



GUIDANCE NOTES ON

THE APPLICATION OF ERGONOMICS TO MARINE SYSTEMS

AUGUST 2013 (Updated February 2014 – see next page)

**American Bureau of Shipping
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Updates

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- August 2013 version plus Corrigenda/Editorials

Foreword

The maritime industry is increasingly responsive to the important influence the human element has on effective safety standards and practices. With increased attention to human element concerns being paid by organizations such as the United States Coast Guard (USCG), the United Kingdom's Health and Safety Executive (HSE), and the International Maritime Organization (IMO), among others, it is expected that the application of ergonomic data and principles to maritime systems will expand rapidly. This is entirely appropriate since many studies and authorities cite human error as the principal component for a majority of maritime accidents, yet the amount of ergonomic design guidance available to marine architects, designers, and engineers remains sparse. To meet this need, in 1998 ABS initially published its *Guidance Notes on the Application of Ergonomics to Marine Systems*, which underwent revision in 2003. The document has enjoyed an enthusiastic reception by the maritime industry, and many organizations have adopted the Guidance Notes as a design reference. That success is due to the provision of industry-specific, internationally applicable ergonomic principles and criteria.

Since its initial publication, and revision, on-going use and review of the document has led to industry feedback motivating ABS to again revise and update these Guidance Notes. This edition updates the previous Guidance Notes through the inclusion of more recent data and includes new, industry-requested guidance with respect to applications not included in the predecessor Guidance Notes.

This revision to the ABS *Guidance Notes on the Application of Ergonomics to Marine Systems* will continue the promotion, application, and understanding of ergonomic data and principles to vessel and offshore installation design. It is hoped that as these Guidance Notes are used, in concert with human-system interface design processes, they will provide a wide range of information and data needed to integrate humans and systems, and thereby improve personnel performance and safety, and reduce human error.

The ergonomic data and principles contained are provided as guidance. Compliance is not required, although ABS advises designers, owners, and operators to consider adopting this guidance where feasible.

These Guidance Notes become effective on the first day of the month of publication.

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

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

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SECTION 1 Introduction (1 August 2013)

1 General

The importance of the human element in maritime safety is increasingly being recognized by the shipping and offshore communities and is receiving increased levels of attention due to the efforts of organizations such as the United States Coast Guard (USCG), the United Kingdom's Health and Safety Executive (HSE), and the International Maritime Organization (IMO). IMO's primary efforts have concentrated on human element issues relating to management, training, and personnel, as reflected by the *International Management Code for the Safe Operation of Ships and for Pollution Prevention* (the ISM Code) in 1993 and the update of the *International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers* (STCW) in 2012. While organizations like IMO have issued other documents, circulars, and guidelines related to aspects of ergonomics, systematic application of ergonomics in the maritime industry remains limited. This lack of systematic application occurs even though ergonomics has been recognized to be central to improving safety and productivity. These Guidance Notes are intended to promote the application and understanding of ergonomic knowledge to maritime and offshore systems.

Ergonomics (also called human factors engineering) can be defined as follows:

Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theoretical principles, data, and methods to design in order to optimize human well-being and overall system performance (International Ergonomics Association, 2012).

The focus of ergonomics is the design of the human-system interface. This includes interfaces between personnel and the hardware, software, and physical environments associated with systems. It also involves the interfaces between personnel, individual tasks, and the overall work system (e.g., its structure, management, policies, and procedures).

These Guidance Notes introduce important ergonomic principles and criteria that need to be considered during the design of a vessel or offshore installation. A development effort without ergonomic considerations is likely to result in designs that encourage human error. Applying the ergonomic principles and criteria contained in this document within the context of engineering design processes allows for improved safety, productivity, and efficiency. For guidance for vessels or structures operating in cold environments, please see the *ABS Guide for Vessels Operating in Low Temperature Environments*.

Adherence to the ergonomic guidance in this document is recommended, but compliance is not mandatory.

2 The ABS Ergonomics Model: Elements that Enhance Safety

The ABS Ergonomics Model (See Section 1, Figure 1, "ABS Ergonomics Model") encapsulates important elements that affect safety and efficiency in job performance: vessel or offshore installation design and layout considerations, workplace ambient environmental elements, management and organizational issues related to operations, and the personnel who operate the vessel or offshore installation. Insufficient attention to any of these elements may adversely affect safety, productivity, and efficiency. These Guidance Notes primarily address ergonomic design and layout concerns, and to a lesser extent the ambient environment.

FIGURE 1
ABS Ergonomics Model



2.1 Design and Layout Considerations

It is the design and layout aspect of the ABS Ergonomics Model that forms the basis for these Guidance Notes. Design and layout considers the integration of personnel with equipment, systems, and interfaces. Examples of interfaces include: controls, displays, alarms, video-display units, computer workstations, labels, ladders, stairs, and overall workspace arrangement.

2.2 Ambient Environmental Considerations

The ambient environmental aspect of the ABS Ergonomics Model addresses the habitability and occupational health characteristics related to human whole-body vibration, noise, indoor climate, and lighting.

2.3 Considerations Related to People

Personnel readiness and fitness-for-duty are essential for vessel or offshore installation safety. This is particularly so as tasks and equipment increase in complexity, requiring ever greater vigilance, skills, and experience. The following factors should be considered when selecting personnel for a task:

- i) Knowledge, skills, and abilities that stem from an individual's basic knowledge, general training, and experience
- ii) Maritime-specific or craft-specific training and abilities (certifications and licenses), and vessel or offshore installation-specific skills and abilities
- iii) Bodily dimensions and characteristics of personnel such as stature, shoulder breadth, eye height, functional reach, overhead reach, weight, and strength
- iv) Physical stamina; capabilities, and limitations, such as resistance to and freedom from fatigue; visual acuity; physical fitness and endurance; acute or chronic illness; and substance dependency
- v) Psychological characteristics, such as individual tendencies for risk taking, risk tolerance, and resistance to psychological stress

2.4 Management and Organizational Considerations

This aspect of the ABS Ergonomics Model considers management and organizational considerations that impact safety throughout a system lifecycle. The effective implementation of a well-designed safety policy that includes ergonomics creates an environment that minimizes risks and reflects a good corporate safety culture. Commitment of top management is essential if a safety policy is to succeed.

3 Terminology

Access Aid: A device that makes operation of, or access to, operating or maintenance components possible, or more immediate. For example, a reach rod that extends access to a valve actuator below a deck grating, or a ladder of an access platform.

Accessibility: The ability for personnel to access equipment that requires maintenance, inspection, removal, or replacement while wearing the appropriate clothing, including personal protective equipment, and the ability to use all necessary tools and test equipment.

Accessible Valves: Readily or Immediately Accessible Valves are:

- Located in a space entered without requiring tools or keys
- Clear of obstructions, moving equipment and hot surfaces
- Within operator's reach without requiring use of extenders, ladders, or other access aids

Accommodations: Areas where the primary purpose is to rest or recreate. Accommodations spaces include cabins and staterooms, medical facilities, offices, and public and recreational rooms. Accommodations also include service spaces, such as mess rooms, laundry, storerooms, and workshops.

Active Protection: A safety design or device that actively (or directly) requires a person to take specific actions before a potential loss, for example, donning a fall arrestor fitted to both the ladder and the climber.

Alarm Priority: A predicted assessment of the potential consequence of a condition or situation and the resulting urgency of mitigating responses required of personnel. Generally, the more severe the potential consequence, the higher the alarm priority.

Alarm: A visual and/or audible signal of a condition, or a predetermined out-of-tolerance condition, for machinery, equipment, components, or systems that require attention.

Ambient Environment: Ambient environmental conditions that personnel are exposed to during periods of work, leisure, or rest. Ambient environmental conditions include human whole-body vibration, noise, indoor climate, and lighting.

Anthropometrics: The measurement of human variability of body dimensions and strength as a function of gender, race and regional origin.

Assisted Lifting: The use of devices such as cranes, hoists, counter-balancing mechanisms, trolleys, monorails, come-alongs, padeyes, or A-frames by personnel to perform materials handling tasks.

Audible Alarm: An alarm comprised of tones, verbal messages, or verbal messages preceded by tones. Not all audible alarms are associated with visual alarms.

Auditory Display: A device that provides readings, status or condition of machinery, equipment, or systems operating parameters through the use of sound signals or spoken messages.

Case: The part of equipment that encloses and protects the equipment from its surroundings and protects the surroundings—including personnel—from the equipment.

Cognition: The mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment.

Communications: Human voice communication for a vessel or offshore installation, whether internal or external.

Console: A group of controls and displays associated with one or more individual pieces of equipment or systems mounted together on a structure dedicated to the control and monitoring of those individual equipment or systems. Consoles may be freestanding units, and include angled and vertical surfaces.

Continuous Control: A continuous control is an actuator that operates at any point or value along a continuous scale (e.g., engine throttle).

Control: A device an operator or maintainer uses to input a signal or uses to change the operating status of equipment or systems. Examples include switches, knobs, cranks, thumbwheels, levers, keyboards, and foot pedals.

Crew Habitability: The acceptability of vessel or offshore installation conditions in terms of vibration, noise, indoor climate, and lighting as well as physical and spatial characteristics, according to prevailing research and standards for human efficiency and comfort.

Crew Member: Any person on board a vessel, including the Master, who is not a passenger. This term is used interchangeably throughout this document with “seafarer”.

Cross-Coupling: The movement of the follower (e.g., cursor or tracking symbol) in the orthogonal direction.

Design Load: The maximum intended load, being the total of all loads including the weight of the personnel, materials, and equipment, including the means of access structure.

Detent Controls: A type of discrete control, characterized by the control locking into each position setting until the operator exerts extra force to move the control out of the setting. These types of controls are preferable for machinery equipment or system operation requiring control in discrete steps or different modes.

Discrete Control: A discrete control is an actuator that allows for the selection between two or more mutually exclusive operating functions or points along a scale (e.g., switching a machine ON or OFF, or selecting one of three pumps to run).

