



GUIDANCE NOTES  
GD 28-2018

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR UNDERWATER RADIATED  
NOISE OF SHIPS

2018

Effective from 15 Oct. 2018

**Beijing**

## **Foreword**

In recent years, with the emergence of ships equipped with hydro-acoustic equipment and the requirement to reduce the impact of underwater radiation noise on the environment, the demand for technical standards of underwater radiated noise of ships from the industry is becoming more and more urgent. In order to meet the demand of the industry and improve the level of underwater radiated noise control in the field of ship design and construction in China, CCS carries out further research on the technical requirements and measurement procedures of underwater radiated noise based on the Guidelines for Testing of Underwater Radiated Noise of Ships (2016), develops the Guidelines for Underwater Radiated Noise of Ships (2018) in combination with the actual situation of shipbuilding in China, and provides ship classification services for the industry on this basis. Upon the entry into force, the Guidelines for Underwater Radiated Noise of Ships (2018) will supersede the Guidelines for Testing of Underwater Radiated Noise of Ships (2016).

CCS encourages ship designers, shipyards, ship owners and product manufacturers to feedback experience and information to constantly improve the Guidelines.

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## Chapter 1 General

### 1.1 Scope of application

1.1.1 The purpose of the Guidelines is to provide classification requirements for underwater radiated noise of ships, and procedures and technical requirements for measurement.

1.1.2 The Guidelines are applicable to ships applying for CCS class notation in 1.2 below to perform the essential service functions by operating hydro-acoustic equipment and ships required to reduce the impact of underwater radiated noise on the environment.

1.1.3 If the ship has undergone a major conversion that may affect the ship's underwater radiated noise, the class notation specified in the Guidelines is to be reconfirmed.

### 1.2 Class notations

1.2.1 Ships that have been measured to meet the requirements of Chapter 2 of the Guidelines may be assigned the following class notation for underwater radiated noise of ships:

Underwater Noise N

N means underwater radiated noise level, N=1, 2 or 3, in which 1 represents the highest level of underwater radiated noise.

1.2.2 The class notation for underwater radiated noise of ships may be assigned in frequency bands (10-100Hz, 100-1000Hz, 1000-100000Hz) if only the requirements of the specified frequency band are satisfied, which is to be indicated in the class notation.

### 1.3 Requirements for documentation

1.3.1 The noise measurement program is to be submitted to CCS for approval prior to the measurement of underwater radiated noise of ship. The measurement program is to at least include the following:

- ① Measurement equipment, such as acoustic measurement equipment, distance measurement equipment, speed measurement equipment, etc.;
- ② Measurement conditions, including the location of the sea area under test, the water depth of the sea area under test and the conditions of the seabed, and the information of the sea conditions (such as wind, waves, etc.);
- ③ The operation status of the ship under test, such as speed, pitch and power of propeller or side thrust; main engine power and speed; ship speed; loading condition of the ship;
- ④ Measurement procedure, such as hydrophone arrangement, ship's sailing path, etc.

1.3.2 After the measurement is completed, the measurement report is to be submitted to CCS for approval. The measurement report is to include at least the following:

- ① Measurement equipment;
- ② Measurement conditions, the operation status of the ship and list of running equipment;
- ③ Differences with the measurement program, such as required measurement conditions, ship operation status, measurement procedure, etc.
- ④ Background noise spectrum, background noise correction method;
- ⑤ Result and criterion of sound source frequency band sound pressure level of one-third octave band.

### 1.4 Symbols and definitions

1.4.1 Sound pressure level  $L_p$ : 20 times the logarithm to the base 10 of the ratio of the sound pressure to a reference sound pressure, in dB. The sound pressure level is given by the following equation:

$$L_p = 20 \lg \frac{p}{p_0}$$

Where:  $p$ —effective sound pressure, in Pa;

$p_0$ —reference sound pressure, being  $1\mu Pa$  in water.

1.4.2 One-third octave band: frequency interval is used to represent the interval or frequency band width between two frequencies of sound, expressed in terms of the logarithm between the upper limit frequency  $f_u$  and the lower limit frequency  $f_l$ ; this logarithm is usually based on 2, in octave, i.e.:

$$n = \log_2 \frac{f_u}{f_l}$$

When  $n = \frac{1}{3}$ , it corresponds to one-third octave band.

1.4.3 Sound source level  $L_{p\ 1m}$ : The sound pressure level at a distance of 1 m from the equivalent sound center obtained by conversion, in dB.

1.4.4 Transmission loss ( $L_T$ ): the transmission loss of sound wave in seawater medium. The sound pressure decreases with the increase of distance from the sound source and the transmission loss increases with the increase of distance from the sound source. Assuming that position 1 is closer to the sound source than position 2, the transmission loss is:

$$L_T = 20 \log \frac{p_1}{p_2}$$

where:

P1— sound pressure of position 1, in Pa;

P2— sound pressure of position 2, in Pa;

When the transmission distance between two positions is  $r$ , the transmission loss is:

$$L_T = X \lg \frac{r}{r_{1m}}$$

where:  $r$  —distance between the sound source and the hydrophone, to be taken as  $\sqrt{D_H^2 + D_V^2}$ , in m;

$D_H$  — distance at the closest point of approach of the hydrophone, in m;

