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RADIALLY LEANED OUTLET GUIDE VANES FOR FAN SOURCE NOISE REDUCTION

by

S.B. Kazin

GENERAL ELECTRIC COMPANY

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I. SUMMARY

A radially leaned outlet guide vane was tested on two single-stage fans. The vane assembly, common to both fans, was leaned 30 degrees in the direction of rotor rotation. One fan, Fan B, had a design tip speed of 1160 ft/sec (353.568 m/sec) and a design pressure ratio of 1.5 . The other, Fan C, had a supersonic design tip speed, 1550 ft/sec (472.44 m/sec) and a design pressure ratio of 1.6. Both fans had 26 rotor blades, 60 outlet guide vanes (OGV's), and two rotor tip chord spacing between the rotor and OGV's.

Data were acquired for both radial and leaned vanes for both vehicles. Table I is a summary of 200-foot (60.96 m) sideline extrapolations of the front and aft quadrant maximum perceived noise levels (PNL's) scaled to a full-size Quiet Engine. Comparisons between Fan C and Fan B are not possible due to the different test configurations employed. However, the data on each fan forms a consistent set. Table II contains the efficiency for the approach and takeoff points.

The results with the subsonic tip speed fan showed reductions of from 0.7 to 2.3 PNdB. It should also be noted that the takeoff efficiency increased 1.8%. Data from the supersonic tip speed fan, however, showed a loss of 0.9% in efficiency at takeoff, and a noise increase of from 0.5 to 3.5 PNdB. The Fan C noise increase was largely associated with increased high frequency broadband noise.

It is possible that the Fan C noise increase is associated with an aerodynamic problem (as exemplified by the efficiency decrease) rather than an inherent incompatibility between leaned OGV's and supersonic tip speed fans.

Table I. PNL Leaned and Radial Vanes 200-Foot (60.96 m) Sideline.

	Approach		Takeoff	
	Front	Aft	Front	Aft
Fan B Radial	101.5	105.3	113.0	117.3
Fan B Leaned	100.5	103.0	112.3	115.0
Fan C Radial	99.0	101.0	114.0	116.0
Fan C Leaned	99.5	104.5	117.0	118.0

Table II. Efficiency for Leaned and Radial Vanes.

	Approach	Takeoff
Fan B Radial	82.0	81.0
Fan B Leaned	84.1	82.8
Fan C Radial	80.9	83.0
Fan C Leaned	81.4	82.1

II. INTRODUCTION

It has long been recognized that one of the principal mechanisms of fan and compressor noise generation involves the interaction of the rotor's viscous wake and the downstream stator (outlet guide vane, OGV). Initially, this interaction was associated with blade passing frequency (BPF) noise generation only. There is also a possibility that the tubulence in the wake impinging on the OGV generates significant broadband noise through random fluctuations in the OGV's pressure field.

In an attempt to weaken the influence of the wake-OGV interaction, one of the first design modifications done to reduce source noise was to open the spacing between the blade rows. Another method which has been investigated theoretically[1] and experimentally[2] is by leaning the OGV's. The principle of this operation is to cause the wake to "scissor" across the OGV at an angle thus reducing not only the inlet velocity perturbation but also the radial extent of the interaction at any given instant in time. As regards the latter phenomenon, there is a certain degree of "scissoring" action even with radial vanes due to the skewness of the wake. Generally the rotor hub absolute air exit angles are larger than those at the tip. This tends to make the wake take a shape which is leaning in the direction opposite to the rotor rotation (although due to variations in the angle along the blade the line of the wake is seldom straight). Therefore, in order to take advantage of this phenomenon, the OGV physical lean is in the direction of rotor rotation.

The amount of leaning is governed by aerodynamic rather than acoustic considerations. For the case of the straight vane (this is usually the easiest and cheapest approach) the acute angle between the vane and the hub casing becomes so small that corner losses rapidly increase. Generally, a limit of about 30 degrees of lean relative to a radial line through the vane root has been set due to this performance consideration. In any event, the leaned vane is not the radial vane leaned; but requires some modification due to radial forces imparted to the air by the vane.

In the course of the Quiet Engine Program, two scale model fans were constructed. One, designated Fan B, had a tip speed of 1160 ft/sec (353.568 m/sec) and a pressure ratio of 1.5 at design and the other, Fan C, had a tip speed of 1550 ft/sec (472.44 m/sec) and a pressure ratio of 1.6 at design. The leaned outlet guide vane was run with both fan rotors. As will be seen, the behavior of these two rotors was quite different from both an acoustic and performance viewpoint.

III. VEHICLE AND TEST FACILITY DESCRIPTION

As noted, the two fans tested were scale models. In each case only the outer (bypass) flowpath was modeled. Table III contains some comparative model-to-full scale parameters and Figures 1 and 2 show the vehicle cross sections. Except for the radius ratio difference, all dimensions and aerodynamic parameters obey the usual scaling rules. The radius ratio divergence is shown by the dashed lines. Motive power for the fan was through a front shaft as shown in the photograph in Figure 3.

Since both vehicles contain 26 blades and 60 outlet guide vanes, it was possible to utilize much of the same hardware for both. In fact, due to similar aerodynamic designs, it was possible to use the same leaned OGV hardware on both (Figure 4). The leaned vane aerodynamic design was determined from calculations which specifically accounted for the radial forces imparted to the air by the vane. The hardware was, however, designed for Fan B. When these vanes were used in Fan C they were staggered closed 1.2 degrees.

As can be seen in Figures 1 and 2, Fan B was run with frame acoustically absorbing treatment in and around the fan. This amount of treatment has been defined as that associated with the engine as opposed to the engine's nacelle. Fan C, however, was run with additional treatment in the inlet. This was included so that at high fan speeds the multiple pure tones (shock noise) of the supersonic tip speed fan would not mask any effects of the leaned OGV's on aft radiated fan noise.

The treatment in both vehicles was made up of a hard backing plate, 1/2 inch (1.3 cm) of polyurethene foam, and a perforated plate having an open area of 22-1/2%. The holes were 1/16 inch (0.2 cm) in diameter.

IV. TEST PROGRAM AND DATA ANALYSIS

Each configuration was setup on the test facility and run through operating speed range in steps sufficiently numerous (10 or 11 points operating line) to fully define part power characteristics. In addition each configuration was run with exhaust nozzles which were smaller (6%) and larger (16%) than the nominal nozzle.

Noise data were FM recorded at 60 inches (152.4 cm) per second by microphones placed on a 100-foot (30.48 m) arc centered at the fan inlet. The microphones were located at 10 degree intervals form 30 to 160 degrees referenced to the inlet centerline. The surface between the microphones and the vehicle was covered with asphalt. All microphones were placed at the fan centerline height - approximately 12-1/2 feet (3.81 m) above the ground plane.

Noise data were recorded at each microphone for two minutes at each corrected speed point. This procedure was repeated once so that all data were the average of these points unless otherwise stated. The recorded data were processed through a General Radio 1/3-octave analyzer utilizing a 32 second averaging time. Standard corrections[3] were then applied to bring these data to a standard day of 59° F and 70% relative humidity.

The data were, of course, the noise signature of the scale model. In order to better assess the PNL results, these data were scaled to full scale by adding a factor of 10 log of the ratio of the full scale to scale model weight flows to all the data and shifting the frequency down by the ratio of the blade passing frequencies of the full scale and scale model. Unless otherwise noted, all the data presented in this report have been scaled to full size.

Also of interest are extrapolation of these data to flight. The flight noise calculation was enhanced by adding a predicted core jet and accounting for the relative velocity effect. Core jet noise and relative velocity effects were predicted according to published SAE practices.[4] This method was deemed acceptable for comparative purposes.

Table III. Scale Model and Full-Scale Fan Design Parameters

	Fan B		Fan C	
	Scale Model	Full Scale	Scale Model	Full Scale
Diameter, in. (cm)	35.5(90.17)	73.35(186.309)	36.0(91.44)	68.3(173.482)
Scale Factor	.491	--	.527	--
Design Tip Speed, ft/sec (m/sec)	1160	1160	1550(472.44)	1550(472.44)
Design Pressure Ratio	1.5	1.5	1.6	1.6
Bypass Weight Flow, lbm/sec (kg/sec)	188(85.352)	802(364.108)	212(96.248)	763(346.402)
Radius Ratio	.579	.465	.570	.360
Number of Blades	26	26	26	26
Blade-to-Vane Spacing, true tip chords	2.0	2.0	2.0	2.0
Number of Vanes	60	60	60	60

V. SUBSONIC TIP SPEED FAN

A. Acoustic Data Analysis

Figures 5 through 7 contain 200-foot (60.96 m) sideline data at 90% (takeoff) corrected fan speed. The PNL, Figure 5, shows a definite reduction in rear quadrant noise. At 120 degrees, the reduction is about 2-1/2 PNdB; front angles, however, show very little change in noise. The 70 degree spectra, Figure 6, show that the controlling element is the blade passing frequency (1650 Hz) and the second harmonic. Above the blade passing frequency (BPF) there is a pattern of lower noise with the leaned outlet guide vanes (OGV's) lower by 1-1/2 to 3-1/2 dB.

At 120 degrees, Figure 7, the second harmonic (3150 Hz) is the controlling tone in the spectrum so that the decrease in noise above the BPF results in a measureable decrease in PNL. The spectral decreases run from 3-1/2 at the second harmonic to less than 1-1/2 dB at 2500 Hz. Thus the PNL decrease is a result of decreased high frequency noise; particularly the second harmonic.

As the fan speed is decreased, Figure 8 through 10, the aft quadrant continues to show a decrease with the leaned OGV's. At 60% (approach) fan speed there is also an indication of some front quadrant reduction. The 70 degree spectra, Figure 11, show small but rather uniform reduction from 630 to 8000 Hz with a larger decrease at the second harmonic (2000 Hz). At 120 degrees, Figure 12, the tones are noticeably down with the BPF decreased by 4 dB. Reductions of about 2 dB also extend to 10 KHz.

The general nature of the reductions (i.e., both pure tone and broadband at all speeds) indicates that the leaned OGV's tend to reduce the source noise generation due to the two mechanisms cited earlier. That is:

- Rotor - OGV periodic wake interaction
- Turbulence - OGV impingement

In addition to the nominal nozzle data, noise levels were obtained on each configuration with large (16% open) and small (6% closed) nozzles. Figures 13 and 14 show the front maximum 200-foot (60.96 m) sideline PNL for, respectively, radial and leaned OGV's vs. fan thrust. With radial OGV's the large nozzle clearly has the lowest PNL over a range of fan thrusts. The leaned vanes also show the large nozzle with the lowest PNL over most of the thrust range. Table IV shows the takeoff and approach levels for each nozzle.

Table IV. 200-Foot (60.96 m) Sideline Maximum PNL Front Angle.

	Radial Vanes			Leaned Vanes		
	Small	Nominal	Large	Small	Nominal	Large
Takeoff	115.3*	113.0	111.0	113.1	112.3	110.3
Approach	103.0	101.5	99.9	103.0	100.5	98.9

*Extrapolated

In general at each point shown in the table, the leaned vanes resulted in lower noise with the lowest absolute levels being recorded when the large nozzle was used.

Figures 15 and 16 show the rear maximum 200-foot (60.96 m) sideline PNL for the two configurations with the three nozzles. The radial vane results show the large nozzle with the lowest noise. Also interesting is the reaction of the leaned vanes to higher aerodynamic loading (small nozzle, Figure 16). The increase in noise is generally greater than when the small nozzle was used with the radial vanes, indicating less noise tolerance to higher loading levels with leaned vanes

Table V summarizes the aft maximum multiple nozzle results at approach and takeoff.

Table V. 200-Foot (60.96 m) Sideline Maximum PNL Rear Angle.

	Radial Vanes			Leaned Vanes		
	Small	Nominal	Large	Small	Nominal	Large
Takeoff	118.0*	117.3	116.8	116.7	115.0	114.5
Approach	105.4	105.3	103.0	105.3	103.0	102.2

*Extrapolated

Although the small nozzle leaned OGV's noise did increase considerably relative to the nominal, it still was not higher in absolute level than the small nozzle radial vanes.

Figures 17 through 20 contain the PNL and PNLT data extrapolated to flight conditions for takeoff and approach power settings. Each set of data was "flown" on a level course at 0.25 flight mach number. Although core jet noise was added, it has little effect on the noise level since full SAE[4] spectral relative velocity effect was used. The relative velocity correction was applied from 50 to 315 Hz for both takeoff and approach.

Figures 17 and 18 show the takeoff results. Generally these data follow the 200-foot (60.96 m) sideline results (Figure 5). When the data is tone corrected the maximum aft decrease in level is about 1.5 PNdB.

At approach (Figure 19 and 20), the tone corrected data for the leaned vanes show a greater reduction relative to the radial vanes than is observed without tone correction at some angles. As was shown in Figure 12, this is largely due to elimination of the tones from the radial OGV spectrum when leaned OGV's are employed.

B. Aerodynamic Performance

For each configuration tested, a complete set of aerodynamic performance data was taken. Figure 21 is a performance map showing the two sets of data. Within the accuracy of the data there is no difference in flow or pressure ratio at a given speed.

Figure 22 contains the trends of efficiency with speed for each nozzle for which acoustic data were taken. In each case, there is a definite indication that the leaned OGV improved the efficiency; although the radial vane data does scatter at low fan speeds.

A word should be said about the absolute level of efficiency. Since the fan is only a scale of the outer flowpath of a full scale fan, the hub wall is in a region where boundary layer buildup is greater than it would be for a full-span blade. Thus absolute efficiency levels are 2 to 3% lower than they would be for full-scale hardware. The comparison of scale model data to other scale model data is, however, consistent.

The pressure and temperature profiles at 90% speed are shown in Figure 23. Most of the efficiency improvement has occurred in the region from the midspan to the hub; although at the hub the efficiency has dropped as expected (due to the acute angle between the vane and hub wall). Since no rotor exit transverse data are available, the details of the rise in efficiency cannot be ascertained. However close examination of the OGV exit rake data indicates that improved rotor efficiency is, in part, responsible for the increase.

VI. SUPERSONIC TIP SPEED FAN

A. Acoustic Data Analysis

Figure 24 shows the 90% speed (takeoff) 200-foot (60.96 m) sideline PNL. Clearly the noise has increased with the leaned OGV's. The front maximum is up 2.8 PNdB (70 degrees) and the rear maximum is up 2.5 PNdB (130 degrees). These increases are about the same as the decreases noted with the subsonic tip speed fan.

A spectral comparison at 70 degrees, Figure 25, shows that the chief problem lies at high frequencies; from 2500 Hz on up. An overlay of two narrowband (20 Hz filter width), scale model data analyses of the same data, Figure 26, shows this in more detail. The high frequency spectrum shows an appreciable increase in the background noise (lower envelope of the data) with leaned OGV's. The multiple pure tones (MPT's) associated with supersonic tip speed fans have also increased in some areas.

The 120 degree spectra, Figures 27 and 28, show a similar high frequency noise increase. Although the 1/3-octave containing the blade passing frequency (2000 Hz) shows an increase, the narrowband data shows the tone levels to be about the same; however the leaned OGV's produced more noise in the bands on either side of the tones. The broadband noise above the second harmonic has risen to such an extent that the front radiated MPT's have been covered.

Dropping off in speed, Figures 29 through 31, show much the same result as at takeoff. At the approach fan speed, Figure 31, the 70 and 130 degree angles indicate, respectively 3.1 and 3.5 PNdB increases in noise with leaned OGV's. The 1/3-octave spectra at 70 and 120 degrees, Figures 32 and 33, show increased noise at the BPF (1250 Hz) and again, at high frequencies. Narrowband analysis at 120 degrees, Figure 34, indicates a general rise in broadband noise between the fundamental and second harmonic. The BPF and third harmonic also show measureable increases.

In addition to the nominal nozzle data, runs were also made with large (16% oversized) and small (6% undersized) nozzles. Figures 35 and 36 contain, respectively, the 200-foot (60.96 m) sideline maximum front quadrant PNL for the radial and leaned OGV's vs. fan thrust. The approach and takeoff levels are summarized in Table VI.

Table VI. 200-Foot (60.96 m) Sideline Maximum PNL Front Angles.

	Radial Vanes			Leaned Vanes		
	Large	Nominal	Small	Large	Nominal	Small
Takeoff	117.0*	114.0	116.4	119.0*	117.0	116.0
Approach	98.0	99.0	100.0	100.0	99.5	100.3

*Extrapolated

At low power settings the data are tightly grouped (± 1.0 PNdB). In the region around takeoff there is more spread with the nominal nozzle being lower for radial vanes and the small for leaned vanes. The small nozzle takeoff level with leaned OGV's is unusual since it is generally the case that loading the blades increases noise (e.g. Figure 14 for the subsonic tip speed fan).

Figures 37 and 38 contain the aft maximum PNL's. These data show only small changes with the various nozzles. Table VII summarizes the takeoff and approach results.

Table VII. 200-Foot (60.96 m) Sideline Maximum PNL Rear Angles.

	Radial Vanes			Leaned Vanes		
	Large	Nominal	Small	Large	Nominal	Small
Takeoff	116.5*	116.0	116.5	118.0*	118.0	117.0
Approach	102.0	101.0	102.9	103.3	104.5	104.1

* Extrapolated

At each point, the leaned OGV's are higher in noise level than the radial vanes.

Figures 39 through 42 contain the takeoff and approach data "flown" on a level course at 0.25 flight mach number. As with the subsonic tip speed fan, a core jet was added and a relative velocity correction applied below 315 Hz.

The takeoff results (Figures 39 and 40) show about the same trends as the static data (Figure 24) with a noteable exception at 120 degrees when the data is tone corrected. The 120 degree spectra, Figure 27, show that this increase is largely due to an increase in the blade passing frequency with little increase at the neighboring bands.

At approach power (Figures 41 and 42), the flight data show a somewhat larger problem with the leaned OGV's than indicated by the static data (Figure 31), particularly when the tone correction is applied. As noted at takeoff, the blade passing frequency increase is largely responsible for the PNLT increase (Figure 33).

B. Aerodynamic Performance

Figure 43 is a performance map of Fan C scale model with both radial and leaned vanes. The leaned OGV's show a trend toward higher flow (higher operating lines) at a given corrected fan speed. There is no apparent reason for this behavior.

The trend of efficiency with fan speed for each fan nozzle is shown in Figure 44. There is some loss in efficiency with leaned vanes with the nominal nozzle. When the small and large nozzles were used, the leaned vanes produce higher efficiencies at several speed points.

Figure 45 contains radial distributions of pressure, temperature, and the resulting efficiency at 90% fan speed with the nominal fan nozzle. The small decrease in average efficiency with leaned OGV's is largely due to a temperature increase. Since no interstage data was available, it was not possible to determine whether or not the temperature rise was due to changes in the rotor or in the OGV.

Nevertheless, it is interesting to note that unlike the subsonic tip speed fan on which noise went down and efficiency went up, the supersonic tip speed fan's noise went up and its efficiency went down.

VII. AERO-ACOUSTIC RELATIONSHIPS

Figure 46 is a plot of the radial distribution of efficiency for the two fans with radial and leaned OGV's at takeoff fan speed with the nominal fan nozzle. The low speed fan has a lower average efficiency and a less uniform profile than the supersonic tip speed fan when radial vanes are used. With leaned OGV's the subsonic tip speed fan's efficiency profile smooths out and the supersonic tip speed fan's profile drops.

The implication is that some problem existed with Fan B's OGV's which was cleared up by leaning the vanes while the opposite was true on Fan C.

As was noted in Section III the leaned vanes were actually designed for Fan B's stagger and as a result were 1.2 degrees closed for Fan C. Ordinarily this small angle would be thought of as within the range of calculation accuracy. It is apparent that a performance degradation has been accompanied by a noise increase on Fan C, implying that an aerodynamic problem, not necessarily related to lean vanes per se, may have caused Fan C's noise to have increased. Detailed aerodynamic traversing of the fan and a redesign of the OGV may have shown a different result.

VIII. CONCLUSIONS

Radially leaned OGV's can be used to reduce the noise of a subsonic tip speed fan.

Radially leaned OGV's increased the supersonic tip speed fan's noise level. However, there are indications that this is not a result which is generally applicable to all high speed fans.

APPENDIX A - FIGURES AND ILLUSTRATIONS

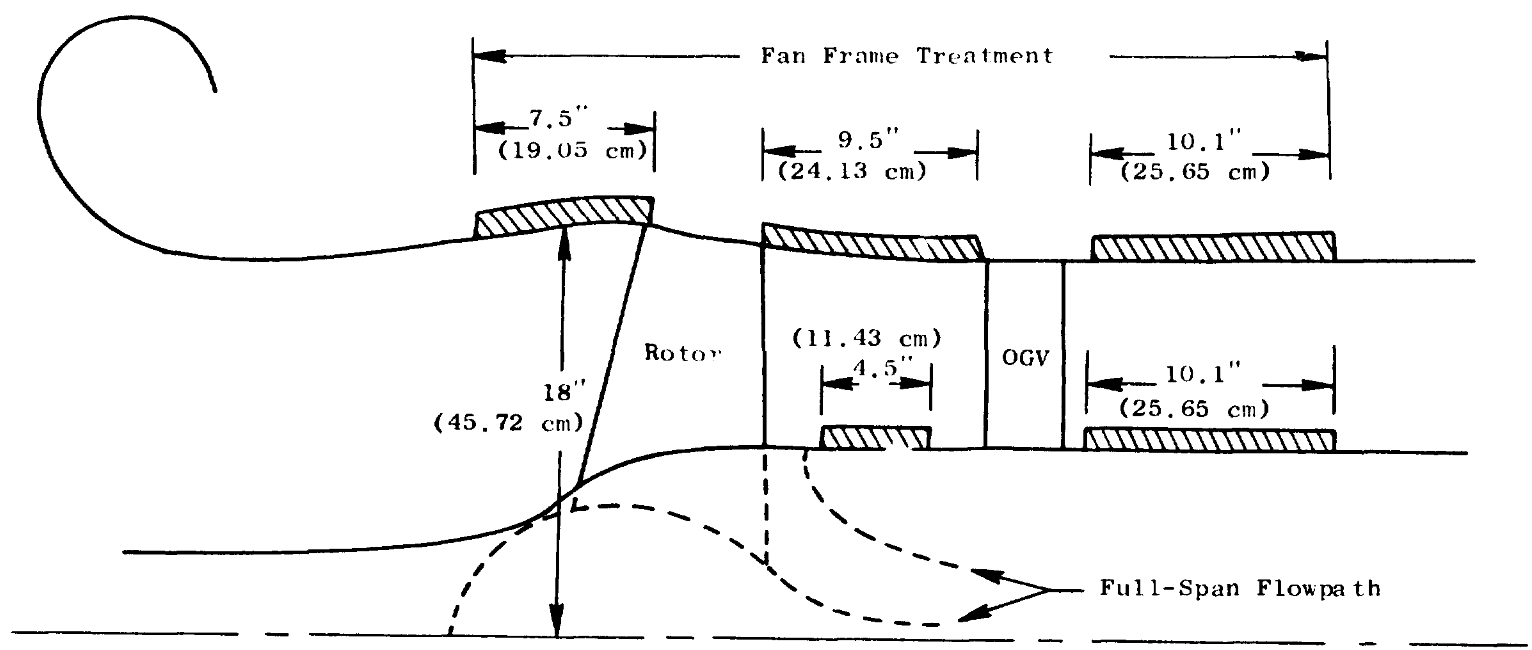

Figure 1. Fan B Scale Model Treatment Lengths.

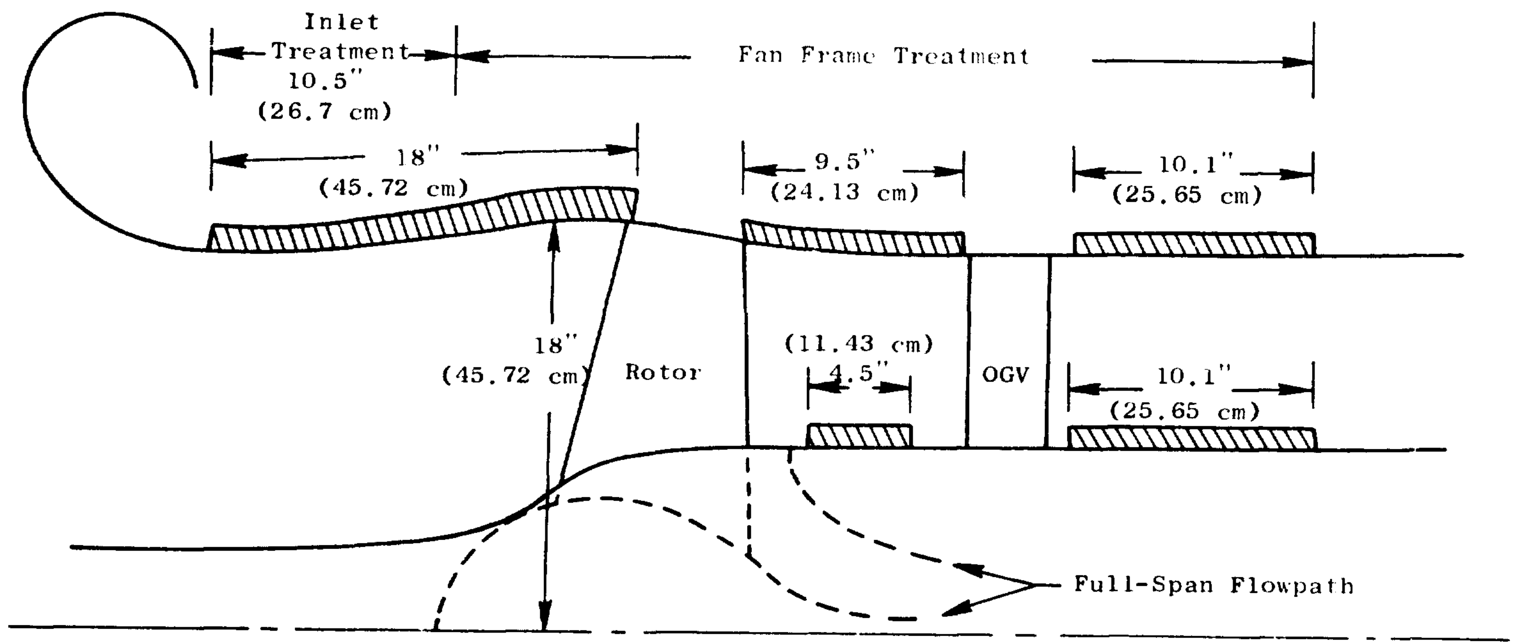

Figure 2. Fan C Scale Model Treatment Lengths.

Figure 3. Fan Test Facility.

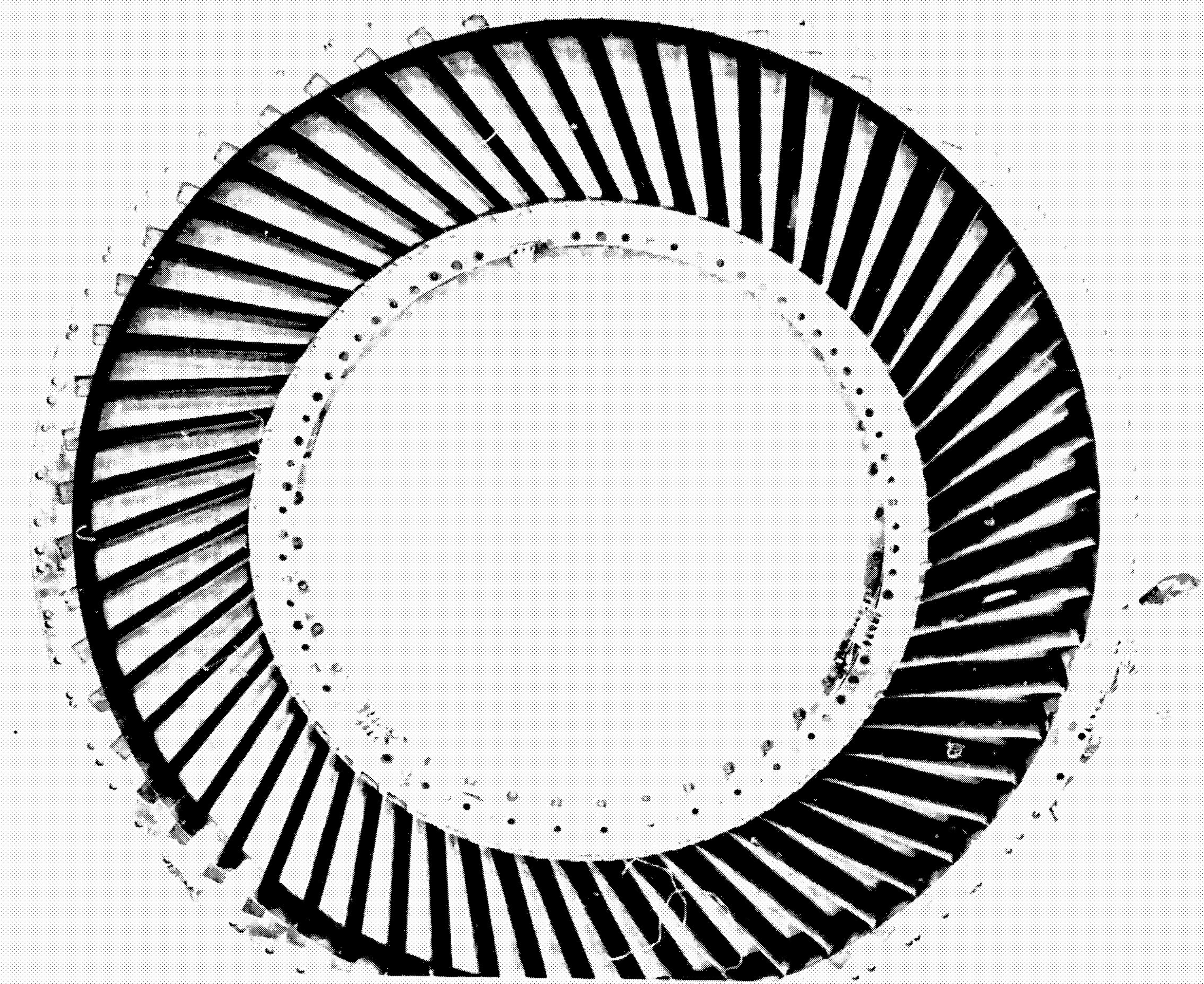

Figure 4. 30° Leaned Outlet Guide Vane.

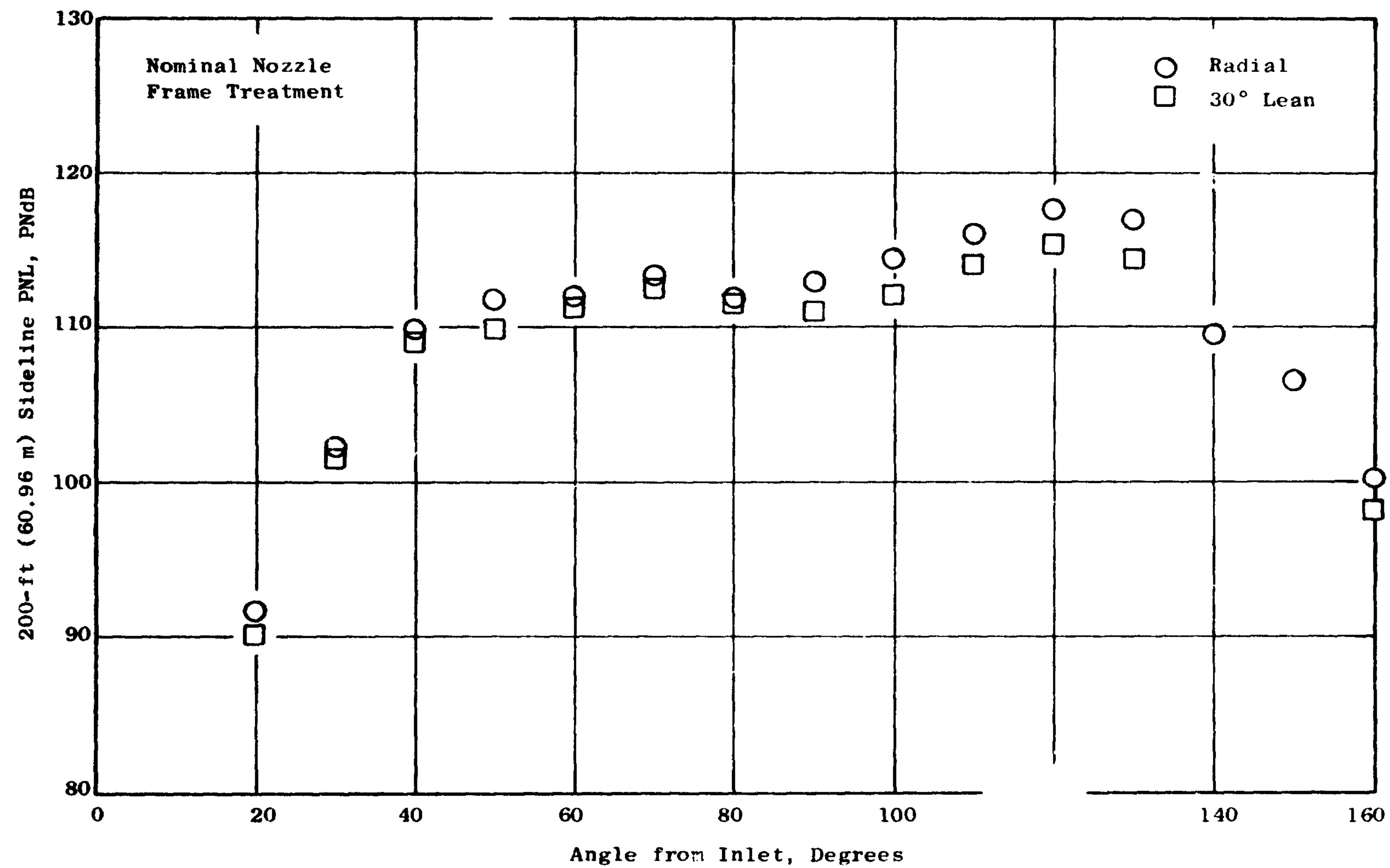

Figure 5. Fan B 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, Takeoff.

