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Aircraft Noise Prediction Program (ANOPP) Fan Noise Prediction for Small Engines

Joe W. Hough and Donald S. Weir
AlliedSignal Engines, Phoenix, Arizona

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AIRCRAFT NOISE PREDICTION PROGRAM (ANOPP) FAN NOISE PREDICTION FOR SMALL ENGINES

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By

Joe W. Hough

and

Donald S. Weir

SUMMARY

ANOPP has been successfully revised to include a module which improves fan noise prediction capability with small turbofan engines. The modifications have been verified with measured data from three separate AlliedSignal fan engines. Comparisons of the revised prediction show a significant improvement in overall and spectral noise predictions. The revised technique provides predictions which now coincide with the measured data spread from the AlliedSignal engines. The most notable revisions to the Heidmann method include the reduction of peak discrete tone levels and combination tone levels.

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1.0 STATEMENT OF WORK

1.1 Background

In 1982, AlliedSignal Engines (then Garrett Turbine Engine Company) produced a "Computer Program to Predict the Noise of General Aviation Aircraft," (NASA CR-168050) under contract with NASA Lewis Research Center under the General Aviation Synthesis Program (GASP). This study identified a need to modify the Heidmann fan noise prediction procedure in the NASA Aircraft Noise Prediction Program (ANOPP) to better correlate measurements of fan noise from engines in the 3000- to 6000-pound thrust range. Additional measurements made by AlliedSignal since that time have confirmed the need to revise the ANOPP fan noise method for smaller engines.

1.2 Objective

The NASA ANOPP has been used successfully for predictions of large transport aircraft. Application of ANOPP to smaller regional transport and business aircraft has demonstrated a need to improve the fan noise prediction capability. The objective of this task is to integrate a fan noise prediction capability for smaller engines into ANOPP. Four subtasks include:

(1) Update of small engine data base
(2) Develop small engine fan noise prediction method
(3) Code and validate a revised ANOPP fan noise module
(4) Document and report results

1.3 Summary

ANOPP has been successfully revised to include a module which improves fan noise prediction capability with small turbofan engines. The modifications have been verified with measured data from three separate AlliedSignal fan engines. Comparisons of the revised prediction show a significant improvement in overall and spectral noise predictions.

Figure 1 shows the improved prediction as compared to the Heidmann and GASP predictions. The revised technique provides predictions which now coincide with the measured data spread from the AlliedSignal engines. The most notable revisions to the Heidmann method include the reduction of peak discrete tone levels and combination tone levels.

The small engine revisions have been incorporated into the ANOPP fan noise module. The revised module has been verified with measured data and a test case has been included for demonstration purposes.

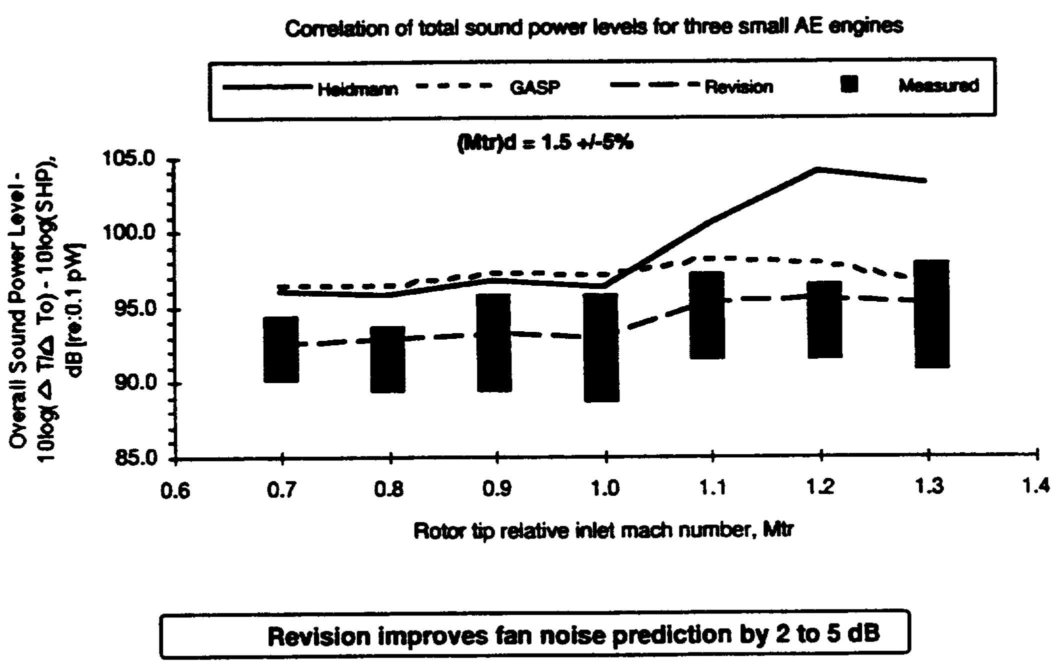

Figure 1. Revised Fan Noise Module Shows Overall Improvement In AlliedSignal Small Engine Prediction.

2.0 RESULTS

2.1 Technical Approach

The proposed fan noise prediction revisions in the small engine revision are intended to improve upon the well-established source noise prediction procedures originally developed by The Boeing Company under contract with NASA-Ames and later improved by full-scale engine data from NASA Lewis under the direction of M. F. Heidmann. In the Heidmann prediction procedure fan noise is divided into five separate modules:

- o Broadband noise emitted from the inlet and discharge ducts
- o Discrete tone noise emitted from the inlet and discharge ducts
- o Combination tone noise emitted from the inlet duct

Predictions within each module provide a one-third octave band spectrum shape function, a total spectrum level, and a free-field directivity at a radius of one-meter from the source. Total fan noise then is calculated through the logarithmic summation of the sound levels within each of the five modules.

Several engine performance parameters and engine build parameters are specified within this procedure and drive the predictions. Given that only three engines were available for AlliedSignal's proposed revision procedure, some of these parameters did not appreciably vary from engine-to-engine, and were not fully investigated in this procedure. The influential prediction parameters are shown below:

Performance Parameters

- o Mass flow rate

- o Total temperature rise across the fan

- o Design rotor tip relative inlet Mach number - This parameter remained nearly constant for the three engines, $(M_{tr})_d = 1.5$ ±5 percent. No attempt was made to modify the Heidmann corrections where $(M_{tr})_d$ was used

- o Operating rotor tip relative inlet Mach number

Engine Build Parameters

- o Rotor-Stator Spacing (RSS) - RSS for the three engines did not vary enough to improve the RSS correction.

- o Presence of Inlet Guide Vanes (IGVs) - AlliedSignal's engines do not have IGVs. Therefore, the corrections which vary due to IGVs could not be adjusted.

- o Presence of Inlet Flow Distortion (ground effects; static operation) - During acoustic testing, AlliedSignal uses an inlet flow control device (ICD) to eliminate flow distortion into the inlet. Therefore, inlet flow distortion effects were not examined in this investigation. AlliedSignal does have separate engine data with and without the ICD and can use this data for future studies.

AlliedSignal's revised predictions concentrate on the adjustments to the spectrum level, spectrum shape, and directivity adjustments within each module based on the measured data of three small engines.

No attempt was made to add new modules to the prediction or to incorporate different prediction procedures not related to the Heidmann approach.

2.2 Update Of Small Engine Data Base

Subtask 1 calls for the identification of strengths and weaknesses of the Heidmann and GASP predictions based on the AlliedSignal engine data. Figure 2 shows a comparison of small engine fan noise data with the correlation of NASA Lewis full-scale fan data. Clearly, it is evident that the small engine fan noise data does not obey the same correlation function for large fan data. Specifically, the current Heidmann fan noise routine significantly overpredicts inlet and discharge fan tone noise levels, inlet buzz-saw peak noise and spectrum content, and, to a lesser degree, broadband peak noise level and spectrum content.

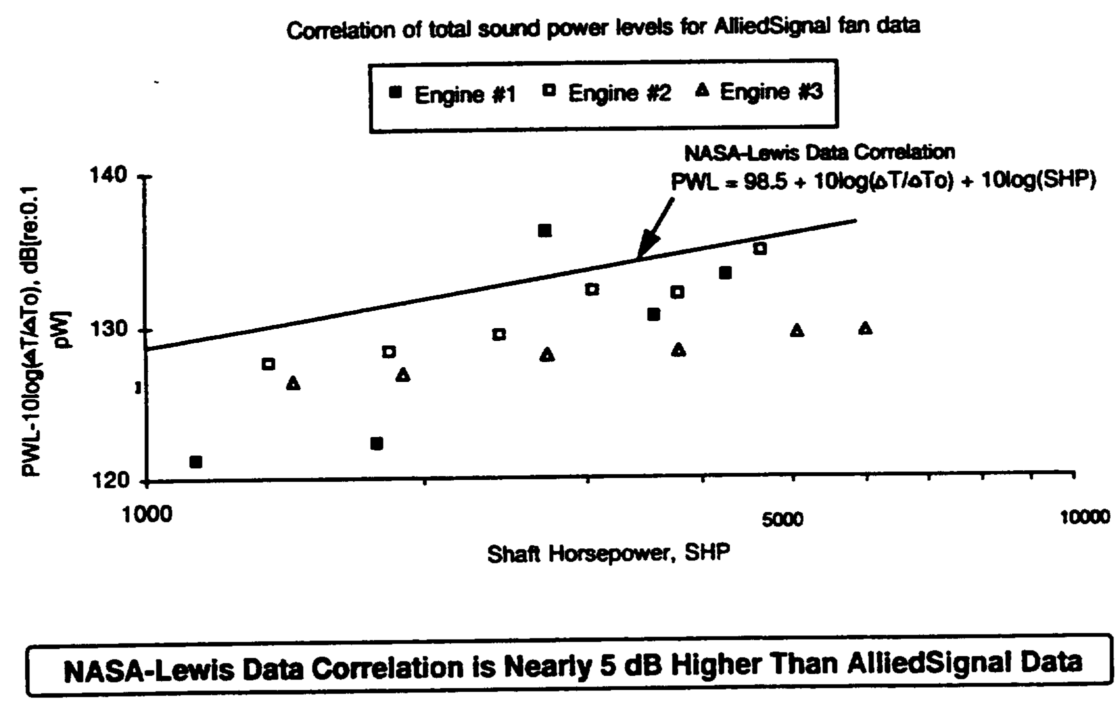

Figure 2. AlliedSignal Small Engine Data Does Not Correlate Well With NASA Lewis Fan Data.

2.2.1 Engine Fan Design

Provided in Table 1 are the fan design property ranges for the three AlliedSignal test engines. Each of the geared or ungeared fans has a single stage. Corrected thrust output varies from 400 pounds at ground idle to 6500 pounds at full speed. These engines do not have IGVs and inlet distortion is eliminated with the use of an inlet flow control device for static engine acoustic testing.

TABLE 1. AlliedSignal FAN DESIGN PROPERTY RANGES

Fan	Total Pressure Ratio, PR	Mass Flow Rate, lb/sec	Rotor Tip Mach Number, M_t	Rotor Tip Design Relative Inlet Mach Number $(M_{tr})d$	Vane-to-Blade Ratio, V/B	Blade Passage Frequency, f_b, Hz	Cut-Off Factor, δ	Rotor-Stator Spacing Factor, RSS, percent	Inlet Guide Vanes
1, 2, and 3	1.5 - 1.6	100 - 220	0.3 - 1.2	1.45 - 1.53	2.0 - 2.5	3600 - 5300	0.77 - 1.15	170 - 214	None

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2.2.2 Dominant Engine Fan Noise Frequencies

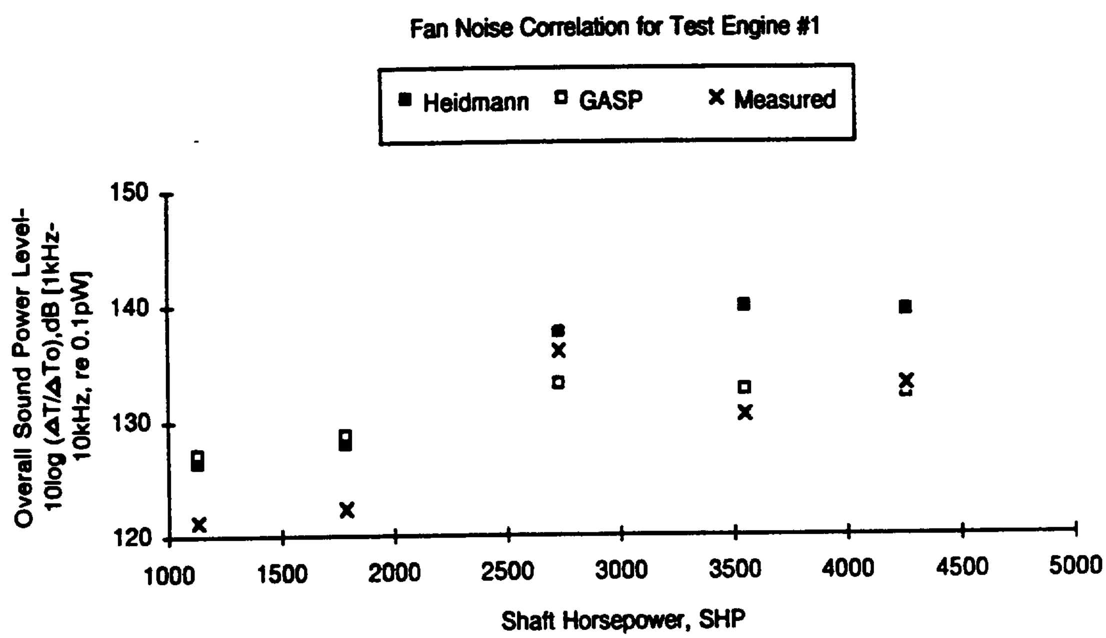
AlliedSignal measures engine noise with a multimicrophone array in the far-field over a reflecting plane. All engine noise components are measured in this arrangement. AlliedSignal routinely performs noise source separation and has determined that fan noise, for most engine speeds, is the dominant engine source for frequencies above 1 kHz. In some lower speed engine operating points, jet noise can contribute up to ~3 kHz in the aft microphone arc.

Given the strong noise contributions by other engine sources in the lower frequency bands, fan noise is only shown for one-third octave bands from 1 kHz to 10 kHz. Overall noise levels shown in the provided figures are computed from this frequency range.

2.2.3 ANOPP And GASP Predictions Versus Data From Engine 1

Figure 3 shows the correlation of sound power levels for Engine 1 and the associated fan noise predictions using the Heidmann and GASP routines. For subsonic tip speeds, the Heidmann and GASP routines consistently provide sound power predictions a maximum 6- to 7-dB higher than measured fan data. Examination of the predictions for blade pass tones and their harmonics shows an average 2- to 6-dB over the measured data. Broadband noise levels and spectrum content appear to be mismatched as well.

For supersonic tip speeds, the predictions fair better against the measured data. However, fan tones are still overpredicted by 2 to 4 dB and the combination tone noise spectra are slightly higher than test data.



Discrete Tones and Combination Tones Require Revision

Figure 3. Heidmann And GASP Show Slight To Moderate Fan Noise Overprediction For Engine 1.

2.2.4 ANOPP And GASP Predictions Versus Data From Engine 2

Figure 4 shows the correlation of sound power levels for Engine 2. Unlike Engine 1, blade pass tones and their harmonics are only 2- to 3-dB over the measured data for subsonic tip speeds, but 4- to 7-dB over measured data for supersonic tip speeds. Combination tone noise is underpredicted during the early introduction of buzz-saw and overpredicted as fan speed increases.

Broadband noise is predicted well, however, the spectral distribution appears to peak at a lower frequency than $2.5f_b$.

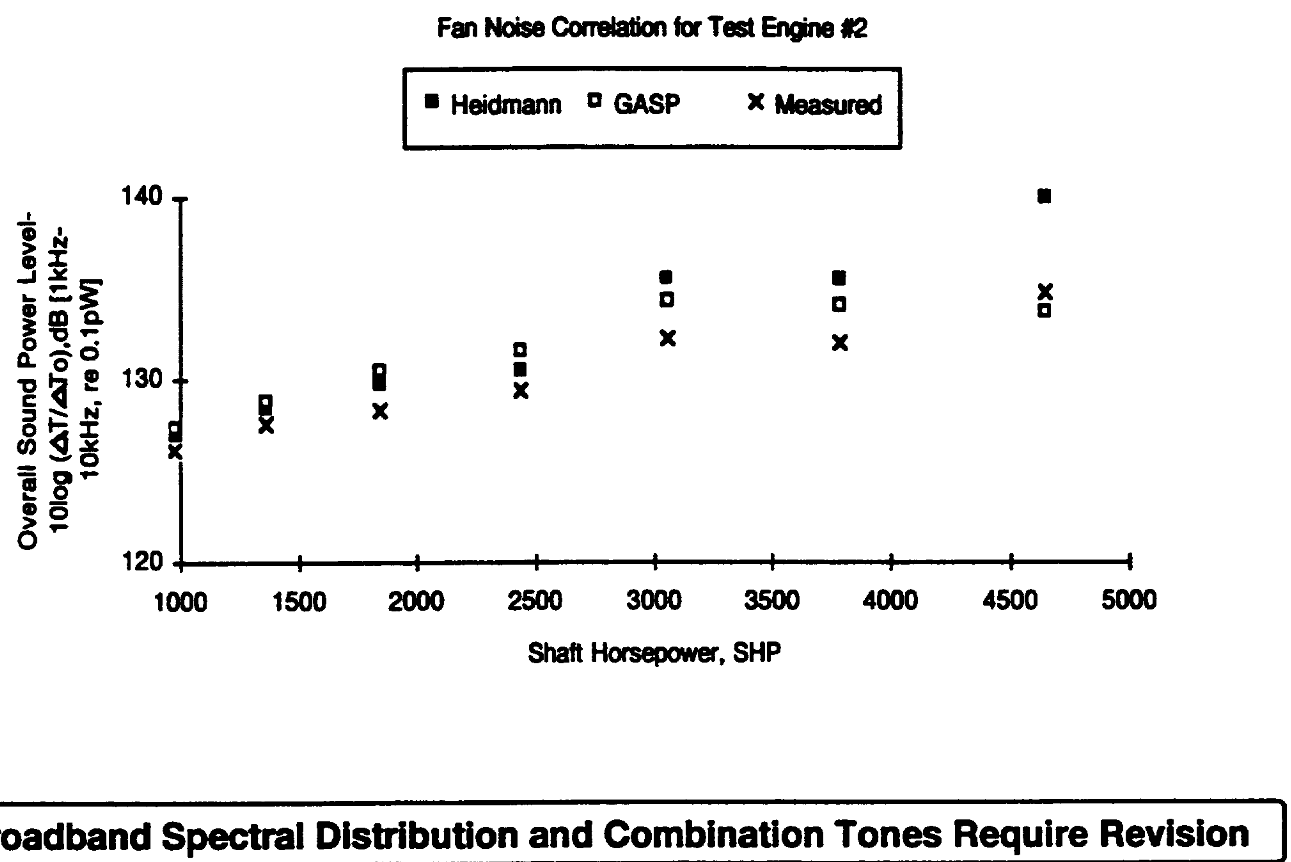


Figure 4. Heidmann And GASP Show Moderate Fan Noise Overprediction For Engine 2.

2.2.5 ANOPP and GASP Predictions Versus Data From Engine 3

Figure 5 shows the correlation of sound power levels for Engine 3. The transition to supersonic tip speeds is the least evident in the fan noise spectra with this engine. Fan tones are still overpredicted by 2 to 7 dB for all fan speeds and combination tone noise is well above the measurements. Broadband noise levels match well at the lower fan speeds but are overpredicted by 3 to 5 dB especially for high fan speeds.

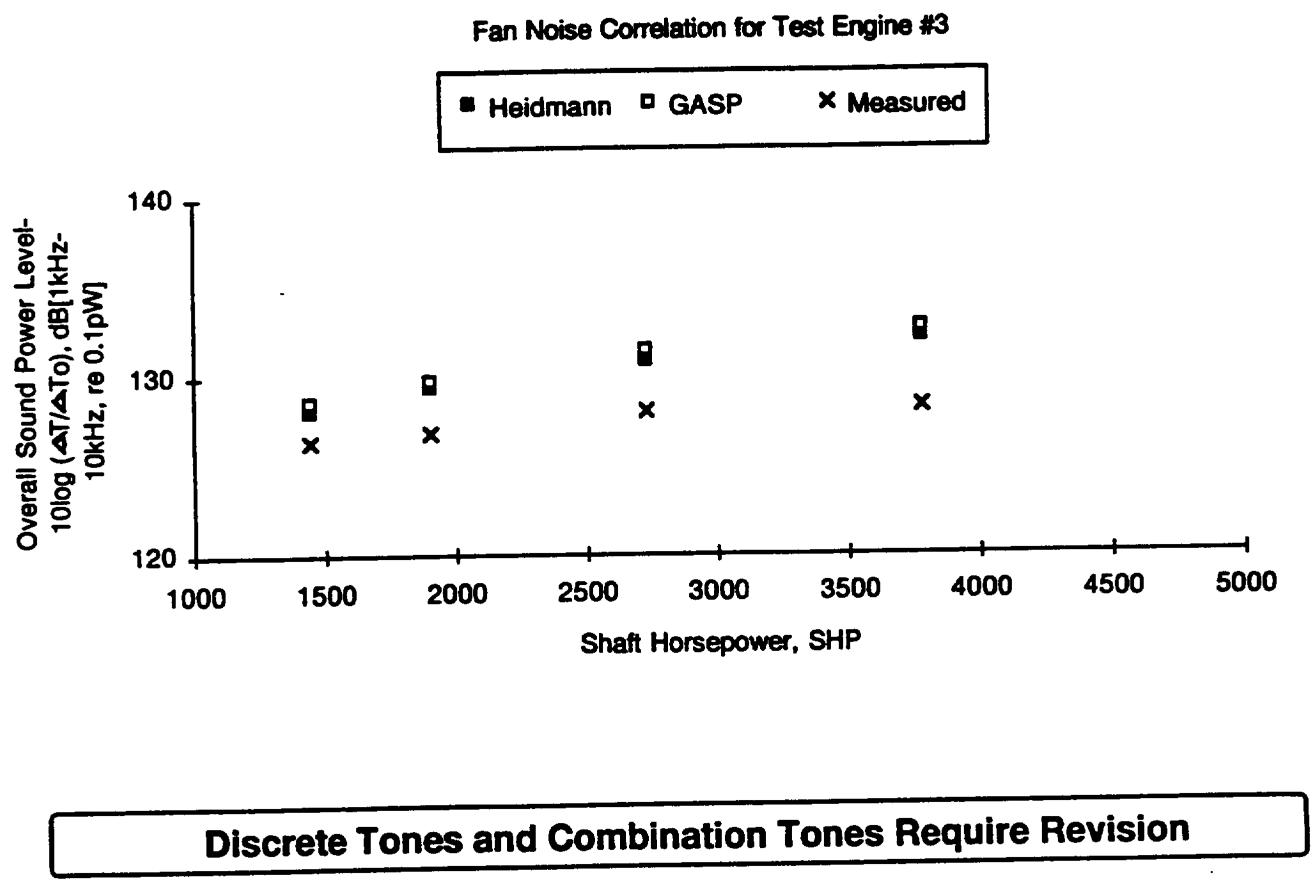


Figure 5. Heidmann And GASP Show Significant Fan Noise Overprediction For Engine 3.

2.2.6 Generalized Small Engine Revisions

For each of the three engines, it is clear that many revisions are necessary to the peak sound pressure levels, directivity, and spectrum distribution. For example, broadband peak noise and spectra content were either overpredicted or centered too high in frequency. Inlet and discharge tone directivity functions did not match test data well in the 70- to 100-degree midarc angles, and combination tone noise predictions sometimes were so overpredicted that they dominated a majority of the fan noise spectra.

Following a review of the predictions and their agreement or disagreement with the measured data, a summary of the required revisions is provided below. Further discussion is supplied in paragraph 2.3.

- o Inlet prediction revisions relative to the Heidmann approach:
  - Peak pressure of the fundamental tone has been decreased by 6 dB
  - Rolloff of the first harmonic has been increased from 3 to 9.2 dB
  - Rolloff of the second harmonic is 1.6 dB
  - Rolloff of the remaining harmonics remains 3 dB
  - Tone directivity has been slightly modified
  - Peak pressure of the combination tone noise has been significantly decreased
  - Peak pressure of the broadband noise has been decreased by 3 dB
  - Broadband noise spectrum has been shifted lower in frequency

- o Discharge prediction revisions relative to the Heidmann approach:

  - Peak pressure of the fundamental tone has been decreased by 4 dB
  - Rolloff of the first harmonic has been increased from 3 to 9.2 dB
  - Rolloff of the second harmonic is 1.6 dB
  - Rolloff of the remaining harmonics remains 3 dB
  - Tone directivity has been slightly modified
  - Peak pressure of the broadband noise has been decreased by 2 dB
  - Broadband noise spectrum has been shifted lower in frequency

The changes in the small engine revision module are provided in detail in Figures 6 to 19. The ANOPP manual has been updated as well, see Appendix I.

2.3 Develop Small Engine Fan Noise Prediction Method

The procedure for predicting inlet and discharge fan noise is a two-stage process:

(a) Calculate the characteristic one-third octave band SPL, L_c

$$L_c = 20 \log(\Delta T/\Delta T_o) + 10 \log(m/m_o) + F_1[M_{tr}, (M_{tr})_d] + F_2[RSS] + F_3[\theta] + C$$

where:

L_c = one-third octave band characteristic partial sound pressure level of a single-stage fan at 1-meter radius, dB

ΔT = total temperature rise across fan, °R

ΔT_o = reference value of T, 1°R

m = mass flow rate through fan, lb/sec

m_o = reference value of m, lb/sec

M_{tr} = rotor tip relative mach number

$(M_{tr})_d$ = design point value of M_{tr}

RSS = rotor-stator spacing in percent at rotor tip

θ = directivity or polar angle relative to inlet axis, degrees

C = correction for IGVs

The function F_1 determines the peak inlet or discharge discrete or broadband noise level. The variance of F_1 is determined by the values of M_{tr} and $(M_{tr})_d$. F_2 determines the influence of rotor-stator spacing with a dependency on inlet flow distortion. F_3 determines the directivity function for each noise contributor.

(b) Calculate the spectrum shape function, SPL(f)

where $SPL(f) = L_c + F_4(f/f_b)$

The sound pressure level for each contributor, Lc, is then given a spectrum shape function, F_4, which is centered on a multiple value of the blade passage frequency. For supersonic rotor tip speeds, a combination tone noise component is included and has its own spectral shape function.

The process of calculating L_c and SPL(f) is performed separately for the five fan noise components listed:

(1) Inlet discrete tone noise
(2) Inlet combination tone noise (when applicable)
(3) Inlet broadband noise
(4) Discharge discrete tone noise
(5) Discharge broadband noise

Total fan noise is obtained through the energy summation of these five noise components. These calculations provide one-third octave band sound pressure levels of the free-field noise at a one-meter radius.

To accelerate the revision process, AlliedSignal created a PC-based Excel spreadsheet of the GASP and Heidmann fan noise modules. Each of the five component noise sources was programmed in a separate file, and each file was linked to a total fan noise file. As influence parameters were modified, the changes in both the corresponding component and total fan noise contributions were readily observed. The accuracy of the spreadsheet was verified against the documented fan noise version in the GASP library.

Using the temporary spreadsheet, revisions were made to each component and compared with measured data from the three engines. This process was repeated many times until satisfactory prediction agreement with measured data was achieved. The result is a revised prediction method which provides a significant improvement in AlliedSignal small fan noise. The revisions to each component are provided in the following sections and are referred to as small engine revision or revision. Suggestions for further improvements in this model are requested.

2.3.1 Inlet Discrete Tone Noise

The characteristic peak sound pressure level for the fundamental tone is:

$$L_c = 20 \log(\Delta T/\Delta T_o) + 10 \log(m/m_o) + F_1[M_{tr}, (M_{tr})_d] + F_2[RSS] + F_3[\theta]$$

(a) Changes to $F_1[M_{tr}, (M_{tr})_d]$: Figure 6 shows the revisions to the normalized peak SPL function, F1. A 6-dB reduction was chosen due to the overall improvement of the fundamental tone level with measured data for all three engines.

Notes for future investigation of F_1: A value of 0.72 for M_{tr} is used as a transition parameter between prediction functions. The measured data indicates that this 0.72 value may need to be increased possibly to the value of 0.9 or even 1.0. More investigation is required to determine a better approximation of this transition value.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr},(M_{tr})_d]} + F_2[RSS] + F_3[\theta]$$

- For $(M_{tr})_d>1$, $M_{tr}<0.72$

Heidmann, GASP – $60.5 + 20\log(M_{tr})_d$

revision – $54.5 + 20\log(M_{tr})_d$

- For $(M_{tr})_d>1$, $M_{tr}>0.72$

Heidmann, GASP – lesser of: $60.5 + 50\log(M_{tr}/0.72)$
or $59.5 + 80\log((M_{tr})_d/M_{tr}))$

revision – lesser of: $54.5 + 50\log(M_{tr}/0.72)$
or $53.5 + 80\log((M_{tr})_d/M_{tr}))$

Reference Figure 10a shown in Appendix X

Figure 6. Inlet Discrete Tone Noise Revisions Improve Peak SPL.

(b) Changes to $F_3[\theta]$: Figure 7 shows the revisions to the directivity function, F_3. The slope of the directivity function relative to the maximum angles (20 to 40 degrees) was slightly decreased.

Notes for future investigation of F_3: Narrowband data analysis can be used to better evaluate the tone rolloff in future studies.

The sound pressure level spectrum is:

$$SPL(f) = L_c + 10 \log[10^{0.1F_4(f/f_b)}]$$

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr},(M_{tr})_d] + F_2[RSS] + \boxed{F_3[\theta]}$$

Theta	Heidmann	GASP	Revision
0	-3.0	-4.5	-3.0
10	-1.5	-3.0	-1.5
20	0.0	-1.5	-1.5
30	0.0	-1.5	-1.5
40	0.0	-1.5	-1.5
50	-1.2	-2.5	-2.0
60	-3.5	-4.0	-3.0
70	-6.8	-6.0	-4.0
80	-10.5	-8.5	-6.0
90	-14.5	-12.5	-9.0
100	-19.0	-17.0	-12.5
110	-24.5	-20.5	-16.0
120	-30.0	-24.0	-19.5
130	-35.5	-27.5	-23.0
140	-41.0	-31.0	-26.5
150	-46.5	-34.5	-30.0
160	-52.0	-38.0	-33.5
170	-57.5	-41.5	-37.0
180	-63.0	-45.0	-40.5

Reference Figure 13a shown in Appendix X

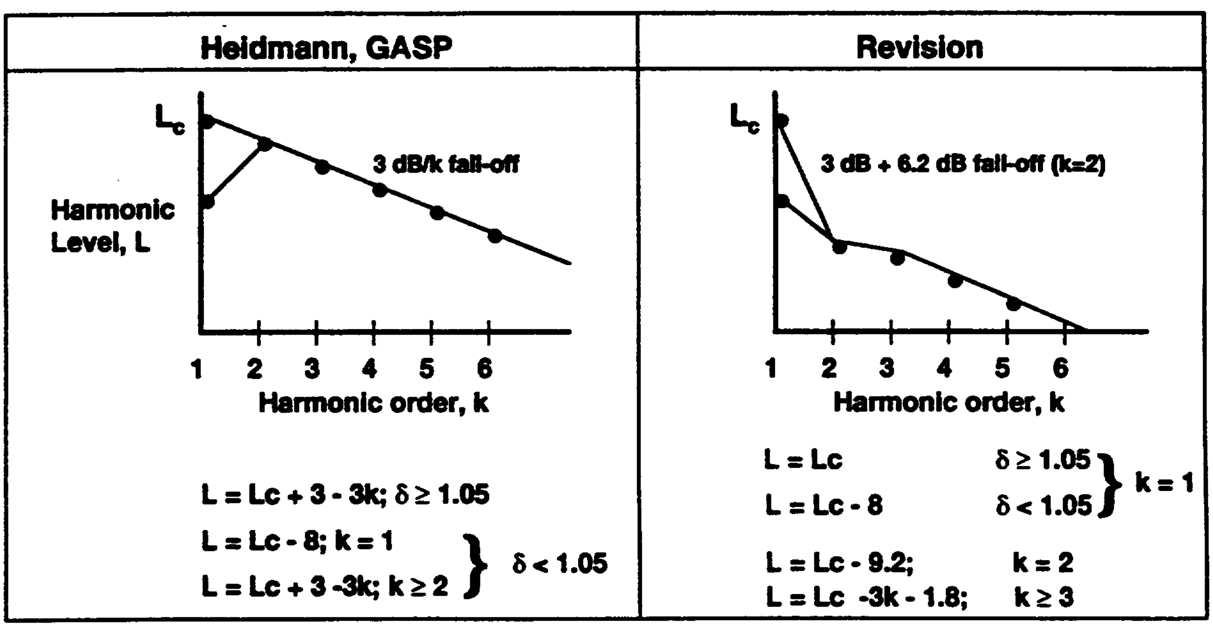
Figure 7. Inlet Discrete Tone Noise Revisions Improve Directivity Correction.

(c) Changes to $F_4(f/f_b)$: Figure 8 shows the revision to the rotor-stator interaction discrete tone harmonic rolloff levels. Rolloff of the second harmonic has been increased from 3 to 9.2 dB. Rolloff of the third harmonic is 1.6 dB, and the remaining harmonics retain a 3-dB rolloff.

Notes for future investigation of F_4: Only one of the three engines operating at low fan speed does not completely exhibit the revised harmonic tone rolloff. For this fan operating at low speed, the fundamental 1/3-octave band tone level is barely visible above broadband sources, inconsistent with the other two fans.

Harmonic tone rolloff for fans operating at low-speed points may require a closer examination for follow-up studies.

$$SPL(f) = L_c + 10 \log [10^{\boxed{0.1F_4(f/fb)}}]$$



Reference Figure 8a shown in Appendix X

Figure 8. Inlet And Discharge Discrete Tone Noise Revisions Improve Interaction Tone Harmonic Levels.

2.3.2 Inlet Combination Tone Noise

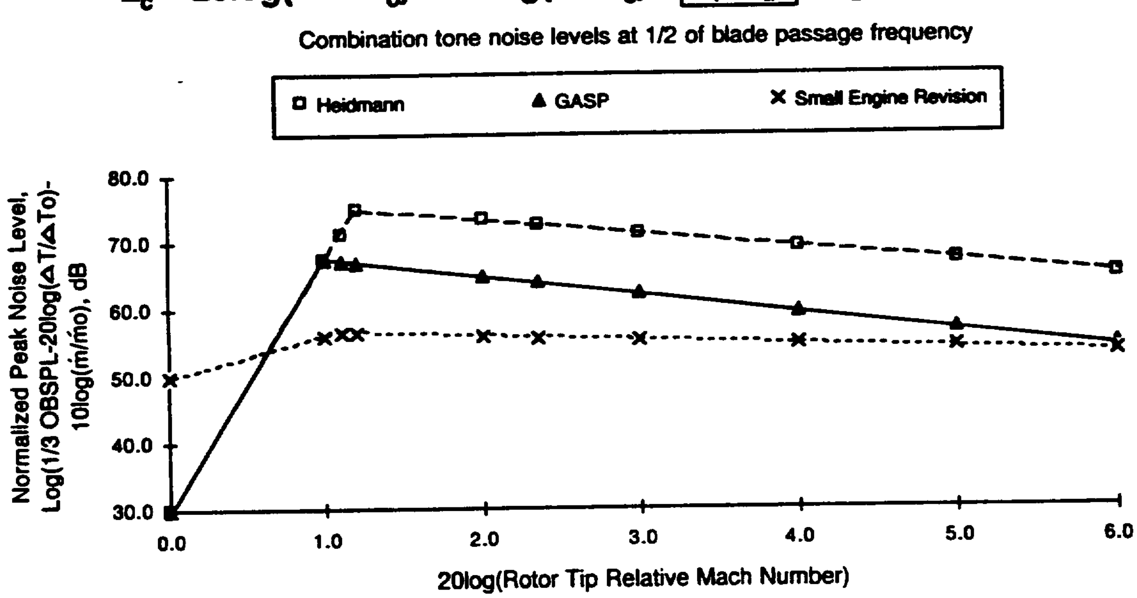
The characteristic peak sound pressure level for the fundamental tone is:

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr}] + F_2[\theta] + C$$

(a) Changes to $F_1[M_{tr}]$: Figures 9, 10, and 11 show the revisions to the normalized peak SPL function, F_1. The peak levels for the 1/2, 1/4, and 1/8 tones were reduced significantly. The slopes of the F_1 curves were also changed to better match the peak measured levels. Furthermore, note the "20log[M_{tr}]" distribution rather than the "M_{tr} distribution which is used in the Heidmann curves.

$$(f/f_b = 1/2)$$

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr}]} + F_2[\theta] + C$$



Reference Figure 15a shown in Appendix X

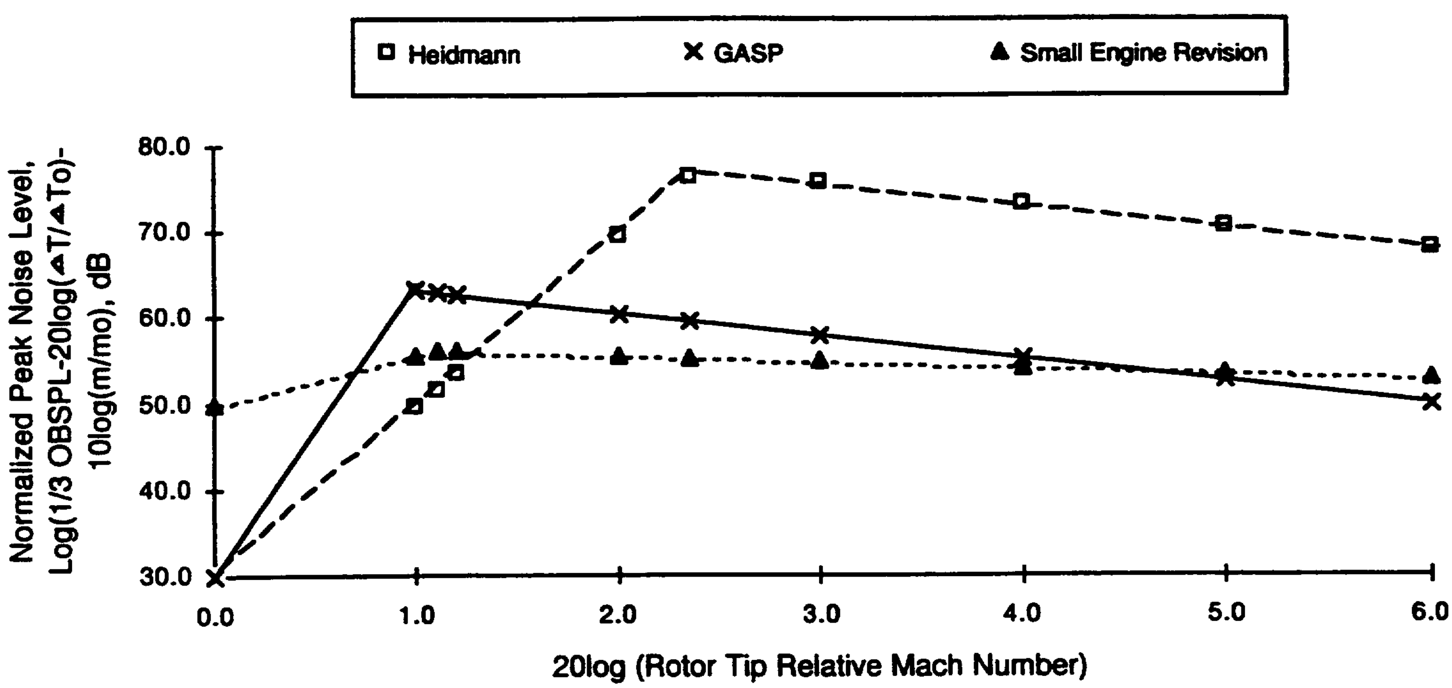
Figure 9. Inlet Combination Tone Noise Revisions Improve Peak SPL Correction.

Notes for future investigation of F_1: The peak combination tone levels currently are predicted by GASP to occur at $M_{tr} = 1.0$ for 1/2 and 1/4 tones, and $M_{tr} = 3.0$ for 1/8 tones. The measured data suggests that the actual peak levels may not be solely dependent on the value of M_{tr}. Also, further investigation likely will reveal the need to improve the slopes of the normalized peak level curves.

$$(f/f_b = 1/4)$$

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr}]} + F_2[\theta] + C$$

Combination tone noise levels at 1/4 of blade passage frequency

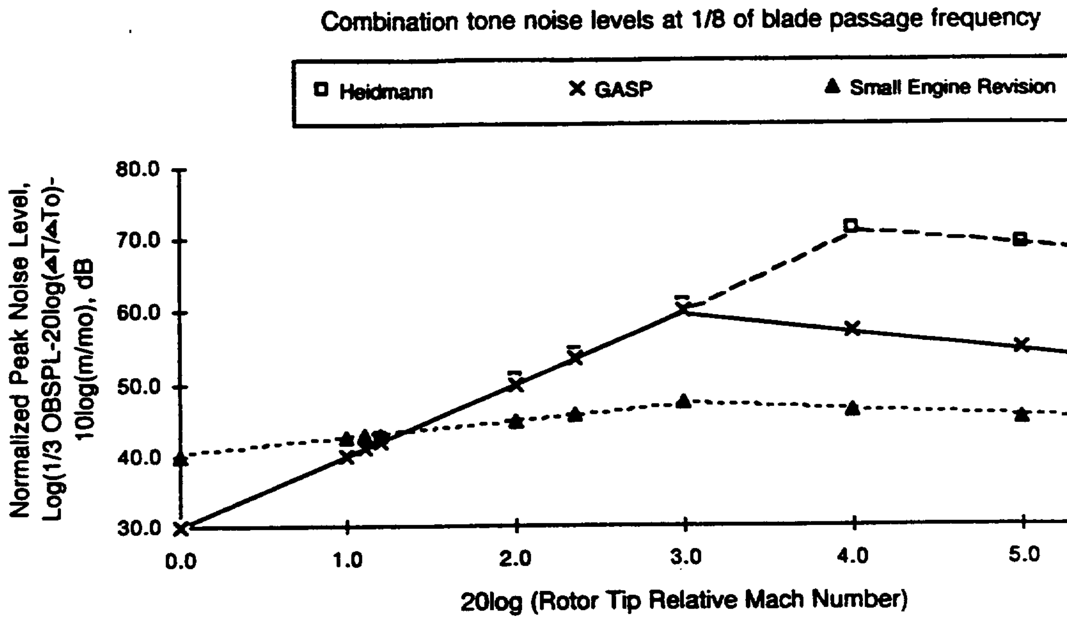


Reference Figure 15a shown in Appendix X

Figure 10. Inlet Combination Tone Noise Revisions Improve Peak SPL Correction.

$(f/f_b = 1/8)$

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr}]} + F_2[\theta] + C$$



Reference Figure 15a shown in Appendix X

Figure 11. Inlet Combination Tone Noise Revisions Improve Peak SPL Correction.

(b) Changes to $F_2[\theta]$: Figure 12 shows the revision to the directivity function, F_2. The slope of the function has been decreased.

The sound pressure level spectrum is:

$$SPL(f) = L_c + F_3(f/f_b)$$

(c) Changes to $F_3(f/f_b)$: Figure 13 shows the revision to the combination tone noise spectrum content. The distribution was decreased from 30log to 15log for the 1/2 combination tone spectrum. The 1/4 and 1/8 combination tone spectra were not changed.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr}] + \boxed{F_2[\theta]} + C$$

Theta	Heidmann	GASP, Revision
10	-8.5	-4.5
20	-7.0	-3.0
30	-5.0	-1.5
40	-2.0	0.0
50	0.0	0.0
60	0.0	0.0
70	-3.5	0.0
80	-7.5	-2.5
90	-9.0	-5.0
100	-9.5	-6.0
110	-10.0	-6.9
120	-10.5	-7.9
130	-11.0	-8.8
140	-11.5	-9.8
150	-12.0	-10.7
160	-12.5	-11.7
170	-13.0	-12.6
180	-13.5	-13.6

Reference Figure 16 shown in Appendix X

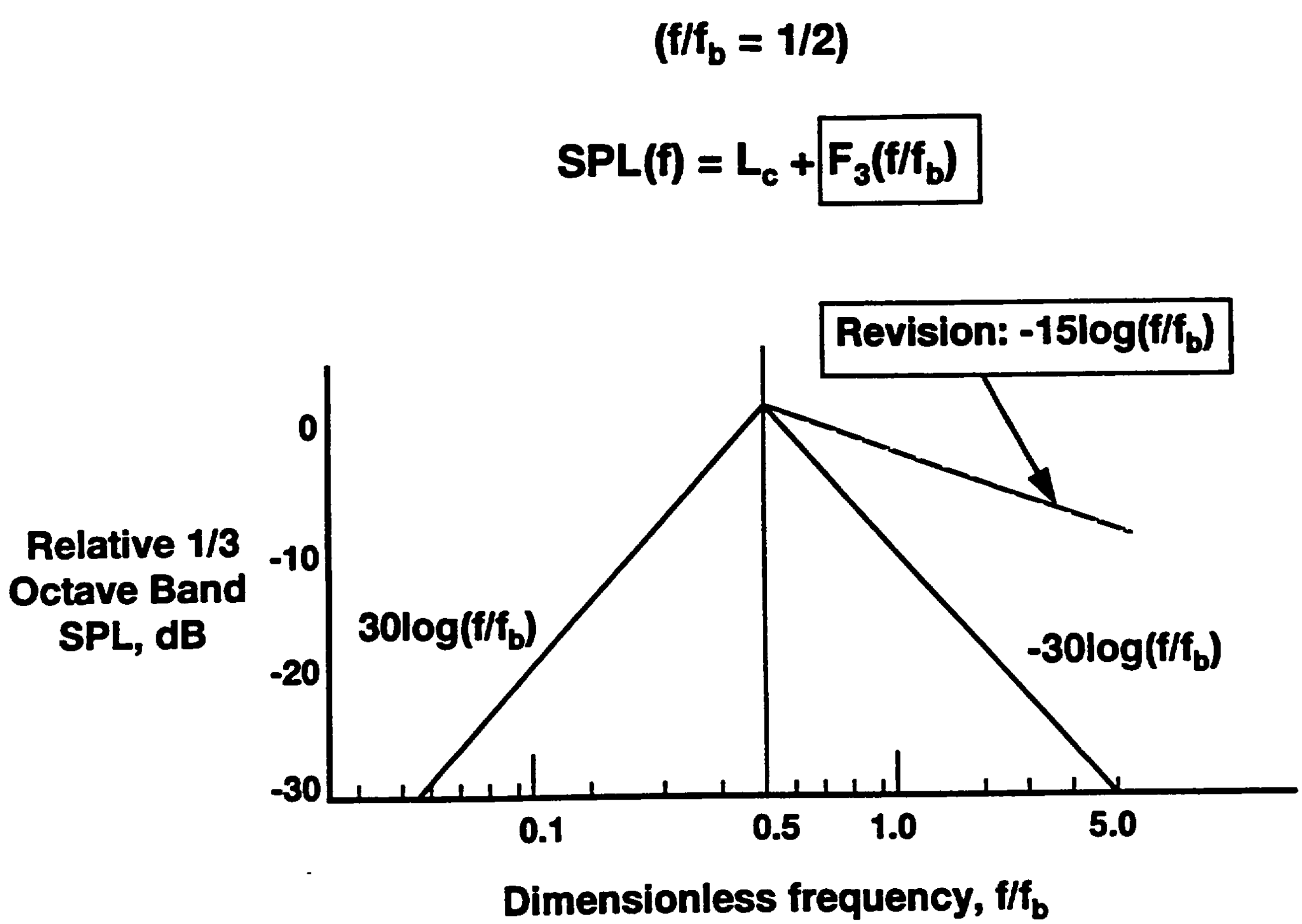
Figure 12. Inlet Combination Tone Revisions Improve Directivity Correction.

Notes for future investigation of F_3: The combination tone levels were so highly overpredicted that revisions to the spectral content were not thoroughly investigated. Measured data suggests significant room for improvement for F_3.

2.3.3 Inlet Broadband Noise

The characteristic peak sound pressure level for the single fan stage is:

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr}, (M_{tr})_d] + F_2[RSS] + F_3[\theta]$$



Reference Figure 14a shown in Appendix X

Figure 13. Inlet Combination Tone Noise Revisions Improve Spectrum Content.

(a) Changes to $F_1[M_{tr}, (M_{tr})_d]$: Figure 14 shows the revisions to the normalized peak SPL function, F_1. A 3-dB decrease was made for an overall improvement of the inlet broadband noise. The parameter of M_{tr} = 0.9 is agreeable with the measured data.

The sound pressure level spectrum is:

$$SPL(f) = L_c + F_4(f/f_b)$$

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr},(M_{tr})_d]} + F_2[RSS] + F_3[\theta]$$

	• For $(M_{tr})_d > 1$, $M_{tr} \leq 0.9$
Heidmann, GASP	$-58.5 + 20\log((M_{tr})_d)$
revision	$-55.5 + 20\log((M_{tr})_d)$
	• For $(M_{tr})_d > 1$, $M_{tr} > 0.9$
Heidmann, GASP	$-58.5 + 20\log((M_{tr})_d) - 20\log(M_{tr})$
revision	$-55.5 + 20\log((M_{tr})_d) - 20\log(M_{tr})$

Reference Figure 4a shown in Appendix X

Figure 14. Inlet Broadband Noise Revisions Improve Peak SPL.

(b) Changes to $F_4(f/f_b)$: Figure 15 shows the revision to the spectrum content correction. The log normal distribution center frequency has been shifted down from 2.5 f/f_b to 2.0 f/f_b. Sound level rolloff has been decreased for frequencies below f/f_b, and increased for frequencies above f/f_b.

Notes for future investigation of F_4: NASA Lewis data analysis suggests that broadband spectral noise content follows two log normal distribution functions, one centered at 2.5 f/f_b and the other centered near 20 f/f_b. The measured engine data agree with the log distribution but suggests the possible need for a second spectrum distribution function.

$$SPL(f) = L_c + \boxed{F_4(f/f_b)}$$

- **Heidmann, GASP**
  - $10\log(\exp(-0.5(\frac{\ln(f/2.5f_b)}{\ln 2.2})^2))$ **for all f**

- **Revision**
  - $10\log(\exp(-0.35(\frac{\ln(f/2.0f_b)}{\ln 2.2})^2))$ **for $f < 2f_b$**
  - $10\log(\exp(-2.0(\frac{\ln(f/2.0f_b)}{\ln 2.2})^2))$ **for $f \geq 2f_b$**

Reference Figure 3a shown in Appendix X

Figure 15. Inlet And Discharge Broadband Noise Revisions Improve Spectrum Content Correction.

2.3.4 Discharge Discrete Tone Noise

The characteristic peak sound pressure level for the fundamental tone is:

$$L_c = 20\ \log(\Delta T/\Delta T_o) + 10\ \log(m/m_o) + F_1[M_{tr},\ (M_{tr})_d] + F_2[RSS] + F_3[\theta] + C$$

(a) Changes to $F_1[M_{tr},\ (M_{tr})_d]$: Figure 16 shows the revisions to the normalized peak SPL function, F_1. A 4-dB rolloff was chosen due to the overall improvement of the blade passage level with measured data.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr},(M_{tr})_d]} + F_2[RSS] + F_3[\theta] + C$$

- For $(M_{tr})_d > 1$, $M_{tr} < 1$

Heidmann, GASP	$- 63.0 + 20\log((M_{tr})_d)$
revision	$- 59.0 + 20\log((M_{tr})_d)$

- For $(M_{tr})_d > 1$, $M_{tr} > 1$

Heidmann, GASP	$- 63.0 + 20\log((M_{tr})_d) - 20\log(M_{tr})$
revision	$- 59.0 + 20\log((M_{tr})_d) - 20\log(M_{tr})$

Reference Figure 10b shown in Appendix X

Figure 16. Discharge Discrete Tone Noise Revisions Improve Peak SPL.

(b) Changes to $F_3[\theta]$: Figure 17 shows the revisions to the directivity function, F_3. The slope of the directivity function below the peak level angles (110 to 130 degrees) was slightly decreased.

The sound pressure level spectrum is:

$$SPL(f) = L_c + F_4(f/f_b)$$

(c) Changes to $F_4(f/f_b)$: Revisions to the discrete tone harmonic rolloff is provided in Figure 8.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr},(M_{tr})_d] + F_2[RSS] + \boxed{F_3[\theta]} + C$$

Theta	Heidmann	GASP	Revision
10	-35.0	-32.5	-30.0
20	-31.0	-28.5	-26.0
30	-27.0	-24.5	-22.0
40	-23.0	-20.5	-18.0
50	-19.0	-16.5	-14.0
60	-15.0	-12.5	-10.5
70	-11.0	-8.5	-6.5
80	-8.0	-5.5	-4.0
90	-5.0	-2.5	-1.0
100	-3.0	-0.5	0.0
110	-1.0	0.0	0.0
120	0.0	0.0	0.0
130	0.0	0.0	0.0
140	-2..0	-2.0	-1.0
150	-5.5	-5.5	-3.5
160	-9.0	-9.0	-7.0
170	-13.0	-13.0	-11.0
180	-18.0	-18.0	-16.0

Reference Figure 13b shown in Appendix X

Figure 17. Discharge Discrete Tone Noise Revisions Improve Directivity Correction.

2.3.5 Discharge Broadband Noise

The characteristic peak sound pressure level for the single fan stage is:

$$L_c = 20\ \log(\Delta T/\Delta T_o) + 10\ \log(m/m_o) + F_1[M_{tr},\ (M_{tr})_d] + F_2[RSS] + F_3[\theta] + C$$

(a) Changes to $F_1[M_{tr},\ (M_{tr})_d]$: Figure 18 shows the revisions to the normalized peak SPL function, F_1. A 2-dB decrease in the peak sound pressure level was made for an overall improvement of the inlet broadband noise with measured data.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + \boxed{F_1[M_{tr}, (M_{tr})_d]} + F_2[RSS] + F_3[\theta] + C$$

- For $(M_{tr})_d > 1$, $M_{tr} < 1$

Heidmann, GASP	$- 60.0 + 20\log((M_{tr})_d)$
revision	$- 58.0 + 20\log((M_{tr})_d)$

- For $(M_{tr})_d > 1$, $M_{tr} > 1$

Heidmann, GASP	$- 60.0 + 20\log((M_{tr})_d) - 20\log(M_{tr})$
revision	$- 58.0 + 20\log((M_{tr})_d) - 20\log(M_{tr})$

Reference Figure 4b shown in Appendix X

Figure 18. Discharge Broadband Noise Revisions Improve Peak SPL.

(b) Changes to $F_3[\theta]$: Figure 19 shows the revisions to the directivity function, F_3. The slope of the directivity function below the maximum level angle (130 degrees) has been decreased.

The sound pressure level spectrum is:

$$SPL(f) = L_c + F_4(f/f_b)$$

(c) Changes to $F_4(f/f_b)$: Revisions to the discharge broadband spectrum content are provided in Figure 15.

$$L_c = 20\log(\Delta T/\Delta T_o) + 10\log(m/m_o) + F_1[M_{tr},(M_{tr})_d] + F_2[RSS] + \boxed{F_3[\theta]} + C$$

Theta	Heidmann, GASP	Revision
10	-36.0	-29.5
20	-32.0	-26.0
30	-28.0	-22.5
40	-24.0	-19.0
50	-20.0	-15.5
60	-16.0	-12.0
70	-11.5	-8.5
80	-8.0	-5.0
90	-5.0	-3.5
100	-2.7	-2.5
110	-1.2	-2.0
120	-0.3	-1.3
130	0.0	0.0
140	-2.0	-3.0
150	-6.0	-7.0
160	-10.0	-11.0
170	-15.0	-15.0
180	-20.0	-20.0

Reference Figure 7b shown in Appendix X

Figure 19. Discharge Broadband Noise Revisions Improve Directivity Correction.

3.0 REVISED PREDICTION COMPARISONS WITH MEASURED DATA

The small engine revisions have been verified against measured data from three AlliedSignal engines. Differences of the predicted and measured far-field sound pressure levels (40 degrees - midangle of inlet noise arc, 80 degrees - near midangle between inlet and exhaust, and 120 degrees - midangle of exhaust noise arc) and sound power levels for the three engines are provided in Appendices II, III, and IV. These plots show 1/3-octave band spectral differences in ΔdB SPL and ΔdB PWL from 1 kHz to 10 kHz. The data points cover a spread of fan speeds from 60 to 100 percent of the design speed. Tabulated 1/3-octave band level differences and overall level differences for all angles, 10 to 160 degrees, are provided in Appendices V, VI, and VII.

3.1 Engine 1 (See Appendices II And V)

Five data points were used for this engine. Fan speeds ranged from 65 to 99 percent speed. The revised prediction method shows a significant improvement in inlet noise for the 65 and 75 percent fan speeds, but discharge noise still remains slightly over-predicted especially for the exhaust noise angles, 100 to 160 degrees.

This particular engine seems to have an abrupt combination tone noise cut-on behavior as seen in the inlet midangles for the 85 percent speed point. At this speed, the buzz-saw noise prediction has improved but the predictions for inlet fan tones has worsened.

Conversely, the 95 and 99 percent speeds show a significant improvement with the revised prediction method. Predictions for buzz-saw noise fair well and inlet and discharge discrete tones and broadband noise show improvement.

Notes for future prediction improvements:

- o Inlet and discharge discrete tones and broadband noise are still overpredicted for low fan speeds

- o Inlet and discharge broadband noise is slightly underpredicted for higher fan speeds

- o Combination tone noise is still overpredicted for higher fan speeds

3.2 Engine 2 (See Appendices III And VI)

Seven data points were used for this engine. Fan speeds ranged from 61 to 100 percent speed. The revised prediction method shows a significant improvement in discharge noise for all fan speeds, but inlet noise is slightly to marginally underpredicted especially for the 61 to 88 percent speed points. The discrete tone rolloff is not severe for the 65 to 75 percent speeds, but as fan speed increases, the rolloff begins to show characteristics similar to the revised prediction.

Buzz-saw noise prediction has improved tremendously. An improvement of 10 dB and more is seen in the peak combination tone levels.

For the higher fan speeds inlet fundamental tones, harmonics and broadband noise show improvement with the revised prediction method.

Notes for future prediction improvements:

- o Inlet and discharge discrete tones and harmonics are now slightly underpredicted for lower fan speeds

- o Inlet broadband noise is slightly underpredicted for lower fan speeds

3.3 Engine 3 (See Appendices IV And VII)

Four data points were used for this engine. Fan speeds ranged from 60 to 87 percent speed. The revised prediction method shows excellent agreement for the 60 to 75 percent fan speeds. Agreement also is improved for the higher fan speeds where the buzz-saw noise has improved over 10 dB.

Discrete fundamental tones are still being overpredicted with the revised method, but by only 2 to 5 dB instead of 9 to 15 dB with Heidmann and GASP. Broadband noise has improved but is still slightly overpredicted as well.

Notes for future prediction improvements:

- Inlet and discharge discrete tone and broadband noise are still slightly overpredicted for high fan speeds

- Combination tone noise is overpredicted for the 1/4 tone

4.0 SMALL ENGINE REVISION TEST CASE

A sample fan noise prediction test case using the small engine revision module has been compared to measured Engine 1 data, see Appendix VIII.

Using the supplied engine parameters for Engine 1, fan noise predictions were made with the Heidmann, GASP, and Small Engine Revision modules. The results of these predictions are provided in four tables and figures which show the following:

- Third-octave sound power level spectra
- Third-octave sound pressure level spectra 40 degrees from inlet
- Third-octave sound pressure level spectra 80 degrees from inlet
- Third-octave sound pressure level spectra 120 degrees from inlet

The ANOPP theoretical manual has been modified to reflect the revisions in the Small Engine Revision procedure, see Appendix I.

Appendix IX contains a description of the ANOPP code changes.

5.0 REFERENCES

1. Interim Prediction Method For Fan And Compressor Source Noise, M. F. Heidmann, NASA Lewis Research Center, NASA TM X-71763, June 1975.

2. Aircraft Noise Prediction Program Theoretical Manual, W. E. Zorumski, NASA Technical Memorandum 83199, Parts 1 and 2.

APPENDIX I

ANOPP THEORETICAL MANUAL UPDATE

Power Function, $F(M_r)$, For Inlet Combination Tones (1/2 Combination Tone)

Heidmann:	0	$M_r < 1$
	$10^{-31.85\,(1.146-Mr)}$	$1 \le M_r \le 1.146$
	$10^{-1.41\,(Mr-1.146)}$	$1.146 < M_r$
GASP:	0	$M_r < 1$
	$10^{-30.74\,(1.122-Mr)}$	$1 \le M_r \le 1.122$
	$10^{-1.49\,(Mr-1.122)}$	$1.122 < M_r$
Small Engine Revision:	0	$M_r < 1$
	$10^{-4.81\,(1.135-Mr)}$	$1 \le M_r \le 1.135$
	$10^{-0.36\,(Mr-1.135)}$	$1.135 < M_r$

Power Function, $F(M_r)$, For Inlet Combination Tones (1/4 Combination Tone)

Heidmann:	0	$M_r < 1$
	$10^{-14.75\,(1.322-Mr)}$	$1 \leq M_r \leq 1.322$
	$10^{-1.33\,(Mr-1.322)}$	$1.322 < M_r$
GASP:	0	$M_r < 1$
	$10^{-27.15\,(1.122-Mr)}$	$1 \leq M_r \leq 1.122$
	$10^{-1.49\,(Mr-1.122)}$	$1.122 < M_r$
Small Engine Revision:	0	$M_r < 1$
	$10^{-4.52\,(1.135-Mr)}$	$1 \leq M_r \leq 1.135$
	$10^{-0.36\,(Mr-1.135)}$	$1.135 < M_r$

Power Function, $F(M_r)$, For Inlet Combination Tones (1/8 Combination Tone)

Heidmann:	0	$M_r < 1$
	$10^{-6.75\,(1.610-Mr)}$	$1 \le M_r \le 1.610$
	$10^{-1.21\,(Mr-1.610)}$	$1.610 < M_r$
GASP:	0	$M_r < 1$
	$10^{-7.26\,(1.413-Mr)}$	$1 \le M_r \le 1.413$
	$10^{-1.38\,(Mr-1.413)}$	$1.413 < M_r$
Small Engine Revision:	0	$M_r < 1$
	$10^{-1.77\,(1.413-Mr)}$	$1 \le M_r \le 1.413$
	$10^{-0.53\,(Mr-1.413)}$	$1.413 < M_r$

Acoustic Power Due To Combination Tone Noise (K revision for 1/2 Combination Tone)

Heidmann:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where K = 0.002525

GASP:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where K = 0.00031788

Small Engine Revision:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where K = 0.00002525

Acoustic Power Due To Combination Tone Noise (K revision for 1/4 Combination Tone)

Heidmann:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where $K = 0.002030$

GASP:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where $K = 0.00007413$

Small Engine Revision:

$\pi^* = K\ G\ (i,j)\ (m^*/A^*)\ (\Delta T^*)^2\ F(M_r)$
where $K = 0.00001471$

Acoustic Power Due To Combination Tone Noise
(K revision for 1/8 Combination Tone)

Heidmann:

$\pi^* = K\,G\,(i,j)\,(m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$
where $K = 0.0006225$

GASP:

$\pi^* = K\,G\,(i,j)\,(m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$
where $K = 0.00004722$

Small Engine Revision:

$\pi^* = K\,G\,(i,j)\,(m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$
where $K = 0.00000254$

Acoustic Power Due To Inlet Broadband Noise (Revision to K)

Heidmann and GASP:

$$\pi^* = K\,(s^*)^{-a(k,l)} M_m^{\,2} (m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$$

where $K = 1.552 \times 10^{-4}$

Small Engine Revision:

$$\pi^* = K\,(s^*)^{-a(k,l)} M_m^{\,2} (m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$$

where $K = 7.778 \times 10^{-5}$

Acoustic Power Due To Inlet Rotor-Stator Interaction Tones (Revision to K)

Heidmann and GASP:

$$\pi^* = K\, G(i,j)\, (s^*)^{-a(k,l)}\, M_m^{4.31} (m^*/A^*)\, (\Delta T^*)^2\, F(M_r, M_m)$$

where $K = 2.683 \times 10^{-4}$

Small Engine Revision:

$$\pi^* = K\, G(i,j)\, (s^*)^{-a(k,l)}\, M_m^{4.31} (m^*/A^*)\, (\Delta T^*)^2\, F(M_r, M_m)$$

where $K = 6.739 \times 10^{-5}$

Acoustic Power Due To Discharge Broadband Noise

Heidmann:

$$\pi^* = K\,G(i,j)\,(s^*)^{-a(k,l)} M_m^{\;2} (m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$$

where $K = 3.206 \times 10^{-4}$

Small Engine Revision:

$$\pi^* = K\,G(i,j)\,(s^*)^{-a(k,l)} M_m^{\;2} (m^*/A^*)\,(\Delta T^*)^2\,F(M_r)$$

where $K = 2.023 \times 10^{-4}$

Acoustic Power Due To Discharge Rotor-Stator Interaction Tones

Heidmann and GASP:

$$\pi^* = K\, G(i,j)\, (s^*)^{-a(k,l)}\, M_m^{\,2}\, (m^*/A^*)\, (\Delta T^*)^2\, F(M_r)$$

where $K = 2.643 \times 10^{-4}$

Small Engine Revision:

$$\pi^* = K\, G(i,j)\, (s^*)^{-a(k,l)}\, M_m^{\,2}\, (m^*/A^*)\, (\Delta T^*)^2\, F(M_r)$$

where $K = 1.052 \times 10^{-4}$

Revisions To Directivity Levels For Inlet Fan Noise

Theta, deg.	Inlet								
	Broadband directivity level			Discrete tone directivity level			Combination tone directivity level		
	Heidmann	GASP	Revision	Heidmann	GASP	Revision	Heidmann	GASP	Revision
0	0.43	no change		0.30	0.15	0.30	-0.43	-0.08	same as
10	0.53			0.45	0.30	0.45	-0.33	0.07	GASP
20	0.63			0.60	0.45	0.45	-0.18	0.22	
30	0.63			0.60	0.45	0.45	0.02	0.37	
40	0.63			0.60	0.45	0.45	0.32	0.52	
50	0.43			0.48	0.35	0.40	0.52	0.52	
60	0.18			0.25	0.20	0.30	0.52	0.52	
70	-0.12			-0.08	0.00	0.20	0.17	0.52	
80	-0.47			-0.45	-0.25	0.00	-0.23	0.27	
90	-0.87			-0.85	-0.65	-0.30	-0.38	0.02	
100	-1.32			-1.30	-1.10	-0.65	-.043	-0.08	
110	-1.87			-1.85	-1.45	-1.00	-0.48	-0.17	
120	-2.42			-2.40	-1.80	-1.35	-0.53	-0.27	
130	-2.97			-2.95	-2.15	-1.70	-0.58	-0.36	
140	-3.52			-3.50	-2.50	-2.05	-0.63	-0.46	
150	-4.07			-4.05	-2.85	-2.40	-0.68	-0.55	
160	-4.62			-4.60	-3.20	-2.75	-0.73	-0.65	
170	-5.17			-5.15	-3.55	-3.10	-0.78	-0.74	
180	-5.72			-5.70	-3.90	-3.45	-0.83	-0.84	

Revisions To Directivity Levels For Discharge Fan Noise

Theta, deg.	Discharge					
	Broadband directivity level			Discrete tone directivity level		
	Heidmann	GASP	Revision	Heidmann	GASP	Revision
0	-3.70	same as	-2.84	-3.45	-3.20	-2.95
10	-3.27	Heidmann	-2.49	-3.05	-2.80	-2.55
20	-2.84		-2.14	-2.65	-2.40	-2.15
30	-2.41		-1.79	-2.25	-2.00	-1.75
40	-1.98		-1.44	-1.85	-1.60	-1.35
50	-1.55		-1.09	-1.45	-1.20	-0.95
60	-1.12		-0.74	-1.05	-0.80	-0.60
70	-0.69		-0.39	-0.65	-0.40	-0.20
80	-0.34		-0.04	-0.35	-0.10	0.05
90	-0.04		0.11	-0.05	0.20	0.35
100	0.19		0.21	0.15	0.40	0.45
110	0.34		0.26	0.35	0.45	0.45
120	0.43		0.33	0.45	0.45	0.45
130	0.46		0.46	0.45	0.45	0.45
140	0.26		0.16	0.25	0.25	0.35
150	-0.14		-0.24	-0.10	-0.10	0.10
160	-0.54		-0.64	-0.45	-0.45	-0.25
170	-1.04		-1.04	-0.85	-0.85	-0.65
180	-1.54		-1.54	-1.35	-1.35	-1.15

Inlet and Discharge Broadband Spectral Function

Heidmann and GASP:

$$S = 0.116 \exp\left\{ -0.5 \left[\frac{\ln(\eta/2.5)}{\ln(\sigma)} \right]^2 \right\} \qquad \text{all } f$$

Small Engine Revision:

$$S = 0.116 \exp\left\{ -0.35 \left[\frac{\ln(\eta/2.0)}{\ln(\sigma)} \right]^2 \right\} \qquad f < 2\, f_b$$

$$S = 0.116 \exp\left\{ -2.0 \left[\frac{\ln(\eta/2.0)}{\ln(\sigma)} \right]^2 \right\} \qquad f \geq 2\, f_b$$

Revision To Inlet and Discharge Rotor-Stator Interaction Discrete Spectral Function

Heidmann and GASP:

$$S = \begin{bmatrix} 0.499 & 0.136 \\ 0.799 & 0.387 \end{bmatrix} \qquad n=1$$

$$S = \begin{bmatrix} 0.250 & 0.432 \\ 0.101 & 0.307 \end{bmatrix} \times 10^{-0.3\,(n-2)} \qquad n>1$$

Small Engine Revision:

$$S = \begin{bmatrix} 0.499 & 0.136 \\ 0.799 & 0.387 \end{bmatrix} \qquad n=1$$

$$S = \begin{bmatrix} 0.060 & 0.103 \\ 0.101 & 0.307 \end{bmatrix} \qquad n=2$$

$$S = \begin{bmatrix} 0.042 & 0.052 \\ 0.101 & 0.307 \end{bmatrix} \times 10^{-0.3\,(n-2)} \qquad n>2$$

Inlet Combination Tone Noise Spectral Function
(1/2 Fundamental Tone)

Heidmann and GASP:

$$S(\eta) = \begin{cases} 0.332(2\eta)^{3} & (\eta \leq 0.5) \\ 0.332(2\eta)^{-3} & (\eta > 0.5) \end{cases}$$

