3-1 GENERAL

This chapter discusses basic considerations for design and review of ACES Center projects in relation to the individual space criteria and space organization principles in Chapters 4 and 5. The discussion includes the design requisites and documentation required, basic site development and building design criteria, considerations for related furnishings and equipment and provisions for user information. In addition, there are several overriding considerations that must be accounted for in all aspects of design.

a. BARRIER FREE DESIGN. ACES Centers must be accessible to all persons. Provisions will conform to ER 1110-1-102 and EM 1110-1-103, Design for the Physically Handicapped. Barrier free design is extremely important in both site development and building design and will provide valuable conveniences to the able-bodied as well as the handicapped.

b. ENERGY CONSERVATION. Use of energy conserving techniques relates to both site development and building design. Solar orientation, building compactness, and passive conservation measures as well as active measures will be considered for application as appropriate to each individual project.

c. FLEXIBILITY. The need for flexibility primarily relates to the need to make internal functional changes that may occur during the course of normal operation. Changes may routinely occur in courses being taught, teaching or training techniques and equipment, and student load. Multi-purpose use should be considered in the design of floor loads, ceiling heights, and wall systems. Provision of adequate storage spaces is extremely important as is the capability for adapting environmental services to changing requirements. Space specifically designed for a single purpose or space containing permanently installed equipment reduces flexibility and should be limited, insofar as possible, to areas whose functional requirements dictate that multi-purpose use is inappropriate.

d. LIFE CYCLE ENHANCEMENT. During design, consideration must be given not only to the initial cost of construction, but also to the cost of operation, maintenance, and custodial care during the intended life of the building. Both initial and life costs must be analyzed, especially in the selection of utility systems, exterior materials and interior finishes.

3-2 DESIGN REQUISITES AND DOCUMENTATION.

Project design development is discussed in AR 415-20. Use of the Project Development Brochure and DD Form 1391 data as approved by HQDA for inclusion in the proposed (or approved) military construction program, is prerequisite to design development which is the responsibility of the design agency.

a. CONCEPT DESIGN. Initially, concept design drawings and analyses are required to help verify costs, and further define the functional aspects of the facility before initiation of final design. Generally, the concept design will be completed by the design agency and *approved* by the installation before construction funds are actually appropriated. The following level of detail in documentation is required.

3-2 DESIGN REQUISITES AND DOCUMENTATION (cont'd)

(1) Site Plans. Site plans will show, as a minimum, floor elevations, existing and finished grades, existing and proposed buildings, roads, parking and utilities in the immediate project vicinity, outside utility connections, signage, existing vegetation, proposed lawns and planting masses, and solar orientation. Grading, paving, utility and landscape development plans must also be shown.

(2) Design Drawings. Design drawings will include as a minimum a graphic description of the design, including floor plans, sections, and elevations, with sufficient detail to describe the geometric and construction characteristics of the building; written specifications describing the required properties and/or performance of the construction, including materials, installation, workmanship and methods; and an interior design scheme with complete schedules of finishes, colors, patterns, and furnishings and equipment (attached and detached).

(3) Design Analyses. Design analyses will contain supporting data for all aspects of the design, including architectural, structural, mechanical, electrical and communication, fire safety, etc. Cost estimates for both primary and supporting facilities, will contain basic determinations commensurate with the level of detail of the rest of the design.

b. FINAL DESIGN. Final design will be based on the approved concept design. To, assure that approved concept requirements have been met, an in-process review of design documents by the installation should be made near completion of final design. Final documents must be sufficient to allow the project to proceed to competitive bidding and construction contract award. Basically, the final design will include a design analysis, drawings and specifications prepared in accordance with ER 1110-345-700, 710, and 720 respectively.

3-3 SITE DEVELOPMENT

Design of supporting facilities as part of the site development will be consistent with the project requirements previously established. Successful site design is embodied in developing an appropriate relationship between building and site, an efficient vehicular and barrier-free pedestrian system, and an overall landscaping and signage plan. These considerations are discussed in the following paragraphs. Reference should also be made to TM 5-803-3, Site Planning.

a. BUILDING-SITE RELATIONSHIP. In developing an appropriate building-site relationship, the terrain, soil characteristics, local vegetation, and climatic conditions of the site must be considered along with the utilities support, and relationships to other buildings in the area.

(1) Terrain Configuration and Site Coverage. The site design process requires analysis of the scale and character of the geographic and topographic features of the site. Large scale features, such as site slope characteristics, generally require specific architectural and landscape responses. Both large and small scale features should be considered from the standpoint of their potential landscape value. The building should be designed to blend with the contours of the terrain. If other considerations, such as solar orientation, dictate that the building cross contours, a multi-level building may be desirable. As a

3-3 SITE DEVELOPMENT (cont'd)

rule of thumb, the maximum recommended coverage of the site by the building is 40 percent. Optimum coverage is generally considered to be about 30 percent. Allowances for future expansion should also be considered.

(2) Soil Characteristics and Drainage. The organic composition and drainage characteristics of the soil is important to the design of building foundations and the economy of construction, as well as to the landscaping of the site. The drainage characteristics and compressive bearing strength of the soil are critical in foundation design and must be determined in accordance with TM 5-818-1, Procedures for Foundation Design of Buildings and other Structures. The determination of soil drainage characteristics will also include assessing the effects of the proposed building and its adjacent paved areas on the ground water level. Overlot grading must be established to provide positive drainage of the entire site away from the building and outside facilities. Grading should be designed for optimum preservation for existing ground forms and drainage patterns.

(3) Vegetation and Tree Coverage. Existing vegetation and trees should be preserved in their natural setting to the greatest extent possible consistent with functional requirements. This can help reduce the environmental affects of wind and sun, as well as the requirement for landscape planting and temporary erosion controls.

(4) Climatic Conditions. Skillful utilization of natural environmental controls can significantly increase building utility and efficiency.

(a) Wind. Structures affect air movement. They block or divert winds or channel them through narrow openings. Normally, the entrance should face away from the prevailing winds, or should be shielded by vegetation or part of the building. Features should be placed on the site so as to control wind-blown trash or snow, and aid in dispersal of emissions (smoke, fumes, dust).

(b) Sun. Solar controls should be planned to help achieve maximum energy savings. External shading devices are the most effective means of solar shading. Deciduous trees can provide shade in summer and penetration of sunlight in the winter.

(5) Exterior Utilities. Utility support systems must be carefully analyzed with respect to location, connection into the building and subsequent operation and maintenance. Utility areas, such as for transformers, utility connections, etc., shall be screened by use of plantings, land forms, or architectural screens to blend with the surroundings.

(6) Relationship to Other Buildings. The ACES Center will have been located during the planning process so as to establish some relationship to other community-type facilities. Subsequently, the site must be arranged to develop the relationship between the ACES Center and any existing spaces being used as well as the main library and service facilities such as the exchange, commissary, etc.

