U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: AIRPORT MASTER PLANS

Date: June 1985
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Change:

SUBJECT: AIRPORT MASTER PLANS

1. **Purpose.** This advisory circular provides guidance for the preparation of airport master plans, pursuant to the provisions of the Airport and Airway Improvement Act of 1982.

2. **Background.** The Advisory Circular 150/5070-6, "Airport Master Plans," published in February 1971, guided the preparation of master plans since enactment of the Airport and Airway Development Act of 1970. Significant experience has been gained and airport and related planning processes have undergone basic changes, with more attention to the environmental consequences of airport development. There is a need for updated airport master planning guidance, consistent with contemporary airport planning requirements and processes.

3. **Cancellation.** This cancels Advisory Circular 150/5070-6, Airport Master Plans, dated February 5, 1971.

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CONTENTS

Chapter 9. *Airport Plans*

Chapter 10. *Plan Implementation*

Appendices

CHAPTER 1 INTRODUCTION

Final Approach to Washington National Airport

1. **GENERAL.**

This advisory circular (AC) provides national guidance for the preparation of airport master plans. It may be used for preparing individual airport master plans pursuant to the provisions of the Airport and Airway Improvement Act of 1982, or for airport planning generally, irrespective of Federal involvement.

b. This publication is intended primarily for use by the aviation community, especially those directly involved in preparing master plans—airport operators, staffs, and their airport consultants. It will also be useful to state aviation officials, airport board members, municipal officials, state/regional/local planning personnel and the general public, all of whom are part of the airport planning process.

c. AC 150/5070-6, "Airport Master Plans," published in February, 1971, has guided the preparation of master plans since enactment of the Airport and Airway Development Act of 1970. During this period, significant experience has been gained due to the stimulus in airport planning activities provided by this law. Over 1500 master planning projects have received Federal aid.

d. Airport and related planning processes have changed. The integration of airport planning

with the other planning processes at state and regional governmental levels has introduced broader policy and planning considerations. The direct involvement in airport planning by state transportation authorities and regional transportation planning organizations has reinforced this change.

e. The National Environmental Policy Act of 1969 (NEPA) has significantly affected airport planning, requiring that environmental impacts be considered early and throughout the planning process. The investigation of alternative development concepts and the mitigation of environmental impacts extend the planning process beyond aeronautical and cost considerations.

f. The Airport and Airway Improvement Act of 1982 responds to the airport and airway system needs of the eighties by providing substantial increases in financial assistance for development and planning. Revised guidance for airport master planning, based upon contemporary processes and methods, is needed to accommodate the anticipated level of planning activities.

2. **MASTER PLAN DEFINITION.** The airport master plan is the planner's concept of the long-term development of an airport. It displays the concept graphically and reports the data and logic upon which the plan is based. Master plans are prepared to support modernization of existing airports and creation of new airports, regardless of size, complexity, or role.

3. **GOAL AND OBJECTIVES OF A MASTER PLAN.** The goal of a master plan is to provide guidelines for future airport development which will satisfy aviation demand in a financially feasible manner, while at the same time resolving the aviation, environmental and socioeconomic issues existing in the community. Specific objectives are:

a. To provide an effective graphic presentation of the future development of the airport and anticipated land uses in the vicinity of the airport.

b. To establish a realistic schedule for the implementation of the development proposed in the plan, particularly for the short term capital improvement program.

c. To propose an achievable financial plan to support the implementation schedule.

d. To justify the plan technically and procedurally through a thorough investigation of concepts and alternatives on technical, economic and environmental grounds.

e. To present for public consideration, in a convincing and candid manner, a plan which adequately addresses the issues and satisfies local, state and Federal regulations.

f. To document policies and future aeronautical demands for reference in municipal deliberations on spending and debt incurrence and land use controls, e.g., subdivision regulations and the erection of potential obstructions to air navigation.

g. To set the stage and establish the framework for a continuing planning process. Such a process should monitor key conditions and adjust plan recommendations if required by changed circumstances.

4. **ORGANIZATION AND USE OF THE ADVISORY CIRCULAR.**

a. The information presented in this AC covers the planning requirements for all airports, regardless of size, complexity or role. However, the scope of a study must be tailored to the individual airport, with the level of effort limited to its specific needs and problems. Based on an airport's specific needs, certain master planning elements may be emphasized while others will not be considered at all.

b. In using this AC, it should be remembered that the guiding principle of the planning process is the development of a safe and efficient airport through the use of acceptable standards.

c. The steps in a master planning process are not necessarily mutually exclusive. There are certain considerations, particularly financial and environmental, which must be accounted for throughout the process. While this AC treats them in separate chapters, they are not intended to be applied piecemeal or sequentially, but in an iterative way throughout the planning process.

d. The availability of planning information from Federal, state and local governmental organizations may eliminate the need for developing similar information in the master planning effort.

e. A master planning effort may involve only the verification of the currency of available information, the updating of plans and implementation schedules, and the production of an abbreviated report.

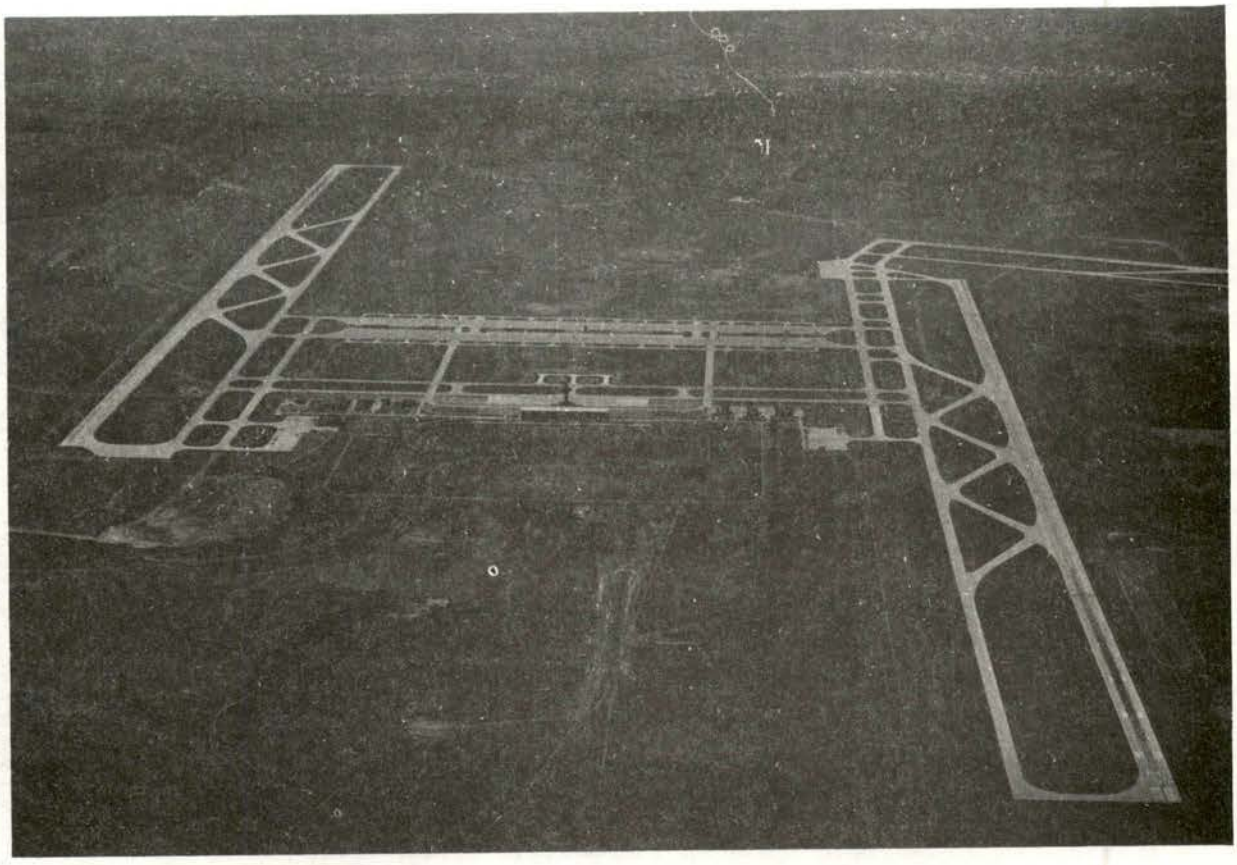
f. This AC does not provide information on airport design. That information is available in other FAA publications, which are referenced herein.

5. **INTERNATIONAL APPLICATION.**

a. This AC applies to U.S. airports with international aviation roles and may be useful in planning airports outside the U.S. Planners should be aware of the existence and applicability of international standards and recommended practices.

b. Standards and recommended practices for airports used in international civil aviation are promulgated by the International Civil Aviation Organization (ICAO), headquartered in Montreal. See "Annex 14 to the convention on International Civil Aviation." ICAO also publishes, from time to time, relevant information on airport master planning, land use and environmental controls, etc., which the planner may find useful.

CHAPTER 2 THE PLANNING PROCESS



Dulles International Airport

1. **GENERAL.**

a. The airport master planning process involves collecting data, forecasting demand, determining facility requirements and developing plans and schedules. These steps cannot be undertaken effectively without understanding other aviation, transportation and comprehensive planning requirements.

b. The master planning process must consider airport tenants and users as well as the general public who may be affected by its results. Their involvement throughout the master planning process avoids "surprises" and helps develop a consensus. Early progress towards consensus on master plan recommendations can pave the way for effective environmental assessment and impact statement reviews. Public involvement in master planning can also lead to productive public hearings when they are required to determine the consistency of individual projects with a community's goals and objectives.

c. Thorough preplanning activities can expedite a project and identify issues, decide which existing data will be used, clarify airport operator/consultant relationships, and establish schedules, financial resources and overall project scope.

d. Figures 2-1, 2-2 and 2-3 depict the steps in the master planning process, including organization and preplanning.

