

Chapter 4. Guidelines for Specific Controls

In this chapter are guidelines that are specific to each of the controls selected for the handbook. General guidelines applicable to all the controls in the handbook are in chapter 3.

Foot Pushbuttons

12. WHEN TO USE:

Foot pushbuttons should be used only in those cases where the user is likely to have both hands occupied at the time the pushbutton is actuated, or where load-sharing among limbs is desirable. Because foot pushbuttons are susceptible to accidental actuation, their *use* should be limited to noncritical or infrequent operations, such as press-to-talk communications.⁽¹⁴⁾

13. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of foot pushbuttons should conform to the applicable general guidelines for controls that are in chapter 3.

14. LOCATION:

A foot pushbutton should be located so that:

- a. It can be operated by the toe or ball of the foot rather than by the heel. It should not be located so near an obstruction that the user cannot position the sole of the shoe squarely (centered) on the pushbutton. A pedal may be used atop the button to aid in locating and operating the switch.
- b. The user has some normal heel-resting position on the floor or a floor board. Avoid placing a foot pushbutton beneath or behind a pedal where it might be possible for the user's foot to become momentarily entangled or trapped during the transfer between the pushbutton and a pedal.
- c. Avoid placing a foot pushbutton where it might be stepped on and accidentally actuated, and/or where typical shifting from one foot control to another creates a high probability that the foot or clothing might be entrapped by an intervening control as the user shifts the foot from one control to another.⁽¹⁴⁾

15. USE IN A WET ENVIRONMENT:

When a foot pushbutton is used in an environment in which it may become wet and slippery, it should have a frictional surface to minimize the possibility of the foot slipping off it.⁽¹⁴⁾

16. INDICATION OF ACTUATION:

Resistance should start low, build up rapidly, then drop suddenly to indicate that the control has been actuated. A positive indication of control actuation should be provided: a snap feel (accomplished by the resistance just specified), an audible click, or associated visual or auditory display change.^(14,25)

Comment: Reference 25 notes the possibility of environmental noise masking an audible click. This is certainly relevant for the AHS environment, where there are several possible sources of noise (e.g., radio, blower fan, conversation).

17. SPECIFICATIONS:

Foot pushbuttons should conform to the specifications shown in table 8.⁽¹⁴⁾

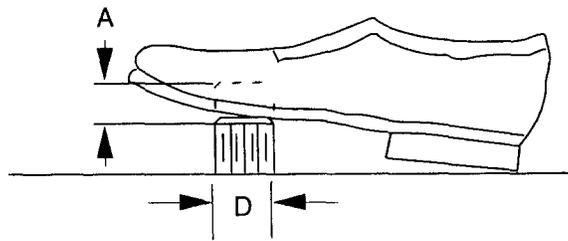


Figure 5. Reference figure for foot pushbutton specifications.

Table 8. Specifications for foot pushbuttons. (See figure 5 for reference letters.)

	Diameter (D)	Resistance		Displacement (A)		Separation ¹
		Foot Will Not Rest on the Pushbutton	Foot Will Rest on the Pushbutton	Operation with Normal Shoes	Operation with Heavy Boots	
Minimum	13mm (.5 in)	18N (4.1 lbf)	45 N (10.1 lbf)	13 mm (.5 in)	25 mm (1 in)	<ul style="list-style-type: none"> • Horizontal: 75 mm (3 in) • Vertical 200 mm (7.9 in)
Maximum		90 N (20.3 lbf)	90N (20.3 lbf)	65 mm (2.6 in)	65 mm (2.6 in)	

¹ One switch per foot is preferred. Separations are for the case where there must be more than one pushbutton for the foot to operate.

Joysticks

Two types of joysticks are included in this handbook. Comparisons between them are shown first, followed by separate sections of guidelines for each. Only finger-operated and thumbtip-/fingertip-operated joysticks are considered (i.e., larger, hand-operated joysticks are excluded).

DEFINITIONS:

- a. **Isometric joystick:** An isometric joystick does not move in response to user commands. The controlled object moves in relation to the amount and direction of force applied to the stick. The isometric joystick is also known as a stiff stick, force stick, or pressure joystick.
- b. **Isotonic joystick:** An isotonic joystick moves in response to user commands. The controlled object moves in relation to the amount and direction of displacement of the stick. The isotonic joystick is also known as a displacement stick.

18. WHEN TO USE:

- a. **Isometric joysticks** should be used for applications that require return to center after each entry, in which user feedback is primarily visual from some system response, and where there is minimal delay and tight coupling between control input and system reaction. They should not be used where it is necessary for the user to maintain a constant force on the stick to generate a constant output over a sustained period of time.
- b. **Isotonic joysticks** should be used for control of various display functions, such as data pickoff from a cathode ray tube. When used for rate control, the joystick should be spring loaded for return to center when the hand is removed.⁽¹⁴⁾

19. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of joysticks should conform to the applicable general guidelines for controls that are in chapter 3.

Joysticks: Isometric

20. INDICATORS FOR HOW TO BRING THE CONTROLLED OBJECT BACK ONTO THE DISPLAY WHEN USED IN RATE-CONTROL APPLICATIONS:

In rate-control applications (where speed of movement of the controlled object, such as a cursor, is proportional to the force applied to the joystick), which may allow the controlled object to travel beyond the

edge of the display, indicators should be provided to advise the user on how to bring the controlled object back onto the display.⁽¹⁴⁾

21. USE OF WRIST OR FOREARM SUPPORT:

An isometric joystick should be mounted to provide wrist or forearm support.⁽¹³⁾

22. RELATIONSHIP BETWEEN APPLIED FORCE AND X/Y OUTPUT:

For an isometric joystick, the x and y output should roughly approximate the magnitude of the applied force as perceived by the user.⁽¹⁴⁾

23. SPECIFICATIONS:

Isometric joysticks should conform to the specifications shown in table 9.⁽¹⁴⁾

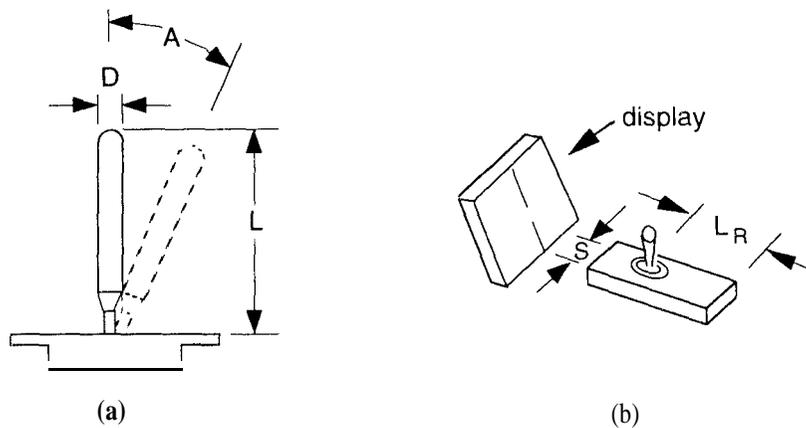


Figure 6. Reference figure for joystick specifications.