3-3 SITE DEVELOPMENT (cont'd)

b. PEDESTRIAN AND VEHICULAR SYSTEM. A safe and convenient pedestrian and vehicular system must be established. The system should separate pedestrian and vehicular activities as much as possible and incorporate requirements for the physically handicapped in accordance with EM 1110-1-103.

(1) Walkways. The pedestrian system is essentially established by the pattern of walkways designed to support access and egress to and from usable entrances of the ACES Center. Generally, walkways should be designed to complement the natural flow of pedestrian traffic, be 6' wide, and slope no more than 1 in 24 blending to a common level with other surfaces. Where significant level changes are required, both steps and ramps should be provided. Walks crossing roadways must be marked and provided with curb ramps, if curbs are used.

(2) Roadways. Vehicular arterials should not run through the ACES Center grounds or between the Center and closely related facilities such as the library. A pedestrian drop-off and pick-up zone should be provided near the main entrance to the Center, and be designed to be barrier free.

(3) Parking. A principal part of the vehicular system involves parking facilities for the cars and motorcycles of students and staff. The number of parking spaces required shall be based on a traffic analysis at the installation, taking into consideration time and space intervals related to the ACES instructional activities, and available mass transportation, car pooling, etc. A portion of the car parking spaces will be designed for use by handicapped drivers and *carefully* located to avoid having to cross a roadway to gain access to the building. Parking should be orderly and if possible dispersed and accented with landscape features.

(4) Service Access. Service roads and areas should be separated whenever possible from pedestrian oriented roadways, parking and walkways. In the outside areas related to vocational training; service requirements, car storage and parking may be combined. However, it is essential that the vehicular system provide access for fire fighting equipment, trash removal and other servicing equipment as well as for deliveries. Service areas and service roads must be sized to accommodate the turning radii and maneuvering requirements of the largest vehicles. At the same time, the extent of paving should be minimized. Screening for service areas should be accomplished in conjunction with the screening of utilities features.

c. LANDSCAPING AND SIGNAGE PLAN. In conjunction with establishing the building-site relationship and the pedestrian-vehicular system, a landscaping and signage plan will be developed.

(1) Signage. Direction signs and signs identifying buildings, parking areas, service areas, and facilities for the handicapped are required and shall be developed as an overall system together with the signage required for the building. Design shall conform to the signage criteria discussed under Building Design.

3-3 SITE DEVELOPMENT (cont'd)

(2) Landscape Perception. An important part of the landscape plan is consideration for the visual experience. A landscape is usually seen from an unlimited number of viewpoints, but a selected set of viewing positions can be designed into the landscape plan from where special features would be enhanced when viewed from those positions. Viewing positions will be established in conjunction with the design of the pedestrian system and the architectural image of the building. Sight lines from these positions must be carefully analyzed with respect to the visual and other aesthetic experiences to be created by the landscape plan; and with respect to the overall image to be established for the ACES Center. Sight lines from inside building windows are also important in developing the landscape plan as windows often function as focal points on the landscape as well as provide natural light.

(3) Planting Design. Existing land forms, trees and vegetation should be preserved and incorporated into the landscape plan wherever possible. Plants can be used to modify or enhance climatic characteristics, reduce noise levels and control the flow of air. New plant materials should be available locally, easily maintained, and compatible with the surrounding environment without excessive irrigation needs. Where new materials are used, the initial plant size should be adequate to give the desired visual and protective effects. Parking areas should be screened with buffer planting and variegated with substantial islands of vegetation. For details on planting design, reference should be made to TM 5-830-1.

(4) Outside Furnishings. Where outside instructional activities or other functions such as study or waiting occur, appropriate furniture and equipment will be provided as part of the overall landscape plan. Provide bicycle racks to accommodate bicycle parking as appropriate. Trash receptacles, bollards, light standards and other common site elements shall be designed as part of an overall scheme. Items, fully attached to the site or building, will be included as part of the construction contract. Portable items will be included as part of the Related Furnishings and Equipment information to be developed for procurement by the installation.

(5) Lighting. Provide general parking and walkway lighting of 2 foot-candles at ground level. Areas accessible to the handicapped after dark must be lighted to 5 foot-candles at ground level.

3-4 BUILDING DESIGN

Building design will basically conform to the project requirements previously established, and applicable DOD, Army and Engineer criteria. The quality of building design may very well determine whether or not the ACES facility will maintain its usefulness and value. In this respect, successful development of the building's architectural image, functional layout, structure and environmental support systems, and interior detailing is of prime importance.

a. ARCHITECTURAL IMAGE. The architectural image is established by the characteristics of design that make the building appear inviting, adapted to the environment, and identifiable as an ACES Center.

3-4 BUILDING DESIGN (cont'd)

(1) Inviting Design Characteristics. The ACES Center must reinviting and convenient to visitors as well as routine users. Especially important are the location, expression, and identification of entrances in relation to the approaches on the building site. The design of the ACES Center should reflect the scale and nature of the activities involved and invite participation therein.

(2) Adaptation to Environmental Context. One measurement of good building design is the success with which the facility is adapted to its particular environment. Specifically, such factors as site and climate provide the basis for determining appropriate architectural responses. For example, a hot, sunny environment requires a facility that provides protection from heat and glare, with entrances that accomplish a comfortable transition between the bright sun on the exterior and the relatively dark interior. In wet climates, rain protection at exits and between building elements should be considered, and in colder climates, compact buildings that increase floor space per unit area of exterior surface and door circulation should be used. Environmental considerations such as these are an integral part of an attractive and functional design.

(3) Facility Identity and Perception. The ACES Center building must be readily identifiable as a unit and have a visually apparent organization that facilitates orientation and circulation. These basic perceptual qualities are essential to the further development of a system of viewing positions and settings to communicate the aesthetic intent of the building design. A series of viewing positions, intentionally planned into the approaches to the building and continuing on into the space organization within, shall be established for this purpose, and identified in the design analysis. The settings will be composed of elements of the building design, such as the sizes and shapes of the building's exterior masses and interior spaces, the color, texture and lighting of those elements, and the visual articulation or decoration thereof.

(4) Exterior Detailing. The color, texture and scale of building materials should generate visual interest, as well as establish characteristics appropriate to the overall scale and image of the installation. The articulation of the exterior mass of the building is also an important consideration.

(a) Wall Shading. A substantial proportion of the air conditioning requirement for most buildings results from solar energy absorbed by building surfaces. By simply shading those portions of building receiving the most sun, cooling requirements can be significantly reduced. Methods of wall shading which should be considered include applying various forms of canopies or louvers to the walls, and use of deciduous trees. Each wall of the building may require a different treatment depending upon its orientation to the sun.

