



2023

Guidance for External Airborne Noise from Ship (draft)

– for external opinion inquiry –

APPLICATION OF “GUIDANCE FOR EXTERNAL AIRBORNE NOISE FROM SHIPS”

1. Unless expressly specified otherwise, the requirements in the Guidance apply to ships for which the application for Classification Survey is submitted to the Society on or after 1 July 2023.

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CHAPTER 1 GENERAL

Section 1 General

101. Application

1. This Guidance is to apply to new and existing ships upon request of optional classification notation "EAN" for external airborne noise (hereinafter referred to EAN) from ship.
2. EAN notation is classified as "sailing" and "berthing" depending on the EAN measurement conditions and procedures of the ship.

102. Definitions

1. **Decibel** is a unit that expresses the relative loudness of sound, expressed in dB.
2. **Sound pressure level (L_p)** means to the mean squared sound pressure level measured with an underwater hearing device, and is expressed in units with the following formula.

$$L_p = 20 \log_{10} \left(\frac{p_{rms}}{p_0} \right) \quad (dB)$$

p_{rms} : root-mean-square sound pressure

p_0 : reference sound pressure (20 μ Pa).

3. **A-weighted sound pressure level** is the quantity measured by a sound level meter in which the frequency response is weighted according to the A-weighting curve, obtained by using the frequency weighting A(dB(A)) which is the unit of external airborne noise level(see IEC 61672-1). The A-weighted sound pressure is corrected so that the measured sound pressure of each frequency gives the same magnitude to the human hearing in consideration of the sensitivity of hearing for each frequency felt by humans.
4. **Root mean square(r.m.s) value** is the square root value of time-average of the squared instantaneous values during a cycle.

103. Class notations

1. Ships whose owner applies for inspection and that meet the requirements of this guidance may be assigned the additional classification notations of **EAN**. **EAN-SM[x,y]**, **EAN-S1** and **EAN-S2** are assigned for "sailing", and **EAN-BM[x,y]**, **EAN-B1** and **EAN-B2** for "berthing", respectively.
2. EAN-SM[x, y] and EAN-BM[x, y] may be assigned when measured EAN do not meet the acceptance criteria. Here, M indicates that EAN of this ship was measured, x indicates the broadband total EAN level(dB(A)) in the range of 31.5~8000 Hz, and y indicates the low frequency band total EAN level(dB(A)) in the range of 31.5 to 160 Hz.
3. Additional classification notation of EAN may be assigned together when the acceptance criteria for sailing and berthing in **Ch 3, Sec 6** are satisfied, respectively. For example, EAN-(S1, B2) may be assigned when the ship satisfies the acceptance criteria EAN-S1 and EAN-B1. In addition, EAN-(SM[x, y], B2) may be assigned when EAN for sailing is measured and EAN for berthing meets the acceptance criteria EAN-B2.

Section 2 Plans and Documents

201. General

1. For ships to be inspected, the EAN measurement plan specified in **202. 1** below is to be submitted to the Society for approval. In addition, after the EAN measurement in the presence of the Surveyor of the Society has been carried out, a report of the measurement results including the items specified in **202. 2** below is to be submitted to the Society for approval. If deemed necessary by the Society, the submission of additional documents may be requested.

202. Plans and documents to be submitted

1. EAN measurement plan

A detailed measurement plan developed for the measurement of the EAN from ship prior to the measurement. The plan is to include the following.

- (1) Ship information
 - (A) Ship's name, hull number, class number, etc., as well as the ship's main dimensions
- (2) Measuring equipment
 - (A) Details of the sound pressure meter (or sound level meter), windscreen, sound pressure calibrator and distance measurement system (e.g. manufacturer, type and serial number, accuracy, sampling frequency and resolution)
 - (B) Calibration plans and current calibration certificates of all measurement instruments
- (3) Measurement Condition
 - (A) Details of test site location.
 - (B) Wind speed and sea surface conditions for planned tests
 - (C) Operating condition of essential devices for sailing or/and berthing (e.g. operating condition of main engine, shaft speed(rpm) and setting of controllable pitch propeller, operating condition of auxiliary engines and auxiliary machinery)
- (4) Measuring location
 - (A) Location information of the vessel and the measuring point where the measurement is to be performed
 - (B) Details of the measurement location
- (5) Data acquisition and analysis
 - (A) Description of procedures for data acquisition and analysis
 - (B) Information on software and devices

2. EAN measurement report

A ship-specific EAN measurement report containing test information, description of data processing, analysis of measured sound pressure data and compliance evaluation against applicable criteria. The report is to include the following.

