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SUMMARY

As part of the NASA Quiet Clean General Aviation Turbofan (QCGAT) engine mixer-nozzle exhaust system program, static jet exhaust noise was recorded at microphone angles of 45° to 155° relative to the nozzle inlet for a conventional profile coaxial nozzle and three 12-lobed coaxial mixer nozzles. Both flows in all four nozzles are internally mixed before being discharged from a single exhaust nozzle. The conventional profile coaxial nozzle jet noise is compared to the current NASA Lewis coaxial jet noise prediction and after applying an adjustment to the predicted levels based on the ratio of the kinetic energy of the primary and secondary flows, the prediction is within a standard deviation of 0.9 dB of the measured data. The mass average (mixed flow) prediction is also compared to the noise data for the three mixer nozzles with a reasonably good fit after applying another kinetic energy ratio adjustment (standard deviation of 0.7 to 1.5 dB with the measured data). The tests included conditions for the full-scale engine at takeoff (T.O.), cutback (86 percent T.O.) and approach (67 percent T.O.).

INTRODUCTION

The NASA Quite Clean General Aviation Turbofan (QCGAT) engine program goal was to apply known large size turbofan technology to a small general aviation turbofan engine, thus improving the environmental characteristics of civil aircraft by reducing noise and pollution that restrain growth of civil aviation. The program required the design of a full-scale co-annular reference exhaust nozzle and mixer exhaust nozzle systems. Scale-model testing of several mixer nozzle designs was accomplished. However, the acoustic test results were questionable because of the test arena used. As a result, four 0.35 scale QCGAT nozzles were tested acoustically at the NASA Lewis Research Center outdoor coaxial jet acoustic facility (fig. 1). The component parts of the four nozzles were those tested for Garrett Corporation under NASA Contract NAS3-20585 by Fluidyne Engineering Corporation (ref. 1).

The purpose of this paper is to present the acoustic test results of the four model nozzles: a conventional profile coaxial nozzle and three 12-lobe core mixer coaxial nozzles, with the core flow temperature up to 1123 K (2022 °R). The jet noise was recorded at microphone angles from 45° to 155° referenced to the nozzle inlet. The noise data of the four nozzles are compared with the current NASA Lewis coaxial jet noise prediction (ref. 2.).

SYMBOLS

A	area
c	speed of sound
D	diameter
f	1/3-octave band center frequency
h	annulus height
K.E.	kinetic energy
M	Mach number
N	number of data points
OASPL	overall sound pressure level, dB re 20 $\mu N/m^2$
OAPWL	overall power level, dB re 10^{-13} W
P	total pressure
PWL	power level
p	static pressure
R	nozzle-to-microphone distance
R*	nozzle-to-microphone distance for distributed noise sources (ref. 1)
SPL	1/3-octave band sound pressure level, dB re 20 $\mu N/m^2$
STD DEV	standard deviation
T	total temperature
t	static temperature
V	velocity
V_e	effective jet exhaust velocity (mass average)
W	mass flow rate
γ	ratio of specific heats
θ	directivity angle from inlet axis (fig. 2), deg, relative to nozzle exit
θ*	directivity angle from inlet axis (fig. 2), deg, for distributed noise sources (ref. 2)
Δ	$(OASPL_{exp} - OASPL_{adj})$
Δ_M	prediction adjustment equal to $(OASPL_{exp} - OASPL_{pred})$

Subscripts

a	ambient
adj	adjusted
e	effective
exp	experimental
p	primary
pred	predicted
s	secondary

APPARATUS AND PROCEDURE

Facility

A photograph of the dual-stream heated jet facility is shown in figure 1. Both streams could be heated to around 1100 K and operated to nozzle pressure ratios of 3.0. Flow rate, total pressure, and total temperature were measured for both streams. Mufflers in each line attenuated flow control valve noise and internal combustion noise. A detailed description of the flow facility is given in reference 3.

In order to produce a single free-field (no reflections) spectrum at each microphone angle, two microphone arrays were used as shown in figure 2. Nine 0.635-cm condenser microphones at the nozzle centerline elevation were mounted on poles. The protective metal grid caps were removed to improve the microphone performance at high frequencies. Nine 1.27-cm condenser microphones, mounted on metal plates, were placed on the ground at the same angle and acoustic ray distance as the corresponding centerline microphone. The microphones up to and including 135° were at a sideline distance of 33 core nozzle diameters (6.67 m). The microphones at 145°, 150°, and 155° were at the same radial distance as the 135° microphone because of space and acoustic level considerations. The angle θ is referenced to the centerline of the nozzle exit plane. The angle θ^* is referenced to assumed distributed noise sources in the jet as discussed in reference 4 and are within one degree of the angles determined by the assumptions of reference 2. The ground plane of the acoustic area was asphalt interspersed with patches of concrete.

Test Nozzles

Schematics of the four coaxial nozzles are shown in figure 3. All the configurations have a plug in the primary flow and the primary and secondary flows mix before exiting from a single nozzle. QCGAT II (mixer A) and III (mixer C) have parallel walled lobes and differ only in length. QCGAT IV (mixer D) is the same length as III but has modified radial walls.

Procedure

All tests were conducted at steady state flow conditions for given nozzle total pressures and temperatures. Upstream plenum chamber total pressures and total temperatures were used to calculate nozzle exhaust velocities assuming isentropic expansion to atmospheric conditions. Nozzle exit static temperatures were calculated from the measured total temperatures after correcting the total temperature for thermocouple radiation heat loss. In order to simulate the QCGAT engine flows, only the primary (core) nozzle flow was heated.

An on-line analysis of the noise signal from each microphone in succession was performed. One-third octave band sound pressure level spectra were digitally recorded. Atmospheric attenuation and ground reflection corrections were applied to the spectral data to give free-field lossless data for each microphone at each angle. A single spectrum for each measurement angle was obtained by combining the centerline and ground microphone spectra. The ground microphone spectrum was used over the frequency range of 100 to

1000 Hz; the centerline microphone spectrum was used over the frequency range from 5000 to 8000 Hz. For the intermediate frequency range of 1250 to 4000 Hz the data from both microphones were arithmetically averaged.

RESULTS

The test conditions for the four nozzles are given in table I. Runs 3, 5, and 7 simulate the QCGAT engine operating line for takeoff fan speed, cutback (86 percent takeoff fan speed) and approach (67 percent takeoff fan speed) respectively. Runs 1, 2, 4, and 6 extend the data range.

A tabulation of the measured lossless free-field spectra for all nine directivity angles used in the tests for each nozzle is given in table II. At the higher frequencies, after including the atmospheric attenuation correction, there was a reversal of the slope of the sound pressure level (SPL) with frequency that occurred because the magnitude of the input signal at the higher frequencies was lower than the internal noise floor of the spectrum analyzer; therefore, all the listings have been deleted beyond the frequency where the slope reversal began.

Predicted jet noise spectra of the four QCGAT nozzles were generated using the method of reference 2. The separate flow coaxial jet condition was used for QCGAT I and a mass averaged (mixed flow) condition was used for QCGAT II, III, and IV. The test conditions of QCGAT I were used for both predictions since they were nominally the same for all four nozzle tests. The predicted spectra for QCGAT I are listed in table III and for QCGAT II, III, and IV are listed in table IV.

Comparing the directivities of all the measured and predicted OASPL's, it was noted the trends were similar but the levels were different. The data will be discussed later. Using an adjustment based on a kinetic energy ratio of the primary (core) flow to the secondary (fan) flow brought the predicted and measured OASPL data together for a respectable fit. The adjustment, $\Delta_M = (OASPL_{exp} - OASPL_{pred})$, is shown in figure 4. Using a kinetic energy ratio accounts for some of the internal natural mixing of the two jets before they leave the exit nozzle. The kinetic energy ratio exponent for the mixer nozzles is one-half the exponent of the conventional profile (QCGAT I) nozzle. After applying the adjustments to the predicted OASPL's, a statistical comparison was made of the differences between the experimental and adjusted predicted OASPL. The results, shown in table V, are that the standard deviation of all the differences for the four nozzles averaged 1 dB with QCGAT II at 0.7 dB and QCGAT III at 1.5 dB.

The OASPL directivities for the four nozzles are shown in figure 5. Even and odd numbered runs are separated for clarity. Figure 5(a) shows the good fit of the measured data and the adjusted predicted levels for the QCGAT I nozzle. For unknown reasons the measured and predicted levels disagree for angles greater than 120° for the highest velocity run (run 1). The directivities of the three mixer nozzles is shown in figure 5(b). The adjusted prediction levels closely match the measured levels except for the QCGAT II nozzle for angles over 125°.

Spectral data are shown in figure 6 for the QCGAT I nozzle at directivity angles, θ^* of 45°, 90°, 125°, and 145°. The adjusted predicted levels in general predict the data trends. Shown in figure 7 are the spectral data for the three mixer nozzles at the same directivity angles. Although there are some deviations between the data and the adjusted prediction, the trends are fairly well represented. In the mid-to-high-frequency range generally the measured data are higher than the adjusted predicted level, but are parallel to the prediction. In reference 5, measured engine noise was greater than the ANOPP predictions and could have been due to jet and/or core noise. Since the present data are somewhat above the mass average (mixed flow) adjusted prediction, the discrepancy here and in reference 5 may be due to incomplete mixing causing higher jet noise.

The acoustic power level spectra for the four QCGAT nozzles are listed in table VI. Predicted power level spectra are listed in table VII. Far field acoustic power level comparisons of the full-scale QCGAT engine (ref. 6) and scaled-up data of the four QCGAT nozzles are shown in figure 8. The effective jet exhaust velocity (mass averaged) is

$$V_e = \frac{W_p V_p + W_s V_s}{W_p + W_s}$$

where W_p and W_s are primary and secondary mass flows, respectively and V_p and V_s are primary and secondary velocities, respectively. The data were scaled up by adding 9.1 dB ($20 \log_{10} 1/0.35$) to the measured OAPWL and the levels are in agreement with the full scale engine. The engine data in the V_e range of the model data fall between the adjusted and scaled up predictions. The mass average prediction fairly well represents all the scaled up mixer nozzles (QCGAT II, III, and IV) and is linear with the velocity to the eighth-power. The adjusted and scaled up separate flow prediction data points are close to the measured data points but are scattered relative to the eighth-power slope. The lower velocity engine data are above an extension of an eighth-power slope indicating core noise dominates over jet noise.

Acoustic power level spectral comparisons are shown in figure 9 between the QCGAT engine (ref. 6) and QCGAT I and II scale nozzles. Run 6 was used because the V_e was nearly identical to the engine V_e at 89 percent rated fan speed. The scale model frequencies were shifted downward by three frequency bands (1/0.35), and 9.1 dB were added to the power levels. The predictions were adjusted the same as the SPL and OASPL discussed earlier. The engine and model data are in substantial agreement in the low frequency range (50 to 400 Hz). Above 400 Hz both engine configurations have higher power levels than the scaled model data. The engine mixer nozzle data begins to deviate from the scale model mixer nozzle data at about 100 Hz. For both nozzles the far field engine spectrum at 89 percent speed has low frequency peaks and higher frequency turbine tones that are not in the scale model data. Based on the agreement of the engine and scale model data at low frequency it is concluded that the low frequency acoustic power at 89 percent engine speed is dominated by jet noise.

CONCLUDING REMARKS

Static acoustic tests of four QCGAT 0.35 model-scale nozzles were made and jet noise was recorded at 45° to 155° from the nozzle inlet. The nozzles were a conventional bypass, and three 12-lobed mixer-type bypass. The noise data from the four nozzles is compared to the current NASA Lewis coaxial jet noise prediction and, after adjusting the prediction with a kinetic energy ratio function to account for internal mixing, substantial agreement was obtained. The measured and predicted OASPL data had a standard deviation of 0.7 to 1.5 dB. The trends of the spectral data are in good agreement with the adjusted prediction.

The model data were scaled up and compared with full-scale engine data and the adjusted prediction on a power level basis. The overall power levels as a function of effective jet exhaust velocity are in agreement. The power level spectra in the low frequency range (50 to 400 Hz) generally agree with the adjusted prediction.

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TABLE I. - NOZZLE TEST CONDITIONS

(a) QCGAT I - Constant Ambient Conditions: temperature, t_a = 296 K (532 °R); pressure, P_a = 98.8 kN/m^2 (14.33 psia); relative humidity, 35 percent

	Primary							Secondary						
Run	Pressure ratio, P_p/P_a	Exit total temperature T_p, K (°R)	Exit Mach number M_p	Exit sonic velocity, c_p m/sec (ft/sec)	Ideal exit velocity, V_p m/sec (ft/sec)	Ratio of specific heats, γ_p	Mass flow rate, kg/sec (lb_m/sec)	Pressure ratio, P_s/P_a	Exit total temperature T_s, K (°R)	Exit Mach number M_s	Exit sonic velocity, c_s m/sec (ft/sec)	Ideal exit velocity, V_s m/sec (ft/sec)	Ratio of specific heats, γ_s	Mass flow rate, kg/sec (lb_m/sec)
1	1.610	1123 (2022)	.881	614 (2015)	541 (1776)	1.295	3.024 (6.667)	1.707	293 (527)	.909	318 (1044)	289 (949)	1.399	15.26 (33.64)
2	1.488	1032 (1858)	.799	595 (1953)	476 (1561)	1.304	2.848 (6.278)	1.625	294 (529)	.863	321 (1053)	277 (908)	1.399	14.36 (31.66)
3	1.425	846 (1522)	.747	545 (1788)	407 (1336)	1.327	2.959 (6.523)	1.448	293 (528)	.747	326 (1069)	243 (798)	1.399	12.24 (26.99)
4	1.296	994 (1789)	.633	598 (1963)	379 (1242)	1.306	2.275 (5.015)	1.441	293 (528)	.742	326 (1069)	242 (794)	1.399	12.15 (26.78)
5	1.292	827 (1488)	.631	546 (1791)	344 (1130)	1.330	2.500 (5.512)	1.334	294 (529)	.655	330 (1083)	216 (709)	1.399	10.60 (23.37)
6	1.173	996 (1793)	.493	607 (1990)	299 (982)	1.303	1.745 (3.848)	1.269	294 (529)	.594	332 (1090)	198 (648)	1.399	9.539 (21.03)
7	1.144	804 (1447)	.449	550 (1803)	247 (810)	1.333	1.784 (3.932)	1.199	294 (529)	.516	335 (1099)	173 (568)	1.399	8.224 (18.13)
(b) QCGAT II - Constant Ambient Conditions: temperature, t_a = 297 K (535 °R); pressure, P_a = 98.5 kN/m^2 (14.28 psia); relative humidity, 34 percent														
1	1.593	1122 (2019)	.864	618 (2028)	532 (1747)	1.295	2.962 (6.529)	1.709	296 (533)	.910	319 (1048)	291 (954)	1.399	14.88 (32.80)
2	1.485	1036 (1864)	.789	600 (1968)	473 (1553)	1.304	2.808 (6.191)	1.603	296 (532)	.850	322 (1057)	274 (899)	1.399	13.79 (30.39)
3	1.433	841 (1514)	.747	545 (1789)	408 (1337)	1.327	2.964 (6.534)	1.453	296 (532)	.751	327 (1072)	245 (805)	1.399	12.01 (26.48)
4	1.290	998 (1797)	.627	600 (1968)	376 (1234)	1.301	2.229 (4.914)	1.434	295 (531)	.737	327 (1074)	241 (791)	1.399	11.78 (25.97)
5	1.291	823 (1481)	.625	547 (1794)	342 (1122)	1.331	2.476 (5.459)	1.324	295 (531)	.647	331 (1086)	214 (702)	1.399	10.22 (22.53)
6	1.172	985 (1773)	.492	603 (1979)	297 (975)	1.303	1.740 (3.836)	1.269	295 (531)	.594	333 (1093)	198 (648)	1.399	9.326 (20.56)
7	1.150	790 (1422)	.462	540 (1773)	250 (819)	1.333	1.837 (4.049)	1.197	297 (534)	.514	336 (1103)	173 (567)	1.399	7.979 (17.59)
(c) QCGAT III - Constant Ambient Conditions: temperature, t_a = 296 K (533 °R); pressure, P_a = 98.8 kN/m^2 (14.33 psia); relative humidity, 44 percent														
1	1.614	1120 (2016)	.884	613 (2011)	542 (1778)	1.295	3.117 (6.872)	1.713	295 (531)	.912	319 (1047)	291 (955)	1.399	14.81 (32.66)
2	1.496	1032 (1858)	.805	595 (1952)	479 (1571)	1.304	2.945 (6.492)	1.634	295 (531)	.869	321 (1054)	279 (915)	1.399	14.01 (30.89)
3	1.426	851 (1532)	.748	547 (1794)	409 (1342)	1.327	3.029 (6.677)	1.443	295 (531)	.743	327 (1073)	243 (798)	1.399	11.78 (25.97)
4	1.302	996 (1792)	.646	594 (1949)	384 (1259)	1.306	2.371 (5.227)	1.444	295 (531)	.744	327 (1072)	243 (798)	1.399	11.79 (26.00)
5	1.291	817 (1470)	.629	543 (1782)	342 (1121)	1.332	2.574 (5.675)	1.320	295 (531)	.643	331 (1086)	213 (699)	1.399	10.06 (22.18)
6	1.168	999 (1798)	.487	607 (1993)	296 (971)	1.303	1.764 (3.890)	1.266	295 (531)	.591	333 (1093)	197 (646)	1.399	9.190 (20.26)
7	1.150	796 (1433)	.462	543 (1780)	251 (822)	1.333	1.889 (4.165)	1.198	296 (533)	.515	339 (1112)	175 (573)	1.399	7.933 (17.49)
(d) QCGAT IV - Constant Ambient Conditions: temperature, t_a = 297 K (535 °R); pressure, P_a = 99.1 kN/m^2 (14.37 psia); relative humidity, 49 percent														
1	1.590	1123 (2022)	.869	615 (2017)	535 (1754)	1.295	3.064 (6.754)	1.689	295 (531)	.899	319 (1048)	287 (943)	1.399	14.61 (32.21)
2	1.478	1034 (1861)	.793	596 (1956)	472 (1550)	1.303	2.900 (6.393)	1.645	295 (531)	.874	321 (1052)	280 (920)	1.399	14.16 (31.21)
3	1.432	852 (1533)	.752	547 (1793)	411 (1348)	1.326	3.055 (6.736)	1.452	295 (531)	.750	327 (1072)	245 (804)	1.399	11.93 (26.31)
4	1.288	996 (1792)	.626	599 (1966)	375 (1230)	1.303	2.309 (5.087)	1.439	295 (531)	.741	327 (1073)	242 (794)	1.399	11.77 (25.94)
5	1.286	822 (1479)	.624	545 (1787)	340 (1115)	1.330	2.552 (5.626)	1.319	295 (531)	.642	331 (1087)	212 (697)	1.399	10.07 (22.20)
6	1.180	994 (1790)	.503	606 (1987)	304 (999)	1.303	1.834 (4.044)	1.273	295 (531)	.598	333 (1092)	199 (653)	1.399	9.330 (20.57)
7	1.143	789 (1420)	.452	540 (1773)	244 (802)	1.333	1.860 (4.100)	1.195	296 (532)	.511	336 (1102)	172 (563)	1.399	7.897 (17.41)

TABLE II. - LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(a) QCGAT I

Fre- quency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	76.7	78.6	83.7	85.8	88.3	93.0	94.5	98.9	99.4
125		77.2	80.7	83.5	87.7	88.6	95.9	96.9	98.8	102.7
160		79.8	81.4	86.5	90.7	91.1	97.2	102.5	104.7	102.4
200		81.5	87.9	91.6	97.7	102.7	105.4	107.1	109.5	106.8
250		84.1	87.6	89.7	93.6	99.7	103.6	106.7	108.0	108.1
315		84.2	87.2	92.0	95.8	100.9	104.3	109.0	109.1	109.3
400		85.0	89.2	92.5	96.7	103.3	106.8	110.1	111.1	109.4
500		87.2	90.7	93.8	99.3	104.4	108.9	109.4	110.0	109.5
630		88.8	92.2	97.5	101.6	107.3	111.5	110.9	109.2	108.8
800		91.1	94.1	98.9	101.7	108.1	110.5	109.7	109.2	107.8
1000		89.9	94.2	99.0	103.1	109.0	110.3	108.9	107.3	107.0
1250		88.8	93.5	98.0	102.5	108.2	108.9	108.1	107.7	106.5
1600		90.7	94.4	98.2	103.5	105.7	109.2	110.6	108.8	107.0
2000		89.8	93.0	98.3	103.3	105.8	108.9	110.2	108.5	107.1
2500		88.9	91.9	97.2	103.2	105.1	107.7	109.5	108.7	106.6
3150		86.8	93.1	95.5	102.8	103.4	106.9	107.7	106.5	104.0
4000		87.4	91.5	95.3	101.1	102.0	104.0	104.9	103.6	100.6
5000		85.6	89.4	94.3	97.2	100.6	97.5	101.1	97.8	96.8
6300		84.3	89.6	96.3	98.2	95.2	96.4	97.1	94.7	93.2
8000		83.9	89.6	95.8	97.3	93.7	94.0	95.0	91.8	90.6
10000		83.1	89.2	92.4	96.3	93.6	92.9	89.7	88.6	86.5
12500		80.7	87.0	91.1	95.1	91.6	92.7	88.1	86.3	-----
16000		80.1	87.3	91.0	94.3	91.1	91.4	-----	-----	-----
20000		78.6	86.5	89.7	92.9	89.5	-----	-----	-----	-----
25000		77.1	85.7	88.2	89.9	-----	-----	-----	-----	-----
31500		-----	-----	88.1	90.2	-----	-----	-----	-----	-----
40000		-----	-----	87.3	89.1	-----	-----	-----	-----	-----
50000		-----	-----	86.9	88.6	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		100.4	104.5	109.1	113.5	117.0	119.9	120.7	120.4	119.3
100	2	74.7	74.3	80.9	83.7	89.1	87.0	94.7	94.1	96.7
125		76.2	76.2	81.4	83.6	88.3	90.0	96.9	96.5	97.4
160		76.8	78.8	84.4	84.1	90.7	92.9	98.5	99.2	101.0
200		81.2	84.5	90.8	96.1	102.5	104.5	108.3	109.1	108.5
250		80.3	84.2	86.9	91.9	97.1	99.1	104.8	105.5	105.2
315		81.2	88.0	90.1	93.5	98.6	101.0	106.1	107.0	105.6
400		83.3	87.5	90.5	94.7	99.5	103.3	106.5	106.2	105.8
500		85.3	88.0	92.7	96.2	99.1	103.1	106.4	104.7	105.8
630		84.0	89.2	94.4	97.5	102.4	104.9	107.0	105.6	104.7
800		85.8	90.4	94.3	99.6	103.4	104.6	105.8	105.2	103.3
1000		86.7	90.4	95.1	99.2	103.8	105.3	102.6	103.6	102.4
1250		86.8	90.2	93.7	98.5	102.1	100.8	101.7	101.7	100.0
1600		87.0	90.2	93.4	98.2	100.0	101.7	103.0	102.8	101.2
2000		86.8	89.3	93.4	98.1	100.1	100.3	100.8	101.3	99.9
2500		85.6	88.6	92.6	97.1	99.9	98.4	99.8	101.0	100.2
3150		85.5	87.3	90.8	96.3	97.1	94.5	97.4	98.1	96.8
4000		84.0	86.4	91.3	95.4	96.3	93.0	95.4	96.1	93.9
5000		82.2	86.0	91.3	93.4	93.1	90.1	90.7	94.2	87.9
6300		83.2	85.7	89.3	92.9	91.2	89.7	88.7	89.9	85.8
8000		81.5	85.0	89.7	90.5	90.4	88.7	85.5	86.4	82.0
10000		79.3	85.0	88.8	91.6	88.9	89.2	85.0	83.9	80.6
12500		77.8	84.2	88.7	90.7	87.2	88.5	83.1	82.8	80.0
16000		77.4	84.0	88.0	90.0	87.3	87.2	81.4	82.7	79.5
20000		76.7	82.4	86.7	88.4	84.7	88.0	81.0	81.7	-----
25000		75.9	81.4	85.1	86.8	84.5	86.4	-----	81.8	-----
31500		75.6	81.2	84.6	86.2	-----	84.7	-----	-----	-----
40000		-----	79.9	83.1	84.3	-----	-----	-----	-----	-----
50000		-----	-----	82.1	83.7	-----	-----	-----	-----	-----
63000		-----	-----	-----	83.3	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		97.3	101.0	105.1	109.2	112.4	113.9	116.2	116.2	115.6
100	3	75.4	74.0	79.2	84.3	84.8	88.3	89.9	91.1	94.0
125		75.9	74.2	80.1	84.9	87.0	90.1	93.8	95.0	96.0
160		76.2	77.3	82.3	85.1	88.4	91.4	96.4	96.3	96.3

