# Chapter 8. AIR AND GROUND NAVIGATION AND TRAFFIC CONTROL AIDS AT AIRPORTS

## 8.1 ABOUT THIS CHAPTER

Planning of airports must include provision for facilities which will support the air traffic control system, for navigation aids for aircraft approaching the airport and, finally, for control of aircraft and vehicles on the surface of the airport. The purpose of this chapter is to describe the requirements for such control aids as pertain to airport master planning. Specific information on performance of equipment and on siting of navigation and control aids, among others, may be found in Annex 10, Annex 14 and the *Aerodrome Design Manual,* Part 4.

## 8.2 VISUAL AIDS

8.2.1 The selection of the visual aids to be provided at an airport will depend primarily on the visibility conditions under which it is intended operations be conducted and on the type of aircraft to be operated at the airport. The specifications in Annex 14 indicate for each visual aid the operating conditions under which it should be provided. In general, approach and runway lighting aids are related to the type of runway which is planned, that is non-instrument, instrument approach or precision approach Category I, II or III, and this must be resolved before any planning for visual aids is done.

8.2.2 The type of visual aids to be planned both initially and in the future should be determined during the initial planning of the airport, as requirements for approach lighting may require the purchase of additional land for installation, or the clearance of obstacles in the approach area to ensure visibility to pilots approaching to land. The future development of lighting systems may also have an effect in other areas, which might best be prevented by making provision for it in the initial construction phase. An example of this would be duct capacity underneath paved areas. Installation of ducts after pavements have been constructed, besides being costly, requires closure of the area involved and, unless carefully constructed, results in unsatisfactory pavement surface conditions. It is therefore prudent to install more than adequate duct capacity during initial construction. Similarly, if in the near future it is planned to upgrade a runway to precision approach Category II or III, involving in-pavement lights, then it may be found more economical and convenient to include ducts for these lights in the initial pavement construction.

## 8.3 RADIO NAVIGATION AIDS

8.3.1 Most modern airports are likely to have all or some of the following navigation aids:

a) instrument landing system (ILS)*/microwave landing system (MLS);

b) VHF omnidirectional radio ranges (VOR);

c) distance measuring equipment facilities (DME) (generally collocated with VOR or ILS or MLS);

d) collocated tactical air navigation systems and VOR (VORTAC);

e) radars — approach, secondary and surveillance type.

8.3.2 When the types of navigation aids needed at the airport have been decided, the site selection should be carried out with the assistance of the individual expert associated with the aid. Unless the proposed site happens to be flat with few obstructions, some preliminary site clearing and grading would be necessary, depending on the nature of the site, the quality and nature of the navigational facility required and the associated costs. All preliminary grading and site preparation is usually

* ILS will cease to be an ICAO standard system on 1 January 1998. However, on the basis of Regional Agreement, the ILS can remain in service at international airports until 1 January 2000, after which it ceases to be an ICAO Standard system.

included in the airport construction contract. Subsequently, each site should be flight checked using portable equipment, if this is not too difficult to obtain. Unless the selected sites happen to be ideal, the best choice of variables to arrive at the most economical configuration of the required navigation aid can be determined only by means of a flight check.

8.3.3 It is very difficult to specify exact sizes for the buildings for the sites, because the choices and the combinations of the navigation aids are quite numerous. The rapid developments and advances in electronic technology and the consequential miniaturization of equipment may offer radically different concepts, so far as the installation of navigation aids at the airport of tomorrow is concerned. Up-to-date information should be obtained from experts in each field to allocate appropriate areas for the required facilities. However, some general guidance is provided in the following paragraphs.

8.3.4 Parts of the instrument landing system (i.e. markers and non-directional beacons) are not usually located on the airport; however, the control for all facilities and power for the middle and inner markers are usually provided from the airport. The required power supply can be provided more economically from the airport than by separate individual power sources at each of the facilities, with the exception of outer markers and non-directional beacons.

