COMPLIANCE CHECKLIST

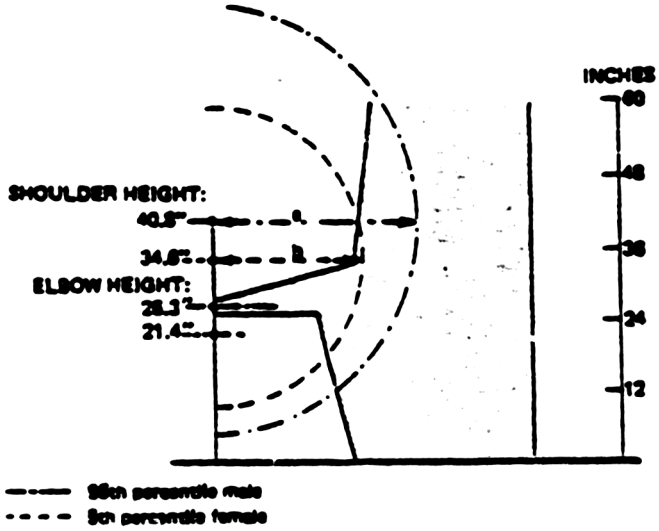
N/A	Yes	No	Reference/Comment

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 28.2

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)

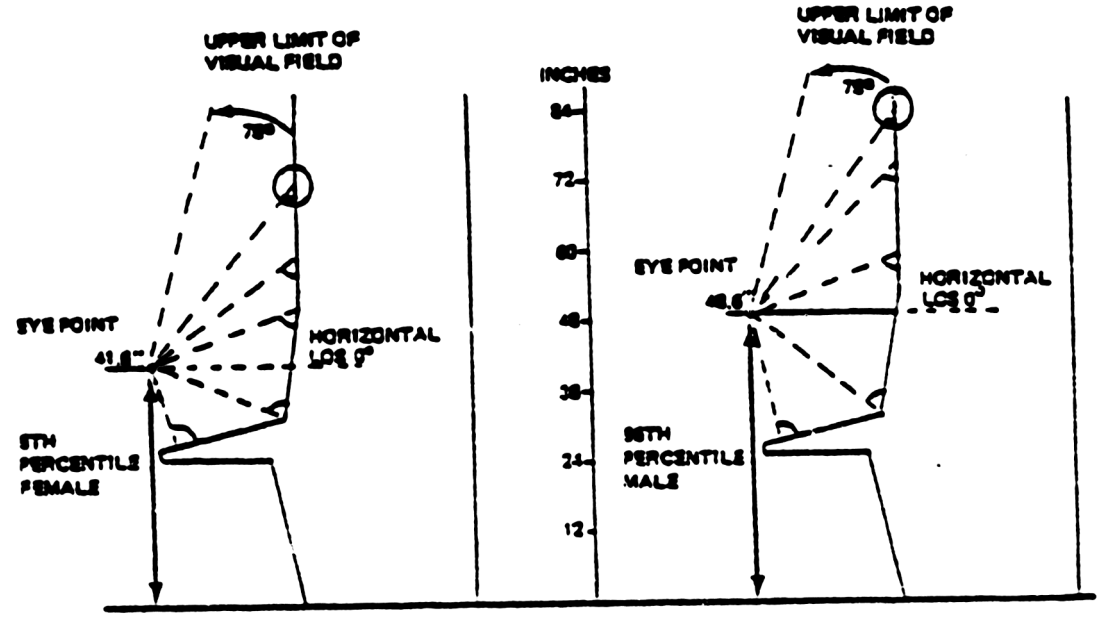
e. DISPLAY POSITIONING (Cont'd)

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	Reference/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).

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

1.2.3 SIT-DOWN CONSOLE DIMENSIONS (Cont'd)

e. DISPLAY POSITIONING (Cont'd)

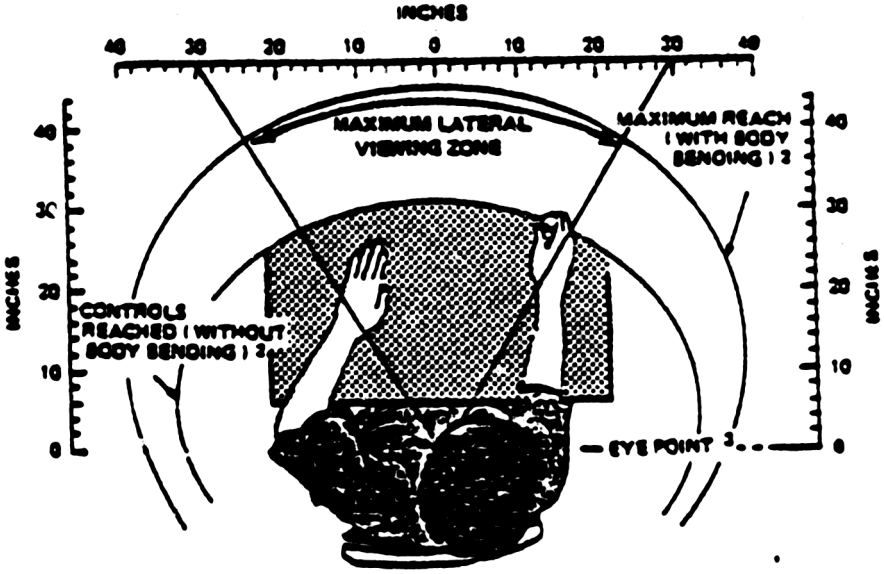
(2) In addition, all displays should be mounted so that the angle from the line of sight to the display face plane is 45° or greater (see Exhibit 1-10). The 5th percentile female determines the upper limit. (Practically, there is no lower limit for a plausible sit-down console design.)

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.

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 Kubokawa, 1968; reprinted by permission of the Institute of Electrical and Electronic Engineers in the *Bioastronautics Data Book*, Second Edition, 1973)

COMPLIANCE CHECKLIST

N/A	Yes	No	References/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)

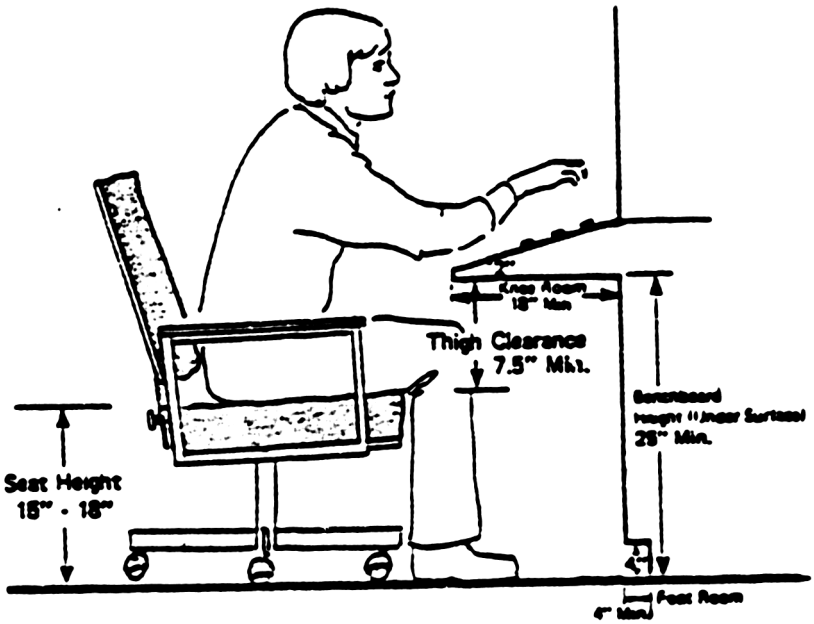


Exhibit 1-12. Leg and foot room dimensions.