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(a) Continued. QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
200	3	78.7	80.1	84.6	88.1	91.4	97.2	98.1	100.0	100.8
250		82.4	82.4	86.8	91.0	92.8	97.6	101.2	100.8	101.2
315		81.0	83.4	88.4	90.1	94.9	100.5	103.3	103.1	102.3
400		81.7	85.9	89.3	93.1	97.5	101.0	103.7	103.8	104.4
500		82.8	87.3	90.9	93.8	97.8	102.0	105.2	103.1	102.7
630		83.8	88.7	93.4	96.2	99.6	102.8	104.2	102.3	103.4
800		84.1	89.7	93.5	96.9	99.1	102.4	101.9	101.5	102.5
1000		86.6	89.9	93.9	97.2	99.8	101.2	101.5	100.2	100.2
1250		85.5	89.0	92.9	97.6	99.8	99.0	99.4	98.5	98.0
1600		84.7	88.9	91.7	97.7	97.9	98.1	97.7	97.4	97.5
2000		84.4	87.4	91.4	96.9	97.4	96.8	96.0	94.9	96.2
2500		83.9	86.3	91.0	95.7	96.4	94.9	93.6	92.5	92.9
3150		82.9	86.7	89.5	94.5	93.9	91.5	90.2	88.4	89.2
4000		82.0	84.4	89.1	93.5	90.9	90.1	86.4	87.0	85.4
5000		79.7	82.4	87.4	91.4	87.7	86.3	83.9	84.5	82.7
6300		80.6	84.3	88.4	90.7	88.1	88.8	83.3	80.5	79.9
8000		77.4	83.8	88.4	90.8	87.3	87.7	82.8	80.3	80.0
10000		76.7	81.8	86.3	89.1	86.4	85.7	80.3	80.1	78.8
12500		75.0	81.1	85.0	87.3	85.4	85.7	79.4	78.2	78.5
16000		74.1	80.1	84.4	86.8	83.9	85.2	79.0	77.9	77.5
20000		73.8	78.2	82.8	85.3	83.1	86.2	-----	-----	-----
25000		72.5	-----	81.0	83.8	82.6	82.8	-----	-----	-----
31500		-----	-----	80.4	-----	-----	-----	-----	-----	-----
40000		-----	-----	79.6	-----	-----	-----	-----	-----	-----
50000		-----	-----	78.7	----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		95.7	99.3	103.5	107.3	109.0	111.2	112.7	111.9	112.3
100	4	71.9	73.1	77.6	79.9	81.7	86.4	88.3	90.0	89.8
125		72.3	75.5	79.1	80.6	82.6	88.2	90.5	91.3	93.2
160		73.9	77.2	78.6	82.8	84.8	90.3	93.6	94.0	93.9
200		76.5	78.7	82.5	85.4	87.3	92.8	94.5	95.8	97.7
250		79.2	82.1	83.8	85.8	89.8	93.0	96.1	98.0	99.2
315		76.9	80.9	85.2	88.9	90.5	95.3	97.5	98.9	98.5
400		78.4	83.6	87.1	90.4	91.6	95.2	98.2	100.5	98.5
500		79.4	84.8	88.6	89.8	93.6	96.4	97.7	97.9	96.6
630		80.5	85.9	88.3	92.0	93.4	96.5	98.0	97.5	95.7
800		81.2	86.6	89.2	92.9	93.8	95.1	96.5	96.5	94.1
1000		81.9	86.6	89.4	93.4	94.1	96.0	94.7	93.6	92.7
1250		83.5	86.0	88.7	92.4	93.8	92.9	92.8	92.1	90.4
1600		82.3	86.4	88.7	91.9	91.8	92.2	92.1	90.7	88.8
2000		82.7	84.5	88.4	91.8	91.3	91.1	89.8	89.0	87.2
2500		81.3	83.9	87.3	90.8	90.7	89.0	88.6	87.3	85.4
3150		80.1	83.5	85.2	89.3	89.1	87.8	86.1	84.5	83.6
4000		79.4	83.5	87.1	90.5	88.0	86.1	85.9	80.9	81.1
5000		78.6	80.9	84.9	86.5	84.7	83.0	83.0	79.3	76.7
6300		78.0	79.9	85.4	87.3	84.4	82.6	82.0	80.8	77.6
8000		77.4	81.2	84.0	86.4	84.9	83.4	79.9	80.0	76.8
10000		76.2	80.3	83.9	85.2	83.5	83.7	78.1	78.9	75.5
12500		75.4	80.1	82.8	84.7	82.2	82.1	77.7	76.6	75.0
16000		74.1	79.1	82.1	82.7	82.8	-----	-----	-----	-----
20000		72.3	77.2	81.3	82.4	81.1	-----	-----	-----	-----
25000		71.3	-----	79.7	81.0	-----	-----	-----	-----	-----
31500		-----	-----	78.8	80.0	-----	-----	-----	-----	-----
40000		-----	-----	78.6	79.1	-----	-----	-----	-----	-----
50000		-----	-----	78.2	79.0	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		92.9	96.8	100.0	102.5	103.7	105.6	106.9	107.6	107.0
100	5	73.5	71.8	74.9	77.7	82.4	83.5	85.1	88.8	89.3
125		75.7	73.2	77.8	80.1	83.6	85.8	90.1	89.6	91.2
160		72.0	73.1	77.8	80.4	86.1	88.2	90.1	93.5	92.1
200		73.7	76.9	81.0	85.1	87.0	91.0	92.7	96.4	95.1
250		76.4	80.2	81.3	85.9	88.7	92.5	95.4	95.9	96.6
315		74.9	81.3	83.3	87.0	90.8	93.9	96.5	95.2	97.5
400		76.1	80.9	85.1	88.6	92.6	94.0	96.8	96.7	97.0

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(a) Continued. QCGAT I

Fre-quency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
500	5	78.6	84.7	87.7	89.7	92.0	94.1	97.6	96.8	96.9
630		78.2	83.5	88.4	91.7	93.3	95.3	97.9	95.7	95.7
800		79.3	84.3	87.6	91.6	93.6	93.9	94.3	93.3	92.6
1000		79.3	85.2	87.6	91.8	94.6	93.6	91.7	90.5	90.2
1250		78.9	83.3	86.0	91.2	93.6	91.1	90.3	89.5	87.3
1600		79.1	83.5	86.0	90.9	91.2	90.6	90.8	88.3	85.8
2000		79.2	82.3	85.4	89.6	89.9	89.7	87.6	85.9	83.6
2500		77.3	80.7	84.7	88.2	89.2	87.5	85.5	83.4	80.9
3150		78.3	80.1	83.4	86.8	87.5	84.8	82.6	79.1	77.4
4000		75.5	80.6	82.7	86.0	86.4	83.2	80.6	77.6	75.8
5000		74.5	79.3	83.1	84.6	84.6	80.0	79.2	77.7	72.9
6300		74.9	77.6	81.9	84.2	82.9	79.3	78.8	78.7	74.4
8000		73.4	77.6	80.4	82.5	82.0	80.5	76.2	75.4	71.9
10000		71.9	75.6	80.4	81.9	79.8	79.4	75.5	74.9	-----
12500		69.7	74.9	77.9	80.7	80.5	80.2	-----	74.5	-----
16000		68.6	74.5	77.5	80.3	77.4	79.5	-----	-----	-----
20000		68.6	73.9	77.3	77.4	76.2	-----	-----	-----	-----
25000		67.0	74.0	75.4	77.1	75.3	-----	-----	-----	-----
31500		-----	-----	-----	77.0	-----	-----	-----	-----	-----
40000		-----	-----	-----	76.4	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		90.2	94.6	97.8	101.4	103.3	104.0	105.7	105.4	105.5
100	6	71.0	72.3	74.5	75.0	79.0	77.9	80.9	82.7	86.7
125		73.6	73.4	76.5	77.2	80.5	79.9	85.0	85.5	86.8
160		70.1	71.9	75.6	79.2	80.6	84.1	86.9	87.4	86.1
200		78.1	79.0	80.5	81.8	82.9	85.0	87.6	89.2	89.4
250		72.5	75.7	79.6	82.4	83.6	86.1	88.0	90.3	90.4
315		73.1	74.6	80.5	83.4	82.7	86.7	88.7	90.2	90.2
400		78.1	78.2	83.5	84.7	86.2	87.0	90.3	88.9	90.1
500		74.2	78.7	81.7	83.8	84.5	86.7	89.4	89.7	88.6
630		74.8	79.4	83.5	84.2	87.3	88.8	89.6	88.9	87.6
800		77.1	80.8	83.8	85.6	86.9	86.9	88.6	86.7	85.9
1000		75.8	79.7	83.6	86.5	87.5	86.9	87.2	84.6	83.5
1250		75.3	79.5	81.4	85.0	87.0	84.8	83.7	82.2	80.1
1600		75.0	78.1	80.5	84.6	84.0	83.7	82.7	82.1	79.5
2000		74.8	76.9	80.0	82.9	82.9	81.5	80.4	79.3	77.2
2500		73.4	76.0	78.8	81.7	81.6	80.1	78.8	78.0	75.4
3150		73.2	74.3	77.7	79.7	78.8	76.3	76.9	75.4	73.4
4000		71.2	75.2	77.5	79.8	78.1	77.4	75.8	74.3	70.7
5000		69.4	73.5	76.7	76.6	77.4	75.1	74.0	72.6	70.9
6300		68.8	72.7	75.7	77.2	75.8	75.6	71.5	73.3	68.3
8000		69.2	74.1	75.3	77.3	75.6	74.2	70.7	71.3	68.8
10000		67.9	72.0	74.2	76.6	75.8	74.4	71.1	70.5	67.5
12500		67.3	70.9	73.7	76.0	74.3	73.8	70.1	69.4	67.8
16000		66.2	71.1	73.3	74.8	74.0	73.5	69.7	68.9	67.6
20000		65.2	69.6	72.1	73.8	72.8	74.1	69.3	-----	-----
25000		63.7	-----	71.0	73.6	72.4	73.3	-----	-----	-----
31500		-----	-----	70.3	73.1	-----	-----	-----	-----	-----
40000		-----	-----	68.6	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		87.5	90.3	93.6	95.8	96.7	97.3	98.9	99.0	98.8
100	7	71.6	69.4	74.5	74.7	76.0	75.4	77.9	80.8	80.0
125		74.3	71.2	76.1	75.5	80.0	78.7	80.2	81.1	82.4
160		69.3	74.8	77.1	76.5	79.2	79.1	81.6	83.1	81.9
200		72.2	76.8	77.6	79.6	79.1	80.0	84.9	85.4	87.4
250		67.7	71.9	75.6	78.7	80.7	83.2	85.5	86.6	85.5
315		72.6	74.0	78.2	79.2	81.0	83.0	85.7	85.7	85.6
400		75.7	77.7	80.0	80.5	82.9	84.6	84.7	85.8	85.4
500		71.4	77.0	79.2	81.1	83.8	83.8	84.4	84.7	84.3
630		71.2	76.8	79.6	80.4	82.7	85.0	84.3	83.8	82.1
800		72.6	78.0	78.8	82.4	83.7	83.9	83.6	81.4	80.1
1000		72.3	76.9	80.8	81.4	83.9	83.1	82.7	78.9	78.8

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(a) Concluded. QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
1250	7	70.3	75.1	76.7	80.8	82.9	79.9	78.7	77.6	75.2
1600	↓	71.6	74.4	76.7	79.7	79.5	79.5	78.3	77.2	75.2
2000		71.1	73.4	76.2	78.6	78.8	77.3	74.9	74.8	72.1
2500		69.6	72.6	75.1	76.9	78.0	76.1	73.4	73.0	70.5
3150		68.9	74.0	75.6	78.0	77.9	76.4	73.1	71.8	70.5
4000		67.9	73.7	74.5	77.7	74.7	76.7	72.6	71.5	70.6
5000		67.0	69.7	70.8	73.6	72.5	72.6	68.7	71.3	65.1
6300		66.9	70.2	71.5	72.8	70.4	70.9	67.5	70.0	64.0
8000		63.7	68.9	70.2	73.0	71.5	70.0	66.6	69.2	63.7
10000		61.9	68.7	69.7	72.0	70.1	-----	66.3	67.0	62.8
12500		61.2	68.6	69.0	71.1	70.5	-----	66.2	66.1	62.3
16000		60.9	67.1	68.4	71.0	69.2	-----	-----	-----	62.1
20000		-----	66.3	66.8	69.0	68.2	-----	-----	-----	62.2
25000		-----	-----	65.8	68.6	-----	-----	-----	-----	-----
31500		-----	-----	65.2	68.4	-----	-----	-----	-----	-----
40000		-----	-----	-----	68.0	-----	-----	-----	-----	-----
50000		-----	-----	-----	67.8	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	84.3	87.9	90.2	92.1	93.5	93.8	94.6	94.8	94.4

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(b) QCGAT II

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	77.5	76.5	83.3	84.9	87.2	88.8	95.9	95.9	94.3
125	↓	78.7	79.7	85.4	85.3	89.4	90.9	96.9	98.7	97.6
160		77.3	81.1	84.8	88.0	91.5	93.4	99.2	99.9	101.0
200		80.3	83.9	88.9	91.1	95.0	98.3	102.3	103.7	104.9
250		81.7	85.5	88.8	92.8	96.1	99.5	104.5	104.6	104.9
315		82.7	85.8	90.0	92.0	95.4	98.9	105.1	106.6	106.4
400		83.1	87.2	91.2	93.4	98.6	101.2	107.0	108.2	107.7
500		85.2	88.6	92.9	95.3	98.7	102.4	105.4	106.8	106.3
630		85.4	90.7	95.1	96.8	99.2	103.1	106.2	106.2	102.9
800		86.7	91.4	95.4	97.3	98.9	102.3	105.0	104.5	100.9
1000		88.3	91.3	95.6	98.4	101.3	101.4	102.4	100.8	99.3
1250		86.1	91.5	93.7	98.6	101.2	98.7	99.9	99.5	97.4
1600		88.1	91.7	94.6	98.6	99.3	99.4	100.0	98.3	96.5
2000		88.8	91.7	95.1	98.9	98.9	97.7	97.6	96.6	94.3
2500		88.0	90.9	94.7	99.3	99.0	96.7	96.5	95.2	92.8
3150		88.2	90.9	95.0	99.8	98.9	93.7	95.5	93.8	92.3
4000		88.5	91.0	94.6	99.3	97.5	95.0	94.1	92.1	91.4
5000		85.5	92.1	94.6	98.3	97.0	94.8	93.7	92.1	91.6
6300		85.6	90.6	94.9	99.0	96.7	94.4	92.1	92.6	92.1
8000		83.5	90.5	94.1	98.8	97.0	93.7	91.6	90.9	90.0
10000		82.0	90.6	93.7	97.3	95.2	93.5	91.6	89.3	88.7
12500		81.1	90.0	93.1	95.1	94.6	93.3	87.8	86.9	88.4
16000		81.1	87.6	91.6	94.4	94.3	92.8	87.7	86.3	86.9
20000		78.4	86.4	90.1	93.9	92.5	93.2	85.8	84.7	-----
25000		77.5	87.0	88.8	91.3	91.7	92.2	85.4	83.5	-----
31500		-----	-----	-----	90.9	90.6	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	99.0	103.4	107.0	110.6	111.4	112.0	115.0	115.4	114.7
100	2	76.3	74.9	81.4	83.2	84.7	89.4	91.6	95.6	94.7
125	↓	77.1	75.6	82.3	82.9	85.1	89.9	94.2	96.6	95.8
160		75.6	77.7	83.4	86.4	88.0	92.8	95.8	98.7	97.7
200		79.3	81.4	85.5	88.9	91.3	95.8	99.3	102.5	100.6
250		78.6	82.8	86.8	90.3	92.0	97.8	101.9	102.8	103.3
315		80.2	85.3	87.8	90.9	93.0	97.1	101.4	102.0	103.0
400		81.0	87.5	88.4	91.8	95.4	99.1	102.2	102.8	103.5
500		83.8	86.6	88.4	93.1	95.3	99.4	102.5	101.3	101.4
630		84.7	87.4	91.5	93.9	97.8	100.6	102.7	101.1	99.6
800		85.0	89.5	92.2	95.0	98.1	99.6	100.3	99.4	97.1
1000		84.9	88.4	93.2	95.0	98.1	99.6	98.2	95.8	95.5
1250		84.7	89.0	91.4	95.4	98.1	96.2	96.3	94.5	93.3
1600		85.8	89.3	91.5	95.6	95.9	96.0	96.5	94.5	93.7
2000		85.5	88.7	92.3	95.6	96.3	95.1	94.6	92.6	90.9
2500		84.6	88.2	91.9	96.0	96.1	94.0	93.3	91.7	90.0
3150		84.5	88.2	92.3	95.6	96.3	91.7	92.5	89.9	87.4
4000		85.4	88.7	91.2	95.0	94.6	92.2	91.1	88.0	87.6
5000		83.3	89.7	89.8	93.8	93.8	90.2	90.8	87.6	88.1
6300		82.1	88.1	90.0	93.5	93.1	90.2	89.9	89.7	85.7
8000		78.5	86.0	89.9	93.5	92.1	89.1	87.4	87.1	86.2
10000		78.5	85.1	89.4	92.4	91.9	89.0	86.3	84.4	84.6
12500		78.5	85.8	88.5	92.5	91.2	88.9	85.4	83.0	83.2
16000		78.0	84.6	88.0	90.1	91.4	88.3	82.3	82.7	82.4
20000		75.7	82.2	87.3	89.4	89.4	89.0	81.7	81.8	81.0
25000		-----	-----	85.9	87.3	88.7	87.0	-----	-----	-----
31500		-----	-----	-----	-----	87.3	86.1	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	96.3	100.6	103.7	107.0	108.5	109.5	111.4	111.4	111.1
100	3	75.0	73.4	78.6	80.6	82.5	84.6	88.4	91.1	89.6
125	↓	76.5	76.2	80.8	80.5	87.0	88.3	91.2	89.0	92.1
160		73.6	77.6	82.0	83.8	86.8	87.7	92.9	94.6	95.9
200	↓	77.1	79.9	84.2	86.6	89.9	89.5	95.1	96.9	97.2

