AC 150/5360-2

AIRPORT CARGO FACILITIES

ADVISORY CIRCULAR

Federal Aviation Agency

APRIL 1964

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO:	AC 150/5360-2
	AIRPORTS
EFFECTIVE:	4/6/64

SUBJECT: AIRPORT CARGO FACILITIES

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1. PURPOSE

This advisory circular presents background and guidance material on air cargo facilities. This information has been developed to encourage the growth of all segments of the air cargo industry and to provide assistance in the planning of airport facilities.

2. REFERENCES

Other Federal Aviation Agency publications which provide additional related information are the following:

a. "Airport Design," 1961, Supplement No. 1, 1962.

b. "Airport Terminal Buildings," 1960.

3. AIR CARGO INDUSTRY

In the broadest terms, the air cargo industry includes that segment of commercial air transportation which handles the transfer of everything but passengers and baggage. Air freight, air express, air mail, and parcel post are all part of the air cargo picture; but mail and parcel post are usually handled in ground facilities which are separate from the normal airport cargo facilities. This advisory circular discusses the latter in detail. Airport Mail Facility requirements are a special case within the province of the Post Office Department and not covered in this publication except for statistical data and brief references.

4. HOW TO GET THIS PUBLICATION

Obtain additional copies of this circular, AC 150/5360-2, "Airport Cargo Facilities," from the Federal Aviation Agency, Distribution Section, HQ-438, Washington, D.C., 20553.

Chester T. Bowers

for COLE MORROW, *Director,*
Airports Service.

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CHAPTER 1. AIR CARGO INDUSTRY

SECTION 1. INTRODUCTION

1. AIR CARGO, PAST TO PRESENT

a. In 1910, when Philip O. Parmalee flew a bolt of silk from Dayton to Columbus, Ohio, in a Wright Brothers biplane, the air cargo industry was born. However, it did not begin to spread its wings in the United States until more than 30 years after this historic incident. The "bush" flyers of Canada were supplying outlying regions of that country early in aviation history. During the twenties and thirties, industry in some countries of Europe and Latin America was profiting by shipping commodities by this new mode of transportation.

Although some commercial airlines were stowing freight on passenger aircraft as early as 1932, it was not until 1944 that the first regularly scheduled all-cargo DC-3 service was started by a certificated carrier. During World War II, the airplane demonstrated conclusively its capability of hauling almost every conceivable commodity, large and small. Following the War, the air cargo industry began to grow; and by 1947, 38 million ton-miles of freight were carried domestically. Economic soothsayers at all levels were optimistic about the future of the air cargo business.

2. EARLY FORECASTS AND PERFORMANCE

a. The Department of Commerce, Civil Aeronautics Administration, in a staff study issued in 1952, forecasted that by 1955 this growing domestic industry would be flying an estimated 400 million ton-miles of cargo. In contrast, some elements of the industry were very optimistic and had forecasted over a billion ton-miles by 1955. Actual growth, however, fell considerably short of this mark. The 350 million ton-miles flown in the year 1955, and slightly more than 600 million ton-miles in 1960, quite closely followed the more conservative forecasts.

b. Figure 1 is a graphic presentation of the air cargo industry's growth in the United States from 1950 to 1962 and indicates the nominal growth during this period. The growth patterns of four communities with cargo operations over this same period are illustrated in figure 2 on page 3.

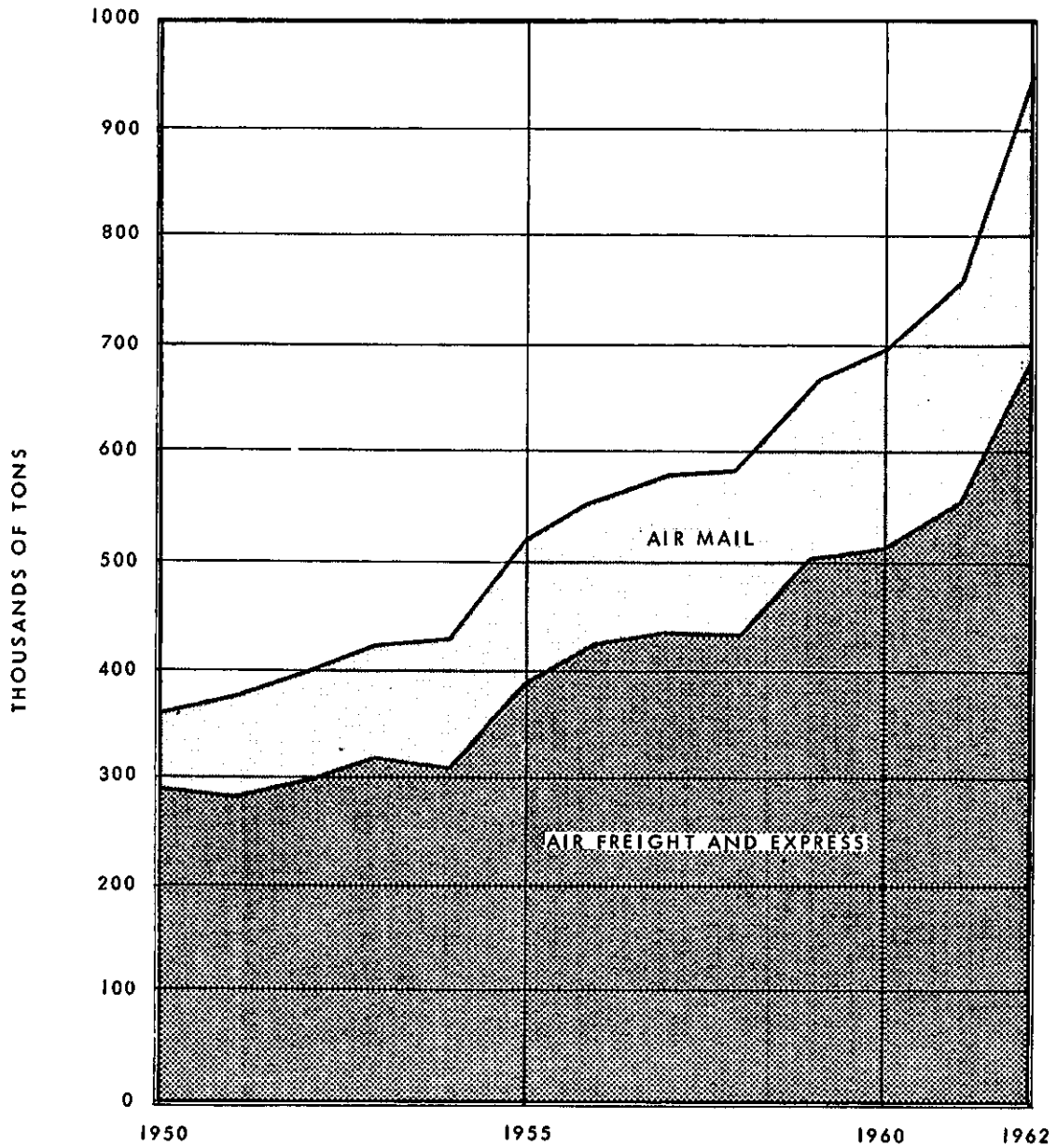


FIGURE 1. DOMESTIC AIR CARGO GROWTH.

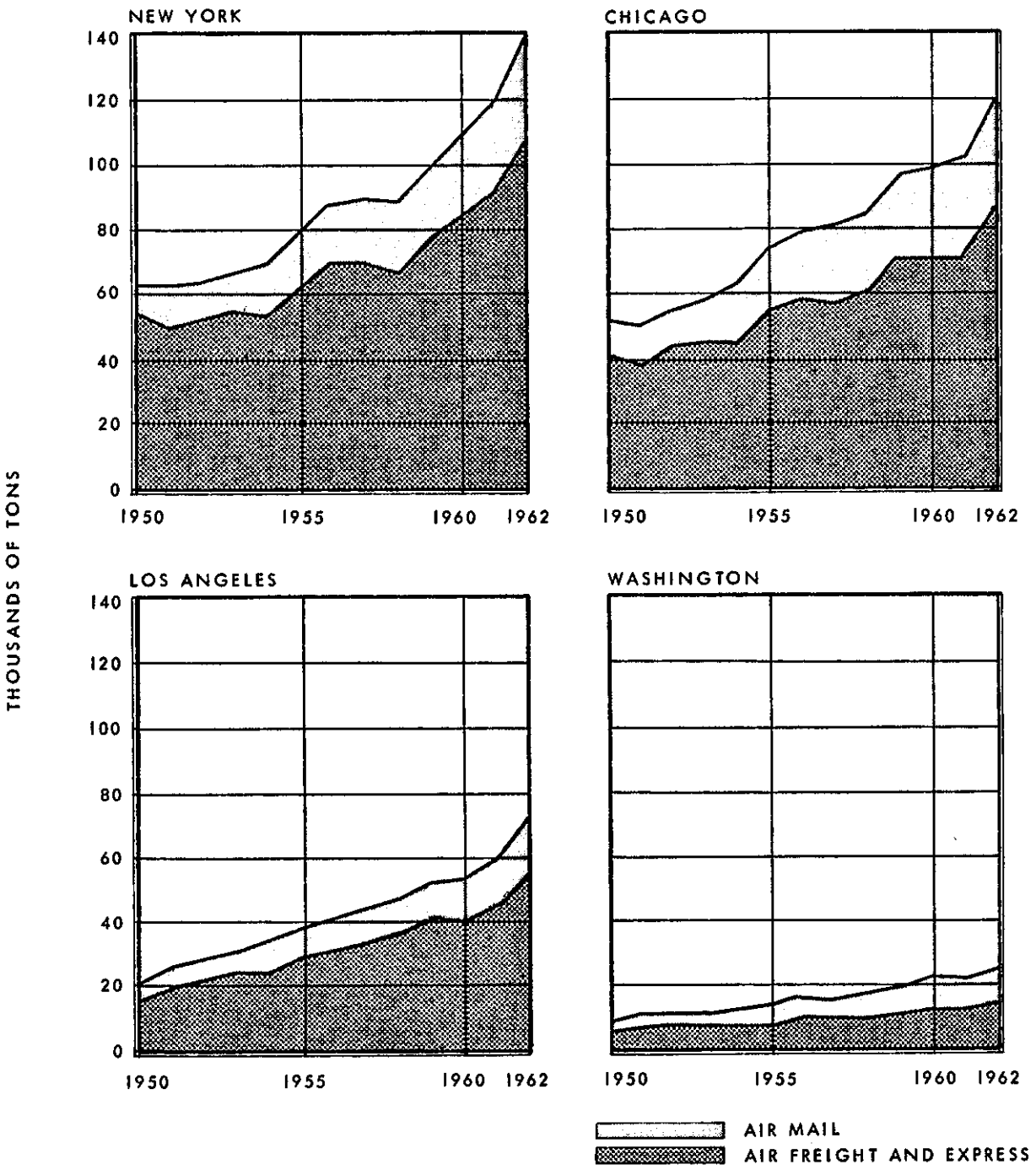


FIGURE 2. DOMESTIC GROWTH AT SELECTED COMMUNITIES.

SECTION 2. GROWTH POTENTIAL

3. MODES OF TRANSPORTATION. Air cargo business interests have been cautious in preparing plans for future growth perhaps because of early erratic growth and lag in reaching the more optimistic predictions of accomplishment. Unquestionably, a high potential for increased business exists. In 1961, only six-hundredths of 1 percent of all domestic intercity freight was shipped by air. Figure 3 illustrates intercity ton-miles, public and private, by surface modes of transportation for the two-decade period ending in 1960, as reported by the Interstate Commerce Commission.

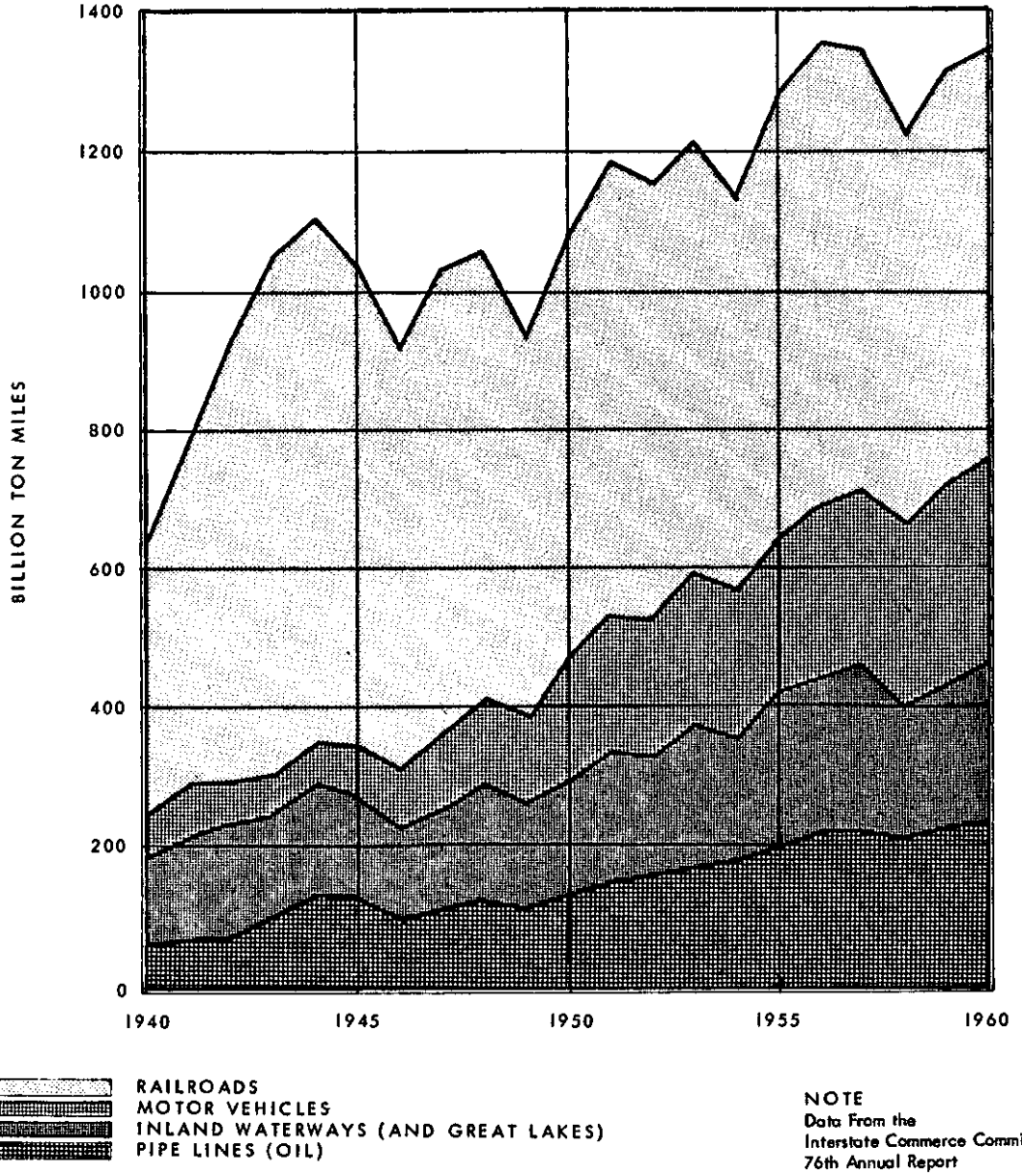


FIGURE 3. INTERCITY FREIGHT SURFACE MOVEMENTS.

4. TRENDS IN AIR CARGO TRANSPORTATION

a. The conversion by major air carriers to turbojet and turboprop aircraft which began in 1957 has had an effect on the air cargo industry. The baggage compartments of these combination passenger aircraft have several times the carrying capacity of like compartments of piston-type aircraft. These combination-type aircraft will continue to maintain an important role in the total supply of air cargo transportation. Many of the large piston-type aircraft have been converted for all-cargo operations. The all-cargo aircraft, Canadair CL–44, Boeing B707–321C, B707–323C, and B707–373C, and Douglas DC–8F, have been integrated into air freight service; the Boeing B707–320C and B707–331C have been on order for some time with delivery beginning this year; and the Lockheed L–300, commercial version of the C–141, is scheduled for delivery in 1966. This increased available capacity for transporting air cargo has caused aviation interests to re-evaluate total industry potential.

b. Together, the air carriers and aircraft manufacturers have embarked on a program of research on commodities being carried by surface transport. The types and densities of various commodities shipped, as well as their origin and destination, are being closely studied in an effort to develop a basis for better forecasting. Programs of study for more efficient management and materials handling systems have been initiated. The progress of the U.S. Air Force in its development of air freight facilities for the Military Air Transport Service is being watched closely by the aviation industry. Most of the studies being made are aimed at finding ways to reduce total operating costs which would place the air freight carriers in a better position to compete with surface transport carriers. Information available indicates that costs to the shipper are in the range of 3 cents to 8 cents per ton-mile by surface transport in contrast to an average of 25 cents per ton-mile for the same service by air.

c. Trends in the industry point to:

(1) Mechanized systems for ground handling of air freight.

(2) Integration of systems with ground and air transportation and materials handling operations.

(3) Containerization of shipments.

(4) Automation of documentation and communication in an effort to reduce indirect costs of terminal handling.

(5) Utilization of all-cargo aircraft designed specifically for the carrying of air cargo and capable of handling larger loads, traveling greater distances, and operating at much lower systems costs.

5. GROWTH FORECASTS

a. Some forecasters remain optimistic about the future growth of the air cargo industry and are predicting a rate of growth of as much as 25 percent per year during the decade ending in 1970. This would indicate that there will be about 6 billion ton-miles of air cargo flown during the year ending this period of forecast—a tenfold increase in 10 years. Should such forecasts prove to be correct, airports in some of our large hub communities will be noticeably affected.

b. The Federal Aviation Agency is considerably more conservative in its forecast and predicts 2 billion domestic air cargo ton-miles for 1970—a fourfold increase. Figure 4 is a graphic presentation of the future growth of air cargo as viewed by the FAA.

c. In sharp contrast to the domestic situation, developments in the air cargo industry for foreign trade are moving more rapidly. In 1960, carriers of overseas shipments reported a 40 percent increase over the previous year in ton-miles of freight and express transported. Major airlines involved are taking steps to maintain this growth by planning large-scale improvements in freight-handling facilities.

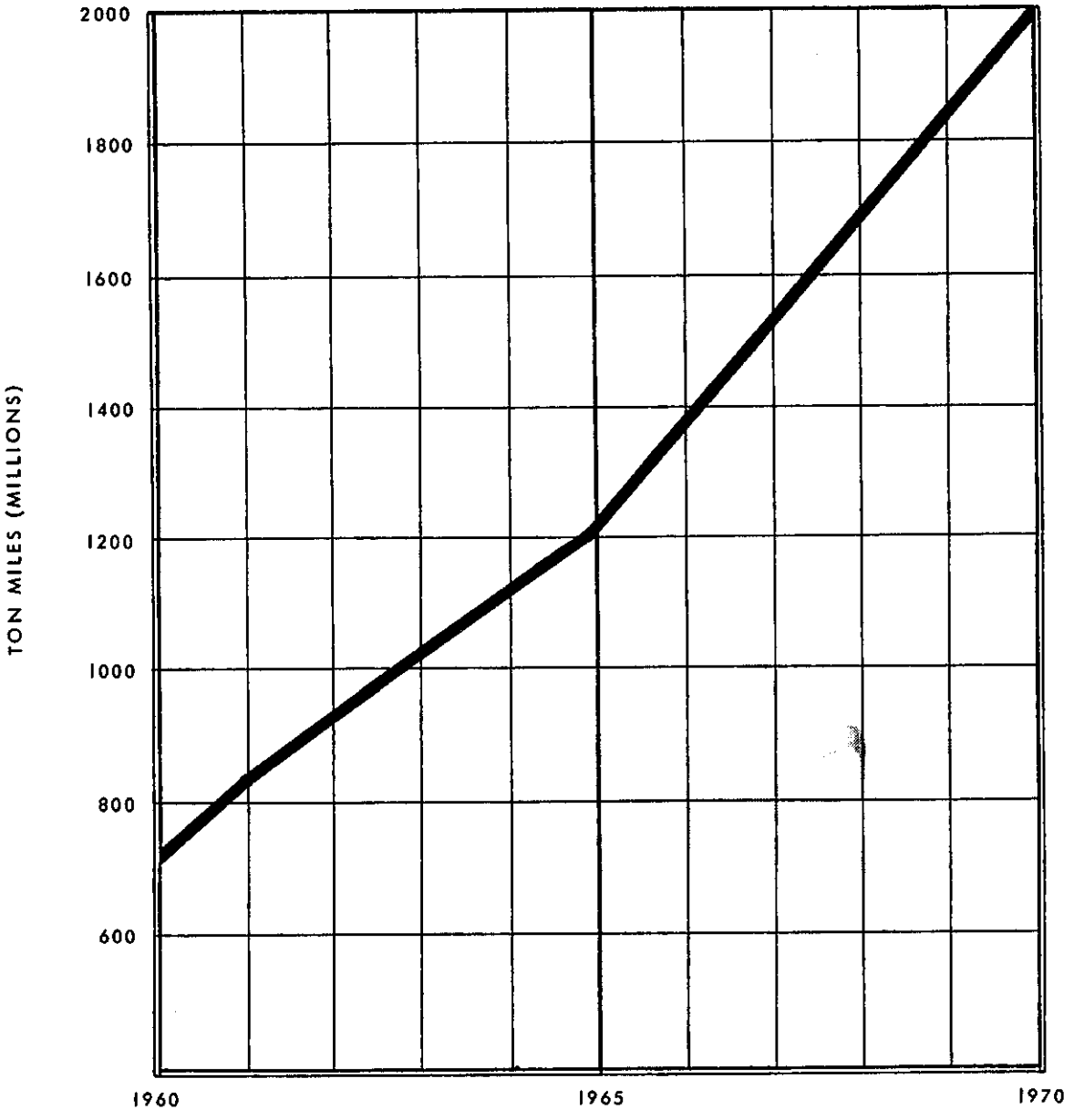


FIGURE 4. AIR CARGO PROJECTION, FAA.

SECTION 3. COMPONENTS OF THE INDUSTRY

6. MAJOR COMPONENTS. There are five major components of the air cargo industry which must be considered and which influence analysis of airport cargo facilities. A number of components may be found to be associated with the air carrier facility, particularly in the case of an all-cargo airline. The major components are the air carrier facilities with associated trucking company facilities, air freight forwarder facilities, air express facilities, and air mail facilities. These are discussed in terms of their associated facilities and their distinguishing characteristics in order to give the architect-engineer background information.

7. AIRPORT MAIL FACILITY

a. The volume of air mail processed averages approximately one-third that of air freight and express. The Post Office Department offers to the shipper of small packages a fast, economical, and reliable service through Domestic Air Parcel Post. It generally is cheaper to ship packages of 2 pounds or less through this service because other services have minimum rates for small shipments generally in excess of the Post Office Department's rate.

b. The use of the airways for sending mail has been increasing steadily. Indications are that the increase will continue. Procedures for handling mail are continuously being evaluated by the Post Office Department. Improvements, as made, will affect revisions in space requirements for mail facilities on the airport. Present plans call for greatly expanded mail-handling facilities at a number of the major airports in the country.

c. Air mail and air parcel post are tendered to air carriers for priority loading and unloading at the destination. First-class-mail-by-air is placed on combination aircraft for "topoff" loading space available to an acceptable aircraft weight. Although the greater percentage of air mail and air parcel post is transported on combination aircraft, there is some use made of all-cargo equipment. To provide the service to the patron desired by the Post Office Department, fast handling in the airport mail facility and in exchanges with air carriers is most important. It is frequently necessary that volume dispatches to a particular flight bypass the airport mail facility. Thus, the airport mail facility needs to be conveniently located with access to both the airline cargo facilities and the passenger terminal loading apron. Adequate access roadways not crossing runways or taxiways are most important.

d. Although the volume is not as great at airports which do not have an airport mail facility, fast and efficient exchange with air carriers at a central point is highly desirable. Such a facility could consist merely of a truck dock for this purpose with the capability of storing mail available in advance of flight or truck departure. This area should be centrally located and readily accessible to aircraft parking aprons. The functions to be accomplished include receiving and dispatching to carriers, coordinating post office truck movements, and overseeing air carrier postal activities.