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	Reference/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	References/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.

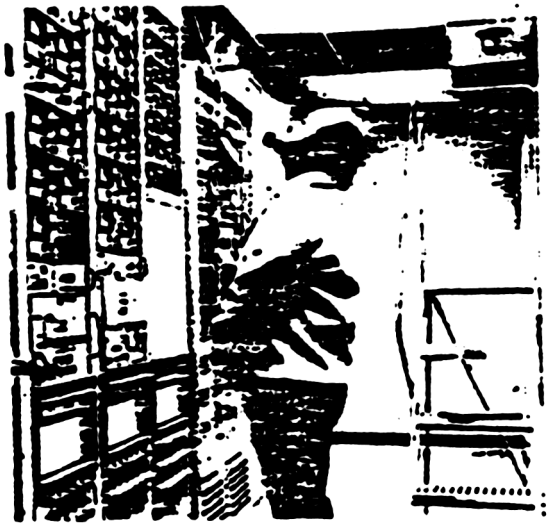


Exhibit 1-13. Poor practice: radiation monitoring console with panels placed too high and too low for normal viewing. Note ladder provided for operation of upper panels. (from Seminara et al., 1977)

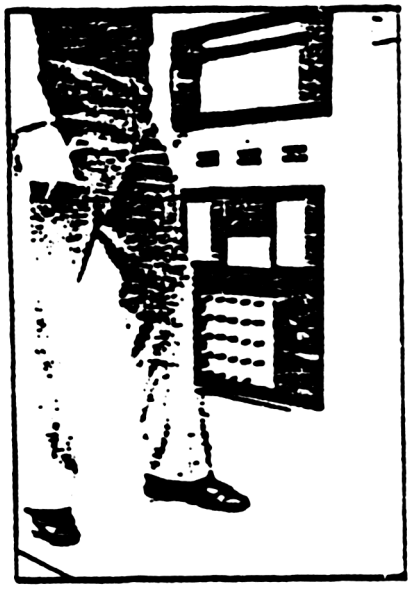


Exhibit 1-14. Poor practice: controls placed too low.

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.

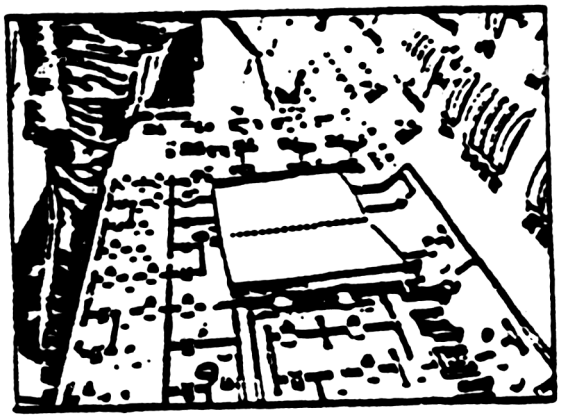


Exhibit 1-15. Poor practice: procedures should not be layed on the benchboard. (from Seminara et al., 1977)

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.

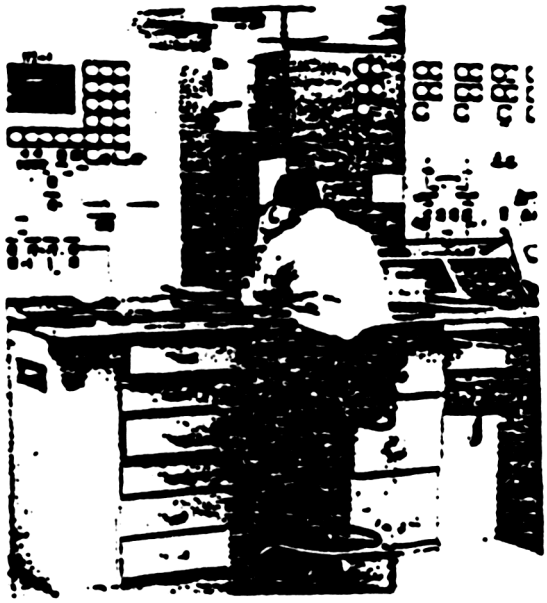


Exhibit 1-17. Poor practice: center desk operator's station with desk surface slightly too high and chair that does not compensate adequately (foot support and backrest too low). (from Seminara et al., 1977)

CONTROL ROOM WORKSPACE 1.0
WORK STATION DESIGN 1.2
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).

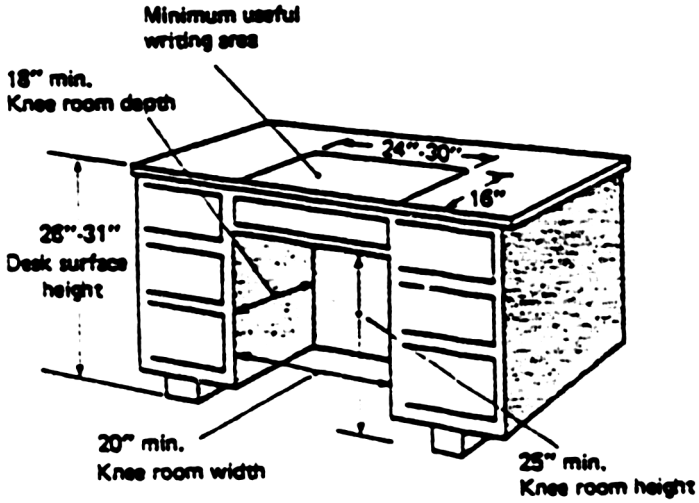


Exhibit 1-18. Recommended desk dimensions.

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)

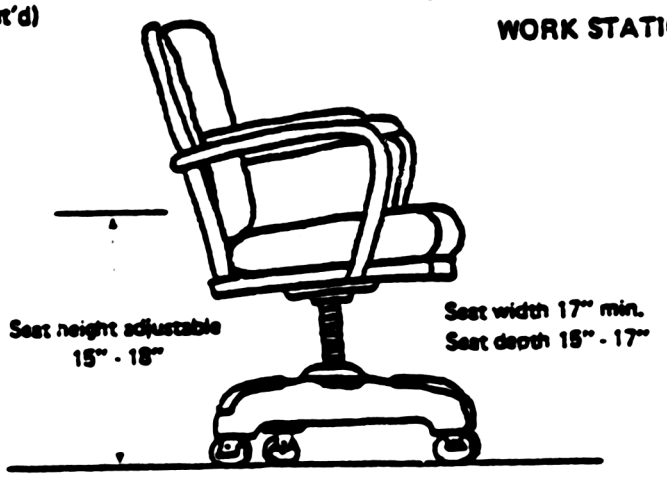


Exhibit 1-19. Recommended chair dimensions for seated operator stations.

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).

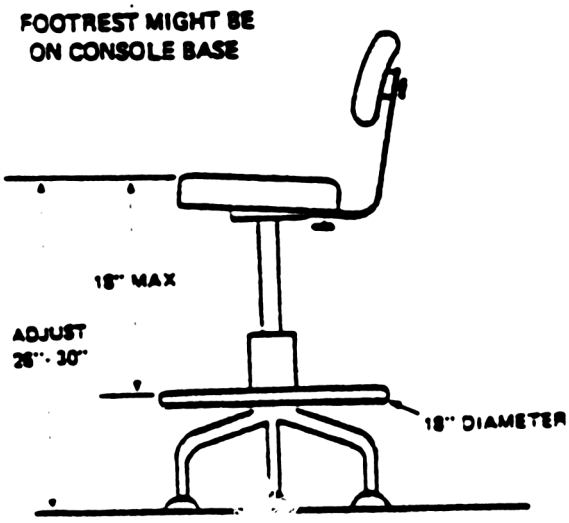


Exhibit 1-20. Recommended chair dimensions for sit-stand stations.