$D_V$  — Vertical distance from the hydrophone to the acoustic center, in m;

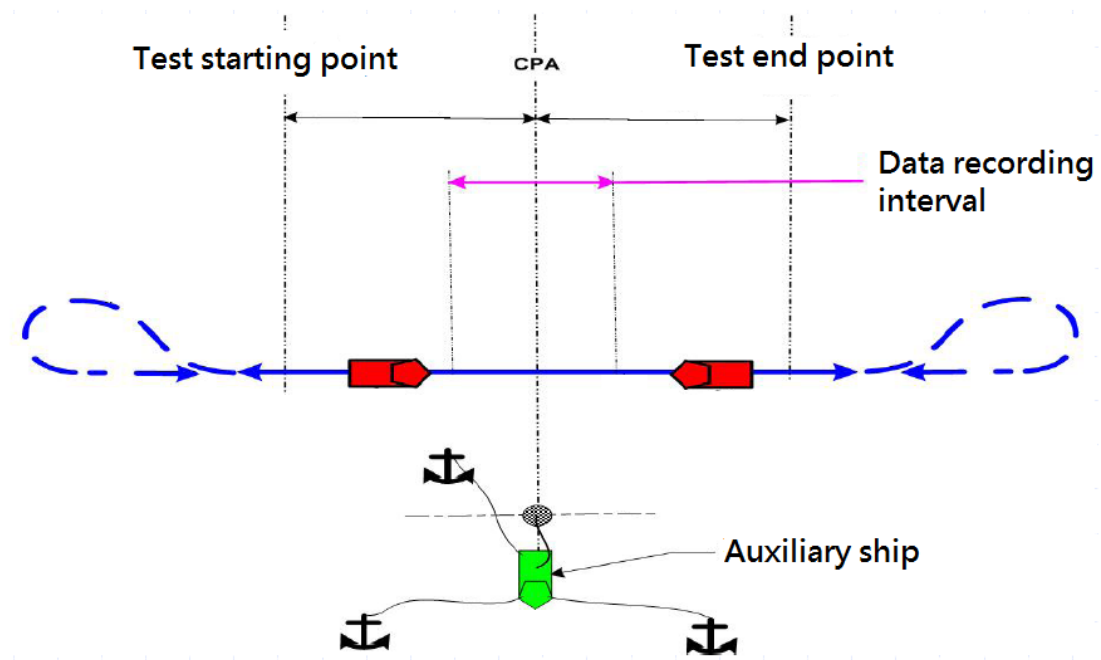
$r_{1m}$  —At a reference distance of 1 m from the sound source, to be taken as 1 m;

$X$  — According to the actual real sound field, when the sound wave is transmitted as a

spherical wave, 20 is taken. When the sound wave is transmitted as a cylindrical wave, 10 is taken. For a ship, when the water depth  $d$  is measured to be more than 100 m, 20 is taken. When the water depth  $d$  is not more than 100 m, 18 is taken.

1.4.5 Acoustic center: the position of the sound source for the postulated point. The acoustic center is taken longitudinally as the midpoint of the distance between the propeller and the main engine, and vertically at  $2/3$  of the draft below the waterline.

1.4.6 Closest point of approach (CPA): In the measurement of underwater radiated noise, the vertical foot is obtained from the trajectory of hydrophone to ship acoustic center.



**Figure 1.4.6 Diagram of closest point of approach**

1.4.7 Distance at the closest point of approach ( $d_{cpa}$ ): The horizontal distance from the closest point of approach to the hydrophone, in m.

1.4.8 Background noise: The environmental noise in water received by the hydrophone, which is not affected by the ship noise under test.

1.4.9 Sound celerity profile: a curve in which the speed of sound varies with the depth of water.

## Chapter 2 Criteria for Underwater Radiated Noise

### 2.1 General provisions

2.1.1 The allowable underwater radiated noise limits of the class notation for underwater radiated noise of ships (Underwater Noise N, N= 1, 2, 3) are specified in this Chapter. For ships which perform the essential service functions by operating hydro-acoustic equipment, the underwater radiated noise limits are given in 2.2. For other ships required to reduce the impact of underwater radiated noise on the environment, the underwater radiated noise limits are to be considered by CCS separately.

2.1.2 The one-third octave band frequency band sound pressure level of underwater radiated noise of ships is to be measured and the sound source level at 1 m from the equivalent acoustic center is to be obtained by conversion.

2.1.3 The underwater radiated noise limit is in the form of one-third octave band, which is converted to 1 m distance from acoustic center of ship.

2.1.4 For the side thruster condition, it is not considered as the assessment condition of underwater radiated noise.

### 2.2 Underwater radiated noise limits

2.2.1 The underwater radiated noise limit is one-third octave band frequency band sound pressure level, as shown in Figure 2.2.1.

