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JAPANESE INDUSTRIAL STANDARD

**Methods of Noise Level
Measurement for Oil
Hydraulic Pumps and Motors**

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

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Methods of Noise Level Measurement for
Oil Hydraulic Pumps and Motors

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1. Scope

This Japanese Industrial Standard specifies methods of noise level measurement for stationary noise ⁽³⁾ radiated from oil hydraulic pumps ⁽¹⁾ hereinafter referred to as "pump" and motors ⁽²⁾ hereinafter referred to as "motor".

Notes ⁽¹⁾ A positive-displacement pump for oil hydraulic driving.

⁽²⁾ A positive-displacement motor for oil hydraulic driving, in the range of operation not less than 50 min^{-1} in rotational speed.

⁽³⁾ A sound continuing approximately stationarily at least over not less than 30 sec.

- Remarks 1. Influences of appliances and pipe lines at least limit required for driving of pump or load of motor, if noises radiated therefrom are within the range specified in this Standard, may be neglected.
2. Methods of measurement of band sound pressure level in decibels and sound power level in decibels are respectively shown in Informative Reference 1 and Informative Reference 2.
3. The test apparatus and methods of measurement are in accordance with ISO 4412/1 and ISO 4412/2, as appropriate.

2. Definitions

For the purpose of this Standard main definitions are in accordance with JIS Z 8106 and in addition the following definitions apply:

- (1) sound pressure level 10 times of common logarithm of ratio of square of root-mean-square value of sound pressure to the square of reference sound pressure. The reference sound pressure is $20 \mu\text{Pa}$. The unit is decibel and the symbol of unit is dB.
- (2) noise level 10 times the common logarithm of ratio of square of root-mean-square value P_A of sound pressure weighted by A characteristic specified in JIS C 1502 or JIS C 1505 to the square of reference sound pressure P_0 ($20 \mu\text{Pa}$). The unit is decibel and the symbol of unit is dB. Noise level L_{pA} is defined according to the following formula:

$$L_{pA} = 10 \log_{10} (P_A^2 / P_0^2) \text{ (dB)}$$

Applicable Standards, Corresponding International Standards and Reference Standards: See page 16.

- (3) band sound pressure level The sound pressure level of sound included in a frequency band. In the case where the width of the frequency band is 1 octave or 1/3 octave, respectively it is called the octave band sound pressure level or 1/3 octave band sound pressure level. The unit is decibel, and the symbol of unit is dB.
- (4) sound power level in decibels⁽⁴⁾ 10 times the common logarithm of ratio of sound power⁽⁵⁾ radiated from sound source to the reference sound power. The reference sound power is 1 pW. The unit is decibel and the symbol of unit is dB.

Notes (4) It is called also a sound power level of a source in decibels. In the case where there is no fear for confusion, it may be called the power level.

(5) It is called also the sound power of a source.

- (5) background noise The noise level, sound pressure level or band sound pressure level of sound radiated from matters other than measuring objective (pump or motor) during noise measurement at the measuring point.
- (6) reference sound source A small type broad band noise characteristic sound source having sufficient and stabilized power, flat frequency characteristic and good whole directionality, of which sound power level in decibels, when set on a reflection surface, is calibrated⁽⁶⁾ according to JIS Z 8732. This sound power level in decibels is called calibrated sound power level in decibels of reference sound source.

Note (6) In the case where it is used only for measurement of double distance attenuation characteristics of sound field, the sound power level in decibels may not be calibrated.

3. Measuring Item

Under the operating conditions of 4.2 the noise level at a definite position of periphery of pump (or motor) shall be measured.

- Remarks 1. In the case where the band sound pressure level is required, it shall be measured by referring the method shown in Informative Reference 1 or Informative Reference 2.
2. In the case where the sound power level in decibels is required, it shall be measured by referring the method shown in Informative Reference 2. In this case, from the obtained A characteristic sound power level in decibels the average sound level (informative reference value) may be calculated.