Table 9. Specifications for isometric joysticks. (See figure 6 for reference letters.)

	Force for Full Output	Length (L)	Diameter (D)	Hand- or Arm-Rest Length (L _R)	Separation Between Display Centerline and Stick Centerline (S)
Minimum	—	—	—	120 mm (4.7 in)	—
Maximum	45 N (10.1 lbf)	120 mm (4.7 in)	15 mm (.6 in)	—	400 mm (15.7 in)

Joysticks: Isotonic

24. INDICATORS FOR HOW TO BRING THE CONTROLLED OBJECT BACK ONTO THE DISPLAY WHEN USED IN RATE-CONTROL APPLICATIONS:

In rate-control applications (where speed of movement of the controlled object, such as a cursor, is proportional to the displacement of the joystick), which may allow the controlled object to travel beyond the edge of the display, indicators should be provided to advise the user on how to bring the controlled object back onto the display.⁽¹⁴⁾

25. SPRING LOADING FOR RATE-CONTROL APPLICATIONS:

An isotonic joystick used for rate control (where speed of movement of the controlled object, such as a cursor, is proportional to the displacement of the joystick) should be spring loaded for return to center when the hand is removed.⁽¹⁴⁾

26. USE OF WRIST OR FOREARM SUPPORT:

An isotonic joystick should be mounted to provide wrist or forearm support.⁽¹³⁾

27. SPECIFICATIONS:

Isotonic joysticks should conform to the specifications shown in table 10.⁽¹⁴⁾

Table 10. Specifications for isotonic joysticks. (See figure 6 for reference letters.)

	Length (L)	Diameter (D)	Resistance	Displacement (A)	Separation Between Display Centerline and Stick Centerline (S)	Hand- or Arm-Rest Length (L _R)	Clearance Around Stick
Minimum	75 mm (3 in)	6.5 mm (.25 in)	3.3 N (.7 lbf)	–	–	120 mm (4.7 in)	Maximum stick excursion plus 100 mm (3.9 in)
Maximum	150 mm (5.9 in)	16 mm (.6 in)	8.9 N (2 lbf)	45°	400 mm (15.7 in)	250 mm (9.8 in)	–

Key Operated Switches

28. WHEN TO USE:

Key operated switches should be used to prevent unauthorized machine operation. They may also be used to provide ON-OFF functions.^(14,27)

29. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of key operated switches should conform to the applicable general guidelines for controls that are in chapter 3.

30. COLOR, SHAPE, AND SIZE CODING:

Color, shape, and size coding of key operated switches should be considered under the following conditions:

- a. Color may be used to aid in identifying keys by function or use location, where illumination is adequate to differentiate the colors. Red should be reserved for emergency functions.
- b. Shape coding may be used to aid in tactile identification of a given key. When shape coding is used, sharp corners should be avoided.
- c. Size coding may be used as long as no more than two sizes are employed. The dimensions should reflect the approximate differences between minima and maxima shown in table 11.⁽¹⁴⁾

31. LOCATION OF KEY TEETH:

Reversible key designs should be used, i.e., it is preferable to have keys that will operate the lock with either side up. If a key design is used that has teeth on only one side, the lock should be oriented so that the teeth will be on the top to enter a vertical slot and to the left to enter a horizontal slot.⁽¹⁴⁾

32. LOCATION OF OFF:

Locks should be oriented so that the key's vertical position is the OFF position.⁽¹³⁾

33. DIRECTION OF MOVEMENT:

Actuation of an item by a key operated switch should be accomplished by turning the key clockwise from the vertical OFF position.⁽¹³⁾

34. REMOVING THE KEY FROM THE LOCK:

A user should not be able to remove the key from the lock unless the switch is turned OFF.⁽¹³⁾

35. SPECIFICATIONS:

Key operated switches should conform to the specifications shown in table 11.⁽¹⁴⁾

