



GUIDE FOR

PASSENGER COMFORT ON SHIPS

DECEMBER 2001

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Foreword

One of the fastest growing sectors of the marine industry is passenger vessels. Such vessels may be purely recreational in nature (cruise vessels) or others may fulfill a transportation need (passenger ferries and high speed craft). As more vessels become available and more people choose to commute, travel or vacation on board vessels, consumers will become quite selective about how they wish to spend their time and money. One of their primary concerns will be comfort.

Passengers will determine their acceptance of a vessel based on comfort. This means that passengers will make judgments based on their experience with regards to a vessel's layout and furnishings as well as its ambient environment. Thus, the quality of the accommodations where a vessel's passengers dine, sleep, congregate and recreate will influence their perception of comfort and overall sense of well-being. The levels of vibration, noise, temperatures and lighting that passengers are exposed to will have an effect on these judgments.

Until now, the vessel owner or operator could not identify one source or standard with comprehensive criteria and assessment methodologies with regards to passenger comfort. ABS has produced the *Guide for Passenger Comfort on Ships* to meet this need. ABS has established objective assessment criteria and measurement methodologies for comfort based on current research and standards relating to human psychological and physiological responses. This Guide provides comfort evaluation criteria for both passenger accommodations and the vessel's ambient environment.

This Guide provides the assessment criteria and describes the measurement methodology for obtaining a Comfort notation. It is intended for use by vessel owners or companies requesting the optional notations of Comfort (**COMF**) or Comfort Plus (**COMF+**). For the Comfort (**COMF**) notation, this Guide focuses on five (5) categories of comfort criteria that may be controlled, measured and assessed in passenger spaces on vessels: accommodations design, whole-body vibration, noise, indoor climate and lighting. For the Comfort Plus (**COMF+**) notation, this Guide provides additional whole-body vibration evaluation criteria aimed at the assessment of passenger comfort and potential motion sickness. To receive the Comfort Plus (**COMF+**) notation, the vessel must also have met all comfort level criteria.

The ABS *Guide for Passenger Comfort on Ships* focuses on evaluation criteria and measurement methodologies specific to receiving the optional ABS Comfort notation. In addition, a separate Guide, *ABS Guide for Crew Habitability on Ships*, has been issued for the assessment of crew habitability on vessels.

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SECTION 1 General

1 Introduction

The American Bureau of Shipping recognizes the positive impact that appropriate comfort requirements and design practices have on the comfort, safety and overall well-being of passengers. The *ABS Guide for Passenger Comfort on Ships* has been developed with the objective of providing criteria that will assist in improving the comfort of the passengers on board passenger vessels. These comfort criteria have been chosen to provide a means to increase the comfort, enjoyment and satisfaction of passengers.

2 Application

This Guide is applicable to new and existing passenger vessels carrying more than twelve (12) passengers for which an optional Comfort (**COMF**) or a Comfort Plus (**COMF+**) notation has been requested. The comfort criteria are a measure of the acceptability of passenger accommodations and their associated ambient environmental criteria. These criteria apply to passenger vessels used for such purposes as commuting, traveling, vacationing and recreating. Such vessels would include cruise vessels and ferries, both conventional and high speed craft.

A separate document, the *ABS Guide for Crew Habitability on Ships*, has been developed providing criteria aimed at improving the quality of crewmember performance and comfort.

3 Scope

The Guide focuses on five (5) comfort aspects of vessel design and layout that can be controlled, measured and assessed. These five (5) aspects are broken into two (2) major types in this Guide: accommodations and ambient environment.

Accommodations criteria relate to dimensional or physical aspects of spaces and open deck areas where passengers dine, sleep, congregate, recreate and conduct their daily activities.

The ambient environmental aspects of comfort pertain to the environment that the passengers are exposed to on board vessels. Specifically, this Guide provides criteria, limits and measurement methodologies for the following:

- i) Whole-body Vibration
- ii) Noise
- iii) Indoor Climate
- iv) Lighting.

The criteria provided in this Guide are based on currently available research data and standards. This Guide does not specifically address passenger safety since safety is comprehensively covered by the International Maritime Organization (IMO), Flag Administrations, Class Society Rules and Port States. However, where appropriate, compliance with this Guide may warrant an enhancement in some safety systems on board the vessel. The Guide is largely aimed at providing a basic level of passenger comfort.

The various criteria, test conditions, measurement locations, test methods and instruments required by this Guide may differ from the more rigorous and scientific methods reported and practiced elsewhere by the scientific community. They were, however, selected with the aim of providing a practical Guide that could be applied internationally by ABS and vessel owners/shipbuilders with reliability and acceptable validity.

While producing this Guide, ABS has taken steps to minimize the associated costs of acquiring this notation by economizing on measurements, test personnel (External Specialists) and test equipment.

4 Terminology

Accommodations: Vessel areas where the primary purpose is to rest or recreate. Passenger accommodations spaces include cabins, staterooms, dining areas, recreation rooms, medical facilities and other public spaces. For the purposes of this Guide, accommodations are primarily restricted to the spaces passengers would normally use on board vessels. However, several crew member work spaces (i.e., galley and scullery) have been included, since the design of such areas could have an impact on passenger health.

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

Associated Documentation: Documents referenced in this Guide that are needed to provide measuring techniques and guidance.

Cargo Vessel: A cargo vessel is any vessel not considered a passenger vessel. Such are involved in commercial trade.

Comfort: The acceptability of the conditions of a vessel as determined by its vibration, noise, thermal, indoor climate and lighting qualities as well as its physical and spatial characteristics, according to prevailing research and standards for human comfort.

Crew Member: Any person on board a vessel, including the Master, who is not a passenger.

External Specialists: Specialized test personnel who must meet the requirements of Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing."

High Speed Craft: Vessels that meet the requirements of the ABS *Guide for Building and Classing High Speed Craft*.

Occupied Passenger Spaces: For the purposes of this Guide, any space where passengers may be present for twenty (20) minutes or longer at one time for transit, rest or leisure purposes.

Passenger: A passenger is every person other than the Master and the members of the crew or other persons employed or engaged in any capacity on board a vessel for the business of that vessel.

Passenger Vessel: A vessel whose primary purpose is to carry more than twelve (12) passengers for transportation or recreational purposes. Such vessels include cruise vessels and ferries, both conventional and high speed craft.

Public Spaces: Those portions of the passenger spaces which are used for halls, dining, lounges, theaters and similar permanently enclosed spaces.

Shall: Expresses a provision that is mandatory.

Should: Expresses a provision that is a recommended or preferred guideline.

Test Plan: Document containing the requisite information regarding vessel 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.

5 Associated Documentation

Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing", defines the process for External Specialist approval and certification with regard to testing and evaluating ambient environmental conditions on board vessels.

6 Notation

At the vessel owner or shipyard's request, a vessel complying with the minimum criteria for passenger accommodations and the ambient environment (i.e., vibration, noise, indoor climate and lighting) provided in this Guide, shall be assigned a notation of **COMF**. A vessel complying with the more stringent criteria with respect to whole-body vibration (including motion sickness), shall be distinguished in the *Record* by the notation **COMF+**. A summary of the differences between each of the notations is given below.

Notation	Accommodations	Ambient Environment			
		Vibration	Noise	Indoor Climate	Lighting
COMF	Must meet criteria for accommodations	Must meet comfort-based vibration level criteria	Must meet criteria for noise	Must meet criteria for indoor climate	Must meet criteria for lighting
COMF+	No difference between COMF and COMF+	Must meet comfort-based vibration level criteria as well as motion sickness criteria	No difference between COMF and COMF+	No difference between COMF and COMF+	No difference between COMF and COMF+

7 Data and Plans to be Submitted

7.1 General

The following General Arrangement type drawings of the vessel shall be submitted:

- i) Inboard profile detailing the location of the main vertical zone boundaries, the location of the main watertight bulkheads as well as the various deck levels.
- ii) Plan view of each deck annotating the various spaces on each deck.

7.2 Accommodations

At a minimum, scaled arrangement drawings of the various passenger accommodations spaces (elevation and plan views) and the vessel's passenger accommodations specifications shall be submitted to ABS Engineering. Details of the passenger accommodations data requirements are provided in 2/6, "Accommodations Documentation".

7.3 Ambient Environment

The following items are to be submitted for each ambient environmental aspect.

7.3.1 Test Plans

Test plans shall serve as the principal means for verifying the measurements for the ambient environmental aspects of comfort. Separate test plans are required for vibration, noise, indoor climate and lighting. Specific test plan details for the various ambient environmental criteria are outlined in later sections of this Guide as follows:

<i>Environmental Aspect</i>	<i>Test Plan Details</i>
Whole-body Vibration	3/6
Noise	4/6
Indoor Climate	5/6
Lighting	6/6

The test plans require approval by ABS Engineering before any measurements are made. ABS Engineering shall notify the vessel owner or shipyard whether the test plans have been approved or require alteration. An ABS approved copy of the Test Plan shall become part of the vessel’s official documentation.

7.3.2 Test Reports

Upon completion of the ambient environmental testing, test reports shall be submitted to the ABS Surveyor. In addition, a copy of the test reports shall become part of the vessel’s official documentation. These reports contain ambient environmental information such as test results, testing details, measurement equipment details, etc. The specific report contents for the various ambient environmental criteria are outlined in later sections of this Guide as follows:

<i>Environmental Aspect</i>	<i>Test Report Details</i>
Whole-body Vibration	3/8
Noise	4/8
Indoor Climate	5/8
Lighting	6/8

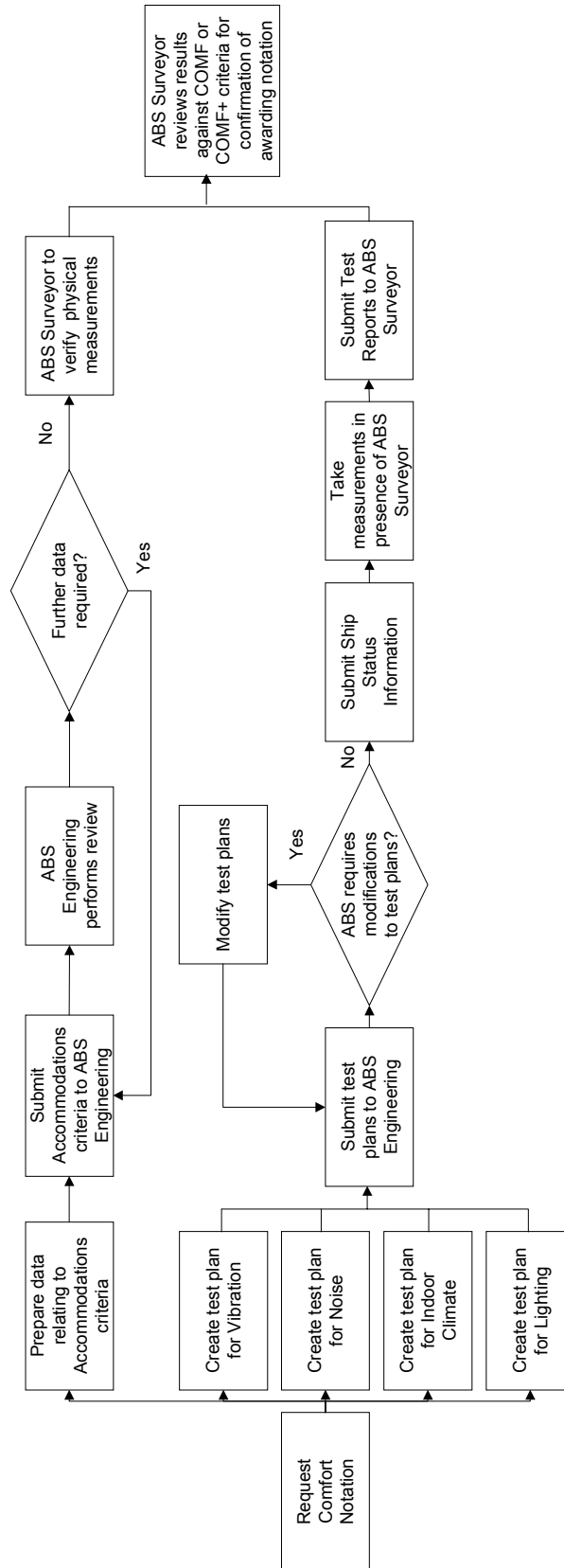
8 Process for Obtaining a Notation

Prior to scheduling passenger accommodations verification or ambient environmental testing activities, the vessel owner or shipyard shall certify the operational status of the vessel as being fully operational and/or inclusive of all equipment and furnishings. If the vessel is not fully operational then a complete listing of deficient areas, components, equipment, etc. shall be submitted to an ABS Technical Office for review.

The ABS Technical Office shall then make a determination and notify the vessel owner or shipyard as to whether passenger accommodations verification activities or ambient environmental testing can commence.

Section 1, Figure 1, "Comfort Notation Process for Initial Requirements", charts the process for obtaining a **COMF** or **COMF+** notation. The following paragraphs briefly describe the notation process.

FIGURE 1
Comfort Notation Process for Initial Requirements



8.1 Accommodations

Arrangement drawings, plans and vessel design specifications for passenger accommodations spaces shall be prepared and submitted to ABS Engineering for review. For new construction, the drawings shall be provided to ABS Engineering during the detailed design phase. For existing vessels, the arrangement drawings and plans, reflecting the current passenger accommodations configurations shall be provided to and approved by ABS Engineering in advance of ABS Surveyor verifications.

Follow-up physical verification measurements of accommodations criteria shall be performed by an ABS Surveyor. Verification measurement sites shall be selected by the ABS Surveyor.

The results of the ABS Engineering review and actual ABS Surveyor verification shall be reviewed by the ABS Surveyor during the notation confirmation process.

8.2 Ambient Environment

Ambient environmental test plans for vibration, noise, indoor climate and lighting shall be prepared and submitted to ABS Engineering.

Information submitted to ABS Engineering shall serve as a primary vehicle for verifying the measurement locations and measurement process, as well as specifying the external specialist who will perform the ambient environmental testing.

Testing, inspections and data collection shall be performed by External Specialists and witnessed by an ABS Surveyor. Test reports for ambient environmental testing shall be prepared by External Specialists and submitted to the ABS Surveyor for review.

8.3 Results

The ABS Engineering passenger accommodations assessment, ABS Surveyor verification measurements, ambient environmental test reports and test results shall be reviewed by the ABS Surveyor for determination of notation confirmation.

9 Initial Requirements

The initial process for obtaining a Comfort notation (either **COMF** or **COMF+**) shall be comprised of ABS Engineering reviews, ABS Surveyor verifications and ambient environmental testing. Testing shall be in accordance with the submitted test plans reviewed and approved by ABS Engineering in advance of the testing. Testing shall be witnessed by an ABS Surveyor. If the criteria specified in this Guide have been met then the appropriate notation shall be confirmed.

10 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.

10.1 Annual Surveys

In order to maintain the **COMF** or **COMF+** 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 to identify issues that could affect the Comfort notation:

- i) Vessel's log since previous Initial, Annual or Special Periodical Survey
- ii) Chief Engineer's log since previous Initial, Annual or Special Periodical Survey

- iii)* Collision and grounding reports since previous Initial, Annual or Special Periodical Survey
- iv)* Fire, repair and damage reports since previous Initial, Annual or Special Periodical Survey
- v)* A list of all alterations to the vessel since previous Initial, Annual or Special Periodical Survey
- vi)* Verification that equipment and facilities continue to be fit for purpose and are operating in accordance with Accommodations Criteria stated within this Guide
- vii)* Verification that geographical area of vessel operations has not changed since previous Initial, Annual or Special Periodical Survey.

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 Comfort notation. As a result, the vessel may be subject to the review, ambient environmental testing and inspection requirements of this Guide.

10.2 Special Periodical Surveys

In order to maintain the **COMF** or **COMF+** 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.

10.2.1 Special Periodical Survey Number 1 (Age ≤ 5 Years)

The Survey shall be comprised of ABS Engineering reviews, ABS Surveyor verifications and ambient environmental testing. The Survey will cover all five (5) Comfort aspects.

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

- i)* Collision and grounding reports since previous Annual Survey
- ii)* Fire, repair and damage reports since previous Annual Survey
- iii)* A list of all alterations to the vessel since previous Annual Survey
- iv)* Notice in any change in geographical area of vessel operations since Initial Survey
- v)* Any drawings/arrangements of passenger accommodations spaces, crew spaces, HVAC, electrical, etc. affected by alterations
- vi)* Copy of approved Initial Test Plans and Test Reports
- vii)* Test Plans and Test Reports resulting from Annual Surveys
- viii)* 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 accommodations areas 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 each ambient environmental aspect of Comfort shall be submitted in accordance with the criteria stated below. The approved Initial Test Plans can be used as a basis for creating the Special Periodical Survey Test Plans.

For creation of the Special Periodical Survey Test Plans, Subsection 6, "Test Plan" and Subsection 7, "Test Requirements" of this Guide specify the requirements for each ambient environmental aspect (i.e., 3/6, 3/7, 4/6, 4/7, etc.). For specifying measurement locations for the Special Periodical Survey Test Plans, the following changes to 7.4.1, "Selection of Spaces where Measurements are to be Conducted", of each ambient environmental aspect of Comfort shall be followed:

- i)* Measurements shall be taken in all areas affected by vessel alterations. Measurements would be limited to the ambient environmental aspect affected by the alteration. For example, structural changes would require both vibration and noise measurements. Structural changes would not necessarily require indoor climate or lighting measurements. Changes to luminaires would require lighting measurements but not vibration, noise or indoor climate measurements.
- ii)* Measurements shall be taken in all worse case or problem area locations. Worse case or problem area locations for a particular ambient environmental aspect shall be selected based on the requirements set forth in 7.4.1, "Selection of Spaces where Measurements are to be Conducted", of the appropriate section of this Guide. For example, worse case for vibration is described in 3/7.4.1i).
- iii)* For whole-body vibration, additional measurements shall be taken in passenger cabins and staterooms. For vessels with fewer than 100 passenger cabins and staterooms, five (5) percent of these cabins and staterooms shall be measured.

For vessels with 100 or more passenger cabins and staterooms, apply the following:

- In the forward one-third ($1/3$) of the vessel, three (3) percent or 1 in 33 of cabins and staterooms shall be measured
- In the midsection (center $1/3$) of the vessel, two (2) percent or 1 in 50 of cabins and staterooms shall be measured
- In the aft one-third ($1/3$) of the vessel, five (5) percent 1 in 20 of the cabins and staterooms shall be measured.

Within each one-third ($1/3$) section of the vessel, measurement locations shall be distributed throughout the length of each section and on each deck.

Regardless of the number of cabins and staterooms on a passenger vessel, attention must be given to selecting a variety of locations port, starboard, fore, amidships and aft. The worst case locations can be considered as part of the representative sample for passenger cabins and staterooms, if applicable.

- iv)* For whole-body vibration, additional measurements shall be taken in public spaces. Where the number of public spaces (e.g., public seating areas on a ferry) on board a vessel are few (less than 10), each public space shall be selected for measurement. The number of measurements within a space shall be selected according to Section 3, Table 2, "Distribution of Transducer Positions within Spaces (see 3/7.4.3, "Transducer Measurement Positions)". The worst case locations are to be considered part of the representative sample, if applicable.

