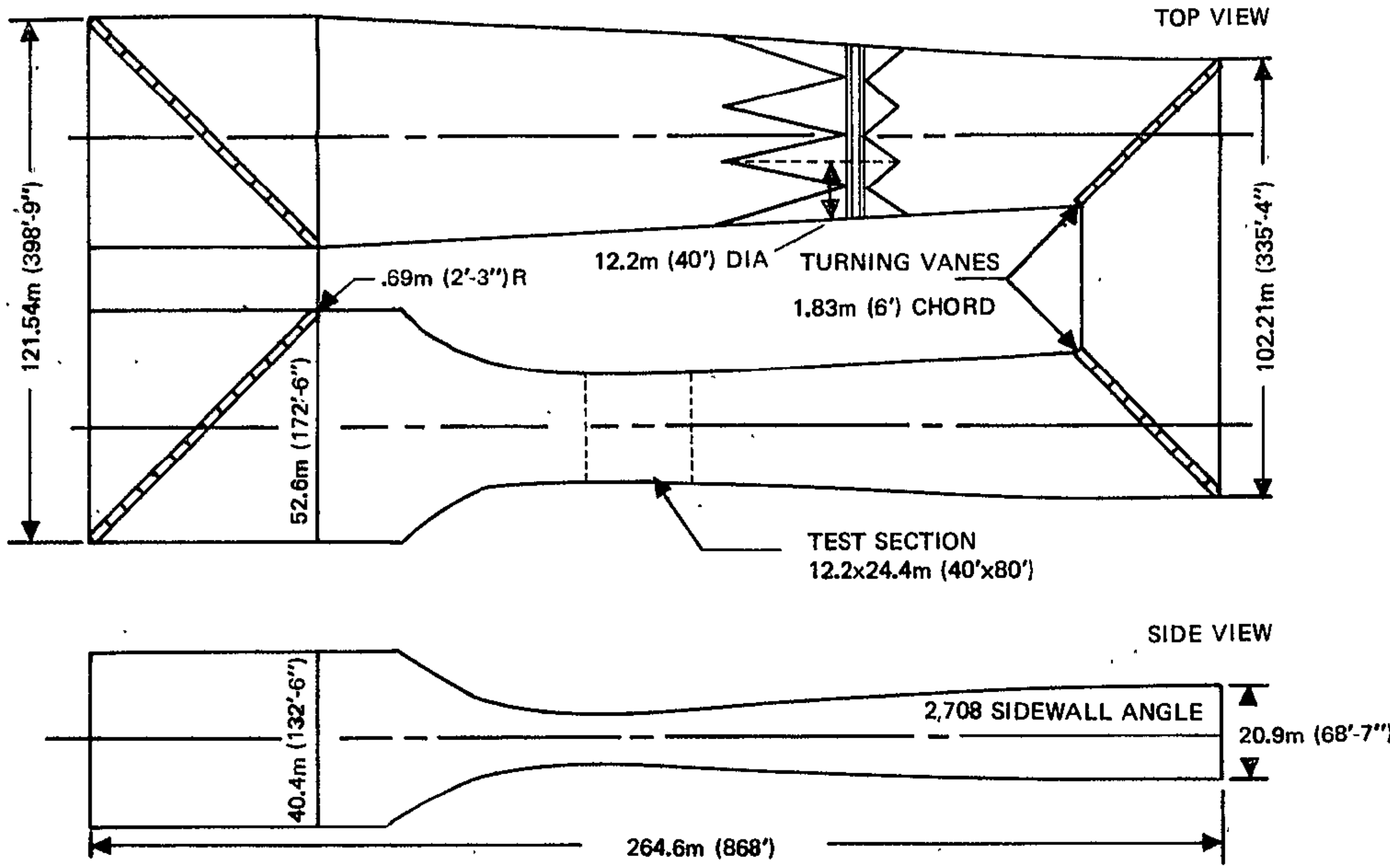


Figure 1 . Ames 40x80 Foot Wind Tunnel (12.2mx24.4m)

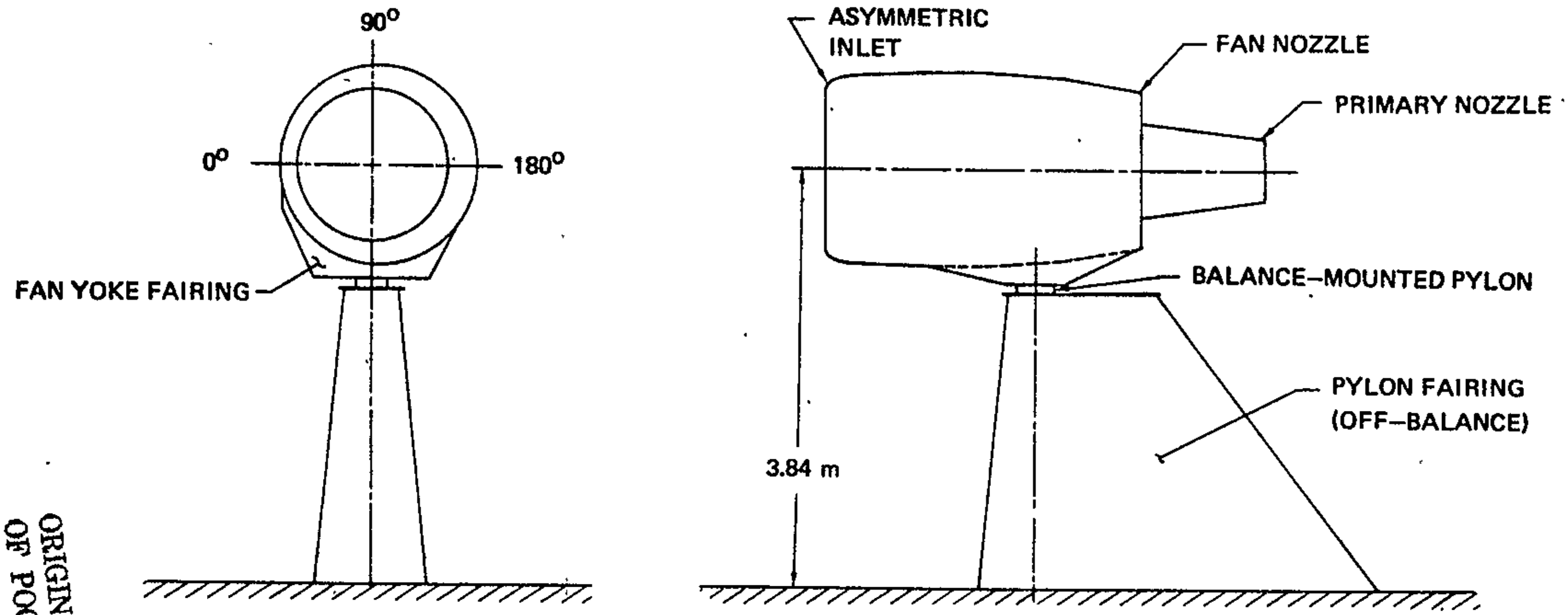
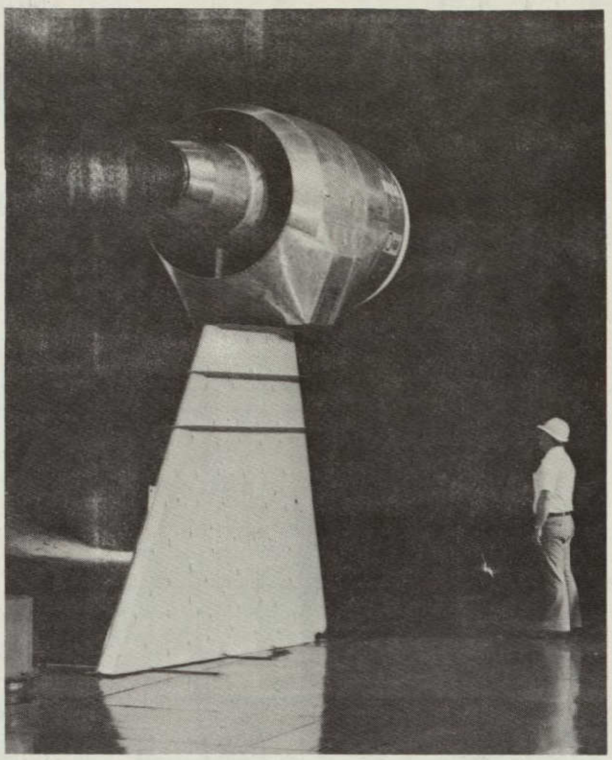
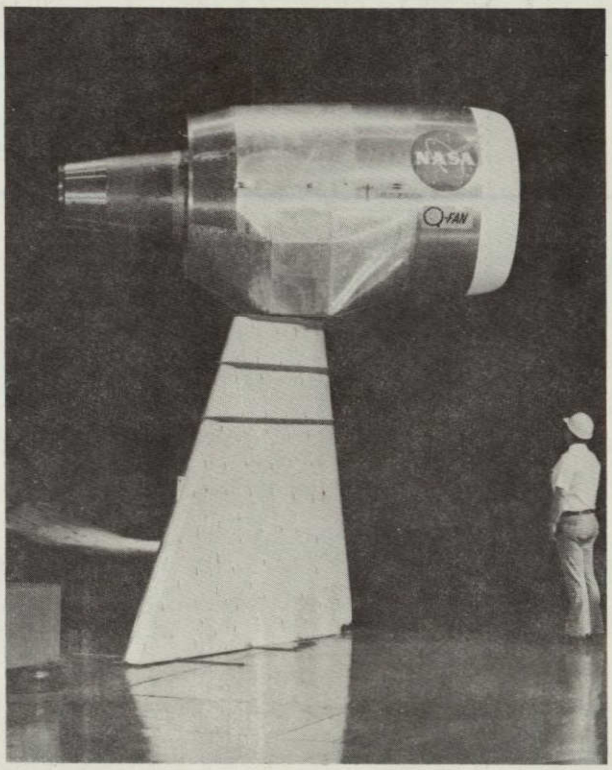


Figure 2. Wind Tunnel Installation Schematic

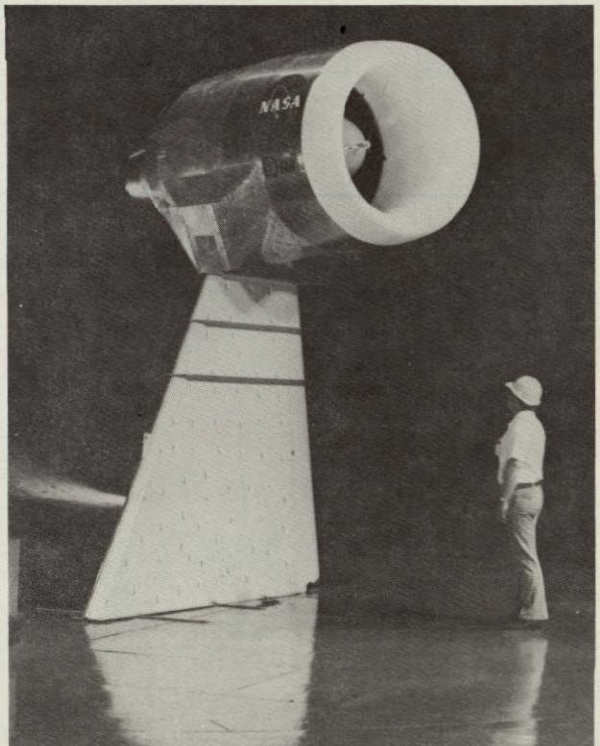


AFT VIEW $\alpha = 0^{\circ}$

FRONT VIEW $\alpha \cong 30^{\circ}$



$\alpha = 60^{\circ}$



$\alpha = 120^{\circ}$

Figure 3. Model Installation

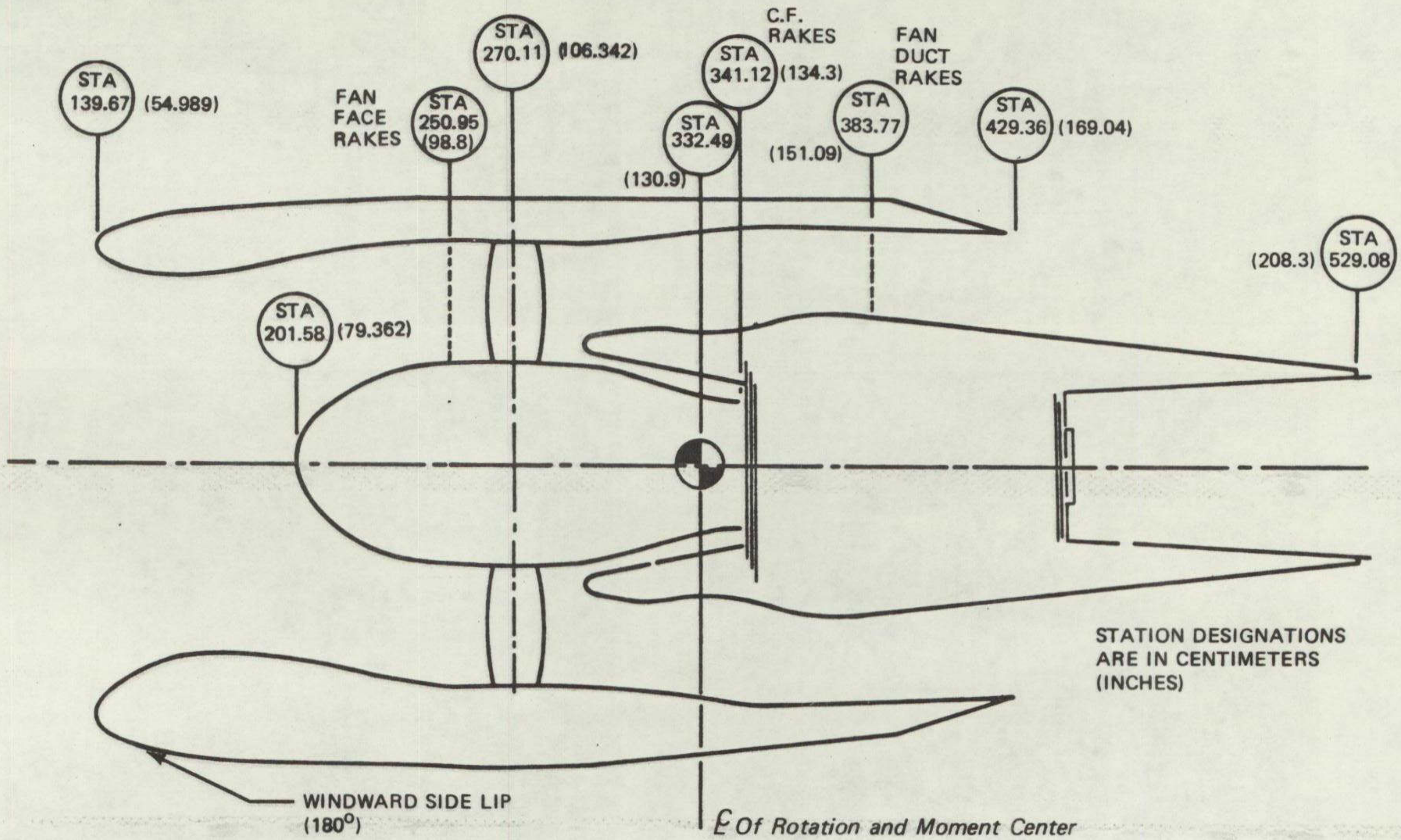


Figure 4. Nacelle Schematic

P_C NO.	LEEWARD (0°) COWL STATIC PRESSURES X/R_{FAN}	R_L/R_{FAN}	S/R_{FAN}
1	.1242	1.0650	-.1628
2	.0466	1.0300	-.0775
3	.0137	1.0036	-.0352
4	.0021	.9844	-.0127
5	0	.9719	0
6	.0007	.9640	.0079
7	.0042	.9519	.0205
8	.0109	.9399	.0343
9	.0209	.9280	.0499
10	.0500	.9057	.0865
11	.1048	.8810	.1468
12	.1817	.8620	.2261
13	.2987	.8524	.3436
14	.4445	.8573	.4895
15	.5954	.8709	.6410
16	.8136	.9011	.8613
17	1.0317	.9368	1.0824
18	1.3590	.9836	1.4130

P_C NO.	WINDWARD (180°) COWL STATIC PRESSURES X/R_{FAN}	R_L/R_{FAN}	S/R_{FAN}
19	.1242	1.2602	-.1932
20	.0466	1.2227	-.1067
21	.0137	1.1849	-.0563
22	.0021	1.1527	-.0220
23	0	1.1308	0
24	.0007	1.1183	.0125
25	.0042	1.0999	.0313
26	.0109	1.0811	.0513
27	.0209	1.0619	.0729
28	.0500	1.0244	.1204
29	.1048	.9781	.1923
30	.1817	.9342	.2809
31	.2936	.8927	.4003
* 32	.4445	.8619	.5545
33	.5954	.8524	.7058
34	.8136	.8691	.9248
35	1.0317	.9084	1.1465
36	1.3590	.9741	1.4803

P_C NO.	SIDE COWL STATIC PRESSURES X/R_{FAN}	R_L/R_{FAN}	Θ
37	.4982	.8588	90°
38	.4982	.8588	270°

*STEADY STATE & DYNAMIC PICKUP (FLUSH MOUNTED KULITE, PDS)

P_C NO.	FAN FACE COWL STATIC PRESSURES X/R_{FAN}	R_L/R_{FAN}	Θ
39	1.5931	≅ 1.0	15.7°
40	↓	↓	67.1
41			118.6
42			170.0
43			221.4
44			272.9
45			324.3

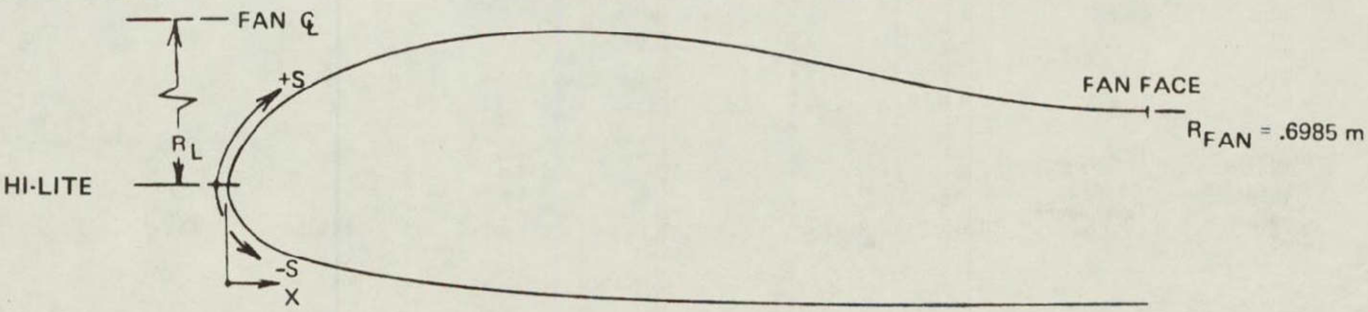


Figure 5. Cowl Static Pressure Instrumentation

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FAN FACE RAKE PROBE COORDINATES

AND NUMBERING

	RAKE 1	RAKE 2	RAKE 3	RAKE 4	RAKE 5	RAKE 6	RAKE 7	RING RADIUS R/R_{FAN}	% AREA FOR RING
RING 1	PTF 1	PTF 11	PTF 21	PTF 31	PTF 41	PTF 51	PTF 61	.9901	5%
RING 2	2	12	22	32	42	52	62	.9700	5%
RING 3	3	13	23	33	43	53	63	.9286	15%
RING 4	4	14	24	34 [1]	44	54	64	.8627	15%
RING 5	5	15	25	35	45	55	65	.7914	15%
RING 6	6	16	26	36	46	56	66	.7129	15%
RING 7	7	17	27	37	47	57	67	.6247	15%
RING 8	8	18	28	38	48	58	68	.5582	5%
RING 9	PTF 9	PTF 19	PTF 29	PTF 39 [2]	PTF 49	PTF 59	PTF 69	.5218	5%
	PP1	PP2	PP3	PP4	PP5	PP6	PP7	.5017	--
RING 10	PTF10	PTF 20	PTF 30	PTF 40 [3]	PTF 50	PTF 60	PTF 70	.4813	5%
RAKE ANGLE (deg)	25.7	77.1	128.6	180.0	213.4	282.3	334.3		

1 PDF 1
2 PDF 2
3 PDF 3

} Dynamic total pressure probe mounted side by side with steady state probe

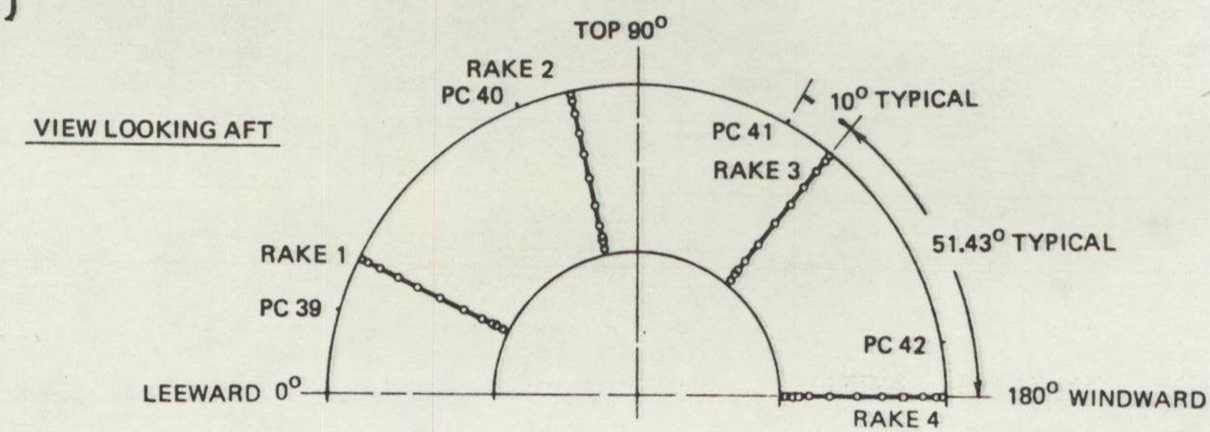

Figure 6 Fan Face Instrumentation

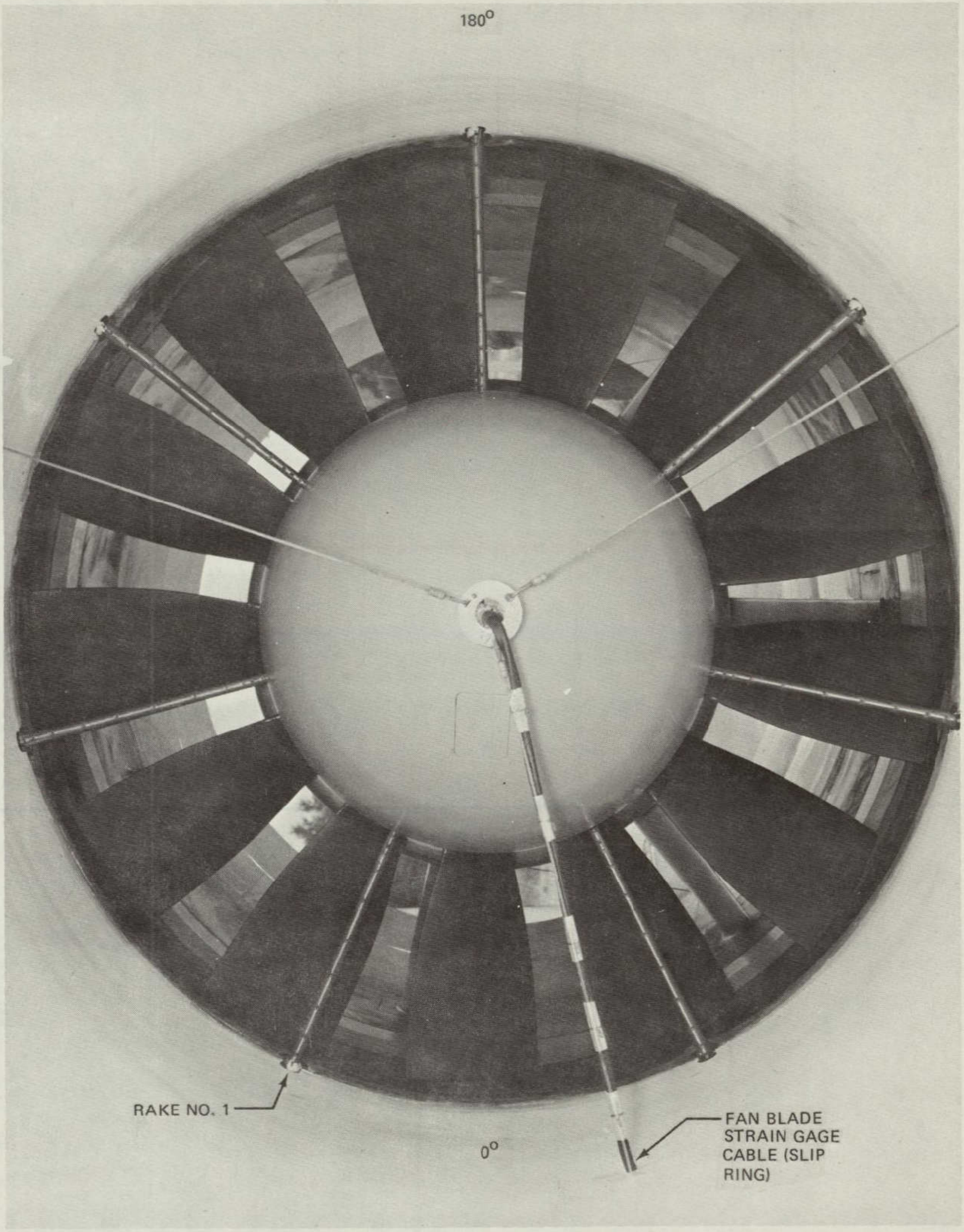

Figure 7 Fan Face (Front View)

0° PROBES	180° PROBES	RADIUS R/R_{FAN}	ΔA/AR
NOZZLE WALL	NOZZLE WALL	1.0676	
PM1	PM3	1.0640	
PTM1	PTM11	1.0447	.142
PTM2	PTM12	.9964	.134
TTM1	TTM4	.9738	
PTM3	PTM13	.9513	.121
PTM4	PTM14	.9084	.110
PTM5	PTM15	.8676	.100
PTM6	PTM16	.8287	.091
TTM2	TTM5	.8102	
PTM7	PTM17	.7916	.083
PTM8	PTM18	.7556	.077
PTM9	PTM19	.7211	.071
TTM3	TTM6	.7044	
PTM10	PTM20	.6876	.073
CORE CASE	CORE CASE	.6676	

