Measurement of Noise from Air-Cooled Heat Exchangers

API RECOMMENDED PRACTICE 631M
FIRST EDITION, JUNE 1981
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American Petroleum Institute
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Refining Department

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FOREWORD

This recommended practice is based on the accumulated knowledge and experience of petroleum refiners, air-cooled heat exchanger manufacturers, and engineering contractors. The objective of this publication is to provide a standard test procedure for measurement of noise emanating from air-cooled heat exchangers. Separate procedures for testing of an isolated single bay and for testing of a single bay of an installed unit are given. Testing the isolated single bay is considered a more accurate procedure.

The test procedure for installed air-cooled heat exchangers is similar to the procedure given in CONCAWEE Report Number 5/78, "Method for Determining the Sound-Power Levels of Air-Cooled (air-fin) Heat Exchangers." Comparative tests have shown that the two procedures yield similar results within ± 2 decibels.

Although it is recognized that the purchaser may desire to modify, delete, or amplify sections of the practice, it is strongly recommended that all such changes be made by supplementing this practice rather than by rewriting or by incorporating sections into another complete practice.

Suggested revisions are invited and should be submitted to the director of the Refining Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Measurement of Noise from Air-Cooled Heat Exchangers

SECTION 1—GENERAL

1.1 Purpose

This recommended practice establishes standard procedures for measuring and reporting sound-pressure levels (*SPL*) and sound-power levels (*PWL*) of air-cooled heat exchangers.

1.2 Scope

This procedure applies to air-cooled exchangers used for general refinery service, including both forced- and induced-draft type units. The procedures are based on testing complete air-cooled exchangers and are not intended for testing individual components such as fans, motors, gears, and so forth. Separate procedures are given for the following types of tests:

1. Test of an isolated single-bay air-cooled exchanger for determining sound-power levels and sound-pressure levels (Section 2).
2. Test procedures for conducting noise tests on a single bay of installed air-cooled exchangers (normally multibay installations) (Section 3).

1.3 Instrumentation

The following are the required instrumentation and applicable specifications to be used to perform the measurements required.

Instrument	Specification
Sound level meter, including microphone, Type 1, precision	ANSI S1.4-1971 (R1976)
Octave band filter, Type E, Class II	ANSI S1.11-1966 (R1975)
Acoustic calibrator of coupler type	ANSI S1.4-1971 (R1976)
Wind screen	ANSI S1.4-1971 (R1976)

1.4 Nomenclature and Definitions

1.4.1 NOMENCLATURE

The following abbreviations are used in this recommended practice.

Abbreviation	Definition	Unit
B	Measuring distance from surface	meter
D	Fan diameter	meter
dB	Unit of measure for sound level	decibel
dB(A)	Decibel weighted to correspond to standard "A" scale	decibel
H	Height of geometric center	meter
hp	Horsepower	—
Hz	Hertz, sound frequency	cycle/second
L	Length of bay	meter
N	Number of fans per bay	—
n	Number of measurement positions per source	—
PWL	Sound-power level	decibel
R	Radius of hemisphere and cyclinder	meter
S	Surface area (measuring surface)	square meter
S_o	Reference area of 1 square meter	square meter
SPL	Sound-pressure level	decibel
$\overline{SPL}$	Mean sound-pressure level	decibel
W	Width of one bay	meter

1.4.2 DEFINITIONS

A *bay* is one or more tube bundles served by two or more fans complete with structure, plenum, and attendent equipment.

The *geometric center* is located at the center of a bay on a plane midway between the air inlet and the air outlet for both forced-draft and induced-draft units. The geometric center is also considered the acoustic center of a bay for calculations.

Octave bands are the preferred frequency bands.

The *sound level* is the sound-pressure level when frequency is weighted according to the standardized A, B, or C weighting used in sound-level meters. Only A weighted readings [dB(A)] are referenced in this procedure.

The *sound-power level* is ten times the logarithm to base 10 of the ratio of the total acoustic power radiated by a sound source to the reference power of 10^{-12} watt.

The *sound-pressure level* is twenty times the logarithm to base 10 of the ratio of the root mean square sound pressure to the reference sound pressure of 2×10^{-5} newtons per square meter.

A *unit* is one or more tube bundles in one or more bays for an individual service.

NOTE: For additional definitions see API Publication EA 7301, *Guidelines on Noise*.

SECTION 2—PROCEDURE FOR CONDUCTING NOISE TESTS ON AN ISOLATED SINGLE BAY

2.1 Procedure for Obtaining Noise Test Data

2.1.1 DESCRIPTION OF TEST SET-UP

The more accurate noise tests on air-cooled heat exchangers are those which are performed on a single bay without interference from nearby noise or structures. Such accuracy is usually precluded on an operating installation but is attainable at the point of assembly. Units which have typical overall dimensions of from 4 to 6 meters wide, 7 to 12 meters long, and 2 to 5 meters high are discussed here.

For test, the unit should be supported above grade high enough for reasonable air access during the test. An elevation 3 to 6 meters from grade to air inlet is usually adequate to minimize ground effects. There are several optional pieces of equipment which influence noise to a negligible degree and such pieces may be omitted from the assembly for noise test purposes. Included in this category are louvers, walkways, and recirculation chambers. (The presence or absence of recirculation walls will have little effect on the total noise emitted but may cause noise to be emitted in a different direction or at a different location.)

In many cases tests will be conducted as units are completed immediately prior to shipment. However, if noise levels are critical and a large number of units are involved, consideration should be given to testing a single unit early enough to permit design changes.

2.1.2 TEST CONDITIONS

The equipment should be operating as near as is practical to design fan tip speed and motor horsepower. Since most tests must be run at conditions other than design conditions, it is desirable to agree beforehand on the corrections to be made for these variables. If the customer requires, the blade angle can be set to duplicate design horsepower when temperature or elevation differs appreciably from design. Refer to 2.2.2.4 if corrections need to be made for test conditions which differ from design conditions.

2.1.3 LOCATION OF TEST MEASURING POINTS

A radius of 10 meters used to define imaginary hemispherical and cylindrical surfaces surrounding the equipment to be tested is recommended. The test measuring points shall be located on this surface. There should be nine points on the hemisphere and four points on the cylinder. (See Figure 1 and Table 1 for the location of these test points.)

The geometric center is located at the center of the unit on a plane midway between the air inlet and air outlet for both forced- and induced-draft units. A radius of 10 meters is recommended; however, the radius could range from 9 to 12 meters with little effect on results. The test points should be far enough from the equipment to minimize near field distortions, yet near enough to allow positioning the microphone at the various points on the imaginary enclosing surface. All fans should be running during these tests.

In addition to the above readings, which are used to calculate *PWL*, a set of readings at a single point should be taken below each fan. On forced-draft units, the point should be on a horizontal plane 1 meter below the lower edge of the fan ring. The maximum reading attainable on this plane should be taken by placing the microphone no closer than 1 meter from the motor, machinery mount, or other members. On induced-draft units, this measurement point should be on a horizontal plane 1 meter below the finned tubes. Again, the maximum reading attainable on this plane should be taken while placing the microphone no closer than 1 meter from the motor, machinery mount, or other members. [The noise meter should be reading dB(A) while finding the maximum noise point.] Again, all fans should be running during these readings. This data is taken for future reference in correlating *PWL* and sound level data and for estimating noise levels directly below the unit.

Table 1—Test Point Coordinates for Figure 1

Position	Coordinates[a] x	y	z
1	0	0	+1.000*R*
2	0	+0.745*R*	+0.667*R*
3	+0.745*R*	0	+0.667*R*
4	0	−0.745*R*	+0.667*R*
5	−0.745*R*	0	+0.667*R*
6	+0.689*R*	+0.689*R*	+0.222*R*
7	+0.689*R*	−0.689*R*	+0.222*R*
8	−0.689*R*	−0.689*R*	+0.222*R*
9	−0.689*R*	+0.689*R*	+0.222*R*
10	0	+1.000*R*	−0.500*H*
11	+1.000*R*	0	−0.500*H*
12	0	−1.000*R*	−0.500*H*
13	−1.000*R*	0	−0.500*H*

[a] Coordinates x, y, and z for all positions are measured from an origin located at the geometric center of the unit.