- (1) General
 - (A) The report is to be prepared in pdf format and submitted to the Surveyor of the Society.
 - (B) All measured data (raw data) and evaluated data should be available for further evaluation and will be provided to the Society upon request.
 - (C) All data is to be recorded at a minimum of 31.5 Hz to 8,000 Hz (10 Hz to 10 kHz, if possible) at 1/3 octave band level and at broadband level including 1/3 octave band.
- (2) Official details of the report
 - (A) First page
 - (a) The first page must contain at least the following information.
 - Ship name including ship number and registration number
 - Company name (measurement performed)
 - Address of the company
 - Report date
 - Date of measurement
 - Measurement location (port and pier name)
 - Name of the person involved (author and measurement individual)
 - Information on the total number of pages in the report, including appendices
 - (Optional) quality procedure items
 - (B) Continuous information on the next page
 - (A) All pages after the first page are to contain the following information.
 - Company name
 - Date
 - Numbering

- (C) Signature
 - In general, the report is to be signed by its supervisor.
- (3) Content to be documented in the report
 - (A) General information
 - (a) Day, time and place of measurement (test site, port name or berth name)
 - (b) Meteorological conditions during measurements (including wind speed, wind direction, temperature, barometric pressure, humidity). This information shall preferably be requested from the ship owners/crew (measurement data from the ship itself)
 - (B) Ship's general information
 - (a) Ship type
 - (b) Name of ship including IMO registration number
 - (c) Year of built of the ship
 - (d) Dead weight tonnage
 - (e) Length and width of the ship
 - (f) Sketch of the ship's contour, indicating relevant sound sources, the position of the funnel outlet(s), bow and stern of the ship;
 - (C) Ship's technical information
 - (a) Number of auxiliary engines (including number and type of different auxiliary engine systems; number of funnel outlets)
 - (b) The existence of a silencer in the exhaust system of the auxiliary engines
 - (c) Maximum possible load of each auxiliary engine in kW
 - (d) Rotational speed of the auxiliary engine(s) in maximum possible load
 - (e) Maximum combined electric load of all pumps/heaters/lights etc. installed that could be used while moored in kW
 - (f) Number of each sound source on board (e.g. number of openings from the different ventilation inlets and outlets, number of cooling containers/reefers on board)
 - (g) Maximum possible number of plugged in reefers
 - (h) Typical average number of reefers at berth
 - (i) Average electrical load that normally occurs while moored
 - (D) General information on the measurements
 - (a) Number of each sound source on board that was in operation during the measurements
 - (b) Electrical load of each auxiliary engine during the measurements, preferably documented over time.
 - (c) Number of plugged in reefers during the measurements
 - (d) Sketch of the measurement positions at a certain distance from the ship with respect to the ship contour and orientation of the ship (bow and stern), including the position of the funnel outlet
 - (e) Height of the funnel above quay ground
 - (f) Height of the microphone at the measurement positions at a certain distance from the ship above quay ground (h_m)
 - (E) Acoustic information
 - (a) Acoustic measurement equipment used during measurement (including type, serial number and calibration documents before/after measurement)
 - (b) All recorded time signals including the ship name, date of measurement and time of measurement location (which is a sampling rate of at least 16 bits and a sampling frequency of 24 kHz.
 - (c) For each measured sound source (measurement of noise emission from ship)
 - (i) L_{Aeq} : equivalent A-weighted continuous sound pressure level
 - (ii) L_{Ceq} : equivalent C-weighted continuous sound pressure level
 - (iii) $L_{AF,max}$: Maximum sound pressure level during the measurement period
 - (d) The total broadband EAN level ($L_{EAN \leq 8000}$) of the ship (including all 1/3 octave bands from 31.5 Hz to 8,000 Hz)
 - (e) The total low-frequency EAN level ($L_{EAN \leq 160}$) of the ship (including all 1/3 octave bands from 31.5 Hz to 160 Hz)
 - (F) Additional information
 - (a) Type (and recorded level) of residual noise/background noise (e.g. what kind of sources causing residual noise were present during measurements and at which time; for example passing ships and air planes, port noise etc.)
 - (b) In addition, each deviation from the measurement guidelines needs to be documented. Including sketches if possible. Any comments and information regarding reproducibility or