Where there are a large number (10 or more) of public spaces and/or those spaces extend or are situated over a large portion of a deck on a vessel, whole-body vibration measurement locations shall be distributed in accordance with the following:

- Select the public spaces most forward on the deck or portion of the deck. Ensure that measurement locations are selected as close to the vessel centerline as is practicable. Measurements shall also be taken in the areas corresponding to most port and starboard locations within the forward spaces.
- Select the public spaces corresponding to the mid-section (center $\frac{1}{3}$) of the deck. Ensure that measurements are taken as close to the vessel centerline as is practicable. In addition, measurements shall be taken in the spaces in the areas corresponding to most port and starboard locations within the mid-section.
- Select the public spaces most aft on the deck or portion of the deck. Ensure that measurement locations are selected as close to the vessel centerline as is practicable. Measurements shall also be taken in the areas corresponding to most port and starboard locations within the aft spaces.

The worst case locations can be considered part of the public spaces representative sample, if applicable.

- v) For the **COMF+** notation, vibration measurement locations relating to motion sickness shall be selected in accordance with the applicable criteria in 3/7.4.1, "Selection of Spaces where Measurements are to be Conducted".
- vi) For noise, indoor climate and lighting, where a single instance of a particular passenger space exists, a representative sample of at least ten (10) percent of these spaces shall be selected for measurement. The worst case locations can be considered part of the single instance representative sample, if applicable.
- vii) For noise and indoor climate, where multiple instances of a particular type of passenger space exist, a representative sample of at least ten (10) percent of these spaces shall be selected for measurement. The worst case locations can be considered part of the multiple instance representative sample, if applicable.
- viii) For lighting, select a sample of at least ten (10) percent of spaces where passengers are involved in recreational activities (e.g., dining rooms, lounges, theater, gymnasium, etc.) for measurement.

Where a number of cabins and sanitary spaces are identical in configuration in terms of lighting systems, surface treatments, geometry, furnishings and equipment layout, only two (2) of the spaces shall be selected to determine whether the lighting requirements are met. A sample of at least fifteen (15) percent of the remaining spaces shall be visually inspected.

The worst case locations can be considered part of these lighting representative samples, if applicable.

For all ambient environmental conditions, visual inspections shall be conducted in accordance with 7.4.2 of the appropriate section of this Guide.

10.2.2 Special Periodical Survey Number 2 (5 Years < Age ≤ 10 Years)

The Survey will be comprised of ABS Engineering reviews, ABS Surveyor verifications and ambient environmental testing. The Survey will cover all five (5) Comfort areas and will follow the same procedures and requirements as the Initial Survey except for the drawing and information submittals stated here.

The following is to be submitted to an ABS Technical Office three (3) months prior to carrying out the ambient environmental testing:

- i) Collision and grounding reports since previous Annual Survey
- ii) Fire, repair and damage reports since previous Annual Survey

- iii)* A list of all alterations to the vessel since previous Annual Survey
- iv)* Notice of any change in geographical area of vessel operations since previous Initial, Annual or Special Periodical Survey
- v)* Any drawings/arrangements of passenger accommodations spaces, crew spaces, HVAC, electrical, etc. affected by alterations
- vi)* Copies of approved Initial Test Plans and Reports
- vii)* Test Plans and Test Reports resulting from Annual Surveys
- viii)* Previous Special Periodical Survey Test Plans and reports
- ix)* Proposed Special Periodical Survey Test Plans for current survey.

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

A Special Periodical Survey Test Plan for each ambient environmental aspect of Comfort shall be submitted in accordance with Subsection 6, "Test Plans" and Subsection 7, "Test Requirements", of the appropriate ambient environment section. The Test Plan shall incorporate the same procedures and requirements as the Initial Survey with the following addition. Measurement locations will be specified for spaces where vessel alterations have occurred or where such alterations may affect the ambient environmental aspects associated with a space. Regardless, the approved Initial Test Plans can be used as a basis for creating the new Special Periodical Survey Test Plans.

10.2.3 Special Periodical Survey Number 3 (10 Years < Age ≤ 15 Years)

The Survey is to follow the same procedures and requirements as described in 1/10.2.1, "Special Periodical Survey Number 1 (Age ≤ 5 Years)".

10.2.4 Subsequent Special Periodical Surveys (Age > 15 Years)

The Survey is to follow the same procedures and requirements as described in 1/10.2.2, "Special Periodical Survey Number 2 (5 Years < Age ≤ 10 Years)".

10.3 Requirements for Vessel Alterations

No alterations which affect or may affect the Comfort notation, including alterations to the structure, machinery, electrical systems, piping, furnishings or lighting systems, are to be made to the vessel unless plans of the proposed alterations are submitted and approved by an ABS Technical Office before the work of alteration is commenced. If the ABS Technical Office determines that the alteration will affect the Comfort notation, the altered vessel shall be subject to the review, verification and ambient environmental testing requirements of this Guide.

10.4 Requirements for Geographical Area of Vessel Operations

When it is intended to change the geographical area of vessel operations, which may affect the Comfort notation, the details of such a change are to be submitted to the ABS Technical Office for review. If the ABS Technical Office determines that the change will affect the Comfort notation, the vessel shall be subject to the review and testing requirements in Section 3, "Whole-body Vibration", Section 4, "Noise", and/or Section 5, "Indoor Climate" of this Guide.

11 Alternatives

11.1 General

ABS will consider alternative arrangements, criteria and procedures, which can be shown to meet the performance standards contained in 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.

11.2 National Regulations

ABS will consider for its acceptance alternative arrangements and details, which can be shown to comply with standards recognized in the country (flag state) in which the vessel is registered or built, provided they are not less effective.

11.3 Departures from Criteria

The criteria contained in this Guide envision application to vessels that are engaged in the usual trades and services expected of such vessels, 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 in Length*
- *ABS Guide for Building and Classing High Speed Craft*
- *ABS Guide for Building and Classing Passenger Vessels*
- *ABS Guide for Building and Classing Motor Pleasure Yachts*
- *ABS Guide for Building and Classing Aluminum Vessels*
- *ABS Rules for Building and Classing Steel Vessels for Service on Rivers and Intracoastal Waterways*
- *ABS Rule Requirements for Materials and Welding: Aluminum and Fiber Reinforced Plastics.*

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 design of the accommodations or ambient environmental (e.g. vibration, noise, indoor climate and/or lighting) test results contain departures from the stated criteria, these will be the subject of special consideration upon the receipt of details about the departure. Depending on the degree and consequences of the departure, the 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.

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SECTION 2 Accommodations

1 Background

One of the major concerns of passengers on board cruise vessels, ferries and high speed craft is comfort. One factor that will help determine a passenger's acceptance of a vessel is their perception of the quality and condition of the vessel's accommodations. For passengers to perceive their sailing experience as rewarding, the vessel's accommodations facilities must meet or exceed their expectations.

Accommodations spaces where the vessel's design can have a favorable impact on expectations include areas where passengers rest, recreate, relax and dine. Other accommodation considerations that will affect passenger expectations are the sanitary spaces as well as stair and walkway design.

All of these factors as a whole or in part, affect the passengers' perceptions about their experience on board the vessel and their willingness to use the vessel or the vessel's services on future occasions.

2 Scope

This Section and Appendix 3, "Accommodations Criteria", provide the assessment and measurement criteria for passenger accommodations on cruise vessels, ferries and high speed craft. The passenger stairs and walkways, cabins/staterooms, dining and recreation areas, as well as the medical facilities are to be evaluated using the criteria in Appendix 3.

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

3 Terminology

Accommodations: Vessel areas where the primary purpose is to rest or recreate. Passenger accommodations spaces include cabins, staterooms, dining areas, recreation rooms, medical facilities and other public spaces. For the purposes of this Guide, accommodations are primarily restricted to the spaces passengers would normally use on board vessels. However, several crew member work spaces (i.e., galley and scullery) have been included since the design of such areas could have an impact on passenger health.

4 Associated Documentation

Appendix 3, "Accommodations Criteria".

5 Criteria

The passenger accommodations criteria for the **COMF** and **COMF+** notations are identical. The criteria for the Comfort notation are provided in Appendix 3, "Accommodations Criteria".

The objective of the **COMF** and **COMF+** notations is to provide passengers with accommodations that will help meet their comfort expectations.

6 Accommodations Documentation

As stated in 1/7.2, "Accommodations", passenger accommodations documentation shall be prepared and submitted to ABS Engineering for review. Confirmatory verification measurements shall be performed by an ABS Surveyor. The following data shall be submitted to ABS Engineering:

6.1 Data Requirements

The submitted data shall serve as a means for validating and verifying that the vessel meets the passenger accommodations criteria specified in Appendix 3, "Accommodations Criteria".

6.1.1 New Construction

For new construction, scaled arrangement drawings of the passenger accommodations spaces (elevation and plan views), details of the accommodations outfitting and vessel's design specification in relation to the accommodations spaces shall be submitted to ABS Engineering. Drawings and specifications shall be provided during the detailed design phase.

6.1.2 Existing Vessels

For existing vessels, appropriate arrangement drawings and plans, reflecting the current passenger accommodations configurations shall be provided to ABS Engineering along with any current vessel accommodations design specifications.

7 Submittal Review and Verification

Arrangement drawings, plans and vessel specifications for the passenger accommodations shall be prepared and submitted for review by ABS Engineering. For new construction, the drawings shall be provided to ABS Engineering during the detailed design phase. For existing vessels, the arrangement drawings and plans, reflecting the current passenger accommodations configurations shall be provided to ABS Engineering, in advance of on-board ABS Surveyor verifications.

ABS Engineering shall review the submitted accommodations documentation. ABS Engineering shall report any deviation from criteria to the owner/shipyard for resolution and shall also identify any criteria which the ABS Surveyors must field verify.

The ABS Surveyor shall verify that the submitted drawings match the constructed vessel. ABS Survey shall also verify any criteria that are outstanding from the ABS Engineering review and document deviations from criteria.

8 Results

The results of the ABS Engineering review and actual ABS Surveyor verification shall be reviewed by the ABS Surveyor during the notation confirmation process.

SECTION 3 Whole-body Vibration

1 Background

Transport in vessels, whether conventional or high speed, can impose a series of low- and high-frequency mechanical vibrations as well as single-impulse shock loads on the human body.

Low-frequency vibrations (i.e., oscillations) are generally imposed by vessel motions, which are produced by the various sea states in conjunction with vessel speed. Oscillation may 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 because of vessel size, speed and wave conditions.

High-frequency vibration is often associated with high speed rotating machinery. The imposition of higher frequency vibrations induces corresponding motions and forces within the human body, creating discomfort and possibly resulting in degraded health (Griffin, 1990), *Handbook of Human Vibration*.

2 Scope

This Section provides the criteria and methods for assessing whole-body vibration relating to passenger comfort on board vessels. The criteria were selected to improve passenger comfort and to limit vibration interference with passenger activities.

Consideration of the external loads imposed is restricted to motions transmitted from surrounding structures to the entire human body through the feet of a standing person in the frequency range 0.1 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 motion 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 passengers will be exposed.

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

3 Terminology

Acceleration: A vector quantity that specifies the rate of change of velocity (i.e., meters-per-second squared, m/s^2).

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

Crest Factor: The ratio of the peak value to the root-mean-square (rms) value of the acceleration after it has been frequency weighted by the appropriate frequency weighting network.

$$\text{Crest Factor} = \frac{\text{weighted peak acceleration}}{\text{weighted rms acceleration}}$$

Frequency: The number of complete cycles of a periodic process occurring per unit time. Frequency is expressed in Hertz (Hz) which corresponds to one (1) cycle-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 the various human responses. The units of a frequency weighting should be those of the response divided by those of the vibration waveform, but it is often assumed that the weighting is non-dimensional.

The frequency weightings used to evaluate whole-body vibration in this Guide are as follows:

- i) W_b : Frequency weighting used to evaluate z-axis vibration when standing with respect to comfort
- ii) W_d : Frequency weighting used to evaluate x-axis and y-axis vibration when standing with respect to comfort
- iii) W_f : Frequency weighting used to evaluate z-axis motion with respect to motion sickness.

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 8041:1990/Amd.1:1999, 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.

Occupied Passenger Space: Any space where a passenger may be present for twenty (20) minutes or longer at one (1) time during normal, routine, daily activities.

Peak Value: The largest deviation of a signal from the arithmetic mean of that signal. The positive peak value is the maximum positive deviation; the negative peak value is the maximum negative deviation.

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

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.

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.

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.

4 Associated Documentation

The following documents provide details about test plan preparation, test measurement procedures and/or test reporting:

BS 6841: 1987, Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock.

ISO 8041: 1990/Amd.1:1999, Human response to vibration – Measuring instrumentation.

ISO 5348:1987, Mechanical mounting of accelerometers for measuring mechanical vibration and shock

World Meteorological Organization: 1995, Sea State Code.

Further guidance can be found in:

ISO 2923: 1996, Acoustics – Measurement of noise on board vessels.

ISO 4867: 1984, Code for the measurement and reporting of on board vibration data.

5 Criteria

The whole-body vibration criteria for the Comfort (**COMF** and **COMF+**) notations are provided in Section 3, Table 1, "Whole-body Vibration Levels". The severity of the vibration shall be indicated by the weighted root-mean-square (a_w) acceleration as defined in ISO 8041:1990/Amd.1:1999.

Vibration measurements shall only be taken in passenger accommodations and recreation spaces/areas occupied by passengers for twenty (20) minutes or longer at a time. Specific locations are referred to in 3/7.4, "Measurement Locations".

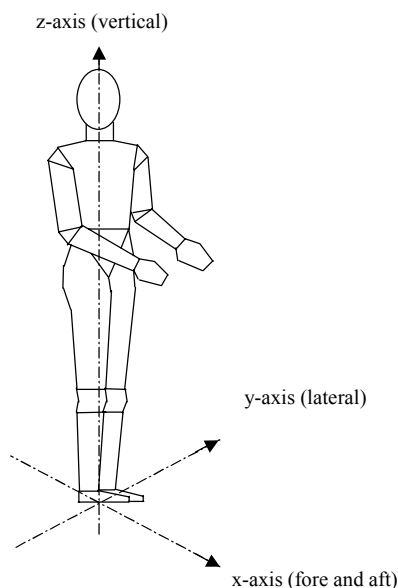
The maximum vibration levels in Section 3, Table 1, "Whole-body Vibration Levels", shall not be exceeded for the **COMF** notation. For the **COMF+** notation, in addition to the Maximum Root-Mean-Square Acceleration Level (a_w), the Motion Sickness Dose Value Level ($MSDV_z$) provided in Section 3, Table 1 shall not be exceeded. The levels for the **COMF+** notation are aimed at facilitating optimal passenger comfort and to restrict the incidence of motion sickness to ten (10) percent or less among passengers.

TABLE 1
Whole-body Vibration Levels

<i>Notation</i>	<i>Frequency Range</i>	<i>Acceleration measurement</i>	<i>Maximum level</i>
COMF	0.5 - 80 Hz	a_w	0.315 m/s ²
COMF+	0.1 - 0.5 Hz	$MSDV_z$	30 m/s ^{1.5}
	0.5 - 80 Hz	a_w	0.20 m/s ²

For the purpose of this Section, the notation applies to the vibration levels occurring on the deck supporting the human body in the three (3) translational (x-, y- and z-) axes as shown in Section 3, 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 level must be less than or equal to the maximum level expressed in Section 3, Table 1. The Motion Sickness Dose Value Level ($MSDV_z$) is computed in the z-axis only. 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 3, Table 1.

FIGURE 1
Measurement Axes



6 Test Plan

As stated in 1/7.3.1, "Test Plans", a Test Plan shall be developed to serve as the principal means for verifying the measurements to be performed to verify compliance with vibration criteria. The Test Plan shall include the following:

6.1 Documentation

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

6.2 Test Personnel

The Test Plan shall provide information on the External Specialists who shall be conducting the test and their approval and certification in accordance with Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing".

6.3 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. Information shall be submitted to ABS Engineering within the Test Plan with regards to the most probable sea state expected for a vessel based on the geographical area of vessel operation. The sea state will be stated in accordance with the World Meteorological Organization (WMO) (1995) *Sea State Code*. Further details about test conditions are given in 3/7.3, "Test Conditions".

6.4 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 3/7.4, "Measurement Locations".

6.5 Data Acquisition and Instruments

Information shall be provided 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 8041:1990/Amd.1:1999 and frequency range. More details on data acquisition and instruments are provided in 3/7.2, "Data Acquisition and Instruments".

6.6 Data Analysis

Information shall be provided regarding the methods, software and instrumentation to be used for data analysis.

6.7 Test Schedule

Information shall be provided regarding the proposed test schedule.

7 Test Requirements

7.1 General

Whole-body vibration measurements shall be in accordance with the procedures described in BS 6841. When the procedures described in this Guide deviate from any requirements or procedures mentioned in BS 6841, the requirements of this Guide take precedence.

The relationship between the various factors to be considered when taking whole-body vibration measurements and computing results is illustrated in Section 3, Figure 2, "Process for the Measurement and Analysis of Whole-body Vibration" A comprehensive resource with regards to human response to whole-body vibration is provided in Griffin's (1990) *Handbook of Human Vibration*.

7.2 Data Acquisition and Instruments

For the **COMF** notation, a single 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. In the case of high speed craft, each whole-body vibration measurement sample shall be at least 227 seconds in duration.

For the **COMF+** notation, at least three (3) series of data shall be collected, each consisting of four (4) motion sickness measurements made at locations specified in 3/7.4.1, "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 series and the first motion sickness measurement in the following series. 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.

The above measurement samples shall all be taken using the appropriate Type 1 instrumentation (ISO 8041:1990/Amd.1:1999), then frequency weighted and analyzed in accordance with BS 6841. It is desirable to employ equipment that records and stores acceleration time histories.

7.3 Test Conditions

The test conditions required for the whole-body vibration measurements shall be in accordance with the following subparagraphs, which are taken or adapted from ISO 4867 and ISO 2923. These conditions are consistent with those for noise measurements covered in 4/7.3, "Test Conditions".

7.3.1 Power Output

The propulsion machinery shall run at normal service speed and at no less than eighty (80) percent of the maximum continuous rating (MCR).

