GUIDELINE

1.1.4 DOCUMENT ORGANIZATION AND STORAGE

A good system is needed for organizing and storing documents so they can be accessed quickly and easily. The types of documents include, for example, plant schematics, procedures, checkoff sheets, emergency plans, technical manuals, and station and general administrative orders.

No one system can be specified for all control rooms. The system must be tailored to the particular work space. Issues that should be addressed include:

a. ACCESSIBILITY

(1) All procedures and other documents that may be needed for ready reference should be kept in the control room.

(2) Reference documents should be stored where they are easy to locate and extract for use. They should not be locked up, stored in places too low or too high for large and small personnel to access easily, in cramped spaces, or where poor illumination exists.

b. LOCATION AIDS

(1) Clearly visible title labels should be provided to identify specific documents.

(2) Labels should distinguish documents as much as possible.

(3) Putting many volumes in one location creates a search problem, especially if titles are similar. One means of reducing search time would be to put operational documentation in one location and other documentation in a secondary location.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.1.4 DOCUMENT ORGANIZATION AND STORAGE (Cont'd)

c. CONVENIENCE OF USE

(1) Documents should not be fixed in racks; it should be possible to remove documents for use.

(2) Documents should be bound so that they can be opened fully and will remain open at the desired place without holding.

d. PROTECTION—Documents should be protected from wear so that they do not become dog-eared, dirty, loose, torn, and difficult to read.

e. DEDICATED SETS OF PROCEDURES—Sets of procedures should be separately stored for each unit in a multiunit control room.

CONTROL ROOM WORKSPACE 1.0
GENERAL LAYOUT 1.1

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.1.5 SPARE PARTS, OPERATING EXPENDABLES, AND TOOLS

Spare parts, such as indicator lamps, and any tools that are needed by operating personnel should be stored in suitable, designated space(s) within the control room.

a. SUPPLY—There should be an adequate supply of expendables and spare parts: fuses, bulbs, ink and inking pens, recorder charts, printer paper, etc.

b. ACCESSIBILITY—Expendables and spare parts should be readily accessible.

c. TOOLS—All necessary or special replacement tools needed to install expendables and spare parts should be available.

d. STORAGE SPACE—There should be adequate storage space for expendables and spare parts.

e. CODING—When different types, sizes, or styles of expendables and spare parts are required, they should be clearly and distinctively marked to avoid misapplication.

f. INVENTORY—Records should be kept as to the status of expendables and spare parts.

CONTROL ROOM WORKSPACE 1.0
GENERAL LAYOUT 1.1

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.1.6 SUPERVISOR ACCESS

a. ACCESS—The shift supervisor's office should be located so as to permit prompt physical access to the control room under all conditions, including control room isolation. The preferred location is within the control room isolation boundary, with placement to permit good visual and voice contact with the primary operational area.

b. COMMUNICATIONS—When the shift supervisor's office is not within the control room boundary, dedicated communications links between the primary operating area and the shift supervisor's office should be provided. (See Guideline 2.1.7.)

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.1.7 NONESSENTIAL PERSONNEL ACCESS

Provision should be made to limit the access and movement of nonessential but authorized personnel to prescribed areas within the control room.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

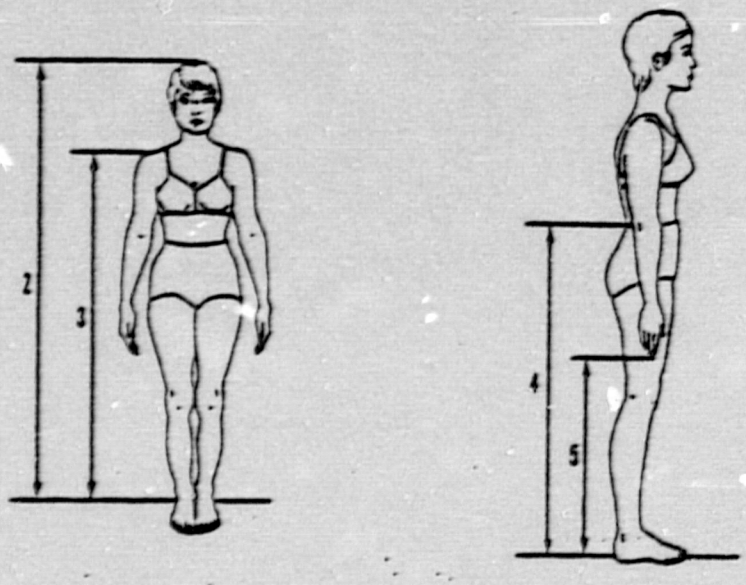
1.2.1 ANTHROPOMETRIC BASIS FOR EQUIPMENT DIMENSIONS

Generally it is recommended that equipment dimensions accommodate the 5th to 95th percentile of the user population. Five percent of the population represented can be expected to measure equal to or smaller than the 5th percentile value, while 5 percent can be expected to measure equal to or larger than the 95th percentile value. Thus the range from the 5th to the 95th percentile takes in 90 percent of the population.

No anthropometric (human measurement) studies have been made to establish pertinent characteristics of commercial nuclear power plant control room operators as a separate population. The equipment dimensions recommended here have been derived from EPRI and military studies. Exhibit 1-5 presents the anthropometric data used to set limits for equipment dimensions in these guidelines. Measurements for adult females define the 5th percentile. Measurements for adult males define the 95th percentile. (This procedure results in more than 90 percent of the total measured population being included in the range from the 5th to the 95th percentile.)

EXHIBIT 1 - 5 ANTHROPOMETRIC DATA USED TO SET LIMITS FOR EQUIPMENT DIMENSIONS

SUMMARY STATISTICS FOR SELECTED BODY DIMENSIONS



DEFINITIONS OF MEASUREMENTS

1. WEIGHT: the nude or essentially nude weight.

2. STATURE: the height from the floor to the top of the head (vertex) when standing fully erect.

3. SHOULDER HEIGHT: the height from the floor to the tip of the shoulder (acromion) when standing fully erect.

4. ELBOW HEIGHT: the height from the floor to the mid-point of the elbow (radiale) when standing fully erect.

5. FINGERTIP HEIGHT: the height from the floor to the tip of the middle finger (dactylion) when standing erect, with arms at the sides of the body.

6. SITTING HEIGHT: the height from the sitting surface to the top of the head (vertex) when sitting fully erect.

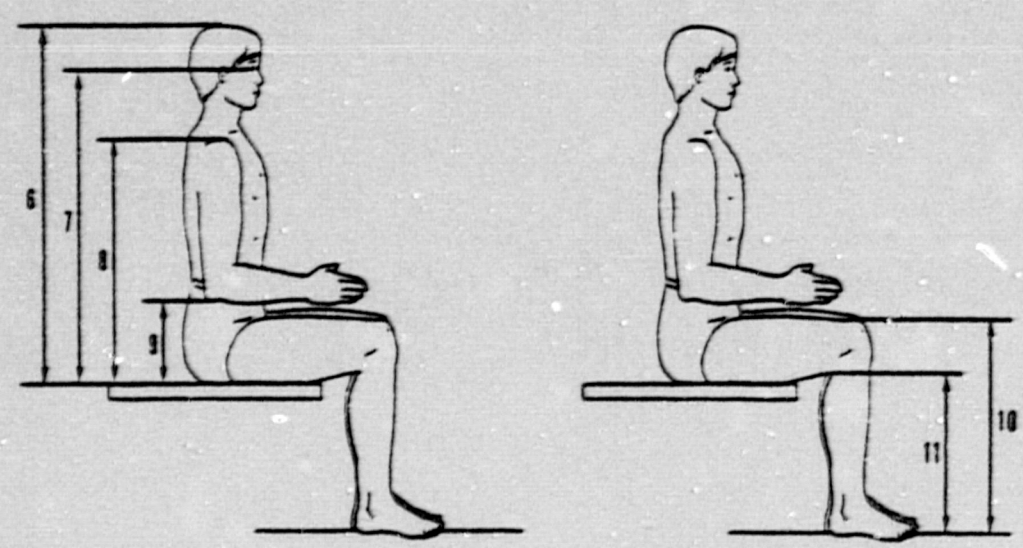
7. EYE HEIGHT (SITTING): the height from the sitting surface to the external corner of the eye (ectocanthus) when sitting fully erect.

8. SHOULDER HEIGHT (SITTING): the height from the sitting surface to the tip of the shoulder (acromion) when sitting fully erect.

9. ELBOW REST HEIGHT: the height from the sitting surface to the bottom of the tip of the flexed elbow (olecranon) when sitting erect.

10. KNEE HEIGHT (SITTING): the height from the floor to the top of the bent knee.

11. POPLITEAL HEIGHT: the height from the floor to the underside of the upper leg when sitting erect, knee bent.



DEFINITIONS OF MEASUREMENTS

12. BUTTOCK-KNEE LENGTH: the horizontal distance from the back of the buttock to the front of the bent knee when sitting erect.

13. BUTTOCK-POPLITEAL LENGTH: the horizontal distance from the back of the buttock to the back of the lower leg when sitting erect, knee bent.

14. SHOULDER-ELBOW LENGTH: the vertical distance from the top of the shoulder (acromion) to the bottom of the tip of the flexed elbow (olecranon).

15. ELBOW-GRIP LENGTH: the horizontal distance from the back of the tip of the flexed elbow (olecranon) to the center of the clenched fist.

16. THUMB-TIP REACH: the horizontal distance from the wall to the tip of the thumb when the arm is extended forward, with shoulders firmly against the wall.