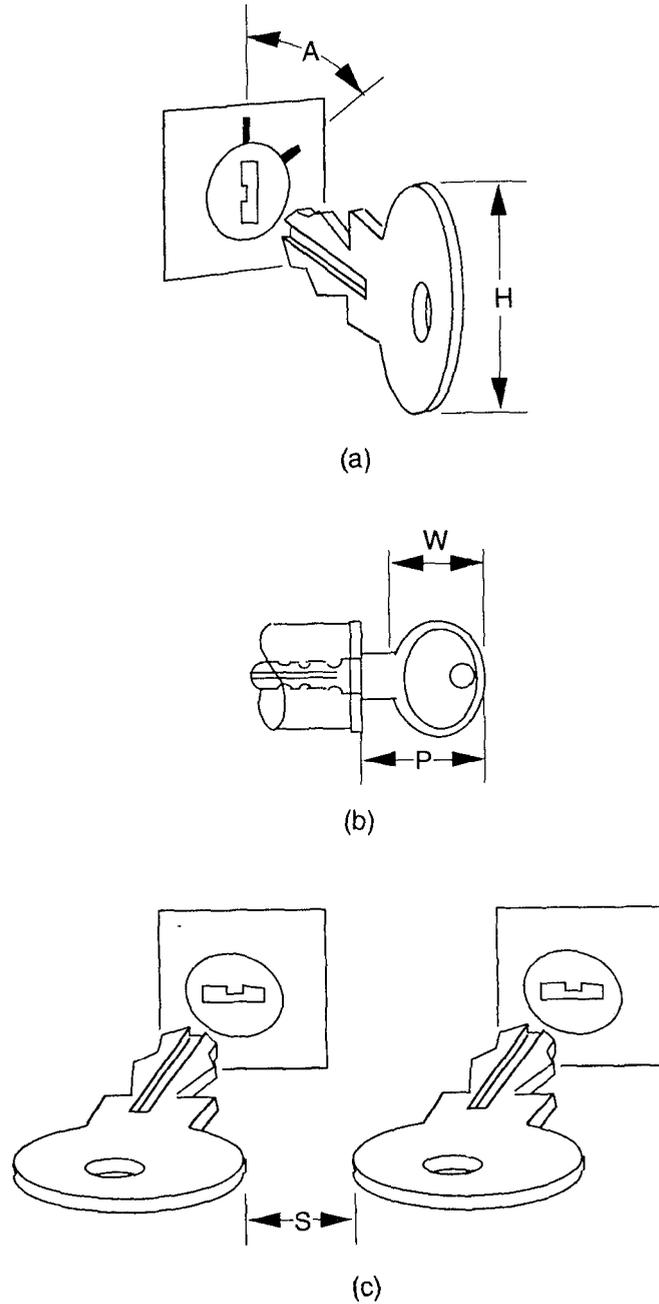


Figure 7. Reference figure for key operated switch specifications.

Table 11. Specifications for key operated switches. (See figure 7 for reference letters.)

	Height (H)	Width (W)	Amount Exposed When Key is Fully Inserted Into Lock (P)	Displacement (A)	Separation (S)	Resistance ¹
Minimum	13 mm (.5 in)	13 mm (.5 in)	20 mm (.8 in)	<ul style="list-style-type: none"> • With more than two positions: 30° (and total displacement 1120°) • For only two positions: 90°. 	25 mm (1 in)	.1 N•m (14 ozf•in)
Maximum	75 mm (3 in)	38 mm (1.5 in)	-	90°	-	7 N•m (99.2 ozf•in)

¹ When the lock is new.

Knobs (Continuous)

36. WHEN TO USE:

Knobs should be used when low forces or precise adjustments of a continuous variable are required.⁽¹⁴⁾

37. USE OF GENERAL CONTROLS GUIDELINES:

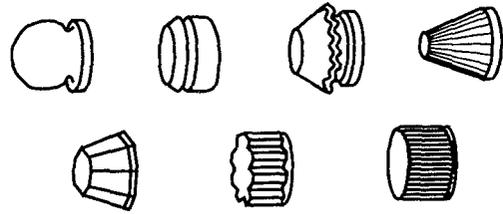
The design and use of knobs should conform to the applicable general guidelines for controls that are in chapter 3.

38. WHEN ADJUSTMENT REQUIRES REFERENCE TO A SCALE:

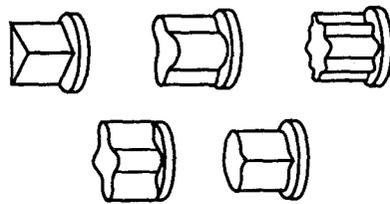
If the adjustment of a knob requires reference to a scale, the scale should be placed on a panel and an index line should be inscribed on the knob.⁽¹⁴⁾

39. WHEN MOVEMENT INVOLVES MORE THAN 360° OF ROTATION:

If the range of knob movement involves more than 360° of rotation, scales should not be used.



(a) Knobs for more than one full turn



(b) Knobs for less than one full turn

Figure 9. Recommended shapes for coding knobs.

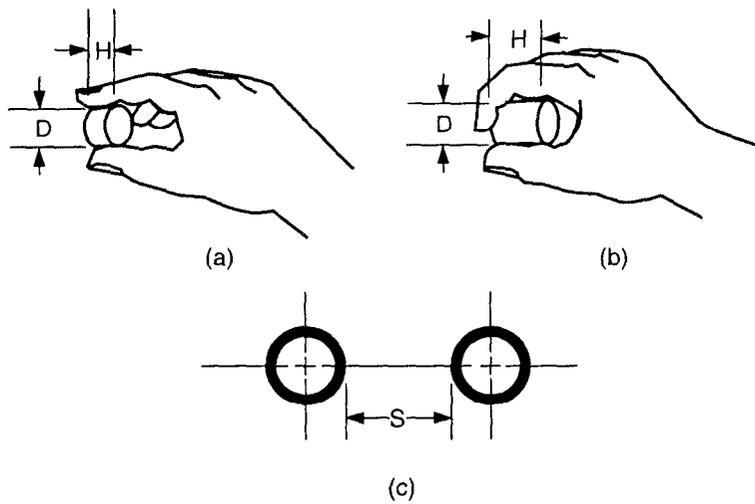


Figure 10. Reference figures for knob specifications.

Table 12. Specifications for knobs. (See figure 10 for reference letters.)

	Fingertip Grasp		Thumb and Finger Encircles		Separation		Torque	
	Height (H)	Diameter (D)	Height (H)	Diameter (D)	One Hand Individually	Two Hands Simultaneously	For Diameters ≤ 25mm (1 in)	For Diameters ≥ 25mm (1 in)
Minimum	13 mm (.5 in)	10mm (.4 in)	13mm (.5 in)	25 mm (1 in)	25 mm (1 in)	75mm (2.9 in)	-	-
Optimum	≥ 19mm (.75 in) ¹	25 to 50mm (1 to 2 in) ¹	-	-	50 mm (2 in)	125mm (4.9 in)	-	28.2 to 70.6 mNm (4 to 10 ozf in) ¹
Maximum	25 mm (1 in)	100 mm (3.9 in)	25 mm (1 in)	75mm (2.9 in)	-	-	32 mN•m (4.5 ozf•in)	42 mN•m (6 ozf•in)

¹ Reference 10 states that these values will accommodate a user who is wearing gloves.

Legend Switches

45. WHEN TO USE:

Legend switches should be used to display qualitative information on an important system status, to reduce the demands for the user to interpret information, and when functional grouping or a matrix of controls and displays is required but space is very limited.⁽¹⁴⁾

46. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of legend switches should conform to the applicable general guidelines for controls that are in chapter 3.

