# COMMISSION DIRECTIVE

## of 2 August 1989

## adapting to technical progress Council Directive 86/662/EEC on the limitation of noise emitted by hydraulic excavators, rope-operated excavators, dozers, loaders and excavator-loaders

(89/514/EEC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community,

Having regard to Council Directive 86/662/EEC of 22 December 1986 on the limitation of noise emitted by hydraulic excavators, rope-operated excavators, dozers, loaders and excavator-loaders (1), and in particular Article 8, first indent, thereof,

Whereas, in view of the experience gained, the present state of technical progress and the international standardization work that has been carried out it is now necessary to adapt the provisions of Annex II to Directive 86/662/EEC in order to take into account the most recent advances;

Whereas the measures provided for in this Directive are in accordance with the opinion of the Committee on Adaptation to Technical Progress set up under the Directive relating to the determination of the noise emission of construction plant and equipment, which is competent to adapt the Annexes to Directive 86/662/EEC, and in particular to adopt the real, dynamic measurement method referred to in Annex II to that Directive,

HAS ADOPTED THIS DIRECTIVE:

*Article 1*

Annex II to Directive 86/662/EEC is hereby replaced by the Annex to this Directive.

*Article 2*

Member States shall bring into force the necessary provisions in order to comply with this Directive by 1 January 1990 and shall forthwith inform the Commission thereof.

*Article 3*

This Directive is addressed to the Member States.

Done at Brussels, 2 August 1989.

*For the Commission*

Carlo RIPA DI MEANA

*Member of the Commission*

(1) OJ L 384, 31. 12. 1986, p. 1.

*ANNEX*

*'ANNEX II*

**DYNAMIC TEST METHOD OF MEASUREMENT OF AIRBORNE NOISE EMITTED BY HYDRAULIC EXCAVATORS, ROPE-OPERATED EXCAVATORS, DOZERS, LOADERS AND EXCAVATOR-LOADERS**

SCOPE

This method of measurement is applicable to hydraulic excavators, rope-operated excavators, dozers, loaders and excavator-loaders, hereinafter referred to as 'earthmoving machines'. It lays down the test procedures to be applied, under conventional working conditions, for determining the sound-power level of such earthmoving machines with a view to EEC type-examination and checking for conformity.

These technical procedures comply with the requirements laid down in Annex I to Council Directive 79/113/EEC (1) and the provisions of that Annex are applicable to earthmoving machines subject to the following additions:

4. CRITERIA TO BE USED FOR EXPRESSING RESULTS

4.1 **Acoustic criterion for the environment**

The acoustic criterion for the environment of an earthmoving machine is expressed by the sound-power level $L_{WA}$.

6.2 **Operation during measurements**

The noise emitted is measured with the earthmoving machine operating under the conventional working conditions for each type of machine as defined in 6.2.2.

6.2.1. *Testing of the sound source when idling*

Not applicable.

6.2.2 *Test under load*

The conventional working conditions for each type of machine are described below.

All of the appropriate safety rules and designer's instructions for operating the machine have to be complied with during the test.

No signalling device such as a warning horn or reversing alarm is to be operated during the test.

6.2.2.1 Hydraulic or rope-operated excavator

The excavator must be fitted with an attachment devised by the designer, such as a backhoe, loader, clamshell or dragline attachment. Warm up the engine and the hydraulics to normal operating conditions for the prevailing ambient temperature. Move the accelerator to the maximum position (idling). All movements have to be effected at maximum speed, though without actuating the safety valves and without jolting at the end of travel.

The axis of rotation of the superstructure of the excavator must pass through the centre C of the hemisphere (see figure 5). The longitudinal axis of the machine must coincide with axis x and the front of the machine must face point B.

The dynamic cycle, without movement of material, consists of three rotary movements through 90°, from axis x to axis y and back to axis x. During each rotation the front end of the attachment is operated in the sequence described under A, B, C or D below.