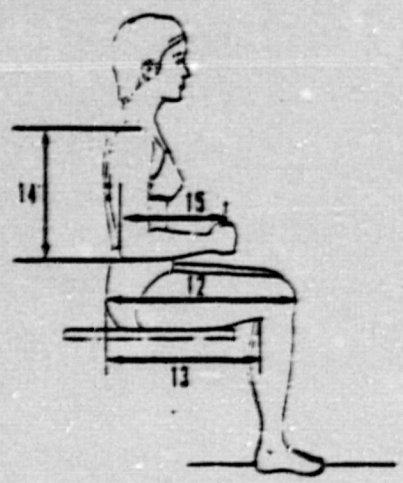
17. THUMB-TIP REACH EXTENDED: the distance from the wall to the tip of the thumb, with the center of the back against the wall but with the shoulder rotated forward and the arm extended.

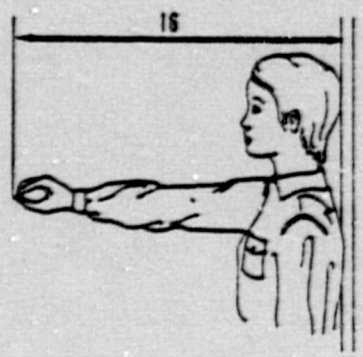
18. SHOULDER BREADTH: the maximum horizontal distance across the upper arms, with arms resting at sides.

19. HIP BREADTH: the maximum breadth of the hips.

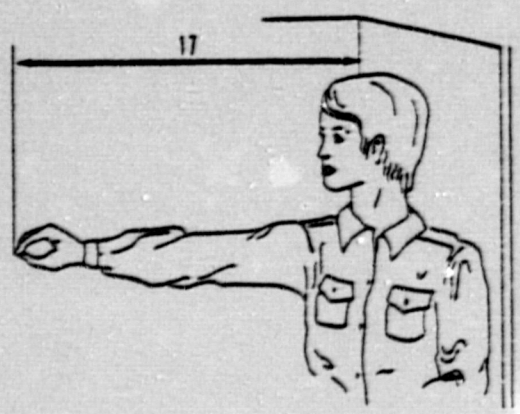
20. HIP BREADTH (SITTING): the maximum breadth across the hips or thighs when sitting erect, knees together.

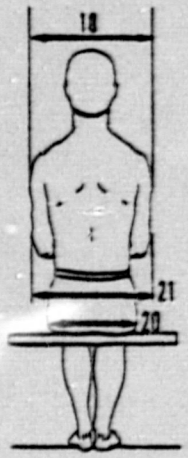
21. FOREARM TO FOREARM BREADTH: the maximum horizontal distance across the forearms, with the elbows bent and lightly touching the body.

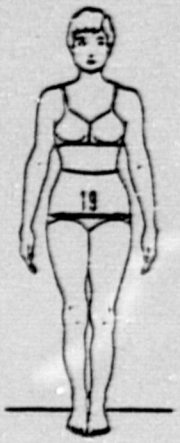




VARIABLE		PERCENTILES	
	Mean	5th	95th
1. Weight (pounds)			
Male	178.9	143.3	221.2
Female	127.3	102.3	156.3
2. Stature (inches)			
Male	70.6	66.4	74.5
Female	63.8	60.0	67.8
3. Shoulder Ht (inches)			
Male	57.9	54.0	61.5
Female	51.9	48.4	55.6
4. Elbow Ht (inches)			
Male	44.8	41.6	47.7
Female (Not measured in 1968 survey)			
5. Fingertip Ht (inches)			
Male	26.9	24.5	29.2
Female (Not measured in 1968 survey)			
6. Sitting Ht (inches)			
Male	37.0	35.0	39.1
Female	33.7	31.7	35.8
7. Sitting Eye Ht (inches)			
Male	32.2	30.2	34.3
Female	29.0	27.1	31.0
8. Sitting Shoulder Ht (inches)			
Male	24.3	22.5	26.2
Female (Not measured in 1968 survey)			
9. Elbow Rest Ht (inches)			
Male	10.1	8.3	11.8
Female	8.9	7.4	10.6
10. Knee Ht Sitting (inches)			
Male	22.2	20.6	23.8
Female (Not measured in 1968 survey)			
11. Popliteal Ht (inches)			
Male	17.4	15.9	18.9
Female	16.2	15.0	17.4







VARIABLE	PERCENTILES		
	Mean	5th	95th
12. Buttock-Knee Length (inches)			
Male	24.1	22.3	25.9
Female	22.6	21.0	24.4
13. Buttock-Calf Lgth (inches)			
Male	20.1	18.4	21.8
Female	18.8	17.1	20.7
14. Shoulder-Elbow Lgth (inches)			
Male	14.3	13.2	15.4
Female (Not measured in 1968 surve			
15. Elbow-Grip Lgth (inches)			
Male	14.0	13.0	15.0
Female (Not measured in 1968 surve			
16. Thumb-tip Reach (inches)			
Male	32.0	29.4	34.6
Female	29.2	26.6	31.7
17. Thumb-tip Reach Extended (inches)			
Male	35.6	32.6	38.7
Female	33.0	29.9	36.3
18. Shoulder Breadth (inches)			
Male	19.1	17.5	21.0
Female	16.5	15.1	18.1
19. Hip Breadth (inches)			
Male	14.0	12.8	15.5
Female	13.8	12.4	15.3
20. Hip Breadth Seated (inches)			
Male	15.1	13.6	16.8
Female	15.0	13.3	17.0
21. Forearm to Forearm Breadth (inches)			
Male	21.6	19.1	24.2
Female (Not measured in 1968 survey)			

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GUIDELINE

1.2.2 STAND-UP CONSOLE DIMENSIONS

a. CONSOLE HEIGHT TO SEE OVER—When it is necessary for a standing operator to see over the top, console height (with or without annunciator panels) should not exceed 58 inches.

b. CONTROL HEIGHT—The range of suitable control height on stand-up consoles is defined by the reach radius of the 5th and 95th percentiles (as defined in Exhibit 1-5). Measurements should be made using shoulder height and functional reach with the shoulder in line with the leading edge of the benchboard, as shown in Exhibit 1-6. The exhibit shows the results of two console designs with differing benchboard slope and depth. Controls may be placed somewhat higher on consoles with shallower and/or more steeply angled benchboards, which allow the shoulder reference point to be closer to the back of the benchboard and to the vertical panel.

(1) The highest control on a stand-up console should be within the highest reach of the 5th percentile female without stretching or using a stool, ladder, etc.

(2) The lowest controls on a stand-up console should be within the lowest reach of the 95th percentile male without bending or stooping.

c. BENCHBOARD SLOPE—The benchboard slope, in conjunction with its depth, should result in all controls being within the reach radius of the 5th percentile female, as illustrated in Exhibit 1-6.

d. CONTROL DISTANCE FROM THE FRONT EDGE OF THE CONSOLE

(1) Controls should be set back a minimum of 3 inches from the front edge to protect against accidental activation.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

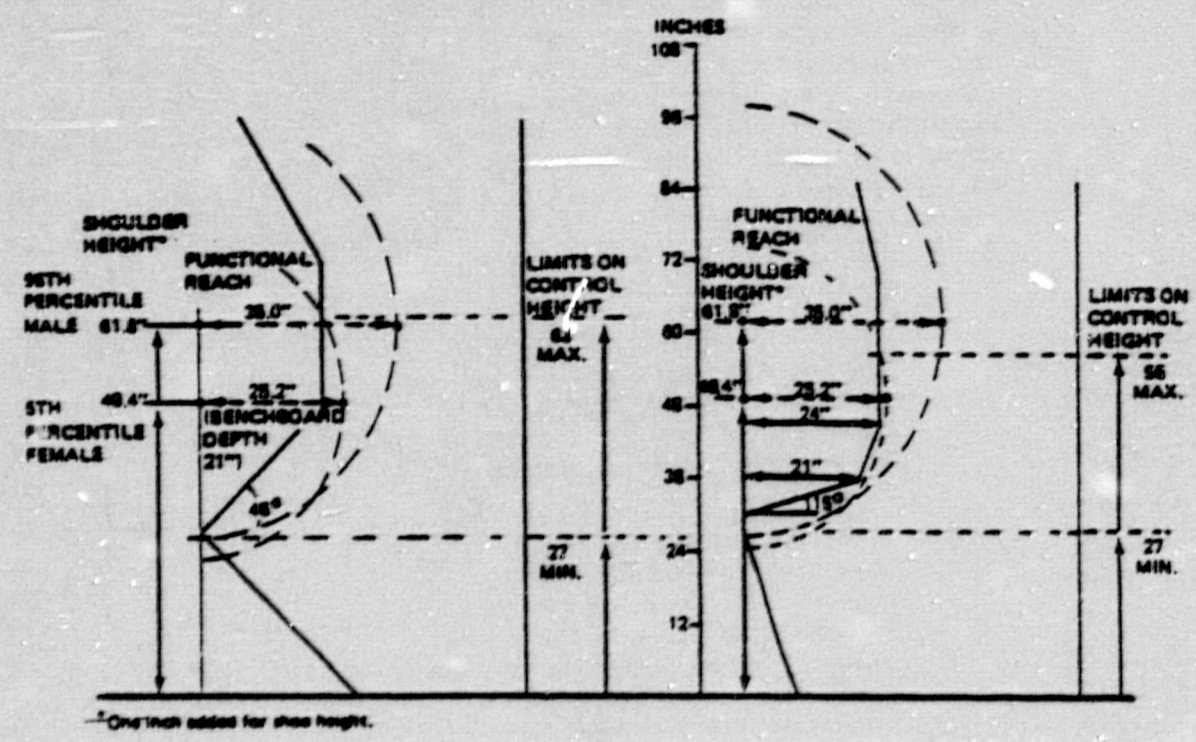
COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.2 STAND-UP CONSOLE DIMENSIONS (Cont'd)

d. CONTROL DISTANCE FROM THE FRONT EDGE OF THE CONSOLE (Cont'd)

(2) No control should be more than 25 inches from the front edge of the console. This accommodates the maximum reach of the 5th percentile female adult as illustrated in Exhibit 1-6.