adjustments to the results of the noise measurement should be documented at the end of the report. This includes any problems encountered during the measurement and is relevant to the report. ⚓

CHAPTER 2 CLASSIFICATION AND SURVEYS

Section 1 General

101. General

1. The requirements not specified in this Chapter are to comply with those specified in **Pt 1 of Rules for the Classification of Steel Ships**.

Section 2 Classification

201. General

1. In cases where a ship is to be surveyed in accordance with this Guidance, it is the responsibility of the Owner to notify Surveyors of the locations where they wish to undergo the relevant survey.
2. Applicants for surveys are to arrange supervisors who are well conversant with all of the survey items required for the preparation of such surveys and who are able to provide all assistance necessary per Surveyor request during such surveys.
3. Surveys may be suspended in cases where necessary preparations have not been made, no appropriate supervisor is present, or the Surveyor considers that the safety needed for the execution of the survey is not ensured.
4. In cases where repairs are considered to be necessary as a result of surveys, Surveyors are to notify survey applicants of their findings. Applicants, upon receiving such notification, are to obtain Surveyor verification after carrying out any such repairs.

Section 3 Periodical Surveys

301. General

1. Periodical Surveys are to be carried out at the Annual Survey, Intermediate Survey and Special Survey.
2. During Periodical Surveys, the non-existence of any alternations which may affect the EAN level is to be confirmed. Additional EAN measurements may be required in cases where deemed necessary by the Society in order to ascertain whether the relevant requirements given in this Guidance are satisfied.

Section 4 Occasional Surveys

401. General

1. Occasional Surveys are to be carried out on the following occasions at times other than Initial Surveys or Periodical Surveys:
 - (1) In cases where any conversion affecting the EAN of a ship are carried out.
 - (2) In cases where any applications for surveys are submitted by owners.
2. Occasional Surveys are to be carried out and EAN levels are to be confirmed as complying with those specified in this Guidance. ⚓

CHAPTER 3 EXTERNAL AIRBORNE NOISE MEASUREMENT

Section 1 General

101. General

1. The measurement and result analysis are to be performed in accordance with the requirements in **Sec 2** to **Sec 5** and the criteria specified in **Sec 6** are to be met.
2. Measurement of EAN is to be performed by the service supplier registered with the Society.

102. Sound source on board of the ships

1. The overall sound emission radiated from each ship can be traced back to several individual sound sources on board of the ship. The most relevant noise sources to be measured are listed below but not limited to.
 - (1) The funnel outlet(s) of main and/or auxiliary engines
 - (2) The opening(s) of engine room ventilation inlets and outlets
 - (3) The opening(s) of the cargo holds ventilation and air-conditioning inlet(s) and outlet(s).
 - (4) The opening(s) of the ventilation and air-conditioning of passenger rooms
 - (5) Additional relevant ventilation openings (e.g., sanitary or galley exhaust).
 - (6) Cargo loading and unloading facilities
2. The operation of cooled containers/reefers on container ships is strongly depending on several indicators such as (cooling) type of the container, type and size of the ship, ships load and port conditions. Furthermore, their operation is also belonging to the cargo handling process of a ship at berth. Therefore, the cooled containers/reefers are not considered for measurements and will not be considered for the calculation of the total sound power level of the measured ship in this Guidance.