8. AIR EXPRESS FACILITY

a. Air express is handled by the Air Express Division of REA Express (Railway Express Agency) and is forwarded on combination and all-cargo aircraft of the certificated airlines. Packages are picked up directly from shippers and delivered to consignees in all cities and principal towns. There are differences in the rate structures of minimum charges which determine whether it is more economical to ship packages by indirect or direct carriers. Air express is loaded on aircraft at a priority below passengers rather than on a first available space priority as is air freight and first-class-mail-by-air. Statistics from the Civil Aeronautics Board indicate that air express averages approximately 10 percent of domestic air freight tonnage.

b. The majority of air express shipments are placed on combination aircraft. The movement of shipments from the air express facility to the cargo processing facilities of the air carrier is a transfer operation. This processing is necessary to maintain efficiency in aircraft loading. The air express facility needs to be conveniently located

with access to both the air carrier cargo facilities and the passenger terminal loading apron.

9. AIR FREIGHT FACILITIES

a. Nonprohibited shipments of any size, weight, and shape can be sent by air, limited only by dimensional characteristics of the aircraft and its gross weight limitations. Almost all scheduled airline flights carry air freight. Also, all-cargo aircraft are now operated between most major cities with either direct or connecting trucking service available to points beyond communities served directly by air. The customer has a choice of air freight services—the services of an air freight forwarder or the direct carrier service of an airline. When using the air carrier, he may request door-to-door service, or he may deposit the shipment at the airport of origin and have the consignee pick it up at the airport of destination. This latter type of service is generally known as an airport-to-airport service.

b. The interrelationships involved in the various kinds of air freight facilities are not as clear cut as the relationships described in paragraphs 7 and 8. Much depends upon the individual circumstances at an airport and the number of possible services available. The overriding factors affecting these interrelationships are the number of airlines operating passenger services, the number of airlines operating separate cargo facilities, and the number of competitive systems of ground transportation to and from the airport for air freight.

10. AIR FREIGHT FORWARDER FACILITY

a. The air freight forwarder operates as an indirect carrier under authorization of the Civil Aeronautics Board and provides all services except the direct operation of aircraft. Since the forwarder is not limited in regard to routes and points served, its tariffs are filed and approved for worldwide services. The forwarder provides complete transportation service from shipper to consignee. The amount of air freight generated by the forwarder is relatively high. Of the total domestic freight revenue, approximately $160 million for 1960, forwarders grossed approximately $35 million or approximately one-fifth of airline domestic freight revenue.

b. The operations of the forwarder, more than one of which may be located within the airport complex, generally consist of consolidating package units for shipment and transferring these shipments from his facility to those of the airlines. The 1960 statistics for larger forwarders indicate that they received almost 3.5 million shipments and consigned approximately 92,000 consolidated shipments to the airlines. Since the forwarder has basically a transfer and consolidation operation, a large percentage of the releases to the airlines will pass through an air carrier cargo facility with the remainder going aboard combination aircraft. Thus, convenient access to both the air carrier cargo facilities and passenger terminal loading apron is essential.

11. AIR CARRIER CARGO FACILITY

a. The facilities of the airlines for handling air cargo are the core of cargo operations and the center about which the other related services and activities are located. The purpose of this discussion is to establish the relationship of all other components of the industry to the direct carrier actually accomplishing air cargo movement.

b. Airport-to-airport service in which shipments are deposited at the air carrier cargo facility has been identified as one type of air freight service. To satisfy demands of customers for door-to-door service, the airlines normally do not operate a fleet of trucks but contract with truckers to have this work done for them. This is accomplished through Air Cargo, Inc., an organization owned by all of the dometic airlines. Air Cargo, Inc., arranges for one trucker to handle all door-to-door shipments of all airlines at a particular airport at a given rate.

c. The relationship of contract truckers to air carriers is influenced by the type of air carrier operation. Normally, air carriers providing door-to-door service have established sufficient sales volume of air freight to have warranted cargo facilities. The type of operations conducted by the trucker is influenced by the number of air carrier cargo facilities. The requirements of the truckers for the shipment-sorting operation to the airlines and for delivery to local customers may be quite closely associated with the operations within the air carrier cargo facilities. However, where there are a number of separate air carrier cargo facilities, a separate air cargo trucking facility should be investigated.

CHAPTER 2. AIR CARGO HANDLING

SECTION 1. CARGO FLOW

12. IMPORTANCE OF TIME

a. An aircraft not flying is not using its earning capacity. Present jet-cargo aircraft have a gross earning potential of over $4,000 per hour. Therefore, groundtime (the time required to unload, load, and service) is a critical factor in air cargo operations. Systems in use in the past for loading and unloading aircraft generally required much manual handling of freight. New and more efficient loading systems and equipment are being provided by the industry to reduce groundtime to a minimum and to reduce the time and cost of loading, unloading, and processing of shipments.

b. Background information on materials flow and materials handling equipment and systems is presented in the pages that follow. It is most important that the architect, the engineer, and others responsible for the planning and design of airport cargo facilities consult with the air carriers involved from the inception of the program and throughout its development to determine specific requirements of individual materials handling systems. Knowledge of the technique of packaging and materials handling is essential in designing functionally efficient air cargo facilities.

13. ENPLANING AND DEPLANING CARGO

a. In the sequence of operations, the first step is to unload the air cargo from trucks as depicted in figure 5. The shipment is accepted and weighed, and necessary data recorded. Information about weight and destination of the shipment permits scheduling for flight and load placement. Marked packages are moved to a staging area to be processed for loading on the aircraft.

b. The removal of cargo from the aircraft initiates a process which is the reverse of enplaning with disposition of the shipment dependent upon final destination. If the airport is the final destination of the shipment, it is moved to an area where it awaits pickup. If the airport is an intermediate stop and packages are to be transferred to another aircraft, the shipment is again moved into the load-staging area.

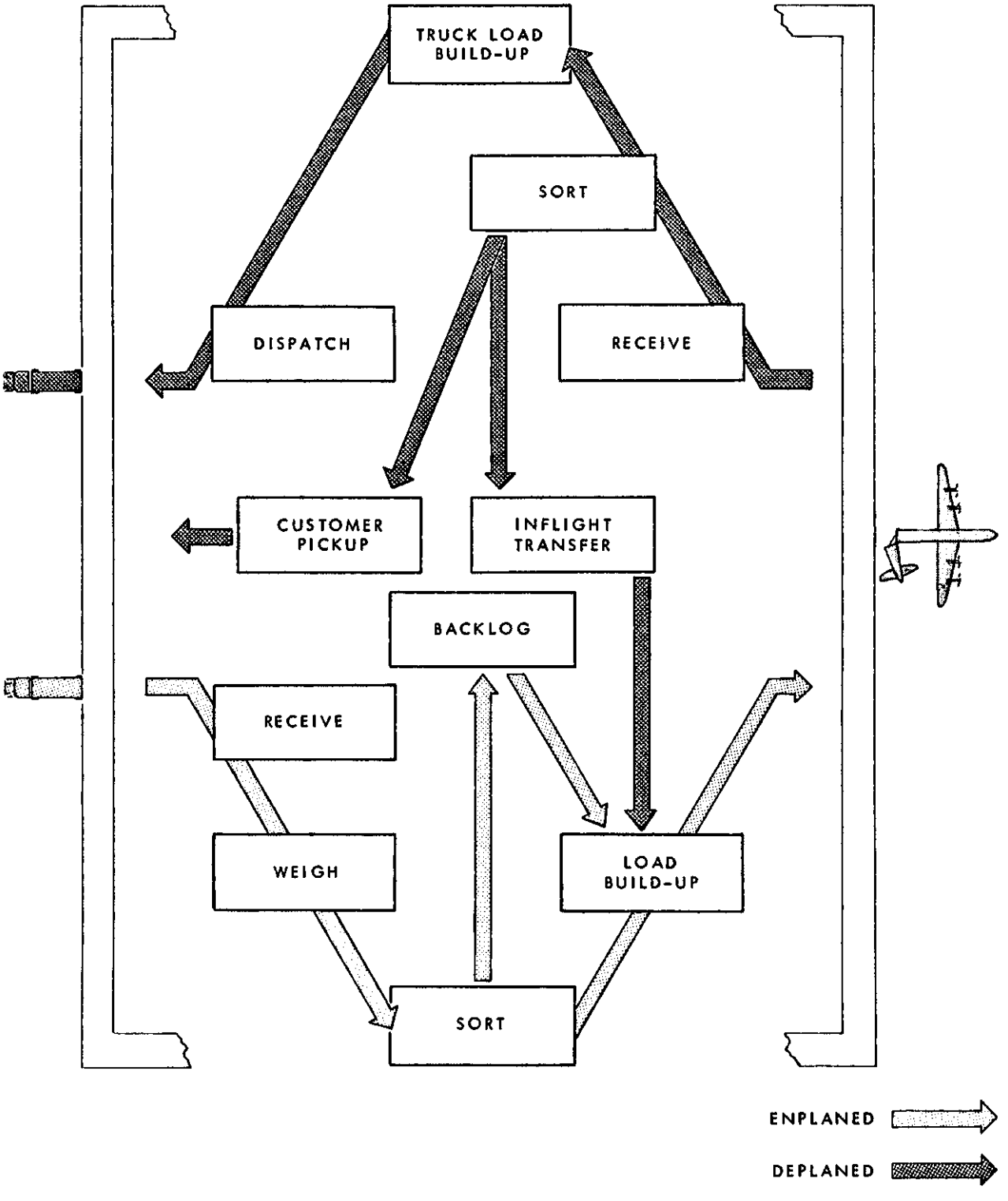


FIGURE 5. MATERIALS FLOW.

SECTION 2. CARGO HANDLING EQUIPMENT

14. BASIC CONSIDERATIONS. Techniques used in moving shipments from one area to another within the facilities and for load build-up vary considerably depending on the nature of the commodities and the total quantity of air cargo being shipped from a community. Shipments may vary from small fragile packages to bulky and heavy items. Equipment of various types is used to handle freight.

15. WEIGHING EQUIPMENT. Scales for weighing shipments may be portable or built into the materials handling system. Since most packages moving through air cargo facilities weigh less than 300 pounds per unit, this capacity scale would normally be adequate. A larger auxiliary scale may be required depending upon the nature of air freight handled.

16. UNITIZING EQUIPMENT. Many small packages can be more efficiently handled if unitized, that is, consolidated into a single unit or group of units. Unitizing may be accomplished in the cargo processing facility or may be done by the customer, and the packed unit brought to the facility ready for loading on the aircraft.

a. **Pallets** are portable platforms on which shipments are stacked. They are generally constructed so they can be moved by a forklift truck or other device. Warehouse pallets presently in use are about 30 inches by 40 inches, but these are generally being replaced. Larger pallets, 80 inches by 108 inches and 88 inches by 125 inches, have been adopted for the air cargo industry. A flexible pallet, used in conjunction with a pallet support, also has been designed. This pallet may be used as an integral part of the aircraft load. Dollies are pallets or pallet supports on wheels. They may be moved manually or by a mechanical system. Figure 6 shows a number of types of pallets and a dolly.

b. **Containers** most commonly in use today are of two general types. One type is designed to be stowed in the belly compartment, or underside, of large jet aircraft. These are normally made of aluminum and shaped to fit the lower portion of the aircraft fuselage. The other type of container is a modification of the pallet, having sides hinged to the pallet or in separate sections that fit together. Various types of containers are illustrated in figure 7 on page 13.

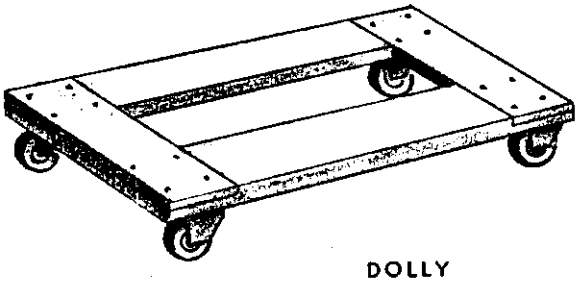
17. PIT ELEVATORS. Hydraulic lifts equipped to support pallets or containers are being used to assist in unit build-up. By use of the lift, it is possible to keep the top of the load of the stack at a satisfactory working level by lowering the stack below the floor. After the cargo stack is complete, it is returned to the floor level.

18. MATERIALS MOVING EQUIPMENT. Many types of equipment are used to handle cargo. Handling techniques employ not only mobile equipment such as handtrucks and forklift trucks but also conveyors and other devices which may be installed as part of an integrated freight handling system.

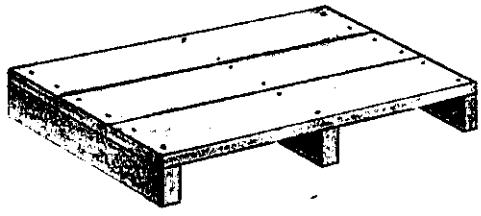
a. **Handtrucks** are generally employed in the storage area to move relatively small loads. The operation that processes only nominal amounts of air freight per day would have little need for anything more than this basic type of handling equipment. Both two-wheel trucks and four-wheel trucks are in general use. Two-wheel trucks normally are limited in capacity to less than 2,000 pounds. Four-wheel trucks are designed for capacities up to 5,000 pounds. Several may be hooked together in train fashion and moved by a motorized tug.

b. **Forklift trucks** vary in size with capacities from 1,500 pounds to 20,000 pounds. The forklift offers more flexibility for the movement of cargo than the handtruck because of its capability for moving loads vertically. It is an effective device for moving loaded pallets from the processing facilities to the floor level of the aircraft. However, it is limited in the size of pallets it can carry.

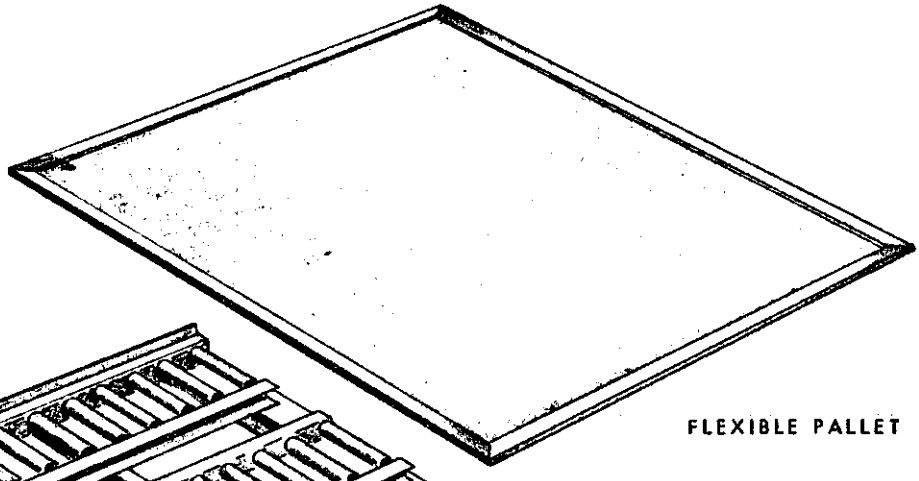
c. **Scissors lifts** may be utilized in transporting freight from the cargo building to the aircraft or as a lifting device in the loading operation. This equipment can transport much larger loads than the forklift truck. Its use is expected to increase in freight handling.



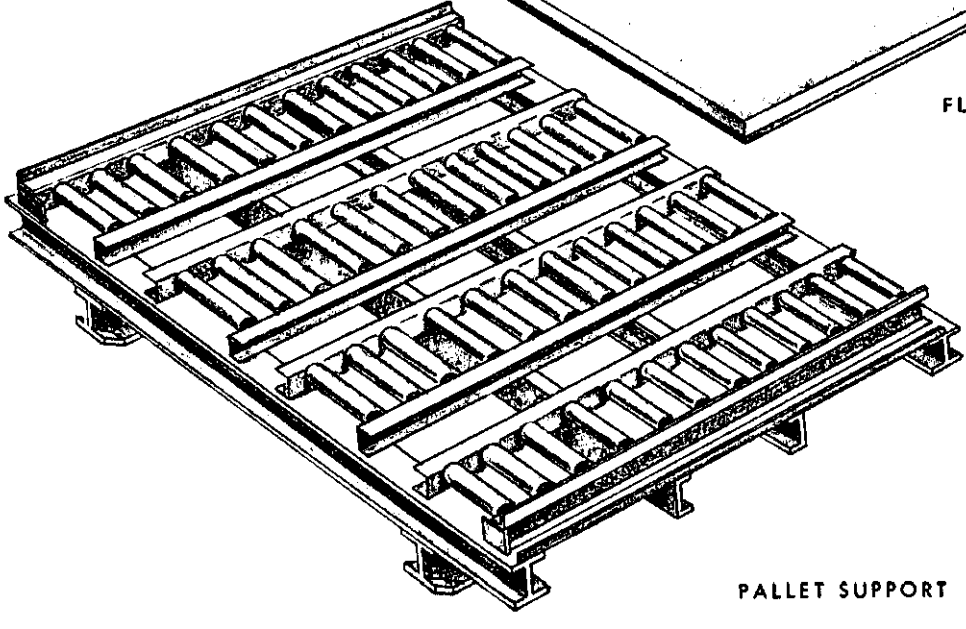
DOLLY



PALLET

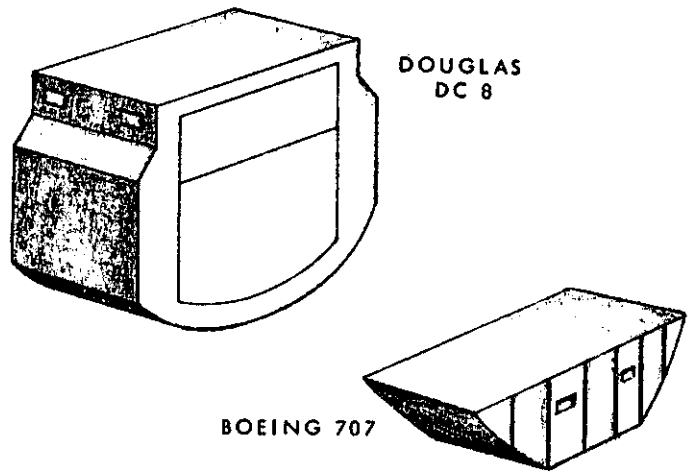


FLEXIBLE PALLET

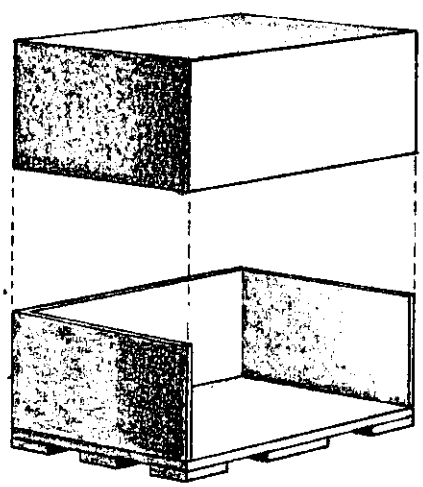


PALLET SUPPORT

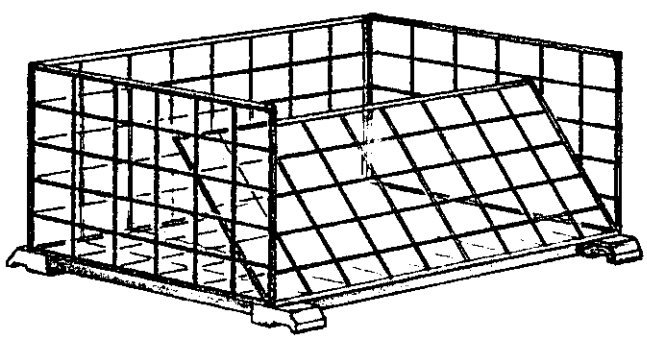
FIGURE 6. PALLETS AND DOLLY.



JET AIRCRAFT "BELLY" CONTAINERS



THREE-SIDED CONTAINERS



COLLAPSIBLE CONTAINER

FIGURE 7. CONTAINERS.

d. **Overhead hoists** have been used to provide efficient movement of very heavy shipments. Complete coverage can be attained by means of track-mounted traveling girders spanning the entire width of the processing area. With this arrangement, movement of the hoisting equipment is possible in any direction; and there is complete control of the item being handled. The installation of such equipment, however, is costly.

e. **Conveyors** may be used effectively in materials handling. They may consist of a series of rollers, endless belts, or a continuous chain as illustrated in figure 8.

(1) *Roller conveyors* may be gravity activated or motor driven. They may be portable or fixed The portable roller conveyor is most often used in loading or unloading at the truck dock. It may also be used within the aircraft or the processing facility. Unit conveyors, each 10 feet in length, can be joined together when the distance requires a longer run. Gravity type roller conveyors are most ideally suited for unloading or loading of objects which must be moved to a lower level. Motor driven roller conveyors, generally known as live conveyors, are advantageously used when objects must be moved a distance greater than 25 feet and the path of travel is not to a lower level.

(2) *Belt conveyors* transport items on a continuous motor driven belt. They may be used advantageously for moving objects from a lower to a higher level. They may be employed as a portable unit or incorporated into a conveyor system acting in concert with other types of conveyors. Portable units are often mounted on vehicles and used to load or unload freight from an aircraft.

(3) *Dragline conveyors* or tow-type conveyors are continuously moving chains to which carts or trucks are secured. The chain may be placed in a track recessed into the floor or it may be moved on an overhead beam. The floor recessed chain, though more costly to install, eliminates the need for overhead suspended moving parts with the attendant safety hazard.

19. CONVEYOR SYSTEMS. These systems, used for the handling of materials, are arrangements of various types of conveyor components and are considered as a key item in an integrated materials handling system. A system may be an "open system" or a "closed system." Open systems consist of continuous conveyor lines on which it is possible to place or remove an article at any point. If the article is not removed, it will continue around and may be removed at any time without affecting other items in the line. The towveyor, by the nature of its operation, can only be considered an open system. Closed systems contain branchoffs and one or more dead ends.

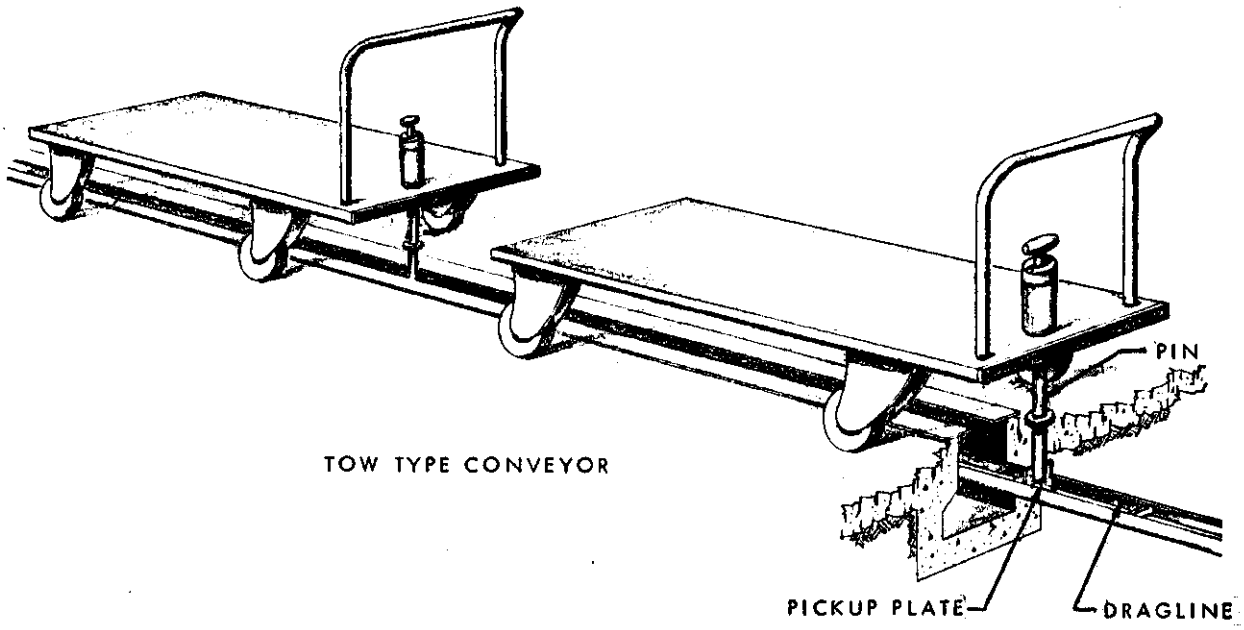
20. INTEGRATED SYSTEMS. Materials handling equipment may be integrated in such a way as to incorporate a combination of the closed and open systems and a number of diverse types of equipment. Figure 9 on page 16 illustrates various types of conveyor-equipment systems. A system may include a towveyor, or roller or belt conveyor equipment in an integrated arrangement for handling of freight. Large-volume freight operations can be handled most efficiently by integrating both the truck and the aircraft into the materials handling system of the freight facilities.