*One inch added for shoe height.

Exhibit 1-6. Reach capabilities and control height on stand-up consoles.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment
[redacted]			

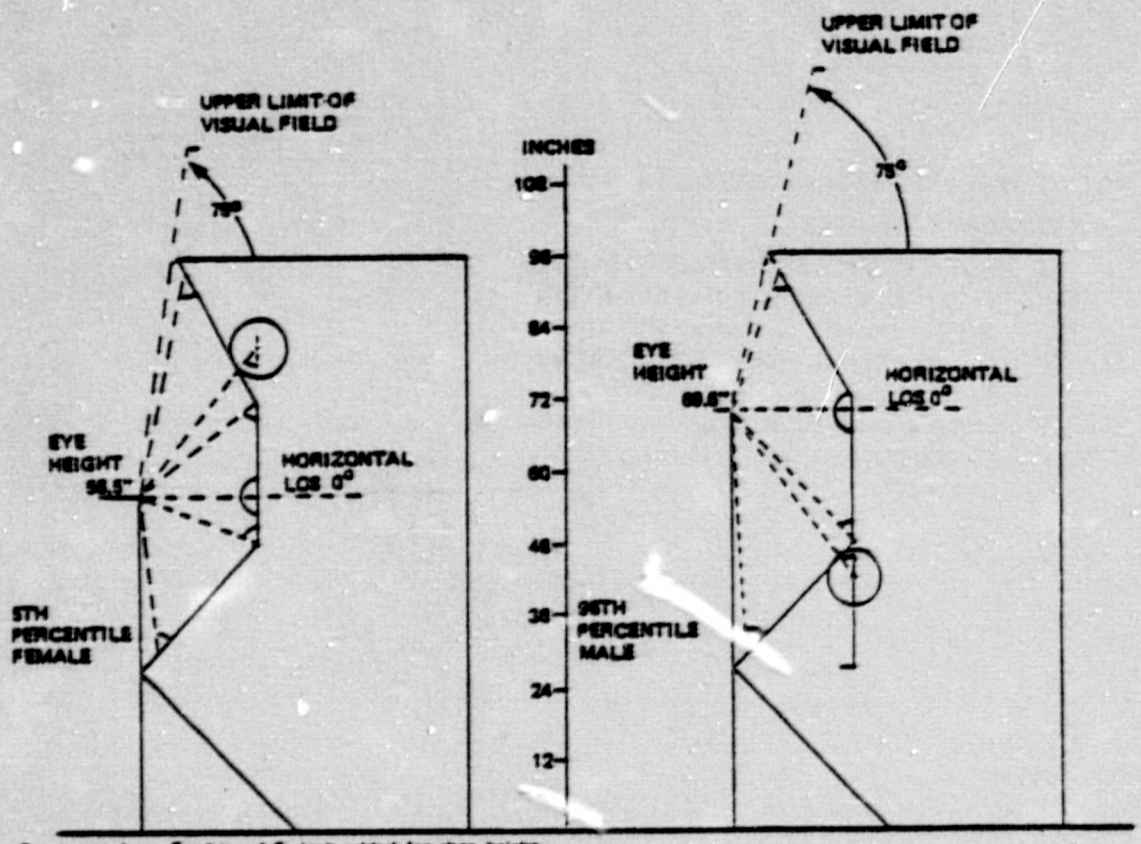
1.2.2 STAND-UP CONSOLE DIMENSIONS (Cont'd)

e. DISPLAY POSITIONING—The principal factors affecting the readability of displays, including annunciator tiles, are: (1) display height and orientation relative to the operator's line of sight when he/she is standing directly in front of the display; (2) display distance and orientation relative to the operator's straight-ahead line of sight when the operator must read the display from an off-side position; and (3) the size of display markings relative to the distance at which the display must be read. Marking/character size is addressed in Guideline Section 5.1, and is not considered here. Except as specifically noted, measurements of angles should be made with the eye point in line with the leading edge of the benchboard. This is illustrated in Exhibit 1-7.

(1) DISPLAY HEIGHT AND ORIENTATION

(a) All displays, including annunciator tiles, should be mounted so that they are within the upper limit of the visual field (75° above the horizontal line of sight) of the 5th percentile female.

(b) In addition, all displays and annunciators should be mounted so that the angle from the line of sight to the face plane is 45° or greater. The 5th percentile female determines the upper limit. The 95th percentile male determines the lower limit.



Eye height from Exhibit 1-6; inch added for shoe height

Angle would be too small for readability if display were mounted on vertical surface

Exhibit 1-7. Display height and orientation relative to standing operator LOS (line of sight).

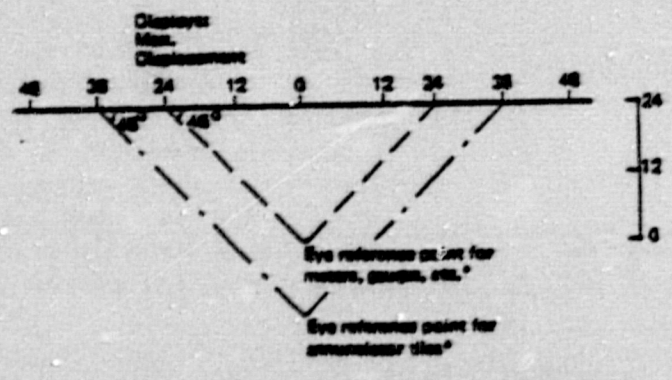
COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.2.2 STAND-UP CONSOLE DIMENSIONS (Cont'd)

e. DISPLAY POSITIONING (Cont'd)

(2) HORIZONTAL DISPLACEMENT – The oblique angle from the line of sight to a display located to either side of the working position from which the display must be read should be at least 45°. This includes annunciator tiles, which should be readable from the acknowledge button. (See Exhibit 1-8.)



*For meters and other displays which may have to be read while a control anywhere on the benchboard is operated, measurement should be made with the eye reference point in line with the leading edge of the benchboard. For annunciator tiles, the eye reference point may be back from the benchboard edge. The distance back should be consistent with the ability of the 5th percentile female to reach the annunciator response pushbuttons. 12 inches is a suitable nominal distance back for most consoles.

Note: A wraparound panel would allow greater displacement.

Exhibit 1-8. Limit on horizontal displacement of displays from straight-ahead line of sight at the required reading position.

COMPLIANCE CHECKLIST

1.2.2 STAND-UP CONSOLE DIMENSIONS (Cont'd)

f. LATERAL SPREAD OF CONTROLS AND DISPLAYS—The operator should be able to perform task sequences at a given work station with minimum repositioning. The amount of operator movement required depends on the arrangement of controls and displays, not simply on the lateral dimensions of the segments of the control board. The maximum lateral spread of controls and displays at a single-operator work station should not exceed 72 inches.

g. FOOT ROOM—Enough foot room is needed to allow the operator to get close to the board without leaning. A clearance of 4 inches vertically and 4 inches horizontally is recommended.

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.3 SIT-DOWN CONSOLE DIMENSIONS

a. CONSOLE HEIGHT TO SEE OVER

(1) If the seated operator must see over the console, the console height should be no more than approximately 27 inches above the seat to accommodate the 5th percentile adult female. Assuming seat height adjusted to 18 inches, maximum console height should therefore be 45 inches above the floor.

(2) See-over console heights above 45 inches may be acceptable, for example, where the seated operator need only monitor (not read) status lights and annunciators beyond the console, if they are at a suitable distance and height.

b. CONTROL HEIGHT—All controls on a sit-down console should be within the reach radius of the 5th percentile female. Measurements should be made using seated shoulder height with the shoulder in line with the leading edge of the benchboard. This is illustrated in Exhibit 1-9.

c. BENCHBOARD SLOPE – The benchboard slope, in conjunction with its depth, should be such that all controls are within the functional reach radius of the 5th percentile female (as illustrated in Exhibit 1-9) and all displays and markings can be read.

COMPLIANCE CHECKLIST

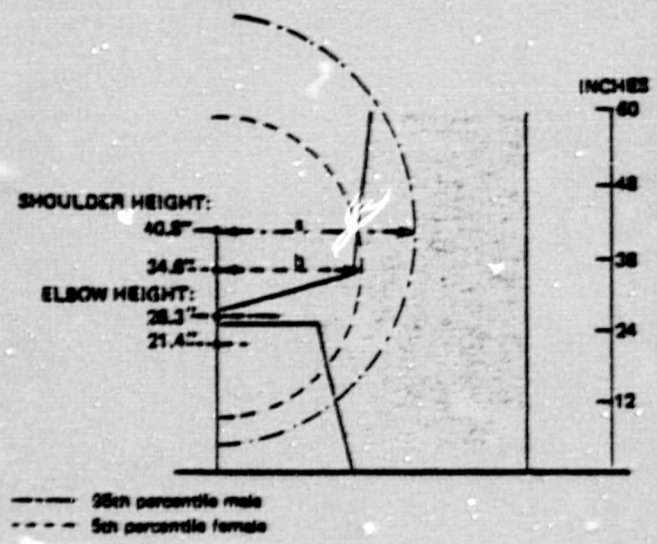
N/A	Yes	No	References/Comment

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)

d. CONTROL DISTANCE FROM THE FRONT EDGE OF THE CONSOLE

(1) Controls should be set back a minimum of 3 inches from the front edge to protect against accidental activation.