ΔA: Area assigned to total pressure probe

AR: Flow area at rake face = 1.064 m^2

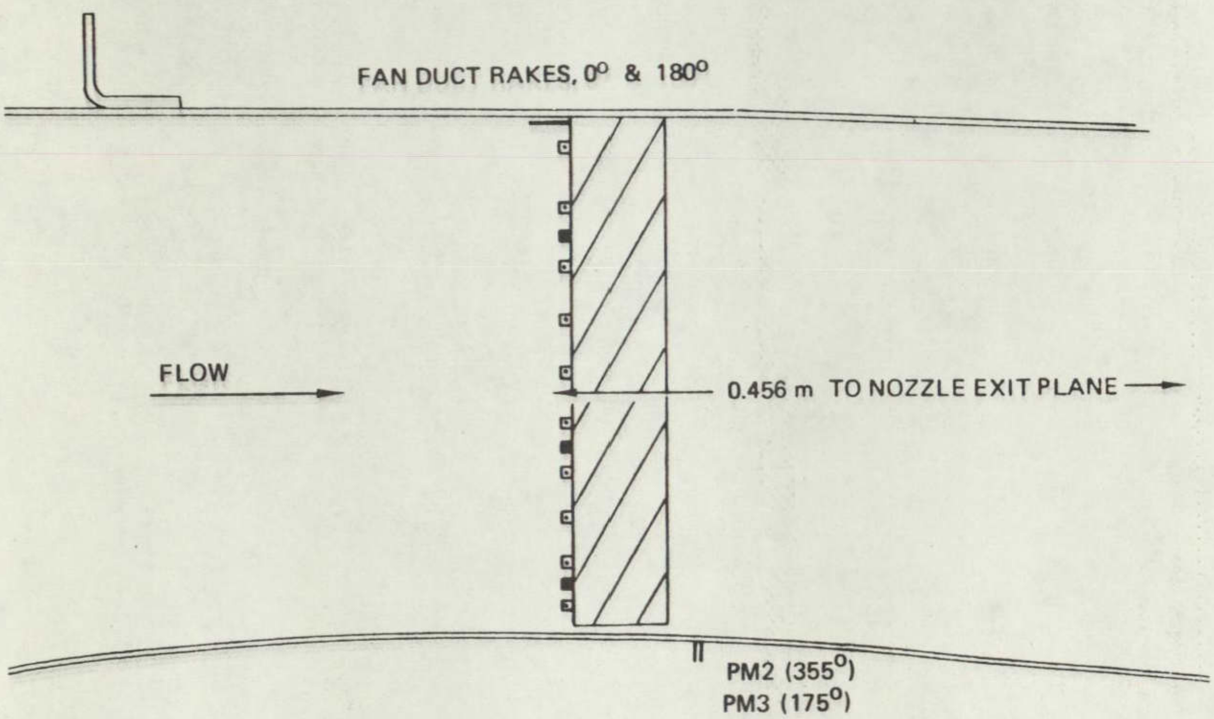

Figure 8. Fan Duct Instrumentation

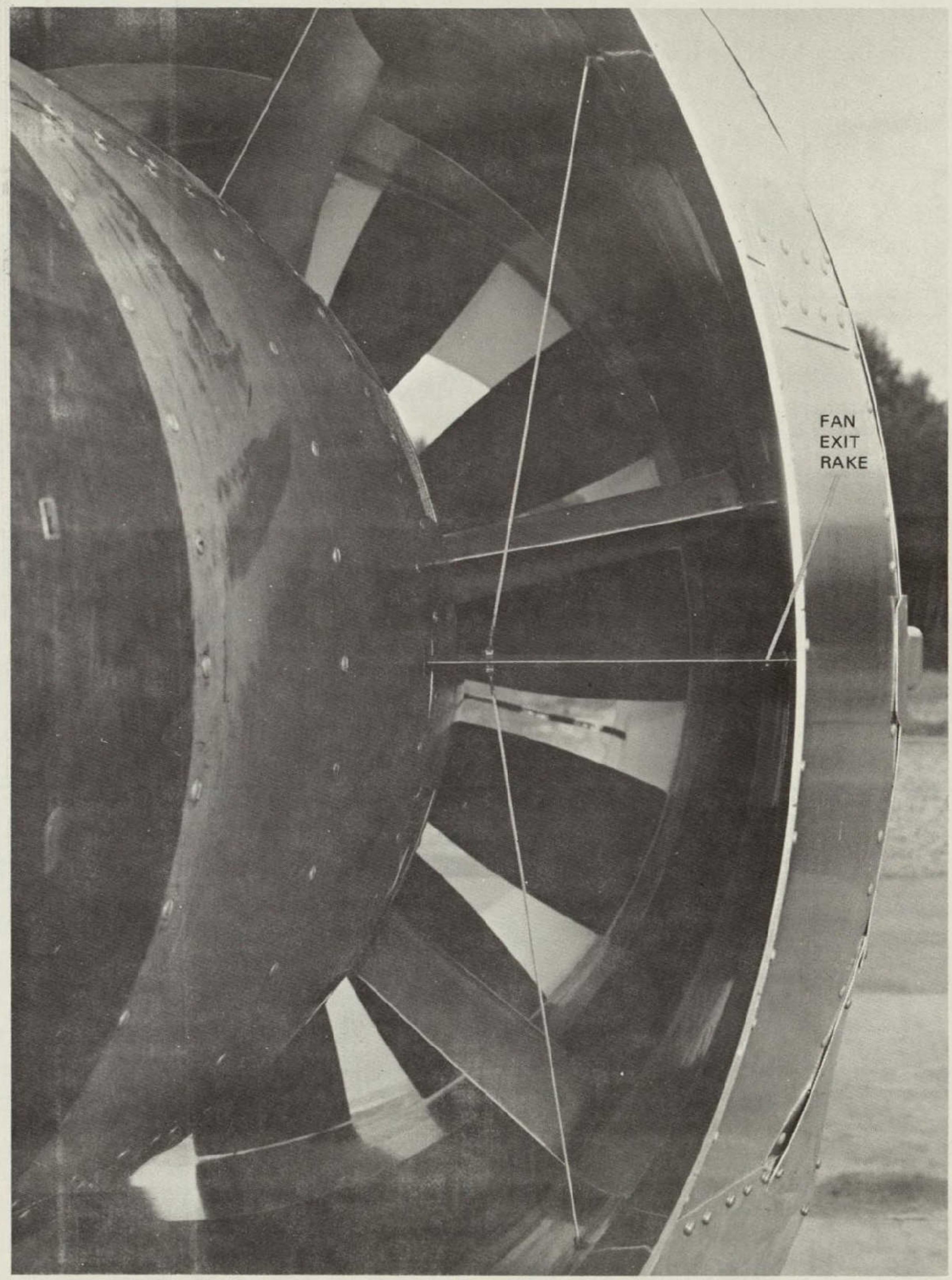

Figure 9. Aft View Fan Nozzle Exit

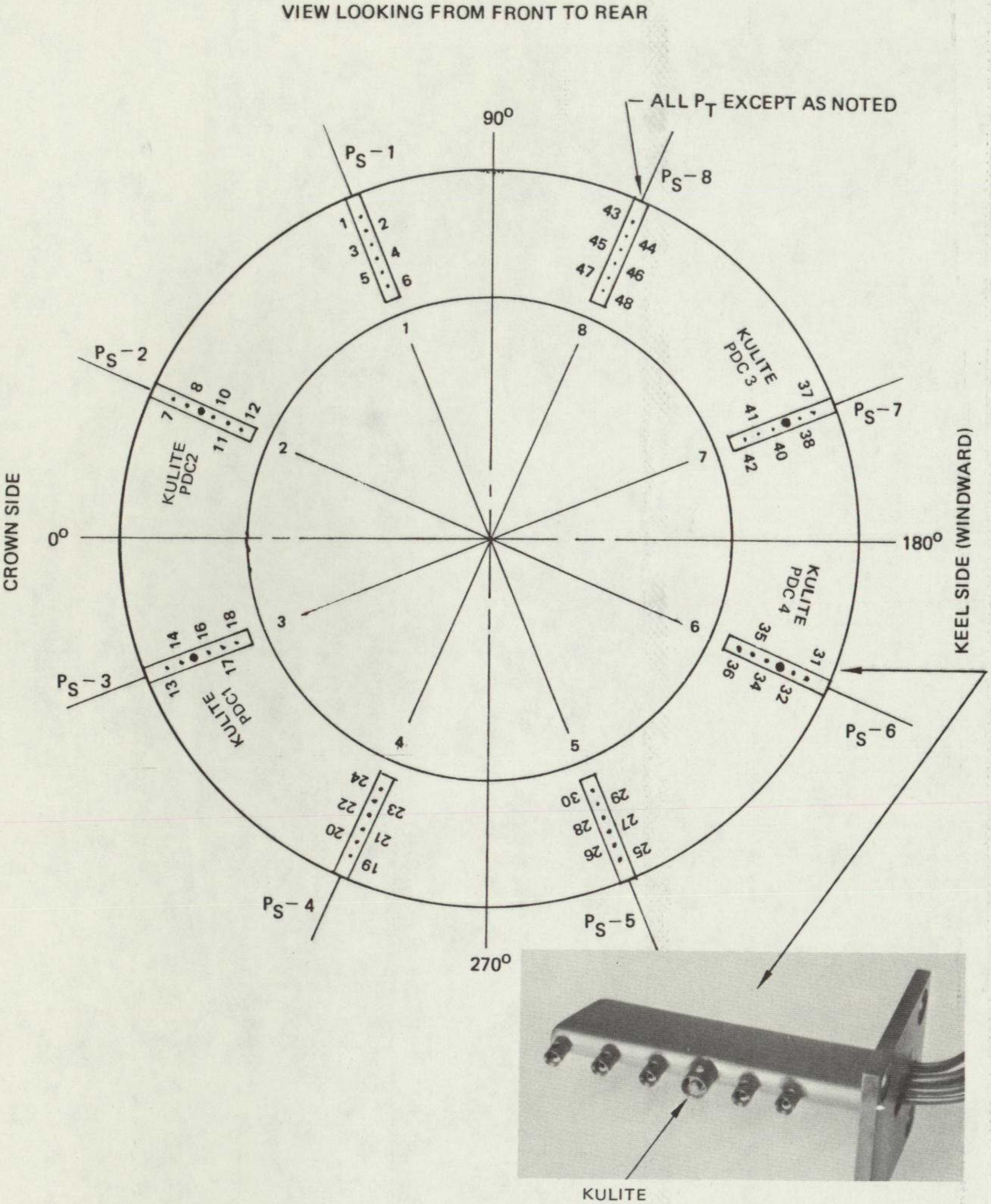

Figure 10. Compressor Face Instrumentation

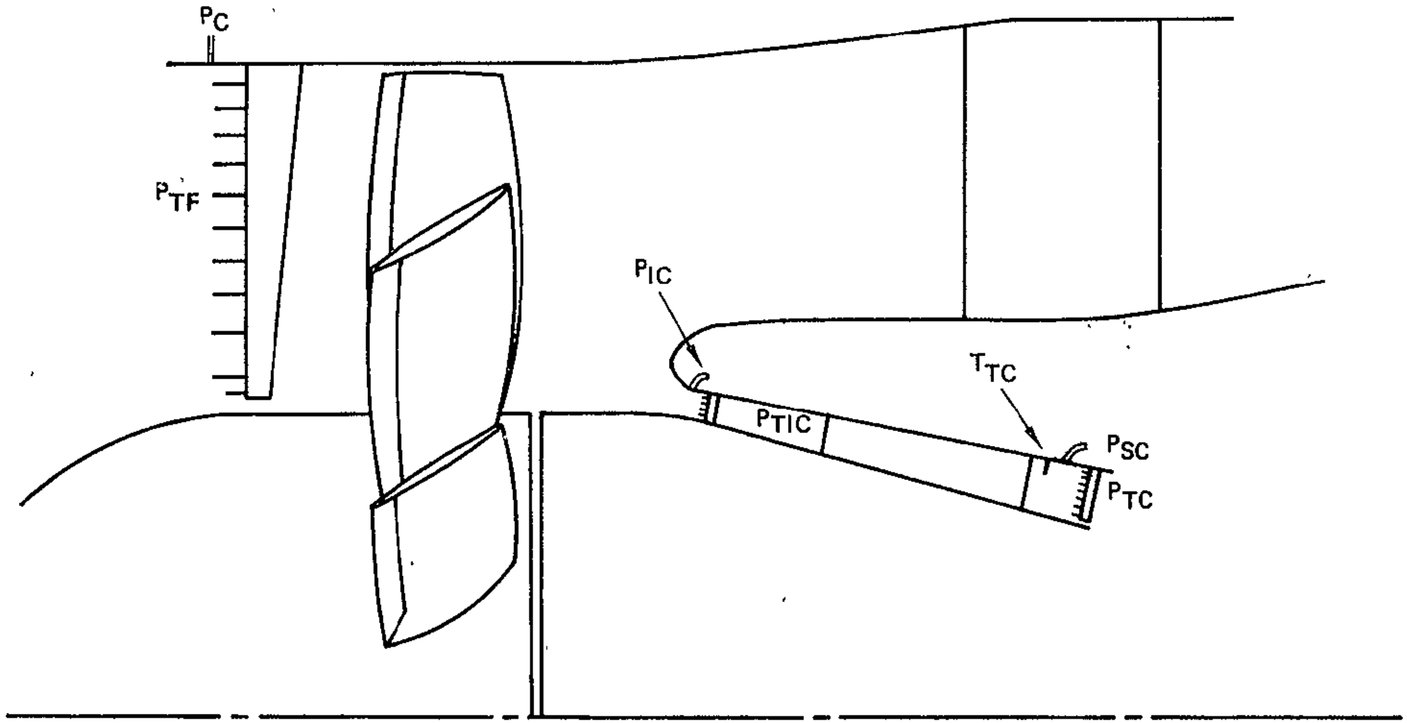

Figure 11. Core Engine Inlet Instrumentation

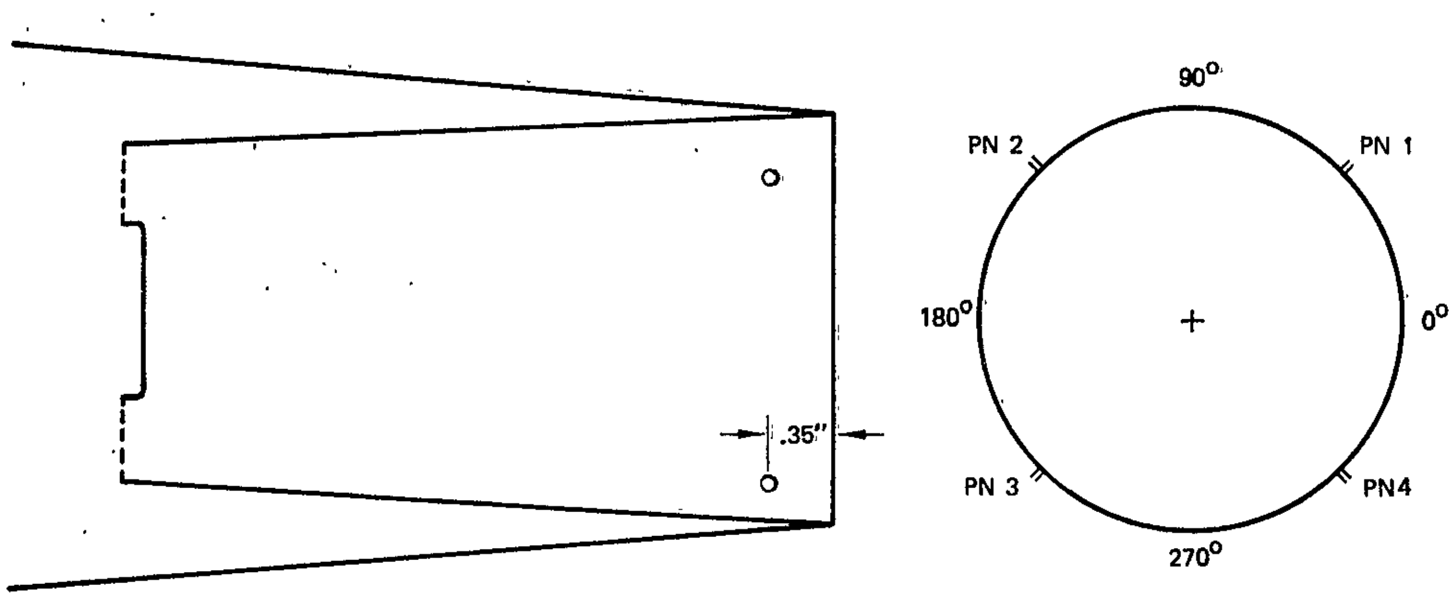

Figure 12. Core Engine Nozzle Instrumentation

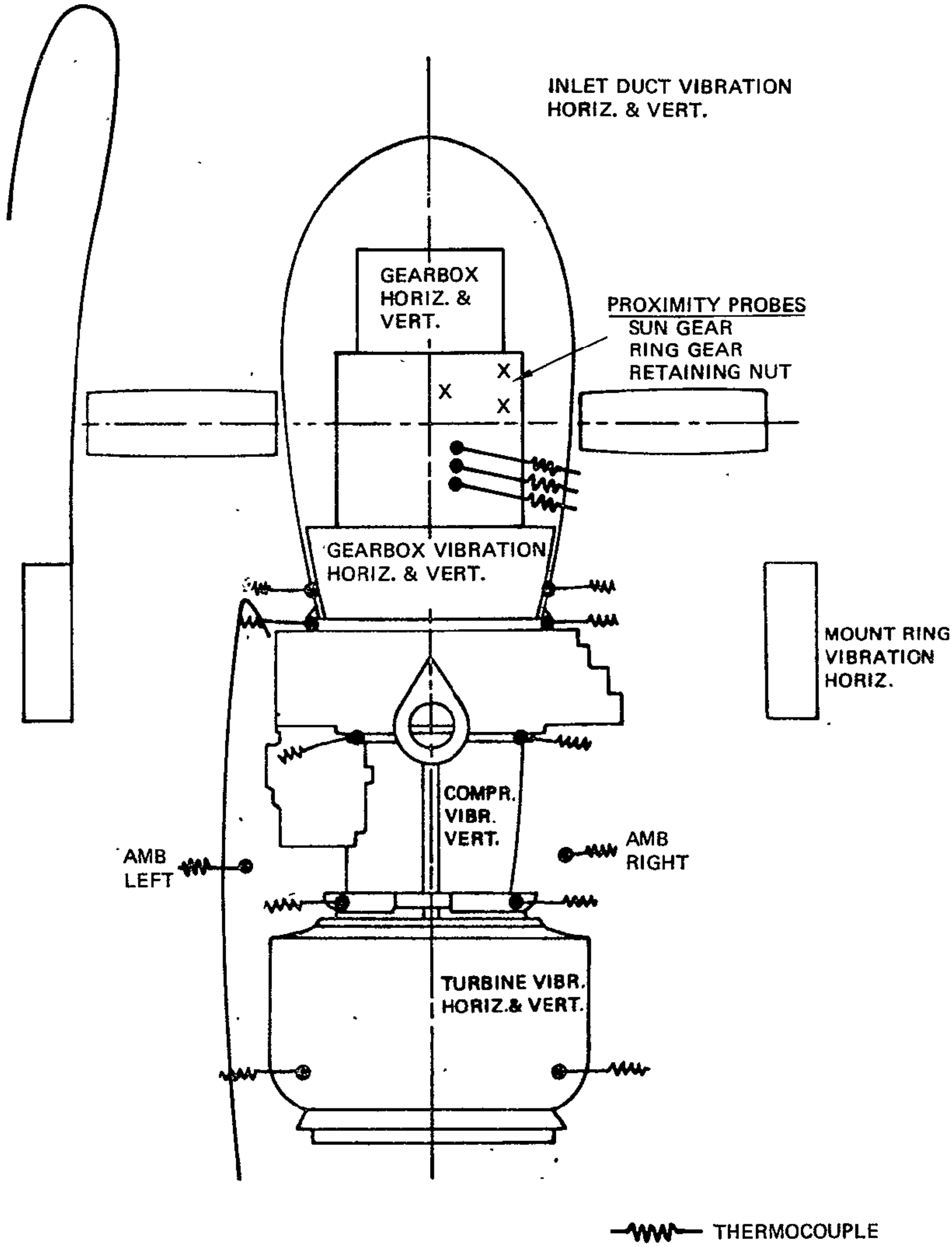

Figure 13. Nacelle Operational Health Monitoring Locations

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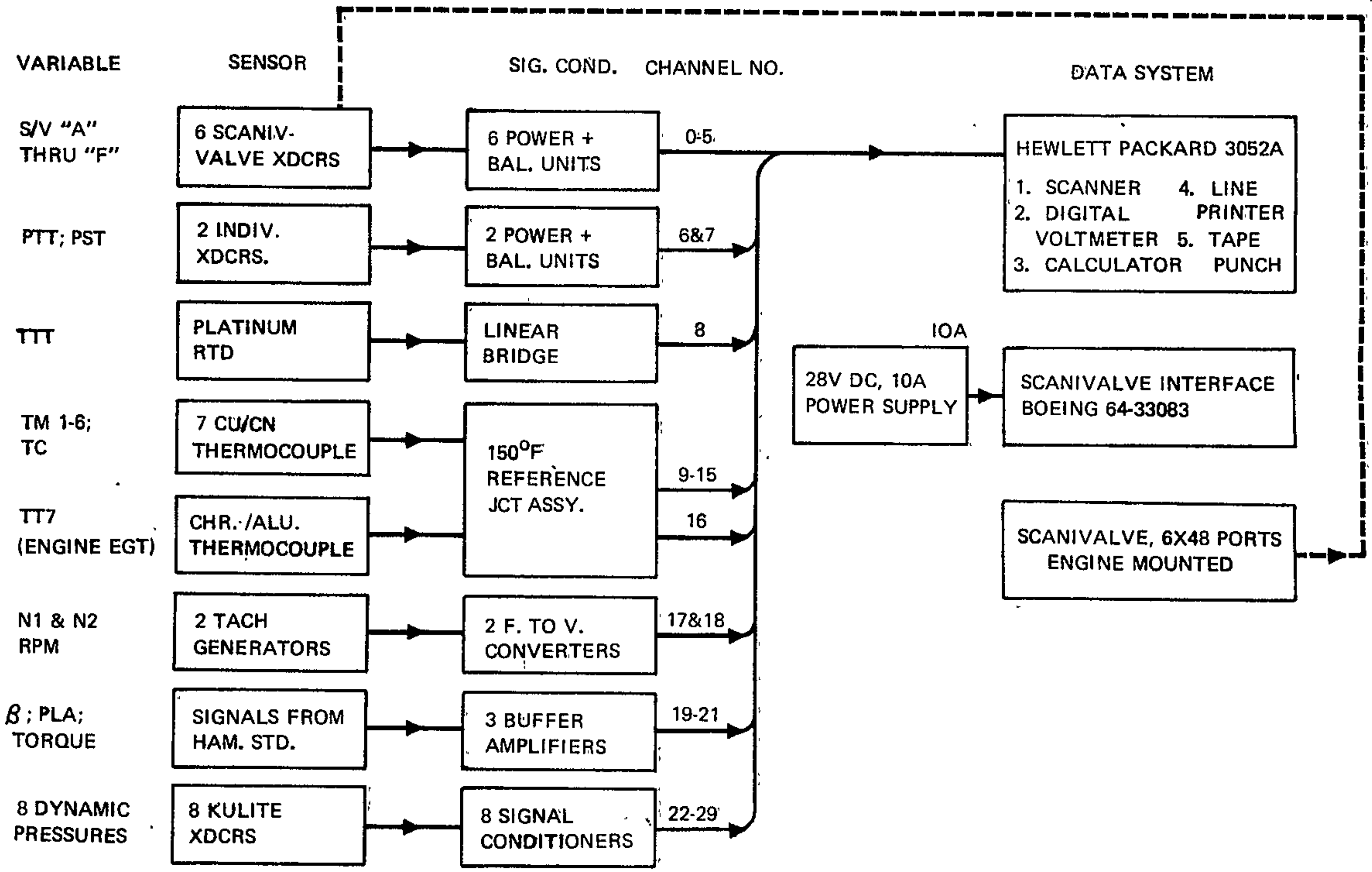

Figure 14. Block Diagram, Steady State Data Acquisiton System

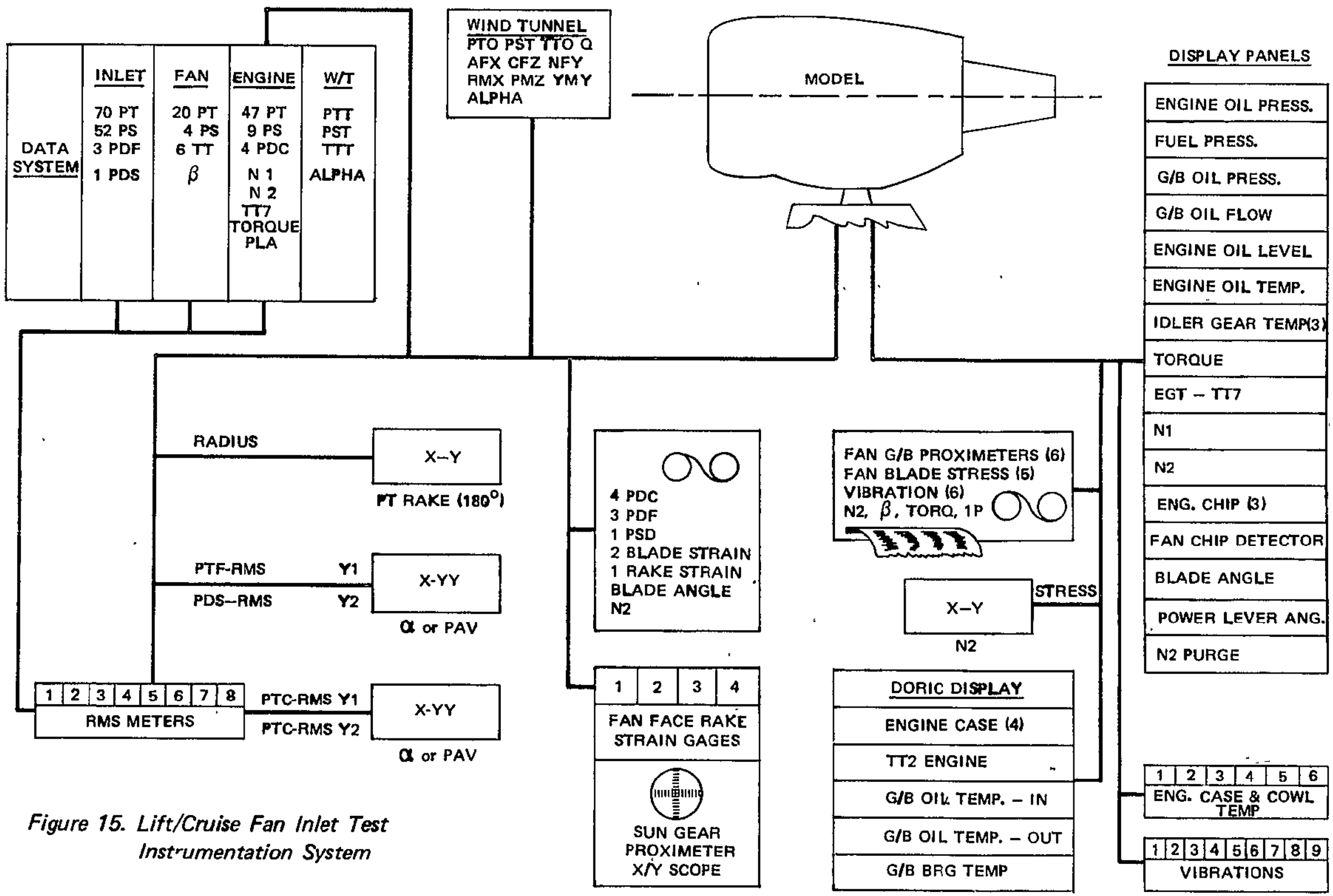

Figure 15. Lift/Cruise Fan Inlet Test Instrumentation System

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L/CFA Q-FAN INLET TEST NASA-ARC 40X80 WIND TUNNEL

RUN	COND	(1) TEST NO.	VO	ALPHA	QPSF	PTO	PO	TTO	CONF	DATE	(3) PBAR
1.	1.	2593.	0.0	0.00	0.0	14.676	14.676	531.0	1.	91577.	14.660

(2) VO, ALPHA, QPSF, PTO, PO, TTO

(4) WK1 103.7 (6) PTFA 0.9963 (7) DISF 0.0246 (27) FBA 117.9 (9) WKF 30.7 (28) PLA 15.8 (11) WKE 15.2 (12) PTCA 1.0013 (13) DISC 0.0212 (17) VN -0. (30) PTT 14.682 PST 14.690 TTT 528.7

(5) W1 102.4 (19) WK2 173.8 (6a) PTFAV 14.621 (21) FPR 0.998 (8) WF 30.2 (10) WE 15.0 (23) KN1 9858. (14) EP -1. (16) FN -0.1 (31) TT7 1265.8 WK1A 8.0 (4a)

(20) W3 45.2 (18) W2 171.5 (9a) PTMAV 14.598 (22) VM 0. (10a) TTC 529.9 (24) KN2 4489. (14a) ET -1. (15) FKN -0.1

STEADY STATE RAKE PRESSURES

	FAN FACE							(8a) (8b) FAN NOZZLE	
	RK25.7	RK77.1	RK128.	RK180	RK231	RK282	RK334	RK1	RK2
(18a)	PC39	PC40	PC41	PC42	PC43	PC44	PC45	PM1	PM3
(6b)	PTF1	PTF11	PTF21	PTF31	PTF41	PTF51	PTF61	PTM 1	PTM11
	2	12	22	32	42	52	62	2	12
	3	13	23	33	43	53	63	3	13
	4	14	24	34	44	54	64	4	14
	5	15	25	35	45	55	65	5	15
	6	16	26	36	46	56	66	6	16
	7	17	27	37	47	57	67	7	17
	8	18	28	38	48	58	68	8	18
	9	19	29	39	49	59	69	9	19
(18b)	PTF10	PTF20	PTF30	PTF40	PTF50	PTF60	PTF70	PTM10	PTM20
	PP1	PP2	PP3	PP4	PP5	PP6	PP7	PM2	PM4

COMPRESSOR FACE

	RK1	RK2	RK3	RK4	RK5	RK6	RK7	RK8
(10b)	PSC1	PSC 2	PSC 3	PSC4	PSC5	PSC6	PSC7	PSC8
(11a)	PTC1	PTC 7	PTC13	PTC19	PTC25	PTC31	PTC37	PTC43
	2	8	14	20	26	32	38	44
	3	10	16	21**	27	34	40	45
	4	10	16	22	28	34	40	46
	5	11	17	23***	29	35	41	47
	PTC6	PTC12	PTC18	PTC24****	PTC30	PTC36	PTC42	PTC48

(8c) TEMPERATURES FAN DUCT

RK1	RK2
TTM1	TTM4
TTM2*	TTM4
TTM3	TTM6

(29) DYNAMIC RMS

FAN	COMP
PDF1	PDC1
PDF2	PDC2
PDF3	PDC3
PDS	PDC4

INLET COWL STATIC PRESSURES

1)	PC1	PC2	PC3	PC4	PC5
6)	6	7	8	9	10
11)	11	12	13	14	15
16)	16	17	18	19	20
(25a) 21)	21	22	23	24	25
26)	26	27	28	29	30
31)	31	32	33	34	35
36)	36	37	38	39	40
41)	PC41	PC42	PC43	PC44	PC45

(25) COWL SURFACE MACH NUMBERS

PC1 PC2 PC3 PC4 PC5

PC6 . . . . same as static . . . . . . pressure array

CORE INLET LIP PRESSURES

PIC 0.975

PTIC: PTIC1, PTIC2, PTIC3

CORE NOZZLE STATIC PRESSURES (PSIA)

PN1 PN2 PN3 PN4

(26) FORCE BALANCE

LBS				FT-LBS		
FX	FY	FZ	FXY	QY	QX	QZ
-549.0	-5.0	28.0	549.0	-248.0	113.0	56.0

* Replaced with TTM3 - Runs 19 & on
** Replaced with PTC16 - Runs 23 & on
*** Replaced with PTC17 - Runs 23 & on
**** Replaced with PTC18 - Runs 23 & on

FIGURE 16 - DATA SHEET FORMAT

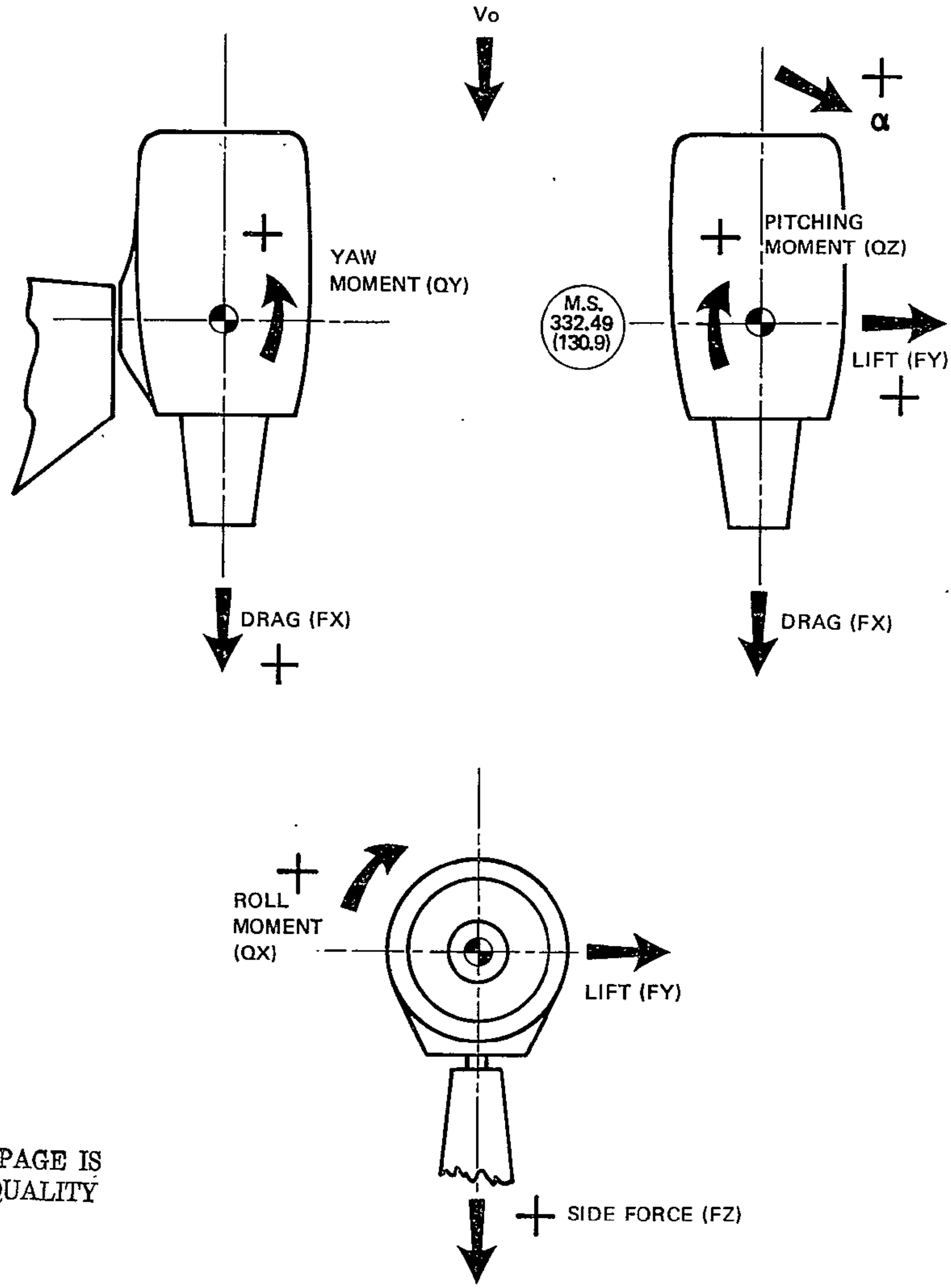

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Figure 17. Nacelle Force Measurements — Nomenclature and Sign Convention

APPENDIX A

Q-FAN DEMONSTRATOR
LIFT FAN TECHNOLOGY
BLADE STRESS REPORT

Q-FAN DEMONSTRATOR

LIFT FAN TECHNOLOGY PROGRAM

BLADE STRESS REPORT

BLADE VIBRATORY STRESSES

FOR

Q-FAN DEMONSTRATOR

AT

NASA AMES 40' x 80' WIND TUNNEL

Purchase Contract No. N-947295-9578
NASA Prime Contract 2-9640

Prepared by ______________ Project Manager
W. J. Demers

______________ Project Engineer
D. P. Currie

______________ Head of Applied Mechanics
Dr. Robert W. Cornell

Reviewed by: ______________ Program Manager
D. J. Nelson

Prepared for: Boeing Aerospace Company, Seattle, Washington

SUMMARY

The Hamilton Standard QFT-55 full scale Q-Fan Demonstrator propulsor was utilized by Boeing Aerospace Company to fabricate a large scale variable pitch Lift/Cruise fan nacelle. The unit was tested in 1976 at Boeing's Tulalip, Washington static test facility and the NASA Ames 40' x 80' wind tunnel under a NASA Prime Contract NAS2-9215. A Blade Stress Report covering those tests was submitted to Boeing on 16 November 1976.

This report covers the more recent tests which were conducted in the NASA Ames 40' x 80' Wind Tunnel during September-October 1977 under the NASA Prime Contract NAS2-9640. These tests included operation at higher nacelle tilt angles and free stream velocities than those tested in 1976.

TEST DESCRIPTION

In connection with the Boeing-NASA V/STOL aircraft program, blade vibratory stresses were measured during the testing of the Hamilton Standard Q-Fan Demonstrator in the NASA Ames 40' x 80' wind tunnel. This document reports on the results of these measurements.

The rotating components of the test unit were identical to those described in Report NAS CR-121265 (HSER 6163) which covered the stresses as measured at Hamilton Standard. Referring to Figure 6 (Pg. 239) of that report or Figure 1 included in the appendix of this report, stresses were measured using the bending strain gages located at 362 mm (14.25 in.) from the blade tip on Blades No. 1, 6 and 7 and the vee strain gages located at 89 mm (3.5 in.) from the blade tip on blades 2 and 9 during this test program. These stress measurements were recorded on magnetic tape and played back onto Sanborn records. Also recorded and played back were torque, fan speed and fan blade angle. Wind tunnel air speed, fan angle of attack (actually yaw inflow angle) and the power lever angle (PLA) were noted on the test log. An X-Y plotter was also used to record Blade No. 1 bending stress vs. N_2 (engine rpm). A number of the recordings were played back to determine the dominant frequencies of the vibratory stressing at this gage location.

The tests were conducted on the 15th thru the 21st Sept. 1977 and the 13th thru 15th October 1977. The interruption in testing was caused by an unscheduled shutdown of the wind tunnel.

Tunnel wind speeds set during the tests were 0, 40, 60, 75, 90, 105, 125, 140 and 160 knots. Inflow angles (yaw angles) were varied from 0° to 120°. The maximum fan speed and fan blade angle were 3250 RPM and 56° respectively.

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TEST RESULTS

Bending stresses were generally acceptable using a continuous limit of ± 38 MN/m^2 (± 5500 psi) observed for these tests. This level was slightly exceeded when operating at combinations of angle of attack, tunnel speed and torque that produced flow separation at the duct inlet. This was evident in Test Points 27 and 31.

Bending stresses also became significant when operating near a first flatwise (1f) mode critical speed; that is, where the aerodynamic excitation at a multiple (nF) of the fan speed is near the first flatwise natural bending frequency of the blade. A critical speed diagram is shown in Figure 2. This diagram is also shown on Figure 5-39 of Report NASA CR-121265 (HSER 6163). This type of stressing was particularly evident in Test Points 30 with a maximum duct angle of attack of 120°. For instance, Test Point 30.2 showed moderate 2F/1f response at 3250 RPM and Test Point 30.7 showed significant 3F/1f response at 2300 RPM. This stress behavior was also evident in previous running of this Q-Fan.

Maximum shear stressing measured was 10.0 MN/m^2 (± 1450 psi) occurring during operation at maximum power with a maximum duct angle of attack of 120°. This amplitude of shear stressing is acceptable.

Appended to this report are copies of the on-line X-Y plots relating Blade No. 1 total vibratory stress (± psi) at 362 mm (14.25 in.) from the tip and the power turbine speed, N2. To obtain the fan speed, the N_2 speed is divided by the 4.75 gear ratio. Marked on these plots are the freestream tunnel velocity, V; duct angle of attack, α, (actually a yaw angle in the tunnel); fan blade angle, β, at the 75% blade radius station; date of the test, and the Run Number (same as Test Point Number) designated by Boeing. The sequence of the testing, which at times influenced the stressing, was in the order of increasing Run Number.

Twenty-four such plots are given. (Not all of the runs are shown on these plots). The 43° blade angle points for Boeing Run Nos. 13 and 25 show moderate stressing. Likewise, stressing is moderate for Run No. 30. All of these conditions are at combinations of high duct angle of attack, tunnel speeds of 39 m/s (75 knots) or less, and comparatively low torque. In addition, the stress peaks generally occur near the N_2 speed of 10,000 RPM, corresponding to a fan speed of about 2100 RPM. Inlet flow separation is believed to have occurred during the deceleration for Boeing Run No. 13.

Also given in the Appendix are six pages summarizing the stresses measured during the testing. These tables were prepared from the Sanborn playbacks. Identification of the test condition is given by the HS Run No. correlated with the Boeing Test Point No. Maximum bending stresses were noted during Test Points Nos. 27, 30, and 31. As above, the points for Nos. 27 and 30 were at combinations of high angle of attack, moderate tunnel speeds, and low torque. Test Points for No. 31 were unique in that this is the only run in which the variable was the duct angle of attack. Tunnel speed and fan power were kept constant. Upon increasing angle of attack, significant stressing occurred only as the maximum angle of 80° was approached. This stressing was maintained until an angle of less than 78° was reached. This hysteresis may be a characteristic of duct inlet separation.

Test Results (continued)

The Appendix also includes 15 frequency spectrum plots for conditions selected from the stress tabulations. These results confirm that the major bending stress response is at frequencies which are integer multiples of the fan speed - 1F, 2F, 3F, etc. Stressing can become significant when one of these frequencies is near the blade natural frequency just above 100 Hz. Test Point 30.7, for instance, shows predominant response near 112 Hz. This is the 3F/1f condition. Likewise, Test Points 30.1 and 30.2 show moderate stressing near 105 Hz. This is the 2F/1f condition.

These frequency spectrum plots also show stress response in the first flatwise natural bending mode when this frequency is not an integer multiple of the fan speed. This response was evident, for instance, for Boeing Test Points 27.5, 31.4, and 31.5. It was also evident in Points 27.6 and 27.8 where the response was very close to but not exactly at the 3F frequency. This type of response could very well be caused by turbulence associated with duct inlet separation.

In summary, the vibratory stress levels measured in this investigation were acceptable. No significant structural fatigue damage accrued from these tests. Major stress response was due to the proximity of a frequency of aerodynamic excitation to the first natural blade bending frequency. This type of response was evident in previous tests of this Q-Fan. Some stress response was noted in the first natural bending mode at a frequency not equal to an integer multiple of the fan speed. This response would be expected from the turbulent nature of the air flow associated with separation within the duct.

APPENDIX

TO

Q-FAN DEMONSTRATOR

LIFT FAN TECHNOLOGY PROGRAM

BLADE STRESS REPORT

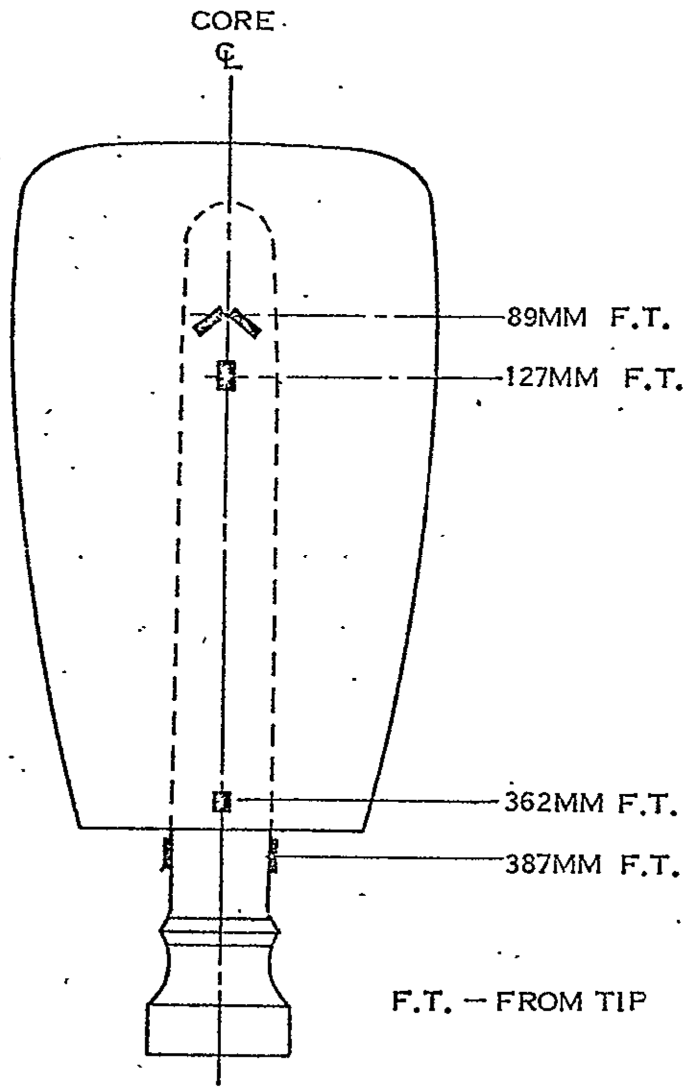
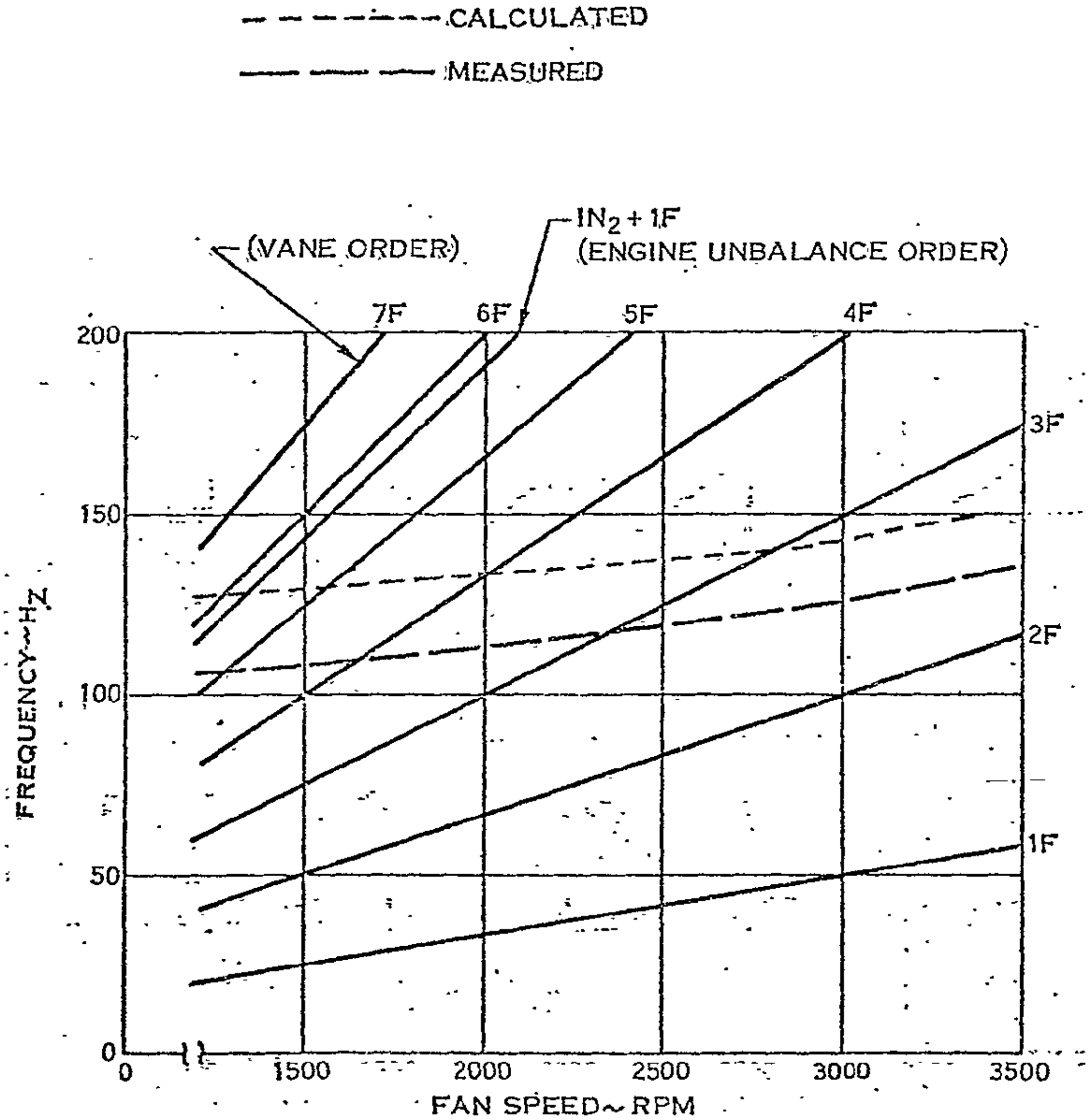