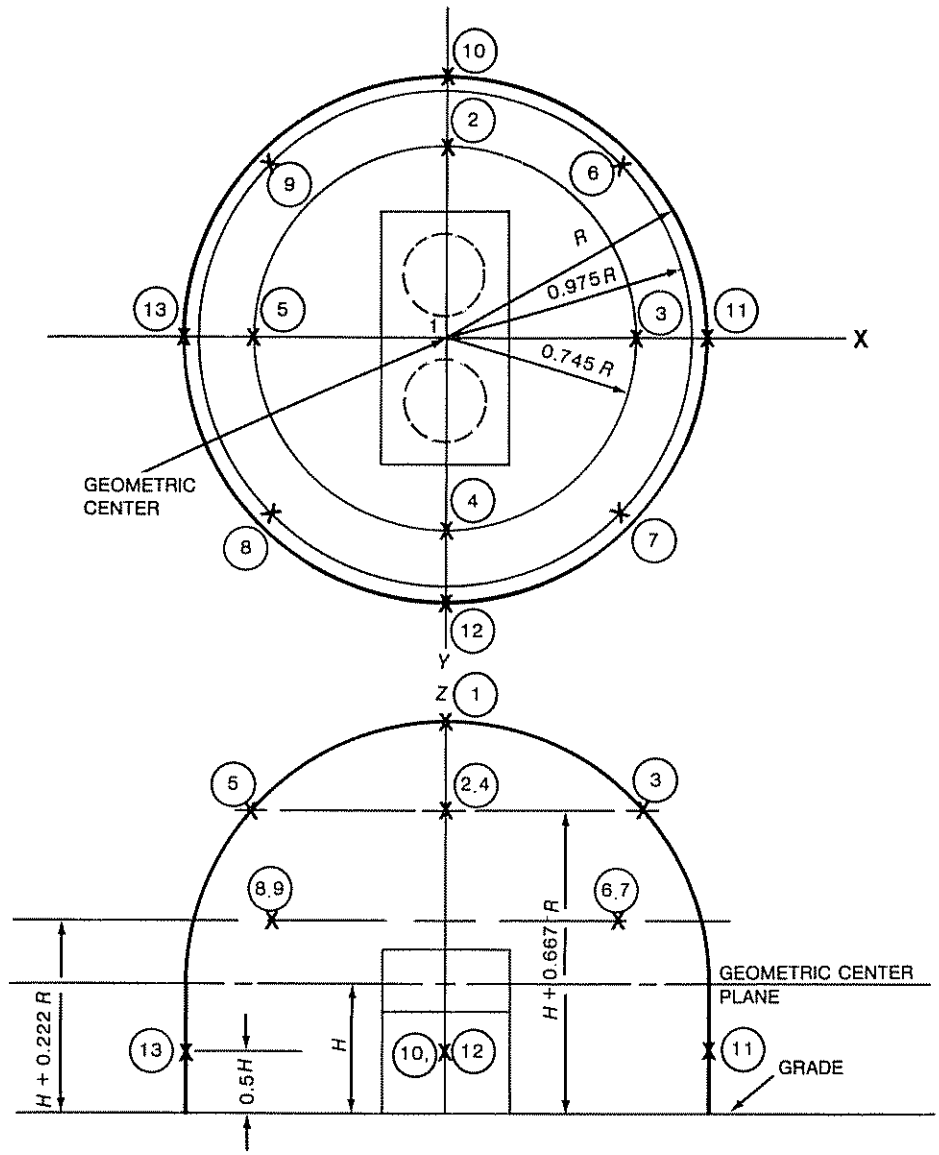


Figure 1—Isolated Single Bay Noise Measurement Points

2.1.4 CHECKLIST

A noise test will usually be run immediately before a unit is shipped. Therefore, all required steps must be performed and all pertinent data must be recorded, since it is impractical to recall the equipment and rerun the test at a later date. The following steps should aid operators in preparing for a test.

1. Prepare all drawings and data forms prior to the test. Lay out the test points in the x,y plane and paint spots on the working surface. Then, only the z dimension need be measured during the test.
2. Check that all noise test equipment is in working order and calibrated. A discharged battery, a faulty connection, or similar problem has invalidated many tests.
3. Check that equipment necessary to position the microphone at all test points is on hand prior to beginning the test.
4. Check the weather forecast. The test should not be run during rain or while winds are above 10 miles per hour.
5. Do a preliminary check of motor amperes and volts to assure the operation of motors near design speed.
6. Start the unit and check it for any unusual noises or problems. Is either fan running backwards? Is there any unusual belt noise, gear noise, motor noise, or bearing noise? Are there any loose parts rattling?
7. Be aware that toothed sheaves with lobed or toothed belts create a dominant noise in the 1000 to 2000 Hz range.

2.1.5 RECORDING OF DATA

Prior to recording the data, a preliminary survey should be conducted with the sound level meter on the dB(A) setting. If the noise levels for either the hemisphere or cylinder differ by more than 6 dB(A), either additional measurement positions should be used or the hemisphere and cylinder radius should be increased. If the large difference results from the background noise, it may be necessary to record background noise at each measuring point. If it is not possible to measure the noise emission at a particular point because of high background noise, either the source of the background noise should be reduced or eliminated or the measurement from a similar point may be used. The latter procedure is not recommended, and any such similar point shall be noted in the test report.

Record all data as required on the data sheet (see 2.3 and Appendixes A and B). The calibration readings shall be recorded at the start and finish of a noise test. Background readings shall be taken at every fifth test point (more often if either party feels conditions warrant it). All sound level readings should be taken with the meter set to "slow" response and with a wind screen over the microphone.

2.2 Calculations and Interpretation

2.2.1 REDUCING TEST DATA

2.2.1.1 Correction for Background Noise

If the test point reading exceeds the background level by more than 10 dB, no correction of the test point reading is required. When the difference between the noise level and the background is less than 3 dB, the measurements have no significance and valid test results cannot be obtained. If the difference between the test point reading and the background level is greater than 3 dB but less than or equal to 10 dB, the measured noise level shall be corrected according to Table 2.

Table 2—Corrections for Background Noise

Difference Between Total Noise Level and Background[a]	Decibels to be Subtracted from the Total Measured Noise Level[b]
3	3.0
4	2.2
5	1.7
6	1.3
7	1.0
8	0.7
9	0.6
10	0.5
>10	0.0

[a] Difference is defined as the test point reading minus the background noise level.
[b] Correction is defined as the dB value to be subtracted from the test point reading

2.2.1.2 Determining Mean Sound-Pressure Levels

Adjust the test point readings at each location for background noise. For dB(A) plus each of the nine frequencies, determine $\overline{SPL}$ for both the hemisphere and the cyclinder. The mean sound-pressure level ($\overline{SPL}$) values are determined using the following calculations.

If the maximum difference between values to be averaged is greater than 6 dB, $\overline{SPL}$ is derived from the following equation:

$$\overline{SPL} = 10 \log \left[(1/n) \left(\text{antilog} \frac{SPL}{10^1} + \text{antilog} \frac{SPL}{10^2} + \text{antilog} \frac{SPL}{10^n} \right) \right]$$

If the maximum difference between the values to be averaged is 6 dB or less, $\overline{SPL}$ is derived from the following equation:

$$\overline{SPL} = 1/n \, (SPL_1 + SPL_2 + \ldots SPL_n)$$

2.2.1.3 Sound-Power Level

Convert the representative $\overline{SPL}$s to *PWL*s. This is done for each of the nine frequencies plus the overall dB(A). It is done separately for the hemisphere and for the cylinder.

To convert $\overline{SPL}$ to *PWL* for the hemisphere or cylinder use the following equation:

$$PWL = \overline{SPL} + \log (S/s_o)$$

Where:

S = the surface area of the hemisphere or cylinder, in square meters.
s_o = a reference area of 1 square meter.
$2\pi R^2$ = area of hemisphere
$2\pi RH$ = area of cylinder
SPL_{bay} = sum of *PWL* for the hemisphere and the cylinder.

To add *PWL*s use:

$$PWL_{bay} = 10 \log \left(\text{antilog} \frac{PWL_{cylinder}}{10} + \text{antilog} \frac{PWL_{hemisphere}}{10} \right)$$

Sound-power level per fan can be determined as follows:

$$PWL_{fan} = PWL_{bay} - 10 \log N$$

Where:

N = the number of fans per bay.