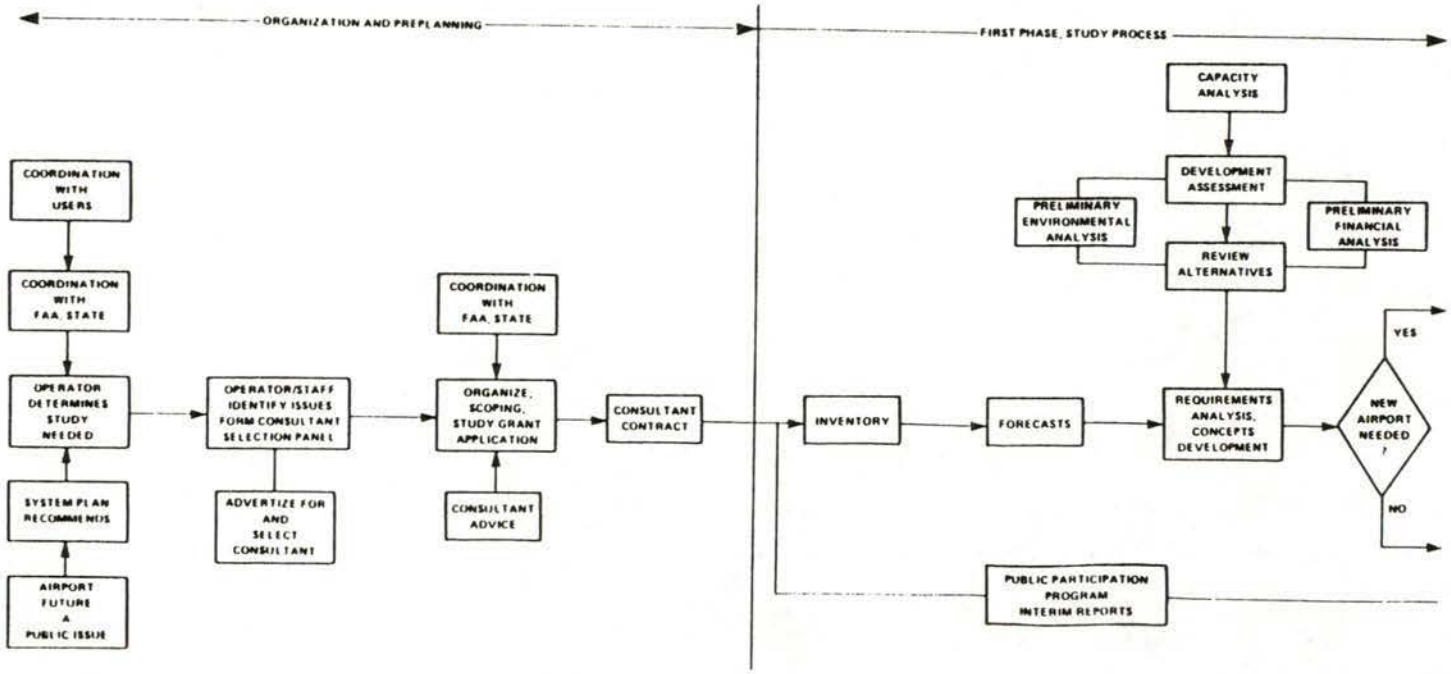


FIGURE 2-1. STEPS IN THE MASTER PLANNING PROCESS—ORGANIZATION AND PREPLANNING AND FIRST PHASE

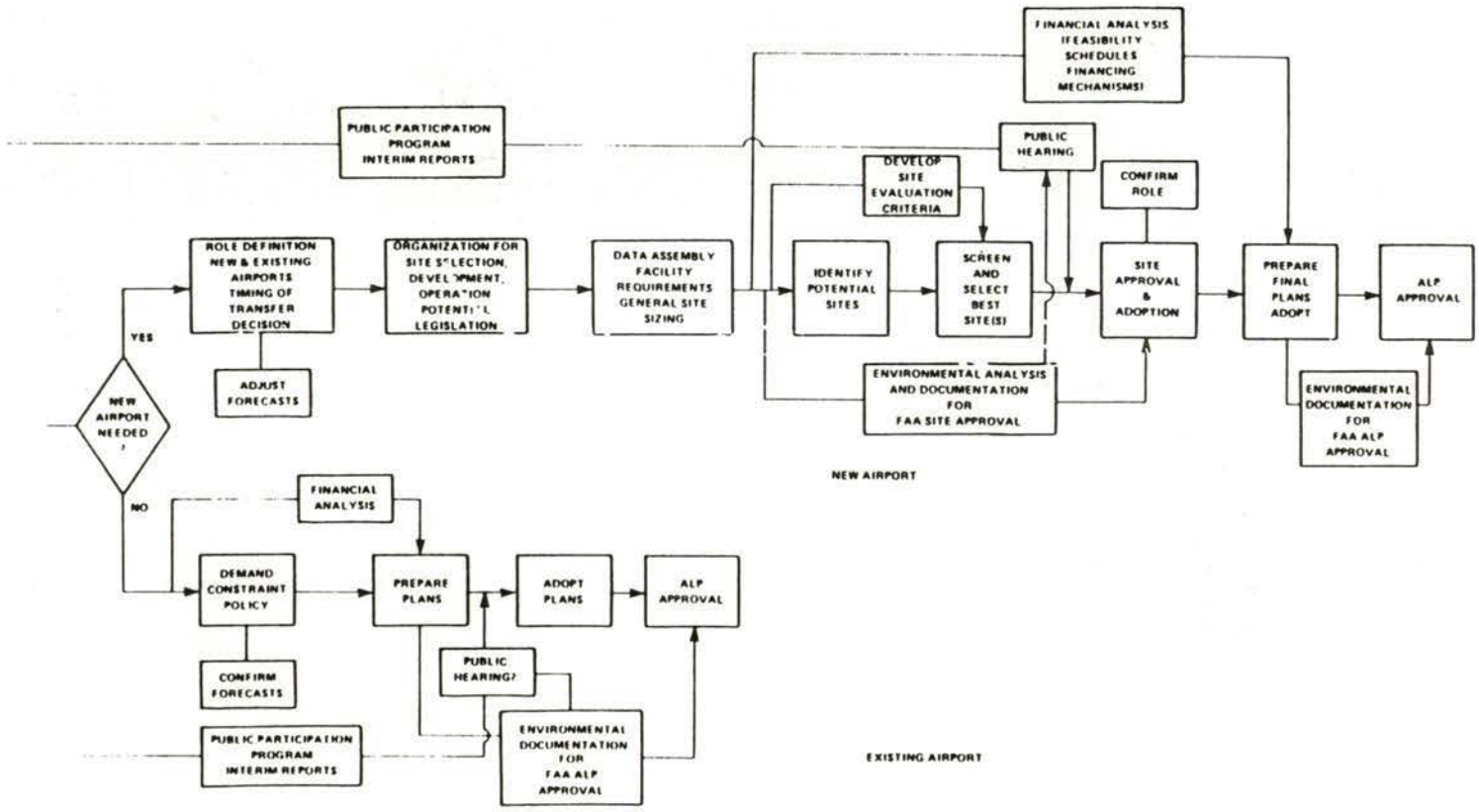


FIGURE 2-2. STEPS IN THE MASTER PLANNING PROCESS, SECOND PHASE—PLANNING THE EXISTING AIRPORT

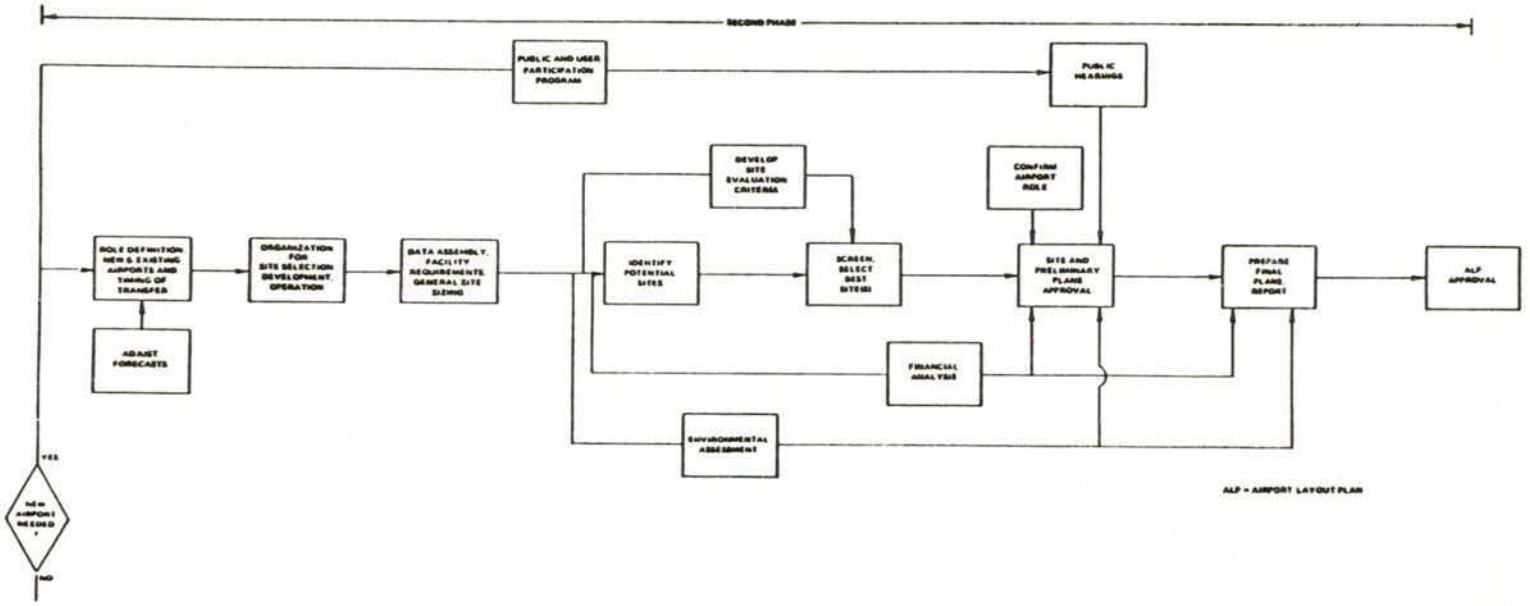


FIGURE 2-3. STEPS IN THE MASTER PLANNING PROCESS, SECOND PHASE—NEW AIRPORT SITE SELECTION

2. THE HIERARCHY OF PLANNING.

a. Airport plans at the national, state, region/metropolitan area and individual airport levels of government are formulated on the basis of overall transportation demands and coordinated with other transportation planning and comprehensive land use planning.

b. Airport planning in the United States is performed at several levels as follows:

(1) The National Plan of Integrated Airport Systems, a 10-year plan continually updated and published biennially by the FAA, lists the public use airports and their development which are considered to be in the national interest and thus eligible for financial assistance for airport planning and development under the Airport and Airway Improvement Act of 1982.

(2) Statewide Integrated Airport Systems Planning identifies the general location and characteristics of new airports and the general expansion needs of existing airports to meet statewide air transportation goals. This planning is performed by state transportation or aviation planning agencies.

(3) Regional/Metropolitan Integrated Airport Systems Planning identifies airport needs for large regional/metropolitan areas. Needs are stated in general terms and incorporated into statewide system plans. This planning is done by regional/metropolitan planning agencies.

(4) Airport Master Plans are prepared by the operators of individual airports, usually with the assistance of consultants. They detail the specific long-range plans of the individual airport within the framework of statewide and regional/metropolitan system plans.

c. Airport master planning must be responsive to areawide comprehensive transportation planning. This can be achieved by building into the master planning process appropriate review, coordinative and participatory mechanisms.

3. MASTER PLANNING ELEMENTS.

a. The elements of a master planning process will vary in complexity and degree of application, depending on the size, function and problems of the individual airport. The technical steps described in this AC are generally applicable. Each step should be undertaken only to the extent necessary to produce a meaningful product for a specific airport. It is not always necessary to undertake every task.

b. For example, a general aviation airport in a non-urban environment with, 25,000 annual operations, might only require the production of a set of plans and a brief report giving the basis for what is contained in the plans. Extensive inventory and background information would not be necessary. Forecasts and capacity data would probably be available from local, state or federal agencies, and the balance of the planning process, with the possible exception of the financial plan, is usually straightforward.

c. Study elements for complex, busy airports may involve sophistication beyond that detailed in this AC. For example, off airport land use planning strategies and public participation processes may require highly innovative approaches. Environmental impact assessments may require techniques not discussed here, and evaluation criteria for alternatives analysis may be predicated on circumstances not covered in this AC.

d. The master planning study, as an activity aimed at problem solving, may require emphasis on certain elements, depending on the airport. As examples:

- Where there is a question whether to recommend pavement reconstruction or an overlay, a preliminary pavement evaluation study including testing and coring may be necessary. The study should be limited in scope to that required to make the determination.
- Obstruction evaluation, including survey work, may be an important safety issue.
- Feasibility study of potential non-aeronautical revenue producing property, including possible industrial park development, long term leases and land releases may be advantageous.
- The cost effectiveness of a specific development recommendation may have to be carefully weighed. For instance, there may be a theoretical need for a runway

extension, but the cost may be high. Another example is whether a 150 ft. wide runway should be extended at that width when only a 100 ft. wide runway is required to meet current standards.

e. Master plan elements in general are:

(1) *Existing Conditions and Issues.* After the organization and preplanning phase, an inventory is made of pertinent data. Data is collected on the airport and airspace infrastructure and airport-related land uses. Pertinent airport-related issues and institutional mechanisms are defined.

(2) *Aviation Demand Forecasts.* Aeronautical demand, expressed in units necessary to determine the required capacity of airport facilities, is forecast for short, intermediate and long range time frames. While 20-year periods are usually targeted for long-range projections, a 10-year intermediate period is a more reasonable target in terms of forecast accuracy. A 5-year forecast should be of sufficient accuracy to justify a short-term capital improvement program.

(3) *Requirements Analysis and Concepts Development.* The capability of the existing airport to support the forecast demand must be determined. Airside capacity requirements are expressed in numbers and dimensions of runways and associated taxiways, apron areas, etc. Landside capacity requirements include terminal building space, auto parking and surface access. Should it be determined that the airport is capable of providing the required capacity, then the detailed planning steps for the existing site ensue. If there are serious reservations about the capacity of the existing site, there must be an investigation of alternatives such as developing new, replacement or additional sites, modifying the role of the existing airport or providing new general aviation facilities.

(4) *Airport Site Selection.* When the capability of the existing airport to meet forecast demand is questionable or when there has been a decision to construct a new airport, a site selection process is necessary. In the former case, the emphasis is on the need for and feasibility of a new airport. The review of potential new sites should, at least initially, be limited in scope to that which is necessary to make that kind of decision. In the latter case, the process will be significantly more detailed, leading to the selection of a specific site.

