AIR MOBILITY COMMAND

FLIGHT LINE SUPPORT FACILITIES DESIGN GUIDE

Air Mobility Command's aircraft maintenance troops do great work in keeping the fleet ready to do its Global Reach mission. They need help to make sure they can get spare parts quickly and easily, and that's what this Flight Line Support Facility Design Guide is all about.

This Guide provides the roadmap for planning, programming, and designing projects that will give AMC the facilities it needs to preposition parts on the flight line and put them into the hands of maintainers when they need them. The result will be improved morale and productivity for AMC's people and greater mission capability for the Air Mobility Team.

"The Air Mobility Team…Responsive Global Reach for America… Every Day!"

Table of Contents

Table of Contents (Cont'd.)

Table of Contents (Cont'd.)

List of Figures

List of Tables

Chapter 1
Introduction

A. Purpose

This guide provides the basic criteria to evaluate, plan, program, and design Air Mobility Command (AMC) flight line support facilities to sustain a supply of parts and components to maintain aircraft. This facility supports the following AMC aircraft: C-5, C-17, C-141, and KC-135. The C-9, C-21, and KC-10 are supported by Contractor Operated and Managed Base Supply (COMBS), and their facility requirements are governed by government contracts.

It is intended to make commanders and their staffs aware of important design considerations and to aid in project development. Planning and programming for a flight line support facility should consider all aspects of parts storage and handling necessary to support aircraft maintenance and repair. Additionally, a quality design will maximize effective use of available space to support an efficient aircraft parts flow process.

B. Design Guide Scope and Use

This guide applies to the design of all new construction and renovation projects for flight line support facilities. It provides the overall criteria for determining requirements, site evaluation and planning, and design of exterior and interior areas.

Use this guide to supplement other Air Force and Department of Defense (DoD) policies and instructions to identify individual construction project requirements. The Requirements and Management Plan (RAMP) defines the program for design of an individual Military Construction (MILCON) project. It includes functional requirements, design criteria, and cost information. The material in this guide provides the basis for preparing the RAMP.

1. Project Initiation

Information required for preparation of the DD Form 1391, which initiates project development, is found in Chapter 2. This includes considerations of the space criteria to determine overall building size, site evaluation, and special factors to be used in the cost estimates.

2. Site Selection

This is generally part of the master planning process. It is completed prior to preparing a DD Form 1391 for an individual project. However, project programming requirements developed in the DD Form 1391 phase may require a re-evaluation of site selection decisions.

For guidance in evaluating sites for a project, see Chapter 2, Section G, Site Evaluation.

3. Design

a. The design of a project is typically developed in progressive phases, i.e., planning and programming, concept and preliminary drawings, and final working drawings. Design guidance for all of these design phases is covered in Chapters 2 through 4.

b. Chapter 2 provides basic planning and programming criteria, along with tables for determining square footage requirements.

c. Chapter 3 presents concept and preliminary design considerations such as the location of a facility on a site, the design of the facility and support utilities, as well as specific technical guidance.

d. Chapter 4 addresses specific design issues concerning individual functional areas, which are important for preliminary and working drawings. In this chapter, illustrative designs and photographs help clarify the design guidance of the preceding chapters.

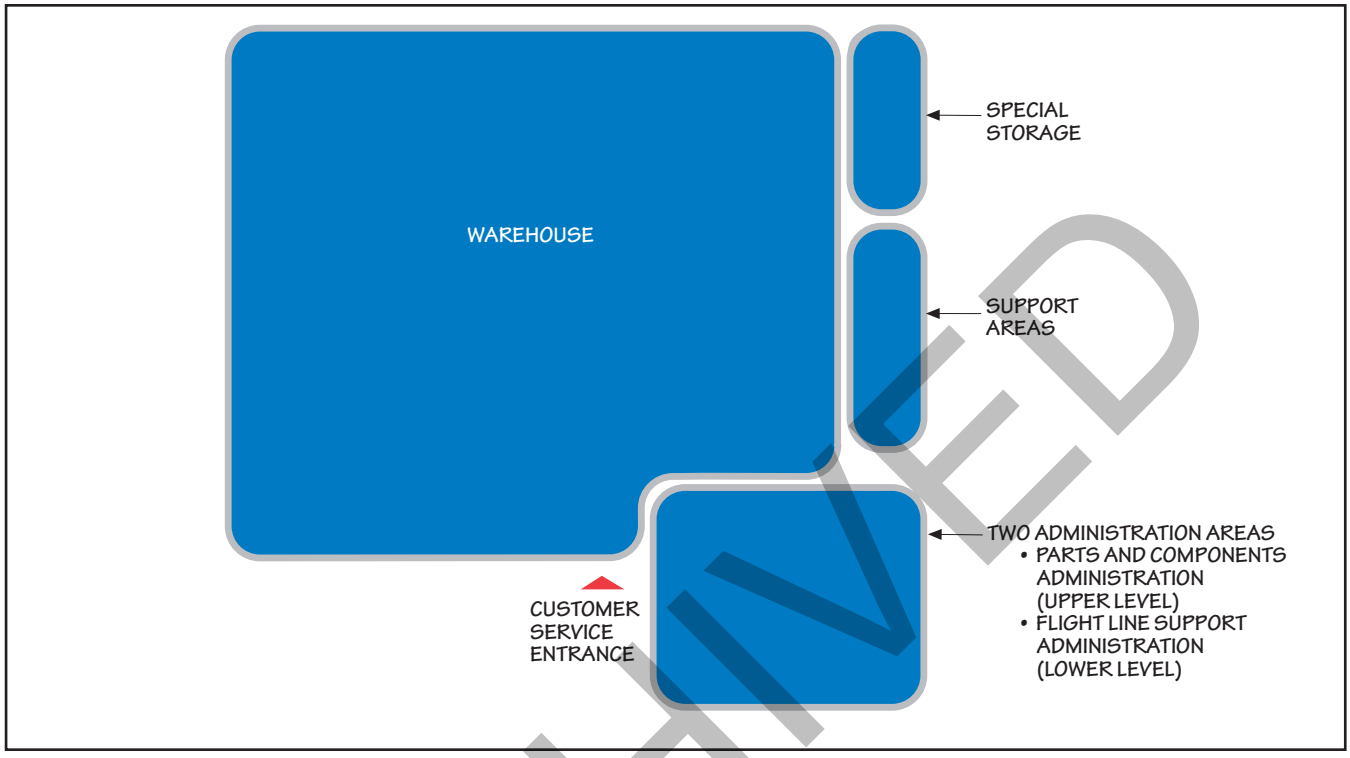

Figure 1-A: Functional Area Relationships for the Warehouse and Support Areas within the Flight Line Support Facility.

4. Interior Finishes and Furnishings

Chapter 5 provides recommendations for selection of interior materials, finishes, and colors. Carefully selected interior finishes and furnishings are essential for a quality design.

C. Flight Line Support Facility

See Figure 1-A for functional area relationships of the warehouse and support areas within the flight line support facility.

a. The flight line support facility is an essential element of the aircraft maintenance program. Its function is to provide maintenance units with avionics, components, spare parts, and assemblies necessary to maintain aircraft. Also, the readiness spares packages (RSPs) are assembled and maintained in this area.

b. This facility has four components:

- Administrative Areas
  - Parts and components
  - Flight line support
- Support areas
- Warehouse
- Special storage

c. The administrative space is separated into two different spaces (flight line support administration, and parts and components administration). Space requirements may include private supervisory offices and administrative support for ordering, tracking, and distributing aircraft avionics, components, spare parts, and assemblies. Parts and components administration also provides visual security for the warehouse area.

d. The support area includes space for electrical, communications, mechanical, and rest rooms.

e. The warehouse includes space to store and retrieve aircraft parts. Specific space requirements are necessary for high-density storage, RSP pallet buildup, RSP pallet storage, bulk storage, RSP loading dock, truck loading dock, parts counter, and reparable parts, tail number parts, and time compliance technical order (TCTO) parts.

f. The special storage area includes avionics and electronic components, classified storage (sensitive/pilferable materials), and battery storage. ■

Chapter 2

Program

A. General

1. Planning and Programming Considerations

a. Planning, programming, and designing a flight line support facility normally requires extensive coordination. This coordination is important because of the different organizations involved in developing facility requirements.

b. Personnel likely to have facility planning and design inputs are as follows:

- Wing commander
- Wing safety officer
- Operations group commander
- Logistics group commander
- Support group commander
- Supply squadron commander
- Aircraft generation squadron commander
- Communications squadron commander
- Transportation squadron commander
- Civil engineer squadron commander
- Fire chief
- Security police squadron commander

Facilities should present a cohesive architectural image as the facility above demonstrates.