8.3.5 The number of instrument landing systems at an airport would depend on the precision approach runways required. Usually the ILS/MLS is planned to serve the prevailing bad weather wind direction, but since the fair weather use of ILS/MLS is becoming more common for safer operation, especially for large aircraft, some runways are planned to have instrument landing systems at both ends. Since the integrity of the radio signals in space depends on the reflecting properties of the terrain surrounding the antennas, minimal roughness and slope with adequate drainage and soil stability is highly desirable. The roughness of localizer course and glide path depends on the number of unwanted signal reflections received by the aircraft. The number and magnitude of unwanted reflections depend on the number, size and material of objects (e.g. buildings, hangars, vehicles, etc.) and distance of the objects illuminated by the antennas. At those sites where the number of significant objects is unavoidably large, the signal quality can be improved with the help of directional antennas, which are usually more costly and much larger than the standard type of antennas.

8.3.6 Most of the site grading work, construction of access roads and provision of ducts under the runways for the power supply and control of navigation aids should be included in the airport construction contract.

## 8.4 BUILDINGS FOR RADIO NAVIGATION AIDS

When planning buildings for radio navigation aids, the following points should be taken into consideration:

a) *Size.* Particular attention should be paid to the future needs and possible extension or modification of the facilities. In the case of localizers and glide paths, provision of space for dual installations should be considered, from the point of view of both the future construction at the airport and the upgrading of performance to accommodate faster and larger aircraft. Additional space should be allocated for standby powerplants or air conditioning equipment where called for by virtue of equipment design or local climatic conditions.

b) *Power supply.* At those sites where an independent self-contained unit power station cannot be provided, the power supply transformers and associated accessories have to be installed inside the building. Appropriate isolation and ventilation of the radio equipment is necessary to dissipate the additional heat generated by the power equipment. Where standby plants are employed, diesel engine noise is also a factor which should be considered.

c) *Drainage.* Provision should be made to drain the site adequately. Poor drainage, particularly at the glide path sites, can cause appreciable changes to the signal in space and accumulated water in the vicinity of the building could even cause equipment shutdown. Drainage ditches in the vicinity of the glide path antenna must be of such dimension that they do not adversely affect the signals in space.

d) *Access roads.* Restoration of a facility to normal operation depends a great deal on fast and easy access to the building. For those facilities which are located on the airport, access via the runways could cause considerable delays if the traffic is heavy and separate access roads should therefore be considered. If proper planning precedes the choice of the building sites, the cost of construction and maintenance of the access road could be reduced considerably.

## 8.5 DEMARCATION OF CRITICAL AREAS

The areas immediately surrounding the localizer and glide path antennas form a part of the "critical areas" within which obstacles or any sort of vehicle movement is prohibited. These areas are designated as "critical" because presence of reflecting objects can cause intolerable distortion of the signals in space. Particular attention should be paid to the critical areas, so far as demarcation of boundaries and restriction of other airport activities is concerned. The critical areas associated with ILS/MLS are described in Attachment C to Part I of Annex 10, Volume I.

## 8.6 AIR TRAFFIC SERVICES

8.6.1 The requirements for accommodation of air traffic services units and associated equipment on an airport will vary according to the plans developed by the appropriate air traffic services authority for the air traffic services organization. The minimum requirement for all airports is for an airport control tower to accommodate a unit providing airport control service and for accommodation of an air traffic services reporting office. This latter office, however, may not necessarily be a separate unit. At airports planned to be equipped with aids for instrument approach and departure there may be an additional requirement for an approach control office, but in many cases the equipment and staff for such an office are located in the control tower room. At some airports there may also be a need to accommodate an area control centre or a flight information centre. It is important that these requirements be determined at an early stage in consultation with the appropriate air traffic services authorities and that the planning of buildings on the airport take these requirements fully into account. It is also important that flexibility in the arrangements of air traffic services units and adequate expansion possibilities be reflected in the planning.