(5) *Environmental Procedures and Analysis.* Existing and potential environmental impacts and appropriate mitigating measures must be considered throughout the master planning process. Airport development projects must eventually meet the requirements of NEPA in order to receive Federal financial support. The master planning process is an ideal vehicle for reviewing potential environmental conflicts.

(6) *Simulation.* A useful tool in determining the most efficient airport configuration is the airport simulation model. Computer simulation may be warranted for a complex airport or when development of great magnitude is being considered. Simulation allows the planner to analyze the merits of alternative development proposals, particularly as they relate to time and fuel savings. A variety of simulation models have been developed for airport planning. A careful review is needed to determine which is best for a particular application. Computer simulation often involves considerable expense for data collection and analysis and should only be undertaken when benefits are expected to exceed these expenses.

(7) *Airport Plans.* A set of drawings is the product of the master planning process. The individual plans described here may be combined for low activity airports.

(a) The Airport Layout Plan (ALP) shows the airport boundary, the landing area configuration and the areas reserved for landside facilities. The location of navigational facilities and approach and runway clear zone areas are also depicted on the ALP.

(b) The Land Use Plan shows areas recommended for the passenger terminal complex, maintenance and cargo facilities, general aviation fixed base operator facilities, commercial and industrial areas, and other facilities within the airport boundary. Existing and recommended off-airport land uses should also be shown, based on considerations of noise levels, obstruction clearance criteria, and any activities which may affect the safety of aircraft operations.

(c) The Terminal Area Plan displays the various terminal area components and their relationships. Separate large scale drawings may be appropriate for important elements of the terminal area plan, such as terminal building areas, cargo building areas, and hangar areas.

(d) Access plans will show major highway routes from the airport to the Central Business District and points of connection with key arterial systems. They will also show other modes of access such as rail, if appropriate. The development of access plans involves cooperation with surface transportation agencies, particularly for access routings beyond the airport boundary. Special studies of access systems beyond the airport boundary are not normally included in a master planning project.

(8) *Plan Implementation.* This step involves the preparation of development schedules and costs. The schedules for development must be financially feasible. The master plan must show the sources of revenue which will cover capital improvement program costs as well as operation and maintenance costs. Financial feasibility must be considered throughout the planning process, especially during the requirements analysis and site selection activity. Schedules are normally based on short (5 years), intermediate (10 years) and long term (20 years) development needs.

4. **MASTER PLANNING PRODUCTS.** The products of the master planning process will vary with the complexity of the project. The basic documents are the master plan report and a set of drawings. The master plan report should contain the results of those investigations and analyses accomplished during the development of the plan. There should be an explanation if facilities are located or sized in an unusual way or variances to FAA standards are required or have been granted. Supporting technical reports may supplement the master plan report.

A summary document is useful to bring together pertinent facts, conclusions and recommendations for public consumption. This is an excellent place for highlighting the economic benefits which flow to the community from the airport. These may offset negative impacts such as noise. For small projects, the master plan report and summary report may be combined, especially if wide distribution is not anticipated.

The airport operator may also find visual aids, including slides and models, useful in explaining the development plan.

During complex master planning, it may be necessary to produce interim reports for coordination with FAA, state and users and for public information as required by a public participation program.

5. **PLAN CURRENCY.** Ideally, the master plan should reflect an up-to-date assessment of what exists and what is required. For the larger airports, with active management and staffs, this is feasible and also necessary in view of the active, sometimes confrontational, relationship between the airport and the community it serves. Maintenance of demand data allows a continuing assessment of the credibility of forecasts, enabling adjustment of development schedules that are demand sensitive. The data from noise monitoring systems can be used in conjunction with a review of aircraft operational procedures to determine the appropriate off-airport land use strategies.

Updating airport plans to reflect airport modification and off airport development is a necessity. In fact, airports receiving Federal financial assistance are required to keep their airport layout plan current. Aside from maintaining the currency of its airport layout plan, smaller airports do not require a continuing updating of the master plan. Once an adequate master plan has been produced, a revision should only be necessary to deal with unforeseen and substantive changes in activity or the emergence of critical issues.

6. **PRODUCT APPROVAL.** The approval of the products of the master planning process by the airport operator should be timely so as to expedite consultant reimbursement and FAA payments under federally assisted planning projects. FAA approval of the master plan extends only to assuring completion of work elements specified in the grant agreement.

CHAPTER 3 ORGANIZATION AND PREPLANNING

Parking Apron Congestion

1. **GENERAL.** Critical to the success of the master planning process is the preplanning stage. This is where an organization for the study is established, the work program developed, and the means for financing the effort are worked out. The need for a master planning study will have been identified by the airport operator based on obvious existing or potential shortcomings. These deficiencies may be the result of demand exceeding capacity, the introduction of more demanding aircraft, or the emergence of a critical environmental problem. National, state, or regional planning may have called attention to demands deserving planning attention on the part of the operator. On the other hand, airport users, such as the scheduled airlines, may have identified demands which prompted the airport operator to undertake the study. Such demands are often identified in Joint Planning Conferences, held at the airport.

2. **ORGANIZATION.** Once it has been determined that an airport master plan would be useful, an organization for its accomplishment must be established. The sophistication of the organization will depend on the complexity of the project. In any case, the airport operator must be the focus of the organization and take the lead in the initiation and accomplishment of the master planning project.

An airport operator's understanding of the premises and facts underlying the plan's recomendations can be crucial in gaining political approval for implementation. In addition, the airport operator's awareness of the usefulness of certain types of data in the planning process could result in that data being continually collected to maintain master plan currency.

a. For less complex projects, an airport operator and a consultant may be the only organization required, as long as there is coordination with appropriate municipal officials and the airport board as well as citizen participation through public information sessions, conducted separately or in conjunction with other public meetings or events. Coordination with areawide or state aviation, transportation and comprehensive planning agencies, and the FAA may occur through written communication and informal contact, rather than formal committees.

b. For complex projects, it may well be necessary to organize in a more sophisticated fashion with formal policy, technical and review committees meeting on a regular basis and with structured communications systems, including public hearings and public information sessions. These mechanisms can exist exclusively at the regional or state governmental levels or with a mutual state-regional effort.

Participation of the FAA as well as aviation industry organizations is generally considered a must. FAA's advice concerning airspace management, navigation aid and approach aid installation, instrument runway designation, potential financing of planning and development, and safety and security matters will be essential. The local FAA Airports Program representative can coordinate the several FAA organizational interests in the airport's development and operation. Advice from the airlines concerning aircraft types, operational and financial matters, will also be vital for effective planning.

Airport management staff will likely participate in the day to day activities of the master planning project in a working as well as management role. The large airport operator will likely have a more extensive management staff structure than the operators of smaller airports.

c. Airport management staff can be expected to keep a master plan, or at least the drawings, current and to update the plan routinely when necessary. However, the initial planning study and any major revision will usually require professional assistance by airport consultants. The selection of a consultant should take place early in the organizational phase so that timely professional advice during preplanning can be obtained.

3. **CONSULTANT SELECTION.** The selection of a consultant should be done by an unbiased and technically qualified selection panel, which solicits and reviews technical qualifications from a number of firms. The FAA should not be expected to serve on this panel. The qualifications of the firms should be judged on experience in similar work and professional credentials. The master planning project team proposed by the consultant should be composed of individuals experienced in their respective areas of involvement and committed to the project in the amount of time specified. It is not uncommon for several firms to join together for purposes of providing specialized skills or local expertise.

While the review of the technical qualifications of numerous firms is appropriate, the actual solicitation of technical proposals should be limited to a few. The preparation and presentation of quality technical proposals is time consuming and costly. Moreover, the selection panel cannot be expected to make a thorough assessment of the technical proposals and conduct effective interviews when a multitude of consultants are involved.

Before soliciting technical proposals and interviewing consultants, the airport operator should have a clear understanding of the issues and why the airport needs a master plan. The consultant is hired to provide the technical expertise which the airport operator cannot supply, not to manage totally the master planning process and control its results, or, on the other hand, to justify a decision already made. The airport operator must take responsibility for the overall policy direction, management and control of the planning process, including the study.

AC 150/5100-14, "Architectural, Engineering and Planning Consultant Services for Airport Grant

Projects" provides important guidance for consultant selection, and its use is recommended.

4. **PROJECT SCOPING.** After the organizational phase but prior to the award of a consultant contract, the airport operator and consultant should (1) identify the pertinent issues involved in the airport's development and (2) determine the type and magnitude of effort needed to address each issue individually. This step, known as "scoping," is an important one in designing the master planning study, regardless of its complexity. It is at this point that the aviation-related issues in particular are reviewed and a preliminary assessment is made of what it will take to resolve each of them. Typical issues for large airports may relate to noise problems, potential need for a replacement or supplemental airport, internal or external surface access limitations, etc. For smaller airports, the issues might include financial solvency, maintenance of scheduled service, operational safety or reliability.

a. If the project will involve the investigation of new airport sites, this is the time to decide whether the site selection process will be sufficiently detailed to recommend a specific site or whether its focus will be only on the analysis of alternatives, e.g., whether to select a new site or other alternatives, with detailed site investigation to occur later under a new project.

b. An attempt should be made to determine the required environmental documentation for the development which will be recommended; that is, whether an environmental assessment will likely be required or whether categorical exclusions will apply. If an assessment is likely to be required, then there should be an indication of the nature of the alternatives that must be reviewed. Also, it may be useful to determine whether to seek a long-term unconditional approval of the airport layout plan, or unconditional approval of only short-term development items.

c. Available data such as the activity forecasts and capacity assessments produced by state and regional system plans and FAA Terminal Area Forecasts must be reviewed and decisions made on potential use. If these data are not to be used, the reasons for their inadequacy should be well understood and accepted by all parties, including the FAA. This is especially true for low activity airports where demand/capacity relationships are not critical.

d. The length of the short, intermediate and long-term activity forecasts should be decided. while 5-10-20 year time frames are typical, there may be justification for using different time frames. In any event, the short-term forecast should support a capital improvement program, the intermediate-term a realistic assessment of needs, and the long-term a concept oriented statement of needs.

The schedules for airport development that are directly related to forecast demand levels should be tied to such levels, rather than dates, because of the possibility of the forecasts being off target.

e. Schedules showing milestones for completion of technical products as well as coordination/review activities must be agreed upon. The need for realism in schedule development is important. From a practical standpoint, adhering to schedules for controversial projects, such as long-range plans for high activity airports, is very difficult. For small airport projects this should not be the case. However, experience has shown that even with the noncontroversial airports, completion schedules for master plans should be set, insofar as possible, so that all reviewing officials are aware of their responsibilities with respect to the agreed upon time targets.

There must be a clear identification of decision points, beyond which work should not proceed without airport operator approval. The airport operator should recognize the importance of timely decisions in meeting planning process deadlines.

f. The specific products of the master planning process should be agreed upon at the outset. The number, type and format of reports and drawings should be specified in the consultant contract.