4. Measuring Conditions

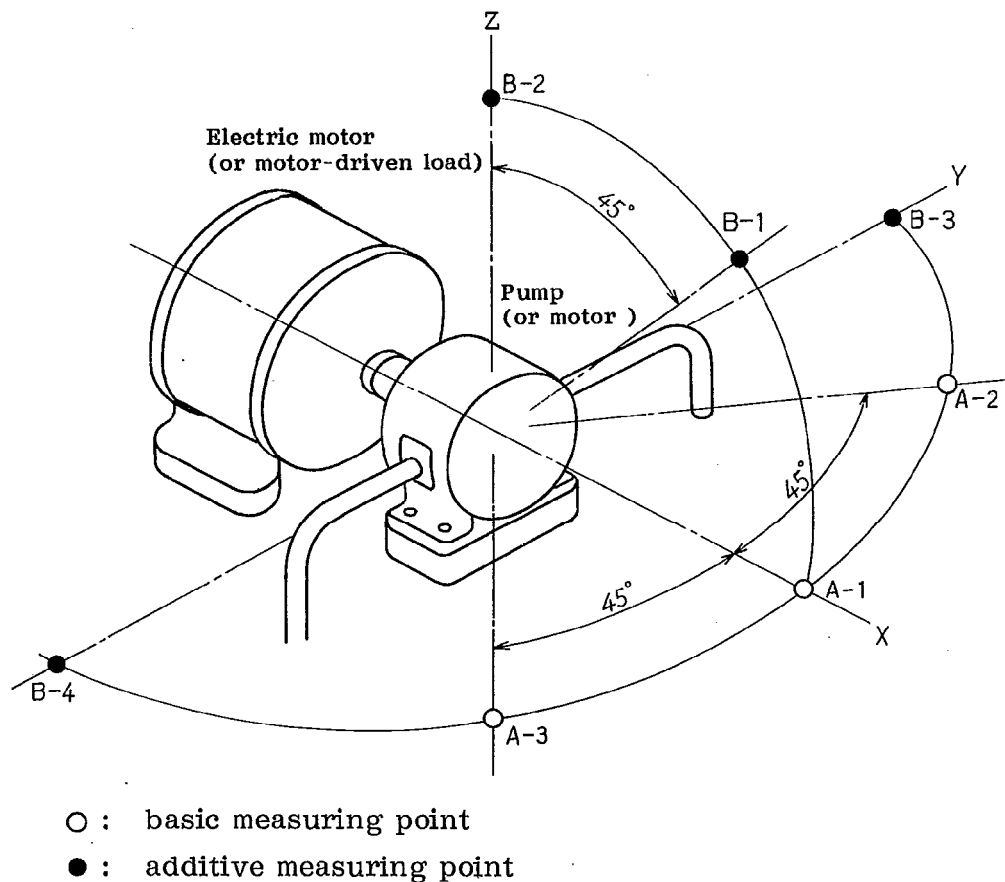
4.1 Measuring Environment

4.1.1 Measuring Place The measuring place shall be little in reflection of sound from matters other than floor surface and, comply with following each condition.

- (1) **Floor Surface** Generally, the floor surface shall be a smoothly finished concrete or that having reflection rate equivalent thereto. However, in the case where a sufficient sound absorption treatment is executed on the floor surface, the read out value added with 3 dB may be used as the noise level of measuring objective sound source.
- (2) **Distance from Inside Wall Surface of Room** The measuring points shown in Fig. 1 shall be apart by at least 1.2 m or more from all inside wall surface of room. However, in the case where a sufficient sound absorption treatment is executed, the measuring points for confirming the distance attenuation may not be secured with this distance.

Fig. 1. Measuring Points of Noise Test

(A-1 to 3: basic measuring point, B-1 to 4: additive measuring point)



- (3) Double Distance Attenuation The noise level difference at respective distances of 1 m and 2 m from the surface of measuring objective shall be 5 dB or more, or in the case where a small type sound source such as reference sound source or the like is installed in adjacent to floor surface, the difference of read out values of noise levels at respective distances of 1 m and 2 m from the centre of sound source shall be 5 dB or more. However, exclusively in the case where this difference is 3 dB or 4 dB, the read-out value of noise level of objective sound source may be used with it corrected. The correction value shall be in accordance with Table 1.

Table 1. Correction Values of Sound Field Based on Double Distance Attenuation Characteristics of Reference Sound Source

Unit: dB		
Difference of read-out values of noise levels at respective distances of 1 m and 2 m	3	4
Correction value	-2	-1

Remark: In the case where the double distance attenuation is less than 3 dB, the measuring result shall be used only as the informative reference value. In this case, the condition of measuring place (inside room dimensions, arrangement, piping, sound field measuring result, etc.) shall be described specially on recording paper.