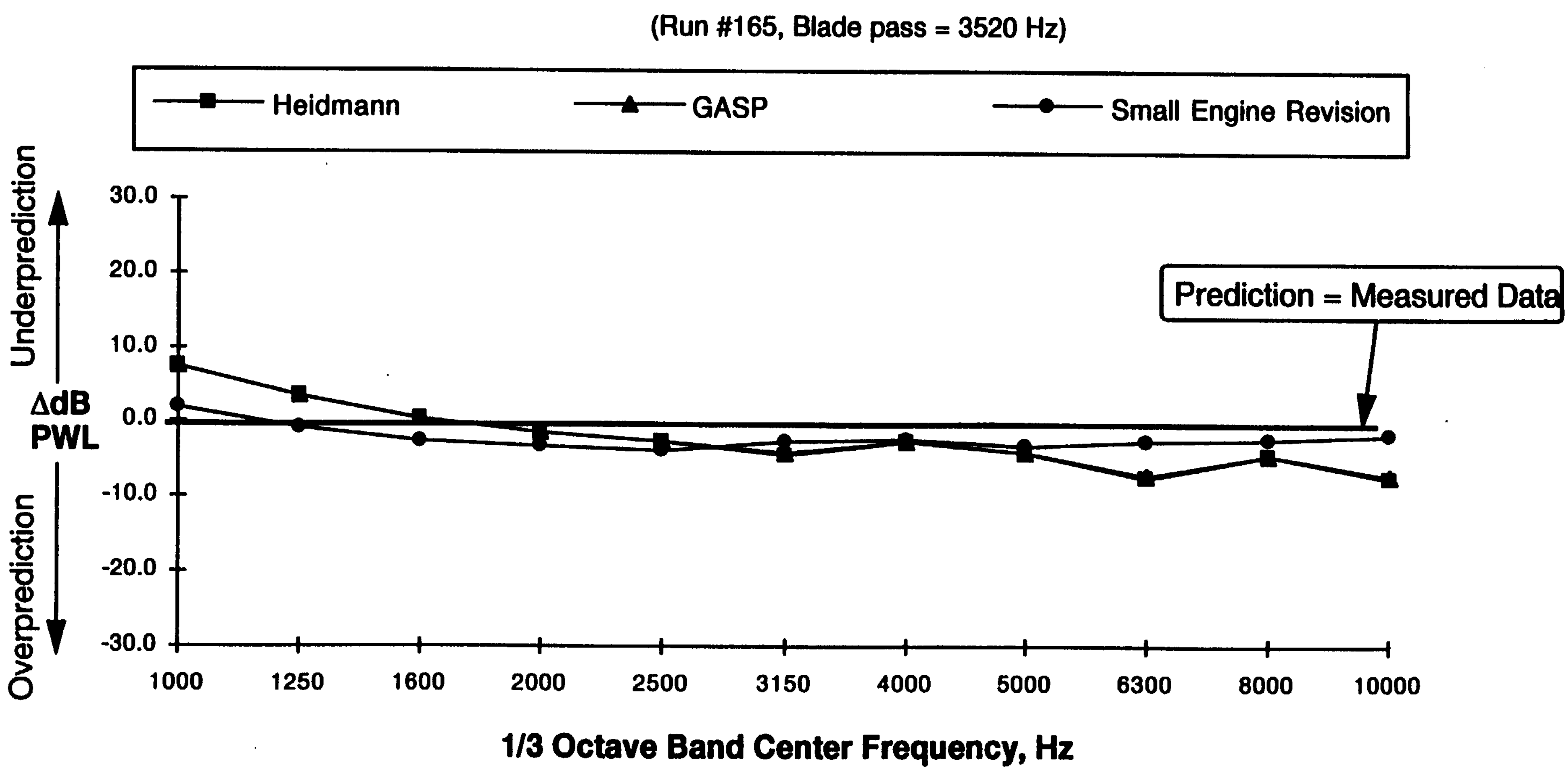
Small Engine Revision:

$$S(\eta) = \begin{cases} 0.332(2\eta)^{3} & (\eta \leq 0.5) \\ 0.332(2\eta)^{-1.5} & (\eta > 0.5) \end{cases}$$

APPENDIX II

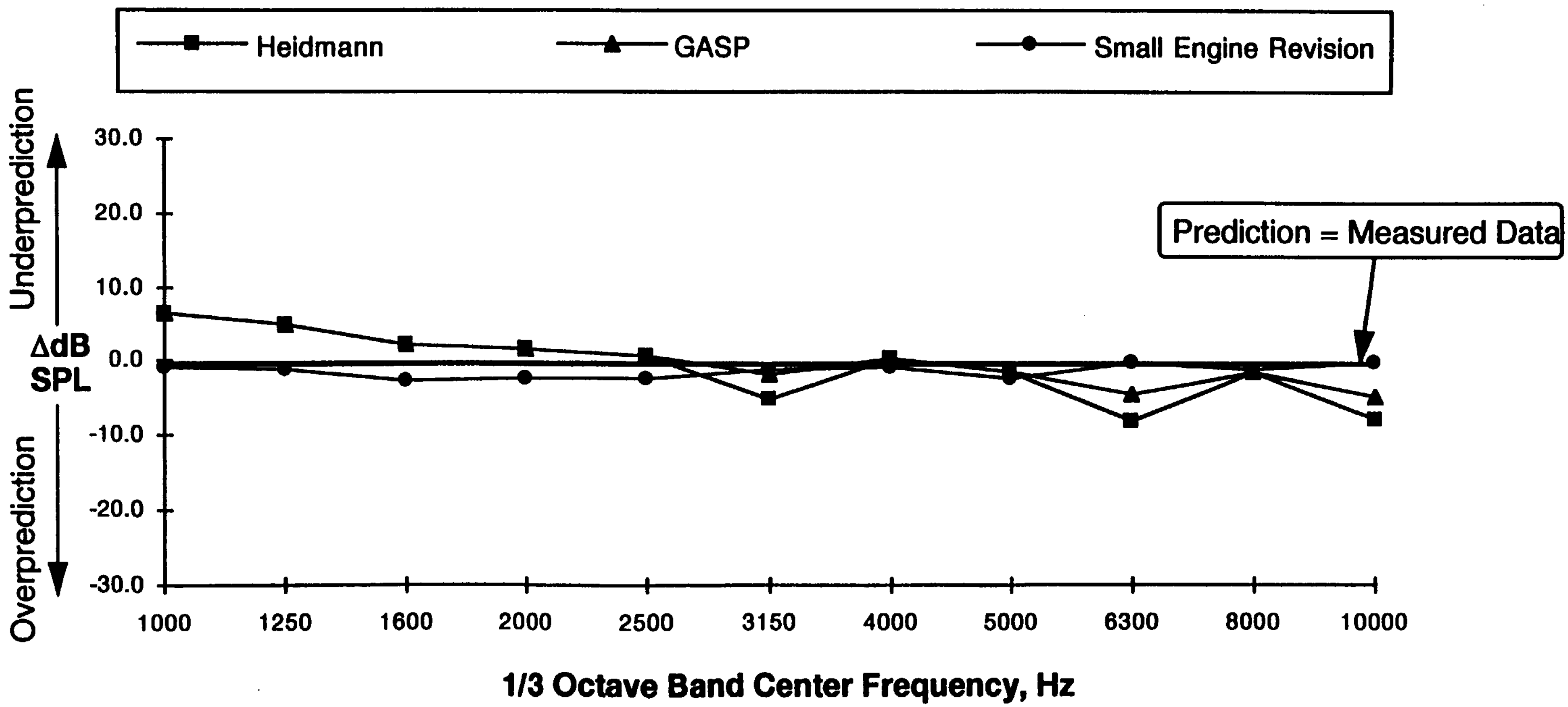
MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 1
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHz, dB

Revised Prediction versus Heidmann and GASP
Engine 1, 65% speed, Mtr = 0.9

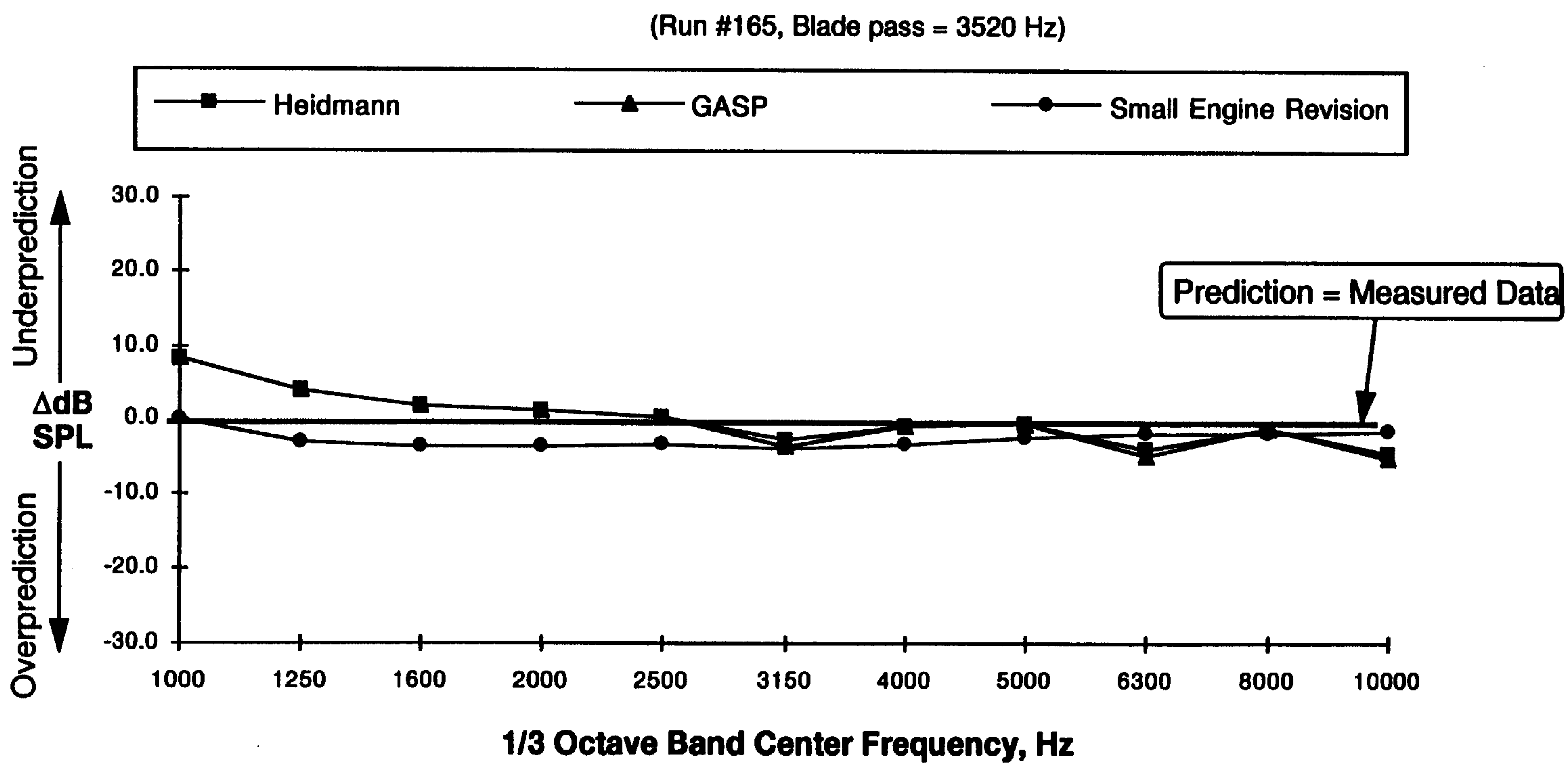


Revised Prediction versus Heidmann and GASP
Engine 1, 65% speed, Mtr = 0.9
(40° from inlet centerline)

(Run #165, Blade pass = 3520 Hz)

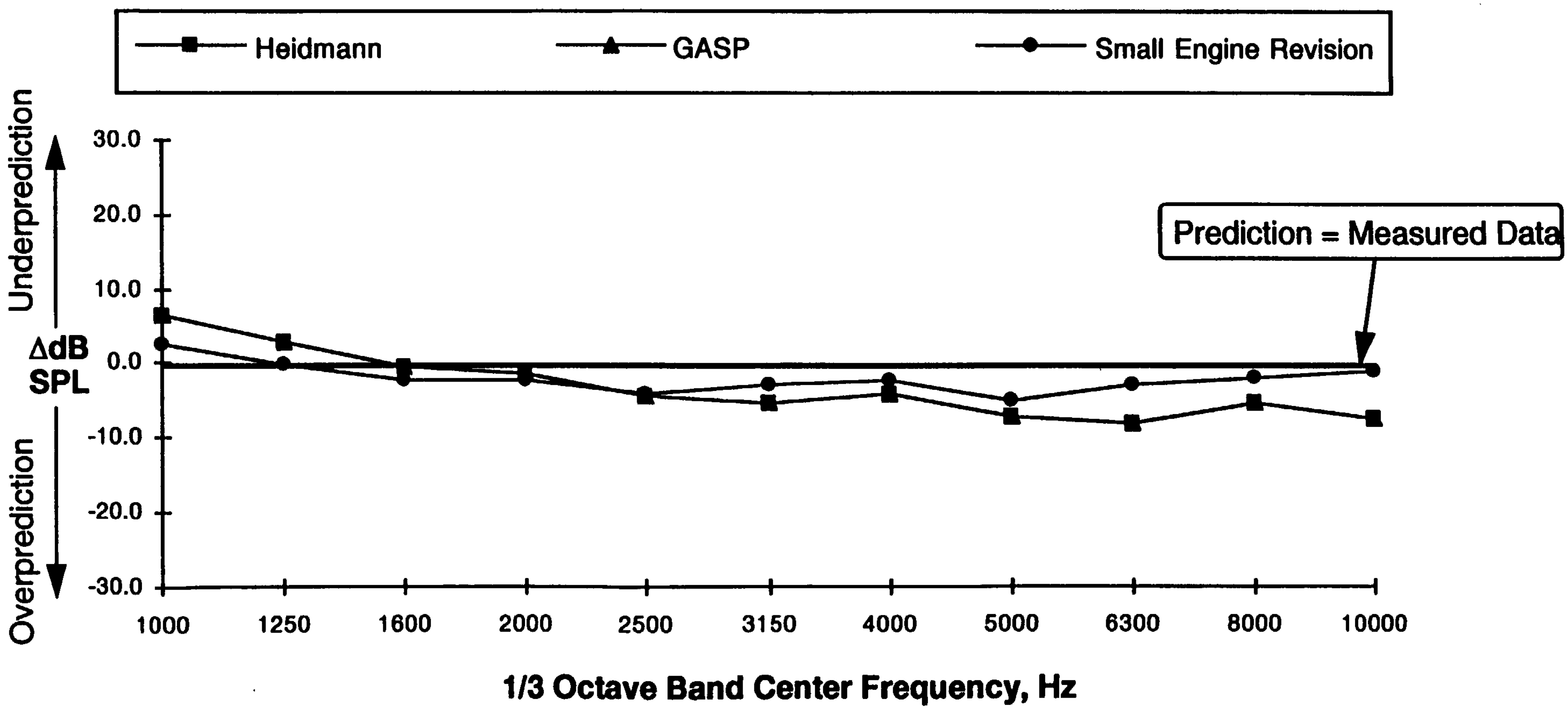


Revised Prediction versus Heidmann and GASP
Engine 1, 65% speed, Mtr = 0.9
(80° from inlet centerline)

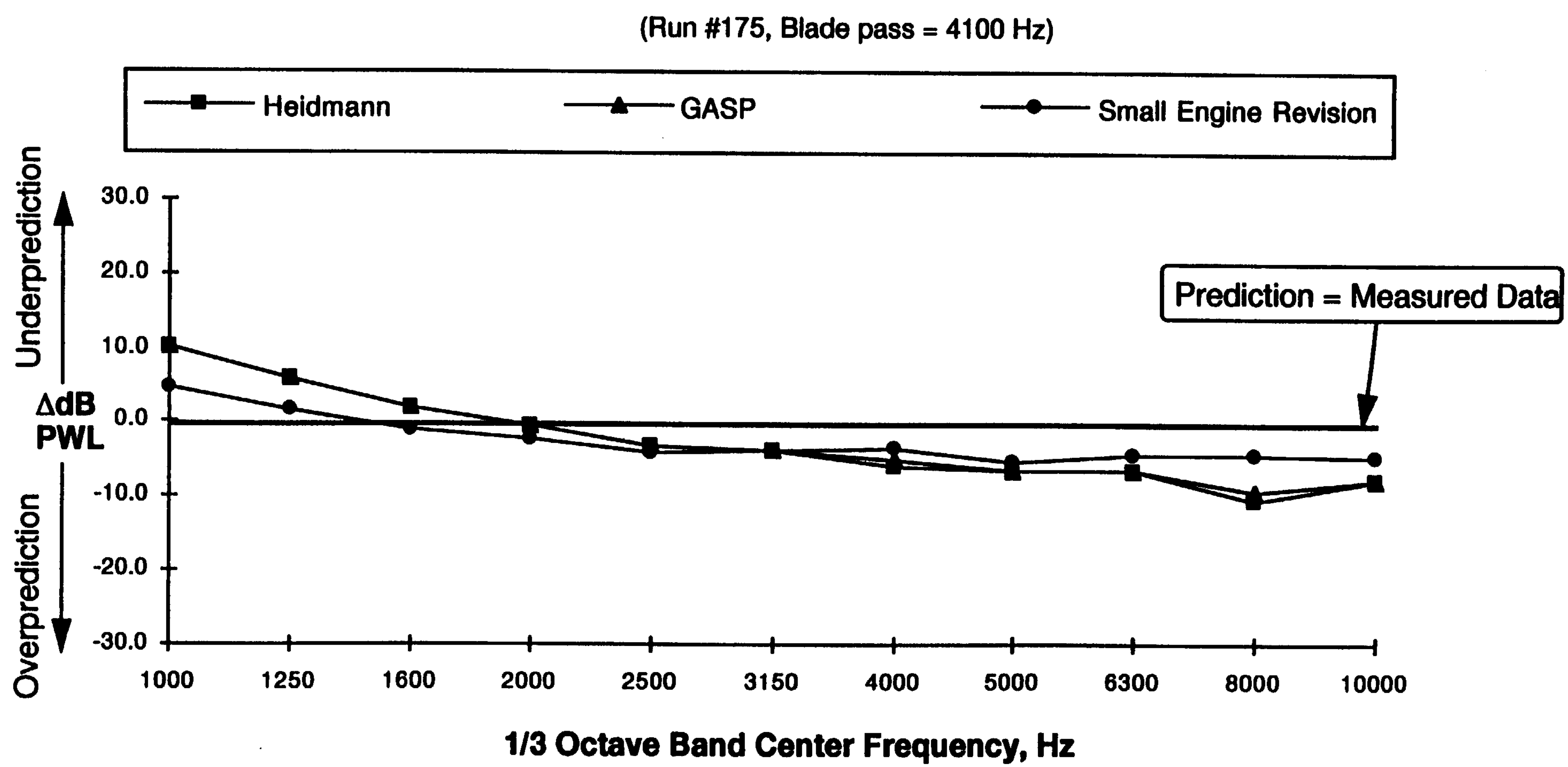


Revised Prediction versus Heidmann and GASP
Engine 1, 65% speed, Mtr = 0.9
(120° from inlet centerline)

(Run #165, Blade pass = 3520 Hz)

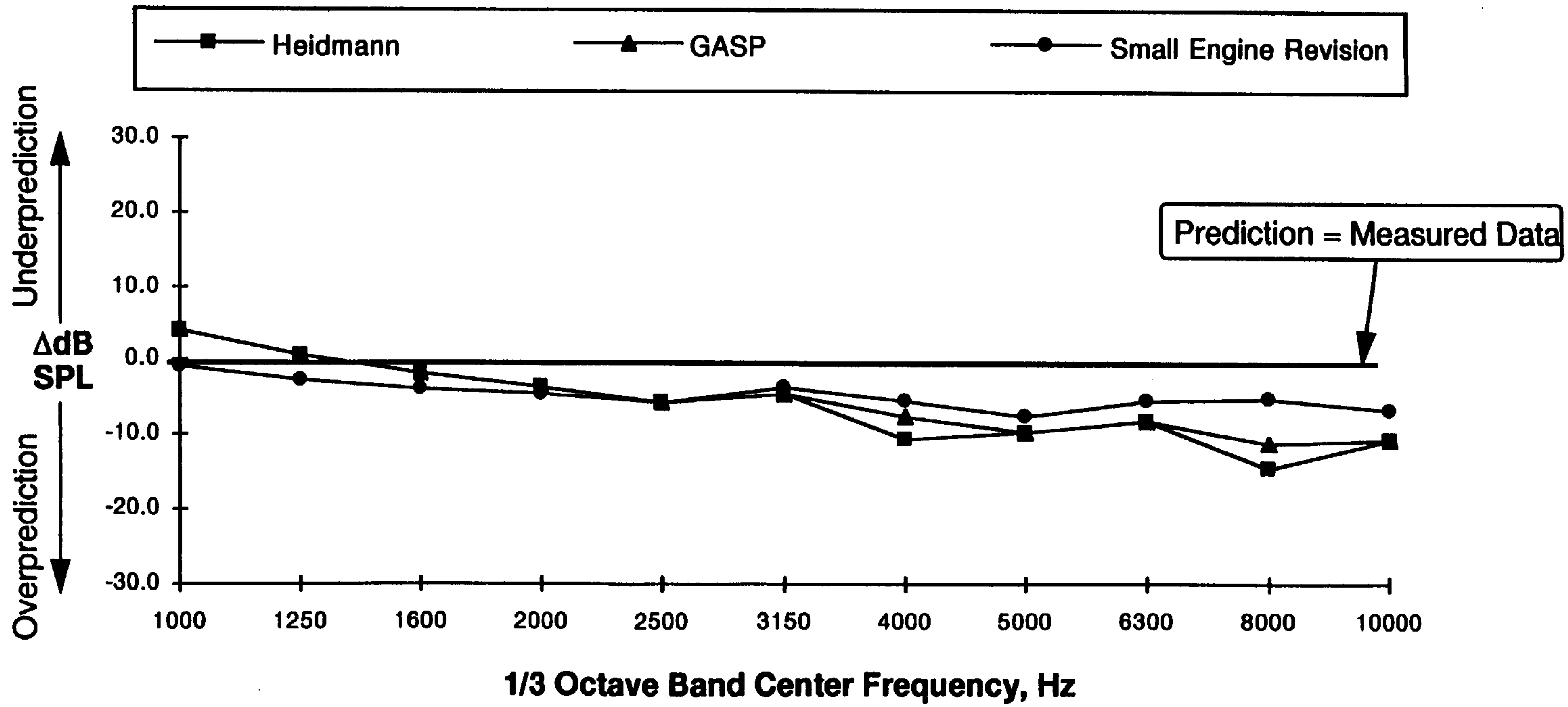


Revised Prediction versus Heidmann and GASP
Engine 1, 75% speed, Mtr = 1.0

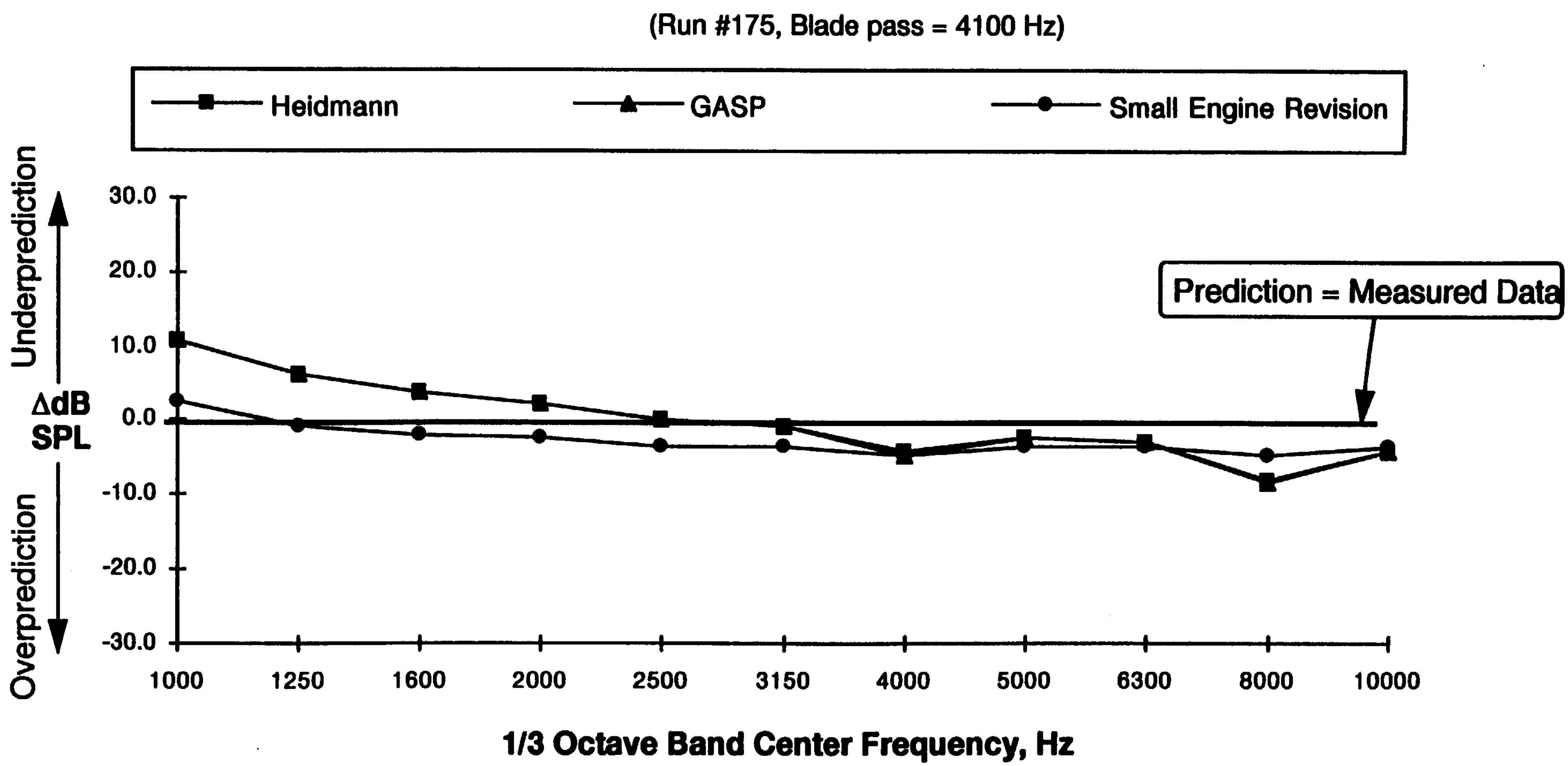


Revised Prediction versus Heidmann and GASP
Engine 1, 75% speed, Mtr = 1.0
(40° from inlet centerline)

(Run #175, Blade pass = 4100 Hz)

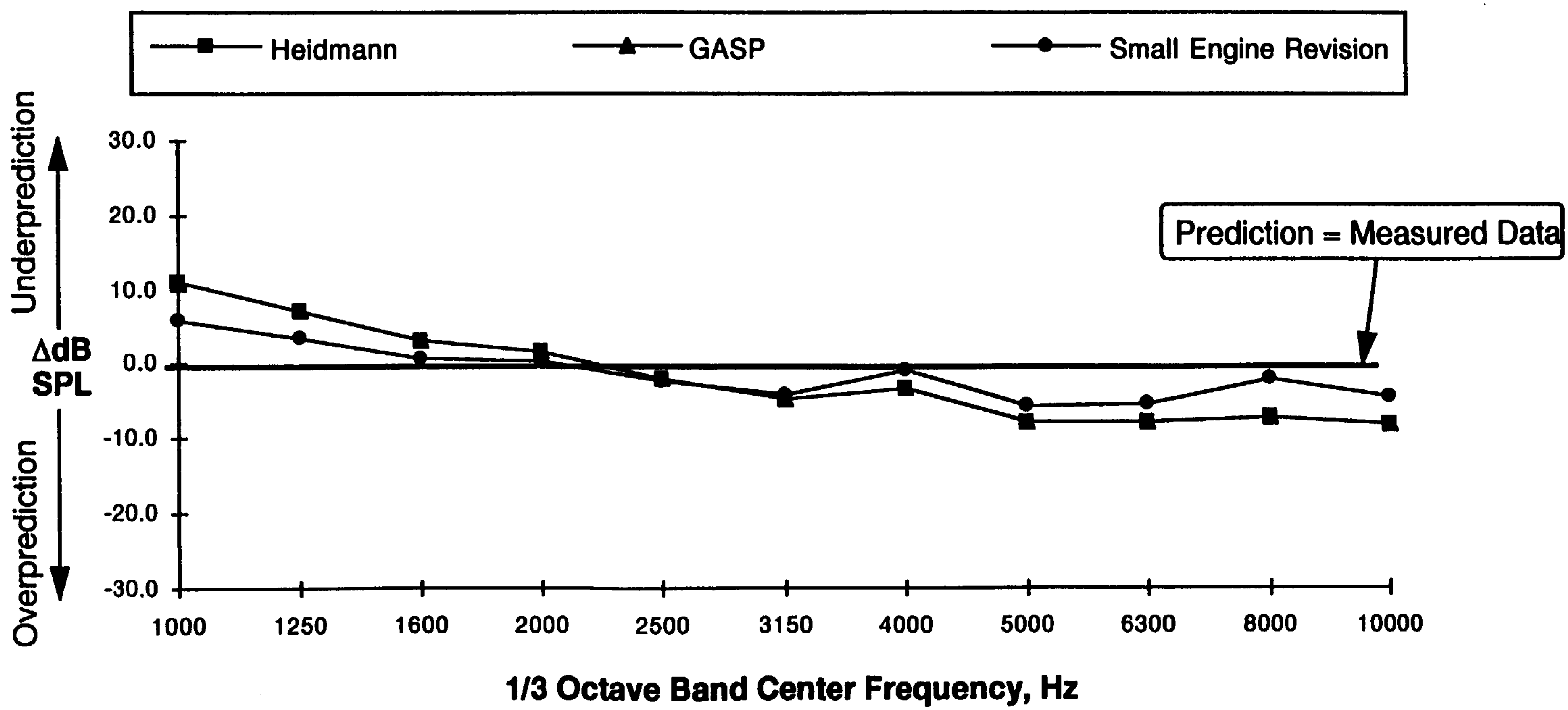


Revised Prediction versus Heidmann and GASP
Engine 1, 75% speed, Mtr = 1.0
(80° from inlet centerline)

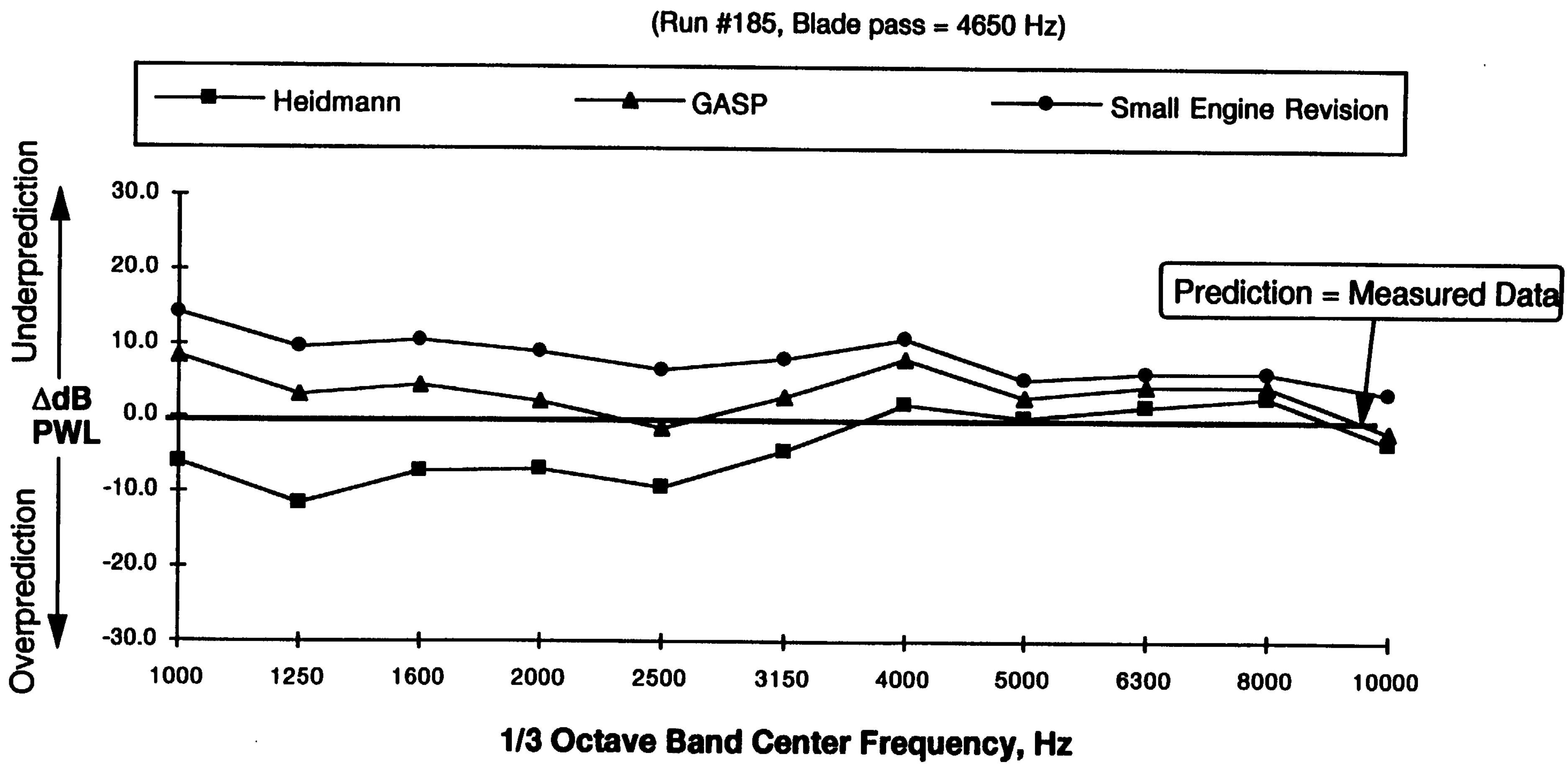


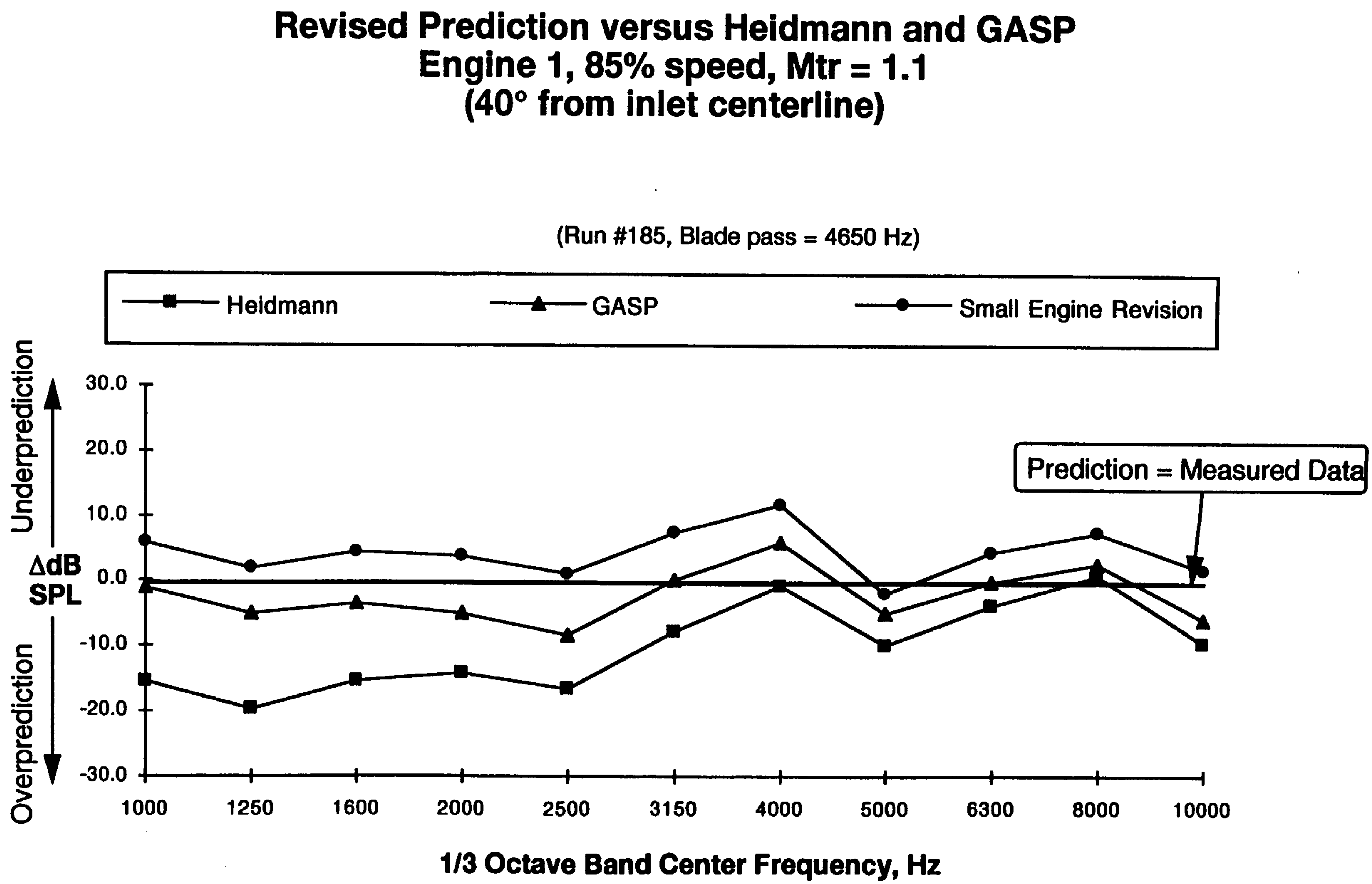
Revised Prediction versus Heidmann and GASP
Engine 1, 75% speed, Mtr = 1.0
(120° from inlet centerline)

(Run #175, Blade pass = 4100 Hz)



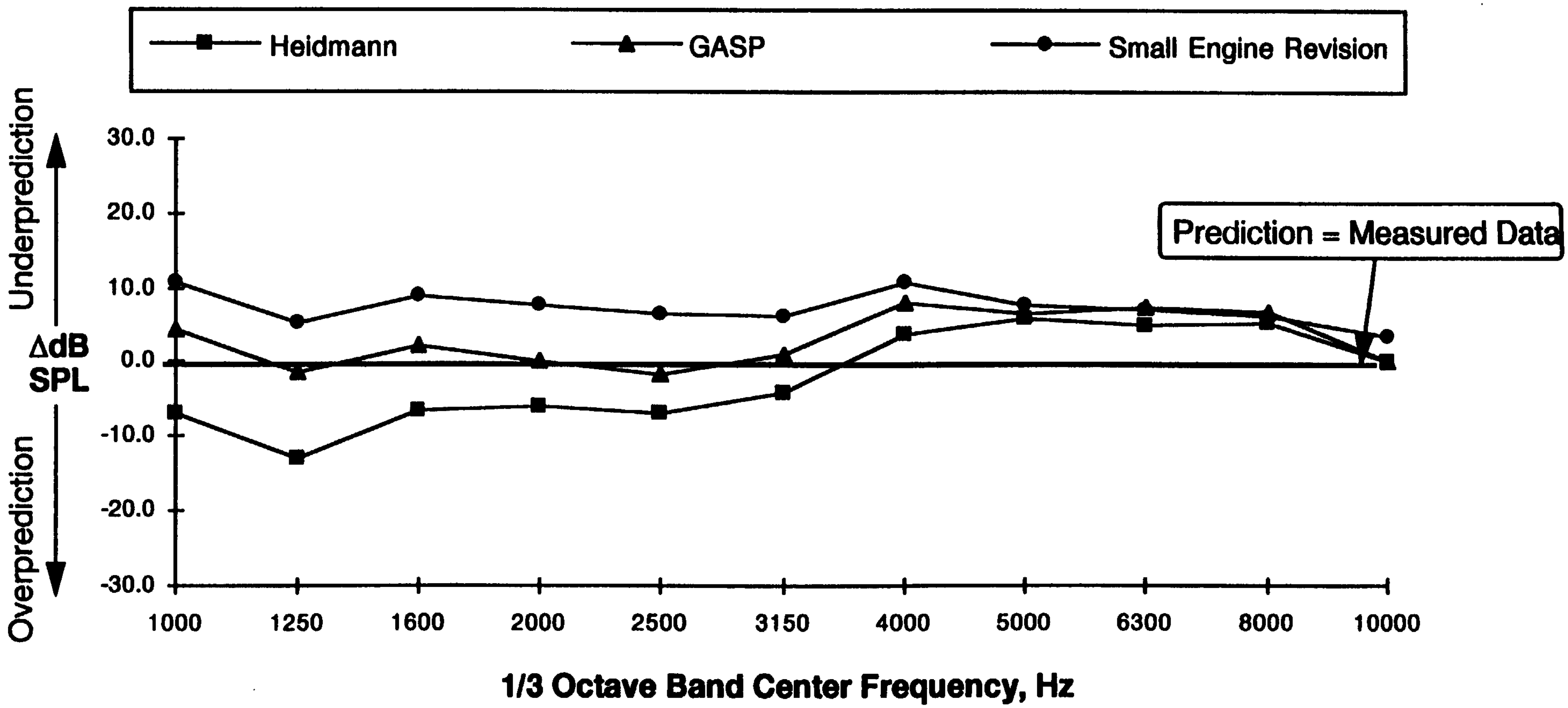
Revised Prediction versus Heidmann and GASP
Engine 1, 85% speed, Mtr = 1.1




Revised Prediction versus Heidmann and GASP
Engine 1, 85% speed, Mtr = 1.1
(40° from inlet centerline)
(Run #185, Blade pass = 4650 Hz)
Heidmann
GASP
Small Engine Revision
Prediction = Measured Data
Underprediction
ΔdB SPL
Overprediction
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
1/3 Octave Band Center Frequency, Hz

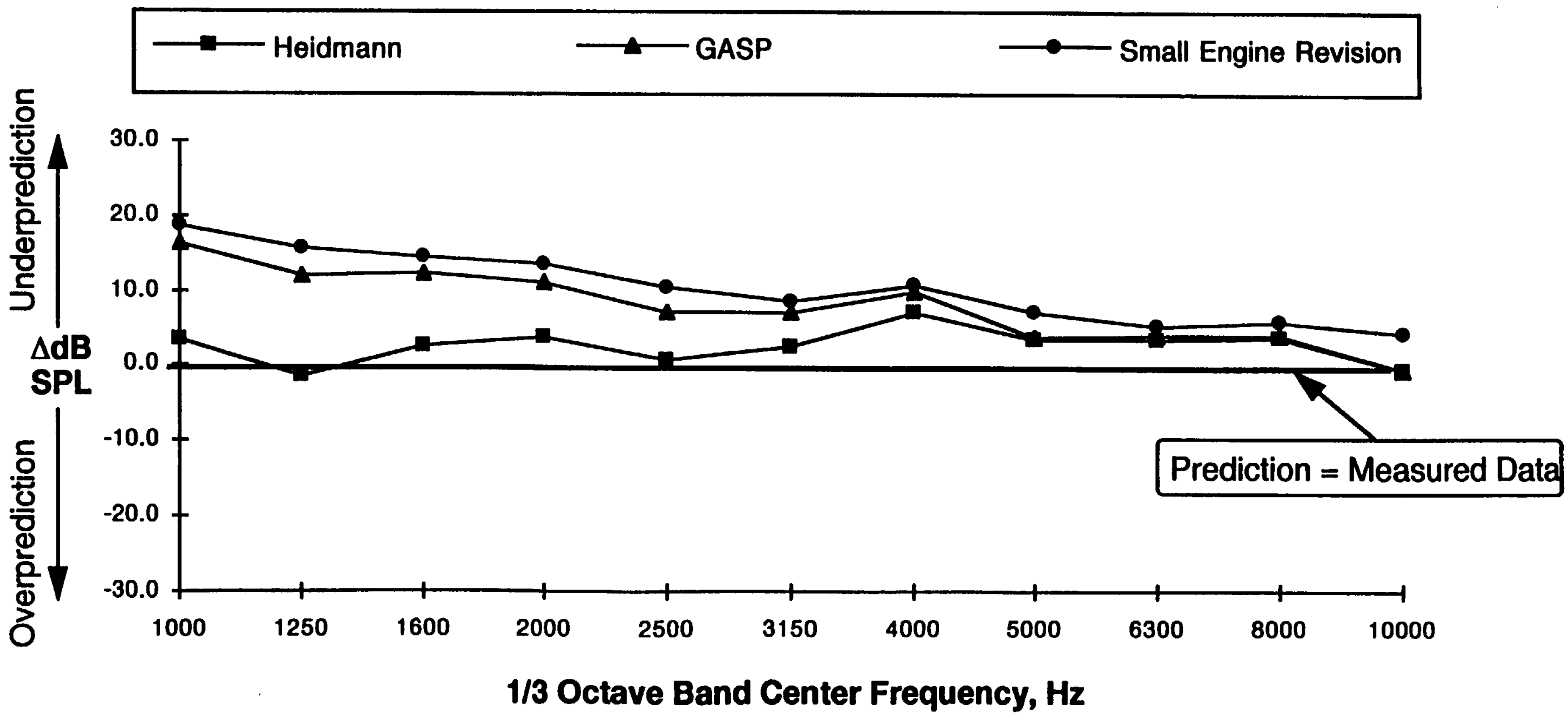
Revised Prediction versus Heidmann and GASP
Engine 1, 85% speed, Mtr = 1.1
(80° from inlet centerline)

(Run #185, Blade pass = 4650 Hz)



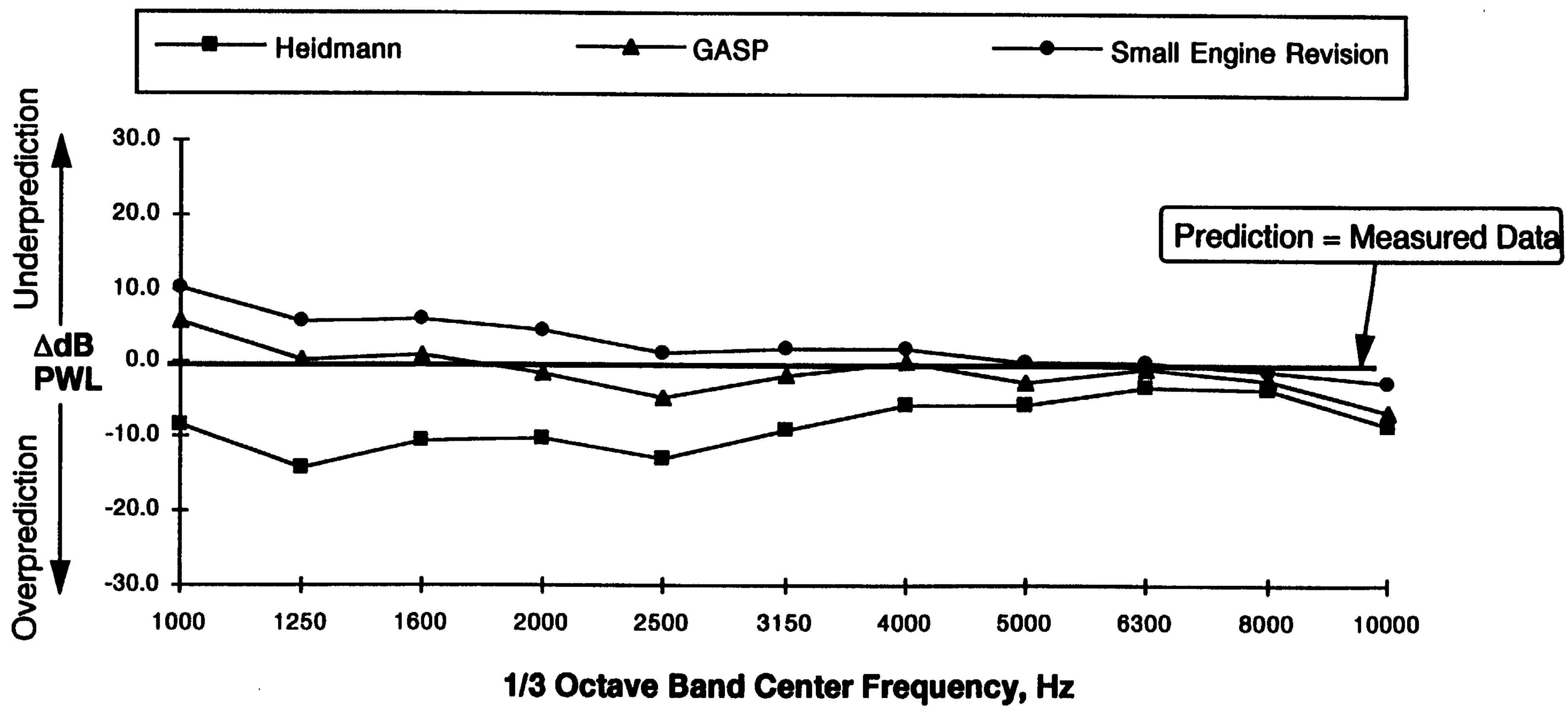
Revised Prediction versus Heidmann and GASP
Engine 1, 85% speed, Mtr = 1.1
(120° from inlet centerline)

(Run #185, Blade pass = 4650 Hz)

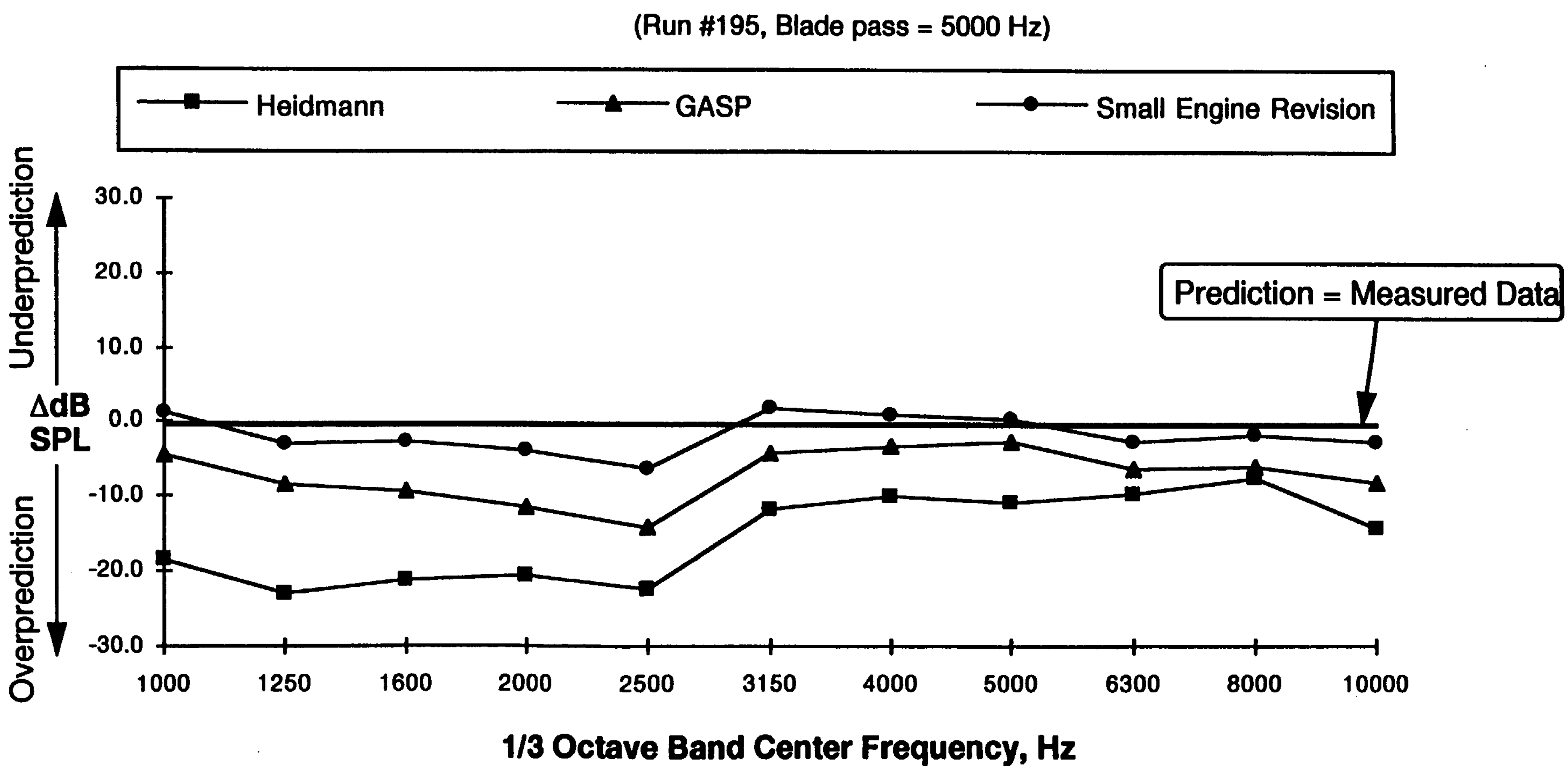


Revised Prediction versus Heidmann and GASP
Engine 1, 95% speed, Mtr = 1.2

(Run #195, Blade pass = 5000 Hz)

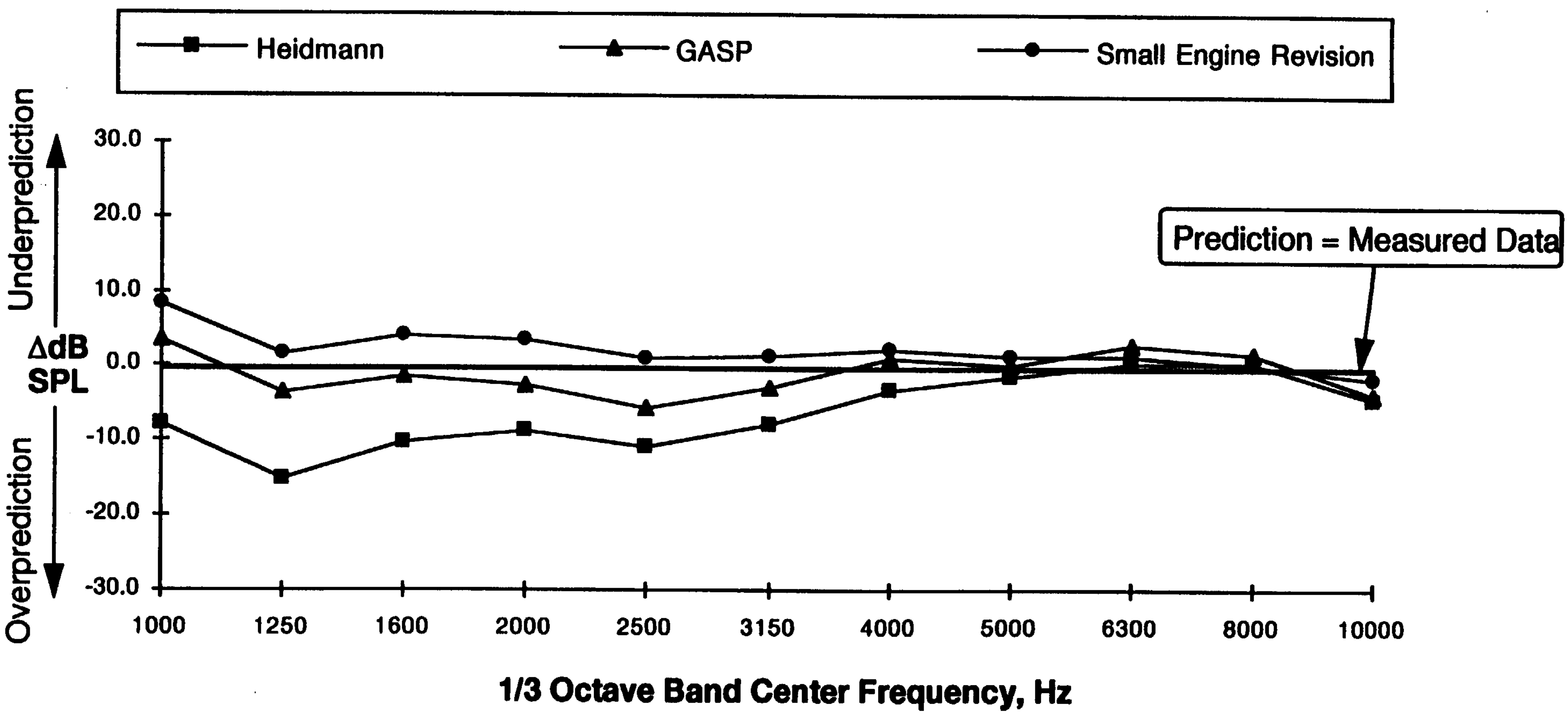


Revised Prediction versus Heidmann and GASP
Engine 1, 95% speed, Mtr = 1.2
(40° from inlet centerline)

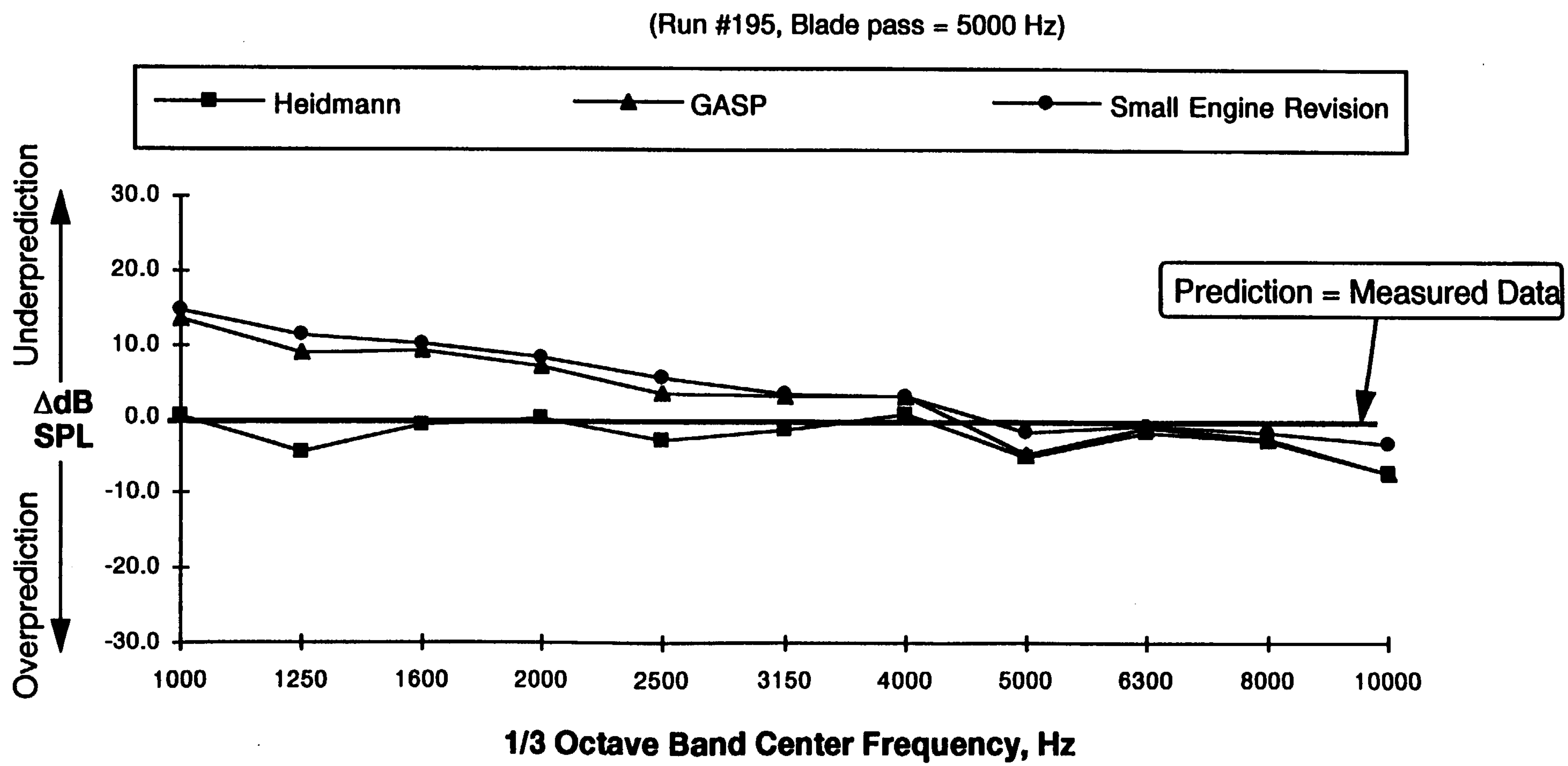


Revised Prediction versus Heidmann and GASP
Engine 1, 95% speed, Mtr = 1.2
(80° from inlet centerline)

(Run #195, Blade pass = 5000 Hz)

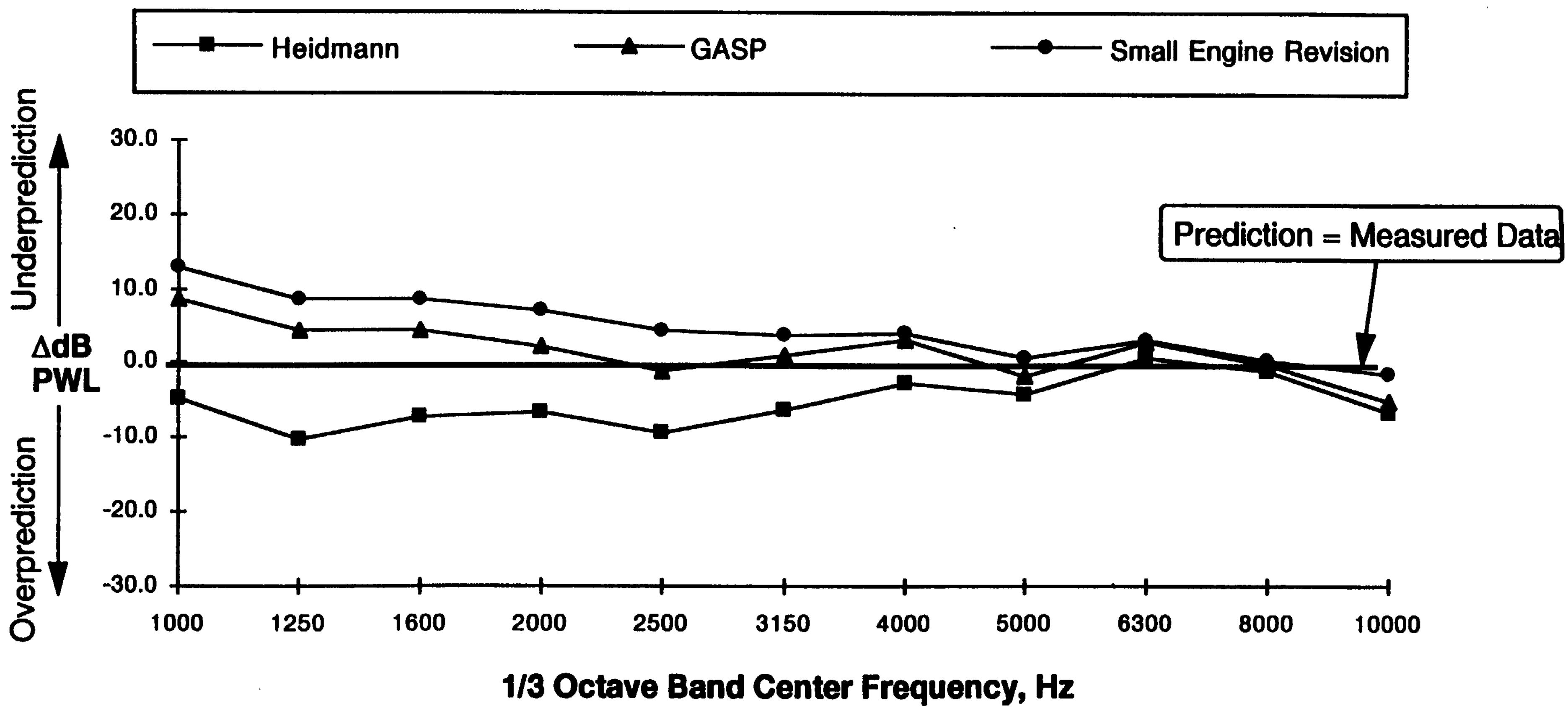


Revised Prediction versus Heidmann and GASP
Engine 1, 95% speed, Mtr = 1.2
(120° from inlet centerline)

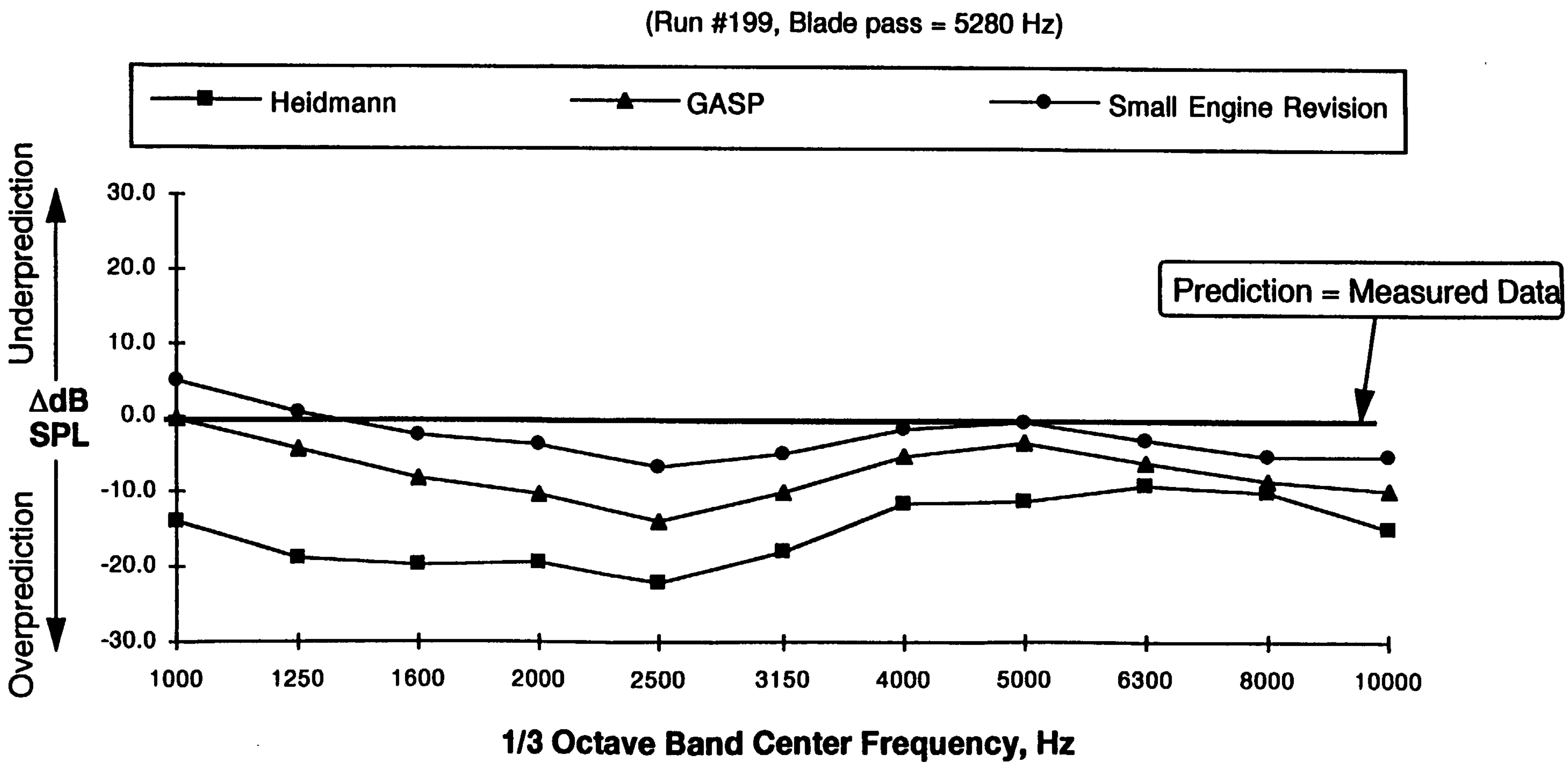


Revised Prediction versus Heidmann and GASP
Engine 1, 99% speed, Mtr = 1.3

(Run #199, Blade pass = 5280 Hz)

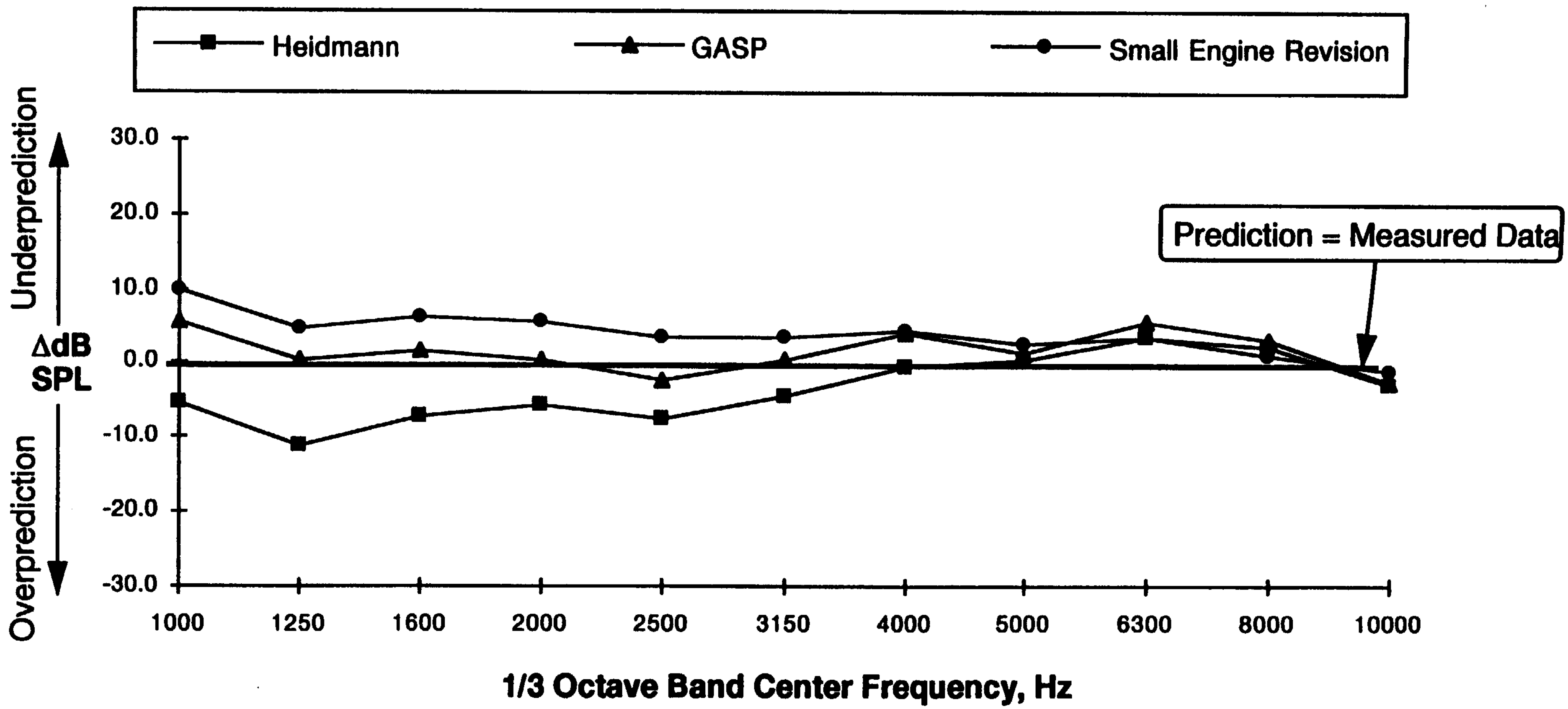


Revised Prediction versus Heidmann and GASP
Engine 1, 99% speed, Mtr = 1.3
(40° from inlet centerline)