(2) Other controls may be mounted as far back as 25 inches from the console edge. This distance accommodates the extended functional reach of the 5th percentile as defined.



a. Functional reach, 95th percentile male 35.0
b. Functional reach, 5th percentile female 25.2

Exhibit 1-9. Reach capabilities and control height on sit-down consoles.

e. DISPLAY POSITIONING—The principal factors affecting the readability of displays, including annunciator tiles, are: (1) display height and orientation relative to the operator's line of sight when he/she is standing directly in front of the display; (2) display distance and orientation relative to the operator's straight-ahead

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)

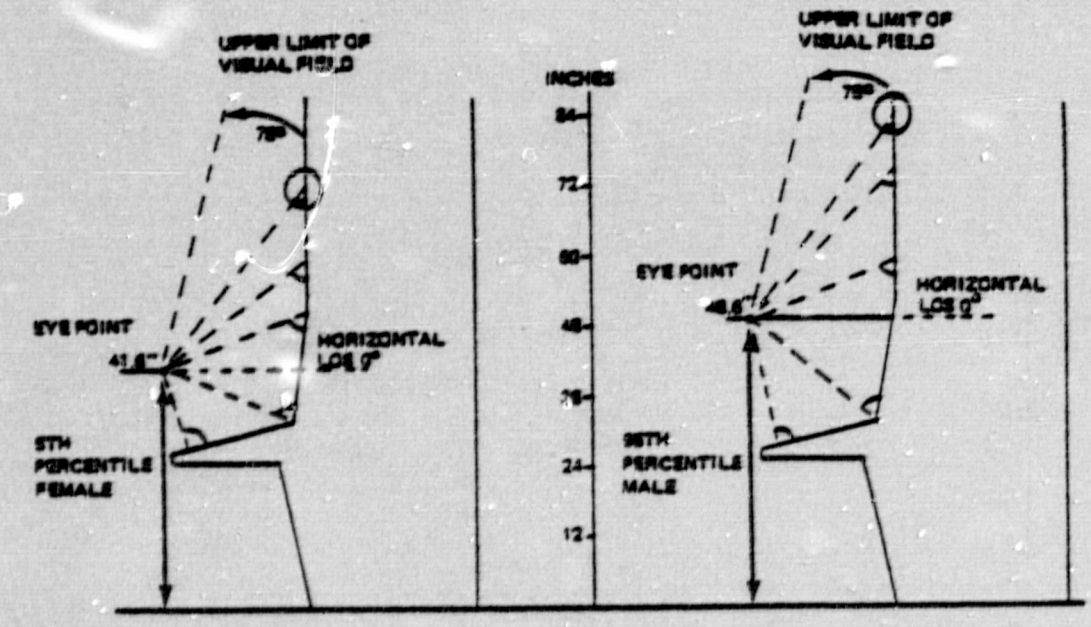
e. DISPLAY POSITIONING (Cont'd)

line of sight when the operator must read the display from an off-side position; and (3) the size of display markings relative to the distance at which the display must be read. Marking/character size is addressed in Guideline Section 6.5.1, and is not considered here. Except as specifically noted, measurements of angles should be made with the eye point in line with the leading edge of the benchboard. This is illustrated in Exhibit 6.1-7.

(1) All displays, including annunciator tiles, should be mounted so that they are within the upper limit of the visual field—75° above the horizontal line of sight—of the 5th percentile female (see Exhibit 1-10).

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment



Angle from line of sight to display face would be too small for readability unless the panel tilted forward at this height.

Exhibit 1-10. Display height and orientation relative to seated operator LOS (line of sight).

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)

e. DISPLAY POSITIONING (Cont'd)

(2) In addition, all displays should be mounted so that the angle from the line of sight to the display face plane is 45° or greater (see Exhibit 1-10). The 5th percentile female determines the upper limit. (Practically, there is no lower limit for a plausible sit-down console design.)

f. LATERAL SPREAD OF CONTROLS AND DISPLAYS—The acceptable lateral spread of controls and displays on sit-down consoles depends primarily on the reach of the users, panel orientation, the grouping of controls and displays, and the freedom of the operator to adjust seat position (center reference point) given task sequence requirements. Exhibit 1-11 illustrates reach and viewing range related to lateral and forward distance from a center reference point.

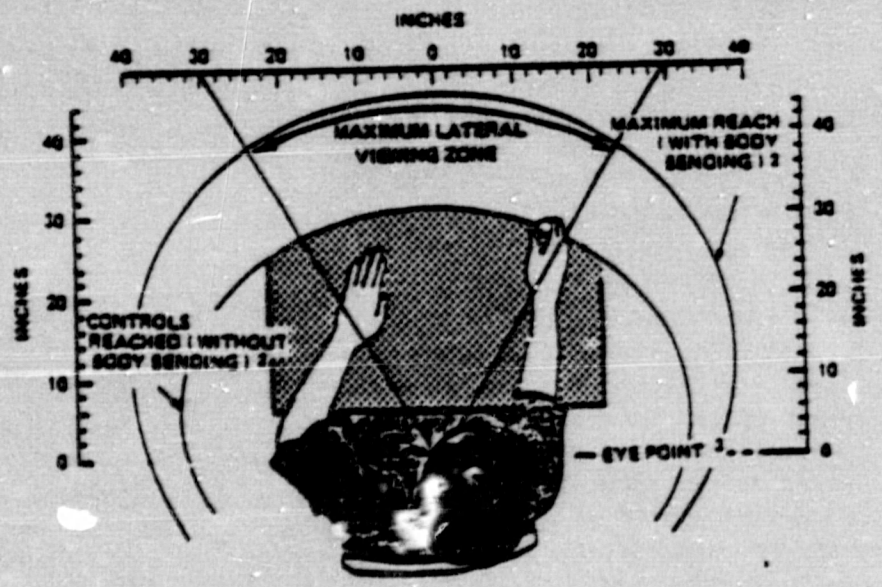
(1) For control and monitoring actions that must occur in sequence, all necessary controls and displays should be within the maximum extended reach and the viewing range of the seated operator from a single reference point.

(2) For the situation described in item 1, above, and sustained or precise control action, the operator should be able to reach the controls without having to bend/stretch significantly.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment
[redacted]			

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)



[1] 28 inches forward of the eye point is the maximum distance for displays when viewing is limited by reach (control-display relationship). Viewing distance may be extended provided display is properly designed. Greater lateral spread of displays would require a wraparound panel.

[2] Based on 5th percentile male data; less for 5th percentile females.

[3] Console edge approximately 4" to 6" forward of eye point for 5th-95th percentile.

Exhibit 1-11. Reach and visual range related to lateral and forward distances from center reference point. (adapted from Kubes, 1968; reprinted by permission of the Institute of Electrical and Electronic Engineers in the *Biomedical Data Book*, Second Edition, 1973)

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

g. LEG AND FOOT ROOM—Sufficient leg and foot room should be provided to enable seated operators to avoid awkward and uncomfortable positions. Exhibit 1-12 shows the dimensions involved and gives minimums and ranges necessary to accommodate the 5th to 95th percentiles (as defined in Exhibit 1-5).

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)

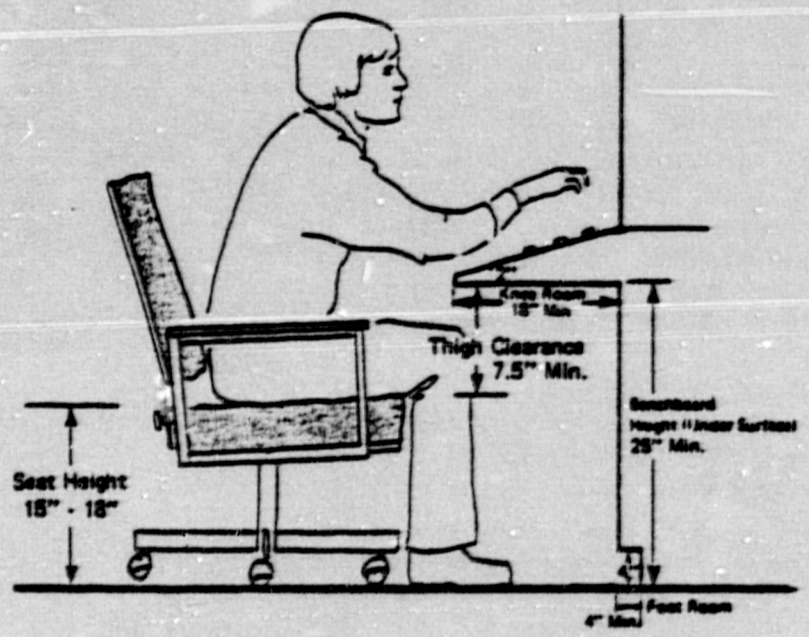


Exhibit 1-12. Leg and foot room dimensions.

h. **WRITING SPACE ON CONSOLES**—Writing space may be needed by operators working at consoles.

(1) An area at least 16 inches deep and 24 inches wide is recommended where these dimensions in the total configuration would fit operator reach capabilities. Less space may be adequate considering the frequency and duration of writing requirements at control room consoles.

(2) If writing space is provided on the console itself, it should not interfere with viewing and manipulation of controls and displays.

(3) If writing is necessary but space on the console is not available, other arrangements such as a nearby desk or table should be provided.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.4 SIT-STAND WORK STATIONS

Sit-stand combinations are recommended when operators need mobility to monitor large panel areas but also need the stability of seated operation for precise task sequences. This is especially true when such task sequences go on for fairly long periods and require sustained attention (e.g., reactor startup/shutdown).

a. CONTROL AND DISPLAY POSITIONING—The height and lateral limits for controls and displays should conform to the guidelines given for stand-up consoles (Guideline 1.2.2).

b. CHAIR HEIGHT—The operator should be provided with a high chair so that the seated eye height is approximately the same as standing eye height.

c. KNEE ROOM—Knee room and comfortable foot support should be provided.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.2.5 VERTICAL PANELS

Exhibits 1-13 and 1-14 show common problems resulting from poor placement of controls and displays on vertical panels. The following limits are recommended.

a. CONTROL HEIGHT

(1) Controls should be placed in an area between 34 inches and 70 inches above the floor.