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 8.0.				
(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.

CONTROL ROOM WORKSPACE 1.0
EMERGENCY EQUIPMENT 1.4

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	Reference/Comment

CONTROL ROOM WORKSPACE 1.0
EMERGENCY EQUIPMENT 1.4

GUIDELINE

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.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

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.

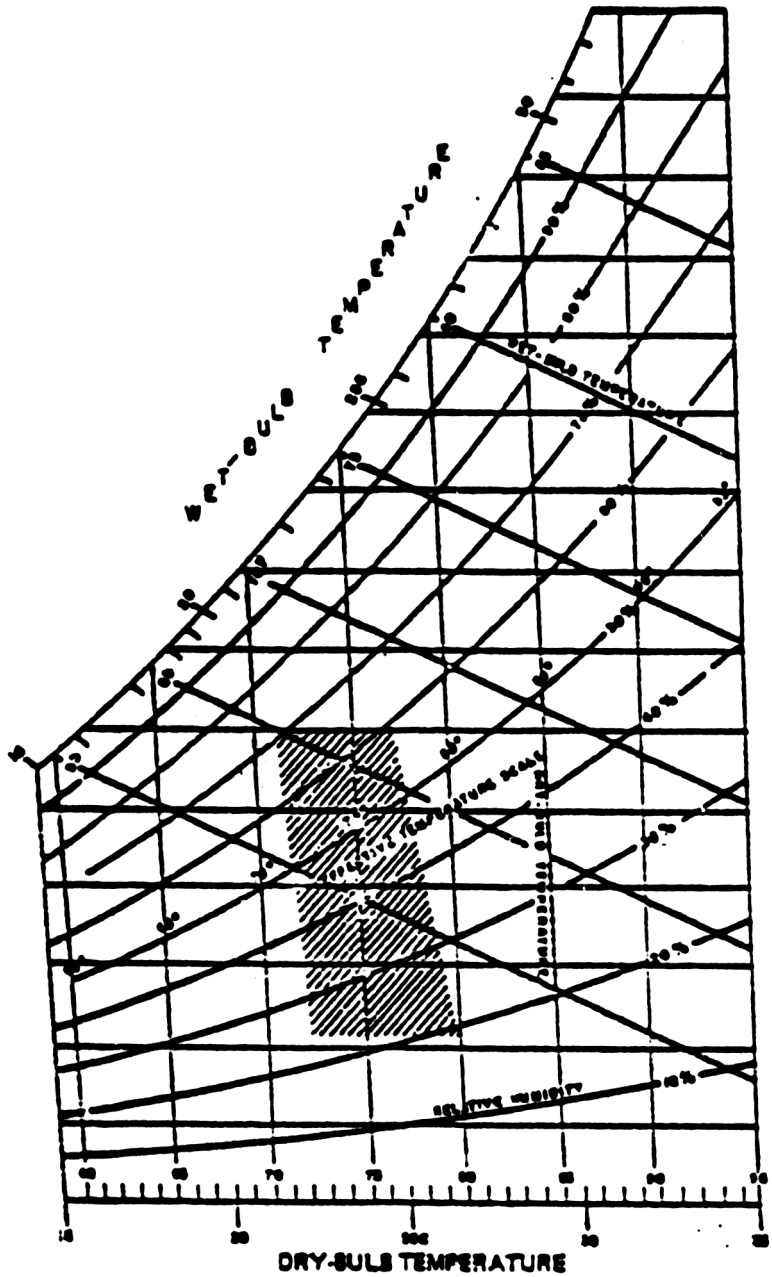


EXHIBIT 1-21. ASHRAE Effective Temperature Scale.
Shaded Area is Environmental Comfort Zone.
ASHRAE = Amer. Soc. of Heating, Refrig. and A/C Engineers.

CONTROL ROOM WORKSPACE 1.0
ENVIRONMENT 1.5

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/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	References/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	Reference/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	References/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	Permissable
[a]Ceiling	80%	60-86%
Upper Wall	50%	40-60%
Lower Wall	15-30%	
Instruments/Displays	80-100%	
Cabinet/Consoles	20-40%	
Floor	30%	15-30%
Furniture	35%	25-45%

[a]Recommended reflectances are for finish only. Over-all average reflectances of acoustic materials may be somewhat lower. The upper walls (one to two feet below the ceiling) may be painted with the same 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
Seaweed	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.

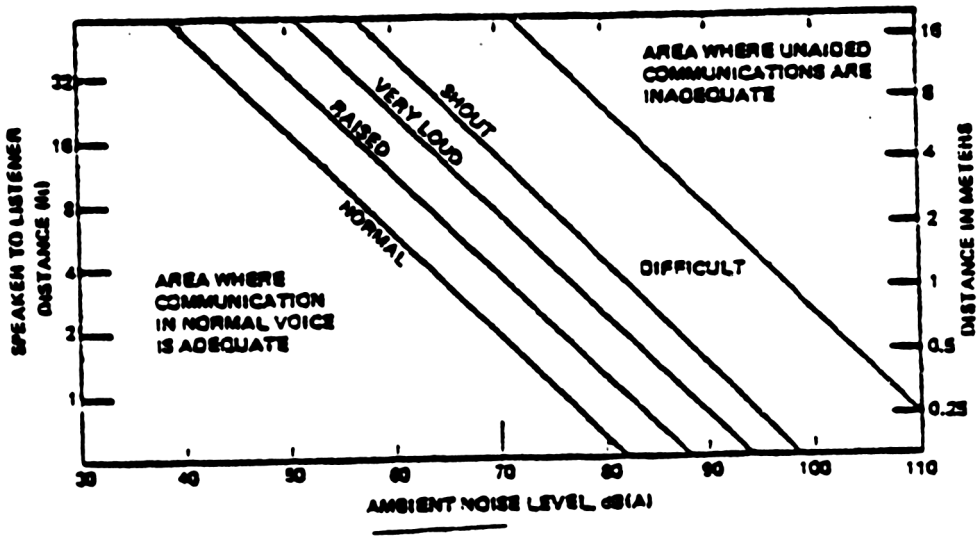


Exhibit 1-25. Voice level as a function of distance between speaker and listener and ambient noise level.

COMPLIANCE CHECKLIST

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.

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

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	References/Comment

1.5.9 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

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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

COMMUNICATIONS 2.0

VOICE COMMUNICATION SYSTEMS 2.1

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 common, 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	Reference/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	References/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 independent 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 pressures, 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
7.1.8 ACCESS AIDS As a rule, control room operators lack the in-depth computer training and experience of computer system engineers and programmers. While some operators become very proficient users of the computer system, their expertise is usually focused on the portions of the system with which they interface most frequently over an extended period. In addition, their attention is more likely to be directed toward the characteristics and functioning of plant systems than to that of the computer. This guideline addresses provisions for bridging the gaps in the control room operator's knowledge and experience regarding the effective use of the computer.				
a. COMPUTER SYSTEM PROCEDURES (1) A complete set of computer system operating procedures and contingency procedures should be available in the control room.				
(2) Procedures should be prepared from the point of view of the control room operator.				
(3) Procedures should be in hard-copy form.				
(4) Operating procedures should describe: (a) The overall computer system.				
(b) The computer system components with which the operator can interface.				
(c) The specific procedures necessary to accomplish all of the operator-computer interface functions.				