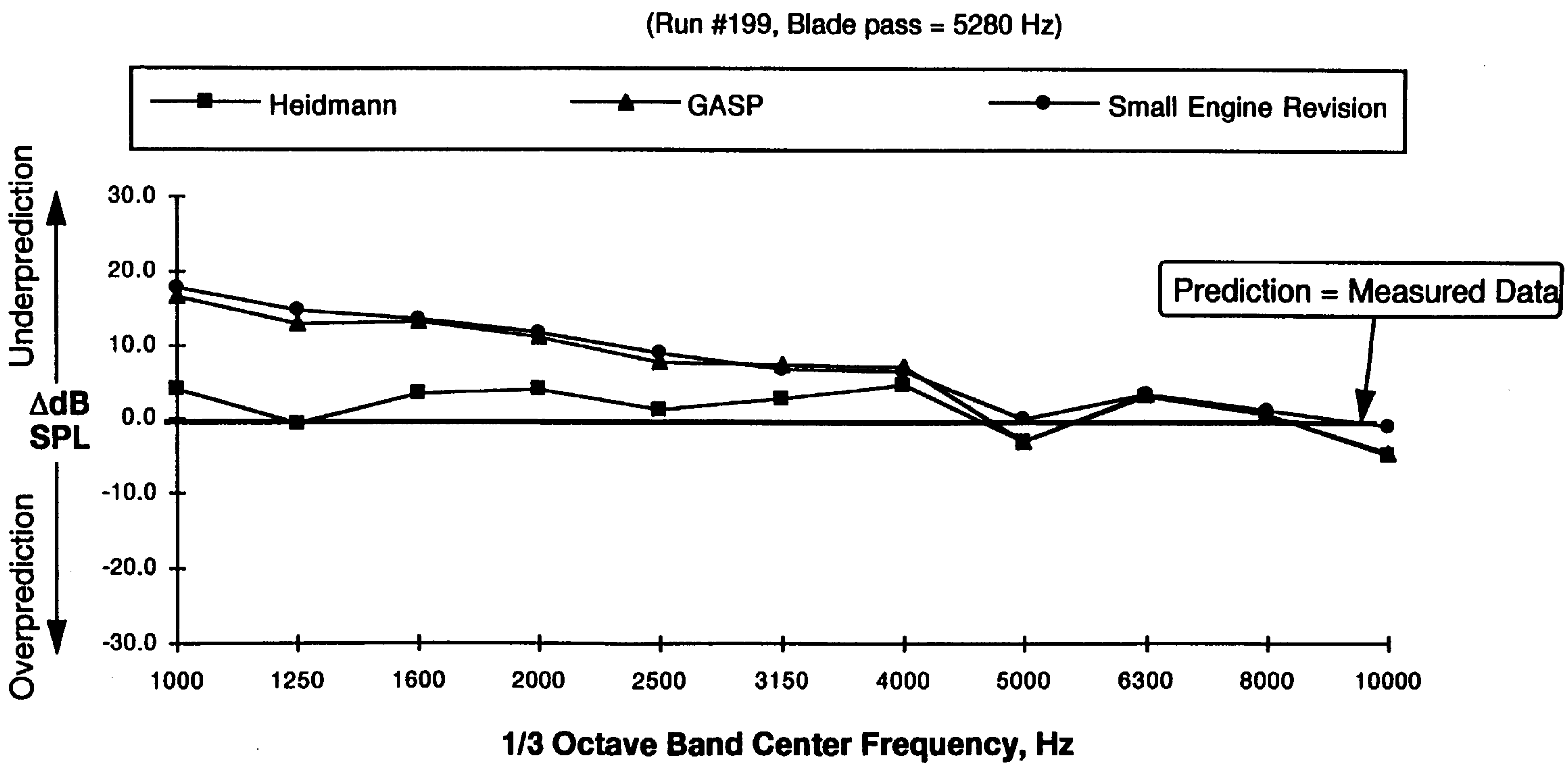


Revised Prediction versus Heidmann and GASP
Engine 1, 99% speed, Mtr = 1.3
(80° from inlet centerline)

(Run #199, Blade pass = 5280 Hz)



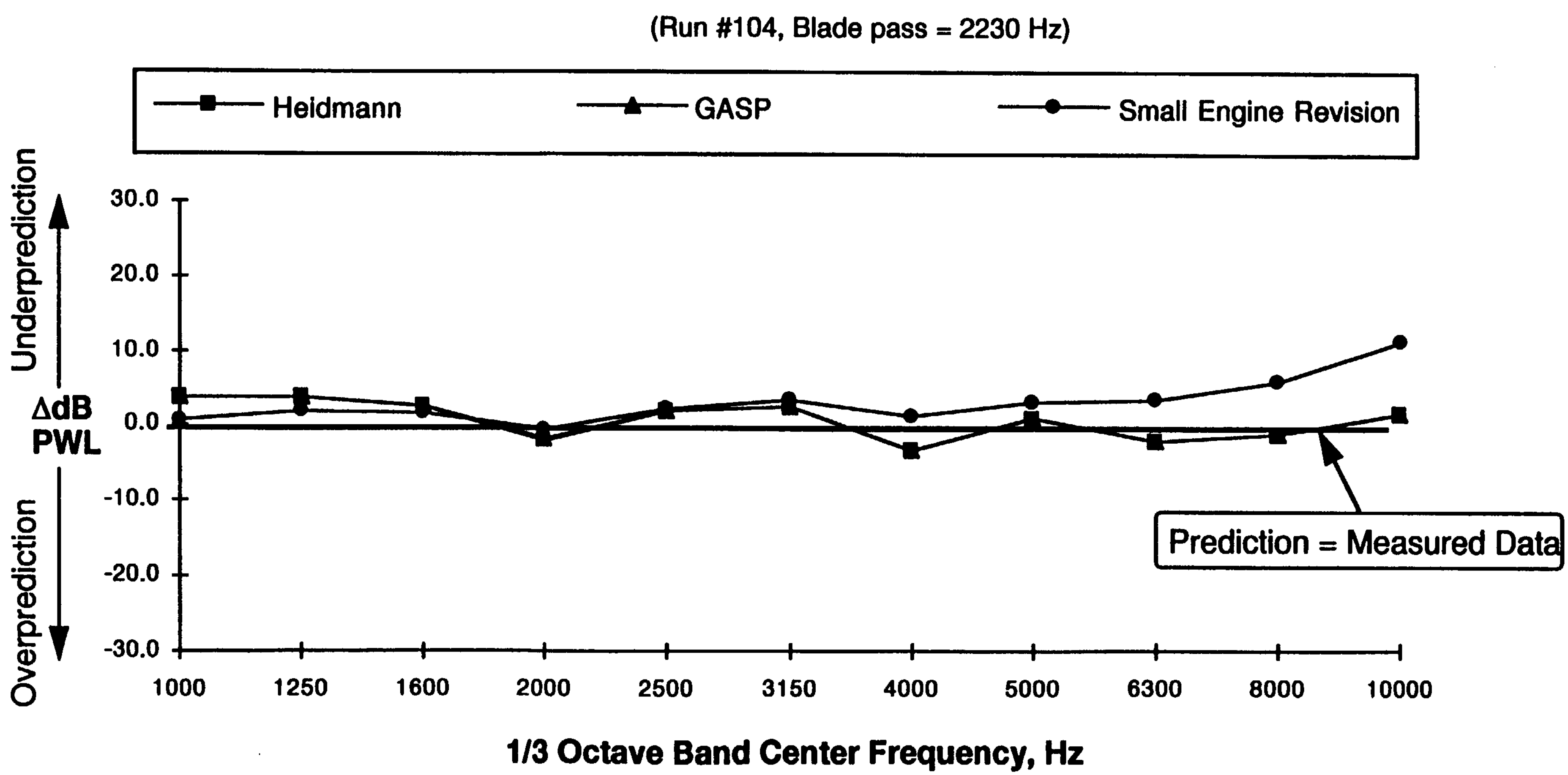
Revised Prediction versus Heidmann and GASP
Engine 1, 99% speed, Mtr = 1.3
(120° from inlet centerline)



APPENDIX III

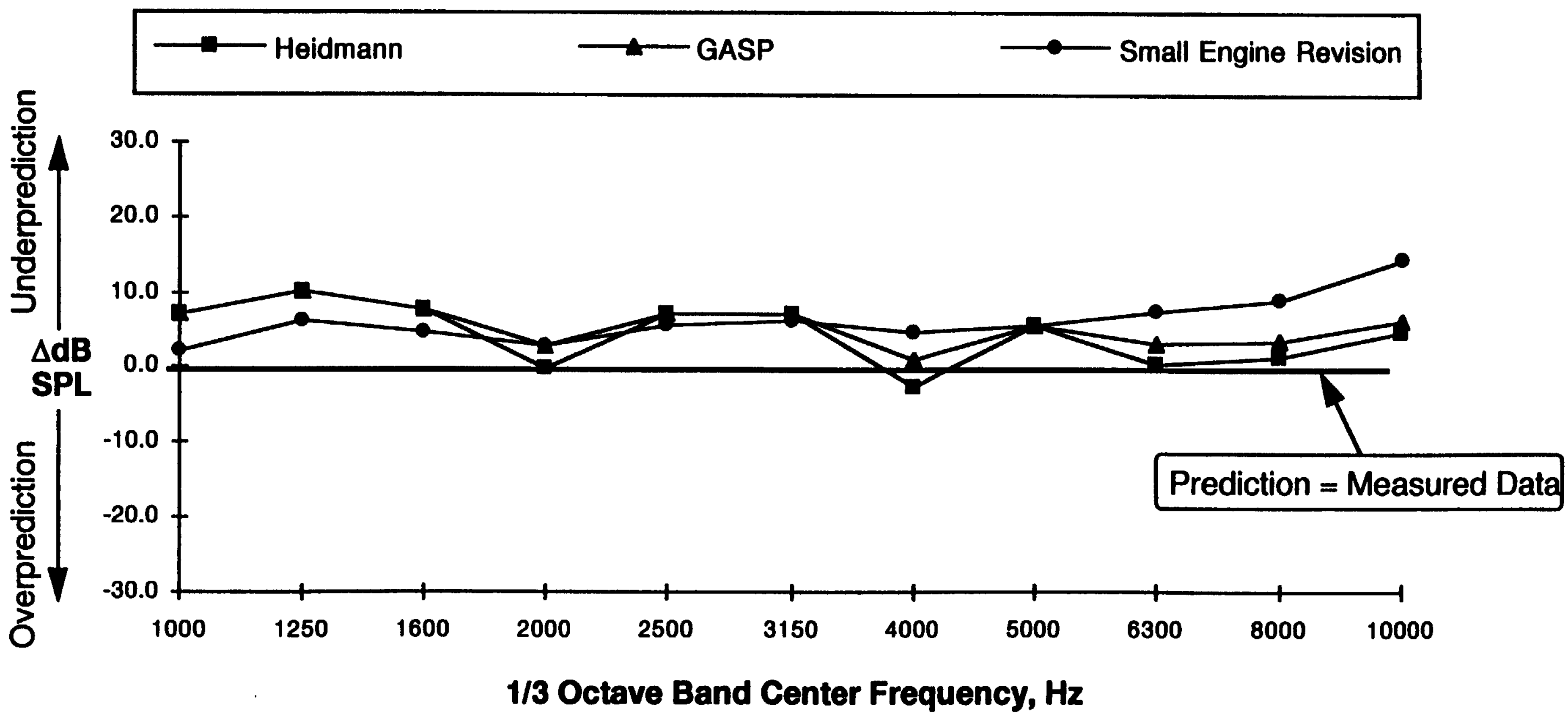
MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 2
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHz, dB

Revised Prediction versus Heidmann and GASP
Engine 2, 61% speed, Mtr = 0.8



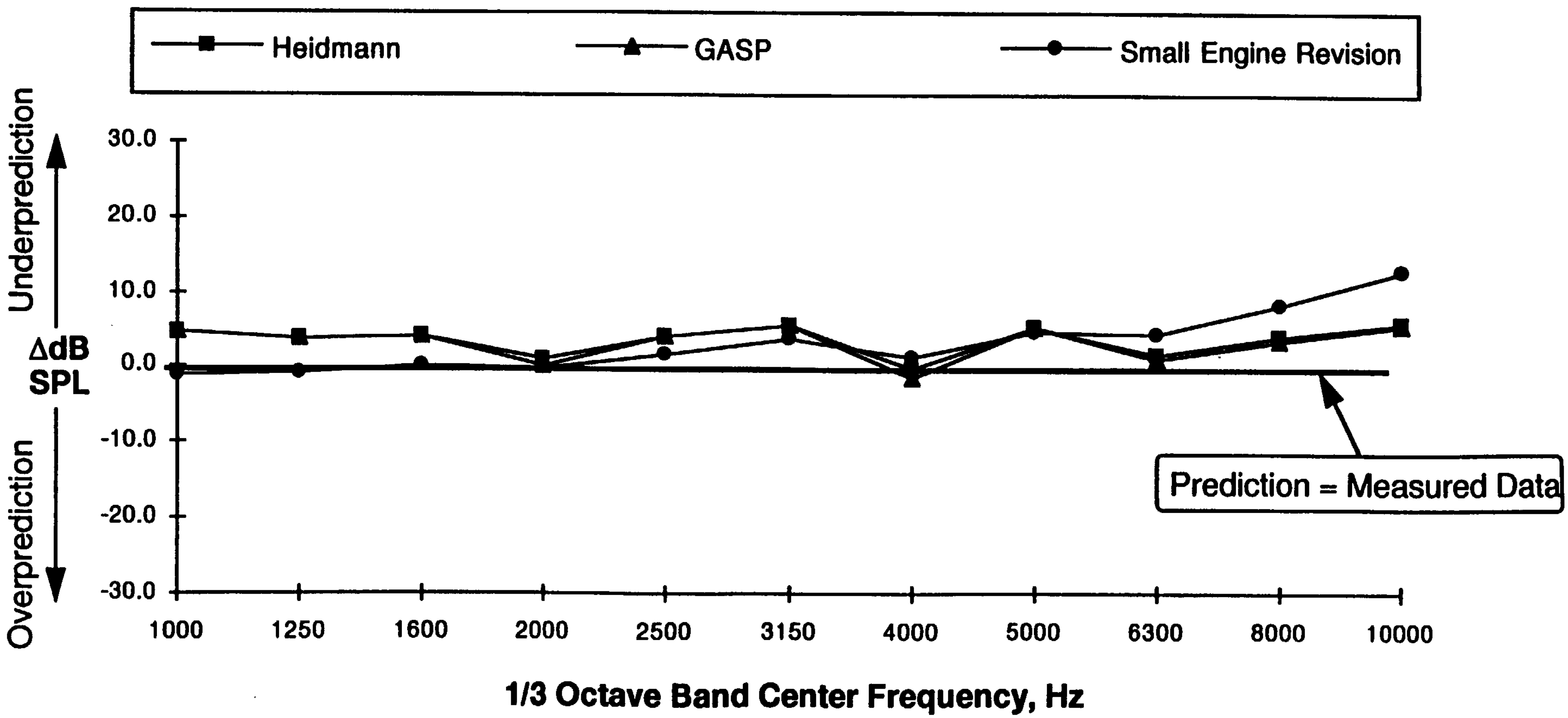
Revised Prediction versus Heidmann and GASP
Engine 2, 61% speed, Mtr = 0.8
(40° from inlet centerline)

(Run #104, Blade pass = 2230 Hz)

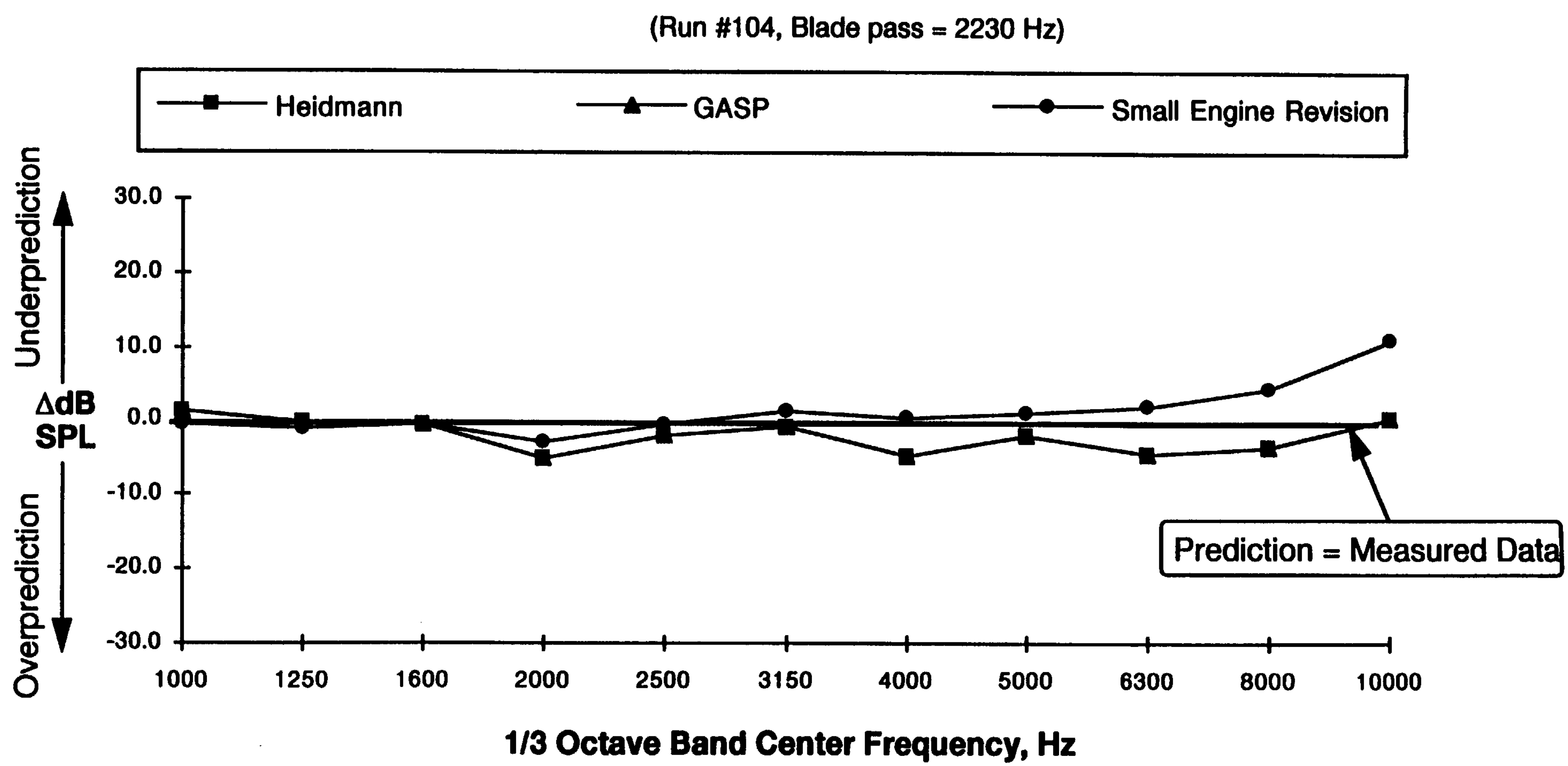


Revised Prediction versus Heidmann and GASP
Engine 2, 61% speed, Mtr = 0.8
(80° from inlet centerline)

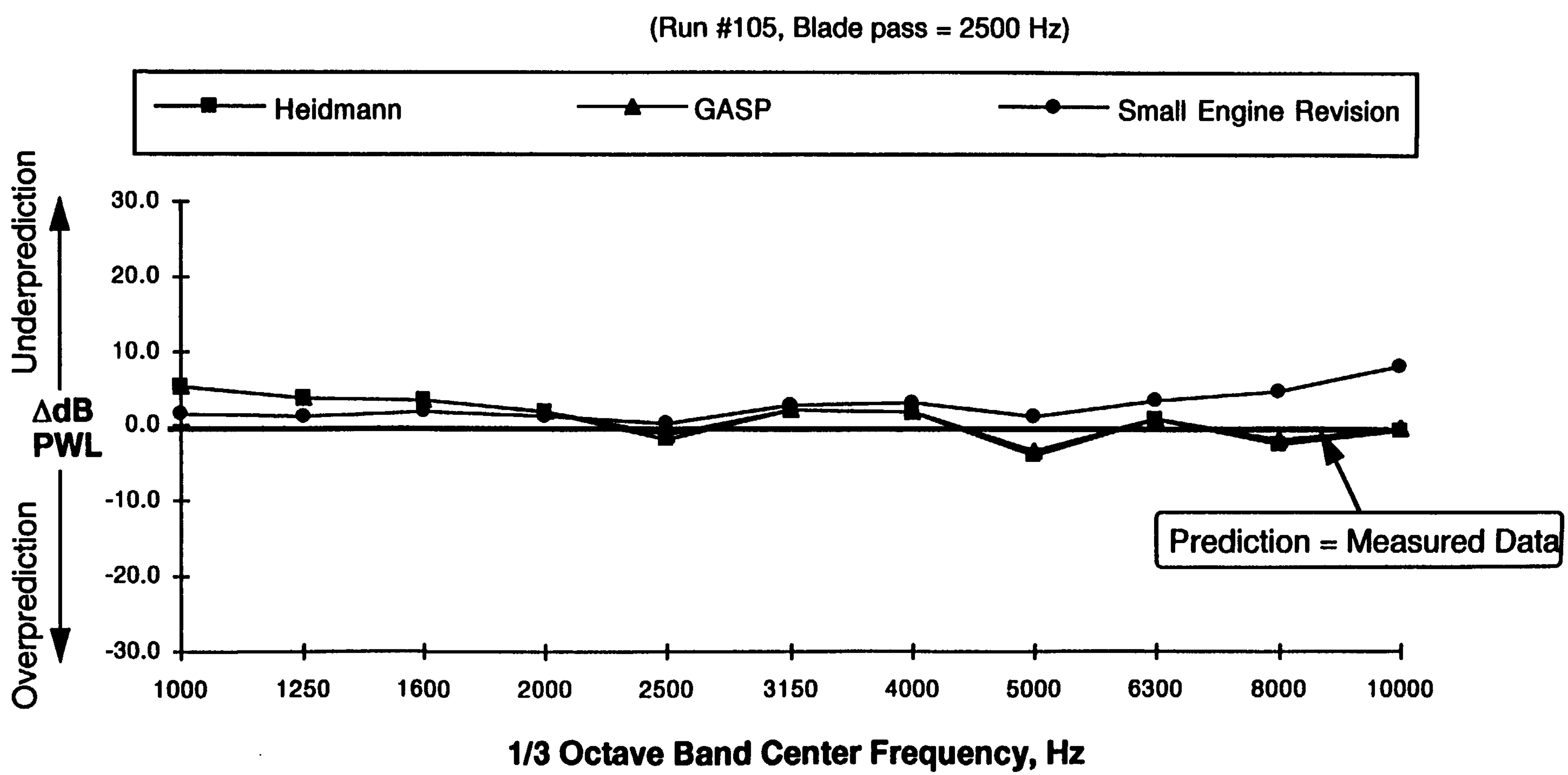
(Run #104, Blade pass = 2230 Hz)



Revised Prediction versus Heidmann and GASP
Engine 2, 61% speed, Mtr = 0.8
(120° from inlet centerline)

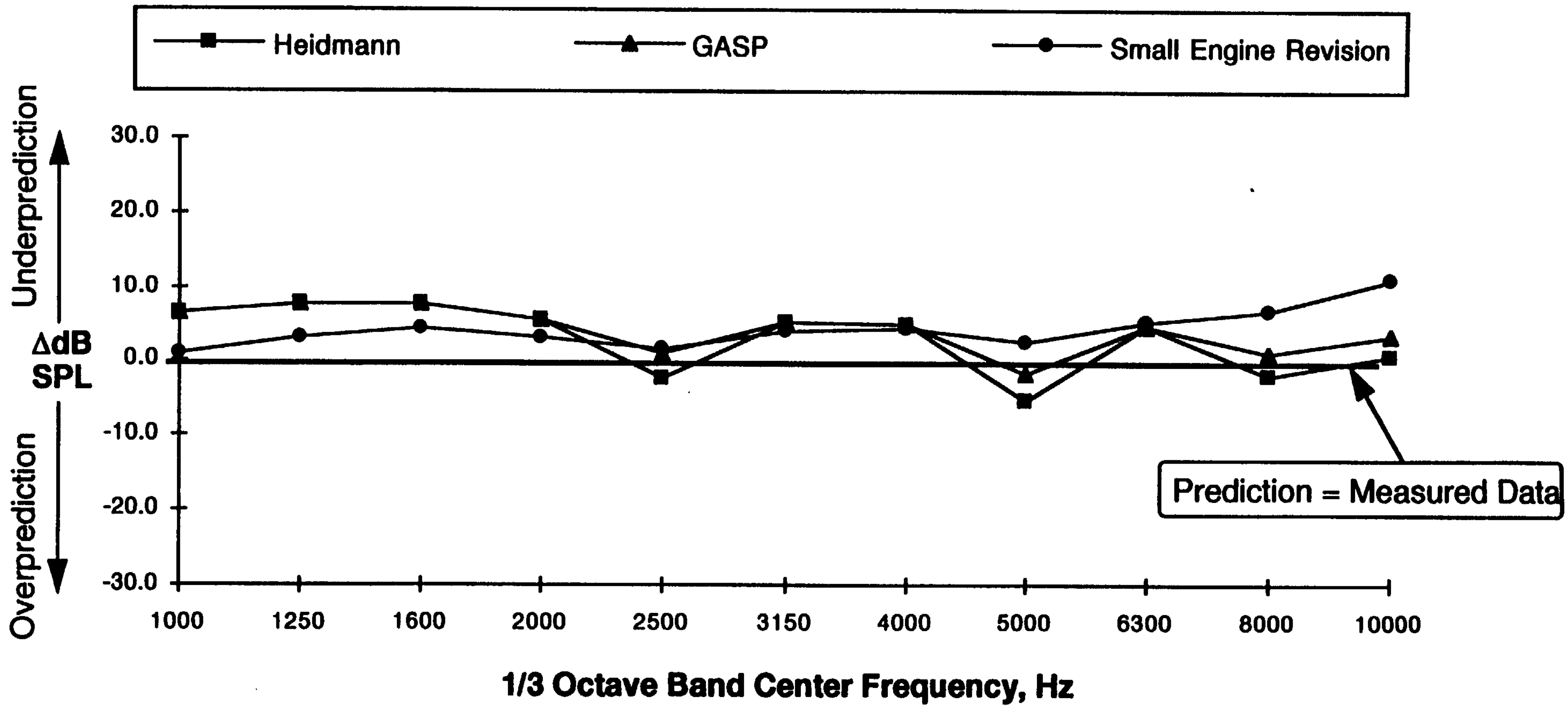


Revised Prediction versus Heidmann and GASP
Engine 2, 68% speed, Mtr = 0.9

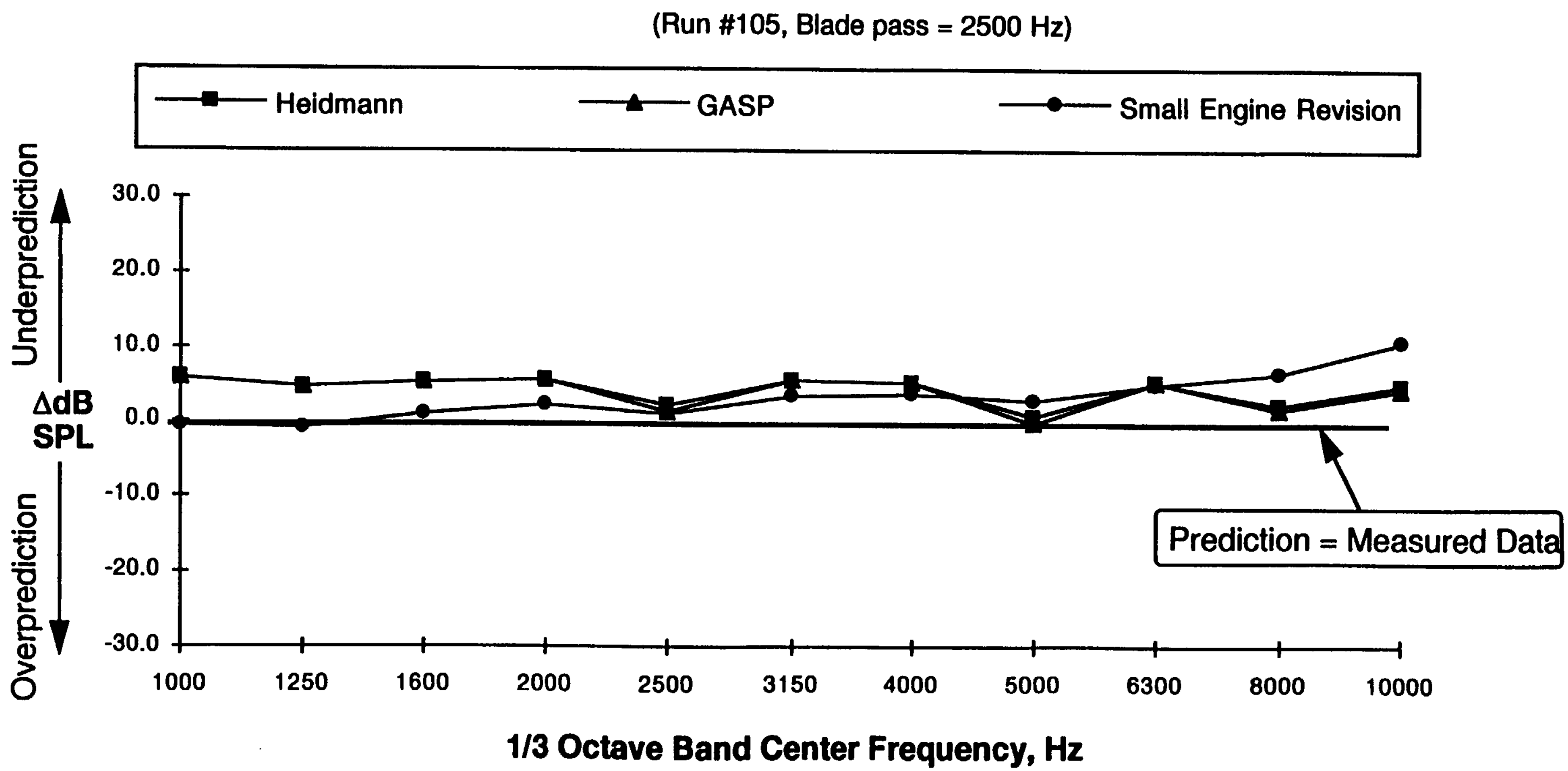


Revised Prediction versus Heidmann and GASP
Engine 2, 68% speed, Mtr = 0.9
(40° from inlet centerline)

(Run #105, Blade pass = 2500 Hz)

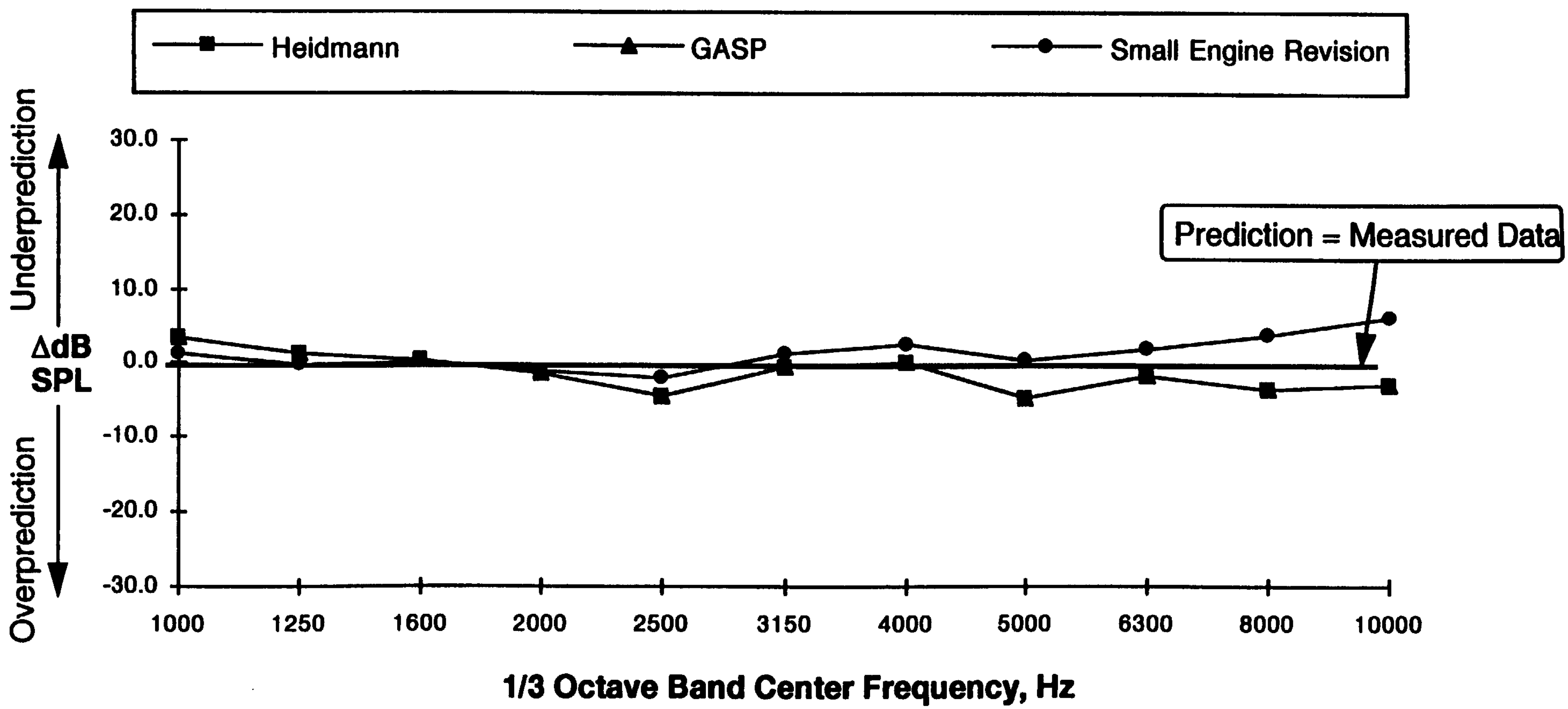


Revised Prediction versus Heidmann and GASP
Engine 2, 68% speed, Mtr = 0.9
(80° from inlet centerline)



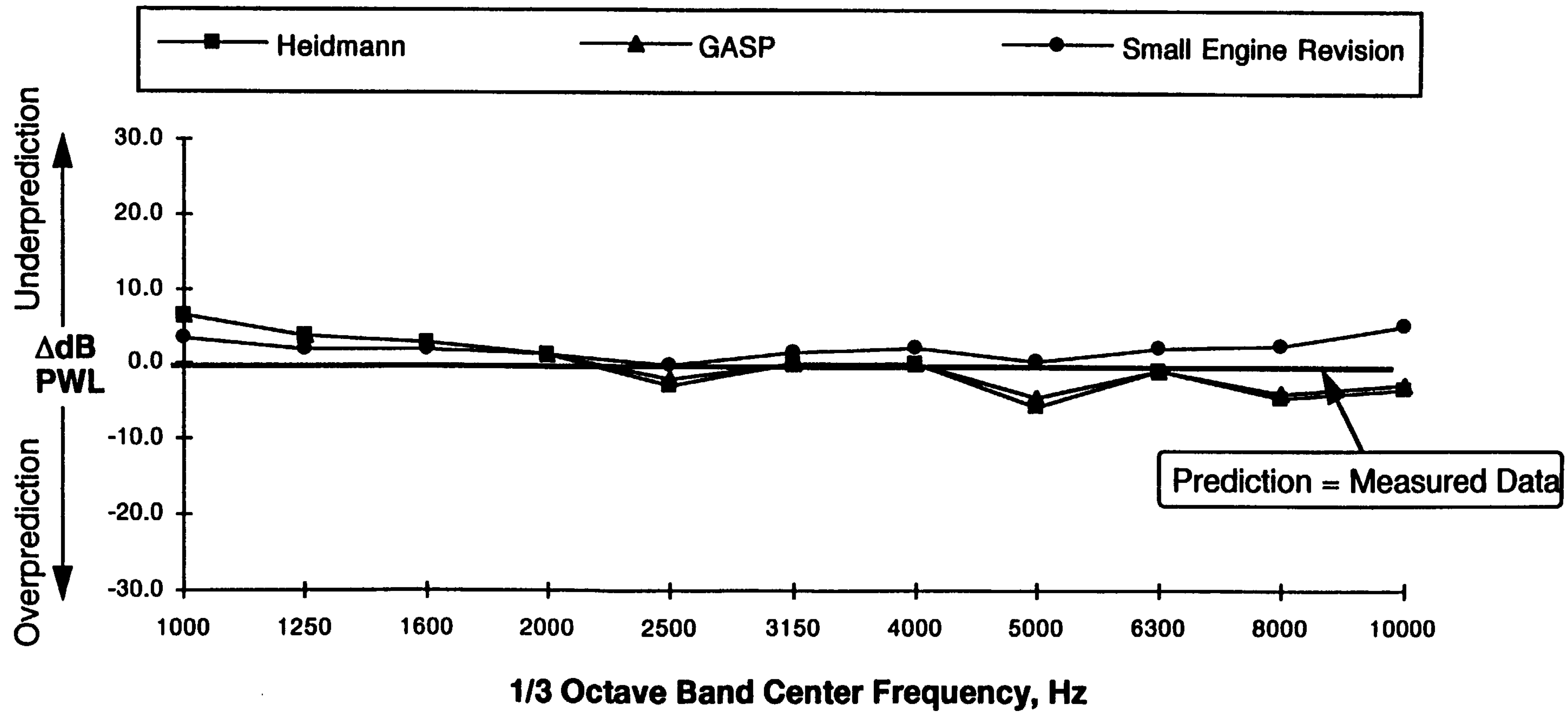
Revised Prediction versus Heidmann and GASP
Engine 2, 68% speed, Mtr = 0.9
(120° from inlet centerline)

(Run #105, Blade pass = 2500 Hz)



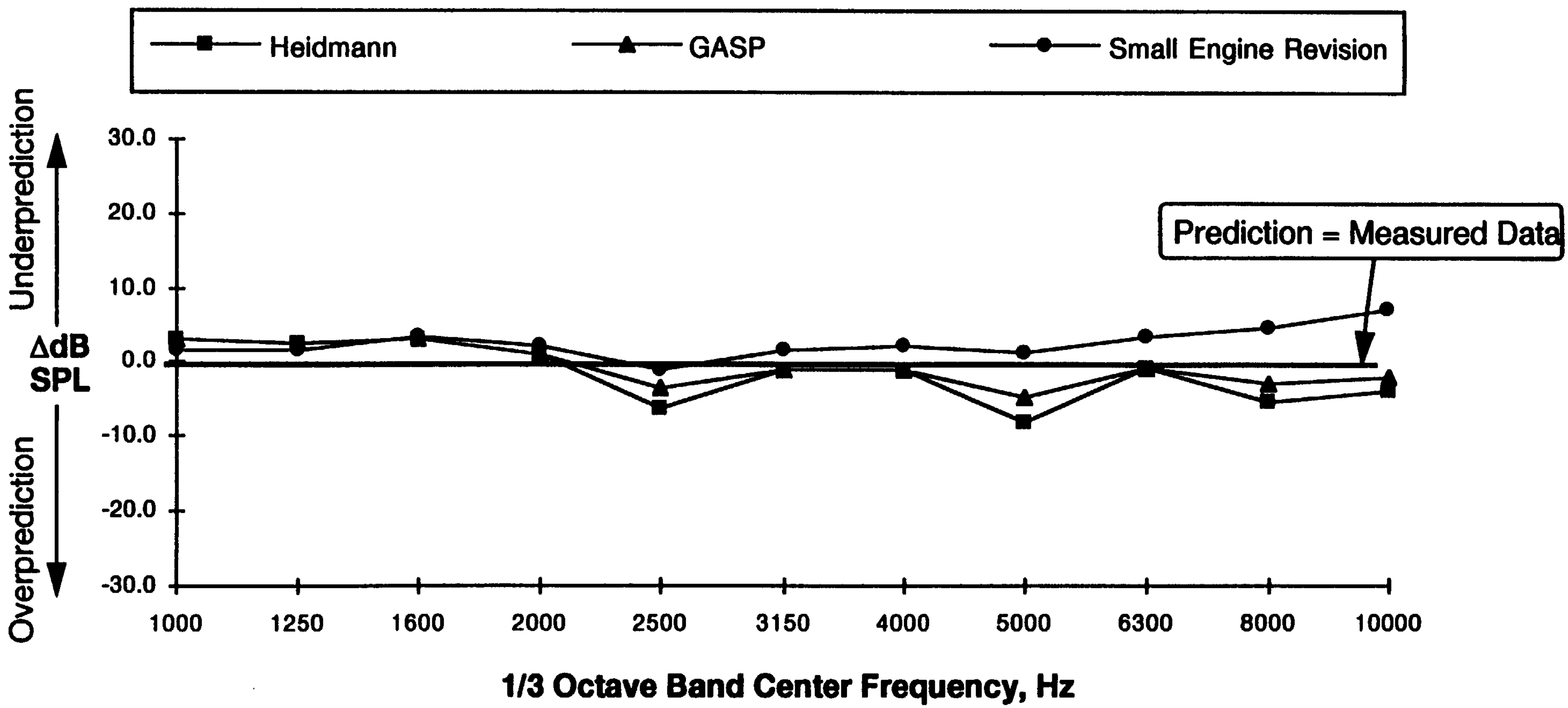
Revised Prediction versus Heidmann and GASP
Engine 2, 75% speed, Mtr = 1.0

(Run #106, Blade pass = 2750 Hz)

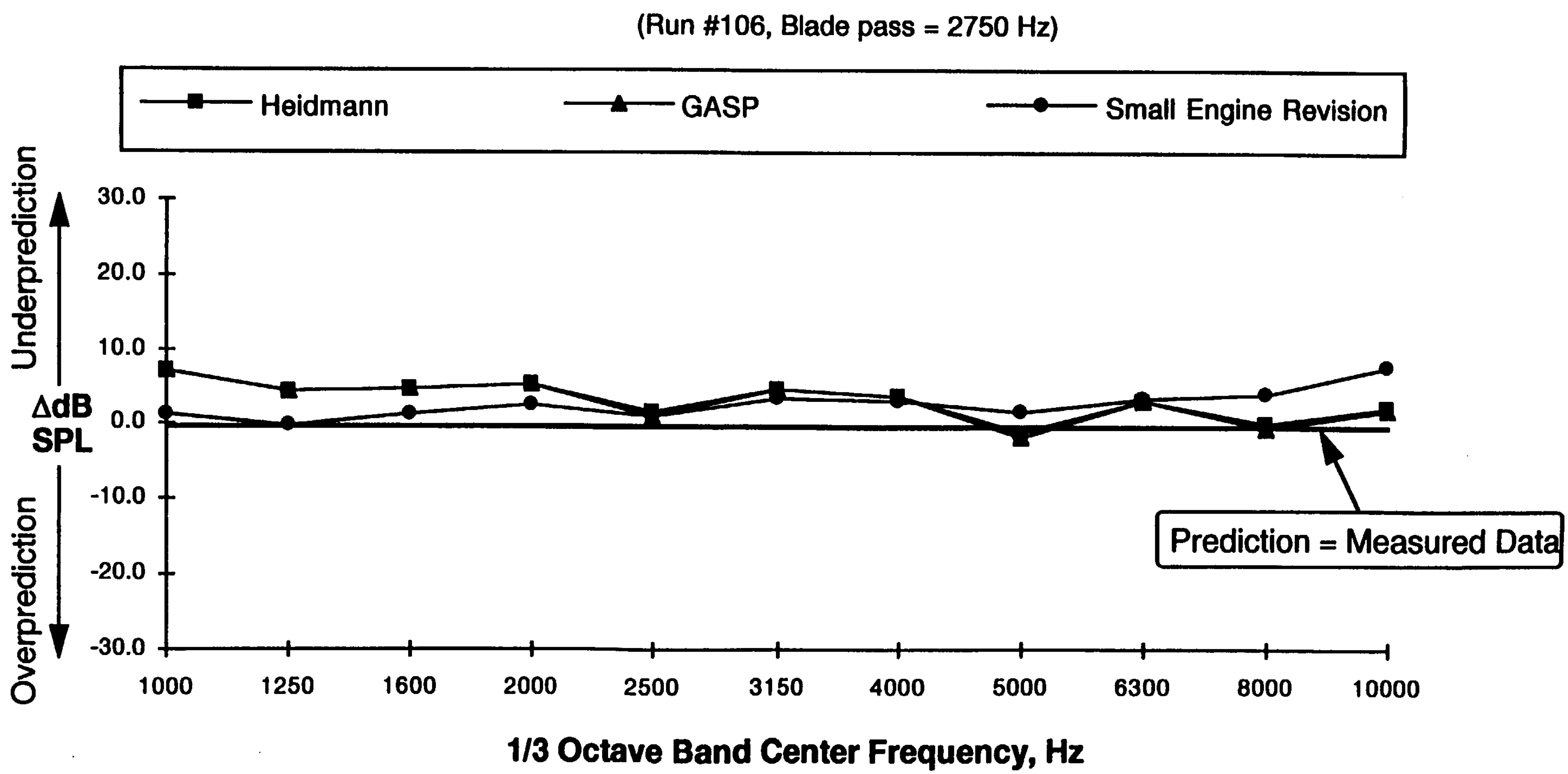


Revised Prediction versus Heidmann and GASP
Engine 2, 75% speed, Mtr = 1.0
(40° from inlet centerline)

(Run #106, Blade pass = 2750 Hz)

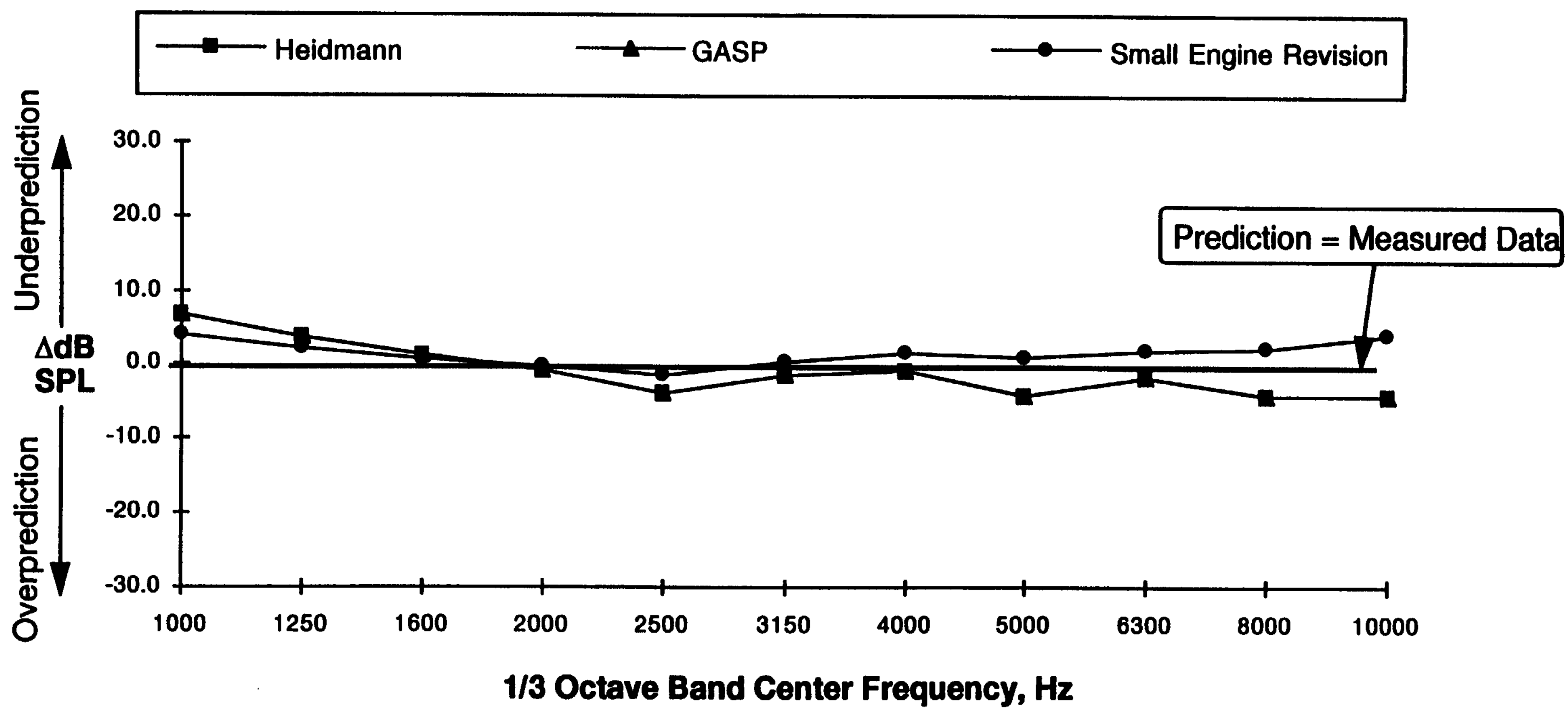


Revised Prediction versus Heidmann and GASP
Engine 2, 75% speed, Mtr = 1.0
(80° from inlet centerline)



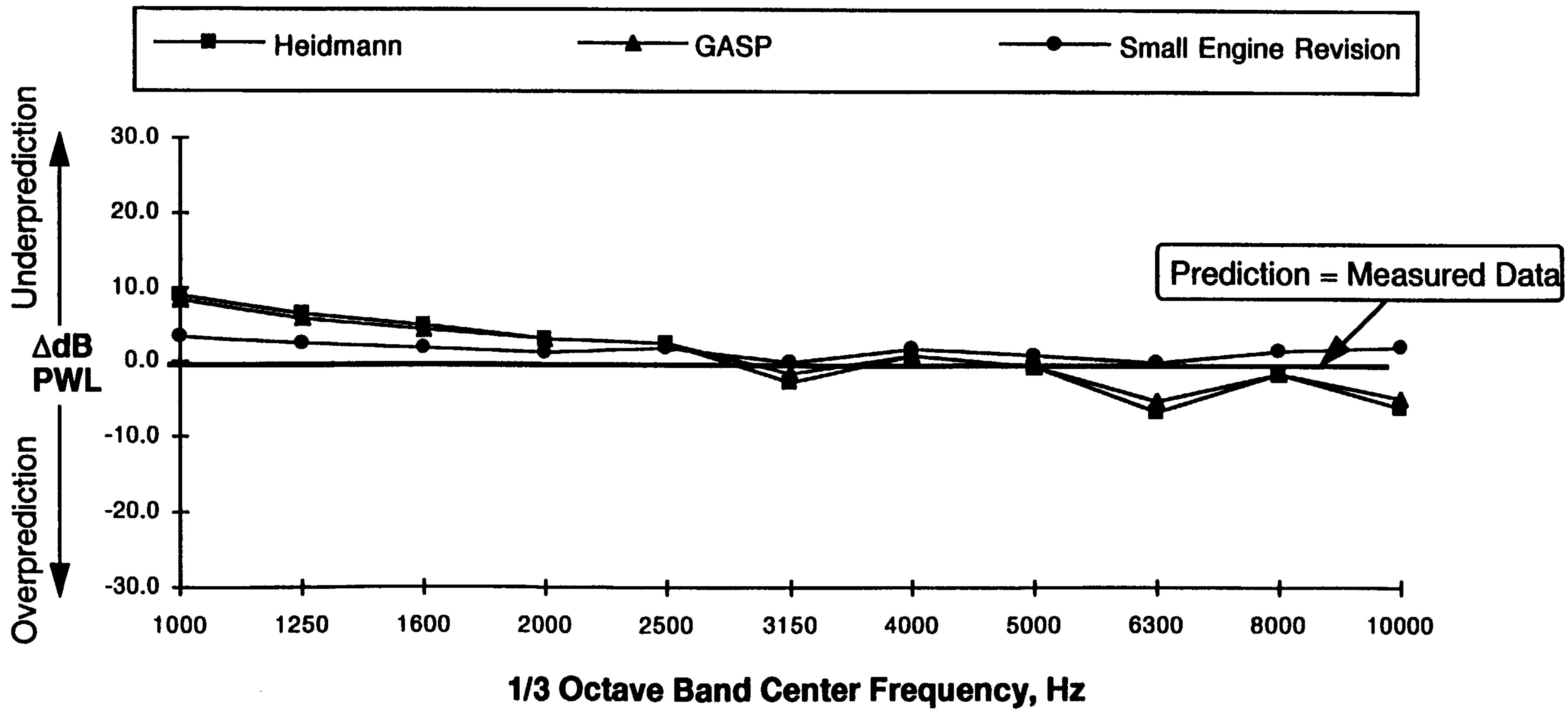
Revised Prediction versus Heidmann and GASP
Engine 2, 75% speed, Mtr = 1.0
(120° from inlet centerline)

(Run #106, Blade pass = 2750 Hz)

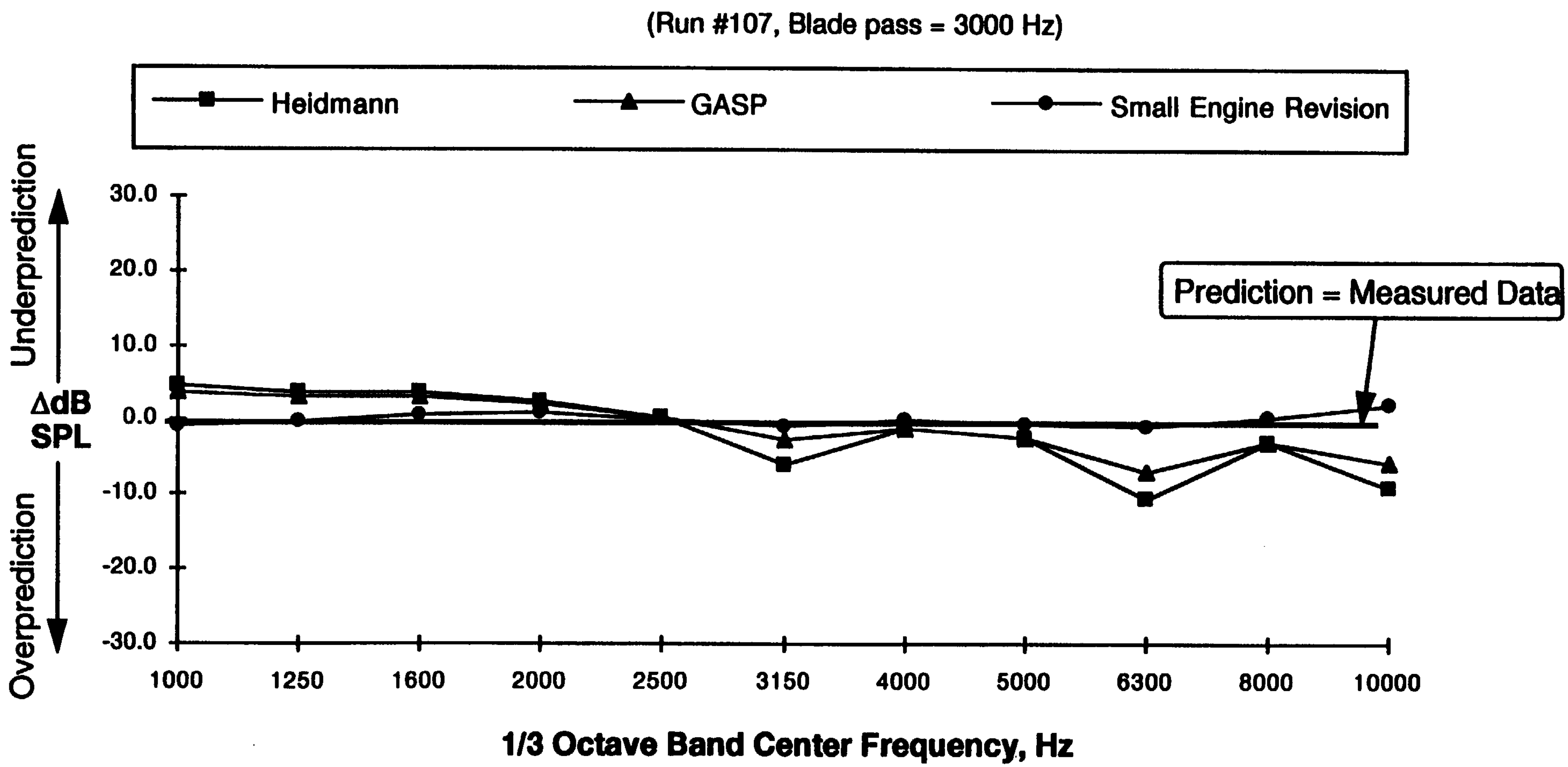


Revised Prediction versus Heidmann and GASP
Engine 2, 82% speed, Mtr = 1.05

(Run #107, Blade pass = 3000 Hz)

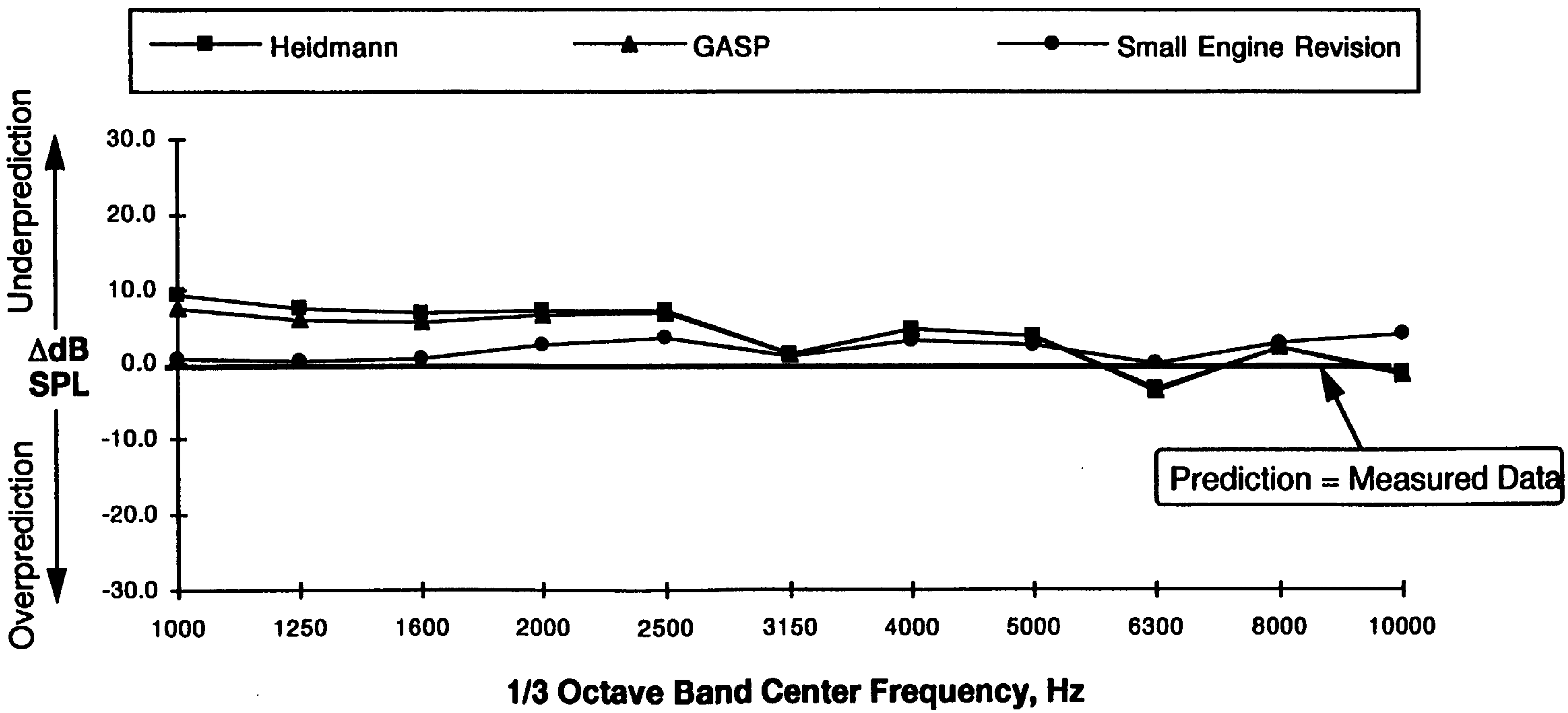


Revised Prediction versus Heidmann and GASP
Engine 2, 82% speed, Mtr = 1.05
(40° from inlet centerline)



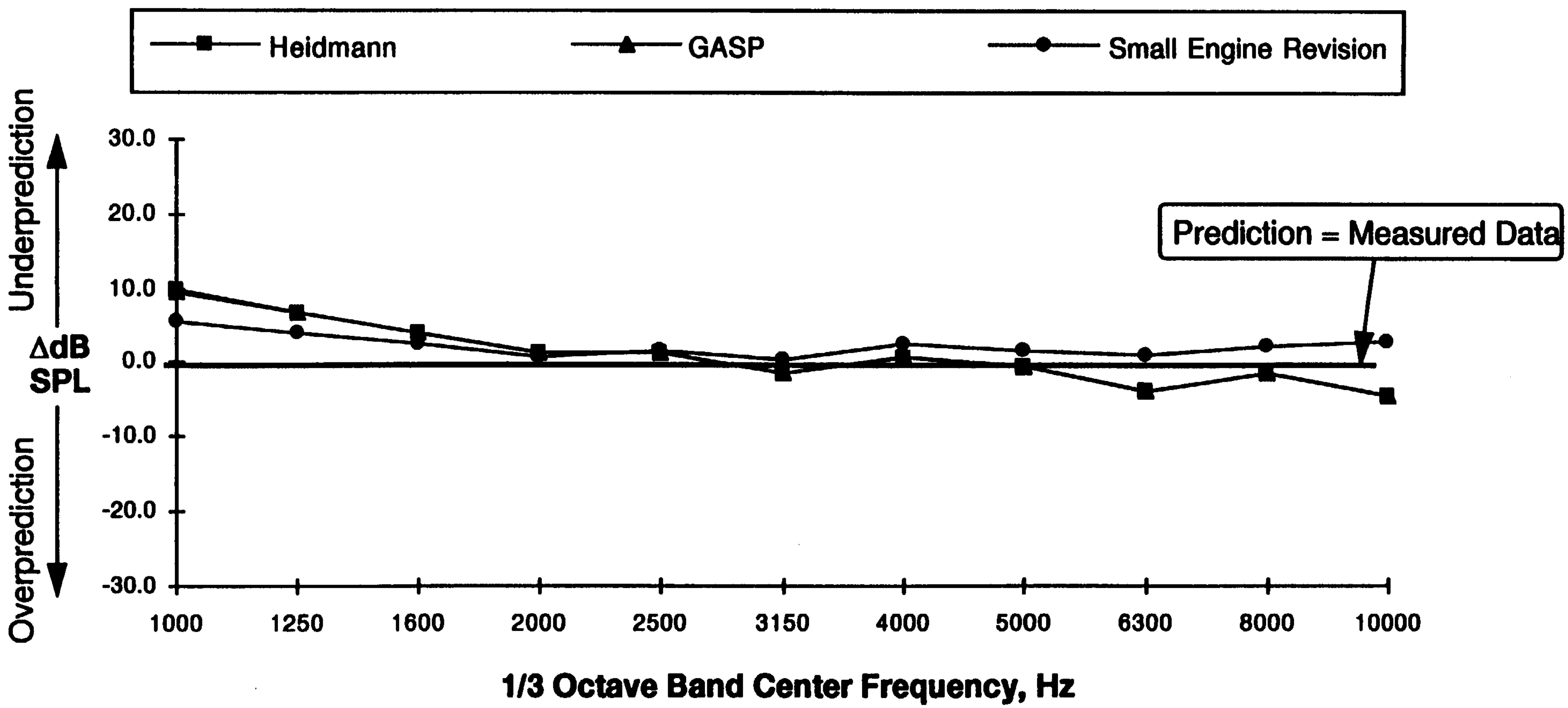
Revised Prediction versus Heidmann and GASP
Engine 2, 82% speed, Mtr = 1.05
(80° from inlet centerline)

(Run #107, Blade pass = 3000 Hz)



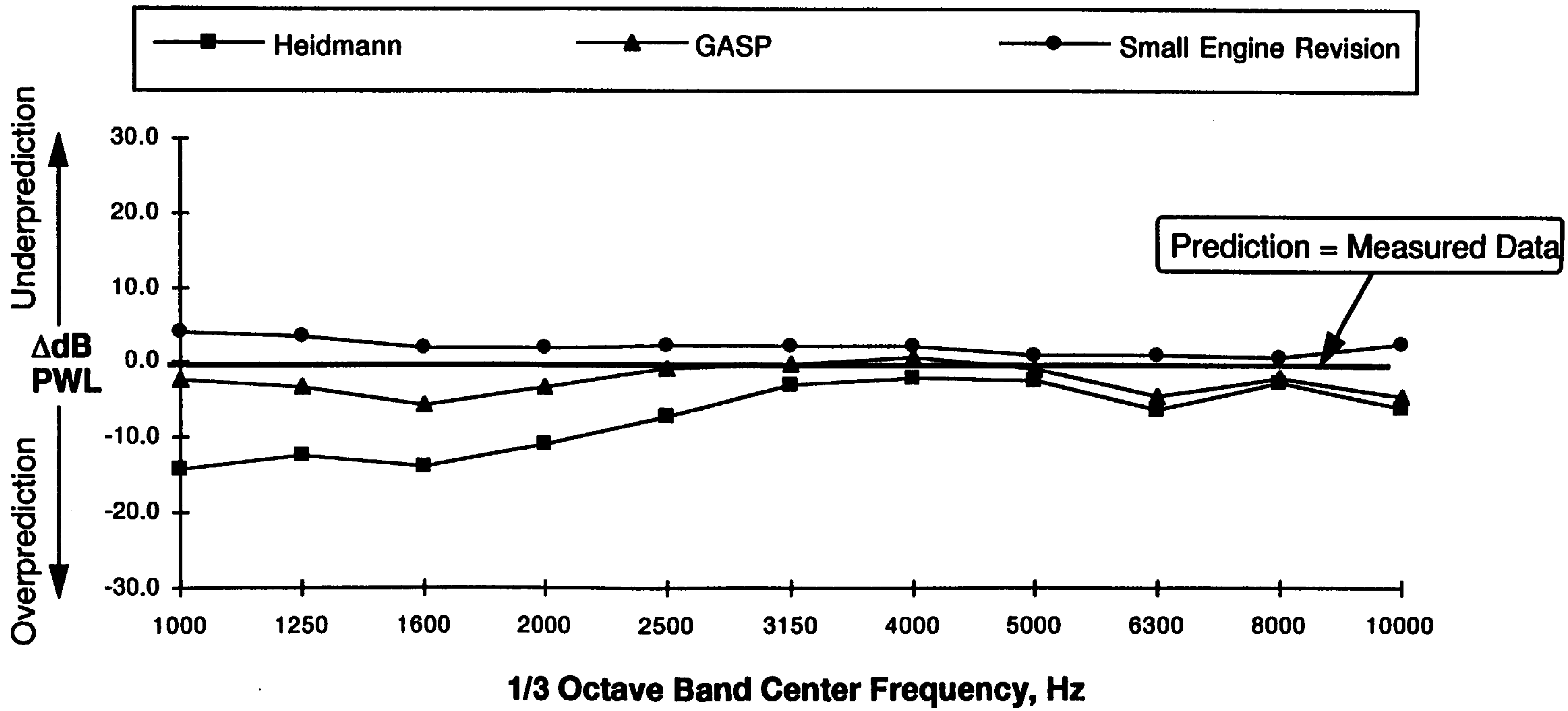
Revised Prediction versus Heidmann and GASP
Engine 2, 82% speed, Mtr = 1.05
(120° from inlet centerline)

(Run #107, Blade pass = 3000 Hz)