2.2.1.4 Design versus Test Horsepower

Since a test is seldom run with the motor at design horsepower, it is necessary to adjust test conditions to design conditions.

If a watt meter or plant power factor data are not available, the following approximation for test horsepower can be used:

$$hp_{test} = hp_{nameplate} \times \left(\frac{\text{Volts}_{test} \times \text{Amperes}_{test}}{\text{Volts}_{nameplate} \times \text{Amperes}_{nameplate}} \right)$$

To convert sound-power level calculated at test motor horsepower (PWL_{test} at hp_{test}) to predicted sound-power level at design power (PWL_{design} at HP_{design}) use the following equation:

$$PWL_{design} = PWL_{test} + 10 (\log hp_{design} - \log hp_{test})$$

Test horsepower should be within 15 percent of design horsepower to use this equation.

2.2.2 APPLICATION OF REDUCTION PROCEDURES

2.2.2.1 Background Noise

Adjust test point readings for background noise level. Prepare a tabulation of adjusted values for each position. The example in Table 3 illustrates the procedure

2.2.2.2 Sound-Pressure Level

Consider a test in which an imaginary cylinder has the following dimensions: R equals 10 meters and H equals 4.88 meters with adjusted test point readings of 81.9, 74.8, 80.8, and 75.4 dB in one octave band and adjusted test point readings of 51.8, 53.8, 52.9, and 52.3 dB in another octave band.

In the first case, the maximum difference in values to be averaged is 7.1 (81.9 − 74.8); therefore, the representative SPL equals:

$$\overline{SPL} = 10 \log \left[1/4 \left(\text{antilog} \frac{81.9}{10} + \text{antilog} \frac{74.8}{10} + \text{antilog} \frac{80.8}{10} + \text{antilog} \frac{75.4}{10} \right) \right]$$

$$= 10 \log [1/4 (1.5488 \times 10^8) + (.3020 \times 10^8) + (1.2023 \times 10^8) + (.3467 \times 10^8)]$$

$$= 79.3 \text{ dB}$$

In the second case, the maximum difference in values to be averaged is 2.0 (53.8 − 51.8); therefore, the representative $\overline{SPL}$ equals:

$$\overline{SPL} = \frac{51.8 + 53.8 + 52.9 + 52.3}{4}$$

$$= 52.7 \text{ dB}$$

2.2.2.3 Sound-Power Level

Convert representative SPL for the cylinder in the first case to PWL. From 2.2.2.2, SPL equals 79.3 dB.

$$PWL = SPL + 10 \log (2\pi RH)$$
$$= 79.3 + 10 \log (2 \times \pi \times 10 \times 4.88)$$
$$= 79.3 + 10 \log 306.6$$
$$= 79.3 + 24.9$$
$$= 104.2 \text{ dB}$$

Table 3—Example of Reduction Procedures for Test on an Isolated Unit

		Octave Band Center Frequency								
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
Position 1										
Test Value	77	82	83	80	79	75	72	68	62	56
Background	68.5	76	75	71	69	67	62	61	51	44
Difference	8.5	6	8	9	10	8	10	7	11	12
Correction	−0.7	−1.3	−0.7	−0.6	−0.5	−0.7	−0.5	−1.0	0.0	0.0
Adjusted Test Point Value										
Position 1	76.3	80.7	82.3	79.4	78.5	74.3	71.5	67.0	62.0	56.0

Determine the sound-power level per bay, assuming that the hemispherical *PWL* equals 106 and the cylindrical *PWL* equals 104.2.

$$PWL_{bay} = 10 \log \left(\text{antilog}\frac{106}{10} + \text{antilog}\frac{104.2}{10}\right)$$

$$= 10 \log (6.6114 \times 10^{10})$$
$$= 10 \times 10.82$$
$$= 108.2 \text{ dB}$$

Determine the sound-power level per fan in a two fan bay if the *PWL* per bay is 108.2.

$$PWL = 108.2 - 10 \log 2$$
$$= 108.2 - 3$$
$$= 105.2$$

2.2.2.4 Design versus Test Horsepower

If nameplate horsepower is 25, nameplate voltage is 460, nameplate amperage is 31, test voltage is 470, and test amperage is 27, then—

$$hp_{test} = 25 \times \frac{470}{460} \times \frac{27}{31}$$

$$= 22.3$$

If design horsepower is 23.7, test horsepower is 22.3, and test *PWL* per fan is 105.2 dB, determine adjusted *PWL* per fan at design horsepower.

$$PWL_{design} = 105.2 + 10 (\log 23.7 - \log 22.3)$$
$$= 105.2 + 10 (1.3747 - 1.3488)$$
$$= 105.2 + (10 \times 0.0264)$$
$$= 105.5 \text{ dB}$$

2.3 Reporting of Data

2.3.1 GENERAL REQUIREMENTS

The noise test report shall include a summary sheet with the main results, a description of the equipment tested, and the noise test data. Appendix A provides a model format for noise test reports. Appendix B provides a completed noise test report for a noise test conducted on an isolated single bay.

2.3.2 SUMMARY

The summary shall make reference to this API recommended practice.

The principal results of the test are to be reported on one sheet. These results are to be supported by the test data, calculations, and sketches which follow. All calculations and interpretation of data shall be in accordance with 2.2. The calculations shall be appended to the noise test report.

The test results shall include the following:

1. The overall sound power levels and the octave band sound power levels shall be tabulated.
2. Measurements taken at special locations for future reference in correlating sound-power level and sound level data and for estimating noise levels below the unit shall be shown separately. Corrected and uncorrected noise levels shall be reported.

2.3.3 REQUIREMENTS FOR DATA SHEET

1. A sketch of the test layout and microphone locations shall be provided. Special measuring locations shall be noted on the sketch.
2. A description of the equipment tested and its operating conditions shall be provided.
3. Details of the measuring equipment including make, model, and serial number shall be recorded.
4. A tabulation of all test data [dB(A) and octave band sound pressure levels] shall be provided, which includes:
   a. Sound level measurements at each test point.
   b. Background sound level measurements at selected points.
   c. Sound level measurements at special locations.

SECTION 3—PROCEDURE FOR CONDUCTING NOISE TESTS ON INSTALLED UNITS

3.1 Procedure for Obtaining Noise Test Data

3.1.1 DESCRIPTION AND REQUIREMENTS OF TEST

This section covers procedures for noise testing on installed units. However, it should be noted that a more accurate test procedure for the determination of noise levels of air-cooled heat exchangers is given in Section 2. The Section 2 procedure would not usually be satisfactory for application on installed air-cooled heat exchangers in operating plants.

The test procedure outlined in Section 2 is ideally suited for shop test situations and employs measurements of sound pressure levels of an imaginary hemisphere and cylinder having a radius of about 10 meters. This large measuring distance, 10 meters, would be impractical for installed exchanger situations and would yield inaccurate results because of noise interference from other operating

plant equipment and the measurement location interference of nearby equipment. In order for a noise test procedure for use on installed multibay operating units to yield reasonably accurate results the noise reading locations must:

1. Be within easy reach using the sound level meter, microphone (with wind screen), microphone cable, and short extension pole.
2. Be 1 meter from the fan and tube bundle to minimize interference from other plant noise sources. The 1 meter measuring distance of sound-pressure level reading has been widely used to determine sound-power levels.
3. Provide representative average sound-pressure levels for the imaginary projected surface of the fan and tube bundle, at a 1 meter distance, so that the sound power level of the individual exchanger and the entire exchanger bank can be determined by calculation.
4. Be far enough away from the adjacent exchanger bays so that the background noise level is a minimum of 3 dB (preferably 6 dB) below the level of the test bay. It will normally be necessary to shut down the immediately adjacent bays to reduce sufficiently the ambient noise level of the test bay in order to yield more accurate results

The following noise test procedure for installed-operating equipment to determine sound-power levels should yield an accuracy of ± 2 dB compared to the more accurate shop test procedure of Section 2. The degree of accuracy is heavily influenced by the background noise level at the time of the test. Every effort should be made to reduce background noise levels to a minimum by making the test before plant startup or by shutting down adjacent exchangers during the test.

The test accuracy could be detrimentally affected when the air-cooled heat exchanger is located very close to grade or directly adjacent to buildings. These situations would increase the sound pressure levels because sound reflection will cause erroneous readings.