Display: Means by which a device presents information to an operator or maintainer, including conventional instrumentation.

Enclosed Space: The interior portions of a vessel where people work and live.

Equipment and Room/Space Identification Label: A type of label used to identify individual equipment, (e.g., valves, gauges, junction boxes, filters, pumps, transmitters, controls, pressure vessels), or spaces (e.g., rooms, buildings, etc.).

Error Control: Exercising control over the probability, frequency, criticality, and recoverability from human error.

Function: The appropriate action of any special components or parts of a system to meet some defined purpose or objective; specific occupation or role, or an assigned duty or activity.

General Emergency Alarms: An alarm given in the case of an emergency to all persons on a vessel or offshore installation. Often, its purpose is to summon personnel to muster stations. These alarms typically sound throughout a vessel or offshore installation and are intended to be heard by all personnel. General emergency alarms relate to conditions of a serious nature such as announcing a fire or flooding, demanding evacuation of an area, or demanding abandonment of a vessel or offshore installation.

Glare: The luminance, or amount of light per unit area emitted or reflected from a surface, within a specific area of the operator’s or maintainer’s field of view, which is greater than the luminance to which the eye is adjusted compared to the remainder of the field of view.

Graphic Label: A type of label used to present information through line schematics, diagrams, charts, tables, pictures, etc.

Guardrail (or safety rail): Device for protection against accidental fall or accidental access to a hazardous area, with which stairs, step ladders or landings, platforms and walkways, or deck edges and other fall points, may be equipped.

Handle or Handgrab: Bent round bar of various sizes for use above access openings, on miscellaneous access opening covers or on hatch covers.

Handrail: Top element designed to be grasped by the hand for body support which can be used individually or as the upper part of a rail.

Hazard Identification Sign: A type of sign used to identify and provide information about situations that may be hazardous to personnel, equipment, or the environment. There are three types of hazards, “DANGER”, “WARNING”, and “CAUTION”.

Heuristic: A speculative formula or conceptual model that serves as a guide in the investigation or solution of a problem; a “rule of thumb”.

Human Task: A piece of work performed; a function performed; an objective.

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

Information Label or Placard: A type of label or placard used to present non-procedural information of a general nature.

Instruction Label: A type of label used to present instructions for accomplishing a specific task or tasks, along with any hazard or safety information related to performing the task(s).

Layout: Physical arrangement of the parts and components that make up a module or a unit of equipment.

Maintainability: The ability to carry out maintenance tasks, such as testing, servicing, calibrating, adjusting, removing, replacing or repairing rapidly and effectively in order to allow equipment and systems to achieve a specified level of performance.

Maintenance Item, Critical: Includes those maintenance actions which are system and safety critical, meaning a system critical to the safe operation of the vessel cannot function without that aspect being functional, and moderate to frequent maintenance actions are required. These are referred to as Category 1 maintenance items for maintenance access criticality categorization purposes.

Maintenance Item, Non-Critical: Includes those maintenance actions which are not system critical as defined above but are maintenance actions that are required frequently for the proper operation of the vessel. These are referred to as Category 2 maintenance items for maintenance access criticality categorization purposes.

Maintenance Item, Infrequently Used Non-Critical: Includes those maintenance actions which are considered to be non-critical to system status and safety, and that do not require frequent access. These are referred to as Category 3 maintenance items for maintenance access criticality categorization purposes.

Maintenance: All activities necessary to keep equipment in, or restore it to, a specified level of performance.

Manual Materials Handling: Actions taken by personnel to physically (manually) lift, lower, push, pull, hold, or carry loads.

Manual Valve: A valve that is manually opened by a human operator using a handwheel, lever, chain, extender, or other hand-operated device.

Monitoring: To keep track of systematically with a view to collecting information in order to detect any changes.

Motor Task: Human motion in moving, posturing, and manipulating equipment.

Newton: SI unit of force. One Newton is equal to the amount of net force required to accelerate a mass of one kilogram at a rate of one meter per second squared.

Newton-meters (N-m): SI unit of torque. One Newton-meter is equal to the torque resulting from a force of one Newton applied perpendicularly to a moment arm which is one meter long.

Operating Alarms: Alarms presented within specific operating spaces that are intended to prompt a response by personnel in those spaces.

Operating Torque: The force an operator or maintainer exerts by pushing or pulling on a lever or turning a handwheel.

Panel: Any surface where controls, displays, and/or alarms relating to equipment or system conditions are placed. Panels typically are flat vertical surfaces. Panels are sometimes referred to as control boards.

Passive Protection: A safety design or device that requires a person to take no specific action prior to a potential loss, for example, a safety cage permanently fitted to a ladder. See also “Active protection” above.

Percentile: Given the range of variability of [human] bodily dimensions, anthropometric data are typically expressed as percentile statistics, such as 5th or 95th percentile. A percentile statistic defines the anthropometric point at which a percentage of a population falls above or below that value. For example, the seated eye height of a 95th percentile North American male is 853 mm (33.5 in.), so by definition, 5% of North American males will have a seated eye height of greater than this figure, and 95% will have a lesser seated eye height.

Perception: The acquisition and processing of physical energy and matter to see, hear, taste, smell or feel the environment.

Pipe Marker Labels: Labels with colored markings (e.g., bands of color), text, and flow arrows. These are placed on pipes to identify pipe contents and flow direction.

Pound Force: One pound force is equal to the gravitational force exerted on a mass of one pound on the surface of the Earth.

Reach Rod: A rod for operating a remote valve that would otherwise not be accessible (for example, to operate a valve below a deck grating).

Saturation: The extent to which a chromatic color differs from a gray of the same brightness. It is a measure on an arbitrary scale from 0 percent (gray) to 100 percent.

Seafarer: Any person onboard a vessel, including the Master, who is not a passenger. This term is used interchangeably throughout this document with “crew member”.

Shall: Expresses a provision that is mandatory.

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

Situation Awareness: The degree of accuracy by which a person’s perception of the current environment reflects reality.

Staffing Levels: The number of personnel who will staff systems during operations. This addresses workload, both immediate (number of tasks that must be performed in a short period of time) and ongoing (work done over the course of a voyage).

Stair: One of a flight or series of steps for going from one level to another, as opposed to a ladder offering two vertical or nearly vertical risers between which rungs forming a means of climbing up or down.

Static Lift: The physical act of a person lifting a load using muscle contraction but no motion. A static lift is also known as an isometric lift.

Task-Based Design: Design of interfaces based on the complexity, sequence, importance and error tolerance of tasks performed at a workstation.

Toeboard: A barrier placed along the edge of a walking surface to prevent personnel from placing their foot over the edge of an elevated walking surface. It should also prevent objects from sliding or rolling over the edge onto personnel below.

Valve, Critical: Valves that require rapid and/or frequent access during normal operations or emergency conditions. These are referred to as Category 1 Valves for valve criticality categorization purposes.

Valve, Infrequently Used Non-Critical: Valves that are not critical for operations or routine maintenance and that are infrequently used for particular tasks like commissioning, start-up, shutdown, or rarely performed maintenance tasks. These are referred to as Category 3 Valves for valve criticality categorization purposes.

Valve, Non-Critical: Valves that are not critical for operations but that are required for routine maintenance. These are referred to as Category 2 Valves for valve criticality categorization purposes.

Visual Alarms: Alarms presented visually, and carry visually loaded information, such as coding priority by color, or the presenting of text information.

Visual Display: A device that provides readings, status, or condition of machinery, equipment, or systems operating parameters. Examples of visual displays include: indicators, annunciators, sight glasses, gauges, digital counters, computer monitors, or video display units.

Work Schedules: The number of continuous hours and the work shift patterns performed by personnel.

Workspaces: Areas allocated for work. Categories of workspaces include: navigation spaces, service spaces (galley, laundry) and machinery spaces.

Workstation: Position at which one or several tasks constituting a particular activity are carried out. This position includes a combination of all job-related items, such as the console with all devices, equipment, and furniture, to perform certain tasks.

4 Scope of the Guidance Notes

These Guidance Notes **provide** the design and layout **guidance related to ergonomics at sea, including** the design of human-system interfaces at the individual task and workstation levels. Physical and perceptual issues for the design of the personnel interface with controls, displays, alarms, video-display units, labeling, workspace access, and workspace arrangement are discussed in the document.

These Guidance Notes can be used in designing human-system interfaces that are required to be “easily accessible”, “readily operable”, designed based on “sound ergonomic principles”, and similar terms used extensively in ABS documents. Ergonomic guidance is derived from empirical data, operator and maintainer expectations, models of human behavior, **reasoned** from known facts **and research, and user** and expert opinion.

The **benefit of addressing** human element concerns is **noted** in **numerous** international, flag Administration, national, and industry documents. These include International Maritime Organization (IMO), International Labor Organization (ILO), United Kingdom Health Safety Executive (UK HSE), United States Code of Federal Regulations (US CFR), etc. Most of the principles and criteria providing ergonomic guidance are found in industry standards and ergonomic design references. Examples include American Society for Testing and Materials (ASTM), International Organization for Standardization (ISO), and British Standards (BS). **The source of** all guidelines, standards, and recommendations **stated** in these Guidance Notes are **referenced** in Appendix 3, “References/**Bibliography**” of this document.

5 Contents of the Guidance Notes

These Guidance Notes **address numerous** aspects of ergonomics. **The early Sections** cover human-system interface issues that can directly affect equipment and system performance. The following Sections discuss ergonomic aspects that have traditionally been associated with occupational health and safety concerns. **Appendix 1, “Anthropometric Design Principles and Dimensions” is provided to allow designers and engineers to modify criteria as needed to match the needs of various groups of people throughout the world.** **Appendix 2, “Application of Ergonomics to Design” presents a simplified explanation of a human-system interface design process and two application examples.**

SECTION 2 Controls (1 August 2013)

1 General (1 August 2013)

1.1 Application

The principles and guidelines of this Section generally apply to devices used for control, on equipment, consoles and panels.