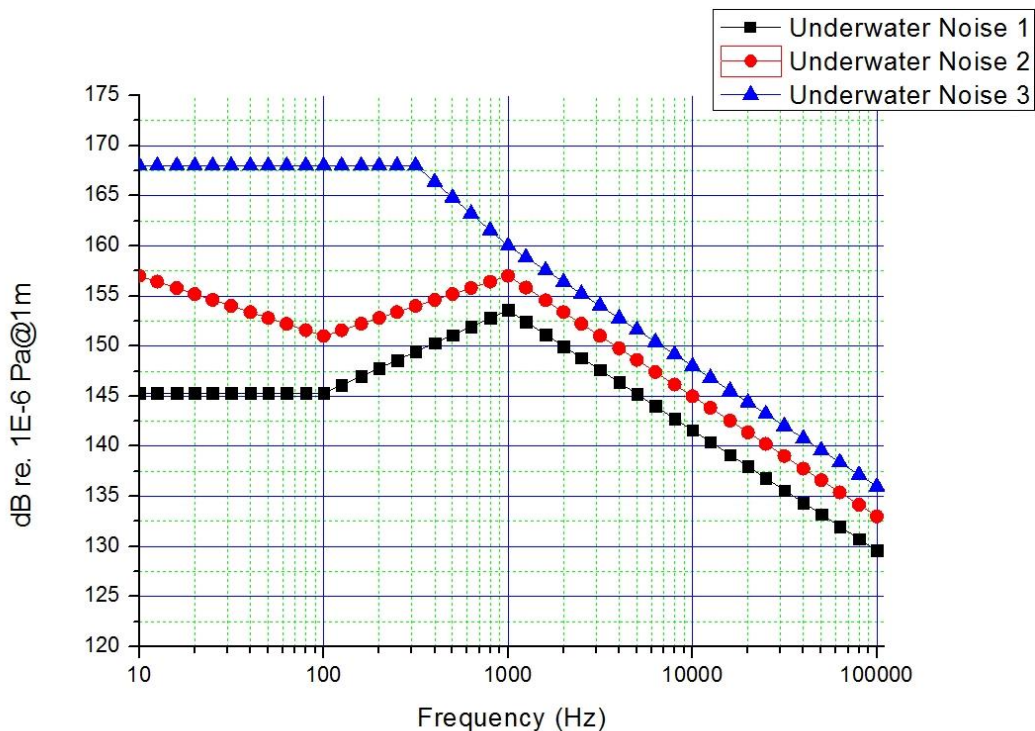


Figure 2.2.1 Underwater radiated noise limits

2.2.2 See Table 2.2.2 for the formula of underwater radiated noise limits.

**Underwater radiated noise limits****Table 2.2.2**

Class notation category	Limit criteria dB (reference sound pressure 1μPa)	Frequency range
Underwater Noise 1	145.3	10 Hz-100 Hz
Underwater Noise 1	128.7+8.3 lg f(Hz)	100 Hz-1kHz
Underwater Noise 1	153.6-12 lg f(kHz)	1 kHz-100 kHz
Underwater Noise 2	163-6 lg f(Hz)	10 Hz-100 Hz
Underwater Noise 2	139+6 lg f(Hz)	100 Hz-1kHz
Underwater Noise 2	157-12 lg f(kHz)	1 kHz-100 kHz
Underwater Noise 3	168	10 Hz-315Hz
Underwater Noise 3	208-16 lg f(Hz)	315Hz-1 kHz
Underwater Noise 3	160-12 lg f(kHz)	1 kHz-100 kHz

Note: f—one-third octave band center frequency

## Chapter 3 Measurement of Underwater Radiated Noise

### 3.1 General provisions

3.1.1 The underwater radiated noise is to be measured by CCS or by a firm approved by CCS. The measurement process is to be witnessed by a CCS surveyor.

3.1.2 Single-hydrophone or multiple-hydrophone method may be used for the measurement of underwater radiated noise.

### 3.2 Measurement equipment

3.2.1 The underwater radiated noise measurement system of a ship includes acoustic measurement equipment, distance measurement equipment and speed measurement equipment, and each measurement equipment is to be synchronized.

3.2.2 Acoustic measurement equipment

3.2.2.1 When the single-hydrophone method is used:

(1) The acoustic measurement equipment consists of an omni-directional hydrophone and data recording equipment (a measuring amplifier may be fitted if necessary). The measurement equipment can be located in a moored auxiliary ship if measurements are taken offshore or when land access is limited.

(2) The auxiliary structure of the hydrophone is not to affect the test results. An open cage structure can be used and the structural members of the cage are to be slim. The base of the cage is to be between 0.4 m<sup>2</sup> and 0.7 m<sup>2</sup>.

3.2.2.2 When the multiple-hydrophone method is used, the acoustic measurement system at least consists of three omni-directional hydrophones and data recording equipment (a measuring amplifier may be fitted if necessary).

Note: The acoustic measurement system for shipboard deployment consists of at least one omni-directional hydrophone, and ships carrying out onboard deployment are to have the capability of self-propulsion, deployment and recovering acoustic measurement systems.

3.2.2.3 The sampling frequency of data recording equipment is at least to be 2 times the maximum analysis frequency.

3.2.2.4 The hydrophone is to be fitted with a preamplifier. The hydrophone sensitivity is to have a maximum uncertainty within 3dB within the frequency range from 10 Hz to 50 kHz.

3.2.2.5 The instrumentation used to record and analyse the data is to have a dynamic range of 90 dB or higher.

3.2.2.6 Hydrophones and data recording equipment are to be calibrated by a qualified organization and within the validity period.

3.2.3 Distance measurement equipment

(1) The distance is to be measured in order to determine the distance between the ship to be tested and the hydrophone.

(2) The distance measurement accuracy is to be within  $\pm 5$  m.