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

N/A	Yes	No	References/Comment

7.1.7 COMPUTER RESPONSE TIME TO OPERATOR QUERIES

Timely response to operator inputs can be an important factor in reduction of operator errors, as well as for achievement of operator acceptance of the computer system. Undue delays in responding to operator inputs may lead the operator to assume that the input was not accepted, or that the input was made incorrectly, or that something is wrong with the computer. Responses to an input or request within 1 to 3 seconds will generally maintain the operator's attention and thus reduce operator error. The nature of the query, the complexity of the programmed response logic, and the speed of the computer are determinants of response time.

a. MAXIMUM RESPONSE TIMES—The computer system should provide the correct response to each type of query within the recommended response times listed in Exhibit 7-6.

b. RESPONSE DELAY MESSAGES—When response time for any query exceeds 3 seconds, a delay message should be presented to maintain the operator's attention and to confirm normal computer operation. (See also Guideline 7.2.6.)

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/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.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

7.1.5 COMPUTER FUNCTION CONTROLS (Cont'd)

d. FUNCTION CONTROLS (Cont'd)

(3) Each function control is clearly labeled to indicate its function to the operator.

(4) Multiple computer consoles exist in the control room, the design and layout of the function controls is consistent for all consoles.

(5) When function keys are included with an alpha-numeric keyboard, the function keys should be physically separate from the alpha-numeric keys.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

2.1.7 POINT-TO-POINT INTERCOM SYSTEMS

Such systems should be provided to interconnect the control room with important plant areas such as the Shift Supervisor's Office, Plant Security Office, operator's lounge, locker rooms, and possibly restrooms.

a. INTELLIGIBILITY – At a minimum, the intercom system should provide transmission of the voice spectrum to telephone standards (200 to 3300 Hz).

b. GAIN ADJUSTMENT – Gain should be adjustable at each intercom unit, but adjustability should be limited to preclude reducing volume below an audible level.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

7.1.4 DATA ENTRY—KEYBOARDS (Cont'd)

e. KEY DISPLACEMENT AND RESISTANCE—To provide positive key movement feedback to the operator, and to reduce inadvertant activation of keys,

(1) Key displacement should be as shown in Exhibit 7-4.

(2) Key resistance should be as shown in Exhibit 7-4.

f. POSITIVE INDICATION—To provide positive key actuation feedback to the operator, a definite indication should be provided (e.g., snap, feel, audible click, release of resistance).

g. KEYBOARD SLOPE—Keyboards should have a slope between 15° and 25° from the horizontal (see Exhibit 7-5).

h. VISUAL FEEDBACK—Data being entered via keyboards should be displayed as it is keyed.

i. RELEVANT KEYS—The presence of non-relevant keys, such as might be used by programmer personnel, adds to keyboard complexity and induces operator errors. Control room keyboards should contain only those keys which are used by operators.

Displacement (inches)

	Numeric	Alpha-numeric
Minimum	0.03	0.06
Maximum	0.19	0.25

Resistance (ounces)

	Numeric	Alpha-numeric
Minimum	3.5	0.9
Maximum	14.0	5.3

Exhibit 7-4. Recommended key displacement and resistance.

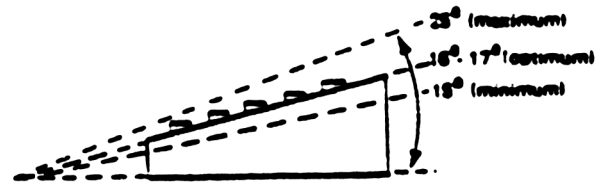

Exhibit 7-5. Keyboard slope limits.

GUIDELINE

2.2.1 USE OF AUDITORY SIGNALS

Auditory signals are used to attract operator attention and to present information independent of operator position or head orientation. Auditory signals have some drawbacks, since they may interfere with speech communication and are limited in their capability to indicate what is wrong and what to do.

a. DEDICATED USE—Systems used to transmit non-verbal auditory signals should be used only for that purpose, unless priorities have been established for transmission of verbal and non-verbal information.

b. LOCALIZATION—Auditory signals should provide localization cues that direct operators to those control room work stations where operator attention is required.

c. SELECTION

(1) Auditory signals should be selected to avoid confusion with ambient control room noises.

(2) Auditory signals should be selected to avoid interference with other auditory sources, including verbal communication.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

PROCESS COMPUTERS 7.0
COMPUTER ACCESS 7.1

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comments

7.1.4 DATA ENTRY—KEYBOARDS (Cont'd)

b. NUMERIC KEYBOARD ARRANGEMENT—The configuration of a keyboard used to enter solely numeric data are a 3x3+1 matrix, either "telephone" style or "calculator" style. See Exhibit · 7-2.

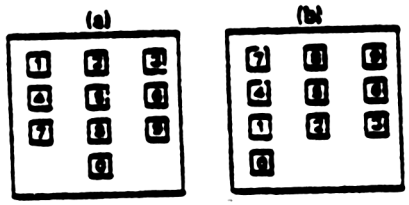

Exhibit 7-2. Acceptable arrangements of keys in a numeric-only keyboard.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment
			SEE PLANT COMMUNICATION TECH. SPECS.

2.2.3 AUDITORY CODING TECHNIQUES

Auditory signals may be coded. For example, coding can be used to prioritize signals or to direct operator attention to areas outside the primary operating area. If auditory coding is employed, the following principles should be applied:

a. DISTINCTIVE CODING—Coding methods should be distinct and unambiguous, and should not conflict with other auditory signals.

b. PULSE CODING—Auditory signals may be pulse coded by repetition rate, but the number of codes should be limited (2 or 3). Repetition rates should be sufficiently separated to ensure operator discrimination.

c. FREQUENCY CHANGE CODING—If modulation of the frequency (Hz) of a signal denotes information, center frequencies should be between 500 and 1000 Hz.

d. DISCRETE FREQUENCY CODING—Discrete-frequency codes may be used for audible signal coding. Frequencies should be broad band (±100 Hz) and widely spaced within the 200-5000 Hz range. No more than 5 separate frequencies should be used.

e. CODING BY INTENSITY — Coding by intensity is not recommended.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

7.1.3 PROMPTING AND STRUCTURING

The ability of operators to interact successfully with the computer system can be aided significantly by attention to structuring of input and output information and by providing prompts to orient and guide the user.

a. OPERATOR REQUESTS—The computer system should contain prompting and structuring features by which an operator can request additional information.

b. CORRECTION OF DATA—The computer system should contain prompting and structuring features by which an operator can request corrected information when an error is detected.

c. MODE/FILE DISPLAY—Are the displays appropriately titled to allow operator recognition of the processing being performed?

d. SPECIFIC ERROR CORRECTION—The computer system should permit correction of individual errors without requiring re-entry of correctly entered data.

e. ENTRY FILE—The computer system should contain a sequential file of operator entries, available upon operator request.

