

# US Air Force Interior Design Standards July 2002

|                 |  |
|-----------------|--|
| CHAPTER 1:      | Overview   |
| CHAPTER 2:      | Furniture Systems  |
| ATTACHMENT 1:   | Guide Specification for Furniture Systems<br>(Corp of Engineers) |
| CHAPTER 3:      | Interior Design Cost Estimating Guide<br>(FY2002)                |
| CHAPTER 4:      | Interior Design Principles                                       |
| CHAPTER 5:      | Ergonomics in the Work Environment                               |
| CHAPTER 6:      | RESERVED   |
| CHAPTER 7:      | Carpet Selection Handbook  |
| ATTACHMENT 7.1: | Guide Specification - Carpet Reclamation                         |
| ATTACHMENT 7.2: | Guide Specification - Sample Specifications                      |
| CHAPTER 8:      | RESERVED   |
| CHAPTER 9:      | Interior Color Selection   |
| CHAPTER 10:     | Light and Lighting   |
| CHAPTER 11:     | Interiors Acquisition  |

## CHAPTER CONTENTS

|   |
|---|
| INTRODUCTION                            |
| AIR FORCE INTERIOR DESIGNERS            |
| AIR FORCE INTERIOR DESIGN               |
| INTERIOR DESIGN PROCESS                 |
| DESIGN FOR THE DISABLED                 |
| ENVIRONMENTAL RESPONSIBILITY            |
| ACQUISITION OF SERVICES<br>AND PRODUCTS |
| GLOSSARY                                |

# Overview

## INTRODUCTION

Our interior design policies and practices support the Air Force Civil Engineer Strategic Plan. These practices are an essential element for wise facility investment strategies. In this era of right sizing and limited funding, smart selections of building materials and furnishings are necessary. Interior design is also a major component in providing Air Force personnel with quality facilities, which in turn contributes to the retention and attraction of a quality workforce.

The US Air Force Interior Design Standards are intended for the following primary users:

- Project planners and managers
- Base planners
- Base design personnel
- Remote site civil engineering staff
- Maintenance engineering personnel
- Design team members for AF projects.

The Standards provide general guidance in the field of interior design. In doing so they will also be useful to the following:

- Commanders and others in leadership positions
- Facility managers
- Services facility managers
- A/Es and design/construction agents under contract to the Air Force
- AFIT course instructors.

The Interior Design Standards are an Air Force document and may be supplemented by MAJCOM guidance.

## AIR FORCE INTERIOR DESIGNERS

While providing guidance, the Standards can in no way serve as a substitute for the services of a design professional. Fortunately, in the Air Force such professional help is close at hand.

- Some installations have on-staff interior designers who are responsible for all interior design or services.
- Most MAJCOMs have trained interior designers available to assist base personnel. Their services are provided subject to demand and availability.

- AFCEE/DCD has an interior design staff which is available to assist at the Base or MAJCOM level. Here again, services are provided subject to personnel availability.

Some MAJCOMs have established interior design guidance which should be incorporated into the interior design process at the base level.

In recent years the interior design profession has made great strides in obtaining recognition of the unique contributions of its members. FIDER approval of interior design degree programs, and uniform testing in the form of the NCIDQ examination, are major steps in achieving this recognition. We should seek personnel with these educational and testing credentials.

A/E selection criteria should be structured to stress the importance of the inclusion of trained interior designers to the design team. Specific language should be included in solicitations for services requiring that the educational background of interior design team members be provided. This language could also include a requirement for licensing, but approved professional education programs and uniform testing are better indicators of background and skill. Not all states have licensing programs, and in some that do, architects and other professionals can be licensed as interior designers without proof of experience or testing.

#### AIR FORCE INTERIOR DESIGN

Interior design contributes to the Air Force quality of life.

- Well-designed working, living, and recreational facilities attract and retain good people, sustaining the Force.
- Attractive and comfortable work environments enhance productivity.
- Good design contributes to the health and sense of well being of building users.

Interior design adds value to Air Force installations.

- Good interior design practice considers the life-cycle costs of materials, finishes, furniture and equipment
- Well-designed building interiors project a positive image of the Air Force.

Interior designers contribute to the facility delivery process in the following areas.

- Programming Assistance: Evaluate data to ensure that scope of interiors projects are adequately identified and that the projects are correctly budgeted.
- Reviews: Review projects at the various stages of design. The interior designer should be routinely included in the makeup of review panels.
- IDIQ: Prepare specifications for material purchases and monitor installation by IDIQ contractors.
- Project Management: Provide assistance to PMs throughout a project. The interior designer should be the approving entity for submittals involving systems furniture, carpet and similar interiors components.

- Specifications: Prepare appropriate portions of specifications for projects developed by Air Force architects and design sections as well as review specifications prepared by AEs and other contractors.
- Space Planning: Provide space planning for projects designed in-house by the Air Force and evaluate space plans prepared by contractors and vendors to ensure compliance with MAJCOM or base standards.
- Design Consulting: Work with customers and other design team members as a consultant in areas including lighting, acoustical treatment, architectural materials and finishes.
- Maintainability: Provide input, based on experience, on maintenance issues regarding materials and products proposed for the project.
- Cost Estimating: Serve as a reference for general pricing for work stations, individual pieces of furniture and materials such as carpet.
- Design: Draw from the unique character of interior design knowledge to subtly alter the character of a space, make awkward plan and detail conditions less apparent or conceal architectural rough edges. And do it without negatively impacting the project budget.

Air Force project design is a team effort, whether done in-house or by a contractor, and the interior designer is a key member of the team. Good architecture requires good interior design. Both require sound engineering input, and all of these demand a well-developed site. The success of every project is dependent on the active involvement of all team members throughout the design process.

On a typical project, the interior designer may work with any or all of the following:

- Architect
- Structural Engineer
- MEP Engineer
- Civil Engineer
- Landscape Architect
- Base Planner
- Environmental Consultant
- Programmer
- Contracting Personnel
- User.

#### INTERIOR DESIGN PROCESS

The role of the interior designer in a project starts before the design process — at the project planning stage. Planning establishes parameters in terms of programming and budget and it is critical that building finishes, furniture systems, furniture and other elements of interior design requiring resources be planned into a project from its inception.

The interior designer should be responsible for delineating the detailed scope and budget for finishes, systems and furnishings.

Once the project scope and budget are determined, the interior designer should begin working with Base Contracting personnel to ensure that there is an understanding of project interior design requirements. Maintaining a collaborative working relationship with Contracting ensures that specific requirements of interior design are addressed. It's the best way to be sure that the customer receives what was specified.

As a member of the design team, the interior designer participates in general layout activities, makes material and finish selections, and prepares specifications for these for incorporation into the project specifications. During design, the interior designer also:

- Finalizes functional program requirements for furniture and equipment
- Makes preliminary selections and presents them to user representatives
- Finalizes selections for furniture systems, furniture and equipment and prepares drawings and specifications in prescribed AF format.

The role of the interior designer continues after the project is complete. Post-occupancy evaluations are the only sure way to improve programming and design skills so that user needs are consistently met. Interior design plays a very large role in user satisfaction. Following are some of the areas which can be addressed in an interior design post-occupancy evaluation.

- Does your furniture and equipment accommodate the tasks you perform?
- Is adequate storage available to house the materials you routinely use and need?
- Are power and data outlets available and well located?
- Is lighting adequate?
- Does the office layout encourage interaction among personnel?
- Does your work space provide an environment conducive to concentration? How might this be improved?
- Is your work (or living) space a pleasant place to be? How might this be improved?

#### DESIGN FOR THE DISABLED

Though initially intended for the disabled population, ADAG and UFAS regulations are beneficial to the temporarily impaired, parents with strollers, the elderly and anyone using wheeled equipment or luggage. Interior designers should take a pro-active stance. The requirements are relatively easy to deal with ñ a little more space and the flexibility inherent in the better systems and furniture lines usually suffice. Provisions for the visually and hearing impaired are generally dealt with by building systems, but can have subtle implications for interior designers, so applicable regulations should be consulted.

*Funding Interior Design Services***ENVIRONMENTAL RESPONSIBILITY**

The Air Force purchases large quantities of products which are within the purview of the interior designer. The environmental impact of these is substantial. Interior designers must be knowledgeable regarding the recycled content of materials, reconditioning of systems and furniture, environmentally-friendly paint and other finishing processes, off-gassing of chemical finishes of fabrics and yarns, and the reduction of waste in manufacturing and packaging.

**ACQUISITION OF SERVICES AND PRODUCTS**

Interior design services for MILCON projects are funded with the project as a part of the A-E services. Services of interior design firms separate from the A-E can be likewise funded. Base O&M funds are normally used to fund interior design services for smaller renovation projects and upgrades.

Design services for furniture systems projects are provided as a line item cost in addition to the costs of the product and installation on AF Form 9.

MAJCOM and base level interior designers, when available, typically provide services without charge or with charges only to cover TDY expenses.

*Acquisition Funding*

The elements which comprise SID are typically included in the general construction of a project. As such, they are funded with MILCON or NAF. Furniture systems can be made part of SID by programming them into the building design for purposes of budgeting and coordination with the building utilities. Furniture systems are identified on DD Form 1391 as "equipment funded from other sources". Furniture, furniture systems and all other elements of CID are funded from O&M or NAF.

*Acquisition Strategies*

The acquisition of all elements of CID projects is governed by the Federal Acquisition Regulation (FAR), Part 8, and the Defense Federal Acquisition Regulation Supplement (DFARS), Part 208. The FAR is accessible on the Internet through the GSA home page.

The interior designer, or the facility point of contact, should meet with contracting personnel prior to submitting procurement documents for a CID project. This will ensure an understanding of the scope of the CID and the design intent, as well as allowing contracting personnel to plan for the work load.

*Sources for Acquisition*

CID products are available through a number of resources. Items may be purchased through Federal Supply Schedules, through UNICOR (Federal Prison Industries) or open market. The FAR establishes the rules of procurement with each of these resources. NAF contracts are also available for projects using NAF funds.

The FAR establishes Federal Prison Industries, Inc. (FPI) as a mandatory source for products which it manufactures. In ordinary situations, a waiver must be obtained to by-pass UNICOR products. FPI is not a mandatory source for NAF projects or for products bought and used outside the United States.

## GLOSSARY

|            |   |
|------------|---|
| A/E or A-E | Architect and or Engineer, or their companies                                     |
| ADAG       | Americans with Disabilities Accessibility Guidelines                              |
| AF         | Air Force   |
| AFCEE      | Air Force Center for Environmental Excellence, Brooks AFB TX                      |
| AFIT       | Air Force Institute of Technology, Wright-Patterson AFB OH                        |
| CID        | Comprehensive Interior Design   |
| DFARS      | Defense FAR Supplement  |
| FAR        | Federal Acquisition Regulation  |
| FIDER      | Foundation for Interior Design Examination Research                               |
| GSA        | the General Services Administration   |
| IDIQ       | Indefinite Delivery Indefinite Quantity, type of contract                         |
| MAJCOM     | Major Command (ACC, AMC, USAFE, PACAF, etc.)                                      |
| MEP        | Mechanical, Electrical, and Plumbing  |
| MILCON     | Military Construction Program   |
| NAF        | Non-Appropriated Funds  |
| NCIDQ      | National Council of Interior Design Qualifications                                |
| O&M        | Operations and Maintenance  |
| SID        | Structural Interior Design  |
| TDY        | Temporary Duty assignment, term for an Air Force business trip                    |
| UFAS       | Uniform Federal Accessibility Standards   |
| UNICOR     | A division of Federal Prison Industries which produces furniture and furnishings. |

## CHAPTER CONTENTS

|   |
|---|
| INTRODUCTION                                  |
| BACKGROUND                                    |
| SYSTEM TYPES                                  |
| PARTS AND PIECES                              |
| POWER AND DATA PROVISIONS                     |
| BUDGETING FOR FURNITURE SYSTEMS               |
| PROGRAMMING FURNITURE SYSTEMS                 |
| DESIGN ISSUES                                 |
| LESSONS LEARNED                               |
| CONSTRUCTION DOCUMENTS                        |
| BID/PROPOSAL EVALUATION                       |
| OPERATIONS AND MAINTENANCE                    |
| ENVIRONMENTAL ISSUES                          |
| POST-OCCUPANCY EVALUATION                     |
| CHANGING WORK STYLES AND<br>SYSTEMS FURNITURE |
| TELECOMMUTING                                 |
| MATRIX  |
| GUIDE SPECIFICATIONS                          |

# Furniture Systems

## INTRODUCTION

Furniture systems are a wide range of furniture types comprised of components which combine to create a custom designed work environment to meet specific functional needs. This chapter is intended to give users a working knowledge of the basic types of furniture systems available today. It also touches on other types of furniture systems which have more limited application.

The primary audience for this chapter includes base civil engineers, MAJCOM and base interior designers, base contracting, facility managers and design contractors.

The secondary audience includes command level personnel and representatives of user groups who may benefit from a general understanding of the types of available furniture systems and their advantages and disadvantages.

No manufacturer or product line is mentioned by name except in the matrix section which lists the manufacturers holding current GSA contracts (Federal Supply Schedule, FSC Group 71, Part II, Section E). The three most-used systems are represented in the product lines of most of the major manufacturers; however, UNICOR, at present, markets *only a panel supported system*. Chapter users should consult manufacturers' catalogs for specific information on product lines. Though the basic concept of each furniture system type is similar, there is significant variation in detail among manufacturers.

We recognize that manufacturers are constantly developing and introducing new products which will eventually be incorporated into the Federal Government's contracts; therefore, this section will need to be updated from time-to-time. All commercial furniture manufacturers should be able to adhere to the stringent testing performed by BIFMA (Business and Institutional Furniture Manufacturers Association).

## BACKGROUND

Systems furniture is ergonomically designed to meet all types of conditions and requirements. Work stations fully defined by panels are no longer perceived to be flexible enough to accommodate the ways more and more people are working and how they will work in the future. The manufacturers are responding and furniture systems continue to evolve. Current technology and modularity remains a driving force behind the design and development of workstations. Some manufacturers have specifications available in both metric and the U.S. standard measurement systems.

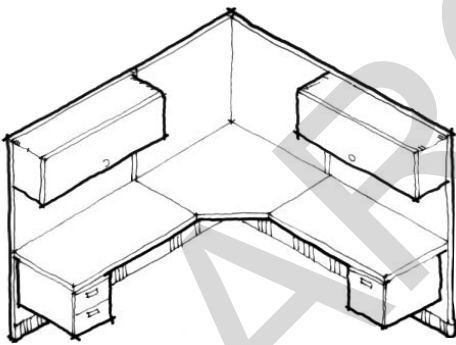


### SYSTEM TYPES

The basic advantages of furniture systems are two. The standard unit of measure for the cost of office space is the square foot of floor area. First, furniture systems save floor area by taking advantage of the vertical dimension – using space above work surfaces for storage or filing and by stacking storage and filing components. They are also carefully designed to make every square inch of horizontal area count. The second advantage is that they can be rearranged to accommodate changing needs.

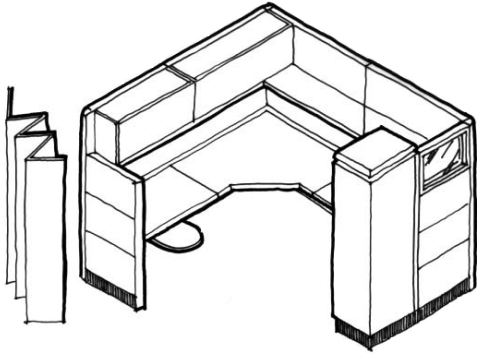
There are three basic types of furniture systems: panel-supported, stackable panel and desk-supported. There are combinations and permutations of these and also of some other basic types which are less used. Most panel systems can only accommodate their own components. You can not mount Brand X components on Brand Y panels; however, we understand even this will be changing in the future. A premium is paid for systems furniture, which is the price paid for flexibility to rearrange furniture as missions and work place locations change. This premium is wasted when more than one system's manufacturer is used in a facility, because it defeats the flexibility for future changes. It is strongly recommended a single manufacturer be used throughout a facility or organization. Another recommendation is to select a system which can be easily converted from panels to floor supported and back again. This furniture type will meet almost any requirement which could arise.

*Panel-Supported System*



This is the original type and is referred to herein as the traditional panel system. Panels are available in a variety of modular heights and widths. They typically have a steel perimeter frame; the core can be of a variety of materials and the panels can be surfaced with any number of materials. Virtually all panel systems have some provision for power and data distribution, though the sophistication of these varies greatly. All product lines incorporate storage units, filing units and work surfaces – mountable at varying heights on the panels – as well as a variety of accessories.

This is the system we see most frequently in Air Force installations. It is the basic system offered by UNICOR at this time and a large number of product lines are on the GSA Schedule. Construction, quality of detailing, extent and flexibility of power provisions and materials are reflected in the relative cost of product lines. This system still dominates the industry, though this is changing. The panels can be used as space dividers in non-traditional office areas. These systems can be reconfigured but panel heights, once chosen, cannot be altered; conversion to the somewhat more open work stations, popular now, may require the purchase of additional panels of varying heights.

*Stackable Panel System*

When you buy a traditional panel you have a panel with a height which can't be changed. By the late 1980s this came to be viewed as unduly limiting. The result is the stackable panel system.

This system also consists of panels of varying width and height. Once selected, the width is fixed. The height, however, can be increased by stacking one or more additional panels, of the height desired, on top of the base panel. Completed panel height can be anything from the work surface to the ceiling and heights can be changed on-site by adding or deleting panels. Construction details vary, but each stackable unit typically consists of a steel frame designed for easy fastening to the panels above and below. Panel surfaces are referred to as "tiles" and can be left open, glazed or covered with a variety of materials.

Like traditional panel systems, stackable systems incorporate a number of options for power and data distribution and also accommodate work surfaces, storage and filing components mountable at varying heights. Since stackable panels are a second generation product, the variety and flexibility of components and power capabilities tend to be greater than in the traditional panel systems.

Words of caution: Some manufacturers appear to have stacking panels because the "tiles" can be interchanged. However, the basic frame, which the tiles are attached, is not adjustable in height. A scored pattern of "tiles" on a panel installation does not always mean that it is a stackable system. Some vendors of traditional panels use the scored/grid pattern only as a design motif.

Stackable panel systems cost somewhat more than traditional panel systems. Most major lines are on the GSA schedule and more are being added. Stackable panel installations are more easily adapted to some of the newer work station concepts than traditional panel systems. Like traditional panels, stackable panels can be used as space dividers in non-traditional office installations and can be equipped with writing or layout areas.

*Desk-Based Systems*

By the early 1990s, major panel users were becoming dissatisfied. The flexibility inherent in the panel systems they purchased was not being used – either it was not really needed or it was too cumbersome to accomplish. The increasing sophistication of the panel construction had also made them increasingly expensive. Too much enclosure inhibited the evolving collaborative work styles. The users began to question how many panels were really needed or, in some situations, if they were needed at all.

The industry responded with desk-based systems. The work surfaces are floor supported. Vertical structural elements (columns and stanchions) are available that can support shelves, overhead cabinets, and filing components. Privacy is maintained by the use of partitions that can be mounted to the work surface generally no more than 24 inches in height.

Hard-wired power provisions are incorporated into better desk-based systems. These can be extensive and flexible and used in conjunction with electrified panel systems. Data cabling can easily be run in most systems and cable management is comprehensive.

Desk-based systems cost less than either traditional or stackable panel systems if used alone. However, these systems are frequently used in combination with one of the panel systems and this can substantially affect the total cost per station. Desk-based systems are well represented on the GSA schedule.

### *Clusters*

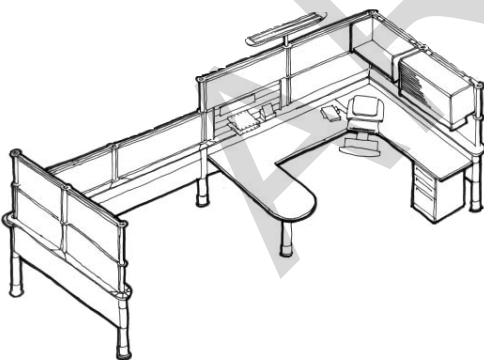


These consist of three or four work stations arranged pinwheel fashion around a core or common point. The core element can be used as the power distribution source and can also accommodate air distribution. Few panels are required to form a cluster and the work stations are typically small and basic. Clusters generally take more floor space because they require circulation space on all sides. Clusters are also not easily reconfigured without significantly altering and/or replacing their major parts. The GSA schedule defines clusters and lists vendors; the systems are very economical.



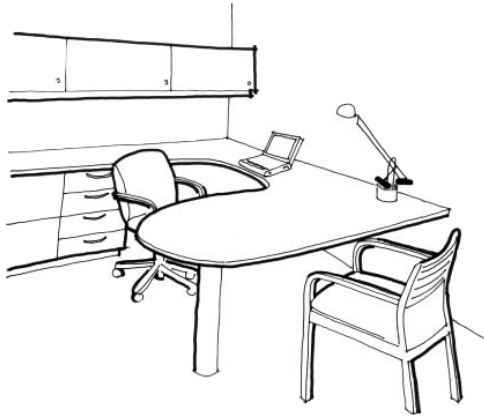
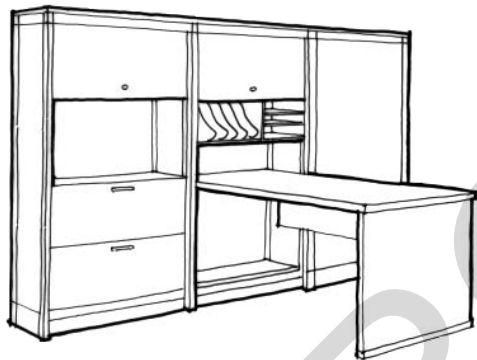
Cluster arrangements can be achieved with either panel system or desk-based systems; however, the use of overhead cabinets or shelves would have to be considered and minimized in a five-pod configuration for example. The advantages are the same as for manufactured clusters and the clustered work stations can be customized and equipped to better meet user needs.

### *Beam-Supported Systems*



In these systems, a structural beam, usually incorporating a power raceway, spans between vertical posts. Work surfaces and pedestals are cantilevered off the beam, with the advantage that the work surfaces can be of any length desired – they do not have to span between panel joints, where the mounting brackets are located in panel systems. Overhead storage units and privacy panels are mounted to posts which are extensions of the posts supporting the beam.

Beam-supported systems do not lend themselves to frequent reconfiguration; the beam and its supporting posts are the limiting elements. These systems compare in cost to a desk-based system used in combination with one of the panel systems.

*Wall-Based Systems**Cabinet-Based Systems**Demountable Walls*

All panel systems have bracket-mounted work surface and storage components. These can be mounted to building partitions as well. This usually requires a vertical track, which is secured to the partition, and this track is clearly visible. A few manufacturers have track systems which are specifically designed for mounting to partitions; horizontal tracks concealed by the component being supported are used, so no mounting hardware is visible.

Good applications for these are where existing partitioning is retained but where the flexibility and appearance of furniture systems components are desirable. Advantage is also in small office areas. Components can be moved horizontally.

Typically used in conjunction with other systems types. These generally consist of relatively tall cabinet units which can be outfitted with shelves or file drawers. Work surfaces can be connected to the cabinets at right angles and traditional panels can often be integrated into groupings of cabinet units. Power and communication/data raceways at the cabinet base and top, with extensions to the beltline, are common. Cabinets can store a great quantity in a small floor space. A variety of finishes are available.

Either traditional or stackable panel systems can be used to build full-height partitions, incorporating standard doors where necessary. Either system can be used as an acoustical barrier when sound privacy is an issue. Panels used in this manner and demountable wall systems are not cost effective for the construction of private offices; drywall construction is more economical initially. Demountable walls if reconfigured or moved a few times would be more cost effective and less disruptive. However, be aware that demountable walls are purchased with O&M funding and are not counted against the construction budget. Also they are environmentally friendly by saving landfill space that would be used when changing drywall offices. Some demountable walls have a “universal” track, which allows for Brand X components to be mounted to Brand Y wall track. Existing sprinkler systems and air circulation are important considerations if demountable walls are entertained. If demountable walls are specified and installed correctly, the ceiling tiles shouldn't have to be cut.

## RECOGNIZED SOUND TRANSMISSION CLASS OF COMMON PARTITIONING MATERIALS

|  |       |
|--|-------|
| Average Hollow Metal Door              | 18    |
| Solid Core Wood Door, Not Gasketed     | 22    |
| 1/4" Safety Laminated Glass            | 34    |
| 2-1/2" Gypsum Board, 4" Wood Studs     | 38-40 |
| 2-5/8" Gypsum Board, Metal Studs       | 42    |
| Movable Metal Partition                | 38-42 |
| Double Laminate Gypsum & Steel Stud    | 50    |
| Concrete 4"                            | 46    |
| Concrete 6"                            | 49    |
| Concrete 8"                            | 51    |
| Concrete 12"                           | 53    |
| Concrete 16"                           | 58    |
| Concrete Block 4", Painted Both Sides  | 41    |
| Concrete Block 6", Painted Both Sides  | 43    |
| Concrete Block 8", Painted Both Sides  | 45    |
| Concrete Block 12", Painted Both Sides | 48    |
| 1/4" Steel Plate                       | 38    |
| Dual Glazed Windows, 1/4" Thick Lights | 38-42 |
| Staggered Steel Drywall Partition      | 45    |

### *Hybrids*

One of the strengths of the furniture systems industry is the imagination which has been used in assuring that different product lines can be used together. Desk-based or free-standing components can be combined with panel systems in almost limitless combinations. So far, these combinations are generally limited to the products of a single manufacturer, though there are initiatives underway to make at least some products adaptable to those of other manufacturers. The future will bring more of these.

### PARTS AND PIECES

Furniture systems are composed of many elements and each product line is unique in some way. However, there is some commonality among parts; the descriptions which follow illustrate some of the common components of which traditional panel, stackable panel and desk-based furniture systems are composed.

#### *Traditional Panel*

Panel construction differs, but there is typically a perimeter steel frame on a separate base section. The core can be a combination of gypsum, sheet metal, acoustical or non-acoustical, tackable or non-tackable, and other material. Surface materials can be glazed, fabric, laminate, wood or metal.

#### *Stackable Panel Frame and Tiles*

Stackable panels typically have a perimeter steel frame, usually resting on a separate base. Core materials vary and some system panels have no core. The "tiles" clip into the frame. Tiles can be covered in a variety of materials or can be glazed. Eliminating tiles, but retaining the frame, saves money and provides a sense of definition with openness; below the work surface, tile deletion or the

*Non-Modular Panel Connection*

use of perforated tiles improves air circulation and helps dissipate heat from electronic equipment.

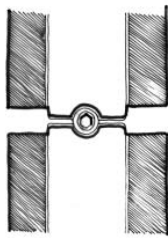
*Desk-Supported Work Surface*

Some panel systems can accommodate T or X connections at points other than panel ends. This allows greater flexibility in rearranging panels.

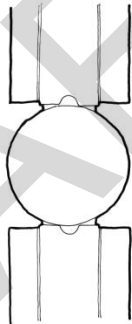
*Base Levelers*

The supports take the form of structural legs, often called stanchions, at the back corners. The work surface is bracket-mounted off the stanchions. The stanchions can be extended vertically to accommodate overhead storage elements.

There is almost always some sort of leveling device which adjusts to compensate for unlevel floor conditions. Typically, the base section, powered or unpowered, supports the levelers. To improve airflow in work stations where CPU's are placed under the work surface, levelers may be used to elevate panels by an inch or more to create some air movement.

*Panel-to-Panel Connection*

Each manufacturer uses somewhat different panel connectors. Here, a section at the top "grabs" the panel on each side and is tightened by turning a threaded rod. Narrow, well-detailed and consistent vertical panel joints are typical of better-designed systems.

*Panel-to-Post Connection*

Here, the panel connector device takes the form of a vertical column, incorporating slots for mounting work surfaces and storage units. This system alleviates panel creep.

*Typical Panel End*

Sometimes the slots for component mounting are incorporated into the end of the panel, rather than in the panel connector device.

*End Trim Piece*

Configurations vary, but panels always have a snap-on trim piece at exposed panel ends. Some manufacturers treat this piece as a design device to give their product a distinctive appearance.

*Panel Cap with Cable Tray*

Most systems have an available tray at the top of the panels which can accommodate communication and data cable. With or without the cable tray there is a top trim piece which can take a number of configurations. Panel-top cable trays do not work with panels of varying heights.

*Corner Piece with Cable Shown*

Fiber optic cable requires gentle bends (usually a minimum 4 inch radius) at corners. Corner sections of most systems will accommodate this.

*Pedestal-Floor, Suspended, Wheeled, Bracket*

Pedestals – usually called “peds” – incorporate storage or files. They can be floor-supported, in which case they can also be used to support work surfaces; bracket-mounted from panels or desk-based system stanchions; suspended from the work surface; or mounted on casters for versatility.

*Overhead Storage Unit — Ways to Mount*

Overhead storage or filing components are bracket-mounted and can be mounted to panels, to vertical stanchions for desk-based systems or to tracks mounted to building partitions (wall mounted).

*Overhead Storage Unit Doors*

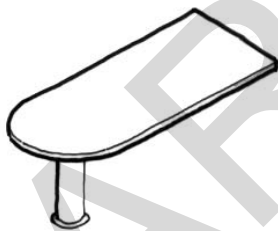
Doors can lift and roll over the unit top, can lift and slide over the top or lift and slide under the top. Some have pneumatic lifts for ease of operation. Surface materials vary; fabric surfaces tend to soil.

*Desk-Based Corner Table*

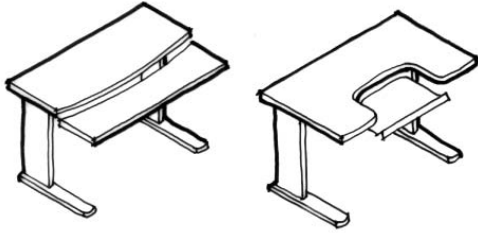
Corner units to make an L transition in desk-based system units can be curved or square. Cable troughs and raceways continue around the corner and power can be supplied from the pedestal.

*Peninsular Work Surface*

A peninsular work surface extending beyond the end of adjoining work stations makes a good place for informal meetings. Mounting these on casters makes them usable as free-standing conference tables.

*Universal Design Work Surfaces*

Some manufacturers produce work surfaces to be either left or right handed, but universal design is also available. Universal design eliminates the number of parts to count when ordering and helps eliminate ordering errors. Reconfiguring universal parts is more readily accomplished since all ends are finished and will work either as left or right handed. There are conditions when a handed work surface provides a better solution. It should be evaluated case by case.

*Split Level Table Work Station*

Available from several manufacturers, split level work surfaces allow each surface to be adjusted independently, even to stand-up height. Manual adjustment takes little effort and power adjustment is also available. Adjustment device should be integrated and not a separate part which can be misplaced.

*Vertical Storage Unit with Power*

Vertical storage units can accommodate power and data distribution through the base or through the top.

*Portable Work Surface Companion*

These portable units provide storage and can also accommodate a working surface for laptop computing and a place to secure the laptop while plugged in and charging.

*Power Base*

Panel bases provide the most common raceway for power distribution. Knock-out ports provide locations for outlets. A manufacturer-supplied power feed connects the raceway to building power.

*Belt Power Strip*

More and more systems are providing a power raceway above work surface height, for the convenience of users and installers alike.

*Vertical Power*

Power can be extended vertically through stackable panels and in some traditional panels as well. Or, vertical power raceways can be incorporated, extending to the ceiling if this is the power source.

*Vertical Power Panel*

In some traditional panel systems, power is brought from the powered base to the beltline with a vertical power panel. One of these is required at each point where power above the work surface is required.

*Desk Top Power*

Power at the work surface can be provided at small pedestals mounted to the surface from the vertical stanchions of desk-based components, from vertical power panels or from a continuous horizontal raceway.

*Desk-Based Data Raceway*

Data raceways can be added to desk-based systems, often concealed behind modesty panels.

*Cable Trough*

Cable troughs to contain the tangle of chords and cables are typically provided beneath work surfaces in all systems. These must usually be specified as an accessory.

*Panel Top Ambient Light*

Ambient up-lights provide diffuse reflected light in the work station, where it is needed. Most ceiling fixtures could be eliminated using this type fixture over large areas.



|   |  |
|---|--|
| <i>Under Storage Task Light</i>   | Every manufacturer has a task light which is mounted to the underside of overhead storage units. They provide general illumination but not necessarily the right light for specific tasks.   |
| <i>Bracket-Mounted Task Light</i>   | Bracket-mounted task lights fit into the panel or stanchion slots which also secure storage units and work surfaces. With the best of these you can get the light where it's needed.   |
| <i>Desk-Based Screen</i>  | Screens to increase visual privacy can be bracket mounted to desk-based work surfaces.   |
| <i>Desk-Based Modesty Panel</i>   | Modesty panels are typically provided at exposed fronts of desk-based system units. These are also used to conceal data raceways as well.  |
| <i>Deep-Drawer at Knee Space</i>  | Dual-depth drawers which slide under the work surface provide storage with no loss of knee space. The front is shallow for pencils (or for placement of the keyboard) while the back is deep enough for filing or personal storage.  |
| <i>Accessory Rail, Tool Bar or Accessory Tiles on Panel</i>   | All panels have provision for an accessory rail or rails. Many rails are generic, i.e. they work on panels supplied by a number of manufacturers.  |
| <i>Accessory Rail on Desk-Based Unit</i>  | Accessory rails can also be mounted to desk-based systems, either mounted to vertical stanchions or cantilevered off the work surface. These are also typically generic.   |
| <i>Accessories</i>  | Every manufacturer offers a number of different accessories including paper management accessories (file holders, letter trays), telephone stands, small white boards, pencil cups and computer support accessories.   |
| <i>Central Processing Unit Drawer</i>   | Slide-out drawers for CPUs get them off the floor, provide ventilation and good accessibility for service.   |
| <i>Slip-on 45 Degree Corner Adapter</i>   | A channel-shaped section slips over the edge of the work surfaces in an L configuration to provide a 45 degree position for computer use.  |
| <i>Ergonomic Accessories (refer to Air Force Ergonomic &amp; Environmental Standards for further information)</i> | Every manufacturer also offers a number of different accessories with ergonomic benefits including lumbar support pads, wrist pads, foot rests, and adjustable keyboard trays.   |
| <i>Monitor Support</i>  | Adjustable monitor supports allow users of all sizes to get the right elevation and tilt of the monitor screen. Monitors may also be mounted under the work surfaces. This is beneficial for certain conditions. (Examples: when user's workspace is limited and/or user's computer time is not extensive or when confidentiality is important). |
| <i>Separately Adjustable Mouse Pad</i>  | Adjustable mouse pads, mounted to the keyboard tray, provide a variety of positions for right or left-handed mouse users. Mouse pad should be at the same height as keyboard to avoid wrist problems.  |

*Adjustable Integral Wrist Rest*

Adjustable wrist rests attached to the keyboard tray can be adjusted for the comfort of the user.

*Tools*

Tools – the fewer required the simpler it is to make the changes which make furniture systems really work for you. At least one manufacturer says that only one tool is required for one of its lines.

*Coordination***POWER & DATA PROVISIONS**

A frequent problem is the lack of coordination between the civil engineers and the communication squadron regarding furniture systems power and data provisions. Provisions for furniture systems electrical requirements must be made as a part of the construction documents. A timeline is also necessary to allow for electrical and communications hookup after the furniture installation.

*Power*

Power in furniture systems is distributed in enclosed raceways. In panels, these are almost always at the base and the metal housing forms the panel base. Secondary raceways at work surface height (beltline) can be installed in most stackable panel systems; power at the work surface in traditional panel systems is supplied by vertical raceway extensions or vertical power panels installed where power is required. In desk-based systems the raceway is usually mounted under the work surfaces with vertical extensions in the stanchions.

Each panel is either powered or unpowered; unpowered panels are more economical. Jumpers, typically sections of flexible conduit, are used to extend power through unpowered panels to the next powered panel. Outlets occur only in powered panels. Raceways typically are 8-wire (3-4 circuits) and the power wires can be configured in several ways. Load requirements determine the length of run of powered/unpowered panels between connections to the building power source.

*Power/Communication/Data Separation*

It was originally believed that power and communication/data wiring should be separated by one meter to eliminate electromagnetic interference (EMI). Most data cable is now Category 5. Some engineers maintain that no separation is required between this category cable and power wiring while others believe that they should be separated.

*Communication/Data*

The raceways in most furniture systems will accommodate communication and data wiring, separated from the power wiring by some form of barrier. In panels this means that the comm/data wiring would be at the base. In desk-based systems this cable would be in the raceway just under the work surface; separate data raceways are also used, paralleling the power raceway.

Also used for panel installations are raceways for communication and data mounted at the tops of the panels. To access these, the top cap is removed and the cables laid into the raceway, with drops through panels (where possible) or through panel connector assemblies. This location provides separation, but also easy installation inasmuch as the installer does not have to enter work stations

to access a base raceway. These raceways cannot be used when panels are of varying heights.

*Integrated Wiring*

Certain manufacturers allow power/communication/data wiring to be specified as integral parts of the panel. It is possible to divide the work stations into zones. Multi-service feeder cables can be installed from the wiring closet to points within each zone which in turn feeds the receptacles within each work station. This eliminates the need to reroute, remove, or recable each panel each time a work station is reconfigured.

*Fiber Optic Cable*

Where fiber is proposed for use inside a building, care should be used in selecting furniture systems which can accommodate it. Typically, minimum bends are 4 inch radius. Most, but not all, system corner assemblies and raceways can accommodate this.

*Connection to Building Power*

All power from furniture system components must be connected to the building power supply by a licensed electrician using a power feed. The power feed, usually like a section of flexible conduit, is supplied by the panel manufacturer and has a device to connect to the raceway. It is connected to the building power by splicing wires. The following are some of the termination devices for building power which you may encounter.

*Wall Supply*

Simple and inexpensive, a wall box (junction box or J-box) is the obvious choice where a panel or desk-based piece is near a partition or a column which can be furred out.

*Ceiling Supply*

If no walls or columns are available, ceiling supply is the most economical. Power poles can be used, though they are almost universally disliked because they break up established unity. Their use should be kept to a minimum in order to prevent the creation of an unsightly forest of power poles. Some panel manufacturers offer extensions of vertical raceways which blend with the panels better than power poles.

Architectural devices can be incorporated to provide ceiling supply. Sometimes called portals, these are usually fake columns, though they can be treated in a manner which reinforces the overall design.

*Flat Wire*

If no floor or wall box is available where needed, flat wire can bridge the gap between building power outlet and systems installation. Use only under carpet tile. Wheeled cart traffic can disrupt some data transmissions.

*Tombstones*

These raised metal monuments can be added by coring the floor slab but may not occur precisely where you want them because they must miss structural obstructions below the floor. They cannot be used where there is no access from below (including slabs on grade) unless the electrical rough-in is already in place. Tombstones must miss storage/filing pedestals under work surfaces and tend to be awkward when they occur in knee spaces below work surfaces.

*Floor Boxes*

These come in a variety of configurations but have surfaces flush with the floor, eliminating obstructions within work stations except for the conduit necessary between the box and the base raceway. Adding a floor box is very expensive; they should be designed into the building. As with tombstones, precise location is usually not possible because they must avoid structural obstructions below the slab.

*Access Floor*

The most flexible, but justifiable only in areas with very intensive communication and data requirements. Conduit can drop through floor at any point.

**BUDGETING FOR FURNITURE SYSTEMS**

Furniture systems represent a significant portion of the cost of a project housing office functions. It is essential that their cost be budgeted into the project from its inception. The time involved in furniture systems acquisition must also be budgeted into the project from the beginning. Be sure, in large projects, to build adequate time into the schedule for programming. Be aware that the lead-time for the furniture system acquisition can take several months. Specific details on budget and procurement are contained in the acquisitions chapter.

Furniture systems can be part of a SID project if they are specifically identified on the DD Form 1391. They are O&M funded and can be included in the general construction contract along with such items as built-in casework. Furniture systems are listed on the DD Form 1391 as a non-add entry in Block 9 for "Equipment Provided from Other Appropriations". In Block 12b, the furniture systems should be as an O&M funded item, the fiscal year the funds are requested and the line item cost. Accessories can account for a significant portion of the furniture systems package and should be budgeted with the basic system components.

**PROGRAMMING FURNITURE SYSTEMS**

The programmer will find input from three levels to be of value in making determinations regarding what to plan and design: from the user; from the department head; and from a senior manager. The design cannot respond to every need, but a thorough programming effort will identify a range of work station types which satisfy most needs and which can be provided with additional or special components to address specific user needs.

The following are items which could be included on programming questionnaires circulated to the three groups. No form replaces a personal programming conference and this should be done wherever possible.

Future work station users supply the following information

- Time of day when most difficult tasks are faced
- Number of hours per week spent reading
- Type of reading, e.g. memos, orders, computer reports, creative materials, sorting/collection

- Number of hours per week spent at VDT screen
- Number of hours per week spent writing
- Proportion of writing time spent sitting vs. standing
- Number of hours per week spent in computer input, phone calls received and placed, and intercom
- Number of hours per week that you are away from your work station
- Who visits you in your work space, how often, for what purpose and for how long
- Whose work spaces do you visit, how often, for what purpose and for how long
- Average number of times per day that you enter and leave your work space
- Percentages of your work which is confidential, including paperwork, conferences and telephone conversations
- Percentage of time that your tasks require isolation for concentration and listing of these tasks
- Frequency with which you need access to files aside from what is close at hand, including: access when on telephone; access once or twice daily; frequent access within 15-30 minutes; occasionally; never
- Composition of files in your work area, including: contracts; reports; correspondence; data tapes; diskettes; financial information; employee records; other.
- Type of filing systems used, including: vertical; lateral; portable
- Number of separate projects worked on in the average day, including the following task types: keyboard; writing; other.
- Number of active projects going on at the same time
- Duration of paper tasks: one hour; four hours; one day; one week; longer
- List of items normally on work surface: CPU; VDT; keyboard; mouse; printer; telephone; in/out trays; folders; computer printouts; writing pads; paper piles.
- Are you right or left handed
- List of items needed in your work space: computer; printer; telephone; typewriter; calculator; dictation equipment
- Supplies needed in your work space: letterhead; notebooks; forms; other
- Items for which you need lockable storage: files; supplies; currency; reference materials; personal items
- Statement of aspects of the work environment that you like or consider helpful in your work

Department heads take a broader view of the organization and can provide the following more general information.

- Diagram of organizational structure
- Description of services provided by your unit, focusing on a typical workday and the type of interaction or activity in which you and members of your unit engage
- Listing of employees in your unit indicating usable square footage appropriate for each and the type of work area needed, e.g. private work station, shared private work station, open work station
- Diagram indicating adjacency requirements among the various staff components of your unit

- Indication of contact between personnel of your unit and: personnel of other on-base units; vendors; contractors; general public; other
- Define computer screen orientation in terms of security concerns when users are away from their desks
- Identify requirements for safes and security restrictions
- Existing or proposed power provisions and the availability of clean power
- Identification of conference facilities required by your unit: formal and private; semi-private; informal. Also, a listing of equipment required for each space
- Number of file drawers (vertical, lateral or other) which your unit presently has, together with a projection of need over the next five years. Also, indicate whether or not the files are active and are secured
- Number of linear feet of shelving which your unit presently has together with a projection of need over the next five years
- Listing of equipment required by your unit: computer stations; drafting stations; fax; printer; plotter; copier. Also, the power requirements and what pieces require dedicated circuits. Indicate future equipment needs which are known

Senior management possesses information which will chart future directions which is very important to designers.

- Identification of future equipment considered for the unit in the new layout of which middle management may not be aware
- Substantial changes contemplated for the unit structure which could impact the new layout
- Description of shortcomings of existing unit layout
- Description of image which the new office layout should communicate
- Three to five adjectives that would best describe the atmosphere of the new office layout to unit personnel and visitors

#### DESIGN ISSUES

- Layout
- Evaluation of the programmatic material will yield patterns which will begin to suggest the basic design of a range of work stations. These include:
  - Commonality in terms of basic tasks
  - Storage needs
  - Equipment needs
  - Shared equipment needs
  - Requirements for confidentiality
  - Need for privacy
  - Patterns of collaborative work
  - Formal and informal conference spaces
  - Need for conferencing space within work stations
  - Adjacency requirements based on work process
  - Telephone/networking requirements

More specific guidance on the interior design or space planning services will be included in the acquisitions chapter.

People aren't made with cookie cutters and work stations shouldn't be either. Develop a series of basic work station designs, then customize individual stations with storage and filing components and accessories to meet the specific requirements of the user. Recognize and express in the design, the differences in the jobs of the various users.

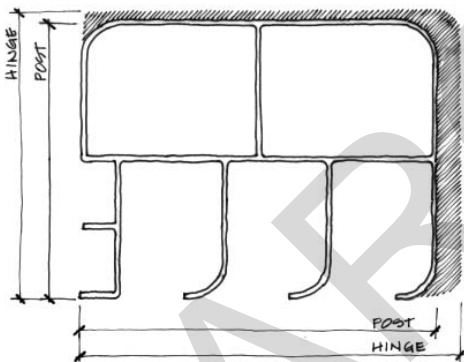
Status should be related to the task performed and recognized with upgraded materials and better accessory packages, not by increasing the square footage beyond that which the task justifies.

Building code regulations for corridor widths and dead end corridors typically apply to systems furniture layouts. Consult your code. Life safety issues must also be considered and codes consulted for specific issues such as egress, panel heights, and buildings with or without a sprinkler systems.

Field measurements are essential to verify actual clear dimensions available. Modifying components to fit existing conditions is costly and can void the warranty.

Require vendors to provide record drawings, both in hard copy form and electronic medium form, along with a products parts list (including product numbers).

Panel creep involves the addition of inches along a run of panels due to connections from panel-to-panel. These inches can add up to a significant dimension per the number of panel connections. Panel-to-post connection requires measurement from post centerline to centerline resulting in accurate dimensioning and no creep.



Do not rely on the construction documents floor plans. Check the lighting, power, communication and fire alarm plans. Identify all elements and devices which could be in conflict with your installation and then verify the actual placement of these devices. Particularly troublesome devices are thermostats, fire alarm components, air handlers, control panels and sprinkler heads. Consult your code. Have final layouts reviewed and approved by CE/MAJCOM design staff, Fire Marshall, and Safety prior to ordering.

If traditional panels are used, the height should be held to the minimum commensurate with privacy requirements and the need for overhead storage. Varying the panel heights adds interest, but could limit flexibility in rearrangement.

If stackable panels are used, consideration should be given to a base panel height just above the work surface, with additional units stacked on where

required for privacy or overhead storage. This gives maximum flexibility for future rearrangement.

If overhead storage units are stacked, manufacturers often require equal distribution on either side of the panel. Consideration should be given to the strength of the connector that attaches the panel to the next panel. Panels are only as strong as their connectors. It is generally less expensive if freestanding files or bookshelves are used rather than stacking overhead storage units.

Carpet tile is preferable for use in areas where furniture systems are to be installed. Replacing carpet tile under panels and desk-supported elements is laborious, but easy compared to replacing roll goods.

#### *Responsibilities*

The vendor is responsible for checking the field measurements and for all code and ADA compliance. The government's representative, such as the AE or an in-house knowledgeable party, is responsible for checking the construction documents. A vendor should never break a life safety code to please a customer.

#### *Accommodation for the Disabled*

Furniture systems accommodate well. The ability to reconfigure them to provide more maneuvering room and to adjust the heights of work surfaces and storage components make accommodation for the mobility impaired relatively easy. Pedestal units suspended from the work surface allow clear toe space for maneuvering. Pedestal-base tables are more wheelchair friendly, but leg-supported tables are preferable when someone uses the table edge for support. Power and data outlets above the work surface are easier to reach. Some drawer/door pulls are easier to grasp than others.

For those with visual impairments, work surfaces which are medium to light in tone should be used in lieu of dark tones or white. Contrasting-color edge banding make edges more visible. Rounded corners and edge banding are preferable to sharp corners. More and more designs are cognizant of universal design.

#### *Upgrading Programs*

Leading manufacturers have programs for upgrading existing products. Surfaces can be recovered and there are retrofit products for components in excess of 20 years old. These include provisions for power distribution, data cabling, wire management, storage and filing components and accessories. This long-term commitment to product improvement reduces life-cycle costs while ensuring that installations can be kept up to date visually as well as technologically.

#### *Acoustics*

Typewriters and dot printers are noisemakers of the past. The use of acoustical ceilings and carpet is virtually universal. The acoustically absorptive quality of panel products is not as important as it once was. Acceptable office environments can be achieved using all, or mostly all, hard surfaces. Where confidentiality of speech is a consideration, consider special acoustical cores for the panels. The cost of acoustical panels can be up to 10% more expensive than non-acoustical panels. Once components, such as tackboards and overhead cabinets are added, this extra cost is wasted. Acoustical panels should



only be installed in areas where their benefits are actually used. In certain situations providing suitable background noise or white sound can blend speech into the background to prevent conversation from being overheard.

### *Integration of Lighting*

All systems offer standard task lights, usually either fluorescent strips mounted to the underside of overhead storage units or bracket-mounted to a vertical support or anchorage element. Many are interchangeable among manufacturers. Most provide diffused general light on the work surface but do not necessarily provide appropriate background light for computer users or adequate lighting for document holders.

Some manufacturers offer ambient up-lighting fixtures which can be mounted to the tops of panels or stanchion-mounted to desk-supported units. In large installations these can almost totally replace ceiling fixtures, providing diffuse reflected light at the work stations, where it is needed.

### *Materials*

Combinations of basic and upgrade materials for panels, work surfaces, pedestals and overhead filing/storage units can be used to enhance status or create a hierarchy of work station design.

If dark panel colors are used in large areas they tend to drink light and can make the installation appear somber or gloomy, except in areas with abundant natural light. They can also create undesirable visual contrasts for writing and as backgrounds for work at VDTs. Material selection must be considered in concert with the lighting conditions. For example, an application where dark colors may be beneficial is one where a low level of general lighting and minimal glare is necessary for intense computer applications. A panel fabric with a medium color value and a subtle pattern is a good soil hiding device.

### **LESSONS LEARNED**

#### *Electrical/Communication Coordination*

Proper coordination between all parties involved in providing power and data is necessary to the installation of a furniture system. Refer to Coordination (page 11 of this chapter).

#### *Creep*

Creep can cause the addition of unplanned inches to a row of panels. If not planned for, the problem may only be discovered during installation. Refer to creep paragraph of Design Issues (page 16 of this chapter).

#### *Ergonomics*

The mouse pad and keyboard should be a contiguous/integrated unit. It should not be necessary to reach for them from awkward positions. Monitors should be positioned where the user should not have to look up to the screen.

#### *Loading Factors*

Panel runs require counter supports and perpendicular support at intervals to avoid tipping over.

Verification of existing conditions with construction drawings is necessary to avoid finding an unforeseen column or chase or any conflicting dimension during installation.

|                                |   |
|--------------------------------|---|
| <i>Additional Items</i>        | Sprinkler heads need a minimum of 12” of space to pop-down and water distribution cannot be blocked. Exit signs must be visible from all points within an area when standing. Maintain minimum corridor space. Avoid winding, dead-end walkways. Ensure compliance with ADA   |
| <i>Construction Drawings</i>   | <p><b>CONSTRUCTION DOCUMENTS</b></p> <p>The requirements for construction drawings for furniture systems for Air Force projects are set forth in the Air Force Interior Design Presentation Format.</p>   |
| <i>Specifications</i>          | Two sample specifications, one for desk based and one for stackable, based on U.S. Army Corps of Engineers Guide Specification Section 12705 are included at the end of this chapter. The following are general specification requirements which should be considered for any installation.   |
| <i>Component Inventory</i>     | A computerized inventory of each part and piece comprising the installation should be required of the vendor. The identity of the component is required not just the product number. When the installation is reconfigured, knowing sizes and quantities of various components simplifies the revised layout.   |
| <i>As-Built CAD Files</i>      | CAD files of the completed installation, in a format usable by the base civil engineering staff and reflecting modifications made during installation, should be required of the vendor.  |
| <i>Installation Provisions</i> | <p>Installers must be licensed or certified by the manufacturer of the system which is provided. This should be both specified and verified prior to award of contract.</p> <p>Some installations will require the presence of security personnel during working hours. Identify the party responsible for paying for security costs which may be incurred.</p> <p>Specify the make-up of the installation crews. A good composition is one supervisor, two or three trained mechanics and three or four movers.</p> <p>Don't specify the unreasonable. Find out from the manufacturer's representative how many man-hours will be required to assemble one of your typical work stations, from start of unloading to completion of clean-up. State your timetable for installation in the specifications. Let the bidders know if night work is possible. Consider limiting the hours worked per shift; the quality of work will drop off with excessively long shifts.</p> <p>A licensed electrician is required to make hard-wired connections to the building power source. Identify the party responsible for retaining the electrician – supplier, installer or the base.</p> |
| <i>Warranty</i>                | Warranties are available from one year to lifetime (with some exclusions). You will pay for what you specify, so specify only what you need. In most cases it's very difficult to anticipate the use of a system or product more than ten years out.  |

### BID/PROPOSAL EVALUATION

In evaluating bids all parties should be aware that more than just the bottom line needs to be considered. For example, if the specifications call for tackboards and the bidder comes in with tackable panels instead, in order to lower the bottom line, take into consideration that some tackable panels are not really tackable.

Require each vendor to provide a mock-up workstation of their exact product as bid, so the buyer can examine what they will be getting first hand before awarding furniture contract.

### OPERATIONS & MAINTENANCE

Determine who will be responsible for retaining the list of components which comprise any installation. The list should be updated as new components are acquired, existing components refurbished or damaged components eliminated. Make sure the list of components state the identity and not just the product number.

If the installation is reconfigured, update the CAD files to reflect this and reference the components list so that there is a record of what is used where. Reconfiguring a furniture systems installation without the presence of a licensed installer can void the warranty.

### ENVIRONMENTAL ISSUES

The furniture industry in general is making a genuine effort toward sustainable design, though some manufacturers are much further along than others. The Air Force should encourage these efforts by considering sustainability issues in the products selected for its projects.

Initiatives in this field, which are documented in product literature, include reduction of VOCs by the use of powder coatings, use of low solvent coating processes and solvent-free or low-solvent solutions for adhesives, foams and wood finishing products. Wood is obtained from domestic sources or from tropical forests only where documentation is available of management according to sustained yield principles, e.g. excess materials are eliminated from products and aggressive programs reduce manufacturing waste and recycle its byproducts.

Several furniture system manufacturers have initiated programs for the purchase of their early products for remanufacture and resale at prices substantially less than for new elements. GSA Schedule pricing for new products is so advantageous that it unfortunately makes these remanufactured products generally uncompetitive for AF projects.

*Green Manufacturing*

*Recycled Products*

*Packaging*

Furniture system components can be shipped either in cardboard cartons or blanket-wrapped. Carton packing generates an enormous amount of waste. Blanket-wrapping should be required for all large AF projects; however, it is generally not available for orders smaller than one truckload.

**POST-OCCUPANCY EVALUATION**

Soliciting feedback from those occupying work stations in the installations we have designed is the only positive way to ensure that the design has responded to their needs and that mistakes are identified so that they are not repeated. The adaptable nature of furniture systems makes it relatively easy to correct mistakes or miscalculations by reconfiguration and retrofit.

A POE should ask the following.

- Do the work surfaces accommodate the tasks which you perform and the equipment you use to accomplish them?
- Is adequate storage available to house the materials you use on a regular basis?
- Are power and data outlets available where needed and can they be relocated if the need arises?
- Is ambient and task lighting available and adequate?
- Does the office layout encourage interaction among personnel?
- Does your work space provide an environment conducive to concentration? How might this be improved?
- Is your work space a pleasant place to be? How might this be improved?

**CHANGING WORK STYLES AND SYSTEMS FURNITURE**

The offices we work in today are very different from those of 15 years ago and those of 15 years from now will be far more different still. The pace of change in the Air Force will not be that of the private sector, but the basic forces which drive change are the same. Downsizing is a reality everywhere and the Air Force will see a flattening in the organization of many units. The imperatives of the do more with less business climate are already prodding the Air Force to adopt new technologies. With these basic changes a certainty, how does office planning and design respond?

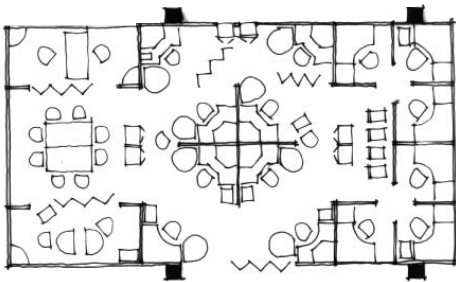
A few things are clear. Space will be more universally used as a tool for productivity, not a measure of status. The ability to adapt to changing project and work process needs quickly, with minimum disruption and at minimal cost, will be essential. Flexibility will be even more important and the role of furniture systems will be even greater than in the past. But the systems will also change.

There will still be panels, but far fewer of them than in the past, and layouts will be less rectilinear. Mobility – the ability to change work station configurations quickly – will be one of the key elements in system selection. It's already here in some systems where components including work surfaces, carts, lockers, tables, pedestals and communications tools such as easels and

display items are on wheels. Work stations will consist of combinations of relatively fixed and completely mobile elements. All of this will enable office organizations and individual users to take control of their surroundings, independent of an installer's schedule.

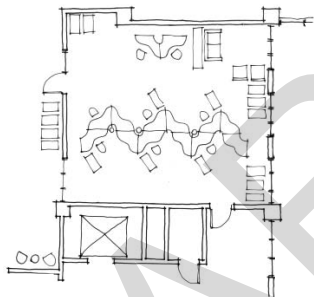
The following are descriptions and illustrations of some of the alternative concepts which reflect these changing work styles. None will be ideal for any installation, but elements of one or more may have application when used in combination with more traditional layouts. A rigorous programming effort will indicate the right mix.

### *Teaming*

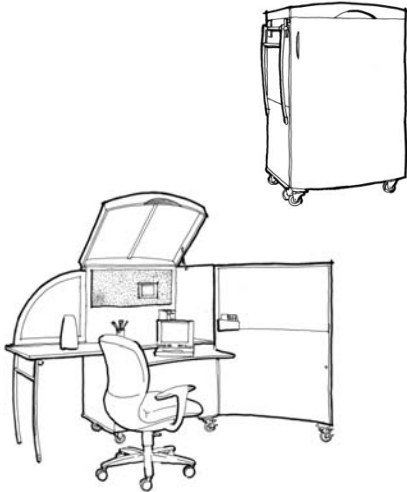


The term is over-used but the concept is a reality. Organizations are forming self-managed work units as never before. The goal is to make employees accessible to one another, enhancing collaboration, improving communications and increasing productivity – all while helping organizations run lean. Teaming layouts have fewer barriers and more common space that promotes mentoring and collaborative work. It does not save space overall, but redistributes it; the physical limits of work stations are not precisely defined and the distinction between an individual's space and common space is blurred.

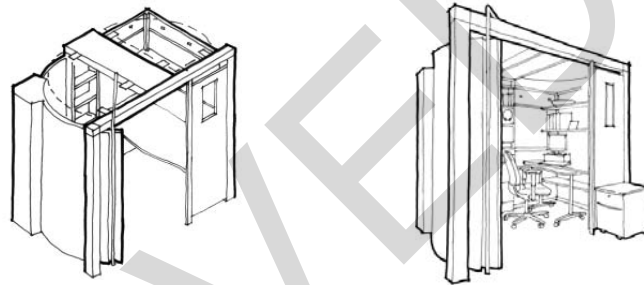
### *Hoteling*



More people are in their offices less and less of the time, accomplishing their work on the road or at a remote assignment. Hoteling is a space-effective way to provide a home base for some of these workers in some situations. Unassigned work stations providing work surfaces, panels if appropriate, telephones, power and data ports, etc. are either reserved ahead or assigned on a daily basis by a facility manager. Workers are provided with a dedicated locker and, usually, a mobile pedestal which contains filing material and lockable storage.

*Office in a Box*

There are only a few of these on the market and manufacturers are still experimenting as to what and how much to incorporate into them. Some users see the concept as ideal for temporary offices to staff up for a project, as an element to complement teaming arrangement by providing a space for private work or as the work station in a hoteling concept. It could also be shipped to a remote location to serve as a site office. One unit on the market is somewhat permanent and can be closed off with a sliding door. Another is on casters and can be completely folded up to resemble a piece of furniture.

**TELECOMMUTING**

Not new, telecommuting has been around for over 20 years. It works for people who do most of their work away from the office but must remain electronically connected. Telecommuting lends itself well to the hoteling concept. In another variation, employees work in a facility near their work location owned by the employer. GSA maintains such facilities in the Washington, DC area for its staffers. The drawback to telecommuting is that the telecommuter is having to maintain or coordinate the repair of complicated office equipment. Telecommuting works best as an adjunct to the office rather than a replacement.

**MATRIX**

For the user's convenience, we have categorized all the current Federal Government Furniture Systems Contractors into panel supported, stackable, cluster, floor-to-ceiling walls, desk-base, beam-supported, wall-based, cabinet-base, hybrid and work stations accessories.

**PANEL SUPPORTED SYSTEMS**

| Contractor                  | Product Name          | Contract #   |
|-----------------------------|-----------------------|--------------|
| Advance Office Concepts     | Status Seeker II      | GS-29F-0227G |
| Allsteel, Inc.              | 8000 Series           | GS-29F-0120G |
| Allsteel, Inc.              | Aurora                | GS-29F-0120G |
| The Alma Group              |                       | GS-29F-0182G |
| American Seating            | Framework Office      | GS-29F-0124G |
| American Seating            | Invitation Wood       | GS-29F-0124G |
| Artopex Plus, Inc           |                       | GS-29F-0200G |
| ASC Office Environments     | Diversified's Delta   | GS-29F-0162G |
| Cano Corp.                  |                       | GS-29F-0218G |
| Capitol Furniture Dist. Co. | La-Z-Boy's RJ Plus II | GS-29F-0135G |
| CenterCore Group            | Spacemaker 2000       | GS-29F-0145G |
| Domore                      | Series System 7       | GS-29F-0182G |

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### PANEL SUPPORTED SYSTEMS (CONT.)

| Contractor                  | Product Name           | Contract #   |
|-----------------------------|------------------------|--------------|
| Executive Office Concepts   | Options                | GS-29F-0214G |
| Flex-Y-Plan Industries      | Workplace System       | GS-29F-0201G |
| GF Office Furniture         | OPS/Connections        | GS-29F-0139G |
| Glen O'Brien Partition      | Opus One               | GS-29F-0215G |
| Hamilton Sorter             |                        | GS-29F-0194G |
| Haworth, Inc                | Places                 | GS-29F-0137G |
| Haworth, Inc                | Unigroup               | GS-29F-0137G |
| Herman Miller               | Action Office Series 1 | GS-29F-0150G |
| Herman Miller               | Action Office Series 2 | GS-29F-0150G |
| Herman Miller               | Action Office Series 3 | GS-29F-0150G |
| The Hon Co.                 | Concensys              | GS-29F-0163G |
| The Hon Co.                 | Simplicity II          | GS-29F-0163G |
| Interior Systems            |                        | GS-29F-0208G |
| Invincible Office Furniture | Systems Furniture      | GS-29F-0203G |
| Kimball International       | Cetra                  | GS-29F-0177G |
| Knoll, Inc.                 | Equity                 | GS-29F-0140G |
| Knoll, Inc.                 | Morrison Network       | GS-29F-0140G |
| Marvel Group                | Unison                 | GS-29F-0168G |
| Packard Industries          | Officenter 2000        | GS-29F-0176G |
| Panel Concepts              | Top Line               | GS-29F-0172G |
| Panel Concepts              | Bottom Line            | GS-29F-0172G |
| Pleion Corp                 |                        | GS-29F-0180G |
| Rosemount Office Systems    | Basic Solutions        | GS-29F-0152G |
| Rosemount Office Systems    | Private Spaces         | GS-29F-0152G |
| Southern Metal Industries   | Synerflex              | GS-29F-0213G |
| Steelcase, Inc.             | Series 9000            | GS-29F-0141G |
| TAB Products                | Panels & Posts         | GS-29F-0116G |
| Tibbet, Inc.                |                        | GS-29F-0183G |
| Transwall Corp              | Sounddivider           |              |
| Trendway Corp               | Choices                | GS-29F-0165G |
| UNICOR                      | Systems XXI            | Mandatory    |

### STACKABLE PANEL SYSTEMS

| Contractor              | Product Name        | Contract #   |
|-------------------------|---------------------|--------------|
| ASC Office Environments | Diversified's Delta | GS-29F-0162G |
| Haworth                 | Premise             | GS-29F-0137G |
| Herman Miller           | Ethospace           | GS-29F-0150G |
| Kimball International   | Cetra               | GS-29F-0177G |
| Knoll                   | Reff                | GS-29F-0140G |
| Transwall               | Reasons             | GS-29F-0114G |

### CLUSTER WORKSTATION SYSTEMS

| Contractor             | Product Name        | Contract #   |
|------------------------|---------------------|--------------|
| ASC Office Environment | Diversified's Delta | GS-29F-0162G |
| CenterCore             | Spacemaker 2000     | GS-29F-0145G |
| Datum Filing Systems   | Apollo              | GS-29F-0185G |

(continued on next page)

### CLUSTER WORKSTATION SYSTEMS (CONT.)

| Contractor                | Product Name        | Contract #   |
|---------------------------|---------------------|--------------|
| Datum Filing Systems      | Eclipse             | GS-29F-0185G |
| Domore                    | Series System 7     | GS-29F-0182G |
| Executive Office Concepts | Options             | GS-29F-0214G |
| Hamilton Sorter           |                     | GS-29F-0194G |
| Knoll                     | Equity              | GS-29F-0140G |
| Packard Industries        | Axis                | GS-29F-0176G |
| Southern Metal Industries | Synerflex           | GS-29F-0213G |
| TAB Products              | Cluster Workstation | GS-29F-0116G |
| Transwall Corp            | Soundivider         | GS-29F-0114G |
| Trendway Corp             | Choices             | GS-29F-0165G |

### FLOOR TO CEILING WALLS

| Contractor              | Product Name      | Contract #   |
|-------------------------|-------------------|--------------|
| Artopex Plus, Inc.      |                   | GS-29F-0200G |
| ASC Office Environments | Diversified Delta | GS-29F-0162G |
| Herman Miller           | V-Wall            | GS-29F-0150G |
| Interior Systems, Inc.  |                   | GS-29F-0208G |
| Knoll                   | Reff              | GS-29F-0140G |
| Transwall Corp          | Corporate         | GS-29F-0114G |
| Transwall Corp          | Twinline          | GS-29F-0114G |
| Trendway Corp           | TrendWall         | GS-29F-0165G |

### DESK-BASED SYSTEMS

| Contractor                  | Product Name              | Contract #   |
|-----------------------------|---------------------------|--------------|
| ASC Office Environments     | Diversified's Series 4300 | GS-29F-0161G |
| Capitol Furniture Dist. Co. | La-Z-Boy's RJ Plus II     | GS-29F-0135G |
| Executive Office Concepts   | Options                   | GS-29F-0214G |
| Executive Office Concepts   | WCF System                | GS-29F-0214G |
| Flex-Y-Plan                 | Factors Modular           | GS-29F-0201G |
| GF Office Furniture         | OPS Desk Collection       | GS-29F-0139G |
| GF Office Furniture         | Stratum Desk              | GS-29F-0139G |
| GF Office Furniture         | Connections Desk          | GS-29F-0139G |
| Haworth                     | Crossings                 | GS-29F-0228D |
| Haworth                     | Premise                   | GS-29F-0137G |
| Haworth                     | Tango                     | GS-29F-0137G |
| Herman Miller               | Arrio                     | GS-29F-0150G |
| Herman Miller               | Newhouse Group            | GS-29F-0150G |
| Herman Miller               | Relay                     | GS-29F-0150G |
| Jax International           | Synergy                   | GS-29F-0117G |
| Jax International           | Master Series             | GS-29F-0117G |
| Kimball International       | Cetra                     | GS-29F-0177G |
| Kimball International       | Footprint                 | GS-29F-0177G |
| Knoll, Inc.                 | Morrison Network          | GS-29F-0140G |
| Marvel                      | Desk Systems              | GS-29F-0199G |
| Marvel Group                | Ensemble                  | GS-29F-0168G |
| Omni International          | Omni Space/Station        | GS-29F-0113G |

(continued on next page)



**DESK-BASED SYSTEMS (CONT.)**

| Contractor                | Product Name | Contract #   |
|---------------------------|--------------|--------------|
| Southern Metal Industries | Interface    | GS-29F-0213G |
| Steelcase                 | Context      | GS-29F-0141G |
| Steelcase                 | Ellipse      | GS-29F-0153G |
| Watson Furniture Systems  | Basik 1      | GS-29F-0109G |

**BEAM-SUPPORTED SYSTEMS**

| Contractor               | Product Name    | Contract #   |
|--------------------------|-----------------|--------------|
| Haworth                  | Race            | GS-29F-0137G |
| Rosemount Office Systems | Velocity System | GS-29F-0152G |

**WALL-BASED SYSTEMS**

| Contractor            | Product Name | Contract #   |
|-----------------------|--------------|--------------|
| Kimball International | Footprint    | GS-29F-0177G |

**CABINET-BASED SYSTEMS**

| Contractor    | Product Name | Contract #   |
|---------------|--------------|--------------|
| Herman Miller | Liaison      | GS-29F-0150G |

**HYBRIDS**

| Contractor | Product Name     | Contract #   |
|------------|------------------|--------------|
| Steelcase  | Personal Harbors | GS-29F-0153G |

**WORKSTATION ACCESSORIES**

| Contractor | Product Name | Contract #   |
|------------|--------------|--------------|
| Knoll      | Orchestra    | GS-29F-0140G |
| Knoll      | Knoll Extra  | GS-29F-0140G |
| Steelcase  | Details      | GS-29F-0141G |
| Steelcase  | Details      | GS-29F-0153G |

**GUIDE SPECIFICATIONS**

Refer to Stackable Panel Furniture Systems Guide Specifications.

Refer to Desk-Based Furniture Systems Guide Specifications.