(2) Controls requiring precise or frequent operation and emergency controls should be placed in an area between 34 inches and 53 inches above the floor.

b. DISPLAY HEIGHT

(1) Displays should be placed in an area between 41 inches and 70 inches above the floor.

(2) Displays that must be read frequently or precisely should be placed in an area between 50 inches and 65 inches above the floor.

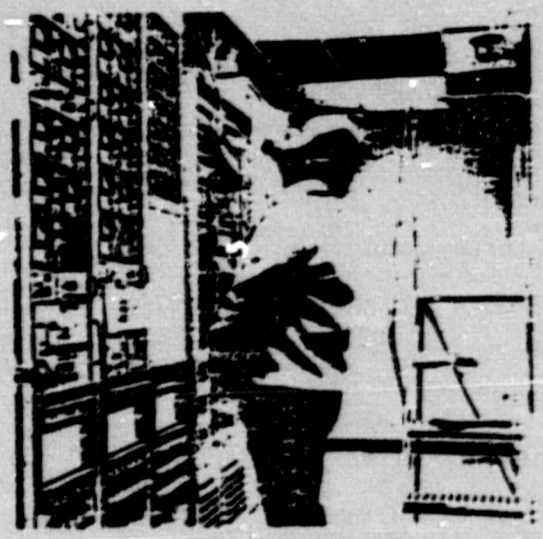


Exhibit 1-13. Poor practice: radiation monitoring console with panels placed too high and too low for normal viewing. Note ladder provided for operation of upper panels. (from Seminara et al., 1977)

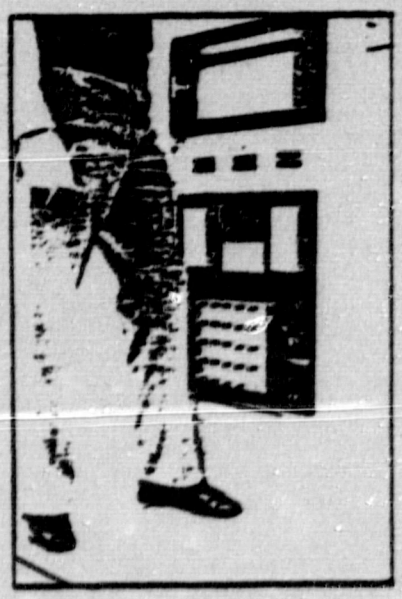


Exhibit 1-14. Poor practice: controls placed too low.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.2.6 USE OF PROCEDURES AND OTHER REFERENCE MATERIALS AT CONSOLES

Provision should be made so that the procedures manuals and other reference materials can be consulted easily while task sequences are performed at the consoles. Exhibit 1-15 shows the poor practice of laying manuals down on the benchboard when no convenient place has been provided for them. Exhibit 1-16 shows a good solution adopted by several plants: a rolling bookcase is provided for storing and using procedures manuals.

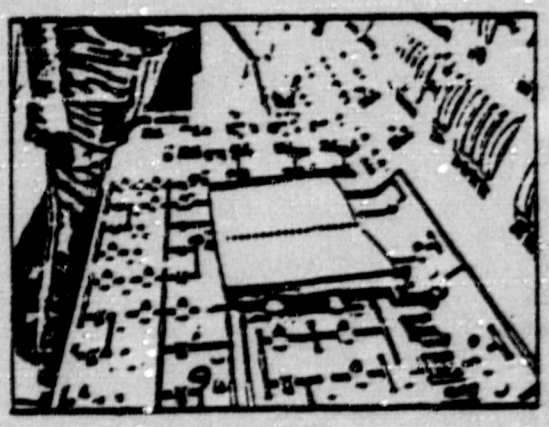


Exhibit 1-15. Poor practice: procedures should not be layed on the benchboard. (from Seminara et al., 1977)

Exhibit 1-16. One good solution: a rolling bookcase is provided for storing and using procedures.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.7 DESK DIMENSIONS

a. WORKING SPACE—Desks should provide enough clear working space for all materials required for task performance.

b. CHAIR POSITIONS—The desk should allow for different chair positions as required, with adequate knee space.

c. OPERATOR COMFORT—The relationships of working surface height and area, knee room, and chair height should allow operators to work comfortably. Exhibit 1-17 illustrates an uncomfortable situation created by desk height and chair design.

Exhibit 1-17. Poor practice: center desk operator's station with desk surface slightly too high and chair that does not compensate adequately (foot support and backrest too low). (from Seminara et al., 1977)

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.7 DESK DIMENSIONS (Cont'd)

d. DIMENSIONS—The following desk dimensions are recommended and shown in Exhibit 1-18:

(1) For seated work only, 26 to 31 inches above the floor (29 inches is a standard height).

(2) For sit-stand desks, 36 to 38 inches above the floor.

(3) Work surface area depth: 16 inches minimum.

(4) Work surface area width: 24 inches minimum if tasks involve reading and writing only; 30 inches minimum if other kinds of tasks are required.

(5) Knee room height: A distance of approximately 25 inches from the floor to the under-surface of the desk top should provide adequate clearance for 5th to 95th percentile male and female adults at sit-down-only stations.

(6) Knee room depth: 18 inches minimum.

(7) Knee room width: 20 inches minimum (greater width preferred).

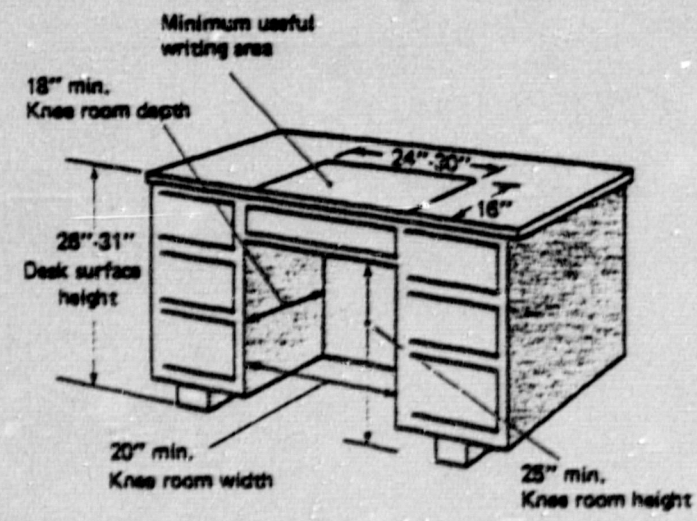


Exhibit 1-18. Recommended desk dimensions.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.8 CHAIRS

Chair comfort depends on the use and the user, but the following basic specifications are generally preferred.

a. MOBILITY—Chairs should pivot so that operators can readily adjust position. Mobile bases (casters) are recommended for chairs at sit-only stations.

b. BACKRESTS—Chairs should support at least the lower back curvature (lumbrosacral region). The recommended angle between the back and the seat is about 100° for office tasks (such as keyboard tasks). A greater angle is preferred for reading and resting.

c. ARMRESTS—Where personnel may remain seated for relatively long periods, chairs with armrests are preferred. Adjustable or retractable armrests may be necessary to allow the elbows to rest in a natural position and for compatibility with a particular desk/console.

d. CUSHIONING—Seat and backrest should be cushioned with at least 1 inch of compressible material, enough so that some resilience remains when the chair is occupied.

e. SEAT AREA—The thighs and the backs of the knees should not be compressed so as to cause fatigue and circulation problems. The seat should be at least 17 inches wide. Seat depth should be 15-17 inches (see Exhibit 1-19).

1.2.8 CHAIRS (Cont'd)

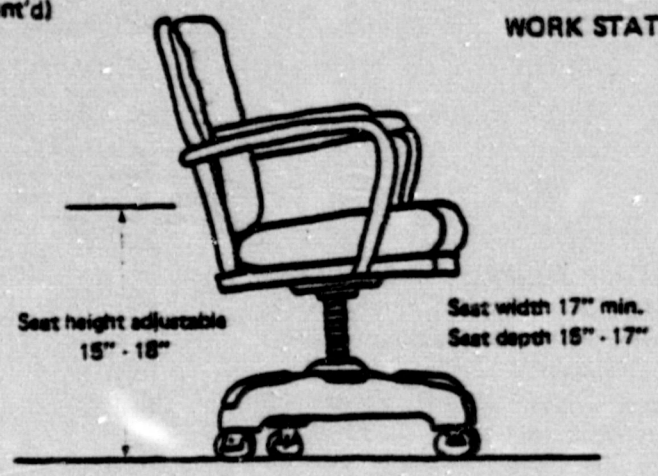


Exhibit 1-19. Recommended chair dimensions for seated operator stations.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

f. SEAT ADJUSTABILITY—For chairs at sit-down stations, seat height should generally be adjustable from 15 to 18 inches (Exhibit 1-19). For chairs at sit-stand stations, seat height should be adjustable from 26 to 32 inches (Exhibit 1-20).