2. Flight Line Support Facility

a. The supply and distribution of stored aircraft parts and war reserve operating materials are managed in this facility. Major supply functions include the following:

- Demand processing and mission capable stock control
- Reparable parts processing
- Inventory processing
- Bench stock inventory control
- Processing of readiness spares and in-place spares packages
- Storage and issue of stocks
- Re-supply of enroute system
- Combat supply operations

3. Aircraft Parts Flow Process

a. To fully understand the functional area relationships of this facility, it is important to consider the various activities and flow of parts, components, and assemblies through the flight line support facility.

b. There are specific requirements for each type of aircraft when developing a functional layout for a flight line support facility. Investigate shipping and receiving requirements, and tailor them to the base supply system of operation. In developing the requirements for support facilities, the primary consideration is the flow of material into and out of the facility.

c. After receipt of a part, component, or assembly at the flight line support facility, the item is processed and stored in its respective storage area. Special storage areas for specific material items are required as follows:

- Aircraft Electronic Components - An environmentally controlled area
- Batteries - A specifically designed battery room
- Classified Storage - A secure room

d. The parts and components administration function requisitions specific parts, components, or assemblies when a minimum inventory stockage level occurs.

e. Deployable units have RSP kit requirements. These kits are maintained in the RSP pallet area on cargo pallets. Flight line support is responsible for inventorying and restocking the kits.

B. Administrative Functions

a. Parts and Components Administration - Coordinates the requisition and distribution of parts, components, and assemblies to support aircraft operations 24-hours a day, seven days a week.

b. Flight Line Support Administration - Provides the primary interface with the customer, and manages the flight line support facility 24-hours a day, seven days a week.

c. Officer-in-Charge/Noncommissioned Officer-in-Charge (OIC's/NCOIC's) Office - For management functions in the facility

C. Support Area Functions

a. Customer Service Entrance - Locate the entrance so that it is clearly visible for public access of visitors and customers.

b. Rest Rooms - Centrally locate rest rooms for men and women.

c. Mechanical Room - Space for heating, ventilating, and air conditioning equipment (HVAC), electrical service, and fire detection and alarm equipment.

d. Electrical Room - Room for primary electrical systems necessary to support the entire facility.

e. Communications Room - A location for the building telecommunications systems and telephone switching equipment.

D. Warehouse Functions

a. High-Density Storage - This area consists of a number of high bay storage racks with aisles wide enough for the material handling equipment to maneuver easily.

b. RSP Pallet Buildup Area - This large open area within the warehouse is for the buildup and maneuvering of RSPs.

c. RSP Pallet Storage Area - The type of aircraft and the squadron size will determine the overall size of this area. This area is adjacent to the RSP buildup area and accommodates the RSP containers and cargo pallets. Position the pallets in single rows.

d. Bulk Storage - Provide an area for parts that are too large for high-density storage. Locate these items on the mezzanine above the RSP pallet storage area.

e. RSP Loading Dock - This area is for 463L cargo pallets and loader equipment. Provide an in-floor mounted scale that will handle cargo pallets and is capable of accurately measuring cargo pallet weights of up to 10,000 pounds. Locate the scale near the RSP dock.

f. Truck Loading Dock - A location to receive parts and components from base supply or depots.

g. Parts Counter - An area located near the customer service entrance.

h. Reparable Parts/Tail Number Parts/TCTO Parts - An area near the truck loading dock for storage of parts until they are picked up by a maintenance unit.

E. Special Storage Functions

1. Inside Storage

a. Avionics and Electronic Components Storage - An environmentally controlled storage area for avionics and other electronic components.

b. Classified Storage - An area for storage of sensitive or pilferable materials. Enclose this room with fire-rated walls and a vault door.

c. Battery Storage - A special storage area with ventilation and special exhaust for nickel cadmium battery cells. Provide a battery shop and recharging capability within the flight line support facility if the base does not have one.

2. External Storage

a. Outside Storage - A fenced, paved, and lighted area for material and for operating material handling equipment.

b. Covered Storage - Space to store supplies, equipment, and material not requiring closed warehouse space, but requiring covered protection from the weather. Covered storage space is constructed without complete side and end walls. This space can be included within the warehouse in cold climates.

F. Space Criteria

1. Planning Considerations

a. Define the size, type, number, and functional area relationships of spaces required to support the flight line support facility.

b. Development of space requirements should take into consideration

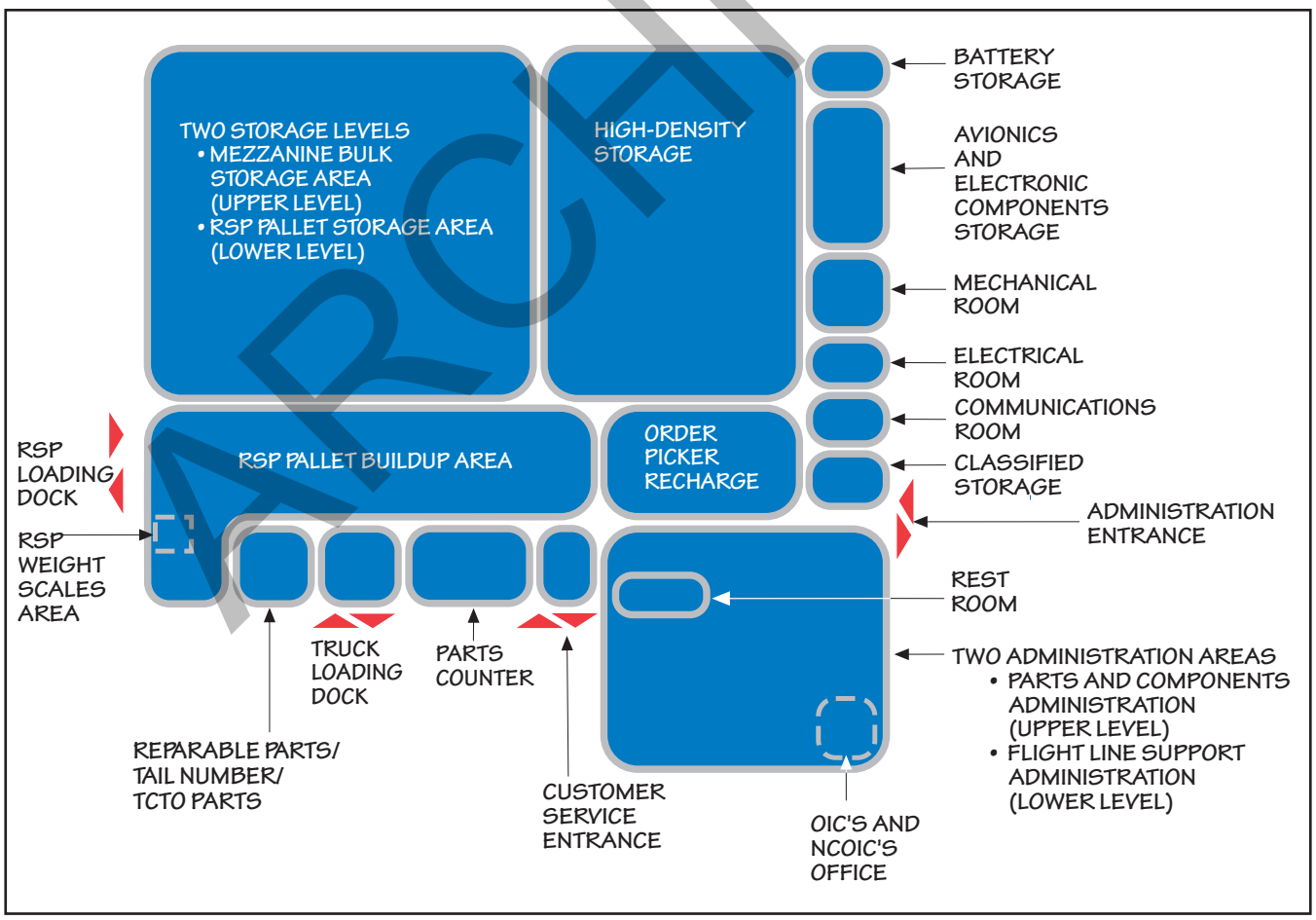

Figure 2-A: Functional Area Relationships for the Flight Line Support Facility.

the existing facilities relative to current and future needs. Requirements are governed largely by the types of aircraft assigned to the base and the number of parts and components necessary to support the overall maintenance effort. Other considerations are as follows:

- Circulation and storage of material handling equipment
- Sufficient space for the number of RSPs necessary to support a 30-day deployment
- Administrative areas for accountability and control of parts
- Space for receiving and shipment of reparable parts, components, and assemblies between the facility, depots, and manufacturers

2. Standard Facility Requirements

a. The size of the facility is detemined by the number of aircraft assigned and RSP pallet requirements.