A. Backhoe attachment

The purpose of the dynamic cycle is to simulate excavating a trench and dumping the excavated material alongside it. At the start of the cycle, position the boom and the balance beam such that the attachment is at 75 % of its maximum outreach and 0,5 m above the ground. Set the cutting edge of the attachment to its forward position at an angle of 60° to the surface of the test site.

(1) OJ No L 33, 8. 2. 1979, p. 15.

First raise the boom and retract the balance beam at the same time in order to keep the attachment at 0,5 m above the test site for 50 % of the remaining travel of the boom and balance beam. Then extend or pull in the attachment. Raise the attachment by raising the boom and continue to retract the balance beam to simulate sufficient ground clearance to pass over the side of the trench. (30 % of the maximum lifting height of the attachment). Rotate 90° to the driver's left. Raise the boom while rotating and extend the balance beam until the attachment reaches 60 % of the boom's maximum lifting height. Then extend the balance beam to 75 % of full extension. Extend the backhoe attachment to bring the cutting edge back to the vertical. Tilt the backhoe attachment back to the starting position with the boom down and the backhoe attachment pulled in.

Repeat the above operation twice more in succession to complete a dynamic cycle.

The dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

B. Loader attachment

The purpose of the dynamic cycle is to simulate loading at the height of a high wall. At the start of the cycle, with the cutting edge of the attachment parallel to the ground, position the attachment 0,5 m above the ground and 75 % retracted.

Then extend the attachment to 75 % of its outreach, while keeping the bucket in its original orientation. Extend or retract the attachment and raise it to 75 % of its maximum lifting height with the balance beam extended 75 %. Rotate 90° to the driver's left and at maximum rotation actuate the bucket discharge mechanism. Rotate back to the starting position with the bucket in the position specified at the beginning of this section.

Repeat the above operation twice more in succession to complete a dynamic cycle.

The dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

C. Clamshell attachment

The purpose of the dynamic cycle is to simulate excavating a pit. At the start of the cycle, ensure that the clamshell is open and 0,5 m above the test site.

Close the clamshell and raise it to medium height. Rotate 90° to the driver's left. Open the clamshell. Rotate back while lowering the clamshell to its original position.

Repeat the above operation twice more in succession to complete a dynamic cycle.

The dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

D. Dragline attachment

The purpose of the dynamic cycle is to simulate excavating a layer in a trench and dumping the excavated material alongside it. During the cycle the boom must be inclined 40°. The bucket hangs vertically from the end of the boom and 0,5 m above the test site, without the chains touching the ground.

Retract the bucket to bring it as close as possible to the machine while keeping it at 0,5 m above the test site. As soon as the bucket is retracted, rotate 90° to the driver's left. At the same time, raise the bucket to 75 % of its maximum lifting height and move it out as far as its loaded position. Rotate back while actuating the bucket discharge mechanism and retracting it to its original position.

Repeat the above operation twice more in succession to complete a dynamic cycle.

The dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

6.2.2.2 Dozer

The machine has to be fitted with the blade intended for it by the designer. Warm up the engine and the hydraulics to normal operating conditions for the prevailing ambient temperature.

The path covered by the machine is shown in figure 5. The axis of the path is x, and the longitudinal axis of the machine coincides with it. The length of the measurement path AB is equal to 1.4 times the radius of the hemisphere. The mid-point of this path must coincide with the centre C of the hemisphere.

The machine must move forwards in the direction A-B and reverse in the direction B-A.

Operate the machine with the blade lowered to the transport position 0,3 ± 0,05 m above the surface of the test path. In every case in question, run the engine at maximum governed rpm (in a no-load state) and at constant forward and reverse speed. Forward speed must be close to, but no more than, 4 km/h for tracked and steel-wheeled machines and 8 km/h for machines with rubber tyres. The same gear ratio must be used for reversing irrespective of the speed. With most machines this is done in first forward gear and first reverse gear. The speed of machines with hydrostatic drives may be between 3,5 and 4 km/h in the case of tracked and steel-wheeled machines and between 7 and 8 km/h in the case of rubber-tyred machines since it is difficult to adjust the travel speed controls to exact values.