(3) Distance measurement is to be continuously recorded in 2 second cycles for each complete voyage.

3.2.4 The ship's speed for each measurement voyage is to be recorded. In general, the speed measurement equipment fitted on a ship can be used.

3.2.5 Measurement equipment (if used) of celerity profile and calibration

3.2.5.1 In order to calculate the transmission loss more accurately, either a CTD (Conductivity, Temperature, Depth) measurement device or a direct sound speed sensor can be used.

3.2.5.2 If applicable, the measuring celerity profile device is to be calibrated every two (2) years..

### **3.3 Measurement conditions**

3.3.1 Water depth of measuring site

1) When the single-hydrophone method is used, the keel clearance is in general not to be less than 40 m or  $0.64V^2$ , whichever is the greater, where  $V$  is the measured ship speed during measurement, in m/s.

2) When the multiple-hydrophone method is used, the minimum water depth of measuring site is in general not to be less than 60 m or  $0.3V^2$ , whichever is the greater, where  $V$  is the measured ship speed during measurement, in m/s.

3.3.2 The seabed of the sea area under test is to be as flat as possible and is not to affect the underwater acoustic measurement results. The seabed soil is to be soft to reduce the impact of seabed reflection; however, it is to be ensured that the fixed auxiliary device of hydrophone does not sink.

3.3.3 The sea area of the measuring site is to be wide and far away from the navigation channel to ensure that the ship under measurement has sufficient maneuvering range. At the same time, there is no disturbance from self-propelled ships within 5 nautical miles, and the current speed is less than 1.5 kn.

3.3.4 The measurement is to be carried out under conditions where the sea state is not more than level 3 and the wind force is not greater than Beaufort wind scale 4.

### **3.4 Condition of the ship to be tested**

3.4.1 The measurement is to be carried out after the ship is fully outfitted and in normal navigation state.

3.4.2 Except for the hydro-acoustic equipment, all equipment that might be normally in use is to be turned on at the same time and in normal working state. Hydro-acoustic equipment is to be turned off during the measurements except if these systems are necessary for safe navigation of the ship. If hydro-acoustic equipment has to be used for safety reasons, the type of equipment and frequency range of the signals are to be stated in the record of measuring conditions.

3.4.3 During the measurement process, the operating status of all running mechanical equipment is to be recorded.

3.4.4 The ship is to be tested for a standard set of operating conditions which represent typical or expected operating conditions for the ship.

3.4.5 The conditions that are representative of the typical navigational state of the ship and the speed profile for the ship's hydro-acoustic equipment (if fitted) are to be submitted to CCS prior to the measurement. The speed profile is to contain the maximum speed allowed when using the main hydro-acoustic equipment as well as expected operational speed(s) for the majority of the operations. The profile is also to indicate if side thrusters are expected to be used.

For ships achieving essential service functions by the operation of hydro-acoustic equipment:

(1) Ships of greater than 50 m in length are to sail at 11 knots without towing any object and without the use of side thrusters.

(2) Ships of not greater than 50 m in length are to sail at 8 knots without towing any object and without the use of side thrusters.

Where the ship is required to reduce the effect of underwater radiated noise on the environment, its speed is considered separately by CCS.

3.4.6 During the measurement, the propulsion system is to be in a stable working condition. For the side thruster condition, measurements are to be carried out with the thruster(s) operating at 40% of the rated load for the thruster(s). Where it is clearly specified that side thruster(s) are not used when the hydro-acoustic equipment is working, side thruster(s) may not be turned on during the measurement.

3.4.7 For ships designed with towing capabilities, measurements are to be carried out towing the ordinary seismic equipment or simulated equivalent towing load. The equivalent towing load procedure is to be submitted to CCS prior to measurement.

3.4.8 Equivalent load is to be established by calculations or from measured experience data from other vessels with similar seismic gear.

### **3.5 Background noise**

3.5.1 The background noise at the test site is to be monitored at least at the start and end of the measurement survey. When the background noise is measured, the ship to be tested is to drift in an area away from the hydrophone. The background noise is to be measured for at least 2 minutes. During the measurement, the stability of the real-time signal is to be checked to ensure the reliability of the measurement.

3.5.2 The underwater sound pressure level of the ship to be tested is to be at least 3 dB higher than the background noise. If the background noise is in the range 3-10 dB below the original underwater sound pressure level, it is to be corrected on a power basis.