- Table 2-A: Space Requirements for the Flight Line Support Facility and Storage Areas - Use this table to determine space requirements and how to calculate the gross square footage for the C-5, C-17, C-141, and KC-135 flight line support facilities and open/covered storage.

- Table 2-B: RSP Space Requirements for Pallets - Use this table to determine space requirements for the RSP pallet storage and buildup areas for the C-5, C-17, C-141, and KC-135 aircraft. In addition, a formula is included to calculate the square footage requirements. (Figure 2-B graphically illustrates the RSP storage space.)

b. The recommended sizes of the functional areas for a flight line support facility are shown in Tables 2-C through 2-F, and graphically illustrated in Figure 2-A, page 5.

- Table 2-C: Space Requirements for Administration Areas - Square footage requirements for the parts and components administration, and flight support administration open office areas are determined from this table.

- Table 2-D: Space Requirements for Support Areas - This table provides an example of areas required for the flight line support facility.

Space Requirements per Assigned Aircraft Type

	C-5	C-17	C-141	KC-135
Flight Line Support Facility[1]	857 SF	625 SF	546 SF	625 SF
Open Storage	396 SF	396 SF	198 SF	198 SF
Covered Storage	100 SF	100 SF	30 SF	30 SF

Gross Square Footage Calculation Example

Assume: 32 assigned C-5 aircraft

Example:

• Flight Line Support Facility	32 aircraft x 857 SF =	27,424 SF	2,548 SM[2]
• Open Storage	32 aircraft x 396 SF =	12,672 SF	1,177 SM[2]
• Covered Storage	32 aircraft x 100 SF =	3,200 SF	297 SM[2]

Legend for Table 2-A.
SF - Square Footage
SM - Square Meters

(1) Square footage has been adjusted for high-density storage and storage requirements for RSP are included (see Figure 2-B for space allocation).
(2) SM = .0929 x SF (all measurements are rounded).

Table 2-A: Space Requirements for the Flight Line Support Facility and Storage Areas.

Space Requirements for RSP Pallets				
Type of Storage	C-5	C-17	C-141	KC-135
RSP Pallet Storage Area (per Pallet)	146.4 SF	146.4 SF	146.4 SF	146.4 SF
RSP Pallet Buildup Area (per Pallet)	32 SF	32 SF	32 SF	32 SF

Established Criteria:

- A 463L cargo pallet is 108” x 88” (7.3’ x 9’) or 65.7 SF
- Using Figure 2-B for illustration, the space required to store 25 pallets of RSP, including 5 foot aisles on all sides, plus an additional pallet space to permit pallet movement while on the conveyor system would be:
  - 48.8’ x 75’ = 3,660 SF
  - 3,660 SF divided by 25 pallets = 146.4 SF of storage space per pallet

Example using 32 Pallets (Note that Figure 2-B does not apply):

- RSP Pallet Storage Area: 32 pallets x 146.4 SF per pallet = 4,685 SF 435 SM(1)
- RSP Pallet Buildup Area: 32 pallets x 32 SF per pallet = 1,024 SF 95 SM(1)

Legend for Table 2-B.
SF - Square Footage
SM - Square Meters
(1) SM = .0929 x SF (all measurements are rounded).

Table 2-B: RSP Space Requirements for Pallets.

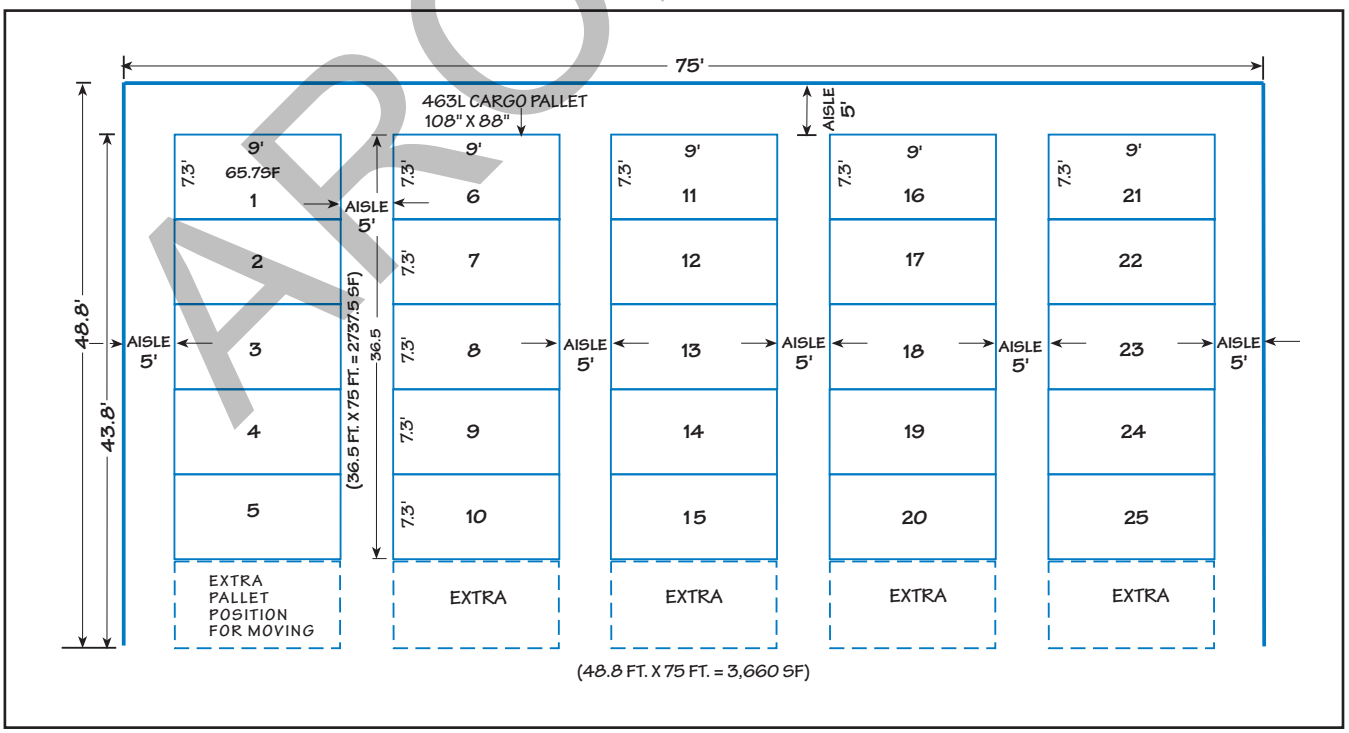

Figure 2-B: Graphic Illustration of Readiness Spares Package (RSP) Pallet Storage Space.

Functional Space Requirements for Administration

Area	SF	SM
Parts and Components Administration[2]	990	92
Flight Line Support Facility Administration[2]	990	92
OIC's/NCOIC's Office[3]	270	25
Net Subtotal Administration	2,250	209[1]

Table 2-C: Space Requirements for the Administration Areas.

Functional Space Requirements for Support Areas

Area	SF	SM
Customer Service	100	9
Mechanical Room[4]	240	22
Electrical Room	48	4
Communications Room	48	4
Rest Rooms[5]	408	38
Break Room[6]	600	56
Janitor's Closet	50	5
Net Subtotal Support Area	1,494	139[1]

Table 2-D: Space Requirements for the Support Areas.

Functional Space Requirements for Warehouse

Area	SF	SM
High-Density Storage	12,383	1,150
RSP Pallet Storage Area[7]	4,685	435
RSP Pallet Buildup Area[7]	1,024	95
RSP Loading Dock	150	14
Truck Loading Dock	250	23
Reparable Parts/ Tail Number Parts/ TCTO Parts[3]	1,500	139
Net Subtotal Warehouse	19,992	1,856[1]

Table 2-E: Space Requirements for the Warehouse Areas.

Functional Space Requirements for Special Storage

Area	SF	SM
Avionics and Electronic Components Storage[3]	1,000	93
Classified Storage[3]	300	28
Battery Storage[3]	150	14
Net Subtotal Special Storage	1,450	135[1]

Table 2-F: Space Requirements for the Special Storage Areas.

Legend for Tables 2-C Through 2-F.

SF - Square Footage

SM - Square Meters

(1) SM = .0929 x SF (all measurements are rounded).

(2) Square footage is based on 90 Net SF per person with systems furniture.

(3) Individual units may have specific requirements which drive an increase or decrease in space for specific functional areas. These deviations from this standard should be fully justified and documented during planning and programming of the facility.