2 Principles

2.1 Labeling

Controls should be labeled to convey the information needed for proper identification and utilization of the control. Principles of control labeling are described in Section 8, “Labeling, Signs, Graphics, and Symbols”.

2.2 Feedback

Personnel should be provided with a positive indication of control activation. This can be provided via feel (e.g., snap action), an audible clicking noise, or a display.

2.3 Integration with Displays and Alarms

Displays and alarms can be used to provide feedback of control action. For principles and criteria covering the integration of controls with their associated displays and alarms, see Section 5, “Integration of Controls, Displays, and Alarms”.

2.4 Coding

Any coding used to enhance the transfer of information to personnel should be consistent and meaningful. The coding system should also be appropriate for the industry, organization, and culture of the personnel aboard the vessel or offshore installation.

2.5 Simultaneous Operation of Controls

Controls should be placed so that simultaneous operation of two controls will not require a crossing or interchanging of hands. Controls required to be used by two operators should be duplicated, where practical, or otherwise centered between the two operators, or positioned nearest to the operator having the greatest need. If any control is required to be operated with the operator’s preferred hand, such as operating a keyboard or fine setting a continuous control knob, duplicate controls should be provided.

2.6 Controls for Maintenance

Controls used solely for maintenance or adjustment should be covered or otherwise protected during normal operations, but within arm’s reach and visible when needed for maintenance.

2.7 Prevention of Accidental Activation

Controls should be designed and located so they are not susceptible to accidental activation. Methods to reduce the likelihood of accidental activation include:

- i) Locating and orienting the control so that bumping is unlikely to cause an activation
- ii) Providing sufficient control resistance to prevent unintentional movements
- iii) Requiring complex motions for control activation, such as an interlock or rotary motion
- iv) Restricting access to controls by isolating them or by providing a cover guard or physical barrier

2.8 Compatibility with Clothing

It should be possible to operate controls wearing both normal clothing and personnel protective equipment (e.g., gloves, boots).

3 General Guidelines

3.1 Control Selection

The following guidelines should be used in selecting controls:

- i) Controls requiring rapid or precise setting should be assigned to the hands.
- ii) Controls requiring large or continuous forward applications of force generally should be assigned to the feet. Although a considerable number and variety of controls can be assigned to the hands, each foot should not have more than two controls assigned to it, and these should require only fore-aft or ankle flexion movement.
- iii) Controls should be distributed so that no one limb is overburdened.
- iv) Select, locate, and orient controls so that their motion is compatible with the movement of the associated display element, equipment, component, vessel or offshore installation.
- v) Select multi-rotation controls (e.g., cranks) when precise settings are required over a wide range of adjustments. Because the range of movement of a linear control is limited, it does not permit high precision over a wide range of adjustment. With this type of control, desired precision can be obtained by appropriate gearing, although consideration will need to be given to its effect on operating time.
- vi) Select discrete-adjustment (detent) controls or pushbutton arrays rather than continuous-adjustment controls when the controlled object is to be adjusted for discrete positions or values only. Discrete-adjustment controls are preferred when a limited number of settings are required, or when precision requirements are such that a limited number of settings can represent the entire continuum.
- vii) Discrete-adjustment controls (i.e., controls that snap into place) can be positioned with one movement. Continuous adjustment controls require a slowing movement and a fine adjustment movement and thus more time and attention.
- viii) Continuous-adjustment controls should be selected when precise adjustment along a continuum is needed.
- ix) Select controls that can be easily identified. All controls should be made identifiable, in part by standardizing their locations. All critical and emergency controls should be identifiable both visually and by touch (e.g., shape coding). Identification information should not hinder the manipulation of the control nor increase the likelihood of accidental activation.
- x) Combine functionally related controls to reduce reaching movements, to aid in sequential or simultaneous operations, or to economize panel space.
- xi) Multi-axis continuous controllers (e.g., joysticks, track balls) should be used to provide continuous control within a two-dimensional space (e.g., positioning a pointer on a computer screen) or a three-dimensional space (e.g., operating a crane).

3.2 Control Movement

Direction of control movement should be consistent among the same function and application and should operate according to the cultural expectations of the intended operators. Widely accepted movement expectations are indicated in [Section 2](#), Figure 1, “Control Movement Expectations” and [Section 2](#), Table 1, “Control Movement Expectations”. This figure demonstrates that control movement expectations change depending on the location of the control in reference to an operator or maintainer’s body position. Note that a toggle switch located above and behind the head operates in a different orientation to a toggle switch located directly in front of the body. For this reason, this figure should be closely examined when assigning control settings.

3.3 Control Spacing

Adequate spacing should be provided between controls and controls and obstructions so that manipulation of one will not inadvertently affect the others. Minimum spacing between controls is shown in Section 2, Table 2, "Minimum Spacing Between Two Controls". Spacing between a control and an obstruction or two different types of controls should be at least the comparable distance in Section 2, Table 2. Unless otherwise specified, dimensions for hand-operated controls assume bare-handed operation, and should be increased as necessary if the personnel may be wearing gloves.

FIGURE 1
Control Movement Expectations

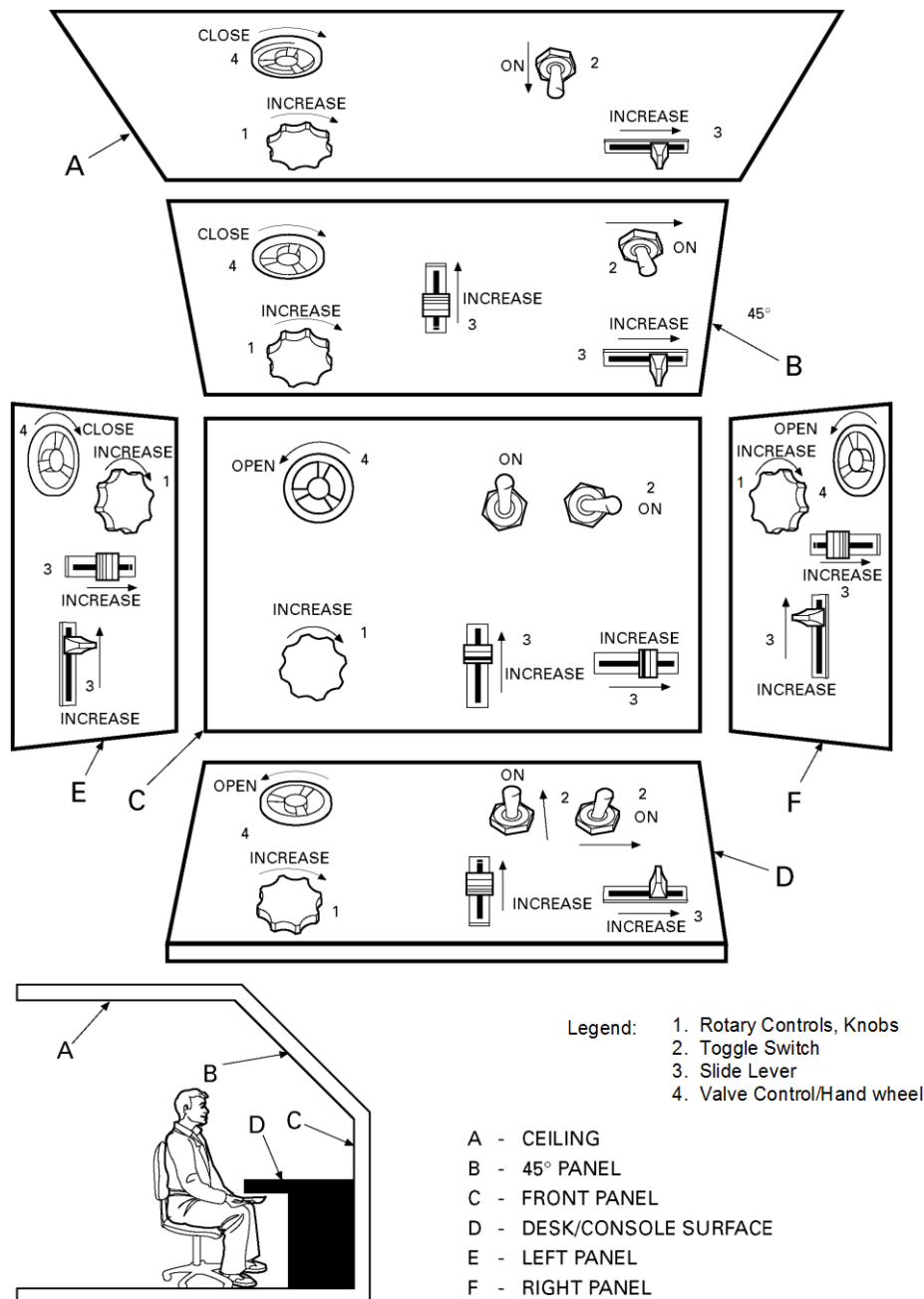


TABLE 1
Control Movement Expectations*

<i>Direction of Movement</i>	<i>Function</i>
Up, right, forward, clockwise, pull (push-pull type switch)	on
Down, left, rearward, counterclockwise, push	off
Clockwise, right	right
Counterclockwise, left	left
Up, back	raise
Down, forward	lower
Up, rearward, pull	retract
Down, forward, push	extend
Forward, up, right, clockwise	increase
Rearward, down, left, counterclockwise	decrease
Counterclockwise (valve)	open valve
Clockwise (valve)	close valve

* Reprinted with permission from the Annual Book of ASTM Standards, copyright American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

TABLE 2
Minimum Spacing Between Two Controls

	<i>Toggle Switches</i>	<i>Pushbuttons*</i>	<i>Continuous Rotary Controls</i>	<i>Rotary Selector Switches</i>	<i>Discrete Thumbwheel Controls</i>
Toggle switches	19 mm (0.75 in.)	13 mm (0.5 in.)	19 mm (0.75 in.)	19 mm (0.75 in.)	13 mm (0.5 in.)
Pushbutton	13 mm (0.5 in.)	13 mm (0.5 in.)	13 mm (0.5 in.)	13 mm (0.5 in.)	13 mm (0.5 in.)
Continuous rotary controls	19 mm (0.75 in.)	13 mm (0.5 in.)	25 mm (1.0 in.)	25 mm (1.0 in.)	19 mm (0.75 in.)
Rotary selector switches	19 mm (0.75 in.)	13 mm (0.5 in.)	25 mm (1.0 in.)	25 mm (1.0 in.)	19 mm (0.75 in.)
Discrete thumbwheel controls	13 mm (0.5 in.)	13 mm (0.5 in.)	19 mm (0.75 in.)	19 mm (0.75 in.)	10 mm (0.4 in.)