4.1.2 Background Noise The background noise level at measuring point should preferably be smaller by 10 dB than the read-out value of objective sound source. However, in case where this condition is not able to be obtained, exclusively in the case where the difference of read-out values is in the range of 6 to 9 dB, the read-out value of noise level of objective sound source may be used by correcting. The correction value shall be in accordance with Table 2.

Table 2. Correction Values to Influence of Background Noise

Unit: dB		
Difference of read-out values when the measuring objective sound source is covered and not covered.	4, 5	6, 7, 8, 9
Correction value	-2	-1

- Remarks 1. When the measuring object is covered with a sound isolation material having transmission loss of at least 10 dB over the whole frequency range influencing upon the noise level of measuring objective sound, the read-out value at each measuring point is taken as background noise.
2. In the case where the difference of read-out values is 4 dB or 5 dB, the correction may be performed, but the measuring results shall be used exclusively as informative reference value. In this case, the condition of measuring place (inside room dimensions, arrangement, piping, sound field measuring results, etc.) shall be described specially on recording paper.

3. In case where a sufficiently large difference of read-out values can not be obtained, apparatus and the like other than oil hydraulic pump (or motor) in the test room shall be sound-isolated.

4.2 Operation Conditions The measurement of noise shall, as a rule, be executed under rated operation conditions⁽⁷⁾. In case where it is executed inevitably under conditions other than this condition, the agreement shall be performed between the parties concerned with delivery and the operation conditions shall be described clearly. The permissible variation value of operation conditions shall be in accordance with Annex.

Note ⁽⁷⁾ The rated operation conditions mean the conditions to be the reference of design at the manufacturer, and generally expressed by pressure and rotational speed. The oil temperature at the time of test shall be in the range of 20 to 50°C.

5. Measuring Device and Test Apparatus

5.1 Measuring Device The sound level meter according to JIS C 1502 (or precession sound level meter according to JIS C 1505), which has received verification by the Measurement Law or the measuring device hereinafter referred to as "sound level meter" having performance equivalent or superior thereto shall be used.

5.2 Test Apparatus The test apparatus shall be as follows.

- (1) Accessory Appliances and Piping The following countermeasures shall be applied so as conditions of background noise of 4.1.2 to be satisfied.
 - (a) Electric Motor for Pump Driving (or Motor-Driven Load)
The electric motor for pump driving (or motor-driven load) shall, as a rule, be installed at outside of room. In the case of installing inside the room, it shall be covered with a sound isolation box.
 - (b) Loading Valve (or Oil Hydraulic Source) The loading valve (or oil hydraulic source) should preferably be installed at outside of test room, but in case where it is impossible, it shall be installed for apart from the pump (or motor). However, if the sufficient sound isolation is possible, it may be installed near the pump (or motor).
- (2) Installation of Pump (or Motor) The height of shaft center at the installing position shall be, as a rule, 0.5 to 1 m from the floor surface.
- (3) Oil Hydraulic Circuit The oil hydraulic circuit for test shall be in accordance with the circuit to be used for type test⁽⁸⁾ under stationary load as shown in Fig. 2.1 (for pump) or Fig. 2.2 (for motor), as appropriate, and should preferably be capable of being verified with existence of variation of performance of specimen pump (or specimen motor) before and after noise test.

For piping diameter, working oil, and filter, those recommended by manufacturer shall be used.

As loading valve, a variable throttle valve without freely movable part should preferably be used, but if the working is stable, an automatic valve such as relief valve may be used.

Note (⁸) Relating to newly manufactured or revised type of pump (or motor), the tests for performance, endurance, reliability, etc. to be carried out for confirming the rated capability or marked performance.