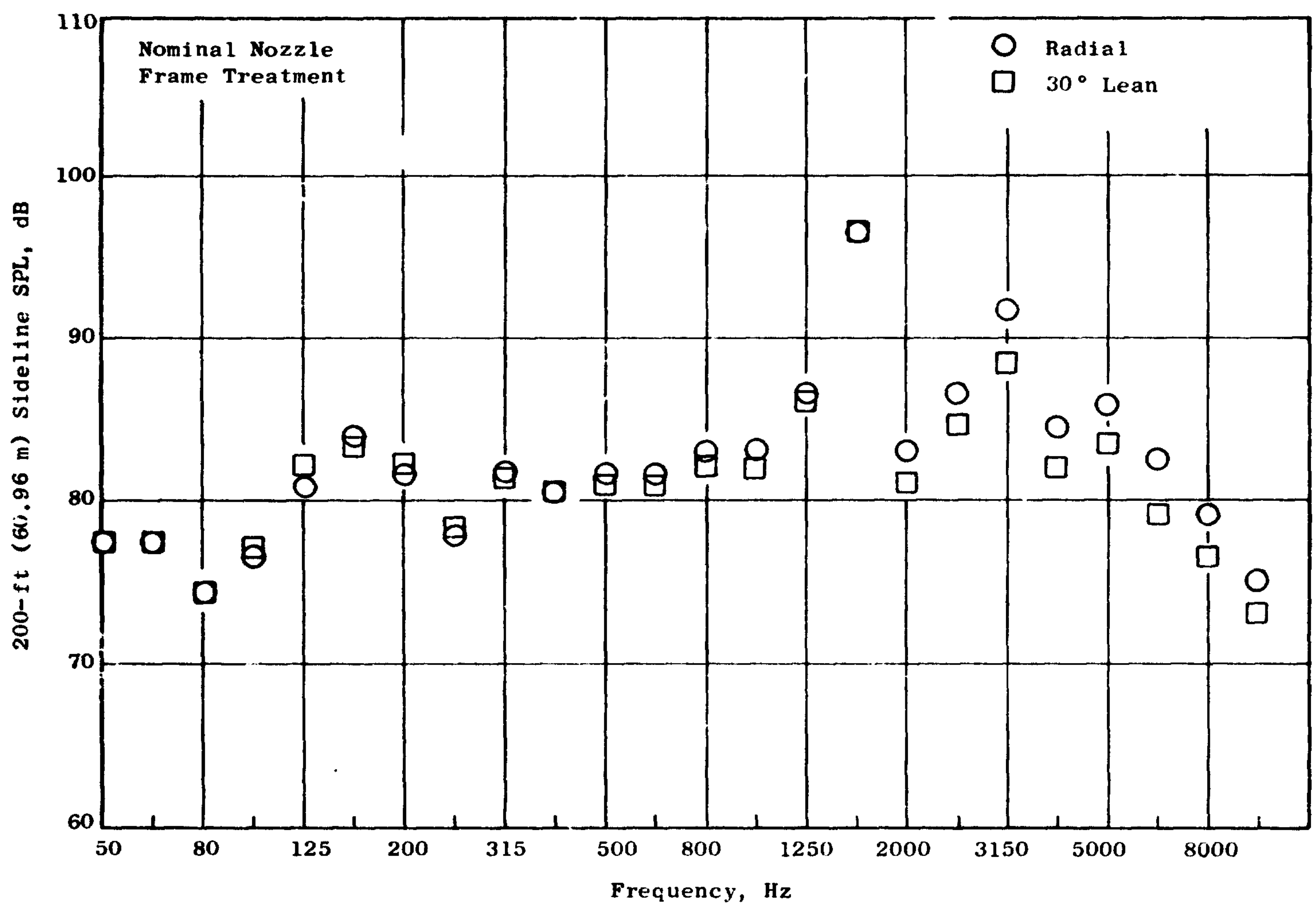

Figure 6. Fan B 200-ft (60.96 m) Sideline SPL Vs. Frequency, 70°, Takeoff.

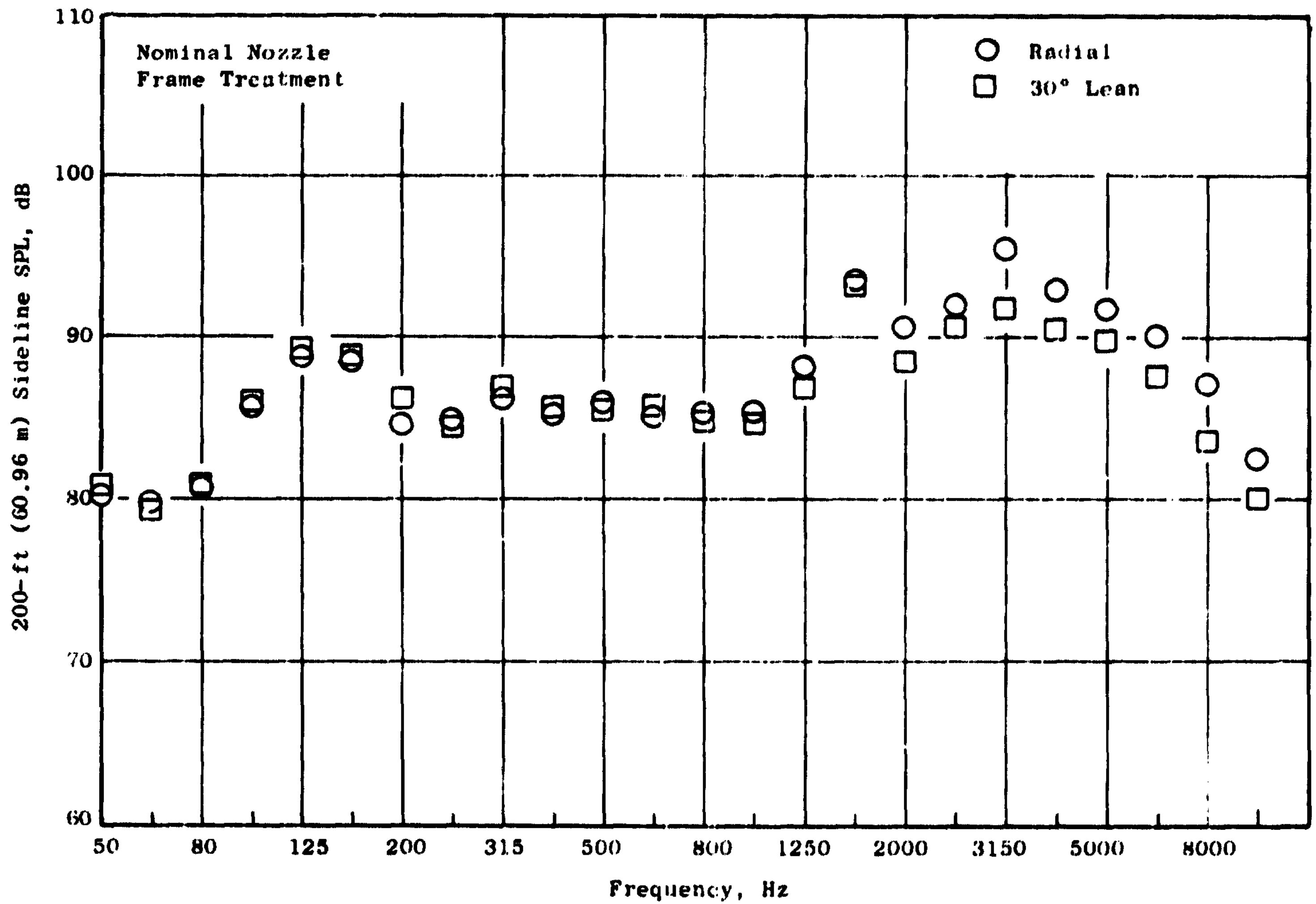

Figure 7. Fan B 200-ft (60.96 m) Sideline SPL Vs. Frequency, 120°, Takeoff.

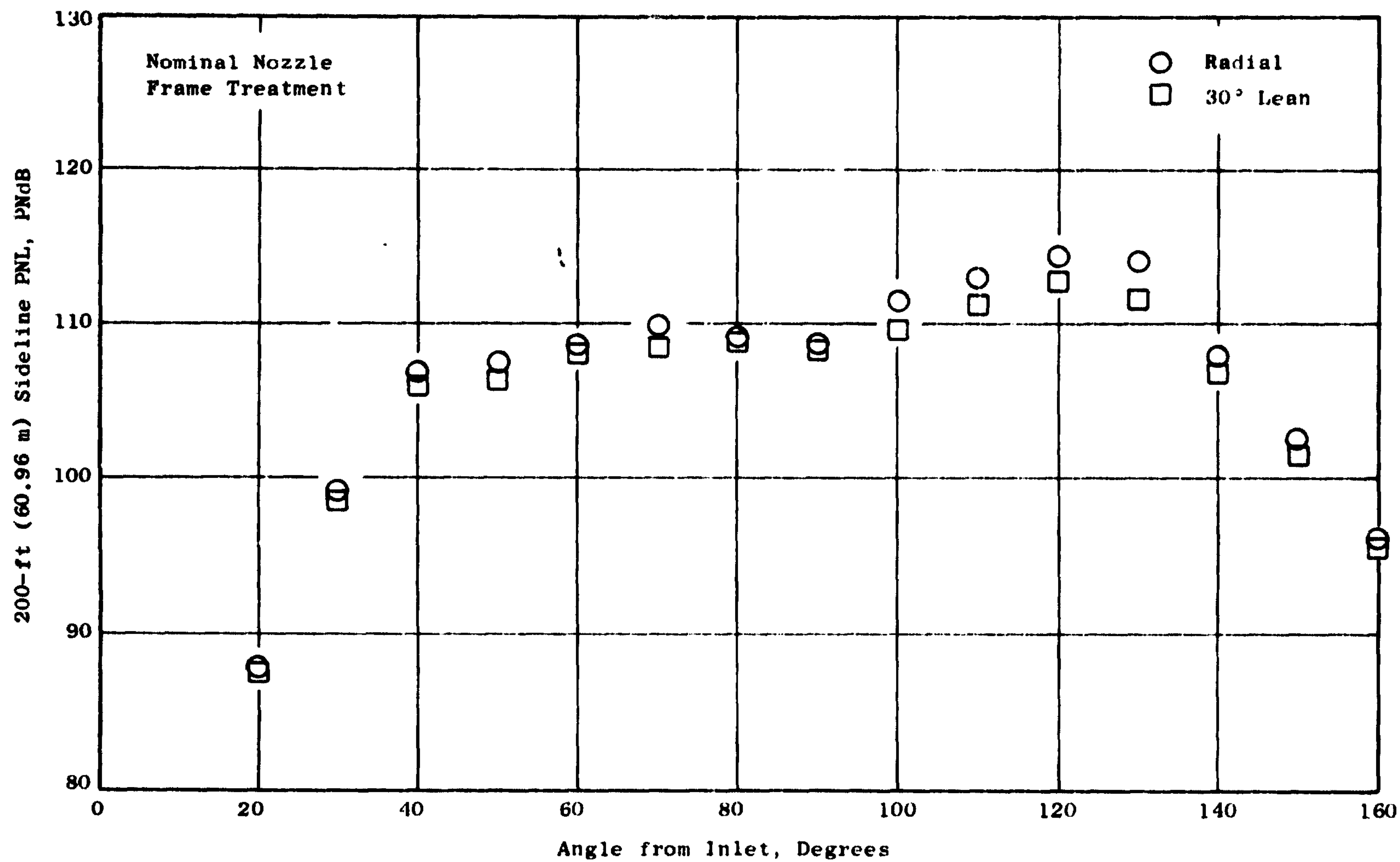

Figure 8. Fan B 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, 80% Fan Speed.

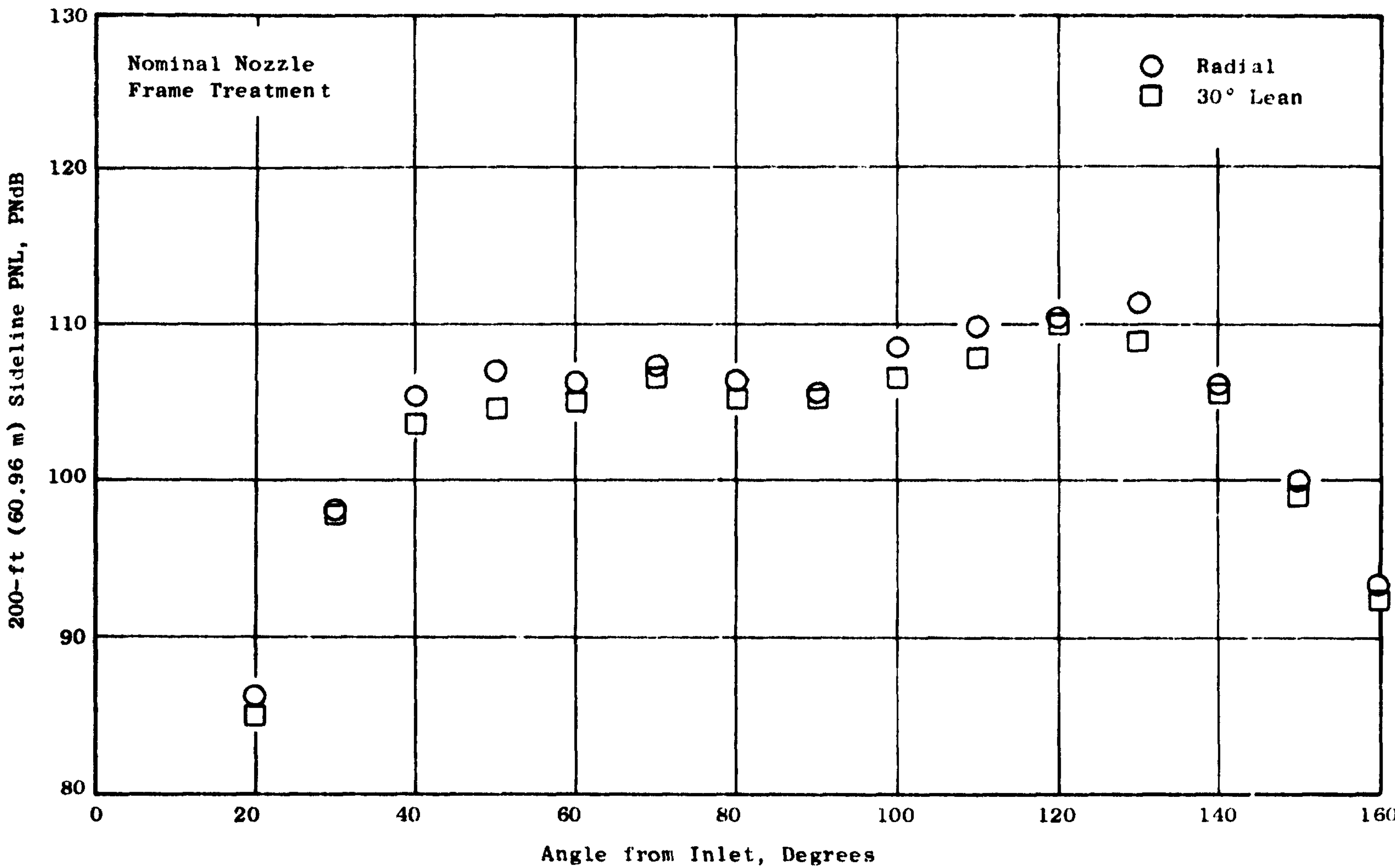

Figure 9. Fan B 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, 70% Fan Speed.

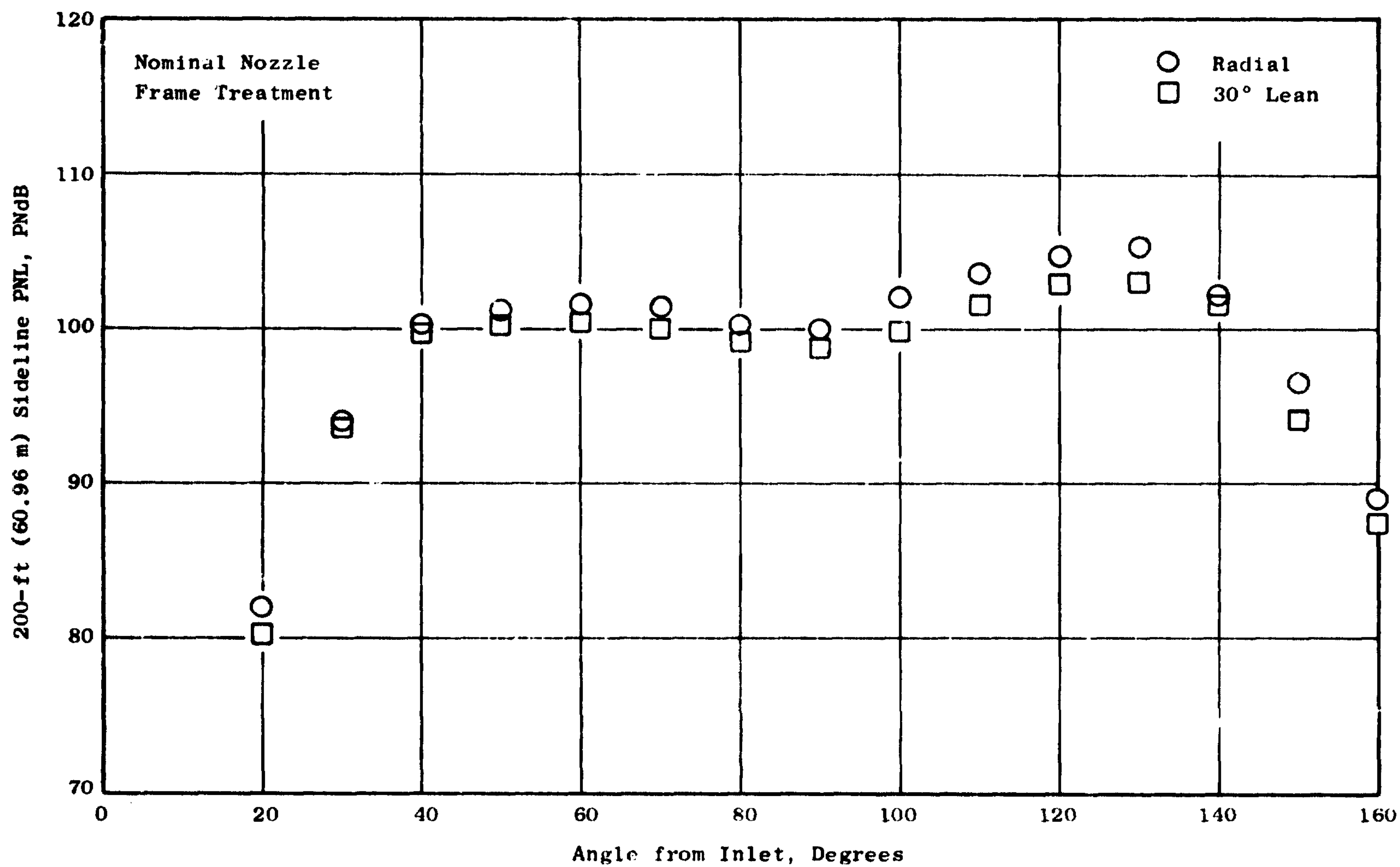

Figure 10. Fan B 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, Approach.

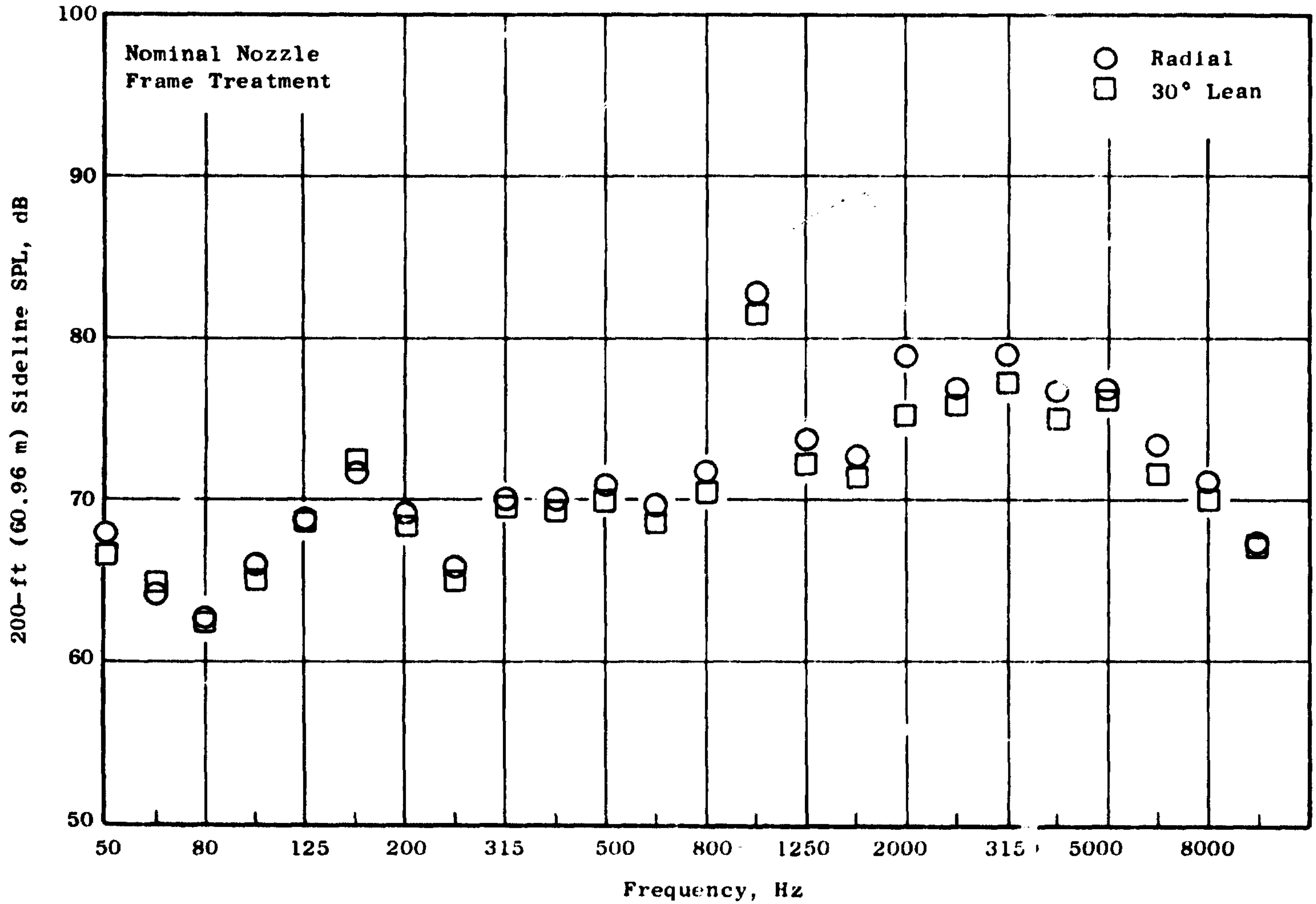

Figure 11. Fan B 200-ft (60.96 m) Sideline SPL Vs. Frequency, 70°, Approach

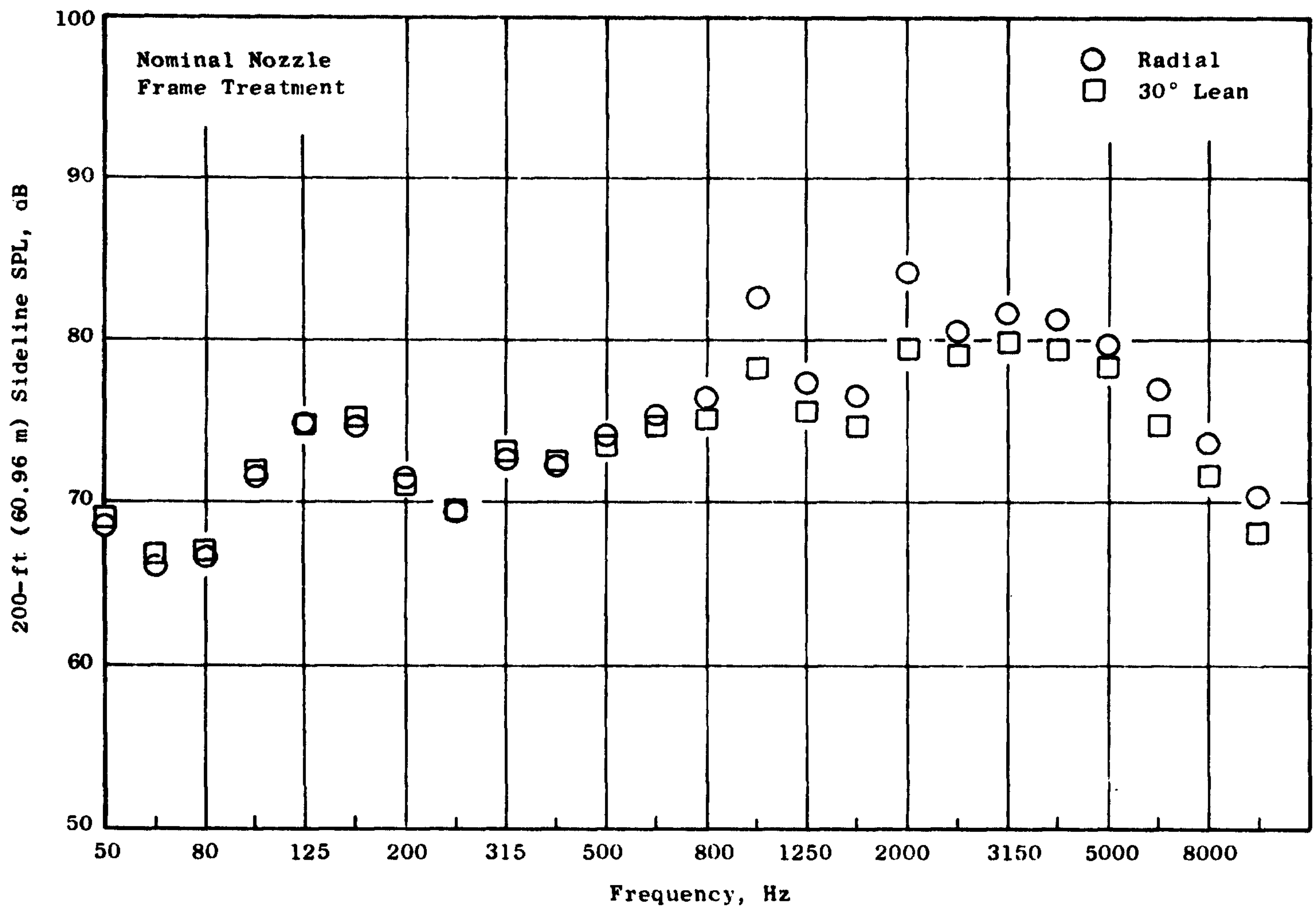

Figure 12. Fan B 200-ft (60.96 m) Sideline SPL Vs. Frequency, 120°, Approach.

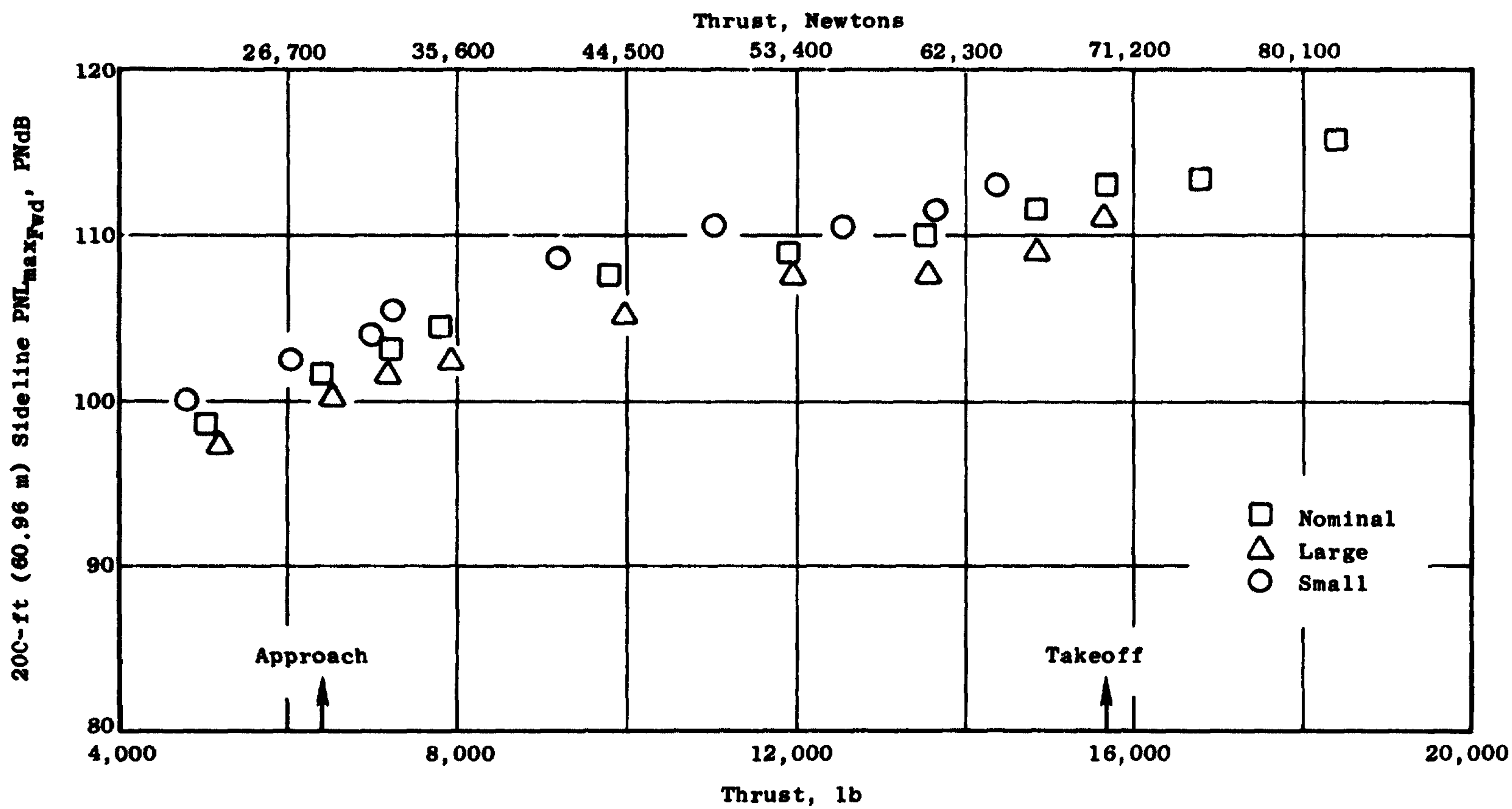

Figure 13. Fan B 200-ft (60.96 m) Sideline Front Maximum PNL Vs. Thrust, Radial Vanes.

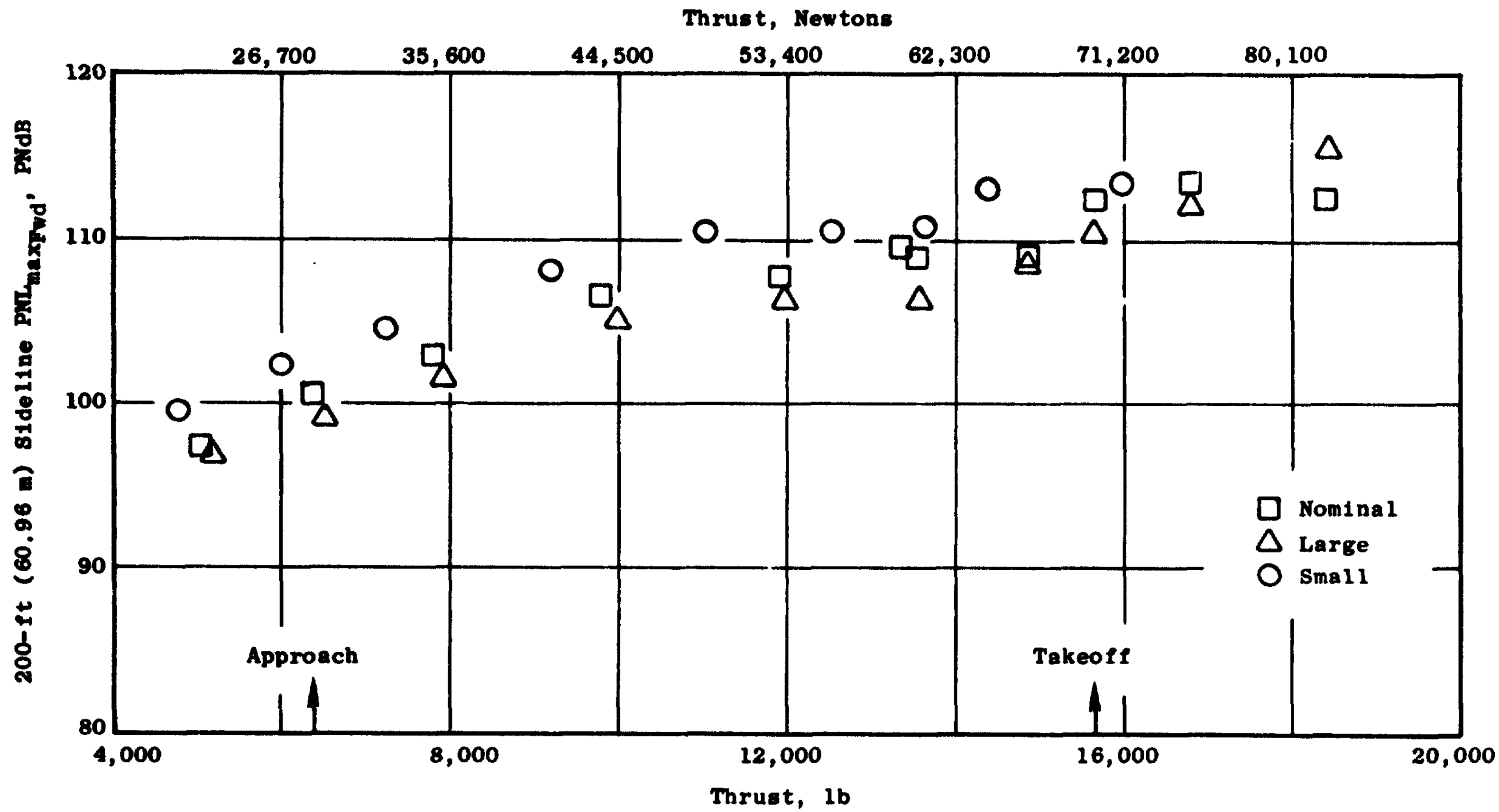

Figure 14. Fan B 200-ft (60.96 m) Sideline Front Maximum PNL Vs. Thrust, Leaned Vanes.