* For pushbuttons not separated by barriers.

Notes:

- 1 All values are for one hand operation.
- 2 Distances are measured from the edge of each control.

3.4 Mounting

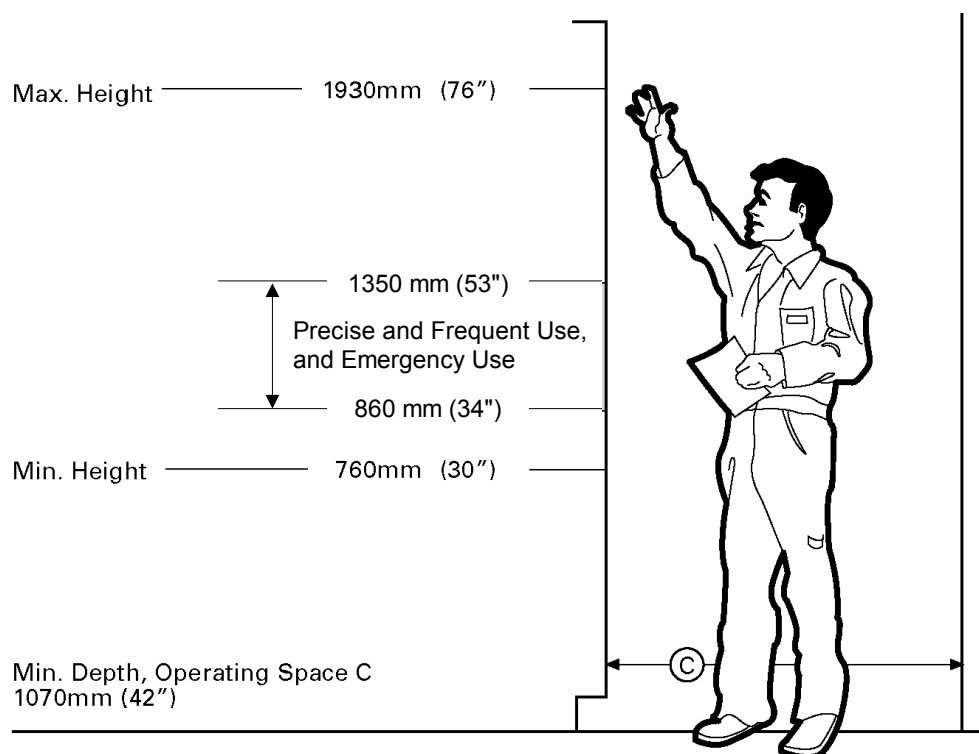
3.4.1 Mounting Heights on Panels

Preferred mounting heights for controls are indicated in [Section 2](#), Figure 2, “Control Mounting Height for Standing Personnel” and [Section 2](#), Figure 3, “Control Mounting Height for Seated Personnel”. Frequently used controls should be located within a radius of 460 mm (18 in.) from the operator’s centerline while less frequently used controls should be located within a radius of 800 mm (31.5 in.) from the operator’s centerline.

3.4.2 Mounting Heights for Kneeling and Squatting

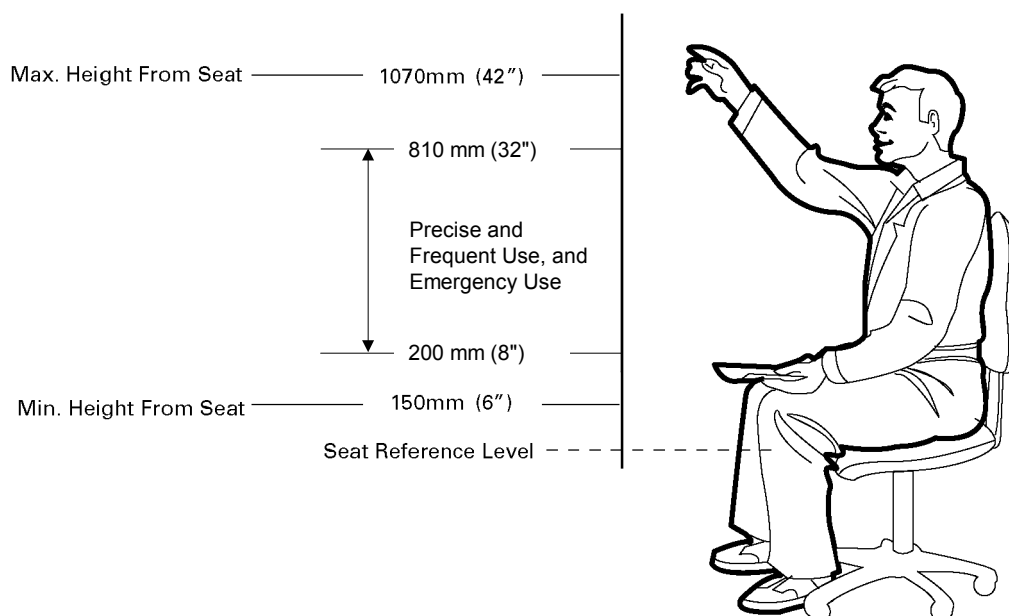
While not preferred for normal operations or maintenance, if necessary, kneeling or squatting positions may be adopted by personnel. For kneeling, see [Section 2](#), Table 3, “Controls and Kneeling Dimensions”, and for squatting, see [Section 2](#), Table 4, “Controls and Squatting Dimensions”.

FIGURE 2
Control Mounting Height for Standing Personnel*



* Dimensions are based on North American males.

FIGURE 3
Control Mounting Height for Seated Personnel*



* Dimensions are based on North American males.

TABLE 3
Controls and Kneeling Dimensions*

<i>Dimension</i>	<i>Size</i>
Maximum Height	1450 mm (57 in.)
Preferred Maximum Height	1080 mm (42.5 in.)
Preferred Minimum Height	540 mm (21 in.)
Minimum Height	460 mm (18 in.)
Minimum Depth for Kneeling	1070 mm (42 in.)

* Dimensions are based on North American males.

TABLE 4
Controls and Squatting Dimensions*

<i>Dimension</i>	<i>Size</i>
Maximum Height	1250 mm (49 in.)
Preferred Maximum Height	800 mm (32 in.)
Preferred Minimum Height	400 mm (16 in.)
Minimum Height	360 mm (14 in.)
Minimum Depth for Squatting	915 mm (36 in.)

* Dimensions are based on North American males.

3.5 Coding

Coding refers to the use of size, shape, color, texture, location, labeling, or other scheme to assist with the identification of states and control functions. Several coding methods may be combined to achieve maximum identification and differentiation.

3.5.1 Color

Color coding should be used as a redundant form of information with other coding techniques. Color coding is most effective when a specific meaning can be attached to a color, and the color is used consistently with the associated meaning. Cultural expectations¹ should be considered when color coding. Only the following colors should be used for color coding of controls: red, green, orange-yellow, and white. Blue may be used only if an additional color is absolutely necessary. If red ambient lighting could be used at any time in which the color-coded control would be operated (e.g., night time on the navigation bridge), controls that would otherwise be color coded red should be coded orange-yellow with black striping. Controls that are not color coded should be black or gray.

For additional information concerning factors to be considered when determining color codes, see 3/3.5, "Color Coding".

3.5.2 Shape

Coding by shape is useful when controls should be identified without the use of vision. Using different shapes provides for tactile identification of controls and aids in visual identification. Where feasible, shapes that suggest the purpose of the control should be used.

3.5.3 Size

Coding by size is useful when controls are to be identified without the use of vision. Controls can be coded by size, but if personnel are to rely on touch alone, at most three sizes of controls should be used. Size coding, as with other coding methods, should be used consistently. In general, knobs should differ by at least 13 mm (0.5 in.) in diameter or by 10 mm (0.4 in.) in thickness to be identified accurately by touch.

3.5.4 Precautions with Shape and Size Coding

The shape or size coding should not interfere with operation of the control and should be identifiable by feel regardless of the position or orientation of the control. Knobs and handles, which are shape or size coded, should be attached to their shafts so as to preclude removal and incorrect replacement. If individuals wearing gloves will use the control, the shape or size should be identifiable by feel through the gloves.

3.5.5 Texture

Use of texture differences can provide effective coding when knobs are to be identified by feel. Three surface characteristics can be used together to provide reasonably accurate discrimination: smooth, fluted, and knurled. Different degrees of fluting or knurling should not be used together to provide discrimination.

¹ A study of differences in color perception between populations of the US and China revealed that of the 784 Chinese participants, comprising both sexes from various occupational groups, less than 50% associated the color red with stop and green with go. The ratio for their American counterparts was almost 100% (Courtney, 1986).

SECTION **3** **Displays** (1 August 2013)

1 **General** (1 August 2013)

1.1 **Application**

The principles and guidelines in this Section apply to instruments or devices that present visual or audible information.

2 **Principles**

2.1 **Labeling**

Visual displays should be labeled to convey the basic information needed to identify and interpret displayed information. Principles of display labeling are described in Section 8, “Labeling, Signs, Graphics, and Symbols”.

2.2 **Content**

Displays are intended to convey information to operators or maintainers. Displayed information should be clear, concise, consistent, and follow appropriate standards and conventions. For principles covering the integration of displays with their associated alarms and controls, see Section 5, “Integration of Controls, Displays, and Alarms”.