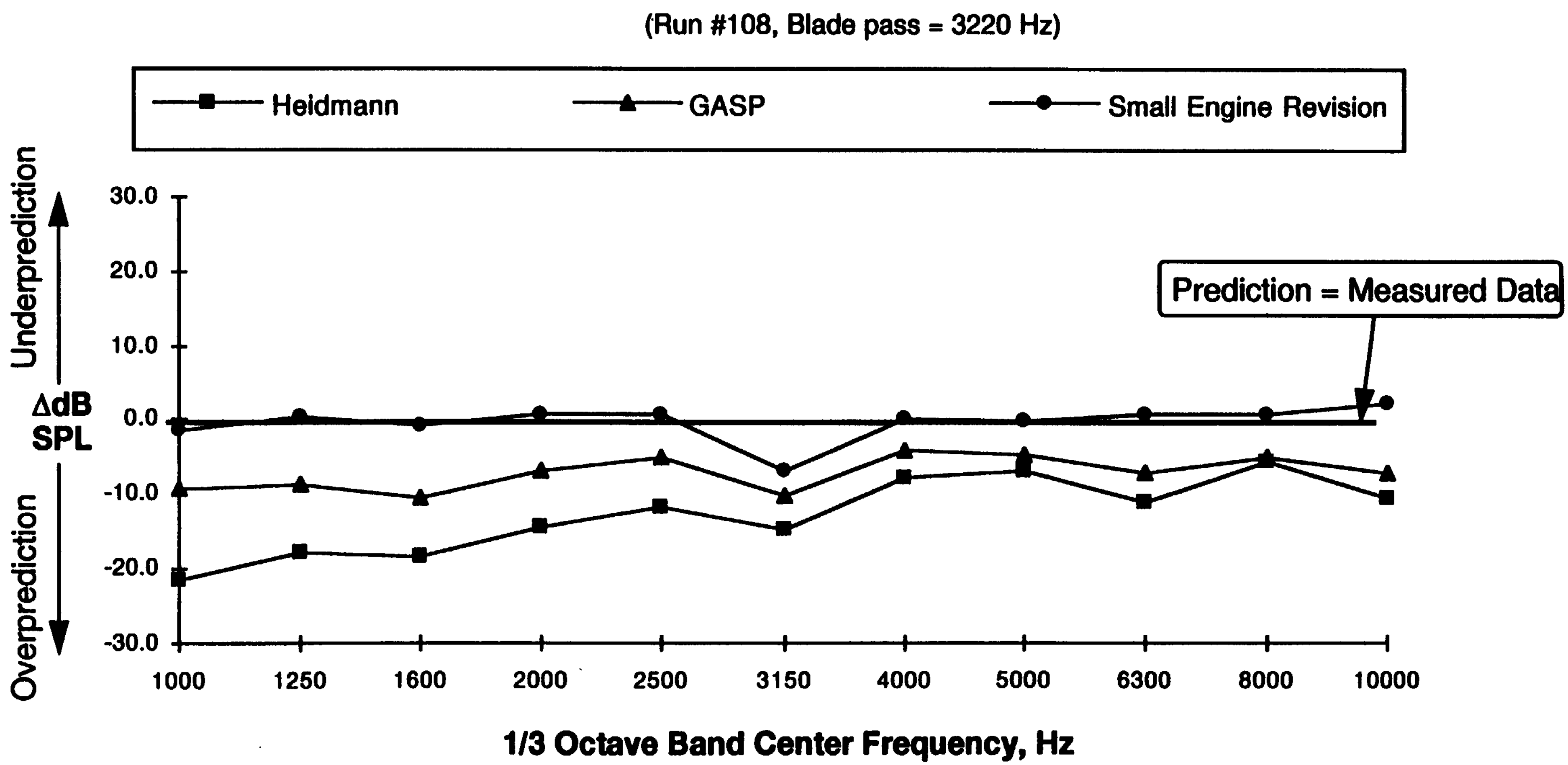


Revised Prediction versus Heidmann and GASP
Engine 2, 88% speed, Mtr = 1.1

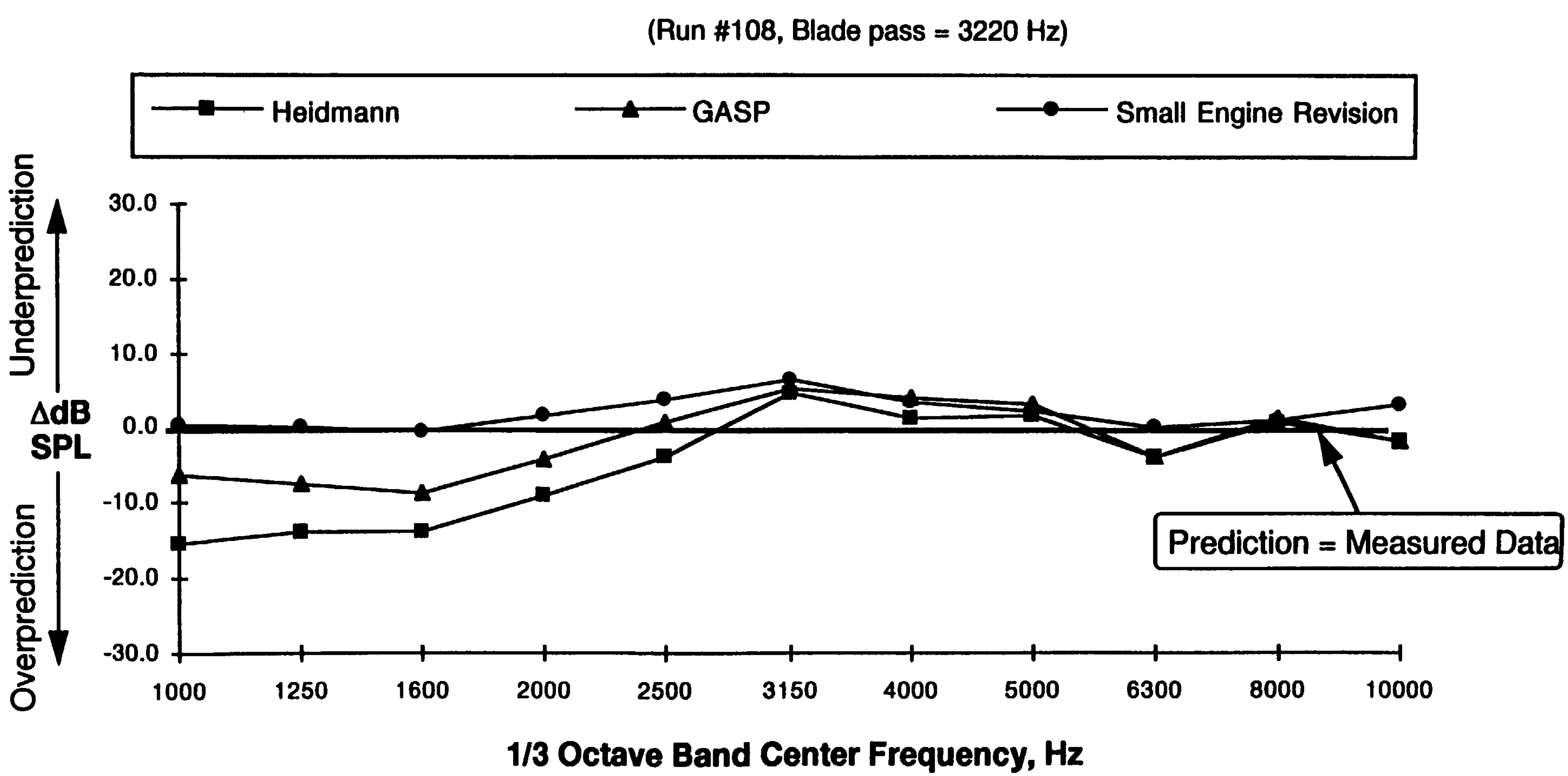
(Run #108, Blade pass = 3220 Hz)



Revised Prediction versus Heidmann and GASP
Engine 2, 88% speed, Mtr = 1.1
(40° from inlet centerline)

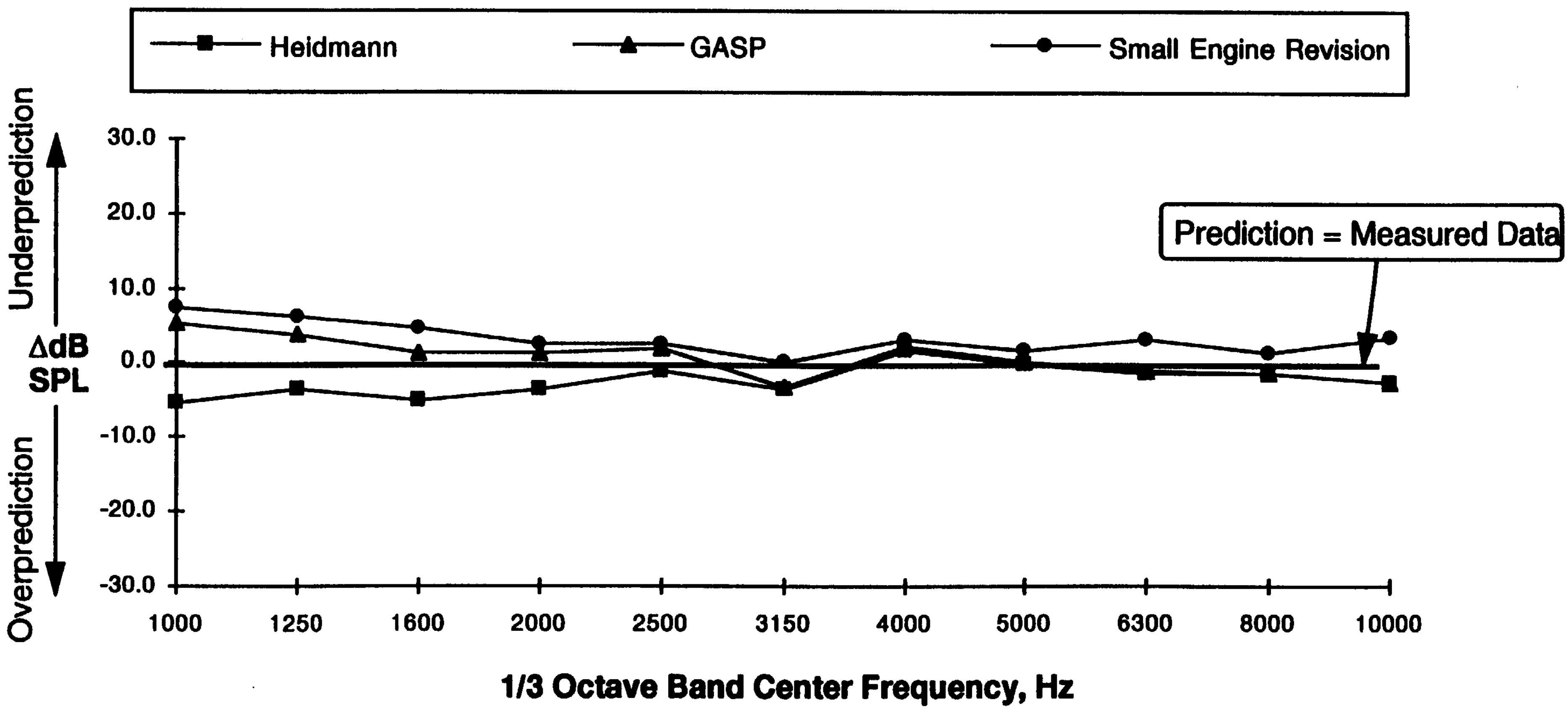


Revised Prediction versus Heidmann and GASP
Engine 2, 88% speed, Mtr = 1.1
(80° from inlet centerline)

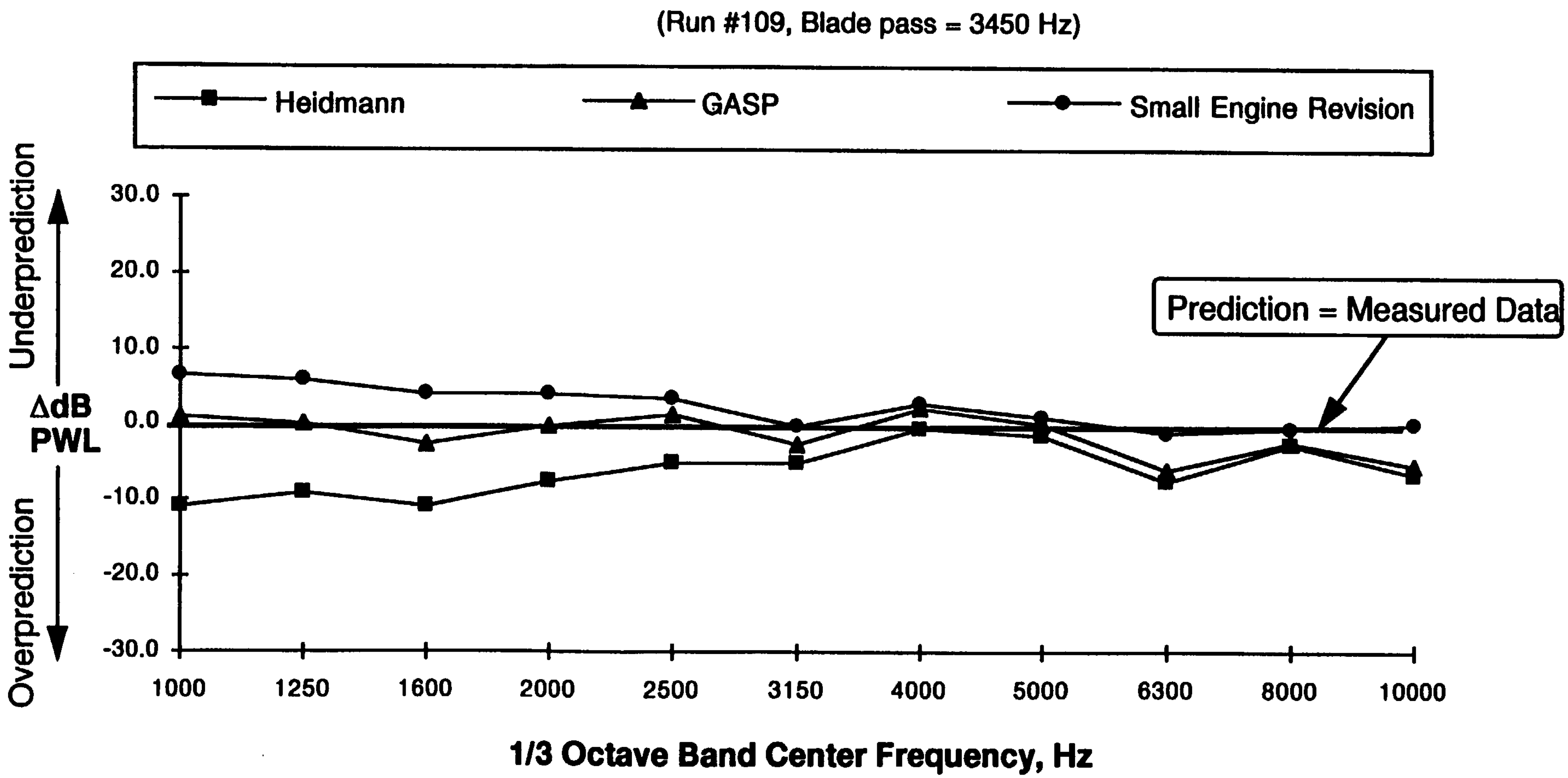


Revised Prediction versus Heidmann and GASP
Engine 2, 88% speed, Mtr = 1.1
(120° from inlet centerline)

(Run #108, Blade pass = 3220 Hz)

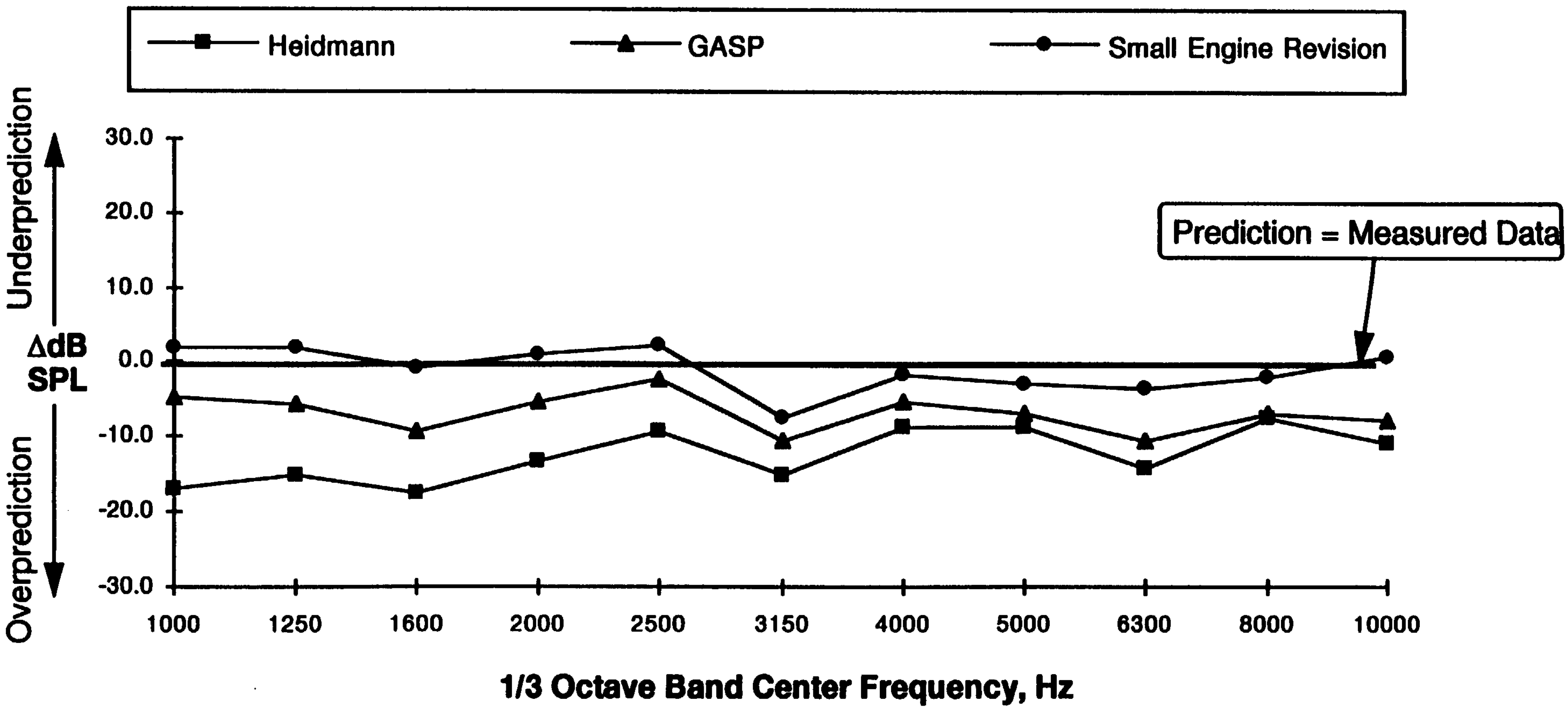


Revised Prediction versus Heidmann and GASP
Engine 2, 94% speed, Mtr = 1.2

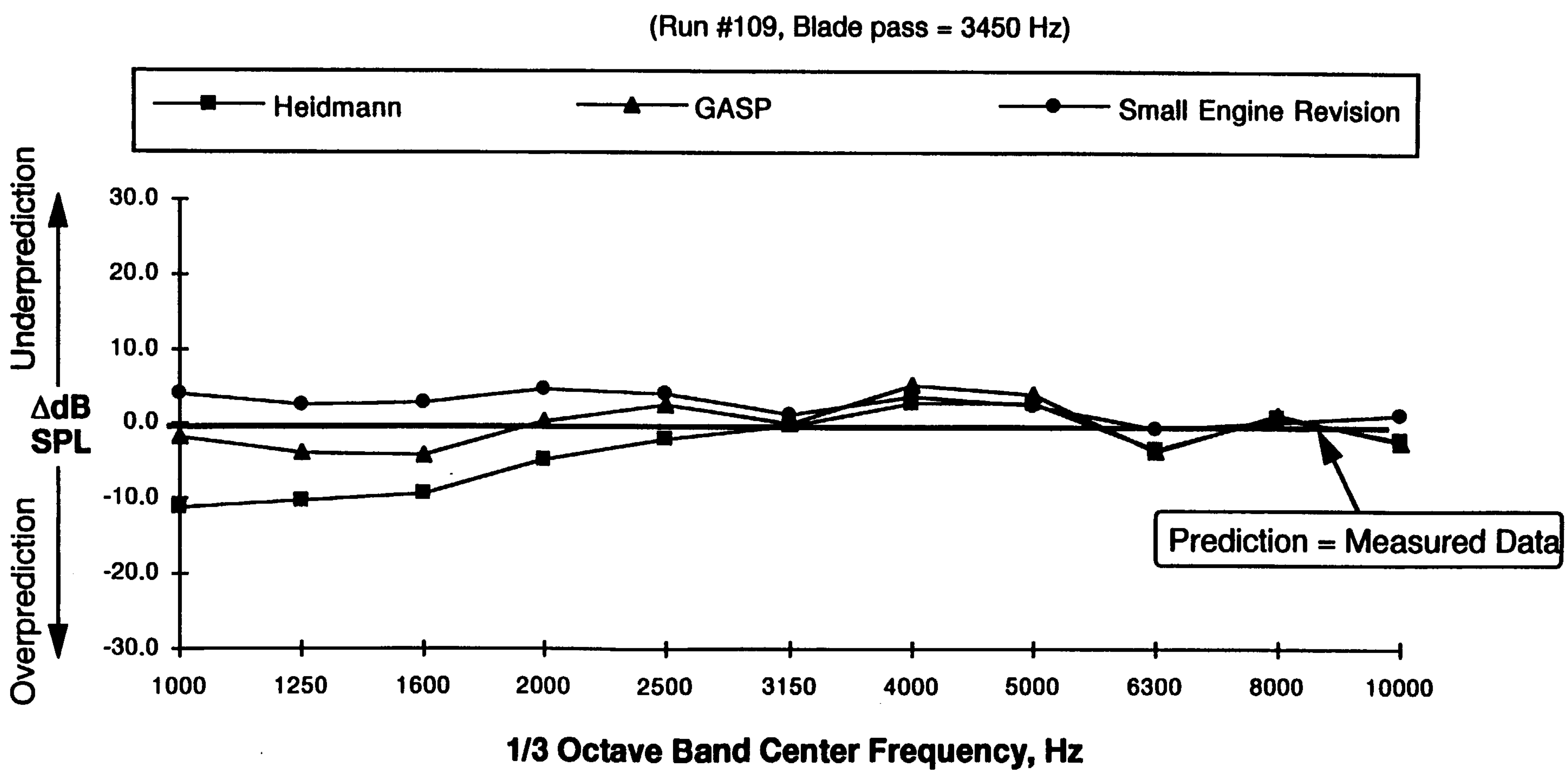


Revised Prediction versus Heidmann and GASP
Engine 2, 94% speed, Mtr = 1.2
(40° from inlet centerline)

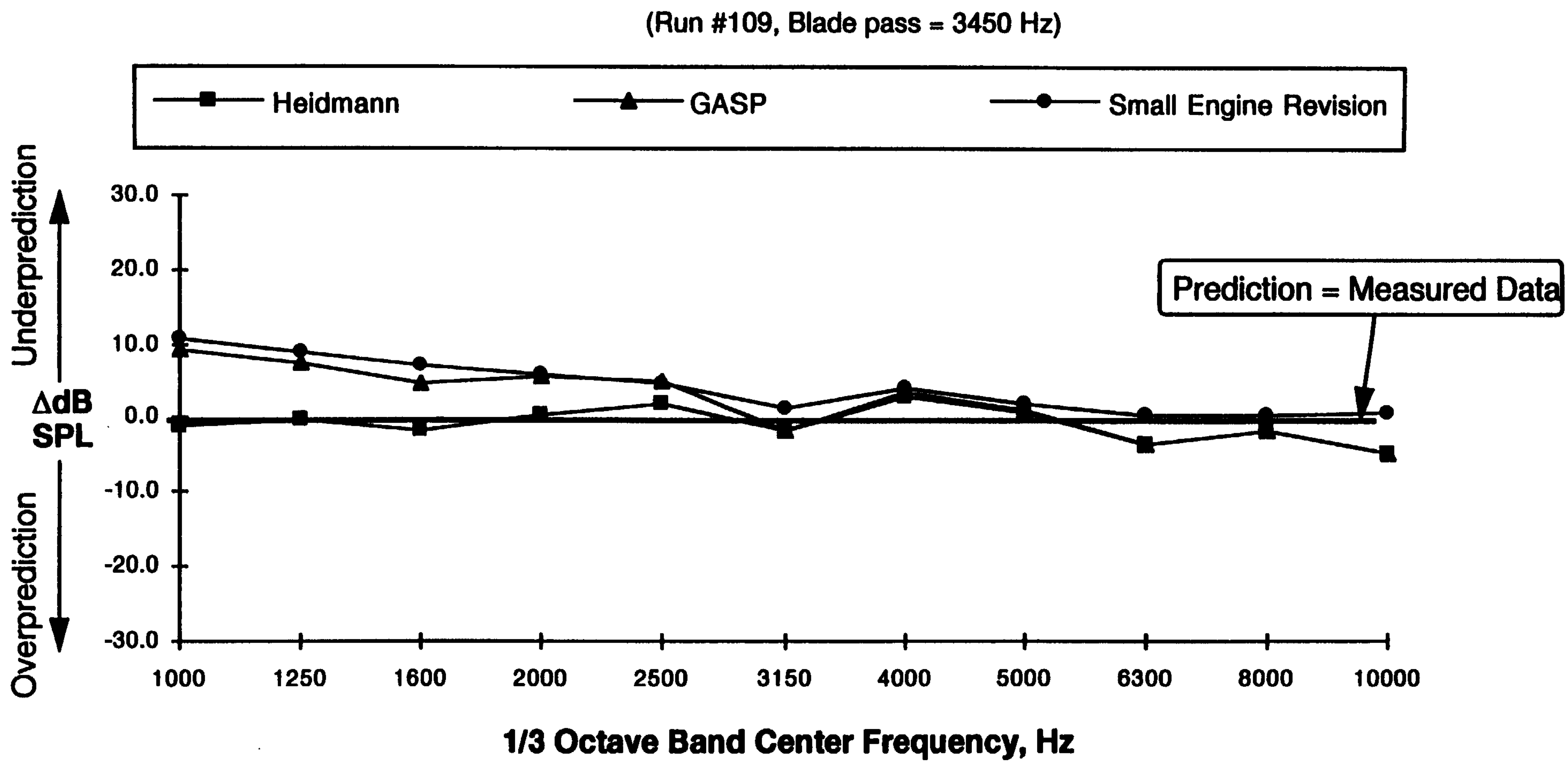
(Run #109, Blade pass = 3450 Hz)



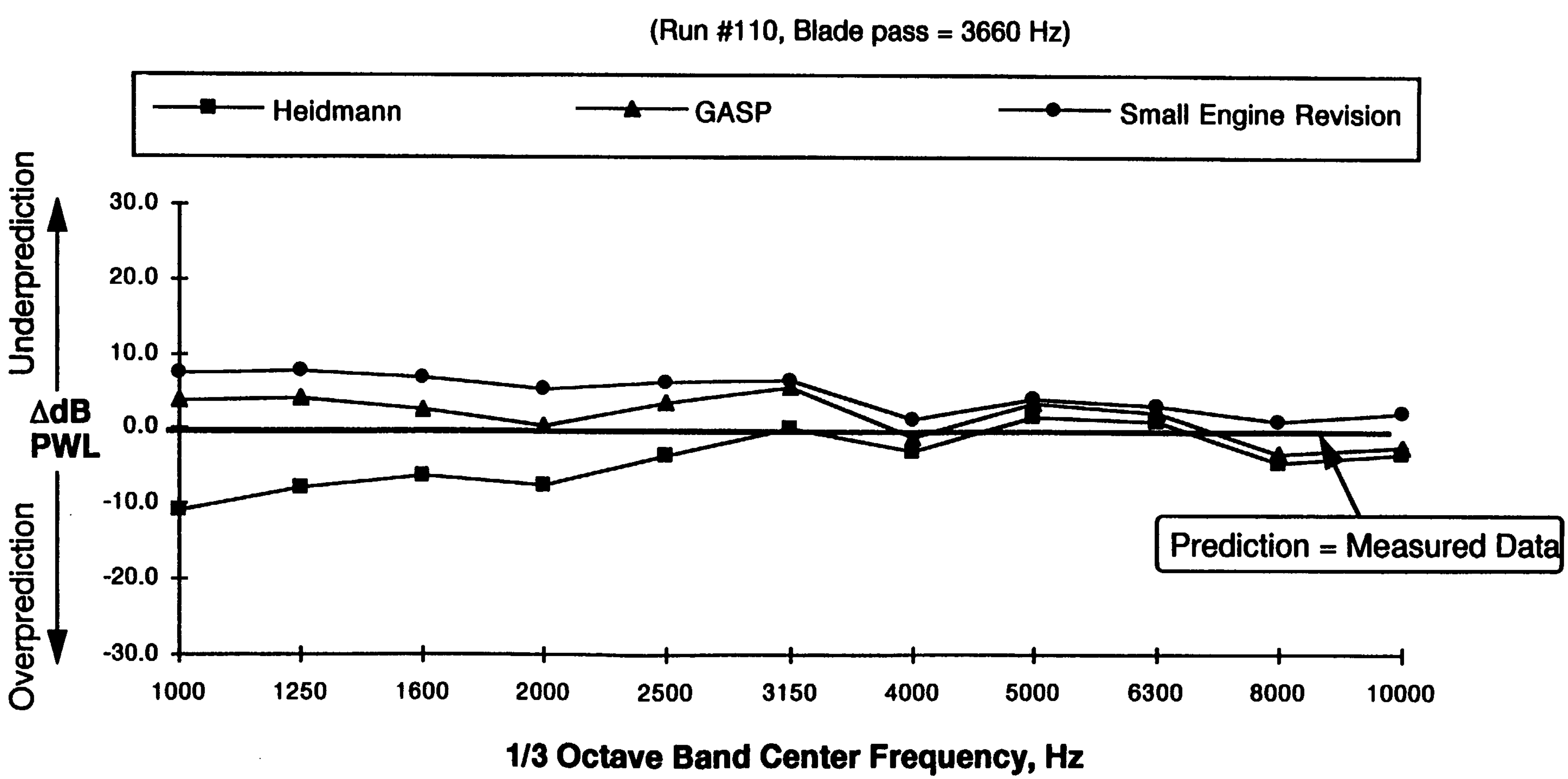
Revised Prediction versus Heidmann and GASP
Engine 2, 94% speed, Mtr = 1.2
(80° from inlet centerline)



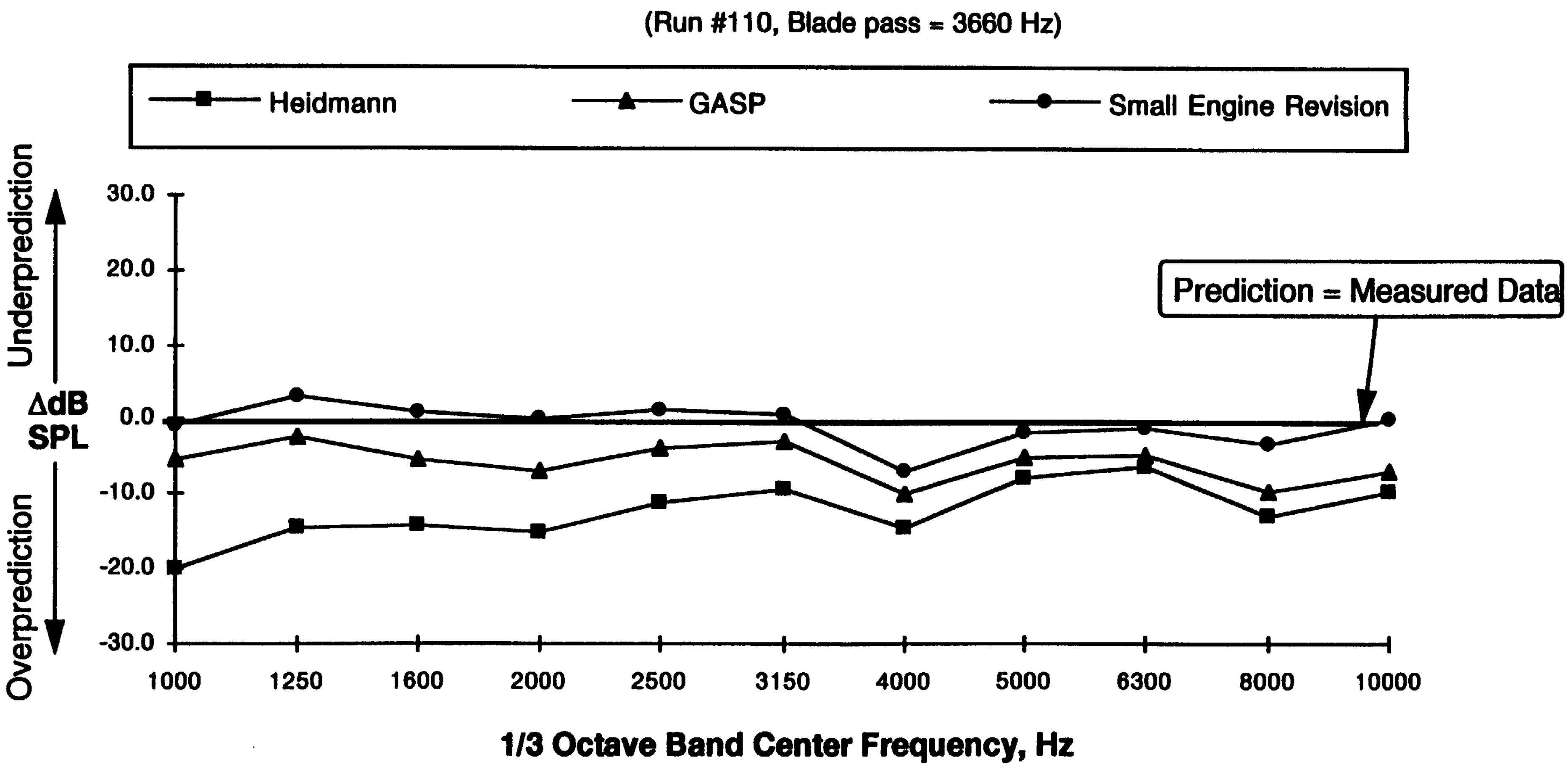
Revised Prediction versus Heidmann and GASP
Engine 2, 94% speed, Mtr = 1.2
(120° from inlet centerline)



Revised Prediction versus Heidmann and GASP
Engine 2, 100% speed, Mtr = 1.38

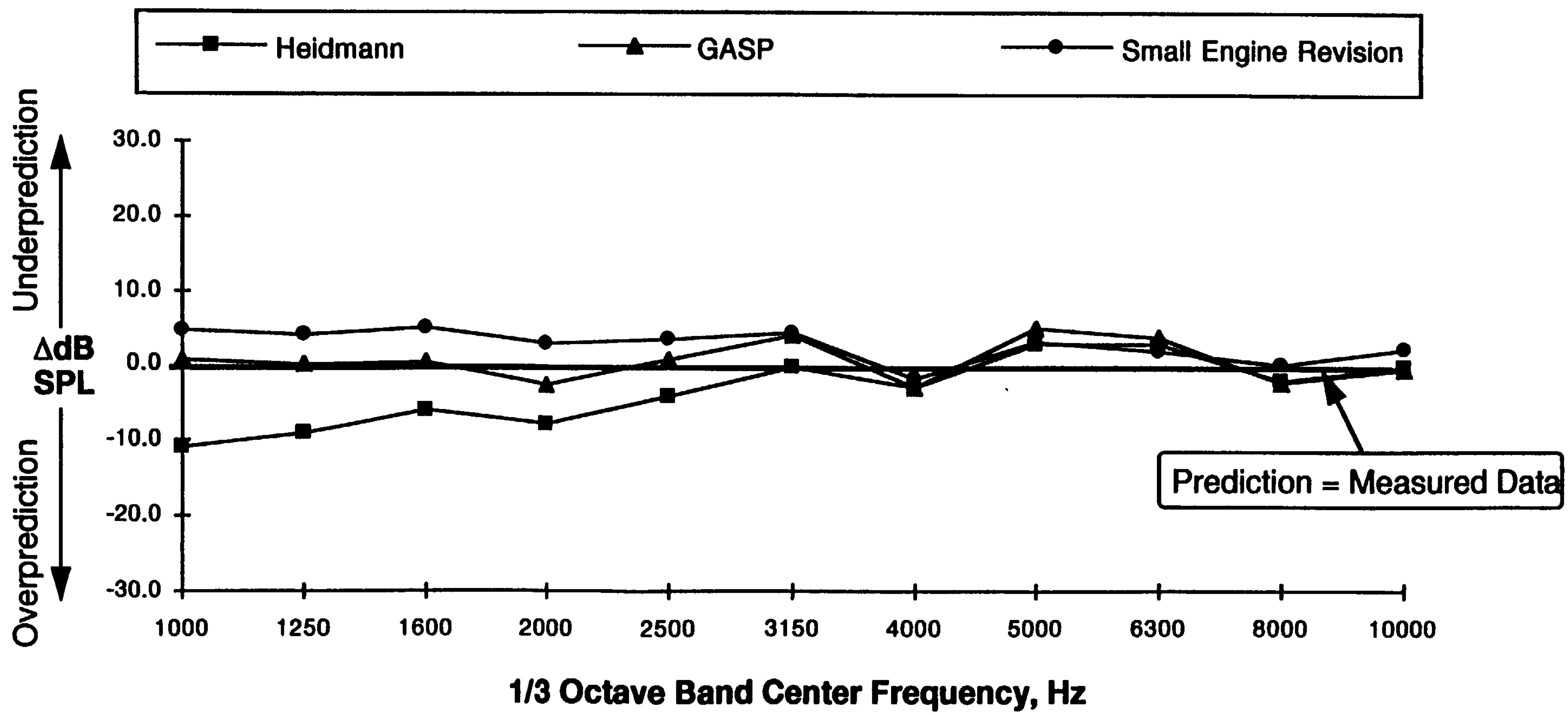


Revised Prediction versus Heidmann and GASP
Engine 2, 100% speed, Mtr = 1.3
(40° from inlet centerline)



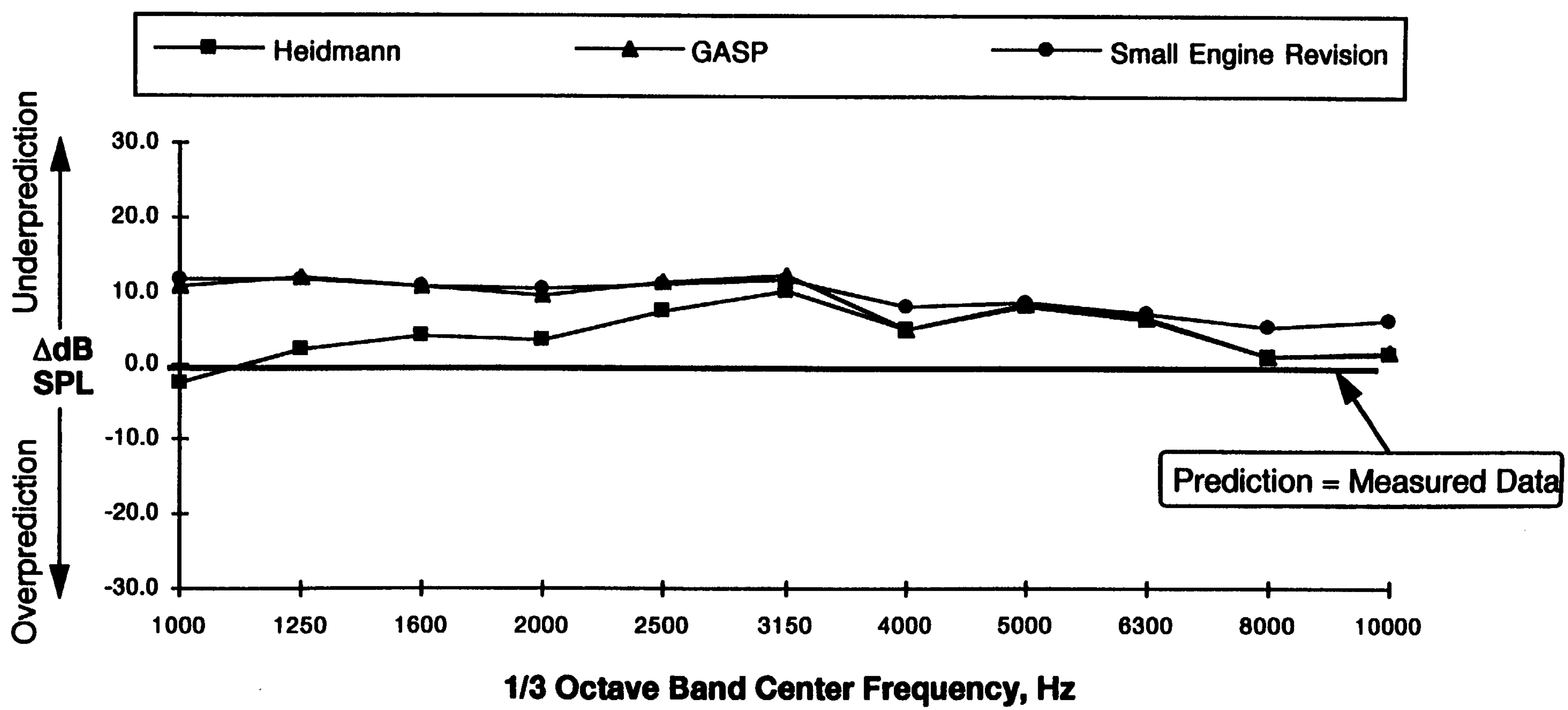
Revised Prediction versus Heidmann and GASP
Engine 2, 100% speed, Mtr = 1.38
(80° from inlet centerline)

(Run #110, Blade pass = 3660 Hz)



Revised Prediction versus Heidmann and GASP
Engine 2, 100% speed, Mtr = 1.3
(120° from inlet centerline)

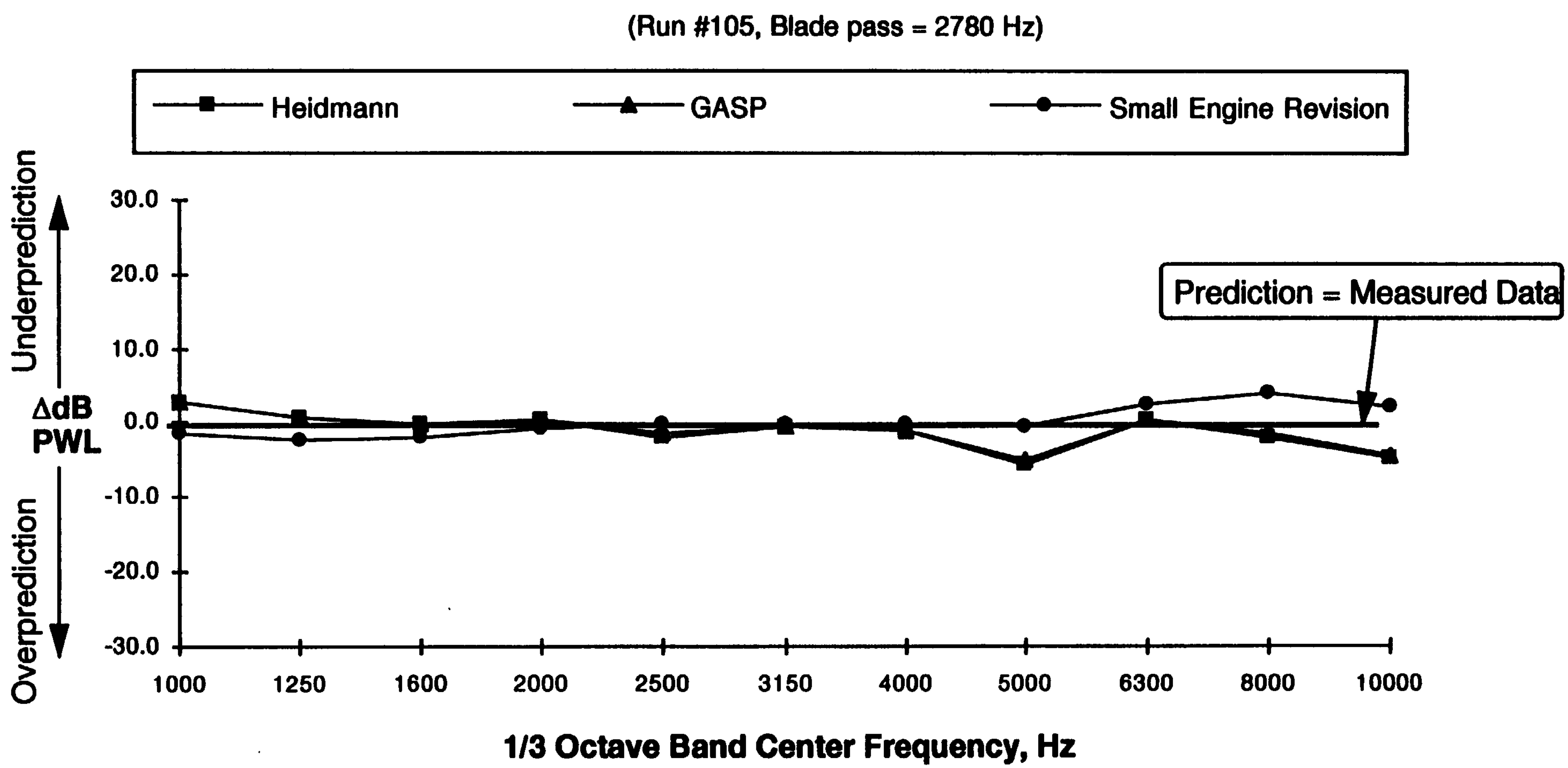
(Run #110, Blade pass = 3660 Hz)

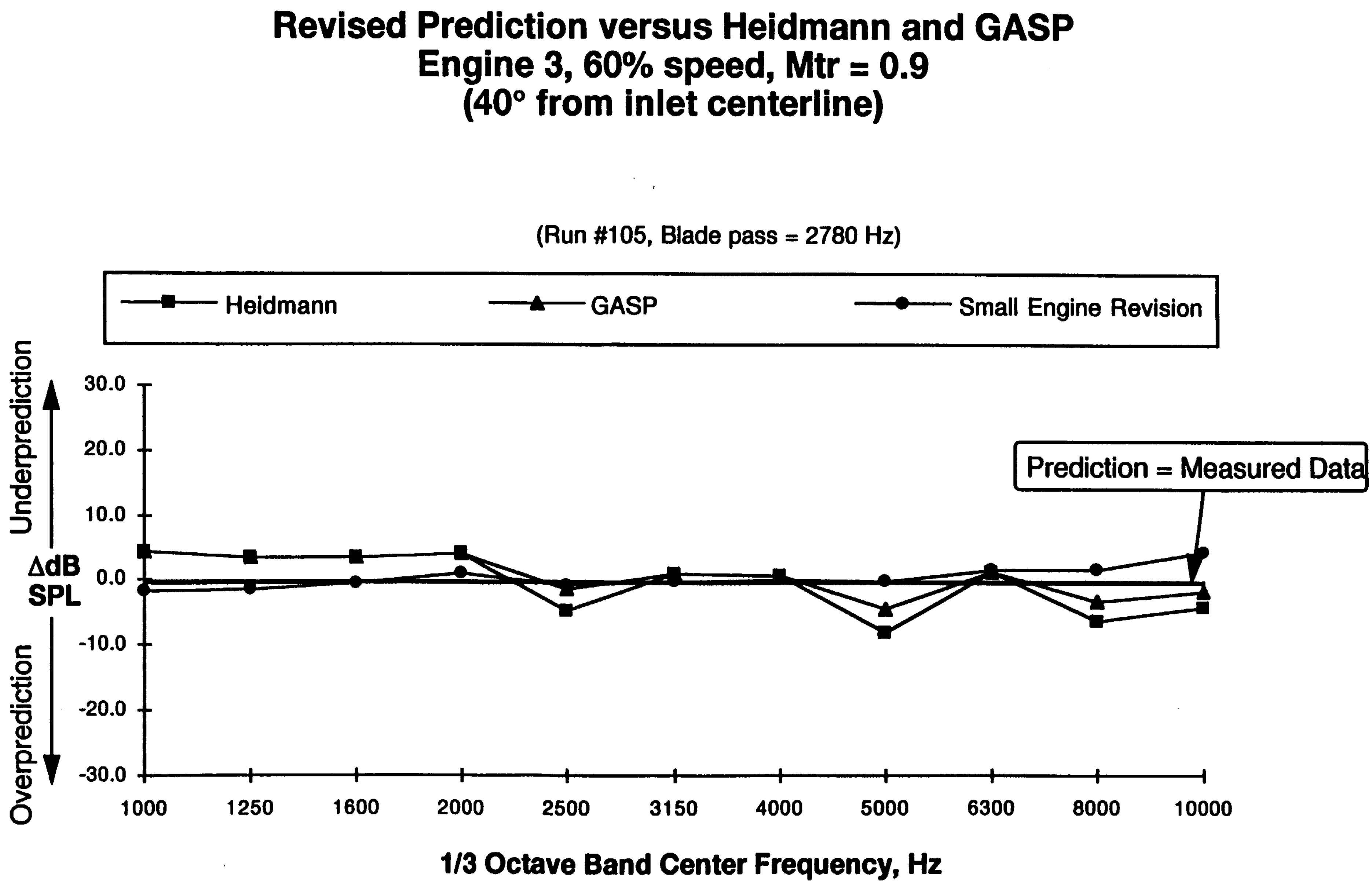


APPENDIX IV

MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 3
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHz, dB

Revised Prediction versus Heidmann and GASP
Engine 3, 60% speed, Mtr = 0.9

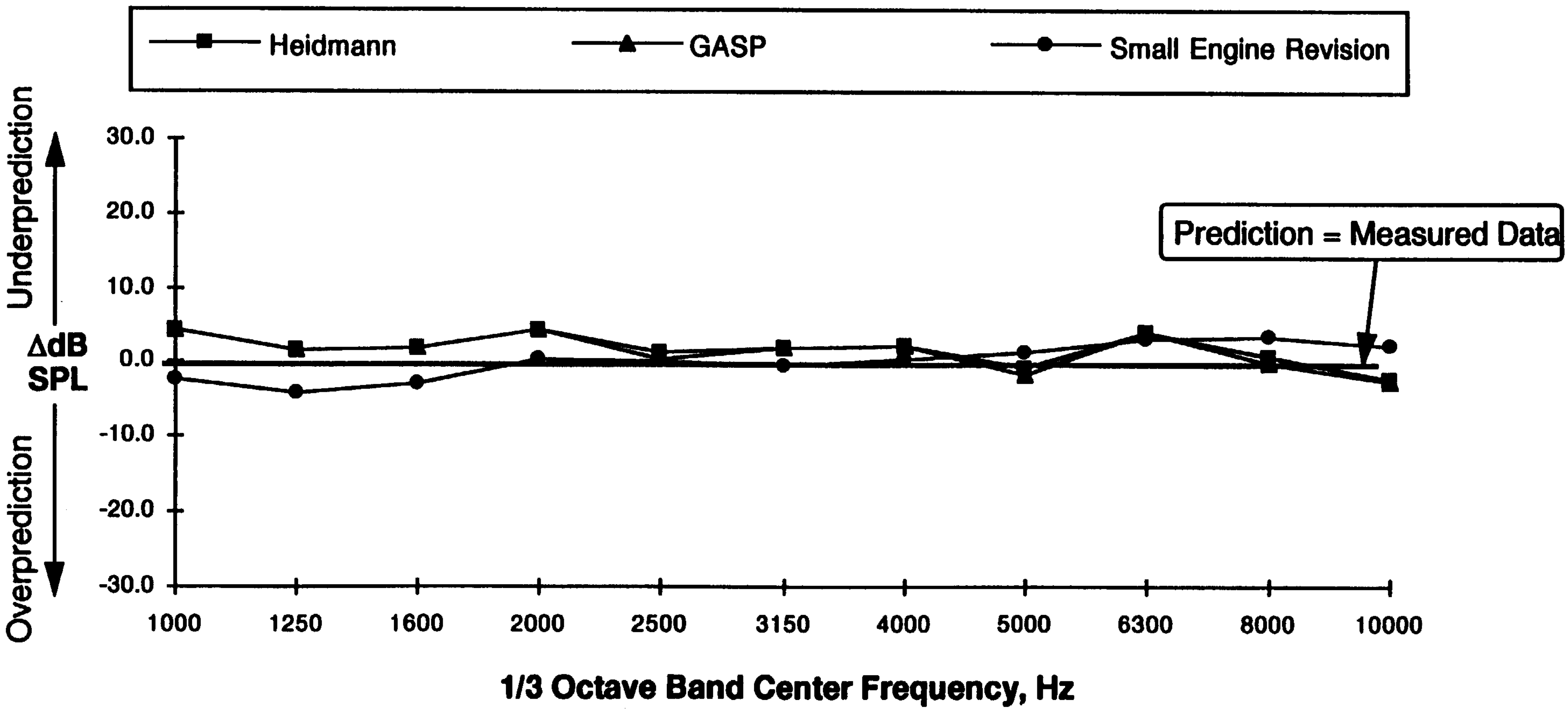




Revised Prediction versus Heidmann and GASP
Engine 3, 60% speed, Mtr = 0.9
(40° from inlet centerline)
(Run #105, Blade pass = 2780 Hz)
Heidmann
GASP
Small Engine Revision
Prediction = Measured Data
Underprediction
ΔdB SPL
Overprediction
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
1/3 Octave Band Center Frequency, Hz

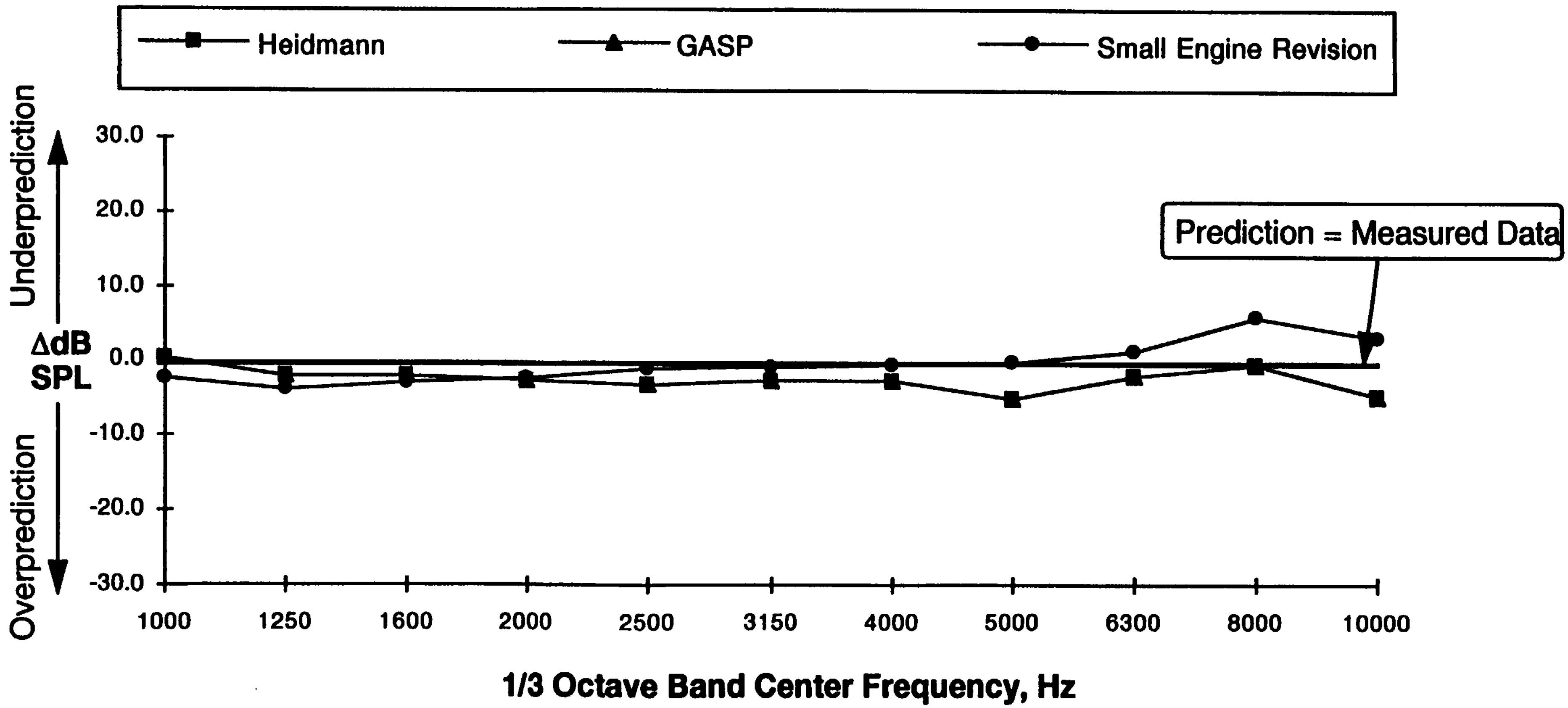
Revised Prediction versus Heidmann and GASP
Engine 3, 60% speed, Mtr = 0.9
(80° from inlet centerline)

(Run #105, Blade pass = 2780 Hz)



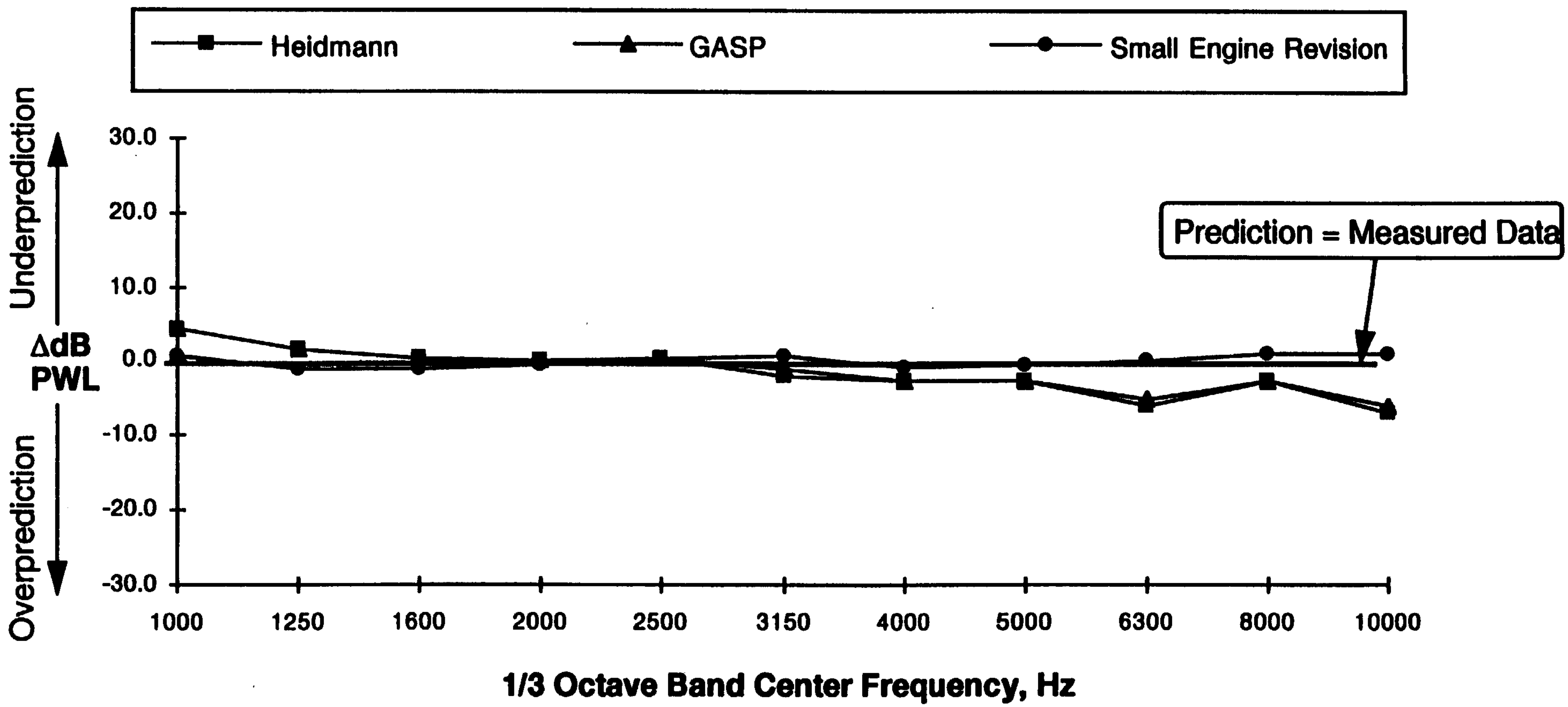
Revised Prediction versus Heidmann and GASP
Engine 3, 60% speed, Mtr = 0.9
(120° from inlet centerline)

(Run #105, Blade pass = 2780 Hz)



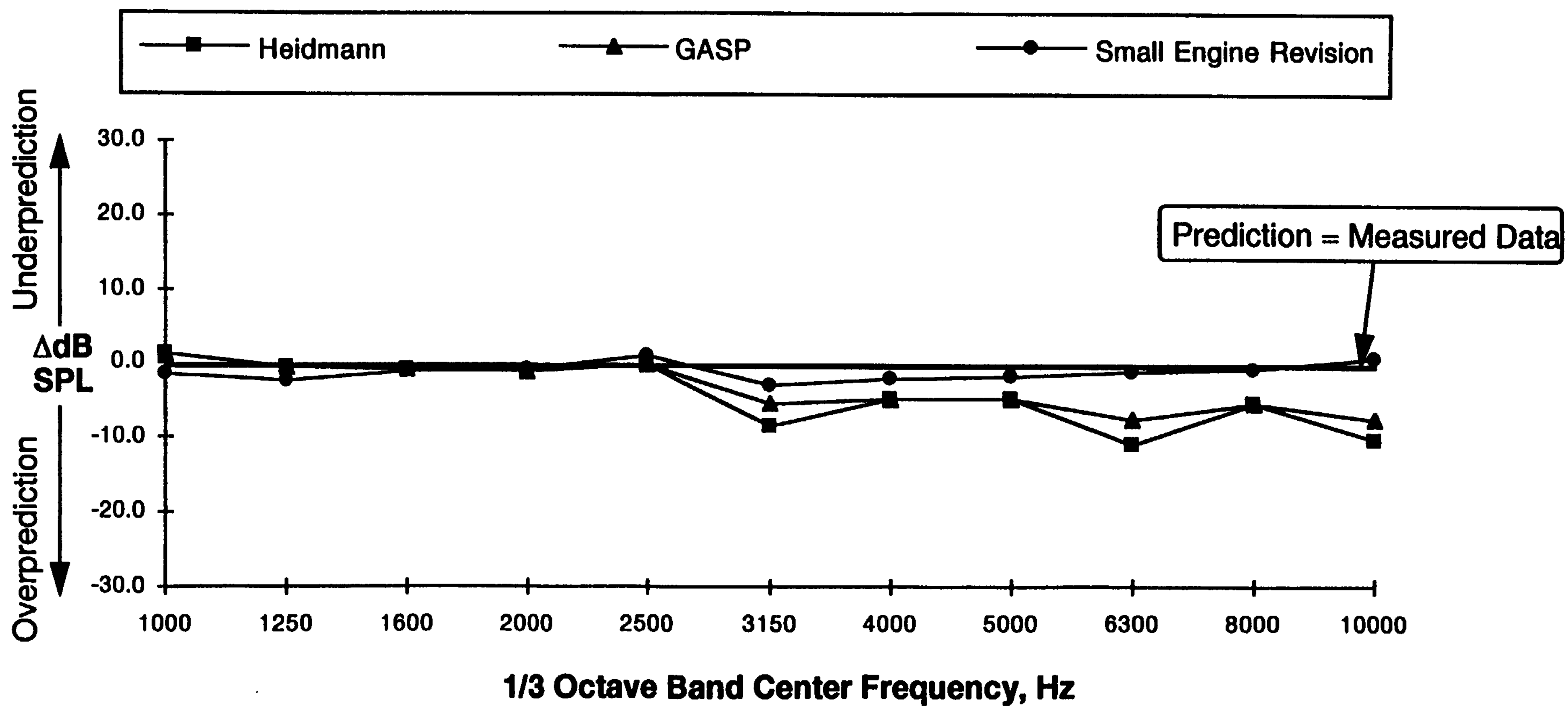
Revised Prediction versus Heidmann and GASP
Engine 3, 68% speed, Mtr = 1.0

(Run #106, Blade pass = 3150 Hz)

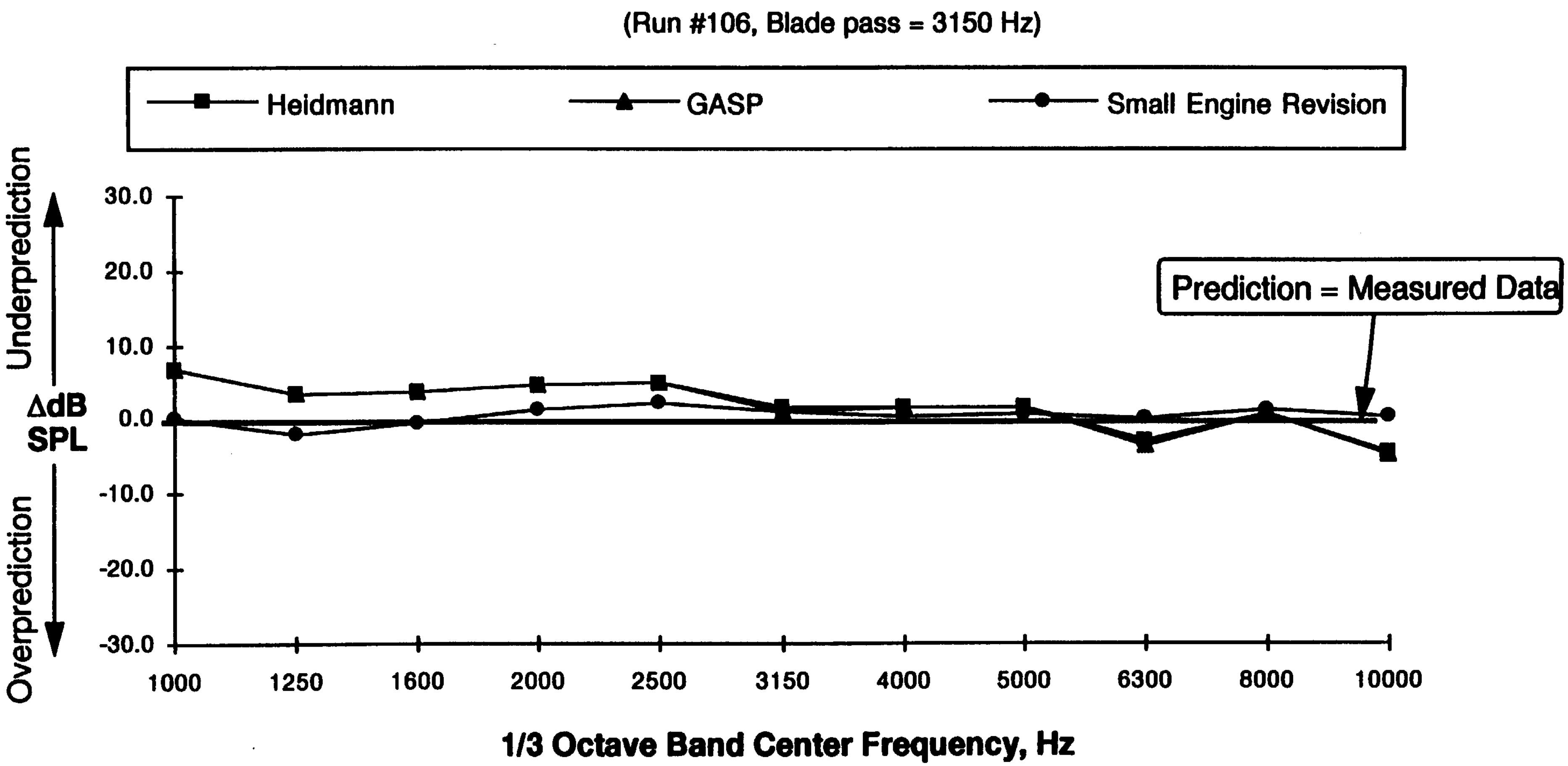


Revised Prediction versus Heidmann and GASP
Engine 3, 68% speed, Mtr = 1.0
(40° from inlet centerline)

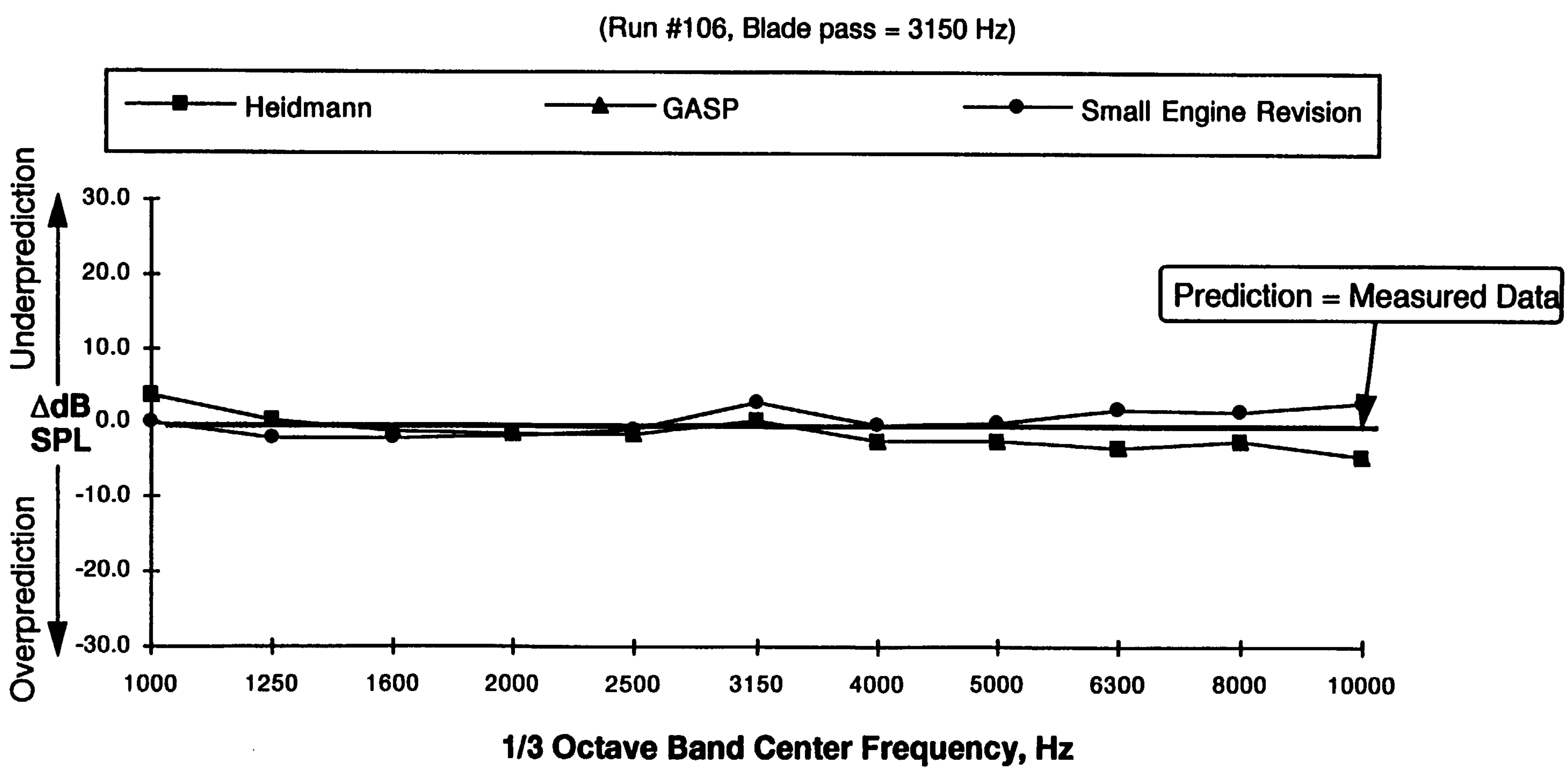
(Run #106, Blade pass = 3150 Hz)



Revised Prediction versus Heidmann and GASP
Engine 3, 68% speed, Mtr = 1.0
(80° from inlet centerline)

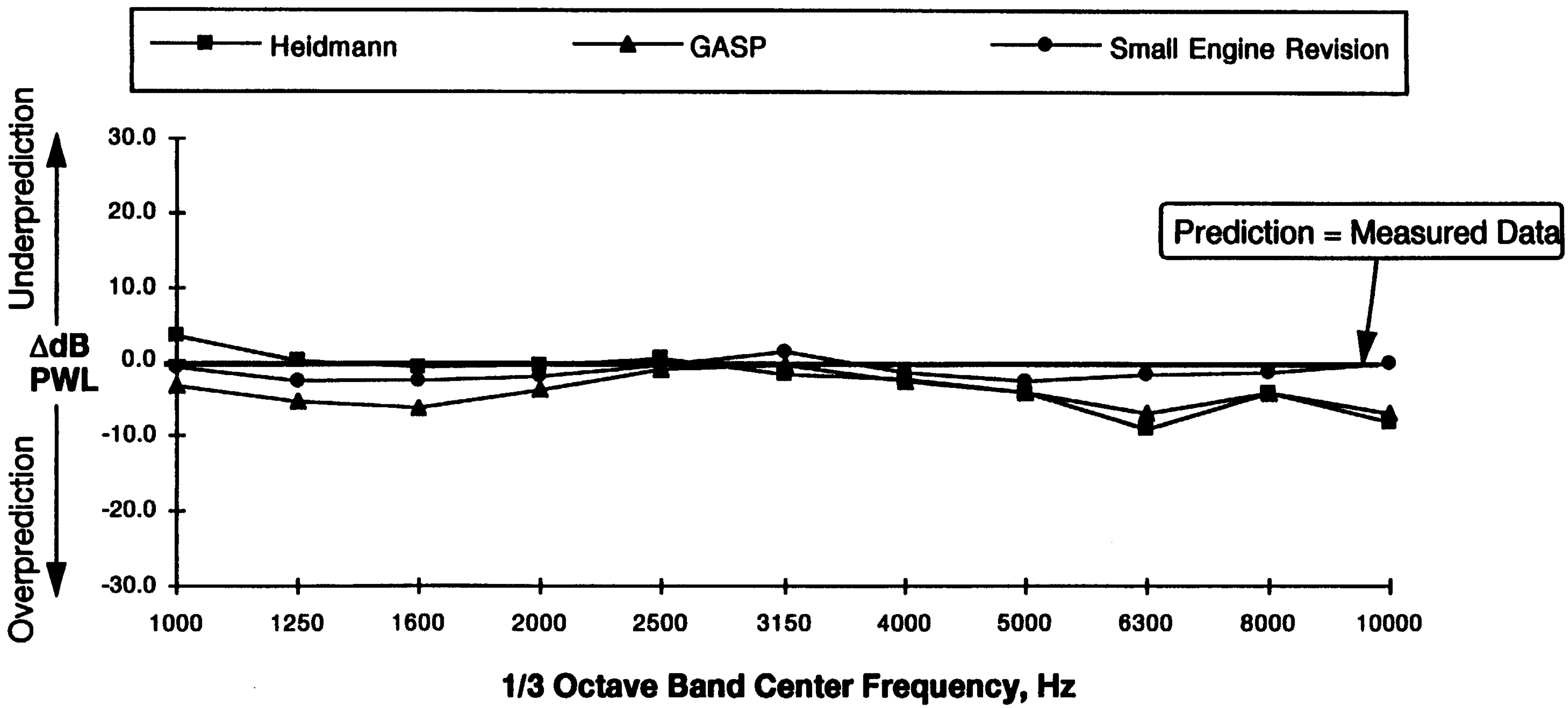


Revised Prediction versus Heidmann and GASP
Engine 3, 68% speed, Mtr = 1.0
(120° from inlet centerline)