3.1.2 TEST CONDITIONS

The equipment should be operating as near as is practical to design fan tip speed and motor horsepower. Since most tests must be run at conditions other than design conditions, it is desirable to agree beforehand on the corrections to be made for these variables. For example, the blade angle can be set to duplicate design horsepower. (Refer to 3.2.2.4 if corrections need to be made because test conditions differ from design conditions.)

3.1.3 LOCATION OF TEST MEASURING POINTS

Figures 2 and 3 show the recommended measuring locations for induced- and forced-draft unit applications, respectively.

To avoid excessive noise contribution from the fan drive, the microphone should be placed no closer than 1 meter from the motor, machinery mounts, or other members.

3.1.4 CHECKLIST

A noise test on operating equipment must usually be run within a short period of time, particularly when adjacent operating bays are shut down to reduce background noise for improved test accuracy. Therefore, the recording of all pertinent data must be accomplished as quickly as possible.

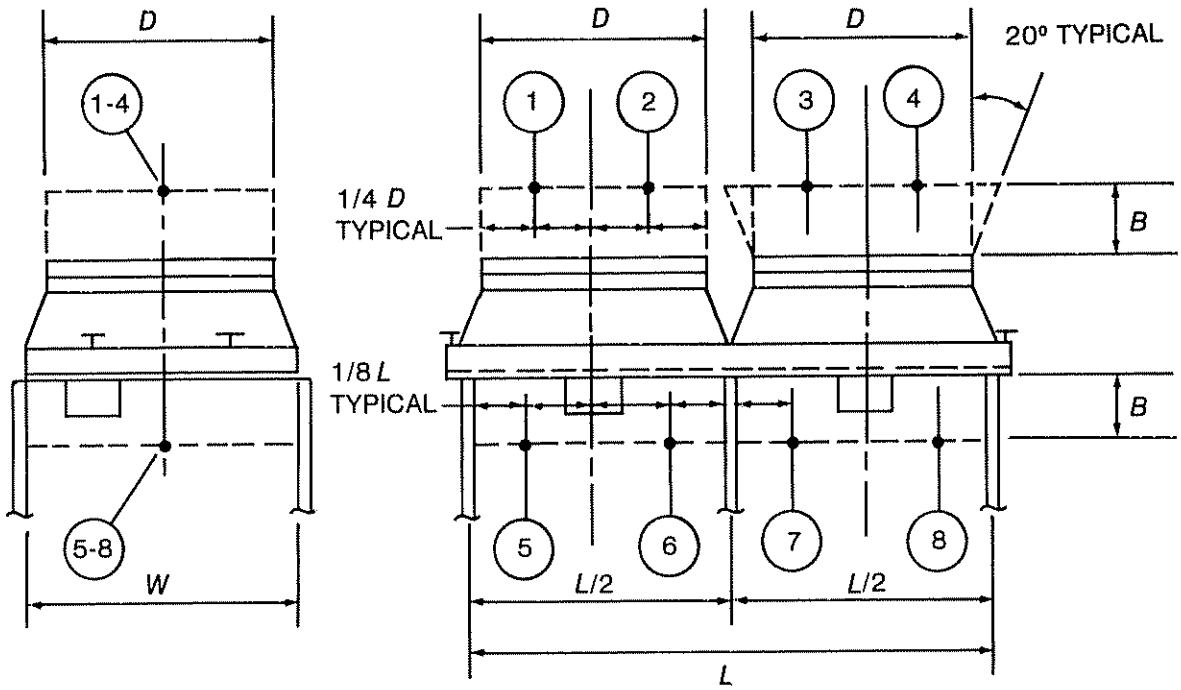
The following steps should aid operators in preparing for tests:

1. Prepare all drawings and data forms prior to the test.
2. Check that all noise test equipment is in working order and calibrated. A discharged battery, a faulty connection, or similar problem has invalidated many tests
3. Check that equipment necessary to position the microphone at all test points is on hand prior to beginning the test.
4. Check the weather forecast. The test should not be run during rain or while winds are above 10 miles per hour.
5. Do a preliminary check of motor amperes and volts to assure the operation of motors near design speed.
6. Check the unit for any unusual noises or problems. Is there any unusual belt noise, gear noise, motor noise, or bearing noise? Are there any loose parts rattling?
7. Check that there are no intermittent noise sources or steam leaks adjacent to the test location that could cause inaccurate test readings
8. Be aware that toothed sheaves with lobed or toothed belts create a dominant noise in the 1000 to 2000 Hz range.

3.1.5 RECORDING OF DATA

Prior to recording the data, a preliminary survey should be conducted with the sound level meter on the dB(A) setting. If the noise levels differ by more than 6 dB(A) across any radiating surface, additional measurements shall be taken. A subjective impression by ear should be made to decide whether the noise is from the source under test or another source. If it is not possible to obtain valid noise data from a particular surface because of background noise, the source of the background noise will have to be reduced or eliminated. The only other option is to conduct the test on another bay of identical design and construction.

Record all data as required on the data sheet (see 3.3 and Appendixes A and C). The calibration readings shall be recorded at the start and finish of a noise test. Back-



Legend
D = inside diameter of fan shroud, in meters
L = length of unit bay, in meters
W = width of bay, in meters.
B = 1.0 meter from fan shroud and bundle face.

NOTE: This example is for installed equipment in an operating plant situation

Figure 2—Air-Cooled Heat Exchanger *SPL* Test Measurement Points for an Induced-Draft Unit

ground readings shall be taken at points 1, 4, 5, and 8 and at additional locations if conditions warrant. All sound level readings should be taken with the meter set to "slow" response and with a wind screen over the microphone.

3.2. Calculations and Interpretation

3.2.1 REDUCING TEST DATA

3.2.1.1 Background Noise

If the test point reading exceeds the background level by more than 10 db, no correction of the test point reading is required. When the difference between the noise level and the background is less than 3 db, the measurements have no significance and valid test results cannot be obtained. If the difference between the test point reading and the background level is greater than 3 dB but less than or equal to 10 dB, the measured noise level shall be corrected according to Table 2.

3.2.1.2 Determining Mean Sound-Pressure Levels

Adjust test point readings at each location for background noise. Determine $\overline{SPL}$ for both fans and bundles for the overall db(A) plus each of the nine frequencies.

The mean sound-pressure level values are determined using the following equations.

If the maximum difference between values to be averaged is greater than 6 dB, $\overline{SPL}$ is derived from the following equation:

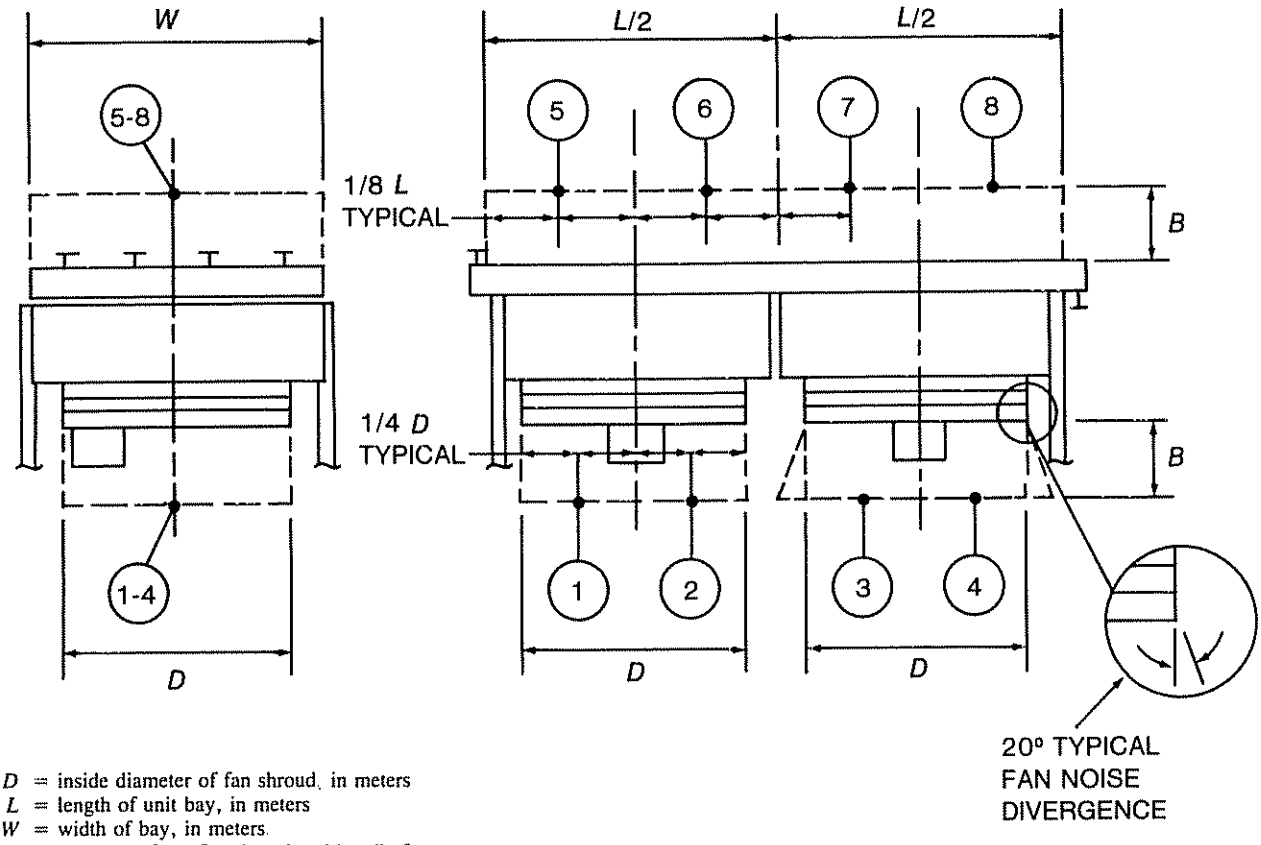
$$\overline{SPL} = 10 \log \left[1/n \left(\text{antilog} \frac{SPL_1}{10} + \text{antilog} \frac{SPL_2}{10} + \text{antilog} \frac{SPL_n}{10}\right)\right]$$