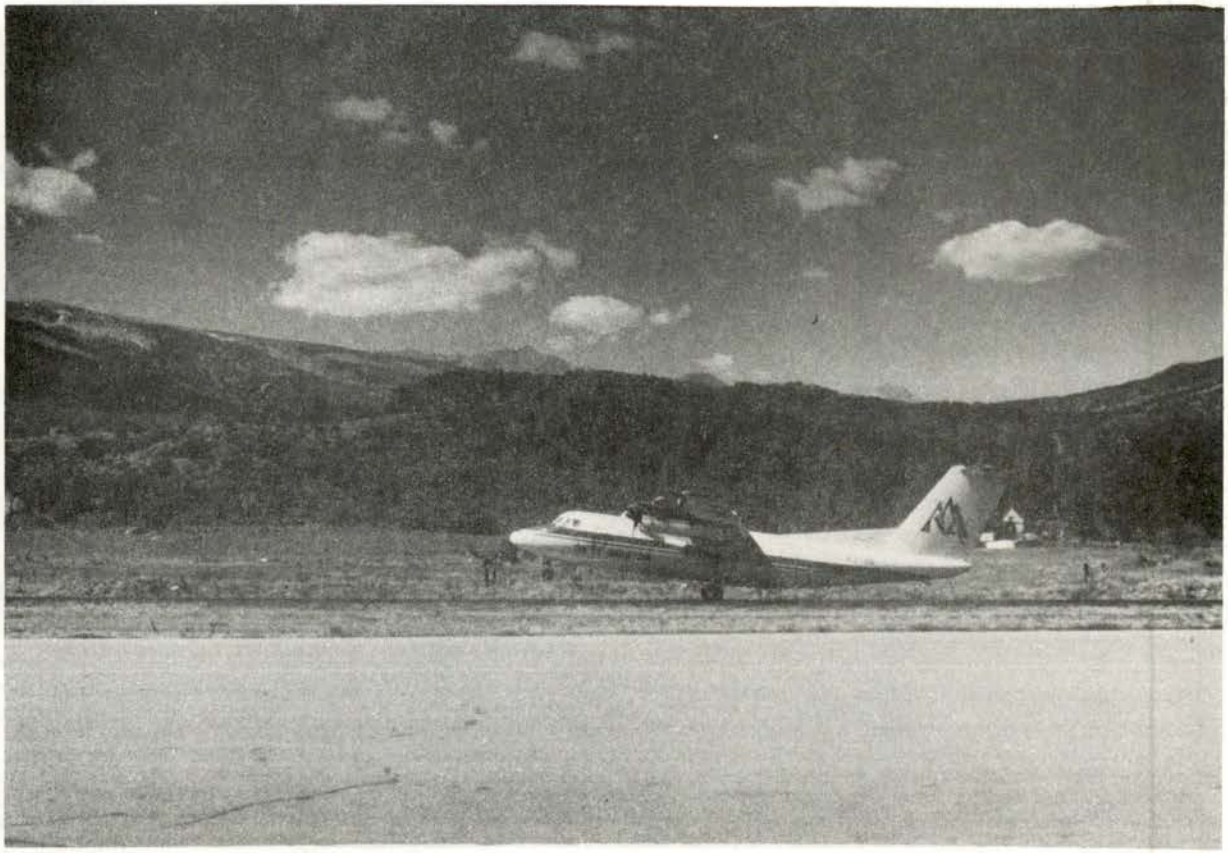
5. **CONSULTANT CONTRACTS.** After scoping the project and selecting a consultant, a price for the consulting services must be agreed upon and a contractual arrangement entered into. The normal type of agreement between the airport operator and the consultant will be a firm fixed price contract. This is advisable whenever the level of effort can be

fairly well predicted and where reasonable prices can be established at the outset.

Where the level of effort or duration of the project is uncertain, a cost-plus-fixed-fee contract or time and materials contract may be necessary. The fixed price type of arrangement is preferable, however, and most common for master planning projects. This type of contract imposes a minimum administrative burden and provides incentive for effective cost control and contract performance. Contracts based on a cost plus percentage of cost are not recommended and are not allowable if Federal financial assistance for the project is contemplated.

6. **PROJECT APPLICATION.** Most master planning projects for public airports are supported financially with Federal funds. An application for such funding should be prepared by the airport operator, with assistance from the consultant, after coordination with FAA regarding eligibility and need. FAA involvement in the scoping process is essential to the development of a financially supportable planning project that can be processed in a timely fashion. Indeed, FAA involvement prior to scoping or designing the study is important if financial aid in project formulation costs is to be requested.

CHAPTER 4 ISSUES AND EXISTING CONDITIONS



Operation at a Commercial Service airport

1. **GENERAL.** While an overview of issues and existing conditions should occur at the preplanning stage in order to effectively scope the project, an early activity in the study will be to assemble and review all existing information pertinent to the accomplishment of subsequent planning steps. For example, an understanding of the aeronautical, environmental and socioeconomic issues related to the airport will be necessary in order to deal with them in the planning exercise. A knowledge of the institutional and policy framework within which the master planning will take place is essential in order to produce an implementable plan.

A compilation of prior planning studies and knowledge of other planning efforts which are underway should provide a valuable resource and avoid duplication. An inventory of the existing physical plant and an assessment of its condition and useful life are critical to determining the need for expanding facilities. An assessment of land use on and adjacent to the airport will provide a basis for decisions on the potential expansion.

Site-specific knowledge of air traffic management will influence capacity determinations. Data on airport revenues and expenses will assist in determining the financial feasibility of airport improvements, while an array of aviation, socioeconomic and demographic information will provide the basis for aviation forecasts.

While the types of data discussed herein will be generally required for most master planning projects, the degree and emphasis of the data collection will vary substantially with the size and complexity of the airport.

2. **THE ISSUES.** The issues which may influence the master plan's recommendations should be identified through discussions with the airport operator, airlines and other users, the FAA, and public officials responsible for policy, land use and transportation planning. A thorough identification of the issues will assist in developing strategies for dealing with them, including study emphasis.

Typical issues may include:

— Aviation growth, in general; expansion of scheduled service; expectations of obtaining regional carrier service.
— The potential need for a new airport and the roles of the existing and new airports.
— Major expansion for capacity.
— Ground access problems. For example, the expansion of terminal capacity may be dependent on gaining approval for a major interchange; thus the sequencing of airport and off-airport actions is crucial.
— Relocation problems related to roads, powerlines and people.
— Obstructions and landfill site problems.

Many issues relate to the environmental impact of an airport. At an existing airport avoidance of increased noise affecting residents of adjacent communities while increasing airport capacity is perhaps the most notable environmental problem. However, other environmental considerations may be more important when planning a new airport.

3. **BACKGROUND.** The accumulation of concise information on how the airport evolved, its aeronautical role, its place in the community's public facility infrastructure, and a quantification/qualification of socioeconomic benefits and costs may prove useful in planning and as background information for the master plan report and summary document. The practice of collecting quantities of remotely relevant information for use as filler material is to be avoided, however.

4. **EXISTING PLANT.** The existing airport facilities can be inventoried by referring to current plans, as built drawings and other documents on file with airport management. If there are no verifiable reports on the condition of individual facilities, such as airfield pavements, lighting, drainage and utilities and landside buildings, roads, utilities, then visual inspection and inquiries may be appropriate in determining condition and useful life. Typical airport facilities to be inventoried would be:

— Runways, taxiways and aprons and related lighting, marking and signing;
— Passenger and cargo buildings and other terminal buildings and areas, by function;
— General aviation buildings and areas, by function; fire fighting and rescue buildings, Federal facilities;
— Aviation fuel and aircraft servicing systems;
— Utilities, including water, gas, electric, telephone, drainage and sewage.

5. **LAND USE.** Land uses on the airport property and immediately adjacent to it must be reviewed together because the planning does not end at the airport property line. Access systems and commercial areas which serve the airport, or are served by it, are important in planning for airport modernization and expansion. Also it is important to know the land uses in those environs which will be exposed to the airport's negative impacts of noise and air pollution. Land usage is a continuously changing process, particularly in urban environments. Therefore, the land use inventory must include all available intelligence on planned and proposed land uses, in addition to the data on existing uses.

Most land uses are considered compatible with noise levels less than the 65 day-night average sound level (Ldn) contour. (See AC 150/5020-1, Noise Control Compatibility Planning for Airports and AC 150/5050-6 Airport-Land Use Compatibility Planning.) While the land use inventory may begin early in the study, its completion should await the estimation of the Ldn generated by the aircraft using the airport in question.

If the airport operator has undertaken a noise compatibility planning program under the provisions of the Aviation Safety and Noise Abatement

Act of 1979, a wealth of land use information will exist.

The existence of any governmental programs designed to direct land use patterns in the area under review should be noted. General property values based on recent sales figures and tax assessments should be identified.

A collection of all applicable documents, such as official maps, the latest areawide comprehensive land use and transportation plan, applicable municipal zoning ordinances and other land use controls and unusual building code provisions, will be needed. Important to recommending practical land use strategies will be an understanding of the contemporary political context and local preference regarding potential land use projects.

Land uses which may affect the safe operation of the airport, or which may influence the way it can be expended, must be ascertained. Principal among the concerns are the location of structures which could constitute obstructions to air navigation or the existence of other airports which may interfere with the operations of the airport being studied. Land uses which may be attractive to birds, thus presenting a potential hazard to aircraft, should be identified. For example, such land uses as flood control areas, stockyards, and sanitary land fills, may be critical if located near the airport.

Aerial photographs, topographical maps, obstruction charts, aeronautical charts, approach plates and other mapping tools should be used to examine and display land use details.

6. **GROUND ACCESS, CIRCULATION AND PARKING.** Data should be gathered about on-airport access roads, circulation and service roads, parking and curb space. Data should include alignments, condition and capacity. Public transportation services, such as bus, rail, taxi and limousine, should be noted. The split between personal and public transportation should be ascertained. Consultation with state and local transportation agencies responsible for planning and operating surface transportation systems should produce data on proposed highway and transit plans as well as traffic density statistics relative to surface systems leading to and from the airport. These data will be used to project surface access requirements.

7. **ENVIRONMENTAL DATA.** In addition to the land uses discussed in paragraph 5, there may be other land uses or conditions which must be identified in order to account for environmental consequences. These consequences will likely not be as critical as the noise impacts but, nonetheless, must be investigated. Information to be collected will include air and water quality data used in determining compliance with Federal and state standards. Other data to be collected, where applicable, would include:

- solid waste generation and disposal;
- toxic material disposal;
- floodplains, wetlands;
- endangered/threatened flora and fauna;
- biotic communities;
- parklands/recreational areas;
- historic/architectural/archaeological/cultural resources, and prime and unique farmland.

Additionally, the assessment of impacts of potential major expansion or transfer to a new site may require socioeconomic data to determine employment losses or community disruptions.

8. **AIR TRAFFIC MANAGEMENT.** Information should be compiled on the use of the airspace and how the airport's air traffic is, or will be, managed. This would include information on operational limitations due to traffic interaction with other airports or reserved airspace, obstructions, noise abatement procedures, airfield or navigation aid shortcomings. This type of information can be obtained from FAA personnel who can also provide suggestions on how to mitigate the limitations. The FAA can also provide information on plans for installation of air navigation and approach aids and designation of instrument runways. Available aeronautical charts and instrument approach and departure plates should be examined.

9. **METEOROLOGICAL DATA.** Historical data on weather conditions need to be ascertained because of the weather's effect on airport operations and capacity. In determining runway orientation and use, it is important to know the location's prevailing wind direction and velocity over time. Also, the average annual ceiling and visibility conditions affect airport capacity because aircraft spacing usually must increase as these conditions deteriorate.

Weather data for specific locations is available from the National Oceanic and Atmospheric Administration's Environmental Data Service (EDS). The EDS's National Climatic Center is located in the Federal Building, Asheville, N.C. 28801.

10. **FINANCIAL DATA.** In order to determine the financial feasibility of the master plan's recommendations and to develop a financial plan, it is necessary to assemble current financial data. A compilation of current revenues and costs should be available from airport management. Typical revenues would come from landing, parking and hangar fees, ground handling charges, aviation fuel and oil concessions, fixed base operator rentals and concessions. Typical sources of terminal area revenue would include terminal rentals and concessions for airline ticketing, shops, restaurants, bars; auto rental and parking concessions; rentals for hotels and other on-airport commercial facilities. Costs are incurred in operations, maintenance, administration, and amortization of outstanding debt.

11. **AVIATION ACTIVITY, SOCIO-ECONOMIC, DEMOGRAPHIC DATA.** The body of data necessary for forecasting aviation demand is discussed in detail in Chapter 5, Aviation Forecasts. The assembly of this data should take place early in the inventory phase.

CHAPTER 5 AVIATION FORECASTS

Queueing up for takeoff

1. **GENERAL.** Estimates of the timing of certain threshold events are the basis for effective planning decisions. In airport master planning, these events correspond to levels of aviation demand which exceed existing or planned capacities of the airport.

a. *Level of Effort.* Forecasts of these thresholds for different airport master planning projects have ranged from informed guesses to highly structured projections. While the art of forecasting can be practiced with a wide range of tools and techniques, it is important to gear the level of forecast effort employed to the level of costs "at risk" at the airport if the forecast proves to be substantially in error. Thus, for a major project at a large airport, more effort and expense in reducing the probability and range of error in the forecast is justified than for a minor project or a smaller airport with respectively lesser costs due to forecast error.

b. *Cost of Forecast Errors.* In the case of airport master planning forecasts, the "costs" of errors in forecasts are related to the timing for investments to be made to meet new demands at the airport. The costs of forecast errors can be substantial.

(1) If investments are made too early because of an overly optimistic forecast of growth in aviation activity, premature capital costs and unnecessary operating expenses can be incurred, and

more efficient uses of the investment capital can be lost.