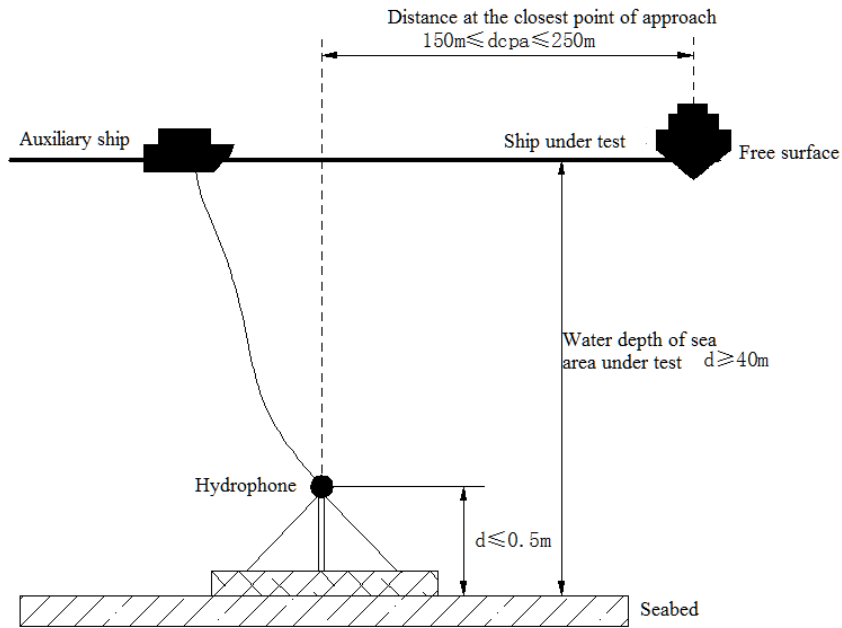
3.5.3 The auxiliary ship is to be anchored or drift in accordance with the measurement program.

3.5.4 During the measurement process, the auxiliary ship is to stop the operation of all non-essential mechanical equipment, stop all activities affecting noise measurement, and ensure low noise power supply.

### **3.6 Measurement procedures**

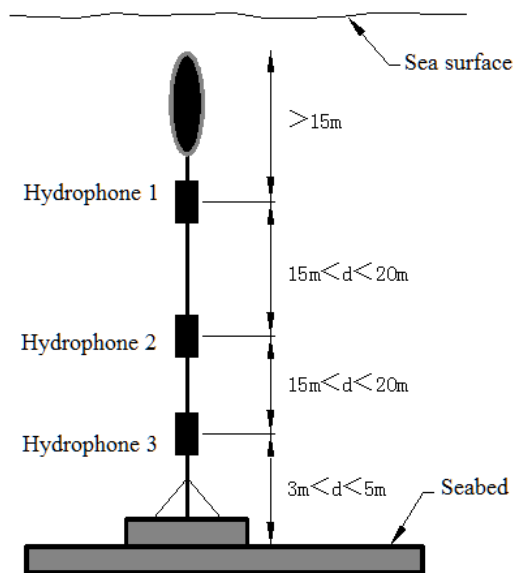
#### **3.6.1 Hydrophone deployment**

(1) When the single-hydrophone method is used, deployment is in accordance with Figure 3.6.1(1) and it is to be ensured that the distance from the hydrophone to the seabed is not greater than 0.5 m.

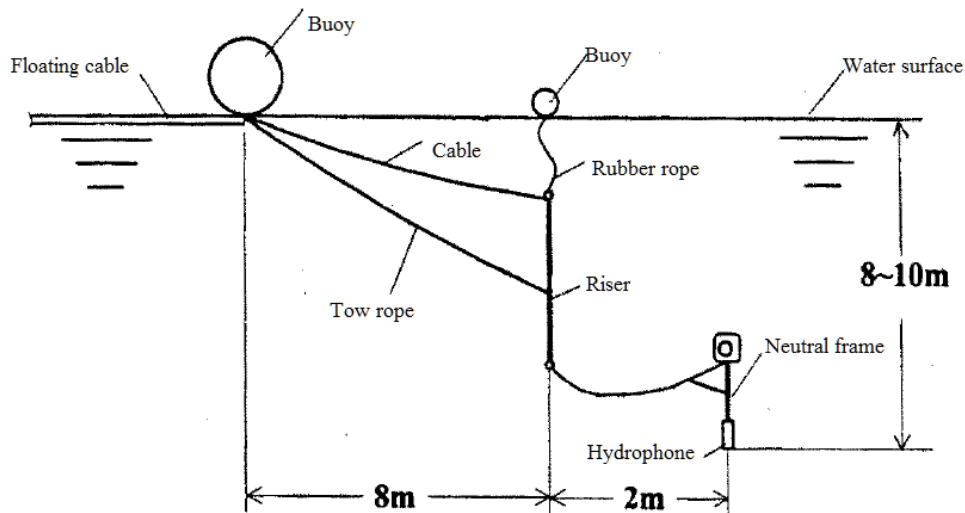


**Figure 3.6.1(1) Hydrophone Deployment**

(2) When the multiple-hydrophone method is used, measurements may be carried out by means of bottom mounted deployment or onboard deployment. Bottom mounted deployment is shown in Figure 3.6.1(2) and onboard deployment is shown in Figure 3.6.1(3). Hydrophones are to be far away from the ship to be tested with a distance not less than 100 m.