Fig. 2.1. Oil Hydraulic Circuit for Noise Test
(For Oil Hydraulic Pump)

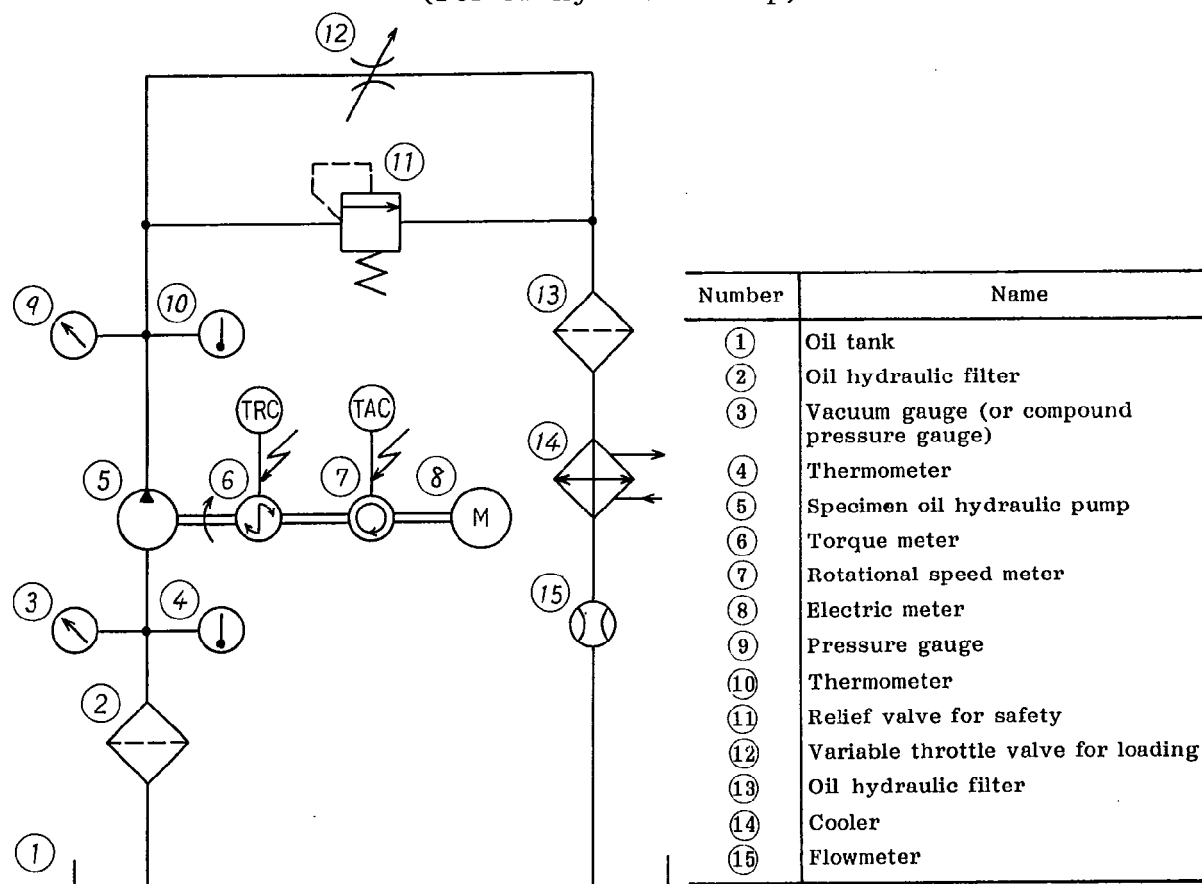
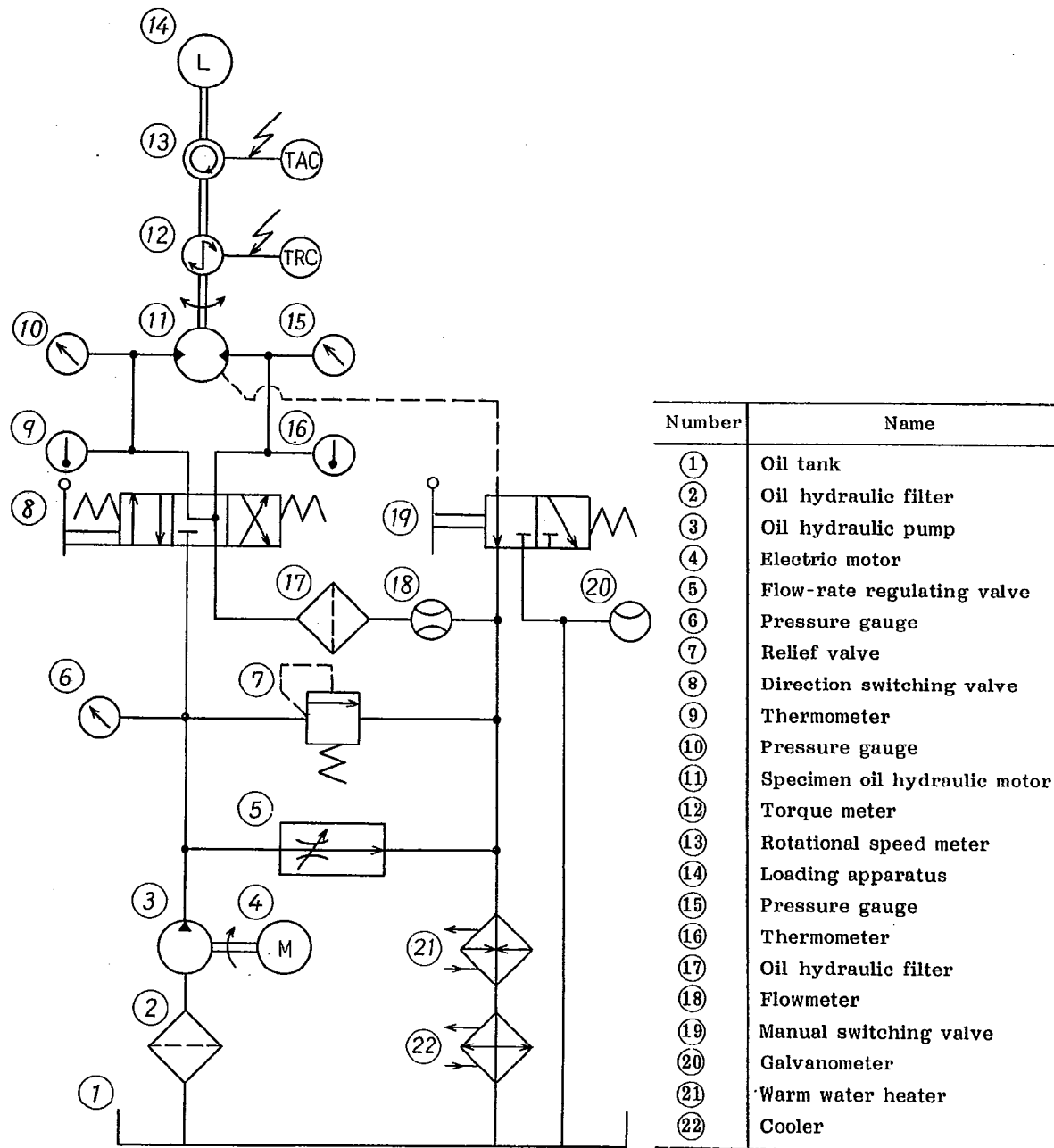


