Designation: F1166 – 07 (Reapproved 2013)

An American National Standard

Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities[1,2]

This standard is issued under the fixed designation F1166; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice provides ergonomic design criteria from a human-machine perspective for the design and construction of maritime vessels and structures and for equipments, systems, and subsystems contained therein, including vendor-purchased hardware and software.

1.1.1 The focus of these design criteria is on the design and evaluation of human-machine interfaces, including the interfaces between humans on the one side and controls and displays, physical environments, structures, consoles, panels and workstations, layout and arrangement of ship spaces, maintenance workplaces, labels and signage, alarms, computer screens, material handling, valves, and other specific equipments on the other.

1.2 The criteria contained within this practice shall be applied to the design and construction of all hardware and software within a ship or maritime structure that the human crew members come in contact in any manner for operation, habitability, and maintenance purposes.

1.3 Unless otherwise stated in specific provisions of a ship or maritime structure design contract or specification, this practice is to be used to design maritime vessels, structures, equipment, systems, and subsystems to fit the full potential user population range of 5th % females to 95th % males.

1.4 This practice is divided into the following sections and subsections:

TABLE OF CONTENTS

Section and Subsections	Title
1	Scope
2	Referenced Documents
3	Terminology
4	Significance and Use
5	Controls
5.1	Principles of Control Design
5.2	General Design Guidelines
5.3	Control Movement
5.4	Control Spacing
5.5	Coding of Controls
5.6	Control Use and Design
6	Displays
6.1	Visual Displays
6.2	Location, Orientation, Lighting, and Arrangement of Displays
6.3	Display Illumination
6.4	Display Types
6.5	Audible Displays
7	Alarms
7.1	General Alarm Requirements
7.2	Visual Alarms
7.3	Audible Alarms
7.4	Voice Messages
7.5	Alarm Initiation Stations
7.6	Alarm Requirements by IMO
8	Integration of Controls, Displays, and Alarms
8.1	Principles of Design
8.2	Grouping Relationships—Principles of Arrangement
8.3	Separating Groupings
8.4	Position Relationships of Displays and Alarms
8.5	Position Relationships of Controls to Associated Displays and Alarms
8.6	Control and Display Movement Relationships
8.7	Spatial Relationship Between Controls, Displays, and Equipment
8.8	Alternative Approach to Grouping Design
8.9	Special Requirements for Control and Display Integration on Bridges
9	Anthropometry
9.1	General Design Requirements
9.2	Static Anthropometric Data
10	Workplace Arrangements
10.1	Basic Principles of Workplace Design
10.2	Seated Workstation
10.3	Standing Workstation
10.4	Kneeling Workstation
10.5	Squatting Workstation
10.6	Shelving
10.7	Status Boards and File Cabinets
10.8	Work Benches
10.9	Vertical Strainers and Filters
10.10	Reach Limitations at Workstations
10.11	Safety Eyewash Fountains and Showers
10.12	Pedestal-Mounted Controls and Displays
10.13	Hand Cranks and Pumps
10.14	Bulkhead-Mounted Equipment
10.15	Equipment Racks, Cabinets, and Individual Equipment Spacing

[1] This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.07 on General Requirements.

Current edition approved Oct. 1, 2013. Published October 2013. Originally approved in 1988. Last previous edition approved in 2007 as F1166 – 07. DOI: 10.1520/F1166-07R13.

[2] A user-friendly format of this standard is available for download from ASTM's website. While the content is the same, ASTM Practice F1166 in standard published format should be considered the official version (for any legal or liability purposes).

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

TABLE OF CONTENTS

Section and Subsections	Title
10.16	Consoles and Control Panels
10.17	Bridge Design
11	Access Aids: Stairs, Handrails, Railings, Vertical Ladders, Ramps, Doors, Lightening Holes, Hatches, Kick-Out Panels, Passageways and Walkways, and Work Platforms)
11.1	Stairs, Ladders, and Ramps
11.2	Stairs
11.3	Ramps
11.4	Vertical Ladders
11.5	Vertical Ladders with Safety Cages
11.6	Vertical Ladders with Positive Fall Protection Devices
11.7	Special Ladder Requirements
11.8	Handle/Hand Grab
11.9	Individual Rung Ladders
11.10	D-Ring Ladders
11.11	Handrails
11.12	Walkways, Passageways, and Alternate Means of Personnel Movement
11.13	Elevated Work Platforms
11.14	Hatches, Manways, Lightening Holes, Inspection Ports, and Kick-Out Panels
11.15	Doors and Arches
11.16	Permanent Means of Access (PMA)
12	Valve Placement, Orientation, and Location
12.1	General Design Requirements
12.2	Valve Criticality and Location
12.3	Valve-Mounting Heights and Orientations: Handwheel Operated
12.4	Valve-Mounting Heights and Orientations: Lever-Operated Valves
12.5	Alternative Valve Orientations
12.6	Valve Manifolds
13	Human-Computer Interface
13.1	General Design Requirements
13.2	System Operations
13.3	Computer Displays
13.4	Display Content
13.5	Display Coding
13.6	Dynamic Displays
13.7	Display Format
13.8	Textual Data Displays
13.9	Graphic Displays
13.10	Audio Displays
13.11	Data Entry
13.12	Interactive Control
13.13	Graphic Controls
13.14	Windows
13.15	Menus
13.16	Forms
13.17	Alarms
13.18	Language
13.19	Feedback
13.20	Prompts
13.21	Defaults
13.22	Error Management/Data Protection
13.23	Data Security
13.24	Help
13.25	Software
13.26	Data Transmission/Messaging
13.27	Input Devices
13.28	Cursors
13.29	Printing
14	Habitability
14.1	Noise
14.2	Indoor Climate
14.3	Lighting
14.4	Whole-body Vibration and Shock
15	Labeling
15.1	Design Criteria of Labels
15.2	Abbreviations
15.3	Symbols
15.4	Component Labels on Consoles and Panels
15.5	Equipment Identification Labels
15.6	Electrical System Labels
15.7	Room, Deck Space, and Void Identification Labels
15.8	Pipe Marker Labels

TABLE OF CONTENTS

Section and Subsections	Title
15.9	Safe Working Load Identification Labels
15.10	Load Weight Identification Labels
15.11	Hazard Identification Signs
15.12	Information Signs
15.13	Instruction Labels
15.14	Graphical Schematics or Diagrams
15.15	Orientation Plans
15.16	Emergency Instructions
16	Material Handling
16.1	Design to Support Manual Material Lifting and Carrying
16.2	Weight Lifting
16.3	Weight Carrying
16.4	Design to Push for Manual Material Handling
16.5	Design of Handles and Grasp Areas
16.6	Design of Auxiliary Hoisting and Carrying Devices
16.7	Hand Trucks and Wheeled Dollies
16.8	Crane Design
17	Maintenance
17.1	General Design Requirements
17.2	Maintenance Accessibility
17.3	Maintenance Environments
17.4	Lubrication
17.5	Cases
17.6	Covers
17.7	Fasteners
17.8	Hatches, Manways, Lightening Holes for Maintenance Access
17.9	Diagnostics and Troubleshooting
17.10	Equipment Modularization
17.11	Equipment Mounting and Installation
17.12	Standardization
17.13	Electrical Wires and Cables
17.14	Conductors
17.15	Connectors
17.16	Test Equipment
17.17	Fuses and Circuit Breakers
17.18	Hydraulic Systems
17.19	Stored Energy Devices
17.20	Pipe Flanges, Spools, and Blinds
17.21	Test and Sample Points
18	Hazards and Safety
18.1	Safety Labels, Signs, and Excluded Area Markings
18.2	General Workplace Hazards
18.3	General Equipment-Related Hazards
18.4	Electrical Hazards
18.5	Mechanical Hazards
18.6	Fluid Hazards
18.7	Safety Barriers
18.8	Fall Protection
18.9	Emergency Egress
19	Communications
19.1	Communication System Requirements
19.2	Microphones
19.3	Headsets
19.4	Loudspeakers
19.5	Telephone Systems
Appendix X1	Human Factors Engineering (HFE) Design Checklist

LIST OF FIGURES

Figure	Title
1	Control Movement Expectations
2	Foot-Operated Switches Design Requirements
3	Pedal Location and Design Requirements
4	Lateral Spacing for Pedals
5	Design Criteria for Discrete Rotary Controls
6	Separation Requirements for Discrete Rotary Controls
7	Dimension, Resistance, and Separation of Continuous Rotary Controls
8	Proper Mounting of Rapidly Operated Cranks
9	Dimensions, Resistance, and Separations Required for Cranks
10	Design Criteria for Pushbuttons
11	Two Types of Legend Switches (Backlit Pushbuttons)
12	Size, Displacement, and Resistance for Legend Switches

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

LIST OF FIGURES

Figure	Title
13	Design Requirements for Various Types of Toggle Switches
14	Design Requirements for Rocker Switches
15	Dimensions, Resistance, and Separation for Discrete Slide Switch Controls
16	Dimensions, Resistance, and Separation for Continuous Slide Controls
17	Dimensions, Resistance, and Separation for Levers
18	Dimensions, Resistance, and Separation for Slide Levers
19	Dimensions, Displacement, and Separation of Push-Pull Controls
20	Visual Lines of Sight
21	Primary and Secondary Fields-of-View
22	Design Criteria for Major, Intermediate, and Minor Scale Markings
23	Scale Graduation, Pointer Position, and Scale Numbering Alternatives
24	Scale Number Placement
25	Color and Shape Coding of Ranges on an Analog Display
26	Zero Position and Pointer Movement for Circular Dial Displays
27	Aligned Pointers for Rapid Check Readings
28	Digital Display Design Requirements
29	Grouping Controls and Displays by Common Function
30	Grouping Controls and Displays by Individual Equipments
31	Mirror-Imaged Arrangement of Individual Equipment Control and Display Groupings (Not Recommended)
32	Grouping Controls and Displays by Common Equipment
33	Grouping Controls and Displays by Sequence of Use
34	Grouping with Physical Separation
35	Grouping with Boundary Lines and Borders
36	Grouping with Colored and Shaded Pads
37	Grouping with Sub-panels
38	Position of Individual Controls and Associated Displays for Right-Handed Operator
39	Arrangement of Multiple Rows of Controls and Displays
40	Arrangement of Multiple Rows of Displays and a Single Row of Controls
41	Positional Relationship between Alarm, Display, and Control
42	Positional Relationship between Control Pointer and Status Indicator
43	Control and Display Movement Relationship
44	Spatial Relationship Between Controls, Displays, and Equipment
45	Spatial Relationships Between Equipment and Control Panels
46	Spatial Relationships for Redundant Controls and Displays
47	Panel Layout That Replicates Location of Equipment in Remote Space
48	Mimic of Physical Equipment Functional Layout
49	Mimic of Functional Groups Irrespective of Equipment Layout
50	Standing Body Dimensions
51	Seated Body Dimensions
52	Depth and Breadth Dimensions
53	Hand and Foot Dimensions
54	Gloved Hand Dimensions
55	Seated Workspace Dimensions
56	Dimensions for a Computer Workstation
57	Dimensions for Single or Multiple Personnel at a Table or Other Duty Station Not Requiring a Desk
58	Seating at CRT-Type Workstations
59	Clearance Behind a Seated Workstation
60	Control Mounting Height for Seated Personnel
61	Display Mounting Height for Seated Personnel
62	Control Mounting Height for Standing Personnel
63	Display Mounting Height for Standing Personnel
64	Control Mounting Height for a Kneeling Person
65	Display Mounting Height for Kneeling Personnel
66	Required Dimensions for a Kneeling Worker
67	Control Mounting Height for Squatting Personnel
68	Display Mounting Heights for Squatting Personnel
69	Required Dimensions for a Squatting Worker
70	Workplace Dimensions for Shelves with Full Access
71	Workplace Dimensions for Shelves Located Above a Cabinet
72	Workplace Dimensions for Shelves Requiring Vision Over the Top

LIST OF FIGURES

Figure	Title
73	Front Clearance Requirement for Lower Shelves
74	Mounting Height of Status Boards
75	Clearance in Front of Filing Cabinets
76	Workbench Dimensions
77	Safe Reach Distances Over an Obstacle or Barrier
78	Mounting Heights for Bulkhead-Mounted Equipment in Passageways
79	Mounting Heights for Common Electrical Fixtures
80	Direct Spatial Relationships Between Controls and Equipment
81	Spatial Relationship of Fore and Aft Equipment to Controls and Displays on a Console Located Athwartship
82	Seated Single-Operator Console Dimensions
83	Wraparound Seated Console
84	Special Width Console
85	Multi-Tiered Standing Console
86	Multi-Tiered Seated Console
87	Dimensions for Desktop Standing Console
88	Cargo and Ballast Transfer Consoles
89	Stair Dimensions
90	Straight Run Ramp Dimensions
91	Ramp with Turning Platform
92	Ramp with Switchback Turning Platform
93	Vertical Ladder Dimensions
94	Dimensions for a Vertical Ladder Arrangement
95	Platform/Landing Dimensions for Vertical Ladder Penetration
96	Caged Ladder Dimensions
97	Cage Shape and Size
98	Ladder and Climber Safety Device Dimensions
99	Extended Railing for Ladder Fall Protection (Front View)
100	Extended Railing for Ladder Fall Protection (Side View)
101	Extended Railing and Cage for Ladder Fall Protection (Front View)
102	Extended Railing and Cage for Ladder Fall Protection (Side View)
103	Handles or Hand Grabs for Use as Ladder Extensions
104	Handle for Transition from a Ladder to an Intermediate Platform
105	Recommended Design Criteria for Individual Rung Ladders
106	Dimensions for D-Ring Ladders
107	Fixed Handrail Design
108	Removable Handrail Dimensions
109	Special Handrail Design Dimensions
110	Transition Handrail Dimensions
111	Additional Personnel Movement-Related Design Features
112	Dimensions for Rectangular Access Openings Installed in a Vertical Orientation Requiring a Step to Reach the Opening
113	Dimensions for Rectangular, Square, and Round Hatches, Manways, and Lightening Holes
114	Dimensions for Lightening Holes
115	Access to Vertical Escape Hatches
116	Access to Overhead Hatch
117	Access into a Cargo Hold Through a Raised Hatch
118	Door Placement
119	Desirable Upper Limits for Handwheel Torque
120	Mounting Heights for Handwheel Valves With Vertical Stems
121	Mounting Heights for Handwheel Valves With Horizontal Stems
122	Mounting Heights for Handwheel Valves With Angled Stems
123	Mounting Heights for Lever-Operated Valves With Vertical Stems
124	Mounting Heights for Lever-Operated Valves With Horizontal Stems
125	Direction of Travel for Valve Levers Accessible From One Side Only
126	Physical Reach from a Stooping or Squatting Position
127	Mounting Position for Valve Levers and Handwheels Below Standing Surface
128	Orientation and Reach from Ladder Parallel to Valves
129	Orientation and Reach from Ladder Perpendicular to Valves
130	Operating Valves from a Ladder
131	Valve Manifold for Tanks Located Athwartship
132	Valve Manifold for Tanks Located Fore and Aft
133	Valve Manifold for Fill, High-Suction, and Low-Suction Valves
134	Default Push Button

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

LIST OF FIGURES

Figure	Title
135	Push Button States
136	Radio Buttons
137	Check Boxes
138	Slider Control
139	Message Window Design
140	Finger-Operated Displacement Joystick Specifications
141	Trackball Dimensions, Resistance, and Clearance
142	Permissible Noise Exposure Limits
143	Large Enclosure Ventilation Requirements
144	Surface Reflectance Values
145	Health Guidance Zones for Limited Exposures
146	Independent Symbols
147	Guidelines for Labels on Consoles and Panels
148	Control and Control Setting Labels
149	Control and Display Group Labels
150	Control Setting Labels for Multiple Controls
151	Equipment Label Format
152	Sensor Label
153	Pipe Marker Labels
154	Pipe Marker Labels with Two Colors
155	Hazard Signal Word Headers
156	Examples of Text and Symbol on Signs
157	Example of Information Sign
158	Examples of Push-Pull Forces
159	Handle Dimensions
160	Use of Hand Trucks
161	Use of Dollies
162	Case Orientation
163	Access Opening Covers
164	Example of Alignment Pins
165	Cable Arrangements
166	Suggested Cable Arrangement in a Junction Box
167	Fluid Line Connection Recommendations
168	Areas Not To Place Items on Bulkhead
169	Safety Barriers

LIST OF TABLES

Table	Title
1	Recommended Manual Controls
2	Control Movement Expectations
3	Minimum Spacing Between Two Controls
4	Comparison of Displacement and Isometric Controls
5	Typical Status Display and Alarm Color Codes for North American Industry
6	Character Sizes for Digital Displays
7	Functional Evaluation of Types of Audio Signals
8	Guidelines for Color Coding of Visual Alarms
9	General Recommendations for Sound Loudness and Frequency
10	Guidelines for Selecting Audible Alarm Sounds
11	Clothing and Postural Effects
12	International Geographical Regions for Which Anthropometric Data Are Available
13	Standing Height Dimensions—International Population
14	Seated Eye Height Dimensions—International Population
15	Forward Functional Reach Dimensions—International Population
16	Male Anthropometric Data from Four Regions of the World
17	Female Anthropometric Data from Four Regions of the World
18	Weights for American Adult Females and Males
19	Seated Workspace Dimensions
20	Dimensions for a Seated Computer Workstation
21	Maximum Overhead Extended and Gripping Reach
22	Selection of Access Type
23	Stair Dimensions
24	Stair Widths
25	Handrail Arrangements
26	Recommended Ramp Angle Inclinations
27	Walkway and Passageway Dimensions
28	Dimensions for Additional Personnel Movement-Related Features
29	Access Opening and Mounting Depth Dimensions for Levers and Handwheels Mounted Below the Standing Surface

LIST OF TABLES

Table	Title
30	System Response Time Limits
31	Advantages and Disadvantages of Nonkeyboard Input Devices
32	Keyboard Push-Button Characteristics
33	Pointer Shapes and Associated Functions
34	Pointing Device Button Actions
35	Limiting Dimensions for Mouse
36	Maximum Permissible Noise Levels
37	Noise Attenuation from Hearing Protectors
38	Lighting Levels for Ships and Maritime Structures
39	Maximum Brightness Ratios
40	Operational Environment Types
41	Examples of Equipment Labels
42	Pipe Label Format
43	Example Color-Coding Scheme for Vessel/Structure Piping
44	Chromaticity Coordinates for Color Coding
45	Message Text Character Heights
46	Design Weight Limits for Lifting
47	Design Weight Limits for Carrying
48	Limiting Factors
49	Seated, Forward Reach (Both Arms)
50	Cross-Legged Seated, Forward Reach (Both Arms)
51	Standing, Forward Reach (Both Arms)
52	Standing, Forward Reach (Preferred Arm)
53	Standing, Lateral Reach (Preferred Arm)
54	Opening Dimensions for Single-Hand Access with Tools
55	Opening Dimensions for Single-Hand Access without Tools
56	Opening Dimensions for Arm Access without Tools
57	Opening Dimensions for Two-Hand Access
58	Thermal Temperature Limits
59	Shock Current Intensities and Their Probable Consequences
60	Minimum Speech Intelligibility Scores
X1.1	Human Factors Checklist for Design

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *Overall References:*

ABS Guidance Notes for the Application of Ergonomics to Marine Systems, April 2003

MIL-STD-1472F Department of Defense Design Criteria Standard: Human Engineering

2.2 *Alarms:*

DOT/FAA/CT—96/1 Human Factors Design Guide

Engineering Equipment and Materials User's Association (EEMUA) Publication # 191, Alarm Systems, a Guide to Design, Management and Procurement

International Maritime Organization (IMO) Resolution A.830(19) Code on Alarms and Indicators

2.3 *Integration of Controls, Displays, and Alarms:*

ABS (October 2003) Guidance Notes on Ergonomic Design of Navigation Bridges

2.4 *Anthropometry:*

ADULTDATA: The Handbook of Adult Anthropometrics and Strength Measurements—Data for Design Safety, Institute for Occupational Ergonomics, University of Nottingham, UK, 1998

International Labor Office (ILO) International Data on Anthropometry, 1990

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

McDowell, M. A., Fryar, C. D., Hirsch, R., and Ogden, C. L., Anthropometric Reference Data for Children and Adults: U.S. Population, 1999-2002, Advance Data from Vital and Health Statistics No. 361, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, July 2005

Woodson, W., Human Factors Design Handbook, 1981

2.5 *Access Aids:*

ABS Guide for Means of Access to Tanks and Holds for Inspection, Draft, March 2006

International Maritime Organization (IMO) Guidelines for Safe Access to Tanker Bows, IMO Resolution MSC.62 (67), 1996 International Maritime Organization (IMO) International Convention on Loadlines, 1966

2.6 *Human-Computer Interface:*

Defense Information Systems Agency (DISA) Common Operating Environment (COE) User Interface Specifications (UIS), 2003

FAA Human Factors Design Standard (HFDS) for Acquisition of Commercial-Off-the-Shelf (COTS) Subsystems, Non-Developmental Items (NDI), and Developmental Systems, 2003

ANSI/HFS Standard No. 100-2001 (DRAFT) American National Standard for Human Factors Engineering of Visual Display Terminal Workstations, Human Factors Society, Inc., Santa Monica, CA, 2001

MPR Associates, Common Presentation Layer Specification (DRAFT), 2005

2.7 *Habitability:*

ABS (December 2001) Guide for Crew Habitability on Ships

Directive 2002/44/EC of the European Parliament and of the Council (25 June 2002) on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration)

International Maritime Organization (IMO) Resolution A.468 (XII), Code on Noise Levels on Board Ships

International Standards Organization (ISO) 2631-1 Evaluation of Human Exposure to Whole-Body Vibration, Parts 1 and 5

Peterson, R., Price, B., LaBrecque, J., Bass, D., and Ziemba, A., Development of Impact Injury Design Rule for High Speed Craft, Naval Surface Warfare Center, Panama City, FL, August 26, 2004

2.8 *Labeling:*

ANSI Z535.2 Environmental and Facility Safety Sign Standard

ANSI Z535.3 Criteria for Safety Symbols

2.9 *Material Handling:*

Lifting: TLV Physical Agents, 7th edition, American Conference of Governmental Industrial Hygienists, 2005

FAA Human Factors Design Standard (HFDS) for Acquisition of Commercial-off-the-Shelf (COTS) Subsystems, Non-Developmental Items (NDI), and Developmental Systems

Kroemer, K., Kroemer, H., and Kroemer-Elbert, K., Ergonomics: How to Design for Ease and Efficiency, Prentice Hall, Englewood Cliffs, NJ, 1999

2.10 *Maintenance:*

MIL-HDBK-454 General Guidelines for Electronic Equipment

MIL-STD-130 Department of Defense Standard Practice for Identification Marking of U.S. Military Property

2.11 *Communications:*

DOT/FAA/CT—96/1 Human Factors Design Guide

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accessible, adj*—an item is considered accessible when it can be operated, manipulated, inspected, serviced, removed, or replaced by the suitably clothed and equipped user with applicable body dimensions conforming to the anthropometric range and database specified by the procuring activity or, if not specified by the procuring activity, with applicable 5th to 95th percentile body dimensions as defined in Section 9.

3.1.1.1 *Discussion*—Applicable body dimensions are those dimensions that are design critical to the operation, manipulation, inspection, service, removal, or replacement task.

3.1.2 *advisory signal, n*—signal that indicates a safe or normal configuration, condition of performance, or operation of equipment or attracts attention and imparts information for routine action purposes.

3.1.3 *alarm, n*—visual or audible signal or both of a condition, or a predetermined out-of-tolerance condition, for machinery, equipment, components, or systems that require attention and response by a crewmember.

3.1.4 *alarm filtering, n*—technique by which unnecessary alarms are eliminated.

3.1.5 *alarm priority, n*—predicted assessment of the potential consequence of a condition or situation and the resulting urgency of mitigating responses required of personnel, that is, the more severe the potential consequence, the higher the alarm priority.

3.1.6 *alarm suppression, n—(1)* technique in which when a single-alarm event leads to subsequent alarm events (for example, cascading alarms), the initiating alarm is presented but the subsequent events are not (that is, are suppressed); and *(2)* technique by which alarm messages are not displayed but are available to the user upon request.

3.1.7 *analog display, n*—type of display that shows the complete range of a measured parameter on a continuous scale and by means of a pointer, or equivalent, indicating an instantaneous value of the parameter on the scale.

3.1.8 *angle of inclination, n*—angle that the stair rises measured from the deck or surface on which the stair is sitting to the underside of the stair stringers.

3.1.9 *annunciator, n—(1)* type of transilluminated display that provides written text, pictorial data, or both to a user to show status or condition of a system or equipment; and *(2)* (also called a legend light) type of transilluminated display consisting of a light source located behind a cover that contains a printed label (that is, legend).

3.1.9.1 *Discussion*—The color of the light usually used,

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

green, white, or blue), whether it is ON or OFF, and the printed label all provide information to the operator about the status of a piece of equipment or system.

3.1.10 *anthropometrics, n—(1)* study of the physical size, strength, and range of motion of the human body and the application of that data to the design of systems, equipment, workspaces, and tools to maximize human performance and safety in a work setting; and *(2)* measurement of human variability of body dimensions and strength as a function of gender, race, and regional origin.

3.1.11 *anti-two-block alarm, n*—alarm used to warn a crane operator of the impending collision of the traveling block and crane tip sheave.

3.1.12 *articulation index (AI), n*—technique used to measure how intelligible (that is, understandable) spoken words are that are received over communication equipment and is expressed as a percentage of speech units that are understood by a listener when heard out of context.

3.1.13 *assembly, n*—number of parts or subassemblies or any combination thereof joined together to perform a specific function and capable of disassembly.

3.1.13.1 *Discussion*—The distinction between an assembly and a subassembly is determined by the individual application. An assembly in one instance may be a subassembly in another in which it forms a portion of an assembly.

3.1.14 *assisted lifting devices, n*—items such as cranes, hoists, mobile A-frame and hydraulic jacking units, monorails, trolleys, or padeyes used by individuals to lift or move materials and equipment or both that is too heavy for direct manual lifting or carrying.

3.1.15 *audible alarm, n*—alarm comprised of tones, verbal messages, or verbal messages combined with tones and not all audible alarms are associated with visual alarms.