**Figure 3.6.1(2) Bottom Mounted Deployment of Acoustic Measurement System**

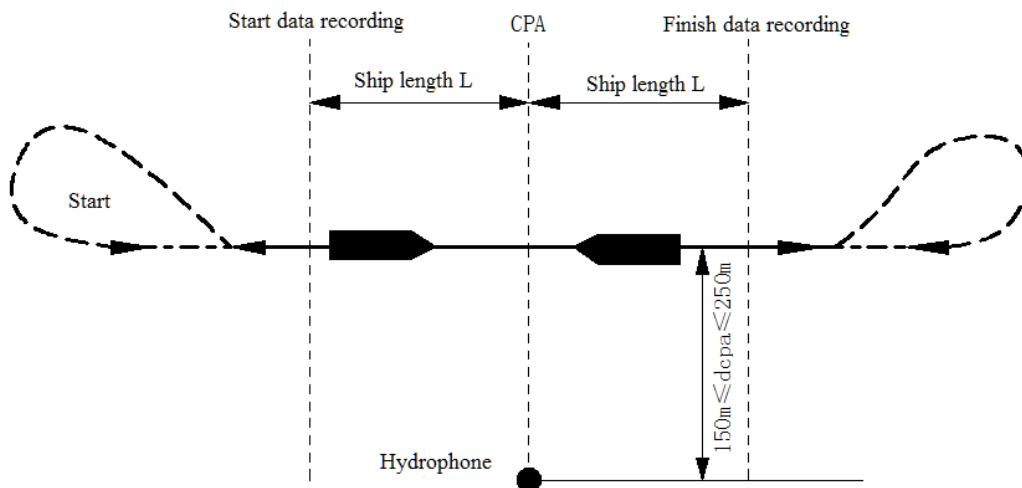


**Figure 3.6.1(3) Onboard Deployment of Acoustic Measurement System**

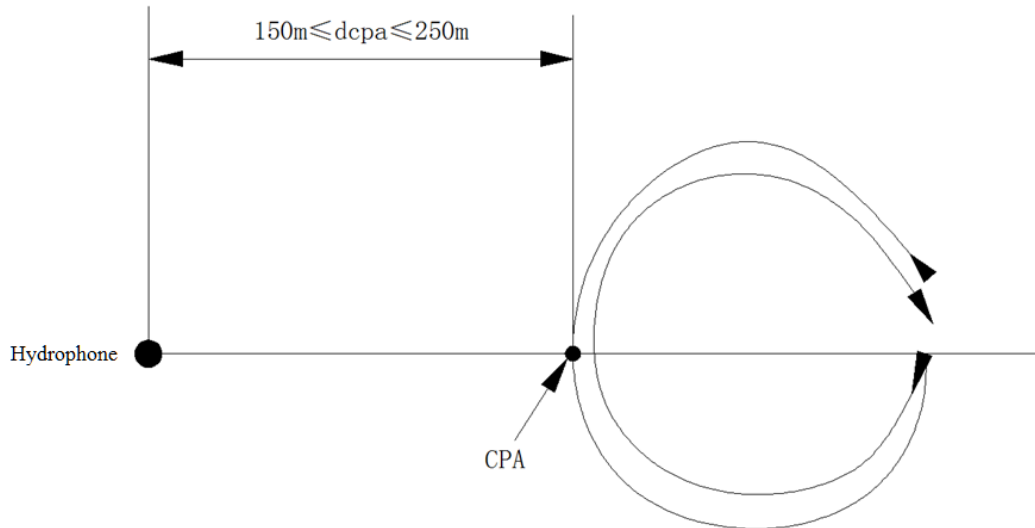
### 3.6.2 Maneuvering mode of ship

3.6.2.1 For ships achieving essential service functions by the operation of hydro-acoustic equipment:

- (1) The distance at the closest point of approach is to be greater than 150 m and less than 250 m during measurement.
- (2) The ship under test is to sail past the hydrophone as indicated in Figure 3.6.2.1(1) for free sailing ships. The ship is to sail in a straight line with minimal use of rudders and side thrusters.
- (3) The ship is to sail past the hydrophone as indicated in Figure 3.6.2.1(2) for thruster spins. The ship is to rotate as close to the hydrophone as possible within the defined measuring range, but the minimum horizontal distance between the ship and the hydrophone is to be within the range of 150 m to 250 m.



**Figure 3.6.2.1(1) Free Sailing**



**Figure 3.6.2.1(2) Sailing in Thruster Spin Condition**

3.6.2.2 For free sailing, data is to be recorded from when the bow of the ship under test is with a distance of one ship length from CPA until the ship has passed CPA and the stern is with a distance of one ship length from CPA. Before the ship reaches the position of data recording, the ship is to achieve the required sailing state.

3.6.2.3 For free sailing, two sets of measurements are to be taken with the ship sailing in opposite directions at the same operating condition. The results of the two runs are to be averaged on a power basis.

3.6.2.4 For thruster tests, the spin is to start with the bow facing the hydrophone position. Data recording starts after stabilization. Data is to be averaged over a time of 15 seconds respectively on both sides of the maximum value of the time domain signal. Distance correction is to be carried out for segments of approximate 10 seconds of data using the average distance within each segment for each distance correction.