COMMUNICATIONS 2.0

AUDITORY SIGNAL SYSTEMS 2.2

GUIDELINE

2.2.4 PROPAGATION OF SIGNALS

a. DIRECTION OF SOUND – Sound sources (speakers, buzzers, etc.) should direct sound toward the center of the primary operating area.

b. AUDIBILITY – Auditory alert and warning signals should be audible in all parts of the control room.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment
			SEE PLANT COMMUNICATION TECH. SPECS.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

7.1.2 OPERATOR/COMPUTER DIALOGUE

Users of computer systems interact most successfully with the system through the use of a "dialogue" which both the person and the computer can understand. This dialogue is usually called "command language." Selection of a command language can depend on many factors including the type of computer system, the expertise of the user, the frequency of interaction, the type of interaction, etc. The following guidelines should be considered.

a. LANGUAGE CHARACTERISTICS

(1) Dialogue should be based on the operator's point of view, not the programmer's.

(2) Dialogue should be logical.

(3) Dialogue should be used in a consistent manner.

(4) Dialogue should reflect the vocabulary and syntax of the expected user population.

(5) Input words (e.g., keywords) should approximate real words.

(6) Dialogue should require an explicit command in order to terminate an interaction.

b. ENTRY LENGTH—Individual input words which must be typed should not exceed 7 characters.

COMMUNICATIONS 2.0
AUDITORY SIGNAL SYSTEMS 2.2

GUIDELINE

2.2.7 RELIABILITY

a. FAILURE OF ALARM CIRCUITRY—Failure of auditory signal circuitry should not adversely affect plant equipment.

b. FALSE ALARMS—Auditory alarm systems should be designed so that false alarms are avoided.

c. SYSTEM TEST—Auditory signal system test capabilities should be provided.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

6.6.3 USE OF MIMICS (Cont'd)

c. SYMBOLS

(1) Graphic symbols should be readily understood and commonly used.

(2) Symbols should be used consistently.

ALARM SYSTEMS 3.0

GENERAL SYSTEM CHARACTERISTICS 3.1

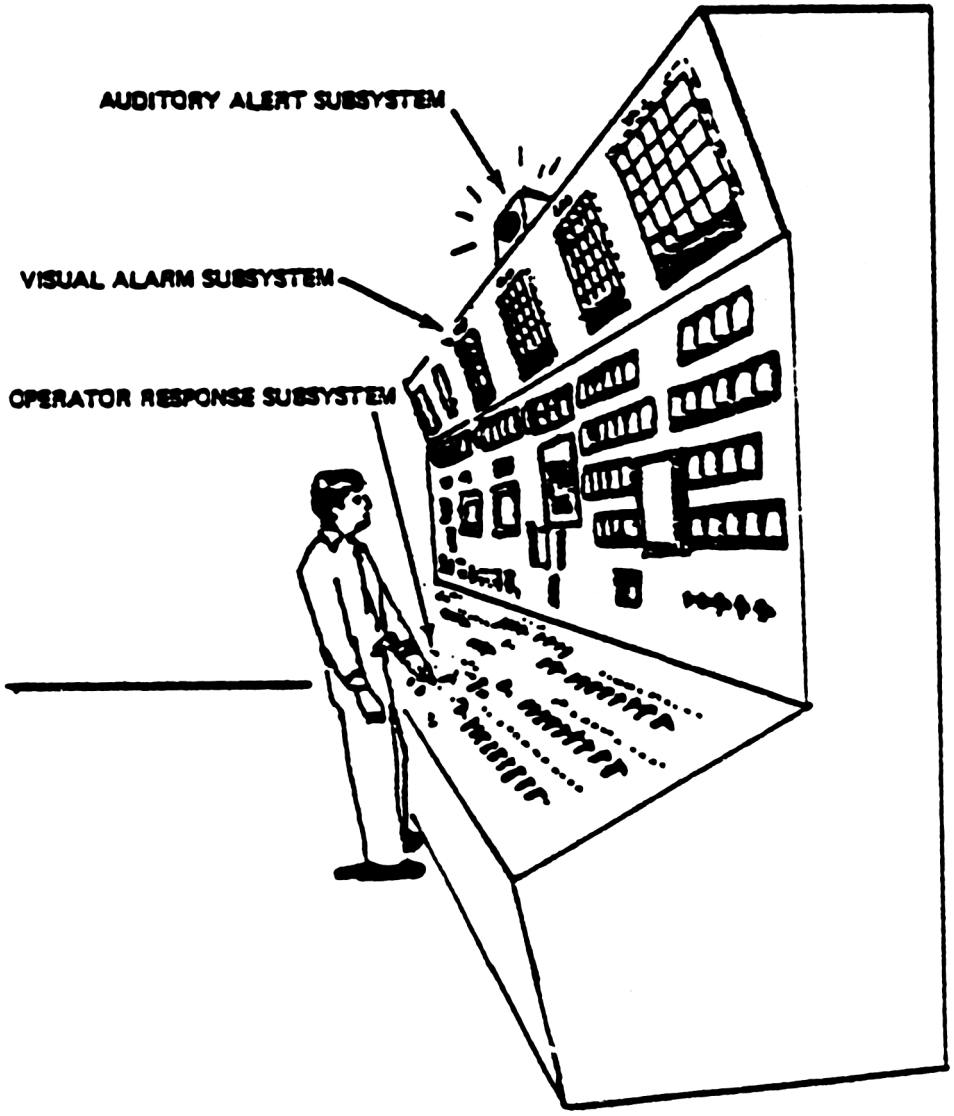

Exhibit 3-1. Alarm system

LABELS AND LOCATION AIDS 6.0
LOCATION AIDS 6.6

GUIDELINE

GUIDELINE

6.6.1 DEMARCATION

a. CONTRAST—Lines of demarcation should be visually distinctive from the panel background.

b. PERMANENCE—Lines of demarcation should be permanently attached.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

GUIDELINE

6.6.2 COLOR

Color should be dedicated to specific functions or conditions throughout the control room in order for the code to elicit the expected operator response. The color coding scheme should be used consistently throughout the control room.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

3.1.2 ALARM PARAMETER SELECTION

Plant parameters selected for inclusion in the annunciator warning system and the limits or alarm set points for those parameters should be established to ensure compliance with technical specifications and to allow the operator to monitor the status of the plant and respond to out-of-tolerance conditions effectively. The following general guidelines are suggested to increase the operational effectiveness of the annunciator warning system.

a. SET POINTS—The limits or set points for initiating the annunciator warning system should be established to meet the following goals:

(1) Alarms should not occur so frequently as to be considered a nuisance by the operators.

(2) However, set points should be established to give operators adequate time to respond to the warning condition before a serious problem develops.

b. GENERAL ALARMS

(1) Alarms that require the control room operator to direct an auxiliary operator to a given plant location for specific information should be avoided.

(2) If general alarms must be used, they should only be used for conditions that allow adequate time for auxiliary operator action and subsequent control room operator action.

c. MULTICHANNEL OR SHARED ALARMS

(1) Annunciators with inputs from more than one plant parameter set point should be avoided. Multi-input alarms that summarize single-input annunciators elsewhere in the control room are an exception.

LABELS AND LOCATION AIDS 6.0

USE AND CONTROL OF TEMPORARY LABELS 6.5

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

6.5.1 USE

When necessary to identify out-of-service equipment; accommodate unique, one-time plant activities; or to improve operator understanding and efficiency, temporary labels may be used until permanent labels are available or until the temporary label is no longer necessary.

a. NECESSITY—Temporary labels should be used only when necessary.

b. HUMAN FACTORS PRACTICES—Temporary labels should conform to good human engineering principles.

c. VISIBILITY—Temporary labels should not obscure prior permanent labels unless the old label is to be replaced.

d. IDENTIFICATION—Tag-out labels should clearly identify out-of-service components and equipment.

e. MOUNTING—Tag-outs should be securely affixed.

f. OBSCURATION—Tag-outs should not obscure the label associated with the non-operable device.

g. ACTIVATION—Tag-outs should be designed to physically prevent actuation of a control.

h. ADJACENT DEVICES—Tag-outs should not obscure any adjacent devices or their associated labels.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

3.1.3 FIRST OUT ANNUNCIATORS

As an aid to diagnostic procedures, provision should be made for identifying the initiating event (first out) associated with automatic plant shutdowns.

a. REACTOR SYSTEM

(1) A separate first out panel should be provided for the reactor system.