3.1.16 *auditory display, n*—device that provides readings, status, or condition of machinery, equipment, or system-operating parameters through the use of sound signals or spoken messages.

3.1.17 *band pass, n*—electronic filter designed to respond only to selected audio frequencies while blocking all other frequencies.

3.1.17.1 *Discussion*—Commonly used in telephones.

3.1.18 *binaural, n*—sound coming to a headset from dual channels or signal paths with a different channel or signal path presented to each headset.

3.1.19 *case, n*—part of an item of equipment that encloses and protects the equipment from its surroundings and protects the surroundings—-including personnel-—from the equipment.

3.1.20 *caution signal, n*—signal that indicates the existence of a condition requiring attention but not immediate action.

3.1.21 *coaming, n*—vertical steel plate extending up 50 to 76 mm (2 to 3 in.) from the deck and placed around equipment or other areas in which liquids (for example, oil, water, grey or black water, and oily water) could be spilled to contain the liquids within a confined area.

3.1.22 *color pad, n*—area on a console or panel face that is shaded a different color than the panel itself to highlight a set of controls, displays, and/or alarms that are related in some manner.

3.1.23 *command, n*—instructions that cause a device to perform some action.

3.1.24 *command language, n*—limited programming language used strictly for executing a series of commands (for example, Linux or any DOS shells).

3.1.25 *console, n*—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 the individual equipment or systems.

3.1.25.1 *Discussion*—Consoles may be freestanding units and include angled and vertical surfaces.

3.1.26 *continuous control, n*—continuous control is an actuator that operates at any point or value along a continuous scale (for example, engine throttle).

3.1.27 *contrast ratio, n*—ratio of the differences in luminance between the item on a video display and the background.

3.1.28 *control, n—(1)* any switch, pushbutton, knob, lever, keyboard, mouse, or other device manually manipulated by the operator/maintainer to alter or maintain the status of a particular piece of equipment or system; and *(2)* a device an operator or maintainer uses to input a signal, change the operating status of equipment or systems, or to manipulate displayed data. Examples include switches, knobs, cranks, thumbwheels, levers, keyboards, and foot pedals.

3.1.29 *cursor, n*—marker on the display screen that indicates the position where the computer expects the next input or will display the next output.

3.1.29.1 *Discussion*—The cursor may be positioned by the computer or by the user.

3.1.30 *danger signal, n*—signal that indicates the existence of a hazardous condition requiring immediate action to prevent loss of life, major equipment damage or environmental contamination, or serious loss of mission capability.

3.1.31 *dead-man switch, n*—control that automatically stops machinery or systems from operating once the control is released by the operator.

3.1.32 *dependent symbol, n*—symbols that alone do not impart any specific information to the user but require the existence of supporting data to provide useful information.

3.1.33 *detent control, n—(1)* 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.

3.1.33.1 *Discussion*—These types of controls are preferable for machinery equipment or system operation requiring control in discrete steps or different modes.

(2) type of discrete control in which each control position setting is identified by a audible click and the control " locks" into that position setting until the operator exerts extra force to move the control out of that setting and into the next one.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

3.1.34 *digital display, n*—type of display that uses numeric characters to provide an instantaneous value of a parameter.

3.1.35 *directly accessible, adj*—to be directly accessible, an object, space, component, or piece of equipment shall be in an area reachable without having to use tools or disassemble an access opening; be clear of, or protected from, obstructions, moving equipment, hot surfaces, or other obstructions that would prevent safe contact by the user; allow the user to get as close as necessary (for example, arm's reach) to perform the required tasks; be reachable via a permanent access; and allow all of the above by a person wearing the required protective clothing and carrying tools, spare parts, and test equipment as required.

3.1.36 *directly visible, adj*—a directly visible object (for example, control, display, hazard warning, and so forth) shall not be located behind a door or other closure cover and shall be readable from the normal user position within the provided ambient lighting and from a position that does not require the reader to stand on pipes, cable trays, structural members, or other surfaces not intended to be a regular working surface or assume awkward body postures.

3.1.37 *discrete control, n*—actuator that allows for the selection between two or more mutually exclusive operating functions or points along a scale (for example, switching a machine ON or OFF or selecting one of three pumps to run).

3.1.38 *displacement joystick, n*—joystick that moves out of the detent in the direction it is pushed.

3.1.38.1 *Discussion*—Displacement joysticks are usually spring-loaded so that they return to a neutral center (detent) position.

3.1.39 *display, n*—any gauge, light counter, printer, annunciator, sight glass, horn, siren, digital counter, cathode ray tube (CRT) screen, or any other device that provides visual or auditory information to the human operator/maintainer about the status of a piece of equipment or system.

3.1.40 *dynamic display, n*—display screen that is, or has portions within that are, updated on a regular basis, primarily alphanumeric values.

3.1.41 *emergency shutdown stations (ESDs), n*—manual controls that are located throughout a ship or maritime structure that shut down equipments, systems, or complete structures and initiate an alarm at the same time.

3.1.42 *fixed ladder, n*—ladder permanently attached to a structure, building, or equipment.

3.1.43 *foot candle, n*—measure of the amount of light striking a surface.

3.1.44 *foot lambert, n*—measure of the amount of light reflected from the surface.

3.1.45 *flicker, n*—perception of rapid fluctuations in luminance levels characterized by an impression of jerky movements.

3.1.46 *function keys, n*—labeled keys that serve as keyboard shortcuts (for example, F1, F2, F3, or with the function name such as Delete or Insert) by combining in one key the actions of a sequence of individual keys.

3.1.47 *general emergency alarms, n*—alarm given in the case of an emergency involving all persons on a vessel or other maritime facility and these alarms sound throughout a vessel or maritime installation and are intended to be heard by all personnel.

3.1.47.1 *Discussion*—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 installation.

3.1.48 *glare, n*—luminance or amount of light-per-unit area emitted or reflected from a surface, within a specific area of personnel's field of view, that is greater than the luminance to which the eye is adjusted compared to the remainder of the field of view.

3.1.49 *graphic label, n*—type of label used to present information through line schematics, diagrams, charts, tables, and pictures.

3.1.50 *handle or handgrab, n*—U-shaped bar attached directly to bulkheads or other structures used by a person to hold onto where handholds are required such as when passing through hatches or lightening holes or climbing vertically through deck openings.

3.1.51 *handrail, n*—vertical barrier consisting of two or more horizontal rails connected to vertical stanchions that are erected along exposed edges of floor openings, wall openings, ramps, steps, platforms, and walkways to prevent a person from falling from one elevation to another.

3.1.52 *hazard identification sign, n*—type of sign used to identify and provide information about situations that may be hazardous to personnel, equipment, or the environment; there are two types of hazards: "DANGER" and "CAUTION."

3.1.53 *hazard label, n*—type of label used to identify and provide information about situations that may be hazardous to personnel, equipment, or the environment and only two types of hazards should be allowed, that is, "DANGER" and "CAUTION," based on the following criteria.

3.1.53.1 *DANGER*—used where the hazard could result in serious injury or death to a person, serious damage to vital equipment, or a major environmental problem.

3.1.53.2 *CAUTION*—used where the hazard could result in a minor injury to a person, minor damage to the equipment, or a minor environmental problem.

3.1.54 *hierarchical menus, n*—large series of options or menus that are organized as a multilevel, branching structure in which an option in a higher-level menu is the name of another menu at the next lower level and the options in the lowest-level menus are not the names of other menus.

3.1.55 *human engineering (ergonomics), n*—scientific discipline concerned with the understanding of interactions among humans and other elements of a system and the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance.

3.1.56 *human systems integration (HSI), n*—systems engineering discipline that is focused on human performance,

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

human skills and training, manpower, personnel survivability, health and safety, and quality of life at sea.

3.1.57 *hyperlinks, n*—text that provides the capability to, when selected using a pointing device or ENTER key, direct the user to another location within the window or another window.

3.1.57.1 *Discussion*—Hyperlinks are generally indicated by textual formats such as alternate text color or underlining or both.

3.1.58 *icon, n*—picture or drawing that represents an actual piece of equipment or system on the ship or maritime structure.

3.1.59 *identification label, n*—type of label used to: *(1)* identify, and be placed on, all individual equipments or components, for example, valves, gauges, junction boxes, filters, pumps, sensor, consoles, transmitters, pressure vessels, control panels, local motor controllers, fans, heaters, cabinets, lockers, and all other items used by the crew for operation, maintenance, or habitability use; *(2)* identify spaces (for example, rooms, compartments, open deck areas, buildings, tanks, voids, or any area in which the crew may enter); and *(3)* identify individual controls, displays, alarms, or groups thereof as shown in Section 8 that appear on consoles, control panels, or are individually mounted.

3.1.60 *independent symbol, n*—pictorial representation that alone provides information to personnel without requiring elaboration by supporting text.

3.1.61 *individual rung ladder, n*—fixed ladder, each rung of which is individually attached to a structure, building, or equipment rather than to ladder stringers.

3.1.62 *information label or placard, n*—type of label or placard used to present nonprocedural information of a general nature related to health, first aid, sanitation, rules, housekeeping, and general conduct.

3.1.63 *instruction label, n*—instruction label provides step-by-step instructions for accomplishing a specific task (operation or maintenance related) along with hazard and safety information related to performing the task.

3.1.64 *isometric joystick, n*—joystick that has no perceptible movement but output is a function of applied force.

3.1.65 *jitter, n*—interference in electron-gun displays (for example, CRT displays) as a result of magnetic fields from other devices such as motors and generator sets.

3.1.66 *keyboard lockout, n*—state determined by an application in which the application does not accept input from the keyboard.

3.1.67 *kickout panel, n*—part of a joiner bulkhead or wall that is marked and designed especially to be "kicked out" and used as an emergency escape exit.

3.1.68 *label, n*—term, when used alone, shall mean any type of plate, sign, placard, inscription, legend, marking, or combination of these, that is used for purposes of identification or to impart visual information or instructions to the reader.

3.1.68.1 *Discussion*—This term is used generically herein to describe all the specific types of labels described in Section 15.

3.1.69 *ladder, n*—appliance consisting of two side rails (that is, stringers) joined at regular intervals by crosspieces called rungs, or steps, on which a person steps during ascent or descent of the ladder from one elevation to another.

3.1.70 *legible, adj*—defines the state in which alphanumeric characters or other written information is presented in a form such that each character or number is recognized as being different from the other.

3.1.71 *lighted pushbutton, n*—type of annunciator in which the pushbutton lights up when it is pushed and goes off when the button is pushed again.

3.1.71.1 *Discussion*—The pushbutton serves as a control and display since the light indicates the status (that is, ON or OFF, OPEN or CLOSED, and so forth) of the controlled item.

3.1.72 *lightening hole, n*—hole (often oval in shape) cut in the steel structure of an inner-bottom plate at specific locations so as to reduce the weight of the ship without degrading its structural integrity; allow liquids that might be in a tank or hold to move freely; and provide personnel access from one tank or space to another for maintenance, repair, and construction purposes.

3.1.73 *local operating alarms, n*—alarms located within specific operating spaces close to the equipment or systems they monitor.

3.1.74 *luminance, n*—total light emitted from a video display calculated on the basis of the brightest portion or average level over the entire area of video display.

3.1.75 *maintainability, design for, n*—design decisions made directed toward achieving those combined characteristics of equipment and facilities that will enable the accomplishment of necessary maintenance quickly, safely, accurately, and effectively with minimum requirements for personnel, skills, special tools, and cost.

3.1.76 *maintenance, n*—all actions necessary for retaining material in (or restoring it to) a condition capable of a specified level of performance.

3.1.76.1 *Discussion*—Maintenance includes inspecting, servicing, removal, replacement, repair, modification, modernization, overhaul, condition determination, corrosion control, and initial provisioning of support items.

3.1.77 *manual material handling, v*—act of a person physically lifting, carrying, pushing, pulling, or holding any item or load as a part of performing any duty.

3.1.78 *may, v*—term is used in this practice to mean that the related criteria can or cannot be used at the discretion of the designer without the procuring authority or organization being notified.

3.1.79 *menu, n*—list of options from which a user makes a selection or selections.

3.1.80 *modified rhyme test (MRT), n*—another technique used to measure how intelligible spoken words are that are received over communication equipment.

3.1.81 *monaural, n*—sound coming to a headset from a single channel or signal path.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

3.1.82 *noise-canceling microphone, n*—design feature that reduces the masking effect of ambient noise upon speech impressed on a microphone to make the speaker's voice more intelligible.

3.1.83 *normal line of sight, n*—line drawn from the human eye to a visual object, such as a gauge or panel, which is 15° below horizontal as a result of the downward tilt of the human head under normal conditions.

3.1.84 *nose or nosing, n*—that portion of a tread projecting beyond the face of the tread immediately below.

3.1.85 *open riser, n*—air space between treads of a stairway without upright members (risers) between the treads.

3.1.86 *palettes (graphic menus), n*—set of unlabeled symbols, typically presented within small rectangles in which the symbols may be icons, patterns, characters, or drawings that represent an operation.

3.1.86.1 *Discussion*—Palettes are used widely in drawing and painting packages but are commonly found in word-processing applications as well.

3.1.87 *panel, n—(1)* any surface in which controls, displays, and/or alarms relating to equipment or system conditions are placed.

3.1.87.1 *Discussion*—Panels typically are flat vertical surfaces. Panels are sometimes referred to as control boards.

(2) concentration of individual controls and displays used to operate one or more pieces of equipment, usually mounted on a flat plate attached to, or located near, the equipment itself.

3.1.88 *panel and console labels, n*—labels that appear on operator consoles and panels to identify individual controls or displays or groups of controls and displays.

3.1.89 *peak clipping, v*—simple form of signal processing that limits the amplitude of signals that exceed a predetermined level to prevent the audio output from being too loud and causing listener discomfort.

3.1.90 *percentile, n*—given the range of variability of (human) bodily dimensions, anthropometric data are typically expressed as percentile statistics, such as 5th or 95th percentile and a percentile statistic defines the anthropometric point at which a percentage of a population falls above or below that value.

3.1.90.1 *Discussion*—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.

3.1.91 *permanent access, n*—means of access (for example, walkway, passageway, stair, ladder, platform, clear deck area, and so forth) shall be a permanent structure (that is, not portable) firmly secured in place or kept clear of any obstruction or both and always immediately available for use without requiring the operator to reconfigure structures.

3.1.92 *pipe marker labels, n*—labels with colored markings (for example, bands of color), text, and flow arrows placed on pipes to identify pipe content and flow direction.

3.1.93 *pixel, n*—smallest discrete element on a video screen.

3.1.94 *pointer, n*—symbol displayed on a video display that is controlled by a pointing device.

3.1.94.1 *Discussion*—Its shape may change depending on the function that is invoked or its location on the video display.

3.1.95 *pointing device, n*—non-keyboard device that allows personnel to navigate rapidly around a video display and specify and select objects for manipulation and action.

3.1.95.1 *Discussion*—Examples include a mouse, track ball, stylus and grid, and light pen.

3.1.96 *positive fall protection, n*—device that attaches to a vertical ladder and a safety harness worn by a ladder climber that eliminates the chance for the climber to fall from the ladder.

3.1.97 *primary field of view, n*—area approximately 15° above and below the normal line of sight and 15° to the right and left of the center line of the human head (that is, a 30° cone drawn on any visual object viewed by the human eye).

3.1.98 *query, n*—process of specifying, locating, and retrieving data matching specified characteristics from a database.

3.1.99 *radio buttons (exclusive buttons or option buttons), n*—single, two-state choices, that are mutually exclusive from each other.

3.1.100 *railing, n*—single horizontal pipe or other material attached to stairs with three or less steps to a bulkhead or other structure at stairs enclosed on both sides regardless of the number of steps or to bulkheads or other structures along corridors or walkways that a person walking can hold on to for stability.

3.1.101 *readable, adv*—state in which the alphanumeric characters or other written or pictorial information is presented in such a way as to be understandable and transmits a meaningful message to the user.

3.1.102 *resolution, n*—number of individual points of color contained on a video display expressed in terms of the number of pixels on the horizontal axis and the number on the vertical axis.

3.1.103 *rise, n*—vertical distance from the top of a tread to the top of the next higher tread.

3.1.104 *riser, n*—upright member of a step that connects the back of a lower tread to near the leading edge of the next higher tread.

3.1.105 *rung, n*—ladder crosspieces of a circular or square cross section on which a person steps to climb up or down the ladder.

3.1.106 *safety cage, n*—enclosure that is fastened to the stringers of a vertical ladder so as to encircle the person climbing the ladder to protect against falls from the ladder.

3.1.107 *saturation, n*—extent to which a chromatic color differs from a gray of the same brightness.

3.1.107.1 *Discussion*—It is a measure on an arbitrary scale from 0 (gray) to 100 %.

3.1.108 *scrolling, v*—method used to move through the contents of a window or list in a dialogue box using the scroll bar or scroll arrows.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

3.1.109 *shall, v*—in this practice, shall means that the use of the criteria identified is mandatory and can only be replaced or rejected by written authority from the procuring agency or organization.

3.1.110 *should, v*—in this practice, should means that the criteria identified are to be used unless there is a justifiable reason to replace the given criteria with some other and that the procuring authority or organization is so notified of the change.

3.1.111 *sight gauge, n*—tube, normally attached to the side of a tank or other vessel, that is filled with the tank's liquid, or some other indicator, to show the depth of the liquid in the tank or vessel.

3.1.112 *simple indicator, n*—light with no text or pictorial presentation but color coded to show the status of a piece of equipment or system.

3.1.113 *spatial relationship, n*—placement of controls, displays, and their related equipment so that it is visually obvious to an operator or maintainer that all components of a particular system are related.

3.1.113.1 *Discussion*—Consoles and workstations shall be designed and oriented so the individual displays and controls on the consoles or workstations are arranged, as viewed by the operator facing the console or workstation, in the same spatial arrangement as the actual equipment located on the ship or maritime structure that is being controlled or monitored at the console or workstation (for example, controls and displays on the left side of a panel relate to equipment on the left side of the operator as viewed by the operator facing the panel or console).

3.1.114 *speech interference level (SIL), n*—measure of the effectiveness of noise in masking speech; it is the arithmetic mean of the same pressure levels of interfering noise in the four octave bands centered on the frequencies 500, 1000, 2000, and 4000 Hz, respectively.

3.1.114.1 *Discussion*—The unit of speech interference is the decibel (dB (A)).

3.1.115 *steps, n*—flat crosspieces of a stair on which a person steps to go up or down the stairs.

3.1.116 *stringers, n*—two vertical side rails (usually made of pipe) to which the rungs are attached on a vertical ladder or the two beams on either side of a stair to which the stair steps are attached.

3.1.117 *subassembly, n*—two or more units that form a portion of an assembly or a unit replaceable as a whole but having a part or parts that are individually replaceable.

3.1.118 *toeboard, n*—barrier placed along the edge of a walking surface to prevent personnel from placing their foot over the edge of an elevated walking surface or prevent objects from sliding or rolling over the edge onto personnel below.

3.1.119 *transilluminated display, n*—any display that is illuminated by sources within the display.

3.1.120 *tread, n*—horizontal member of a step (that is, the walking surface of a stair).

3.1.121 *tread depth, n*—horizontal distance from the front to back of a tread including the nosing when used.

3.1.122 *unit, n*—assembly or any combination of parts, subassemblies, and assemblies mounted together normally capable of independent operation in a variety of situations.

3.1.123 *vertical ladder, n*—ladder consisting of stringers and rungs that runs vertically from one deck level to another and is installed at an angle of between 75 and 90° from the horizontal.

3.1.124 *video-display unit, n*—display devices such as CRTs, flat plasma displays, liquid-crystal displays, and other flat panel technologies.

3.1.125 *visible, adj—(1)* term visible means the operator can see the control from the normal working position without having to stand on pipes, wire ways, or structures; without assuming an awkward posture; without obstructions to the line of sight; and with ambient illumination under all operating conditions; and *(2)* state in which a display, label, sign, or any other printed or pictorially presented information can be seen from among all the other visual displays available within a user's field of view.

3.1.126 *visual alarm, n*—alarm comprised of flashing lights, lighted annunciators, rotating beacons, strobe lights, or some other form of visually presented information to the crew member.

3.1.127 *visual display, n*—type of display that visually provides information on the condition or status of a piece of equipment or system or of the environment.

3.1.128 *workplace, n*—contained or otherwise defined area occupied by the human operator/maintainer to monitor, operate, maintain, repair, calibrate, or replace a piece of equipment or total system or to complete any task required as a part of the person's assigned duties.

3.1.128.1 *Discussion*—Workplaces can contain one or more consoles, panels, pieces of equipment, and/or individual controls and displays.

4. Significance and Use

4.1 The objective of this practice is to provide ergonomic design criteria for maritime vessels and structures to ensure that maritime systems and equipment are designed in compliance with requirements for human performance, human workload, health and safety, survivability, and habitability.

4.2 *Principles of Human Behavior:*

4.2.1 There are basic principles of human behavior that control or influence how each person performs in their workplace. Some of these behaviors are culturally derived, while others are general and uniform across all cultures and geographical regions of the world. These behaviors influence a person's physical, social, and psychological approach toward the work they do and how safely they do that work. Failure to satisfy these behavioral principles in the design of a ship or maritime structure can encourage, or even coerce, maritime personnel into taking unsafe risks in their everyday activities. It is, therefore, imperative that designers of ships and maritime equipment, systems, and facilities know these principles to provide a safe and efficient workplace for maritime personnel.

4.2.2 These principles include:

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

4.2.2.1 If the design of the ship or maritime facility is considered to be unsafe or inefficient by the crew, it will be modified by the users, often solving the initial problem but introducing others that may be as bad, or worse, than the original.

4.2.2.2 Equipment design shall be such that it encourages safe use, that is, does not provide hardware and software that can be used in an unsafe manner.

4.2.2.3 If the equipment or system is not designed to operate as the users' cultural and stereotypical expectations lead them to think that it will operate, the chance for human error is significantly increased.

4.2.2.4 If equipment or systems are perceived by operators/maintainers to be too complex or require more effort to operate or maintain than they believe is necessary, they will always look for a "shortcut." Further, this "shortcut" may be perceived as being safe when it is not.

4.2.2.5 No amount of training, company or organizational policy, threats of retaliatory action, warning notes in a technical manual or training guide, or pleading with personnel to be safe on the job can overcome poor design that encourages, leads, or even coerces personnel into unsafe acts on the job. The most efficient way to prevent unsafe design from contributing to an accident is to eliminate the unsafe design.

4.2.2.6 Equipment users tend to be very unimaginative when it comes to identifying unsafe features and they do not visualize the consequences of unsafe acts. Therefore, do not expect that an "obviously dangerous" task will always be recognized as such by every user.

4.2.2.7 Designers shall consider the possibility for human error and design equipment so that incorrect use (deliberate or accidental) will result in little or no harm to the user.

4.2.2.8 Equipment operators and maintainers tend to make guesses as to what a label, instruction, or operational chart states if it is not complete, legible, readable, and positioned correctly.

4.2.2.9 Designers and engineers shall never use themselves as the standard against which a particular design is evaluated. People come in many shapes, sizes, mental capacities, and capabilities. Therefore, design for the full range of potential users, physically, mentally, and socially.

4.2.2.10 People shall be protected against themselves. Designers cannot create an unsafe piece of equipment or system and expect the users to assume full responsibility for its safe use.

4.2.2.11 Ease of equipment maintenance affects the equipment's reliability, that is, the harder it is to be maintained, the less it will be maintained.

4.2.2.12 Equipment designed to require multiple operators working together simultaneously increases the likelihood of operator errors.

4.2.2.13 Operational/maintenance procedures shall be clear, definitive, and comprehensive, otherwise, they will be misinterpreted or ignored.

4.2.2.14 Structural items such as piping, cable trays, or any other item that appears strong enough to be used by a person to hold onto or stand on, and is placed in a convenient location to use for that purpose, will eventually be used for that purpose.

4.2.2.15 Humans expect consistency in the design and arrangement of their workplace. Therefore, if that workplace, or any part thereof, appears in more than one place in their work environment, it is expected to be located and look the same way at every location.

4.2.2.16 When controls and displays associated with particular pieces of equipment are placed on a console or control panel, they shall be located on that console or panel to replicate the actual location of the equipment on the ship or structure as both are viewed by the operator. Therefore, equipment that is to the operator's left as he/she faces the control station shall appear on the left of the control panel or console, and equipment to the right shall appear on the right side of the console or panel. This "spatial relationship" between the real world and the controls and displays that are associated with the equipments and systems of that world is extremely important in the design of ships and maritime structures.

4.2.3 Humans develop behavioral patterns based on their cultural experiences. Designing a ship or structure that ignores or violate those culturally derived behavior patterns will inevitably lead to human error.