Fig. 2.2. Oil Hydraulic Circuit for Noise Test
(For Oil Hydraulic Motor)

6. Measurement of Noise Level

6.1 Preparation for Measurement The preparation for measurement shall be in accordance with the following.

- (1) Confirmation of Sound Field Conditions Prior to installation of pump (or motor), confirm that the test sound field satisfies conditions of (3) of 4.1.1 by using a reference sound source or the like. In the case where confirmation of sound field conditions is carried out by using specimen pump (or specimen motor), it shall be executed after completion of preparation operation of (2).

- (2) Preparation Operation Carry out the preparation operation under a suitable load until the permissible variable range shown in Annex Table is secured by installing a pump (or a motor) and the oil temperature in oil tank and instruments become equivalent condition.
- (3) Measurement of Background Noise Prior to measurement of noise of measuring objective sound, carry out measurement of background noise at each measuring point.

Remark: It is preferable to confirm that there is no difference before and after testing by carrying out measuring of background noise also after testing.

6.2 Measuring Points The basic measuring points are shown in A-1 to 3 of Fig. 1 and the additive measuring points, in B-1 to 4 of Fig. 1. In the case where the coordinate origin is taken at the geometrical center of axial center of pump (or motor), X axis, at axial direction of pump (or motor), Y axis, in direction perpendicular to it on a horizontal plane, and Z axis, at the upper vertical part, each measuring point shall be as follows.

- (1) Basic Measuring Points Basic measuring points shall be at a distance of 1 m from the sound source surface on X-Y surface, generally, A-1 point, at opposite side of electric motor (or motor-driven load), A-2 and A-3 points, respectively at both sides of A-1 point in the direction of 45° from the coordinate origin. However, if the reason on piping of specimen pump (or specimen motor), or the reason to make less the influence of other sound source or reflection exists, the direction may be different from the above-mentioned.