### Airport Control Tower

8.6.2 The effective provision of airport control service requires a clear and unobstructed view of the entire movement area of an airport and of air traffic in the vicinity of the airport. The airport control tower should therefore be so located and be of such a height that aprons, taxiways, runways and the airspace surrounding the airport, particularly approach and departure areas, are clearly visible from the control room and that future developments of the manoeuvring area or future construction of buildings would not restrict this view. In determining the location of the control tower, the need to avoid sun glare is also an important consideration. The cable requirements associated with the need for remote control or monitoring of the operation of approach and landing aids, and airport lighting and the provision radar and communication facilities should be taken into account. Another important factor is the security of the control tower, and it may be preferable to locate the tower away from public areas avoiding places such as tops of passenger terminal buildings. The control room should be large enough to accommodate control desks, associated devices and operating personnel and provision should be made for equipment rooms, office space and rest facilities immediately underneath the control room. Requirements for special lighting, noise protection, air conditioning and special accommodation of sensitive equipment should be taken into account.

### Approach Control Office

8.6.3 The approach control office, where required as a separate entity, should be located conveniently close to the airport control tower room. The office should be large enough to accommodate control desks, associated devices and operating personnel, and provision should be made for equipment rooms, office space and rest facilities near by. Requirements for special lighting, noise protection, air conditioning and special accommodation of sensitive equipment such as radar should be taken into account.

### Area Control Centre/Flight Information Centre

8.6.4 The area control centre or flight information centre, where required, should preferably be located conveniently close to the airport control tower room and the approach control office. The centre should be large enough to accommodate control desks, associated devices and operating personnel, and provision should be made for equipment rooms, office space and rest facilities near by. Requirements for special lighting, noise protection, air conditioning and special accommodation of sensitive equipment such as radar and computer equipment should be taken into account.

### Air Traffic Services Reporting Office

8.6.5 If required to be established as a separate unit, rather than as a part of another air traffic services unit or aeronautical information service unit, the air traffic services reporting office should be located in close

proximity to other briefing and reporting offices, e.g. meteorological briefing office, aeronautical information services unit, etc. The office should be easily accessible to flight crews of departing and arriving aircraft and to flight operations officers of airlines. It should be sufficiently large to accommodate necessary staff and equipment and to enable flight crews and other personnel to prepare flight plans and reports. Additional information relating to briefing offices may be found in the *Aeronautical Information Services Manual.*

## 8.7 SEARCH AND RESCUE SERVICES

At some airports there may be a need to accommodate a rescue co-ordination centre collocated with or conveniently close to the area control or flight information centre or a rescue sub-centre collocated with or conveniently close to an appropriate air traffic services unit. For information on the accommodation of rescue co-ordination centres and rescue sub-centres see Part I of the *Search and Rescue Manual.*

## 8.8 APRON MANAGEMENT SERVICE

The number and complexity of aircraft and vehicle movements on an apron may create a need for an apron management service and thus separate accommodation for the staff, with clear sight to all parts of the apron in their charge. Requirements for special lighting, noise protection, air conditioning and communications should be taken into account.

## 8.9 COMMUNICATIONS

### Aeronautical Fixed Services

8.9.1 Telecommunications are required to many parts of an airport and, in many cases, to more distant remotely controlled transmitter and receiver stations. Because of the complexity of equipment and connexions to the points to be served (usually by means of cables for which underground conduits and conduits within buildings must be provided), the communications centre installation is relatively inflexible once it is established. It should, therefore, be allotted sufficient space to serve the ultimate point-to-point communications needs of the airport without requiring relocations, and should be sited to avoid restricting the expansion of other facilities. Where point-to-point AFTN or direct ATS speech circuits are operated by radio, remote transmitter and receiver buildings are, in most cases, required. In siting such buildings, several factors should be taken into consideration, such as radio interference, adequate and appropriate space for antennas, accessibility, reasonable distance from the central installation in the communications centre (usually accommodated in or near the passenger building), availability and reliability of power sources, etc.