4.3 *Conflicts*—Where conflicts exist between the design criteria contained in this practice and other sources of ergonomic design criteria, this practice should prevail except where the conflicting criteria were produced by a regulatory authority

4.4 *Coverage*—The design of vessels, structures, systems, subsystems, and equipment shall use the design criteria contained herein to provide the following:

4.4.1 Safe atmospheric conditions including temperature and humidity;

4.4.2 Limits on acoustic noise and vibration that will prevent performance degradation and physiological damage;

4.4.3 Space for personnel, their equipment, and free volume for the movements and activities they are required to perform for operational and maintenance tasks under both normal and emergency conditions;

4.4.4 Physical, visual, auditory, and other communication links between individual personnel and between personnel and their equipment under both normal and emergency conditions;

4.4.5 Efficient arrangement of operation and maintenance workplaces, equipment, structural elements, controls, and displays;

4.4.6 Natural or artificial illumination at levels suitable to perform all operational and maintenance tasks under both normal and emergency conditions;

4.4.7 Safe passageways, hatches, stairs, ladders, walkways, platforms, ramps, and other provisions for ingress, egress, and passage under both normal and emergency conditions;

4.4.8 Provision for protective equipment and clothing, systems, equipments, vessels, and structures that are designed to be operated and maintained by personnel wearing the equipment and clothing;

4.4.9 Compatibility of control/display interfaces with human information processing capability;

4.4.10 Immediate, accurate, and pertinent feedback to the operator of equipment or system performance after each control movement or action taken by the operator;

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

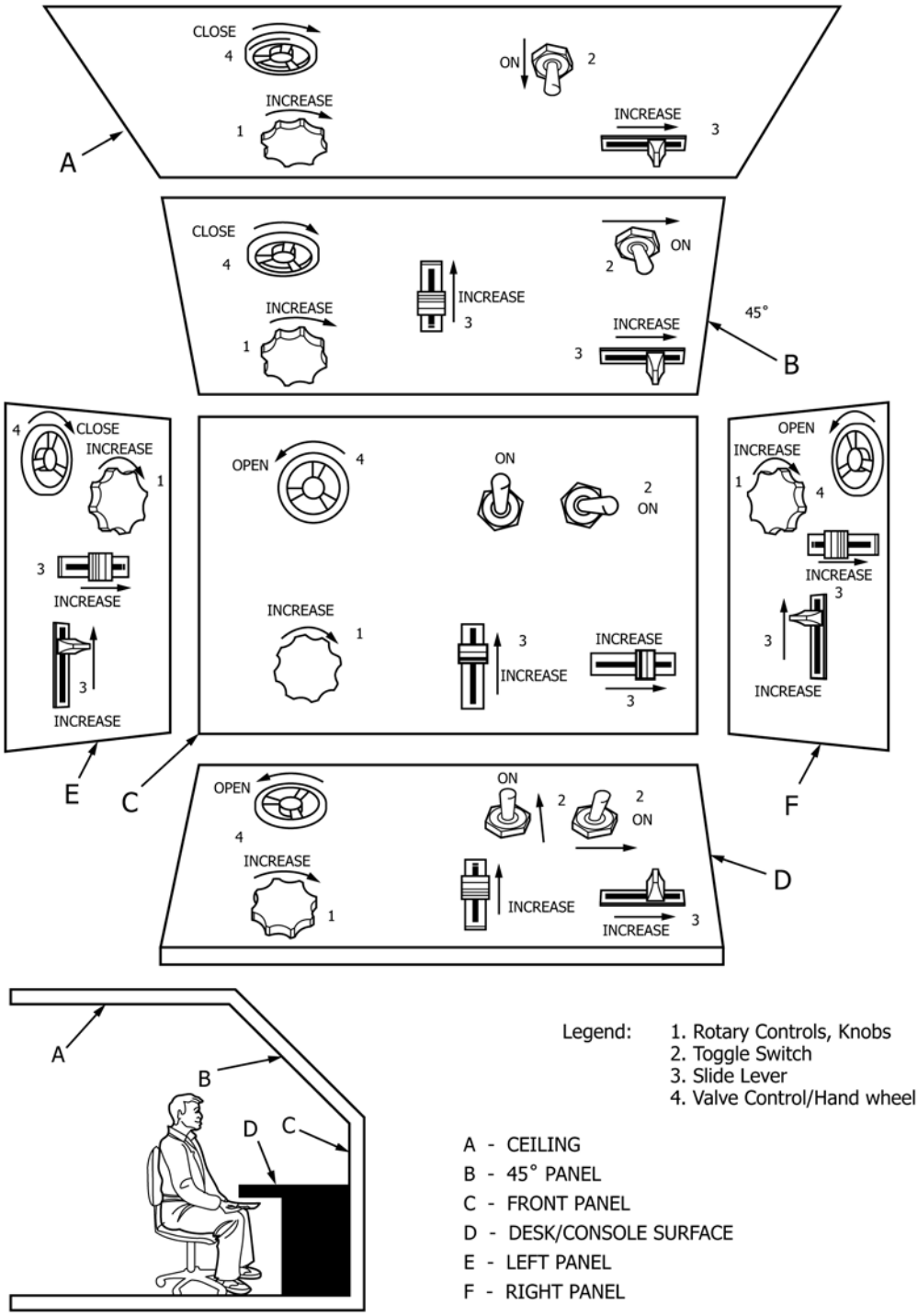


FIG. 1 Control Movement Expectations

4.4.11 Designs that satisfy human behavioral needs such as spatial relationships, consistency, homeostasis, and cultural and equipment expectations;

4.4.12 Provision for labels, hazard signage, instructions, and procedures that are clear, concise, and understandable;

4.4.13 Provision for fail-safe designs in those areas in which failure can disable a vital system or cause catastrophic damage to equipment, injury to personnel, or loss of mission capability;

4.4.14 Designs that minimize potential human error incidence in the operation and maintenance of the system, particularly under conditions of stress and designs that ensure that errors, having been committed, can be corrected in time (the design is error tolerant);

4.4.15 Designs that minimize training time and costs and encourage simplicity so as to reduce personnel special skills or innate abilities required to operate or maintain them;

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

4.4.16 Designs that minimize the adverse impact of ship motion on human performance and health and safety; and

4.4.17 Designs that provide for safe and efficient operation and maintenance by user populations from all geographical regions of the maritime world.

4.5 *Standardization*—Controls, displays, markings, coding, labeling, and arrangement schemes for equipment and panel layouts shall be uniform for those items or designs that appear more than once on the vessel or structure. Human-machine interfaces shall exhibit common design approaches based on conventions and conformance to operator and maintainer expectations.

4.6 *Off-the-Shelf Equipment*—One criterion for selecting off-the-shelf commercial or government-furnished equipment should be the degree to which the equipment conforms to the design criteria of this practice. Where off-the-shelf equipment requires modification to interface with other equipment, the modification should be designed to comply with this practice.

4.7 *Minimize Personnel*—The design objective of the vessel or structure, equipments, systems, and subsystems shall be to reduce the number of personnel involved, especially simultaneously, in completing a particular task. Another design objective shall be to optimize ship or system manning, defined as the minimum number of personnel consistent with human performance, workload and safety requirements, reliability, affordability, and risk constraints.

4.8 *Completeness*—It is realized that no design guide or practice can cover every design requirement that might occur through the course of a ship or maritime structure's evolution. It is recognized that there will be occurrences in which a particular design requirement may have to be interpreted from the data that do exist. There may also be occasions in which design criteria may have to be acquired from a source other than this practice. When those occurrences arise, it is important that assistance be provided by trained human factors engineering (HFE) professionals familiar with this, and other, maritime-oriented design guidelines and standards and experienced in the application of these guidelines to the design of ships and maritime structures.

5. Controls

5.1 *Principles of Control Design:*

5.1.1 *Labeling*—Controls shall be labeled in compliance with the requirements described in Section 15.

5.1.2 *Feedback*—Positive indication of control activation shall be provided via feel (for example, snap action), an audible clicking noise, or a display.

5.1.3 *Users*—The type of control selected and the location of the motion envelope provided for control operation shall ensure that suitably clothed and equipped expected or defined user populations with applicable 5th through 95th percentile body dimensions (see Section 9, "Anthropometry") can operate them.

5.1.4 *Right versus Left-Handed Operation*—Since more operators are right handed than left handed, equipment shall be designed for right-handed operation. This is especially important for controls that require the finest degrees of setting accuracy, or the most force to operate.

5.1.5 *Multi-rotation Control*—Multirotation controls shall be used when precision is required over a wide range of adjustment.

5.1.6 *Detent Control*—Detent controls shall be selected whenever the operational mode requires control operation in discrete steps.

5.1.7 *Simultaneous Operation of Controls*—Controls shall 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 shall be duplicated, 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 shall be provided.

5.1.8 *Controls for Maintenance*—Controls used solely for maintenance or adjustment shall be covered or otherwise protected during normal operations, but within the maintainer's reach and visual envelopes when needed for maintenance.

5.1.9 *Prevention of Accidental Activation*—Controls shall be designed and located so they are not susceptible to accidental activation. Acceptable methods to reduce the likelihood of accidental activation include:

(1) Locating and orienting the control so that bumping is unlikely to cause an activation,

(2) Providing sufficient control resistance to prevent unintentional movements,

(3) Requiring complex motions for control activation, such as an interlock or rotary motion, and

(4) Restricting access to controls by isolating them or by providing a cover guard or physical barrier.

5.1.9.1 *Hidden or Internal Controls*—Hidden or internal controls shall be protected from inadvertent activation or unintentional movement. They shall also be located so the operator cannot come in contact with electrical contacts, hot pipes or other hazards.

5.1.10 *Clothing/PPE*—All controls shall be operable by personnel wearing both normal clothing and personnel protective equipment (PPE) such as boots, gloves, and hazard material clothing.

5.1.11 *Consistent Arrangement*—Functionally similar or identical controls shall be consistently arranged, and oriented from one panel, console, or workstation to another throughout the individual equipments, systems, or total ship or maritime structure.

5.2 *General Design Guidelines:*

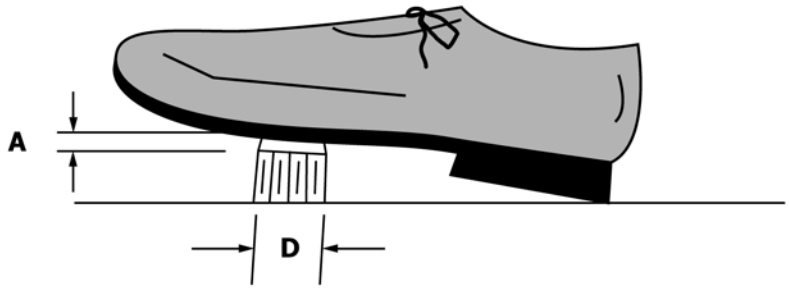
5.2.1 *Selecting Controls*—The following guidelines described below and in Table 1 shall be used in selecting controls:

5.2.1.1 Assign controls requiring rapid or precise setting to the hands vice the feet.

5.2.1.2 Assign controls requiring large or continuous forward applications of force 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.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIAMETER	RESISTANCE		DISPLACEMENT			
	D			A			
		Foot Will Not Rest On Control	Foot Will Rest On Control	Normal Operation	Heavy Boot Operation	Ankle Flexion Only	Total Leg Movement
Minimum	13 mm (1/2 in)	18 N (4 lb)	45 N (10 lb)	13 mm (1/2 in)	25 mm (1 in)	25 mm (1 in)	25 mm (1 in)
Maximum	—	90 N (20 lb)	90 N (20 lb)	65 mm (2 1/2 in)	65 mm (2 1/2 in)	65 mm (2 1/2 in)	100 mm (4 in)

FIG. 2 Foot-Operated Switches Design Requirements

5.2.1.3 Controls shall be distributed so that no one limb is overburdened.

5.2.1.4 Select, locate, and orient controls so that their motion is compatible with the movement of the associated display element, equipment, component, vessel, or structure.

5.2.1.5 Select multi-rotation controls (for example, cranks) when precise settings are required over a wide range of adjustments with attention given to its effect on operating time.

5.2.1.6 Select discrete-adjustment (detent) controls or push-button 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.

5.2.1.7 Continuous-adjustment controls shall be selected when precise adjustment along a continuum is needed.

5.2.1.8 Select controls that can be easily identified. All critical and emergency controls shall be identifiable both visually and by touch (for example, shape coding) and possibly by location. Identification information shall not hinder the manipulation of the control nor increase the likelihood of accidental activation.

5.2.1.9 Locate functionally related controls together to reduce reaching movements, aid in sequential or simultaneous operations, or economize panel space.

5.2.1.10 Multi-axis continuous controllers (for example, joysticks) should be used to provide continuous control within a two dimensional space (for example, positioning a pointer on a computer screen) or a three dimensional space (for example, operating a crane).

5.2.1.11 Ambient or internal illumination or both shall be provided so as to make all controls visible under all operational conditions.

5.2.1.12 Locate most important or frequently used controls in the most favorable position with respect to operator reach and grasping.

5.2.1.13 Controls operated in sequence should be arranged in that order.

5.3 *Control Movement:*

5.3.1 *Direction*—The direction of control movement shall be consistent among the same function and application and shall operate according to the cultural expectations (that is, design expectations) of the intended operators. Widely accepted movement expectations for the majority of maritime personnel worldwide are indicated in Table 2 and Fig. 1. 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.

5.4 *Control Spacing:*

5.4.1 *Control Spacing*—Minimum separation between controls shall be as shown in Table 3.

5.4.2 *Blind Operation*—"Blind" operational controls shall be avoided, but where necessary, hand controls shall be shape coded or separated from adjacent controls by at least 127 mm (5 in.).

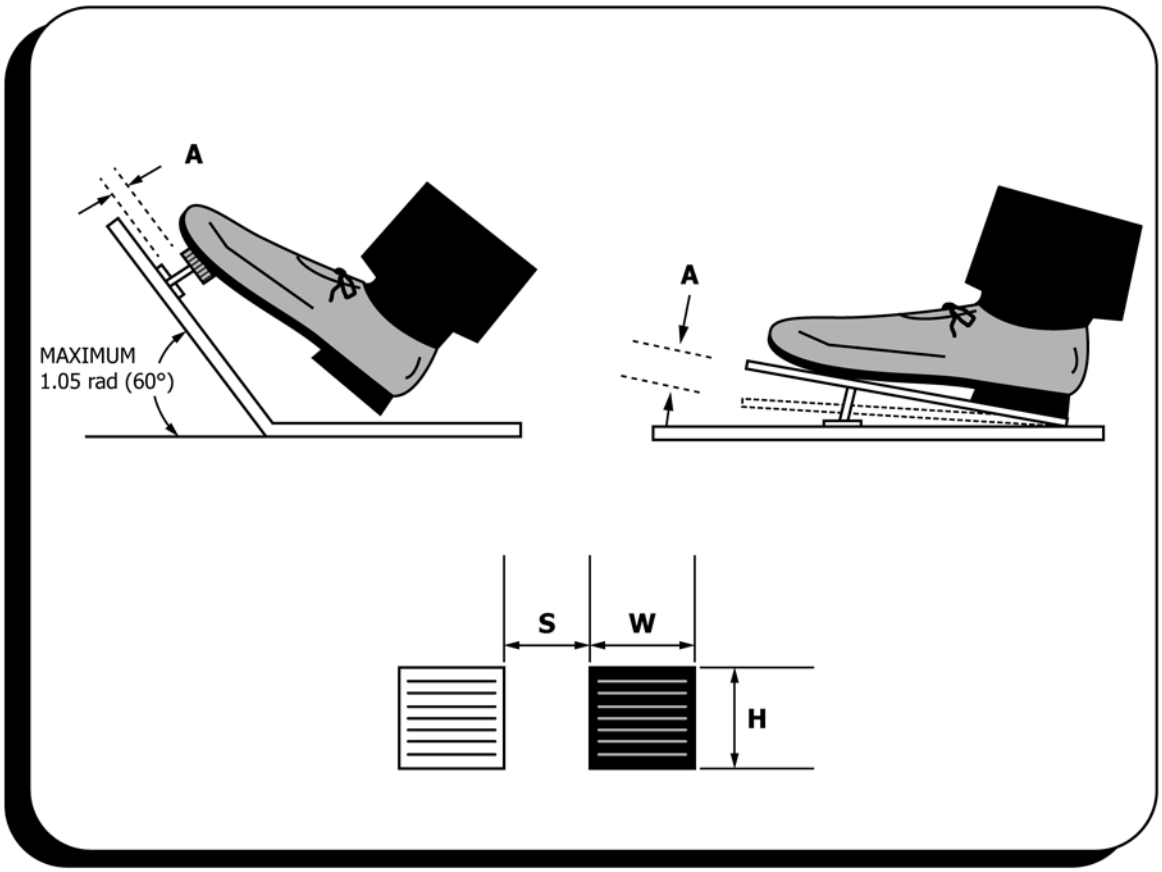
5.5 *Coding of Controls:*

5.5.1 *Control Coding*—Coding of controls through shape, size, color, texture, location, labeling, or other schemes to assist with the identification of a particular control or control function should be used provided the design requirements provided in 5.5.2 – 5.5.6 are met.

5.5.2 *Color Coding*—Color coding shall 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

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIMENSIONS		DISPLACEMENT			
	H	W	A			
	Height	Width	Normal Operation	Heavy Boots	Ankle Flexion	Total Leg Movement
Minimum	25 mm (1 in)	75 mm (3 in)	13 mm (1/2 in)	25 mm (1 in)	25 mm (1 in)	25 mm (1 in)
Maximum	–	–	65 mm (2 1/2 in)	65 mm (2 1/2 in)	65 mm (2 1/2 in)	180 mm (7 in)

	RESISTANCE			
	Foot Not Resting on Pedal	Foot Resting on Pedal	Ankle Flexion Only	Total Leg Movement
Minimum	18 N (4 lb)	45 N (10 lb)	–	45 N (10 lb)
Maximum	90 N (20 lb)	90 N (20 lb)	45 N (10 lb)	800 N (180 lb)

	SEPARATION	
	S	
	One Foot Random	One Foot Sequential
Minimum	100 mm (4 in)	50 mm (2 in)
Maximum	150 mm (6 in)	100 mm (4 in)

FIG. 3 Pedal Location and Design Requirements

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

TABLE 1 Recommended Manual Controls

Control Function	Control Type
Small actuation force controls:	
2 Discrete positions	Key lock Pushbutton Toggle switch Legend switch Slide switch
3 Discrete positions	Rotary selector switch Toggle switch Pushbutton
4 to 24 Discrete positions	Rotary selector switch
Continuous setting (linear and less than 360°)	Continuous rotary knob Joystick or lever
Continuous slewing and fine adjustment	Crank Continuous rotary knob
Large actuation force controls:	
2 Discrete positions	Foot pushbutton Hand pushbutton Detent lever
3 to 24 Discrete positions	Detent lever Rotary selector switch
Continuous setting (linear and less than 360°)	Handwheel Joystick or lever Crank Two-axis grip handle
Continuous setting (more than 360°)	Crank Handwheel Valve Two-axis grip handle

TABLE 2 Control Movement Expectations

Direction of Control Movement	Function
Up, right, forward, clockwise, pull (push-pull type)	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

associated meaning. 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 (for example, night time on the navigational 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.

5.5.2.1 *When Not to Color Code*—Color coding of control surfaces shall not be used when visibility of the controls is restricted or obstructed, or when illumination lighting is below 0.35 cd/m^2 (0.1 ft-L) or of some color other than white.

5.5.2.2 *Consistency*—When related controls and displays are color coded, they shall be coded the same color.

5.5.2.3 *Color Coding Under Red Lighting*—All emergency controls used under only white lighting shall be colored red. If red lighting is to be used during any portion of a mission, controls which would have been coded red shall be coded by orange-yellow and black striping. Color coding of other controls shall be kept to a minimum.

5.5.3 *Shape Coding*—Coding by shape is useful when controls should be identified without the use of vision. Shapes that suggest the purpose of the control (for example, round for a wheel, flap shape for an airplane wing flap) should be used.

5.5.3.1 Shapes shall be identifiable by the hand regardless of the position and orientation of the control knob or handle.

5.5.3.2 The number of shapes to be identified by each operator based on absolute discrimination shall be not more than ten.

5.5.3.3 Shapes shall be tactually identifiable when gloves are worn.

5.5.3.4 Shape coded knobs and handles shall be positively and non-reversibly attached to their shafts to preclude incorrect attachment when replacement is required.

5.5.4 *Size Coding*—Coding by size is useful when controls are to be identified without the use of vision. If personnel are to rely on touch alone, at most three sizes of controls shall be used and knobs shall differ by at least 13 mm (0.5 in.) in diameter or by 10 mm (0.4 in.) in thickness. Size coding, as with other coding methods, should be used consistently. Controls used for performing the same function on different items of equipment shall be the same size.

5.5.5 *Texture Coding*—Three surface characteristics shall be used together to provide accurate discrimination through texture: smooth, fluted, and knurled. Different degrees of fluting or knurling should not be used together to provide discrimination.

5.5.6 *Location Coding*—Controls that are used frequently shall be located in a specific location with respect to the operator to facilitate finding them rapidly, and this location shall be common at all workstations and panels.

5.6 *Control Use and Design:*

5.6.1 *Foot-Operated Controls:*

5.6.1.1 *Use*—Foot-operated controls may be used under the following conditions:

(1) Control operation requires greater force than the upper body can provide.

(2) The operator's hands are generally occupied by other manual control tasks at the same moment that an additional control action is required.

(3) A safety shutdown control is required during an operation in which the operator's hands cannot be freed to reach a safety switch.

(4) Specific foot-operated controls have been so well established that the operator expects such operating functions to be performed using foot controls (for example, aircraft rudder/brake pedals, automotive clutch, brake, and accelerator pedals).

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

TABLE 3 Minimum Spacing Between Two Controls

NOTE 1—All values are for one hand operation.

NOTE 2—Distances are measured from the edge of each control.

NOTE 3—Unless otherwise specified, all dimensions cited herein are for bare hands and should be increased for use with gloves or mittens.

	Toggle Switches	Pushbuttons[A]	Continuous Rotary Controls	Rotary Selector Switches	Discrete Thumbwheel Controls
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.)

[A] For pushbuttons not separated by barriers.

5.6.1.2 *Avoidance of Use*—Foot-operated controls shall not be used under the following conditions:

(1) Where a standing operator is confronted with a sensitive balancing requirement (for example, a moving platform where balancing on the non-operating foot may become difficult as the operating foot is moved from a support to actuating position).

(2) Precise control operations are required.

(3) Selection from among three or more separate controls is required.

5.6.2 *Foot-Operated Switches:*

5.6.2.1 *Use*—Foot-operated switches shall be used only where the operator is likely to have both hands occupied when switch activation may be required or when load sharing among limbs is desirable. Their uses shall be limited to noncritical or infrequent operations such as press-to-talk communication or vehicle headlight dimming.

5.6.2.2 *Operation*—Foot switches shall be positioned for operation by the toe and the ball of the foot rather than by the heel. They shall not be located so near an obstruction that the operator cannot center the ball of the foot on the switch button. When the switch may become wet and slippery, the switch-cap surface shall possess a frictional surface to minimize the possibility of the foot slipping off the switch.

5.6.2.3 *Design*—Dimensions, resistance, and displacement of foot-operated switches shall conform to the criteria in Fig. 2. Although not recommended (only one switch per foot is preferred), when one foot is required to operate more than one switch, such switches shall be at least 75 mm (3 in.) apart horizontal; 203 mm (8 in.) apart vertical.

5.6.2.4 *Feedback*—A positive indication of control activation shall be provided (for example, snap feel, audible click, associated visual, or auditory display).

5.6.3 *Foot-Operated Pedals:*

5.6.3.1 *Use*—Pedal controls shall be used only when the operator is likely to have both hands occupied when control operation is required or control system force is too high for manual force capability of the operator, or standardized use of pedals has created a stereotype expectancy (for example, vehicle pedal control configurations such as clutch, brake, and accelerator or aircraft rudder).

5.6.3.2 *Location*—Pedal controls shall be located so that the operator can reach them without extreme stretching or torso twisting and can reach the maximally displaced pedals within anthropometric limits and force capabilities (see Fig. 3). Pedals that may be held or shall be adjusted shall be located so the so the operator's heel can rest on the floor while articulating the ankle/foot.

5.6.3.3 *Lateral*—Lateral spacing between pedals shall conform to Fig. 4. However, the overall array shall not exceed 737 mm (29 in.) as measured from the outermost pedal centerlines.

5.6.4 *Discrete Rotary Controls:*

5.6.4.1 *Use*—Rotary selector switches shall be used for discrete functions when three or more detented positions are required. Rotary selector switches shall not be used for a two-position function unless prompt visual identification of control position is of primary importance and speed of control operation is not critical.

5.6.4.2 *Design Criteria*—A rotary selector switch that is not visible to the operator during normal system operation shall have no more than 12 positions. A rotary switch that is constantly visible to the operator shall have not more than 24 positions. In addition, the following design criteria shall apply:

(1) Rotary switch positions shall not be placed opposite each other unless knob shape precludes confusion as to which end of the knob is the pointer.

(2) Mechanical detents shall be provided as the switch cannot be positioned in between nominal switch positions.

(3) A reference line shall be provided on rotary switch controls. This line shall have at least 75 % luminance contrast with the control color under all lighting conditions.

(4) Actuating torque requirements shall be compatible with control knob sizes, that is, knob dimensions of 25 mm (1 in.) or less shall not require a torque of more than 350 N/m (2 lbf·in.). Medium-sized knobs, 25 to 50 mm (1 to 2 in.), shall have a torque of less than 1050 N/m (6 lbf·in.). The larger knobs, diameters of 75 mm (3 in.), shall not require an actuation torque greater than 1576 M/m (9 lbf·in.).

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

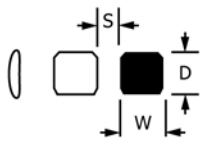
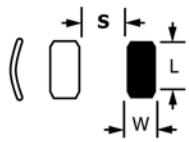
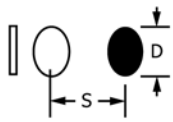
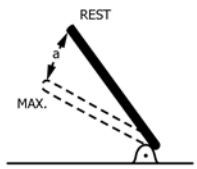
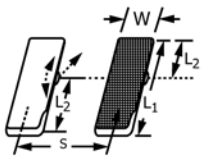
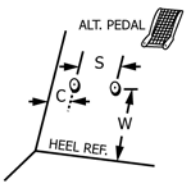
	DESIGN CRITERIA		
	DIMENSIONS	DISPLACEMENT	SEPARATION
	W = 76 mm (3 in) D = 50 mm (2 in)		S = 50 mm (2 in)
	W = 50 mm (2 in) L = 76 mm (3 in)		S = 127 mm (5 in) Shoes S = 184 mm (7 ¼ in) Boots
	D = 76 mm (3 in)	25 mm (1 in) Min 64 mm (2 ½ in) – 102 mm (4 in) Preferred	S = 311 mm (12 ¼ in) Min S = 470 mm (18 ½ in) Max
  	W = 50 mm (2 in) L = 260 mm (10 ¼ in) Min 311 mm (12 ¼ in) Max	30° (Shoes) 20° (Heavy Boots)	
	W = 76 mm (3 in) Min W = 152 mm (6 in) Max L = 260 mm (10 ¼ in) Min L = 311 mm (12 ¼ in) Max		S = 387 mm (15 ¼ in) Min S = 540 mm (21 ¼ in) Max
	D = 25 mm (1 in) Min H = 184 mm (7 ¼ in) Min H = 260 mm (10 ¼ in) Max C = 76 mm (3 in) Min	13 mm (½ in) Min Shoes 25 mm (1 in) Min Boots 64 mm (2 ½ in) Max	S = 76 mm (3 in) Min

FIG. 4 Lateral Spacing for Pedals

(5) Rotary control dimensions, switch displacement, and control separation shall conform to criteria in Figs. 5 and 6.