If the maximum difference between values to be averaged is 6 dB or less, $\overline{SPL}$ is derived from the following equation:

$$\overline{SPL} = 1/n \, (SPL_1 + SPL_2 + \ldots SPL_n)$$

3.2.1.3 Sound-Power Level

Convert the mean sound-power levels ($\overline{SPL}$s) to *PWL*s. This is done for each of the nine frequencies plus the over-



Legend
D = inside diameter of fan shroud, in meters
L = length of unit bay, in meters
W = width of bay, in meters
B = 1.0 meter from fan shroud and bundle face

NOTE: This example is for installed equipment in an operating plant situation

Figure 3—Air-Cooled Heat Exchanger *SPL* Test Measurement Points for a Forced-Draft Unit

all dB(A) and is done separately for each fan and bundle.

To convert $\overline{SPL}$ to *PWL* use the following equation:

$$PWL = \overline{SPL} + 10 \log (S/s_o)$$

Where:

S = the projected surface area as defined in Figures 2 and 3, in square meters.

s_o = a reference area of 1 square meter.

Note that the 20 degree divergence angle is an empirical means of causing the near field test results to match closely with the far field test results.

$$\text{Area}_{\text{fans}} = N\,(\pi/4)[D + (2 \times \tan 20° \times B)]^2$$
$$= N\,(\pi/4)[D + (1.73 \times B)]^2$$

Where:

N = number of fans per bay.

LW = area bundles.

Sound-power level per bay equals the sum of PWL for fans plus bundles.

To add *PWL*s:

$$PWL_{\text{bay}} = 10 \log \left[\text{antilog} \frac{PWL_{\text{fans}}}{10} + \text{antilog} \frac{PWL_{\text{bundles}}}{10}\right]$$

Sound-power level per fan can be determined as follows:

$$PWL_{\text{fan}} = PWL_{\text{bay}} - 10 \log N$$

3.2.1.4 Design versus Test Horsepower

Since a test is seldom run with the motor at design horsepower, it is necessary to adjust test conditions to design conditions. In most cases the following approximation for test horsepower can be used:

$$hp_{\text{test}} = hp_{\text{nameplate}} \left(\frac{\text{Volts}_{\text{test}} \times \text{Amperes}_{\text{test}}}{\text{Volts}_{\text{nameplate}} \times \text{Amperes}_{\text{nameplate}}} \right)$$

To convert sound power level calculated at test motor horsepower (PWL_{test} at hp_{test}) to predicted sound power level at design power (PWL_{design} at hp_{test}) use the following equation:

$$PWL_{design} = PWL_{test} + 10 (\log hp_{design} - \log hp_{test})$$

Test horsepower should be within 15 percent of design horsepower to use this equation.

3.2.2 APPLICATION OF REDUCTION PROCEDURES

3.2.2.1 Background Noise

Adjust test point readings for background noise level. Prepare a tabulation of adjusted *SPL* values for each test position. The example in Table 4 illustrates the procedure.

3.2.2.2 Sound-Pressure Level

Consider a test in which the fans have adjusted test point readings of 86.6, 87.7, 86.6, and 85.5 dB in one octave band and 88.6, 82.7, 90.8, and 88.6 dB in another octave band.

In the first case, the maximum difference in values to be averaged is 2.2 (87.7 − 85.5); therefore:

$$\overline{SPL} = \frac{86.6 + 87.7 + 86.6 + 85.5}{4}$$

$$= 86.6 \text{ dB}$$

In the second case, the maximum difference in values to be averaged is 8.1 (90.8 − 82.7); therefore:

$$\overline{SPL} = 10 \log \left[1/4 \left(\text{antilog}\frac{88.6}{10} + \text{antilog}\frac{82.7}{10} + \text{antilog}\frac{90.8}{10} + \text{antilog}\frac{88.6}{10}\right)\right]$$

$$= 10 \log (7.0934 \times 10^8)$$

$$= 88.5 \text{ dB}$$

3.2.2.3 Sound-Power Level

Convert $\overline{SPL}$ for the fans in the first case to *PWL*. From 3.2.2.2, $\overline{SPL}$ equals 86.6 dB. Assume two fans 3.66 meters in diameter.

$$PWL = 86.6 + 10 \log \left[\frac{2\pi}{4}(3.66 + 173)^2\right]$$

$$= 101.4 \text{ dB}$$

If $\overline{SPL}$ for the bundle in the first case is 84.7, *L* equals 9.15 meters, and *W* equals 4.88 meters, bundle *PWL* is:

$$PWL = 84.7 + 10 \log (9.15 \times 4.88)$$

$$= 101.2 \text{ dB}$$

Determine the sound-power level per bay. In the first case:

$$PWL_{bay} = 10 \log \left(\text{antilog}\frac{101.4}{10} + \text{antilog}\frac{101.2}{10}\right)$$

$$= 104.3 \text{ dB}$$

The sound-power level per fan is determined as follows:

$$PWL_{fan} = 104.3 - 10 \log 2$$

$$= 101.3 \text{ dB}$$

3.2.2.4 Design versus Test Horsepower

If nameplate horsepower is 25, nameplate voltage is 460, nameplate amperage is 31, test voltage is 470, and test amperage is 27, then—

$$hp_{test} = 25 \times \frac{470}{460} \times \frac{27}{31}$$

$$= 22.3$$

Table 4—Example of Reduction Procedures for Test on an Installed Unit

		Octave Band Center Frequency								
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
Position 1										
Test Value	87	91	93	90	89	84	82	78	72	66
Background	79	84	85	82	81	77	74	70	64	58
Difference	8	7	8	8	8	7	8	8	8	8
Correction	−0.7	−1.0	−0.7	−0.7	−0.7	−1.0	−0.7	−0.7	−0.7	−0.7
Adjusted Test Values										
Position 1	86.3	90	92.3	89.3	88.3	83	81.3	77.3	71.3	65.3

If design horsepower is 23.7, test horsepower is 22.3, and test *PWL* per fan is 102.4, determine adjusted *PWL* per fan at design horsepower.

$$PWL_{design} = 102.4 + 10 (\log 23.7 - \log 22.3)$$
$$= 102.4 + 0.3$$
$$= 102.7 \text{ dB}$$

3.3 Reporting of Data

3.3.1 GENERAL REQUIREMENTS

The noise test report shall include a summary sheet with the main results, a description of the equipment tested, and the noise test data. Appendix A provides a model format for noise test reports. Appendix C provides a completed noise test report for a noise test conducted on an installed unit.