47. USE OF BARRIERS:

Barriers, when used, should not obscure visual access to controls, labels, or displays, and should have rounded edges. (Dimensions for barriers are given in table 13.)⁽¹³⁾

48. INDICATION OF SWITCH ACTUATION:

For positive indication of switch actuation, a legend switch should be provided with a detent or click.⁽¹³⁾

Comment: Reference 25 notes the possibility of environmental noise masking an audible click. This is certainly relevant for the AHS environment, where there are several possible sources of noise (e.g., radio, blower fan, conversation).

49. LEGEND LEGIBILITY:

The legend on a legend switch should be legible with or without internal illumination.⁽¹⁴⁾

50. WHEN A LAMP TEST IS REQUIRED:

If a legend switch does not have duplicate bulbs, dual filament, or equivalent reliability, the legend switch circuit should permit a positive test of the lamp.⁽¹⁴⁾

51. LAMP REPLACEMENT:

Lamps within a legend switch should be replaceable from the front of the panel by hand, and the legends or covers should be keyed to prevent the possibility of interchanging the legend cover.⁽¹³⁾

52. NUMBER OF LINES OF LETTERING:

There should be a maximum of three lines of lettering on the legend plate of a legend switch.⁽¹³⁾

53. LOCATION WITHIN THE VISUAL FIELD:

A legend switch should be located within a cone between the horizontal line of sight and 30° below the horizontal.⁽¹⁴⁾

54. SPECIFICATIONS:

Legend switches should conform to the specifications shown in table 13.⁽¹³⁾

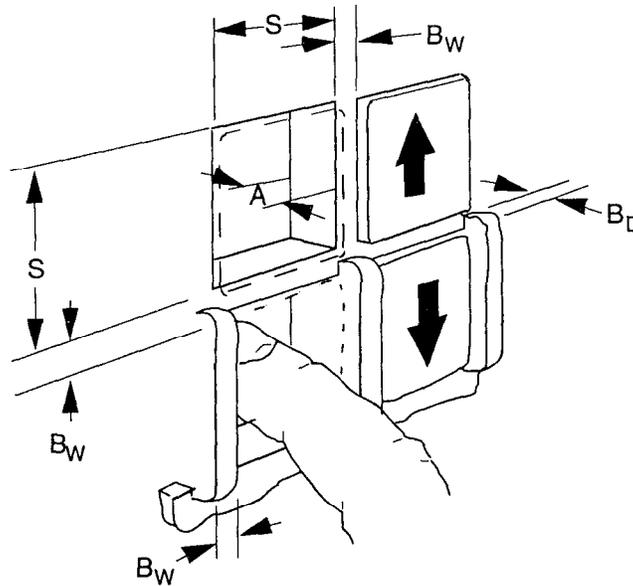


Figure 11. Reference figure for legend switch specifications.

Table 13. Specifications for legend switches. (See figure 11 for reference letters.)

	Size (S)		Displacement (A)	Barrier Dimensions ¹		Resistance
	When the Switch is Not Depressed Be- low the Panel	When the Switch Is Depressed Be- low the Panel		Width (Bw) ²	Depth (B _D)	
Minimum	15 mm (.6 in)	19mm (.75 in)	3mm (.1 in)	3 mm (1 in)	6 mm (.2 in)	2.8 N (.6 lbf)
Maximum	38 mm (1.5 in)	38 mm (1.5 in)	6 mm (.2 in)	6 mm (.2 in)	6 mm (2 in)	16.7 N (3.8 lbf)

¹ Barriers should have rounded edges.

² Separation between switches is the same as barrier width.

Pushbuttons

55. WHEN TO USE:

Pushbuttons should be used primarily for simple switching between two conditions, selection of alternate ON-OFF functions from an array of related conditions or subsystem functions, release of a locking system (such as on a parking brake), or entry of a discrete control order. Pushbuttons should not be used indiscriminately merely to make all panel controls look alike or where another type of switch could be used to save panel space (e.g., toggle switch). Pushbuttons may be used for any of the following kinds of operations singly or in combination:

- a. **Momentary contact.** This should be used for single push-HOLD/release-OFF functions.
- b. **Alternate action.** Alternate action for a single function may be implemented either as a single button or in a two-button format. With the single-button type, a first press sets the switch to the ON state and a second press sets it to OFF. With the two-button type, the buttons are mechanically interlocked so that one button is depressed when the other button is in the up position.
- c. **Reconfigurable.** The button top has a legend on it that indicates the current state of the function being controlled. Liquid crystals, light emitting diodes, or hard labels alternately illuminated may be used to provide the legend.
- d. **Stepping action.**⁽¹⁴⁾ This type is not included in the handbook.

56. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of pushbuttons should conform to the applicable general guidelines for controls that are in chapter 3.

57. INDICATION OF SWITCH ACTUATION/DEACTUATION:

Positive feedback should be provided to indicate that the pushbutton switch has been actuated or deactuated. The following methods should be considered:

- a. Switch displacement should be visible.
- b. Provide tactile and auditory indications, i.e., a gradual resistance buildup to a sudden resistance release as the button snaps into place, accompanied by an audible click.
- c. Provide an accompanying visual indication (e.g., an illuminated switchcap).⁽¹⁴⁾

Comment: Reference 25 notes the possibility of environmental noise masking an audible click. This is certainly relevant for the AHS environment, where there are several possible sources of noise (e.g., radio, blower fan, conversation).