Section 2 Instrumentation

201. General

1. In order to quantify the EUN from ships, three main instrumentation components are required: (1) microphone and signal conditioning, (2) data acquisition, recording, processing and display system, and (3) distance measurement system.

202. Measuring equipment

1. The equipment for acoustic measurements must consist of the following equipment.
 - (1) Integrating sound level meter with a microphone, (cable) and windscreen, in compliance with IEC 61672-1 and IEC 61672-2, class 1.
 - (2) Acoustic calibrator in compliance with IEC 60942, class 1
2. The microphones need to be equipped with a windscreen (diameter ≥ 6 cm) for each measurement.
3. The calibration of the measuring system needs to be checked with the sound calibrator before and after each measurement series.
4. For post processing, analysis software is required comprising the following methods.
 - (1) 1/3 octave band analysis according to IEC 61672-1.
 - (2) Frequency weighting, time weighting and averaging.
5. During all measurements the time weighting fast (F) is to be used.
6. Distance measuring system is to have an accuracy of 2 % with results from 0.1 to 600 m.
7. Acoustic measuring system and distance measuring system are to be checked for calibration certificate and valid calibration status during measurement.

Section 3 Measurement Location

301. General

1. Measurements are to be carried out taking into account the location of noise sources specified in 102. 2. Additional measurements are to be carried out as required by the Society in case of excessive noise level is identified.
2. Measurements are to be made at a distance of 100 m from the hull surface for at least 30 seconds. All measurement points are to be at least 4 m above sea surface or ground surface where the microphone is located.
3. Distance measurement is necessary to determine the distance between the vessel surface and the measuring point. If 100 m distance is not practical, measurement can be performed at a distance of 80 ~ 120 m from the vessel. If the measured distance differs from 100 m, it should be recorded and corrected during the data post-processing.

302. EAN for berthing

1. The recommended distance between the hull side and the microphone is 100 m. The side of the vessel is to be directly exposed to the microphone, and there is to be no barrier or reflecting surface between the noise source (vessel) and the receiver (microphone).
2. At least 4 noise measurements is to be taken on each side of the vessel (starboard and port). One point corresponds to a point 100 m vertically from the position of the funnel outlet of auxiliary engines, and two points in the bow direction is to be at $1/4$ and $1/2$ points of the ship length (L), and one point at the $1/4 L$ point in the stern direction. However, in case of ships having a biased auxiliary engine outlet toward bow or midsection, the $1/2 L$ point in the bow direction may be adjusted to the $1/2 L$ point in the stern direction.
3. Background noise is to be measured before and after measuring EAN for each side of the ship. The background noise is to be at least 3 dB lower than that of each measurement point.

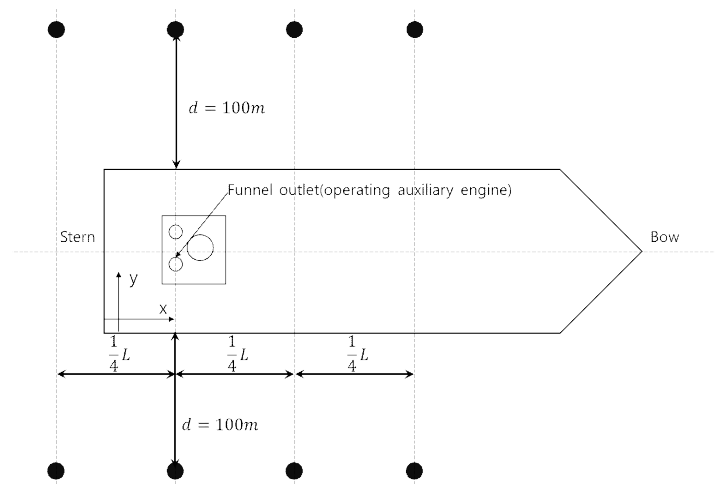


Figure 3.1 Measurement outline of EAN for berthing

303. EAN for sailing

1. The ship under test is to pass a straight course to achieve the required distance (d_{CPA}) at closet point of approach (CPA). d_{CPA} which is the distance between hull surface and microphone is 100 m.
2. The data window length (DWL) is from 200 m before arrival (start data) to 200 m after passing (end

data) based on the closest point of approach.