*Contributing manufacturers:*

Centercore  
Haworth  
Herman Miller  
Kimball  
Knoll  
Steelcase  
Transwall

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DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS

CEGS-12705 (January 2001)  
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Superseding  
CEGS-12705 (November 1999)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12705

FURNITURE SYSTEMS

01/01

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL
- 1.3 SUBMITTALS
- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.5 PATTERN AND COLOR
- 1.6 ALTERNATE DESIGN
  - 1.6.1 Workstation Size and Configuration
  - 1.6.2 Component Requirements
  - 1.6.3 Layout
  - 1.6.4 Wiring Configuration
- 1.7 WARRANTY

PART 2 PRODUCTS

- 2.1 PERFORMANCE AND SAFETY REQUIREMENTS
  - 2.1.1 Selected Components
  - 2.1.2 Panel Acoustics
  - 2.1.3 Fire Safety
  - 2.1.4 General Safety
  - 2.1.5 Electrical System
  - 2.1.6 Panel Glazing
- 2.2 [PANEL SYSTEM] [SPINE WALL SYSTEM] [DESK-BASED SYSTEMS]
  - 2.2.1 Panel System
  - 2.2.2 Stacking Panel-Frame System
  - 2.2.3 Spine Wall System
  - 2.2.4 Desk-Based Systems
  - 2.2.5 Finishes
  - 2.2.6 Raceways
  - 2.2.7 Leveling Glides
  - 2.2.8 Panel and Spine Wall Connection System
  - 2.2.9 Wall Mounted Panels
    - 2.2.10 Glazed Panels
    - 2.2.11 Door Panels
- 2.3 WORK SURFACES

- 2.3.1 Finishes
  - 2.4 PEDESTALS
    - 2.4.1 Construction
    - 2.4.2 Finishes
    - 2.4.3 Drawer Requirements
  - 2.5 STORAGE
    - 2.5.1 Shelf Unit Construction
    - 2.5.2 Flipper Door Unit Construction
    - 2.5.3 Lateral File Unit Construction
    - 2.5.4 Finish
  - 2.6 ACCESSORIES
    - 2.6.1 Coat Storage
    - 2.6.2 Keyboard Tray
    - 2.6.3 Computer Turntables
    - 2.6.4 Tackboards
    - 2.6.5 Erasable Marker Boards
    - 2.6.6 Paper Management Unit
    - 2.6.7 Wall Mounted Components
    - 2.6.8 CPU Holder
  - 2.7 MISCELLANEOUS HARDWARE
  - 2.8 LOCKS AND KEYING
  - 2.9 ELECTRICAL
    - 2.9.1 Panel Raceways
    - 2.9.2 Spine Wall
    - 2.9.3 Power Distribution
      - 2.9.3.1 Receptacles
      - 2.9.3.2 Power Cabling Variations
    - 2.9.4 Electrical Connections
      - 2.9.4.1 Internal Connections
      - 2.9.4.2 Connections to Building Services
    - 2.9.5 Wire Management
    - 2.9.6 Circuit Layout
    - 2.9.7 Service Entry Poles
    - 2.9.8 Task Lighting
      - 2.9.8.1 Luminaire Configuration
      - 2.9.8.2 Wiring
    - 2.9.9 Communications
    - 2.9.10 Special Systems
- PART 3 EXECUTION
- 3.1 INSTALLATION
  - 3.2 CLEANING

-- End of Section Table of Contents --

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U.S. ARMY CORPS OF ENGINEERS                          -----
                                                       Superseding
                                                       CEGS-12705 (November 1999)

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 12705
FURNITURE SYSTEMS
01/01

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NOTE: This guide specification covers the requirements for furniture systems which include panel-supported, stackable panel, spine wall and desk-supported furniture systems.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Use of electronic communication is encouraged.

\*\*\*\*\*

PART 1 GENERAL

\*\*\*\*\*

NOTE: Various provisions of this guide specification may be irrelevant to or in conflict with the requirements of any given project. The guide should be carefully tailored to fit the needs of each specific application. Portions must be deleted, if not applicable, and additional material inserted where necessary to adequately delineate requirements. Brackets and blanks identify provisions which involve alternates; the editor must select and/or insert the appropriate requirements.

\*\*\*\*\*

1.1 REFERENCES

\*\*\*\*\*

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

\*\*\*\*\*

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 423 (1999a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

ASTM C 1048 (1997b) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

ASTM E 84 (2000a) Surface Burning Characteristics of Building Materials

ASTM E 290 (1997a) Bend Testing of Material for Ductility

BIFMA INTERNATIONAL (BIFMA)

BIFMA ANSI/BIFMA X5.5 (1989) Desk Products - Tests

BIFMA ANSI/BIFMA X5.6 (1993) Panel Systems - Tests

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/TIA/EIA-569-A (1998) Commercial Building Standard for Telecommunications Pathways and Spaces

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1 (1999) General Color Requirements for Wiring Devices

NEMA WD 6 (1997) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 101 (2000) Life Safety Code

NFPA 255 (2000) Method of Test of Surface Burning Characteristics of Building Materials

NFPA 265 (1998) Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings

UNDERWRITERS LABORATORIES (UL)

UL 723 (1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials

UL 1286 (1999) Office Furnishings

1.2 GENERAL

This specification establishes the minimum requirements for the acquisition and installation of a complete and usable system of workstations composed of panels, stacking panel-frames, spine walls, freestanding work surfaces or base units, supporting components, electrical hardware, communications, special electrical features, and accessories. Workstation requirements and configurations shall be in accordance with the furniture layout and typical workstation types shown in drawings and specified herein. Components, and hardware shall be provided by a single manufacturer and shall be a standard product as shown in the most recent published price lists or amendments. Electrical components shall be products of a single manufacturer to the extent practicable (different types of components may be of different manufacturers, but all units of a given component shall be from a single source). The completed installation shall comply with NFPA 70 and NFPA 101.

The Contractor shall coordinate the work of this section with that to be performed under other sections. This specification may include items which are not manufactured by the furniture manufacturer; any such items shall be furnished by the Contractor under this section.

1.3 SUBMITTALS

\*\*\*\*\*

**NOTE:** Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space following the name of the item requiring the submittal by using "G" when the submittal requires Government approval. Submittals not classified as "G" will show on the submittal register as "Information Only". For submittals requiring Government approval, a code of up to three characters should be used following the "G" designation to indicate the approving authority; codes of "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval are recommended.

**SD-04:** Task lights may be omitted from the list of samples in small projects (under 20 lights total).

\*\*\*\*\*

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [\_\_\_\_\_] Installation; [\_\_\_\_], [\_\_\_\_\_]

Drawings showing the proposed workstation installation at a scale of 1:100 (1/4 inch = 1 foot), 1/4 inch = 1 foot, unless otherwise specified. Drawings showing communications, electronic data processing (EDP) and local area network (LAN) locations may be provided as a separate submittal from remaining workstation drawings. Drawing requirements, which are the furniture manufacturer's responsibility, shall be provided as a single submittal. Electronic drawings shall be provided to the user for future re-configuration in the software package requested by the user. The electronic drawings shall include all modifications made during installation.

a. Overall reference drawings: Drawings showing workstation locations and overall plan view within each floor. The scale shall be [1:400 (1/16 inch = 1 foot) 1/16 inch = 1 foot][1:100 (1/8 inch = 1 foot) 1/8 inch = 1 foot]. Layouts shall reflect field verified conditions.

b. Installation drawings: Drawings showing workstations, panels, spine walls, components, and plan view within each floor. Workstations shall be identified by workstation type. Scale of drawings shall be identical to Architectural plans. Installation drawings shall reflect field verified conditions.

c. Workstation elevations: Dimensioned workstation elevations showing each type of workstation with panel frame [and spine wall frame] configurations and all components identified with manufacturer's catalog numbers. Elevations shall be drawn at 1:50 (1/2 inch = 1 foot) 1/2 inch = 1 foot scale.

d. Panel drawings: Panel [and Spine Wall] drawings showing panel [and spine wall] locations and critical dimensions from finished face of walls, columns, panels, including clearances and aisle widths. Assemblies shall be keyed to a legend which shall include width, height, configuration and composition of frame covers finishes and fabrics (if different selections exist within a project), power or nonpower, connectors and wall mount hardware. Drawings shall reflect field verified conditions.

e. Electrical drawings: Drawings showing power provisions including type and location of feeder components (service entry poles, base or ceiling feeds), activated outlets and other electrical components. Wiring configuration (circuiting, switching, internal and external connections) shall be identified and a legend provided as applicable.

f. Wire management capacity drawings.

g. Communication drawings showing telephone provisions: Drawings indicating the type and location of feeder components and outlets with wiring configuration identified where applicable.

h. Communication drawings showing electronic data processing provisions: Drawings indicating the type and location of feeder components, outlets, or accessories with wiring configuration identified where applicable.

i. Communication drawings showing local area network provisions: Drawings indicating the type and location of feeder components and data outlets with extra ports for future expansion with wiring configuration identified where applicable.

j. Reflected ceiling plan for projects specified with power poles.

#### SD-03 Product Data

Installation Instructions; G, [\_\_\_\_\_]

Manufacturer's product and construction specifications which provide technical data for furniture system and components specified, including task lighting and illumination performance information. Literature shall include adequate information to verify that the proposed product meets the specification.

Warranty; G, [\_\_\_\_\_]

Two copies of the warranty.

Workstation Components; [\_\_\_\_], [\_\_\_\_\_]

Complete listing of part/model numbers for all components to be furnished, including names and codes of components referenced on updated drawings.

#### SD-04 Samples

Workstations; G, [\_\_\_\_\_]

Four sets of the following finish samples. The Government reserves the right to reject any finish samples that do not satisfy the construction or color requirements. The Contractor shall submit additional samples as required to obtain final approval. Work shall not proceed without sample approval in writing from the Contracting Officer.

a. Panel tackboard and flipper door fabric. Minimum 150 x 150 mm 6 x 6 inches with label designating the manufacturer, color, fiber content, fabric weight, fire rating, and use (panel and/or tackboard).

b. Panel, spine wall, work surface, modesty panel, and component finish. Minimum 60 x 75 mm 2-1/2 x 3 inches with label designating the manufacturer, material composition, thickness, color, and finish.

c. Task lights.

d. Panel and spine wall glazing. Glazing samples with label designating the material and safety ratings.



SD-06 Test Reports

Selected Components; G, [\_\_\_\_\_]
Panel Acoustics; G, [\_\_\_\_\_]
Fire Safety; G, [\_\_\_\_\_]
Electrical System; G, [\_\_\_\_\_]

One complete set of test reports for the proposed system.

SD-07 Certificates

Workstations; [\_\_\_\_\_] , [\_\_\_\_\_]

Two complete sets of certificates attesting that the proposed workstation meets specified requirements. The certificate shall be dated after the award of contract, shall name the project, and shall list specific requirements being certified.

SD-10 Operation and Maintenance Data

Product Assembly Manual; [\_\_\_\_\_] , [\_\_\_\_\_]

Three sets of assembly manuals describing assembly and reconfiguration procedures.

Product Maintenance Manuals; [\_\_\_\_\_] , [\_\_\_\_\_]
Cleaning; [\_\_\_\_\_] , [\_\_\_\_\_]

Three sets of maintenance manuals describing proper cleaning and minor repair procedures.

Electrical System; [\_\_\_\_\_] , [\_\_\_\_\_]

Three sets of electrical system manuals describing the functions, configuration, and maintenance of the electrical system (power [, communications] [, data]). This material may be included in the above 2 manuals at the Contractor's option.

1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked thereon. Components shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

1.5 PATTERN AND COLOR

\*\*\*\*\*

NOTE: Include a reference to Section 09915 COLOR SCHEDULE or drawings for all items requiring a finish color. This includes the following items when applicable: Work surfaces, Pedestals and Drawers, Flipper Doors, Tackboards, Panel Supported Storage, Panels, Stacking Panel Frames, Spine walls, Screens, Connectors, Trim and Accessories. Specify both sides of panels, stacking panel frames and spine walls.

\*\*\*\*\*

Pattern and color of finishes and fabrics for panels [and spine walls], components, and trim shall be [in accordance with Section 09915 COLOR SCHEDULE] [as shown on the drawings] [\_\_\_\_\_].

1.6 ALTERNATE DESIGN

\*\*\*\*\*

**NOTE: Minor differences exist among different manufacturer's product. This paragraph pertaining to an "alternate design" was written in order not to exclude a manufacturer when an equally acceptable solution is proposed. List minimum requirements if applicable to the project. Examples of minimum project requirements might include: minimum linear footage of overhead storage, limitation of number of panel widths, and non-handed components.**

\*\*\*\*\*

Manufacturers who are unable to provide workstations that conform exactly to the furniture layouts and typical workstation types shown in the contract drawings, may submit alternate designs for consideration by the Contracting Officer. Alternate designs must meet or exceed the following criteria. Alternate designs that are submitted but do not meet these criteria will be rejected.

1.6.1 Workstation Size and Configuration

The alternate design shall provide workstations and components of the same basic size and configuration shown, with only the sizes of the individual components within the workstation changed to meet the standard product of the manufacturer.

1.6.2 Component Requirements

The types of components or elements utilized shall be as shown on the drawings and as specified in PART 2 PRODUCTS of this specification.

1.6.3 Layout

The storage capacity, number of workstations accommodated, width of aisles, or workstation configuration shall not be reduced.

1.6.4 Wiring Configuration

Alternate configurations must support the circuiting and connection capabilities identified under the provisions pertaining to power distribution of paragraph ELECTRICAL. Generally any alternate will be acceptable which involves only a variation in size or quantity that exceeds the specified configuration.

1.7 WARRANTY

The Contractor shall warrant the furniture systems for a period of 10 years with the following exceptions: fabrics and other covering materials, and paper handling products shall be guaranteed for 3 years, and task lights shall be warranted for 2 years. [Electromagnetic ballasts shall be

warranted for 2 years.] [Electronic ballasts shall be warranted for 3 years.] [The electronic ballast warranty shall include a \$10 labor allowance for each ballast.] Warranties shall be signed by the authorized representative of the manufacturer. Warranties accompanied by document authenticating the signer as an authorized representative of the guarantor, shall be presented to the Contracting Officer upon the completion of the project. The Contractor shall guarantee that the workstation products and installation are free from any defects in material and workmanship from the date of delivery.

PART 2 PRODUCTS

\*\*\*\*\*  
**NOTE: The designer must ascertain that the combination of products specified are not proprietary and that they can be provided by several manufacturers. The workstation layout shall conform to NFPA 101, and for buildings not excluded by TI 800-01 Design Criteria shall be accessible in accordance with 36 CFR 1191. Considerations for height adjustable work surfaces and storage design shall be made when ADA conformance within the workstation is required. The use of existing reconditioned furniture systems shall be considered when appropriate.**  
 \*\*\*\*\*

2.1 PERFORMANCE AND SAFETY REQUIREMENTS

Panels, spine walls, frames and frame covers, connection system, work surfaces, pedestals, shelf units, flipper door units, lateral files, locks, accessories, and miscellaneous hardware shall meet testing as specified. ISO 9001 certified manufacturers may perform in-house testing. Manufacturers not ISO 9001 qualified shall be required to produce testing by an independent testing laboratory. Component specific requirements are listed in appropriate paragraphs.

2.1.1 Selected Components

Workstations shall conform to the requirements of BIFMA ANSI/BIFMA X5.5 and BIFMA ANSI/BIFMA X5.6 with the following exceptions: Panels, spine walls and panel, or spine wall supported components shall be tested and pass in accordance with the requirements of BIFMA ANSI/BIFMA X5.6 and representative items shall be selected for testing based on worst case situations (i.e., the deepest and widest work surface or shelf). The keyboard drawer or shelf test shall be performed applying a 19 kg (50 lb) 50 lb load to the center of the keyboard shelf for a period of 5 minutes. Any loosening of attachments, permanent deflection or damage to the operation of the drawer or shelf will be cause for rejection.

2.1.2 Panel Acoustics

\*\*\*\*\*  
**NOTE: Acoustical panels and acoustical frame covers will not be used when panel-hung storage units cover more than half the panel surface. In these situations the acoustical advantage is lost and the stronger non-acoustical unit is less expensive.**  
 \*\*\*\*\*

Acoustical performance ratings should be based upon the workstation design. While NRC and STC ratings contribute to overall acoustical performance, the acoustical role of panels is relatively minimal in the overall environment when compared to sound absorptive properties of other finish surfaces. In addition, panel hung components greatly reduce the quantity of acoustical contributing area. For this reason, acoustical panels and acoustical frame covers will not be used behind storage components, nor will acoustical frame covers be used lower than 750 mm (30 inches) above the floor. Most major manufacturers do not comply with the higher 0.80 NRC and 24 STC without providing their more costly high performance panels. The designer must determine if the additional acoustical performance is worth the added cost to the Government. Designer must coordinate NRC and STC requirements for panel heights above 1200 mm (48 inches).

Delete paragraph if acoustical panels are not required.

\*\*\*\*\*

Acoustical panels shall have a minimum noise reduction coefficient (NRC) of [0.65] [0.80] [\_\_\_\_\_] when tested in accordance with ASTM C 423 and a minimum sound transfer coefficient (STC) of [14] [20] [24] [26] [\_\_\_\_\_] when tested in accordance with ASTM E 290. The test shall be conducted on the entire assembled panel, full face area (the complete core, adhesive, decorative fabric, frame and joining components).

2.1.3 Fire Safety

\*\*\*\*\*

**NOTE: Select flame spread and smoke development in accordance with MIL-HDBK 1008C. Verify that flame spread and smoke development ratings can be met with fabric specified.**

\*\*\*\*\*

Components shall meet requirements for flame spread and smoke development as specified by NFPA 101 except as follows. Testing shall have been conducted in accordance with either ASTM E 84, UL 723, or NFPA 255 on the entire assembled panel and each different combination of fabric and interior construction. In addition, fabric shall meet the requirements of NFPA 265. Panel flame spread shall not exceed [[25 for Class A] [75 for Class B] [200 for Class C]] and panel smoke development shall not exceed 450 for Class A, B and C.

2.1.4 General Safety

Workstation products shall be free of rough or sharp edges. [Panel and spine wall supported components shall have a positive, integral locking device which secures components without the use of additional screws or clamps to prevent the components from being accidentally pulled or knocked

off the panels.] [Desk-based workstation components shall have the option for a positive, integral locking device that secures components to the base units.]

2.1.5 Electrical System

Task lights shall be UL approved and shall meet the requirements of NFPA 70. The electrical system shall meet the requirements of UL 1286.

2.1.6 Panel Glazing

\*\*\*\*\*  
**NOTE: Curved glazed panels should not be specified since most products utilize an acrylic glazing. Acrylic glazing is not acceptable since it does not meet flame spread and smoke development requirements.**  
 \*\*\*\*\*

Tempered glass shall conform to ASTM C 1048, Kind FT, Condition A, Type I, [Class 1 Transparent] [Class 3 - Light reducing, tinted or translucent].

2.2 [PANEL SYSTEM] [SPINE WALL SYSTEM] [DESK-BASED SYSTEMS]

\*\*\*\*\*  
**NOTE: A spine wall system may be used in combination with a panel system. In these applications, the spine wall serves as the core of a cluster of workstations. Spine wall systems can be used with other manufacturer's panel systems.**  
 \*\*\*\*\*

2.2.1 Panel System

Accessories and appurtenances for a completely finished panel assembly shall be supplied complete with the system. The system shall be capable of structurally supporting cantilevered work surfaces, shelves, files, and other components in the configurations shown on the drawings. The panel system shall be capable of structurally supporting more than one fully loaded component per panel per side. Panels shall be either tackable or capable of accommodating fabric covered tackboards. The panel system shall be available in a variety of nominal widths and heights as designated on the drawings. Heights shall be measured from the finished floor to the top of the panel. Powered and nonpowered panels shall be compatible in height. Panel heights shall be coordinated with the HVAC and electrical designs.

2.2.2 Stacking Panel-Frame System

Accessories and appurtenances for a completely finished panel assembly shall be supplied complete with the system. The system shall be capable of structurally supporting cantilevered work surfaces, shelves, files, and other components in the configurations shown on the drawings. The panel system shall be capable of structurally supporting more than 1 fully loaded component per panel per side. Panels shall be either tackable or capable of accommodating fabric covered tackboards. The system shall be capable of lowering or raising the overall panel assembly height, at horizontal connections, by either removing or adding panel-frames on-site without disturbing adjacent panel components. The panel system shall be available

in a variety of nominal widths and heights as designated on the drawings and shall be vertically stackable. Heights shall be measured from the finished floor to the top of the panel assembly. Panel heights shall be coordinated with the HVAC and electrical designs.

2.2.3 Spine Wall System

Accessories and appurtenances for a completely finished spine wall assembly shall be supplied complete with the system. The wall system shall be capable of structurally supporting cantilevered work surfaces, shelves, files, and other components in the configurations shown on the drawings, as well as allow various off module attachment locations horizontally for these components. The spine wall system shall be capable of structurally supporting more than one fully loaded component per panel per side. It shall be available in a variety of nominal widths and heights as designated on the drawings. [Wall height may be lowered or raised at horizontal connections by either removing or adding wall tiles on-site without disturbing adjacent wall components.] Heights shall be measured from the finished floor to the top of the panel. Wall heights shall be coordinated with the HVAC and electrical designs. Electrical and data management will be easily accessible by removable wall covers which can be removed while workstation components are still attached. Cables shall be laid in the system, not threaded through the frame.

2.2.4 Desk-Based Systems

Accessories and appurtenances for a completely finished desk-based assembly shall be supplied complete with the system. The desk-based system shall be free-standing and independent of panel system support. It shall be capable of structurally supporting work surfaces, shelves, and other components in the configurations shown on the drawings. The system shall be available in a variety of nominal widths as defined on drawings.

2.2.5 Finishes

\*\*\*\*\*

**NOTE: Specify a finish and fabric for applicable items. Include fabric content, ex: 50% Nylon, 50% Wool. The designer must verify that fabric content, pattern, and color specified are not proprietary and that several manufacturers can provide a similar product to that specified.**

**Filler trim incurs added cost and should be omitted unless it is desired for aesthetic reasons.**

\*\*\*\*\*

a. The panels shall be available in the following options: [acoustical,] [non-acoustical,] [safety glazed,] [open frame] [\_\_\_\_\_]. Exposed panel trim shall have a [factory baked enamel or epoxy powder] [wood,] finish. [Filler trim shall either match the panel trim or be fabric covered to match the panel fabric.] [Filler trim shall not be provided.] Each fabric-faced panel shall have a seamless width of fabric stretched over the entire face of the panel and the color of each fabric utilized shall be consistent throughout the installation. Curved panels may use adhesives on curved sections. The fabric shall be attached securely and continuously along the entire perimeter of the panel and shall allow for easy removal and replacement in the field (with the exception of

curved panels). Fabric shall be factory installed and panel fabric content shall be [\_\_\_\_\_].

b. The stacking panel-frames shall accommodate covers which are available in the following options: [safety glazed,] [acoustical,] [open pass through frames,] [wood veneer,] [upholstered,] [lamine/vinyl,] [cable access channels,] [rail organizer,] [marker surface,] [tackable surface,] [work tools accommodation,] [\_\_\_\_\_]. [Frame covers may have different options on either side of the frame.] Exposed panel trim shall have a [factory baked enamel or epoxy powder] [wood] finish. [Filler trim shall either match the panel trim or be fabric covered to match the panel fabric.] [Filler trim shall not be provided.] Each upholstered frame cover shall have a seamless width of fabric stretched over the entire face of the cover, and the color of each fabric used shall be consistent throughout the installation. The fabric shall be attached securely and continuously along the entire perimeter of the cover and shall allow for easy removal and replacement in the field. Fabric shall be factory installed and panel fabric content shall be [\_\_\_\_\_].

c. The spine wall frames shall accommodate covers which are available in the following options: [safety glazed,] [painted] [acoustical] [wood veneer] [upholstered] [lamine/vinyl] [tackable surface] [marker surface] [paper management] [vertical storage] [cable access] [\_\_\_\_\_]. Frame covers may have different options on either side of the frame. Exposed trim shall have a [factory baked enamel or epoxy powder] [wood] [metal] finish. Spine wall covers must be easily removable even while panels and workstation components are attached. Each fabric-faced frame cover shall have a seamless width of fabric stretched over the entire face of the cover, and the color of each fabric used shall be consistent throughout the installation. The fabric shall be attached securely and continuously along the entire perimeter of the cover and shall allow for easy removal and replacement in the field. Fabric shall be factory installed and have a content of [\_\_\_\_\_].

2.2.6 Raceways

Raceways shall be an integral part of the panel and spine wall. Panels and spine walls, whether powered or nonpowered, shall be provided with a raceway cover. Magnet held base covers will not be accepted.

2.2.7 Leveling Glides

The system shall provide precise alignment of adjacent panels and spine walls and shall include leveling glides to compensate for uneven floors. On panel-to-panel products, each panel shall have 2 leveling glides. On panel-to-post products each connector shall contain a leveling glide. On stacking panel frames each vertical panel assembly shall have two leveling guides. A minimum 20 mm 3/4 inch adjustment range is required for all systems.

2.2.8 Panel and Spine Wall Connection System

\*\*\*\*\*  
**NOTE: Delete connection of 2 panels for setting the panels at any angle if not required. This connection limits sources.**  
\*\*\*\*\*

The panel and spine wall system shall have connectors which accommodate a variety of configurations as shown on the drawings. A straight line

connection of 2 panels (180 degrees), corner connection of 2 panels (90 degrees), T connection of 3 panels (90 degrees), cross connection of 4 panels (all 90 degrees), and a connection of 2 panels for setting the panels at any angle. The connector system shall provide tight connections with continuous visual and acoustical seals. All two-way and T connections should have plastic, painted metal, fabric or wood finish to match system. The connector system shall allow removal of a single panel or spine wall within a typical workstation configuration, without requiring disassembly of the workstation or removal of adjacent panels or spine walls. The connector system shall provide for connection of panels or spine walls of similar or dissimilar heights. When stacking panel frames are specified, taller panel assemblies of adjacent dissimilar height panel assemblies shall be provided with trim pieces to finish the exposed edge. Right angle (90 degree) connections between panels shall not interfere with the capability to hang work surfaces and other components on any adjacent panel. The connector system shall provide, as required, for the continuation of electrical and communications wiring within workstations and from workstation to workstation. Filler posts shall be level with the panel or spine wall top rail.

#### 2.2.9 Wall Mounted Panels

Wall-mount accessories shall be used when it is necessary to attach panels or vertical panel-frame assemblies to the building walls. Wall panels shall have structural support as required.

#### 2.2.10 Glazed Panels

Glazed panel inserts shall be comprised of tempered glass in accordance with ANSI Z97.1. Acrylic glazing will not be accepted.

#### 2.2.11 Door Panels

Door panels shall have a rigid metal frame with rails, a threshold, and a [wood] [laminate] [safety glazed] [\_\_\_\_\_] clad door adaptable to either hand swing. Door panels shall be of a dimension that will allow for a 810 mm 32 inch clear opening. Door panels shall include connectors, hinges, and [brushed chrome] [epoxy powder] [baked enamel] finished ADA compliant door knob.

### 2.3 WORK SURFACES

Work surfaces shall be constructed to prevent warpage. [Work surfaces shall be either fully supported from the panels [or spine wall] or supported jointly by the panels [or spine wall] and supplemental legs, pedestals, or furniture end panels. Supplemental end supports shall be used only under work surfaces when the work station configuration does not permit full support by the panels [or spine wall]. Metal support brackets shall be used to support work surfaces from the panels [or spine wall], provide metal-to-metal fitting to the vertical uprights of the panels [or spine wall], shall be vertically adjustable, and shall lock the work surfaces in place without panel [or spine wall] modifications.] [Work surfaces shall be fully floor supported with legs, pedestals, or furniture end panels.] Abutting work surfaces shall mate closely and be at equal heights when used in side-by-side configurations in order to provide a continuous and level work surface. Work surfaces shall either have pre-drilled holes to accommodate storage components, pedestals and additional supports, or holes shall be able to be drilled at the job site to accommodate these items. Work surfaces shall be provided in sizes and



configurations shown on the drawings. Work surfaces shall be available in nominal depths of [510 mm (20 inches),] [20 inches,] [and] [610 mm (24 inches),] [24 inches,] [and] [760 mm (30 inches),] [30 inches,] plus or minus 50 mm, 2 inches, nominal lengths from 610 to 1830 mm (24 to 72 inches), 24 to 72 inches, and a nominal thickness from 25 to 45 mm 1 to 1-3/4 inches. Work surfaces shall be height adjustable in 25 to 40 mm 1 to 1 1/2 inch increments from 630 to 1040 mm 25 to 41 inches above the finished floor. Work surfaces abutting at equal heights shall provide a continuous and level work surface. [Corner work surfaces,] [peninsula work surfaces,] [and] [counter/transaction work surfaces] shall be provided as shown on the drawings and shall include hardware necessary to provide firm and rigid support.

2.3.1 Finishes

The work surfaces shall have a finished top surface of [high pressure plastic laminate], [veneer] and shall have a smoothly finished underside. The work surface shall not be affected by ordinary household solvents, acids, alcohols, or salt solutions, and shall be capable of being cleaned with ordinary household cleaning solutions. Metal support brackets shall match the color and finish of trim. Edges shall be [post formed or vinyl molding] [solid wood].

2.4 PEDESTALS

Drawer configurations and pedestal height shall be as shown on the drawings. The deepest possible pedestal shall be provided for each work surface size specified.

2.4.1 Construction

With the exception of drawer fronts, pedestals and drawers shall be of steel construction. Drawer faces shall be securely attached to the drawer front.

2.4.2 Finishes

The finish of steel surfaces shall be a factory baked enamel finish or powder coated. Drawer fronts shall be [either steel, plastic laminate, or molded plastic] [veneer].

2.4.3 Drawer Requirements

\*\*\*\*\*  
**NOTE: Delete reference to 380 mm (15 inch) high EDP drawers if not required.**  
 \*\*\*\*\*

Pedestals shall be field interchangeable from left to right, and right to left, and shall retain the pedestal locking system capability. Pedestals shall be designed to protect wires from being damaged by drawer operation. Pedestals shall be work surface hung, or shall support work surfaces, or shall be free standing; as shown. Drawers shall stay securely closed when in the closed position and each drawer shall contain a safety catch to prevent accidental removal when fully open. File drawers shall have either a cradle type or full extension ball bearing suspension with hanging folder frames or compressor dividers. File drawers shall be 305 mm 12 inch high. Box drawers shall be provided with [pencil trays] [and] [stationary trays]. All EDP file drawers shall be 380 mm 15 inch high and shall accommodate

EDP printout sheets. Center pencil drawer shall be mounted under the work surface and shall contain a removable pencil tray.

2.5 STORAGE

[Flipper door cabinets,] [shelf units] [and] [lateral files] shall be provided in the sizes and configurations shown on the drawings. [Flipper door] [and] [shelf unit] cabinets shall accommodate task lighting and shall have a [depth to accommodate a standard three ring binder] [and] [minimum 380 mm 15 inch depth to accommodate computer printouts].

2.5.1 Shelf Unit Construction

The shelf pan shall be of metal construction with formed edges. Shelf supporting end panels shall be constructed of metal, high density particle board, molded phenolic resin, or molded melamine. Shelf units shall accommodate relocatable shelf dividers.

2.5.2 Flipper Door Unit Construction

Flipper door unit shall be of equal construction to shelf units. Units shall remain securely fastened when in the locked position. Doors shall utilize a suspension system.

2.5.3 Lateral File Unit Construction

Lateral files shall be of steel construction. File fronts, top and end panels shall be of equal construction to shelf units. File drawers shall have full extension ball bearing drawer slides or rack and pinion suspension. File drawers shall have hanging folder frames, compressor dividers or rails and shall be capable of hanging side-to-side or front-to-back.

2.5.4 Finish

\*\*\*\*\*  
**NOTE: Designer should not remove an option for a factory baked enamel flipper door from this paragraph since a limited number of manufacturers offer a fabric flipper door. If fabric flipper doors are not desired for maintenance reasons, the fabric option may be eliminated since a metal flipper door is readily available.**  
 \*\*\*\*\*

Shelves and dividers and top dust cover shall have a factory baked enamel finish. Shelf supporting end panels shall have either a factory baked enamel or laminate finish. Shelf bottom shall match end panel color. Metal doors shall have an exterior finish of factory baked enamel or a factory installed fabric covering and an interior finish of factory baked enamel. Metal drawers shall have a factory baked enamel finish. Fabric content of flipper doors shall be [\_\_\_\_\_]. [[Flipper doors] [and lateral files] shall have a wood veneer surface.]

2.6 ACCESSORIES

2.6.1 Coat Storage

One [panel] [spine wall] mounted coat hook per workstation occupant shall be provided at each workstation.

2.6.2 Keyboard Tray

\*\*\*\*\*  
**NOTE: Delete reference to wrist supports if not required.**  
 \*\*\*\*\*

Work surfaces shall be capable of accepting [an articulating keyboard] [a keyboard shelf] on workstations as shown on the drawings. The keyboard tray shall have the capability to be fully recessed under the work surface and extend to give the user full access to the keyboard. Side travel rotation shall be a 180-degree swing. The keyboard tray shall have tilting capability and shall contain a wrist support. It should also include a mouse pad at the same level as the keyboard, and accommodate either right or left-handed users.

2.6.3 Computer Turntables

Turntables shall be provided on workstations as shown on the drawings. Turntables shall contain a stop mechanism to prevent tangled cords.

2.6.4 Tackboards

Fabric shall be factory installed and fabric content of tackboards shall be [\_\_\_\_\_]. Location and size shall be as shown on the drawings.

2.6.5 Erasable Marker Boards

Marker boards shall have a white writing surface which can be easily written on and erased and shall be unaffected by common marker board cleaning/conditioning agents and shall contain a storage tray. Size and location shall be as shown on the drawings.

2.6.6 Paper Management Unit

Paper management units shall be provided as indicated on the drawings. These units shall be constructed of coated steel or injection molded plastic and shall accommodate either legal or letter size lengths. Unit shall not be freestanding and shall be provided as shown on the drawings.

2.6.7 Wall Mounted Components

Wall tracks shall be utilized when components are shown attached directly to wall surfaces. Tracks shall be of heavy duty extruded metal. Finish and color of tracks shall match the panel trim. Vertically aligned tracks shall be slotted on 25 mm (1 inch) 1 inch centers in heights required. Slot spacing shall match slot spacing for wall panels.

2.6.8 CPU Holder

A mounting device shall be provided to support the computer hard drive. Desk top and floor locations are not acceptable.

2.7 MISCELLANEOUS HARDWARE

Brackets, supports, hangers, clips, panel supported legs, connectors,

adjustable feet, cover plates, stabilizers, and other miscellaneous hardware shall be provided.

2.8 LOCKS AND KEYING

\*\*\*\*\*  
**NOTE: The quantity of different key operations required is dependent on the size of the project. The number specified should not exceed the quantity of workstations. The maximum quantity utilized shall not exceed 150.**  
 \*\*\*\*\*

Drawers, flipper door cabinets, and lateral files shall have keyed locks, unless otherwise noted. Field changeable lock cylinders shall be provided with a minimum of [100] [\_\_\_\_\_] different key options. Each workstation shall be individually keyed and locks within a workstation shall be keyed alike. Drawers within a pedestal shall be lockable either by a central lock that controls all pedestals under one work surface or an individual keyed lock in each pedestal. Central file and storage units which are grouped together but are not a part of a workstation shall be keyed alike unless otherwise specified. Door panels shall have keyed [door knob] [\_\_\_\_\_] set. Two keys shall be provided for each lock or 2 keys per workstation when keyed alike, and 3 master keys shall be provided per area as shown on the contract drawings. Keys and lock cylinders shall be numbered for ease of replacement. Locks shall be clearly labeled with a key number, except for those manufacturers who have removal format locks.

2.9 ELECTRICAL

\*\*\*\*\*  
**NOTE: It is recommended that the type of cabling assembly (wiring, harnesses, or buses) be left as a Contractor selection unless necessary to restrict for compatibility with existing equipment.**  
 \*\*\*\*\*

Both powered and nonpowered panels [and spine walls] shall have base raceways capable of distributing power circuits, [communication cables] [and] [data lines]. Nonpowered bases shall be capable of easy field conversion to powered base without requiring the panel [spine wall] to be dismantled or removed from the workstation. The system shall use copper [cable assemblies,] [wiring harnesses] [or] [electrified bus] and shall meet requirements of UL 1286 and NFPA 70, Article 605. Conductors shall consist of 20 amp [90] [75] degree C, #12 AWG wires (unless indicated otherwise) or the equivalent in the bus configuration. The label or listing of Underwriter's Laboratories, Inc. will be accepted as evidence that the material or equipment conforms to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency shall be submitted indicating that the items have been tested in accordance with required procedures of UL and that the materials and equipment comply with contract requirements. Electrical work not addressed in this section shall conform to the requirements of Section 16415ELECTRICAL WORK, INTERIOR.

2.9.1 Panel Raceways

\*\*\*\*\*

**NOTE: Raceways are available in various locations, such as base, desk height and top-of-panel. Revise to meet project requirements.**

**When specifying desk height raceways the overhead storage unit requirements should be carefully coordinated.**

\*\*\*\*\*

Panels shall have hinged or removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. The raceway shall not extend past either [panel face][frame cover] by more than 13 mm 1/2 inch. Metal or plastic covers which attach securely to the raceway shall be provided as required and shall match the finish and color of the panel trim. Raceways [in full size over 610 mm 24 inches powered panels] [on panel frames] shall have a minimum of 2 knockouts (doors) per side for electrical connections or outlets as indicated elsewhere. Other raceways must be flush with [panel face][frame covers].

2.9.2 Spine Wall

Spine walls must be able to support lay-in cabling and have a large capacity for power and data. The interior of the spine wall frame shall provide ample space for storing excess wires and fiber optic cables. Power and data systems shall be easily accessed in the spine wall without having to move return panels or components. The spine wall system must have the ability to provide power to a wall-attached panel system and/or an adjacent desk system. Raceways shall be located in numerous locations such as the base, beltline, and below and above the beltline. Spine wall frames shall have hinged or removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. The base raceway shall not extend past the spine wall face by more than 13 mm 1/2 inch. Other raceways must be flush with the wall face. Metal or plastic raceways covers shall match the finish and color of the panel trim, unless otherwise stated. A termination center or utility closet may be utilized in the wall or at the end of a spine wall run.

2.9.3 Power Distribution

\*\*\*\*\*

**NOTE: The 8-wire system should be utilized for applications serving mixed loads including electronic data processing equipment. Since EDP equipment generates high levels of harmonics (\* see footnote below), a full size neutral should be provided for each EDP circuit. Alternately, it is recommended that the phase conductor not be loaded to more than 12A or that an oversized neutral be specified. To minimize interference from electronic noise to sensitive data processing components, the EDP equipment should be placed on the dedicated circuits. In the absence of other criteria, use of an isolated ground conductor is not recommended for the EDP circuits (See IEEE Std. 1100). If the amount of EDP load is extensive and the conventional**

load is minimal, a modified 8-wire system should be provided. The preferred configuration would be 3 phases, 3 neutrals, an EDP ground, and a conventional ground. Non-EDP load should be connected to one phase, one neutral, and the conventional ground. The other two phases and neutrals and EDP ground should be dedicated for EDP type loads. As a second choice the 8 wires could be designated as follows: 3 dedicated phase, 1 dedicated oversize neutral (#10 with 14 amp maximum phase loading), and isolated ground, a conventional phase, neutral, and ground conductor. The non-EDP load should be placed on the conventional conductors. (An 8-wire configuration with 3 phases, 3 neutrals, an isolated ground, and a conventional ground could also be used. Non-EDP load should be connected to the conventional ground and least loaded phase conductor.) The 5-wire system may be used if no EDP loads are to be supplied. The 6-wire system is a less reliable, hybrid configuration in which EDP and non-EDP loads use a shared neutral. It could also be used for Air Force shared ground applications with the isolated ground connector either disconnected or interconnected with the equipment ground.

Non-linear loads such as computers, copiers, laser printers, electronic lighting ballasts, and uninterruptible power supplies cause harmonic distortion on power distribution systems. The majority of workstation loads are non-linear, harmonic producing loads. Designers must ensure that the building power distribution equipment can support these non-linear loads. IEEE Std 519 and 1100 provide details concerning the causes, effects, and means of compensation for non-linear, harmonic producing loads on power systems. Harmonic compensation may include, but is not limited to: specifying K-rated transformers, derating transformers, oversizing neutrals to 200% of the ampacity of the phase conductors or phase bus, using phase conductors and terminals with higher ampacities and/or higher temperature ratings, supplying non-linear loads from dedicated isolation transformers, and installing shunt filters. See CEGS-16415 for further guidance.

Surge suppression and power conditioning receptacle modules are available. However power conditioning for specific loads (particularly portable equipment) is normally a User responsibility and is not furnished as part of the construction contract. The Air Force has identified specific responsibilities of the user and suppliers of end-use equipment.

(See Air Force ETL 89-6 for specific criteria or verify specific requirements for electrical support.)

\*\*\*\*\*

Power distribution shall be provided as indicated on the drawings. The panels [and] [spine wall] shall have an internal [power] [and] [communications] raceway and the capability of disconnecting and connecting external circuits to the electrified raceway in the panel [and] [spine wall]. The communications receiving raceway shall have capacity for at least [six] [twelve] [twenty] 4-pair category 5 cables. Power and communications wiring may share a common wireway if a metal divider is included to ensure electrical isolation. Doors or access openings shall be included for entry of communications cable. The electrified power raceway shall be of the [8-wire] [6-wire] [or] [5-wire] configuration indicated. [Unless otherwise indicated, conductors of the 8-wire system shall be allocated as follows: the three-phase system shall have one equipment ground, one isolated ground, [one neutral] [one oversized (133% minimum) neutral], and two each dedicated phase.] [Unless otherwise indicated, conductors of the 8-wire system shall be allocated as follows: the three-phase system shall have one equipment ground, one isolated ground, [one neutral per phase] [one oversized (133% minimum) neutral per phase], and one each dedicated phase.]

2.9.3.1 Receptacles

\*\*\*\*\*

**NOTE: 15 AMP receptacles are the current industry standard. If 20 amp receptacles are required, the channel depth for the receptacle may have to be increased. Coordinate with the panel and/or spine wall thickness.**

\*\*\*\*\*

Power receptacles shall be provided in the powered panels [and spine walls]. Devices shall be placed at the locations indicated on the plans and shall be connected to the designated circuits. [Electrical outlets should have the ability to be hung at [200 mm 8-inch] [multiple] [\_\_\_\_\_] vertical increments throughout the frame via power harnesses.] Unless otherwise indicated, receptacles shall be [15 amp (NEMA 5-15R)] [20 amp (NEMA 5-20R)] commercial grade conforming to NEMA WD 1 and NEMA WD 6. If receptacles are not interchangeable or will not permit field adjustment of phase and circuit selection, 10 percent spare devices of each type shown on these plans shall be furnished. [All] [General use] receptacles shall be of the duplex configuration; unless otherwise indicated, special use receptacles shall be of the simplex configuration with the blade/pin arrangement identified on the plans. The color of receptacle bodies shall be coordinated with the color of the panel [and spine wall] trim. Isolated ground receptacles shall [be orange] [or] [have distinct markings] [be of a different color than other receptacles]. Field applied identification shall be permanent; stick-on or non-setting adhesives shall not be used. A minimum of [5] [\_\_\_\_\_] receptacle removal tools shall be provided for systems that require special tools for proper receptacle removal.

2.9.3.2 Power Cabling Variations

The paragraph Power Distribution has identified specific cabling configurations. Since universal conventions have not been established, variant configurations available from various manufacturers will be

considered. Alternates shall allow the same circuiting, device connections, neutral and ground separation, and upstream feeder connections as shown on the plans. Variations shall be approved in advance. See paragraph ALTERNATE DESIGN. Examples of acceptable variations include:

- a. Use of 1 oversized neutral in lieu of 2 or 3 specified neutrals (neutral must have 150 percent minimum of phase conductor ampacity, i.e. #10 TW neutral if replacing 2 #12 TW conductors; 173 percent and #8 if replacing 3 neutrals) or vice versa.
- b. Providing a 6-wire system in lieu of a 5-wire system shown on plans.
- c. Use of a manufacturer's configuration which allocates individual conductors differently, but which has the same quantity of conductors and allows devices to be physically connected in the field as shown on the plans. It is not necessary that the manufacturer's labeling codes or terminology match the designations used on project plans or in the specifications; however, neutrals and grounds shall have insulation color coded per standard practice or be provided with tags, colored tape, colored ribbons or similar identification. (The reference to "dedicated" conductors in this specification pertains to circuit connections upstream and load connections downstream of panels; it is not necessary that manufacturer's designations correspond.)

2.9.4 Electrical Connections

\*\*\*\*\*

**NOTE:** The direct wired configurations should be suitable for most applications. All wiring should be contained within raceways or wireways. The exposed cord/plug arrangement should not be used, unless specifically requested by the user. If used, ensure that the design conforms to the limitations of Article 605-8 of NFPA 70. Code-enforcing personnel in some areas require separate hard wired junction box interfaces from building services to furniture system installations. If the facility will be under their jurisdiction, the design must conform and the junction box configuration must be provided in lieu of the direct wired. If the facility will not be under local jurisdiction, the direct wired configuration could be provided per User request; however, it is preferred that the Government design be consistent with local practice.

If top entry service poles are used for power interfacing, the junction box configuration is preferred for all locations.

\*\*\*\*\*

2.9.4.1 Internal Connections

\*\*\*\*\*

**NOTE:** Some local codes require hardwired connections with the panels and/or spine walls. If local codes are to be followed, this item will need



to be verified.

\*\*\*\*\*

Internal panel-to-panel [spine wall-to-spine wall] [spine wall-to-panel] power connections shall utilize [straight or flexible plug/receptacle connector assemblies] [hardwired connections] and shall be installed to provide the powered configurations shown on the drawings.

2.9.4.2 Connections to Building Services

External [power] [and] [communications] services shall be supplied to the panels [spine walls] via [direct-wired [top] [base] entry modules.] [hard wired [top] [base] entry junction box assemblies.] [Wiring from building services shall be extended to the entry modules or panel [spine wall] bases in metal conduit or tubing or in flexible liquidtight conduit 1830 mm 6 foot maximum.] [Wiring from building services shall be extended to junction box assemblies in metal conduit or tubing. Wiring from junction boxes shall be flexible liquid-tight conduit 1830 mm 6 foot maximum or in metal conduit or tubing.] Cord and plug assemblies shall not be used for any portion of external links. [Base feed modules shall plug into the end or either side of the raceway at receptacle doors.] [Top entry [modules] [junction box assemblies] shall extend the [power] [and] [communications] wiring into service entry poles attached to the electrified panels.] External wiring shall conform to Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.5 Wire Management

Wire management capability shall be provided at all workstations. Actual wire management capacity shall accommodate all cable types specified, including the applicable manufacturer required bending radius at corners. Raceways and interfaces to the raceways shall be designed to accommodate the bend radius as shown in EIA ANSI/TIA/EIA-569-A for Category [5] [\_\_\_\_\_] [and] [fiber optic cables] communication wiring [whichever is greater]. The capability may be accomplished by cable access cutouts (1 minimum per work surface), covered wire management troughs in vertical end panels, horizontal wiring troughs, internal midpanel (beltline) raceways, or rear gaps (between the back edge of the work surface and the facing support panel). Grommet kits or another suitable finish arrangement shall be provided for all cable cutouts. Accessories for an externally mounted vertical and horizontal wire management and concealment system shall be provided [as indicated on the contract drawings] [as recommended by the manufacturer]. Horizontal wire managers shall be supplied for mounting under all work surfaces. The wire managers shall be attached either to the underside of the work surface or to the vertical panel [and spine wall] without damaging the face. Exposed or loose wiring will not be acceptable.

Wire managers shall be prefinished and shall secure, conceal, and accommodate outlet cords as well as electrical and communications wiring. Wire channels shall match color of panel [and spine wall] trim, attach by means of clip-on attachment, and shall conceal wires routed vertically. Power wiring shall be separated from communication wiring by use of separate raceways or by placement of channels in joint use troughs or wireways.

2.9.6 Circuit Layout

The circuit layout for workstations shall be as shown on the drawings. Devices shall be connected to the designated circuits in the neutral and ground configurations indicated. Connections shall be made to the building electrical distribution system as shown on the contract drawings and in

accordance with Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.7 Service Entry Poles

\*\*\*\*\*  
**NOTE: Coordinate requirements with paragraph Power Distribution.**  
 \*\*\*\*\*

Service poles shall be provided as indicated on the contract drawings and shall be capable of minimally accommodating the [8-wire] [6-wire] [5-wire] power configuration described in paragraph Powered Panels and the equivalent of [six] [twelve] [twenty] 4-pair category 5 cables. Poles shall have metal barriers or channels to separate power and communications wiring. Pole dimensions shall be allowed to be equal to maximum panel [spine wall] thickness. The pole finish and color shall [match the finish and color of the panel [spine wall] trim] [conform to requirements shown on the plans]. Designated poles shall have the capability of being opened along the vertical access to permit the lay-in of wiring. Each pole shall have a wiring interface, an end cap and a ceiling trim plate which extends a minimum of 40 mm 1-1/2 inches from all sides of the pole. Poles for power service shall include a junction box either as part of the pole assembly or in a field installed configuration. Service poles shall be securely attached to the panels [spine wall] and shall be installed plumb. Wiring and interface components shall be provided as required to connect the building power supply to power poles.

2.9.8 Task Lighting

Task light size and placement shall be provided as indicated on the contract drawings. Such lights shall be a standard component of the manufacturer's workstation products. The ends of the task light length shall not extend beyond the edges of the overhead unit. Task lights shall have structurally sound mounting devices which will prevent accidental displacement, but will allow easy removal and replacement when necessary. Fixtures shall be UL approved for use in the configurations indicated on the drawings.

2.9.8.1 Luminaire Configuration

\*\*\*\*\*  
**NOTE: The lamp and ballast types should be indicated on the drawings. Use of electronic ballasts and T8 lamps is strongly encouraged as a means of meeting energy conservation goals for the building. Although there are no national standards for electronic ballasts, technical requirements are covered in CEGS-16415 Electrical Work, Interior. Electronic ballasts are the most efficient fluorescent ballasts, eliminate visual flicker and are quiet. When used, the electrical design must consider the harmonics and electromagnetic energy generated by these ballasts. Specific areas which should not have electronic ballasts are medical electronic equipment areas and areas equipped with infrared remote control or security devices. It is important to inform Users of the benefits and risks**

**of electronic ballasts and to involve them in the decision regarding their use.**

\*\*\*\*\*

Luminaires shall be the fluorescent type and shall have prismatic lenses, baffles, or reflector systems configured to minimize glare by shielding the lamp from the view of a seated user. Task lights for each workstation shall provide a minimum of [810] [650] lx [75] [60] foot candles of light (horizontally measured), without veiling reflections, on the work surface directly below and a maximum of 500 mm 20 inches from the fixture. All diffusers, grilles or other coverings shall be easily removable to permit cleaning and relamping. Fixtures shall be provided with energy efficient ballasts and lamps as indicated. If the type is not identified on the plans, F32T8 lamps in 1220 mm 4 foot units with electronic ballasts shall be used. Each luminaire shall have an easily accessible on-off switch and one rapid-start ballast. A variable intensity control is acceptable if the low setting is equivalent to "off" with zero energy consumption. Multiple switching is also acceptable. Ganged fixtures or shared ballasts shall not be used. Lamps and ballasts shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.8.2 Wiring

\*\*\*\*\*

**NOTE: If the facility will be under the jurisdiction of a city code, verify requirements. Some locations require hard wired connections.**

\*\*\*\*\*

Each fixture shall have a 1830 mm 6 foot minimum, factory installed, heavy duty electrical cordset with a grounded plug. Direct or hard wire connections are not acceptable. Unless otherwise indicated, cords shall be concealed. Cord concealment shall be built-in within panels [and spine walls] or shall utilize field installed, manufacturer approved accessories. Cords may be extended through dedicated channels located at any point within panels [and spine walls] or may be placed in vertical slots or in the space between panels [and spine walls] if held in place by retainers and concealed by a cover plate. Vertical wire managers shall be prefinished and cut to size and shall extend from the task light level down to the top of the work surface below the task light. Each manager shall be attached to a panel vertical edge or connector strip without damage to the surfaces.

2.9.9 Communications

Communications wiring shall be extended to, and installed in, the electrified panels [and spine walls] as shown on the plans. Communications outlets shall be installed at designated locations. Communications work may be performed in conjunction with the installation of workstations or may be separately executed at the Contractor's option; however, equipment, materials, and installation shall conform to the requirements of [Section 16415 ELECTRICAL WORK, INTERIOR] [Section 16710 PREMISES DISTRIBUTION SYSTEM] [\_\_\_\_\_] and all interfaces must be properly coordinated.

2.9.10 Special Systems

\*\*\*\*\*

**NOTE: Include this paragraph only in projects where**

requirements for shielded facilities (TEMPEST, Red/Black, EMP, etc.) and secure wiring have been called out in project criteria. Specific requirements for cable arrangement, separation of Red/Black lines, etc., need to be verified for each project. Provide metal raceway, channels, etc. throughout. Separation distances required for exposed cable or wiring in nonmetallic raceways are much greater than for wiring installed in totally enclosed metal raceway. Site specific details and/or notes should be prepared for each project.

\*\*\*\*\*

Designated raceway systems shall provide management for secure and nonsecure power, computer and telecommunications cabling. Secure distribution shall be separated from nonsecure distribution [in accordance with details shown on the plans] [by running secure lines along top located raceway and nonsecure along the bottom of the workstation panel [and spine wall]].

PART 3 EXECUTION

3.1 INSTALLATION

The workstations shall be installed by certified installers in accordance with manufacturer's recommended installation instructions. Workstation components shall be installed level, plumb, square, and with proper alignment with adjoining furniture. The components shall be securely interconnected and securely attached to the building where required. Three sets of special tools and equipment necessary for the relocation of panels and other components shall be furnished.

3.2 CLEANING

Upon completion of installation, all products shall be cleaned and polished and the area shall be left in a clean and neat condition. Any defects in material and installation shall be repaired, and damaged products that cannot be satisfactorily repaired shall be replaced.

-- End of Section --

CHAPTER CONTENT  
 INFLATION  
 SCOPE OF ESTIMATE  
 OVERSEAS CONSIDERATION  
 OTHER VARIABLES  
 TABLE 1  
 TABLE 2  
 GSA ADVANTAGE!

# Interior Design Cost Estimating Guide

FY 2002

## INFLATION

The estimates noted below are based on fiscal year 2002 costs. Inflation should be compounded at 2.5% per year for subsequent years.

## SCOPE OF ESTIMATE

The guidelines represent the cost to purchase and install interior improvements to a space. Depending on the project, examples of items that may be included are:

- Furniture
- Window treatments
- Accessories
- Cabinets and millwork
- Installation of specified items

Examples of items that are not included are:

- Profit
- Overhead
- Shipping
- Building construction or modification

## OVERSEAS CONSIDERATION

Projects overseas will have costs that vary from country to country. Variables include the cost of local materials or items, if used; the cost of local labor, if used; and the exchange rate.

## OTHER VARIABLES

Because many factors influence the cost of Interior Design projects, there are additional factors that should be noted.

- Size of project. Economies of scale exist, which means that improving 1 room will have a higher cost per room than improving 100 rooms.
- Schedule. Projects which have an aggressive timeline will often cost more than those which have a longer timeline.
- Project-specific conditions that may have not been considered in the average costs noted. An example would be the cost of installing window treatments in a training room with floor to ceiling glass on three sides; this would have a higher cost for window treatments, compared to the average or range noted below.

TABLE 1: SQUARE FOOT BUDGETING

| Facility type                                   | Specific information                       | \$/sq. foot |
|---|--|-------------|
| Administrative space                            | Conventional furniture, standard level.    | \$9.50      |
|   | Conventional furniture, executive level.   | \$18.00     |
|   | Systems furniture, standard level.         | \$41.50     |
| Airmen' Club                                    | Excluding kitchen equipment.               | \$15.50     |
| Alert Facility                                  |  | \$15.50     |
| Auditorium                                      | Fixed seating.                             | \$42.00     |
| Base Ops DV Lounge                              |  | \$24.00     |
| Chapel  |  | \$31.00     |
| Child Development Center                        |  | \$17.00     |
| Classroom                                       |  | \$17.00     |
| Clinic or Dental Clinic                         | Excluding equipment.                       | \$19.00     |
| Conference Room                                 | Standard finish level.                     | \$24.00     |
|   | Executive finish level.                    | \$64.00     |
| Dining Facility                                 | Excluding kitchen equip. and serving line. | \$47.50     |
| Distinguished Visitor's Suite                   | In lodging.                                | \$36.00     |
| Family Housing Office                           |  | \$19.00     |
| Fire Station                                    |  | \$15.50     |
| Golf Clubhouse                                  |  | \$18.00     |
| Judge Advocate Facility                         | Including courtroom.                       | \$33.00     |
| Library   |  | \$33.00     |
| Lodging Office                                  |  | \$18.00     |
| Open Mess, NCO & Officers                       | Excluding kitchen equipment.               | \$35.50     |
| Physical Fitness Center                         | Excluding fitness equipment.               | \$14.00     |
| Recreation Center                               |  | \$14.00     |
| Temporary Lodging Facility (TLF)                |  | \$19.00     |
| Training Center                                 |  | \$16.50     |
| Unaccompanied Enlisted Personnel Housing (UEPH) |  | \$21.50     |
| Unaccompanied Officer Personnel Housing (UOPH)  |  | \$24.00     |
| Visiting Quarters (VQ)                          |  | \$32.00     |
| Youth Center                                    |  | \$15.50     |

**TABLE 2: UNIT BUDGETING**

| Facility Type                                   | Specific information                     | \$ / unit   |
|---|--|-------------|
| Administrative space                            | Conventional furniture, standard level.  | \$1,140.00  |
|   | Conventional furniture, executive level. | \$2,140.00  |
|   | Systems furniture, standard level.       | \$4,992.00  |
| Lobby / Lodging Office                          | With front desk.                         | \$83,208.00 |
|   | Without front desk                       | \$20,802.00 |
| Temporary Lodging Facility (TLF)                |  | \$20,802.00 |
| Unaccompanied Enlisted Personnel Housing (UEPH) | Bedroom only.                            | \$8,320.00  |
|   | One bedroom suite.                       | \$11,292.00 |
| Unaccompanied Officer Personnel Housing (UOPH)  | Per person.                              | \$5,943.00  |
| Visiting Quarters (VQ)                          | Single room.                             | \$9,000.00  |
|   | Single suite.                            | \$12,000.00 |
|   | Double suite.                            | \$20,200.00 |

**GSA ADVANTAGE!**

Note that GSA may be a source for purchase of items for interior spaces, and purchasing through this service will often yield a cost savings over other sources. Contact your Resource Advisor to determine the applicability.

## CHAPTER CONTENTS

OVERVIEW

DESIGN DEVELOPMENT

DESIGN EXECUTION

STANDARDS

INTERIOR FINISHES

FURNITURE

FUNCTIONAL AREAS

FINISHES FOR FUNCTIONAL GROUPS

BUILDING CODES

FIRE TESTING

## OVERVIEW

The Interior Design Principles provide and describe interior design policies and practices that support Air Force Civil Engineering. The audience for this chapter includes: base interior designers, facility managers, A/E contractors, interior design contractors, and others involved with Air Force interior projects. In this era of right sizing and limited funding, smart selections of building materials and furnishings are necessary. Well designed interiors are major components in providing quality facilities, that, in turn, attract and retain quality personnel to sustain the Air Force.

### *Philosophy*

Quality interior design reflects “understated excellence” and assures that facilities are attractive, environmentally safe, operationally efficient and maintainable. Interior designers must strive for sound, economical, functional, and aesthetic design achievements. Well designed facilities satisfy users’ needs, install pride in ownership, and promote productivity in the workplace.

### *Function*

Functional interior designs ensure that each aspect of an interior environment performs efficiently for its users. A good working relationship between users and designers will help accomplish this goal. Each facility type presents unique functional requirements that will ultimately affect the selection of finish materials and furnishings. It is important that designers investigate all aspects of spatial requirements via the users.

### *Cost Effectiveness*

All interior selections must reflect the “best buy” for the Air Force in terms of aesthetic value, maintenance characteristics, and life-cycle costs. Inexpensive, short-term solutions do not necessarily produce cost savings.

### *Life Cycle Cost and Appeal*

When making selections, designers must consider product performance and longevity of appeal, as well as initial costs. As the appeal of finish materials degrade, users want to replace them; therefore, products which keep their appearance and shape longer are better choices even when initial costs are higher.

### *Durability*

Durable designs and finishes pass the “test of time.” Designers must be concerned with material durability and wearability while considering budget restrictions. Selections of quality materials and products must also be appropriate to the function and level of use of each facility.



*Maintainability*

The use of easily maintained finishes is critical. While certain finishes may provide excellent durability, designers must give serious consideration to maintaining the appeal of materials. It is critical that designers be familiar with finishes that wear well and require low maintenance.

*Compatibility*

Each installation has its own compatibility plans that reflect regional, environmental, and architectural considerations. Designers should be familiar with installation plans to achieve unified scales, traditions, and excellence in facilities.

*Design*

Facilities must meet as many “human” needs at as many levels as possible. Now, more than ever, working and living environments are within the control of those who design and build them. Well designed interiors can contribute to higher achievements in the work place, and enhance pleasure and relaxation in hospitality and recreational facilities.

*Creativity*

Budget constraints place increased importance on design creativity. Proper planning and research of innovative design features will aid designers in providing quality facility interiors within restricted budgets.

*Flexibility*

Flexible designs are essential to meet dynamic requirements. While the primary function of each facility must be first priority, designers must keep in mind which functions evolve, and which facilities may require future modifications. Rapid technological advancements often demand upgraded equipment, power and communication requirements.

*Timelessness*

The elements of pure design, including structural expression, suitability of materials, harmonious visual and tactile features, and classic furnishings, will always remain the foundation of good design. Designers should avoid trendy or dated finishes and design features. Interior spaces should be creative but not extreme, reflect quality but not opulence, and be capable of being updated without requiring significant changes to materials, and functions.

*Terminology*

The following terms are universal in all fields of the arts and architecture; however, for our purposes, these definitions pertain to interior design.

- *Repetition* – the use of the same visual effect several times in a space. Repetition may produce a sense of harmonious relationships, obviously planned patterns, or rhythmic movements.
- *Rhythm* – a sense of movement created by regulated patterns.
- *Variety* – the use of opposing, contrasting, changing, elaborating, or diversifying elements in a composition to add individualism and interest.

- *Balance* – a feeling of equilibrium in weight. A symmetrical balance is easily achieved by dividing a space in two and identically designing each half. An asymmetrical balance is more difficult to achieve when placing items in a space to create harmony while fulfilling functional requirements.
- *Harmony* – the repetition of visual elements with similar characteristics assist in creating comfort in a space.
- *Proportion* – the relationship of object sizes in a space. When proportions are out of scale, spaces can feel awkward. History shows that mathematical proportions are most pleasing when they are based on human and natural elements.
- *Scale* – the relationship of object sizes to the size of the human figure enhances comfort.

#### DESIGN DEVELOPMENT

The design development process begins when designers understand the functional and aesthetic requirements of each space. Designs must be effectively communicated to all parties involved in the design process. Users should be confident that their spatial and functional needs will be met. Design documentation is necessary to illustrate a comprehensive theme with interior detailing. The designer should provide written explanations or a “design narrative” to inform users of the specific selections chosen and why. Rendered plans, elevations, sections, and perspectives should clearly illustrate each carefully planned concept. Material finishes and furniture boards should display well-coordinated schemes. Users’ satisfaction is as important as the longevity of interior designs. Educate users to appreciate the long-term qualities of good designs and give them the opportunity for direct input throughout the submittal process and during each stage of design development. The final design should not present users with surprises or issues that were not previously identified or addressed.

*Design Communication*

*Required Documents*

Specific guidance, presentation format, and detailed information on the development of the Structural Interior Design (SID) and Comprehensive Interior Design (CID) packages can be found in the *Air Force Center for Environmental Excellence Interior Design Presentation Format* handbook. This handbook outlines, in detail, the sections and drawings required during the submittal process with presentation formats. It includes a CID cost estimating guide as well as A-E contract information and an index of reference standards to be used by interior designers during design development.

#### DESIGN EXECUTION

Once final approval of the design concept and finishes have been accomplished, a completed design package must be submitted. The contract documents must clearly convey the design intent and provide the information

*Implementation*

necessary to implement and construct the design. As mentioned above, the *Air Force Center for Environmental Excellence Interior Design Presentation Format* provides information on required documents.

*Scope of Work* Brief but thorough descriptions of work to be performed by the contractor should be prepared by each design team. The contracting office will utilize this information to synopsise the project for the bid advertisement.

*Drawings* Drawings are reviewed by users for adequacy of space and function as well as used by contractors for bidding and construction information. Drawings include demolition plans, floor plans, reflected ceiling plans, design details, elevations, mechanical plans, electrical plans, plumbing plans, finish material placement, and other information as needed.

*Specifications* The product specifications are critical for achieving a successful design. They must be very detailed and should be closely reviewed to ensure the Air Force receives quality products, materials, and craftsmanship. DOD policy is to utilize commercial specifications in lieu of federal and military specifications when they clearly meet the proper requirements.

*Philosophy*

#### STANDARDS

The diverse missions in the Air Force require unique facilities to support several programs. This presents a challenge for designers regarding quality standards, use of materials, functional requirements and budget limitations. Standardizing interior building finishes throughout facilities establishes a benchmark for desired results. Many facilities are multifunctional and accommodate many different organizations. This can make one single set of standards difficult to apply. Following the installation, standards help to ensure a facility keeps its architectural integrity and interior scheme as functions change.

The following section defines standards for building finish materials according to finish application and criteria for individual building types and functional areas. These standards should be used as general guidelines for choosing the most advantageous products available. Due to varying locations, circumstances and requirements, alternate material choices may be required. Designers and users must research these early in the project.

#### INTERIOR FINISHES

Choosing finishes and colors can be “fun”; however, one must make selections that not only meet appropriate standards for functionality and durability, but also conform with Uniform Building Codes – Fire and Life Safety, and the Americans with Disabilities Act (ADA). (*See Building Codes and Fire Testing*, page 38.)

Note: All finishes are to be installed according to manufacturers’ instructions and properly maintained as per manufacturers’ warranty specifications.

*Floor Finishes*

Floor finishes are major design elements in interior spaces. These materials chosen are to be appropriate for the function of the space as well as aesthetically appropriate. Acoustical properties of floor finishes have great impact on noise levels, and the colors of the finishes impact the lightness or darkness in spaces. Extremely light colors, especially white, should be avoided in high traffic areas due to soiling and possible glare. Floor patterns or changes in floor finishes may be used to create circulation paths or separation between spaces. Of all finishes, floors will get the most wear and are usually the most expensive finish material.

There are three basic categories of floor coverings:

- Hard surfaces – concrete, wood, stone, ceramic, and terrazzo
- Resilient surfaces – vinyl composition tile, sheet vinyl, rubber, and linoleum
- Soft surfaces – carpet and area rugs

*Concrete*

Concrete is the basic structural material of floors in most new construction and, when scored, painted, stained, or glazed, can provide an aesthetically pleasing finish.

*Wood*

Wood flooring is typically an expensive upgraded finish that is applied in special areas. Hardwoods, such as oak and maple are much more durable than softwoods. Softwoods are susceptible to indentions over time from moderate to heavy traffic. The following applies to wood finishes:

- Usually installed in large planks, smaller strips, or parquet slats, and can be simple or very intricate in design.
- Usually 3/4" thick, but thinner products are produced and may not withstand sanding or refinishing; therefore, its life is limited.
- Finished in the field with oil based polyurethanes, water based polyurethanes, or by acid curing. Acid curing and oil based polyurethanes have high Volatile Organic Compound (VOC) ratings and must be installed with caution. Water-based polyurethanes have lower VOC ratings but are thinner and will require several applications. They are also more expensive due to the labor intensive process.

*Stone*

Stone floors include slate, granite, marble, limestone, and travertine among others. Stone is available in a variety of colors and finished in one of three ways:

- Polished finish – requires high maintenance, has poor slip resistance, and should not be used in heavy traffic areas, especially adjacent to building entrances.
- Honed finish – has a dull, smooth finish with good slip resistance.
- Thermal finish – has a great deal of texture and is very slip resistant.



*West Missile Range Operational  
Control Center*  
Vandenberg Air Force Base, California

All stone may be used in interior or exterior applications; however, some stone, such as slate, requires applied sealants when used indoors. Granites are very durable surfaces that can be used in most applications. Marbles range from hard to soft and are classified as such. Marbles usually require the most maintenance.

#### *Ceramic Floor Tile*

Ceramic tile is made up of either clay or porcelain. The types of ceramic tiles available are mosaic, quarry, and paver. There are four absorption categories: nonvitreous, semivitreous, vitreous and impervious, with impervious being the least absorptive. The lower the absorption level, the greater resistance there is to staining. The following applies to using ceramic tile:

- In heavy traffic areas, such as vestibules and shopping mall corridors, a quarry, paver, or heavy duty porcelain tile is recommended. Larger tiles require fewer grout seams per square foot; therefore, they are easier to maintain.
- A mottled or shaded tile camouflages stains and is easier to maintain than an overall flat color.
- Mosaics are small tiles that are typically less than 1" wide and can be used for intricate designs and patterns. Webbing may be applied to the back of the tile for easy installation.
- Quarry tiles are thick and durable. These are usually installed in heavy traffic areas such as commercial kitchens.
- Pavers are larger tiles that are typically found with textured surfaces. These tiles may be installed with a cement-based mortar in a thick set or thin set method; the thin set method is most preferred. The thick set method works well where slopes and drains are desired.
- Consider the use of Epoxy grouts to avoid discoloration. If sand grouts are the only possibility due to budget restraints, use dark colors.

#### *Terrazzo*

Terrazzo is a flooring material of various sizes of marble chips in cement mortar. Metal divider strips are used as expansion joints. Terrazzo mixtures are typically installed two inches thick, but can be installed in thinner settings.

#### *Vinyl Composition Tile (VCT)*

Vinyl composition tile is an economical floor covering that is easy to install, clean, and repair. The following applies to VCT:

- 12" x 12" (305 mm x 305 mm) tile, 1/8" (3.2 mm) gauge, pattern to go full depth of tile.
- "No wax" finishes should be limited to residential or light traffic wear.

#### *Sheet Vinyl*

- Vinyl sheet flooring is produced in large sheets to allow for few joints.
- Minimum of .085" (2.16 mm) gauge, pattern to go full depth of wear level (.50" or 1.27 mm).
- "No wax" finishes should be limited to residential or light traffic wear.
- Give special care to seams.

*Linoleum*

Linoleum is a natural product that is made up of linseed oil, cork, and wood flour. These materials combined provide a durable finish with superior thermal and acoustic properties. Linoleum can be purchased in sheets or large tiles in a variety of colors, and unlimited patterns can be created.

*Carpet*

Carpet is a popular floor finish that is manufactured in broadloom rolls or carpet tiles. There are two processes for constructing carpet – tufting and weaving. The tufted process is more common involving yarns tufted into a backing then covering the backing with latex to secure the yarns. Woven carpet is a strong, heavy carpet in which the pile and backing yarns are woven together.

Carpet, of good quality, is popular because of its durability, soft touch and appearance, and acoustic properties. It aids in sound reduction more than any other floor finish.

The following apply when selecting and installing carpet:

- See ETL 94-3 Air Force Carpet Standards for all facilities.
- See Air Force Family Housing Carpet Standards dated Sept 94.
- Provide reducers, metal strips, or other edging in areas where carpet abuts other floor surfaces.
- Patterned carpets help to “mask” soiling in traffic areas. Choose patterned carpets with distinguishable designs of two or more different colors. Tone on tone color combinations do not hide soil. Solid colored carpets should only be placed in commanders’ suites, chapels, DV suites and family housing units.

*Access Flooring*

Access flooring, also known as raised flooring, involves elevated, lift-out floor panels supported by an understructure. It is installed to allow cabling, HVAC or electrical wires to run under the floor for easy access. Access flooring is typically installed between 6”-12” high. Cost of access floor is often offset by eliminating extensive installation of overhead electrical and cable systems. Carpet tiles should be used with access flooring instead of rolled goods.

*Wall Finishes*

Typical wall systems include wood or metal studs, wood post and beam framing, steel and reinforced concrete framing, and masonry. Interior walls and partitions may be load bearing or non-load bearing. Wall surfaces must be able to accept desired finishes.

Gypsum board is installed as the wall substrate in most commercial interior projects. Gypsum board is also referred to as wallboard, sheet rock and drywall. Typically a Type “X” gypsum board is used when a fire rating is required. Other types of gypsum board include: green board or moisture resistant

gypsum board; foil backed board used as a vapor barrier; blue board used as a substrate for veneer plaster, and pre-finished gypsum board that has a decorative vinyl or fabric finish.