Under these conditions the machines are run through the hemisphere without stopping, in both directions and without moving the blade. If the lower gear ratio produces a higher speed than that specified, carry out the test at this ratio with the engine running at maximum governed rpm in a no-load state). In the case of machines with hydrostatic drives, set the engine to maximum governed rpm (in a no-load state) and adjust the travel speed control so as to reach the speeds specified above.

Measure the sound-pressure level only when the centre of the machine is on the working path between points A and B in figure 5.

The driver may make steering adjustments while the machine is moving along the track in order to keep it to the centre line of the test track.

One dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

6.2.2.3 Loader

The machine has to be fitted with the bucket intended for it by the designer. Warm up the engine and the hydraulics to normal operating conditions for the prevailing ambient temperature.

All movements have to be effected at maximum speed, though without actuating the safety valves and without jolting at the end of travel.

A. Test in moving state

The test path covered by the machine must be as shown in figure 5. The axis of the path is x, and the longitudinal axis of the machine coincides with it. The length of the measurement path AB is equal to 1.4 times the radius of the hemisphere. The mid-point of this path must coincide with the centre C of the hemisphere.

The machine must move forwards in the direction A B and reverse in the direction B-A.

Operate the machine with the empty bucket lowered to the transport position, 0,3 ± 0,05 m above the surface of the test path. In every case in question, run the engine at maximum governed rpm (in a no-load state) and at constant forward and reverse speed. Forward speed must be close to, but no more than, 4 km/h for machines with caterpillar tracks and 8 km/h for machines with wheels. The same gear ratio must be used for reversing irrespective of the speed.

With most machines this is done in first forward gear and first reverse gear. The speed of machines with hydrostatic drives may be between 3,5 and 4 km/h in the case of tracked machines and between 7 and 8 km/h in the case of rubber-tyred machines since it is difficult to adjust the travel speed controls to exact values.

Under these conditions the machines are run through the hemisphere without stopping, in both directions and without moving the bucket. If the lower gear ratio produces a higher speed than that specified, carry out the test at this ratio with the engine running at maximum governed rpm (in a no-load state). In the case of machines with hydrostatic drives, set the engine to maximum governed rpm (in a no-load state) and adjust the travel speed control so as to reach the speeds specified above.

Measure the sound-pressure level only when the centre of the machine is on the working path between points A and B in figure 5.

The driver may make steering adjustments while the machine is moving along the track in order to keep it to the centre line of the test track.

One dynamic cycle consists of one forward pass and one reverse pass.

The dynamic cycle is repeated at least three times to satisfy the requirements of 7.2.

B. Test in static-hydraulic state

The longitudinal axis of the loader must coincide with axis x and the front of the machine must face point B. The mid-point of the basic length 1 in figure 3 must coincide with the centre of the hemisphere C in figure 5. Run the engine at maximum governed rpm (in a no-load state). Select neutral gear. Raise the bucket from the transport position to 75 % of its maximum lifting height and return it to the transport position three times in succession. This sequence constitutes one static-hydraulic cycle.

The cycle is repeated at least three times to satisfy the requirements of 7.2.

6.2.2.4 Excavator-loader

The excavator-loader has to be fitted with the backhoe and bucket intended for it by the designer. Warm up the engine and the hydraulics to normal operating conditions for the prevailing ambient temperature.

In excavator mode, set the accelerator control to maximum (in the no-load state) or to the position specified by the designer. All movements of the bucket have to be effected at maximum speed, though without actuating the safety valves and without jolting at the end of travel.

A. Excavator mode

The longitudinal axis of the machine must coincide with axis x and the front of the machine must face point B, i.e. the excavator end of the excavator-loader in figure 4 must face point B. The mid-point of the basic length 1 in figure 4 must coincide with the centre of the hemisphere C in figure 5.