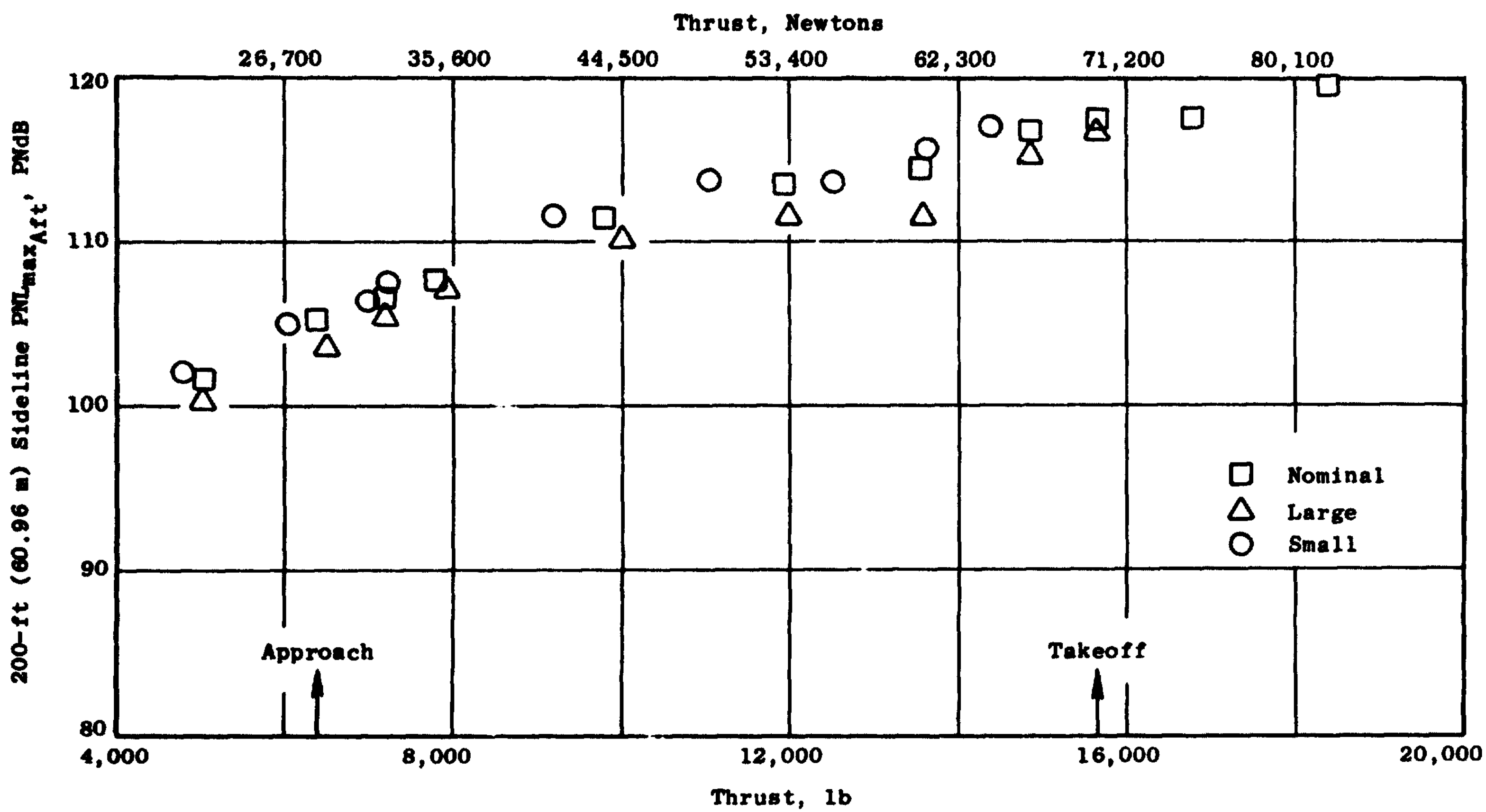

Figure 15. Fan B 200-ft (60.96 m) Sideline Rear Maximum PNL Vs. Thrust, Radial Vanes.

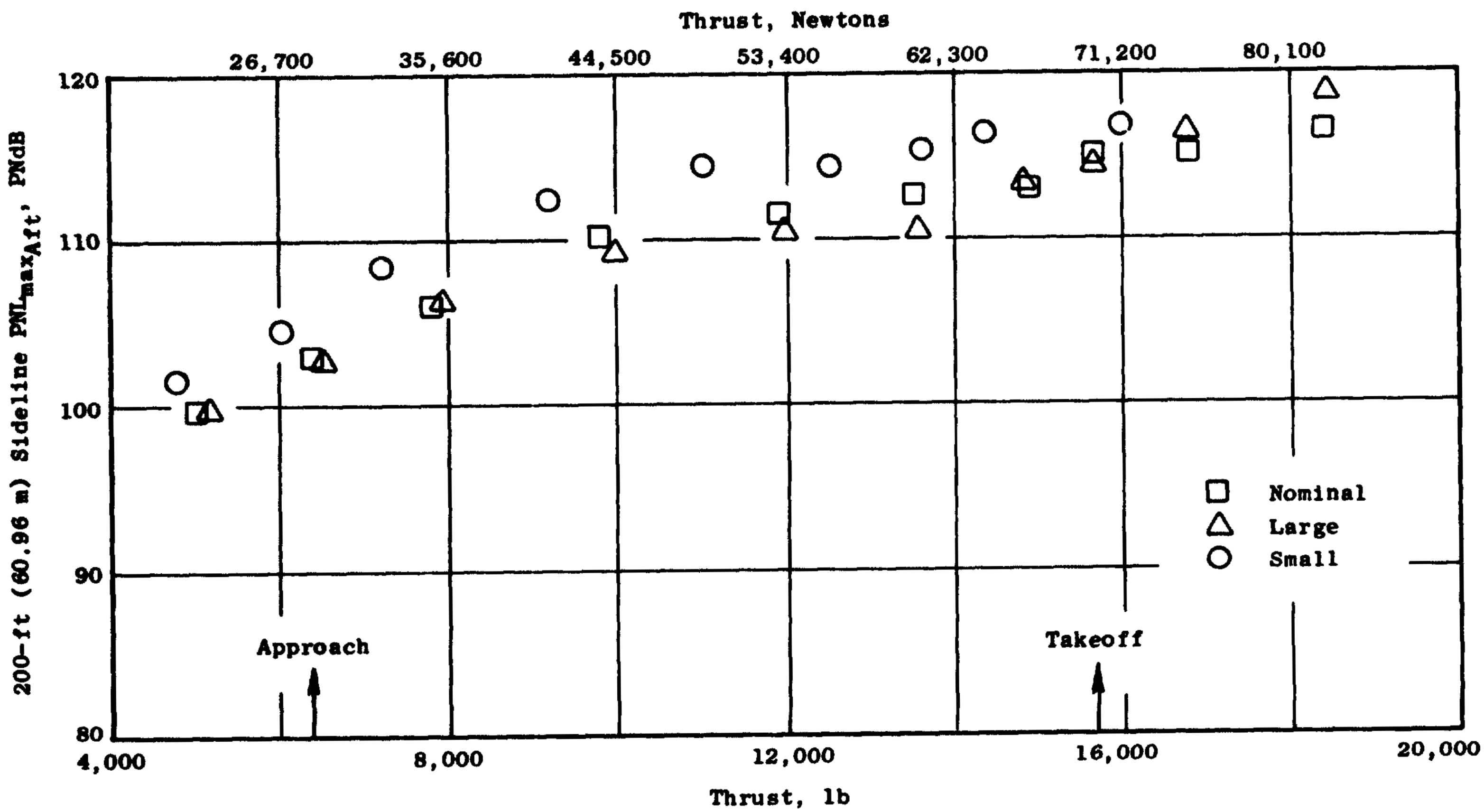

Figure 16. Fan B 200-ft (60.96 m) Sideline Rear Maximum PNL Vs. Thrust, Leaned Vanes.

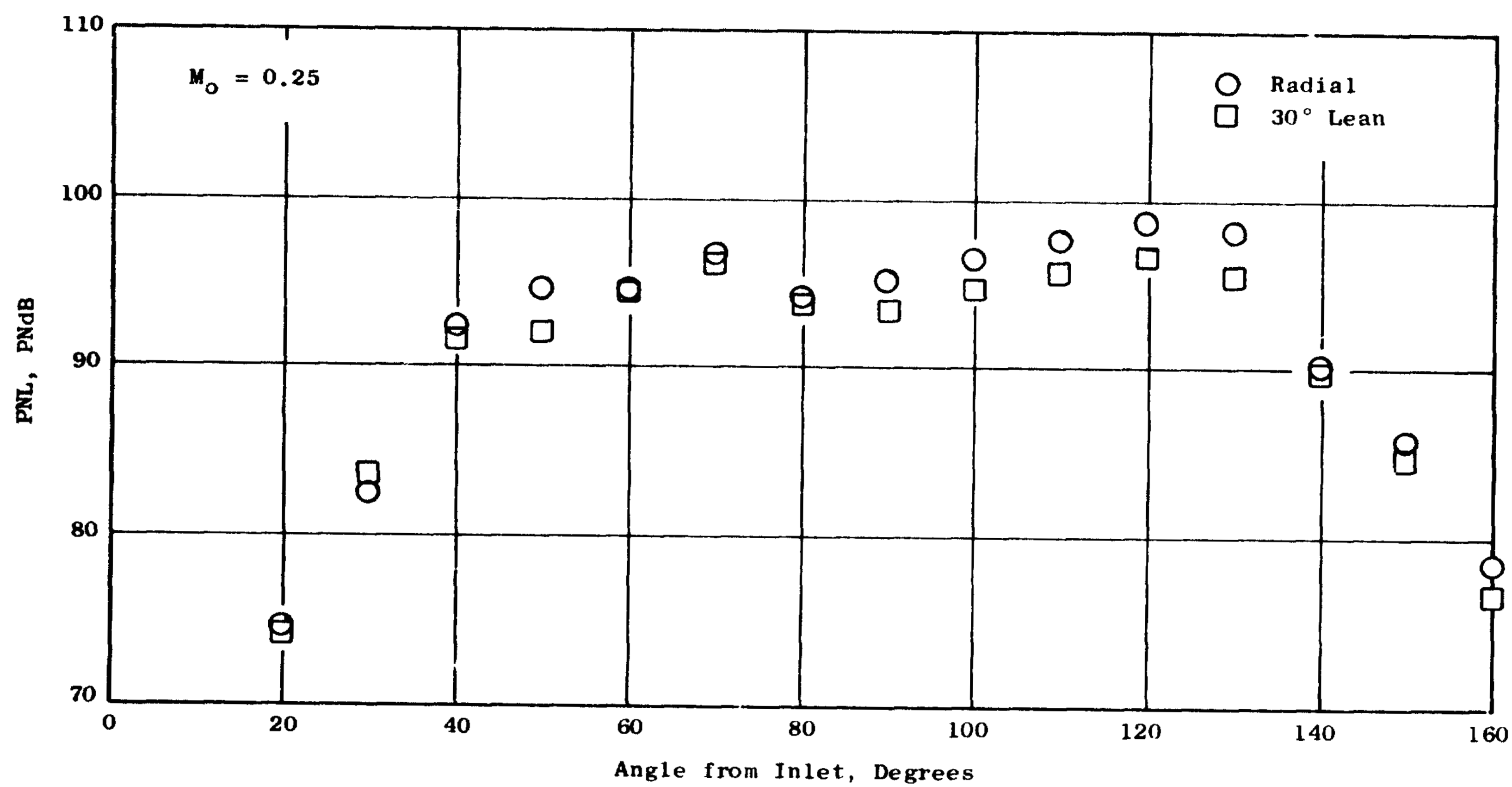

Figure 17. Fan B 1000-ft (304.8 m) Level Flyover PNL, Takeoff, Fan and Jet Noise.

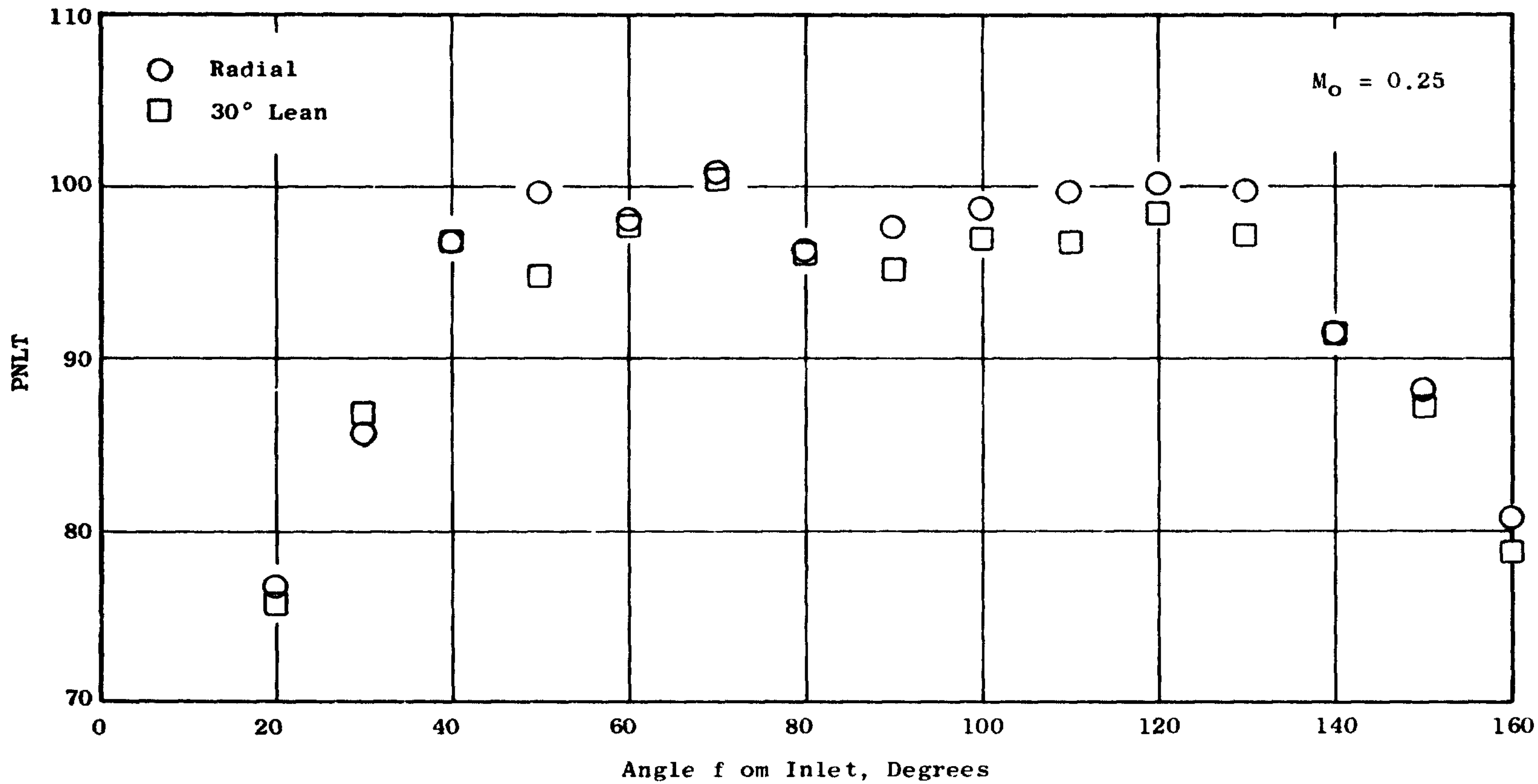

Figure 18. Fan B 1000-ft (304.8 m) Level Fly‹‹ er PNLT. Takeoff, Fan and Jet Noise.

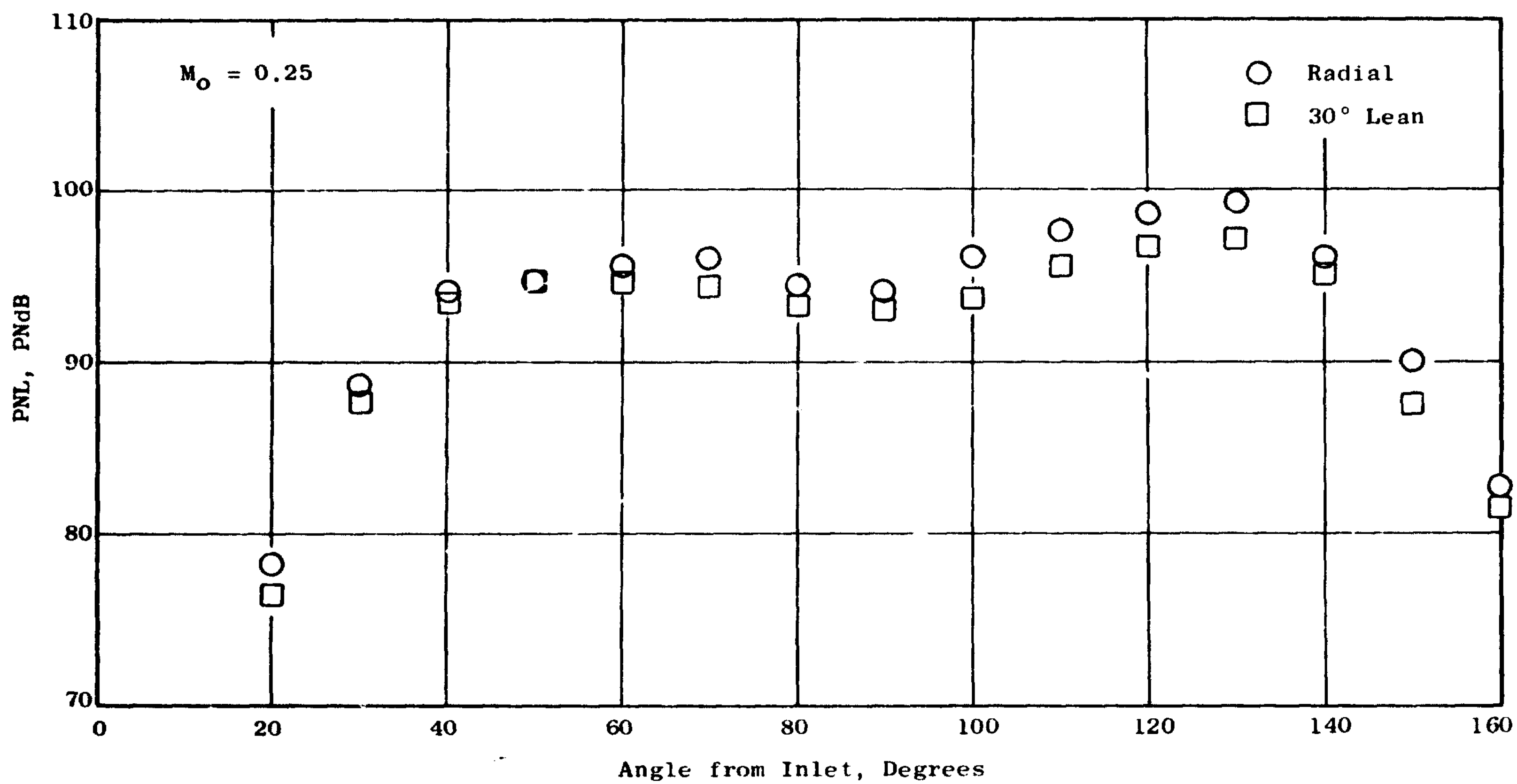

Figure 19. Fan B 370-ft (112.8 m) Level Flyover PNL, Approach, Fan and Jet Noise.

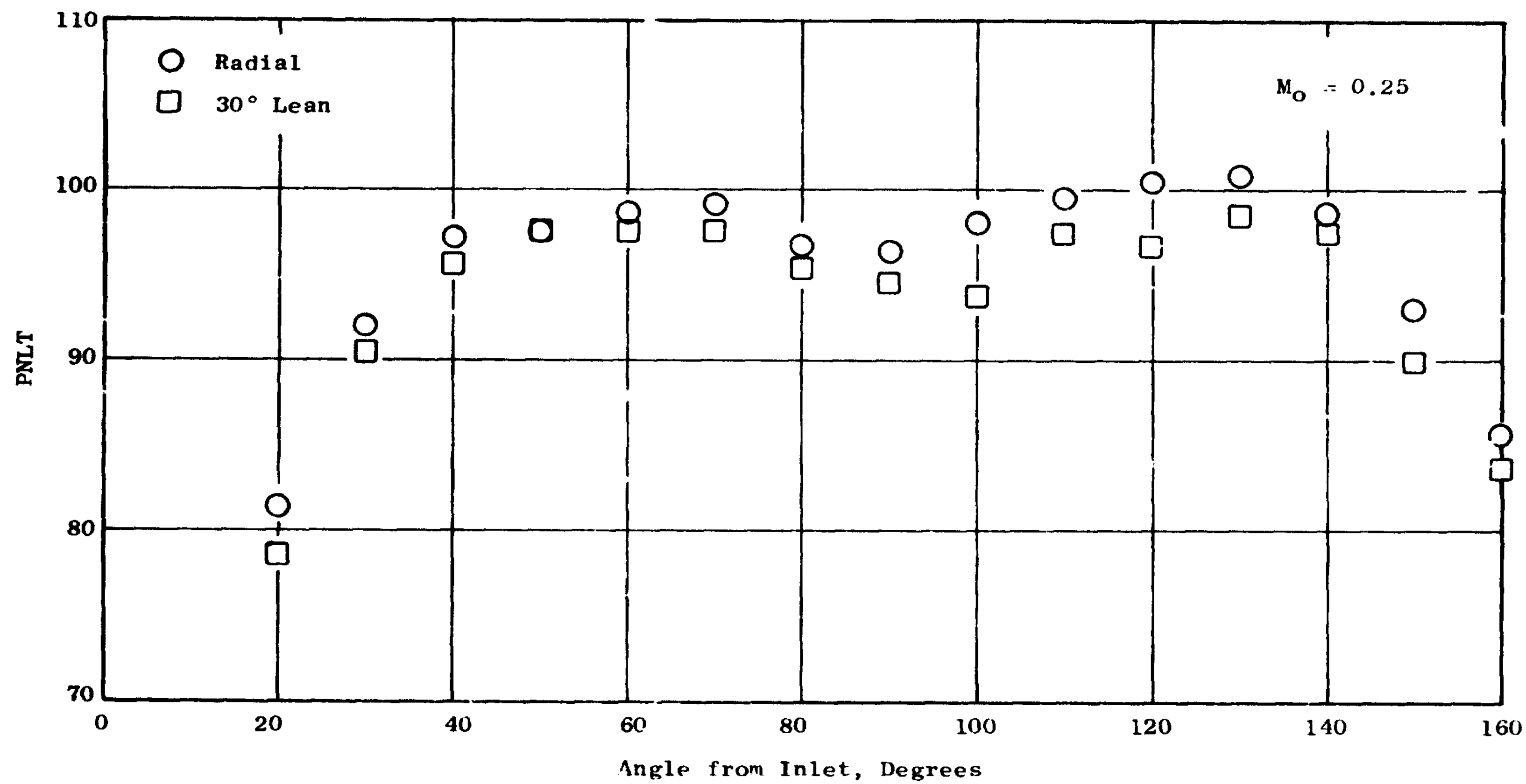

Figure 20. Fan B 370-ft (112.8 m) Level Flyover PNLT, Approach, Fan and Jet Noise.

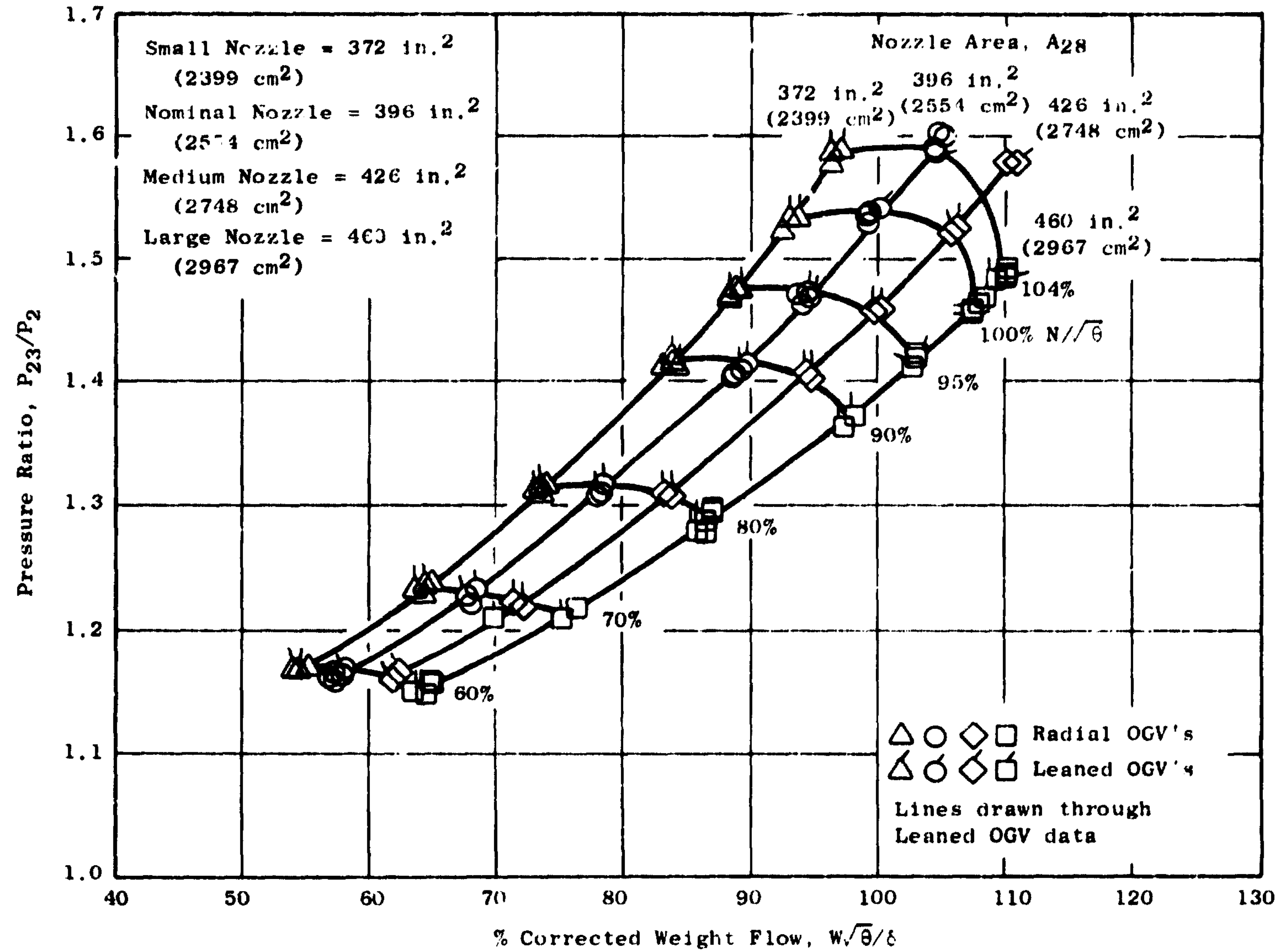

Figure 21. Fan B Aerodynamic Performance, Radial and Leaned OGV's.

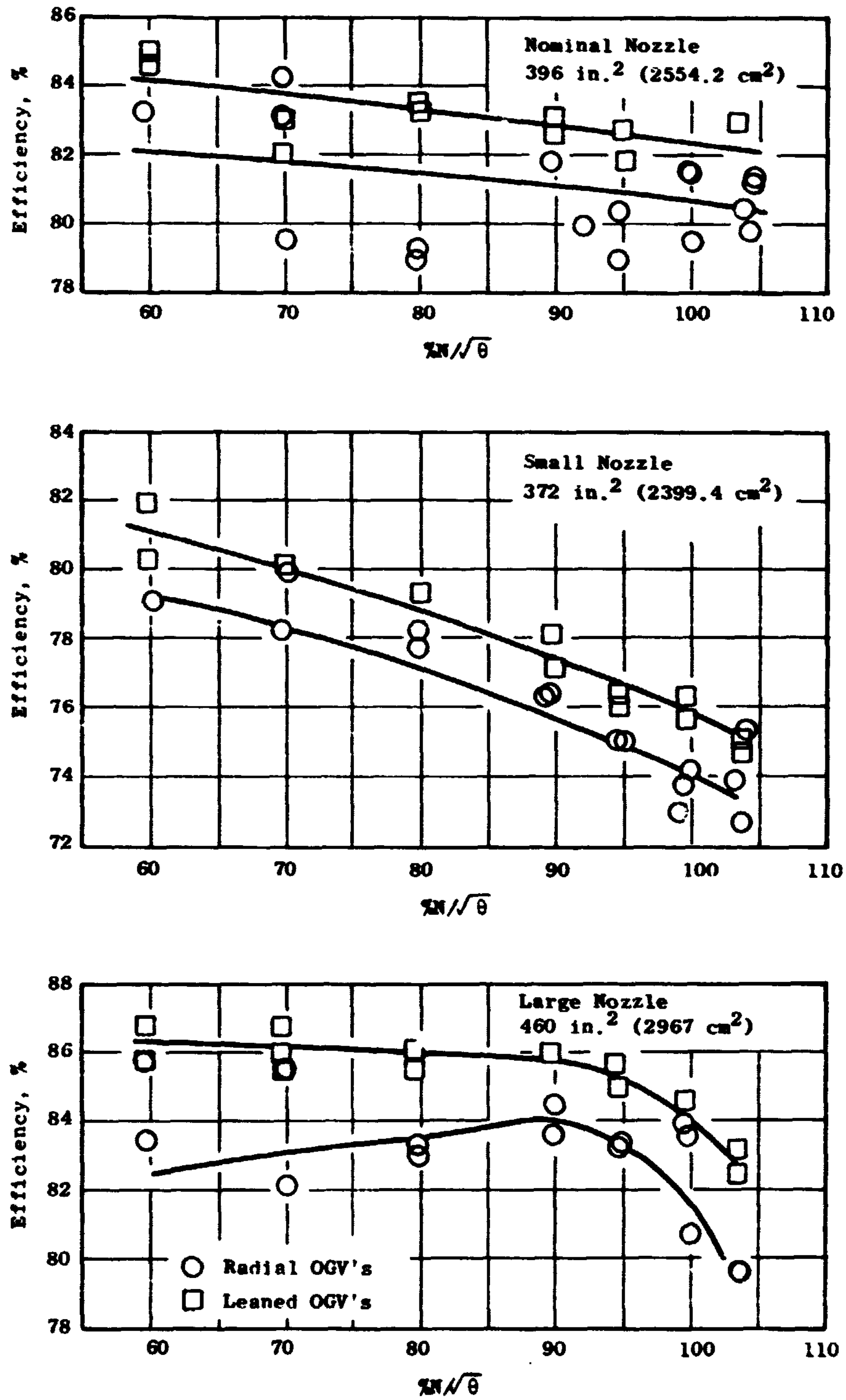

Figure 22. Fan B Efficiency Trends with Speed for Small, Nominal, and Large Nozzles.

