



GUIDE FOR

COMFORT ON YACHTS

SEPTEMBER 2014

**American Bureau of Shipping
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the State of New York 1862**

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Foreword

This *ABS Guide for Comfort on Yachts* presents guidance for measuring the comfort of Owners and their guests while occupying cabins, dining spaces, lounges, cocktail bars and other Owner and guest spaces onboard.

The assessment criteria and measurement methodology outlined in this Guide can lead to obtaining **an** ABS Comfort notation for yachts. The criteria allow a measure of the comfort of a yacht related to the ambient environmental aspects of whole-body vibration and noise onboard. The Owner/guest comfort criteria are applicable to new and existing yachts for which an optional Comfort – Yacht (**COMF(Y)**) or a Comfort Plus – Yacht (**COMF+(Y)**) notation has been requested.

This Guide, originally published in December 2008, has undergone significant revision. Key revision areas include changes to the Whole-body Vibration (WBV) measurement and evaluation methodology and criteria as well as changes to the Noise criteria. These revisions are due to several factors, including:

1. Input from industry (i.e., Owners, designers, and construction yards)
2. Revisions to standards referenced in this Guide
3. Revised statutory regulations
4. Changes in current design practices and principles

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



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SECTION 1 General

1 Introduction

ABS recognizes the positive impact that appropriate comfort requirements and design practices can have on the Owner and their guests' comfort, safety, and overall well-being. The Owner/guest comfort criteria contained in this Guide have been developed to provide a means to measure and assess the level of comfort of Owners and their guests on yachts.

3 Application

The Owner/guest comfort criteria are applicable to new and existing yachts for which an optional Comfort – Yacht (**COMF(Y)**) or a Comfort Plus – Yacht (**COMF+(Y)**) notation has been requested. The Owner/guest comfort criteria are a measure of the acceptability of a yacht related to the ambient environmental aspects of whole-body vibration and noise.

A separate document, the *ABS Guide for Passenger Comfort on Ships*, can be referenced for criteria on two (2) additional ambient environmental aspects of comfort; indoor climate and lighting. Compliance with those criteria for indoor climate and lighting are not a requirement for the Comfort – Yacht (**COMF(Y)**) or the Comfort Plus – Yacht (**COMF+(Y)**) notation.

5 Scope

The optional Comfort notations focus on two (2) Owner/guest comfort related aspects of yacht design, whole-body vibration and noise. The comfort criteria are based on currently available research data and standards. The test conditions, measurement locations, test methods and instruments were selected to provide a practical methodology that can be applied internationally with reliability and suitable validity.

7 Terminology

Accommodation Areas: Yacht areas where the primary purpose is to rest **and** recreate. Owner/guest accommodation spaces include cabins, staterooms, dining areas, entertainment areas, recreation rooms, and other Owner/guest spaces. For the purposes of this Guide, accommodation **areas** are primarily restricted to the spaces Owners and their guests would normally use onboard yachts.

Ambient Environment: Ambient environment refers to the environmental conditions that Owners and their guests are exposed to during periods of transit, leisure, or rest. Specifically, this Guide provides criteria and limits for whole-body vibration and noise.

Comfort: The acceptability of the conditions of a yacht as determined by its vibration and noise qualities according to prevailing research and standards for human comfort.

Testing Specialists: Specialized test personnel who must meet the requirements of Appendix 2, “Procedural Requirements for **ABS Recognized Ambient Environmental Testing Specialists**” of the *ABS Guide for Passenger Comfort on Ships*.

Occupied Owner/Guest Spaces: For the purposes of this Guide, any space used for rest, entertainment, **and** dining where the Owner or their guests may be present for twenty (20) minutes or longer at one time.

Owner/Guest: Every person onboard other than the Master and the members of the crew or other persons employed or engaged in any capacity on board a yacht for the business of that yacht.

Shall: Expresses a provision that is mandatory.

Test Plan: Document containing the requisite information regarding yacht design and layout, test personnel, test conditions, measurement locations, data acquisition, instruments, data analysis and test schedule necessary for verifying the measurements for the ambient environmental aspects of comfort.

Test Report: Document containing the actual testing result from the Ambient Environmental tests including details of the testing conditions, measurement locations, measurement equipment, and the results of the data collected and analyzed.

9 Notation

At the yacht Owner or shipyard’s request, a yacht complying with the minimum criteria for Owner/guest comfort **may** be assigned a notation of **COMF(Y)**. A yacht complying with the **motion sickness** criteria with respect to whole-body vibration, **may** be assigned the notation **COMF+(Y)**. A summary of the differences between these notations is given below.

<i>Notation</i>	<i>Whole-body Vibration</i>	<i>Noise</i>
COMF(Y)	Must meet comfort-based vibration level criteria	Must meet criteria for noise
COMF+(Y)	Must meet comfort-based vibration level criteria as well as motion sickness criteria	No difference between COMF(Y) and COMF+(Y)

11 Process for Obtaining a Notation

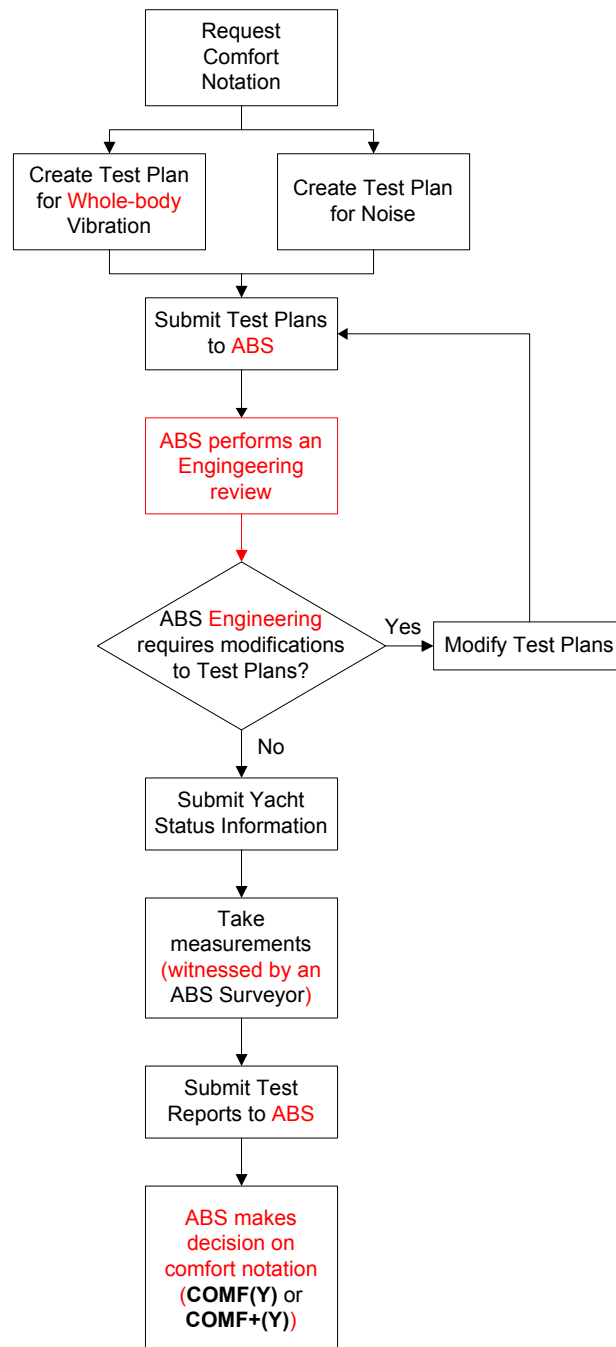
Prior to scheduling ambient environmental testing activities, the yacht Owner or shipyard shall certify the operational status of the yacht as being fully operational and/or inclusive of all equipment and furnishings. If the yacht is not fully operational, then a complete listing of **deficient** areas, components, equipment, etc., shall be submitted to ABS **Engineering for review**. ABS **shall then** make a determination and notify the yacht Owner or shipyard as to whether ambient environmental testing can commence. **The intent is to align sea trial activities with the ambient environmental testing so that all testing is completed during this time.**