Operate the machine in excavator mode in accordance with the method described in 6.2.2.1, point A, substituting 45° as the angle of rotation in place of the 90° specified there.

B. Loader mode

Operate in accordance with the method described in 6.2.2.3, with the backhoe bucket in the transport position.

6.3 **Measurement site**

6.3.1 *General*

Three types of surface, described in 6.3.2., 6.3.3 and 6.3.4, are authorized for the test site:

(a) hard reflecting plane (made of concrete or non-porous asphalt);

(b) combination of an hard reflecting plane and sand;

(c) sand surface or sandy soil.

The hard reflecting plane must be used for testing the following machines:

— rubber-tyred machines: all operating conditions;

— excavators: all operating conditions;

— tracked loaders and tracked excavator-loaders: operation in static-hydraulic state.

The combination of a hard reflecting plane and sand must be used for testing loaders, excavator-loaders and tracked dozers moving over a sandy surface, with the microphones positioned above the hard reflecting plane.

An alternative test site with sand only may be used for tracked loaders and dozers in the moving and the static-hydraulic state provided that:

1. the environmental correction factor $K_2$, determined in accordance with section 8.6.2 of Annex I to Directive 79/113/EEC, is less than 3,5 dB, and

2. the correction is taken into account for calculating the sound-power level if $K_2$ is greater than 0,5 dB.

6.3.2 *Hard reflecting plane*

The test area surrounded by the microphones must be made of concrete or non-porous asphalt.

6.3.3 *Combination of a hard reflecting plane and sand*

The surface of the path covered by the machine or of its work site must consist of wet sand of a grain size less than 2 mm or sandy soil. The depth of sand must be at least 0,3 m. If the depth necessary for penetration of the tracks is more than 0.3 m, the thickness of the layer or of the sandy soil must be increased accordingly. The ground surface between the machine and the microphone must be a hard reflector in accordance with 6.3.2, thus providing a reflecting plane rather than an absorbent surface for the measuring environment.

Another solution is to use a combined site of minimum dimensions consisting of a sandy track running alongside a reflecting plane. Run the machine forwards twice, in opposite directions, for each of the three microphone positions. The test in reverse may be carried out in identical fashion.

6.3.4 *All-sand site*

The sand must meet the requirements set out under 6.3.3.

6.4 **Measuring surface, measuring distance**

The measuring surface to be used for the test must be hemispherical.

The radius of the hemisphere must be determined by the basic length (1) of the machine (see figures 1, 2, 3 and 4).

The basic length of the machine corresponds:

— in the case of excavators, to the total length of the superstructure excluding the attachments and the main moving parts, such as the boom and the balance beam;

— in the case of the other machines, to the total length of the machine excluding the attachments such as the blade of the dozer and the bucket.

The radius must be:

— 4 m if the basic length 1 of the earthmoving machine is 1,5 m or less;

— 10 m if the basic length 1 of the earthmoving machine is more than 1,5 m but less than or equal to 4 m;

— 16 m if the basic length 1 of the earthmoving machine is more than 4 m.

6.4.2 *Location and number of measuring points*

There shall be six measuring points, numbered 2, 4, 6, 8, 10 and 12, arranged in accordance with section 6.4.2.2 of Annex I to Directive 79/113/EEC.

7. MEASUREMENTS

7.1.1 *Extraneous noise*

Only background noise shall be taken into account for correction.

7.1.5 *Presence of reflecting objects*

A visual check in a circular area of radius three times that of the measuring hemisphere, the centre of which coincides with that of the hemisphere, is adequate to ensure that the provisions of the third paragraph of section 6.3 of Annex I to Directive 79/113/EEC are complied with.

7.2 **Measurement of the sound pressure level $L_{pA}$**

Sound pressure levels $L_{pA}$ shall be measured in accordance with the provisions of the first paragraph of section 7.2 of Annex I to Directive 79/113/EEC.