#### *Vinyl Wall Coverings*

Fabric-backed and paper-backed vinyl wall coverings are popular for their low maintenance. Fabric-backed wall coverings are the most durable. Roll goods are generally 27/28" wide and approximately 5 1/3 lineal yards. Yard goods are 53/54" wide and sold by the lineal yard. Vinyl wall coverings come in three types, Type I, II, and III. Type I is less durable, and therefore, used in lower traffic areas. Type II is used in heavier traffic areas such as corridors and public spaces. Type III is the least used due to its high cost and limited applications, but is excellent for walls that take extreme abuse. The following applies to vinyl wall coverings:

- When installing wall coverings over CMU, first fill grooves, then prep each surface with a skim-coat of plaster, or as specified by the manufacturer.
- Vinyl wall coverings and paneling used in corridors, stairs, fire exits, or sleeping rooms, must have "Class A" fire ratings. See NFPA 101, 6-5.3.5.
- Avoid the use of vinyl wall coverings on the inside of exterior walls in humid climates. The low permeability of most vinyls will interfere with vapor transmission and will result in rapid deterioration of the wallboard.
- Wherever possible, wall coverings should be ended in an inside corner where walls meet. If this is not feasible, always provide edging to protect exposed edges at outside corners, matching wall surfaces when possible.

#### *Fabric and Acoustical Wall Coverings*

Fabric wall coverings can be beautiful wall finishes that are typically used in upscale spaces with low traffic. Conference rooms and areas that require speech privacy are good candidates for fabric wall coverings. The follow applies to fabric wall coverings:

- Fabric wall coverings usually require a paper or latex backing for stability and protection from glues seeping through the fabric.
- Install acoustical wall coverings in areas where acoustical properties are important. Acoustical wall coverings are generally 36" to 40" or 53/54" wide and sold by the lineal yard.
- Upholstered wall coverings are a field installed wall finish in which the fabric covers a frame that attaches to the wall. The selected fabric should be compatible as a wall treatment. Designers should typically avoid nylon, rayon and viscose in these applications due to sagging.
- Textile wall coverings are only permitted if they are Class A and if the building is fully sprinklered.
- All textile wall coverings must be tested and pass the NFPA Test 265.

#### *Wallpaper*

Wallpaper is typically used for residential projects due to its limited resistance to wear and maintenance. See NFPA 101, 6-5.

### *Paint*

Paint is an inexpensive finish that is easily applied and can be used to create various textures. Paints come in two options: latex (water based) and oil (solvent based).

Paint is produced in four basic sheens:

- Flat or matte finish – produces the least glare but is also the least durable. This finish is applied in low traffic areas.
- Satin or eggshell finish – has a light sheen and is more durable than the flat finish.
- Semigloss finish – has a good sheen and is yet even more durable. Apply to areas that required frequent cleaning, such as kitchens, bathrooms, door trims and moldings.
- Gloss finish – has a very shiny appearance and is very durable. It is difficult to apply a new finish over gloss.

Avoid stark white as a color choice for paint. Off-whites and “toned-down” or subdued hues aid in hiding soil.

### *Ceramic Wall Tile*

There are several options of glazed and unglazed ceramic tiles for surfacing walls. Wall tiles have low impact resistance and are typically glazed. Install tiles from floors to ceilings on wet walls, such as showers, and at least wainscot height behind lavatories and toilets is preferred.

### *Wood Paneling*

Wood paneling is an expensive wall treatment, and therefore is usually applied to upscale spaces. Wood veneer wall coverings give luxurious looks without the expense of wood paneling. The veneer can be installed finished or unfinished, and since veneers are so thin, it is imperative that substrates be very smooth. Exposed edges of wood paneling at chair rails (30” to 32” on center) or at wainscot (42” to 48”) heights should be finished with wood trim moldings stained to match paneling. It is not recommended using imitation wood finishes, paper, or vinyl top applications to simulate wood. Wood paneling must have the appropriate wall and ceiling fire classifications to meet NFPA 101 requirements for the areas in which they are used.



*Iditarod Dining Facility*  
Elmendorf Air Force Base, Alaska

### *Ceilings*

There are several materials that may be used for ceilings, such as hardwood, reinforced concrete, metal, plaster, drywall, and acoustical tile.

### *Acoustical Tiles*

Acoustical ceiling tile (ACT) is a mineral fiber board product that offers many options and advantages. It works well with H.V.A.C. systems; provides easy access to above areas; provides noise reduction properties, and provides light reflectance properties. Some available options include: anti-microbial solutions, fire resistances, a variety of styles, i.e., tegular tiles, scored, flat lay-in, and



textured, and they may come in a selection of colors. The following apply to acoustical tiles:

- Use 2' x 2' size when replacing ceiling systems or in new construction.
- Tiles can be installed directly onto a finished surface, or suspended from a metal grid.
- Suspension systems can be exposed, semi-exposed, or concealed depending on the desired look, but typically should not be in contrasting colors.
- Suspended acoustical tile systems should not be used in family housing.
- Avoid using acoustical tiles on walls for sound absorption. See Wall Finishes above.
- Water marked or damaged ceiling tiles should be replaced immediately.
- Purchase additional ceiling tile stock to have on hand for replacement.
- Consider replacing existing 24" x 48" tiles with a scored 24" x 48" ceiling tile or 24" x 24" system for corridors or office areas. The scored ceiling tiles give the illusion of a 24" x 24" ceiling grid without the expense of installing a new grid to support 24" x 24" tiles.

#### *Gypsum Board*

Gypsum board ceilings are the norm for most construction. They may have a smooth finish or be textured with a thin layer of plaster for visual interest and to improve acoustical performance. Gypsum board is applied directly to wood or metal frame systems. The boards are usually 4' x 8' and the seams are finished off with a tape and float process. Surfaces may be painted or finished with a vinyl wall covering.

#### *Plaster Ceilings*

Plaster ceilings are seldom used in new construction but are often encountered in renovation projects. Plaster is applied over a metal lath in a three-coat process, or over a gypsum lath in a two-coat process. Plaster ceilings should be suspended from wood, steel, or concrete systems that allow for flexible finishes that resist cracking. When plaster is applied to lath that is directly attached to structure, chances of cracking are greater.

#### *Reinforced Concrete Ceilings*

Reinforced concrete ceilings look industrial due to the exposure of the structure, ductwork, lighting systems, and sprinkler systems. These exposed areas may be painted neutral or nondescript colors so that they "blend" with the concrete for a uniform appearance. This works well in spaces where there is a great deal of activity at eye level such as dining facilities or retail environments. Other spaces may benefit from an emphasis played on ceilings, and therefore, contrasts in colors and materials should be used.

#### *Metal Ceilings*

Metal ceilings are typically decorative and are installed as ceiling systems. There are several options available including linear metal, reflective surfaces, open plenum, and stamped metal panels. When using pre-manufactured ceiling systems, lighting, air handling, suspension and acoustical properties are usually accommodated within these systems.



*Health and Wellness Center  
Eglin Air Force Base, Florida*



*Iditarod Dining Facility*  
Elmendorf Air Force Base

#### *Window Treatments*

#### *Wood Ceilings*

Wood ceilings are more commonly used in geographical regions where wood is plentiful. Wood can be used to give a rustic lodge look, or a beautiful planked ceiling look. Options for wood ceilings include paneling, siding, and wood planks. The underside of a wood plank floor system can also be used as the finished ceiling below. Wood ceilings must have flame spread index ratings of 25 or less. Wood has an excellent insulating value that is helpful in cold climates.

Window treatments have thermal impacts as well as decorative impacts on spaces. When considering solar protection, there are many options: vertical or horizontal blinds, shades, and drapery. All window treatments, including lining materials, must be fire rated. Window coverings for all sleeping areas in lodging should have separate soft-suede blackout linings to block out sunlight. This will accommodate shift workers and transient guests that will sleep during the day. Colors and patterns of window treatments are to be coordinated with interior color schemes. See NFPA 101, 6-6 for fire safety considerations.

#### *Miscellaneous*

#### *Hardware*

Hardware should be chrome brushed aluminum, anodized bronze or antique brass for ease in maintenance. Polished brass surfaces require frequent maintenance. Nonconforming hardware should be replaced during renovations or as the budget allows. The colors and tone of electrical switch plates, electronic devices, and light switches should “blend” with the adjacent surface, i.e., light colors on light, dark colors on dark.

#### *Wiring, Etc.*

Special attention should be taken to conceal all conduit, pipes, electrical wires, communication and computer cables. Where these items cannot be concealed, they should be painted to match wall surfaces or ceiling colors.

#### *Fire Extinguishers*

Fire extinguishers should be placed in metal cabinets that are flush or partially recessed into walls and are clearly identified with the words “fire extinguisher.” Fire extinguishers hanging on walls from hooks are not acceptable. Signs for fire extinguishers or fire notices/exits, etc. and alarm fixtures themselves do not have to be in the color red.

## **FURNITURE**

Specifications in this chapter provide the minimum standards for furniture purchased by the Air Force. The Air Force utilizes several types of furniture; residential; lodging; food service; office/administration; maintenance/warehouse; recreation; medical; educational; religious, and squadron operations. Furniture should be purchased for its functionality, durability, and aesthetic features. See NFPA 101, 6-6.

Furniture construction can be separated into two categories: wood and metal.

#### *Wood*

Wood furniture is either made of softwoods which are evergreens, or hardwoods which are deciduous. Softwoods are used for residential grade furniture and are not recommended for the majority of AF facilities.

Hardwoods are used to construct seating frames, base cabinetry, and solid furniture. Hardwoods make good surface finishes.

Veneers are thin sheets of wood that are glued to base materials, then stained and finished. Premium pieces should be veneered on both sides of each board for stability. These pieces can be very decorative depending on the placement of veneers.

#### *Metal*

Metals are used a great deal for office furniture. These metals include steel, aluminum, and alloys. Steel is strong but will rust if not properly treated with a plating or painting process. Stainless steel is very expensive and used only in areas where high durability is required. Aluminum is not as strong but does not rust. The finishes on metal furniture should not chip which will almost always lead to rust and corrosion.

Metal is measured by the gauge – the smaller the gauge the thicker the sheet. For example, an 8 gauge sheet is much thicker than a 16 gauge sheet. The connections of metal furniture are either welded or bolted.

#### *Textiles*

When selecting fabrics, there are several factors to consider: color, durability, price, fire resistance, and fiber type. There are natural fibers and artificial fibers. The most common natural fibers for textiles are wool, mohair, cotton, silk and linen. The most common synthetics are polyester, acrylics, nylons, polyurethane, polyvinyl chloride, olefin, and rayon.

There are several treatments that can enhance the performance of textiles. Antibacterial and mildew resistance treatments protect against the growth of mold and mildew. Anti-static treatments aid in reducing static electricity. Fireproofing, fire-retardant, and flame resistance treatments help fabric to resist ignition, slow flame spread, and provide fireproofing. Scotchguard, Soil-repellant Zelan and Zepel are soil, stain and water resistant treatments.

#### *Conventional Furniture*

Conventional furniture is the arrangement of free-standing furniture including, but not limited to: administration furniture, dormitory furniture, lobby furniture, dining furniture, etc. Conventional furniture is usually acquired on a DD 1348-6 through Air Force base supply.

#### *Seating*

##### *Operational Seating*

The awareness of ergonomics is important when choosing task chairs. Five prong base chairs with casters are suggested to provide excellent stability and mobility. Casters should be composed of a dual hard wheel for use on carpet,



*Air Force Senior Noncommissioned  
Officer Academy*  
Gunter Annex, Maxwell Air Force Base,  
Alabama

and single soft wheel for use on hard flooring surfaces. Chair arms should be replaceable or removable in the field. Molded plastic arms, used for most applications, are easier to maintain; upholstered arms tend to soil easily with high use. Adjustable arms are required for intensive use by computer operators. Chair frames should be finished in chrome or a powder coated epoxy. Wood based chairs are more expensive and may be chosen for executive use.

#### *Stationary Chairs*

Stationary chairs with four posted legs are suggested. These chairs are not often moved since they are used as office side chairs or perimeter seating in conference rooms.

Sled based chairs offer sliding motions when scooting in and out from under tables and desks. Provide appropriate chair glides for either carpet or hard floor surfaces. Clear glides are preferred on hard floor surfaces since black glides tend to leave marks.

Seating used in dining facilities and cafeterias should have “wipe-out channels” or chair backs that are spaced from their seats for ease of cleaning.

#### *Lounge Seating*

Lounge seating is defined as fully upholstered seating for lobbies, waiting areas, lounge areas, and private executive offices.

All internal frame parts should be kiln-dried hardwoods. All exposed parts should be cut from #1 common or better grade hardwood with uniform grain and color uniformity.

Frame joints should be carefully fitted and secured with dowels. Frames must be reinforced with corner blocks mitered to fit securely.

Each seat foundation is to be 8-1/2 gauge sinuous wire springs clinched to insulated tie wires and strapped to tie rails and back post. Back construction is 11 gauge wire spring construction stretched between top and bottom spring rails and secured with double staples. The spring system should be covered with noise free insulating fabric and stapled to the frame on all sides.

Seats are to be cushioned with 1.80 lbs. density polyurethane foam with 32 lbs. of construction. Each seat cushion is wrapped with resin treated polyester fiber to give a smooth even finish. Chair backs and cushions should be 1.10 lbs. density polyurethane foam with 20 lbs. for back compression and 35 lbs. for arm compression. Backs and arms should be topped with blended fiber battings for smooth even appearances. All units should be constructed to allow for field reupholstering and repair.

Upholstery patterns should be marked on the vertical and horizontal for a uniform pattern. Upholstery should be treated with soil retardants.



Waiting area seating for medical facilities should accommodate children, pregnant women, the elderly, heavy or tall people, and the physically weak. All seating should have arms for ease in and out of seated positions. Chair seats shall be firm, level with the floor, and not at a decline toward the backs of the chairs.

#### *Children's Furniture*

Children's furniture should be very durable and scaled down to child size. Most manufacturers with children's lines will offer scaled down furniture primarily for preschoolers and first graders, and junior sized furniture for children eight to twelve years of age. Once a child reaches age seven or eight, they will prefer to sit in "grown up" furniture when given a choice.

#### *Tables and Countertops*

The undersides of table tops may not be less than 28 inches from floors, while table tops, for sitting applications, are not to exceed 30 inches from floors. The height of tables for standing applications is not to exceed 36 inches from the floor.



*Child Development Center*  
United States Air Force Academy,  
Colorado

Each table top should be constructed of one piece unless the table length is too long to fit in a doorway and, therefore, must be shipped in two or more pieces. Core materials must meet or exceed strength requirements for commercial standards. Particle board must have a minimum density of 48 lbs. per cubic feet. Cores must be sanded from top to bottom leaving smooth edges. Laminates or veneers must be glued uniformly and evenly to ensure adhesion and stability. Applied edging must be mitered, and all wood edges must be hardwood. Laminate tops are to be used with vinyl edging, self-edging, or solid wood edging. Wood veneer tops are appropriate for conference rooms and executive areas.

All bases must be appropriately sized to their tops and be equipped with leveling glides. All metal bases should be finished in powder coatings.

Consider the size of tables for each application. A good rule of thumb for dining tables and conference tables is to allow 24" to 30" of edge space per person. When selecting end tables, always consider the height of adjacent objects so that they are complemented by end table.

Several small tables may be used to form one large table or various table formations for flexibility. High quality folding tables may be used in dining rooms to allow changes in table layout. When table legs are desired (in place of table bases), it is important to make sure legs do not interfere with users.

Table manufacturers are meeting the needs of providing more "functional" tables. For example, there are several styles of tables that can be purchased with casters for mobility. Tables that fold, dismantle, or that can be raised or lowered, are popular when flexibility is essential. As telecommunication and data communication technology advances, tables are introduced with new options for power and communications cabling.

### *Freestanding Office Furniture – Casegoods*

Freestanding office furniture includes desks, credenzas, computer tables, executive “u” units, and bookcases.

Metal casegoods with laminate work surfaces should meet the standards and construction of systems furniture, yet, they are floor supported (free standing). Wood veneers should be edged with hardwoods, and all units should have glides for leveling.

Desk tops should be equipped with two grommets (two inches minimum in diameter) to allow for electrical cords. Location of grommets will vary depending on application. Work surface tops with rolled/soft edges are preferred to a straight edge for comfort. Drawers must use full extension, stop action progressive slides with precision ball bearing, and no metal to metal connection for a smooth, quiet operation. Dovetail construction should be used on all corners. All drawers should be able to receive dividers and accommodate other filing options needed. Drawers should also be lockable and keyed alike, within each workstation, with removable cylinders for re-keying.

### *Filing Cabinets*



*Air Mobility Command Design Center  
Scott Air Force Base, Illinois*

Metal filing cabinets should be manufactured with rolled metal that is seamless on three sides and rounded at the corners for a smooth finish. When wood file cabinets are appropriate, use veneer surfaces and hardwood edges. An interlock system is required on drawers so that only one drawer will extend at one time. Drawers should have ball-bearing suspension systems with anti-rebound devices, and drawer pulls should be recessed so they do not get knocked off or get in the way of traffic.

All lateral files should have front-to-back and side-to-side filing options. Cabinets should be flexible to allow for fixed shelves on five high units, or roll-out shelves and drawers. All units should be equipped with glides of leveling devices to ensure drawers or doors open properly. Color should be electrostatically applied at the factory.

### *Temporary Living Facilities and Dormitories – Casegoods*

Furniture for these spaces include: headboards, bed frames, night stands, wardrobes, units with drawers or open shelves, TV armoires, desks, writing tables, dressers, chests, mirrors, end tables, coffee tables, various types of seating/hide-a-beds, dining tables, computer accessibility, etc.

All furniture should be constructed of solid wood veneers, hardwood solids, or five-ply lumber-core with wood veneers. The suggested wood for all solid parts and veneers should be northern red oak or equal durable hardwood. The finished product can be treated and stained for the desired look. Particle board and cardboard are not acceptable. Back pieces must be equal to the sides in thickness, or a minimum of 1/4” inch thick.

Drawer fronts, doors, desk tops, and other components should be removable and replaceable on site. This extends the life of a product by changing individual damaged parts rather than ordering an entire new unit.



*Family Housing Phase I*  
Vandenberg Air Force Base, California

*Systems Furniture*



*Building 32 Rehabilitation*  
Wright-Patterson Air Force Base, Ohio

The dry construction method, with metal-to-metal connections, is the preferred method of construction. This method creates a stronger, more durable casegood; glue joints tend to fail. Screws, hinges, etc., should be concealed or inserted into the lumber for a clean, high quality look. Units held together only with glue and staples are unacceptable.

Dove-tail joinery should be used as drawer joints. Drawer pulls should be flush or recessed for furniture that is highly used. This prevents the pulls from being knocked off, or pulled off. Drawer bottoms should sit in grooves and the drawer sides should be reinforced. Epoxy coated metal drawer slides with nylon bearing rollers with automatic stop feature are suggested. TV armoires and shelving units should have grommet holes in the backs in which to run electrical and telephone cords. All large units should come with leveling glides.

Systems furniture, also known as furniture systems, modular furniture, and ADP furniture, is distinguished from conventional furniture by its modularity. Systems furniture is a combination of various sized panels that support individual components to create work areas and workstations. Components, such as work surfaces, shelving, storage units, lighting, tackboards, paper organizers, and other accessories, are assembled to create a custom work space. The work space may be conventionally wired or wired through systems panels. Systems furniture may have solid panels, stacking panels, or floor supported components without panels.

Open office plans are ideal spaces for systems furniture. The open office plan is the elimination of interior hard walls while maintaining essential divisions. Semi-private spaces are developed through the use of partial height panels arranged to facilitate work flow and functional tasks. To accommodate the dual needs of privacy and communication, work areas should provide visual privacy while allowing for personal interaction.

Private work areas surrounding common group areas should be provided for team settings and personnel with complex tasks. Place panels to separate adjacent work areas only where necessary to avoid excessively compartmentalized mazes. It is not cost effective to purchase panels for placement against existing walls that already provide privacy such as private offices. When designing open office plans, keep in mind support areas such as copier space, storage space, coffee bars, break areas, and coat storage.

A “standard” for systems furniture should be adopted so that there is uniformity throughout each facility. It is recommended to choose one product line from a single manufacturer as well as standard finishes for systems furniture. A hierarchy of spaces should be designed that range from clerical/secretarial levels up to supervisory levels. Workstation sizes, layouts, components, and privacy are determined for each level of hierarchy and should be standardized throughout an entire facility. Panel heights may vary according

to hierarchy and add interest to spaces. Tall panels of approximately 60" high are good for spaces requiring visual privacy and acoustical support when occupants are at seated positions. Lower panels of approximately 42" high may be used for secretarial stations to allow for direct communication by supervisors and personnel. This panel height is suggested for placement at windows, utility vents, and fire pulls.

Most office systems furniture layouts rely heavily or exclusively on square component shapes and orthogonal space layouts. The introduction of curved panels, panels placed at different angles, and panel windows provide physical and visual relief, helping to break-up the "boxy" maze of repetitive spaces. Locations appropriate for these treatments include corner panels at beginnings and ends of series of panels, at intersections of circulation aisles, and at workstations that are visible from reception areas. Glazed, fire-rated panels offer privacy without confinement and should be integrated into overall interior landscapes. Acrylic window panels are unacceptable as they exceed flame and smoke development requirements.

Acoustical performance ratings should be based upon workstation designs. While the sound transmission class (STC) and noise reduction coefficient (NRC) ratings contribute to overall acoustical performance, the acoustical role of panels is relatively minimal in the overall environment when compared to sound absorptive properties of other finish surfaces such as carpet and acoustical ceiling tiles. In addition, panel hung components greatly reduce the quantity of acoustical contributing area.

Systems furniture is usually acquired on an AF Form 9 and procured directly through the base contracting office. Base Supply is by-passed. The installation is typically provided by the systems furniture contractor. The CE interior designer will either design the package or contact a contractor. Systems furniture projects shall be reviewed/approved by the CE interior designer, the MAJCOM interior design office, fire marshal and Base Safety Offices.

#### *Pre-wired Workstations*

The term "pre-wired workstation" is now obsolete. Pre-wired workstations were funded with Military Construction funds (3300 funds) and provided by the building contractor. Systems furniture may still be provided by the construction contractor; however, it is now funded with O&M 3400 funds. An overall review of the electrical system should be performed by a qualified electrical engineer prior to the purchase of the systems furniture to ensure the building can support the new furniture's wiring.

#### *Miscellaneous*

##### *Artwork*

Artwork should be used to enhance all areas including: lobbies; waiting rooms; general office areas; corridors; conference rooms; break rooms; restaurant and cafeterias; lodging, and recreational areas.



Create themes for artwork throughout facilities and follow established standards for matting, framing and displaying. Facilities with multiple floors can have varied themes from floor to floor as long as there are smooth transitions between each theme. Avoid suggestive or controversial subjects when choosing artwork. All hanging artwork must be attached to walls so that each piece is straight and aligned. Consider using security locks on artwork that could easily be pilfered.

#### *Plants*

Plants bring nature into interior spaces. They also have an impact on good health and the environment. Choose live plants whenever possible. If artificial plants are the only alternative, they should be flame retardant rated.

#### *Bulletin Boards and Tackboards*

Bulletin boards and tackboards should be provided in common areas to display notices and announcements. These boards should coordinate with signs and other adjacent building finishes. Avoid taping literature to walls, doors or windows. This is unprofessional and tape creates a tacky film that may harm surfaces.

#### *Warranties*

An important feature to consider when purchasing furniture is the warranty. Research how each manufacturer handles their warranties and response time. To maintain furniture, it is important to abide by the terms of each warranty. When furniture is altered without manufacturers' guidance or assistance, warranties become void.

### FUNCTIONAL AREAS

#### *Entries and Lobbies*

Entries and lobbies should be designed with highly durable finishes while introducing facilities with themes and pleasant, welcoming environments.

Building entries and lobbies provide transitions from the exterior to the interior. First impressions are created in these spaces when a person enters the building. Consequently, the highest quality materials should be used in these spaces whenever possible. Nonskid paver tiles or ceramic tiles in neutral colors are wise choices as floor surfaces and wall bases. These are durable and easy to maintain in high traffic areas, and they hold up to exposure from outside elements. Consider using tile as wainscot up to 36" on walls to protect wall surfaces. Provide recessed walk-off mats or stiff bristle-type mats in all entry areas where carpet is not present. This is especially important in an entry without a vestibule.

Extending exterior finishes into lobbies creates natural transitions provided the materials are aesthetically pleasing for interior concepts. For example, brick can be extended into a lobby, and with an interesting pattern or changes in texture and relief, a dynamic focal point can be created. Live foliage is also suggested to further give smooth transitions from the outdoors to interior spaces.



Consider soft textures against hard surfaces for contrast and interest. When seating is required, use carpet islands inserted into tile to define seating areas. Artwork will add to the decor to emphasize the concept of the space. Light fixtures, when strategically placed, can provide patterns, textures and interesting shadows. Light levels may be low and either incandescent or indirect in lobbies; however, lighting should be used to accentuate areas such as information desks, elevator doors, directories and artwork. Directories and signs are important in the absence of reception areas. The fire alarm panels should be discreet while easily accessible in emergencies.

### *Corridors*



*Nellis Federal Hospital  
Nellis Air Force Base, Nevada*

Second to lobbies, corridors are the most public spaces of building interiors and, as such, should convey strong visual statements. Corridors receive more wear than interior rooms; therefore, they require extra care when selecting finish materials. Interesting corridors can be designed with floor patterns, wall textures, accent lighting for artwork, wall washing, and wall sconces. Utility corridors should be given attention as well. See NFPA 101, 6-5.

When faced with long “tunnel like” corridors, emphasize vertical elements for balance. Install carpet “islands” with borders running perpendicular to walls will shorten long corridors. If carpet islands or borders are used, the center area should be either darker than the borders or “busier” than the borders, i.e., patterned designs. Integrating 12” x 48” lighting fixtures, installed perpendicular to the corridor walls, will also visually shorten long corridors. Avoid accentuating horizontal elements. The combination of chair rails, carpet borders, and lighting that runs parallel to the corridors, greatly increases the visual length of corridors.

When corridors are narrow, consider wall washers for light fixtures to visually push the wall outward. Also, darker floor colors compared to that of walls “widen” corridors.

Interior finishes in the corridors should coordinate with other finishes within each facility. Way finding with carpet, wall coverings, or borders, are good solutions in some facilities. If carpet is not a good option, patterns and borders can be created using VCT, sheet vinyl, or ceramic tiles at little additional cost, if any.

### *Stairwells and Landings*

Significant stairwells and landings, with high public visibility such as those that stem from lobby areas, should have finish materials that complement adjacent areas. Stairwells can be used as transition spaces that tie all floors together for coordinated overall design. Utility stairwells and fire exits need durable finishes that are easy to maintain. Stairs in dormitories must be able to withstand frequent moves in and out of facilities. See NFPA 101, 6-5 for fire safety considerations.

### *Restrooms*

Restrooms should be designed with materials that can be easily cleaned and maintained. Restroom fixtures should be wall-mounted to ease the cleaning of the floors. Accessories should include paper towel dispensers, mirrors, soap

dispensers, clothes hooks on toilet partitions and in shower areas, and trash receptacles. Paper towel dispenser should be adjacent to lavatories for convenience and the avoidance of wet hands dripping water onto floors. Lavatories should be integrated with counters while free-standing, decorative sinks have separate vanity areas close by. Avoid small medicine cabinet style mirrors. Choose one color for entire toilet fixture, i.e., white seats on white toilets.

Ceilings in all bathrooms and locker areas need to be water resistant. Flooring should be monolithic tile, while walls can be either monolithic tile or glazed tile. It is recommended that tile be used on all walls behind wet areas such as sinks, toilets, urinals and showers. Lighting should be bright for good grooming and cleaning.

*Locker Rooms*

Locker rooms are to be well ventilated and designed with materials that are easily cleaned. An adequate number of lockers should be installed with vents, shelves and clothes hooks. Space between the top of the lockers and ceilings shall be finished and flush with locker fronts to avoid dust collection. Lockers should be finished in factory baked enamel or be electrostatically painted.

*Conference Rooms*

Conference rooms range from formal to casual, large to small, depending on the functions that will take place in these rooms. Flexibility can be maximized with the use of adjustable lighting, multipurpose seating, creative ceiling finishes, acoustical and/or tackable wall treatments, and multi-media presentation systems. Carefully plan the location of electrical outlets and consider flush mounted floor outlets for audiovisual equipment and computers. Chairs around conference tables should have casters for easy mobility. Stationary chairs may be placed along walls.

*Control Centers and Computer Rooms*

Access flooring systems are ideal for control centers and computer rooms for easy access to cables and wiring. Floor tiles should be finished with static dissipate vinyl tile, conductive vinyl tile, or low KV (<2.5) static rated carpet tiles. Furniture systems can be configured to accommodate various types and sizes of equipment. Quality ergonomic seating should be required for all office personnel who frequently work at computer terminals.

*Break Areas/Coffee Bars*

Break areas and coffee bars require material finishes that can be easily cleaned and maintained. A counter area with a sink and storage for coffee, snacks, utensils, etc. is recommended. Larger areas may include a designated space and electrical outlets for refrigerators and microwaves. Rooms used for eating and drinking should have ceramic tile, VCT or seamless resilient vinyl sheet floors for ease in clean-up.

*Copy and Fax Areas*

Hard, acoustical surface flooring, such as linoleum, is recommended for these areas. Toner staining is difficult to remove from carpet; however, acoustical properties are needed to absorb noise created by copy and fax machines. Consider acoustical wall finishes to damper noise.



*Air Force Senior Noncommissioned  
Officer Academy*  
Gunter Annex, Maxwell Air Force Base,  
Alabama

#### FINISHES FOR FUNCTIONAL GROUPS

The main factors affecting finish material selections and applications include: foot traffic; presence of food; liquids; chemicals; grease or other potential soilage; activity type, and the level of quality required. Facilities with similar function types are grouped together in the *Reference Charts* listed on the following pages. Each chart lists material selections appropriate for each “use” category (heavy use, medium use, and light use). Specialized areas are also addressed to provide general design requirements.

Some facilities fit into several functional groups, and therefore, designers must coordinate finish materials from each applicable *Reference Chart*. For example, a building with administrative offices, training facilities, and a large cafeteria, will require specific finishes from the “*office/administrative*” group, the “*educational*” group, and the “*food service*” group.

*Office/Administrative Facilities*

Office/administrative areas often have the highest number of occupants. These areas vary from private offices to open work spaces filled with conventional furniture to large arrangements of systems furniture. Consider all areas carefully when selecting finish materials. Care should be taken to coordinate and conceal electrical, telecommunications and data communication cables. Conference and meeting rooms should be carpeted to help with acoustic controls. *Reference Chart 1* lists the types of materials that are most suitable from heavy to light use conditions.

## REFERENCE CHART 1

## Office/Administrative Interior Design Materials Selection Chart (Heavy-Use)

|                 |  |
|-----------------|--|
| Materials       | <p><b>Heavy-Use</b><br/>entrances, foyers, lobbies, main circulation corridors, stairwells, elevators, restrooms, large conference or meeting rooms, snack bars, coffee areas, loading dock, and media production areas</p> <p>OFFICE / ADMINISTRATIVE</p> |
| Floor           | <p>carpet (loop)<br/>ceramic tile<br/>quarry tile<br/>vinyl composition tile</p>   |
| Base            | <p>ceramic tile<br/>quarry tile<br/>rubber base<br/>wood</p>   |
| Walls           | <p>ceramic tile<br/>paint<br/>vinyl wall covering<br/>masonry (if carried in from the exterior)</p>  |
| Chair Rail      | <p>molded plastic<br/>wood</p>   |
| Ceiling         | <p>acoustical tile<br/>gypsum board<br/>specials</p>   |
| Lighting        | <p>fluorescent<br/>incandescent<br/>specials</p>   |
| Window Covering | <p>vertical blinds<br/>horizontal blinds<br/>lined draperies</p>   |
| Upholstery      | <p>fabric (50,000+ DR)<br/>vinyl</p>   |

REFERENCE CHART 1 (CONTINUED)  
Office/Administrative Interior Design Materials Selection Chart (Medium-Use)

Materials                      Medium-Use  
internal circulation, staff office areas, and  
small conference rooms

OFFICE / ADMINISTRATIVE

Floor                              carpet (loop)

Base                                wood  
rubber base

Walls                              paint  
vinyl wall covering  
fabric wall covering (heavy duty)  
masonry (if carried in from the exterior)

Chair Rail                        molded plastic  
wood

Ceiling                            acoustical tile

Lighting                         fluorescent  
incandescent  
specials

Window Covering              vertical blinds  
horizontal blinds  
lined draperies

Upholstery                        fabric (25,000+ DR)

## REFERENCE CHART 1 (CONTINUED)

## Office/Administrative Interior Design Materials Selection Chart (Light-Use)

|           |   |
|-----------|---|
| Materials | Light-Use<br>commander's suite and private office areas |
|-----------|---|

## OFFICE / ADMINISTRATIVE

|       |                                |
|-------|--------------------------------|
| Floor | carpet (loop, cut & loop, cut) |
|-------|--------------------------------|

|      |                     |
|------|---------------------|
| Base | wood<br>rubber base |
|------|---------------------|

|       |  |
|-------|--|
| Walls | paint<br>vinyl wall covering<br>fabric wall covering<br>masonry (if carried in from the exterior)<br>wood (wainscot) |
|-------|--|

|            |      |
|------------|------|
| Chair Rail | wood |
|------------|------|

|         |                                 |
|---------|---------------------------------|
| Ceiling | gypsum board<br>acoustical tile |
|---------|---------------------------------|

|          |   |
|----------|---|
| Lighting | fluorescent (indirect, selected direct)<br>incandescent<br>specials |
|----------|---|

|                 |   |
|-----------------|---|
| Window Covering | vertical blinds<br>horizontal blinds<br>lined draperies |
|-----------------|---|

|            |                                |
|------------|--------------------------------|
| Upholstery | fabric (25,000+ DR)<br>leather |
|------------|--------------------------------|

### Training/Educational Facilities



*Child Development Center*  
Hanscom Air Force Base, Massachusetts



*Air Force Senior Noncommissioned Officer Academy*  
Gunter Annex, Maxwell Air Force Base, Alabama

Education facilities include grade schools, high schools, specialized training facilities, professional and technical classrooms, and centers for college extension programs. *Reference Chart 2* lists the types of materials that are most suitable from heavy to light use conditions.

#### REFERENCE CHART 2 Educational Interior Design Materials Selection Chart (Heavy-Use)

| Materials          | Heavy-Use<br>entrances, foyers, snack bars and cafeteria service areas, restrooms, fitness areas, simulator rooms, and technical classrooms.                    |
|--------------------|---|
| <b>EDUCATIONAL</b> |   |
| Floor              | carpet (loop); child development center play areas:<br>use cut pile to avoid "carpet burn"<br>vinyl composition tile/sheet vinyl<br>ceramic tile<br>quarry tile |
| Base               | ceramic tile<br>quarry tile<br>rubber base<br>covered sheet vinyl   |
| Walls              | paint<br>ceramic tile<br>vinyl wall covering (type II)  |
| Chair Rail         | molded plastic  |
| Ceiling            | gypsum board<br>acoustical tile   |
| Lighting           | fluorescent<br>High-intensity discharge (HID)   |
| Window Covering    | horizontal blinds<br>vertical blinds  |
| Upholstery         | vinyl<br>molded plastic   |



## REFERENCE CHART 2 (CONTINUED)

## Educational Interior Design Materials Selection Chart (Medium-Use)

**Materials**                      **Medium-Use**  
 administrative offices, conference and briefing rooms,  
 classrooms, and corridors

## EDUCATIONAL

**Floor**                              carpet (loop)  
 vinyl composition tile/sheet vinyl

**Base**                                rubber base  
 covered sheet vinyl

**Walls**                             paint  
 vinyl wall covering (type II)  
 acoustical wall treatment (heavy duty)

**Chair Rail**                        wood  
 molded plastic

**Ceiling**                            gypsum board  
 acoustical tile

**Lighting**                         fluorescent  
 incandescent

**Window Covering**            horizontal blinds  
 vertical blinds  
 lined draperies

**Upholstery**                      vinyl  
 fabric (25,000+DR)  
 molded plastic  
 wood

REFERENCE CHART 2 (CONTINUED)  
Educational Interior Design Materials Selection Chart (Light-Use)

Materials                      Light-Use  
principal's office and commander's suite

EDUCATIONAL

Floor                              carpet (loop, cut & loop, cut)

Base                                rubber base  
wood

Walls                              paint  
vinyl wall covering)  
fabric wall covering

Chair Rail                        wood  
molded plastic

Ceiling                            gypsum board  
acoustical tile

Lighting                         fluorescent  
incandescent

Window Covering            horizontal blinds  
vertical blinds  
lined draperies

Upholstery                      vinyl  
fabric (25,000+DR)  
molded plastic  
wood  
leather

Maintenance and warehouse facilities include all functional areas in which vehicles or heavy equipment are operated, chemicals are used, exposure to weather occurs, product dust and dirt are present, and bulk items are stored. Most areas within these facilities fall under the heavy-use heading. *Reference Chart 3* lists the types of materials that are most suitable from heavy to light use conditions.

#### REFERENCE CHART 3

#### Maintenance/Warehouse Interior Design Materials Selection Chart (Heavy-Use)

**Materials**                      **Medium-Use**  
administrative areas located separately from the heavy-duty areas

#### MAINTENANCE/WAREHOUSE

**Floor**                              concrete (sealed)  
ceramic tile  
quarry tile

**Base**                                ceramic tile  
quarry tile  
rubber base

**Walls**                             paint  
masonry (if carried in from the exterior)

**Chair Rail**                        none

**Ceiling**                            exposed  
gypsum board (water resistant)

**Lighting**                         fluorescent  
High-intensity discharge (HID)  
specials

**Window Covering**            horizontal blinds

**Upholstery**                      vinyl

## REFERENCE CHART 3 (CONTINUED)

## Maintenance/Warehouse Interior Design Materials Selection Chart (Medium-Use)

**Materials**                      **Medium-Use**  
administrative areas located separately from the  
heavy-duty areas

## MAINTENANCE/WAREHOUSE

**Floor**                              carpet (loop)  
vinyl composition tile

**Base**                                rubber base

**Walls**                             paint  
masonry (if carried in from the exterior)  
vinyl wall covering type II

**Chair Rail**                        molded plastic

**Ceiling**                            acoustical tile

**Lighting**                         fluorescent

**Window Covering**            horizontal blinds  
vertical blinds

**Upholstery**                      fabric (50,000+DR)  
vinyl

## REFERENCE CHART 3 (CONTINUED)

## Maintenance/Warehouse Interior Design Materials Selection Chart (Light-Use)

Materials                      Medium-Use  
commander's suite if separate from high-use areas

## MAINTENANCE/WAREHOUSE

Floor                              carpet (loop, cut & loop, cut)

Base                                wood  
rubber base

Walls                              paint  
masonry (if carried in from the exterior)  
vinyl wall covering type II  
fabric wall covering

Chair Rail                        wood

Ceiling                            acoustical tile  
gypsum board

Lighting                         incandescent  
fluorescent

Window Covering              horizontal blinds  
vertical blinds  
lined draperies

Upholstery                        fabric (25,000+DR)  
leather

*Food Service*

*Kenai Dining Facility*  
Elmendorf Air Force Base, Alaska



*Iditarod Dining Facility*  
Elmendorf Air Force Base

Food service facilities include dining halls, flight kitchens, open mess facilities – officer and enlisted clubs, snack bars, and cafeterias. Most areas in these facilities can be considered heavy-use because they are subject to high traffic and frequent food and beverage spills. Carpet is required in the seating areas of dining halls and open messes, and is desirable in other dining areas such as golf course restaurants and large cafeterias in administrative areas. Some food service facilities may incorporate woods, metals, or other structural materials used for decorative affects. Structural and mechanical elements may be exposed if intended by the overall design scheme. Consideration should be taken to provide dedicated areas for shared use of microwaves, refrigerators, and counters with the appropriate amount of space as well as an efficient number electrical outlets. Materials with good acoustical properties should be used to baffle noise from kitchens and dishwashing rooms. Provide menu boards that coordinate with room finishes and are easily changeable in the field. *Reference Chart 4* lists the types of materials that are most suitable from heavy to medium use conditions.

REFERENCE CHART 4  
Food Service Area Interior Design Materials Selection Chart (Heavy-Use)

**Materials**      **Heavy-Use**  
high traffic areas, lobby, wet areas, restrooms, corridors,  
and serving lines

FOOD SERVICE

**Floor**            ceramic tile  
quarry tile  
vinyl composition tile

**Base**             ceramic tile  
quarry tile  
rubber base

**Walls**            ceramic tile  
paint  
vinyl wall covering type II or type III  
masonry (if carried in from the exterior)

**Chair Rail**        molded plastic  
plastic laminate  
wood

**Ceiling**          gypsum board (water resistant)  
specials

**Lighting**        fluorescent  
incandescent  
specials

CHART 4 CONTINUES ON NEXT PAGE

|                 |                                      |
|-----------------|--------------------------------------|
| Window Covering | vertical blinds<br>horizontal blinds |
|-----------------|--------------------------------------|

|            |                              |
|------------|------------------------------|
| Upholstery | fabric (50,000+ DR)<br>vinyl |
|------------|------------------------------|

REFERENCE CHART 4 (CONTINUED)  
Food Service Area Interior Design Materials Selection Chart (Medium-Use)

|           |   |
|-----------|---|
| Materials | Medium-Use<br>dining areas, management and administrative areas |
|-----------|---|

FOOD SERVICE

|       |  |
|-------|--|
| Floor | carpet in admin areas (loop pile)<br>carpet in dining rooms (cut pile)<br>vinyl composition tile |
|-------|--|

|      |             |
|------|-------------|
| Base | rubber base |
|------|-------------|

|       |   |
|-------|---|
| Walls | paint<br>vinyl wall covering type II<br>masonry (if carried in from the exterior) |
|-------|---|

|            |  |
|------------|--|
| Chair Rail | wood, plastic laminate, molded plastic |
|------------|--|

|         |   |
|---------|---|
| Ceiling | fluorescent<br>gypsum board<br>specials |
|---------|---|

|          |                             |
|----------|-----------------------------|
| Lighting | fluorescent<br>incandescent |
|----------|-----------------------------|

|                 |                                      |
|-----------------|--------------------------------------|
| Window Covering | vertical blinds<br>horizontal blinds |
|-----------------|--------------------------------------|

|            |                     |
|------------|---------------------|
| Upholstery | fabric (25,000+ DR) |
|------------|---------------------|

## Dormitories and Family Housing



*Cadet Dormitory Furniture*  
United States Air Force Academy,  
Colorado

The residential category is composed of Military Family Housing (MFH) and Unaccompanied Personnel Housing (UPH), also known as dormitories. *Reference Chart 5* lists the types of materials that are most suitable for heavy use to medium use conditions. Refer to the *Air Force Dormitory Design Guide* for more details.

### REFERENCE CHART 5 Residential Design Materials Selection Chart (Heavy-Use)

| Materials          | High-Use<br>high traffic areas, entrance foyers, kitchens, bathrooms,<br>stairwells, laundry, vending areas, corridors, hallways, |  |
|--------------------|---|--|
|                    | DORMITORIES   | FAMILY HOUSING                                 |
| Hard Surface Floor | ceramic tile<br>quarry tile<br>vinyl composition tile   | ceramic tile<br>sheet vinyl<br>wood            |
| Carpet             | loop pile   | cut pile                                       |
| Base               | ceramic tile<br>quarry tile<br>rubber base  | ceramic tile<br>wood<br>rubber base            |
| Walls              | ceramic tile<br>paint<br>plastic laminate   | paint<br>vinyl wall covering type I            |
| Chair Rail         | molded plastic<br>plastic laminate<br>wood  | wood   |
| Ceiling            | acoustical tile<br>gypsum board   | gypsum board                                   |
| Lighting           | incandescent<br>fluorescent   | incandescent<br>fluorescent (kitchens)         |
| Window Covering    | vertical blinds<br>lined draperies  | shades<br>lined draperies<br>horizontal blinds |
| Upholstery         | vinyl<br>fabric (50,000+ DR)  | N/A  |



REFERENCE CHART 5 (CONTINUED)  
Residential Design Materials Selection Chart (Medium-Use)

| Materials       | Medium-Use<br>dayroom, family room, dining room, TV room, offices,<br>sleeping rooms |  |
|-----------------|--|--|
|                 | DORMITORIES  | FAMILY HOUSING   |
| Floors          | carpet<br>(cut or cut & loop)  | wood<br>carpet<br>(cut or cut & loop)  |
| Base            | wood<br>rubber base  | wood<br>rubber base  |
| Walls           | vinyl wall covering<br>(type II)<br>paint  | paint<br>vinyl wall covering<br>wall paper   |
| Chair Rail      | wood   | wood   |
| Ceiling         | acoustical tile<br>gypsum board  | gypsum board   |
| Lighting        | fluorescent<br>incandescent  | fluorescent (kitchens)<br>incandescent   |
| Window Covering | vertical blinds<br>lined draperies   | shades<br>lined draperies<br>horizontal blinds<br>vertical blinds<br>sheer draperies |
| Upholstery      | vinyl<br>fabric (25,000+ DR)   | N/A  |

*Chapel*

Chapel facilities include all spaces for worship. These include community worship, individual meditation, pastoral counseling, and religious education. These sacred areas receive a great deal of traffic and are considered in the high use category, yet should convey warmth and beauty through the use of wood finishes and furnishings. *Reference Chart 6* lists the types of materials that are most suitable from heavy to light use conditions.

#### REFERENCE CHART 6 Residential Design Materials Selection Chart (Heavy-Use)

| Materials                   | Heavy-Use   |
|-----------------------------|---|
|                             | worship area, sanctuary, narthex, choir room, cry room, blessed sacrament and reconciliation room, entrance foyer, kitchen, cafeteria/assembly room, activities center, restrooms |
| <b>RELIGIOUS ACTIVITIES</b> |   |
| Floor                       | carpet (loop, cut, cut & loop)<br>vinyl composition tile<br>ceramic tile<br>quarry tile   |
| Base                        | ceramic tile<br>quarry tile<br>rubber base<br>wood  |
| Walls                       | paint<br>ceramic tile<br>vinyl wall covering (type II)  |
| Chair Rail                  | molded plastic<br>wood  |
| Ceiling                     | gypsum board<br>acoustical tile (avoid suspended in religious services spaces)  |
| Lighting                    | fluorescent<br>High-intensity discharge (HID)   |
| Window Covering             | horizontal blinds<br>vertical blinds  |
| Upholstery                  | fabric (50,000+DR)<br>vinyl<br>molded plastic<br>wood   |

## REFERENCE CHART 6 (CONTINUED)

## Religious Activities Interior Design Materials Selection Chart (Medium-Use)

|                 |  |
|-----------------|--|
| Materials       | <p>Medium-Use<br/>administrative offices, conference and briefing rooms,<br/>classrooms, and corridors</p> <p>RELIGIOUS ACTIVITIES</p> |
| Floor           | <p>carpet (loop or cut &amp; loop)<br/>vinyl composition tile/sheet vinyl</p>  |
| Base            | <p>rubber base</p>   |
| Walls           | <p>paint<br/>acoustical wall treatment<br/>vinyl wall covering (type II)</p>   |
| Chair Rail      | <p>molded plastic<br/>wood</p>   |
| Ceiling         | <p>acoustical tile (avoid suspended in religious services spaces)</p>  |
| Lighting        | <p>fluorescent<br/>incandescent</p>  |
| Window Covering | <p>horizontal blinds<br/>vertical blinds<br/>lined draperies</p>   |
| Upholstery      | <p>fabric (25,000+DR)<br/>vinyl<br/>molded plastic<br/>wood</p>  |

## REFERENCE CHART 6 (CONTINUED)

## Religious Activities Interior Design Materials Selection Chart (Light-Use)

Materials                      Light-Use  
 chaplain's office and commander's suite

## RELIGIOUS ACTIVITIES

Floor                              carpet (loop, cut & loop, cut)

Base                                rubber base  
 wood

Walls                              paint  
 fabric wall covering  
 vinyl wall covering

Chair Rail                        wood

Ceiling                            gypsum board  
 acoustical tile

Lighting                         fluorescent  
 incandescent

Window Covering            horizontal blinds  
 vertical blinds  
 lined draperies

Upholstery                      fabric (25,000+DR)  
 wood

*Lodging*

Transient lodging facilities consist of visiting personnel quarters (VOQ's, VAQ's) and Temporary Lodging Facilities (TLF's). VOQ's and VAQ's are equivalent to mid-priced hotels and maintain very high occupancy rates. These facilities require heavy-use quality materials and furnishing that conform to established Air Force Standards. TLF's are small efficiency apartments used by families arriving and leaving the base, and receive heavy use, year around. These facilities reflect a residential quality in furnishings and materials and require very special attention to durability and maintenance.

*Recreation*

*Youth Activity Center*  
Andrews Air Force Base, Maryland

Recreation facilities encompass the most diverse functions of all the categories. They include gymnasiums, fitness centers, golf course clubhouses, bowling, youth and community centers, libraries, and theaters. Facilities such as fitness centers have constant traffic throughout the day, while facilities such as theaters have high concentrations for short periods. Golf courses, clubhouses, and bowling centers include food service spaces that required appropriate material selections for these areas. Many of these facilities require a specialized flooring treatment for each activity as well as acoustical wall treatments for sound control.

**BUILDING CODES**

ADA and Federal Access Codes must be incorporated in all new construction, remodeling and historical renovation projects.

There are also three model building codes that set forth minimum requirements for design and construction in order to protect public health and safety. The Basic Building Code, developed by the Building Officials and Code Administration International (BOCA), is the official code adopted for any standard not already addressed by AF publications. The Southern Building Code, developed by the Southern Building Code Congress International (SBCCI), is used primarily in the south. The Uniform Building Code, developed by the International Conference of Building Officials (ICBO), is used primarily in the western states. Building codes are adopted and enforced by the states, counties, or cities having jurisdiction. Enforcing officials will often modify codes to include a specific topic in their region. Codes are regionalized due to different building conditions in each region. For example, northern states incur heavy snow loads, western states experience earthquakes, and southern states endure hurricanes. By the year 2000, it is likely that all three codes will be combined into one code – The International Building Code.

There are four model fire codes that are typically performance based and deal primarily with the preservation of human life, and the contents of buildings. The National Fire Prevention Code (NFC) is sponsored by BOCA. The

Unified Fire Code (UFC) is sponsored by ICBO, and The Standard Fire Prevention Code (SFC) is sponsored by SBCCI. The National Fire Codes (NFC) written by the National Fire Protection Association (NFPA), which includes the NFPA 101 Life Safety Code, is the best known of all fire codes. Most importantly, the National Fire Codes are the only fire codes officially adopted by DOD.

As designers, we must select construction materials and material finishes that are safe for the environments we create. There are several tests that have been developed to determine the safety of products. Usually manufacturers have their products tested, if not, you may request them to do so. There are four major institutions that monitor these tests: American National Standards Institute (ANSI); American Society for Testing and Material (ASTM); National Fire Protection Association, (NFPA), and Underwriters Laboratory (UL).

#### FIRE TESTING

The following are some of the tests performed on material finishes:

##### *The Wyzenbeek Test*

The Wyzenbeek test, or Oscillatory Cylinder Method, tests abrasion resistance of fabric by measuring the number of times a machine rubs a fabric. The number of cycles a fabric can endure is the measurement of the fabric. The fabric is then classified as light duty at 3,000 cycles, medium duty at 9,000 cycles, and heavy duty at 15,000 cycles.

##### *Steiner Tunnel Test – also known as ASTM E84*

The Steiner Tunnel Test is performed on interior finishes for walls and ceilings. This process begins by mounting a 24”x21” wide sample to the ceiling of a tunnel, then igniting it for ten minutes. The *flame-spread index* measures the maximum distance the flame spreads along the length of the sample. Rated materials are compared to Red Oak flooring which rates 100. A Class A rating has a *flame-spread index* of 25 or less. A Class B rating has a *flame-spread index* of 26 – 75, and a Class C rating has a *flame-spread index* of 76-200.

##### *Flooring Radiant Panel Test – ASTM-E-648*

This test involves exposing a floor material to radiant heat and igniting flames. The objective of this test is to measure the resistance of floor coverings to heat and flames to limit the progression of fully developed fires through corridors. The rating is based on Critical Radiant Flux values that measures the distance flooring systems burn to extinguishment.

##### *Methenamine Pill Test – DOC-F-170*

This test measures the reaction of a burning methenamine pill placed on carpet. If the flame spreads, the carpet must be labeled as flammable. This test is required by Federal regulations on all carpet sold, and transported across state borders.

*Room Corner Test – UBC-42-2*

This procedure was designed to test textile wall coverings in realistic circumstances involving fires. An 8'x8' room is prepared with the sample wall fabric on three walls, then exposed to a flame source for ten minutes. The rating is pass or fail based on whether flashover occurs.

*Cigarette Ignition Resistance Test for Furniture Composites*

This test determines the resistance to ignition of a piece of upholstered furniture. Three lighted cigarettes are placed on a piece of upholstered furniture and are covered with cotton sheeting to intensify heat. If there is flaming combustion or if char develops more than two inches in any direction, the furniture composites fail the test.

*Cal Tech 133 – Full Seating Test*

This is the most stringent test of fire resistance for commercial seating. It is required in some jurisdictions for commercial interiors with high-risk occupancies such as auditoriums and health care facilities. A pass or fail rating is given as the test measures the rate of heat release, smoke obscuration, and carbon monoxide.

*Vertical Ignition Test*

This tests the flame resistance of fabrics that hang vertically such as window treatments. It is performed either in large or small scale and the results are pass or fail.

*Smoke Density Test*

The Smoke Density Test measures the smoke released by a flaming or smoldering material. The smoke density is determined and reported in terms of maximum optical density based on an arbitrary scale of zero to 800. A smoke-density rating of 450 or less is required in most jurisdictions.

## CHAPTER CONTENTS

## INTRODUCTION

## ERGONOMICS AND THE HUMAN BODY

## ERGONOMICS AND HUMAN PSYCHOLOGY

## ERGONOMICS AND THE JOB

## ERGONOMIC DESIGN APPLICATIONS

## FURNITURE

## ACOUSTICS

ERGONOMICS IN THE  
COMPUTER ENVIRONMENT

## INDOOR AIR QUALITY (IAQ)

## SAFETY AND SECURITY

## HEALTH HAZARDS

## TEMPERATURE CONTROL


## ENVIRONMENTAL CONSIDERATIONS

## FUTURE TRENDS

## CONCLUSION

## ATTACHMENT A: GLOSSARY OF TERMS

## ATTACHMENT B: REFERENCES

ATTACHMENT C: ERGONOMIC CHECKLIST  
FOR COMPUTER WORKSTATIONS


# Ergonomics in the Work Environment

## INTRODUCTION

Ergonomics (or “Human Factors” as it has traditionally been called) is a multi-disciplinary study of the relationships between the person and the environment. Ergonomics includes information from Engineering, Biomechanics, Environmental Psychology, Physiology and other fields about how human beings are affected by their environment, especially in the workplace. It is intended to enhance safety, productivity, and quality of life.

This guidebook offers an overview of the ways an interior designer may engage in human factor and environmental issues. It is not intended to deal with technical applications of ergonomics like industrial product design nor job task engineering. Rather, it focuses on how the designer can influence the comfort and safety of the people for whom they design.

It is generally taken for granted that all design is concerned with creating objects and spaces to serve the needs of their user. Many buildings, interiors and furnishings fall short of optimally serving human needs, however. In some cases, design has not kept up with the complexities of modern technology or the evolution of organizations. In other cases, people or agencies may have directed design with little background or awareness of the needs of users. Economic forces often exert considerable pressure, and can take precedence over information about actual requirements. Designers often assume that they know how to design for all human needs based upon personal experience, or they assume that their own requirements are typical of those of all others.

*Goals*

Designing the work environment ergonomically, that is, to meet the needs of the user, is critical to overall mission success. Specific goals of Air Force ergonomic programs are intended to:

- decrease the occurrence and cost of accidents, injuries and disabilities
- improve the well-being and readiness of the organization
- optimize the performance of organizational systems
- decrease physical and cognitive stress on personnel
- increase job satisfaction and productivity

*Impact*

Why the emphasis on ergonomics? The answer is simple: because the consequences of poorly designed objects and environments – especially at work – are serious and costly. At a minimum, poorly applied ergonomics can cause schedule delays, recurring discomfort, or a decrease in performance or output. At the extreme, the consequences can be permanent injury or even death.





We human beings are amazingly adaptable. Practically speaking, even under the most adverse conditions, the job must somehow get done. We routinely adjust to the task, furniture or equipment that we have been given. However, there are costs associated with this adaptation. Many of the serious problems on the job fall under the categories of Cumulative Trauma Disorders (CTD), or Repetitive Motion Injuries (RMI). These costly injuries are often a specific result of the body's adaptation to a repetitive task or an inappropriate posture. Their effects are widespread and often have long term consequences.

By all accounts, there is a serious, quantifiable impact when ergonomic issues are not dealt with in the workplace. It is a rising cost that cannot be ignored, and good design is a valuable component of the solution.

### *Role of the Interior Designer*

The ways in which a designer may use human factor information will vary with the nature and scope of individual design problems. In typical areas of responsibility, an interior designer:

- investigates and considers the needs and preferences of actual users and occupants
- chooses materials, finishes and products to meet aesthetic, practical and environmental goals
- selects furniture to fit individual and group needs
- plans the placement of elements and people in relation to natural light and ventilation
- directs or advises on space allocation or densities
- designs workstations and layouts
- guides and educates those who establish and oversee budgets about ergonomic cost/benefits
- observes workplace problems that may be indicators of poor ergonomic design

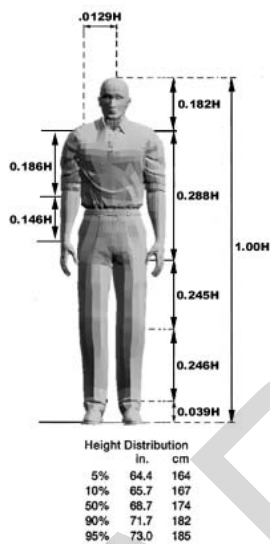
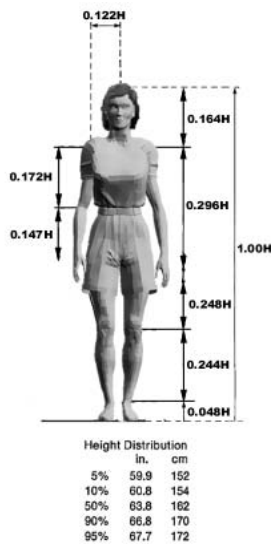
Although these concepts are obvious to most designers, they may seem strange to individual clients and to client organizations that focus on different goals and lowest possible first cost. However, there is a clear obligation on the part of every designer to make a case for social responsibility and to point out the broader benefits derived from the application of ergonomics.

### ERGONOMICS AND THE HUMAN BODY

#### *Anthropometrics*

Despite the great variability in work places and job tasks, the human body serves as a constant. In order to make informed design decisions, it is important to understand how the body responds to and moves about in its environment.

A fundamental consideration for the designer is the size of the body – its spatial requirements. Measurements of population dimensions come from an area of study called “anthropometry.” These findings are relevant to such design tasks as selecting furniture, allocating space or placing equipment.



*Body Posture*

*Stressors*

Anthropometry can provide the dimensions of an entire population or a target range within that population. Manufacturers often target measurements to the 50th percentile, or so-called “average” user. All this means is that 50% of the population are larger and 50% are smaller. By this definition, “average” does not really exist, and it is dangerous to design to this standard alone.

In more cases, it is necessary to design for an entire range of a population, from the smallest to the largest of those likely to use the particular space or equipment over time. For example, the height of cabinets or storage space might be set so that 90 percent of a typical office population can reach it, whereas a doorway may be designed so that 99 percent of the entire population can pass through it without stooping.

As a point of departure, the interior designer should consider criteria that cover the size of the fifth percentile of the adult female population through the 90th percentile of the adult male population. At left are some frequently used measurements.

It is also important to understand the inherent limitations of anthropometric data, and why they should be used as guidelines rather than hard and fast mandates. First, there is no one set of data that has been universally agreed upon. It is not uncommon to find values listed in different sources that vary by several inches for the same measurement.

Also, it should be obvious that the applicability of any measurements used in a design solution depends upon the similarity between the population studied and the population who will be performing the task or using the product.

The designer should also refer to the provisions of the Americans with Disabilities Act (ADA) to ensure that reasonable accommodation of the disabled is taken into consideration. An informed designer will be able to achieve the best fit between the individual and his or her environment.

The selection and placement of furniture and equipment will also determine the postural requirements in a workplace. Ergonomic research used to stress the importance of maintaining the body in a “neutral” position for as long as possible to minimize the stress on muscles and joints. Current research indicates that in addition to maintaining healthful posture, it is important for the individual to vary or alternate pressure points and body positions at will. This will allow the body to increase its available strength, postpone fatigue, and minimize the likelihood of injury. Whenever possible, a design scheme should accommodate this need for the body to change positions. Providing spaces for people to walk short distances, adjust their chairs or to alternate between seated and standing tasks can have a healthful effect.

We know that maintaining any posture or performing any movement exerts force on, or stresses, the body. These stresses exist somewhat in any situation, although they are not necessarily hazardous. Whether or not they have a



negative effect depends upon the amount of demand imposed on the individual through exertion, intensity, duration or repetition. It can also be a combination of these factors which produces dramatic increases in work effort, fatigue, pain, discomfort and injury.

An example of a stressor is the amount of force required in moving or lifting an object, such as opening a file cabinet or raising a flipper to retrieve an item from overhead. It is important that the strength requirements are within the level of the capabilities of the population who will be performing the task.

Some stressors can be reduced by simple rearrangement once the ergonomic risk has been identified. In other cases, it is necessary to replace furniture or products that are dated or dangerous with newer, more ergonomically designed products. One example is the selection of overhead storage units with a hydraulic assist on the flipper. The unit can be the same size as the one it replaces, but the amount of effort required to operate it is much lower. Consider user ease and access when making purchasing or placement decisions.

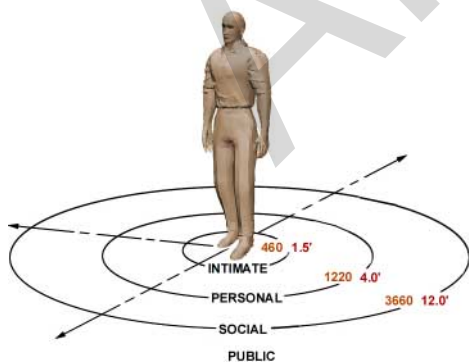
### *Personal Space*

#### ERGONOMICS AND HUMAN PSYCHOLOGY

Studies have shown that the design and condition of one's space contributes directly to feelings of comfort, motivation, safety, stress tolerance, and well being. This "state of mind" in turn, effects error rate, fatigue, accident rates, productivity and quality of work.

The effects of population density have important implications for the interior designer, and the basic standards for space allocation are covered in this guide. In addition to needing enough space to move about and perform various tasks, people react to space in a variety of ways, depending upon their culture and conditioning.

Researchers have defined the space surrounding the individual in terms of the way in which people in a given culture typically respond to others. "Intimate space" is that area immediately surrounding the individual's body. This area is most private and inviolate to the individual. A person tends not to allow any one to intrude in intimate space unless intimate relationships are expected. "Personal Space" is that area in which a person tends to allow only selected friends or fellow workers with whom personal discussion is desired. "Social space" or "Distant Personal Space" is that area within which the individual expects to make purely social contacts on a temporary basis. In addition, finally, "Public Space" is that area within which the individual does not expect to have direct contact with others.



Obviously, the more intimate the spatial relationship becomes, the more people resist intrusion by others. If their implied limits or boundaries are breached, tension or anxiety can result. While absolute distance criteria are not applicable, the following approximations are useful design considerations.

*Typical Subjective Responses  
to Spatial Features*

It is important to recognize how people may feel when they interface with the architectural features in their environment. Again, attitudes toward privacy, reliance on subtle cues to signal their intentions or desires, and attitudes toward work in general are culturally influenced, but some generalizations can be helpful.

- *Size (generally volume).* If the space is too small for the number of people, furnishings, equipment or other objects, people will consider it crowded. They may accept a crowded condition on a temporary basis, they will object to working or living in such a space for extended periods of time, and anxiety and stress-related problems will surface. If the space is too large, people will consider it “unfriendly” and inconvenient.
- *Shape (generally proportion).* If a space is out of proportion (too narrow, wide, high, etc.), people will consider it distracting or oppressive. If the space contains distortions such as all curved surfaces, acute wall junctures, and too many projections or surface changes, people will consider it confusing and difficult to maneuver. When a ceiling is extremely high relative to the lateral dimension of the space, people feel as if they are working in a pit, or that the walls are closing in on them. When a ceiling is extremely low, and the space in front of the viewer is very long, people feel like the room is uncomfortably “endless.” To compensate, they may instinctively duck their heads or hold their heads in an unhealthful posture.
- *Color and illumination.* If a space is too dark, people tend to be less active, or they may feel anxious. If a space is too bright, people may feel overly exposed, or they will complain of glare or thermal discomfort. If there are too many different colors, too large an expanse of very saturated color, or too many “busy” patterns of color within a space, people will become irritated after more than a brief exposure to the space. If there is too little color, no visual pattern, texture, or other decorative break in the visual environment, people will find the space monotonous, and irritating to the point of subconsciously wanting to escape.
- *Windows.* Generally, most people do not like to live and work in a space that is devoid of windows. First, people seem to need some sort of contact with the outside world for reassurance and the perception of safety. On the other hand, too many windows, or oversized windows such as the floor to ceiling type, can cause the following negative reactions: glare, over-exposure (“fishbowl” effect), vulnerability or anxiety.
- *Attractiveness.* Good design is, in itself, healthful. People experience feelings of comfort, ownership, and mastery in attractive surroundings. Self-esteem can also improve when an individual is placed in a well-designed and well-maintained environment. A luxurious setting has the psychological effect of making people speak more quietly.
- *Proximity to others.* People enjoy watching other people, but they do not like to be in situations where they can be directly observed. People especially do



not like to encounter others as they come out of the restroom. Generally, individuals like to be seated so that the entrance to the room is still within their line of sight. People will generally select a seat in a public area which is closest to the entrance they used, and they will seek out a seat that is not next to an occupied one if given a choice.

- *Circulation.* Effective circulation spaces move people efficiently from place to place. The most efficient paths are arranged in a straight line, and offer an unimpeded view of the destination. If a path is too complicated, people will react to it with frustration and “instinctively” resist using it.

### *Personalization*

Self-expression is an essential element in worker productivity and ambition. Whenever possible, there should be some allowances made for personalization of a workspace. The selection of objects or finishes in a person's area imparts a feeling of mastery and comfort. Personalization also allows for the honoring of the traditions of rank and promotion, which can have a cohesive and stabilizing effect in an organization.

### ERGONOMICS AND JOB TASKS

Work design is traditionally the domain of the Industrial Engineer, however, with a background in ergonomic principles, interior designers can also contribute to this area. They are often in a position to observe and gather information during the design process that identifies and lessens potential problems.

The following signal risk factors on job tasks:

- repetitive motions
- fixed or awkward postures
- forceful hand exertions
- vibration from hand tools or equipment
- manual material handling
- unassisted lifting >25 lb.
- recurrence of slips and falls

### *Programming*

### ERGONOMIC DESIGN APPLICATIONS

Effective ergonomic design focuses on anticipating and meeting the needs of the user. Before finalizing any scheme, several common sense steps can be employed by the designer to help achieve ergonomic design goals.

- *Step 1.* Define and examine the needs of the total user population; do not concentrate only on the primary resident, but look at the needs of his or her visitors or clients and the people who serve the primary client.
- *Step 2.* Question motivations and unrealistic desires to separate them from genuine needs. The desire for “more closets,” for example, may indicate a need for other kinds of storage that will be more serviceable. A wish for a

windowed corner office may come less from any practical need than from a desire for heightened status – a value that may or may not deserve consideration.

- *Step 3.* Examine and define the various tasks that each of the users has to perform. Determine what these tasks imply in terms of space, privacy, environmental control, supportive furnishings, and utilities.
- *Step 4.* Explore the interactions between various users and their furnishings and equipment. Examine alternative arrangements to determine the most convenient organization of people, furnishings, and equipment.
- *Step 5.* Bring all needs and desires into some realistic relationship not only with the project's budget and priorities but also with the underlying economic forces.
- *Step 6.* Retest and rework alternatives back through the user population as many times as is practical, and adjust the scheme as necessary before finalizing it.

Also refer to the “Furniture Systems Guide” for a detailed programming checklist.

#### *General Design Approaches*

Ergonomic guidelines have been established by drawing upon information from a number of different scientific disciplines. In spite of the specialization within the individual fields, there are several common design objectives:

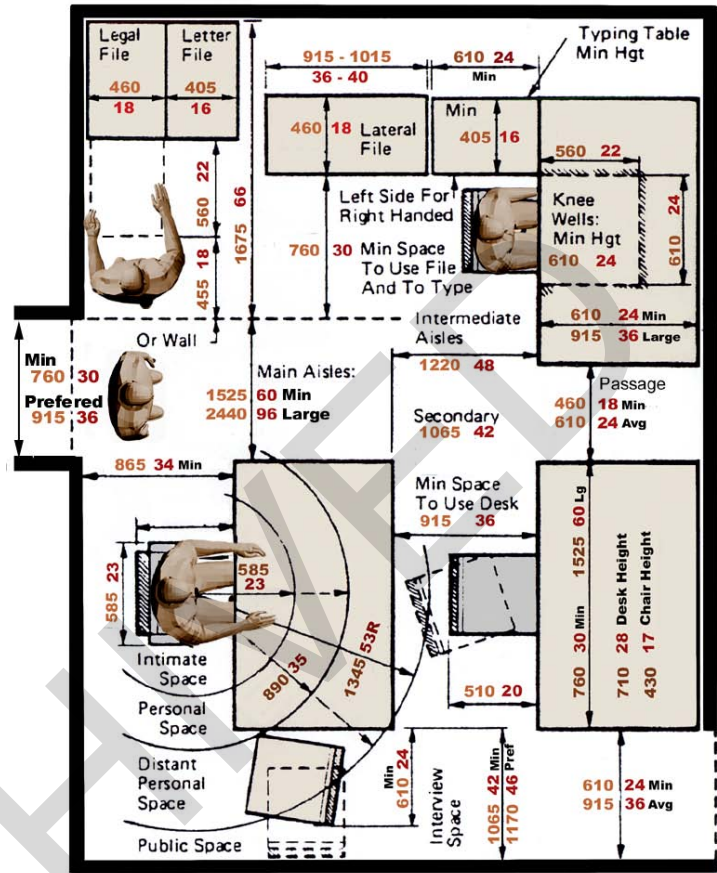
- *Design for flexibility.* Designing for flexibility can be the key to solving several problems with a single approach. Select furniture and systems that can be adjusted to the greatest number of individual needs, and easily reconfigured to meet the evolution of an organization's need.
- *Consider every design choice to be part of a total, interactive system.* For example, a chair must not only fit the individual, but also the requirements of the task, and it must work within the environment in which it will be used, over time, etc.
- *Provide the most “intuitive” design solution.* In other words, design objects and spaces in a way that is natural or logical to the average person's experience. Intuitive design provides smooth information transfer. Research indicates there are sets or natural behaviors or associations that can be expected:
  - control switches are expected to move up, to the right, or clockwise to turn on
  - people assume that water and liquid valve handles that are operated with the right hand rotate clockwise to increase flow
  - people have become conditioned to certain color meanings: red for danger, fire and hot; green for OK, go and acceptable; yellow or amber for caution, yield; and blue for cold or cool



- people’s attention is drawn to bright and vivid colors, bright lights, loud noises, flashing lights, repeated sounds
- people assume a relationship between objects on the basis of their proximity; they assume that things are related somehow when they are located together, and that they cannot possibly be related unless they are together
- things that are unfamiliar may appear complex and may easily confuse people. Spaces and systems should convey one, simple organizational principle, pattern or sequence
- *Make designs as safe as possible.* This is an extension of “intuitive” design, and it may prevent misuse or injury. Based upon research, designers can anticipate certain behaviors from people, and plan for them:
  - people generally regard products to be safe. Thus, they proceed to touch or manipulate things without caution, and they do not check before hand.
  - people don’t read labels, they tend to first explore with their hands
  - people take deliberate risks and shortcuts; refuse to look at and read signs or other visual warnings; this is especially strong when people become stressed or hurried
  - it takes very little to distract someone
  - people are generally aware of the capabilities of their bodies. For example, they assume that if an object is small enough to get a hold of, it is also light enough to pick up. They do not recognize how strains, sprains or fractures are caused, or how easily they may be thrown off balance
  - people expect handrails, balconies, stages and ramps to be strong enough to support them at all times
  - when about to lose their balance or fall, they instinctively reach for and grab the nearest thing
- *Design to minimize muscle fatigue.* Avoid the following:
  - workspace layouts that require people to sit in a twisted position in order to watch a display or operate some control
  - workspaces that require a person to reach or hold their hands above their head
  - spatial or furniture layouts that require frequent lifting, stooping or squatting

### *Space Allocation*

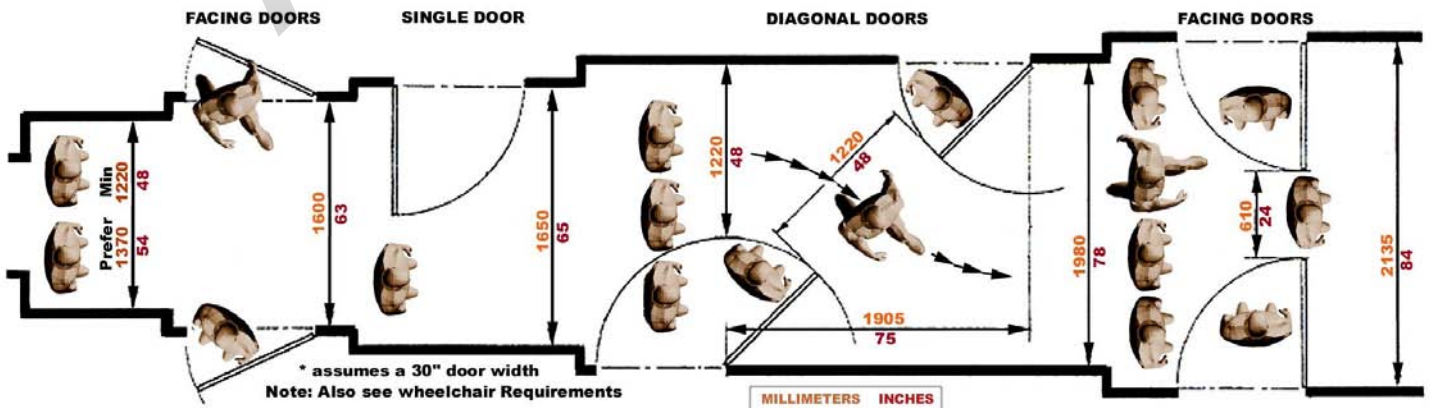
Once the designer knows the potential uses for a space, he or she can apply anthropometric data as a basis for a design scheme. Certain standard measurements can aid the designer in the allocation of space. Refer to the illustration for guidelines.