(2) If investments are made too late because of underestimation of aviation growth, lost revenues and inconvenience can be substantial. In some cases, the costs of forecast errors can spill over in the form of adverse impacts on the general public outside the airport.

c. *Purpose of Forecasts.* The purpose of aviation forecasts is to indicate the relative timing for airport investments in a manner that minimizes forecast error costs. The idea is to forecast the different elements of aviation demand, compare that demand over time with the capacity of an airport's various facilities, and to identify the time when new or expanded airport facilities may be necessary. When this basic approach is integrated into a continuous master planning process, during which actual aviation activity is compared with previously forecast demand for that period, the future year forecasts can be updated to reflect the appropriate time for phasing in capital investments or other measures.

2. **FORECAST ELEMENTS.** There are certain specific aviation demand elements which must be forecast for the development of a master plan at an individual airport.

a. *Types of Activity.* To determine the new demands at a master plan airport, it is essential to develop forecasts for aircraft operations and for enplaning passengers at the airport. The number of based aircraft and the mix of aircraft must also be considered, as well as additional aviation demand elements for some special purpose or large airports.

(1) In regard to aircraft operations, the total number of landings (arrivals) and takeoffs (departures) from an airport must be forecast. There are two types of operations—local and itinerant—which should be separately forecast. Estimates of the local and itinerant aircraft operations must be developed for each of the four major user categories: Air Carriers, Air Taxi and Commuters (Regionals), General Aviation, and Military.

(a) *Local Operations.* Arrivals and departures of aircraft which operate in the local traffic pattern or within sight of the tower and are known to be departing for or arriving from flights in local practice areas within a 20-mile radius of the airport and/or control tower; plus simulated instrument approaches or low passes at the airport executed by any aircraft.

(b) *Itinerant Operations.* All aircraft arrivals and departures other than the local operations described above. Additionally, for those airports where instrument operations are possible, there should be a forecast of instrument activity. Where capacity may be a problem and when appropriate weather data is available, forecasts should be for instrument operations during specific instrument meterological conditions (IMC).

(2) *For enplaning passengers,* the total number of passengers departing an airport, on aircraft including originations and transfer passengers, must be forecast. Passenger enplanement forecasts should be made for each of the three civil user categories: Air Carriers, Air Taxis, and Commuters (Regionals).

(3) The mix of aircraft which will be based at the airport should be forecast. This can be particularly important if basic changes in the types of aircraft are expected. For example, a number of design criteria for length, width, and strength of runways and taxiways are tied directly to the weight, wing span, and speed of the aircraft that will use the facilities.

(4) *Annual Instrument Approaches (AIA)* at the master plan airport should be forecast where such information is needed for planning or upgrading of navigational aids and landing systems.

(5) At those airports where special facilities are now provided or anticipated for processing domestic and international passengers, or for other categories of passenger enplanements, each such category of traffic should be forecast. Similarly, if general aviation passenger facilities are located apart from facilities for other passenger traffic, or if general aviation passenger traffic is a significant portion of total passenger traffic, then a separate forecast should be prepared.

(6) If *air cargo or air mail* is a major factor at the master plan airport, that type of activity should also be forecast. Helicopter operations at the airport may need to be forecasted as well.

(7) *Summary.* The aviation demand elements that need to be forecast for airport master planning are:

Mandatory	*Additional Where Appropriate*
Aircraft Operations	Domestic vs.
Itinerant	International
Air Carrier	Annual Instrument
Air Taxi &	Approaches
Commuter	IFR vs. VFR Operations
(Regional)	Helicopter
General Aviation	
Military	
Local	
General Aviation	
Military	
Passenger	Domestic vs.
Enplanements	International
Air Carrier	General Aviation
Air Taxi	Helicopter
Commuter	
Based Aircraft	Air Cargo and Air Mail
Aircraft Mix	

b. *Levels of Annual Activity.* Forecasts for airport master planning purposes are usually prepared in terms of levels of annual activity for 5, 10 and 20 year horizons. In this way the forecasts for years 1-5 can be the focus for short-term operational planning and 6-10 the focus for intermediate-term capital improvements. The longer range estimates can be useful for long-term general concept planning.

c. *Peak Load Forecasts.* Demand at many master plan airports may be relatively smoothly distributed over the hours, days, and months of operation of the airport. However, there may be many airports with peak periods of demand that far surpass the average conditions. This situation is particularly important for airports that serve as hubs in a hub-spoke route system for one or more air carriers, or airports with high levels of international traffic. Whether it involves peak numbers of passengers traversing the terminal building and landside access or peak numbers of aircraft operations, or both, it is important to try to mitigate the extreme stresses demand peaks put on airport facilities.

It is not appropriate to design airport facilities to meet infrequent and short-lived peaks in demand—this would be an inefficient use of limited resources. Rather, some middle ground between average and peak requirements needs to be estimated in order to predict the extent and timing of the capacity-expanding investments that may be needed in the future. A commonly used concept in this regard is the "design hour" which is an estimate of the peak hour of the average day of the busiest month. This concept is needed for applying several planning tools cited elsewhere in this Circular.

For the busier airports, where there may be several busy months, a more desirable design hour may be the peak hour which occurs about 10 percent of the days of the year.

Additional peaking characteristics may need to be forecast in planning commercial service airport terminal facilities, such as peak 20 minutes (baggage claim facilities) or the ratio of enplaned to deplaned passengers during the design hour. Should these forecasts not be possible, there are alternative ways of sizing terminal components such as the Equivalent Aircraft (EQA) factor used in AC 150/5360-7A "Planning and Design Guidelines for Airport Terminal Facilities."

3. **FACTORS AFFECTING DEMAND FORECASTS.** The art of forecasting the elements of aviation demand has undergone considerable study and advancement in recent years. The following six factors have been found to be of particular significance and should be considered in forecasting demand for individual airport master plans and in updating and refining those forecasts.

a. *Economic Growth and Changes in Industrial Activity.* A community's economic character affects its air traffic generating potential. In addition to overall national and regional economic activity, this factor includes consideration of specific, identifiable, local activity that distinguishes the geographic area served by the airport from the aggregate conditions across the region. This factor is particularly important in connection with business travel by commercial and general aviation and with air freight traffic. Manufacturing and many service industries tend to generate greater air transport activity than primary

and resource industries, such as mining. Also, much can depend on established and potential patterns of trade, both within and outside the airport area. Other aviation activities such as agricultural and instructional flying and aircraft sales are included in this factor.

b. *Demographic Patterns.* The size and composition of the area's population—and its potential growth rate—are basic ingredients in creating demand for air transportation services. This includes an area's population profile and changes in its age, educational and occupational distribution. Demographic factors influence the level of airport traffic, its composition, and its growth—both in terms of incoming traffic from other states, regions, or cities, and traffic generated by the local or regional populations. In this regard, identifiable changes or differences in local conditions compared to regional average conditions in leisure time and recreational activities along with other local lifestyle factors indicating a propensity for aviation activity, may be important factors but difficult to measure.

c. *Disposable Personal Income.* The discretionary purchasing power available to residents over any period of time is a good indicator of consumers' financial ability to travel. High levels of average personal disposable income in the area served by the master plan airport provide a strong basis for higher than average levels of consumer spending on air travel. Distinct local preferences for particular modes of transportation may be a factor; but in some cases, alternative modes of transportation may not be available or economically feasible. For these reasons, significant and identifiable changes or differences in local levels of disposable personal income per capita and transportation preferences, compared to regional average conditions may be important factors for updating existing forecasts for the master plan airport.

d. *Geographic Attributes.* The geographic distribution and distances between populations and centers of commerce within the area served by the master plan airport may have a direct bearing on the type and level of transportation services that will be demanded. The physical characteristics of the land and local climatic differences may also be important, sometimes limiting aviation demand. On the other hand, physical and climatic attractions often stimulate holiday traffic and tourism and the demand for aviation services that they generate. The relationship of the master plan airport to other airports and to the routes and airways in the regional and national systems may have a strong bearing on types and levels of aviation services that might be demanded at the master plan airport. To the extent that local conditions and differences from regional averages can be identified, there might be a basis for adjusting existing forecasts for the airport.

e. *Other External Factors.* There are a number of other factors that might affect aviation demand at all or certain types of airports or at a specific airport. Fuel price changes, changes in the regulatory environment, changes in the levels and types of taxes, fees, and currency restrictions are such factors. To the extent such factors may affect all aviation activity in a region or nationally, their impacts will be reflected in the corresponding forecasts prepared by the FAA. However, one or another of these factors may affect aviation demand in a particular locale and then the appropriate adjustments should be made in the forecasts for master plan airports. In addition, changes in local attitudes toward the environmental impacts of aviation may affect demand and should be considered in forecasting or updating forecasts. Similarly, the granting of new routes for international air service can induce important changes in the volume of traffic at the specific airports receiving the international service.

f. *Local Aviation Actions.* There are a number of actions that local airport authorities take that have the conscious or unintended effect of either stimulating or retarding growth in aviation demand at the airport. The types of ground access and support services provided, user charges, and plans for future development can each affect future growth of aviation demand. The development of a master plan for the airport and the implementation of investment decisions generated by the plan, of course, can produce some significant changes by removing physical constraints to airport growth and the forecasts should reflect these changes.

4. FORECASTING STEPS.

a. The forecast process for airport master planning consists of six standard steps which vary from

airport to airport only in the degree of effort expended on each step. They are:

(1) Obtain existing FAA and other related forecasts for the area served by the master plan airport.

(2) Determine if there are significant local conditions or changes in forecast factors.

(3) Make and document any adjustments to the aviation activity forecast to account for such conditions or factors.

(4) Where applicable, consider the effects of changes in uncertain factors affecting demand for the airport services.

(5) Evaluate the potential for peak loads within the overall forecasts of aviation activity.

(6) Monitor actual activity levels over time to determine if adjustments are necessary in the forecasts.

b. Each of these six steps are described in the following paragraphs.

(1) *Existing FAA and Other Forecasts.* As part of its comprehensive forecasting program, the FAA produces forecasts each year for over 3600 airports in the National Plan of Integrated Airport Systems (NPIAS). These forecasts are based on, and controlled in the aggregate by, the FAA National Aviation Forecasts. The airport forecasts provide estimates for each of the next 15 years for the mandatory aviation demand measures, as well as for the instrument operations. These estimates are available in the Terminal Area Forecast Data System (TAFDS), which also lists actual historical demand for the past five years. The TAFDS also provides airport identification information, tower status, and the number of currently based aircraft.

Any assumptions specific to the forecast for a particular airport are also provided in the TAFDS listing. The underlying assumptions for the general forecast factors are provided in the FAA national aviation forecast report. For airports located in major hubs, additional information on assumptions is provided in the respective hub forecast report prepared by the FAA. The TAFDS information for the top 900 airports is also available in the Annual Terminal Area Forecast Report, along with regional and state summaries of aviation activity which are used in determining forecast growth rates for the remaining airports in each respective area.

State and regional aviation activity forecasts produced under system planning activities are important because they reflect local conditions and policy considerations. Access to these and to FAA forecasts, explanations of special forecast factors affecting the master plan airport, and assistance in locating other sources of forecast factor estimates can be obtained through the FAA Regional Office. Other sources are listed in the FAA reports cited.

The Air Transportation Association of America (ATA) prepares "Airline Airport Demand Forecast Reports" which, along with individual airline forecasts, should be secured when master planning an airport served by the scheduled airlines. Appendix 2 shows the Airport Master Planning Questionnaire used by ATA. Information of this type should prove highly useful in the planning for commercial service airports.

(2) *Significant Local Conditions.* There are two noteworthy situations in which the FAA and other forecasts for the master plan airport may need to be adjusted for master plan purposes: unusual local conditions or changed local conditions not accounted for in the existing forecasts. *For unusual local conditions,* the forecaster needs to identify and document any ways in which the forecast factors for the area served by the airport differ radically from areas served by other similarly-sized airports in the region. For example, the economy and population of the airport service area may be growing faster, the disposable personal income in the area may be above average, or the geographic attributes of the site may generate a higher than average aviation demand.

In the case of *changed local conditions,* attention should be paid to predictable changes from past trends, e.g., sharp changes from growth trends for the local economy, disposable income, or demographic characteristics. In addition, some factors specific to the master plan airport may be constraining demand forecasts, such as limited airport capacity or ground access or environmental constraints. To the extent that plans for removal or abatement of these constraints can be documented, the basis may exist for adjusting the aviation de-

mand forecast. For instance, if the existing forecast is based on a limited number of based aircraft, and plans to increase tie-downs or to establish a new fixed base operator can be documented, there may be a reason to adjust the aviation demand forecast.