8.9.2 The size of the transmitter and receiver buildings should be adequate to accommodate the ultimate point-to-point (and possibly aeromobile) radio equipment, workshop, stores, offices, emergency power plant, and other facilities required for efficient operation. In many cases, it may not be possible to site the transmitter and receiver buildings within the airport boundaries, but they should nevertheless be considered as part of the airport installation as far as control and operational aspects are concerned.

### Aeronautical Mobile Services

8.9.3 Air-ground communications for airport traffic control, surface movement control and approach control are operated by the corresponding air traffic services, and the associated terminal equipment should be suitably sited in relation to these services. If air-ground communications for en-route air traffic control or other services are to be provided, the associated terminal equipment should be suitably sited in relation to the corresponding area control centre/flight information centre or other services concerned. The relative inflexibility of these installations, once established, is comparable to that of the aeronautical fixed services, and similar planning provisions should be made. The radio transmitters and receivers associated with the aeronautical mobile service are frequently located at the remote transmitter and receiver buildings mentioned under the aeronautical fixed services heading.

*References*

Annex 10 — *Aeronautical Telecommunications.*

*Aerodrome Design Manual* (Doc 9157).

*Aeronautical Information Services Manual* (Doc 8126).

*Search and Rescue Manual* (Doc 7333).

"Site Requirements for Terminal Navigational Facilities", U.S. Federal Aviation Administration, AC 150/5300-2D, October 1980.

# SECTION THREE — LAND SIDE DEVELOPMENT

## INTRODUCTORY NOTES

Land side refers to that area of an airport from a point where the passenger loading device connects with the passenger building, through and including the passenger building and through and including cargo facilities, to and including the ground access system.

The major elements comprising the land side of an airport may be identified as: the passenger building, cargo facilities, and ground transport and vehicle parking.

Land side development includes all areas of the airport and buildings to which the non-travelling public has free access as well as the non-public portions containing airline operations and cargo facilities, airport administration, and government facilities.

# Chapter 9. PASSENGER BUILDING

## 9.1 ABOUT THIS CHAPTER

This chapter deals with planning for facilities to accommodate those activities associated with the transfer of passengers and their baggage from the point of interchange between ground transportation and the passenger building to the point of connexion with the aircraft, and with the transfer of connecting and in-transit passengers and their baggage between flights. Planning principles, factors affecting the type and scale, and specific planning details of various passenger building functions are presented in this chapter.

## 9.2 GENERAL CONSIDERATIONS

9.2.1 In passenger building planning it is necessary to provide the means for passengers to enter and leave their cars or public transport vehicles, parking for cars and public transport vehicles, buildings in which aircraft operators can undertake passenger processing and where government control authorities can undertake their inspections and in which all necessary facilities for passengers' comfort and assistance can be provided.

9.2.2 Aircraft operations will be less costly and more efficient if the passenger building is as close as possible to the runways. This reduces taxiing distances, and hence fuel consumption, and helps to avoid congestion by reducing the time spent by aircraft in ground movement. Care must be exercised, however, to ensure that expansibility and flexibility are not compromised. Therefore, the location of passenger facilities is inseparably associated with the planning of the over-all runway layout and the total airport plan.

9.2.3 The type and size of the passenger building and the various components within the building will evolve from land-use requirements activity forecasts (Chapter 3, 3.2 to 3.4), and site evaluations (Chapter 5, 5.2).

9.2.4 For many airports to which this manual is directed, passenger building facilities will be contiguous, with one general location on the airport. However, in certain circumstances, particular functions such as aircraft maintenance may be situated at locations remote from the main passenger building.

9.2.5 In keeping with the objectives of airport master planning, the development of passenger building plans should be limited to conceptual studies and drawings. Such drawings should not be so detailed as to preclude adjustments which evolve later in the detailed planning phase. Such changes frequently occur as an airport development project moves beyond the master planning phase to final design and construction.