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(b) Continued. QCGAT II

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
250	3	77.6	80.8	84.6	87.5	89.2	92.6	96.9	97.5	99.0
315		78.9	79.8	85.9	86.9	90.7	94.4	97.3	98.8	99.0
400		79.5	82.9	86.6	89.3	91.7	93.6	97.9	96.8	98.3
500		80.0	85.9	87.0	90.4	92.7	92.6	96.1	95.5	96.2
630		80.9	85.7	88.7	91.5	93.8	94.8	96.5	95.4	94.0
800		81.4	85.0	88.6	93.8	94.0	94.6	94.0	93.5	91.9
1000		82.3	86.0	89.2	92.9	94.9	94.2	93.6	91.4	89.6
1250		82.0	85.7	88.7	92.5	94.7	91.4	91.8	89.6	88.1
1600		83.2	86.4	89.3	92.6	92.8	91.9	92.1	90.1	88.2
2000		83.2	86.6	89.8	93.3	93.1	90.8	90.8	88.5	85.9
2500		82.7	85.5	89.4	93.0	92.8	89.4	89.3	87.4	85.2
3150		82.6	86.2	89.7	93.0	92.4	88.2	88.2	85.7	84.6
4000		81.0	86.3	88.8	91.8	92.6	87.7	88.1	85.2	82.6
5000		80.4	86.0	89.8	91.4	90.4	86.7	88.0	85.2	84.7
6300		80.1	84.8	88.7	90.8	89.4	87.1	88.1	86.0	83.3
8000		77.7	83.7	87.5	90.2	89.7	85.4	84.1	83.4	82.9
10000		76.3	82.9	87.0	89.9	88.5	85.8	82.3	81.6	80.9
12500		75.9	83.3	87.1	88.8	88.4	84.7	81.3	79.0	80.6
16000		75.6	82.1	85.8	87.0	87.5	-----	80.3	-----	79.3
20000		73.5	79.7	84.9	85.9	85.6	-----	79.2	-----	79.1
25000		-----	-----	83.8	85.2	84.4	-----	77.8	-----	-----
31500		-----	-----	82.6	-----	84.2	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		93.8	97.9	101.5	104.4	105.3	104.5	106.6	106.4	106.7
100	4	72.5	74.8	78.1	81.0	81.6	81.5	85.9	89.3	89.2
125		76.4	77.5	80.3	81.3	82.4	84.4	89.0	90.1	90.2
160		72.4	75.9	80.3	82.3	84.2	88.0	88.5	90.6	92.4
200		73.8	76.8	81.4	84.3	86.0	89.3	94.1	95.3	95.3
250		75.1	78.7	82.1	85.8	87.7	90.7	93.3	94.6	93.9
315		76.1	80.4	84.6	86.9	89.5	91.1	94.6	93.3	94.4
400		76.8	82.9	85.2	87.9	90.6	91.9	95.8	94.6	94.5
500		78.4	82.1	84.9	86.9	90.8	91.1	94.6	93.4	92.5
630		78.1	83.4	87.4	89.6	91.9	92.8	94.0	91.7	91.3
800		80.2	84.9	87.0	90.8	92.2	92.3	93.4	91.2	89.9
1000		81.3	85.1	87.3	89.8	92.7	90.6	92.0	88.4	86.9
1250		80.2	85.2	86.6	89.5	91.9	89.1	89.2	87.5	85.5
1600		80.6	84.7	87.1	89.9	90.4	89.5	89.4	87.2	86.3
2000		80.6	84.3	87.1	90.1	90.0	88.3	88.1	85.8	84.2
2500		79.7	83.4	87.2	90.2	89.8	86.3	86.5	84.7	82.8
3150		78.5	84.5	85.0	91.0	89.1	84.6	85.1	81.8	81.1
4000		78.5	83.0	85.3	90.2	88.9	84.9	84.9	81.4	80.5
5000		77.5	81.4	84.4	88.4	88.1	84.4	83.0	81.3	79.2
6300		75.5	79.9	82.3	84.2	87.0	83.4	81.9	80.1	80.9
8000		74.0	80.9	84.3	85.4	85.9	81.6	81.3	77.3	79.2
10000		72.6	80.6	83.8	85.2	84.5	-----	78.9	77.1	77.4
12500		72.5	79.7	82.4	83.7	84.9	-----	76.5	76.4	76.6
16000		72.4	78.6	82.3	83.4	82.6	-----	-----	-----	-----
20000		70.6	76.5	80.8	82.1	82.0	-----	-----	-----	-----
25000		-----	76.2	79.3	80.8	81.0	-----	-----	-----	-----
31500		-----	-----	78.9	80.2	80.4	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		91.3	95.9	98.7	101.6	102.7	102.0	104.2	103.5	103.3
100	5	73.3	73.3	74.3	78.3	79.0	82.2	84.9	85.5	83.5
125		75.7	76.0	77.1	80.7	80.1	82.5	87.7	86.0	89.2
160		72.6	73.6	77.4	81.3	82.4	83.0	88.9	88.4	90.4
200		72.9	74.2	81.0	82.7	84.5	87.7	90.0	92.4	92.5
250		72.0	75.7	80.0	83.4	84.3	88.7	91.3	93.2	92.5
315		73.9	76.4	82.9	84.8	86.6	88.2	90.5	91.9	91.2
400		74.6	78.6	82.5	86.6	86.9	87.9	90.5	90.7	90.2
500		75.5	79.3	83.9	86.6	86.4	88.2	88.9	90.0	89.7

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(b) Continued. QCGAT II

Fre- quency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
630	5	75.0	81.5	85.0	87.6	87.6	89.7	90.3	90.0	88.0
800		77.1	83.0	84.9	88.2	88.4	88.8	89.1	88.1	86.4
1000		77.7	82.0	86.3	88.5	89.9	88.5	87.2	85.7	84.9
1250		77.0	81.8	83.6	87.1	89.0	86.8	85.6	84.9	83.7
1600		78.2	82.5	84.6	88.0	87.7	86.2	86.1	83.8	83.5
2000		77.9	82.1	84.9	87.6	87.2	85.2	84.4	83.1	81.3
2500		77.2	81.2	84.8	87.6	87.3	84.0	82.8	81.5	80.0
3150		78.0	80.3	82.7	87.5	85.4	83.8	82.5	80.0	78.0
4000		77.1	81.9	84.4	87.7	85.4	83.5	82.5	79.6	77.3
5000		74.7	81.8	84.6	86.1	86.0	80.1	80.6	77.1	77.1
6300		73.1	78.2	81.8	84.6	83.8	82.1	79.5	77.3	75.3
8000		71.0	79.5	82.4	84.7	82.7	81.1	77.7	74.7	75.9
10000		70.0	77.8	81.9	84.1	82.4	79.4	74.7	72.3	75.0
12500		70.0	76.8	79.5	81.9	82.4	79.3	72.6	73.1	73.9
16000		69.8	76.0	79.9	81.4	81.4	79.7	71.6	71.3	73.3
20000		68.4	75.3	78.3	80.0	81.0	79.1	-----	70.4	72.7
25000		67.2	74.5	76.4	78.9	80.4	76.7	-----	-----	-----
31500		-----	-----	-----	-----	-----	75.9	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		89.0	93.5	96.7	99.6	99.6	99.5	100.6	100.9	100.6
100	6	73.8	70.7	74.3	77.9	77.9	77.4	80.3	82.1	81.3
125		75.9	74.8	76.3	78.4	79.4	77.6	82.2	82.4	81.6
160		67.9	70.7	73.6	79.9	79.7	79.6	83.2	84.2	85.0
200		71.5	73.3	77.5	78.8	81.4	81.5	86.7	86.9	85.3
250		70.8	75.0	77.9	79.8	82.3	83.9	85.3	85.3	86.5
315		72.8	74.9	78.2	81.5	83.0	82.9	85.6	85.8	84.2
400		72.1	75.9	77.9	81.8	82.3	83.6	84.5	85.3	84.5
500		73.2	78.3	79.4	82.9	82.2	83.3	83.8	84.3	83.2
630		73.5	79.0	81.2	83.8	85.8	84.3	84.9	84.6	82.8
800		74.1	78.7	80.7	84.4	84.9	84.2	83.9	82.8	80.1
1000		75.0	79.7	81.4	83.2	84.6	83.7	82.7	81.5	78.4
1250		73.5	78.7	80.5	83.4	85.2	81.3	80.9	79.5	78.1
1600		74.9	79.5	80.8	83.5	82.7	81.3	81.4	79.7	77.9
2000		74.4	78.6	81.2	83.5	83.1	80.0	79.8	78.3	76.0
2500		73.6	77.4	79.8	83.2	82.9	79.5	78.0	77.3	75.1
3150		72.5	76.6	79.8	82.8	79.4	76.5	76.4	74.9	72.5
4000		72.7	75.6	77.7	80.7	80.4	77.6	74.7	74.4	72.1
5000		69.7	73.7	78.9	78.7	78.4	74.4	74.4	72.4	-----
6300		70.5	75.2	76.6	79.2	77.4	75.1	72.5	71.8	-----
8000		69.3	74.4	76.6	76.7	78.0	72.8	70.8	70.8	-----
10000		67.6	74.3	74.9	77.2	75.2	-----	70.1	68.8	-----
12500		65.9	73.5	73.2	77.2	76.3	-----	68.7	67.7	-----
16000		66.3	72.3	74.0	75.6	74.8	-----	-----	-----	-----
20000		64.7	71.7	71.9	74.1	-----	-----	-----	-----	-----
25000		64.4	-----	71.5	-----	-----	-----	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		86.2	90.1	92.3	95.0	95.4	94.2	95.4	95.4	94.4
100	7	72.8	70.8	70.7	72.4	75.4	75.0	74.4	77.8	77.5
125		75.3	73.9	74.2	75.9	76.4	74.9	76.0	79.1	77.7
160		64.5	64.1	72.1	74.0	76.3	75.0	79.3	79.1	76.7
200		65.6	67.9	73.9	76.1	77.0	79.4	79.6	80.6	80.5
250		67.6	70.8	71.8	75.6	77.1	76.7	81.3	80.3	80.9
315		66.7	69.8	73.1	76.4	77.6	77.3	77.6	81.5	79.0
400		66.9	72.3	75.2	76.0	77.9	77.7	79.3	80.4	78.8
500		68.6	73.7	74.8	76.7	78.7	78.5	80.1	79.7	77.6
630		68.2	73.3	76.8	75.9	78.9	79.6	80.9	80.5	77.5
800		69.7	74.2	76.1	77.0	79.1	77.8	77.7	78.5	75.2
1000		69.5	74.2	77.2	77.4	79.4	78.4	77.5	77.1	73.8
1250		69.7	74.1	76.3	78.0	78.8	76.5	75.5	75.0	73.2

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(b) Concluded. QCGAT II

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
1600	7	71.0	74.3	76.3	77.9	77.7	77.1	76.9	75.0	73.9
2000		70.6	74.5	76.7	77.8	78.1	75.3	74.9	73.4	71.8
2500		69.8	73.1	76.0	77.2	78.1	74.8	73.5	72.4	71.0
3150		70.4	73.0	75.0	76.1	76.7	74.3	73.3	69.9	69.5
4000		69.9	72.5	74.0	75.1	75.3	75.0	71.9	69.7	68.1
5000		67.1	74.2	72.9	73.8	74.0	70.0	70.5	67.8	-----
6300		66.2	71.9	72.4	73.4	72.4	70.2	69.9	67.6	-----
8000		64.2	73.0	71.5	73.3	72.1	69.2	67.5	67.2	-----
10000		62.6	71.0	71.6	73.7	71.0	68.6	66.1	65.6	-----
12500		61.6	71.3	70.7	71.5	-----	-----	65.5	64.9	-----
16000		61.8	70.0	69.7	70.6	-----	-----	-----	-----	-----
20000		60.7	69.3	68.2	69.7	-----	-----	-----	-----	-----
25000		-----	69.0	66.6	-----	-----	-----	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		82.8	86.4	88.1	89.4	90.3	89.5	90.3	90.7	89.1

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(c) QCGAT III

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	77.4	76.4	83.7	85.8	87.6	90.4	94.1	95.8	98.3
125		78.8	78.4	85.0	86.7	90.2	92.7	97.7	97.2	101.6
160		76.3	78.8	84.4	86.5	93.0	95.9	99.5	101.5	102.7
200		81.4	84.3	87.5	91.3	95.4	99.9	104.8	106.1	105.4
250		81.1	84.9	89.9	91.5	98.5	100.7	105.5	106.0	106.9
315		82.2	86.3	89.6	93.5	99.0	103.6	107.9	107.7	107.1
400		84.4	86.8	92.1	96.0	100.6	106.0	108.6	109.4	108.5
500		83.2	89.6	92.7	97.5	101.8	106.2	108.9	107.5	108.4
630		85.6	90.9	94.1	98.0	103.8	107.2	108.6	107.6	107.8
800		87.0	91.1	95.2	100.0	103.2	107.4	108.0	106.4	104.8
1000		87.7	92.1	95.4	99.7	103.9	106.4	106.1	104.1	102.5
1250		87.1	91.8	95.1	98.4	103.1	104.2	103.9	-----	100.0
1600		88.0	92.4	95.3	99.2	101.6	103.9	103.3	-----	99.7
2000		88.5	91.7	95.7	98.6	100.9	102.5	100.8	-----	97.4
2500		88.1	92.0	95.6	98.7	100.5	100.3	98.7	-----	95.6
3150		89.5	90.8	93.4	98.8	100.1	97.8	95.4	-----	91.3
4000		88.1	92.3	94.3	99.7	99.0	97.3	93.8	-----	91.2
5000		85.3	91.1	94.2	98.3	96.7	94.4	91.8	-----	90.1
6300		85.3	90.1	93.6	99.1	93.6	94.2	89.4	-----	91.6
8000		83.5	90.1	94.9	96.0	94.2	92.3	87.4	-----	90.2
10000		80.9	90.3	93.8	94.8	94.3	89.6	86.4	-----	86.8
12500		81.0	88.8	92.3	92.2	94.0	88.5	85.6	-----	85.5
16000		80.3	86.9	91.9	92.0	92.3	89.0	84.3	-----	83.7
20000		77.6	84.9	90.4	90.4	91.2	87.0	83.3	-----	82.0
25000		76.4	-----	89.3	89.3	89.5	86.2	-----	-----	-----
31500		-----	-----	88.6	88.6	88.8	-----	-----	-----	-----
40000		-----	-----	88.1	88.5	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		99.0	103.4	107.2	110.7	113.3	115.9	117.4	116.4	116.6
100	2	75.0	75.3	81.3	83.0	85.6	89.3	93.2	94.0	92.5
125		77.3	76.3	83.2	85.4	86.9	91.4	95.9	96.3	94.8
160		75.1	80.0	83.5	87.8	89.4	92.9	96.7	98.3	100.1
200		77.9	80.9	85.4	90.7	92.6	95.4	99.9	102.1	102.9
250		81.3	83.9	88.1	88.9	94.1	98.2	102.9	104.8	103.9
315		81.6	83.3	88.1	91.7	97.1	100.3	104.2	105.9	105.8
400		82.2	86.9	89.2	93.4	98.7	101.5	106.0	104.7	105.7
500		83.7	87.5	90.3	93.8	97.6	1017	104.9	104.3	105.5
630		83.8	89.6	92.2	95.9	98.9	101.4	104.4	105.1	104.3
800		85.5	90.4	93.6	95.7	98.6	100.9	102.3	103.1	100.8
1000		86.5	90.8	93.1	96.0	99.1	99.9	100.9	100.2	98.7
1250		84.5	89.2	92.0	95.2	99.6	98.4	98.0	-----	95.8
1600		85.7	89.7	92.3	95.8	96.8	98.2	97.8	-----	94.1
2000		85.8	89.9	92.3	95.4	96.6	95.9	95.8	-----	92.0
2500		85.0	88.9	92.2	95.5	96.5	94.0	93.4	-----	90.2
3150		84.9	89.7	91.3	94.4	96.3	92.7	91.0	-----	87.6
4000		84.6	88.7	91.5	95.7	94.8	92.2	89.3	-----	84.1
5000		82.9	86.7	89.2	94.0	94.0	89.7	86.2	-----	84.2
6300		81.8	86.0	89.1	91.9	91.6	90.4	86.1	-----	84.2
8000		80.3	87.2	89.7	92.5	91.3	89.2	85.0	-----	80.9
10000		79.4	85.5	89.7	91.3	90.4	87.3	83.3	-----	80.3
12500		78.5	84.6	87.0	90.0	90.5	86.7	82.0	-----	79.5
16000		76.2	83.2	86.5	88.7	89.2	84.9	81.8	-----	79.1
20000		75.9	83.0	85.8	87.6	88.5	84.7	80.4	-----	78.8
25000		74.4	82.0	84.8	86.8	-----	83.9	-----	-----	-----
31500		-----	80.8	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		96.6	101.1	103.9	107.1	109.4	110.7	113.3	113.4	113.6
100	3	74.3	73.1	78.3	81.4	83.7	84.5	89.2	93.6	90.4
125		76.3	75.9	80.0	81.2	84.1	87.2	91.4	95.2	93.2
160		73.8	76.8	78.9	85.0	85.8	91.0	93.0	96.7	93.7
200		75.0	77.5	83.9	84.7	88.8	92.9	95.2	98.9	98.9

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(c) Continued. QCGAT III

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
250	3	75.9	78.9	83.5	86.8	90.8	92.5	97.1	98.9	99.7
315		76.1	80.8	84.8	88.3	91.8	93.9	98.2	98.8	100.6
400		78.8	83.1	87.1	88.7	92.4	94.7	98.3	100.3	100.1
500		79.4	84.2	84.9	89.7	92.9	94.6	97.9	99.0	98.4
630		78.8	85.3	89.1	90.5	93.8	96.6	98.6	97.4	96.4
800		81.5	87.1	88.6	90.9	94.7	96.3	96.4	94.7	93.4
1000		82.4	86.8	90.4	92.3	95.6	95.5	94.4	91.5	91.5
1250		82.2	86.6	89.3	92.1	94.9	93.5	92.3	-----	88.5
1600		83.3	87.0	89.8	92.7	92.5	93.0	92.2	-----	87.6
2000		83.1	87.5	90.3	92.9	92.7	92.3	90.3	-----	86.0
2500		82.7	87.2	90.8	92.8	92.3	91.0	89.1	-----	85.5
3150		84.4	87.2	89.9	93.5	90.4	89.5	88.3	-----	84.0
4000		84.7	87.0	90.7	93.6	91.5	90.0	86.7	-----	82.9
5000		82.3	86.5	90.4	90.9	90.4	87.7	87.5	-----	82.3
6300		81.6	85.3	90.5	90.4	89.9	86.8	87.1	-----	83.0
8000		79.7	85.1	89.2	90.5	88.9	86.9	84.3	-----	81.6
10000		77.8	83.4	87.1	89.9	88.4	85.6	82.5	-----	79.5
12500		76.0	84.7	86.8	88.4	86.9	83.8	80.8	-----	77.4
16000		74.3	82.2	86.0	86.9	86.6	82.8	79.9	-----	-----
20000		74.7	80.0	84.5	84.7	86.1	81.7	79.4	-----	-----
25000		72.5	79.5	82.5	83.4	-----	-----	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		94.3	98.6	102.0	104.1	105.2	105.8	107.3	107.9	107.9
100	4	74.1	72.3	77.9	81.0	80.7	82.3	87.5	88.1	90.8
125		75.1	73.1	78.2	82.1	82.7	84.0	89.0	90.7	91.9
160		71.2	73.6	79.4	83.4	86.5	88.3	91.9	94.0	94.4
200		74.9	76.2	83.3	84.7	86.9	89.7	94.0	95.9	98.1
250		76.4	77.8	84.1	87.8	89.4	92.1	95.3	98.4	99.2
315		76.3	80.0	83.1	88.0	89.4	93.0	96.1	96.7	100.1
400		77.8	81.8	86.1	87.6	90.6	94.2	98.4	96.7	98.5
500		78.4	83.2	85.3	88.0	91.1	93.7	97.0	95.1	96.3
630		79.3	83.6	87.3	90.5	93.2	95.2	96.4	95.5	93.5
800		80.1	84.2	87.9	90.1	92.5	93.8	93.9	93.0	91.8
1000		80.2	84.0	86.9	90.6	93.3	93.6	92.3	90.1	88.6
1250		79.0	83.9	86.6	89.5	92.5	90.3	89.9	-----	85.2
1600		80.3	84.4	87.0	89.5	90.1	91.3	90.7	-----	85.2
2000		80.2	84.1	86.6	88.7	89.8	89.6	87.6	-----	83.6
2500		79.3	83.3	86.4	88.5	89.0	87.9	85.9	-----	81.9
3150		79.4	82.3	86.0	87.2	88.5	85.7	83.4	-----	79.9
4000		79.9	82.8	85.6	87.5	87.4	85.4	82.1	-----	77.0
5000		76.8	80.2	86.1	84.5	86.9	82.9	82.4	-----	76.3
6300		76.2	81.5	84.3	83.1	86.6	82.5	81.4	-----	74.9
8000		75.6	79.2	84.5	83.8	86.2	82.7	79.7	-----	-----
10000		72.8	79.7	83.5	83.6	85.5	80.7	77.7	-----	-----
12500		71.6	79.0	82.2	83.0	-----	80.4	-----	-----	-----
16000		70.4	78.1	82.1	81.0	-----	79.3	-----	-----	-----
20000		69.8	76.3	80.3	80.4	-----	-----	-----	-----	-----
25000		68.1	76.1	79.3	79.3	-----	-----	-----	-----	-----
31500		-----	-----	78.9	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		91.4	95.3	98.8	100.9	102.6	103.7	105.8	105.4	106.9
100	5	70.7	69.6	74.6	77.4	79.2	81.9	84.0	86.5	87.9
125		73.6	72.1	77.6	80.6	81.3	84.4	87.1	88.3	89.2
160		69.6	71.8	79.0	82.0	83.6	85.9	88.0	90.9	91.1
200		72.9	75.0	80.9	82.8	86.4	88.8	91.8	94.3	93.9
250		72.9	76.4	80.4	82.4	85.1	89.3	91.5	94.9	93.7
315		74.5	77.2	80.5	84.9	87.0	89.7	91.9	93.1	93.5
400		74.5	79.2	83.3	85.6	88.6	89.4	92.9	93.8	93.6
500		75.2	80.4	85.2	85.1	89.0	88.4	91.6	91.7	90.9