(4) Square footage is based on 8% of gross administration area.

(5) Square footage is based on National Plumbing Code for occupancy and number of fixtures for up to 100 people.

(6) Square footage is based on 40 seats at 15 SF per seat, plus vending area.

(7) Square footage is based on 32 pallets (see Table 2-B and Figure 2-B).

- Table 2-E: Space Requirements for Warehouse Areas - Area requirements for general purpose and support areas include high-density storage, RSP pallets, loading docks, reparable parts, and TCTO kits.
- Table 2-F: Space Requirements for Special Storage Areas - Use this table to determine square footage requirements for areas that have special needs, i.e. security fencing, special ventilation and exhaust, and security/surveillance.
- Table 2-G: Space Requirements for a Flight Line Support Facility - This table provides an example of the square footage requirements for a typical facility.

G. Site Evaluation

1. Location

a. Locate the flight line support facility adjacent to the flight line, near the center of aircraft maintenance activities.

b. Include vehicle access for parts delivery and pickup.

c. Include sufficient parking for personnel and customers.

2. Size

a. Site size depends upon gross building square footage; space required for access, maneuvering and parking of tra ctor trailers; and space required for access and parking of government-owned vehicles (GOVs) and privately owned vehicles (POVs) away from the major roadways.

b. Prior to the preparation of DD Form 1391, preliminary site design should be performed to ensure the facility, parking, loading docks, and exterior storage can be accommodated.

c. Include fire lanes in accordance with local fire codes.

Gross Total Functional Space Requirements for a Flight Line Support Facility

Area	SF	SM
Subtotal Administration (Table 2-C)	2,250	209
Subtotal Support Area (Table 2-D)	1,494	139
Subtotal Warehouse (Table 2-E)	19,992	1,856
Subtotal Special Storage (Table 2-F)	1,450	135
Net Total Flight Line Support Facility	25,186	2,339
15% Walls and Circulation	3,778	351
Gross Total Flight Line Support Facility	28,964	2,690[1]

Table 2-G: Space Requirements for a Typical Flight Line Support Facility.

Legend for Table 2-G.
SF - Square Footage
SM - Square Meters
(1) SM = .0929 x SF (all measurements are rounded).

H. Special Project Considerations

Consider special factors when establishing initial estimates of project costs (see relevant sections of Chapters 3 and 4). Special considerations are:

- Weather Conditions - Evaluate local wind, snow, and seismic conditions for their impact on project costs.
- Preliminary Soil Analysis - Determine whether specialized site and foundation work will be required.
- High-Bay Construction - Required to support high-density storage with 30-foot minimum clearance under the roof structure.
- Mezzanine - Design structural columns to accommodate a mezzanine at a height of 15 feet above the floor.
- High-Density Rack Storage - In earthquake zones, incorporate bracing.
- Mid-Level Sprinklers - Locate in high-density rack storage and under mezzanines in accordance with applicable fire code requirements.
- Standby Power Generation - Install an uninterruptible power supply for computers controlling inventory and electrical material handling equipment.
- Recessed Floor-Mounted Scale - Provide a scale to weigh cargo pallets.
- Floor Design - Floors must be level. Design to support 500 pounds per square foot loading for rack storage and material handling equipment.

Chapter 3

Overall Project Design

A. General

This chapter presents broad criteria for locating a flight line support facility on a site, design of the facility and its supporting utilities, and technical requirements.

B. Site Design

1. Selection

a. See Figure 3-A for the site organization concept.

b. Facilities should comply with airfield clearance requirements for building height and setbacks.

c. A typical site layout and the site's organizational relationship to the flight line and maintenance units are illustrated in Figure 3-B.

d. Building orientation should take into account the following factors:

- Protection from winds and glare

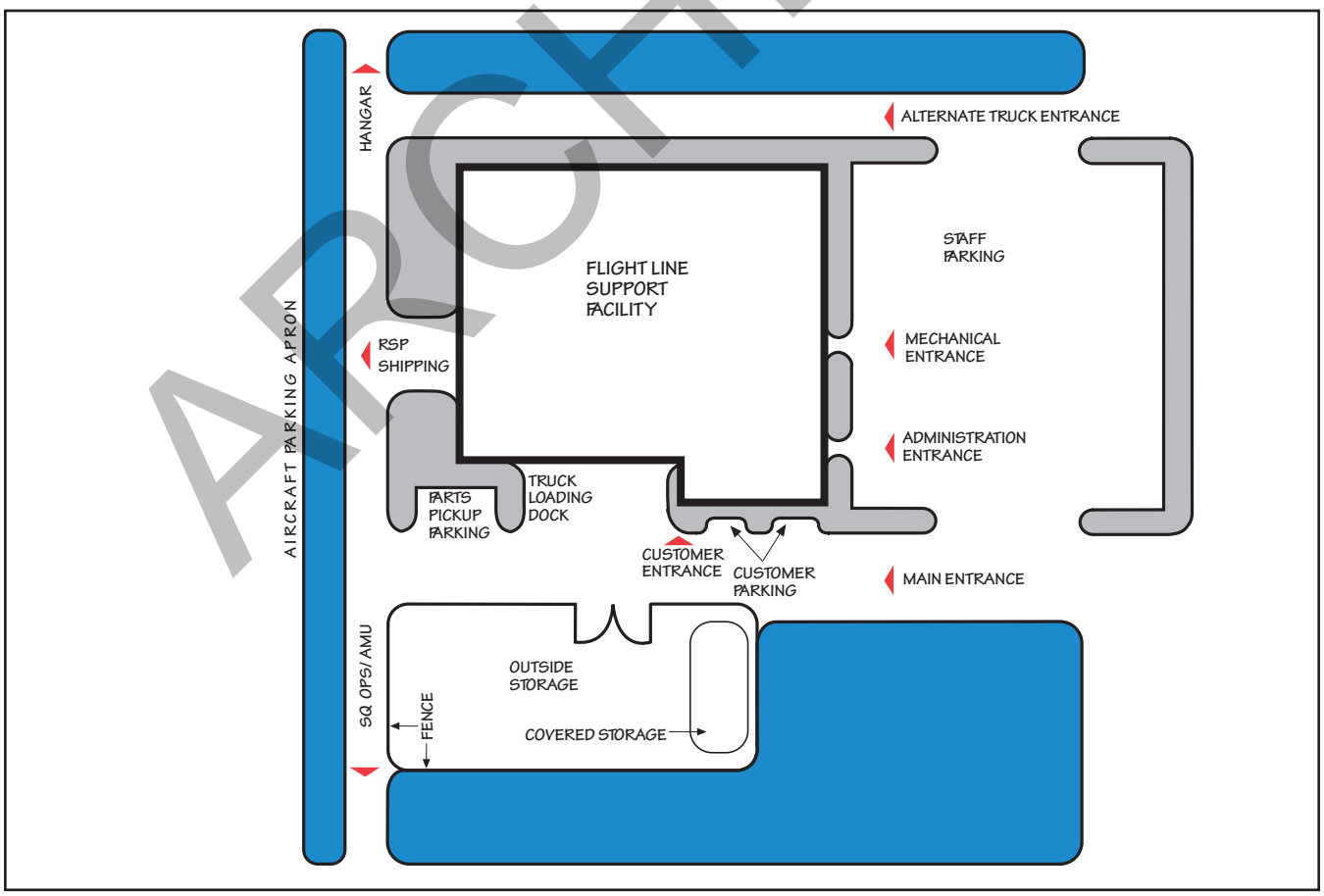

Figure 3-A: Site Organization Concept for the Flight Line Support Facility.

- Shade from excessive sun in warm climates
- Orient operable windows to take advantage of summer breezes
- Maximum sun exposure in cold climates

2. Access

a. Locate the building on the site with two vehicle entrances: a convenient main entrance and an alternate truck entrance.

b. Design a clearly identifiable access route to the customer entrance from the customer parking lots.

c. Segregate service traffic from other traffic and pedestrian access. Keep traffic control signs to a minimum and use them only for safe integration of vehicle traffic.

3. Utilities

a. In accordance with local service procedures, provide:

- Water, sanitary sewer, and stormwater systems, plus natural gas, steam service, or fuel/oil systems
- Electric, telephone, sprinkler, fire alarm, and communications systems

4. Landscaping

a. Use landscape elements to define the site and the main entrances. Landscaping should present an attractive image for the facility, as well as natural screening for separation between parking areas.