9.2.6 One of the most important objectives in the development of the passenger building is provision for all of the necessary passenger services at an optimum cost, while recognizing the need for flexibility and expansibility, as well as economy of any future passenger building expansion.

### Planning Principles

9.2.7 The passenger building's function — interchange between transport modes — combines with passengers' physical and psychological characteristics to make the passenger area a most sensitive part of the whole air transport system. In considering the planning of these facilities any preconceptions about the result should be eliminated, except that the facilities should provide comfortable, convenient and speedy movement of passengers and baggage between air and ground transport at the lowest effective cost and should be able to accommodate expanding traffic without extensive modification.

*Characteristics of passenger areas*

9.2.8 Well-designed passenger buildings are usually the result of close co-operation between all the members of the planning team concerned, both those whose task it is to lay down the requirements and those, particularly architects and engineers, who have to translate the requirements into detailed designs. Although each group has its own primary responsibility, it can also help the other in many ways. In what follows there is no attempt to

lay down principles of design but only to set out some planning principles that are likely to influence design.

a) For general layout, passengers should be thought of as forming a homogeneous flow, whether constant or intermittent.

b) The majority of passengers are content to form part of the main flow and require clear indications of what they are expected to do and the flow routes they should follow.

c) Passengers have individual needs, preferences and (sometimes) disabilities. Some of these requirements involve the airport in extra expense (e.g. facilities for invalids, disabled and elderly persons); others can bring in revenue (e.g. concessions).

d) A system that attracts passengers to the routes required by the flow pattern will often give better results than one that appears to offer no alternative, particularly if it also gives some freedom for individual requirements.

*Separation of functions*

9.2.9 The key to achieving the planning objectives is simplicity. In the context of passenger planning it means simple, obvious flow routes. Complex flow routes usually arise from complex plans and buildings. Complex buildings are usually costly, inflexible and not readily expansible as a logical extension of the plan and operating system. The facilities may still be costly if so desired, but this will not be an unavoidable consequence of the plan and operating concept. Separation of functions is the principal aid to achievement of simplicity. If other facilities, such as multi-storey office blocks, car parks, control towers, etc., are incorporated with passenger buildings, not only does the flow plan tend to be distorted but flexibility is seriously compromised by the presence of these facilities, and also by the structural features they impose on the building. Figure 9-1 illustrates each of the important functions of a passenger building and gives an approximation of various passenger and baggage processing interrelationships. Planning requirements for each of these components are described, in turn, in subsequent sections of this chapter.

*Size of passenger buildings*

9.2.10 For passenger convenience, a large area in the passenger building should be broken down into units or modules, since it is difficult to construct a single building which can accommodate aircraft parking positions for high runway capacities and still maintain passenger walking distances within reasonable limits. A walking distance of about 300 m from the centre of the air side of the passenger building to the farthest aircraft parking position has been generally accepted as the reasonable limit. However, even this can result in passengers having to walk long distances to make connexions between one aircraft, although judicious allocation of stands can reduce such cases to a minimum. The size of the modular passenger unit is very important and should be the best compromise responding to the physical limitations of passengers and the economics of construction and operation of the passenger building and apron. Further discussion on factors affecting passenger terminal size may be found in 9.2.32 through 9.2.39.

*Layout of passenger buildings*

9.2.11 Passenger buildings should be associated with car parks and aprons, etc., of the necessary capacity. When the passenger movement rate exceeds the capacity of the optimum size building, additional buildings should be provided, each complete with its own associated full complement of facilities. The layout of these modular passenger units within the passenger building plan should include the necessary apron space, car parking and road circulation space in the most compact arrangement to minimize transfer distances between the passenger buildings, and between the associated facilities within each modular unit.