*Circulation*

Before laying out any circulation patterns, the designer should contact the person in charge of an area or department to learn about the general demands and workings of that work area. There is a need to discuss such issues as: which equipment is used most frequently, adjacency requirements, peak demand times, or what specialized equipment may be justified to make the job easier or safer. Once these questions have been answered, the designer can lay out optimal local traffic flow patterns within and between areas.

Anthropometric data ensure that enough space is provided for individuals to move freely and safely. Refer to the illustrations on this page for allocation guidelines.







In addition to providing enough space for individuals to move freely and safely, the design lay out should minimize the potential for them to walk unnecessarily long distances.

### *Storage*

Storage space is a very important item in the ergonomic design of a workplace. It is important that the items used most frequently are placed closest to the worker. This optimizes time as well as reduces the number of awkward postures required performing common work tasks. In order to be effective, the storage space should be large enough to hold large batches of supplies and resources, to accommodate the busiest work periods and provide storage for supplies nearest the locations where they will be used. Again, apply the ergonomic principles of smooth information transfer, flexibility, and intuitive design when planning storage areas.

Methods of equipment storage directly effect the physical effort required to replace and remove equipment from its stored location. For example, overhead storage cabinets with doors >48" can be too heavy to maneuver. Heavy objects should not be stored close to the floor or above shoulder height. It is better to store them in the "lifting power zone" – approximately knee to chest height – to prevent fatigue and injury. Refer to the illustration, p. 12, on shelf height and depth.

### FURNITURE

#### *General Furniture Guidelines*

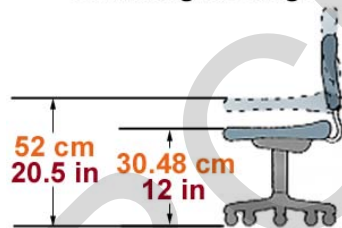
- *What's ergonomic and what's not.* Ergonomics is a hot topic. Manufacturers are eager to label furniture and accessories "ergonomically correct" or "ergonomically designed," much like food products are liberally labeled "all natural" or "new and improved." Keep in mind that there are very few standards for ergonomic equipment and furniture, and even fewer enforceable standards. Designers should be wary of these claims, and rely on their knowledge of ergonomic principles when making selections.
- *Flexibility and fit.* Again, the choice of furniture depends greatly upon the work that will be performed and the characteristics of the individual who will use it. The highest consideration should be for flexibility and accommodation to reduce the problems that have already been discussed. The idea that "one size fits all" is incorrect. Consider the dimensions and anatomical characteristics of the user to make sure that the furniture fits them, supports them properly, and adjusts to their activities.
- *Safety.* Avoid sharp contact points. Base selection on the durability, balance and stability of the item's structure. Consider flammability, fire ratings, and toxic emission when specifying fabrics and upholstered seating.

## Seating

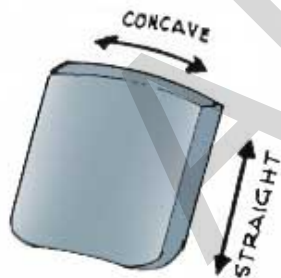
The chair is a primary interface between the body and the environment, especially in the workplace. A fully ergonomic chair can make up for many deficiencies in other equipment. Generally, it should support a wide range of postures, be easy to get in and out of, and provide proper adjustment. In the office and lodging, these features relate directly to an individual's potential for comfort and low stress posture.

- *Office seating.* When adjusted properly, the chair should provide good lower back support, and allow the individual to rest his or her feet on the floor (or footrest). The chair should place the person within a comfortable reach the task, and position elbows at surface height. Research and debate continue on the issue of armrests in the workplace. Standard, fixed chair arms can prevent the operator from being able to get his or her legs underneath a desk or table; this forces a continuous, mild trunk bending and low back pain risk. If the specific job demands are uncertain, chairs without arms or, more preferably, with low or height-adjustable arms should be considered. Generally speaking, armrests are desirable only if they are well padded, and adjustable up and down, or they can be removed or folded away. Refer to the illustrations for the important factors in office seating.

## Seat Height Range

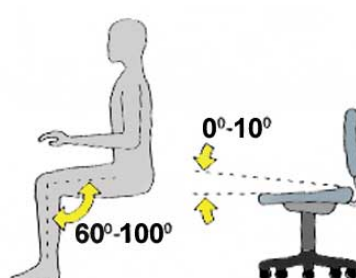


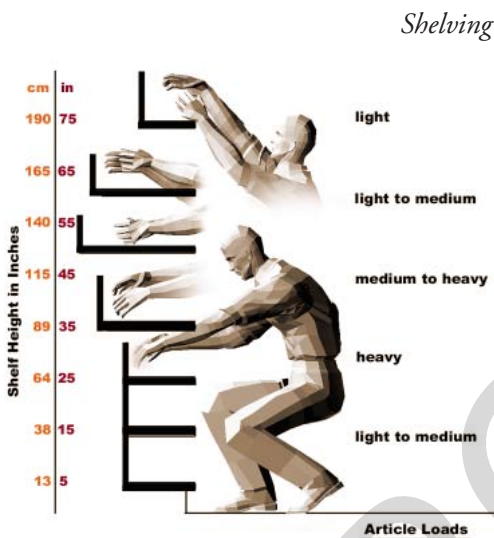
## Seat Width



## Arm Rest Clearance

46.23 cm 18.2 in





### *Panels*

- *Sofas and upholstered chairs.* Observe the previously defined seat-length guidelines. Keep in mind that most sofa seats are too long. Select firm cushions and provide adequate kick room at the front of the seat so people can place their feet near the center of gravity when they rise.
- *Dining chairs and stools.* Select chairs and/or stools at the same time the table is chosen to get the proper seat-height to table-height relationship. Select the chair first, then select the table. The accompanying illustrations provide important guidelines for designing or selecting the proper size of table for the particular application. The guidelines shown are for adults. For children between the ages of 10-13, reduce by 15%; for younger children, reduce by about 20%.

When selecting cabinetry or shelving-type storage units, keep in mind the nature of the potential storage items and retrieval tasks involved. This requires attention to the following:

- size and weight of the articles to be stored
- how high and how far the particular user can reach
- size, strength and mobility limitations of the user at various positions (stretching, bending, stooping, and kneeling)
- flexibility for rearrangement
- stability
- drawer control and overhead door ease of operation
- handle and latch operability
- compartment identification
- separation and control of materials inside the cabinet

Avoid the temptation to assume that shelf height is the only consideration. The sketch also illustrates the importance of shelf depth. Although it may appear wasteful not to take advantage of the total available depth of a cabinet, it is not necessarily an advantage to the user.

The need to rearrange one's immediate workspace from time to time suggests mobile cabinetry. Providing files or supplies on wheels allows the user to arrange stored materials so there is less risk from reaching or straining.

Furniture panels are available in a wide range of structures and finishes. The "Furniture Systems Guide" discusses various types of panels, their application and sound absorption properties. Ergonomic considerations for selecting panels have to do with their safety, acoustical properties, and their ability to provide adequate visual screening while allowing daylight and air circulation.

Taller panels, even when they function only as visual screens, make people feel like their space is more private. Screens between workstations should be at least 150 cm (5 ft) in height and break the line of sight in all directions by 30 cm (12 in) or more. Higher panels or demountable walls should be used around copy machines, scanners, fax machines and other noisy equipment when construction that is more durable is not feasible. Lower partitions in teamwork



areas can have an energizing effect and allow natural light and fresh air to circulate in the work area.

### *Noise*

#### ACOUSTICS

Noise is defined as unwanted or excessive sound. It is a stimulant that, in the right amount, spurs productivity. However, research shows that noise contributes more to workplace distractions than poor lighting or air quality. Exposure to noise increases our mental workload, which in turn affects heart rate levels and our capacity for physical activities.

Office noisemakers like fax machines, speakerphones, and sound-emitting computers are becoming more prevalent. Since more work today is being done in teams, verbal interaction has increased. Cost-driven organizations have contributed to the rising noise level by increasing worker density. Contemporary design trends toward hard plaster walls and ceilings, wood floors, metallic finishes and expanses of glass do very little to absorb unwanted noise.

There are several solutions to reducing non-productive noise levels. Major acoustical problems may call for the services of specialized consultants, but most can be dealt with by the interior designer through planning and material selection.

### *Acoustical Space Planning*

The most effective way to reduce the noise level in a space is by lowering occupant density. People should be located as far apart as possible, balanced against the efficient use of space. If possible, locate adjacent workers at least 8 ft. apart.

Directional characteristics of sound should be considered in layout. Since the human voice is loudest directly in front of the talker, less loud to the sides, and quietest to the rear, a designer should lay out stations so that people are oriented back to back rather than facing. Seating people side to side or in a cluster arrangement is a compromise.

Isolate noisemakers. Private offices should be located away from sounds from an elevator, conference area or bathroom. Noisy equipment like fax machines or printers should be isolated whenever possible by placing them in enclosed areas of solid or durable and insulated construction.

### *Finishes and Materials*

Soft colors, wallcoverings and subdued lighting make any space – even an open office plan – more peaceful. In the past, acoustically rated materials represented limited choices and inattention to design characteristics. There has been significant development of these materials lately. The “Noise Reduction Coefficient” (NRC) is a standard industry rating that can aid the designer in material selection and specification. The NRC is a single number indicating the effectiveness of a material in absorbing sound. With a range of 1.00 to .00,

a NRC of .99 would indicate almost total absorption; .01 virtually none. The following chart indicates general NRC's for common materials:

- bare concrete floor = .05
- tile or linoleum on concrete = .05
- carpet (1/8" pile) = .15
- carpet (1/4" pile) = .25
- carpet (7/16" pile) = .40
- carpet over padding = up to .65
- plaster ceiling = .45
- metal pan acoustic ceiling = .60
- acoustical ceiling systems = up to .90

Since lighting fixtures cover a large amount of a ceiling's surface area, ceiling-mounted luminaires with flat lenses wider than 12 inches should be avoided. A compensating design strategy is to eliminate ceiling-mounted fixtures, use 6" wide units or select units with parabolic louvers. Ceilings should have a NRC of at least 0.75. The sound transmission classification of common partitioning materials can be found in the "Furniture Systems Guide."

Since floors cover a large amount of surface area, they are also good targets for noise control. Carpeting floors will reduce the noise of heel clicks, chair scraping, and other annoying noises that originate from the floor. As the above chart indicates, the padding and length of pile that a designer chooses can make a substantial difference in absorbing noise.

The American Society of Interior Designers recommends that systems furniture panels have a Noise Reduction Coefficient (NRC) of at least .75. Gasketing panels prevent noise from migrating through cracks. Stagger the openings on panels on either side of a circulation path so that the line of sight and noise transfer is broken.

Another acoustical solution is to add noise mitigation, that is, to install a sound masking system. Sound masking is a sort of glorified stereo that generates broadband, low-level white noise at a constant volume. The system produces a steady whooshing noise that sounds like a well designed ventilating system.

Every effort should be made to "plug" sound leaks around doors and through ducts and chases. Double or triple glazing windows and gasketed doors can also help. Corridors and closets can act as a sound buffer between spaces.

#### ERGONOMICS IN THE COMPUTER ENVIRONMENT

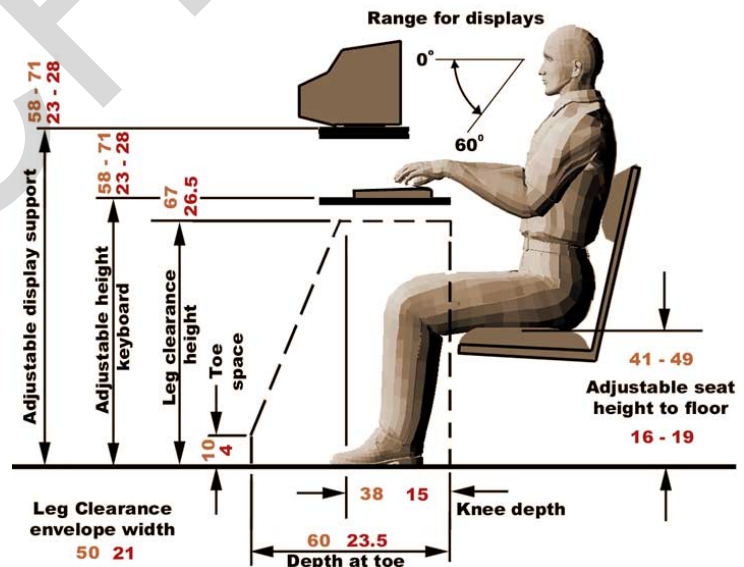
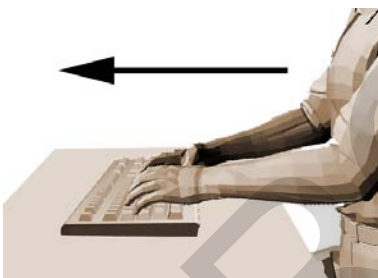
Over the last few years, the use of computers has risen dramatically, and will continue to do so. A person who sits at a computer more than two hours during an eight hour day, or who works more than 60 minutes at a computer without a break is considered to be a substantial user, and therefore at some risk for stress and injury.

*Set Up**Computer Input Devices*

The setup of a computer workstation should allow the user to adopt optimal working postures while allowing some freedom of movement. The computer workstation should provide the necessary resources to perform other job tasks between periods of lengthy computer use. This will reduce the repetitive motion stress to the worker while providing a mental stimulus to prevent boredom.

- **Keyboards.** There is serious research and competition among manufacturers to come up with the optimum keyboard design. Although a variety of choices exists, there are some common ergonomic design goals that should be considered.

Most ergonomic research reinforces the desire for an ideal keying posture, that is, one in which muscle loads are minimized and the wrist is “naturally” held. Typing at a keyboard on a desk is a common condition for many computer users. In this position, it is difficult to maintain a neutral posture because the forearms sag as they tire; this puts the wrists into greater extension and restricts blood flow to the hand. It also increases the muscle load in the upper arms, shoulders and neck. Working in this posture for more than 3-4 hours invariably leads to muscle fatigue. It is more desirable to have a separate work surface such as a split-level work station or extension for the keyboard which falls at or slightly below elbow height.



There is also considerable debate about the proper slope of the keyboard. Keyboard slopes should not cause the user's wrists to flex too far back nor extend too far forward for extended periods of time.

Keyboards should not rock or slip, be easily repositioned on the work surface and detachable if available.

### Monitors or Video Display Terminals (VDTs)

- *Mouse.* A recent RSI is a condition called “mouse shoulder,” caused by frequently reaching for and moving a mouse. The key is to keep the mouse close to minimize reaching movements, and to keep the forearm supported. The mouse should also be placed at approximately the same height as the home-row of the keyboard for easy transfer.
- *Trackball.* This is essentially a mouse on its back. Its best virtue is the elimination of most of the arm movements that cause mouse shoulder, however, there is an increased amount of thumb and finger movement.
- *Scanners.* These devices can aid in data input by reducing the amount of direct keyboard entry and its resultant wear and tear on the hand and wrist.

There are three ergonomic concerns about monitors: eye strain, neck strain and electromagnetic emissions.

Several cost-free options are available to reduce eye strain. Most importantly, avoid natural or artificial light striking the display. Place the monitor 45 to 60 cm (1.5 to 2 ft) away from the user, and allow for personal adjustment. Preferences for viewing depth vary widely, but research indicates that a preferred viewing distance ranges between 60 and 90 cm (24 and 36 in). Lower the contrast between a bright screen and a dark background. If glare is unavoidable, consider placing an anti-glare screen over the monitor, but ensure that the image is not so degraded that it causes additional eye strain to see it clearly.

Neck strain is simple to alleviate by adjusting the height and slope of the monitor to the individual’s needs. Consider a person’s eye level, height, the nature of the task they are to perform and the duration of time required. Monitor height can be adjusted by placing the monitor on books or blocks of wood. As a design guideline, most workers prefer a centerline height for the screen at or slightly below eye level.

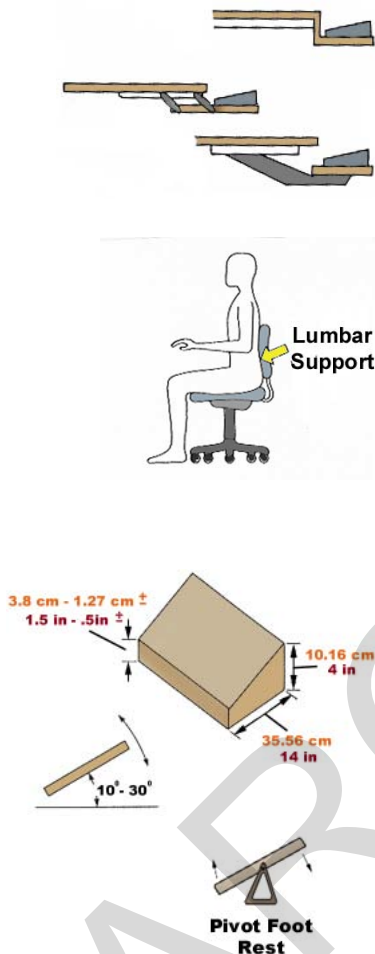
The health and safety implication of Video Display Terminals (VDTs) is a subject of serious debate and research, but no clear conclusions have resulted.

### Computer Accessories

Many accessories can improve the ergonomics of the computer workstation. Some of the more popular items are listed below along with some considerations for their use:

- if the operator frequently types from hard copy or draws using computer-aided-design (CAD) while looking at drawings, or maps, provide a *flexible copy holder* directly next to the screen, and ensure that it rests at the proper distance, tilt, and eye level to reduce eye strain
- *wrist rests* may be used to improve the posture of the wrist while typing, but it is imperative that the operator places the device under the base of the palms and not under his or her wrists. Wrist rests should be made of soft material and allow for easy flow of motion from keyboard to mouse.





- *CPU stands* are useful when there is limited desk space, but they may restrict the leg position if they are placed in the knee well. They should be placed to the side of the desk. They should not be used if very frequent access to the CPU is required (for example, to regularly change-out discs or CDs) since this often requires risky bending, reaching or twisting motions.
- *keyboard trays* can be useful for extending the “reach” of the keyboard, or as a retrofit for a workstation that was not originally designed for keyboard use. As with wrist rests, the front edge of the tray should fit comfortably under the base of the palm, and be made of soft material. They should be sturdy and have no lip or sharp edges to pressure the wrists.
- *monitor risers* and *monitor arms* can also be used to position the monitor at the proper eye level and tilt. This is particularly helpful to the taller user.
- *lumbar supports* for chairs typically do not improve the sitting comfort significantly enough to encourage their use; new chairs with appropriate lumbar support in the backrest are recommended instead.
- *task lighting lamps* are a good solution when operators need to look frequently or closely at small items, such as assembly, maintenance or typing from hard copy. It is also helpful to the older worker who needs higher illumination levels.
- *footrests* are very good for shorter operators whose workstations do not adjust to their height. Many now come with a tilt option so that you can easily flex or extend the ankles.

Other considerations for the design of the computer workstation can be found by following the ergonomic checklist in Attachment C of this guide.

#### INDOOR AIR QUALITY (IAQ)

The quality of indoor air influences the health, comfort and productivity of occupants and visitors. The Environmental Protection Agency ranks indoor air pollution among the top five environmental risks to public health. The phenomenon termed “sick building syndrome” made headlines for a time, and research began in the late '80s to identify and eliminate the contributors to the stew of emissions that can collect and circulate in a building.

Many materials in common use, as well as certain practices, can have an unfavorable impact on air quality within a building. Asbestos, long a favorite insulation material and an ingredient in various building products, is now well known as a carcinogen. The re-circulation of air in air-conditioned interiors may favor both the short-term danger of infection and the long-term risks related to exposure to low levels of air pollutants.



Traditional methods to ensure good indoor air quality relied almost exclusively on ventilation strategies – fresh air was introduced into the space to dilute contaminants that build up over time. Other more proactive and more cost-effective strategies now exist.

“Source control” strategies eliminate possible sources of contamination before they are introduced into the building. Examples include designating a building as a non-smoking building, and specifying bacteria/moisture/mildew inhibitors in paint and other materials. Limiting materials with a great deal of accessible surface area (“fleecy” materials such as carpet, upholstery and ceiling tiles) will also control the release of chemicals into the environment.

“Source isolation controls” attempt to contain sources of contamination that cannot be eliminated. For instance, buildings may contain copy machines, housekeeping chemical storage, food preparation areas, loading docks and toilet rooms. These areas can pose significant risk to the air supply in case of an accidental spill or release. All of these areas should be separately ventilated to the outside so that return air is not recirculated into the building. Building pressurization and careful location of building openings are also used to reinforce source isolation.

Installation procedures also have an effect on exposure to harmful or irritating substances. A great many user complaints come from carpet change-out. Tests indicate that carpet emissions are released upon installation, but with proper ventilation they will dissipate within 48 to 72 hours. There are some common sense guidelines for installation or remodeling:

- plan for sensitive occupants to leave the building during removal of old carpet and/or the installation of new carpet
- vacuum old carpet thoroughly before removal to minimize airborne dust particles
- provide adequate ventilation during installation and the following 72 hours
- increase fresh air ventilation to flush out remaining contaminants
- specify low emitting adhesives and carpet cushions

#### SAFETY AND SECURITY

##### *General Safety*

The threat of accidents is generally associated with means of travel and public streets, but indoor accidents are actually a major cause of injury and death. The National Safety Council reports that each year there are over 3 million disabling indoor fall accidents, including over 4000 deaths.

Stairways and steps pose real dangers. Rest rooms, with their slippery surfaces, hard projections, mirrors, glass, and hot water, are notorious accident locations. Kitchens – both residential and commercial – with open flames, gas or electric elements, boiling water, heated fats or other hot liquids, and sharp objects present other risks. Glass always poses a danger, particularly in the form of large windows and doors that can sometimes be virtually invisible under certain

lighting conditions. High locations such as balconies, windows and platform edges need the best possible guardrails or bars, marking, and lighting. Polished floor surfaces are a hazard especially outdoors or near entrances where water, snow, or ice can add to the risk. Small rugs and mats and the edges of larger rugs can cause falls. Projecting furniture legs and edges, or furniture that overturns easily are also involved in a surprising number of accidents. As a guide for designers, they should:

- avoid the use of rugs or chair mats that can skid or cause a trip hazard.
- specify non-slip floor surfaces wherever practical, especially if there is a possibility that they will become wet. Ensure they do not become slippery when wet.
- provide nonskid treads on stairs and clearly mark the beginning of stairway.
- avoid level changes and single steps if possible. If not, mark level change clearly through contrasting colors, material or design. Provide rails and/or safety lights.
- ensure that steps and stairs are free of obstructions.
- eliminate sharp edges, corners on cabinetry and furniture.
- ensure adequate clearances for circulation, especially around machinery or moving objects.
- ensure that no cords need to be stretched across the workstation resulting in a trip or fire hazard. Wherever practical, provide several power outlets throughout the workstation, consider ceiling supply or access flooring to minimize cable hazards.
- select and place light fixtures carefully to ensure adequate lighting in storage closets and hallways.
- provide emergency lights at key locations.
- observe glass doors and large windows under as many lighting conditions as possible to anticipate any potential hazard they present, and offer correction.
- do not use large ceiling-to-floor glass windows or doors without appropriate barriers.
- control access to pools and other hazards in lodging.
- provide thermostatically controlled mixing faucets for tubs and showers.


#### *Fire Safety*

Code compliance is not, in itself, assurance that all fire safety issues have been fully addressed by the designer. The dangers are multiplied by modern closed spaces with artificial ventilation, often on high floors where rescue access is difficult.

In addition to the adequate number, size and marking of exit routes, there is the specialized equipment such as smoke detectors, fire alarms, extinguishers, sprinkler systems, and hose connections that need to be integrated into the project design. The interior designer can also make it a point to avoid choosing synthetic materials that give off toxic fumes when burning.

#### *Security*

This is an issue closely related to safety and, unfortunately, an increasingly important consideration particularly in areas where social conditions have brought about an increase in robbery, vandalism and even terrorism. Design



cannot control every aspect of such problems, but both basic planning and suitable details and equipment can help to minimize risks. Dark halls, and hidden areaways invite trouble, while open and visible access points are somewhat self-protecting. Ensure adequate lighting fixtures, especially in and around parking areas and at entry doorways.

#### HEALTH HAZARDS

In addition to safety hazards that create the possibility of injury, building interiors can create other problems that may impinge on occupants' health. Concern has recently developed for hazards that may be associated with exposure to electromagnetic fields (EMF). Such magnetic fields are created wherever electrical devices are in use. Where small currents are involved, the strengths of the fields are not great and their levels fall off short distances from the sources. There is strong disagreement among researchers about the levels of risk involved EMF exposure.

Other health hazards have been traced to the presence of lead in paints and water that comes from pipes or plumbing devices such as faucets. The danger is of special concern in projects where children will be the user/occupants. Radon gas in interiors and even very small amounts of mercury that might come from fluorescent lighting tubes or from discarded batteries is an additional source of health problems.

Health hazards related to the deprivation of full-spectrum lighting are discussed in the "Light and Lighting" guide.

#### TEMPERATURE CONTROL

The temperature of our environment can have a significant effect on our physical capacity. As we all know, when it is excessively hot or humid we tend to move slower and become tired faster, because these conditions require more energy. Similarly, cold environments can cause a tightening of the muscles which also limits our ability to perform some tasks. Climate control is particularly important for minimizing effort and for the reduction of muscle injury.

It is often assumed that blanket conditioning of all spaces will effectively accommodate all types of organizational needs. This is not the case. Consequently, when a new design concept is introduced into a building, modification of the building's base systems (like cooling, ventilation, ceilings or acoustics) also needs to be considered in the design.

Temperature control is one area where it may be necessary and more economical to consult an expert before a new scheme is implemented.

Wherever possible, variations in environmental conditions should be controllable within a facility. Special consideration should be given to weather patterns for unprotected or frequently exposed areas such as loading docks, outdoor passages, and unconditioned storage spaces.

#### ENVIRONMENTAL CONSIDERATIONS

The interior designer can participate in a number of activities aimed at the recovery and preservation of our environment through waste reduction, reclamation and recycling.

Many manufacturers have initiated programs aimed at environmentally sound ways of handling waste. First, the goal is to reduce the amount of waste generated in the manufacturing process – often referred to as “pre-cycling.” Second, they have found ways to re-claim used materials from the job site, recondition those materials, and return them at a substantial savings over new products. Finally, manufacturers are finding many ways to recycle previously wasted materials into economically feasible uses, and make these products available to the consumer.

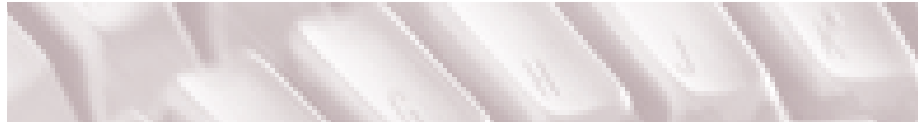
Interior designers can make a significant contribution to these efforts by working with environmentally responsible manufacturers, especially in the area of carpet purchase. About six billion pounds of carpet is replaced in the United States each year. Federal agencies are directed by Executive Order to enhance the purchase of products, including carpet, which contain recycled materials or that are otherwise environmentally preferable. At the present time, carpet fibers made from post-consumer recovered material commonly include polyester and nylon, among others.

As this technology progresses, more and more construction materials can also be re-cycled. Some manufacturers of acoustical ceiling tiles will take back products, rejuvenate or recycle them, and provide them for resale. This saves money and is an environmentally sound alternative that should be pursued.

#### FUTURE TRENDS

Designing for the comfort and safety of users is has always been a basic challenge. In addition, work populations are increasingly diverse and organizations are evolving at increasing speed. Several trends in technology and workstyle are emerging:

- mobile workstations, portable offices and just-in-time workspaces are in greater demand. More desks, filing cabinets and office equipment will need to be on wheels.
- there is a trend toward different work plane heights. Combination sit/stand workstations are on the increase.
- communication, computer and electrical hook-up cabling must be flexible for maximum reconfiguration. Consider cables that descend from overhead tracks; they're ADA compliant as a bonus. Fiber optic cabling will be increasingly used.
- there will be increased biofeedback from office equipment
- computer size and shape is shrinking; laptops offer great flexibility, and second and third monitors will be common



#### CONCLUSION

This guide is intended to increase the understanding of all readers in the fundamentals of ergonomics in the work environment. Informed readers become informed users.

Finally, it is probably safe to say that ergonomic problems are now, or soon will be, everyone's problems. Rather than relying on researchers and manufacturers, many of the best and most creative solutions can come from informed designers who work with opinions from their users and apply the basics of ergonomics.

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## ATTACHMENT A: GLOSSARY OF TERMS

|   |   |
|---|---|
| <i>adaptation</i>                       | Adjustment to conditions in the environment. Adaptation to temperature changes is referred to as <i>acclimatization</i> .   |
| <i>anthropometry</i>                    | The study of the physical dimensions of people, including size, breadth, girth, distance between anatomical joints, and joint range of motion.  |
| <i>awkward posture</i>                  | A deviation from the neutral position of any particular joint. Examples include extreme flexing, extending, bending or rotating parts of the body, reaching behind the trunk, holding arms above the shoulders, etc.                    |
| <i>biomechanics</i>                     | The application of mechanical principles, such as levers and forces, to the analysis of body-part structure and movement.   |
| <i>bursitis</i>                         | Inflammation of a sac found near a joint such as the shoulder or knee. The inflammation is attributed in some cases to excessive use of the joint.  |
| <i>capacity</i>                         | The maximum ability of a person to perform in a given set of conditions.  |
| <i>Carpal Tunnel Syndrome</i>           | Entrapment of the median nerve of the hand and wrist in the passageway (tunnel) through the carpal bones of the wrist; usually results in numbness in the fingers and pain on gripping.   |
| <i>Cathode-ray Tube (CRT)</i>           | Element providing the screen for television or computer monitor.  |
| <i>contact stress</i>                   | A type of trauma inflicted by direct contact of various body parts with work surfaces or tools.   |
| <i>Cumulative Trauma Disorder (CTD)</i> | [See Work-related Musculoskeletal Disorder.]  |
| <i>displacement</i>                     | The difference between the initial position of an object and its position later. In Biomechanics, the object may be the body or a particular body segment.  |
| <i>dynamics</i>                         | The biomechanical aspects of the human body in motion.  |
| <i>efficiency</i>                       | The effectiveness with which a task or operation is done, usually measured in energy spent, cost or time required.  |
| <i>endurance</i>                        | The ability to sustain an activity over time.   |
| <i>engineering controls</i>             | Physical changes to work stations, equipment, materials, facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to ergonomic risk factors.  |
| <i>environment</i>                      | The circumstances, conditions, and influences that affect the behavior and performance of people in the workplace; physical factors such as noise, vibration, lighting, temperature humidity and air flow as they factor in job design. |

|  |   |
|--|---|
| <i>Ergonomics</i>                        | The field of study that seeks to fit the job to the person. This is achieved by the evaluation and design of workplaces, environments, jobs, tasks, equipment, and processes in relationship to human capabilities and interactions in the workplace. |
| <i>fixed posture</i>                     | Prolonged muscle contraction without movement. Examples include stringing cable overhead or prolonged gripping of a hand tool.  |
| <i>heavy effort</i>                      | Physical work that can be sustained for only one hour or less; also the handling of objects weighing more than 18kg (40 lb.).   |
| <i>job design</i>                        | The arrangement of tasks over a work shift.   |
| <i>kinetics</i>                          | In Biomechanics, the study of the forces that influence movement of the human body.   |
| <i>lateral</i>                           | Toward the side of the body away from the midline.  |
| <i>light assembly tasks</i>              | Work with low energy expenditure demands that are often performed in a seated position.   |
| <i>light effort</i>                      | Physical work that may be sustained for at least eight hours a day.   |
| <i>moderate effort</i>                   | Physical work that can be sustained for about two hours without a major work break; also the handling of objects weighing up to 18 kg (40 lb.).   |
| <i>musculoskeletal</i>                   | Pertaining to the muscles, bones, and joints.   |
| <i>Noise Reduction Coefficient (NRC)</i> | A standard industry rating indicating the effectiveness of a material in absorbing sound.   |
| <i>overuse syndrome</i>                  | [See Work-related Musculoskeletal Disorder.]  |
| <i>posture</i>                           | The relative arrangement of body parts, specifically the orientation of the limbs, trunk, and head during a work task.  |
| <i>productivity</i>                      | The amount of good product completed during a shift in relation to the amount of input needed to produce it.  |
| <i>psychosocial</i>                      | Factors that produce both psychological and social effects.   |
| <i>recovery time</i>                     | Work periods when a task demands are light or when rest breaks are scheduled to permit a person to recover from heavy effort work or exposure to an environmental extreme.  |
| <i>risk factors</i>                      | Attributes, experiences, and exposures that increase the probability of occurrence of WRMD.   |

|  |  |
|--|--|
| <i>routine exposure</i>                                    | Approximately daily; three or more times per week.   |
| <i>Sound-Transmission Class (STC)</i>                      | A number that represents the ability of a barrier or an assembly to reduce the intensity of sound as it passes through it.   |
| <i>stress</i>  | Physiological, psychological, or mental effects that may produce fatigue or degrade a person's performance.  |
| <i>task</i>  | The smallest unit of work that will be used for assessing worker exposure; a distinct activity.  |
| <i>task analysis</i>                                       | An analytical process that measures behavior on a job against time to determine the demands of the job.  |
| <i>tendonitis</i>  | Inflammation of a tendon usually associated with repetitive, forceful exertions, often involving rotation around a joint.  |
| <i>Video Display Terminal (VDT)</i>                        | The screen unit used to display computerized information.  |
| <i>work analysis</i>                                       | The systematic investigation of work activities to identify risk factors, evaluate their probable causes, and develop controls to minimize or eliminate the identified risk factors.   |
| <i>Work-Related Musculoskeletal Disorder (WRMD or WMD)</i> | Illness or injury of the muscles, tendons, ligaments, peripheral nerves, joints, bones, and or supporting blood vessels in the body that are associated with routine exposure to ergonomic risk factors such as repetitive tasks or forceful exertion. Commonly used terms, such as " <i>Cumulative Trauma Disorder (CTD)</i> ," " <i>Repetitive Strain Injury or Illness</i> ," " <i>Repetitive Motion Disorder, Injuries or Illness</i> ," and " <i>Repetitive Stress Injury or Illness</i> " are included in this definition. |
| <i>workstation</i>   | An individual's work area, such as a desk, cubical, or a maintenance or inspection station   |



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*Ergobilt web*

*ErgoWeb*

*RSI Network*

*Scott Wright's Ergonomic Resources home page*

*U.S. Occupational Safety and Health Administration, and the U.S. National Institute for Occupational Health and Safety's ergonomics pages*

<http://www.engi.umich.edu/dept/ioc/c4E/projects/index.html>

<http://www.acq.osd.mil>

Computer Electronic Accommodation Program  
 Defense Medical Information Management  
 Office of the Assistant Sec. of Defense (Health Affairs)  
 (703) 681-8811/DSN: 761-8811/fax: 703 6819075  
[cap@ga.osd.mil](mailto:cap@ga.osd.mil)  
<http://www.ha.osd.mil/hpcap2.html>

For information on making reasonable accommodation, assistance in construction and renovation specs, and or referral to other ADA information agencies:

ADA InfoCalling Line  
 1-800-ADA-WORK

## ATTACHMENT C: CHECKLIST FOR COMPUTER WORKSTATIONS

This checklist can be used to evaluate present or proposed workstation needs. It is not meant to be an exhaustive list, and the appropriate rating will depend upon the specific population of users, the nature of the task, and the work environment. Ratings range: S=Satisfactory; C=Compromise, but acceptable; U= unacceptable.

|   | Satisfactory | Compromise | Unacceptable |
|---|--------------|------------|--------------|
| <i>Chairs</i>   |              |            |              |
| Is the range of height adjustment adequate?                     | ( )          | ( )        | ( )          |
| Can the chair height be adjusted easily?                        | ( )          | ( )        | ( )          |
| Can the chair height be adjusted from a seated position?        | ( )          | ( )        | ( )          |
| Are footrests available?  | ( )          | ( )        | ( )          |
| Does the chair have a high backrest?                            | ( )          | ( )        | ( )          |
| Does the backrest tilt back?                                    | ( )          | ( )        | ( )          |
| Is the tension of the backrest adjustable?                      | ( )          | ( )        | ( )          |
| Does the backrest lock in position?                             | ( )          | ( )        | ( )          |
| Is the lumbar support sufficient?                               | ( )          | ( )        | ( )          |
| Does the lumbar support adjust up and down?                     | ( )          | ( )        | ( )          |
| Does the chair have armrests?                                   | ( )          | ( )        | ( )          |
| Are armrests appropriate for the job?                           | ( )          | ( )        | ( )          |
| Do armrests interfere with movement or reach?                   | ( )          | ( )        | ( )          |
| Are armrests sufficiently padded?                               | ( )          | ( )        | ( )          |
| Are armrests adjustable up and down?                            | ( )          | ( )        | ( )          |
| Are armrests adjustable side to side?                           | ( )          | ( )        | ( )          |
| Do armrests prevent the user from pulling up close to the task? | ( )          | ( )        | ( )          |
| Does the seatpan have a rounded front edge?                     | ( )          | ( )        | ( )          |
| Does the seatpan tilt?  | ( )          | ( )        | ( )          |
| Is the seatpan tension adjustable?                              | ( )          | ( )        | ( )          |
| Does the seatpan position lock?                                 | ( )          | ( )        | ( )          |
| Does the chair have a 5-leg base?                               | ( )          | ( )        | ( )          |
| Is the chair free from pinch points or rough surfaces?          | ( )          | ( )        | ( )          |
| Are casters matched to the type of floor surface?               | ( )          | ( )        | ( )          |
| Are all adjustments safe against unintentional release?         | ( )          | ( )        | ( )          |
| Does the chair material and fabric meet applicable fire codes?  | ( )          | ( )        | ( )          |

Satisfactory                      Compromise                      Unacceptable

*Work Surfaces*

|  |     |     |     |
|--|-----|-----|-----|
| Are surface heights easily adjustable to the user or the task? | ( ) | ( ) | ( ) |
| Are corners and edges rounded and smooth?                      | ( ) | ( ) | ( ) |
| Are working surfaces stable when loaded?                       | ( ) | ( ) | ( ) |
| Is the surface thin enough to provide adequate leg space?      | ( ) | ( ) | ( ) |
| Is the range of height adjustability acceptable?               | ( ) | ( ) | ( ) |
| Are surfaces non-reflective?                                   | ( ) | ( ) | ( ) |

*Work Space*

|  |     |     |     |
|--|-----|-----|-----|
| Is there adequate space to perform all tasks?  | ( ) | ( ) | ( ) |
| Is there adequate space for all equipment?   | ( ) | ( ) | ( ) |
| Can the workspace be adapted for right or left-hand use?   | ( ) | ( ) | ( ) |
| Are all items of equipment and information that are frequently used within normal reach of the user?   | ( ) | ( ) | ( ) |
| Does the arrangement of the work area allow access to all job aids without excessive bending or reaching?  | ( ) | ( ) | ( ) |
| Is the work area free of pinchpoints and protrusions?  | ( ) | ( ) | ( ) |
| Is there adequate legroom so the user can adopt different postures?  | ( ) | ( ) | ( ) |
| Is the area under the work surface free from obstructions that might interfere with movements between different tasks?   | ( ) | ( ) | ( ) |
| Is hardware recessed or flush-mounted to prevent hazards?  | ( ) | ( ) | ( ) |
| Is the location, size of equipment such that it can be easily operated and maintained by at least the 5th percentile (female) to 95th percentile (male) of the population who will use it? | ( ) | ( ) | ( ) |
| Are workstations positioned to avoid glare and reflection?   | ( ) | ( ) | ( ) |

*Panels*

|   |     |     |     |
|---|-----|-----|-----|
| Do panels provide sufficient privacy?                                   | ( ) | ( ) | ( ) |
| Do panels hold noise to an acceptable level?                            | ( ) | ( ) | ( ) |
| Does panel height allow for adequate natural light and air circulation? | ( ) | ( ) | ( ) |

Satisfactory                      Compromise                      Unacceptable

*Keyboards*

|   |     |     |     |
|---|-----|-----|-----|
| Is the height of the keyboard at the “home row” adjustable?                 | ( ) | ( ) | ( ) |
| Can the keyboard be easily repositioned on the work surface?                | ( ) | ( ) | ( ) |
| Does the keyboard rock or slip in use?                                      | ( ) | ( ) | ( ) |
| Does the operator’s wrists rest in a neutral position when keying?          | ( ) | ( ) | ( ) |
| Is the wrist rest soft yet offer adequate support?                          | ( ) | ( ) | ( ) |
| Is the keyboard reach sufficient?   | ( ) | ( ) | ( ) |
| Can the keyboard surface be tilted?   | ( ) | ( ) | ( ) |
| Is the mouse at the same height as the keyboard?                            | ( ) | ( ) | ( ) |
| Does the area directly in front of the keyboard keep the forearm supported? | ( ) | ( ) | ( ) |

*Monitors*

|  |     |     |     |
|--|-----|-----|-----|
| Is the monitor size sufficient for the task?       | ( ) | ( ) | ( ) |
| Can the monitor be placed at the proper eye level? | ( ) | ( ) | ( ) |
| Is the contrast and brightness easily adjustable?  | ( ) | ( ) | ( ) |
| Can monitor be placed at user-preferred distance?  | ( ) | ( ) | ( ) |
| Can display be tilted up and down?                 | ( ) | ( ) | ( ) |
| Can display be rotated side to side?               | ( ) | ( ) | ( ) |

*Miscellaneous/Accessories*

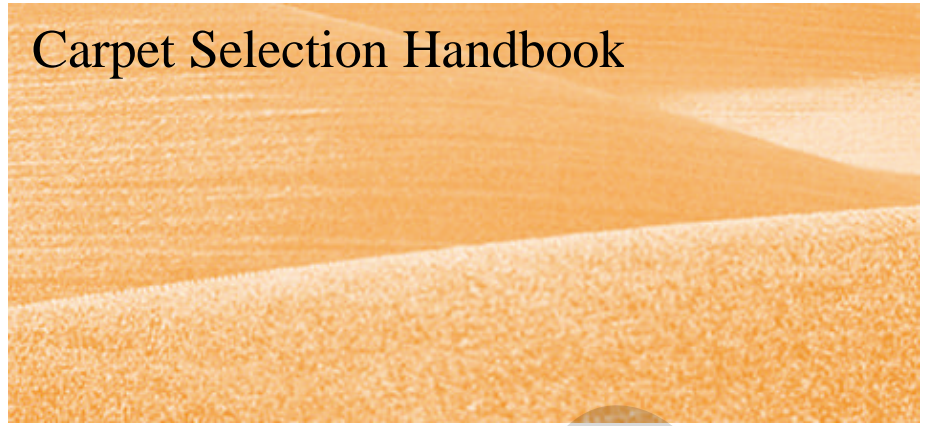
|  |     |     |     |
|--|-----|-----|-----|
| Is there a copy holder for operators who frequently work from hard copy or drawings?                                 | ( ) | ( ) | ( ) |
| Can cables be routed out of the way to avoid tripping?   | ( ) | ( ) | ( ) |
| Are task lights provided as necessary?   | ( ) | ( ) | ( ) |
| Is the user’s view free from glare?  | ( ) | ( ) | ( ) |
| Is the ambient lighting in the area of the VDT minimized?  | ( ) | ( ) | ( ) |
| Is adequate space provided for storage of copies, handbooks, documents, reference materials and personal belongings? | ( ) | ( ) | ( ) |

CHAPTER 6

RESERVED

ARCHIVED

**CHAPTER CONTENTS**  
INTRODUCTION  
CARPET CONSTRUCTION  
INSTALLATION  
SUSTAINABILITY  
MAINTENANCE  
GLOSSARY  
REFERENCES



#### INTRODUCTION

This handbook is intended to assist in the selection of carpet and carpet tile for use in all types of Air Force facilities except Military Family Housing. It begins with background information on the types of fibers used in carpet making, and continues with a discussion of the various methods of carpet construction, including appropriate applications for the various types of carpet. Chapter 2 contains information on installation techniques along with a discussion of the pros and cons of the various methods. Chapter 3 concerns maintenance. It begins with information on the various types of soil and then discusses the importance of developing a proper maintenance program. Soil prevention techniques and cleaning methods complete the chapter. An extensive glossary of carpet terms provides reference information for the handbook, and is followed by a bibliography of references for those wishing to further expand their knowledge of carpets.

### CARPET CONSTRUCTION

The performance of carpet is largely a matter of appearance retention. A carpet is initially selected because of its appearance (aesthetics), and its performance is judged on how well it maintains that original appearance. Carpets manufactured today will suffer unacceptable deterioration in appearance before suffering unacceptable wear. How well a carpet will maintain its original appearance under normal wear and maintenance is one of the primary considerations in selecting new carpet.

A rating system has been developed that allows specifiers to match the End-Use Classification, which relates the application to a class of traffic, to an Appearance Retention Rating (ARR), which is the predicted durability of a carpet under traffic conditions. For example, a Closed Private Office is classified as Heavy, so carpet with at least an ARR of Heavy (3.0 to 3.5) should be considered for specification. The ARR is determined by simulating foot traffic in a hexapod machine. The machine is basically a round drum, which is lined with the test carpet sample. The drum spins, causing the six-sided weight (hexapod) inside to fall repeatedly and randomly on the carpet. Once the carpet has been tumbled with the hexapod for the prescribed number of cycles, the carpet is visually compared to photographic wear standards provided by the Carpet & Rug Institute to determine its ARR, on a scale from 1 (most visible change) to 5 (no visible change). Based on that score, most carpets are assigned one of three ratings: Moderate (2.5 to 3.0), Heavy (3.0 to 3.5), and Severe (3.5 to 4.0).

The ARR quantifies how well a finished carpet sample performs under traffic. However, almost every carpet component and every part of the manufacturing process has an impact. The critical variables in carpet construction are: (1) pile fiber, (2) carpet construction method, (3) choice of backing, and (4) color, pattern, and finishes. Each of these variables is discussed below. The fifth critical variable in carpet performance is maintenance, which is discussed in Chapter 3.

#### PILE FIBER

The basic element of any carpet is the fiber that is converted into yarn and tufted or woven to form the pile. Almost all carpet manufactured in the United States today is made from one or a blend of the five fibers listed below:

- Wool
- Acrylic
- Nylon
- Olefin (polypropylene)
- Polyester

Each of these fibers has positive and negative characteristics which should be considered in carpet selection.

#### *Wool*

Wool is the carpet fiber that has been in use the longest. It is the only natural fiber in extensive use, and is the standard by which synthetic fibers are judged, although it represents only a fractional part of the commercial market. It has inherent resiliency, and does not hold dirt and surface dust readily because of



the scaly character of the fiber. In addition, it is naturally flame resistant, charring rather than melting or dripping. Its major disadvantage is the high initial cost. Lower cost wool blends have become popular in recent years. A common blend is wool/nylon, at a recommended ratio of 80% Wool to 20% Nylon.

*Acrylic* Acrylic fibers have been little used in carpet recently. Acrylic is wool-like in appearance, but soils and mats easily. It is not recommended for commercial applications.

*Nylon* Nylon is used for 70% of commercial carpets. Of the synthetic fibers, it is the strongest, the most resilient, and offers the best performance characteristics. It is resistant to abrasion, has the greatest resistance to crushing and matting, and is easy to maintain. Since it takes dye well, it also has the greatest styling flexibility. Carpets are made of either Type 6,6 or Type 6. The two types have different molecular constructions. Type 6 is softer and easier to dye, and Type 6,6 is harder (more resilient) and more stain resistant.

Most nylon manufactured in the United States is made by one of the following companies, and most carpet manufactured in the United States is made from nylon fiber produced by one of these firms. Fibers produced by these firms are referred to as branded nylon, and are available to any carpet manufacturer. They are well understood and their performance is well documented. Non-branded nylon fiber should be specified only with extreme caution and after careful research. The primary branded nylons are:

| Brand                                  | Type     |
|--|----------|
| Monsanto Ultron                        | Type 6,6 |
| Dupont Antron, DSDN, Pro Select        | Type 6,6 |
| ICI (Rarely seen in the United States) | Type 6,6 |
| BASF Zeftron                           | Type 6   |
| Allied Anso                            | Type 6   |
| Camac Camalon                          | Type 6   |

*Olefin  
(Polypropylene)*

Olefin is a synthetic polymer fiber whose base is ethylene, polypropylene, or a similar substance. It has excellent strength and resistance to chemicals and is highly moisture and stain resistant. It is usually solution dyed. Olefin is very low in resilience, crushes and packs quickly, and is not recommended for heavy traffic or extended wear areas. It is somewhat less expensive than nylon and is recommended for projects with tight budgets or for short term installations.

*Polyester*

Polyester has excellent color clarity, retains its luster well, and is resistant to water soluble stains, but its crush resistance is poor. Polyester is more commonly used for residential carpet.

### FIBER PERFORMANCE CHARACTERISTICS

| Characteristic      | Branded Nylon  | Olefin    | Polyester | Wool      |
|---------------------|----------------|-----------|-----------|-----------|
| Color               | Excellent      | Limited   | Good      | Limited   |
| Abrasion Resistance | Excellent      | Excellent | Good      | Fair      |
| Resilience          | Excellent      | Poor      | Poor      | Excellent |
| Soiling             | Very Good      | Good      | Fair      | Good      |
| Cleaning            | Very Good/Good | Excellent | Fair/Good | Good      |
| Spot Removal        | Fair/Good      | Excellent | Good      | Fair/Good |
| Pilling             | Excellent      | Excellent | Poor      | Good      |
| Static Electricity  | Poor/Very Good | Good      | Good      | Bad/Good  |
| Allergy Problems    | Good           | Good      | Good      | Fair      |
| Chemical Resistance | Good           | Good      | Good      | Fair      |

### CONSTRUCTION METHODS

There are many different carpet construction methods in use today. The construction method of a carpet has a major effect on the performance and appearance of the carpet. There are three carpet construction types acceptable for Air Force projects. These are tufted, woven, and fusion bonded.

#### *Tufting*

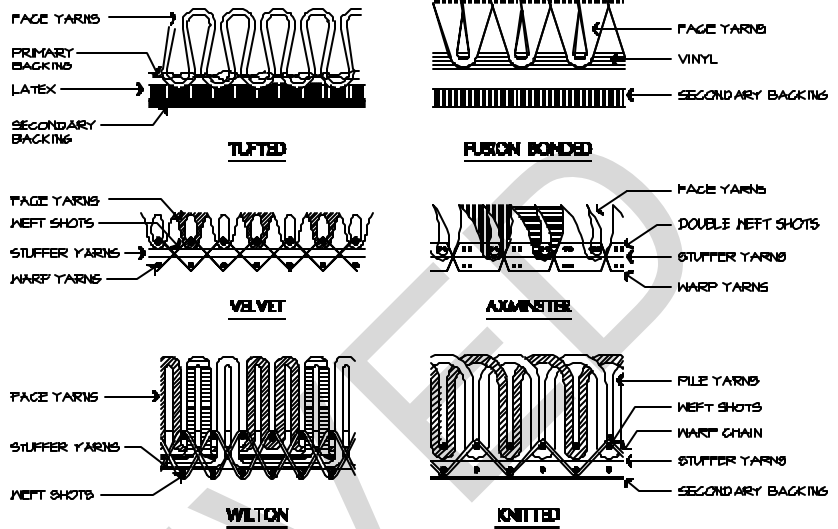
Tufting is the most widely used construction method. In tufting, loops of yarn are punched into a primary backing material and locked on the underside with a secondary latex backing. Tufted loop pile carpet has a greater potential for snagging and running than woven carpet.

#### *Weaving*

Weaving is the second most popular method of construction. The pile yarns are interlaced in one of many different techniques, each of which gives a different appearance to the carpet. Woven carpets are generally more expensive than tufted carpets, but have better appearance retention. Woven carpets also require less pile weight to achieve the same performance as tufted carpet. Some types of woven carpet are Velvet, Wilton, Axminster, and Knitted.

#### *Fusion Bonding*

Fusion bonding is a newer method of construction than tufting or weaving. Yarn is embedded between two parallel sheets of adhesive coated backing, which are then split apart, forming two sheets of cut pile carpet. This type of carpet has a higher density so it usually performs very well. Bonded carpet is available in both carpet tiles and six foot or twelve foot wide roll goods.

*Construction Modes**Performance Factors*

There are several variables in carpet construction which affect wear and appearance retention and which are measurable. These performance factors are discussed below.

*Density*

Carpet density is a key factor in soiling and resiliency. In an adequately dense pile, dirt will remain on the surface so that it is easily vacuumed away. In addition, more compact fibers are less likely to crush since the tufts tend to support each other in the upright position.

Density is determined by the number of tufts (stitches) per unit area and the size of the yarn in the tufts. These factors are called gauge, pitch, stitches per inch, and yarn count. Pile density is the amount of pile yarn in a given area of carpet face. A useful formula is:

$$\text{Average Pile Density} = \frac{36 \times \text{Pile Yarn Weight}}{\text{Pile Height}}$$

See Table 2 in the ETL 94-3 Air Force Carpet Standard for recommended density factors.

*Gauge*

The gauge of a tufted carpet is the number of tuft rows (rows of stitches) across a unit width of carpet. Gauge is obtained by counting the number of ends of yarn in one inch across the carpet and then taking the inverse of that number (I. e. one over the number.) For example, if a tufted carpet has eight ends of yarn per inch, the gauge is 1/8. If it has ten ends of yarn per inch, the gauge is 1/10. The smaller the gauge, the more dense the carpet. 1/10 gauge (10 tufts per inch of width) is more dense than 1/8 gauge (8 tufts per inch of width). Tufted carpet should have a minimum of 1/8 gauge or 1/10 gauge for good appearance retention.

*Pitch*

The density of woven carpet is described in terms of pitch. The pitch of a carpet is obtained by counting the number of ends of yarn in 27 inches of width.

To convert gauge to pitch, take the inverse of the gauge and multiply by 27. For example, if the gauge is 1/8, taking the inverse gives 8, and multiplying by 27 gives a pitch of 216. To convert pitch to gauge, divide the pitch by 27 and then take the inverse.

A good method of comparing carpets is to bend each carpet as it would be bent over the nosing of a stair tread and compare the amount of backing material exposed. Better carpet will have less visible backing, as a result of closely-spaced tufts.

*Stitches per Inch*

Density is also affected by the number of stitches per unit length of tuft row. The number of stitches (tufts) per running inch of carpet is usually specified directly for tufted carpet, but is called "rows per inch" for woven carpet.

Multiplying tuft rows per inch of width by stitches per inch of length will result in the number of tufts per square inch, or tuft density. Equal tuft placement gives the best performance, i.e., stitches per inch of length should be approximately equal to rows per inch of width. A high quality tufted carpet should have a minimum of 56 tufts per square inch.

*Yarn Count, Twist, and Heat setting*

The yarn count (or size) is an important factor in determining carpet quality. The larger the yarn for a given construction and pile density (that is, the more weight per unit length), the denser and heavier the carpet will be.

Yarn twist and heat setting are extremely important for cut pile carpets. The yarn is first twisted and then heat set, giving it a springy character. This gives the carpet resiliency, enabling it to spring back when stepped on. A loose twist or a poor heat set will cause the carpet to mat and tangle. Five or more twists per inch is recommended for good appearance retention in cut pile carpet.

*Pile Height*

Pile height in tufted or bonded carpet is measured from the primary backing to the top of the tufts. In woven carpet it is the measurement between the steel blades on the loom on which the tufts are formed. If the carpet is multilevel, all pile heights should be specified. A low level loop performs best for severe wear applications, while a high pile gives a feeling of luxury. Carpets with low, dense piles will crush less than those having higher piles.

*Pile Yarn Weight*

Yarn weight is the amount of yarn, including buried portions of the pile yarn, that is contained in one square yard of carpet. This weight is usually given in ounces. Since some yarn is lost in production, the specifier may want to determine if the weight given is the finished weight or the tufting specification. Pile yarn weight should not be confused with total finish weight. The total finish weight includes all backing materials, latex, foams, topical finishes, and face yarns, and is not necessarily indicative of quality.

*Surface Texture*

The texture of a carpet is the combined effect of the visual and tactile surface characteristics. Surface texture is not merely an aesthetic factor, but also impacts the appearance retention of carpet. The most common textures are defined below:

- **Level Loop Pile:** Single level, uncut loop pile that makes a smooth and level surface. It offers excellent wear resistance, but shows dirt, stains, and lint easily.
- **Multi Level Loop Pile:** This texture is constructed with two or more different height loops. The texture hides footprints, dirt, and dust better than a level loop, but may show crushing and compression with wear. Sometimes a pattern is created using the different heights of tufts, or the levels may be random, creating a texture.
- **Cut Pile:** This type of carpet has an upright pile with cut ends. This forms an even surface that is subject to shading, the illusion of color change caused by bent yarns reflecting light in different directions. The specifier should examine the cut pile carpet from several different angles and directions if color is critical. Difference in the amount of twist in the yarn creates different looks, such as:
  - a) **Plush Finish:** Made from yarn with very little twist which leaves a very smooth finish surface where tuft ends blend together. It is sometimes called "velvet plush." Velvet plushes show shading depending upon how light hits the pile. Shading is normal for this style and adds richness to the color.
  - b) **Saxony:** Uses yarns of two or more plies, twisted together and heat set to lock the twist into the yarn, thus giving it stability and permanency. This results in a distinctive appearance quite different from velvet plush because each tuft end is distinguishable on the surface.
  - c) **Frisé: (Pronounced free-zay)** Composed of tightly twisted, well defined yarns that give an overall nubby or pebbly texture. Carpets of frisé design wear well and do not have the pronounced shading effect that other cut piles exhibit.
  - d) **Shag:** A carpet texture characterized by long pile (1 1/2" to 3") tufts laid over in random directions in such a manner that the sides of the yarn form the traffic surface. Modern shags are made from plied, heat set yarns and can be either cut pile or cut and loop styles.
- **Cut and Loop:** An infinite variety of surface textures can be achieved by combining cut pile with loop pile. Tip sheared, random-sheared, and sculptured effects can be achieved by combining different loop heights and varying the cut pile areas.

## CARPET BACKING

Carpet backing gives carpet dimensional stability. The term backing has a different meaning for woven carpet, for tufted carpet, and for carpet tile. Additionally, a carpet will often have a primary and a secondary backing.

### *Woven Carpet*

Backings for woven carpets consist of yarns called stuffers that are interwoven with the face yarn during the construction process. Polypropylene yarn is used as the primary backing for woven carpets. A latex backcoating or foam is added for maximum stability. Since the yarns are interlocked components of the carpet, a secondary backing is not required. Woven carpet is not subject to the delamination and long yarn runners that can affect tufted carpeting.

### *Tufted Carpet*

In tufted carpet, the primary backing is woven or non-woven fabric into which the pile yarn is inserted by the tufting needles. A secondary backing of woven or non-woven material is adhered to the underside of the carpet, providing additional tuft bind and dimensional stability. Secondary backings are usually made of jute or man made materials such as polypropylene, latex foam, thermoplastics or vinyl. For carpet tiles, polyvinyl chloride, amorphous resin, ethylene vinyl acetate, polyethylene, asphaltic bitumen, or polyurethane are used. Jute backing is not recommended under any circumstances since it is an organic material subject to mildew, odors, bacterial growth, stretching, delamination, and deterioration. Jute should be carefully avoided in climates with high humidity.

Unitary backing is another type of tufted carpet backing. It consists of a chemical backcoating without an added secondary backing. Unitary backed carpet is most appropriate for glue down installations.

### *Carpet Tile*

Carpet tiles typically have one of two general types of secondary backings, either hard or cushion. Within these classes of backings, there is a great deal of variety in the materials and methods of construction.

- Hard backings may consist of PVC, fiberglass reinforced vinyl (such as GlasBac), polyurethane, or PVC-free materials such as amorphous resins (used in Millikin's EverWher backing).
- Cushion backings may be made of polyurethane (such as Dow's Enhancer and Lifespan backings) or PVC. Carpet manufacturers recommend the use of a cushion backing, stating that the backing enhances the carpet's appearance retention, comfort, and acoustic properties.

### *Tests for Carpet Backing*

There are several tests performed on carpet backing that indicate quality and suitability for a particular application.

- Tuft bind: Tuft bind is the amount of force required to pull a tuft from the carpet. This measurement is important to consider when selecting carpet for high abuse areas such as schools or child development centers where there is a potential for unraveling. The minimum tuft bind, in average pounds of force, should be 10 pounds on any single pull, 12 pounds average on 8 pulls for loop pile, and 3 pounds for cut pile. Testing is done according to ASTM

Method D1335-67, "Tuft Bind of Pile Floor Coverings."

- Peel Strength of Secondary Backing: Testing is done according to Federal Test Method Standard 191, Textile Test Method 5950. The minimum acceptable peel strength is 3.35 pounds/inch.
- Dimensional Stability: A suitable test for measuring the stability of finished broadloom carpet has not yet been developed. Dimensional change is rarely encountered with glue down installations, and is seldom a problem when power stretched carpets are properly installed. A dimensional stability test for carpet tiles is the Aachen Test. It consists of four individual tests in both the machine direction and the cross direction. The required result is the average of the four tests and should be  $\pm 0.027$ .
- Tear Strength: Testing is done according to ASTM D2261-64 "Tearing Strength of Woven Fabrics." The minimum acceptable tear strength in both length and width is:
  - Carpets for Glue Down Installation: 25 lb.
  - Carpets for Power Stretch Installation: 35 lb.

#### COLOR, PATTERN, & FINISHES

The choice of carpet color has a major impact on the interior of a space. While choice of color is at the discretion of the specifier, color is also an important factor in appearance retention.

#### Observations on Selecting Carpet Color:

- Color is the dominant impact of carpeting.
- The floor is the second largest color area in the interior.
- Color is affected by the kind of light it is seen in - daylight, incandescent light, or fluorescent light.
- Color is affected by the amount of traffic the carpet receives and how soiled it is.
- Extremes of color magnify soiling.
- Yellow, gold, and tan show more soiling.
- Patterns and mixtures of color show less soil than solid colors.

Color can be applied to carpet fiber at any one of three different times during the manufacturing process: before spinning the yarn, after spinning the yarn, or after weaving the carpet.

*Dyeing Before Yarn is Spun*

- Solution Dyed: The fiber is dyed in its liquid state before it is spun into yarn. The color becomes a permanent part of the fiber and will not fade or bleach out. The precolored fibers are supplied to the carpet mills by the fiber manufacturers. This method is common for olefins (polypropylenes), nylons, and polyesters.
- Stock Dyed: After the fibers are made, they are dipped into a bath of dye where heat and pressure force color into the fiber before it is spun into yarn. There is a wide range of color choices, but fibers dyed with this process are

*Dyeing After Yarn is Spun*

more susceptible to fading, bleaching out, and staining. This method is used in dyeing wool, acrylics, polyesters, and some nylons.

- Skein Dyed: Yarns are spun into skeins, which are stored and dyed as orders are obtained. This method can be used for spun yarns, bulked continuous filament yarns, heat set yarns, and non heat set yarns of almost any fiber type.
- Package Dyed: This method is similar to skein dyeing, except that the yarns are wound on perforated packages and the dye stuff is forced under pressure from inside the package through the yarn. Package dyeing is used infrequently for carpet yarns.
- Space Dyeing: The yarn is treated with three or more colors along the length of the yarn. This gives the carpet pile a random pattern. There are three methods of space dyeing: *knit-print-deknit*, *warp sheet printing*, and *multicolor skein dyeing* (similar to the skein dyeing process described above).

a) In the knit-print-deknit method, yarn is knitted into a tube or sock which is printed on both sides, usually in diagonal and horizontal stripes. The sock is then unraveled, and wound onto tufting cones. Knit-print-deknit is often used for loop style, contract carpet.

b) In warp sheet printing, yarns are unwound from a beam and carried side by side under the print rollers that apply the diagonal and horizontal stripes in varying widths. The yarn is then wound onto cones. Warp printed yarns tend to be straighter and leaner than knit-deknit yarns. This method is well suited to cut pile and cut loop carpet.

*Dyeing After Carpet is Woven*

- Piece Dyeing: Color is applied from a dye beck (stainless steel tank) onto unfinished carpet consisting only of primary backing and undyed yarns. Piece dyeing is generally for solid colors, but a tweed or moresque effect can be achieved in a single dye bath by treating some fibers to accept or reject certain dyes. Piece dyeing is generally associated with nylon and polyesters.
- Batch Piece Dyeing: This is similar to piece dyeing but the carpet is moved in and out of the bath by a motorized reel.
- Continuous Piece Dyeing: Dye is applied via a polished roller rotating in a continuously fed, full width dye trough. The full width of the carpet moves under the applicator. Continuous piece dyeing requires great skill and operational care.
- Random Multicolor Dyeing: This is similar to continuous piece dyeing but the applicators are modified to control the flow of dyestuff. This method creates random, multicolored patterns. The machines for this process were developed by the Kusters Corporation of Germany, and are called TAK or Multi-TAK applicators.
- Printing: Carpet printing is similar to textile printing but uses larger machines. There are three methods of printing - *roller printing*, *screen printing*, and *jet*



*printing.* Printed carpet can simulate woven patterns at a much lower cost.

a) In roller printing the carpet is placed on a moving belt and dye is squeezed from a roll or drum through a pattern attachment.

b) In screen printing the carpet is placed on a flatbed and the dye stuff is forced through screens by an electromagnetic system.

c) Jet Printing: In jet printing, jets intermittently inject color into the carpet pile in response to signals sent by a computer. Designs are stored on magnetic tapes, and can be changed instantly. Jets can be used for continuous solid color dyeing, random patterns similar to those produced by TAK applicators, controlled geometric patterns, and oriental or other formal patterns.

#### *Color Fastness*

Dyes applied to carpet pile yarns are subject to chemical attack and the action of sunlight and atmospheric contaminants such as ozone and nitrogen oxides. There are several tests to assure that dyes are properly fixed on the pile yarn, that they will resist fading, and that they will not rub off when dry or bleed when wet. Dyes should also be unaffected by accepted industry cleaning methods. Carpets that meet the following standards can be expected to offer acceptable fade resistance in indoor applications.

- Light Fastness: AATCC Test Method 16E-1976. Shade changes after 80 standard fading hours (Xenon Arc) should not be less than an International Gray Scale Rating of 3.
- Crock Fastness: AATCC Test Method 8-1974. Minimum stain ratings, International Gray Scale, should be Wet: 4, Dry: 4.
- Wet Fastness: Dupont Carpet Spot Bleed Test. Run with both hard water and alkaline detergent. Stain or color change rating after two cycles in either test, should be no less than an International Gray Scale Rating of 3.
- Atmospheric Fading: AATCC Test Method 129-175. Ozone/AATCC Test Method 23-1975 - Burnt Gas. Minimum shade change after two cycles in each test should be no less than an International Gray Scale Rating of 3.

#### *Patterned Carpet*

Patterned carpet contains decorative ornamental or abstract forms and shapes. The pattern may be an integral part of the construction or may be applied through a printing process. Pattern can be incorporated through texture, color, or the combination of both. Patterns can enhance appearance retention by acting as a camouflage. They hide seams, mask soiling, and obscure traffic patterns.

In assessing carpet designs for appearance retention, random patterns are best, followed by regular geometric patterns, tweeds, heathers, and solid colors. Tweed designs contain two or more colors that are interwoven. They may be used where heavy soiling is not anticipated. Heather designs are similar to tweeds but much more subtle. The multicolor effect in heathers and tweeds is

produced by blending fibers of different colors prior to spinning the yarn. In a tweed, the multicolor effect is more pronounced because the actual yarn tufts are multicolored. In both cases, the more colors used the better the appearance retention that is achieved. Multicolored (more than two or three colors), patterned, and/or tweed carpet should be used for all high traffic areas that are subject to stains and spillage such as dining halls, child care centers and clubs. Solid carpet is only recommended for General Officers' office suites and distinguished visitors' (DV) areas in transient lodging facilities.

#### Observations on the Use of Pattern:

- Avoid orienting geometric carpet patterns with predominant lines parallel to walls in areas of long proportion such as corridors, unless the pattern is installed as an inset. This prevents the appearance that the carpet is running askew to the walls and will also make the corridor appear longer.
- Be aware of the scale of the carpet pattern. Large scale patterns should generally only be used in large areas such as ballrooms, dining rooms, etc.

In areas where cigarettes or boot polish may be a problem, a carpet containing black, dark blue or dark brown in the pattern helps to camouflage any burns or stains.

#### *Antimicrobial, Soil Resistant, and Stain Resistant Finishes*

Chemical finishes are a recent innovation that has greatly improved appearance retention and ease of maintenance for carpeting. These finishes include soil resisters, stain resisters, and antimicrobial treatments. These protections should be built in so that the finish is permanent and never requires reapplication due to moisture, shampooing, or steam cleaning. Solution dyed carpet is inherently stain resistant. Antimicrobial treatments should be registered with the United States Environmental Protection Agency (EPA) for the express purpose of providing protection.