(b) Control of Glass Areas. In cases where the shading methods (mentioned above) are not practical, the choice of window glass becomes important. At a radiation angle of incidence of 40 degrees, ordinary glass admits 85% of the solar thermal energy that strikes the glass surface, while reflective glass admits 63%, heat-absorbing glass 60% and certain specialized glasses as little as 28%. Windows may also be recessed as illustrated in Figure 3-1. Such a design shades the window glass, substantially reducing the amount of solar energy striking the glass surface.

3-4 BUILDING DESIGN (cont'd)

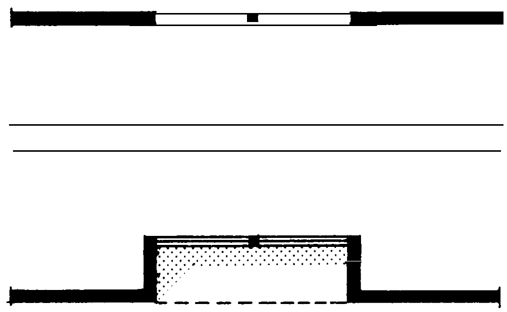


Figure 3-1 Glass Shading, South Elevation

b. FUNCTIONAL LAYOUT. The layout of ACES facilities is an extremely important part of the building design, affecting both the operational efficiency and performance of ACES activities as well as the cost of construction. An effective functional layout must relate to a standard space module, accommodate circulation flow and adjacency requirements, and conform to life safety criteria.

(1) Standard Space Module. Buildings are generally more economical to construct if designed in relation to a standard space module. A commonly accepted module in the building industry is the 5-foot square. Systems such as for ceilings, walls, lighting and air distribution are manufactured to readily adapt to the 5-foot module. Space allocation criteria contained in Chapter 4 reflect use of the 5-foot module in defining the NASF allowed for the various functions of the ACES program.

(2) General Instruction Space Modules. instructional spaces are required that will seat 12 to 25 students, occasionally up to 50; be easily convertible to other uses; and minimize disruption of activities during modification of use. Based on these requirements, a general instructional module of 30' x 25', expandable to 30" x 50' as shown in Figure 3-2 will be used where practicable. This 750 SF module provides ample space, in the proper dimensional proportions for 25 students seated at tables, for general classroom activities. Two 750 SF modules placed side by side form a 1500 SF module ample enough for 50 students for large lecture activities. Divided by fixed or movable walls into 375 SF modules, there is ample room for 12 students for seminar purposes.

(3) Adjacency Requirements. In developing the building design to meet the performance needs of the ACES program, spaces must be laid out to achieve essential adjacency relationships. Basically, there are three kinds of spaces needed to accommodate ACES program functions; staff spaces, instructional (academic and vocational) spaces, and support spaces. Each group of spaces represents in itself an overall adjacency relationship. The relationship of one group to another is an element of basic spatial organization as discussed in Chapter 5. The relationship of one individual space to

3-4 BUILDING DESIGN (cont'd)

another, as discussed in Chapter 4, is an element of functional layout. Generally, this is based on the degree of interaction of personnel, material or activities between two or more spaces. The greater the degree of interaction, the closer the spaces should be together unless there are interposing requirements for safety, or need for acoustic or visual separation.

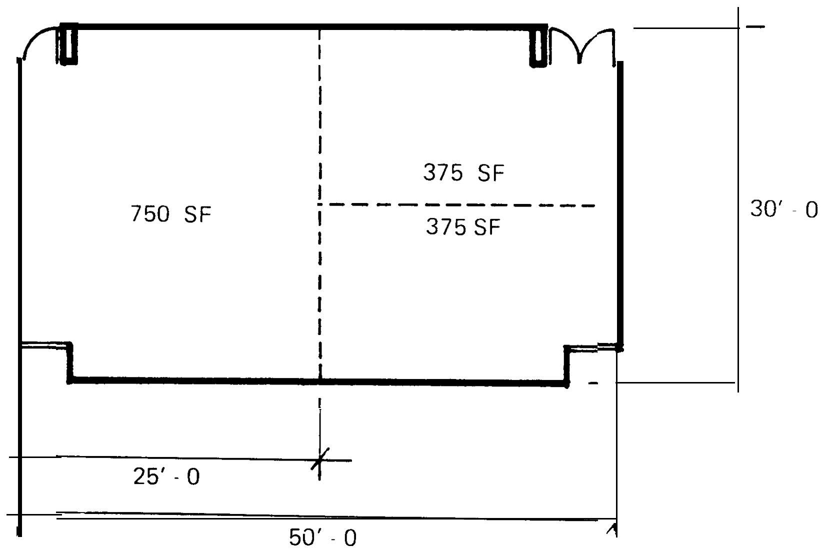


Figure 3-2 Modular General Instruction Space

(4) Circulation Flow. Corresponding with the layout of space adjacencies, a convenient and workable circulation flow must be established. The flow of students and staff; materials and services should not interfere with one another even though they must interface at certain points. Circulation requirements will greatly depend upon how well adjacency requirements are satisfied, and whether or not space organization assists orientation to the building. Spaces used frequently by persons unfamiliar with the ACES Center should be near the main entrance, and those that generate heavy traffic should be located close to entrances or circulation nodes. Like most education facilities, there will be predictable surges of circulation at the beginning of the instructional day, during break periods and the lunch hour, and at the end of the instructional day. Circulation systems must be capable of safely and comfortably handling these routine peak loads as well as those that might be experienced during an emergency evacuation of the building.

(5) Circulation Nodes. Horizontal circulation spaces should widen at points of queuing and decision, such as at corridor intersections, toilets and entrances to stairways. Such nodes should permit places for people to pause and possibly sit. At building entrances, the circulation space must provide for entering personnel to orient themselves and exiting personnel to prepare for outdoor

3-4 BUILDING DESIGN (cont'd)

weather conditions. A circular node should also be provided at elevators required to accommodate physically handicapped persons in multi-storied facilities.

(6) Evacuation. The building's functional layout must conform to life safety requirements. Evacuation during an emergency depends upon getting all of the occupants out of the building safely. This, in turn, means that limitations may have to be placed upon space sizes, locations and distances from exits. Also exits and passageways from the building must be sufficient in number and size. In most emergencies, elevators will become unusable; therefore, rescue areas or other measures may have to be considered for protection of the handicapped in multi-storied buildings.

(7) Related Considerations. Functional layout may also be affected by other considerations. For example, areas where surveillance is desired should be laid out in such a way as to allow visual control of circulation and other activities. Spaces with functions having common characteristics such as high noise levels or fire hazards; or special requirement for interior detailing, structure and environmental support; should be grouped together insofar as functional requirements for adjacencies will allow. Analyses should incorporate these and other considerations as appropriate to meet the requirements of each individual project.

c. STRUCTURE AND ENVIRONMENTAL SUPPORT. A successful building design must provide economical structure and environmental support systems selected for their ability to effectively support functional requirements and to operate efficiently. Environmental support includes heating, ventilation and air conditioning, lighting, electrical power and communication, plumbing, fire safety and acoustics.