3. The distance from the start test range location and the end test range location to the closest point of approach is to be 800m or more.
4. Unless otherwise required by the ship's test plan, the ship under test is to maintain a constant speed, fixed engine conditions and minimum use of helm to maintain course until it has passed the end test range location.
 - (1) At the start and the end of each measurement test run, the background noise measurement is to be carried out and recorded for at least 1 minute with the ship under test located at the farthest distance or at a distance of at least $\geq 2,000$ m from the microphones, with the same microphone and data acquisition methods.
 - (2) During the recording of the background noise measurement, all main engines and generators are to operate only in idle conditions or not to be in operation.
 - (3) After the completion of the background noise measurement, the ship under test is to proceed to operate at the prescribed operating condition as specified in the approved measurement plan. The operating conditions such as the main and auxiliary engine output, ship speed, propeller RPM and nominal pitch, and loading condition are to be recorded accordingly.
 - (4) Before the acoustic center (funnel outlet of main engines) of the ship reaches the start test range location, the intended operating conditions of the ship under test are to be achieved. Between the start test range location and the end test range location, the direction and ship operating conditions are to remain the same.
 - (5) The data recording of the test measurement for the EAN (where the mechanical output signal of the microphones is sent to the data acquisition system) is only to commence when the acoustic center (funnel outlet of main engine) of the ship under test reaches the start test range location and is to terminate when the acoustic center of the ship under test reaches the end test range location as shown in **Figure 3.2**.
 - (6) Distance measurements are to be recorded for the ship under test. These include the distance (d_{CPA}) at the closest point of approach, horizontal distance from the hull surface of the ship to each microphone.
 - (7) The ship under test is to make a turn after passing the end test range location, where the ship will maneuver and prepare for the next set of runs on the alternate side of the ship repeating the measurement procedure from (1) to (6).
 - (8) A complete test course requires the ship under test to perform two (2) repeated runs (with alternating approach) each on the port and starboard side of the ship under the same operating conditions.

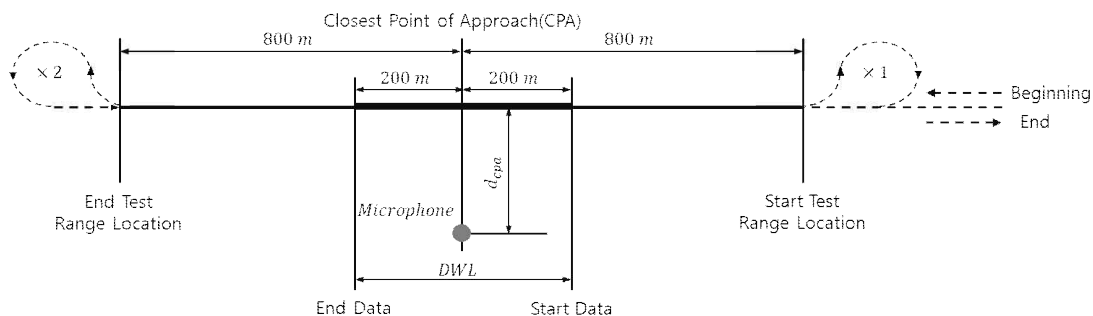


Figure 3.2 Measurement outline of EAN for sailing

Section 4 Measurement Condition

401. General

1. Sea trials are to be carried out with the ship in loaded or ballast condition. The actual condition during the measurements is to be recorded on the measurement report.
2. The main propulsion and auxiliary machinery conditions are to be set up according to the conditions

as specified in the approved measurement plan. The operating conditions are to be verified by the Surveyor.