The process for obtaining a **COMF(Y)** or **COMF+(Y)** notation is presented in Section 1, Figure 1. The following paragraph briefly describes the notation process.

Ambient environmental **Test Plans** for whole-body vibration and noise shall be prepared and submitted to ABS Engineering for review and approval. Information submitted to ABS Engineering shall serve as a primary vehicle for verifying the measurement locations and measurement process, as well as specifying the **Testing Specialist** who will perform the ambient environmental testing. Testing, inspections and data collection shall be performed by **Testing Specialist** and witnessed by an ABS Surveyor. **Test Reports** for ambient environmental testing shall be prepared by the **Testing Specialist** and submitted to the ABS Surveyor for review for determination of notation confirmation. Specific **Test Plan** and **Test Reporting** details for whole-body vibration and noise are outlined in the following locations:

<i>Environmental Aspect</i>	<i>Test Plan Details</i>	<i>Test Report Details</i>
Whole-body Vibration	Subsection 2/11	Subsection 2/15
Noise	Subsection 3/11	Subsection 3/15

FIGURE 1
Comfort Notation Process for Initial Requirements



13 Surveys after Construction

It is intended that all surveys after construction are to be aligned with Classification Surveys. Harmonization of surveys is to be carried out at the first available opportunity. See Section 7-9-17 of the *ABS Rules for Survey After Construction (Part 7)* for the survey requirements.

13.1 Annual Surveys

In order to maintain the **COMF(Y)** or **COMF+(Y)**, notation, an Annual Survey shall be made within three (3) months before or after each annual anniversary date of the crediting of the Initial Survey or the previous Special Periodical Survey. The following information shall be reviewed by the attending ABS Surveyor for issues that could affect the notation.

- i)* Collision and grounding reports since previous Initial, Annual or Special Periodical Survey
- ii)* Fire, repair, and damage reports since previous Initial, Annual or Special Periodical Survey
- iii)* A list of all structural or mechanical modifications to the vessel since previous Initial, Annual or Special Periodical Survey
- iv)* Verification that equipment and facilities continue to be fit for purpose and are operating in accordance with the criteria stated within this Guide

During the attending ABS Surveyor's review of the submitted information, a determination will be made as to whether changes or alterations have taken place that could affect the notation. As a result, the vessel may be subject to the review, ambient environmental testing, and inspection requirements of this Guide.

13.3 Special Periodical Surveys

In order to maintain the **COMF(Y)** or **COMF+(Y)** notation, a Special Periodical Survey shall be completed within five (5) years after the date of build or after the crediting date of the previous Special Periodical Survey. A Special Periodical Survey will be credited as of the completion date of the survey but not later than five (5) years from date of build or from the date recorded for the previous Special Periodical Survey. If the Special Periodical Survey is completed within three (3) months prior to the due date, the Special Periodical Survey will be credited to agree with the effective due date. The Special Periodical Survey may be commenced fifteen (15) months prior to the due date and be continued with completion by the due date.

13.3.1 Survey Requirements

The Survey shall comprise ABS Surveyor verifications and ambient environmental testing. The Survey will cover both comfort aspects.

The following shall be submitted to ABS three (3) months prior to carrying out the ambient environmental testing:

- i)* Fire, repair, or damage reports since previous Annual Survey
- ii)* A list of all structural or mechanical modifications to the vessel since previous Annual Survey
- iii)* Drawings/arrangements of passenger spaces affected by alterations
- iv)* Copy of approved Initial Test Plans and Test Reports
- v)* Test Plans and Test Reports resulting from Annual Surveys
- vi)* Previous Special Periodical Survey Test Plans and Reports, if applicable
- vii)* Proposed Special Periodical Survey Test Plans for the current survey

The Special Periodical Survey data submittal serves three purposes. The first is to perform an ABS Engineering review of passenger spaces against any alterations to the vessel since the Initial Survey, with measurements verified by an ABS Surveyor. The second purpose is to provide a history of ambient environmental testing, as well as the Special Periodical Survey ambient environmental Test Plans for review and approval. The third is to allow scheduling of measurement verifications and ambient environmental testing.

A Special Periodical Survey Test Plan for both ambient environmental aspect of comfort shall be submitted in accordance with the criteria stated below. The approved Initial Test Plans should be used as a basis for creating the Special Periodical Survey Test Plans.

13.5 Requirements for Vessel Alterations

No alterations which affect or may affect the yacht comfort notation awarded are to be made to the vessel unless plans of the proposed alterations are submitted to and approved by ABS before the work of alteration is commenced. If ABS determines that the alteration will affect the yacht Comfort notation, the altered vessel may be subject to the review, verification, and ambient environmental testing requirements of this Guide.

15 Alternatives

ABS will consider alternative arrangements, criteria and procedures, which can be shown to meet the criteria directly cited or referred to in this Guide. The demonstration of an alternative's acceptability can be made through either the presentation of satisfactory service experience or systematic analysis based on valid engineering principles.

15.1 Departures from Criteria

The criteria contained in this Guide are envisioned to apply to yachts within the scope of the following:

- *ABS Rules for Building and Classing Steel Vessels*
- *ABS Rules for Building and Classing Steel Vessels Under 90 Meters (295 Feet) in Length (Part 5)*
- *ABS Rules for Materials and Welding (Part 2)*
- *ABS Guide for Building and Classing Yachts*

It is recognized that unusual or unforeseen conditions may lead to a case where one or more of the parameters of interest in granting a notation may temporarily fall outside the range of acceptability.

When a departure from criteria is identified, during either the notation's initial issuance or reconfirmation process, it shall be reviewed by ABS in consultation with the Owner. When the departures from the stated criteria are found, these departures will be subject to special consideration upon the receipt of details about the departure. Depending on the degree and consequences of the departure, the shipyard or Owner may be required to provide an assessment and remediation plan to obtain or maintain the notation. Failure to complete the agreed remediation by the due date will lead to withdrawal of the notation.