C. Building Design

1. Organization and Circulation

a. The main entrance should provide direct access to the parts counter.

b. Design functional spaces for maximum flexibility to allow for efficient storage and retrieval of aircraft parts. The general warehouse consists of large, open bay areas of bulk, bin, and RSP storage. The maximum storage height is 24 feet.

c. Locate the mezzanine above the RSP pallet storage area. This area provides storage for large bulk items.

d. Maintain a large open area, adjacent to the RSP area, for buildup and maneuvering of the RSP pallets.

e. Locate the loading dock for RSP shipping on the side of the building nearest the flight line.

f. Locate the parts and components administration office so that the staff can maintain visual supervision and security of the warehouse.

g. The rest rooms should have a centralized, prominent location.

2. Architectural Character, Materials, and Finishes

a. Integrate the architectural and interior design of the facility. The architectural style and form should be consistent with the base Architectural Compatibility Guide.

b. The design team should use comprehensive interior design services to ensure interior finishes and furnishings are properly coordinated, as well as appropriate. See Chapter 5 for suggested interior finishes.

c. The overall complex should present a cohesive architectural image.

d. Provide a variety of spaces and subspaces to accommodate different size groups and activities. Use modular systems furniture in the parts and components and flight line support administration areas to economize on space, to provide flexibility, and to promote a sense of organization and visual order.

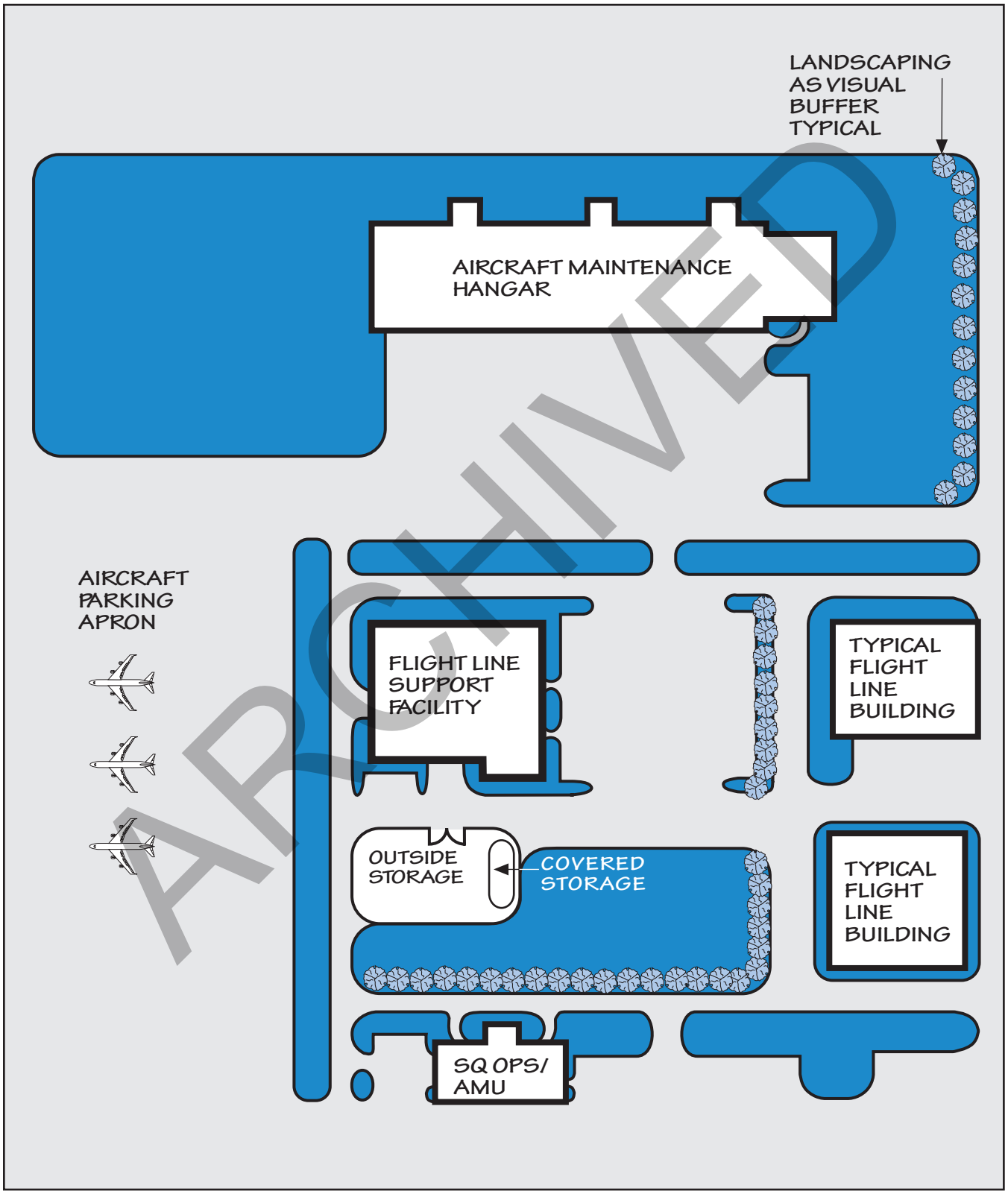

Figure 3-B: Site Organization Relationships for the Flight Line Support Facility.

3. Supervision and Security

a. The flight line support administrative facility handles a high-value inventory which requires security and supervision.

b. The parts and components administration function should provide visual supervision of the warehouse area.

c. Limit access to high-value storage areas to assigned personnel. Use card access for all access points inside and outside the facility. The access system should identify and record all persons who enter or leave the facility.

4. Flexibility and Expansion Potential

a. Design the warehouse site to accommodate change or expansion as mission or assigned aircraft change. Consider providing land adjacent to the warehouse to accommodate a 100% facility expansion.

b. The large RSP buildup area is a perfect example of flexible space usage since it is used for buildup of pallets, movement of parts, and other large components.

5. Disabled Access

All areas should be barrier free and accessible to the physically disabled in accordance with the Americans with Disabilities Act (ADA) and Uniform Federal Accessibility Standards.

6. Special Considerations for Renovations

a. Two factors that may necessitate new construction are the availability of high-bay areas with a minimum clearance of 30 feet, and the ability of the floor to sustain 500 pounds per square foot loadings. This may limit the use of otherwise available existing space.

b. When retrofitting an existing building, select a suitable, permanent structure large enough to accommodate the full range of storage functions. The structural system and floors should be open and relatively column-free. The building layout should control customer access and provide security for the warehouse.

c. Survey and analyze existing buildings for energy efficiency upgrade.

D. Building Systems

1. Structural

a. Select a cost-effective framing system based on size, projected load requirements, and availability of materials and local labor.

- Projected load requirements for the facility include the following:
  - Floor slab
  - High-bay parts storage system loading
  - Bulk storage loading
  - High-bay clear spans

b. Select and design the structural system based on analysis of projected future needs to accommodate expansion easily and economically; however, do not "over design" the initial construction.

c. Design building structural components to reflect space requirements, economy, and subsystem dimensions (e.g., ceiling grid, masonry units, framing members, etc.).

2. Heating, Ventilating, and Air Conditioning

a. Perform a life-cycle cost analysis of available energy sources.

b. Interior design temperatures and relative humidity levels should conform to Air Force standards.

c. Provide mechanical air circulation in public areas with limited or no air conditioning.

d. The mechanical air system should introduce outside fresh air.

A large open area is required to build up and maneuver RSP pallets. The mezzanine area is used for bulk storage. (Grand Forks AFB, ND)

e. Design this facility to meet federal energy conservation standards defined in 10 CFR (Code of Federal Regulations), "Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings."

f. Provide zone controls (temperature sensors with remote adjustment instead of thermostats) to maintain different environmental conditions in all functional areas. Some areas of the facility may require operation of environmental systems when other areas are closed.

g. Provide mechanical exhausts for the rest rooms.

h. Provide for connection to the base Energy Monitoring and Control System (EMCS).

3. Plumbing

a. Provide domestic hot and cold water, sanitary and storm drainage, plus propane or natural gas systems, if required.

b. For general use, provide hot and cold water to all rest rooms, sinks, and janitor's closets.

c. Provide shut-off valves at all plumbing fixtures.

d. Provide frost-free hose bibs on all exterior walls if local climate conditions justify them.

4. Electrical

a. Provide electric service, including distribution equipment, wiring, receptacles and grounding, interior and exterior lighting and controls, emergency lighting, telephone, and fire alarms.

b. Provide a back-up generator for 24-hour operation.

c. Evaluate and include the following power needs to determine the total electric service capacity:

- Photo card key access
- Engine warming receptacles when needed in severe cold climates

d. All service equipment should be Underwriters Laboratories-listed.