(1) Structural Design. Design Loads and criteria will be in accordance with DOD 4270. 1-M and TM 5-809-1 through 6, 8 through 12. The structural systems and materials selected will be suitable for permanent type construction, be capable of carrying the required loads, conform to the standard space module, and be compatible with fire protection requirements, architectural concepts and functional requirements. The structure selected will be that system which is the most economical and suitable based on comparative cost studies for the building.

(2) Protective Construction. Design of structures for protection against seismic events and wind storms is prescribed in TM 5-809-10 and TM 5-809-11 respectively. In locations where a deficit in PF 100 fallout shelter space exists under the Army Survival Measures Plan, described in AR 500-72, selected areas of the structure will also be designed for dual use as fallout shelters. Technical and other requirements will be in accordance with TM 5-800-1, Construction Criteria for Army facilities. Single-line plans showing locations, occupant loads, and minimum protection factors for the selected shelter areas shall be developed and included in project design analyses and completion records.

(3) Ventilation, Temperature and Humidity Control. A controlled thermal environment is an important factor in designing comfortable, safe, and effective instructional spaces. Investigations in the area

3-4 BUILDING DESIGN (cont'd)

of human performance show that when temperature and humidity become high, working efficiency decreases, errors increase, and under extreme conditions health is adversely affected. In areas such as shops, in which students are working with equipment and machinery, temperature and humidity control may be required for safety purposes. Likewise, ventilation or exhaust systems may be required for health. All provisions must be consistent with applicable Occupational Safety and Health Act (OSHA) standards.

(a) Temperature Control. Whenever the daytime outside temperature is above 55 degrees F., heat gains will usually outweigh losses. Therefore, the fundamental problem in controlling the thermal environment in an ACES Center is cooling, rather than heating the facility. The desirable temperature for a building depends on the activity of its occupants. Acceptable temperature limits vary from 60-70 degrees for vigorous activity to 68-78 degrees for sedentary activity. In an ACES Center, where learning activities range from sedentary to vigorous, separate temperature zoning should be provided. For example, shop areas should be zoned for lower temperature than classrooms or staff areas.

(b) Humidity Control. Relative humidity has little influence on comfort, provided that it is in the intermediate range (30% to 70%). Humidity levels above 70% can impair human performance and levels below 30% can cause respiratory discomfort and create undesirable levels of static electricity in activity spaces.

(c) Ventilation. In a closed, occupied space, the amount of oxygen in the air decreases and the amount of carbon dioxide increases. Normally, ventilation of 6-10 air changes per hour is sufficient for maintaining the proper balance between oxygen and carbon dioxide. Dust, pollen, and bacteria should be eliminated by air filtration. Ventilation criteria for individual spaces are summarized in Chapter 4, Table 4-1. Air distribution systems should provide uniform air velocities generally not exceeding 40 feet per minute for an air-conditioned draft-free environment.

(4) Mechanical Design. Heating, air conditioning and mechanical ventilation shall conform to the applicable portions of DOD 4270. 1-M and TM 5-810-1. Heating and air conditioning load calculations shall comply with the procedures of the latest ASHRAE Handbook of Fundamentals. The "U" values for exterior walls, ceilings, and floors shall be in accordance with DOD 4270.1-M. Design temperatures shall be 68°F. for heating; 78°F. for cooling. Various systems should be considered to accommodate the environmental requirements of the different types of spaces in the ACES Center. Selection will be based on performance, least energy use and cost of operation and maintenance. Energy recovery systems should be investigated and incorporated into the design if economical. Reasons for selection and rejection of systems must be included in project design analyses.

(5) Lighting. An appropriate visual environment with adequate lighting is essential for effective learning. A well lighted classroom enhances auditory as well as visual perception.

(a) Illumination Levels. Research has established that a lighting level between 20 and 50 foot-candles is adequate for the comfortable and efficient completion of most tasks. However, it is

3-4 BUILDING DESIGN (cont'd)

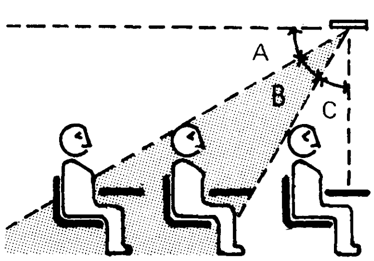
recommended that illumination be designed to supply 70 foot-candles on all educational and office tasks, since accurate reading of pencil handwriting demands higher illumination levels than most other visual tasks. Lighting levels higher than 70 foot-candles are not required. Lighting level criteria for individual spaces are summarized in Chapter 4, Table 4-1.

(b) Adapting to Illumination Changes. In moving from one space to another, an important consideration is the ability of the eye to adapt to light and darkness. Only 35 seconds are required for partial, yet safe, adaptation when moving from a dark space to a lighted area. When moving from light to dark, however, minimal adaptation requires two minutes, total adaptation up to half an hour. Since personnel entering the ACES Center will be coming from the outdoors, where the level of illumination may be anywhere from 2,000 to 5,000 foot-candles, it is important to provide adequate lighting in entry spaces to permit gradual adaptation to interior light levels.

(c) Lateral Differences in Illumination. When personnel are placed in an environment where illumination on either their left or right is significantly greater than that on the opposite side, their eyes are subjected to distracting and uncomfortable stresses. This situation often occurs in classrooms where windows allow exterior light to stream in from one side of the students' field of vision while the other side is more dimly lighted from the interior. Avoid such conditions by designing the seating so that the windows are behind the students or when this is not possible, moderate the entering light with shading or other light-attenuating devices.

(d) Task-Background Illumination Levels. In general, the task (paper, book, item of equipment) confronting the student should be brighter than the surrounding environment. For optimum contour and depth perception, it should be three times as bright. Contrasts greater than this produce distortions. In no case should the task illumination level exceed ten times the general lighting level.

(e) Veiling Reflections. Design lighting so as to minimize light which is reflected off the task or nearby surfaces directly into the student's eyes. In general, this involves selecting and placing the light fixture so that the angle of incidence measured from the vertical is greater than 30 degrees, with as much light as possible falling within the 30 to 60 degree core as shown in Figure 3-3.



A O degrees – 30 degrees
Fixture Glare

B 30 degrees – 60 degrees
Optimum Light

C 60 degrees – 90 degrees
Veiling Reflections

Figure 3-3 Optimum Lighting

3-4 BUILDING DESIGN (cont'd)

(f) Glare. Design lighting so as to minimize light shining directly from the light sources into the student's eyes. This can be accomplished by selecting and placing light fixtures to direct the light below a 60 degree angle of incidence, with, again, as much light as possible falling in the 30 to 60 degree core (see Figure 3-3). Lighting fixtures with low brightness characteristics that produce a "bat-wing" light distribution pattern, as shown in Figure 3-4, are one means of satisfying this requirement.