2.3 **Coding**

Any coding used to enhance the transfer of information to personnel should be consistent and meaningful. The coding system should also be appropriate for the industry, organization, and culture of the personnel aboard the vessel or offshore installation.

2.4 **Status Information**

Visual displays should provide a positive indication of the state of the equipment such as: ready, running, not running, or “out-of-tolerance”. The absence, or non-activated state, of a visual display should not be relied upon to convey status information. Where equipment status must always be available (e.g., stop/start, on/off, etc.), it is appropriate to provide status indication of each state.

2.5 **Operations versus Maintenance**

Separate and distinct information required for operations and maintenance should not be combined in a single display. Displays used solely for maintenance should be covered or non-visible during normal operations, but should be immediately available to the maintainer when required for use.

2.6 **Avoid Clutter**

Markings (e.g., trademarks, company names, or other similar markings) should not interfere with the reading of the visual display.

2.7 **Detectability of Audible Displays**

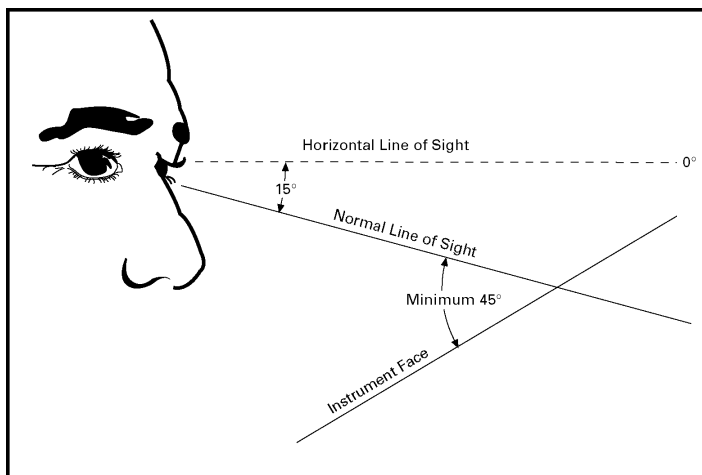
When information is conveyed to personnel through sound signals, the signals should be distinct and detectable under all expected conditions.

3 General Visual Display Guidelines

3.1 Line-of-Sight and Orientation

A display should be perpendicular to the normal line-of-sight but not less than 45 degrees, as indicated in [Section 3](#), Figure 1, “Line-of-Sight”. The normal line-of-sight is typically 15 degrees below the horizontal line-of-sight.

FIGURE 1
Line-of-Sight



3.2 Readability

3.2.1 Accuracy

Visual displays should be located to allow reading to the required degree of accuracy from the normal operating position. The normal reading distance for displays is 330 mm (13 in.) to 710 mm (28 in.).

3.2.2 Local Displays

Individual local displays, such as sight gauges on tanks and thermometers or pressure gauges attached to pipes, should be mounted so they are read upright without requiring personnel to assume awkward, uncomfortable, or unsafe postures. In addition, personnel should not have to use or stand on structures not meant to be walking or standing surfaces in order to view displays.

3.2.3 Lighting Levels

Lighting levels should be sufficient to permit visual display viewing under all conditions of operation without the use of a flashlight or other temporary light source. Guidance for specific lighting levels can be found in the [various ABS Guides for Crew Habitability \(for ships, workboats, offshore installations, or MODUs\)](#).

3.2.4 Location for Operations

In general, visual displays used for operations should be readily visible at all times. Display locations which require the removal of a cover or deck plate should only be used for non-critical operations and infrequently used displays. These locations should be provided with a clearly marked quick-opening access door requiring no tools to open or close it.

3.3 Mounting

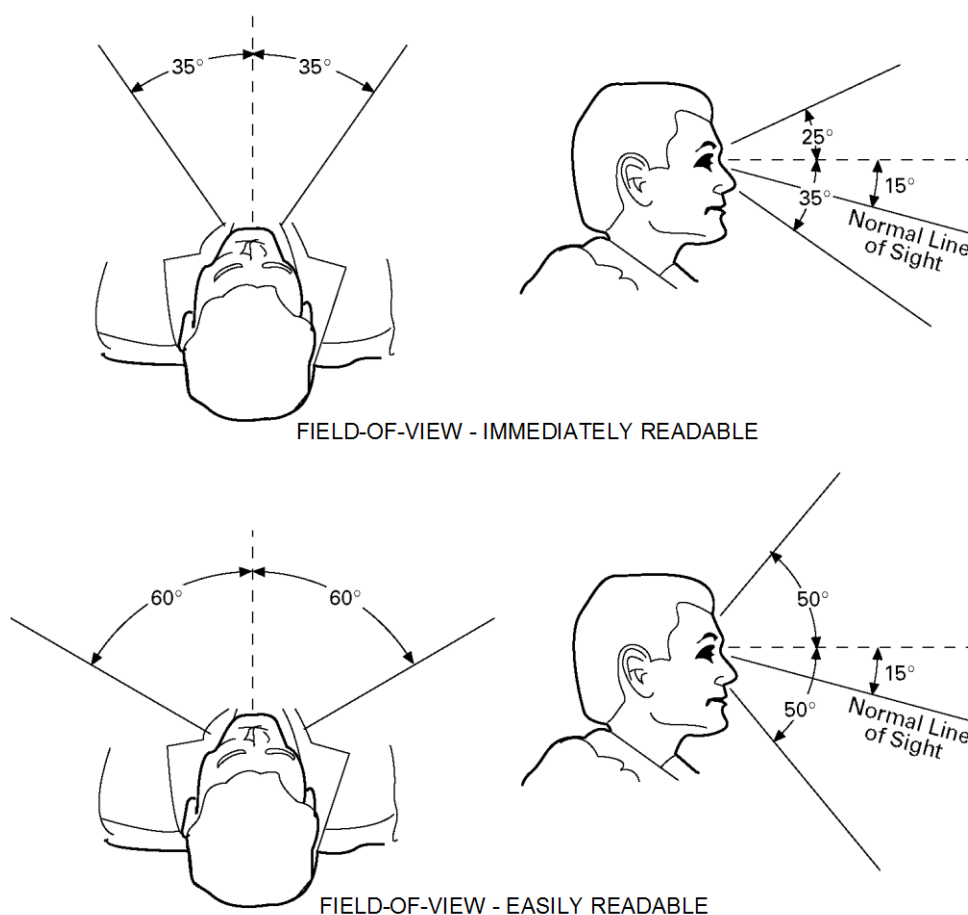
3.3.1 Field-of-View – Primary Displays

Primary displays include those used frequently, those used for obtaining precise readings or those used in emergencies. These should be located within personnel's immediately readable field-of-view as indicated in Section 3, Figure 2, "Field-of-View".

3.3.2 Field-of-View – Secondary Displays

Secondary displays include those used for normal operations and those not requiring accurate readings. These should be located within personnel's easily readable field-of-view as indicated in Section 3, Figure 2, "Field-of-View". Reference displays that are used infrequently may be located in an area outside personnel's easily readable field-of-view.

FIGURE 2
Field-of-View*

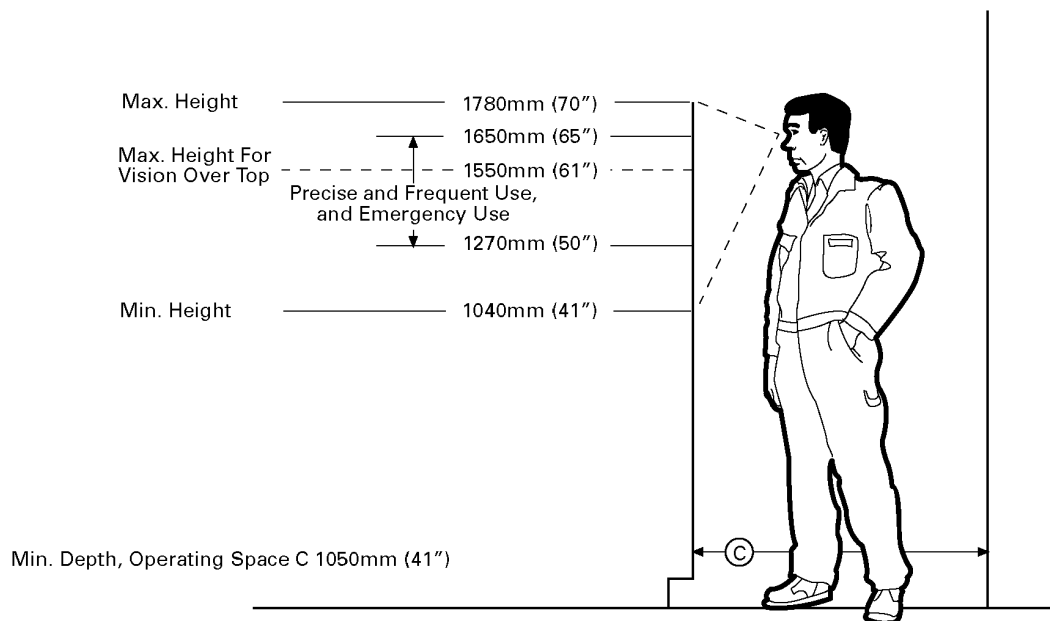


* Dimensions are based on North American males.