9.2.12 These units should be arranged in the simplest manner possible to provide an easily comprehensible environment to facilitate free flow of vehicles and people, and to provide a flexible and expansible layout capable of adaptation to future possible requirements. Transfer routes will be required for passengers and baggage on the air side, within customs bond, and land side. The nature of these transport systems should be considered in conjunction with town centre/airport public transport systems to which all the passenger buildings should be conveniently linked.

*Flow principles*

9.2.13 The following flow principles should be considered, to the extent it is practical, and evaluated against local circumstances. Particular regard should be paid to the separation of functions. The passenger flow plan should be the first to be considered. Baggage movement is of equal importance since it should be integrated with the passenger flow but, because baggage is inanimate,

it is easier to make the baggage flow compatible with the best passenger flow. In practice the flow plans should be tested against one another at all stages.

9.2.14 Flow principles to consider with respect to passengers include:

a) Routes should be short, direct and self-evident. They should not, as far as is practicable, conflict with nor cross the flow routes of other passenger, baggage or vehicular traffic.

b) Changes in level of pedestrian routes should be avoided as far as is practicable.

c) Passengers should be able to proceed through a building without the need to rely on guidance or instruction from staff. The flow system should be for "trickle flow" rather than controlled movement in groups.

d) In heavy traffic conditions, mass flows can only be achieved by the use of trunk routes. Particular categories of passengers should be diverted from the main flow route to pass through specific controls only at the last point on the main flow route where the character of the traffic changes.

e) Departing passengers should have an opportunity to check their baggage at the earliest possible point.

f) Each flow route should, as far as is practicable, be in one direction only. Where a reverse flow has to be provided it should be via a self-contained and separate route. Flow routes and milling spaces (areas of random movement) are necessarily complementary to each other but are separate functions. Therefore, milling spaces should be adjacent to but not part of the flow routes.

g) Free flow through all parts of the routes between air and ground transport should be interrupted as little as possible. While government control authorities and aircraft operators determine their own procedures, the plan should provide for them in the best manner to achieve passenger convenience, maximum security, optimum utilization of staff and minimum cost for aircraft operators and control authorities.

Every control point in the flow system has a potential to delay and also to irritate and confuse passengers. The delay is caused not only by the time needed for officials to carry out their procedures but also the reaction time of passengers. This reaction time consists of the time taken to realize that a control has to be passed, to understand its nature and to find the necessary documents. This time will be increased for some passengers by lack of understanding of foreign languages, illiteracy, or confusion. These effects can be reduced minimizing controls and concentrating them at the fewest number of points. This can also improve utilization of staff by permitting great flexibility.

h) Passengers should not have to pass through the same type of control more than once. Thus, if procedures or controls are established in more than one place the flow routes should be planned to permit passengers to bypass all subsequent controls of the same type.

i) The last control which passenger should pass through is security. Any controls established at an airport for screening of passengers and their hand baggage should be sufficiently remote from the boarding gate as to provide maximum restriction of unauthorized access to aircraft. Moreover, provision should be made for a "sterile" buffer area between the security control point and the aircraft. See Doc 8973 and Annex 9 for further information.

j) Flow routes should be planned to give visual continuity to the maximum possible extent. As a minimum it is essential that there should be visual continuity from one functional stage of the flow route to the next, e.g. from baggage claim to customs or from check-in to immigration. Such continuity assists passengers' understanding of the flow system and draws them on in a steady flow through each successive stage. A visual blockage, such as exists where each function or authority is contained in a separate room, is confusing and creates the need for signs, broadcast instructions or staff supervision of passengers.

k) Features which cause hesitancy, such as ambiguous terminology on signs, flow routes which appear to lead in the wrong direction, and multi-directional junctions should be avoided.

l) The speed of flow and capacity of the passenger routes should be matched to that of other systems, such as baggage flow and aircraft turnaround time, and to the over-all capacity of the airport. The fastest possible passenger flow or highest possible capacity, far from being an advantage, will create frustration, delay, congestion and criticism if it is not balanced by all parts of the airport system.