5.6.5 *Continuous Adjustment Rotary Controls:*

5.6.5.1 *Use*—Knobs for continuous adjustment control shall be used when low forces or precise adjustments of a continuous variable are required. A moving knob with fixed scale is preferred over a moving scale with fixed index. If positions of single revolution controls shall be distinguished, a pointer or marker shall be available on the knob.

5.6.5.2 *Knob Design*—The dimensions and resistance of knobs, and the separation between adjacent edges of knobs, shall be within the limits specified in Fig. 7.

5.6.6 *Hand Cranks:*

5.6.6.1 *Use*—Cranks shall be used for tasks requiring many rotations of a control, particularly where high rates or large forces are involved. Where cranks are used for tuning, or other processes involving numerical selection, each rotation shall correspond to a multiple of 1, 10, 100, and so forth.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

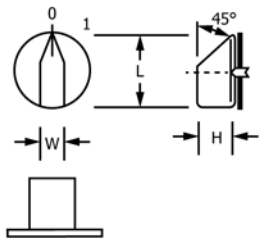
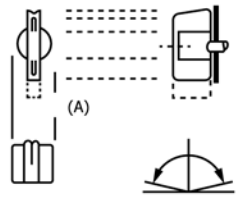
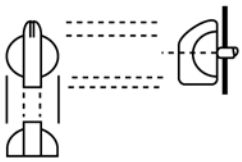
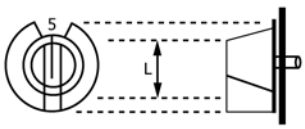
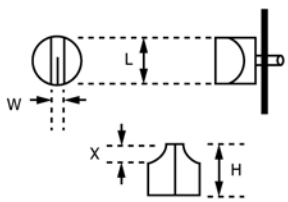
	DESIGN CRITERIA				
	DIMENSIONS			DISPLACEMENT	SEPARATION
	L = 38 mm to 100 mm (1 1/2 in to 4 in) IF GLOVES ARE WORN, ADD 13 mm (1/2 in)	W = 13 mm to 25 mm (1/2 in to 1 in)	H = 16 mm to 75 mm (5/8 in to 3 in)	MIN = 15° MIN POS'N 1D = 30° MAX = 40°; MAX FOR BLIND POSITIONING = 90°	SEE FIG. 6 FOR SIMULTANEOUS OPERATION OF ADJACENT KNOBS (TWO HANDS) ADD 25 mm (1 in), 38 mm (1 1/2 in) FOR GLOVES
	SEE ABOVE	SEE ABOVE	SEE ABOVE	SEE ABOVE	SEE ABOVE
	SEE ABOVE	SEE ABOVE	SEE ABOVE	SEE ABOVE	SEE ABOVE
	L = MIN 25 mm (1 in) OTHER SAME AS A	SEE ABOVE	SEE ABOVE	SEE ABOVE	SEE ABOVE
	L = MIN 19 mm (2/3 in)	W = MIN 6.5 mm (1 1/4 in)	Y = MIN 13 mm (1/2 in)	SEE ABOVE	25 mm (1 in)

FIG. 5 Design Criteria for Discrete Rotary Controls

5.6.6.2 *Crank Handle*—The crank grip handle shall be designed so that it turns freely around its shaft. If a crank handle could become a hazard to persons passing by, or it is critical that the handle not be inadvertently displaced by being accidentally bumped, a folding handle-type control shall be used.

5.6.6.3 *Orientation*—Cranks that must be turned rapidly shall be mounted so their turning axis are between 60° and 90° from the frontal plane as shown in Fig. 8.

5.6.6.4 *Location*—For standing operators, crank handle travel shall be between 914 and 1219 mm (36 and 48 in.) above the floor as measured to the crank handle center line.

5.6.6.5 *Design Criteria*—Dimensions, resistance, and separation between adjacent swept circular areas of cranks shall conform to the criteria of Fig. 9.

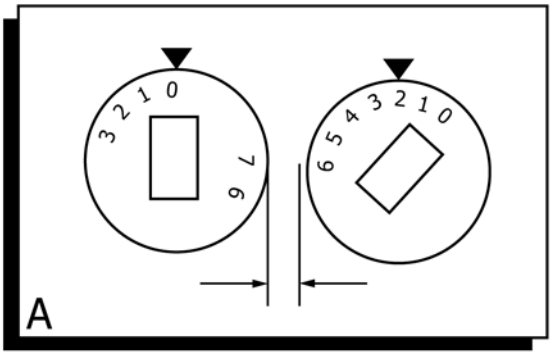
5.6.7 *Pushbuttons:*

5.6.7.1 *Use*—Pushbuttons shall be used when a control or an array of controls is needed for momentary contact or for activating a locking circuit, particularly in high-frequency-of-use situations. Pushbuttons should not be used for discrete control where the functions status is determined exclusively by a position of the switch, for example, an on-off pushbutton that is pressed in and retained to turn a circuit on and pressed again to release the pushbutton and turn the circuit off.

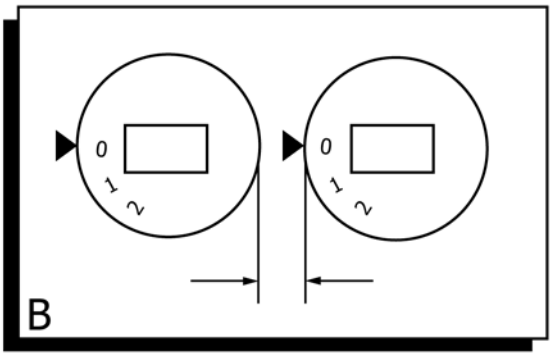
5.6.7.2 *Shape*—The pushbutton surface shall normally be concave (indented) to fit the finger. When this is impractical, the surface shall provide a high degree of frictional resistance to prevent slipping. Large, hand or fist-operated, mushroom-shaped buttons should be used only as EMERGENCY STOP controls.

AVA Documents
Document Sharing Hub

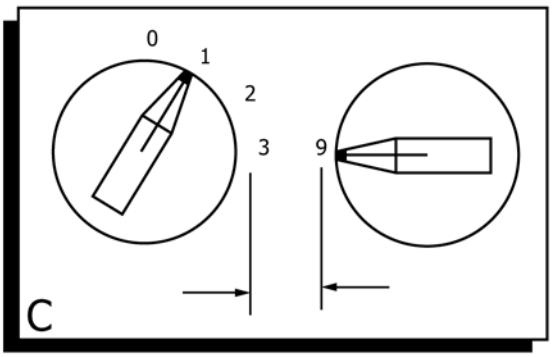
Full document details: ASTM F1166-07(2013)



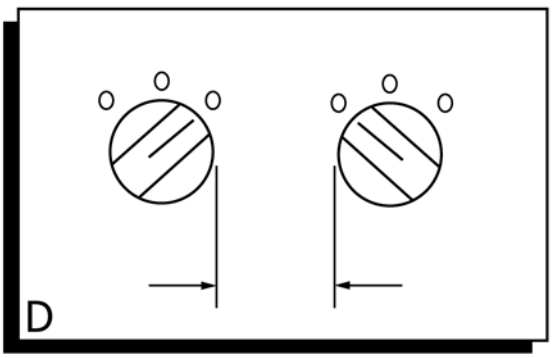
Nominal separation between moving-scale knobs requires only that there is adequate physical separation between the knob skirts to prevent knob movement interference when the zere or referencing index is at the 12-o'clock position.



Separation between moving-scale knobs that have the referencing index at the 3 or 9-o'clock position should be sufficient to ensure that there is not visual confusion regarding the knob to which the index mark refers. Minimum should be about twice the nominal character width.



Separation between moving-pointer / fixed-scale configurations should be based on clear visual separation of the adjacent scale characters. The minimum should be at least four character widths. However, if the knob length extends the full width of the skirt and the handle is not tapered at the pointing end, there should be at least a 25 mm (1 in) separation between knobs when they are end to end.



Separation between small, detented knob configurations as shown should be at least 25 mm (1 in) unless there are adjacent panel referencing marks or characters, in which case separation minimums should be established on the basis of (C) above or the 25 mm (1 in) criterion, whichever is greater,

FIG. 6 Separation Requirements for Discrete Rotary Controls

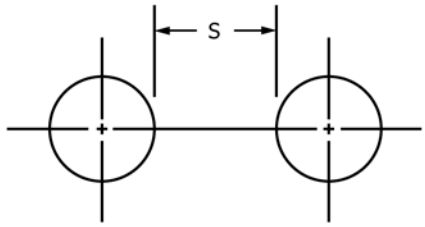
5.6.7.3 *Feedback*—A positive indication of control activation shall be provided (snap feel, audible click, or integral light).

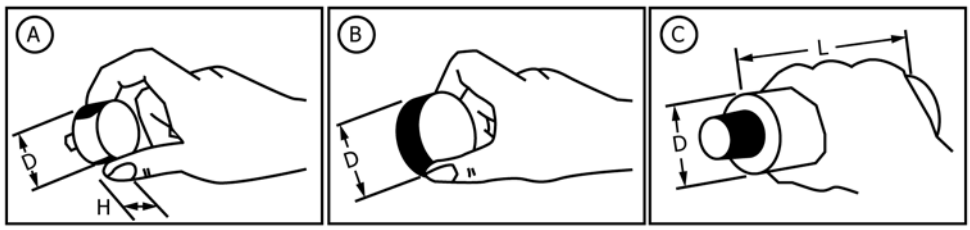
5.6.7.4 *Control Guard*—A channel or cover guard shall be provided when it is imperative to prevent accidental activation of the controls. When a cover guard is in the open position, it shall not interfere with operation of the protected device or adjacent controls.

5.6.7.5 *Design Criteria*—Except for use of pushbuttons in keyboards, the control dimensions, resistance, displacement,

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)





	DIMENSIONS				
	A Fingertip Grasp		B Thumb and Finger Encircled	C Palm Grasp	
	H Height	D Diameter	D Diameter	D Diameter	L Length
Minimum	18 mm (1/2 in)	10 mm (3/8 in)	25 mm (1 in)	88 mm (11/2 in)	75 mm (3 in)
Maximum	25 mm (1 in)	100 mm (4 in)	75 mm (3 in)	75 mm (3 in)	
	TORQUE		SEPARATION		
	*	**			
Minimum	-	-	25 mm (1 in)	50 mm (2 in)	
Optimum	-	-	50 mm (2 in)	125 mm (5 in)	
Maximum	32 nM-m (4 1/2 in - oz)	42 nM-m (6 in - oz)	-	-	

* - To and including 25 mm (1 in) diameter knobs.

** - Greater than 25 mm (1 in) diameter knobs.

FIG. 7 Dimension, Resistance, and Separation of Continuous Rotary Controls

and separation between adjacent edges of finger- or hand-operated push buttons shall conform to the criteria in Fig. 10.

5.6.7.6 *Resistance*—Single-finger, 2.8 N (10 oz) to 11 N (40 oz). Thumb or palm, 2.8 N (10 oz) to 23 N (80 oz).

5.6.7.7 *Interlocks or Barriers*—Mechanical interlocks or barriers may be used instead of the spacing required by Fig. 10.

5.6.8 *Legend Switches (Backlit Pushbuttons):*

5.6.8.1 *Use*—Backlit pushbuttons should be used to incorporate a control and its feedback display within a single device. These controls have labels on the surface of the control and use backlighting to indicate status.

5.6.8.2 *Lamp Test*—Means to test the working condition of the light bulbs in backlit pushbuttons shall be provided. Removal of light bulbs to test or inspect is not an adequate means of testing.

5.6.8.3 *Switch Type*—There are two basic types of legend switches with the preferred design providing a control that has a split display with one half of the display always illuminated indicating the current setting. The other option, acceptable only for noncritical control functions, toggles backlighting between on and off, and therefore can be ambiguous regarding status of equipment or the working status of light bulbs. Both types are shown in Fig. 11.

5.6.8.4 *Design Criteria*—Dimensions, resistance, displacement, and separation between adjacent edges of legend switches shall conform to the criteria in Fig. 12.

5.6.8.5 *Other Design Criteria*—Other design criteria include:

(1) Legend switches shall be provided with a detent or click for positive indication of switch activation.

(2) The label (that is, legend) on the face of the switch shall be legible with or without internal illumination. If these controls are to be used in direct sunlight, legends and the control status shall remain readable and discernible when exposed to full sunlight. Internal pushbutton illumination shall be sufficient to discern the status of the display under all conditions of ambient lighting.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

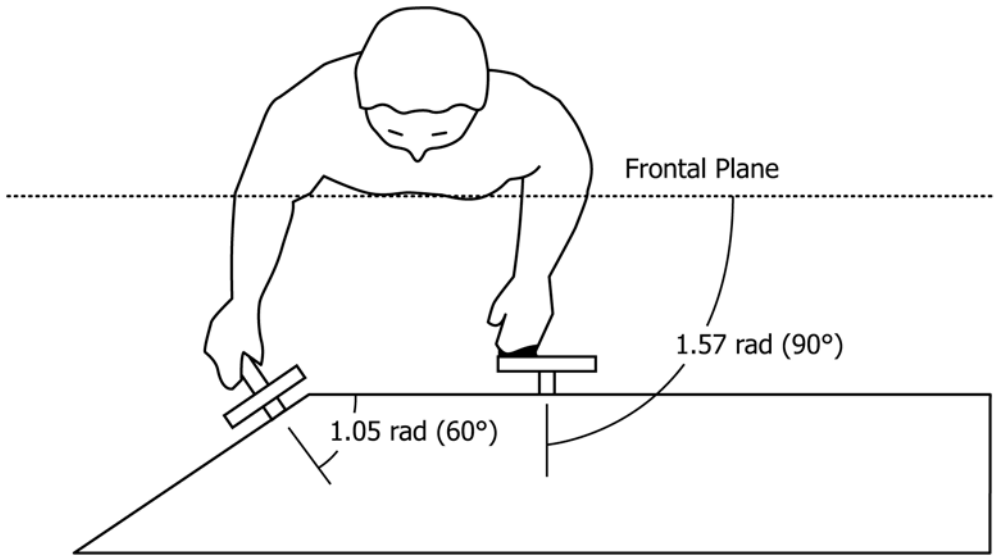


FIG. 8 Proper Mounting of Rapidly Operated Cranks

(3) Lamps within the legend switch shall be replaceable from the front of the panel by hand and the legends or covers shall be keyed to prevent the possibility of interchanging the legend covers.

(4) There shall be a maximum of three lines of lettering on the legend plate.

(5) Legend switches shall be distinguishable to the operator from legend lights.

5.6.9 *Toggle Switch:*

5.6.9.1 *Use*—Toggle switches shall be used for functions that require two discrete positions or where space limitations are severe. Toggle switches with three positions shall be used only where the use of a rotary control or legend switch control are not feasible or when the toggle switch is of the spring-loaded, center position-off type. Three position toggle switches that are spring-loaded to center-off from only one other position shall not be used release from the spring-loaded position results in switch handle travel beyond the off position. Toggle switches are considered herein to be discrete position controls. Small controls that are the same size and shape as toggle switches and used for making continuous adjustments are described herein as levers.

5.6.9.2 *Switch Guard*—When the prevention of accidental activation is of primary importance (critical, dangerous, or hazardous conditions would result), channel guards, lift-to-unlock switches, or other equivalent prevention mechanisms shall be provided. Safety or lock wire shall not be used. Resistance of lift-to-unlock mechanisms shall not exceed 13 N (3 lb). If a cover guard is used, its location when open shall not interfere with the operation of the protected device or adjacent controls.

5.6.9.3 *Feedback*—An indication of control activation shall be provided (snap feel, audible click, associated or integral light).

5.6.9.4 *Orientation*—Toggle switches shall be vertically oriented with OFF in the down position. Horizontal orientation and actuation of toggle switches shall be used only for compatibility with the controlled function or equipment location. For horizontal orientation ON shall be to the right. Switch orientation and toggle switch movement for ON are shown in Fig. 13.

5.6.9.5 *Design Criteria*—Dimensions for various types of toggle switches are shown in Fig. 13. Resistance shall gradually increase, then drop when the switch snaps into position. The switch shall not be capable of being stopped between positions. Resistance for a small switch ranges from 2.8 N (10 oz) minimum to 4.5 N (16 oz) maximum. For large switches, the forces are 2.8 N (10 oz) minimum to 11 N (40 oz) maximum.

5.6.10 *Rocker Switches:*

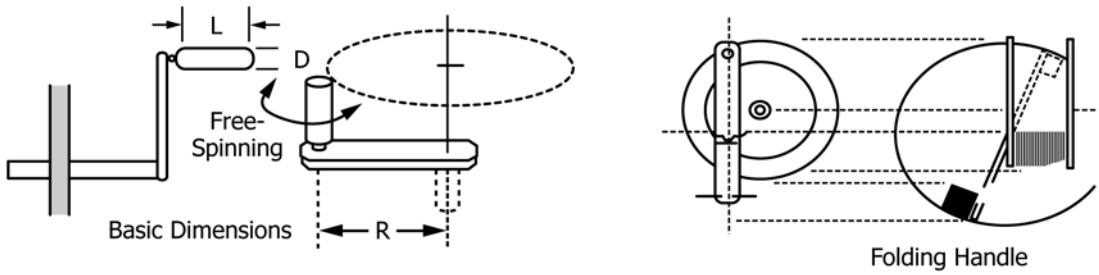
5.6.10.1 *Use*—Rocker switches may be used in lieu of toggle switches for functions that require two discrete positions. Rocker switches with three positions shall be used only where the use of a rotary control, legend switch control, or other control type is not feasible and if the control is spring-loaded with the center position being OFF.

5.6.10.2 *Feedback*—An indication of control activation shall be provided (snap feel, audible click, associated or integral light).

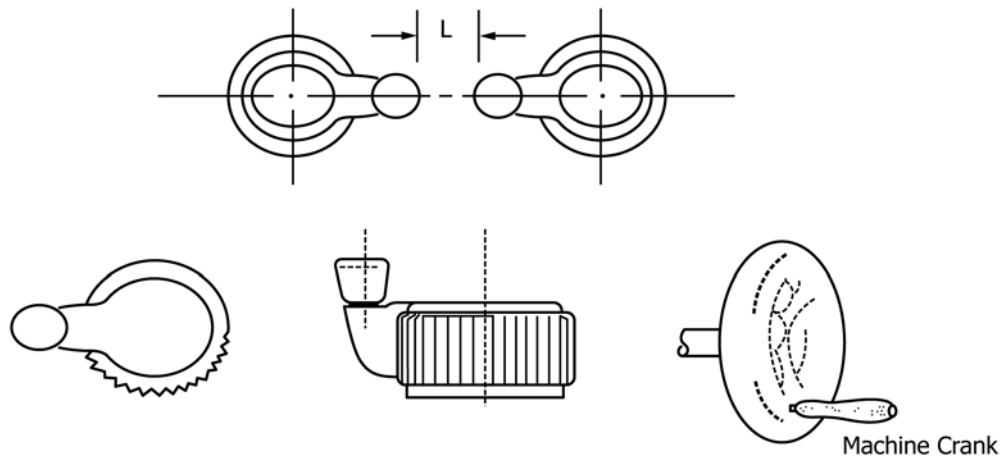
5.6.10.3 *Orientation*—Rocker switches should be vertically oriented. Activation of the upper wing shall turn the equipment or component ON, or cause the quantity to increase, or cause the equipment or component to move forward, clockwise, to the right, or up. Horizontal orientation of rocker switches shall be used only for compatibility with the controlled function or equipment location. If rocker switches are oriented horizontally, the switch labeling shall be read horizontally.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



Combined Finger/Spinner Styles (Consoles)



LOAD	SPECIFICATION	HANDLE				R, TURNING RADIUS			
		L, LENGTH		D, DIAMETER		RATE BELOW 100 RPM		RATE ABOVE 100 RPM	
		mm	in	mm	in	mm	in	in	in
LIGHT LOADS: Less than 22 N (5 lb). (Wrist and finger movement)	MINIMUM	25	1	10	3/8	38	1 1/2	13	1/2
	PREFERRED	38	1 1/2	13	1/2	75	3	65	2 1/2
	MAXIMUM	75	3	16	5/8	125	5	115	4 1/2
HEAVY LOADS: More than 22 N (5lb). (Arm movement)	MINIMUM	75	3	25	1	190	7 1/2	125	5
	PREFERRED	95	3 3/4	25	1	–	–	–	–
	MAXIMUM	–	–	38	1 1/2	510	20	230	9

S = Separation between adjacent controls or any adjacent obstruction 75 mm (3 in) minimum

FIG. 9 Dimensions, Resistance, and Separations Required for Cranks

5.6.10.4 *Color and Illumination*—Alternate colors may be used to denote the ON and OFF portions of a rocker switch. Alternate illumination of either the ON or OFF switch position may be used to provide positive recognition of current switch position. For areas in which ambient illumination will provide display luminance below 3.5 cd/mz (1 ft·L), the rocker switch shall be internally illuminated. Digits and letters shall appear as light or white illuminated characters on an opaque background and their dimensions shall approximate the following:

(1) Height, 4.8 mm (3⁄16 in.);

(2) Height-to-width ratio, 3:2; and

(3) Height-to-stroke width ratio, 10:1.

5.6.10.5 *Design Criteria*—Dimensions, resistance, displacement, and separation between centers of rocker switches shall conform to the criteria in Fig. 14. Resistance shall gradually increase, then drop when the switch snaps into position. The switch shall not be capable of being stopped between positions.

5.6.11 *Discrete Slide Switch Controls:*

5.6.11.1 *Use*—Discrete slide switch controls should be used for functions that require two discrete positions. Discrete slide switch controls should also be used for functions that require a higher number of discrete positions in which switches are arranged in a matrix to permit easy recognition of relative

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

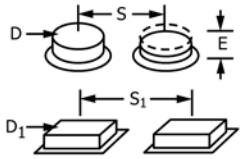
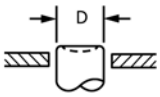
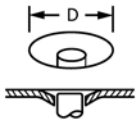
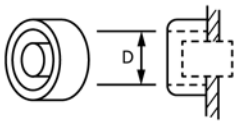
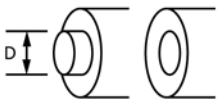
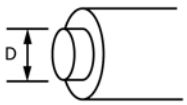
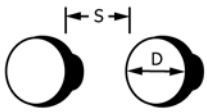
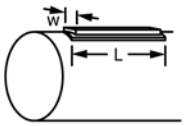
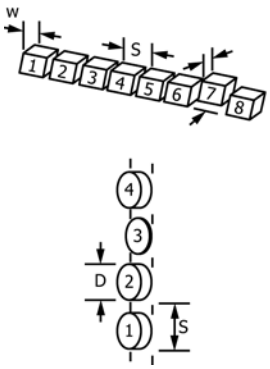
	DESIGN CRITERIA				
	DIMENSIONS			DISPLACEMENT	SEPARATION
	FINGERTIP D - MIN DIAM. OR DIMENSION (D_1) = 10 mm* (3/8 in) D-MAX = 25 mm (1 in)	THUMB OR PALM D - MIN = 19 mm (3/4 in)	– PREFERRED MIN	PREFERRED MIN S_1 -MIN = 13 mm (1/2 in) MIN = 3.2 mm (1/8 in) PREFERRED MAX = 6.5 mm (1/4 in) ADD FOR GLOVED OP'N 13 mm (1/2 in) NOTES: (1) THE DEPRESSED BUTTON (E)	S_1-MIN = 19 mm (3/4 in) WITH GLOVES 25 mm (1 in)
	D-MAX = 19 mm (3/4 in) D-MIN = 13 mm (1/2 in)	–	–	SHALL REMAIN EXPOSED BY AT LEAST 2.5 mm (.1 in) (2) SWITCHES WITH MOTION (e.g. THERMAL)	
	OPENING = 19 mm (3/4 in)	D-MIN WELL 32 mm (1 1/4 in) WITH GLOVES	TO THE APPROVAL BY THE PROCURING ACTIVITY	MISIBLE SUBJECT	
	–	SAME AS ABOVE	–		
	D-MINIMUM DIAM 10 mm (3/8 in)	–	–	SAME AS ABOVE	N/A
	D-MINIMUM- 13 mm (1/2 in)	–	–	SAME AS ABOVE	N/A
	D-MIN = 25 mm (1 in)	–	–	SAME AS ABOVE	S - MIN FOR PALM OPM = 75 mm (3 in)
	W-MIN = 6.5 mm (1/4 in)	L - PREFERRED MIN = 25 mm (1 in)	–	SAME AS ABOVE	N/A
	W OR D MIN = 10 mm (3/8 in) FOR GLOVES 13 mm (1/2 in)	–	–	x.a - MIN EXPOSURE WHEN DEPRESSED = 3.2 mm (1/8 in) x.b - MIN DEPRESSION TO ACTIVATE (PREFERRED = 5 mm (1/5 in)) NOTE: MAX DISPLACEMENT SHALL NOT EXCEED 13 mm (1/2 in)	S - CTR-CTR SPACING MIN = 19 mm (3/4 in) FOR GLOVES 25 mm (1 in)

FIG. 10 Design Criteria for Pushbuttons

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

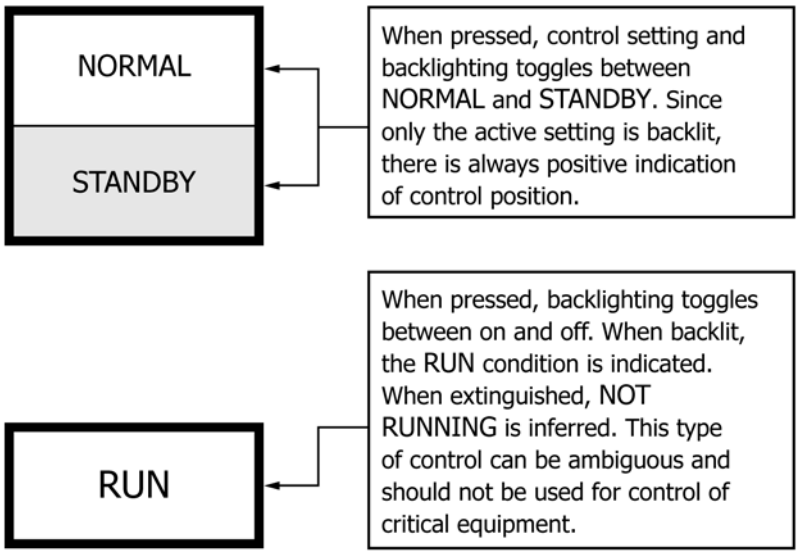
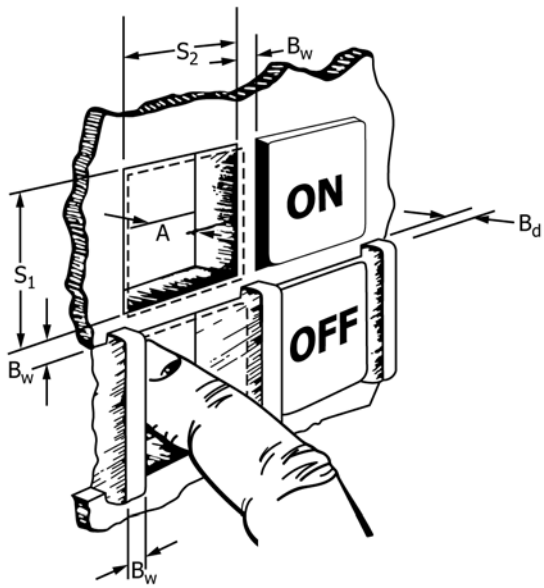


FIG. 11 Two Types of Legend Switches (Backlit Pushbuttons)



	S_1, S_2 SIZE	A DISPLACEMENT	BARRIERS		RESISTANCE
			B_w	B_d	
MINIMUM	19 mm* (3/5 in.)	3 mm** (1/8 in.)	3 mm (1/8 in.)	5 mm (3/16 in.)	2.8 N*** (10 oz.)
MAXIMUM	36 mm (1 1/2 in.)	6 mm (1/4 in.)	6 mm (1/4 in.)	6 mm (1/4 in.)	16.7 N (60 oz.)