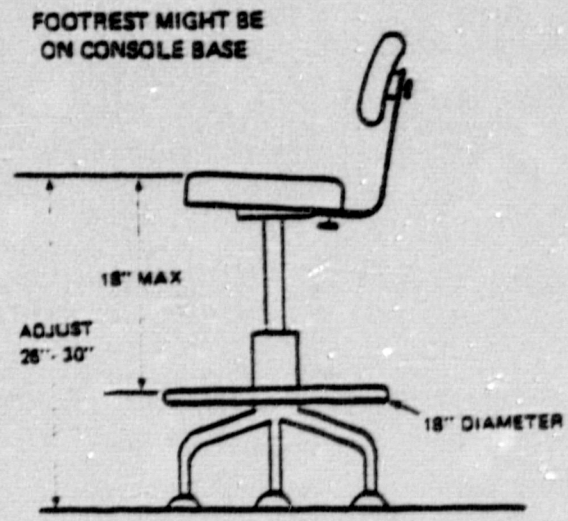


Exhibit 1-20. Recommended chair dimensions for sit-stand stations.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.2.8 CHAIRS (Cont'd)

g. FOOTRESTS—An adjustable footrest or heel catch should be provided to support the feet at a level no more than 18 inches below the seat surface. If a footrest is part of the chair, a circular design is recommended, diameter 18 inches. The footrest might be provided on the console base.

CONTROL ROOM WORKSPACE 1.0
MULTIUNIT CONTROL ROOMS 6.1.3

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.3.1 UNIT INTEGRATION AND INTERFERENCE

a. EQUIPMENT ARRANGEMENT – Equipment should be arranged with movement and communication patterns in mind, so that unit operations do not interfere with each other.

b. SENIOR OPERATOR STATION – Senior operators who supervise and assist operations of more than one unit need to be stationed so that they can communicate effectively with operators in each unit and have an unobstructed visual path to the control boards of each unit.

c. SHARING OF PERSONNEL–Where operators may assist those of another unit, potential task loading should be evaluated to assure that each unit can be covered adequately in all situations.

d. SHARING OF PROCEDURES–Each unit should have its own set of procedures and other reference documents as required to make sure that references are easily available to personnel in each unit, and to avoid conflicting needs for the same reference.

e. SHARED EQUIPMENT – Control of some items of plant equipment may be shared by the control rooms of multiple-unit nuclear power plants. When this is the case, care must be taken to ensure that status and availability data for this equipment are available in each control room, and that equipment operation from the control room for one unit will not affect other unit operations.

(1) Control of plant equipment from one control room should not affect the ability of operators of other control rooms to maintain control of their respective units.

CONTROL ROOM WORKSPACE 1.0

MULTIUNIT CONTROL ROOMS 1.3

COMPLIANCE CHECKLIST

	N/A	Yes	No	References/Comment
1.3.1 UNIT INTEGRATION AND INTERFERENCE (Cont'd) e. SHARED EQUIPMENT (Cont'd) (2) The status of plant equipment under the control of one control room should be displayed in all control rooms capable of controlling that equipment.				
(3) If control of plant equipment from one control room renders that equipment unavailable to other control rooms, availability status indications should be displayed in all control rooms.				
(4) A single, centrally located control panel/console may be used for dual-unit control rooms within the same isolation boundary when this design does not conflict with the panel layout and control-display integration guidelines of Sections 3.0.				
(5) Administrative procedures should be in place which assign responsibility for allocation of use of controls of shared plant equipment to a single control room.				

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.3.2 UNIT MIRROR IMAGING

Some control rooms are designed with the control boards of two units laid out symetrically, side-by-side, so that one is a complete or nearly complete reversal of the other. Operators who work both units have to deal with two opposite patterns of controls and displays, and must reorient their expectations completely when they switch from unit to unit. This requirement violates the principle of positive transfer of training and is highly unfavorable for task performance reliability. The potential for confusion is greater when the reversal is incomplete (e.g., control boards mirror imaged, but annunciator panels arranged identically in both units). If a mirror image design has been used:

a. DEDICATED CREWS – Operational crews should be committed to one or the other unit. They should not be allowed to alternate between the two mirrored units. This includes operators manning a single center desk station.

b. ACCENTUATE DIFFERENCES—The distinction between the mirrored units should be heightened as much as possible so that there will be no confusion about where one unit ends and the other begins. This can be done by using a different color scheme for the elements of each unit, including carpeting, desks, and other work station equipment, as well as the board surface areas.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.4.1 OPERATOR PROTECTIVE EQUIPMENT

a. TYPES OF EQUIPMENT—Protective equipment should include protective clothing and breathing apparatus.

b. ANTHROPOMETRY—Protective clothing and breathing equipment should be compatible with operator body sizes and tasks to provide adequate tactile sensitivity and ability to see, reach, move, communicate, and hear.

c. PERIODIC CHECKS—Operator protective equipment should be periodically checked to determine if it is in good condition.

d. QUANTITY—There should be protective equipment available in sufficient quantities and sizes for the required number of operators.

e. MARKING—Protective clothing sizes should be clearly identifiable.

f. EXPENDABLES—There should be an adequate supply of personal protection equipment expendables, such as filters.

g. ACCESSIBILITY—All protective equipment should be easily and readily accessible.

h. TRAINING—Operators should be well practiced in donning protective equipment.

i. PROCEDURES—Instructions for donning, doffing, and controlling personal protective equipment should be provided.

CONTROL ROOM WORKSPACE 1.0
EMERGENCY EQUIPMENT 1.4

GUIDELINE

1.4.2 FIRE, RADIATION, AND RESCUE EQUIPMENT

a. PERIODIC CHECKS—All equipment should be periodically checked to determine if it is in good condition.

b. ACCESSIBILITY—All equipment should be easily and readily accessible.

c. TRAINING—Operators should be trained in the use of all emergency equipment.

d. PROCEDURES—There should be a written, administratively approved procedure for each type of emergency or combination of emergencies.

e. AUTOMATIC WARNING SYSTEM – There should be an automatic fire warning system for control room fires.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

CONTROL ROOM WORKSPACE 1.0
EMERGENCY EQUIPMENT 1.4

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.4.3 EMERGENCY EQUIPMENT STORAGE

a. PROPER STORAGE—Provision should be made for the orderly storage, in the control room, of emergency equipment that is needed by control room personnel.

b. ACCESS—The storage location(s) may be away from the primary operating area but should be accessible, clearly marked, and known to all personnel.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.5.1 TEMPERATURE AND HUMIDITY

a. COMFORT ZONE—The climate control system should be capable of maintaining temperature and humidity within the shaded area comfort zone shown in Exhibit 1-21.

b. TEMPERATURE DIFFERENTIAL—Air temperature at floor level and at head level should not differ by more than 10°F.

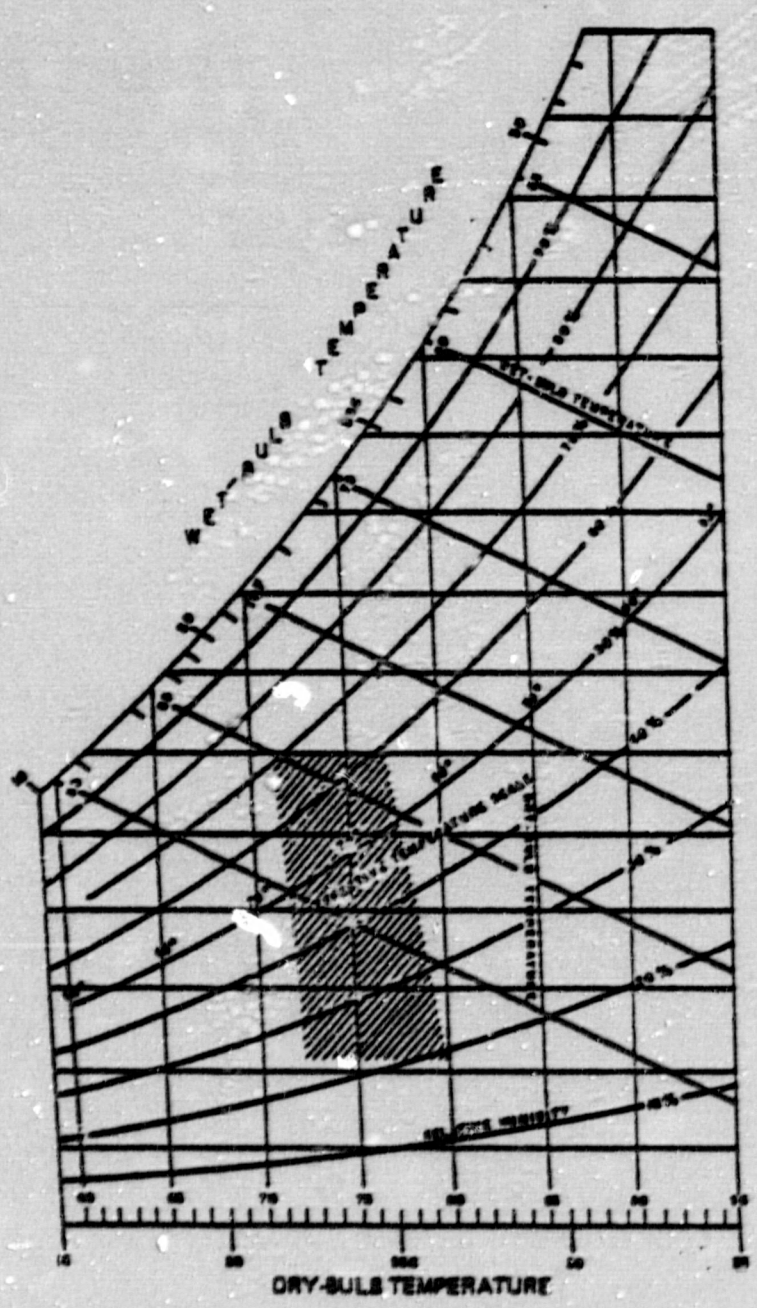


EXHIBIT 1-21. ASHRAE Effective Temperature Scale. Shaded Area is Environmental Comfort Zone. ASHRAE = Amer. Soc. of Heating, Refrig. and A/C Engineers.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.5.2 VENTILATION

a. AIR QUANTITY – The ventilation system should be capable of introducing outdoor air into the control room at a rate of at least 15 cubic feet per minute (cfm) per occupant.

b. AIR VELOCITY – Air velocities in the primary operating area should not exceed 45 feet per minute (fpm) measured at operator head level and should not produce a noticeable draught.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.5.3 ILLUMINATION

Adequate levels of illumination are necessary to ensure that visual effectiveness is sufficient for task performance. While the following illumination levels should generally be observed, specific task situations may dictate other illumination levels.

a. LEVELS – Do the normal, standby and emergency illumination levels, in foot candles conform to TVA electrical design standard, DSE 17.1.1, Section 6.0?