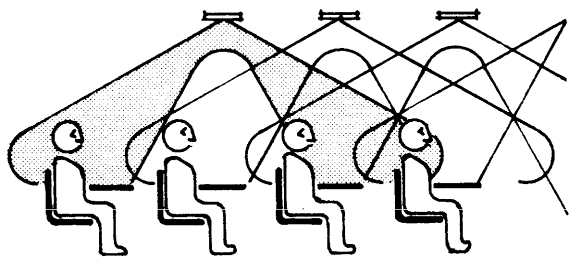


Figure 3-4 Bat-Wing Lighting Distribution

(6) Communications. The building telephone and intercommunication requirements are summarized in Chapter 4, Table 4-1. Telephones and lines will be provided by the installation Communications/Electronics Officer, however, outlets and the distribution system must be provided as part of the building design.

(a) Intercom-PA System. Provide an intercommunication-public address system consisting of a master station in the staff area capable of selectively paging through individual loudspeakers in selected areas and offices. The loudspeaker stations should be the talk-back type, and include a conveniently located master station call button. The master station should have volume controls on input and output, an all-call feature, and indicators for announcing incoming calls. Speakers should be the flush-mounted type. Medium and large size classrooms must be furnished with receptacle and wiring for microphones and speakers for amplified audio distribution.

(b) Central Television System. Where a central television system is required, the system must be coordinated with the installation Communications/Electronics Officer at the earliest practicable phase of design. TV outlets must be located for convenience, given the room layout and functional activity involved. Choice of using existing CATV or MATV system facilities, or the provision of a complete building antenna must be determined. Where a non-Government owned system is to be utilized, built-in system features such as empty conduits and pull wires, terminal cabinets, and outlets only will be provided in the building design.

3-4 BUILDING DESIGN (cont'd)

(7) Electrical Design. Electrical design must conform to DoD 4270.1-M and TMs 5-811-1 through 4. The system selected will provide efficient and economical electrical service throughout the ACES Center. Voltages selected will be of the highest order consistent with the load served. Three phase 208Y/120 volts should generally be used to serve incandescent and small fluorescent or mercury vapor lighting loads, small power loads, and receptacles. Consideration should be given to the use of three-phase 480Y/277 volt systems where such is feasible. Distribution of power within the building should be located to afford maximum flexibility in room power supply and ready accessibility for circuit revisions. Primary electric service will be underground to a pad mounted transformer(s) located outside below grade where possible, and as close to the load centers as practicable. Building telephone service will also be underground with main terminal cabinets located in mechanical or electrical equipment rooms. Communication systems must be coordinated with the local Communications/Electronics Officer. Evidence of such coordination will be provided in the project design analysis document.

(8) Toilet Fixtures. Both female and male toilets shall be provided to allow for convenient use by staff and students, including those who may be handicapped. Male-female ratio and fixture allocation are specified in Chapter 4 under individual space criteria for toilets, paragraph 4-5.e. At least one water closet and lavatory for each sex will be provided for the physically handicapped in accordance with the distance of travel and other criteria contained in EM 1110-1-103. Provide at least one drinking fountain per 100 persons. All computations should be based on the peak daily occupant load determined by adding up the occupant loads of all of the instructional and staff space in the ACES Center.

(9) Plumbing Design. Plumbing must be in accordance with TM 5-810-5 (and TM 5-810-6 if gas fittings are required). Water supply facilities must be as prescribed in TM 5-813-3 and 6. Sanitary sewers must be as prescribed in TM 5-814-1. Plumbing and fixtures shall comply with the "American National Plumbing Code A 40.8" or the "National Standard Plumbing Code," within the limits established by DoD 4270.1-M.

(10) Life Safety. Design provisions shall be made to assure health and safety as set forth in Occupational Safety and Health Act (OSHA) standards and National Fire Protection Association (NFPA) Codes augmented by DOD and Army criteria. Fire protection is a significant part of building design and involves the provision of resistive construction, detection and alarm systems, and extinguishment systems.

(a) Resistive Construction. Requirements for fire-rated walls, doors, floors, etc., depend upon the type of occupancy or hazards within a space. The objective is to contain and retard fires to allow evacuation, rescue and extinguishment. Resistive construction is especially important around passageways used for emergency exit.

(b) Detection and Alarm. Alarm systems are used as a general alert of danger whenever a fire occurs and is detected. Alarms can be supplemented by either heat or smoke detectors that sound an alarm automatically. In designing a system, consideration should be given to visual as well as audible alarms to aid those with hearing handicaps; to resisting vandalism; and to maintaining and checking the system's performance. Tie-in with the installation fire department may also be required along with annunciators to show which detectors and/or alarms are activated.

(c) Extinguishment. Sprinkler or other systems may be used or required in high hazard areas, e.g., in educational or storage spaces where hazardous materials are handled. These systems are normally activated automatically by heat. An automatic sprinkler system shall be provided in all portions of ACES Center buildings located below the floor of exit; in all windowless classrooms, shops and educational spaces not having exits leading directly to the outside; and in all shops, classrooms and storerooms in which hazardous materials are handled. Spaces where special electrical or mechanical devices such as computers, simulators, etc., are to be housed must be identified so that alternative extinguishment systems can be designed accordingly.

(d) Safety Signals, Lights and Symbols. Emergency exits from corridors should be marked so that a sign indicating the nearest exit is visible from every point in the corridor. Provisions for those with visual, as well as other physical impairments, must be made in accordance with applicable design criteria used in design for the physically handicapped. Illuminated exit signs and emergency lights for all emergency exits and passageways will be provided as required by the Life Safety Code, NFPA No. 101. The location of fire protection and other fire safety equipment should be emphasized, where possible, with pictographs such as shown in Figure 3-5. Safety markings; signs for danger, warning or caution such as shown in Figure 3-6, should be designed in accordance with AR 385-30, Safety Color Code Markings and Symbols, and OSHA requirements.

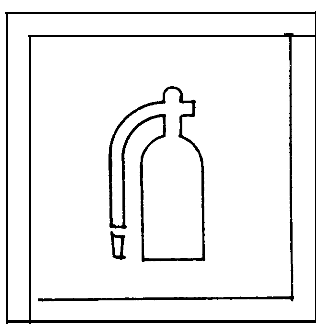


Figure 3-5 Pictograph of Fire Extinguisher

3-4 BUILDING DESIGN (cont'd)

Figure 3-6 Safety Marking

(11) Fire Protection Design. Criteria for fire protection, including fire and/or smoke detection, fire alarm and extinguishment systems, are prescribed in DoD 4270.1-M, TM 5-812-1 and TM 5-813-6. These are generally based on the NFPA's National Fire Codes. Corridors, rooms and exits must conform to the requirements for "flexible plan" buildings given in the NFPA Life Safety Code 101. Single-line plans showing fire-rated construction, location of detection and alarm systems, the location of exits and travel distances to them, areas where sprinkler and/or extinguishing systems are provided, and the location of other fire protection features shall be developed and included in project design analyses and completion records. These documents will indicate coordination of the fire safety design with the installation fire marshal.