- As an alternative, provide published proof from a bona fide independent testing laboratory.

e. General convenience receptacles and special power outlets should be commercial grade. Convenience receptacles should be a maximum of 12 feet apart. Provide special power outlets and circuits for all computer equipment as required.

f. General lighting in office areas should be fluorescent with low temperature energy efficient ballasts and lamps. Indirect lighting systems of the high-intensity discharge or fluorescent types may be used where practical.

g. Use of incandescent lighting should be kept to a minimum because of energy efficiency and frequency of maintenance. Incandescent lighting should have an extended life of at least 2,500 hours.

h. Lighting control systems should include dimmers to automatically reduce intensity levels of artificial lighting when natural light is available.

i. Use high-intensity discharge light sources for exterior lighting of parking areas, walkways, and building entrances.

j. Install illuminated exit signs, public address systems, and battery powered emergency lighting.

k. Surveillance systems in designated areas should have at least two levels of detection.

5. *Fire Protection*

a. Facilities should be of noncombustible construction.

b. Hazardous or combustible supplies must be contained within a fire-rated enclosure.

c. Provide sprinkler coverage in the aircraft wheel and tire assemblies storage area.

6. *Communications*

a. The base communications squadron, in coordination with the system telecommunications engineering manager, can provide details on communications requirements and design for the buildings' internal and external phone and data connectivity, as well as alarm system wiring.

b. Incorporate requirements into building design specifications and include connectivity to base phones, with data infrastructure systems sufficient to support the maximum planned number of building occupants. These requirements are as follows:

- Phone Connections - Provide sufficient preinstalled connections to support the maximum planned number of people in each area. Consider future growth, modem connections, and special requirements (pay phones, etc.).
- Administrative Data Connections (Local Area Networks - LANs) - Provide administrative computer and LAN printer connectivity. Also provide specialized computer connectivity to support the base mission when required.
- Fiber Optic Connectivity - May be required (internally to several locations and/or externally to system nodes) to support AMC command, control, communications, and computer systems.
- Hands-Free, Two-Way Intercom (Public Address System) - Provide throughout the facility, with wall-mounted speaker units.

7. *Material Handling System*

a. The Material Handling Engineering Branch at Wright-Patterson AFB, OH (DSN: 787-3078), is the focal point for designing and funding material handling systems. The following material handling guidance includes recommendations that may be altered after further study at base level.

b. Store most parts in a high-density system with a maximum storage height of 24 feet. Storage should be a combination of the following:

- Bins - Stored on adjustable shelving set initially 6 inches apart.
- Open Shelf Storage - Wire rack over framework, 24 inches high and/or 30 inches deep, with adjustable heights for maximum use.

- Pallet racks - Design for standard Air Force Pallets, 40” deep x 48” wide (not to be confused with 463L cargo pallets which are 108” x 88”). Design should consider a possible load overhang of four inches total in either direction, a 3,000 pound load, and adjustable vertical spacing for maximum use.
- Special Rack - For storage of tire and wheel assemblies. This rack maintains the tires in an upright, secured position to prevent them from rolling. Because of tire weight and size, they should be stored on the floor or on the first level of the racks.
- Parts Carousel - For small parts
- Cantilever Racks - For storing hydraulic tubing, sheet metal, and items too bulky for rack storage. The length of the support arms and load capacity must be suitable for specific items to be stored.

c. Items that are too bulky for rack storage can be stored on the open mezzanine above the cargo pallet storage area.

d. Aircraft parts in the high-density system are stored and retrieved using man-up turret trucks. Note that storing high-demand items at levels below six feet will permit manual picking of many of these items without the turret trucks.

e. In-rack sprinkler systems are required for racks over 12 feet high.

f. Use a pallet jack to move materials stored on the mezzanine. Equip the mezzanine storage areas with a 1,000-pound capacity vertical reciprocating conveyor (VRC) for lifting and lowering material to the mezzanine level. The mezzanine should also have a removable section of railing for lifting items too bulky for the VRC and as a backup in case of VRC malfunction.

Vertical spacing of high-density storage racks should be adjustable for maximum use. (Grand Forks AFB, ND)

g. Provide floor-mounted roller conveyors for staging the cargo pallets.

h. Building floors should be level within 0.125 inches in 10 feet, with no more than 0.5 inch deviation in the entire building area used by turret trucks. Aisle width between rack faces should be 68 inches for turret trucks and 60 inches for order-picking trucks.

i. The storage racks and shelves should be designed for rail guidance. (The floor rail down the aisle and curbs at the ends of the shelving, painted yellow in the photo below, prevent the turret truck from coming in contact with the storage racks.) The lowest level of storage must be even with or above the top of the rail. Design the racks, shelves, and rail guidance so that the area under the rack or shelf is either cleanable or sealed to prevent the accumulation of trash or dust.

j. Provide a battery charging area for the turret trucks. This area should be large enough for two to three vehicles and permit removal of batteries with minimum manual effort. Provide adequate ventilation to prevent hydrogen accumulation during charging. ■

High density storage and mechanized turret trucks contribute to efficient handling of aircraft parts. (Grand Forks AFB, ND)

Chapter 4
Functional Area and Space Criteria

A. General

This chapter presents criteria for designing a flight line support facility. Primary design considerations include the use, performance, organization, character, and relationships of component spaces. For each area, specific criteria are provided concerning space size and critical dimensions. These recommendations may be modified to reflect mission requirements. The sizes of functional areas are specified in Tables 2-C through 2-F, page 8.

The parts and components administration area should overlook the entire warehouse area. Ordering, tracking, and accounting for specific parts require a well-organized computer area. (Grand Forks AFB, ND)

B. Administration

1. Design Considerations

See Figure 4-A for an illustrative floor plan.

a. Use and Performance

- Two administrative functions are contained within a flight line support facility:
  - Parts and components administration is for ordering and expediting parts.
  - Flight line support administration is the primary customer interface.
- Collocate the administrative areas so that rest rooms and support functions can be shared.

b. Space Organization and Character

- Provide a private office for the OIC and NCOIC within the flight line support administration area.

2. Parts and Component Administration

a. Furnishings and Equipment

- Use modular systems furniture for the work stations and private offices.
- Provide lockable cabinets for storage of manuals.
- Include an area for file cabinets and vertical files.

b. Technical Requirements

- Wiring for LAN computers.
- Provide telecommunications data/computer outlets.

3. Flight Line Support Administration

a. Furnishings and Equipment

- Use modular systems furniture for work stations.

- Provide lockable cabinets for storage of manuals.
- Include an area for file cabinets and vertical files.

b. Technical Requirements

- Wiring for LAN computers.
- Provide telecommunications data/computer outlets.

4. OIC's/NCOIC's Office

a. Furnishings and Equipment

- Desks and desk chairs
- Side chairs
- File cabinets
- Personal computers

b. Technical Requirements

- Telecommunications data/ computer outlets
- Wiring for LAN computers
- Security devices to control public access

C. Support Areas

1. Design Considerations

a. Use and Performance

The support areas should include the following:

- Customer Service Entrance - Main entrance should be easy to identify from the principal access road. Interior traffic areas should be logical, efficient, and easy to follow from the main entrance.
- Mechanical Room - Location of primary equipment for HVAC, plumbing, and other building system equipment
- Electrical Room - Location of primary electrical systems for the building
- Communications Room - Contains computer distribution equipment and telephone service panels
- Rest Rooms - Locate centrally within the facility.

b. Space Organization and Character

- The mechanical room should have outside access.
- All mechanical, electrical, and communications rooms should be adjacent to each other for servicing convenience.

2. Customer Service Entrance

a. Furnishings and Equipment

- Provide pedestrian entrance mats.

b. Technical Requirements

- Provide easily cleaned, water- and mud-resistant flooring materials at all entrances.

3. Mechanical Room

a. Furnishings and Equipment

- Provide a floor-mounted mop sink.

b. Technical Requirements

- Size and critical dimensions will vary with building system requirements and climate conditions.

4. Electrical Room

a. Technical Requirements

- Provide for standby power generation and uninterruptible power supply.
- Locate adjacent to the computer and mechanical rooms.

5. Communications Room

a. Technical Requirements

- Provide for various personal computers, as required.
- Provide surge protection for all computer equipment.
- Design for a sound transmission class rating of 52.

6. Rest Rooms

a. Furnishings and Equipment

- Men: Water closets, lavatories, urinals, soap dispensers, paper towel dispenser and disposal units, toilet paper holders, grab bars, mirrors, coat hooks, and partitions
- Women: Same as men, minus urinals, plus sanitary napkin dispenser and disposal units

b. Technical Requirements

- Sound transmission class rating: 45 between adjacent rooms
- Finish floors with non-skid ceramic tile.
- Finish walls with ceramic tile installed either full height or as a wainscot.
- Use plastic laminate for lavatory counters.