(3) *Adjustments to Forecasts.* If the forecaster is able to identify any unusual local conditions or changed local conditions, then adjustments should be made in the existing master plan forecasts. For this purpose, there are three general methods that might be used to develop new demand estimates: extrapolation, analysis, and judgment. All the underlying assumptions, deductions and methods used to adjust forecast numbers for aviation demand need to be well documented because they will be reviewed by the FAA.

(a) *Extrapolation.* The rationale underlying the extrapolation procedure is that some past tendency or trend in the demand for aviation reflects future trends. It may be possible to quantify this tendency or trend and to infer its effect on future demand by projecting the numbers derived from the past into the future. This approach would be useful where there are unusual local conditions that are expected to continue and which differentiate the master plan airport from other airports in the region.

(b) *Analysis.* This approach essentially combines diagnosis and prediction. Explanations are sought of the factors influencing the activity levels to be forecast and a mathematical relationship is estimated between these factors and future demand. Analytical forecasting requires complete and consistent data series on the factors causing the change in aviation demand.

(c) *Judgment.* This method entails an individual who is closely acquainted with the factors related to the demand being forecasted making an estimate of future demand. The demand-affecting factors are weighed and evaluated according to the experience and intuition of the analyst. This method permits a broad range of information to be brought to bear on the forecast—national trends, local employment, political considerations, etc. This method is especially advantageous when used in conjunction with the other methods where there are a large number of demand elements for which little data are available, or when intangible factors are expected to play a major role. On the other hand, the forecasts derived from this method alone are the most difficult to defend under scrutiny and may be subject to the forecaster's biases.

(4) *Uncertain Factors.* If aviation demand at the master plan airport is expected to be particularly sensitive to one or a small number of forecast factors or events, then the planner should estimate the impact on future demand that would likely result from a reasonable change in any such factors which is different from the underlying assumptions. The usual effect will be to accelerate or retard the growth in aviation demand. The problem for the forecaster becomes one of estimating the displacement, in terms of time, of the affected threshold. For example, if future expected growth in aircraft operations is highly dependent on the continued existence of a fixed base operator (FBO) and there is a reasonable possibility that the FBO may close, then the impact in the form of delay in timing for reaching one of the threshold levels of demand should be estimated.

If there are major determining factors and their timing is uncertain, the forecaster can construct a time line illustrating the length of time during which an investment or demand constraints or diversion of air traffic to another airport may be needed—depending on the occurrence of the uncertain demand generation factor. In this respect, the number of operations or enplanements forecast for any specific future year becomes less important than the estimate that a particular threshold will be breached during the planning period and that the threshold may fall within a certain time range, say 5 to 8 years forward of the base period. This approach highlights, first, that demand may exceed the capacity of one or more of the airport's facilities; and second, that there is a range of time (with a range of forecast error costs) in which this problem will have to be dealt with.

(5) *Evaluating Peak Loads.* The determination of a design hour is a key step in the forecasting process for high activity airports. A case-by-case analysis will be necessary, taking into account the airport specific factors which shape peaking characteristics. Reference should be made to AC 150/5060-5 and 150/5360-7A.

It is important that design hour forecasts be subjected to a rigorous testing of their sensitivity to

the factors underlying their prediction. This is particularly important if the design hour figure possesses an abnormal peaking characteristic, compared to the average airport with a similar role and demand level as the master plan airport.

The typical peaking characteristics against which the forecast design hour should be compared are:

- The ratio of peak hour operations to average daily operations (for the busiest month), which may range from 7-11 percent, and
- The ratio of average daily operations to annual operations, which may range from 0.29 percent to 0.34 percent.

These ratios are directly related to the size and demand level of the airport—with the lower percentages common to the busiest commercial service airports and the highest common to the low activity airport. It should be noted that these ratios should not go below 6.25 percent (16 hour day) and 0.27 percent, respectively, which represents a steady, no peak demand pattern.

(6) *Monitoring Actual Activity.* Continuous planning will help cut down forecast error costs. For a truly effective continuous planning process, demand at the master plan airport needs to be monitored so that adjustments can be made in the forecasts. In this way the forecaster can not only update and refine the forecast demand levels for the years ahead, but can also narrow the time band of the period within which a threshold will be reached.

The accuracy of the base data for forecasting and monitoring aviation activity at the master plan airport is often as important as the method used for forecasting. In many cases, more accurate and useful forecasts can be obtained through extra effort on improving the data base than on more sophisticated forecast methods. This is particularly the case for non-towered airports where such techniques as actual counts during survey periods and mechanical or acoustical counters can be used to establish accurate data on actual demand. Periodic surveys to establish general relationships between numbers of itinerant operations and enplanements can also be useful.

5. **SOURCES OF INFORMATION AND ASSISTANCE.** The following are sources of information and assistance for master plan forecasting.

a. *Terminal Area Forecasts.* The initial basis for forecasts at any public use airport in the United States is the FAA Terminal Area Forecast (TAF). The TAF is available as an annual document from FAA Regional Offices and from the FAA Office of Aviation Policy and Plans in Washington, D.C. The TAF is also available as the Terminal Area Forecast Data System (TAFDS), a data base on a commercial computer time-sharing service. Information and assistance on obtaining access to the TAFDS are available from the Regional Offices of the FAA.

b. *National Forecasts.* The FAA Office of Aviation Policy and Plans publishes an annual report entitled FAA Aviation Forecasts, which provides national and regional summary forecasts of aviation activity at FAA facilities. These facilities include airports with FAA control towers, air route traffic control centers, and flight service stations. Detailed forecasts are made for the four major users of the national aviation system: air carriers, air taxi/commuters, general aviation, and the military. This document also presents descriptions of the FAA forecast modeling methodology, assumptions, and historical data bases.

c. *Historical Data Sources.* Both the TAF and the FAA national forecasts present historical data on aviation activity. Prior to January 1, 1985, enplanements were based on data submitted to the Civil Aeronautics Board (CAB). However, since the Sunset of the CAB, enplanements are based on data submitted to the Research and Special Programs Administration of the Department of Transportation. U.S. certificated air carriers submit enplanement data on RSPA Form 41 while Regional Air Carriers (commuters) provide data on RSPA Form 298. These data are supplemented by an FAA survey of air taxi operators, and by reports of foreign flag traffic from the Immigration and Naturalization Service. State aviation commission reports and airport manager reports are used to complement and verify enplanements.

Historical operations data at FAA towered airports are from FAA Air Traffic Activity reports. U.S. air carrier departures at non-towered airports are obtained from RSPA form 41 reports. Other opera-

tions at non-towered airports are based on special traffic surveys and estimates provided in the FAA Airport Master Record Form 5010-1. Instrument operations handled by FAA towered airports and air route traffic control centers and instrument approaches for all airports are reported in the FAA Air Traffic Activity and the FAA Airport Activity Statistics.

d. *Statistical Sampling*. Activity counts at non towered airports can be obtained by using statistical methods for estimating aircraft operations. Handbook FAA-APO-85-7 Statistical Sampling of Aircraft Operations at Non Towered Airports provides a sound method for estimating aircraft operations and is written for planners, engineers, airport operators responsible for airport planning, and persons who collect data for FAA Airport Master Records.

e. Further assistance in forecasting tools, techniques, and methods can be obtained from FAA Regional Offices. Whether the aviation forecasts are being prepared by the airport planning staff or by consultants, early and periodic discussions with FAA airports and forecasting staffs are encouraged. These discussions on forecasts are particularly important where significantly different forecast assumptions and methods are contemplated in developing the basis for a specific airport master plan or where there are differences between existing forecasts covering the airport.

These early discussions will also be especially useful where the forecast development results indicate that expenditure of federal funds for airport improvements would be justified at an earlier time than indicated in the existing FAA Terminal Area Forecast for the master plan airport.

CHAPTER 6 REQUIREMENTS ANALYSIS AND CONCEPTS DEVELOPMENT

Terminal gate at a Commercial Service airport

1. **GENERAL.** Armed with demand forecasts and having inventoried the existing airport plant and reviewed its condition, the planning proceeds to an investigation of the capability of the airport to accomodate the forecasted demand. The unconstrained airside and landside capacity needs are determined. Should there be financial, physical or environmental limitations in accomodating capacity expansion, then the possibilities of diverting air traffic to another airport or providing for a new facility must be addressed. The latter will involve decisions on the roles of the existing and new airports and the extent of development at each.

The time frame for assessing development needs usually involves short (up to 5 years), intermediate (10 years) and long term (20 years) periods. While this is discussed further in Chapter 10, "Plan Implementation", long range planning is concerned with the ultimate role of the airport and its related development. The intermediate range involves a more detailed assessment of needs. The short term is geared to an immediate action program and may include details not appropriate to the longer time periods. On the other hand, the intermediate and long term periods will target development needs based on the attainment of specific demand levels.

2. **DEMAND-CAPACITY ANALYSIS.** Airside capacity is calculated and matched against aircraft demand forecasts to determine the need and timing for investments. AC 150/5060-5, "Airport Capacity and Delay," presents a straightforward methodology for performing this analysis. The methodology gives hourly capacities and annual service volumes, and permits the estimation of aircraft delay levels as demand approaches and exceeds the "throughput" capacity of the airfield configuration being reviewed.

Decisions can be made on the timing of new airside components by comparing the cost of the facilities with the benefits of avoiding delays. A comparison of annual delay with and without the additional facilities produces a theoretical delay reduction in units of time. This total, when multiplied by average unit aircraft operational costs and passenger time values, can be compared with the annual debt amortization, operational and maintenance costs of the new facilities to arrive at a cost/benefit relationship.

a. Landside capacity is determined for terminal area and gates, curbside, surface access and automobile parking. For commercial service airports the AC 150/5360-7A, "Planning and Design Guidelines for Airport Terminal Facilities" provides guidance of a general nature for airports of all activity levels. The AC 150/5360-9, "Planning and Design of Airport Terminal Facilities at Nonhub Locations" provides comprehensive guidance applicable to the lower activity commercial service airports. The FAA Report (DTFA-01-83-P-88004), "Access to Commercial Service Airports" is a useful reference for the planning of an on-airport ground access systems.

For general aviation airports, the guidance in AC 150/5300-4B, "Utility Airports, Air Access to National Transportation", should prove useful.

b. The level of detail of airside and landside demand/capacity analyses will vary with the complexity of the airport. For low activity airports, capacity needs may, like the forecasts, already be available from other studies. If not, the determination of airside capacity can be readily obtained by using AC 150/5060-5.

c. For highly complex airport planning studies, it may be necessary to employ computer programs for capacity and delay analyses, such as the FAA's Upgraded Airfield Capacity Model and Annual Delay Model, for which tapes are available. Report DOT/FAA/PM-84/2 Airfield Delay Simulation Model (ADSIM) can also be used to study airport capacity and delay.

For determining terminal capacity for a highly complex study, research of available literature on the subject as well as visits to airports where state of the art landside planning has taken place may be desirable.

As with aviation demand forecasting, the effort and expense in capacity and delay analyses should be geared to the investment error costs of inadequate analysis.

3. **DEVELOPMENT ASSESSMENT.** The unconstrained airside and landside capacity requirements are imposed on the existing airport and an assessment is made as to whether and how the expanded facilities can be accommodated. This process includes a melding of airside and landside concepts to achieve a balance in capacity among all components. In addition to determining the physical capability of expansion, as well as its timing based on development costs versus delay reduction benefits, operational reliability and safety are critical considerations. Of course, the ability of the airport authority to finance the improvements is crucial to the timing decision and must be reviewed at this point.

a. The airport must be designed to standards which will accommodate the most demanding airplane (critical aircraft). Key guidance documents to be used in the assessment of an airports physical development capability are the current editions of AC 150/5300-12, "Airport Design Standards - Transport Airports" and AC 150-5300-4B, "Utility Airports, Air Access to National Transportation." The latter document contains terminal guidance for general aviation airports as well as physical standards for airports serving aircraft having approach speeds of less than 121 knots. An assessment of the landside expansion capability of airports with scheduled airline service can be guided by the information contained in the publications listed in paragraph 2.