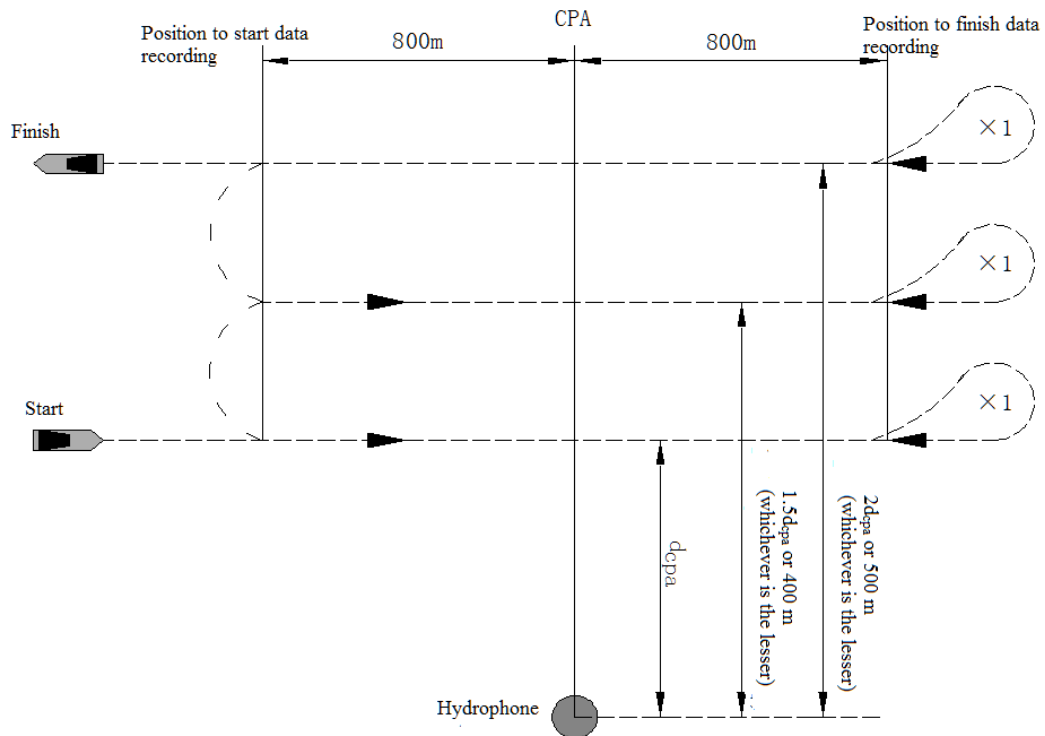
3.6.2.5 For thruster tests, two sets of measurements are to be taken for each operating condition with the thrusters running in opposite directions during the two runs. The results of the two runs are to be averaged on a power basis.

3.6.2.6 Before the start of the tests, the position and depth of the hydrophone are to be determined within an accuracy of  $\pm 2$  m. The position of the ship is to be recorded by differential GPS or equivalently accurate navigation equipment.

3.6.3 For ships required to reduce the effect of underwater radiated noise on the environment:

(1) During the process of measurement of ship's underwater radiated noise, the ship under test is to maneuver in accordance with Figure 3.6.3. A total of 6 voyages need to be measured.

Data recording starts when the bow of the ship under test is with a distance of 800 m or a voyage of 4 min (whichever is the lesser) from CPA and it ends when the ship has passed CPA and the stern is with a distance of 800 m or a voyage of 4 min (whichever is the lesser) from CPA. Before the ship reaches the position of data recording, the ship is to achieve the required sailing state. For the ship under test of more than 10000 GT, measurements of two voyages are only needed when the ship under test is at the CPA with a distance of  $d_{cpa}$ . In such case, the uncertainty of measurement will be raised by 1.5 dB.



**Figure 3.6.3 Maneuvering Mode of the Ship under Test**

- (2) The minimum value of the distance at the closest point of approach ( $d_{cpa}$ ) is to be 200 m or one ship length, whichever is the greater.
- (3) In the measurement of underwater radiated noise of ships, when the signal-to-noise ratio is less than 3dB at a long distance, or when the ship under test has been subjected to vibration and noise reduction design,  $d_{cpa}$  is to be reduced to 100 m or one ship length, whichever is the greater.

## Chapter 4 Data Processing and Measurement Report

### 4.1 General provisions

4.1.1 The data recorded by the hydrophone is to be analyzed integrally as a sample.

4.1.2 The underwater radiated noise and background noise sound pressure level obtained by the test are converted to 1/3 octave band sound pressure level, and the background noise correction and transmission loss correction are performed according to the 1/3 octave band sound pressure level.

4.1.3 In the actual measurement, when the high frequency band (50k-100kHz) is difficult to measure, it can also be estimated based on the measured data of 10k-50kHz.

### 4.2 Background noise correction

For each 1/3 octave band sound pressure level, correction is carried out in accordance with the following steps:

① The linear average background noise level  $L_n$  is calculated in accordance with the following formula:

$$L_n = \frac{L_{n,s} + L_{n,e}}{2}$$

where:  $L_{n,s}$  — background noise band sound pressure level measured by the hydrophone prior to commencement of measurement;

$L_{n,e}$  — background noise band sound pressure level measured by the hydrophone after completion of measurement.

② The background noise variation  $\Delta L_n$  between the beginning and the end of measurements is equal to:

$$\Delta L_n = |L_{n,s} - L_{n,e}|$$

③ The difference between the original underwater noise sound pressure level (including background noise)  $L_{pn}$  and the background noise  $L_n$  is calculated in accordance with the following formula:

$$\Delta = L_{pn} - L_n$$

For all 1/3 octave band:

① For  $\Delta > 10dB$ , no background noise correction is needed.

② For  $3 < \Delta \leq 10dB$  with sufficient steadiness, background noise correction is to be carried out in accordance with the following formula:

$$L_p = 10 \lg [10^{\frac{L_{pn}}{10}} - 10^{\frac{L_n}{10}}]$$

where:  $L_p$  – band sound pressure level subject to background noise correction.