(2) The first out panel should consist of separate annunciator tiles for each of the automatic reactor trip functions.

(3) In the event of a reactor trip, the tile associated with the event should illuminate, and no other.

b. TURBINE-GENERATOR SYSTEM—A separate first out panel, similar in function to the reactor system panel, is recommended.

c. POSITION—First out panels should be located directly above the main control work station for the system.

d. APPLICATION—First out annunciators should conform to the general auditory, visual, and operator response guidelines of this section.

LABELS AND LOCATION AIDS 6.
LABEL LETTERING 6.4

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3.1.4 PRIORITIZATION (Cont'd)

b. PRIORITY CODING

(1) Some method for coding the visual signals for the various priority levels should be employed. Acceptable methods for priority coding include color, position, shape, or symbolic coding.

(2) Auditory signal coding for priority level is also appropriate. See Guideline 2.2.3 for recommended coding techniques.

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comments

GUIDELINE

6.3.9 ACCESS OPENING, DANGER, WARNING, AND SAFETY INSTRUCTION LABELING

a. ACCESS OPENING LABELS—Each access opening used by control room operators should be labeled to identify the function of items accessible through it.

b. DANGER, WARNING, AND SAFETY INSTRUCTION LABELS—All danger, warning, and safety instruction labels should be in accordance with appropriate safety standards.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

3.2.1 SIGNAL DETECTION

The first requirement for an effective annunciator warning system is rapid penetration of the operator's awareness under any and all conditions. Some "worst case" conditions might be: (a) during the first graveyard shift after four days off-duty, (b) the sixteenth hour of work occasioned by the sudden illness of the relief operator, (c) a warning signal appearing while the operator is very busy attending to the three or more immediately preceding problems, or (d) a warning signal appearing after a series of false or nuisance alarms. Specific principles for the auditory alert subsystem follow.

a. INTENSITY—The signal should be such that operators can reliably discern the signal above the ambient control room noise. A nominal value of 10 dB(A) above average ambient noise is generally adequate.

b. CONTROL—Signal intensity, if adjustable, should be controlled by administrative procedure.

c. LIMITS—The signal should capture the operator's attention but should not cause irritation or a startled reaction.

d. DETECTION—Each auditory signal should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operating area.

e. RESET—The annunciator auditory alert mechanism should automatically reset when it has been silenced.

f. IDENTIFICATION—The operator should be able to identify the work station or the system where the auditory alert signal originated.

GUIDELINE

6.3.7 FUNCTIONAL GROUPS

a. FUNCTIONAL RELATIONSHIP—Labels should be used to identify functionally grouped controls or displays.

b. LOCATION—Labels should be located above the functional groups they identify.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

ALARM SYSTEMS 3.0
VISUAL ALARM SUBSYSTEMS 3.3

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

3.3.1 VISUAL ANNUNCIATOR PANELS

Annunciator panels are generally organized as matrices of visual alarm tiles. These matrices, separated into groups by function, are usually positioned along the top of the control boards or consoles (see Guidelines 1.2.2 and 1.2.3).

a. LOCATION—Visual alarm panels should be located above the related controls and displays which are required for corrective or diagnostic action in response to the alarm. (See Exhibit 3-4.)

b. LABELING

(1) Each panel should be identified by a label above the panel.

(2) Panel identification label height should be visible when viewed from a control position within the primary operating area.

c. LAMP REPLACEMENT

(1) If a lamp replacement requires legend tile removal, there should be a way to ensure that the tile is replaced in the correct location.

(2) Lamp replacement should not subject the operator to a shock hazard.

(3) Operator aids should be provided if needed for lamp replacement.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

6.3.5 BREVITY

Brevity should not be stressed if the results will be unfamiliar to operating personnel. Words on labels should be concise and still convey the intended meaning. See Exhibit 6-7.

24 VDC SWITCHBOARD	24 VOLT DIRECT CURRENT SWITCHBOARD
PREFERRED	NON-PREFERRED

Exhibit 6-7. Labeling brevity.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

3.3.2 VISUAL ALARM RECOGNITION AND IDENTIFICATION

Specific guidelines for visual recognition and identification of alarmed tiles follow:

a. FLASHING – The specific tile(s) on an annunciator panel should use flashing illumination to indicate an alarm condition.

b. FLASH RATE – Flash rates should be from three to five flashes per second with approximately equal on and off times.

c. FLASHER FAILURE – In case of flasher failure of an alarmed tile, the tile light should illuminate and burn steadily.

d. CONTRAST DETECTABILITY – There should be high enough contrast between alarming and steady-on tiles, and between illuminated and non-illuminated tiles, so that operators in a normally illuminated control room have no problem discriminating alarming, steady-on, and steady-off visual tiles.

e. "DARK" ANNUNCIATOR PANELS – A "dark" annunciator panel concept should be used. This means that under normal operating conditions no annunciators would be illuminated; all of the visual tiles of the annunciator panels would be "dark."

f. EXTENDED DURATION ILLUMINATION – If an annunciator tile must be "ON" for an extended period during normal operations (e.g., during equipment repair or replacement), it should be:

(1) Distinctively coded for positive recognition during this period, and

(2) Controlled by administrative procedures.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

6.3.3 CONSISTENCY

a. ADMINISTRATIVE CONTROL—A list of standard names, acronyms, abbreviations, and part/system numbers used should be per appropriate TVA procedures and standards.

b. INTERNAL CONSISTENCY—Labels should be consistent within and across pieces of equipment in their use of words, acronyms, abbreviations, and part/system numbers. See Exhibit 6-6.

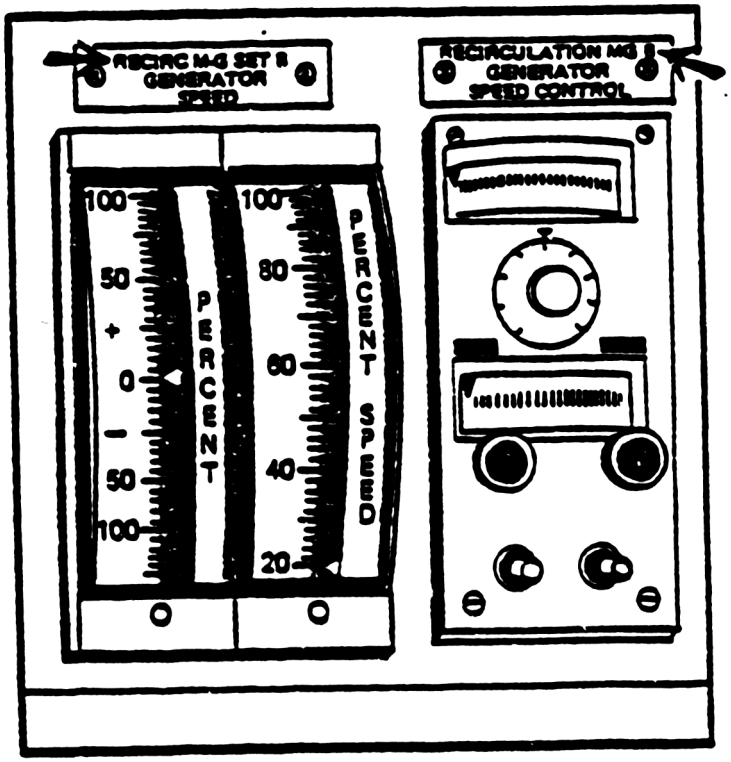

Exhibit 6-6. Inconsistent labeling.