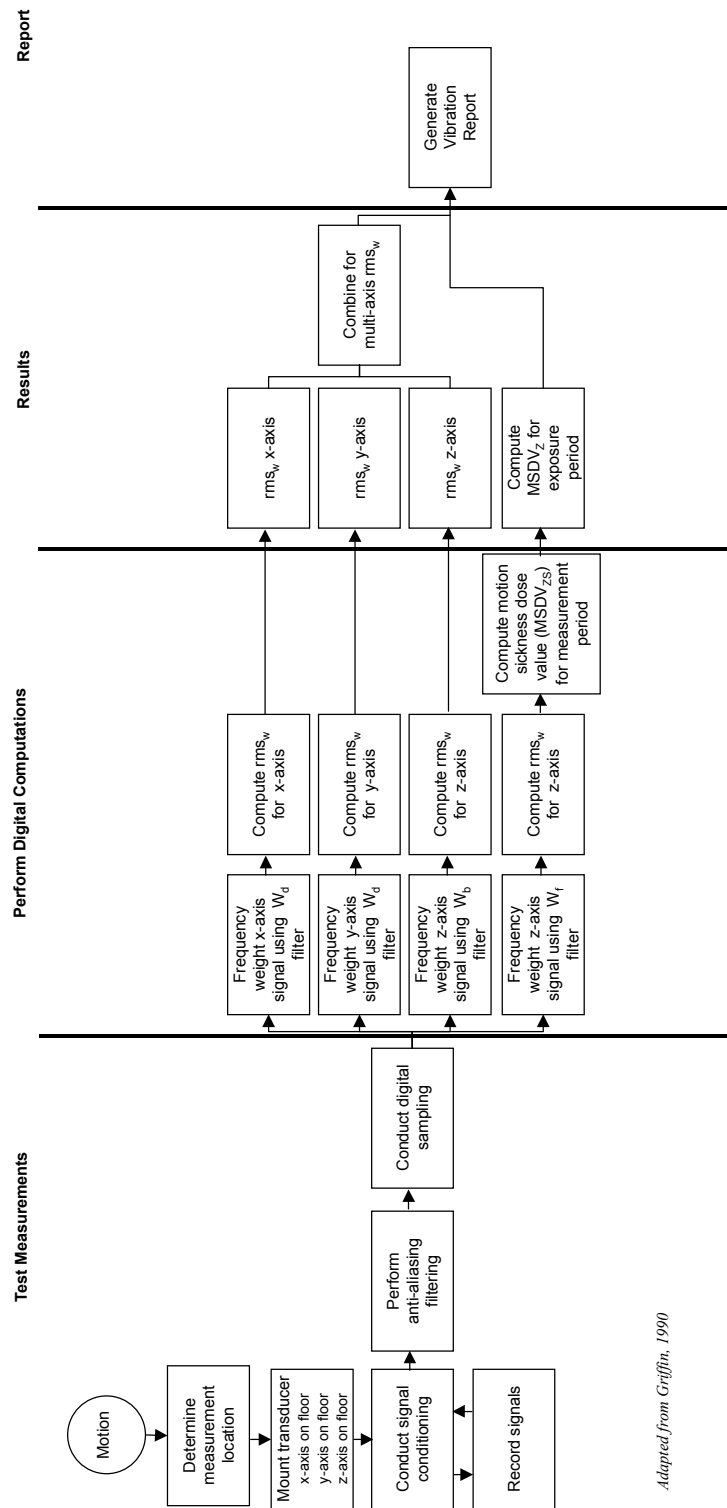
7.3.2 Equipment Operation

All other rotating machinery essential for vessel 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.

7.3.3 Course and Water Depth

Where possible, whole-body vibration measurements are to be taken with the vessel in a depth of water not less than five (5) times the draft of the vessel. For vessels that do not operate in water depths of five (5) times draft, measurements shall be taken under normal operating and steady state transit conditions. Measurements shall be taken under the predicted worst case condition with regards to heading (e.g., dead into the swell, 90° to the swell). The vessel shall maintain a single heading and a constant speed during the test.

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



Adapted from Griffin, 1990

7.3.4 Rudder Angle

The rudder angle shall be restricted to a range of $0^\circ \pm 2^\circ$. Minimal rudder action is desirable.

7.3.5 Sea Conditions

Based on the most probable sea state condition stated in the Vibration Test Plan (see 3/6.3, "Test Conditions"), the tests will be conducted at that value plus or minus one (1) sea state condition. For example, if Sea State 5 was predicted as most probable, then vibration measurements should be taken in sea conditions between Sea State 4 to 6 on the World Meteorological Organization (WMO) (1995) *Sea State Code*.

Test measurements may be taken under more severe sea state conditions, however, the resulting values must conform to the vibration limits presented in 3/5, "Criteria", to be acceptable.

The Comfort (**COMF** and **COMF+**) notations are awarded for a specific geographical area. If the vessel changes geographical operational area and the predicted most probable sea state changes, testing may need to be repeated (see 1/10.4, "Requirements for Geographical Area of Vessel Operations").

7.3.6 Loading Conditions

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

7.3.7 Test Interference

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

7.4 Measurement Locations

7.4.1 Selection of Spaces where Measurements are to be Conducted

The aim when selecting vibration measurement locations shall be to obtain a representative sample of data that reflects the actual conditions in passenger accommodations. For practical reasons, it is important to select the locations such that an appropriate amount of sample data can be collected during the testing phase. The following is provided to assist with the selection of whole-body vibration measurement locations on board passenger vessels seeking a **COMF** or **COMF+** notation.

For passenger cabins and staterooms, whole-body vibration measurement locations shall be selected in accordance with the following criteria:

- i) Select potential worst case locations based on their proximity to vibration emitting sources such as propulsion machinery and rotating machinery or where vibration is likely to be transmitted to passenger cabins/staterooms space via the vessel's structure. Measurements shall be taken in all identified worst case locations. Note that some decks (e.g., lower decks) or areas of decks (e.g., near air conditioning equipment) may have a larger number of measurement locations than others (e.g., higher decks) in order to obtain measurements for all worst case locations.
- ii) Select a representative sample of cabins and staterooms throughout the vessel. For vessels with fewer than one hundred (100) cabins and staterooms, ten (10) percent of cabins and staterooms shall be measured.

For vessels with one hundred (100) or more cabins and staterooms, apply the following:

- In the forward one-third ($1/3$) of the vessel, five (5) percent or 1 in 20 of cabins and staterooms shall be measured
- In the midsection (center $1/3$) of the vessel, four (4) percent or 1 in 25 of cabins and staterooms shall be measured
- In the aft one-third ($1/3$) of the vessel, seven (7) percent 1 in 15 of the cabins and staterooms shall be measured.

Within each one-third ($1/3$) section of the vessel, measurement locations shall be distributed throughout the length of each section and on each deck.

Regardless of the number of cabins and staterooms on a passenger vessel, attention must be given to selecting a variety of locations port, starboard, amidships, fore and aft. The worst case locations can be considered part as the representative sample for cabins and staterooms, if applicable.

For public spaces, whole-body vibration measurement locations shall be selected in accordance with the following:

- i)* Select potential worst case locations based on their proximity to vibration emitting sources such as propulsion machinery and rotating machinery or where vibration is likely to be transmitted to public or recreation spaces via the vessel's structure. Measurements shall be taken in all identified worst case locations. Note that some decks (e.g., lower decks) or areas of decks (e.g., near air conditioning equipment) may have a larger number of measurement locations than others in order to obtain measurements for all worst case locations.
- ii)* Where the number of public spaces on board a vessel are few (less than 10) (e.g., public seating areas on a ferry), each public space shall be selected for measurement. The number of measurements within a space shall be selected according to Section 3, Table 2, "Distribution of Transducer Positions within Spaces". The worst case locations are to be considered part of the representative sample, if applicable.
- iii)* Where there are a large number (10 or more) of public spaces and/or those spaces extend or are situated over a large portion of a deck on a vessel, measurement locations shall be distributed in accordance with the following:
 - Select the spaces most forward on the deck or portion of the deck. Ensure that measurement locations are selected as close to the vessel centerline as is practicable. Measurements shall also be taken in the areas corresponding to most port and starboard locations within the forward spaces.
 - Select the spaces corresponding to the mid-section (center $1/3$) of the deck. Ensure that measurements are taken close to the vessel centerline as is practicable. In addition, measurements shall be taken in the spaces in the areas that correspond to port and starboard.
 - Select the spaces most aft on the deck or portion of the deck. Ensure that measurement locations are selected as close to the vessel centerline as is practicable. Measurements shall also be taken in the areas corresponding to most port and starboard locations within the aft spaces.

The worst case locations can be considered part of the public spaces representative sample, if applicable.

For the **COMF+** 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 passenger spaces, irrespective of deck level.

7.4.2 Walkthrough Verification Inspection Locations

An additional sample of at least twenty-five (25) percent of all passenger spaces not covered by physical measurements shall be subject to a walkthrough verification inspection. The ABS Surveyor shall identify these spaces from those that were not selected for physical measurement under 3/7.4.1, "Selection of Spaces where Measurements are to be Conducted". The purpose of the walkthrough verification is to subjectively assess the whole-body vibration qualities of the selected spaces. The walkthrough verification inspection shall be conducted by the External Specialist during on-board testing. If any space is deemed to deviate from the whole-body vibration requirements provided in this Guide, it shall be verified by the External Specialist by conducting spot measurements and the results recorded in the Test Report.

7.4.3 Transducer Measurement Positions

Vibration transducers (accelerometers) shall be located and attached properly to the floor surface to indicate the vibration at the interface between the standing passenger and the source of vibration. The mounting of accelerometers shall comply with ISO 5348:1987. When the vibration enters the human body from a non-rigid or resilient material (e.g., floor covering) it shall be necessary to interpose the transducer between the foot of a standing person and the contact areas of the surface (i.e., the point where the foot comes into contact with the deck, with floor covering). This may be best achieved by securing the transducers within a suitably formed mount that does not greatly alter the pressure distribution on the surface of the resilient floor covering.

In cabins and staterooms, 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 fairly representative sample of the exposure conditions for the person occupying the cabin.)

For larger spaces (public rooms, dining rooms, recreation areas, 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 3, 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 40 m ² (431 ft ²)	1
Less than 80 m ² (861 ft ²)	2
Less than 200 m ² (2142 ft ²)	3
Greater than or equal to 200 m ² (2142 ft ²)	4

In cases where passengers may stand for 20 minutes or more (e.g., a ferry with limited service), transducers shall be located at standing positions normally occupied by passengers near the port side, near the centerline and near the starboard side. Transducers shall be evenly distributed fore and aft. Seating areas will be evaluated according to the criteria (in the paragraph above) for larger spaces.

Transducers located at one (1) measurement position shall be orthogonally positioned to measure whole-body vibration levels 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.

8 Test Report

As stated in 1/7.3.2, "Test Reports", a Test Report shall be submitted to the ABS Surveyor to determine whether the vibration levels meet the whole-body vibration limits and whether this part of the notation requirement has been met. The details listed in the following paragraphs shall be provided in the Vibration Test Report.

8.1 Test Details

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

- i)* Loading (mean draft and trim)
- ii)* Number of crew, number of passengers and number of other persons on board during testing
- iii)* Machinery operating conditions (including all shaft RPM - power output)
- iv)* Vessel course, speed, latitude and longitude coordinates during the test
- v)* Average water depth under keel
- vi)* Weather conditions and meteorological data (i.e., ambient outdoor air temperature, outdoor humidity, wind speed and direction)
- vii)* Sea state
- viii)* Indications of number of instances of rudder angle exceeding $\pm 2^\circ$
- ix)* Vessel's equipment operated during the test
- x)* Any indications of abnormal activity during the test that might skew results
- xi)* Direction of swell relative to vessel heading.

8.2 Transducer Measurement Positions

Actual measurement locations and transducer positions shall be indicated on appropriate drawings.

8.3 Measurement Equipment Details

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

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

8.4 Results

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

- i)* Measurement position (i.e., space and location within space)
- ii)* Axis (See Section 3, Figure 1, "Measurement Axes")
- iii)* Measurement period
- iv)* Sample number
- v)* Weighting filter used (e.g., W_d , W_b or W_f). See BS 6841.
- vi)* Weighted rms-per-axis (a_w)
- vii)* Weighted Maximum Peak Value per axis
- viii)* Crest Factor per axis
- ix)* Multi-Axis weighted rms
- x)* Motion Sickness Dose Value ($MSDV_2$)
- xi)* Exposure period
- xii)* Note 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 space
- ii)* Walkthrough verification inspection results
- iii)* Spot measurement results (where appropriate).

8.5 Deviations

All deviations from the approved Test Plan shall be reported.

8.6 Surveyor Witnessing Documentation

The equipment calibration and data collection process of the vibration tests shall be witnessed by an ABS Surveyor. The ABS Surveyor shall provide documentation stating whether all steps of the on-board vibration testing were completed to his/her satisfaction. A copy of the witnessing document shall be given to the person conducting the testing, for insertion into the final Test Report. The original shall be retained for the ABS files.

9 Results

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

SECTION 4 Noise

1 Background

Noise is any unwanted sound, which may result in annoyance, disturbance of sleep, speech interference or hearing impairment. Compliance with noise level criteria specified for various passenger accommodations and recreation spaces in this Section of this Guide will contribute to the comfort and well-being of passengers when using these spaces for their intended purpose.

The criteria in this Section, to determine appropriate noise levels for a comfortable space, are based on the answers to the following questions and a review of available noise data:

- i) What activities typically take place in the space?
- ii) What is the frequency of occupation of the space (e.g., continuous, intermittent, or infrequent)?
- iii) What are the communication requirements within the space?
- iv) What noise levels do people typically expect in the space?

Based on the answers to the preceding questions, and a review of available noise data, the criteria in this Section were selected.

A more detailed discussion of noise is provided in Kryter (1994), *The Handbook of Hearing and the Effects of Noise: Physiology, Psychology and Public Health*.

2 Scope

In this Section, noise criteria have been selected to enhance passenger comfort. In this instance, “comfort” means the ability of the passengers to use a space for its intended purpose, with minimal interference or annoyance from noise.

This Section primarily applies to vessel accommodations and recreation spaces occupied by passengers for twenty (20) minutes or longer at any one time, for example, cabins, staterooms, dining and recreation spaces.

Compliance with this Section is one requirement for the Comfort (**COMF**) or Comfort Plus (**COMF+**) notation confirmation.

3 Terminology

A-weighted sound pressure level: The magnitude of a sound, expressed in decibels (re. 20 micropascals); the various frequency components are adjusted according to the A-weighted values given in IEC 60651 in order to account for the frequency response characteristics of the human ear. The symbol is L_A ; the unit is dB(A).

Calibration Checks: Field calibration of a sound measuring instrument conducted before and after a field test using a reference sound signal of known frequency and sound pressure level.

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.

4 Associated Documentation

The following documents provide details about test plan preparation, test measurement procedures and/or test reporting:

ISO140-4, (1998): Acoustics – Measurement of sound insulation in buildings and of building elements – Part 4: Field measurements of airborne sound insulation between rooms

ISO 140-7, (1998): Acoustics – Measurement of sound insulation in buildings and of building elements – Part 7: Field measurements of impact sound insulation of floors

ISO 717-1, (1996): Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation

ISO 717-2, (1996): Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation

ISO 2923, (1996): Acoustics – Measurement of noise on board vessels

IEC 60804, (2000): Integrating-averaging sound level meters

IEC 60651, (1979): Sound level meters

IMO Resolution A.468(XII) (1981): Code on noise levels on board ships

WMO, (1995): Sea State Code.

Further guidance can be found in:

ISO 4867, (1984): Code for the measurement and reporting of on board vibration data.

5 Criteria

5.1 Equivalent Continuous A-weighted Sound Pressure Level

The noise criteria are the same for both **COMF** and **COMF+**. Noise levels shall be determined for the test conditions specified in 4/7.3, "Test Conditions", and shall not exceed the maximum acceptable levels indicated in Section 4, Table 1, "Noise Criteria – Vessels with Passenger Berthing Cabins" or Section 4, Table 2, "Noise Criteria – Vessels without Passenger Berthing Cabins" for each type of space or area. The maximum acceptable levels in Section 4, Table 1 and Section 4, Table 2 are L_{Aeq} values, determined as appropriate to the character of the noise (see 4/7.3).

TABLE 1
Noise Criteria – Vessels with Passenger Berthing Cabins

<i>Spaces and Open Recreation Areas</i>	<i>Maximum Acceptable L_{Aeq} Value dB(A)</i>
Cabins and Staterooms	45
Passageways near Cabins	55
Dining Spaces	55
Indoor Public Spaces (including Lounges, Cocktail Bars, etc.)	55
Indoor Recreation Spaces	55
Discotheques, Dinner Theatres, Entertainment Spaces	60
Passageways near Public Areas	60
Gymnasiums	65
Outdoor Public Spaces	65
Medical, Dental and First Aid Spaces	45

TABLE 2
Noise Criteria – Vessels without Passenger Berthing Cabins

<i>Spaces and Open Recreation Areas</i>	<i>Maximum Acceptable L_{Aeq} Value dB(A)</i>
Indoor Public Spaces (including Snack Bars, Dining Spaces, Lounges, Cocktail Bars, etc.)	55
Indoor Seating Areas (Grouped Seating on Ferries or HSC)	60
Indoor Recreation Spaces and Game Rooms	65
Passageways near Public Areas	65
Outdoor Public Spaces and Outdoor Seating Areas	70
Medical and First Aid Spaces	55

5.2 Acoustic Insulation

Acoustic insulation between spaces and between decks shall be provided such that the criteria stated in Section 4, Table 1, "Noise Criteria – Vessels with Passenger Berthing Cabins", and Section 4, Table 2, "Noise Criteria – Vessels without Passenger Berthing Cabins", is achieved under normal operating conditions with passengers and crew on board the vessel.

In order to meet this requirement, acoustic insulation requirements shall be calculated using ISO 717-1 and ISO 717-2. The airborne sound pressure levels to be considered when designing acoustic insulation are provided in Section 4, Table 3, "Maximum Sound Pressure Level – Vessels with Passenger Berthing Cabins", and Section 4, Table 4, "Maximum Sound Pressure Level – Vessels without Passenger Berthing Cabins".

In addition, the shipyard or owner shall conduct testing to demonstrate that sufficient acoustic insulation has been installed. Testing shall be conducted with all noise attenuating components installed and finished. Sound transmission avenues (such as open cabin doors or deadlights) shall be closed or sealed, as appropriate for testing. Field measurements/testing shall be conducted in accordance with ISO 140-4 for airborne sound and in accordance with ISO 140-7 for impact sound.

TABLE 3
Maximum Sound Pressure Level – Vessels with Passenger Berthing Cabins

<i>Spaces and Open Recreation Areas</i>	<i>dB(A)</i>
Cabins and Staterooms	80
Passageways near Cabins	85
Dining Spaces	85
Indoor Public Spaces (including Lounges, Cocktail Bars, etc.)	85
Indoor Recreation Spaces	85
Discotheques, Dinner Theatres, Entertainment Spaces	105
Passageways near Public Areas	90
Gymnasiums	85
Outdoor Public Spaces	90
Medical, Dental and First Aid Spaces	80

TABLE 4
Maximum Sound Pressure Level – Vessels without Passenger Berthing Cabins

<i>Spaces and Open Recreation Areas</i>	<i>dB(A)</i>
Indoor Public Spaces (including Snack Bars, Dining Spaces, Lounges, Cocktail Bars, etc.)	85
Indoor Seating Areas (Grouped Seating on Ferries or HSC)	85
Indoor Recreation Spaces and Game Rooms	90
Passageways near Public Areas	90
Outdoor Public Spaces and Outdoor Seating Areas	90
Medical and First Aid Spaces	80

6 Test Plan

As stated in 1/7.3.1, "Test Plan", 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:

6.1 Documentation

The Test Plan shall include appropriate design information including noise specifications for the vessel. It should 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 to the criteria set in this Guide.

The Test Plan shall also include the acoustic insulation plan, calculations and relevant supporting documentation for review and approval by ABS Engineering. With the Test Plan, field measurement test results of the acoustic insulation shall be submitted for review.

6.2 Test Personnel

The Test Plan shall provide information on the External Specialists who will be conducting the test and their approval and certification in accordance with the procedures provided in Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing".

6.3 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. Information shall be submitted to ABS Engineering within the Test Plan with regards to the most probable sea state expected for a vessel based on the geographical area of vessel operation. The sea state will be stated in accordance with the World Meteorological Organization (WMO) (1995) *Sea State Code*. Further details about test conditions are given in 4/7.3, "Test Conditions".