	$W\sqrt{\theta}/\delta$ lb/sec	$W\sqrt{\theta}/\delta$ kg/sec	$\%N/\sqrt{\theta}$	Efficiency, %	P_{23}/P_2
○ Radial OGV's	160.4	72.8	89.8	81.7	1.411
□ Leaned OGV's	159.3	72.3	90.0	83.2	1.414

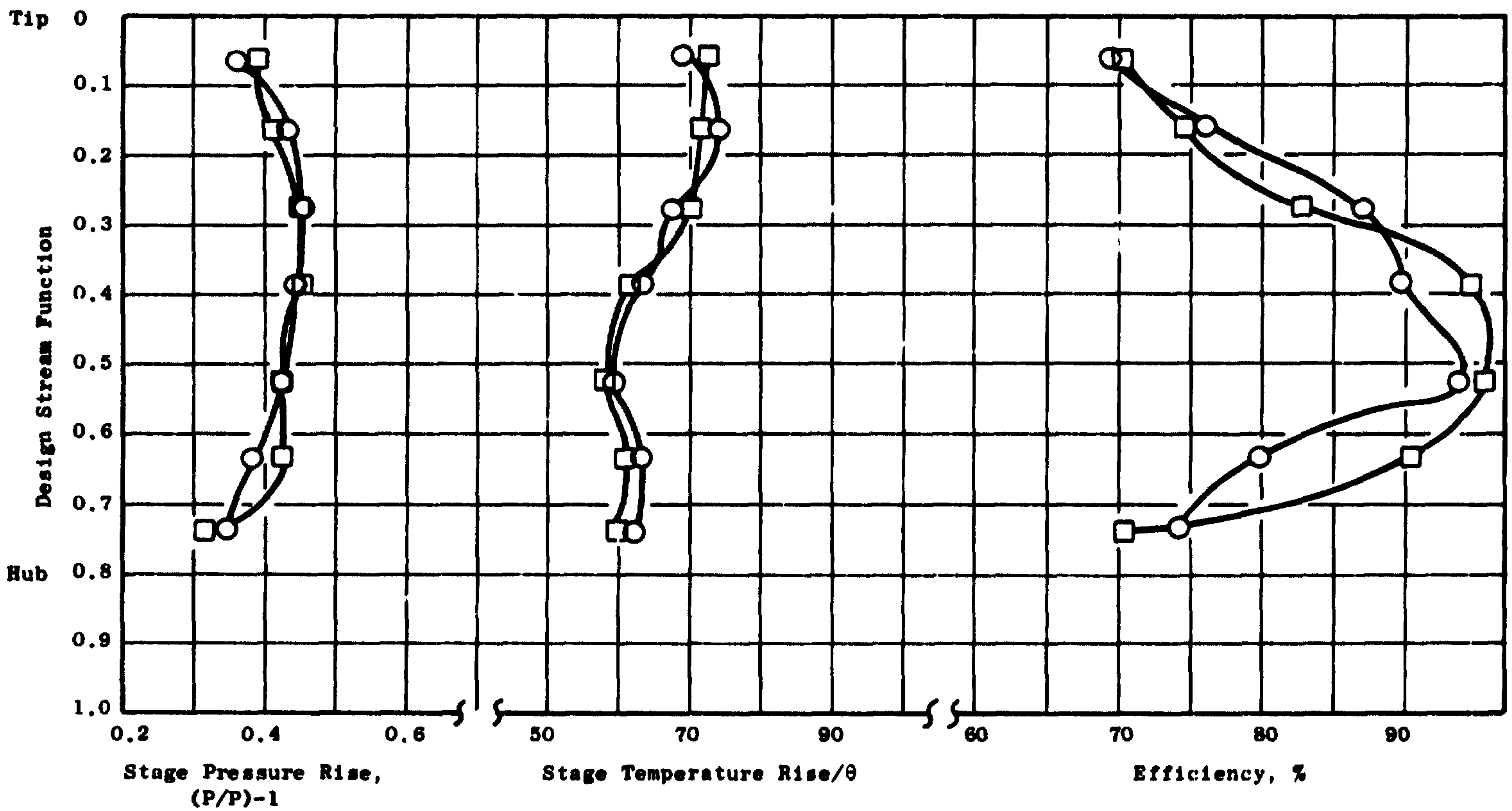

Figure 23. Fan B Radial Distribution of Pressure Rise, Temperature Rise, and Resulting Efficiency at Takeoff Fan Speed.

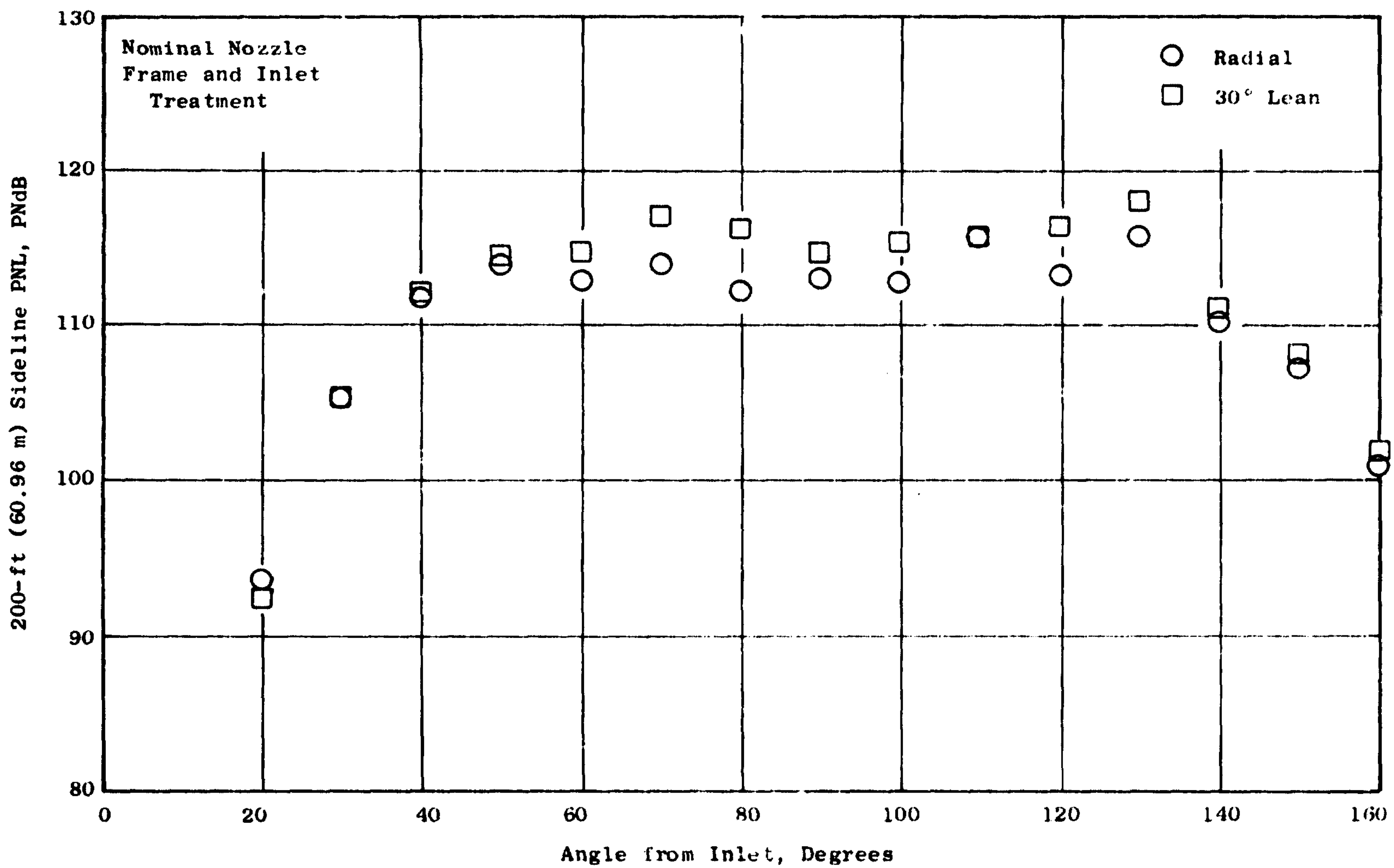

Figure 24. Fan C 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, Takeoff.

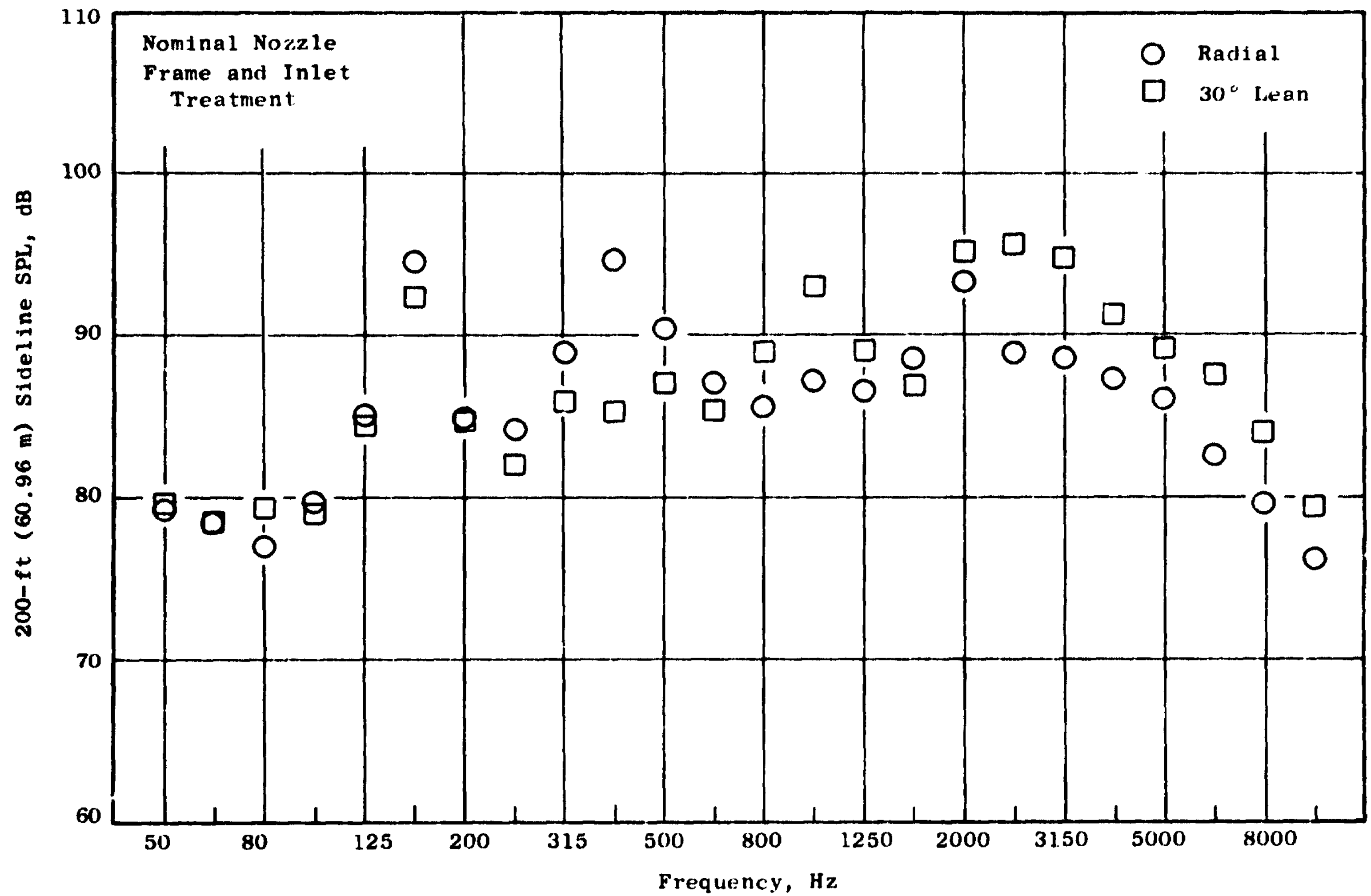

Figure 25. Fan C 200-ft (60.96 m) Sideline SPL Vs. Frequency, 70°, Takeoff.

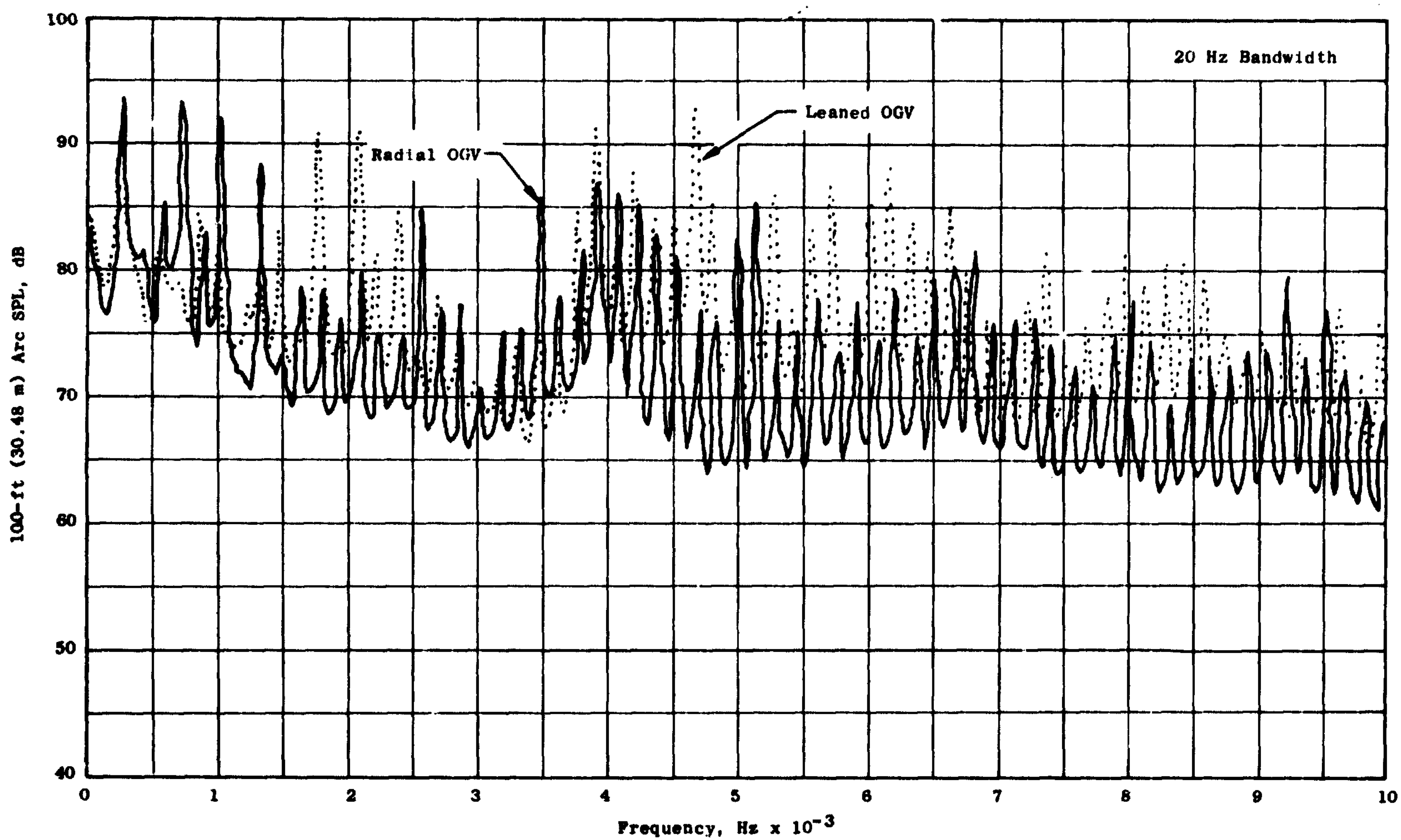

Figure 26. Fan C Spectral Comparison of Radial and Leaned OGV's, 100-ft (30.48 m) Arc, 70°, Takeoff.

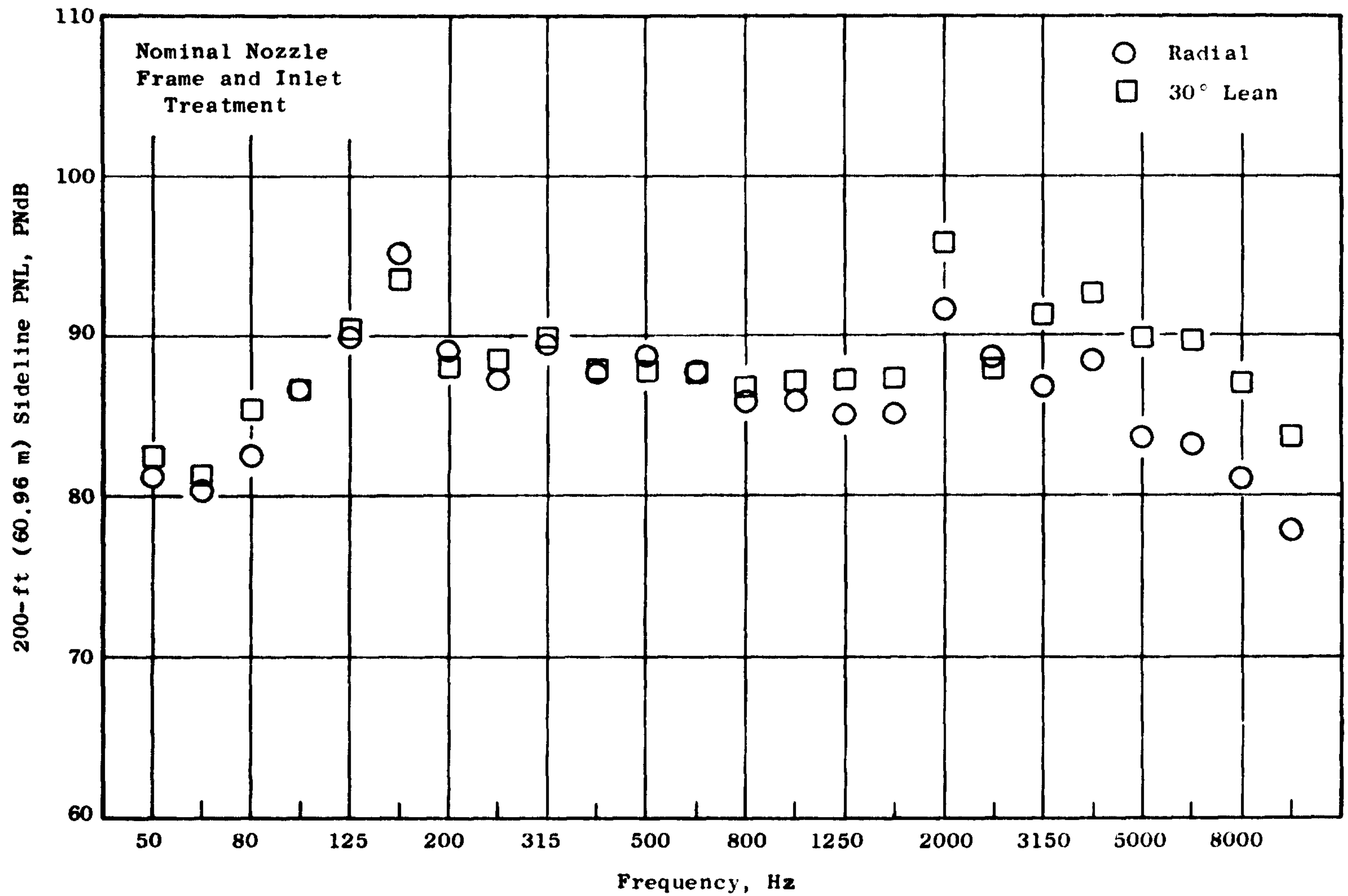

Figure 27. Fan C 200-ft (60.96 m) Sideline SPL Vs. Frequency, 120°, Takeoff.

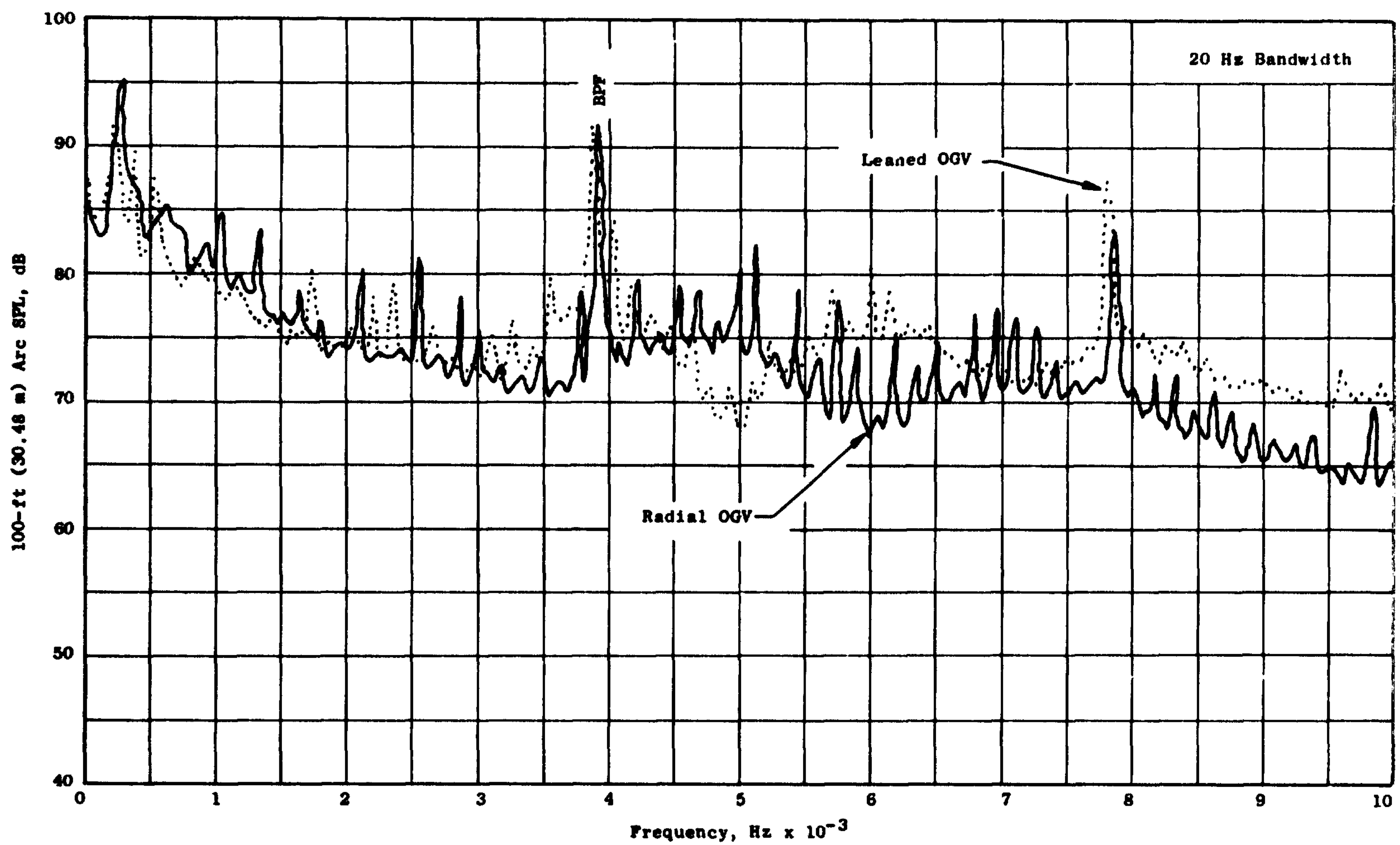

Figure 28. Fan C Spectral Comparison of Radial and Leaned OGV's, 100-ft (30.48 m) Arc, 120°, Takeoff.

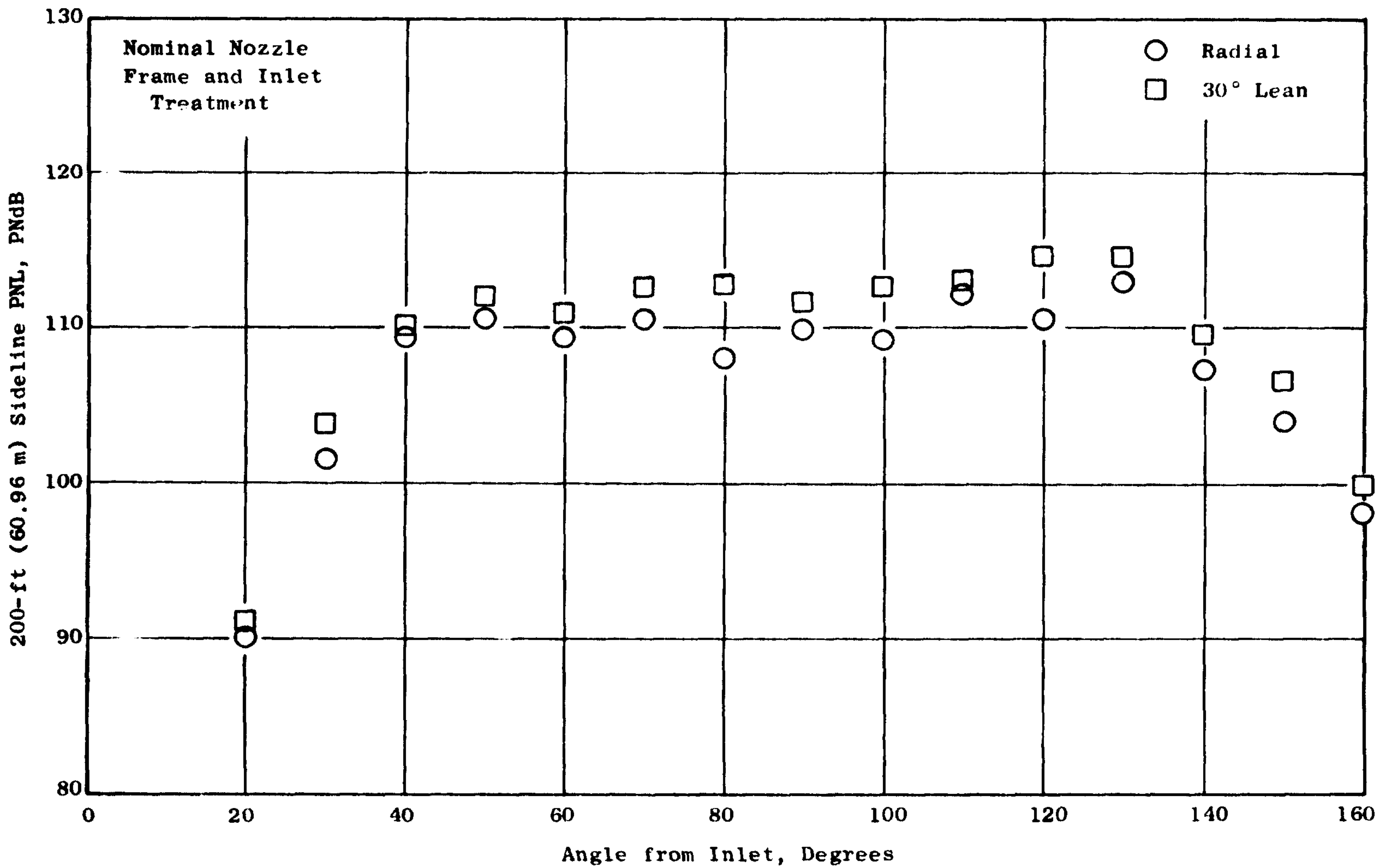

Figure 29. Fan C 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, 80% Fan Speed.

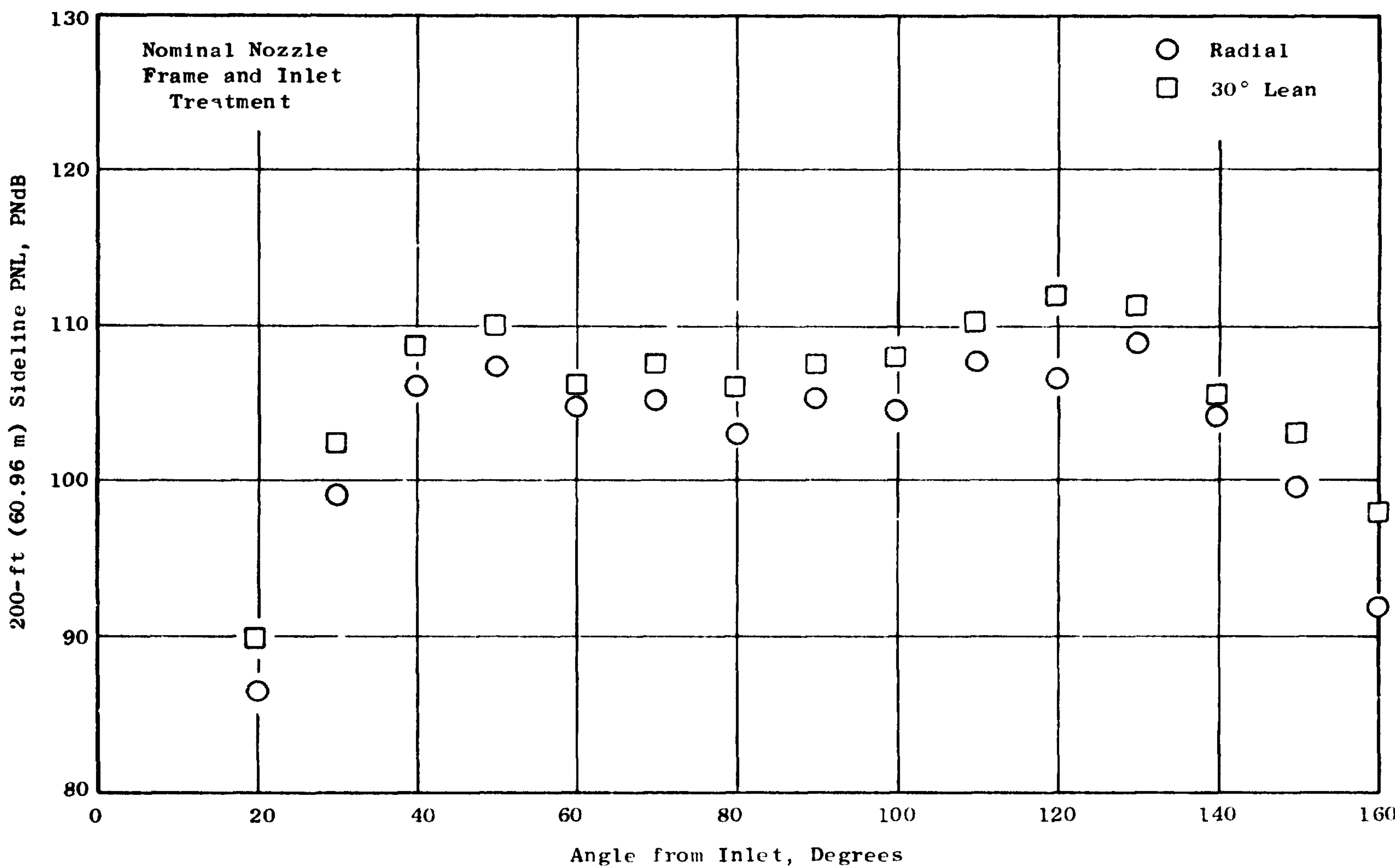

Figure 30. Fan C 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, 70% Fan Speed.

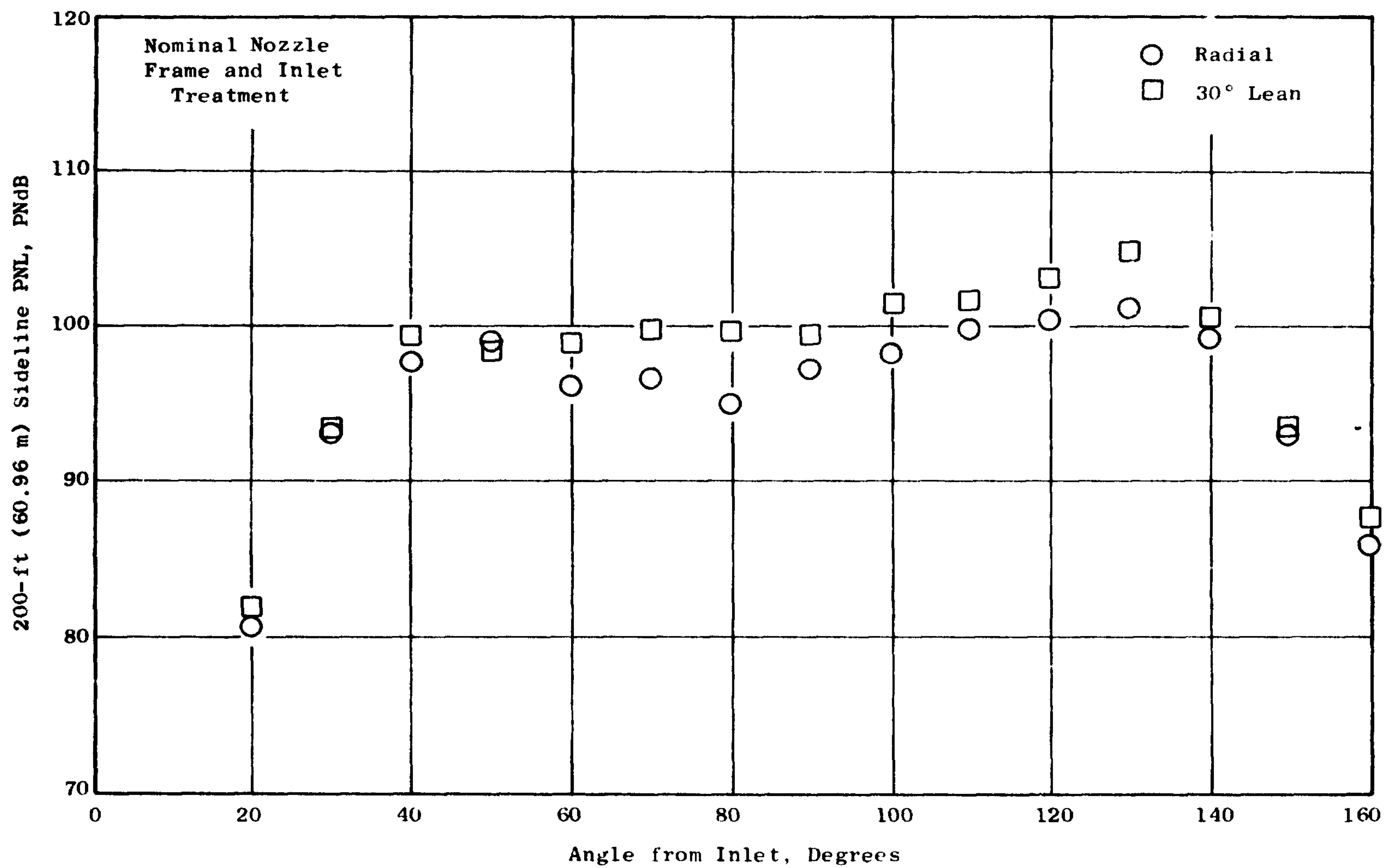

Figure 31. Fan C 200-ft (60.96 m) Sideline PNL Vs. Angle from Inlet, Approach.