SECTION 2 Whole-body Vibration

1 Background

Traveling in yachts **may** impose a series of **generally** low-frequency mechanical vibrations as well as single-impulse shock loads on the human body.

Low-frequency vibrations **can also be** imposed by yacht motions **which are** produced by **the** various sea states in conjunction with yacht speed. **These motions can** result in motion sickness, body instability, fatigue, discomfort and increased health risk aggravated by shock loads induced by **vessel** slamming. **Vessel** slamming may be caused by dynamic impact loads being exerted on the **vessel's bottom** or bow flare **due to** yacht size, speed, and wave conditions.

Higher-frequency vibration **influencing comfort** is **often** associated with rotating machinery. The imposition of higher frequency vibrations (**about 1 to 80 Hz**) induces corresponding motions and forces within the human body, creating discomfort and possibly resulting in degraded levels of comfort and health (Griffin, 1990).

3 Scope

This Section provides criteria and methods for assessing whole-body vibration relating to Owner/guest comfort onboard yachts. The criteria were selected to **limit potential vibration related interference with Owner/guest activities and to** improve comfort.

Consideration of the **vibration** loads imposed **on the body** is restricted to motions transmitted from surrounding structures to the entire human body through the feet of a standing person in the frequency range **1** to 80 Hertz (Hz). Motions transmitted to the body of a seated or recumbent person **have been omitted from this Guide**. Due to the provision of resilient or non-rigid surfaces on seats and beds, these surfaces will generally attenuate the transfer of **vibration** to levels that are lower than those experienced when standing. The motions transmitted through the feet are expected to be the highest vibration levels to which Owners and their guests will be exposed.

Whole-body vibration limits defined in this Section are based on currently available standards. Compliance with **this Section** is a prerequisite for the Comfort – Yacht (**COMF(Y)**) or Comfort Plus – Yacht (**COMF+(Y)**) notation confirmation.

5 Terminology

Acceleration: **The rate of change of velocity over time** (i.e., meters-per-second squared, m/s²).

Exposure Action Value: **The value of vibration/repetitive shock above which controlling the whole-body vibration exposure to humans is recommended.**

Exposure Limit Value: **A value of vibration/repetitive shock above which humans should not be exposed.**

Frequency: The number of complete cycles of a periodic process occurring per unit time. Frequency is expressed in Hertz (Hz) which corresponds to **the number of cycles observed-per-second**.

Frequency Weighting: A transfer function used to modify a signal according to a required dependence on vibration frequency.

- In human response to vibration, various frequency weightings have been defined in order to reflect known or hypothesized relationships between vibration frequency and human responses.
- **The frequency weighting used to evaluate whole-body vibration in this Guide is W_m (whole-body) for all three axes (x, y, and z), in accordance with ISO 6954.**

Motion Sickness: Various undesirable effects including sweating, nausea and vomiting caused by low-frequency (normally less than 0.5 Hz) oscillation in the vertical z-axis of the human body, primarily in the standing and sitting postures.

Motion Sickness Dose Value (MSDV_Z): A cumulative measure of exposure to low-frequency oscillation that may be used to provide an indication of the probable incidence of motion sickness. The vertical Motion Sickness Dose Value $MSDV_Z$, in $m/s^{1.5}$, is defined by the following expression:

$$MSDV_Z = \sqrt{\int_0^T a_{zw}^2(t) dt}$$

where $a_{zw}(t)$ is the z-axis acceleration as a function of time in meters-per-second squared (m/s^2), weighted by the W_f frequency weighting as defined in BS 6841:1987 and ISO 8041:2005, and T is the duration of the motion in seconds.

In the case of shorter exposure periods with continuous motion of approximately constant magnitude, the Motion Sickness Dose Value may be estimated from the frequency-weighted **RMS** value determined over a short period. The Motion Sickness Dose Value ($m/s^{1.5}$) for the exposure period T_0 (s) is defined by the following expression:

$$MSDV_Z = a_w T_0^{1/2}$$

Multi-Axis Acceleration Value: The Multi-Axis Acceleration Value is calculated from the root-sums-of-squares of the weighted **RMS** acceleration values in each axis (a_{xw} , a_{yw} and a_{zw}) at the measurement point using the following expression:

$$a_w = \sqrt{a_{xw}^2 + a_{yw}^2 + a_{zw}^2}$$

where a_{xw} , a_{yw} and a_{zw} are the weighted **RMS** acceleration values measured in the x-, y-, and z-axes, respectively.

Multi-Axis Vibration: Mechanical vibration or shock acting in more than one (1) direction simultaneously.

Reference Calibration: Calibration of a measuring instrument conducted by an accredited Testing and Calibration Laboratory with traceability to a national or international standard.

Vibration: The variation with time of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value.

Weighted Root-Mean-Square Acceleration Value (a_w): The weighted root-mean-square (**RMS**) acceleration a_w , in meters-per-second, is defined by the expression:

$$a_w = \sqrt{\frac{1}{T} \int_0^T a_w^2(t) dt}$$

where $a_w(t)$ is the weighted acceleration as a function of time in meters-per-second squared (m/s^2) and T is the duration of the measurement in seconds.

Whole-body Vibration: Mechanical vibration (or shock) transmitted to the human body as a whole. Whole-body vibration is often due to the vibration of a surface supporting the body.

7 Associated Documentation

The following documents provide details about **Test Plan** preparation, test measurement procedures and/or **Test Reporting**:

- **ISO 6954:2000, Mechanical Vibration and Shock – Guidelines for the Measurement, Reporting and Evaluation of Vibration with Regard to Habitability on Passenger and Merchant Ships.**
- **ISO 2631-2:2003, Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration – Part 2, Vibration in Buildings.**

- ISO 8041:2005, Human response to vibration – Measuring instrumentation.
- ISO 5348:1998, Mechanical vibration and shock – Mechanical mounting of accelerometers.
- **WMO**: 1995, Sea State Code.

Further guidance can be found in:

- ISO 2923:1996, Acoustics – Measurement of noise on board vessels.
- **ISO 20283-2:2008, Mechanical Vibration – Measurement of Vibration on Ships – Part 2: Measurement of Structural Vibration.**
- **BS 6841:1987, Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock.**

9 Criteria

The whole-body vibration criteria for the Comfort – Yacht (**COMF(Y)**) and Comfort-Plus – Yacht (**COMF+(Y)**) notations are provided in Section 2, Table 1, “**Maximum Root-Mean Square Acceleration Level**”. The severity of the vibration shall be indicated by the weighted root-mean-square acceleration value (a_w) as defined in ISO 8041.

Whole-body vibration measurements shall only be taken in Owner/guest accommodation areas, recreation spaces/areas, and open deck areas occupied by Owners and their guests for twenty (20) minutes or longer at a time. Specific locations are referred to in 2/13.7, “**Measurement Locations**”.