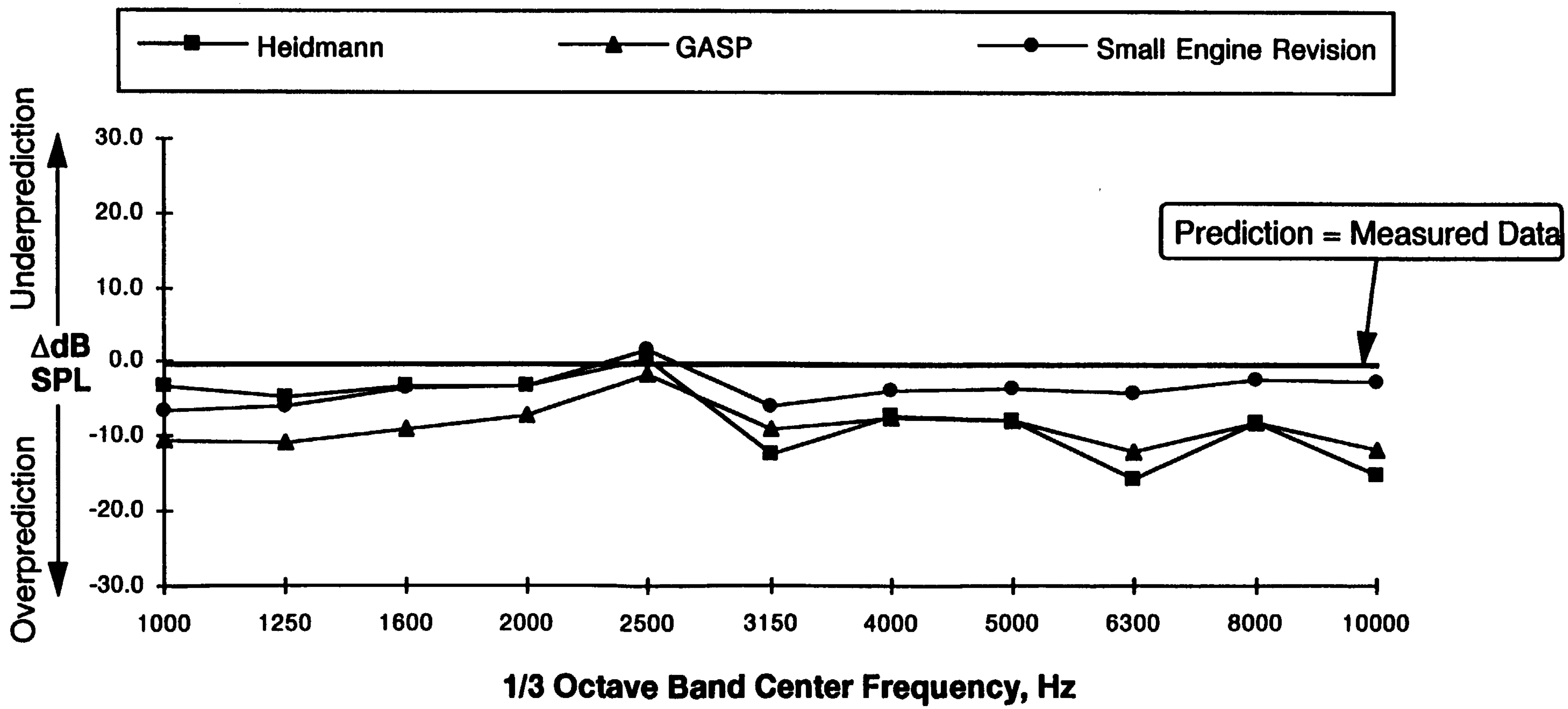
Revised Prediction versus Heidmann and GASP
Engine 3, 75% speed, Mtr = 1.1

(Run #107, Blade pass = 3470 Hz)



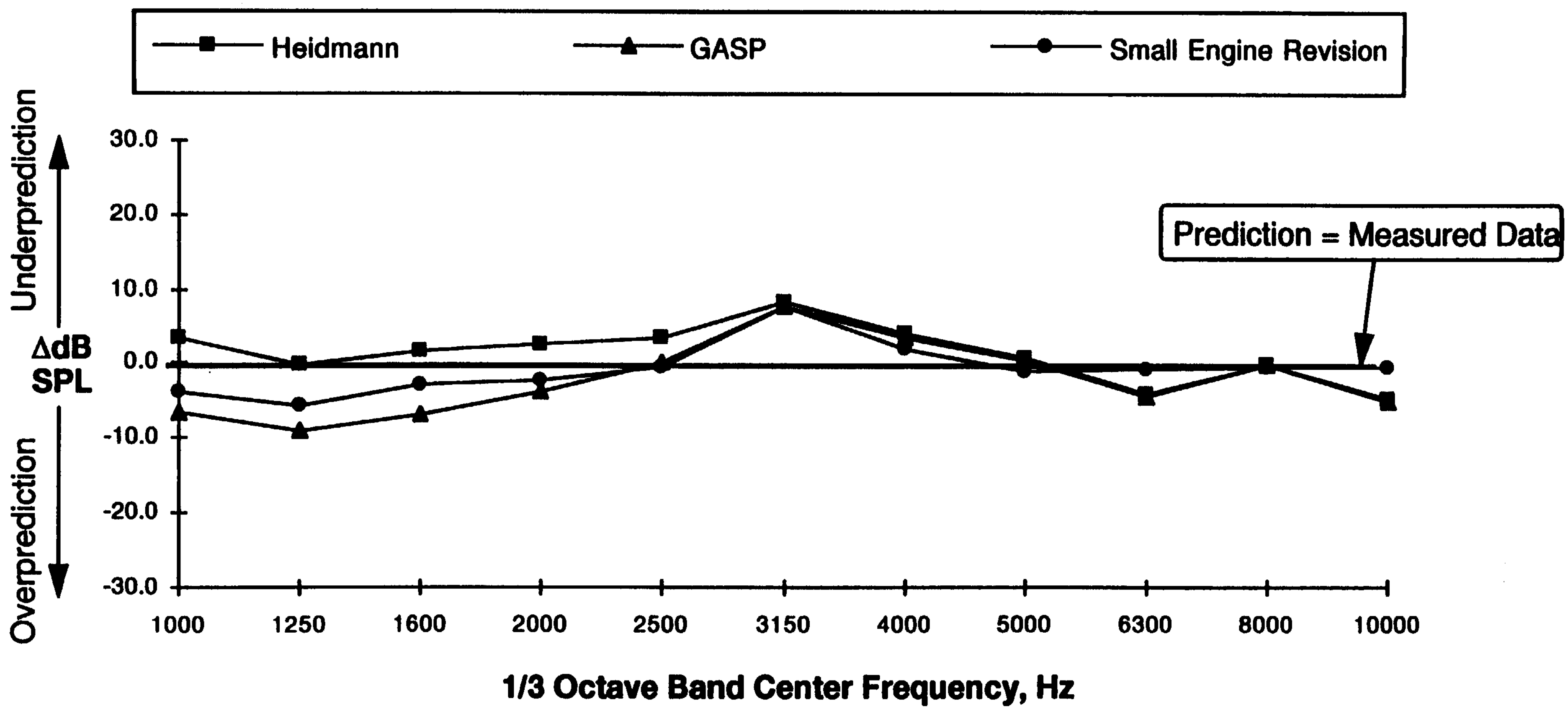
Revised Prediction versus Heidmann and GASP
Engine 3, 75% speed, Mtr = 1.1
(40° from inlet centerline)

(Run #107, Blade pass = 3470 Hz)



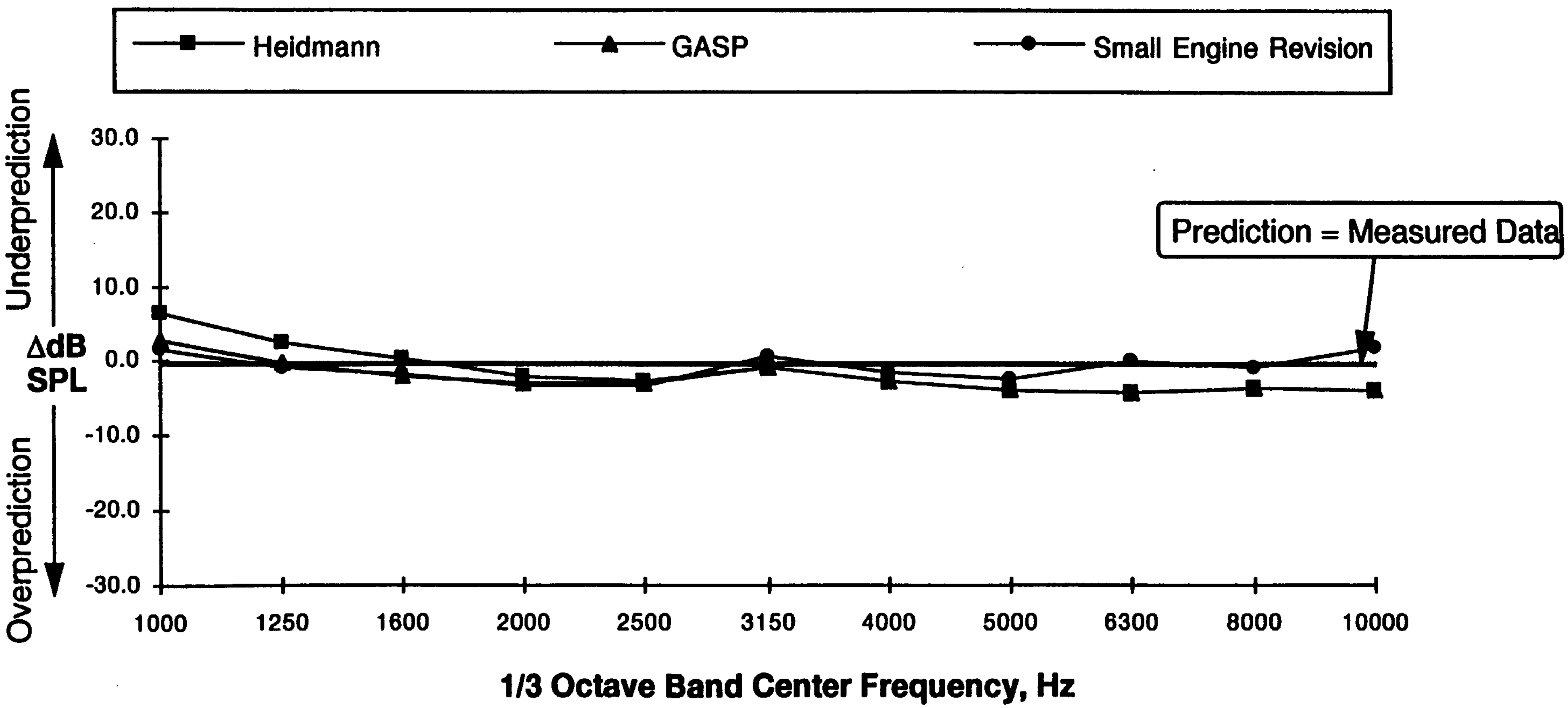
Revised Prediction versus Heidmann and GASP
Engine 3, 75% speed, Mtr = 1.1
(80° from inlet centerline)

(Run #107, Blade pass = 3470 Hz)



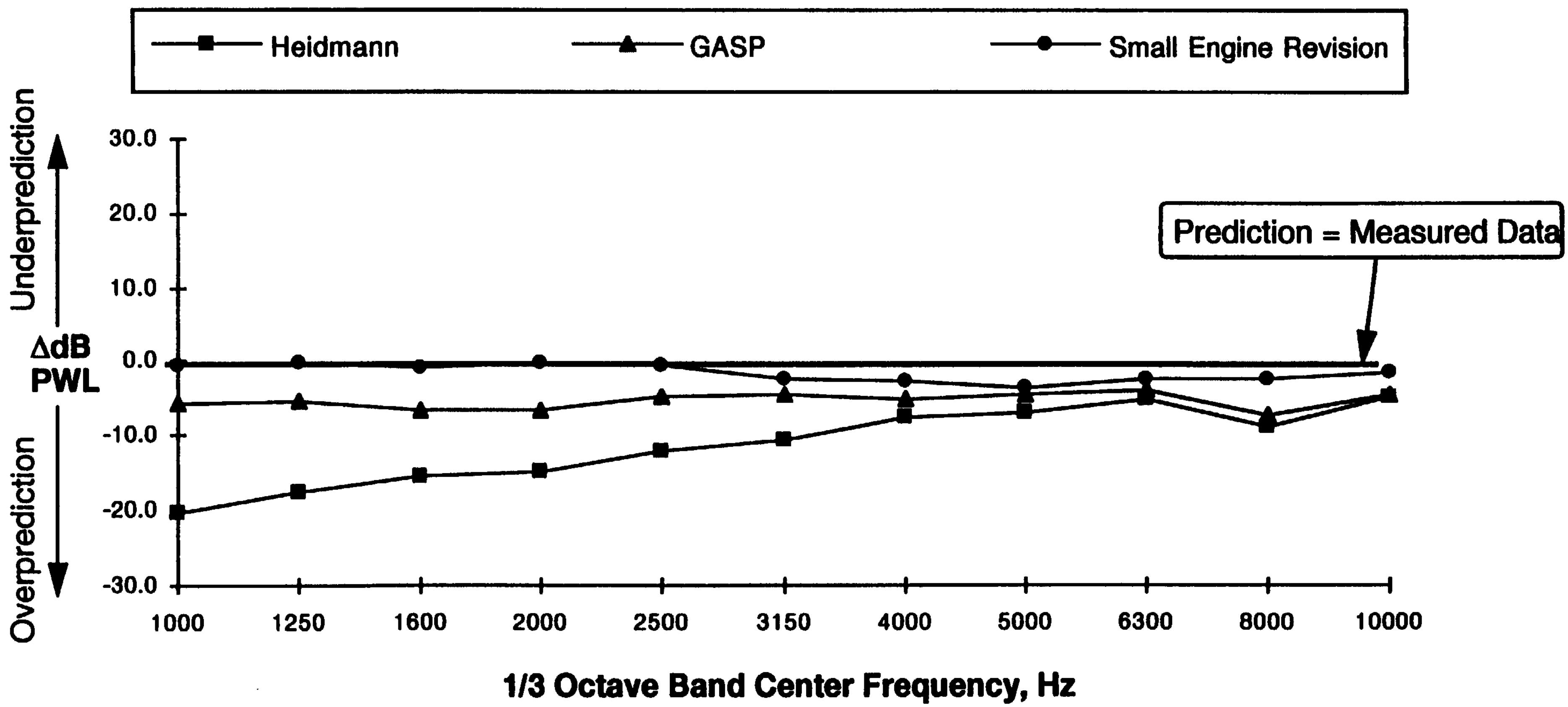
Revised Prediction versus Heidmann and GASP
Engine 3, 75% speed, Mtr = 1.1
(120° from inlet centerline)

(Run #107, Blade pass = 3470 Hz)



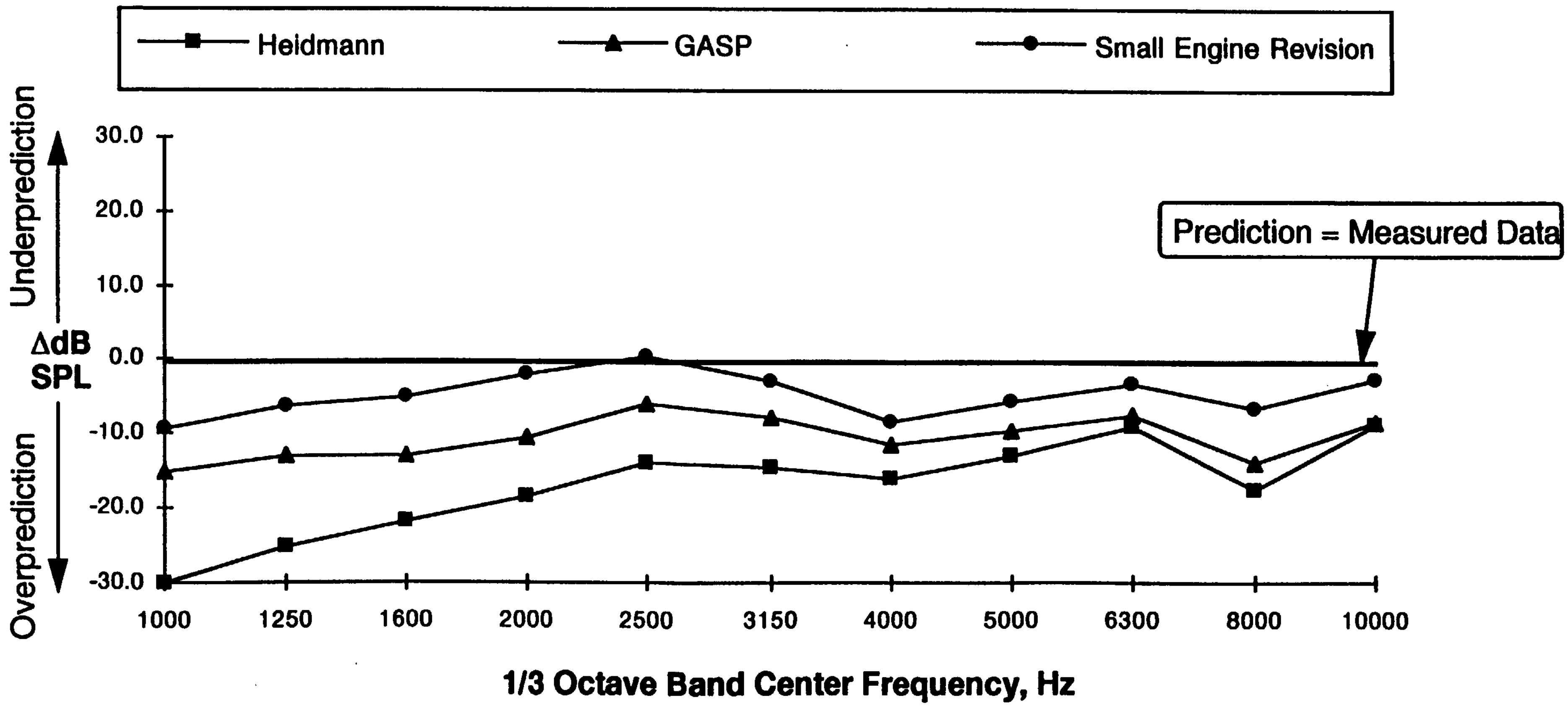
Revised Prediction versus Heidmann and GASP
Engine 3, 82% speed, Mtr = 1.2

(Run #108, Blade pass = 3800 Hz)

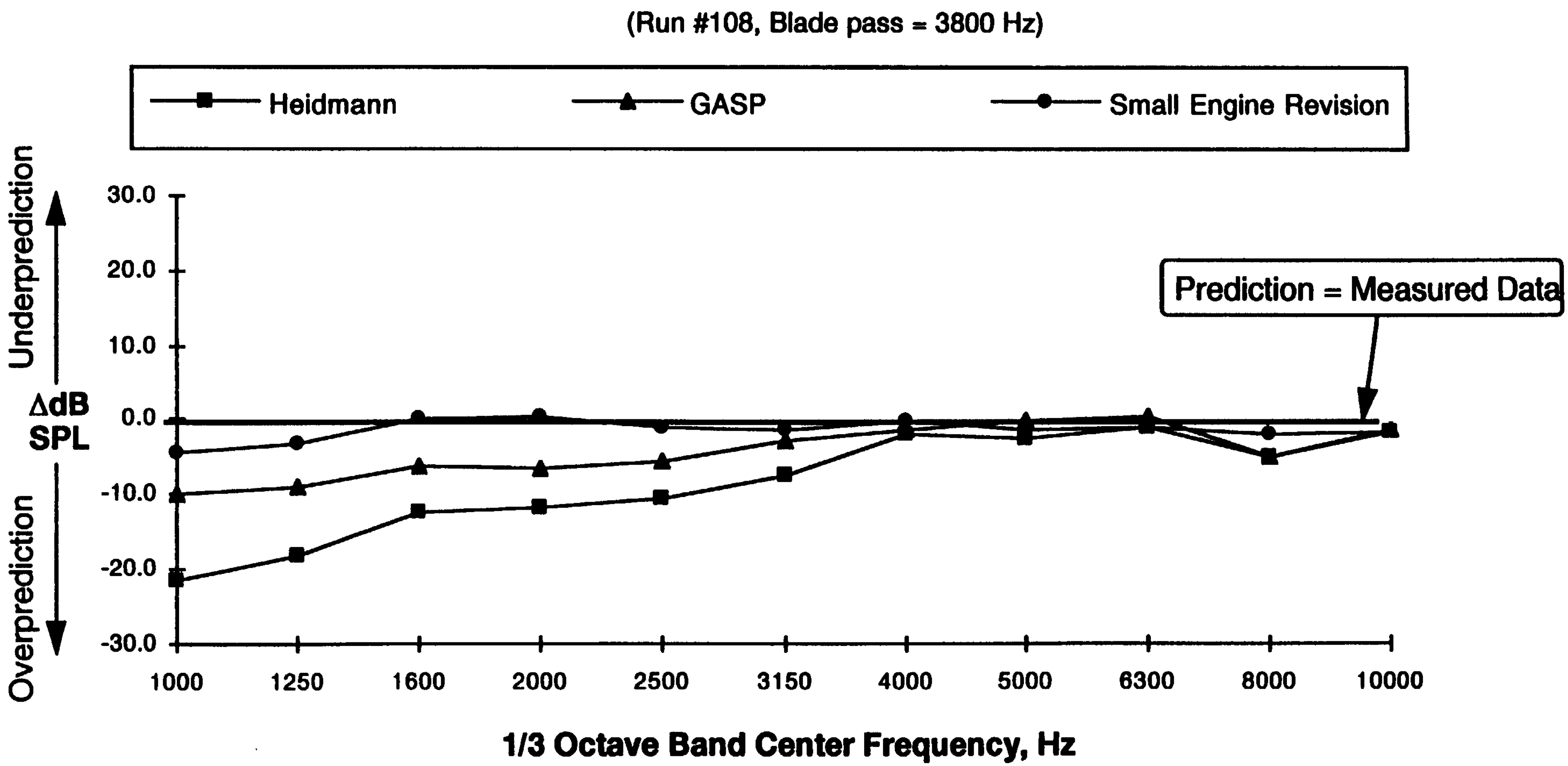


Revised Prediction versus Heidmann and GASP
Engine 3, 82% speed, Mtr = 1.2
(40° from inlet centerline)

(Run #108, Blade pass = 3800 Hz)

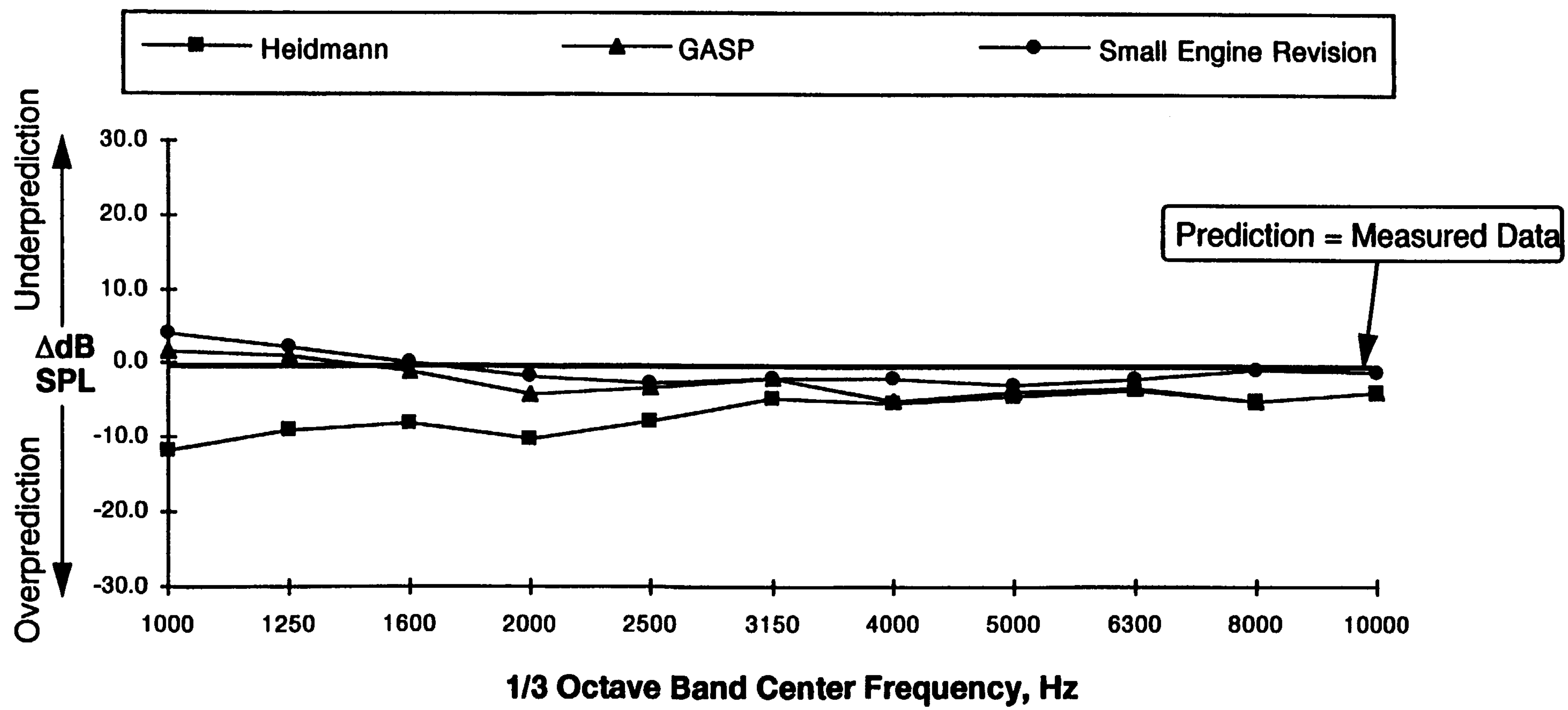


Revised Prediction versus Heidmann and GASP
Engine 3, 82% speed, Mtr = 1.2
(80° from inlet centerline)



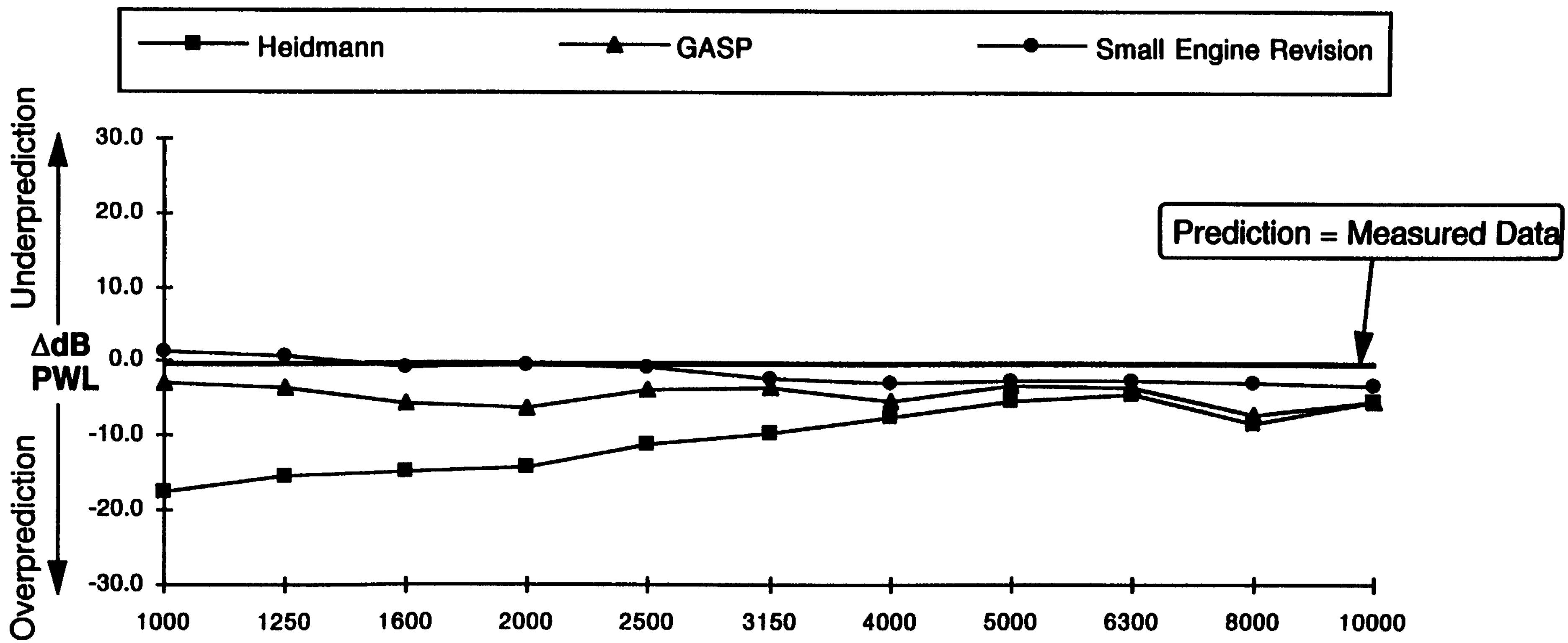
Revised Prediction versus Heidmann and GASP
Engine 3, 82% speed, Mtr = 1.2
(120° from inlet centerline)

(Run #108, Blade pass = 3800 Hz)



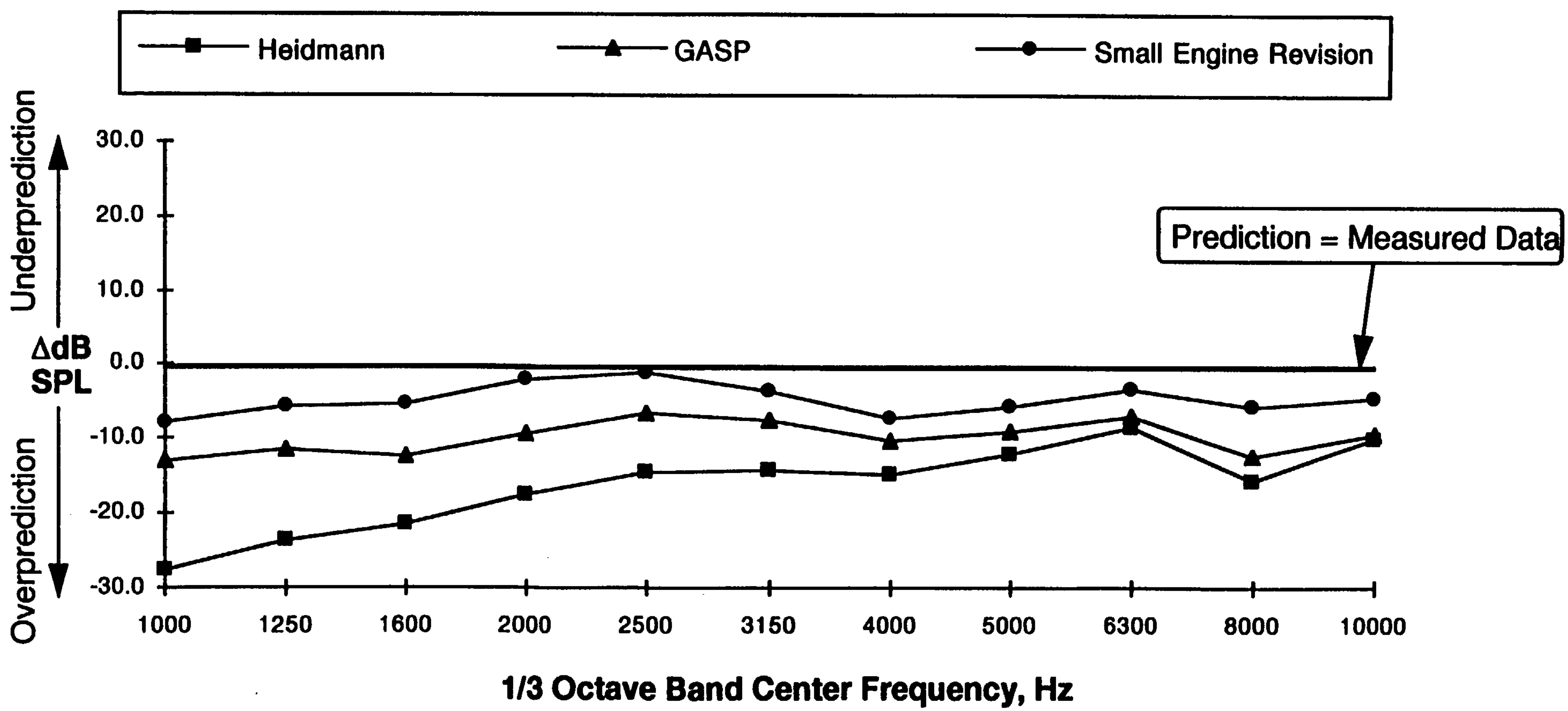
Revised Prediction versus Heidmann and GASP
Engine 3, 87% speed, Mtr = 1.3

(Run #109, Blade pass = 4000 Hz)

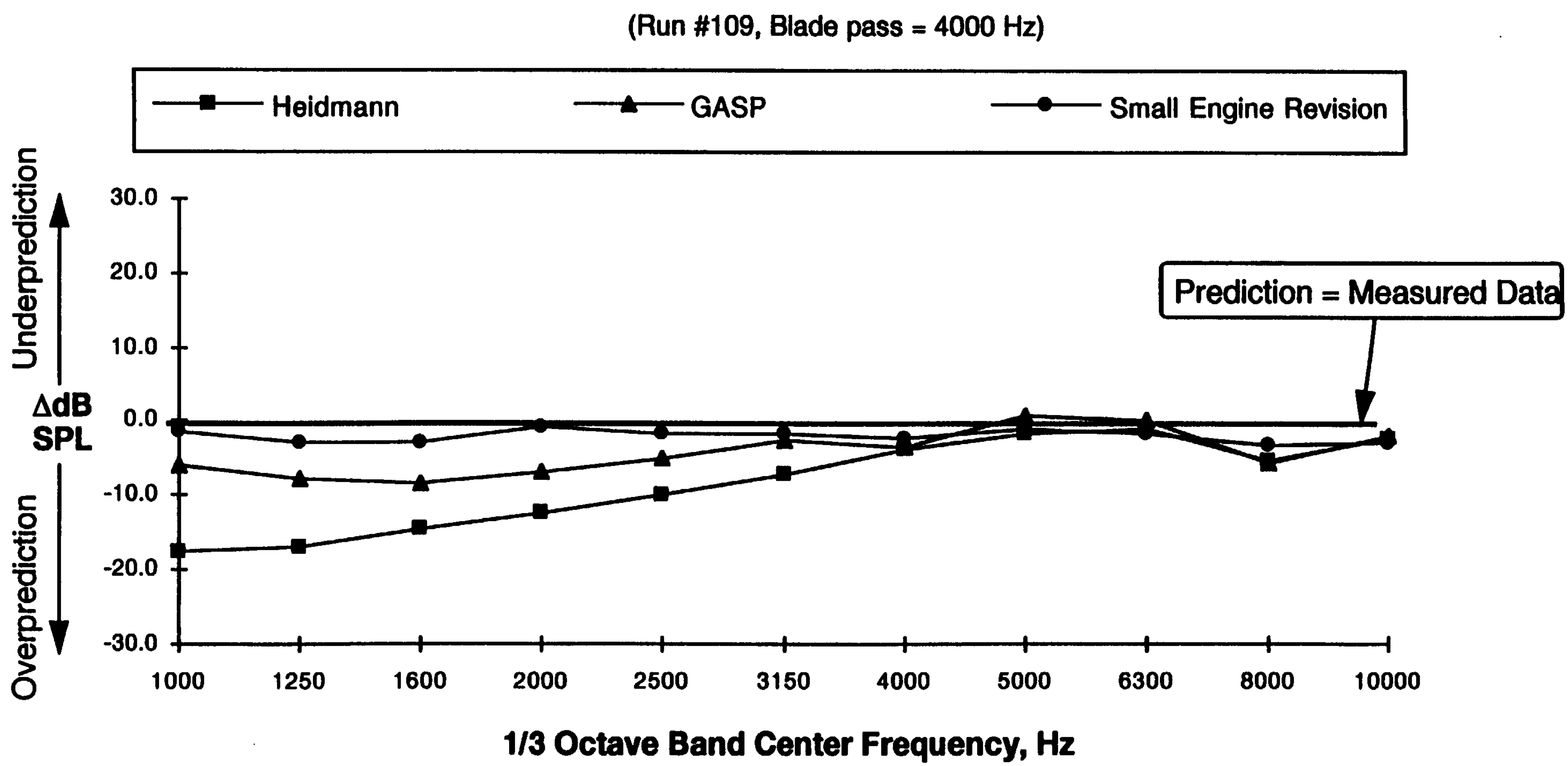


Revised Prediction versus Heidmann and GASP
Engine 3, 87% speed, Mtr = 1.3
(40° from inlet centerline)

(Run #109, Blade pass = 4000 Hz)

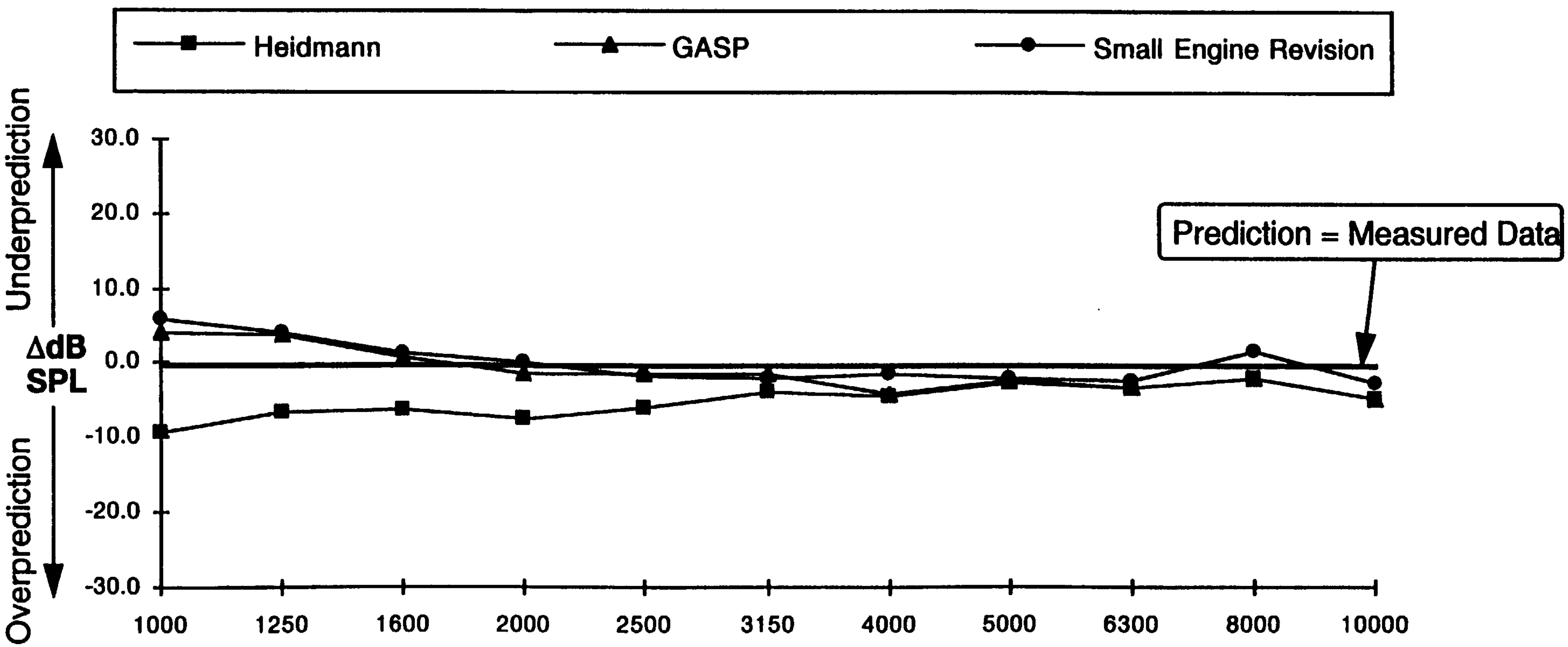


Revised Prediction versus Heidmann and GASP
Engine 3, 87% speed, Mtr = 1.3
(80° from inlet centerline)



Revised Prediction versus Heidmann and GASP
Engine 3, 87% speed, Mtr = 1.3
(120° from inlet centerline)

(Run #109, Blade pass = 4000 Hz)



APPENDIX V

MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 1
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHz, dB

Engine/Run #: 139FF165

Blade pass freq[Hz]= 3521.3

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	7.4	7.3	7.3	6.6	8.5	6.6	9.7	10.8	10.6	8.3	5.8	5.8	5.6	6.7	8.2	6.6	8.4	11.8
1250	3.5	3.5	4.4	3.6	4.9	5.1	6.3	7.8	6.8	4.0	1.3	1.7	2.0	2.8	3.9	1.9	4.0	7.7
1600	0.3	0.3	3.2	1.9	2.2	2.1	3.9	4.2	4.8	2.1	-1.7	-1.6	-1.2	-0.5	0.0	-1.9	0.6	4.5
2000	-1.3	-1.2	2.5	1.2	1.9	1.6	2.2	3.7	1.9	1.3	-1.9	-3.6	-3.3	-1.4	-2.7	-4.6	-1.9	2.2
2500	-2.6	-2.4	3.4	1.4	2.6	0.8	3.3	3.3	2.2	0.5	-3.4	-5.2	-5.6	-4.3	-5.1	-7.1	-4.0	0.0
3150	-4.4	-4.2	-5.2	-2.9	-1.1	-4.9	-2.8	-1.6	0.2	-2.7	-3.5	-6.1	-7.7	-5.2	-5.5	-10.1	-6.4	-3.7
4000	-2.6	-2.2	1.0	0.8	2.8	0.6	3.5	5.1	3.6	-0.9	-1.2	-5.1	-6.2	-4.0	-4.8	-8.7	-6.4	-2.6
5000	-4.3	-3.8	-0.3	-1.5	-0.1	-1.4	2.3	2.6	2.7	-0.6	-2.6	-6.3	-6.3	-7.2	-6.6	-10.5	-8.3	-4.2
6300	-7.5	-6.9	-8.0	-10.3	-8.0	-8.0	-5.9	-4.9	-3.1	-3.8	-6.4	-8.1	-6.5	-8.1	-6.3	-12.3	-11.0	-8.3
8000	-4.4	-3.5	-2.6	-3.1	-1.9	-1.3	2.1	3.2	2.0	-1.0	-4.0	-5.8	-4.5	-5.2	-4.7	-8.3	-7.7	-4.8
10000	-7.4	-6.1	-9.2	-9.6	-10.1	-7.7	-2.9	-3.5	-1.8	-4.4	-3.8	-5.7	-6.0	-7.4	-8.6	-12.0	-10.8	-7.2
OA(1K-10K)	-5.0	-4.3	-4.3	-5.0	-3.4	-4.7	-2.0	-1.1	0.0	-2.0	-3.6	-5.7	-5.6	-5.5	-5.2	-8.7	-6.7	-3.3

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	7.4	7.3	7.3	6.6	8.5	6.6	9.7	10.8	10.6	8.3	5.8	5.8	5.6	6.7	8.2	6.6	8.4	11.8
1250	3.5	3.5	4.4	3.6	4.9	5.1	6.3	7.8	6.8	4.0	1.3	1.7	2.0	2.8	3.9	1.9	4.0	7.7
1600	0.3	0.3	3.2	1.9	2.2	2.1	3.9	4.2	4.8	2.1	-1.7	-1.6	-1.2	-0.5	0.0	-1.9	0.6	4.5
2000	-1.3	-1.2	2.5	1.2	1.9	1.6	2.2	3.7	1.9	1.3	-1.9	-3.6	-3.3	-1.4	-2.7	-4.6	-1.9	2.2
2500	-2.6	-2.4	3.4	1.4	2.6	0.8	3.3	3.3	2.2	0.5	-3.4	-5.2	-5.6	-4.3	-5.1	-7.1	-4.0	0.0
3150	-4.0	-3.7	-2.0	0.5	2.3	-1.6	0.4	0.7	0.7	-3.5	-4.8	-7.4	-8.2	-5.2	-5.5	-10.1	-6.4	-3.7
4000	-2.6	-2.2	1.0	0.8	2.8	0.6	3.5	5.1	3.6	-0.9	-1.2	-5.1	-6.2	-4.0	-4.8	-8.7	-6.4	-2.6
5000	-4.3	-3.8	-0.3	-1.5	-0.1	-1.4	2.3	2.6	2.7	-0.6	-2.6	-6.3	-6.3	-7.2	-6.6	-10.5	-8.3	-4.2
6300	-7.0	-6.4	-4.4	-6.7	-4.4	-4.4	-2.5	-2.5	-2.6	-4.7	-7.8	-9.7	-7.1	-8.1	-6.3	-12.3	-11.0	-8.3
8000	-4.4	-3.5	-2.6	-3.1	-1.9	-1.3	2.1	3.2	2.0	-1.0	-4.0	-5.8	-4.5	-5.2	-4.7	-8.3	-7.7	-4.8
10000	-7.1	-5.8	-6.3	-6.5	-7.1	-4.7	0.0	-1.4	-1.4	-5.1	-4.8	-6.8	-6.4	-7.4	-8.6	-12.0	-10.8	-7.2
OA(1K-10K)	-4.7	-4.0	-1.8	-2.4	-0.8	-2.1	0.6	0.7	0.3	-2.6	-4.5	-6.6	-5.9	-5.5	-5.2	-8.7	-6.7	-3.3

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	1.9	1.9	0.1	-0.6	1.2	-0.7	2.2	3.1	2.4	0.1	-1.0	0.4	1.1	2.4	3.9	2.3	4.1	7.5
1250	-0.7	-0.8	-1.6	-2.5	-1.1	-1.0	0.0	1.3	-0.2	-2.9	-4.2	-2.5	-1.2	-0.2	0.9	-1.1	1.0	4.7
1600	-2.7	-2.7	-1.6	-2.9	-2.6	-2.7	-1.1	-1.1	-1.0	-3.6	-6.0	-4.6	-3.2	-2.3	-1.8	-3.7	-1.2	2.7
2000	-3.3	-3.2	-1.3	-2.6	-1.9	-2.3	-1.8	-0.6	-2.9	-3.4	-5.2	-5.6	-4.3	-2.2	-3.5	-5.4	-2.7	1.4
2500	-3.7	-3.5	0.5	-1.5	-0.4	-2.2	0.2	-0.1	-1.7	-3.3	-5.9	-6.3	-5.8	-4.2	-5.0	-7.0	-3.9	0.1
3150	-2.7	-2.4	-2.2	1.0	2.7	-1.1	0.8	0.9	0.3	-3.9	-4.3	-5.8	-6.0	-3.0	-3.3	-8.2	-5.0	-2.2
4000	-2.2	-1.8	-0.4	-0.6	1.4	-0.9	1.9	3.2	1.2	-3.2	-2.1	-4.7	-4.8	-2.4	-3.2	-7.1	-4.8	-1.0
5000	-3.3	-2.9	-1.2	-2.4	-0.9	-2.3	1.2	1.3	0.9	-2.3	-2.9	-5.3	-4.3	-5.0	-4.5	-8.4	-6.2	-2.1
6300	-2.5	-1.9	-0.8	-2.5	-0.2	-0.3	1.8	1.7	0.8	-1.7	-4.2	-4.9	-1.9	-3.0	-1.3	-7.6	-6.6	-3.8
8000	-2.4	-1.5	-2.4	-2.9	-1.8	-1.2	2.1	2.9	1.2	-1.7	-3.4	-3.8	-1.5	-2.0	-1.5	-6.1	-4.5	-1.6
10000	-1.6	-0.4	-2.1	-2.0	-2.5	-0.2	4.7	3.3	2.5	-1.5	-0.3	-1.2	-0.1	-1.2	-2.4	-6.0	-5.0	-1.3
OA(1K-10K)	-2.4	-1.9	-1.2	-1.4	0.1	-1.2	1.6	1.7	0.7	-2.5	-3.3	-4.3	-2.9	-2.5	-2.3	-5.9	-4.0	-0.6

Engine/Run #: 139FF175

Blade pass freq[Hz]= 4080.7

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	10.1	10.0	3.3	3.0	5.5	4.0	7.1	9.2	10.8	10.9	9.7	10.1	10.0	11.0	11.9	11.1	12.8	15.7
1250	5.8	5.7	0.3	-0.3	0.7	0.9	2.2	5.1	6.7	6.1	5.1	5.7	6.1	7.2	7.5	6.1	7.8	11.3
1600	2.0	2.0	-2.2	-3.3	-2.5	-1.6	0.7	1.8	4.8	3.8	1.2	1.8	2.2	3.1	3.0	1.8	4.0	7.6
2000	-0.4	-0.3	-4.5	-3.4	-2.6	-3.4	-1.2	0.4	0.9	2.3	0.2	-1.1	-0.7	1.7	-0.6	-1.1	1.1	4.8
2500	-3.1	-2.9	-3.0	-4.9	-3.8	-5.5	-2.9	-1.6	-0.3	0.1	-2.2	-3.8	-4.0	-2.0	-3.8	-4.5	-1.7	1.4
3150	-3.7	-3.5	-3.3	-4.7	-3.1	-4.3	-1.6	-0.2	1.3	-0.7	-2.1	-4.7	-5.3	-4.6	-5.7	-7.3	-3.6	-0.3
4000	-6.0	-5.6	-8.8	-10.6	-6.9	-10.4	-5.2	-5.3	-4.1	-4.2	-1.5	-4.3	-6.7	-3.2	-7.1	-7.4	-6.3	-1.3
5000	-6.6	-6.1	-8.5	-9.1	-7.9	-9.4	-5.1	-2.9	-0.9	-2.2	-3.0	-6.8	-6.7	-7.6	-7.5	-9.9	-7.5	-3.8
6300	-6.5	-5.8	-8.2	-9.1	-7.6	-8.0	-4.4	-2.8	-0.9	-2.8	-3.5	-5.6	-5.1	-7.9	-8.3	-10.2	-8.5	-5.0
8000	-10.5	-9.6	-15.3	-14.7	-15.1	-14.4	-11.8	-10.1	-8.3	-7.9	-7.8	-8.3	-8.0	-7.1	-7.6	-11.2	-10.7	-7.9
10000	-7.8	-6.5	-10.5	-11.9	-12.5	-10.5	-5.2	-3.1	-0.8	-4.0	-3.9	-6.0	-5.3	-8.2	-9.2	-9.8	-8.2	-5.0
OA(1K-10K)	-6.5	-5.7	-9.4	-10.4	-8.8	-10.0	-6.6	-5.2	-3.1	-3.4	-3.3	-5.0	-4.7	-4.4	-5.4	-6.8	-5.1	-1.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	10.1	10.0	3.3	3.0	5.5	4.0	7.1	9.2	10.8	10.9	9.7	10.1	10.0	11.0	11.9	11.1	12.8	15.7
1250	5.8	5.7	0.3	-0.3	0.7	0.9	2.2	5.1	6.7	6.1	5.1	5.7	6.1	7.2	7.5	6.1	7.8	11.3
1600	2.0	2.0	-2.2	-3.3	-2.5	-1.6	0.7	1.8	4.8	3.8	1.2	1.8	2.2	3.1	3.0	1.8	4.0	7.6
2000	-0.4	-0.3	-4.5	-3.4	-2.6	-3.4	-1.2	0.4	0.9	2.3	0.2	-1.1	-0.7	1.7	-0.6	-1.1	1.1	4.8
2500	-3.1	-2.9	-3.0	-4.9	-3.8	-5.5	-2.9	-1.6	-0.3	0.1	-2.2	-3.8	-4.0	-2.0	-3.8	-4.5	-1.7	1.4
3150	-3.7	-3.5	-3.3	-4.7	-3.1	-4.3	-1.6	-0.2	1.3	-0.7	-2.1	-4.7	-5.3	-4.6	-5.7	-7.3	-3.6	-0.3
4000	-5.1	-4.7	-6.0	-7.7	-4.0	-7.5	-2.2	-3.0	-3.2	-4.7	-2.5	-6.5	-7.2	-3.2	-7.1	-7.4	-6.3	-1.3
5000	-6.6	-6.1	-8.5	-9.1	-7.9	-9.4	-5.1	-2.9	-0.9	-2.2	-3.0	-6.8	-6.7	-7.6	-7.5	-9.9	-7.5	-3.8
6300	-6.5	-5.8	-8.2	-9.1	-7.6	-8.0	-4.4	-2.8	-0.9	-2.8	-3.5	-5.6	-5.1	-7.9	-8.3	-10.2	-8.5	-5.0
8000	-9.4	-8.5	-12.0	-11.3	-11.7	-11.0	-8.5	-7.5	-7.2	-8.5	-9.1	-9.8	-8.6	-7.1	-7.6	-11.2	-10.7	-7.9
10000	-7.8	-6.5	-10.5	-11.9	-12.5	-10.5	-5.2	-3.1	-0.8	-4.0	-3.9	-6.0	-5.3	-8.2	-9.2	-9.8	-8.2	-5.0
OA(1K-10K)	-5.9	-5.1	-7.5	-8.4	-6.8	-8.0	-4.5	-3.6	-2.5	-3.7	-4.0	-5.7	-5.0	-4.4	-5.4	-6.8	-5.1	-1.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	4.6	4.5	-1.3	-1.6	0.8	-0.7	2.2	3.7	3.7	2.7	2.4	3.9	4.8	6.0	7.0	6.2	7.9	10.8
1250	1.6	1.5	-3.1	-3.7	-2.7	-2.6	-1.5	0.8	0.9	-0.9	-1.0	0.8	2.2	3.5	3.8	2.4	4.1	7.6
1600	-1.0	-0.9	-4.3	-5.4	-4.7	-3.8	-1.7	-1.2	0.3	-1.9	-3.6	-1.8	-0.4	0.7	0.6	-0.6	1.6	5.2
2000	-2.3	-2.2	-5.6	-4.5	-3.7	-4.5	-2.6	-1.4	-2.5	-2.3	-3.5	-3.6	-2.3	0.3	-2.0	-2.5	-0.3	3.4
2500	-4.1	-3.9	-3.1	-5.0	-3.9	-5.7	-3.3	-2.6	-2.8	-3.5	-5.0	-5.3	-4.6	-2.4	-4.2	-4.9	-2.1	1.0
3150	-3.8	-3.5	-2.5	-3.9	-2.3	-3.6	-1.1	-0.3	-0.3	-3.4	-4.0	-5.5	-5.0	-4.1	-5.2	-6.8	-3.1	0.2
4000	-3.4	-2.9	-4.5	-5.4	-1.7	-5.3	-0.3	-1.5	-2.8	-4.7	-2.0	-3.9	-4.9	-0.9	-4.8	-5.4	-4.7	0.4
5000	-5.2	-4.7	-6.3	-6.9	-5.8	-7.3	-3.2	-1.5	-1.0	-3.6	-3.5	-6.1	-5.1	-5.7	-5.6	-8.0	-5.6	-1.9
6300	-4.6	-3.9	-5.4	-6.4	-4.9	-6.3	-1.9	-0.9	-0.6	-3.6	-3.4	-4.3	-2.9	-6.5	-5.9	-7.8	-6.1	-2.6
8000	-4.3	-3.4	-6.5	-6.2	-6.6	-6.0	-2.5	-1.8	-2.7	-4.8	-6.3	-6.1	-1.3	-1.9	-2.5	-6.5	-6.2	-3.4
10000	-4.6	-3.4	-6.5	-7.9	-8.6	-6.6	-1.5	0.0	0.7	-3.6	-2.6	-3.5	-1.9	-4.6	-5.5	-6.1	-4.5	-1.3
OA(1K-10K)	-3.5	-2.9	-4.8	-5.4	-3.9	-6.1	-1.6	-1.1	-1.3	-3.5	-3.3	-3.9	-2.5	-1.9	-2.9	-4.5	-2.8	0.7

Engine/Run #: 139FF185
Blade pass freq[Hz]= 4637.1

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-5.8	-5.9	-11.1	-11.7	-11.1	-15.3	-16.2	-15.6	-11.6	-8.7	-4.4	-1.2	1.0	3.4	4.8	4.2	2.0	1.4
1250	-11.4	-11.4	-15.9	-16.9	-17.6	-19.7	-21.7	-20.8	-16.8	-13.0	-10.3	-6.6	-4.4	-1.4	-0.9	-2.3	-3.7	-4.5
1600	-7.3	-7.3	-10.1	-11.1	-8.7	-15.2	-16.7	-15.6	-9.6	-6.5	-6.7	-3.2	-1.0	2.5	1.7	1.1	1.5	-0.2
2000	-6.7	-6.6	-10.7	-11.0	-12.1	-14.1	-15.3	-14.7	-12.0	-5.9	-4.2	-1.8	0.3	3.9	1.4	1.6	0.2	-0.4
2500	-9.2	-9.0	-8.1	-9.0	-11.0	-16.5	-18.7	-16.0	-12.8	-6.9	-6.4	-4.8	-3.0	0.7	-1.4	-1.8	-2.2	-2.9
3150	-4.4	-4.2	1.4	-0.2	-1.6	-7.6	-8.0	-8.9	-5.9	-4.0	-2.3	-1.8	0.0	2.5	1.3	0.4	2.0	1.2
4000	1.8	2.2	5.2	3.6	4.1	-0.8	0.1	-1.0	1.2	3.6	5.5	4.7	3.9	7.3	4.1	5.5	6.8	6.0
5000	0.3	0.8	-5.6	-8.4	-3.6	-9.8	-0.6	-3.1	2.8	5.9	6.5	4.4	0.7	3.6	0.6	4.6	8.1	8.0
6300	1.8	2.4	-0.5	-2.2	-1.7	-3.7	-1.0	0.7	2.8	5.0	6.3	4.3	5.3	3.4	3.0	3.3	4.6	6.2
8000	2.9	3.8	2.5	0.8	0.7	0.7	3.9	4.4	4.7	5.3	5.6	4.3	5.4	3.8	2.4	3.1	4.2	5.9
10000	-3.3	-2.0	-4.8	-9.9	-9.8	-9.6	-3.5	-1.5	0.3	0.1	2.2	1.3	1.7	-0.4	-1.7	-1.0	0.5	2.9
OA(1K-10K)	-4.6	-4.6	-4.7	-6.7	-6.0	-10.9	-8.7	-9.9	-6.2	-2.7	-1.0	-0.6	0.1	2.4	1.1	1.7	2.0	1.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	8.3	8.2	1.0	0.4	1.5	-1.1	0.0	0.6	1.1	4.5	7.7	11.1	13.6	16.3	17.8	17.7	16.2	16.2
1250	3.2	3.1	-3.3	-4.3	-4.5	-5.1	-5.1	-4.2	-3.6	-1.4	2.3	6.2	8.7	12.0	12.6	11.7	11.0	10.7
1600	4.3	4.3	-0.5	-1.5	1.4	-3.5	-3.0	-1.8	0.7	2.2	2.9	6.4	8.9	12.4	11.6	11.7	13.0	12.0
2000	2.2	2.3	-3.8	-4.1	-4.7	-5.1	-4.2	-3.6	-4.4	0.2	2.8	5.1	7.5	11.0	8.5	9.4	9.0	9.1
2500	-1.2	-1.0	-2.2	-3.0	-4.4	-8.4	-6.6	-5.8	-6.1	-1.7	-0.4	1.2	3.2	7.0	4.9	5.1	5.6	5.7
3150	2.9	3.2	6.6	5.1	4.4	0.1	1.8	1.0	0.6	0.9	3.2	3.4	5.0	7.2	5.8	5.6	8.7	9.1
4000	8.0	8.4	9.1	7.7	9.0	5.9	9.2	8.4	7.4	8.1	9.9	8.4	7.0	10.0	6.5	8.5	11.4	12.4
5000	2.8	3.3	-1.3	-4.1	0.8	-5.1	4.4	1.6	5.5	6.4	5.9	3.1	0.3	3.8	0.8	4.9	8.7	9.2
6300	4.5	5.1	0.8	-0.7	0.3	-0.3	4.8	7.6	7.3	7.5	8.0	5.4	6.1	4.0	3.4	4.0	6.0	8.8
8000	4.3	5.2	3.1	1.5	1.8	2.6	7.7	9.3	7.8	6.8	6.4	4.8	5.7	4.1	2.6	3.4	4.8	7.2
10000	-1.6	-0.3	-1.2	-6.2	-6.1	-5.8	0.3	1.8	1.9	0.0	1.2	0.0	1.2	-0.4	-1.7	-0.9	0.6	3.2
OA(1K-10K)	3.0	3.5	1.5	-0.3	1.2	-2.1	2.4	1.6	2.1	3.6	4.9	4.1	4.5	6.5	4.9	6.3	8.5	9.3

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	14.2	14.2	7.5	7.0	8.4	5.9	7.2	7.9	8.3	10.8	12.8	15.2	17.0	18.6	19.3	20.0	20.2	21.6
1250	9.6	9.5	3.4	2.5	2.5	2.0	2.1	3.1	3.5	5.3	8.0	11.2	13.1	15.5	15.4	15.2	15.9	16.7
1600	10.6	10.6	6.7	5.9	9.2	4.5	5.3	6.6	8.9	9.1	7.9	10.3	12.0	14.5	12.8	13.6	16.9	17.6
2000	9.1	9.2	4.1	4.0	3.9	3.9	5.0	5.9	4.8	7.7	8.2	9.3	10.9	13.4	10.2	11.7	13.2	15.1
2500	6.4	6.6	6.4	5.7	4.7	1.1	3.2	4.1	3.5	6.5	5.9	6.4	7.6	10.4	7.5	8.4	10.8	12.6
3150	8.0	8.2	13.1	11.7	11.5	7.5	9.6	9.0	8.1	6.3	6.4	5.8	7.0	8.6	6.7	7.0	11.3	13.3
4000	10.9	11.3	14.1	12.8	14.5	11.6	15.1	14.4	12.6	10.7	10.8	9.1	8.0	10.8	7.1	9.3	12.8	14.7
5000	5.4	5.9	0.5	-0.9	4.0	-1.9	7.2	4.0	7.0	7.7	7.4	5.7	3.6	7.1	4.0	7.4	10.6	11.1
6300	6.2	6.9	5.5	4.0	5.0	4.3	9.1	11.2	9.2	7.1	7.5	5.7	7.3	5.3	4.7	5.3	7.4	10.3
8000	6.2	7.2	8.2	6.6	6.8	7.4	12.0	12.6	9.0	6.1	6.1	5.5	7.3	5.8	4.4	5.1	6.6	9.0
10000	3.6	4.9	5.7	1.6	1.7	1.8	7.6	8.3	6.8	3.6	4.7	4.3	6.0	4.3	2.9	3.4	4.7	7.3
OA(1K-10K)	7.2	7.7	5.9	4.9	6.8	3.9	8.3	7.6	7.6	7.5	7.5	7.0	7.6	9.3	7.5	8.7	11.2	12.8

Engine/Run #: 139FF195

Blade pass freq[Hz]= 5003.1

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-8.4	-8.4	-13.9	-14.4	-14.2	-18.4	-19.0	-17.6	-13.2	-7.8	-6.3	-3.7	-1.9	0.6	2.2	1.3	-0.8	-2.0
1250	-14.1	-14.1	-19.2	-20.2	-20.5	-23.1	-25.2	-23.8	-19.1	-15.2	-12.9	-9.4	-7.2	-4.3	-3.4	-4.5	-6.6	-7.8
1600	-10.6	-10.6	-15.9	-16.8	-18.0	-21.0	-21.4	-20.7	-14.2	-10.2	-9.8	-6.4	-3.5	-0.7	-0.4	-1.2	-3.3	-4.1
2000	-10.2	-10.1	-15.3	-15.4	-16.2	-20.4	-20.7	-18.5	-14.8	-8.7	-7.6	-6.0	-3.3	0.1	-1.0	-1.3	-3.4	-4.1
2500	-12.8	-12.6	-17.0	-18.0	-18.6	-22.4	-21.9	-21.5	-16.7	-10.9	-9.9	-7.9	-6.1	-2.9	-3.7	-4.1	-5.8	-7.2
3150	-9.1	-8.8	-0.3	-10.2	-7.9	-11.7	-16.5	-15.4	-11.4	-7.8	-6.3	-5.7	-3.8	-1.4	-1.6	-2.4	-3.3	-4.2
4000	-5.7	-5.3	-4.8	-6.8	-5.8	-9.9	-10.2	-11.2	-7.2	-3.3	-0.8	-1.8	-1.2	0.7	-0.3	-0.9	-1.7	-1.9
5000	-5.6	-5.1	-7.5	-9.9	-10.5	-10.9	-4.4	-8.8	-2.9	-1.3	0.3	-1.8	-4.3	-4.9	-5.4	-5.8	-4.8	-1.9
6300	-3.2	-2.6	-7.0	-8.9	-8.9	-9.4	-5.6	-7.9	-2.8	0.4	1.4	-0.7	0.0	-1.7	-0.4	-0.1	-0.3	0.4
8000	-3.4	-2.5	-6.4	-7.5	-7.1	-7.5	-2.4	-5.2	-1.9	0.5	0.3	-1.8	-1.1	-2.8	-2.2	-1.0	-1.0	0.1
10000	-8.5	-7.2	-11.9	-14.8	-15.0	-14.0	-7.2	-8.4	-4.7	-4.4	-3.1	-5.7	-5.5	-7.2	-6.3	-4.8	-5.2	-3.8
OA(1K-10K)	-9.5	-9.4	-9.2	-13.1	-13.2	-16.2	-14.4	-16.8	-11.8	-7.8	-5.8	-5.2	-4.1	-2.4	-2.2	-2.6	-3.9	-4.4

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	5.6	5.6	-1.8	-2.3	-1.6	-4.3	-2.9	-1.5	-0.5	3.3	5.8	8.5	10.7	13.4	15.1	14.8	13.4	12.7
1250	0.5	0.5	-6.6	-7.6	-7.4	-8.4	-8.5	-7.1	-5.9	-3.5	-0.3	3.3	6.0	9.1	10.1	9.6	8.1	7.5
1600	1.0	1.0	-6.3	-7.1	-7.9	-9.3	-7.6	-6.9	-3.9	-1.4	-0.2	3.3	6.4	9.2	9.5	9.4	8.3	8.1
2000	-1.3	-1.2	-8.4	-8.4	-8.6	-11.4	-9.6	-7.3	-7.1	-2.6	-0.5	1.0	3.9	7.2	6.1	6.5	5.4	5.5
2500	-4.8	-4.6	-11.0	-12.0	-12.0	-14.2	-11.6	-11.2	-9.9	-5.6	-3.8	-1.8	0.2	3.3	2.5	2.8	2.1	1.4
3150	-1.7	-1.4	4.9	-4.8	-1.9	-4.1	-6.6	-5.4	-4.8	-2.8	-0.8	-0.5	1.1	3.2	2.7	2.7	3.2	3.6
4000	0.3	0.7	-1.0	-2.8	-1.0	-3.3	-1.2	-1.7	-1.0	1.1	3.6	1.7	1.8	3.2	2.0	2.0	2.8	4.3
5000	-2.5	-2.0	0.5	-1.8	-2.4	-2.7	4.3	-0.9	1.7	0.0	-0.3	-3.2	-4.8	-4.7	-5.2	-5.6	-4.2	-0.9
6300	-0.8	-0.2	-5.9	-7.7	-7.1	-6.3	-0.1	-1.4	1.5	2.7	2.9	0.2	0.6	-1.2	0.0	0.5	0.9	2.7
8000	-2.2	-1.3	-5.9	-6.9	-6.2	-5.8	1.0	-0.8	0.9	1.8	1.0	-1.4	-0.8	-2.6	-2.0	-0.8	-0.5	1.2
10000	-6.5	-5.3	-6.3	-6.9	-9.2	-8.1	-0.9	-2.7	-1.5	-3.9	-4.0	-7.1	-6.1	-7.2	-6.2	-4.7	-5.1	-3.5
OA(1K-10K)	-1.7	-1.1	-1.8	-5.5	-5.0	-6.4	-2.4	-4.6	-3.0	-1.3	-0.1	-0.9	-0.2	1.2	1.0	1.5	2.0	3.4

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	10.3	10.3	3.3	2.9	3.9	1.4	2.9	4.4	5.2	8.4	9.6	11.4	13.0	14.7	15.7	16.0	16.3	16.9
1250	5.5	5.4	-1.3	-2.2	-1.8	-2.8	-2.8	-1.4	-0.2	1.7	4.1	7.0	9.1	11.4	11.8	11.8	11.8	12.1
1600	6.0	6.0	-0.4	-1.1	-1.5	-2.6	-0.7	0.1	2.9	4.1	3.5	5.9	8.3	10.1	9.6	10.2	10.9	12.4
2000	4.3	4.4	-1.8	-1.7	-1.4	-3.8	-1.7	0.7	0.6	3.6	3.5	4.0	6.1	8.4	6.6	7.6	8.4	10.3
2500	1.5	1.7	-3.8	-4.7	-4.2	-6.2	-3.3	-2.8	-1.7	1.1	1.1	2.0	3.3	5.5	4.0	4.8	6.0	7.0
3150	2.0	2.3	10.1	0.5	3.8	2.0	-0.2	1.2	1.3	1.2	1.2	0.6	1.9	3.5	2.6	2.9	4.7	6.5
4000	2.0	2.4	2.9	1.2	3.2	1.2	3.4	2.9	2.8	2.4	3.3	1.3	1.8	3.1	1.6	1.8	3.1	5.5
5000	0.1	0.6	2.8	1.5	0.9	0.6	7.1	1.6	3.5	1.5	1.3	-0.6	-1.7	-1.7	-2.2	-3.2	-2.6	0.8
6300	0.1	0.7	-2.0	-3.8	-3.3	-2.8	3.1	1.1	2.2	1.4	1.5	-0.2	1.0	-0.7	0.8	1.1	1.5	3.4
8000	-1.0	-0.1	-1.5	-2.6	-2.0	-1.8	4.5	1.7	1.2	0.2	-0.1	-1.5	0.0	-1.5	-1.0	0.3	0.5	2.2
10000	-2.6	-1.3	-0.9	-3.2	-3.6	-2.7	4.1	1.5	1.2	-1.8	-1.2	-3.2	-1.8	-3.1	-2.2	-0.9	-1.5	0.2
OA(1K-10K)	1.7	2.3	2.9	-0.5	0.3	-0.8	3.3	1.0	2.0	1.9	1.9	1.3	2.3	3.4	3.1	3.4	4.1	6.1