3.3.2 SUMMARY

The summary shall make reference to this API recommended practice.

The principal results of the test are to be reported on one sheet. These results are to be supported by the test data, calculations, and sketches which follow. All calculations and interpretation of data shall be in accordance with 3.2. The calculations shall be appended to the noise test report.

The test results shall include the following:

1. The overall sound power levels and the octave band sound power levels shall be tabulated.
2. Measurements taken at special locations, such as for hearing conservation purposes or for future reference, shall be shown separately. Corrected and uncorrected noise levels shall be reported.

3.3.3 REQUIREMENTS FOR DATA SHEET

1. A sketch of the test layout and microphone locations shall be provided. Special measuring locations shall be noted on the sketch.
2. A description of the equipment tested and its operating conditions shall be provided.
3. Details of the measuring equipment, including make, model, and serial number, shall be provided.
4. A tabulation of all test data db(A) and octave band sound pressure levels shall be provided, which includes:
   a. Sound level measurements at each test point.
   b. Background sound level measurements at selected points.
   c. Sound level measurements at special locations.

APPENDIX A
MODEL FORMAT FOR NOISE TEST REPORT

Job No. _____
Date of Report _____
Page _____ of _____

NOISE TEST REPORT

I. SUMMARY

For the measurement and calculation procedures used in this report, reference is made to API RP 631M, *Measurement of Noise from Air-Cooled Heat Exchangers*

Author(s): _____

Department: _____

Date of measurements: _____

Model: _____

Plant location: _____

Specify: isolated _____ installed _____

Manufacturer: _____

Item number: _____

Serial number: _____

Service: _____

Sound Power Level Per Fan [dB(A)]

Identification	Octave Band Center Frequencies (Hz)									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000

Sound Level and Octave Band Readings at Special Locations [dB(A)]

Identification	Octave Band Frequencies									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000

NOISE TEST REPORT

Job No. _____

Date of Report _____

Page _____ of _____

Description of Measuring Location	Reason for Measurement

II. DESCRIPTION OF BAY OR UNIT AND OPERATING CONDITIONS

1. Sketch of unit or bay (indicate test layout and location of microphones). See Figures 1, 2, and 3 for example sketches

Job No _____

Date of Report _____

Page _____ of _____

NOISE TEST REPORT

Job No. _____

Date of Report _____

Page _____ of _____

NOISE TEST REPORT

2. Information from Equipment Data Sheet

Fans(s).

forced draft: _____ induced draft: _____

rpm: _____

capacity (ACFM): _____

diameter: _____

static pressure: _____

Number of bays: _____

Number of fans per bay: _____

Driver

Type: _____

Rated horsepower: _____

rpm: _____

Auxiliaries (such as gears): _____

_____

_____

_____

_____

III. TEST CONDITIONS

Fan rpm: _____

Fan pitch: _____

Motor nameplate: amps _____ volts _____

Motor measured: amps _____ volts _____

Static pressure (In. W.C.): _____

Weather conditions:

Wind velocity (mph): _____

Wind direction: _____

Ambient temperature (degrees Fahrenheit): _____

Remarks: _____

_____

_____

_____

NOISE TEST REPORT

Job No. _____
Date of Report _____
Page _____ of _____

IV. MEASURING EQUIPMENT

Microphone.

Make: _____

Model: _____

Serial number: _____

Sound level meter.

Make: _____

Model: _____

Serial number: _____

Octave band analyzer.

Make: _____

Model: _____

Serial number: _____

Acoustical calibrator.

Make: _____

Model: _____

Serial number: _____

Other. _____

Make: _____

Model: _____

Serial number: _____

V. NOISE DATA SHEET

All noise data shall be recorded on the noise data sheet on page ____ of this report. The tabulation shall include sound level measurements at each test point, background sound levels at selected points, and sound level measurements at special locations.

VI. CALCULATIONS

The calculations made to prepare this report are appended to this report and appear on pages ____ through ____.

Job No. ____________________

Date of Report ____________________

NOISE TEST REPORT

Page ________ of ________

NOISE AND BACKGROUND DATA SHEET

Point No.	Description		dB									
			A	31	63	125	250	500	1000	2000	4000	8000
		Measured										
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										
		Measured										
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		Background										
		Corrected										
		Measured										
		Background										
		Corrected										

APPENDIX B
EXAMPLE NOISE TEST REPORT FOR AN ISOLATED SINGLE BAY TEST

Job No. *Sample Report*
Date of Report *1/5/81*
Page *1* of *7*

NOISE TEST REPORT

I SUMMARY

For the measurement and calculation procedures used in this report, reference is made to API RP 631M, *Measurement of Noise from Air-Cooled Heat Exchangers*.

Author(s): *Name*

Department: *Department name*

Date of Measurements: *1/4/81*

Model: *16 × 32 forced draft*

Plant location: *Chicago*

Specify: isolated ✓ installed

Manufacturer: *ABC Corporation*

Item number: *E-138*

Serial number: *25713*

Service: *Condenser*

Sound Power Level Per Fan [dB(A)]

Identification	Octave Band Center Frequencies (Hz)									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
	100.2	*105.3*	*106.4*	*103.4*	*102.6*	*98.3*	*95.6*	*91.2*	*85.6*	*79.6*

Sound Level and Octave Band Readings at Special Locations [dB(A)]

Identification	Octave Band Frequencies									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
Position 14	*86.5*	*90.4*	*92.5*	*89.5*	*88.5*	*83.4*	*81.5*	*77.5*	*71.5*	*65.5*
Position 15	*88.0*	*91.5*	*91.4*	*91.0*	*90.0*	*83.4*	*83.0*	*79.0*	*73.0*	*67.0*

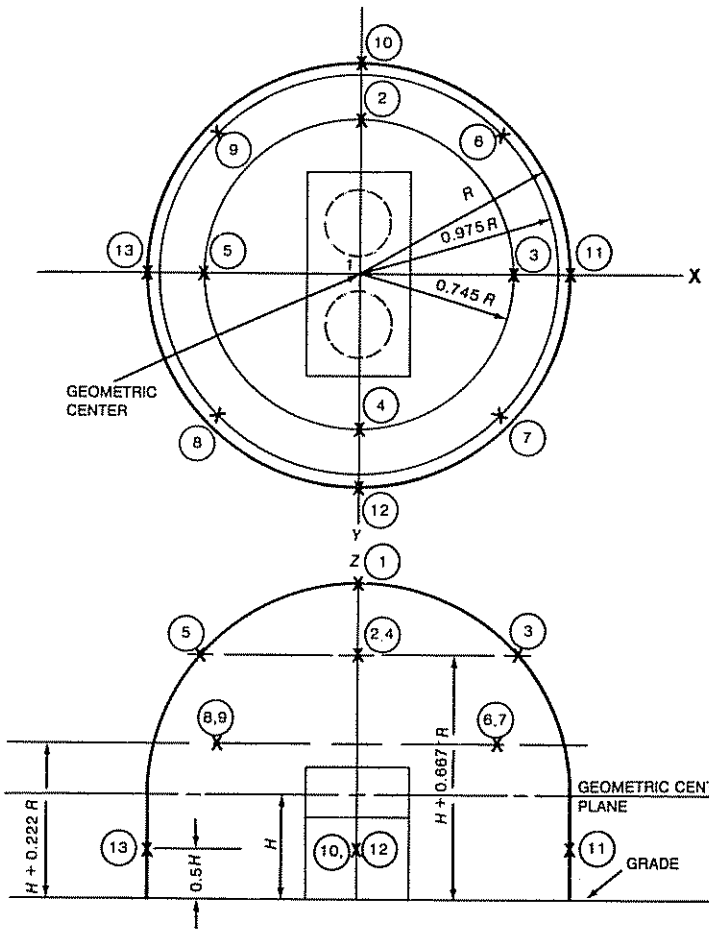
Job No. *Sample Report*
Date of Report *1/5/81*
Page *2* of *7*

NOISE TEST REPORT

Description of Measuring Location	Reason for Measurement
1 meter below fans	*personnel exposure and comparison*

II. DESCRIPTION OF BAY OR UNIT AND OPERATING CONDITIONS

1. Sketch of unit or bay (Indicate test layout and location of microphones). See Figures 1, 2, and 3 for example sketches.