It should be noted that carpets will still require maintenance programs to preserve their appearance. No antimicrobial treatment will overcome unhygienic conditions of spilled food and dirt left unattended, and a soil resistant finish does not mean that a carpet is soil proof. A good maintenance plan is mandatory for all carpets.

#### ADDITIONAL TESTING

In addition to the tests mentioned that are specific to fiber, colorfastness, and Appearance Retention Rating, there are a number of other tests which are commonly performed on carpets.

#### *Electrostatic Tests*

- Electrostatic Propensity (AATCC 134) measures the amount of static electricity is generated as a person walks over the carpet. The rating should be less than 3.5 kV for general commercial areas.
- Electrostatic Resistivity (ASTM D-134) measures the extent to which the carpet inhibits the transmission of electric charge.

*Flammability Tests*

- The Flooring Radiant Panel (ASTM E-648) test measures the critical radiant flux of a carpet in a simulated building assembly when exposed to heat and flame. Class I is considered to be a minimum rating of 0.45 watts per square cm. Class II is considered to be a rating of 0.22 watts per square cm or greater.
- The Methenamine Pill test (ASTM D-2859) determines flammability, as in ignition characteristics of a finished carpet sample. A carpet is required to pass at least 7 times from 8 samples tested.
- The Smoke Density test (NFPA-258-T or ASTM E-662) measures the optical density of smoke generated by materials while exposed to heat.

### INSTALLATION

A quality installation provides long lasting value, performance, and satisfaction. Installation should be performed by an installer approved and certified by the carpet manufacturer or by an experienced installation technician. The Carpet and Rug Institute has published a guidebook called How to Specify Commercial Carpet Installation. Carpet specifiers should refer to this volume and to CRI-104, Standard for Installation of Commercial Textile Floor Covering Materials for comprehensive installation information. These guides are available for a small fee through the Carpet and Rug Institute:

The Carpet and Rug Institute  
 PO. Box 2048  
 Dalton, Georgia 30722  
 (706) 226-2477 or (706) 278-3176

There are three principal methods of commercial carpet installation: *stretch-in*, *direct glue down* (including attached cushion), and *double glue down*. Carpet with attached cushion, secondary, unitary, or woven backing may be used for glue down installations. Separate cushion stretch-in installations are usually limited to woven carpets or tufted carpets with secondary backings.

The following issues should be considered when installing carpet:

*Pattern Match* - Extra carpet must be allowed when estimating quantities of patterned carpet needed. Even cut and loop effects, such as sculptured carpet, require matching.

*Seaming* - Care should be taken to avoid seams in high traffic areas such as doorways, hallways, and pivot points.

#### *Stretch-in Installation*

In the stretch-in method, carpet is stretched over a separate cushion using tackless strips at the outer edges of the area to hold the carpet in place. There may be problems with wrinkling or buckling, usually resulting from insufficient stretch during the initial installation, or from a cushion that does not adequately support the carpet. Adequate stretch can only be attained by using power stretchers. A firm, low profile cushion with small deflection should be used in commercial traffic areas. Cushions that are too thick and soft will permit carpet backings to stretch and eventually wrinkle.

Additional information concerning the correct amount of stretch for each carpet and the preferred type of cushion should be obtained from the carpet manufacturer prior to stretchin installations.

Good seams are of the utmost importance for a quality installation. The manufacturer's recommendations must be followed closely. Most modern installations employ hot melt tape seams, but woven carpet constructions may require hand sewing or other specialized techniques. In all cases, cut edges should be buttered with the appropriate sealer prior to seaming

*Direct Glue Down &  
Double glue down installations*

Installations using adhesive can be made using carpet with an attached cushion or carpet without an attached cushion. Adhesive installations are better suited than stretch-in installations to heavy and rolling traffic conditions. Adhesive installations are also better suited to large open areas because of the considerable difficulty of stretching carpet over a large area.

*Direct Glue Down Installations*

This type of installation is used for carpet with or without an attached cushion. Carpet without cushion is inexpensive and provides adequate wear, good dimensional stability, ease of use for rolling equipment, and good stability for standing partitions in direct glue down installations. Carpet with an attached cushion provides good wear, greater softness underfoot, and better acoustics than carpet without an attached cushion. The cushion may break down, however, under severe wear conditions or when subjected to wheeled equipment traffic. If the cushion breaks down, the carpet may need to be replaced sooner.

*Double glue down installations*

Double glue down installations combine cushion and carpet into a floor covering system by gluing the cushion to the floor and the carpet to the cushion. This method is popular since it combines the stability of direct glue down with the cushioning benefits of a separate cushion. The cushion must be a type that is designed for this method.

In both types of glue down installation, adhesive is applied to the floor to obtain the required 100% adhesive transfer into the carpet back. If too little adhesive is used, carpet will not adequately adhere to the floor. It is also very important to allow adequate open time for adhesives to develop tack prior to laying carpet. Ensure that proper glue and tape are used.

*Moisture Problems*

Moisture can prevent adhesion of carpet to floors, and can be present in both concrete and wood subfloors. It is extremely important to test for and correct moisture problems prior to glue down, since moisture may carry alkaline substances that can attack adhesives and destroy the bond between the floor and the carpet.

**INDOOR AIR QUALITY**

There has recently been a good deal of concern about indoor air pollution, which has led to questions about the relationship between carpet products and indoor air quality. Indoor air quality can be improved by taking the following steps during installation:

- Plan ahead.
- Ask the carpet supplier for information on emissions from carpet.
- If adhesives are needed, request low emitting ones.
- Use low VOC (volatile organic compounds) adhesives in all glue down installations.
- Use low VOC (volatile organic compounds) adhesives in all carpet tile installations.
- Ensure that the ventilation system is in full working order before installation begins.
- Be sure the supplier requires the installer to follow Carpet and Rug Institute installation guidelines.

*Choosing an Installation Method*

- Open doors and windows, if possible, during and after installation.
- Consider using window fans, room air conditioning units, or other means to exhaust emissions to the outdoors.
- Operate the ventilation system with maximum outdoor air during installation and for 48 to 72 hours afterwards.
- Consider leaving the premises during and immediately after carpet installation. Schedule the installation for a time when most people will be out of the facility.
- Contact the carpet supplier if objectionable odors persist.
- Follow the manufacturer's instructions for proper carpet maintenance.

**CAUTION:** Some carpet tile backings have an adverse chemical reaction when they come into contact with the cut back adhesive that is used to install vinyl composition tile (VCT). Be careful to remove all adhesive from floor or to install carpet tile on top of VCT. This procedure will avoid the breakdown of the carpet tile backing and subsequent wicking of adhesive to the surface of the carpet tile.

**ADVANTAGES OF THE STRETCH-IN METHOD:**

- Patterned carpet is more easily matched
- Stretched carpet is more resilient than carpet that has been glued down.
- It extends carpet life.
- There is less crushing and packing of pile.
- It adds insulation value.
- It gives higher sound absorbency (NRC) values.
- It responds better to vacuuming.
- It can be used for floors that are not acceptable for glue down.
- Removal costs less than removal of a direct glue down installation.
- Corrective measures, such as seam repair, are easier to perform.

**ADVANTAGES OF THE DIRECT GLUE DOWN METHOD:**

- The cost of the cushion is eliminated.
- The labor for direct glue down is usually lower in cost.
- It is suitable for rolling traffic and ramp areas.
- The seams are more durable since there is no vertical flexing.
- Buckling is minimized in buildings that have the HVAC turned off for extended periods, such as schools, churches, theaters, etc.
- Restretch is never necessary.
- It facilitates access to electrical and telephone lines under the floor.
- Seam peaking is practically eliminated.
- It is unrestricted by the size of the area, and is therefore suitable for large areas such as ballrooms, etc.
- Intricate borders and inlay are possible.
- It is better for handicapped accessibility.

**ADVANTAGES OF DIRECT GLUE DOWN WITH ATTACHED CUSHION METHOD:**

- Appearance retention and foot comfort are improved over direct glue down installations.
- Has high tuft bind capabilities.
- There is increased delamination strength and improved edge ravel resistance.

- It functions as an effective moisture barrier.
- Thermal and acoustical performance are improved.
- The second adhesive required for double glue down installation is not necessary.

**ADVANTAGES OF THE DOUBLE GLUE DOWN METHOD :**

- It combines the stability of direct glue down carpet with the cushioning benefits of separate cushion stretch-in installations.
- It improves carpet appearance retention, foot comfort, and overall performance over direct glue-down installations.
- Carpet bordering and inlaying are simplified.
- It is suitable for wheeled traffic.
- It is unrestricted by the size of the area.

**SUSTAINABILITY**

The notion of recycling carpet has become increasingly popular for at least two reasons. One is the realization that a relatively large amount of energy is used in the manufacture of carpet. A second reason is the growing sensitivity to the vast amount of material currently being placed in landfills.

*Recycling*

Seventy percent of all new carpet manufactured will be used to replace existing material. Every year between three and a half and four billion pounds of carpet is discarded and sent to landfills. This amounts to one percent of solid waste by weight and two percent by volume. Each of these is a tremendous amount when you consider that carpet is just one of millions of products placed in landfills every day.

Virgin nylon is the most valuable resin used to make new carpet (fibers). While the resin itself is relatively inexpensive, the manufacturing process is energy intensive (especially in the use of fossil fuels). In addition, the resin is made from petrochemicals. This makes it somewhat precious from the standpoint of the use of natural resources. So it is generally assumed that to reclaim the nylon will be a primary driver in the recycling of carpet.

**RECLAIMING**

Unfortunately, the broadloom carpet that we've become accustomed to covering the floors (wall to wall) of our homes and offices with is difficult to recycle. Currently only about one percent of used carpet is being recycled. First the used product has to be collected and transported to a facility for processing. Then the nylon fiber has to be separated from the backing (usually polypropylene fabric and SB latex), the adhesive used for installation and dirt that has accumulated in it over time. Then the fibers must be reprocessed into a resin of such a quality as is required for making new carpet fibers. There are various technologies that have been developed for these purposes but none is easy or inexpensive. It is difficult to make economic sense of recycling carpet as long as it is less expensive to buy virgin nylon and then to landfill it than it is to reprocess old carpet. Finally there is still a lot of material (e.g. the backing materials) which is of little value that is left over once the nylon is reclaimed.

*Manufacturers*

Most recycling of broadloom carpet is currently being conducted by the manufacturers of the nylon. There are four major makers in the U.S.; DuPont, Monsanto, AlliedSignal and BASF. BASF and AlliedSignal both make fiber of nylon 6 which is considered to be simpler and easier to reprocess than the more complex nylon 6,6 made by DuPont and Monsanto. Both DuPont and BASF have begun collection programs and are processing used carpet commercially.

*Reclamation*

DuPont's Partnership for Carpet Reclamation is a collection program which has been in operation since 1991 and has expanded to a network of 61 collection sites. They expected to take back and process 28 million pounds of carpet in 1997 including any carpet removed by their network of retailer regardless of whether it was made with DuPont nylon or not. The dealers do charge to remove the old carpet but the cost is intended to be in line with the cost of alternative disposal methods (i.e. landfill). This program is a step in the right direction but is not truly closed loop recycling since the nylon is sold for uses



other than new carpet. Thirty to thirty five percent of the carpet collected ultimately becomes “under the hood” auto parts (Ford has made a significant commitment) like air cleaner housings. Some becomes fibrous padding and soundproofing and five percent goes to a waste-to-energy incinerator.

In 1994 BASF committed to take back any carpet made with their own face fiber through their 6ix Again Program. But the necessary identification tags have only been attached to their product since the program began so not much has been collected. They only have six collection sites, can't promise to take the carpet back for less than the cost to landfill it and reserve the right to incinerate what they don't reprocess.

### *3<sup>rd</sup> Party Recycling*

A couple of other players have made contributions toward the success of recycling carpet. United Recycling, Inc. in Minnesota's Twin Cities area is working on various technologies for reprocessing carpet and are close to commercialization of a new mechanical process for “decomposing” carpet into its constituent fibers. They currently process used carpet for both DuPont and BASF and can process more than a million pounds per month at their Minnesota plant.

Shaw Industries, Image Industries and Talisman Mills are using recycled polyester or PET (soda bottle plastic) to manufacture new residential carpet. Shaw and Hoechst Celanese are testing an all polyester product (i.e. face fiber and backing) which could be easier to recycle for other purposes and will only use virgin resin to make the new carpet.

### **ENVIRONMENTAL ISSUES**

Other carpet related environmental issues are the fiber dyeing process and indoor air quality (IAQ). The traditional “piece dyeing” process produces lots of contaminated wastewater. Continuous “solution dyeing” is becoming more common and is less wasteful of water. The IAQ concerns center around the SB latex secondary backing and SB latex-based adhesives commonly used in glue-down installations. The SB latex off-gasses volatile organic compounds (VOC's) like styrene and PC-4. Some manufacturers like W.F. Taylor and the Henry Co. sell only low VOC adhesives (about 5% more expensive to install than more common types of adhesive).

### *Indoor Air Quality*

The Carpet and Rug Institute has instituted an indoor air quality testing program (ASTM-D-5116). As a part of the program, CRI has established criteria defining the maximum allowable VOC emissions from new carpet. Manufacturers whose product meets the criteria can display the green CRI indoor air quality program sticker on their product.

### *Design Challenges*

Interior designers can mitigate the environmental impact of carpet use through some careful choices early in the design process. First, consider whether a particular space really needs to be carpeted. Perhaps a hard floor softened by an area rug of natural fibers would suffice. Try to avoid using carpet at entrances where they can collect toxins, dirt and other irritants or allergens. Consider the use of carpet tile instead of broadloom carpet.

*Carpet Tile*

Carpet tiles offer some distinct environmental advantages over broadloom carpet. First, it can be replaced incrementally instead of all at once and so help limit the amount that must go to a landfill. The products of the major manufacturers are installed using integral “peel and stick” adhesives which off-gas much less than conventional paste adhesives. Usually the backing material is PVC or olefin which are easier to recycle than the common broadloom backings. In addition the carpet tile manufacturers are addressing environmental issues with their products more effectively than the broadloom industry.

Milliken, through their Earthwise Ennovations program will take back their own “worn out” tile and resurface it for resale. Recognizing that old tiles are usually (80-90%) in fine shape except for dirt, discoloration and compression of the face fibers, Milliken has developed a process to deep clean the tiles, retexture the surface and then overprint a new pattern on top of the existing color. They have the capacity to resurface millions of yards a year and the refurbished product costs only about half as much as new.

In 1995 Collins & Aikman initiated a program through which they make lower-value products like traffic stops and industrial flooring from old carpet. Now they have gone a step further and take back used carpet tile from any manufacturer and make backing for new carpet tile which is of 100% recycled content. Old carpet is ground, size reduced, blended with post-industrial manufacturing waste and then re-extruded as what amounts to a PVC backing reinforced with short nylon fibers from the old facing. They call the new backing ER-3 and sell the product at the same price (\$17-\$23 / yard) and with the same warranty as their conventional product.

**RENEWABLE RESOURCES**

Interface Flooring has taken a long term approach to environmental issues looking for ways to use renewable resources and financial incentives to achieve true closed-loop recycling. They’ve initiated the first program to lease new carpet (instead of selling) to customers. Through this program, the customer pays a monthly stipend for installation, cleaning and replacement of old carpet and the manufacturer takes ultimate responsibility for their own product forever. In addition Interface is pursuing other initiatives like establishing a worldwide network to minimize transportation requirements. In partnership with others, Interface is developing a process for cryogenic (deep freeze) grinding of PVC, allowing carpet tile backing to be more easily and efficiently recycled and working with a Canadian source for the fiber, they are developing a broadloom carpet made entirely from hemp.

*Performance Specification Requirements*

When broadloom carpet is the appropriate choice for floor covering, it’s environmental impact can be mitigated through requirements in the specifications. Consider including the following provisions:

1. Require safety warranties ensuring indoor air quality.
2. Require material bearing the CRI label for IAQ.
3. Specify only low-VOC adhesives and seam sealers.
4. Require old carpets to be cleaned before removal (to allow offering to charitable organizations).

5. Require maximum ventilation during installation.
6. Require a ventilation period after installation to flush initial VOC off-gassing and allow as long as possible before occupying the space.
7. Clean the new carpet before occupying the space.

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### MAINTENANCE

A good maintenance program is essential to the performance, life, and beauty of carpet. Good carpet maintenance also contributes to good indoor air quality. Both preventive maintenance and corrective maintenance must be performed in order to prolong appearance retention.

#### *Types of Soils*

In order to understand how to keep carpet clean, it is helpful to understand dirt and soil. Dirt is the substance that causes soiling just as spills cause staining. Soil is what is seen as visual contrast. That is why spots and spills stand out in contrast to the carpet. Similarly, heavy traffic areas will appear darker than adjoining areas of carpet. An effective soil management program must deal with two types of soiling: real soiling and visible soiling. Soil gets into the carpet in three ways: it is tracked in, it is deposited from the air, and it is spilled directly on the carpet.

#### *Tracked in Soil*

Tracked in soil represents 80% or more of the soil deposited on carpets at entry points. Shoe soles track dirt in from outside, and it is dispersed throughout the carpeted area over a period of time. Tracked in soil particles are usually oily and small in size. If the dirt is not removed as it is deposited, it builds up in the carpet and causes scratches and abrasion damage. This accumulated dirt flattens the fibers and tufts, resulting in a crushed and matted carpet.

#### *Airborne Soil*

Airborne soil is made up of very small dust particles, volatilized oils, industrial wastes, auto emissions, tobacco smoke and other air pollutants such as pollens, human skin flakes and hair. Much of this type of dirt is oily or sooty in nature. Once the oily soil content of carpets becomes large enough, soil complexes composed of combinations of oily and dry soil begin to form a sticky film that holds other dirt. These complexes adhere to the carpet fibers, binding them together, preventing the efficient removal of soil by normal vacuuming, and causing the carpet to appear dingy.

#### *Spills*

Spills usually create the most noticeable contrasts in carpets. They consist of localized high concentrations of soiling matter. When spills first occur, they are in a wet, mobile state. If they are allowed to dry or to penetrate carpet fibers they become difficult stains, which may be impossible to remove.

### MAINTENANCE PROGRAMS

Maintenance programs should begin as soon as the carpet is installed. Minimum maintenance will result in decreased use life of the carpet and an increased total cost over the long term. An effective maintenance program involves four elements that combine to preserve the carpet's appearance and extend its wear life. These are *prevention*, *daily cleaning*, *periodic cleaning* and *repair*. The maintenance program should be carefully designed to consider traffic loads and soiling rates. Using a floor plan, identify the most likely areas for soiling and spilling. Color code the floor plan to indicate frequencies and procedures for maintenance in critical areas. Plan to give special attention to areas where soil is tracked off, where foot traffic is most concentrated, and where spilling is most likely to occur. Always take immediate action to identify and remove stains and spills.

### SOIL PREVENTION

Carpet maintenance can be reduced by taking measures to prevent soiling and the appearance of soil. Some of these measures are careful initial selection of carpet, maintenance of exterior areas, soiling barriers, chair pads, and anti soiling treatments.

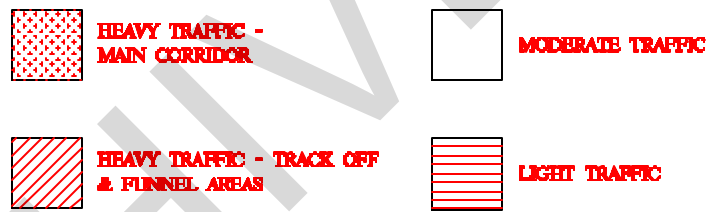
- *Careful Carpet Selection:* Very light colors, dark colors, and solid colors tend to show dirt, while middle toned, multi colored, patterned, tweed and heather carpets camouflage it.
- *Maintenance of Exterior areas:* Parking lots, sidewalks, garages and other exterior areas of a building should be swept often to keep them free from dirt. This will help prevent dirt from being tracked in. When possible, snow and ice should be manually removed rather than being treated with chemicals or sand.
- *Soiling Barriers:* Install walk off mats at entrances and removable carpets in elevators to collect abrasive dirt before it reaches the carpet inside. Walk off mats should be large enough so that at least two or three steps are taken across them before the carpet is stepped on. Elevators with removable carpets also accumulate dirt that would otherwise be tracked into the main carpeted areas.
- *Chair pads:* Chair pads are not needed with most glue down level loop broadloom or carpet tile installations. Chair pads may be required in executive offices that have plush carpet installed over a cushion.
- *Anti Soiling Treatments:* Fluorochemical treatments can help carpets resist soil and stains. They increase vacuuming efficiency by helping oily dirt to release more easily. These treatments are marketed under several patented trade names by carpet manufacturers. Use products formulated for permanent protection rather than ones that are removed by cleaning processes.
- *Miscellaneous Prevention Methods:* There are several additional measures that will help prevent carpet soiling. Use good HVAC filters in the building to decrease the amount of airborne soil. Limit smoking to areas with high exhaust. Designate eating and drinking areas, or reduce the level of beverages in cups. Install floor mats and use heavy garbage bags in areas of likely abuse such as coffee bars and copy areas.

#### CLEANING PROGRAMS

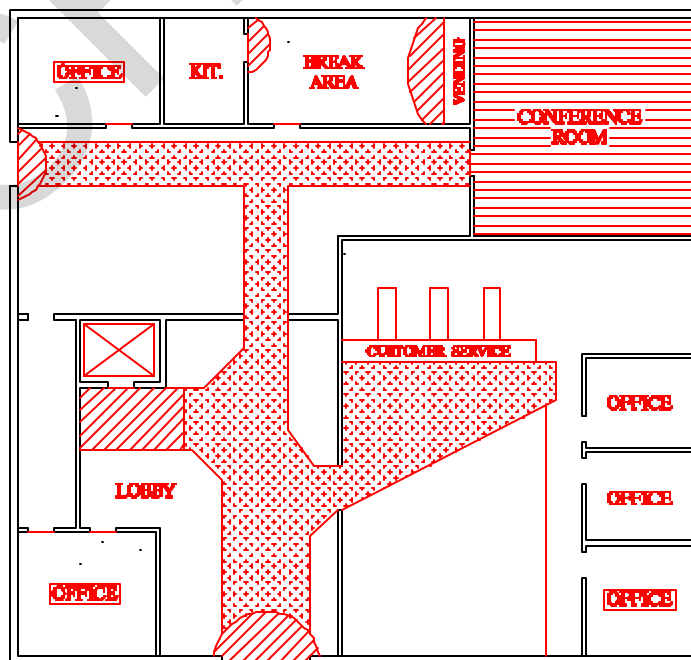
- Regular cleaning is an essential part of a good maintenance program. Routine vacuuming is the most effective and important of the regular cleaning procedures. Carpeted areas should be classified on the maintenance floor plan as low, medium, or high traffic exposure. (See sample maintenance floor plan on the next page.) High traffic areas should be vacuumed more frequently than low traffic areas. If soiling or traffic patterns change, the vacuuming schedule should be adjusted accordingly. The following schedule should serve as a guide only since every area differs in traffic and soiling rates.

- *High Traffic Areas:* (Walk off areas, congested channels, and principle passage routes): Vacuum daily.
- *Medium Traffic Areas:* Vacuum twice weekly (more if needed).
- *Light Traffic Areas:* Vacuum once or twice weekly (as determined by inspection).

The effectiveness of vacuuming can be determined by a visual examination of the carpet pile. Spread the pile apart with the fingers and inspect the carpet yarns and the back. If loose soil is observed along the yarns and on the back, then more vacuuming is needed. A routine can be established by making several passes over the carpet and then examining the carpet pile for loose soil. If all the soil is not removed, then more vacuuming is required. It is important to remove as much loose soil as possible. It is also important to regularly inspect the vacuum cleaner for air flow and suction, since a full bag of dirt can inhibit the air flow.



Sample Maintenance  
Floor Plan



#### SPOT & STAIN REMOVAL

Spills should be spot cleaned promptly to prevent stains, since stains are difficult or impossible to remove. Although certain chemicals can cause

permanent damage to the yarn or dye in a carpet, this damage can be minimized by prompt action.

The first step should be to scrape, blot, or absorb the excess spillage immediately. This quick action may remove the substance before it penetrates the pile of the carpet. If the spot is liquid, absorb it with tissue or paper towels until the absorbent material no longer picks up the liquid. Semi solids should be scraped up gently with a smooth, round object, such as a spoon. Solids or powders respond better to vacuuming.

A spot removal kit should be kept on hand. These are usually available from carpet cleaning, dry cleaning, and janitorial supply houses.

#### SPOT REMOVAL PROCEDURES

| Type of Spot<br>Oil and Grease | Method of Removal<br>(If more than one method is shown, apply in sequence —until the entire spot is removed) |
|--------------------------------|--|
| Asphalt                        | Dry cleaning fluid   |
| Copier powder                  | Non-oily paint remover   |
| Cosmetics                      | Amyl acetate nail polish remover   |
| Crayon                         | Dry cleaning fluid   |
| Duco Cement                    | Wet/dry spotter  |
| Grease                         | Detergent solution   |
| India Ink                      | 5% acetic acid (white vinegar)<br>3% Ammonia   |
| Oils                           | Detergent solution   |
| Rubber Cement                  | Water  |
| Shoe polish                    | Dry extraction cleaning compound   |
| Tar                            |  |

#### SPOT REMOVAL PROCEDURES

| Type of Spot<br>Liquids | Method of Removal<br>(If more than one method is shown, apply in sequence —until the entire spot is removed) |
|-------------------------|--|
| Beer                    | Detergent solution   |
| Cocktails               | Wet/dry spotter  |
| Coffee                  | 5% acetic acid (white vinegar)   |
| Colas                   | 3% ammonia   |
| Fruit juices            | 1% Hydrogen peroxide   |
| Soft drinks             | Detergent solution   |
| Tea                     | Water  |

|         |                                  |
|---------|----------------------------------|
| Tobacco | Dry extraction cleaning compound |
| Urine   | Dry extraction cleaning compound |

#### SPOT REMOVAL PROCEDURES

| Type of Spot<br>Food and Body Waste | Method of Removal<br>(If more than one method is shown, apply in sequence —until the entire spot is removed) |
|-------------------------------------|--|
| Animal glues                        | Detergent solution   |
| Blood                               | 3% Ammonia   |
| Catsup                              | Wet/dry spotter  |
| Chocolate                           | Detergent solution   |
| Cream                               | Digestor   |
| Eggs                                | Detergent solution   |
| Feces                               | Water  |
| Gravy                               | Dry extraction cleaning compound   |
| Ice cream                           | Dry extraction cleaning compound   |
| Starch                              | Dry extraction cleaning compound   |
| Vomit                               | Dry extraction cleaning compound   |

#### SPOT REMOVAL PROCEDURES

| Type of Spot:<br>Dyes, Inks, Medicines | Method of Removal<br>(If more than one method is shown, apply in sequence —until the entire spot is removed) |
|--|--|
| Colored paper                          | Detergent solution   |
| Food                                   | Alcohol  |
| Furniture                              | 5% Acetic acid (white vinegar)   |
| Inks                                   | 3% Ammonia   |
| Marking pens                           | Wet/dry spotter  |
| Medicines                              | 1% Hydrogen peroxide   |
| Soft drinks                            | Detergent solution<br>Water<br>Dry extraction cleaning compound  |



## SPOT REMOVAL PROCEDURES

| Type of Spot:<br>Chewing Gum, Rust | Method of Removal<br>(If more than one method is shown, apply in<br>sequence —until the entire spot is removed) |
|------------------------------------|---|
| Chewing gum                        | Chemical freezing compound (cool with ice<br>until brittle)<br>Dry cleaning fluid                               |
| Rust                               | Rust remover<br>Detergent solution<br>Water   |

Note: When using a dry extraction cleaning compound or dry cleaning fluid, apply it to a towel and blot from outside toward the center. Do not apply directly to the carpet and do not rub it into the carpet.

## DEEP CLEANING

Periodic deep cleaning is required to remove oily materials that have become bonded to the carpet fibers, and to collect dirt particles that have been pushed into the spaces between fibers and onto the fibers by the pressure of foot traffic. There are five main methods that are used to clean carpet. There are many variations on the basic methods, multiple names for the same process, and various combinations of methods. Operator training and experience are needed to use any of the methods successfully.

- *Absorbent Compound:* This method uses the least moisture. A pre-conditioner may be applied before the main treatment in heavily soiled areas. Powder is sprinkled liberally over the surface of the carpet, then worked in with a stiff brush or mechanical agitator. The dirt particles are knocked off the carpet fibers. The chemicals in the powder break the oil bonds and adhere to the dirt particles. The absorbent compound is then removed by vacuuming. The carpet should always be thoroughly vacuumed both before and after using this cleaning method. The carpet will normally take between one and three hours to dry completely.
- *Absorbent Pad or Bonnet (dry):* This is another minimum moisture system. A solution of detergent and water is sprayed onto the carpet, a rotating pad agitates the carpet tufts, and the dirt is collected in the pad, which is washed out and re-used as needed. The pad or bonnet must be replaced as it becomes saturated with soil in order to prevent resoiling. The cleaning agents should dry to a powder so that they do not leave a sticky residue that acts as a soil collector. Drying time is normally one to three hours, after which the carpet needs to be thoroughly vacuumed. This method is not recommended for cut pile carpet.
- *Dry Foam Cleaning:* A dry foam detergent solution is produced by means of an air compressor or mechanical agitating device. This foam is then forced down through or around a revolving cylindrical brush, which combs the foam through the carpet pile so each fiber is individually cleaned. The cleaning compounds dissolve oil bonds and encapsulate the dirt particles. Dirt is removed in the foam that is vacuumed from the carpet. Follow up vacuuming when the carpet is dry gets loosened dirt particles out of the pile. The cleaning agents dry to a powder so that they do not leave a sticky

residue.

· *Shampoo Cleaning*: A shampoo solution is fed through a brush into the carpet. A rotating brush agitates the solution into the carpet pile, knocking dirt particles off the fibers and opening up matted carpet pile. The cleaning compounds dissolve the oil bonds and help prevent dirt particles from reattaching to the fibers. Drying time may run from one to twelve hours and up to 24 hours in extreme cases. The cleaning agents should dry to a powder so that they do not leave a sticky residue. Follow up vacuuming is required to remove loosened dirt particles from the pile.

· *Hot Water Extraction (Steam Cleaning)*: Hot water and detergent are driven down into the carpet under pressure. The cleaning chemicals dissolve oil bonds and prevent dirt particles from reattaching to the fibers. The flushing action of the water gets the loosened dirt particles out of the carpet pile. Maximum drying time is 24 hours.

## GLOSSARY

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### A

*Acrylic* - A manufactured fiber in which the fiber forming substance is any long chain synthetic polymer composed of at least 85% by weight of acrylonitrile units. (Acrylics are not recommended for commercial applications.)

*Antimicrobial Carpet* - Carpet chemically treated to reduce the growth of common bacteria, fungi, yeast, mold, and mildew.

*Antistatic* - The ability of a carpet system to dissipate an electrostatic charge before it reaches the threshold of human sensitivity.

*Appearance Retention (Performance)* - The ability of a carpet to maintain its original appearance with use over time. Factors that affect appearance retention are type of fiber, color, pattern, density, pile texture, and maintenance.

*Attached Cushion* - A cushioning material, such as foam, rubber, urethane, etc., adhered to the backing fabric side of a carpet to provide additional dimensional stability, thickness, and padding.

*Average Pile Yarn Weight* - Mass per unit area of the pile yarn including portions buried in the backing. In the U.S., this is usually expressed as ounces per square yard.

*Axminster Carpet* - Carpet woven on an Axminster loom. Pile tufts are individually inserted from varied colored yarns arranged on spools. This process makes it possible to produce carpet and rugs of complex designs with many colors, such as Oriental design rugs.

### B

*Backing* - Materials (fabrics or yarns) comprising the back of the carpet as opposed to the carpet pile or face.

1. *Primary Backing* - In tufted carpet, a woven or non woven fabric in which the pile yarn is inserted by the tufting needles. Usually, woven or non woven polypropylene for carpet, and often, cotton duck for scatter rugs.
2. *Secondary Backing* - In tufted carpet, the fabric laminated to the back of carpet to reinforce and increase dimensional stability. Usually, woven jute or woven or non woven polypropylene. (Jute backing is not recommended due to its inability to withstand moisture and humidity.)
3. *Woven Carpet Backings* - the construction yarns comprising chain warp, stuffer warp, and shot or fill which are interwoven with the face yarn during carpet fabric formation.

*Back Seams* - Installation seams made with the carpet turned over or face down. Opposite of "face seams" made with the carpet face up. (Both kinds of seam are on the back of the carpet.)

*BCF* - Abbreviation for *bulked continuous filament*. Continuous strands of synthetic fiber formed into yarn bundles of a given number of filaments and texturized to increase bulk and cover. Texturizing changes the straight filaments into kinked or curled configurations.

*Bearding* - Long fiber fuzz on carpet caused by fiber snagging and inadequate anchorage.

*Berber* - A carpet constructed with coarse yarns having randomly spaced flecks of color against a background of a base color.

*Binding* - A band or strip sewn over a carpet edge to protect, strengthen, or decorate the edge.

*Bleeding* - Transfer of fiber dyes from carpet or other fabrics by a liquid, usually water, with subsequent redepositing on other fibers.

*Blend* - A mixture of two or more types of yarn or fiber.

*Bonded Carpet* - Bonded or fusion bonded carpet Is a kind of tufted carpet made by inserting pile yarn directly into liquid vinyl plastisol. These components are then fused together. This produces a carpet with a continuous impermeable vinyl back and with a tuft lock superior to any other cut pile carpet construction. Solid color, heather, and prints on base carpeting can be produced by the bonding process.

*Breaking Strength* - The ultimate tensile load or force required to rupture a material.

*Broadloom* - A term used to denote carpet produced in widths wider than six feet.

#### c

*Carpet Cushion* - A term used to describe any kind of material placed under carpet to provide softness and adequate support. It usually provides added acoustical benefits and longer wear life for the carpet. In some cases, the carpet cushion is attached to the carpet when it is manufactured. Also referred to as "lining," "padding," or "underlay," although "carpet cushion" is the preferred term.

*Carpet Modules* - Carpet packaged as squares, generally 18 inches by 18 inches (457 x 457 mm), with or without attached cushion backing. Also referred to as "carpet tiles."

*Construction* - Carpet construction is defined by stating the manufacturing method (tufted, woven, etc.) and the final arrangement of materials achieved by following the specifications.

*Continuous Dyeing* - Process of dyeing carpet in a continuous production line, rather than in batch lots. In continuous dyeing, special equipment flows dyestuff onto the carpet, as opposed to batch lot dyeing where the carpet is submerged in separate dye becks.

*Continuous Filament* - A process in which continuous strands of synthetic fibers are extruded into yarn rather than spun like natural fibers and synthetic staple fibers.

*Count* - 1. A number identifying yarn size or weight per unit length or vice versa (depending on the particular system being used.) 2. The number of warp ends and filling ends per inch of a fabric.

*Crocking* - Term used to describe excess color rubbing off because of improper dye penetration, fixation, or selection.

*Cross Seams* - Seams made by joining the ends of carpet together.

*Cushion Back Carpet* - A carpet having a cushioning lining, padding, or underlay material as an integral part of its backing. Same as attached cushion carpet.

*Cut* - A length of carpet cut from a full roll to fill an order.

*Cut Pile* - A carpet or fabric in which the face is composed of cut ends of pile yarn.

#### D

*Delamination* - Separation of the secondary backing or attached cushion from the primary backing of the carpet.

*Delamination Strength* - Force required to remove secondary backing from a finished carpet.

*Denier* - A direct numbering system for expressing the linear density of a yarn, filament, fiber, or other textile strand. The denier is equal to the mass in grams per 9000 meters of fiber. The higher the denier, the larger the yarn or fiber.

*Density, Average Pile* - The weight of pile yarn in a unit volume of carpet expressed in ounces per cubic yard is given by the formula  $D = W \times 36 T$  in which **D** is density, **W** is pile yarn weight in ounces per square yard, and **T** is pile thickness (height) in inches.

*Dimensional Stability* - The ability of a fabric to retain its original size and shape; may be enhanced by chemical treatments or by mechanical means, such as the secondary backing.

*Direct Glue Down* - Installation process where carpet is adhered directly to the subfloor without a cushion.

*Double Glue Down* - An installation method whereby the carpet cushion is adhered to the subfloor with an adhesive, and then the carpet is adhered to the cushion by another adhesive.

*Drop Match* - See *match*.

*Dry Compound Cleaner* - A carpet cleaning preparation consisting of absorbent granules impregnated with dry cleaning fluids, detergents, and other cleaners. The dry powder is sprinkled on the carpet, worked into the pile with a brush, left to absorb soil for a short time, and then removed along with the absorbed soil by vacuuming.

*Dry Foam* - A detergent solution containing only a small amount of water. It is mechanically worked into the surface of the carpet, and the loose soil is then removed by vacuuming.

*Dry Rot* - A condition caused by micro organisms attacking fibers of textiles, carpets, or other materials, which results in decreased strength and integrity. Dry rot in carpet backings permits carpet to break and tear easily. Natural materials such as jute are susceptible to dry rot, but polypropylene and most other synthetics are resistant.

*Dyeing* - Coloring fibers, yarns, fabrics, carpet or other materials by addition or incorporation of small amounts of highly colored materials known as dyes and pigments. See individual dye methods, including *piece dyeing*, *continuous dyeing*, *space dyeing*, *skein dyeing*, *stock dyeing*, *printing*, and *solution dyeing*.

*Dye Lots* - When carpet is dyed by certain methods, several separate tanks of dye solution (dye lots) may have to be prepared to dye the total number of square yards of carpet specified for an installation. As a result, the carpet may vary slightly in color from one dye lot to the next. Carpet from one dye lot should not be installed right beside carpet from a different dye lot.

## F

*Face Seams* - Sewn or cemented seams made without turning the carpet face down. They are used during installation when back seaming is not possible.

*Face Weight* - The weight of the carpet pile including those portions of the pile that extend into the backing structure. Generally expressed in ounces per square yard.

*Fadeometer* - A laboratory device for determining the effects of light on the properties of yarns, fibers, fabrics, carpet, plastic, and other materials. It uses a standard light source to simulate the spectrum of sunlight. It is generally used for measuring fade resistance of carpet colors, which are rated according to the number of units exposure required to produce visible loss of color.

*Fading* - Loss of color. Caused by actinic radiation, such as sunlight or artificial light; atmospheric gases, including ozone, nitric oxide, and hydrogen sulfide; cleaning and bleaching chemicals, such as sodium hypochlorite and other

household and industrial products, chlorine chemicals for swimming pools, and other factors. Colorfast carpet for commercial installations prone to these exposures should be selected with extreme care.

*Fastness* - Retention of color by carpet or other materials, usually with reference to specific exposures, e.g., light fastness and wash fastness. Dyestuff, fiber type, and dyeing method influence the ability of colored carpets and fabrics to withstand the effects of color destroying agents.

*Fiber* - The natural or man made substance which forms the basic element of fabrics and other textile structures. Fiber is defined as having a length at least 100 times its diameter or width. Useful textile fibers have high tensile strengths, flexibility, and resistance to heat, light, chemicals, and abrasives.

*Filament* - A single continuous strand of natural or synthetic fiber.

*Filling Yarns* - The yarns that run widthwise in a woven carpet. There may be several sets of filling yarns in a complicated pattern.

*Finishing* - A collective term denoting final processing of carpet and textiles subsequent to tufting, weaving, and dyeing. Carpet finishing processes include shearing, brushing, application of secondary backing, application of attached foam cushion, application of soil retardant and anti static chemicals, back beating, and steaming.

*Flooring, Radiant Panel* - Laboratory testing device for measuring critical radiant flux on horizontally mounted floor covering systems exposed to a flaming ignition source in a graded radiant heat energy environment.

*Fluffing* - Appearance on carpet surface of loose fiber fragments left during manufacture; not a defect, but a characteristic that disappears after carpet use and vacuuming. Sometimes called "fuzzing" or "shedding."

*Frisé* - Pronounced "free-zay" - 1) A tightly twisted yarn that gives a rough, nubby appearance to carpet pile and carpet. 2) Carpet or textile having the rough, nubby appearance described above.

*Full Roll* - A length of carpet roll goods approximately 100 feet long; also called a shipping roll by carpet manufacturers. Shipping roll standards vary and may be as short as 30 feet, depending upon carpet thickness and manufacturers' quality criteria. In the United States almost all roll goods are 12 or 15 feet wide, with 12 foot width the most prevalent.

## G

*Gage or Gauge* - The distance between two needle points expressed in fractions of an inch. Applies to both knitting and tufting.

*Gauge/Pitch* - The number of ends of surface yarn counting across the width of carpet. For tufted carpet, gauge is the standard of measurement. Gauge is obtained by counting the number of ends of yarn in one inch across the carpet

and then taking the inverse of that number (I. e. one over the number.) If a tufted carpet has eight ends of yarn per inch, the gauge is 1/8. If it has ten ends of yarn per inch, the gauge is 1/10. For woven carpet, pitch is the standard of measurement. Pitch is obtained by counting the number of ends of yarn in 27 inches of width. If a woven carpet has eight ends per inch, the pitch is 216, or 8 x 27. If it has ten ends per inch, the pitch is 270, or 10 x 27. To convert gauge to pitch, take the inverse of the gauge and multiply by 27. For example, if the gauge is 1/8, taking the inverse gives 8, and multiplying by 27 gives a pitch of 216.

*Glue Down* - An installation method whereby the carpet is adhered to the floor with adhesive.

*Ground Color* - The background color against which the top colors create a pattern or figure in the design.

#### H

*Hand* - The tactile aesthetic qualities of carpet and textiles. Factors that determine how a carpet feels to the hand include pile weight, stiffness, lubricants, fiber type, denier, density, and backing.

*Heather* - A multicolor effect provided by blending fibers of different colors prior to spinning carpet yarn.

*Heat Setting* - A process for stabilization of carpet yarns by exposure to heat. Conventional autoclave heat setting treats yarns in relaxed skein configuration with pressurized steam, usually at temperatures in the 240 to 400 degrees F range. The principal benefits are twist retention in plied yarns in cut pile carpet and general stabilization of yarn configuration.

*Heatset Yarn* - Carpet yarns thermally stabilized to a final crimp or twist configuration so as to reduce loss of twist and bulk in service.

*High-Low* - Multi-level carpet style combining high and low loop pile areas or high cut pile and low loop areas. The latter is also called cut and loop.

*Hue* - A color itself, as red or blue. Many tones of the same hue are possible. A tint is made by adding white to a hue, and a shade is made by adding black to a hue.

#### J

*Jute* - A natural bast fiber made from certain plants of the linden family, which grown in warm climates, such as India and Bangladesh. Jute yarns are used for woven carpet construction (backing) yarns. Woven jute fabrics are used in tufted carpet as secondary backing.

#### K

*Knee Kicker* - A carpet installation tool consisting of a pinned plate connected to a short section of metal tubing. The end of the tubing opposite the plate has a padded cushion that the installer strikes with his knee to position carpet, which is gripped by the pinned plate.



In general, adequate stretching of carpet installations cannot be achieved with knee kickers. A power stretcher should always be used for stretching carpet during installation.

*Knitted Carpet* - A type of woven carpet produced in a fabric formation process by interlacing yarns in a series of connected loops. Pile and backing are produced simultaneously as multiple sets of needles interlace pile, backing and stitching yarns in one operation.

#### L

*Latex* - A compound consisting of either natural or synthetic rubber which is used to coat the back of carpet or rugs in order to adhere carpet components to one another. Most carpet latex consists of styrene-butadiene synthetic rubber (SBR) compounded with powdered fillers, such as calcium carbonate.

*Level Loop* - A carpet construction in which the yarn on the face of the carpet forms a loop with both ends anchored into the carpet back. The pile loops are of substantially the same height and are uncut, making a smooth and level surface.

*Loop Pile* - Carpet style having a pile surface consisting of uncut loops. May be woven or tufted. Also called "round wire" in woven carpet terminology.

*Luster* - Brightness or sheen of fibers, yarns, carpet, or fabrics. Synthetic fibers are produced in various luster classifications including bright, semi bright, semi dull, and dull. Bright fibers usually are clear (have no white pigment); whereas the duller designations have small amounts of white pigments such as titanium dioxide. Luster of finished carpet also depends upon yarn heat setting methods, dyeing, and finishing. In high traffic commercial areas, duller carpet is often preferred for its soil hiding ability.

#### M

*Match, Set or Drop* - The arrangement and dimensions of the repeating units that comprise the design of a patterned carpet, including woven patterns, prints, tufted high-lows, and others. A typical pattern repeat might be 36 inches wide x 24 inches long. In set match, the rectangular pattern unit is arranged in parallel rows across the carpet width. In drop match, each pattern unit is lowered a certain amount along the carpet length with respect to the pattern unit it adjoins. In a half drop match, the start of each pattern repeat unit is transposed to the midpoint of the side of the adjacent unit. In the 24" x 36" example given above, each adjacent unit would start 12 inches down the side of the neighboring one. In quarter drop match, each unit in the example would start six inches past the neighboring pattern unit's starting point.

Thus, pattern repeat units in drop match repeat diagonally across the width, and in setmatch, they repeat straight across the width perpendicular to the length. Pattern repeat dimensions and match are significant to specifiers and purchasing agents because they influence the amount of excess carpet (over the measured area) needed in multiple width installations.

*Matting* - Severe pile crush combined with entanglement of fibers and tufts.

**Metallic Fiber** - Fiber made of metal, metal coated plastic, or plastic coated metal sometimes used in small amounts in carpet to dissipate static electricity and prevent shock.

**Molding** - A wooden or plastic strip attached to the bottom of a baseboard or wall to cover the joint between wall and floor.

**Monofilament** - A single, continuous strand of synthetic polymer in the form of a filament large and strong enough to be used as a textile yarn.

**Multifilament** - Synthetic yarns composed of a multiplicity of continuous fiber strands extruded together, usually from the multiple holes of a single spinneret. Multifilament carpet yarns are texturized to increase bulk and cover and are called "bulked continuous filament" yarns or BCF yarns.

## N

**Needle, Axminster Weave** - An eyed needle that delivers filling yarn across the loom through the warp yarn shed.

**Needle, Knitting** - Hooked needles that form the loops of knitted fabric.

**Needle, Needlepunching** - Barbed felting needles that entangle and compress fibrous fleeces into needled felts, such as those used for outdoor carpet.

**Needle, Tufting** - An eyed needle that inserts yarns into primary backing to form tufts.

**Nylon** - Synthetic thermoplastic of the polyamide family widely used as a carpet face yarn in either BCF or staple yarn form. Two chemical types, nylon-6,6 and nylon-6, are used in carpet. Nylon-6,6 is polyhexamethylene adipamide and nylon-6 is polycaprolactam.

## O

**Olefins** - Any long chain, synthetic polymer composed of at least 85% by weight of ethylene, propylene, or other olefin units. Polypropylene is used in carpet as both backing and as pile fiber. See Polypropylene.

**Oriental Rug** - Hand-woven rug made in the Middle East or Asia.

**Outdoor Carpet** - Carpet that may be used outdoors without rapid fading or deterioration. The principal requirements are resistance to sunlight and to water. Most outdoor carpet pile yarns are solution-dyed polypropylene containing ultraviolet stabilization additives. Coatings and backing materials are synthetics that are water and rot resistant.

## P

**Pattern** - Decorative design on a carpet. It may be printed, woven with colored yarns, or sculptured in multiple pile heights.

**Pile** - The visible wear surface of carpet consisting of yarn tufts in loop and/or cut configuration. Sometimes called "face" or "nap."

*Pile Crush* - Loss of pile thickness due to compression and bending of tufts caused by traffic and heavy furniture. The tufts collapse into the air space between them. If the yarn has inadequate resilience, and/or the pile has insufficient density for the traffic load it may be irreversible.

*Pile or Tuft Length* - The length of the extended tufts measured from the primary backing top surface to their tips. Pile tufts should be gently extended, not stretched during this measurement.

*Pile Setting* - A procedure in carpet cleaning in which the damp and disheveled pile is lifted after shampooing by a pile brush or pile lifting machine.

*Pile Yarn* - The yarn that forms the tufts of the carpet. Also called "face yarn."

*Pilling* - A condition of the carpet face in which fibers from different tufts become entangled with one another, forming hard masses of fibers and tangled tufts. Pilling can be caused by heavy traffic. Pills may be cut off with scissors.

*Pill Test* - Flammability test for carpet to determine its ease of ignition by a small incendiary source, i.e., a methenamine timed burning tablet. Federal regulations require all carpet sold to pass the pill test (FF1-70).

*Pitch* - See gauge/pitch.

*Plied Yarn* - A yarn composed of two or more single yarns twisted together. Many 2 ply yarns are used in carpet. In a cut pile carpet such as a saxony, plied yarns must be heat set to prevent untwisting under traffic. Multiple continuous filament yarns are sometimes air entangled rather than twisted.

*Plush Finish* - A smooth textured carpet surface in which individual tufts are only minimally visible, and the overall visual effect is that of a single level of fiber ends. This finish is normally achieved only on cut pile carpet produced from non heat set single spun yarns by brushing and shearing. It is sometimes called "velvet plush."

*Ply* - 1. A single end component in a plied yarn. 2. The number which tells how many single ends have been ply twisted together to form a plied yarn, for example, 2-ply or 3- ply.

*Polyester* - A fiber-forming, thermoplastic synthetic polymer. Nearly all polyester carpet fiber is staple, and the yarns are spun yarns. Polyester for carpet is made from terephthalic acid and ethylene glycol and is known chemically as polyethylene terephthalate.

*Polymers* - High molecular weight chemical compounds formed by repeated linking of smaller chemical units called monomers. Polymers from which fibers are made are long chain molecules in which the monomers are linked end to end in a linear fashion. Synthetic polymers used for carpet fiber include nylon-

6,6 and nylon-6 (polyamides), polyester, polypropylene, and polyacrylonitrile (acrylics). In popular terminology, polymers are also called plastics or resins.

*Polypropylene* - Synthetic, thermoplastic polymer used for molded items, sheets, films, and fibers. The Federal Trade Commission (U.S. Government) classification is olefin. This polymer is made by stereospecific polymerization of propylene. Most polypropylene carpet fiber is solution dyed and sometimes contains ultraviolet stabilizers for outdoor use. The carpet fiber is available as both bulked continuous filament yarns and staple for spun yarn production. Slit film polypropylene is used in woven carpet backing.

*Power Stretcher* - A carpet installation tool used to stretch carpet for installation on tackless strip. It consists of a pinned plate that grips the carpet, tubular extensions, a padded end that is used to brace against an opposing wall or other structure, and a lever system that multiplies the installer's applied stretching force.

*Primary Backing* - A component of tufted carpet consisting of woven or non woven fabric into which pile yarn tufts are inserted by the tufting needles. It is the carrier fabric for the pile yarn, and should not be confused with secondary backing, which is a reinforcing fabric laminated to the back of tufted carpet subsequent to the tufting process. Most primary backing is either woven or non woven polypropylene. Some synthetic primary backings have nylon fiber attached to their upper surfaces to make them union dyeable with nylon pile yarns.

*Prime Urethane Cushion* - Separate carpet cushion made from virgin polyurethane foam. The sheet of foam is cut from large "loaves." As opposed to prime cushion, rebounded polyurethane is made from recovered scrap.

*Printed Carpet* - Carpet having colored patterns applied by methods analogous to those used for printing flat textiles and paper. These include flatbed screen printing using woven fabric screen, rotary screen printing with perforated sheet steel screens, Stalwart printing with sponge rubber pattern elements on wooden rollers, and computer programmed jet printing.

## R

*Random Sheared* - A carpet texture created by shearing either level loop or high-low loop carpet lightly so that only the higher loops are sheared. The sheared areas are less reflective than the unsheared loops, which appear brighter and lighter in color. Random shearing of high-low loop carpet produces a texture somewhat similar to cut and loop.

*Repeat* - The dimensions of the basic pattern unit in any type of patterned carpet including printed, woven, high-low tufted loop, cut and loop, etc. See match for further discussion.

*Resilience* - The ability of carpet pile or cushion to recover original thickness after being subjected to compressive forces or crushing under traffic.

*Restretch* - A carpet installation term used to describe carpet stretching performed subsequent to original installation in order to remove wrinkles, bubbles, or loose fit. Most restretching is caused by failure of the installer to adequately stretch the carpet during original installation. Restretching should be performed with power stretchers and not with knee kickers, as should all stretching operations in overpad, tackless strip installations.

*Rotary Brushing* - A carpet cleaning technique in which a detergent solution is worked into the pile by a motor-driven rotating brush. Loosened soil and spent solution is often subsequently removed by vacuuming.

*Rows or Wires* - In woven carpet, the number of pile yarn tufts per running inch lengthwise. Called "rows" in Axminster and "wires" in Wilton and velvet carpet. Analogous to "stitches per inch" in tufted carpet.

*Rubber* - A term sometimes applied to carpet cushion made from rubber (foam or sponge), which is used for both separate and attached cushion.

*Rug* - Carpet cut into room or area dimensions and loose laid.

## S

*Saxony* - A cut pile carpet texture consisting of heat set plied yarns in a relatively dense, erect configuration, with well defined individual tuft tips. Tip definition is more pronounced than in singles plush.

*Sculptured* - Any carpet pattern formed from high and low pile areas, such as high-low loop or cut and loop.

*Secondary Backing* - Woven or nonwoven fabric reinforcement laminated to the back of tufted carpet, usually with latex adhesive, to enhance dimensional stability, strength, stretch resistance, lay flat stiffness, and hand. Most secondary backings are woven jute, woven polypropylene, or nonwoven polypropylene. The term is sometimes used in a broader sense to include attached cushion and other polymeric back coatings. Because secondary backing is visible, whereas primary backing is concealed under the pile yarn in finished carpet, most dealers and installers refer to the secondary backing simply as "backing."

*Self-Tone* - A pattern of two or more tones of the same color. When two tones are used in a pattern or design, it is called "two-tone."

*Selvages* - Carpet edges at sides of rolls.

*Serging* - A method of finishing edges of carpet base or area rugs cut from roll goods by use of heavy, colored yarn sewn around the edges in a close, overcast stitch.

*Shade* - A hue (color) produced by a pigment or dye mixture with some black in it.

*Shading* - A change in the appearance of a carpet due to localized distortions in the orientation of the fibers, tufts, or loops. Shading is not a change in color or

hue, but a difference in light reflection. It is sometimes referred to as "temporary shading," "tracking," or "pile reversal."

*Shag* - A carpet texture characterized by long pile tufts laid over in random directions in such a manner that the sides of the yarn form the traffic surface. Modern shags are made from plied, heat-set yarns and are either cut pile or cut and loop styles.

*Shearing* - Carpet manufacturing process for producing a smooth carpet face, removing fuzz, or creating random sheared textures. Carpet shears have many steel blades mounted on rotating cylinders that cut fibers on carpet surfaces in a manner analogous to a lawnmower cutting grass. Depth of shearing may be indicated by a modifying word, e.g., defuzz and tip shear suggest a shallow cut, whereas a full shear implies a deep cut such as is used for producing mirror finished plush.

*Side Seams* - Seams running the length of the carpet. Sometimes called length seams.

*Skein Dyed Yarn* - Pile yarn dyed while loosely wound in large skeins.

*Soil Resist Treatment* - Application of a chemical agent that gives low surface energy properties to carpet face fiber, in order to inhibit wetting of the fibers by oil or water based materials. Treatments are usually fluoro-chemically based.

*Soil Retardant* - A chemical finish applied to fibers or carpet and fabric surfaces, which inhibits attachment of soil.

*Solution Dyed Fiber* - Synthetic fiber colored by pigments dispersed in the polymer melt or solution prior to extrusion into fiber. Sometimes referred to as dope dyed or spun dyed.

*Space Dyed* - Yarn dyed in two or more colors that alternate along the length.

*Spinning* - A term used in yarn or fiber production. To a fiber manufacturer, spinning is synonymous with extrusion of polymer through the small holes of the spinneret into synthetic fiber. To the conventional textile yarn mill, spinning is the conversion of staple fiber into spun yarn.

*Sponge Cushion* - Carpet cushion of rubber foam material that is chemically blown to form a cushion product.

*Stain* - Foreign material (soil, liquids, etc.) on carpet that is not removable by standard cleaning methods.

*Stain Resist Treatment* - Chemical treatment, primarily for nylon carpet, to minimize stains from food colors. Chemical stain resist treatments are not commonly used for commercial carpet.

*Staple Fiber* - Short lengths of fiber, which may be converted into spun yarns by textile yarn spinning processes. Also called "staple." Staple may also be

converted directly into nonwoven fabrics, such as needle-punched carpet. For carpet yarns spun on the common modified worsted systems, most staple is six to eight inches long.

*Static Shock* - Discharge of electrostatic charge from carpet through a person to a conductive ground such as a doorknob. The friction of shoes against carpet fiber causes the build up of an electrostatic charge. Various static control systems and finishes are used for contract carpet to dissipate static charge before it builds to the human sensitivity threshold.

*Stay Tacking* - A carpet installation term for temporary nailing or tacking to hold the stretch until the entire installation is stretched over and fastened onto the tackless strip. An important technique in large contract installations, which are too large to stretch in one step.

*Stiffness* - Resistance of a material to bending.

*Stitches* - Stitches per inch. The number of yarn tufts per running inch of a single tuft row in tufted carpet.

*Stitch Length* - Total length of yarn from which a tuft is made. It is numerically equal to twice the pile height plus the associated back stitch behind the primary backing.

*Stock Dyed Yarn* - Colored spun yarn produced from fibers dyed in staple form. The term does not apply to yarns spun from solution dyed staple.

*Streak* - Any lengthwise, narrow, visual defect in carpet. Dye streaks may be caused by a single pile end having different dye affinity from the others. Other streaks may be yarn defects, such as tight twist, stretched yarn, or yarns larger or smaller than the rest.

*Stretch* - A carpet installation term for the amount of elongation of carpet when it is stretched over cushion onto tackless strip. Generally one to two percent.

*Stretch-In* - Installation procedure for installing carpet over separate cushion using a tackless strip.

*Stuffer* - A backing yarn in woven carpet. Stuffers are normally large warp yarns (lengthwise yarns) which add weight, strength, hand, stiffness, and stability.

*Swatch* - A small carpet sample. Carpet specifiers should retain swatches to verify color, texture, weight, and other quality factors when carpet is delivered.

#### T

*Tackless Strip* - Wood or metal strips fastened to the floor near the walls of a room containing either two or three rows of pins angled toward the walls, on which the carpet backing is stretched and secured in a stretch in installation.

*Tensile Strength* - The greatest stretching force a material such as a yarn, fabric, or carpet can bear without breaking.

*Texture* - Visual and tactile surface characteristics of carpet pile, depending on such aesthetic and structural elements as high-low or cut and loop patterning, yarn twist, pile erectness or lay over, harshness or softness to the touch, luster, and yarn dimensions.

*Thermal Conductivity* - Ability of a material to transmit heat. Good insulators, including some carpet, have high thermal resistivity (R-value) and low thermal conductivity.

*Tip Shearing* - Light, shallow shearing to add surface interest to carpet texture or to clean up and defuzz carpet during finishing.

*Top Colors* - In printed or woven colored patterns, top colors are the ones forming the pattern elements, as distinguished from background or ground colors.

*Total Weight* - Weight per square yard of the total carpet pile, yarn, primary and secondary backings, and coatings.

*Traffic* - The passing back and forth of people and equipment over a carpet surface area.

*Tuft Bind* - Force required to pull a tuft from the carpet.

*Tufted Carpet* - Carpet manufactured by the tufting process, which involves insertion of pile tufts by a row of eyed needles that penetrate a primary backing fabric, thus forming tufts from the yarn threaded through the eyes of the tufting needles.

*Tufts* - The cut or uncut loops of a pile fabric.

*Twist* - The number of turns per unit length about the axis of a yarn. Twist direction is either right or left handed, also called "Z-twist" or "S-twist." Carpet yarns usually have rather low twists, in the 2.5 to 6.0 turns per inch (TPI) range, with the majority from 3.5 to 5.0 TPI.

*Twist Carpet* - Carpet having a pile texture created with tightly twisted yarns in which the ply twist is substantially greater than the singles twist, causing the yarn to curl. Most twist styles are cut pile, and the unbalanced, hard twist causes a nubby texture. See also frisé.

*Twist Retention* - The ability of heat set yarns to retain their twist. The stronger the yarn twist, the better the appearance retention of the carpet will be, particularly in cut pile carpet.

## U

*Underlay* - See *Carpet Cushion*.



*Unitary Carpet* - Type of carpet used for glue down installations that has an application of high quality backcoating latex to increase tuft bind performance properties without the addition of a secondary backing.

#### v

*Velvet Carpet* - Carpet woven on a velvet loom. Velvet carpet is typically cut pile or level loop in solid or tweed colorings, though textured and patterned effects are possible.

*Velvet Finish* - A smooth surface texture on dense plush carpet.

*Vinyl* - Colloquial term for the synthetic polymer, polyvinyl chloride (PVC). PVC is used as a carpet back coating for marine and outdoor use. PVC foams can be used as attached cushions. Many walk off mats have solid, sheet vinyl backings, and carpet modules (tiles) are also often PVC backed.

#### w

*Warp* - A weaving term for yarns that run lengthwise in woven fabrics and carpets. Warp yarns are usually delivered to the loom from a beam, a large spool with hundreds of ends of yarn wound on it and mounted behind the loom. Woven carpets usually have three sets of warp yarns, which may be wound on three beams. These include stuffer warp for lengthwise strength and stiffness, pile warp, which forms the carpet surface tufts, and chain warp, which interlaces with fill yarn to lock the structure together.

*Watermarking* - A special case of non reversible shading where large areas of the carpet appear randomly light or dark. The term "watermarking" stems from the fact that this type of shading looks like puddles of water. The appearance is due to adjacent tuft areas leaning in opposite directions, reflecting different amounts of light from the tips and sides. Extensive research has shown that this condition is not a manufacturing defect, and the cause remains unknown.

*Weaving* - A fabric formation process used for manufacturing carpet in which yarns are interlaced to form cloth. The weaving loom interlaces lengthwise (warp) and widthwise (filling) yarns. Carpet weaves are complex, often involving several sets of warp and filling yarns. See Axminster, Wilton, Velvet, and Knitted.

*Weft* - Yarn which runs widthwise in woven cloth or carpet, interlacing with the warp yarns. Also called filling yarns.

*Wilton Carpet* - Carpet woven on a loom with a Jacquard mechanism, which utilizes a series of punched cards to select pile height and yarn color. The Wilton loom can produce carpet with complex multicolor patterns and highly textured pile surfaces of multilevel cut and looped yarns.

*Woven Backing* - A term for primary or secondary backing that is manufactured for tufted carpet by the weaving process. Secondary backings are usually woven jute or woven polypropylene. Primary backings are usually woven (or nonwoven) polypropylene.

*Woven Carpet* - Carpet produced on a loom through a weaving process by which the lengthwise (warp) yarns and widthwise (weft or filling) yarns are interlaced to form the fabric. Carpet weaves such as Wilton, Axminster and velvet are complex, often involving several sets of warp and filling yarns for the pile and backing.

*Yarn* - A continuous strand composed of fibers or filaments and used in tufting, weaving, and knitting to form carpet and other fabrics. Carpet yarn is often plied and may be either spun from staple or extruded as a continuous filament.

*Yarn Dyeing* - Dyeing yarn before tufting or weaving it into carpet.

*Yarn Ply* - The number of singles yarns ply twisted together to form a plied yarn.

*Yarn Size* - Same as *Yarn Count*. See *Count*.

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**Section 01350  
SPECIAL PROJECT PROCEDURES – CARPET RECLAMATION**

**SPEC NOTE:** This section specifies requirements for removal and recycling of used carpet and scrap from new installation.

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Furnishing of separate contract with Reclamation Agency for used carpet reclamation.
2. Procedures for removal and reclamation of used carpet.

**B. Related Sections:**

1. Section 01738 – Selective Demolition
2. Section 02222 – Building Demolition
3. Section 09680 – Carpeting

**1.02 SUBMITTALS**

**A. Proposed dust-control measures.**

**B. Proposed packing and transportation measures.**

**C. Schedule of carpet reclamation activities indicating the following:**

1. Detailed sequence of removal work.
2. Inventory of items to be removed and recycled.

**D. Reclamation agency records indicating receipt and disposition of used carpet.**

**1.03 QUALITY ASSURANCE**

**SPEC NOTE:** If non-DuPont removal firms are allowed to provide reclamation services or carpet removal services, modify paragraphs 1.03. A&B to indicate that designated firms listed in Part 2 will be considered as carpet removers or reclamation agencies.

**A. Reclamation Agency:** DuPont Flooring System Firm [or designated agent firm] providing used carpet recycling under the DuPont Carpet Reclamation Program.

**B. Carpet Remover:** DuPont Flooring System Firm [or designated agent firm] providing carpet removal services for recycling purposes.

**C. Regulatory Requirements:** Comply with governing regulations. Comply with hauling and disposal regulations of authorities having jurisdiction.

**SPEC NOTE:** Record off-site removal of debris and materials and provide the following information regarding the removed materials. Time and Date of removal; Type of Material; Weight and Quantity of Materials; Final Destination of materials.

D. Certification: Reclamation Agency and Carpet Remover shall certify in writing that used carpet was removed and recycled in accordance with the DuPont Carpet Reclamation Program.

#### 1.04 PROJECT CONDITIONS

A. Environmental Requirements: Obtain approval of Owner [Facilities Manager, Construction Administrator] before performing operations which generate contaminants.

### PART 2 – PRODUCTS

#### 2.01 CARPET RECLAMATION AGENCY

- A. [List DuPont Flooring System Firm]
- B. [List DuPont Flooring System Firm]

#### 2.02 CARPET REMOVERS

- A. [List Carpet Removal Firm]
- B. [List Carpet Removal Firm]

#### 2.03 MATERIALS

A. Adhesive Removal Solvents: Comply with Carpet and Rug Institute Publication 104 subparagraph 6.1.9.

**SPEC NOTE:** Liquid Adhesive Removers may cause problems with new adhesive and new carpets. CRI Publication 104, Standard for Installation of Commercial Textile Floorcovering Materials should be consulted.

B. Used Carpet: Maintain possession of removed used carpet. Immediately remove from Site and place in container or trailer. Carefully remove, store, and protect designated materials and equipment for re-installation under other Sections or to be retained by Owner.

C. Carpet Pad: Provide recycling of carpet padding where locally available or as designated by Reclamation Agency.

### PART 3 – EXECUTION

### 3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.

1. Do not proceed until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Provide, erect, and maintain barricades, lighting, and guard rails as required to protect general public, workers, and adjoining property.

B. Vacuum used carpet before removal.

### 3.03 CARPET REMOVAL

**SPEC NOTE:** Where appropriate include new carpet scrap and waste in the reclamation process. Modified 3.03. B as indicated.

A. Remove used broadloom carpets in large pieces, roll tightly and pack neatly in container. [Include carpet scrap and waste from new installation.]

B. Deposit only clean, dry used carpets in containers. Clean shall be defined as carpet free from demolition debris or asbestos contamination, garbage, and tack strips.

C. Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI).

**SPEC NOTE:** If carpet disposal method is known, delete 3.04 or 3.05 as appropriate. If disposal method is unknown or if both are to be used, retain both articles.

### 3.04 CONTAINER DISPOSAL

A. Place used carpet in 40-yd container supplied by reclamation agency. Containers are fully enclosed, front (end) loading. Place only used commercial carpeting in collection container. Container shall be kept locked or supervised.

B. Use effective packing techniques to maximize the amount of material in the container. On average, container holds 2000 to 3000 square yards.

C. Neatly stack carpet tiles or repack in cardboard boxes prior to placing in container.

D. When container is full, contact reclamation agency to coordinate pickup and drop-off of replacement container. If

container is locked for security purposes, remove the lock prior to pickup.

3.05 TRUCK TRAILER DISPOSAL

- A. Place used carpet in 53-foot trailer supplied by Reclamation Agency. The same packing techniques should be followed for packing container.
- B. Comply with Department of Transportation regulations for weight limits. Typical maximum weight of used carpet on the trailer is 45,000 lbs.
- C. If packing carpet tiles, do not stack higher than 6 feet.

|  |
|--|
| <p><b>SPEC NOTE:</b> Edit article 3.06 as necessary to reflect any special interior conditions that exist when removing used carpet.</p> |
|--|

3.06 INTERIOR OPERATIONS

- A. Contaminants from work that occurs within a single room may be contained by sealing doors and other openings with duct tape at head, jamb, and sill.
- B. Use window exhaust systems to establish negative pressure in contaminant producing work area, ensuring continuous flow of air into work area. Do not open windows in work area except when an exhaust fan is used. Close windows at end of each work shift.
- C. Seal exhaust system ductwork which might leak into building or mechanical systems.
- D. Damp mop hard surface floors in work area daily to minimize tracking of contaminants from work area. In carpeted areas, protect carpet with plastic and plywood; provide hard surfaced area at entrances for daily damp mopping.

**END OF SECTION**



1 **Air Force Interior Design Guides**  
2 **Chapter 7 – Attachment 2: Sample Specifications**  
3 **Blank Specification**  
4  
5

6 **CSI Section 09680 – Carpet**  
7

8 **Project:** <Insert name and location of project.>  
9  
10

11 **1. Part 1 – General**  
12

13 **1.1. Summary:** This Section includes woven carpet, tufted carpet, carpet tile, and carpet cushion.  
14

15 **1.2. Submittals**  
16

17 **1.2.1.** Product Data: For each product indicated.  
18

19 **1.2.2.** Shop Drawings: Include the following: <Edit list below to suit project.>

- 20 • Existing floor materials to be removed.
  - 21 • Existing floor materials to remain.
  - 22 • Seam locations.
  - 23 • Pattern type, repeat, location, direction, and starting point.
  - 24 • Pile direction.
  - 25 • Insets and borders.
  - 26 • Transition, and other accessory strips.
  - 27 • Transition details to other flooring materials.
- 28

29 **1.2.3.** Samples: For each carpet, cushion, and exposed accessory and for each color and pattern  
30 required, as per Contracting Officer request. <Previous paragraph assumes manufacturer's  
31 **standard-size samples are acceptable. Revise to suit project.**>  
32

33 **1.2.4.** Product Schedule: Use same room and product designations indicated on Drawings and in  
34 schedules.  
35

36 **1.2.5.** Maintenance data.  
37

38 **1.3. Quality Assurance**  
39

40 **1.3.1.** Contractor/Installer Qualifications: All work is to be performed by contractors/installers who are  
41 CFI Certified Floorcovering Installers (International Certified Flooring Installer Association), or  
42 manufacturer's approved installers. Foremen on the job-site must be "Certified C-II Minimum."  
43

44 **1.3.2.** Inspection: All materials to be made available for inspection as per Contracting Officer request.  
45

46 **1.3.3.** Install mockups as per Contracting Officer request. Approved mockups may become part of the  
47 completed Work if undisturbed at time of Substantial Completion.  
48

49 **1.4. Delivery, Storage, Handling, and Labeling**  
50

51 **1.4.1.** Comply with CRI 104, Section 5, "Storage and Handling."  
52

53 **1.4.2.** Labeling:

- A label meeting the Federal Labeling Requirements, as stated in the Textile Products Identification Act under the Federal Trade Commission, shall be attached to the certification sample and the product delivered to the purchaser.
- The manufacturer is required to put all information as to the country of origin, fiber content, manufacturer's name or RN number, or a label or tag attached to a conspicuous place on the outside of the carpet. This information should be set forth consecutively and separately in type or lettering plainly legible and of equal size.

## 1.5. Project Conditions

1.5.1. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."

1.5.2. Environmental Limitations: Do not install carpet and cushion until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.5.3. Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by manufacturer. ~~<Delete previous paragraph if products are not adhesively applied to concrete substrates. Revise to suit Project.>~~

1.5.4. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

## 1.6. Warranty

1.6.1. Carpet Warranty: Manufacturer's standard form in which manufacturer agrees to replace carpet that does not comply with requirements or that fails within [10] ~~<Insert number>~~ years from date of Substantial Completion. Warranty does not include deterioration or failure of carpet from unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.