The maximum vibration levels for Owner/guest spaces shall not be exceeded under normal operation conditions for the **COMF(Y)** and **COMF+(Y)** notations. For the **COMF+(Y)** notation, in addition to the Maximum Root-Mean-Square Acceleration Level (a_w), the Motion Sickness Dose Value Level ($MSDV_z$) provided in Section 2, Table 1 shall not be exceeded. The more stringent maximum levels for the **COMF+(Y)** notation are aimed at facilitating optimal Owner/guest comfort and to restrict the incidence of motion sickness to ten (10) percent or less among Owners and their guests.

TABLE 1
Maximum Root-Mean Square Acceleration Level

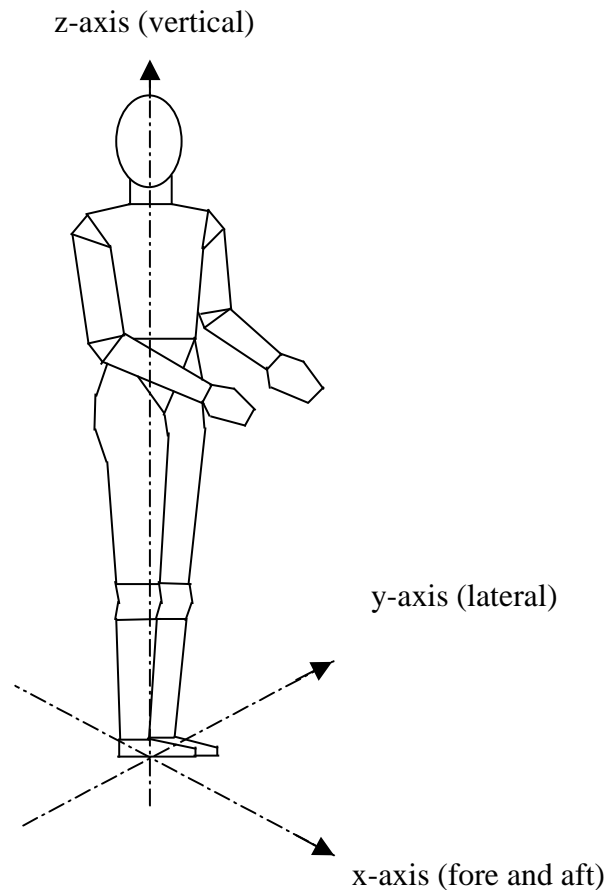
Notation	Frequency Range	Acceleration Measurement	Maximum RMS Level
			Transit Conditions
COMF(Y)	1 - 80 Hz	a_w	71.5 mm/s ² (2 mm/s)
COMF+(Y)	0.1 - 0.5 Hz	$MSDV_z$	30 m/s ^{1.5}
	1 - 80 Hz	a_w	71.5 mm/s ² (2 mm/s)

For the purpose of this Section, the notation applies to the whole-body vibration levels occurring on the deck supporting the human in the three (3) translational (x-, y- and z-) axes as shown in Section 2, Figure 1, “**Measurement Axes**”.

The vibration levels are computed for each axis individually, as well as combined as a multi-axis acceleration value. Each is expressed as a frequency weighted root mean square (a_w) value. To meet the vibration criteria, the single-axis and multi-axis a_w levels must be less than or equal to the maximum level expressed in Section 2, Table 1.

The Motion Sickness Dose Value Level ($MSDV_z$) is computed in the z-axis only and adjusted to the duration of a typical voyage. If the duration of a typical voyage exceeds six (6) hours, the $MSDV_z$ shall be computed for a duration of six (6) hours. To meet the Motion Sickness Dose Value Level, the computed $MSDV_z$ value must be equal to or lower than the $MSDV_z$ value expressed in Section 2, Table 1.

FIGURE 1
Measurement Axes



11 Test Plan

As stated in Subsection 1/11, “**Process for Obtaining a Notation**”, a Test Plan shall be developed to serve as the principal means for verifying the measurements to be performed to verify compliance with **whole-body** vibration criteria. The Test Plan shall include the following:

11.1 Documentation

The Test Plan shall include appropriate drawings indicating the location of all vibration sources.

11.3 Test Personnel

The Test Plan shall provide information **about** the **Testing** Specialist who **will** be conducting the test and their approval and certification in accordance with Appendix 2, “Procedural Requirements for **ABS Recognized Ambient Environmental Testing Specialists**” of the *ABS Guide for Passenger Comfort on Ships*.

11.5 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. Further details on test conditions are provided in 2/13.5, “Test Conditions”.

11.7 Measurement Locations

The Test Plan shall document in detail, on appropriate drawings, all spaces where measurements will be taken. In addition, transducer measurement positions shall be indicated. Details on selecting measurement locations and determining transducer measurement positions are provided in 2/13.7, “Measurement Locations”.

11.9 Data Acquisition and Instruments

The Test Plan shall provide information regarding the methods and instrumentation to be used for measurement and data collection. Instrumentation specification details shall include type of instruments to be used, accuracy, calibration, sensitivity, conformance with ISO 8041, and frequency range. More details on data acquisition and instruments are provided in 2/13.3, “Data Acquisition and Instruments”.

11.11 Data Analysis

The Test Plan shall provide information regarding the methods, software and instrumentation to be used for data analysis.

11.13 Test Schedule

The Test Plan shall provide information regarding the proposed test schedule.

13 Test Requirements

13.1 General

Whole-body vibration measurements shall be in accordance with the procedures described in ISO 6954. When the procedures described in this Guide deviate from any requirements or procedures mentioned in ISO 6954, the more stringent requirement shall take precedence.

The relationship between the various factors to be considered when taking whole-body vibration measurements and computing results is illustrated in Section 2, Figure 2, “Process for the Measurement and Analysis of Whole-body Vibration”.