6.4 Measurement Locations

The Test Plan shall document in detail on appropriate drawings all passenger spaces or areas where measurements will be taken. In addition, measurement positions shall be indicated. Details on selecting measurement locations and determining transducer positions are provided in 4/7.4, "Measurement Locations".

6.5 Data Acquisition and Instruments

Information shall be provided 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, response time, calibration and sensitivity. More details on data acquisition and instruments are provided in 4/7.2, "Data Acquisition and Instruments".

6.6 Data Analysis

Information shall be provided regarding the methods, software and instrumentation to be used for data analysis.

6.7 Test Schedule

Information shall be provided regarding the proposed test schedule.

7 Test Requirements

7.1 General

In general, the noise measurements shall be carried out in accordance with the requirements of ISO 2923. However, where ISO 2923 requirements differ from those in this Guide, this Guide shall take precedence.

7.2 Data Acquisition and Instruments

The integrating-averaging sound level meter shall meet the requirements for a Type 1 instrument specified in IEC 60651 and IEC 60804.

7.3 Test Conditions

The test conditions required for the noise measurements shall be in accordance with the following paragraphs, which are taken or adapted from ISO 4867 and ISO 2923. These conditions are consistent with those for whole-body vibration measurements covered in 3/7.3, "Test Conditions".

7.3.1 Power Output

The propulsion machinery shall run at normal service speed and at no less than eighty (80) percent of the maximum continuous rating (MCR).

7.3.2 Equipment Operation

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

7.3.3 Course and Water Depth

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

7.3.4 Rudder Angle

The rudder angle shall be restricted to a range of $0^\circ \pm 2^\circ$. Minimal rudder action is desirable.

7.3.5 Sea Conditions

Based on the most probable sea state condition stated in the Noise Test Plan (see 4/6.3, "Test Conditions"), the tests will be conducted at that value plus or minus one (1) sea state condition. For example, if Sea State 5 was predicted as most probable, then noise measurements should be taken in sea conditions between Sea State 4 to 6 on the World Meteorological Organization (WMO) (1995) *Sea State Code*.

Test measurements may be taken under more severe sea state conditions, however, the resulting values must conform to the noise limits presented in 4/5.1, "Equivalent Continuous A-weighted Sound Pressure Levels", to be acceptable.

The Comfort (**COMF** and **COMF+**) notations are awarded for a specific geographical area. If the vessel changes geographical operational area and the predicted most probable sea state changes, testing may need to be repeated (see 1/10.4, "Requirements for Geographical Area of Vessel Operations").

7.3.6 Loading Conditions

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

7.3.7 Test Interference

During the noise measurements, noise and vibration 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. Passengers shall not be present during the noise measurements.

Doors and windows shall be closed, except where they are normally left open. Any open doors or windows shall be noted in the Noise Test Report. Spaces shall be furnished with all usual equipment and furnishings normally found in the space. Equipment shall be configured to operate in its normal operating mode.

7.4 Measurement Locations

7.4.1 Selection of Spaces where Measurements are to be Conducted

The aim when selecting noise measurement locations shall be to obtain a representative sample of data that reflects the actual conditions in passenger spaces listed in Section 4, Table 1, "Noise Criteria – Vessels with Passenger Berthing Cabins" or Section 4, Table 2, "Noise Criteria – Vessels without Passenger Berthing Cabins", as appropriate. For practical reasons, it is important to select the locations such that an appropriate amount of sample data can be collected during the testing phase. The measurement locations shall be selected in accordance with the following criteria:

- i)* Select potential worst case locations based on their proximity to noise emitting equipment, noise sources or where noise is likely to be transmitted to passenger accommodations, public, or recreation space, via the vessel's structure. Measurements shall be taken in all identified worst case locations.
- ii)* Where a single instance of a type of passenger space exists within the vessel (e.g., public lounge on a ferry), the location shall be selected for measurement.
- iii)* Where multiple instances of a particular type of space exist (e.g., cabins/staterooms, passageways, dining areas, or public/recreation areas), a representative sample of at least twenty (20) percent of each type shall be selected for measurement. The worst case locations are to be considered part of the representative sample, if applicable.
- iv)* Measurements in passageways shall be conducted at distances not smaller than 2 m (6.5 ft) and not greater than 7 m (23 ft) throughout the space. The worst case locations (e.g. inlets and outlets of air-circulation systems, locations adjacent to stairwells and elevator shafts) shall be considered part of the measurements, if applicable.

If any of the spaces or passageways identified for measurement extend or are situated over a large portion of the vessel, measurement locations shall be selected throughout the length of the vessel and on each deck. Additionally, attention must be given to selecting a variety of locations port, starboard, amidships, fore and aft.

7.4.2 Walkthrough Verification Inspection Locations

An additional sample of at least twenty-five (25) percent of all passenger spaces not covered by physical measurements shall be subject to a walkthrough verification inspection. The ABS Surveyor shall identify these spaces from those that were not selected for physical measurement under 4/7.4.1, "Selection of Spaces where Measurements are to be Conducted". The purpose of the walkthrough verification is to subjectively assess the noise qualities of the selected spaces. The walkthrough verification inspection shall be conducted by the External Specialist during on-board testing. If any space is deemed to deviate from the noise requirements provided in this Guide, it shall be verified by the External Specialist by conducting spot measurements and the results recorded in the Test Report.

7.4.3 Measurement Positions

The measurement positions described below are taken or adapted from ISO 2923 and IMO Resolution A.468(XII) (1981).

Measure at positions where passengers 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.

If practicable, do not measure closer than 1000 mm (40 in) from operating machinery, air inlets, or from decks, bulkheads or other large surfaces. Where this is not possible, measure midway between the machinery and an adjacent reflecting surface.

7.5 Measurement Procedures and Recorded Results

7.5.1 Persons Present During Measurements

When External Specialist personnel are conducting noise level measurements in any space, only crew members necessary for the operation of that space should be present. Passengers shall not be present during the noise measurement.

7.5.2 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.

7.5.3 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.

7.5.3 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.

8 Test Report

As stated in 1/7.3.2, "Test Reports", a Test Report shall be submitted to the ABS Surveyor to determine whether the noise levels meet 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.

8.1 Test Details

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

- i)* Loading (mean draft and trim)
- ii)* Number of passengers, number of crew and number of other persons on board during testing
- iii)* Machinery operating conditions (including all shaft RPM – power output)
- iv)* Vessel course, speed, latitude and longitude coordinates
- v)* Weather conditions and meteorological data (i.e., ambient outdoor air temperature, outdoor humidity, wind speed and direction)
- vi)* Average water depth under keel
- vii)* Sea state
- viii)* Indications of number of instances of rudder angle exceeding $\pm 2^\circ$
- ix)* Vessel's equipment operated during the test
- x)* Any indications of abnormal activity during the test that might skew results.

8.2 Measurement Positions

Actual measurement location positions shall be indicated on appropriate drawings.

8.3 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.

8.4 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 people 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.

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 verification inspection results
- iii)* Spot measurement results (where appropriate).

8.5 Deviations

All deviations from the approved Test Plan shall be reported.

8.6 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 his/her 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 the ABS files.

9 Results

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

SECTION 5 Indoor Climate

1 Background

Thermal comfort is defined in ISO 7730:1994(E) as “...that condition of mind which expresses satisfaction with the thermal environment”. The sensation of thermal comfort is therefore largely subjective and will vary from person to person. Due to a difference in metabolism, there are distinct individual differences between people’s perception of comfort and temperature. Acclimatization, habits and established traditions may also affect the comfort temperature. Because of these individual differences, it is difficult to specify a thermal environment that will satisfy everyone. A thermal environment is therefore normally specified to be acceptable to at least eighty percent (80%) of the occupants of an interior space.

Thermal comfort is largely determined by the interaction of thermal environmental factors such as air temperature, mean radiant temperature, air velocity, humidity and the personal factors of activity and clothing.

The thermal control or Heating, Ventilation and Air Conditioning (HVAC) systems on a vessel should be designed to effectively control the indoor thermal environmental parameters to within acceptable limits to ensure the thermal comfort of the passengers.

2 Scope

This Section provides the assessment criteria, verification and measurement methodology for indoor climate relating to comfort on passenger vessels. The criteria defined are based on currently available standards and were selected to provide an index of passenger thermal comfort.

The thermal environmental variables covered by this Guide include the ambient qualities of air temperature, air velocity and relative humidity. Vertical gradient measurements indicate areas where temperature differentials might exist between a passenger’s head and feet. The berthing area horizontal gradient temperature differential between the temperature of inside bulkhead surfaces adjacent to berthing and the average air temperature within the space is another parameter selected as an indication of potential thermal discomfort.

The thermal environmental criteria provided in this Guide are for persons wearing typical indoor clothing occupied with light, primarily sedentary activity and should provide a thermal environment acceptable to the majority of passengers.

This Section applies to indoor accommodations and recreation spaces occupied by passengers for twenty (20) minutes or longer at any one time, for example, cabins, staterooms, public seating spaces, dining areas and hospitals.

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

3 Terminology

Air Velocity or Movement: The rate of displacement of ambient air in a specific direction in meters-per-second (m/s) or feet-per-second (ft/s).

Air Temperature: The temperature of the air surrounding a person, measured with a standard thermometer whose bulb is kept dry and shielded from radiation.

Comfort Zone: That range of environmental conditions in which at least eighty (80) percent of passengers experience thermal comfort.

Horizontal Gradient: The difference between the inside surface temperatures of the bulkheads bounding the berth and the average air temperature within the cabin. This is used as an indication of potential thermal discomfort due to radiant thermal sources within the cabin.

HVAC Zone: A space or group of spaces that are simultaneously controlled for temperature, humidity, cleanliness and distribution. A zone is usually comprised of common duct work feed from an air handler. Each zone will be independently controlled via a thermostat.

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

Relative Humidity (RH): The ratio of the amount of vapor contained in the air (absolute humidity) to the maximum amount of vapor the air can hold at a given temperature before precipitation (condensation) occurs.

Thermal Comfort: An ordinal ranking or subjective index of “that condition of mind which expresses satisfaction with the thermal environment”. (ISO 7730:1994)

Ventilation: Ventilation is the process of supplying air to and removing air from any space by natural or mechanical means. From the standpoint of comfort and health, ventilation issues involve both quantity and quality.

Vertical Gradient: The vertical air temperature difference within an enclosed space. The vertical gradient is used as an indication of potential local discomfort at the head and feet.

4 Associated Documentation

The following documents provide details about test plan preparation, test measurement procedures and/or test reporting:

ANSI/ASHRAE 55a-1995, Thermal Environmental Conditions for Human Occupancy

ISO 7726: 1998 (E), Ergonomics of the thermal environment – Instruments for measuring physical quantities

NEBB 1998, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

5 Criteria

The indoor climate criteria for the **COMF** and **COMF+** notations are identical and are presented in Section 5, Table 1, "Summary of Indoor Climate Requirements".

Indoor climate measurements shall be taken only in passenger accommodations and recreation spaces occupied by passengers for twenty (20) minutes or longer at a time. Specific locations are referred to in 5/7.4, "Measurement Locations".

The thermal environmental comfort ranges and conditions shall be achievable, under the test conditions specified in 5/7.3, "Test Conditions", for normal operating conditions, in selected passenger spaces.

The Comfort (**COMF** and **COMF+**) notation criteria is aimed at enhancing passenger comfort by making provision for adjusting indoor climate conditions, with regard to air temperature and air velocity, to suit personal needs within a particular space.

5.1 Air Temperature

For a Comfort (**COMF** and **COMF+**) notation, the HVAC system shall be capable of sustaining an adjustable range of air temperatures between $\geq 18^{\circ}\text{C}$ (64°F) and $\leq 26.5^{\circ}\text{C}$ (80°F) in all passenger accommodations and recreation spaces. This temperature shall be maintained by a temperature controller. For passenger cabins, an individual thermostatic control device shall be provided within each cabin. For all other accommodations and recreation spaces, a central thermostatic control device shall be provided.

5.2 Relative Humidity

The HVAC system shall be capable of providing and maintaining a relative humidity within a range from thirty (30) percent minimum to seventy (70) percent maximum.

5.3 Enclosed Space Vertical Gradient

The difference in temperature at 100 mm (4 in) above the deck and 1700 mm (67 in) above the deck shall be maintained within 3°C (6°F).

5.4 Air Velocity

Air velocities shall not exceed 30 meters-per-minute or 100 feet-per-minute (0.5 m/s or 1.7 ft/s) at the center of the space.

5.5 Berthing Area Horizontal Gradient

In cabins, the difference between the inside bulkhead surface temperature adjacent to berthing and the average air temperature within the cabin shall be less than 10°C (18°F).

5.6 Summary

A summary of the indoor climate requirements is presented in the Section 5, Table 1, "Summary of Indoor Climate Requirements".

**TABLE 1
Summary of Indoor Climate Requirements**

<i>Item</i>	<i>Requirement or Criterion for Notation</i>
Air Temperature	Adjustable range of air temperatures between $\geq 18^{\circ}\text{C}$ (64°F) and $\leq 26.5^{\circ}\text{C}$ (80°F).
Relative Humidity	A range from 30% minimum to 70% maximum.
Vertical Gradient	The acceptable range is $0\text{-}3^{\circ}\text{C}$ ($0\text{-}6^{\circ}\text{F}$).
Air Velocity	Not exceed 30 meters-per-minute or 100 feet-per-minute (0.5 m/s or 1.7 ft/s) at the center of the space.
Horizontal Gradient (Berthing)	The horizontal temperature gradient in cabins shall be $<10^{\circ}\text{C}$ (18°F).

6 Test Plan

As stated in 1/7.3.1, "Test Plans", a Test Plan shall be developed to serve as the principal means for submitting design details of the HVAC system for review by ABS Engineering and for verifying the measurements to be performed to verify compliance with indoor climate criteria. The Test Plan shall include the following documentation:

6.1 Documentation

The Test Plan shall include the following documentation and data to enable the ABS Surveyor to verify compliance to the indoor climate criteria set in this Guide and to identify spaces where measurements shall be taken:

- i) Appropriate vessel and HVAC system design specifications
- ii) Schematics/layout drawings of the HVAC system
- iii) General arrangement drawings of the vessel.

A report of the total system Testing, Adjusting and Balancing (TAB) shall be provided to ABS Engineering for review of indoor climate system suitability. The total system TAB shall be in accordance with the National Environmental Balancing Bureau (NEBB) standard "*NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems*" or other similar certification standards. The NEBB is a nonprofit organization that establishes and maintains HVAC system industry standards, procedures and specifications.

6.2 Test Personnel

The Test Plan shall provide information on the External Specialists who will be conducting the testing and their approval and certification in accordance with Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing".

6.3 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. Details about test conditions are given in 5/7.3, "Test Conditions".

6.4 Measurement Locations

The Test Plan shall document, in detail, on appropriate drawings, all passenger spaces or areas where measurements will be taken. In addition, transducer measurement positions shall be indicated. Details on selecting measurement locations and determining transducer positions are provided in 5/7.4, "Measurement Locations".

6.5 Data Acquisition and Instruments

Information shall be provided 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, response time, calibration and sensitivity. More details on data acquisition and instruments are provided in 5/7.2, "Data Acquisition and Instruments".

6.6 Data Analysis

Information shall be provided regarding the methods, software and instrumentation to be used for data analysis.

6.7 Test Schedule

Information shall be provided regarding the proposed test schedule.

7 Test Requirements

7.1 General

Indoor climate measurements shall be in accordance with the procedures of ANSI/ASHRAE 55a-1995. When the procedures described in this Guide deviate from those in ANSI/ASHRAE 55a-1995, the requirements of this Guide take precedence.

7.2 Data Acquisition and Instruments

The thermal measurement instrumentation shall meet or exceed the minimum characteristics of instruments for measuring physical quantities characterizing an environment specified in ISO 7726:1998(E).

The following quantities shall be measured in each of the spaces or zones identified in the Test Plan and the results noted in the Indoor Climate Test Report:

- i)* Air temperature
- ii)* Relative humidity
- iii)* Air velocity
- iv)* Vertical gradient
- v)* Horizontal gradient (in cabins only).

The air temperature and humidity measurements shall be made at least every five (5) minutes for a minimum period of two (2) hours. The minimum, maximum and average values for the 2-hour period shall be reported for each space measured. For both the **COMF** and **COMF+** notations, the temperature control for a specific space shall be set to the lower requirement level of 18°C (64°F) for the first hour and to 26.5°C (80°F) for the second hour of measurement.

The measuring period for determining the average air velocity at any location shall be three (3) minutes.

Surface temperatures for all wall surfaces that are adjacent to berthing shall be measured for determining the horizontal gradient in cabins.

7.3 Test Conditions

In order to determine the effectiveness of the HVAC system at providing the environmental conditions specified in this Guide, measurements shall be made under the following conditions:

7.3.1 Testing at Sea

Testing of identified spaces shall be accomplished at sea with all normally functioning equipment in its operational mode.

7.3.2 Equipment Operation

The HVAC system shall be operating in the normal operation or mode.

7.3.3 Doors and Windows

The space doors and windows shall be closed during the evaluation period, except for routine entry and exit. Any open doors or windows should be noted in the Indoor Climate Test Report.

7.3.4 Equipment and Furnishings

Spaces shall be furnished with all usual equipment and furnishings normally found in the space. Equipment shall be configured to operate in its normal operating mode.

7.3.5 Weather and Climatic Conditions

When thermal conditions in the occupied zone have a high sensitivity to time of day and weather conditions, the measurement should be made such that the high and low extremes of the thermal parameters are determined. If possible, measurements should be taken with little or no cloud cover.

The Comfort notations (**COMF** and **COMF+**) are awarded for a specific geographical area. If the vessel changes geographical operational area and the predicted most probable sea state changes, testing may need to be repeated (see 1/10.4, "Requirements for Geographical Area of Vessel Operations").

7.3.6 Test Interference

During the indoor climate measurements, any activity that might affect the indoor climate in the space 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.

Doors and windows shall be closed, except where they are normally left open. Any open doors or windows shall be noted in the Indoor Climate Test Report. Spaces shall be furnished with all usual equipment and furnishings normally found in the space. Equipment shall be configured to operate in its normal operating mode.

7.4 Measurement Locations

7.4.1 Selection of Spaces where Measurements are to be Conducted

The aim when selecting indoor climate measurement locations shall be to obtain a representative sample of data that reflects the actual conditions in passenger accommodations. For practical reasons, it is important to select the locations such that an appropriate amount of sample data can be collected during the testing phase. The measurement locations shall be selected in accordance with the following criteria:

- i)* Select potential problem areas where the influence of internal conditions or factors may adversely impact the quality of the indoor climate in accommodations, public and recreation areas. Internal conditions include space proximity to equipment that radiates or absorbs heat (e.g., engine exhaust trunks, freezer spaces, galley, scullery, etc.) and surfaces with thermal differentials in excess of 10°C (18°F) from the ambient temperature in the space. Measurements shall be taken in all identified problem areas.
- ii)* Select potential problem areas where the influence of external ambient environmental conditions (e.g., sun, wind, precipitation, etc.) may adversely impact the quality of the indoor climate. These areas include accommodations, public and recreation areas which may be outboard or adjacent to the vessel's hull. Measurements shall be taken in all identified problem areas.
- iii)* Where a single instance of a type of space exists within the vessel (e.g., public lounge on a ferry), the location shall be selected for measurement.
- iv)* Where multiple instances of a particular type of space exist (e.g., cabins/staterooms, dining areas, or public/recreation areas), a representative sample of at least twenty-five (25) percent of each type shall be selected for measurement. The worst case locations are to be considered part of the representative sample, if applicable.