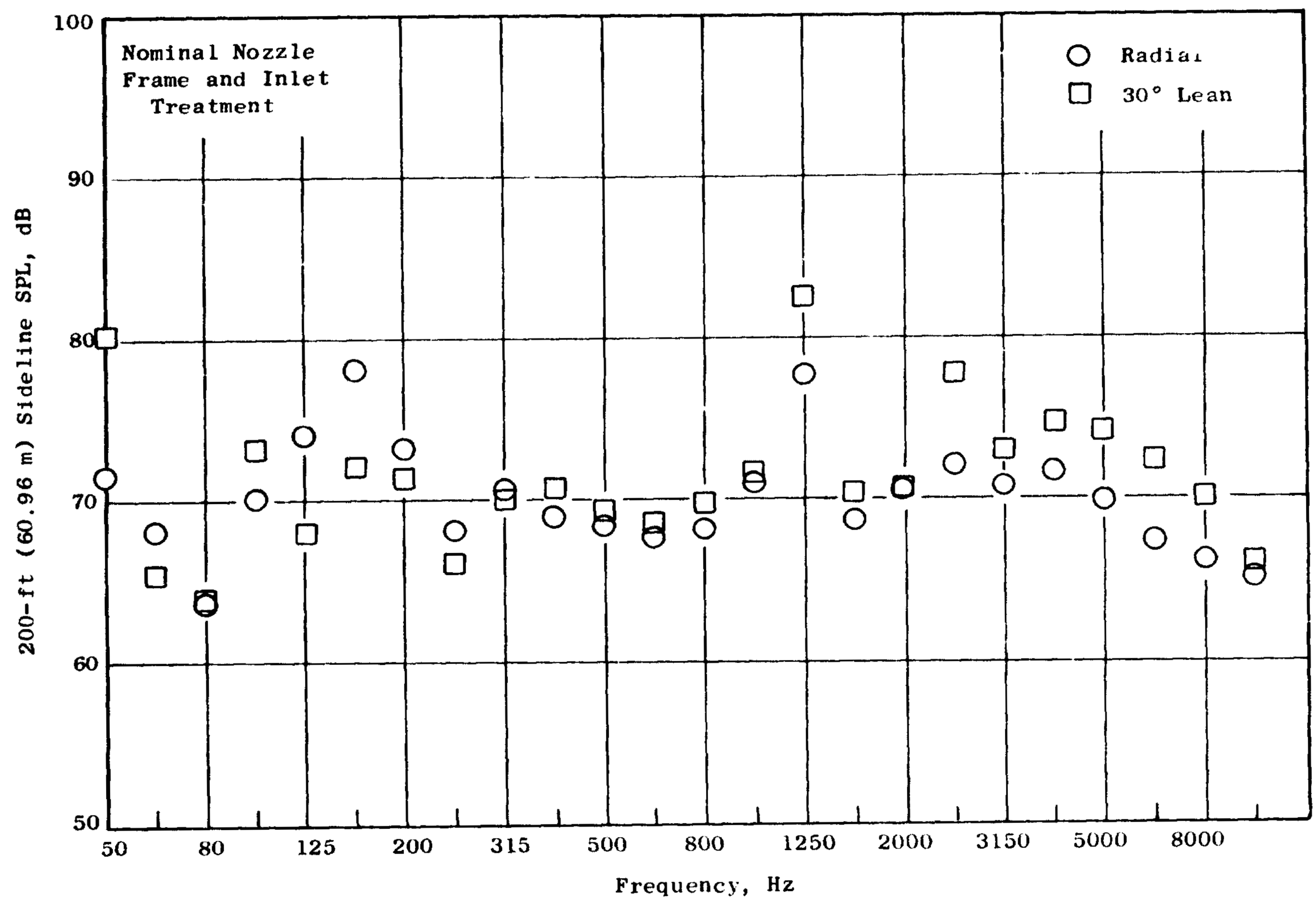

Figure 32. Fan C 200-ft (60.96 m) Sideline SPL Vs. Frequency, 70°, Approach.

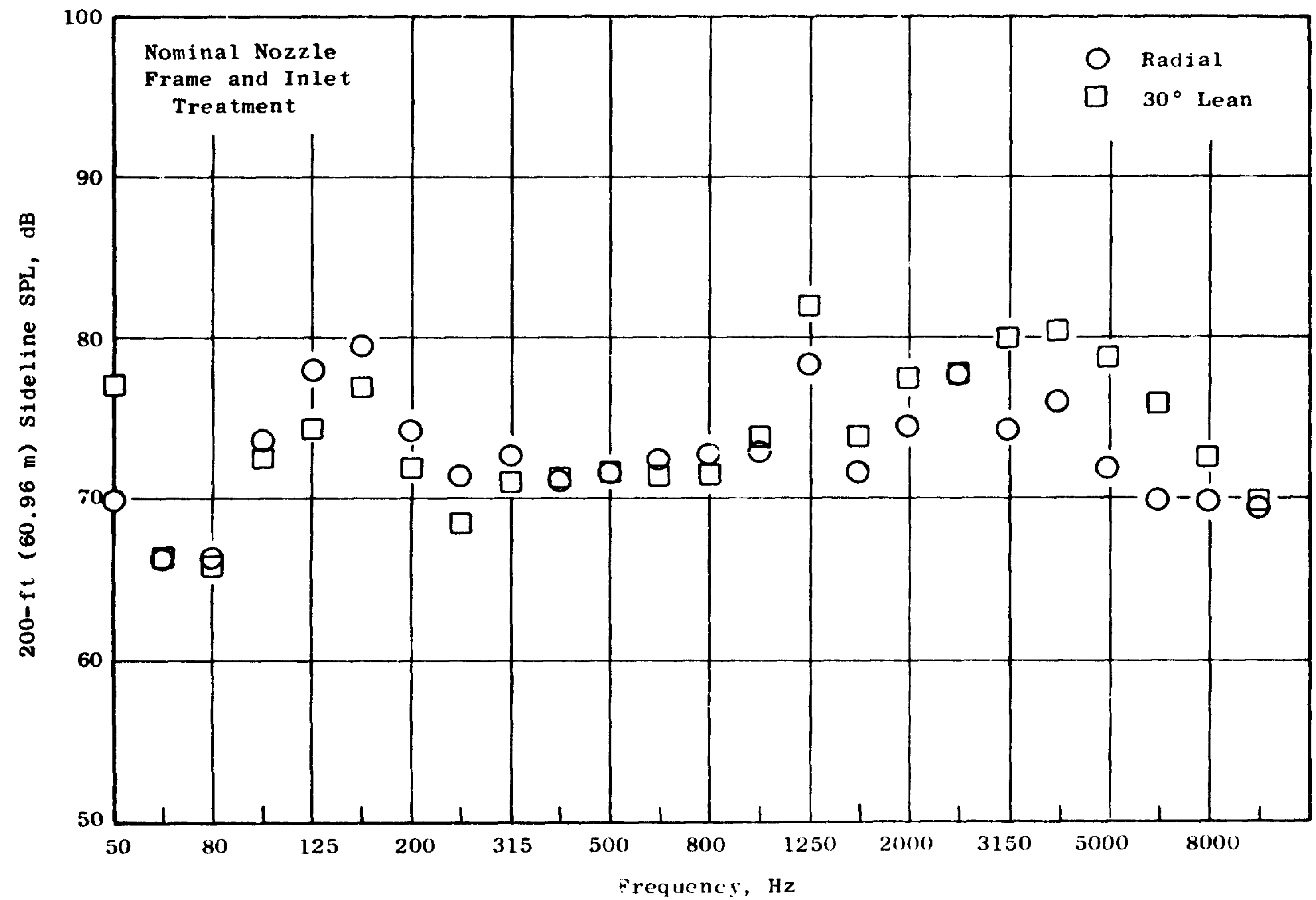

Figure 33. Fan C 200-ft (60.96 m) Sideline SPL Vs. Frequency, 120°, Approach

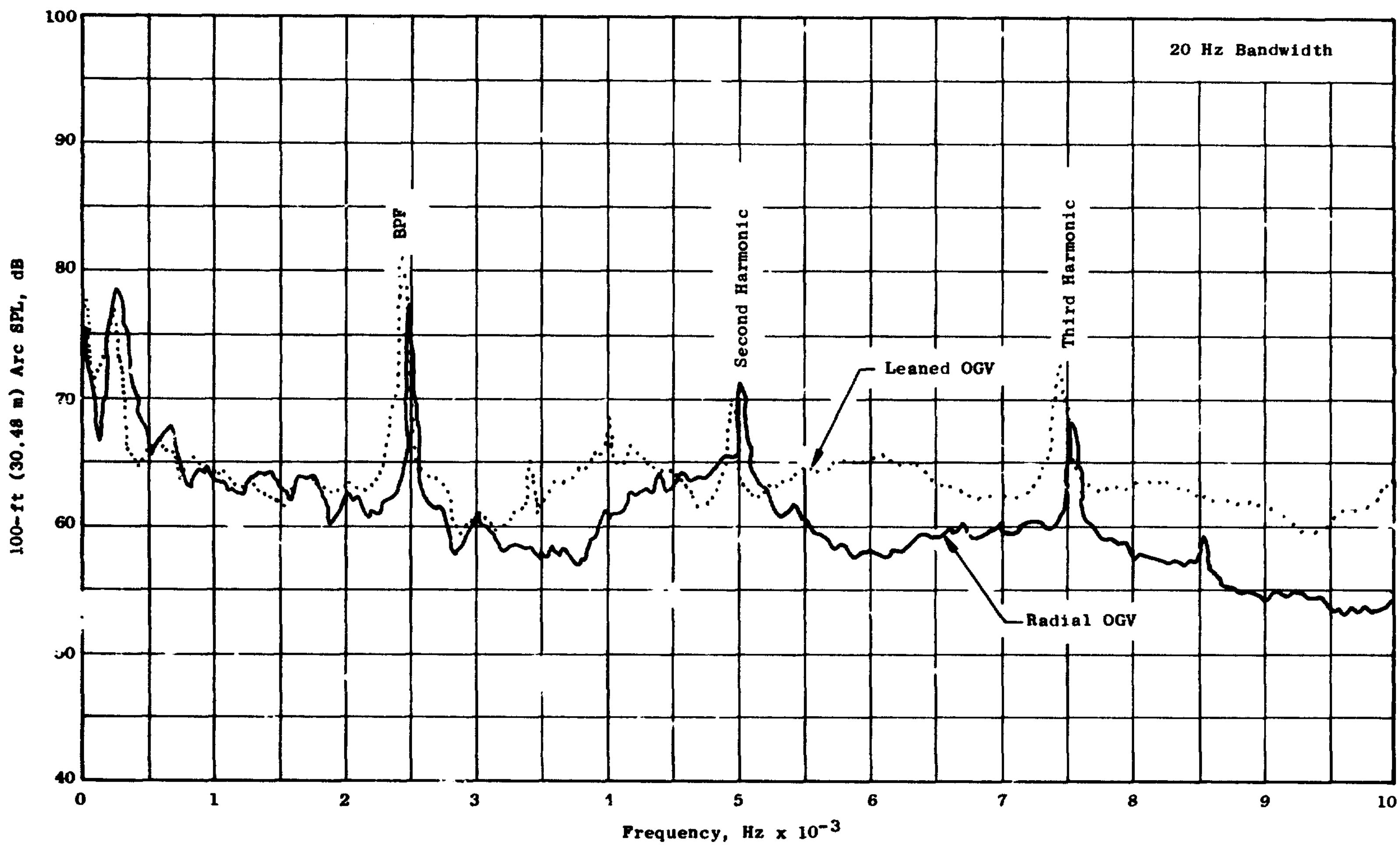

Figure 34. Fan C Spectral Comparison of Radial and Leaned OGV's, 100-ft (30.48 m) Arc, 120°, Approach.

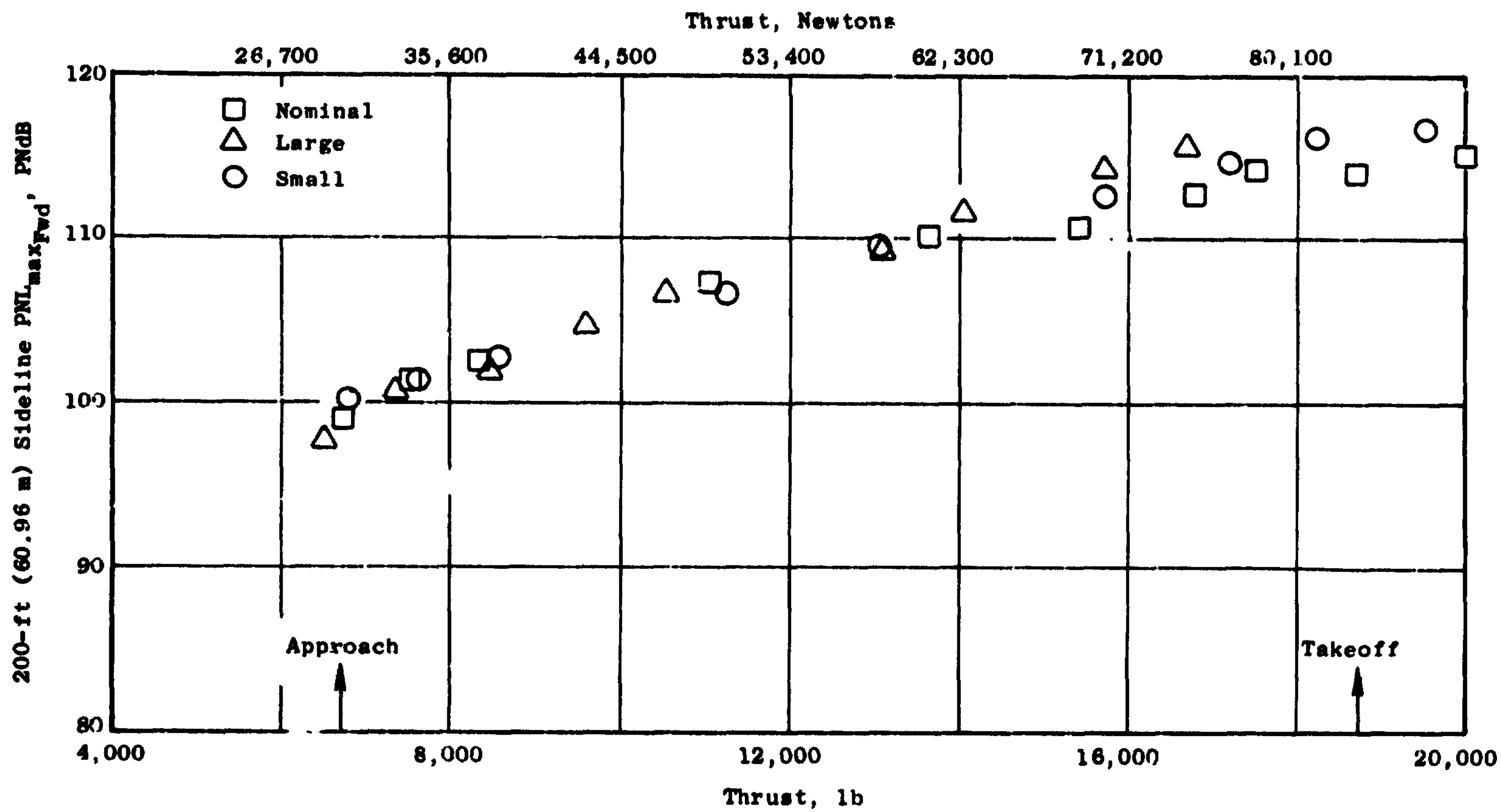

Figure 35. Fan C 200-ft (60.96 m) Sideline Front Maximum PNL Vs. Thrust, Radial Vanes.

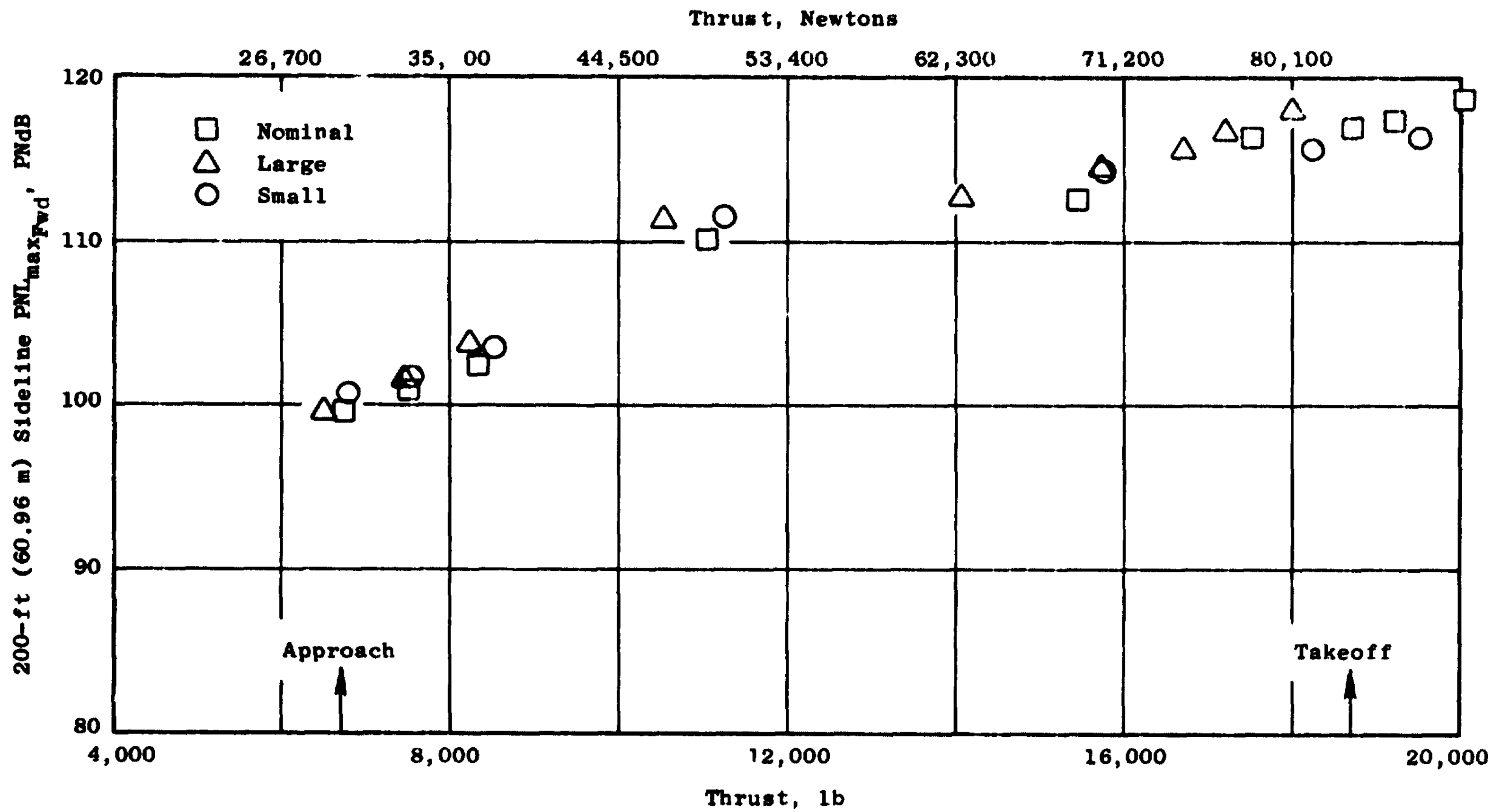

Figure 36. Fan C 200-ft (60.96 m) Sideline Front Maximum PNL Vs. Thrust, Leaned Vanes.

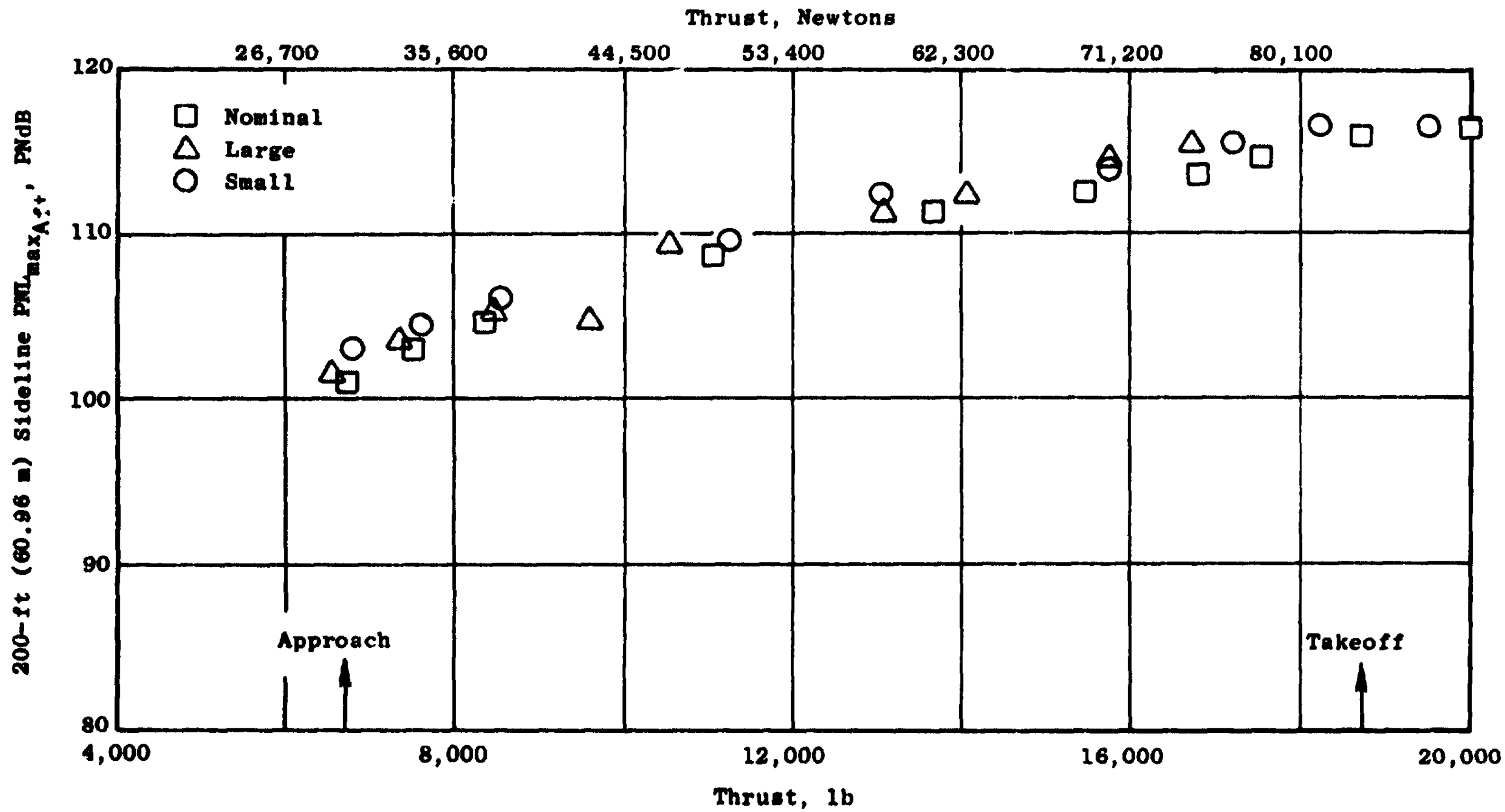

Figure 37. Fan C 200-ft (60.96 m) Sideline Rear Maximum PNL Vs. Thrust, Radial Vanes.

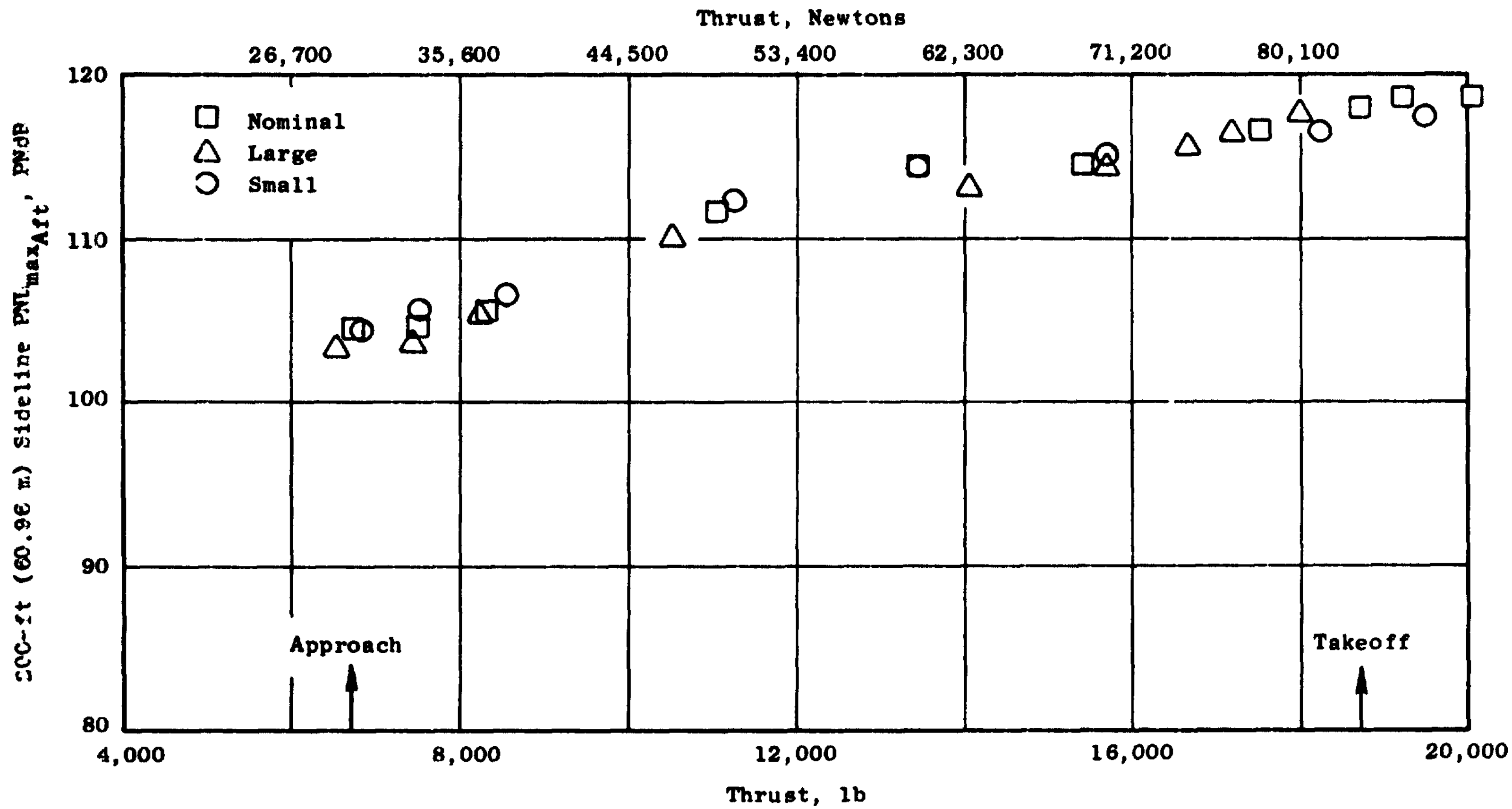

Figure 38. Fan C 200-ft (60.96 m) Sideline Rear Maximum PNL Vs. Thrust, Leanded Vanes.

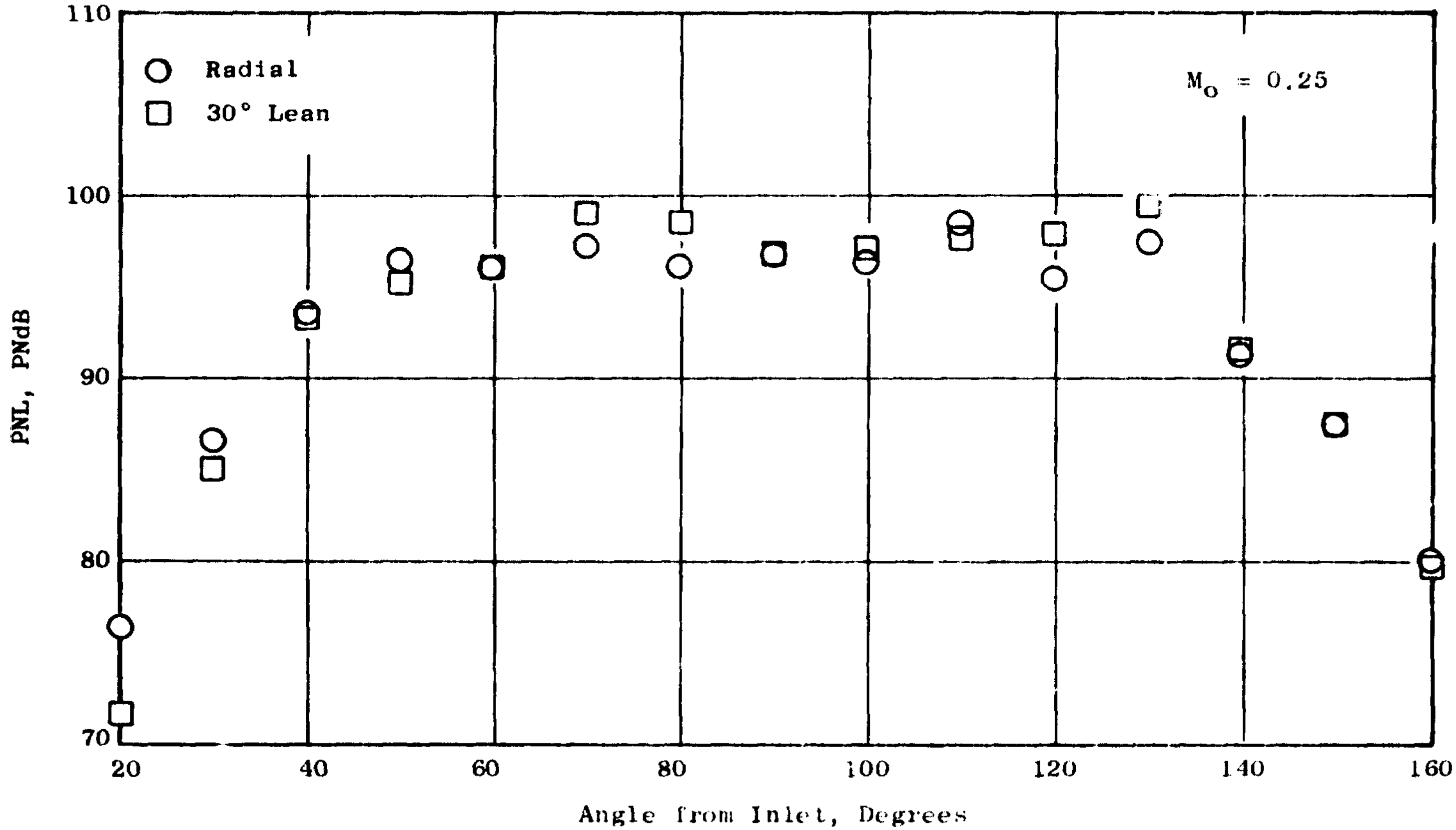

Figure 39. Fan C 1000-ft (304.8 m) Level Flyover PNL, Takeoff, Fan and Jet Noise.