Engine/Run #: . 139FF199
Blade pass freq[Hz]= 5281.9

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-4.8	-4.9	-9.9	-12.7	-13.2	-13.8	-17.7	-14.0	-9.5	-5.3	-3.3	-0.3	2.3	4.2	5.9	4.8	3.0	1.6
1250	-10.1	-10.2	-15.0	-18.4	-19.8	-18.6	-24.3	-19.7	-14.6	-11.2	-8.9	-5.7	-2.8	-0.4	0.7	-1.0	-2.6	-4.0
1600	-7.1	-7.1	-12.6	-15.3	-15.3	-19.7	-20.1	-17.8	-11.5	-7.2	-6.2	-2.9	0.1	3.4	3.7	1.9	0.0	-1.7
2000	-6.6	-6.5	-11.7	-15.4	-16.4	-19.3	-19.0	-15.1	-11.4	-5.7	-4.0	-2.2	0.5	4.0	3.3	1.9	0.1	-1.2
2500	-9.1	-8.9	-17.2	-17.6	-18.1	-22.0	-20.4	-18.5	-13.9	-7.6	-6.1	-4.1	-2.2	1.4	0.6	-0.9	-2.3	-4.0
3150	-6.4	-6.1	-12.4	-12.9	-14.0	-17.7	-15.7	-14.9	-9.4	-4.6	-2.3	-1.1	0.3	2.9	2.5	0.5	-0.4	-1.7
4000	-2.7	-2.3	-5.8	-6.9	-5.9	-11.5	-9.1	-9.8	-5.2	-0.5	2.9	2.4	3.0	4.8	3.4	1.7	1.2	1.1
5000	-4.0	-3.5	-8.3	-11.8	-10.6	-11.1	-8.1	-7.5	-1.0	0.4	2.5	-0.5	-1.1	-3.0	-3.0	-4.2	-2.8	-0.8
6300	0.6	1.2	-6.5	-9.0	-8.3	-9.0	-4.9	-5.7	-0.2	3.5	5.7	4.1	4.9	3.2	3.8	2.7	3.3	3.7
8000	-1.2	-0.2	-8.7	-10.6	-9.8	-10.0	-3.1	-4.2	-1.0	2.1	3.1	1.8	2.4	0.7	0.8	0.6	1.3	2.4
10000	-6.5	-5.2	-11.6	-15.2	-15.5	-14.9	-7.0	-7.0	-3.7	-2.8	-0.9	-2.6	-2.9	-4.6	-4.7	-4.5	-3.5	-2.2
OA(1K-10K)	-6.4	-6.3	-11.1	-13.8	-13.8	-16.1	-15.4	-14.7	-9.4	-5.2	-2.4	-1.8	-0.1	1.3	1.4	0.3	-0.6	-1.5

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	8.8	8.8	1.8	-1.0	-1.0	0.0	-1.9	1.8	2.8	5.5	8.4	11.5	14.6	16.7	18.5	18.0	16.8	16.0
1250	4.4	4.4	-2.4	-5.8	-6.7	-4.0	-7.6	-3.0	-1.4	0.5	3.7	7.0	10.3	13.0	14.2	13.1	12.1	11.2
1600	4.5	4.5	-3.1	-5.7	-5.1	-8.0	-6.3	-4.0	-1.2	1.6	3.4	6.8	10.0	13.3	13.6	12.5	11.5	10.5
2000	2.4	2.5	-4.7	-8.4	-8.8	-10.2	-7.8	-3.9	-3.7	0.5	3.1	4.9	7.7	11.1	10.4	9.7	8.9	8.3
2500	-1.1	-0.9	-11.1	-11.6	-11.5	-13.8	-10.1	-8.1	-7.0	-2.3	0.0	2.0	4.1	7.7	6.8	6.0	5.6	4.7
3150	1.0	1.3	-7.2	-7.5	-7.9	-9.9	-5.8	-4.8	-2.7	0.5	3.2	4.1	5.2	7.4	6.8	5.5	6.2	6.1
4000	3.3	3.7	-2.0	-3.0	-1.1	-5.0	-0.1	-0.3	1.0	4.0	7.2	5.8	5.9	7.3	5.6	4.4	5.5	7.1
5000	-1.5	-1.1	-0.7	-4.0	-2.8	-3.3	0.3	0.2	3.1	1.2	1.6	-2.1	-1.6	-2.8	-2.9	-4.0	-2.3	0.1
6300	2.9	3.5	-5.5	-7.8	-6.6	-6.0	0.3	0.6	4.0	5.7	7.1	5.0	5.5	3.6	4.1	3.2	4.4	5.8
8000	-0.1	0.8	-8.3	-10.1	-9.1	-8.5	0.0	-0.1	1.7	3.3	3.8	2.1	2.6	0.8	1.0	0.8	1.8	3.3
10000	-5.1	-3.8	-6.8	-10.1	-10.3	-9.7	-1.4	-2.0	-1.1	-2.7	-2.0	-4.0	-3.4	-4.5	-4.7	-4.5	-3.5	-2.0
OA(1K-10K)	1.1	1.7	-3.9	-6.5	-5.8	-6.4	-3.5	-2.6	-0.7	1.2	2.9	2.1	3.4	4.6	4.4	4.0	5.0	6.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	12.9	12.9	6.4	3.7	3.9	5.0	3.2	7.0	7.9	9.9	11.8	14.1	16.4	17.6	18.7	18.8	19.3	19.7
1250	8.5	8.5	2.0	-1.3	-2.1	0.7	-2.9	1.8	3.3	4.8	7.2	9.9	12.7	14.6	15.2	14.6	14.9	15.0
1600	8.7	8.7	1.9	-0.6	0.3	-2.2	-0.4	2.1	4.7	6.2	6.3	8.7	11.2	13.5	13.0	12.5	13.3	14.0
2000	7.1	7.2	0.9	-2.6	-2.5	-3.6	-1.0	3.1	3.1	5.7	6.3	7.0	9.1	11.6	10.1	10.0	11.1	12.3
2500	4.3	4.5	-4.9	-5.2	-4.7	-6.7	-2.8	-0.7	0.2	3.5	4.0	4.9	6.4	9.1	7.5	7.2	8.6	9.3
3150	3.8	4.1	-2.9	-3.1	-3.1	-4.8	-0.4	0.7	2.3	3.5	4.3	4.4	5.3	6.9	5.9	5.0	6.8	8.1
4000	4.2	4.6	1.1	0.1	2.3	-1.4	3.6	3.3	3.8	4.4	6.1	4.7	5.1	6.4	4.6	3.5	5.2	7.5
5000	0.9	1.4	1.5	-1.1	0.1	-0.3	2.8	2.4	4.6	2.5	3.2	0.5	1.4	0.1	0.0	-1.8	-0.8	1.7
6300	3.1	3.8	-2.1	-4.5	-3.4	-3.0	2.9	2.4	3.9	3.6	5.1	3.9	5.4	3.6	4.1	3.2	4.5	5.9
8000	0.6	1.5	-4.4	-6.3	-5.4	-5.0	2.9	1.8	1.3	1.1	2.1	1.5	2.9	1.4	1.5	1.4	2.3	3.9
10000	-1.5	-0.2	-1.9	-5.1	-5.4	-5.0	2.9	1.6	1.1	-1.0	0.5	-0.5	0.6	-0.7	-1.0	-1.0	-0.2	1.4
OA(1K-10K)	3.9	4.5	0.2	-2.1	-1.2	-1.6	1.4	2.3	3.5	3.7	4.3	4.0	5.5	6.5	6.1	5.5	6.6	8.2

APPENDIX VI

MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 2
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHZ, dB

Engine/Run #: 179FF104
Blade pass freq[Hz]= 2232.6

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	3.8	3.8	9.3	8.8	9.4	7.1	10.2	11.2	8.2	4.6	2.2	1.1	0.6	1.3	2.3	1.0	0.2	6.0
1250	3.9	3.8	10.3	10.5	10.4	10.1	10.7	11.2	9.2	3.9	1.6	0.5	-0.5	-0.1	0.8	-0.9	-0.6	3.6
1600	2.7	2.7	9.9	9.1	8.2	7.7	10.1	9.0	8.5	4.0	-0.2	-0.4	-1.1	-0.6	0.4	-1.6	-0.5	3.3
2000	-1.9	-1.8	1.5	0.4	0.7	-0.3	1.0	2.6	1.8	1.2	-3.1	-3.6	-3.6	-5.1	-4.6	-5.8	-3.6	0.0
2500	1.8	2.0	9.0	7.8	8.0	7.0	9.6	9.5	7.4	4.1	0.0	-0.8	-1.2	-1.9	-1.6	-3.9	-2.4	1.8
3150	2.6	2.9	9.5	8.2	8.8	7.3	10.1	9.7	8.2	5.5	2.3	0.5	-0.3	-0.7	0.1	-3.7	-2.5	1.9
4000	-3.3	-2.8	-1.4	-2.3	-1.5	-2.5	-0.2	1.5	1.2	-0.2	-2.9	-4.2	-4.4	-4.8	-4.6	-8.5	-8.5	-4.4
5000	1.2	1.7	5.1	4.9	6.7	5.7	9.2	9.9	8.5	5.4	2.3	-1.5	-2.5	-2.0	-2.1	-6.0	-5.1	-0.9
6300	-2.0	-1.4	-0.5	-0.3	0.1	0.4	2.5	3.3	4.6	1.8	-1.3	-3.3	-3.8	-4.3	-4.0	-7.5	-8.4	-3.5
8000	-1.0	-0.1	-0.2	-0.2	0.7	1.3	3.8	5.8	5.6	4.2	0.5	-1.7	-1.9	-3.6	-2.3	-5.8	-6.6	-2.1
10000	1.6	2.9	1.5	2.2	2.3	4.6	6.3	7.6	8.3	6.0	4.3	3.8	2.9	0.5	-1.2	-3.8	-4.2	0.7
OA(1K-10K)	-0.2	0.3	3.0	2.2	2.8	2.2	4.4	5.4	5.4	3.3	0.3	-1.2	-1.8	-2.7	-2.4	-5.3	-4.9	-0.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	3.8	3.8	9.3	8.8	9.4	7.1	10.2	11.2	8.2	4.6	2.2	1.1	0.6	1.3	2.3	1.0	0.2	6.0
1250	3.9	3.8	10.3	10.5	10.4	10.1	10.7	11.2	9.2	3.9	1.6	0.5	-0.5	-0.1	0.8	-0.9	-0.6	3.6
1600	2.7	2.7	9.9	9.1	8.2	7.7	10.1	9.0	8.5	4.0	-0.2	-0.4	-1.1	-0.6	0.4	-1.6	-0.5	3.3
2000	-1.8	-1.7	4.5	3.5	3.9	2.8	3.9	4.5	1.9	0.2	-4.4	-4.9	-4.1	-5.1	-4.6	-5.8	-3.6	0.0
2500	1.8	2.0	9.0	7.8	8.0	7.0	9.6	9.5	7.4	4.1	0.0	-0.8	-1.2	-1.9	-1.6	-3.9	-2.4	1.8
3150	2.6	2.9	9.5	8.2	8.8	7.3	10.1	9.7	8.2	5.5	2.3	0.5	-0.3	-0.7	0.1	-3.7	-2.5	1.9
4000	-3.1	-2.7	2.0	1.2	2.0	0.9	3.1	3.6	1.3	-1.4	-4.4	-5.7	-5.0	-4.8	-4.6	-8.5	-8.5	-4.4
5000	1.2	1.7	5.1	4.9	6.7	5.7	9.2	9.9	8.5	5.4	2.3	-1.5	-2.5	-2.0	-2.1	-6.0	-5.1	-0.9
6300	-1.9	-1.2	2.2	2.5	2.9	3.2	5.2	5.1	4.7	0.9	-2.4	-4.4	-4.2	-4.3	-4.0	-7.5	-8.4	-3.5
8000	-0.9	0.0	1.8	1.9	2.9	3.4	5.9	7.2	5.7	3.6	-0.2	-2.4	-2.2	-3.6	-2.3	-5.8	-6.6	-2.1
10000	1.6	2.9	3.0	3.8	3.9	6.2	7.9	8.7	8.3	5.5	3.7	3.3	2.7	0.5	-1.2	-3.8	-4.2	0.7
OA(1K-10K)	-0.1	0.4	5.2	4.5	5.1	4.5	6.7	6.9	5.5	2.6	-0.5	-2.0	-2.2	-2.7	-2.4	-5.3	-4.9	-0.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	0.8	0.8	4.5	4.0	4.5	2.1	5.0	5.8	2.3	-1.2	-2.1	-2.0	-1.5	-0.6	0.4	-0.9	-1.7	4.1
1250	1.8	1.8	6.5	6.7	6.5	6.1	6.5	6.8	4.3	-0.9	-1.8	-1.6	-1.6	-1.0	-0.1	-1.8	-1.5	2.7
1600	1.6	1.7	7.0	6.2	5.3	4.7	6.9	5.6	4.6	0.2	-2.5	-1.5	-1.2	-0.5	0.5	-1.5	-0.4	3.4
2000	-0.4	-0.3	4.1	3.7	4.1	3.0	4.0	4.5	1.3	-0.2	-3.9	-3.3	-1.9	-2.9	-2.4	-4.0	-2.2	1.5
2500	2.2	2.4	7.5	6.3	6.6	5.5	7.9	7.5	4.9	1.8	-0.9	-0.4	0.2	-0.3	0.0	-2.3	-0.8	3.4
3150	3.6	3.9	8.6	7.3	8.0	6.3	8.9	8.3	6.3	3.8	2.0	1.4	1.7	1.5	2.3	-1.5	-0.3	4.1
4000	1.3	1.8	5.2	5.0	5.7	4.6	6.9	7.3	4.4	1.4	-0.8	-1.0	0.2	0.3	0.4	-3.8	-4.1	0.1
5000	3.2	3.6	5.2	5.0	6.8	5.7	9.0	9.5	7.6	4.6	3.0	0.4	0.4	1.1	1.0	-2.9	-2.0	2.2
6300	3.5	4.1	5.9	6.8	7.0	7.3	9.4	9.2	8.3	4.4	2.1	1.2	2.0	1.8	2.1	-1.8	-2.8	2.3
8000	6.0	7.0	7.2	7.6	8.6	9.1	11.5	12.6	10.6	8.4	5.6	4.6	5.7	4.3	5.5	1.9	0.9	5.4
10000	11.3	12.6	11.1	12.3	12.3	14.5	16.1	16.6	15.6	12.9	12.2	12.9	13.2	11.2	9.5	6.7	6.0	10.8
OA(1K-10K)	3.0	3.3	6.4	6.1	6.6	6.0	8.2	8.3	6.3	3.4	1.4	1.1	1.6	1.1	1.4	-1.7	-1.4	3.0

Engine/Run #: 179FF105
Blade pass freq[Hz]= 2492.2

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	5.2	5.2	8.1	7.7	8.7	6.5	9.7	11.2	8.8	5.8	3.9	3.2	2.7	3.6	4.9	3.7	2.8	8.8
1250	3.9	3.8	8.2	8.0	8.0	7.7	9.0	10.1	9.0	4.6	2.6	2.0	0.9	1.2	2.0	0.7	1.1	5.6
1600	3.5	3.5	9.8	8.2	7.8	7.7	10.2	9.5	9.3	5.2	1.0	0.8	-0.3	0.5	1.7	-0.7	0.3	4.6
2000	2.1	2.2	7.0	6.1	6.6	5.7	8.1	9.7	7.2	5.6	0.8	0.0	-0.9	-1.5	-1.4	-2.5	-0.3	3.6
2500	-1.6	-1.4	-0.1	-2.0	-1.7	-2.3	0.5	2.2	2.4	2.2	-0.1	-0.7	-3.0	-4.4	-4.7	-6.3	-2.3	0.9
3150	2.3	2.5	7.6	7.2	7.4	5.3	8.7	8.4	7.5	5.5	2.5	0.3	-0.5	-0.6	0.4	-4.1	-2.8	1.6
4000	1.9	2.3	5.4	5.0	6.5	5.1	7.8	9.5	7.8	5.3	2.2	0.4	0.1	0.1	-0.3	-4.4	-3.5	0.7
5000	-3.9	-3.4	-3.6	-5.3	-3.5	-5.4	-2.3	-0.7	0.2	0.7	-0.4	-4.0	-5.5	-4.7	-4.7	-8.2	-8.2	-4.4
6300	1.0	1.6	2.9	2.4	4.8	4.6	7.8	9.0	8.5	5.2	1.9	-0.5	-0.9	-1.7	-1.6	-5.8	-5.7	-1.2
8000	-2.2	-1.3	-4.4	-4.8	-3.0	-2.1	0.1	2.4	2.4	2.4	0.1	-2.0	-0.8	-3.5	-2.4	-6.7	-7.1	-2.3
10000	-0.6	0.7	-1.6	-1.7	-1.6	0.8	3.0	5.3	6.1	5.0	2.7	0.9	0.0	-2.9	-3.1	-5.6	-6.2	-1.1
OA(1K-10K)	-0.5	0.1	0.8	-0.3	0.6	0.0	2.5	4.1	4.5	3.5	1.1	-0.8	-1.5	-2.3	-1.9	-5.1	-4.2	0.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	5.2	5.2	8.1	7.7	8.7	6.5	9.7	11.2	8.8	5.8	3.9	3.2	2.7	3.6	4.9	3.7	2.8	8.8
1250	3.9	3.8	8.2	8.0	8.0	7.7	9.0	10.1	9.0	4.6	2.6	2.0	0.9	1.2	2.0	0.7	1.1	5.6
1600	3.5	3.5	9.8	8.2	7.8	7.7	10.2	9.5	9.3	5.2	1.0	0.8	-0.3	0.5	1.7	-0.7	0.3	4.6
2000	2.1	2.2	7.0	6.1	6.6	5.7	8.1	9.7	7.2	5.6	0.8	0.0	-0.9	-1.5	-1.4	-2.5	-0.3	3.6
2500	-1.1	-0.9	3.1	1.3	1.6	0.9	3.7	4.5	2.9	1.5	-1.2	-1.9	-3.5	-4.4	-4.7	-6.3	-2.3	0.9
3150	2.3	2.5	7.6	7.2	7.4	5.3	8.7	8.4	7.5	5.5	2.5	0.3	-0.5	-0.6	0.4	-4.1	-2.8	1.6
4000	1.9	2.3	5.4	5.0	6.5	5.1	7.8	9.5	7.8	5.3	2.2	0.4	0.1	0.1	-0.3	-4.4	-3.5	0.7
5000	-3.3	-2.8	0.1	-1.6	0.2	-1.8	1.2	1.8	0.8	-0.2	-1.9	-5.6	-6.2	-4.7	-4.7	-8.2	-8.2	-4.4
6300	1.0	1.6	2.9	2.4	4.8	4.6	7.8	9.0	8.5	5.2	1.9	-0.5	-0.9	-1.7	-1.6	-5.8	-5.7	-1.2
8000	-1.8	-0.9	-1.4	-1.7	0.1	1.1	3.2	4.6	2.9	1.7	-1.0	-3.1	-1.3	-3.5	-2.4	-6.7	-7.1	-2.3
10000	-0.3	1.0	0.9	0.9	1.0	3.4	5.6	7.1	6.5	4.5	1.9	0.1	-0.3	-2.9	-3.1	-5.6	-6.2	-1.1
OA(1K-10K)	-0.2	0.4	3.3	2.3	3.3	2.6	5.1	6.0	4.9	3.0	0.3	-1.6	-1.8	-2.3	-1.9	-5.1	-4.2	0.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	1.6	1.6	2.7	2.3	3.3	1.1	4.1	5.3	2.4	-0.5	-1.0	-0.4	0.1	1.2	2.5	1.3	0.4	6.4
1250	1.3	1.3	3.9	3.7	3.6	3.3	4.4	5.3	3.7	-0.7	-1.2	-0.5	-0.6	-0.1	0.7	-0.6	-0.2	4.3
1600	2.0	2.0	6.4	4.9	4.5	4.3	6.6	5.7	5.0	1.0	-1.8	-0.8	-0.8	0.2	1.4	-1.0	0.0	4.3
2000	1.4	1.5	4.5	3.6	4.1	3.2	5.4	6.7	3.7	2.3	-1.2	-0.7	-0.5	-0.9	-0.8	-1.9	0.3	4.2
2500	0.3	0.5	3.1	1.9	2.2	1.5	4.2	4.8	2.6	1.1	-0.7	-0.2	-1.2	-2.1	-2.5	-4.4	-0.8	2.5
3150	2.9	3.2	6.5	6.1	6.3	4.2	7.4	6.8	5.4	3.4	1.9	1.0	1.2	1.3	2.3	-2.2	-0.9	3.5
4000	3.1	3.5	4.8	4.4	5.9	4.5	7.0	8.4	6.2	3.9	2.1	1.6	2.3	2.5	2.1	-2.0	-1.1	3.1
5000	1.3	1.6	3.9	2.9	4.7	2.7	5.8	6.2	4.4	2.9	1.6	-0.8	-0.9	0.4	0.3	-3.5	-3.7	0.1
6300	3.5	4.1	3.7	3.1	5.5	5.3	8.3	9.3	8.3	5.1	3.2	2.1	2.7	2.1	2.2	-2.0	-1.9	2.6
8000	4.7	5.6	4.1	4.3	6.0	6.9	9.1	10.4	8.0	6.4	4.5	3.5	6.0	3.7	4.7	0.2	-0.4	4.4
10000	8.1	9.3	8.0	8.5	8.5	11.0	13.0	14.3	13.0	10.8	9.1	8.5	8.9	6.4	6.1	3.4	2.5	7.5
OA(1K-10K)	2.7	3.1	4.7	4.1	5.0	4.3	6.9	7.6	5.9	3.7	2.0	1.2	1.7	1.3	1.6	-1.7	-0.9	3.3

Engine/Run #: 179FF106
Blade pass freq[Hz]= 2748.9

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	6.6	6.5	3.1	3.6	4.6	3.3	6.5	8.6	7.7	7.1	6.3	6.0	5.4	6.8	7.4	7.7	7.7	12.7
1250	3.8	3.7	3.0	2.8	2.5	2.4	3.8	5.7	6.8	4.5	3.0	3.6	2.3	3.9	4.2	3.2	3.3	8.2
1600	2.8	2.9	4.2	2.3	3.1	3.1	5.4	5.5	7.4	4.8	1.5	1.8	0.9	1.3	2.1	0.3	0.9	5.7
2000	1.4	1.5	2.1	1.4	1.4	1.0	3.1	5.7	4.9	5.3	1.3	0.7	0.1	-0.7	-0.4	-1.4	0.3	4.7
2500	-2.9	-2.7	-3.9	-5.5	-5.8	-6.3	-3.4	-0.5	1.1	1.7	-1.2	-0.8	-2.0	-3.8	-4.8	-5.8	-3.5	-0.1
3150	0.0	0.3	0.9	-0.6	0.3	-1.1	2.0	3.3	4.8	4.6	2.4	0.4	-1.0	-1.5	-2.7	-5.6	-3.0	1.0
4000	0.1	0.5	-0.1	-0.5	0.8	-1.0	1.8	4.3	4.6	3.8	1.9	0.4	-0.2	-0.7	-1.7	-5.2	-3.8	0.3
5000	-5.5	-5.0	-7.4	-8.8	-6.5	-8.1	-6.7	-4.7	-2.4	-1.2	-1.0	-3.7	-5.2	-4.0	-4.4	-9.3	-8.3	-4.6
6300	-0.9	-0.3	-2.7	-3.3	-0.6	-0.8	1.6	3.1	5.0	3.2	1.2	-0.6	-1.3	-1.6	-2.3	-6.0	-6.1	-1.5
8000	-4.5	-3.6	-8.2	-7.5	-7.2	-5.3	-4.2	-1.9	-0.4	0.0	-1.4	-1.6	-2.1	-4.1	-4.6	-7.5	-7.7	-3.4
10000	-3.1	-1.8	-6.3	-6.6	-5.8	-3.7	-0.5	0.8	3.2	2.3	0.8	-0.9	-1.4	-4.0	-5.1	-6.5	-7.1	-1.8
OA(1K-10K)	-2.3	-1.7	-3.6	-4.6	-3.5	-3.9	-1.8	0.1	1.9	1.9	0.4	-0.8	-1.7	-2.3	-2.7	-5.0	-4.2	0.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	6.6	6.5	3.1	3.6	4.6	3.3	6.5	8.6	7.7	7.1	6.3	6.0	5.4	6.8	7.4	7.7	7.7	12.7
1250	3.8	3.7	3.0	2.8	2.5	2.4	3.8	5.7	6.8	4.5	3.0	3.6	2.3	3.9	4.2	3.2	3.3	8.2
1600	2.8	2.9	4.2	2.3	3.1	3.1	5.4	5.5	7.4	4.8	1.5	1.8	0.9	1.3	2.1	0.3	0.9	5.7
2000	1.4	1.5	2.1	1.4	1.4	1.0	3.1	5.7	4.9	5.3	1.3	0.7	0.1	-0.7	-0.4	-1.4	0.3	4.7
2500	-2.1	-1.9	-1.2	-2.6	-2.9	-3.4	-0.6	1.7	2.0	1.2	-2.3	-2.1	-2.4	-3.8	-4.8	-5.8	-3.5	-0.1
3150	0.0	0.3	0.9	-0.6	0.3	-1.1	2.0	3.3	4.8	4.6	2.4	0.4	-1.0	-1.5	-2.7	-5.6	-3.0	1.0
4000	0.1	0.5	-0.1	-0.5	0.8	-1.0	1.8	4.3	4.6	3.8	1.9	0.4	-0.2	-0.7	-1.7	-5.2	-3.8	0.3
5000	-4.5	-4.0	-4.2	-5.5	-3.2	-4.9	-3.5	-2.2	-1.5	-1.8	-2.3	-5.1	-5.8	-4.0	-4.4	-9.3	-8.3	-4.6
6300	-0.9	-0.3	-2.7	-3.3	-0.6	-0.8	1.6	3.1	5.0	3.2	1.2	-0.6	-1.3	-1.6	-2.3	-6.0	-6.1	-1.5
8000	-3.8	-2.8	-5.8	-5.0	-4.7	-2.8	-1.7	0.1	0.3	-0.4	-2.3	-2.6	-2.5	-4.1	-4.6	-7.5	-7.7	-3.4
10000	-2.6	-1.3	-4.5	-4.8	-4.0	-1.9	1.4	2.3	3.7	2.0	0.2	-1.6	-1.7	-4.0	-5.1	-6.5	-7.1	-1.8
OA(1K-10K)	-1.8	-1.1	-1.7	-2.6	-1.5	-1.9	0.3	1.8	2.5	1.6	-0.3	-1.6	-2.0	-2.3	-2.7	-5.0	-4.2	0.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	3.6	3.5	1.4	1.9	2.9	1.5	4.5	5.9	3.2	1.3	1.3	2.2	2.5	4.2	4.8	5.1	5.1	10.1
1250	1.9	1.8	2.4	2.2	2.0	1.8	2.8	4.2	3.5	-0.1	-0.9	0.9	0.6	2.3	2.6	1.6	1.7	6.6
1600	2.0	2.1	4.8	2.8	3.6	3.5	5.6	5.0	5.1	1.2	-1.3	0.1	0.3	0.9	1.7	-0.1	0.5	5.3
2000	1.4	1.6	3.5	2.8	2.8	2.3	4.2	6.1	3.5	2.6	-0.6	-0.1	0.3	-0.2	0.1	-0.9	0.8	5.2
2500	-0.3	-0.1	0.7	-0.1	-0.4	-0.9	1.6	3.4	2.5	1.2	-1.7	-0.4	-0.1	-1.5	-2.6	-3.9	-1.9	1.5
3150	1.6	1.8	3.8	2.3	3.1	1.7	4.5	5.1	4.8	3.4	2.0	1.1	0.7	0.4	-0.8	-3.7	-1.1	2.9
4000	2.2	2.6	3.4	3.0	4.2	2.4	4.9	6.7	5.2	3.1	2.1	1.7	2.1	1.8	0.8	-2.7	-1.3	2.8
5000	0.6	1.1	1.5	0.8	3.1	1.4	2.7	3.6	3.0	1.8	1.5	-0.4	-0.5	1.1	0.7	-4.5	-3.9	-0.1
6300	2.2	2.9	1.8	1.2	3.9	3.8	5.7	6.5	6.6	3.8	2.4	1.7	2.0	1.9	1.2	-2.5	-2.8	2.0
8000	2.6	3.5	1.3	2.5	2.8	4.6	5.7	7.0	5.8	4.0	2.6	3.3	4.0	2.4	1.8	-1.3	-1.6	2.8
10000	5.4	6.6	4.3	4.4	5.2	7.2	10.3	10.7	10.6	7.8	6.5	5.8	6.5	4.2	3.2	1.6	0.7	6.0
OA(1K-10K)	1.8	2.2	2.5	1.9	3.0	2.5	4.6	5.6	4.9	2.9	1.5	1.3	1.5	1.3	0.9	-1.6	-0.9	3.4

Engine/Run #: 179FF107

Blade pass freq[Hz]= 3005.2

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	9.0	8.9	5.0	5.1	6.6	4.8	7.7	9.6	9.4	9.4	8.7	8.6	8.3	9.7	10.3	10.3	9.9	15.5
1250	6.4	6.4	4.2	3.7	3.6	3.8	5.7	7.8	9.0	7.3	6.2	6.4	5.9	6.8	7.2	6.5	6.4	11.5
1600	4.9	4.9	6.3	4.3	3.9	3.9	6.6	6.6	8.7	6.8	3.9	4.3	3.6	4.2	4.5	3.0	3.6	8.5
2000	3.2	3.3	4.0	3.2	2.3	2.5	5.1	7.4	6.5	7.1	3.0	2.7	2.0	1.5	1.6	0.8	2.2	6.7
2500	2.7	2.9	1.8	0.9	1.1	0.5	3.7	5.9	7.2	7.1	4.3	4.3	2.4	1.3	0.0	-0.7	1.6	5.6
3150	-2.6	-2.4	-3.7	-4.5	-4.5	-5.9	-5.0	-3.4	0.7	1.5	1.8	1.6	-1.6	-1.5	-4.6	-5.6	-2.1	1.3
4000	1.1	1.6	-0.7	0.8	2.0	-1.1	2.4	4.9	5.3	4.8	3.3	2.1	1.9	0.9	-1.8	-3.7	-1.8	2.0
5000	-0.4	0.1	-2.1	-3.1	-1.0	-2.3	1.3	2.6	3.9	3.8	3.3	0.5	-0.4	-0.4	-2.4	-5.2	-2.7	0.6
6300	-6.6	-6.0	-12.1	-13.8	-10.3	-10.6	-6.5	-6.4	-3.6	-3.3	-2.7	-3.0	-3.6	-3.8	-4.1	-8.0	-2.9	-3.5
8000	-1.4	-0.5	-4.3	-4.9	-3.9	-3.0	1.0	2.6	3.2	2.4	1.2	0.5	1.1	-1.5	-2.9	-5.2	-4.7	-0.3
10000	-6.1	-4.8	-10.9	-11.8	-11.0	-8.9	-5.8	-4.1	-1.1	-1.1	-1.1	-1.9	-1.9	-4.4	-5.6	-6.7	-7.3	-1.9
OA(1K-10K)	-2.3	-1.5	-4.7	-5.6	-4.8	-5.5	-2.7	-1.1	1.1	1.8	1.3	0.7	-0.1	-0.8	-1.8	-3.4	-1.6	2.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	8.2	8.2	4.4	4.4	5.7	3.7	6.5	8.0	6.4	7.3	7.9	8.2	8.0	9.6	10.1	10.2	9.6	14.9
1250	6.0	5.9	3.9	3.3	3.0	3.1	5.0	6.7	6.9	5.9	5.7	6.1	5.7	6.7	7.1	6.4	6.3	11.2
1600	4.4	4.4	6.0	3.9	3.3	3.3	6.0	5.6	6.7	5.5	3.4	4.0	3.4	4.1	4.4	2.9	3.4	8.2
2000	3.1	3.2	3.9	3.0	2.2	2.3	4.8	7.0	5.7	6.6	2.8	2.6	1.9	1.5	1.6	0.8	2.1	6.6
2500	2.6	2.8	1.8	0.9	1.0	0.4	3.6	5.7	6.9	6.9	4.2	4.3	2.4	1.3	0.0	-0.7	1.6	5.6
3150	-1.3	-1.1	-0.6	-1.3	-1.3	-2.7	-1.8	-0.8	1.9	1.2	0.9	0.5	-2.0	-1.5	-4.6	-5.6	-2.1	1.3
4000	1.1	1.5	-0.7	0.8	1.9	-1.1	2.3	4.9	5.3	4.8	3.3	2.1	1.9	0.9	-1.8	-3.7	-1.8	2.0
5000	-0.4	0.1	-2.1	-3.1	-1.0	-2.3	1.2	2.6	3.9	3.8	3.3	0.5	-0.4	-0.4	-2.4	-5.2	-2.7	0.6
6300	-5.0	-4.4	-8.5	-10.1	-6.6	-6.9	-2.9	-3.5	-2.3	-3.6	-3.9	-4.4	-4.2	-3.8	-4.1	-8.0	-2.9	-3.5
8000	-1.4	-0.5	-4.3	-4.9	-3.9	-3.0	1.0	2.6	3.2	2.4	1.2	0.5	1.1	-1.5	-2.9	-5.2	-4.7	-0.3
10000	-4.8	-3.5	-7.8	-8.6	-7.8	-5.7	-2.6	-1.6	0.0	-1.4	-2.0	-3.0	-2.3	-4.4	-5.6	-6.7	-7.3	-1.9
OA(1K-10K)	-1.3	-0.6	-2.2	-3.0	-2.2	-2.9	-0.1	1.0	2.0	1.6	0.6	-0.1	-0.4	-0.8	-1.8	-3.4	-1.6	2.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]																
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	3.5	3.5	0.2	0.2	1.4	-0.8	1.7	2.6	0.6	0.8	1.8	3.2	4.0	5.7	6.3	6.4	5.6	10.8
1250	2.5	2.4	0.9	0.3	-0.1	-0.1	1.4	2.6	2.0	0.3	0.7	2.2	2.8	4.0	4.5	3.7	3.5	8.3
1600	1.9	1.9	4.1	2.0	1.2	0.9	3.1	2.2	2.5	0.8	-0.6	1.2	1.6	2.5	2.9	1.3	1.7	6.2
2000	1.5	1.6	2.9	2.1	1.1	0.9	3.0	4.5	2.0	2.5	-0.3	0.7	1.1	0.8	1.0	0.1	1.4	5.7
2500	2.0	2.2	1.8	0.8	0.9	0.1	2.9	4.3	4.1	3.6	2.0	3.3	2.4	1.5	0.2	-0.5	1.7	5.6
3150	0.1	0.4	0.7	0.8	0.7	-0.8	-0.2	0.3	2.0	0.9	1.1	1.8	0.0	0.6	-2.6	-3.9	-0.8	2.7
4000	2.1	2.5	0.8	2.3	3.4	0.3	3.4	5.3	4.3	3.0	2.5	2.5	3.3	2.5	-0.2	-2.1	-0.2	3.5
5000	1.0	1.5	-0.1	-1.1	1.0	-0.4	2.9	3.7	3.5	2.6	3.0	1.4	1.6	1.7	-0.3	-3.1	-0.6	2.6
6300	0.0	0.8	-3.0	-3.8	-0.3	-0.7	3.3	2.3	2.4	0.1	-0.2	0.1	0.9	1.1	0.7	-3.5	1.4	0.9
8000	1.7	2.6	-0.6	-1.2	-0.3	0.5	4.3	5.3	4.5	2.8	2.6	3.1	4.6	2.2	0.9	-1.5	-1.0	3.4
10000	2.3	3.6	-0.3	-0.5	0.3	2.3	5.4	6.0	6.4	4.1	3.6	3.7	5.0	2.9	1.6	0.2	-0.6	4.9
OA(1K-10K)	1.3	1.8	0.6	0.3	1.0	0.1	2.8	3.4	3.2	2.0	1.6	2.0	2.3	2.0	0.9	-0.8	0.8	4.5

Engine/Run #: 179FF108
Blade pass freq[Hz]= 3221.9

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Frequency [Hz]	PWL	<SPL>	Angle from inlet centerline[deg] 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-14.2	-14.3	-16.0	-16.1	-16.4	-21.5	-22.1	-20.4	-19.8	-15.5	-12.2	-9.6	-8.2	-5.2	-4.5	-4.8	-9.1	-6.0
1250	-12.5	-12.5	-12.7	-14.2	-15.2	-17.8	-19.1	-19.3	-15.9	-13.7	-10.7	-8.1	-5.9	-3.6	-3.1	-4.0	-8.0	-5.9
1600	-13.8	-13.7	-9.6	-14.1	-16.1	-18.5	-19.0	-20.7	-15.5	-13.8	-12.3	-9.0	-7.6	-5.1	-5.1	-6.9	-9.3	-8.3
2000	-10.7	-10.6	-6.3	-8.2	-11.4	-14.5	-15.6	-15.0	-13.2	-9.0	-8.8	-6.2	-5.0	-3.6	-3.8	-4.9	-6.8	-5.5
2500	-7.1	-6.9	-5.7	-7.5	-8.6	-11.9	-12.3	-12.0	-8.9	-3.8	-3.4	-1.6	-1.7	-1.1	-2.3	-2.7	-3.6	-1.9
3150	-3.0	-2.7	-4.1	-6.1	-14.2	-14.7	-7.2	-5.7	-7.2	4.7	4.0	5.1	-2.8	-3.4	-2.7	2.1	2.1	8.2
4000	-2.0	-1.6	-3.5	-4.0	-4.6	-7.8	-6.8	-6.0	-3.1	1.4	1.9	2.3	2.1	1.6	-1.8	-2.2	-1.3	1.9
5000	-2.2	-1.7	-3.8	-6.1	-4.3	-6.9	-5.0	-5.5	-1.9	1.6	2.6	1.0	0.5	-0.2	-3.2	-4.7	-2.5	0.2
6300	-6.4	-5.7	-8.9	-14.3	-12.7	-11.1	-10.0	-8.5	-5.8	-3.8	-2.8	0.1	-1.0	-1.3	-3.9	-4.2	-3.3	1.0
8000	-2.5	-1.5	-4.6	-6.2	-4.9	-5.6	-3.0	-2.4	-0.2	0.9	0.6	0.5	1.3	-1.4	-3.8	-4.8	-3.8	0.0
10000	-5.8	-4.6	-11.0	-11.9	-11.6	-10.5	-7.7	-5.9	-2.5	-1.8	0.2	-0.9	-0.6	-2.7	-5.1	-1.6	-0.8	0.7
OA(1K-10K)	-7.4	-7.3	-6.6	-8.8	-12.5	-14.4	-12.7	-12.6	-10.8	-3.1	-2.6	-0.9	-2.8	-2.6	-3.6	-2.2	-3.5	-0.1

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Frequency [Hz]	PWL	<SPL>	Angle from inlet centerline[deg] 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-2.3	-2.3	-6.0	-6.1	-5.8	-9.4	-8.0	-8.2	-9.1	-6.3	-2.2	0.4	2.2	5.2	6.0	6.3	2.9	6.6
1250	-3.3	-3.4	-5.5	-7.1	-7.5	-8.6	-7.8	-8.0	-8.0	-7.4	-3.5	-0.9	1.5	3.9	4.4	4.2	1.1	3.8
1600	-5.8	-5.7	-3.6	-8.0	-9.6	-10.4	-8.8	-10.5	-8.8	-8.6	-6.3	-2.9	-1.3	1.3	1.3	0.1	-1.4	0.3
2000	-3.2	-3.1	-0.9	-2.8	-5.3	-6.7	-5.7	-5.0	-6.7	-4.0	-3.2	-0.9	0.2	1.3	0.9	0.6	0.1	2.4
2500	-0.6	-0.5	-1.5	-3.1	-3.4	-4.9	-3.1	-2.4	-2.6	0.8	1.3	2.4	1.8	1.9	0.4	0.8	1.4	4.7
3150	-0.2	0.0	0.3	-1.7	-9.8	-10.1	-2.3	-1.2	-4.6	5.3	3.5	3.8	-3.3	-3.1	-2.4	2.5	2.8	9.5
4000	0.8	1.2	-2.1	-2.5	-2.5	-4.2	-0.9	1.0	1.5	4.0	3.7	3.5	2.9	2.2	-1.3	-1.5	0.1	4.5
5000	-0.7	-0.2	-3.1	-5.4	-3.2	-4.8	-1.1	-0.4	1.3	3.1	3.5	1.6	0.9	0.1	-3.0	-4.3	-1.8	1.6
6300	-4.4	-3.8	-5.1	-10.4	-8.9	-7.2	-6.1	-5.2	-4.0	-3.8	-3.7	-1.2	-1.5	-1.2	-3.9	-4.1	-3.2	1.3
8000	-2.1	-1.2	-4.4	-6.0	-4.7	-5.0	-1.7	-0.5	0.9	1.3	0.9	0.6	1.4	-1.4	-3.8	-4.7	-3.7	0.4
10000	-4.3	-3.0	-7.7	-8.5	-8.2	-7.1	-4.2	-3.1	-1.1	-1.8	-0.6	-1.9	-1.0	-2.7	-5.1	-1.6	-0.8	0.8
OA(1K-10K)	-2.0	-1.6	-2.0	-4.1	-7.3	-7.9	-4.2	-3.6	-4.7	1.0	0.9	1.6	-0.6	-0.4	-1.6	0.3	0.5	5.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Frequency [Hz]	PWL	<SPL>	Angle from inlet centerline[deg] 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	4.2	4.1	1.2	1.2	1.9	-1.4	0.3	2.1	-1.0	0.6	3.0	4.6	5.5	7.5	7.4	8.4	6.9	12.4
1250	3.6	3.6	2.3	1.0	1.0	0.4	1.4	1.4	1.0	0.1	1.9	3.4	5.0	6.4	6.0	6.5	5.4	10.0
1600	1.9	2.0	5.0	0.7	-0.4	-0.9	0.9	-0.6	0.9	-0.4	0.1	2.3	3.1	4.7	4.0	3.5	3.9	7.3
2000	1.9	2.0	5.6	3.9	1.8	0.8	2.1	3.0	0.9	1.5	0.2	1.6	2.2	2.7	1.7	1.9	2.7	6.7
2500	2.3	2.5	3.4	2.0	2.0	0.8	3.0	3.7	2.7	3.7	2.3	3.0	2.6	2.5	0.7	1.3	2.7	7.0
3150	2.3	2.5	2.0	1.4	-6.6	-7.0	0.4	1.0	-3.2	6.5	4.8	6.3	-0.1	0.1	0.8	4.9	4.6	11.3
4000	2.4	2.8	2.4	2.0	1.9	0.2	3.2	4.4	3.2	3.5	3.0	3.6	3.8	3.3	-0.2	-0.4	1.3	5.9
5000	1.0	1.5	1.8	-0.5	1.6	-0.2	3.1	2.7	2.4	2.2	2.9	2.0	2.3	1.6	-1.5	-2.8	-0.3	3.2
6300	1.0	1.6	1.9	-2.4	-0.9	0.7	1.4	1.6	1.1	0.0	-0.3	3.0	3.2	3.3	0.5	0.0	0.7	5.3
8000	0.8	1.7	1.7	0.1	1.3	0.8	3.5	3.5	2.4	1.2	1.4	2.3	4.0	1.4	-1.0	-1.9	-0.9	3.1
10000	2.6	3.8	1.1	1.1	1.3	2.3	4.7	5.1	5.3	3.1	4.3	3.7	5.2	3.5	1.1	4.4	5.0	6.6
OA(1K-10K)	2.1	2.4	2.3	1.2	-1.8	-2.1	1.4	1.8	0.2	4.4	3.3	4.4	2.6	2.6	1.3	3.1	3.3	9.0

Engine/Run #: 179FF109
Blade pass freq[Hz]= 3439.0

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
						Angle from inlet centerline[deg]												
1000	-10.9	-10.9	-14.2	-14.0	-14.1	-16.9	-19.5	-17.9	-15.3	-11.0	-9.1	-6.3	-5.3	-1.1	-1.6	-1.7	-5.3	-3.0
1250	-9.1	-9.1	-9.7	-10.2	-11.2	-15.0	-15.8	-17.5	-14.3	-10.1	-6.4	-3.3	-2.1	-0.2	-0.7	-1.1	-3.9	-1.8
1600	-10.7	-10.7	-8.2	-12.6	-14.5	-17.4	-16.3	-17.6	-14.8	-9.3	-8.6	-4.9	-4.5	-1.7	-2.3	-3.9	-4.6	-4.4
2000	-7.6	-7.5	-5.6	-6.8	-10.0	-13.2	-13.5	-12.5	-10.3	-4.7	-5.5	-3.2	-1.4	0.6	-0.7	-1.7	-3.4	-1.5
2500	-4.9	-4.7	-6.7	-5.3	-7.1	-9.3	-10.0	-9.6	-6.5	-2.1	-2.1	-0.2	0.0	2.1	0.5	-0.2	-0.7	0.6
3150	-5.0	-4.7	-10.1	-12.6	-10.3	-15.1	-7.0	-6.8	-2.8	-0.2	-1.6	-1.8	0.5	-1.8	-5.1	-2.3	-0.9	1.6
4000	-0.4	0.0	-3.7	-5.1	-3.9	-8.6	-4.6	-3.9	-0.4	2.8	3.0	2.8	3.5	3.0	0.2	0.6	1.7	4.2
5000	-1.3	-0.8	-5.7	-7.2	-6.8	-8.8	-6.0	-4.7	-0.4	2.8	4.0	1.9	1.4	0.8	-2.2	-3.3	-1.4	1.8
6300	-7.3	-6.7	-12.6	-12.4	-13.0	-14.2	-11.2	-8.8	-5.3	-3.3	-2.0	-2.6	-2.7	-3.6	-6.5	-7.6	-7.4	-3.0
8000	-2.7	-1.8	-6.3	-6.9	-7.2	-7.4	-4.3	-2.3	0.9	1.0	0.7	0.1	0.9	-1.7	-3.8	-4.7	-4.9	0.0
10000	-6.6	-5.3	-10.9	-12.4	-11.9	-10.7	-6.8	-5.6	-2.2	-2.0	-1.7	-2.2	-1.6	-4.6	-7.4	-6.9	-6.9	-1.8
OA(1K-10K)	-7.0	-6.9	-9.2	-10.6	-10.8	-14.0	-12.0	-12.1	-8.4	-4.5	-3.5	-2.4	-1.1	-0.9	-2.8	-2.6	-3.2	-1.3

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
						Angle from inlet centerline[deg]												
1000	1.1	1.1	-4.2	-4.0	-3.5	-4.8	-5.3	-3.7	-4.6	-1.8	1.0	3.8	5.1	9.4	9.0	9.4	6.7	9.7
1250	0.1	0.0	-2.5	-3.0	-3.4	-5.7	-4.5	-6.1	-6.4	-3.6	0.9	3.9	5.3	7.3	6.8	7.1	5.2	8.0
1600	-2.6	-2.6	-2.2	-6.5	-7.8	-9.3	-6.1	-7.4	-8.0	-4.1	-2.4	1.3	1.9	4.8	4.1	3.1	3.4	4.3
2000	-0.1	0.0	-0.2	-1.3	-3.8	-5.4	-3.6	-2.5	-3.7	0.3	0.1	2.1	3.8	5.5	3.9	3.7	3.4	6.5
2500	1.5	1.7	-2.6	-0.9	-1.9	-2.4	-0.8	0.0	-0.2	2.4	2.6	3.7	3.4	5.0	3.0	3.0	4.2	7.1
3150	-2.6	-2.4	-5.8	-8.2	-5.9	-10.5	-2.1	-2.2	-0.2	0.2	-2.4	-3.3	0.0	-1.6	-4.9	-2.0	-0.4	2.7
4000	2.1	2.5	-2.5	-3.7	-1.9	-5.3	1.1	2.8	4.0	5.3	4.6	3.8	4.2	3.6	0.6	1.3	2.9	6.6
5000	0.0	0.5	-5.1	-6.5	-5.8	-7.0	-2.4	0.0	2.6	4.2	4.8	2.4	1.7	1.0	-2.0	-3.1	-0.8	3.0
6300	-5.8	-5.2	-9.0	-8.8	-9.3	-10.5	-7.5	-5.6	-3.7	-3.5	-3.0	-4.0	-3.3	-3.6	-6.5	-7.5	-7.3	-2.7
8000	-2.4	-1.5	-6.2	-6.8	-7.0	-6.9	-3.3	-0.7	1.8	1.3	0.8	0.2	1.0	-1.6	-3.7	-4.6	-4.7	0.2
10000	-5.4	-4.2	-8.0	-9.4	-8.9	-7.7	-3.7	-3.1	-1.0	-2.2	-2.6	-3.2	-2.0	-4.6	-7.4	-6.9	-6.9	-1.7
OA(1K-10K)	-1.9	-1.4	-4.7	-6.0	-5.7	-7.4	-3.4	-3.0	-2.2	-0.4	-0.3	-0.3	0.9	1.0	-1.1	-0.4	0.4	4.0

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
						Angle from inlet centerline[deg]												
1000	6.5	6.5	1.9	2.3	3.1	2.1	1.7	3.5	2.4	4.0	5.1	6.9	7.4	10.7	9.5	10.7	9.8	14.4
1250	6.0	5.9	4.3	4.0	4.0	2.0	3.6	2.1	1.5	2.7	5.3	7.2	7.9	8.8	7.5	8.5	8.5	13.1
1600	4.0	4.0	5.3	1.1	0.2	-0.9	2.5	1.4	0.4	3.0	2.8	5.5	5.3	7.2	5.8	5.5	7.5	10.2
2000	3.9	4.1	5.2	4.3	2.2	1.0	3.1	4.4	2.7	4.7	2.4	3.5	4.8	5.9	3.9	4.0	5.1	9.8
2500	3.5	3.7	1.4	3.1	2.5	2.3	4.1	4.9	4.0	4.2	2.6	3.4	3.4	4.8	2.6	2.8	4.6	8.5
3150	-0.2	0.1	-4.1	-5.2	-2.8	-7.4	0.6	0.0	1.2	1.3	-1.0	-0.8	3.1	1.5	-1.9	0.3	1.3	4.4
4000	3.0	3.4	1.3	0.1	1.8	-1.7	4.4	5.4	4.8	3.9	3.2	3.2	4.5	4.0	1.0	1.7	3.4	7.2
5000	1.1	1.6	-0.9	-2.3	-1.7	-3.0	1.1	2.4	2.9	2.6	3.6	2.2	2.4	2.0	-1.1	-2.1	0.1	3.9
6300	-1.1	-0.5	-2.5	-1.4	-2.0	-3.4	-0.6	0.5	0.7	-0.5	-0.1	-0.1	1.0	0.5	-2.5	-3.8	-3.7	0.9
8000	-0.4	0.6	-0.8	-1.5	-1.8	-1.9	1.2	2.5	2.5	0.3	0.5	1.0	2.7	0.4	-1.7	-2.6	-2.8	2.2
10000	0.3	1.5	0.0	-0.8	-0.4	0.6	4.2	4.1	4.2	1.5	1.3	1.6	3.3	0.6	-2.2	-1.9	-1.9	3.3
OA(1K-10K)	1.6	2.1	-0.5	-1.0	-0.5	-2.1	1.8	2.0	2.1	2.3	1.5	2.1	3.6	3.6	1.3	1.8	2.7	6.8

Engine/Run #: 179FF110

Blade pass freq[Hz]= 3661.5

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-10.7	-10.7	-16.4	-16.5	-14.6	-19.9	-17.0	-15.1	-11.9	-10.9	-7.6	-6.8	-5.4	-2.4	-2.3	-1.9	-4.8	-3.1
1250	-7.7	-7.8	-12.5	-13.7	-13.6	-14.3	-16.7	-16.0	-12.2	-9.0	-5.8	-3.0	-0.9	2.3	1.0	1.2	-1.6	0.1
1600	-6.3	-6.2	-7.2	-10.6	-12.2	-14.2	-14.1	-15.1	-9.5	-5.9	-4.8	-1.2	0.3	4.1	1.7	1.5	-0.4	0.9
2000	-7.5	-7.4	-8.9	-9.3	-11.0	-14.9	-16.1	-15.7	-13.1	-7.8	-6.4	-3.1	-0.3	3.6	0.0	-0.6	-0.8	-0.3
2500	-3.5	-3.3	-7.8	-3.3	-4.5	-11.2	-11.8	-13.0	-9.5	-4.1	-2.4	0.4	2.9	7.5	2.6	1.8	2.7	3.3
3150	0.0	0.3	-5.6	-6.3	-6.7	-9.1	-9.5	-10.3	-5.2	-0.3	2.3	4.2	5.5	10.1	4.7	3.4	4.2	6.6
4000	-2.8	-2.4	-12.2	-14.4	-13.3	-14.4	-10.1	-9.4	-5.1	-2.9	-1.4	0.6	0.6	4.9	-0.8	-1.7	-1.4	4.1
5000	1.6	2.0	-6.9	-8.0	-5.1	-7.8	-6.0	-5.4	-1.3	3.0	4.9	3.6	4.7	7.9	2.9	1.8	1.7	6.0
6300	1.2	1.8	-6.6	-8.0	-5.3	-6.2	-4.1	-3.7	0.8	2.8	3.3	3.3	4.4	6.3	1.1	0.5	-0.3	4.4
8000	-4.4	-3.4	-14.2	-15.9	-13.8	-13.0	-9.9	-7.7	-3.9	-1.9	-1.3	-0.9	0.5	1.2	-2.7	-3.4	-4.7	0.4
10000	-3.1	-1.8	-11.7	-12.7	-11.5	-9.4	-6.0	-4.6	-0.1	0.0	0.6	0.3	1.6	1.8	-2.9	-1.9	-4.1	1.5
OA(1K-10K)	-5.1	-5.0	-10.6	-10.8	-10.8	-13.9	-13.4	-13.3	-9.1	-5.3	-2.9	-0.9	0.8	4.4	0.2	-0.3	-1.0	1.2

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	3.8	3.7	-3.9	-4.0	-1.5	-5.3	-0.4	1.6	1.3	0.7	5.0	5.8	7.6	10.7	10.9	11.9	9.8	12.1
1250	4.1	4.0	-2.8	-3.9	-3.2	-2.3	-2.6	-1.9	-1.5	0.1	4.1	6.8	9.0	12.1	10.7	11.6	9.9	12.5
1600	2.6	2.6	-0.5	-3.8	-4.8	-5.2	-3.0	-3.9	-1.8	0.3	2.1	5.5	7.1	10.8	8.2	8.7	8.1	10.3
2000	0.4	0.6	-3.0	-3.4	-4.5	-6.8	-5.9	-5.4	-6.3	-2.5	-0.3	2.8	5.7	9.4	5.7	5.9	6.8	8.2
2500	3.6	3.8	-2.8	1.7	1.4	-3.7	-2.1	-3.0	-2.9	0.8	2.9	5.2	7.3	11.5	6.3	6.3	8.7	10.7
3150	5.6	5.8	-2.2	-2.7	-2.2	-2.9	-0.7	-1.0	1.0	4.0	6.3	7.3	8.0	12.2	6.5	5.8	8.1	12.2
4000	-1.0	-0.5	-8.1	-10.2	-9.1	-9.9	-5.3	-4.8	-2.7	-2.8	-2.4	-1.0	0.0	5.1	-0.6	-1.5	-1.0	4.9
5000	3.5	4.0	-6.0	-7.0	-3.6	-5.1	-1.2	0.5	2.5	4.9	6.1	4.4	5.2	8.3	3.2	2.2	2.6	7.8
6300	2.1	2.8	-6.1	-7.6	-4.5	-4.8	-1.2	0.2	3.2	3.8	3.9	3.8	4.6	6.5	1.3	0.7	0.1	5.2
8000	-3.3	-2.4	-11.0	-12.6	-10.5	-9.7	-6.4	-4.8	-2.6	-2.3	-2.5	-2.3	0.0	1.2	-2.7	-3.4	-4.6	0.6
10000	-2.3	-1.0	-9.3	-10.2	-8.9	-6.8	-3.2	-2.2	0.9	-0.4	-0.3	-0.7	1.2	1.8	-2.8	-1.8	-4.1	1.6
OA(1K-10K)	1.1	1.6	-5.4	-5.4	-4.5	-6.0	-3.2	-2.5	-1.4	0.0	1.4	2.1	3.5	6.9	2.4	2.6	3.5	7.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	7.6	7.5	0.4	0.3	3.0	-0.7	4.4	6.3	6.0	4.8	8.0	8.1	9.3	11.6	11.1	12.7	12.0	15.5
1250	7.7	7.6	1.8	0.8	1.9	3.1	3.0	3.9	4.0	4.1	6.2	7.9	9.5	11.6	9.6	11.1	11.1	15.4
1600	6.7	6.7	4.8	1.6	1.2	1.1	3.7	2.9	4.7	5.0	4.6	7.0	7.9	10.7	7.6	8.6	9.7	13.6
2000	5.4	5.5	3.0	2.8	2.1	0.2	1.3	1.9	0.8	2.8	3.1	5.2	7.5	10.4	6.0	6.7	9.3	12.3
2500	6.2	6.4	1.4	6.1	6.1	1.4	3.3	2.4	2.0	3.5	3.6	5.4	7.3	11.2	5.6	5.9	9.3	12.6
3150	6.6	6.9	1.1	0.7	1.4	0.9	3.1	2.6	3.7	4.3	5.2	6.3	7.5	11.7	5.9	5.2	8.0	12.8
4000	1.4	1.8	-6.3	-7.2	-6.1	-6.9	-2.7	-2.7	-1.5	-1.8	-1.1	1.4	3.0	8.0	2.2	0.7	0.6	6.6
5000	4.1	4.6	-2.4	-3.3	-0.1	-1.7	1.8	2.6	2.6	3.1	4.4	3.7	5.4	8.6	3.6	2.5	3.0	8.3
6300	3.1	3.7	-2.0	-3.5	-0.6	-1.0	2.1	2.3	3.1	1.9	2.5	3.3	5.2	7.3	2.1	1.5	0.9	6.0
8000	1.0	1.9	-4.9	-5.9	-3.9	-3.2	-0.2	0.7	1.1	0.1	0.2	1.4	4.1	5.2	1.2	0.2	-1.1	4.2
10000	2.3	3.6	-2.3	-2.8	-1.6	0.3	3.5	3.7	4.8	2.2	2.6	3.1	5.7	6.2	1.4	2.3	0.0	5.8
OA(1K-10K)	4.0	4.5	-1.4	-0.9	0.1	-1.2	1.5	2.0	2.4	2.2	2.8	4.0	5.7	9.0	4.3	4.4	5.3	9.9

APPENDIX VII

MEASURED DATA VERSUS REVISED PREDICTION, GASP, AND HEIDMANN
ENGINE 3
1/3-OCTAVE BAND LEVEL DIFFERENCES
FROM 1 TO 10 kHZ, dB

Engine/Run #: 152FF105

Blade pass freq[Hz]= 2779.0

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	2.8	2.8	5.9	5.7	6.3	4.4	7.4	9.1	6.9	4.5	2.1	1.0	0.3	0.6	1.3	1.6	3.5	6.1
1250	0.7	0.6	4.7	4.4	3.9	3.6	4.6	6.7	5.1	1.5	-0.2	-0.8	-1.9	-2.0	-0.4	-1.1	0.7	3.8
1600	-0.1	-0.1	4.9	3.7	3.2	3.3	5.1	4.4	5.5	1.9	-1.6	-1.5	-2.4	-2.0	-2.1	-3.1	-1.3	3.0
2000	0.4	0.5	6.5	4.8	5.1	4.0	5.4	7.3	6.0	4.3	-1.0	-1.3	-2.9	-2.5	-2.6	-4.2	-2.6	2.0
2500	-1.8	-1.7	-2.9	-4.6	-3.1	-4.8	-1.8	0.2	4.5	1.3	1.9	0.3	-5.6	-3.2	-3.9	-6.2	-4.0	0.7
3150	-0.6	-0.3	2.2	1.6	2.6	1.2	4.8	5.8	6.5	1.9	1.0	-1.1	-3.4	-2.5	-3.0	-6.0	-4.0	1.1
4000	-1.2	-0.8	2.2	1.1	2.3	0.9	4.5	6.1	4.4	2.2	-0.4	-2.5	-2.9	-2.6	-2.9	-6.1	-4.7	-0.6
5000	-5.6	-5.1	-7.4	-7.7	-7.2	-8.0	-4.7	-3.3	-2.4	-0.7	-2.3	-4.8	-6.0	-5.1	-5.6	-9.6	-9.0	-4.5
6300	0.5	1.1	0.7	0.5	1.6	1.4	4.6	5.7	5.7	4.0	2.0	-0.3	3.5	-1.9	-1.1	-4.7	-4.1	0.2
8000	-1.9	-0.9	-6.6	-5.1	-6.8	-6.1	-2.6	-1.8	-0.1	0.6	-1.4	2.6	2.3	-0.4	-3.5	-5.9	-5.3	-0.9
10000	-4.9	-3.6	-4.9	-5.2	-5.4	-4.2	-1.2	-0.1	0.7	-2.2	-3.0	-4.3	-2.9	-4.8	-5.3	-7.2	-7.1	-2.4
OA(1K-10K)	-2.3	-1.7	-2.7	-3.5	-3.0	-3.7	-0.8	0.7	2.3	1.1	-0.4	-0.9	-0.9	-2.7	-3.5	-6.1	-5.0	-0.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	2.8	2.8	5.9	5.7	6.3	4.4	7.4	9.1	6.9	4.5	2.1	1.0	0.3	0.6	1.3	1.6	3.5	6.1
1250	0.7	0.6	4.7	4.4	3.9	3.6	4.6	6.7	5.1	1.5	-0.2	-0.8	-1.9	-2.0	-0.4	-1.1	0.7	3.8
1600	-0.1	-0.1	4.9	3.7	3.2	3.3	5.1	4.4	5.5	1.9	-1.6	-1.5	-2.4	-2.0	-2.1	-3.1	-1.3	3.0
2000	0.4	0.5	6.5	4.8	5.1	4.0	5.4	7.3	6.0	4.3	-1.0	-1.3	-2.9	-2.5	-2.6	-4.2	-2.6	2.0
2500	-1.3	-1.1	0.4	-1.2	0.3	-1.4	1.5	2.5	5.1	0.5	0.7	-0.9	-6.1	-3.2	-3.9	-6.2	-4.0	0.7
3150	-0.6	-0.3	2.2	1.6	2.6	1.2	4.8	5.8	6.5	1.9	1.0	-1.1	-3.4	-2.5	-3.0	-6.0	-4.0	1.1
4000	-1.2	-0.8	2.2	1.1	2.3	0.9	4.5	6.1	4.4	2.2	-0.4	-2.5	-2.9	-2.6	-2.9	-6.1	-4.7	-0.6
5000	-5.0	-4.5	-3.7	-4.0	-3.5	-4.4	-1.2	-0.8	-1.8	-1.6	-3.7	-6.3	-6.6	-5.1	-5.6	-9.6	-9.0	-4.5
6300	0.5	1.1	0.7	0.5	1.6	1.4	4.6	5.7	5.7	4.0	2.0	-0.3	3.5	-1.9	-1.1	-4.7	-4.1	0.2
8000	-1.4	-0.5	-3.6	-2.0	-3.7	-3.1	0.4	0.3	0.4	0.0	-2.4	1.5	1.8	-0.4	-3.5	-5.9	-5.3	-0.9
10000	-4.6	-3.3	-2.5	-2.7	-2.9	-1.8	1.3	1.7	1.1	-2.6	-3.7	-5.0	-3.2	-4.8	-5.3	-7.2	-7.1	-2.4
OA(1K-10K)	-1.9	-1.3	-0.1	-0.8	-0.3	-1.0	1.8	2.6	2.7	0.6	-1.2	-1.7	-1.2	-2.7	-3.5	-6.1	-5.0	-0.6

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-1.3	-1.4	0.0	-0.2	0.3	-1.6	1.2	2.7	-0.1	-2.4	-3.4	-3.1	-2.8	-2.4	-1.7	-1.4	0.5	3.1
1250	-2.4	-2.4	-0.2	-0.5	-0.9	-1.3	-0.5	1.3	-0.7	-4.2	-4.5	-3.9	-3.9	-3.8	-2.2	-2.9	-1.1	2.0
1600	-2.1	-2.0	1.2	0.0	-0.6	-0.5	1.1	0.2	0.7	-2.8	-4.9	-3.4	-3.4	-2.8	-2.9	-3.9	-2.1	2.2
2000	-0.7	-0.6	3.6	1.9	2.2	1.1	2.3	3.9	2.1	0.5	-3.3	-2.3	-2.9	-2.3	-2.4	-4.0	-2.4	2.2
2500	-0.1	0.1	0.3	-0.6	0.8	-0.9	1.9	2.8	4.7	0.0	1.0	0.5	-3.9	-1.1	-1.9	-4.5	-2.6	2.1
3150	-0.2	0.0	0.8	0.2	1.2	-0.3	3.1	3.9	4.1	-0.4	0.1	-0.7	-2.0	-0.9	-1.4	-4.4	-2.4	2.7
4000	-0.2	0.2	1.4	0.3	1.5	0.0	3.4	4.8	2.6	0.5	-0.7	-1.5	-0.9	-0.4	-0.7	-3.9	-2.5	1.6
5000	-0.6	-0.1	0.0	0.4	0.8	-0.1	3.2	3.5	1.6	1.3	-0.2	-1.8	-1.6	-0.1	-0.7	-5.0	-4.7	-0.1
6300	2.5	3.1	0.9	0.7	1.8	1.6	4.8	5.4	4.9	3.3	2.8	1.7	6.4	1.2	2.0	-1.8	-1.0	3.3
8000	4.0	4.9	0.8	2.8	1.1	1.7	5.4	5.2	4.4	3.6	2.1	7.1	8.1	5.8	2.7	0.1	0.5	5.0
10000	2.4	3.7	3.3	3.4	3.2	4.3	7.3	7.6	6.2	2.3	2.2	2.0	4.6	3.1	2.6	0.6	0.4	5.1
OA(1K-10K)	0.8	1.1	1.1	0.7	1.2	0.5	3.4	4.1	3.5	1.1	0.3	1.0	2.1	0.6	-0.2	-3.0	-1.9	2.5

Engine/Run #: 152FF106

Blade pass freq[Hz]= 3136.0

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	4.5	4.5	1.4	1.8	3.0	1.3	4.6	7.3	7.3	6.8	4.8	4.0	3.4	3.7	4.4	5.6	7.2	9.1
1250	1.7	1.7	0.1	0.4	-0.7	-0.6	0.6	4.1	6.0	3.4	2.0	2.2	0.9	0.4	1.5	1.4	3.5	5.9
1600	0.5	0.6	0.9	0.4	-1.0	-0.6	1.0	2.5	6.4	3.8	0.4	0.5	-1.3	-0.9	-0.5	-1.1	1.2	4.2
2000	0.1	0.2	2.4	1.1	-0.7	-1.1	0.8	3.8	4.9	4.7	0.4	-0.5	-1.9	-1.5	-1.7	-3.2	-1.2	3.1
2500	0.3	0.5	0.9	2.3	-1.1	-0.1	0.9.	3.9	6.7	4.9	1.3	-0.6	-1.9	-1.4	-2.0	-4.5	-1.6	2.3
3150	-2.0	-1.8	-7.5	-7.7	-8.2	-8.2	-2.5	1.3	0.9	1.5	0.0	0.3	-3.7	0.5	-1.2	-4.7	-0.3	2.0
4000	-2.5	-2.0	-3.5	-4.2	-3.5	-4.8	-1.6	0.4	1.2	1.5	-0.1	-1.9	-2.6	-2.3	-2.6	-6.2	-4.1	-0.3
5000	-2.5	-2.0	-4.0	-3.6	-3.4	-4.9	-1.3	0.1	1.3	1.5	0.9	-2.0	-2.1	-2.2	-3.2	-6.8	-5.1	-0.6
6300	-6.1	-5.4	-9.1	-9.9	-10.7	-10.7	-8.0	-7.3	-3.6	-2.8	-2.6	-4.3	-1.5	-3.1	-4.4	-7.7	-7.3	-2.8
8000	-2.4	-1.5	-4.7	-4.2	-6.1	-5.4	-2.0	-1.3	1.0	0.6	1.5	0.8	0.5	-2.2	-3.3	-6.5	-4.8	-1.2
10000	-6.8	-5.5	-11.1	-11.0	-12.3	-10.0	-6.5	-6.1	-3.2	-4.3	-2.6	-3.4	-2.1	-4.3	-6.0	-7.9	-7.3	-2.6
OA(1K-10K)	-3.6	-2.8	-5.8	-6.0	-7.1	-7.0	-4.0	-1.8	0.1	0.3	-0.4	-1.5	-1.6	-2.0	-3.1	-5.7	-3.5	-0.1

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	4.5	4.5	1.4	1.8	3.0	1.3	4.6	7.3	7.3	6.8	4.8	4.0	3.4	3.7	4.4	5.6	7.2	9.1
1250	1.7	1.7	0.1	0.4	-0.7	-0.6	0.6	4.1	6.0	3.4	2.0	2.2	0.9	0.4	1.5	1.4	3.5	5.9
1600	0.5	0.6	0.9	0.4	-1.0	-0.6	1.0	2.5	6.4	3.8	0.4	0.5	-1.3	-0.9	-0.5	-1.1	1.2	4.2
2000	0.1	0.2	2.4	1.1	-0.7	-1.1	0.8	3.8	4.9	4.7	0.4	-0.5	-1.9	-1.5	-1.7	-3.2	-1.2	3.1
2500	0.3	0.5	0.9	2.3	-1.1	-0.1	0.9	3.9	6.7	4.9	1.3	-0.6	-1.9	-1.4	-2.0	-4.5	-1.6	2.3
3150	-1.1	-0.9	-4.8	-4.9	-5.4	-5.5	0.3	3.5	1.8	1.1	-1.0	-0.8	-4.2	0.5	-1.2	-4.7	-0.3	2.0
4000	-2.5	-2.0	-3.5	-4.2	-3.5	-4.8	-1.6	0.4	1.2	1.5	-0.1	-1.9	-2.6	-2.3	-2.6	-6.2	-4.1	-0.3
5000	-2.5	-2.0	-4.0	-3.6	-3.4	-4.9	-1.3	0.1	1.3	1.5	0.9	-2.0	-2.1	-2.2	-3.2	-6.8	-5.1	-0.6
6300	-5.0	-4.4	-5.9	-6.6	-7.5	-7.4	-4.7	-4.8	-2.6	-3.4	-3.8	-5.8	-2.0	-3.1	-4.4	-7.7	-7.3	-2.8
8000	-2.4	-1.5	-4.7	-4.2	-6.1	-5.4	-2.0	-1.3	1.0	0.6	1.5	0.8	0.5	-2.2	-3.3	-6.5	-4.8	-1.2
10000	-6.0	-4.7	-8.6	-8.4	-9.7	-7.4	-3.8	-4.1	-2.4	-4.7	-3.5	-4.5	-2.5	-4.3	-6.0	-7.9	-7.3	-2.6
OA(1K-10K)	-2.9	-2.2	-3.8	-3.9	-5.0	-5.0	-1.9	-0.1	0.7	0.0	-1.1	-2.2	-1.9	-2.0	-3.1	-5.7	-3.5	-0.1