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(c) Continued. QCGAT III

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
630	5	76.3	81.4	85.3	87.5	90.5	90.1	92.6	92.4	90.1
800	↓	76.5	82.1	84.8	88.3	89.3	90.2	89.9	90.0	87.2
1000		78.4	82.0	85.8	89.0	89.0	89.5	89.0	87.1	84.9
1250		77.6	81.9	84.8	86.7	89.9	87.9	85.6	-----	82.5
1600		78.7	82.7	85.0	87.4	87.8	87.6	86.9	-----	82.5
2000		79.6	82.8	85.9	87.5	87.3	87.1	84.1	-----	80.6
2500		78.1	83.0	85.6	87.2	87.3	85.3	83.2	-----	79.5
3150		77.9	83.7	84.3	89.4	84.9	83.6	82.2	-----	78.4
4000		78.0	83.4	83.0	87.5	85.8	83.9	81.2	-----	75.9
5000		76.7	81.7	86.8	87.1	85.0	81.8	80.8	-----	76.8
6300		74.5	79.5	84.6	83.8	83.8	81.4	78.8	-----	76.1
8000		73.6	79.2	83.2	82.8	82.9	80.2	75.9	-----	74.3
10000		71.3	79.0	81.7	82.1	83.6	79.2	76.1	-----	71.4
12500		70.2	77.0	80.6	79.9	82.6	78.6	73.0	-----	68.8
16000		69.6	76.3	80.7	79.1	82.2	76.8	72.4	-----	-----
20000		68.8	73.8	78.4	77.6	81.5	75.6	70.6	-----	-----
25000		66.1	-----	75.8	76.1	-----	74.7	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	89.5	94.0	97.3	99.3	100.5	100.4	101.7	102.4	102.0
100	6	70.3	68.8	73.7	75.7	79.1	78.5	81.8	83.7	86.4
125	↓	74.0	71.2	74.2	78.2	80.6	80.0	83.3	83.4	86.4
160		68.5	69.7	74.1	78.4	82.1	83.5	86.2	85.1	87.4
200		71.2	72.7	77.3	80.3	81.5	86.7	87.1	89.5	89.3
250		71.2	75.0	79.0	79.6	82.8	86.7	89.5	88.4	91.0
315		70.2	75.6	79.3	81.3	85.2	86.4	87.2	90.6	91.1
400		72.2	76.3	79.6	82.4	86.5	85.9	88.0	89.2	88.8
500		72.4	77.8	80.9	82.4	85.7	85.7	87.5	88.3	86.8
630		72.7	78.5	81.9	83.3	86.7	85.5	87.5	88.0	85.9
800		74.2	79.8	81.8	84.4	85.2	84.7	85.9	85.2	83.2
1000		74.4	78.6	82.2	83.1	86.3	86.0	83.9	82.3	81.3
1250		72.9	77.2	80.2	82.2	85.5	82.2	82.1	-----	77.9
1600		74.0	77.6	80.0	82.2	83.2	82.6	81.8	-----	77.5
2000		73.8	77.1	79.5	81.4	83.0	81.1	79.2	-----	75.3
2500		72.2	76.1	79.2	80.6	82.4	79.7	77.8	-----	73.7
3150		72.8	76.2	77.7	78.8	82.3	77.6	74.8	-----	72.7
4000		73.3	75.4	77.5	78.0	-----	77.6	75.5	-----	70.8
5000		70.2	72.0	76.6	75.2	-----	74.4	73.6	-----	69.0
6300		71.0	72.4	76.7	74.8	-----	72.6	73.3	-----	68.8
8000		67.7	71.8	76.8	75.0	-----	73.9	73.8	-----	65.7
10000		65.9	71.3	75.4	74.9	-----	72.3	69.9	-----	-----
12500		65.5	70.9	72.9	74.6	-----	71.1	-----	-----	-----
16000		64.1	69.3	72.7	72.8	-----	70.8	-----	-----	-----
20000		64.0	68.3	72.3	71.5	-----	-----	-----	-----	-----
25000		63.1	-----	71.2	-----	-----	-----	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	85.4	89.2	92.4	93.9	96.2	96.3	97.5	97.9	98.4
100	7	72.1	67.7	71.4	71.6	75.1	74.8	79.8	78.2	80.4
125	↓	72.3	69.7	72.7	73.0	76.3	77.0	80.6	78.8	82.8
160		68.4	67.2	70.8	75.7	76.9	76.4	79.4	81.7	82.5
200		69.0	70.0	74.2	77.3	77.3	77.9	80.2	81.1	83.1
250		68.2	70.5	74.4	75.7	77.9	77.8	80.9	82.8	82.2
315		67.9	71.0	74.1	76.6	78.2	80.3	81.7	81.5	83.3
400		67.5	72.7	76.9	76.5	79.4	80.5	81.1	82.1	82.2
500		67.7	72.5	75.7	77.6	78.4	79.6	80.7	80.2	80.3
630		67.9	72.4	76.8	78.8	80.2	81.0	82.4	80.2	79.4
800		68.7	74.6	77.0	79.9	79.6	79.8	80.2	77.8	76.9
1000		69.5	74.1	76.9	78.8	79.7	78.4	78.4	76.3	74.5
1250	↓	69.5	72.9	76.5	78.2	79.5	77.1	75.7	-----	71.6

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(c) Concluded. QCGAT III

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
1600	7	70.5	73.3	76.0	77.5	77.2	77.0	76.2	-----	72.3
2000		69.7	73.1	76.3	77.4	78.1	76.1	74.3	-----	70.5
2500		68.8	71.5	75.3	75.9	77.1	74.4	72.6	-----	69.0
3150		67.7	70.2	74.5	74.0	77.3	72.8	73.1	-----	68.9
4000		66.5	68.7	73.8	72.2	77.4	71.5	73.3	-----	67.8
5000		65.5	67.4	73.2	70.5	77.4	70.4	68.4	-----	62.3
6300		65.4	68.0	72.3	70.9	76.3	69.6	69.3	-----	63.5
8000		62.3	67.3	72.9	71.4	76.4	68.8	67.7	-----	63.6
10000		62.6	66.1	70.0	71.7	-----	67.7	65.8	-----	60.9
12500		61.7	65.7	69.5	70.3	-----	67.8	66.6	-----	60.2
16000		61.4	65.4	68.4	68.4	-----	67.0	64.8	-----	-----
20000		60.4	64.6	66.7	67.9	-----	-----	-----	-----	-----
25000		58.6	64.6	66.7	66.7	-----	-----	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	81.9	84.6	88.3	89.6	91.2	90.4	91.6	91.0	91.8

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(d) QCGAT IV

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	74.8	75.6	82.8	86.7	87.3	90.1	95.0	96.5	96.8
125		76.7	77.2	82.8	87.8	88.4	92.6	95.1	99.2	99.0
160		75.5	79.3	83.4	87.9	89.4	95.1	100.8	100.3	101.2
200		80.3	82.9	87.9	91.0	94.1	97.0	102.4	103.5	102.3
250		79.9	82.4	88.8	93.3	96.6	97.9	104.3	107.5	104.1
315		81.5	86.3	89.9	91.7	98.3	100.1	105.1	106.7	105.2
400		83.5	88.9	92.4	94.2	98.4	102.2	104.9	105.7	106.0
500		84.3	89.1	92.0	95.3	98.5	101.7	105.6	104.5	105.2
630		85.5	89.1	94.2	94.9	100.5	103.1	103.8	102.4	102.2
800		86.7	92.0	94.1	97.6	101.3	101.8	102.2	101.8	101.2
1000		87.3	92.4	94.8	99.6	101.4	100.8	100.2	98.2	97.6
1250		87.5	92.0	94.4	99.0	102.0	98.1	95.3	96.0	94.4
1600		89.0	93.4	95.5	99.7	100.2	99.5	96.1	96.6	96.3
2000		89.7	93.6	96.4	100.1	100.4	98.4	94.6	95.5	94.8
2500		89.1	93.4	97.2	100.7	100.7	97.6	93.9	95.6	94.2
3150		89.7	93.5	96.8	101.8	100.6	95.6	93.4	93.8	94.2
4000		88.9	93.4	97.9	101.1	99.6	97.5	95.7	96.5	94.0
5000		86.5	92.5	97.7	97.0	100.2	95.4	91.4	96.7	94.5
6300		87.4	91.9	95.7	102.0	98.5	94.6	92.2	95.3	95.6
8000		83.7	91.4	95.6	99.8	97.3	94.8	88.1	94.3	93.5
10000		82.5	89.0	93.7	98.3	95.0	92.0	85.0	92.4	89.4
12500		80.8	88.6	92.8	95.7	94.4	89.6	82.7	88.0	86.0
16000		80.1	88.5	91.4	95.2	93.7	88.2	79.5	85.2	83.3
20000		77.7	86.3	89.9	94.2	92.1	87.8	77.1	82.5	81.3
25000		76.9	85.5	88.6	92.5	90.2	85.6	76.3	-----	-----
31500		-----	84.9	88.5	92.1	-----	-----	-----	-----	-----
40000		-----	83.9	87.9	91.5	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		99.5	104.5	108.1	111.8	112.4	112.0	113.8	114.6	113.7
100	2	73.4	75.3	80.2	82.1	86.1	89.6	91.7	93.9	96.2
125		74.5	77.1	83.3	84.4	86.6	90.0	93.3	95.0	97.0
160		76.1	78.4	83.3	86.1	87.8	89.2	96.7	96.8	98.6
200		79.2	80.4	85.0	87.6	91.2	95.0	101.5	101.0	101.0
250		79.7	82.6	86.4	90.0	90.7	95.4	101.7	103.4	105.2
315		80.5	84.8	88.0	90.9	93.0	96.4	102.4	102.6	104.1
400		81.6	86.3	89.8	92.0	94.8	96.7	102.7	103.5	102.2
500		83.0	88.8	90.1	92.3	95.0	97.9	101.6	101.8	100.3
630		83.9	90.6	93.0	94.8	97.1	98.0	100.5	101.4	99.3
800		85.2	91.3	92.1	94.6	96.1	97.2	99.1	98.6	96.4
1000		85.5	91.0	92.5	95.0	97.5	97.2	95.8	95.7	94.3
1250		84.9	90.2	91.7	95.8	97.7	93.9	90.6	92.2	91.5
1600		85.7	90.9	92.0	95.4	94.9	95.2	91.7	92.6	92.0
2000		86.5	90.3	92.9	95.6	95.5	93.5	89.2	91.6	90.3
2500		86.1	89.9	92.6	95.9	95.1	92.1	88.0	89.9	89.1
3150		86.1	88.4	91.8	95.9	94.5	90.1	88.6	88.8	87.3
4000		83.6	88.9	90.3	95.8	93.6	90.0	86.2	87.4	86.5
5000		83.0	87.0	91.6	94.4	93.1	86.7	-----	86.1	85.2
6300		81.9	87.3	89.1	93.3	89.8	86.5	-----	84.8	83.3
8000		80.4	85.2	89.8	93.2	89.6	86.6	-----	84.0	81.4
10000		78.8	86.1	88.2	93.4	89.1	85.4	-----	81.4	80.4
12500		76.9	83.9	88.3	91.3	87.6	83.6	-----	81.0	79.6
16000		77.7	84.4	87.5	90.8	87.6	83.2	-----	79.4	78.5
20000		75.2	82.1	87.0	89.6	86.1	82.6	-----	78.8	77.9
25000		74.3	81.4	84.1	87.6	85.0	81.5	-----	-----	-----
31500		-----	80.4	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		96.5	101.5	104.0	107.1	107.4	107.5	110.6	111.3	111.4
100	3	72.0	74.4	77.4	80.8	83.1	85.1	89.0	88.3	89.7
125		73.6	77.1	79.7	81.5	83.4	86.4	91.9	91.9	90.3
160		74.1	75.0	81.5	84.1	86.2	89.0	93.4	93.7	94.8
200		75.1	79.6	83.0	85.1	89.6	92.2	96.8	97.3	97.4

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(d) Continued. QCGAT IV

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
250	3	76.9	79.0	85.4	85.5	90.7	91.7	97.5	97.5	98.0
315		78.9	82.3	86.0	86.0	91.7	94.1	97.0	96.4	98.7
400		78.9	84.6	86.8	89.8	92.1	93.3	95.7	97.7	95.8
500		80.7	85.5	88.1	89.8	92.9	93.0	94.0	94.8	95.4
630		80.9	87.4	89.9	91.5	94.1	94.6	95.6	92.8	92.4
800		82.9	88.8	90.2	92.8	94.6	95.0	93.2	92.9	91.2
1000		83.8	88.6	90.9	93.5	96.0	93.7	93.0	91.1	89.6
1250		83.3	88.9	90.4	94.1	95.9	92.6	89.0	90.3	88.4
1600		84.5	88.9	91.2	94.9	94.3	92.9	89.3	90.2	88.9
2000		85.6	89.7	92.0	95.4	94.0	92.1	88.5	89.7	87.9
2500		85.2	89.6	92.4	95.9	94.4	91.5	87.5	88.7	87.9
3150		85.5	91.2	91.9	95.0	94.3	90.3	86.1	88.4	86.7
4000		85.3	89.3	92.0	95.4	93.5	92.2	86.6	88.8	86.5
5000		80.7	87.7	91.8	93.8	91.2	88.4	-----	85.9	83.3
6300		80.3	86.3	90.3	93.9	91.3	88.8	-----	85.3	85.5
8000		78.7	86.0	91.5	92.1	89.6	86.6	-----	84.6	82.0
10000		77.0	84.5	88.2	92.5	89.9	84.9	-----	79.5	80.6
12500		76.0	83.6	86.2	90.6	88.2	81.6	-----	77.8	76.9
16000		74.9	82.7	85.2	88.0	88.3	81.5	-----	76.7	74.7
20000		72.7	81.0	83.9	86.1	85.5	79.8	-----	73.8	73.7
25000		71.0	80.6	82.4	-----	85.0	78.4	-----	73.9	73.7
31500		-----	80.3	82.2	-----	-----	-----	-----	-----	-----
40000		-----	79.7	81.9	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		95.2	100.5	103.2	106.0	106.1	105.1	105.8	106.1	106.0
100	4	73.5	72.3	77.5	80.1	82.8	87.0	87.7	87.8	89.2
125		74.4	73.0	79.0	80.5	83.4	85.9	89.7	90.0	89.9
160		72.0	77.5	79.9	83.0	84.2	86.3	93.0	92.7	92.6
200		74.6	79.4	83.3	83.9	85.5	89.5	93.5	95.5	95.2
250		75.7	82.5	83.8	84.9	89.8	90.8	94.5	96.6	94.1
315		77.8	81.7	84.4	85.2	89.5	92.8	93.9	94.5	96.5
400		78.0	82.4	85.5	87.3	90.7	92.1	93.4	94.5	93.8
500		78.0	82.8	85.7	89.0	91.2	91.6	93.5	92.8	91.7
630		78.9	83.9	86.8	89.6	91.4	92.1	92.8	91.9	88.6
800		80.3	85.5	87.4	89.8	91.5	92.0	92.1	90.5	88.3
1000		81.9	85.0	87.4	88.6	91.6	91.0	90.2	87.6	86.4
1250		80.4	85.0	87.1	90.3	93.0	89.3	85.6	86.6	84.7
1600		81.2	84.9	87.0	90.6	90.6	89.1	85.1	86.5	85.0
2000		81.2	84.7	86.9	90.6	90.0	88.0	83.2	85.0	82.5
2500		80.8	84.1	87.0	90.0	89.5	86.9	81.9	83.3	81.9
3150		78.4	85.2	85.6	90.6	87.6	84.5	79.8	81.5	79.2
4000		79.1	83.2	87.7	90.2	87.0	85.9	80.8	80.7	78.4
5000		77.8	81.1	84.4	86.2	83.5	81.4	-----	79.5	77.3
6300		76.2	80.4	84.0	86.4	83.1	83.1	-----	79.0	78.6
8000		76.8	79.6	83.8	85.7	84.1	82.6	-----	78.5	75.9
10000		73.9	79.5	82.2	85.9	83.4	80.7	-----	76.8	75.0
12500		72.3	78.9	80.9	84.2	83.2	79.0	-----	74.3	-----
16000		71.7	77.4	80.6	83.0	82.3	78.4	-----	73.2	-----
20000		69.9	76.5	78.8	82.3	81.1	76.6	-----	71.8	-----
25000		68.5	75.5	77.4	81.3	79.6	76.0	-----	-----	-----
31500		-----	-----	-----	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		91.8	96.2	98.8	101.5	102.4	102.4	103.3	103.9	103.2
100	5	71.5	71.5	76.1	76.2	78.6	80.3	83.8	85.8	86.7
125		74.8	74.3	78.4	79.4	78.4	81.7	83.8	87.2	85.5
160		70.4	73.3	76.6	78.9	81.3	84.1	86.2	85.4	87.9
200		70.9	76.5	78.9	81.0	84.1	85.1	91.2	90.5	91.9
250		70.8	77.2	79.1	82.5	85.1	86.5	90.7	90.6	89.6
315		71.7	77.5	79.6	82.4	85.6	87.6	89.9	90.6	90.2
400		74.8	79.4	81.9	83.8	86.7	87.7	88.6	88.9	88.7
500		75.1	80.9	83.1	85.2	87.6	88.8	89.3	89.5	87.9

TABLE II. - Continued. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(d) Continued. QCGAT IV

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
630	5	76.3	82.1	84.3	86.2	89.1	88.8	88.7	89.1	86.0
800		77.8	83.4	85.2	87.5	88.8	88.1	88.6	87.6	84.8
1000		79.1	84.0	85.7	88.0	89.9	87.8	88.1	85.7	82.9
1250		78.8	84.2	85.0	88.6	90.0	86.7	83.3	84.8	82.4
1600		80.6	84.7	86.6	88.7	88.7	86.9	83.2	84.4	83.1
2000		80.4	84.3	87.2	89.5	88.7	86.1	82.4	83.0	81.8
2500		79.5	84.5	87.7	90.3	88.1	84.5	81.1	82.3	81.0
3150		79.0	84.4	86.1	90.3	88.1	81.6	80.2	82.1	80.0
4000		78.6	83.0	86.1	88.0	87.4	83.6	79.5	80.7	77.6
5000		76.7	82.1	87.9	87.3	87.7	81.9	-----	81.2	77.9
6300		76.3	83.1	87.2	88.9	84.5	79.8	-----	77.5	76.7
8000		73.4	80.6	84.6	85.6	84.5	79.9	-----	75.0	74.3
10000		68.8	79.2	82.3	84.9	81.5	76.0	-----	73.0	72.9
12500		68.9	78.1	80.5	82.6	81.2	75.4	-----	72.5	73.2
16000		68.9	77.5	79.5	81.4	81.1	75.2	-----	71.3	72.6
20000		68.1	74.2	79.6	79.9	78.2	73.4	-----	69.4	-----
25000		66.9	75.0	77.5	78.8	76.6	72.1	-----	-----	-----
31500		-----	74.7	76.7	-----	-----	-----	-----	-----	-----
40000		-----	73.8	76.1	-----	-----	-----	-----	-----	-----
50000		-----	-----	76.1	-----	-----	-----	-----	-----	-----
63000		-----	-----	75.8	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		90.1	95.4	98.2	100.2	100.3	98.8	99.5	99.8	99.2
100	6	69.5	70.4	72.7	76.7	77.4	77.1	81.6	81.5	84.8
125		72.1	72.0	75.2	78.7	78.8	79.5	81.0	81.8	84.9
160		68.8	70.5	75.0	76.8	78.3	80.2	83.5	84.3	85.6
200		70.0	73.6	76.8	78.5	81.5	82.2	85.3	85.1	88.5
250		71.7	75.1	77.8	79.6	81.9	81.8	84.7	87.3	89.1
315		71.8	76.4	78.1	80.2	83.3	83.0	85.9	86.6	88.1
400		72.5	77.5	78.5	82.6	82.5	82.8	86.6	85.8	83.7
500		73.0	79.1	79.3	81.2	83.5	82.8	82.9	84.7	84.8
630		73.2	78.6	81.5	83.6	84.6	83.9	85.6	82.9	83.6
800		73.9	79.0	81.8	84.7	83.1	84.2	83.8	82.7	81.3
1000		74.9	80.0	82.6	83.5	84.8	83.1	82.1	80.6	79.1
1250		73.6	78.7	80.9	83.9	84.7	82.2	77.8	78.3	77.2
1600		74.9	78.9	81.3	83.6	83.4	81.2	78.0	79.0	77.2
2000		74.8	78.1	80.9	83.5	82.8	81.0	76.1	76.8	75.4
2500		73.4	77.6	80.5	82.6	82.3	79.0	74.2	75.8	74.5
3150		73.6	75.7	78.2	81.0	80.2	76.2	72.7	73.1	71.0
4000		72.1	77.5	79.0	78.9	80.1	75.8	72.0	73.6	70.1
5000		67.8	73.8	78.0	77.0	78.9	74.7	-----	70.6	70.2
6300		69.2	73.0	75.5	78.0	77.5	73.4	-----	68.5	70.0
8000		68.0	73.8	75.1	77.9	76.1	74.0	-----	69.3	67.7
10000		65.8	73.1	75.3	76.5	75.8	71.4	-----	68.1	67.2
12500		64.8	70.2	72.8	76.1	75.2	70.3	-----	67.0	65.6
16000		64.7	69.4	72.5	74.9	73.8	69.9	-----	67.4	-----
20000		63.7	68.3	71.4	73.1	73.1	-----	-----	66.8	-----
25000		62.9	68.3	70.1	72.3	73.0	-----	-----	-----	-----
31500		-----	-----	69.7	-----	-----	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		85.7	90.0	92.5	94.6	95.2	94.1	95.0	95.2	96.4
100	7	71.5	71.0	71.5	72.6	74.0	76.8	78.9	81.3	78.4
125		73.8	73.1	73.4	73.0	73.7	77.6	80.6	82.0	80.6
160		67.7	68.1	73.1	74.3	73.8	76.3	80.3	80.9	80.1
200		67.0	72.0	72.5	75.0	78.2	78.7	80.0	82.2	81.0
250		66.7	72.6	71.3	76.7	77.6	79.1	80.8	80.2	80.6
315		66.5	72.7	74.9	76.6	78.7	77.7	80.1	81.4	79.3
400		67.0	73.0	76.3	77.2	77.5	78.4	79.1	81.0	79.3
500		68.9	73.6	75.9	76.6	78.6	78.4	79.2	80.6	78.6
630		68.4	73.9	76.9	78.3	79.0	79.3	78.9	78.5	76.4
800		70.5	75.2	76.2	79.3	79.4	79.0	77.1	77.4	74.5
1000		70.1	76.6	76.7	78.7	79.8	78.9	76.0	74.0	73.0
1250		69.9	74.9	75.7	78.5	78.6	76.0	72.7	74.0	72.1

TABLE II. - Concluded. LOSSLESS, FREE-FIELD JET MIXING NOISE DATA

(d) Concluded. QCGAT III

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
1600	7	71.2	74.7	76.0	78.7	77.4	76.1	72.6	73.7	73.8
2000		70.7	74.2	75.9	78.2	77.0	74.9	70.4	71.8	72.0
2500		69.5	73.0	74.7	77.1	75.8	73.2	68.8	69.9	69.9
3150		68.9	73.6	73.0	75.9	75.8	71.2	68.6	67.5	68.8
4000		67.8	72.4	71.5	74.7	73.4	71.1	68.3	67.2	68.6
5000		63.8	68.7	69.6	73.3	72.5	68.2	-----	68.6	-----
6300		63.4	67.6	70.8	71.8	71.8	67.9	-----	68.1	-----
8000		63.0	67.0	69.8	71.8	70.7	66.2	-----	65.9	-----
10000		61.8	66.8	68.2	71.3	70.8	66.4	-----	63.5	-----
12500		58.9	66.6	67.6	71.0	69.4	64.1	-----	62.4	-----
16000		59.7	65.2	66.4	69.6	67.9	64.1	-----	61.0	-----
20000		59.3	63.9	64.8	68.0	67.5	63.3	-----	60.5	-----
25000		57.4	-----	64.6	67.3	66.6	62.3	-----	-----	-----
31500		-----	-----	-----	-----	66.2	-----	-----	-----	-----
40000		-----	-----	-----	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	82.3	86.2	87.6	89.8	90.1	89.7	90.1	91.2	89.5