If the read-out values at three points of 6.2 under the same operation conditions are all in the range of ± 2 dB of its average value, the average value of measured values at three points of 6.2 performed with correction to floor surface conditions shown in 4.1.1 (1), correction to sound field conditions shown in 4.1.1 (3) and correction to background noise shown in 4.1.2, may be taken as the average noise level of measuring objective sound source.

When the bias of read-out value from the average value is not in the range of 6.2, the additive measuring points shown in the following shall be added.

- (2) Additive Measuring Points Any of additive measuring points shall be at a distance of 1 m from the sound source surface and B-1 point, be in the direction of 45° from A-1 point on X-Z surface, B-2 point, on Z axis, B-3 and B-4 points, at both sides of pump (or motor) on Y axis.

Out of read-out values at total seven points of basic measuring point and additive measuring points, the values at two points of which bias from the average value is largest shall be deleted and the average noise level, calculated from the measured values at remaining five points.

6.3 Measuring Methods Measuring method shall be in accordance with the following.

- (1) Correction Circuit for Frequency of Sound Level Meter As to the correction circuit for frequency of sound level meter A-characteristics shall be used.

Remarks 1. When the measuring points for calculation of average noise level are three points of basic measuring points (A points of Fig. 1), at one point out of them, and when seven points added with additive measuring points (A point and B point of Fig. 1), at two points out of them, it is preferable to measure together with sound pressure level.

2. In the case where the measurement of band sound pressure level in decibels is carried out also, it is preferable to measure in the direction where the sound pressure level in decibels is measured.

- (2) Direction of Sound Level Meter Let the microphone of sound level meter direct to the direction of sound source.
- (3) Dynamic Characteristics of Sound Level Meter As to the dynamic characteristics of sound level meter, the slow dynamic characteristics (SLOW) shall be used.
- (4) Reading-Out of Noise Level The read-out value of noise level shall be the integer value nearest to the indicating value.

Remarks 1. The whole measuring system including sound level meter, cable, etc., shall be carried out with calibration by sound calibrator having positive accuracy within ± 0.5 dB, before and after measurement.

2. At the time of measuring, cares shall be so taken that the influence of reflection from all surfaces including the measuring person himself other than the floor surface is made as small as possible.

7. Calculation Method of Average Noise Level

The average noise level $\overline{L_{pA}}$ [dB] shall be the energy average of measured values⁽⁹⁾⁽¹⁰⁾ at each measuring point, be obtained according to the following formula, and be the integer value nearest thereto.

$$\overline{L_{pA}} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^N 10^{L_{pAi}/10} \right] \dots\dots\dots (1)$$

where, L_{pAi} : measured value of noise level at i -th measuring point (dB)

N : number of measured values

Notes (9) Relating to read-out value at each measuring point, the correction to the influence of background noise of 4.1.2 shall be performed.

- (¹⁰) In the case where the measurements are carried out at total seven points of three points of basic measuring points and four points of additive measuring points, the read-out values at two points where the bias from average value is largest are deleted and the measured value is calculated from the measured values of remaining five points.

8. Record Data and Record Format

8.1 Record Data On the test report, measured value of noise level at each measuring point and average noise level of measuring objective sound source calculated therefrom and in addition, the type of specimen pump (or specimen motor), main elements, test conditions, using measuring device, and test sound field conditions shall be recorded and marked. When required, the performance test results of specimen pump (or specimen motor) before and after test shall be recorded and marked.

8.2 Record Format The measuring results together with test conditions shall be recorded in accordance with Fig. 3, Table 3 and Table 4, as appropriate.

- Remarks 1. In cases where test conditions do not satisfy the sound field conditions and conditions to background noise specified in this Standard or the operation conditions do not satisfy the permissible variation value, the fact that the measuring results of noise level are informative reference value shall be described clearly on the remark column and the like.
2. In the case where the measurement of sound power level in decibels is executed according to Informative Reference 2, the fact that the average noise level (informative reference value) converted from this is the value obtained according to Informative Reference 2 shall be described clearly and may be used as auxiliary data.

Fig. 3. Arrangement Figure for Noise Test