3. Measurements are to be taken under conditions of Sea State 3 or less. Wind velocity is to be below 7 m/s and measurements are to only be performed when no rain or snow is present.
4. The microphone and measuring instruments used in the data acquisition system are to be calibrated prior to the EAN measurements. The relevant instrumentation reference calibration certificates, together with the results of the field setup and calibration check are to be provided to the Surveyor.
5. The recognized service supplier for EAN measurement is to verify that all the measurement systems for carrying out the EAN measurement are put in place and are functioning correctly.
6. Residual noise (or background noise) is to be avoided as far as possible in the vicinity of the measurement location, and measurements are not to be distorted by background noise and surroundings (eg. large reflecting surfaces).

402. EAN for berthing

1. During measurements, the ship is to be operating in the characteristic/normal load of the ship at berth. It must be ensured that the load condition during measurements is chosen in such a way that the measured sound emissions will not be exceeded at berth in any further calling port (in most cases during high / maximum load conditions of the ship). It is important that the electric load is kept as constant as possible during all measurements.
2. To adjust the electric load of the auxiliary engine(s) to the representative load, consumers on board might need to be switched on or off. Consumers that (in most cases) can be controlled manually are as follows.
 - (1) cargo hold fans,
 - (2) engine room fans,
 - (3) fans and air-conditioning of passenger rooms and
 - (4) further fans on board.
3. Furthermore, the operating conditions during all measurements need to be documented in detail.

403. EAN for sailing

1. During measurement, the propeller output is to be the normal seagoing speed of ship or at least 85 % of the maximum continuous rating (MCR) of the main engine.
2. Notwithstanding 1 above, the case for ships confirmed to sail in sea areas within 1 km from inland or in smooth water areas under separately set operating conditions. In this case, the operational conditions are to be specified in the measurement plan. If the operating speed is not specified in the approved measurement plan, the operating speed is 12 knots for container ships and car carriers and 10 knots for other ship types.
3. Ship's course has to be kept constant, with rudder angle less than 2 degrees portside or starboard, for the duration of the measurement. If ship maneuvering is need, measurements are to be stopped until recovery of heading.
4. All machinery essential for ship operation is to operate under normal conditions throughout the measurement period. The list of machinery and equipment that are to operate normally during the measurement period is limited to the installed equipment.
5. Controllable pitch and Voith-Schneider propellers, if any, are to be in the normal seagoing position. For ships with special propulsion and power configurations, such as diesel-electric systems, the actual ship's design or operating parameters as defined in the ship's specifications will be used and are to be recorded on the measurement report.
6. Any deviations from operating conditions specified in the approved measurement plan is to be recorded in the measurement report.

Section 5 Data Post-processing

501. General

1. The measured EAN by a microphone is to be subjected to post-processing steps such as background noise adjustments and distance adjustments.
2. The data post-processing described in 502. through 504. is to be performed per 1/3 octave band in the range of 31.5 ~ 8,000 Hz.

502. Background noise adjustments

1. The difference (ΔL) between the measured sound pressure level ($L_{p_{s+n}}$) and background noise level (L_{p_n}) for each 1/3 octave band is determined by the following equation.

$$\Delta L = L_{p_{s+n}} - L_{p_n} = 10 \log_{10} \left(\frac{p_{s+n}^2}{p_n^2} \right)$$

ΔL : signal-plus-noise-to-noise level difference (dB) for each 1/3 octave band

p_{s+n} : root-mean-square sound pressure at the microphone (μPa). This value includes both the desired signal and undesired background noise

p_n : root-mean-square sound pressure of the background noise at the microphone (μPa)

$L_{p_{s+n}}$: root-mean-square sound pressure level (dB) with ship under test present for each run

L_{p_n} : background root-mean-square sound pressure level with the ship under test not influencing the measurement away 2,000 m from microphones (dB)

2. The sound pressure level (L'_p) of the ship under test is determined as follows depending on the magnitude of ΔL .

(1) For $\Delta L > 10 \text{ dB}$

$$L'_p = L_{p_{s+n}}$$

L'_p : background noise adjusted root-mean-square sound pressure level of the ship under test (dB)