58. USE IN THE DARK:

Illuminating a pushbutton is useful when it needs to be located in the dark.⁽¹⁰⁾

59. WHEN INTERNAL ILLUMINATION IS USED:

When a pushbutton is internally illuminated, a lamp test capability and/or dual lamp reliability should be provided, except for switches using light-emitting diodes in place of incandescent lamps. Incandescent lamps should be replaceable from the front of the panel, by hand, and the legend or cover should be keyed to prevent the possibility of interchanging legend covers.⁽¹⁴⁾

60. HEIGHT ABOVE THE PANEL WHEN DEPRESSED:

A pushbutton should extend at least 2.5 mm (0.1 in) above the panel when it is in the depressed position to allow the user to press the switch far enough to make contact.⁽¹⁴⁾

61. SWITCHCAP SHAPE:

Switchcap surfaces should, in general, be flat, but with rounded edges. However, for proper finger centering, which should be ensured, the surface may be concave. General switchcap shapes may be round, square, or rectangular as long as they provide an adequate contact area (see table 14) and are compatible with identification or legend criteria.⁽¹⁴⁾

62. LABELING:

Although pushbuttons may be identifiable by means of panel labels and/or symbols, labels placed on the switchcap (where size and other use factors are compatible) are preferred. Criteria for labels, symbols,

and legends should be followed. Legends normally should be legible with or without internal illumination. No more than three lines of lettering should normally be used on a legend plate.⁽¹⁴⁾

63. DIAMETER WHEN MOUNTED AT THE END OF A HANDLE:

Pushbuttons located at the end of a handle should have the following minimum diameters (see figure 12):

- a. Finger operated: 10 mm (0.4 in).
- b. Thumb operated: 13 mm (0.5 in).⁽¹⁰⁾

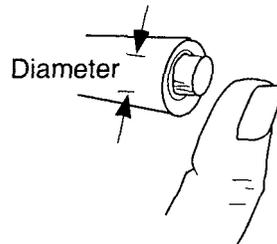


Figure 12. A handle-mounted pushbutton.

64. VISIBILITY WHEN MOUNTED AT THE END OF A HANDLE:

A pushbutton located at the end of a handle should be visible from the user's normal eye reference position.⁽¹⁰⁾

65. NONINTERFERENCE WITH THE HOST CONTROL WHEN MOUNTED ON THE END OF A HANDLE:

When a handle-mounted pushbutton is used, care should be taken to ensure that its location and action do not disturb the control on which it is mounted.⁽¹⁴⁾

66. FEEDBACK WITH A SINGLE-BUTTON ALTERNATE-ACTION PUSH-BUTTON:

With a single-button alternate-action pushbutton, feedback to indicate the ON state should be provided either by a switchcap lamp or legend, or by a closely associated lamp or legend.⁽¹⁴⁾

67. FEEDBACK WITH A TWO-BUTTON ALTERNATE-ACTION PUSHBUTTON:

With a two-button alternate-action pushbutton, although the depressed button provides feedback on switch state, additional feedback by means of a switchcap lamp or closely associated lamp or legend should normally be provided.⁽¹⁴⁾

68. PREVENTION OF ACCIDENTAL ACTUATION:

When it is important to preclude accidental actuation, a pushbutton can be recessed so that it is below the plane of the adjacent panel surface. The “well” for such configurations needs to be at least 2.5 cm (1 in) in diameter for bare-hand operation and at least 5.1 cm (2 in) for gloved-hand operation. Tapering the sides of the well will help the user find the button without having to be so accurate.⁽¹⁰⁾ See figure 13.

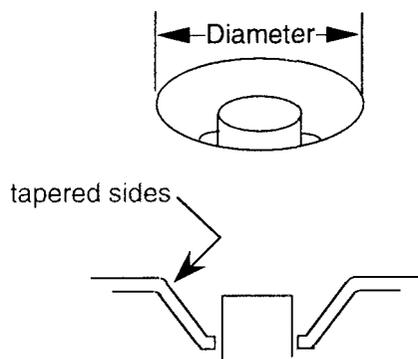


Figure 13. A recessed pushbutton.

69. COLOR OF A PALM PUSHBUTTON WHEN USED AS AN EMERGENCY CONTROL:

When used as an emergency control, a palm pushbutton should be colored red.⁽¹⁴⁾

70. SPECIFICATIONS:

Thumb and finger pushbuttons should conform to the specifications shown in table 14. Palm pushbuttons should conform to the specifications shown in table 15.^(13,14,28)

Rocker Switches

71. WHEN TO USE:

Rocker switches should be used for functions that require two discrete positions, as an alternate to toggle switches. They should be considered where the toggle switch handle might snag the user's clothing, etc., or where there is insufficient panel space for separate labeling of switch positions. Rocker switches with three positions should be used only where the use of a more suitable three-position switch (rotary selector or toggle switch) is not feasible, or where the rocker switch is spring loaded with the center OFF.⁽¹⁴⁾

72. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of rocker switches should conform to the applicable general guidelines for controls that are in chapter 3.

73. ORIENTATION WHEN USED FOR ON-OFF FUNCTIONS:

Rocker switches used for ON-OFF functions should be oriented so that the handle moves in a vertical plane, except where a lateral motion is to be related to a left-right display relationship.⁽¹⁴⁾

74. SWITCH FEEL:

Resistance should gradually increase, then drop when the switch snaps into position. The switch should not be capable of being stopped between positions.⁽¹⁴⁾

75. DIFFERENTIATING SWITCH POSITIONS:

Alternate colors may be used to denote ON and OFF positions, and alternate illumination of either position may also be used to provide positive feedback as to which position the switch is in. Where ambient illumination will provide luminance of less than 3.5 cd/m² (1 fl), the switch should be internally illuminated.^(13,14)

Comment: See guideline 76 also, regarding character dimensions for internally illuminated rocker switches.

76. CHARACTER DIMENSIONS FOR INTERNALLY ILLUMINATED SWITCHES:

Where ambient illumination dictates the use of internal illumination of switch positions (i.e., when it is less than 3.5 cd/m² [1 fl]), digits and letters on the switch should be illuminated characters on an opaque background, with the following approximate dimensions:

- a. Height: 4.8 mm (0.19 in).
- b. Height-to-width ratio: 3:2.
- c. Height-to-stroke-width ratio: 10:1.⁽¹³⁾

77. USE OF A GUARD TO PREVENT ACCIDENTAL ACTUATION:

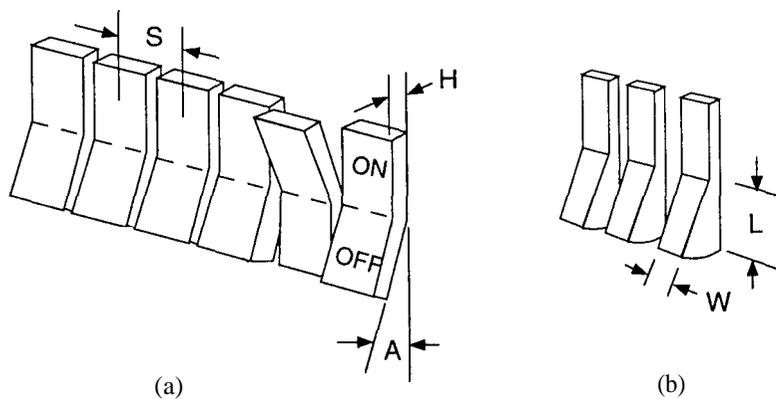
A guard may be used to prevent accidental actuation of a rocker switch. When one is used, the separation between the inside edges of the guards should be:

- a. For use without gloves: switch width plus 17 mm (0.7 in). (Based on reference 26.)
- b. For use with gloves: switch width plus 30 mm (1.2 in). (Based on reference 14.)