NOISE TEST REPORT

2. Information from Equipment Data Sheet

Fans(s)

forced draft: ✓ induced draft: _____

rpm: *239*

capacity (ACFM): *170,000*

diameter: *12 feet*

static pressure: *0.45 in W.C.*

Number of bays: *1*

Number of fans per bay: *2*

Driver

Type: *Electric motor*

Rated horsepower: *25 hp*

rpm: *1750 rpm*

Auxiliaries (such as gears): *None*

III. TEST CONDITIONS

Fan rpm: *241 rpm*

Fan pitch: *10°*

Motor nameplate: amps *1 31 2 31* volts *1 460 2 460*

Motor measured: amps *1 26 2 26* volts *1 480 2 480*

Static pressure (In. W.C.): *1 0.45 2 0.46*

Weather conditions:

Wind velocity (mph): *8 mph*

Wind direction: *From northeast*

Ambient temperature (degrees Fahrenheit): *60 to 70°*

Remarks:

NOISE TEST REPORT

Job No. *Sample Report*
Date of Report *1/5/81*
Page *4* of *7*

IV. MEASURING EQUIPMENT

Microphone.

Make: *GR ½ inch*

Model:

Serial number: *4876*

Sound level meter.

Make: *GR*

Model: *1933*

Serial number: *3433*

Octave band analyzer.

Make: *GR*

Model: *1933*

Serial number: *3433*

Acoustical calibrator.

Make: *GR*

Model: *1562 A*

Serial number: *19512*

Other.

Make:

Model:

Serial number:

V. NOISE DATA SHEET

All noise data shall be recorded on the noise data sheet on page *6* of this report. The tabulation shall include sound level measurements at each test point, background sound levels at selected points, and sound level measurements at special locations.

VI. CALCULATIONS

The calculations made to prepare this report are appended to this report and appear on pages *5* through *7*

Job No. *Sample Report*
Date of Report *1/5/81*
Page *5* of *7*

NOISE TEST REPORT

NOISE AND BACKGROUND DATA SHEET

Point No	Description		dB									
			A	31	63	125	250	500	1000	2000	4000	8000
	calculated	Measured				*114*	*114.1*	*114.2*	*114.4*	*114.0*		
		Background										
		Corrected										
1		Measured	*77*	*82*	*83*	*80*	*79*	*75*	*72*	*68*	*62*	
		Background	*63.5*	*71*	*70*	*66*	*64*	*62*	*57*	*56*	*46*	
		Corrected	*77.0*	*82.0*	*83.0*	*80.0*	*79.0*	*75.0*	*72.0*	*68.0*	*62.0*	
2		Measured	*71*	*77*	*78*	*75*	*74*	*70*	*67*	*63*	*57*	
		Background	*63.5*	*71*	*70*	*66*	*64*	*62*	*57*	*56*	*46*	
		Corrected	*70.0*	*75.7*	*77.3*	*74.4*	*73.5*	*69.3*	*66.5*	*62.0*	*57*	
3		Measured	*73*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Background	*63.5*	*71*	*70*	*66*	*64*	*62*	*57*	*56*	*46*	
		Corrected	*72.4*	*78.3*	*79.5*	*77.0*	*76.0*	*71.5*	*69.0*	*65.0*	*59.0*	
4		Measured	*72*	*78*	*79*	*76*	*75*	*71*	*68*	*64*	*58*	
		Background	*63.5*	*71*	*70*	*66*	*64*	*62*	*57*	*56*	*46*	
		Corrected	*71.3*	*77.0*	*78.4*	*75.5*	*75.0*	*70.4*	*68.0*	*63.3*	*58.0*	
5		Measured	*71*	*77*	*78*	*75*	*74*	*70*	*67*	*63*	*57*	
		Background	*63.5*	*71*	*70*	*66*	*64*	*62*	*57*	*56*	*46*	
		Corrected	*70.0*	*75.7*	*77.3*	*74.4*	*73.5*	*69.3*	*66.5*	*62.0*	*57.0*	
6		Measured	*74*	*80*	*81*	*78*	*77*	*73*	*70*	*66*	*60*	
		Background	*61.5*	*69*	*68*	*64*	*62*	*60*	*55*	*54*	*44*	
		Corrected	*74.0*	*80.0*	*81.0*	*78.0*	*77.0*	*73.0*	*70.0*	*66.0*	*60.6*	
7		Measured	*73*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Background	*61.5*	*69*	*68*	*64*	*62*	*60*	*55*	*54*	*44*	
		Corrected	*73.0*	*78.5*	*80.0*	*77.0*	*76.0*	*72.0*	*69.0*	*65.0*	*59.0*	
8		Measured	*74*	*80*	*81*	*78*	*77*	*73*	*70*	*66*	*60*	
		Background	*61.5*	*69*	*68*	*64*	*62*	*60*	*55*	*54*	*44*	
		Corrected	*74.0*	*80.0*	*81.0*	*78.0*	*77.0*	*73.0*	*70.0*	*66.0*	*60.0*	
9		Measured	*72*	*78*	*79*	*76*	*75*	*71*	*68*	*64*	*58*	
		Background	*61.5*	*69*	*68*	*64*	*62*	*60*	*55*	*54*	*44*	
		Corrected	*72.0*	*77.4*	*79.0*	*76.0*	*75.0*	*71.0*	*68.0*	*63.4*	*58.0*	

Job No. *Sample Report*
Date of Report *1/5/81*
Page *6* of *7*

NOISE TEST REPORT

NOISE AND BACKGROUND DATA SHEET

Point No.	Description		dB A	31	63	125	250	500	1000	2000	4000	8000
10		Measured	*73.5*	*80*	*79*	*76*	*76*	*71*	*68*	*64*	*58*	
		Background	*61.5*	*69*	*68*	*64*	*62*	*60*	*55*	*54*	*44*	
		Corrected	*73.5*	*79.4*	*78.4*	*76.0*	*76.0*	*70.4*	*68.0*	*63.4*	*58.0*	
11		Measured	*74*	*78*	*79.5*	*78*	*75.5*	*73*	*70*	*66*	*60*	
		Background	*62.5*	*70*	*69*	*65*	*63*	*61*	*56*	*55*	*45*	
		Corrected	*74.0*	*77.3*	*79.5*	*78.0*	*75.5*	*73.0*	*70.0*	*66.0*	*60.0*	
12		Measured	*73*	*79*	*81*	*77*	*75*	*72*	*69*	*65*	*79*	
		Background	*62.5*	*70*	*69*	*65*	*63*	*61*	*56*	*55*	*45*	
		Corrected	*73.0*	*78.4*	*81.0*	*77.0*	*75.0*	*71.0*	*69.0*	*64.4*	*59.0*	
13		Measured	*75*	*78.5*	*80*	*76.5*	*77*	*71.5*	*68.5*	*64.5*	*58.5*	
		Background	*62.5*	*70*	*69*	*65*	*63*	*61*	*56*	*55*	*45*	
		Corrected	*75.0*	*77.8*	*80.0*	*76.5*	*77.0*	*71.5*	*68.5*	*63.9*	*58.5*	
	$\overline{SPL}$ *9 pt. Hem*	Measured	*73.2*	*78.8*	*79.6*	*76.6*	*75.8*	*71.6*	*68.8*	*64.5*	*58.9*	
		Background										
		Corrected										
	PWL Hem	Measured	*101.2*	*106.7*	*107.6*	*104.6*	*103.8*	*99.6*	*96.8*	*92.5*	*86.9*	
		Background										
		Corrected										
	$\overline{SPL}$ *4 pt. Cyl*	Measured	*73.9*	*78.2*	*79.7*	*76.9*	*75.9*	*71.5*	*68.9*	*64.4*	*58.9*	
		Background										
		Corrected										
	PWL Cyl	Measured	*98.8*	*103.1*	*104.6*	*101.8*	*100.8*	*96.4*	*93.8*	*89.3*	*83.8*	
		Background										
		Corrected										
	Total PWL	Measured	*103.2*	*108.3*	*109.4*	*106.4*	*105.6*	*101.3*	*98.6*	*94.2*	*88.6*	
		Background										
		Corrected										
	PWL/Fan	Measured	*100.2*	*105.3*	*106.4*	*103.4*	*102.6*	*98.3*	*95.6*	*91.2*	*85.6*	
		Background										
		Corrected										

Job No. *Sample Report*
Date of Report *1/5/81*
Page *7* of *7*

NOISE TEST REPORT

NOISE AND BACKGROUND DATA SHEET

Point No	Description		A	31	63	125	250	500	1000	2000	4000	8000
			dB									
14		Measured	87	91	93	90	89	84	82	78	72	
		Background	62.5	70	69	65	63	61	56	55	45	
		Corrected	86.5	90.4	92.5	89.5	88.5	83.4	81.5	77.5	71.5	
15		Measured	88	92	92	91	90	84	83	79	73	
		Background	77	82	83	80	79	75	72	68	62	
		Corrected	88.0	91.5	91.4	91.0	90.0	83.4	83.0	79.0	73.0	
	calculated	Measured				113.8	113.9	114.0	114.1	113.8		
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										
		Measured										
		Background										
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		Measured										
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										

APPENDIX C
EXAMPLE NOISE TEST REPORT FOR AN INSTALLED UNIT

Job No. *Sample Report*
Date of Report *1/5/81*
Page *1* of *6*

NOISE TEST REPORT

I. SUMMARY

For the measurement and calculation procedures used in this report, reference is made to API RP 631M, *Measurement of Noise from Air-Cooled Heat Exchangers*.