If any of the spaces identified for measurement extend or are situated over a large portion of the vessel, measurement locations shall be selected throughout the length of the vessel on each deck. Additionally, attention must be given to selecting a variety of locations port, starboard, amidships, fore and aft.

7.4.2 Walkthrough Verification Inspection Locations

An additional sample of at least twenty-five (25) percent of passenger accommodations not covered by physical measurements shall be subject to a walkthrough verification inspection. The ABS Surveyor shall identify these spaces from those that were not selected for physical measurement. The purpose of the walkthrough verification is to subjectively assess the indoor climatic qualities of the selected spaces. The walkthrough verification inspection shall be conducted by the External Specialist during on-board testing. If any space is deemed to deviate from the indoor climate requirements provided in this Guide, it shall be verified by the External Specialist by conducting spot measurements and the results recorded in the Indoor Climate Test Report.

7.4.3 Transducer Measurement Positions

For each space identified in the Test Plan, the transducer locations shall be standardized as follows:

- i)* Air temperature and relative humidity measuring instrumentation shall be set up approximately in the middle of the space to measure general space temperature and humidity levels. Air temperature shall be simultaneously measured at approximately 100 mm (4 in), 1100 mm (43 in), and 1700 mm (67 in) above the deck. Relative humidity shall be measured at a height of approximately 1700 mm (67 in) above the deck.
- ii)* Air velocity data shall be captured at approximately 100 mm (4 in), 1100 mm (43 in) and 1700 mm (67 in) above the deck in spaces where passengers will be lying, seated or standing for twenty (20) minutes or longer, as applicable (to assure air velocity is not excessive at these positions). This measurement should be taken in the center of the space.
- iii)* Inside wall surface temperatures shall be captured from all walls surrounding berthing location of approximately 1100 mm (43 in) from the deck on all the wall surfaces.

8 Test Report

As stated in 1/7.3.2, "Test Reports", a Test Report shall be submitted to the ABS Surveyor to determine whether the indoor climate levels meet the criteria and whether this part of the notation requirement has been met. The details listed in the following paragraphs shall be provided in the Indoor Climate Test Report.

8.1 Test Details

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

- i)* Loading condition
- ii)* Crew size and total number of persons on board during testing
- iii)* Machinery operating conditions
- iv)* Vessel course, speed, latitude and longitude coordinates during testing
- v)* Weather conditions and meteorological data (i.e., wind speed and direction, ambient outdoor air temperature, outdoor humidity, barometric pressure)
- vi)* Sea state
- vii)* Any indications of abnormal activities or conditions during the test that might skew results.

8.2 Transducer Measurement Positions

Actual measurement locations and transducer positions shall be indicated on appropriate drawings.

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

8.4 Results

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

- i)* Measurement position
- ii)* Number of people present in space at time of measurement
- iii)* Measurement period
- iv)* Time at start of measurement
- v)* Air temperature (minimum, maximum and average) at 100 mm (4 in) above deck
- vi)* Air temperature (minimum, maximum and average) at 1100 mm (43 in) above deck
- vii)* Air temperature (minimum, maximum and average) at 1700 mm (67 in) above deck
- viii)* Relative humidity (minimum, maximum and average) at 1700 mm (67 in) above deck
- ix)* Air velocity at 100, 1100 and 1700 mm (4, 43 and 67 in) above deck
- x)* Vertical gradient (Average air temperature at 1700 mm (67 in) minus average air temperature at 100 mm (4 in) above deck)
- xi)* Horizontal gradient (Side wall surface temperature in cabin minus average air temperature at 1100 mm (43 in) above deck)
- xii)* Wind speed and direction, ambient outdoor air temperature, outdoor humidity, and barometric pressure corresponding to indoor measurement periods.

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 verification inspection results
- iii)* Spot measurement results (where appropriate).

8.5 Deviations

All deviations from the approved Test Plan shall be reported.

8.6 Surveyor Witnessing Documentation

The equipment calibration and data collection process of the indoor climate tests shall be witnessed by an ABS Surveyor. The ABS Surveyor shall provide documentation stating whether all steps of the indoor climate testing were completed to his/her satisfaction. A copy of the witnessing document shall be given to the person conducting the testing, for insertion into the Indoor Climate final Test Report. The original shall be retained for the ABS files.

9 Results

The Indoor Climate Test Report and test results shall be reviewed by the ABS Surveyor against the indoor climate criteria for determination of the notation confirmation.

SECTION 6 Lighting

1 Background

The lighting of passenger spaces should facilitate visual comfort, support passenger activities appropriately and aid in the creation of an appropriate visual environment. Lighting design involves integrating these aspects to provide adequate illuminance for the comfort and well-being of passengers as well as for the various leisure activities passengers will be involved in on board vessels.

The selection of appropriate illuminance levels for specific tasks and crew spaces is an important consideration in the design of lighting systems. There is a difference of opinion as to what levels of light may be considered best for visual tasks. Since illuminance recommendations are generally consensus values, for any task a range of illuminances may apply.

Since passenger accommodations and recreation spaces on board a vessel are generally similar to spaces encountered ashore, requirements for illuminance on vessels generally correspond to those in living and recreation areas on shore.

In addition to the illuminance level, external factors such as contrast with respect to the background, object size, brightness, the time available for viewing or recognition and reflectance determine the visibility of an object within the visual field. Other considerations include discomfort glare, veiling reflections and shadows. From a subjective viewpoint, aesthetics, color and the psychological effects of lighting must also be considered. These factors are all interrelated and should be considered during the process of selecting illuminance levels, but will not be separately quantified.

2 Scope

This Section provides criteria for assessing the illuminance levels of general lighting and activity lighting on vessels. The main objective of the assessment is to determine whether the various lighting systems comply with minimum standards to facilitate passenger comfort and well-being as well as accommodate passenger activities in accommodations and recreation spaces.

Lighting criteria are defined based on currently available standards and research data. Compliance with this Section is a pre-requisite for the Comfort (**COMF**) or Comfort Plus (**COMF+**) notation confirmation.

3 Terminology

Activity Lighting: Lighting provided to meet the illuminance requirements of a specific passenger activity. Activity lighting refers to the total illuminance requirement that may be obtained by supplementary lighting provided in addition to the general illuminance.

Activity Plane: The horizontal, vertical, or inclined plane in which the visual activity is performed. If no information is available, the activity plane may be considered to be the horizontal and at 750 mm (29.5 in) above the deck for seated activities and 1000 mm (39.5 in) for standing activities.

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

Disability Glare: Glare which reduces the ability to perform a visual task. (IESNA RP-12-97)

Discomfort Glare: Glare which produces viewer discomfort, but which does not significantly interfere with visual task performance or visibility. (IESNA RP-12-97)

General Lighting: Lighting designed to provide a substantially uniform level of illuminance throughout an area, exclusive of any provision for special, localized activity requirements. (IESNA RP-12-97)

Glare: The discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings. (CIBS Code, 1984)

Illuminance: The luminous flux density at a surface (or the amount of light falling on an object or surface), i.e., the luminous flux incident-per-unit area. (Ryer, 1997). Illuminance is measured in units of Lux (lm/m^2) or foot-candles (fc ; lm/ft^2). One foot-candle equals 10.76 Lux.

Lumen: The International System of Units (SI) unit of luminous flux, used in describing a quantity of light emitted by a source or received by a surface. (CIBS Code, 1984)

Luminaire: A complete lighting unit consisting of a lamp(s) together with the parts designed to distribute the light, to position and protect the lamp and to connect the lamp to the power supply. (ANSI/IESNA RP-1-1993)

Luminance: The photometric brightness of an illuminated surface (or the amount of light emitted or reflected from the surface). The SI unit of luminance is candela-per-square meter (cd/m^2). (CIBS Code, 1984)

Luminous Flux: The light emitted by a source, or received by a surface and indicates the intensity of a source. Flux is expressed in lumens. (CIBS Code, 1984)

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

Uniformity Ratio: The ratio of the minimum illuminance (or luminance) to the average illuminance (or luminance) applied to the values on the working plane. (DEF STAN 00-25 (PART 6)/2)

4 Associated Documentation

IESNA RP-12-97, Recommended Practice for Marine Lighting, provides details about test plan preparation, test measurement procedures and test reporting.

5 Criteria

The lighting criteria for the Comfort (**COMF** and **COMF+**) notations are identical and provided in Section 6, Table 1, "Lighting Criteria for Passenger Spaces". In this Section, general lighting and activity lighting requirements are provided for passenger activities and accommodations and recreation spaces normally encountered on passenger vessels. The lighting levels provided in Section 6, Table 1 are for new lamps.

The following minimum maintained illuminance levels shall be achieved under the test conditions specified in 6/7.3, "Test Conditions", measured with supplementary sources turned on where provided but with daylight excluded. These levels were selected from a variety of sources which are listed in Appendix 1, "References". Where human factors data existed with regard to recommended lighting levels, these values are provided in parentheses in Section 6, Table 1. It is strongly recommended that these values are adhered to, in order to facilitate passenger comfort and well-being above and beyond the minimum required lighting levels.

Emergency lighting is covered in SOLAS and IMO Resolutions and was not considered in the selection of the lighting levels provided in this Guide.

6 Test Plan

As stated in 1/7.3.1, "Test Plans", a Test Plan shall be developed to serve as the principle means for submitting design details of the lighting system for review by ABS Engineering and for verifying the measurements to be performed to verify compliance with lighting criteria. The Test Plan shall include the following:

6.1 Documentation

The Test Plan shall include appropriate design information and layout drawings showing the hull outline, bulkheads, access routes, location of luminaires, outlines of major furniture and equipment and the space name and number. The drawings shall be to a scale and sized to permit the scaling of survey points (required by 6/7.4, "Measurement Locations") and lighting equipment and the recording of illuminance and other relevant data.

6.2 Test Personnel

The Test Plan shall provide information on the External Specialists who will be conducting the test and their approval and certification in accordance with Appendix 2, "Procedural Requirements for External Specialists Providing Ambient Environmental Testing".

6.3 Test Conditions

The Test Plan shall detail the conditions under which the tests will be performed. Details about test conditions are given in 6/7.3, "Test Conditions".

6.4 Measurement Locations

The Test Plan shall document, in detail, on appropriate drawings, all spaces or areas where measurements will be taken. In addition, measurement positions shall be indicated. Details on selecting measurement locations are provided in 6/7.4, "Measurement Locations".

6.5 Data Acquisition and Instruments

Information shall be provided 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, response time, calibration and sensitivity. More details on data acquisition and instruments are provided in 6/7.2, "Data Acquisition and Instruments".

6.6 Data Analysis

Information shall be provided regarding the methods used for data analysis.

6.7 Test Schedule

Information shall be provided regarding the proposed test schedule.

TABLE 1
Lighting Criteria for Passenger Spaces

<i>Spaces</i>	<i>Illuminance level in Lux</i>	<i>Spaces</i>	<i>Illuminance level in Lux</i>
Entrances and Passageways			
Interior Walkways, Passageways, Stairways and Access Ways	110 (215)	Exterior Walkways, Passageways, Stairways and Access Ways (night)	110
Embarkation Area	200		
Cabins, Staterooms and Sanitary Spaces			
General Lighting	150	Bath/Showers (General Lighting)	325
Reading and Writing (Desk or Bunk Light)	540	All other Areas within Sanitary Space (e.g., Toilets, Change Room)	150
Mirrors (Personal Grooming)	540	All other Living Spaces	150
Lounge/Recreation Areas within Cabin Spaces	300		
Dining Spaces			
Dining Room	300	Coffee Shop, Cafeteria	500
Fine Dining	100	Vending Machine Area	75
Recreation Areas			
Ball Rooms	150	Swimming Pools (General Lighting)	150
Lounges/Cocktail Lounges	300	Gymnasiums	300 (500)
Library	540	TV Room	150
Multimedia Resource Center	300	Barber and Beauty Shop	500
Theater/Auditorium - General	100	All other Recreation Spaces (e.g., Game Rooms)	300
- During Program	1	Bulletin Boards/Display Areas	150
Medical, Dental and First Aid Center			
Dispensary	540	Operating Room	
Doctor's Office	540	- General Lighting	1 500
		- Operating Table	20 000
Medical and Dental Treatment/Examination Room	810 (1075)	Wards	
		- General Lighting	100
		- Critical Examination	810 (1075)
Surgical Dressing Room	810 (1075)	- Reading	540
Medical Waiting Areas	540	- Toilets	150
All other Medical and Dental Spaces	325		
Laboratory	810		

Notes:

- 1 Values in parenthesis are recommended, but not required, illuminance levels.
- 2 One Lux equals 0.093 foot-candle.

7 Test Requirements

7.1 General

Illuminance measurements shall be carried out in accordance with the requirements of IESNA RP-12-97. When the procedures described in this Guide deviate from those in IESNA RP-12-97, the requirements of this Guide shall take precedence.

7.2 Data Acquisition and Instruments

The illuminance meter (light meter) shall meet the requirements of Section B.5 in IESNA RP-12-97.

7.3 Test Conditions

The test conditions specified in Section B.4 in IESNA RP-12-97 shall apply. In addition, the following test conditions shall apply:

7.3.1 Location

Lighting measurements may be taken in port, at sea, or both, since the measurements are not dependent on vessel transit.

7.3.2 Spaces with Windows/Portholes

In spaces with windows or portholes where the minimum lighting level should be provided by artificial light sources only, lighting measurements shall be taken after dark.

7.3.3 Spaces without Windows/Portholes

Interior spaces with no windows or portholes could be measured during daylight hours.

7.3.4 Stray Light

Stray light (e.g., dock lighting and moonlight) shall be masked out as far as practicable. Where it is not possible, measurements of stray light, at appropriate positions, with all lighting turned off shall be obtained. These readings shall then be deducted from readings taken at the same positions, with the lighting turned on, to determine the illuminance from the lighting.

7.3.5 Test Interference

During the lighting measurements, shadows on the light meter caused by any kind of 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.

Doors and windows shall be closed, except where they are normally left open. Any open doors or windows shall be noted in the Lighting Test Report. Spaces shall be furnished with all usual equipment and furnishings normally found in the space.

7.4 Measurement Locations

7.4.1 Selection of Spaces where Measurements are to be Conducted

The aim when selecting lighting measurement locations shall be to obtain a representative sample of data that represents the actual conditions in passenger spaces in Section 6, Table 1, "Lighting Criteria for Passenger Spaces". For practical reasons, it is important to select the locations such that an appropriate amount of sample data can be collected during the testing phase. The measurement locations shall be selected in accordance with the following criteria:

- i)* Select problem areas based on the potential for excessive external illumination (daylight) into the space (e.g., dining areas, lounges, etc.). Measurements shall be taken in all identified problem areas.
- ii)* Select potential problem areas based on the positioning of luminaires in the space as indicated on the drawings (e.g., uneven spacing of luminaires resulting in non-uniform illuminance levels and dimly lit areas). Measurements shall be taken in all problem areas.
- iii)* Select a sample of at least twenty-five (25) percent of spaces where passengers are involved in recreational activities (e.g., dining rooms, theater, gymnasium, etc.).
- iv)* Where a number of cabins and sanitary spaces are identical in configuration in terms of lighting systems, surface treatments, geometry, furnishings and equipment layout, only two (2) of the spaces shall be selected to determine whether the lighting requirements are met. A sample of at least twenty-five (25) percent of the remaining spaces shall be visually inspected.
- v)* Where a single instance of one (1) type of space exists within the vessel (e.g., library), the location shall be selected for measurement.

7.4.2 Visual Inspection Locations

A sample of at least twenty-five (25) percent of the passenger spaces and activity areas not covered by physical measurements shall be subject to a walkthrough verification inspection by the External Specialist to verify that the lighting equipment is installed as specified. The ABS Surveyor shall identify these spaces. In spaces where the External Specialist regards the lighting levels to be below the minimum required levels, spot checks shall be made of the general and activity lighting levels in such spaces by taking a single lighting measurement in the center of the space at a height of approximately 750 mm (30 in) above the deck and a single lighting measurement on each work surface or activity plane.

If the measured spot check lighting level is below the required minimum level, the space shall be subjected to a full lighting test as described in 6/7.4.3, "General Illuminance Measurement Positions" and 6/7.4.4, "Activity Lighting Measurement Positions".

When assessing activity illuminance, the presence of disability glare and discomfort glare at specific passenger positions (e.g., mirrors, writing and reading surfaces, etc.) and where visual displays (e.g., TV monitors) are used shall be assessed by means of visual inspection.

Disability glare is caused by specular reflections from glossy surfaces such as dials and metallic surfaces. To assess disability glare, visual inspections shall be conducted from the normal viewing position of the passenger to determine whether there are any specular reflections from display surfaces caused by luminaires.

Discomfort glare is caused by a light source positioned close to the line of sight, a high source luminance, large source area and low background luminance. A visual inspection from the normal viewing position of the passenger at specific locations shall be conducted to determine whether luminaires might be sources of discomfort glare.

Any glare should be noted in the Test Report.

7.4.3 General Illuminance Measurement Positions

General lighting levels shall be measured with all lights turned on except supplementary lights for detail activity lighting, such as desk lights and berth lights. Daylight shall be excluded during the measurements. Measurements shall be taken on a horizontal plane approximately 750 mm (30 in) above the deck. For traffic areas, readings shall be taken on the deck.

General lighting measurements in selected passenger spaces shall be conducted in accordance with the measurement techniques presented in Section B.8 and Section B.10.3 in IESNA RP-12-97.

Average illuminance of regular spaces with symmetrically spaced luminaires and spaces with asymmetrical luminaire arrangements shall be measured and calculated in accordance with the sampling technique presented in Section B.10.3 in IESNA RP-12-97. This technique uses the relationship of symmetry and incorporates a statistical averaging procedure to minimize the required number of data points.

The method presented in Section B.10.3 in IESNA RP-12-97 assumes that there is a large overlap in the luminaire light distribution (low uniformity ratios), that the illuminance variation between maximum, middle and minimum data points is approximated by a straight line, and that identical luminaires are installed in a regular grid pattern throughout the space. This method is not valid where these assumptions are not correct and may not reveal areas in the space where lighting levels are inadequate.

In situations where the statistical method is not valid, the space must be divided into a grid and measurements shall be taken as described in Section B.8 in IESNA RP-12-97.

7.4.4 Activity Lighting Measurement Positions

Activity lighting measurements in selected passenger spaces (e.g., example on reading and writing surfaces) shall be conducted in accordance with the measurement techniques presented in Section B.8 and Section B.10.4 in IESNA RP-12-97.

For activity lighting, a representative set of readings shall be taken over the activity surface with the person in the normal seated or standing position. Activity lighting shall be measured with both general and supplementary activity lighting turned on. Daylight shall be excluded during the measurements.

Measurements of activity lighting must be made on the surface or in the plane of the activity (horizontal, vertical or at an angle). For small activity surfaces (smaller than 0.2 m² (2.15 ft²)), a single measurement shall be taken at the center of the activity surface. For large activity surfaces (0.2 m² (2.15 ft²) or larger), the illuminance shall be measured by dividing the activity surface into a grid and averaging the measurements taken at the grid intersections. The recommended number of measurements for activity surfaces is provided in Table B.1 in IESNA RP-12-97.