See table 16 for switch width recommendations. (Based on references 14,26.)

78. SPECIFICATIONS:

Rocker switches should conform to the specifications shown in table 16.⁽¹⁴⁾



The minimum width is especially desirable for use with gloves

Figure 15. Reference figures for rocker switch specifications.

Table 16. Specifications for rocker switches. (See figure 15 for reference letters.)

	Width (W) ¹		Length (L)	Height (H)	Angle of the Face (A)	Separation (S)		Resistance
	Without Gloves	With Gloves				Without Gloves	With Gloves	
Minimum	6.5 mm (.25 in)	6.5 mm (.25 in)	13 mm (.5 in)	3mm (.12 in)	30°	19 mm (.75 in)	32 mm (1.26 in)	2.8 N (.63 lbf)
Maximum	-	-	-	-	-	-	-	11 N (2.48 lbf-)

¹ The width shown is especially good for gloved use.

Rotary Selectors

79. WHEN TO USE:

Rotary selectors should be used for discrete functions when three or more detented positions are required. They should not be used for a two-position function unless prompt visual identification is of primary importance and speed of control operation is not critical.⁽¹⁴⁾

80. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of rotary selectors should conform to the applicable general guidelines for controls that are in chapter 3.

81. PREFERRED SHAPE:

The preferred shape for a rotary selector is shown in figure 16.^(10,28)

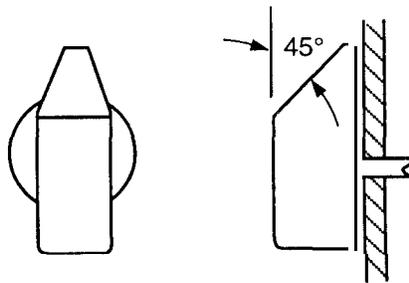


Figure 16. Preferred shape for a rotary selector.

82. NUMBER OF SELECTABLE POSITIONS:

Rotary selectors should have no more than 12 selectable positions if the knob is not visible to the user at all times, and no more than

24 positions for constantly visible switches. Detents should use the angular separations shown in table 17.⁽²⁴⁾

Comment: Although 24 positions are allowed for constantly visible switches, information is shown in table 17 for only 12 positions because it is believed that that number will be more than adequate for any AHS application.

Table 17. Recommended starting positions and angular displacements for rotary selectors.¹

Total Number of Settings	Recommended Starting Position, degrees			Recommended Angular Displacement, degrees
	Left Hand Operation	Right Hand Operation	Either Hand	
3	16.00	264.00	320.00	40.00
4	354.17	254.65	304.00	37.06
5	335.34	246.58	290.96	34.52
6	318.91	239.54	279.22	32.31
7	304.49	233.35	268.92	30.36
8	291.66	227.86	259.76	28.64
9	280.24	222.96	251.60	27.10
10	269.96	218.56	244.26	25.72
11	260.71	214.59	237.65	24.47
12	252.36	211.01	231.68	23.33

¹ Assumes visual positioning of the control.

83. GENERAL CRITERIA:

Rotary selectors should meet the following criteria:

- a. It should be clear to the user which end of the control is the pointer.**
- b. Stops should be provided at the beginning and end of the range of control positions if the switch is not required to be operated beyond the end positions or specified limits.**
- c. Switch resistance should be elastic, building up between positions and then decreasing as each position is approached, so the control snaps into position without stopping between adjacent positions.^(14,29)**

Comment: Reference 14 suggests that shape must be used to indicate to the user which end of the control is the pointer. It would seem that where visual access to the control will be assured, however, a marker on the control could also serve that purpose (see figure 17 for an example).

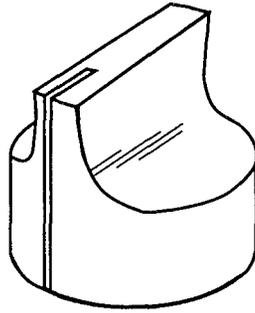


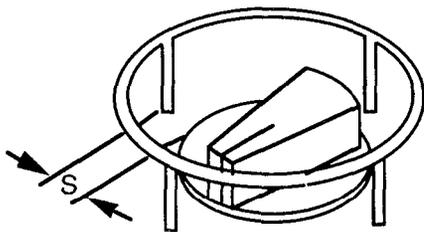
Figure 17. The pointer end is indicated by the marker on the control.

84. USE OF A GUARD TO PREVENT ACCIDENTAL ACTUATION:

A guard may be used to prevent accidental actuation of a rotary selector. When one is used, it should conform to the spacing specifications shown in figure 18.

85. SPECIFICATIONS:

Rotary selectors should conform to the specifications shown in table 18.⁽¹⁴⁾



	Spacing (S)	
	Without Gloves ⁽²⁶⁾	With Gloves (Based on reference 14.)
Minimum	10 mm (4 in)	23 mm (9 in)
Maximum	40 mm (1.6 in)	53 mm (2.1 in)

Figure 18. Spacings for a rotary selector guard.

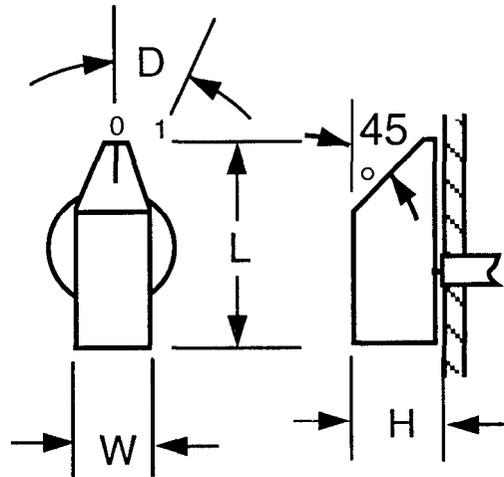


Figure 19. Reference figure for rotary selector specifications.