21. PILOT SYSTEM

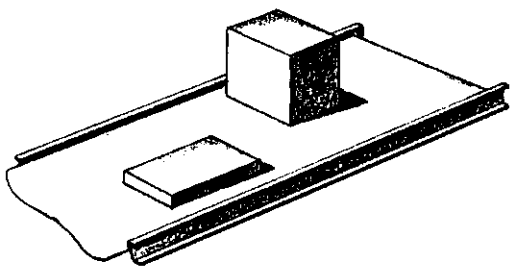
a. A system has been developed for the U.S. Military Air Transport Service (MATS) bases using conveyor lines in the building and conveyorized floors, rollers installed as an integral part of the floor, in both surface and air transport units. Where hundreds of tons of freight are moved daily, it can be processed in minutes instead of the hours required for a nonintegrated system.

b. When a truck pulls up to the dock, a conveyorized arm or telescoped roller conveyor is used to reach the floor of the truck. A push bar on the truck is activated by a winch within the truck which moves the entire contents from the conveyorized floor of the van onto the conveyorized arm. The freight is then moved on to the conveyor system where it is to be processed to an assigned aircraft flight and section. Freight is stored on branch conveyors until it is time for load build-up or to palletize freight. All freight is unitized on special pallets and is moved on to the conveyor lines designated by destination and section number. In this way, loads for each flight can be set up in sequence automatically.

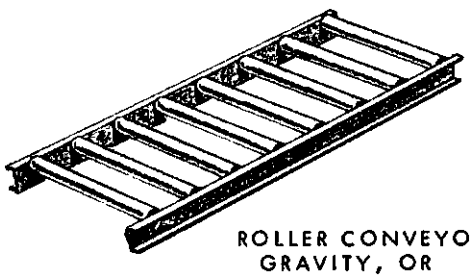
c. Pallets are guided throughout their travel by tracks and slide on roller conveyors to a final position on the floor of the aircraft. All conveyors are designed into a common system so that it is possible to unload an aircraft while freight to be enplaned is prepared for shipment. Pallets con-



TOW TYPE CONVEYOR



MOTORIZED BELT CONVEYOR



ROLLER CONVEYOR,
GRAVITY, OR
MOTOR DRIVEN

FIGURE 8. CONVEYOR TYPES.

taining loads up to 10,000 pounds are moved by mobile loading equipment having a roller-conveyor-type floor. These loaders are designed to move one or more pallets depending upon the requirements of the system complex. Unitized freight can be loaded on the aircraft in a time approaching that required for refueling and servicing of the aircraft.

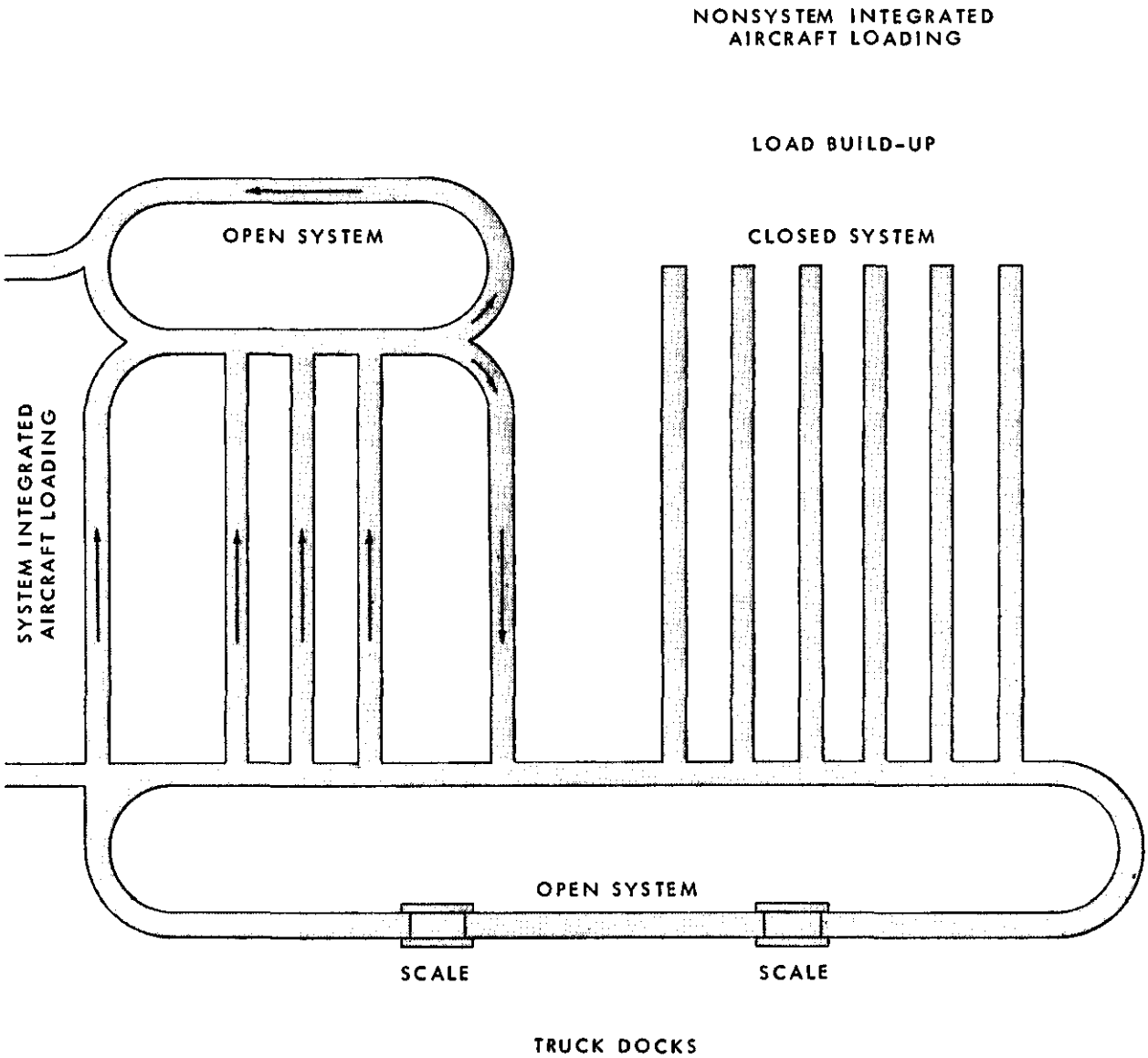


FIGURE 9. CONVEYOR SYSTEMS.

SECTION 3. AIRCRAFT LOADING

22. MAJOR FACTORS. Those factors associated with aircraft loading also influence the planning of operations in air carrier cargo facilities. Four major points to consider in analysis of materials handling systems and building-space requirements are payload factors at takeoff, aircraft center of gravity or weights and balances, destination and routing, and aircraft loading characteristics.

23. PAYLOAD. The payload factor is the ratio between tons of freight actually loaded and the tons of freight permitted to be loaded on the aircraft. An aircraft capable of a takeoff payload of 30,000 pounds but carrying only 18,000 pounds is operating with a payload factor of 60 percent. In such a case, the aircraft is not earning its full potential. It is important that loading permit as high a payload factor as practicable.

24. AIRCRAFT CENTER OF GRAVITY. Federal Aviation Regulations establish performance requirements for aircraft. Control of weights and balances, thus the aircraft center of gravity, is essential to the proper performance of the aircraft. In all-cargo aircraft, the interior of the fuselage is divided into sections. The manufacturer designates the maximum allowable weight which may be stowed in each section considering floor loading limits and proper securing of freight for safe performance of the aircraft. An example of a longitudinal cross section of an aircraft fuselage indicating station divisions and the maximum allowable load for each station is illustrated in figure 10. This type of chart is used in establishing aircraft loading.

25. DESTINATION AND ROUTING

a. For an aircraft scheduled to fly from one terminus to another, loading is quite different from that for a flight with intermediate stops. In the former case, only weights and balances must be considered; but in the latter, it is necessary to consider also the sequence loading. When freight must be removed at intermediate stops, loads must be arranged so that the deplaning freight can be removed easily without disturbing freight designated for other points. Freight also may be taken on at these intermediate locations to replace that which was removed. When replacement loads are not provided, the freight retained on the aircraft may have to be rearranged to assure proper distribution of loads.

b. The destination of the aircraft is a determinant in the amount of fuel that is carried. Generally, an aircraft scheduled to fly a short distance may be capable of carrying a greater amount of freight than if it were to fly a long, nonstop route. However, the amount of payload that can be substituted for fuel is limited by the structural characteristics of the aircraft. This is an important consideration that influences the preparation of aircraft loads.

26. AIRCRAFT CHARACTERISTICS

a. The location of the aircraft loading entrances is a consideration in determining the preparation of materials handling. All-cargo aircraft may be loaded from the side, at either end, or both ends. On aircraft that are side loaded, the large freight doors are usually on the left side of the fuselage. The swing-tail all-cargo aircraft is an innovation in design now used.

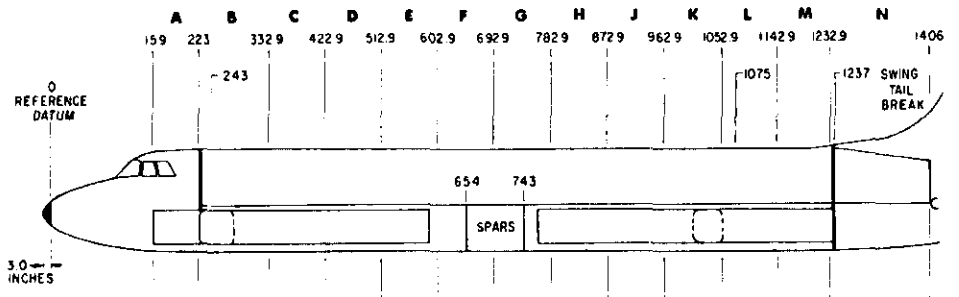
b. The floor height of the aircraft varies from 44 inches, which is a "truck bed" floor height, up to 12 feet in which case the aircraft is known as "high floor" aircraft. It is possible to load or unload a "truck bed" floor height aircraft directly from the freight truck and to design the entire system for this common height. Some means of lifting the freight to the floor level of a "high floor" aircraft are needed.

c. Controlling the proper load distribution in combination aircraft is not as simple as in the all-cargo configuration. Generally, cargo is placed in baggage compartments in the underside of the passenger aircraft as "topoff" load. The number of passengers and their baggage will vary considerably and controls the amount of cargo that may be

stowed in the baggage compartment. This variance also makes the maintenance of proper load distribution more complex.

d. For piston-type combination aircraft, the space designed for cargo and baggage has not allowed for an efficient mechanized system of containerized loading. Consequently, it is necessary to load freight and baggage manually. However, the amount of space available for baggage in such an aircraft is relatively small and the time required to place a load on the aircraft is not critical.

e. On some large jet combination aircraft, baggage and cargo loaded in the underside of the plane are carried in special containers. These containers, shaped to fit the aircraft fuselage, slide into the lower compartment of the airplane and have a capacity of approximately 1,500 pounds. They are preloaded in the air cargo facility, delivered to the aircraft on the loading apron, placed aboard the aircraft by means of a special hoist, and installed in the baggage compartment. With such a system, the freight is offloaded and onloaded within the time it takes to deplane and enplane passengers and to refuel the aircraft.



NOTE
Between Sta 223 and 243 Above Floor is an Equipment Access Area, No Cargo is Loaded.

	A	B	C	D	E	F	G	H	J	K	L	M	N
MAXIMUM COMPARTMENT LOAD INCLUDING UNDERFLOOR COMPS (POUNDS)	1600	8250	8250	8250	8250	8250	8250	8250	8250	8250	5757	5170	3000
ACCUMULATED LOAD FORWARD/AFT OF THESE STATIONS NOT TO EXCEED (POUNDS)	⇐ 1600	⇐ 9300	⇐ 15,600	⇐ 21,900	⇐ 28,200	⇐⇒ 36,325	⇐⇒ 36,325	⇒ 30,515	⇒ 23,620	⇒ 17,320	⇒ 11,020	⇒ 6760	⇒ 3000
COMPARTMENT CG POSITIONS AFT OF REFERENCE DATUM ABOVE FLOOR (INCHES)	191	278	378	468	558	648	738	828	918	1008	1098	1188	1321
COMPARTMENT CG POSITIONS AFT OF REFERENCE DATUM BELOW FLOOR (INCHES)			385			X			1006				
MAXIMUM LOCAL FLOOR LOADING ABOVE FLOOR (LBS/SQ FT)			200			300			200				150
MAXIMUM LOCAL FLOOR LOADING BELOW FLOOR (LBS/SQ FT)			75			X			75				X
MAXIMUM LOADING MAIN COMP AND UNDERFLOOR COMPS (LBS/FT RUN)	300		840			1100			840			480	215
FRAME STRENGTH LIMITATIONS (LBS/FT RUN)	300					1100						660	300
MAXIMUM LOADS IN LOWER COMPS (POUNDS)			10775 EVENLY DISTRIBUTED			X			11563 EVENLY DISTRIBUTED				X

NOTE
Data Taken From Canadair Integrated Cargo System 2nd Edition October 1960

FIGURE 10. AIRCRAFT LOAD LIMITS.

CHAPTER 3. AIRPORT CARGO CENTER AND ITS BUILDINGS

SECTION 1. AIRPORT CARGO FACILITIES

27. INTERRELATIONSHIPS OF FACILITIES. As the air cargo industry grows, the complex on the airport designed to handle air cargo becomes a significant element in airport planning and design. The discussion of the various components of air cargo industry in chapter 1 explained in part the essential interrelationships of the facilities that may be necessary at an airport cargo complex. These facilities must provide for the efficient transfer of air cargo between surface transportation and aircraft. For larger airports, the complex may include a number of air carrier cargo facilities or multiple-occupancy buildings.

28. DESIGN CONSIDERATIONS

a. The elements that compose the airport cargo center facilities and establish their character, size, and configuration will depend on the level of activity of the air cargo industry in the community served. The architect-engineer should work closely with the air carriers, air freight forwarders, truckers, and airport management to determine what is needed including any special requirements peculiar to these facilities. The resulting design must satisfy present requirements and provide the flexibility necessary for future expansion. Buildings should be oriented, and land should be available to enable a logical expansion plan. This is discussed in section 3 of this chapter.

b. The air carrier cargo facility is the core of the cargo center, and the emphasis in this chapter is on that facility. It may be treated as a single building or combination of elements under one roof sufficiently integrated to permit operation as a single entity.

c. The design program, in the architect's vocabulary, denotes the building users space requirements. It is one of the basic essentials for a successful solution to the design of any building. Fundamental considerations in developing a program are the elements of the building, the amount of space needed by each element, and the relationships between the spaces.

SECTION 2. AIR CARRIER CARGO BUILDINGS

29. ELEMENTS OF THE BUILDING

a. An air carrier cargo building may be planned for single or multiple occupancy. The type of occupancy normally will depend on the potential for air cargo industry growth in the community being served and the volume of business generated by each of the airlines. At airports where there are a number of carriers, each generating only nominal amounts of freight daily, a multiple-occupancy building can provide adequate space to satisfy the needs of all. Single- or double-occupancy buildings with adequate aircraft apron space should be considered for those air carriers that operate all-cargo schedules and handle larger amounts of air freight.

b. There are four major functional elements to consider in the design of the air carrier cargo building. These are the freight-handling areas, administration area, personnel and customer accommodations, and service facilities. Figure 11 indicates diagrammatically the space relationships for functions within the air carrier cargo facilities. Airport cargo buildings should be designed for planned expansion in both length and depth, where economically feasible, and fixed support facilities so located to avoid interference with such expansion.

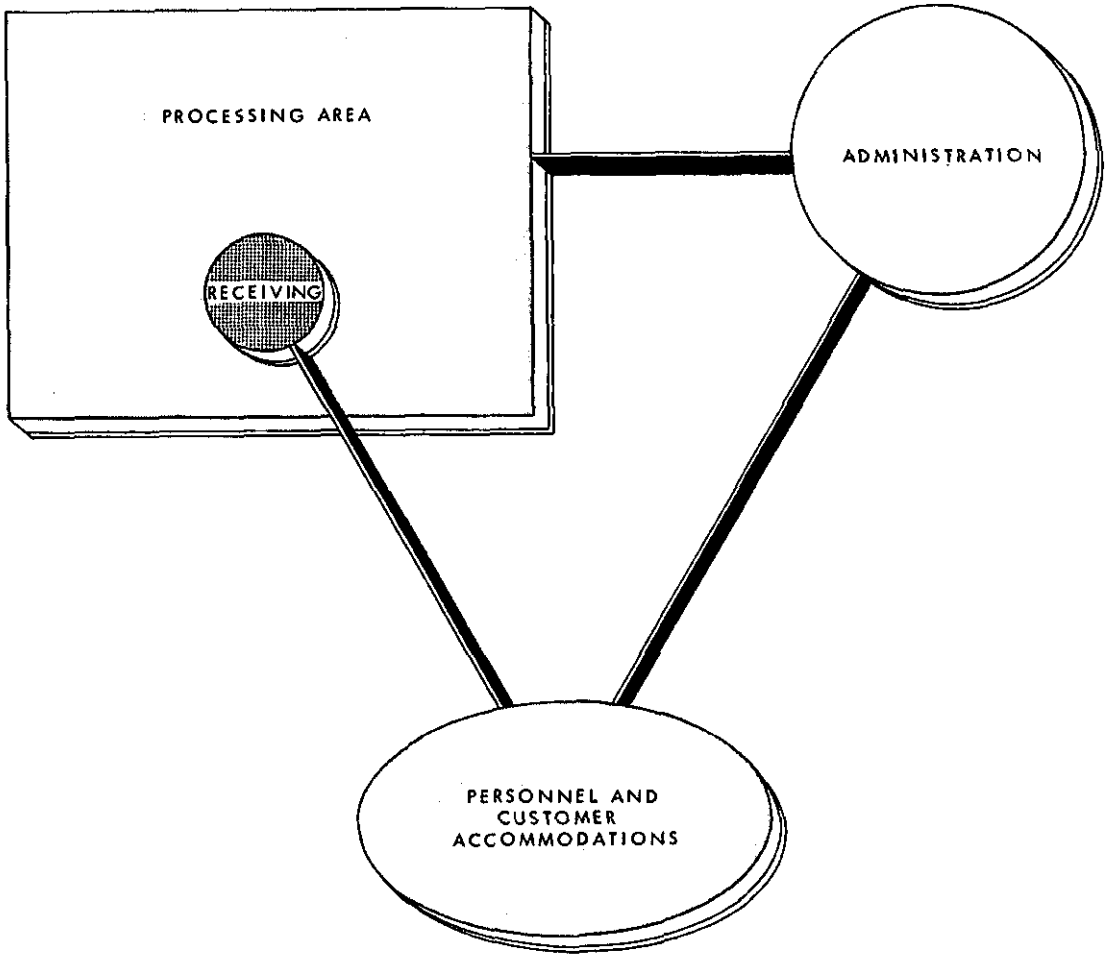


FIGURE 11. SPACE RELATIONSHIPS WITHIN BUILDINGS.

30. TRUCK DOCK FACILITIES

a. There must be a sufficient number of truck stations to serve truckers, air freight forwarders, and others for both incoming and outgoing shipments. In addition to truck dock positions, consideration should be given to providing facilities for the airport-to-airport customers who use other than trucks to deliver or pickup small shipments.

b. The number of truck dock spaces will vary with the airline operation and the community. To determine the optimum number requires detailed analysis of truck arrival in a peak hour, the service time at the dock, and the acceptable waiting time for those experiencing delays.

c. The minimum number of dock spaces required for incoming trucks can readily be determined. Assume for example a normal "stripping" or unloading rate at each dock space of approximately 5,000 pounds per hour. This rate includes time allowed for delays and spotting of vehicles. For an inbound volume from trucks of 90,000 pounds of freight and a time allowed for "stripping" vehicles of 3 hours, the unloading would have to be accomplished at the rate of 30,000 pounds per hour. Thus, there would be a requirement for 6 truck spaces at the dock for this operation.

d. The width of each truck station should be a minimum of 12 feet to allow for parking of large vehicles. Building door openings at each station should be a minimum of 10 feet wide by 10 feet high. Extensive open platforms are not recommended because freight left in the open is subject to pilferage and damage from inclement weather. Protection from the weather for freight and personnel during stripping or loading operations should be provided by an overhang canopy of at least 5 feet. Clearance above the top of the parked freight van should be approximately 18 inches.

e. Building floor heights may vary from 44 to 47 inches above grade. There are a number of leveling devices for accommodating truck bed heights ranging from 30 inches for a pickup truck to 50 inches for a large tractor-trailer.

31. PROCESSING AREA

a. Receiving, sorting, weighing, labeling, and building up of loads for shipment are the major activities in the processing of freight from the truck to the aircraft. There are a number of factors which have a profound effect on total space requirements.

(1) *Cargo turnover* is affected by such variables as types of aircraft, frequency of service, time of day of arrivals and departures inbound, outbound, and directional preponderance of cargo.

(2) *Density of cargo* accounts for considerable dimensional disparity. A ton of cut flowers occupies many times more space than a ton of machine parts.

(3) *Character of cargo* creates a need for specific space allocation. Refrigerated storage is required for perishable cargo, and other temperature controlled areas are needed for live cargo. Bonded storage is needed for customs, import/export control, as well as security accommodations for valuable cargo.

(4) *Methods of handling and storing* cause variations in space requirements. Operations utilizing forklifts and pallets require more square footage for circulation and maneuvering.

b. The arrangement of space in the load build-up areas is also influenced by aircraft loading characteristics. Space should be planned for sequence loading to provide for distribution of weight in the aircraft and for easy removal of loads at destinations. Freight to be loaded on combination aircraft should be kept separate from freight to be loaded on all-cargo aircraft. Loads to be unitized on pallets, loads to be unitized in containers, and those to be loaded on aircraft manually should be controlled by providing separate but adequate space for each. The types of aircraft and the numbers of each type being served by the facility should be given careful study.

c. Consultation with the users as to the type of materials handling systems to be employed is essential and will be most helpful in this area of design. As materials handling systems for the air cargo industry are developed and improved, space requirements for the load build-up area and other operations may be reduced substantially. Figure 12 indicates diagrammatically suggested space requirements for receiving and processing areas.

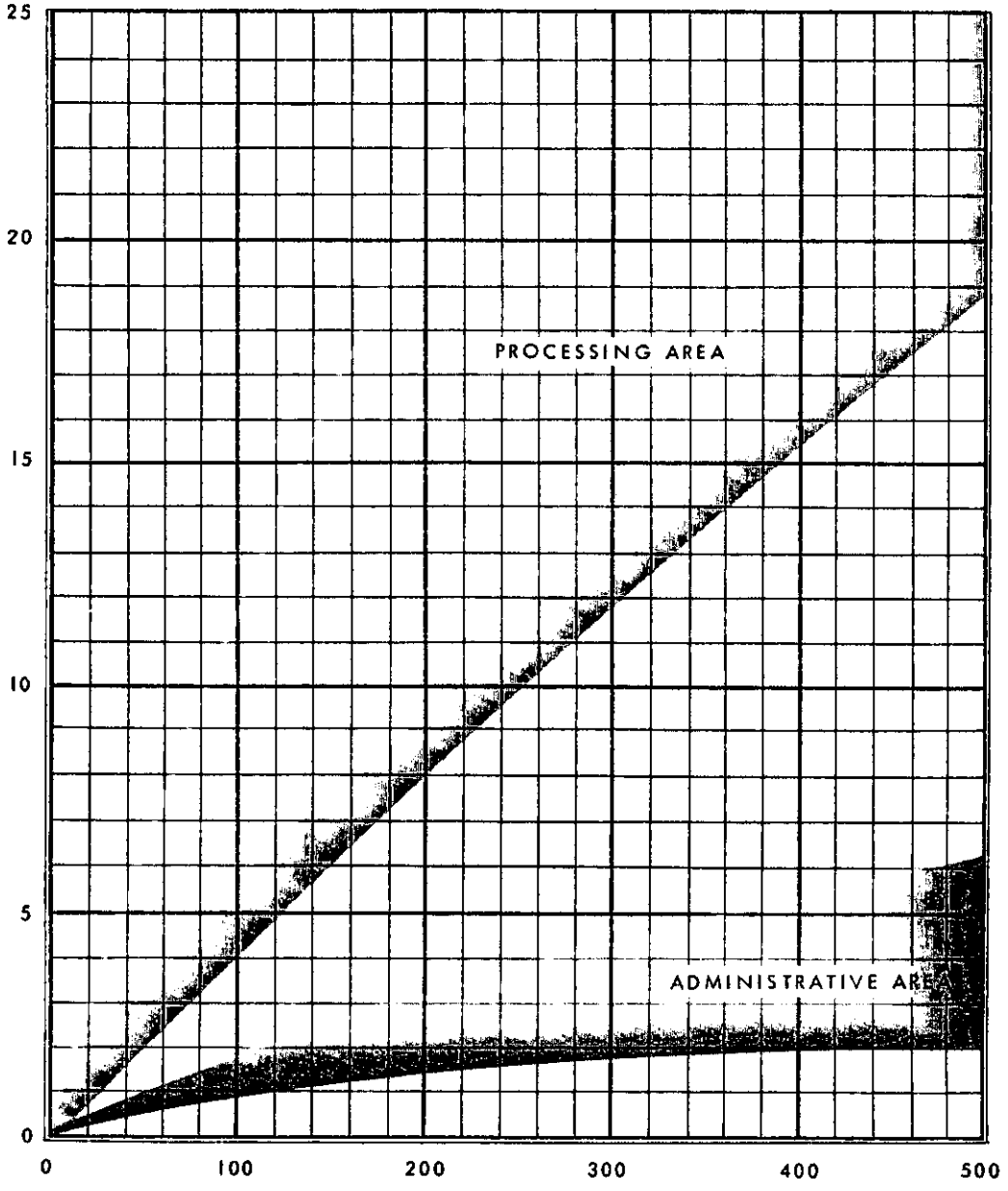


FIGURE 12. BUILDING AREA SPACE REQUIREMENTS.