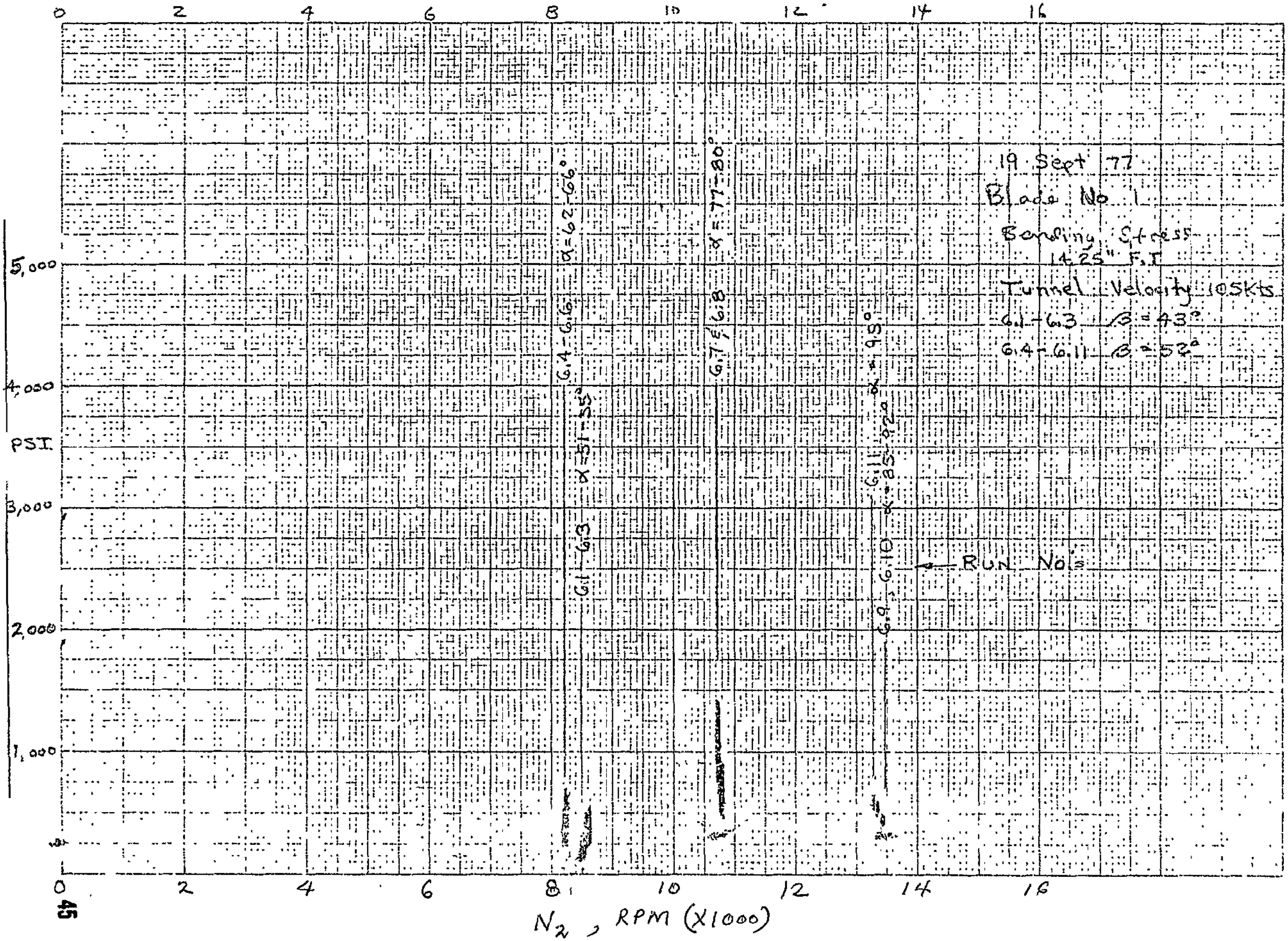
FIGURE 1

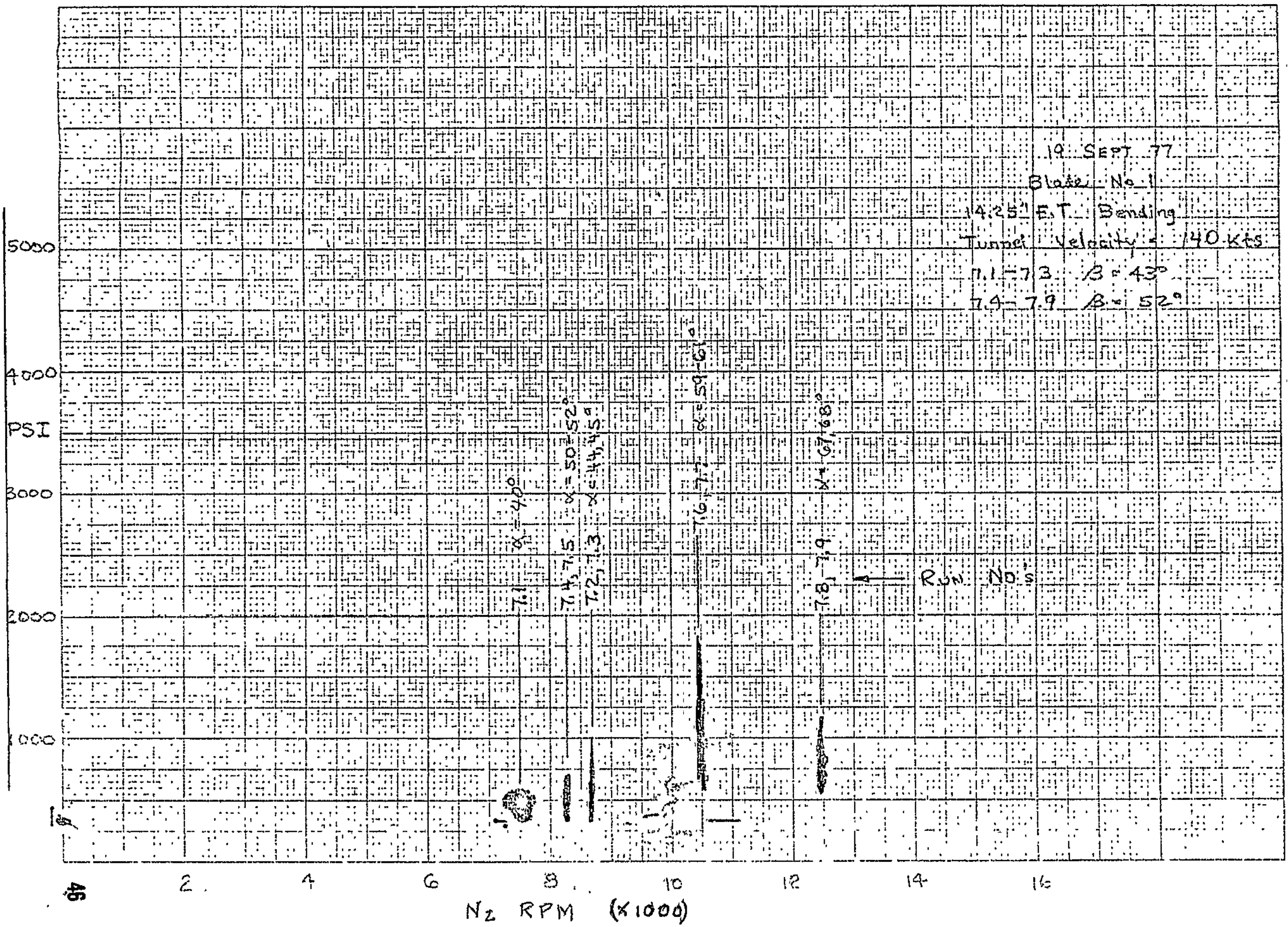
APPROXIMATE FREQUENCY
OF FIRST FLATWISE BLADE MODE
IN FORWARD THRUST



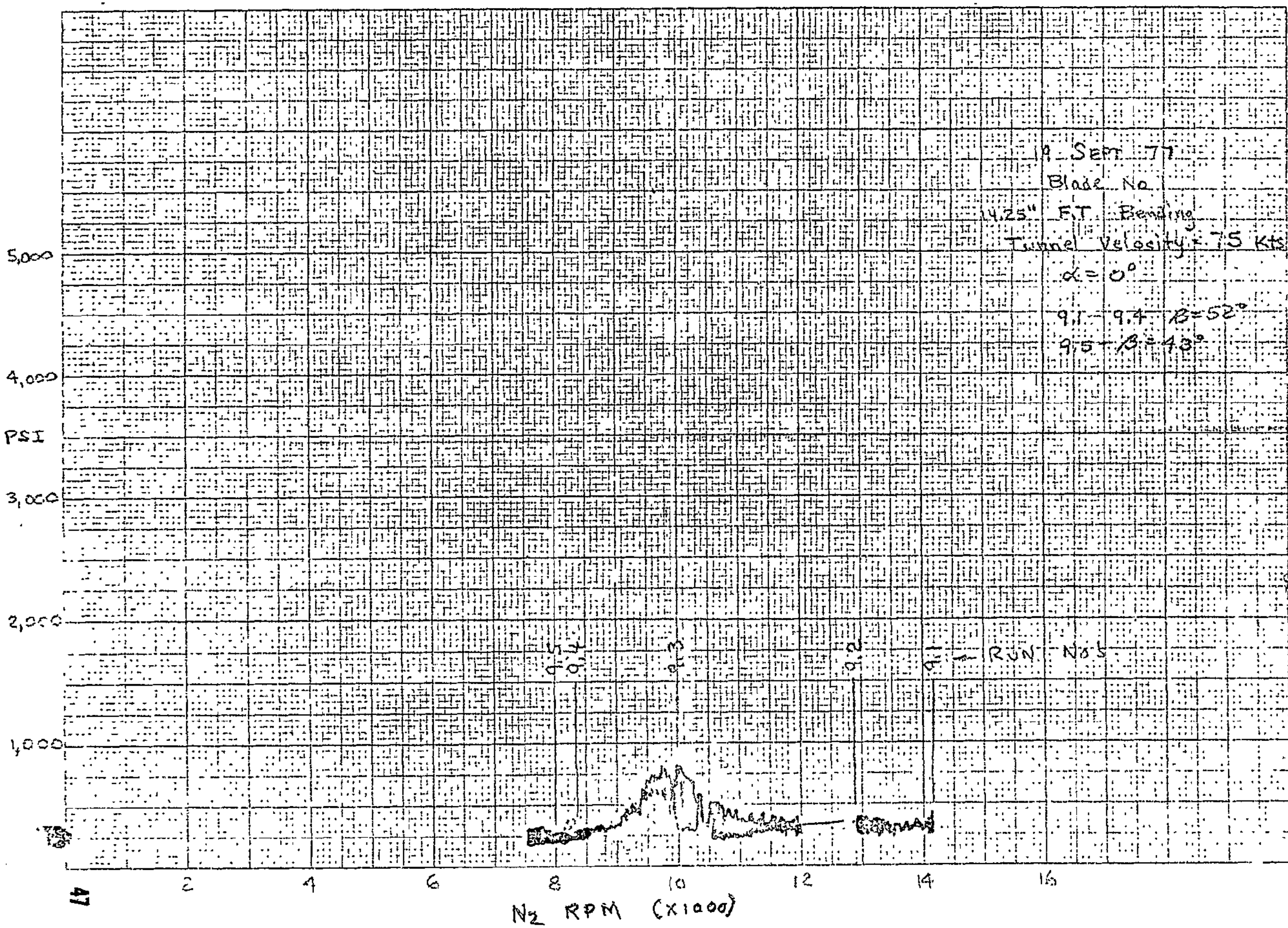
1.4 M DIAM. Q—FAN DEMONSTRATOR
CRITICAL SPEED DIAGRAM

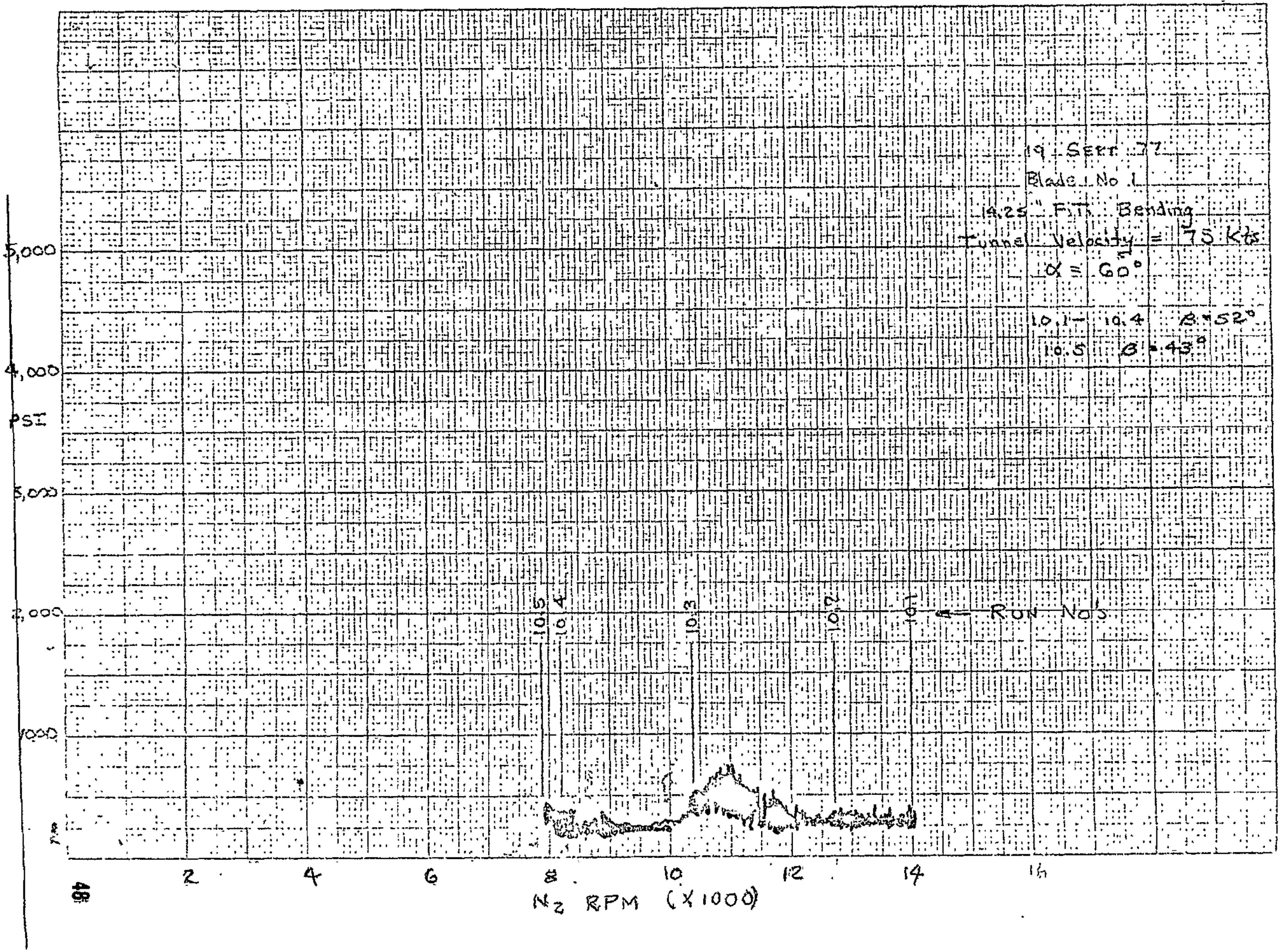
FIGURE 2

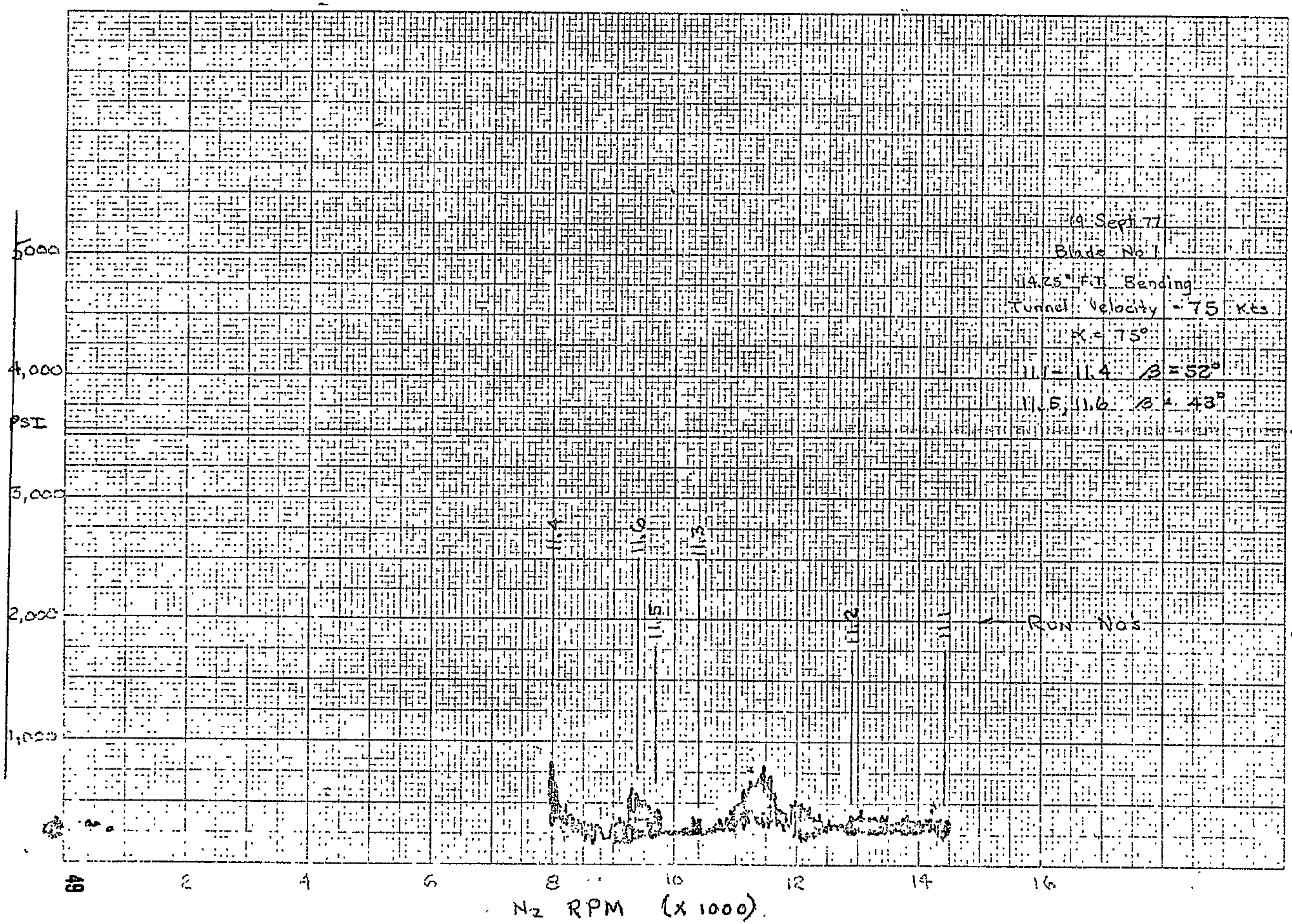

0 2 4 6 8 10 12 14 16
5,000
4,000
PSI
3,000
2,000
1,000
19 Sept 77
Blade No 1
Bending Stress
14.25" F.T.
Tunnel Velocity 105Kts
6.1-6.3 β = 43°
6.4-6.11 β = 52°
6.4-6.6 α = 62-66°
6.1 6.3 α = 51-55°
6.7, 6.8 α = 77-80°
6.9, 6.10 α = 85-92°
6.11 α = 95°
RUN No's
N2, RPM (X1000)


19 SEPT 77
Blade No 1
14.25" E.T. Bending
Tunnel Velocity = 140 Kts
7.1-7.3 β = 43°
7.4-7.9 β = 52°
5000
4000
PSI
3000
2000
1000
7.1 α = 40°
7.4, 7.5 α = 50-52°
7.2, 7.3 α = 44, 45°
7.6, 7.7 α = 59-61°
7.8, 7.9 α = 67, 68°
RUN NO's
2
4
6
8
10
12
14
16
N2 RPM (X1000)

46


19 SEPT 77
Blade No
14.25" F.T. Bending
Tunnel Velocity = 75 Kts
α = 0°
9.1 – 9.4 β = 52°
9.5 – β = 43°
5,000
4,000
PSI
3,000
2,000
1,000
9.5
9.4
9.3
9.2
9.1 – RUN No 5
2
4
6
8
10
12
14
16
N2 RPM (X1000)


19 Sept 77
Blade No 1
14.25" F.T. Bending
Tunnel Velocity = 75 Kts
α = 60°
10.1 – 10.4 β = 52°
10.5 β = 43°
5,000
4,000
PSI
3,000
2,000
1000
10.5
10.4
10.3
10.2
10.1
← Run No's
2
4
6
8
10
12
14
16
N2 RPM (X1000)


5000
4,000
PSI
3,000
2,000
1,000
2
4
6
8
10
12
14
16
N2 RPM (X 1000)
19 Sept 77
Blade No 1
14.25" F.T. Bending
Tunnel Velocity - 75 Kts
K = 75°
11.1 - 11.4 B = 52°
11.5, 11.6 B = 43°
11.4
11.6
11.3
11.5
11.2
11.1
Run No's

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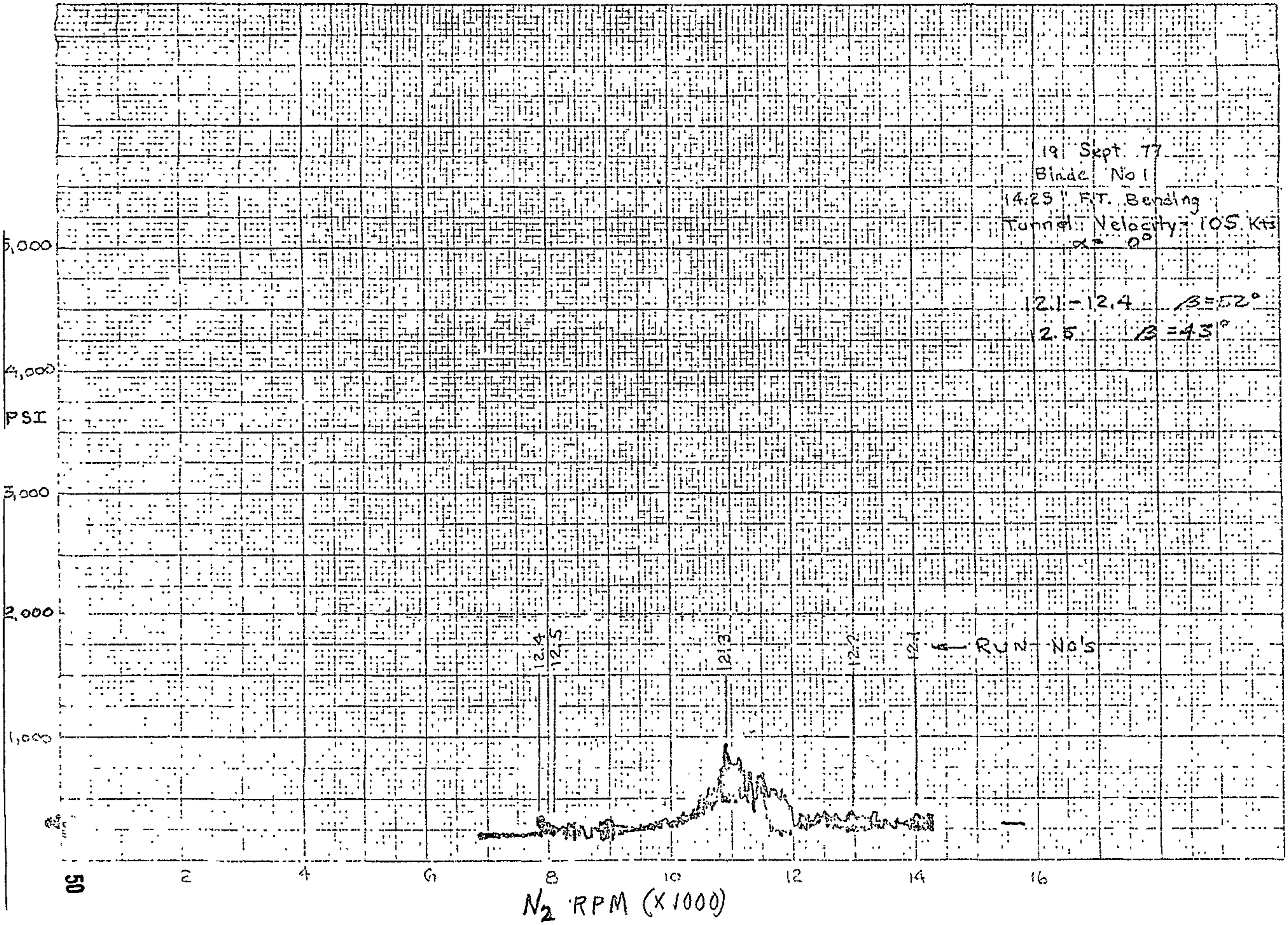

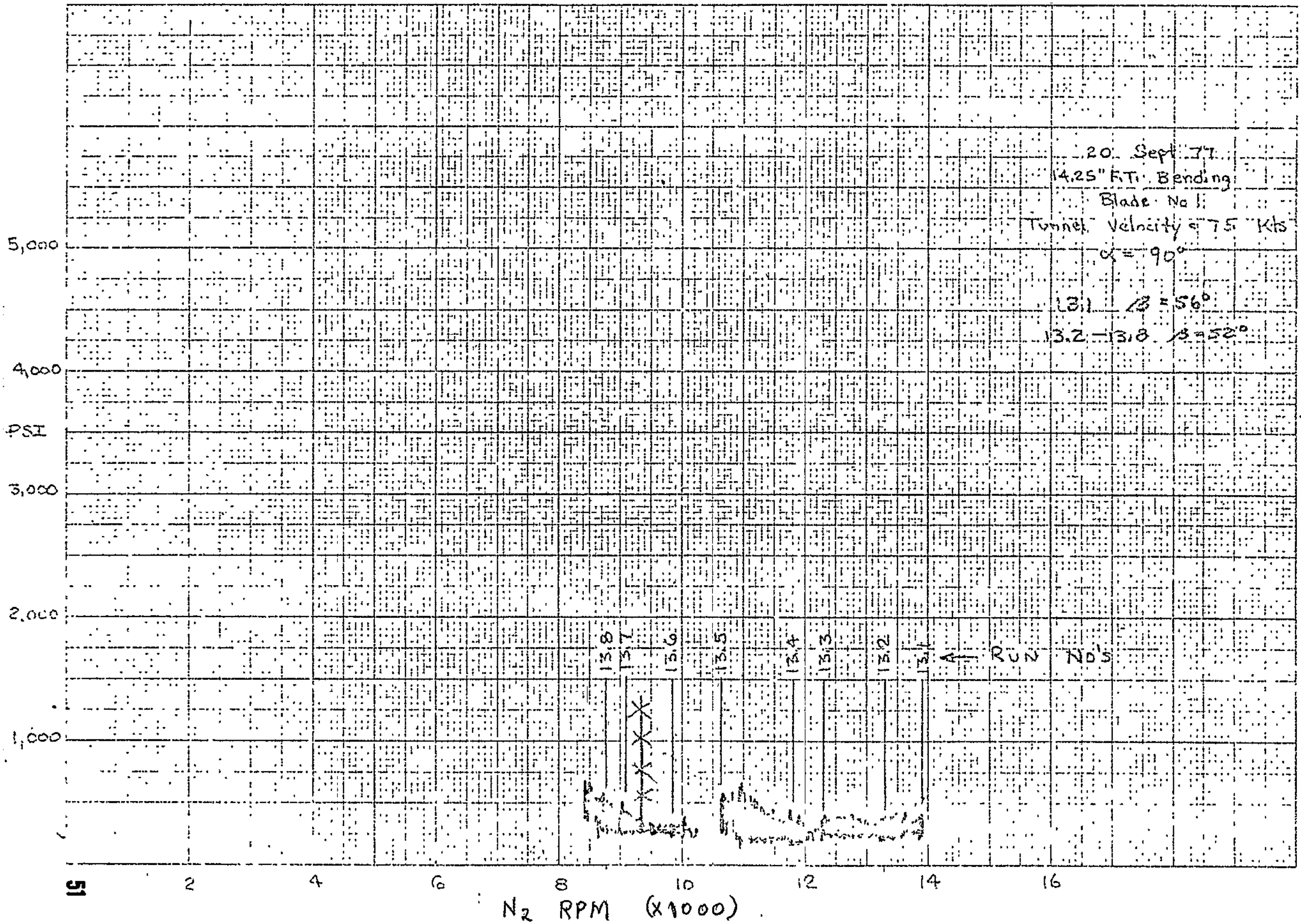

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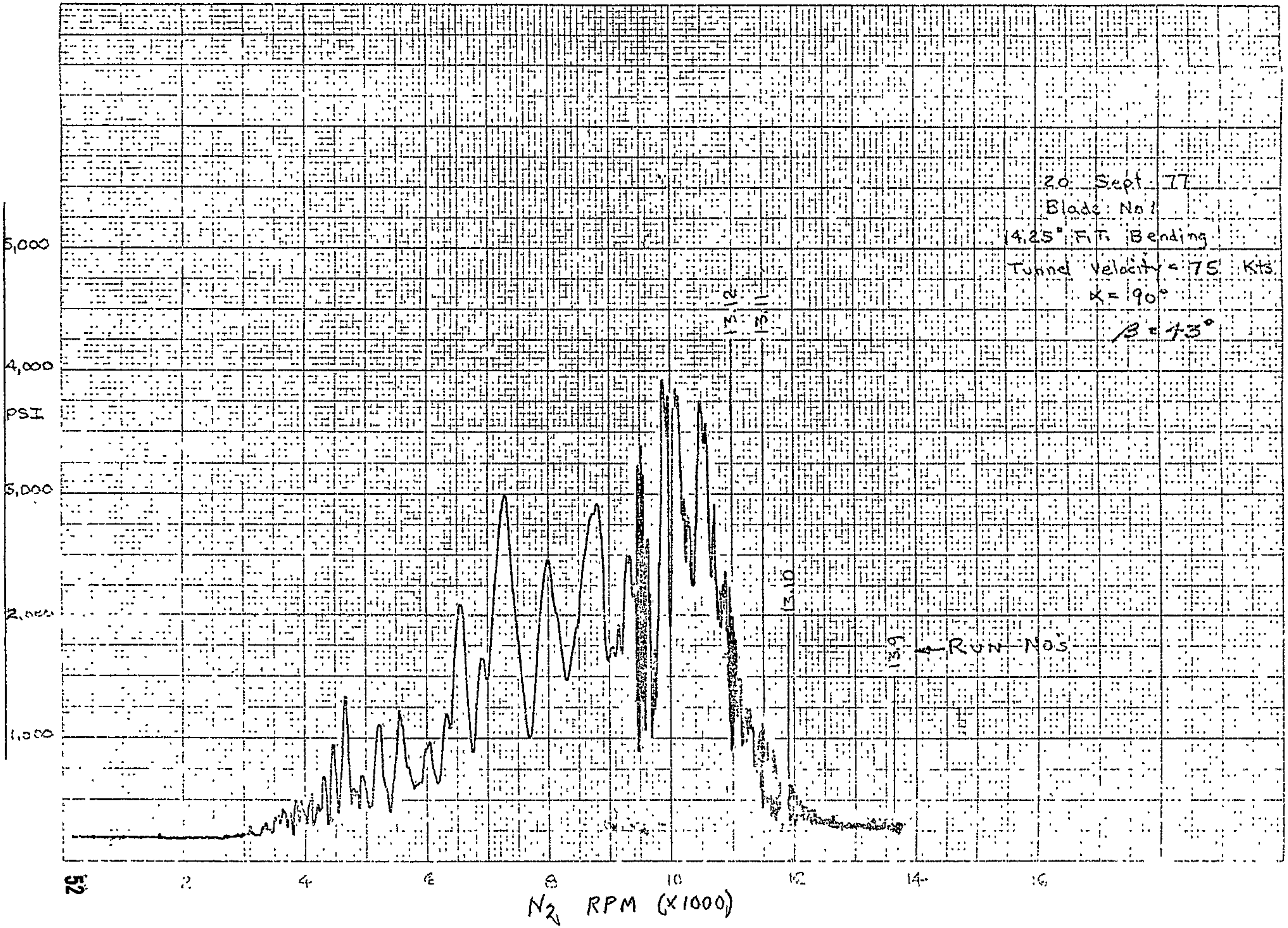

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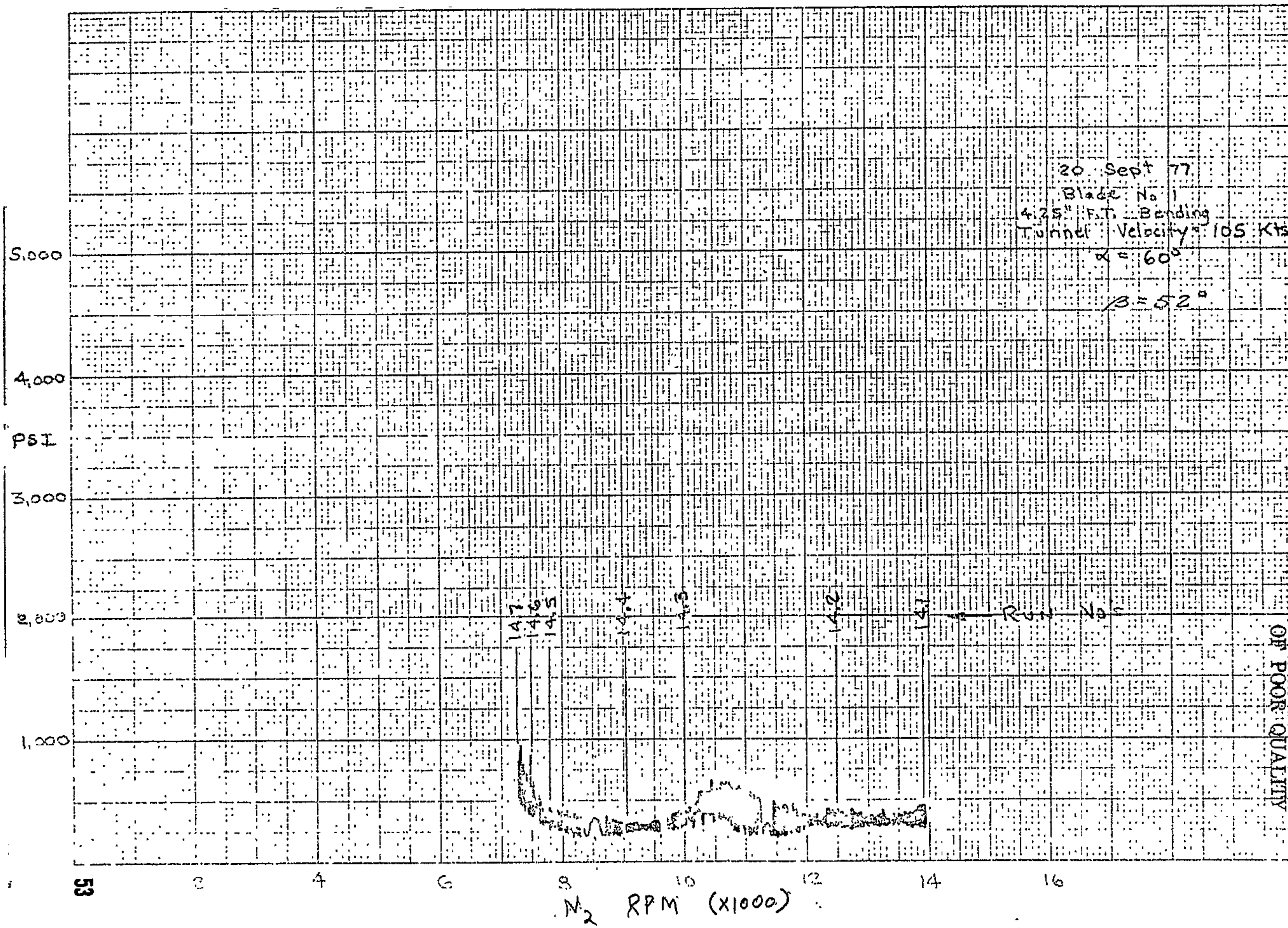