Measurements for mirrors shall be taken approximately 400 mm (16 in) away from the surface of the mirror. For berths and bunks, measurements shall be taken at a point approximately 300 mm (12 in) above the top of the mattress and 600 mm (24 in) from the head of the bed.

8 Test Report

As stated in 1/7.3.2, "Test Reports", a Test Report shall be submitted to the ABS Surveyor to determine whether the lighting levels meet the minimum requirements and whether this part of the notation requirement has been met. The details listed in the following paragraphs shall be provided in the Lighting Test Report.

8.1 Test Details

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

- i)* Power source for lighting during testing
- ii)* External lighting conditions (e.g., Were measurements taken in port or at sea? Were measurements taken during daylight hours or after dark?).

8.2 Measurement Positions

Actual measurement locations shall be indicated on appropriate drawings.

8.3 Measurement Equipment Details

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

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

8.4 Results

The following results, per space, shall be provided in table format:

- i)* Name and number of space
- ii)* Activity areas (if any) in space
- iii)* Average lighting level for general lighting
- iv)* Average lighting level for activity lighting on each activity surface or plane in space
- v)* Presence of glare at specific activity surfaces within the space.

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

- i)* Name and number of space
- ii)* Visual inspection results
- iii)* Activity areas (if any) in space
- iv)* Single lighting level for general lighting (where appropriate)
- v)* Single lighting level for activity lighting on each activity surface or plane in space (where appropriate).

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 verification inspection results
- iii)* Spot measurement results (where appropriate).

8.5 Deviations

All deviations from the approved Test Plan shall be reported.

8.6 Surveyor Witnessing Documentation

An ABS Surveyor shall witness the equipment calibration and data collection process of the lighting tests. The ABS Surveyor shall provide documentation stating whether all steps of the lighting testing were completed to his/her satisfaction. A copy of the witnessing document shall be given to the person conducting the testing, for insertion into the final Lighting Test Report. The original shall be retained for the ABS files.

9 Results

The Lighting Test Report and test results shall be reviewed by the ABS Surveyor against the lighting criteria for determination of the notation confirmation.



APPENDIX 1 References

1 General References

- 1 American Bureau of Shipping. *Guide for Building and Classing Aluminum Vessels*. Houston, TX: Author.
- 2 American Bureau of Shipping. *Guide for Building and Classing High Speed Craft*. Houston, TX: Author.
- 3 American Bureau of Shipping. *Guide for Building and Classing Motor Pleasure Yachts*. Houston, TX: Author.
- 4 American Bureau of Shipping. *Guide for Building and Classing Passenger Vessels*. Houston, TX: Author.
- 5 American Bureau of Shipping. *Guide for Crew Habitability on Ships*. Houston, TX: Author.
- 6 American Bureau of Shipping. *Rule Requirements for Materials and Welding: Aluminum and Fiber Reinforced Plastics*. Houston, TX: Author.
- 7 American Bureau of Shipping. *Rules for Building and Classing Steel Vessels*. Houston, TX: Author.
- 8 American Bureau of Shipping. *Rules for Building and Classing Steel Vessels for Service on Rivers and Intracoastal Waterways*. Houston, TX: Author.
- 9 American Bureau of Shipping. *Rules for Building and Classing Steel Vessels Under 90 meters in Length*. Houston, TX: Author.

2 Accommodations References

- 1 American National Standards Institute. (1995). *Thermal environmental conditions for human occupancy* (ANSI/ASHRAE 55a-1995). Atlanta, GA: The American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
- 2 Human Factors Society, Inc. (1988). *American national standard for human factors engineering of visual display terminal workstations* (ANSI/HFS Standard No.100-1988). Santa Monica, CA: Author.
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- 14 U.S. Coast Guard, Department of Transportation. (1998). Coast Guard Regulation 32, Subpart 32.40, *Accommodations for officers and crew*, (Code of Federal Regulations, 46CFR32.40, pp. 398-400). Washington, DC: U.S. Government Printing Office.
- 15 U.S. Coast Guard, Department of Transportation. (1998). Coast Guard Regulation 92, Subparts 92.10 to 92.25, 92.10-1 to 92.25-90 *Construction and arrangement*, (Code of Federal Regulations, 46CFR92.10-92.25, pp. 51-56). Washington, DC: U.S. Government Printing Office.
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APPENDIX 2 Procedural Requirements for External Specialists Performing Ambient Environmental Testing

1 Terminology

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

External Specialists: Companies providing test or measurement services on behalf of the owner of a vessel or shipyard for the purposes of meeting ABS Habitability (**HAB** or **HAB+**) or Comfort (**COMF** or **COMF+**) notation requirements.

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

2 Objective

The objective of this procedure is to set basic standards for qualifying and certifying External Specialists performing ambient environmental testing and evaluation.

3 Application

This procedure applies to the approval of External Specialists that provide the following ambient environment test services:

- i) Whole-body Vibration measurements and analysis
- ii) Noise measurements and analysis
- iii) Indoor Climate measurement and analysis
- iv) Lighting measurement and analysis.

General requirements concerning External Specialists are given in this Appendix's 4.2, "General Requirements". Specific requirements for the test services listed above are in this Appendix's 8, "Detailed Requirements by Ambient Environmental Aspect".

4 Procedure for Approval and Certification

4.1 Submission of Documents

The following documents are to be submitted to an ABS Technical Office for review:

- i) An outline of the company (e.g., organization and management structure) including subsidiaries or subcontractors to be included in the approval/certification

- ii)* A list of company experience in the specific ambient environmental aspect
- iii)* A list of test personnel documenting training and experience in conducting tests within the relevant ambient environmental aspect and qualifications according to recognized national, international or industry standards, as relevant
- iv)* Description of equipment used for the measurement and analysis of the particular ambient environmental aspect for which approval is sought (e.g., calibration, accuracy, etc.)
- v)* A guide for operators of such equipment
- vi)* Training programs for test personnel
- vii)* Draft checklists and data recording sheets for recording results of the services referred to in this Appendix's 3, "Application"
- viii)* Quality Manual and/or documented procedures covering requirements in this Appendix's 4.5, "Quality Assurance System"
- ix)* Evidence of approval/acceptance by certifying bodies, if any
- x)* Information about other activities which may present a conflict of interest
- xi)* Record of customer claims and of corrective actions requested by certification bodies for the past year
- xii)* Where relevant, list and documentation of licenses granted by equipment's manufacturer.

4.2 General Requirements

4.2.1 Extent of approval

The External Specialist shall demonstrate, as required by this Appendix's 4.2.2 through 4.2.9, "General Requirements", that they have the competence, quality control and quality assurance needed to perform the test and analysis services for which approval is sought.

4.2.2 Training of personnel

The External Specialist is responsible for the qualification and training of its personnel to a recognized national, international or industry standard as applicable. Where such standards do not exist, the External Specialist is to define standards for the training and qualification of its personnel relevant to the functions each is authorized to perform. The personnel shall also have adequate experience and be familiar with the operation of any necessary equipment. Test personnel shall have had a minimum of one (1) year tutored on-the-job training.

4.2.3 Supervision

The External Specialist shall provide supervision for all services provided. The responsible supervisor shall have had a minimum of two (2) years experience in supervising tests in the ambient environmental aspect for which the External Specialist is approved.

4.2.4 Personnel records

The External Specialist shall keep records of the approved test personnel. The records shall contain information about formal education, training and experience for the ambient environmental test services for which they are approved.

4.2.5 Equipment and facilities

The External Specialist shall have the necessary equipment and facilities for the ambient environmental aspect to be tested. A record of the equipment used for ambient environmental testing shall be kept. The record shall contain information about maintenance and calibration.

4.2.6 Procedures

The External Specialist shall have documented work procedures covering all ambient environmental test services supplied.

4.2.7 Subcontractors

The External Specialist shall give information of agreements and arrangements if any parts of the services provided are subcontracted. Particular emphasis shall be given to quality management by the External Specialist in following-up of such subcontracts. Subcontractors providing anything other than subcontracted personnel or equipment shall also meet the requirements of this Appendix's 4.2, "General Requirements" and 4.5, "Quality Assurance System".

4.2.8 Verification

The External Specialist shall verify that the services provided are carried out in accordance with approved procedures.

4.2.9 Reporting

The report shall be prepared in a form acceptable to the ABS Technical Office as outlined within this Guide. The report shall include a copy of the Certificate of Approval.

4.3 Auditing of the External Specialist

Upon reviewing the submitted documents with satisfactory result, the External Specialist shall be audited every three (3) years in order to ascertain that the External Specialist is duly organized and managed in accordance with the submitted documents and that it is considered capable of conducting the test services for which approval/certification is sought.

4.4 Certification

Certification is conditional on a practical demonstration to the ABS Technical Office or its agent of the specific ambient environmental test service performance as well as a sample of a satisfactory report.

4.5 Quality Assurance System

The External Specialist shall have a documented system covering at least the following:

- i)* Operating instructions for the test equipment
- ii)* Maintenance and reference calibration of equipment
- iii)* Training programs for test personnel
- iv)* Supervision and verification to ensure compliance with test procedures
- v)* Recording and reporting of information
- vi)* Quality management of subsidiaries and sub-contractors
- vii)* Job preparation
- viii)* Periodic review of test process procedures, complaints, corrective actions and issuance maintenance and control of documents.

A documented Quality Assurance system complying with the applicable ISO 9000 standard or equivalent and including the above items would be considered acceptable.

4.6 External Specialist Relations with the Test Equipment Manufacturer

A company which works as a service station and conducts reference calibrations of equipment for a manufacturer (and is an External Specialist in this field) shall be assessed by the manufacturer(s) and nominated as their agent. The manufacturer shall ensure that appropriate instruction manuals, material, etc., are available for the agent as well as ensuring proper training of the agent's technicians has occurred. Such External Specialists shall be approved either on a case by case basis or as follows:

If a manufacturer of equipment (and External Specialist) applies for inclusion of its nominated agents and/or subsidiaries in the approval, then the manufacturer must have implemented a quality assurance system certified in accordance with the relevant ISO 9000 standard or equivalent. The manufacturer must have effective controls of its agents and/or subsidiaries and these agents/subsidiaries must have an equally effective quality control system complying with the relevant ISO 9000 or equivalent. Such approvals shall be based upon an evaluation of the quality assurance system implemented by the applicable company ISO 9000 or equivalent. The ABS Technical Office shall follow-up the adherence to this quality assurance system by performing audits on such agents or subsidiaries against the relevant ISO 9000 standard or equivalent.

5 Certificate of Approval

Upon satisfactory completion of both the audit of the External Specialist and practical demonstration, the ABS Technical Office shall issue a Certificate of Approval stating that the External Specialist's test and analysis service operation system has been found to be satisfactory and that the results of test and analysis services performed in accordance with that system may be accepted and utilized by ABS in making decisions affecting optional Habitability/Comfort classification notations. The Certificate shall clearly state the type and scope of services and any limitations or restrictions imposed. The External Specialist shall also be included in ABS's records of approved External Specialists.

Where several ambient environmental aspect measurements are conducted by a given company, each aspect is to be assessed and approved except as specified in this Appendix's 4.6, "External Specialist Relations with the Test Equipment Manufacturer".

5.1 Renewal

The Certificate of Approval is subject to renewal or endorsement at intervals not exceeding three (3) years per External Specialist procedure. The renewal or endorsement shall be accomplished by verification through audits to ensure that approved conditions are maintained.

6 Alterations

When any alteration to the certified test and analysis service operation system of the External Specialist is made, the ABS Technical Office is to be immediately notified. Re-audit may be required when deemed necessary by the ABS Technical Office.

7 Cancellation of Approval

Approval may be cancelled in the following cases:

- i)* Where the service was improperly carried out or the results were improperly reported
- ii)* Where deficiencies are found in the approved services of the External Specialist and appropriate corrective action is not taken
- iii)* Where the External Specialist fails to inform the ABS Technical Office of any alteration, as in this Appendix's 6, "Alterations"

- iv)* Where a renewal audit, if requested per this Appendix's 5.1, "Renewal", has not been carried out
- v)* Where willful acts or omissions are ascertained.

ABS Technical Office reserves the right to cancel the approval if any of these cases are met.

An External Specialist whose approval was cancelled may apply for re-approval provided the non-conformities, which resulted in cancellation, have been corrected and that the ABS Technical Office is able to confirm that the corrective action has been effectively implemented.

8 Detailed Requirements by Ambient Environmental Aspect

8.1 Whole-body Vibration

8.1.1 Extent of engagement

Whole-body vibration measurement External Specialists are engaged to conduct vibration measurements and analyses on board vessels.

8.1.2 Supervisor

The supervisor shall:

- i)* be qualified to Level II according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* be a Certified Industrial Hygienist (CIH) with experience in this ambient environmental aspect or
- iii)* have a documented history of at least two (2) years supervising vibration testing on board marine vessels.

The supervisor shall have sufficient knowledge of vessel structures and equipment, measurement and analysis of whole-body vibration according to BS 6841, to ensure that test procedures are compliant with the required test conditions.

8.1.3 Test personnel

The test personnel carrying out the measurements shall:

- i)* be qualified to Level I according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* have a documented history of at least two (2) years supervised experience in performing vibration environmental testing on board marine vessels.

The test personnel shall have adequate knowledge of vessel structures and equipment.

8.1.4 Equipment

The ABS Technical Office shall verify that the equipment to be used is in accordance with the applicable measurement standard. It shall be demonstrated to the ABS Technical Office that it is fit for the intended purpose.

8.1.5 Procedures

Documented work procedures or test instructions are to contain, at a minimum, information about the following:

- i)* Test preparation
- ii)* Selection and identification of measurement locations

- iii)* Surface preparation
- iv)* Calibration checks
- v)* Testing methods
- vi)* Equipment handling
- vii)* Report preparation and content
- viii)* Method for handling previous results if subsequent calibration shows instruments to be out of tolerance.

8.1.6 Reporting

The report shall be based on the instructions given in 3/8, "Test Report".

8.1.7 Verification

The External Specialist must include a copy of the ABS Surveyor's witness documentation in the Test Report.

8.2 Noise

8.2.1 Extent of engagement

Noise measurement External Specialists are engaged to conduct noise measurements and analyses on board vessels.

8.2.2 Supervisor

The supervisor shall:

- i)* be qualified to Level II according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* be a Certified Industrial Hygienist (CIH) with experience in this ambient environmental aspect or
- iii)* have a documented history of at least two (2) years supervising noise testing on board marine vessels.

The supervisor shall have sufficient knowledge of vessel structures, measuring equipment, ISO 2923, IEC 60651 and IEC 60804, to ensure that test procedures are compliant with the required test conditions.

8.2.3 Test personnel

The test personnel carrying out the measurements shall:

- i)* be qualified to Level I according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* have a documented history of at least two (2) years supervised experience in performing noise testing on board marine vessels.

The test personnel shall have adequate knowledge of vessel structures and measuring equipment.

8.2.4 Equipment

The ABS Technical Office shall verify that the equipment to be used is in accordance with the applicable measurement standard. It shall be demonstrated to the ABS Technical Office that it is fit for the intended purpose.

8.2.5 Procedures

Documented work procedures or test instructions are to contain, at a minimum, information about the following:

- i)* Test preparation
- ii)* Selection and identification of measurement locations
- iii)* surface preparation
- iv)* Calibration checks
- v)* Testing methods
- vi)* Equipment handling
- vii)* Report preparation and content
- viii)* Method for handling previous results if subsequent calibration shows instruments to be out of tolerance.

8.2.6 Reporting

The report shall be based on the instructions given in 4/8, "Test Report".

8.2.7 Verification

The External Specialist must include a copy of the ABS Surveyor's witnessing documentation in the Test Report.

8.3 Indoor Climate

8.3.1 Extent of engagement

Indoor climate measurement External Specialists are engaged to conduct indoor climate measurements and analyses on board vessels.

8.3.2 Supervisor

The supervisor shall:

- i)* be qualified to Level II according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* be a Certified Industrial Hygienist (CIH) with experience in this ambient environmental aspect or
- iii)* have a documented history of at least two (2) years supervising ambient environmental testing on board marine vessels.

The supervisor shall have sufficient knowledge of vessel structures, measuring equipment, ANSI/ASHRAE 55a and ISO 7726, to ensure that test procedures are compliant with the required test conditions.

8.3.3 Test personnel

The test personnel carrying out the measurements shall:

- i)* be qualified to Level I according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* have a documented history of at least two (2) years supervised experience in performing ambient environmental testing on board marine vessels.

The test personnel shall have adequate knowledge of vessel structures and equipment.

8.3.4 Equipment

The ABS Technical Office shall verify that the equipment to be used is in accordance with the applicable measurement standard. It shall be demonstrated to the ABS Technical Office that it is fit for the intended purpose.

8.3.5 Procedures

Documented work procedures or test instructions are to contain, at a minimum, information about the following:

- i)* Test preparation
- ii)* Selection and identification of measurement locations
- iii)* Surface preparation, if applicable
- iv)* Testing methods
- v)* Equipment handling
- vi)* Report preparation and content
- vii)* Method for handling previous results if subsequent calibration shows instruments to be out of tolerance.

8.3.6 Reporting

The report shall be based on the instructions given in 5/8, "Test Report".

8.3.7 Verification

The External Specialist must include a copy of the ABS Surveyor's witnessing documentation in the Test Report.

8.4 Lighting

8.4.1 Extent of engagement

Lighting measurement External Specialists are engaged to conduct illuminance measurements and analyses on board vessels.

8.4.2 Supervisor

The supervisor shall:

- i)* be qualified to Level II according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* be a Certified Industrial Hygienist (CIH) with experience in this ambient environmental aspect or
- iii)* have a documented history of at least two (2) years supervising ambient environmental testing on board marine vessels.

The supervisor shall have sufficient knowledge of vessel structures, measuring equipment and IESNA RP-12, to ensure that test procedures are compliant with the required test conditions.

8.4.3 Test personnel

The test personnel carrying out the measurements shall:

- i)* be qualified to Level I according to a recognized national or international Non-Destructive Testing (NDT) standard (ANSI/ASNT CP-189, ISO 9712 or EN 473) or
- ii)* have a documented history of at least two (2) years supervised experience in performing ambient environmental testing on board marine vessels.

The test personnel shall have adequate knowledge of vessel structures and equipment.

8.4.4 Equipment

The ABS Technical Office shall verify that the equipment to be used is in accordance with the applicable measurement standard. It shall be demonstrated to the ABS Technical Office that it is fit for the intended purpose.

8.4.5 Procedures

Documented work procedures or test instructions are to contain, at a minimum, information about the following:

- i)* Test preparation
- ii)* Selection and identification of measurement locations
- iii)* Surface preparation
- iv)* Calibration checks
- v)* Testing methods
- vi)* Equipment handling
- vii)* Report preparation and content
- viii)* Method for handling previous results if subsequent calibration shows instruments to be out of tolerance.

8.4.6 Reporting

The report shall be based on the instructions given in 6/8, "Test Report".

8.4.7 Verification

The External Specialist must include a copy of the ABS Surveyor's witnessing documentation in the Test Report.