32. ADMINISTRATIVE AREA, AND CUSTOMER AND PERSONNEL ACCOMMODATIONS

a. Adequate administrative space is necessary for efficient management of cargo operations. The control of all activity is dependent upon decision-making personnel who must have adequate office accommodations. A thorough analysis of the duties and responsibilities of the administrative personnel should be made prior to preparing the design program of the building. The number of employees that may ultimately be employed in the management of operations should be studied.

b. Reception areas should be provided to handle customers. In addition to serving as a receiving point for visitors, small packages may be claimed or bills may be paid here. There should be sufficient space for a counter, accommodations for customers, and cases for display of brochures and other sales material.

c. Sales offices may be required by some airlines. Space in the sales office should provide for desks, files, and facilities for telecommunications. Files should be readily accessible to all the salesmen. The sales office may serve also as a customer service center or clearinghouse for telephone inquiries. Close communication must be maintained between this office, receiving, aircraft space control, and accounting.

d. Management and general office space requirements are dependent upon variables such as the type of operation, the amount and type of freight processed, and the community being served. Accounting and records offices may be necessary facilities for operations of any sizable magnitude. The space required varies with the type of record-keeping and accounting equipment that may be used such as automatic filing systems and data-processing equipment.

e. Communications centers assist management in the efficient movement of freight. Each facility component must be kept informed of changes in schedule, cargo space available, and of special shipments requiring unusual attention. The communications center can serve as the central nerve system. It can provide the link between administration and operations. Space may be required for teletype machines and closed-circuit television facilities in addition to sufficient desk space for communications personnel.

f. Aircraft space control office requirements are dependent upon the amount of freight handling activity. This office may be placed in the receiving area or in the administration offices. Space must be provided for computing and communications equipment and for aircraft charts indicating cargo space available on the aircraft. These functions are closely related to those of receiving and processing and to those of the communications center. Provisions should be made to facilitate close liaison with these interrelated functions.

g. The number of personnel employed in cargo operations will vary not only with the type and volume of freight handled but also with the materials handling system used and the scheduling of aircraft loading operations. A careful study should be made of all factors including local codes and state labor laws to assure adequate provision for employee needs. Figure 12 indicates suggested space requirements. This overall area may be allocated to administration, customer accommodations, and personnel accommodations such as rest rooms, locker rooms, and lunchrooms. A first aid room, pilot-ready room, or other specialized area may be included dependent on circumstances peculiar to proposed facilities.

33. MAINTENANCE, SERVICES, AND STORAGE

a. In order to provide for an efficient operation, equipment must be kept in good working order at all times. Maintenance and storage of materials handling equipment, such as containers, should not be overlooked. The functions of maintenance and storage may be joined, or they may be completely separated. The manner in which these functions are handled depends largely on the type and amount of equipment used.

b. For large operations, maintenance and servicing shops may be necessary to provide repairs for such items as pallets and containers, forklift trucks, conveyors, and other materials handling equipment. Webbing used to secure freight against dislodgment in aircraft requires periodic repair. The maintenance and the servicing shops may be centrally located in the cargo complex, or they may be constructed as a part of the air carrier's individual freight handling facilities.

c. Garage or hangar space may be required for larger pieces of equipment, such as scissors lifts,

mobile freight loaders, or other vehicles used in the freight loading operations. In some cases, it may be economically more practical for the air carriers if this space and this type of equipment are furnished by the airport management on a rental basis.

d. Space required for building utilities, such as plumbing, heating, ventilating, air conditioning, electricity, and gas depends primarily on the geographical location of the airport. Other factors, such as requirements of servicing equipment, type of fuel available in the area, and accessibility of public utilities to the airport cargo center, also must be considered. All utilities may be centrally located on the airport and furnished to users by airport management. Each building may house its own space for the provision of these utilities. Careful consideration must be given by the architect-engineer to this aspect of the building design in order to make sufficient provision for all necessary building areas.

34. SPECIAL HANDLING

a. Some types of freight require special handling, that is, facilities and techniques not ordinarily used for normal items. Requirements depend on the policy of the air carrier in accepting shipments that require special techniques. Basically, four types of shipments which fall into the special handling category are live animals, perishables (pharmaceuticals, meats, produce, and flowers), and bonded and valuable shipments.

b. If the volume of live animal shipments is expected to be large, special provisions for them should be given consideration. Heating, ventilation, cleaning facilities, fresh water supply, cages and stables, and storage facilities for handling, cleaning, and feeding equipment will require study. Consultation with the local chapter of the Society for Prevention of Cruelty to Animals (SPCA) is suggested.

c. Perishables are being shipped in increasing quantities. Bonded and other valuable freight processed varies not only with the economic character of the community but also with the seasons.

35. FACILITIES AT INTERNATIONAL AIRPORTS. Air carriers providing service for overseas shipments at international airports will require space for inspection of deplaned freight. Consultation with Bureau of Customs, Agricultural Research Service, and Public Health Service officials in addition to the airlines is essential in developing a proper design program for this area.

36. BUILDING CONSTRUCTION

a. Building design consistent with functional requirements and the need for economical construction and maintenance cannot be overemphasized. Airport buildings are often constructed in areas beyond the jurisdiction of a city building code. Materials and methods of construction and design of an airport cargo building may or may not be governed by a building code of the local community or regulations established in state labor laws. When local codes are applicable, particularly in small communities, the standards designated in such codes are sometimes below those acceptable as good architectural or engineering practice for buildings on airports.

b. It is suggested that airport owners voluntarily adopt standards from one of several recognized sources. Standards representing good practice can be found in the "Recommended Building Code" of the National Board of Fire Underwriters (NBFU). "The Uniform Building Code" adopted by the Pacific Coast Building Officials Conference and the "Southern Standard Building Code" prepared by the Southern Building Code Congress are also excellent guides.

c. Selection of the structural system to be used for the building should be based on careful consideration of the insurance rates for various classes of building construction and occupancy. The initial cost of fire-resistant construction may be higher than other types of construction, but a lower insurance rate will often offset this higher initial cost. Fire is not the only hazard about which the designer must concern himself. Protection against pilferage, vandalism, or possible sabotage in time of emergency should be considered in choosing materials of construction. The location of the building and the types of commodities moved through the facility will also influence the type of construction.

d. Structural systems having the capability of economically spanning as much as 100 feet provide greater flexibility in building design and space arrangement. Clear-span structures are desirable because they allow for greater maneuverability of

forklift trucks and other freight handling equipment. Large-space areas, free of columns and bearing walls, can be divided and adapted to satisfy the changing demands of functional operations. Roof construction and roof design loads vary with the area of the country. The recommended code of the NBFU suggests that ordinary roofs, either flat, pitched, or curved, be designed for not less than 20 pounds per square foot of horizontal projection in addition to the dead load and wind or other loads.

e. Floor construction, according to the NBFU-recommended National Building Code, should be designed and constructed for the greatest loads that are anticipated by the user. Provision should be made for such items as floor scales, pit elevators, and recessed tracks for towveyor systems. Floors in the office areas, where extensive filing systems are maintained, should be designed to carry a minimum uniformly distributed load of 125 pounds per square foot.

f. Selection of doors must be given careful consideration. Overhead and roll-up doors are suggested in areas where there is movement of freight. The tracks of the overhead-type door should be installed to provide as much headroom as possible within the building.

g. Bumpers and guards for protecting truck-dock edges are available in many designs. The nature of activity, the devices used for loading operations, and the amount of traffic are the determinants in making a selection. The use of bumpers and guards will help keep maintenance of dock areas to a minimum.

h. Interior finishes depend upon local factors, but they should be selected from the standpoint of minimum maintenance. The functional use of the area should be the determining factor in the selection of the finishes. In the processing and storage areas of the building, a smooth concrete finish for the floor should be adequate. A hardening additive may be used in the concrete to make a durable surface.

i. The toilet rooms should have floors and walls finished with a hard impervious material for ease of cleaning and maintenance. The wall finishes may be an integral part of the wall construction, such as glazed partition block or glazed brick where budgets permit. The locker room floor should have a painted, smooth finished concrete floor if costs must be kept at a minimum. Walls may be painted masonry units or plaster. Since locker rooms are generally noisy places, an acoustic ceiling should be considered for this area.

j. There is a wide selection of finishes available for administrative areas. For the floors, rubber and vinyl tile finishes generally provide a durable floor but may be difficult to maintain in areas adjacent to the processing areas. Walls may be painted plaster, wood veneer, or plastic. Prefinished or plastic-coated wood veneers are available that can be economically installed and provide a durable surface requiring little maintenance. Acoustic ceilings are recommended for these areas. "Airport Terminal Buildings" contains information on noise control which may be helpful to the designer.

37. UTILITIES

a. Heating and ventilating requirements vary with the climate and the requirements of the user. It may be possible to integrate systems with the humidity and temperature control required for handling special commodities. A system which will provide proper year-round conditioning of air particularly in administrative areas is important.

b. Electrical and lighting systems should be adequate for the designed functions. The requirements of the electrical service vary with the size and character of the facility. Much will depend upon the nature of the materials handling system used. Minimum required lighting levels may be governed by local codes or state labor laws; however, these may sometimes be below those acceptable as good architectural or engineering practice for buildings on airports. It is recommended that airport owners voluntarily adopt the standards from one of several recognized sources.

SECTION 3. AIRPORT CARGO CENTER LOCATION

38. IMPORTANCE OF SITE PLANNING. The complex on the airport specifically designed for the handling of air cargo is one of the major elements on the airport. The airport cargo center must be sited in a location that will contribute to the efficient transfer of cargo between surface and air transport. The selection of an appropriate site is the decision which determines to a large extent the effectiveness of the air cargo operation. The location of the elements of the complex in proper relationship to each other is of equal importance.

39. LOCATION ON THE AIRPORT

a. Four primary considerations dictate the selection of the site on an airport for the cargo complex.

(1) Taxi distance from the most used runways should be as short as possible, and yet there should not be interference with passenger operations.

(2) The site should be readily accessible by surface vehicles from the passenger aircraft loading positions for efficient servicing of aircraft carrying both passengers and cargo.

(3) The complex should be readily reached from all access roads to the airport to assure nonintereference of vehicular traffic with aircraft movement areas.

(4) Adequate space should be allowed for expansion of air cargo operations without encroaching on other airport functions particularly without interfering with the expansion of the passenger terminal.

b. These four primary considerations indicate the general relationships with other functions and activities. They require extensive study to determine the degree to which they can be met on any individual airport. This study can best be made through the medium of an airport layout plan in which the advantages of possible locations and their effect on other airport facilities and operational activities can be objectively weighed. The importance of making provision for airport cargo center facilities in the airport layout plan cannot be overemphasized.

40. PLANNING CONSIDERATIONS. The general location of the cargo complex having been established and the preliminary design concept of the building groups selected, a number of other factors should also be studied prior to adoption of a siting plan.

a. The arrangement of buildings and associated support facilities is important to satisfactory and efficient use, and it also affects future expansion of individual buildings. Important in this regard is consideration of spacing of buildings for access, vehicular circulation, and fire and safety clearances. Vehicular access and roadways, and parking areas are discussed in detail in the paragraphs that follow. Proper orientation of buildings, with respect to these factors and the prevailing winds, is essential to the functional operation of the buildings. Economical design dictates the need for balance of requirements for paved areas with other considerations discussed heretofore. Good drainage, consistent with driveway, parking, and pedestrian access requirements, is a necessary design consideration.

b. Noise is a consideration which must not be overlooked. Acoustical treatment has been mentioned in paragraph 36 on page 25, but there are additional efforts which can be made through proper landscape planting for sound absorption.

41. CARGO CENTER SITE PLAN

a. To illustrate the application of functional relationships discussed in this chapter and in chapter 1, a diagrammatic site plan has been developed. Figure 13 indicates the relationships of facilities for a number of air carrier cargo operators, truckers, air freight forwarders, air express (REA), and airport mail facility (AMF).

b. The site plan orientation on the airport establishes optimum relationships of aircraft parking apron, and access and service roads discussed in the following paragraphs. Guidance material on the total concept of the airport layout plan may be found in "Airport Design."

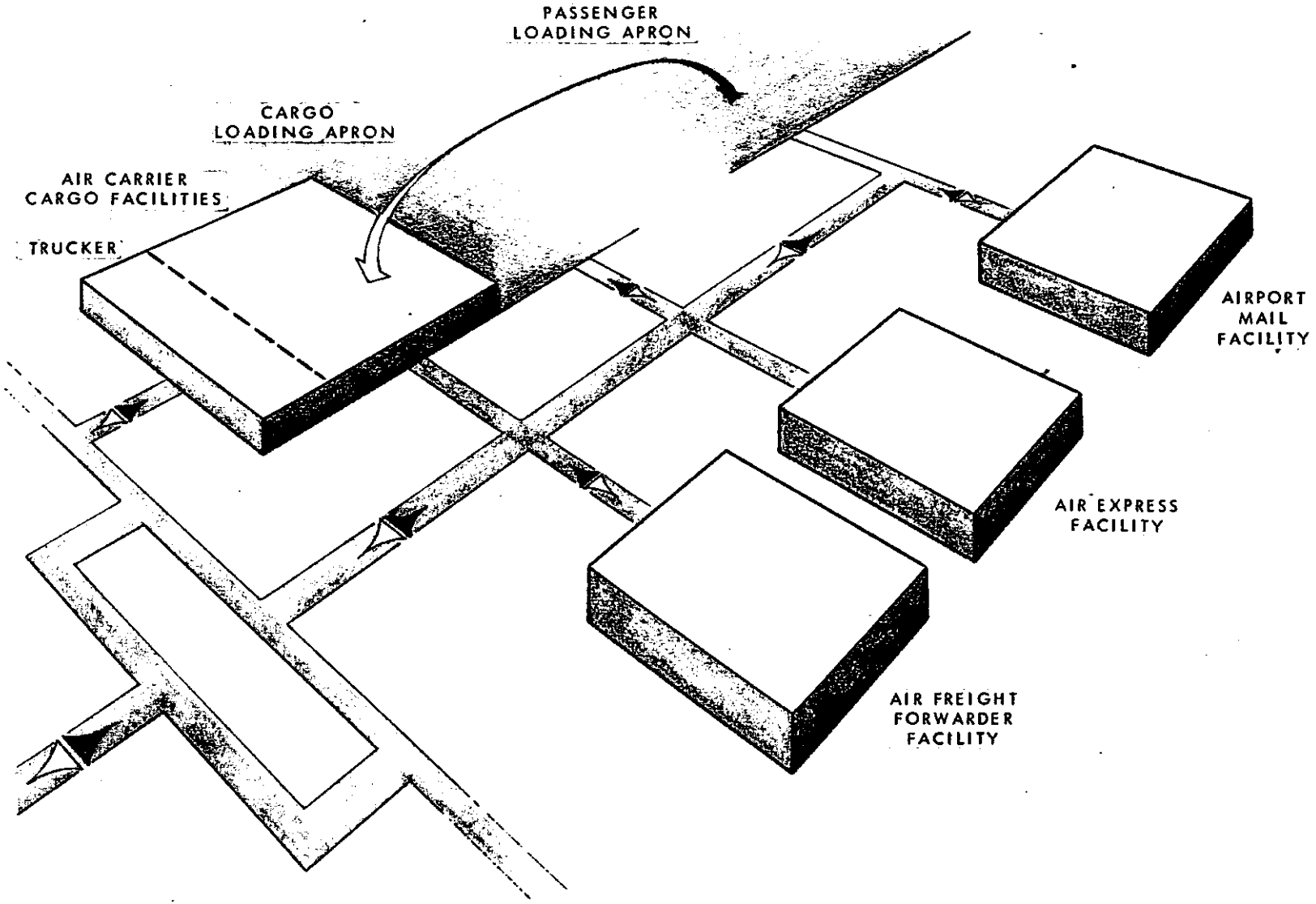


FIGURE 13. RELATIONSHIPS OF CARGO FACILITIES.

42. AIRCRAFT PARKING APRONS. Paved apron requirements for aircraft parking and loading positions adjoining air carrier cargo facilities are dependent upon the type and size of aircraft used, airline schedules, and the type of materials handling system used. The discussion in chapter 1 introduced the relationships of facilities to aircraft parking aprons. This discussion clearly indicates the importance of direct access from certain facilities to the passenger loading apron, of access to both combination and all-cargo aircraft aprons for others, and for completely integrated building-apron relationships for certain material handling systems. Information on space requirements for aircraft apron parking positions can be found in "Airport Design."

43. ACCESS, CIRCULATION, AND PARKING. Discussion of ground vehicle movement considerations is presented in general terms. Detailed guidance material for the planning and design of traffic and parking facilities can be found in "Airport Terminal Buildings."

a. **Roads.** Access to and egress from the airport cargo complex and circulatory roads within it should be direct and unimpeded. There should be as little interference as possible with airport passenger vehicular traffic. In those cases, where the number and types of trucks using the access roads will cause frequent passenger traffic congestion, separate roads should be designed specifically for truck traffic leading directly to the cargo center. Visitors, passengers, and customers should be provided convenient access from the passenger terminal area.

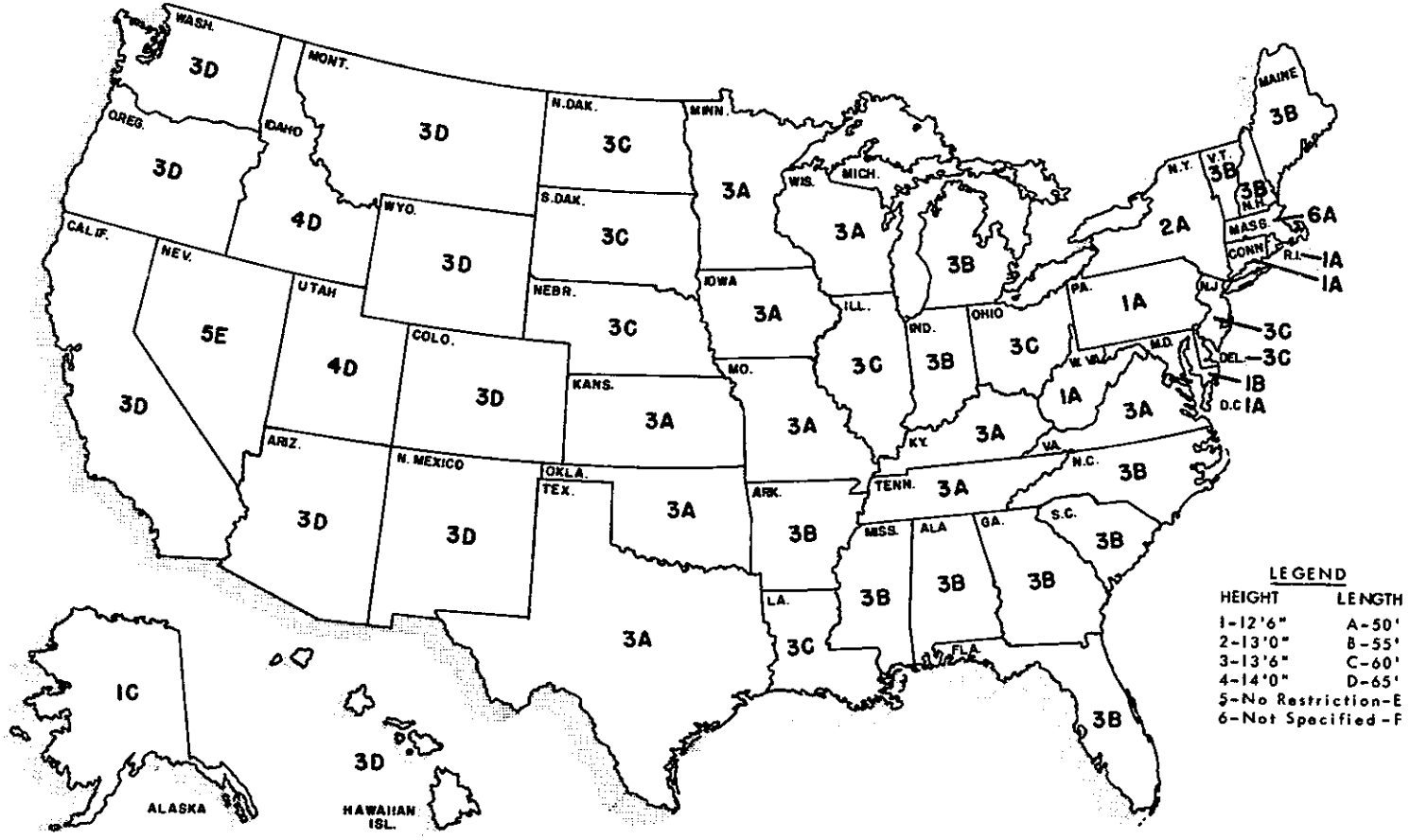
b. **Truck Parking**

(1) Parking areas required include those designed to serve the trucker, the customer and visitor, and the employee. Planning of truck parking spaces and maneuvering areas will probably present a difficult problem because of the many variables. Maximum truck sizes vary from state to state as shown in figure 14. Trucks bringing freight to the cargo center will be of many types and sizes. Parking areas and truck-dock facilities with adequate maneuvering space must be provided for movement of vehicles without creating bottlenecks during peak loading and unloading hours.

(2) Generally, the recommended distance for maneuvering from the loading platform to the nearest obstruction is twice the length of the largest road vehicle expected to use the facility. The Air Transport Association suggests a minimum overall depth of 100 feet for the terminal-truck apron which will allow 75 feet for maneuvering of trucks plus a 25-foot-wide access roadway. Minimum interference distances may in effect be less when tractors with smaller turning radii are used, when the spacing between trailers is increased, or when a saw-toothed loading platform design is used. Other problems, such as combination vehicle maneuvering distances, determining width of an entrance gate, or space required for saw-toothed dock designs, require detailed analysis.

c. **Customer and Visitor Parking.** Those seeking service should have the most direct access possible to the reception areas of individual air carriers, freight forwarders, and other service facilities. These parking spaces may be adjacent to the building in conjunction with the truck parking area. Permanent parking areas should not be located where expansion of buildings is being contemplated.

d. **Employee Parking.** Sufficient parking should be provided for employees' cars which are generally parked for a period equal to the length of the working day. Since the employee does not usually require ready access to his car during this period, it is not necessary to locate the employee parking area directly adjacent to the freight handling facilities. Where the airport is relatively small, an employee parking area common to all operational functions on the airport may be adequate for parking needs. For the larger airport, strategically located parking spaces which may be used by all employees of the airport cargo complex should be considered. There may be just one of these areas planned near the center of activity, or there may be several dependent upon the size and spread of the airport cargo complex. Administrative personnel usually require parking spaces adjacent to the office area because they may have to use their cars frequently during the working day.