ALARM SYSTEMS 3.0
VISUAL ALARM SUBSYSTEMS 3.3

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

3.3.3 ARRANGEMENT OF VISUAL ALARM TILES (Cont'd)

e. OUT-OF-SERVICE ALARMS—Cues for prompt recognition of an out-of-service annunciator should be designed into the system.

f. BLANK TILES—Blank or unused annunciator tiles should not be illuminated (except during annunciator testing).

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

6.3.1 KINDS OF INFORMATION

Labels should describe the function of equipment items. If needed for clarity, engineering characteristics or nomenclature may also be described.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

3.3.5 VISUAL TILE READABILITY

a. DISTANCE—The operator should be able to read all the annunciator tiles from the position at the work station where the annunciator acknowledge control is located.

Letter height should conform to the values given in Table 3.3 on Page 3-19.

(1) Letter height should be identical for all tiles, based on the maximum viewing distance. Separate calculations should be made for stand-up and sit-down work stations.

b. TYPE STYLE—The size and style of lettering should meet the following:

(1) Type styles should be simple.

(2) Type styles should be consistent on all visual tiles.

(3) Only upper-case type should be used on visual tiles.

c. LEGEND CONTRAST—Legends should provide high contrast with the tile background.

(1) Legends should be engraved.

(2) Legends should be dark lettering on a light background.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

6.2.3 SPATIAL ORIENTATION

Improperly oriented labels can lead to confusion and cause delays in location and identification of important controls and/or displays.

a. HORIZONTAL ORIENTATION

(1) Where possible labels should be oriented horizontally so that they may be read quickly and easily from left to right.

b. CURVED PATTERNS—Curved patterns of labeling should be avoided. See Exhibit . 6-5.

Exhibit 6-5. Poor practice: Curved pattern.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

3.4.1 CONTROLS

Controls for operator response to the annunciator system include silence, acknowledge, reset, and test controls. (See Exhibit 3-5.)

a. SILENCE

(1). A method of silencing the audible alert should be provided.

(2) It should be possible to silence an auditory alert signal from any set of annunciator response controls in the primary operating area.

b. ACKNOWLEDGE

(1) A control should be provided to terminate the flashing of a visual tile and have it continue at steady illumination until the alarm is cleared.

(2) Acknowledgement should be possible only at the work station where the alarm originated.

c. RESET

(1) If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared.

(2) The reset control should silence any audible signal indicating clearance and should extinguish tile illumination.

(3) The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.

d. TEST

(1) A control to test the auditory signal and flashing illumination of all tiles in a panel should be provided.

(2) Periodic testing of annunciators should be required and controlled by administrative procedure.

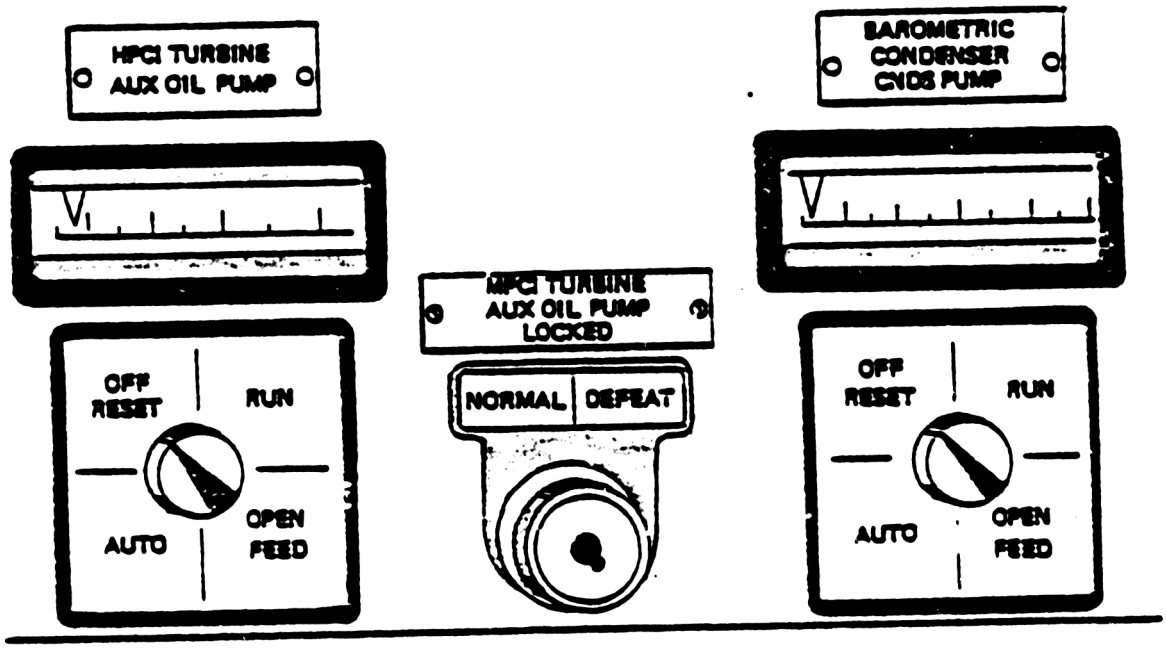

Exhibit 6-4. Adjacent labels with good separation.

ALARM SYSTEM 3.0
OPERATOR RESPONSE SUBSYSTEM 3.4

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

3.4.2 CONTROL SET DESIGN

a. POSITIONING OF REPETITIVE GROUPS—Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations. This is to facilitate "blind" reaching.

b. CONTROL CODING—Annunciator response controls should be coded for easy recognition using techniques such as:

Color coding;

color shading the group of annunciator controls;

demarcating the group of annunciator controls.

c. NONDEFEATABLE CONTROLS—Annunciator control designs should not allow the operator to defeat the control. For example, some pushbuttons used for annunciator silencing and acknowledgement can be held down by inserting a coin in the ring around the pushbutton. This undesirable design feature should be eliminated.

GUIDELINE

6.2.1 PLACEMENT

a. NORMAL PLACEMENT – Labels should be placed above the panel element(s) they describe.

b. PANEL LABELING—The placement of labels on control panels should conform to the guidance shown in Exhibit 6-1.

c. VISIBILITY ENHANCEMENT—Labels for elements located above eye level should be positioned to ensure label visibility.

d. PROXIMITY—Labels should be placed close to the panel element. See Exhibit 6-2.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

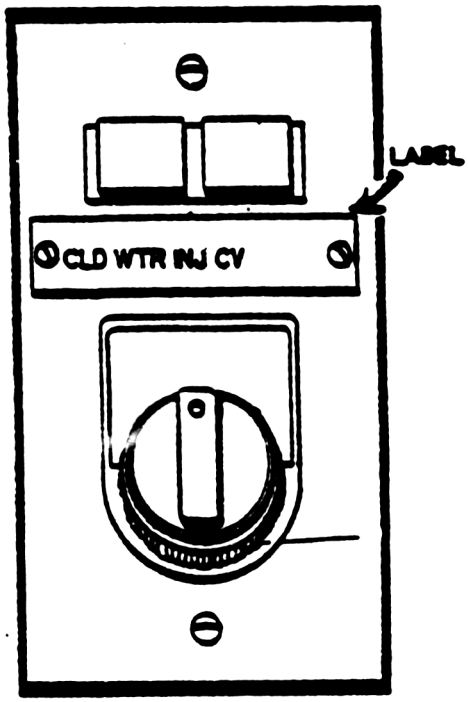

Exhibit 6-2. Label in close proximity to panel element.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

6.1.2 HIERARCHICAL SCHEME

To reduce confusion, operator search time, and redundancy, a hierarchical labeling scheme should be used. (See Exhibit 6-1.)

a. RANKING

(1) Major labels should be used to identify major systems or operator work stations.