TABLE III. - UNADJUSTED PREDICTED (SEPARATE FLOW) LOSSLESS FREE-FIELD JET NOISE SPECTRA, QCGAT I

Fre-quency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	79.6	82.4	85.3	87.8	92.8	95.8	99.2	100.8	102.3
125		81.8	84.6	87.6	90.2	95.7	99.0	102.5	103.9	105.1
160		84.0	86.9	89.8	92.5	98.5	102.5	105.8	106.9	107.7
200		85.8	88.9	92.0	94.7	101.3	105.5	108.6	109.6	110.1
250		87.2	90.5	94.1	96.9	104.1	108.2	110.8	111.4	112.0
315		88.3	92.0	95.8	99.0	106.2	110.1	112.4	112.9	113.4
400		89.2	93.0	97.1	100.7	107.7	111.6	114.0	114.4	114.7
500		90.1	93.9	98.2	102.2	109.0	112.7	115.2	115.6	115.7
630		90.7	94.7	99.1	103.5	110.3	113.7	116.2	116.6	116.3
800		91.0	95.2	99.9	104.7	111.0	114.3	116.6	116.8	116.0
1000		91.3	95.6	100.4	105.4	111.1	114.0	116.1	116.3	115.0
1250		91.4	95.8	100.8	105.9	110.9	113.2	114.8	114.8	113.3
1600		91.3	95.7	101.0	105.9	110.1	112.0	113.2	113.0	111.4
2000		91.0	95.6	101.0	105.8	109.0	110.6	111.4	111.1	109.4
2500		90.6	95.3	100.9	105.5	107.9	108.9	109.5	109.3	107.5
3150		89.9	94.8	100.6	105.1	106.6	107.2	107.8	107.4	105.5
4000		89.2	94.1	100.0	104.5	105.3	105.7	106.0	105.5	103.5
5000		88.4	93.4	99.3	103.7	104.0	104.0	104.2	103.6	101.6
6300		87.4	92.5	98.6	102.8	102.7	102.5	102.4	101.8	99.6
8000		86.4	91.5	97.8	101.9	101.4	100.9	100.6	99.9	97.7
10000		85.3	90.5	96.8	101.0	100.0	99.3	98.8	98.0	95.7
12500		84.2	89.3	95.7	99.9	98.7	97.6	97.0	96.1	-----
16000		83.0	88.2	94.6	98.7	97.3	96.0	-----	-----	-----
20000		81.8	87.1	93.5	97.6	95.9	-----	-----	-----	-----
25000		80.7	85.9	92.3	96.4	-----	-----	-----	-----	-----
31500		-----	-----	91.1	95.2	-----	-----	-----	-----	-----
40000		-----	-----	90.0	94.0	-----	-----	-----	-----	-----
50000		-----	-----	88.8	92.9	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	102.4	106.8	111.7	116.2	120.5	123.1	125.1	125.3	124.7
100	2	78.6	81.5	84.1	86.2	90.4	93.3	96.3	97.6	98.9
125		80.9	83.7	86.3	88.5	93.2	96.6	99.7	100.8	101.7
160		82.9	85.8	88.6	90.7	95.7	99.6	102.7	103.6	104.3
200		84.5	87.7	90.7	93.0	98.6	102.6	105.2	105.7	106.3
250		85.7	89.1	92.6	95.1	101.0	104.6	107.0	107.3	107.8
315		86.7	90.3	94.0	96.9	102.7	106.2	108.5	108.9	109.2
400		87.6	91.3	95.1	98.3	104.0	107.4	109.8	110.3	110.4
500		88.3	92.1	96.1	99.6	105.4	108.5	110.9	111.4	111.2
630		88.8	92.7	96.9	100.7	106.3	109.3	111.5	112.0	111.3
800		89.1	93.1	97.5	101.6	106.7	109.1	111.3	111.7	110.6
1000		89.3	93.4	97.9	102.1	106.6	108.6	110.2	110.5	109.2
1250		89.2	93.8	98.2	102.3	106.2	107.5	108.7	108.7	107.3
1600		89.1	93.4	98.3	102.3	105.2	106.1	107.0	106.9	105.4
2000		88.6	93.1	98.2	102.1	104.1	104.6	105.2	105.0	103.5
2500		88.1	92.7	97.9	101.9	103.0	103.1	103.5	103.2	101.6
3150		87.4	91.9	97.4	101.4	101.8	101.5	101.7	101.3	99.6
4000		86.6	91.3	96.8	100.7	100.5	99.9	100.0	99.5	97.7
5000		85.8	90.5	96.1	99.9	99.3	98.4	98.2	97.6	95.7
6300		84.7	89.6	95.3	99.1	97.9	96.8	96.4	95.8	93.9
8000		83.6	88.6	94.4	98.1	96.7	95.3	94.7	93.9	91.9
10000		82.5	87.2	93.3	97.1	95.4	93.7	92.9	92.1	90.0
12500		81.4	86.3	92.2	96.0	94.0	92.1	91.1	90.2	88.2
16000		80.2	85.2	91.1	94.8	92.7	90.5	89.3	88.3	86.0
20000		79.0	83.7	89.9	93.7	91.4	89.0	87.5	86.5	-----
25000		77.9	82.9	88.7	92.5	90.0	87.4	-----	84.6	-----
31500		76.7	81.6	87.6	91.3	-----	85.9	-----	-----	-----
40000		-----	80.5	86.4	90.2	-----	-----	-----	-----	-----
50000		-----	-----	85.2	89.0	-----	-----	-----	-----	-----
63000		-----	-----	-----	87.8	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	100.3	104.5	109.3	113.1	116.2	118.2	120.0	120.4	119.8
100	3	77.2	80.1	82.7	84.4	87.8	90.9	93.7	94.5	95.2
125		79.4	82.4	84.9	86.6	90.0	93.8	96.9	97.5	97.9
160		81.3	84.4	87.1	88.9	93.0	97.0	99.5	99.8	100.1
200	↓	82.7	86.1	89.1	91.0	95.7	99.4	101.5	101.6	101.7

TABLE III. - Continued. UNADJUSTED PREDICTED (SEPARATE FLOW) LOSSLESS FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
250	3	83.9	87.3	90.7	92.9	97.3	100.9	103.0	103.2	103.1
315		84.8	88.3	91.9	94.4	98.7	102.1	104.4	104.9	104.5
400		85.6	89.3	92.8	95.6	100.5	103.3	105.4	106.1	105.5
500		86.3	90.0	93.7	96.6	101.4	104.0	106.2	106.8	106.0
630		86.7	90.5	94.4	97.5	102.0	104.0	106.1	106.7	105.4
800		86.9	90.8	94.9	98.1	102.2	103.6	105.2	105.6	104.2
1000		87.0	91.0	95.2	98.4	101.9	102.9	103.8	103.9	102.3
1250		86.9	91.0	95.4	98.6	101.1	101.5	102.2	102.0	100.4
1600		86.7	90.9	95.3	98.5	100.1	100.1	100.5	100.2	98.6
2000		86.2	90.5	95.1	98.4	99.0	98.5	98.8	98.4	96.7
2500		85.6	90.0	94.7	98.0	98.0	97.0	97.0	96.6	94.8
3150		84.9	89.3	94.1	97.4	96.8	95.5	95.2	94.7	92.8
4000		84.1	88.0	93.4	96.7	95.6	94.0	93.6	92.9	91.0
5000		83.1	87.7	92.7	96.0	94.3	92.5	91.8	91.1	89.1
6300		82.1	86.7	91.8	95.1	93.1	91.0	90.1	89.3	87.2
8000		81.0	85.6	90.8	94.1	91.9	89.5	88.3	87.4	85.3
10000		79.9	84.5	89.7	93.1	90.6	88.0	86.6	85.6	83.5
12500		78.7	83.4	88.6	91.9	89.3	86.5	84.8	83.7	81.5
16000		77.5	82.0	87.4	90.8	88.0	84.9	83.1	81.9	79.6
20000		76.4	81.0	86.2	89.7	86.7	83.5	-----	-----	-----
25000		75.2	-----	85.1	88.5	85.3	81.9	-----	-----	-----
31500		-----	-----	83.9	-----	-----	-----	-----	-----	-----
40000		-----	-----	82.7	-----	-----	-----	-----	-----	-----
50000		-----	-----	81.5	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		98.0	102.0	106.4	109.4	111.7	113.2	114.8	115.1	114.3
100	4	77.3	79.9	81.9	83.2	85.9	89.0	91.7	92.4	92.8
125		79.2	82.0	84.2	85.4	88.2	91.8	94.8	95.2	95.4
160		80.8	83.8	86.3	87.7	91.1	95.1	97.5	97.5	97.5
200		82.0	85.3	88.1	89.7	93.3	97.2	99.3	99.1	99.0
250		83.1	86.4	89.5	91.4	95.1	98.6	100.8	100.9	100.6
315		83.9	87.3	90.6	92.7	96.7	99.7	102.0	102.5	101.8
400		84.5	88.1	91.5	93.8	98.2	100.9	103.0	103.7	102.8
500		85.1	88.7	92.3	94.8	99.2	101.5	103.6	104.3	103.1
630		85.4	89.1	92.9	95.6	99.7	101.4	103.3	104.0	102.6
800		85.6	89.4	93.3	96.1	99.7	100.9	102.4	102.7	101.3
1000		85.4	89.5	93.5	96.4	99.3	100.0	101.0	101.0	99.4
1250		85.3	89.3	93.6	96.5	98.5	98.7	99.4	99.2	97.5
1600		85.0	89.1	93.5	96.4	97.6	97.2	97.6	97.4	95.4
2000		84.4	88.6	93.2	96.3	96.6	95.8	95.9	95.5	93.8
2500		83.7	88.0	92.7	95.9	95.5	94.3	94.2	93.7	91.9
3150		82.9	87.3	92.0	95.2	94.3	92.8	92.5	91.9	90.1
4000		82.0	86.5	91.3	94.5	93.2	91.3	90.7	90.1	88.2
5000		81.0	85.5	90.5	93.8	91.9	89.8	89.0	88.3	86.3
6300		79.9	84.5	89.6	92.9	90.7	88.4	87.3	86.5	84.0
8000		78.8	83.4	88.5	91.9	89.5	86.9	85.6	84.6	82.6
10000		77.7	82.3	87.4	90.8	88.2	85.4	83.8	82.8	80.7
12500		76.6	81.1	86.3	89.7	86.8	83.7	82.1	81.0	78.7
16000		75.3	79.8	85.1	88.6	85.6	-----	-----	-----	-----
20000		74.2	78.8	83.9	87.4	84.3	-----	-----	-----	-----
25000		73.0	-----	82.8	86.2	-----	-----	-----	-----	-----
31500		-----	-----	81.6	85.0	-----	-----	-----	-----	-----
40000		-----	-----	80.4	83.9	-----	-----	-----	-----	-----
50000		-----	-----	79.2	82.7	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		96.6	100.5	104.7	107.5	109.3	110.2	112.2	112.5	111.5
100	5	76.0	78.7	80.8	82.0	84.1	87.5	90.6	91.1	91.2
125		78.0	80.8	83.1	84.3	86.8	90.8	93.5	93.6	93.6
160		79.5	82.5	85.2	86.5	89.3	93.5	95.7	95.6	95.3
200		80.7	83.9	86.8	88.4	91.3	95.2	97.3	97.2	96.8
250		81.6	85.0	88.1	89.9	93.1	96.3	98.7	99.1	98.3
315		82.5	85.9	89.1	91.0	94.7	97.5	99.7	100.6	99.3
400		83.2	86.7	90.0	92.0	96.0	98.4	100.5	101.5	100.3
500		83.7	87.3	90.7	92.8	96.8	98.6	100.7	101.7	100.2
630		83.9	87.7	91.3	93.5	97.2	98.4	100.1	100.8	99.4

TABLE III. - Continued. UNADJUSTED PREDICTED (SEPARATE FLOW) LOSSLESS FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
800	5	84.2	87.9	91.6	93.9	97.1	97.8	99.0	99.2	97.6
1000		84.0	87.9	91.8	94.2	96.5	96.7	97.4	97.4	95.8
1250		83.9	87.8	91.7	94.3	95.7	95.3	95.7	95.6	93.9
1600		83.5	87.4	91.6	94.2	94.8	93.9	94.0	93.8	92.1
2000		82.9	87.0	91.3	94.1	93.8	92.4	92.4	92.0	90.2
2500		82.2	86.3	90.7	93.6	92.7	90.9	90.7	90.2	88.4
3150		81.5	85.6	90.0	93.0	91.6	89.5	89.0	88.4	86.5
4000		80.5	84.8	89.3	92.3	90.4	88.0	87.2	86.6	84.7
5000		79.5	83.8	88.4	91.5	89.2	86.6	85.6	84.8	82.8
6300		78.4	82.8	87.4	90.6	88.0	85.2	83.9	83.0	81.0
8000		77.3	81.7	86.3	89.6	86.8	83.7	82.1	81.2	79.1
10000		76.2	80.6	85.2	88.5	85.6	82.3	80.1	79.4	-----
12500		75.0	79.4	84.1	87.3	84.3	80.8	-----	77.5	-----
16000		73.8	78.2	82.9	86.2	83.0	79.3	-----	-----	-----
20000		72.7	77.0	81.7	85.0	81.8	-----	-----	-----	-----
25000		71.5	75.8	80.6	83.8	80.5	-----	-----	-----	-----
31500		-----	-----	-----	82.7	-----	-----	-----	-----	-----
40000		-----	-----	-----	81.5	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		95.1	98.9	102.8	105.4	106.8	107.8	109.4	109.9	108.7
100	6	75.8	78.3	80.0	80.5	81.8	84.7	87.6	88.1	88.1
125		77.4	80.1	82.1	82.8	84.5	87.8	90.4	90.6	90.3
160		78.6	81.5	83.8	84.8	86.7	90.0	92.2	92.3	91.9
200		79.5	82.6	85.2	86.4	88.5	91.4	93.8	94.1	93.5
250		80.4	83.5	86.2	87.6	90.1	92.6	94.9	95.6	94.8
315		81.1	84.3	87.2	88.6	91.6	93.8	95.9	96.7	95.9
400		81.5	84.9	87.9	89.5	92.7	94.5	96.6	97.4	96.3
500		81.8	85.3	88.5	90.3	93.3	94.4	96.2	97.0	95.9
630		82.0	85.5	88.9	90.8	93.5	94.2	95.4	95.9	94.7
800		81.9	85.5	89.1	91.1	93.2	93.4	94.2	94.3	92.9
1000		81.8	85.5	89.1	91.3	92.5	92.2	92.7	92.6	91.2
1250		81.3	85.2	89.0	91.2	91.8	90.9	91.1	90.9	89.4
1600		80.7	84.8	88.7	91.1	90.9	89.6	89.4	89.1	87.4
2000		80.0	84.1	88.2	90.7	90.0	88.2	87.8	87.3	85.7
2500		79.3	83.4	87.5	90.1	88.9	86.8	86.1	85.6	83.7
3150		78.4	82.5	86.8	89.4	87.8	85.4	84.5	83.8	82.1
4000		77.4	81.6	86.0	88.7	86.7	84.1	82.9	82.1	80.3
5000		76.3	80.6	85.0	87.8	85.5	82.6	81.2	80.3	78.4
6300		75.2	79.5	83.9	86.8	84.3	81.2	79.5	78.5	76.6
8000		74.1	78.4	82.8	85.7	83.2	79.8	77.8	76.8	74.8
10000		72.9	77.2	81.7	84.6	81.9	78.4	76.2	75.0	73.0
12500		71.7	76.0	80.5	83.5	80.7	77.0	74.5	73.2	71.1
16000		70.5	74.8	79.3	82.3	79.4	75.6	72.9	71.5	69.3
20000		69.3	73.7	78.2	81.1	78.2	74.1	71.2	-----	-----
25000		68.1	-----	77.0	80.0	76.9	72.7	-----	-----	-----
31500		-----	-----	75.8	78.8	-----	-----	-----	-----	-----
40000		-----	-----	74.6	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		93.0	96.6	100.2	102.2	103.2	103.8	105.2	105.7	104.7
100	7	73.8	76.4	78.2	78.7	79.5	82.1	85.2	86.0	85.6
125		75.2	78.0	80.0	80.7	81.8	84.3	87.2	87.8	87.2
160		76.2	79.1	81.5	82.3	83.5	85.8	88.6	89.4	88.8
200		77.2	80.1	82.6	83.6	85.2	87.2	89.7	90.5	90.1
250		77.9	81.0	83.5	84.6	86.6	88.5	90.8	91.5	91.1
315		78.5	81.7	84.3	85.5	87.7	89.3	91.2	92.1	91.5
400		78.9	82.2	84.9	86.2	88.4	89.5	91.1	91.7	91.1
500		79.1	82.7	85.3	86.8	88.7	89.3	90.4	90.7	89.8
630		79.1	82.6	85.6	87.1	88.5	88.7	89.4	89.4	88.3
800		79.0	82.5	85.6	87.3	88.1	87.6	87.7	87.8	86.6
1000		78.7	82.3	85.5	87.2	87.5	86.4	86.3	86.1	84.8
1250		78.2	81.9	85.3	87.1	86.8	85.2	84.7	84.4	83.5
1600		77.6	81.3	84.8	86.8	86.0	83.9	83.1	82.7	81.3
2000		76.9	80.6	84.2	86.2	85.0	82.6	81.5	81.0	79.5

TABLE III. - Concluded. UNADJUSTED PREDICTED (SEPARATE FLOW) LOSSLESS FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
2500	7	76.0	79.8	83.5	85.5	84.0	81.3	80.0	79.3	77.7
3150		75.1	78.9	82.7	84.8	82.9	80.0	78.4	77.6	76.0
4000		74.0	77.9	81.7	83.9	81.8	78.6	76.9	75.9	74.2
5000		72.9	76.8	80.7	82.9	80.7	77.3	75.2	74.2	72.4
6300		71.8	75.7	79.6	81.9	79.5	76.0	73.7	72.5	70.6
8000		70.6	74.6	78.5	80.8	78.3	73.6	72.1	70.8	68.9
10000		69.4	73.4	77.3	79.7	77.1	-----	70.5	69.1	67.1
12500		68.3	72.2	76.1	78.4	75.8	-----	68.8	67.3	65.2
16000		67.1	71.1	74.9	77.2	74.6	-----	-----	-----	63.5
20000		-----	69.9	73.8	76.1	73.4	-----	-----	-----	61.7
25000		-----	-----	72.6	74.9	-----	-----	-----	-----	-----
31500		-----	-----	71.4	73.7	-----	-----	-----	-----	-----
40000		-----	-----	-----	72.5	-----	-----	-----	-----	-----
50000		-----	-----	-----	71.3	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	90.1	93.5	96.7	98.3	98.7	98.8	100.1	100.6	99.9

TABLE IV. – UNAJUSTED PREDICTED (MASS AVERAGE) LOSSLESS,FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
100	1	76.5	79.8	83.1	85.2	87.9	91.2	94.3	95.1	95.4
125		78.7	82.0	85.7	87.4	90.1	94.1	97.5	97.9	98.2
160		80.9	84.3	87.5	89.6	92.9	97.3	100.2	100.3	100.2
200		83.0	86.4	89.7	91.9	95.4	99.8	102.2	102.0	101.8
250		84.7	88.2	91.6	93.9	97.3	101.3	103.7	103.9	103.4
315		86.0	89.6	93.1	95.4	98.9	102.4	105.0	105.6	104.7
400		87.0	90.6	94.3	96.6	100.7	103.7	105.9	106.8	105.8
500		87.9	91.6	95.2	97.6	101.9	104.4	106.6	107.5	106.2
630		88.7	92.4	96.1	98.5	102.7	104.5	106.5	107.3	105.8
800		89.3	93.0	96.7	99.2	103.0	104.1	105.6	106.0	104.4
1000		89.6	93.3	97.1	99.7	102.9	103.5	104.3	104.3	102.6
1250		89.9	93.6	97.4	100.0	102.2	102.2	102.7	102.5	100.8
1600		89.8	93.6	97.5	100.1	101.4	100.8	101.0	100.7	98.9
2000		89.7	93.5	97.4	100.0	100.5	99.4	99.3	98.9	97.0
2500		89.4	93.3	97.2	99.9	99.5	97.9	97.6	97.1	95.0
3150		88.8	92.8	96.8	99.5	98.3	96.4	95.9	95.3	93.3
4000		88.2	92.1	96.2	98.9	97.2	95.0	94.2	93.5	91.0
5000		87.5	91.4	95.5	98.2	96.1	93.3	92.5	91.7	89.6
6300		86.6	90.6	94.7	97.5	94.9	92.1	90.8	89.9	87.8
8000		85.6	89.6	93.8	96.5	93.7	90.6	89.1	88.1	85.9
10000		84.5	88.6	92.7	95.5	92.5	89.2	87.4	86.3	84.1
12500		83.4	87.4	91.6	94.4	91.2	87.7	85.6	84.4	-----
16000		82.3	86.3	90.5	93.3	90.0	86.3	-----	-----	-----
20000		81.1	85.2	89.4	92.2	88.7	-----	-----	-----	-----
25000		79.9	84.0	88.2	91.0	-----	-----	-----	-----	-----
31500		-----	-----	87.0	89.8	-----	-----	-----	-----	-----
40000		-----	-----	85.9	88.7	-----	-----	-----	-----	-----
50000		-----	-----	84.7	87.5	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		100.9	104.7	108.6	111.2	112.6	113.7	115.3	115.7	114.5
100	2	75.2	78.5	81.7	83.6	86.0	89.2	92.4	93.2	93.5
125		77.4	80.7	83.9	85.8	88.2	92.0	95.4	95.9	96.1
160		79.7	83.0	86.1	88.0	90.9	95.2	98.1	98.3	98.0
200		81.7	85.0	88.3	90.2	93.3	97.3	99.7	99.7	99.4
250		83.3	86.7	90.0	92.1	95.2	98.7	101.3	101.7	101.0
315		84.5	88.0	91.4	93.5	96.9	99.9	102.4	103.2	102.3
400		85.5	89.1	92.5	94.7	98.4	101.1	103.4	104.3	103.3
500		86.4	90.0	93.5	95.6	99.5	101.8	104.0	104.9	103.5
630		87.1	90.8	94.3	96.5	100.2	101.6	103.5	104.3	103.0
800		87.6	91.3	94.9	97.1	100.4	101.3	102.6	102.9	101.3
1000		88.0	91.6	95.3	97.5	100.3	100.6	101.2	101.1	99.5
1250		88.2	91.9	95.5	97.8	99.4	99.3	99.6	99.4	97.6
1600		88.1	91.8	95.5	97.9	98.8	98.0	98.0	97.6	95.8
2000		88.0	91.7	95.4	97.8	97.9	96.6	96.3	95.8	94.0
2500		87.6	91.4	95.2	97.6	96.9	95.1	94.5	94.0	92.2
3150		87.0	90.8	94.7	97.1	95.8	93.6	92.7	92.2	91.3
4000		86.3	90.1	94.0	96.5	94.8	92.3	91.2	90.4	88.5
5000		85.6	89.4	93.3	95.8	93.6	90.8	89.5	88.7	86.7
6300		84.7	88.6	92.5	95.0	92.4	89.4	87.9	86.9	84.8
8000		83.7	87.6	91.6	94.1	91.2	88.0	86.1	85.1	83.0
10000		82.6	86.5	90.5	93.1	90.0	86.6	84.5	83.3	81.1
12500		81.5	85.4	89.4	91.9	88.8	85.0	82.8	81.5	79.3
16000		80.4	84.3	88.3	90.8	87.5	83.7	81.1	79.7	77.6
20000		79.2	83.1	87.1	89.7	86.3	82.2	79.4	77.9	-----
25000		78.0	81.9	85.9	88.5	85.0	-----	-----	76.1	-----
31500		76.9	80.8	84.8	87.3	-----	-----	-----	-----	-----
40000		-----	79.6	83.6	86.2	-----	-----	-----	-----	-----
50000		-----	-----	82.4	85.0	-----	-----	-----	-----	-----
63000		-----	-----	-----	83.8	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		99.2	102.9	106.6	109.0	110.1	111.0	112.6	113.0	111.9
100	3	72.7	75.9	78.8	80.4	82.1	85.0	88.4	89.3	89.5
125		74.9	78.0	81.0	82.6	84.6	88.0	91.3	92.0	91.8
160		77.1	80.4	83.3	84.9	87.2	90.7	93.5	93.9	93.5
200		78.9	82.2	85.3	86.9	89.2	92.4	95.1	95.6	95.1