Table 18. Specifications for rotary selectors. (See figure 19 for reference letters.)

	Length (L)		Width (W)	Height (H)	Displacement (D)		Resistance	Separation (One Hand Random Operation)
	Without Gloves	With Gloves			Visual Positioning	Blind Positioning		
Minimum	38 mm (1.5 in)	51 mm (2 in)	13 mm (.5 in)	16 mm (.6 in)	15°	30°	.11 N·m (15.6 ozf·in)	25 mm (1 in)
Maximum	100 mm (3.9 in)	113 mm (4.4 in)	25 mm (1 in)	75 mm (2.9 in)	40° ¹	40° ¹	.68 N·m (96.3 ozf·in)	–

¹ Displacement can be up to 90° when special requirements demand large separations.

Slide Switches

86. WHEN TO USE:

Slide switches should be used for functions that require two discrete positions. Slide switches may also be used for functions that require a higher number of discrete positions in which the switches are arranged in a matrix to permit easy recognition of relative switch settings, but should not be used where mispositioning is to be avoided.⁽¹⁴⁾

87. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of slide switches should conform to the applicable general guidelines for controls that are in chapter 3.

88. SWITCH FEEL:

Detents should be provided for each control setting. Resistance should gradually increase, then drop when the switch snaps into position. The switch should not be capable of stopping between positions.⁽¹⁴⁾

89. ORIENTATION:

When practicable, slide switches should be vertically oriented with movement of the slide up or away from the user 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 or actuation of slide switches should be employed only for compatibility with the controlled function or equipment location.⁽¹⁴⁾

90. INDICATION OF SETTING WHEN THERE ARE MORE THAN TWO POSITIONS:

Slide switch controls involving more than two positions should be designed to provide a positive indication of control setting, preferably a pointer located on the left side of the slide handle.⁽¹⁴⁾

91. USE OF A GUARD TO PREVENT ACCIDENTAL ACTUATION:

A guard may be used to prevent accidental actuation of a slide switch. When one is used, the separation between the inside edges of the guards should be:

- a. For use without gloves: switch width plus 17 mm (0.7 in). (Based on reference 26.)
- b. For use with gloves: switch width plus 30 mm (1.2 in). (Based on reference 14.)

See table 19 for switch width recommendations. (Based on references 14,26.)

92. SPECIFICATIONS:

Slide switches should conform to the specifications shown in table 19.^(14,30)

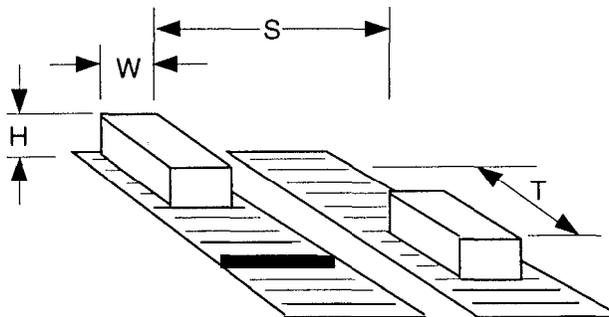


Figure 20. Reference figure for slide switch specifications.

Table 19. Specifications for slide switches. (See figure 20 for reference letters.)

	Travel (T)	Width (W)	Height (H)		Separation (S)			Resistance
			Without Gloves	With Gloves	Single Finger Operation	Single Finger Sequential Operation	Simultaneous Operation by Different Fingers	
Minimum	3 mm (.1 in)	6 mm (.2 in)	6.3 mm (.2 in)	13 mm (.5 in)	19 mm (.75 in)	13 mm (.5 in)	16 mm (.6 in)	3 N (.7 lbf)
Optimum	6 to 13 mm (.2 to .5 in)	–	–	–	50 mm (2 in)	25 mm (1 in)	19 mm (.75 in)	–
Maximum	–	25 mm (1 in)	–	–	–	–	–	11 N (2.5 lbf)

Toggle Switches

93. WHEN TO USE:

Toggle switches should be used for functions that require two discrete positions or where space limitations are severe. They may also be used for three discrete positions, but a rotary selector or pushbutton array is usually preferred for this application.⁽¹⁴⁾

94. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of toggle switches should conform to the applicable general guidelines for controls that are in chapter 3.

95. ORIENTATION:

Toggle switches should be oriented vertically, with OFF in the down

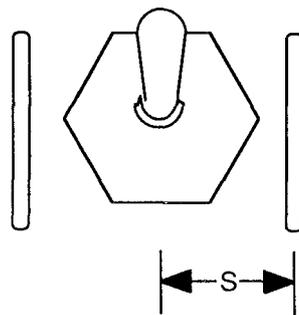
position. Horizontal orientation and actuation should be used only for compatibility with the controlled function or equipment location.⁽¹³⁾

96. SWITCH FEEL:

Resistance should gradually increase, then drop when the switch snaps into position. The switch should not be capable of being stopped between positions.⁽¹³⁾

97. USE OF A GUARD TO PREVENT ACCIDENTAL ACTUATION:

A guard may be used to prevent accidental actuation of a toggle switch. When one is used, it should conform to the spacing specifications shown in figure 21. Where a guard is not appropriate, a lift-to-unlock toggle switch may be used. When a lift-to-unlock switch is used, the resistance to pull the switch into its unlocked position should not exceed 13 N (2.9 lbf).⁽¹³⁾



Spacing (S):
Without gloves: 225 mm (1.0 in)
With gloves: 232 mm (1.3 in)⁽¹⁴⁾

Figure 21. Spacings for a toggle switch guard.