(12) Physical Security. The lock and keying system along with requirements for intrusion detection and protective lighting must be coordinated with the installation facilities engineer. Normally, locks will be grand master keyed to the installation's master key system and with the ACES Center keyed to a sub-master key. The further need for master keys for selected parts of the Center should be considered. Overall, the physical security system must be designed so that its operation can be maintained effectively without interfering with life safety features.

(13) Acoustics.

(a) Ambient Noise. Ambient noise is the background noise associated with a given space. It is generally a composite of sounds from mechanical equipment, street noise, and noise from nearby habitable spaces. The design ambient noise level for each ACES Center space is given in Chapter 4, Table 4-1 in terms of A-weighted sound levels in decibels (dB).

(b) Generated Noise. Generated noise is the estimated overall peak airborne sound level in a given space, created by typical activities. The peak estimated sound levels for each individual space are also given in Table 4-1 for consideration in determining noise compatibility. These levels are generally 10-15 dB higher than the average long-term levels should be for each respective space.

3-4 BUILDING DESIGN (cont'd)

Table 3-1 Sound Reduction Goals

Group	Spaces	Within group	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
GROUP 1	Rehearsal Recording Studio			55	60	65	70	varies
GROUP 2	Director's Office Administrator Office Clerk Office Counselor Office MOS Library Testing Room	40	55		45	50	55	varies
GROUP 3	Classroom Lecture Room Seminar Room Language Laboratory Science Laboratory Self-Paced Instruction	40	60	45		45	50	varies
GROUP 4	Staff Lounge Student Lounge Vending Area Training Aids Preparation Typist Area Information/Registration	40	65	50	45		45	no acoustic requirement
GROUP 5	Htg/Refrig/AC Shop Electrical Shops Automotive Shops Building Trades Shops Toilets Receiving Room	40	70	55	50	45		no acoustic requirement
GROUP 6	Storage Areas		varies	varies	varies	no acoustic requirement	no acoustic requirement	

Numbers represent sound reduction goals in decibels (dB) between spaces

Sound reduction should be measured in accordance with ASTM E 597-77T

3-4 BUILDING DESIGN (cont'd)

(c) Sound Quality. This relates to the type of response a room should make to the noise generated within. A "live" room should have a low average absorption coefficient with hard surfaces to reflect most of the sound. Conversely, a "dead" room should have a high absorption coefficient with surfaces to absorb sound. Values given in Chapter 4, Table 4-1 for sound quality are abbreviated as follows: L = live, ML = medium-live, AVE = average, MD = medium-dead, D = dead.

(d) Sound Reduction. Building design should allow a reduction in sound between ACES spaces as indicated in Table 3-1, Sound Reduction Goals. Each group of spaces have similar acoustic requirements. Reduction is achieved by a combination of interposed distance and barriers.

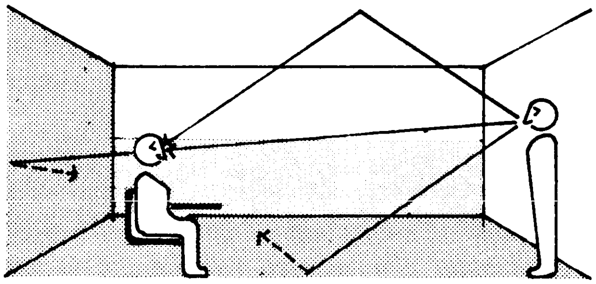
(e) Maximum Sound Level. Loud and sustained noise can be a hazard to hearing. The safe limit for an unprotected ear is approximately 135 dB. At 150 dB even short-term exposure may cause damage. These facts have important implications for the design of shop areas, where high intensity noise is frequently a problem.

(f) Effect of Distance and Interposing Barriers. Sound dissipates over distance. Doubling the distance from a sound source reduces the level of sound received by 6 dB. A similar reduction occurs for each doubling of distance between source and receiver. The operation of heavy armor or transportation equipment produces between 80 and 120 dB of sound at a distance of 20 feet. Aircraft may produce in excess of 140 dB. Assuming 100 dB at 20 feet, such sound would diminish to 94 dB at 40 ft., 88 dB at 80 ft., 82 dB at 160 ft., 76 dB at 320 ft., on up to 34 dB at 40,000 ft. (7 1/2 miles), etc. Since 35 decibels is the maximum desired ambient noise level for classrooms and study areas, distance alone generally is not a practical solution to reducing sound between the classroom environment and the outside environment or other related environments containing high noise producing sources. However, if such sources can be located at a distance remote enough to allow reduction of the noise to an ambient noise level around classrooms of 65 decibels, normal construction barriers can be reasonably designed to further reduce the noise to acceptable ambient levels within the classroom.

(9) Background Noise. Background noise is most distracting when the frequency range of the desired audio stimuli and the background noise are similar. For example, voice noise of 35 dB is more disruptive than mechanical ventilation noise of 35 dB.

(h) Reflective and Absorptive Surfaces. To reinforce an instructor's voice and help eliminate distracting reverberations in classrooms and other similar rooms, the ceiling, the wall behind the instructor's station, and the upper half of the side walls should be provided with sound reflective surfaces as shown in Figure 3-7. The remaining surfaces of the room should be sound absorptive so that noise generated close to the floor, e.g. dropping objectives, scuffling of shoes, or the moving of chairs, is reduced.

3-4 BUILDING DESIGN (cont'd)



Sound reflective surfaces indicated in white

Sound absorptive surfaces indicated in tone

Figure 3-7 Sound Control In Classrooms

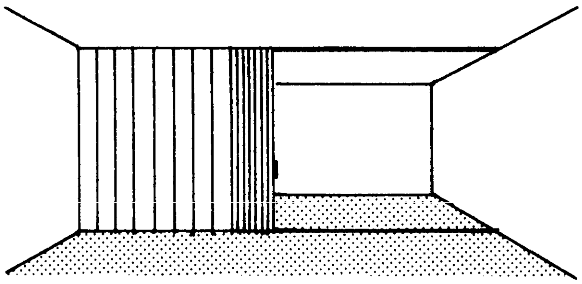
(i) Structural Considerations. Sounds should be isolated and/or reduced at their source, if possible. Machines producing high intensity sound can be enclosed with sound absorbing walls or shielded with sound absorbing material. Machines that produce high-intensity structure-borne sound should be acoustically isolated by special mounts.