* 15 mm (5/8 in.) where switch is not depressed below the panel.
** 5 mm (3/16 in.) for positive position switches.
*** 5.6 N (20 oz.) for use in moving vehicles. NOTE: B_w also refers to switch seperation.

FIG. 12 Size, Displacement, and Resistance for Legend Switches

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

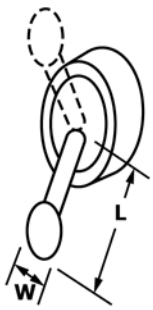
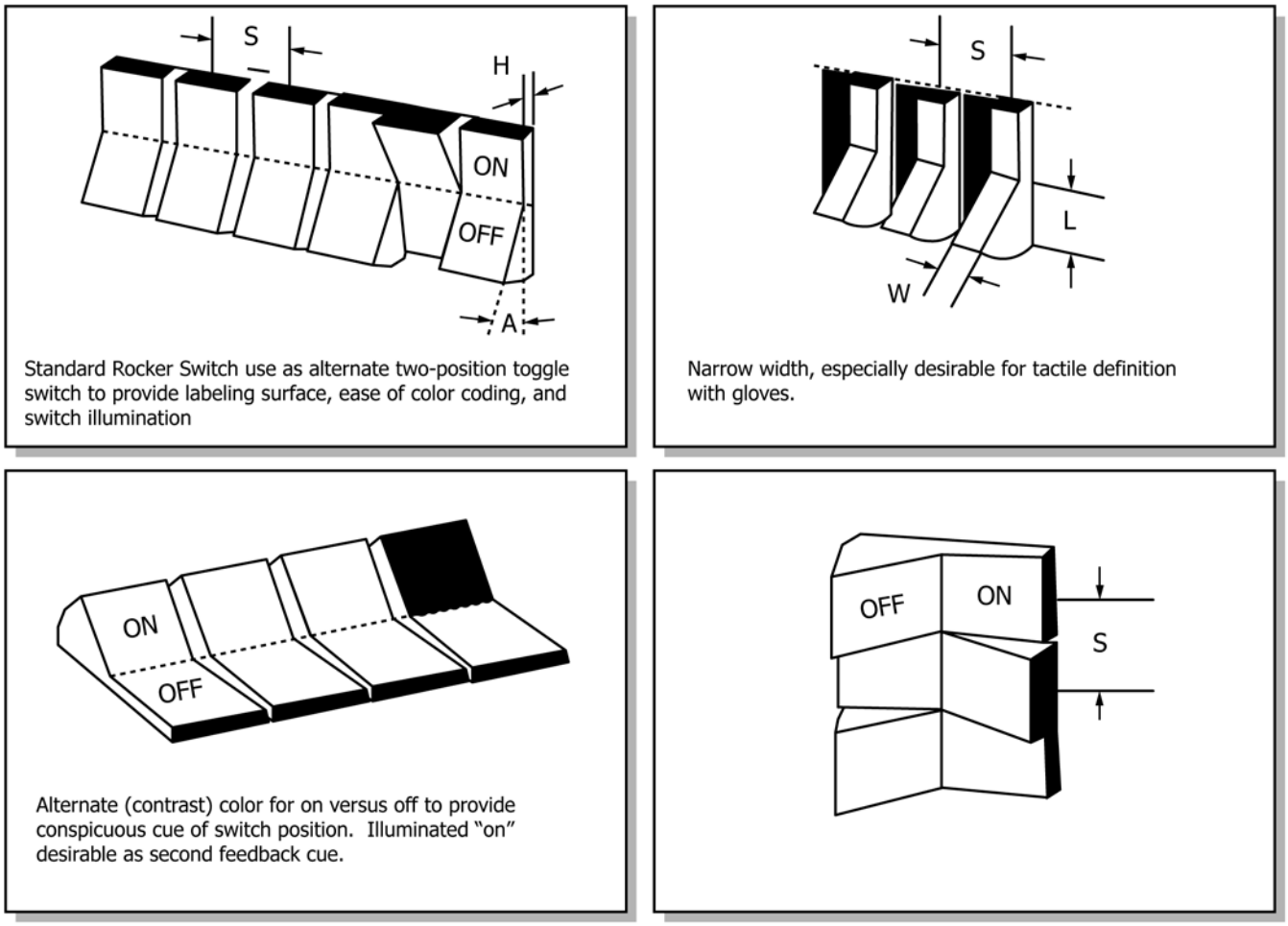
	DESIGN CRITERIA		
	DIMENSIONS		
	W-MIN DIAM = 3.3 mm (.13 in)	L-MIN LENGTH = 13 mm (1/2 in)	
	W-MIN DIAM = 4.5 mm (.18 in) MAX = 7.8 mm (.31 in)	LENGTH MIN = 13 mm (1/2 in) MAX = 50 mm (2 in)	
	W-MIN BAL DIAM =4.5 mm (.18 in) MAX = 7.8 mm (.31 in)	SAME AS ABOVE	
			W-MIN HANDLE WIDTH = 4.5 mm (.18 in)
		L-10 mm (.40 in) PREFERRED MAX = 25 mm (1 in)	W-10 mm (.40 in) PREFERRED MIN = 4.8 mm (.19 in) MZX = 18 mm (1.5 in)

FIG. 13 Design Requirements for Various Types of Toggle Switches

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIMENSIONS		RESISTANCE
	W - WIDTH	L - LENGTH	
MINIMUM	6 mm (1/4 in)	13 mm (1/2 in)	2.8 N (10 oz)
MAXIMUM	N/A	N/A	11 N (40 oz)

	DISPLACEMENT		SEPARATION (Center-to-Center)	
	H, HT, DEPRESSED	A, ANGLE	S (Bare Hand)	S (Gloved Hand)
MINIMUM	3 mm (1/8 in)	.52 rad (30°)	6 mm (1/4 in)	6 mm (1/4 in)

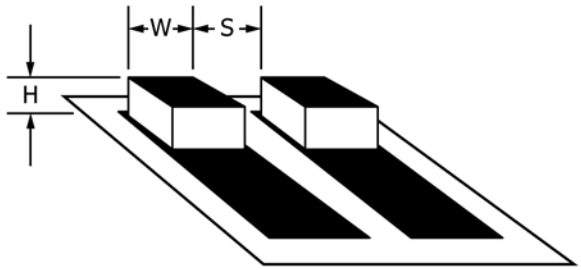
FIG. 14 Design Requirements for Rocker Switches

switch settings (for example, audio settings across frequencies), but shall not be used where misunderstanding is to be avoided.

5.6.11.2 *Orientation*—Slide switches shall be vertically oriented with movement of the slide up or away from the operator turning the equipment or component on, causing a quantity to increase, or causing the equipment or component to move forward, clockwise, to the right or up. Horizontal orientation of actuation slide switches shall be used only for compatibility with the controlled function or equipment location. Movement of the slide lever to the right, shall increase the variable being controlled.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIMENSIONS			RESISTANCE	
	H ACTUATOR HEIGHT *	H ACTUATOR HEIGHT **	W ACTUATOR WIDTH	SMALL SWITCH	LARGE SWITCH
MINIMUM	6 mm (1/4 in)	13 mm (1/2 in)	6 mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
MAXIMUM	N/A	N/A	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

* Use by bare finger.
** Use with heavy handwear.

	S, SEPARATION		
	SINGLE FINGER OPERATION	SINGLE FINGER SEQUENTIAL OPERATION	SIMULTANEOUS OPERATION BY DIFFERENT FINGERS
MINIMUM	19 mm (3/4 in)	13 mm (1/2 in)	16 mm (5/8 in)

FIG. 15 Dimensions, Resistance, and Separation for Discrete Slide Switch Controls

5.6.11.3 *Design Criteria*—Dimensions, resistance, and separation of slide switch controls shall conform to criteria in Fig. 15. Detents shall be provided for each control setting. Resistance shall gradually increase, then drop when the switch snaps into position. The switch shall not be capable of stopping between positions.

5.6.11.4 *Setting Indicator*—Slide switch controls involving more than two positions shall be designed to provide positive indication of control setting, preferably a pointer located on the left side of the slide handle.

5.6.12 *Continuous Slide Controls:*

5.6.12.1 *Use*—Slide controls should be considered when continuous control is needed (for example, engine speed, adjustment of variable lighting or sound systems) and space on the console or panel is limited. Movement of the slide lever up, forward, or to the right, should increase the variable being controlled.

5.6.12.2 *Orientation*—Slide controls should be vertically oriented with movement of the slide up or away from the operator turning the equipment or component on, causing a quantity to increase, or causing the equipment or component to move forward, clockwise, to the right or up. Horizontal orientation of actuation slide controls shall be used only for compatibility with the controlled function or equipment location. Movement of the slide lever up, forward, or to the right, should increase the variable being controlled.

5.6.12.3 *Design Criteria*—Dimensions, resistance, and separation of continuous slide controls shall conform to the criteria in Fig. 16. Resistance shall be consistent over the full run of the control. The control shall be capable of stopping at any position on the scale.

5.6.12.4 *Setting Indicator*—Slide controls shall be marked with a line and a scale to show the relative setting of the control to the full range of the scale, which shall be shown on the left side of the control.

5.6.13 *Levers:*

5.6.13.1 *Use*—Levers may be used when large amounts of force or displacement are involved or when multidimensional movements of controls are required.

5.6.13.2 *Coding*—When several levers are grouped in proximity to each other, the lever handles shall be coded.

5.6.13.3 *Labeling*—All levers shall be labeled as to function and direction of motion.

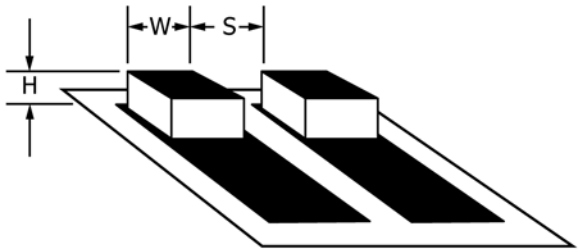
5.6.13.4 *Design Criteria*—The length of levers shall be determined by the mechanical advantage needed. When the lever or grip handle is spherical, its diameter, resistance, displacement and separation shall conform to the criteria in Fig. 17. When the levers are of the slide type, dimensions and separations shall comply with Fig. 18.

5.6.14 *Hand-Operated Displacement Joysticks:*

5.6.14.1 *Use*—Joystick controls should be used when the task requires precise or continuous control in two or more

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIMENSIONS			RESISTANCE	
	H ACTUATOR HEIGHT *	H ACTUATOR HEIGHT **	W ACTUATOR WIDTH	SMALL SWITCH	LARGE SWITCH
MINIMUM	6 mm (1/4 in)	13 mm (1/2 in)	6 mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
MAXIMUM	N/A	N/A	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

* Use by bare finger.
** Use with heavy handwear.

	S, SEPARATION		
	SINGLE FINGER OPERATION	SINGLE FINGER SEQUENTIAL OPERATION	SIMULTANEOUS OPERATION BY DIFFERENT FINGERS
MINIMUM	19 mm (3/4 in)	13 mm (1/2 in)	16 mm (5/8 in)

FIG. 16 Dimensions, Resistance, and Separation for Continuous Slide Controls

related dimensions. Their primary uses are for controlling equipment in two or three dimensions. Specific uses of displacement joysticks include: *(1)* picking data from video displays; *(2)* generating free-drawn graphics; *(3)* controlling in two to three dimensions (for example, a submerged vehicle, a crane, drill heads); *(4)* aiming sensors; and *(5)* serving as a mounting platform for a secondary control such as thumb or finger-operated switches. In rate control applications, which allow the follower (cursor or tracking symbol) to transit beyond the edge of the display, indicators shall be provided to aid the operator in bringing the follower back onto the display. If accuracy is more important than speed, a displacement joystick should be used rather than an isometric joystick. For a comparison chart, see Table 4. Displacement joysticks that are used for rate control shall be spring-loaded for return to the center when the hand is removed. In addition to the general use, hand operated displacement joysticks may be used as vehicle controllers and aiming sensors.

5.6.14.2 *Control Motion*—Movement shall not exceed 45° from the center position. Movement shall smooth in all directions, and positioning of a follower shall be attainable without noticeable backlash, cross-coupling, or need for multiple corrective movements. Control ratios, friction, and inertia shall meet the dual requirements of rapid gross positioning and precise fine positioning. Delay between control movement and confirming display response shall be minimized and shall not exceed 0.1 s.

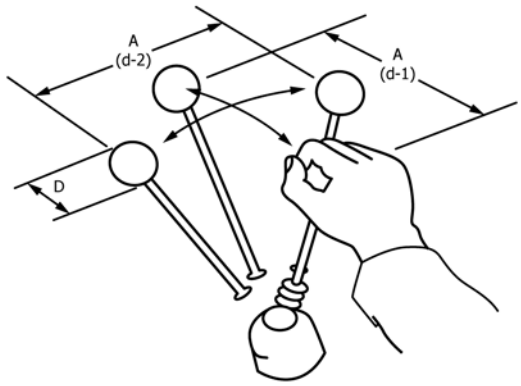
5.6.14.3 *Design Criteria*—The hand grip length shall be in the range of 102 to 178 mm (4 to 7 in.). The grip diameter shall not exceed 50 mm (2 in.). Clearances of 100 mm (4 in.) to the side and 50 mm (2 in.) to the rear shall be provided to allow for hand movement. Joysticks shall be mounted to provide forearm support. Modular devices shall be mounted to allow actuation of the joystick without slippage, movement, or tilting of the mounting base.

5.6.15 *Hand-Operated Isometric Joysticks:*

5.6.15.1 *Use*—Also known as stiff stick, force stick, or pressure stick, isometric joystick controls may be used when the task requires precise or continuous control in two or more related dimensions. Isometric joysticks are particularly appropriate for the following applications: *(1)* tasks require precise return to center after each use; *(2)* operator feedback is primarily visual rather than tactile feedback from the control itself; and *(3)* minimal delay and tight coupling between control and input and system reaction. Isometric sticks shall ordinarily not be used in applications in which it would be necessary for the operator to maintain a constant force on the control for a long period of time or in which there is no definitive feedback when maximum control inputs have been exceeded. Joystick controls may be used when the task requires precise or continuous control in two or more related dimensions. When positioning speed is more critical than positioning accuracy, isometric joysticks shall be selected over displacement joysticks (for a comparison of the two types of joysticks,

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)



	DIAMETER		RESISTANCE			
	D		(d-1)		(d-2)	
	Finger Grasp	Hand Grasp	One Hand	Two Hands	One Hand	Two Hands
Minimum	13 mm (0.5 in.)	38 mm (1.5 in.)	9 N (2 lb)	9 N (2 lb)	9 N (2 lb)	9 N (2 lb)
Maximum	38 mm (1.5 in.)	75 mm (3 in.)	135 N (30 lb)	220 N (50 lb)	90 N (20 lb)	135 N (30 lb)

	DISPLACEMENT		SEPARATION	
	A			
	Forward (d-1)	Lateral (d-2)	One Hand Random	Two Hands Simultaneously
Minimum	-	-	50 mm (2 in.)	75 mm (3 in.)
Preferred			100 mm (4 in.)	125 mm (5 in.)
Maximum	360 mm (14 in.)	970 mm (38 in.)		

FIG. 17 Dimensions, Resistance, and Separation for Levers

see Table 4. Isometric joysticks may also be used for various display functions such as data pickoff from a CRT. In rate control applications, which may allow the follower (cursor or tracking symbol) to transit beyond the edge of the display, indicators shall be provided to aid the operator in bringing the follower back onto the display. In addition to the general use, hand operated isometric joysticks may be used as vehicle controllers and aiming sensors. Hand-operated isometric joysticks may be used as mounting platforms for secondary controls, such as thumb- and finger-operated switches. Operation of secondary controls has greater induced error on the isometric hand grip than does displacement handgrip joysticks.

5.6.15.2 *Control Motion*—The controller has no perceptible movement, but its output is a function of force applied.

5.6.15.3 *Design Criteria*—The hand grip length shall be in the range of 110 to 180 mm (4.3 to 7.1 in.). The grip diameter shall not exceed 50 mm (2 in.). Clearances of 100 mm (4 in.) to the side and 50 mm (2 in.) to the rear shall be provided to allow for hand movement. Joysticks shall be mounted to provide forearm support. Modular devices shall be mounted to allow actuation of the joystick without slippage, movement, or tilting of the mounting base. Maximum force for full output shall not exceed 118 N (26.7 lb).

5.6.16 *Push-Pull Controls:*

5.6.16.1 *Use*—This type of control may be considered only for two-position controls (ON–OFF, OPEN–CLOSE).

5.6.16.2 *Control Motion*—Pulling a push-pull control toward the human body shall turn ON or activate the equipment or function. Pushing the push-pull control away from the human body shall turn OFF or deactivate the equipment or function.

5.6.16.3 *Design Criteria*—Handle dimensions, displacement, and clearances shall comply with Fig. 19.

5.6.16.4 *Resistance*—Force for pulling a push-pull control with fingers shall be not more than 18 N (4 lb), for pulling a T-bar with four fingers shall be not more than 45 N (10 lb).

5.6.16.5 *Detents*—Mechanical stops at the ends of the push-pull control travel shall be incorporated into push-pull controls to provide tactile indication of the maximum travel limit.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

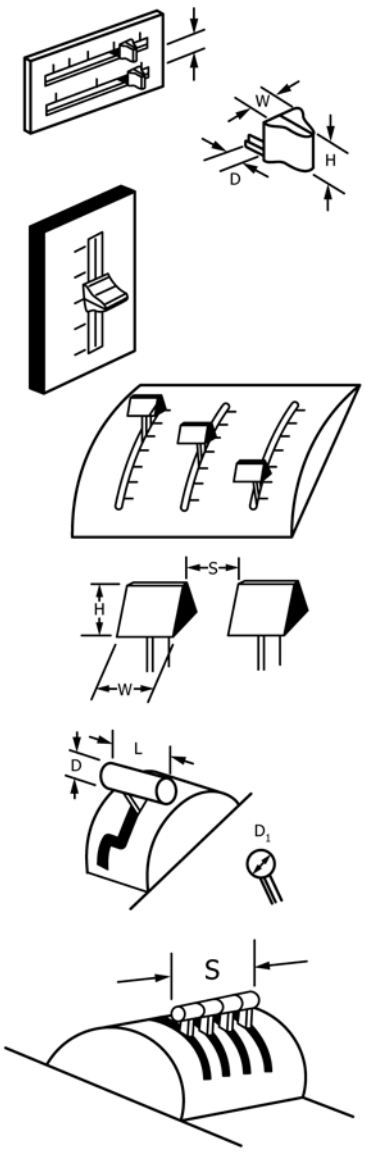
	DESIGN CRITERIA	
	DIMENSIONS	SEPARATION
	D = 13 mm (½ in) Min D = 19 mm (3/4 in) with Gloves W = 6.5 mm (¼ in) Min H= 16 mm(5/8 in) Min	S = 19 mm (3/4 in) Min S = 25 mm (1 in) with Gloves
	Cylindrical: D = 19 mm (3/4 in) Min D = 28 mm (1 1/8 in) Max	S =50 mm (2 in) Min finger clearance on all sides
	Spherical: D = 32 mm (1 ¼ in) Min L = 65 mm (2 ½ in) Min	S = 100 mm (4 in) Min S = 125 mm (5 in) Max

FIG. 18 Dimensions, Resistance, and Separation for Slide Levers

TABLE 4 Comparison of Displacement and Isometric Controls

Type of Lever or Joystick	Advantages	Disadvantages
Isometric	Positioning Accuracy Less force required Less fatiguing Best for secondary switches	Slower operation Requires more operating room
Displacement	Faster Center or null position is simple to locate Requires less operating room	Provides less tactile feedback of control position Does not provide tactile feedback

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

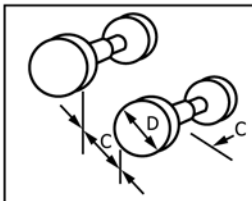
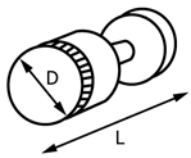
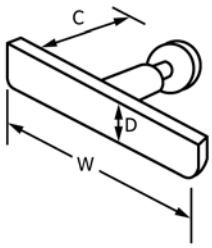
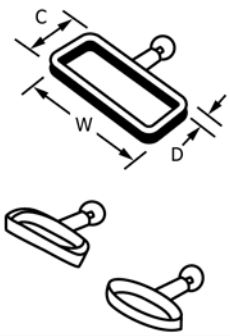
	DESIGN CRITERIA			
	CRITERIA	DIMENSIONS	DISPLACEMENT	SEPARATION
	Push-pull control, low resistance for two positions, mechanical and/or electrical systems.	D = 19 mm (3/4 in) Min C = 25 mm (1 in) Min Clearance C = 38 mm (1½ in) for gloved hand	13 mm (½ in) Min 38 mm (1½ in) for gloved hand	S = 38 mm (1½ in) Min S = 50 mm (2 in) for gloved hand
	Alternate handle: Miniature electrical panel switch only. Avoid glove use application.	D = 19 mm (3/4 in) Min L = 19 mm (3/4 in) Min	13 mm (½ in) Min	S = 25 mm (1 in) Min
	High-force push-pull for two-position mechanical system only.	W = 100 mm (4 in) D = 16 mm (5/8 in) Min D = 38 mm (1½ in) C = 38 mm (1½ in) Min Clearance C = 76 mm (3 in) for gloved hand	25 mm (1 in) Min 50 mm (2 in) Preferred	
	Same as above. Preferred where garment or cabling-snag possibility exists.	W = 100 mm (4 in) W = 125 mm (5 in) for gloved hand D = 16 mm (5/8 in) Min D = 38 mm (1½ in) C = 38 mm (1½ in)	25 mm (1 in) Min 50 mm (2 in) Preferred	S = 13 mm (½ in) Min

FIG. 19 Dimensions, Displacement, and Separation of Push-Pull Controls

6. Displays

6.1 *Visual Displays:*

6.1.1 *General:*

6.1.1.1 Visual displays shall be used to provide the operator with an indication of equipment or system conditions by providing a positive indication of the state of the equipment such as: ready, running, not running, or "out-of-tolerance," and/or the current performance level of the equipment or system.

6.1.1.2 The absence, or nonactivated state, of a visual display shall not be relied upon to convey status information (that is, a darkened display shall not be used to indicate that a piece of equipment is OFF) but is an acceptable indication of the absence of power (that is, POWER OFF) for an operational display but not for maintenance displays.

6.1.1.3 Where equipment status must always be available to the operator (for example, STOP/START, ON/OFF), a status indicator shall be provided for each state (for example, if the operator must always know if a piece of equipment is ON or OFF there shall be separate indicators for each condition, one of which must always be lit).

6.1.2 *Information Content*—The content of information displayed to an operator shall allow the operator to perform the intended mission, but shall be only limited to that which is necessary to perform specific actions or to make decisions.