In developing the scope of the master plan study consideration must be given to rotocraft operations. Even at airports which presently have few helicopter operations the master plan should include approximations of future activity, designation of current and proposed operating areas and estimates of related facility requirements. At most airports in depth studies will not be required, only coverage appropriate to realistic expectations. It should not be assumed however that even when rotorcraft requirements are nominal, they can be planned independent of the airport. Likewise, development proposed for fixed-wing aircraft should be reviewed to make sure it does not adversely impact present or projected rotorcraft operations. Rotorcraft guidance can be obtained in the current edition of AC 150/5390-1 "Heliport Design Guide".

While deviations from FAA standards are not encouraged, it is at the planning stage that the airport operator should discuss with the FAA potential deviations. If deviations from standards must occur, there should be a complete discussion in the master planning documentation of the rationale and coordination that led to the adjustment.

b. Coordination with local transportation planning authorities during the inventory phase should have produced sufficient information to allow an assessment of surface access capability, and whether that which exists or is planned can meet airport demand.

With the exception of the busier commercial service airports where access is a capacity constraint, airport access planning by local transportation agencies has historically been effective and probably will not emerge as the critical constraint of airport capacity expansion. This is not to say that off-airport access requirements should be limited in emphasis. To the contrary, the master planning study should produce specific recommendations for removing any existing or potential limitations to efficient airport access.

The study effort can also serve as an opportunity for a dialogue on eliminating minor bottlenecks or achieving more efficient access through immediately implementable non-capital intensive measures such as signing, directional flow control, etc.

c. In addition to the assessment of the physical capability of the airport to accommodate expansion, consideration must be given to the environmental consequences of an expanded airport operation and whether they are acceptable. The potential environmental impacts must be considered while reviewing the alternative airside and landside concepts for achieving balanced capacity, thus introducing an element which could severely limit the available options. The requirements and process for considering environmental impacts are covered in detail in Chapter 8.

4. **LAND USE CRITERIA.** Land use criteria provide the policy and priorities that will dictate the general arrangement and sizing of landside facilities and their relationship to airside facilities. The land use criteria also suggest the potential requirements for capital investment and the opportunities for revenue production.

Land use criteria will vary in accordance with the role of the airport, primarily whether it be a commercial service or general aviation airport, and the policy requirements of the airport operator. There are, however, criteria which will likely be applicable in all cases, such as:

- Adherence to standards in support of safety in aircraft operations. These include FAA design and obstruction standards, such as building restriction lines, distances between taxiway centerlines and aircraft parking aprons and obstacles and obstructions defined by the imaginary surfaces established in Federal Aviation Regulation, Part 77.
- Non-interference with line of sight or other operational restrictions inherent in siting criteria for FAA control towers, navigation aids, weather equipment, etc. For example, to protect line of sight from an existing or planned air traffic control tower, a shadow diagram should be included as part of the master plan. Guidance is provided in FAA Order 6480.4 "Airport Traffic Control Tower Siting Criteria" which may be reviewed at FAA Regional Offices.
- Use of existing facilities, insofar as possible and depending on their location, con-

dition, and any obligations with respect to their use such as long term leases.
- Attention to factors which may affect construction cost such as available utilities and topography.
- Flexibility in being able to accomodate changes in demand and expansion, both vertically and horizontally.
- Efficiency in ground access to the served communities.
- Priority accorded aeronautical activities where available land is limited.
- Encouragement of revenue producing land uses which support an aviation-oriented infrastructure.
- Flexibility of non-aeronautical uses so as to permit expansion of aeronautical facilities.

In developing and applying the land use criteria, attention must be given to the existing and potential uses of land in the vicinity of the airport. This is necessary in view of the possible need to acquire additional land for airport related activities; because of environmental impacts which may be minimized through some form of land use control; and because of the need to protect aircraft operations from hazards to air navigation, i.e., the erection of tall structures, operation of other landing areas or establishment of land uses attractive to birds.

Direct control, such as ownership, by the airport operator of land use within the 75 LDN noise contour is a desirable objective, but it is not always achievable. If the airport operator, in conjunction with municipal authorities, can influence how the environmentally sensitive areas are used, the reduction of impacts can be achieved without land acquisition. If the land can be devoted to such aviation-related activities as air parcel handling facilities, off-airport long-term parking, rental auto parking and processing, etc., both the airport and the environs benefit. For a discussion of noise planning compatibility see Chapter 9, Par. 5 "Noise Compatibility Plan".

5. **TERMINAL PLANNING CRITERIA.** In addition to the application of land use criteria, as outlined in paragraph 4, the following considerations are important in applying and integrating landside and airside concepts.

a. *General Aviation Airports.*

- Locate the administration area within easy access of auto parking and public transportation.
- Fixed base operator facilities should be located so as to maximize exposure to marketing opportunities, but separate from the administration building.
- Minimize the separation, or splitting, of general aviation functional areas.
- Minimize taxiing times from parking, tie down, hangar storage, and fixed base operator areas, with priority access to itinerant operations.
- Locate itinerant operational and fueling areas close to the administration building.

b. *Commercial Service Airports.*

- Separate airline, general aviation and commuter traffic in the apron area but provide for easy access of general aviation and commuter passengers to the airline terminal.
- Consolidate general aviation functional areas.
- Separate special air carrier functions such as shuttle, commuter, charter and international, but provide for ease of access to each other and to domestic services.
- Facilitate the inter-airline transfer of passengers and baggage.
- Encourage the joint use of airline facilities.
- Minimize the curbside to apron walking distance, processing and transit time.
- Minimize auto parking to curbside access time and walking distance and access times to rental car facilities.
- Provide a convenient and reliable public transportation - curbside interface.
- Simplify internal airport vehicle circulation and terminal access systems; separate commercial/service vehicles from passenger vehicles.
- Centralize administration facilities and provide adequate employee service facilities, such as convenient auto parking, access to public transportation and direct access to off airport highway systems.

- Allow for cargo growth potential and possible expansion of all-cargo aircraft activity. Facilitate cargo transfer and access. If separate cargo buildings are warranted, they should be in reasonable proximity to the passenger terminal.
- Provide for potential growth in helicopter traffic.
- Provide for efficiency in apron operations, particularly with respect to aircraft and service vehicle maneuvering.
- Locate modern fire, crash and rescue facilities so as to meet or exceed response time criteria.
- Locate aircraft refueling facility within reasonable proximity to terminal area and provide access separate from public entrance road.
- Locate rental car maintenance facilities so that they are accessible to terminal area.

The application of these criteria, as well as the development and application of other criteria appropriate to the individual airport case, should be a coordinated undertaking among airport operator, consultant and users.

6. **ALTERNATIVES REVIEW.** Should the assessment of the airport's capacity show that substantial expansion would be necessary to accommodate projected demand, there should be an investigation of alternatives. The alternative of doing nothing and transferring some or all of the operations to another airport (existing or new) should be studied in order to determine whether the investment required to expand the existing airport's capacity can be supported on aeronautical, financial and environmental grounds. A most important objective in this review is making the best use of existing facilities.

a. The consequences of doing nothing should be carefully investigated and reviewed in the light of the community's social and economic goals. The short term consequences of inaction may not be readily quantifiable but the long-term impacts may be severe and the opportunities for providing additional capacity diminished.

b. The provision of separate "reliever" airports for general aviation that will draw traffic from the busy commercial service airport is a well recognized way of reducing general aviation demand. The division of airline traffic by type, such as international, domestic, and shuttle among two or more airports can systematically balance demand and capacity.

c. The investigation of new site possibilities should be general in nature, and limited in scope to that which is necessary to make a decision on alternatives. The principal considerations for comparison of new sites to the existing airport will be airspace and airspace capacity, airfield and ground access development costs, user ground access costs, (including value of time), aircraft operational costs, environmental impacts, financial feasibility, and long-term viability. Consideration also must be given to alternative roles for the existing airport and alternative transfer times to a hypothetical new airport.

7. **AIRSPACE AND AIR TRAFFIC CONTROL.** In discharging its responsibility for managing the air traffic control system and in assuring flight safety, the FAA performs a number of functions which have a direct bearing on the development of the airport master plan. The planner should be familiar with the pertinent activities and how and when they may be applicable.

Areas of particular importance involve the establishment of air traffic procedures concerned with the use of the terminal airspace, particularly for approaches and departures; the determination of what constitutes an obstruction to air navigation; and the provision of electronic and visual approach and landing aids.

The airport master planning and layout plan approval process serves as a focal point for FAA recommendations with respect to the future development and operation of the airport.

a. In developing instrument terminal flight procedures, the FAA is guided by the document "United States Terminal Instrument Procedures" (TERPS) and by FAR Part 91 for VFR procedures. A similar document, "Procedures for Air Navigation Services - Aircraft Operations" (PANS-OPS), promulgated by ICAO, is applicable in the development of procedures for non-U.S. airports. Familiarity with the material contained in these publications will assist the planner in determining

potential interaction of contemplated operations at the airport under study and other airports, and possible obstructions to aircraft operations.

In using AC 150/5060-5 for determining airport capacity, the planner should be aware the guidance assumes there are no airspace limitations which would adversely affect flight operations or otherwise restrict aircraft which could operate at the airport. The "throughput" model on which the capacity and delay data are based assumes the continuous demand by an aircraft to be serviced by the runway system. Limitations on terminal airspace could limit the ability of the system to deliver aircraft, uninterrupted, to the landing area. Therefore, consultation with the FAA on potential airspace limitations is advisable.The causes of airspace limitations could include:

- Permanent obstructions to operations such as high terrain and buildings which could limit the creation of additional arrival streams or maneuvering areas;
- The need to restrict the use of the airspace at one airport to accomodate operations at another where there is a sharing of airspace due to their proximity;
- Requirements for circuitous routing through intermediate control points;
- An overloading of the air traffic control system due to peak demands and adverse weather; and
- Electromagnetic interference affecting communications or navigational equipment in the cockpit or on the ground.

A typical traffic pattern for an individual runway at an airport is shown in Fig. 6-1. Fig. 6-2 shows the controlled airspace for an airport with a control tower. The Airman's Information Manual (AIM) (Basic Flight Information and ATC Procedures) gives a description of terminal flight procedures for both Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) cases.

Under Part 157 of the Federal Aviation Regulations, "Notice of Construction, Alteration, Activation, and Deactivation of Airports," proponents of such actions must give notice to the FAA. The FAA, in turn, conducts an aeronautical study of the proposal and advises the proponent as to its effect on the safe and efficient use of the airspace. Timely coordination with the FAA during the course of the master plan study, particularly during review and approval of the airport layout plan, should facilitate the development of an acceptable plan.

AC 70-2D, "Airspace Utilization Considerations in the Proposed Construction, Alteration, Activation and Deactivation of Airports" may prove to be a useful reference.

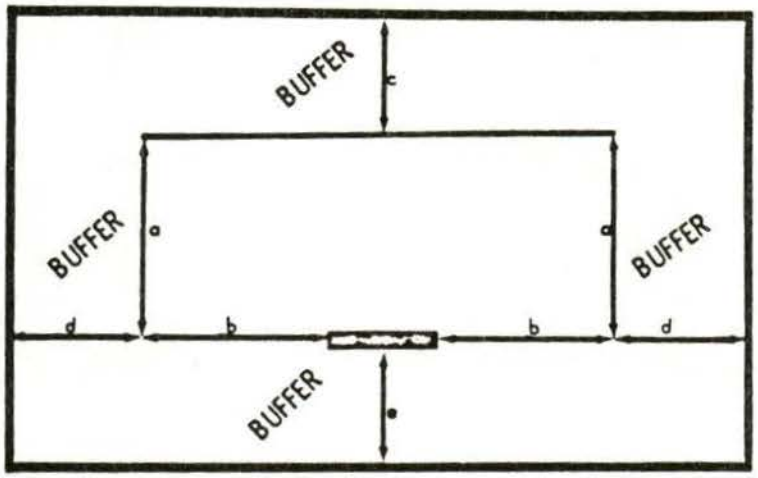
b. *Obstructions to Air Navigation.* As discussed in paragraph 7a., the application of TERPS will give the planner insight on the relationship of objects which penetrate the airspace and aircraft operations. The FAA applies the TERPS in its studies of objects which may affect the navigable airspace under PART 77 of the Federal Aviation Regulations, "Objects Affecting Navigable Airspace." Under this regulation, standards are promulgated for determining obstructions to air navigation, requirements are established for proponents of proposed construction to notify the FAA of same, and provisions are made for the FAA to conduct aeronautical studies of the proposals to determine their effect on the safe and efficient use of the airspace by aircraft.