Error due to background noise correction is to be calculated in accordance with the following formula:

$$Error = 10 \lg \left( \frac{1 - 10^{\frac{-\Delta}{10}}}{1 - 10^{\frac{-\Delta + \Delta L_n}{10}}} \right) < 2 \text{ dB}$$

The measurement is invalid when error due to background noise correction is greater than 2 dB.

③ For  $\Delta \leq 3\text{dB}$ , the measurement is invalid and it is to be carried out again.

### 4.3 Transmission loss correction

(1) The transmission loss due to sound propagation into water is to be taken into account to obtain the underwater sound pressure levels at a reference distance of 1 m from the source.

(2) Distance transmission loss correction is carried out to the underwater noise sound pressure level in accordance with the following formula:

$$L_{po} = L_p + L_T$$

$$L_T = 18 \lg r$$

where:  $L_{po}$  – underwater noise sound pressure level at a reference distance of 1 m from the sound source subject to distance correction;

$r$  – distance between the sound source and the hydrophone, in m.

Note: when the water depth of measuring site is greater than 100 m,  $L_T = 20 \lg r$ .

(3) Considering the reflection effect of the free surface and the seabed, the sound pressure level of each 1/3 octave band is to be corrected by -5dB.

### 4.4 Measurement report

After completion of measurement, a measurement report is to be developed based on the data processing above. Basic contents are given in 1.3.2 and the form is given in the Appendix.

**Appendix Format of Measurement Report of Underwater Radiated Noise of Ships**

**Measurement Report of Underwater Radiated Noise of Ships**

**Stamp of measurement organization**

**Signature of measurement personnel**

1 Basic information			
Measurement location:		Date:	
Name of measurement organization:			
Person in charge of measurement:		Telephone:	e - mail:
Name of ship:		Ship registration number:	IMO number:
Ship type:	Shipyard:	Shipyard number:	Date of construction: Location of construction:
2 Main dimensions			
Length between perpendiculars (m):			
Moulded breadth (m):			
Maximum draft (m)			
3 Propulsion machinery			
Type:		Number of cylinders:	
Quantity:		Maximum rated power (KW):	
Maximum rated speed (R/M):		Installing form:	
4 Auxiliary diesel engine			
Type:		Number of cylinders:	
Quantity:		Rated power (KW):	
Rated speed (R/M):		Installing form:	
5 Thruster			
Type:		Number of blades per propeller:	
Quantity of thrusters:		Nominal pitch:	
Design speed (R/M):		Diameter:	
Other:			
Date of last cleaning of hull and propeller:			
Echo sounder closed (Yes/No):			
6 Underwater radiated noise measurement equipment			
Type of hydrophone:			
Sensitivity of hydrophone:			
Depth of hydrophone deployment:			
Data recording equipment (including sampling rate):			
Preamplifier (if used) :			
Distance measurement equipment:			
Speed measurement equipment:			
Data processing equipment:			
7 Weather conditions at the time of measurement			



11 Other known issues and concerns that may affect the measurement of underwater radiated noise of ships								
12 Sound pressure level of underwater radiated noise of ships (when single hydrophone method is adopted)								
One-third octave band center frequency (Hz)	Sound pressure level of underwater radiated noise of ships with one-third octave band frequency band							
	( ) conditions				( ) conditions			
	$L_{ps}$	$L_{p1}$	$L_{p2}$	$L_{pe}$	$L_{ps}$	$L_{p1}$	$L_{p2}$	$L_{pe}$
10								
12.5								
16								
20								
25								
31.5								
40								
50								
63								
80								
100								
125								
160								
200								
250								
315								
400								
500								
630								
800								
1000								
1250								
1600								
2000								
2500								
3150								
4000								
5000								
6300								
8000								
10000								
12500								
16000								

20000								
25000								
31500								
40000								
50000								
63000								
80000								
100000								

13 Sound pressure spectrum source level of underwater radiated noise of ships (when multi-hydrophone method is adopted)

One-third octave band center frequency (Hz)	Sound pressure spectrum source level of underwater radiated noise of ships with one-third octave band frequency band						
	Voyage 1 (corrected by low frequency)	Voyage 2 (corrected by low frequency)	Voyage 3 (corrected by low frequency)	Voyage 4 (corrected by low frequency)	Voyage 5 (corrected by low frequency)	Voyage 6 (corrected by low frequency)	L <sub>ps0</sub> (corrected by low frequency)
10							
12.5							
16							
20							
25							
31.5							
40							
50							
63							
80							
100							
125							
160							
200							
250							
315							
400							
500							
630							
800							
1000							
1250							
1600							
2000							
2500							

3150							
4000							
5000							
6300							
8000							
10000							
12500							
16000							
20000							
25000							
31500							
40000							
50000							

Note:  $L_{ps}$  is the test value of background noise before test;  $L_{p1}$  is the test value of port;  $L_{p2}$  is the test value of starboard;  $L_{pe}$  is the test value of background noise after completion of test.

14 Remarks: the measurement organization is to provide complete and effective original time domain record data to CCS.

Annex 1: Certificate of Calibration of Measurement Equipment

Annex 2: Detailed information on calculation of transmission loss (if applicable)

Annex 3: Figure of sound pressure spectrum source level of underwater radiated noise of ships with one-third octave band frequency band

Annex 4: Main radiated noise control measures

Annex 5: Propeller condition