1.6.2. Carpet Cushion Warranty: Manufacturer's standard form agreeing to replace carpet cushion that does not comply with requirements or that fails within [10] ~~<Insert number>~~ years from date of Substantial Completion. Warranty does not include deterioration or failure of carpet cushion from unusual traffic, failure of substrate, vandalism, or abuse. Failure includes, but is not limited to, permanent indentation or compression.

## 1.7. Extra Materials

1.7.1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet: Full-width rolls or uncut carpet tiles equal to [10] ten percent of amount installed for each type indicated, but not less than [10 sq. yd. (8.3 sq. m)].

## 1.8. Applicable Publications:

1.8.1. Carpet and Rug Institute

- CRI 104, *Standard for Installation of Commercial Carpet*
- CRI 105, *Standard for Installation of Residential Carpet*
- CRI TM-102
- CRI Indoor Air Quality (IAQ) "Green Label" Testing Programs
- Commercial Carpet Specification Guidelines

Order from: The Carpet and Rug Institute

109 P.O. Box 2048  
110 Dalton, GA 30722-2048  
111 Fax 706-278-8835  
112 Telephone (706)278-0232 or 1-800-882-8846  
113

114 **1.8.2. American Society for Testing and Materials (ASTM):**

- 115 • ASTM D-5793, *Standard Test Method for Binding Sites Per Unit Length or Width of Pile*
- 116 *Yarn Floor Coverings*
- 117 • ASTM D-418, *Standard Test Methods for Testing Pile Yarn Floor Covering Construction*
- 118 • ASTM D-5116, *Standard Guide for Small-Scale Environmental Chamber Determinations*
- 119 *of Organic Emissions from Indoor Materials/Products*
- 120 • ASTM D-5848, *Standard Test Method for Mass Per Unit Area of Pile Yarn Floor*
- 121 *Coverings*
- 122 • ASTM D-1335, *Standard Method of Test for Tuft Bind of Pile Floor Coverings*
- 123 • ASTM D-3936, *Test Method for Delamination Strength of Secondary Backing of Pile*
- 124 *Floor Coverings*
- 125 • ASTM D-3574, *Standard Test Methods for Flexible Cellular Materials – Slab, Bonded,*
- 126 *and Molded Urethane Foams*
- 127 • ASTM D-3676, *Standard Specification for Rubber Cellular Cushions Used for Carpet or*
- 128 *Rug Underlay*
- 129 • ASTM E-648, *Standard Test Methods for Critical Radiant Flux of Floor-Covering Systems*
- 130 *Using a Radiant Heat Energy Source*
- 131 • ASTM D-2859, *Standard Test Method for Ignition Characteristics of Finished Textile*
- 132 *Floor Covering Materials*

133  
134 Order from: <http://www.document-center.com/home.cfm/sid=20478080/>  
135

136 **1.8.3. Headquarters Air Force Center for Environmental Excellence (HQ AFCEE):**

- 137 • ETL 00-6: Air Force Carpet Standard
- 138 • *Carpet Selection Handbook*

139  
140 (reference <http://www.afcee.brooks.af.mil/dc/dcd/interior/intdespu.htm>)  
141

142 **1.8.4. American Association of Textile Chemists and Colorists (AATCC):**

- 143 • AATCC 20, *Qualitative Fiber Analysis*
- 144 • AATCC 134-1996, *Electrostatic Propensity of Carpets*
- 145 • AATCC 165, *Colorfastness to Crocking: Carpets - AATCC Crockmeter Method*
- 146 • AATCC 16 Option E, *Colorfastness to Light: Water-Cooled Xenon-Arc Lamp, Continuous*
- 147 *Light*
- 148 • AATCC 171, *Carpets: Cleaning of, Hot Water Extraction Method*

149  
150 Order from: <http://www.aatcc.org/>  
151

152 **1.8.5. Federal Specification**

- 153 • DDD-C-0095A Shrinkage, Carpet and Rugs, Wool, Nylon, Acrylic, Modacrylic, Polyester,
- 154 Polypropylene
- 155 • Uniform Federal Accessibility Standards (refer to [http://www.access-](http://www.access-board.gov.bfdg.bfdg.htm)
- 156 [board.gov.bfdg.bfdg.htm](http://www.access-board.gov.bfdg.bfdg.htm) )

157  
158 **1.8.6. Environmental Protection Agency**

- 159 • EPA *Comprehensive Procurement Guidelines*

160  
161 Refer to <http://www.epa.gov/cpg/index.htm>  
162

163 1.8.7. National Fire Protection Association  
164 • NFPA 99, *Standard for Healthcare Facilities*  
165  
166 Order from <http://www.nfpa.org/Codes/index.asp>.  
167

168 1.8.8. Public Law  
169 • Code of Federal Regulations (CFR) Part 1630, *Standard for the Surface Flammability of*  
170 *Carpets and Rugs (FF 1-70)* (reference  
171 [http://www.access.gpo.gov/nara/cfr/waisidx\\_99/16cfr1630\\_99.html](http://www.access.gpo.gov/nara/cfr/waisidx_99/16cfr1630_99.html).)  
172 • Public Law 101-336, Americans with Disabilities Act (reference  
173 <http://www.usdoj.gov/crt/ada/pubs/ada.txt>.)  
174

## 175 2. Part 2 - Products

176  
177 2.1 Carpet <Insert drawing designation, e.g., CPT-1.>  
178 <Copy and re-edit this Article for each carpet required.>  
179

180 2.1.1. End-use Application: <Insert End-use Application> Application to be selected from CRI  
181 *Commercial Carpet Specification Guidelines* document, Table 1, pages 2-5.  
182

183 2.1.2. Appearance Retention Rating: <Insert ARR> Rating as specified in Section 2.3, page 5, of the  
184 CRI *Commercial Carpet Specifications Guidelines* document.  
185

186 2.1.3. Minimum Use Classification: <Insert Use Classification> Classification to be selected from CRI  
187 *Commercial Carpet Specification Guidelines* document, Table 1, pages 2-5.  
188

189 2.1.4. Carpet type: <Insert Carpet Type> Carpet type to be selected from *Appendix A-1, Specification*  
190 *Guidelines*, pages 8-55.  
191

192 2.1.5. Pile Fiber Content: <Insert content by percentage, i.e. 100% Antron Nylon> The fiber shall  
193 consist of 100% branded (i.e., federally registered trademark) soil-hiding and static-resistant, with a  
194 permanent integral static control element (antistatic topical coatings are not acceptable), advanced  
195 generation fiber which may contain reclaimed polymer. Apart from meeting any denier, ply, and/or weight  
196 requirements, the yarn must have sufficient twist and/or entanglement properties to achieve the specified  
197 Appearance Retention Rating (ARR). Pile fiber identity is to be tested in accordance with AATCC 20.  
198

199 2.1.6. Recycled Content:  
200

201 2.1.6.1. Carpet: <Insert either "a" or "b," as indicated below.> Carpet is included in the EPA's  
202 *Comprehensive Procurement Guidelines* for affirmative procurement of recycled content products.  
203

204 a. Recycled content carpet, meeting the EPA requirements at [www.epa.gov/cpg/products/carpet.htm](http://www.epa.gov/cpg/products/carpet.htm)  
205 is specified for this project. Submit manufacturer's label or cut sheets indicating the recycled  
206 material content.

207 b. Recycled content carpet does not meet price or availability requirements and/or performance  
208 requirements for this project, and has not been selected.  
209

210 2.1.6.2 Cushion: <Insert either "a" or "b," as indicated below.> Cushion is included in the EPA's  
211 *Comprehensive Procurement Guidelines* for affirmative procurement of recycled content products.  
212

213 a. Recycled content cushion, meeting the EPA requirements at [www.epa.gov/cpg/products/carpet.htm](http://www.epa.gov/cpg/products/carpet.htm)  
214 is specified for this project. Submit manufacturer's label or cut sheets indicating the recycled  
215 material content.

216 b. Recycled content cushion does not meet price or availability requirements and/or performance  
217 requirements for this project, and has not been selected.

218  
219 **2.1.7.** Surface Texture: [Cut pile (same height, pattern, or geometric designs)] [Loop pile (or textured  
220 loop, multi-level loop, or pattern)] [Cut and loop pile (same height combination or varying levels of pile  
221 height and pile texture)] <Select one.>  
222  
223 **2.1.8.** Yarn: [Singles] [Multi-ply or commingled] <Select one.>  
224  
225 **2.1.9.** Yarn Twist: <Insert twists/inch, optional information.>  
226  
227 **2.1.10.** Tufting Machine Gauge: [1/8] [1/10] [1/12] [1/13] [5/64] <Select one.> Gauge is to be  
228 measured in accordance with *ASTM D-5793*.  
229  
230 **2.1.11.** Number of Stitches: <Insert stitches/inch.>  
231  
232 **2.1.12.** Finished Pile Thickness: <Insert number of inches.> Thickness is to be tested in accordance  
233 with *ASTM D-418*.  
234  
235 **2.1.13.** Average Finished Pile Weight (w): <Insert oz/square yard.> Pile weight to be tested in  
236 accordance with *ASTM D-5848*.  
237  
238 **2.1.14.** Dye Method: [Piece] [Continuous] [Yarn or solution dyed] [Printed] <Select one.>  
239  
240 **2.1.15.** Colors: < To be selected by Contracting Officer with Design Agent approval from a  
241 potential vendor color line.>  
242  
243 **2.1.16.** Pile Density: <Insert oz/cu. yd.> Density is to be a minimum of 4000 oz/cu. yd. for commercial  
244 applications. Contracting Officer may elect to allow carpet with a density of 3500 oz/cu. yd. for residential  
245 applications, provided that the product meets all other applicable requirements.  
246  
247 **2.1.17.** Backing: <Insert either a or b, as indicated below.>  
248  
249 a. A primary backing made from 100% synthetic material and a secondary scrim backing made from  
250 100% synthetic material. Backing material identity is to be tested in accordance with *AATCC 20*.  
251 b. A unitary backing for direct glue-down installations only. Primary backing made from 100%  
252 synthetic material and with an application of high quality latex to increase tuft bind performance  
253 properties without the addition of a secondary scrim backing. Backing material identity is to be  
254 tested in accordance with *AATCC 20*.  
255  
256 **2.1.18.** Performance characteristics as follows:  
257  
258 • Tuft Bind: <Insert average value.> Tuft bind to be a minimum of 20.0 lbs. average for  
259 broadloom and 15.0 lbs. average for carpet tile, tested according to *ASTM D-1335*.  
260 • Dimensional Stability for carpet tiles: <Insert % value.> Dimensional stability to be tested  
261 according to *Aachener Test*.  
262 • Delamination Resistance of the Secondary Backing: <Insert value.> Resistance is to be tested  
263 according to *ASTM D-3936* (not applicable to unitary).  
264 • Colorfastness to Crocking: <Insert value, for entire color line.> Not less than 4, wet and dry,  
265 per *AATCC 165*.  
266 • Colorfastness to light: <Insert value, for entire color line.> Not less than 4 after 40 AFU  
267 (AATCC fading units) per *AATCC 16E*.  
268 • Fluorochemical Finish: <Insert value.> Finish to be tested according to *CRI TM-102*.  
269 • Electrostatic Propensity: <Insert kV.> Propensity to be a maximum of 3.5 kV for commercial  
270 applications and a maximum of 5.0 kV for residential applications, as tested in accordance with  
271 *AATCC 134*. Computer grade carpets, by special request, shall have electrostatic propensity of  
272 no more than 2.0 kV (*AATCC 134*), and electrical resistance of no less than 25,000 ohms and no

- 273 more than 109 ohms (*NFPA 99*). All shall have a static control construction which gives  
 274 adequate durability and performance. All GSA carpets except those made with natural fiber shall  
 275 be cleaned for 3 cycles (one with detergent, followed by two clear water rinses) before testing for  
 276 electrostatic propensity (*AATCC 134*). Cleaning shall be in accordance with *AATCC 171*.  
 277 • Electrical resistance measured according to general methodology of *NFPA 99* for conductive  
 278 floors, modified to measure in required range – 70oF (20oC), 20% RH, and to use 100 volts in  
 279 lieu of 500 volts. Appropriate instrumentation as recommended by IBM for performance of their  
 280 version of the *NFPA* method. Electrical resistance requirements relate to an installed carpet.  
 281 NOTE: For carpet tiles, in addition to the surface-to-ground test, surface-to-surface testing is  
 282 required.
- 283 • Methenamine Pill Test/ Tablet Test: Comply with *Federal Flamability Standards CPSC FF 1-70*,  
 284 when tested according to *ASTM D 2859*.
  - 285 • Radiant Panel Test: A minimum critical radiant flux of 0.45 watts per cm. sq. when tested over  
 286 fiber cement board (or over carpet and pad assembly) according to *ASTM E-648*.
  - 287 • Indoor Air Quality - Carpet: All products must be certified with the CRI Indoor Air Quality (IAQ)  
 288 Carpet Testing Program “Green Label” or tested for compliance to meet the CRI IAQ Carpet  
 289 Testing Program requirements and criteria. All products must be retested on a quarterly basis to  
 290 ensure continuing compliance with the CRI test program requirements. Products are additionally  
 291 subject to compliance with *ASTM D-5116*.
  - 292 • Indoor Air Quality - Cushion: Separate cushion for stretch-in installations shall only be those  
 293 certified with the CRI Indoor Air Quality (IAQ) Carpet Testing Program “Green Label” or tested for  
 294 compliance to meet the CRI IAQ Carpet Testing Program requirements and criteria. All products  
 295 must be retested on a quarterly basis to ensure continuing compliance with the CRI test program  
 296 requirements. Products are additionally subject to compliance with *ASTM D-5116*.
  - 297 • Indoor Air Quality - Adhesives: Installation adhesives and seam sealers shall only be those  
 298 certified with the CRI Indoor Air Quality (IAQ) Carpet Testing Program “Green Label” or tested for  
 299 compliance to meet the CRI IAQ Carpet Testing Program requirements and criteria. All products  
 300 must be retested on a quarterly basis to ensure continuing compliance with the CRI test program  
 301 requirements. Products are additionally subject to compliance with *ASTM D-5116*.

303 **2.1.19. Certifications:** The manufacturer will be required to submit copies of independent laboratory  
 304 reports showing the results of the following tests:

- 305 • Electrostatic (*AATCC 134*)
- 306 • Electrical Resistance (*NFPA 99*)
- 307 • Flooring Radiant Panel Test (*ASTM E-648*, report should be 2 years old or less)

309 **2.2. CARPET CUSHION** <Insert drawing designation, e.g., **CPTC-1**.>

310 <Copy and re-edit this Article for each carpet cushion required. If known, insert names of manufacturers  
 311 and products.>

313 **2.2.1. Traffic Classification:** CCC Class [I, moderate traffic] [II, heavy traffic] [III, extra-heavy traffic].  
 314 <Select one.>

316 **2.2.2. Rubber Cushion:**

- 317 • [Flat] [Textured flat] [Reinforced]. <Select one.>
- 318 • Weight: <Insert oz./sq. yd. (g/sq. m).>
- 319 • Thickness: <Insert inches (mm)> plus 5 percent maximum.
- 320 • Compression Resistance: <Insert lb/sq. in. (kg/sq. m)> at [25] [65] percent per ASTM D 3676.
- 321 • Density: <Insert lb/cu. ft. (kg/cu. m).>

323 **2.2.3. Polyurethane Foam Cushion:**

- 324 • Type: [Grafted prime] [Densified] [Bonded] [Mechanically frothed] foam. <Select one.>
- 325 • Compression Force Deflection at 65 Percent: <Insert lb/sq. in. (kg/sq. m) of polymer density>  
 326 per ASTM D 3574.

- 327       • Thickness: <Insert inches (mm).>  
328       • Density: <Insert lb/cu. ft. (kg/cu. m).>  
329

330   **3. Part 3 - Execution**

331  
332   **3.1 Installation**

333  
334   **3.1.1.** Comply with *CRI 104*, Section [8, "Direct Glue-Down."] [9, "Double Glue-Down."] [10, "Attached  
335 Cushion."] [11, "Stretch-in Utilizing Tackless Strip."] <Select one.>  
336

337   **3.1.2.** Comply with *CRI 104*, Section 12, "Carpet on Stairs."  
338

339   **3.1.3.** Maintain uniformity of carpet direction and lay of pile. At doorways, center seams under door in  
340 closed position. Bind or seal cut edges as recommended by carpet manufacturer.  
341

342   **3.1.4.** Install pattern parallel to walls and borders.  
343

344   **3.1.5.** Install per manufacturer's recommendations and specifications.  
345

346   <End of Section 09680, Carpet Specification>

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347 **Air Force Interior Design Guides**  
348 **Chapter 7 – Attachment 2: Sample Specifications**  
349 **Blank Specification**

350  
351  
352 **CSI Section 09680 – Carpet**

353  
354 **Project: Jones Retail Store**

355  
356  
357 **1. Part 1 – General**

358  
359 **1.1. Summary:** This Section includes woven carpet, tufted carpet, carpet tile, and carpet cushion.

360  
361 **1.2. Submittals**

362  
363 **1.2.1. Product Data:** For each product indicated.

364  
365 **1.2.2. Shop Drawings:** Include the following:

- 366 • Existing floor materials to be removed.
- 367 • Existing floor materials to remain.
- 368 • Seam locations.
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- 370 • Pile direction.
- 371 • Insets and borders.
- 372 • Transition, and other accessory strips.
- 373 • Transition details to other flooring materials.

374  
375 **1.2.3. Samples:** For each carpet, cushion, and exposed accessory and for each color and pattern  
376 required, as per Contracting Officer request.

377  
378 **1.2.4. Product Schedule:** Use same room and product designations indicated on Drawings and in  
379 schedules.

380  
381 **1.2.5. Maintenance data.**

382  
383 **1.3. Quality Assurance**

384  
385 **1.3.1. Contractor/Installer Qualifications:** All work is to be performed by contractors/installers who are  
386 CFI Certified Floorcovering Installers (International Certified Flooring Installer Association), or  
387 manufacturer's approved installers. Foremen on the job-site must be "Certified C-II Minimum."

388  
389 **1.3.2. Inspection:** All materials to be made available for inspection as per Contracting Officer request.

390  
391 **1.3.3. Install mockups as per Contracting Officer request.** Approved mockups may become part of the  
392 completed Work if undisturbed at time of Substantial Completion.

393  
394 **1.4. Delivery, Storage, Handling, and Labeling**

395  
396 **1.4.1. Comply with CRI 104, Section 5, "Storage and Handling."**

397  
398 **1.4.2. Labeling:**



- A label meeting the Federal Labeling Requirements, as stated in the Textile Products Identification Act under the Federal Trade Commission, shall be attached to the certification sample and the product delivered to the purchaser.
- The manufacturer is required to put all information as to the country of origin, fiber content, manufacturer's name or RN number, or a label or tag attached to a conspicuous place on the outside of the carpet. This information should be set forth consecutively and separately in type or lettering plainly legible and of equal size.

## 1.5. Project Conditions

1.5.1. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."

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1.6.2. Carpet Cushion Warranty: Manufacturer's standard form agreeing to replace carpet cushion that does not comply with requirements or that fails within ten [10] years from date of Substantial Completion. Warranty does not include deterioration or failure of carpet cushion from unusual traffic, failure of substrate, vandalism, or abuse. Failure includes, but is not limited to, permanent indentation or compression.

## 1.7. Extra Materials

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## 1.8. Applicable Publications:

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- CRI TM-102
- CRI Indoor Air Quality (IAQ) "Green Label" Testing Programs
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Order from: The Carpet and Rug Institute  
P.O. Box 2048

454 Dalton, GA 30722-2048  
455 Fax 706-278-8835  
456 Telephone (706)278-0232 or 1-800-882-8846  
457

458 **1.8.2. American Society for Testing and Materials (ASTM):**

- 459 • ASTM D-5793, *Standard Test Method for Binding Sites Per Unit Length or Width of Pile*
- 460 *Yarn Floor Coverings*
- 461 • ASTM D-418, *Standard Test Methods for Testing Pile Yarn Floor Covering Construction*
- 462 • ASTM D-5116, *Standard Guide for Small-Scale Environmental Chamber Determinations*
- 463 *of Organic Emissions from Indoor Materials/Products*
- 464 • ASTM D-5848, *Standard Test Method for Mass Per Unit Area of Pile Yarn Floor*
- 465 *Coverings*
- 466 • ASTM D-1335, *Standard Method of Test for Tuft Bind of Pile Floor Coverings*
- 467 • ASTM D-3936, *Test Method for Delamination Strength of Secondary Backing of Pile*
- 468 *Floor Coverings*
- 469 • ASTM D-3574, *Standard Test Methods for Flexible Cellular Materials – Slab, Bonded,*
- 470 *and Molded Urethane Foams*
- 471 • ASTM D-3676, *Standard Specification for Rubber Cellular Cushions Used for Carpet or*
- 472 *Rug Underlay*
- 473 • ASTM E-648, *Standard Test Methods for Critical Radiant Flux of Floor-Covering Systems*
- 474 *Using a Radiant Heat Energy Source*
- 475 • ASTM D-2859, *Standard Test Method for Ignition Characteristics of Finished Textile*
- 476 *Floor Covering Materials*

477 Order from: <http://www.document-center.com/home.cfm/sid=20478080/>

478 **1.8.3. Headquarters Air Force Center for Environmental Excellence (HQ AFCEE):**

- 481 • ETL 00-6: Air Force Carpet Standard
- 482 • *Carpet Selection Handbook*

483 (reference <http://www.afcee.brooks.af.mil/dc/dcd/interior/intdespu.htm>)

484 **1.8.4. American Association of Textile Chemists and Colorists (AATCC):**

- 487 • AATCC 20, *Qualitative Fiber Analysis*
- 488 • AATCC 134-1996, *Electrostatic Propensity of Carpets*
- 489 • AATCC 165, *Colorfastness to Crocking: Carpets - AATCC Crockmeter Method*
- 490 • AATCC 16 Option E, *Colorfastness to Light: Water-Cooled Xenon-Arc Lamp, Continuous*
- 491 *Light*
- 492 • AATCC 171, *Carpets: Cleaning of, Hot Water Extraction Method*

493 Order from: <http://www.aatcc.org/>

494 **1.8.5. Federal Specification**

- 497 • DDD-C-0095A Shrinkage, Carpet and Rugs, Wool, Nylon, Acrylic, Modacrylic, Polyester,
- 498 Polypropylene
- 499 • Uniform Federal Accessibility Standards (refer to [http://www.access-](http://www.access-board.gov/bfdg.bfdg.htm)
- 500 [board.gov/bfdg.bfdg.htm](http://www.access-board.gov/bfdg.bfdg.htm) )

501 **1.8.6. Environmental Protection Agency**

- 503 • EPA *Comprehensive Procurement Guidelines*

504 Refer to <http://www.epa.gov/cpg/index.htm>

505 **1.8.7. National Fire Protection Association**

- 508                   • NFPA 99, *Standard for Healthcare Facilities*  
509  
510                   Order from <http://www.nfpa.org/Codes/index.asp>.

511  
512 **1.8.8. Public Law**

- 513                   • Code of Federal Regulations (CFR) Part 1630, *Standard for the Surface Flammability of*  
514                    *Carpets and Rugs (FF 1-70)* (reference  
515                    [http://www.access.gpo.gov/nara/cfr/waisidx\\_99/16cfr1630\\_99.html](http://www.access.gpo.gov/nara/cfr/waisidx_99/16cfr1630_99.html).)  
516                   • Public Law 101-336, Americans with Disabilities Act (reference  
517                    <http://www.usdoj.gov/crt/ada/pubs/ada.txt>.)  
518

519 **2. Part 2 - Products**

520  
521 **2.1 Carpet: CPT-1**

522  
523 **2.1.1. End-use Application: Retail Store Office.** Application to be selected from CRI *Commercial*  
524 *Carpet Specification Guidelines* document, Table 1, pages 2-5.

525  
526 **2.1.2. Appearance Retention Rating: Heavy.** Rating as specified in Section 2.3, page 5, of the CRI  
527 *Commercial Carpet Specifications Guidelines* document.

528  
529 **2.1.3. Minimum Use Classification: Heavy.** Classification to be selected from CRI *Commercial Carpet*  
530 *Specification Guidelines* document, Table 1, pages 2-5.

531  
532 **2.1.4. Carpet type: Tufted.** Carpet type to be selected from *Appendix A-1, Specification Guidelines*,  
533 pages 8-55.

534  
535 **2.1.5. Pile Fiber Content: 100% Antron Nylon, type 6,6.** The fiber shall consist of 100% branded (i.e.,  
536 federally registered trademark) soil-hiding and static-resistant, with a permanent integral static control  
537 element (antistatic topical coatings are not acceptable), advanced generation fiber which may contain  
538 reclaimed polymer. Apart from meeting any denier, ply, and/or weight requirements, the yarn must have  
539 sufficient twist and/or entanglement properties to achieve the specified Appearance Retention Rating  
540 (ARR). Pile fiber identity is to be tested in accordance with AATCC 20.

541  
542 **2.1.6. Recycled Content:**

543  
544 **2.1.6.1. Carpet: (b)** Carpet is included in the EPA's *Comprehensive Procurement Guidelines* for  
545 affirmative procurement of recycled content products.

546  
547     **c.** Recycled content carpet, meeting the EPA requirements at [www.epa.gov/cpg/products/carpet.htm](http://www.epa.gov/cpg/products/carpet.htm)  
548     is specified for this project. Submit manufacturer's label or cut sheets indicating the recycled  
549     material content.

550     **d.** Recycled content carpet does not meet price or availability requirements and/or performance  
551     requirements for this project, and has not been selected.

552  
553 **2.1.6.2 Cushion: (a)** Cushion is included in the EPA's *Comprehensive Procurement Guidelines* for  
554 affirmative procurement of recycled content products.

555  
556     **c.** Recycled content cushion, meeting the EPA requirements at [www.epa.gov/cpg/products/carpet.htm](http://www.epa.gov/cpg/products/carpet.htm)  
557     is specified for this project. Submit manufacturer's label or cut sheets indicating the recycled  
558     material content.

559     **d.** Recycled content cushion does not meet price or availability requirements and/or performance  
560     requirements for this project, and has not been selected.

561  
562 **2.1.7. Surface Texture: Textured loop**

563  
564 **2.1.8. Yarn: 3-ply Comingled**  
565  
566 **2.1.9. Yarn Twist: N/A**  
567  
568 **2.1.10. Tufting Machine Gauge: 1/10 GA.** Gauge is to be measured in accordance with *ASTM D-5793*.  
569  
570 **2.1.11. Number of Stitches: 13.5 stitches/inch.**  
571  
572 **2.1.12. Finished Pile Thickness: 0.160 inches average.** Thickness is to be tested in accordance with  
573 *ASTM D-418*.  
574  
575 **2.1.13. Average Finished Pile Weight (w): 32 ounces/square yard.** Pile weight to be tested in  
576 accordance with *ASTM D-5848*.  
577  
578 **2.1.14. Dye Method: Solution-dyed.**  
579  
580 **2.1.15. Colors: To be selected by Contracting Officer with Design Agent approval from a potential**  
581 **vendor color line.**  
582  
583 **2.1.16. Pile Density: 4,200 oz/cu. yd.** Density is to be a minimum of 4000 oz/cu. yd. for commercial  
584 applications. Contracting Officer may elect to allow carpet with a density of 3500 oz/cu. yd. for residential  
585 applications, provided that the product meets all other applicable requirements.  
586  
587 **2.1.17. Backing: (a)**  
588  
589 c. A primary backing made from 100% synthetic material and a secondary scrim backing made from  
590 100% synthetic material. Backing material identity is to be tested in accordance with *AATCC 20*.  
591 d. A unitary backing for direct glue-down installations only. Primary backing made from 100%  
592 synthetic material and with an application of high quality latex to increase tuft bind performance  
593 properties without the addition of a secondary scrim backing. Backing material identity is to be  
594 tested in accordance with *AATCC 20*.  
595  
596 **2.1.18. Performance characteristics as follows:**  
597  
598 • Tuft Bind: **22.0 lbs average.** Tuft bind to be a minimum of 20.0 lbs. average for broadloom and  
599 15.0 lbs. average for carpet tile, tested according to *ASTM D-1335*.  
600 • Dimensional Stability for carpet tiles: **N/A** Dimensional stability to be tested according to  
601 *Aachener Test*.  
602 • Delamination Resistance of the Secondary Backing: **3.0 lbs per square inch** Resistance is to  
603 be tested according to *ASTM D-3936* (not applicable to unitary).  
604 • Colorfastness to Crocking: **4 wet, 4 dry.** Not less than 4, wet and dry, per *AATCC 165*.  
605 • Colorfastness to light: **(4)** Not less than 4 after 40 AFU (AATCC fading units) per *AATCC 16E*.  
606 • Fluorochemical Finish: **375 ppm average.** Finish to be tested according to *CRI TM-102*.  
607 • Electrostatic Propensity: **3.0 kV.** Propensity to be a maximum of 3.5 kV for commercial  
608 applications and a maximum of 5.0 kV for residential applications, as tested in accordance with  
609 *AATCC 134*. Computer grade carpets, by special request, shall have electrostatic propensity of  
610 no more than 2.0 kV (*AATCC 134*), and electrical resistance of no less than 25,000 ohms and no  
611 more than 109 ohms (*NFPA 99*). All shall have a static control construction which gives  
612 adequate durability and performance. All GSA carpets except those made with natural fiber shall  
613 be cleaned for 3 cycles (one with detergent, followed by two clear water rinses) before testing for  
614 electrostatic propensity (*AATCC 134*). Cleaning shall be in accordance with *AATCC 171*.  
615 • Electrical resistance measured according to general methodology of *NFPA 99* for conductive  
616 floors, modified to measure in required range – 70oF (20oC), 20% RH, and to use 100 volts in  
617 lieu of 500 volts. Appropriate instrumentation as recommended by IBM for performance of their

- 618 version of the NFPA method. Electrical resistance requirements relate to an installed carpet.  
619 NOTE: For carpet tiles, in addition to the surface-to-ground test, surface-to-surface testing is  
620 required.
- 621 • Methenamine Pill Test/ Tablet Test: Comply with *Federal Flammability Standards CPSC FF 1-70*,  
622 when tested according to *ASTM D 2859*.
  - 623 • Radiant Panel Test: A minimum critical radiant flux of 0.45 watts per cm. sq. when tested over  
624 fiber cement board (or over carpet and pad assembly) according to *ASTM E-648*.
  - 625 • Indoor Air Quality - Carpet: All products must be certified with the CRI Indoor Air Quality (IAQ)  
626 Carpet Testing Program "Green Label" or tested for compliance to meet the CRI IAQ Carpet  
627 Testing Program requirements and criteria. All products must be retested on a quarterly basis to  
628 ensure continuing compliance with the CRI test program requirements. Products are additionally  
629 subject to compliance with *ASTM D-5116*.
  - 630 • Indoor Air Quality - Cushion: Separate cushion for stretch-in installations shall only be those  
631 certified with the CRI Indoor Air Quality (IAQ) Carpet Testing Program "Green Label" or tested for  
632 compliance to meet the CRI IAQ Carpet Testing Program requirements and criteria. All products  
633 must be retested on a quarterly basis to ensure continuing compliance with the CRI test program  
634 requirements. Products are additionally subject to compliance with *ASTM D-5116*.
  - 635 • Indoor Air Quality - Adhesives: Installation adhesives and seam sealers shall only be those  
636 certified with the CRI Indoor Air Quality (IAQ) Carpet Testing Program "Green Label" or tested for  
637 compliance to meet the CRI IAQ Carpet Testing Program requirements and criteria. All products  
638 must be retested on a quarterly basis to ensure continuing compliance with the CRI test program  
639 requirements. Products are additionally subject to compliance with *ASTM D-5116*.

641 **2.1.19. Certifications:** The manufacturer will be required to submit copies of independent laboratory  
642 reports showing the results of the following tests:

- 643 • Electrostatic (*AATCC 134*)
- 644 • Electrical Resistance (*NFPA 99*)
- 645 • Flooring Radiant Panel Test (*ASTM E-648*, report should be 2 years old or less)

646  
647 **2.2. CARPET CUSHION: N/A**

### 649 **3. Part 3 - Execution**

#### 650 **3.1 Installation**

651 **3.1.1.** Comply with *CRI 104*, **Section 8, "Direct Glue-Down."**

652  
653 **3.1.2.** Comply with *CRI 104*, Section 12, "Carpet on Stairs."

654  
655 **3.1.3.** Maintain uniformity of carpet direction and lay of pile. At doorways, center seams under door in  
656 closed position. Bind or seal cut edges as recommended by carpet manufacturer.

657  
658 **3.1.4.** Install pattern parallel to walls and borders.

659  
660 **3.1.6.** Install per manufacturer's recommendations and specifications.

661  
662  
663 **<End of Section 09680, Carpet Specification>**  
664

CHAPTER 8

RESERVED

ARCHIVED

## CHAPTER CONTENTS

INTRODUCTION  
 HISTORY  
 COLOR AND EMOTION  
 COLOR PREFERENCES  
 COLOR AND LIGHT  
 OPTICAL EFFECTS  
 BASIC COLOR THEORY  
 COLOR SCHEMES  
 APPLYING COLOR IN FACILITIES



*SAC Theater and Lobby*  
 Offutt Air Force Base, Nebraska



*SAC Theater and Lobby*  
 Offutt Air Force Base, Nebraska

# Interior Color Selection

## INTRODUCTION

*Color* is defined as the perceived quality of light reflected or emitted by an object. The term “perceived” is important because each of us views color differently. Some of us are extremely sensitive to color and its application, while others do not consciously take notice. We can hardly ignore the drama of a beautiful sunset or an impressive landscape, but color in interior spaces is often ignored. Color has a big impact on how we feel and behave in a space. In a drab dark room we may feel uncomfortable, while in a bright, vibrant room, spirits tend to be cheery and delightful. Yet we don’t realize that these emotions can stem from color.

The National Bureau of Standards estimates that the human eye can distinguish over ten million colors. Yet, color is much more than reflected light, it is one of the most expressive elements of design because its quality affects our emotions directly and immediately. Successful interior designs harmonize form, space, light, texture, and color. Color is the integral element in every design, for a well-planned color scheme can completely change the appearance and mood of a space.

## HISTORY

History shows that color trends change with the times. The following color synopsis for the last century was provided by The Color Marketing Group.

- 1900** – “You can have it in any color as long as it is black.” Henry Ford.
- 1910** – Victorian era clothing is black and white, but color is added to Victorian homes with somber golds and reds.
- 1920** – Color is in full swing.
- 1930** – The depression brings in what is known as the “taupe age”.
- 1940** – World War II brings a palette of heavy grays, somber teals, and thick reds.
- 1950** – Color explodes into bright pastels, appliances in aqua, pale yellow and pink. Another favorite color is chartreuse green.
- 1960** – Avocado green and harvest gold are in homes all across America. Yellows and Orange permeate the culture.
- 1970** – Earthtones dominate.
- 1980** – Gray takes over from beige as the neutral. Light blues and mauve are popular.
- Early 1990** – Colors are rich with jeweltones. Several shades of green are popular, teal, sage and hunter.
- Late 1990** – Corals, soft yellows and yellow greens. Effects such as pearlescent, iridescent, holographic and metallic are changing the future of color.



*Air Force Global Weather Center  
Heritage Hall  
Offutt Air Force Base, Nebraska*



*Shade of red*



*Oranges and Yellows*

## COLOR AND EMOTION

Some theories suggest that people give meaning to color by an intuitive sense that is universal to everyone. Another theory suggests that associations of color are learned and are dependent upon a society, place and time. More than likely it is a combination of both. The basic reaction of the emptiness of solid white, black and gray, and the excitement of red, yellow and orange seem to be basic reactions for everyone.

Society in the United States comes into play when we think of red, yellow and green as stop, caution and go; pink and light blue for infants; black for mourning; white for weddings, and red, white and blue for the U.S. flag.

### *Red*

Reds are typically warm colors. They are exciting colors that promote heat, intensity and force. Red is often used on warning signs, such as a stop sign or a fire exit. It is also a cheerful color that is associated with patriotism, Christmas, and St. Valentine's Day. Red is a color that has remained popular throughout the years and never seems to go out of style. It can raise body temperature, pulse rate, blood pressure, and experiments have shown that red will speed tissue healing. When red is tinted to pink, it loses some of its impact and becomes associated with femininity, charm and delicacy. When it is shaded, it becomes a warm brown.

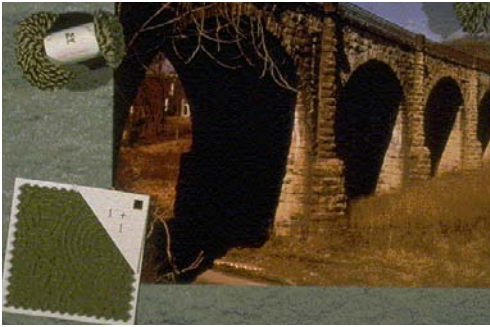
### *Orange*

Orange is the combination of red and yellow, and shares their characteristics. It has the excitement of red but is somewhat subdued by the yellow. Orange inherits its sense of cheer from yellow, and is considered a happy color. Bright orange is best used in small quantities; however its tints of beige and tan are favored as background colors. Its shades are variations of brown.

### *Yellow*

Yellow is the lightest of the warm colors and is associated with cheerfulness. It is less aggressive than red, yet it is open and expansive with a high level of reflectivity. It promotes activity and mild stimulation. Yellow's tints are cream and beige that are popular background colors. Its shades are tans, lighter browns and dark brown. Yellow is also a symbol of "caution" with its use on street signs, and on school buses.





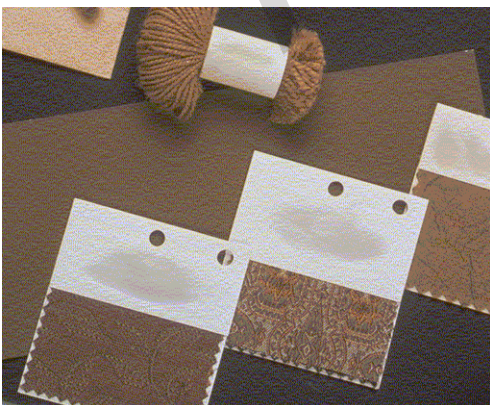
*Shades of Green*



*Shades of Blue*



*Shades of Violet*



*Shades of Browns*

### *Green*

Green is the combination of yellow and blue and is considered a cool color. It is the warmest of the cool colors due to its yellow content. Green has the cheerfulness of yellow, yet holds the calmness of blue. It is commonly used in restful spaces. Green is associated with nature; grass, trees and other vegetation. It is the color of "GO".

### *Blue*

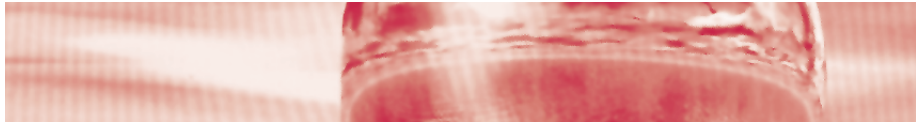
Blue is the coolest of cool colors. It is associated with calmness, rest, simplicity, truth, and purity, but can also have a depressive effect if overused. It can encourage thought, contemplation and meditation and is considered the color of intellectual activity. Intense blue is a good accent color but it lacks the energy of red, orange and yellow. Blue is associated with nature – air, sky, and water. Blue can lower body temperature, pulse rate, and blood pressure, and is said to slow down tissue healing. It is a color associated with authority and its coolness may cause negative implications. Tints of blue have the same relaxing affect while shades of blue tend to be heavy and potentially depressive. Most people, when asked their favorite color, reply "blue".

### *Violet*

Violet is the combination of blue and red and carries with it the contrast of liveliness and calmness. This may be why violet is associated with tension and ambiguity. Violets and purples should be avoided in some contexts because they can be disturbing to many people. At the same time, violet is viewed as subtle, sensitive and artistic. It is associated with royalty and spirituality. Lavender, a pale tint of violet, is light and playful. Deeper shades are thought of as dignified.

### *Browns*

Browns are the deeper shades of red, orange and yellow. They tend to take on some of the characteristics of these colors and appear warm and comforting but lack energy. They can have the negative connotations of soil and dirt. They also take on positive thoughts associated with the qualities of wood, brick, tile and stone.



### *White*

White is a safe color that can be used in large proportions. It is associated with cleanliness, purity, clarity and simplicity. White can also be associated with emptiness and boredom. Use of white can make a space seem larger. It can also make space feel stark or sterile. Adding very slight amounts of pigmentation creates a range of whites referred to as “cool” whites and “warm” whites. These hues are used to control the “mood” of white.



### *Black*

Black has strong associations with strengths, seriousness, dignity and formality. It also has negative associations of emptiness, depression, and death. Black is a heavy color that can be depressing if poorly used. When used well, it can be very elegant. When used with white, black is powerful and sharp but also stern and forbidding.



### *Gray*

Gray is the combination of black and white, or mixture of complementary colors. Similarly to white, there are “cool” or slightly blue toned grays, and “warm” slightly red toned grays. Light grays do not project strong associations and are often used as background colors. Dark grays can be associated with depression or authority.

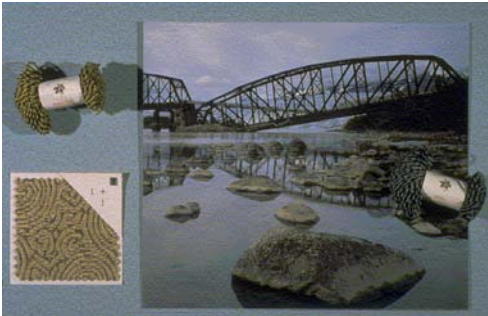


*A Rainbow of Color*

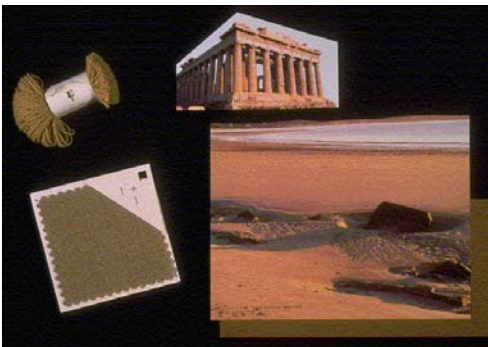
### COLOR PREFERENCES

There have been studies that test the preferences of colors at different ages with the following results:

- Babies and children, to the ages of six, prefer bright stimulating colors such as red, orange and yellow.
- At age seven to eight, there is a change from the preference of reds to the preference of blues. The theory is that this is also a change within the stages of childhood development.
- The preferences from age eight to sixty years old are blue, green, and violet, interchangeably, then red, yellow and orange.
- As a person grows older, his or her eyes grow weak and sometimes it is difficult to distinguish between green and blue. Cool greens and blues are preferred.



*Northern Light*



*Southern Light*



*Western Light*



*Incandescent Light*

### COLOR AND LIGHT

Determining the source of light is essential when working with color. As a light source changes, so does color. Natural white light is the presence of all color, while darkness, or black, is the absence of all color. The primary colors of light are red, green and blue, and when combined equally, they produce a white light.

When selecting colors, it is very important to look at them in the same light in which they will remain. A certain shade of red in natural light will look very different in fluorescent light. The source of natural light, as well as the time of day, will effect color.

*Natural light* has the following properties:

- Northern light – cold greenish cast
- Southern light – warm pink cast
- Eastern light – harsh yellow cast
- Western light – red-orange cast

*Artificial light* has the following properties:

- Fluorescent light – blue cast; however, a color corrected bulb can be used
- Tungsten light – bright yellow cast
- Halogen light – bluish cast
- Incandescent light – yellow-orange cast

## CHAPTER CONTENTS

INTRODUCTION  
 HISTORY  
 COLOR AND EMOTION  
 COLOR PREFERENCES  
 COLOR AND LIGHT  
 OPTICAL EFFECTS  
 BASIC COLOR THEORY  
 COLOR SCHEMES  
 APPLYING COLOR IN FACILITIES

*Warm Colors vs. Cool Colors**Simultaneous Contrast*

## OPTICAL EFFECTS

A room painted in a light color will seem larger than that same room painted in a dark color. This is because light colors tend to recede while dark colors advance. Warm colors seem closer while cool colors seem farther away. A long narrow room will seem more in proportion if its far wall is dark and its side walls are light. A room with a low ceiling painted white will seem higher than a ceiling painted dark.

Colors are often said to be warm or cool in temperature and thus all colors are classified in one of these two families that create strong and different impressions.

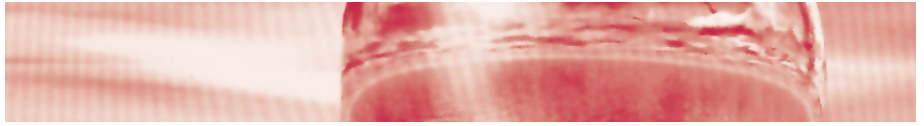
*Warm colors* such as red, orange, and yellow, are associated with sun and fire, and therefore create a sensation that a space is several degrees warmer than actuality. Warm colors appear to advance toward its viewer as well as excite and cause a sense of aggression.

*Cool colors* such as blue, violet and green, are associated with air, sky and water, and thus, are naturally cool and soothing. Cool colors tend to recede in a space and can create feelings of passiveness and calmness.

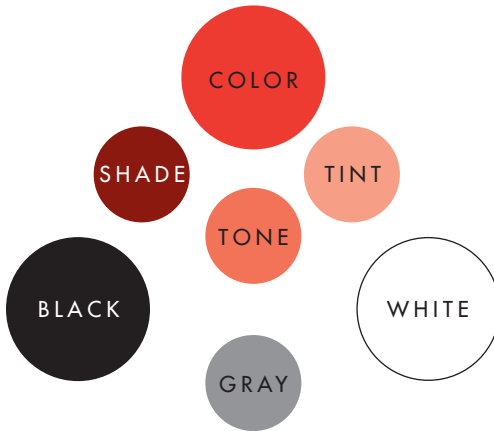
Note that there can be cool shades of red and warm shades of blue that are determined by mixtures of hues. In addition, the quality of warmth and coolness in a color may be altered by its neighboring hues. For example, when a warm hue is in contrast with a cool hue, the warm hue appears warmer and the cool hue appears cooler.

The rule of Simultaneous Contrast is the effect of one hue upon another. Whenever two different hues come into direct contact, the contrast intensifies their differences. The greatest contrast occurs with complementary colors. For example, red seems brightest next to green, as green seems brightest when seen with red. There is an effect with closely related colors, for example, a yellow-green surrounded by green appears yellowish, but surrounded by yellow, the yellow-green seems more noticeably green.

The contrast can be in value or intensity as well as in hue. A gray-blue looks brighter when placed against a gray background; however, the same gray-blue neutralizes when placed against a bright blue background. These are just a few examples of the tricks colors play and why it can be difficult applying color.



### *The Three Dimensions of Color*



### *Hue and the Color Wheel*

#### BASIC COLOR THEORY

Successful color selection in interior design is a combination of experience, schooling and talent. Developing the ability to properly apply color begins with studying the basic principles of color theory.

The properties of color are based on three dimensions; *hue*, *value* and *intensity*.

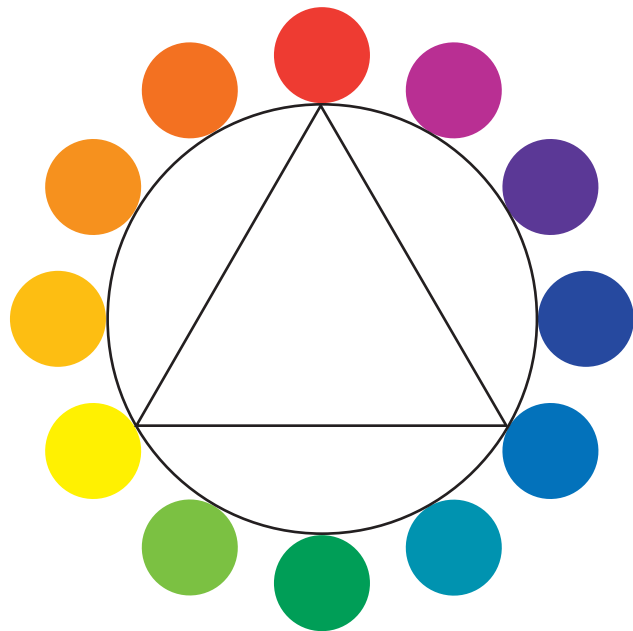
*Hue* is the name of a color, such as red, blue and yellow.

*Value* is the lightness or darkness of a color that indicates the quantity of light reflected.

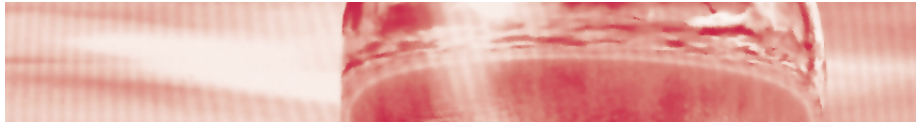
*Intensity* is the saturation or strength of a color determined by the quality of light reflected from it. A vivid color is of high intensity; a dull or muted color, of low intensity.

Hues are defined and organized by the *color wheel* which is made up of the following twelve colors, each at their full intensity:

Primary Colors: Red, Yellow, Blue  
 Secondary Colors: Orange, Green, Violet  
 Tertiary Colors: Red-orange, Orange-yellow, Yellow-green  
 Green-blue, Blue-violet, Violet-red



*The Color Wheel*



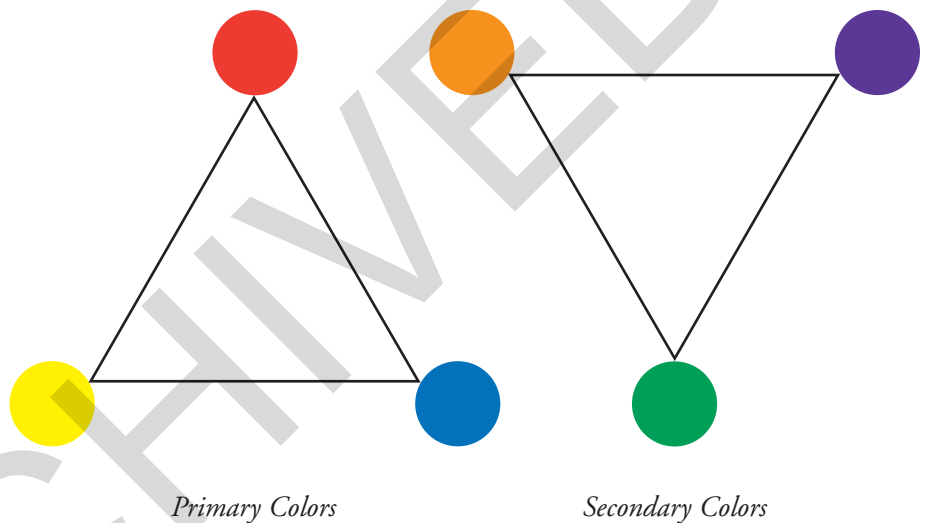
The *primary colors* are red, blue, and yellow. When the three primaries are mixed in pairs, or all together in equal or unequal amounts, all possible colors can be produced

Secondary colors are created by combining two primary colors:

Red + Yellow = Orange

Red + Blue = Violet

Blue + Yellow = Green

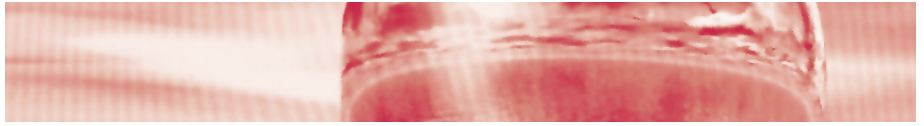


#### *Value*

Value is the relative lightness or darkness of a color that is determined by the amount of black or white present in a color.

A "*tint*" is created when white is added to lighten a color. This also gives a color a high value.

A "*shade*" is created when black is added to darken a color. This also gives a color a low value.



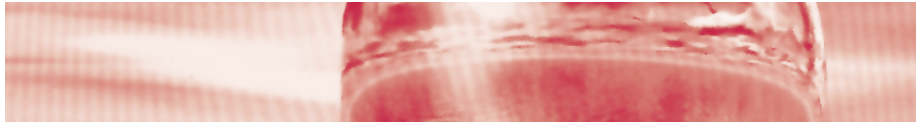
The value of color is graded on the *gray value scale* with white as the highest value, black as the lowest value, and several *tints* and *shades* of gray in between. If a black and white photograph were taken of a room full of colors, their equal values could be compared with the *gray value scale*. Note: Black and white printers and black and white copiers do not give the same effect as black and white photography.



*Color Value Scale*

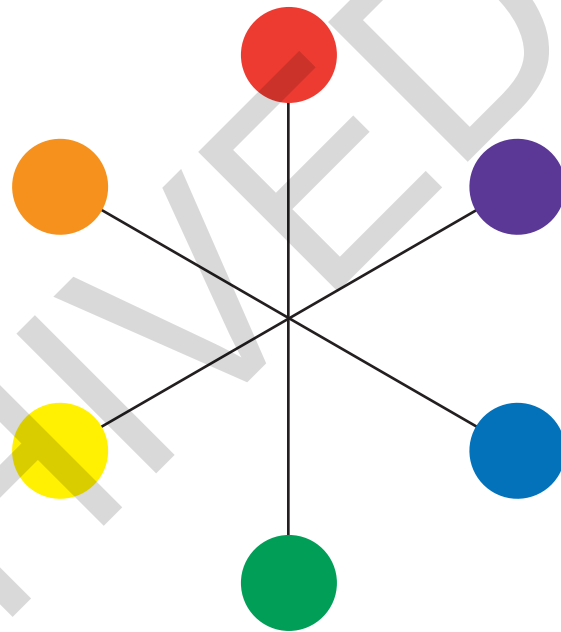
*Intensity*

Intensity, or the saturation of color, is determined by the amount of gray added to a color. The “*pure*” color of red will have a strong intensity while a muted color of red will have a low intensity.



### *Color Relationships*

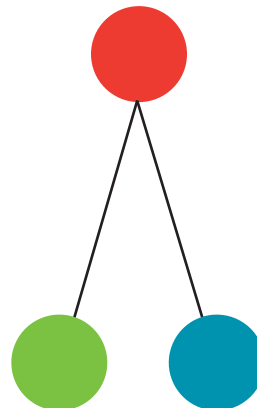
The successful use of color is dependent upon a clear understanding of color relationships. A single color retains a certain character, but adding other colors to its surrounding may change its characteristics. Colors may be closely related or in contrast. The greatest contrast occurs with *complementary colors*, two colors that appear directly opposite each other on the color wheel. For example, red and green are complementary colors just as violet and yellow, and blue and orange are complementary colors.



*Complementary Colors (extreme contrast)*

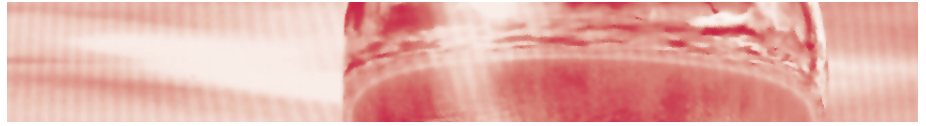
### *Split Complementary Colors*

A split complementary system involves a color with two colors on either side of its complement. This results in a variation that has less contrast because of the short interval between colors on the color wheel.

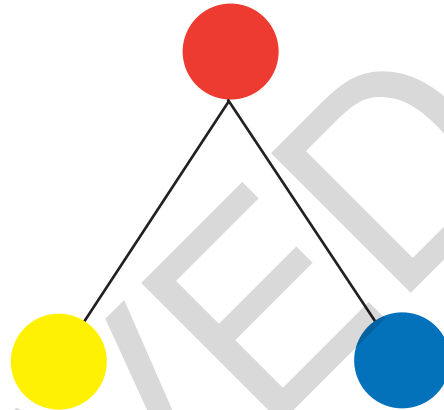


*Split Complementary Colors*



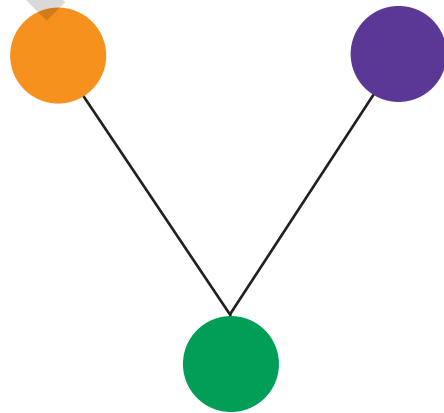


There is less contrast when three colors are spaced equally apart on the color wheel and used together. The first group is called the primary triad which consists of red, yellow and blue. This triad provides the most striking contrast.

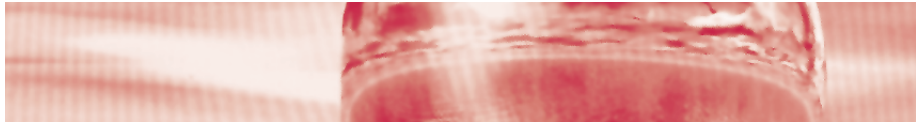


*Primary Triad (vibrant contrast)*

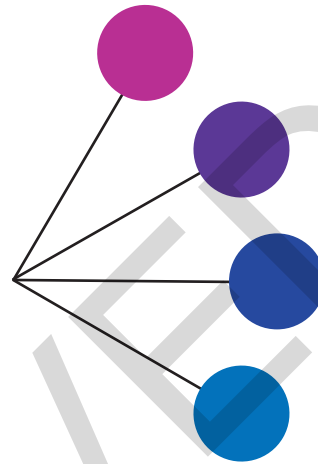
The secondary triad, composed of orange, green and violet, has the same interval between hues, yet gives a softer contrast.



*Secondary Triad (soft contrast)*



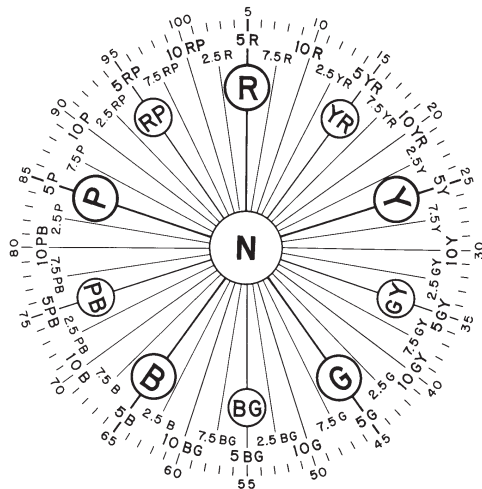
Analogous colors appear next to each other on the color wheel, and because they have the shortest interval between them, they have the most harmonious relationship.



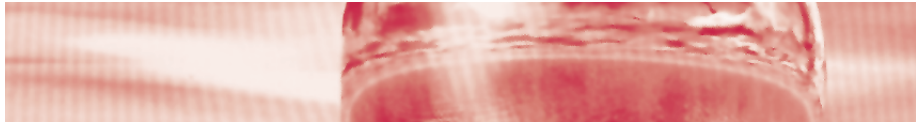
*Analogous Colors (Close relationships)*

### *The Munsell System*

Our fascination with color has resulted in the development of a number of color systems. The most widely used system for identifying color was developed in the early 1900's by the American artist, Albert Munsell. Munsell's system shows the relationships between color, tints and shades. The system was used to give names to the many varieties of hues that result from mixing different colors with each other or mixed with the neutral colors black and white. In 1943, American industry adopted the Munsell system as its standard for naming colors. The United States Bureau of Standards in Washington, D.C. also adopted this system.



*Munsell Color Wheel*



The Munsell system has five basic colors: red, yellow, green, blue and purple (violet). *Intermediate colors* are created by the mixture of any two of the basic colors that are adjacent on the color wheel. For example, the mixture of red and yellow is the intermediate color red-yellow. Other intermediate hues include green-yellow, blue-green, purple-blue, and red-purple.

Munsell devised a three-dimensional color system that classifies the variations of colors according to the qualities of hue, value, and intensity.

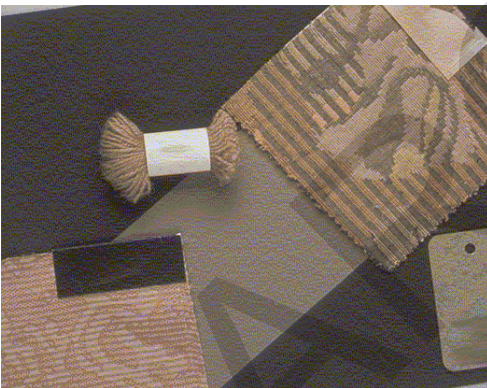
Each hue is indicated by the notation found on the inner circle of the color wheel – R for red, Y for yellow, G for green, B for blue, and P for purple. The intermediate or tertiary colors are described with two letters such as RP for red-purple. The value number of a color follows the hue designation. For example, YG/7 is a yellow-green with a value matching step 7 of the gray scale. The intensity number comes last; thus, YG/7/4 indicates a yellow-green hue at a value of 7 and intensity of 4.

#### COLOR SCHEMES

There are several color schemes; some simple while others are very complex. As expected, the more complex a color scheme the more skill is required to achieve a successful design. The concept of harmony lies behind the development of each color scheme.

##### *Neutral (monotone) Color Schemes*

A neutral or monotone color scheme consists of various tints and shades of a neutral color such as black, white, gray, beige, tan or taupe. A neutral scheme is easily composed by selecting a neutral then building upon several values of that neutral. This scheme is often used as a backdrop for a striking accent color or for non-competing backgrounds when an important element is displayed, such as artwork. Neutral color schemes can become monotonous if not accented properly; however, a successful scheme can be considered sophisticated, elegant, and refined. They are used when a soft but formal space is desired, such as a hotel, bank or museum.



*Neutrals*



*Monochromatic Color Scheme*



*Analogous Color Scheme*



*Complementary Color Schemes*

### *Monochromatic Color Schemes*

The monochromatic color scheme consists of one chosen hue with several values and intensities of that hue used to create depth and interest. Spaces with a single color can look dramatic, but this scheme may create monotony. The monochromatic color scheme works well in spaces where we don't spend a great deal of time, for example, a private hotel suite or an upscale retail store.

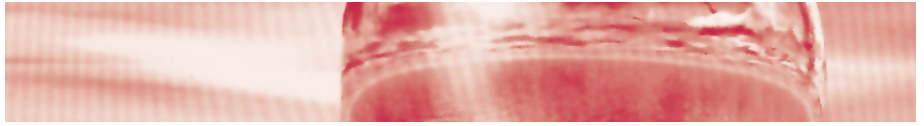
### *Analogous Color Schemes*

Using colors that are adjacent on the color wheel have close relationships and create analogous color schemes. Blue-green, blue, and blue-violet make up an analogous scheme. This scheme easily creates harmony, is usually vibrant, and works well in spaces that encourage high energy such as daycare centers and sports facilities.

### *Complementary Color Schemes*

Colors that are located across from each other on the color wheel are complementary and thus make up a complementary color scheme. For example, red and green, yellow and purple, and blue and orange are complements. Complements have the greatest intensity when seen together and can be extremely pleasing. When designed correctly, the scheme brings feelings of energy and cheerfulness. However, it can be difficult to succeed at this scheme for it can become too bright or garish if the colors are not properly balanced.

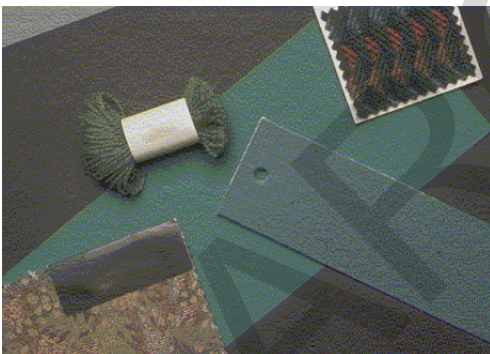
Fast food restaurants often use complementary color schemes. The result is an interior that exudes high energy, but also does not make the customer too comfortable. The effect is that many are attracted, but at the same time there is the high turnover necessary to achieve profit.



*Yellow-Green*



*Red*



*Blue-Green*

### *Split Complementary Color Schemes*

The split complementary color scheme consists of one hue with the two hues adjacent to its complement. The two adjacent hues are harmonious while the complement adds a vibrant contrast. When used together, the palettes of yellow-green, red, and blue-green, will create a split complementary color scheme.



*Child Development Center*  
Hanscom Air Force Base, Massachusetts



*Gossick Leadership Center Renovation*  
Arnold Air Force Base, Tennessee



*Typical Office*

### *Triad Color Scheme*

The triad color scheme incorporates three hues that are equally spaced on the color wheel. The most common triad scheme is used with the primary colors - red, yellow and blue in energetic spaces such as schools, sports arenas, and movie theaters. Varying the values of triad hues can create a sophisticated look, but this is difficult to master without creating harshness and confusion within a space.

### *Tetrad Color Schemes*

The tetrad color scheme incorporates four hues that are equally spaced on the color wheel. Vivid tones give a lively feeling, while muted tones bring a subtler mood. Tetrad color schemes are rare and difficult to produce since they often create harsh and confusing spaces.

## APPLYING COLOR IN FACILITIES

The basics of incorporating color apply to every type of interior space. Yet, many variables interact with color (e.g., location, the size of the space, and natural and artificial lighting). The Federal Standard 595B color fandeck may be used as a reference when selecting colors. The fandeck may be ordered from the General Services Administration (GSA) catalogue, stock #7690-01-162-2210.

The following generalizations are suggested for each space type.

### *Offices – General*

The objective for designing an office is to create an environment that promotes productivity for the many users who work long hours. Color plays an important role in stimulating productivity without creating distraction. Bright warm colors work best in areas where physical tasks take place, and calmer, cooler colors work best where visual and mental tasks are performed. Livelier colors should be applied in limited areas with related quiet tones in larger spaces. In multi-floor or large offices, each floor or department can possess an identifying color tonality, with strong colors in lobbies, corridors, and entrance points, while related softer hues are used in the general office areas.

- Desks and work surfaces – light toned neutral desks and work surfaces are good choices since neutrals are not distracting, and their low brightness contrast (glare) minimizes eye fatigue. Light gray, tan, beige, taupe and ivory are soft colors that work well and have a light reflectance of approximately 30%.
- Flooring – medium to light toned floor surfaces are suggested to reduce brightness contrast between the floor color and tasks or work surfaces. The light reflectance range should be 20% – 50%. The color of soil in a given geographical region plays a part in the color selection of flooring so as to camouflage soil.



*Building 32 Rehabilitation*  
Wright-Patterson Air Force Base, Ohio



*Air Mobility Command Design Center*  
Scott Air Force Base, Illinois

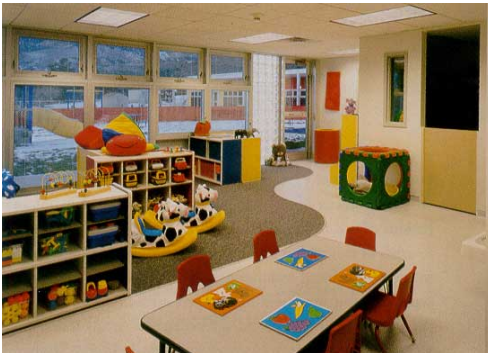
- Walls and panels – a light reflectance range of 40% - 60% is suggested for walls and panels. An accent wall, in a soft hue, can be added for interest and to relieve monotony. Deep colors may be used behind a desk, or in frontal view, but should not be used on a window wall due to the high contrast.
- Ceilings – bright ceilings of white are functional for good light reflectance.
- Corridors – bright, bold, and contrasting colors may be added to corridors for visual stimulation.
- Doors – various colors for doors can be used anywhere.
- Private offices and conference rooms – variations of colors may be used in private offices and conference rooms. Avoid use of dark colors in spaces with low light levels. However, dark hues, when balanced with lighter hues, complement spaces that have an abundance of natural and artificial light.

#### *Industrial Plants*

Color is important in the industrial setting to reduce fatigue, annoyance, and to promote efficiency and safety. Certain colors in these settings also reduce absenteeism, and improve labor morale.

Colors may offset problem areas, for example, the use of cool blues and greens are desirable in a space with excessive heat. Conversely, reds and oranges warm a cold space or can compensate for the lack of natural light. Incorporating soft hues, especially tints of green, may calm noisy spaces.

- General surfaces – brightness contrasts are to be considered; glossy surfaces that produce glare should be avoided.
- Walls – colors should be in light hues; however, a tinted accent hue with a reflectance of 25% - 40% may be used on an end wall to reduce monotony and lessen eye fatigue.
- Upper walls – should have a light reflectance between 50% - 70%.
- Ceilings – white should be used on ceilings to provide maximum light reflectance.



*Child Development Center*  
United States Air Force Academy, Colorado



*Air Force Senior Commissioned  
Officer Academy*  
Gunter Annex,  
Maxwell Air Force Base, Alabama



*Health and Wellness Center*  
Elgin Air Force Base, Florida

- Colors and safety – various colors have been adopted for safety purposes in industrial settings. Green is the choice color for machinery and equipment. Yellow marks potential hazard areas while red indicates fire-safety equipment, containers of dangerous materials, and control switches and buttons on machinery. Blue indicates electrical controls and repair areas, and white indicates trash containers, drinking fountains, and food-service locations. Black striping indicates traffic areas, aisles, and stairways.

#### *Schools*

Studies have shown that the proper use of color in schools plays an important role in the performance of students. This is especially true in the early years of children. A warm brighter, color scheme not only offers positive affects on the academics of students, but their behavior as well.

One of the most important interior elements in schools is illumination. A goal of effectively controlling illumination with color is to keep eyestrain and glare to a minimum. The way to accomplish this is to keep the brightness ratios somewhat consistent.

Walls, floors, furniture and equipment - these areas should be painted in mild color schemes with a 50-60% light reflectance. A stronger color painted end wall can add interest. Gray or green chalkboards can seem less drab when surrounded by contrasting colors.

- Ceilings – white or off-white ceilings should be installed for maximum light reflectance.
- Auditorium – several hues of warm tones are suggested, including tints of green.
- Shops, and art rooms – light hues are appropriate and work well in these spaces.
- Gymnasium – luminous tones work well in gyms, while colors that reflect flattering light, such as coral, work best in locker and dressing rooms.
- School facilities such as libraries, offices and teachers lounges, should be designed with subdued tones.
- Corridors and stairways – bolder colors may be used to offer stimulation in these transition spaces.





### *Hotels*

A hotel design should present a welcome, pleasant experience for its guests. The climate and customs of the region can add to the characteristics of the chosen color schemes and style. For example, brightly colored tiles and fabrics combined with white walls may suggest a tropical location.

- Lobby and lounge – the front lobby and reception desk can accept strong use of color that creates lasting impressions. Warm colors in lobbies and lounges provide comfort for people who will occupy these spaces for long periods. Dark woods and marbles suggest solidity and tradition, whereas bright saturated colors imply a casual and playful atmosphere.
- Guestrooms – colors may vary, as suggested above, to reflect climate and region. However, the chosen color scheme should promote comfort and relaxation.
- Corridors - a lively color scheme is suggested for the corridors, incorporating a dark color at one end to give interest when walking down a long hallway.



*Area Dental Lab*

Peterson Air Force Base, Colorado

### *Medical and Healthcare Facilities*

The interest of the patient is the primary concern when designing medical and healthcare facilities. Research studies suggest that the environmental ambience plays a significant role in the rate of patient recovery. Visual contact with the out-of-doors, natural materials such as wood, and warm colors contribute to a faster rate of recovery. Warmer colors in hospital rooms flatter users' skin tones when reflected in mirrors.

Cooler colors offer a calming ambience and are appropriate for intensive care units. Bluish-green is a standard for operating rooms because it provides visual relief of personnel from the red tones of blood and tissue. Cooler colors, which calm, are appropriate for examination rooms, while warmer tones are used in areas such as dermatology and obstetrics. However, color should be restrained to avoid the possibility of environmental color reflection interfering with patient diagnosis.