The planner should be familiar with the standards set forth in this regulation and may want to refer to the AC 70/7460-2G, "Proposed Construction or Alteration of Objects That May Affect the Navigable Airspace." Obstructions in the vicinity of an airport, as determined by these standards, may not necessarily constitute hazards to aircraft operations or impose strict limitations on the way aircraft can operate to and from the airport. However, the standards will serve as useful geometric measures for examining airfield configuration alternatives, signaling potential operational limitations, and triggering more detailed analysis under TERPS.

c. The FAA establishes, operates and maintains the principal electronic and visual approach and landing aids (the airport operator is responsible for airfield lighting) at an airport. The need for such facilities, in accordance with the demand forecasts of traffic and occurence of adverse weather, should be determined based on interpretation of FAA criteria for their establishment. FAA's Airway Planning Standard No. 1 gives activity levels at which an airport will be an eligible candidate for the establishment of such air traffic control, navigation aid and approach and landing aids as control towers,

AIRCRAFT CATEGORY TYPES	DISTANCE IN NAUTICAL MILES				
	a	b	c	d	e
A	.75	.75	.5	.5	.25
B	1.00	1.00	.5	.5	.25
C	1.75	1.75	.5	.5	.5
D	3.00	2.00	1.0	1.0	.5

NOTE: The above trafic pattern airspace should be increased by one-half the length of "b" (final and departure dimensions) when more than four aircraft of the same category are anticipated operating in the traffic pattern at any one time.



LEGEND

a. Base leg and crosswind.
b. Final and departure. (Measure from end of runway)
c. Downwind buffer area.
d. Base leg and crosswind buffer area.
e. Final and departure buffer area

FIGURE 6-1. TRAFFIC PATTERN AIRSPACE

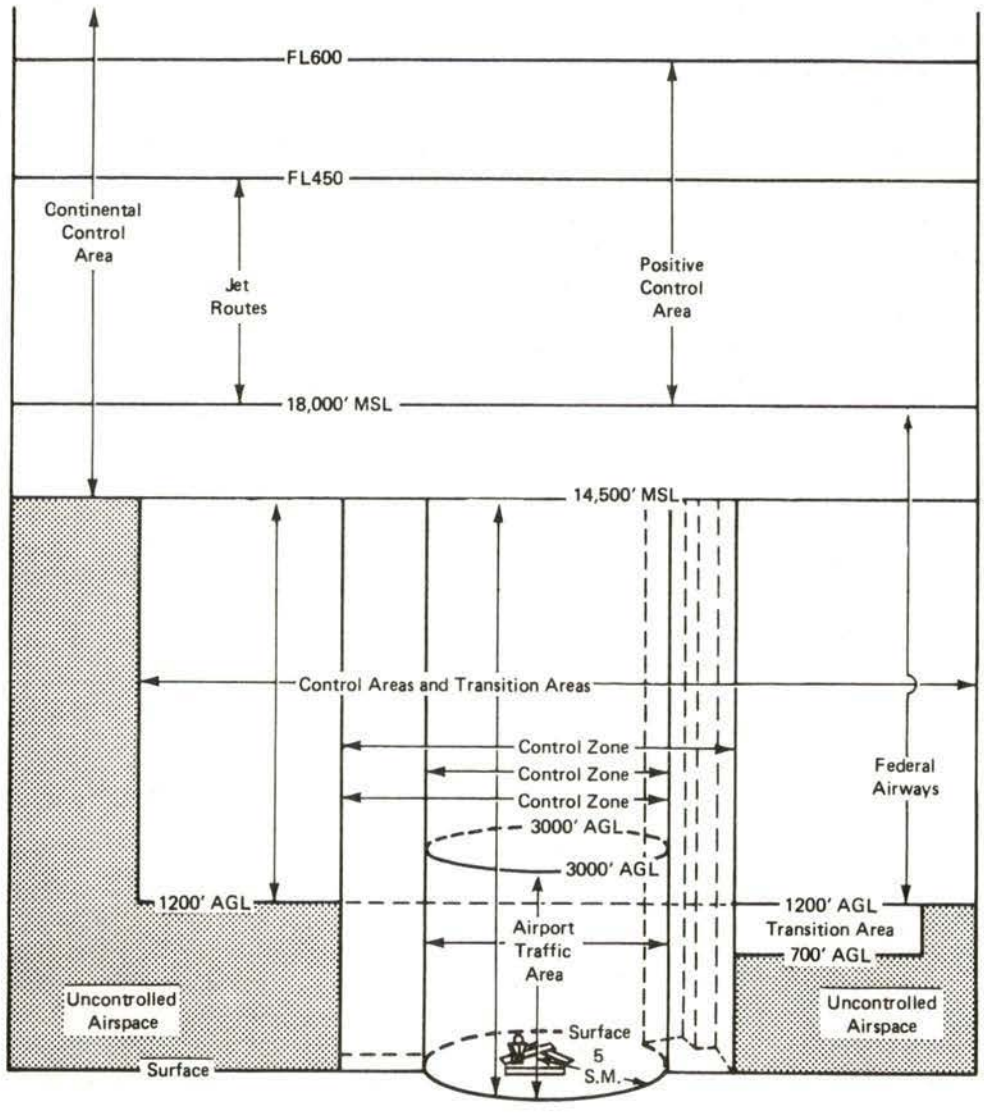


FIGURE 6-2. CONTROLLED AIRSPACE

tion and plans. Also, the FAA should be consulted early with respect to the designation of the airports instrument runway(s), a responsibility of the agency. Early designation of the instrument runway(s) and its depiction on the airport layout plan is important so that long-term protection can be facilitated for instrument operations under the contemplated weather minima.

8. **TECHNOLOGY AND OPERATIONAL IMPROVEMENTS.** Airport capacity analysis, using current FAA guidance may not take into account long term improvements in operational environment or technology which could increase efficiency and enhance airport capacity. For long-term planning purposes, it may be useful to consider potential state of the art improvements which could affect the timing of investment decisions.

Any decisions related to long range planning should consider how sensitive the plan is to the possible occurrence of various events, be they improvements in capacity or changes in demand forecasts. Thus, the need to adjust forecasts based on experience will go hand in hand with a requirement to monitor the potential for capacity enhancement through technology advances and improved operational environments.

a. A significant factor affecting airport capacity is the longitudinal spacing required between aircraft in landing and in departing because this affects the number of aircraft that can be delivered to or released from a runway in a given unit of time. Before the introduction of wide-bodied jets, the landing separation standard under instrument flight rules was 3 miles. The advent of the heavy jet (greater than 300,000 pounds) added new separation standards of 4, 5 and 6 miles due to the wake vortex phenomenon (the smaller the following aircraft the larger the separation) and doubled departure release times from 60 seconds to 120 seconds. At the busiest airports with a substantial percentage of heavy jets, capacity can be reduced almost 20 percent because of wake vortex. Research and development on wake vortex advisory and avoidance systems indicate a capability of substantially reducing the problem. The complete elimination of the problem can only be achieved by aerodynamic modifications, something probably not likely in the foreseeable future.

A key R&D program that could, in the long term, achieve a goal of 2.5 mile standard separation (for an aircraft pair least sensitive to wake vortex) in conjunction with a satisfactory wake vortex avoidance system involves metering and spacing. The automation assistance in the rate, order and separation of successive aircraft may result in significant overall airport capacity increases.

It is expected that these potential efficiencies in terminal airspace operations will be consistent with an improved system of delivering aircraft to terminal airspace as a result of implementation of FAA's National Airspace System Plan, which is a complete modernization of the ATC system.

b. The Microwave Landing System (MLS) which will eventually replace the Instrument Landing System (ILS), will be gradually integrated into the National Airspace System with implementation of 1250 MLS's by the year 2000 (see Figure 6-3). The MLS will provide:

- Precision instrument guidance where ILS is not practical;
- Ease of siting, allowing more flexibility in planning airport facilities;
- Enhanced airport capacity by its application to short, converging and triple parallel runways, and by its capability to allow higher angle glide paths, wide angle coverage and multiple glide paths possible;
- Precision instrument approach capability for helicopters;
- Reduced weather minima due to siting flexibility;
- A reliable and accurate signal; and
- Help in avoiding wake vortex by allowing light aircraft trailing heavy aircraft to approach and land at a higher glide angle.

c. The most critical capacity determinant is the runway use configuration. The second most critical is runway occupancy time which might otherwise permit substantial reductions in arrival spacing of aircraft. Operational improvements in the way runway systems are used are important. For example, computerized airfield/airspace management systems at the busier airports could be used to instantly select the highest capacity and most energy efficient runway use configuration for the prevailing circumstances of wind, visibility, traffic mix, arrival-to-departure ratio, and noise abatement.

Improved surveillance equipment and procedures could result in reduced runway separation standards. A substantial reduction from the current 4300 feet in parallel runway separation for independent IFR operations may be achievable. Also, the current minimum 3 mile separation to a third paral-

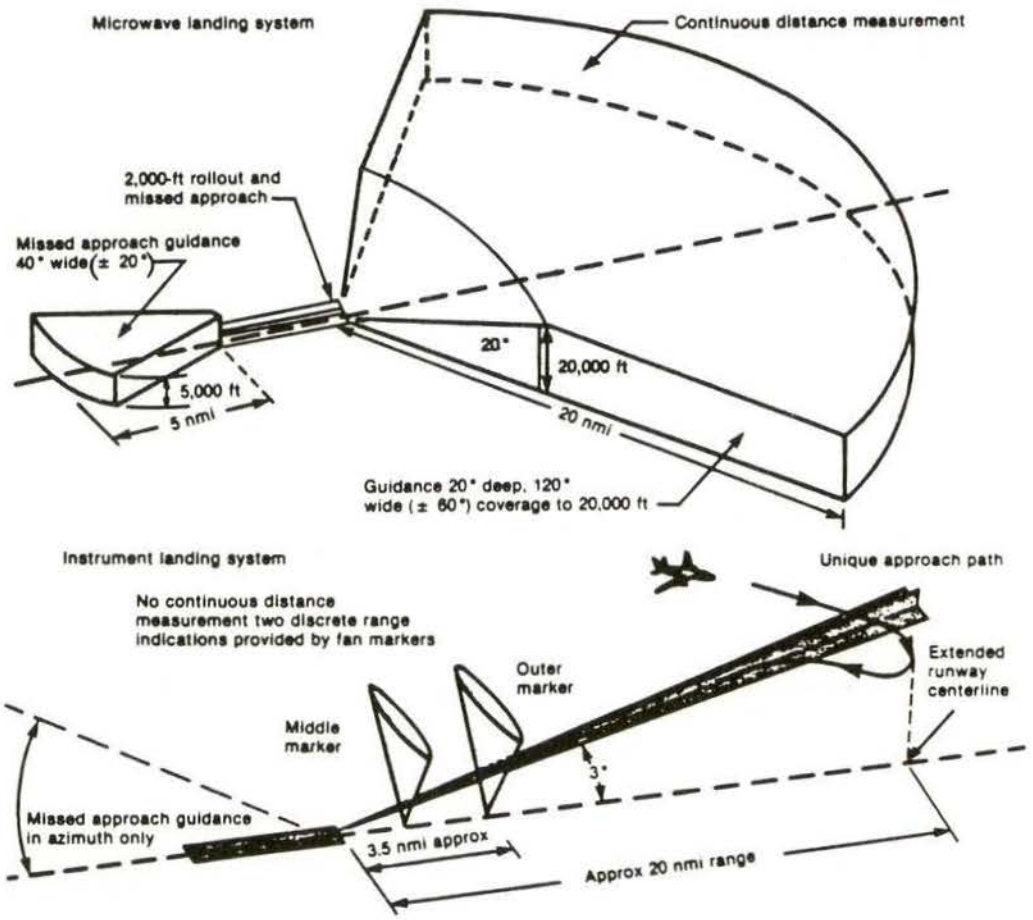


FIGURE 6-3. COMPARISON OF MICROWAVE LANDING SYSTEM AND INSTRUMENT LANDING SYSTEM

lel runway for three independent IFR arrival streams could be reduced by application of MLS and procedural changes. While runway separation standards are the responsibility of the FAA, and the planner does not have the discretion to apply reductions, knowledge of these potential changes should prove useful.