(2) Subordinate labels should be used to identify subsystems or functional groups.

(3) Component labels should be used to identify each discrete panel or console element.

(4) Labels should not repeat information contained in higher-level labels.

b. LETTER GRADATIONS—If possible labels should be graduated in letter size such that:

(1) System/work station labels are about 25% larger than

(2) Subsystem/functional group labels which are about 25% larger than

(3) Component labels which are about 25% larger than

(4) Control position identifiers.

CONTROLS 4.0

SELECTION OF CONTROLS 4.1

COMPLIANCE CHECKLIST

N/A	Yes	No	References/Comment

4.1 GENERAL PRINCIPLES (Cont'd)

d. COMPATIBILITY WITH EMERGENCY GEAR —If used while wearing protective equipment (e.g., oxygen masks, protective gloves), controls should be:

(1) Easy to identify.

(2) Easy to activate.

e. DURABILITY—Controls should be sufficiently rugged to withstand normal and emergency use. Each control should retain its appearance, "feel," and functional characteristics during its service life.

(1) Broken, chipped, or crumbled control surfaces should not ordinarily occur.

(2) Control knobs or handles should not rotate, slip, or move loosely on their shafts.

(3) No internal wear or breakage should occur which alters the "feel" or other sensory feedback of a control. Controls should not develop internal looseness, binding, or backlash.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

5.5.2 ELECTRONIC COUNTERS

Electronic counters using "Nixie" tubes, light emitting diodes (LEDs), or other electroluminescent devices may be preferred over mechanical counters in many control room applications.

a. NUMERICAL PRESENTATION FACTORS

(1) ORIENTATION – Multi-digit counters should be oriented to read horizontally from left to right.

(2) CHARACTER STYLE–Simple character fonts should be used. Styles using variable stroke widths, slanted characters, etc. should be avoided.

(3) NUMERAL HEIGHT–Numerals should be of such a height as to subtend a visual angle of 15 minutes from the farthest anticipated viewing distance.

(4) WIDTH-TO-HEIGHT RATIO – Width-to-height ratio of numerals should be approximately 3:5.

(5) SPACING–Horizontal spacing between numerals should be between one-quarter and one-half the numeral width.

b. RATE OF CHANGE – Numerals should not follow each other faster than two per second when the operator is expected to read the numerals consecutively.

CONTROLS 4.0

SELECTION OF CONTROLS 4.1

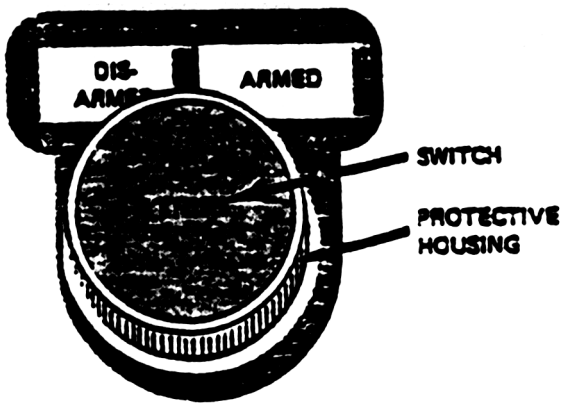

Exhibit 4-1. Recessed pushbutton switch.

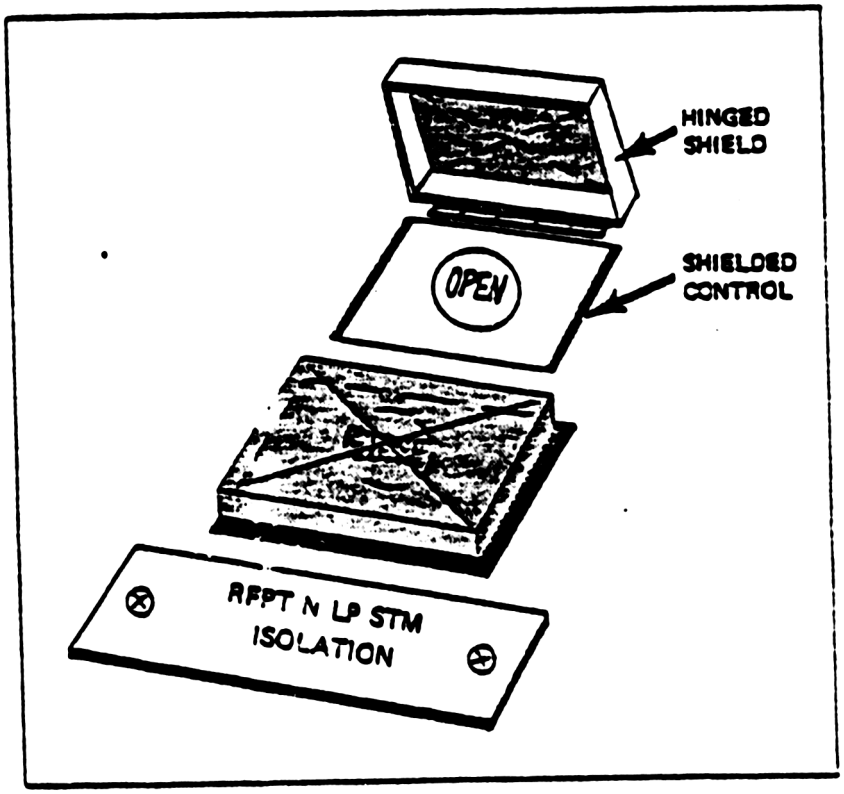

Exhibit 4-2. Control with hinged plastic shield.

GUIDELINE

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

5.5.1 DRUM-TYPE COUNTERS

Counter-type presentation of information is useful when there is a need for quick, precise reading of quantitative value and trend information is not needed.

a. NUMERICAL PRESENTATION FACTORS

(1) ORIENTATION – Multi-digit numbers formed by several counter drums should be read horizontally from left to right (see Exhibit 5-14).

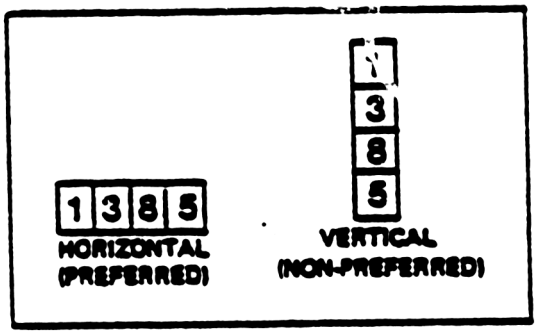

Exhibit 5-14. Preferences for counter orientation.

(2) WIDTH-HEIGHT RATIO—To compensate for the distortion imposed by the curved surface of the drum, counter numerals should reflect a width-height ratio of 1:1, not 3:5 as recommended for numerals of other displays.