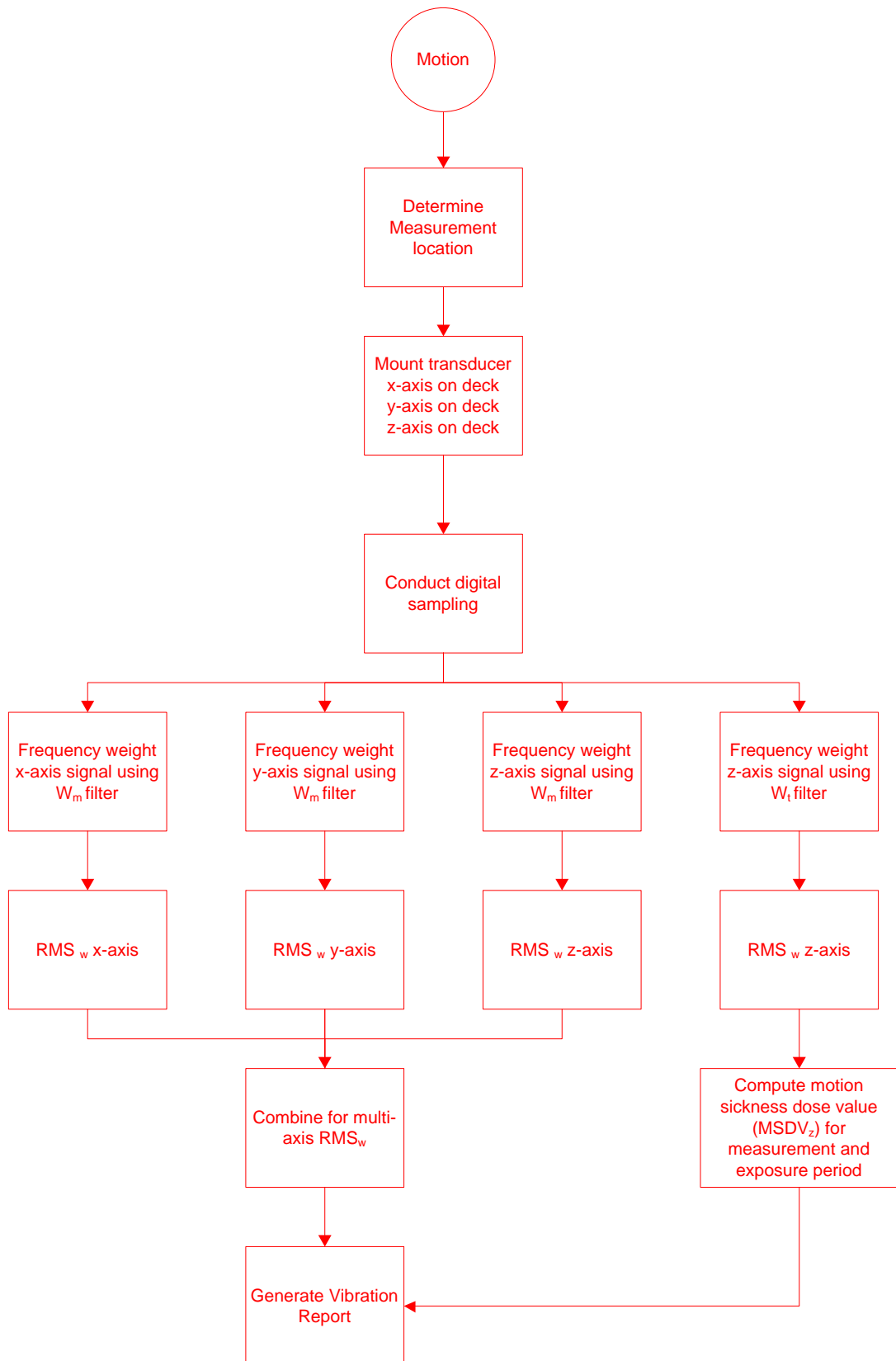
13.3 Data Acquisition and Instruments

For the **COMF(Y)** notation, a sample of data shall be recorded for each whole-body vibration measurement position. Each whole-body vibration measurement sample shall be at least sixty (60) seconds in duration.

For the **COMF+(Y)** notation, motion sickness measurements shall be taken in addition to the whole-body vibration measurements. Motion sickness measurement locations shall be made in the most aft-and-port, aft-and-starboard, forward-and-port and forward-and-starboard Owner/guest spaces, irrespective of deck level.

The above measurement samples shall all be taken using the appropriate Type 1 instrumentation (ISO 8041), then frequency weighted and analyzed in accordance with BS 6841. It is desirable to employ equipment that records and stores acceleration time histories.

FIGURE 2
Process for the Measurement and Analysis of Whole-body Vibration



13.5 Test Conditions

The test conditions required for the whole-body vibration measurements shall be in accordance with the following Subparagraphs.

13.5.1 Power Output

The propulsion machinery shall run at **contractual service conditions or with at least 40% power on the thrusters.**

13.5.2 Equipment Operation

All machinery essential for yacht operation shall operate under normal conditions throughout the measurement period. Heating, Ventilation, and Air Conditioning (HVAC) systems are to be running as for normal seagoing conditions during the whole-body vibration measurements.

13.5.3 Course and Water Depth

Whole-body vibration measurements are to be taken with the yacht in a depth of water not less than five (5) times the draft of the yacht. For yachts that do not operate in water depths of five (5) times draft, measurements shall be taken under normal operating and transit conditions. The yacht shall maintain a single heading and a constant speed during the test, as far as practicable.

13.5.4 Rudder **Conditions**

The rudder **action** shall be **minimized.**

13.5.5 Sea Conditions

Measurements are to be taken under conditions of a Sea State 3 or less, as defined by the World Meteorological Organization (WMO) (1995) *Sea State Code.*

13.5.6 Loading Conditions

The loading condition of the yacht shall be as close as possible to normal operating conditions. If this is not practicable, the loading condition shall be recorded in the **Whole-body Vibration Test Report.**

13.5.7 Test Interference

During the whole-body vibration measurements, vibration arising from every kind of unnecessary human activity shall be avoided. For this reason, only the personnel needed for the normal operation in the space and those carrying out the measurements shall be present in the space being tested.

13.7 Measurement Locations

13.7.1 **Selection of Spaces where Measurements are to be Conducted**

Whole-body vibration measurements shall be taken in all Owner/guest spaces. The number of measurements within a space shall be selected according to Section 2, Table 2, "**Distribution of Transducer Positions within Spaces**".

13.7.2 **Walkthrough Verification Inspection Locations**

All Owner/Guest spaces shall be subject to a walkthrough inspection by the ABS Surveyor. The number and locations of the walkthrough inspections will be determined by the ABS Surveyor. The purpose of the walkthrough verification is to subjectively assess the vibration qualities. At the discretion of the ABS Surveyor, additional measurements may be required.

13.7.3 **Transducer Measurement Positions**

Vibration transducers (accelerometers) shall be located and attached properly to the **deck** surface to **measure** the vibration at the interface between the standing Owner/guest and the source of vibration. The mounting of accelerometers shall comply with ISO 5348. When the vibration enters the human body from a non-rigid or resilient material (e.g., **deck** covering), **secure** the transducers with a suitably formed mount that does not alter the pressure distribution on the surface of the **deck** covering.

In cabins or staterooms, the vibration transducers shall be placed on the deck in the center of the space. (Note: This location may not provide the maximum vibration levels for this particular space. The objective is to minimize the number of measurements yet still obtain a fair and representative sample of the exposure conditions for the person occupying the cabin or stateroom.)

For larger spaces (entertainment areas, dining rooms, meeting rooms, etc.) it shall be necessary to place transducers at a number of locations in order to obtain a representative sample of the whole-body vibration levels for that space. Transducer locations shall be evenly distributed throughout the space. For a specific room size, the minimum number of measurement locations shall be as indicated in Section 2, Table 2, “Distribution of Transducer Positions within Spaces”.

TABLE 2
Distribution of Transducer Positions within Spaces

<i>Space Size</i>	<i>Minimum Number of Measurement Positions in Room</i>
Less than or equal to 40 m ² (431 ft ²)	1
Greater 40 m ² (431 ft ²)	2

Transducers located at one (1) measurement position shall be orthogonally positioned (positioned at a 90 degree angle) to measure whole-body vibrations in the vertical, longitudinal, and transverse axes. Translational accelerometers oriented in different axes at a single measurement position shall be as close together as possible.