6.1.3 *Format*—Information shall be presented to the operator in a directly usable format that shall not require transposing, computing, interpolating, or mentally translating to other units.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

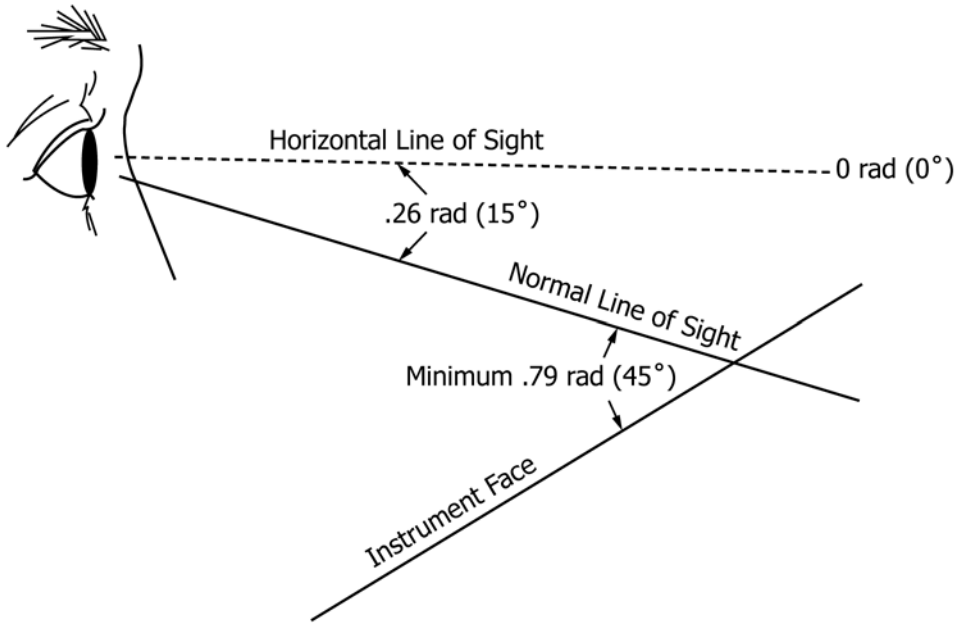


FIG. 20 Visual Lines of Sight

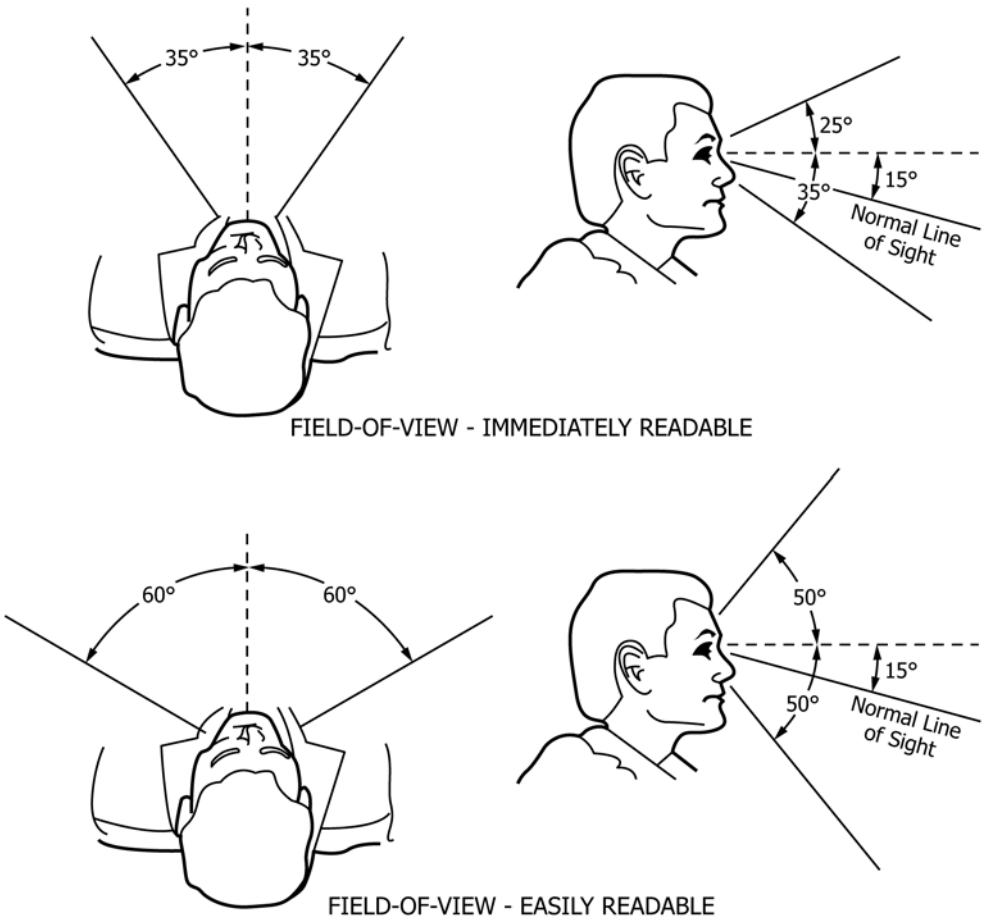
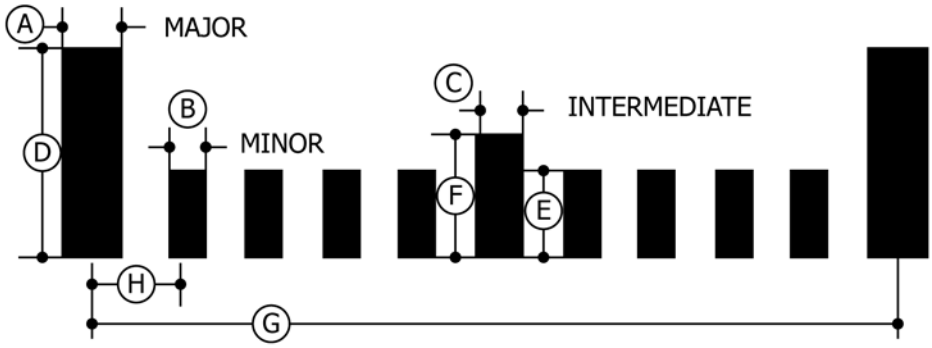


FIG. 21 Primary and Secondary Fields of View

Documents
Document Sharing Hub
Full document details: ASTM F1166-07(2013)



	Viewing Distance		
Dimension, mm (in)	710 (28.0)	910 (35.9)	1525 (60.2)
A (Major index width)	0.89 (.035)	1.14 (.045)	1.90 (.075)
B (Minor index width)	0.64 (.025)	0.81 (.032)	1.37 (.054)
C (intermediate index width)	0.76 (.030)	0.99 (.039)	1.63 (.064)
D (Major index height)	5.59 (.221)	7.19 (.283)	12.0 (.473)
E (Minor index height)	2.54 (.100)	3.28 (.129)	5.44 (.214)
F (intermediate index width)	4.06 (.160)	5.23 (.206)	8.71 (.343)
G (Major index separation between midpoints)	17.8 (.701)	22.9 (.902)	38.0 (1.50)
H (Minor index separation between midpoints)	1.78 (.070)	2.29 (.090)	3.81 (.150)

FIG. 22 Design Criteria for Major, Intermediate, and Minor Scale Markings

6.1.4 *Redundancy*—Redundancy in the display of information to a single operator shall be avoided unless it is required to achieve specified reliability.

6.1.5 *Combining Information*—Operator and maintainer information shall not be combined in a single display unless the information content and format is well suited to and time is available for both.

6.1.6 *Display Failure*—A method shall be provided to determine if a display or circuit has failed. The fact that a display has failed shall be immediately perceptible to the operator.

6.1.7 *Display Circuit Failure*—Failure of the display circuit shall not cause a failure in the equipment associated with the circuit.

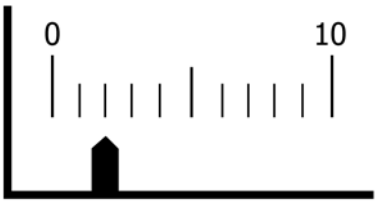
6.1.8 *Unrelated Markings*—Trademarks and company names or other similar markings not related to the panel function shall not be displayed on the panel face or on the displays. If needed for maintenance purposes, such information should be placed on the side or back of the console or instrument face.

6.1.9 *Duration of Displayed Information*—For signals or displays that frequently or consistently change their outputs, the information displayed shall have a duration of sufficient length to be reliably detected under expected operator workload and operational environment.

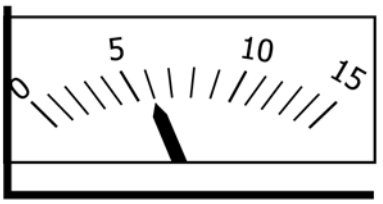
6.1.10 *NBC Compatible*—Display characteristics (for example, clarity, legibility) shall allow viewing of displays while wearing a nuclear, biological, and chemical (NBC) or

AVA Documents
Document Sharing Hub

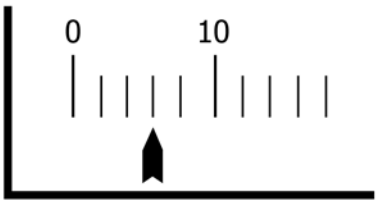
Full document details: ASTM F1166-07(2013)



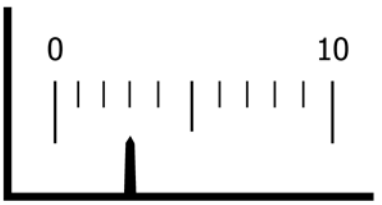
A Fixed scale moving pointer preferred: three-level marking, numbered at each major mark. Pointer adjacent to graduation marks to preclude obscuration of either marks or numbers.



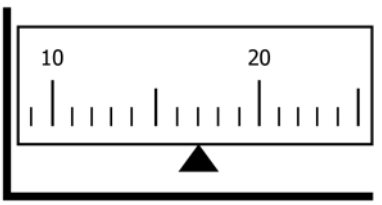
B For short, finite scale, every 5th graduation is marked; using only two-level marking.



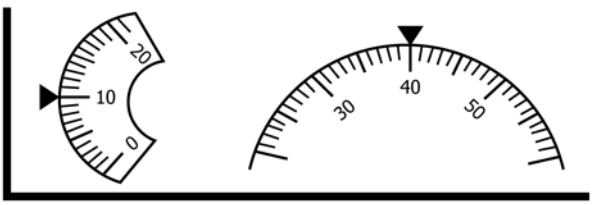
C When scale crowding makes pointer-mark association difficult, scale may be graduated in units of two, with two-level scale marking and numbering at each major marking.



D When dial face is deeply inset within instrument case and visibility of numbers is more important that scale mark-pointer association, pointer may be located inside the graduations along with numbers at major markings. Pointer width should be narrowed at point in which it passes numbers.



E Moving scale against an index mark or pointer may be used when scale length precludes the fixed scale format (i.e., graduation marks would be too close together). Open window configuration helps operator focus on significant scale area.



F When open window configuration is oriented in vertical position, numbers should appear up-right as each number passes the index mark or pointer. Total scale exposure is desirable when operator needs to refer to other portions of the scals.

FIG. 23 Scale Graduation, Pointer Position, and Scale-Numbering Alternatives

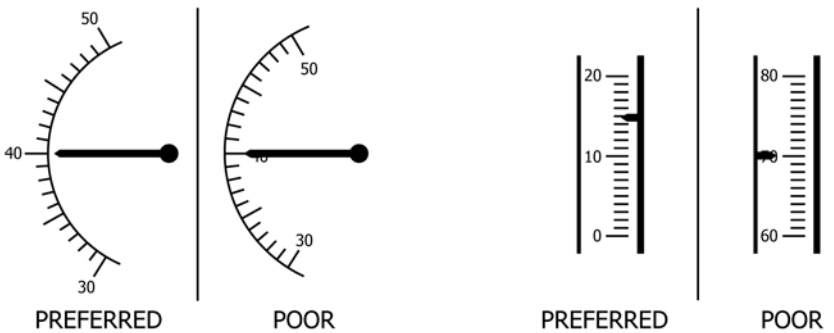


FIG. 24 Scale Number Placement

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

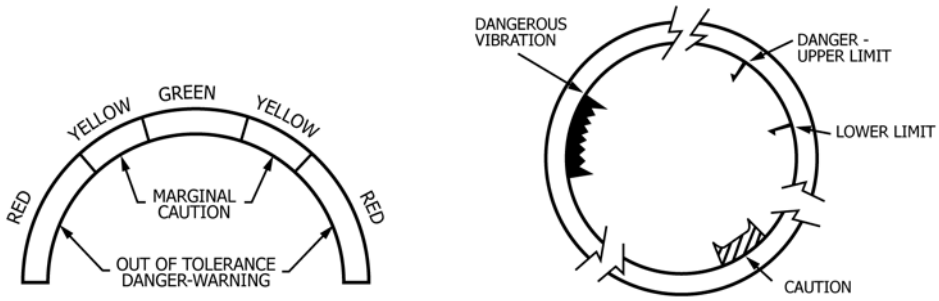
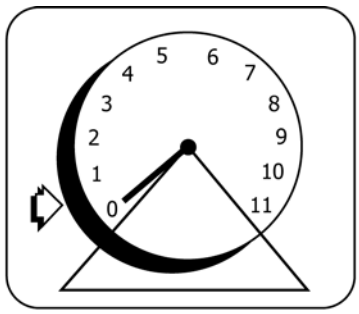
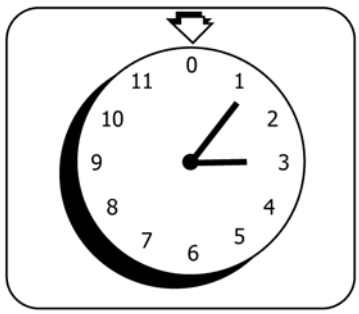


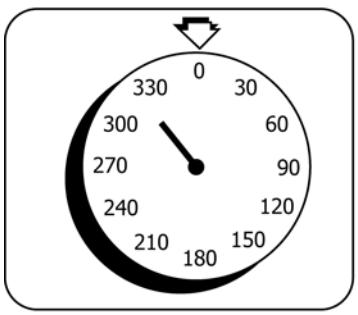
FIG. 25 Color and Shape Coding of Ranges on an Analog Display



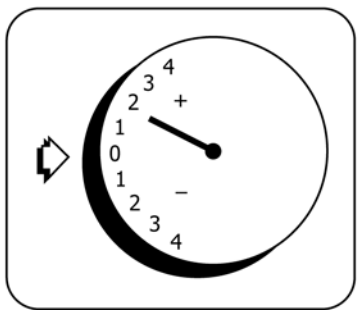
When a dial scale is of finite length, it should be numbered so that value increase is clockwise. The zero starting point should be approximately at the 7 o'clock position. There should be an obvious "break" between the two ends of the scale of at least 10° of arc.



When multirevolution pointer movement is involved, the zero reference should be at the top of the dial, and there should be no break between scale ends. No more than two pointers shall be used except for special cases, e.g., clock (with second hand).



Azimuth dial scales shall be laid out with the zero (or north) reference at the top of the dial, and scale values shall increase clockwise at least every 30° reference should be numbered.



Positive/negative dial formats shall be laid out with the zero (or "null" position) located at the 9-, 12-, or 3-o'clock position. Scale values shall increase right or left, or up or down as appropriate to provide positive/negative pointer movement relationships.

FIG. 26 Zero Position and Pointer Movement for Circular Dial Displays

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

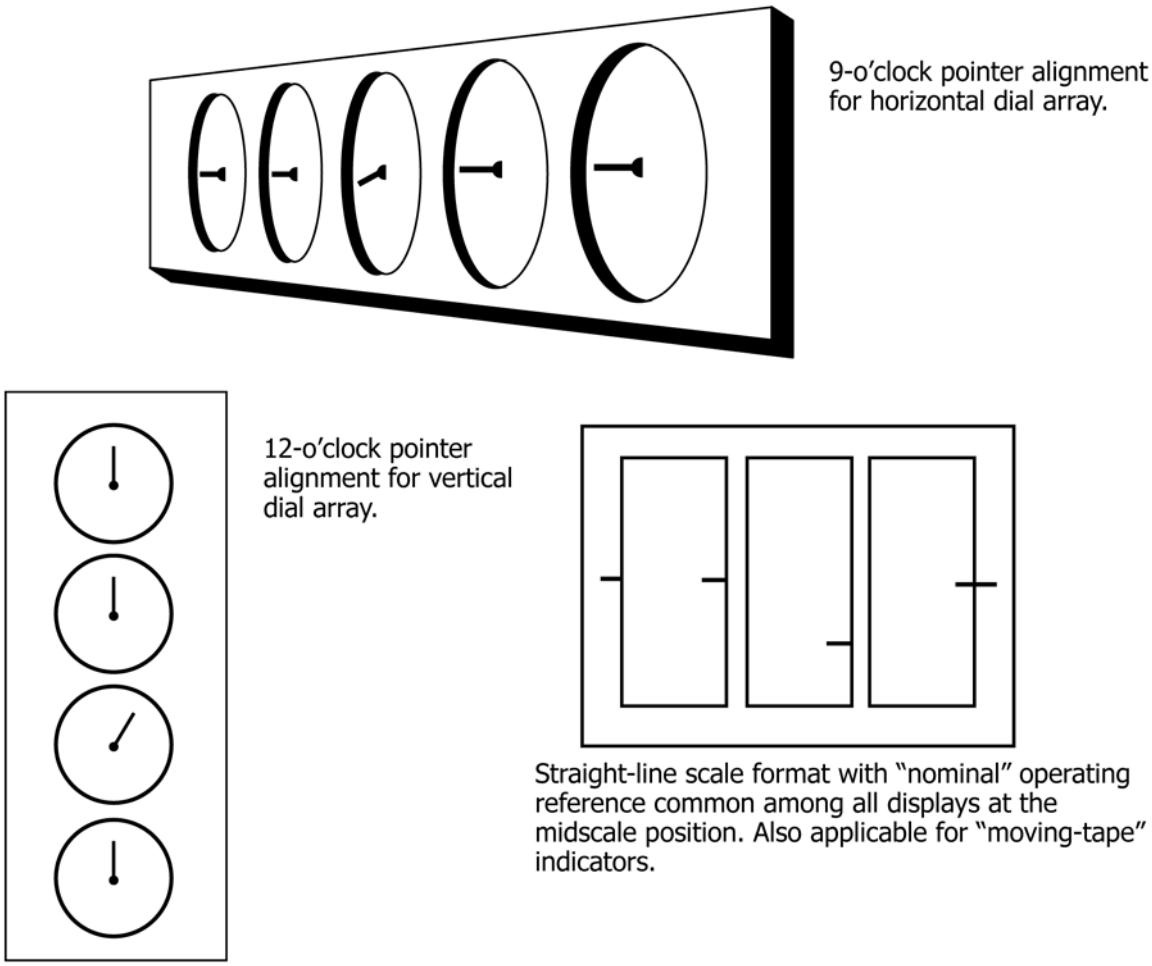


FIG. 27 Aligned Pointers for Rapid Check Readings

other protective mask. Displays or indicators that show the presence of NBC or other environmental contamination agents shall also show when such agent concentrations decrease to safe levels.

6.1.11 *Coding*—Coding techniques (for example, color, shape, location) used to enhance the transfer of information from a display shall be clear, concise, and consistently applied wherever that display is used. Coding shall be appropriate for the industry, organization, and culture of the personnel who shall use the display.

6.1.12 *Legibility*—Displays shall be legible under all anticipated viewing conditions with due consideration given to ambient lighting and viewing distance.

6.1.13 *Units of Measure*—Displays of quantitative information shall include units of measure.

6.1.14 *Analog Versus Digital:*

6.1.14.1 Display information should be presented in either analog or digital form. Analog displays include meters, plotters, bar charts, simple indicator lights, and legend lights. Use analog displays when trend information is required or when values need to be compared to ranges or zones.

6.1.14.2 Digital displays include digital counters and numbers displayed on a screen. Use digital displays when quick, precise readings of quantitative values are required. Do not use digital displays alone, if perception of a trend, pattern, or variation is important or where value changes occur too slowly or too rapidly to be easily detected.

6.2 *Location, Orientation, Lighting, and Arrangement of Displays:*

6.2.1 *Location*—Displays, including sight gauges, shall be located and designed so that they may be read to the degree of accuracy required by personnel in the normal operating or servicing positions without requiring the operator to assume an uncomfortable, awkward, or unsafe position.

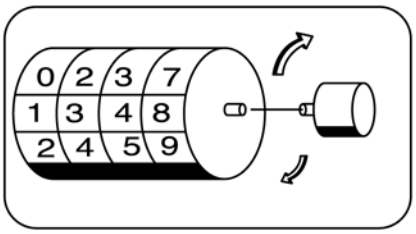
6.2.2 *Dual Gauge Arrangement*—Dual gauges providing an IN and OUT reading (for example, suction and discharge, voltage in and out, pressure in, reduced pressure out) shall be arranged so that the gauge with the IN or LOW reading is on the left (preferred) or top, and the gauge with the OUT reading is on the right (preferred) or bottom, unless the IN and OUT displays are a part of a system mimic that does not permit this arrangement. Using the reverse order from that described above shall require written approval of the procuring organization.

6.2.3 *Visual Access:*

6.2.3.1 Visual displays shall be visually accessible from the normal work position without requiring the operator to stand on equipment components, handrails, walkways, or other way

AVA Documents
Document Sharing Hub

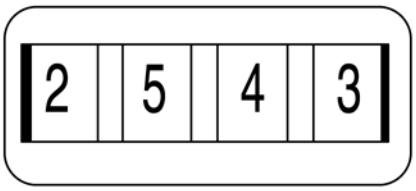
Full document details: ASTM F1166-07(2013)



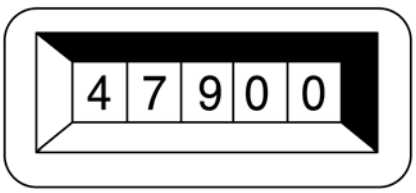
A Counter drums should be numbered so that a clockwise rotation of drums and/or reset control produce increasing numerical values.

Numerals should "snap" into position so that the entire numeral appears within the viewing window.

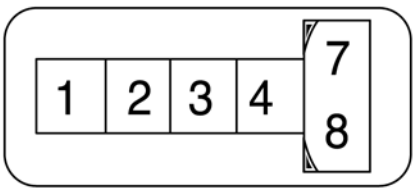
Number height : width proportions should be within the range of 5:3 to 1:1 (1:1 is the preferred ratio) except for number "1".



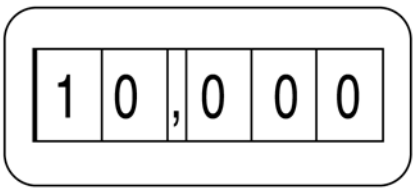
B Spacing between adjacent numerals should not exceed 1/4th width of wide numerals; 1/2 the width of narrow numerals when several numbers are to read as a total value.



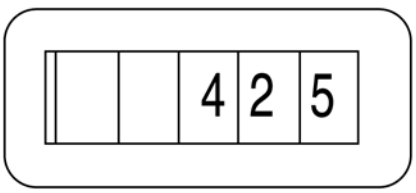
C Counter drums should be mounted as close to the front panel surface as practical, and the edges of the viewing window should be beveled to provide at least 45° off-angle view of the display.



D When numbers on right drums need not be read accurately, these may move in a continuous motion, in which case at least two of the numbers should be visible.



E Decimal points may be inserted within the viewing window or placed on the panel when the position remains constant. Commas should not be used unless more than four numbers appear in the window.



F If left-hand numbers are seldom used, provide a blanking system rather than present several preceding zeros (i.e., the blanking device exposes left-hand drums only when numerical value is displayed).

FIG. 28 Digital Display Design Requirements

supports, pipes (bare or insulated), or any structure that is not specifically designed and provided for supporting a person's weight.

6.2.3.2 No display shall require the removal of a cover (for example, sheathing, deck plate) or any other component to be visible, unless the display is noncritical and a clearly marked quick access door is provided. The access door should be of transparent material.

6.2.3.3 Light-emitting diodes (LEDs) used on PC boards inside consoles for calibration or troubleshooting shall be visible from the maintainer's normal work position once the console doors or maintenance access openings are open.

6.2.4 *Display Orientation:*

6.2.4.1 Displays, such as thermometers and pressure gauges, that are attached directly to a pipe shall be mounted so they are read upright, or turned no more than 90° from the upright position if the upright orientation cannot be achieved.

6.2.4.2 Displays located within 305 mm (12 in.) of a walkway shall not be located lower than 457 mm (18 in.) above the deck unless the display face is protected by a non-breakable transparent material.

6.2.4.3 Armored sight gauges shall be oriented so the sight gauge is directly visible from the normal work position.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

6.2.5 *Consistency*—The location, design and arrangement of displays within a system shall be consistent from application to application wherever those displays appear throughout the ship or maritime structure.

6.2.6 *Grouping*—All displays necessary to support an operator activity or sequence of activities should be grouped together.

6.2.7 *Frequency of Use*—Displays used most frequently should be grouped together and placed in the primary field of view (see 6.2.17, Fig. 21).

6.2.8 *Importance*—Important or critical displays shall be located in the primary field-of-view or otherwise highlighted (see 6.2.17, Fig. 21).

6.2.9 *Function and Sequence*—Displays shall be arranged in relation to one another according to their sequence of use or the functional relations of the components they represent. They shall be arranged in sequence within functional groups, whenever possible, to provide a viewing flow from left to right or top to bottom.

6.2.10 *Ambient Lighting Levels*—Ambient lighting levels shall 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 Section 14.

6.2.11 *Ambient Illumination Reflection*—Displays shall be constructed, arranged, and mounted to prevent reduction of information transfer as a result of the reflection of the ambient illumination from the display cover. Reflection of instruments and consoles in windows and other reflective surfaces shall be prevented.

6.2.12 *Sight Gauges*—Sight gauges that contain clear liquid shall be designed with a color backing, color float, or other technique to provide a distinctive color indication of the liquid level in the gauge.

6.2.13 *Vibration*—Vibration of visual displays shall not degrade user readability below the level required for mission accomplishment. The effects of excessive vibration should be countered by coupling the operator and displays to the same platform, by arranging the operator and display to minimize relative motions or enlarging the display character's and/or number's size.

6.2.14 *Minimum Viewing Distance*—The viewing distance from the operator's eye to the face of the displays, with the exception of cathode ray tube displays, shall never be less than 330 mm (13 in.) and preferably not less than 508 mm (20 in.) and not more than 711 mm (28 in.). All displays shall be accurately read within these viewing distances.

6.2.15 *Maintenance Displays*—Displays used solely for maintenance and adjustment shall be covered or nonvisible during normal equipment operation, but shall be immediately accessible when required.

6.2.16 *Line of Sight*—A display should be perpendicular to the normal line of sight but not less than 45°, as indicated in Fig. 20. The normal line of sight is 15° below the horizontal line-of-sight.

6.2.17 *Primary and Secondary Visual Field*—Displays used most frequently, those used for obtaining precise readings, or those used in an emergency shall be placed in the primary (immediately readable) visual field in accordance with Fig. 21. Those displays used for normal operations and those not requiring accurate readings shall be located in the secondary (easily readable) field-of-view as indicated in Fig. 21. Reference displays that are used infrequently may be located in an area outside the primary and secondary field of view.