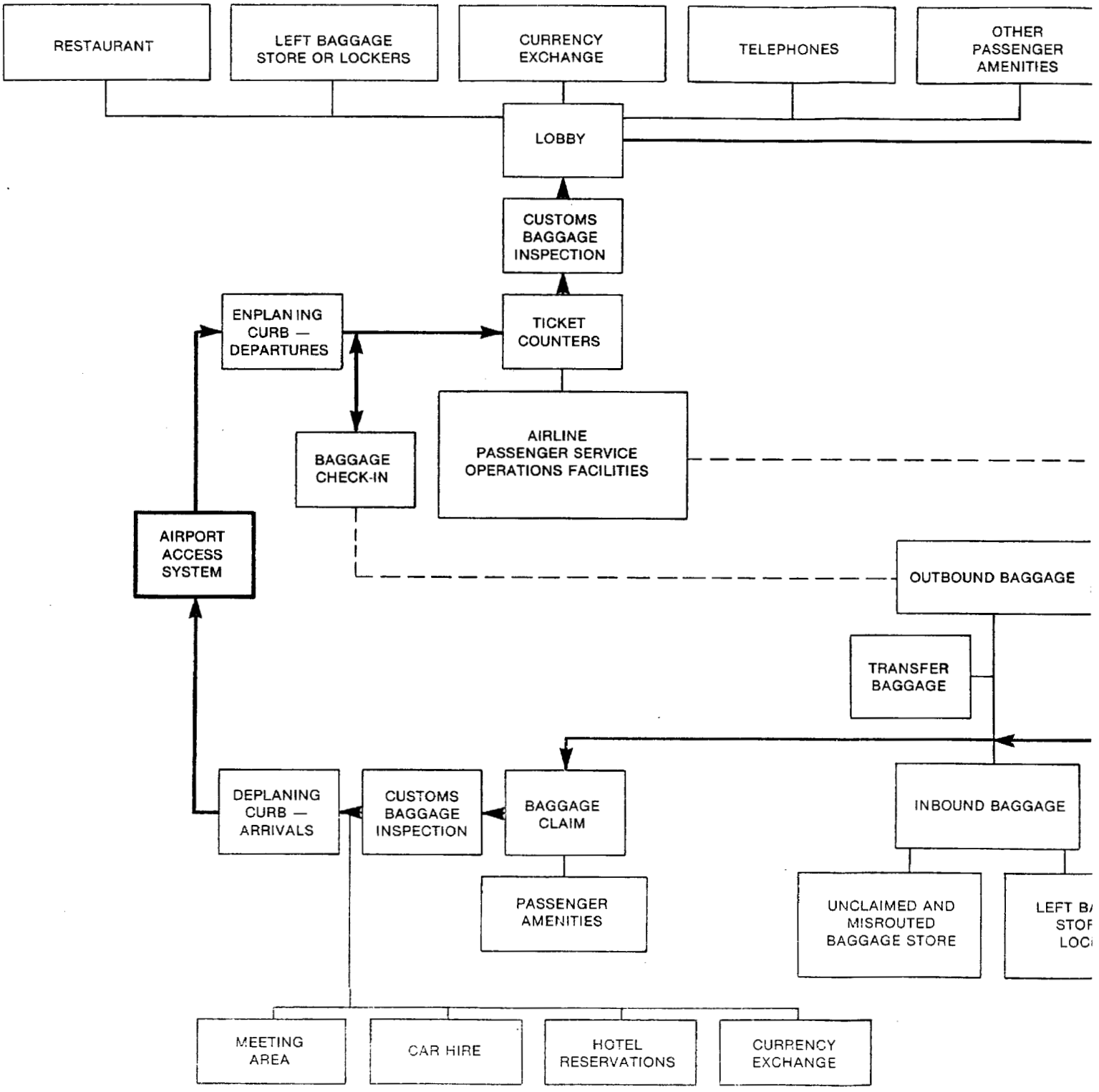


Figure 9-1. Passenger building functional relationships