NOTE: SIZE LIMITS FOR COMMERCIAL VEHICLES HAS BEEN TAKEN FROM DATA COMPILED BY THE AMERICAN TRUCKING ASSOCIATION

FIGURE 14. ALLOWABLE TRUCK SIZES.

APPENDIX 1. BIBLIOGRAPHY OF REFERENCE MATERIAL

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U.S. Department
of Transportation
**Federal Aviation
Administration**

Airport Cargo Facilities

AC: 150/5360-2
DATE: 4/6/64

Advisory Circular

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ADVISORY CIRCULAR

SUBJECT: AIRPORT CARGO FACILITIES

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1. PURPOSE

This advisory circular presents background and guidance material on air cargo facilities. This information has been developed to encourage the growth of all segments of the air cargo industry and to provide assistance in the planning of airport facilities.

2. REFERENCES

Other Federal Aviation Agency publications which provide additional related information are the following:

a. "Airport Design," 1961, Supplement No. 1, 1962.

b. "Airport Terminal Buildings," 1960.

3. AIR CARGO INDUSTRY

In the broadest terms, the air cargo industry includes that segment of commercial air transportation which handles the transfer of everything but passengers and baggage. Air freight, air express, air mail, and parcel post are all part of the air cargo picture; but mail and parcel post are usually handled in ground facilities which are separate from the normal airport cargo facilities. This advisory circular discusses the latter in detail. Airport Mail Facility requirements are a special case within the province of the Post Office Department and not covered in this publication except for statistical data and brief references.

4. HOW TO GET THIS PUBLICATION

Obtain additional copies of this circular, AC 150/5360-2, "Airport Cargo Facilities," from the Federal Aviation Agency, Distribution Section, HQ-438, Washington, D.C., 20553.

Chester T. Bowers

For COLE MORROW, *Director,*
Airports Service.

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CHAPTER 1. AIR CARGO INDUSTRY

SECTION 1. INTRODUCTION

1. AIR CARGO, PAST TO PRESENT

a. In 1910, when Philip O. Parmalee flew a bolt of silk from Dayton to Columbus, Ohio, in a Wright Brothers biplane, the air cargo industry was born. However, it did not begin to spread its wings in the United States until more than 30 years after this historic incident. The "bush" flyers of Canada were supplying outlying regions of that country early in aviation history. During the twenties and thirties, industry in some countries of Europe and Latin America was profiting by shipping commodities by this new mode of transportation.

Although some commercial airlines were stowing freight on passenger aircraft as early as 1932, it was not until 1944 that the first regularly scheduled all-cargo DC-3 service was started by a certificated carrier. During World War II, the airplane demonstrated conclusively its capability of hauling almost every conceivable commodity, large and small. Following the War, the air cargo industry began to grow; and by 1947, 38 million ton-miles of freight were carried domestically. Economic soothsayers at all levels were optimistic about the future of the air cargo business.

2. EARLY FORECASTS AND PERFORMANCE

a. The Department of Commerce, Civil Aeronautics Administration, in a staff study issued in 1952, forecasted that by 1955 this growing domestic industry would be flying an estimated 400 million ton-miles of cargo. In contrast, some elements of the industry were very optimistic and had forecasted over a billion ton-miles by 1955. Actual growth, however, fell considerably short of this mark. The 350 million ton-miles flown in the year 1955, and slightly more than 600 million ton-miles in 1960, quite closely followed the more conservative forecasts.

b. Figure 1 is a graphic presentation of the air cargo industry's growth in the United States from 1950 to 1962 and indicates the nominal growth during this period. The growth patterns of four communities with cargo operations over this same period are illustrated in figure 2 on page 3.

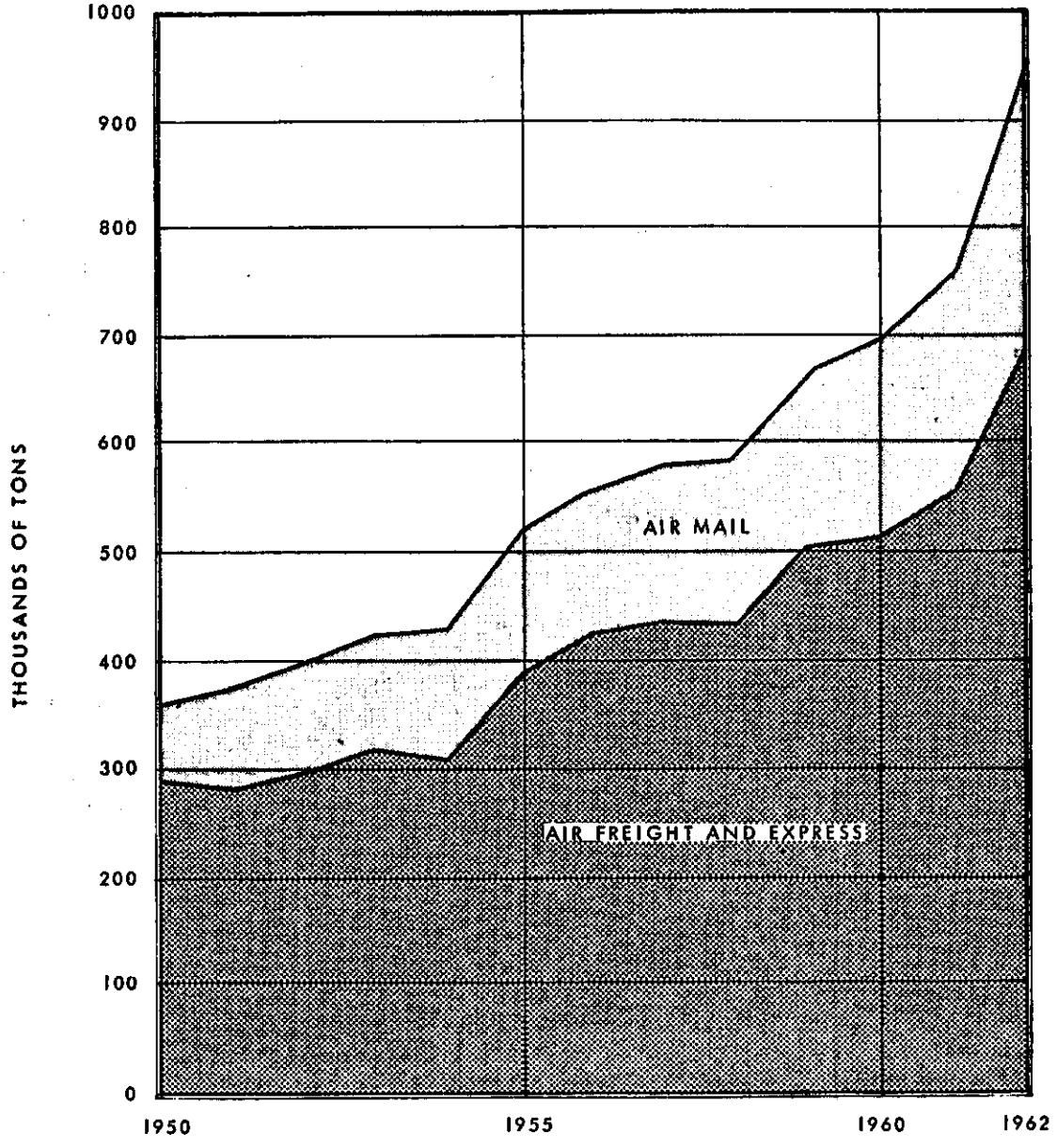


FIGURE 1. DOMESTIC AIR CARGO GROWTH.

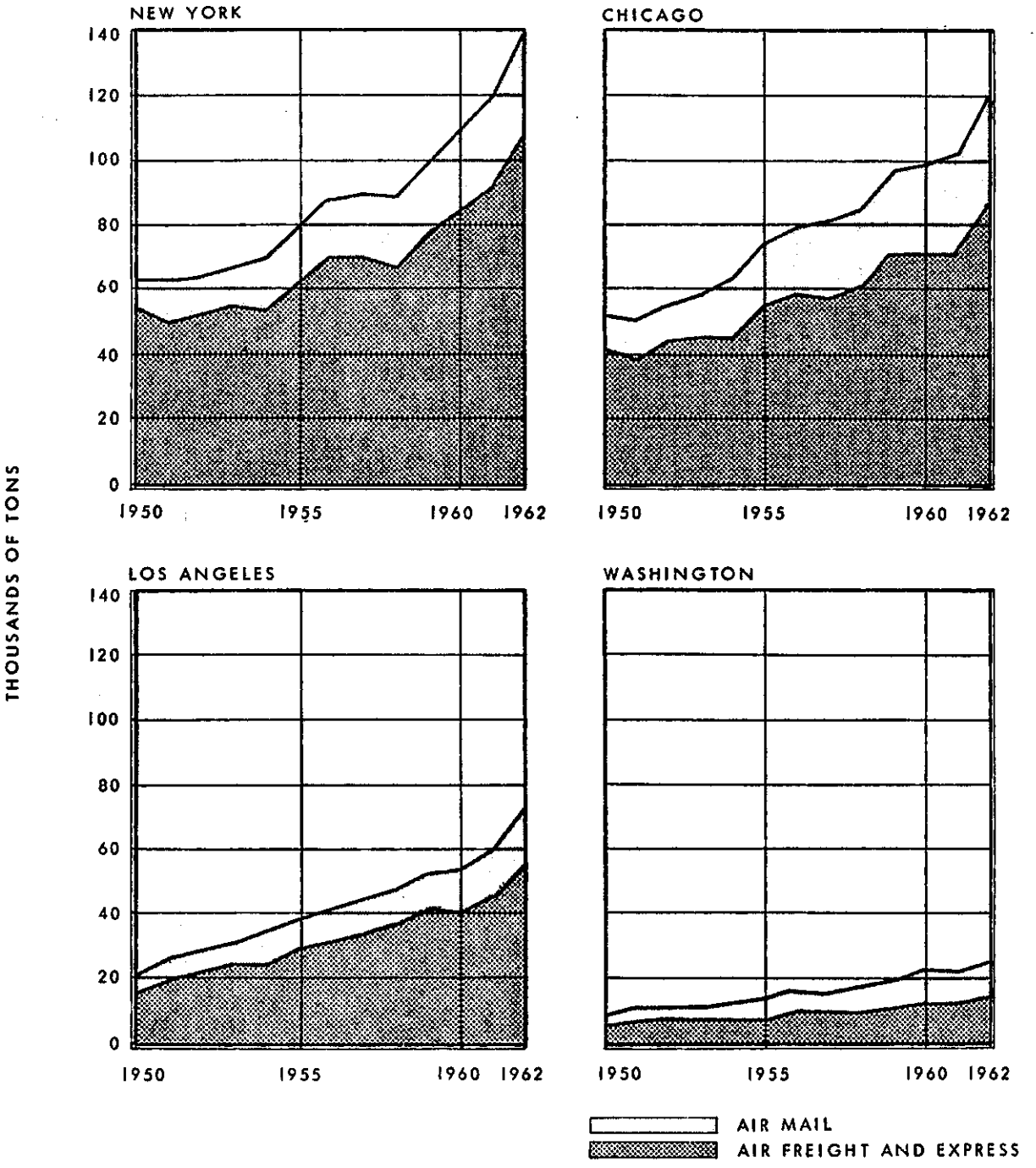


FIGURE 2. DOMESTIC GROWTH AT SELECTED COMMUNITIES.

SECTION 2. GROWTH POTENTIAL

3. MODES OF TRANSPORTATION. Air cargo business interests have been cautious in preparing plans for future growth perhaps because of early erratic growth and lag in reaching the more optimistic predictions of accomplishment. Unquestionably, a high potential for increased business exists. In 1961, only six-hundredths of 1 percent of all domestic intercity freight was shipped by air. Figure 3 illustrates intercity ton-miles, public and private, by surface modes of transportation for the two-decade period ending in 1960, as reported by the Interstate Commerce Commission.

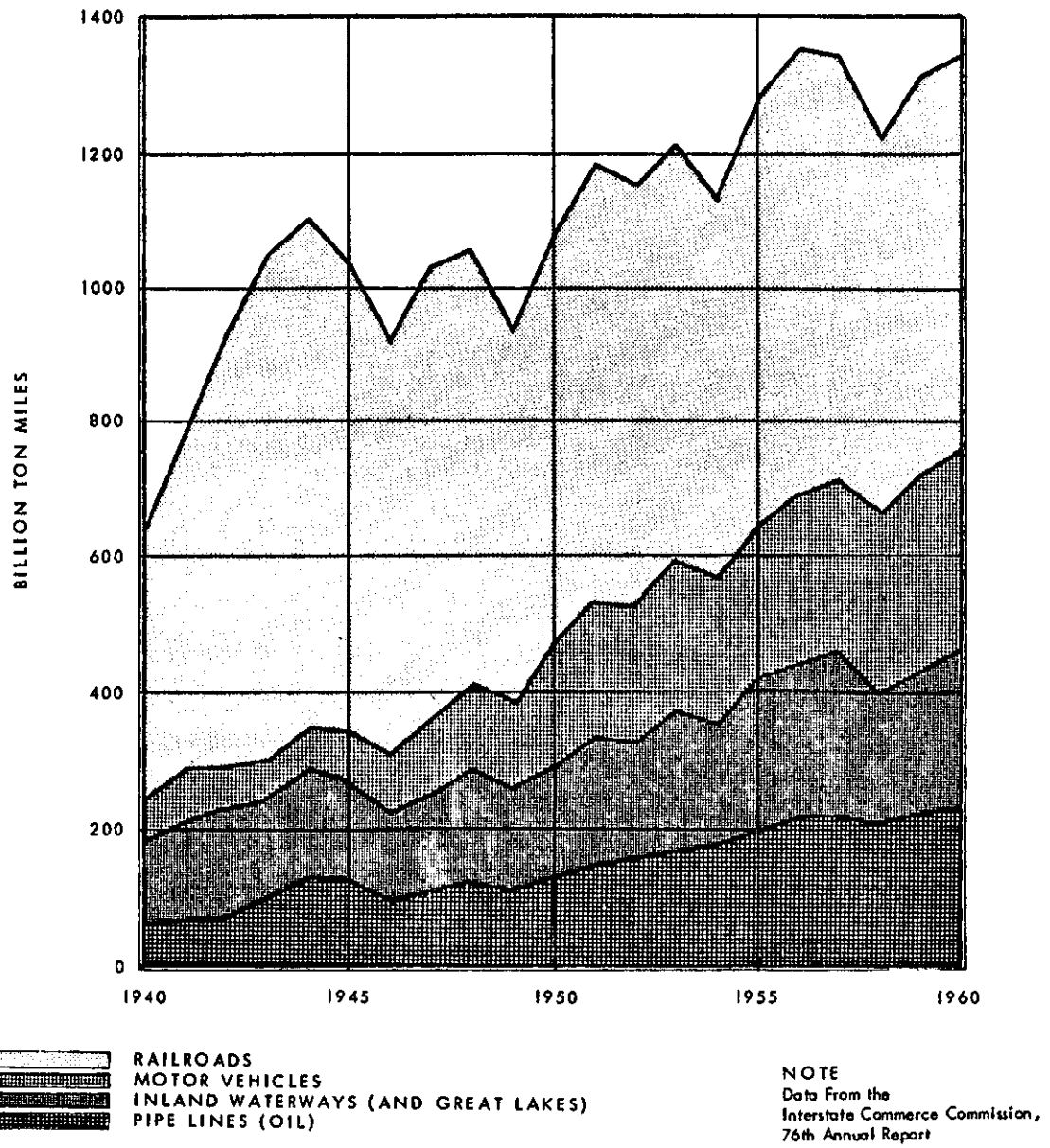


FIGURE 3. INTERCITY FREIGHT SURFACE MOVEMENTS.

4. TRENDS IN AIR CARGO TRANSPORTATION

a. The conversion by major air carriers to turbojet and turboprop aircraft which began in 1957 has had an effect on the air cargo industry. The baggage compartments of these combination passenger aircraft have several times the carrying capacity of like compartments of piston-type aircraft. These combination-type aircraft will continue to maintain an important role in the total supply of air cargo transportation. Many of the large piston-type aircraft have been converted for all-cargo operations. The all-cargo aircraft, Canadair CL-44, Boeing B707-321C, B707-323C, and B707-373C, and Douglas DC-8F, have been integrated into air freight service; the Boeing B707-320C and B707-331C have been on order for some time with delivery beginning this year; and the Lockheed L-300, commercial version of the C-141, is scheduled for delivery in 1966. This increased available capacity for transporting air cargo has caused aviation interests to re-evaluate total industry potential.

b. Together, the air carriers and aircraft manufacturers have embarked on a program of research on commodities being carried by surface transport. The types and densities of various commodities shipped, as well as their origin and destination, are being closely studied in an effort to develop a basis for better forecasting. Programs of study for more efficient management and materials handling systems have been initiated. The progress of the U.S. Air Force in its development of air freight facilities for the Military Air Transport Service is being watched closely by the aviation industry. Most of the studies being made are aimed at finding ways to reduce total operating costs which would place the air freight carriers in a better position to compete with surface transport carriers. Information available indicates that costs to the shipper are in the range of 3 cents to 8 cents per ton-mile by surface transport in contrast to an average of 25 cents per ton-mile for the same service by air.

c. Trends in the industry point to:

(1) Mechanized systems for ground handling of air freight.

(2) Integration of systems with ground and air transportation and materials handling operations.

(3) Containerization of shipments.

(4) Automation of documentation and communication in an effort to reduce indirect costs of terminal handling.

(5) Utilization of all-cargo aircraft designed specifically for the carrying of air cargo and capable of handling larger loads, traveling greater distances, and operating at much lower systems costs.

5. GROWTH FORECASTS

a. Some forecasters remain optimistic about the future growth of the air cargo industry and are predicting a rate of growth of as much as 25 percent per year during the decade ending in 1970. This would indicate that there will be about 6 billion ton-miles of air cargo flown during the year ending this period of forecast—a tenfold increase in 10 years. Should such forecasts prove to be correct, airports in some of our large hub communities will be noticeably affected.

b. The Federal Aviation Agency is considerably more conservative in its forecast and predicts 2 billion domestic air cargo ton-miles for 1970—a fourfold increase. Figure 4 is a graphic presentation of the future growth of air cargo as viewed by the FAA.

c. In sharp contrast to the domestic situation, developments in the air cargo industry for foreign trade are moving more rapidly. In 1960, carriers of overseas shipments reported a 40 percent increase over the previous year in ton-miles of freight and express transported. Major airlines involved are taking steps to maintain this growth by planning large-scale improvements in freight-handling facilities.

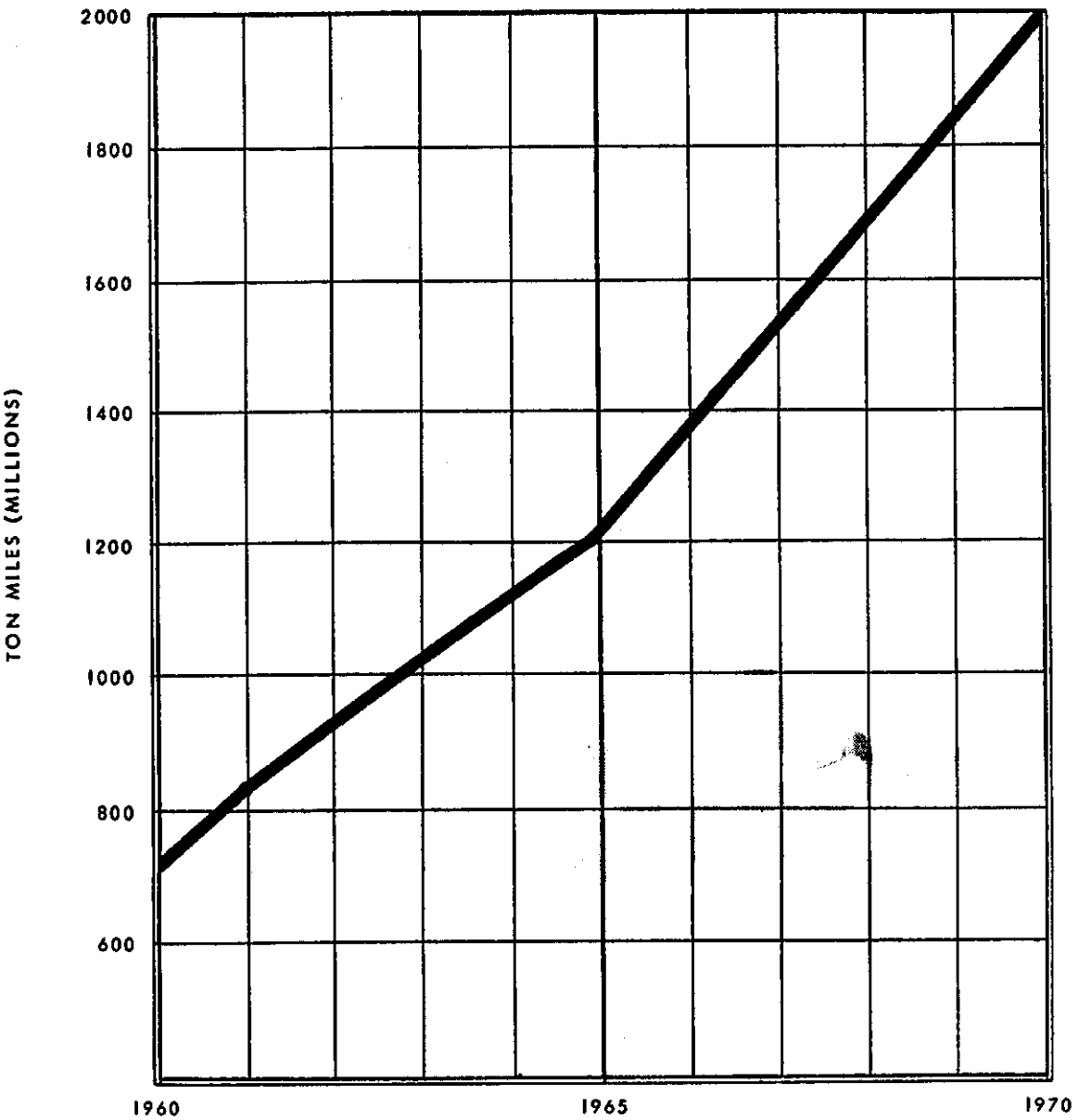


FIGURE 4. AIR CARGO PROJECTION, FAA.

SECTION 3. COMPONENTS OF THE INDUSTRY

6. MAJOR COMPONENTS. There are five major components of the air cargo industry which must be considered and which influence analysis of airport cargo facilities. A number of components may be found to be associated with the air carrier facility, particularly in the case of an all-cargo airline. The major components are the air carrier facilities with associated trucking company facilities, air freight forwarder facilities, air express facilities, and air mail facilities. These are discussed in terms of their associated facilities and their distinguishing characteristics in order to give the architect-engineer background information.

7. AIRPORT MAIL FACILITY

a. The volume of air mail processed averages approximately one-third that of air freight and express. The Post Office Department offers to the shipper of small packages a fast, economical, and reliable service through Domestic Air Parcel Post. It generally is cheaper to ship packages of 2 pounds or less through this service because other services have minimum rates for small shipments generally in excess of the Post Office Department's rate.

b. The use of the airways for sending mail has been increasing steadily. Indications are that the increase will continue. Procedures for handling mail are continuously being evaluated by the Post Office Department. Improvements, as made, will affect revisions in space requirements for mail facilities on the airport. Present plans call for greatly expanded mail-handling facilities at a number of the major airports in the country.

c. Air mail and air parcel post are tendered to air carriers for priority loading and unloading at the destination. First-class-mail-by-air is placed on combination aircraft for "topoff" loading space available to an acceptable aircraft weight. Although the greater percentage of air mail and air parcel post is transported on combination aircraft, there is some use made of all-cargo equipment. To provide the service to the patron desired by the Post Office Department, fast handling in the airport mail facility and in exchanges with air carriers is most important. It is frequently necessary that volume dispatches to a particular flight bypass the airport mail facility. Thus, the airport mail facility needs to be conveniently located with access to both the airline cargo facilities and the passenger terminal loading apron. Adequate access roadways not crossing runways or taxiways are most important.

d. Although the volume is not as great at airports which do not have an airport mail facility, fast and efficient exchange with air carriers at a central point is highly desirable. Such a facility could consist merely of a truck dock for this purpose with the capability of storing mail available in advance of flight or truck departure. This area should be centrally located and readily accessible to aircraft parking aprons. The functions to be accomplished include receiving and dispatching to carriers, coordinating post office truck movements, and overseeing air carrier postal activities.