For the COMF+(Y) notation, at least three (3) sets of data shall be collected, each consisting of four (4) motion sickness measurements made at locations specified in 2/13.7.1, “Selection of Spaces Where Measurements are to be Conducted”. For exposure periods greater than or equal to three (3) hours there shall be at least thirty (30) minutes elapsed between the final motion sickness measurement in a set and the first motion sickness measurement in the following set. For exposure periods shorter than three (3) hours, motion sickness measurements may be made in succession. Each motion sickness measurement sample shall be at least six hundred (600) seconds in duration.

15 Test Report

As stated in Subsection 1/11, “Process for Obtaining a Notation” a Test Report shall be submitted to the ABS Surveyor to determine whether the vibration levels meet the whole-body vibration criteria and whether this part of the notation requirement has been met. The details listed in the following paragraphs shall be provided in the Whole-body Vibration Test Report.

15.1 Test Details

The following details shall be recorded for each period of testing:

- i) Loading (mean draft and trim)
- ii) Number of persons present during testing
- iii) Bridge confirmation that operating conditions complied with contractual service conditions
- iv) Yacht course and speed, as well as latitude and longitude coordinates of tests
- v) Average water depth under keel
- vi) Weather conditions and meteorological data at the onset of every data collection period and at intervals of every four (4) hours (if needed) during any data collection period. Weather conditions shall also be reported at the end of each data collection period.
- vii) Sea state
- viii) Yacht equipment operated during the test
- ix) Any indications of abnormal activity during the test that might skew results

15.3 Transducer Measurement Positions

Actual transducer positions **within the measured spaces** shall be indicated on appropriate drawings.

15.5 Measurement Equipment Details

Details of measurement and analysis equipment (e.g., manufacturer, type and serial number, accuracy and resolution), including frequency analysis parameters (e.g., resolution, averaging time, filtering) shall be provided.

15.7 Results

The following results, per sample period, as appropriate for notation, shall be provided in table format:

- i)* Measurement position (i.e., space and location within space)
- ii)* Measurement period **if different from requirements**
- iii)* Sample number
- iv)* Weighted **RMS**-per-axis (a_w)
- v)* Multi-Axis weighted **RMS values**
- vi)* Motion Sickness Dose Value ($MSDV_z$)
- vii)* Exposure period
- viii)* Equipment operating in proximity to the measurement position

For all the remaining spaces that were checked through walkthrough verification inspection and spot check measurements, the following information shall be provided:

- i)* **Name and number of spaces**
- ii)* **Walkthrough inspection observations**
- iii)* **Measurement results, if necessary**

15.9 Deviations

All deviations from the approved Test Plan shall be reported.

15.11 Surveyor Witnessing Documentation

The equipment calibration, **as applicable**, and data collection process of **whole-body** vibration tests **conducted at sea** shall be witnessed by an ABS Surveyor. The ABS Surveyor shall provide documentation stating whether all steps of the testing were completed to **their** satisfaction. A copy of the witnessing document shall be given to the person conducting the testing for insertion into the final **Whole-body Vibration** Test Report. The original shall be retained for ABS' files.

17 Results

The Whole-body Vibration Test Report shall be reviewed by the ABS Surveyor against the appropriate **COMF(Y)** and **COMF+(Y)** criteria for notation confirmation.

SECTION 3 Noise

1 Background

Noise is any unwanted sound which may result in annoyance, disturbance of sleep, or interfere with activities or speech. Compliance with the noise level criteria specified herein will contribute to the comfort and well-being of the yacht's Owner and guests when using these spaces for their intended purpose.

A detailed discussion of **the effects of noise on human performance, health, and comfort** is found in Kryter (1994) *The Handbook of Hearing and the Effects of Noise: Physiology, Psychology and Public Health*.

3 Scope

In this Section, noise criteria have been selected to **improve** the comfort of the Owner and their guests. In this instance, "comfort" means the ability **of the owner and their guests** to use a space for its intended purpose, with minimal interference or annoyance from noise.

This Section applies to Owner/guest spaces occupied for twenty (20) minutes or longer at any one time (e.g., cabins, staterooms, dining and recreation spaces).

Compliance with **this Section** is a **prerequisite** for the Comfort-Yacht (**COMF(Y)**) or Comfort Plus-Yacht (**COMF+(Y)**) notation confirmation.

5 Terminology

A-weighted Sound Pressure Level: The magnitude of a sound, expressed in decibels (i.e., 20 micropascals); the various frequency components are adjusted according to the A-weighted values given in IEC 61672-1 in order to account for the frequency response characteristics of the human ear. The symbol is L_A ; the unit is dB(A). **The measurement L_{Aeq} is an equivalent continuous A-weighted sound pressure level, measured over a period of time.**

Accommodation Areas: Yacht areas where the primary purpose is to rest or recreate. Owner/guest accommodation spaces include cabins, staterooms, dining areas, entertainment areas, recreation rooms, and other Owner/guest spaces. For the purposes of this **Guide**, accommodation **areas** are primarily restricted to the spaces Owners and their guests would normally use on board yachts.

Calibration Checks: Field calibration of a measuring instrument conducted before and after a field test using a reference **calibrated signal or through zero calibration.**

Equivalent Continuous A-weighted Sound Pressure Level: The A-weighted sound pressure level of a notional steady sound over a certain time interval, which would have the same acoustic energy as the variable-loudness real sound under consideration, over the same time interval. The symbol is L_{Aeq} ; the unit is dB(A).

Reference Calibration: Calibration of measuring instrument conducted by an accredited Testing and Calibration Laboratory with traceability to a national or international standard.

7 Associated Documentation

The following documents provide details about Test Plan preparation, test measurement procedures and/or Test Reporting:

- ISO 2923:1996. Acoustics – Measurement of noise on board vessels
- IEC 61672-1: 2004. Electroacoustics – Sound Level Meters – Part 1: Specifications IEC 61672-1 (2004)
- IMO Resolution A.468(XII): 1981, Code on noise levels on board ships
- WMO: 1995, Sea State Code.

9 Criteria

9.1 Equivalent Continuous A-weighted Sound Pressure Level

The noise criteria for the Comfort-Yacht (COMF(Y)) and Comfort-Plus Yacht COMF+(Y)) notations are provided in Section 3, Table 1, “Noise Criteria”. Noise levels for comfort shall be determined for the test conditions specified in 3/13.5, “Test Conditions”.