9 References

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- 2 American Society for Nondestructive Testing. (1995). *Qualification and certification of nondestructive testing personnel* (ANSI/ASNT CP-189-1995). Washington, DC: American National Standards Institute.
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- 5 Illuminating Engineering Society of North America. (1997). *Recommended practice for marine lighting* (IESNA RP-12-97). New York: Author.
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APPENDIX 3 Accommodations Criteria

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Access/Egress		
	Requirement	Meets COMF Requirements
DOORS		
GENERAL		
1	Doors in all accommodations spaces, stairways, stair towers and corridors are oriented vertically.	
2	All doors are capable of operation from either side by one person.	
3	If doors are equipped with rectangular vision panels, the panels are approximately 200 mm (8 in) wide by 500 mm (20 in) high, or 400 mm (16 in) by 400 mm (16 in) and centered 1600 mm (63 in) above the deck.	
4	If doors are equipped with round vision panels, the panels are approximately 250 mm (10 in) in diameter and are centered 1600 mm (63 in) above the deck.	
5	Glass sliding doors have a means to show if they are open or closed.	
6	Handles for sliding doors are designed to avoid accidental crushing of fingers.	
7	All doors are operable with one hand.	
8	The initial force required to open a vertical door in passenger spaces, does not exceed: <ul style="list-style-type: none"> ▪ Hinged doors: 65 Newton (14.6 pounds) ▪ Sliding doors: 50 Newton (11.2 pounds). 	
9	Vertical doors have the following dimensions: <ul style="list-style-type: none"> ▪ a clear opening width of at least 915 mm (36 in) in width ▪ the sum of the width of all doors and passageways used as means of escape is greater than 8.5 mm (0.333 in) multiplied by the number of persons for which the space is designed ▪ the distance from the deck to the top of the door is at least 2030 mm (80 in). 	
EMERGENCY		
10	Every door, hatch, or scuttle used as a means of escape is capable of being operated by one (1) person, from either side, in both light and dark conditions.	
11	The method of opening a means of escape is obvious and rapid.	
12	Doors in accommodation spaces (with the exception of staterooms), stairway, stair tower, passageway, or control space, open in the direction of escape, where practicable.	

Accommodations Criteria – Access/Egress		
	Requirement	Meets COMF Requirements
13	The means of escape is adequately marked if it is not readily apparent to a person from both the inside and outside.	
14	Deck scuttles that serve as a means of escape are fitted with a quick acting release and a holdback device to hold the scuttle in an open position.	
15	Deck scuttles that serve as a means of escape have the following dimensions: <ul style="list-style-type: none"> ▪ at least 670 mm (26.4 in) in diameter if round ▪ at least 330 mm (13 in) by 670 mm (26.4 in) if rectangular. 	
16	Access to lifeboats is provided such that a person in a stretcher can be easily embarked into the survival craft (e.g., a ramp).	
RAILINGS		
17	Rails are installed parallel to the deck along deck edges and walkways and around open hatches, elevators, antenna platforms and along other boundaries in the following areas: <ul style="list-style-type: none"> ▪ wherever there is danger falling 610 mm (24 in) or more ▪ Wherever there is danger of passengers becoming enmeshed with hazardous operating machinery ▪ around every unprotected opening in a floor or deck into which a person may slip, trip or fall. 	
18	Suitable storm rails/handrails are provided in all interior passageways where passengers have normal access and have the following design: <ul style="list-style-type: none"> ▪ storm rails/handrails are installed on both sides of passageways that are 1830 mm (72 in) or more in width ▪ storm rails/handrails are 865 mm (34 in) to 965 mm (38 in) high ▪ the distance between storm rails/handrails and any obstruction is 75 mm (3 in) or greater. 	
19	Deck/guard railings have the following design: <ul style="list-style-type: none"> ▪ the heights of rails or bulwarks are at least 1070 mm (42 in) from the deck ▪ rail courses or equivalent are installed between a top rail and the deck so that the opening below the lowest course does not exceed 230 mm (9 in) and the distance between the remaining courses is not more than 380 mm (15 in) ▪ toeboards which are 100 mm (4 in) in height and have no more than a 6 mm (0.25 in) clearance between the bottom edge of the toeboard and the walking surface ▪ vertical stanchions for railings are spaced no more than 2400 mm (96 in) apart ▪ chain or wire rope used as a rail is set such that the sag is not greater than 25 mm (1 in) at the chain/ropes centerspan ▪ maximum lengths of openings protected by wire or chain are 1830 mm (72 in). 	

Accommodations Criteria – Access/Egress		
	Requirement	Meets COMF Requirements
STAIRS		
20	Curved, spiral, or winding stairways have the specific approval of the Flag Administration.	
21	A clear landing at least as wide as the tread width and a minimum of 915 mm (36 in) long is provided at the top and bottom of each stairway.	
22	Any change of direction in a stairway is accomplished by means of an intermediate landing at least as wide as the tread width and a minimum of 915 mm (36 in) long.	
23	An intermediate landing is provided at each deck level serviced by a stair, or a maximum of every 3.6 m (12 ft) of vertical travel for stairs with a vertical rise of 6.1 m (20 ft.).	
24	Passenger stairways have a maximum angle of inclination from the horizontal of 38 degrees.	
25	Clear headroom (free height) maintained in all stairs is at least 2030 mm (80 in).	
26	Stair risers and treads have the following design: <ul style="list-style-type: none"> ▪ the riser height is no more than 200 mm (8 in) and the tread depth is approximately 280 mm (11 in), including a 25 mm (1 in) tread nosing ▪ in an individual flight of stairs in a stairway or stair tower, the depth of the tread and the height of riser are consistent ▪ the minimum tread width on stairs is at least 915 mm (36 in) ▪ the minimum tread width for stairs used in emergencies is 1120 mm (44 in) ▪ once a minimum tread width has been established at any deck, it is not decreased in the direction of escape ▪ all nosings have a non-slip surface. 	
27	Stairway or stair towers are fitted with handrails with the following design: <ul style="list-style-type: none"> ▪ the handrail is on both sides of the stair ▪ the vertical height above the tread at its nosing is at least 890 mm (35 in) ▪ the handrails are parallel to the pitch line of the stair flight and level at landings ▪ the handrail is continuous from the top to the bottom of the stairway and terminates in a safe manner at both ends ▪ the distance between handrails and any obstruction is 75 mm (3 in) or greater ▪ stairways or stair towers of more than 1680 mm (66 in) in width are also fitted with a center handrail ▪ handrails on adjacent, parallel stair flights have a minimum of 100 mm (4 in) clear distance between rails. 	

Accommodations Criteria – Access/Egress		
	Requirement	Meets COMF Requirements
PASSAGEWAY/WALKWAY DESIGN		
28	<p>Passageways or walkways have the following design features:</p> <ul style="list-style-type: none"> ▪ designed so that passenger areas can be evacuated as quickly as possible in an emergency ▪ free from obstructions and hazards ▪ for ease of passenger orientation, passageways, stairways, connection doors, emergency exits, etc., should be located in the same place and direction at each level. 	
29	The walkway width for normal traffic or any means of egress that leads to an exit or entrance is at least 915 mm (36 in).	
30	The corridor or passageway width, which serves as a required exit, is at least 1.1 m (44 in).	
31	Headroom in all passageways is at least 2030 mm (80 in).	
LADDERS		
32	All ladders and handrails are located so as not to interfere with the opening and closing of hatches, doors, gratings, or manholes.	
33	<p>Each ladder used as a means of escape has the following design features:</p> <ul style="list-style-type: none"> ▪ the ladder is mounted at least 205 mm (8 in) from the nearest permanent object in the back of the ladder ▪ rungs are at least 410 mm (16 in) in width ▪ rungs are between 275 mm (11 in) and 300 mm (12 in) apart ▪ rungs are uniformly spaced for the length of the ladder ▪ the side rails of an open-air vertical ladder extend at least 1070 mm (42 in) above top level ▪ there is at least 760 mm (30 in) clearance in front of the ladder (climbing space) ▪ safety treads are located at the head and foot of all inclined ladders. 	
34	Where vertical ladders lead to hatches, manholes or passageways, horizontal or vertical handgrabs or grab bars are provided that extend at least 1070 mm (42 in) above the landing platform or access/egress level served by the ladder.	
RAMPS		
35	Ramps are sloped between 8 and 15 degrees for inclined walking surfaces.	
36	Ramps have a non-skid surface.	
37	Ramps have a handrail on any open side of the ramp if the distance from the ramp to the nearest adjacent surface is 610 mm (24 in) or more.	
WINDOWS		
38	Windows or port lights in bulkheads adjacent to passageways do not extend below a point 910 mm (36 in) above the deck unless storm rails/handrails (structurally independent of the glass) are fitted in the passageways.	
39	All port lights are equipped with a cover. In air conditioned spaces the cover is fitted on the air conditioned side.	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Berthing		
	Requirement	Meets COMF Requirements
LOCATION		
1	Passenger cabins are not located: <ul style="list-style-type: none"> ▪ further forward in the vessel than a vertical plane located at five (5) percent of the vessel’s length abaft of the forward side of the stem at the designed summer load water line ▪ immediately beneath working alleyways ▪ below the load line amidships or aft ▪ forward of the collision bulkhead. 	
2	Main steam and exhaust pipes for winches, electric cableways, ducting and similar gear/equipment do not pass through alleyways leading to passenger accommodations or through the passenger accommodations.	
3	Location, means of access, structure and arrangement in relation to other spaces of passenger accommodations is to: <ul style="list-style-type: none"> ▪ ensure adequate security ▪ protect against weather and sea ▪ insulate from heat and cold ▪ insulate from undue noise and effluvia from other spaces. 	
4	Officer and crew cabins are secluded from passengers.	
ROOM DESIGN		
General		
5	Maximum number of persons to be accommodated in any cabin is marked indelibly and legibly in some conveniently seen place in the room.	
6	An individual letter or number clearly visible from outside the room identifies each cabin.	
7	Double occupancy cabins are at least 13.9 m ² (150 ft ²) in area.	
8	Deck coverings (e.g., mats, carpeting, etc.) are supplied where slips are possible due to occasional water or liquid on the floors.	
9	Wall surfaces and decks in sleeping rooms are washable and impervious to damp or moisture absorption.	
10	Painted wall surfaces in sleeping rooms are light in color.	
11	Internal bulkheads are of approved material that is not likely to harbor vermin.	
12	Wall surfaces are not constructed from tongued and grooved boarding or any other form of construction likely to harbor vermin.	
13	Ventilation ducts or other installations do not obstruct berthing arrangements.	
14	HVAC vents shall not be directed at the heads of berths.	
15	Radiators and other heating apparatus are so placed and, where necessary, shielded as to avoid risk of fire or danger or discomfort to the occupants.	

Accommodations Criteria – Berthing		
	Requirement	Meets COMF Requirements
16	Passenger living and recreation and leisure spaces have different color schemes to provide personnel with a visual change in environment in their daily routines.	
Emergency		
17	An emergency alerting system is present for all passenger cabins.	
18	Every door used as a means of escape is capable of being operated by one (1) person, from either side, in both light and dark conditions.	
19	The method of opening a means of escape is obvious and rapid.	
20	A means of escape that is not readily apparent to a person from both the inside and outside of the space is adequately marked.	
Outfitting		
21	Drawers and doors have latches (operable with one hand) to prevent opening and closing due to vessel movement.	
22	Kick space 100 mm (4 in) high by 100 mm (4 in) deep is provided around clothes lockers, berths, etc.	
23	The door latch design is such that it is obvious when the drawer or door is not fastened/locked.	
24	Cabins with port lights have curtains.	
25	Grab bars and stepping surfaces are provided for access to upper berths, if equipped.	
26	An electric reading light is provided at the head of each berth.	
27	A means of switching on/off room lighting is provided so that no person must enter a darkened cabin.	
28	Mattresses are innerspring construction. The finished thickness is 180 ± 13 mm (7 ± 0.5 in).	
29	Each passenger cabin is provided with the following furniture as a minimum: <ul style="list-style-type: none"> ▪ clothes lockers ▪ a table and chair ▪ a mirror with a light ▪ a small cabinet for toilet requisites for each person in the room ▪ a book rack. 	
30	Furniture is of smooth, hard material not liable to warp or corrode.	
DIMENSIONAL ASPECTS		
General		
31	Outside corners of cabin bulkheads, doors, etc., have a radius of 0.75 mm (0.03 in) or more.	
32	All edges that passengers may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	

Accommodations Criteria – Berthing		
	Requirement	Meets COMF Requirements
33	Headroom in all cabins is at least 2050 mm (80 in).	
Berths		
34	Berths are at least 405 mm (16 in) above the deck.	
35	Head clearance above each berth is at least 81 cm (32 in).	
36	Berth inside dimensions are at least 202 cm (80 in) by 96.5 cm (38 in).	
Doors		
37	Doors to cabins are at 1980 mm (78 in) high by 660 mm (26 in) wide or more.	
38	Doors to cabins can be locked from the inside with an ability to override the lock from the outside in the event of an emergency.	
39	The initial force required to open the door does not exceed 65 Newtons (14.6 pounds).	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Sanitary Spaces		
	Requirement	Meets COMF Requirements
GENERAL		
1	Non-slip type deck covering is supplied in all sanitary spaces.	
2	Public sanitary spaces are gender identifiable without entering the space.	
3	Someone standing on a wet deck in sanitary spaces cannot reach light switches or electrical outlets without ground fault interrupters.	
4	Radiators and other heating apparatus are placed, and where necessary, shielded to avoid risk of fire, danger or discomfort to the occupants.	
5	Ingress and egress in public sanitary spaces are arranged to avoid the need to pass through the toilet area enroute to the washbasin areas.	
6	Toilets are located as far from access doors into the sanitary space as practicable.	
7	Single or double occupancy cabins have a private sanitary space with a toilet, shower or tub and washbasin modules.	
8	Washbasins, toilets and urinals are located so that, when in use, passengers face forward or aft.	
9	Free space area per person in sanitary spaces is at least 1.1 m ² (12 ft ²).	
10	Drawers and doors have latches: <ul style="list-style-type: none"> ▪ to prevent opening and closing due to vessel motion ▪ that are operable with one hand ▪ that are designed so that it is obvious when the drawer or door is not fastened/locked. 	
11	Headroom in all sanitary spaces is at least 2050 mm (80 in).	
12	All edges that passengers may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	
13	Outside corners of sanitary space bulkheads, doors, etc., have a radius of 0.75 mm (0.03 in) or more.	
14	A kick space 100 mm (4 in) high by 100 mm (4 in) deep is provided at the base of dressers, counters, etc.	
SHOWERS/BATHS		
15	All showers and baths are equipped with adequate plumbing, including hot and cold potable running water.	
16	Water heaters supplying showers: <ul style="list-style-type: none"> ▪ do not support areas that have higher water temperature requirements, such as food service areas ▪ are provided with anti-scalding devices. 	
17	Handholds are provided for shower and bath sanitary spaces.	
18	Showers are individual stall types with minimum dimensions of 900 mm (36 in) by 900 mm (36 in).	

Accommodations Criteria – Sanitary Spaces		
	Requirement	Meets COMF Requirements
19	In sanitary spaces intended for more than one (1) person, the shower is screened.	
20	Baths, where provided, are at least 1680 mm (66 in) long by 690 mm (27 in) wide and 560 mm (22 in) deep.	
21	Hot water is supplied to showers within ten (10) seconds.	
CLEANING/MAINTENANCE		
22	Clearance is provided around and behind sanitary fixtures: <ul style="list-style-type: none"> ▪ to easily adjust, service, or repair them ▪ to reach important plumbing connections and pipes ▪ to facilitate cleaning. 	
23	Decks and bulkhead surfaces are easily cleaned and impervious to damp or moisture absorption.	
24	Areas likely to get soiled are accessible for cleaning.	
25	Fixtures are bulkhead mounted for ease of cleaning.	
26	Cleaning gear locker with service sink and deck drain is located near sanitary spaces.	
TOILETS		
27	Public toilets have doors, which are self-closing and lockable from the inside.	
28	The width of the toilet stall is 810 mm (32 in) or greater.	
29	The clearance between the toilet and the stall door is at least 915 mm (36 in).	
30	All toilets have adequate plumbing for flushing.	
31	All toilet spaces have a hand washing station.	
32	All toilets have ventilation to the open air, independent of any other part of the space.	
33	All sanitary spaces are ventilated sufficiently to be reasonably free of disagreeable odors and condensation.	
34	Gravity flush toilets face fore and aft to minimize the siphoning effect on traps due to vessel roll.	
35	Toilet enclosures begin no more than 300 mm (12 in) above the floor.	
36	Handholds are provided for use of toilets.	
WASHBASINS		
37	All washbasins are equipped with adequate plumbing, including hot and cold potable running water.	
38	Water heaters supplying washbasins: <ul style="list-style-type: none"> ▪ do not support areas that have higher water temperature requirements ▪ are provided with anti-scalding devices. 	
39	Facilities to dry hands are provided at all washbasins.	
40	Washbasins are constructed of material with a smooth surface not liable to crack, flake or corrode.	

Accommodations Criteria – Sanitary Spaces		
	Requirement	Meets COMF Requirements
41	The dimension between the centerlines of two hand washbasins side-by-side is 710 mm (28 in) or greater.	
42	The dimension between the centerline of a hand washbasin and a bulkhead next to the hand washbasin is 380 mm (15 in) or greater.	
43	The top of the washbasin is between 735 mm (29 in) and 915 mm (36 in) above the deck surface.	
44	Washbasins are large enough so that users can get their hands and faces inside it without bumping their heads on the faucet or having water run down their arms.	
45	Hot water is supplied to washbasins within 10 seconds.	
URINALS		
46	Urinals have privacy partitions between units and at the end of rows if not provided by permanent structures.	
47	The dimension between the centerline of two (2) urinals side-by-side is 690 mm (27 in) or greater.	
48	The dimension between the centerline of a urinal and a bulkhead next to the urinal is 380 mm (15 in) or greater.	
49	The height of the front edge of a urinal is between 455 mm (18 in) and 605 mm (24 in) above the deck surface.	
50	Handholds are provided for use of urinals.	
51	Partitions between urinals start 530 mm (21 in) or less above and run to 1450 mm (57 in) or more above the deck.	
52	Partitions between urinals mounted against the bulkhead and protrude at least 460 mm (18 in) toward the user.	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Office		
	Requirement	Meets COMF Requirements
GENERAL		
1	Painted wall surfaces and deck heads in offices are light in color.	
2	Drawers and doors have latches: <ul style="list-style-type: none"> ▪ to prevent opening and closing due to vessel motion ▪ that are designed so that it is obvious when the drawer or door is not fastened/locked. 	
3	Open shelves have battens and upward flanged edges on open sides to retain their contents.	
4	Headroom in all offices is at least 2050 mm (80 in).	
5	Port lights are installed in each office, based on each 3 m (10 ft.) of weather boundary.	
DIMENSIONAL ASPECTS		
6	Offices that must accommodate up to two (2) visitors: <ul style="list-style-type: none"> ▪ have a minimum desk working/meeting surface area of 1.7 m² (18 ft²) ▪ occupy a floor area of at least 2590 mm (102 in) by 2590 mm (102 in). 	
7	Service counters are between 1015 mm (40 in) and 1040 mm (41 in) high.	
8	A kick space of approximately 100 mm (4 in) high by 100 mm (4 in) deep is provided at the base of the counter, on the passenger side.	
9	Outside corners of office bulkheads, doors, etc., have a radius of 0.75 mm (0.03 in) or more.	
10	All edges (e.g., on furniture) that passengers may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Food Service Areas		
	Requirement	Meets COMF Requirements
GENERAL		
1	Non-slip type deck covering is supplied where occasional water, oil or liquid on the floors is expected.	
2	Painted wall surfaces and deck heads are light in color.	
3	Wall and deck surfaces are capable of being easily cleaned.	
4	Access is provided to all areas requiring cleaning, painting, or treating with pesticide/insecticide.	
5	There are no crevices or inaccessible voids, which might harbor vermin, cooking or food waste, or other extraneous matter.	
6	Food preparation areas are protected against leakage or seepage of lubricants or other extraneous or foreign substances.	
7	Distributive systems such as piping, wiring and HVAC ducts are minimized in food service areas.	
8	Outside corners of food service bulkheads, doors, etc., have a radius of 13 mm (0.5 in) or more.	
9	All edges that personnel may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	
10	Flow of food through vessel allows for adequate separation of clean and soiled operations.	
11	Headroom in food service areas is at least 2050 mm (80 in).	
12	Door characteristics: <ul style="list-style-type: none"> ▪ doors should be easily cleaned ▪ traffic doors in mess and galley areas are provided with stainless steel push and kick plates. 	
DINING AREAS		
General		
13	Dining lines and Dining rooms are protected from weather, objectionable sights (such as garbage disposal areas) and objectionable odors (such as from engines, holds, toilets, fire room, etc.).	
14	Lighting in dining rooms is provided by means of natural light and artificial light.	
15	The tops of tables and seating are capable of being easily cleaned.	
Outfitting		
16	Tray slides (or rails) are provided along food and beverage serving lines.	
17	A transparent sanitation shield is installed to completely shield the entire length of the food serving lines above the tray rail.	