8. AIR EXPRESS FACILITY

a. Air express is handled by the Air Express Division of REA Express (Railway Express Agency) and is forwarded on combination and all-cargo aircraft of the certificated airlines. Packages are picked up directly from shippers and delivered to consignees in all cities and principal towns. There are differences in the rate structures of minimum charges which determine whether it is more economical to ship packages by indirect or direct carriers. Air express is loaded on aircraft at a priority below passengers rather than on a first available space priority as is air freight and first-class-mail-by-air. Statistics from the Civil Aeronautics Board indicate that air express averages approximately 10 percent of domestic air freight tonnage.

b. The majority of air express shipments are placed on combination aircraft. The movement of shipments from the air express facility to the cargo processing facilities of the air carrier is a transfer operation. This processing is necessary to maintain efficiency in aircraft loading. The air express facility needs to be conveniently located

with access to both the air carrier cargo facilities and the passenger terminal loading apron.

9. AIR FREIGHT FACILITIES

a. Nonprohibited shipments of any size, weight, and shape can be sent by air, limited only by dimensional characteristics of the aircraft and its gross weight limitations. Almost all scheduled airline flights carry air freight. Also, all-cargo aircraft are now operated between most major cities with either direct or connecting trucking service available to points beyond communities served directly by air. The customer has a choice of air freight services—the services of an air freight forwarder or the direct carrier service of an airline. When using the air carrier, he may request door-to-door service, or he may deposit the shipment at the airport of origin and have the consignee pick it up at the airport of destination. This latter type of service is generally known as an airport-to-airport service.

b. The interrelationships involved in the various kinds of air freight facilities are not as clear cut as the relationships described in paragraphs 7 and 8. Much depends upon the individual circumstances at an airport and the number of possible services available. The overriding factors affecting these interrelationships are the number of airlines operating passenger services, the number of airlines operating separate cargo facilities, and the number of competitive systems of ground transportation to and from the airport for air freight.

10. AIR FREIGHT FORWARDER FACILITY

a. The air freight forwarder operates as an indirect carrier under authorization of the Civil Aeronautics Board and provides all services except the direct operation of aircraft. Since the forwarder is not limited in regard to routes and points served, its tariffs are filed and approved for worldwide services. The forwarder provides complete transportation service from shipper to consignee. The amount of air freight generated by the forwarder is relatively high. Of the total domestic freight revenue, approximately $160 million for 1960, forwarders grossed approximately $35 million or approximately one-fifth of airline domestic freight revenue.

b. The operations of the forwarder, more than one of which may be located within the airport complex, generally consist of consolidating package units for shipment and transferring these shipments from his facility to those of the airlines. The 1960 statistics for larger forwarders indicate that they received almost 3.5 million shipments and consigned approximately 92,000 consolidated shipments to the airlines. Since the forwarder has basically a transfer and consolidation operation, a large percentage of the releases to the airlines will pass through an air carrier cargo facility with the remainder going aboard combination aircraft. Thus, convenient access to both the air carrier cargo facilities and passenger terminal loading apron is essential.

11. AIR CARRIER CARGO FACILITY

a. The facilities of the airlines for handling air cargo are the core of cargo operations and the center about which the other related services and activities are located. The purpose of this discussion is to establish the relationship of all other components of the industry to the direct carrier actually accomplishing air cargo movement.

b. Airport-to-airport service in which shipments are deposited at the air carrier cargo facility has been identified as one type of air freight service. To satisfy demands of customers for door-to-door service, the airlines normally do not operate a fleet of trucks but contract with truckers to have this work done for them. This is accomplished through Air Cargo, Inc., an organization owned by all of the dometic airlines. Air Cargo, Inc., arranges for one trucker to handle all door-to-door shipments of all airlines at a particular airport at a given rate.

c. The relationship of contract truckers to air carriers is influenced by the type of air carrier operation. Normally, air carriers providing door-to-door service have established sufficient sales volume of air freight to have warranted cargo facilities. The type of operations conducted by the trucker is influenced by the number of air carrier cargo facilities. The requirements of the truckers for the shipment-sorting operation to the airlines and for delivery to local customers may be quite closely associated with the operations within the air carrier cargo facilities. However, where there are a number of separate air carrier cargo facilities, a separate air cargo trucking facility should be investigated.

CHAPTER 2. AIR CARGO HANDLING

SECTION 1. CARGO FLOW

12. IMPORTANCE OF TIME

a. An aircraft not flying is not using its earning capacity. Present jet-cargo aircraft have a gross earning potential of over $4,000 per hour. Therefore, groundtime (the time required to unload, load, and service) is a critical factor in air cargo operations. Systems in use in the past for loading and unloading aircraft generally required much manual handling of freight. New and more efficient loading systems and equipment are being provided by the industry to reduce groundtime to a minimum and to reduce the time and cost of loading, unloading, and processing of shipments.

b. Background information on materials flow and materials handling equipment and systems is presented in the pages that follow. It is most important that the architect, the engineer, and others responsible for the planning and design of airport cargo facilities consult with the air carriers involved from the inception of the program and throughout its development to determine specific requirements of individual materials handling systems. Knowledge of the technique of packaging and materials handling is essential in designing functionally efficient air cargo facilities.

13. ENPLANING AND DEPLANING CARGO

a. In the sequence of operations, the first step is to unload the air cargo from trucks as depicted in figure 5. The shipment is accepted and weighed, and necessary data recorded. Information about weight and destination of the shipment permits scheduling for flight and load placement. Marked packages are moved to a staging area to be processed for loading on the aircraft.

b. The removal of cargo from the aircraft initiates a process which is the reverse of enplaning with disposition of the shipment dependent upon final destination. If the airport is the final destination of the shipment, it is moved to an area where it awaits pickup. If the airport is an intermediate stop and packages are to be transferred to another aircraft, the shipment is again moved into the load-staging area.

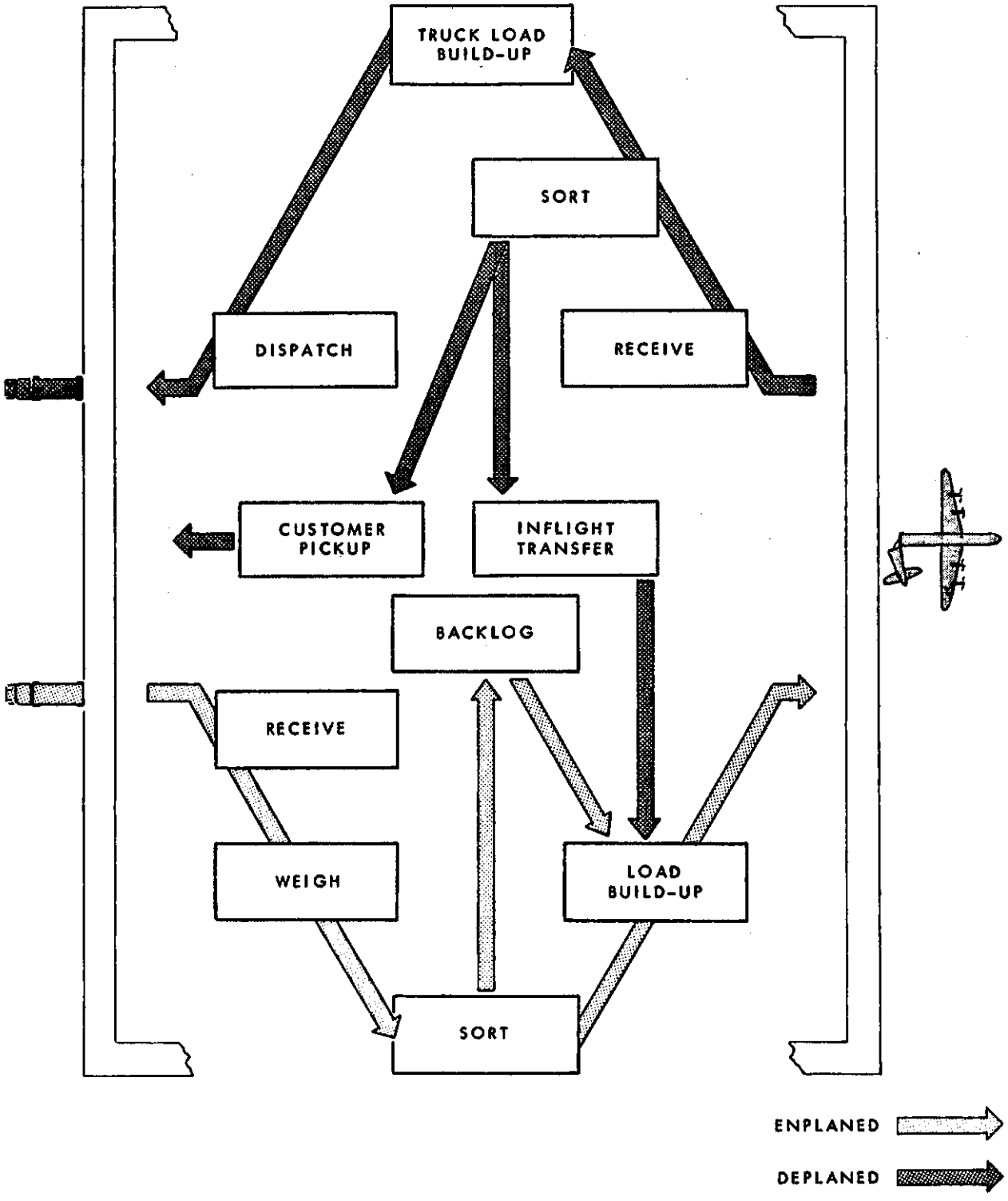


FIGURE 5. MATERIALS FLOW.

SECTION 2. CARGO HANDLING EQUIPMENT

14. BASIC CONSIDERATIONS. Techniques used in moving shipments from one area to another within the facilities and for load build-up vary considerably depending on the nature of the commodities and the total quantity of air cargo being shipped from a community. Shipments may vary from small fragile packages to bulky and heavy items. Equipment of various types is used to handle freight.

15. WEIGHING EQUIPMENT. Scales for weighing shipments may be portable or built into the materials handling system. Since most packages moving through air cargo facilities weigh less than 300 pounds per unit, this capacity scale would normally be adequate. A larger auxiliary scale may be required depending upon the nature of air freight handled.

16. UNITIZING EQUIPMENT. Many small packages can be more efficiently handled if unitized, that is, consolidated into a single unit or group of units. Unitizing may be accomplished in the cargo processing facility or may be done by the customer, and the packed unit brought to the facility ready for loading on the aircraft.

a. **Pallets** are portable platforms on which shipments are stacked. They are generally constructed so they can be moved by a forklift truck or other device. Warehouse pallets presently in use are about 30 inches by 40 inches, but these are generally being replaced. Larger pallets, 80 inches by 108 inches and 88 inches by 125 inches, have been adopted for the air cargo industry. A flexible pallet, used in conjunction with a pallet support, also has been designed. This pallet may be used as an integral part of the aircraft load. Dollies are pallets or pallet supports on wheels. They may be moved manually or by a mechanical system. Figure 6 shows a number of types of pallets and a dolly.

b. **Containers** most commonly in use today are of two general types. One type is designed to be stowed in the belly compartment, or underside, of large jet aircraft. These are normally made of aluminum and shaped to fit the lower portion of the aircraft fuselage. The other type of container is a modification of the pallet, having sides hinged to the pallet or in separate sections that fit together. Various types of containers are illustrated in figure 7 on page 13.

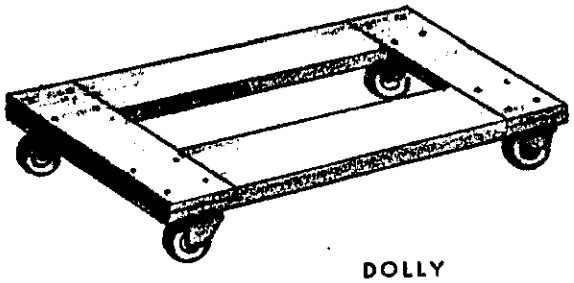
17. PIT ELEVATORS. Hydraulic lifts equipped to support pallets or containers are being used to assist in unit build-up. By use of the lift, it is possible to keep the top of the load of the stack at a satisfactory working level by lowering the stack below the floor. After the cargo stack is complete, it is returned to the floor level.

18. MATERIALS MOVING EQUIPMENT. Many types of equipment are used to handle cargo. Handling techniques employ not only mobile equipment such as handtrucks and forklift trucks but also conveyors and other devices which may be installed as part of an integrated freight handling system.

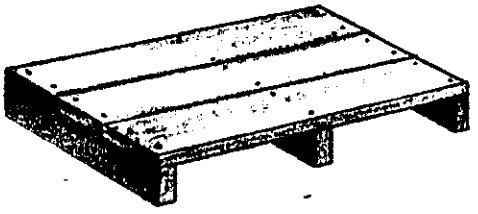
a. **Handtrucks** are generally employed in the storage area to move relatively small loads. The operation that processes only nominal amounts of air freight per day would have little need for anything more than this basic type of handling equipment. Both two-wheel trucks and four-wheel trucks are in general use. Two-wheel trucks normally are limited in capacity to less than 2,000 pounds. Four-wheel trucks are designed for capacities up to 5,000 pounds. Several may be hooked together in train fashion and moved by a motorized tug.

b. **Forklift trucks** vary in size with capacities from 1,500 pounds to 20,000 pounds. The forklift offers more flexibility for the movement of cargo than the handtruck because of its capability for moving loads vertically. It is an effective device for moving loaded pallets from the processing facilities to the floor level of the aircraft. However, it is limited in the size of pallets it can carry.

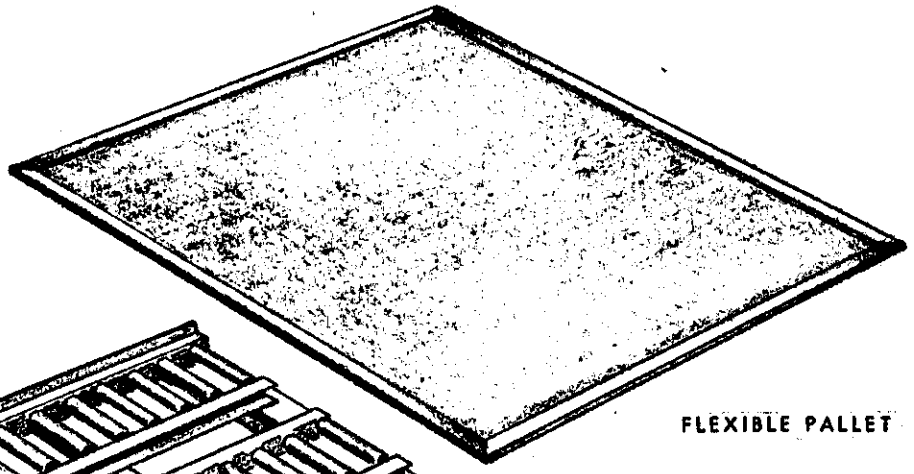
c. **Scissors lifts** may be utilized in transporting freight from the cargo building to the aircraft or as a lifting device in the loading operation. This equipment can transport much larger loads than the forklift truck. Its use is expected to increase in freight handling.



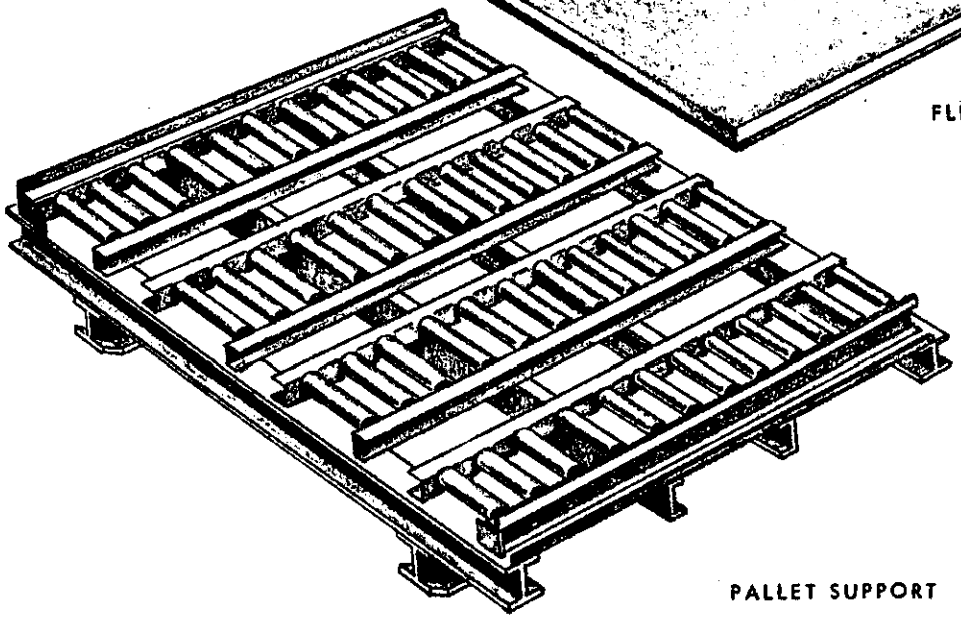
DOLLY



PALLET

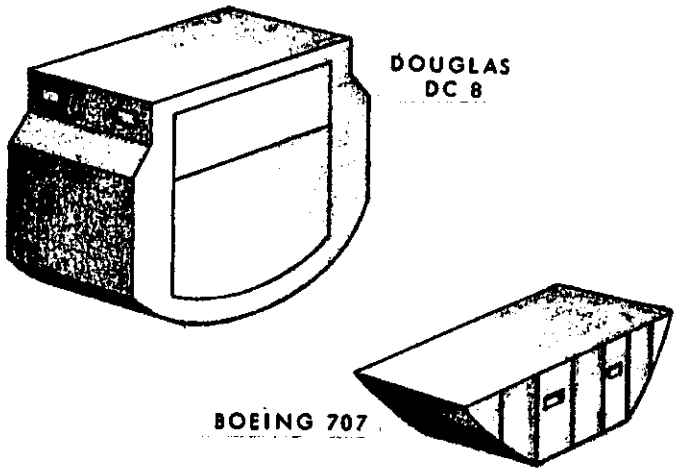


FLEXIBLE PALLET

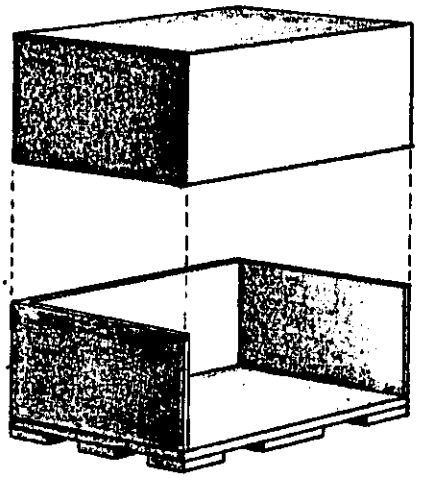


PALLET SUPPORT

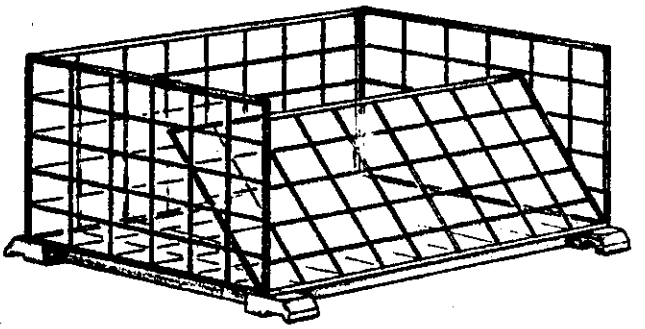
FIGURE 6. PALLETS AND DOLLY.



JET AIRCRAFT "BELLY" CONTAINERS



THREE-SIDED CONTAINERS



COLLAPSIBLE CONTAINER

FIGURE 7. CONTAINERS.

d. **Overhead hoists** have been used to provide efficient movement of very heavy shipments. Complete coverage can be attained by means of track-mounted traveling girders spanning the entire width of the processing area. With this arrangement, movement of the hoisting equipment is possible in any direction; and there is complete control of the item being handled. The installation of such equipment, however, is costly.

e. **Conveyors** may be used effectively in materials handling. They may consist of a series of rollers, endless belts, or a continuous chain as illustrated in figure 8.

(1) *Roller conveyors* may be gravity activated or motor driven. They may be portable or fixed The portable roller conveyor is most often used in loading or unloading at the truck dock. It may also be used within the aircraft or the processing facility. Unit conveyors, each 10 feet in length, can be joined together when the distance requires a longer run. Gravity type roller conveyors are most ideally suited for unloading or loading of objects which must be moved to a lower level. Motor driven roller conveyors, generally known as live conveyors, are advantageously used when objects must be moved a distance greater than 25 feet and the path of travel is not to a lower level.

(2) *Belt conveyors* transport items on a continuous motor driven belt. They may be used advantageously for moving objects from a lower to a higher level. They may be employed as a portable unit or incorporated into a conveyor system acting in concert with other types of conveyors. Portable units are often mounted on vehicles and used to load or unload freight from an aircraft.

(3) *Dragline conveyors* or tow-type conveyors are continuously moving chains to which carts or trucks are secured. The chain may be placed in a track recessed into the floor or it may be moved on an overhead beam. The floor recessed chain, though more costly to install, eliminates the need for overhead suspended moving parts with the attendant safety hazard.

19. CONVEYOR SYSTEMS. These systems, used for the handling of materials, are arrangements of various types of conveyor components and are considered as a key item in an integrated materials handling system. A system may be an "open system" or a "closed system." Open systems consist of continuous conveyor lines on which it is possible to place or remove an article at any point. If the article is not removed, it will continue around and may be removed at any time without affecting other items in the line. The towveyor, by the nature of its operation, can only be considered an open system. Closed systems contain branchoffs and one or more dead ends.

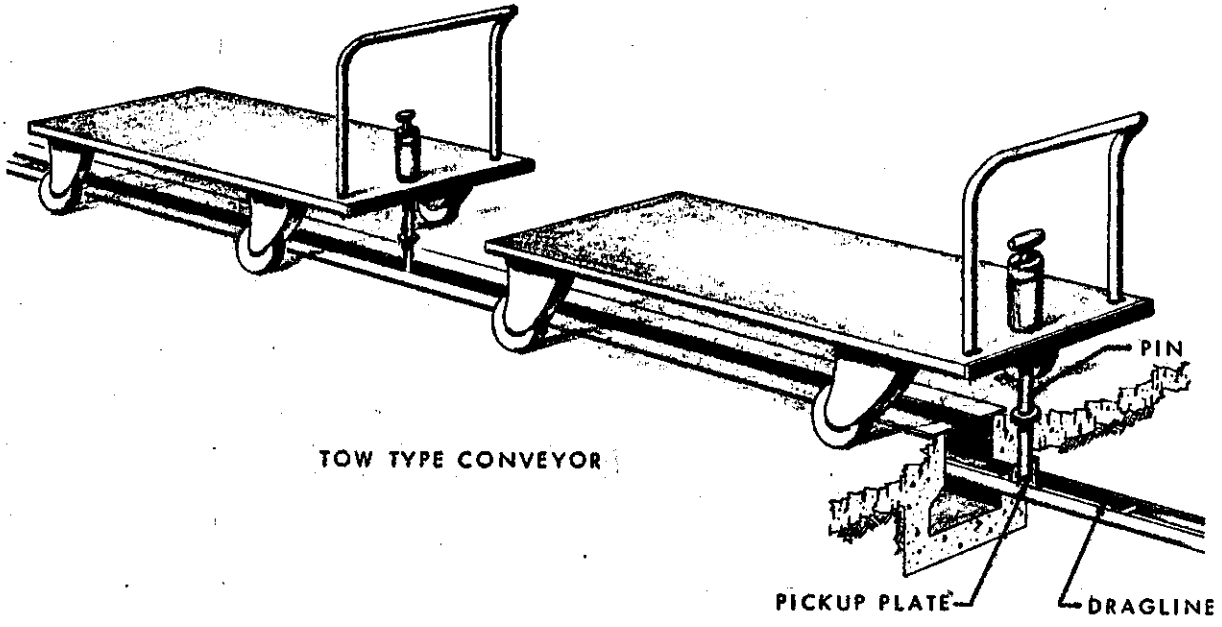
20. INTEGRATED SYSTEMS. Materials handling equipment may be integrated in such a way as to incorporate a combination of the closed and open systems and a number of diverse types of equipment. Figure 9 on page 16 illustrates various types of conveyor-equipment systems. A system may include a towveyor, or roller or belt conveyor equipment in an integrated arrangement for handling of freight. Large-volume freight operations can be handled most efficiently by integrating both the truck and the aircraft into the materials handling system of the freight facilities.