TABLE IV. - Continued. UNAJUSTED PREDICTED (MASS AVERAGE) LOSSLESS, FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
250	3	80.3	83.7	86.8	88.5	90.9	93.7	96.4	97.1	96.5
315		81.4	84.8	88.0	89.8	92.6	95.0	97.4	98.3	97.6
400		82.4	85.8	89.0	90.8	93.8	96.0	98.2	99.0	98.2
500		83.2	86.6	89.9	91.7	94.8	96.4	98.3	99.0	98.0
630		83.8	87.3	90.6	92.4	95.3	96.3	97.6	98.0	96.9
800		84.2	87.7	91.1	92.9	95.4	95.8	96.6	96.6	95.2
1000		84.5	88.0	91.3	93.3	95.0	94.8	95.2	95.0	93.5
1250		84.5	88.1	91.5	93.5	94.4	93.2	93.5	93.2	91.7
1600		84.4	88.0	91.4	93.4	93.7	92.3	91.9	91.5	89.9
2000		84.2	87.6	91.3	93.3	92.8	91.0	90.3	89.7	88.0
2500		83.7	87.4	90.9	92.9	91.9	89.7	88.7	88.0	86.3
3150		83.1	86.8	90.3	92.4	90.8	88.3	87.0	86.3	84.5
4000		82.4	86.1	89.6	91.7	89.7	86.9	85.4	84.5	82.7
5000		81.6	85.3	88.9	91.0	88.6	85.5	83.7	82.8	80.9
6300		80.7	84.4	88.0	90.1	87.4	84.1	82.1	81.0	79.0
8000		79.6	83.3	87.0	89.1	86.3	82.8	80.5	79.3	77.2
10000		78.5	82.2	85.9	88.0	85.1	81.4	78.9	77.5	75.4
12500		77.4	81.1	84.7	86.9	83.8	79.9	77.2	75.8	73.6
16000		76.2	80.0	83.6	85.8	82.6	78.5	75.6	75.0	71.8
20000		75.0	78.6	82.4	84.6	81.3	77.1	-----	-----	-----
25000		73.9	-----	81.2	83.4	80.1	75.7	-----	-----	-----
31500		-----	-----	80.1	-----	-----	-----	-----	-----	-----
40000		-----	-----	78.9	-----	-----	-----	-----	-----	-----
50000		-----	-----	77.7	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		95.6	99.1	102.6	104.5	105.3	105.7	107.1	107.5	106.6
100	4	72.3	75.6	78.4	79.9	81.5	84.4	87.9	88.8	88.9
125		74.6	77.8	80.6	82.1	84.1	87.6	90.8	91.5	91.3
160		76.7	80.0	82.9	84.4	86.6	90.1	92.9	93.3	92.9
200		78.5	81.8	84.8	86.4	89.8	91.7	94.5	95.0	94.5
250		79.9	83.3	86.3	88.0	90.3	93.0	95.7	96.5	95.8
315		81.0	84.4	87.5	89.2	91.9	94.4	96.7	97.5	96.9
400		81.9	85.3	88.5	90.2	93.2	95.3	97.5	98.3	97.4
500		82.7	86.1	89.3	91.1	94.2	95.6	97.4	98.1	97.2
630		83.3	86.8	90.0	91.8	94.6	95.5	96.8	97.1	95.5
800		83.7	87.2	90.5	92.3	94.7	95.1	95.7	95.7	94.4
1000		83.9	87.5	90.8	92.6	94.2	94.0	94.2	94.1	92.6
1250		84.0	87.6	90.9	92.8	93.6	92.8	92.7	92.3	90.8
1600		83.9	97.5	90.8	92.7	92.9	91.5	91.0	90.6	88.5
2000		83.6	87.2	90.7	92.6	92.1	90.2	89.4	88.9	87.2
2500		83.1	86.8	90.2	92.2	91.1	88.8	87.8	87.1	85.4
3150		82.5	86.1	89.6	91.7	90.1	87.5	86.2	85.4	83.6
4000		81.8	85.4	88.9	91.0	89.0	86.1	84.6	83.7	81.8
5000		81.0	84.6	88.2	90.3	87.9	84.7	82.9	81.9	80.0
6300		80.0	83.7	87.3	89.4	86.7	83.4	81.3	80.2	78.2
8000		79.0	82.7	86.2	88.4	85.5	82.0	79.7	78.5	76.5
10000		77.9	81.6	85.1	87.3	84.4	80.6	78.0	76.7	74.6
12500		76.7	80.4	84.0	86.1	83.1	79.2	76.4	74.9	72.8
16000		75.6	79.3	82.9	85.0	81.9	-----	-----	-----	-----
20000		74.4	78.1	81.7	83.8	80.6	-----	-----	-----	-----
25000		73.2	-----	80.5	82.6	-----	-----	-----	-----	-----
31500		-----	-----	79.4	81.5	-----	-----	-----	-----	-----
40000		-----	-----	78.2	80.3	-----	-----	-----	-----	-----
50000		-----	-----	77.0	79.1	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		95.0	98.5	102.0	103.9	104.6	105.0	106.3	106.8	105.8
100	5	70.2	73.4	76.0	77.3	78.6	81.2	84.7	85.9	85.9
125		72.5	75.6	78.3	79.6	81.1	84.1	87.5	88.4	88.0
160		74.6	77.7	80.4	81.7	83.4	86.3	89.4	90.1	89.6
200		76.2	79.3	82.2	83.5	85.2	87.9	90.7	91.6	91.1
250		77.4	80.7	83.5	84.9	86.8	89.1	91.8	92.7	92.2
315		78.4	81.9	84.6	86.1	88.3	90.4	92.8	93.5	93.1
400		79.2	82.6	85.5	87.0	89.5	91.2	93.3	94.0	93.4
500		80.0	83.3	86.3	87.8	90.2	91.3	92.9	93.4	92.7

TABLE IV. - Continued. UNAJUSTED PREDICTED (MASS AVERAGE) LOSSLESS, FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
630	5	80.5	83.9	86.9	88.4	90.6	91.2	92.1	92.3	91.3
800		80.8	84.2	87.2	88.8	90.5	90.5	91.0	90.9	89.7
1000		81.0	84.4	87.5	89.1	90.0	89.4	89.4	89.2	87.9
1250		80.9	84.3	87.5	89.1	89.5	88.3	87.9	87.5	86.1
1600		80.8	84.2	87.4	89.0	88.7	87.0	86.3	85.8	84.4
2000		80.4	83.9	87.1	88.8	87.9	85.8	84.6	84.1	82.6
2500		79.8	83.3	86.6	88.3	87.0	84.5	83.1	82.4	80.8
3150		79.1	82.6	85.9	87.7	86.0	83.1	81.5	80.7	79.1
4000		78.4	81.9	85.2	87.0	84.9	81.8	80.0	79.0	77.2
5000		77.5	81.1	84.4	86.2	83.8	80.5	78.4	77.3	75.5
6300		76.5	79.1	83.4	85.2	82.7	79.1	76.8	75.6	73.7
8000		75.4	79.0	82.4	84.2	81.6	77.8	75.2	73.9	72.0
10000		74.3	77.9	81.3	83.1	80.3	76.4	73.6	72.2	-----
12500		73.2	76.8	80.1	81.9	79.0	75.0	-----	70.4	-----
16000		72.0	75.6	79.0	80.8	77.9	73.6	-----	-----	-----
20000		70.8	74.4	77.8	79.6	76.7	-----	-----	-----	-----
25000		69.7	73.3	76.6	78.4	75.4	-----	-----	-----	-----
31500		-----	-----	-----	77.3	-----	-----	-----	-----	-----
40000		-----	-----	-----	76.1	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		92.0	95.4	98.5	100.2	100.6	100.7	102.1	102.5	101.8
100	6	68.7	71.6	74.1	75.2	76.2	78.5	82.3	83.6	83.3
125		70.9	73.9	76.4	77.4	78.5	81.1	84.6	85.7	85.2
160		72.7	75.8	78.4	79.5	80.6	83.0	86.3	87.3	86.8
200		74.1	77.2	79.9	81.1	82.4	84.5	87.5	88.4	88.1
250		75.2	78.4	81.1	82.3	83.9	86.0	88.6	89.4	89.2
315		76.2	79.4	82.1	83.3	85.3	87.1	89.4	90.1	89.9
400		77.0	80.2	83.0	84.3	86.3	87.6	89.5	90.1	89.8
500		77.6	80.9	83.6	85.0	87.1	87.7	89.0	89.4	88.8
630		78.0	81.3	84.1	85.5	87.1	87.4	88.1	88.3	87.4
800		78.3	81.6	84.4	85.8	86.9	86.6	86.8	86.8	85.7
1000		78.3	81.7	84.6	86.0	86.5	85.6	85.4	85.1	84.0
1250		78.2	81.6	84.5	85.9	85.9	84.4	83.8	83.5	81.2
1600		78.0	81.4	84.4	85.8	85.2	83.2	82.3	81.8	80.5
2000		77.5	80.9	83.9	85.5	84.4	82.0	80.7	80.1	78.7
2500		76.9	80.2	83.3	84.9	83.5	80.8	79.2	78.4	76.9
3150		76.2	79.6	82.6	84.2	82.5	79.4	77.6	76.8	75.2
4000		75.4	78.8	81.9	83.5	81.4	78.1	76.0	75.1	73.5
5000		74.4	77.9	81.0	82.6	80.3	76.9	74.5	73.4	71.7
6300		73.4	76.8	80.0	81.6	79.3	75.6	73.0	71.7	69.9
8000		72.3	75.7	78.9	80.5	78.1	74.2	71.7	70.1	68.2
10000		71.2	74.6	77.8	79.4	76.9	72.9	69.9	68.4	66.0
12500		70.0	73.5	76.6	78.3	75.6	71.5	68.2	66.7	64.6
16000		68.8	72.3	75.4	77.1	74.4	70.2	66.8	65.0	62.9
20000		67.6	71.1	74.3	75.9	73.2	68.8	65.2	-----	-----
25000		66.5	-----	73.1	74.8	72.0	67.5	-----	-----	-----
31500		-----	-----	71.9	93.6	-----	-----	-----	-----	-----
40000		-----	-----	70.7	-----	-----	-----	-----	-----	-----
50000		-----	-----	-----	-----	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL		89.4	92.7	95.6	97.0	97.3	97.2	98.4	98.9	98.3
100	7	65.6	68.5	70.7	71.5	71.9	74.0	78.0	79.7	79.3
125		67.6	70.6	72.8	73.7	74.2	76.2	80.0	81.4	80.6
160		69.2	72.2	74.6	75.5	76.0	77.8	81.3	82.5	82.5
200		70.4	73.5	75.9	76.8	77.7	79.4	82.4	83.3	83.5
250		71.4	74.5	76.9	77.9	79.0	80.8	83.4	84.1	84.4
315		72.3	75.4	77.9	78.9	80.3	81.7	83.9	84.5	84.8
400		73.0	76.1	78.6	79.7	81.1	82.0	83.5	84.0	84.0
500		73.5	76.6	79.2	80.3	81.6	82.1	83.0	83.3	82.9
630		73.8	77.0	79.6	80.7	81.6	81.6	82.0	82.1	81.3
800		74.0	77.2	79.8	80.9	81.4	80.6	80.5	80.5	79.7
1000		73.9	77.1	79.8	80.9	81.0	79.7	79.1	78.9	77.9
1250		73.8	77.0	79.7	80.8	80.5	78.6	77.6	77.2	76.0

TABLE IV. - Concluded. UNAJUSTED PREDICTED (MASS AVERAGE) LOSSLESS, FREE-FIELD JET NOISE SPECTRA, QCGAT I

Frequency, Hz	Run	Directivity angle, θ*								
		45°	65°	90°	110°	125°	135°	145°	150°	155°
		Sound pressure level, SPL, dB								
1600	7	73.5	76.7	79.4	80.6	79.8	77.5	76.1	75.6	74.5
2000		72.9	76.1	78.8	80.1	79.0	76.2	74.6	74.0	72.8
2500		72.2	75.4	78.2	79.4	78.1	75.1	73.1	72.3	71.0
3150		71.5	74.7	77.5	78.7	77.1	73.8	71.6	70.7	69.3
4000		70.6	73.9	76.6	77.9	76.1	72.5	70.1	69.1	67.6
5000		69.6	72.9	75.7	77.0	75.0	71.3	68.6	67.4	65.9
6300		68.5	71.8	74.6	75.9	73.9	70.0	67.1	65.8	64.1
8000		67.4	70.7	73.5	74.8	72.7	68.7	65.6	64.2	62.4
10000		66.3	69.6	72.4	73.7	71.5	-----	64.2	62.6	59.7
12500		65.0	68.4	71.2	72.5	70.3	-----	62.6	60.9	59.0
15000		63.9	67.2	70.0	71.3	69.1	-----	-----	-----	57.2
20000		-----	66.1	68.9	70.2	67.9	-----	-----	-----	55.5
25000		-----	-----	67.7	69.0	-----	-----	-----	-----	-----
31500		-----	-----	66.5	67.8	-----	-----	-----	-----	-----
40000		-----	-----	-----	66.6	-----	-----	-----	-----	-----
50000		-----	-----	-----	65.4	-----	-----	-----	-----	-----
63000		-----	-----	-----	-----	-----	-----	-----	-----	-----
80000		-----	-----	-----	-----	-----	-----	-----	-----	-----
OASPL	↓	85.0	88.2	90.9	92.0	91.9	91.6	92.7	93.3	93.1

TABLE V. - STATISTICAL COMPARISON OF DIFFERENCE BETWEEN EXPERIMENTAL AND ADJUSTED PREDICTED OASPL

(a) QCGAT I nozzle. Separate flow (ref. 1). For all 63 points: mean[a] = -0.4 dB; variance[b] = 0.8 dB; standard deviation[c] = 0.9 dB

Run	$(OASPL_{exp} - OASPL_{adj})$ dB = Δ									Overall		
	Angle from inlet axis, θ*, deg									Mean	Variance	Standard deviation
	45°	65°	90°	110°	125°	135°	145°	150°	155°			
1	0.4	0.1	-0.2	-0.3	-1.1	-0.8	-2.0	-2.5	-2.0	-1.0	2.4	1.5
2	0.5	0	-0.7	-0.4	-0.3	-0.8	-0.3	-0.7	-0.7	-0.4	0.3	0.5
3	0.2	-0.2	-0.4	0.4	-0.2	0.5	0.4	-0.7	0.5	0.1	0.2	0.4
4	1.4	1.4	0.4	0.1	-0.5	0.5	-0.2	0.2	0.6	0.4	0.3	0.6
5	-1.6	-1.0	-1.7	-0.7	-0.2	-0.5	-0.4	-1.2	0.1	-0.8	1.0	1.0
6	0.2	-0.6	-0.9	-1.3	-0.8	-0.8	-0.6	-1.0	-0.2	-0.6	0.6	0.8
7	-0.5	-0.3	-1.2	-0.9	0.1	0.3	-0.2	-0.5	-0.2	-0.4	0.3	0.6
Mean	0.1	-0.1	-0.7	-0.4	-0.4	-0.2	-0.5	-0.9	-0.4	----	---	---
Variance	0.8	0.5	0.9	0.5	0.3	0.4	0.7	1.4	1.5	----	---	---
Standard deviation	0.9	0.7	0.9	0.7	0.6	0.6	0.8	1.2	1.2	----	---	---

(b) QCGAT II nozzle. Mass averaged single flow (ref. 1). For all 63 points: mean[a] = -0.1 dB; variance[b] = 0.5 dB; standard deviation[c] = 0.7 dB

1	-0.8	-0.2	-0.5	-0.5	-0.1	-0.6	0.8	0.8	1.3	0.1	0.5	0.7
2	-1.2	-0.6	-1.2	-0.3	0.1	0.2	0.5	0.1	0.9	-0.2	0.5	0.7
3	-0.7	-0.1	0	1.0	1.1	-0.1	0.6	0	1.2	0.3	0.5	0.7
4	-1.3	-0.2	-0.9	0.1	0.5	-0.6	0.3	-0.9	-0.1	-0.3	0.5	0.7
5	-1.5	-0.4	-0.3	0.9	0.5	0.3	0	-0.1	0.3	0	0.4	0.6
6	-0.5	0.1	-0.6	0.7	0.8	-0.3	-0.3	0.8	-1.2	-0.2	0.4	0.7
7	0.2	0.6	-0.4	-0.2	0.8	0.3	0	-0.2	-1.6	-0.1	0.4	0.7
Mean	-0.8	-0.1	-0.6	0.4	0.5	-0.1	0.3	-0.2	0.1	----	---	---
Variance	1.0	0.1	0.4	0.4	0.4	0.1	0.2	0.3	1.1	----	---	---
Standard deviation	1.0	0.4	0.7	0.6	0.7	0.4	0.5	0.6	1.1	----	---	---

[a]Mean = $\Sigma\Delta/N$
[b]Variance = $\Sigma\Delta^2/N$
[c]Standard deviation = $\left(\Sigma\Delta^2/N\right)^{1/2}$

TABLE V. - Continued. STATISTICAL COMPARISON OF DIFFERENCE BETWEEN EXPERIMENTAL AND ADJUSTED PREDICTED OASPL

(c) QCGAT III nozzle. Mass averaged single flow (ref. 1). For all 63 points: mean[a] = 0.8 dB; variance[b] = 2.3 dB; standard deviation[c] = 1.5 dB

Run	$(OASPL_{exp} - OASPL_{adj})$ dB = Δ									Overall		
	Angle from inlet axis, θ*, deg									Mean	Variance	Standard deviation
	45°	65°	90°	110°	125°	135°	145°	150°	155°			
1	-0.8	-0.2	-0.3	0.6	1.8	3.3	3.2	2.0	3.2	1.4	4.4	2.1
2	-0.9	-0.1	-1.0	-0.2	1.0	1.4	2.4	2.1	3.4	0.9	3.0	1.7
3	-0.2	0.6	0.5	0.7	1.0	1.2	1.3	1.5	2.4	1.0	1.5	1.2
4	-1.2	-0.8	-0.8	-0.6	0.4	1.1	1.9	1.0	3.5	0.5	2.4	1.5
5	-1.0	0.1	0.3	0.6	1.4	1.2	1.1	1.4	1.7	0.8	1.2	1.1
6	-1.3	-0.8	-0.5	-0.3	1.6	1.8	1.8	1.7	2.8	0.8	2.5	1.6
7	-0.7	-1.2	-0.2	0	1.7	1.2	1.3	0.1	1.1	0.4	1.0	1.0
Mean	-0.9	-0.3	-0.3	0.1	1.3	1.6	1.9	1.4	2.6	----	---	---
Variance	0.9	0.4	0.3	0.2	1.8	3.1	3.9	2.4	7.4	----	---	---
Standard deviation	0.9	0.7	0.6	0.5	1.4	1.8	2.0	1.5	2.7	----	---	---

(d) QCGAT IV nozzle. Mass averaged single flow (ref. 1). For all 63 points: meana = 0.1 dB; variance[b] = 0.9 dB; standard deviation[c] = 0.9 dB

1	-0.3	0.9	0.6	1.7	0.9	-0.6	-0.4	0	0.3	0.3	0.6	0.8
2	-1.0	0.3	-0.9	-0.2	-1.0	-1.8	-0.2	0	1.2	-0.4	0.9	0.9
3	0.7	2.5	1.7	2.6	1.9	0.5	-0.2	-0.3	0.5	1.1	2.3	1.5
4	-0.8	0.1	-0.8	0	0.2	0.2	-0.5	-0.5	-0.2	-0.3	0.2	0.5
5	-0.4	1.5	1.2	1.5	1.2	-0.4	-1.1	-1.2	-1.1	0.1	1.3	1.1
6	-1.0	0	-0.4	0.3	0.6	-0.4	-0.7	-1.0	0.8	-0.2	0.4	0.7
7	-0.3	0.4	-0.9	0.2	0.6	0.5	-0.2	0.3	-1.2	-0.1	0.4	0.6
Mean	-0.4	0.8	0.1	0.9	0.6	-0.3	-0.5	-0.4	0	----	---	---
Variance	0.5	1.4	1.0	1.7	1.1	0.6	0.3	0.4	0.7	----	---	---
Standard deviation	0.7	1.2	1.0	1.3	1.0	0.8	0.6	0.6	0.9	----	---	---

[a]Mean = $\Sigma\Delta/N$
[b]Variance = $\Sigma\Delta^2/N$
[c]Standard deviation = $\left(\Sigma\Delta^2/N\right)^{1/2}$

TABLE VI. - POWER LEVEL SPECTRA dB (RE 10^{-13} W)