3.3.3 Height on Panels

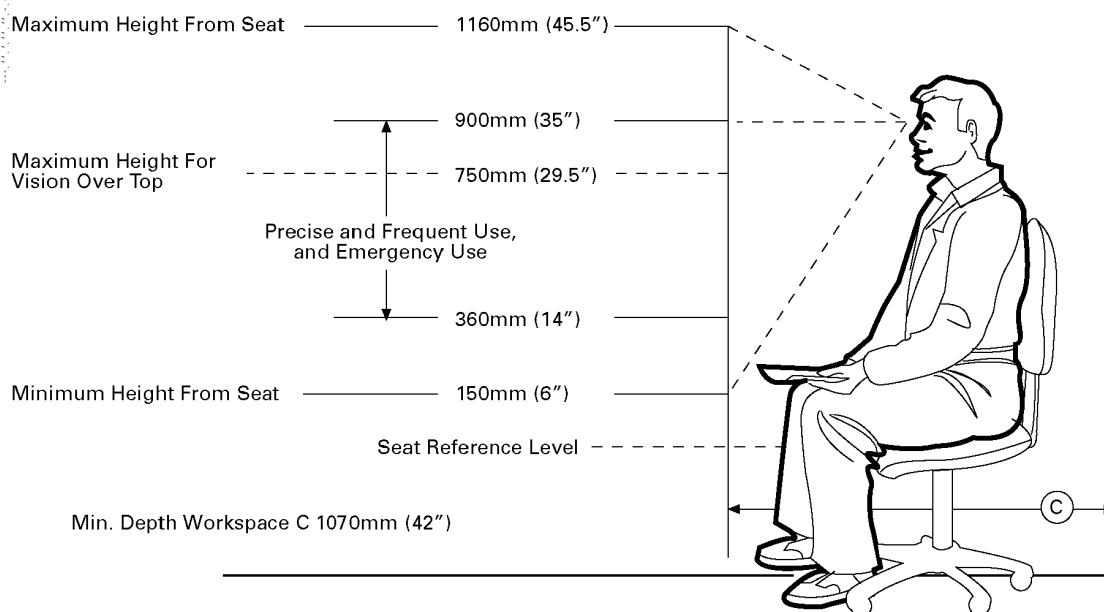
Preferred mounting heights for vertical displays on a flat surface such as a panel or bulkhead are shown in Section 3, Figure 3, "Display Mounting Height for Standing Personnel" and Section 3, Figure 4, "Display Mounting Height for Seated Personnel". Displays located immediately adjacent to a walkway should not be located within 460 mm (18 in.) of the standing surface (e.g., deck) in order to prevent them from being easily damaged.

FIGURE 3
Display Mounting Height for Standing Personnel*



* Dimensions are based on North American males.

FIGURE 4
Display Mounting Height for Seated Personnel*



* Dimensions are based on North American males.

3.3.4 Heights for Kneeling and Squatting

While not preferred for normal operations or maintenance, if necessary, kneeling or squatting positions may be adopted by personnel. For kneeling, see [Section 3](#), Table 1, "Displays and Kneeling Dimensions", and for squatting, see [Section 3](#), Table 2, "Displays and Squatting Dimensions".

TABLE 1
Displays and Kneeling Dimensions

<i>Dimension</i>	<i>Size</i>
Maximum Height	1450 mm (57 in.)
Preferred Maximum Height	1320 mm (52 in.)
Preferred Minimum Height	950 mm (37 in.)
Minimum Height	700 mm (28 in.)
Minimum Depth for Kneeling	1150 mm (45 in.)

TABLE 2
Displays and Squatting Dimensions

<i>Dimension</i>	<i>Size</i>
Maximum Height	1250 mm (49 in.)
Preferred Maximum Height	1020 mm (40 in.)
Preferred Minimum Height	750 mm (30 in.)
Minimum Height	520 mm (20 in.)
Minimum Depth for Squatting	1050 mm (41 in.)

3.4 Size Coding (1 August 2013)

When size coding is used with displays such as simple indicator lights, no more than three distinct sizes should be used, and two are preferred. Each size progression should be a minimum of twice (or half) the size (in square area of the next larger [or smaller] size). Size-coded displays should be in close proximity to one another.

Most displays are designed for a viewing distance of up to 710 mm (28 in.). Where the viewing distance (y) is greater, the size (x) of the display markings and numbers must be increased, using the following formula:

Dimension at y (mm) = [dimension at 710 mm] $\times$ [y mm]/710; or

Dimension at y (in.) = [dimension at 28 in.] $\times$ [y in.]/28

3.5 Color Coding

The interpretation of color codes by personnel is contingent on a number of factors, including:

3.5.1 Culture

Where color meanings may be particular to a geographic area. For example, in parts of Europe, the colors white-on-green are used on emergency exit signs, while in North America, the colors white and red are used for emergency exit signs.

Another example of the effect of culture on color meanings is demonstrated in a study between populations of the United States and China. The results revealed that of the 784 Chinese participants, comprising both sexes from various occupational groups, less than 50% associated the color red with stop and green with go. The ratio for their American counterparts was almost 100% (Courtney, 1986).

3.5.2 Personnel History and Expectations

Personnel's history and expectations influence the learned associations of color meanings, and it is based on an individual's experience in operating equipment that employs specific color coding. Different personnel may have different expectations. For example, some personnel with commercial electrical-power generation experience associate an open/flowing state with red and a closed/stop state with green, while some United States Navy personnel have the reverse associations (EPRI NP-3659). In other instances, an individual may have been exposed to many different, often conflicting color codes.

3.5.3 Context (1 August 2013)

The context of color-coded information varies according to the context of presentation, and personnel quickly learn to associate coded meanings within those contexts. For example, a yellow-orange alarm may convey an out-of-tolerance condition, while yellow-orange on a pipe marker label may indicate the pipe contains gas.

In most industrial contexts, there are many more demands to code information than can be provided using eleven or so different colors. For example, in North American culture, red may be used to denote: danger, immediate operator attention is required, a pump is running, a valve is open, a circuit breaker is closed or a pipe is conveying fire fighting media, among others. It is context that allows personnel to quickly and reliably identify a color's meaning.

For displays, two basic contexts exist: display of equipment status and display of alarm/annunciation conditions. When an operator is overlooking a sea of red and green indicator lights associated with, for example, a ballast control panel, there is no immediate call for operator action as long as the sea of lights presents the normal status of valves, pumps, and so on. When that same operator notes red indicators within a panel dedicated to alarms (an entirely different context), red immediately assumes an entirely different meaning, and a different operator response.

Given this, there are several general principles associated with the use of color coding:

- Devise and use color codes that are consistent with the expectations of the majority of personnel, whether derived from native culture or operating experience.
- Employ those color codes consistency throughout a vessel, fleet, offshore installation, or a company.
- Use color coding consistently and strictly within each context. For example, when designing a control station or computer program to align and control ballasting systems, avoid physically locating an alarm such that it could be hidden amongst the alignment indicator status lights. It is better to dedicate specific alarm panels that allow quick scanning and that resolve all contextual ambiguity where color coding of alarms is concerned.

Section 3, Table 3, “Typical Display and Alarm Color Codes for North American Industry”, presents commonly used color-coding schemes in North America. This Table does not provide specific recommendations for color coding of displays and alarms for all applications or geographical regions, as there can be variance across industries and cultures. Designers should identify regional and industry color meaning expectations, as well as any statutory requirements, when defining color-coding requirements.

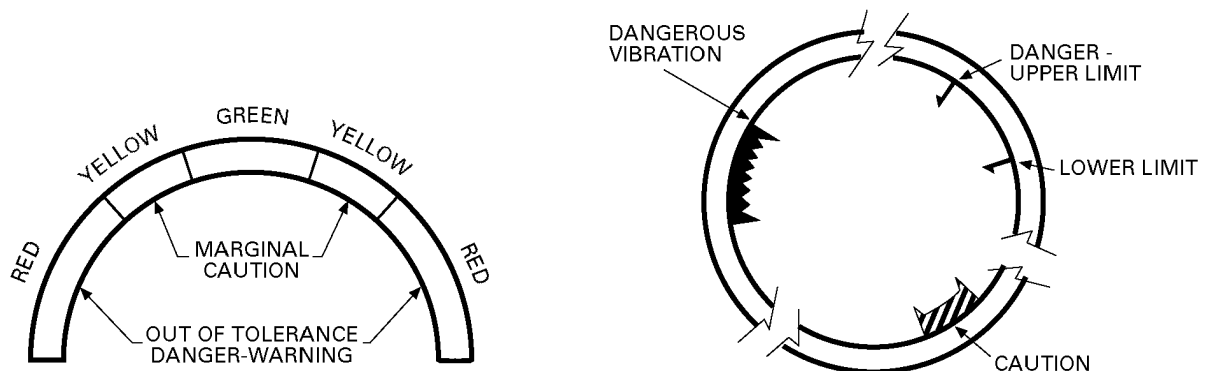
3.6 Scale Coding (1 August 2013)

Where operating values fall within a range, the ranges may be identified by a color or shape coding applied to or adjacent to the face of the display as indicated in Section 3, Figure 5, “Color and Shape Coding of Ranges on an Analog Display”.

TABLE 3
Typical Display and Alarm Color Codes for North American Industry

<i>Color</i>	<i>Typical Display/Alarm Color Meanings</i>
Red	Danger, hot, unsafe condition, critical parameter value is out-of-tolerance Immediate operator action is required
Amber	Caution, test, hazard, potentially unsafe condition Amber can be used to indicate that a condition exists that is marginal or beyond operation action, or where caution, recheck, or unexpected delay is necessary. Amber may also be used to indicate that equipment is moving from one condition to another (e.g., valve is opening).
Green	Parameters normal, condition is clear or safe, no operator action required, parameter values are within tolerance. Green can also indicate that monitored equipment is operating satisfactorily or that a condition is satisfactory and it is safe to proceed.
White	White should be used to indicate system conditions that do not have right or wrong implications, such as alternative functions (e.g., Pump No. 1 selected), or transitory conditions (e.g., action or test in progress, function available), provided such indication does not imply success or failure of operations.
Blue	Blue may be used for an advisory light, but use of blue should be avoided whenever possible.

FIGURE 5
Color and Shape Coding of Ranges on an Analog Display (1 August 2013)



4 Auditory Displays

There are three basic forms of information displays using sound:

- i) Voice communications (aided and unaided)
- ii) Alarm and warning signals (denoting off-normal or emergency situations)
- iii) General auditory display of information (to present simple status information such as to indicate completion of a time interval or to orient operator attention)

Guidance for the design of the audible portion of alarm systems is presented in Section 4, "Alarms". Guidelines for design of general auditory displays are presented below.