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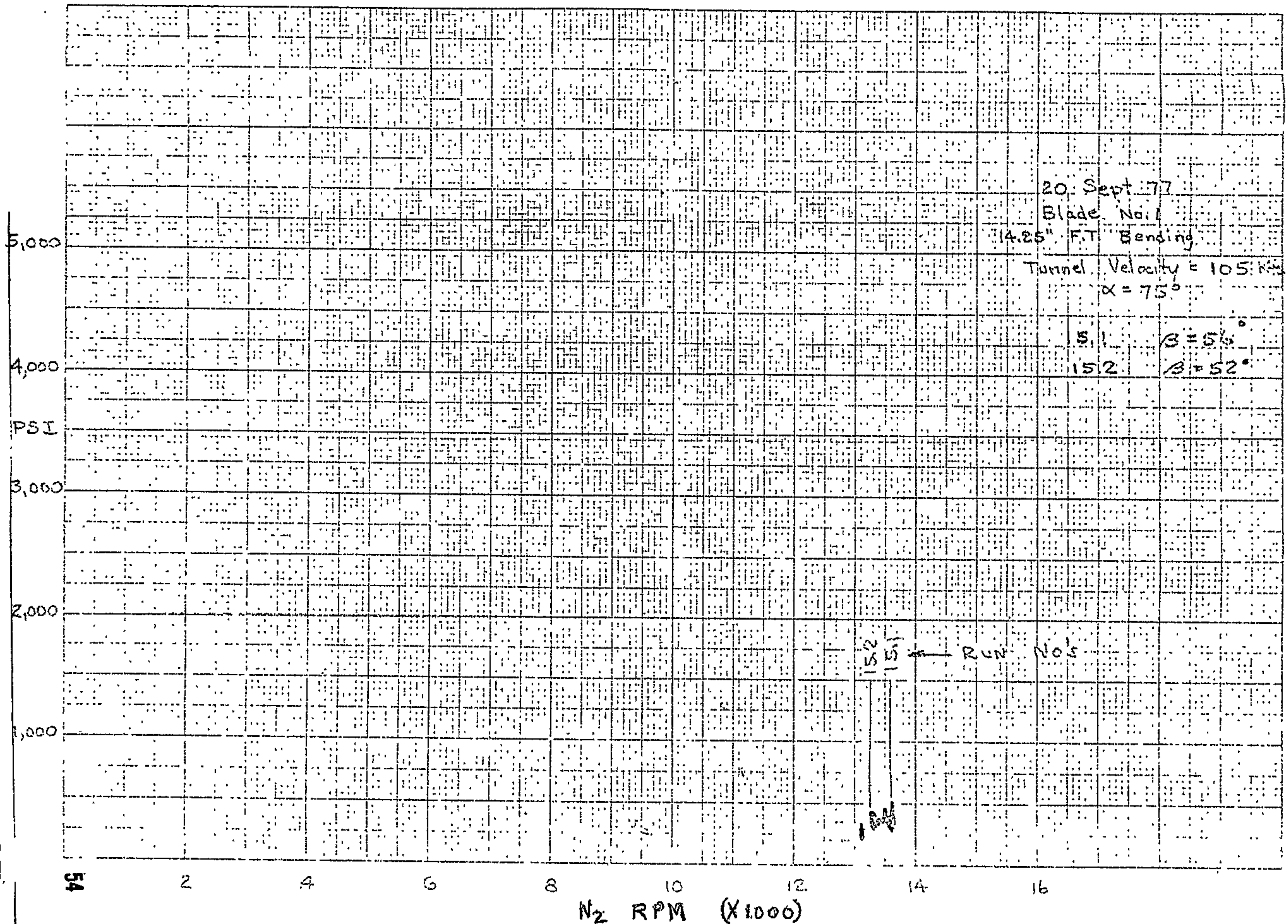
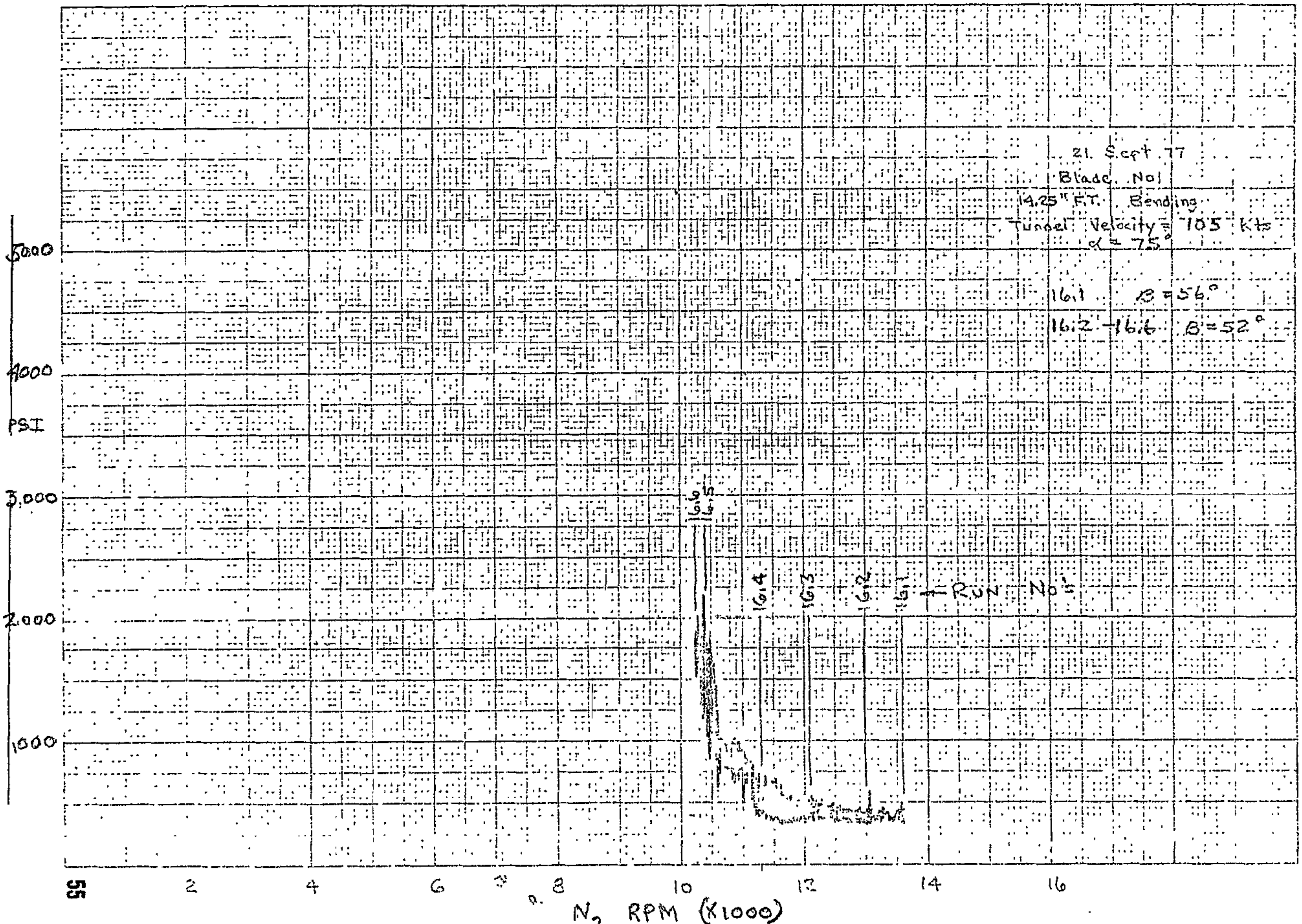
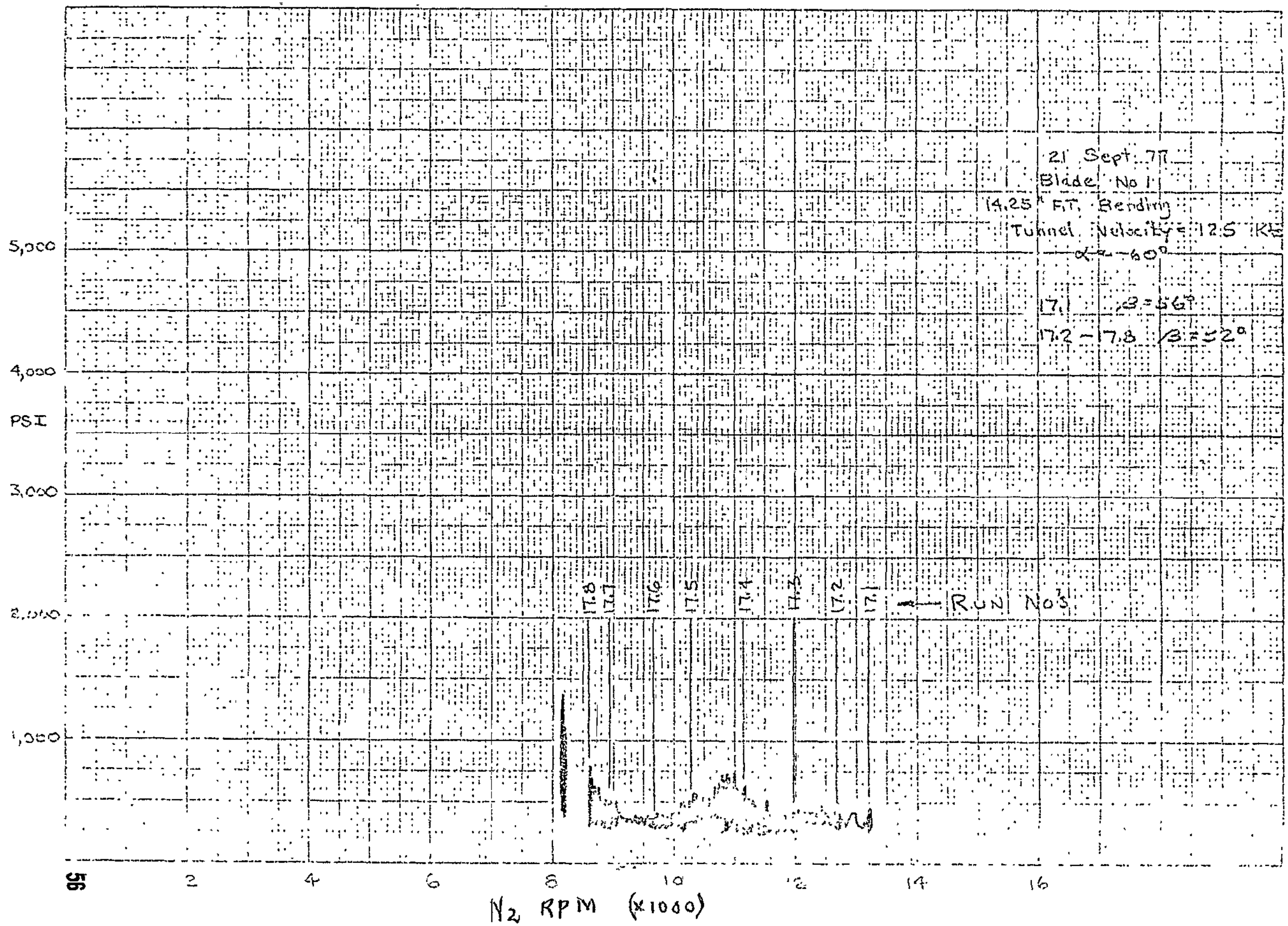
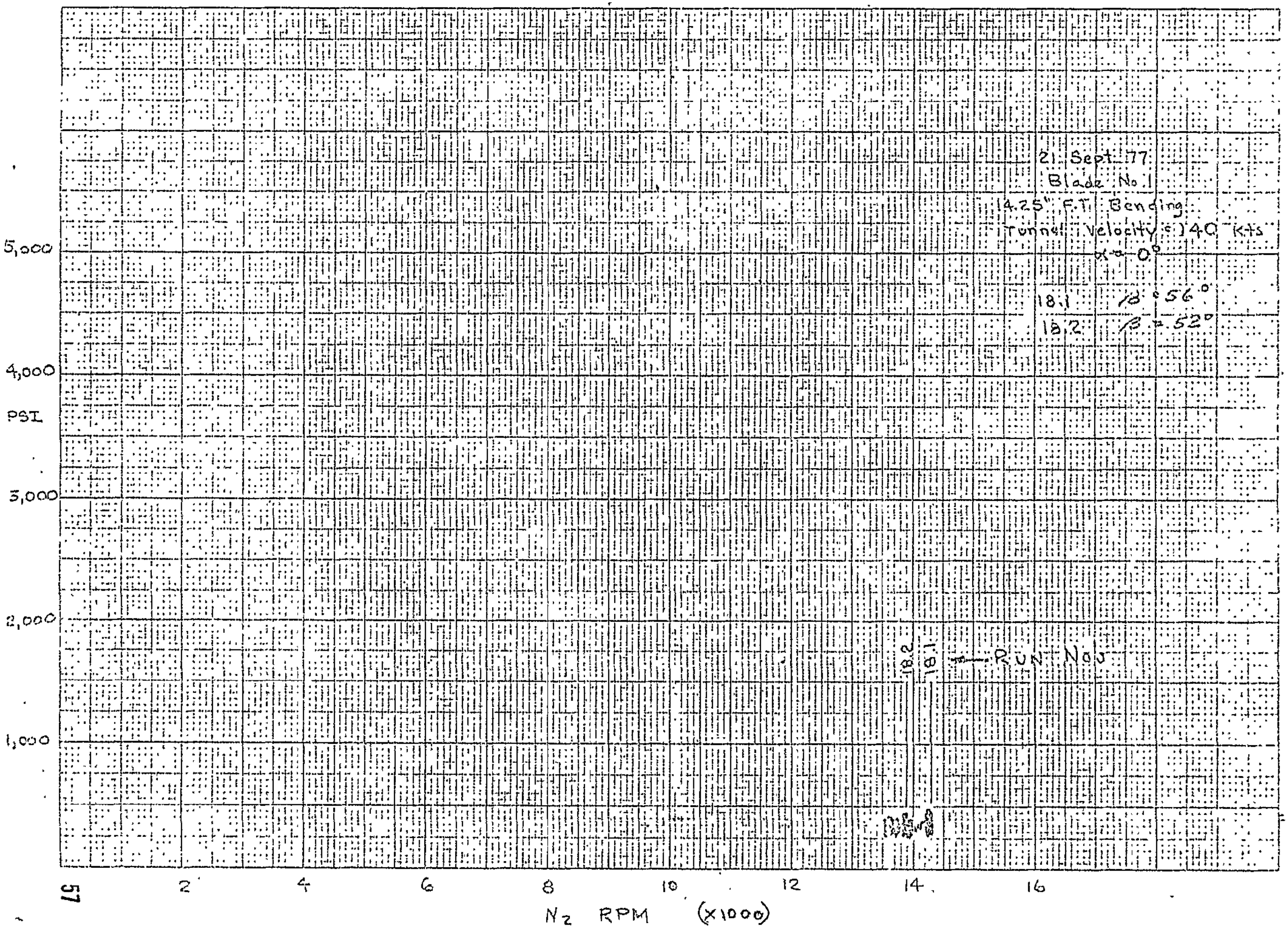
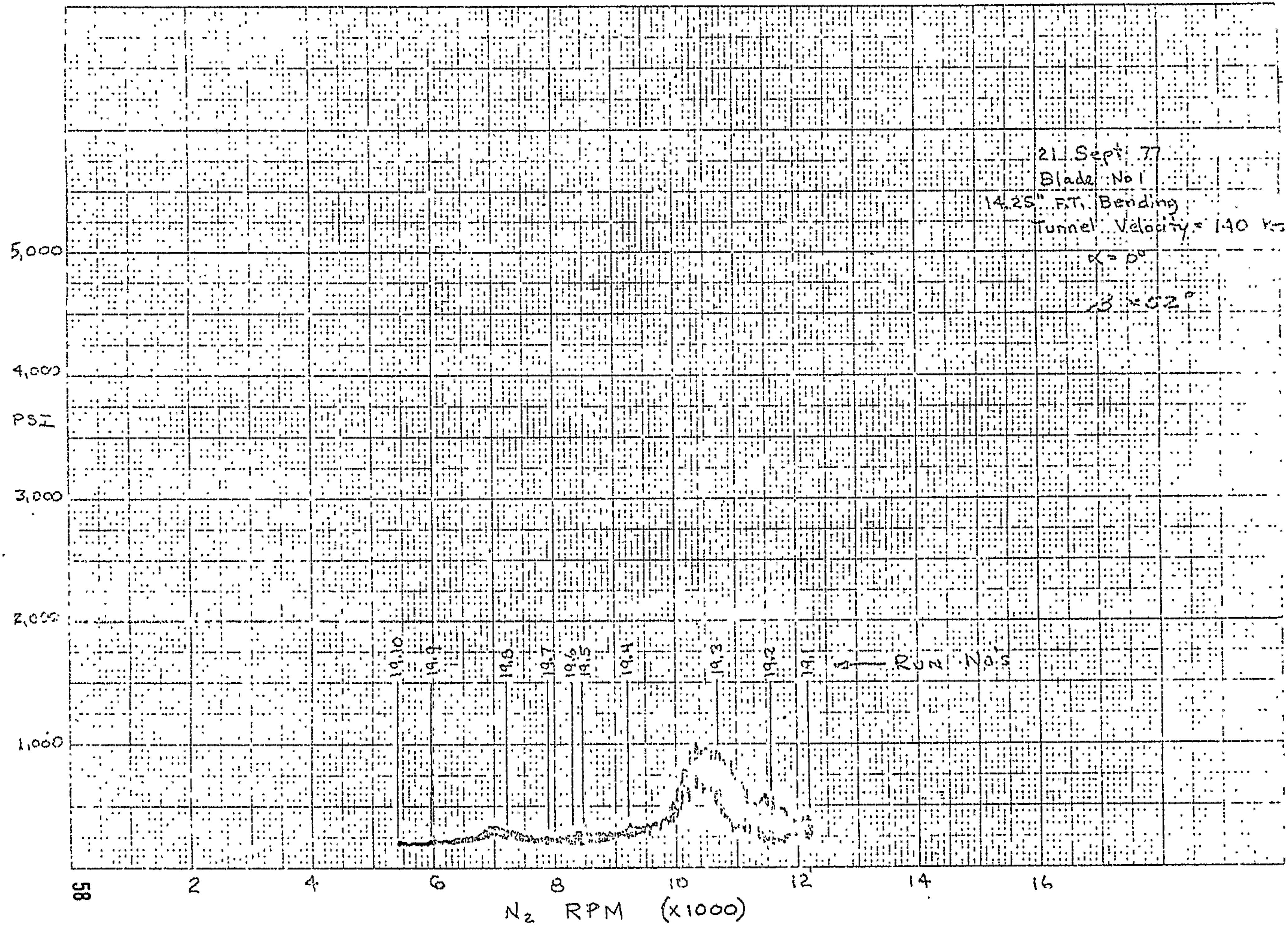


20 Sept 77
Blade No. 1
14.25" F.T. Bending
Tunnel Velocity = 105 K
α = 75°
151 β = 5½°
152 β = 52°
152
151
RUN No's
5,000
4,000
PSI
3,000
2,000
1,000
2
4
6
8
10
12
14
16
N2 RPM (X1000)


21 Sept 77
Blade No 1
14.25" F.T. Bending
Tunnel Velocity = 105 Kts
α = 75°
16.1 β = 56°
16.2 - 16.6 β = 52°
16.6
16.5
16.4
16.3
16.2
16.1
← Run No's
5000
4000
PSI
3,000
2,000
1000
2
4
6
8
10
12
14
16
N2 RPM (X1000)


21 Sept 77
Blade No 1
14.25" F.T. Bending
Tunnel Velocity = 12.5 K
α = -60°
17.1 β = 56°
17.2 - 17.8 β = 2°
17.8
17.7
17.6
17.5
17.4
17.3
17.2
17.1
Run No 3
5,000
4,000
PSI
3,000
2,000
1,000
2
4
6
8
10
12
14
16
N2 RPM (x1000)


21 Sept 77
Blade No. 1
4.25" F.T. Bending
Tunnel Velocity = 140 Kts
α = 0°
18.1 β = 56°
18.2 β = 52°
18.2
18.1
RUN No.
5,000
4,000
PSI
3,000
2,000
1,000
2
4
6
8
10
12
14
16
N2 RPM (x1000)



21 Sept 77
Blade No 1
14.25" F.T. Bending
Tunnel Velocity = 140 K
α = 0°
β = 52°
5,000
4,000
PSI
3,000
2,000
1,000
19.10
19.9
19.8
19.7
19.6
19.5
19.4
19.3
19.2
19.1
← Run No's
2
4
6
8
10
12
14
16
N2 RPM (x1000)

58

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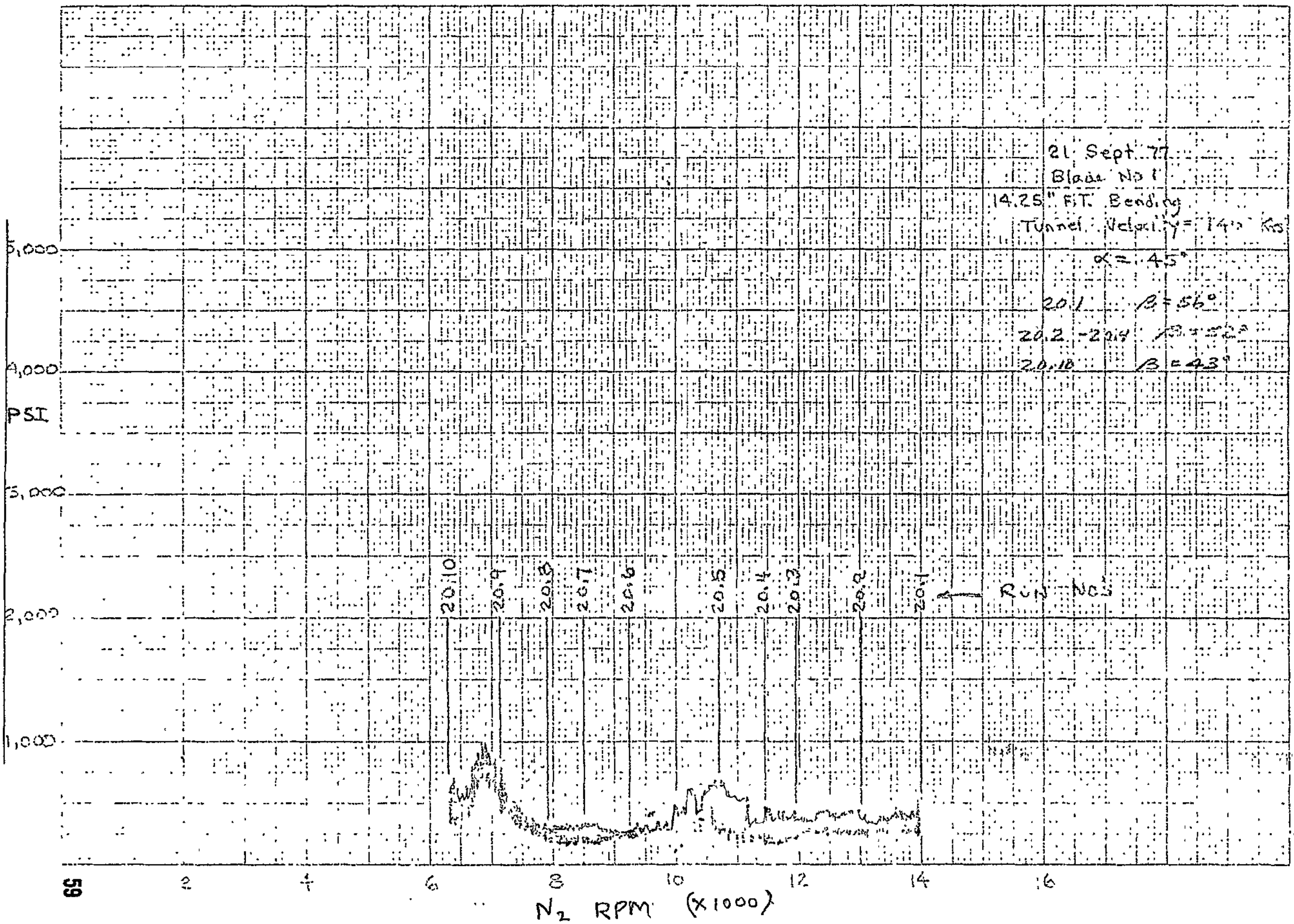

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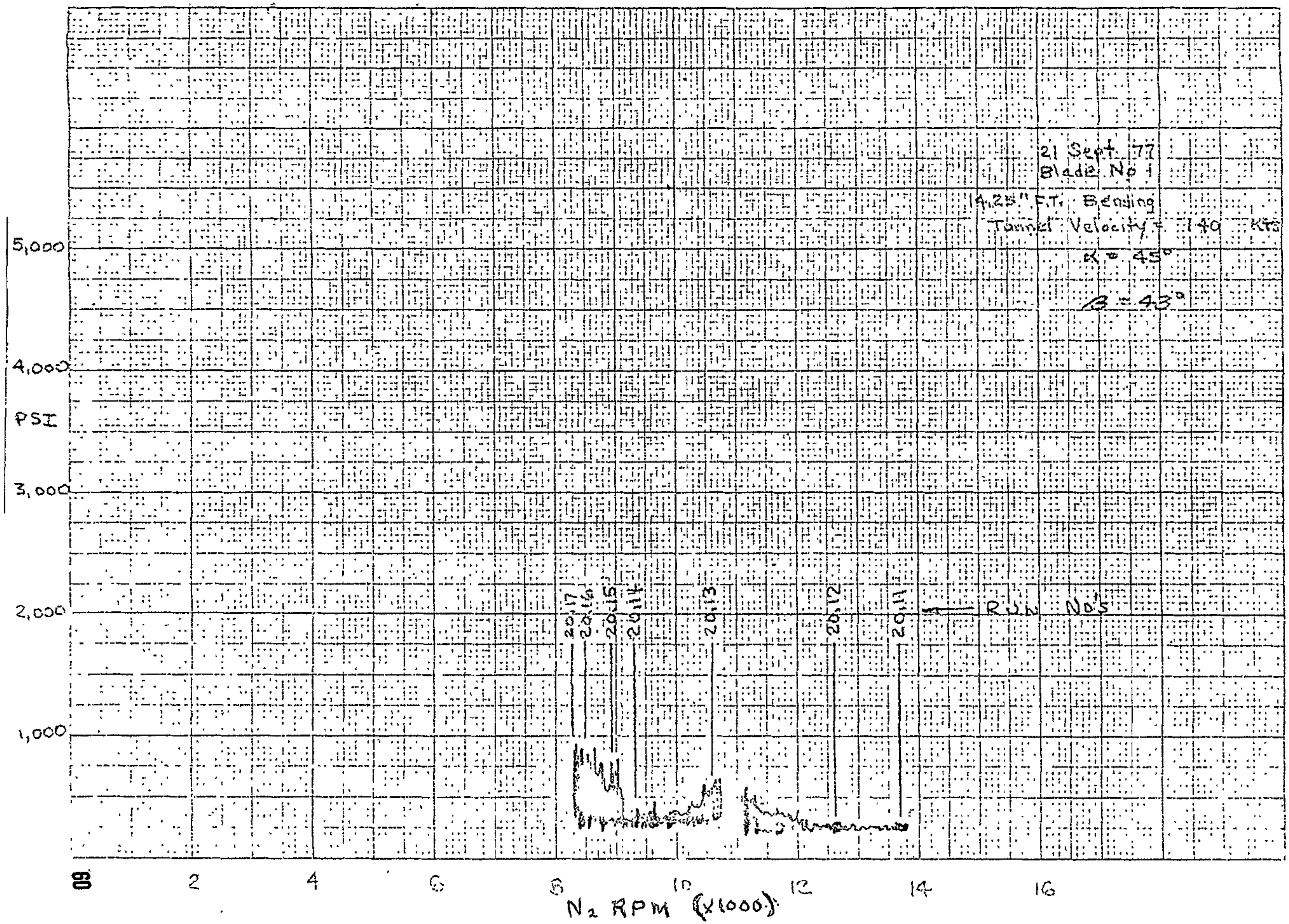
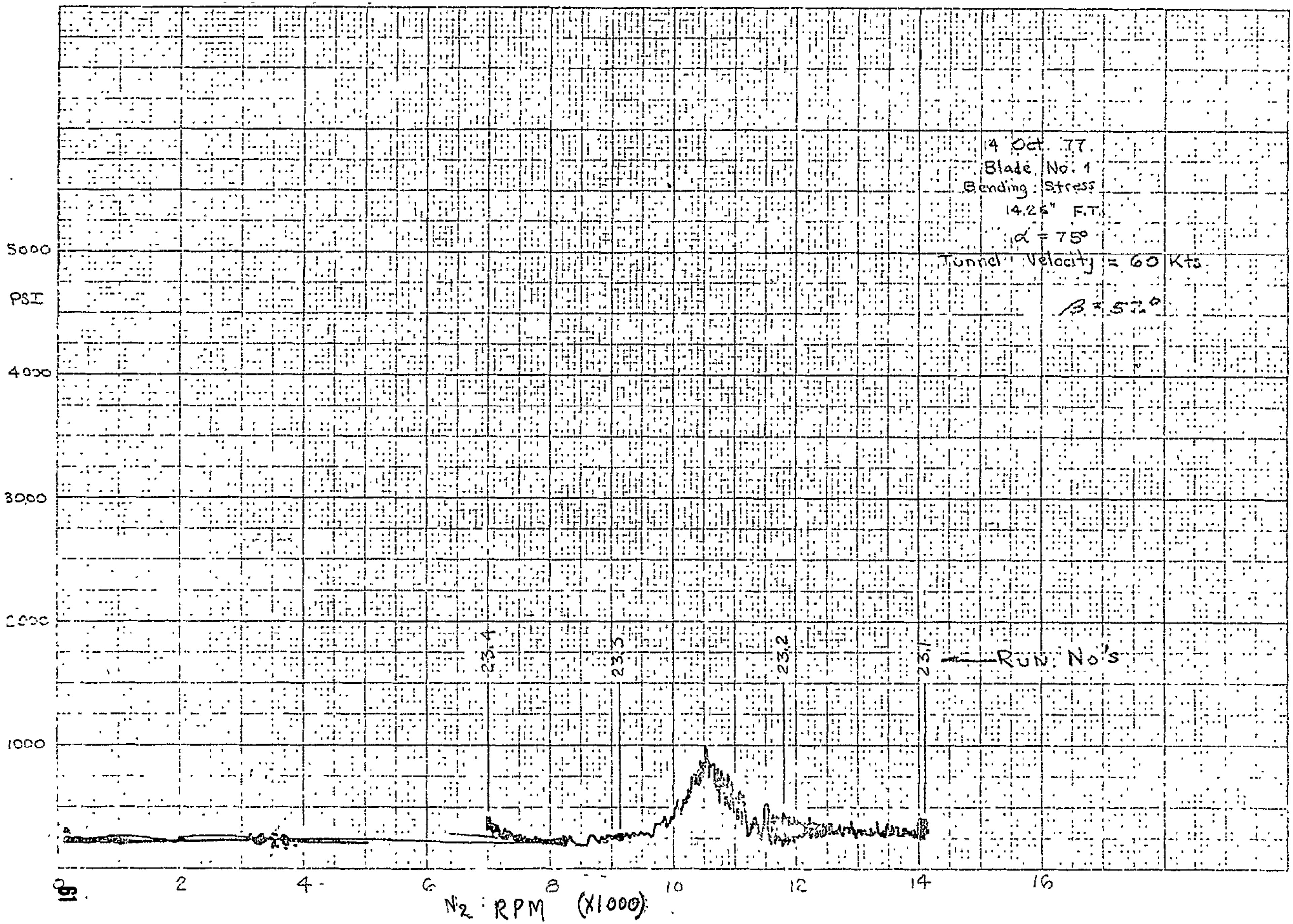
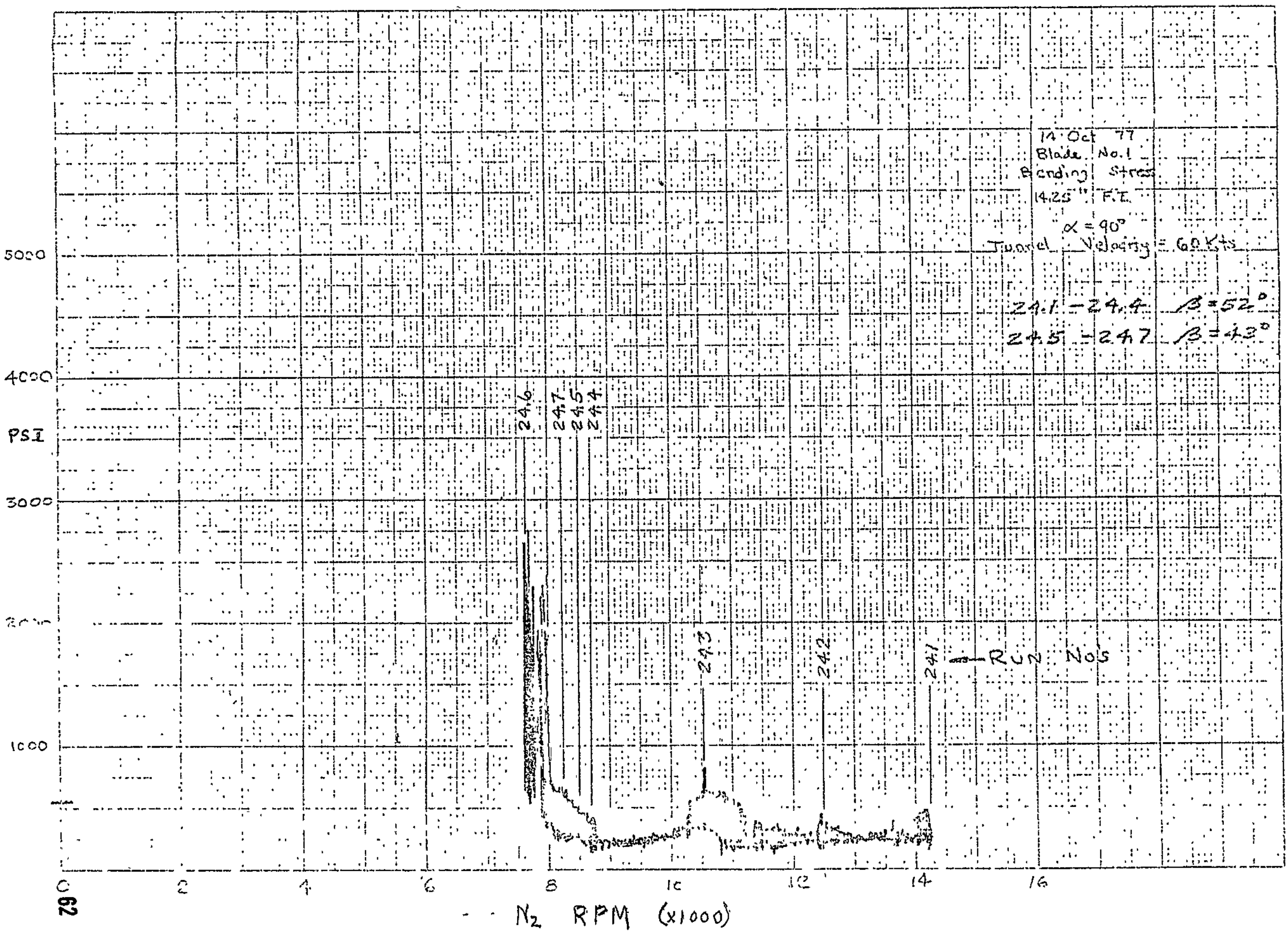



14 Oct. 77
Blade No. 1
Bending Stress
14.25" F.T.
α = 75°
Tunnel Velocity = 60 Kts.
β = 57°
23.4
23.5
23.2
23.1
← Run No's
5000
PSI
4000
3000
2000
1000
2
4
6
8
10
12
14
16
N2 RPM (X1000)

20 X 20 PER INCH

MADE IN U.S.A.



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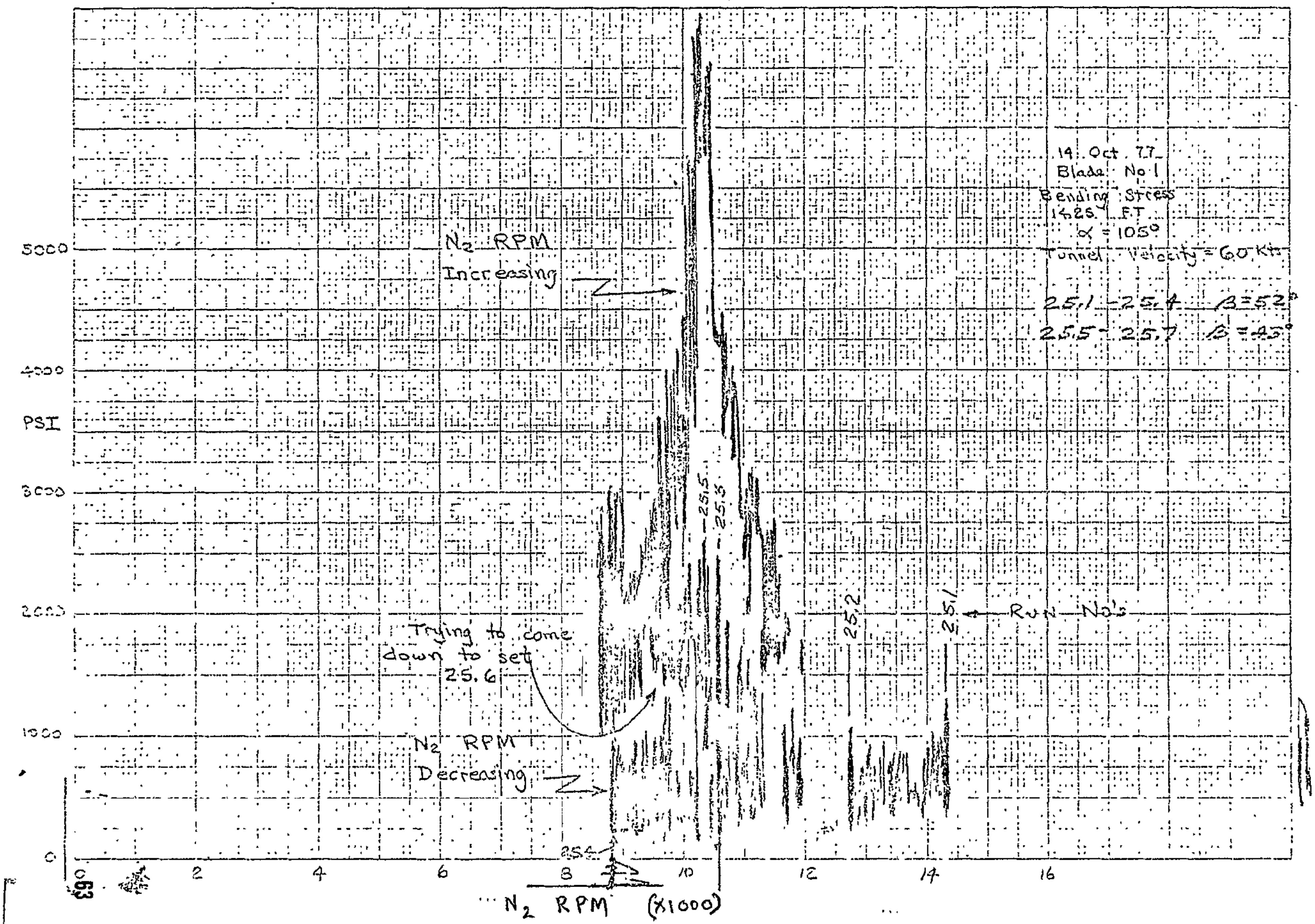

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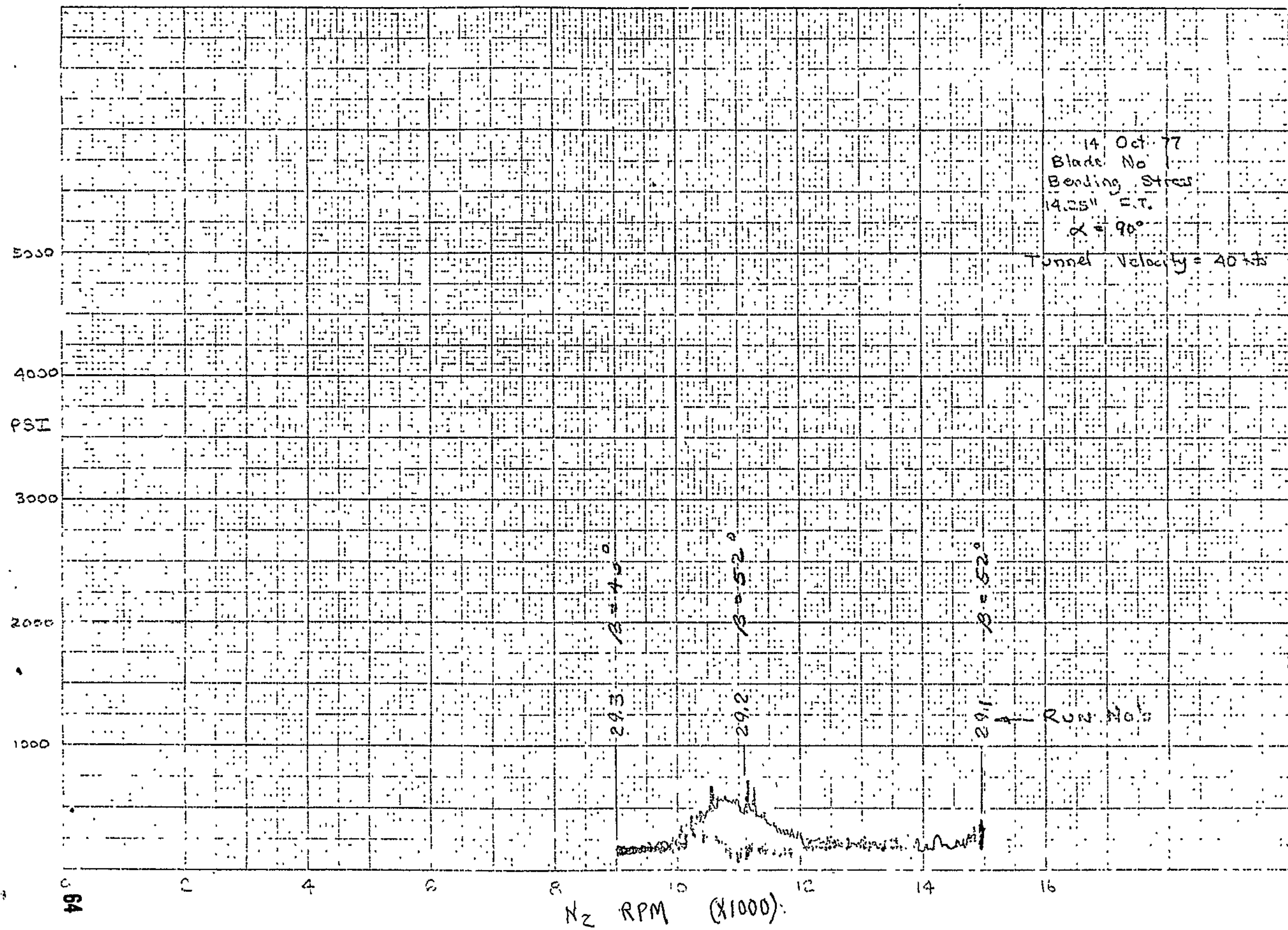

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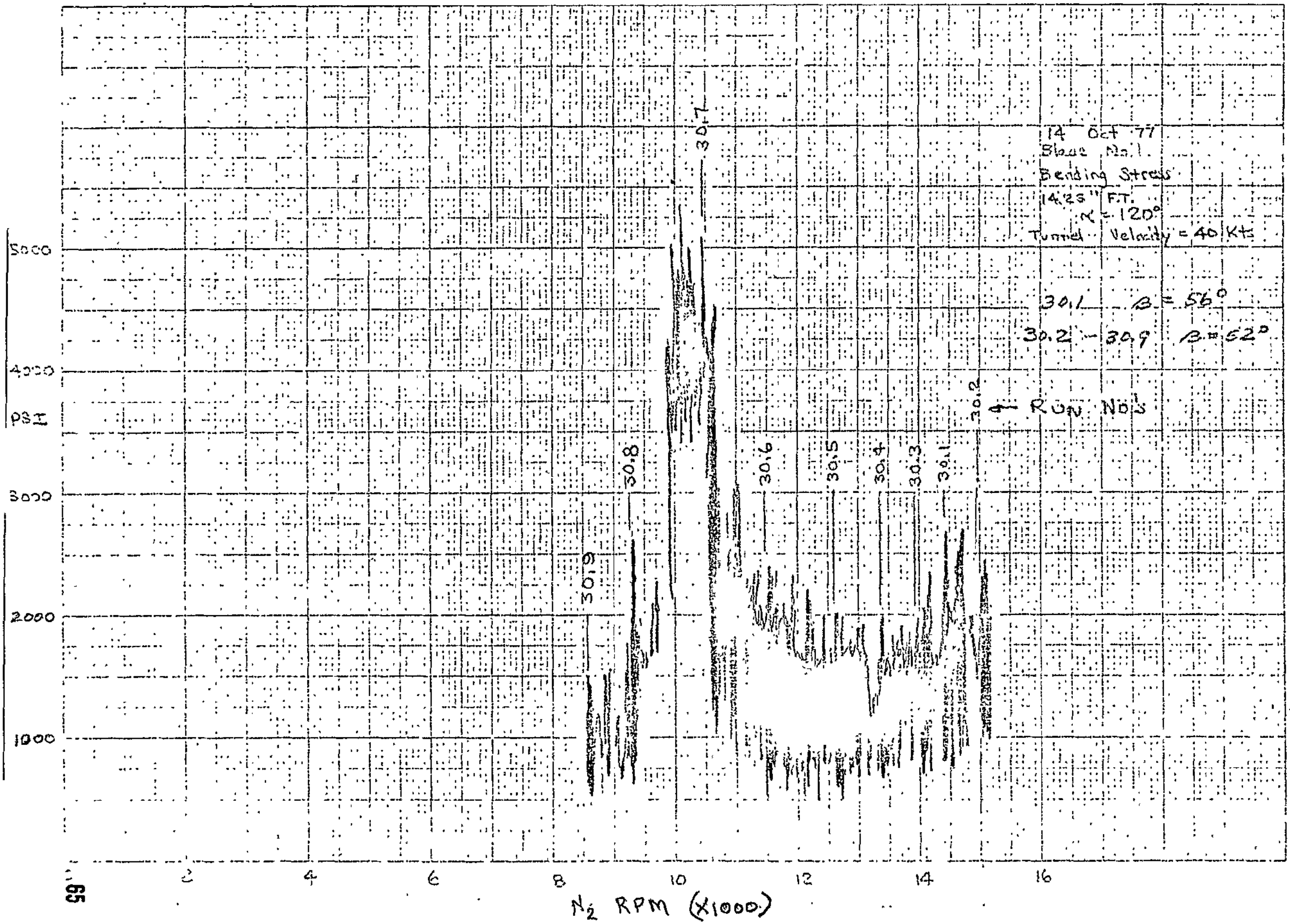
14 Oct 77
Blade No. 1
Bending Stress
14.25" F.T.
α = 120°
Tunnel Velocity = 40 Kts
30.1 β = 56°
30.2 - 30.9 β = 62°
← RUN NO's
30.9
30.8
30.7
30.6
30.5
30.4
30.3
30.1
30.2
5000
4000
PSI
3000
2000
1000
2
4
6
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10
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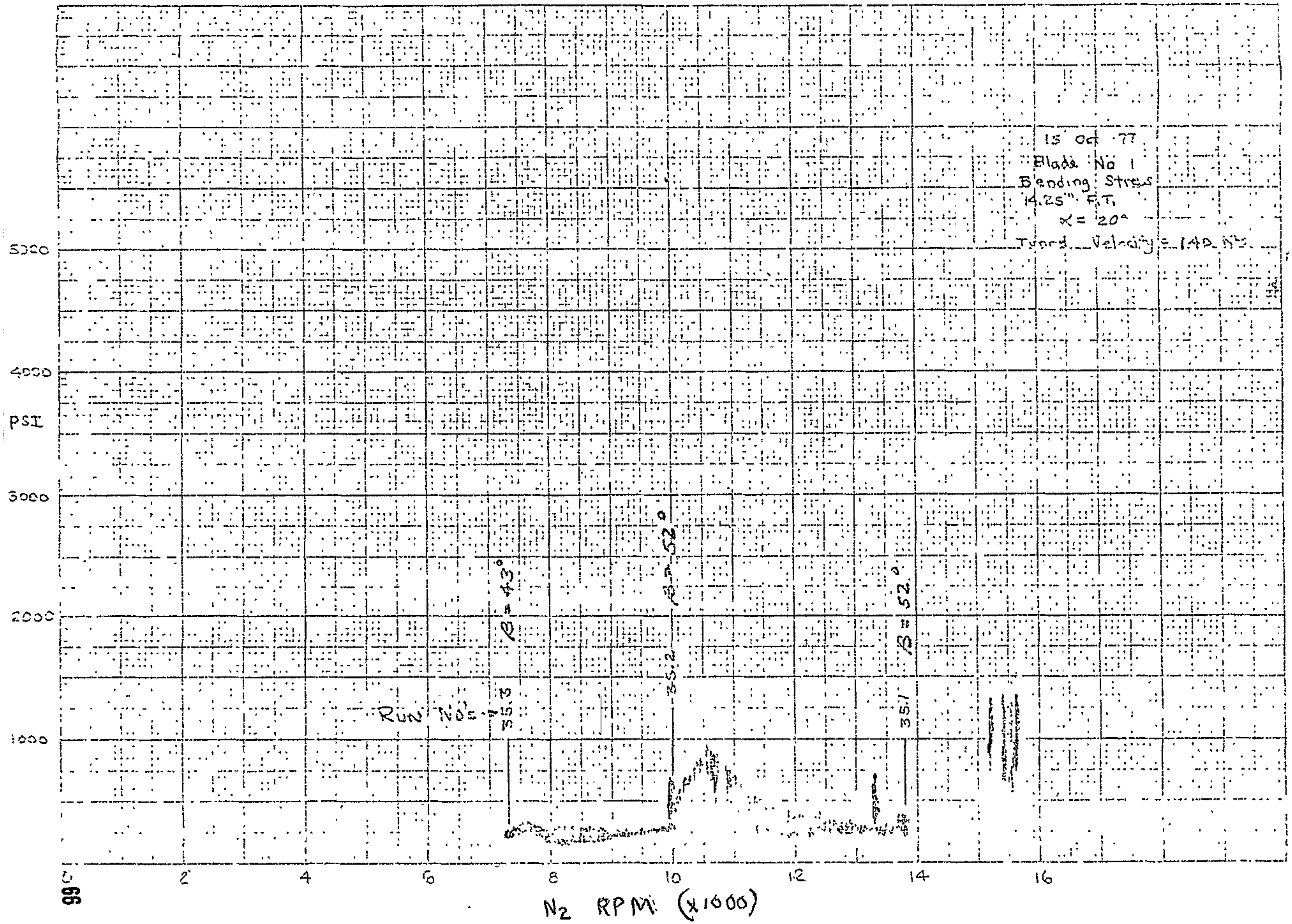
14
16
N2 RPM (X1000)