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.5.3 ILLUMINATION (Cont'd)

b. UNIFORMITY – The level of illumination should not vary greatly over a given work station.

c. SUPPLEMENTAL LIGHT–Supplemental lighting should be provided for personnel performing specialized visual tasks in areas where fixed illumination is not adequate.

d. TASK AREA LUMINANCE RATIOS – To determine task lighting requirements, it is necessary to consider the levels of lighting which surround a task. Great disparities between task and background lighting can lead to adaptation problems. To ensure effective visual performance, the task area luminance ratios in Exhibit 1-22 should not be exceeded.

e. SHADOWING–To reduce operator fatigue and eyestrain, shadows should be avoided.

(1) Ambient illumination should be provided via indirect or diffuse lighting.

(2) Labels, instructions, and other written information should not be in shadowed positions.

Areas	Luminance Ratio
Task area versus adjacent darker surroundings	3:1
Task area versus adjacent lighter surroundings	1:3
Task area versus more remote darker surfaces	10:1
Task area versus more remote lighter surfaces	1:10
Luminaries versus surfaces adjacent to them	20:1
Anywhere within normal field of view	40:1

Exhibit 1-22 Maximum task area luminance ratios.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.5.3 ILLUMINATION (Cont'd)

f. **GLARE**—Glare increases the probability that an individual will misread a display or will fail to notice displayed information. Glare can also produce discomfort. Direct sources of glare include light emitted from luminaires, indicators, and displays. Indirect sources of glare include reflected light from all surfaces, e.g., painted, metal, glass. Glare should not interfere with the readability of displays, labels, or indicators.

g. **REFLECTANCE** — The amount of reflected light is affected by illuminated surface colors. Reflectance should conform to the recommendations shown in Exhibit 1-23. (See also Exhibit 1-24.)

h. **COLOR**—Surface colors should be recognizable under both normal, standby and emergency lighting conditions.

Surface	Reflectances	
	Preferred	Permissible
*Ceiling	80%	60-85%
Upper Wall	60%	40-60%
Lower Wall	15-20%	
Instruments/Displays	80-100%	
Cabinet/Consoles	20-40%	
Floor	30%	15-30%
Furniture	35%	25-45%

*Recommended reflectances are for finish only. Over-all average reflectance of acoustic materials may be somewhat lower. The upper wall (one to two feet below the ceiling) may be painted with the ceiling paint as is used on the ceiling.

Exhibit 1-23. Recommended workplace reflectance levels.

Color	Reflectance
White	85
Light:	
Cream	75
Gray	75
Yellow	75
Buff	70
Green	65
Blue	55
Medium:	
Yellow	65
Buff	63
Gray	55
Green	52
Blue	35
Dark:	
Gray	30
Red	13
Brown	10
Blue	8
Green	7
Wood Finish:	
Maple	42
Satinwood	34
English Oak	17
Walnut	16
Mahogany	12

Exhibit 1-24 Surface color reflectance values.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.5.4 STANDBY LIGHTING (A.C.)

a. AUTOMATIC ACTION - A control room standby lighting system should be automatically activated and immediately available upon failure of the normal control room lighting system. This system should be independent of any other plant lighting system that is available in the control room.

b. OPERABILITY - Failure of the normal control room lighting system should not degrade operability of the standby lighting system.

c. LIGHTING LEVELS - The control room standby illumination system should be designed to provide a minimum illumination level of 10 footcandles at all work stations in the primary operating area.

1.5.5 EMERGENCY LIGHTING (D.C.)

a. AUTOMATIC ACTION - A control room emergency lighting system should be automatically activated and immediately available upon failure of the normal control room lighting system. This system should be independent of any other plant lighting system that is available in the control room.

b. OPERABILITY - Failure of the normal control room lighting system should not degrade operability of the emergency lighting system.

c. LIGHTING LEVELS - The control room emergency illumination system should be designed to provide a minimum illumination level of 3 footcandles at all work stations in the primary operating area.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.5.5 AUDITORY ENVIRONMENT

The acoustic design of the control room should ensure that verbal communications between operators are not impaired; auditory signals are readily detected; and auditory distraction, irritation, and fatigue of operators are minimized.

a. BACKGROUND NOISE – Background noise should not impair verbal communication between any two points in the primary operating area. Verbal communications between these points should be intelligible using normal or slightly raised voice levels. See Exhibit 1-25.

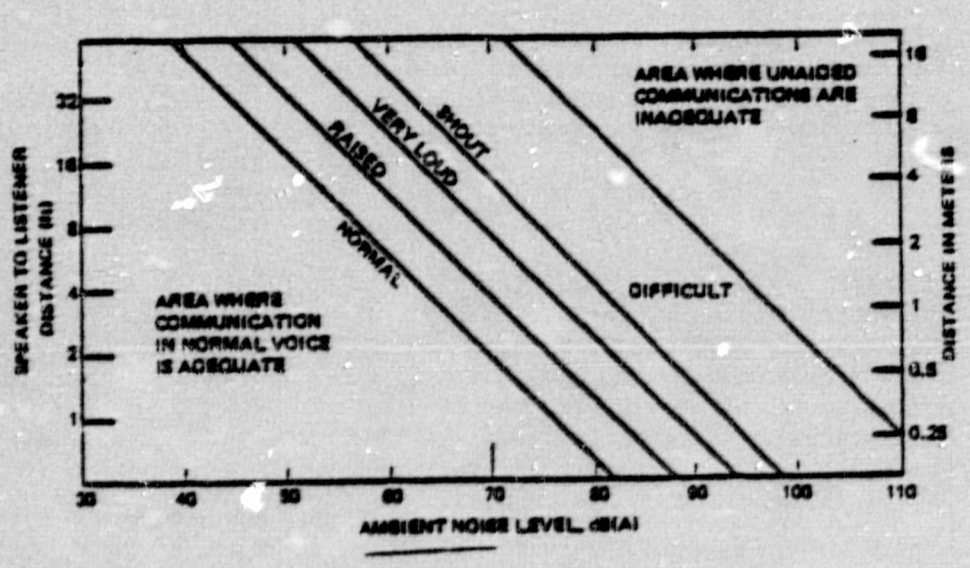


Exhibit 1-25. Voice level as a function of distance between speaker and listener and ambient noise level.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

1.5.6 AUDITORY ENVIRONMENT (Cont'd)

b. LIMIT—Background noise levels should not exceed 65 dB(A).

c. FURTHER REDUCTIONS—Further reductions in background noise may be required where communications between the primary operating area and other control room locations are necessary and voice transmission systems are not provided.

d. NOISE DISTRACTIONS – Noise distractions generated either inside or outside the control room should be minimized.

e. REVERBERATION TIME AND SOUND ABSORPTION—The acoustical treatment of the control room should limit reverberation time to one second or less.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comments

1.5.7 PERSONAL STORAGE

a. STORAGE LOCATIONS—There should be a suitable, out-of-the-way but secure place in which control room personnel may keep their coats and other personal belongings.

b. STORAGE SUITABILITY—If lockers are provided, they should be large enough to hold the items that can reasonably be expected to go into them.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.5.8 AMBIENCE AND COMFORT

An effort should be made to create a pleasant and comfortable work setting in view of the long hours and confining aspects of the control room operator's job.

a. DECOR – Features to be considered include:

(1) Color coordination.

(2) Use of color and lighting to create a cheerful atmosphere (without introducing glare and brightness to a degree that causes eye fatigue or an overly intense atmosphere).

(3) Visual relief from arrays of instrumentation.

(4) Comfortable seating.

(5) Carpeting to lessen the fatigue of standing and walking.

b. RESTROOM AND EATING FACILITIES

(1) A restroom and kitchen or eating area should be provided within (preferably) or near the control room isolation boundary.

(2) Since formal breaks are not scheduled in most control rooms, it is important that personnel have access to these facilities without delay. It is preferable that they be used only by control room personnel.

(3) Provision should be made for communication if facilities are out of voice contact, so that an operator taking a break can be contacted as necessary by personnel in the control room. (See Guideline 2.1.7.)

c. REST AREA/LOUNGE—Consideration should be given to providing a rest area (possibly in conjunction with the eating area) conducive to relaxation and revitalization, especially where shifts are long.