4.1 Use of Auditory Signals

Auditory signals can be used:

- i) Where messages or information are simple and short (e.g., on/off, cycle complete, watertight doors closed)
- ii) When information will not need to be referred to at a later time
- iii) To orient an operator to a location (e.g., to direct visual attention to a radar display)
- iv) When an immediate action is required (e.g., alarms and warnings)
- v) When vision is poor (e.g., smoke filled spaces, in holds and tanks)
- vi) To present information independent of visual orientation

4.2 Design Characteristics of Auditory Display

Design characteristics of auditory displays should be consistent with the following:

- i) Each signal has a single specific meaning or required operator action.
- ii) Signals are clearly distinct from each other.
- iii) The number of coded signals should be limited to five. Where more than five coded signals are needed, use a two-phase signal.
- iv) When using a two-phase signal, use the same signal characteristics for the alerting portion of the signal. For the second phase, use intelligible spoken messages to indicate the condition that initiated the alarm and/or any actions to be taken.
- v) Each signal should have sufficient attention-demanding properties (see [Section 4](#), Table 2, “General Recommendations for Sound Loudness and Frequency” and [Section 4](#), Table 3, “Guidelines for Selecting Audible Signal Devices”).
- vi) Signals are clearly audible in the expected normal or worst case ambient noise environment.
- vii) Signal sound source should propagate from the immediate vicinity of where operator or maintainer action (e.g., examine a display or operate a control) is performed.
- viii) Signals are of fixed duration and termination is automatic (e.g., operator or maintainers do not have to acknowledge or manually silence an audible signal, except under alarm conditions).
- ix) Audible signals should be clearly detectable, but should not be so loud as to invoke a startle response.

SECTION 4 Alarms

1 General (1 August 2013)

IMO Resolution A.1021(26), *Code on Alerts and Indicators*, presents “general design guidance to promote uniformity of type, location, and priority...” for alerts and indicators. Where applicable, that IMO resolution should be used for determining design and implementation of alarms, alerts, and associated indicators. The document also presents tables of required alarms and indicators for spaces of different functionality, machinery, and ship or structure type.

1.1 Application

The principles and guidelines of this Section apply to visual and auditory alarms/alerts and associated controls, local and remote, which require the attention of personnel. Alarms can generally be categorized as follows:

- i) Visual alarms
- ii) Visual alarms accompanied by audible tones
- iii) Audible alarms

2 Principles

These principles apply to visual and audible alarms located on local panels or central control area panels or consoles (e.g., control rooms, navigation bridges). These principles do not necessarily apply to general emergency alarms.

2.1 Types of Alarms

Alarms are used to indicate an out-of-tolerance condition to personnel. Visual alarms can be coded for priority as system conditions escalate or change. Visual alarms may be used in high noise areas to attract attention and inform personnel of out-of-tolerance conditions (e.g., a hydrogen-sulfide beacon).

Audible alarms can also be used to indicate an out-of-tolerance condition to personnel. These alarms are generally used in conjunction with visual alarms to call attention to or emphasize the information.

Audible alarms with verbal messages may include the general emergency alarm, abandonment alarm, and those alarms demanding immediate personnel response to attend to conditions such as a fire, collision, or flooding. These allow specific instructions to be conveyed to personnel.

2.2 Alarm Set Points

The limits or set points for initiating the alarm signals should:

- i) Not occur so frequently as to be considered a nuisance by personnel
- ii) Provide personnel adequate time to respond to the condition

2.3 False Alarms

A means should be provided to prevent normal operating conditions from causing false alarms. These methods may include the provision of time-delays or allowance for transient signals.

2.4 Alarm Priorities

When simultaneous alarms are active, the alarms should be prioritized so that personnel can first respond to those conditions that are more urgent. Prioritization should be accomplished using two to four levels. Priority can be conveyed with either visual or auditory coding methods. Prioritization should be based on a combination of:

- i) Relative severity of the consequences of not responding to the condition or situation
- ii) Time constraints imposed on personnel to respond

If alarms are presented on a dedicated printer, those of higher priority should be presented first, and the others presented in descending order of priority. If alarms are presented on a video display, active alarms should be viewable as sorted by priority, onset sequence or by system function.

2.5 Alarm Integration

In the event of a complete system failure, a single summary alarm (e.g., “Diesel Generator Set B Failure”) should indicate the failure rather than requiring personnel to integrate the information presented by numerous component level alarms (e.g., “Low Bus Voltage”, “Stator Trouble”, or “Lube Oil Pressure Low”).

2.6 Alarm Response

Each alarm should prompt personnel action. Where multiple alarm conditions prompt the same action, there should only be one alarm. If there is no action required, then that function should not be conveyed via an alarm, but through a status indication.

2.7 Alarm Acknowledgement

Alarms should require personnel acknowledgment after alarm onset. An acknowledge control should be provided. The control should terminate the flashing of a visual alarm and allow the alarm to remain illuminated until the alarm condition is cleared. The control can also mute the audible signal or a separate silence control can be provided. An acknowledge control should be provided near the controls and displays associated with the alarm.

2.8 Master Silence Control

The master silence control should only silence active audible signals. It should not block audible signals at the onset of subsequent alarms. The master silence control should not affect the visual portion of the alarm.

2.9 Subsequent Alarms

Each alarm onset should activate visual and audible signals such as a flashing visual indicator and audible alerting signal. This should occur regardless of the condition of any other active alarms (e.g., acknowledged, not acknowledged, cleared, uncleared, or reset). If a single alarm has multiple inputs, any new alarm condition should reactivate that alarm.

2.10 Repetitive Alarms/Controls

Repetitive groups of alarms should have the same arrangement and relative location on different panels and consoles. Any alarm controls (e.g., silence, acknowledge, reset, clear) should be consistent between panels and consoles.

2.11 Test Function

For control consoles or panels, a means should be provided to test the flashing and auditory signals associated with alarms without disrupting the normal operation of the alarm system.

2.12 Temporary Disconnection of Alarms

Alarm circuits may be temporarily disabled (e.g., for maintenance) if such action is coordinated with appropriate personnel (e.g., operations centers, the bridge, engine control room) and is clearly indicated at all locations where such information may be required. These locations include the specific piece of equipment, the local control panel or console, the central control room, and work permits. Permanent alarms (e.g., fixed lights or tiles, as opposed to computer driven displays) should be provided with a means to indicate their status (e.g., by tag out or sticker indicating that the alarm is disabled).

3 Visual Alarms

3.1 General Guidance

Additional general guidance applicable to alarms can be found in Section 3, “Displays”.

3.2 Alarm Onset

Visual alarms should flash at onset. Flash rates should be three to five flashes per second with approximately equal on and off time. The flashing display should change to a steady state upon alarm acknowledgment. The steady state should remain activated, either individually or in a summarized fashion, until the alarm condition is corrected.

3.3 Alarms and Normal Operations

Under normal operating conditions, no visual alarms should be illuminated. Exceptions include provisions for alarms associated with equipment under repair or receiving servicing. When this is the case, alarms should be tagged or otherwise marked to indicate the status of the display and equipment. Alarms that are illuminated as a general case should undergo review to determine if that alarm should be reclassified as a status indicator, and if so, removed and relocated.

3.4 Priority Coding

A method for coding the visual alarms for the various priority levels should be employed. Acceptable methods for priority coding include color, position, shape, size, flash rate, or symbols.

3.5 Color Coding

Where applicable, visual alarms should be color coded in conformance with the IMO Assembly Resolution A.830(19), “Code on Alarms and Indicators”. In other cases, [Section 4](#), Table 1, “Guidelines for Color Coding” should be followed. This color-coding scheme should be used throughout the vessel or offshore installation.

TABLE 1
Guidelines for Color Coding

<i>Color</i>	<i>Meaning</i>	<i>Explanation</i>	<i>Typical applications</i>
Red	Danger or alarm	Warning of danger or a situation that requires immediate action.	Stop of essential machinery, (e.g., lubricating oil pump for the propulsion engine or motor, failure of pressure in the lubricating system for the propulsion machine, etc.) Temperature and pressure values (water, oil, etc.) at critical levels Activation of a safety system
Yellow	Caution	Change or impending change of conditions.	Temperature and pressure values which differ from the normal levels, but not critical
Blue	Instruction/Information (specific meaning assigned according to the case considered)	Blue may be given specific meaning that is not covered by the colors: red, yellow, and green.	Motor ready to start No-load generator ready to be connected Electrical heating circuit for idle electrical machines
White	No specific meaning assigned (neutral)	Any meaning; may be used whenever doubt exists about the application of the colors red, yellow, and green, often used for confirmation.	Earth insulation indicators Synchronizing lamps Telephone calls Appliances automatically controlled

3.6 Flasher Failure

If a panel or console alarm flasher fails, then at the onset of an alarm condition the alarm light should illuminate and burn steadily, rather than not illuminate.

3.7 Contrast Detection

There should be sufficient contrast between flashing and fully illuminated alarms, and between illuminated and non-illuminated alarms, so that personnel can reliably discriminate each state.

3.8 Text Visibility and Legibility

The text on visual alarms should be easily readable whether or not the alarm is illuminated.

3.9 Wording Criteria

If text is used for alarms, wording should be in accordance with the following criteria:

- i) Wording should be concise, specific, and unambiguous.
- ii) Wording should address a specific condition (e.g., do not use one alarm for HIGH-LOW, TEMPERATURE-PRESSURE).
- iii) Abbreviations and acronyms should have consistent usage throughout the vessel or offshore installation.
- iv) Words should be legible in worst-case conditions.
- v) Personnel should be able to read all the text associated with visual alarms from the position at the panel or console where the alarms acknowledgment control is located.