15 Oct 77
Blade No 1
Bending Stress
14.25" F.T.
$\alpha = 20°$
5000
4000
PSI
3000
2000
1000
Run No's - 35.3
35.2
35.1
$\beta = 43°$
$\beta = 52°$
$\beta = 52°$
0
2
4
6
8
10
12
14
16
N_2 RPM (x1000)

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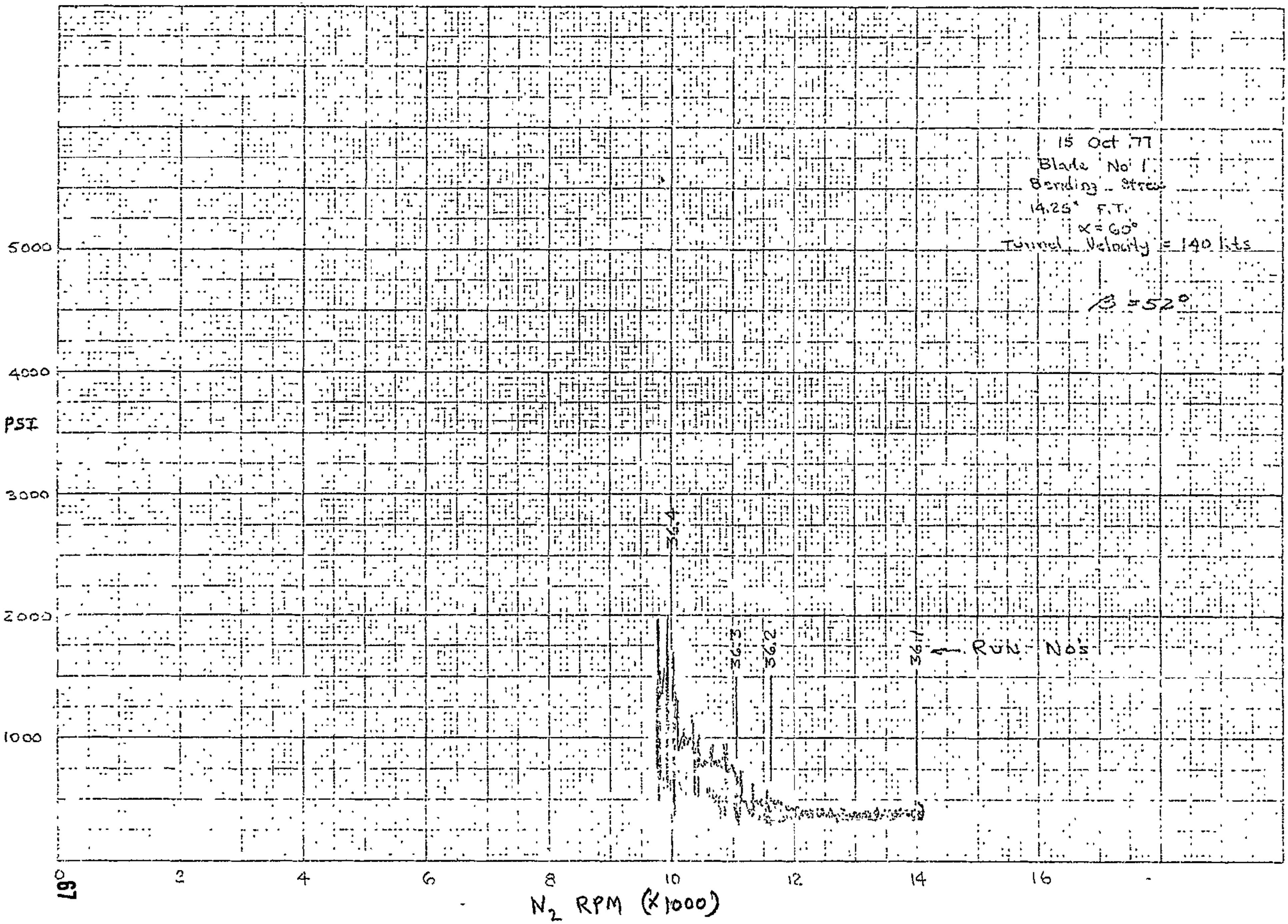

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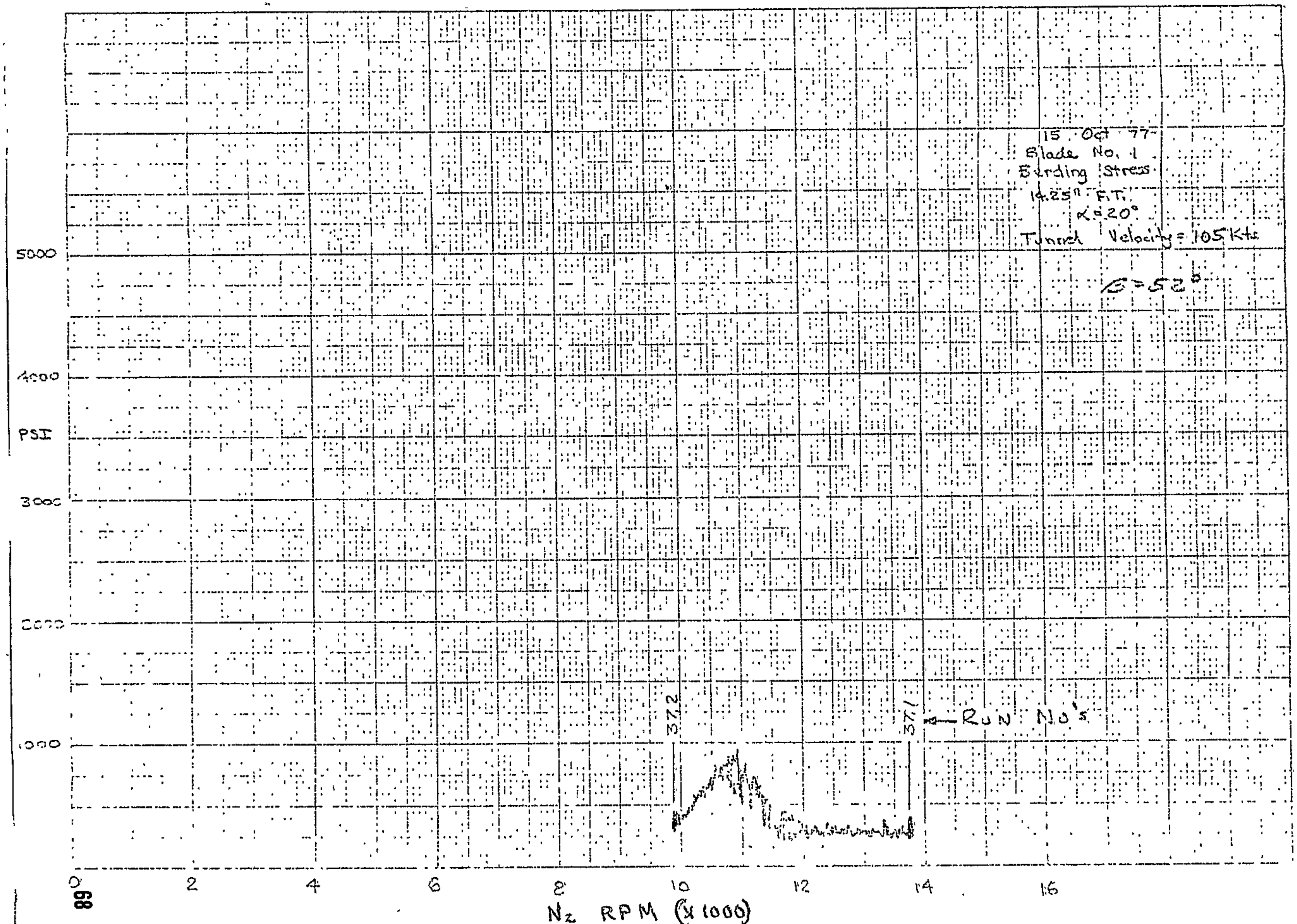

BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

RUN # HS	TEST POINT # BOEING	% TORQUE	Fan RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 9
0	3.1	99	3250	1550	2100	2100	300	225
1	3.2	82	3075	1450	1950	1600	350	350
2	3.3	67	2725	1600	1600	1500	350	500
3	3.4	49	2300	2000	2050	1850	175	175
3	3.5	33	1950	1000	1200	1000	100	150
4	3.6	14	1750	750	950	700	75	75
5	4.1	12	1750	200	350	200	100	70
6	4.2	12	1750	1500	1900	1750	350	350
7	5.1	10	1750	300	450	300	100	75
8	5.2	10	1750	400	600	450	150	125
9	5.3	10	1750	1100	1450	1150	300	275
10	5.4	20	1625	900	1450	1250	125	150
11	5.5	20	1625	1400	2000	1800	225	175
12	5.6	29	1925	1000	1400	1100	250	200
13	5.7	29	1900	1100	1500	1200	300	200
14	6.1	9	1825	650	1000	700	120	100
15	6.2	9	1825	900	1300	1050	150	125
16	6.3	9	1825	1700	1750	1550	225	200
17	6.4	22	1700	800	1300	700	175	125
18	6.5	22	1700	950	1750	1100	225	150
19	6.6	22	1700	1600	2000	1800	300	200
20	6.7	42	2300	2100	2450	2000	300	350
21	6.8	42	2300	3200	3700	3000	375	400
22	6.9	59	2700	1300	1700	1350	350	350
23	6.10	59	2700	1500	1950	1850	450	375
24	6.11	59	2700	2000	2900	2200	500	425
25	7.1	2	1600	1450	1950	1300	150	100
26	7.2	6	1850	1600	2100	1800	275	225
27	7.3	6	1850	2800	2750	2800	300	300
28	7.4	18	1750	1200	1550	1100	200	200
29	7.5	18	1750	2400	2600	2400	350	300
30	7.6	36	2275	2850	3200	2900	400	425
31	7.7	36	2275	4200	4800	4200	475	500
32	7.8	53	2725	2300	2800	2300	575	525
33	7.9	53	2725	2700	3200	2900	700	650
34	8.1	79	3100	950	1400	1000	250	275
35	9.1	79	3075	900	1400	1200	275	200
36	9.2	66	2800	900	1200	850	225	175
37	9.3	48	2350	1200	1700	1350	150	225
38	9.4	33	2000	500	900	500	150	75
39	9.5	11	1700	250	650	300	75	70
40	10.1	77	3050	900	1350	950	225	200
41	10.2	63	2750	700	1400	800	200	200
42	10.3	41	2225	1150	1550	1150	150	150
43	10.4	21.5	1675	400	700	575	100	60
44	10.5	8.5	1650	800	1350	800	100	60

Ref # 013451

BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

RUN #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 9
45	11.1	76	3075	1000	1400	1100	300	225
46	11.2	60	2725	800	1200	800	250	225
47	11.3	37	2175	800	1350	800	150	175
48	11.4	19	1600	1800	2150	1300	200	200
49	11.5	15	2000	1200	1500	1100	275	225
50	11.6	13	1925	1700	2100	1500	350	300
51	12.1	75	3050	950	1450	950	250	200
52	12.2	62	2775	850	1350	900	200	200
53	12.3	43	2325	1700	1950	1550	150	175
54	12.4	18	1600	650	950	450	75	85
55	12.5	8	1650	450	900	350	100	75
56	13.1	93	2950	600	700	600	350	250
57	13.2	73	2800	400	600	400	250	300
58	13.3	62	2600	350	500	400	550	350
59	13.4	57	2500	350	500	450	500	400
60	13.5	45	2250	500	700	450	250	225
61	13.6	38	2050	450	700	500	250	200
62	13.7	30	1850	550	700	500	200	200
63	13.8	28	1825	850	900	800	400	225
64	13.9	36	2900	300	450	350	250	250
65	13.10	25	2500	550	800	600	450	450
66	13.11	23	2425	900	1050	900	450	475
67	13.12	21	2300	1950	2400	2000	475	475
68	—		—		—	—	—	—
69	14.1	75	2950	450	600	500	250	250
70	14.2	59	2600	400	500	350	300	250
71	14.3	33	2000	350	550	300	200	150
72	14.4	27	1850	250	400	250	200	80
73	14.5	18	1600	450	550	400	225	100
74	14.6	16	1550	700	800	650	225	175
75	14.7	15	1500	1000	1350	950	250	175
76	15.1	88	2900	600	800	700	300	225
77	15.2	68	1925	550	750	600	300	275
78	16.1	88	2900	650	850	800	300	225
79	16.2	68	2775	500	800	550	300	275
80	16.3	58	1550	500	700	450	550	500
81	16.4	50	2400	650	950	650	425	450
82	16.5	41	2200	1850	2000	1600	400	350
83	16.6	39	2175	2500	2700	2400	450	425
84	17.1	82	2800	475	600	500	300	300
85	17.2	60	2700	500	750	450	275	275
86	17.3	52	2550	400	550	450	550	475
87	17.4	44	2350	600	600	450	350	325
88	17.5	35	2175	650	1000	700	225	175
89	17.6	30	2025	500	1150	500	250	225
90	17.7	25	1900	600	850	650	300	275
91	17.8	21	1800	775	1400	13.50	475	475

REEL 013491 (runs 45–55)

REEL 013492 (from run 56)

BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

	RUN #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 7
REEL 013492	92	18.1	91	3050	650	800	600	250	325
	93	18.2	73	2975	450	650	500	200	225
	94	19.1	57	2600	450	575	475	250	300
	95	19.2	50	2450	475	600	550	275	325
	96	19.3	42	2250	800	975	700	175	200
	97	19.4	30	1950	300	450	300	150	100
	98	19.5	23	1750	200	350	250	175	90
	99	19.6	23	1750	200	400	250	175	100
	100	19.7	18	1650	200	350	200	100	100
	101	19.8	14	1500	250	400	225	100	75
	102	19.9	6	1250	150	300	175	100	75
	103	19.10	4	1175	125	325	200	100	75
	104	20.1	89	3000	550	850	600	275	275
	105	.2	64	2800	375	700	450	250	225
	106	.3	53	2575	300	475	400	300	300
	107	.4	48	2450	375	550	480	300	325
	108	.5	38	2250	650	800	600	225	225
	109	.6	26	1950	300	450	300	200	175
	110	.7	20	1800	250	450	250	175	125
	111	.8	16	1650	275	550	400	175	100
	112	.9	10	1500	700	800	800	150	150
	113	.10	6	1300	800	950	750	225	175
	114	.11	26	2950	250	450	300	250	225
	115	.12	20	2750	250	550	325	250	175
	116	.13	12	2300	600	850	700	200	125
	117	.14	6.5	2000	550	750	600	275	150
	118	.15	5	1900	650	900	700	325	175
	119	.16	4	1800	1000	1500	1500	400	275
	120	20.17	3	1750	1300	1575	1700	450	325
REEL 013494	121	23.1	79	3000	450	550	450	250	175
	122	.2	57	2550	400	450	450	400	275
	123	.3	32	1950	300	450	225	150	80
	124	.4	16	?	350	450	175	150	100
	125	23.5	10		300	700	350	150	100
	126	24.1	80	3050	500	650	500	300	325
	127	.2	63	2575	450	500	375	250	300
	128	.3	45	2250	700	800	500	200	175
	129	.4	28	1875	300	400	200	125	150
	130	.5	14	1850	500	700	500	250	275
	131	.6	11	1625	3000	3800	3900	750	1100
	132	24.7	12	1750	800	950	900	350	375
	133	25.1	80	3050	1900	2900	2600	950	1650
	134	.2	67	2750	2200	2400	2000	850	850
	134	.3	46	2300	2800	3200	2900	625	550
	135	.4	30	1900	1150	1600	1300	500	475
	136	.5	20	2200	1250	1700	1700	500	650
	137	.6	15	1850	4410	5100	4400	700	700
	138	25.7	35	2875	1400	1300	1300	700	750

BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

REEL [illegible]

RUN #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 9
139	26.1	75	3000	500	700	450	300	325
140	.2	60	2700	400	600	350	250	300
141	.3	38	2175	600	700	475	225	175
142	.4	22	1725	250	450	200	150	100
143	.5	10	1800	350	500	300	250	200
144	.6	9	1725	500	600	550	225	150
145	.7	8	1650	900	1000	975	350	225
146	26.8	4	1375	2800	2850	2800	450	550
147	27.1	73	3000	575	700	550	300	350
148	.2	58	2675	450	600	400	350	350
149	.3	37	2150	550	850	500	200	175
150	.4	26	1850	550	750	550	300	225
151	.5	20	1650	5000	5800	6000	850	750
152	.6	16	2000	5800	5600	5900	850	1000
153	.7	32	2000	450	650	475	300	175
154	.8	16	2000	5800	6200	5700	950	850
155	27.9	20	2350	1450	1980	1400	425	350
156	28.1	77	3050	600	650	550	450	350
157	.2	60	2700	500	700	475	400	300
158	.3	50	2450	650	950	650	475	500
159	.4	46	2350	950	1350	750	475	425
160	28.5	40	2225	2800	3350	2600	525	425
161	29.1	85	3200	600	900	800	450	400
162	.2	50	2400	600	800	600	325	350
163	29.3	16	1950	200	380	250	175	120
164	30.1	97	3150	5000	4600	4900	1350	1400
165	.2	87	3250	4000	4900	4800	1450	1200
166	.3	79	3050	3300	4800	3850	1350	1425
167	.4	73	2900	3200	3950	4400	1275	1200
168	.5	66	2750	3200	3900	3400	1150	1000
169	.6	55	2500	3100	4500	3800	1100	1050
170	.7	46	2300	5500	5700	5000	900	800
171	.8	34	2000	3400	3700	3500	800	750
172	30.9	29	1850	2300	2400	2650	650	600

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BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

RUN #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	35" VEE 2	35" VEE 9
REEL 613414 173	31.1	24	1750	300	450	300	150	150
174	31.2	"	1750	500	700	500	225	200
175	31.3	"	1750	1300	1500	1400	350	325
176	31.4	"	1750	6000	5400	6400	800	850
177	31.5	"	1750	5800	5800	6000	850	800
178	31.6	"	1750	700	950	750	325	375
179	31.7	"	1750	700	975	650	275	350
180	32.1	11	1950	200	400	225	150	100
181	.2	11	1950	250	475	350	200	150
182	.3	11	1950	475	650	500	275	225
183	.4	11	1950	900	1500	1000	550	350
184	.5	26	1900	300	450	400	200	200
185	.6	26	1900	350	550	450	250	225
186	.7	26	1900	500	750	550	300	225
187	.8	26	1900	1350	1450	1350	525	350
188	.9	41	2350	600	700	500	250	275
189	.10	42	2300	1000	1400	1000	375	400
190	.11	43	2300	1400	1800	1400	475	500
191	.12	43	2300	2200	2600	2350	600	650
192	.13	66	2900	600	850	500	250	275
193	.14	66	2900	800	950	800	475	400
194	.15	66	2900	900	1200	925	525	500
195	.16	66	2875	1100	1450	1150	625	675
196	.17	66	2875	1250	1500	1400	700	775
197	.18	89	3050	650	875	650	350	300
198	.19	89	3050	950	1100	1000	525	475
199	.20	89	3050	1350	1450	1450	600	725
200	32.21	89	3050	1450	1750	1850	725	850
201	33.1	84	3000	1450	1500	1475	675	725
202	33.2	84	3000	1750	1900	1850	775	875
203	34.1	3	1725	350	550	450	150	125
204	.2	2	1725	900	1150	1050	350	300
205	.3	26	2000	400	550	350	225	200
206	.4	26	2025	800	1000	700	300	225
207	.5	26	2025	1200	1600	1025	450	400
208	.6	50	2600	450	500	350	375	350
209	.7	50	2600	650	850	650	400	400
210	.8	50	2600	700	900	800	450	450
211	.9	50	2600	1150	1300	1100	575	550
212	.10	77	2850	475	600	550	250	325
213	.11	76	2850	1000	1350	1150	575	775
214	.12	76	2850	1675	2000	1700	850	1125
215	35.1	70	2950	400	600	450	200	250
216	.2	34	2150	500	850	400	150	175
217	.3	5	1550	200	375	200	100	100

BOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

	RUN #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	35" VEE 2	35" VEE 9
REEL 13494	218	36.1	70	3025	600	950	600	400	375
	219	.2	46	2500	500	650	500	575	600
	220	3	40	2400	650	850	700	450	450
	221	.4	31	2150	1900	2500	1450	475	475
	222	36.15	30	2100	2500	2975	1975	650	575
13495	223	37.1	71	2950	450	500	500	225	275
	224	37.2	40	2250	750	1100	750	200	225
	225	37.3	4.5	1400	200	300	250	125	100
	226	38.1	81	3150	500	600	650	300	225
	227	38.2	45	2325	900	900	950	225	325
	228	38.3	10	1700	300	300	350	150	150

END OF BOEING TEST

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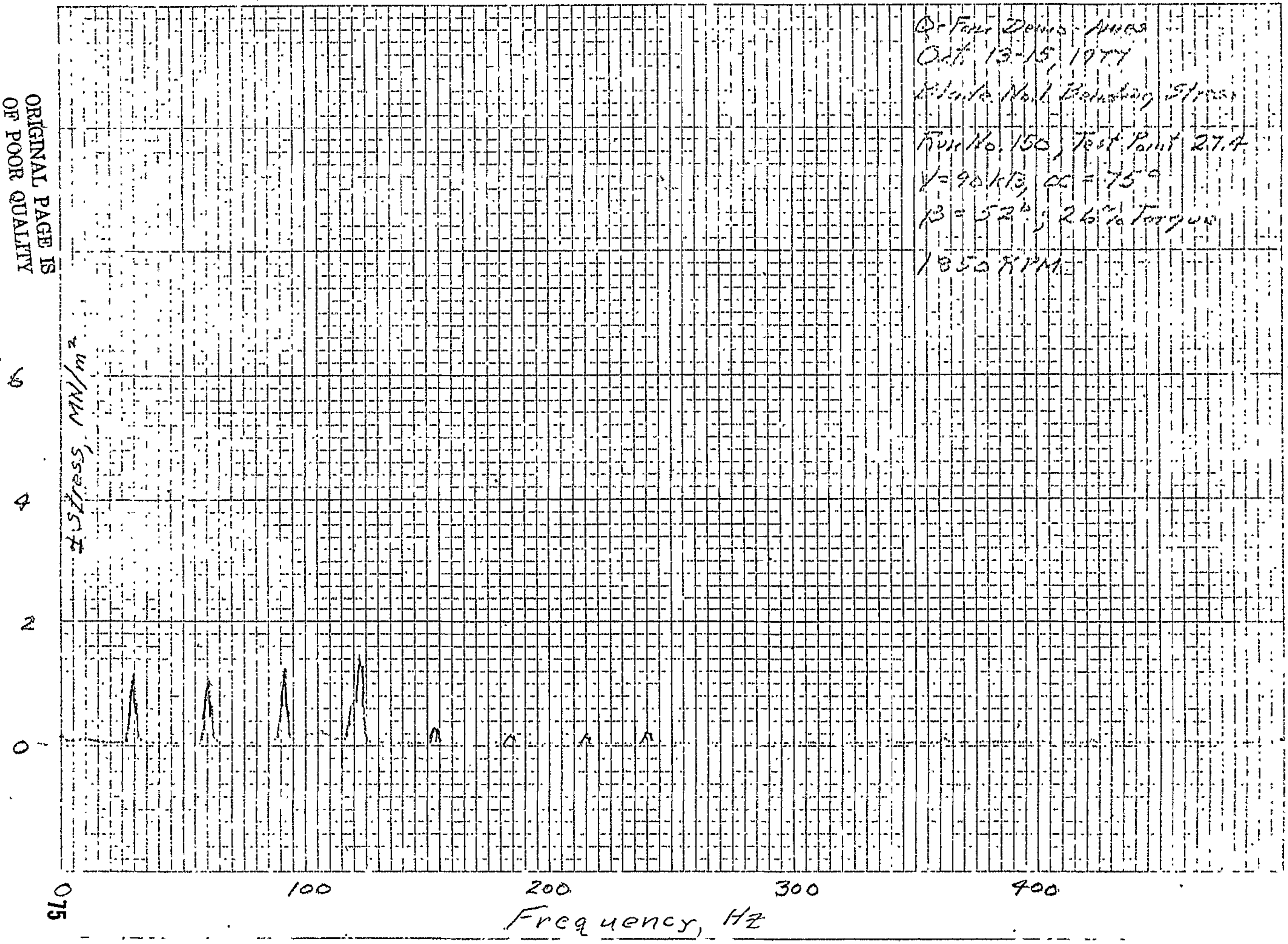
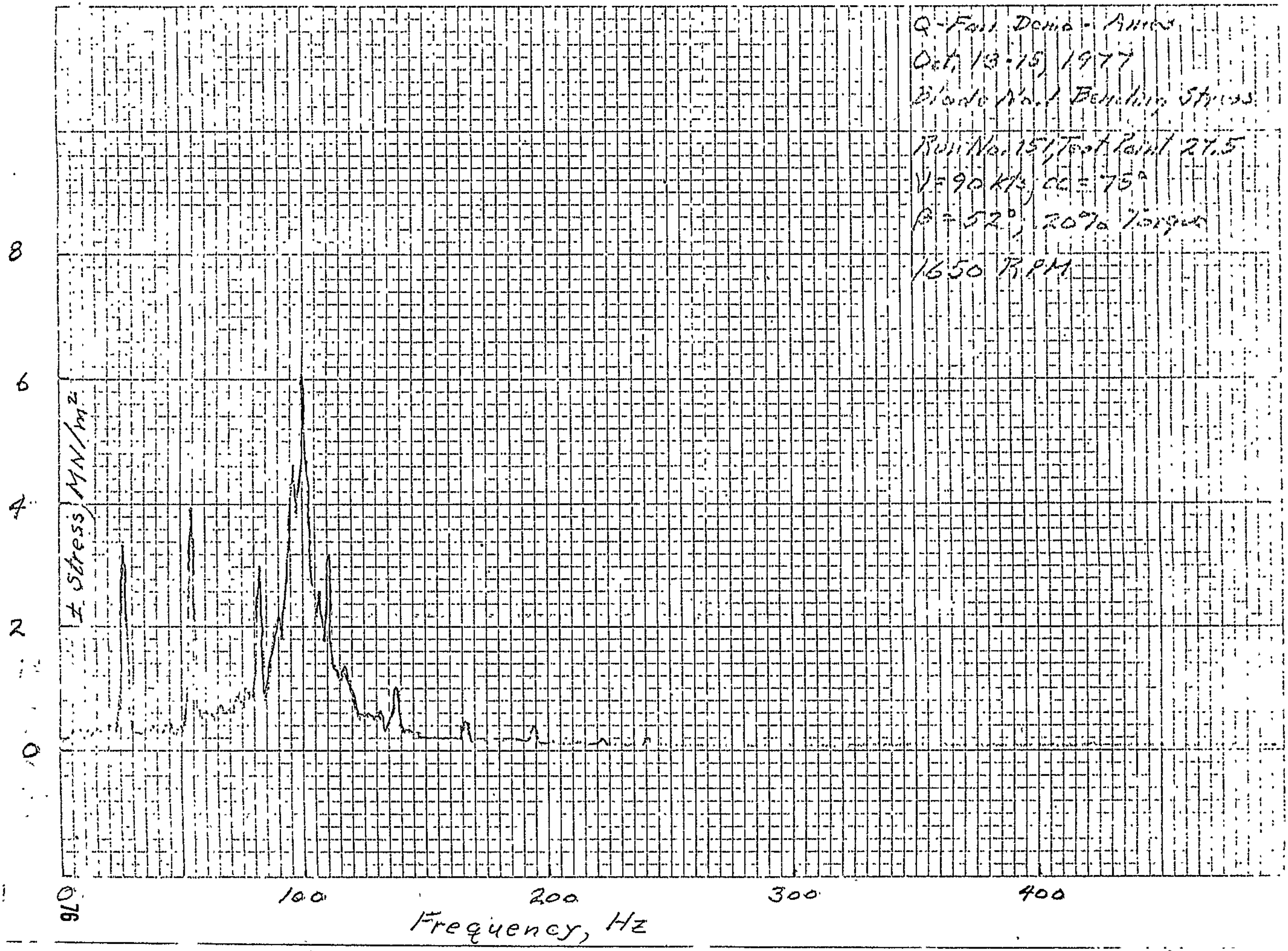

Q-Fan Demo - Ames
Oct 13-15, 1977
Blade No. 1 Bending Stress
Run No. 150, Test Point 27.7
V = 90 kts, α = 75°
β = 52°, 26% Torque
1850 RPM
± Stress, MN/m²
6
4
2
0
0
100
200
300
400
Frequency, Hz



Q-Fan Demo - Runs
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 15 / Test Point 27.5
V = 90 KTS, α = 75°
β = 52°, 20% Torque
1650 RPM
8
6
4
2
0
± Stress MN/m²
0
100
200
300
400
Frequency, Hz