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	0.6	0.6	-1.3	-1.0	0.2	-1.4	1.5	3.7	1.9	0.1	-1.1	-0.7	-0.3	0.2	0.9	2.1	3.7	5.6
1250	-1.0	-1.1	-1.4	-1.1	-2.3	-2.2	-1.3	1.6	1.8	-2.1	-2.7	-1.4	-1.6	-1.9	-0.8	-0.9	1.2	3.6
1600	-1.1	-1.0	0.5	0.0	-1.5	-1.1	0.2	1.2	3.4	-0.6	-3.2	-1.9	-2.7	-2.1	-1.7	-2.3	0.0	3.0
2000	-0.6	-0.5	2.9	1.6	-0.2	-0.7	1.0	3.4	2.8	1.2	-2.2	-1.9	-2.4	-1.8	-2.0	-3.5	-1.5	2.8
2500	0.5	0.7	2.3	3.7	0.2	1.2	2.0	4.3	5.4	2.3	-0.4	-1.2	-1.5	-0.8	-1.4	-3.9	-1.0	2.9
3150	0.7	0.9	-3.0	-2.4	-2.9	-3.0	2.5	5.2	2.3	1.0	-0.5	0.7	-1.9	2.8	1.1	-2.7	1.3	3.6
4000	-0.9	-0.5	-0.7	-1.4	-0.7	-2.1	0.9	2.2	1.3	0.3	-0.4	-1.1	-0.8	-0.3	-0.6	-4.2	-2.1	1.7
5000	-0.4	0.1	-0.8	-0.4	-0.2	-1.7	1.6	2.5	1.9	0.9	1.0	-0.7	0.1	0.2	-0.8	-4.4	-2.7	1.8
6300	0.1	0.7	-0.3	-0.4	-1.2	-1.2	1.4	1.0	1.9	0.1	-0.1	-1.1	3.1	2.0	0.5	-3.1	-2.9	1.7
8000	1.1	2.0	-0.1	0.4	-1.5	-0.8	2.3	2.5	3.0	1.4	3.0	3.5	4.2	1.6	0.6	-2.6	-0.9	2.7
10000	0.9	2.2	-0.9	-0.3	-1.6	0.6	4.1	3.5	3.8	0.4	2.0	2.0	4.6	2.8	1.0	-1.1	-0.7	4.1
OA(1K-10K)	0.2	0.6	-0.2	0.0	-1.1	-1.2	1.8	3.2	2.7	0.8	0.2	0.1	1.1	1.0	0.0	-2.8	-0.7	2.8

Engine/Run #: 152FF107

Blade pass freq[Hz]= 3468.3

The levels represent the difference between measurement and prediction, I.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	3.6	3.5	-1.4	-1.0	-0.3	-3.2	-3.0	-2.0	0.2	3.6	4.5	5.2	5.4	6.5	7.3	8.7	9.8	10.0
1250	0.2	0.1	-3.4	-2.3	-3.5	-4.7	-5.7	-4.5	-1.9	0.0	0.9	2.2	1.5	2.6	3.3	4.4	5.4	5.9
1600	-0.7	-0.7	4.3	-1.0	-3.8	-3.1	-2.3	-3.6	0.5	1.6	-0.3	0.8	-0.8	0.6	-0.2	0.7	2.0	2.9
2000	-0.5	-0.3	7.5	0.8	2.0	-3.2	-1.0	-0.3	0.5	2.4	-1.0	-1.0	-2.3	-1.8	-2.1	-1.5	-0.1	2.6
2500	0.4	0.5	3.6	0.9	2.3	0.4	3.5	4.3	4.8	3.5	-0.4	-1.6	-3.5	-2.6	-3.8	-3.7	-1.2	1.7
3150	-1.8	-1.6	-11.8	-7.8	-7.6	-12.4	-7.2	-3.7	-0.4	8.2	1.4	2.8	-1.6	-0.9	0.4	-4.2	-0.4	4.5
4000	-2.4	-2.0	-5.7	-5.4	-4.3	-7.3	-3.3	-0.5	1.0	4.2	0.1	-1.4	-3.0	-2.5	-2.7	-5.3	-2.6	1.2
5000	-4.0	-3.5	-5.7	-6.1	-5.5	-7.8	-4.5	-3.0	-0.7	0.6	0.6	-2.7	-3.6	-3.7	-5.1	-7.6	-5.4	-1.1
6300	-8.8	-8.2	-12.2	-12.6	-13.1	-15.7	-12.9	-12.8	-6.9	-4.2	-0.7	-3.8	-4.8	-4.2	-6.7	-10.3	-8.3	-4.2
8000	-4.1	-3.1	-6.6	-6.6	-7.6	-8.0	-4.9	-4.4	-0.8	-0.1	0.1	-1.0	-1.2	-3.4	-4.8	-7.3	-5.2	-1.6
10000	-8.2	-6.9	-14.7	-14.7	-14.0	-14.9	-11.5	-11.5	-7.8	-4.8	-0.4	-3.3	-1.7	-3.7	-6.0	-7.7	-6.4	-1.9
OA(1K-10K)	-4.9	-4.1	-6.9	-6.8	-8.4	-10.8	-7.6	-5.9	-2.8	2.2	0.0	-1.2	-2.5	-2.7	-3.4	-5.3	-3.1	0.5

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	-3.3	-3.3	-8.3	-8.1	-8.0	-10.6	-9.3	-8.5	-9.5	-6.5	-3.2	-1.0	0.7	2.8	4.2	5.2	4.9	4.1
1250	-5.4	-5.5	-9.0	-8.1	-9.9	-10.9	-10.9	-9.9	-10.4	-8.9	-5.6	-2.7	-2.1	-0.1	1.1	1.9	1.7	1.2
1600	-6.1	-6.1	-1.1	-6.7	-9.9	-9.1	-7.2	-8.8	-7.8	-6.9	-6.6	-3.9	-4.2	-2.0	-2.3	-1.7	-1.6	-1.6
2000	-3.7	-3.6	4.7	-2.3	-1.7	-7.1	-4.7	-4.7	-6.3	-3.7	-4.6	-3.3	-3.8	-2.9	-2.9	-2.4	-1.7	0.0
2500	-1.1	-0.9	2.4	-0.3	0.7	-1.6	1.2	1.3	0.2	0.0	-2.0	-2.5	-4.0	-3.0	-4.1	-4.1	-1.8	0.6
3150	-0.4	-0.1	-8.5	-4.3	-4.2	-9.1	-4.0	-1.4	0.3	7.6	0.3	1.5	-2.1	-0.9	0.4	-4.3	-0.6	4.3
4000	-2.6	-2.2	-5.9	-5.6	-4.6	-7.6	-3.8	-1.1	-0.1	3.6	-0.1	-1.5	-3.1	-2.5	-2.7	-5.3	-2.7	1.0
5000	-4.1	-3.6	-5.8	-6.2	-5.6	-7.9	-4.7	-3.2	-1.2	0.4	0.5	-2.7	-3.7	-3.7	-5.1	-7.6	-5.5	-1.2
6300	-7.0	-6.3	-8.4	-8.7	-9.2	-11.9	-9.2	-9.8	-5.4	-4.3	-1.8	-5.2	-5.4	-4.2	-6.7	-10.3	-8.3	-4.2
8000	-4.1	-3.1	-6.6	-6.6	-7.6	-8.0	-4.9	-4.5	-0.9	-0.1	0.0	-1.0	-1.2	-3.4	-4.8	-7.3	-5.2	-1.6
10000	-6.7	-5.4	-11.5	-11.4	-10.7	-11.6	-8.2	-8.9	-6.5	-4.9	-1.2	-4.3	-2.1	-3.7	-6.0	-7.7	-6.4	-1.9
OA(1K-10K)	-4.3	-3.6	-4.6	-6.4	-6.2	-8.9	-5.8	-5.1	-3.8	0.6	-1.3	-2.3	-3.1	-2.9	-3.5	-5.5	-3.4	-0.1

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
							Angle from inlet centerline[deg]											
1000	-0.7	-0.8	-4.9	-4.6	-4.1	-6.4	-5.0	-4.1	-5.3	-3.7	-2.0	-0.7	0.4	1.7	2.6	4.0	5.3	6.0
1250	-2.5	-2.6	-5.0	-3.9	-5.3	-5.9	-5.7	-4.6	-5.5	-5.6	-4.2	-2.2	-2.2	-0.8	-0.1	1.1	2.3	3.3
1600	-2.5	-2.4	3.7	-1.8	-4.7	-3.6	-1.5	-3.0	-2.4	-3.0	-4.4	-2.6	-3.3	-1.7	-2.5	-1.5	0.0	1.3
2000	-2.0	-1.9	8.2	1.3	2.1	-3.1	-0.7	-0.6	-2.9	-2.3	-4.8	-3.7	-4.1	-3.3	-3.6	-2.9	-1.6	1.1
2500	-0.5	-0.3	5.6	2.8	3.8	1.6	4.2	4.0	1.8	-0.5	-3.4	-3.4	-4.3	-3.2	-4.4	-4.3	-1.9	0.9
3150	1.3	1.6	-6.4	-1.2	-1.1	-6.0	-1.4	0.6	1.2	7.7	0.4	2.6	-0.4	0.8	2.0	-2.9	0.5	5.4
4000	-1.5	-1.1	-1.6	-1.4	-0.5	-3.7	-0.5	1.0	0.0	2.0	-1.3	-1.6	-2.2	-1.5	-1.7	-4.3	-1.7	2.0
5000	-2.5	-2.0	-0.9	-1.4	-0.9	-3.4	-0.8	-0.6	-0.9	-1.0	-0.2	-2.3	-2.3	-2.2	-3.6	-6.1	-3.9	0.3
6300	-1.6	-1.0	-1.4	-0.7	-1.3	-4.0	-1.7	-3.0	-0.3	-0.6	1.6	-1.0	-0.8	0.3	-2.3	-6.2	-4.4	-0.2
8000	-1.4	-0.5	-0.6	-0.6	-1.7	-2.3	0.2	-0.6	0.3	-0.5	0.4	0.4	1.3	-0.7	-2.1	-4.6	-2.6	1.0
10000	-0.3	1.0	-2.9	-2.1	-1.5	-2.5	0.5	-0.9	-0.4	-0.5	3.1	0.9	3.6	2.0	-0.4	-2.2	-1.0	3.5
OA(1K-10K)	-0.9	-0.4	0.6	-0.7	-0.6	-3.3	-0.6	-0.4	-0.4	2.3	0.0	-0.4	-0.6	-0.5	-1.2	-3.3	-1.1	2.5

Engine/Run #: 152FF108
Blade pass freq[Hz]= 3797.3

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-20.2	-20.3	-25.1	-25.3	-25.1	-29.8	-29.6	-28.3	-25.9	-21.5	-18.7	-15.9	-14.2	-11.7	-9.8	-9.2	-11.2	-13.1
1250	-17.3	-17.4	-19.0	-22.1	-22.5	-25.1	-27.4	-25.3	-21.9	-18.1	-15.1	-12.5	-11.6	-9.0	-7.1	-7.2	-8.3	-10.9
1600	-15.4	-15.4	-13.5	-16.2	-17.9	-21.9	-21.6	-23.6	-16.7	-12.3	-13.2	-10.6	-9.7	-8.2	-7.4	-7.3	-8.5	-9.9
2000	-14.6	-14.5	-8.2	-9.2	-12.8	-18.5	-18.1	-20.8	-15.9	-11.7	-12.8	-9.1	-9.6	-10.2	-9.8	-8.9	-10.4	-11.4
2500	-11.9	-11.7	-8.0	-10.3	-10.2	-13.7	-15.6	-13.6	-11.9	-10.5	-9.4	-7.6	-9.2	-7.6	-8.0	-8.2	-8.6	-9.3
3150	-10.4	-10.2	-8.4	-8.3	-9.5	-14.3	-15.6	-16.3	-12.4	-7.5	-5.4	-5.8	-6.7	-4.6	-5.8	-6.8	-6.6	-6.2
4000	-7.5	-7.1	-15.0	-15.3	-13.4	-15.9	-14.7	-10.4	-6.5	-1.9	1.9	-0.9	-6.5	-5.2	-4.9	-7.9	-5.7	-1.3
5000	-7.0	-6.5	-9.5	-10.1	-10.4	-12.8	-11.7	-11.8	-7.3	-2.5	-1.5	-3.4	-3.9	-4.3	-6.3	-7.4	-5.9	-3.6
6300	-5.1	-4.5	-6.9	-8.0	-7.9	-9.1	-7.3	-8.1	-3.7	-1.0	-0.6	-2.2	-2.0	-3.4	-6.3	-7.8	-5.9	-2.9
8000	-8.8	-7.8	-17.0	-17.6	-18.2	-17.4	-13.7	-13.2	-8.4	-5.1	-2.2	-3.8	-1.8	-5.1	-5.5	-9.2	-7.0	-3.8
10000	-4.7	-3.4	-8.0	-8.8	-9.9	-8.8	-5.4	-6.2	-2.4	-1.7	0.0	-1.0	0.6	-3.8	-7.4	-7.9	-5.6	-1.1
OA(1K-10K)	-12.3	-12.3	-12.8	-13.9	-14.8	-18.4	-18.7	-18.3	-14.3	-9.6	-6.4	-6.7	-7.0	-6.9	-6.9	-8.2	-8.5	-8.2

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-5.7	-5.7	-12.6	-12.7	-12.0	-15.2	-13.0	-11.7	-12.7	-9.9	-6.1	-3.1	-1.1	1.7	3.7	4.8	3.4	2.1
1250	-5.4	-5.5	-9.1	-12.1	-12.0	-13.0	-13.3	-11.2	-11.3	-8.9	-5.1	-2.5	-1.4	1.2	3.1	3.7	3.6	1.7
1600	-6.5	-6.5	-6.7	-9.3	-10.4	-12.8	-10.4	-12.4	-9.0	-6.1	-6.2	-3.7	-2.6	-1.1	-0.4	0.4	0.3	-0.4
2000	-6.6	-6.5	-2.2	-3.2	-6.3	-10.4	-7.9	-10.6	-9.1	-6.5	-6.7	-3.0	-3.4	-4.0	-3.6	-2.1	-2.6	-2.8
2500	-4.6	-4.4	-2.8	-5.0	-4.2	-6.0	-5.8	-3.6	-5.3	-5.5	-3.9	-2.5	-4.3	-3.1	-3.7	-3.1	-2.0	-1.5
3150	-4.3	-4.1	-4.5	-4.2	-4.6	-7.7	-6.6	-6.8	-6.2	-3.0	-1.0	-2.2	-3.6	-2.0	-3.5	-3.9	-2.1	0.0
4000	-5.1	-4.6	-10.7	-11.0	-9.1	-11.3	-9.8	-5.8	-3.9	-1.4	1.2	-2.3	-9.0	-4.9	-4.7	-7.6	-5.1	-0.2
5000	-4.5	-4.1	-8.3	-8.8	-8.5	-9.6	-6.2	-5.2	-2.9	-0.2	0.1	-2.4	-3.2	-3.8	-5.8	-6.8	-4.7	-1.3
6300	-3.8	-3.2	-6.4	-7.4	-7.0	-7.3	-3.7	-3.4	-0.8	0.3	0.1	-1.8	-1.7	-3.1	-6.1	-7.5	-5.3	-1.7
8000	-7.1	-6.2	-13.4	-14.0	-14.6	-13.7	-9.9	-10.0	-6.8	-5.2	-3.2	-5.1	-2.3	-5.0	-5.4	-9.1	-6.9	-3.5
10000	-4.3	-3.0	-7.9	-8.6	-9.6	-8.3	-4.2	-4.4	-1.3	-1.4	0.2	-0.9	0.7	-3.8	-7.4	-7.9	-5.5	-0.8
OA(1K-10K)	-5.4	-5.0	-7.2	-8.2	-8.3	-10.3	-8.3	-7.4	-6.4	-3.8	-1.2	-2.7	-3.4	-3.6	-4.0	-4.5	-3.0	-0.8

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

			Angle from inlet centerline[deg]															
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-0.4	-0.5	-7.0	-7.1	-6.2	-9.3	-6.9	-5.6	-6.8	-4.4	-1.6	0.7	2.2	4.2	5.5	7.1	7.3	7.0
1250	-0.2	-0.3	-3.1	-6.0	-5.4	-6.2	-6.3	-4.0	-4.3	-3.3	-1.2	0.2	0.6	2.2	3.4	4.6	6.3	6.2
1600	-0.8	-0.8	0.1	-2.4	-3.0	-5.0	-2.3	-4.1	-1.0	0.2	-2.0	-0.6	-0.3	0.2	0.3	1.7	3.4	4.6
2000	-0.1	0.0	5.2	4.4	1.8	-2.0	0.7	-1.8	-0.7	0.5	-1.6	1.0	-0.1	-1.6	-2.0	0.2	1.4	2.9
2500	-0.6	-0.4	2.6	0.6	1.9	0.4	1.0	3.3	1.1	-1.2	-1.7	-1.0	-3.1	-2.5	-3.5	-2.6	-0.3	1.8
3150	-2.3	-2.0	-0.3	0.0	-0.1	-2.8	-1.6	-1.9	-2.0	-1.3	-0.9	-2.3	-3.3	-1.9	-3.6	-3.8	-1.4	1.6
4000	-2.6	-2.2	-9.0	-7.9	-5.9	-8.2	-7.1	-3.6	-2.6	-0.3	2.5	0.2	-5.9	-2.0	-1.7	-5.3	-3.5	1.6
5000	-3.4	-2.9	-4.2	-4.7	-4.5	-5.7	-2.6	-2.4	-1.9	-1.3	-1.0	-2.7	-2.6	-3.0	-5.1	-6.0	-3.8	-0.4
6300	-2.4	-1.8	-1.8	-2.9	-2.6	-3.1	0.0	-0.8	-0.2	-1.0	-0.8	-1.7	-0.6	-1.9	-4.9	-6.3	-4.0	-0.4
8000	-2.3	-1.4	-6.8	-6.5	-7.2	-6.4	-3.0	-3.7	-2.3	-2.1	-0.2	-1.3	2.0	-0.9	-1.4	-5.4	-3.3	0.2
10000	-1.5	-0.2	-1.8	-2.6	-3.7	-2.6	0.9	-0.6	0.0	-1.6	0.7	0.7	3.3	-1.0	-4.6	-5.1	-2.7	1.9
OA(1K-10K)	-1.9	-1.5	-3.2	-3.3	-3.2	-5.0	-3.1	-2.2	-1.8	-0.9	0.6	-0.5	-0.9	-1.3	-1.9	-2.5	-0.8	2.0

Engine/Run #: 152FF109
Blade pass freq[Hz]= 4000.3

The levels represent the difference between measurement and prediction, i.e Negative #'s indicate overprediction

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): H

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	-17.4	-17.5	-24.8	-22.9	-22.9	-27.5	-25.6	-23.6	-22.9	-17.6	-15.9	-13.2	-11.7	-9.1	-7.3	-6.5	-8.5	-10.3
1250	-15.4	-15.4	-21.2	-21.0	-21.7	-23.4	-26.2	-24.4	-20.8	-16.9	-14.3	-10.9	-9.6	-6.5	-5.0	-4.6	-6.3	-7.9
1600	-14.7	-14.7	-14.9	-15.4	-17.6	-21.4	-23.1	-23.4	-18.3	-14.5	-13.5	-10.3	-9.2	-6.3	-5.0	-4.8	-6.3	-7.6
2000	-14.2	-14.1	-7.8	-6.6	-12.3	-17.5	-20.8	-20.3	-16.9	-12.2	-12.4	-11.1	-10.9	-7.5	-7.4	-6.9	-8.0	-8.7
2500	-11.2	-11.0	-6.8	-6.5	-9.6	-14.3	-12.2	-14.5	-13.9	-10.0	-10.0	-8.4	-7.8	-5.9	-5.9	-5.7	-6.0	-6.8
3150	-9.5	-9.3	-9.3	-7.7	-10.1	-14.1	-14.1	-15.2	-11.2	-7.1	-5.6	-5.1	-5.0	-3.8	-5.0	-5.0	-4.0	-3.8
4000	-7.5	-7.1	-13.3	-15.1	-13.3	-14.7	-11.5	-10.3	-7.2	-3.7	-0.9	-0.3	-6.1	-4.4	-8.1	-8.6	-3.2	0.3
5000	-5.4	-4.9	-8.9	-9.3	-9.0	-11.9	-9.3	-9.6	-5.7	-1.6	0.1	-2.0	-2.9	-2.6	-5.0	-5.4	-2.5	-0.3
6300	-4.5	-3.9	-7.0	-7.8	-6.0	-8.5	-6.9	-7.1	-2.9	-1.0	-0.3	-1.6	-1.2	-3.2	-6.7	-6.9	-2.9	-0.4
8000	-8.3	-7.4	-14.5	-14.6	-16.4	-15.7	-13.1	-11.5	-7.7	-5.3	-4.1	-5.7	-3.1	-2.1	-7.9	-9.1	-5.6	-2.8
10000	-5.5	-4.2	-8.7	-9.5	-11.2	-9.8	-6.1	-6.3	-2.1	-2.3	-0.9	-2.2	-1.1	-4.7	-8.3	-7.4	-1.2	0.9
OA(1K-10K)	-11.6	-11.6	-12.1	-11.9	-14.2	-17.8	-17.3	-17.8	-14.4	-10.1	-7.4	-6.2	-6.5	-5.2	-6.7	-6.5	-5.8	-5.8

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): G

Angle from inlet centerline[deg]

Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000 •	-2.9	-2.9	-12.3	-10.3	-9.8	-12.9	-9.0	-7.0	-9.8	-6.0	-3.3	-0.4	1.4	4.2	6.1	7.5	6.1	4.9
1250	-3.4	-3.5	-11.3	-11.0	-11.1	-11.4	-12.1	-10.3	-10.2	-7.6	-4.3	-0.9	0.6	3.7	5.2	6.3	5.6	4.7
1600	-5.7	-5.7	-8.0	-8.5	-10.1	-12.3	-11.9	-12.2	-10.5	-8.3	-6.5	-3.4	-2.1	0.7	2.0	3.1	2.5	1.9
2000	-6.2	-6.1	-1.8	-0.6	-5.6	-9.4	-10.6	-10.0	-10.1	-6.9	-6.3	-5.0	-4.7	-1.3	-1.3	-0.1	-0.2	0.0
2500	-3.8	-3.6	-1.6	-1.2	-3.6	-6.6	-2.4	-4.5	-7.3	-5.0	-4.4	-3.3	-3.0	-1.4	-1.8	-0.7	0.5	1.0
3150	-3.5	-3.3	-5.5	-3.7	-5.3	-7.5	-5.1	-5.8	-4.9	-2.7	-1.3	-1.6	-2.0	-1.3	-2.8	-2.2	0.4	2.3
4000	-5.4	-5.0	-9.1	-10.9	-9.0	-10.2	-6.5	-5.7	-4.6	-3.4	-1.8	-1.8	-6.7	-4.1	-7.9	-8.4	-2.6	1.3
5000	-3.1	-2.6	-7.9	-8.1	-7.3	-8.9	-4.0	-3.2	-1.5	0.6	1.6	-1.1	-2.3	-2.2	-4.7	-4.9	-1.4	1.8
6300	-3.4	-2.8	-6.5	-7.3	-5.2	-6.9	-3.7	-2.7	-0.1	0.2	0.4	-1.2	-1.0	-3.0	-6.5	-6.6	-2.4	0.6
8000	-7.0	-6.1	-11.2	-11.2	-13.0	-12.3	-9.5	-8.5	-6.3	-5.6	-5.1	-7.0	-3.6	-2.1	-7.9	-9.1	-5.5	-2.6
10000	-5.2	-3.9	-8.6	-9.4	-11.0	-9.3	-5.1	-4.6	-1.3	-2.0	-0.7	-2.1	-1.1	-4.7	-8.3	-7.4	-1.1	1.1
OA(1K-10K)	-4.9	-4.5	-6.6	-6.2	-7.7	-9.6	-6.8	-6.8	-6.5	-4.4	-2.6	-2.6	-3.3	-2.2	-4.1	-3.1	-0.7	1.3

GASP(G), Heidmann(H), or 1994 Revision(J)?(G,H,J): J

Angle from inlet centerline[deg]

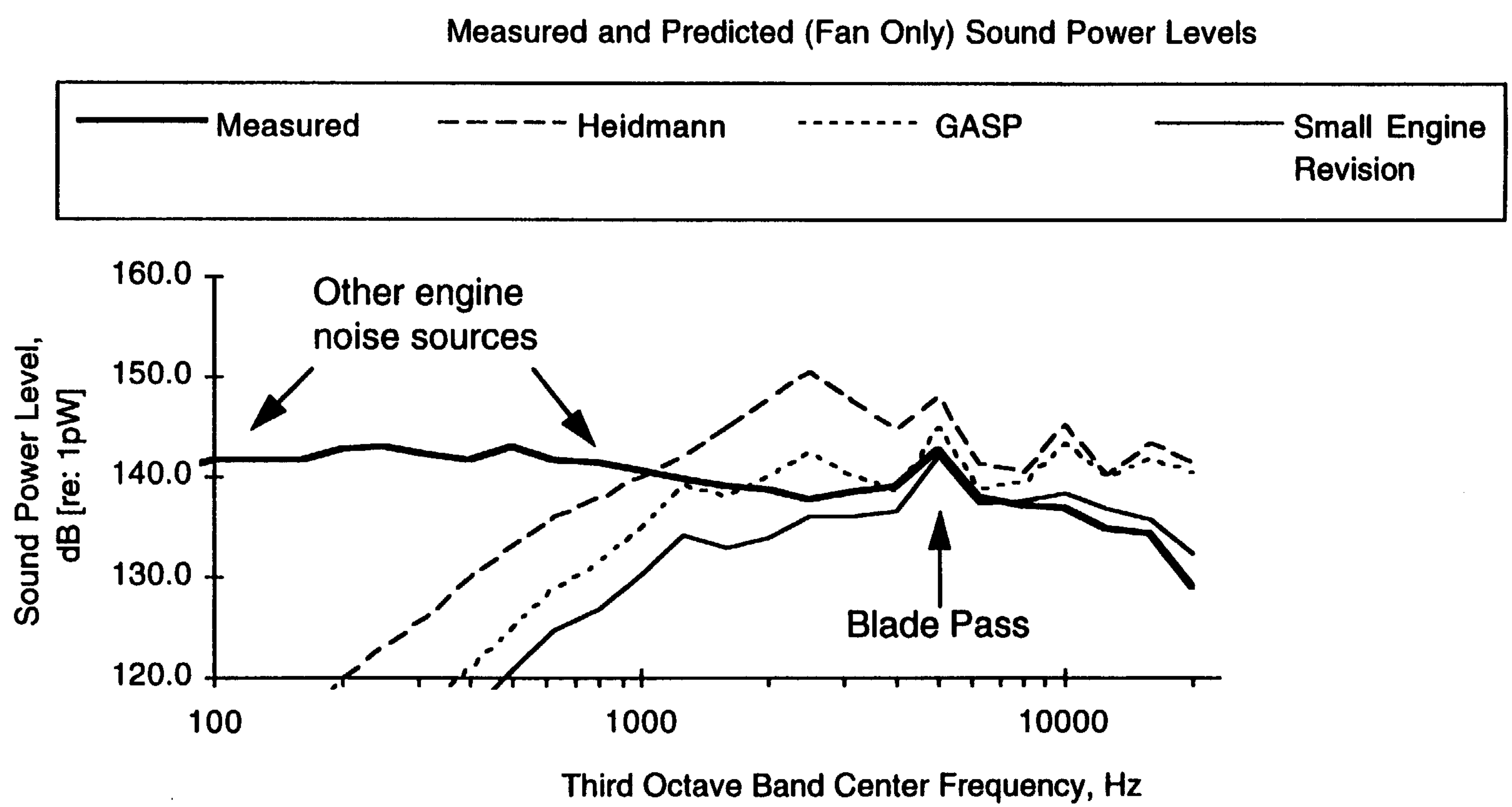
Frequency [Hz]	PWL	<SPL>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1000	1.5	1.4	-7.6	-5.6	-4.9	-7.9	-3.9	-1.8	-4.7	-1.4	0.4	2.6	3.9	5.9	7.2	9.1	9.1	8.9
1250	0.9	0.8	-6.1	-5.8	-5.5	-5.5	-6.0	-4.1	-4.2	-3.0	-1.2	1.1	1.9	4.0	4.8	6.4	7.6	8.4
1600	-0.9	-0.8	-2.1	-2.4	-3.6	-5.4	-4.7	-4.8	-3.5	-2.9	-3.1	-1.1	-0.6	1.4	1.9	3.6	4.8	6.0
2000	-0.6	-0.5	4.7	6.1	1.4	-1.9	-2.9	-2.2	-2.6	-0.9	-2.1	-1.9	-2.2	0.2	-0.4	1.4	3.0	4.8
2500	-0.7	-0.5	3.0	3.5	1.6	-1.1	3.4	1.4	-1.9	-1.6	-3.1	-2.7	-2.6	-1.5	-2.3	-0.9	1.5	3.4
3150	-2.2	-2.0	-2.0	-0.2	-1.5	-3.5	-0.9	-1.7	-1.7	-1.8	-2.0	-2.4	-2.5	-1.9	-3.5	-2.8	0.4	3.0
4000	-3.0	-2.6	-7.3	-7.9	-5.9	-7.2	-4.0	-3.5	-3.4	-2.3	-0.5	0.6	-3.7	-1.3	-5.1	-6.2	-1.1	2.9
5000	-2.5	-2.1	-4.3	-4.6	-3.8	-5.6	-1.1	-1.1	-1.2	-1.1	-0.1	-1.9	-2.2	-1.9	-4.4	-4.6	-1.1	2.2
6300	-2.5	-1.9	-2.4	-3.3	-1.3	-3.2	-0.5	-0.6	-0.2	-1.6	-1.1	-1.8	-0.4	-2.3	-5.8	-5.9	-1.6	1.4
8000	-2.8	-1.9	-5.0	-4.3	-6.2	-5.6	-3.2	-2.9	-2.5	-3.1	-2.6	-3.6	0.3	1.7	-4.2	-5.6	-2.2	0.8
10000	-3.1	-1.8	-3.2	-4.0	-5.8	-4.3	-0.6	-1.6	-0.6	-2.9	-1.0	-1.3	0.8	-2.6	-6.2	-5.3	1.0	3.1
OA(1K-10K)	-2.0	-1.5	-2.7	-1.7	-3.0	-4.8	-2.0	-2.2	-2.5	-2.0	-1.2	-0.9	-1.2	-0.3	-2.3	-1.5	1.1	3.6

APPENDIX VIII

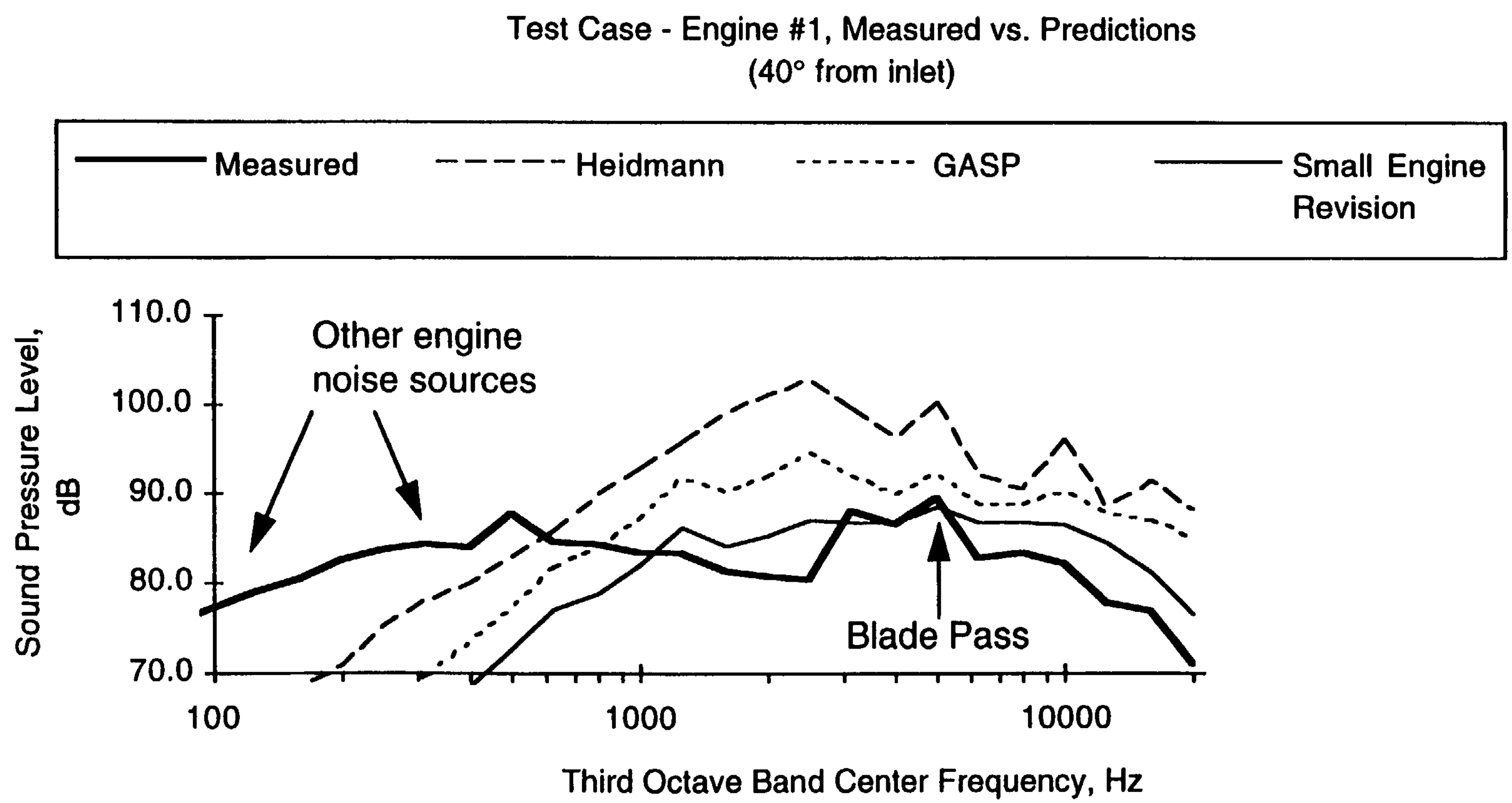
SMALL ENGINE REVISION FAN NOISE PREDICTION TEST CASE

Engine #1 input parameters for Small Engine Revision test case	
Engine Information:	Engine #1
Fan blade #:	30
Stator blade #:	61
Fan speed,rpm:	10006
Fan blade pass,Hz:	5003
Fan physical flow,lb/s:	132.48
Fan diameter,ft:	2.455
Inlet total temp,°R:	537
Discharge total temp,°R:	617
Rel. Tip mach #:	1.200
T,°R:	80
Rel. Tip mach # (design):	1.446
RSS, %:	170
Reference mass flow,lb/s:	1
Reference total temp,°R:	1
GASP(G), Heidmann(H), or Small Engine Revision(J)?(G,H,J):	J

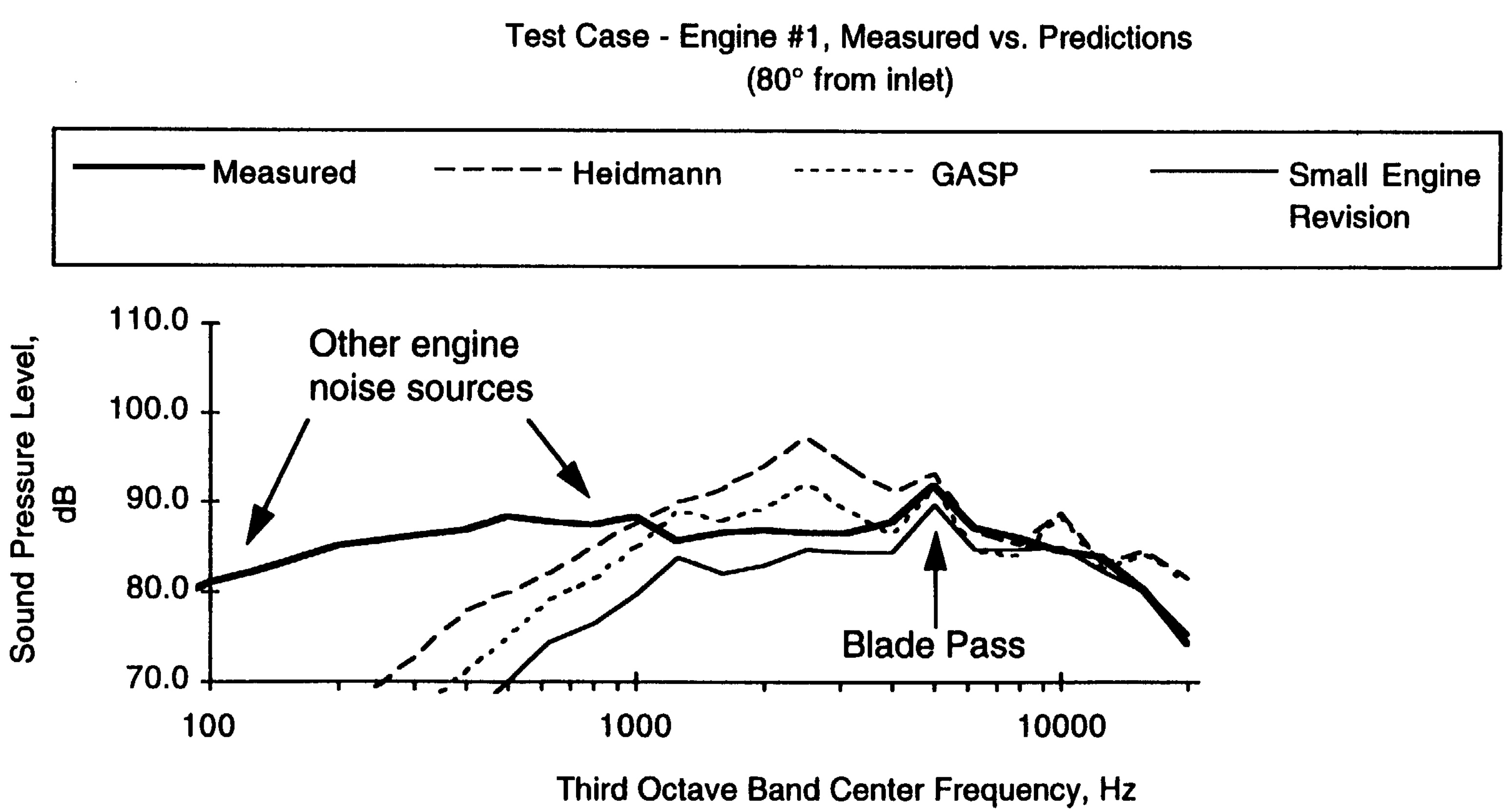
Test Case - Engine #1
Fan Noise Predictions vs. Measurement



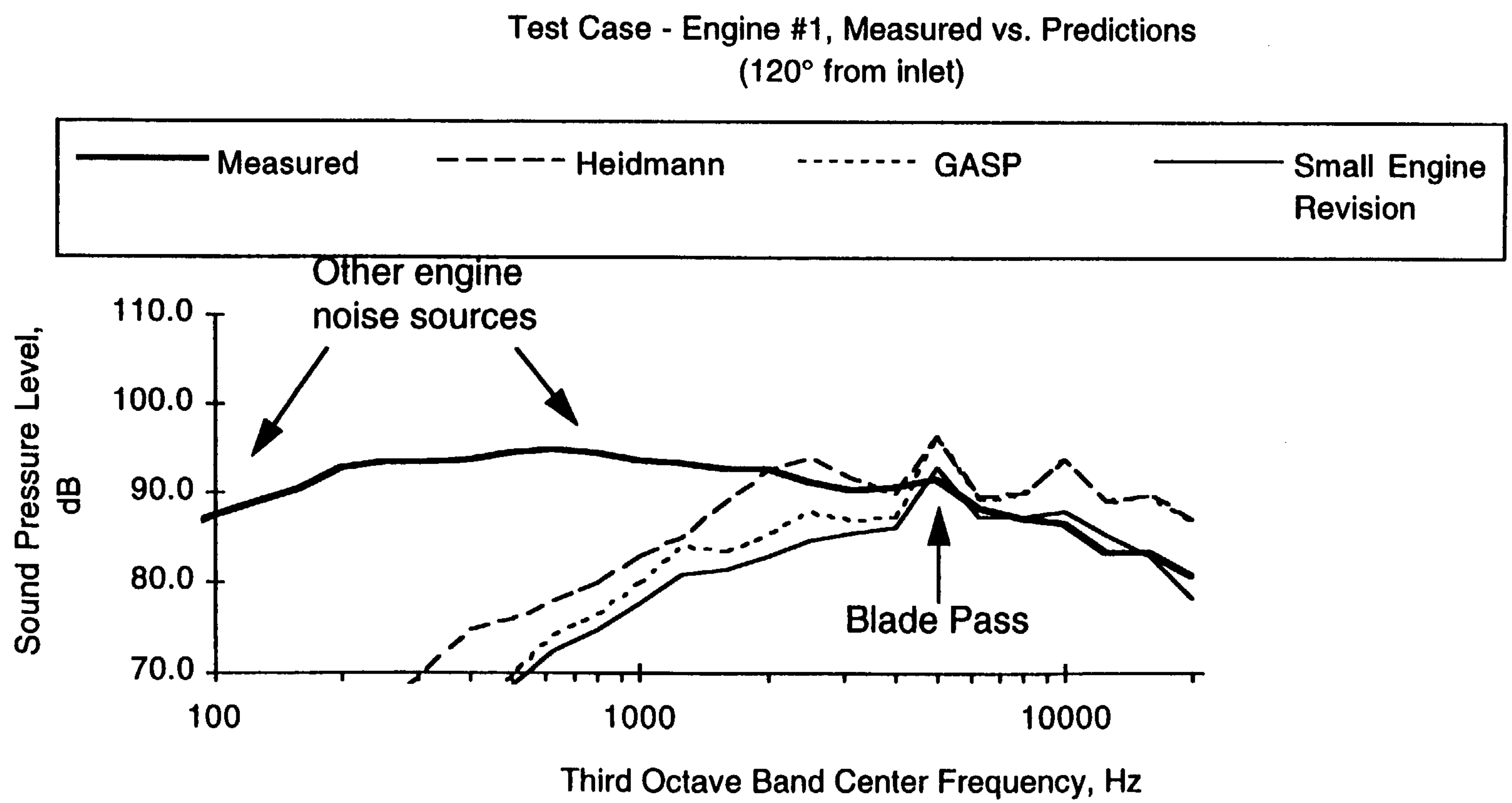
Test Case - Engine #1
Fan Noise Predictions vs. Measurement



Test Case - Engine #1
Fan Noise Predictions vs. Measurement



Test Case - Engine #1
Fan Noise Predictions vs. Measurement



Engine 1: Measured Fan Noise (Observer distance = 100 ft, no atmospheric attenuation)

Frequency [Hz]	Sound Pressure Level [dB] 10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°
50	69.5	69.6	66.5	70.9	71.7	72.6	73.7	75.1	77.0	78.3	79.5	81.3	83.9	88.2	93.0	96.5
63	72.0	72.0	69.7	73.1	74.5	75.7	76.5	77.1	78.3	79.6	81.3	83.3	85.8	90.1	94.8	98.5
80	73.5	74.1	72.9	75.2	76.2	77.2	78.4	78.7	80.9	81.8	83.4	85.5	88.2	92.5	96.7	100.3
100	75.3	75.5	75.3	77.1	77.8	78.8	79.9	80.8	82.2	83.6	85.2	87.4	90.4	95.0	98.5	100.3
125	76.6	77.5	77.6	78.8	79.5	80.2	81.2	82.1	83.3	84.9	86.6	88.8	91.5	95.9	99.3	98.7
160	78.8	78.8	79.4	80.3	80.8	81.3	82.3	83.5	84.9	86.2	87.8	90.3	93.0	96.5	99.2	96.9
200	80.5	79.9	81.0	82.4	82.6	83.3	83.9	84.9	86.6	87.9	89.6	92.5	95.5	98.1	98.0	97.4
250	82.0	80.8	82.7	83.4	83.5	84.2	84.5	85.7	87.7	88.8	90.6	93.3	95.9	98.0	98.1	96.9
315	82.1	81.5	83.2	84.1	84.8	85.1	85.0	86.2	88.0	89.5	90.9	93.4	95.7	97.4	96.0	93.6
400	81.3	81.7	83.0	84.0	84.5	84.9	85.9	86.8	88.6	89.6	91.3	93.5	95.4	96.5	95.0	92.6
500	87.7	85.8	84.8	87.7	87.8	88.5	89.4	88.3	90.1	90.7	93.0	94.4	95.4	96.5	96.7	93.9
630	82.1	81.9	83.8	84.5	85.0	85.8	86.6	87.6	89.5	90.8	92.4	94.8	95.6	94.8	93.0	90.7
800	81.5	82.1	84.5	84.2	84.8	85.4	87.9	87.5	89.3	90.7	92.0	94.6	95.1	93.9	91.6	89.4
1000	81.4	82.4	84.6	83.4	84.8	86.2	87.1	88.5	88.5	90.3	91.7	93.6	94.5	93.1	90.5	88.8
1250	80.8	81.3	83.0	83.4	83.3	84.7	85.9	85.8	86.6	89.3	91.1	93.4	93.6	92.0	89.4	87.7
1600	80.1	80.7	81.4	81.4	83.0	83.7	86.7	86.7	85.6	88.3	90.8	93.0	92.6	91.3	88.7	87.3
2000	79.8	81.2	82.4	81.1	82.8	85.0	85.2	87.3	87.0	87.9	90.2	93.0	91.3	90.4	87.7	86.5
2500	79.9	80.3	81.7	80.9	83.4	83.8	85.1	86.9	86.4	87.7	89.2	91.8	90.4	89.4	87.1	85.1
3150	93.7	85.3	89.4	88.5	85.7	86.8	87.3	87.0	87.1	87.2	88.8	90.9	90.2	88.6	86.7	85.1
4000	86.8	86.2	88.8	87.4	88.9	87.9	88.4	88.5	90.0	88.8	89.6	91.5	90.3	88.5	86.0	84.7
5000	91.7	90.8	90.4	90.4	96.5	90.7	93.6	92.7	94.4	93.3	92.3	92.5	92.0	89.7	87.5	87.3
6300	82.6	81.9	82.7	83.7	88.4	85.7	87.7	88.2	89.4	88.5	90.2	89.2	90.7	89.2	85.7	83.7
8000	83.3	83.3	84.1	84.6	89.7	86.1	86.6	87.3	88.1	87.6	89.6	88.7	89.5	88.8	85.1	82.9
10000	84.8	83.3	83.1	84.2	90.0	86.8	87.8	86.5	88.6	87.5	89.3	88.5	89.6	89.1	85.0	82.9
OA(50-10K)																
[dB]	101.7	103.0	103.6	104.4	103.8	103.3	103.0	101.3	100.7	101.5	102.0	102.1	102.1	100.2	97.0	94.2
[dBA]	101.8	103.2	103.9	104.8	104.3	103.9	103.6	101.8	100.9	101.6	101.9	102.0	101.9	100.1	97.1	94.4

Engine 1: Fan Noise Prediction - GASP Version (Observer distance = 100 ft, no atmospheric attenuation)

	Sound Pressure Level [dB]															
Frequency [Hz]	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°
50	40.5	42.0	43.5	45.0	45.0	45.0	45.0	42.5	40.0	39.1	38.1	37.2	36.2	35.3	34.3	33.4
63	43.6	45.1	46.6	48.1	48.1	48.1	48.1	45.6	43.1	42.1	41.2	40.2	39.3	38.3	37.4	36.4
80	46.7	48.2	49.7	51.2	51.2	-2.1	51.2	48.7	46.2	45.3	44.3	43.4	42.4	41.5	40.5	39.6
100	49.7	51.2	52.7	54.2	54.2	54.2	54.2	51.7	49.2	48.2	47.3	46.3	45.4	44.4	43.5	42.5
125	52.6	54.1	55.6	57.1	57.1	57.1	57.1	54.6	52.1	51.2	50.2	49.3	48.3	47.4	46.4	45.5
160	56.0	57.5	59.0	60.5	60.5	60.5	60.5	58.0	55.5	54.5	53.6	52.6	51.7	50.7	49.8	48.8
200	59.0	60.5	62.0	63.5	63.5	63.5	63.5	61.0	58.5	57.6	56.6	55.7	54.8	53.8	52.8	51.9
250	62.2	63.7	65.2	66.7	66.7	66.7	66.7	64.2	61.7	60.8	59.8	58.9	57.9	57.0	56.0	55.1
315	65.6	67.1	68.6	70.1	70.1	70.1	70.1	67.6	65.1	64.2	63.2	62.3	61.4	60.4	59.4	58.4
400	69.3	70.8	72.3	73.8	73.8	73.7	73.7	71.3	68.8	67.8	66.9	66.0	65.1	64.1	63.1	62.1
500	72.9	74.4	75.9	77.4	77.4	77.4	77.4	74.9	72.4	71.5	70.6	69.7	68.8	67.8	66.8	65.8
630	76.9	78.4	32.7	81.4	81.3	81.3	81.3	78.8	76.4	75.5	74.6	73.7	72.9	71.8	70.8	69.7
800	80.3	81.8	83.3	84.8	84.8	84.7	84.7	82.3	79.8	78.9	78.0	77.2	76.4	75.3	74.2	73.2
1000	84.2	85.7	87.2	88.7	88.7	88.7	88.7	86.2	83.7	82.8	82.0	81.1	80.3	79.3	78.1	77.1
1250	88.5	90.0	91.4	92.9	92.9	92.9	92.9	90.4	87.9	87.1	86.2	85.3	84.5	83.5	82.3	81.3
1600	87.4	88.9	90.3	91.8	91.7	91.7	91.7	89.2	86.8	86.1	85.4	84.7	84.0	82.9	81.4	80.2
2000	89.2	90.7	92.1	93.5	93.5	93.4	93.4	90.9	88.6	87.9	87.3	86.7	86.1	84.9	83.3	82.0
2500	91.9	93.4	94.8	96.2	96.1	96.1	96.1	93.6	91.3	90.6	90.0	89.4	88.8	87.5	86.0	84.7
3150	89.7	91.1	92.3	93.6	93.4	93.2	93.2	90.8	88.8	88.6	88.5	88.4	88.2	86.6	84.3	82.4
4000	88.5	89.7	90.6	91.5	91.0	90.6	90.4	88.3	87.2	87.8	88.4	88.8	88.9	87.1	83.9	81.2
5000	96.4	97.8	97.9	98.0	97.1	95.9	95.1	94.6	95.6	97.1	97.6	97.7	97.7	95.7	92.2	88.7
6300	89.0	90.1	90.3	90.6	89.1	87.7	86.9	86.1	87.0	88.7	90.0	90.8	91.1	89.1	85.3	81.5
8000	89.6	90.7	90.8	90.9	89.2	87.4	86.3	86.1	87.5	89.4	90.8	91.7	92.0	90.0	86.0	82.2
10000	94.5	95.9	95.9	95.9	94.7	93.3	92.2	92.1	93.4	95.1	95.8	96.1	96.2	94.2	90.5	86.9
OA(50-10K)																
[dB]	101.7	103.0	103.6	104.4	103.8	103.3	103.0	101.3	100.7	101.5	102.0	102.1	102.1	100.2	97.0	94.2
[dBA]	101.8	103.2	103.9	104.8	104.3	103.9	103.6	101.8	100.9	101.6	101.9	102.0	101.9	100.1	97.1	94.4

FAN NOISE MODULE

INPUT PARAMETERS

```
AE     =   .10000000E+01    RS     =   .10000000E+03    AFAN   =   .47336104E+01    DIAM   =   .24550000E+01
MD     =   .14460000E+01    RSS    =   .17000000E+01    MDOT   =   .15785590E+01    MA     =   .00000000E+00
N      =   .36058101E+00    DELTAT =   .14906740E+00    CA     =   .11354235E+04    RHOA   =   .22976323E-02
NBANDS =     0              METHOD =     1              NENG   =     1              NB     =    30
NV     =    61
IGV    =     1              DIS    =     1              IOUT   =     1              IPRINT =     3
INRS   =     T              INCT   =     T              INDIS  =     F              IDBB   =     T
IDRS   =     T              INBB   =     T              SCRNNN =     1              SCRXXX =    XXX
IUNITS =   ENGLISH          STIME  =   .00000000E+00
```

UNIT MEMBERS

```
SFIELD  (FREQ    ) IS ALTERNATE NAME OF SFIELD  (FREQ    )
HDNFAN  (XXX001  ) IS ALTERNATE NAME OF HDNFAN  (XXX001  )
SFIELD  (PHI     ) IS ALTERNATE NAME OF SFIELD  (PHI     )
SFIELD  (THETA   ) IS ALTERNATE NAME OF SFIELD  (THETA   )
```

FAN NOISE MODULE

NOISE DATA FROM MODULE HDNFAN

OBSERVER DISTANCE = 100.0 (FT) REFERENCE LENGTH = 2.176 (FT) POWER LEVEL = 147.2 DB
SOURCE TIME = .0000E+00

COMPUTED NOISE -INLET BROADBAND- INLET RS TONES- COMBINATION TONE NOISE-DISCH BROADBAND- DISCH RS TONES

****
* TABLE OF SOUND PRESSURE LEVEL VALUES (DECIBELS) *
****

AZIMUTH ANGLE = .00 DEGREES

1/3 OB CTR FREQ (HERTZ)	DIRECTIVITY ANGLE (DEGREES) 10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0
OVERALL	105.0	106.4	107.5	109.5	110.9	110.6	107.3	103.9	103.4	103.9	104.7	105.1	105.1	103.6	101.1	99.3
50.00	45.9	47.4	49.4	52.4	54.4	54.4	50.9	46.9	45.4	44.9	44.4	43.9	43.4	42.9	42.4	41.9
63.00	49.0	50.5	52.5	55.5	57.5	57.5	54.0	50.0	48.5	48.0	47.5	47.0	46.5	46.0	45.5	45.0
80.00	52.1	53.6	55.6	58.6	60.6	60.6	57.1	53.1	51.6	51.1	50.6	50.1	49.6	49.1	48.6	48.1
100.00	55.0	56.5	58.5	61.5	63.5	63.5	60.0	56.0	54.5	54.0	53.5	53.0	52.5	52.0	51.5	51.0
125.00	57.9	59.4	61.4	64.4	66.4	66.4	62.9	58.9	57.4	56.9	56.4	55.9	55.4	54.9	54.4	53.9
160.00	61.1	62.6	64.6	67.6	69.6	69.6	66.1	62.1	60.6	60.1	59.6	59.1	58.6	58.1	57.6	57.1
200.00	64.0	65.5	67.5	70.5	72.5	72.5	69.0	65.0	63.5	63.0	62.5	62.0	61.5	61.0	60.5	60.0
250.00	66.9	68.4	70.4	73.4	75.4	75.4	71.9	67.9	66.4	65.9	65.4	65.0	64.5	64.0	63.4	62.9
315.00	70.0	71.5	73.5	76.5	78.5	78.5	75.0	71.0	69.5	69.0	68.5	68.0	67.5	67.0	66.5	66.0
400.00	73.1	74.6	76.6	79.6	81.6	81.6	78.1	74.1	72.6	72.1	71.6	71.2	70.7	70.2	69.6	69.1
500.00	76.1	77.6	79.6	82.6	84.6	84.6	81.1	77.1	75.6	75.1	74.6	74.1	73.7	73.1	72.6	72.1
630.00	79.2	80.7	82.7	85.7	87.7	87.7	84.2	80.2	78.7	78.2	77.7	77.3	76.8	76.2	75.7	75.2
800.00	82.3	83.8	85.8	88.8	90.8	90.8	87.3	83.3	81.8	81.3	80.9	80.4	79.9	79.4	78.8	78.3
1000.00	85.3	86.8	88.8	91.7	93.7	93.7	90.2	86.2	84.8	84.3	83.9	83.4	83.0	82.4	81.8	81.3
1250.00	88.3	89.8	91.8	94.8	96.8	96.8	93.3	89.3	87.8	87.4	86.9	86.5	86.0	85.5	84.9	84.3
1600.00	91.2	92.7	94.7	97.7	99.7	99.7	96.2	92.2	90.7	90.3	89.9	89.4	89.0	88.4	87.8	87.2
2000.00	94.1	95.6	97.6	100.5	102.5	102.5	99.0	95.0	93.6	93.1	92.7	92.3	91.9	91.3	90.6	90.1
2500.00	97.0	98.5	100.5	103.4	105.4	105.4	101.9	97.9	96.5	96.0	95.6	95.2	94.7	94.1	93.5	93.0
3150.00	94.2	95.7	97.6	100.5	102.4	102.4	98.9	95.0	93.7	93.3	93.1	92.8	92.5	91.7	90.8	90.1
4000.00	91.7	93.1	94.8	97.6	99.4	99.4	95.9	92.1	91.1	91.1	91.2	91.2	91.1	89.9	88.4	87.3
5000.00	97.8	99.2	99.5	100.1	100.0	98.9	95.9	93.6	94.1	95.3	96.8	97.6	97.7	95.8	92.5	89.6
6300.00	89.3	90.5	91.4	93.2	94.2	93.9	90.7	88.0	88.3	89.5	90.5	91.1	91.3	89.6	86.4	83.8
8000.00	89.2	90.3	90.8	91.9	92.1	91.5	88.6	86.9	88.0	89.6	90.9	91.7	91.9	90.0	86.4	83.2
10000.00	95.2	96.6	96.7	96.8	95.9	94.0	91.6	90.5	91.7	93.4	95.0	95.9	96.0	94.1	90.4	86.9

FAN NOISE MODULE

INPUT PARAMETERS

```
AE     =   .10000000E+01   RS     =   .10000000E+03   AFAN   =   .47336104E+01   DIAM   =   .24550000E+01
MD     =   .14460000E+01   RSS    =   .17000000E+01   MDOT   =   .15785590E+01   MA     =   .00000000E+00
N      =   .36058101E+00   DELTAT =   .14906740E+00   CA     =   .11354235E+04   RHOA   =   .22976323E-02
NBANDS =     0             METHOD =     2             NENG   =     1             NB     =    30
NV     =    61
IGV    =     1             DIS    =     1             IOUT   =     1             IPRINT =     3
INRS   =     T             INCT   =     T             INDIS  =     F             IDBB   =     T
IDRS   =     T             INBB   =     T             SCRNNN =     1             SCRXXX =    XXX
IUNITS =   ENGLISH         STIME  =   .00000000E+00
```

UNIT MEMBERS

```
SFIELD  (FREQ    ) IS ALTERNATE NAME OF SFIELD  (FREQ    )
HDNFAN  (XXX001  ) IS ALTERNATE NAME OF HDNFAN  (XXX001  )
SFIELD  (PHI     ) IS ALTERNATE NAME OF SFIELD  (PHI     )
SFIELD  (THETA   ) IS ALTERNATE NAME OF SFIELD  (THETA   )
```

FAN NOISE MODULE

NOISE DATA FROM MODULE HDNFAN

OBSERVER DISTANCE = 100.0 (FT) REFERENCE LENGTH = 2.176 (FT) POWER LEVEL = 139.0 DB
SOURCE TIME = .0000E+00

COMPUTED NOISE -INLET BROADBAND- INLET RS TONES- COMBINATION TONE NOISE-DISCH BROADBAND- DISCH RS TONES

****
* TABLE OF SOUND PRESSURE LEVEL VALUES (DECIBELS) *
****

AZIMUTH ANGLE = .00 DEGREES

1/3 OB CTR FREQ (HERTZ)	DIRECTIVITY ANGLE (DEGREES) 10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0
OVERALL	98.2	98.9	99.1	99.4	98.5	97.7	97.8	98.2	99.2	99.8	100.0	100.4	101.2	98.9	95.6	92.0
50.00	30.2	31.6	33.1	34.5	34.5	34.5	34.5	32.1	29.8	28.9	28.2	27.5	27.1	25.6	24.2	23.0
63.00	33.5	34.9	36.3	37.7	37.7	37.6	37.6	35.3	33.1	32.4	31.8	31.3	31.2	29.4	27.8	26.3
80.00	37.0	38.4	39.8	41.1	41.0	40.9	40.9	38.7	36.8	36.3	35.8	35.5	35.7	33.7	31.6	29.9
100.00	40.5	41.9	43.1	44.4	44.3	44.2	44.1	42.1	40.4	40.1	39.8	39.7	40.1	37.9	35.4	33.5
125.00	44.2	45.5	46.7	47.9	47.6	47.5	47.5	45.6	44.2	44.0	43.9	43.9	44.6	42.1	39.4	37.1
160.00	48.4	49.7	50.7	51.8	51.5	51.3	51.3	49.6	48.5	48.5	48.4	48.6	49.4	46.9	43.9	41.4
200.00	52.2	53.5	54.5	55.6	55.2	54.9	54.9	53.4	52.4	52.5	52.5	52.8	53.7	51.0	47.9	45.3
250.00	56.1	57.4	58.3	59.4	59.0	58.7	58.7	57.3	56.4	56.5	56.5	56.8	57.7	55.1	51.9	49.2
315.00	60.2	61.5	62.4	63.4	63.0	62.7	62.7	61.3	60.4	60.6	60.6	60.9	61.8	59.1	56.0	53.2
400.00	64.4	65.7	66.6	67.7	67.3	67.1	67.1	65.6	64.6	64.6	64.6	64.9	65.8	63.1	60.0	57.4
500.00	68.3	69.6	70.7	71.8	71.5	71.3	71.3	69.6	68.4	68.4	68.3	68.5	69.3	66.8	63.8	61.3
630.00	72.4	73.7	74.9	76.1	75.8	75.7	75.7	73.8	72.4	72.3	72.1	72.1	72.8	70.4	67.6	65.4
800.00	74.7	76.1	77.1	78.3	78.0	77.8	77.8	76.1	74.9	74.8	74.7	74.9	75.7	73.1	70.2	67.8
1000.00	78.1	79.5	80.6	81.8	81.6	81.4	81.4	79.6	78.2	78.0	77.8	77.9	78.6	76.1	73.4	71.1
1250.00	82.0	83.4	84.7	86.0	85.8	85.7	85.7	83.7	81.9	81.5	81.2	81.1	81.5	79.3	76.9	75.0
1600.00	80.9	82.2	83.1	84.1	83.6	83.4	83.3	82.0	81.2	81.4	81.5	81.8	82.7	80.1	76.8	74.0
2000.00	82.2	83.4	84.2	85.1	84.5	84.1	84.1	83.1	82.6	82.9	83.0	83.4	84.5	81.7	78.3	75.3
2500.00	84.1	85.4	86.2	87.2	86.7	86.3	86.3	85.1	84.5	84.7	84.8	85.2	86.2	83.5	80.1	77.2
3150.00	84.4	85.6	86.1	86.9	86.1	85.5	85.5	85.0	85.0	85.5	85.7	86.2	87.4	84.5	80.9	77.6
4000.00	84.9	86.0	86.4	86.9	85.8	85.1	85.0	85.2	85.6	86.3	86.7	87.3	88.5	85.5	81.8	78.2
5000.00	92.0	92.3	92.4	92.5	92.0	91.3	91.5	91.9	93.2	93.9	93.9	94.0	94.3	92.8	90.0	86.4
6300.00	85.9	86.9	87.1	87.3	85.9	84.8	84.8	85.9	86.8	87.6	88.0	88.6	89.9	86.9	83.0	79.2
8000.00	86.1	87.2	87.3	87.5	86.0	84.8	84.7	86.1	87.1	87.9	88.3	89.0	90.3	87.3	83.4	79.5
10000.00	87.5	88.3	88.4	88.5	87.3	86.2	86.2	87.4	88.6	89.4	89.7	90.2	91.2	88.6	85.1	81.3

APPENDIX IX

SMALL ENGINE REVISION USER'S MANUAL
AND
ANOPP CODE DEVELOPMENT

The small engine revision routine discussed in this report can be accessed in ANOPP through the USER PARAMETERS data input as shown in the attached data input section. Under USER PARAMETERS_METHOD:

'1' provides the original Heidman method

whereas,

'2' provides the AlliedSignal Small Engine Method.

The specific changes used in the small engine method have been provided in Appendix I. An electronic version of the coded changes will be provided to NASA following approval of the proposed small engine revision module.