(j) Mechanical Considerations. Air conditioning ducts may have to be treated to reduce noise transmission through the ducts. Space above ceilings, provided for distribution of ducts and other mechanical or electrical items, can allow excessive noise transmission from one space to another. Where such cases may occur, walls or partitions should extend up to the underside of the roof or floor above.

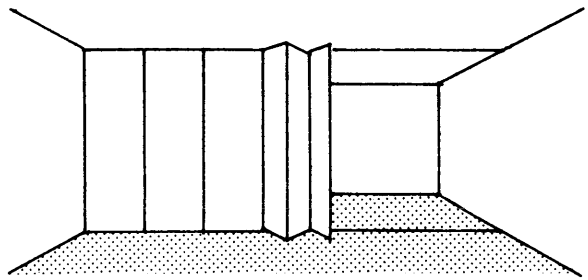
d. INTERIOR DETAILING. The attractiveness and overall usefulness of the building is directly affected by the interior detailing of the building design. Interior detailing will be developed in conjunction with an overall interior design so that items which are part of the building contract are coordinated with related furnishings and equipment to be procured separately by the installation. Interior wall systems, finish materials, signage and color applications must be carefully considered in this regard.

(1) Interior Wall Systems. Permanent walls should be held to a minimum necessary for structural and fire resistance purposes. Transverse walls where practical should be semi-permanent or movable. Employ movable walls in those spaces in which changes in function or class size are relatively frequent. Figure 3-8 shows some of the basic characteristics of the most common types of movable and semi-permanent interior wall systems. Table 3-2 provides data on the comparative cost and flexibility of wall systems. The designer must develop an accurate estimate of the frequency of functional change in a given space, and on that basis, select an appropriate interior wall system.

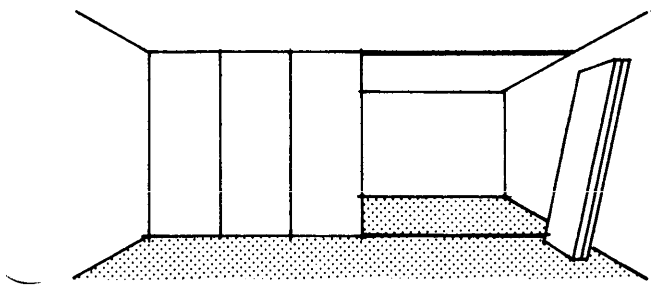
3-4 BUILDING DESIGN (cont'd)



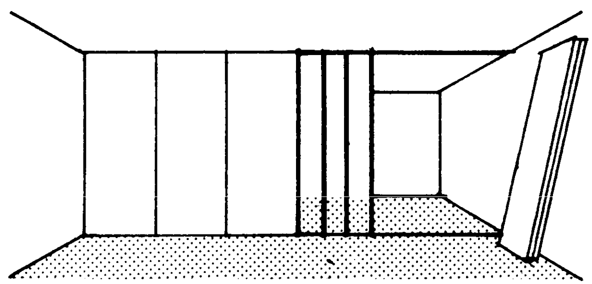
Operable Accordion Wall



Operable Folding Panel Wall



Portable Panel



Movable Stud and Facing Panel Wall

Figure 3-8 Changeable Wall Systems

Table 3-2 Comparative Cost and Flexibility of Wall Systems

PARTITION TYPE	Relative Cost	CHANGE FREQUENCY			
		Hourly	Daily	Monthly	Yearly
Fixed (non-load bearing) 6" Concrete Block or 5" Wood Stud & Plaster	1	No	No	No	Yes
Movable	1.8	No	No	Possible	Yes
Accordion	2.6	Yes	Yes	Yes	Yes
Portable	3.2	No	Possible	Yes	Yes
Folding Panel	5.4	Yes	Yes	Yes	Yes

3-4 BUILDING DESIGN (cont'd)

(2) Doorways. Doorways to instructional spaces should be recessed where possible, and open in the direction of exit as shown in Figure 3-9. This eliminates doors which may open into and impede traffic flows, however, sufficient clearances must be provided so that persons in wheelchairs can reach and pull the door open. Frequently used doors to habitable spaces (including toilet rooms) should have wire or tempered glass vision panels to allow users to see persons approaching the door from the opposite direction.

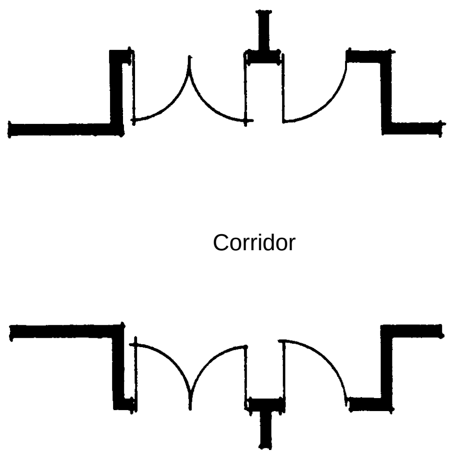


Figure 3-9 Recessed Room Exit

(3) Finish Materials. Interior finishes must be appropriate for the design function of the building and spaces. Selection of materials should be based on low maintenance qualities considering the anticipated use, life cost impact, fire and other safety requirements. Floor coverings should be easily maintained, durable and non-allergenic. They should contribute to sound control and provide a comfortable work surface. Unless otherwise specified, wall-to-wall carpeting should be provided in most areas except corridors, shops, toilets, storage areas, laboratories and vending areas. The color, texture and pattern of materials should complement the overall building design. Native (local) materials should be used to the greatest extent practicable. Long-life materials such as stones, tiles, woods, plastics and vinyls should be selected to provide attractive colors, textures and patterns that will not quickly become outdated. Painted surfaces and patterns are relatively easy and inexpensive to refurbish and can be kept fresh and up-to-date in appearance. Interior finishes must conform to the flame spread and smoke development standards contained in DoD Manual 4270.1-M and NFPA 101.

(4) Color. Use of color in Army facilities is limited to a practical number selected from Federal Standard 595A, Colors. General guidance for color selection is provided in TM 5-807-7, Colors for Buildings. Color should be used to stimulate human physical and emotional reactions and to enhance

3-4 BUILDING DESIGN (cont'd)

the overall functionality of the building. Use soft colors in study areas and consider brighter base colors and accents in casual seeing spaces. In critical seeing areas, glare, brilliant colors and great brightness differences, both in the lighting system and in the color of walls, floors, furnishings and equipment, should be avoided.