2.0 COMMUNICATIONS

Page

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NOTE TO CRDR REVIEWER:
REFER TO PARTICULAR PLANT FSAR SECTION 9.5, AND TO PARTICULAR PLANT OI'S AND EOP'S

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

2.1.1 GENERAL REQUIREMENTS FOR VOICE COMMUNICATION SYSTEMS

Generally there are six varieties of voice communication systems found in control rooms: Conventional-powered telephones, sound-powered telephones, portable UHF/VHF radio transceivers, remote control units hard-wired to fixed-base UHF/VHF radio transceivers located outside the control room, announcing systems, and point-to-point intercom systems. Human factors requirements specific to each type of voice communication system will be considered individually in Guidelines 2.1.2 through 2.1.7 while 2.1.8 will address voice communication by the operator wearing an emergency mask. The following requirements are relevant to communication systems in general.

a. INSTRUCTIONS—Instructions should be provided for use of each communication system, including suggested alternatives if a system becomes inoperable.

b. PERIODIC MAINTENANCE TESTS—These should be performed on all communication systems to ensure that the system is normally operative and effective under changes in ambient noise levels that may have occurred since the last check.

c. EMERGENCY MESSAGES

(1) OUTGOING—Priority procedures should be established for the transmission of emergency messages from the control room by any of the communication systems.

(2) INCOMING—Procedures should be established for handling communications during an emergency and these procedures must be known by all operators.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

2.1.2 CONVENTIONAL-POWERED TELEPHONE SYSTEMS

In control rooms, these systems are generally handsets (mouthpiece and earpiece in a cummon, hand-held mount), the handset being cradled either on a deskstand or vertically mounted holder. Connections are switched by a dialing system. Within the broad selection available in the market, systems should be chosen that fulfill the requirements below.

a. FREQUENCY RESPONSE—The powered telephone system must provide good frequency response in that portion of the auditory spectrum most essential for intelligibility. Standard telephone bandpass is acceptable (200-3300 Hz).

b. HANDSETS—Design should incorporate the following features:

(1) Size and shape should be compatible with operator's hand size and mouth-ear distance (standard telephone dimensions acceptable).

(2) Should maintain firm ear contact by receiver while transmitter is positioned to receive voice waves directly from mouth.

(3) Cords should be of nonkink or self-retracting type.

(4) Cords should be of sufficient length to permit reasonable operator mobility.

(5) Cords should be positioned so as to avoid entangling critical controls or endangering passing traffic.

(6) Vertically mounted handset cradles should be designed and located to prevent the handset from being knocked out of the cradle by passing traffic.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

2.1.2 CONVENTIONAL-POWERED TELEPHONE SYSTEMS (Cont'd)

b. HANDSETS (Cont'd)

(7) Where multiple telephone instruments are located close together (e.g., on a single desk) they should be coded to indicate circuit or function.

(8) If a press-to-talk button is used, the button should be convenient to both left and right hand operation.

c. SWITCHING MECHANISM – Usually the switching function is accomplished by dial switching and the switching mechanism is located in-plant.

(1) Switching should be designed and/or programmed to minimize delay in making desired connections under both normal and emergency conditions.

(2) Switching should be programmed to give the control room automatic priority of access to the switching system.

d. TELEPHONE RINGING—Loudness of ringing should be adjustable at the individual telephone instrument.

e. ANNOUNCING USE – When transmitters, within the powered telephone system, are used as the microphone input to the announcing system, the transmitter should be compatible with the rest of the announcing system.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

2.1.3 SOUND-POWERED TELEPHONE SYSTEMS

In control room use, sound-powered phones are generally of the headset variety (either one or two earphones and a boom microphone in an assembly fitting on the head). Sound-powered phones are independant of external power, a feature of value in emergency use. Additionally the headset configuration, used with conveniently located plug-in jacks, provides mobility for the user when moving to remote locations (back panels or outside the control room).

a. SOUND QUALITY—Within engineering constraints imposed by sound-powering, the system should provide:

(1) Good frequency response in the band from 200 to 3300 Hz (standard telephone quality).

(2) In-phase feedback to the user.

b. HEADSETS—Headsets should reflect the following design requirements:

(1) Earphone cushioning to provide comfort for extended periods of wear. Earphones should cover the outer ear but without causing uncomfortable pressure.

(2) Supporting structure for earpieces should not impose discomforts of weight, concentrated pressure, or metal contact with the skin.

(3) The earpiece should be held firmly in place, yet be easy to remove.

(4) Ideally, headsets should provide hands-free operation. This may have to be compromised, however, to accommodate a push-to-talk switch in anticipation of possible use in areas of high ambient noise.

COMPLIANCE CHECKLIST

	N/A	Yes	No	Reference/Comment
2.1.3 SOUND-POWERED TELEPHONE SYSTEMS (Cont'd) b. HEADSETS (Cont'd) (5) Binaural headsets should be available for use by control room personnel when they are required to leave the control room for plant areas with high ambient noise levels and communicate with the control room from these areas using sound-powered communication equipment.				
(6) A well-marked and accessible place should be provided for headset stowage.				
c. RINGING—Sound-powered phones require supplemental power, which is often hand-generated, to energize a ringing function. Often sound-powered phone circuits have no provision for ringing.				
(1). Need for ringing must be determined for the individual plant depending on the sound-powered phone procedures.				
(2) If ringing is not installed, then the user should be provided capability for accessing the paging system so that a desired party can be called to the line.				
d. JACK PROVISIONS (1) Plug-in jacks for the sound-powered system should be provided within the control room.				
(2) Jacks should be located close to the work stations to prevent need for unduly long cords.				
(3) Jacks should not accommodate plugs of the conventionally powered phone system, in order to avoid wrong instrument-system connections.				

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment
[redacted]			

2.1.3 SOUND-POWERED TELEPHONE SYSTEMS (Cont'd)

e. SWITCHING – Sometimes a sound-powered phone system is installed as a single "party line" without any switching. When switching is used with sound-powered phones, it is accomplished by manually actuated selection switches or patch panels rather than dial-switching as with powered phones.

(1) The requirements for switching must be assessed for the individual plant depending on procedures for use of sound-powered phones.

(2) Patch panels, when used, should be conspicuously marked and located in reasonably accessible places. These requirements are particularly critical in back-panel areas.

(3) A complete set of cords should be provided at each panel if cord-type patching is used.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

2.1.4 PORTABLE RADIO TRANSCEIVERS

Portable transceivers are used in both emergency and normal operations for two-way communications beyond the range of installed telephone connections or as a convenient alternative to the sound-powered phone. However, each licensee/applicant who intends to use radio communications should determine the extent to which radio interference could adversely affect control room operations.

a. SOUND QUALITY—Within the engineering constraints imposed by radio frequency spectrum availability and by design for easy portability, transceivers should realize the same quality desired throughout all of the communications systems, namely:

(1) Good frequency response, preferably to telephone standards of 200 to 3300 Hz.

(2) Sufficient dynamic range and gain to handle instantaneous pressures found in speech and develop necessary signal level at the headphone or loudspeaker.

b. AREA COVERAGE

(1) Modulation and a radio frequency should be chosen, as FCC regulations permit, to provide broad-area communication to the control room. One consideration for frequency selection should be radio-wave penetration of metal or reinforced concrete barriers, which at certain frequencies would tend to attenuate or bounce the signal.

(2) Use of portable transceivers should be prohibited in areas close to low-level analog or digital equipment unless EMI noise susceptibility tests have been conducted that demonstrate that equipment is not affected by the frequency bands used.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

2.1.4 PORTABLE RADIO TRANSCEIVERS (Cont'd)

c. PACKAGING

(1) To the extent permitted by design for effective electrical/RF function, portable transceivers should be small, light, and easy to carry.

(2) Their use should leave one hand available most of the time for other tasks.

(3) The microphone should be integrated into the transceiver package.

d. PARTY IDENTIFICATION—When there are more than two parties on a channel operating at separate locations, procedures must provide for unambiguous identification of the speaker.

e. BATTERY REPLENISHMENT

(1) A supply of fresh replacement batteries should be stowed in an accessible, well-marked space.

(2) The stock should be kept large enough to support long periods of continuous operation in case of emergency.

GUIDELINE

COMPLIANCE CHECKLIST

2.1.5 FIXED-BASE UHF OR VHF TRANSCEIVERS

A fixed-base transceiver may be used for normal and emergency communications between the control room and the following locations similarly equipped with fixed-base transceivers: Dispatcher, Security, and Utility Headquarters (if within range). Each licensee/applicant who intends to use radio communications should determine the extent to which radio interference could affect control room operations.

a. SIGNAL QUALITY— Unlike portable units, fixed-base UHF or VHF transceivers are not constrained by being designed for portability. Therefore, they should readily achieve good voice intelligibility, provided by adequate frequency response at least within telephone standards of 200 to 3300 Hz. They should exhibit sufficient dynamic range to handle instantaneous pressure found in speech and develop sufficient gain to develop the necessary signal level at the loudspeaker.

b. GAIN—Gain should be adjustable, but the gain control should be limited so that even at its lowest setting an audible signal is still presented.

c. PROCEDURES—Procedures should be established (and conspicuously posted) for use of the system.

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

2.1.6 ANNOUNCING SYSTEMS

These systems are made up of amplifiers, loudspeakers, and microphones. The microphone input is provided, in some installations, by a dialable connection to a transmitter of the powered telephone system.

a. INTELLIGIBILITY AND COVERAGE—These are the key factors in announcing system effectiveness. The system must provide rapidly intelligible messages to all areas where personnel subject to page may be located.

(1) Intelligibility requires the integration of carefully selected components (microphones, amplifiers, and loudspeakers) into an overall system providing good frequency response in the audio band which is critical for intelligibility. At a minimum, telephone quality is required (200 to 3300 Hz); higher intelligibility is achieved by a band of 200 to 6100 Hz.

(2) Coverage depends on loudspeaker location. Adequate coverage requires that speakers should be placed so that they are available in all necessary areas and that there are no "dead spots" within any area.

b. MICROPHONE CHARACTERISTICS

(1) Frequency response should be compatible with that of the rest of the system.

(2) If the powered telephone system is used to provide microphone input to the announcing system, the telephone system should contain transmitters of quality compatible with that of the announcing system.

(3) Microphones should have high sensitivity to speech signals.