TABLE 1
Noise Criteria

<i>Spaces</i>	<i>Maximum Acceptable Noise L_{Aeq} Level dB(A)</i>
Owner’s Cabin	45
Passageways serving Owner’s Cabin	50
Guest Cabins	45
Passageways serving Guest Cabin	55
Dining Spaces	55
Indoor Guest Spaces (including Lounges, Cocktail Bars, etc.)	55
Entertainment Spaces (Cinema, Meeting rooms, etc.)	55
Passageways near Guest Spaces	60
Gymnasiums	65
Outdoor Spaces	65
Medical Facilities	55

9.3 Acoustic Insulation/Noise Attenuation

The airborne sound insulation properties for bulkheads and decks within the accommodation shall comply at least with the following weighted sound reduction index (R_w) according to ISO Standard 717-1:1996 as amended (1:2006), part 1:

Cabin to cabin	$R_w = 35$
Messrooms, recreation rooms, public spaces and entertainment areas to cabins and hospitals	$R_w = 45$
Corridor to cabin	$R_w = 30$
Cabin to cabin with communicating door	$R_w = 30$

The airborne sound insulation properties shall be determined by laboratory tests in accordance with ISO 10140-2:2010.

11 Test Plan

As stated in Subsection 1/11, “**Process for Obtaining a Notation**”, a Test Plan shall be developed to serve as the principal means for verifying the measurements to be performed to demonstrate or confirm compliance with noise criteria. The Test Plan shall include the following:

11.1 Documentation

The Test Plan shall include appropriate design information including noise specifications for the yacht. It shall also include layout drawings indicating the locations of all noise sources and noise generating equipment. The information shall be of such detail to enable an ABS Surveyor to verify compliance **with** the criteria set in this Guide.

The Test Plan shall be submitted **to ABS Engineering** for review **and approval**.

11.3 Test Personnel

The Test Plan shall provide information **about** the **Testing Specialist** who will be conducting the test and their approval and certification in accordance with Appendix 2, “Procedural Requirements for **ABS Recognized Ambient Environmental Testing Specialists**” of the *ABS Guide for Passenger Comfort on Ships*.

11.5 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. **Further details on test conditions are provided in 3/13.5, “Test Conditions”.**

11.7 Measurement Locations

The Test Plan shall document in detail on appropriate drawings all spaces where measurements will be taken. In addition, measurement positions shall be indicated. Details on selecting measurement locations and determining transducer positions are provided in 3/13.7, “**Measurement Locations**”.

11.9 Data Acquisition and Instruments

The Test Plan shall provide information regarding the methods and instrumentation to be used for measurement and data collection. Instrumentation specification details shall include type of instruments to be used, accuracy, calibration, and sensitivity. More details on data acquisition and instruments are provided in 3/13.3, “**Data Acquisition and Instruments**”.

11.11 Data Analysis

The Test Plan shall provide information regarding the methods, software and instrumentation to be used for data analysis.

11.13 Test Schedule

The Test Plan shall provide information regarding the proposed test schedule.

13 Test Requirements

13.1 General

In general, the noise measurements shall be carried out in accordance with the requirements of **IMO Resolution A.468(XII) Code on Noise Levels On-board Ships**. However, where **the IMO** requirements differ from those in **this Guide**, **the more stringent requirement** shall take precedence.

13.3 Data Acquisition and Instruments

The integrating-averaging sound level meter shall meet the requirements for a Type 1 instrument specified in IEC 61672-1.

For each location sampled, a measurement shall be taken in accordance with the requirements in 3/13.5, “Test Conditions”.

13.5 Test Conditions

The test conditions required for the noise measurements shall be in accordance with the following Subparagraphs, based on ISO 2923.

13.5.1 Power Output

The propulsion machinery shall run at contractual service conditions or with at least 40% power on the thrusters.

13.5.2 Equipment Operation

All machinery essential for yacht operation shall operate under normal conditions throughout the measurement period. Heating, Ventilation and Air Conditioning (HVAC) systems are to be running as for normal seagoing conditions during the noise measurements.

13.5.3 Course and Water Depth

Noise measurements are to be taken with the yacht in a depth of water not less than five (5) times the draft of the yacht. For yachts that do not operate in water depths of five (5) times draft, measurements shall be taken under normal operating and transit conditions. The course of the yacht shall be as straight as possible and at a constant speed.

13.5.4 Rudder Conditions

The rudder action shall be minimized.

13.5.5 Sea Conditions

Measurements are to be taken under conditions of a Sea State 3 or less, as defined by the World Meteorological Organization (WMO) (1995) *Sea State Code*.

13.5.6 Loading Conditions

The loading condition of the yacht shall be as close as possible to normal operating conditions. If this is not practicable, the loading condition shall be recorded in the Noise Test Report.

13.5.7 Test Interference

During the noise measurements, noise arising from every kind of unnecessary human activity shall be avoided. For this reason, only the personnel needed for the normal operation of the equipment in the space and those carrying out the measurements shall be present in the space being tested. Owners and their guests shall not be present during the noise measurements.

13.7 Measurement Locations

13.7.1 Selection of Spaces where Measurements are to be Conducted

Noise measurements shall be taken in all Owner/guest spaces.

13.7.2 Walkthrough Verification Inspection Locations

All passenger spaces shall be subject to a walkthrough inspection by the ABS Surveyor. The number and locations of the walkthrough inspections will be determined by the ABS Surveyor. The purpose of the walkthrough verification is to subjectively assess the noise qualities. At the discretion of the ABS Surveyor, additional measurements may be required.

13.7.3 Measurement Positions

The measurement positions described below are taken or adapted from ISO 2923 and IMO Resolution A.468(XII).

Measure at positions where Owners and their guests will be seated or standing. The microphone shall be at a height of approximately 1200 mm (47 in.) from the deck to represent seated persons and approximately 1600 mm (63 in.) from the deck to represent standing persons, as appropriate for the measurement position. In cabins, measure in the middle of the space.

For all measurements, the microphone shall not be closer than 500 mm (20 in.) from the boundary surface (e.g., bulkhead) of a space. The measurement time shall be at least fifteen (15) seconds and shall be long enough to enable the measurement of the equivalent continuous A-weighted sound pressure level for any specified time interval within the stated limits of overall measurement uncertainty.

13.9 Measurement Procedures and Recorded Results

13.9.1 Persons Present During Measurements

When **Testing** Specialist personnel are conducting noise level measurements in any space, only crew members necessary for the operation of that space are to be present. Owners and their guests shall not be present during the noise measurement.

13.9.2 Sampling Duration

Equivalent continuous A-weighted sound pressure levels (L_{Aeq}) shall be reported for each measurement location. The L_{Aeq} sampling duration shall be sufficient to achieve a stable reading. Sampling time shall be fifteen (15) seconds or longer.

13.9.3 Cyclic Noise

If the noise within a space is cyclic, the L_{Aeq} sampling duration shall be sufficient to capture an integer number of complete cycles. If a long-duration sample is judged impractical, an L_{Aeq} value shall be determined and reported for the high-noise portion of the cycle.

13.9.4 Intermittent Noise

If the noise within a space is present intermittently, an L_{Aeq} value shall be determined and reported for a period of high-level noise.

13.9.5 HVAC Related Noise

If HVAC system-related noise is a large contributor to the noise level in the space, a noise measurement shall be made approximately 300 mm (12 in.) from the vent, measured in line with the direction of airflow, and recorded in the Noise Test Report.