(a) QCGAT I

Frequency, Hz	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
	PWL, dB						
100	130.6	128.0	125.5	122.5	121.2	117.9	114.5
125	133.1	129.3	127.8	124.8	123.5	119.4	116.8
160	135.2	132.1	128.9	126.6	124.8	120.2	116.9
200	140.8	141.3	132.8	129.2	127.6	122.8	119.8
250	140.2	137.4	134.0	130.7	129.0	123.1	119.4
315	141.6	138.6	135.8	131.3	130.0	123.3	119.8
400	142.8	139.1	137.1	132.0	130.4	124.4	120.7
500	143.2	139.0	137.4	133.1	130.8	123.4	120.1
630	144.6	139.8	137.6	131.6	131.0	124.1	119.7
800	144.1	139.5	136.9	131.0	129.5	123.6	119.7
1000	144.0	139.1	136.3	130.7	129.1	123.2	119.3
1250	143.1	137.0	135.0	129.4	127.7	121.7	117.2
1600	143.6	137.2	134.2	128.5	127.0	120.3	116.2
2000	143.4	136.1	133.1	127.7	125.6	118.9	114.8
2500	142.8	135.5	131.5	126.5	124.2	117.7	113.6
3150	141.3	133.1	129.5	125.0	122.5	115.9	114.0
4000	139.0	131.6	127.8	125.2	121.4	115.5	113.2
5000	135.1	129.2	125.3	122.0	120.1	113.7	109.7
6300	133.5	127.9	125.7	122.1	119.2	113.0	109.1
8000	132.3	126.6	125.2	121.7	118.1	113.0	108.4
10000	130.6	126.3	123.5	120.9	-----	112.2	-----
12500	-----	125.4	122.3	120.0	-----	111.4	-----
16000	-----	124.8	121.6	-----	-----	110.9	-----
20000	-----	-----	-----	-----	-----	-----	-----
25000	-----	-----	-----	-----	-----	-----	-----
OAPWL dB	154.4	149.8	146.8	142.0	140.2	134.2	130.5
Ve, m/sec	331	310	275	264	240	213	186

(b) QCGAT II

100	127.8	126.8	122.6	121.4	118.5	116.2	113.1
125	130.1	127.9	124.9	123.1	121.5	117.5	114.9
160	132.6	130.0	127.3	124.4	122.4	118.1	112.9
200	136.3	133.2	129.2	127.5	124.8	119.8	115.1
250	137.2	135.1	130.7	127.2	125.3	120.2	115.0
315	138.2	134.9	131.3	127.9	125.0	120.0	114.5
400	139.8	135.8	131.1	128.7	124.9	119.9	114.9
500	139.0	135.2	130.2	127.8	124.6	120.0	115.3
630	138.6	135.5	130.6	128.3	125.3	121.3	115.8
800	137.7	134.5	130.2	128.3	125.1	120.8	115.1
1000	137.0	133.9	129.9	127.5	125.1	120.4	115.2
1250	135.9	132.7	129.0	126.6	123.9	119.8	114.7
1600	135.5	132.4	128.9	126.5	123.9	119.6	114.8
2000	134.9	131.8	128.8	126.0	123.4	119.2	114.5
2500	134.5	131.5	128.2	125.5	123.0	118.5	113.7
3150	134.3	131.2	128.1	125.0	122.2	117.3	116.5
4000	133.8	130.4	127.4	124.5	122.4	116.4	116.0
5000	133.2	129.4	126.8	123.3	121.6	-----	-----
6300	133.2	128.8	129.0	121.3	119.7	-----	-----
8000	132.8	128.0	125.2	121.4	119.6	-----	-----
10000	131.7	127.3	124.5	-----	118.7	-----	-----
12500	130.6	127.0	124.0	-----	117.4	-----	-----
16000	129.7	126.0	-----	-----	117.0	-----	-----
20000	-----	124.9	-----	-----	-----	-----	-----
25000	-----	-----	-----	-----	-----	-----	-----
OAPWL dB	149.2	146.0	142.1	139.2	136.7	131.7	127.2
Ve, m/sec	331	308	277	262	239	213	187

(c) QCGAT III

100	129.2	126.0	123.6	122.2	119.6	117.9	114.0
125	132.1	128.3	125.7	123.6	121.7	118.8	115.4
160	133.9	131.2	127.1	126.3	123.3	120.1	115.1

TABLE VI. - Concluded. POWER LEVEL SPECTRA dB (RE 10^{-13} W)

(c) Concluded. QCGAT III

Frequency, Hz	Run						
	1	2	3	4	5	6	7
	PWL, dB						
200	137.6	134.2	130.4	129.0	126.2	122.1	116.1
250	138.7	136.1	131.2	130.5	126.1	123.2	115.9
315	140.0	137.8	132.1	131.0	126.2	123.4	116.7
400	141.5	138.3	132.4	131.1	126.8	122.9	116.8
500	141.5	138.0	131.6	129.9	125.8	122.3	116.0
630	141.8	137.8	131.8	130.1	126.7	122.5	116.9
800	141.1	136.3	130.9	128.9	125.7	121.6	116.3
1000	140.1	135.4	130.7	128.4	125.4	121.4	115.6
1250	138.2	133.9	129.4	126.7	124.2	119.6	114.7
1600	137.8	133.2	129.0	126.6	124.1	119.1	114.2
2000	136.8	132.2	128.9	125.6	123.9	118.3	114.0
2500	135.7	131.5	128.5	124.8	123.3	117.3	112.7
3150	134.5	130.7	128.3	123.8	123.2	116.5	119.3
4000	134.5	130.4	128.5	123.5	122.4	117.4	120.1
5000	132.6	128.6	126.9	122.0	122.4	114.9	110.2
6300	132.3	127.3	126.5	121.2	120.3	117.8	109.6
8000	131.2	127.3	125.7	-----	119.2	116.3	109.5
10000	130.2	126.4	124.5	-----	118.5	-----	-----
12500	128.8	125.2	123.6	-----	117.1	-----	-----
16000	127.9	124.0	-----	-----	-----	-----	-----
20000	126.4	123.3	-----	-----	-----	-----	-----
25000	-----	-----	-----	-----	-----	-----	-----
OAPWL dB	151.1	147.4	142.7	140.5	137.5	133.4	128.7
Ve, m/sec	335	314	277	267	239	213	189

(d) QCGAT IV

Frequency, Hz	1	2	3	4	5	6	7
100	128.7	127.2	122.4	122.2	118.8	116.7	113.9
125	130.5	128.2	124.1	123.0	119.4	117.6	115.4
160	133.1	129.9	126.8	125.3	120.5	118.0	114.2
200	135.0	133.4	129.8	127.4	124.1	120.3	115.4
250	137.3	135.8	130.3	128.1	123.6	120.9	115.4
315	138.0	135.5	130.9	128.8	123.9	121.0	115.3
400	138.5	135.2	130.1	128.1	123.7	120.3	115.4
500	138.2	134.5	129.7	127.8	124.4	120.1	115.4
630	137.5	134.7	130.2	127.6	124.7	121.0	115.6
800	137.2	133.4	130.4	127.7	124.8	120.7	115.7
1000	136.5	133.0	130.6	127.0	125.1	120.6	115.7
1250	135.5	132.0	130.3	126.9	124.7	119.8	114.5
1600	135.8	131.7	130.3	126.4	125.0	119.5	114.7
2000	135.8	131.5	130.5	125.9	125.0	119.0	114.1
2500	135.9	131.0	130.7	125.3	125.0	118.1	112.8
3150	136.0	130.5	130.3	124.6	124.5	116.4	114.7
4000	136.0	129.9	130.3	124.7	123.5	117.4	114.1
5000	134.6	128.7	128.3	121.3	123.3	114.0	108.7
6300	135.2	127.2	127.9	121.1	123.0	113.2	108.5
8000	133.7	126.9	127.0	120.8	120.7	112.9	107.7
10000	131.8	126.4	125.9	120.0	118.8	112.0	108.2
12500	130.0	124.9	124.1	-----	117.3	110.6	108.0
16000	129.2	124.6	122.8	-----	116.6	-----	-----
20000	127.8	123.4	120.9	-----	-----	-----	-----
25000	-----	-----	-----	-----	-----	-----	-----
OAPWL dB	149.2	145.5	142.7	139.1	136.9	132.1	127.5
Ve, m/sec	330	313	279	264	238	216	186

TABLE VII. - PREDICTED POWER LEVEL SPECTRA dB (RE 10^{-13} W)

(a) QCGAT I Separate Flow

Frequency, Hz	Run 1	2	3	4	5	6	7	Full scale engine f, Hz
	PWL, dB							
100	133.5	130.5	127.6	125.6	124.2	121.4	119.5	31.5
125	136.3	133.5	130.3	128.3	126.9	124.0	121.3	40
160	139.3	136.2	132.8	130.8	129.0	126.0	122.8	50
200	141.9	138.5	134.8	132.5	130.6	127.5	124.1	63
250	144.1	140.3	136.4	134.1	132.0	128.8	125.1	80
315	145.7	141.9	137.7	135.4	133.3	129.9	125.8	100
400	147.1	143.0	138.6	136.5	134.2	130.6	125.9	125
500	148.3	144.1	139.5	137.0	134.4	130.5	125.7	160
630	149.1	144.6	139.5	137.0	134.1	130.2	125.2	200
800	149.4	144.4	139.0	136.4	133.4	129.5	124.5	250
1000	149.0	143.7	138.1	135.6	132.5	128.7	123.8	315
1250	147.9	142.5	137.0	134.4	131.6	127.9	123.2	400
1600	146.6	141.3	135.9	133.4	130.7	127.0	122.3	500
2000	145.2	140.0	134.9	132.4	129.8	126.2	121.5	630
2500	143.9	138.8	133.8	131.4	128.8	125.2	120.6	800
3150	142.5	137.5	132.8	130.3	127.9	124.2	119.7	1000
4000	141.2	136.4	131.7	129.3	126.9	123.2	118.6	1250
5000	139.9	135.2	130.6	128.2	125.8	122.1	117.5	1600
6300	139.0	134.0	129.5	127.1	124.7	121.0	116.4	2000
8000	137.2	132.7	128.3	125.9	123.5	119.8	115.2	2500
10000	135.9	131.7	127.1	124.7	122.4	118.6	114.0	3150
12500	134.5	130.2	125.8	123.5	121.1	117.5	112.7	4000
16000	133.1	128.6	124.6	122.3	119.9	116.2	111.5	5000
20000	131.8	127.6	123.4	121.0	118.6	115.0	110.4	6300
25000	130.5	126.3	122.1	119.8	117.4	113.8	109.1	8000
OAPWL dB	158.4	153.8	149.0	146.6	144.0	140.4	136.0	

(b) QCGAT I Mass Average

100	127.9	126.0	122.2	121.6	118.7	116.3	112.4	31.5
125	130.7	128.7	124.7	124.2	121.2	118.5	114.3	40
160	133.1	131.1	126.9	126.3	123.1	120.3	115.8	50
200	135.1	132.9	128.6	128.0	124.6	121.7	117.0	63
250	136.8	134.5	130.0	129.4	125.8	122.9	118.1	80
315	138.1	135.8	131.2	130.5	126.9	123.3	118.8	100
400	139.3	136.9	132.1	131.4	127.5	124.2	118.9	125
500	140.0	137.5	132.4	131.6	127.6	124.2	118.9	160
630	140.1	137.5	132.2	131.4	127.3	123.9	118.6	200
800	139.7	136.9	131.7	131.0	126.9	123.4	118.1	250
1000	138.9	136.4	131.1	130.3	126.3	122.9	117.7	315
1250	138.0	135.4	130.4	129.7	125.7	122.3	117.2	400
1600	137.1	134.6	129.7	129.0	125.1	121.8	116.6	500
2000	136.3	133.9	129.1	128.4	124.5	121.1	115.9	630
2500	135.5	133.1	128.3	127.6	123.7	120.3	115.1	800
3150	134.6	132.2	127.5	126.8	122.9	119.5	114.2	1000
4000	133.7	131.3	126.6	125.9	122.0	118.6	113.3	1250
5000	132.8	130.4	125.7	125.0	121.1	117.6	112.3	1600
6300	131.3	129.1	124.7	124.0	120.0	116.6	111.2	2000
8000	130.7	128.4	123.6	122.9	118.9	115.4	110.0	2500
10000	129.6	127.3	122.5	121.7	117.8	114.3	108.9	3150
12500	128.3	126.1	121.3	120.5	116.6	113.1	107.7	4000
16000	127.2	124.9	120.1	119.4	115.4	111.9	106.4	5000
20000	126.1	123.7	118.9	118.1	114.2	110.7	105.3	6300
25000	124.8	122.5	117.7	116.9	113.0	109.5	104.1	8000
OAPWL dB	149.9	147.4	142.5	141.8	138.0	134.7	129.6	

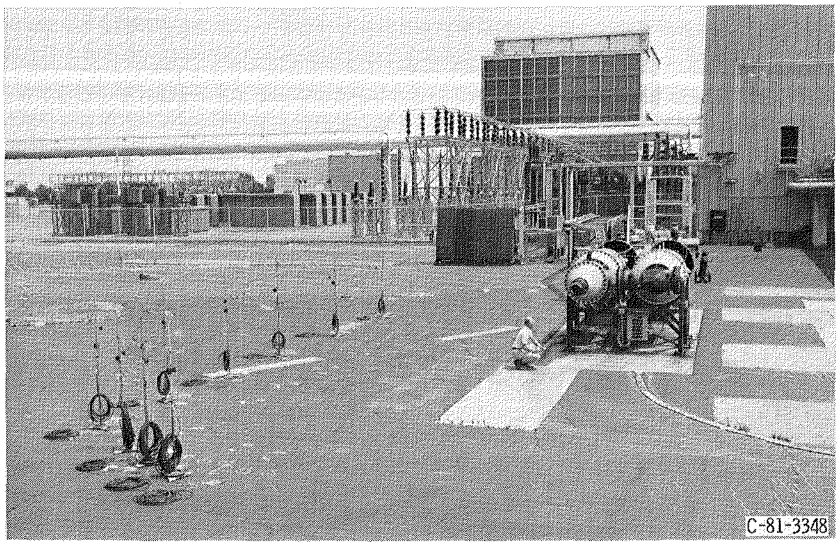
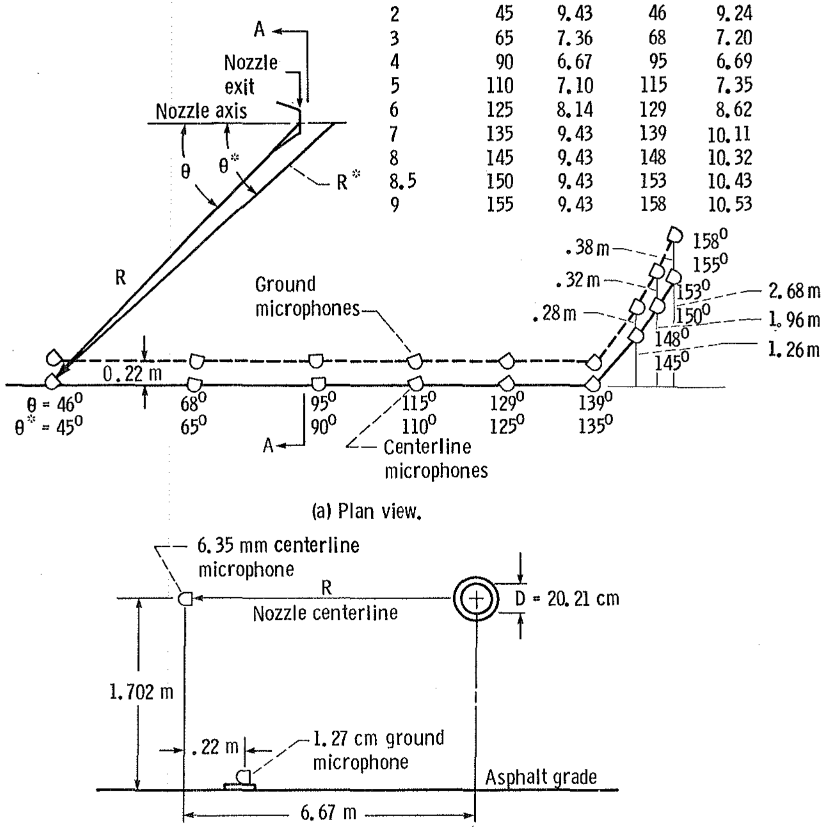


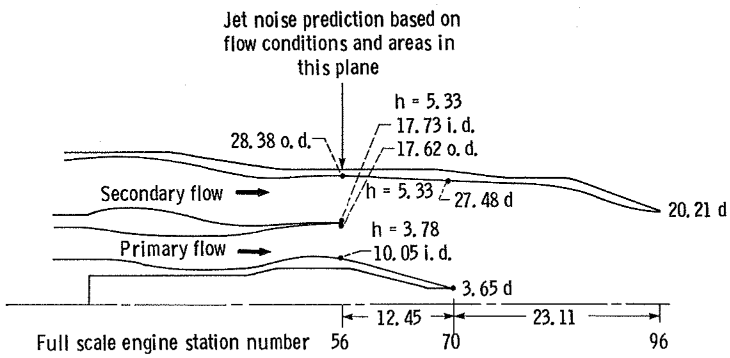
Figure 1. - NASA Lewis outdoor coaxial Jet Acoustic Facility.

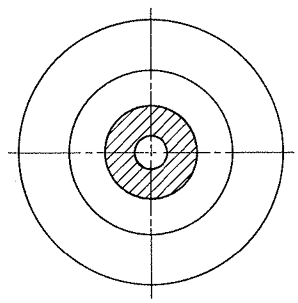
Down stream noise source location, nozzle diam	θ^*, deg	R^*, meters	θ, deg	R, meters
2	45	9.43	46	9.24
3	65	7.36	68	7.20
4	90	6.67	95	6.69
5	110	7.10	115	7.35
6	125	8.14	129	8.62
7	135	9.43	139	10.11
8	145	9.43	148	10.32
8.5	150	9.43	153	10.43
9	155	9.43	158	10.53



(b) Elevation, view A-A.

Figure 2. - Schematic microphone layout.



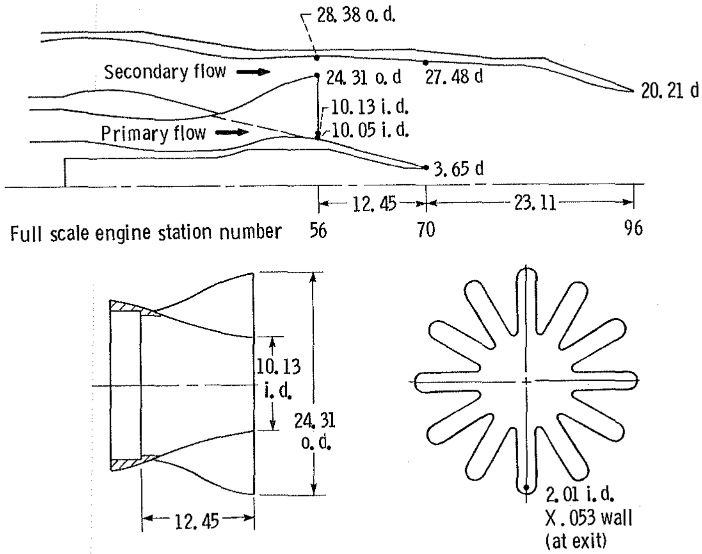


	Primary	Secondary
Exit area, cm^2	164.53	385.80
Equivalent diameter, cm	14.48	22.16

Final exit area = 320.90 cm^2 (D = 20.21 cm)

(a) QCGAT I (splitter)

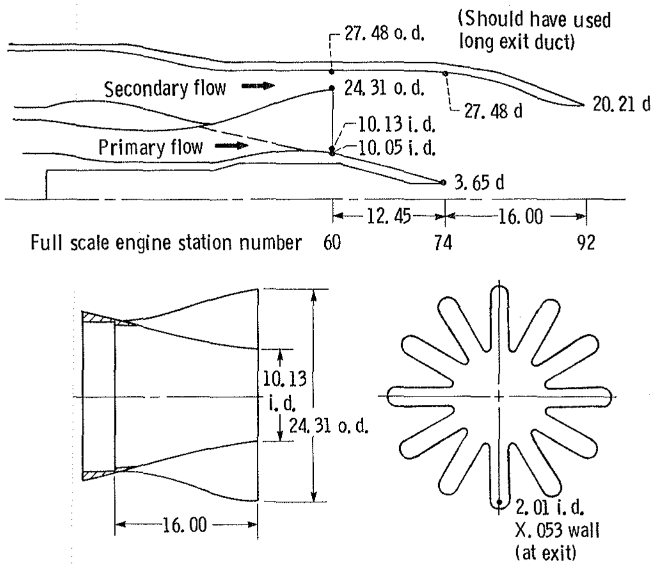
Figure 3. - Nozzle schematics. All dimensions in centimeters.



	Primary	Secondary
Exit area, cm^2	164.02	379.23
Equivalent diameter, cm	14.45	21.97

Final exit area = 320.90 cm^2 (d = 20.21 cm)

(b) QCGAT II (mixer A)

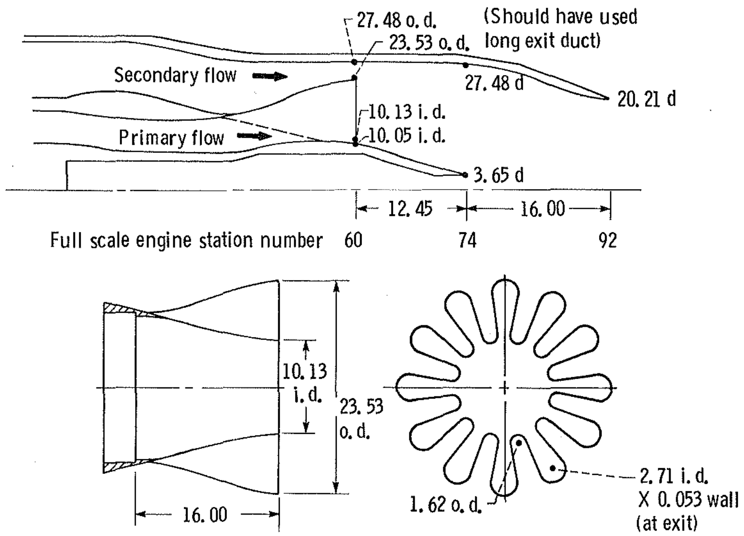


	Primary	Secondary
Flow area, cm^2	168.83	374.42
Equivalent diameter, cm	14.66	21.83

Final exit area = 320.90 cm^2 (d = 20.21 cm)

(c) QCGAT III (mixer C)

Figure 3. - Continued.



