

AN INVENTORY OF RESEARCH NEEDS

A primary goal of the Conference on Airport Landside Capacity was to identify research needs. The statements that were submitted by conference participants have been reviewed, combined to eliminate overlap, and grouped under subject categories. The subject categories and titles of the 65 research statements that follow are given in Table 1. The categories are arranged alphabetically, and the project statements are numbered sequentially.

The numbers or the order of listing does not in any way indicate priority. The statements reflect the feeling that one or several participants had that research deficiencies existed and could be eliminated by the research recommended. Because there was not general agreement either within individual workshops or among them on many of these issues, resolving the conflicting views and assigning priorities within the time constraints of the conference were not feasible. The statements, then, represent an inventory of research needs from which a research program with appropriate priorities can be developed.

AIRCRAFT

1. Aircraft Mix

The sizes of aircraft have only a small effect on airside capacity and service volume but can have a major effect on the landside facilities and, in turn, on airport access and egress. The numbers and combinations of aircraft sizes have a measurable influence on the numbers of passengers and amounts of baggage and

Table 1. Research statement titles by subject category.

Subject Category	Research Statement Title
Aircraft	1. Aircraft mix
Airline activities	2. Effect of airline operations on landside services
Capacity and expansion	3. Airport landside capacity analysis 4. Landside expansion case studies 5. Methodology for analysis of alternative concepts for expanding terminal capacity 6. Benefit-cost analysis of capacity-increasing projects 7. Low-cost alternatives for increasing airport landside capacity 8. High-density movements and capacity enhancement 9. Systemwide effect of capacity changes at one airport 10. Expansion of low- and medium-density airports to accommodate wide-bodied aircraft and high peak hours
Community attitudes	11. Community attitudes 12. Influence of increased social awareness on implementation of airport expansion programs
Competitive modes	13. Effect of intermodal competition on short-haul air traffic
Concessions	14. Impact of concessions and consumer services on landside capacity
Energy conservation	15. Constraining effects of policies to conserve energy
Environment	16. Constraint of environmental statutes on landside capacity development
Financing and funding	17. Evaluation of financial needs and capabilities of air carrier airports 18. Criteria for economic and financial performance of airport landside capacity 19. Airport cash-flow model 20. Uniform code of accounts for airports 21. Factors affecting efficiency of resource use in airport landside capacity 22. Airport service pricing options 23. Cost-benefit analysis of airport landside research 24. Federal landside participation policy 25. Use of ADAP funds to balance airport development 26. Development of measures for cost of capital
Forecasting and simulation	27. Forecasting methodology and monitoring system for airport landside capacity 28. Effect of forecast variability in landside development 29. Conversion of forecast demand factors to daily peaking 30. Sensitivity analysis of demand factors on level of service 31. Development of airport landside simulation capability 32. Application of econometric techniques to demand forecast 33. Calibration of airport planning models
Information	34. Survey and data collection requirements 35. Existing airline data 36. Airport management information support
Intergovernmental relations	37. Jurisdictional cooperation in intermodal and multimodal planning 38. Influence of urban development patterns on airside and landside capacities and operations
Levels of service	39. Criteria for airport landside level of service 40. Policy studies of level-of-service implementation alternatives 41. Establishment of level-of-service values 42. Attitudinal surveys regarding airport landside services 43. Composite measures of walk, serve, and delay time
Marketing	44. Impact of airline marketing practices on airport capacity requirements
Management	45. Management training
Passenger and baggage processing	46. Common, nonrestrictive, and automated passenger and baggage-processing facilities 47. International passenger and baggage processing 48. Passenger information systems for airport terminals 49. Potential and limitations of automation for airport baggage processing
Security	50. Present and future impact of airport security regulations on airport landside capacity
Surface transportation and parking	51. Improving ground transportation service by low-cost techniques 52. Alternative transport systems for airport access 53. Automated guideway transit systems in airport landside capacity improvement 54. Busways for airport accessibility 55. Intermodal ticketing 56. Curbside use at airports 57. Manual for uniform traffic control devices for the airport landside 58. Ground transportation information 59. Off-airport parking 60. Airport access links to major transportation corridors
Terminal design	61. Terminal design to increase service reliability 62. Methodologies for forecasting passenger volumes for designing airport terminals
Terminals, off-airport	63. Off-airport terminals for passengers and cargo
Traffic peaking	64. Methodologies for assessing and evaluating economic, legal, and political implications of peaking of domestic and international air traffic at airports
User characteristics	65. Characteristics of airport population

cargo that must flow through the terminals and the rates at which they must be processed. The limits of the changes should also be investigated to establish the most efficient mixes and the point of imbalance between airside and landside capacities. The proposed research should investigate the sensitivity of landside movements to changes in aircraft sizes and numbers, develop a rational basis for adjustments in aircraft mix for changing demand patterns, develop methods to measure changes in landside requirements resulting from aircraft mix changes, and investigate techniques to ascertain imbalances early.

AIRLINE ACTIVITIES

2. Effect of Airline Operations on Landside Services

Changes in airline activities have a major influence on landside capacity. The cause and effect relations need to be evaluated by the nature and cost of the impact. Research is needed to identify the elements of landside service that are affected by airline activities, characterize the airline activities that require changes in landside capacity (e.g., schedules, equipment changes, bunched operations), analyze the sensitivity of each landside element to each determining airline activity, and relate the effect to system characteristics such as level of service, productivity, and cost.