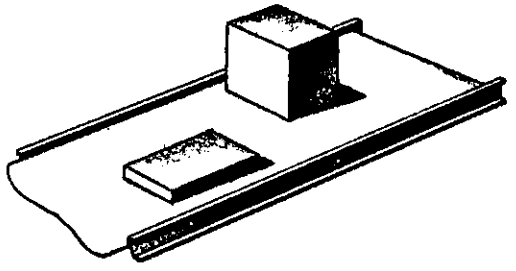
21. PILOT SYSTEM

a. A system has been developed for the U.S. Military Air Transport Service (MATS) bases using conveyor lines in the building and conveyorized floors, rollers installed as an integral part of the floor, in both surface and air transport units. Where hundreds of tons of freight are moved daily, it can be processed in minutes instead of the hours required for a nonintegrated system.

b. When a truck pulls up to the dock, a conveyorized arm or telescoped roller conveyor is used to reach the floor of the truck. A push bar on the truck is activated by a winch within the truck which moves the entire contents from the conveyorized floor of the van onto the conveyorized arm. The freight is then moved on to the conveyor system where it is to be processed to an assigned aircraft flight and section. Freight is stored on branch conveyors until it is time for load build-up or to palletize freight. All freight is unitized on special pallets and is moved on to the conveyor lines designated by destination and section number. In this way, loads for each flight can be set up in sequence automatically.

c. Pallets are guided throughout their travel by tracks and slide on roller conveyors to a final position on the floor of the aircraft. All conveyors are designed into a common system so that it is possible to unload an aircraft while freight to be enplaned is prepared for shipment. Pallets con-





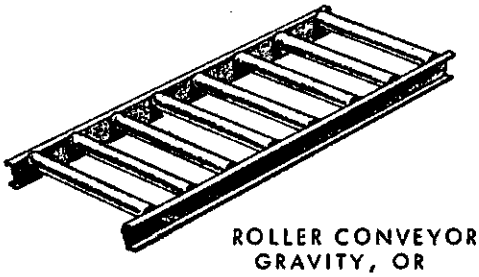


FIGURE 8. CONVEYOR TYPES.

taining loads up to 10,000 pounds are moved by mobile loading equipment having a roller-conveyor-type floor. These loaders are designed to move one or more pallets depending upon the requirements of the system complex. Unitized freight can be loaded on the aircraft in a time approaching that required for refueling and servicing of the aircraft.

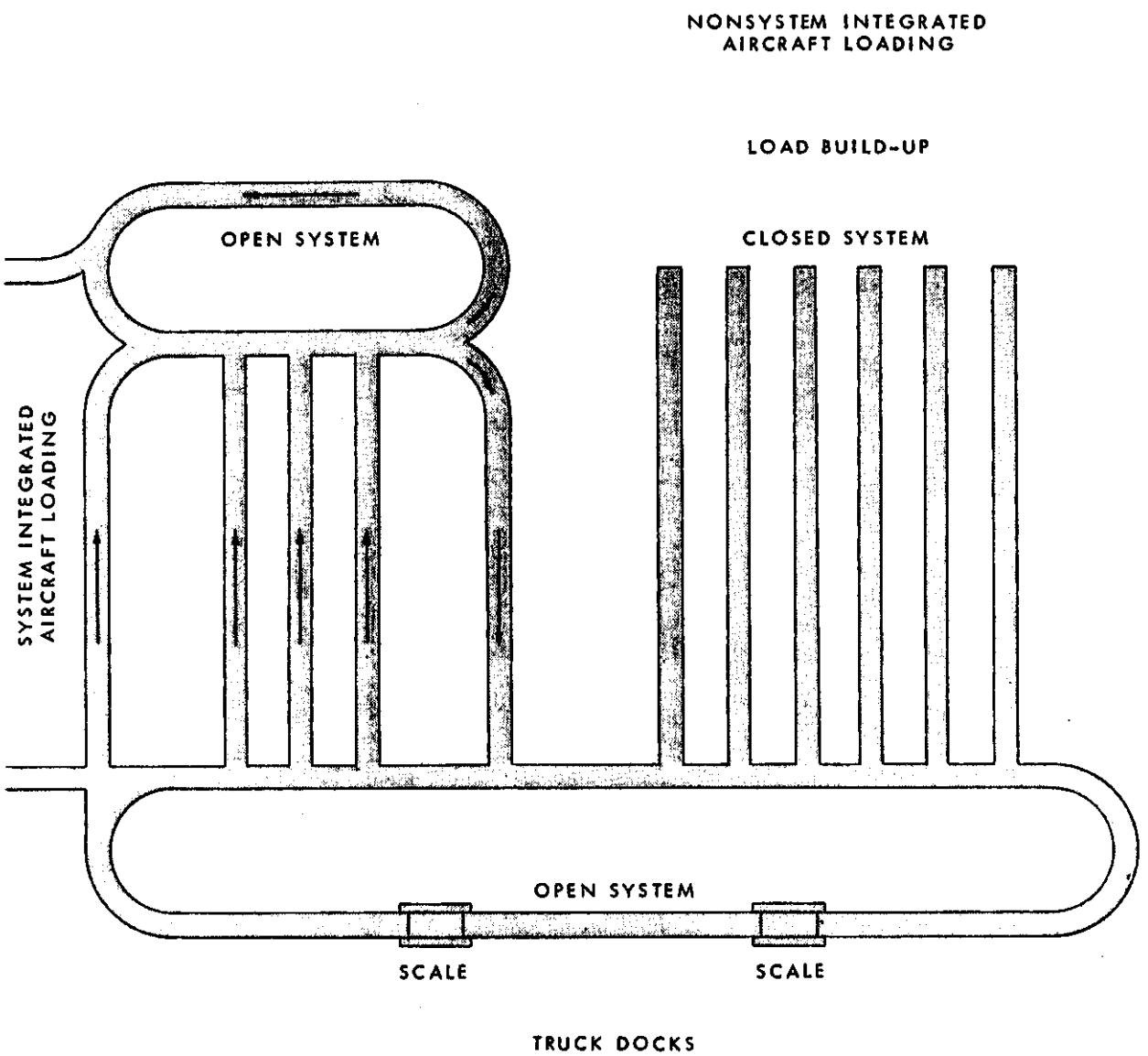


FIGURE 9. CONVEYOR SYSTEMS.

SECTION 3. AIRCRAFT LOADING

22. MAJOR FACTORS. Those factors associated with aircraft loading also influence the planning of operations in air carrier cargo facilities. Four major points to consider in analysis of materials handling systems and building-space requirements are payload factors at takeoff, aircraft center of gravity or weights and balances, destination and routing, and aircraft loading characteristics.

23. PAYLOAD. The payload factor is the ratio between tons of freight actually loaded and the tons of freight permitted to be loaded on the aircraft. An aircraft capable of a takeoff payload of 30,000 pounds but carrying only 18,000 pounds is operating with a payload factor of 60 percent. In such a case, the aircraft is not earning its full potential. It is important that loading permit as high a payload factor as practicable.

24. AIRCRAFT CENTER OF GRAVITY. Federal Aviation Regulations establish performance requirements for aircraft. Control of weights and balances, thus the aircraft center of gravity, is essential to the proper performance of the aircraft. In all-cargo aircraft, the interior of the fuselage is divided into sections. The manufacturer designates the maximum allowable weight which may be stowed in each section considering floor loading limits and proper securing of freight for safe performance of the aircraft. An example of a longitudinal cross section of an aircraft fuselage indicating station divisions and the maximum allowable load for each station is illustrated in figure 10. This type of chart is used in establishing aircraft loading.

25. DESTINATION AND ROUTING

a. For an aircraft scheduled to fly from one terminus to another, loading is quite different from that for a flight with intermediate stops. In the former case, only weights and balances must be considered; but in the latter, it is necessary to consider also the sequence loading. When freight must be removed at intermediate stops, loads must be arranged so that the deplaning freight can be removed easily without disturbing freight designated for other points. Freight also may be taken on at these intermediate locations to replace that which was removed. When replacement loads are not provided, the freight retained on the aircraft may have to be rearranged to assure proper distribution of loads.

b. The destination of the aircraft is a determinant in the amount of fuel that is carried. Generally, an aircraft scheduled to fly a short distance may be capable of carrying a greater amount of freight than if it were to fly a long, nonstop route. However, the amount of payload that can be substituted for fuel is limited by the structural characteristics of the aircraft. This is an important consideration that influences the preparation of aircraft loads.

26. AIRCRAFT CHARACTERISTICS

a. The location of the aircraft loading entrances is a consideration in determining the preparation of materials handling. All-cargo aircraft may be loaded from the side, at either end, or both ends. On aircraft that are side loaded, the large freight doors are usually on the left side of the fuselage. The swing-tail all-cargo aircraft is an innovation in design now used.

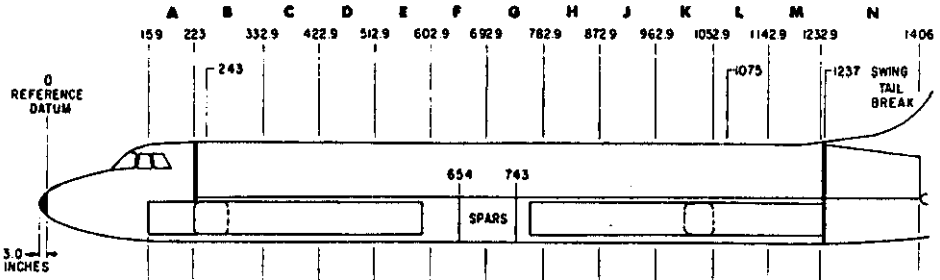
b. The floor height of the aircraft varies from 44 inches, which is a "truck bed" floor height, up to 12 feet in which case the aircraft is known as "high floor" aircraft. It is possible to load or unload a "truck bed" floor height aircraft directly from the freight truck and to design the entire system for this common height. Some means of lifting the freight to the floor level of a "high floor" aircraft are needed.

c. Controlling the proper load distribution in combination aircraft is not as simple as in the all-cargo configuration. Generally, cargo is placed in baggage compartments in the underside of the passenger aircraft as "topoff" load. The number of passengers and their baggage will vary considerably and controls the amount of cargo that may be

stowed in the baggage compartment. This variance also makes the maintenance of proper load distribution more complex.

d. For piston-type combination aircraft, the space designed for cargo and baggage has not allowed for an efficient mechanized system of containerized loading. Consequently, it is necessary to load freight and baggage manually. However, the amount of space available for baggage in such an aircraft is relatively small and the time required to place a load on the aircraft is not critical.

e. On some large jet combination aircraft, baggage and cargo loaded in the underside of the plane are carried in special containers. These containers, shaped to fit the aircraft fuselage, slide into the lower compartment of the airplane and have a capacity of approximately 1,500 pounds. They are preloaded in the air cargo facility, delivered to the aircraft on the loading apron, placed aboard the aircraft by means of a special hoist, and installed in the baggage compartment. With such a system, the freight is offloaded and onloaded within the time it takes to deplane and enplane passengers and to refuel the aircraft.



NOTE
Between Sta 223 and 243 Above Floor is an Equipment Access Area, No Cargo is Loaded.

	A	B	C	D	E	F	G	H	J	K	L	M	N
MAXIMUM COMPARTMENT LOAD INCLUDING UNDERFLOOR COMPS (POUNDS)	1600	8250	8250	8250	8250	8250	8250	8250	8250	8250	5757	5170	3000
ACCUMULATED LOAD FORWARD/AFT OF THESE STATIONS NOT TO EXCEED (POUNDS)	1600	9300	15,600	21,900	28,200	36,325	36,325	30,515	23,620	17,320	11,020	6760	3000
COMPARTMENT CG POSITIONS AFT OF REFERENCE DATUM ABOVE FLOOR (INCHES)	191	278	378	468	558	648	738	828	918	1008	1098	1188	1321
COMPARTMENT CG POSITIONS AFT OF REFERENCE DATUM BELOW FLOOR (INCHES)	385									1006			
MAXIMUM LOCAL FLOOR LOADING ABOVE FLOOR (LBS/SQ FT)	200					300		200					150
MAXIMUM LOCAL FLOOR LOADING BELOW FLOOR (LBS/SQ FT)	75							75					
MAXIMUM LOADING MAIN COMP. AND UNDERFLOOR COMPS. (LBS/FT RUN)	300	840				1100		840			460		215
FRAME STRENGTH LIMITATIONS (LBS/FT RUN)	300	1100									660		300
MAXIMUM LOADS IN LOWER COMPS (POUNDS)	10775 EVENLY DISTRIBUTED							11563 EVENLY DISTRIBUTED					

NOTE
Data Taken From Canadair Integrated Cargo System 2nd Edition October 1960

FIGURE 10. AIRCRAFT LOAD LIMITS.

CHAPTER 3. AIRPORT CARGO CENTER AND ITS BUILDINGS

SECTION 1. AIRPORT CARGO FACILITIES

27. INTERRELATIONSHIPS OF FACILITIES. As the air cargo industry grows, the complex on the airport designed to handle air cargo becomes a significant element in airport planning and design. The discussion of the various components of air cargo industry in chapter 1 explained in part the essential interrelationships of the facilities that may be necessary at an airport cargo complex. These facilities must provide for the efficient transfer of air cargo between surface transportation and aircraft. For larger airports, the complex may include a number of air carrier cargo facilities or multiple-occupancy buildings.

28. DESIGN CONSIDERATIONS

a. The elements that compose the airport cargo center facilities and establish their character, size, and configuration will depend on the level of activity of the air cargo industry in the community served. The architect-engineer should work closely with the air carriers, air freight forwarders, truckers, and airport management to determine what is needed including any special requirements peculiar to these facilities. The resulting design must satisfy present requirements and provide the flexibility necessary for future expansion. Buildings should be oriented, and land should be available to enable a logical expansion plan. This is discussed in section 3 of this chapter.

b. The air carrier cargo facility is the core of the cargo center, and the emphasis in this chapter is on that facility. It may be treated as a single building or combination of elements under one roof sufficiently integrated to permit operation as a single entity.

c. The design program, in the architect's vocabulary, denotes the building users space requirements. It is one of the basic essentials for a successful solution to the design of any building. Fundamental considerations in developing a program are the elements of the building, the amount of space needed by each element, and the relationships between the spaces.

SECTION 2. AIR CARRIER CARGO BUILDINGS

29. ELEMENTS OF THE BUILDING

a. An air carrier cargo building may be planned for single or multiple occupancy. The type of occupancy normally will depend on the potential for air cargo industry growth in the community being served and the volume of business generated by each of the airlines. At airports where there are a number of carriers, each generating only nominal amounts of freight daily, a multiple-occupancy building can provide adequate space to satisfy the needs of all. Single- or double-occupancy buildings with adequate aircraft apron space should be considered for those air carriers that operate all-cargo schedules and handle larger amounts of air freight.

b. There are four major functional elements to consider in the design of the air carrier cargo building. These are the freight-handling areas, administration area, personnel and customer accommodations, and service facilities. Figure 11 indicates diagrammatically the space relationships for functions within the air carrier cargo facilities. Airport cargo buildings should be designed for planned expansion in both length and depth, where economically feasible, and fixed support facilities so located to avoid interference with such expansion.

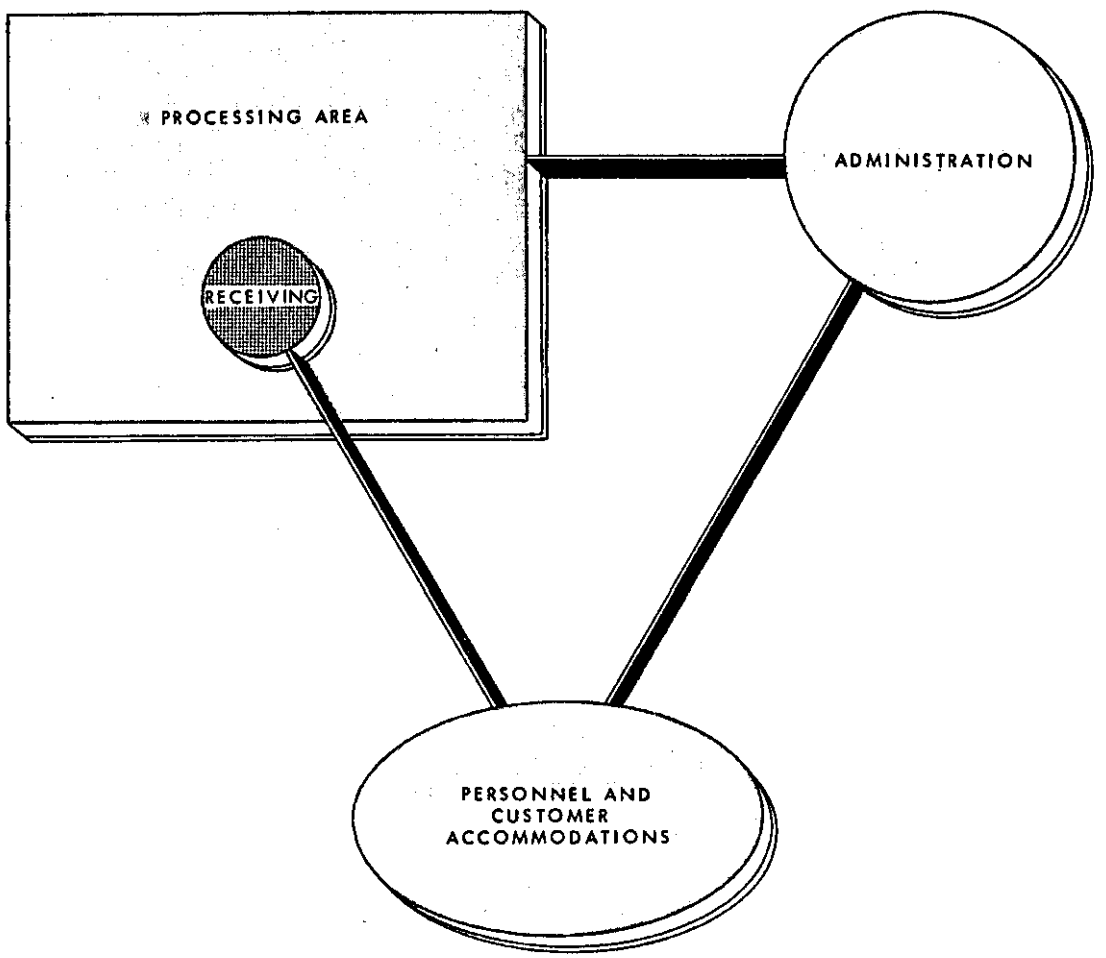


FIGURE 11. SPACE RELATIONSHIPS WITHIN BUILDINGS.

30. TRUCK DOCK FACILITIES

a. There must be a sufficient number of truck stations to serve truckers, air freight forwarders, and others for both incoming and outgoing shipments. In addition to truck dock positions, consideration should be given to providing facilities for the airport-to-airport customers who use other than trucks to deliver or pickup small shipments.

b. The number of truck dock spaces will vary with the airline operation and the community. To determine the optimum number requires detailed analysis of truck arrival in a peak hour, the service time at the dock, and the acceptable waiting time for those experiencing delays.

c. The minimum number of dock spaces required for incoming trucks can readily be determined. Assume for example a normal "stripping" or unloading rate at each dock space of approximately 5,000 pounds per hour. This rate includes time allowed for delays and spotting of vehicles. For an inbound volume from trucks of 90,000 pounds of freight and a time allowed for "stripping" vehicles of 3 hours, the unloading would have to be accomplished at the rate of 30,000 pounds per hour. Thus, there would be a requirement for 6 truck spaces at the dock for this operation.

d. The width of each truck station should be a minimum of 12 feet to allow for parking of large vehicles. Building door openings at each station should be a minimum of 10 feet wide by 10 feet high. Extensive open platforms are not recommended because freight left in the open is subject to pilferage and damage from inclement weather. Protection from the weather for freight and personnel during stripping or loading operations should be provided by an overhang canopy of at least 5 feet. Clearance above the top of the parked freight van should be approximately 18 inches.

e. Building floor heights may vary from 44 to 47 inches above grade. There are a number of leveling devices for accommodating truck bed heights ranging from 30 inches for a pickup truck to 50 inches for a large tractor-trailer.

31. PROCESSING AREA

a. Receiving, sorting, weighing, labeling, and building up of loads for shipment are the major activities in the processing of freight from the truck to the aircraft. There are a number of factors which have a profound effect on total space requirements.

(1) *Cargo turnover* is affected by such variables as types of aircraft, frequency of service, time of day of arrivals and departures inbound, outbound, and directional preponderance of cargo.

(2) *Density of cargo* accounts for considerable dimensional disparity. A ton of cut flowers occupies many times more space than a ton of machine parts.

(3) *Character of cargo* creates a need for specific space allocation. Refrigerated storage is required for perishable cargo, and other temperature controlled areas are needed for live cargo. Bonded storage is needed for customs, import/export control, as well as security accommodations for valuable cargo.

(4) *Methods of handling and storing* cause variations in space requirements. Operations utilizing forklifts and pallets require more square footage for circulation and maneuvering.

b. The arrangement of space in the load build-up areas is also influenced by aircraft loading characteristics. Space should be planned for sequence loading to provide for distribution of weight in the aircraft and for easy removal of loads at destinations. Freight to be loaded on combination aircraft should be kept separate from freight to be loaded on all-cargo aircraft. Loads to be unitized on pallets, loads to be unitized in containers, and those to be loaded on aircraft manually should be controlled by providing separate but adequate space for each. The types of aircraft and the numbers of each type being served by the facility should be given careful study.

c. Consultation with the users as to the type of materials handling systems to be employed is essential and will be most helpful in this area of design. As materials handling systems for the air cargo industry are developed and improved, space requirements for the load build-up area and other operations may be reduced substantially. Figure 12 indicates diagrammatically suggested space requirements for receiving and processing areas.

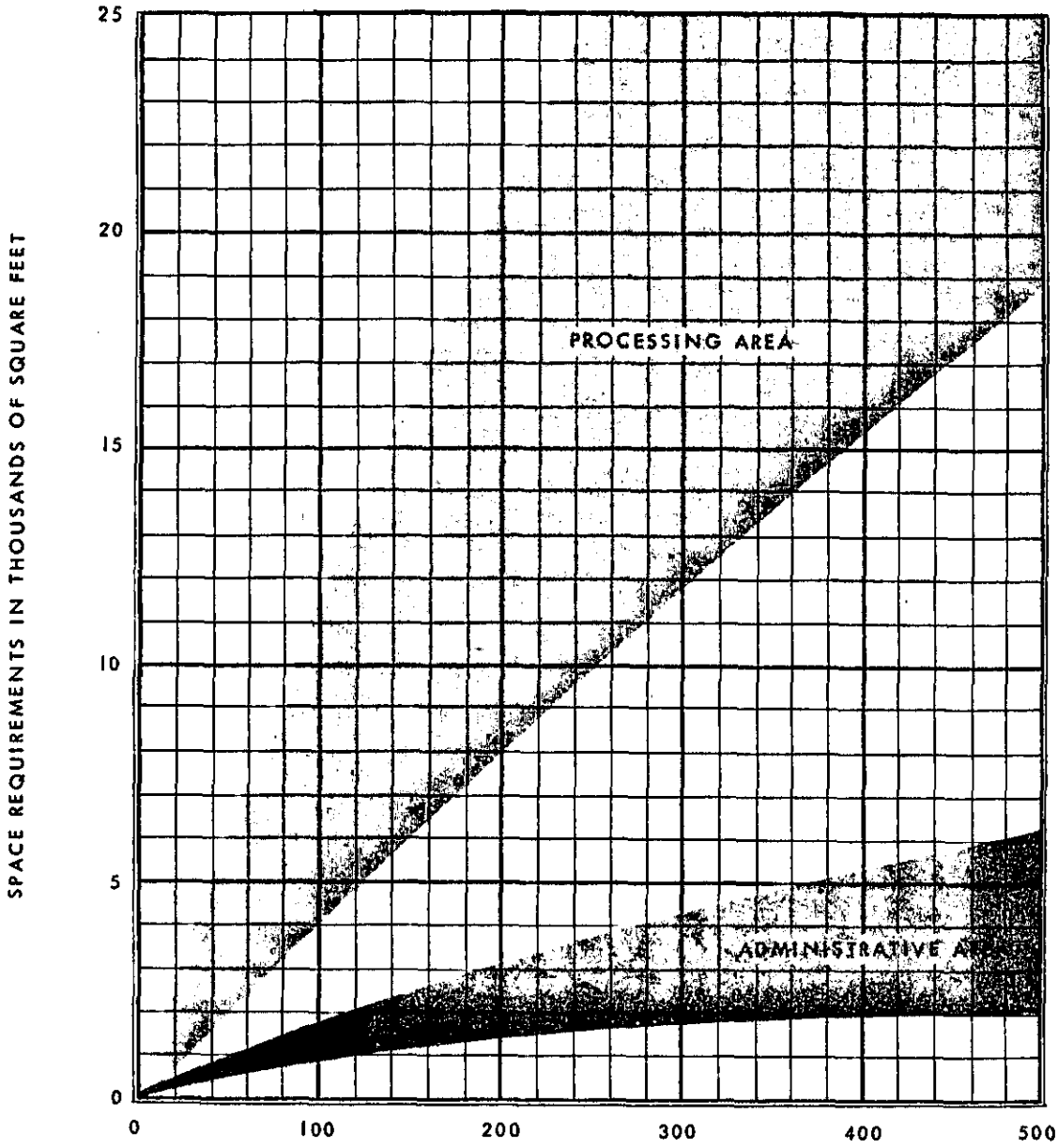


FIGURE 12. BUILDING AREA SPACE REQUIREMENTS.