	Primary	Secondary
Flow area, cm^2	168.79	374.43
Equivalent diameter, cm	14.66	21.83

Final exit area = 320.90 cm^2 (d = 20.21 cm)

(d) QCGAT IV (mixer D)

Figure 3. - Concluded.

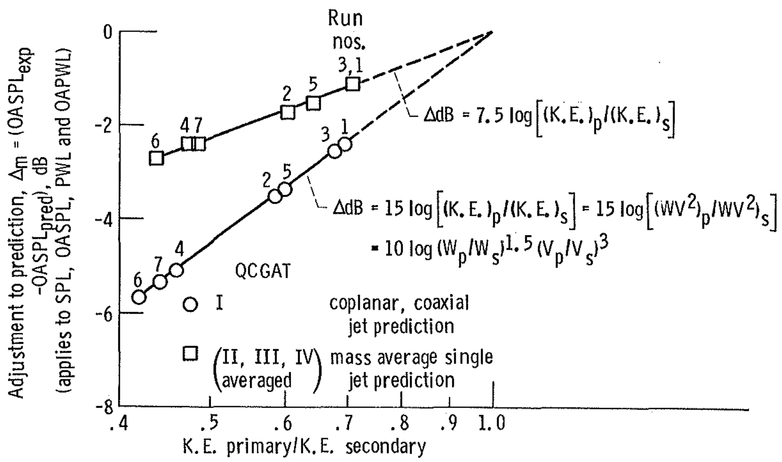
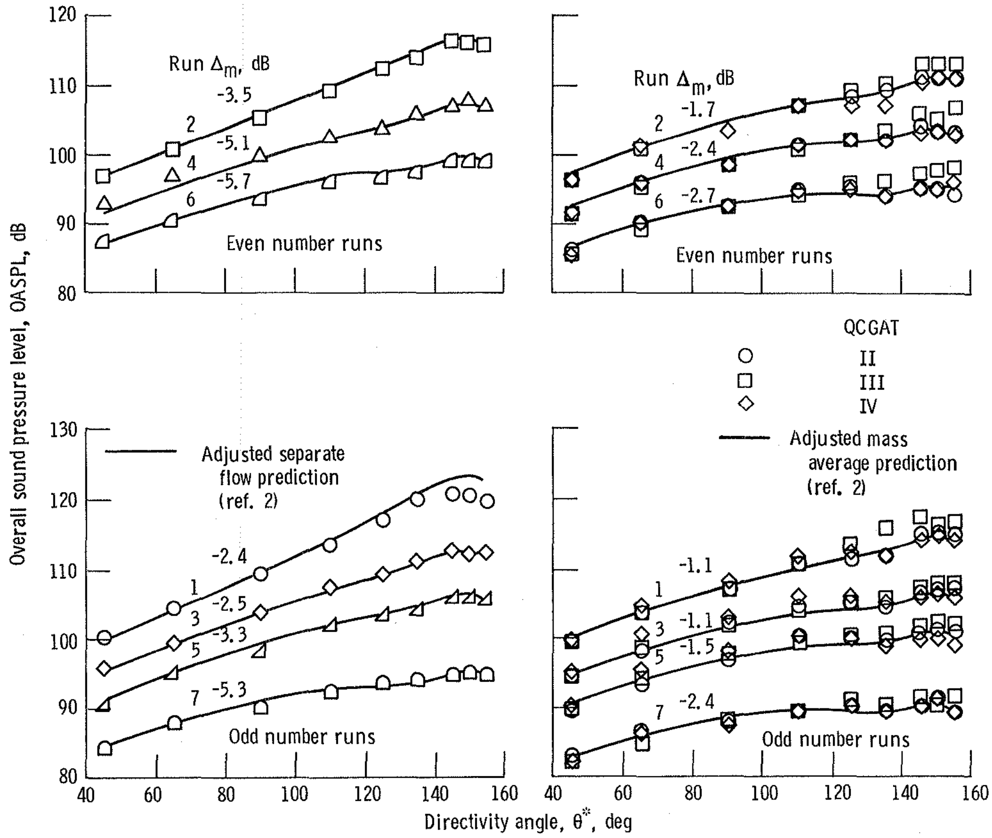


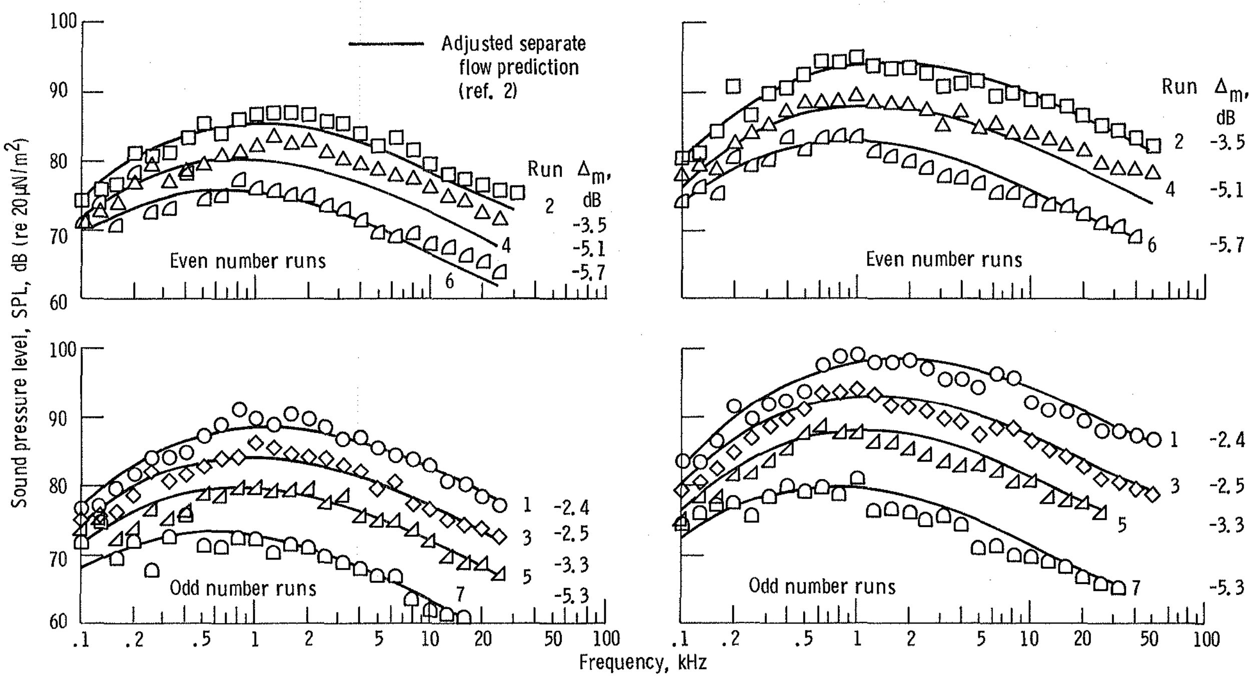
Figure 4. - Adjustment in dB applied to predicted OASPL and SPL as a function of primary to secondary kinetic energy ratio for the 0.35 scale QCGAT I, II, III and IV nozzles.



(a) QCGAT I nozzle.

(b) QCGAT II, III and IV nozzles.

Figure 5. - Comparison of experimental and adjusted predicted lossless free field OASPL directivity.



(a) $\theta^* = 45^0$.

(b) $\theta^* = 90^0$.

Figure 6. - Comparison of experimental and adjusted separate flow predicted spectral results for QCGAT I nozzle at various flow conditions.

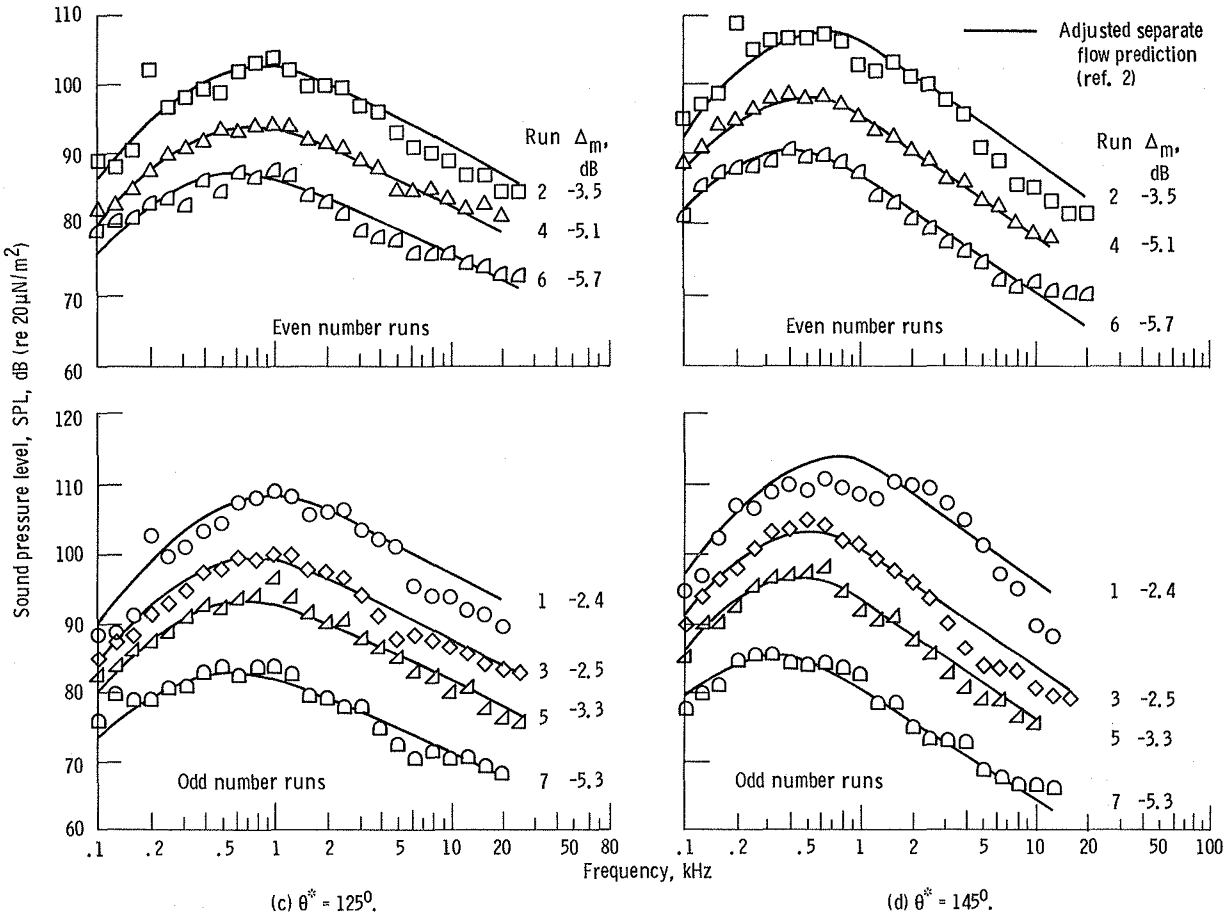
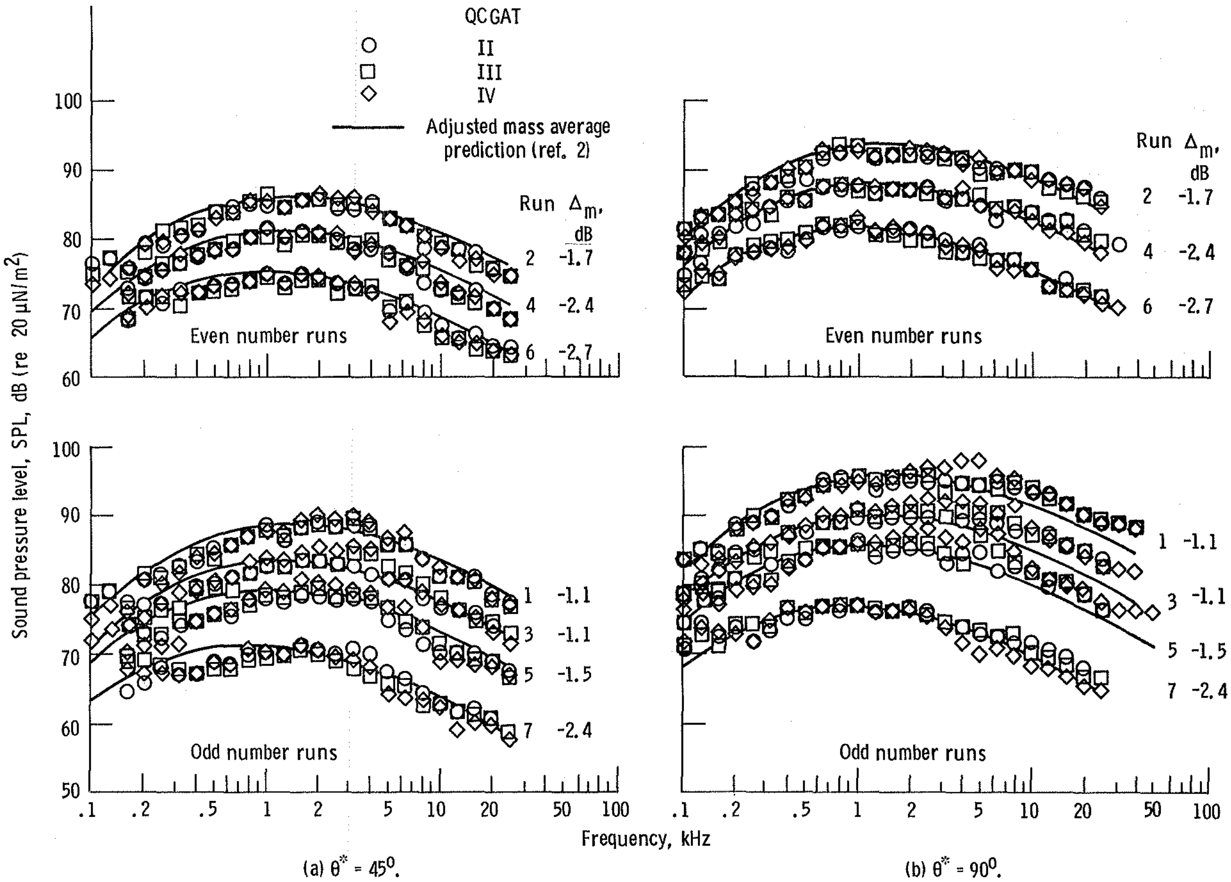


Figure 6. - Concluded.



(a) $\theta^* = 45^0$.

(b) $\theta^* = 90^0$.

Figure 7. - Comparison of experimental and adjusted mass average predicted spectral results for the 0.35 scale QCGAT II, III, and IV nozzles at various flow conditions.

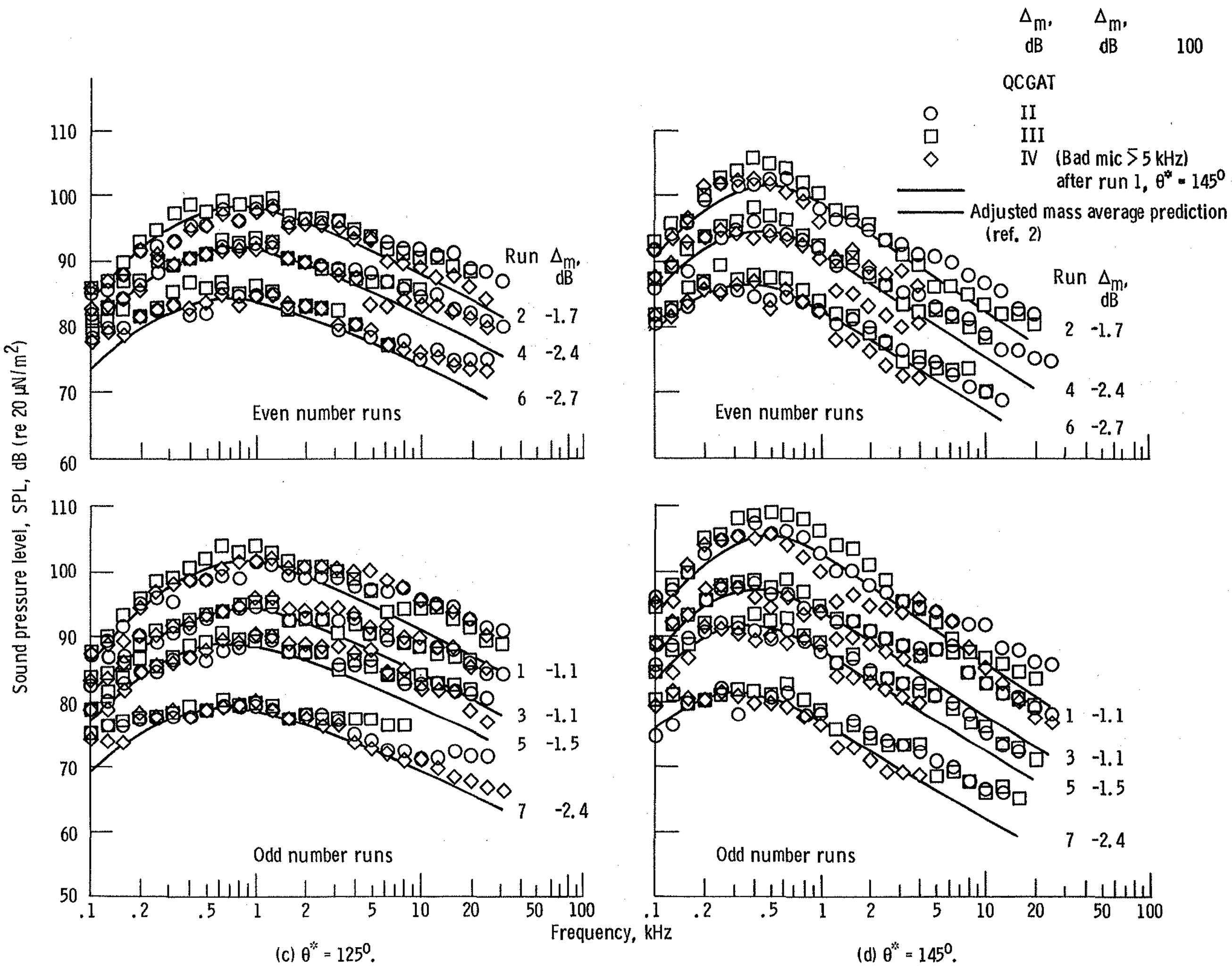


Figure 7. - Concluded.

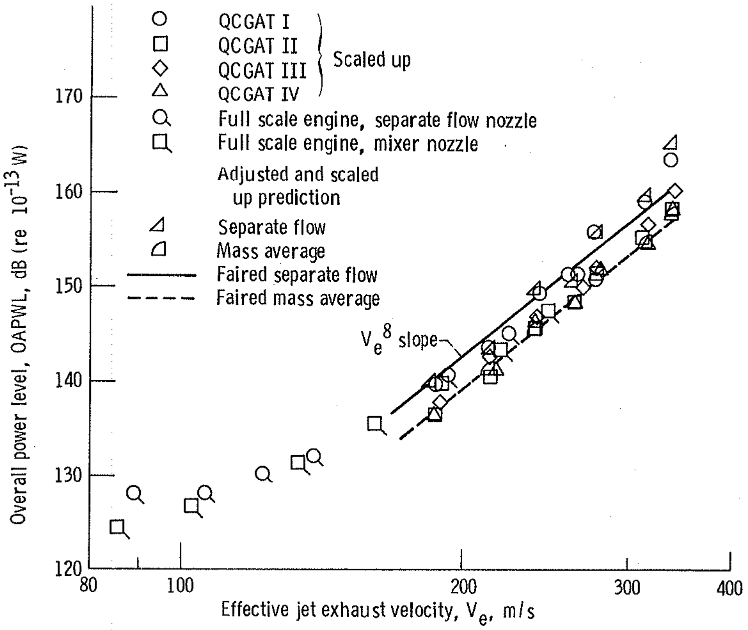


Figure 8. - Far field acoustic power level comparison of full scale QCGAT engine (ref. 6), 0.35 scale model nozzles and ref. 2 predictions.

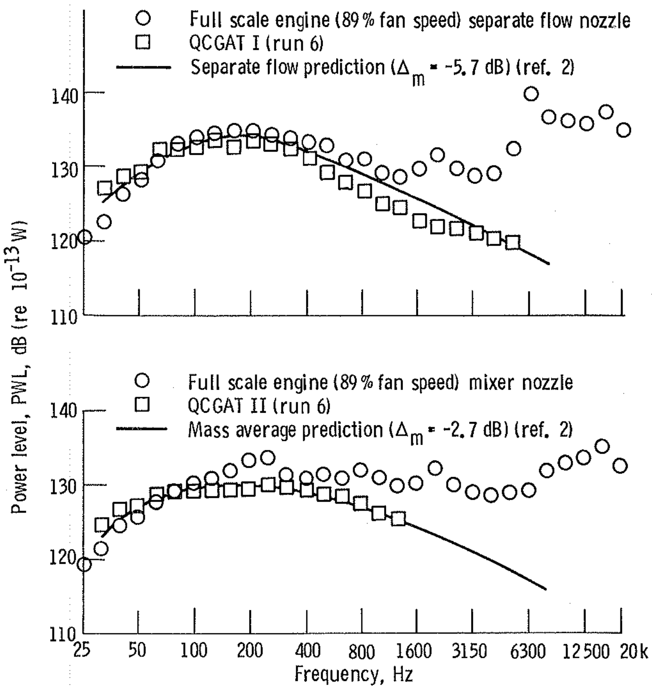


Figure 9. - Far field acoustic power level spectral comparison of full scale QCGAT engine (ref. 6) and scaled up data from 0.35 scale model nozzles.

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16. Abstract

As part of the NASA Quiet Clean General Aviation Turbofan (QCGAT) engine mixer-nozzle exhaust system program, static jet exhaust noise was recorded at microphone angles of 45° to 155° relative to the nozzle inlet for a conventional profile coaxial nozzle and three 12-lobed coaxial mixer nozzles. Both flows in all four nozzles are internally mixed before being discharged from a single exhaust nozzle. The conventional profile coaxial nozzle jet noise is compared to the current NASA Lewis coaxial jet noise prediction and after applying an adjustment to the predicted levels based on the ratio of the kinetic energy of the primary and secondary flows, the prediction is within a standard deviation of 0.9 dB of the measured data. The mass average (mixed flow) prediction is also compared to the noise data for the three mixer nozzles with a reasonably good fit after applying another kinetic energy ratio adjustment (standard deviation of 0.7 to 1.5 dB with the measured data). The tests included conditions for the full-scale engine at takeoff (T.O.), cutback (86 percent T.O.) and approach (67 percent T.O.).

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