The sound pressure levels $L_{pA}$ must be measured at least three times. If two of the sound pressure readings obtained do not differ by more than 1 dB, further measurements will not be necessary; otherwise, the measurements must be continued until two values that do not differ by more than 1 dB are obtained. For the A-weighted sound pressure level, take the arithmetic mean of the two highest values that differ by less than 1 dB.

8. USE OF RESULTS

8.1.1. *Root mean square value et a measuring point*

8.1.1.1. Dozers

Since forward and reverse are two different operating modes, the time and the sound pressure level have to be measured for each direction of travel. The following formula has to be used for calculating the equivalent continuous A-weighted sound pressure level $L_{pAeq,T}$, expressed in decibels, of the combined cycle of the dozer:

$$L_{pAeq,T} = 10 \lg \frac{1}{T_1 + T_2} [(T_1 \times 10^{0,1} L_{pAeq,1}) + (T_2 \times 10^{0,1} L_{pAeq,2})]$$

where:

$T_1$ is the time of forward movement along the specified track;

$T_2$ is the time of reverse movement along the specified track;

$L_{pAeq,1}$ and $L_{pAeq,2}$ are the values determined during the periods $T_1$ and $T_2$.

8.1.1.2. Loaders

(a) Combined result for the two modes of travel

Since forward and reverse are two different operating modes, the time and the sound pressure level have to be measured for each direction of travel. The following formula has to be used for calculating the equivalent continuous A-weighted sound pressure level $L_{pAeq,3}$, expressed in decibels, of the combined cycle of the loader:

$$L_{pAeq,3} = 10 \lg \frac{1}{T_1 + T_2} [(T_1 \times 10^{0,1} L_{pAeq,1}) + (T_2 \times 10^{0,1} L_{pAeq,2})]$$

where:

$T_1$ is the time of forward movement along the specified track;

$T_2$ is the time of reverse movement along the specified track;

$L_{pAeq,1}$ and $L_{pAeq,2}$ are the values determined during the periods $T_1$ and $T_2$.

(b) Combined result for the cycles in the moving state and in the static-hydraulic state

Use the following formula for calculating the combined equivalent continuous A-weighted sound pressure level $L_{pAeq,T}$, expressed in decibels, of a complete cycle of the loader:

$$L_{pAeq,T} = 10 \lg [(0,5 \times 10^{0,1} L_{pAeq,3}) + (0,5 \times 10^{0,1} L_{pAeq,4})]$$

where:

$L_{pAeq,3}$ is the value determined during movement along the specified track;

$L_{pAeq,4}$ is the value determined in the static-hydraulic state.

8.1.1.3. Excavator-loaders

Use the following formula for calculating the combined equivalent continuous A-weighted sound pressure level $L_{pAeq,T}$, expressed in decibels, of a complete cycle of the excavator-loader:

$$L_{pAeq,T} = 10 \lg (0,8 \times 10^{0,1} L_{pAeq,excavator} + 0,2 \times 10^{0,1} L_{pAeq,loader})$$

where:

$L_{pAeq,excavator}$ is the value determined during operation in excavator mode;

$L_{pAeq,loader}$ is the value determined during operation in loader mode.