98. SPECIFICATIONS:

Toggle switches should conform to the specifications shown in table 20.^(13,14)

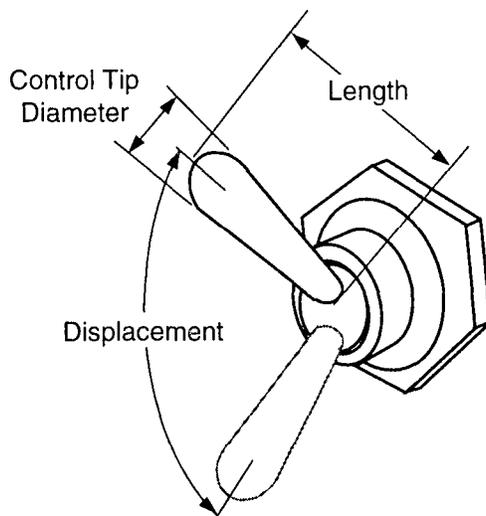


Figure 22. Reference figure for toggle switch specifications.

Table 20. Specifications for toggle switches. (See figure 22.)

	Handle Length		Control Tip Diameter	Displacement		Resistance
	Without Gloves	With Gloves		Two Position	Three Position	
Minimum	13 mm (.5 in)	38 mm (1.5 in)	4.5 mm (2 in)	30°	18°	28 N (13 lbf)
Preferred	-	-	-		25°	
Maximum	50 mm (2 in)	50 mm (2 in)	25 mm (1 in)	80°	40°	11 N (2.5 lbf)

Touch Screens

99. WHEN TO USE:

Touch screens should be used when there is little opportunity for training; when targets are large, discrete, and spread out; when frequency of use is low; and when the task requires little or no text input.⁽³¹⁾

100. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of touch screens should conform to the applicable general guidelines for controls that are in chapter 3.

101. INDICATION OF TOUCH SENSITIVE AREAS:

The touch sensitive areas of a display should be indicated.⁽²⁶⁾

102. SIZE OF TOUCH SENSITIVE AREAS:

Touch sensitive areas should be at least 1.9 cm (0.75 in) square and at least 0.32 cm (0.125 in) apart.⁽³¹⁾

103. LUMINANCE TRANSMISSION:

A touch screen should have sufficient luminance transmission to allow the display with the touch screen installed to be clearly readable in the intended environment and meet the appropriate display luminance requirements (see guideline 123).⁽¹³⁾

104. INDICATION OF ACTUATION:

A positive indication of touch screen actuation (visual and/or auditory) should be provided to acknowledge the system's response to the control action.^(13,31)

105. ACTUATION FORCE:

The force required to operate a force-actuated touch screen should be not less than 0.25 N (0.06 lbf) and not greater than 1.5 N (0.3 lbf).⁽¹³⁾

106. CRITERION TOUCH DURATION:

The system should accept only one touch command at a time and should recognize a touch of approximately 100 ms.⁽³²⁾

Voice Recognition

107. WHEN TO USE:

Voice recognition should be used in situations where the user's hands and/or eyes are busy or mobility is required. It is likely to improve system throughput only in complex tasks that involve high cognitive, visual, and manual loading.^(31,33)

108. USE OF GENERAL CONTROLS GUIDELINES:

The design and use of voice recognition should conform to the applicable general guidelines for controls that are in chapter 3.

109. RESTRICTIONS ON USE:

Given current technology, consider the use of voice recognition only under the following circumstances:

- a. The system can be trained to understand specific users.
- b. The required vocabulary is small (15 to 30 words).
- c. The environment is quiet.
- d. The cost of a recognition error is low.

- e. Identification and correction of errors are easy. When feedback alerts the user to a recognition error, it is very important to ask for repetition (of the control word) quickly, clearly, and without offending the user.
- f. Convenient means are provided to inhibit the system except when voice recognition is intended.
- g. Voice recognition is required infrequently.
- h. Performance will be satisfactory even under stress conditions. (See references 14, 31, 34, 35, and 36.)

110. USE FOR SECURITY PURPOSES:

Voice recognition may be used in systems to positively identify a user or to restrict communication access to specific individuals. If individual speaker recognition is used for security purposes (e.g., to prevent unwanted persons from using the AHS in-vehicle system), it should be used in combination with some other control method to attain sufficient reliability.⁽¹⁴⁾

111. TRAINING CONDITIONS FOR SPEAKER-DEPENDENT SYSTEMS:

Speaker-dependent voice recognition system training should be performed in the context of the operational task—that is, under noise conditions comparable to the expected task environment. (Based on reference 36.)

112. EXPECTED SYSTEM ACCURACY:

The expected voice recognition system accuracy rate of correct procedures being executed on the first prompt is about 95 percent or greater.⁽³⁷⁾

113. USER FEEDBACK:

The user should be assured of receiving appropriate recognition feedback. The major decisions center around the nature and timing of the feedback, and the following considerations should be regarded as minimal:

- a. Feedback may be provided concurrently (after each item in a string has been entered) or terminally (after the whole string has been entered). Generally, concurrent feedback will be useful if it is important to correct errors as the data are being entered. In addition, concurrent feedback can be used to regulate the timing of the input. The feedback shows the user that the utterance was correct and signals the recognition system's readiness to receive the next item.

- b. Timing of the feedback is important in regulating the progress of the task. The more regular and predictable the timing, the better.**⁽³⁶⁾

114. NONDISRUPTION OF TASK SEQUENCES:

No disruption of a task sequence, either by long response delays or by recognition errors, should be permitted.⁽³⁶⁾

Comment: Response delays can negatively affect overall user acceptance when they are very short (<0.8 s) as well as when they are longer (>3 s).⁽³⁶⁾

115. MINIMIZING RECOGNITION ERRORS:

To help minimize recognition errors:

- a. Provide a familiar and distinctive vocabulary. The user will be more consistent when pronouncing familiar words.**
- b. Use longer words and phrases because they will be more discriminable by the recognition system than shorter ones. Thus, letters and digits make poor input; multisyllable words and short phrases make better input.**
- c. Use words that are maximally distinct from one another. Avoid easily confused words like pick and quit (e.g., select and quit will be less likely to be confused).**⁽³¹⁾

116. WHEN NOT TO USE:

Voice recognition is not suited to describing the position or manipulation of objects. Humans have a relatively impoverished vocabulary for pointing at objects in space.⁽³⁵⁾

117. COMBINED WITH OTHER TASKS:

Voice recognition can be combined with other tasks to advantage, but only if they are nonverbal. Less interference will be found if, when two tasks are undertaken simultaneously, one of the tasks is verbal and the other is spatial.⁽³⁵⁾