6.3 *Display Illumination:*

6.3.1 *Normal*—When maximum dark adaptation is not required, low brightness white light (preferably integral and adjustable) should be used; however, when maximum dark adaptation is required, low luminance [0.07-0.35 cd/m^2 (0.02-0.10 ft-L)] red light (greater than 620 nm) should be provided.

6.3.2 *Night Vision Device Compatibility*—When night vision devices will be worn or used by the operator(s), display illumination color shall be low-density blue-green light (incandescent filament through a high-pass filter with a 600-nm cutoff). The color selected shall provide the operator(s) with the capability to obtain required display information rapidly and accurately with unaided eye vision or via viewing with the night vision device. The color selected shall also provide the operator(s) with the ability to obtain required display information rapidly and accurately during any daylight condition. The lighting shall be continuously variable to the full OFF position. In the OFF position, no current shall flow through the lamps.

6.3.3 *Outdoor Panel Lighting Control*—When control or annunciator panels will be viewed by personnel out of doors at night, maximum panel illumination shall be provided when a dimming rotary control is at its extreme clockwise rotation. No current shall be provided to luminaries at extreme counterclockwise rotation of a dimming control. Panel light levels shall be continuously variable from 0.1 cd/m^2 (0.03 fL) near OFF to 3.5 cd/m^3 (1 fL) at 50 % of clockwise rotation.

6.3.4 *Blackout Discipline*—Where operational security or survivability requires blackout discipline, the use of permanently illuminated outdoor displays shall be avoided and illumination of displays within personnel enclosures shall automatically switch off when doors to the enclosure are opened.

6.3.5 *Light Distribution Across a Panel*—Where multiple displays are grouped together, lighting shall be balanced across the instrument panel such that the mean indicator luminance of any two instruments shall not differ by more than 33 % across the range of full ON to full OFF.

6.4 *Display Types:*

6.4.1 *Transilluminated (Status) Display:*

6.4.1.1 *Use*—Transilluminated displays show the current state of equipments or systems through qualitative data provided to the operator. Transilluminated displays may be used as visual alarms that require an immediate response by the operator or as a simple indicator of current equipment or system performance. Status indicators may also be used for maintenance and adjustment functions.

6.4.1.2 *Categories*—Two categories of transilluminated displays shall be used:

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

(1) Simple indicator or pilot lights shall be used when an inscription on the light face is not required to convey status. However, color coding should be used. Simple indicator lights shall be used only if the design precludes the use of legend lights.

(2) Legend lights shall be used when labeling on the light face, highlighted when the light is on, conveys additional information beyond the simple indicator light. The lettering or characters or both used in legend lights shall be visible whether the light is illuminated or not except for alarm lights (that is, danger and caution) which shall be visible only when their display is lit. Legend lights shall be used to provide qualitative information, not to give commands.

6.4.1.3 *Illuminated Label Versus Illuminated Background:*

(1) An illuminated label on an opaque background shall be used:

(a) If dark adaptation of the operator's eyes is required, and

(b) Where display legibility in high ambient illumination is critical.

(2) An opaque label on an illuminated background shall be used:

(a) If the indicator is a critical alerting indicator, such as a master warning light, and

(b) If dark adaptation is not required.

6.4.1.4 *Labeling of Status Displays*—Labeling of status displays shall conform to the label requirements contained in Section 15.

6.4.1.5 *Coding*—Transilluminated displays shall be color coded if they are used for alarms, or providing equipment or system status (see 6.4.1.5*(7)*).

(1) Objective—Coding techniques should be used to facilitate discrimination between individual displays, identify specific displays, identify functionally related displays, provide an indication of relationship between displays, and identify critical information within a display.

(2) Consistency—Coding techniques shall be standardized for all display designs and shall be consistently used wherever a coding technique is used.

(3) Techniques—Displays shall be coded by color, size, location, shape, brightness, or flash coding whenever special coding is required.

(4) Size Coding—When size coding is used with displays no more than three distinct sizes shall 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.

(5) Location Coding—Transilluminated displays that appear on more than one console, panel or individual mounting shall be located in the same or approximate location at each location and in the same relation to other displays or controls that also appear in all the locations.

(6) Brightness Coding—No more than two brightness levels shall be used to code different transilluminated displays.

(7) Color Coding—Meanings of color differ between cultures, therefore, if color codes are provided with displays, select colors that are consistent with the expectations of the expected user populations. Table 5 presents commonly used color-coding schemes in North America. Designers should identify regional and industry color meaning expectations, as well as any statutory requirements, when defining color-coding requirements.

(8) Flash Coding—Alternating the ON-OFF state of a display (that is, flashing) may be used to emphasize certain information relative to other information.

(a) No more than two flash rates shall be used and they shall differ by not less than 2 Hz. The higher flash rate shall reflect the more critical information and should be not greater than 5 Hz. nor less than 3 Hz. The slower flash rate shall be not less than 0.8 Hz for the least critical information. Flashing lights shall turn to steady red when they are acknowledged by the operator.

(b) The percentage of "ON" time should be equal to but not less than the percentage of "OFF" time. A50 % duty cycle is preferred.

(c) Characters that must be read shall not flash. Emphasis should be added by adjacent flashing symbol or flashing background.

(d) Event acknowledgment or flash suppression control shall be provided.

(e) If the display is energized and the flasher device fails, the flashing device shall illuminate and burn steadily.

6.4.1.6 *Lamp Test*—When three or more simple indicator lights are used with incandescent bulbs, a master light test control shall be incorporated. With three or less lights, individual press-to-test bulb testing is allowed.

6.4.1.7 *Display Lighting Level*—When status displays are used under varying ambient illumination levels, a dimming control shall be provided. The control shall be capable of continuous variance of light level but never to full OFF.

TABLE 5 Typical Status Display and Alarm Color Codes for North American Industry

Color	Typical Display/Alarm Color Meanings
Flashing Red	Flashing red shall be used to denote emergency conditions that require immediate operator attention. Flash rate should be between 3-5 per second.
Steady Red	Danger, hot, unsafe condition, critical parameter value is out-of-tolerance. Immediate operator action is required.
Amber[A]	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 (for example, 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 (for example, Pump No. 1 selected), or transitory conditions (for example, 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.

[A] Yellow may also be used for this purpose, and amber and yellow may both be used in a color coding scheme provided there is a distinct visual difference between the two colors, and that the definitions for the two colors are maintained throughout the ship or maritime structure.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

6.4.1.8 *Feedback on Status Displays*—Changes in status displays, including those used in illuminated pushbuttons, shall display actual equipment status, not just that a control command has been initiated (that is, a lit PUMP ON light or legend switch means that the pump is running, not just that the ON control has been pushed or a VALVE CLOSED indicator shall signify that the valve is actually closed, not that the VALVE CLOSED control has been activated).

6.4.1.9 *Grouping*—Master caution, master warning, master advisory, and summation lights used to indicate the condition of an entire subsystem shall be easily discriminated from the lights which show the status of the subsystem components.

6.4.1.10 *False Indications*—Provision shall be made to prevent direct or reflected light from making indicators appear illuminated when they are not, or to appear extinguished when they are illuminated. Self-reflection shall be minimized by proper orientation of the display with respect to the observer.

6.4.1.11 *Lamp Redundancy*—Meters, counters, and other displays that use incandescent bulbs to illuminate the display face may incorporate filament redundancy or dual lamps. When one filament or bulb fails, the intensity of the light shall decrease sufficiently to indicate the need for lamp replacement, but not so much as to degrade operator performance. Lighted annunciators need not have this capability provided a lamp test button is provided.

6.4.1.12 *Lamp Removal:*

(1) Lamps shall be removable and replaceable from the front of the display panel. The procedure for lamp removal and replacement should not require the use of tools and shall be easily and rapidly accomplished. If a tool is required, special stowage for it will be provided on the panel.

(2) Lamp removal and replacement shall be possible while power is applied without causing failure of indicator circuit components or imposing personnel safety hazards.

6.4.2 *Circular and Line Gauges/Displays :*

6.4.2.1 *Use*—Analog displays such as circular and line gauges and displays shall be used when providing information about rates-of-change, trends, or deviations from a given values. They are suitable for the presentation of quantitative or qualitative information. Guidelines for analog scales are shown below.

6.4.2.2 *Types of Scale*—Types of scale indicators that may be used include:

(1) Moving pointer, fixed scale, presented in a circular, curved (arc), horizontal straight, and vertical straight presentation format, and

(2) Fixed pointer, moving scale, presented in a circular, curved (arc), horizontal straight, straight, and vertical straight presentation format.

6.4.2.3 *Scale Preferences*—Moving-pointer, fixed-scale indicators shall be used unless fixed-pointer, moving scale indicators are approved by the procuring agency. Where reading speed is important, circular scales should be used in preference to horizontal scales or vertical scales, and horizontal scales should be used in preference to vertical scales.

6.4.2.4 *Scale Orientation*—Scales should be oriented to meet the expectations of personnel.

(1) Vertical scales are appropriate with parameter such as levels, pressures, or temperatures where personnel have expectations of values rising or falling.

(2) Horizontal or arced scales are appropriate for parameters such as rudder angles, flow, revolutions per minute, or velocities/speed.

(3) Circular scales are best for parameters that have associated circular or around-the-horizon orientations like ship's heading or wind direction.

6.4.2.5 *Linear Scales*—Linear scales shall be used except where system requirements dictate nonlinearity to satisfy operator information requirements. Nonlinear scales shall be used only with the written approval of the procuring activity.

6.4.2.6 *Scale Design Units*—The units of a scale shall be specific to minimize the need for user guessing, interpolating, or performing mental calculation to read the display.

6.4.2.7 *Number of Scales Per Display*—One scale per display is preferred, but no more than two shall be used. If two scales are used, they shall have different scale ranges, scale increments, and colors so as to be visually different from each other.

6.4.2.8 *Scale Range*—The scale range shall be selected so the display pointer's normal operating position is approximately midway between the scale ends.

6.4.2.9 *Scale Markings:*

(1) A scale marker shall be included on the display for every scale unit that is to be read, unless this would result in an overcrowded display. In this case, using fewer scale markers requiring personnel to interpolate is permissible.

(2) Scales shall start and end on a major graduation mark even if this puts either or both ends beyond the usable range of the scale (for example, if the maximum voltage which can be read on an instrument is 23 V, the scale shall go at least to 25 V where there should be a major graduation mark).

(3) Display scales shall start at zero, except where this would be inappropriate for the function involved.

(a) Marking Graduations—Scale graduations shall be in increments of one, two, or five units or decimal multiples thereof. No more than three sizes of marks shall be used on any scale. The scales that require three sizes of marks include those which have numbered values in multiples of ten but are graduated in five- and ten-unit intervals.

(b) Major Markings—Except for measurements that are normally expressed in decimals, whole numbers shall be used for major graduation marks.

(c) Intermediate and Minor—The number of intermediate and minor marks between numbered scale pointers shall not exceed nine as shown in Fig. 22. Examples of the use of intermediate and minor markings are shown in Fig. 23.

(d) Scale Colors—Scale markings and numbers should be black on a white background (preferred) or dark on a light background). Any other contrast should be with the approval of the procuring agency.

6.4.2.10 *Scale Numbers*—Scale numbers should be placed so that the pointer does not obscure the scale numbers. See Fig. 23 and Fig. 25. For small round dial displays where placing the numbers outside of the scale markers would result in crowding of the markers, the markers can be placed on the perimeter of

AVA Documents Document Sharing Hub

Full document details: ASTM F1166-07(2013)

the instrument face and the numbers inside. The numbers should be large enough to be readable when the pointer is over them.

6.4.2.11 *Pointers*—Indicators with scales should have pointers that are relatively wide at the pivot, tapering gradually to a fine tip, arrowhead, or teardrop that is the same width as the smallest graduation mark.

6.4.2.12 *Pointer to Scale Marks Relationship*—Pointers shall meet, but not overlap, the shortest scale-graduation mark. The tips shall never be more than 1.5 mm (1⁄16 in.) from the scale graduations. The tips shall be equal in width to the minor scale graduations.

6.4.2.13 *Luminance Contrast*—Luminance contrast of at least 75 % shall be provided between the scale face, the markings, and the pointer.

6.4.2.14 *Pointer Color*—Pointers shall be the same color as the numbers and scale divisions.

6.4.2.15 *Pointers per Dial*—With the exception of clocks and watches, there shall not be more than two pointers on a single dial.

6.4.2.16 *Calibration Information*—Provision shall be made for placing calibration information on instruments without degrading dial legibility.

6.4.2.17 *Coding*—When operating conditions always fall within a limited range of the total scale, these ranges shall be made readily identifiable by means of pattern, color, or shape coding applied to the face of the instrument. Use of red color coding shall be limited to critical situations. Operating zones may be shape coded when the indicator must be viewed in very low-light-level work environments, 0.07 to 0.7 cd/m^2 (0.02 to 0.2 ft·L) or where the illuminant color will cause difficulty in discrimination of colors. See Fig. 25.

6.4.2.18 *Moving Scale-Fixed Pointer Display*—Moving scale fixed pointer displays shall not be used except only with the approval of the procuring agency. If such scales are used, they shall comply with the following design criteria:

(1) Numbered scales shall increase clockwise, from left to right, or from bottom to top, depending on scale layout (circumferential or linear in a horizontal or vertical axis).

(2) Numbers on fixed scales shall appear vertical (upright) to the observer.

6.4.2.19 *Circular Displays*—Circular displays are best for parameters that have associated circular or round-the-horizon orientations like ship's heading or wind direction or where the parameter shown is not more suited to a straight display.

(1) Scale Reading Pointer Movement—To display values ranging from negative through zero to positive, and consistently, locate the zero point at the 9 or 12 o'clock position. Positive values shall increase when the pointer moves clockwise (to the right), and negative values shall increase when the pointer moves counterclockwise (to the left).

(2) Zero Position and Pointer Movement—When positive and negative values are displayed around a zero point, the magnitude of positive values shall increase with movement of the pointer up or to the right, and the magnitude of negative values shall increase with movement of the pointer down or to the left. The position of the zero value on a numbered scale and the relative pointer movement shall conform to criteria in Fig. 26.

(3) Scale Break—There shall be an obvious break of at least 10° of arc between the two ends of the scale, except on multirevolution instruments such as clocks.

(4) Aligned Pointers for Check Reading—When a stable value exists for given operating conditions in a group of circular scale indicators, they shall be arranged either in rows so that all pointers line up horizontally on the 9 o'clock position under normal operating conditions or in columns so that all pointers line up vertically in the 12 o'clock position under normal operating conditions in accordance with Fig. 27. If a matrix of indicators is needed, preference shall be given to the 9 o'clock position.

6.4.3 *Digital Displays:*

6.4.3.1 *Use*—Use and design criteria for digital displays include:

(1) Numbers shall change by snap action rather than by continuous movement.

(2) If numbers should be read in consecutive order, they shall not change faster than two per second.

(3) Counter drums shall be numbered so that a clockwise rotation of the drums, and/or reset control, produces an increase in the numerical value of the counter.

(4) Counters shall be oriented to be read from left to right or as appropriate for personnel's normal cultural reading practices.

(5) Digital displays shall be mounted as close as possible to the mounting surface.

(6) Digital displays should be dark numbers on a light background.

(7) Design criteria for digital displays are shown in Table 6 and in Fig. 28 a width-height ratio of 3:5 should be provided for letters and numbers (except for "i," "j," and "l" [one]) which should be reduced to 1:5.

6.4.4 *CRT Displays:*

6.4.4.1 *Signal Size*—When a target of complex shape is to be distinguished from a non-target shape that is also complex,

TABLE 6 Character Sizes for Digital Displays[A]

Viewing Distance	Height	Width	Stroke Width	Minimum Separation between Numerals
Normal illumination above 3.4 cd/m^2 (1 ft-L)				
710 mm (28 in.)	3.8 mm (0.15 in.)	3.8 mm (0.15 in.)	0.94 mm (0.04 in.)	0.64 mm (0.02 in.)
910 mm (36 in.)	4.8 mm (0.19 in.)	4.8 mm (0.19 in.)	1.2 mm (0.05 in.)	0.81 mm (0.03 in.)
1525 mm (60 in.)	7.9 mm (0.31 in.)	7.9 mm (0.31 in.)	1.3 mm (0.05 in.)	1.3 mm (0.05 in.)
Low illumination below 3.4 cd/m^2 (1 ft-L)				
710 mm (28 in.)	5.6 mm (0.22 in.)	5.6 mm (0.22 in.)	0.94 mm (0.04 in.)	0.94 mm (0.04 in.)
910 mm (36 in.)	7.1 mm (0.28 in.)	7.1 mm (0.28 in.)	1.2 mm (0.05 in.)	1.2 mm (0.05 in.)
1525 mm (60 in.)	13.0 mm (0.51 in.)	13.0 mm (0.51 in.)	2.1 mm (0.08 in.)	2.1 mm (0.08 in.)

[A] For reading closer than 710 mm (28.0 in.), characters should be at least 3 mm (0.118 in.) high.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

the target signal shall subtend not less than 6 mrad (20 min) of visual angle and shall subtend not less than ten lines or resolution elements.

6.4.4.2 *Viewing Distance*—A 406-mm (16-in.) viewing distance shall be provided. When periods of scope observation will be short, or when dim signals must be detected, the viewing distance may be reduced to 254 mm (10 in.). Design shall permit the observer to view the scope from as close as desired. Displays that must be placed at viewing distances greater than 406 mm (16 in.) as a result of other considerations shall be appropriately modified in aspects such as display size, symbol size, brightness ranges, line-pair spacing, and resolution.

6.4.4.3 *Ambient Illuminance:*

(1) The ambient illuminance in the CRT area shall be appropriate for other visual functions (setting controls, reading instruments, maintenance) but shall not degrade the visibility of signals on the CRT display. When a CRT display is used in variable ambient illuminance, controls shall be provided to dim all light sources, including illuminated panels, indicators, and switches in the immediate area. Automatic adjustment of CRT brightness may be used if the CRT brightness is automatically adjusted as a function of ambient illuminance and the range of automatic adjustment is adequate for the full range of ambient illuminance.

(2) If the ambient illumination in the vicinity of the CRT is 540 lux (50 ft-C) or greater, dark characters and symbols on a light background should be used rather than light characters a dark background.

6.4.4.4 *Contrast Control*—A control shall be provided to vary the luminous symbol/dark background dark symbol/luminous background contrast ratio. Contrast between light characters and a dark screen background shall be not less than 6:1 (10:1 preferred); contrast between dark characters on a light screen background shall be not less than 1:6 (1:10 preferred).

6.4.4.5 *Adjacent Surfaces*—Surfaces adjacent to the scope shall have a dull matte finish.

6.4.4.6 *Pictorial/Graphic Situational Data*—Pictorial or situational data such as plan position indicator data shall be presented as luminous symbols against a dark background.

6.4.4.7 *Installation*—The face of a CRT display shall be flush with the surface of the panel in which it is installed.

6.4.4.8 *Luminance Range of Adjacent Surfaces*—The luminance range of surfaces immediately adjacent to scopes shall be between 10 and 100 % of screen background luminance. With the exception of emergency indicators, no light source in the immediate surrounding area shall be of greater luminance than the CRT signal.

6.4.4.9 *Lamp Replacement*—When replaceable incandescent lamps are used as the illuminant source for integral lighting of panel assemblies on the CRT, lamps shall be accessible without disconnecting the panel(s). A sufficient number of lamps shall be provided so that failure of one lamp will not cause any part of the display to be unreadable.

6.4.4.10 *Panel Marking Brightness Control*—Brightness of illuminated markings and trans-illuminated controls on the CRT shall be compatible with the ambient environment and operating conditions (for example, dark adaptation requirements). Brightness control (dimming) by the operator shall be provided where applicable to control/maintain appropriate visibility and operator dark adaptation level.

6.4.5 *Large-Screen Displays:*

6.4.5.1 *Use*—Large-screen displays shall only be used when the conditions allow satisfactory observational geometry to ensure that all critical operators have direct visual access in terms of viewing distance, angle, and lack of interference from intervening objects, personnel, or ambient lighting.

6.4.5.2 *Mounting Height*—Large-screen displays, such as status boards in Combat Information Center (CIC) rooms, which are mounted vertically, shall be no lower than 457 mm (18 in.) (preferred), 305 mm (12 in.) absolute, above the deck, or no higher than 1981 mm (78 in.) above the deck.

6.4.5.3 *Viewing Distance*—The display shall not be closer to any observer than one half the display width or height, whichever is greater.

6.4.5.4 *Design Criteria*—Large-screen displays shall be designed as follows:

(1) The height of letters and numerals should be not less than 5.8 mrad (20 min) of visual angle, and shall be not less than 2.9 mrad (10 min) of visual angle from the longest anticipated viewing distance.

(2) Character width should be approximately 0.9 of the height.

(3) Dark characters should be displayed on a light background unless the background appears to flicker.

(4) If the display includes color-coded objects, the background shall be a neutral color such as gray.

(5) If characters are formed from dot matrices, the matrix shall be not less than 10 by 14 dots.

6.4.6 *Light-Emitting Diodes (LED):*

6.4.6.1 *Use*—LEDs may be used for transilluminated displays, including legend and simple indicator lights, and for matrix (alphanumeric) displays, but only if the display is bright enough to be readable in the environment of intended use.

6.4.6.2 *Design Requirements*—The design standard for LEDs will be the same as the requirements for the transilluminated displays (6.4.1).

6.4.6.3 *Light Intensity Control*—The dimming of LEDs shall be compatible with the dimming of incandescent lamps.

6.4.6.4 *Color Coding*—LED color coding requirements shall conform to 6.4.1.5*(7)* with the exception that red alphanumeric displays and red bar segments for vertical, horizontal, and circular meters may be used with approval from the procuring activity. However, red LEDs shall not be located in the proximity of emergency red lights.

6.4.7 *Dot Matrix/Segmented Display:*

6.4.7.1 *Use*—Dot matrix, 14-segment, and 16-segment displays may be used for applications involving interactive computer systems, instruments, navigation, and communication equipment, where the presentation of alphanumeric, vector-graphic, symbolic, or real-time information is required. Seven-segment displays shall only be used for applications requiring numeric information.

6.4.7.2 *Design Criteria*—The design criteria below shall be applied to those displays (LED, CRT, gas discharge, liquid

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

crystal, and incandescent) used for presentation of alphanumeric and symbolic information.

(1) Alphanumeric and symbolic characters shall not subtend less than 4.7 mrad (16 min) of visual angle.

(2) Alphanumeric characters shall be uppercase.

(3) Monochromatic displays shall use the following colors in order of preference: green (555 nm), yellow (575 nm), orange (585 nm), and red (660 nm). Blue emitters shall not be used.

(4) Dimming controls shall be provided where applicable to maintain appropriate legibility and operator dark adaptation level.

(5) Red LED/segmented displays shall not be grouped with or located adjacent to red warning lights.

6.4.7.3 *Symbol Definition*—The smallest definition for a dot matrix shall be 5 by 7 dots, with 7 by 9 preferred. If system requirements call for symbol rotation, a minimum of 8 by 11 is required, with 15 by 21 preferred.

6.4.8 *Electroluminescent Displays:*

6.4.8.1 *Use*—Electroluminescent displays may be used wherever system requirements dictate the use of transilluminated displays provided they comply with 6.4.1. In addition, they may replace existing mechanical instrumentation and they may also be used where sudden lamp failure could result in catastrophic consequences.

6.4.8.2 *Design Requirements*—The height of alphanumeric characters and geometric and pictorial symbols shall not subtend less than 4.5 mrad (15 min) of visual angle. Alphanumerical characters shall be composed of uppercase letters. All other design requirements shall comply with those for transilluminated displays in 6.4.1.

6.4.9 *Liquid Crystal Displays (LCDs):*

6.4.9.1 *Use*—LCDs are best used with low ambient illumination backlighting and adjustable viewing angles by the user are available.

6.4.9.2 *Image Contrast*—The image should be light characters on a dark background for reflective LCDs and dark characters on a light background for transmissive (that is, backlit) LCDs.

6.4.10 *Mimic Displays:*

6.4.10.1 *Use*—Mimic displays shall be used to integrate qualitative and quantitative information about relationships between objects in symbolic or pictographic form in order to enhance the operator's ability to conceptualize relationships. Mimic displays shall present information about: *(1)* the relative position and separation of objects, *(2)* functional or actual configuration of equipments and systems, and *(3)* current operational status of equipment or systems.

6.4.10.2 *Spatial Relationship*—Mimic displays shall be displayed to the user so that all equipments and systems are directly spatially related to the operator in the real world as they are shown on the display, for example, equipments and systems on the user's left in the real world shall be shown on the left side of the panel, things to the user's right in the real world shall be shown on the right side of the display.

6.4.10.3 *Design Criteria*—Design criteria for controls, displays, labeling, and control/display integration used in a mimic display shall comply with those criteria defined in this section and Sections 5, 7, 8, 10, and 15.

6.5 *Audible Displays:*

6.5.1 *General*—Three basic forms of information displays using sound include:

6.5.1.1 Voice communications (aided and unaided).

6.5.1.2 Alarm and warning signals (denoting off-normal or emergency situations).

6.5.1.3 General auditory display of information (to present simple status information such as to indicate completion of a time interval or to orient operator attention).

6.5.1.4 Guidance for the design of the audible portion of alarm systems is presented in Section 7. Guidelines for design of general auditory displays are presented below.

6.5.2 *Use*—Audible displays shall be provided when:

6.5.2.1 The information to be processed is short, simple, and transitory, requiring immediate or time-based response.

6.5.2.2 Information will not need to be referred to at a later time.

6.5.2.3 It is important to orient an operator to a location (for example, to direct visual attention to a radar display).

6.5.2.4 Vision is poor (for example, smoke-filled spaces, in holds and tanks).

6.5.2.5 The visual display mode is restricted by overburdening; ambient light variability or limitation; operator mobility; degradation of vision by vibration, or other environmental considerations; or anticipated operator inattention.

6.5.2.6 The criticality of transmission response makes supplementary or redundant transmission of critical data desirable.

6.5.2.7 It is desirable to warn, alert, or cue the operator to subsequent additional response.

6.5.2.8 Custom or usage has created anticipation of an audio display on the part of the operator.

6.5.2.9 It is necessary to present information independent of visual orientation.

6.5.3 *False Alarms or Interference*—The design of audible display devices and circuits shall preclude false alarms or interference from other electronic sources.