Author(s): *Name*

Department: *Department name*

Date of Measurements: *1/4/81*

Model: *16 × 32 Forced draft*

Plant location: *Dallas*

Specify: isolated _____ installed ✓

Manufacturer: *ABC Corporation*

Item number: *E138*

Serial number: *25713*

Service: *Condenser*

Sound Power Level Per Fan [dB(A)]

Identification	Octave Band Center Frequencies (Hz)									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
	100.6	*105.6*	*106.6*	*103.6*	*102.6*	*98.6*	*95.6*	*91.6*	*85.6*	*79.6*

Sound Level and Octave Band Readings at Special Locations [dB(A)]

Identification	Octave Band Frequencies									
	dB(A)	31	63	125	250	500	1000	2000	4000	8000
Position 2	*88.0*	*92.0*	*94.0*	*91.0*	*87.5*	*85.0*	*80.5*	*76.5*	*73.0*	*66.0*

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Description of Measuring Location	Reason for Measurement
1 meter below fan at Position 2	*personnel exposure and comparison*

II DESCRIPTION OF BAY OR UNIT AND OPERATING CONDITIONS

1. Sketch of unit or bay (Indicate test layout and location of microphones) See Figures 1, 2, and 3 for example sketches

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2. Information from Equipment Data Sheet.

Fans(s).

forced draft: ✓ induced draft: _____

rpm: *239 rpm*

capacity (ACFM): *170,000*

diameter: *12 feet*

static pressure: *0.45 in W.C.*

Number of bays: *1*

Number of fans per bay: *2*

Driver.

Type: *Electric motor*

Rated horsepower: *25 hp*

rpm: *1750*

Auxiliaries (such as gears): *None*

III TEST CONDITIONS

Fan rpm: *241 rpm*

Fan pitch: *10°*

Motor nameplate: amps (1) *31* (2) *31* volts (1) *460* (2) *460*

Motor measured: amps (1) *27* (2) *28* volts (1) *470* (2) *470*

Static pressure (In. W.C.): (1) *0.47* (2) *0.48*

Weather conditions:

Wind velocity (mph): *6*

Wind direction: *From south-southeast*

Ambient temperature (degrees Fahrenheit): *65–70°*

Remarks:

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IV MEASURING EQUIPMENT

Microphone

Make: *GR ½"*

Model:

Serial number: *4876*

Sound level meter

Make: *GR*

Model: *1933*

Serial number: *3433*

Octave band analyzer

Make: *GR*

Model: *1933*

Serial number: *3433*

Acoustical calibrator

Make: *GR*

Model: *1562 A*

Serial number: *19512*

Other

Make:

Model:

Serial number:

V. NOISE DATA SHEET

All noise data shall be recorded on the noise data sheet on page *6* of this report. The tabulation shall include sound level measurements at each test point, background sound levels at selected points, and sound level measurements at special locations.

VI. CALCULATIONS

The calculations made to prepare this report are appended to this report and appear on pages *5* through *6*.

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NOISE AND BACKGROUND DATA SHEET

Point No	Description		dB									
			A	31	63	125	250	500	1000	2000	4000	8000
	calculated	Measured				*113.9*	*113.8*	*114*	*113.9*	*114.1*		
		Background										
		Corrected										
1		Measured	*87*	*91*	*93*	*90*	*89*	*84*	*82*	*78*	*72*	
		Background	*76*	*81*	*82*	*79*	*78*	*74*	*71*	*67*	*61*	
		Corrected	*87.0*	*90.5*	*93.0*	*90.0*	*89.0*	*83.5*	*82.0*	*78.0*	*72.0*	
2		Measured	*88*	*92*	*94*	*91*	*88*	*85*	*81*	*77*	*73*	
		Background	*76*	*81*	*82*	*79*	*78*	*74*	*71*	*67*	*61*	
		Corrected	*88.0*	*92.0*	*94.0*	*91.0*	*87.5*	*85.0*	*80.5*	*76.5*	*73.0*	
3		Measured	*87*	*93*	*93*	*90*	*90*	*86*	*83*	*79*	*72*	
		Background	*76*	*81*	*82*	*79*	*78*	*74*	*71*	*67*	*61*	
		Corrected	*87.0*	*93.0*	*93.0*	*90.0*	*90.0*	*86.0*	*83.0*	*79.0*	*72.0*	
4		Measured	*86*	*92*	*92*	*89*	*89*	*85*	*82*	*78*	*71*	
		Background	*76*	*81*	*82*	*79*	*78*	*74*	*71*	*67*	*61*	
		Corrected	*85.5*	*92.0*	*91.5*	*88.5*	*89.0*	*85.0*	*82.0*	*78.0*	*70.5*	
5		Measured	*82*	*87*	*88*	*85*	*84*	*80*	*77*	*73*	*67*	
		Background	*74*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Corrected	*81.3*	*86.3*	*87.3*	*84.3*	*83.3*	*79.3*	*76.3*	*72.3*	*66.3*	
6		Measured	*83*	*88*	*89*	*86*	*85*	*81*	*78*	*74*	*68*	
		Background	*74*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Corrected	*82.4*	*87.4*	*88.4*	*85.4*	*84.4*	*80.4*	*77.4*	*73.4*	*67.4*	
7		Measured	*84*	*89*	*90*	*87*	*86*	*82*	*79*	*75*	*69*	
		Background	*74*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Corrected	*83.5*	*88.5*	*89.5*	*86.5*	*85.5*	*81.5*	*78.5*	*74.5*	*68.5*	
8		Measured	*83*	*88*	*89*	*86*	*85*	*81*	*78*	*74*	*68*	
		Background	*74*	*79*	*80*	*77*	*76*	*72*	*69*	*65*	*59*	
		Corrected	*82.4*	*87.4*	*88.4*	*85.4*	*84.4*	*80.4*	*77.4*	*73.4*	*67.4*	
	calculated	Measured				*113.8*	*113.7*	*113.8*	*113.7*	*113.9*		
		Background										
		Corrected										

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NOISE AND BACKGROUND DATA SHEET

Point No.	Description		dB A	31	63	125	250	500	1000	2000	4000	8000
	$\overline{SPL}$	Measured										
		Background										
		Corrected	86.9	91.9	92.9	89.9	88.9	84.9	81.9	77.9	71.9	
	PWL below	Measured										
		Background										
		Corrected	101.7	106.7	107.7	104.7	103.7	99.7	96.7	92.7	86.7	
	$\overline{SPL}$	Measured										
		Background										
		Corrected	82.4	87.4	88.4	85.9	84.4	80.4	77.4	73.4	67.4	
	PWL above	Measured										
		Background										
		Corrected	99.2	104.2	105.2	102.2	101.2	97.2	94.2	90.2	84.2	
	Total PWL	Measured										
		Background										
		Corrected	103.6	108.6	109.6	106.6	105.6	101.6	98.6	94.6	88.6	
	PWL/Fan	Measured										
		Background										
		Corrected	100.6	105.6	106.6	103.6	102.6	98.6	95.6	91.6	85.6	
		Measured										
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										
		Measured										
		Background										
		Corrected										