4 Audible Alarms

4.1 General

Significant benefits of audible alarms, or of an audible component of a visual alarm, include:

- i) Providing indication to personnel about conditions without requiring constant monitoring of visual displays
- ii) A general reduction in personnel workload associated with equipment and safety monitoring
- iii) A general increase in the reliability of equipment and status monitoring, enhancing safety, production, and efficiency
- iv) The ability to announce the status and conditions of equipment to a wide operating area, immediately alerting those conditions to a potentially wide audience
- v) The ability to immediately compel personnel to attend to off-normal or emergency conditions
- vi) The ability to quickly and effectively influence safety behavior in the form of general emergency alarms

4.2 Content

Audible alarms may be tones or tones used with verbal messages. Audible alarms with verbal messages should consist of an initial alerting (non-speech) signal to attract attention and a brief, standardized verbal message to identify the specific condition and/or suggest an appropriate action.

4.3 Sound Characteristics

The selection of loudness, frequency, and use of sound waveforms should be in accordance with the guidelines given in [Section 4](#), Table 2, “General Recommendations for Sound Loudness and Frequency”.

TABLE 2
General Recommendations for Sound Loudness and Frequency

<i>Conditions</i>	<i>Recommendations</i>
If the distance to the listener is great	Use increased loudness and low frequencies
If the sound is to be heard around obstacles and pass through partitions	Use low frequencies
If background noise is present	Select frequencies lower than those of the background noise. Use several tones differing by an octave
To demand personnel attention	Modulate the signal to give intermittent "beeps" or modulate the frequency to make pitch rise and fall at rate of 1 to 3 Hertz.
To distinguish between different alarms	Use different sound waveforms, with pulse frequency between 0.5 to 2.0 Hertz. Consistently use the same waveform for the same function or purpose. Use no more than three or four different forms in the same space.

4.4 Number of Distinct Audible Alarms

The number of distinct audible alarms (in terms of the auditory characteristics of each) should not exceed seven (7), and it is recommended that the number not exceed four (4) in order to prevent confusion as to the meaning of different alarms.

4.5 Selection of Audible Signal Devices

Devices such as a whistle, siren, bell, klaxon, or horn can be used to provide audible signals. General guidance for the selection of devices is given in [Section 4](#), Table 3, "Guidelines for Selecting Audible Signal Devices". For specific vessel or offshore installation applications, the IMO documents referenced in Subsection [4/7](#), "Alarm Required [Requirements](#) by IMO" should be used.

TABLE 3
Guidelines for Selecting Audible Signal Devices (1 August 2013)

<i>Device</i>	<i>Loudness</i>	<i>Frequency</i>	<i>Attention Demanding</i>	<i>Noise-Penetration Ability</i>
Foghorn	Very high	Very low	Good	Poor with low frequency background noise . Good with high frequency background noise
Horn	High	Low to high	Good	Good
Whistle	High	Low to high	Good if intermittent	Good if frequency is properly chosen
Siren	High	Low to high	Very good with frequent pitch rising and falling	Very good with rising and falling frequency
Bell	Medium	Medium to high	Good	Good in low frequency noise
Buzzer	Low to medium	Low to medium	Good	Fair if spectrum is suited to background noise

4.6 Sound Loudness

Recommended sound loudness qualities are as follows:

- i) Audible signals should be at least 10 dB(A), preferably, 20 dB(A), above ambient noise levels during normal operations.
- ii) Audible alarm sound loudness should be at least 75 db(A) at a distance of 1000 mm (40 in.) from the source and at sleeping positions in cabins.
- iii) A signal-to-noise ratio of at least 20 dB(A) should be provided in at least one octave band between 200 and 5000 Hertz at the operating position of the intended receiver.

- iv) Audible signal sound levels in a space should not exceed 120 dB(A).
- v) For large spaces, more than one audible alarm may be required for the sound level to be heard throughout the space.
- vi) For spaces of unusually high noise levels, a beacon, strobe light, or similar device, installed in a location visible from all parts of the space should supplement the audible signal. Red light beacons should only be used for fire alarms, unless this conflicts with appropriate statutory, regulatory, or class requirements.

4.7 Sound Frequency

With the exception of bells, audible signals should have a signal frequency between 200 and 2500 Hertz, with the preferable range between 500 and 1500 Hertz.

4.8 Control of Loudness

The loudness of an audible signal should be designed to be adjustable. The control mechanism should be restricted and administratively controlled to prevent reducing the volume to an inaudible level or increasing it to an unacceptably high level.

4.9 Detection Level

Each audible signal should be detectable in all locations where personnel may be when their response to the condition is required. For example, signals to be detected by control room personnel should be readily detectable anywhere in the control room. General emergency alarms (e.g., emergency or evacuation) should be readily detectable throughout the vessel or offshore installation (e.g., in hull, topsides, accommodations, etc.).

4.10 Automatic Reset

An automatic reset function should be provided whether the audible signal is designed to terminate automatically, manually, or both. It should be controlled by a sensing mechanism that recycles the alarm system to a specified condition (e.g., alarm active or inactive) as a function of time or the state of the signaling system so that the alarm can sound again if the condition reoccurs.

4.11 Manual Reset

If an automatic reset function is not provided, a control should be provided to reset the system manually after alarms have been cleared.

4.12 Cleared Alarms

Cleared alarms should be accompanied by a dedicated, distinctive audible signal of finite duration.

4.13 Audible Coding of Priority Levels

Coding methods for audible signals include pulse, duration, and frequency. Intensity should not be used as a coding method. If pulse coding is used, the number of levels should not exceed three (3). If duration is used, the number of levels should not exceed three (3). If frequency coding is used, the number of levels should not exceed five (5).

4.14 Caution Signal Controls

Audible caution signals should be provided with manual reset and volume controls.

4.15 Location of Equipment Generating Audible Signals

Equipment for generating audible signals should be positioned in a location and with an orientation that will maximize perception of the signal. The equipment should not be located where personnel may be immediately nearby unless precautions have been taken so that the activation of audible signals will not startle them. The equipment generating audible signals should be located and arranged to remain operable during incidents such as flooding or fire.

4.16 Verbal Messages

4.16.1 Content

Verbal messages should indicate the required response from personnel on the vessel or offshore installation (e.g., abandon ship or offshore installation, or report to emergency stations) rather than simply the nature of the emergency.

In selecting words to be used in verbal messages, priority should be given to intelligibility, appropriateness, and conciseness, in that order.

4.16.2 Type of Voice and Delivery Style

The voice used in recording verbal messages should be distinctive and mature. Verbal messages should be presented in a formal, impersonal manner.

4.16.3 Speech Processing

Verbal messages should be electronically processed only if necessary to increase or preserve intelligibility (e.g., by increasing the strength of consonant sounds relative to vowel strength).

4.16.4 Verbal Message Intensity

Guidance for verbal message intensity is as follows:

- i) Verbal message intensity for critical functions should be at least 20 dB(A) above ambient noise levels at the typical operating positions of the intended receivers, but should not exceed 85 dB(A).
- ii) The message should capture personnel's attention but should not cause irritation or a startle reaction.
- iii) Verbal message intensity, if adjustable, should be controlled by administrative procedures.
- iv) Changes in the intensity of verbal message broadcasts should be followed by tests and verification of speech intelligibility.

5 General Emergency Alarms

General emergency alarms intended to alert a general audience (e.g., all personnel on a vessel or offshore installation) should be indicated primarily by audible alarms, including a unique tone and preferably a verbal message. These include the general emergency alarm, abandonment alarm, and those alarms warning of immediate personnel hazards such as the release of certain fire extinguishing media.

5.1 Guidance by Exception

This Subsection modifies some of the alarm guidance provided above to address specific issues related to the design of general emergency alarms.

5.2 Acknowledgement of Alarms

General emergency alarms should not be acknowledged but cleared when the condition that has triggered the alarm has been resolved or a general alarm of greater priority is engaged.

5.3 Master Silence Control

A master silence control associated with any system or equipment alarms should not silence any general emergency alarm. A separate control should be provided for general emergency alarms.

5.4 Alarm Integration

General emergency alarms should not be integrated with other alarms or alerting devices (e.g., equipment or system alarms).

5.5 Temporary Disconnection of Alarms

General emergency alarm circuits are of such importance to safety that they should not be disabled without the provision of another system for alarm notification.

5.6 Repetitive Controls

Controls that activate the general emergency alarm system should be the same in appearance and operation at each location **at which** they exist throughout the vessel or offshore installation.

5.7 Alarm Content

General emergency alarms may be distinct tones or tones with a verbal message added at regular intervals.

5.8 Caution Signal Controls

General emergency alarms should not be used as caution signals.

5.9 Duration of Alarm Flashing

Visual alarms associated with general emergencies should flash until the emergency is cleared.

5.10 Color and Priority Coding

Guidance for priority coding of general emergency alarms is as follows:

- i) General emergency alarms should use a coding scheme that indicates their high level of priority for the audible portion of the signal.
- ii) Any visual signal should make use of the appropriate color code by referring to appropriate statutory, regulatory, or class requirements. The use of a prominent position for alarm indication should be considered as well as the use of flashing mechanisms for demanding attention.
- iii) The general emergency color-coding scheme should be adhered to throughout the vessel or offshore installation.

6 Navigation Bridge Alarms

Alarms on the navigation bridge should be limited to those that are critical to safety of the vessel or offshore installation. Visual alarms and indicators should not interfere with night vision.

7 Alarm Requirements by IMO (1 August 2013)

Alarm requirements imposed by IMO should follow the guidelines contained in IMO Assembly Resolution A.1021(26), *Code on Alerts and Indicators (2009)*, and further the IMO resolution MSC.128(75) requiring a Bridge Navigational Watch Alarm System.

8 Alarm Requirements Imposed by Other Regulatory Bodies

Where requirements for alarms specified by other regulatory bodies (e.g., Flag State Administrations and Port State authorities) are inconsistent with the guidance contained herein, those requirements take precedence over these Guidance Notes.