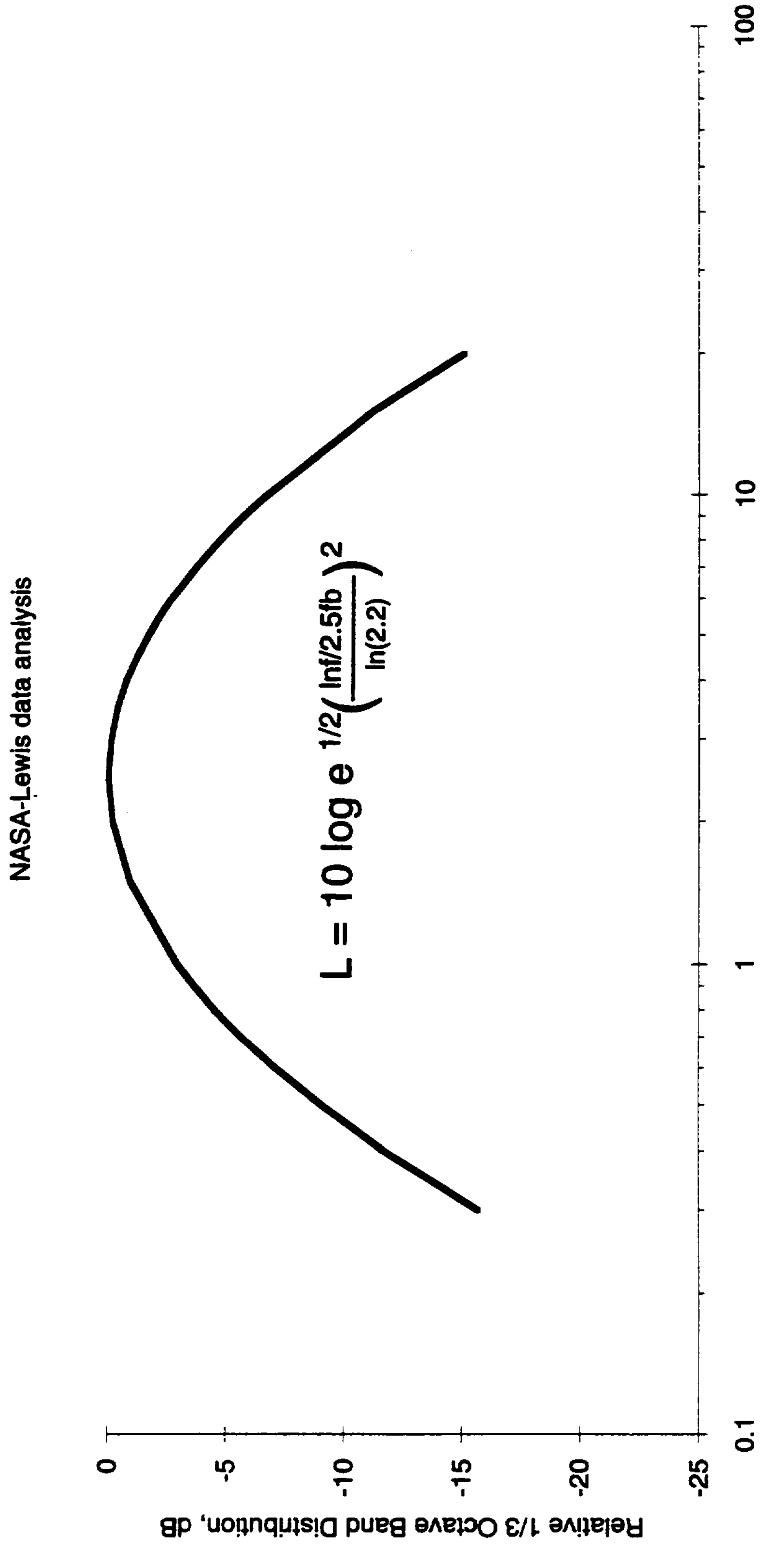
```
***
*       PURPOSE - PREDICT THE BROADBAND NOISE AND PURE TONES FOR AN
*                 AXIAL FLOW COMPRESSOR OR FAN BY THE HEIDMAN METHOD
*                 REFERENCE - NASA TM X-71763, INTERIM PREDICTION
*                 METHOD FOR FAN AND COMPRESSOR SOURCE NOISE, M. F.
*                 HEIDMAN
*
*       AUTHOR  - CBF(L03/00/00)
*               - DSW(         )
*       INPUT
*         USER PARAMETERS
*           AE       -  ENGINE REFERENCE AREA (RS), M**2 (FT**2)
*           RS       -  DISTANCE FROM SOURCE TO OBSERVER (RS), M (FT)
*           AFAN     -  FAN INLET CROSS-SECTIONAL AREA (RS), RE AE
*           DIAM     -  FAN ROTOR DIAMETER (RS), RE SQRT(AE)
*           MD       -  FAN ROTOR RELATIVE TIP MACH NUMBER AT DESIGN
*                       POINT (RS)
*           RSS      -  ROTOR-STATOR SPACING (RS), RE MEAN ROTOR BLADE
*                       CHORD
*           MDOT     -  MASS FLOWRATE (RS), RE RHOA * CA * AE
*           MA       -  AIRCRAFT MACH NUMBER (RS)
*           N        -  ROTATIONAL SPEED (RS), RE CA/DIAM
*           DELTAT   -  TOTAL TEMPERATURE RISE ACROSS FAN (RS), RE TA
*           CA       -  AMBIENT SPEED OF SOUND (RS), M/S (FT/S)
*           RHOA     -  AMBIENT DENSITY (RS), KG/M**3 (SLUG/FT**3)
*           METHOD   -  PREDICTION METHOD FLAG
*                        1, ORIGINAL HEIDMAN METHOD
*                        2, ALLIEDSIGNAL SMALL ENGINE METHOD
*           NBANDS   -  NUMBER OF 1/3 OCTAVE BANDS FOR TONE FREQUENCY
*                       SHIFT (I)
*           NENG     -  NUMBER OF ENGINES (I)
*           NB       -  NUMBER OF ROTOR BLADES (I)
*           NV       -  NUMBER OF STATOR VANES (I)
*           IGV      -  INLET GUIDE VANE INDEX (I)
*                        1,  FOR A FAN WITH NO INLET GUIDE VANES
*                        2,  FOR A FAN WITH INLET GUIDE VANES
*           DIS      -  INLET FLOW DISTORTION INDEX (I)
*                        1,  IF THERE IS NO INLET FLOW DISTORTION
*                        2,  IF THERE IS INLET FLOW DISTORTION
*           STIME    -  SOURCE TIME (RS)
*           IOUT     -  TABLE OUTPUT AND PRINT OUTPUT OPTION (I)
*                        0  NO PRINT BUT GENERATE TABLE HDNFAN(XXXNNN)
*                       -1  PRINT OUTPUT IN DB UNITS, BUT DO NOT
*                           GENERATE TABLE HDNFAN(XXXNNN)
*                       -2  PRINT OUTPUT IN DIMENSIONLESS FORM BUT DO
*                           NOT GENERATE TABLE HDNFAN (XXXNNN)
*                       -3  BOTH OPTIONS -1 AND -2
*                        1  PRINT OUTPUT IN DB UNITS AND GENERATE TABLE
*                           HDNFAN(XXXNNN)
*                        2  PRINT OUTPUT IN DIMENSIONLESS FORM AND
*                           GENERATE TABLE HDNFAN(XXXNNN)
*                        3  BOTH OPTIONS 1 AND 2
*           IPRINT   -  PRINT FLAG (I)
*                        0  NO PRINT DESIRED
*                        1  INPUT PRINT ONLY
*                        2  OUTPUT PRINT ONLY
*                        3  BOTH INPUT AND OUTPUT PRINT
*           SCRNNN   -  INTEGER VALUE, NNN, .GT. 0 USED TO FORM TABLE
*                       UNIT MEMBER NAME HDNFAN(XXXNNN)
*           SCRXXX   -  THREE LETTER CODE XXX USED TO FORM TABLE UNIT
*                       MEMBER NAME HDNFAN(XXXNNN)
*           IUNITS   -  INPUT UNITS FLAG
*                       7HENGLISH, ENGLISH UNITS
*                       2HSI,      SI UNITS
```

```
*          (THE NEXT SIX CODES HAVE THE FOLLOWING VALUES)
*          (.FALSE.    -  DO NOT INCLUDE                 )
*          (.TRUE.     -  INCLUDE IN TOTAL PREDICTION    )
*          INRS       INLET ROTOR-STATOR INTERACTION TONES
*          INCT       COMBINATION TONE NOISE
*          INDIS      INLET FLOW DISTORTION TONES
*          IDBB       DISCHARGE BROADBAND NOISE
*          IDRS       DISCHARGE ROTOR-STATOR INTERACTION TONES
*          INBB       INLET BROADBAND NOISE
*
*        REAL USER PARAMETER LIMITS - SI UNITS
*          PARAMETER     MINIMUM             MAXIMUM          DEFAULT
*            AE           0.01                 50.0           0.785398
*            RS           0.01                100.0           0.886227
*            AFAN          0.1                 10.0                1.0
*            DIAM          0.3                  4.0              1.128
*            MD            0.5                  2.0                1.0
*            RSS           0.2                 10.0                1.0
*            MDOT          0.0                 10.0                0.2
*            MA            0.0                  0.9                0.0
*            N             0.0                  0.5                0.3
*            DELTAT        0.0                  1.3                0.2
*            CA            0.0                400.0            340.294
*            RHOA          0.0                  1.5              1.225
*            STIME      -100.0                500.0                0.0
*
*        REAL USER PARAMETER LIMITS - ENGLISH UNITS
*          PARAMETER     MINIMUM             MAXIMUM          DEFAULT
*            AE         0.1076                500.0              8.454
*            RS        0.03281              328.084              2.908
*            AFAN          0.1                 10.0                1.0
*            DIAM          0.3                  4.0              1.128
*            MD            0.5                  2.0                1.0
*            RSS           0.2                 10.0                1.0
*            MDOT          0.0                 10.0                0.2
*            MA            0.0                  0.9                0.0
*            N             0.0                  0.5                0.3
*            DELTAT        0.0                  1.3                0.2
*            CA            0.0             1312.336            1116.45
*            RHOA          0.0            0.0029105          0.0023769
*            STIME      -100.0                500.0                0.0
*
*        INTEGER/LOGICAL/ALPHA PARAMETER LIMITS
*          PARAMETER     MINIMUM             MAXIMUM          DEFAULT
*            METHOD          1                    2                  1
*            DIS             1                    2                  1
*            IGV             1                    2                  1
*            IOUT           -3                    3                  3
*            IPRINT          0                    3                  3
*            NB              2                  100                 20
*            NBANDS         -3                    3                  0
*            NENG            1                    6                  1
*            NV             10                  200                 50
*            SCRNNN        001                  999                001
*            INRS                                               .TRUE.
*            INCT                                               .TRUE.
*            INDIS                                              .TRUE.
*            IDBB                                               .TRUE.
*            IDRS                                               .TRUE.
*            INBB                                               .TRUE.
*            SCRXXX                                              3HXXX
*            IUNITS                                               2HSI
*
*
```

```
DATA BASE UNIT MEMBERS
*            (DESCRIBED UNDER DATA BASE STRUCTURES)
*            SFIELD(FREQ)
*            SFIELD(THETA)
*            SFIELD(PHI)
*
*        OUTPUT
*          USER PARAMETERS
*            RS          DISTANCE FROM SOURCE TO OBSERVER
*
*          SYSTEM PARAMETERS
*            NERR        .TRUE., IMPLIES AN ERROR WAS ENCOUNTERED
*                        DURING MODULE EXECUTION
*                        .FALSE., NO ERROR ENCOUNTERED
*
*          DATA BASE UNIT MEMBERS
*            HDNFAN(XXXNNN)  SEE FORMAT UNDER DATA BASE STRUCTURES.
*                            NOTE MEMBER NAME XXXNNN IS FORMED
*                            FROM USER PARAMETERS SCRXXX AND SCRNNN.
*                            OUTPUT OF THIS TABLE IS CONTROLLED
*                            BY USER PARAMETER IOUT.
*
*        DATA BASE STRUCTURES
*          SFIELD(FREQ)     - 1 RECORD MEMBER IN *RS FORMAT
*                            CONTAINING VALUES OF 1/3 OCTAVE BAND
*                            CENTER FREQUENCIES IN HZ
*          SFIELD(THETA)    - 1 RECORD MEMBER IN *RS FORMAT
*                            CONTAINING VALUES OF THE POLAR
*                            DIRECTIVITY ANGLE IN DEG
*          SFIELD(PHI)      - 1 RECORD MEMBER IN *RS FORMAT
*                            CONTAINING VALUES OF THE AZIMUTHAL
*                            DIRECTIVITY ANGLE IN DEG
*          HDNFAN(XXXNNN)   - TYPE 1 TABLE CONTAINING MEAN SQUARE
*                            ACOUSTIC PRESSURE AS A FUNCTION OF
*                            (1) FREQUENCY, (2) DIRECTIVITY ANGLE
*                            AND (3) AZIMUTHAL ANGLE
*
*        ERRORS
*          NON-FATAL
*            1.  INSUFFICIENT LOCAL DYNAMIC STORAGE.
*            2.  MEMBER MANAGER ERROR OCCURRED ON SPECIFIED UNIT
*                MEMBER.
*          FATAL - NONE
*
*        REMARKS
*          REFERENCES
*            HEIDMAN, M. F., INTERIM PREDICTION METHOD FOR FAN
*                AND COMPRESSOR SOURCE NOISE, NASA TM X-71763,
*                JUNE 1975.
*            HOUGH, J. AND WEIR, D., ANOPP FAN NOISE PREDICTION FOR
*                SMALL ENGINES, ALLIEDSIGNAL ENGINES REPORT 21-8700,
*                JANUARY 1995.
*
*        LDS REQUIREMENTS
*          LENGTH = (NFREQ * NTHETA * NPHI) + (NTHETA * NPHI)
*                   + NFREQ + NTHETA + NPHI + 3 * ( NFREQ * NTHETA )
*                   + NTHETA
*              WHERE
*                NFREQ  = NUMBER OF FREQUENCY VALUES
*                NTHETA = NUMBER OF DIRECTIVITY ANGLES
*                NPHI   = NUMBER OF AZIMUTHAL ANGLES
*
*        GDS REQUIREMENTS
*          SUFFICIENT ALLOCATION FOR TABLE HDNFAN(XXXNNN)
***
```

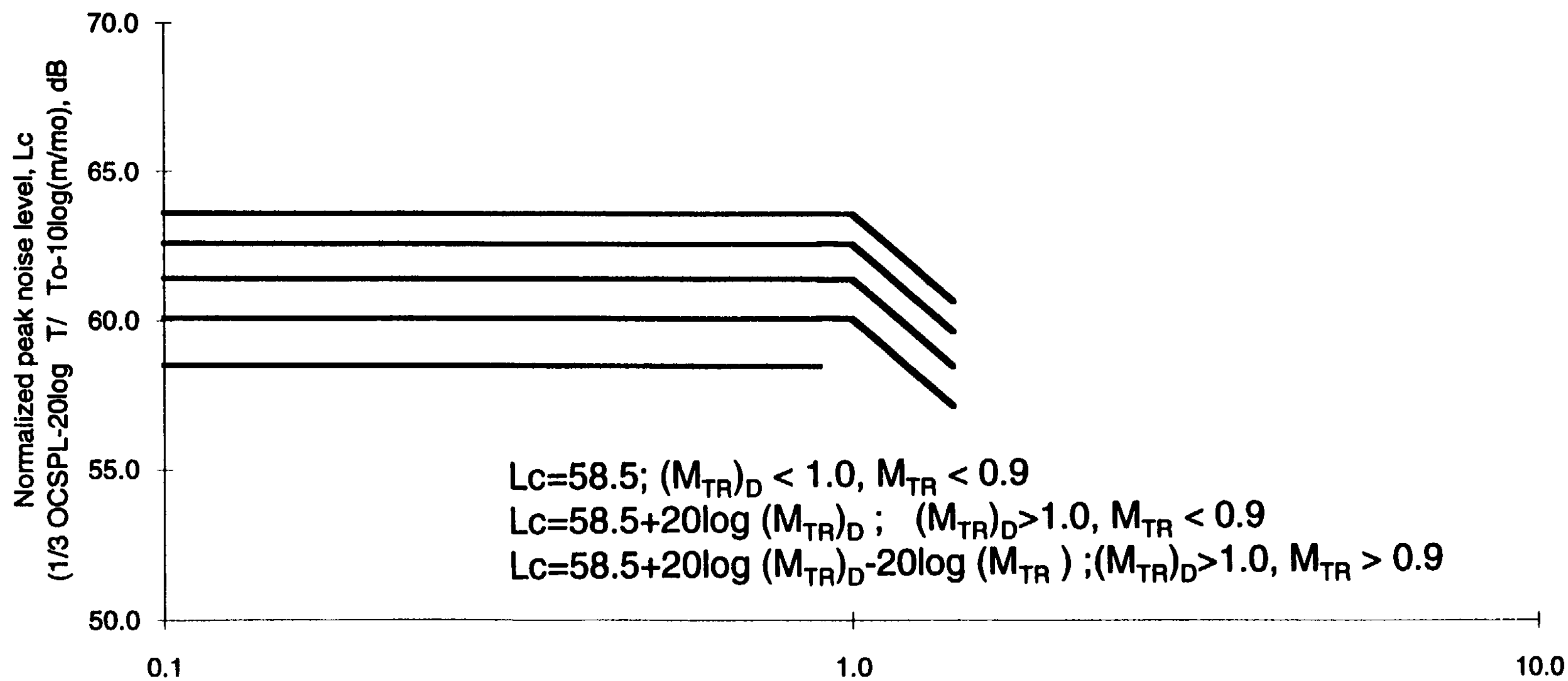
APPENDIX X

INTERIM PREDICTION METHOD FOR FAN AND COMPRESSOR SOURCE NOISE[1] (FIGURES) AND AIRCRAFT NOISE PREDICTION PROGRAM THEORETICAL MANUAL[2] (TABLES)

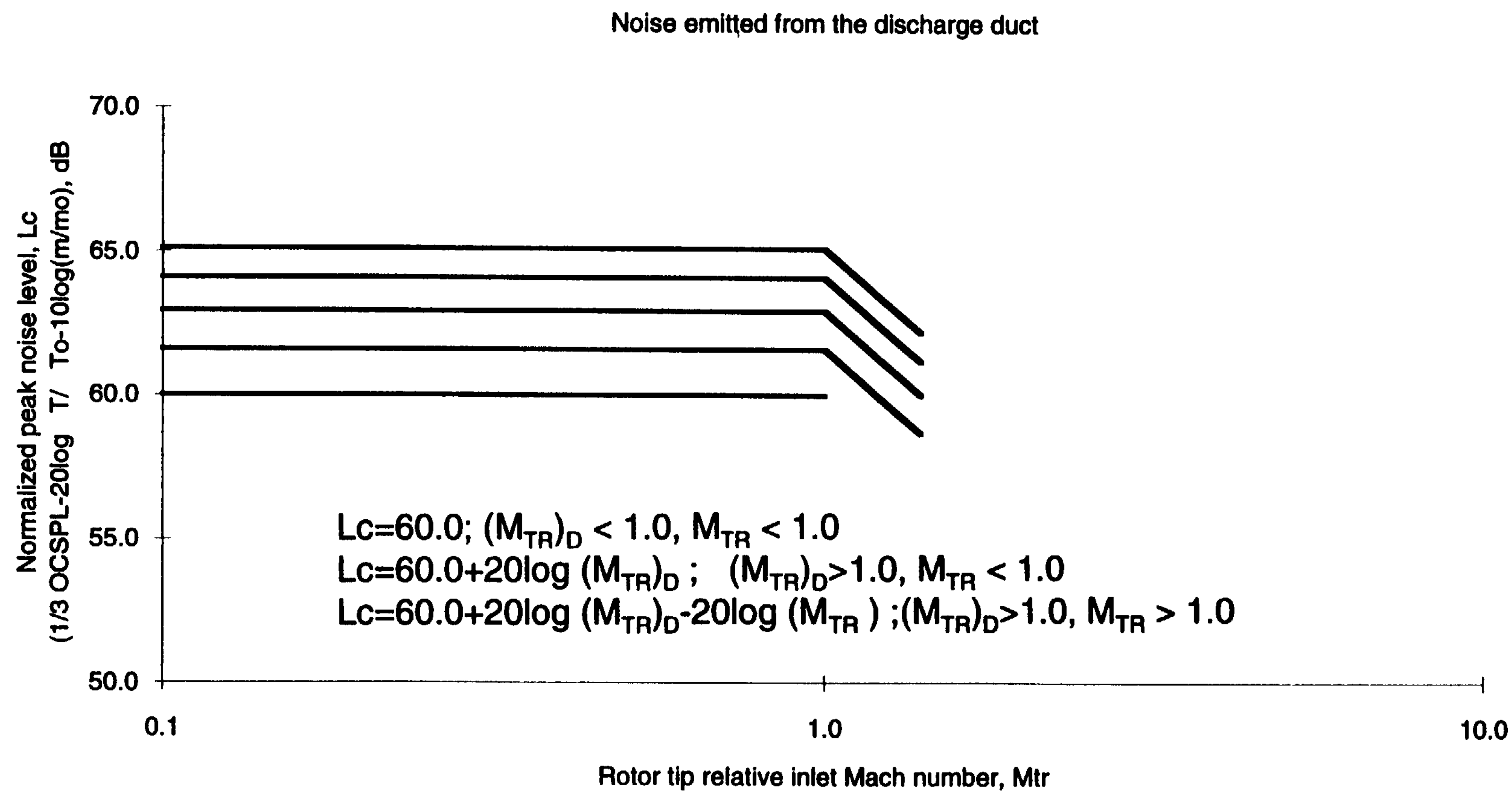


NASA-Lewis data analysis
$L = 10 \log e^{1/2\left(\frac{\ln f/2.5fb}{\ln(2.2)}\right)^2}$
Relative 1/3 Octave Band Distribution, dB
0
-5
-10
-15
-20
-25
0.1
1
10
100
Dimensionless frequency, f/fb

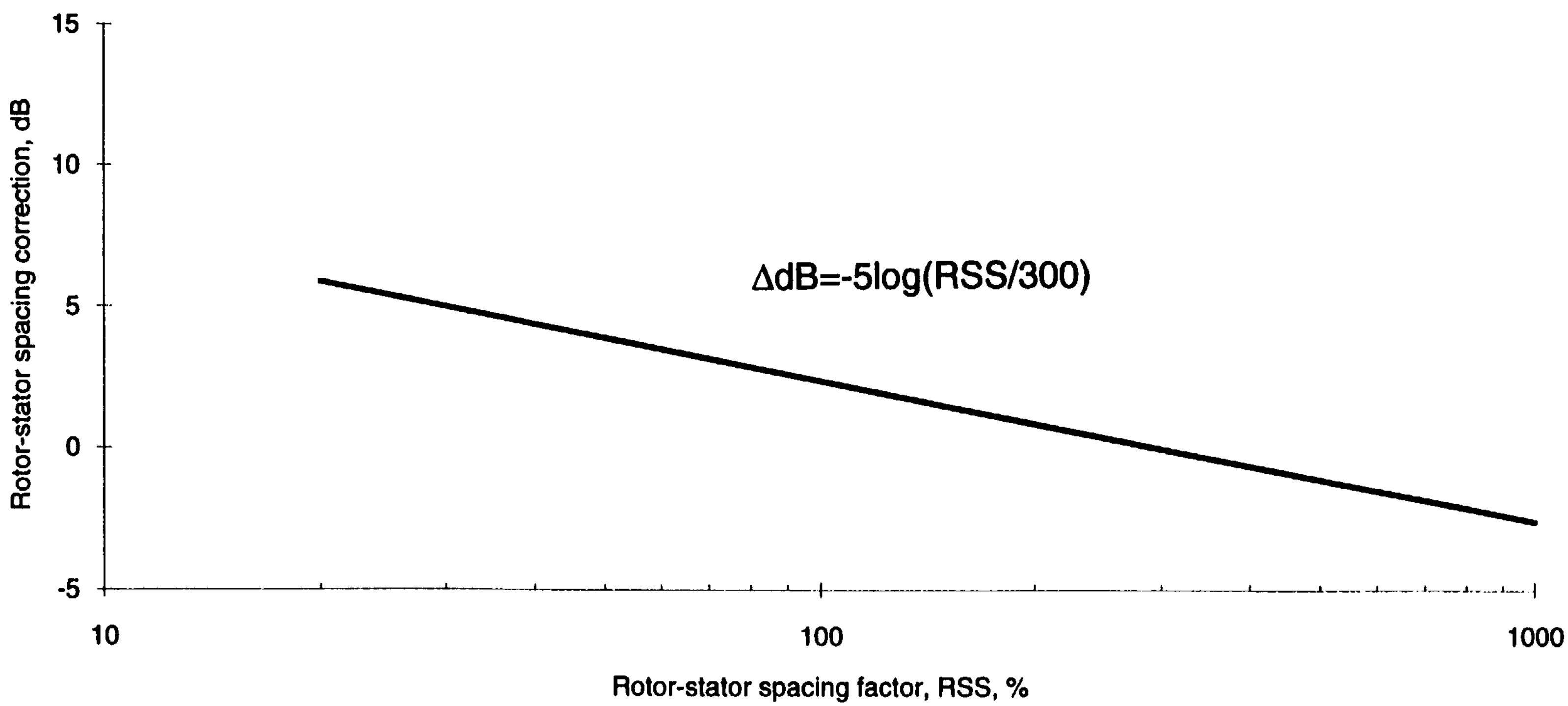
Noise emitted from the inlet duct

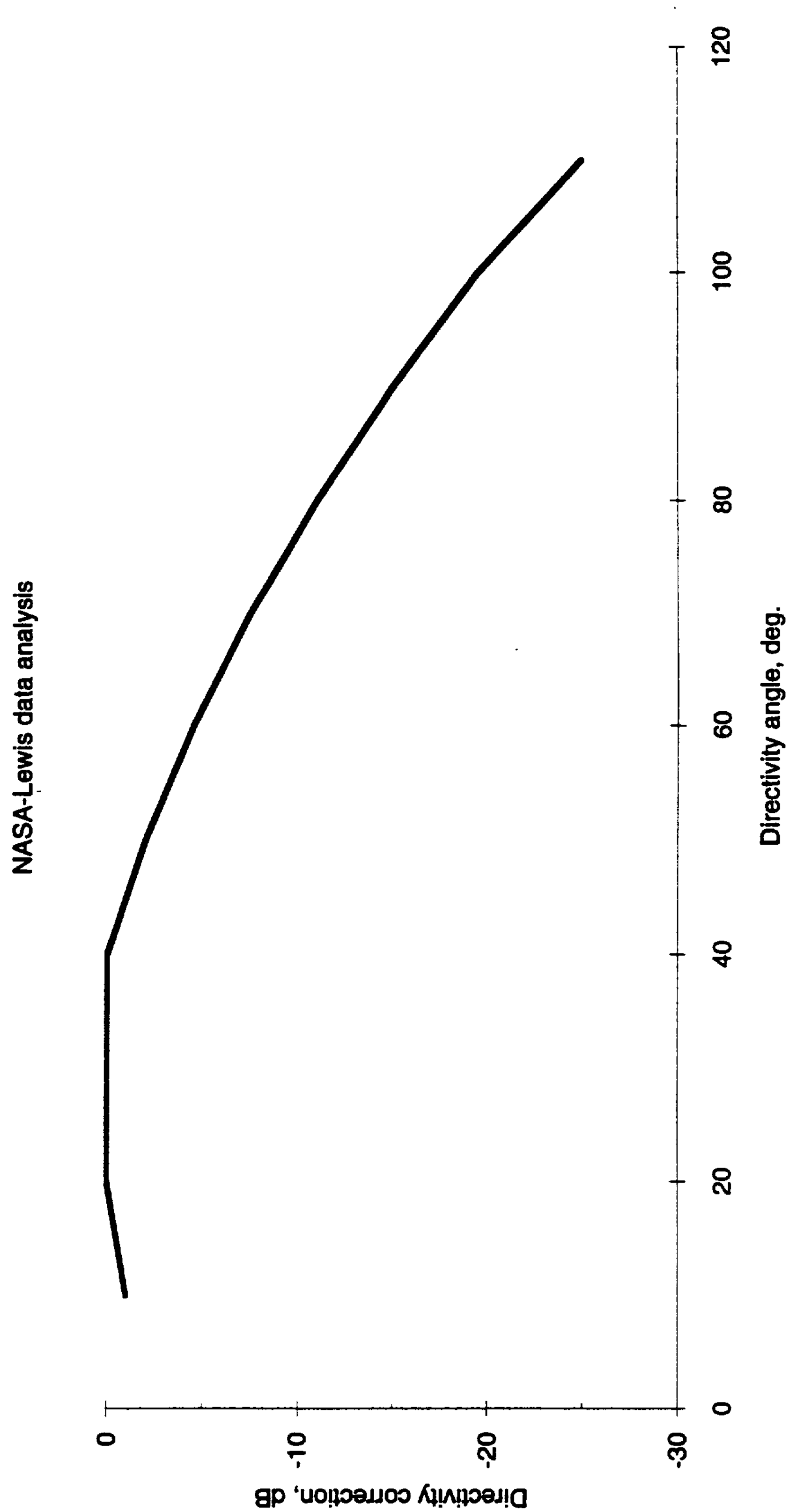


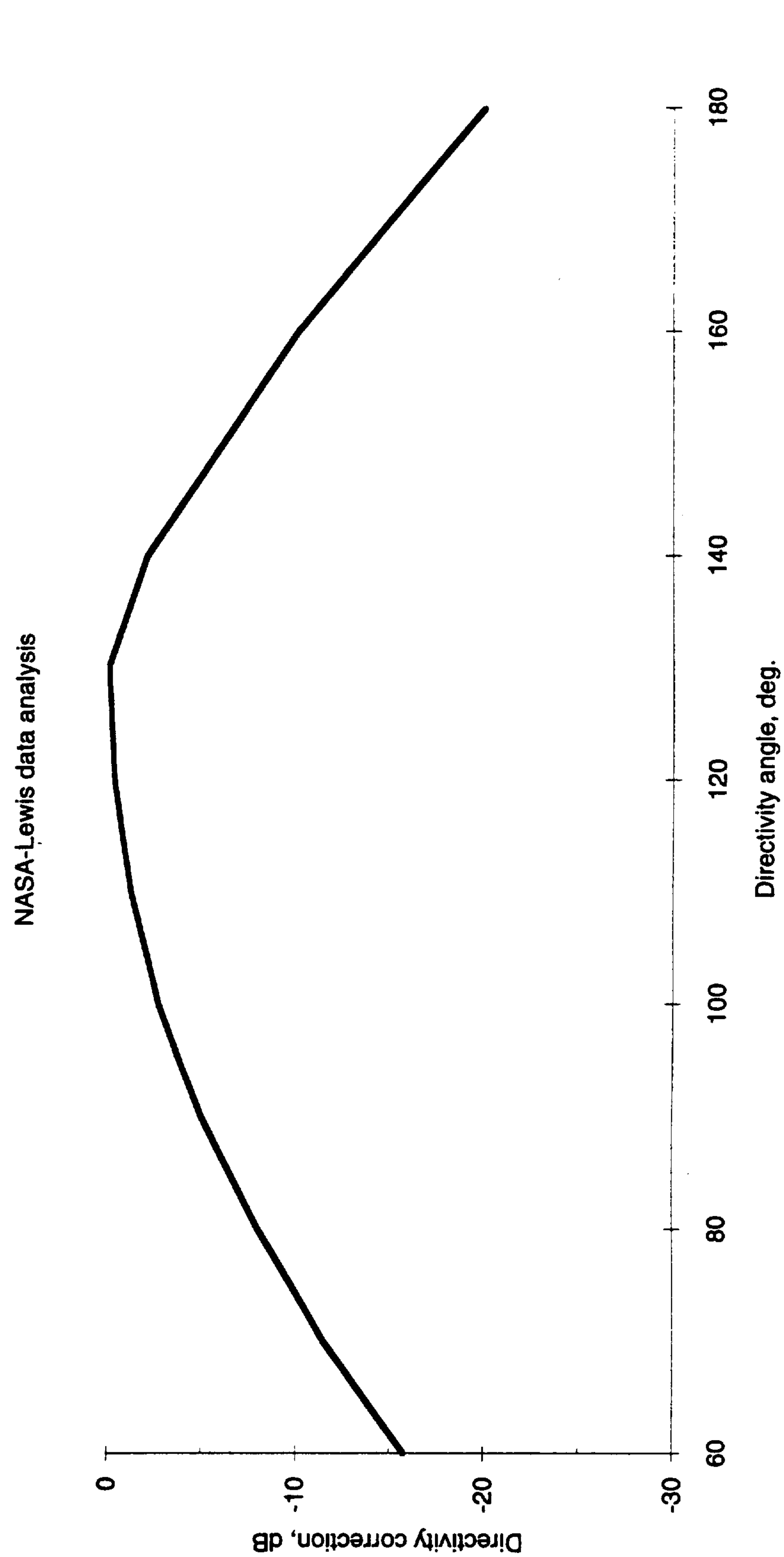
Rotor tip relative inlet Mach number, Mtr


Noise emitted from the discharge duct
Normalized peak noise level, Lc
(1/3 OCSPL-20log T/ To-10log(m/mo), dB
70.0
65.0
60.0
55.0
50.0
0.1
1.0
10.0
Rotor tip relative inlet Mach number, Mtr
Lc=60.0; $(M_{TR})_D < 1.0$, $M_{TR} < 1.0$
Lc=60.0+20log $(M_{TR})_D$; $(M_{TR})_D>1.0$, $M_{TR} < 1.0$
Lc=60.0+20log $(M_{TR})_D$-20log (M_{TR}) ;$(M_{TR})_D>1.0$, $M_{TR} > 1.0$

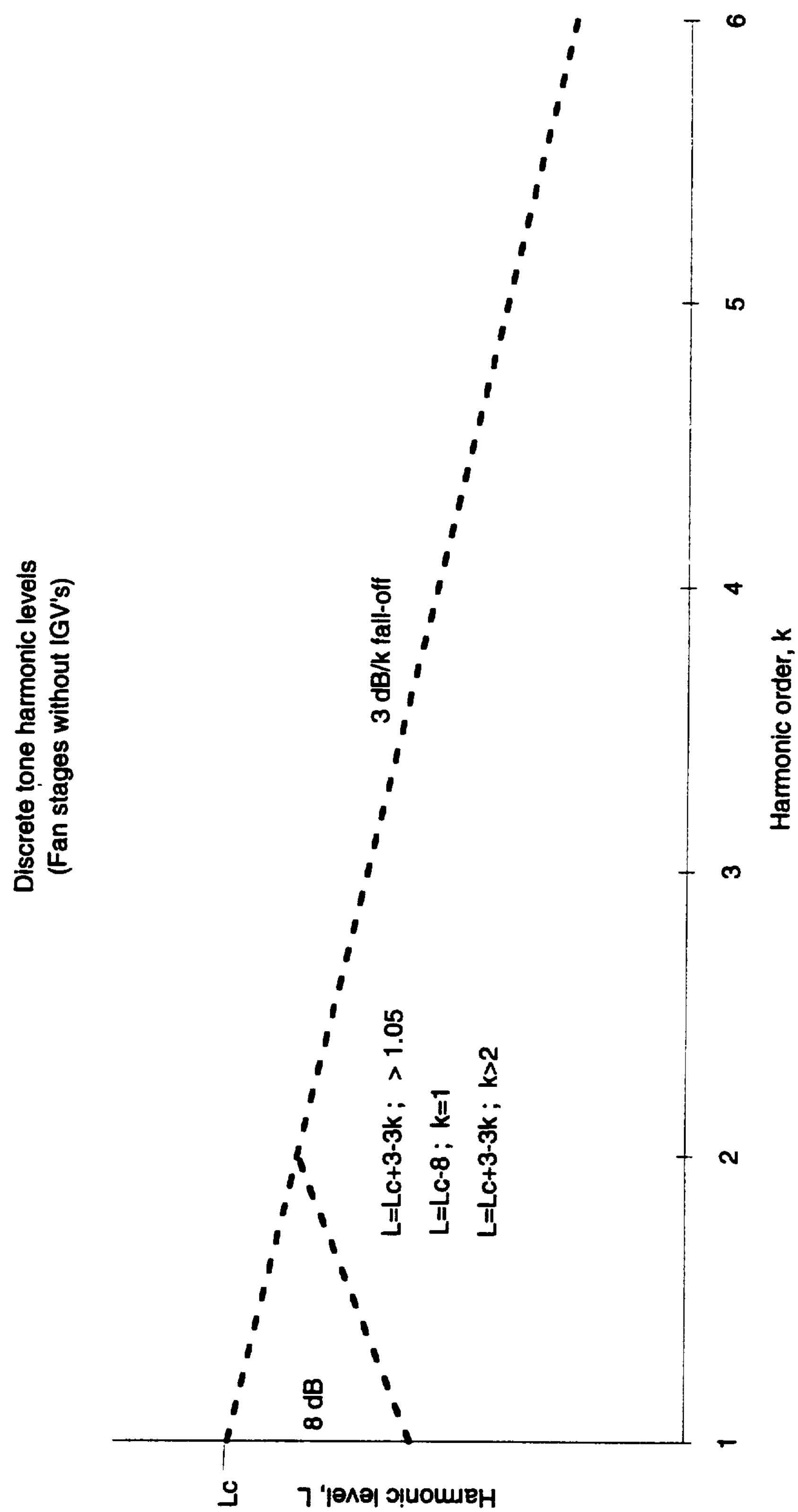
Correction for broadband noise
(Without inlet flow distortions)

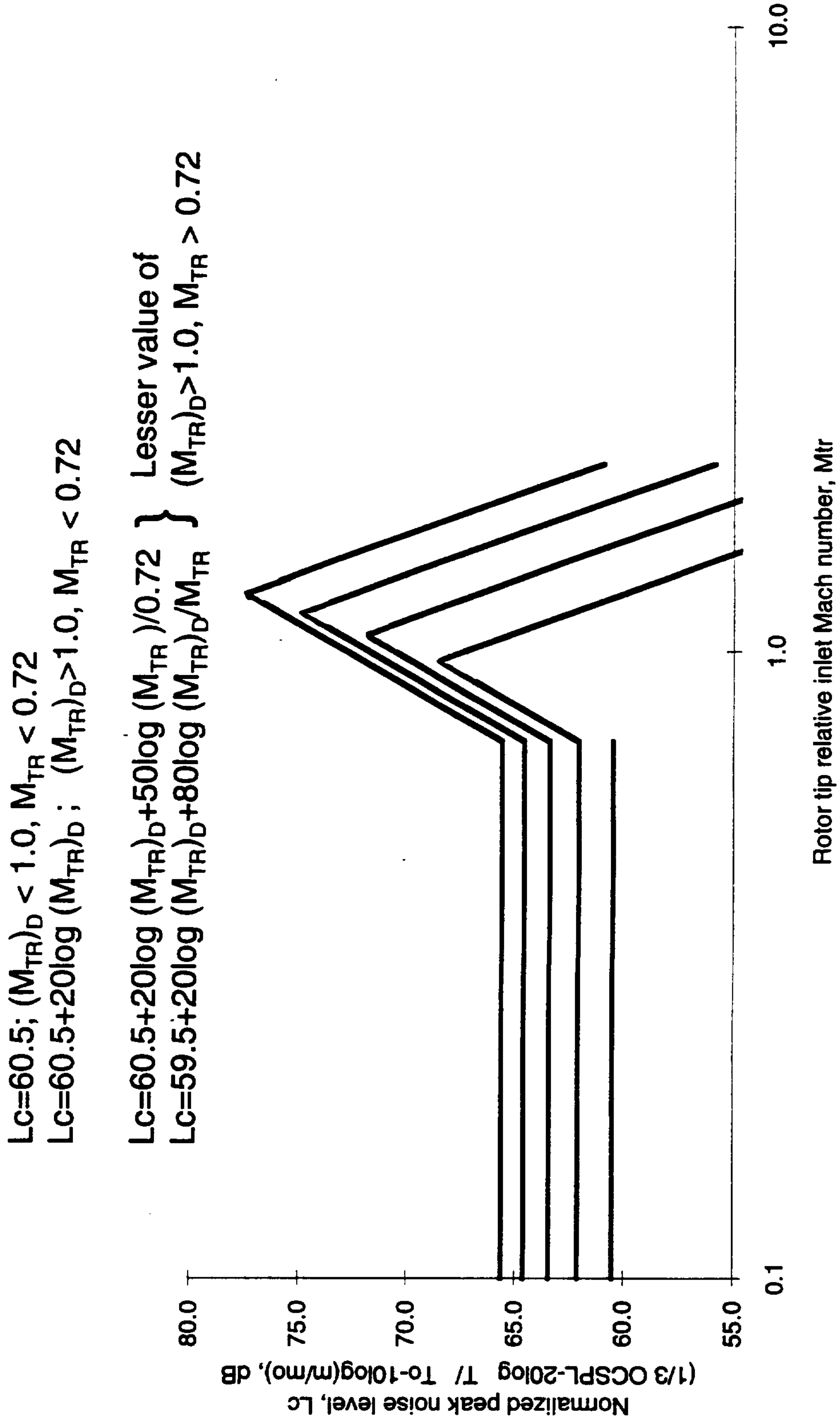


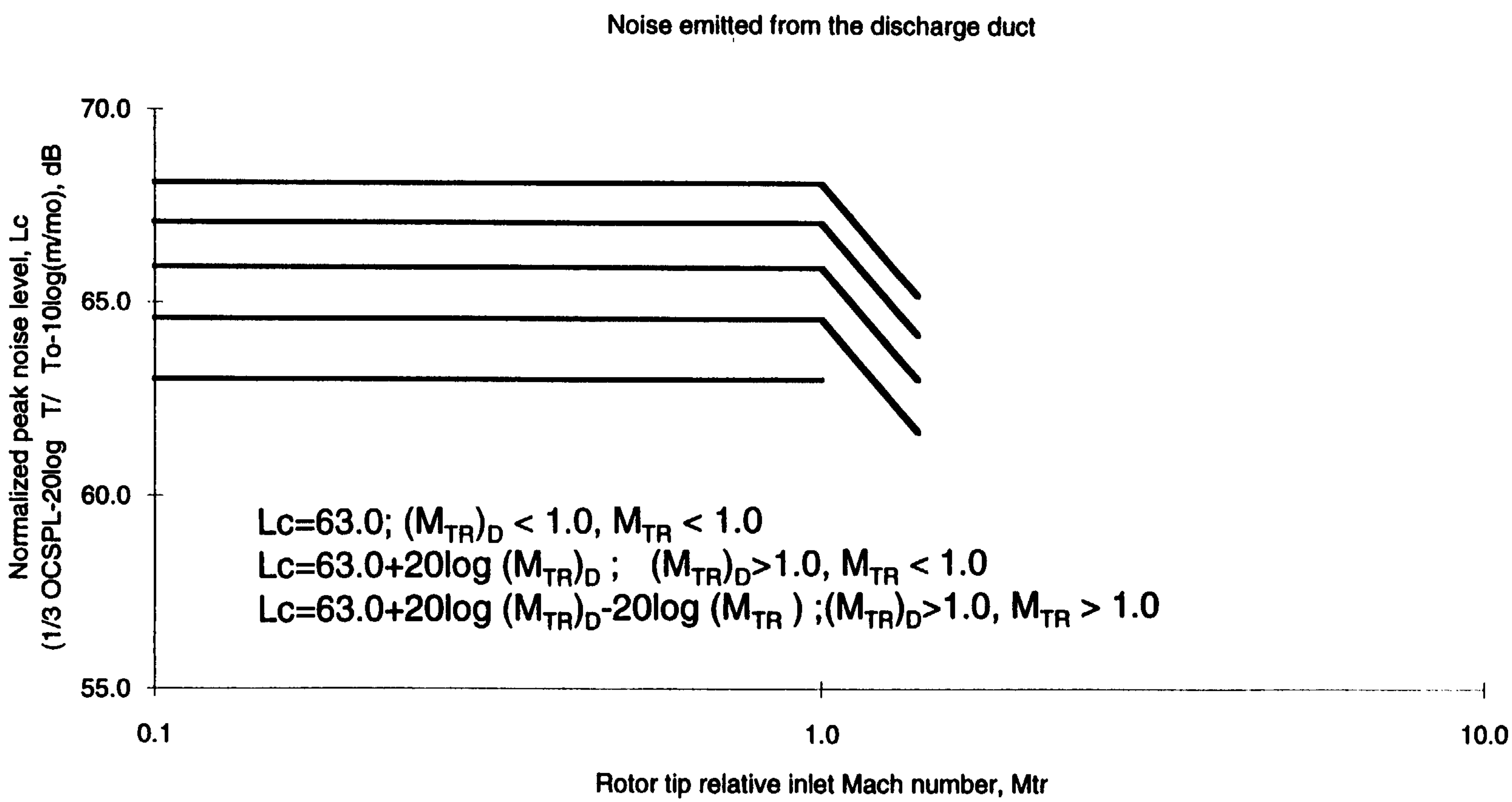

NASA-Lewis data analysis
Directivity correction, dB
Directivity angle, deg.
0
-10
-20
-30
0
20
40
60
80
100
120



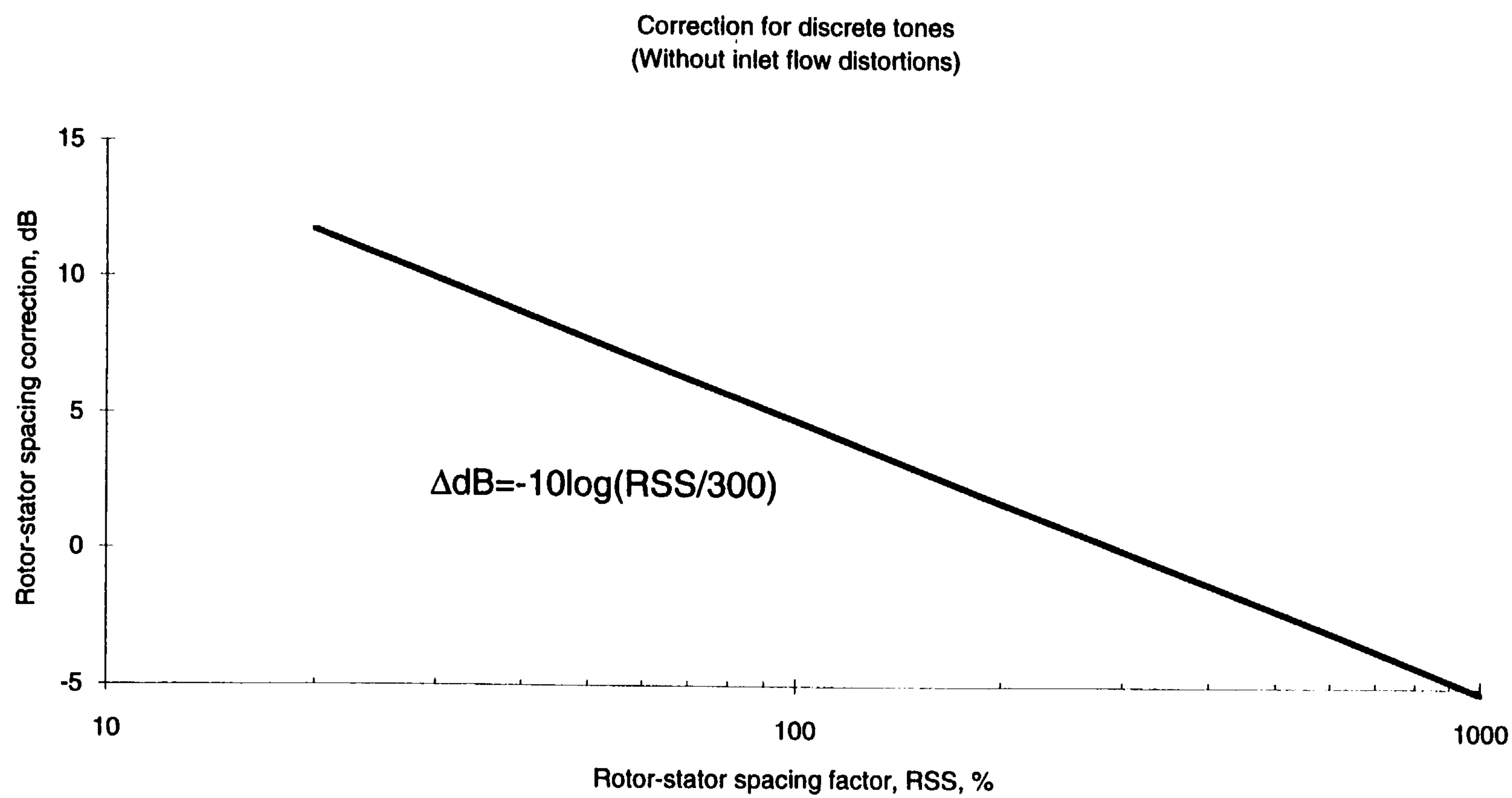
NASA-Lewis data analysis
Directivity correction, dB
0
-10
-20
-30
60
80
100
120
140
160
180
Directivity angle, deg.

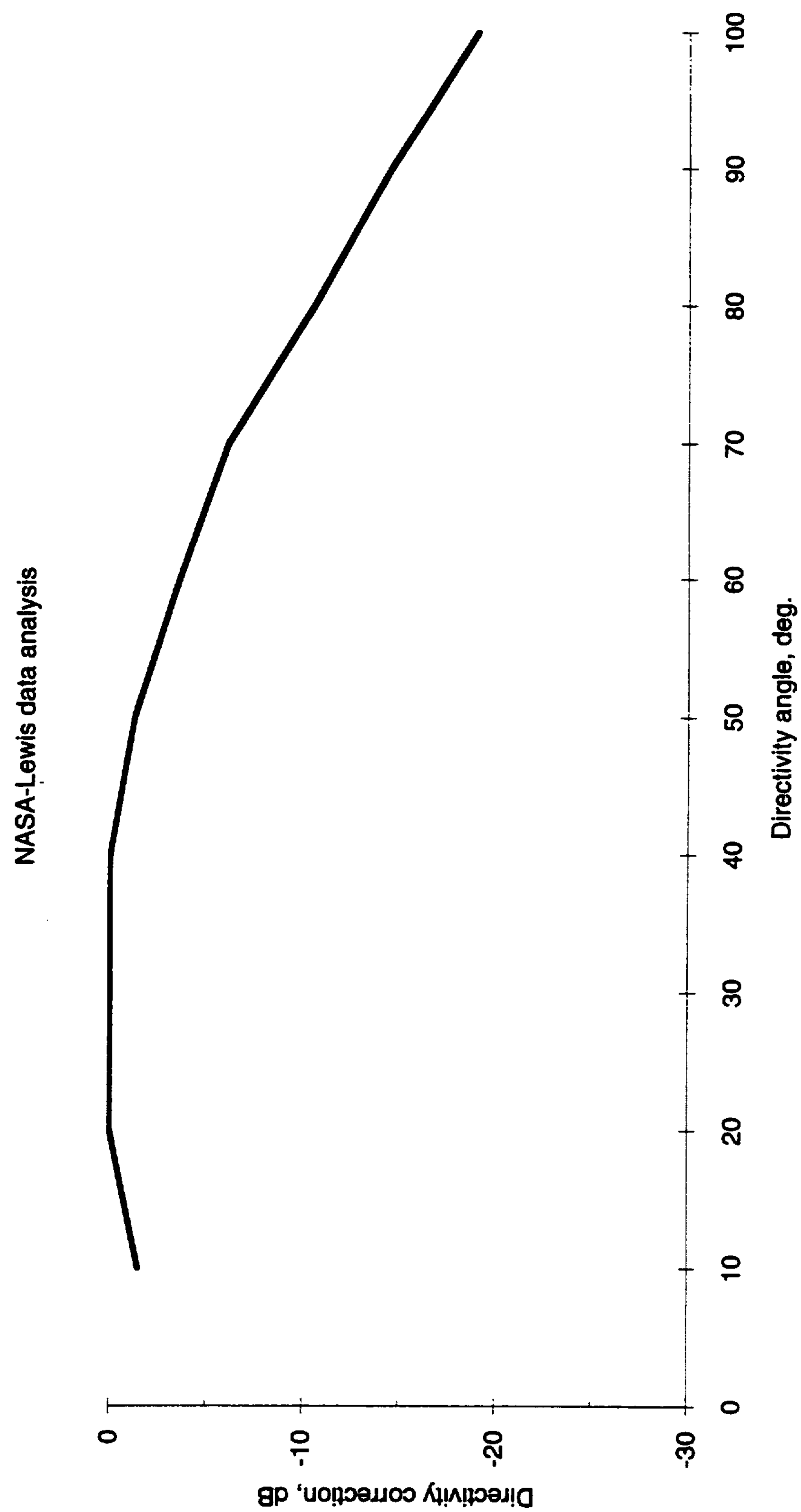

Discrete tone harmonic levels
(Fan stages without IGV's)
3 dB/k fall-off
8 dB
L=Lc+3-3k ; > 1.05
L=Lc-8 ; k=1
L=Lc+3-3k ; k>2
Lc
Harmonic level, L
1
2
3
4
5
6
Harmonic order, k

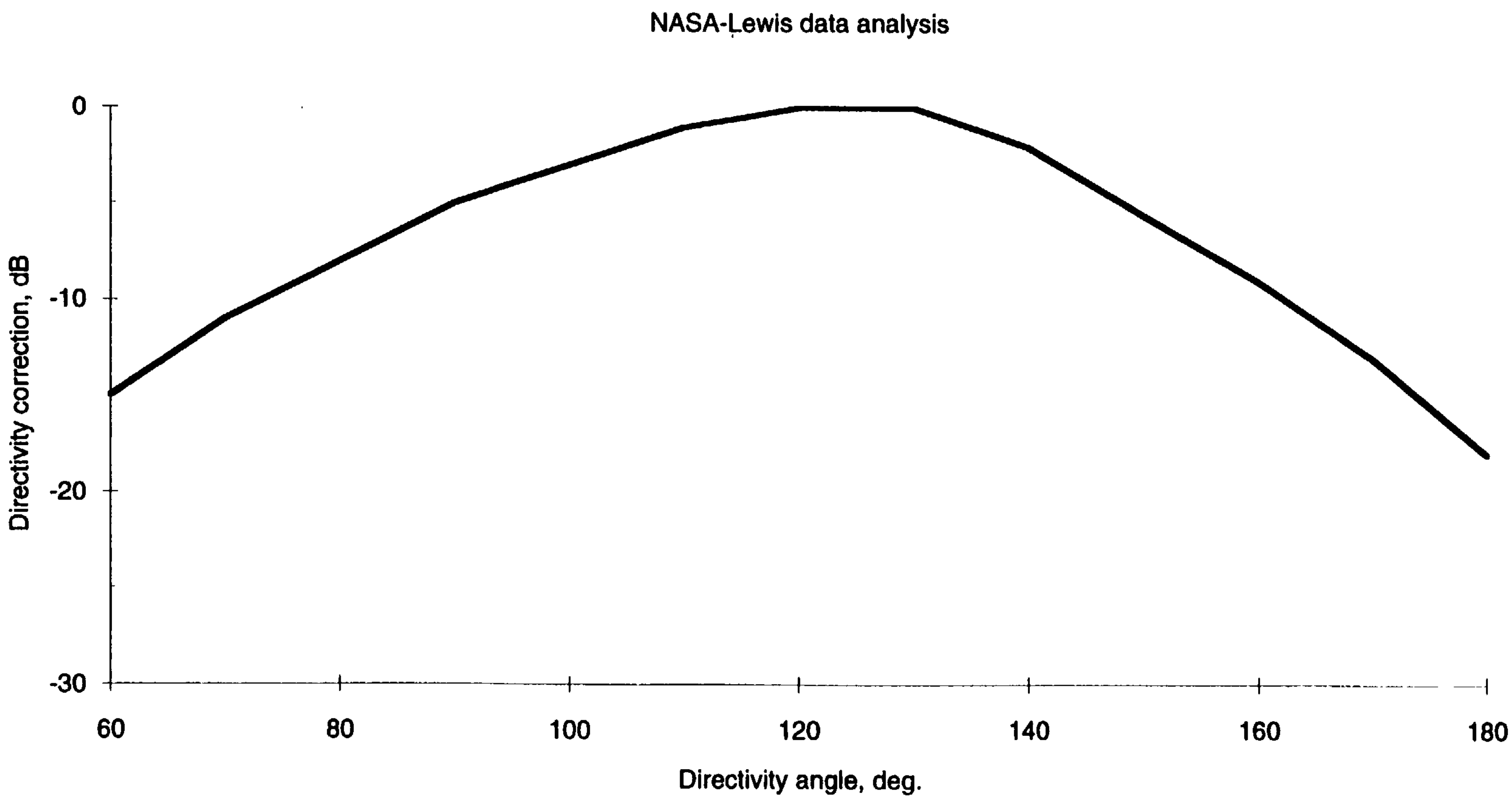

Lc=60.5; (MTR)D < 1.0, MTR < 0.72
Lc=60.5+20log (MTR)D ; (MTR)D>1.0, MTR < 0.72
Lc=60.5+20log (MTR)D+50log (MTR)/0.72
Lc=59.5+20log (MTR)D+80log (MTR)D/MTR
Lesser value of
(MTR)D>1.0, MTR > 0.72
Normalized peak noise level, Lc
(1/3 OCSPL-20log T/ To-10log(m/mo), dB
80.0
75.0
70.0
65.0
60.0
55.0
0.1
1.0
10.0
Rotor tip relative inlet Mach number, Mtr

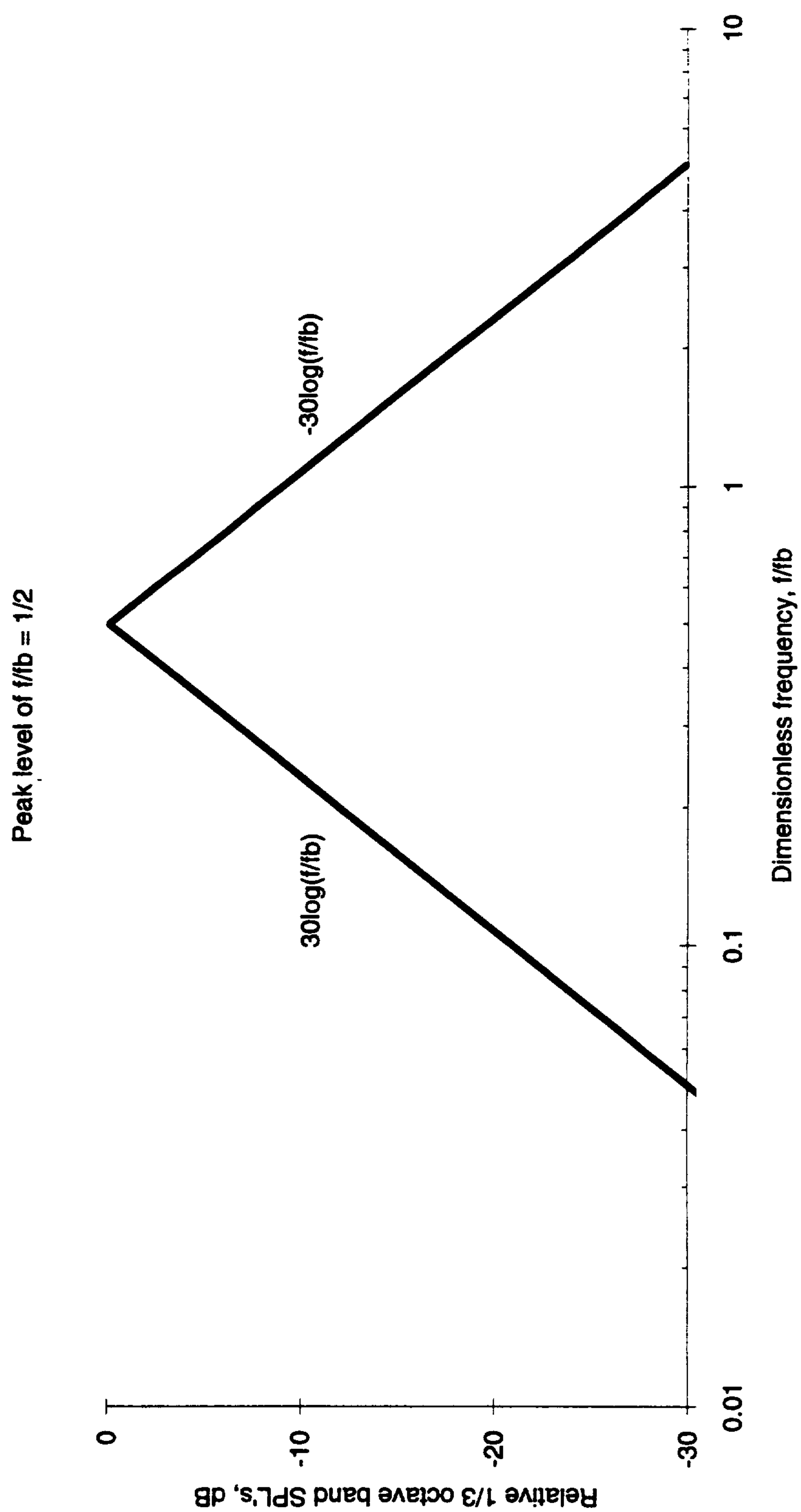


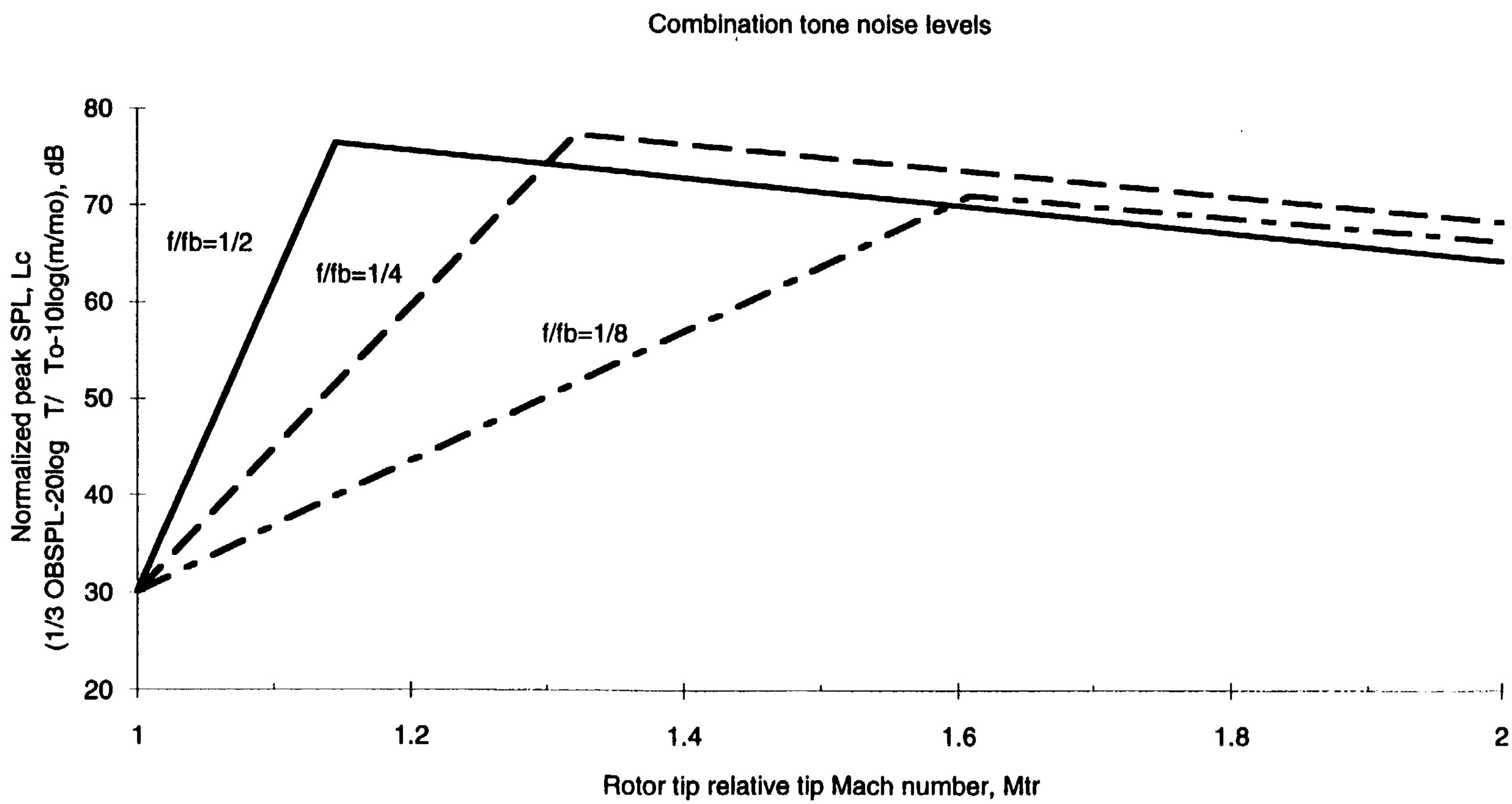
Noise emitted from the discharge duct
Normalized peak noise level, Lc
(1/3 OCSPL-20log T/ To-10log(m/mo), dB
70.0
65.0
60.0
55.0
0.1
1.0
10.0
Rotor tip relative inlet Mach number, Mtr
Lc=63.0; (M_TR)_D < 1.0, M_TR < 1.0
Lc=63.0+20log (M_TR)_D ; (M_TR)_D>1.0, M_TR < 1.0
Lc=63.0+20log (M_TR)_D-20log (M_TR) ;(M_TR)_D>1.0, M_TR > 1.0


Correction for discrete tones
(Without inlet flow distortions)
15
10
5
0
-5
Rotor-stator spacing correction, dB
ΔdB=-10log(RSS/300)
10
100
1000
Rotor-stator spacing factor, RSS, %


NASA-Lewis data analysis
Directivity correction, dB
0
-10
-20
-30
Directivity angle, deg.
0
10
20
30
40
50
60
70
80
90
100


NASA-Lewis data analysis
0
-10
-20
-30
Directivity correction, dB
60
80
100
120
140
160
180
Directivity angle, deg.


Peak level of f/fb = 1/2
30log(f/fb)
-30log(f/fb)
Relative 1/3 octave band SPL's, dB
0
-10
-20
-30
0.01
0.1
1
10
Dimensionless frequency, f/fb



Combination tone noise levels
Normalized peak SPL, Lc
(1/3 OBSPL-20log T/ To-10log(m/mo), dB
80
70
60
50
40
30
20
1
1.2
1.4
1.6
1.8
2
f/fb=1/2
f/fb=1/4
f/fb=1/8
Rotor tip relative tip Mach number, Mtr

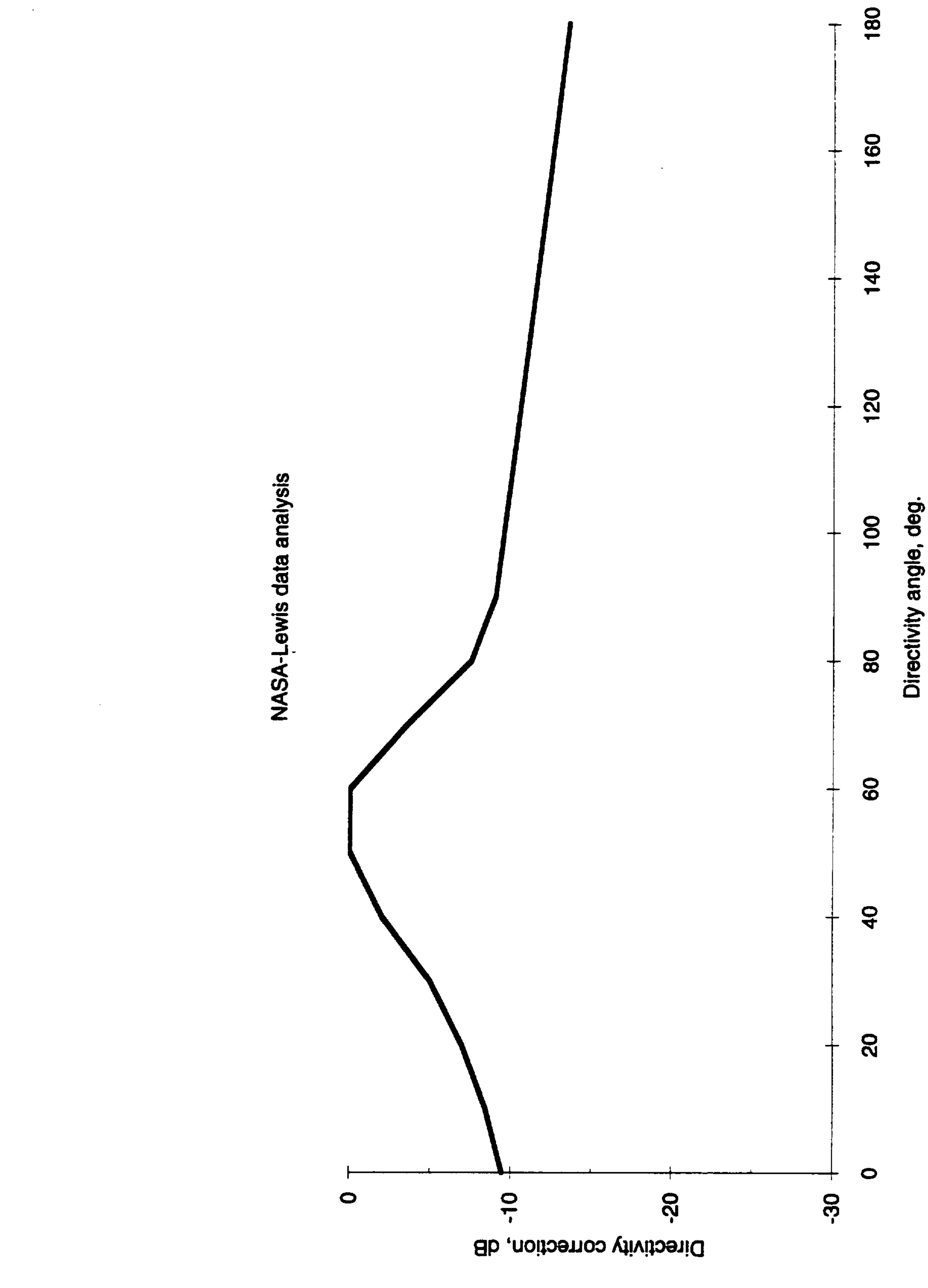

NASA-Lewis data analysis
Directivity correction, dB
0
-10
-20
-30
Directivity angle, deg.
0
20
40
60
80
100
120
140
160
180

TABLE II.- CONSTANTS AND FUNCTIONS FOR FAN ACOUSTIC POWER

Source	K	$\begin{bmatrix} G(1,1) & G(1,2) \\ G(2,1) & G(2,2) \end{bmatrix}$	$\begin{bmatrix} a(1,1) & a(1,2) \\ a(2,1) & a(2,2) \end{bmatrix}$	b	$F(M_r,M_m)$
Inlet broadband noise	1.552×10^{-4}	$\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$	$\begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0 \end{bmatrix}$	2	$\begin{cases} 1 & (M_r \leq 0.9) \\ 0.81M_r^{-2} & (M_r > 0.9) \end{cases}$
Inlet rotor-stator interaction tones	2.683×10^{-4}	$\begin{bmatrix} 1 & 0.580 \\ 0.625 & 0.205 \end{bmatrix}$	$\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$	4.31	$\begin{cases} 0.397M_m^{-2.31} & (M_r \leq 0.72) \\ 2.053M_m^{-2.31}M_r^5 & \left(0.72 < M_r \leq 0.866M_m^{0.462}\right) \\ 0.315M_m^{3.69}M_r^{-8} & \left(M_r > 0.866M_m^{0.462}\right) \end{cases}$
Inlet flow distortion tones	1.488×10^{-4}	$\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$	$\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$	4.31	$\begin{cases} 0.397M_m^{-2.31} & (M_r \leq 0.72) \\ 2.053M_m^{-2.31}M_r^5 & \left(0.72 < M_r \leq 0.866M_m^{0.462}\right) \\ 0.315M_m^{3.69}M_r^{-8} & \left(M_r > 0.866M_m^{0.462}\right) \end{cases}$
1/8 fundamental combination tone noise	6.109×10^{-4}	$\begin{bmatrix} 1 & 1 \\ 0.316 & 0.316 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$	0	$\begin{cases} 0 & (M_r < 1) \\ 10^{-6.75(1.61-M_r)} & (1 \leq M_r \leq 1.61) \\ 10^{-1.21(M_r-1.61)} & (M_r > 1.61) \end{cases}$

TABLE II.- Concluded

Source	K	$\begin{bmatrix} G(1,1) & G(1,2) \\ G(2,1) & G(2,2) \end{bmatrix}$	$\begin{bmatrix} a(1,1) & a(1,2) \\ a(2,1) & a(2,2) \end{bmatrix}$	b	$F(M_r,M_m)$
1/4 fundamental combination tone noise	2.030×10^{-3}	$\begin{bmatrix} 1 & 1 \\ 0.316 & 0.316 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$	0	$\begin{cases} 0 & (M_r < 1) \\ 10^{-14.75(1.322-M_r)} & (1 \le M_r \le 1.322) \\ 10^{-1.33(M_r-1.322)} & (M_r > 1.322) \end{cases}$
1/2 fundamental combination tone noise	2.525×10^{-3}	$\begin{bmatrix} 1 & 1 \\ 0.316 & 0.316 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$	0	$\begin{cases} 0 & (M_r < 1) \\ 10^{-31.85(1.146-M_r)} & (1 \le M_r \le 1.146) \\ 10^{-1.41(M_r-1.146)} & (M_r > 1.146) \end{cases}$
Discharge broadband noise	3.206×10^{-4}	$\begin{bmatrix} 1 & 1 \\ 2 & 2 \end{bmatrix}$	$\begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0 \end{bmatrix}$	2	$\begin{cases} 1 & (M_r \le 1.0) \\ M_r^{-2} & (M_r > 1.0) \end{cases}$
Discharge rotor-stator interaction tones	2.643×10^{-4}	$\begin{bmatrix} 1 & 0.581 \\ 2.50 & 0.820 \end{bmatrix}$	$\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$	2	$\begin{cases} 1 & (M_r \le 1.0) \\ M_r^{-2} & (M_r > 1.0) \end{cases}$

TABLE III.- DIRECTIVITY LEVELS FOR FAN NOISE

θ, deg	Inlet			Discharge	
	Broadband directivity level, $\log_{10} D$	Discrete tone directivity level, $\log_{10} D$	Combination tone directivity level, $\log_{10} D$	Broadband directivity level, $\log_{10} D$	Discrete tone directivity level, $\log_{10} D$
0.	0.43	0.30	-0.43	-3.70	-3.45
10.	0.53	0.45	-0.33	-3.27	-3.05
20.	0.63	0.60	-0.18	-2.84	-2.65
30.	0.63	0.60	0.02	-2.41	-2.25
40.	0.63	0.60	0.32	-1.98	-1.85
50.	0.43	0.48	0.52	-1.55	-1.45
60.	0.18	0.25	0.52	-1.12	-1.05
70.	-0.12	-0.08	0.17	-0.69	-0.65
80.	-0.47	-0.45	-0.23	-0.34	-0.35
90.	-0.87	-0.85	-0.38	-0.04	-0.05
100.	-1.32	-1.30	-0.43	0.19	0.15
110.	-1.87	-1.85	-0.48	0.34	0.35
120.	-2.42	-2.40	-0.53	0.43	0.45
130.	-2.97	-2.95	-0.58	0.46	0.45
140.	-3.52	-3.50	-0.63	0.26	0.25
150.	-4.07	-4.05	-0.68	-0.14	-0.10
160.	-4.62	-4.60	-0.73	-0.54	-0.45
170.	-5.17	-5.15	-0.78	-1.04	-0.85
180.	-5.72	-5.70	-0.83	-1.54	-1.35

TABLE IV.- SPECTRUM FUNCTIONS FOR FAN NOISE

Source	Spectrum function
Inlet broadband noise	$S(\eta) = 0.116 \exp\left\{-0.5\left[\frac{\ln(\eta/2.5)}{\ln 2.2}\right]^2\right\}$
Inlet rotor-stator interaction tones	$S(\eta) = \sum_{n=n_\ell}^{n_u} S(n,i,j)$ where $S(1,i,j) = \begin{bmatrix} 0.499 & 0.136 \\ 0.799 & 0.387 \end{bmatrix}$ $S(n,i,j) = \begin{bmatrix} 0.250 & 0.432 \\ 0.101 & 0.307 \end{bmatrix} \times 10^{-0.3(n-2)} \qquad (n > 1)$
Inlet flow distortion tones	$S(\eta) = 9 \sum_{n=n_\ell}^{n_u} 10^{-n}$
1/8 fundamental combination tone noise	$S(\eta) = \begin{cases} 0.405(8\eta)^5 & (\eta \leq 0.125) \\ 0.405(8\eta)^{-3} & (\eta > 0.125) \end{cases}$

TABLE IV.- Concluded

Source	Spectrum function
1/4 fundamental combination tone noise	$S(\eta) = \begin{cases} 0.520(4\eta)^{5} & (\eta \leq 0.25) \\ 0.520(4\eta)^{-5} & (\eta > 0.25) \end{cases}$
1/2 fundamental combination tone noise	$S(\eta) = \begin{cases} 0.332(2\eta)^{3} & (\eta \leq 0.5) \\ 0.332(2\eta)^{-3} & (\eta > 0.5) \end{cases}$
Discharge broadband noise	$S(\eta) = 0.116 \exp\left\{-0.5\left[\frac{\ln(\eta/2.5)}{\ln 2.2}\right]^{2}\right\}$
Discharge rotor-stator interaction tones	$S(\eta) = \sum_{n=n_{\ell}}^{n_u} S(n,i,j)$ where $S(1,i,j) = \begin{bmatrix} 0.499 & 0.136 \\ 0.799 & 0.387 \end{bmatrix}$ $S(n,i,j) = \begin{bmatrix} 0.250 & 0.432 \\ 0.101 & 0.307 \end{bmatrix} \times 10^{-0.3(n-2)} \quad (n > 1)$

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Joe W. Hough and Donald S. Weir

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Lockheed Aeronautical Systems Company
86 South Cobb Drive
Marietta, GA 30063

(Subcontractor)
AlliedSignal Engines
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The Fan Noise Module of ANOPP is used to predict the broadband noise and pure tones for axial flow compressors or fans. The module, based on the method developed by M. F. Heidmann, uses empirical functions to predict fan noise spectra as a function of frequency and polar directivity. Previous studies have determined the need to modify the module to better correlate measurements of fan noise from engines in the 3000- to 6000-pound thrust class. Additional measurements made by AlliedSignal have confirmed the need to revise the ANOPP fan noise method for smaller engines. This report describes the revisions to the fan noise method which have been verified with measured data from three separate AlliedSignal fan engines. Comparisons of the revised prediction show a significant improvement in overall and spectral noise predictions.

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