### *Food Service*

Many studies have been provided by the food service industry regarding color and the physiological responses to food and its atmosphere. For example, the color red was found to stimulate the appetite.

In general, warm tones are comforting in restaurant settings. Colors to avoid include black, dark gray, cold gray, strong tones of blue and violet, and yellow-green.



*Iditarod Dining Facility*

Elmendorf Air Force Base, Alaska



*Air Force Senior Commissioned  
Officer Academy  
Gunter Annex,  
Maxwell Air Force Base, Alabama*



*BXTRA Open Air Mall  
Hickam Air Force Base, Hawaii*

The style of each food service area should be taken into consideration when applying color. Fast food establishments and cafeterias incorporate bright colors to promote a faster pace. Fine restaurants and traditional eating establishments are typically designed in subdued colors to promote leisurely dining. In each case, the color of floor coverings should be selected to conceal soiling. The color scheme should be versatile with bright lighting at lunchtime and softer lighting at dinner.

Traditional associations of color are appropriate when serving various styles of cuisine. Mexican, Indian and Spanish foods are associated with bright cheerful colors, Greek with blue and white, and Italian with red, green and white. Colors of table settings should complement the food to be served. Care must be taken so that the space does not become a cliché.

Supermarkets apply bright colors in various areas; however, white is preferred in the dairy section, and lighter blues and blue greens are used at the meat counter to complement red meats. Colorful cans and other merchandise are nicely displayed when seen against a neutral background.

#### *Retail Outlets*

Retail outlets display their merchandise in the most attractive setting to achieve high sales volumes. Color has a strong impact on consumer reactions to products including impulse buying.

The general rule of thumb is to use bright colors in low cost, rapid turnover shops, and more subtle sophisticated color schemes in higher priced and leisure shops. Discount stores often use bright colors to stimulate customers; however, a low-end rack outlet may use white walls and gray floors to give the effect of a discount image.

Men's clothing shops tend to have natural wood and brown tones to promote a club-like atmosphere. Women's shops usually retain soft, warm tones, possibly pastels. Bright colors used with metallic, white, black, or gray, tend to promote electronics and other high tech products. Avoid strong color on display backdrops and shelves that may distract from the merchandise. Light grays and tans are good choices. Expensive jewelry and small gift items sparkle against conservative colors.

#### **CONCLUSION**

Along with man's sensitivity to time and space is sensitivity to color. Color can affect perception of size just as it can affect mood. It is important to wisely and carefully incorporate color into all interior projects using it to heighten awareness of the appearance and mood of space.

## CHAPTER CONTENTS

|                              |
|------------------------------|
| INTRODUCTION                 |
| ARTIFICIAL LIGHT             |
| DAYLIGHTING                  |
| LIGHTING DESIGN APPROACHES   |
| APPLICATIONS                 |
| CONCLUSION                   |
| ATTACHMENT A:                |
| GLOSSARY OF TERMS            |
| ATTACHMENT B:                |
| RECOMMENDED                  |
| ILLUMINATION LEVELS          |
| ATTACHMENT C:                |
| QUICK REFERENCE CHART        |
| OF LAMP TYPES                |
| ATTACHMENT D:                |
| STANDARD REFLECTED CEILING   |
| PLAN WITH NOTES              |
| ATTACHMENT E:                |
| STANDARD FURNITURE           |
| PLAN WITH NOTES              |
| ATTACHMENT F:                |
| LIGHTING SIMULATION SOFTWARE |

## INTRODUCTION

It is estimated that seven-eighths of all our perception is through sight. The way objects in our world are illuminated makes a tremendous difference in the way they look to us, and in the way we respond to them. Lighting is an essential design element, and one of the most important aspects of successful interior design.

The complexity of lighting creates an interesting challenge for the designer. Over the course of the past two decades, new technologies, demographic trends, the demand for energy conservation and budget efficiency, as well as the shift from physical labor to visual task work, have intensified and complicated this challenge. Proper lighting design can no longer be an afterthought; it should be considered fundamental to any design effort.

The design of lighting is often limited to providing an adequate, uniform light level, with the assumption that this will take care of all users and their needs. In addition to the level of intensity, seeing well depends upon many additional factors such as shading, shadow, contrast, and color quality. Uniform light level, without considered placement of fixtures, reveals every defect and lights everything equally, offering no focus, variety or subtlety.

It is an unfortunate reality that bad lighting is all too common. It is not necessarily a result of indifference or carelessness; it can also come about in planned situations where a handbook recommendation or manufacturer's advice has been followed. The effects of bad lighting are serious; they hamper safety, utility and may produce anxiety and displeasure with a space, making an otherwise attractive area appear dismal and unwelcome.

On the other hand, good lighting supports convenience, efficiency, comfort, safety and favorable emotional reactions. It has been shown that improving the lighting of a space can be more effective than any other single factor in increasing the overall sense of satisfaction. Just switching off a glaring ceiling fixture and substituting a well-placed task lamp can make a dramatic improvement, often at very little cost.

Good lighting can achieve the following effects:

- *Set a desired mood or atmosphere.* Dim light usually makes a space seem intimate and cozy; bright light, more business-like and energetic.

- *Direct or concentrate attention.* Lighting draws attention to points of interest and helps guide users through space by influencing the timing and direction of their gaze. A brightly-lit wall or spotlight clearly displays artwork, and draws the viewer to it. A good light at a desk, with the surroundings at a lower light level, helps to concentrate attention on work.
- *Enhance or modify a space or structure.* For example, designers know that a dark ceiling appears lower, while a brighter ceiling can seem to float upward, visually enlarging the space.
- *Aid the viewer to see form and texture.* Diffused, even light tends to flatten objects, while sharp shadows emphasize form. A strong cross light—from any direction—brings out texture. These effects are obvious outdoors: the light from a bright and sunny day makes objects seem sharp and crisp, while a cloudy day suggests a dull or somber tone.
- *Provide a sense of security.* Proper lighting can enhance visibility and engender a feeling of safety; it also can be used to illuminate potential hazards, such as a change in floor plane or a moving object.

Lighting is also the primary means of giving space a special character. Every designer needs to have a basic understanding of lighting mechanics in order to deal with design issues directly, as well as to work effectively with engineers or lighting specialists when they are involved in a project.

#### *Fundamental Concepts of Light and Vision*

Light is not what we see, but what we see *by*. Exactly what we perceive depends upon the kind and quality of light available. The light bouncing off objects reflects back to the eye variations of brightness and color that correspond in a complex geometric way with the size, shape, distance, color and texture of those objects.

Almost everyone at one time or another has studied the physiology of the human eye and can recall something of its basic mechanism. It is through this exquisitely complex mechanism that we are able to take in an entire scene or focus on an individual object, and interpret what is there.

The human eye/brain combination is a unique system whose workings effect several design decisions. For example, it is nearly impossible for our visual system to accurately judge the brightness level of a scene, but it is very sensitive to side-by-side, simultaneous comparisons of brightness within a scene. There is also an unavoidable time lag for adjustment to brightness levels called “adaptation”. Because of this phenomenon, the designer should avoid creating situations that require the viewer to make rapid or repeated shifts to accommodate different brightness levels (like looking back and forth from a dim computer screen to a glossy white work surface), which could be stressful and fatiguing.

In addition to adaptation to light levels, the visual system also adapts to colors over time. For example, an over-stimulation of one color will cause “saturation”, and the viewer will momentarily lose the ability to perceive that color accurately.

The most influential factor in the perception of color comes from the light falling on the object. More importantly, the perception of color is a factor of the light that is reflected from the object. That is why viewing a rose under the pure white light from a sunny sky can make it appear brilliant red, while shining an artificial green light on the same rose will cause the viewer to see it as black.

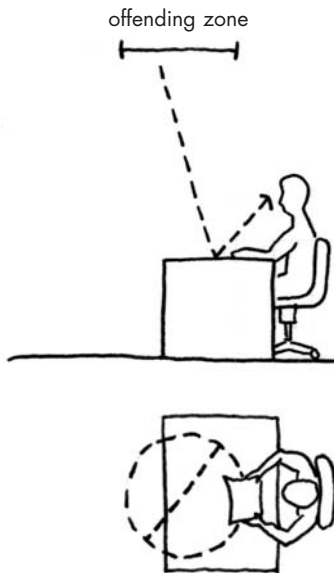
Our visual system is very sensitive and can be influenced strongly by both the light we see by and by our state of adaptation. With knowledge and experience about various aspects of light and lighting, the designer can have a great deal of influence over how an object or a space is perceived.

The goals of lighting are to promote good visibility and to generate qualities of atmosphere that are appropriate to the space under consideration. For every task and every situation, the following issues must be faced:

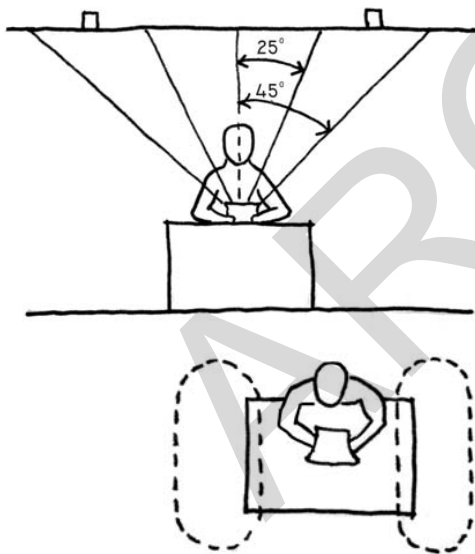
- *Light Level.* This is the simple quantity of light at a task, referred to as “illumination.” Because of the range of adaptation that is possible through our visual system, absolute light level is less important than many other factors. Still, one candle set across the room can not provide enough light for reading, while too much light can create glare and cost much more than necessary.

Some guidelines for light levels for various situations are available in Attachment B. It should be noted, however, that these quantity levels are offered only as preliminary guidelines based on ongoing research by the Illuminating Engineering Society (IES). The quantity of illumination needed on walls, floors, ceilings, and so on, for the creation of a beautiful and functional space is very much left to the designer’s experience and intuition. The proper lighting of tasks--whether functional or aesthetic--is vital to a total design, and the levels in the table should be considered only as recommendations.

- *Control of Glare and Brightness Contrast.* Excessive contrast in brightness levels is one of the most troublesome lighting situations. When the difference between the brightest and dimmest points within the visual field is too great, the eye struggles to find a compromise adjustment. In general, the designer can minimize excessive contrast by:
  - shading direct sources of light such as fluorescent tubes, unshielded lamps or windows which let in bright sunlight
  - avoiding dark backgrounds behind bright objects. Desktops, tabletops, and floors are frequent offenders



*The area above and directly in front of the task is most likely to cause veiling reflections.*



*Locate fixtures in an area 25° – 45° off the task surface.*

- providing fill light to keep less lighted background areas from contrasting with bright visual areas. For example, task lamps can be added on the sides of a drafting table or computer monitor.
- Hiding lamps entirely by using what is called ‘indirect lighting’. An indirect lighting fixture first directs light upward to the ceiling and then down to the work surface. It might at first seem that indirect lighting is an inefficient way to light interior space, but because the configuration of indirect fixtures totally shields the bare lamps from view, the fixtures make much more efficient use of their light output. Indirect lighting is particularly appropriate to offices where intensive work is done on Video Display Terminals (VDTs).

One special form of glare, called “veiling reflection”, comes from looking at a somewhat glossy material or surface placed so that it reflects a source of illumination like a window or light fixture. When this type of glare is experienced, the viewer instinctively moves around or rearranges the space in an effort to kill the glare. Proper fixture and furniture placement is the key to dealing with veiling reflections. An illustration of the problem, and the recommended solution are shown to the left.

Fixtures have also been developed that produce a light distribution that reduces glare and veils reflections. Using these fixtures will lessen the light directly below the fixture, so that even if a fixture is placed in the “offending zone” it will not be as objectionable.

- *Sharpness and Diffusion.* Shade and shadow emphasize form, but conceal detail in shaded areas. Light that comes from a concentrated or point source tends to create strong shade and shadow, while general or diffused light tends to diminish or block out shading. The sun, a point source, casts strong shadows that make objects appear crisp or sharp, while the diffusion of sunlight by clouds can make the same object appear dull or characterless.

High-contrast, point-source artificial lighting, such as a spotlight, accents form and texture, and can make some tasks easier because the shadows it creates aid depth perception. It is important to moderate this effect, however, if the light seems too harsh for the task.

For most situations, a suitable mix of point source and diffused light will serve best.

- *Economic Issues.* Artificial light requires the purchase of fixtures, lamps (bulbs and tubes) and wiring, as well as the ongoing cost of maintenance, replacing lamps and tubes, and energy consumption. In addition, the heat generated by lighting may require additional summer air conditioning, a cost that is rarely offset by conserving heat in the winter. And while even daylight is free, windows and skylights are not. Windows and skylights also admit summer

heat and allow winter heat to escape, at a substantial cost for equipment, space and maintenance.

- *Subjective Impression.* Lighting influences moods and evokes feelings. Studies indicate that:
  - spaciousness is enhanced by brightly lighting the peripheral walls and having a lower illumination level toward the center of the room
  - privacy or intimacy is best achieved by diffused background lighting
  - feelings of relaxation can be induced by non-uniform peripheral wall lighting
  - festivity or playfulness is enhanced with sparkle or kinetic (moving) light
  - somberness is affected by dim and diffused light
  - visual clarity and alertness is enhanced by luminance in the center of a room
  - as little as a 2:1 difference in the lighted area and its background can capture or extend a person's gaze

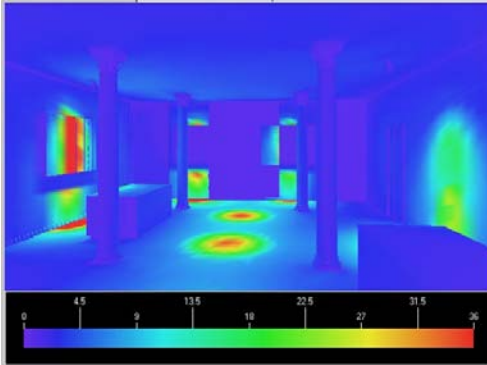
#### ARTIFICIAL LIGHT

With rare exceptions, indoor light in the modern world means electrical light. There is such a variety of light sources and fixtures today that “artificial” light is very useful and controllable in terms of brightness, color, placement and quality. Through skill and experience, a designer can create almost any effect. One way to build that skill is to observe lighting already in use, both good and bad, and develop a memory stock and notes of examples to follow and errors to avoid.

Rather than just accepting that there is a central ceiling fixture in each room, or equally spaced fluorescent fixtures with standard diffusers throughout a workspace, good lighting for a given space depends on careful planning. It begins with an analysis of the users' needs, followed by the intelligent selection of lighting devices designed to meet those needs, and ending with the correct fixture spacing and location to achieve the desired lighting levels and effects.

#### *Developing a Lighting Plan*

- *Define the general goals for the character and atmosphere of the space.* Is the space to be businesslike, efficient, restful, or cozy, etc.? Consider how lighting will enhance, complete, and generally influence the architecture and the perception of the space.
- *Consider the specific purpose for which the lighting is required.* Is the space to be used exclusively for computer tasks, dining, or watching television? Does



*Computer Lighting analysis*



*Computer Lighting rendering*

### *Lamp Selection*

it combine several purposes that might require varied or adjustable lighting? Is there a specific object or area that should be distinguished or highlighted? Begin by gathering information from users, owners, and other interested parties about needs, desires, and expectations of the project's requirements.

- *Balance the proper illumination levels against installation and ongoing maintenance costs.* Efficiency plays a major role in determining lamp type and fixture location, particularly in large installations. Use the recommended light specification levels and the goals and mandates of energy conservation programs as a basis for light source selection.
- *Select fixtures.* Once a decision is made to have particular characteristics and illumination levels in a given area, it is important to select the proper fixture to carry out the lighting plan. There is additional discussion of fixture types in the next section.
- *Place fixtures.* In larger projects, such as offices, warehouses, mechanical facilities or stores, placement is roughed-out by calculation. The number and location of hard-wired fixtures is displayed on a final drawing called a reflected ceiling plan (RCP), while portable light fixtures are indicated on the furniture plan. An example of these plan types can be found in the Attachments at the end of this guide. The placement of electrical outlets for portable fixtures should also be coordinated with the electrical or power plan to avoid running cords across circulation paths, or making it necessary to use extension cords.
- *Test effects.* The ability to select and place fixtures relies heavily on the informed intuition and experience of the designer to envision the total effect that will be produced. However, as technology advances, we are gaining the ability to view various lighting effects before they are installed using computer simulation software. Some software titles are listed in the Attachment F of this guide. Here is an example of the type of “virtual lighting” simulation that is fast becoming a design tool.

The actual selection of lighting devices involves several decisions, all of which entail choosing from a vast range of possibilities. The basic artificial light source—called a “bulb” or “tube” by the lay person but known in the lighting industry as a “lamp”—may be any one of a number of types, including the familiar and widely-used incandescent and fluorescent variety. They all come in an array of sizes, shapes and qualities. In recent years, several other types have become available that are less familiar to the general public but increasingly used by professionals. These sources include cold cathode, neon, fiber optics, and the particularly useful family of lamps known as high intensity discharge (HID). Each of the basic source types has its advantages and disadvantages. In addition to the discussion of types that follow, refer to Attachment C for a quick reference chart of various lamp types.



*Types of Artificial Light Sources*

- *Incandescent Light.* This is the oldest and most familiar source. Incandescent by nature is a point or near-point source that tends to cast sharp shadows and form bright highlights. These characteristics can be modified by frosting or diffusing the lamp, by using certain shapes such as the T or tubular form, or by employing various shades or fixtures. The spectrum of incandescent light contains more red and yellow and less green and blue than daylight, making it warmer and flattering to human coloring, and more pleasing.

Incandescent light can be made to serve virtually all lighting needs, but it presents economic problems. It uses much of the electrical energy it consumes to produce heat as an unwanted by-product of light. This makes it costly in terms of power consumption and it creates heat gain. Incandescent lamps also have a relatively short life span (approximately 1000 hours), which adds to maintenance and replacement costs. For these reasons, incandescent light is seldom used on exteriors, in production facilities, office buildings, and other structures that require a large amount of electricity.

“Tungsten-halogen” is a special type of incandescent that gives off a higher light output than the standard incandescent for a given wattage. They are made in several forms, are generally very compact, and the direction of the light they produce is highly controllable and color-correct. They operate at high temperatures and usually use a heat-resistant quartz glass envelope. Because of their high heat output, there is a need for protective shielding to prevent any combustible material from coming in contact with the lamp, and because of breakage. The light emitted from halogen lamps is flattering to food, people and most types of merchandise. Halogen lamps are also dimmable, and have about a 3000-hour life. Halogen is somewhat more efficient compared to standard sources, placing it between fluorescent and incandescent lamps in terms of cost versus quality of light.

- *Fluorescent Light.* Developed in the 1930’s for general use, fluorescent lighting is a highly economical alternative to incandescent light. Its power consumption for a given light output is about one-half to one-quarter the cost. This economy has made fluorescent lighting the norm for offices, classrooms, warehouses, restaurants and stores.

The typical fluorescent lamp is a long tube and therefore gives off diffused, shadowless light. While this promotes general good vision, it makes certain kinds of detail harder to see and tends to create a bland and monotonous lighting effect.

The most troublesome characteristic of fluorescent light is its color quality. While it gives off the appearance of normal white light, its spectrum distorts the natural coloring of many objects and skin tones, and makes fluorescent light aesthetically unpleasing.

The color problem has been addressed by introducing fluorescent tubes in a variety of colors, such as warm white and deluxe warm white. Unfortunately,

when fixtures are relamped, there is no guarantee that the maintenance staff will use a particular color tube. Most often, they install the basic daylight tube, which is the cheapest and most widely available, and results in the cold, greenish light which makes objects and people take on an unattractive color cast.

There have been important technological advances in fluorescent lighting lately. Manufacturers have introduced a variety of lamps with compact shapes that can be simply screwed into a regular incandescent lamp socket. Dimmable fluorescent is also now available. Although most of these units have high, first-time costs, their energy-saving capabilities make them economical over time.

In spite of the problems with fluorescent lighting, its economic advantages keep it in general use. Where it must be used for economic reasons, re-lamping with tubes of improved color-rendering capability, and, wherever possible, mixing it with incandescent light or natural light will make it a more satisfactory choice.

- *High Intensity Discharge (HID)* HID lighting combines some of the advantages of incandescent and fluorescent. The lamps give point or near-point light; they are cheap and efficient to run, have a very long life, and some types (especially when used in combination) have good color characteristics. On the other hand, there is a high initial cost for both the lamp and the specialized fixture, and they require a bulky and expensive transformer. There are several types of readily available HID lamps:
  - *High Pressure Sodium.* In 50 to 1000-watt versions, it has superior efficiency, but a pronounced orange-yellow color quality. Because its gas is contained under high pressure in glass, there is a slight but potentially high-impact risk of explosion with these lamps.
  - *Low Pressure Sodium.* Typically used for street lighting in 25-1000-watt lamps, it is extremely cheap and efficient to run. Although it gives off a uniform, yellow light, the human eye responds to it well at night; perceiving most things lit in it in a monochrome, but clear manner.
  - *Mercury Vapor.* In 40-1000-watt sizes, it has acceptable efficiency ratings, but a cold color quality. A variation, which uses the mercury at high pressure, offers reasonable light quality at extremely low cost, especially when it is mixed with high-pressure sodium. There are also improved “white” and “deluxe-white” versions available, although they have a somewhat reduced efficiency.
  - *Metal Halide.* Available in 15 to 1500-watt lamps, it has high efficiency and the best HID color quality; in the smaller sizes, it is now suited for some indoor uses.

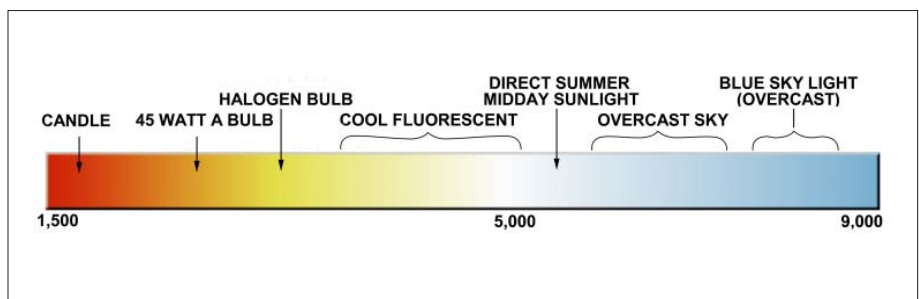
HID lighting is now in extensive use in public outdoor spaces, as a general or background light source in offices, in portable and upright fixtures for homes, and in other general uses.

- *Other Light Sources*

- *Neon.* These tubes are familiar to us in illuminated signs, are available in a full range of colors, including whites. Neon tube life is very long (several years); it is limited by low efficiency, and usually considered for special, decorative applications.
- *Cold Cathode.* This type is very similar to neon, and is sometimes useful in situations such as indirect lighting coves of irregular shape.
- *Fiber Optics.* Strands of glass fibers, usually bundled, can convey light from any source to one or more remote locations, where the light then emerges from the fibers. Various experimental applications are under development, but the only uses available in interior design are decorative.
- *Laser Light.* This is a process in which light is concentrated and emitted in an intense beam. Although laser light can be used in decorative and display functions, it does not yet have extensive practical application.
- *Full Spectrum.* The human organism seems to require light with the full mixture of spectral qualities typical of sunlight; that is, light that includes the invisible components of infrared and ultraviolet. Because of the expanse of time now commonly spent entirely under artificial light, lamps are now available with spectral output that closely matches sunlight. Fortunately, full-spectrum lights are readily interchangeable with standard incandescent lights, and can be put to use experimentally or on a regular basis in a variety of applications in residences, lodging and office or lab settings where access to sunlight is limited.

### *Color Characteristics*

One of the strongest considerations for a lamp choice should be for its color characteristics. The light spectrum can be read in terms of its warmth or coolness. Broadly speaking, it is comparable to heating a bar of iron in a flame. It passes from black to cherry red then to bright red. As the bar gets hotter still, it slowly turns yellow and then white-hot. Thus, the hotter the light, the purer or “whiter” it appears. To make this comparison consistent, the concept of color



temperature, expressed in degrees Kelvin ( $^{\circ}\text{K}$ ), or more recently, simply as Kelvins (K) has been adopted. The chart on the preceding page illustrates the color of light as it is emitted from both natural and artificial light sources.

In order to deal with fluorescent and other discontinuous-spectrum sources, an equivalent color temperature figure is used to make design decisions. It is called the “Correlated Color Temperature (CCT)”. It is important to remember that although an equivalent color temperature correlates from one source to the next, the effects of the lamp on color matching and vision can be quite different. In addition, color temperature shifts as lamps age or are dimmed. To simplify the evaluation of color characteristics, refer to the “Color Rendering Index (CRI)”; this indexes ability of a source to actually render color. The CRI for a given source is a single number, ranging from 1 to 100, with 100 representing perfect color rendition.

#### *Economic Considerations*

In considering the economic impact of the selection of a light source, some complex issues must be faced. They include:

- *Initial material cost* or the purchase price of the fixtures
- *Cost of fixture installation and wiring* is usually an estimate from an electrical contractor
- *Cost of maintenance over time* includes the frequency and ease of repair, cleaning and changing the lamp and ballast
- *Energy consumption costs* estimated over its useful life
- *Additional cost of air conditioning* to offset the heat produced by the light itself
- *Savings (if any) in heating costs* that will result from heat production

Since maintenance and other lifetime costs can only be estimated, exact comparison figures are difficult to produce. Nevertheless, comparing various systems can be helpful when making decisions about large installations, in which even small differences over time can have a major impact. Systems are often compared based on simple energy consumption, or “watt per square foot” calculations. By dividing the total wattage by the floor area, a good index number is obtained to describe the efficiency of the planned installation. Federal regulations, such as Title 10, Part 435 of the Code of Federal Regulations, as well as local codes, try to reduce energy-wasteful lighting practices by specifying the maximum watts per square foot, or Unit Lighting Power Allowance (ULPA) permitted in an installation. Efficiencies of 3 watts per square foot are considered easily achievable; efficient installations achieve levels of 2 or even 1.5 watts per square foot. Most new building codes indicate a maximum of two watts per square foot. Retrofitting an existing facility may be indicated as an important cost control over time.

*Environmental Considerations*

A growing concern for the environmental impacts of energy consumption, combined with the trend toward trimming and downsizing operating costs, has focused new attention on the financial and ecological costs of electrical usage. Proper disposal of spent lamps is also an important health and environmental consideration. With the exception of incandescent, most of the lamps are made up of pressurized gas in glass housings. When the lamp breaks or is broken down in landfill, it gives off toxic chemicals. Installation and disposal should be treated with care, and certain types should have guards to prevent their breakage or explosion while they are in use.

*Fixture Selection*

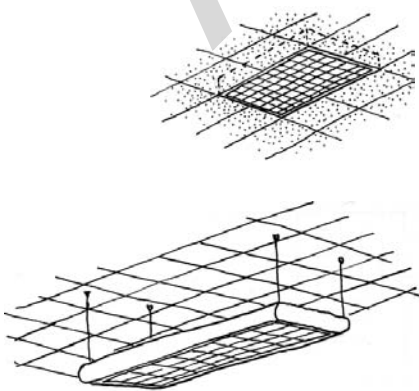
Once the type of light source is selected, the next step is to select the fixtures. Many luminaires (as fixtures are referred to in the lighting profession) will take a variety of lamps, so the selection depends primarily on the types of lighting needed and the appearance of the fixture in a given space.

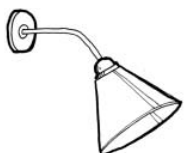
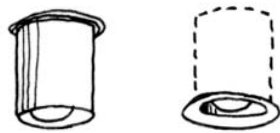
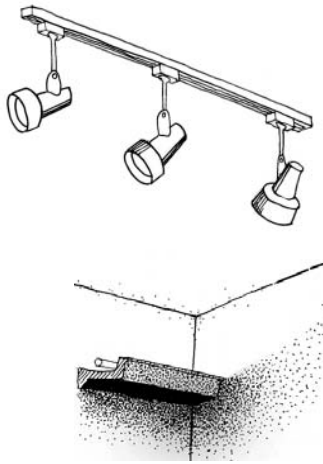
In addition to size, wattage and appearance, a classification can be made based on the way in which the light is delivered from the fixture. Light can be delivered in a concentrating form, which is beaming from a central source, or a diffusing form, so as to scatter light in all directions. Fixtures can deliver light in one, many or all directions. A typical table lamp, for example, produces a complex mix of concentrated light from the actual light bulb, somewhat diffused light from the lampshade, and an upward-directed light, which is reflected from the ceiling to become diffused indirect light. This mixture almost nearly duplicates the light of a sunny day, and creates one of the most satisfactory kinds of lighting.

All lighting devices fall into one of two mounting types: architectural or portable. Architectural lighting is fixed by building in or attaching fixtures to the structure of the building. Fixtures are often recessed, and more or less concealed. Correct architectural lighting is planned and is installed as a space is built or renovated. Portable lighting includes lamps and other moveable lighting devices that are plugged into outlets and can be moved about or replaced at will.

- Types of Architectural Fixtures

*Surface-Mounted, Hanging and Recessed Luminaires.* These widely used architectural lighting devices, typically fitted with fluorescent lamps, provide general lighting. By spacing according to calculations (which are discussed later in this guide), they can deliver predictable levels of consistent light. Unfortunately, low-cost versions of such fixtures are responsible for the glaring ceiling light all too common in offices and other large facilities.





*Track Lighting.* This system uses an electrical track that is usually ceiling mounted. The track can be fitted with many types of adjustable lighting units, both general and spot lighting, which can be moved about with relative ease. This system is particularly useful for display and gallery lighting, and is often used in residential applications.

*Cove Lighting.* This system requires a cove, or pocket, to be built into the ceiling or wall. The light units, typically fluorescent or cold cathode, are concealed from view and provide indirect light.

*Integrated Ceiling Systems.* These systems incorporate general lighting, acoustical treatment and usually air conditioning system into their structures. The fixtures may be fluorescent or incandescent, or a combination. They are commonly used in offices, public spaces, and other large institutional spaces.

*Downlights.* These can-type housings are among the most widely used incandescent architectural lighting devices; usually selected to illuminate a horizontal plane or to provide general lighting. They are typically used with a lens or shield to prevent direct glare. They may be recessed, surface-mounted or hung on a stem. HID versions are coming into use for large spaces with high ceilings. Downlights can be effectively mixed with other ceiling lighting systems to highlight circulation areas.

*Eyeballs and Wall-washers.* These are similar to downlights, but offer concentrated light that can be adjusted to any angle. Wall-washers direct light from the ceiling to an adjacent wall; the glazing, angled light brings out texture in finishes and vertical surfaces.

*Hanging Fixtures or Chandeliers.* These widely used decorative fixtures may imitate historic designs or take on a contemporary look. To provide general light, they may be directed up, down, or both; many are height-adjustable. Residential versions are usually incandescent; fluorescent is used for office and store lighting.

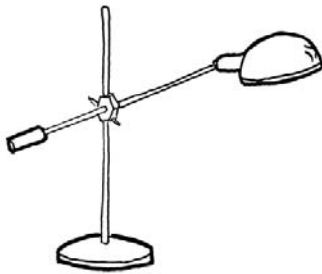
*Sconces.* These fixtures can provide uplight, downlight, patterns and/or color, and are used as both a functional and decorative design elements. Most often, they are wall-mounted.

*Reflectors.* These are similar in application to ceiling-mounted can lights. Many have swivel mountings that provide adjustability for display lighting, or reading in a fixed place.

- Types of Floor, Table, Desk and Specialty Lamps



*Shaded Lamps.* This is probably the most familiar and useful, portable fixture type. The bulb or bulbs are surrounded by a shade, which reduces glare but disperses direct light up, down or both. They can be fitted with incandescent or the new compact fluorescent lamps for energy efficiency. Because such lamps deliver excellent lighting, they are often selected as task lamps to illuminate small areas in offices and residences.



*Reflector Lamps.* These enclose a regular or reflector bulb, either incandescent or halogen, in an opaque reflector that directs light in one direction. They make good reading or work lights but can produce excessive brightness contrast unless fill light is provided from another source. The most familiar version is the cantilever, adjustable neck reflectors that are used as desk lamps. They have become a popular, inexpensive solution to many home and office lighting problems.



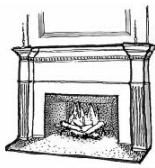
*Globe Lamps.* In these, glass replaces the shade; this reduces the brightness of the enclosed incandescent lamp, and delivers diffused light. Globes are made of clear, frosted, smoked, or colored glass, and the fixtures are either wall-mounted or chandelier. Globe lamps tend to form a spot of glare and deliver unattractive, flat lighting.



*Uplights and Torchieres.* These are usually floor lamps that aim all light output upward to use the ceiling plane as a reflector, providing indirect, general lighting. The source light is usually incandescent, but halogen and HID versions are becoming increasingly popular.



*Clip-on Photo Lights.* This type of luminaire is a very economical form of incandescent fixture that can produce general and spot lighting. Typically, they are fully adjustable and available with many different types of reflectors. They are inexpensive and flexible fill lights, especially in ad hoc or temporary situations.



*Filters and Diffusers*

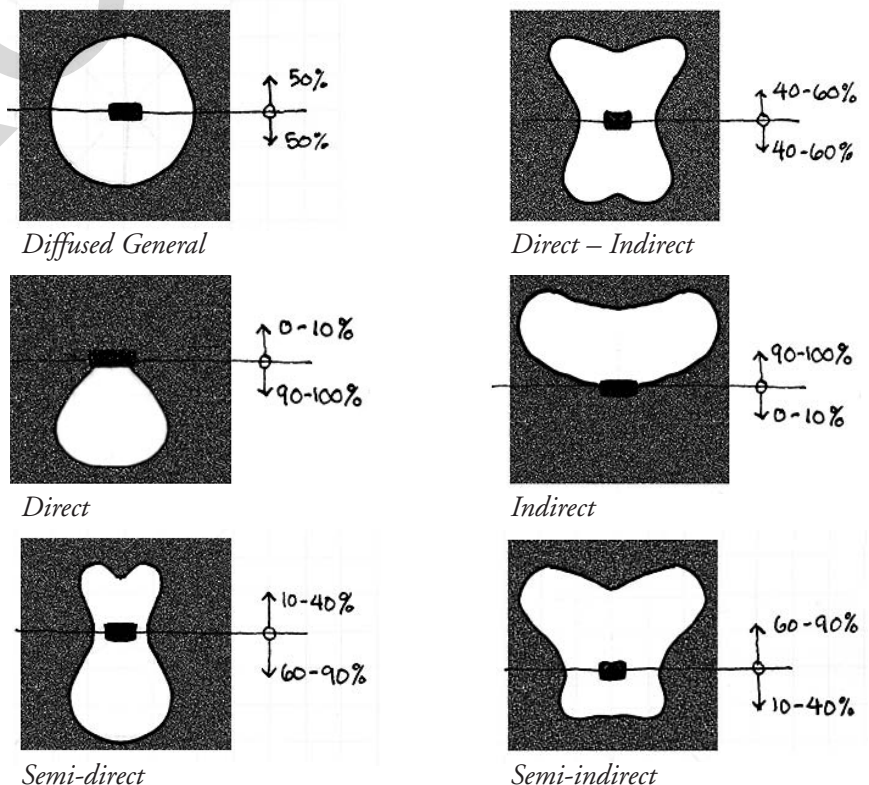
*Interpreting Fixture Data and Calculations*

*Kinetic Fixtures.* The use of kinetic (moving) light, the type from a fireplace or flickering candle, can provide accent and the perception of intimacy and warmth. This natural application has understandable limited use. Artificial kinetic lighting is also used to add to festivity and energy in clubs and ballrooms.

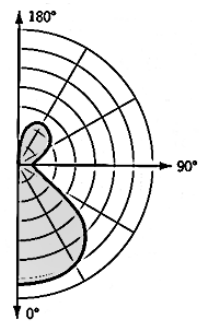
Conventional light fixtures can be transformed by the use of filters, lenses or diffusers. Parabolic louvers are commonly used in offices to control glare within normal viewing angles. Slip-on filters can be used to make color corrections to florescent tubes. It is important to consult a qualified electrician or engineer before experimenting with any alteration to a fixture. Close shading of a light source can cause heat build-up resulting in fire or fixture failure.

Both architectural and portable lighting are classified by standardized information and charts provided from manufacturers. In addition to the size, wattage, appearance and type of mounting, fixtures should be selected by the way, in which they actually deliver light. It is quite easy to become familiar with such information and to gain an immediate idea of the performance of a particular option at a glance.

One useful chart shows the typical distribution of light as a series of contour lines that map the way light output will spread in various directions. The more circular the distribution, the more diffused the light will be in all directions, and the more direct light (like the familiar down light) will appear concentrated on one side or another of the chart. This is a general guide to light distribution.







Photometric Chart

Once the type of light distribution is selected, it is possible to narrow down the fixture choice further. By referring to the various charts and data sheets that are provided in manufacturer's catalogues, a designer can "see" how the intensity of light from a particular fixture is delivered from a given mounting height. This is referred to as a "photometric" chart. A circular (or semi-circular) graph places a light source at a center point and shows its light output or candle-power at several angles. An example of this type of chart is shown at left.

More complex projects with multiple fixtures use formulas to guide selection and placement. Formulas of this sort are most useful in planning the overall lighting of offices, maintenance facilities, classrooms, or similarly uniformly lighted spaces.

While most of the complex calculations are obtained from an engineer, it is easy for the interior designer to do some design planning calculations with just a few known factors. For example, use the following formula to determine the illumination level for a given installation:

$$\text{illumination level desired} = \frac{(\text{lumens per watt} \times \text{wattage})}{\text{area to be lighted}}$$

If the area is in square feet, the illumination level will be in footcandles, or if the area is in meters, the illumination level is in lux.

The same formula can, in reverse, suggest the number and spacing of fixtures needed to produce a desired level of illumination. Again, the basic factors needed to do the calculation are: illumination (in footcandles or lux), lumens per watt, number of watts, and the area to be lighted. If the precise number of lumens per watt is not yet known or unavailable from manufacturer's data, a rule of thumb for approximating is given below:

|               |    |
|---------------|----|
| Incandescent: | 20 |
| Mercury:      | 0  |
| Fluorescent:  | 80 |
| HID:          | 85 |

Here is how the factors relate in an example:

To arrive at 60 footcandles of illumination throughout an area of 6,000 square feet using florescent light, figure:

$$60 \text{ footcandles} = \frac{80 \times \text{required wattage}}{6,000 \text{ square feet}}$$

or:

$$60 = \frac{80 \times \text{wattage}}{6,000}$$

giving:

$$4,500 = \text{wattage required}$$

The wattage could be provided, in this example, by 112, 40-watt tubes. The designer can then make the decision to place the tubes in, for example, 28, evenly spaced, four-tube fixtures.

This calculation is oversimplified, because it doesn't take into account the design of the fixture and its efficiency, the projected changes in output as the fixture ages or becomes dirty, nor the characteristics of the space such as shape, color or the reflectivity of the wall finish. These factors are taken into account in the more complex and precise calculations that are typically done by the engineer or lighting consultant. Refer to the additional information at the end of this guide for the terms used in working with these types of consultants.

While planning is relatively simple with architectural lighting, it cannot easily be done with portable lighting, since lamps may be moved, replacement wattage varies, and an even illumination level is not usually sought. In task-lit or less formal applications, the designer's experience, aided by the use of a simple light meter, is the best guide for the placement of lighting.

#### *Control Systems*

Once in place, lights are sometimes left "idling"—drawing electricity when the building is unoccupied or in areas where daylight is sufficient—accounting for 40 to 80 percent of all lighting costs. Even a small investment in control systems can save hundreds of thousands of dollars a year in a large facility.

- *Dimming Systems* provide control of dimmable sources from a central control panel or switch location. They are useful in conference facilities, assembly spaces, training facilities and in residential use. They are also useful for "partitioning" spaces for multiple uses or for different activities within a space. Dimming adds the necessary versatility to accent changing exhibition products or artwork. In the office, dimming provides workers with an important degree of personal control, like the ability to reduce the glare at a computer workstation.
- *Motion or occupancy sensors* are appropriate in areas of intermittent use, like rest rooms, conference rooms, break rooms, janitor closets, and outdoor areas. If properly selected, installed, adjusted and maintained, occupancy sensors can be just as effective in private offices. It should be noted that there is a higher maintenance cost associated with these sensors, and this cost should be considered against anticipated energy savings.
- *Timers* can be used to turn lights on and off according to the time of day. It is also important for the designer to provide an easy, intuitive means for people working outside normal work hours to override these systems when necessary.
- *Relay Systems* provide on/off control of circuits from a central control panel or switch location. They are useful in large office building, warehouses, and large complexes. Telephone/computer interface is often used to regulate these systems.

- *Alternating.* Alternative rows of lighting can be left off for cleaning and/or restocking. The rows used for these cycles can be rotated to equalize lamp burn hours.
- *Daylight Control Systems* often interact or are part of a lighting system that detects the amount of daylight in a space and automatically adjusts the artificial lights to maintain a certain illumination level. The most sophisticated systems employ actual sunlight tracking systems, and are precisely programmable by area.
- *Integrated Building Control Systems* are part of an integrated circuit that also controls heating, ventilating and air conditioning equipment and security.

#### *Ballasts*

A ballast is a device used with electric discharge lamps (like fluorescent) to obtain the necessary circuit conditions for starting and operating. A lamp operating on a magnetic ballast may flash on and off a few times before finally starting. Most electronic ballasts use instant-start technology that eliminates the flashing. Electronic ballasts operate lamps at a high frequency, which increases the efficiency of the lamp and reduces the flicker sometimes associated with fluorescent lighting.

Fluorescent lights use special starters of several types. The familiar “pre-heat” starting requires pressing a switch for a short interval before the lamp actually lights. “Instant start” (also called “Slimline” after the tubes used in this circuit) require no separate starter and it lights at once, just like incandescent. “Rapid start”, which is widely used in large office and commercial installations, requires no starter and lights after a very brief delay.

#### *Switches*

Any lighting installation will require switching to provide control from convenient locations. Light switches are normally provided at the entry to each room or space. A space that can be entered from two or more directions calls for multiple switching. Switching can also be controlled by sound or heat-sensitive proximity switches that turn light on when people are present and off when people leave.

Dimmers are a further modification of switches that permit a range of light levels from very low up to the maximum available, and provide them in a smooth transition. When incandescent lights are dimmed, they become warmer in color. This effect creates the coziness that is favored in residential spaces and restaurants. Automatic dimmers can alter light levels gradually in response to outside light levels or other design programs.

Although they are minor elements, switches and switch plates should be selected and placed by the interior designer to compliment the design of the space. Wall switch mounting heights are typically left to the contractor to meet codes, but there is some design latitude in location as long as these requirements are met. The Americans with Disability Act (ADA) guidelines require a mounting height for direct reach of 48 inches above the finished floor.

### DAYLIGHTING

Daylight or “natural light” comes from the sun and is reflected from the ground and other surrounding objects. It is estimated that 20-50% of energy needed to light a building can be saved with the good use of daylight. Daylight carries with it significant quantities of heat which, in properly designed buildings, may also be used to conserve energy.

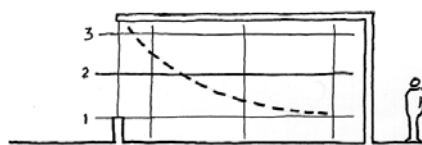
Daylight is highly variable, its angle and brightness change over the course of the day and the year, and with fluctuations in the weather. Because natural light is both horizontal as well as vertical, it helps define the changing contours and textures of surfaces. It also provides light from the entire light spectrum—even those frequencies that we cannot perceive with our eyes.

Some lighting experts argue that the qualities of daylight are essential to a sense of well-being in people, and that lack of daylight leads to boredom, fatigue, lack of concentration, and even a reduction of intellectual capacity. In addition to the stimulating effects of varying the visual environment, the changing quality of daylight triggers and reinforces the body’s natural biological rhythms and systems.

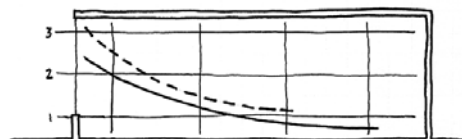
Natural light can quickly become too much of a good thing, however, with brightness or contrast levels that far exceed current recommendations—particularly for the computer user. Design orientation, shape, and use of structure or spaces will influence daylighting decisions.

#### *Daylighting Design Factors*

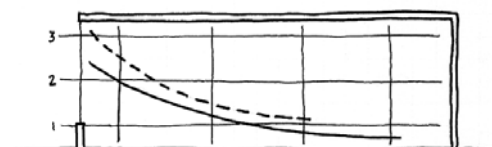
- *Room depth.* Obviously, the level of natural illumination will be less in the interior than near a window, and the deeper the space, the less light can penetrate to its interior. The diagrams below indicate the illumination levels for typically sized rooms.



*24 feet deep*

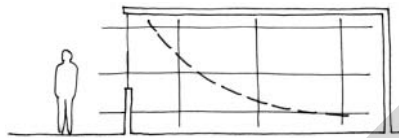


*28 feet deep*

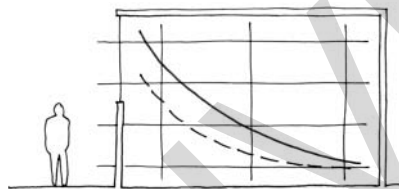


*32 feet deep*

- Window Size and Placement.* A rule of thumb is that daylighting can be effective for average task illumination up to about 20-24 feet away from the windows, but this depends heavily on the size and location of the windows. The higher the window is placed on a wall, the more light there will be in the interior. Windows below the level of the work surface are not effective in providing light for the task. The diagrams below show how window placement influences light distribution.

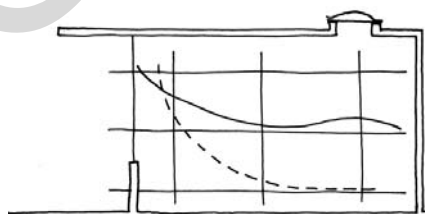


8 foot ceiling

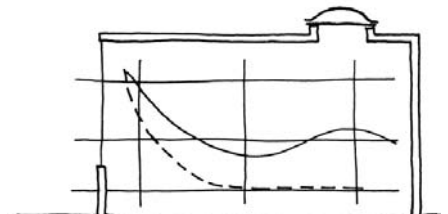


12 foot ceiling

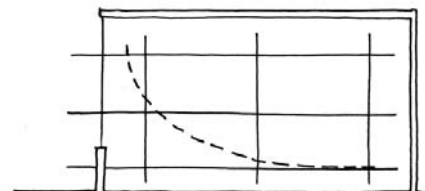
There are several types of openings that emit daylight. The most common form is the standard, vertical plane window. There are also skylights and clerestories that are set in the roof structure to allow the introduction of daylight deep into spaces. Daylight can also be bounced off light shelves or brought deep into the building with the use of light wells. Here are some of the typical openings that are used to admit daylight:



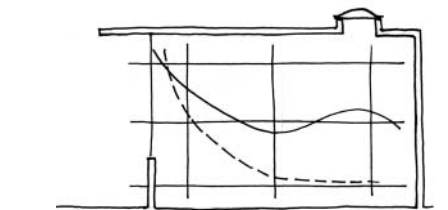
Overhang



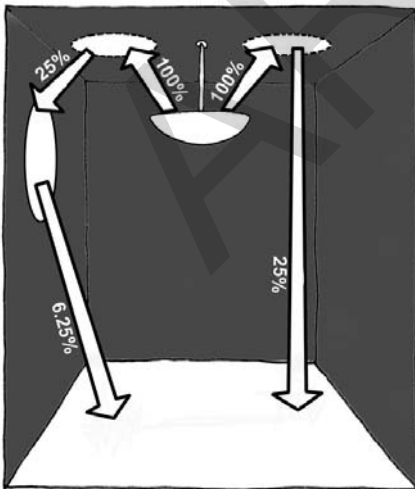
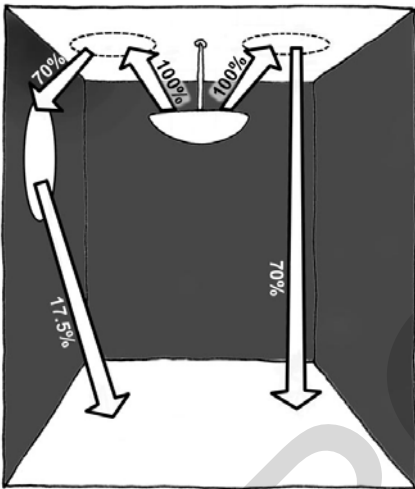
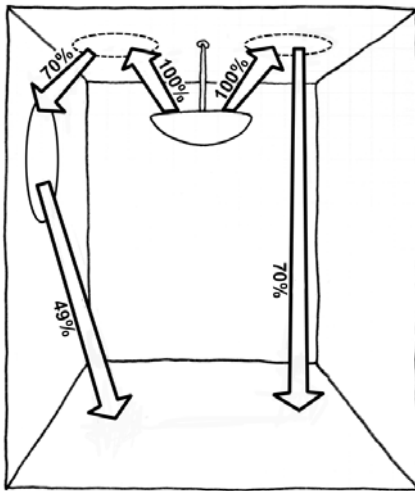
Skylight



Vertical Window



Ground Reflection



- *Finishes.* The color and reflectivity of interior finishes are important in use of daylight and control of luminous ratios. Light colored surfaces enlarge the perception of space and diffuse the light distribution. The ceiling is the most effective surface for reflecting light and typically, it should be very light in color. The floor is one of the least significant, and it is here that the designer has the greatest opportunity for the use of darker colors, such as those found in carpets.

The diagrams at left show how room finishes influence light distribution.

- *Controls.*

There is a complex mix of elements to balance in controlling and maximizing daylight on an interior, especially an interior workplace.

*Orientation.* Good orientation, ideally facing south with appropriate shading, makes a difference in winter and summer. Openings facing north, which never admit direct sun, generally receive cool but consistent light from the north sky. East-facing openings admit strong sunlight early in the morning and lose the sun sometime before noon. West-facing windows receive the late afternoon sun, which is sometimes too much direct daylight on summer afternoons, or in climates with many days of strong sunlight. Even though controlling direct sun by proper orientation of the building or openings usually lies beyond the scope of work of the interior designer, the impact of orientation merits thought and attention because it greatly influences planned and existing situations.

*Shading Devices.* Louvers, overhangs, shades, blinds (with or without draperies), or other devices can be applied creatively to control the excessive illumination and luminance contrast emitted from the sun. This is critical when eyes that are concentrating on an interior task can view the light source. In such cases, the window or skylight should be filtered or shielded from view, or the task should be oriented away from these sources. Excessive daylight becomes even more intolerable in the VDT environment.

*Multiple Glazing.* Multiple glazing uses two, sometimes three, sheets of glass that are factory-assembled into a sandwich. The dead air spaces between the layers minimize winter heat loss or summer heat gain. Special glass tinted to filter out unwanted heat energy while permitting most light to pass through can also be obtained.

- *Furniture Placement.* When placing furniture, it is important to keep bright windows out of the field of vision of any person doing close up tasks like reading or repair work. Seated people who are doing visual tasks with their backs to a window can cause problems because of the shadow cast forward on to the work plane. The traditional advice of “light over the left shoulder” is still good, although light from the right is also satisfactory for most tasks and ideal for left-handed people.

*Strategies***LIGHTING DESIGN APPROACHES**

Old design approaches should give way to recent advances in lighting information and technology. Designers are often in a position to influence design projects directly, or to provide guidance and education to other decision-makers. Several general design strategies can be used to update the thinking on how lighting and energy are used.

- *Keep it Low.* Contrary to the older school of thinking, working in adequate yet dim light will not harm the eyes, anymore than listening to music at lower volumes will hurt the ears. Brighter light is not necessarily better.
- *Uniform Overhead Fixtures Cannot Provide the Only Source of Light.* This is especially true for offices now that computers are the focus of many peoples jobs. Additional and appropriate lighting should accompany each individual task in a work area.
- *Make Lighting Specific.* Tasks need to be identified carefully and lighting chosen for each based on the task itself. It is important to take into consideration the task's size, importance, the duration of time it needs to be performed, its priority in relation to other tasks, general lighting in the area, and the physical condition, age, and expectations of the person performing the task.
- *Let the User Control Lighting Options Whenever Practical.* Because comfort factors will vary dramatically from task to task and person to person, the best task light is one that gives the user the most control over position and intensity. It is also important for the same person to be able to alter light levels to match his or her changing needs over the course of the day or season.

Inappropriate lighting can have a negative effect on more than just peoples' vision. If people try to change their posture to avoid glare on a VDT screen, for example, they may be risking repetitive-strain injuries. Psychologists have also found that the simple act of turning on a light at the beginning of a workday and turning it off at the end is a gesture that carries symbolic importance and satisfaction. Good light means different things to different people, and allowing them a measure of control once the lighting is in a place can have positive returns in morale and productivity.

- *Consider the fixtures as a design element.* Select fixtures that complement the over-all design objective. They should be a compatible scale, color, finish and geometry. Plan placement so that it coordinates with the structure from every view, and does not destroy the harmony of the design.
- *Prepare for the Aging Population.* As people's eyes age, the lenses grow larger and more rigid, requiring more effort for the eye muscles to focus at close range. As a result, low light makes it harder to see clearly, color identification is decreased, and intolerance for both direct and reflected glare increases. In addition to this general loss of visual acuity, depth perception is also impaired. The use of bifocals to correct for the change in near-point vision

*Office*

that occurs between age 45 and 55 complicates matters for people who work at computers. All these vision changes and their accompanying lighting needs will increase the challenge for the designer as our population ages. The Americans with Disabilities Act is a good guideline for consideration in interior design.

**APPLICATIONS**

Since many office buildings allow little or no daylight to reach major interior areas, artificial light becomes the primary source of illumination. In the past, it was considered satisfactory to simply provide overall lighting to deliver a standard level of illumination to the desktop. This is no longer the case.

High levels of uniform lighting tend to deliver glare both from fixtures and from reflections on task materials (like white paper) on the desktop. Such lighting also wastes energy because areas that have no need for high light levels (such as seating, storage and circulation areas) are receiving the same levels as actual work surfaces. The realization of such problems has led to the development of alternative approaches, such as “task-ambient lighting,” in which higher light levels are provided at the desktop or task areas, while ambient light is set at much lower levels. This type of lighting is now available in many office furniture systems, with task lighting set close to work surfaces and ambient lighting supplied indirectly from uplight fixtures that reflect off the ceiling.

The computerization of modern offices has made VDT’s a universal item of office equipment, often in continuous use throughout working hours. Visual comfort at a computer workstation is extremely important in minimizing work stress and physical complaints among office workers, and proper lighting is an essential factor in avoiding such problems.

Because VDT’s are self-luminous, they require little or no lighting themselves; adjacent tasks, however, must be lighted. Reflected glare on the screen or different levels of illumination that cause the VDT users eyes to continually adjust between the different brightness levels of screen and background, and can result in eyestrain. The brightness level of nearby surroundings and of task materials close to the VDT screen should be no more that three times that of the screen itself.

An unshielded fluorescent strip is particularly inappropriate in a VDT environment. Diffusing materials may soften its light, but glare problems are not usually diminished. Light levels must be made as adjustable as possible for the individual user to provide accommodation for different tasks over time.

Private offices and conference rooms also require the same attention to lighting objectives. In these spaces, as well as in open office workstations, some adjustability is usually necessary. It is often desirable to relieve visual monotony by providing an alternative visual focus, so that a brief look away from work materials offers relaxation and the stimulus to return to the task.



*Lodging*

Temporary lodging facilities vary a great deal from location to location, but the lighting design objectives are similar to those of apartments or multiple family housing units.

Well-designed lighting can help to reduce the anxiety and stress that accompanies living in a temporary situation. Lamps that give off warm color light can add to the intimacy and restfulness that is associated with home, and avoid the pallor and glare that is fatiguing.

A combination of task and ambient lighting can also help to distinguish an otherwise undifferentiated space. Task lighting and light levels should be planned to accommodate these primary functions: 1) sleeping, 2) personal hygiene, 3) dressing, 4) television viewing, 5) communication (telephone, writing and computer), 6) temporary apparel and baggage storage and retrieval, 7) and, in facilities with kitchenettes, limited food preparation.

Provide good exterior lighting to engender a feeling of security and to help with way finding. Steps and keyholes should be especially well lighted for safety.

*Dining Halls, Restaurants and Clubs*

The character of the lighting in these facilities goes a long way in communicating price level, quality, and the speed of turnover. The selection of eating facilities is strongly influenced by appearance, and customer satisfaction is influenced by visual impression. Bright, uniform light suggests the briskly paced atmosphere usually associated with cafeterias and fast food outlets where speed and low prices take priority over uniqueness and service.

In facilities with table service, a mid-range ambient level of 30 to 50 foot candles is sufficient for table illumination and circulation. These mid-range restaurants are generally well served by overall lighting. Dimmers are an inexpensive way to alter light levels as the season or time of serving suggests. Although fluorescent light is generally unflattering to the ambience of restaurants that offer table service, this obstacle can be overcome by the use of full-spectrum or warm-tone fluorescent lamps, in combination with limited incandescent and halogen sources.

Bar and behind-bar areas invite strong lighting directed onto the glassware and bottles to generate glitter and kinetic light reflections that add to the lively atmosphere.

Provide auxiliary lighting that is more intense for the cleaning or maintenance work done before or after serving hours.

*Educational Facilities*

The design of classroom and training facility lighting should parallel the strategies used in office lighting. While there must be a standard level of illumination for reading and note taking (in the range of 30-50 footcandles), these facilities also require some level of adjustability and variety.

Incandescent spots and wall washers can illuminate the speaker's platform and peripheral walls, aid in crowd circulation and complement the design of the space. Where traditional slate-type blackboards have been replaced with whiteboards, veiling reflection and glare from this vertical surface can create a problem; a strong point source on a whiteboard is not a good choice.

Dimmers and independent circuits are important to accommodate lighted audiovisual presentations using slide, overhead, and computer projection. Good, isolated task lighting at the speaker's site is also an essential design consideration.

#### *Health Care Facilities*

Lighting in clinics and medical offices involves a complex variety of issues concerning the comfort and well being of patients and visitors and the working needs of the staff. Waiting areas and circulation spaces require moderate light levels (30-50 foot candles), while consulting rooms and private offices are best served with the same ambient light level with additional high-intensity task lighting at desktop level. Examination and treatment rooms require light levels in excess of 100 footcandles.

Patients' rooms, which are often illuminated in older facilities with drab general lighting at a low level, actually call for lighting adjustable to several differing intensities. A low level is suitable for nighttime, while a second, medium level of 30-50 footcandles is needed for daytime. Portable or otherwise moveable light units should be made available as well.

Well-designed lighting can help to reduce anxiety and discomfort in medical facilities. Patients and family members are strongly influenced by the overall appearance of such places, and tend to interpret comfortable and appropriate lighting as an indication of competent, professional care.

#### *Retail Store and Display Spaces*

Lighting plays a major role in communicating the character of merchandise or objects. Bright, even glaring light is typical of supermarkets and similar mass-merchandising facilities. A basic level of 100 footcandles is common, with special displays using levels as high as 500 footcandles supplied by directed spotlighting. In areas offering more personalized service, or for displays that are better suited to a subtle appearance, a moderate level of 50-70 footcandles is appropriate.

The colors of the illuminants selected also serve to make an object to look its best. As already discussed, fluorescent lighting, although economical, is unflattering to colors. Incandescent, halogen and HID lighting are usually more flattering to merchandise in which color is a significant element. Outdoor daylight, of course, is the most flattering light for the majority of people and displays.

#### *Residential*

Nowhere is there more latitude for a designer's intuition, experience and creativity than in residential lighting design. Since the design of the structure, as well as the needs and objectives of people occupying the home are so varied,

it is difficult to generalize about this type of lighting design, and a thorough treatment of the subject is beyond the scope of this guide. Refer to the reference section of this guide for additional sources for residential lighting design.

#### CONCLUSION

The technical complexity of lighting and the constantly increasing variety of lighting sources and devices may tempt the designer to turn over all lighting problems to a specialized consultant. It should be remembered, however, that the consultant is a technical aid. It remains for the designer to suggest the character, atmosphere and visual effects desired for the overall scheme. The more knowledgeable the designer is about the technical issues, the easier it will be to communicate with a consultant, and the greater the probability of a satisfactory result. For small projects that cannot include the services of a consultant, the designer has the opportunity for balancing the technical performance with visual impact for maximum design effect.

#### APPENDIX

- Attachment A: Glossary of Terms
- Attachment B: Table of Recommended Light Levels
- Attachment C: Quick Reference Chart of Lamp Types
- Attachment D: Standard Reflected Ceiling Plan with Notes
- Attachment E: Standard Furniture Plan with Notes
- Attachment F: Lighting Simulation Software

## ATTACHMENT A: GLOSSARY OF LIGHTING TERMS

*Note: Many of these terms may be found in the American National Standard Nomenclature and Definitions for Illuminating Engineering. ANSI/IES RP16-1967. Others have appeared in recent publications. Definitions of electrical terms common to lighting and to other fields are available in American National Standard Definitions of Electrical and Electronics, ANSI/IEEE Std 100-1972. Unless otherwise indicated, all data in this section have been abstracted, with permission, from the IES Lighting Handbook, 5th ed., published by the Illuminating Engineering Society in 1972, and from other publications of the Society. For additional and more detailed definitions, IES Lighting Handbooks, 1987.*

|                               |  |
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| <i>absorption</i>             | General term for the process by which incident flux is dissipated (Note: the process of reflection, transmission and absorption accounts for all incident flux.)   |
| <i>adaption</i>               | Adjustment of a sensory organ to the intensity or quality of the stimulation   |
| <i>accent lighting</i>        | Directional lighting to emphasize a particular object or draw attention to a part of the field of view   |
| <i>ambient light</i>          | Also called “general lighting,” this is the overall level of light in a space  |
| <i>baffle</i>                 | A single opaque or translucent element to shield a source from direct glare at certain angles or to absorb unwanted light  |
| <i>ballast</i>                | A transformer that converts the current in a circuit to that required to start and operate an electrical discharge lamp  |
| <i>“black light”</i>          | Popular term for ultraviolet energy near the visible spectrum  |
| <i>brightness</i>             | [also see luminance.] Intensity of light level produced by a light source or reflected back from a lighted surface. The footlambert (fl) is the unit of measurement for brightness   |
| <i>candela (cd)</i>           | Unit of light intensity approximately equal to the more commonly used foot-candle (fc), which is the level of light falling on a surface with an area of one square foot placed at a distance of one foot from a standard candle |
| <i>candlepower</i>            | Unit of light intensity expressed in candelas  |
| <i>Cathode-ray Tube (CRT)</i> | Element providing the screen for the television set or computer monitor  |
| <i>ceiling area lighting</i>  | General lighting system in which the entire ceiling is, in effect, one large luminaire, as in louvered ceilings and luminous ceilings  |
| <i>ceiling cavity</i>         | Cavity formed by the ceiling, the plane of the luminaires, and the wall surfaces between these two planes  |

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| <i>clerestory</i>                                     | An outside wall pierced with windows, carried above an adjoining roof; also a wall with a window or band of windows placed high                                       |
| <i>channel</i>  | Enclosure containing the ballast, starter, lamp holders, and wiring for a fluorescent lamp  |
| <i>Coefficient of Utilization (CU)</i>                | Coefficient of Utilization (CU): Ratio of the luminous flux (lumens) from a luminaire received on the work plane to the lumens emitted by the luminaire's lamps alone |
| <i>cold-cathode lamp</i>                              | Light source that uses thin, luminous gas-filled tubes; similar to neon lamps   |
| <i>Color Rendering Index (CRI)</i>                    | Ability of a light of a particular kind to permit accurate evaluation of the color of objects   |
| <i>color temperature</i>                              | Single number expressed in Kelvin ( $^{\circ}\text{K}$ ) that indicates the relative warmth or coolness of lighting   |
| <i>continuous spectrum light</i>                      | Light that contains all of the energy wavelengths (colors) that make up white light   |
| <i>cornice lighting</i>                               | Lighting by means of light sources shielded by a panel parallel to the wall and attached to the ceiling   |
| <i>Correlated Color Temperature (CCT)</i>             | Color temperature of a lamp; the higher the temperature, the bluer the light; the lower, the more red or orange the light; measured in Kelvins ( $^{\circ}\text{K}$ ) |
| <i>cove lighting</i>                                  | Lighting by means of sources shielded by a ledge or horizontal recess that distributes light over the ceiling and upper wall  |
| <i>cutoff angle (of a luminaire)</i>                  | The angle measured up from the nadir, between the vertical axis and the first line of sight at which the bare source is not visible                                   |
| <i>daylighting</i>                                    | Intentional, controlled use of natural light to reduce the requirement for artificial light   |
| <i>degrees Kelvin (<math>^{\circ}\text{K}</math>)</i> | Base unit of temperature  |
| <i>diffused reflectance</i>                           | Ratio of the flux leaving a surface or medium by diffused reflection to the incident flux   |
| <i>diffused reflection</i>                            | Process by which the incident flux is redirected over a range of angles   |
| <i>diffused transmission</i>                          | Process by which the incident flux passing through a surface or medium is scattered   |
| <i>diffused lighting</i>                              | Light that is not predominantly incident from any particular direction  |

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| <i>diffuser</i>                     | Device to redirect the light from a source primarily by the process of diffused transmission   |
| <i>direct glare</i>                 | Glare resulting from an unshielded source  |
| <i>direct-indirect lighting</i>     | Variant of general diffused lighting in which the luminaires emit little or no light at angles near the horizontal   |
| <i>direct lighting</i>              | Lighting by luminaires distributing 90 to 100 per cent of the emitted light in the direction (usually downward) of the surface to be illuminated                       |
| <i>disability glare</i>             | Glare resulting in reduced visual performance and visibility   |
| <i>discomfort glare</i>             | Glare producing discomfort but not necessarily impairing visual performance or visibility  |
| <i>discontinuous-spectrum light</i> | Light in which only some wavelengths (colors) are present  |
| <i>downlight</i>                    | Small direct lighting unit that can be recessed, surface-mounted or suspended  |
| <i>electric discharge lamp</i>      | Lamp in which light is produced by the passage of an electric current through a vapor or a gas, as in fluorescent, cold-cathode and mercury lamps                      |
| <i>eyeball</i>                      | Incandescent lighting fixture that contains a pivoting, spherical element that permits direct light to be focused as desired   |
| <i>filter</i>                       | Device for changing, by transmission, the magnitude and/or the spectral composition of the flux incident upon it   |
| <i>fill light</i>                   | Background, ambient or diffused light that reduces the contrast between dark areas or shadows and primary light  |
| <i>floodlight</i>                   | Projector designed for lighting a scene or object to a luminance considerably greater than its surroundings  |
| <i>floor cavity</i>                 | Cavity formed by the work plane, the floor and the wall surfaces between these two planes  |
| <i>fluorescent lamp</i>             | Low-pressure mercury electric discharge lamp in which a fluorescing coating (phosphor) transforms some of the ultraviolet energy generated by the discharge into light |
| <i>flush-mounted or recessed</i>    | Luminaire mounted above the ceiling with the opening of the luminaire flush with the surface of the ceiling  |
| <i>flux</i>                         | Flow of light  |

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| <i>footcandle (fc)</i>                      | Basic unit of measure of illumination or incident light; the illumination of the surface at a distance of one foot from a standard candle        |
| <i>footlambert (fl)</i>                     | Unit of reflected light; the luminance of a perfectly diffusing surface emitting or reflecting light at the rate of 1 lumen per sq. ft.          |
| <i>full-spectrum light</i>                  | Light that contains the complete range of wavelengths present in daylight, including the invisible radiation at each end of the visible spectrum |
| <i>general diffused lighting</i>            | Lighting by luminaires distributing 40 to 60 per cent of the emitted light downward and the balance upward and horizontally                      |
| <i>glare</i>                                | Discomforting sensation generated from a bright source that reduces visibility and task performance  |
| <i>High intensity discharge (HID) light</i> | Lamp employing mercury, metal halide, or high-pressure sodium in a sealed globe to produce an efficient type of electric lighting                |
| <i>horizontal plane</i>                     | [see work plane]   |
| <i>Illuminating Engineer Society</i>        | Or the Illuminating Engineering Society of North America; 120 Wall Street; New York 10005-4001; (212) 248-4000                                   |
| <i>illuminance</i>                          | Density or amount of lumens on a surface per unit of area  |
| <i>illumination level</i>                   | Measure of light falling on a surface. The unit of measure is the lux or foot-candle   |
| <i>incandescent light</i>                   | Most common light source. A lamp that produces light by means of an electrically heated wire filament within a sealed globe                      |
| <i>indirect lighting</i>                    | Lighting directed against a reflective surface, most often a ceiling   |
| <i>instant-start fluorescent lamp</i>       | One designed to start by high voltage without preheating of electrodes   |
| <i>kinetic</i>                              | Of or relating to motion of material bodies  |
| <i>lamp</i>                                 | Generic term for a synthetic source of light that converts electrical energy to light  |
| <i>laser</i>                                | Acronym for "Light Amplification by Stimulated Emission of Radiation." Highly monochromatic and coherent beam with steady oscillation            |
| <i>lens</i>                                 | A glass or plastic shield that covers the bottom of a luminaire to control the direction and brightness of the light it emits                    |

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| <i>Light Loss Factor (LLF)</i>                  | Factor used in calculating level of illumination after a period of time. It takes into account temperature and voltage variations, dirt accumulation, lamp depreciation, etc.                  |
| <i>light spectrum</i>                           | Band of colors, ordered from the longest wavelength (red) to the shortest (violet)   |
| <i>louver</i>                                   | Series of baffles arranged in a geographic pattern used to shield a light source from view at certain angles   |
| <i>louver shielding angle</i>                   | Angle between the horizontal plane of baffles or louver grid and the plane at which the louver conceals all objects above  |
| <i>lumen (lm)</i>                               | Unit of light flow generated by the light of one standard candle   |
| <i>lumens per watt</i>                          | Ratio of lumen output to measure of energy   |
| <i>luminaire</i>                                | Complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply |
| <i>luminaire Dirt Depreciation (LDD)</i>        | Factor used to account for light loss due to dust and dirt   |
| <i>luminaire efficiency</i>                     | Ratio of luminous flux emitted by a luminaire to that emitted by the lamp or lamps used therein  |
| <i>luminance (photometric brightness)</i>       | The luminous intensity of a surface in a given direction per unit of projected area at the surface as viewed from that direction; brightness relative to direction                             |
| <i>luminous ceiling</i>                         | Ceiling area lighting system comprising a continuous surface of diffused transmitting material with light sources mounted above it   |
| <i>luminous density</i>                         | Quantity of light per unit volume  |
| <i>luminous efficacy (of a source of light)</i> | Quotient of the total luminous flux emitted by the total lamp power input expressed in lumens per watt   |
| <i>luminous flux</i>                            | Time rate of flow of light; measured in lumens   |
| <i>luminous intensity</i>                       | Force that generates the flow of light; measured in candela per unit of area   |
| <i>lux</i>                                      | Metric equivalent unit of illumination or incident light. One lux is equal to one lumen per square meter (lm/m <sup>2</sup> ). One lux equals 10.76 footcandles                                |
| <i>maintenance factor</i>                       | [See light loss factor]  |