Accommodations Criteria – Food Service Areas		
	Requirement	Meets COMF Requirements
Dimensional Aspects		
18	Tray rails are between 780 mm (31 in) and 940 mm (37 in) above the deck surface.	
19	The distance between the bottom of the sanitary shield protecting the food and the top of the tray rail is at least 255 mm (10 in).	
20	Table space is at least 740 mm (29 in) wide by 430 mm (17 in) deep for each diner.	
21	Dining tables are between 710 mm (28 in) and 760 mm (30 in) high with at least 180 mm (7 in) clearance between the top of the seat and the bottom of the table structure.	
22	Deck area requirements for seating are at least 1.7 m ² (18.4 ft ²) per person.	
23	The width of serving aisles, measured from service counter or outside edge of tray rail if present, is at least 1118 mm (44 in).	
24	Distance between tables with back to back seating is at least 1525 mm (60 in).	
25	Distance between the seating side of a table and the nearest obstruction is at least 1070 mm (42 in).	
26	Table depth for facing diners is at least 915 mm (36 in).	
GALLEY/SCULLERY		
General		
27	Ventilation hoods are designed to prevent grease or condensation from dripping into food or onto food preparation surfaces.	
28	Toilet and washbasin facilities of suitable design and the following characteristics are provided for crew members: <ul style="list-style-type: none"> ▪ easily-serviced hand washing stations are provided so that no crew member must walk more than 7.5 m (25 ft.) to a station. Slop sinks and scullery sinks are not satisfactory hand washing stations ▪ crew members do not have to squat or reach excessively to wash hands at hand washing station ▪ crew members do not have to travel through a door to reach a hand washing station ▪ hand washing facilities in the galleys have mixing taps which can be operated without the use of the hands. 	
Potable Water		
29	Only potable water is piped to food storage, preparation, or service areas. The exceptions are a food waste grinder eductor (garbage disposal) line and deck washing facilities. The grinder delivery line is protected against back flow.	
30	Potable hot and cold water is easily accessible in all rooms where food is prepared and utensils are cleaned.	
31	Hot and cold potable water available in garbage rooms for washing garbage cans.	
32	Potable water tanks are identified with a number and the words “POTABLE WATER” in letters at least 50 mm (2 in) high.	

Accommodations Criteria – Food Service Areas		
	Requirement	Meets COMF Requirements
33	<p>Potable water piping and fittings are identified as follows:</p> <ul style="list-style-type: none"> ▪ marked on each side of partitions, decks and bulkheads ▪ striped with a 50 mm (2 in) wide blue band at 4575 mm (15 ft.) intervals or, ▪ use a pipe marker label with blue bands with letters ▪ piping marked with flow direction arrows. 	
Drains		
34	There are no floor drains inside provision rooms except the thaw room.	
35	Drainage gutters for flood cleaning of decks are easily accessible for cleaning.	
Maintenance/Cleaning		
36	<p>Cutting boards are:</p> <ul style="list-style-type: none"> ▪ not made of wood ▪ readily removable for cleaning or easily cleanable in place. 	
37	Drawers and bins used as food contact surfaces are readily removable and easily cleaned.	
38	Covers, insets, or receptacles for unpackaged foods or beverages are easily removable or designed for easy cleaning in place.	
39	Stove top or range sea rails are readily removable and easily cleanable, and brackets for sea rails are easily cleanable.	
40	All deck-mounted equipment is elevated on legs that extend at least 150 mm (6 in) above the finished deck to allow for cleaning.	
41	Table mounted equipment, unless easily movable, is either sealed to the tabletop or mounted on legs at least 100 mm (4 in) above the table top to allow cleaning.	
42	Equipment can be operated, maintained and repaired from the front in order to minimize total vessel area and volume requirements and to facilitate maintenance where possible.	
Refrigeration/Freezer		
43	Thermometer is placed in warmest zone of each refrigerator and freezer. A display of the temperature can be read with ease from the inside and outside of the unit.	
44	Refrigerators for the storage of foods are capable of maintaining a temperature at or below 7 °C (45 °F) at all times.	
45	<p>In each freezer and cold storage room there is:</p> <ul style="list-style-type: none"> ▪ an alarm which indicates if a person is “locked-in” ▪ a rising temperature alarm. 	
46	The temperature of the freezer is -20 °C (-9 °F) or lower.	

Accommodations Criteria – Food Service Areas		
	Requirement	Meets COMF Requirements
	Dishwashing	
47	Dish washing machine installation provides: <ul style="list-style-type: none"> ▪ wash water in the machine in the temperature range of 60 – 71 °C (140 – 160 °F) ▪ adequate water supply at 103.4 to 172.4 kPa (15 to 25 psi) of flow pressure on the final rinse line at the machine and not less than 69 kPa (10 psi) at the rinse nozzles ▪ adequate water-heating facilities to maintain a temperature of 82 °C (180 °F) in the final wash-water rinse line ▪ sufficient racks and clean utensil storage area to permit air drying (i.e., 15 seconds) before removal of utensils from racks following washing ▪ an easily readable thermometer for each tank and the final rinse-water line. 	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Recreation		
	Requirement	Meets COMF Requirements
GENERAL		
1	Recreation accommodations, conveniently situated and appropriately furnished are provided for passengers.	
2	The recreational area (s) goal is to provide space for 1/3 of the passengers to participate simultaneously in some form of leisure activity.	
3	Non-slip type deck covering is supplied where occasional water or liquid on the floors is expected.	
4	Painted wall surfaces and deck heads are light in color.	
5	Recreation areas are adequately insulated to prevent condensation or overheating.	
EXERCISE AREAS		
6	Swimming and splash-pools have been provided.	
7	If a swimming pool is a recirculating pool, it is to be capable of complete circulation, replacement and/or filtration of the pool water every six hours or less.	
8	If a swimming pool is a flow-through salt water pool: <ul style="list-style-type: none"> ▪ the water delivery pipe to the pool is separate from any other pipes ▪ the water delivery pipe originates at a point where maximum flushing of the pump and pipe line is effected after leaving polluted waters ▪ it is capable of complete circulation, replacement and/or filtration of the pool water every six hours or less. 	
9	Exercise equipment is provided for passengers.	
10	Physical conditioning equipment is sufficient to provide 1/3 of the passengers with 3, 30-minute exercise periods per week.	
11	Physical conditioning equipment permits aerobic, flexibility and strength training capabilities.	
12	The deck area provided for passenger exercise for each physical fitness station within the exercise space is at least 4.5 m ² (48 ft ²).	
RECREATION AREAS		
13	Shelves have battens and upward flanged edges on open sides to retain their contents.	
14	Natural light shall be provided to the following, where appropriate: <ul style="list-style-type: none"> ▪ recreation areas ▪ canteens ▪ coffee bars. 	

Accommodations Criteria – Recreation		
	Requirement	Meets COMF Requirements
15	At least 1.39 m ² (15 ft ²) is provided for each seat in the lounge.	
DIMENSIONAL ASPECTS		
16	Outside corners of recreation area bulkheads, doors, etc., have a radius of 0.75 mm (0.03 in) or more.	
17	All edges that passengers may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	
18	Headroom in recreational areas is at least 2050 mm (80 in).	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Laundry		
	Requirement	Meets COMF Requirements
GENERAL		
1	Appropriate clearance has been provided for equipment maintenance.	
2	Air vents from laundry space are not re-circulated in the vessel.	
OUTFITTING		
3	Ironing boards are covered with a fireproof cloth cover.	
4	Tumble dryers, if provided, are exhausted directly into the weather, not into the vessel.	
5	Tumble dryers, if provided, are equipped with lint filters in the ventilation extract line and have hinged access panels designed for safe and effective daily cleaning.	

Appendix 3 Accommodations Criteria

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Passenger Accommodations Criteria – Medical		
	Requirement	Meets COMF Requirements
GENERAL		
1	Separate hospital accommodations are provided in vessels engaged in a voyage of more than three days’ duration.	
2	Separate medical/first aid treatment accommodations are provided in vessels engaged in a voyage of less than three days’ duration.	
3	The hospital is fitted with berths in the ratio of 1 berth to every 12 passengers or portion thereof. The number of hospital berths need not exceed 6.	
4	Interior finish materials and furnishings are designed to ease cleaning efforts and improve hospital and medical/first aid accommodations maintenance.	
5	Hospital and medical/first aid accommodations are always ready to receive sick or injured patients.	
6	Hospital and medical/first aid accommodations are not used as a storage area except for medical supplies.	
7	Hospital and medical/first aid accommodations are suitably located to allow for safe and efficient: <ul style="list-style-type: none"> ▪ access for sick or injured passengers ▪ stretcher transportation from accommodations or leisure areas. 	
8	Hospital and medical/first aid accommodations are suitably separated from other spaces and is used for the care of the sick or injured and for no other purpose.	
9	Hospital and medical/first aid accommodations are suitably designed so that the patients may be comfortably housed and receive proper attention in all weathers.	
10	Painted wall surfaces and deck heads are light in color.	
11	Non-slip type deck coverings are supplied where occasional water or liquid on the deck is expected.	
12	The arrangement of the entrance, berths, lighting, ventilation, heating and water supply is designed to ensure the comfort and to facilitate the treatment of passengers.	
OUTFITTING		
13	If the vessel has hospital accommodations, it is staffed with a doctor.	
14	If the vessel has medical/first aid accommodations, it is staffed with a person with suitable medical certification capable of rendering medical attention.	
15	The hospital has the necessary suitable equipment such as a clothes locker, a table and a seat based on the number of possible patients.	
16	The hospital is equipped with a means of sterilizing instruments.	
17	The hospital has a toilet, washbasin and bathtub or shower conveniently situated within the space for the exclusive use of the patients.	
18	The door to the toilet and washbasin shall open outwards and any door latch shall be capable of being opened from the outside.	
19	The medical/first aid accommodations has a toilet and washbasin conveniently situated within the space for the exclusive use of the medical personnel and the patients.	
20	Hospital and medical/first aid accommodations are equipped with first aid kits, which are immediately available for each medically trained person.	

Passenger Accommodations Criteria – Medical		
	Requirement	Meets COMF Requirements
21	The hospital is equipped with a bedside table with a drawer and cabinet for each berth.	
22	Hospital sanitary facilities have a call system for emergency use by patients.	
23	Hospital and medical/first aid accommodations are equipped with stretchers that meet the following: <ul style="list-style-type: none"> ▪ the ability to winch a sick or injured person into a helicopter or vessel. Such a stretcher shall have the capability of floating and self-righting itself in the water. ▪ collapsible and suitable for use in confined spaces. 	
24	A separate water system supplying potable water to the hospital and medical/first aid accommodations is installed.	
25	Hospital and medical/first aid accommodations are equipped with a bed or couch approachable from three sides.	
26	Hospital and medical/first aid accommodations are situated and arranged so that a stretcher can be easily carried into it and placed alongside an examination table or bed.	
27	Hospital and medical/first aid accommodations have lockable storage for drugs, dressings and medical equipment.	
28	The hospital has a bath accessible from three sides.	
29	Hospital and medical/first aid accommodations have an intercom or signaling system (e.g., an emergency call device) to the navigation bridge.	
30	The hospital has morgue facilities.	
31	Shelves and bookracks have battens and upward flanged edges on open sides to retain their contents.	
32	Drawers and doors have latches: <ul style="list-style-type: none"> ▪ to prevent opening and closing due to vessel motion ▪ that are operable with one hand ▪ that are designed so that it is obvious when the drawer or door is not fastened/locked. 	
33	Radiators and other heating apparatus, which may cause a risk of fire, danger, or discomfort to the passengers, are shielded.	
34	If the hospital or medical/first aid accommodations have windows in the ward, then curtains or blinds are provided.	
DIMENSIONAL ASPECTS		
35	Headroom in the hospital and medical/first aid accommodations is at least 2050 mm (80 in).	
36	Outside corners of hospital and medical/first aid accommodations bulkheads, doors, etc., have a radius of 0.75 mm (0.03 in) or more.	
37	All edges (e.g., furniture) that patients may strike are rounded to a radius of 0.75 mm (0.03 in) or more.	

Instructions: For a **COMF** or **COMF+** Notation, the unshaded boxes under “Meets **COMF** Requirements” must be met.

Accommodations Criteria – Passenger Ferry Seating		
	Requirement	Meets COMF Requirements
LAP BELTS		
1	If lap belts are provided, they are capable of being released with one hand.	
SEAT DESIGN		
2	Seat pan design: <ul style="list-style-type: none"> ▪ The provided seating has a rounded front edge with a radius of at least 13 mm (0.5 in). ▪ The vertical height of the highest point of the seat pan’s front edge is 455 mm (18 in) ± 25 mm (1 in) above the deck. ▪ The depth of the seat pan is 460 mm (18 in) ± 25 mm (1 in). ▪ The width of the seat pan is at least 485 mm (19 in) wide. 	
3	If the seat is equipped with armrests, then: <ul style="list-style-type: none"> ▪ the vertical distance between the seat pan and the highest point on the armrest is 210 mm (8 in) ± 13 mm (0.5 in) ▪ the distance between the insides of armrests is 480 mm (19 in) ± 13 mm (0.5 in) ▪ the armrests are at least 200 mm (8 in) long ▪ there is at least a 200 mm (8 in) distance between any obstacle or protrusion (e.g., bulkhead mounted magazine rack) and any component of the seat (i.e., seat’s leading edge or armrest). 	
4	For conventional seating, the distance between the top of the backrest or headrest (if equipped) from the top of the seat pan is between 250 mm (10 in) and 890 mm (35 in).	
5	Where seats are oriented in one direction: <ul style="list-style-type: none"> ▪ a horizontal distance of at least 325 mm (13 in) shall be provided from the front edge of the seat pan and the seat back directly to the front ▪ a horizontal distance of at least 795 mm (31 in) shall be provided between the top of the seat’s backrest and the top of the seat’s back rest directly to the front of the passenger ▪ a horizontal distance of at least 455 mm (18 in) shall be provided from the seat pan edge to a wall or bulkhead directly in front. 	
6	For face-to-face seating the distance between opposing backrests is at least 1600 mm (63 in).	
7	For bench style seating, the vertical height of the highest point of the front edge of the bench seating is 440 mm (17 in) ± 13 mm (0.5 in) above the deck.	
8	For voyages where the transit time at operational speed is greater than 1 hour, the interior seats are equipped with cushions or padding.	

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APPENDIX 4 Acronyms and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
ABS	American Bureau of Shipping
Amd	Amendment
ANSI	American National Standards Institute
API	American Petroleum Institute
ASNT	American Society of Non-destructive Testing
ASTM	American Society of Testing and Materials
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
Avg	Average
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
cd/m ²	Candela-per-square meter
CIBS	Chartered Institution of Building Services
CIH	Certified Industrial Hygienist
dB(A)	Decibels measured using the A weighted scale
DEF STAN	Defense Standard
DOD HDBK	Department of Defense Handbook
ed.	Edition
ft/s	Feet-per-second
fc	Foot-candle
ft	Feet
ft ²	Square feet
COMF	Comfort notation
COMF+	Comfort Plus notation
HFS	Human Factors Society
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
IEC	International Electrotechnical Commission
IESNA	Illuminating Engineering Society of North America
ILO	International Labor Organization
IMO	International Maritime Organization

Appendix 4 Acronyms and Abbreviations

in	Inch
ISO	International Organization for Standardization
kPa	Kilopascals
L_{Aeq}	Equivalent continuous A weighted sound pressure level
lm/m^2	Lumens-per-square meter
lm/ft^2	Lumens-per-square foot
m	Meter
m^2	Square meter
m/s	Meters-per-second
m/s^2	Meter-per-square second
Max	Maximum
MCR	Maximum Continuous Rating
MIL STD	Military Standard
Min	Minimum
mm	Millimeter
$MSDV_z$	Motion Sickness Dose Value
NASA STD	National Aeronautics and Space Administration Standard
NDT	Non-Destructive Testing
NEBB	National Environmental Balancing Bureau
NORSOK	Norwegian Engineering Industries
psi	Pounds-per-square inch
RH	Relative humidity
rms	Root-mean square
RP	Recommended Practice
rpm	Revolutions-per-minute
SI	International System of Units
SOLAS	Safety Of Life At Sea
TAB	Testing, Adjusting and Balancing
TX	Texas
USA	United States of America
W_b	Frequency weighting used to evaluate z-axis vibration when standing with respect to comfort.
W_d	Frequency weighting used to evaluate x-axis and y-axis vibration when standing with respect to comfort.
W_f	Frequency weighting used to evaluate z-axis motion with respect to motion sickness.
WMO	World Meteorological Organization



APPENDIX **5** **Associated Documentation**

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

ANSI/ASHRAE	ANSI 1819 L Street, NW, 6th Fl. Washington, DC, 20036 USA www.ansi.org +1 202-293-8020
British Standard	BSI 389 Chiswick High Road London, W4 4AL United Kingdom www.bsi-global.com +44 (0) 20 8996 9001
IEC	IEC 549 West Randolph Street, Suite 600 Chicago, IL 60661-2208 USA www.iec.org +1 312-559-4100
IESNA	IESNA 120 Wall Street Floor 17 New York, NY, 10005 USA www.iesna.org +1 212-248-5000
ILO	ILO Branch Office in Washington, D.C. 1828 L Street N.W., Suite 600 Washington, DC 20036 USA www.ILO.org +1 202-6553-7652

Appendix 5 Associated Documentation

IMO	IMO 4 Albert Embankment London SE1 7SR United Kingdom www.imo.org +44 (0) 20 7735 7611
ISO	ISO 1, rue de Varembé, Case postale 56 CH-1211 Geneva 20, Switzerland www.iso.org + 41 22 749 01 11
NEBB	NEBB 8575 Grovemont Circle Gaithersburg, MD 20877 USA www.NEBB.org +1 301-977-3698