32. ADMINISTRATIVE AREA, AND CUSTOMER AND PERSONNEL ACCOMMODATIONS

a. Adequate administrative space is necessary for efficient management of cargo operations. The control of all activity is dependent upon decision-making personnel who must have adequate office accommodations. A thorough analysis of the duties and responsibilities of the administrative personnel should be made prior to preparing the design program of the building. The number of employees that may ultimately be employed in the management of operations should be studied.

b. Reception areas should be provided to handle customers. In addition to serving as a receiving point for visitors, small packages may be claimed or bills may be paid here. There should be sufficient space for a counter, accommodations for customers, and cases for display of brochures and other sales material.

c. Sales offices may be required by some airlines. Space in the sales office should provide for desks, files, and facilities for telecommunications. Files should be readily accessible to all the salesmen. The sales office may serve also as a customer service center or clearinghouse for telephone inquiries. Close communication must be maintained between this office, receiving, aircraft space control, and accounting.

d. Management and general office space requirements are dependent upon variables such as the type of operation, the amount and type of freight processed, and the community being served. Accounting and records offices may be necessary facilities for operations of any sizable magnitude. The space required varies with the type of record-keeping and accounting equipment that may be used such as automatic filing systems and data-processing equipment.

e. Communications centers assist management in the efficient movement of freight. Each facility component must be kept informed of changes in schedule, cargo space available, and of special shipments requiring unusual attention. The communications center can serve as the central nerve system. It can provide the link between administration and operations. Space may be required for teletype machines and closed-circuit television facilities in addition to sufficient desk space for communications personnel.

f. Aircraft space control office requirements are dependent upon the amount of freight handling activity. This office may be placed in the receiving area or in the administration offices. Space must be provided for computing and communications equipment and for aircraft charts indicating cargo space available on the aircraft. These functions are closely related to those of receiving and processing and to those of the communications center. Provisions should be made to facilitate close liaison with these interrelated functions.

g. The number of personnel employed in cargo operations will vary not only with the type and volume of freight handled but also with the materials handling system used and the scheduling of aircraft loading operations. A careful study should be made of all factors including local codes and state labor laws to assure adequate provision for employee needs. Figure 12 indicates suggested space requirements. This overall area may be allocated to administration, customer accommodations, and personnel accommodations such as rest rooms, locker rooms, and lunchrooms. A first aid room, pilot-ready room, or other specialized area may be included dependent on circumstances peculiar to proposed facilities.

33. MAINTENANCE, SERVICES, AND STORAGE

a. In order to provide for an efficient operation, equipment must be kept in good working order at all times. Maintenance and storage of materials handling equipment, such as containers, should not be overlooked. The functions of maintenance and storage may be joined, or they may be completely separated. The manner in which these functions are handled depends largely on the type and amount of equipment used.

b. For large operations, maintenance and servicing shops may be necessary to provide repairs for such items as pallets and containers, forklift trucks, conveyors, and other materials handling equipment. Webbing used to secure freight against dislodgment in aircraft requires periodic repair. The maintenance and the servicing shops may be centrally located in the cargo complex, or they may be constructed as a part of the air carrier's individual freight handling facilities.

c. Garage or hangar space may be required for larger pieces of equipment, such as scissors lifts,

mobile freight loaders, or other vehicles used in the freight loading operations. In some cases, it may be economically more practical for the air carriers if this space and this type of equipment are furnished by the airport management on a rental basis.

d. Space required for building utilities, such as plumbing, heating, ventilating, air conditioning, electricity, and gas depends primarily on the geographical location of the airport. Other factors, such as requirements of servicing equipment, type of fuel available in the area, and accessibility of public utilities to the airport cargo center, also must be considered. All utilities may be centrally located on the airport and furnished to users by airport management. Each building may house its own space for the provision of these utilities. Careful consideration must be given by the architect-engineer to this aspect of the building design in order to make sufficient provision for all necessary building areas.

34. SPECIAL HANDLING

a. Some types of freight require special handling, that is, facilities and techniques not ordinarily used for normal items. Requirements depend on the policy of the air carrier in accepting shipments that require special techniques. Basically, four types of shipments which fall into the special handling category are live animals, perishables (pharmaceuticals, meats, produce, and flowers), and bonded and valuable shipments.

b. If the volume of live animal shipments is expected to be large, special provisions for them should be given consideration. Heating, ventilation, cleaning facilities, fresh water supply, cages and stables, and storage facilities for handling, cleaning, and feeding equipment will require study. Consultation with the local chapter of the Society for Prevention of Cruelty to Animals (SPCA) is suggested.

c. Perishables are being shipped in increasing quantities. Bonded and other valuable freight processed varies not only with the economic character of the community but also with the seasons.

35. FACILITIES AT INTERNATIONAL AIRPORTS. Air carriers providing service for overseas shipments at international airports will require space for inspection of deplaned freight. Consultation with Bureau of Customs, Agricultural Research Service, and Public Health Service officials in addition to the airlines is essential in developing a proper design program for this area.

36. BUILDING CONSTRUCTION

a. Building design consistent with functional requirements and the need for economical construction and maintenance cannot be overemphasized. Airport buildings are often constructed in areas beyond the jurisdiction of a city building code. Materials and methods of construction and design of an airport cargo building may or may not be governed by a building code of the local community or regulations established in state labor laws. When local codes are applicable, particularly in small communities, the standards designated in such codes are sometimes below those acceptable as good architectural or engineering practice for buildings on airports.

b. It is suggested that airport owners voluntarily adopt standards from one of several recognized sources. Standards representing good practice can be found in the "Recommended Building Code" of the National Board of Fire Underwriters (NBFU). "The Uniform Building Code" adopted by the Pacific Coast Building Officials Conference and the "Southern Standard Building Code" prepared by the Southern Building Code Congress are also excellent guides.

c. Selection of the structural system to be used for the building should be based on careful consideration of the insurance rates for various classes of building construction and occupancy. The initial cost of fire-resistant construction may be higher than other types of construction, but a lower insurance rate will often offset this higher initial cost. Fire is not the only hazard about which the designer must concern himself. Protection against pilferage, vandalism, or possible sabotage in time of emergency should be considered in choosing materials of construction. The location of the building and the types of commodities moved through the facility will also influence the type of construction.

d. Structural systems having the capability of economically spanning as much as 100 feet provide greater flexibility in building design and space arrangement. Clear-span structures are desirable because they allow for greater maneuverability of

forklift trucks and other freight handling equipment. Large-space areas, free of columns and bearing walls, can be divided and adapted to satisfy the changing demands of functional operations. Roof construction and roof design loads vary with the area of the country. The recommended code of the NBFU suggests that ordinary roofs, either flat, pitched, or curved, be designed for not less than 20 pounds per square foot of horizontal projection in addition to the dead load and wind or other loads.

e. Floor construction, according to the NBFU-recommended National Building Code, should be designed and constructed for the greatest loads that are anticipated by the user. Provision should be made for such items as floor scales, pit elevators, and recessed tracks for towveyor systems. Floors in the office areas, where extensive filing systems are maintained, should be designed to carry a minimum uniformly distributed load of 125 pounds per square foot.

f. Selection of doors must be given careful consideration. Overhead and roll-up doors are suggested in areas where there is movement of freight. The tracks of the overhead-type door should be installed to provide as much headroom as possible within the building.

g. Bumpers and guards for protecting truck-dock edges are available in many designs. The nature of activity, the devices used for loading operations, and the amount of traffic are the determinants in making a selection. The use of bumpers and guards will help keep maintenance of dock areas to a minimum.

h. Interior finishes depend upon local factors, but they should be selected from the standpoint of minimum maintenance. The functional use of the area should be the determining factor in the selection of the finishes. In the processing and storage areas of the building, a smooth concrete finish for the floor should be adequate. A hardening additive may be used in the concrete to make a durable surface.

i. The toilet rooms should have floors and walls finished with a hard impervious material for ease of cleaning and maintenance. The wall finishes may be an integral part of the wall construction, such as glazed partition block or glazed brick where budgets permit. The locker room floor should have a painted, smooth finished concrete floor if costs must be kept at a minimum. Walls may be painted masonry units or plaster. Since locker rooms are generally noisy places, an acoustic ceiling should be considered for this area.

j. There is a wide selection of finishes available for administrative areas. For the floors, rubber and vinyl tile finishes generally provide a durable floor but may be difficult to maintain in areas adjacent to the processing areas. Walls may be painted plaster, wood veneer, or plastic. Prefinished or plastic-coated wood veneers are available that can be economically installed and provide a durable surface requiring little maintenance. Acoustic ceilings are recommended for these areas. "Airport Terminal Buildings" contains information on noise control which may be helpful to the designer.

37. UTILITIES

a. Heating and ventilating requirements vary with the climate and the requirements of the user. It may be possible to integrate systems with the humidity and temperature control required for handling special commodities. A system which will provide proper year-round conditioning of air particularly in administrative areas is important.

b. Electrical and lighting systems should be adequate for the designed functions. The requirements of the electrical service vary with the size and character of the facility. Much will depend upon the nature of the materials handling system used. Minimum required lighting levels may be governed by local codes or state labor laws; however, these may sometimes be below those acceptable as good architectural or engineering practice for buildings on airports. It is recommended that airport owners voluntarily adopt the standards from one of several recognized sources.

SECTION 3. AIRPORT CARGO CENTER LOCATION

38. IMPORTANCE OF SITE PLANNING. The complex on the airport specifically designed for the handling of air cargo is one of the major elements on the airport. The airport cargo center must be sited in a location that will contribute to the efficient transfer of cargo between surface and air transport. The selection of an appropriate site is the decision which determines to a large extent the effectiveness of the air cargo operation. The location of the elements of the complex in proper relationship to each other is of equal importance.

39. LOCATION ON THE AIRPORT

a. Four primary considerations dictate the selection of the site on an airport for the cargo complex.

(1) Taxi distance from the most used runways should be as short as possible, and yet there should not be interference with passenger operations.

(2) The site should be readily accessible by surface vehicles from the passenger aircraft loading positions for efficient servicing of aircraft carrying both passengers and cargo.

(3) The complex should be readily reached from all access roads to the airport to assure nonintereference of vehicular traffic with aircraft movement areas.

(4) Adequate space should be allowed for expansion of air cargo operations without encroaching on other airport functions particularly without interfering with the expansion of the passenger terminal.

b. These four primary considerations indicate the general relationships with other functions and activities. They require extensive study to determine the degree to which they can be met on any individual airport. This study can best be made through the medium of an airport layout plan in which the advantages of possible locations and their effect on other airport facilities and operational activities can be objectively weighed. The importance of making provision for airport cargo center facilities in the airport layout plan cannot be overemphasized.

40. PLANNING CONSIDERATIONS. The general location of the cargo complex having been established and the preliminary design concept of the building groups selected, a number of other factors should also be studied prior to adoption of a siting plan.

a. The arrangement of buildings and associated support facilities is important to satisfactory and efficient use, and it also affects future expansion of individual buildings. Important in this regard is consideration of spacing of buildings for access, vehicular circulation, and fire and safety clearances. Vehicular access and roadways, and parking areas are discussed in detail in the paragraphs that follow. Proper orientation of buildings, with respect to these factors and the prevailing winds, is essential to the functional operation of the buildings. Economical design dictates the need for balance of requirements for paved areas with other considerations discussed heretofore. Good drainage, consistent with driveway, parking, and pedestrian access requirements, is a necessary design consideration.

b. Noise is a consideration which must not be overlooked. Acoustical treatment has been mentioned in paragraph 36 on page 25, but there are additional efforts which can be made through proper landscape planting for sound absorption.

41. CARGO CENTER SITE PLAN

a. To illustrate the application of functional relationships discussed in this chapter and in chapter 1, a diagrammatic site plan has been developed. Figure 13 indicates the relationships of facilities for a number of air carrier cargo operators, truckers, air freight forwarders, air express (REA), and airport mail facility (AMF).

b. The site plan orientation on the airport establishes optimum relationships of aircraft parking apron, and access and service roads discussed in the following paragraphs. Guidance material on the total concept of the airport layout plan may be found in "Airport Design."

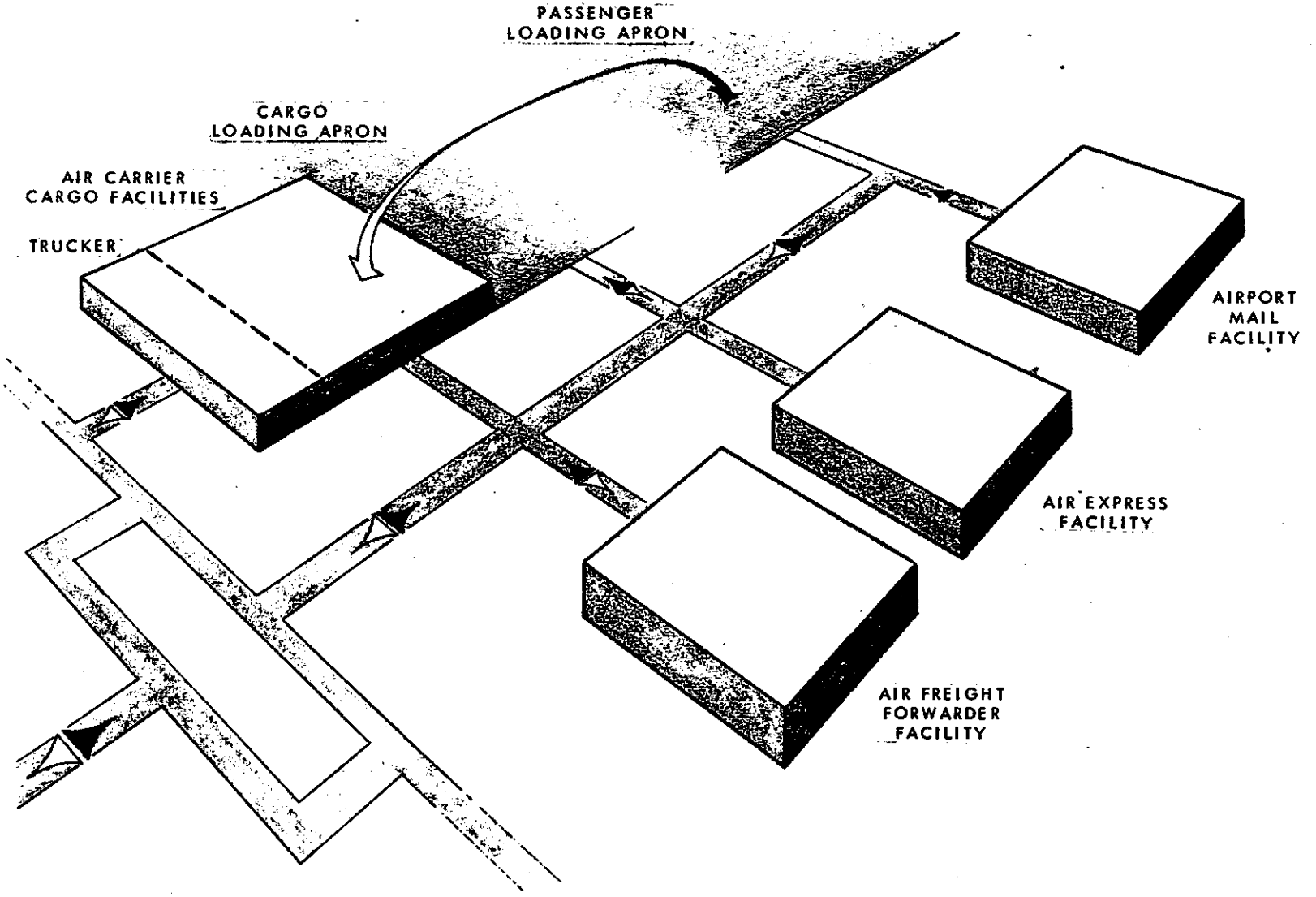


FIGURE 13. RELATIONSHIPS OF CARGO FACILITIES.

42. AIRCRAFT PARKING APRONS. Paved apron requirements for aircraft parking and loading positions adjoining air carrier cargo facilities are dependent upon the type and size of aircraft used, airline schedules, and the type of materials handling system used. The discussion in chapter 1 introduced the relationships of facilities to aircraft parking aprons. This discussion clearly indicates the importance of direct access from certain facilities to the passenger loading apron, of access to both combination and all-cargo aircraft aprons for others, and for completely integrated building-apron relationships for certain material handling systems. Information on space requirements for aircraft apron parking positions can be found in "Airport Design."

43. ACCESS, CIRCULATION, AND PARKING. Discussion of ground vehicle movement considerations is presented in general terms. Detailed guidance material for the planning and design of traffic and parking facilities can be found in "Airport Terminal Buildings."

a. **Roads.** Access to and egress from the airport cargo complex and circulatory roads within it should be direct and unimpeded. There should be as little interference as possible with airport passenger vehicular traffic. In those cases, where the number and types of trucks using the access roads will cause frequent passenger traffic congestion, separate roads should be designed specifically for truck traffic leading directly to the cargo center. Visitors, passengers, and customers should be provided convenient access from the passenger terminal area.

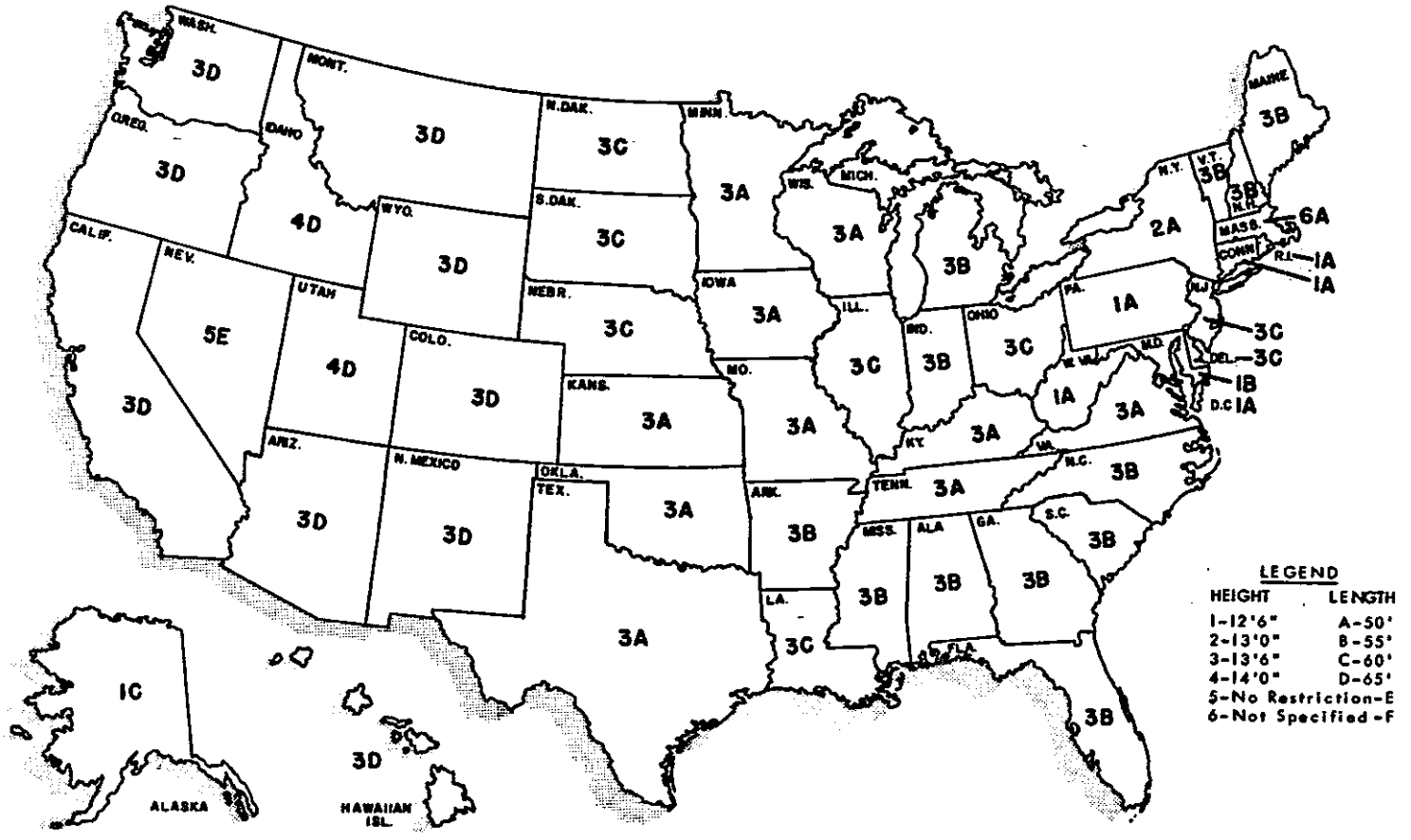
b. **Truck Parking**

(1) Parking areas required include those designed to serve the trucker, the customer and visitor, and the employee. Planning of truck parking spaces and maneuvering areas will probably present a difficult problem because of the many variables. Maximum truck sizes vary from state to state as shown in figure 14. Trucks bringing freight to the cargo center will be of many types and sizes. Parking areas and truck-dock facilities with adequate maneuvering space must be provided for movement of vehicles without creating bottlenecks during peak loading and unloading hours.

(2) Generally, the recommended distance for maneuvering from the loading platform to the nearest obstruction is twice the length of the largest road vehicle expected to use the facility. The Air Transport Association suggests a minimum overall depth of 100 feet for the terminal-truck apron which will allow 75 feet for maneuvering of trucks plus a 25-foot-wide access roadway. Minimum interference distances may in effect be less when tractors with smaller turning radii are used, when the spacing between trailers is increased, or when a saw-toothed loading platform design is used. Other problems, such as combination vehicle maneuvering distances, determining width of an entrance gate, or space required for saw-toothed dock designs, require detailed analysis.

c. **Customer and Visitor Parking.** Those seeking service should have the most direct access possible to the reception areas of individual air carriers, freight forwarders, and other service facilities. These parking spaces may be adjacent to the building in conjunction with the truck parking area. Permanent parking areas should not be located where expansion of buildings is being contemplated.

d. **Employee Parking.** Sufficient parking should be provided for employees' cars which are generally parked for a period equal to the length of the working day. Since the employee does not usually require ready access to his car during this period, it is not necessary to locate the employee parking area directly adjacent to the freight handling facilities. Where the airport is relatively small, an employee parking area common to all operational functions on the airport may be adequate for parking needs. For the larger airport, strategically located parking spaces which may be used by all employees of the airport cargo complex should be considered. There may be just one of these areas planned near the center of activity, or there may be several dependent upon the size and spread of the airport cargo complex. Administrative personnel usually require parking spaces adjacent to the office area because they may have to use their cars frequently during the working day.



NOTE: SIZE LIMITS FOR COMMERCIAL VEHICLES HAS BEEN TAKEN FROM DATA COMPILED BY THE AMERICAN TRUCKING ASSOCIATION

FIGURE 14. ALLOWABLE TRUCK SIZES.

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U.S. GOVERNMENT PRINTING OFFICE: 1964 O—729-866