15 Test Report

As stated in Subsection 1/11, "**Process for Obtaining a Notation**", a Test Report shall be submitted to the ABS Surveyor to determine whether the noise levels **are at or below** the limits and whether this part of the notation requirement has been met. The details listed in the following paragraphs shall be provided in the Noise Test Report.

15.1 Test Details

The following details shall be provided for each period of testing:

- i) Loading (mean draft and trim)
- ii) Number of persons present during testing
- iii) **Bridge confirmation that operating conditions complied with contractual service conditions**
- iv) **Yacht** course, speed, and latitude and longitude coordinates
- v) Weather conditions and meteorological data **at the onset of every data collection period and at intervals of every four (4) hours (if needed) during any data collection period. Weather conditions shall also be reported at the end of each data collection period.**
- vi) Average water depth under keel
- vii) Sea state
- viii) **Yacht** equipment operated during the test
- ix) Any indications of abnormal activity during the test that might skew results.

15.3 Measurement Positions

Actual measurement positions shall be indicated on appropriate drawings.

15.5 Measurement Equipment Details

Details of measuring and analysis equipment (e.g., manufacturer, type and serial number, accuracy, sampling frequency and resolution) shall be provided.

Copies shall be provided of the relevant instrumentation reference calibration certificates, together with the results of field setup and calibration checks before and after the field tests.

15.7 Results

The following results, per measurement location and sample period, as appropriate for notation, shall be provided in table format:

- i)* Measurement position (i.e., space and location within space)
- ii)* Number of persons present in space at time of measurement
- iii)* Measurement period
- iv)* Time at start and finish of measurement
- v)* Equivalent continuous A-weighted sound pressure level (L_{Aeq})
- vi)* Note any open doors and windows
- vii)* Note equipment operating in proximity to the measurement position.
- viii)* Note observed direct sources of noise (such as ventilation devices) and any measurement data collected.

For all the remaining spaces that were checked through walkthrough verification inspection and spot check measurements, the following information shall be provided:

- i)* Name and number of space
- ii)* Walkthrough inspection observations
- iii)* Measurement results, if necessary

15.9 Deviations

All deviations from the approved Test Plan shall be reported.

15.11 Surveyor Witnessing Documentation

The equipment calibration and data collection process of the noise level tests shall be witnessed by an ABS Surveyor. The ABS Surveyor shall provide documentation stating whether all steps of the noise level testing were completed to **their** satisfaction. A copy of the witnessing document shall be given to the person conducting the testing, for insertion into the final Noise Test Report. The original shall be retained for ABS' files.

17 Results

The Noise Test Report and test results shall be reviewed by the ABS Surveyor against the noise criteria for notation confirmation.

APPENDIX 1 References

1 General References

- 1 American Bureau of Shipping. *Guide for Building and Classing Yachts*. Houston, TX.
- 2 American Bureau of Shipping. *Guide for Crew Habitability on Ships*. Houston, TX.
- 3 American Bureau of Shipping. *Rules for Building and Classing High-Speed Craft*. Houston, TX.
- 4 American Bureau of Shipping. *Rules for Building and Classing Steel Vessels*. Houston, TX.
- 5 American Bureau of Shipping. *Rules for Building and Classing Steel Vessels Under 90 Meters (295 Feet) in Length*. Houston, TX.

2 Whole-body Vibration References

- 1 Griffin M. J. (1990). *Handbook of Human Vibration*. London: Academic Press.
- 2 British Standards Institution. (1987). *Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock (BS 6841: 1987)*. London.
- 3 International Organization for Standardization. (2000). *Mechanical Vibration and Shock – Guidelines for the Measurement, Reporting and Evaluation of Vibration with Regard to Habitability on Passenger and Merchant Ships. (ISO 6954:2000)*. Geneva.
- 4 International Organization for Standardization. (2003). *Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration – Part 2, Vibration in Buildings. (ISO 2631-2:2003)*. Geneva.
- 5 International Organization for Standardization. (1996). *Acoustics – Measurement of noise shipboard vessels (ISO 2923: 1996)*. Geneva.
- 6 International Organization for Standardization. (2008) *Mechanical Vibration on Ships – Part 2: Measurement of Structural Vibration (ISO 20283-2:2008)*. Geneva.
- 7 International Organization for Standardization. (1998). *Mechanical mounting of accelerometers for measuring mechanical vibration and shock (ISO 5348: 1998 (E))*. Geneva.
- 8 International Organization for Standardization. (2005). *Human response to vibration – Measuring instrumentation (ISO 8041: 2005)*. Geneva.
- 9 World Meteorological Organization. (1995). *International Codes Vol I.1 Part A Alphanumeric Codes*. Boston, MA: American Meteorological Society.

3 Noise References

- 1 International Electrotechnical Commission. (2004). *Electroacoustics – Sound Level Meters – Part 1: Specifications (International Standards IEC 61672-1)* Geneva: IEC Central Office.
- 2 International Electrotechnical Commission. (2000). *Integrating-averaging sound level meters (International Standard IEC 60804(2000-10))*. Geneva: IEC Central Office.
- 3 International Maritime Organization. (1981). *Code on noise levels on board ships (IMO Resolution A.468(XII))*. London.
- 4 International Organization for Standardization. (1996). *Acoustics – Measurement of noise on-board vessels (ISO 2923: 1996)*. Geneva.
- 5 Kryter, K.D. (1994). *The handbook of hearing and the effects of noise: Physiology, psychology and public health*. San Diego: Academic Press.
- 6 World Meteorological Organization (1995). *International Codes Vol I.1 Part A Alphanumeric Codes*. Boston, MA: American Meteorological Society



APPENDIX 2 Acronyms and Abbreviations

ABS	American Bureau of Shipping
a_w	Multi-axis acceleration value
a_{xw}	The weighted root mean square acceleration values measured along the x-axis
a_{yw}	The weighted root mean square acceleration values measured along the y-axis
a_{zw}	The weighted root mean square acceleration values measured along the z-axis
BS	British Standard
COMF(Y)	Comfort notation for yachts
COMF+(Y)	Comfort Plus notation for yachts
dB(A)	Decibels measured using the A weighted scale
Hz	Hertz
IEC	International Electrotechnical Commission
ILO	International Labor Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
L_{Aeq}	Equivalent continuous A weighted sound pressure level
m^2	Square meter
m/s	Meters-per-second
m/s^2	Meters-per-second squared
Max	Maximum
MCR	Maximum Continuous Rating
Min	Minimum
$MSDV_z$	Motion Sickness Dose Value
RMS	Root-mean square
rpm	Revolutions-per-minute
SOLAS	Safety Of Life At Sea
USA	United States of America
W_m	Frequency weighting used to evaluate x, y, and z-axis vibration with respect to comfort
WMO	World Meteorological Organization



APPENDIX 3 Associated Documentation

Titles listed under the heading of “Associated Documentation” throughout this text can be obtained from the following sources:

ANSI/ASHRAE	www.ansi.org
IEC	www.iec.org
IESNA	www.iesna.org
ILO	www.ilo.org
IMO	www.imo.org
ISO	www.iso.org
NEBB	www.NEBB.org