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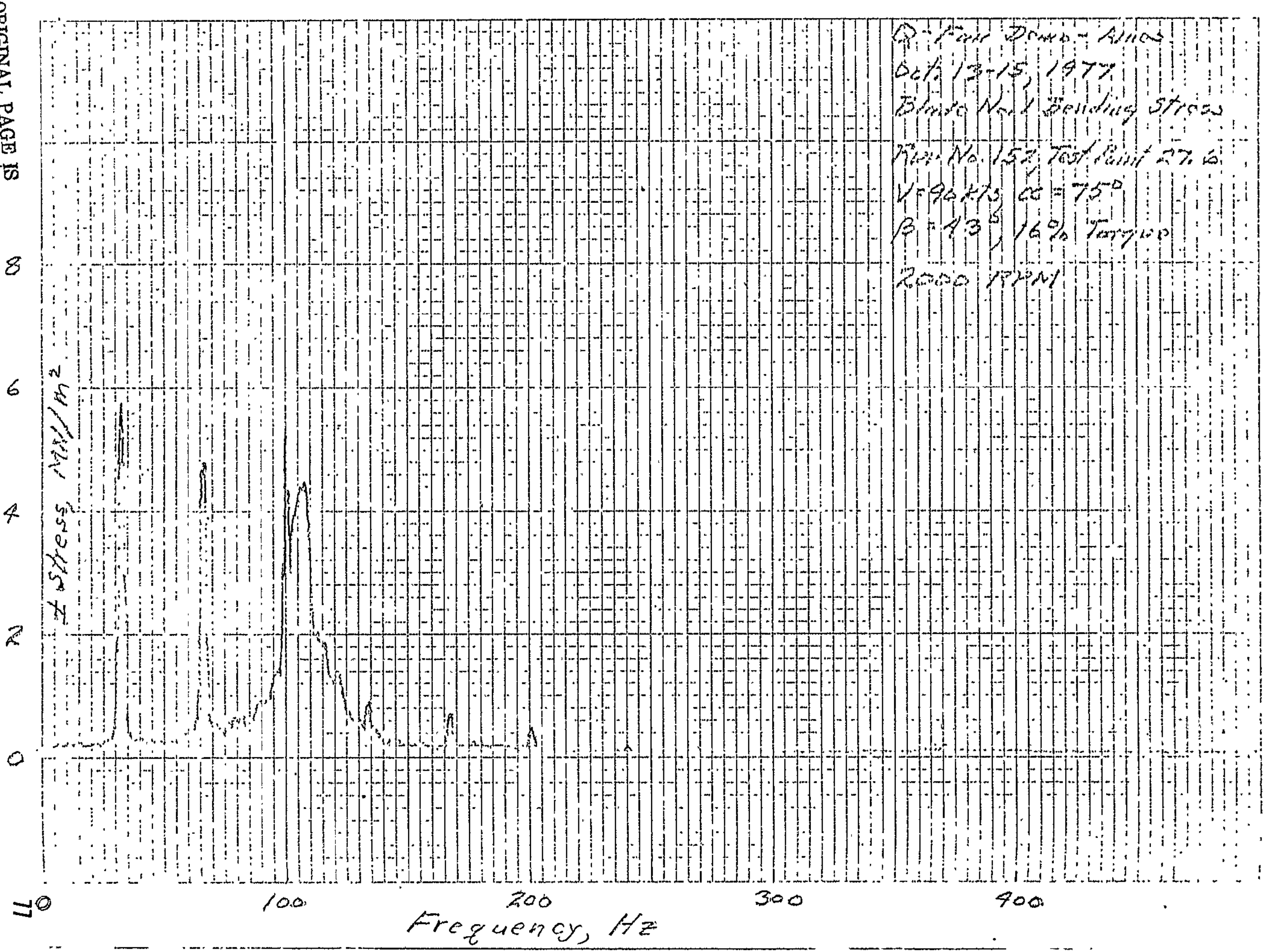
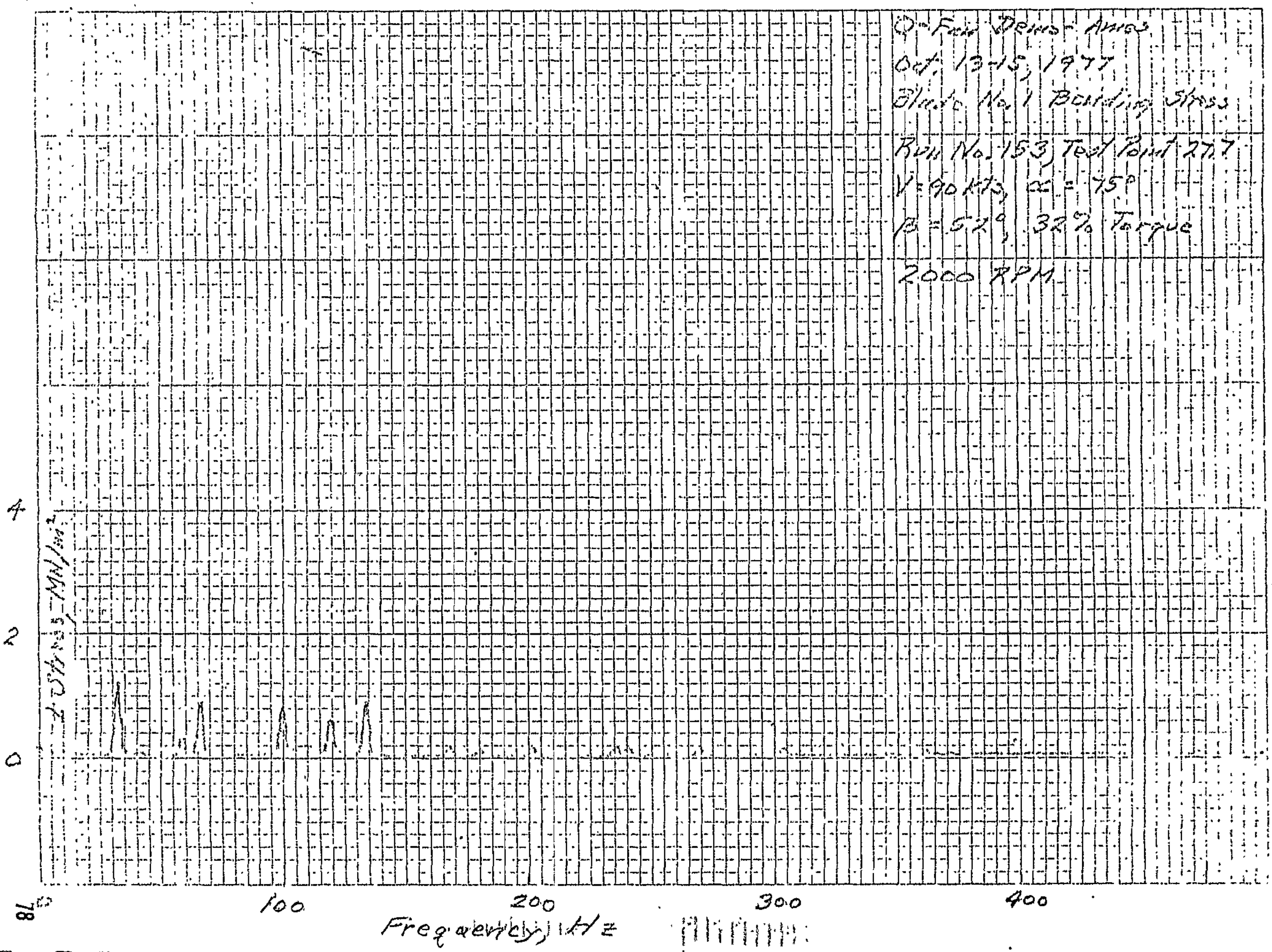
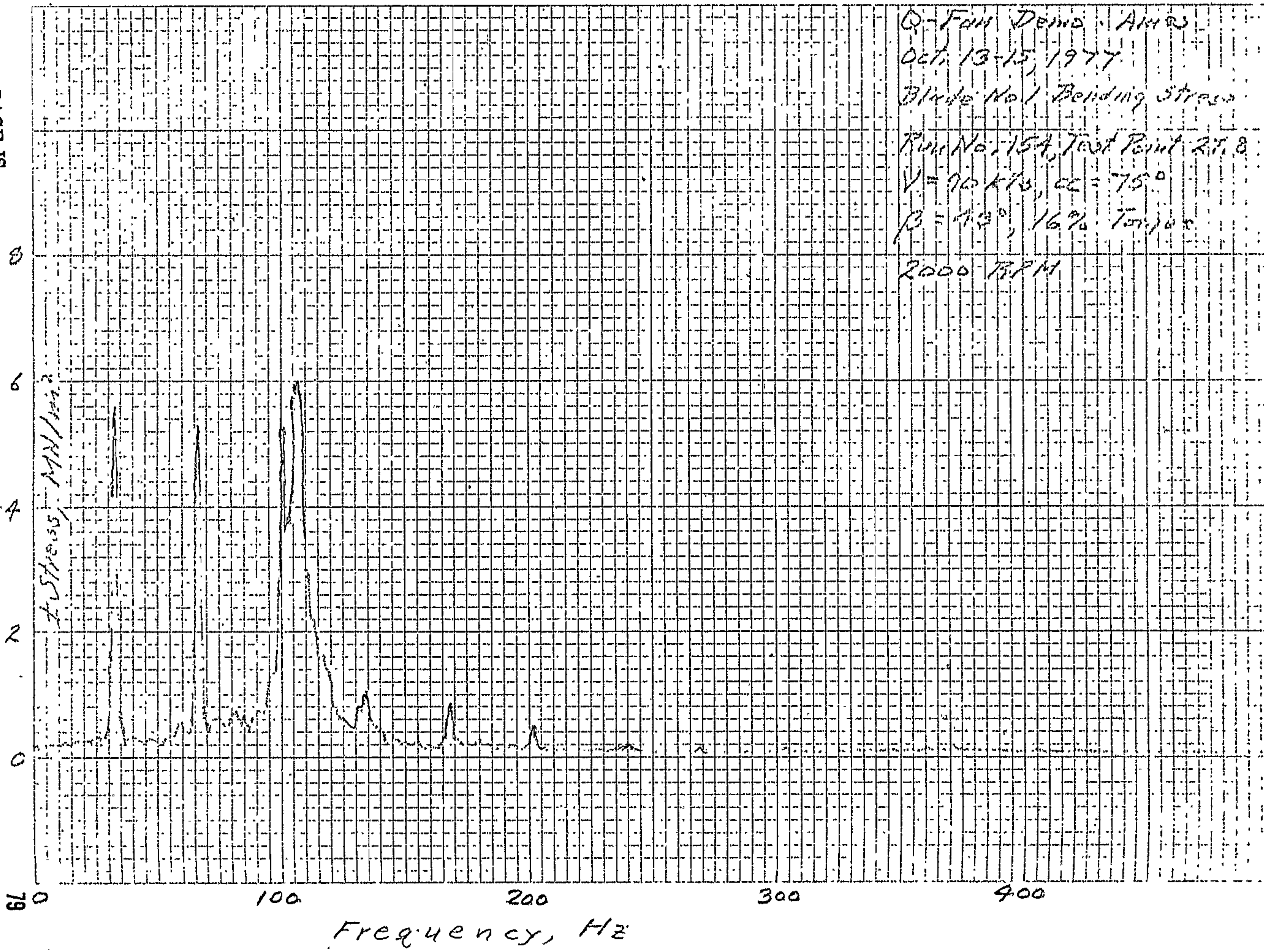
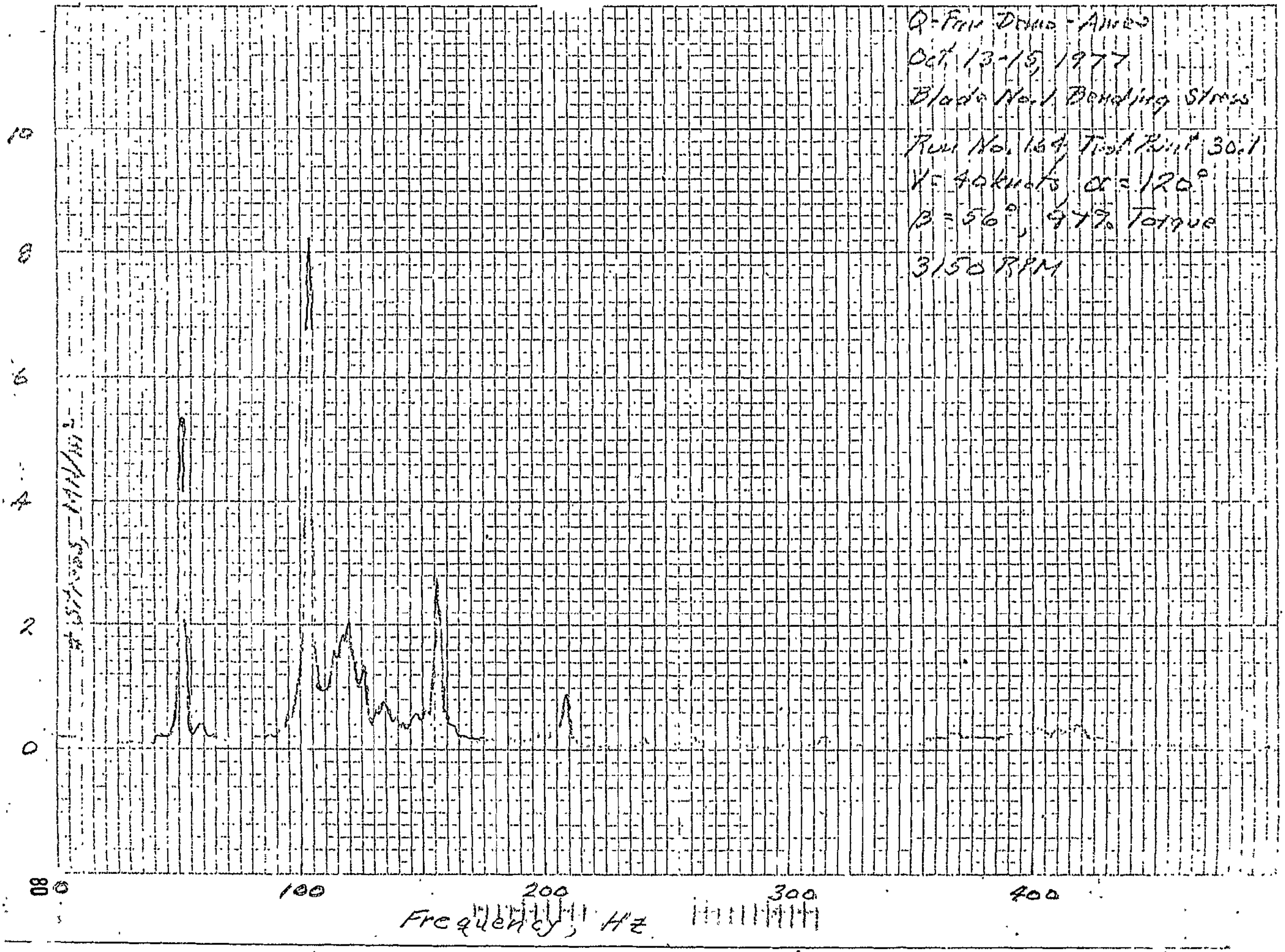
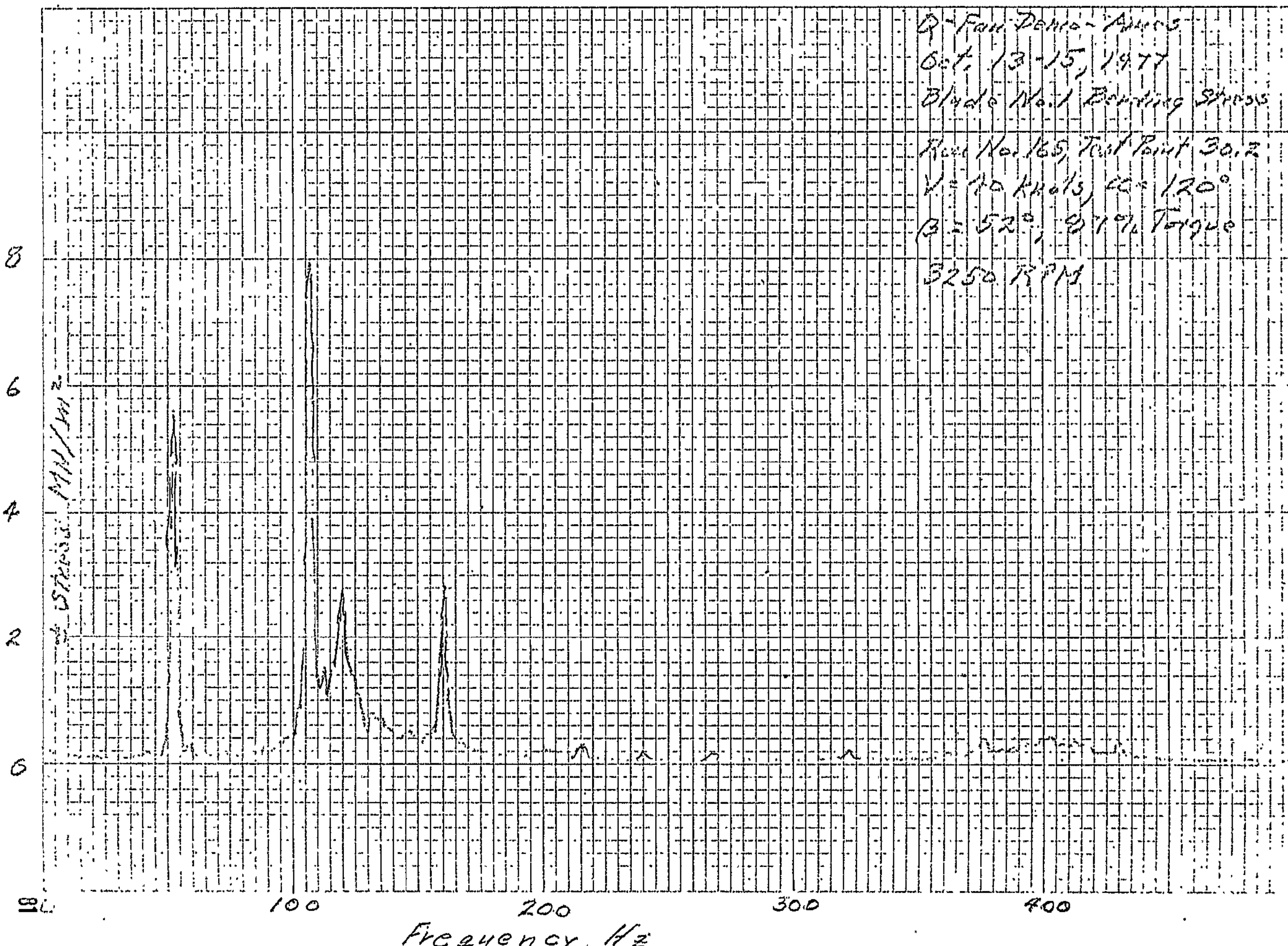
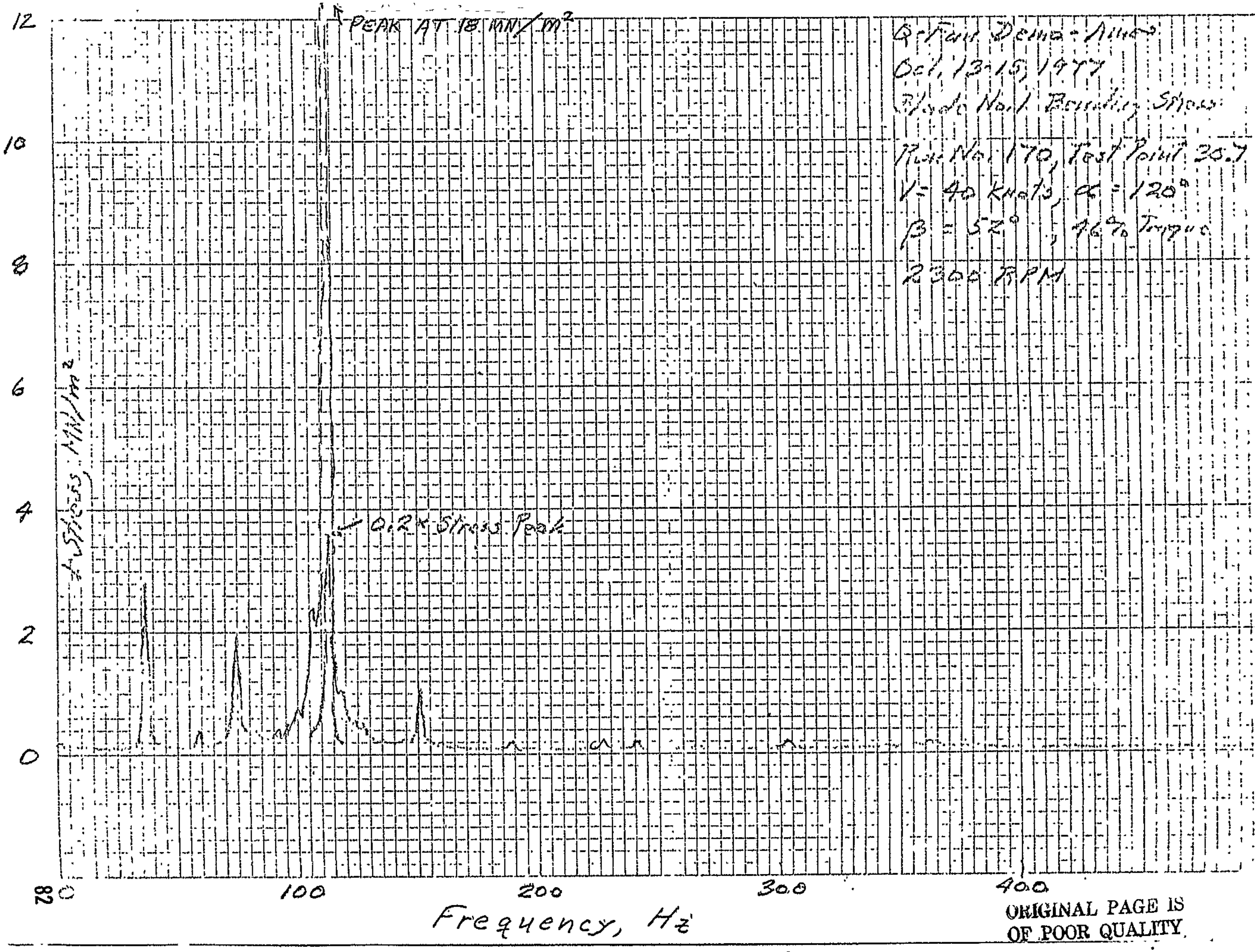


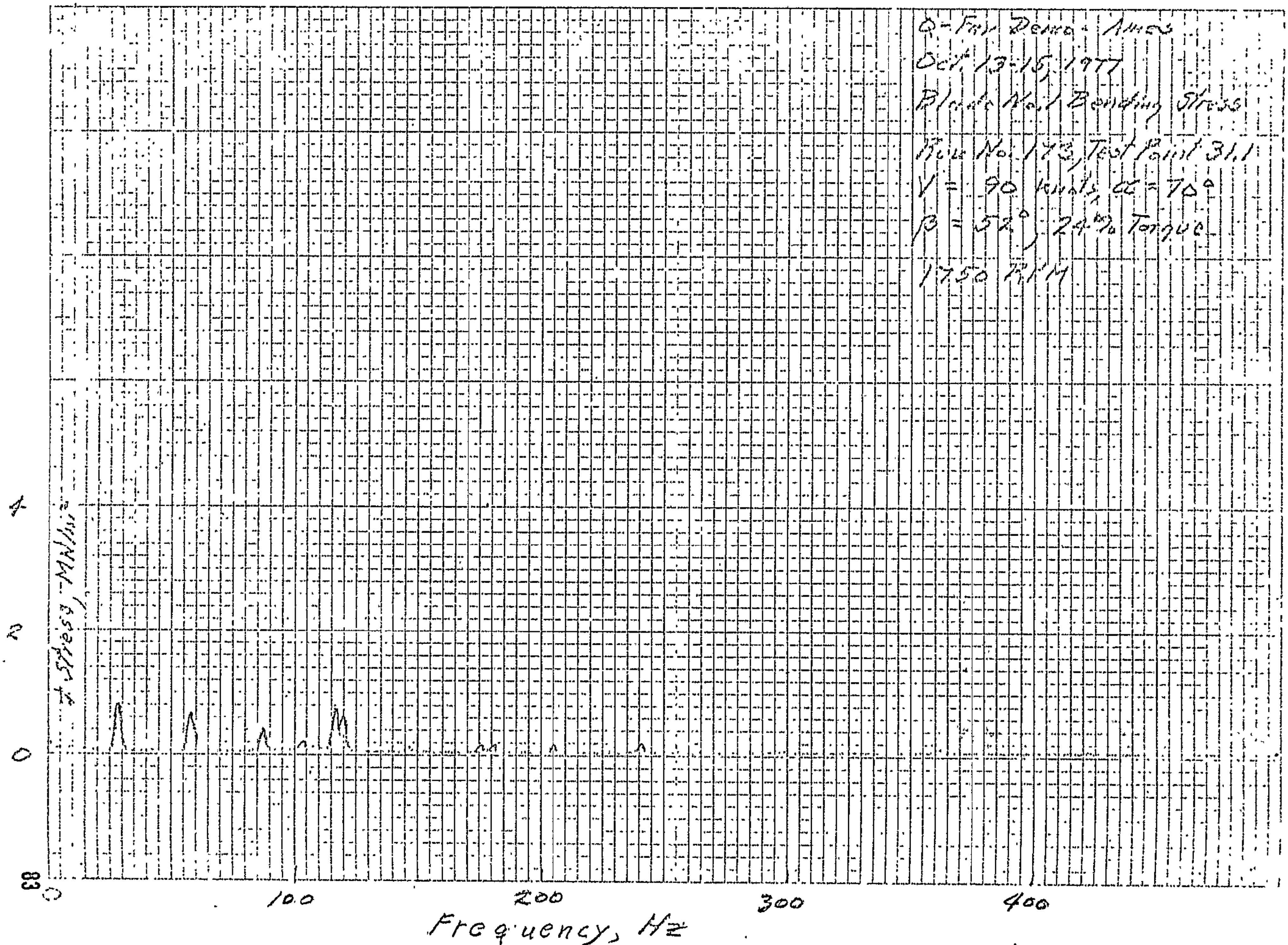

Q-Fan Demo - Ames
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 153, Test Point 27.7
V = 90 Kts, α = 75°
β = 52°, 32% Torque
2000 RPM
4
2
0
100
200
300
400
Frequency, Hz


Q-Fan Demo. Aero
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 154, Test Point RT 8
2000 RPM
± Stress, MN/m²
8
6
4
2
0
0
100
200
300
400
Frequency, Hz


Oct 13-15, 1977
Blade No. 1 Bending Stress
Run No. 154 Test Point 30.1
V = 40 knots, α = 120°
β = 56°, 47% Torque
3150 RPM
10
8
6
4
2
0
0
100
200
300
400
Frequency, Hz


Q-Fan Demo - Ames
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 165, Test Point 30.2
V = 40 Knots, α = 120°
β = 52°, 91% Torque
3250 RPM
± Stress, MN/m²
8
6
4
2
0
100
200
300
400
Frequency, Hz


PEAK AT 18 MN/m²
Q-Fan Demo - Aim
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 170, Test Point 20.7
V = 40 Knots, α = 120°
β = 52°, 76% Torque
2300 RPM
0.2 × Stress Peak
± Stress, MN/m²
12
10
8
6
4
2
0
0
100
200
300
400
Frequency, Hz


Oct 13-15, 1977
Blade No. 1 Bending Stress
Run No. 173, Test Point 311
V = 90 knots, α = 70°
β = 52°, 24% Torque
1750 RPM
± Stress, MN/m²
0
2
4
0
100
200
300
400
Frequency, Hz

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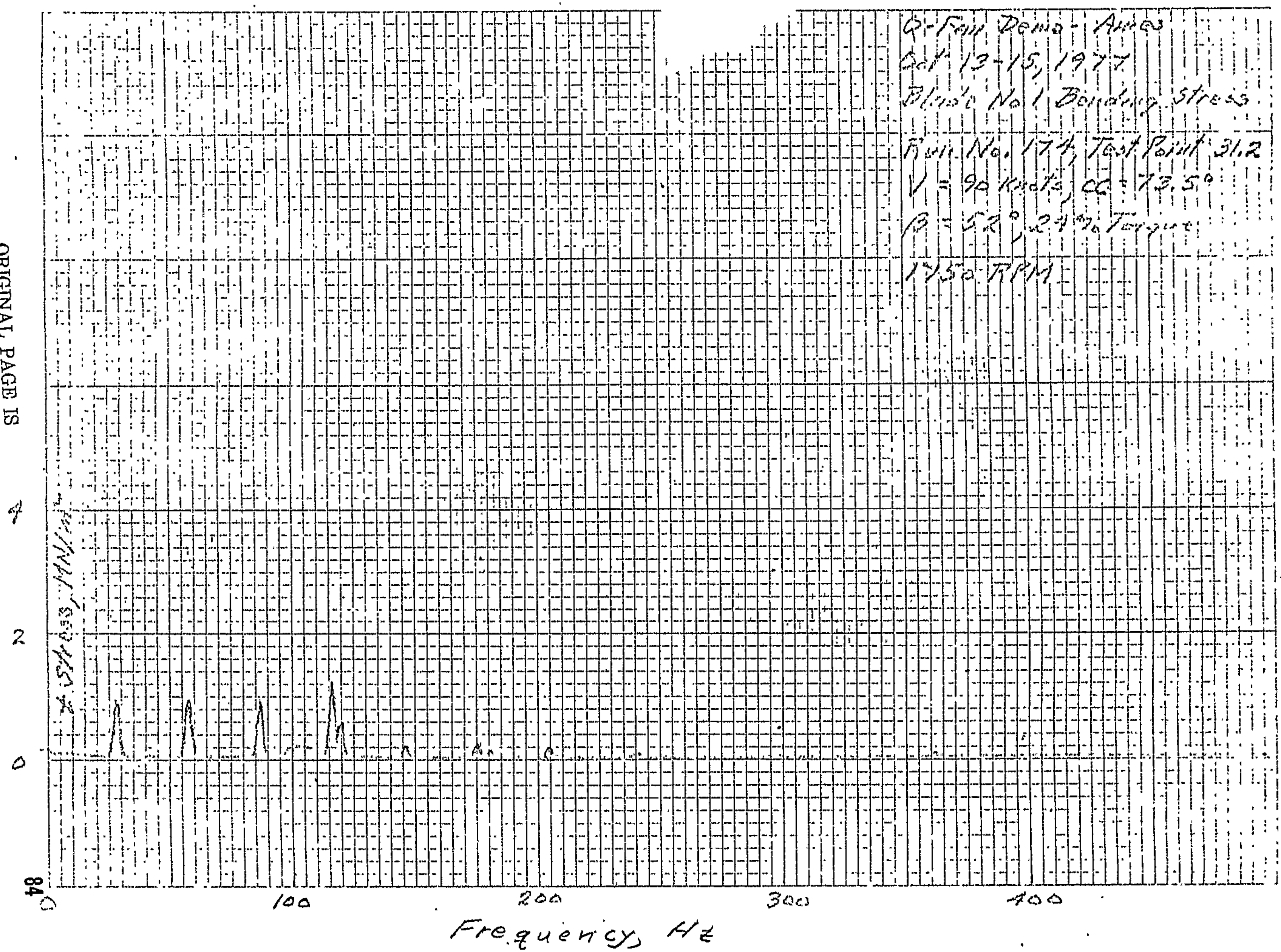

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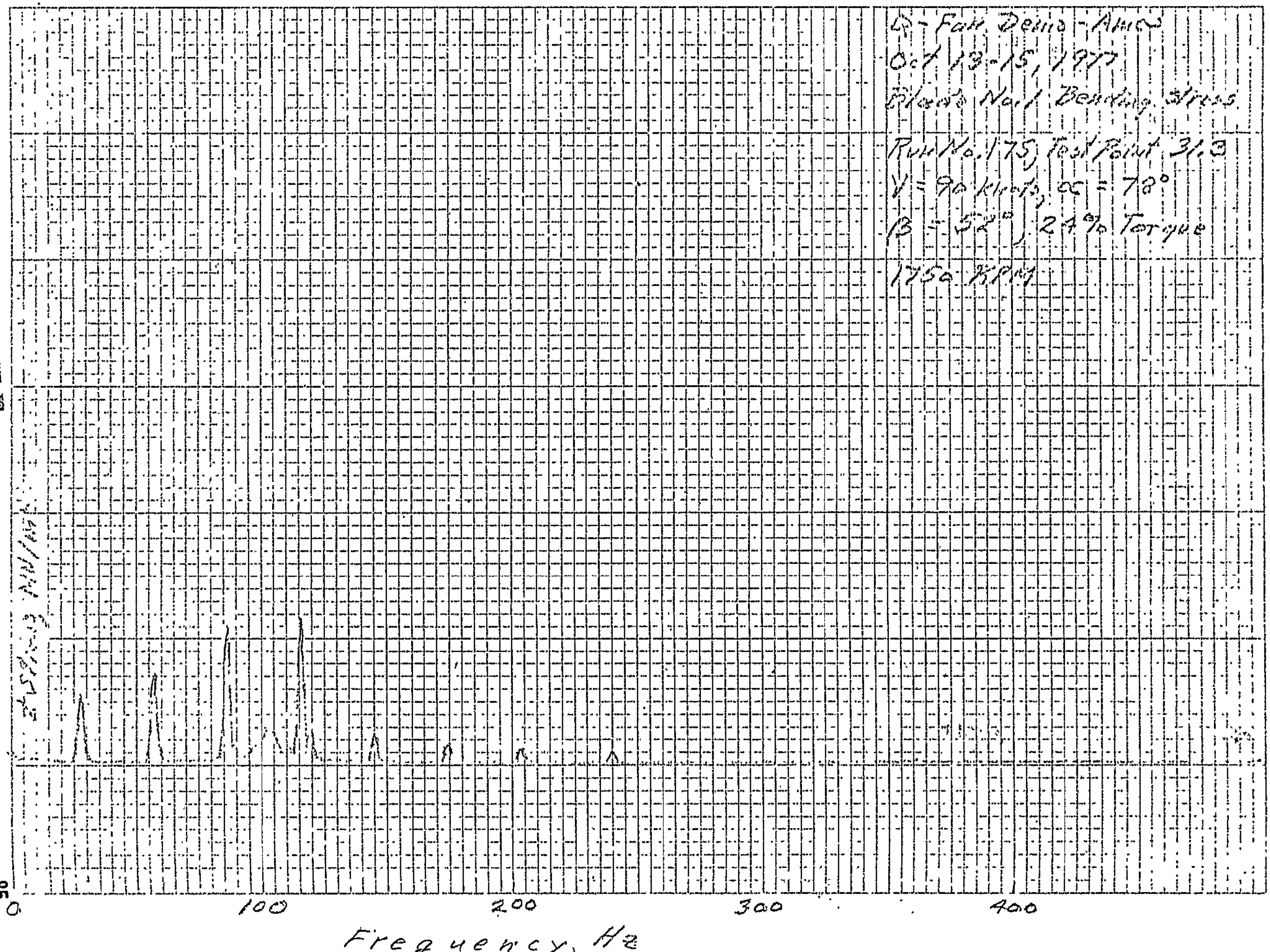
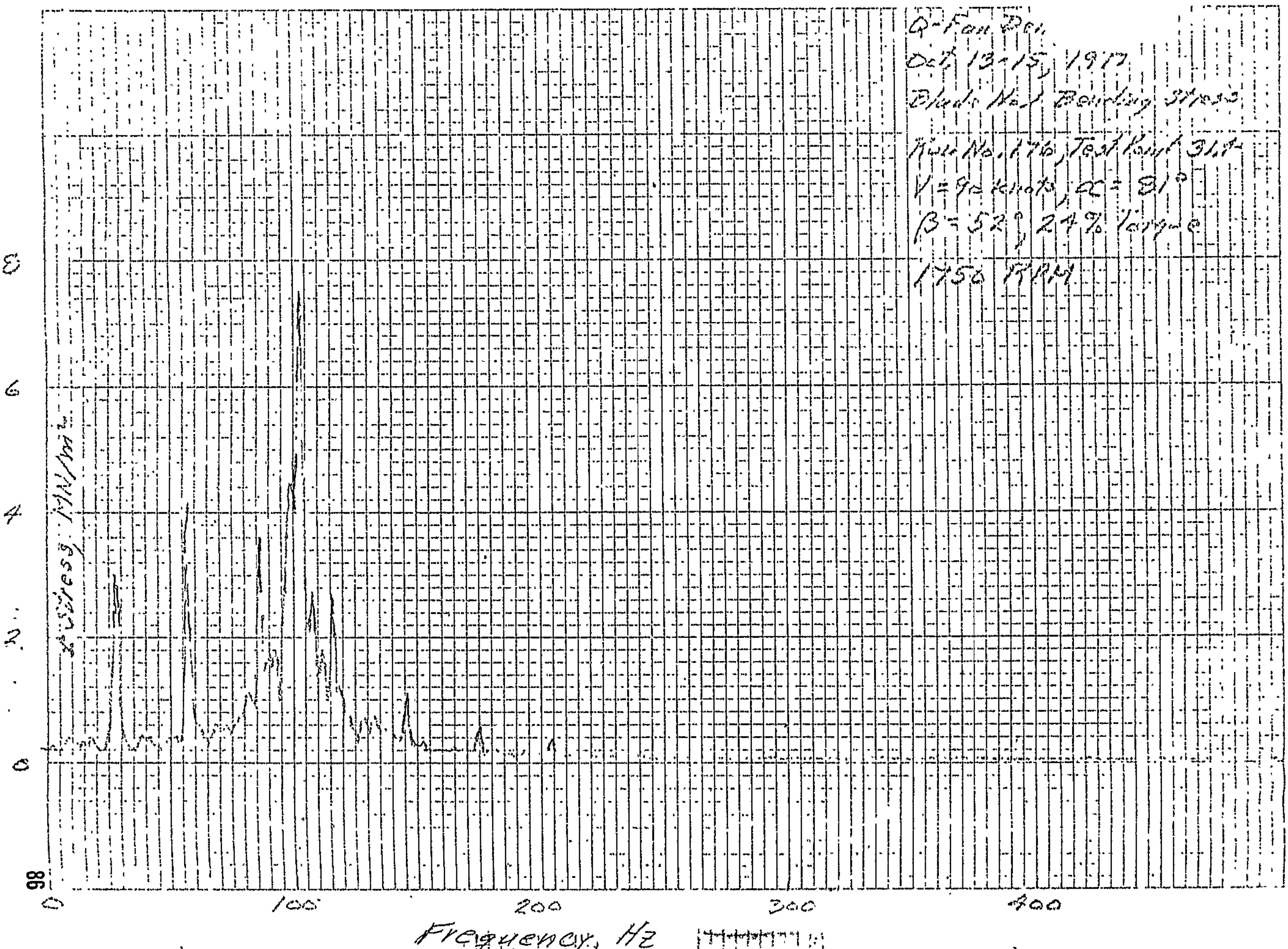
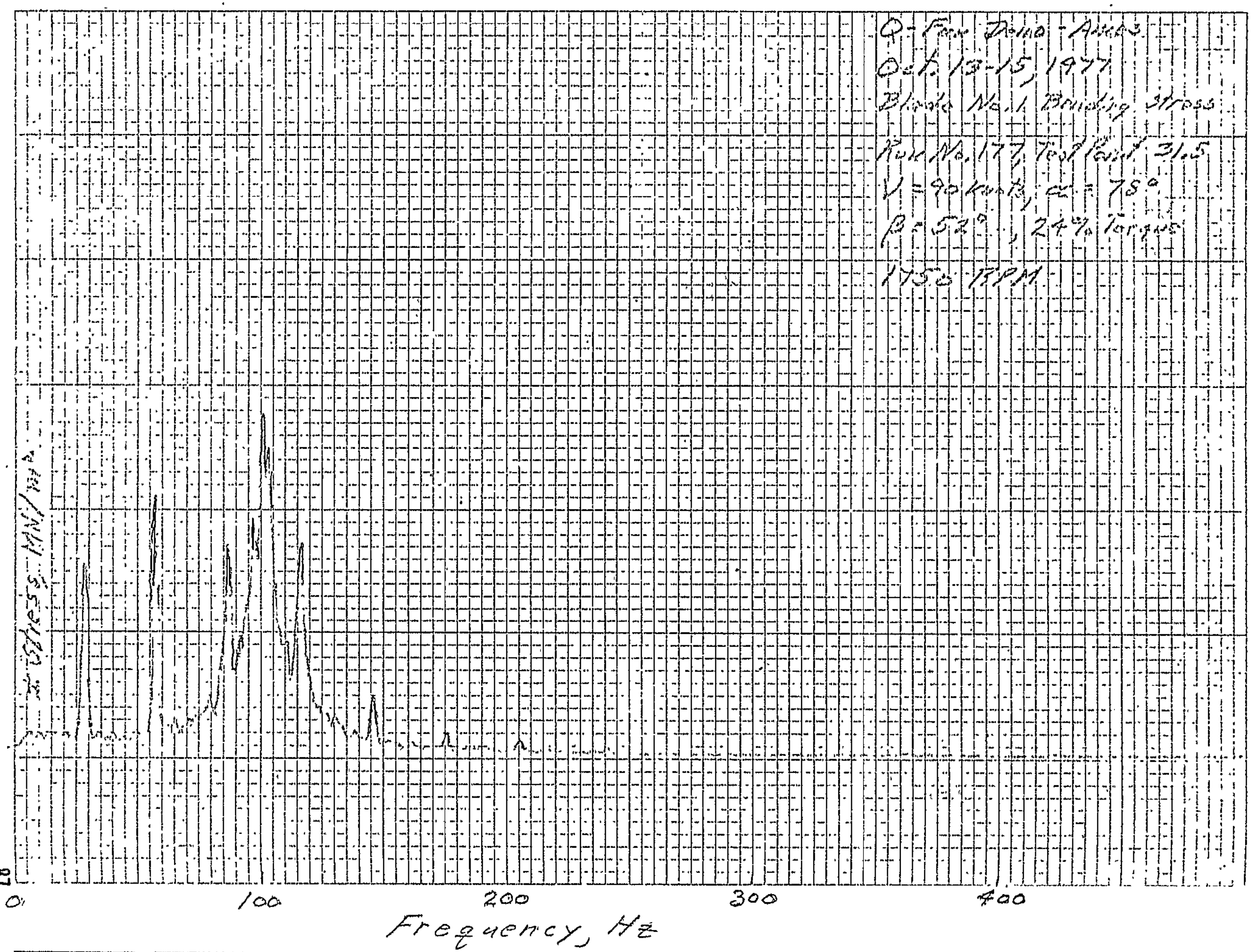
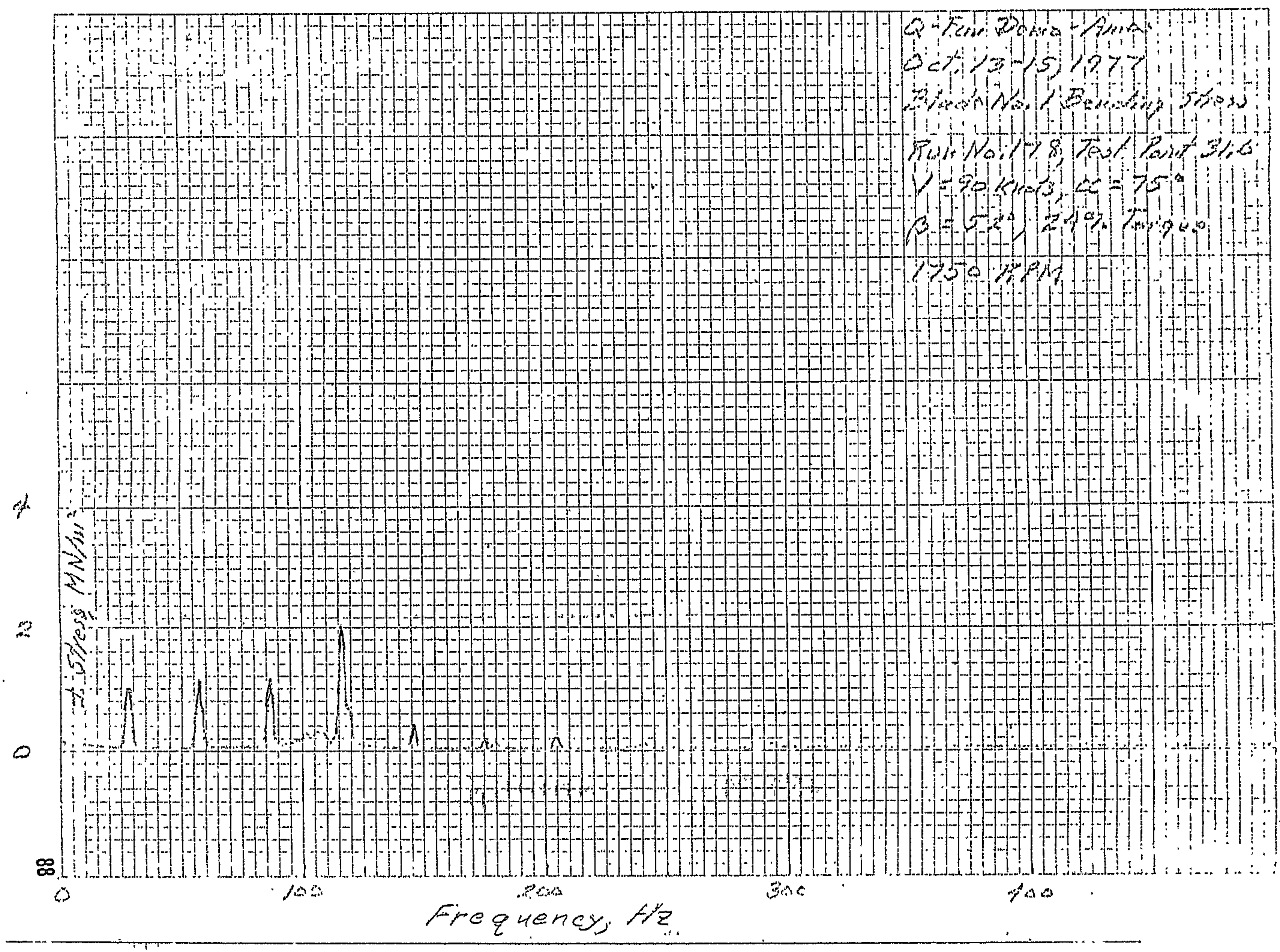
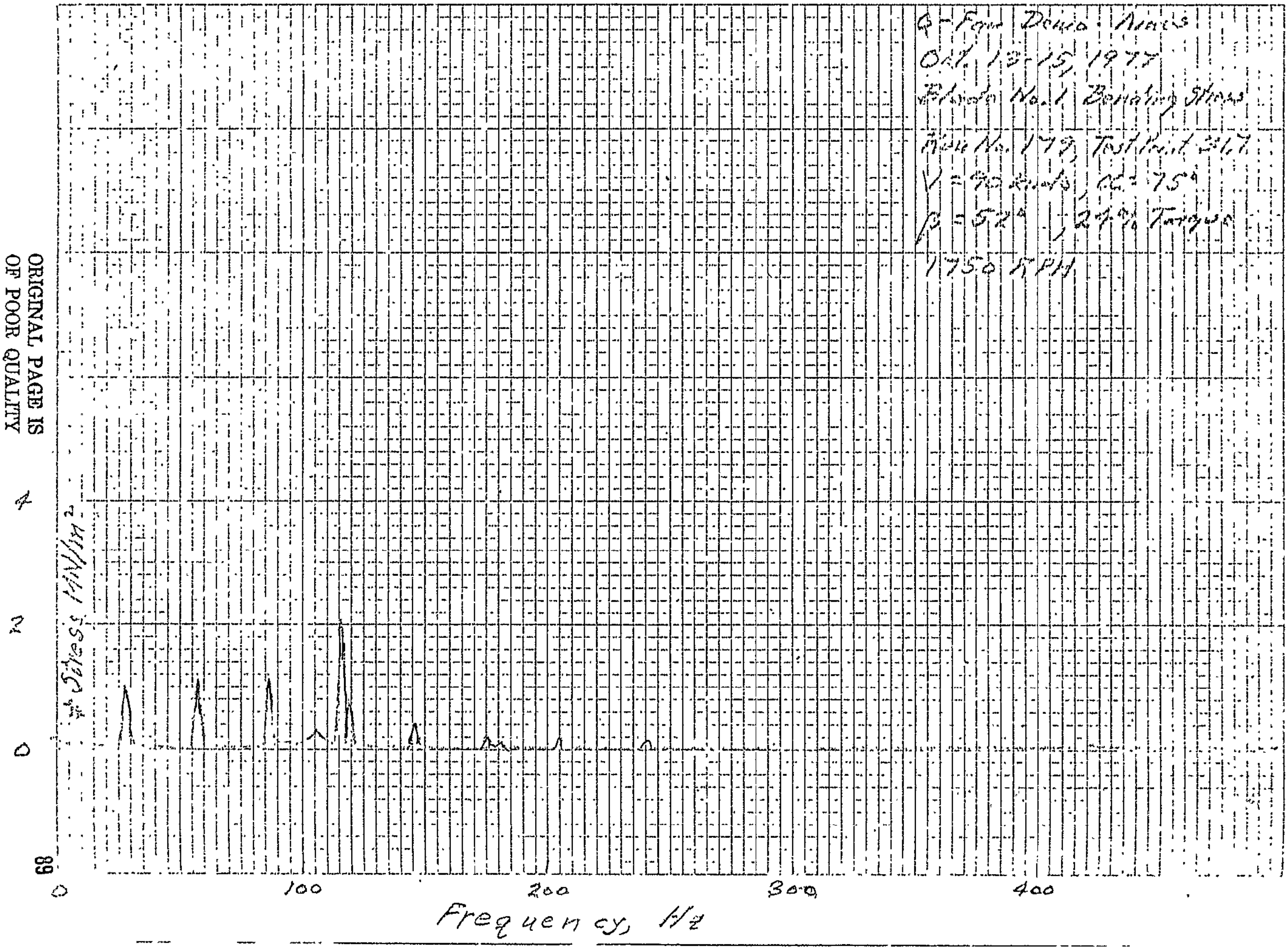



Oct 13-15, 1977
Blade No. 1 Bending Stress
1750 RPM
8
6
4
2
0
Stress, MN/m²
0
100
200
300
400
Frequency, Hz


Q-Fan Demo - Ames
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 177, Test Point 31.5
V = 90 knots, α = 75°
β = 52°, 24% Torque
1750 RPM
± Stress, MN/m²
6
4
2
0
0
100
200
300
400
Frequency, Hz


Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 178, Test Point 316
V = 90 Knots, α = 75°
β = 5.2°, 24% Torque
1750 RPM
± Stress, MN/m²
0
2
4
0
100
200
300
400
Frequency, Hz


Oct. 13-15, 1977
No. 1 Bending Stress
1750 RPM
0
2
4
Stress MN/m²
0
100
200
300
400
Frequency, Hz

APPENDIX B

TAPE RECORD LOGS

DATE 9-15-77 , ____ TAPE REEL NO. 1 , ____ SHEET 1 of 1

TEST NO. ____ TAPE REC. MODEL HONEYWELL 5600C HEAD STACK 1 R 1 6 AMP. GAIN ____

TEST ENGR. ____ TAPE SPEED 3 3/4 TEST LOCATION NASA AMES

INSTRUMENTATION ENGR. Dinick VOICE TK. NO. Edge track TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
			PDF1	PDF2	PDF3	PDS	PDC1	PDC2	PDC3	PDC4	BLADE STRESS	BLADE STRESS	N2	RETA	STTI...
PRESTON AMPLIFIER GAINS			100	100	100	100	100	100	100	100	VARIABLE 2+	VARIABLE 2+	VARIABLE 1+	VARIABLE 1+	VARIABLE 2.X
			←			ECTRON AMPLIFIER GAINS									→
			.1	1	1	1	1	1	1	1	1	1	3	-10dB	1
SYSTEM SENSITIVITY			1.00V / 1.00psi	→							4.55×10^{-4} V / 1 lb	4.15×10^{-4} V / 1 lb	8.22×10^{-5} V / 1 rpm		1×10^[illegible] / 1 rpm
CAL	9-15-77	16.55.00 16.57.30	1.0 Vrms @ 400 Hz, -1.4 VDC, 0 VDC, +1.4 VDC												
1	1	18.03.26 18.13.45	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
CAL	9-16-77	17.03.00 17.05.30	1.0 Vrms @ 400 Hz ; -1.4V, 0V, +1.4V												
2	1	17.38.20 17.43.43	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
2	2	17.48.09 17.53.40	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃		〃	
3	1-6	18.07.15 18.27.55	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	
4	—	20.55.00 20.59.00	Engine didn't start. (Hot start)												
4	1-3	21.00.55 21.58.40													
			END OF REEL #1												

TAPE RECORD LOG

DATE 9-16-77 TAPE REEL NO. 5 SHEET 1 OF 1

TEST NO. E/CFA TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK IRIG AMP. GAIN

TEST ENGR. TAPE SPEED 3 3/4 TEST LOCATION NASA - AMES

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. Edge Track TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
CAL	9-16-77	22.02.00 22.03.45													
5	4-7	22.03.54 22.39.03													
CAL	9-16-77	23.16.00. 23.18.30	1.0 V	rms	@ 40	0 Hz,	-1.4VD	C, 0 V	DC, +	1.4 UDC					
CAL	9-19-77	15.57.00 15.59.30	1.0 V	rms @	400 Hz	-1.4U	DC, 0	VDC, +	1.4VDC						
START UP, ½ speed shutdown		17.40.38 17.50.30													
6	1-11	17.52.55 18.51.00	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
		END	OF	REEL	#2										

TAPE RECORD LOG

DATE 9-19 C-2 TAPE REEL NO. 3 SHEET 1 OF 1

TEST NO. K/CFA TAPE REC. MODEL HONEYWELL 5600C HEAD STACK IRIG AMP. GAIN

TEST ENGR. TAPE SPEED 3 3/4 IPS TEST LOCATION NASA-AMES

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
CAL	9-19-77	18.58.52 19.00.58	1 Vrms @ 400 Hz, -1.4 VDC, 0 VDC, +1.4 VDC												
7	1-9	19.01.00 19.56.09	1	1	1	1	1	1	1	1	1	1	3	-10 dB	1
8	NO DATA TAKEN	22.45.00 23.10.29													
9	1-5	23.51.00													
10	1,2,3,4	00.35.30													
		: :	END OF TAPE #3												
		: :													
		: :													
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TAPE RECORD LOG

DATE 9-20 TAPE REEL NO. 7 SHEET 1 of 1

TEST NO. 4/CFA TAPE REC. MODEL HONEYWELL 5600C HEAD STACK IRIG AMP. GAIN

TEST ENGR. TAPE SPEED 3 3/4 TEST LOCATION NASA-AMES

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
10	4	00.38.00	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
11	1-6	↓ ↓ ↓													
12	1-5	01.33.50													
CAL	9-20-77	01.35.00 / 01.37.30	1Vrms	@	400Hz	, -1.4	VDC,	0VDC,	+1.4VDC						
13	ENGINE DIDNT START	18.42.00 / 18.44.44	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
13	↓	18.46.27 / 18.47.50													
13	\	19.13.00 / 20.04.50													
CAL	9-20-77	21.24.00 / 21.26.30													
			END	OF	REEL		#4								

TAPE RECORD LOG

DATE 9-20-77 TAPE REEL NO. 5 SHEET 1 OF 1

TEST NO. L/CFA TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK IRIG AMP. GAIN

TEST ENGR. TAPE SPEED 3¾ IPS TEST LOCATION NASA-AMES

INSTRUMENTATION ENGR. DIMICK VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
CAL	9-20-77	21.38.15 21.40.45	1Vrms	@	400Hz	,-1.4	VDC,	0VDC,	+1.4VDC						
14	1-7	22.03.36	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
15-	1,2	↓ ↓ ↓ 22.53.40													
CAL	9-21-77	15.59.00 16.01.30	1Vrms	@	400Hz	,-1.4V	DC, 0	VDC, +	1.4VDC						
overspeed check		17.41.40 17.44.07													
16	1-6	17.46.00													
17	1-8	↓ ↓ ↓ 18.43.33													
			END	OF	REEL		#5								

TAPE RECORD LOG

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DATE 9-21-77 TAPE REEL NO. 6 SHEET 1 OF 1

TEST NO. L/CFA TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK IRIG AMP. GAIN

TEST ENGR. TAPE SPEED 3¾ TEST LOCATION NASA-AMES 40 × 80

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
18	1-2	18.47.00 19.03.27	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
CAL	9-21-77	19.04.00 19.06.30	1Vrms	@	400Hz	, -1.4	VDC,	0 VDC	, +1.4	VDC					
19	1-10	00.17.10 ↓ ↓ ↓													
20	1-17	01.50.40													
CAL	9-22-77	15.54.00 15.56.30	1Vrms	@	400Hz	, -1.4	VDC,	0VDC	, +1.4	VDC					
		: :	END	OF	REEL	#6									
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TAPE RECORD LOG

DATE 9-22-77 TAPE REEL NO. 7 SHEET 1 OF 1

TEST NO. L/CFA TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK IRIG AMP. GAIN LINEAR

TEST ENGR. TAPE SPEED 3 3/4 IPS TEST LOCATION NASA-AMES

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1 PDF1	TK 2 PDF2	TK 3 PDF3	TK 4 PDS	TK 5 PDC1	TK 6 alpha	TK 7 PDC3	TK 8 PDC4	TK 9 BLADE STRESS	TK 10 BLADE STRESS	TK 11 N_2	TK 12 θ	TK 13 SCS
CAL	9-22-77	16.18.00 16.20.30	1Vrms	@	400Hz	, -1.	4VDC	, 0VDC	, +1.4	VDC	-	—	—	—	
21	9-22-77	17.31.38 17.35.38	OVER	SPEED	SHUT	DOWN	check								
		: :	1	1	1	1	1	1 (1)	1	1	1	1	3	-10dB	1
CAL	10-13-77	15.47.38 N.G.	N.G. ~~1Vrms @ 400Hz, 1.4VDC, 0VDC, +1.4VDC~~												
CAL	"	15.53.20 15.56.10	1VRMS	@ 400HZ		, -1.414VDC,		0VDC,		+1.414VDC					
22	10/13/77	17.17.44 17.21.58	OVER-SPEED	1	1	1	1	1	1	1	1	1	3	-10dB	1
22		18.19.20 18.32.27	BAD		N_2	ABORT									
CAL		17.19.22 17.22.20	1Vrms	@ 400HZ,		-1.414VDC,		0VDC,		+1.414VDC					
23		17.25.53 17.28.38	OVERSPEED			CHECK									
23	1-5	17.50.55 18.43.36	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
24	1	21.01.24	3 (2) 1	3 1	3 1	3	1	1	1	1	3 1	3 1	3	-10dB	3
		: :													
		: :													

(1) NOTE: CHANNEL #6 is now recording angle of attack, α

(2) GAIN CHANGE FOR CON #6 → 7

TAPE RECORD LOG

DATE [illegible] TAPE REEL NO. 8 SHEET 1 OF

TEST NO. TAPE REC. MODEL HON. 5600C HEAD STACK IRIG AMP. GAIN LINEAR

TEST ENGR. W. SHAIN TAPE SPEED 3 3/4 IPS TEST LOCATION NASA/AMES 40' (E)

INSTRUMENTATION ENGR. ROY BINGO VOICE TK. NO. EDGE "A" TIME CODE TK. NO. 14 (FM)

RUN NO.	COND.	START TIME	TK 1 PDF1	TK 2 PDF2	TK 3 PDF3	TK 4 PDS	TK 5 PDC1	TK 6 α	TK 7 PDC3	TK 8 PDC4	TK 9 BLADE STRESS	TK 10 BLADE STRESS	TK 11 N_2	TK 12 β	TK 13
CAL		21.43.21 21.46.20	400 HZ 1 VRMS, -1.414 VDC, 0 VDC, +1.414 VDC												
25	4-7	21.55.23 22.04.21	/	/	/	3	/	/	/	/	/	/	3	-10dB	/
26	1-8	22.12.52 22.47.08	/	/	/	3	/	/	/	/	/	/	3	-10dB	/
27	1-9	23.12.54	/	/	/	3	/	/	/	/	/	/	3	-10dB	/
28	1-5	23.16.57 23.29.55	/	/	/	3	/	/	/	/	/	/	3	-10dB	/
2[illegible]	1-3	23.36.54 23.44.14	/	/	/	3	/	/	/	/	/	/	3	-10 dB	/
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TAPE RECORD LOG

DATE ______ SHEET ____ F ______

TAPE REEL NO. 9

TEST NO. 513

TAPE REC. MODEL HON. 5600C

HEAD STACK IRIG

AMP. GAIN LIVE

TEST ENGR. W. SHAIN

TAPE SPEED 3 3/4 IPS

TEST LOCATION NASA/AMES 40'X80'

INSTRUMENTATION ENGR. ROY BINGO

VOICE TK. NO. EDGE "A"

TIME CODE TK. NO. 14 (FM)

RUN NO.	COND.	START TIME	TK 1 PDF1	TK 2 PDF2	TK 3 PDF3	TK 4 PDS	TK 5 PDC1	TK 6 α	TK 7 PDC3	TK 8 PDC4	TK 9 BLADE STRESS	TK 10 BLADE STRESS	TK 11 N2	TK 12 θ	TK 13 SEF.
CAC		23.51.17 23.54.30	1VRms @ 400Hz, -1.414VDC, 0VDC, +1.414VDC												
30	1-9	23.54.84 00.29.30	1	1	1	3	1	1	1	1	1	1	3	-10dB	1
31	10/15/97	13.08.29 13.16.30	OVERSPEED CHECK												
11	1-7	13.24.25 13.37.18	1	1	1	3	1	1	1	1	1	1	3	-10 dB	1
32	1-14	13.44.59 14.34.34	1	1	1	3	1	1	1	1	1	1	3	-10 dB	1
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TAPE RECORD LOG

DATE 10/15/77 TAPE REEL NO. 10 SHEET 1 OF 1

TEST NO. 513 TAPE REC. MODEL HON. 5600 C HEAD STACK IRIG AMP. GAIN LINEAR

TEST ENGR. W. SHAIN TAPE SPEED 3 3/4 IPS TEST LOCATION NASA/AMES 40'X80'

INSTRUMENTATION ENGR. ROY BINGO VOICE TK. NO. EDGE "A" TIME CODE TK. NO. 14 (FM)

RUN NO.	COND.	START TIME	TK 1 PDF1	TK 2 PDF2	TK 3 PDF3	TK 4 PDS	TK 5 PDC1	TK 6 α	TK 7 PDC3	TK 8 PDC4	TK 9 BLADE STRESS	TK 10 BLADE STRESS	TK 11 N2	TK 12 β	TK 13 SPL
32	17-21	14.40.45 14.56.06	1	1	1	3	1	1	1	1	1	1	3	-10 dB	1
33	1-2	15.05.36 15.10.57	1 ◁1	1	1	3	1	1	1	1	1	1	3	-10dB	1
34	1-12	16.16.30 16.48.20	1 ◁1	1	1	3	1	1	1	1	1	1	3	-10dB	1
35	1-3	16.51.51 17.03.38	1	1	1	3	1	1	1	1	1	1	3	-10dB	1
36	1-5	17.04.30 17.15.16	1	1	1	3	1	1	1	1	1	1	3	-10dB	1
37		: :													
		: :													
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◁1 TK #1 GAIN CHANGE FROM 1 to .3 FROM COND #2

▽1 " " " " " " " " " " 12 ONLY.

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TAPE RECORD LOG

DATE ______) ______ TAPE REEL NO. 11) ______ SHEET 1) F ______

TEST NO. 513 TAPE REC. MODEL HON. 5600C HEAD STACK IRIG AMP. GAIN LINEAR

TEST ENGR. W. SHAIN TAPE SPEED 3 3/4 IPS TEST LOCATION NASA/AMES 40' X 80'

INSTRUMENTATION ENGR. ROY BINGO VOICE TK. NO. EDGE A TIME CODE TK. NO. 14 (FM)

RUN NO.	COND.	START TIME	TK 1 PDF1	TK 2 PDF2	TK 3 PDF3	TK 4 PDS	TK 5 PDC1	TK 6 α	TK 7 PDC3	TK 8 PDC4	TK 9 BLADE STRESS	TK 10 BLADE STRESS	TK 11 N2	TK 12 θ	TK 13 SRA
CAL		17.23.47 17.26.40	1V Rms @ 400Hz, -1.414VDC, 0V, +1.414VDC												
37	1-3	17.34.58 17.42.06	1	1	1	3	1	1	1	1	1	1	3	-10 dB	
38	1-3	17.48.05 17.53.56	1	1	1	3	1	1	1	1	1	1	3	-10dB	1
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TAPE RECORD LOG

APPENDIX C

FINAL DATA

APPENDIX D

TEST LOGS

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT N_T	β DEG	$\dot{N}_2$ RPM	T_{T0} °F		V_T KTS/q	α DEG				P_{AMB} * IN HG		DATE — TIME
1.1	COMPLETE 5597-1 NACELLE	C/O	–	52	4630	70		0	0			[6]	29.834	[1]	9-15 1805
2.1	OVSPD C/O –	C/O		✓	4550	69		✓	✓			[6]	29.878	[2]	9-16 1740-20
2.2	OVTORK SHUTDOWN	C/O		✓	4720	70		✓	✓			[7]	✓	[3]	✓ 1750
3.1	STATIC RUN	2B	1	56	15000	70		✓	✓				29.881		1812
3.2	✓	✓	2	51.9	14270	71		✓	✓			[6]	✓		1815
3.3	✓	✓	3	✓	12670	73		✓	✓				✓		1817
3.4	✓	✓	4	✓	10850	74		✓	✓				✓		1819
3.5	✓	✓	5	✓	9180	75		✓	✓				✓		1822
3.6	✓	✓	6	43	8430	76		✓	✓				✓	[4]	1824
														[5]	

* CONVERSION CONST = .49116 ~~.....~~/IN. HG

[1] RAN UP TO IDLE – TOOK C/O DATA PT. FOR DATA REDUCTION C/O
~~• C/O~~ LYCOMING OVERSP'D PROTECTION SYSTEM – DID NOT WORK
• C/O HAM. STD OVERSP'D SYSTEM – O.K. ENGINE SHUT DOWN AUTO.

[2] • C/O LYCOMING OSPD SHUTDOWN OK

[3] • C/O OVTORK SHUTDOWN – O.K.

[4] RECORDED TRANSIENT SHUTDOWN FOR NASA – LeRC

[5] N_1 N_2 INPUTS NOT CONNECTED TO DATA SYSTEM DURING RUN 3

[6] S/V'S OUT OF SYNC. BAD DATA

[7] DATA FILE DAMAGED IN SYSTEM – NO DATA

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TEST LOG

BOEING

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_Z RPM	T_{T0} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
4.1	CONFIG 1 L/CFA FAN INLET	1		43°	8270	70		~~46~~ 35 / 5.4	90			▷1	29.884		9-16 2114
4.2	✓	✓		✓	8230	✓		37	115				✓		2122
4.3	✓	✓		✓	8160	✓		36	120				✓		2125
5.1	✓	✓		✓	8370	72		~~75~~ 70 / 19	70				✓		2145
5.2	✓	✓		✓	8400	✓		75	✓				✓		2152
5.3	✓	✓		✓	8340	✓		75	75				✓		2155
5.4	✓	✓		51.8	7830	✓		75	78				✓		2207
5.5	✓	✓		✓	7780	73		75	81			▷2	✓		2209
5.6	✓	✓		✓	9090	74		75	91				✓	▷5	2227
5.7	✓	✓		✓	9020	75		71	94			▷3	✓		2229

▷1 HOT START. 1ST ATTEMPT ABORTED

▷2 INLET SEPARATED AT 88° (TIME 2211) RETRACED α TO 78°–80° BEFORE REATTACHMENT. SOUND OF ENGINE (INLET) CHANGED; PDF1 STEPPED UP, VIB. STEPPED UP, BLADES STRESS JUMPED UP. WHEN INLET SEPARATED. (FAN STALL ?)

▷3 REDUCED DATA STILL HAS BAD N_Z, β, PLA, TORK RUN 3 HAS BAD ATT

▷4 ~~DATA QUESTIONABLE S/V B & E HAVE .03 PSI DRIFT ?~~)

▷5 S/V'S OUT OF SYNC BAD DATA

REC. CHK APPROVED APPROVED REVISED DATE

TEST LOG

BOEING

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6-700C 72

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{T0} °F		V_T KTS/	α DEG				P_{AMB}		DATE — TIME
6.1	L/CFA FAN INLET	1		43°	8720	~~84~~		105/41	51			▷1	14.671		9-19 1805
6.2		1		✓	8740	✓		107	53				✓		1807
6.3		1			✓	85		✓	55			~~▷2~~	✓		1809
6.4		1		51.8	8210	86		106	62				✓		1817
6.5				✓	8220	✓		✓	65				✓		1819
6.6				✓	8190	✓		105	66				29.98		1821
6.7				✓	10820	90		103	77				✓		1831
6.8				✓	10800	91		104	80				✓		1836
6.9				✓	12620	92		102	85				✓		1846
6.10				✓	12530	93		100	92				✓		1849

▷1 CHECKED LYCOMING OVSPD SHUTDOWN OK

~~▷2 BAD DATA S/V'S OUT OF SYNC~~

REC. | CHK | APPROVED | APPROVED | REVISED | DATE

TEST LOG

BOEING

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
6.11	L/CFA FAN INLET	1	1	51.8	12480	93		101.41	95				29.88		9-19 1851
7.1	↓	1	ΔV	43	7660	93		147/72	40			▷1	✓		1909
7.2		1	ΔW	✓	8810	94		146	41				✓		1916
7.3		1		✓	8800	✓		141	45				✓		1918
7.4		1	ΔW	51.8	8390	95		141	50				✓		1926
7.5		1		✓	8370	96		139	52				✓		1932
7.6		1	ΔW	✓	10740	✓		139	59				✓		1938
7.7		1	✓	✓	10920	✓		✓	61				✓		1940
7.8		1	ΔW	✓	12640	98		137	67				✓		1944
7.9		1	✓		12640	✓		138	68				✓		1949

▷1 COULDN'T GET 15#/sec/ft² BECAUSE OF q

APPROVED | APPROVED | CHK | REC. | REVISED | DATE

TEST LOG

BOEING

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6-7000 7.2

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT N_T	β DEG	N_Z RPM	T_{TO} °F		V_T KTS/??	α DEG				P_{AMB} IN. HG		DATE — TIME
8.1	PRIORITY II RUNS	2B	2	51.8	14330	75		15/18.8	0			▷1	29.94 14.705		9-19 2253
9.1	L/CFA FAN INLET	✓	✓	✓	14270	76		74 19	0				29.96 14.715		2359
9.2		✓	3	✓	12980	77		74	✓				✓		9-20 0003
9.3		✓	4	✓	10960	78		✓	✓				✓		0005
9.4		✓	5	✓	9370	✓		75	✓				✓		0009
9.5		✓	6	43	8060	78		✓	✓				✓		0015
10.1		2B	2	51.8	14190	✓		✓	60				✓		0022
10.2		✓	3	✓	12790	80		✓	✓				✓		0027
10.3		✓	4	✓	10380	✓		✓	✓				✓		0030
10.4		✓	5	✓	8770	✓		✓	✓				✓		0034

▷1 S/V's OUT OF SYN. RETOOK PT. - S/V's OUT COMPLETELY ~~ABORTED~~ RUN NO DATA

REC. | REVISED | DATE | CHK | APPROVED | APPROVED

TEST LOG

BOEING

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6-7000 7.2

BOEING TEST LOG

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
10.5	L/CFA FAN INLET	28	6	43	7840	80		75	60				29.96		9-20 0038
11.1			2	51.8	14290	81		✓	75			▷1	✓		0043
11.2			3	✓	12610	82		✓	✓				✓		0051
11.3			4	✓	10130	83		✓	✓				✓		0054
11.4			5	✓	7630	✓		✓	✓				✓		0057
11.5			—	43	9460	✓		✓	✓				✓		0101
11.6			—	✓	9170	✓		✓	✓				✓		0103
12.1			2	51.8	14150	85		105 / 38	0°		▷2		29.97 / 14.72		0115
12.2			3	✓	12920	✓		✓	✓				✓		0119
12.3			4	✓	10820	88		✓	✓				✓		0123

▷1 S/V HANGING UP - SEEMS TO HANG UP EVERYTIME AT HIGH POWER CONDITION

▷2 NO DATA. S/V'S OUT OF STEP.

REC. | CHK | APPROVED | APPROVED | REVISED | DATE

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6-7000 7.2

TEST LOG

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
12.4	L/CFA FAN INLET	2B	5	51.8	7570	86		105	0				29.97		9-20 0125
12.5		✓	6	43	7820	84		105	0				✓		0129
13.1		2C	1	56	13900	80		75	90			▷1	30.01		9-20 1928
13.2		✓	2	51.8	13300	82		75	✓				14.74		1932
13.3		✓	4	✓	12290	✓		✓	✓				✓		1935
13.4		✓	5	✓	11820	✓		76	✓				✓		1938
13.5		✓	6	✓	10690	✓		74	✓				✓		1942
13.6		✓	7	✓	9910	✓		75	✓				✓		1944
13.7		✓	8	✓	9030	✓		✓	✓				✓		1947
13.8		✓	8A	✓	8830	✓		✓	✓			▷2	✓		1951

▷1 LYCOMING OVSPD CHECK OK.

▷2 S/V "D" HAS .010 PSI DRIFT DURING SCAN

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{T0} °F		V_T KTS	α DEG			Notes	P_{AMB} IN HG		DATE — TIME
13.9	L/CFA FAN INLET	2C	10	4/3	13710	82		75	90				30.02		9-20 1953
13.10		✓	12	✓	11700	✓		✓	✓				✓ 14.745		1957
13.11		✓	–	✓	11520	✓		✓	✓				✓		2000
13.12		✓	–	✓	11000	✓		✓	✓			[1]	✓		2002
14.1		2B	2	5/8	13990	76		1 5 104	60			[2]	30.04 14.754		2213
14.2		✓	3	✓	12410	77		✓	✓			[3]	✓		2216
14.3		✓	4	✓	9670	✓		✓	✓				✓		2219
14.4		✓	5	✓	8980	78		✓	✓				✓		2222
14.5		✓	5A	✓	7860	✓		✓	✓			~~[4]~~	✓		2225
14.6		✓	5B	✓	7550	✓		✓	✓				✓		2227

[1] STARTED TO DECREASE RPM PDF1, 2, 3 INCREASED ALONG WITH β. STRESSES. INLET IS APPARENTLY SEPARATED SHUT ENGINE DOWN

[2] BAD DATA S/V's OUT OF SYNC.

[3] S/V D HAS +.010 DRIFT DURING SCAN

~~[4] S/V E HAS .012 DRIFT DURING SCAN~~

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/8	α DEG				P_{AMB} IN HG		DATE — TIME
14.7	L/CFA FAN INLET	2B	5C	51.8	7770	78		105	60				30.04		9-20 2230
15.1		2C	2	56	13670	81		✓	75				✓		2236
15.2			3	51.8	13750	82		✓	✓			▷1	✓	~~▷~~	2240
16.1		2C		56	13670	88		105	75			▷3	29.86 14.666	▷2	9-21 1757
16.2		✓		51.8	13150	91		✓	✓				✓		1759
16.3		✓		✓	12210	92		✓	✓				✓		1802
16.4		✓		✓	11330	✓		✓	✓				✓		1805
16.5		✓		✓	10560	✓		✓	✓				✓		1807
16.6				✓	10370			✓	✓				✓		1810

▷1 2242 · CHIP LIGHT ON #3 BROUGHT α BACK & STARTED DOWN IN RPM WHEN LIGHT CLEARED - ~~RESUMED RUNNING~~ LIGHT BACK ON - SHUT DOWN

▷2 CHECKED N_2 SUPPLY - BOTH BOTTLES AT 2000 PSI

▷3 CHECKED LYCOMING OVSPD OK

~~▷4 BAD DATA S/V'S OUT OF SYNC.~~

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO}		V_T KEAS/q	α DEG				P_{AMB} IN HG		DATE — TIME
17.1	L/CFA FAN INLET	2C		52	13320	94		125/50	60				29.86		9-21 1817
17.2				51.8	12770	95		124	✓				✓		1820
17.3				✓	12030	✓		✓	✓				✓	▷1	1823
17.4				✓	11250	95		✓	✓				✓		1829
17.5				✓	10400	96		✓	✓				✓		1831
17.6				✓	9100	✓		✓	✓				✓	▷2	1833
17.7				✓	9090	✓		✓	✓				✓		1837
17.8				✓	8690	✓		✓	✓				✓		1841
18.1		2C	2	56	14350	98		142	0				29.85 14.661		1854
18.2			3	51.8	14030	✓		✓	✓				✓	▷3	1858

▷1 HAD TO RETAKE TUNNEL DATA (PT3) AT PT. 4 ENGINE CONDITIONS. PT3 FORCE DATA NG

▷2 S/U HUNG UP RETOOK

▷3 FRONT FRAME TEMPS READING HIGH. SHUTDOWN TO CHECK

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_0/N_T	β DEG	N_2 RPM	T_{T0} °F		V_T KB/g	α DEG				P_{AMB} IN HG		DATE — TIME
19.1	L/CFA FAN INLET	2C	4	51.8	12350	70		140/66	0		▷1 ▷2		29.85 14.663		9-22 0024
19.2			5	✓	11600	72		✓	✓				✓		0027
19.3			6	✓	10800	75		✓	✓				✓		0029
19.4			7	✓	9350	✓		✓	✓				✓		0032
19.5			8	✓	8550	78		✓	✓		▷3		✓		0034
19.6			8	✓	✓	✓		✓	✓		▷3		✓		0036
19.7			9	✓	8000	78		✓	✓				✓		0039
19.8			-	✓	7270	79		✓	✓				✓		0042
19.9			-	✓	6000	80		✓	✓				✓		0045
19.10				✓	5500	✓		✓	✓				✓		0047

▷1 ENG. FRT FRAME RT   ENG COMPRES. FRT LFT   COMP REAR LEFT   TEMPS NOT WORKING

▷2 TTM 3 WENT OPEN - TEED ON DATA SYSTEM TO TTM 2

▷3 AIRFLOW UNSTABLE

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F	V_T KTS/g	α DEG	P_{AMB} IN HG	DATE — TIME
20.1	L/CFA FAN INLET	2C		56	14100	84	140	45	29.85	9-22 0055
20.2				51.8	13200	✓	✓	✓	1466	0100
20.3				✓	12150	87	✓	✓	✓	0103
20.4				✓	11580	✓	✓	✓	✓	0105
20.5				✓	10780	88	✓	✓	✓	0107
20.6				✓	9340	✓	✓	✓	✓	0110
20.7				✓	8670	88	✓	✓	✓	0113
20.8				✓	7990	✓	✓	✓	✓	0116
20.9				✓	7260	✓	✓	✓	✓	0120
20.10				✓	6430	✓	✓	✓	✓	0122

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
20.11	L/CFA FAN INLET	2C	14-600	43	13880	88		140	45				29.84 14.4		9-22 0129
20.12			12-500	✓	11500	89		✓	✓				✓		0130
20.13			13-900	✓	10830	90		✓	✓				✓		0133
20.14			14-800	✓	9460	✓		✓	✓				✓		0137
20.15			—	✓	9060	✓		✓	✓				✓		0139
20.16			—	✓	8670	✓		✓	✓				✓		0142
20.17			—	✓	8410	✓		✓	✓				✓		0146
21												⊳1	29.85 14.663	⊳2	9-22 1700

⊳1 LYCOMING OVSPD CHECK OK.

⊳2 WIND TUNNEL DRIVE MOTORS WOULD NOT SYNC. ELECTRICAL PROBLEM IN ONE OF THE LARGE M-G SETS 1-2 WEEKS REPAIR

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_0/N_T	β DEG	N_2 RPM	T_{T0} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
22	LKFA FAN INLET. W/T MG SET Repaired	2B	—	52	—	90		60	75	▷1	▷3	▷3	29.93 14.70		10-13 1715
23.1	▷6		.	✓	14170	83		✓ 12	✓		▷2		29.98 14.725		10-14 1808
23.2				✓	11880	86		✓	✓						1814
23.3				✓	9250	87		✓	✓						1816
23.4				✓	7090	✓		✓	✓						1829
23.5				43	8030	✓		✓	✓		▷4				1836
24.1				52	14350	74		✓	90		▷5		30.03 14.75		10-14 2113
24.2				✓	12560	78		✓	✓		✓		✓		2116
24.3				✓	10650	✓		✓	✓		✓		✓		2119
24.4				✓	8820	✓		✓	✓		✓		✓		2121

▷1 PTC 18, 24, 23, 22, 25 & 26 APPEAR TO HAVE RESIDUAL PRESSURE (SMALL AMOUNTS) TRAPPED IN LINES (4.3, .16, .01, .14, .03, .03) psi + VISUALLY CHECKED RAKES, APPEAR OK

▷2 LYCOMING OVSPD CHECK OK

▷3 LOST N_2 SIGNAL RUN ABORTED NO DATA

▷4 STILL HAVING N_2 PROBLEMS. SHUTDOWN TO TROUBLE-SHOOT PROBLEM APPEARS TO BE IN H.S. SYSTEM

▷5 DRAG & YAW MOMENT DATA RECORDED MANUALLY QUICK LOOK DATA N.G.

▷6 PTC 21, 23 & 24 HAVE RESIDUAL PRESSURE TRAPPED (.15 - .25 psi) DATA VALUES HAVE BEEN REPLACED IN COMPUTER PROGRAM WITH PTC 16, 17 & 18 VALUES - RESPEC. RUNS 23. & ON

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/LG	α DEG				P_{AMB} IN. HG		DATE — TIME
24.5		2B		43	8820	79		60	90	▷1			30.03		10-14 2125
24.6				✓	7700	✓		✓	✓	✓	▷2		✓		2130
24.7				✓	8400	✓		✓	✓	✓	▷3		✓		2132
25.1				52	14450	✓		✓	105	✓			✓		2139
25.2				✓	12840	80		✓	✓	✓			30.04 14.754		2141
25.3				✓	10720	✓		✓	✓	✓			✓		2145
25.4				✓	8930	✓		✓	✓	✓			✓		2149
25.5				43	10370	✓		✓	✓	✓			✓		2153
25.6				✓	8750	✓		✓	✓	✓	▷2		✓		2155
25.7				✓	13520	✓		✓	✓	✓	▷3		✓		2200

▷1 DRAG & YAW DATA RECORDED MANUALLY QUICK LOOK DATA N.G

▷2 IN ~~"STALL"~~ LIP FLOW SEPARATED W1, WK1, CALC. N.G. USE W2, W3 FOR INLET FLOW

▷3 OUT OF "STALL"

RUN NO.	CONFIGURATION	TYPE OF RUN	P_D/N_T	β DEG	N_Z RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE — TIME
26.1		28	1	52	14200	32		90	60	▷1			30.04		10-14 2211
26.2				✓	12600	✓		90	60	✓			✓		2220
26.3				✓	10230	83		✓	✓	✓			✓		2224
26.4				✓	8120	83		✓	✓	✓			✓		2227
26.5				43	8530	✓		✓	✓	✓			✓		2231
26.6				✓	8180	✓		✓	✓	✓			✓		2233
26.7				✓	7810	✓		✓	✓	✓			✓		2236
26.8				✓	6500	82		✓	✓	✓			✓		2240
27.1				52	14130	83		✓	75	✓			30.05 14.759		2247
27.2				✓	12540	✓		✓	✓	✓			✓		2250

▷1 (▷1 RUN 25)

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_0/N_T	β DEG	N_2 RPM	T_{T0} °F		V_T KTS/$\sqrt{\theta}$	α DEG				P_{AMB} IN.HG		DATE — TIME
27.3				52	10060	83		90	75	▷1			14.759		10-14 2254
27.4				✓	8730	✓		✓	✓	✓			✓		2257
27.5				✓	7690	✓		✓	✓	✓	▷2		✓		2300
27.6				43	9530	✓		✓	✓	✓	▷2		✓		2302
27.7				52	9550	✓		✓	✓	✓	▷3		✓		2304
27.8				43	9550	✓		✓	✓	✓	▷2		✓		2307
27.9				✓	11100	✓		✓	✓	✓	▷3		✓		2310
28.1				52	14430	84		90	90	✓			✓		2316
28.2				✓	12660	✓		✓	✓	✓			✓		2318
28.3				✓	11500	✓		✓	✓	✓			✓		2321

▷1 (▷1 RUN 25)

▷2 IN "~~STALL~~" LIP FLOW SEPARATED W1, WK1, CALC N.G. USE W2, W3 FOR INLET FLOW

▷3 OUT OF "STALL"

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_O/N_T	φ DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATE / TIME
28.4		2B		52	11530	85		90	90	▷1			30.05		10-14 2324
28.5				✓	10500	✓		✓	✓	✓			✓		2326
29.1				52	15120	✓		40	✓	✓			✓		2335
29.2				✓	11300	✓		✓	✓	✓			✓		2339
29.3				✓	19190	86		✓	✓	✓			✓		2342
30.1		2C		56	14840	✓		40	120	✓	▷2		✓		2353
30.2				52	15270	87		✓	✓	✓			✓		2358
30.3				✓	14250	✓		✓	✓	✓			✓		10-15 0000
30.4				✓	13550	88		✓	✓	✓			✓		0002
30.5				✓	12840	✓		✓	✓	✓			✓		0004

▷1 (▷1 RUN 25)

▷2 MAX LIMITS N1 & TT7

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN HG		DATA — TIME
30.6	L/CFA FAN INLET	2C		52	11730	88		40	120	▷1			30.05		10-15 0007
30.7				✓	10750	✓		✓	✓	✓			✓		0009
30.8				✓	9480	86		✓	✓	✓			✓		0022
30.9				✓	8730	✓		✓	✓	✓			✓		0024
30.10				43	—	✓		✓	✓	—	▷2		✓		0029
31.1		1		52	8320	77		90 27.3	70		▷3		30.07 14.769		10-15 1323
31.2				✓	✓	78		✓	73.5				✓		1325
31.3				✓	8330	79		✓	78				✓		1328
31.4				✓	8320	✓		✓	81		▷4		✓		1330
31.5				✓	✓	80		✓	78		▷4		✓		1331

▷1 (▷1 RUN 25)

▷2 N_2 DRIFTED AT HIGH RPM LYCOMING OVSP TRIPPED NO DATA 30.10

▷3 LYCOMING OVSPD CHECK OK

▷4 IN ~~"STALL"~~ LIP FLOW SEPARATED WN1, WK1 CALC. N.G. USE W2, W3 FOR INLET FLOW

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_0/N_T	ϕ DEG	N_2 RPM	T_{T0} °F		V_T KTS/$\sqrt{\theta}$	α DEG				P_{AMB} IN HG		DATE — TIME
31.6		1		52	9320	80		90	75	▷1 2			14.764		10-15 1334
31.7				✓	✓	✓		✓	✓	▷1	▷2		✓		1335
32.1				43	9240	83		125 ~~52.5~~	48				✓		1344
32.2				✓	9230	84		122	50				✓		1346
32.3				✓	9248	85		✓	52				✓		1349
32.4				✓	9260	✓		121	53.5				✓		1351
32.5				52	8950	86		✓	59				✓		1355
32.6				✓	9030	88		✓	60				✓		1402
32.7				✓	✓	89		✓	62				✓		1407
32.8				✓	✓	90		✓	64				✓		1411

▷1 OUT OF "STALL"

▷2 RETAKE OF 31.6 FLOW REATTA'tHED DURING 31.6 DATA SCAN

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT N_T	ϕ DEG	N_Z RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN. HG		DATE — TIME
32.9		1		52	10900	92		120	60				14.769		10-15 1418
32.10				✓	✓	93		✓	70				✓		1421
32.11				✓	10870	✓		119	72				✓		1423
32.12				✓	✓	✓		✓	74				✓		1425
32.13				✓	13610	94		122	60				30.04 14.759		1430
32.14				✓	13560	96		118	75				✓		1432
32.15				✓	13590	✓		✓	77				✓		1434
32.16				✓	13510	✓		✓	79				✓		1436
32.17				✓	13520	97		117	81				✓		1439
32.18				56	14280	98		122	60				✓		1444

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RUN NO.	CONFIGURATION	TYPE OF RUN	P_0/N_4	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/q	α DEG				P_{AMB} IN. HG		DATE — TIME
32.19		1		56	14320	100		118	75	▷1			30.04		10-15 1446
32.20				✓	14360	✓		117	81				✓		1450
32.21				✓	14300	✓		116	84	▷2			✓		1452
33.1				✓	14060	104		149/63	70	▷1			✓		1504
33.2				✓	✓	105		✓	71	▷1	▷3		✓		1508
34.1				43	8146	95		160	39				30.03		10-15 1615
34.2				✓	8150	98		✓	41				14.750		1618
34.3				52	9560	99		✓	45				✓		1622
34.4				✓	9600	100		155	50				✓		1624
34.5				✓	✓	101		✓	52				✓		1626

▷1 SIDE FORCE SCALE AT LIMIT

▷2 ABORTED SCAN - RETAKE

▷3 SIDE SUPPORT CABLE ON STRUT FAIRING BROKE (EYE BOLT). FAIRING BUFFETTING SHUT DOWN

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RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} °F		V_T KTS/Q	α DEG				P_{AMB} IN HG		DATE — TIME
34.6		1		52	12230	102		157	45				14.750		10-15 1629
34.7				✓	12280	104		155	57				✓		1631
34.8				✓	✓	✓		✓	59				✓		1633
34.9				✓	12303	✓		✓	61				30.02		1636
34.10				56	13300	106		158	45				14.745		1639
34.11				✓	13360	✓		155	61				✓		1642
34.12				✓	13390	108		✓	63				✓		1644
35.1		2A		52	13920	✓		140/62	20				✓		1651
35.2				✓	10050	✓		142	✓				✓		1654
35.3				43	7380	106		140	✓				✓		1657

REC | CHK | APPROVED | APPROVED

REVISED

DATE

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NO.
PAGE 127

DI 4103 1460 ORIG 3/71

6-7000 7.2

TEST LOG

RUN NO.	CONFIGURATION	TYPE OF RUN		β DEG	N_2 RPM	T_{TO} °F		V_T KTS/g	α DEG				P_{AMB} IN.HG		DATE — TIME
36.1		2B		52	14246	107		140	60				14.745		10-15 1704
36.2				✓	11730	✓		✓	✓				✓		1707
36.3				✓	11270	✓		✓	✓				✓		1709
36.4				✓	10090	108		✓	✓				✓		1711
36.5				✓	9910	✓		✓	✓				✓		1714
37.1				52	13950	102		105	20				✓		1734
37.2				✓	10500	✓		✓	✓				✓		1737
37.3				43	4610	✓		✓	✓				✓		1739
38.1				52	14950	✓		75	✓				✓		1747
38.2				✓	10880	✓		✓	✓				✓		1750
38.3				43	8020			✓	✓				✓		1752

REC | CHK | APPROVED | APPROVED

REVISED | DATE

BOEING

NO.