7. Janitor's Closet

- Provide a floor-mounted mop sink.
- Provide shelves and hooks for cleaning and maintenance equipment.
- Provide a water-resistant, easily maintained floor material, sloped to a floor drain.

D. Warehouse

1. Design Considerations

a. Use and Performance

Primary areas of the warehouse provide fully integrated flight line support for aircraft maintenance.

- High-Density Parts Storage - Used for efficient storage of a large number of small items.

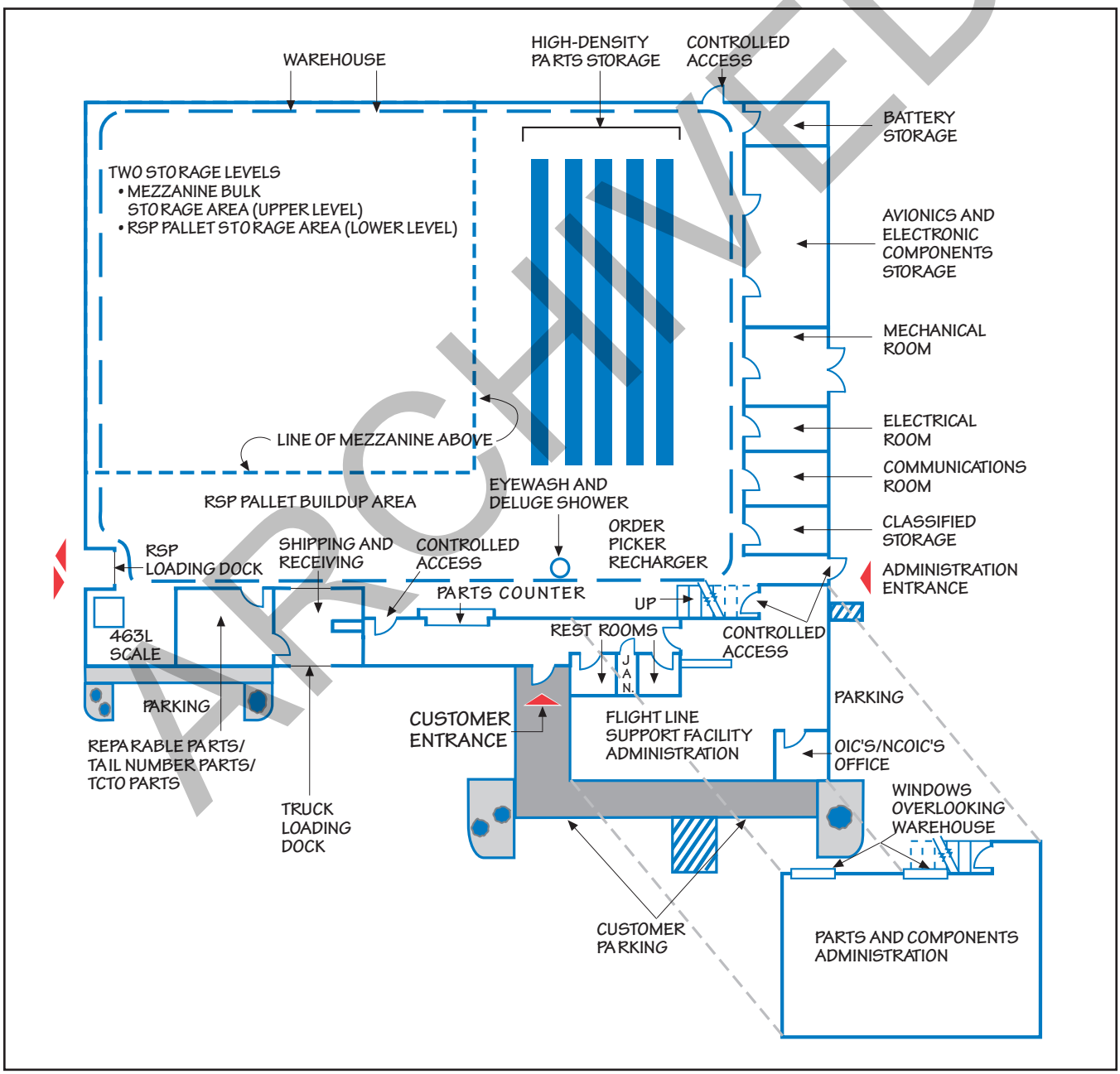

Figure 4-A: Floor Plan for the Typical Flight Line Support Facility.

- RSP Pallet Storage Space - This area includes floor-mounted rollers for storage of RSP kits.
- RSP Pallet Buildup Area - An area to assemble and maneuver RSP containers.
- RSP Loading Dock - The dock provides a transfer area for RSP containers to and from the flight line.
- Truck Loading Dock - The dock provides a transfer area to receive components from base supply, depots, and manufacturers.
- Parts Counter - Customer parts pick-up is at this counter.
- Bulk Storage Area - Parts too large for high-density storage are kept in this area.
- Reparable Parts/Tail Number Parts/TCTO Parts - An area for storing parts until they are sent out for repair.

b. Space Organization and Character

- Provide a large work area for packing, unpacking, and maneuvering RSP kits on cargo pallets with and without material handling equipment. Area should be a large, contiguous open space.
- Locate the RSP pallet storage space adjacent to the dock. Provide an in-floor mounted scale sized to handle cargo pallets, and capable of accurately measuring a pallet which weights up to 10,000 pounds.
- RSP pallet storage space should be adjacent to the RSP buildup area.
- The RSP loading dock should be adjacent to the buildup area.

2. High-Density Parts Storage

Refer to Chapter 3, paragraph D7, "Material Handling System," for a description of storage rack systems and equipment.

a. Furnishings and Equipment

- The high-density storage shelf system should be at least 24 feet high.

b. Technical Requirements

- Ensure that traffic aisles, storage shelving aisles, and equipment can accommodate the material handling equipment.
- Arrange the area so that the required exits are remote from each other, but within 200 feet or less of any point within the facility.
- Floor finish should reflect light and be easily cleaned.
- Provide high-bay construction with 30 feet minimum clearance under the roof structure.
- In earthquake zones, brace high-density storage racks to resist earthquake forces.

3. Readiness Spares Packages Pallet Storage Space

a. Furnishings and Equipment

- Provide floor-mounted roller conveyors sized to handle the RSP kits.
- Locate the cargo pallets in this area.

b. Technical Requirements

- Ensure floors are level within 0.125 inch in 10 feet with no more than 0.5 inch deviation.

4. Readiness Spares Packages Buildup Area

a. Furnishings and Equipment

- Locate the cargo pallets in this area.

b. Technical Requirements

- Provide natural light whenever possible, along with metal halide lighting.
- The floor finish should reflect light and be easily cleaned.

5. Readiness Spares Packages Loading Dock

a. Furnishings and Equipment

- Provide dock levelers to correct the elevation differences between the loading dock and truck bed. Also provide truck restraints to keep the trailer from pulling away from the dock, and dock door seals for weather protection.

b. Technical Requirements

- Use overhead rolling doors at dock openings.
- Incorporate a surveillance system with card key to control access from the exterior.
- Include ramps for forklift traffic at loading docks.

6. Truck Loading Dock

a. Furnishings and Equipment

- Provide dock levelers to correct the elevation differences between the loading dock and truck bed. Also provide truck restraints to keep the trailer from pulling away from the dock, and dock door seals for weather protection.
- Incorporate a surveillance system with card key to control access from the exterior.

b. Technical Requirements

- Use overhead rolling doors at the dock opening.

7. Parts Counter

a. Furnishings and Equipment

- Provide a service counter to separate warehouse workers from customers.
- Provide sufficient space to temporarily store a small number of items.

b. Technical Requirements

- Wiring for LAN computers.
- Provide telephone/computer outlets.
- Control access to the warehouse from the parts counter area.

8. Bulk Storage Area

a. Furnishings and Equipment

- Provide a VRC to carry workers and warehouse items from the ground floor to the mezzanine level.
- Include a storage system for tires and wheel assemblies.

b. Technical Requirements

- Design structural columns for a mezzanine at 15 feet above the floor.
- Install mid-level sprinklers under mezzanines in accordance with applicable fire code requirements.

9. Reparable Parts/Tail Number Parts/TCTO Parts

a. Furnishings and Equipment

- Provide shelving and storage bins.
- Incorporate rollers/material conveyors.
- Include a customer counter in this area.

b. Technical Requirements

- Install wiring for LAN computers.