(2) For $3 \text{ dB} \leq \Delta L \leq 10 \text{ dB}$

$$L'_p = 10 \log \left[10^{\left(\frac{L_{p_{s+n}}}{10} \right)} - 10^{\left(\frac{L_{p_n}}{10} \right)} \right]$$

- (3) For $\Delta L < 3 \text{ dB}$: The result of the measured sound pressure level may be considered as invalid data, and the effectiveness of the data is to be evaluated on a case-by-case basis by the Society.

503. Distance adjustments

1. In order to obtain the EAN level at a reference distance of 100 m from the ship, the transmission loss (TL) due to sound wave transmission in the air should be considered.

$$L_p = L'_p + TL$$

$$TL = 20 \log \left(\frac{d}{d_{ref}} \right)$$

d : the distance from the hull surface of the ship under test to the microphone (m)

d_{ref} : reference distance (=100 m)

504. Determination of the final EAN level

1. For the sound pressure level at the standard distance (100m) from the ship, EAN level per each 1/3 octave band is to be calculated according to the following procedure.
2. Calculate the average sound pressure level per each 1/3 octave band of EAN for berthing.
 - (1) The average sound pressure levels on the port and starboard sides are determined by the following equation.

$$L_{p,P,avg} = 10 \log \left(\frac{1}{n} \sum_{k=1}^n 10^{\frac{L_{p,P}(k)}{10}} \right)$$

$$L_{p,S,avg} = 10 \log \left(\frac{1}{n} \sum_{k=1}^n 10^{\frac{L_{p,S}(k)}{10}} \right)$$

$L_{p,P}(k)$: the sound pressure level for each measuring point (k) on port side

$L_{p,S}(k)$: the sound pressure level for each measuring point (k) on starboard side

n : the number of measuring point (k) on each side

- (2) The average sound pressure level of the ship is determined by the following equation.

$$L_{p,1/3octave} = 10 \log \left[\frac{1}{2} \left(10^{\frac{L_{p,P,avg}}{10}} + 10^{\frac{L_{p,S,avg}}{10}} \right) \right]$$

$L_{p,P,avg}$: the average sound pressure level (dB) on port side

$L_{p,S,avg}$: the average sound pressure level (dB) on starboard side

3. For average sound pressure level per each 1/3 octave band of EAN for sailing, the sound pressure level can be calculated by time averaging the measured sound pressure after background noise adjustments and distance adjustments, or vice versa.
4. The frequency-weighted sound pressure level (L_{Aeq} or L_{Ceq}) is calculated using the 1/3 octave band sound pressure level calculated according to paragraphs 2 and 3.
5. The broadband total EAN level ($L_{EAN \leq 8000}$) is calculated as the sum of sound pressure levels in the 1/3 octave band from 31.5 Hz to 8,000 Hz.
6. The low frequency band total EAN level ($L_{EAN \leq 160}$) is calculated as the sum of sound pressure levels in the 1/3 octave band from 31.5 Hz to 160 Hz.

Section 6 Criteria

601. General

1. The final EAN level of ship under test calculated in 505. 4 and 6 are to meet the acceptance criteria of each EAN level depending on frequency ranges specified in Table 3.1. ↓

Table 3.1 Acceptance criteria of EAN level (dB(A))

Frequency range	For sailing			For berthing		
	EAN-SM[x, y] ⁽¹⁾	EAN-S1	EAN-S2	EAN-BM[x, y] ⁽¹⁾	EAN-B1	EAN-B2
31.5 Hz ~ 8,000 Hz	x	63	58	x	50	45
31.5 Hz ~ 160 Hz	y	58	53	y	45	40
note (1) M indicates that EAN was measured, x indicates the broadband total EAN level(dB(A)) in the range of 31.5 ~ 8000 Hz, and y indicates the low frequency band total EAN level(dB(A)) in the range of 31.5 to 160 Hz.						

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