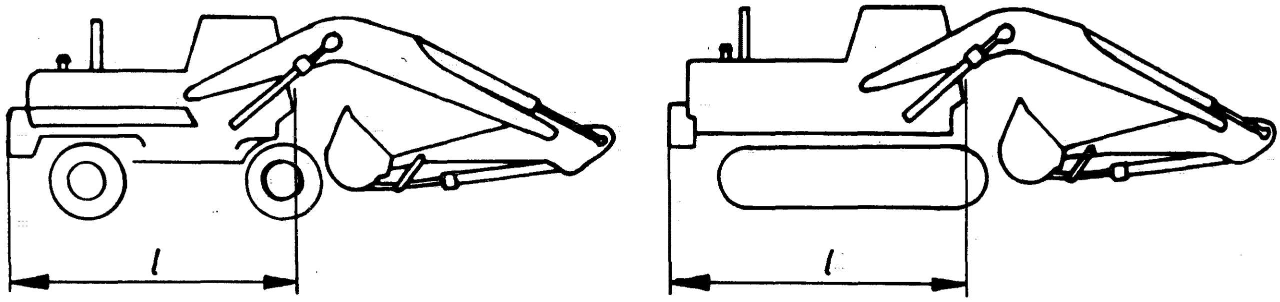


*Figure 1:* Excavator

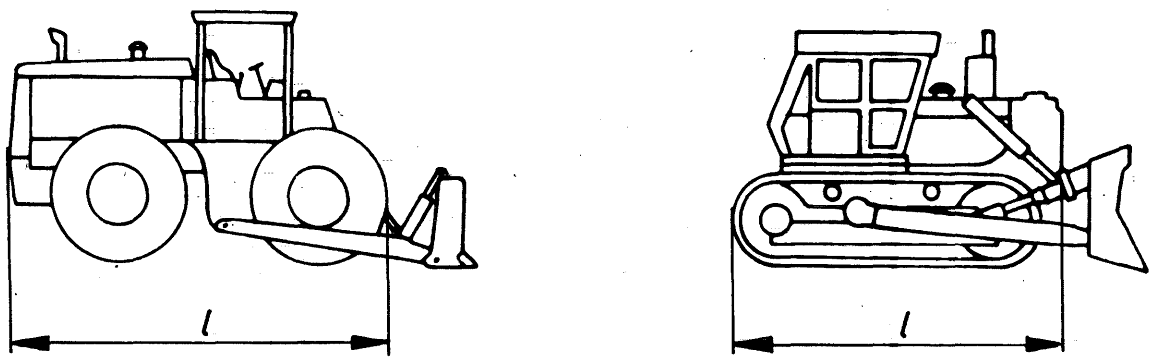


*Figure 2:* Dozer

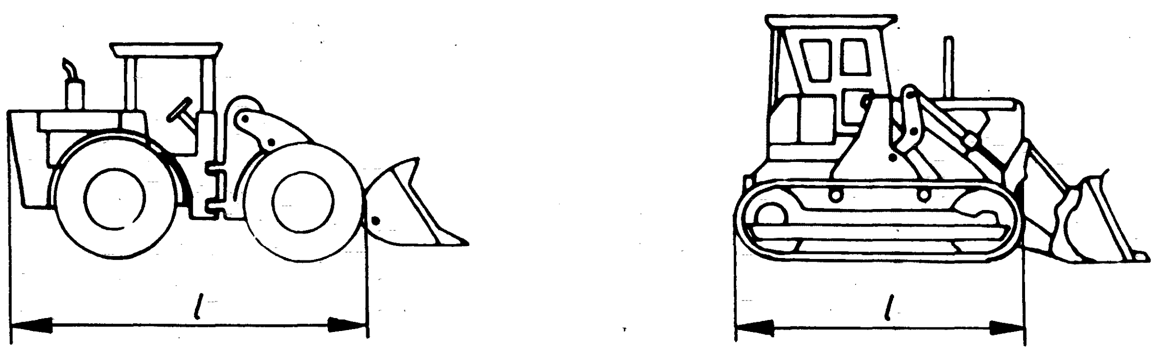