E. Special Storage Requirements

1. Design Considerations

See Figure 4-A, page 21, for location of special storage areas.

a. Use and Performance

The following are the primary areas that have specific storage requirements:

- Avionics and Electronic Components Storage - These items require a separate environmentally controlled storage area to preclude damage to these sensitive parts.

The turret truck and vertical conveyor efficiently move material from the mezzanine storage area to the RSP buildup and storage areas. (Grand Forks AFB, ND)

- Classified Storage - Requires an area enclosed with fire-rated walls and vault door.
- Battery Storage - For storage of nickel cadmium cells and refrigerated storage of individual cells
- Outside Storage - A large space for storage of bulk items and equipment that can be stored outdoors, thus freeing space within the warehouse.

b. Space, Organization, and Character

- Locate battery storage away from administrative areas to facilitate the unobstructed exhausting of fumes.
- Because of the need for security, locate classified storage near the administrative areas.

A typical RSP storage area beneath a mezzanine should be equipped with floor-mounted rollers for easy maneuverability. (Grand Forks AFB, ND)

2. *Avionics and Electronic Components Storage*

a. Furnishings and Equipment

- Provide a shelving system appropriate to accommodate the items to be stored.

b. Technical Requirements

- Provide separate environmental controls.
- Wiring for LAN computers.
- Provide telephone/data communications outlets.

3. *Classified Storage*

a. Furnishings and Equipment

- Include a shelving system to accommodate the items to be stored.

b. Technical Requirements

- Allot approximately 300 square feet for this space.
- Provide fire-rated walls and ceiling.
- Install a vault door.

4. *Battery Storage*

a. Furnishings and Equipment

- Provide safety equipment and facilities, e.g., eyewash, deluge shower.
- Include space to accommodate refrigeration equipment.

b. Technical Requirements

- Use quarry tile or acid-resistant floor coating.
- Use explosion-proof receptacles.
- Finish interior ceiling and walls with non-combustible materials.
- Maintain temperatures in accordance with the manufacturers' recommendations for explosion-proof heaters.
- Provide positive air ventilation and special exhaust to conform to established design requirements and local building codes.
- Provide sufficient electrical outlets to accommodate charging equipment and refrigeration equipment.

5. *Outside Storage*

a. Furnishings and Equipment

- Security fencing is required.

b. Technical Requirements

- Provide a controlled-access gate.
- Paved surfaces are required.
- Provide lighting for night-time visibility and surveillance.
- Locate the covered storage space in this area.

Chapter 5

Interior Finishes

A. General

Finish materials and furnishings should be selected using professional interior design services. Selections should be based on anticipated use, maintenance requirements, life-cycle cost, fire and other life safety requirements, as well as aesthetic qualities.

Coordinate materials, finishes, colors, and texture selections to complement the overall building design and image. Select colors and finishes to express professionalism, warmth, and a strong, positive image.

B. Finish Schedule

Use colors and finishes to highlight and differentiate spaces designed to accommodate different types and levels of activity. For example, the warehouse areas require extremely durable and easy to maintain finishes.

Color schemes should be predominantly neutral. The designer should consider the seasonal temperature range of the base when selecting a color scheme, such as cool colors (blue, green) in hot climates and warm colors (beige, tan) in cold climates.

Furniture is an integral part of the building design and image.

Permanent and semi-permanent surface materials, such as tile, carpet, and the majority of the wallcoverings, should be in neutral colors such as beige, taupe, or gray tones.

Patterned carpet (bold tweeds) can be the basis for the overall color scheme, as well as mask traffic wear.

Paint mechanical and electrical devices to match the background surface. Room finish schedules are listed in Tables 5-A through 5-D. The dashed numbers after the abbreviations (e.g., P-1, VCT-2, VWC-3, etc.) in Tables 5-A through 5-D refer to specific material color board samples in Figure 5-A, pages 30 and 31.

C. Furniture

Furniture is an integral part of the overall building design and image. Coordinate furniture selection for consistency with finish materials, textures, and colors of built-in elements.

Choose furniture that is durable, comfortable, modular, and flexible. Systems furniture, which can be funded as part of a military construction project, is recommended for all administrative areas.

List of Abbreviations

ACT	Acoustical Ceiling Tile	MTL	Metal
CB-E	Concrete Block, Epoxy	NA	Not Applicable
CB-P	Concrete Block, Painted	PL	Plastic Laminate
CONC-S	Concrete, Sealed	QT	Quarry Tile
CPT	Carpet	VB	Vinyl Base
CT	Ceramic Tile	VCT	Vinyl Composition Tile
EXP-P	Exposed Structure, Painted	VWC	Vinyl Wallcovering
GWB-P	Gypsum Board, Painted		

Finish Schedules

Flight Line Support Administration

Functional Area Name	Floors	Base	Walls	Ceiling
Parts and Components Administration	CPT	VB	VWC-3	ACT
Flight Line Support Administration	CPT	VB	VWC-3	ACT

Table 5-A: Finish Schedule for the Flight Line Support Facility — Administration.

Flight Line Support Facility-Support Areas					
Functional Area Name	**Floors**	**Base**	**Walls**	**Ceiling**	**Laminate**
Mechanical	CONC-S	NA	CB-P-1	EXP-P-3	NA
Electrical	CONC-S	NA	CB-P-1	EXP-P-3	NA
Communications	CONC-S	NA	CB-P-1	EXP-P-3	NA
Rest Rooms (men)	CT-1	CT-3	VWC-2/CT-3	GWB-P-3	PL-1
Rest Rooms (women)	CT-2	CT-3	VWC-3/CT-3	GWB-P-3	PL-2
Janitor's Closet	CONC-S	NA	CB-P-1	EXP-P-3	NA

Table 5-B: Finish Schedule for the Flight Line Support Facility — Support Areas.

Flight Line Support Facility-Warehouse					
Functional Area Name	**Floors**	**Base**	**Walls**	**Ceiling**	**Laminate**
High-Density Parts Storage	CONC-S	NA	CB-P-2/MTL	EXP-P-3	NA
RSP Pallet Storage Area	CONC-S	NA	CB-P-2/MTL	EXP-P-3	NA
RSP Buildup Storage Area	CONC-S	NA	CB-P-2/MTL	EXP-P-3	NA
RSP Loading Dock	CONC-S	NA	CB-P-2/MTL	EXP-P-3	NA
Parts Counter	VCT	VB	CB-P-2	ACT	PL-2
Bulk Storage (Mezzanine)	MTL	NA	CB-P-2/MTL	EXP-P-3	NA
Reparable Parts/Tail Number Parts/TCTO Parts	CONC-S	NA	CB-P-2	ACT	NA

Table 5-C: Finish Schedule for the Flight Line Support Facility — Warehouse.

Flight Line Support Facility-Special Storage				
Functional Area Name	**Floors**	**Base**	**Walls**	**Ceiling**
Avionics and Electronic Components Storage	CONC-S	NA	CB-P-1	EXP-P
Classified Storage	CONC-S	NA	CB-P-1	EXP-P
Battery Storage	QT	NA	CB-E	EXP-P

Table 5-D: Finish Schedule for the Flight Line Support Facility — Special Storage.

References

AFM 67-1 Vol. II, Part I	Mechanized Material Handling Systems and Storage Aids Systems
AFM 86-2[1]	Standard Facility Requirements
AFM 88-3	Structural Design Criteria Loads
AFR 89-1[2]	Design and Construction Management
AFR 125-37[3]	Protection of USAF Resources
ADA	Americans with Disabilities Act
DoD 4145.21M1	Material Handling/Storage
DoD 4270.1-M	Construction Criteria Manual
FED STD. 795	Uniform Federal Accessibility Standards
MIL-HDBK 1008B	Military Handbook for Fire Facilities Engineering, Design, and Construction
MIL-HDBK 1190	Military Building Code
NFPA-231 and 231C	Sprinkler Protection for Flammable Liquid Storage
NFPA-101	Life Safety Code 101
NFPA 30: 4-5.6	Flammable and Combustible Liquid Storage for General Purpose Warehouse
AMC	Commander's Guide to Facility Excellence
AMC Bases	Architectural Compatibility Plans
AMC	Hazardous Material Pharmacy Facility Planning and Design Guide
AMC	Interior Design Guide

Legend

(1) When published, AFI 32-1024 (Standard Facility Requirements) will supersede AFM 86-2.

(2) When published, AFI 32-1023 (Design and Construction Standards and Execution of Facility Construction) will supersede AFR 89-1.

(3) When published, AFI 31-209 (Air Force Resources Protection Program) will supersede AFR 127-37.

AIR MOBILITY COMMAND...

...GLOBAL REACH FOR AMERICA

Prepared by Directorate of Civil Engineering
and Directorate of Logistics
March 1999