(5) Signage. Signage shall be designed as an overall building and site system and procured as part of the building construction. The system must be coordinated with signage required in conjunction with provisions for handicapped persons. Economy, ease of procurement and installation, and standardization of application are important considerations. The system should inhibit vandalism, but be flexible enough to enable the addition or deletion of information. The use of symbols instead of words is recommended. Where words are required, use a letterform such as Helvetica Medium, or other suitable letterforms. Letter sizes are designated by the height of the capital letters. Typical uses are 1 inch for locator signs, and 2 inches for directional and identification signs (and any signs where background lines are 3 inches apart). Signs should be located as close to eye-level as possible and be illuminated to provide adequate comprehension, either by room lighting or by special sign lighting avoiding reflection and glare. The building signage system should incorporate the types of signs described under the following headings:

(a) Facility Identifier Sign. This sign should be located in conjunction with the main entrance, oriented toward exterior pedestrian and vehicular traffic. It should identify the building number and the facility function (e.g., Education Center, etc.) and also indicate the hours of operation. Size of lettering and the exact location of the signs should be determined in each individual case in relation to the architectural design and local Facilities Engineer policy.

(b) Activity Locator Sign. This sign should be positioned in a prominent place for use upon entering the building and on each floor of a multi-story building. It must identify and locate building spaces, key activities and personnel and show emergency exits. The sign should also provide a description and/or plan of features for the physically handicapped.

(c) Identification Signs. These signs must identify restrictions, selected spaces, activities and personnel, and also reserved facilities such as for the physically handicapped. The most direct and economical way is by the use of symbols or pictographs. Use sign panels, approximately 6 inches square, for most identification purposes (toilets, phones, housekeeping closets, stairs, handicapped facilities, etc.) Use sign panels, approximately 12 inches square, for prohibitory signs (no entry, no smoking, etc.). When words and numbers are required as part of an individual space identification, use sign panels approximately 3 inches by 24 inches wall mounted next to doors on the side opposite the door hinge. A letterform approximately 2 inches in height, black on white where numbers are required and white on black where words are required, is recommended. The number of 3 inch x 24 inch sign panels for each space will depend upon how much information must be displayed. A symbol sign and a word-number sign are both shown in Figure 3-10.

Figure 3-10 Identification Signs

(d) Directional Signs. These signs can make use of the same sign panels as recommended under Identification Signs, using a black arrow in white panel above the white on black word panels as shown in Figure 3-11.

Figure 3-11 Directional Sign

(e) Notice Boards. Notice Boards help control clutter and can readily accommodate changing information pertaining to instruction schedules, text requirements, etc. They should be used adjacent to entries into individual shops, lecture rooms, seminar and classrooms, and elsewhere as appropriate. A general notice board should be located in the information registration area and in the student lounge. Simple notice boards can be created by providing a 3 foot to 5 foot wide field of a solid base color surmounted at the 6 1/2 foot level by a 6 inch white board with the word “Notices” in a 4 inch black letterform (such as Helvetica Medium). One or two narrow tack strips at the 6 foot and 4 foot levels should be provided as required for thumbtacking notices.

(6) Graphics. While mainly decorative, graphics may frequently incorporate floor numbers, directional indicators, safety markings, Army insignia, and so on. When professionally done, they can be most effective in livening up spaces and producing interest such as in large rooms or circulation spaces.

3-5 RELATED FURNISHINGS AND EQUIPMENT

Final selection of equipment and furnishings will be based on the items identified and data developed during the planning and programing process discussed in paragraph 2-6. During concept and final design, previous requirements and data must be reviewed and coordinated again with the installation. Data must then be updated using the *latest* mandatory source catalogs, and taking into account the pertinent selection factors and procurement support required.

a. SELECTION FACTORS.

(1) Appearance. Furniture is an integral part of the overall building design and must be closely coordinated with the selection of building colors and finish materials for consistency in appearance and quality. Clear relationship between the furnishings finish schedule and the building finish materials schedule should be evident. Similar attention should be given to the selection of equipment.

(2) Durability, Comfort, and Safety. Furnishings and equipment must be carefully selected to insure that the types chosen conform to standards of durability, comfort and safety appropriate for the uses they will receive. Being generally mobile, furniture and equipment items are subject to handling. Parts that receive the most wear should be replaceable, and finishes should sustain regular cleaning. Colors, textures, sizes, proportions, shapes and reflections are important comfort factors that should be considered. Furniture and equipment must withstand loading conditions without damage. Edges and surfaces should be smooth and rounded. Materials must be flame-retardant.

(3) Mobility and Interchangeability. Most furniture and equipment items should not be of a scale which would require more than two persons to relocate them, or be so complicated as to require an undue amount of time to assemble or disassemble. Whenever possible, choose multi-purpose furnishings and equipment which are suitable for a variety of needs and activities. Stackable and foldable items should be considered for reducing bulkiness in storage and transport where such requirements exist.

b. PROCUREMENT SUPPORT. Separate layouts and schedules will be developed to distinguish items which must be procured by the installation separately. Drawings and supporting data will be sufficient to facilitate procurement, and be in a format that can be readily understood by installation personnel who will be responsible for component placement and utilization after delivery. Placement plans, catalog illustrations, material and color samples together with procurement lists, source data and cost estimates should be developed as appropriate to accomplish this objective.

c. DELIVERY AND PLACEMENT. Once the procurement support material is complete, procurement must be scheduled to assure delivery upon completion of construction, otherwise beneficial use of the facility may be delayed. This is the responsibility of the installation. Delivery and placement of the items are extremely important considerations and should be *carefully managed* by the installation. Without such control, it will be difficult to assure quality, and execution of interior design intentions.

3-6 PROVISION OF USER INFORMATION

Records required upon completion of building projects are delineated in AR 415-10. Requirements for additional user information are established in ER 1110-345-700, Design Analysis. Design features which facilitate or aid functionality, housekeeping, etc., must be described and instructions prepared to supplement project completion records. The objective is to *identify how to best utilize the facility design* in a way that facilitates understanding by ACES Center personnel. The following outline indicates types of information that should be developed for this purpose.

a. SPECIAL CONSIDERATIONS.

(1) Barrier-free design features for both handicapped and able-bodied persons.

(2) Energy conservation features.

(3) Occupational safety and health provisions.

(4) Pollution control.

b. SITE DESIGN.

(1) Utility service system.

(2) Landscape features.

c. BUILDING DESIGN.

(1) Functional features of space organization.

(2) Floor load capacities and limitations.

(3) Space flexibility and multi-use provisions.

(4) Viewing positions and settings provided to enhance perception of design qualities and concepts.

(5) Protective construction features for wind resistance, seismic events and fallout.

(6) Sound and vibration controls.

(7) Features of environmental control system; HVAC, lighting, communications, etc.

(8) Fire protection system; detection alarm systems, evacuation routes, resistive construction and extinguishment systems.

3-6 PROVISION OF USER INFORMATION (cont'd)

(9) Security features; keying diagram, protective lighting, etc.

(10) Housekeeping and services supply, trash removal, storage, relamping, equipment repair, postal and engineer service, etc.

(11) Finish materials maintenance.

d. EQUIPMENT AND FURNITURE.

(1) Placement and flexibility.

(2) Storage and maintenance.