*Figure 3:* Loader

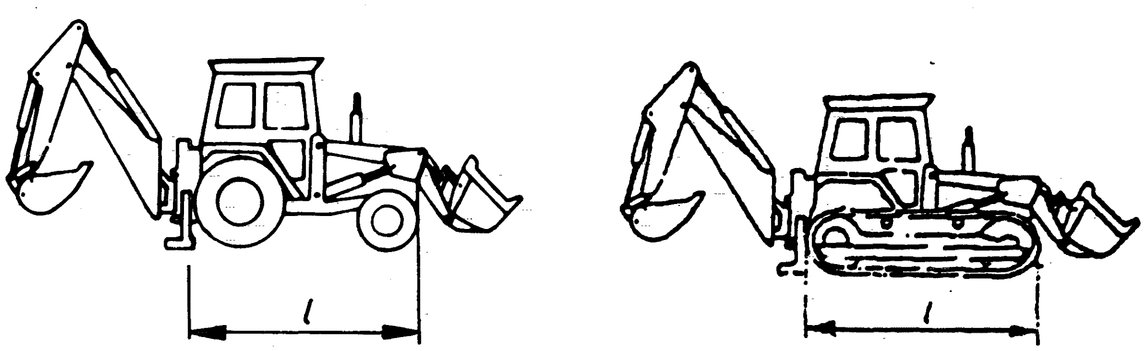


*Figure 4:* Excavator-loader

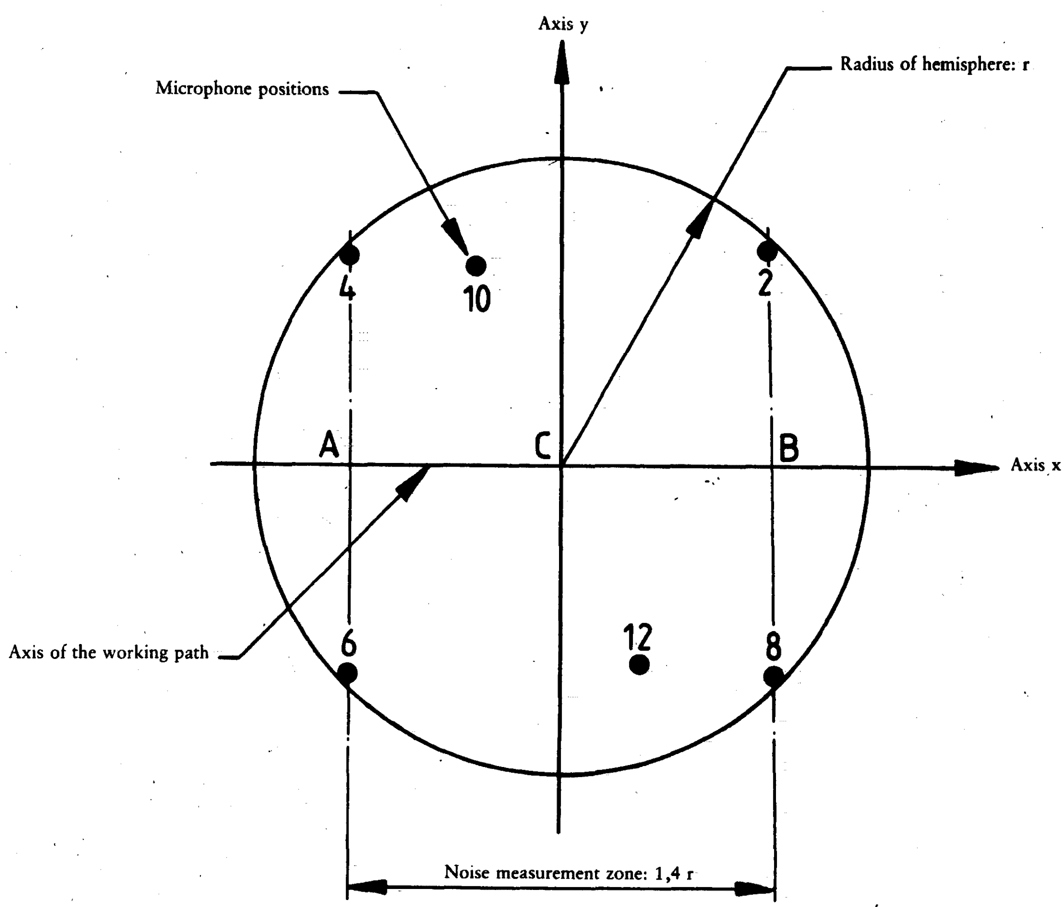


*Figure 5:* Path covered by machine