PAGE 128

AMB TEMP.	64
PRESSURE	
HUMIDITY	
WIND VELOCITY	
WIND DIRECTION	

ORIGINAL PAGE IS OF POOR QUALITY

Q FAN DEMONSTRATOR

DATE Sept. 15, 1977

SHEET NO. 1

NASA AMES WIND TUNNEL TEST

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
START	1803		0														—
1.1	1804			100[illegible]	4580	810	52	16	67	28	4	24	98	96	13	63	
STOP	1812	:09	:09		SHUT DOWN UTILIZING HS OVERSPEED SYSTEM SINCE LYCOMING SYSTEM NOT WORKING												
				— SEPTEMBER 16, 1977 —													
2.1	1739	START	:09	10050	4550	800	52	14	71	23	4	29	82	80	10	49	—
	1743	:04	:13		HALF SPEED SHUTDOWN — — O.K.												
2.2	1748	START	:13	10170	4690	800	52	14									
	1753	:05	:18		OVERTORQUE SHUTDOWN — — OK												

VIBRATION - ± MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
1.8	.3	.2	—	.1	.2	—	—	75	100	205	90	60	80	210	101	103	160
			S		H		U		T		D		O		W		N
			— SEPTEMBER 16, 1977 —														
.4	.3	.2	—	0	.3												
					HALF SPEED SHUTDOWN												
					OVERTORQUE SHUTDOWN — — O.K.												

AMB TEMP. 69
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE SEPT 16, '77
SHEET NO. 2

Q FAN DEMONSTRATOR

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
START			:18	10180	4430	800	56	14	53								—
3.1	1809			18760	15046	1580	56	93	76	81	99	23	97	141	10	46	36854
3.2				17900	14348	1360	52	84	72	98	81	25	98	161	11	42	
3.3	1817			17030	12700	1200	52	71	70	101	65	—	100	162	13	52	—
3.4	1819			16060	10900	1030	52	56	70	101	47	—	104	157	14	53	
3.5	1821			15320	9200	900	52	50	67	98	33	—	108	151	14	55	
3.6	1824			1315	8470	840	43	44	57	96	15	29	115	146	13	49	
	1828	:21	:39			SHUTDOWN											

VIBRATION - + MILS

ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8
2.0	.6						
2.0	0.4	0.3	8.0	0.6			
1.6	0.4	0.4	4.0	1.8	0.1		
1.2	0.3	0.2	0.6	0.1	0.1		
3.8	0.3	0.3	1.0	—	—		
1.2	0.3	0.2	—	-	0.2		

SHUTDOWN

ENG/COWL TEMP DEGS F

1	2	3	4	5	6	7	8	9	10

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AMB TEMP. 70°
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE 9-16-77
SHEET NO. 3

Q FAN DEMONSTRATOR

4.1 YAW TO 120° α

n = 280

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
	2101	START	:39	10120	5640	800	43	14	53	50	4	30	105	106	10.5	40	64
4.1	2106			12740	8220	840	43	41	64	60	11	20	107	118	10.5	40	
	2113			12790	8290	830	43	41	64	76	12	28	110	132	13	51	90°α
	2123			12800	8230	830	43	41	60	80	12	28	117	137	14	51	115°α
	2124			12790	8160	830	43	41	60	80	12	28	120	138	14	51	120°α
5.1	2139			12540	8220	820	43	33	59	81	11	28	131	145	15	51	0°α
5.2	2153			12530	8370	825	43	33	59	81	11	28	134	147	15	52	70°α
5.3				12530	8300	825	43	33	59	81	10.5	28	137	149	15	51	75°α
5.4	2204			13670	7840	835	52	46	63	84	19	28	140	152	14	50	78°α
5.6	2218			14930	9000	950	52	48	68	88	28	28	142	156	14		

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.6	.3	.3	—	—	.2	—	—	70	100	210	130	127	110	211	113	126	164
1.1	.2	.2	—	0.1	.2	—	—										
1.1	.3	.1	—	0.1	.2	—	—										
1.1	.2	.1	—	0.2	.1	—	—										
1.1	.4	.1	—	0.4	0.1	—	—										
1.4	.3	.1	—	0.4	0.1		—										

AMB TEMP. 82
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q FAN DEMONSTRATOR

DATE 9/16 & 9/19/77
SHEET NO. 4

6.1, 6.2 = 15 lb/sec. [illegible]

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
5.6	2226	1:25		15000	9100	960	51.8	49	68	92	28	28	144	161	14	—	90.9
5.7	2229	1:28		15000	9020	950	51.8	49	67	94	28	28	145	162	14		94.[illegible]
	2238	1:37	2:16				SHUTDOWN										
						SEPTEMBER 19, 1977											
	1741	START	2:16	10000	5450	820	43	14	73	24	4	29	81	[illegible]	11	50	S.I.
	1749	:08	2:24			LYC	OVERSPEED SHUTDOWN						[illegible]	—	—	—	
	1755	START	2:24	10170	5610	830	43	15	50	58	4	29	92	99	12	51	S.I.
6.1	1805	:10		12410	8730	840	43	32	59	77	9	29	97	124	13	51	α 5% V=105
6.2	1807	:12		12420	8730	840	43	32	58	—					—	—	9.53 V=13[illegible]

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
					S	H	U	T	D	O	W	N					
				S	E	P	T	E	M	B	E	R	19,	1977			
5.6	—	—	.1	.1	.3	.3	.5										
START																	
6.1	—	0.1	.1	.1	.1	.1	.5	70	115	220	60	131	105	224	[illegible]	[illegible]	[illegible]
—	ALL	QUIET		—	—	—	—										

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ORIGINAL PAGE IS
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AMB TEMP. 84/86/91/93
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE 9-19-77
SHEET NO. 5

Q FAN DEMONSTRATOR

7.1 = 12 lb/sec ft²

6.3 = 15 lb/sec ft²
6.4, 6.5, 6.6 = 20 lb/sec ft²
6.7, 6.8 = 25 " "
6.9 [illegible] 6.11 = 30 "

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
6.3	1809	:14		12420	8730	840	43	32					101	128	13	52	α=55 V=105
6.4	1816	:21		14080	8180	910	52"	47	65	86	22	28	110	135	14	54	α=62 V=105
6.5	1819	:24		14100	8200												α=65 V=105
6.6	1821	:26		14100	8170	920	52	47	64	90	21	29	115	139	12	42	α=66 V=105
6.7	1831	:36		15870	10850	1020	52	55	70	94	42	27	125	160	13	42	α=77 V=105
6.8	1837	:42		15870	10810	1030	52	55	70	96	41	27	[illegible]	164	15	52	α=80 V=105
6.9	1846	:51		16930	12620	1180	52	68	70	99	57	26	142	180	15	52	α=85 V=115
6.10	1849	:54		16910	12540	1180	52	68	70	102	57	26	146	184	15	52	α=92 V=125
6.11	1852	:57		16880	12510	1180	52	68									α=95 V=125
7.1	1908	1:13		10170	7660	840	43	13	46	80	3%	29	160	163	16	52	α=43 V=140

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
[illegible]	—	.1	.4	.2	.4	.2	5	—	(6.3)	—	—	—	—	—	—		
[illegible]	—	.1	.4	.2	1.0	.2	2	—	(6.6)	—	—	—	—	—	—	—	—
[illegible]	—	—	.3	.1	1.2	.1	3	—	(6.7)	—	—	—	—	—	—	—	—
.5	—	—	.8	.1	1.1	.2	4	—	(6.8)	—	—	—	—	—	—	—	—
.8	—	.4	—	—	—	—	—	—	(6.9)	—	—	—	—	—	—	—	—
—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	—	.3	4.0	4.0	1.4	—	4	—	(6.11)	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

AMB TEMP. 94/95/96/98

PRESSURE

HUMIDITY

WIND VELOCITY

WIND DIRECTION

7.2, 7.3 = 15 lb/sec ft²

7.4, 7.5 = 20 lb/sec ft²

7.6 & 7.7 = 25 "

7.8 & 7.9 = 30 lb/sec ft²

DATE 9-19-77

SHEET NO. 6

Q FAN DEMONSTRATOR

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
7.2	1916	1:21		11750	8820	850	43	24	54	82	6	29	157	165	15	54	$\alpha=44$ $V=140$
7.3	1919	1:24		11760	8800	850	43	24	53	83	6	29	156	165	16	54	$\alpha=45$ $V=140$
7.4	1925	1:30		13840	8390	910	52	46	63	89	18	29	155	166	14	46	$\alpha=50$ $V=140$
7.5	1932	1:37		13830	8370	910	52	46	62	93	18	29	155	167	14	47	$\alpha=52$ $V=140$
7.6	1937	1:42		15670	10780	1010	52	52	69	96	36	28	155	176	15	46	$\alpha=59$ $V=140$
7.7	1940	1:45		15650	10700	1010											$\alpha=61$ $V=140$
7.8	1944	1:49		16750	12660	1150	52	66	70	100	52	27	157	189	15	46	$\alpha=67$ $V=148$
7.9	1949	1:54		16745	12670	1160	52	66	70	102	53	23	160	195	15	45	$\alpha=68$ $V=140$
	1956	2:01	4:25			SHUDDOWN											
	2245	START	4:25	10150	4660	820	52	14									

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.5	—	.1	6.0	—	2	—	2										
.5	—	.2	4-6	—	2	.1	2										
.9	—	.1	2	.1	1	.4	4										
1.0	—	.2	1.5	1.0	2	—	2										
							SHUTDOWN										

AMB TEMP. 76/77/78
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

ORIGINAL PAGE IS OF POOR QUALITY

Q FAN DEMONSTRATOR

DATE 9-19-77
SHEET NO. 7

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
8.1	2253			17830	14348	1350	52	82	75	85	77	26	120	163	13	51	—
G.I	2300			SCANI-VALVE PROBLEM --- MUST SHUT DOWN TO INVESTIGATE													
	2310	:25	4:50			SHUTDOWN											
G.I.	2351	START	4:50	10260	47[illegible]	810	—										
9.1	2358	:07		17770	14280	1340	52	80	72	88	76	25	127	167	14	49	θ=0, V=75
9.2	0003	:12		17130	13000	1205	52	72	70	100	65	25	130	176	14	48	"
9.3	0005	:14		16030	10910	1040	52	58	70	100	46	27	134	172			"
9.4	0010	:19		15360	9370	990	52	50	68	97	32	28	141	167	15	49	"
9.5	0014	:23		12450	8080	860	43	32	55	92	11	28	147	161	15	50	"
10.1	0021	:30		17710	14170	1340	52	80	70	99	75	25	150	188	15	47	α=60, V=75

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.7	—	.4	.3	.1	.2	.2	.2	70	220		50	50	170	—			
.8	—	.2	.3	.1	.3	.3	.1										
.5	—	.1	.2	.1	.3	.2	.1										
.4	0	.1	.3	.1	.3	.2	.1										
.8	—	.2	.7	.2	.4	.2	.4										

AMB TEMP. 78/80,81/83
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE 9/19
SHEET NO. 8

Q FAN DEMONSTRATOR

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
10.2	0027	:36		16970	12800	1190	52	70	70	103	61	26	155	192	15	47	α=6; V=7.5
10.3	0030	:39		15640	10400	990	52	53	70	100	39	26	160	185	15	48	
10.4	0034	:43		13950	7960	910	52	47	64	95	21	28	162	174	15	49	—
10.5	0038	:47		11940	7840	850	43	26	54	91	9	29	164	170	15	49	
11.1	0043	:52		17740	14290	1340	52	80	71	97	74	26	163	194	15	47	α 7.5 V 7.5
11.2	0051	1:00		16900	12640	1170	52	69	70	104	58	26	167	200	—	—	"
11.3	0053	1:02		15570	10200	1000	52	52	69	102	36	27	169	193	15	47	"
11.4	0057	1:06		13690	7660	900	52	46	61	98	19	28	172	182	15	48	"
11.5	0100	1:09		13570	9470	920	43	46	61	96	15	28	173	182	15	48	"
11.6	0103	1:12		13250	9090	900	43	45	60	94	13	28	173	181	15	48	"

VIBRATION – 4 MILS

ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8
.9	—	.1	.—	.1	.4	.2	.3
.4	—	—	.5	—	.5	.2	.4
.8	—	.3	.9	.1	.9	.2	—
.7	—	.2	.6	.1	.8	.2	—
1.1	—	.1	1.1	.1	.4	.2	—

ENG/COWL TEMP DEGS F

1	2	3	4	5	6	7	8	9	10

AMB TEMP. 85
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE 9/19 & 9/20
SHEET NO. 9

Q FAN DEMONSTRATOR

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
12.1	0116	1:25		17680	14020	1330	52	80	70	106	72	25	171	207	15	47	α=0 V=785
12.2	0119	1:28		17060	12950	1200	52	70	70	106			174	207			"
12.3	0122	1:31		15870	10800	1030	52	54	69	106	41		177	202	15	47	α=0 V=10
12.4	0125	1:34		13550	7600		52				18		178	189			
12.5	0128	1:37		11790	7820	860	43	25	54	95	7	28	179	183	15	47	"
6.1	0130	1:39		10200	6500												6.1
	0134	1:43	6:33		SHUTDOWN												
					9-20-77												
		START ABORTED DUE TO NO IGNITION -- LOTS OF FUEL IN ENG. SO MOTORED TO GET RID OF IT															

VIBRATION - + MILS ENGINE 1	2	3	INLET 4	5	GB 6	7	DUCT 8
(12.5)	7						
.3	–	.2	.4	.2	.4	.3	.6

ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10

AMB TEMP. 80/82
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q FAN DEMONSTRATOR

DATE 9/20/77
SHEET NO. 10

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
	1913	START	6:33														—
	1916	:03	6:36	LYC OVERSPEED SHUTDOWN - - - O.K.													
	1918	START	6:36	G.I.; THEN UP TO 12000 N_2 WHILE α & β WERE RAISED													G.I.
13.1	1926			18290	14000	1460	56	88	73	94	89.5	25	98	156	13	46	α=90 V=75
13.2	1931			17430	13320	1270	52	76	70	105	69	26	106	168	14	50	"
13.3	1935			16880	12300	1170	52	69	70	104	59	27	117	167	15	55	"
13.5	1941			15900	10660	1020	52	57	69	100	43	28	129	166	14	42	"
13.7	1947			15130	9030	980	52	49	67	98	29	29	139	163	13	44	"
13.9	1953				13710		43	57	69	99	35	28	142	173	14	44	"
13.11	1959			15270	11550	1020	43	49	66	100	23	29	150	178	15	49	"

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.8	—	.3	.6	.4	.9	.3	.9	70	160	—	60	144	130	570	[illegible]	211	[illegible]
.8	—	.3	1	1	.9	.2	1										
.8	N.G.	.3	.8	.4	.9	.3	1.2										

AMB TEMP. 72/74/71/78
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q FAN DEMONSTRATOR

DATE 9/20/77
SHEET NO. 11

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
13.12	2002			14840	10970	980	43	48	29	100	21	—	—	—	—	—	—
	2005	:47	7:23			SHUTDOWN – SEPARATION (PREDICTED) AS SETTING LOWER SPEED											
	2204	START	7:23														G.I
14.1	2212			17490	14000	1280	52	77	72	88	71	27	125	168	14	50	α=60 V=105
14.3	2219			15420	9600	980	52	50	70	96	31	29	133	165	15	50	"
14.5	2225			13590	7870	880	52	46	62	94	19	29	141	158	15	50	"
14.7	2230			13030	7360	870	52	43	60	89	15	29	145	155	—	—	
15.1	2236			17950	13640	1380	56	84	71	25	83	—	—	—		—	α=75 V=105
	2242					ENGINE CHIP #2 SCAV											
						PUT OUT BUT IT CAME ON AGAIN											
	2254	:50	8:13			SHUTDOWN											

VIBRATION – + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.8	—	.3	.6	.2	1.0	.2	.1										
.4	—	.2	.5	.1	1.1	.2	.2										

AMB TEMP. 87/88/90° 91/92/94/95/96.
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

DATE 9/21/77
SHEET NO. 12

Q FAN DEMONSTRATOR

Q-FAN

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
	1741	START	8:13	10180	4310	840	56	16									GI
	1744	:03	8:16			LYC HALF SPEED SHUTDOWN -- OK											
	1746	START	8:16	10290	4450	830	56	16	57	46	4	29	91	94	11	50	GI
15.1	1756	:10		18040	13650	1400	56	84	71	99	83	26	96	160	13	51	α=75 V=105
16.3	1802	:16		16740	12160	1160	52	67	70	103	55	27	109	163	15	56	"
16.5	1807	:21		15790	10550	1020	52	54	70	101			124	161	15		"
17.1	1818	:32		17830	13280	1360	56	82	71	101	78	26	140	182	13	44	α=60 V=125
17.3	1823	:37		16520	12030	1120	52	63	71	104	50	27	147	185	14	45	"
17.5	1831	:45		15620	10420	1020	52	52	69	99	34	27	156	181	14	44	"
17.7	1836	:50		14720	9060	970	52	48	66	100	25	29	161	177	15	44	"

VIBRATION - + MILS

ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8
.2	—	.2	.1	.1	.4	.8	—
.7	—	.2	14	.5	2	2	2
.9	—	.3	.4	.3	1	1	1
.6	—	.2	1	1	1		

ENG/COWL TEMP DEGS F

1	2	3	4	5	6	7	8	9	10

140

AMB TEMP 70/72/75/78/79
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q FAN DEMONSTRATOR

Q-FAN

DATE 9/21/77
SHEET NO. 13

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
17.8	1841	:55		14300	8670	950	52	46	62	100	—						—
18.1	1853	1:07		18390	14440	1490	56	88	72	97	86.5	25	163	190	14	45	α=0 V=140
	1900	G.I					TO SHUT DOWN & CHECK OUT TEMPERATURE INDICATORS										
	1904	1:18	9:34		SHUTDOWN -- PUT 7 ENGINE T'S ON DORIC -- ELIM. METERS												
	0018	START	9:34	10070	4590	800	52	14	60	40	4	29	104	105	14	57	GI.
19.1	0024			16580	12340	1110	52	62	73	72	55	28	107	141	14	57	α=0 V=140
19.3	0029			15730	10840	990	52	52	70	89	40	29	112	150	14	57	"
19.5	0034			14370	8550	910	52	47	65	92	23	29	121	146	16	60	"
19.7	0039			13740	7960	890	52	45	—	—	—	—	—	—	—	—	"
19.9	[illegible]			11140	6000	800	52	20	50	86	7	29	133	142	15	54	"

VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.8	—	.2	.5	.2	.4	1.2	1.6	(18.1)	—	—	—	—	—	—	—		—
—	—																
—																	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.2	—	.2	.1	.1	.4	.2	.2	237	157	135	[illegible]06	107	[illegible]	[illegible]			
—		—		—			—		—	—	—	—	—	—	—	—	—
.4	—	.2	.3	.1	.5	.2	1.2	—	—	—	—	—	—	—	—	—	
.4	—	.2	.3	.2	.9	.6	6	347	260	212	246	173	147	200			
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
[illegible]	—	—	.5	.1	.5	.5		230	158	161	226	151	136	154			

AMB TEMP. 79/84/87/88/90
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q FAN DEMONSTRATOR

Q-FAN

DATE 9/21/77
SHEET NO. 14

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
20.1	0054			18130	14090	1420	56	84	71	97	84	25	135	177	15	52	α=45 V=140
20.3	0102			16480	12120	1100	52	62	70	102	51	27	146	182	15	52	"
20.5	0107			15640	10770	1000	52	52	69	100	37	28	152	179	16	52	"
20.7	0113			14140	8600	920	52	47	63	97	20	29	158	171	16	52	"
20.9	0119			12490	7260	805	52	32	57	92	12	30	159	166	16	52	"
20.11	0127			15680	13880	1040	43	52	69	93	27	29	157	183	16	52	"
20.13	0133			13820	10780	930	43	46	61	98	13	29	159	181	16	52	"
20.15	0139			12070	9070	870	43	28	53	93	7	29	161	174	16	51	"
20.17	0145			11270	8410	850	43	20	52	86	4	29	162	170	16	52	"
	0151	1:33	11:07				SHUTDOWN										

VIBRATION - MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT 8	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10
.7	—	.2	1.0	.3	2	1.1	2.1										
.[illegible]	—	.2	.8	.1	1	3	2	475	389	136	462	175	158	201			
.8	—	.2	1.8														
								294	[illegible]	187	200	171	152	[illegible]			
.6	—	.3	.9	.8	1.6	0.4	1.8	401	314	224	397	196	155	219			

AMB TEMP. ______
PRESSURE ______
HUMIDITY ______
WIND VELOCITY ______
WIND DIRECTION ______

DATE 9/22/77
SHEET NO. 15

Q FAN DEMONSTRATOR

Q-FAN

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
	1733	START	11:07	10850	5130	830	52	18									
	1736	:03	11:10		LYCOMING		OVERSPEED		SHUTDOWN		CHECK		-	-	O.K.		

VIBRATION - + MILS								ENG/COWL TEMP DEGS F									
ENGINE			INLET		GB		DUCT										
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10

Amb. Temp. 90°
Test Loc. NASA ARC

ENGINE LOG
Q-FAN DEMONSTRATOR

Date 10/13/77
Sheet No. 16

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1716	START	11:10	10040	4540	850	52	14	66	28	4	29
1720	:04	11:14	HALF SPEED SHUTDOWN - O.K.								
1818	START	11:14	10040	NO N_2 RDG	850	52	14	51	51	4	29
1831	:13	11:27	TO FIX N_2 SIGNAL PROBLEM (NO SIGNAL)								

RUN 22

L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Vibration Engine 1	Engine 2	Engine 3	Inlet 4	Inlet 5	GB 6	GB 7	Duct	Comments
12	82	9.	48									51
				SHUTDOWN								
79	94	11	48	.1	0	.1	.1	.1	.4	.1	.1	5.5

VIBRATION - ± MILS

ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
COMB EFF	COMP R. RT	COWL CAV RT	COMB RT	FR. FRA LT	COMPR FT, RT	COWL CAV LT						
225	177	145	225	127	119	150				112	110	111

Amb. Temp. 81/84
Test Loc. NASA ARC

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 17

Pt.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
	1725	START	11:27	10030	4480	820	52	14	74	24	3	29
	1728	:03	11:30		HALF SPEED CHECK -- OK							
	1750	START	11:30	10370	4790	820	52	16	53	55	5	29
1	1804	:14	11:44	17850	14200	1360	52	82	72	90	72	26
2	1808	:18	11:48	16680	11950	1150	52	65	70	102	54	27
3	1815	:25	11:55	15400	9250	1020	52	50	67	100	32	28
4	1820	:30	12:00	13130	7050	900	52	44	57	96	16	29
5	1835	:45	12:15	12400	8030	900	43	32	55	88	10	29
0	1842	:52	12:22									

RUN 23

Pt.	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
	[illegible]	79	10	51									
				HALF SPEED CHECK									
	79	101	13	57	.2	-	.2	.2	.1	.5	.3	.1	
1	93	156	13	52	.8	-	.2	.3	.3	.6	.2	.5	STILL A
2	118	169	15	53	.8	-	.2	.3	.2	.5	.6	.6	PROBLEM ~~WITH N2~~
3	127	161											~~WHEN OUR~~
4	133	152	15	55	.4	-	.2	1.2	-	1.0	.4	.3	~~DATA AQ CONNECTED~~
5	144	154	15	53	.4	-	.2	.3	-	.6	.3	.2	
0													

Pt.	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
			HALF SPEED CHECK										
	228	179	142	228	128	118	150				119	116	11[illegible]
1	554	446	139	518	177	155	233				21[illegible]	1[illegible]	22[illegible]
2	500												
3													
4	319	246	181	316	182	157	196				167	159	168
5	296	230	172	293	173	150	187				17[illegible]	166	178

ORIGINAL PAGE IS OF POOR QUALITY

Amb. Temp. 74/78

Test Loc. NASA ARC

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77

Sheet No. 18

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
2100	START	12:22	10630	4990	810	52	17	56.	53	6	29
2112	:12	12:34	17830	14330	1350	52	81	71	92	77	26
2116	.16	12:38	16900	12558	1180	52	68	70	98	60	27
2118	:18	12:40	15840	10660	1020	52	55	70	97	43	27
2121	:21	12:43	14880	8800	970	52	49				
2124	:24	12:46	13170	8820	900	43	44	58	93		
2129	:29	12:51	12380	7740	880	43	31	54	88	10	29
2132	.32	12:54	12800	8400	900	43	39	57	[illegible]	[illegible]	29

RUN 24

L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
27	122	14	48	.2	—	.2	.1	—	.5	.3	—	
124	170	15	51	.7	—	.2	.4	.4	.8	.4	.8	
128	171											
132	168	15	52	.5	—	.2	.4	—	.8	1.0	1.5	
147	157	15										
148	157	15	52									

ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
										141	137	144
551	437	151	521	175	141	246						
291	229	169	211	169	115	144						

Amb. Temp. 78

Test Loc.

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77

Sheet No. 19

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2138	:38	13:00	17880	14410	1370	52	82	71	96	78	25
2	2142	:42	13:04	17120	12880	1210	52	71				
3	2145	:45	13:07	15920	10710	1040	52	55	69	100	43	27
4	2149	:49	13:11	15060	8960	990	52	49	66	97	30	27
5	2152	:52	13:14	14530	10430	970	43	47	64	96	19	28
6	2155	:55	13:17	13280	8790	930	43	44				
7				15920	13540	1060	43	54				

RUN 25

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Vibration – + Mils: Engine 1	Engine 2	Engine 3	Inlet 4	Inlet 5	GB 6	GB 7	Duct	Comments
1	149	185	15	50	.9	–	.2	.4	.6	1.6	1.8	.8	
2	151	190	15	51									
3	155	[illegible]	15.5	51	.5	–	.2	.2	.1	.8	1.0	.4	
4	159	174	15.5	50									
5	161	176											
6					.7	–	.2	.2	.2	1.0	.5	.8	SEPARATION
7													

	Eng/Cowl Temp Degs F: 1	2	3	4	5	6	7	8	9	10	Brg. Race Temps: 1	2	3
1	558	443	162	510	191	146	248				236	214	238
2													
3	454										214	188	203
4													
5	356	272									202	186	212
6	313												
7													

Amb. Temp. 83

Test Loc.

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 20

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2210	1:10	13:32	17650	14130	1320	52	79	71	98	72	26
2	2219	1:19	13:41	16790	12530	1150	52	66	70	99	56	27
3	2223	1:23	13:45	15550	10380	1000	52	51	69	98	35	28
4	2227	1:27	13:49	13970	8150	920	52	46				
5	2230	1:30	13:52	12440	8540	880	43	32	56	[illegible]	9	29
6	2233	1:33	13:55	12070	8180	870	43	27	55	89	8	29
7	2235	1:35	13:57	11650	7810		43				7	
8				10200	6490	860	43					

RUN 26

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Vibration Engine 1	Engine 2	Engine 3	Inlet 4	Inlet 5	GB 6	GB 7	Duct	Comments
1	[illegible]	197	17	55	.8	–	.2	.5	.8	1.0	1.2	.6	
2	173	195	16	50	.9	–	.2	.5	1.8	.8	.6	.6	
3	175	191	16	50									
4													
5													
6	175	178											
7													
7	171	170											

VIBRATION - + MILS

	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
1	545	425	137	518	181	154	243				245	236	249
2	498	386	135	480	178	154	227				240	222	244
3													
4	340	271	190	323	183	159	204				210	197	213
5													
6											195	185	197
7													

Amb. Temp.__________

Test Loc.__________

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date *10-14-77*

Sheet No. *21*

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1				17610	14110	1320	52°	78	71	93	71	26
2				16780	12560	1170	52	66	70	99	55	27
3				15540	10250							
4	2256	1:56	14:18	14610	8760	950	52	48	66	96	24	28
5				13750	7900	920	52	46				
6	2302	2:02	14:24	13730	9530	930	43	46				
7				15340	9430	1000	52	49				
8	2307	2:07	14:29	13740	9600		43					
9	2310	2:10	14:32	14680	11050	970	43	47				

RUN 27

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
1	166	195	15	50	.9	–	.2	.4	.2	2.0	3.0	1.5	ENGINE
2	166	198											TURBINE
3	169	179	16	50									[illegible]
4	170	183											[illegible]
5												—	SEPARATION
6		177											
7	171	178											OUT OF S[illegible]P
8													
9	16?	181			.6	–	.2	.4	.2	1.5	2.0	2.0	

	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS: 1	2	3
1	541	430	119	359	170	147	232				245	226	247
2													
3	418	344	193	374	181	157	220				[illegible]	[illegible]	[illegible]
4													
5													
6											210	196	216
8													

Amb. Temp. 84

Test Loc. ____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 22

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2314	2:14	14:36	17780	14370	1360	52	80	71	100	74	25
2	2318	2:18	14:40	16900	12700	1180	52	68				
3	2321	2:21	14:43	16260	11540	1080	52					
4	2323	2:23	14:45	16020	11110	1060	52	57	69	100	44	27
5	2326	2:26	14:48	15670	10440	1010	52	52	69	90	39	29

RUN 28

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
1	167	200	16	50	1.0	-	.2	.8	.6	2.0	2.5	2.5	
2													
3	171	196											
4	173	194	16	50	.6	-	.2	.8	.4	1.8	3.0	2.0	
5	174	191											

	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS: 1	2	3
1	557	441	202	491	189	156	231				249	230	252
2											231	215	[illegible]
3													
4													
5													

Amb. Temp.__________

Test Loc.__________

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77

Sheet No. 23

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2335	2:35	14:57	18220	15000	1450	52	85			82	
2	2337	2:37	14:59	16250	11290	1080	52	59	RUN 29		48	
3	2342	2:42	15:04	13540	9160	930	43	46			15	
1	2352	2:52	15:14	18620	14620	1540	56	90	72	105	74	
2	2356	2:56	15:18	18330	15158	1490	52	87	71	[illegible]	95	
3	0000	3:00	15:22	17890	14230	1390	52	81	70	111	76	
4	0002	3:02	15:24	17540	13600	1300	52	78	70	110	70	
5	0004	3:04	15:26	17180	12900		52					
6	0006	3:06	15:28	16520	11700	1120	52	63	70	106	52	
7	0009	3:09	15:31	16000	10800							

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
1	176	210	16	50	1.1	–	.3	.2	.4	.6	.2	.2	
2	177	206	15	50									
3													
1	[illegible]	[illegible]											[illegible]
2													
3	184	220				RUN 30							
4													
5													
6	189	211	16	48	1.0	–	.6	.4	–				
7													

	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
1													
2	479	377	167	420	192	152	193						
3													
1													
2													
3													
4													
5	528	401	134	436	201	160	205				241		
6													
7													

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ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Amb. Temp.

Test Loc.

Date 12-14-77

Sheet No. 24

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
0013	3:13	15:35	15500	9450	1020	52	51	69	98	32	28
0023	3:23	15:45	14910	8758	980	52	48	67	98	27	27
0026	3:26	15:48	16950	15850							
0028	3:28	15:50	OVERSPEED SHUTDOWN (LYCOMING)								

RUN 30

L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
188	197	16	50	1.0	–	.4	2.0	–	.6	.8	.5	
197	193	16	49									

ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
299	298	199	370	191	162	227				201	210	237

Amb. Temp. 76

Test Loc.

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77

Sheet No. 25

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
	1307	START	15:50	10530	4800	780	52	16	76	26	4	29
	1310	:03	15:53	LYCOMING HALF SPEED SHUTDOWN CHECK								OK
	1311	START	15:53	10110	4630	910	52	16	64	34	4	29
1	1317	:06	15:59	14280	8350	920	52	48	71	63	23	29
2	1324	:13	16:06	14280	8310	920	52	48	66	83	23	29
3	1327	:16	16:09	14280	8310							
4	1330	:19	16:12	14260	8310	930	52					
5	1331	:20	16:13	14290	8320	930	52	RUN 31				
6	1333	:22	16:15	14280	8310							
7	1335	:24	16:17	14280	8330	930	52					

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
	71	70											L.S. SHUTDOWN
					SHUTDOWN								
	85	87	11	50	.2	-	.2	.2	.1	.5	.1	.2	
1	88	111	12	51	.5	-	.4	.3	—	.6	1.0	.8	70°α
2	96	124	13	53	.4	-	.4						73.5°α
3													78°α
4													81°α
5	104	130	14	55	.5	-	.5	.8	.8				78°α
6													[illegible] 75°α
7													OUT OF STALL 75°α

	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
				SHUTDOWN									
	211	160	113	211	102	99	134				106	113	105
1	347	261	177	292	152	135	194				151	110	151
2											153	144	154
3													
4	348	260	185	300	171	149	189						
5													
6													
7													

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Amb. Temp. 79/83/89/92

Test Loc.

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 26

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	13:42	:31	16:24	12800	9130	880	43	40	57	89	10	28
2	13:47	:36	16:29	12790	9240	880	43	40	58			
3	13:48	:37	16:30	12770	9240	880	43	40	58	86	10	28
4	13:50	:39	16:32	12780	9240	880	43					
5	13:54	:43	16:36	14530	8700	960	52	49	66	87	24	28
6	13:59	:48	16:41	14710	8960	960	52	49	67	91	25	28
7	14:07	:56	16:49	14740	9030	970	52	49	67	94	25	28
8	14:11	1:00	16:53	14760	9040	970	52					
9	14:18	1:07	17:00	15790	10880	1040	52	56	69	95	39	
10	14:20	1:09	17:02	15850	10910	1040	52					

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
1	116	141	15	59	.7	-	.9	1.8	—	1.0	2.5	1.5	α=48°
2													α=50°
3	122	144	15	57									α=52°
4													α=53.5°
5	127	147	15	57	.5	—	1.0	1.4	—	3.0	2.0	3.0	α=59°
6	130	151	16	57									α=60°
7	134	155	16	57	.7	—	.7	1.2	—	1.5	2.5	1.0	α=62°
8													α=64°
9	140	165	15	52									α=60°
10													α=70°

RUN 32

	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
1	300	232	168	280	171	149	181				161	153	167
2													
3	303	233											
4			168	273	168	149	179				168	155	173
5													
6	314	279	194	301	180	166	200				182	166	184
7	311	281	197	310	184	164	201				186	169	172
8													
9													
10											202	176	206

Amb. Temp. 93/97/100

Test Loc. ________

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77

Sheet No. 27

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1423	1:12	17:05	15870	10870	1040	52	56	70	95	40	27
1425	1:14	17:07	15860	10820	1040	52	56				
1429	1:18	17:11	17330	13630	1270	52	76	70	97	63	25
1432	1:21	17:14	17350	13570	1270	52					
1434	1:23	17:16	17340	13550	1270	52	76	70	101	63	[illegible]
1438	1:27	17:20	17360	13580				RUN 32			
1439	1:28	17:21	17350	13500	1280	52					
1443	1:32	17:25	18330	14210	1470	56	89	71	106	86	25
1447	1:36	17:29	18400	14300	1480	56					
1449	1:38	17:31	18400	14350	1480	56					

L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
												α=72°
142	170	15	52									α=74°
145	183	15	52	1.0	–	1.0	.5	–	.8	.6	.8	α=60°
												α=75°
148	192	16	~~52~~									α=77°
150	194											α=79°
153	197											α=81°
158	222	16	51	1.2	–	1.0	.8	.4	1.5	1.8	2.0	α=60°
												α=75°
												α=81

ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
461	364	127	400	172	152	210				[illegible]	152	[illegible]
538	435	142	387	184	162	225						
										224	215	227
595	475	129	458	193	171	218				230	228	232

Amb. Temp. 101/104/92/99
Test Loc. NASA ARC

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 27

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1451	1:40	17:33	18400	14350	1490	56°	89	70	112	85	25
1504	1:53	17:46	18150	14100	1420	56	87	70	109	80	25
1507	1:56	17:49	18160	14060	1440	56	87	70	110	[illegible]	26
1516	2:05	17:58		SHUTDOWN							
[illegible]	START	17:58	10140	5600	870	43	15	45	74	4	29
1615	:12	18:10	10200	8130	870	43	15	46	75	2	29
1618	:15	18:13	10200	8130							
1621	:18	18:16	14948	9490	990	52	50	67	80	25	28
1623	:20	18:18	14990	9600	990	52	50	67	88	25	28
1626	:23	18:21	15010	9600							

L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
162	212	17	55									α = 8?°
177	215	17	55	1.0	–	1.0	.7	.5	2.0	2.0	2.0	α = 7?°
177	217					RUN 33,34						α = 71°
		SHUTDOWN										[illegible] PYLON CABLE IN TUN
142	154	15	50	.4	–	.2	1.0	–	2.0	4.0	6.0	α = 39°
												α = 41
141	160	15	50	.8	–	.2	1.6	–	2.0	3.0	4.0	α = 45
141	163											α = 53°
												α = 52°(?)

ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
										253	[illegible]	256
588	469	129	410	195	171	250				253	[illegible]	260
		SHUTDOWN										
236	188	142	227	145	136	156				162	162	171
										161	176	204

Amb. Temp. 101/104/108
Test Loc. ________

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 29

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
6	1628	:25	18:23	16440	12210	1110	52	63	69	96	46	27
7	1631	:28	18:26	16500	12290	1130	52					
8	1633	:30	18:28	16480	12260	1130	52	RUN 34 35				
9	1636	:33	18:31	16500	12300							
10	1640	:37	18:35	17800	13310	1350	56	82	70	102	74	25
11	1642	:39	18:37	17800	13340							
12	1644	:41	18:39	17810	13380	1350	56	82	70	106	73	26
1	1650	:47	18:45	17620	13900	1330	52	80	70	109	66	27
2	1654	:51	18:49	15730	10060	1070	52	55	66			
3	1656	:53	18:51	10290	7380	880	43	13	41	104	4	29

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS: ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
6	143	173	15	50	.8	-	.2	1.2	1.2	1.2	2.8	2.2	α = 45°
7													α = 57°
8													α = 59°
9	146	184	15	50	1.2	-	.2	2.2	2.2	3.0	3.0	3.0	α = 61°
10	151	191	16	51									α = 45°
11													α = 61°
12													α = 63
1	162	202	16	51	1.0	-	.3	.6	-	.6	.8	1.8	α = 20°
2													
3	167	183											

	ENG/COWL TEMP DEGS F: 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
6	499	383	124	419	181	157	233				[illegible]	[illegible]	[illegible]
7													
8	500	384	124	460	180	151	237				[illegible]	[illegible]	[illegible]
9													
10	567	414	133	480	189	163	257				236	214	242
1													
12													
1													
3	425	328	210	322	212	179	242						

Amb. Temp. 107

Test Loc.

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 30

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	1701	:58	18:56	17700	14130	1340	52	81	70	102	69	26
2	1706	1:03	19:01	16290	11770	1110	52	61	68	108	42	27
3	1709	1:06	19:04	15980	11240		52					
4	1711	1:08	19:06	15620	10130	1060	52					
5	1714	1:11	19:09	15470	9910	1050	52					
1	1731	1:28	19:26	17700	13980	1360	52					
2	1736	1:33	19:31	15850	10490	1050	52	56	68	106	38	21
3	1739	1:36	19:34	10408	6650	880	43	16				

RUN 36 37

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Vibration ± Mils Engine 1	Engine 2	Engine 3	Inlet 4	Inlet 5	GB 6	GB 7	Duct	Comments
1	162	199	16	51	1.1	—	.2	.8	—	2.2	2.2	1.0	α=60°
2	169	203											α=60°
3	170	199											"
4													"
5					1.0	—	.2	2.0	—	3.0	6.0	4.0	"
1													α=20
2	163	194	.6	52	.8	—	.2	.5	—	.5	.4	.2	"
3		181											"

	Eng/Cowl Temp Degs F 1	2	3	4	5	6	7	8	9	10	Brg. Race Temps 1	2	3
1	563	446	141	341	191	165	247				247	330	[illegible]
2													
3													
4													
5											218	303	249
1													
3	251	218	166	236	194	165	186						

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ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Amb. Temp. 102
Test Loc.

Date 10-15-77
Sheet No. 31

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	1745	1:42	19:40	18210	14870	1440	52	87	71	104	78	25
2	1749	1:46	19:44	16100	10920	1080	52	59	69	111	42	27
3	1751	1:48	19:46	12430	8050							

RUN 38

	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS ENGINE 1	ENGINE 2	ENGINE 3	INLET 4	INLET 5	GB 6	GB 7	DUCT	COMMENTS
1	165	201	16	51	1.4	–	.3	.5	.4	.6	.4	.2	α=20°
2	166	199											α=20°

	ENG/COWL TEMP DEGS F 1	2	3	4	5	6	7	8	9	10	BRG. RACE TEMPS 1	2	3
1	594	477	245	430	219	164	284				252	229	260
2													
3													