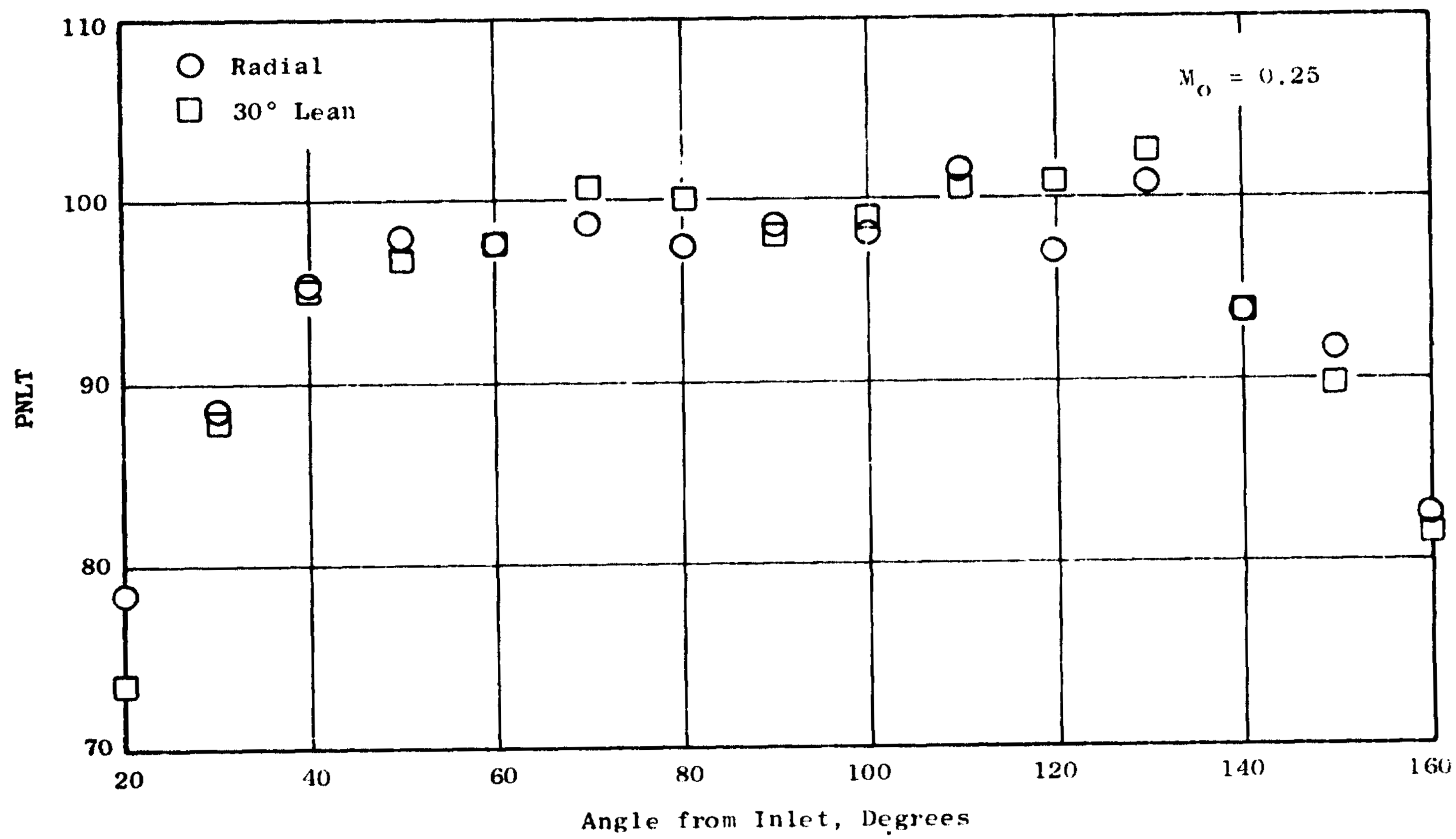

Figure 40. Fan C 1000-ft (304.8 m) Level Flyover PNLT, Takeoff, Fan and Jet Noise.

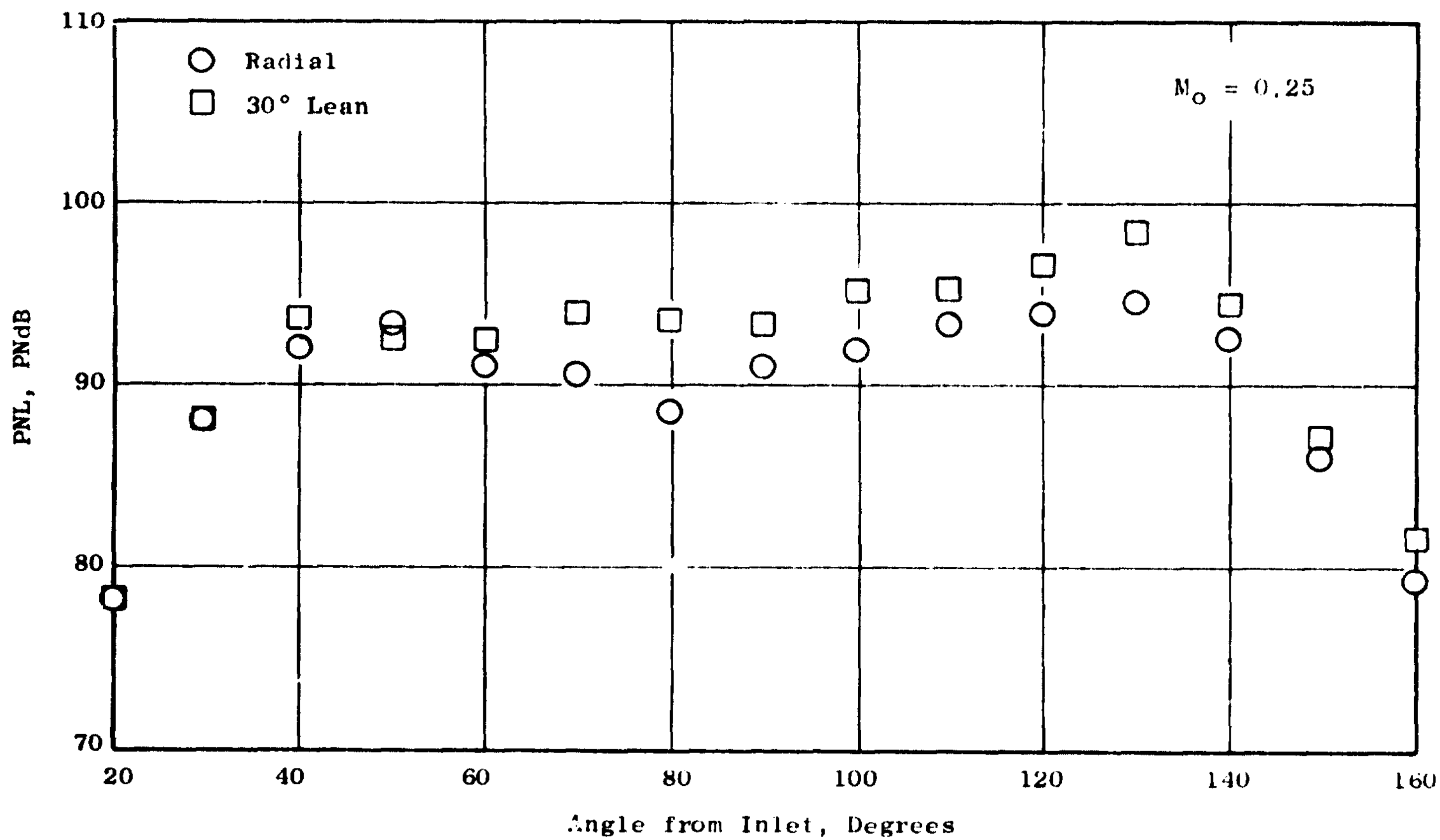

Figure 41. Fan C 370-ft (112.8 m) Level Flyover PNL, Approach, Fan and Jet Noise.

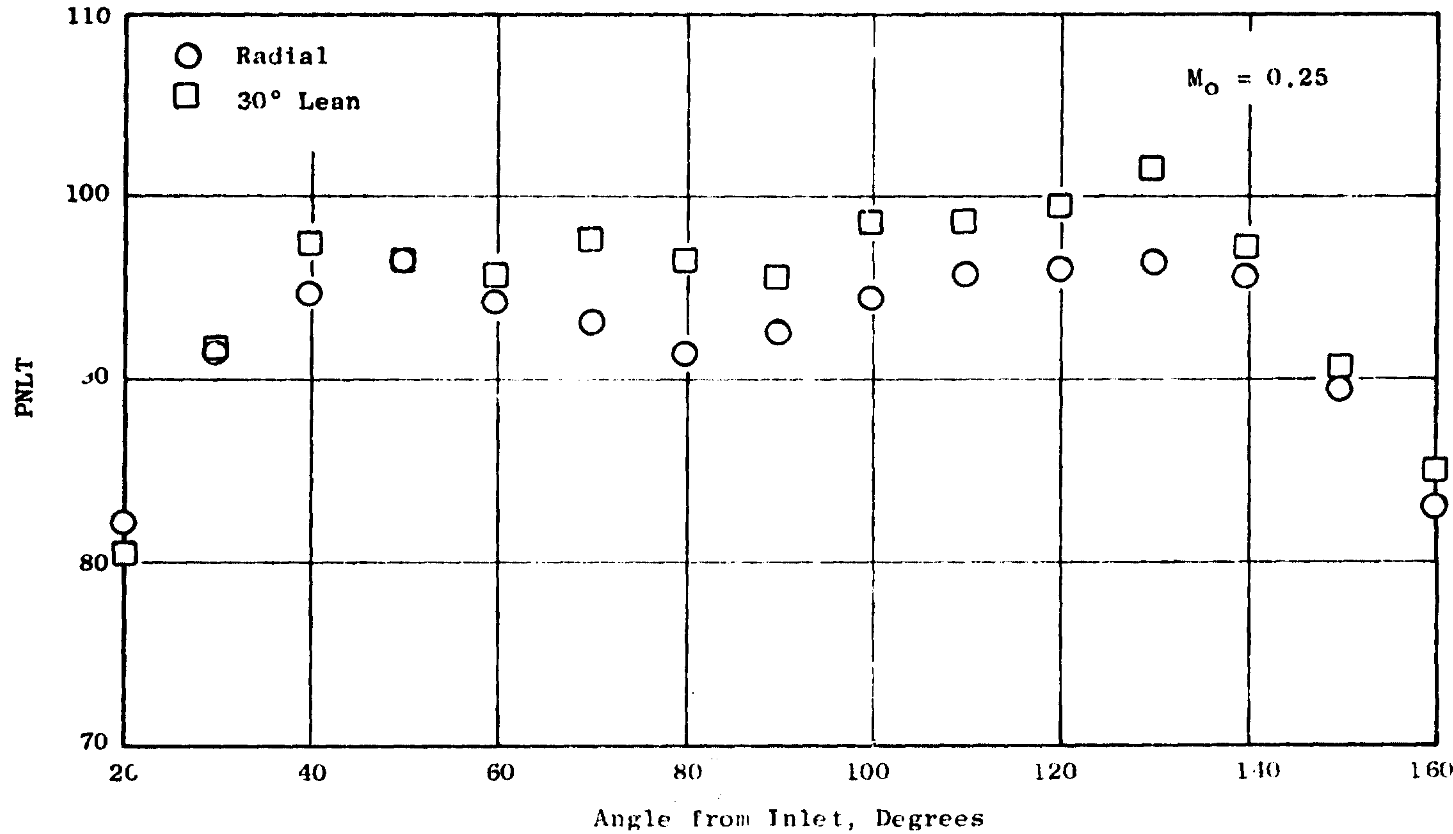

Figure 42. Fan C 370-ft (112.8 m) Level Flyover PNLT, Approach, Fan and Jet Noise.

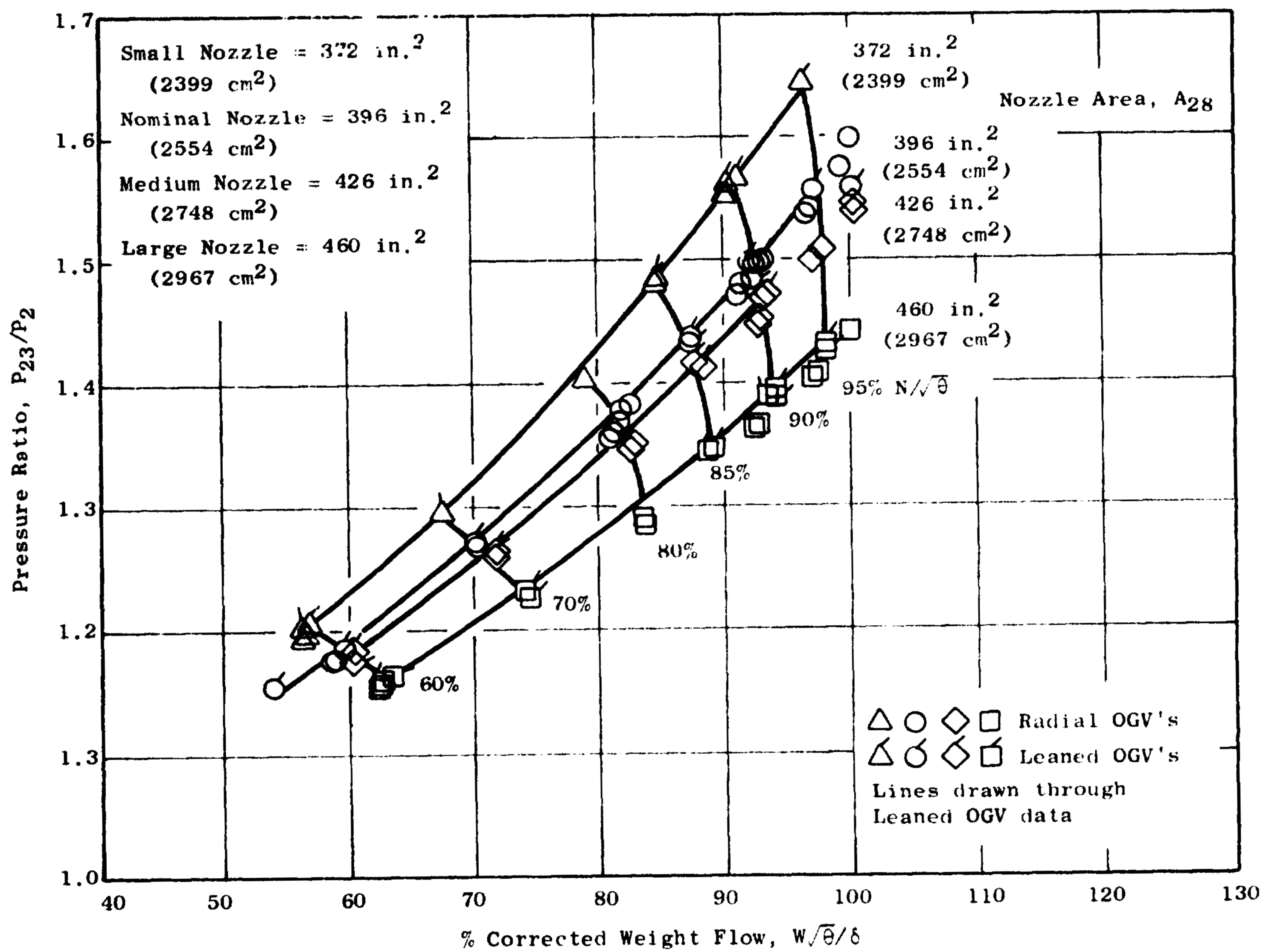

Figure 43. Fan C Aerodynamic Performance, Radial and Leaned OGV's.

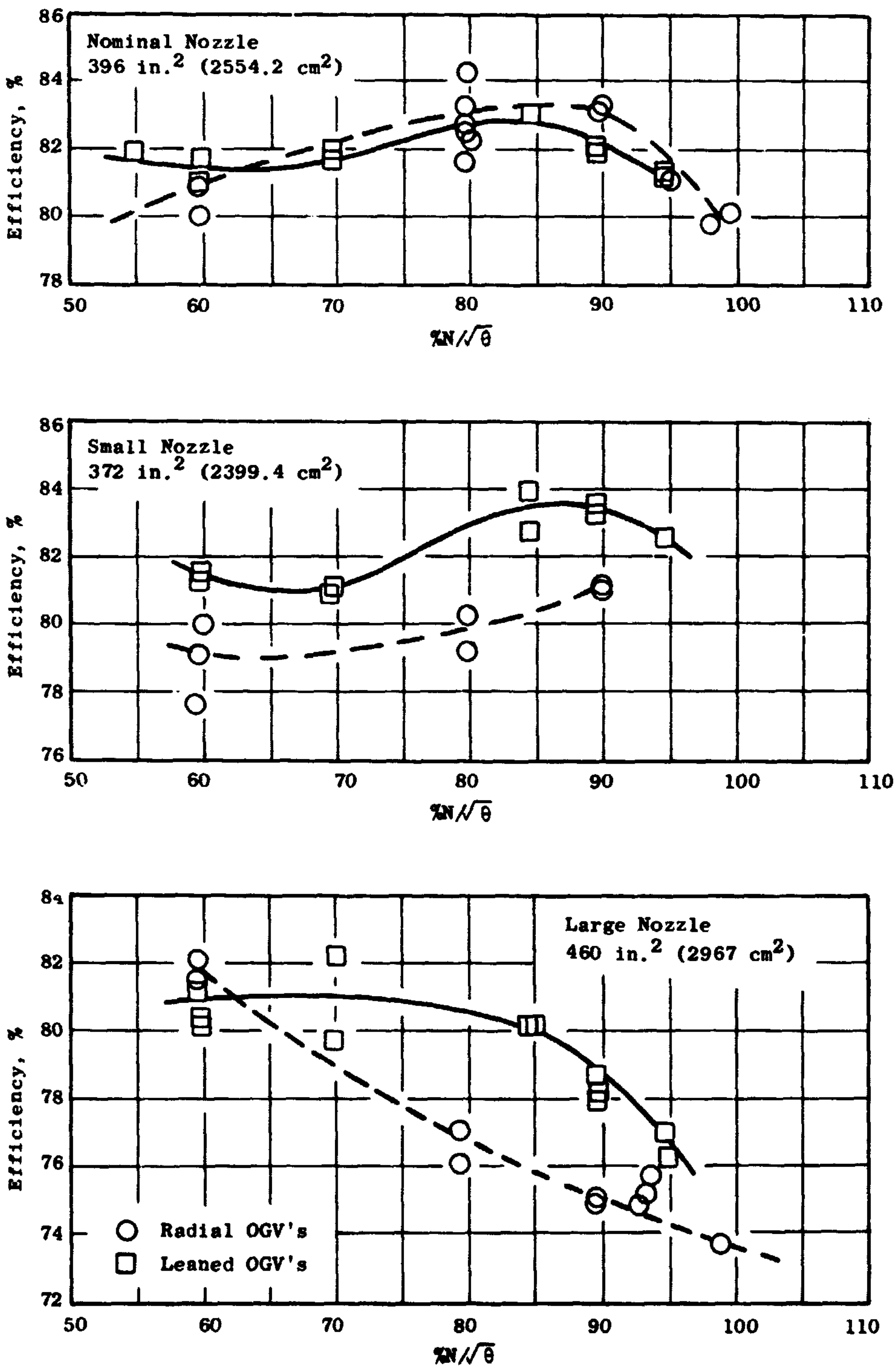

Figure 44. Fan C Efficiency Trends with Speed for Small, Nominal, and Large Nozzles.

	$W\sqrt{\theta}/\delta$ lb/sec	$W\sqrt{\theta}/\delta$ kg/sec	$\%N/\sqrt{\theta}$	Efficiency, %	P_{23}/P_2
○ Radial OGV's	172.2	78.2	89.9	83.1	1.497
□ Leaned OGV's	172.5	78.3	89.7	81.9	1.497

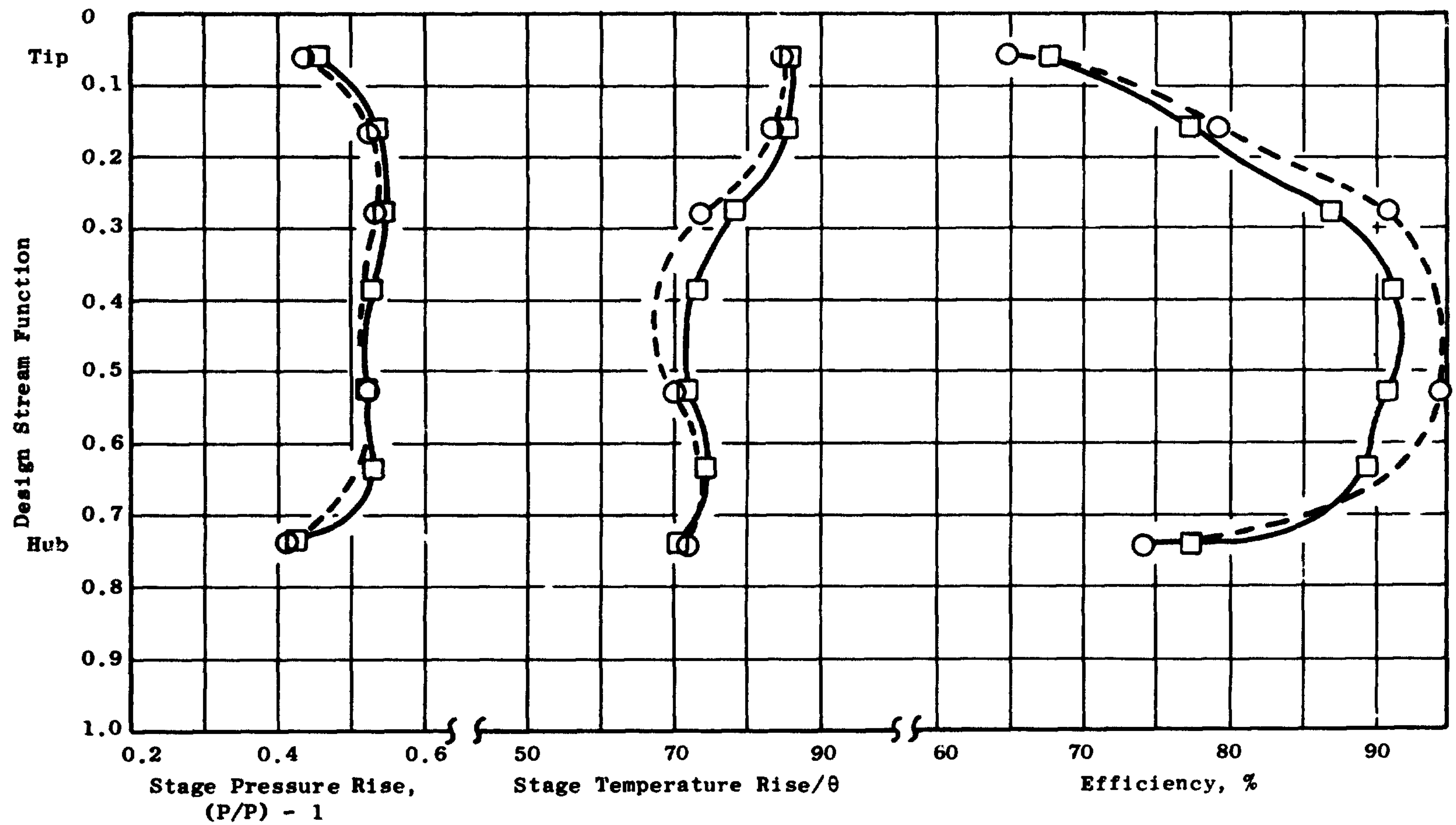

Figure 45. Fan C Radial Distribution of Pressure Rise, Temperature Rise, and Resulting Efficiency at Takeoff Fan Speed.

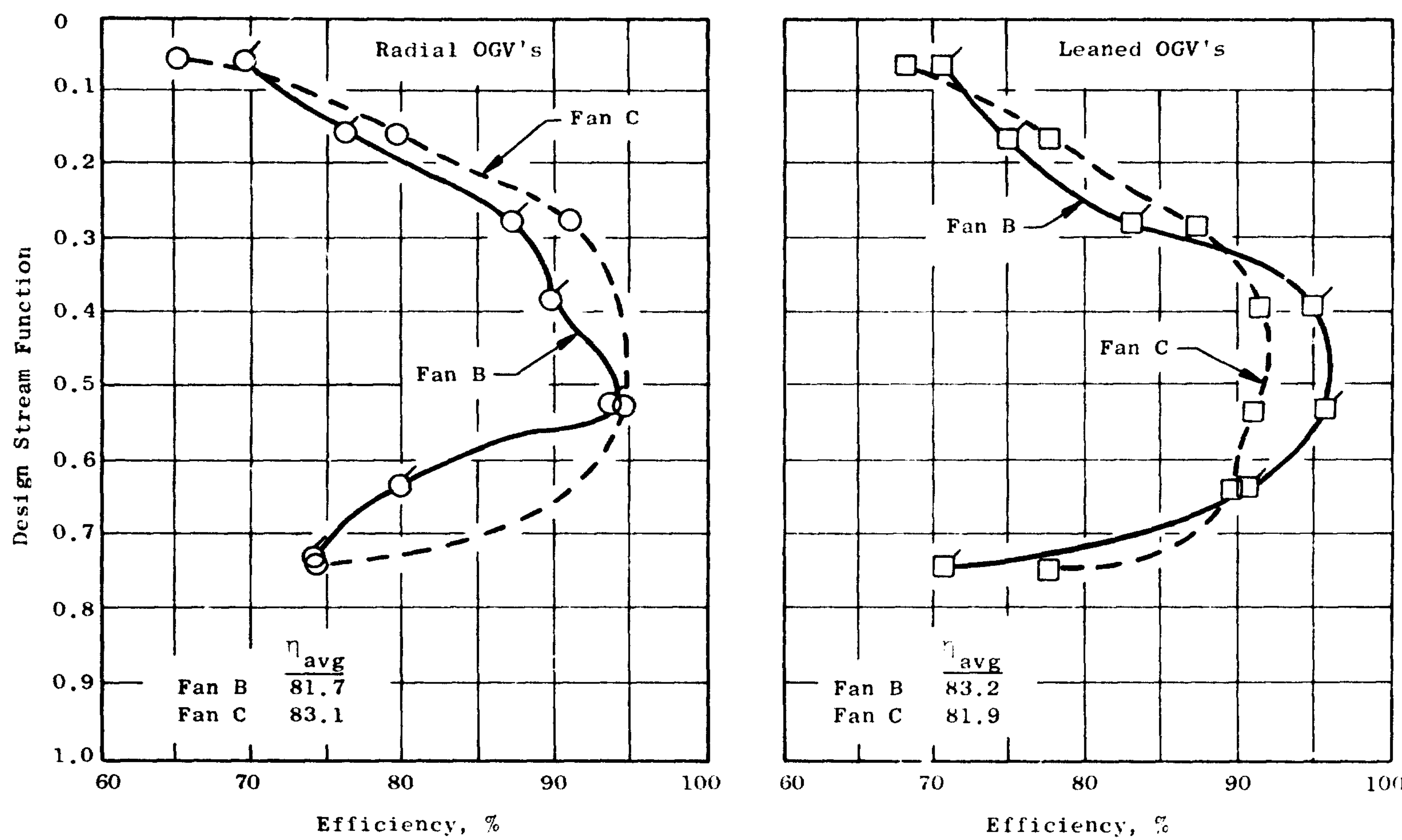

Figure 46. Comparison of Efficiency Profiles of Fan B and Fan C at Takeoff Fan Speed, Nominal Nozzle.

APPENDIX B - ONE-THIRD OCTAVE DATA

This appendix cc·tains 200-foot (60.96 m) sideline full-scale and 100-foot (30.48 m) arc scale model 1/3 octave data. These data have been corrected to 59° F and 70% relative humidity.

Fan C Scale Model
Takeoff
100-ft (30.48 m) Arc
Frame + Inlet Treatment
Radial Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	PWL ( )
50	78.4	78.8	74.0	69.4	78.6	78.7	79.4	80.3	80.6	81.2	81.7	83.9	88.0	92.1	96.3		135.0
63	74.6	77.0	75.4	72.4	80.2	79.3	79.6	81.2	81.6	82.4	83.0	85.1	88.9	92.7	96.7		135.7
80	73.2	76.5	76.8	73.5	79.8	79.1	79.7	80.8	82.0	82.5	83.5	85.2	88.5	91.8	94.6		134.8
100	75.1	78.0	76.4	76.1	80.2	80.4	79.9	80.8	81.3	82.3	83.0	85.0	87.7	90.4	91.1		133.7
125	75.4	78.3	77.6	75.8	80.1	79.3	78.7	80.1	80.2	81.4	82.1	[illegible]	86.0	88.2	89.2		132.3
160	75.2	81.1	80.8	79.2	79.2	78.2	78.6	86.5	82.5	86.7	83.7	86.2	88.5	92.0	93.1		135.5
200	75.1	78.7	77.4	79.0	80.7	80.7	81.2	[illegible]	84.5	86.4	[illegible]	[illegible]	93.3	95.8	94.9		138.2
250	80.1	83.2	84.6	86.2	85.8	86.3	86.6	87.7	88.6	90.3	91.6	93.5	95.7	96.7	95.5		140.8
315	84.4	87.6	92.1	93.0	89.6	95.3	89.1	92.0	92.1	96.8	97.2	100.0	100.3	98.2	96.7		145.7
400	81.7	85.2	85.1	85.7	86.1	86.1	86.5	87.5	89.2	90.6	91.1	91.4	92.4	92.3	90.6		139.2
500	80.6	84.6	85.6	85.3	85.3	85.4	87.6	85.2	87.0	87.7	89.0	91.4	91.8	91.6	89.8		138.3
630	86.6	92.6	91.6	84.9	93.4	89.7	87.8	90.0	91.2	90.6	91.3	92.1	92.6	92.3	90.4		141.9
800	88.5	90.9	93.9	95.4	95.7	93.9	94.4	93.0	94.3	88.9	89.6	91.3	91.1	92.3	88.6		143.4
1000	82.0	84.9	87.8	91.4	91.4	93.0	90.7	88.4	88.8	89.3	90.7	90.2	90.8	89.6	87.2		140.5
1250	80.4	83.4	88.4	91.5	89.6	90.2	86.7	86.4	86.1	87.6	90.1	90.6	90.7	89.1	87.6		139.3
1600	78.3	[illegible]	86.7	91.1	86.1	85.7	83.0	84.9	84.4	85.7	88.3	88.3	88.4	88.0	86.4		137.3
2000	80.5	85.4	90.7	91.1	88.3	87.0	83.1	86.6	84.7	86.9	87.9	[illegible]	89.4	87.8	88.3		138.5
2500	82.9	87.0	90.6	89.2	87.8	87.1	86.1	85.7	86.5	88.7	86.8	88.9	87.2	87.4	85.4		138.4
3150	79.8	85.7	91.7	91.3	86.1	87.9	85.9	85.5	84.8	87.1	87.1	89.8	87.3	87.7	85.6		138.7
4000	86.5	93.0	98.4	95.7	92.4	93.4	90.3	91.1	93.1	99.9	93.0	100.8	94.2	93.5	94.0		146.8
5000	78.9	89.1	92.0	91.5	89.8	89.6	87.0	86.4	88.4	87.8	90.3	89.0	87.7	87.5	84.6		140.3
6300	80.4	88.3	90.7	92.2	92.2	89.5	88.0	87.7	85.3	89.7	89.0	91.3	87.4	87.3	84.2		141.0
8000	77.3	88.5	91.5	92.5	89.8	87.6	85.9	86.8	87.9	88.8	89.9	91.9	88.2	87.0	84.1		141.4
10000	74.7	85.2	88.9	91.3	86.9	87.0	83.2	84.0	82.5	85.1	84.9	86.9	84.5	83.4	80.7		139.2
12500	71.5	82.5	85.4	86.2	82.8	83.0	78.4	80.9	80.7	82.6	84.1	85.8	82.4	80.5	77.3		137.2
16000	68.2	78.6	82.0	82.5	79.4	79.4	75.1	77.7	78.2	81.4	81.8	83.0	79.8	77.3	74.3		136.2
20000	65.4	73.3	77.3	78.0	75.4	75.6	70.7	73.2	72.4	76.2	78.2	78.7	76.3	75.1	71.5		134.5
OVERALL MEASURED	96.7	102.1	105.8	106.0	104.2	104.3	102.3	102.7	103.4	106.1	105.2	107.9	107.1	107.0	106.6		
OVERALL CALCULATED	95.5	103.6	104.0	104.5	102.8	102.8	100.8	101.2	101.9	104.4	103.6	106.4	105.7	105.8	105.8		154.4
PNDB	108.5	114.4	118.6	117.8	115.5	115.7	113.4	114.1	115.1	119.2	116.2	120.6	117.4	117.2	116.7		

Fan C Full Scale
Takeoff
200-ft (60.96 m) Sideline
Frame + [illegible]let Treatment
Radial Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	64.9	71.4	72.1	73.3	78.5	79.4	79.3	80.4	80.7	81.3	81.3	82.2	83.4	83.9	81.0
63	65.0	71.6	73.2	72.9	78.4	78.3	78.1	79.7	79.6	80.4	80.3	80.9	81.6	81.5	78.9
80	64.7	74.3	76.3	76.3	77.4	77.1	78.0	85.9	81.9	85.6	81.9	83.3	84.0	85.1	82.6
100	64.4	71.7	72.9	76.0	78.8	79.6	80.5	82.7	83.8	85.3	86.3	87.6	88.7	88.8	84.2
125	69.3	76.2	80.0	83.2	84.0	85.1	85.8	87.1	87.9	89.2	89.7	[illegible]	91.0	89.7	84.6
[illegible]	73.3	83.4	87.3	89.9	87.8	94.1	88.3	91.3	91.3	95.6	95.3	96.9	95.5	91.0	85.6
[illegible]	70.4	77.9	80.2	82.5	84.1	84.8	85.7	86.8	88.4	89.4	89.1	88.3	87.5	89.0	79.3
[illegible]	69.1	77.2	80.7	82.1	83.2	84.1	86.8	84.5	86.2	86.4	86.9	88.2	86.9	84.2	78.3
315	74.9	85.0	86.6	91.6	91.3	88.3	87.0	89.3	90.3	89.3	89.2	88.8	87.6	84.8	78.6
400	76.5	83.2	88.8	92.0	93.5	92.6	93.4	92.2	93.4	87.6	87.4	88.0	86.1	84.6	76.7
500	69.8	77.1	82.6	88.0	89.2	91.6	89.8	87.6	87.9	87.9	88.5	86.8	85.7	81.9	75.0
630	67.9	75.4	83.1	88.0	87.3	88.8	85.7	85.5	85.1	86.2	87.9	87.1	85.4	81.1	75.2
800	65.6	72.8	81.4	87.5	83.8	84.2	82.0	84.0	83.3	84.2	86.0	84.8	83.0	79.8	73.7
1000	67.5	77.1	85.2	87.5	85.9	85.5	82.0	85.7	83.6	85.4	85.6	85.5	83.9	79.4	75.3
1250	69.5	78.5	85.0	85.6	85.4	85.5	85.0	84.8	85.4	87.1	84.4	85.2	81.6	79.0	72.1
1600	67.0	77.0	86.0	87.6	83.7	86.3	84.8	84.6	83.7	85.5	84.7	86.1	81.6	79.0	71.9
2000	72.4	84.2	92.7	92.0	90.0	91.9	89.3	90.3	92.1	98.4	90.6	97.1	88.5	84.7	80.0
2500	64.5	80.0	86.1	87.7	87.4	88.0	86.0	85.5	87.3	86.2	87.8	85.1	81.8	78.4	70.1
3150	65.5	78.7	84.7	88.3	89.8	88.0	86.9	86.9	84.3	88.2	86.5	87.4	81.5	78.0	69.3
4000	41.6	78.9	85.4	89.0	87.4	86.2	85.0	86.1	87.1	87.4	87.5	88.0	82.1	77.5	68.4
5000	[illegible]	76.0	83.2	87.9	85.1	86.1	82.9	83.9	82.2	84.2	83.0	83.5	78.8	74.1	65.1
6300	54.8	72.9	79.7	83.0	81.3	82.5	78.5	81.2	80.8	82.1	82.6	82.6	76.8	70.8	60.7
8000	50.1	68.6	76.4	79.7	78.5	79.7	76.0	78.8	79.1	81.7	80.9	80.2	74.3	67.3	56.2
10000	45.0	62.6	71.8	75.7	75.1	76.7	72.6	75.2	74.2	77.3	78.0	76.4	70.8	64.4	51.2
OVERALL CALCULATED	83.1	92.4	98.5	101.8	100.6	101.4	99.8	100.4	100.9	103.0	101.4	102.9	100.4	97.8	92.7
PNDB	92.8	104.4	111.5	113.1	112.9	113.0	111.2	111.8	112.5	116.0	112.5	115.3	109.9	106.4	100.5