6.5.4 *Failure*—The audio display device and circuit shall be designed to preclude warning signal failure in the event of system or equipment failure and vice versa.

6.5.5 *Circuit Test*—All audible displays shall be equipped with circuit test devices or other means of operability test.

6.5.6 *Use with Several Visual Displays*—One audible signal may be used in conjunction with up to three visual displays provided that immediate discrimination between visual displays is not critical to personnel safety or system performance.

6.5.7 *Preference for Auditory Displays*—Audible presentation is preferred over visual presentation for:

6.5.7.1 Signals of acoustic origin,

6.5.7.2 Warning signals to call attention to imminent or potential danger,

6.5.7.3 Situations when many displays are visually presented,

6.5.7.4 Presenting information independently of head orientation,

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

6.5.7.5 Situations when darkness limits vision or makes seeing impossible, and

6.5.7.6 When signals must be distinguished from noise, especially periodic signals in noise.

6.5.8 *Signal Characteristics*—The intensity, duration, and source location of the signal shall be compatible with the acoustical environment of the intended receiver as well as the requirements of other personnel in the signal area. Signals shall be intermittent, allowing the user sufficient time to respond. Signals shall be automatically terminated by the operator response action or by manual control.

6.5.9 *Signal Type*—The optimum type of audio signal shall be presented in accordance with Table 7. Audio signals shall not interfere with other sound sources, including verbal communication.

6.5.10 *Signal Meaning*—Each audio signal shall be clearly distinct from the others and have only one specific meaning or required operator response.

6.5.11 *Number of Coded Signals*—The number of coded signals should be limited to five. Where more than five coded signals are needed, use a two-phase signal.

6.5.12 *Location of Signal Source*—Signal sound source should propagate from the immediate vicinity of where operator or maintainer action (for example, examine a display or operate a control) is performed.

6.5.13 *Speech Supplements*—When speech supplements are used, the length of the initial alerting and the actual message shall not interfere with other auditory inputs including interpersonal voice communication unless the message is critical.

6.5.14 *Silent Operations at Night*—In equipment designed for silent operation at night, the sound level at the ear under an earphone shall not be greater than 60 dB(A).

6.5.15 *Manual Overrides*—Noncritical audio signals should be capable of being turned off at the discretion of the user. Where this capability is provided, a visual indication that the signal has been turned off shall be provided to the user.

6.5.16 *Supportive Function*—Audio signals used in conjunction with visual displays shall be supplementary to the visual signals and shall be used to alert and direct the user's attention to the appropriate visual display.

7. Alarms

7.1 *General Alarm Requirements :*

7.1.1 *Purpose*—Alarms shall be designed to:

7.1.1.1 Notify the crew that an out-of-tolerance condition exists.

7.1.1.2 Inform the user of the priority and nature of the problem.

7.1.1.3 Direct the crew to a specific course of action as a result of the condition.

7.1.1.4 Confirm that the user's response corrected the problem.

7.1.2 *Overall Design Strategy*—An overall design strategy and philosophy should be prepared before any alarm design effort is initiated that sets a formal set of principles and policies for all alarms to be placed on a ship or other maritime facility. Each alarm proposed for use should then require a formal justification and a formal defined operator response. The basic principles should be set for each ship or maritime facility but should contain at least the following:

7.1.2.1 Eliminate all duplicate alarms.

7.1.2.2 No alarming of normal or expected events or expected deviations.

7.1.2.3 No alarming of operator actions.

7.1.2.4 Provide no more than one pre-alarm for each trip cause (that is, do not use a cascading alarm design).

7.1.2.5 Prioritize all alarms with no more than three priority levels, and allow only 5 to 10 % of all alarms to be in the "high-priority" category, 15 to 20 % to be in the "medium-priority" category, and 70 to 80 % be in the "low-priority" category.

7.1.2.6 Do not be overly aggressive in setting alarm trip points (that is, do not set trip points so near the actual performance limits so that the slightest deviation from the "normal operational value" will set off an alarm.

TABLE 7 Functional Evaluation of Types of Audio Signals

Function	Type of Signal		
	Tones (Periodic)	Complex Sounds (Non-periodic)	Speech
Quantitative indication	POOR Maximum of five to six tones absolutely recognizable.	POOR Interpolation between signals inaccurate.	GOOD Minimum time and error in obtaining exact value in terms compatible with response.
Qualitative indication	POOR-TO-FAIR Difficult to judge approximate value and direction of deviation from null setting unless presented in close temporal sequence.	POOR Difficult to judge approximate deviation from desired value.	GOOD Information concerning displacement, direction, and rate presented in form compatible with required response.
Status indication	GOOD Start and stop timing. Continuous information where rate of change of input is low.	GOOD Especially suitable for irregularly occurring signals (for example, alarm signals).	POOR Inefficient; more easily masked; problem of repeatability.
Tracking	FAIR Null position easily monitored: problem of signal-response compatibility.	POOR Required qualitative indications difficult to provide.	GOOD Meaning intrinsic in signal.
General	FAIR Good for automatic communication of limited information. Meaning must be learned. Easily generated.	POOR Some sounds available with common meaning (for example, fire bell). Easily generated.	GOOD Most effective for rapid (but not automatic) communication of complex, multidimensional information. Meaning intrinsic in signal and context when standardized. Minimum of new learning required.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

7.1.2.7 Maintain a tight control on changing alarm set points once the system and equipments have become operational.

7.1.2.8 Define what will be an "alert" message (that is, a message that provides the operator with a notice of a change in operations but which requires no immediate action by the operator) and what will be an "alarm" message (that is, an out-of-tolerance that does requires some operator response).

7.1.2.9 Maintain an aggressive program to eliminate "false" alarms.

7.1.2.10 Rely on design to protect the crewmembers from injury, or the ship or structure from damage, not from alarms.

7.1.2.11 Design alarm controls and displays in compliance with this section and Sections 5 and 6.

7.1.2.12 Danger and caution signals shall be immediately and easily discernible from each other and shall be consistently applied for all alarms.

7.1.2.13 All processed alarm information, whether visual or auditory, shall be presented in the most simple and understandable format possible.

7.1.3 *Types of Alarms*—The three types of alarms to be used on ships or maritime structures are:

7.1.3.1 Visual alarms alone (for example, flashing lights, rotating beacons, lighted annunciators on panels) shall be used on consoles or panels to attract attention and inform personnel of out-of-tolerance conditions. In addition, visual alarms shall be used as a supplement in high noise areas to alert crewmembers that an audible alarm has been activated.

7.1.3.2 Audible alarms alone may be used when the sound is unique and understood by the crewmembers to mean a specific out-of-tolerance condition, or when the purpose of the alarm is to serve as a general alert that requires a person to then check a visual display to find the exact nature of the alarmed condition (for example, a local alarm at a panel, console or workstation).

7.1.3.3 Audible alarms (for example, tones, verbal messages, combination of tones and verbal messages) accompanied by visual alarms (for example, rotating beacons, strobe lights, flashing lights, lit annunciators) shall be used in high noise areas, in any other circumstance where the operator may not be able to see, or be aware of, just a visual alarm alone.

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

7.1.5 *Alarm Acknowledge Requirement*—Alarms shall require personnel acknowledgment after alarm onset. An acknowledged control shall be provided, either as a separate control or integrated into each visual alarm display. The control shall terminate a flashing visual alarm and allow the alarm to remain illuminated until the alarm condition is cleared. The control shall also mute the audible signal (if one is provided) or a separate auditory silence control can be provided. The acknowledge control shall be located near the controls and displays associated with the alarm, or in a standardized location on all consoles, panels, and workstations.

7.1.6 *Alarm Rates*—The alarm system should create a presentation rate of alarms as follows:

7.1.6.1 Preferred rate of 6 per hour and a preferred peak rate of 60 per hour.[3]

7.1.6.2 Maximum allowable rate of 60 per hour and a maximum allowable peak rate of 600 per hour.[3]

7.1.6.3 Maximum allowable rate of ten alarms in 10 min following a major plant upset.

7.1.7 *Set Points*—The limits or set points for initiating the alarm signals shall:

7.1.7.1 Not occur so frequently as to be considered a nuisance by personnel, and

7.1.7.2 Provide personnel adequate time to respond to the alarmed condition before it gets beyond the capability of the crew to correct the problem.

7.1.8 *False Alarms*—A means shall 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.

7.1.9 *Simultaneous Alarms*—When two or more incidents or malfunctions occur simultaneously, the one with the higher priority shall be presented first. After presentation of the highest priority message, remaining alarms shall be presented in descending order of priority. Further, if a second alarm occurs in the same equipment or system before an earlier malfunction has been corrected, both the visual and audible alarms shall operate again.

7.1.10 *Alarm Priorities:*

7.1.10.1 Alarms shall be automatically organized and presented to the user in prioritized form. Prioritization shall be accomplished using a maximum of three levels.

7.1.10.2 A message priority system shall be established so that a more critical message shall override the presentation of any message with a lower priority.

7.1.10.3 Priority can be conveyed with either visual or auditory coding methods.

7.1.10.4 Prioritization shall be based on a combination of:

(1) Relative severity of the consequences of not responding to the condition or situation,

(2) Time required for the operator/maintainer to act, and

(3) The tasks required of the operator to respond to the alarm.

7.1.11 *Alarm Integration*—In the event of a complete system failure, a single summary alarm (for example, "Diesel Generator Set B Failure") shall indicate the failure rather than requiring personnel to integrate the information presented by numerous component level alarms (for example, "Low Bus Voltage," "Stator Trouble," or "Lube Oil Pressure Low").

7.1.12 *Master Silence Control*—If a master silence control is provided it shall only silence active audible signals. It shall not block audible signals at the onset of subsequent alarms. The master silence control shall not affect the visual portion of the alarm.

7.1.13 *Subsequent Alarms*—Each subsequent alarm onset shall activate visual and audible signals such as a flashing visual indicator and audible alerting signal. This shall occur regardless of the condition of any other active alarms (for example, acknowledged, not acknowledged, cleared, active, or

[3] These rates shall exist for no more than 10 min.

Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

reset). If a single alarm has multiple inputs, any new alarm condition shall reactivate that alarm.

7.1.14 *Repetitive Alarms/Controls*—Repetitively appearing groups of alarms shall have the same arrangement and relative location on different panels and consoles. Placement of all alarm controls (for example, silence, acknowledge, reset, clear) that appear in more than one location shall be consistent between panels and consoles.

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

7.1.16 *Temporary Disconnection of Alarms*—Alarm circuits may be temporarily disabled or left ON (for example, for maintenance) if such action is coordinated with appropriate personnel (for example, 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 control center. Permanent alarms (for example, fixed lights or tiles, as opposed to computer-driven displays) shall be provided with a means to indicate their status (for example, by tag out or sticker indicating that the alarm is disabled).

7.1.17 *Navigation Bridge Alarms:*

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

7.1.17.2 Alarms on the bridge that are displayed in mimic arrangements on a panel (for example, fire doors, smoke alarm locations) shall be designed so that the mimic lines are visible both in day and night lighting conditions.

7.1.17.3 Alarm panels located on the bridge shall be arranged and located so the individual alarmed items are located within the panel to be spatially related to the actual ship layout as viewed by the operator on the bridge.

7.1.18 *Loss of Redundant Backup*—When part of a redundant system, piece of equipment, module or component becomes inoperable, an alarm signaling the loss of that redundancy shall be provided immediately even if the system, equipment, module or component is functioning normally. The alarm shall be continuously displayed until the redundant system, equipment, module or component has been restored.

7.1.19 *Alarms for Computer Displays*—Alarms contained within computer displays shall provide printed summary messages for each alarm which are both displayed on the screens and contained electronically for data log purposes. These messages are in addition to the standard visual and/or auditory alarms (see Section 13).

7.1.20 *Alarm Filtering*—Alarm filtering shall only be used for alarms that have no current operational significance.

7.1.21 *Suppression*—Alarm suppression may be used where cascading alarms can occur as long as it does not interfere with the completion of users' tasks, and users can retrieve the suppressed alarm information with no more than two discrete steps.

7.2 *Visual Alarms:*

7.2.1 *Types of Visual Alarms*—Visual alarms shall be in the form of:

7.2.1.1 Flashing or rotating lights used in conjunction with audible alarms in spaces with loud noise.

7.2.1.2 Simple indicators that shall be used on panels, consoles or other workstations to call the operator's attention to an out-of-tolerance condition displayed at that site. Indicators

TABLE 8 Guidelines for Color Coding of Visual Alarms

Color	Meaning	Explanation	Typical Applications
Flashing Red	Danger Serious damage to vessel or structure, serious injury or loss of life to crewman, major pollution	Requires immediate operator attention -danger situation	Over pressure, high temperature, impending loss of propulsion, high water level, low levels of critical liquids, over filling of tanks
Red	Danger Emergency condition acknowledged but has not yet been corrected	Warning of dangerous situation that requires immediate action.	Stop of essential machinery, (for example, lubricating oil pump for the propulsion engine or motor, failure of pressure in the lubricating system for the propulsion machine, and so forth) Temperature and pressure values (water, oil, etc) at critical levels Activation of a safety system
Yellow[A]	Caution Condition beyond operational limits exists but does not require immediate operator action	Notice of an out-of-tolerance condition that must be corrected but does not demand immediate attention by the operator.	Temperature and pressure values which differ from the normal levels, but not by critical amount Battery discharging but not yet at a critically low level
Blue	Instruction/test/Information lost, (specific meaning assigned according to the case considered)	Blue may be given specific meaning that is not covered by red, yellow, or white but blue should be avoided whenever possible for alarm use.	Built-in-test (BIT) signal lost Non-essential equipment not working Electrical heating circuit for idle electrical machines not working
White	Neutral	Any meaning; may be used whenever doubt exists about the application of the colors red, yellow, and blue often used for confirmation.	Earth insulation indicators Synchronizing lamps Telephone calls Appliances automatically controlled

[A] Amber is not the same as yellow and can in fact be used as another color if needed. However, it is important to ensure that the two are easily distinguishable.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

shall be a minimum of 25 mm (1.0 in.) in diameter but should be used only if other design considerations preclude the use of annunciators.

7.2.1.3 Annunciators that shall be used in preference to simple indicators, and when used as alarms, should only provide qualitative information and not give commands.

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

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

7.2.4 *Priority Coding*—A method for coding the visual alarms for the various priority levels shall be employed. Acceptable methods for priority coding include color, position, shape, size, flash rate, or symbols.

7.2.5 *Flasher Failure*—If a panel or console visual alarm flasher fails, then at the onset of an alarm condition the alarm light shall illuminate and burn steadily, rather than not illuminate.

7.2.6 *Contrast Detection*—There shall be sufficient contrast between flashing and fully illuminated alarms, and between illuminated and non-illuminated alarms, so that personnel can reliably discriminate each state.

7.2.7 *Text Visibility and Legibility*—The text on visual annunciator alarms shall be readable whether or not the alarm is illuminated.

7.2.8 *Text Wording*—If text is displayed on visual alarms, wording shall be in accordance with the labeling requirements contained in Section 15. Text shall be all capital letters. Abbreviations and acronyms shall comply with Section 15 and have consistent usage throughout the vessel or other maritime installation. Personnel shall 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.

7.2.9 *Color Coding*—Visual alarms shall be color coded in compliance with Table 8. This color-coding scheme shall be consistent throughout the vessel or other maritime facility.

7.2.10 *Visual/Auditory Alarms:*

7.2.10.1 Visual alarms (for example, rotating beacons, strobe lights, flashing lights) shall be used in conjunction with general auditory alarms in spaces with ambient noise limits in excess of 85 db(A), where a high degree of ambient illumination could prevent the detection of just a visual alarm, or under other circumstances where the audible alarms alone might not be discernible.

7.2.10.2 When visual alarms are used in conjunction with audible alarms, the visual alarms shall comply with the following:

(1) Be clearly visible in all parts of the space in which they are used,

(2) Be color coded in compliance with Table 8,

(3) Flash as long as the audible alarm is activated and continue to steady illumination until the alarm condition is cleared, and

(4) Use a single flash rate pattern for all alarm lights throughout the ship or maritime structure.

7.2.11 *Visual Alarm Panels*—Visual alarm panels displaying alarms for fire, gas, or other emergencies that can spread throughout the ship or maritime structure, or that display remote alarm station activation, shall be designed as follows:

7.2.11.1 The individual alarm indicators shall be placed within the overall alarm panel so they are spatially related to the actual location of the alarm sensors within the ship or structure as the panel is viewed by the operator.

7.2.11.2 The panel should be marked by zones corresponding to the fire or gas tight boundaries within the ship or structure.

7.2.11.3 Each visual alarm shall be provided a text label identifying the location of the emergency.

7.2.11.4 Alarm indicators should be coded (for example, color) to assist the operator in identifying the type or hazard level of the emergency (for example, red for fire or fire suppressant release, amber for smoke).

7.2.11.5 The use of a mimic outline of the ship or structure on the panel should be included.

7.2.11.6 If the visual alarm panels are a part of a computer control system the operator shall be capable of retrieving the alarm screens with no more than two key presses.

7.2.11.7 The panels should be designed and arranged so it is obvious which equipments are affected by each alarm, or at least which portions of the ship or structure are affected.

7.2.11.8 An audible alarm shall accompany the display of a visual alarm. It shall be silenced with the acknowledgment of the visual alarm by the operator. The audible alarm shall comply with the requirements of this section.

7.2.12 *Supplemental Alarm Information*—Supplemental visual alarm information shall be provided to the operator whenever an alarm sounds. This information will allow the operator to determine all containment control capabilities (for example, fire stations, damage control stations, deluge sprinklers, fire suppression systems including portable fire extinguishers, vent fans and other damage control equipment). This information may be presented in printed form or via computer display or other visual format.

7.2.13 *Alarm/Display Integration*—Where visual alarm indicators are mounted with controls and/or displays on consoles, panels, or workstations they shall be arranged per the requirements contained in Section 8.

7.3 *Audible Alarms:*

7.3.1 *Audible Alarm for Emergency Response*—Audible alarms, rather than visual alarms, shall be the primary mode used to alert personnel to major ship/structure wide general emergencies (for example, muster, report to fire party, presence of toxic gases such as H_2S, report to lifeboat station). Audible alarm signals shall not be used to indicate normal operations.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

7.3.2 *Content*—Audible alarms shall be stand-alone tones, or tones used with verbal messages. Audible alarms with verbal messages shall consist of an initial alerting signal to attract attention and a brief, standardized verbal message to first identify the specific hazardous condition and then describe the required action on the part of the listener to that condition.

7.3.3 *Sound Character*—The selection of loudness, frequency, and use of sound waveforms shall be in accordance with the guidelines shown in Table 9.

7.3.3.1 Using the same type of signal, but in two different forms, (for example, a continuous bell versus an intermittent bell), to identify two different emergencies (for example, H_2S present versus ship on fire), or to solicit two different responses from an alarm listener (for example, don PPE equipment versus abandon ship) shall not be used.

7.3.3.2 Completely separate and very distinct tones shall be used for all of the ship/structure wide general audible alarms. As an example, one alarm could be a siren, another could be a high-low warbling tone, and a third could be a "yelping" sound (these are all terms defining a specific wave form and frequency offered by a commercial alarm manufacturer). In selecting auditory signals for use as alarms it is preferable to pick tones which carry a preestablished cultural association with the tones in other emergency conditions. As an example, a siren is the long established sound for fire and police vehicles in the United States and as a result a siren could be selected for the fire alarm on a ship or other maritime structure manned by American crew. Likewise, creating new meanings for well established cultural sounds shall not be done.

7.3.4 *Number of Distinct Tones for Alarms:*

7.3.4.1 Electronically generated sounds can be produced in up to 40 different tones or more but the number of distinct audible alarms (in terms of the auditory characteristics of each that the human can hear and quickly respond to should not exceed 7 for ship/structure wide alarms, and it is strongly recommended that the number not exceed 4 to prevent confusion as to the meaning of different alarms.

7.3.4.2 The upper limit of seven (7) different tones may be used for local alarms but none of these should be the same sound as used for the ship/structure wide general alarms.

TABLE 9 General Recommendations for Sound Loudness and Frequency

Conditions	Recommendations
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.

7.3.5 *Number of Distinct Tones for Relative Identification*—The maximum number of audio signals that can be used for relative identification shall not exceed twelve.

7.3.6 *Single Audio Signal*—A single auditory signal used in conjunction with multiple displays shall be used only if immediate identification of the appropriate visual display is not critical to personnel safety or system performance.

7.3.7 *Differing Signals:*

7.3.7.1 Differentiating audible signals that require different user responses shall be accomplished by varying frequency, modulation, pitch, beats or harmonics.

7.3.7.2 Audio signals used as alarms shall be clearly and easily distinguishable from routine signals and noises generated during normal operations.

7.3.8 *Selection of Sounds*—Sounds such as a whistle, siren, bell, klaxon, horn, warble tones, wails, high-low oscillating and a large assortment of other electronically generated alarm sounds can be used to provide distinct audible alarms. General guidance for the selection of sounds is given in Table 10.

7.3.9 *Audible Alarm at Console/Panel :*

7.3.9.1 When an audible alarm is used at a console, panel or other operator workstation to supplement the visual alarms the supplement audible alarm should be a siren (when used in conjunction with the flashing red light) for dangerous situations, and a horn (used in conjunction with the yellow or amber light) for a caution situation.

7.3.9.2 The audible alarm shall be silenced when the visual alarm is acknowledged.

7.3.10 *Headsets*—Operators who normally wear headsets covering both ears shall have the audible alarms presented in their headsets as well as in the work area.

7.3.11 *Sound Loudness*—Sound loudness criteria for alarms are as follows:

7.3.11.1 Audible alarm sound loudness shall be at least 75 db(A) at a distance of 1000 mm (40 in.) from the source and at sleeping positions in cabins.

7.3.11.2 A signal-to-noise ratio of at least 20 dB(A) shall be provided in at least one octave band between 500 and 3000 Hz preferred, 200 and 5000 Hertz allowed, measured within 305 mm (12 in.) of the responder's ear.

7.3.11.3 When signals must travel over 300 m (985 ft), frequencies below 1000 Hz should be used.

7.3.11.4 Frequencies below 500 Hz should be used if signals must bend around obstacles or through partitions.

7.3.11.5 Frequencies between 1500 to 3000 Hz should not be used for alarms that require localization.

7.3.11.6 Audible alarm signal sound levels in a space shall not exceed 120 dB(A).

7.3.11.7 For large spaces, more than one audible alarm may be required to ensure the sound level can be heard throughout the space.

7.3.11.8 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 shall supplement the audible signal. Red light beacons should only be used for fire alarms, unless this conflicts with appropriate statutory, regulatory, or class requirements.

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)

TABLE 10 Guidelines for Selecting Audible Alarm Sounds

Device	Loudness	Frequency	Attention Demanding Ability	Noise-Penetration Ability
Foghorn	Very high	Very low	Good	Poor in ambient backgrounds with low-frequency noise; good in ambient backgrounds with high frequency 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 if pitch is rising and falling frequently	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
Warble	High	Low to high	Very good	Good
Wail	High	Medium to high	Very good	Good
High-low	High	Medium to high	Very good	Very good with high and low frequency alternating

7.3.11.9 Alarms shall not generate a startling reaction. In the first 0.2 s of a signal, avoid having abruptly rising waveforms, square topped waveforms, or maximum sound level, and limit the sound level rise to less than 30 dB(A) in the first 0.5 s.

7.3.12 *Control of Loudness*—The loudness of an audible alarm signal shall be designed to be adjustable. The control mechanism shall be restricted and administratively controlled to prevent reducing the volume to an inaudible level or increasing it to an unacceptably high level.

7.3.13 *Detection Level of Alarm*—Each audible signal shall 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 shall be readily detectable anywhere in the control room. General emergency alarms (for example, emergency or evacuation) shall be detectable throughout the vessel or maritime installation (for example, in hull, topsides, and accommodations).

7.3.14 *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 (for example, 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.

7.3.15 *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.

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

7.3.17 *Priority Coding of Alarm Signals*—Coding methods for audible alarm 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. If duration is used, the number of levels should not exceed three. If frequency coding is used, the number of levels should not exceed four.

7.3.18 *Caution Signal Design*—Audible signals to denote a CAUTION notice shall be noticeably different from audible alarms identifying a DANGER situation. Audible caution signals shall be provided with manual reset and volume controls.

7.3.19 *Location of Alarm Signal Generators*—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 to ensure 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.

7.3.20 *Public Address Systems:*

7.3.20.1 Public address system used in conjunction with the alarm system shall not become distorted through reverberation or interference.

7.3.20.2 Public address announcements shall be audible over the alarm. Announcements shall be at least 10 dB(A) above the alarm signal.

7.4 *Voice Messages:*

7.4.1 *Content*—Voice messages should be incorporated into all ship or structure general alarms. The messages shall identify both what the hazard is that caused the alarm, and what specifically is required of the personnel for this alarm (for example, go to lifeboat, report to muster station, don respirators for H_2S protection, report to emergency stations), rather than simply the nature of the emergency. In selecting words to be used in the verbal messages, priority shall be given to intelligibility, appropriateness, and conciseness, in that order. Voice signals shall be brief and a standardized message.

7.4.2 *Type of Voice*—The voice used in recording verbal messages may be male or female (male is preferred) and shall be distinctive, mature, without a dialect and from the country or region of the user. Verbal messages shall be presented in a formal, impersonal manner.

7.4.3 *Voice Intensity*—Guidance for verbal message intensity is as follows:

7.4.3.1 Verbal message intensity for critical functions shall be at least 20 dB(A) above ambient noise levels at the typical operating positions of the intended receivers, but should not exceed 90 dB(A).

7.4.3.2 The message should capture personnel's' attention but should not cause irritation or a startle reaction.

7.4.3.3 Voice message intensity, if adjustable, should be controlled by administrative procedures and not by an openly available local control.

7.4.4 *Alarm Message Structure*—The structure of the alarm tone and message shall be as follows:

7.4.4.1 The voice signal shall be preceded by a non-speech (sound) alerting signal lasting from 1.0 to 1.5

AVA Documents
Document Sharing Hub

Full document details: ASTM F1166-07(2013)