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| <i>mercury lamp</i>                            | Discontinuous spectrum gaseous discharge lamp in which the major portion of the radiation is produced by excitation of mercury atoms  |
| <i>metal halide light</i>                      | An economical HID lamp that provides high output  |
| <i>mounting height (above the work plane)</i>  | Distance from the work plane to the light center of the luminaire or to the plane of the ceiling for recessed equipment   |
| <i>near-point light</i>                        | Light that comes from a concentrated source nearly identical to a point in space  |
| <i>parabolic louvers</i>                       | Series of baffles arranged in a geometric pattern used to shield a source from view at certain angles or to absorb unwanted light   |
| <i>photometric chart</i>                       | Published graph of luminous exitance value at critical angles   |
| <i>polarization</i>                            | Process by which the transverse vibrations of light waves are oriented in a specific plane  |
| <i>point-source light</i>                      | Light that comes from a concentrated source virtually identical to a point in space   |
| <i>preheat (switch start) fluorescent lamp</i> | One designed for operation in a circuit requiring a starting switch to preheat the electrodes in order to start the arc   |
| <i>rapid-start fluorescent lamp</i>            | One designed for operation with a ballast that provides for preheating the electrodes and initiating the arc without a starting switch or the application of high voltage   |
| <i>recessed</i>                                | [See flush-mounted]   |
| <i>reflectance of a surface or medium</i>      | Percentage of incident light reflected from an illuminated surface  |
| <i>reflected glare</i>                         | Glare resulting from specular reflections of high luminance on polished or glossy surfaces in the field of view, especially within or in close proximity to the visual task |
| <i>reflection</i>                              | Process by which the incident flux leaves a surface or medium from the incident side  |
| <i>reflector</i>                               | Device used to redirect the luminous flux from a source by the process of reflection  |
| <i>refraction</i>                              | Process by which the direction of a ray of light changes as it passes obliquely from one medium to another of a different density   |
| <i>recessed luminaire</i>                      | One mounted above the ceiling with the housing of the luminaire above the ceiling line  |


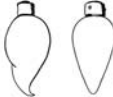






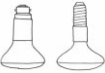




|   |   |
|---|---|
| <i>room cavity</i>                      | Cavity formed by the plane of the luminaires, the work plane and the wall surfaces between these two planes; often used to compute Room Cavity Ratio (RCR)                          |
| <i>semi-direct lighting</i>             | Lighting by luminaires distributing 60 to 90 per cent of their emitted light downward and the balance upward  |
| <i>semi-indirect lighting</i>           | Lighting by luminaires distributing 60 to 90 per cent of their emitted light upward and the balance downward  |
| <i>shade</i>                            | Screen made of opaque or diffusing material designed to prevent a light source from being directly visible at normal angles of view   |
| <i>shielding angle (of a luminaire)</i> | Angle between horizontal line through the light center and the line of sight at which the bare source first becomes visible   |
| <i>sodium light</i>                     | Gaseous-discharge light source that uses sodium gas in a sealed tube  |
| <i>spacing criteria (SC)</i>            | Ratio of luminaire spacing to mounting or ceiling height above the work plane   |
| <i>specular surface</i>                 | One from which the reflection is predominantly regular; a “glossy” surface  |
| <i>starter</i>                          | Device used in conjunction with a ballast for the purpose of starting an electric discharge lamp  |
| <i>surface-mounted luminaire</i>        | One mounted directly on the ceiling   |
| <i>suspended (pendant) luminaire</i>    | One hung from a ceiling by supports   |
| <i>task light</i>                       | Light necessary for specific kinds of work, or tasks, and installed close to a work surface so as to illuminate the area with minimal spill and this with maximum energy efficiency |
| <i>task ambient lighting</i>            | Lighting systems that provide higher intensity illumination on the task only and lower levels of ambient light for general circulation  |
| <i>track lighting</i>                   | System of lighting in which a continuous fixed band, or track, supplies current and supports moveable fixtures  |
| <i>transformer</i>                      | An electrical device that converts an electrical current to a lower or higher voltage for certain elements  |
| <i>transmittance</i>                    | Ratio of the transmitted flux to the incident flux  |
| <i>troffer</i>                          | Recessed lighting unit, usually long and installed with the opening flush with the ceiling  |

|   |  |
|---|--|
| <i>tungsten-halogen light</i>           | Incandescent light source that uses metal halides in compact, highly efficient HID lamps   |
| <i>uplight</i>                          | Light directed upward toward ceilings or the upper sections of walls. The term is also used to describe floor lamps or torchieres that cast all light upward   |
| <i>valance</i>                          | Longitudinal shielding member mounted across the top of a window or high on a wall to conceal light sources  |
| <i>veiling luminance</i>                | Luminance brightness superimposed on the retinal image that reduces its contrast and results in decreased visual performance and visibility  |
| <i>veiling reflection</i>               | Reflection off a light source that partially or totally obscuring the details of the task  |
| <i>Visual Comfort Probability (VCP)</i> | Indicator used to evaluate the direct glare zone of a luminaire. Luminaires are given this rating to indicate the percentage of people who, if seated in the most undesirable location, will be expected to find the luminaire acceptable from the standpoint of glare |
| <i>Video Display Terminal (VDT)</i>     | The screen unit used to display computerized information   |
| <i>wall washer</i>                      | A ceiling mounted adjustable lighting fixture that directs light sideways toward an adjacent wall  |
| <i>wattage/watts</i>                    | Metric unit of power   |
| <i>work plane</i>                       | The plane at which work is usually done. Unless otherwise indicated, it is assumed to be a horizontal plane 30 in. (700 mm) above the floor  |

## ATTACHMENT B: RECOMMENDED ILLUMINATION LEVELS (IN FOOTCANDLES)

| 1 fc  | 2 fc  | 10 fc  | 20 fc   | 30 fc  |
|---|---|--|---|--|
| <ul style="list-style-type: none"> <li>• Movie Theatre</li> </ul>   | <ul style="list-style-type: none"> <li>• Exits, at floor</li> <li>• TV viewing</li> <li>• Theater foyer</li> </ul>  | <ul style="list-style-type: none"> <li>• General residence</li> <li>• Parking garage</li> <li>• Hotel Bath</li> </ul>    | <ul style="list-style-type: none"> <li>• Cleaning</li> <li>• Hospital room</li> <li>• Stairways</li> <li>• Hotel bedroom</li> </ul> | <ul style="list-style-type: none"> <li>• Classrooms</li> <li>• Waiting rooms</li> <li>• Restrooms</li> <li>• Entrance foyers</li> <li>• Laundry</li> <li>• Reading printed material</li> </ul> |
| 50 fc   | 70 fc   | 100 fc   | 150 fc  | 200 fc   |
| <ul style="list-style-type: none"> <li>• Checking and sorting</li> <li>• Rough assembly</li> <li>• Bank lobby</li> <li>• Church pulpit</li> <li>• Inspection</li> </ul> | <ul style="list-style-type: none"> <li>• General reading and writing</li> <li>• Dormitory desk</li> <li>• Commercial kitchen</li> <li>• Craft work</li> </ul> | <ul style="list-style-type: none"> <li>• Office reading</li> <li>• Merchandising areas</li> <li>• Auto repair</li> </ul> | <ul style="list-style-type: none"> <li>• Proofreading</li> <li>• Office fine work</li> <li>• Accounting/bookkeeping</li> </ul>      | <ul style="list-style-type: none"> <li>• Critical visual tasks</li> <li>• Fine drafting</li> <li>• Engraving</li> <li>• Color printing</li> </ul>  |




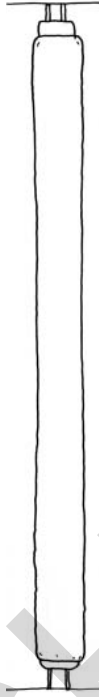



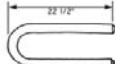



ATTACHMENT C: QUICK REFERENCE CHART OF LAMP TYPES

| Light Sources      | Incandescent  | Reflector   | Par Lamps   | High Voltage Halogen   |
|--------------------|---|---|---|--|
|                    |  "A" type<br>ø 40-80 mm<br>(1 1/2 - 3 1/8)<br> candle<br>ø 30 mm<br>(1 3/16)<br> globe<br>ø 60-75 mm<br>(2 3/8 - 3)<br> appliance<br>ø 25-30 mm<br>(1 - 1 3/16)<br> golfball<br>ø 45 mm<br>( 1 3/4)<br> incandescent<br>tube<br>(length<br>variable) |  silver-tops<br>ø 45-65 mm<br>(1 3/4 - 2 9/16)<br> "R" type<br>reflectors<br>ø 50-95 mm<br>(1 15/16 - 3 3/4)<br> |  flood<br>ø 122 mm<br>(4 13/16)<br> spot<br>ø 122 mm<br>(4 13/16) |  bayonet or ES<br>fitting<br>45 mm (1 3/4)<br> tube fitting<br>ø 20-23 mm<br>(13/16 - 7/8) |
| Wattages Available | 15-200 watt   | 40-150 watt   | 60-150 watt   | 70-700 watt  |
| Beam Angle         | non-specific  | 12°, 16°, 22°, 30°, 32°,<br>35°, 70° silver-top   | 12° spot; 30° flood   | N/A, unless used with<br>reflectors  |
| Light Quality      | warm  | warm  | warm  | bright white   |
| Energy Efficiency  | poor  | poor  | poor  | poor   |
| Lifespan           | 1,000 hours (double life<br>bulbs: 2,000 hours)   | 1,000 hours   | 2,000 hours   | 5,000 hours  |
| Principle Uses     | General lighting. Can be<br>installed to produce any<br>lighting type according to<br>reflectors/diffusers used.  | Accent, task and ambient<br>lighting.   | Accent, task, ambient<br>and exterior lighting.   | Ambient, accent and task<br>lighting.  |

ø = diameter in mm (inches)

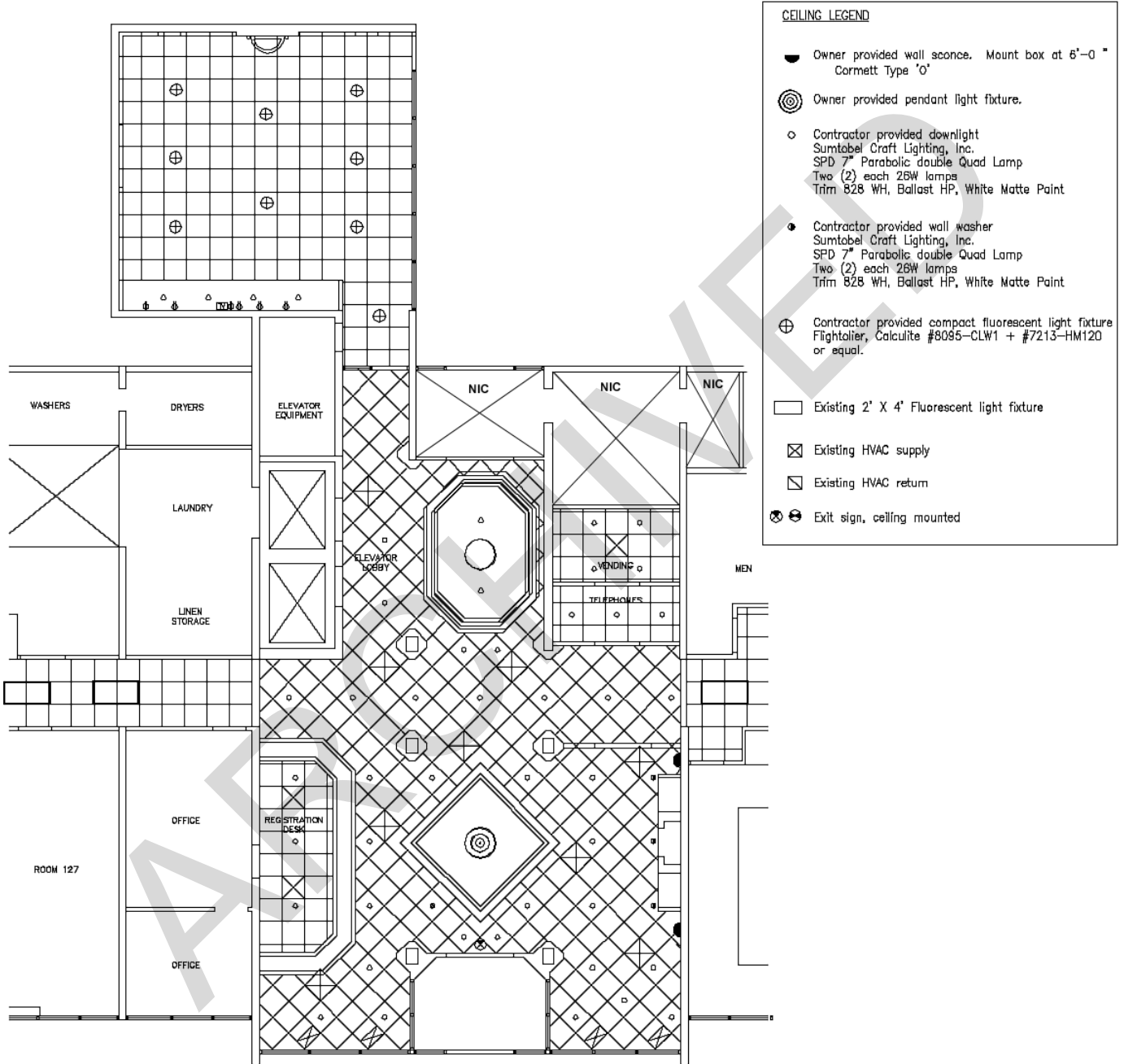
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ATTACHMENT C: QUICK REFERENCE CHART OF LAMP TYPES (CONTINUED)

| Light Sources             | Low Voltage Halogen   | Fluorescent   | Compact Fluorescent  | HID  |
|---------------------------|---|---|--|--|
|                           |  capsule<br>ø 10mm<br>(3/8)<br><br> capsule<br>mounted in<br>dichroic<br>reflector<br><br> tube<br>ø 7 mm<br>(1/4) |  "T" type<br>long tube<br>length<br>20-240 cm<br>(13/16 - 9 7/16)<br><br>(smaller,<br>narrow tubes<br>are now<br>available) |  "D" type<br><br> standard<br>ø 12-70 mm<br>(1/2 - 2 3/4)<br><br> durable or<br>glass<br>protected<br>ø 73 mm,<br>210 mm,<br>305 mm,<br>406 mm<br>(2 7/8, 8 1/4,<br>12, 16)<br><br> 570 mm<br>(22.5) |  "B" type<br>high-pressure<br>sodium, metal<br>halide or<br>mercury<br>ø 55-90 mm<br>(2 3/16 - 3<br>9/16)<br><br> sodium,<br>mercury or<br>metal halide<br>tubular<br>ø 32 mm<br>(1 1/4)<br><br> "BT" Type |
| <b>Wattages Available</b> | 15-50 watt  | 15-75 watt  | 7-36 watt  | 50-250 watt  |
| <b>Beam Angle</b>         | 10°-60°   | linear  | N/A, although can be used with reflectors  | N/A  |
| <b>Light Quality</b>      | bright white  | mixed   | mixed  | sodium: warm<br>mercury: cold<br>halide: white   |
| <b>Energy Efficiency</b>  | average   | very good   | very good (though not as good as long tubes)   | excellent  |
| <b>Lifespan</b>           | 2,000-3,000 hours   | 7,000 hours   | 5,000 hours  | 5,000-10,000 hours   |
| <b>Principle Uses</b>     | Accent, task and decorative lighting.   | Ambient lighting; not dimmable.   | Ambient, accent and decorative lighting; most not dimmable.  | Exterior, industrial, ambient and task lighting.   |

ø = diameter in mm (inches)

ATTACHMENT D: STANDARD REFLECTED CEILING PLAN WITH NOTES

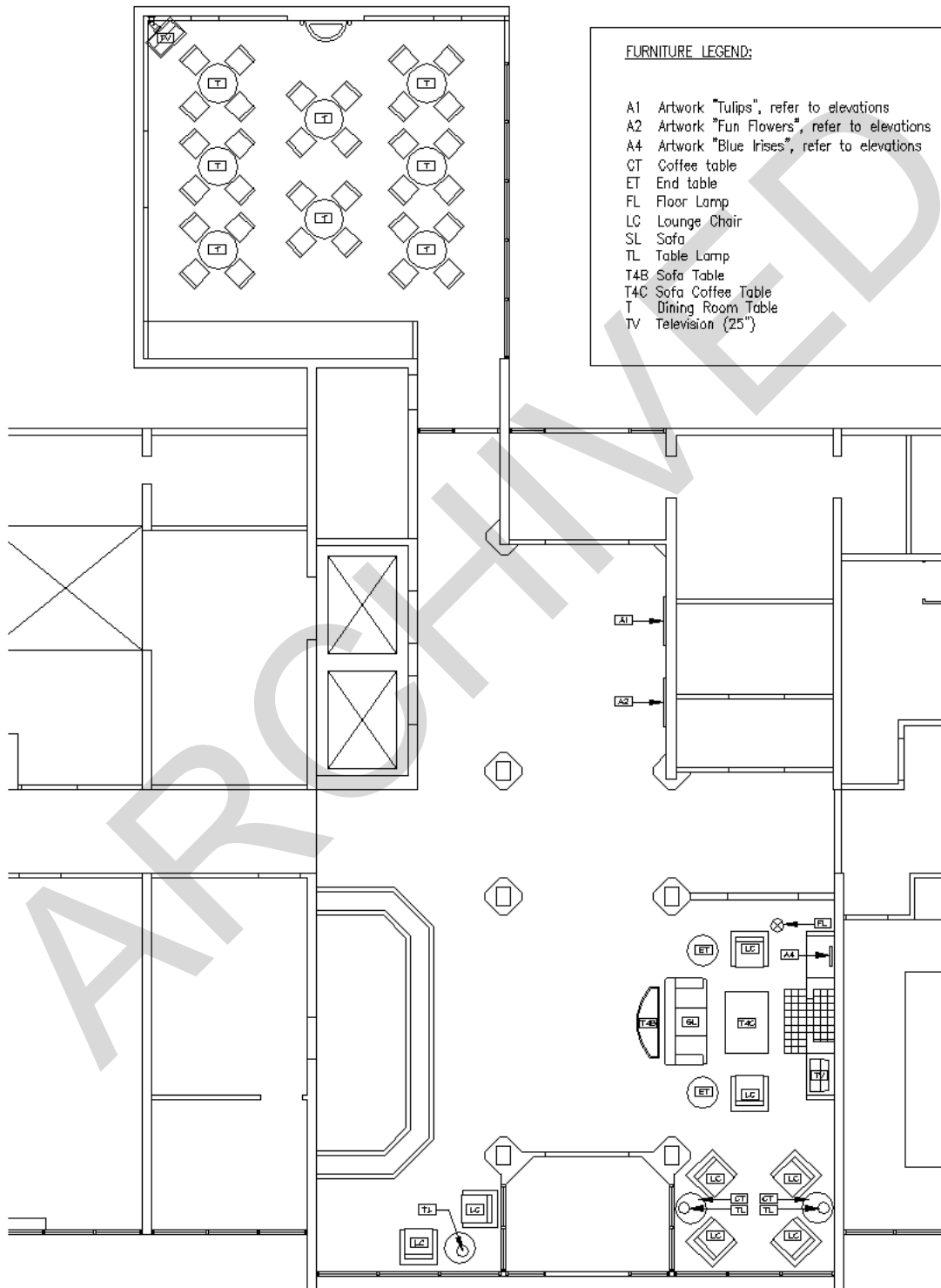


**CEILING LEGEND**

- Owner provided wall sconce. Mount box at 6'-0" Cornett Type "O"
- ⊙ Owner provided pendant light fixture.
- Contractor provided downlight  
Sumtobel Craft Lighting, Inc.  
SPD 7" Parabolic double Quad Lamp  
Two (2) each 28W lamps  
Trim 828 WH, Ballast HP, White Matte Paint
- ◆ Contractor provided wall washer  
Sumtobel Craft Lighting, Inc.  
SPD 7" Parabolic double Quad Lamp  
Two (2) each 28W lamps  
Trim 828 WH, Ballast HP, White Matte Paint
- ⊕ Contractor provided compact fluorescent light fixture  
Flightolier, Calulite #8085-CLW1 + #7213-HM120 or equal.
- Existing 2' X 4' Fluorescent light fixture
- ⊠ Existing HVAC supply
- ⊡ Existing HVAC return
- ⊗ Exit sign, ceiling mounted

1 REFLECTED CEILING PLAN—FIRST FLOOR  
 A13 SCALE: 1/8" = 1'-0"

ATTACHMENT E: STANDARD FURNITURE PLAN WITH NOTES



2 FURNITURE PLAN—FIRST FLOOR  
 A13 SCALE: 1/8" = 1'-0"



## ATTACHMENT F: LIGHTING SIMULATION SOFTWARE

*Lightscape 3.1*<sup>®</sup>

From Discreet Logic  
<http://www.lightscape.com/main>  
phone: 1-888-763-1616  
fax: 1-888-782-1616

*Lumen Micro 7.5*<sup>®</sup>

From Lighting Technologies

*Simply Interior Lighting*<sup>®</sup>

From Lighting Technologies  
<http://www.lighting-technologies.com/>  
phone: 1-303-499-1832  
fax: 1-303-499-1832

*Radiance*<sup>®</sup>

From Lawrence Berkeley Lab  
<http://floyd.lbl.gov/radiance/license.html>  
phone: 1-510-486-4040  
fax: 1-510-486-4089

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## CHAPTER CONTENTS

INTRODUCTION

GOVERNMENT PROCUREMENT

THE ACQUISITION PROCESS

DETAILED DESCRIPTIONS OF  
SPECIFIC SOURCE OFFICES AND  
THEIR FUNCTIONS

GLOSSARY

FIGURE 1 - APPROPRIATED  
FUND ACQUISITION PROCESSFIGURE 2 - NON-APPROPRIATED  
FUND ACQUISITION PROCESS

REFERENCES

## INTRODUCTION

The information in this chapter is intended to help the Civil Engineering design community through the complete interiors acquisition process for both supplies and services. Supplies are tangible objects that are purchased and put into use. Services involve labor, either assembly, installation, or maintenance, to functionally support a supply item(s). Construction and real property related actions are not included in this discussion. Described are the different methods of acquisition of supplies and services depending upon both quantity and funds type, and the authority governing those processes.

The primary audience for this guide includes MAJCOM and Base Civil Engineer designers. The processes in these guidelines are described from the perspective of Civil Engineering (CE) as the customer, and of CE designers specifying supplies and services on behalf of CE customers. The secondary audience includes all levels of Civil Engineering personnel and their customers who may benefit from a general understanding of the supplies and services acquisition process for design projects.

Acquiring supplies and services is a process governed by Federal, Defense, and Air Force Acquisition Regulations (FAR, DFARS, AFFARS) and Public Law (PL). Together with DoD and Air Force Regulations, Instructions, and Directives as well as Executive Orders, there are over 4,000 documents controlling the acquisition process. The acquisition process depends upon: (1) who the customer is, (2) the source of the item to be acquired, and (3) what type of funds are to be used. In general, all discussions in this document surround the use of Appropriated Funds unless Non-Appropriated Funds are specifically referenced.

Several Federal agencies and Air Force offices are involved in the process. Detailed descriptions of their functions and impacts on the acquisition process are included in this chapter. Many references to applicable regulations, forms and instructions are also included.

While the process may apply elsewhere, the acquisition process and references to supplies and services outlined in this chapter refers to acquisition of interior furnishings, fixtures and equipment for completion of post-construction portions of a design projects. Some examples are:

- desks, and other freestanding furniture
- chairs
- file cabinets
- decorative artwork

- artificial plants
- systems furniture
- area carpets
- lounge and dormitory furniture
- lighting fixtures
- specialty seating
- window coverings
- appliances not supplied under housing BPAs
- specialty filing and storage systems
- accessories such as trash receptacles, pamphlet racks, display boards
- any installation/maintenance of the above

#### GOVERNMENT PROCUREMENT - GENERAL

The following elements are involved in the acquisition of interior finishes and furnishings:

##### 1. *The Customer*

The “customer” is the entity who holds the funds for acquiring goods and services. CE may be the customer, or the customer may also be a customer of CE using CE design services. Knowing who the customer is will also be the key for knowing which type of funds will be used. The customer can be a MAJCOM office, an installation office, or any subordinate organization of those entities. While a project designer may be responsible for any specifications or other descriptions necessary to complete the description portion of an acquisition form, the “customer” must, in all cases, complete customer information on any forms (e.g. the accounting information and signature portions of AF Form 9, DD Form 1348-6, AF Form 2005). The customer is also the entity who must work with Supply or Contracting to complete an acquisition action.

##### 2. *Source: The Primary Agencies and Offices*

The federal agency that handles contracting for supplies and services for all federal agencies is the General Services Administration (GSA). GSA negotiates all contracts with private sector businesses, also known as “vendors,” and is the clearinghouse for all agency surplus, also known as “excess,” under the Federal Excess Delivery System (F.E.D.S.) program. Contracts with private businesses include, in catalog form, all supplies and services offered at a “government rate.” Federal Supply Schedules (FSS) are the lists GSA compiles of similar products offered by various vendors. The catalogs, together with the Schedules, comprise the Federal Supply System.

GSA now offers access to all their supply contracts online through *GSA Advantage!* at <http://www.fss.gsa.gov> via IMPAC purchase for orders up to \$2,500, and MIPR for larger purchases. Agencies, including those within the Department of Defense, may order directly from GSA without going through their contracting offices. This “advantage” came about after the elimination of the maximum order limitation that had been mandated by the FAR; the determination by GSA that the maximum nationwide discounts had been achieved by this program; and, assurances that the opportunities and means to make purchases thoroughly meet all FAR, DFARS, and AFFARS requirements.

The signing authority for an installation has the ability to obligate and spend funds under the new simplified acquisition guidelines for purchases up to \$100,000.

Within the Department of Defense (DoD), the Air Force has two primary offices authorized to handle procurement and contracting for supplies and services not available through *GSA Advantage!*. The Operational Contracting office at your base, referred to as Contracting, is, by all laws and regulations, the sole negotiator and signatory authority for all base contracts for commodities, services, and construction acquisition involving the use of Appropriated Funds (APF). The Air Force Non-Appropriated Funds Purchasing Office (AFNAFPO), strictly negotiates contracts for Non-Appropriated Funds (NAF) purchases.

### 3. Funds Types

*Appropriated Funds (APF)* are Congressionally apportioned in the Federal Budget process and are closely monitored. When “spending” appropriated funds other than through *GSA Advantage!*, the customer should involve the Supply and Contracting communities to ensure compliance with all documents controlling the acquisition process especially for purchases over the \$2,500 “micro-purchase” limit defined in FAR Part 2.101. APF customers can still purchase supplies from Federal Supply Schedule resources through Base Supply, from special local contracts called Blanket Purchase Agreements (BPAs), and can also team with Contracting to purchase supplies and services competitively or, in some cases, from a sole source. Normally, purchases over \$100,000 must be made through a competitive process and must involve Supply or Contracting. The goal remains to obtain the best price possible for the Government.

*Non-Appropriated Funds (NAF)* are profits generated from the different services offered to agency personnel by internal resources. Examples include:

- Army and Air Force Exchange Service store
- Officer and Enlisted club system
- Bowling center, skills center, golf clubs
- Commissary profits

The NAF process, because funding is from profits, operates more as a private sector business. NAF customers can purchase from NAF catalogs and NAF Purchasing Agreements (NPAs) and can also purchase from FSS catalogs and schedules and APF contracts. NAF purchasers are not wholly obligated to follow the FAR-dictated priority order in which supplies and services are acquired.

#### THE ACQUISITION PROCESS

This overview of the process is discussed in general terms. Further detail is examined under later sections specific to each organization involved. Unless specifically stated otherwise, the following information applies to appropriated funds customers. Discussed are the procedures that are currently available when a customer chooses NOT to take advantage of the GSA online purchase mechanism, “*GSA Advantage!*”

*Supply vs. Services*

It is important to understand the difference between the acquisition of supplies only, versus acquisition of services whether or not in conjunction with supplies. When acquiring supplies only, the process funnels through the Base Supply system using AF Form 2005 and DD Form 1348-6. Aggregate APF purchases of supplies and services under the FAR Part 13 micro-purchase limit of \$2500 can be made with the customer's I.M.P.A.C.® Visa (FAR 2.101). When services are involved (assembly, installation, maintenance) over the micro-purchase limit, the process is under the purview of Contracting and involves AF Form 9.

For non-appropriated funds customers, acquisition of supplies and services are processed through the AF Non-Appropriated Funds Purchasing Office (AFNAFPO) in San Antonio, Texas, using AF Form 9. Base level NAF offices are responsible for installation service contracts such as wallcovering, carpet, etc. where local labor and local contracts would be used. NAF customers can also use the I.M.P.A.C.® Visa for purchases up to \$2,500 per purchase, paralleling the APF limits. NAF is not restricted by FAR Part 13, however, and that limit can be regulated independently.

*General Accounting*

In spending appropriated funds for the purchase of supplies, the accounting process has a number of critical components.

First, every installation has an assigned DoD Activity Address Code (AAC) with subordinate organizations assigned an "Org" code and their subordinates assigned a "shop" code. These codes are the mechanisms for identifying organizational funds availability and the customer to whom an obligation belongs.

Second, the primary tracking document for the installation is called the Project Funds Management Record (PFMR). The PFMR provides control of expense and status report data for funds availability and expenses by Organization Cost Center Records (OCCR) for the total PFMR. The OCCR provides control of expenses and status report data for funds availability and expenses by organization.

Every organization, or customer, has a Resource Advisor (RA) who has been trained by Base Supply. The RA is responsible for understanding the complete spending process, including correct completion of the customer information on AF Form 2005, DD Form 1348-6, and AF Form 9, and for tracking all organization incomes and expenditures in coordination with the Accounting and Finance Budget Office via the OCCR and PFMR.

Spending non-appropriated funds differs slightly in that these funds are available only to activities which earn this money, primarily category C revenue generating programs (see AFI 32-1022, Table 3.3) such as the bowling center, golf course, etc. Approvals for spending lie with the installation non-appropriated funds Contracting Officer (CO). The custodian is the NAF Resource Management Flight Chief. Purchases can be made from APF sources. However, the bulk of purchases are made through Air Force Non-Appropriated Funds Purchasing Office (AFNAFPO) on AF Form 9.

All customers, irrespective of funds type, have access to credit card purchases in the form of an International Merchant's Purchase Authorization Card (I.M.P.A.C.®) Visa, which is "billed" against their OCCR. The I.M.P.A.C.® allows for the purchase of supplies and services up to \$2,500 per transaction in accordance with FAR Part 13 and micro-purchase definition in FAR 2.101. This card is for the circumstance when Base Supply is out of a stocked item, doesn't carry a particular required item, or when the item is in stock yet needs are so urgent that the system cannot respond quickly enough. At some installations, APF customers wishing to make an I.M.P.A.C.® purchase must obtain a control number from their Base Supply officer indicating Base Supply cannot provide the required item. Contact your local supply officer to learn local procedures.

#### *The I.M.P.A.C.® Visa*

It is of best benefit to the Government if purchases are made from Base Supply or GSA Federal Supply System sources. However, the I.M.P.A.C.® program was designed especially to support urgent need purchases as well as for acquiring items not on a GSA schedule. The I.M.P.A.C.® process has significantly improved the small purchase process and has reduced the amount of separate agreements that Supply and Contracting used to maintain on behalf of their customers.

An I.M.P.A.C.® purchase is governed by the same rules and regulations as other acquisitions. Like any acquisition with spending limits, I.M.P.A.C.® purchases must be "whole." It is improper to purchase a partial order, or to purchase an item that requires a subsequent purchase for operability. For example, charging \$2,500 in one transaction and \$200 in another for an item that requires \$2,700 to make it wholly functional is illegal. Purchase of supplies over \$2,500 must go through Base Supply. Orders over \$2,500 involving services of any level must go through Contracting.

In accordance with FAR 8.001, there is a priority order of eight sources from which appropriated funds customers are required to obtain supplies and four required sources for obtaining services.

#### *The Process in General*

##### Priority Order for Supply Purchases

- The first mandatory source for acquiring supplies is from "agency inventory" which, in the Air Force, is managed by Base Supply (LGS). Agency inventory includes new supplies as well as surplus supply items, also known as "excess," which have been turned in by other offices within the agency. Base Supply also secures guaranteed low prices for commonly ordered supply items by means of Blanket Purchase Agreements (BPAs). Generally, a customer can fulfill nearly any supply requirement directly through Base Supply. Although not a requirement, NAF Customers can acquire supplies through Base Supply as well.

**TABLE 1: FAR SUB - PART 8.001 - PRIORITIES FOR USE OF GOVERNMENT SUPPLY SOURCES**

**(1) SUPPLIES**

| Required Resource  | For APF | For NAF |
|--|---------|---------|
| (i) Agency Inventory   | YES     | NO      |
| (ii) Excess from other Agencies                                  | YES     | NO      |
| (iii) Federal Prison Industries (UNICOR)                         | YES     | NO      |
| (iv) Committee for Purchases from the Blind or Severely Disabled | YES     | YES     |
| (v) Wholesale Supply Sources (41CFR101)                          | YES     | NO      |
| (vi) Mandatory Federal Supply Schedules                          | YES     | NO      |
| (vii) Optional Federal Supply Schedules                          | YES     | NO      |
| (viii) Commercial Sources  | YES     | YES     |

**(2) SERVICES**

|   |     |     |
|---|-----|-----|
| (i) Services available from the Committee for Purchase from People who are Blind or Severely Disabled | YES | YES |
| (ii) Mandatory Federal Supply Schedules   | YES | NO  |
| (iii) Optional Federal Supply Schedules   | YES | NO  |
| (iv) Federal Prison Industries Inc.   | YES | NO  |

- The second APF mandatory source is “excess from other agencies.” Other agency excess is managed by GSA. GSA has developed a comprehensive online system for examining and acquiring excess called the Federal Excess Delivery System, or F.E.D.S. Available on a first come, first served basis, this excess is offered to federal agencies first, then to state agencies, city agencies, public institutions, and finally, to the general public. For offices with low budgets, this process can often fulfill requirements with minimum cost. Costs involved are generally related to shipping the acquisition from the excessing office to the acquiring office.
- Federal Prison Industries’ (FPI) UNICOR follows as the next mandatory source. However, after passage of the FY2002 National Defense Authorization Act, Section 811 requires DoD to conduct market research before purchasing a product listed in the Federal Prison Industries (FPI) catalog to determine whether the FPI product is comparable in price, quality, and time of delivery to products available in the private sector. The Federal Register April 26, 2002 (Volume 67, Number 81) provides interim guidance in Section 208.602 to the Defense Federal Acquisition Regulation Supplement (DFARS) and implements the above Act. Before purchasing and after market research, the following policy is now in effect:

- If the FPI product is comparable, follow the policy at FAR 8.602(a).
- If the FPI product is not comparable –
  - Use competitive procedures to acquire the product; and
  - Consider a timely offer from FPI for award in accordance with the specifications and evaluation factors in the solicitation.

For DoD, FPI clearances are not required if market research shows that the FPI product is not comparable to products available from the private sector that best meet the Government's needs in terms of price, quality, and time of delivery. Clearances are also not required for orders of listed items totaling \$250 or less that require delivery within 10 days. Further discussions on UNICOR appears later in this document.

*NOTE: NAF's are from profits and are, by definition, not federal funds. While the resource is available to them, NAF Customers are not required to consider UNICOR as a source.*

- Fourth is the Committee for the Purchase from People who are Blind or Disabled. The Committee represents a large cross section of organizations who offer goods manufactured by the blind or severely disabled and also offer a growing list of services. The definition for who is affected by this requirement says, "Government, or entity of the Government...including any non-appropriated-fund instrumentality of the Armed Forces." Therefore, both APF and NAF purchasers must use this required resource.
- The wholesale supply sources available through GSA are the fifth mandatory source. GSA offers the equivalent of Base Supply BPAs. GSA contracts offer supplies redundant to Base Supply inventories, but may also include items outside the breadth of supply items commonly used by the Air Force.
- Mandatory and optional Federal Supply Schedules (FSS), in that order, are next in the mandatory priority order for acquiring supplies. For the Department of Defense, the DFARS Sub-Part 208.404-1 supercedes the FAR requirement for mandatory use stating, "The DoD will not be a mandatory user of any schedule unless individual DoD activities elect to provide annual requirements estimates to GSA and become mandatory users." DFARS Sub-Part 208.404-2 Optional Use states, "Make maximum use of the schedules. Other procedures may be used if further competition is judged to be in the best interest of the Government in terms of quality, responsiveness, or cost."
- Commercial sources, or open market, are last in the priority order.

*Priority Order – Contracts for Services*

As soon as any level of service is required, the Air Force customer should work with the Contracting community. The designer will often have service related questions best answered by a particular service contractor or product vendor offering services in support of their product. Contracting would like to ensure the questions are asked within the confines of all applicable laws. For example,



it is unlawful to give a vendor any information leading them to believe they are preferred. It is also unlawful to give a vendor information that would give that vendor an advantage over other vendors in a competitive bidding process. Such actions could end up in a protest filed during bidding, which could significantly delay vendor selection and contract award.

- The first required source of services is the Committee for the Purchase from People who are Blind or Severely Disabled. None of the currently offered services relates to furniture installation or other design related services. However, as this is a required source, your contracting officer will help you fulfill any requirement for documenting any clearances or waivers necessary.
- Next are mandatory Federal Supply Schedules, followed by optional use FSSs. Generally, service contracts have been set up for maintenance of personal property. Your CO can help determine which, if any, of these schedules will be a mandatory source for your order.
- FPI services must be checked before pursuing commercial sources. For example, one of the often-used FPI services is reupholstering. Contracting may have standing contracts for this service.

*Sole Source Purchases and Other Than Full and Open Competition<sup>6</sup>*

Purchasing from a sole source, in some instances, may be the only option, but it is the most highly scrutinized as well. Sole source is sometimes necessary for a number of reasons: a part for one-of-a-kind equipment; only one manufacturer; or only one company offers a particular service. Other than full and open competition may also apply if there is an urgent and compelling need, or for the uninterrupted continuation of an existing service. If a purchase is believed to fall under these categories, work with your CO to ensure that sole source justification is thoroughly and completely executed. Justifications must be accomplished in accordance with FAR Sub-Part 6.3. The local Contracting office may have more specific information to help with the justification preparation.

*Exceptions to the FAR Part 8.001 Priority Order*

The Supply customer should learn idiosyncrasies of the item(s) being ordered. For example, a lengthy delivery schedule may negatively impact a mission. An option would be to order a substitute with a quicker delivery or get authorization to make an I.M.P.A.C.® purchase. For higher dollar items, it may also be necessary to request clearance or a waiver to bypass a portion of the priority order. For APF as well as NAF customers, purchasing and delivery lead times are critical to this process in overseas locations.

Deviance from the priority order must be supported with proper documentation. When, for example, an item is unavailable from a mandatory source, or a required source advises that they are not able to fill the order, or the customer is pursuing a Letter of Waiver from an unqualified source (FAR 8.404-3), each step must be properly documented. These are all reasons why the customer is encouraged to involve their contracting community resources early in the ordering process. Contracting is thoroughly versed in the process for pursuing exceptions.

*Buy American Act and Balance of  
Payments Program (Dec. 1991)*

For DOD projects, DFARS Sub-Part 225.1 supercedes FAR Sub-Part 52.225-3 for the Buy American Act as it applies to the acquisition of supplies. The purpose of the Act is to ensure that government money spent is routed back into American businesses that pay taxes to support the government. Procedures while overseas are the same as those in the United States except for instances where the timeliness of the acquisition is critical. There are other possible exceptions. Your Resource Advisor and Base Supply technician or contracting officer are your best sources for understanding any procedures peculiar to your location.

ARCHIVED

*Base Supply and Contracting***DETAILED DESCRIPTION OF SPECIFIC SOURCE OFFICES AND THEIR FUNCTIONS***Agency Inventory (Base Supply)*

Agency inventory is the mandatory first source for satisfying supply requests for appropriated funds customers. For the most part, every supply item an organization needs which has no requirement for an accompanying service (such as “installation”) is available through Base Supply. The size of an order placed with Base Supply is limited only by the amount of funds available in the OCCR for that Customer. If an organization needs an aircraft wing, for example, at a cost of \$600,000, as long as the Customer has the funds in their OCCR and no services are needed, Base Supply can purchase the wing for them.

Base Supply has access to all Federal Supply Schedule catalogs. Supply maintains inventory only of small, commonly used items purchased through AF and GSA contracts: paper, pens, staplers, etc. Larger commonly ordered supplies, such as side chairs or file cabinets, are tracked by Supply who then coordinates those orders with Contracting. Contracting uses that data to justify the creation of Blanket Purchase Agreements (BPAs) to ensure the best competitive prices for the Base Supply Customer. BPAs can involve Federal Supply Schedule items as well as off-schedule items. They are often used to create opportunities with local and regional resources. An example common to Civil Engineering might be a BPA with Home Depot used to supply Self-Help projects.

*Blanket Purchase Agreements*

Contracting, on behalf of Base Supply, has the authority to set up multiple Blanket Purchase Agreements up to a threshold of \$100,000 per Agreement. BPA limits vary depending upon the ability of Contracting to establish maximum discounts by accessing knowledge of similar contracts via FACNET (Federal Acquisition Computer NETWORK, see FAR 4.504). FACNET allows Contracting to seek and compare similar contract awards and issuance of orders nationwide to ensure the maximum discounts. Without FACNET capability, Contracting is limited to a maximum BPA of \$50,000. Additionally, FAR Sub-Part 13.103(c) warns in part: “Requirements aggregating more than the simplified acquisition threshold [\$100,000] shall not be broken down into several purchases that are less than the threshold merely to permit use of simplified acquisition procedures.”

The coordination between Supply and Contracting has advantages. There are sometimes opportunities for Contracting to add Base Supply order requirements to an on-going contract, or to a contract being formulated and obtain better pricing more quickly than setting up a new BPA. By the same token, Contracting may identify a customer wanting to purchase items who would be as easily served by an existing BPA.

Contracting can help ensure the proper source is being pursued and the associated documentation is being performed for acquisition of services or combined supplies and services. When Contracting has been involved from the beginning, ensuring all the correct steps have been taken and forms are correctly filled out, the acquisition can sometimes be completed in as little as one day.

*Agency Excess (within DoD)*

Before any new items are purchased outside the inventory available through Base Supply, it is a FAR requirement to examine all excess property available. Excessed property is that which was used by another office, installation, or agency, but is either no longer needed or has been replaced. The reality of the past was that these items were chiefly hand-me-down quality items that usually wound up for public sale at the local DRMO. Because of downsizing and closures, this is no longer true. Nearly new office suites are sometimes available from on-base resources. The greatest advantage is that costs for excessed property are generally limited to shipping from the excessing entity to the acquiring office. Those costs are logged against the AAC and org/shop code of the acquiring organization.

Base Supply is the controller of all excess property available on an Air Force installation. The “region depot” Defense Reutilization and Marketing Office (DRMO) will have available all unobligated excess from all AF installations in the area and region from which to choose. The DoD depot in Battlecreek, Michigan, DRMS (Defense Reutilization and Marketing Service), handles DoD agency-wide excess inventory. The DRMO Customer will be responsible for pick-up and transport of claimed excess.

*Federal Excess Delivery System (F.E.D.S.)*

*What is it?*

When DoD resources are exhausted, the next source would be “excess from other agencies.” The GSA handles a resource which is now available online for finding agency excess called the Federal Excess Delivery System or “F.E.D.S.” This system lists all excess of all federal agencies, location of the excessed item, description, and phone numbers for obtaining additional information. As in any excess process, items are available on a first come, first served basis. Although every customer can view this excess listing online, access to this inventory is generally achieved through Base Supply, is reserved using the installation’s DoD AAC, and is purchased on Form SF 122 “Transfer Order of Excess Personal Property.”

The type of excess that is available through F.E.D.S. includes a broad spectrum of furniture and equipment. The listing at any point in time includes hundreds of items. An example might be a microstation computer system which, while out of date for the owner, would be of great value to the customer who does not have the budget for such an expensive item. As more and more downsizings and closures occur, nearly new systems furniture encompassing entire office suites are beginning to appear in the F.E.D.S. site.

Federal excess comes from all agencies, including DoD DRMS. The excess is first offered openly to all Federal Agencies. What remains after a set period of time is then available to State agencies, then local municipalities, and finally, to the general public. Review of excess is mandatory. The requirement is not superseded by either DFARS or AFFARS

*How Do I Access F.E.D.S. online?*

If you have access to the Internet, you can pursue a link to FE.D.S. Begin by linking to <http://www.fss.gsa.gov>. When you reach this screen, select "PERSONAL PROPERTY" from the left column list. You will now see many topics which relate to F.E.D.S. For your first connection to this site, select the title "Introduction" under the SYSTEMS heading in the right hand column. This screen will give a hotlink to USER GUIDE PAGE, which you should select. Scrolling down the Table of Contents you see on the left side you will find a subheading called "Gaining Access." This will explain to you how to get your access information and password. Explore the complete site to see how you may be able to use F.E.D.S.

*Federal Prison Industries – UNICOR*

*"Where Government Shops First."*

As their motto implies, products manufactured by FPI under the name UNICOR are the next required source of supply after agency excess. However for DoD, a market research shall be conducted before purchasing a product listed in the Federal Prison Industries (FPI) catalog to determine whether the FPI product is comparable in price, quality, and time of delivery to products available from the private sector. FPI clearances (waivers) are not required if this market research shows that the FPI product is not comparable. UNICOR offers a comprehensive line of products manufactured by federal prisoners and products supplied through the Federal Prison system. FPI also offers a limited amount of services. Furniture is the most predominant category of supplies of the classes listed in the Schedule of Products made in Federal Penal and Correctional Institutions. UNICOR offers a comprehensive variety of furnishings, which meet the usual comprehensive specification, and performance requirements that most schedule vendors must meet for systems furniture and chairs as well as for dormitory furniture.

FPI also offers furniture reupholstering and refurbishment services. They offer a fairly complete range of upholstery fabrics, which are widely used on government furnishings. FPI, through their GMG contract, also provides professional space planning and interior design services for a fee.

*The Committee for Purchase from the Blind or Severely Disabled*

FAR Sub-Part 8.7 outlines the procedures for implementing the Javits-Wagner-O'Day Act, or JWOD Act, which became effective in February of 1995. The Committee for Purchase from the Blind or Severely Disabled maintains a Procurement List of all supplies and services required to be purchased from JWOD participating non-profit agencies. These agencies are recognized through the National Industries for the Blind (NIB) and National Industry for the Severely Handicapped (NISH), which has been designated to represent JWOD participating non-profit agencies serving people with severe disabilities other than blindness.

*Comprehensive Procurement Guidelines (CPG)  
Recovered Materials Advisory Notice (RMAN)*

The Committee has a Handbook available which enumerates all products available. The JWOD web site also references all available supplies and services. represents products or services which will solve your customer requirements.

As part of its continuing program to promote the use of recovered materials, the Environmental Protection Agency (EPA) issued the "Comprehensive Guideline for Procurement of Products Containing Recovered Materials" (CPG) and its companion piece, the "Recovered Materials Advisory Notice" (RMAN). The CPG designates recycled-content products in eight product categories for which federal procuring agencies need to develop affirmative procurement programs. Its purpose is to stimulate the use of these materials in the manufacture of new products, aiding in the growth of markets for materials recovered from solid waste. The RMAN provides recommendations for purchasing the products designated in the CPG. Through use of these guidelines, the federal government hopes to expand its use of products with recovered materials and to help develop markets for them in other sectors of the economy. EPA's CPG product lists and the corresponding RMAN recommendations are consolidated into tables found at [www.epa.gov/cpg/products](http://www.epa.gov/cpg/products).

*Affirmative Procurement Program (APP)*

The purpose of the APP is to maximize purchases of recovered materials designated by the EPA's

Comprehensive Procurement Guidelines. Under the Resource Conservation and Recovery Act (RCRA), Section 6002 and Executive Order 13101, the affirmative procurement program is an agency's strategy for maximizing its purchases of products designated by EPA. Within a year of the EPA's designation of an item, the agency must make efforts to revise specifications to require the use of the recovered material to the maximum extent without jeopardizing the intended end-use of the product.

The RCRA requires that agency affirmative procurement programs consist of four components:

- A recovered materials preference program
- An agency promotion program
- A program for requiring vendors to estimate and certify the recovered materials content of their products, as well as for reasonably verifying vendor estimates and certifications;
- A program to monitor and annually review the effectiveness of the affirmative procurement program

*What items are included in the CPG?*

(The partial list below is current as of May 2002. Check the EPA's website for the most current list of items.)

*Construction Products*

Building insulation products

Carpet  
 Carpet cushion  
 Cement and concrete containing:
 

- Coal fly ash
- Ground granulated blast furnace slag

 Consolidated and reprocessed latex paint  
 Floor tiles  
 Flowable fill  
 Laminated paperboard  
 Patio blocks  
 Railroad grade crossing surfaces  
 Shower and restroom dividers / partitions  
 Structural fiberboard

Landscaping Products

Garden and soaker hoses  
 Hydraulic mulch  
 Plastic lumber landscaping timber and posts  
 Lawn and garden edging  
 Compost made from yard trimmings or food waste

Park and Recreation Products

Park benches and picnic tables  
 Plastic fencing  
 Playground equipment  
 Playground surfaces  
 Running tracks

Miscellaneous Products

Awards and plaques  
 Mats  
 Signage

Nylon carpet and backing containing recovered materials is still undergoing consideration for the next edition of the comprehensive procurement guideline (CPG IV).

*Biobased Products*

In addition to recycled-content products, EO 13101 discussed the purchase of biobased products, which are commercial or industrial products, other than food or feed, which are made from biological products or renewable domestic agricultural or forestry materials. EO 13101 merely encouraged biobased product purchasing, but on May 13, 2002, President Bush made it a legal requirement by signing the Farm Security and Rural Investment Act of 2002 into law. Section 9002 establishes a biobased product purchasing program similar to the Buy-Recycled program created by the Resource Conservation and Recovery Act. USDA will designate biobased products for Federal agencies to purchase, and will provide recommendations for purchasing these products with biobased content. Federal agencies are required to include the USDA-designated products in their affirmative procurement programs, and to purchase

these products with biobased content unless there is a price, performance, or availability reason not to do so. USDA will also create a voluntary labeling program for biobased products.

#### *Modification of Specs and PWS*

When writing construction specifications or Performance Work Statements (PWS), agencies must include requirements for affirmative procurement of environmentally preferable product. A-E design firms are required under the Federal Acquisition Regulation (FAR) 23.704 to obtain products and services that are environmentally preferable and to promote cost effective waste reduction when creating plans, drawings, specifications, standards and other product descriptions. Environmentally preferable products include recycled-content products listed by the EPA in the CPG, and biobased products that will be identified in a similar list by the US Department of Agriculture (USDA). Consult the base environmental management office for the most current information on biobased product requirements.

Statements of Work (SOW) for A-E services shall require the A-E to specify the maximum practical amount of recovered materials, consistent with performance requirements, availability, price reasonableness and cost effectiveness (FAR 36.601-3). Also, the A-E is required to consider energy conservation, pollution prevention, and waste reduction to maximum extent practical in the specifications (FAR36.601-3).

The SOW or PWS should be clear to all potential vendors that they are required to meet EPA and USDA requirements whenever they provide a recycled-content (as designated by the EPA) or biobased (as designated by the USDA) item to the Government as part of their contract. Language and specific wording is very important to convey specifications. APP requirements can be successfully met as follows:

- Review service contract or project design in detail.
- Identify all of the recycled-content and biobased items to be used.
- Write specific recycled-content and biobased product requirements into all applicable sections of the service contract, PWS, or the construction specifications.

#### *Valid reasons for asking for an Exemption*

There will be occasions where the use of a recycled-content or biobased product would not meet operational needs. The exemptions can be found in EO 13101, 40 CFR 247 and AFI 32-7080. However, recycled-content products, meeting EPA guidelines, and biobased products, meeting USDA guidelines, will be purchased unless such products:

- Are not available within a reasonable period of time; or
- Fail to meet the performance standards set forth in applicable specifications or fail to meet the reasonable performance standards of the procuring agency; or



- Are not available from a sufficient number of sources to maintain a satisfactory level of competition (i.e., available from two or more sources); or
- Are only available at an unreasonable price. If the cost of the recycled-content product exceeds comparable non-recycled-content product costs, the cost is considered unreasonable.

An exemption can be claimed if one or more of these criteria are met. Exemptions involving the purchase of non-recycled-content products require a written justification / explanation by the contracting officer. For purchases less than \$2,000 (“micropurchases,” usually made by government credit card), no justification / explanation is required for use of non-recycled-content products.

MAJCOMs or APP teams may use locally developed forms or the “Recovered Materials Determination Form” as a written justification by the FAR. The Determination Form is found in the appendix to the AF Guide to Green Purchasing, on AFCEE’s website at [www.afcee.brooks.af.mil/eq/ap/gg/default.asp](http://www.afcee.brooks.af.mil/eq/ap/gg/default.asp).

This form can be used in the following two ways:

- When CPG requirements can not be met and an exemption is claimed.
- When the CPG requirements were met and the contracting officer or project manager wishes to document AP compliance for review during future audits or inspections.

#### *General Services Administration*

The office within the Federal Government that negotiates supply contracts with private sector contractors is the GSA. GSA maintains these contracts on behalf of all federally funded agencies including the Department of Defense. These manufacturers publish catalogs of their GSA approved inventory, which are available to Customers using either Appropriated or Non-appropriated funds. The manufacturers’ names appear on various schedules of supplies which they are approved to sell to federal customers.

Schedule Contractors have expended a great amount of time, effort and money to comply with GSA requirements to have their products approved to be in a GSA catalog and on a GSA list of Schedule Contractors. Consequently, by regulations, these products are to be reviewed for government purchase before any consideration for commercial procurement.

#### *GSA Advantage!*

GSA has created an online service for ordering from GSA schedules. This service is called GSA Advantage! *GSA Advantage!* has been available for the online ordering of GSA schedule items since the spring of 1997. In December 1997 nearly all of the GSA’s 120 current FSS catalogs were available online. When entering the site for the first time, first click on the icon for GSA Advantage currently shown in the upper right hand corner of the home page. Use the word “demo” for both the AAC and password. Indicate “yes” when asked if the individual and his address are correct (remember, this is a demo only). Since it is not possible to accidentally order using this entry method, take the time to explore the site in detail. Note that there are many helpful

instructions for you, the customer, so that you can understand and use this ordering system. Be sure to download the *GSA Advantage!* Handbook and the Online Ordering Guide.

Authorization to use this system is contained in a letter from the Office of the Under Secretary of Defense dated March 6, 1997. It states: “Among the many improvements, the elimination of schedule maximum order limitations and the new ability to negotiate prices on individual orders without changing the basic schedule price are especially important. Additionally, DoD procurement offices may establish teaming arrangements among more than one schedule contractor to satisfy a requirement allowing even more flexibility and speed in the placement of orders and the delivery of products. *GSA Advantage!*...offers the convenience of on-line ordering, and, in most cases, acceptance of the government credit card.”

Purchasing through *GSA Advantage!* can be accomplished not only by government credit card, but also by MIPR for larger purchases. Your Resources Advisor can help you determine your eligibility for an access password, can help you with an I.M.P.A.C.® purchase from *GSA Advantage!*, and can help you with accomplishing a MIPR for your larger order. There is a surcharge for using *GSA Advantage!* of about 8%, although that percentage can fluctuate.

#### *Mandatory vs. Optional Schedules*

The DFARS Sub-Part 208.404-1 states Mandatory and Optional Schedules in the priority order for acquiring services. Maintenance, repair and/or rehabilitation of personal property schedules are mandatory if there are contracts in effect. All FSS schedules are optional with emphasis on using schedule vendors when doing so represents a savings to the government.

#### *Air Force Non-Appropriated Funds Purchasing Office (AFNAFPO)*

AFNAFPO is the singular, international, non-appropriated funds purchasing and contracting authority for all branches of the armed forces. AFNAFPO may set up hundreds of contracts similarly to GSA. NAF purchase requests are filled out by the customer on AF Form 9 and are coordinated with the local area NAF Funds Manager (NAFFM). CE design support may fill out the description portion of AF Form 9 with detailed specifications of the item to be purchased. But, the NAF customer must complete the top and bottom portions similarly to the APF customer. After coordination, either the customer or the FM can forward the request to AFNAFPO.

#### *NAF Priority Process*

AFNAFPO also has a priority process through which all NAF purchases are made. This process “was designed to promote the effectiveness of purchasing as a management tool.” This priority process is called the “Commander’s Smart Buy Program (CSBP).” The elements of the program are:

- Non-appropriated Fund Purchasing Agreements (NPAs) – firm fixed pricing agreements
- Catalog Program – comprised of companies having NPAs through AFNAFPO
- Product Bulletin Program – unique buying opportunities arranged with industry

- Consolidated Buys – common requirements consolidated for mass one-time buys
- Trade Show Support – Trade Show discounts generate additional savings over NPAs
- Essential Products (EPP) and Core Products Programs – negotiated single source term contracts
- Construction/Architect & Engineering – contracts to help reduce the time to design, construct and alter NAF facilities.
- Individual Support – AFNAFPO prime purchases on behalf of individual installations

For the first element of the CSBP, AFNAFPO creates Non-Appropriated Funds Purchasing Agreements (NPAs) similar to APF Blanket Purchase Agreements. As with the BPA process, these NPAs ensure best prices nationwide. The differences lie in what products are available through NPAs, such as furniture for VOQs, VAQs, TLFs, etc. and clubs, golf clothing, sports equipment, and store fixtures. All of the other Smart Buy elements are available to the CE designer via the installation NAFFM who has local information on all Smart Buy elements.

In AFM 64-302, paragraph 3.8.1 discusses the required lead-time for overseas purchases through the CSBP. The customer is advised to put a realistic “not later than” date in the appropriate block of the AF Form 9. (The Services Contracting Officer (SCO) for the installation will help determine the criticality of the need to help formulate a brief justification for expediting an overseas purchase.) Expediting in this case will mean a local purchase instead of waiting for delivery from the continental United States (CONUS).

#### *NAF Projects with APF Construction*

When formulating project budgets, the CE designer should meet with their NAF customer and the NAFFM to establish which project elements will be NAF and which will be APF. In accordance with AFI 32-1022, paragraph 3.4, appropriated and non-appropriated funds cannot be mixed without a waiver. However, there are several instances where the NAF project might have a companion APF project and this is not considered a mixing of funds. Therefore, individual elements of a project must be funded by one or the other type of funds, but not by both. For example, APF would replace broken “standard” bathroom fixtures or make the necessary modifications to comply with the Americans with Disabilities Act (ADA). If the fixtures are upgraded for appearance and cost for a NAF interior design project, the upgrade will cause the fixture costs to shift from APF to NAF.

If NAFFM and the customer are to be prepared to support project upgrade costs, the designer should identify these expenses in the NAF budget before the project start-up. The same principle applies to any upgrades (wall finish change from paint to wallcovering, etc.) on a NAF project funded with APF for construction. It is easy to understand how upgrading after the NAF budget is set can easily reduce the NAF amounts planned to be available for project furnishings.

## GLOSSARY OF ACRONYMS AND ABBREVIATIONS

|         |   |
|---------|---|
| ACC     | Activity Address Code   |
| AF      | Air Force   |
| AFFARS  | Air Force Federal Acquisition Regulation Supplement                     |
| AFMC    | Air Force Material Command  |
| AFNAFPO | Air Force Non-Appropriated Funds Purchasing Office                      |
| APF     | Appropriated Funds  |
| APP     | Affirmative Procurement Program   |
| BCE     | Base Civil Engineer or Base Civil Engineering                           |
| BPA     | Blanket Purchase Agreement as authorized by FAR 13.000                  |
| CE      | Civil Engineer or Civil Engineering                                     |
| CO      | Contracting Officer   |
| CPG     | Consumer Procurement Guidelines   |
| CSBP    | Commander's Smart Buy Program   |
| DFARS   | Defense Federal Acquisition Regulation Supplement                       |
| DoD     | Department of Defense   |
| DRMO    | Defense Reutilization and Marketing Office                              |
| DRMS    | Defense Reutilization and Marketing Service                             |
| EO      | Executive Order   |
| EPA     | Environmental Protection Agency   |
| FACNET  | Federal Acquisition Computer Network, FAR 4.500                         |
| FAR     | Federal Acquisition Regulation  |
| F.E.D.S | Federal Excess Delivery System run by GSA                               |
| FPI     | Federal Prison Industries, manufacturers of UNICOR products             |
| FSS     | Federal Supply System or Federal Supply Service                         |
| FSS/FBP | Office symbol for the GSA office for Property Utilization and Donations |
| GSA     | General Services Administration   |

|             |  |
|-------------|--|
| I.M.P.A.C.® | Merchant's Purchase Authorization Card                   |
| JWOD        | Javits-Wagner-O'Day Act, 1985                            |
| LGS         | Logistics Supply known as Base Supply                    |
| MAJCOM      | Major Command  |
| MIPR        | Military Interdepartmental Purchase Request, DD Form 448 |
| NAF         | Non-Appropriated Funds                                   |
| NIB         | National Industry for the Blind                          |
| NISH        | National Industry for the Severely Handicapped           |
| NSN         | National Stock Number                                    |
| NTE         | Not To Exceed  |
| OCCR        | Organization Cost Center Record                          |
| PFMR        | Project Fund Management Record                           |
| PKO         | The office symbol for Operational Contracting            |
| RMAN        | Recovered Materials Advisory Notice                      |
| UNICOR      | See FPI  |

FIGURE 1 - APPROPRIATED FUND ACQUISITION PROCESS

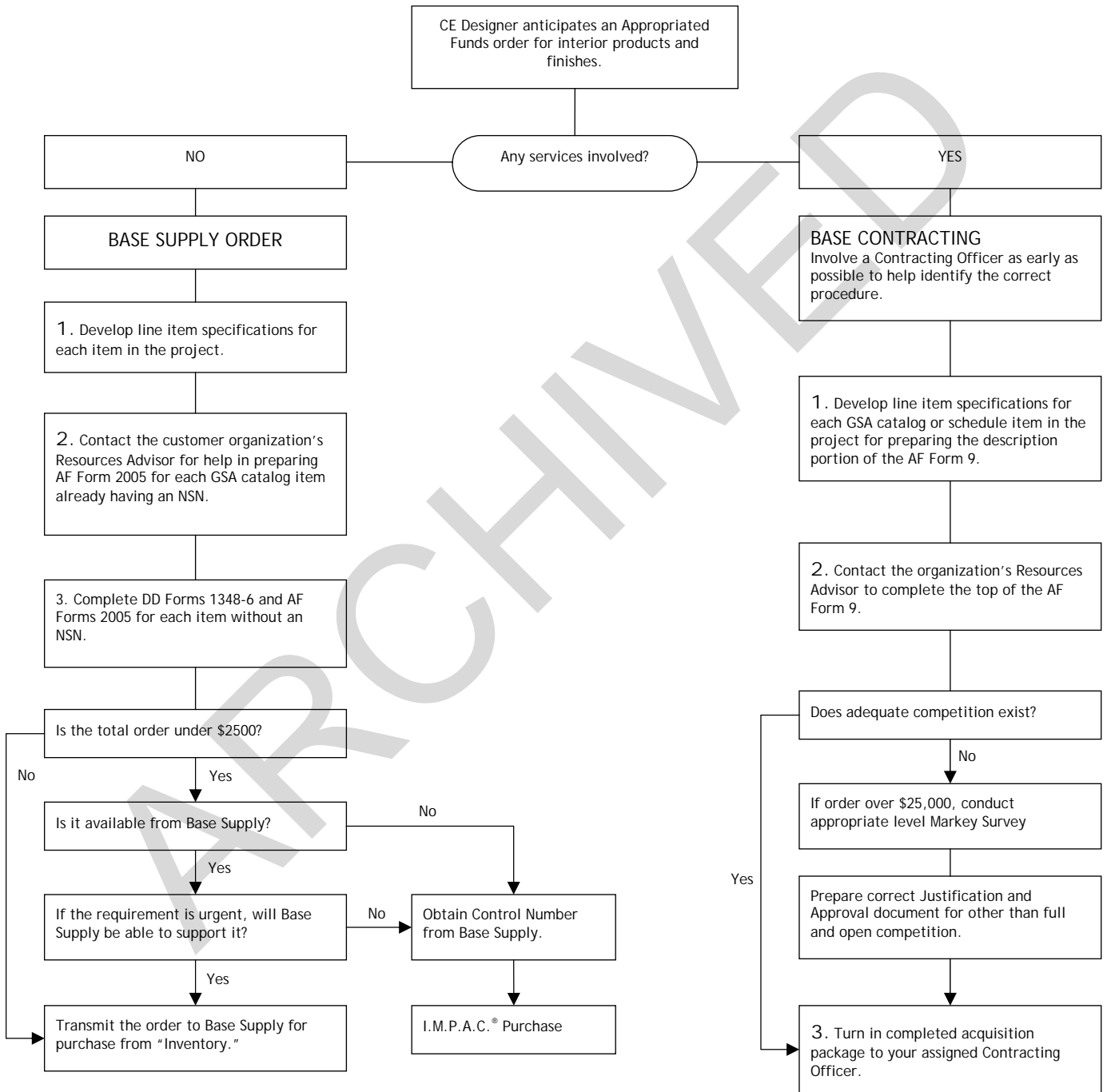
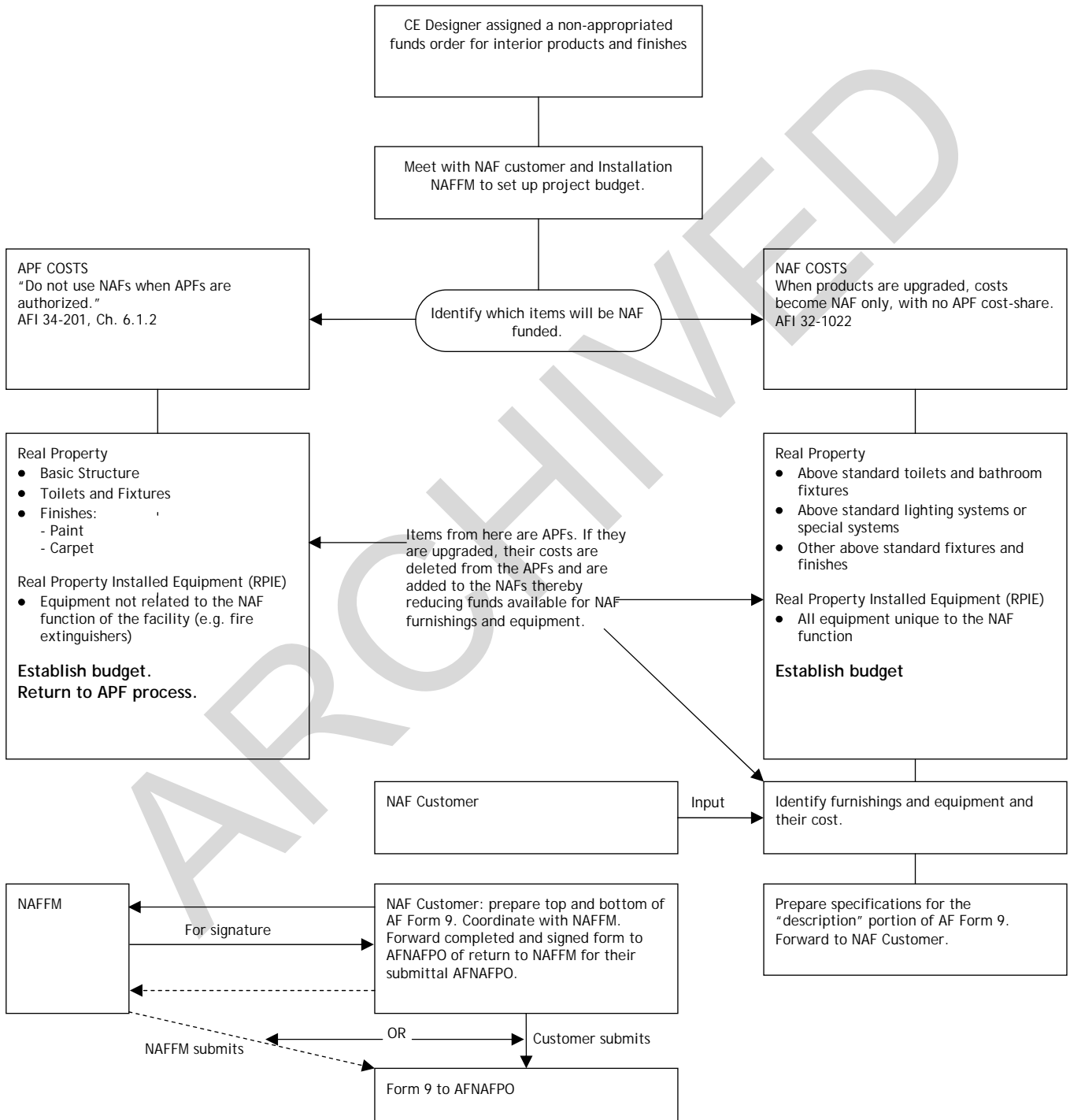


FIGURE 2 - NON-APPROPRIATED FUND ACQUISITION PROCESS



## REFERENCES

The following is a list of AF Instructions and Manuals, and other documents which were used to write this guide and are very useful for further information on the subject matter in this guide.

|                       |   |
|-----------------------|---|
| AFI 32-1021           | Planning and Programming of Facility Construction Projects  |
| AFI 32-1022           | Planning and Programming Non-Appropriated Fund Facility Construction  |
| AFI 32-1023           | Design and Construction Standards and Execution of Facility Construction Projects                                     |
| AFI 32-1031           | Operations Management   |
| AFI 32-1032           | Planning and Programming Real Property Maintenance Projects using Appropriated Funds                                  |
| AFI 34-105            | Programming for Non-Appropriated Fund Facility Requirements   |
| AFI 34-201, Chap. 6   | Use of Non-Appropriated Funds: Real Property and Construction   |
| AFI 34-206            | Non-Appropriated Fund Financial Management and Accounting   |
| AFI 34-209            | Non-Appropriated Fund Financial Management and Accounting   |
| AFMAN 34-214, Chap. 7 | Procedures for Non-Appropriated Fund Financial Management and Accounting: Property                                    |
| AFI 64-109            | Local Purchase Program  |
| AFI 64-302            | Non-Appropriated Fund Contracting   |
| AFI 65-106            | Appropriated Fund Support of Morale, Welfare, and Recreation and Non-Appropriated Fund Instrumentalities              |
| AFI 65-601            | Budget Guidance and Procedures  |
| Brooks AFB            | HSC/PKO Customer Guide on How to Conduct a Market Survey  |
| Brooks AFB            | HSC/PKO Operational Contracting: AF Form 9 Preparation Guide  |
| Brooks AFB            | HSC/PKO: Customer Guide for Proper Preparation of Justification and Approval for Other Than Full and Open Competition |
| AFNAFPO               | AFNAFPO Air Force Non-Appropriated Funds Purchasing Office customer pamphlet  |



|                    |   |
|--------------------|---|
| DFARS              | DoD FAR Supplement as of February 1998: Various Chapters  |
| EO 13101           | <i>Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition</i> , September 14, 1998. This order replaces EO 12873 and reinforces the federal government's buy-recycled efforts. EO 13101 establishes a process for emending the CPG originally promulgated under EO 12873 and requires the EPA to amend the CPG every two years, or as appropriate. The Order also requires EPA to issue RMAN's concurrent with the CPG amendments, and to update them periodically. |
| EPA                | Environmental Protection Agency's <i>Comprehensive Procurement Guide</i> , <a href="http://www.epa.gov/cpg">www.epa.gov/cpg</a>   |
| FAR                | Federal Acquisition Regulation as of February 1998: Various Chapters  |
| Federal Register   | April 26, 2002 (Volume 67, Number 81) DFARS; Competition Requirements for Purchases From a Required Source  |
| Public Law 107-171 | <i>Farm Security and Rural Investment Act</i> , May 2002: Title IX – Energy. This portion of the larger order establishes a new program for the preferred purchase of biobased products by Federal agencies, as well as a voluntary labeling system. Funding is also set aside for testing of biobased products.  |