Fan C Scale Model
Approach
100-ft (30.48 m) Arc
Frame + Inlet Treatment
Radial Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	( )	PWL
50	70.6	69.2	67.9	62.2	68.9	67.6	68.2	69.6	68.8	68.9	68.9	70.8	73.4	74.6	77.3			120.1
63	69.5	66.2	67.7	69.0	73.5	66.1	66.7	73.3	68.1	69.0	69.7	70.6	74.9	74.6	76.9			121.1
80	62.7	63.7	64.9	60.7	66.1	66.4	67.0	68.0	68.4	68.5	69.0	70.3	71.7	72.8	74.2			118.5
100	68.8	68.7	68.6	64.2	71.0	73.5	72.6	74.2	74.4	71.3	72.7	74.5	73.3	72.1	73.7			122.4
125	64.2	64.4	65.1	62.2	66.7	69.1	65.9	67.0	66.7	68.0	67.8	68.2	69.3	70.0	69.8			117.4
160	63.5	64.8	64.8	62.5	65.0	64.6	66.6	66.7	66.7	68.2	67.8	69.0	70.3	71.6	72.8			117.6
200	67.9	67.9	69.6	72.6	72.7	72.3	70.8	72.7	73.3	74.7	75.1	75.3	76.4	76.1	76.7			123.7
250	68.3	71.0	72.8	75.4	75.1	75.0	77.2	78.2	79.2	79.8	79.5	79.5	79.0	78.3	76.9			127.8
315	71.7	74.1	74.8	77.9	79.4	79.3	78.2	79.4	80.6	81.2	81.3	81.4	81.2	79.6	77.0			129.7
400	69.5	73.1	74.8	75.4	73.3	74.0	75.0	74.3	75.9	76.5	76.3	77.1	76.4	75.4	73.8			125.4
500	68.3	71.0	71.0	70.2	68.3	69.3	68.9	69.5	70.4	71.6	73.4	73.0	73.6	72.8	71.4			121.4
630	68.2	71.5	71.3	73.2	70.7	71.6	71.4	72.5	73.5	74.2	74.4	74.4	74.6	74.3	72.2			123.3
800	67.2	70.0	70.3	69.6	69.1	69.8	69.9	71.0	71.3	71.8	72.8	73.1	72.7	73.2	71.9			121.6
1000	66.0	58.7	68.9	69.9	69.0	69.4	68.9	69.8	70.9	72.2	73.2	73.9	73.1	71.8	70.2			121.4
1250	67.0	69.4	70.3	70.8	68.4	68.7	67.9	68.6	69.9	71.9	73.9	74.2	74.3	72.3	70.8			121.6
1600	66.2	70.0	71.0	70.2	68.3	69.2	67.4	68.4	69.6	71.8	74.5	75.0	75.2	72.6	70.8			122.0
2000	68.2	74.1	74.9	74.0	71.0	72.0	69.4	70.8	71.4	73.5	74.7	76.3	77.0	74.2	72.5			124.1
2500	79.3	84.6	84.0	82.9	79.2	77.7	76.9	74.6	78.5	81.3	79.4	81.3	84.7	83.6	83.8			132.0
3150	66.6	72.5	75.7	73.7	69.1	69.7	68.3	69.5	70.1	72.4	73.5	77.1	75.9	73.5	71.2			123.7
4000	67.6	75.6	75.2	74.2	71.3	71.6	69.0	72.1	72.4	75.7	76.5	80.3	79.3	76.0	73.3			126.3
5000	60.4	80.4	82.0	80.0	72.9	73.3	71.2	71.4	75.3	75.9	79.4	79.9	82.3	78.6	74.5			129.1
6300	67.0	75.4	76.7	76.3	71.5	71.7	69.3	72.6	71.4	76.2	76.2	81.9	81.1	75.3	71.8			127.7
8000	65.8	78.1	79.2	79.1	73.2	72.6	69.0	72.5	73.3	76.0	77.9	79.2	81.4	76.3	72.3			128.8
10000	64.2	76.0	76.7	76.6	71.1	70.0	66.3	69.0	69.0	72.8	73.2	76.0	77.5	72.8	69.1			126.5
12500	61.8	73.5	74.1	73.3	67.9	67.2	62.2	65.8	65.6	69.4	71.0	72.9	74.1	69.3	65.5			124.6
16000	60.7	71.1	72.4	71.2	66.3	65.7	59.9	63.8	62.5	67.1	70.7	69.1	70.5	66.1	62.7			124.4
20000	60.5	66.8	69.7	68.1	64.6	64.6	58.6	62.6	60.0	65.9	70.0	64.5	66.3	63.6	60.8			124.6
OVERALL MEASURED	85.1	89.4	90.2	90.5	86.9	87.2	86.9	87.0	88.6	90.1	90.5	90.8	91.7	89.9	89.1			
OVERALL CALCULATED	83.6	89.1	89.7	89.1	86.6	86.4	85.6	86.7	87.7	89.2	89.7	91.1	91.9	89.9	89.0			139.8
PNDB	97.9	103.5	103.7	102.9	99.8	99.2	98.1	98.1	100.1	102.4	102.1	103.9	105.6	103.8	102.9			

Fan C Full Scale
Approach
200-ft (60.96 m) Sideline
Frame + Inlet Treatment
Radial Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	58.7	62.1	64.3	61.4	69.3	72.6	72.0	73.8	73.8	70.3	71.0	71.8	69.0	65.5	63.6
63	53.9	57.7	60.7	59.4	64.9	68.1	65.3	66.5	66.1	67.0	66.1	65.4	64.9	63.3	59.5
80	53.0	58.0	60.3	59.6	63.2	63.5	65.9	66.2	66.1	67.1	66.0	66.1	65.8	64.8	62.3
100	57.2	61.0	65.0	69.6	70.9	71.2	70.1	72.2	72.6	73.6	73.3	72.3	71.8	69.2	66.0
125	57.4	63.9	68.2	72.4	73.2	73.8	76.5	77.6	78.5	78.7	77.6	76.5	74.4	71.2	66.0
160	60.6	66.9	70.1	74.8	77.4	78.1	77.5	78.8	79.8	80.0	79.4	78.3	76.5	72.4	65.9
200	58.2	65.8	70.0	72.2	71.3	72.8	74.2	73.7	75.1	75.3	74.3	73.9	71.6	68.1	62.5
250	56.7	63.4	66.1	67.0	66.3	68.0	68.1	68.8	69.6	70.3	71.4	69.8	68.7	65.4	59.9
315	56.5	64.0	66.3	69.9	68.6	70.3	70.6	71.8	72.6	72.9	72.3	71.2	69.6	66.8	60.5
400	55.2	62.3	65.2	66.3	66.9	68.4	69.0	70.3	70.4	70.5	70.6	69.8	67.6	65.5	59.9
500	53.8	60.8	63.7	66.5	66.8	68.0	68.0	69.0	70.0	70.8	71.0	70.5	67.9	64.0	58.0
630	54.6	61.5	65.1	67.3	66.1	67.3	67.0	67.7	68.9	70.4	71.6	70.7	69.0	64.3	58.3
800	53.4	61.9	65.6	66.7	66.0	67.7	66.3	67.5	68.6	70.3	72.2	71.4	69.8	64.5	58.1
1000	55.2	65.8	69.4	70.3	68.7	70.5	68.3	69.8	70.3	71.9	72.3	72.7	71.5	65.8	59.5
1250	66.0	76.1	78.4	79.2	76.8	76.2	75.8	73.7	77.4	79.8	77.0	77.6	79.1	75.1	70.5
1600	52.9	63.9	70.0	70.0	66.7	68.1	67.3	68.6	69.0	70.8	71.1	73.3	70.2	64.9	57.5
2000	53.6	66.8	69.5	70.5	68.9	70.1	68.0	71.2	71.4	74.2	74.1	76.5	73.6	67.1	59.3
2500	54.0	71.4	76.1	74.1	70.4	71.7	70.1	70.5	74.3	74.3	76.9	76.1	76.4	69.6	60.0
3150	52.1	66.1	70.7	72.4	69.0	70.1	68.3	71.8	70.4	74.7	73.8	78.0	75.1	66.0	56.8
4000	50.1	68.5	73.1	75.2	70.9	71.2	68.1	71.8	72.5	74.6	75.5	75.4	75.3	66.7	56.6
5000	48.6	66.8	71.0	73.2	69.3	69.2	66.0	68.9	68.6	71.9	71.3	72.6	71.8	63.5	53.5
6300	45.1	63.8	68.4	70.1	66.3	66.8	62.4	66.1	65.8	69.0	69.5	69.7	68.4	59.7	48.8
8000	42.6	61.1	66.9	68.5	65.3	65.9	60.7	64.9	63.3	67.4	69.8	66.3	65.0	56.1	44.6
10000	40.1	56.1	64.2	65.8	64.4	65.7	60.4	64.6	61.9	67.0	69.7	62.1	60.8	52.9	40.5
CVERALL CALCULATED	70.6	80.5	84.0	85.5	84.2	85.0	84.6	85.7	86.7	87.8	87.4	87.5	86.3	81.5	76.0
PNDB	80.0	92.8	97.1	98.2	95.2	96.0	94.3	96.4	97.4	99.1	99.6	100.5	98.6	92.3	85.0

Fan C Scale Model
Takeoff
100-ft (30.48 m) Arc
Frame + Inlet Treatment
Leaned Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	( ) PNL
50	79.1	76.8	75.9	78.2	78.1	80.1	80.5	80.8	82.2	82.6	83.5	85.2	89.2	92.8	96.9		135.9
63	75.0	75.0	77.0	77.2	78.3	79.0	79.9	81.0	82.6	82.9	83.6	86.3	89.2	94.1	98.1		136.7
80	75.8	75.3	75.8	78.1	77.6	79.8	80.2	81.2	82.1	83.5	85.2	87.1	90.6	93.8	96.7		136.5
100	75.9	76.0	76.0	79.3	79.0	80.2	81.6	81.6	83.3	83.6	83.6	86.3	89.3	92.1	92.8		135.0
125	76.4	77.2	77.4	78.7	78.2	79.5	79.9	80.2	80.6	82.1	83.1	85.8	87.2	89.3	90.3		133.2
160	80.2	82.6	83.9	82.2	79.9	80.9	79.7	84.0	84.2	85.6	86.6	90.4	91.0	92.2	93.8		136.8
200	78.1	77.0	78.0	79.6	79.0	80.0	82.0	82.8	84.6	86.4	88.1	91.8	93.2	96.2	95.1		138.4
250	81.9	81.6	83.9	85.3	84.2	85.2	86.7	87.6	88.7	89.7	92.0	94.4	96.0	97.1	96.0		141.0
315	88.0	87.7	91.0	91.5	91.2	93.1	92.0	92.8	89.6	94.8	94.9	98.4	97.0	97.9	96.0		144.2
400	83.1	84.6	86.9	84.3	85.0	86.0	86.6	87.7	87.2	88.6	90.0	92.4	93.3	92.9	91.8		139.1
500	81.7	84.7	88.1	83.3	82.0	82.8	84.5	85.5	85.1	87.5	91.5	92.2	91.8	92.7	91.6		138.5
630	82.1	88.2	86.0	86.5	87.3	86.1	87.9	86.2	89.6	90.0	91.9	92.6	93.4	92.3	90.2		139.9
800	80.3	82.8	85.3	84.4	87.4	86.1	88.9	88.0	87.6	88.1	89.8	91.4	92.1	91.0	88.2		138.8
1000	80.2	81.9	83.1	83.5	86.3	88.3	89.0	87.9	87.5	89.0	89.9	92.0	91.2	90.4	88.3		138.9
1250	81.3	83.7	87.0	85.6	86.4	87.4	85.8	86.0	86.6	87.8	89.8	91.5	90.1	89.0	88.2		138.3
1600	81.2	82.9	92.5	88.6	86.3	90.5	86.2	87.9	85.5	86.9	88.2	91.6	90.2	88.1	90.3		139.3
2000	84.1	89.0	97.5	92.7	91.5	94.6	90.0	87.9	87.5	89.2	88.9	94.9	93.3	90.5	91.1		142.8
2500	81.1	86.5	90.0	90.4	87.3	90.1	85.6	85.8	87.2	89.0	89.6	91.7	89.0	88.8	87.7		139.5
3150	79.2	84.9	89.3	88.7	86.4	87.4	86.3	87.0	86.6	88.3	89.2	91.8	88.6	87.5	87.3		139.0
4000	85.9	94.7	97.0	96.7	95.0	96.3	94.7	92.7	95.5	96.7	97.6	101.3	95.3	95.8	92.8		147.5
5000	80.4	89.0	93.3	92.7	92.6	97.7	97.0	92.0	91.6	90.3	89.9	92.6	88.3	88.1	88.3		144.4
6300	82.3	91.1	94.4	95.9	94.7	[illegible]	94.2	92.2	90.8	92.1	93.3	95.8	89.7	90.3	88.3		145.3
8000	79.0	90.8	94.1	93.7	92.1	[illegible]	95.0	92.1	92.7	92.1	94.9	96.7	90.1	87.9	88.2		145.4
10000	78.0	88.5	91.8	91.5	89.1	[illegible]	90.5	88.8	90.1	88.7	91.7	93.4	87.8	86.9	85.7		143.2
12500	75.3	85.3	88.4	88.1	86.7	88.5	89.2	85.3	88.0	88.1	91.3	92.7	85.3	84.4	84.1		142.7
16000	76.6	82.4	85.6	85.2	83.6	84.0	85.4	82.7	86.0	85.4	87.5	88.4	82.8	80.8	80.7		141.3
20000	74.7	77.4	81.0	80.3	79.0	79.0	79.7	76.7	80.3	81.6	84.4	83.3	80.9	76.6	78.7		139.4
OVERALL MEASURED	96.4	100.9	104.3	103.6	103.0	104.1	104.0	101.7	102.4	103.8	104.8	108.4	106.0	106.8	107.1		
OVERALL CALCULATED	95.5	100.9	104.6	103.8	102.7	104.8	103.9	102.2	102.7	103.8	105.2	107.8	103.8	106.6	106.7		155.7
PNDB	108.6	115.3	118.3	117.8	116.5	118.3	117.5	115.6	116.8	117.9	119.0	122.1	118.4	118.6	117.2		

Fan C Full Scale
Takeoff
200-ft (60.96 m) Sideline
Frame + Inlet Treatment
Leaned Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM, DAY)

50	65.8	69.4	71.6	76.5	77.3	79.3	81.1	81.2	82.7	82.7	81.9	83.5	85.0	85.5	82.7
63	66.1	70.5	73.0	75.9	76.5	78.4	79.3	79.7	80.0	81.1	81.4	82.9	82.8	82.6	80.0
80	69.7	75.8	79.4	79.3	78.1	79.9	79.0	83.5	83.6	84.5	84.8	87.5	86.5	85.4	83.3
100	67.4	70.0	73.5	76.6	77.2	78.9	81.4	82.2	83.9	85.3	86.2	88.8	88.6	89.2	84.4
125	71.0	74.6	79.2	82.2	82.3	84.0	86.0	87.0	87.9	88.6	90.1	91.4	91.3	90.1	85.1
160	76.9	80.5	86.3	88.4	89.3	91.9	91.2	92.1	88.9	93.6	93.0	95.3	92.3	90.7	84.9
200	71.8	77.3	82.1	81.1	83.0	84.7	85.8	87.0	86.4	87.4	88.0	89.2	88.5	85.6	80.5
250	70.2	77.2	83.2	80.1	80.0	81.5	83.6	84.8	84.2	86.2	89.4	89.0	86.9	85.2	80.1
315	70.4	80.6	81.0	83.2	85.2	84.8	87.1	85.4	88.7	88.6	89.8	89.3	88.4	84.8	78.5
400	68.4	75.1	80.2	81.0	85.3	84.8	88.0	87.3	86.7	86.8	87.6	88.1	87.0	83.3	76.3
500	68.0	74.0	78.0	80.1	84.1	86.9	88.0	87.1	86.5	87.6	87.7	88.6	86.0	82.5	76.1
630	68.9	75.7	81.7	82.1	84.2	86.0	84.8	85.1	85.6	86.4	87.5	88.0	84.8	81.0	75.7
800	68.5	74.7	87.1	85.1	84.0	89.1	85.1	87.0	84.4	85.4	85.9	88.1	84.9	79.9	77.6
1000	71.1	80.7	92.0	89.1	89.2	93.0	89.0	87.0	86.5	87.7	86.6	91.3	87.8	82.1	78.1
1250	67.8	78.0	84.4	86.7	84.9	88.5	84.5	84.9	86.2	87.4	87.2	88.0	83.4	80.3	74.4
1600	65.5	76.3	83.6	85.0	84.0	86.3	85.2	86.1	85.5	86.8	86.8	88.0	82.9	78.8	73.6
2000	71.9	85.9	91.2	92.9	92.6	94.8	93.7	91.9	94.5	95.2	95.3	97.6	89.5	86.9	78.8
2500	66.0	79.9	87.4	88.8	90.1	96.1	95.9	91.1	90.5	88.7	87.4	88.8	82.4	79.0	73.9
3150	67.4	81.8	88.5	92.0	92.3	95.2	93.2	91.4	89.8	90.6	90.9	92.0	83.7	81.0	73.3
4000	63.3	81.2	88.0	89.9	89.8	91.7	94.2	91.4	91.8	90.6	92.6	92.8	84.0	78.3	72.5
5000	62.4	79.2	86.1	88.1	87.3	89.3	90.2	88.7	89.8	87.9	89.9	90.1	82.1	77.7	70.1
6300	58.7	75.7	82.7	84.9	85.2	88.0	89.3	85.6	88.1	87.6	89.8	89.6	79.6	74.8	67.4
8000	58.5	72.4	80.1	82.5	82.7	84.2	86.2	83.8	86.9	85.6	86.5	85.7	77.3	70.8	62.6
10000	54.4	66.7	75.5	78.0	78.7	80.1	81.5	78.7	82.1	82.7	84.1	81.0	75.4	65.9	58.4
OVERALL CALCULATED	83.1	92.3	99.0	100.1	100.4	103.4	103.0	10[illegible].5	101.8	102.3	102.9	104.3	100.4	98.3	93.3
PNDB	93.2	105.4	111.8	113.9	114.2	117.0	116.9	114.6	115.1	115.3	115.9	117.3	111.1	108.0	101.4

Fan C Scale Model
Approach
100-ft (30.48 m) Arc
Frame + Inlet Treatment
Leaned Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

	20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	160.		PWL
FREQ.	(0.35)	(0.52)	(0.70)	(0.87)	(1.05)	(1.22)	(1.40)	(1.57)	(1.75)	(1.92)	(2.09)	(2.27)	(2.44)	(2.62)	(2.79)	( )	( )
50	69.8	68.6	66.9	67.9	66.9	68.8	69.5	68.8	70.2	70.5	71.7	73.5	73.8	75.9	78.7		121.3
63	65.0	64.7	67.2	66.0	66.0	66.5	68.9	68.7	71.2	69.9	70.6	74.5	75.1	75.8	78.8		121.2
80	65.8	64.6	65.6	66.6	68.6	68.6	69.2	69.3	69.9	70.2	71.5	73.2	73.7	74.6	76.5		120.6
100	70.9	73.9	74.9	74.3	81.3	81.3	79.0	79.8	78.3	75.3	78.7	79.7	78.0	79.0	77.9		128.6
125	64.5	63.9	64.5	65.3	66.3	66.6	66.1	66.9	67.5	67.1	68.1	69.5	69.4	70.3	70.9		117.5
160	65.1	62.7	64.2	64.2	65.0	64.9	66.6	65.9	66.5	67.6	67.6	70.3	71.1	72.0	72.9		117.8
200	68.3	64.8	70.0	74.1	75.0	73.2	74.7	75.7	75.5	74.5	73.9	76.4	76.0	76.1	76.1		124.7
250	66.2	65.9	67.8	69.2	69.3	69.2	71.6	72.7	74.4	75.6	76.6	78.4	77.0	76.8	77.0		124.3
315	69.2	69.9	71.2	74.0	74.9	73.2	73.9	74.7	75.5	78.6	79.0	80.4	79.0	78.0	76.7		126.6
400	68.2	70.6	71.2	70.1	72.0	71.9	71.6	71.7	71.2	73.8	73.8	76.2	75.9	76.0	73.9		123.3
500	67.8	69.4	69.0	67.1	66.8	67.0	67.7	67.8	68.3	69.4	70.4	72.2	72.0	72.5	70.8		119.6
630	69.4	70.1	71.1	70.4	69.5	71.5	70.1	70.9	73.5	72.1	73.1	74.8	75.4	74.2	73.2		122.6
800	70.3	70.8	71.4	69.1	70.1	72.1	71.0	70.8	71.6	72.0	73.0	73.5	74.0	74.0	74.8		122.4
1000	67.2	69.2	69.1	68.5	69.2	71.2	70.1	71.2	72.5	72.1	73.8	75.5	73.1	72.0	72.0		122.2
1250	72.0	70.0	70.1	69.1	69.1	70.0	70.7	70.8	71.6	72.7	73.7	75.6	74.0	71.9	72.1		122.4
1600	71.4	69.9	72.5	69.5	69.5	71.2	70.0	71.2	71.5	71.8	73.8	75.8	75.4	73.2	73.9		122.9
2000	73.4	72.9	75.2	72.2	71.3	73.2	71.2	71.2	72.5	74.8	76.1	78.8	77.3	74.0	74.0		125.1
2500	79.3	84.9	87.2	84.3	82.0	83.9	80.0	79.0	82.5	83.9	83.9	87.4	85.9	84.8	85.0		134.9
3150	72.3	73.3	76.6	73.3	71.6	72.3	71.0	72.0	73.8	73.9	76.2	80.0	78.3	75.3	74.0		125.9
4000	69.8	75.9	76.1	74.1	71.3	72.2	71.6	72.9	74.5	76.8	79.7	83.4	79.2	76.8	73.7		128.0
5000	72.1	81.2	84.3	78.3	77.3	79.3	78.9	76.1	79.9	78.9	80.2	84.7	84.4	79.1	79.0		131.9
6300	73.5	77.3	79.7	77.4	75.4	74.5	74.0	74.4	77.7	80.2	82.4	86.1	82.7	77.5	75.1		131.3
8000	72.9	79.0	82.1	79.1	78.5	76.0	76.9	77.0	79.4	78.7	82.7	85.7	83.3	77.9	77.9		132.0
10000	73.9	78.8	81.2	77.9	75.9	75.0	74.4	74.7	77.1	77.7	80.5	84.2	80.8	76.6	74.5		131.7
12500	70.6	77.2	78.7	76.4	74.3	72.3	72.0	70.4	73.9	75.3	77.3	80.8	78.4	74.4	73.1		130.3
16000	67.6	74.7	75.6	73.0	71.7	69.6	68.4	67.4	71.0	71.6	73.3	76.1	73.9	70.8	71.4		128.6
20000	70.7	69.7	71.7	69.7	67.0	64.9	63.5	62.7	66.0	68.3	69.7	71.4	70.9	66.5	70.8		127.4
OVERALL MEASURED	88.9	89.9	92.0	90.3	89.3	89.0	88.0	88.0	90.3	89.9	91.7	94.6	93.1	91.1	91.0		
OVERALL CALCULATED	85.6	89.8	92.0	89.2	88.7	89.1	87.8	87.7	89.5	90.2	91.8	94.9	93.1	90.9	90.8		142.2
PNDB	99.5	103.7	105.9	103.3	101.9	103.0	100.9	100.6	103.1	104.1	105.1	108.2	106.6	104.8	104.6		

Fen C Full Scale
Approach
200-ft (60.96 m) Sideline
Frame + Inlet Treatment
Leaned Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	60.8	67.4	70.6	71.5	79.6	80.3	78.4	79.4	77.7	74.8	77.0	76.9	73.6	72.4	67.8
63	54.2	57.2	60.1	62.4	64.5	65.6	65.5	66.5	66.9	66.0	66.3	67.0	65.0	63.6	60.6
80	54.6	55.8	59.7	61.3	63.2	63.8	66.0	65.4	65.8	66.5	65.8	67.7	66.6	65.1	62.4
100	57.6	57.9	65.4	71.1	73.2	72.1	74.0	75.2	74.8	73.8	72.1	73.5	71.4	69.2	65.4
125	55.3	58.9	63.1	66.2	67.4	68.0	70.9	72.1	73.7	74.5	74.7	75.4	72.3	69.6	66.1
160	58.1	62.7	66.5	70.9	72.9	72.0	73.1	74.1	74.7	77.5	77.0	77.4	74.2	70.8	65.6
200	56.9	63.3	66.4	67.0	70.0	70.7	70.8	71.0	70.4	72.6	71.8	73.1	71.1	68.7	62.6
250	56.2	62.0	64.0	63.9	64.7	65.8	66.9	67.1	67.5	68.1	68.4	68.9	67.1	65.1	59.3
315	57.7	62.5	66.1	67.2	67.4	70.1	69.3	70.1	72.6	70.8	71.0	71.5	70.4	66.6	61.5
400	58.3	63.1	66.3	65.8	68.0	70.7	70.1	70.0	70.7	70.6	70.9	70.1	68.9	66.3	62.8
500	55.0	61.3	64.0	65.1	67.0	69.8	69.1	70.4	71.5	70.7	71.6	72.1	67.9	64.2	59.8
630	59.6	62.0	64.8	65.6	66.8	68.6	69.7	69.9	70.6	71.3	71.4	72.2	68.7	63.9	59.7
800	58.7	61.7	67.1	65.9	67.2	69.7	69.0	70.3	70.4	70.3	71.5	72.2	70.0	65.0	61.2
1000	60.4	64.6	69.7	68.6	68.9	71.7	70.1	70.3	71.5	73.3	73.7	75.1	71.8	65.7	61.0
1250	65.9	76.5	81.6	80.6	79.6	82.4	78.9	78.1	81.4	82.3	81.5	83.7	80.3	76.3	71.7
1600	58.6	64.6	70.9	69.6	69.1	70.7	69.9	71.1	72.8	72.3	73.8	76.3	72.6	66.7	60.4
2000	55.8	67.1	70.4	70.4	68.9	70.7	70.6	72.1	73.4	75.3	77.3	79.7	73.5	68.0	59.7
2500	57.7	72.2	78.4	74.4	74.8	77.7	77.9	75.2	78.8	77.3	77.8	80.9	78.5	70.0	64.6
3150	58.6	68.0	73.7	73.6	73.0	73.0	73.0	73.5	76.7	78.7	79.9	82.2	76.7	68.2	60.2
4000	57.2	69.5	76.0	75.3	76.1	74.6	76.1	76.3	78.5	77.3	80.4	81.9	77.2	68.3	62.2
5000	58.3	69.5	75.5	74.5	74.0	74.1	74.1	74.5	76.7	76.9	78.6	80.9	75.1	67.3	58.9
6300	53.9	67.6	73.0	73.2	72.8	71.8	72.2	70.7	74.0	74.8	75.8	77.7	72.7	64.7	56.5
8000	49.5	64.7	70.0	70.2	70.7	69.8	69.3	68.5	71.8	71.8	72.4	73.3	68.3	60.8	53.3
10000	50.3	59.0	66.2	67.4	66.7	66.0	65.3	64.8	67.8	69.4	69.4	69.1	65.4	55.8	50.5
OVERALL CALCULATED	72.2	81.0	86.3	85.6	86.5	87.7	86.8	86.9	88.5	88.8	89.5	91.2	87.3	82.3	77.4
PNDB	83.2	93.6	99.2	98.2	98.7	99.5	99.5	99.3	101.4	101.6	102.8	104.6	100.3	93.4	87.6

Fan B Scale Model
Takeoff
100-ft (30.48 m) Arc
Frame Treatment
Radial Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )( )	PWL
50	70.8	75.9	73.7	75.5	76.8	77.0	77.8	78.0	79.4	80.5	81.8	81.2	85.1	90.9	94.1		133.2
63	69.2	73.8	74.6	75.7	76.9	76.1	77.7	77.9	79.6	81.6	81.7	83.1	86.1	91.3	94.2		133.6
80	69.5	72.3	74.5	76.3	76.5	76.0	77.5	78.6	79.2	81.4	82.6	83.0	85.7	89.6	92.6		132.7
100	70.8	73.9	73.7	76.8	77.0	77.3	77.6	78.1	79.7	80.8	81.6	82.0	83.8	87.9	87.8		130.9
125	73.2	74.1	74.9	76.2	78.4	77.6	76.9	76.5	78.8	79.9	80.9	82.4	82.4	86.1	88.3		130.4
160	70.9	72.0	73.8	73.6	75.1	74.4	75.6	76.2	77.8	79.6	81.9	83.5	87.0	90.9	92.0		132.8
200	73.0	73.8	75.5	76.9	76.9	77.1	79.5	81.0	82.8	84.6	86.9	89.2	91.0	94.2	93.1		136.4
250	78.3	79.1	81.8	81.9	81.9	81.2	83.7	85.2	86.9	88.0	90.1	91.6	93.1	95.0	94.1		138.7
315	81.4	82.9	83.9	83.7	85.2	84.5	84.7	85.3	86.9	89.1	89.9	91.4	92.3	93.1	91.4		138.4
400	80.1	82.0	82.5	82.6	82.8	82.3	82.6	82.2	83.6	85.6	85.9	87.1	88.2	87.9	86.9		134.8
500	77.9	78.9	78.7	78.7	79.7	78.2	79.5	81.1	82.7	84.4	86.0	88.2	89.0	89.1	87.1		134.4
630	78.4	80.2	81.2	81.2	82.5	82.5	83.0	84.3	84.9	87.0	88.2	87.8	88.7	89.4	87.3		135.8
800	78.4	79.9	80.6	80.0	81.2	81.4	81.7	82.0	83.9	85.0	86.7	87.2	87.1	88.3	86.0		134.6
1000	78.4	79.3	81.9	81.9	82.1	82.5	82.0	83.3	83.8	85.9	88.1	87.4	87.6	87.6	84.5		135.1
1250	78.1	80.1	82.9	82.7	83.1	82.4	81.7	83.3	83.6	84.9	86.7	88.4	86.1	86.2	85.2		134.9
1600	78.5	79.3	82.8	82.1	83.3	84.3	81.8	83.1	83.0	84.8	87.1	87.4	86.3	85.4	84.4		134.9
2000	78.6	79.5	82.9	80.9	81.4	84.5	82.2	82.3	83.8	85.2	87.3	88.6	86.3	84.1	84.5		135.1
2500	79.3	81.8	87.9	88.0	85.9	87.5	83.6	84.0	85.9	88.7	89.8	92.6	86.1	87.0	85.0		138.3
3150	86.3	90.5	98.9	99.0	95.4	97.5	91.0	93.3	93.9	95.2	95.2	97.6	91.3	93.3	92.5		146.4
4000	78.1	82.8	85.6	84.6	83.8	84.5	84.9	85.2	87.7	88.8	92.8	92.3	87.3	85.9	84.9		138.9
5000	77.6	83.4	88.2	88.0	86.2	87.5	87.1	86.5	90.0	92.0	94.1	94.6	86.7	85.4	84.2		141.0
6300	80.7	89.3	92.2	90.1	91.5	92.5	89.1	90.4	[illegible]	94.1	97.2	97.9	90.6	90.6	89.4		144.6
8000	76.0	84.2	87.8	88.9	86.3	85.2	86.0	87.3	89.8	91.8	95.2	95.7	88.1	86.0	84.0		142.4
10000	75.1	83.9	88.5	87.6	86.1	86.1	85.6	86.7	88.8	90.6	92.9	93.1	86.8	85.7	84.0		141.8
12500	71.7	81.6	85.3	84.3	83.3	82.8	83.1	83.7	87.4	88.2	91.2	90.9	83.4	82.4	81.7		140.7
16000	67.9	78.0	81.6	80.8	80.1	78.1	78.5	79.1	82.6	84.9	87.8	86.1	81.1	78.8	78.9		138.7
20000	64.3	73.2	77.0	76.1	75.3	73.6	74.1	73.1	77.8	80.0	82.1	82.6	78.1	75.0	79.3		136.8
OVERALL MEASURED	92.3	97.0	101.0	101.0	100.0	100.2	98.0	[illegible]	99.9	101.8	104.8	105.7	102.0	104.0	104.3		
OVERALL CALCULATED	92.4	96.6	101.7	101.5	99.7	100.8	98.0	99.2	100.7	102.5	104.6	105.5	102.3	103.8	103.7		153.2
PNDB	107.0	110.9	116.9	116.8	114.7	116.1	112.3	113.8	115.0	116.6	117.7	119.3	114.9	116.0	115.2		

Fan B Full Scale
Takeoff
200-ft (60.96 m) Sideline
Frame Treatment
Radial Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	61.4	68.1	70.1	74.7	76.1	77.0	77.7	78.4	79.9	80.5	80.6	79.9	80.2	82.0	78.4
63	63.6	68.1	71.2	74.1	77.4	77.4	77.1	76.7	79.0	79.6	79.8	80.3	78.8	80.1	78.7
80	61.1	65.9	70.1	71.4	74.0	74.0	75.7	76.4	77.9	79.2	80.8	81.4	83.2	84.8	82.2
100	63.1	67.6	71.7	74.7	75.8	76.7	79.6	81.2	82.9	84.2	85.8	87.0	87.2	88.0	83.1
125	68.2	72.8	77.9	79.6	80.8	80.8	83.7	85.4	86.9	87.6	88.9	89.3	89.2	88.7	83.9
160	71.0	76.5	79.9	81.4	84.0	84.0	84.6	85.4	86.9	88.6	88.7	89.1	88.3	86.6	81.0
200	69.5	75.5	78.4	80.2	81.5	81.8	82.5	82.2	83.5	85.1	84.7	84.7	84.1	81.4	76.3
250	67.2	72.2	74.5	76.2	78.4	77.7	79.4	81.1	82.6	83.9	84.7	85.7	84.8	82.4	76.3
315	67.4	73.4	76.9	78.7	81.1	81.9	82.9	84.3	84.8	86.4	86.9	85.3	84.4	82.6	76.3
400	67.1	72.9	76.3	77.3	79.8	80.8	81.5	82.0	83.7	84.3	85.3	84.6	82.7	81.4	74.8
500	66.9	72.2	77.4	79.3	80.6	81.8	81.7	83.2	83.6	85.2	86.6	84.8	83.1	80.5	73.0
630	66.4	72.8	78.3	80.0	81.6	81.7	81.5	83.2	83.3	84.2	85.2	85.6	81.6	78.9	73.5
800	66.5	71.9	78.1	79.2	81.7	83.5	81.5	83.0	82.7	84.0	85.5	84.5	81.6	77.9	72.4
1000	66.3	71.9	78.1	78.1	79.8	83.7	81.9	82.1	83.5	84.4	85.6	85.7	81.6	76.5	72.2
1250	66.7	74.1	83.1	85.0	84.2	86.6	83.3	83.8	85.5	87.9	88.2	89.6	81.2	79.2	72.4
1600	73.4	82.6	94.0	96.0	93.7	96.6	90.6	93.1	93.6	94.4	93.5	94.6	86.3	85.3	79.6
2000	64.8	74.7	80.6	81.6	82.2	83.8	84.7	85.1	87.5	88.0	91.1	89.3	82.3	77.8	71.6
2500	63.9	75.0	83.0	84.9	84.5	86.6	86.8	86.3	89.7	91.1	92.3	91.5	81.5	77.1	70.5
3150	66.5	80.8	87.0	86.9	89.8	91.7	88.8	90.3	91.0	93.3	95.4	94.8	85.4	82.1	75.2
4000	61.1	75.3	82.4	85.7	84.6	84.6	85.9	87.4	89.7	91.1	93.6	92.6	82.8	77.1	69.1
5000	60.2	75.4	83.6	84.9	84.9	85.9	86.0	87.3	89.2	90.5	91.8	90.5	81.8	77.2	69.2
6300	55.8	72.7	80.4	81.9	82.5	83.0	83.9	84.7	88.2	88.5	90.4	88.4	78.4	73.5	65.8
8000	50.5	68.7	76.8	78.8	79.9	79.0	80.1	81.0	84.2	85.8	87.6	84.1	76.3	69.6	61.5
10000	44.7	63.2	72.2	74.5	75.8	75.4	76.7	75.9	80.3	81.8	82.6	81.0	73.3	65.1	59.7
OVERALL CALCULATED	80.3	88.6	96.8	98.5	98.1	100.0	97.8	99.1	100.6	101.9	103.1	102.6	97.6	96.2	91.2
PNDB	91.3	102.3	109.7	111.5	111.4	112.9	111.4	112.6	114.0	115.6	117.3	116.6	109.3	106.2	99.8

Fan B Scale Model
Approach
100-ft (30.48 m) Arc
Frame Treatment
Radial Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG, F, 70 PERCENT REL. HUM, DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	( )	PWL
50	66.0	66.7	65.7	66.7	67.1	67.0	67.5	68.1	68.7	70.4	70.6	70.8	73.0	75.7	77.8			120.1
63	64.2	64.7	66.8	65.9	66.2	65.4	67.7	67.0	70.8	69.8	70.0	73.0	78.0	76.1	77.2			121.2
80	65.7	65.5	64.2	68.2	66.6	66.7	68.3	68.8	69.2	70.4	71.6	71.8	72.6	74.4	76.5			120.1
100	65.8	66.5	64.5	67.4	68.1	68.2	66.6	67.1	66.8	68.7	69.6	69.1	69.7	72.0	72.1			118.3
125	63.4	62.2	62.9	66.1	65.2	64.3	64.2	65.2	65.2	66.1	67.3	67.5	67.4	70.1	71.4			116.2
160	62.1	60.6	62.6	61.6	61.9	63.1	63.9	64.2	65.6	66.5	67.9	68.9	70.1	72.9	73.9			117.0
200	63.0	61.6	63.6	64.6	64.9	66.4	66.7	68.9	69.8	71.8	72.9	73.9	74.9	75.8	75.9			120.9
250	66.0	64.9	68.9	69.7	70.0	69.4	71.0	73.3	73.7	75.6	76.0	76.3	76.1	77.0	76.0			123.7
315	67.2	67.9	70.5	70.9	73.2	72.2	72.0	73.1	73.7	74.9	76.0	76.0	76.4	75.9	74.0			123.9
4[illegible]	67.2	67.9	69.5	69.8	70.1	70.1	68.6	69.9	70.5	71.5	72.6	72.9	71.9	71.6	70.9			120.9
500	66.8	66.8	67.4	67.4	66.8	67.0	65.8	66.8	68.5	69.6	70.6	71.8	71.8	72.7	70.8			119.3
630	68.6	69.0	71.2	70.9	70.3	70.7	72.1	71.7	72.2	74.2	74.1	74.3	74.3	75.6	73.3			122.9
800	67.3	69.0	70.5	68.8	69.2	71.1	70.8	71.0	72.0	72.9	73.7	73.9	73.0	74.1	72.2			122.1
1000	67.2	68.2	70.8	70.2	71.5	71.4	70.0	71.4	73.0	73.6	76.2	76.5	75.2	73.1	72.5			123.4
1250	67.0	67.9	71.9	70.9	71.2	70.4	69.7	72.2	72.9	74.6	76.7	77.3	77.0	73.9	73.2			124.0
1600	69.3	70.9	73.8	71.8	72.4	72.6	71.1	72.4	72.8	75.0	78.0	78.2	79.2	75.3	74.1			125.3
2000	79.4	81.3	84.0	81.0	82.6	83.7	80.3	79.6	80.3	82.[illegible]	84.3	84.3	86.5	86.2	83.3			133.7
2500	69.1	72.6	75.6	74.5	73.2	75.1	71.7	72.0	74.9	77.7	79.0	81.1	80.0	77.0	74.9			127.2
3150	67.5	73.1	77.0	76.1	74.2	73.3	71.0	73.5	74.1	77.9	78.3	81.6	80.6	77.4	74.4			127.6
4000	74.9	83.0	83.7	81.7	81.3	80.1	78.8	78.3	80.7	82.6	85.8	87.0	88.2	84.9	82.0			134.4
5000	69.2	77.0	80.0	80.0	76.6	77.7	75.9	74.1	79.2	81.0	82.3	85.3	82.3	77.2	76.2			131.2
6300	71.5	79.4	83.0	81.1	80.4	79.8	76.2	76.5	79.3	81.9	83.4	86.4	85.3	81.5	79.6			133.3
8000	70.0	79.9	83.0	81.7	79.2	77.5	76.9	76.3	79.1	80.8	82.9	85.4	84.3	80.0	77.0			133.2
10000	67.7	78.8	82.7	80.5	78.9	77.0	74.7	74.0	77.6	78.4	80.7	83.1	80.8	77.7	75.8			132.2
12500	64.4	76.2	79.3	78.1	75.7	73.7	72.1	70.6	74.0	75.2	78.2	79.7	77.4	74.3	73.3			130.4
16000	61.9	74.7	76.8	75.5	73.8	70.0	69.6	66.1	69.9	71.5	73.8	75.8	73.8	72.0	70.9			129.1
20000	59.0	69.7	72.5	70.7	69.0	65.4	65.0	61.2	65.7	67.9	70.0	72.0	70.0	67.9	71.0			127.6
OVERALL MEASURED	84.0	90.0	91.7	90.7	89.4	89.2	87.8	87.0	89.7	91.0	93.8	95.1	94.3	92.9	92.0			
OVERALL CALCULATED	83.9	89.3	91.9	90.3	89.5	89.2	87.2	87.2	89.2	91.1	93.0	94.7	94.5	92.3	90.6			142.6
PNDB	97.5	103.0	104.8	103.3	102.7	102.4	100.7	100.7	102.8	104.7	107.0	108.4	108.8	106.1	103.9			

Fan B Full Scale
Approach
200-ft (60.96 m) Sideline
Frame Treatment
Radial Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	56.5	60.7	60.9	65.4	67.2	67.9	66.7	67.4	66.9	68.4	68.6	67.0	66.1	66.1	62.7
63	53.9	56.2	59.2	64.0	64.2	64.1	64.3	65.5	65.3	65.8	66.2	65.4	63.8	64.1	61.8
80	52.3	54.6	58.8	59.4	60.9	62.8	64.0	64.4	65.7	66.2	66.8	66.7	66.3	66.8	64.1
100	53.0	55.4	59.8	62.4	63.8	66.0	66.7	69.1	69.9	71.4	71.8	71.6	71.1	69.6	66.0
125	55.8	58.6	65.0	67.4	68.9	69.0	71.0	73.4	73.7	75.2	74.9	74.0	72.2	70.7	65.9
160	56.8	61.5	66.5	68.5	72.0	71.7	72.0	73.2	73.7	74.4	74.8	73.6	72.4	69.4	63.6
200	56.6	61.3	65.4	67.4	68.9	69.6	68.6	70.0	70.4	71.0	71.4	70.5	67.8	65.3	60.3
250	56.0	60.1	63.2	65.0	65.5	66.5	65.7	66.8	68.4	69.1	69.2	69.4	67.6	66.0	60.0
315	57.6	62.2	66.9	68.3	69.0	70.1	71.9	71.7	72.1	73.6	72.7	71.8	70.0	68.8	62.3
400	56.1	62.0	66.2	66.2	67.8	70.4	70.6	71.0	71.8	72.3	72.3	71.3	68.6	67.2	61.0
500	55.7	61.1	66.3	67.5	70.0	70.7	69.8	71.4	72.7	73.1	74.7	73.8	70.7	66.0	61.0
630	55.2	60.7	67.4	68.1	69.7	69.7	69.5	72.1	72.7	73.8	75.2	74.5	72.5	66.6	61.5
800	57.3	63.5	69.1	68.9	70.8	71.9	70.8	72.2	72.5	74.2	76.4	75.4	74.6	67.9	62.1
1000	67.1	73.7	79.2	78.1	81.0	82.9	80.0	79.4	80.0	81.4	82.7	81.4	81.8	78.6	71.0
1250	56.5	64.9	70.7	71.6	71.5	74.3	71.3	71.8	74.5	76.8	77.4	78.1	75.1	69.2	62.3
1600	54.5	65.2	72.1	73.1	72.5	72.5	70.6	73.3	73.8	77.1	76.6	78.6	75.6	69.5	61.5
2000	61.6	74.9	78.7	78.7	79.6	79.4	78.5	78.1	80.5	81.8	84.1	84.0	83.2	76.8	68.7
2500	55.5	68.7	[illegible]	76.9	74.8	76.9	75.6	74.0	78.9	80.2	80.6	82.2	77.1	68.9	62.5
3150	57.3	70.8	77.7	77.9	78.7	79.0	76.0	76.4	79.0	81.2	81.7	83.2	80.0	73.0	65.4
4000	55.1	71.8	77.6	78.6	77.5	76.9	76.7	76.3	79.0	80.1	81.2	82.2	78.9	71.2	62.1
5000	52.8	70.3	77.8	77.9	77.8	76.9	75.2	74.6	78.0	78.3	79.6	80.4	75.8	69.2	60.9
6300	48.5	67.3	74.4	75.7	74.9	73.9	72.9	71.6	74.9	75.5	77.4	77.3	72.5	65.4	57.4
8000	44.5	65.5	72.0	73.4	73.6	71.0	71.2	68.0	71.5	72.4	73.6	73.8	68.9	62.7	53.5
10000	39.4	59.7	67.8	69.1	69.5	67.2	67.5	64.0	68.2	69.7	70.5	70.4	65.2	57.9	51.4
OVERALL CALCULATED	71.4	81.1	86.9	87.4	88.0	88.5	87.0	87.0	89.0	90.3	91.4	91.7	89.4	84.3	77.6
PNDB	81.9	94.1	108.0	100.9	101.2	101.4	99.9	99.8	102.1	103.8	104.5	105.3	102.4	96.5	89.0

Fan B Scale Model

Takeoff

100-ft (30.48 m) Arc

Frame Treatment

Leaned Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM, DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	PWL
50	76.9	76.1	74.4	76.5	74.9	76.6	78.7	78.5	78.6	80.0	81.6	82.6	85.9	90.2	93.5		132.9
63	73.2	73.4	74.7	76.0	75.8	76.2	78.8	78.9	80.7	81.0	82.2	83.1	86.0	91.2	94.0		133.5
80	73.0	73.8	74.5	76.6	75.8	76.5	79.6	78.4	80.4	81.6	83.5	83.7	86.6	89.8	91.4		132.8
100	72.2	74.0	74.5	76.6	78.1	77.8	79.6	78.8	79.7	81.1	81.8	82.7	85.1	88.0	88.7		131.5
125	73.5	74.3	76.0	77.9	79.1	78.3	80.1	78.1	78.9	80.4	80.4	82.0	84.1	86.2	86.8		130.7
160	71.3	72.2	73.6	73.7	74.9	74.9	76.7	76.6	77.7	79.1	82.0	84.0	87.2	90.0	89.7		132.2
200	74.3	74.3	75.8	76.9	78.1	78.1	82.0	81.6	82.0	84.9	87.1	89.0	91.4	94.1	92.0		136.3
250	79.4	80.0	81.8	83.0	83.1	83.1	85.8	85.7	86.0	89.3	91.0	91.0	94.1	95.1	92.0		138.9
315	81.3	83.2	83.4	83.9	85.1	84.0	84.9	85.8	85.5	88.0	89.9	90.9	92.0	93.1	90.7		138.0
400	80.3	82.9	82.5	82.9	83.1	82.7	83.6	82.8	83.9	84.9	87.1	86.7	88.3	89.0	86.5		135.2
500	78.2	80.8	80.4	78.8	79.7	79.0	80.5	80.5	81.8	84.9	85.7	86.6	89.1	89.9	85.7		134.3
630	77.4	80.3	80.8	81.0	83.4	82.1	83.9	84.2	85.0	86.2	88.2	87.4	89.4	89.6	86.2		135.8
800	77.1	80.3	80.6	79.1	80.9	81.2	82.8	82.0	83.8	84.3	87.2	86.9	88.4	88.2	83.9		134.6
1000	77.3	80.2	80.7	81.2	81.9	81.3	83.2	82.9	84.2	85.5	87.1	87.4	87.3	86.2	84.1		134.7
1250	77.0	80.2	81.7	82.9	83.0	82.0	81.9	81.8	83.6	84.9	87.8	86.7	86.9	85.9	83.4		134.7
1600	78.2	79.4	82.7	83.1	83.2	83.0	81.9	82.8	83.9	84.3	87.0	87.3	86.4	85.4	83.8		134.8
2000	77.3	79.2	81.0	82.0	82.1	82.3	82.9	81.9	82.0	84.5	86.2	88.2	85.5	84.2	84.1		134.4
2500	79.3	83.0	87.6	86.0	84.8	86.9	84.0	82.6	84.0	85.9	88.9	90.0	86.2	86.3	83.8		136.9
3150	84.7	91.6	98.8	94.1	94.2	97.5	91.1	89.0	93.3	90.2	95.2	94.4	92.2	93.3	89.9		144.9
4000	76.1	81.0	82.6	84.0	83.2	81.9	83.7	83.6	85.0	88.3	90.2	91.0	87.3	84.2	84.6		137.3
5000	76.5	83.2	85.7	84.9	85.1	86.2	86.1	84.1	85.8	88.5	92.5	89.4	85.4	85.2	83.1		138.3
6300	78.6	87.7	91.2	90.2	90.6	89.4	88.2	87.3	88.0	91.7	93.5	95.3	90.4	85.6	85.9		142.2
8000	74.4	83.2	85.9	84.9	85.1	32.4	86.0	85.1	86.2	88.5	92.5	91.4	85.2	84.4	83.8		139.5
10000	74.2	84.3	86.8	84.9	84.3	83.3	84.1	84.0	86.2	88.2	91.4	91.1	86.1	83.1	83.7		139.8
12500	70.2	80.9	82.7	81.9	80.8	79.0	81.6	81.5	83.6	84.8	88.9	87.8	82.8	80.1	81.5		138.0
16000	70.0	78.6	80.4	78.6	77.8	75.5	78.4	78.5	79.6	82.6	83.8	85.8	79.6	78.6	80.2		136.8
20000	70.5	74.2	77.9	74.0	74.1	72.3	73.2	79.0	75.0	80.3	80.0	86.0	75.4	76.4	77.0		137.4
OVERALL MEASURED	92.4	97.0	100.5	98.7	98.9	99.9	98.0	97.6	98.8	100.2	103.1	103.1	101.9	104.0	103.6		
OVERALL CALCULATED	91.8	96.7	101.1	98.7	98.8	100.0	98.2	97.5	99.1	100.5	103.3	103.4	102.5	103.5	102.6		151.8
PNDB	105.9	111.5	116.5	113.7	113.9	115.6	112.5	111.2	113.8	113.6	117.1	116.9	115.3	115.6	113.5		

Fan B Full Scale
Takeoff
200-ft (60.96 m) Sideline
Frame Treatment
Leaned Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL DATA (59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	62.8	68.2	71.0	74.6	77.1	77.5	79.7	79.1	79.8	80.9	80.8	80.7	81.5	82.1	79.3
63	64.0	68.4	72.3	75.8	78.0	78.0	80.3	79.4	79.0	80.1	79.4	79.9	80.4	80.2	77.2
80	61.5	66.1	69.8	71.5	73.8	74.6	76.8	76.8	77.8	78.8	80.9	81.9	83.5	84.0	79.9
100	64.4	68.1	72.0	74.7	77.0	77.7	82.0	81.8	82.0	84.5	86.0	86.7	87.5	87.9	82.1
125	69.2	73.7	77.9	80.7	82.0	82.7	85.8	85.8	86.1	88.9	89.8	88.7	90.2	88.8	81.9
160	70.9	76.7	79.4	81.6	83.8	83.5	84.9	85.9	85.5	87.5	88.7	88.5	88.0	86.6	80.3
200	69.7	76.4	78.4	80.5	81.8	82.2	83.5	82.9	83.8	84.4	85.8	84.3	84.2	82.5	75.9
250	67.4	74.1	76.2	76.3	78.4	78.4	80.4	80.5	81.7	84.3	84.4	84.2	84.9	83.2	74.9
315	66.4	73.5	76.6	78.5	32.0	81.5	83.8	84.2	84.9	85.6	86.9	84.9	85.1	82.8	75.2
400	65.9	73.3	76.3	76.5	79.5	80.6	82.6	82.0	83.6	83.7	85.8	84.3	84.0	81.2	72.7
500	65.8	73.1	76.3	78.6	80.5	80.7	83.0	82.8	84.0	84.8	85.6	84.7	82.9	79.1	72.6
630	65.3	72.9	77.1	80.1	81.5	81.3	81.7	81.7	83.4	84.1	86.3	83.9	82.4	78.6	71.7
800	66.2	72.0	78.0	80.3	81.6	82.2	81.6	82.6	83.6	83.5	85.4	84.5	81.7	78.0	71.8
1000	65.1	71.7	76.3	79.1	80.5	81.6	82.6	81.7	81.7	83.7	84.6	85.3	80.7	76.6	71.8
1250	66.7	75.2	62.8	83.1	83.1	86.1	83.6	82.4	83.6	85.0	87.3	87.0	81.4	78.5	71.2
1600	71.7	83.7	93.9	91.1	92.5	96.7	90.7	88.8	92.9	89.4	93.5	91.4	87.3	85.4	77.0
2000	62.9	73.0	77.6	81.0	81.5	81.1	83.4	83.5	84.7	87.5	88.6	88.0	82.3	76.1	71.3
2500	62.8	74.9	80.6	81.8	83.4	85.3	85.8	84.0	85.5	87.7	90.7	86.3	80.3	76.8	69.4
3150	64.4	79.2	85.9	87.1	88.9	88.6	87.9	87.2	87.8	90.9	91.8	92.2	85.1	77.1	71.7
4000	59.5	74.4	80.5	81.8	83.5	81.7	85.9	85.2	86.0	87.8	90.9	88.3	79.8	75.5	68.9
5000	59.3	79.8	81.8	82.2	83.1	83.2	84.6	84.6	86.6	88.1	90.3	88.4	81.1	74.5	68.9
6300	54.3	72.0	77.7	79.4	80.0	79.2	82.5	82.5	84.4	85.1	88.1	85.4	77.8	71.2	65.6
8000	52.6	69.3	75.6	76.6	77.6	76.5	80.0	80.4	81.2	83.5	83.6	83.8	74.8	69.3	62.8
10000	50.9	64.2	73.1	72.4	74.6	74.1	75.7	81.8	77.5	82.1	80.5	84.4	70.6	66.4	57.4
OVERALL CALCULATED	79.8	88.9	96.2	95.7	97.2	99.3	97.9	97.4	98.9	99.8	101.7	100.6	97.8	96.0	89.9
PNDB	90.3	101.[illegible]	109.1	108.9	110.5	112.1	111.0	110.6	111.6	113.5	115.0	114.4	109.0	105.0	97.9

Fan B Scale Model
Approach
100-ft (30.48 m) Arc
Frame Treatment
Leaned Vanes

MODEL SOUND PRESSURE LEVELS (59 DEG. F, 70 PERCENT REL. HUM. DAY) - ANGLES FROM INLET IN DEGREES (AND RADIANS)

FREQ.	20. (0.35)	30. (0.52)	40. (0.70)	50. (0.87)	60. (1.05)	70. (1.22)	80. (1.40)	90. (1.57)	100. (1.75)	110. (1.92)	120. (2.09)	130. (2.27)	140. (2.44)	150. (2.62)	160. (2.79)	( )	( ) PWL
50	69.9	67.2	65.6	66.5	65.7	66.7	68.8	67.5	68.8	70.0	70.7	71.6	73.8	74.8	77.4		120.2
63	67.2	65.2	66.6	66.0	65.2	65.8	66.8	66.7	72.8	70.0	70.1	71.9	72.3	74.3	76.0		119.9
80	66.8	65.8	64.5	66.4	65.6	66.5	68.4	68.6	70.4	70.7	73.4	75.5	74.9	76.0	75.4		121.2
100	68.3	65.3	63.5	67.9	66.0	66.7	68.8	66.6	67.6	68.1	70.0	69.8	70.9	72.2	71.6		118.5
125	63.4	62.5	64.0	65.0	67.3	65.0	67.2	65.9	66.0	66.4	68.4	68.1	69.2	70.5	69.9		117.0
160	63.3	62.0	63.6	62.9	63.0	62.9	68.9	66.5	65.8	67.2	68.0	69.0	70.2	72.2	72.8		117.5
200	64.1	63.1	66.6	66.6	66.1	65.1	69.9	69.7	70.0	72.2	73.1	73.8	75.4	76.3	75.0		121.3
250	67.1	67.1	69.6	70.9	70.8	69.1	73.7	72.9	73.8	76.3	75.9	75.9	77.2	78.1	75.7		124.2
315	67.0	69.0	69.5	70.6	72.8	72.7	7[illegible].9	72.8	74.7	74.9	76.7	76.1	77.3	76.3	73.8		124.4
400	67.0	69.0	69.5	69.8	70.7	69.0	71.9	70.6	70.6	72.1	72.8	72.9	72.9	73.9	70.8		121.5
500	66.2	67.0	68.7	66.8	66.9	65.6	67.5	66.7	68.8	69.0	70.7	71.7	72.8	72.8	70.5		119.4
630	66.7	69.2	70.9	69.9	70.4	70.3	72.0	71.1	72.0	72.3	74.4	73.5	75.3	75.3	71.9		122.5
800	66.5	68.2	69.7	68.0	68.9	70.2	71.0	70.7	72.0	72.1	73.9	73.2	73.1	74.1	71.7		121.8
1000	65.6	68.3	69.8	68.8	70.1	70.3	71.2	70.1	72.0	73.2	75.0	75.3	75.2	73.5	71.9		122.6
1250	65.0	67.9	69.8	68.8	70.0	69.7	69.6	70.5	71.9	73.1	75.9	75.0	75.9	73.2	71.6		122.7
1600	66.5	68.5	71.0	70.0	71.0	70.9	71.1	72.1	71.8	73.1	76.3	76.3	77.5	74.1	72.9		123.8
2000	75.6	78.7	81.2	81.0	80.2	81.2	79.0	76.0	74.9	77.6	79.5	81.2	82.6	81.6	80.0		130.4
2500	67.3	71.4	74.6	72.6	71.8	72.8	72.0	70.6	72.0	73.9	77.2	79.2	78.4	75.0	73.6		125.3
3150	65.6	73.3	76.1	74.2	73.3	72.3	69.9	71.1	73.9	74.1	76.4	78.3	78.7	74.5	73.2		125.5
4000	72.0	80.2	81.7	83.0	80.9	75.9	75.7	74.6	75.9	80.1	81.3	84.2	85.3	81.1	80.1		131.8
5000	67.6	76.3	79.0	76.9	74.9	76.1	74.9	73.8	74.9	77.6	80.5	81.2	80.4	76.3	74.9		128.7
6300	70.5	79.6	83.1	81.4	79.5	77.5	75.0	75.0	76.0	79.4	81.4	83.6	84.6	77.6	77.0		131.7
8000	68.6	79.5	81.9	80.1	79.2	75.0	76.3	74.1	75.9	77.3	80.5	83.2	82.4	77.6	77.2		131.3
10000	66.3	78.0	80.8	79.2	77.2	75.3	73.1	72.1	74.9	75.1	79.4	81.2	80.3	75.5	76.1		130.6
12500	63.1	75.9	77.6	76.5	74.6	70.7	70.6	68.5	6[illegible]	71.8	75.0	76.7	75.9	71.2	71.7		128.1
16000	63.8	72.7	75.3	72.6	71.5	68.5	67.4	69.6	66.5	68.6	71.8	73.8	72.0	68.9	68.5		127.2
20000	64.3	68.5	70.8	68.1	67.0	65.3	62.9	70.8	62.9	64.4	68.2	69.0	68.2	67.2	65.8		126.4
OVERALL MEASURED	83.4	88.4	90.6	89.9	88.8	87.8	86.7	86.9	87.0	88.3	90.9	91.9	92.1	90.2	90.0		
OVERALL CALCULATED	82.3	88.1	90.5	89.6	88.4	87.1	86.8	85.7	86.8	88.6	90.7	92.3	92.7	90.1	89.1		140.8
PNDB	95.2	101.3	103.3	103.4	102.1	100.3	99.5	98.4	99.7	102.3	104.1	106.1	106.8	103.5	102.4		

Fan B Full Scale
Approach
200-ft (60.96 m) Sideline
Frame Treatment
Leaned Vanes

FULL SIZE SOUND PRESSURE LEVELS SCALED FROM MODEL T((59 DEG. F, 70 PERCENT REL. HUM. DAY)

50	58.9	59.4	59.9	65.8	65.1	66.5	69.0	66.8	67.8	[illegible]	69.0	67.8	67.3	66.4	62.2
63	53.8	56.5	60.3	62.9	66.3	64.7	67.3	66.1	66.2	[illegible]	67.3	66.0	65.5	64.5	60.3
80	53.5	55.9	59.8	60.7	62.0	62.5	69.0	66.8	65.8	[illegible]	[illegible]	66.9	66.4	66.1	[illegible]
100	54.2	56.9	62.8	64.4	65.0	64.7	70.0	69.9	70.0	71.9	72.0	71.6	71.5	70.0	65.0
125	56.9	60.8	65.7	68.6	69.7	68.6	73.7	73.0	73.8	75.9	74.7	73.6	73.2	71.8	65.5
160	56.7	62.5	65.5	68.2	71.5	72.2	74.9	72.9	74.6	74.5	75.5	73.7	73.3	69.8	63.5
200	56.5	62.4	65.4	67.4	69.5	68.5	71.8	70.7	70.6	71.6	71.5	70.4	68.8	67.3	60.3
250	55.5	60.3	64.5	64.3	65.6	65.1	67.4	66.7	68.7	68.5	69.4	69.2	68.7	66.1	59.7
315	55.7	62.4	66.7	67.4	69.0	69.8	71.9	71.1	71.9	71.7	73.1	70.9	71.0	68.4	60.9
400	55.3	61.2	65.3	65.4	67.5	69.5	70.9	70.7	71.8	71.5	72.5	70.6	68.7	67.1	60.5
500	54.1	61.2	65.4	66.2	68.6	69.6	71.0	70.1	71.8	72.5	73.6	72.6	70.8	66.4	60.4
630	33.3	60.7	65.2	66.1	68.4	69.0	69.3	70.4	71.7	72.4	74.4	72.3	71.4	65.9	59.9
800	54.5	61.0	66.4	67.2	69.4	70.2	70.8	71.9	71.6	72.4	74.8	73.5	72.9	66.7	60.9
1000	63.3	71.1	76.4	78.1	78.6	80.4	78.7	75.9	74.6	76.8	77.8	78.3	77.9	74.0	67.8
1250	54.7	63.6	69.7	69.7	70.2	72.0	71.7	70.4	71.6	73.1	75.5	76.3	73.5	67.3	61.0
1600	52.7	65.3	71.2	71.2	71.7	71.5	69.6	70.9	73.6	73.3	74.7	75.3	73.7	66.6	60.2
2000	58.8	72.1	76.7	80.0	79.3	75.1	75.4	74.5	75.6	79.3	79.6	81.2	80.3	73.0	66.8
2500	53.9	68.0	73.8	73.8	73.2	75.3	74.6	73.6	74.6	76.7	78.7	78.1	75.2	67.9	61.2
3150	56.3	71.0	77.8	78.3	77.8	76.8	74.8	74.9	75.8	78.7	79.7	80.4	79.3	69.1	62.8
4000	53.7	70.6	76.6	76.9	77.5	74.4	76.1	74.2	75.8	76.6	78.8	80.1	77.0	68.8	62.3
5000	51.4	69.5	75.9	76.5	76.1	75.2	73.6	72.7	75.3	75.0	78.3	78.6	75.4	66.9	61.2
6300	47.2	67.0	72.6	74.1	73.8	71.0	71.4	69.5	70.4	72.1	74.2	74.3	71.0	62.3	55.8
8000	46.4	63.4	70.4	70.6	71.3	69.5	69.0	71.4	68.1	69.6	71.6	71.7	67.2	59.6	51.2
10000	44.7	58.6	66.0	66.5	67.5	67.1	65.5	73.6	65.5	66.2	68.7	67.4	63.4	57.2	46.2
OVERALL CALCULATED	69.7	79.9	85.5	86.7	86.9	86.4	86.5	85.7	86.4	87.8	89.1	89.3	87.7	82.2	76.1
PNDB	80.2	93.3	99.4	100.2	100.2	99.4	99.4	98.7	99.4	101.3	102.6	102.9	101.3	93.9	87.4

APPENDIX C - NOMENCLATURE

A_{28} - Exhaust nozzle area, in^2 (cm^2)

BPF - Blade passing frequency

dB - Decibel

M_0 - Flight Mach number

N - Fan speed, rpm

MPT - Multiple pure tone

P_2 - Inlet total pressure

P_{23} - Fan exit total pressure

PNL - Perceived noise level, PNdB

PNdB - Perceived noise decibel

PNLT - Tone corrected PNL, PNdB

OGV - Outlet guide vane

SPL - Sound pressure level, dB

W - Weight flow

δ - Ratio of local pressure to 14.7 psi

η - Adiabatic efficiency

θ - Ratio of local temperature to 519° F

REFERENCES

1. Nemec, J., "Noise of Axial Fans and Compressors: Study of Its Radiation and Reduction," J. Sound and Vibration, (1967) 6 (2), 230 - 236.

2. Kazin, S.B., and Volk, L.J., "LF336 Lift Fan Modification and Acoustic Test Program," NASA CR-1934, December, 1971.

3. SAE ARP 866, "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise," August, 1964.

4. SAE AIR 876, "Jet Noise Prediction," July, 1965.