CAPACITY AND EXPANSION

3. Airport Landside Capacity Analysis

Proposed expenditures on airport airside improvements have been questioned because of the uncertainty that the airport landside facilities can accommodate increased passenger rates. Is there a balance in capacity at the major airports? Research is needed to establish definitions and methodologies for estimating landside and airside capacities at major airports.

4. Landside Expansion Case Studies

Although criteria exist for determining whether new landside capacity is required, the relation between specific criteria and actions taken on them has not been widely disseminated. Therefore, the case studies of landside problems should be collected, analyzed, and disseminated. The proposed research should select approximately 6 representative airports; determine measures of expansion activity; chronicle functional details, such as alternatives, time schedules, size, cost, and performance; and chronicle process details such as federal, state, and local institutional requirements, redirection sources, and perceived success by incident group.

5. Methodology for Analysis of Alternative Concepts for Expanding Terminal Capacity

There is no systematic, comprehensive, and practical analytical procedure for evaluating alternative concepts for terminal expansion at existing sites. Many of the factors that affect expansion at existing airports are not associated with or are of little importance at new sites. The research proposed should identify known expansion concepts and factors affecting choice of concept; outline current procedures used for analyses; explore and test sensitivity of factors to cost, time, flexibility, and ultimate capacity of site; develop or propose guidelines for analyzing each factor, a means of quantifying

all possible factors on various cost bases such as least cost or present worth, a matrix of expansion concepts and factors, and a method of ranking; test and compare actual cases; provide suggested levels or ranges of investigation relative to size of project; and recommend a methodology.

6. Benefit-Cost Analysis of Capacity-Increasing Projects

Many financially feasible projects for increasing the capacity of landside facilities are not undertaken because of opposition from the community or from the principal operators, or because the sponsor cannot determine whether the project will yield a satisfactory return on the investment. In one situation, attractive opportunities may be foregone; in another, liabilities may be contracted. Methods whereby all significant benefits and costs can be assessed in a rational and defensible way are clearly needed.

Two major avenues of research are proposed: (a) identification and quantification of all significant real benefits and costs, i.e., those having a net effect at the regional level without regard for who gains or who loses; and (b) identification and quantification of all significant pecuniary benefits and costs, i.e., who gains (motel owners, for example) and who loses (nearby residents) and by how much? Among the more difficult questions to be addressed are those that relate to differentiation between factors that can be quantified and those that should (at least for the near future) be considered non-quantifiable; selection of an opportunity cost of capital (which could vary for federal, state, and local shares) to be used during the analysis period; and quantification of consumer's surplus.

The principal purpose for identifying and quantifying real benefits and costs is to demonstrate to the community and to the sponsor that the project is economically warranted. The analysis may also serve to put into perspective the priority of the airport project versus the priority of projects requiring other local financial support. The research should result in straightforward techniques for the benefit-cost analysis of real economic impacts on the public, air travelers, air carriers, and airport sponsors. Procedures for identifying and avoiding potential double-counting situations should be developed.

The principal purpose for identifying and quantifying significant pecuniary benefits and costs is to enable the sponsor to deal effectively with local opposition to the project. Since most opposition is bred of uncertainty about an outcome and since support cannot be mustered without a convincing case, the development of a believable projection of results is essential. This aspect of the research should be oriented toward case histories of experiences at Houston, Kansas City, Dallas, and similar airports.

7. Low-Cost Alternatives for Increasing Airport Landside Capacity

Many large, medium, and small commercial airports face or are predicted to face capacity constraints in the components of the landside airport system. The purpose of the proposed research is to identify operational, procedural, and policy measures that will increase airport landside capacity without requiring major capital investments or considerable increases in operation and maintenance costs. The research should identify by airport type and by functional area of the landside system those actions that can alleviate existing or predicted limitations in the landside capacity of existing airports. The research should analyze past experience and should include a discussion of the effects that the proposed action may have on the components of the airport landside system and on the airside capacity.

8. High-Density Movements and Capacity Enhancement

High-density passenger movements by charters and nonreservation shuttle services

have characteristics that should be studied for the purpose of enhancing airport landside capacity. Charter service, for example, accommodates large groups of passengers for long-haul trips usually during off-peak hours. Nonreservation, shuttle service is continual for short-haul trips during peak periods. Common to these differing forms of high-density demand is their ability to be accommodated in an extra system sense. That is, the landside system elements need not be fixed in the landside system but can be isolated and separated from the balance of the landside system if desired. These characteristics are particularly important in the selection of a basic terminal process concept to reconfigure an existing terminal or to plan a new one. A "hybrid" concept will evolve if the high-density features are significant. Equally important is the effect of such a demand on the ability to add incremental capacity to terminals already experiencing saturation.

The proposed research should be conducted in the following 3 areas: (a) policy—document current policy, articulate ideal policy framework relative to capacity enhancement and consumer desire, and postulate likely policy framework for implementing potential regulatory reform; (b) potential demand based on policy framework for national, region, and city pairs; and (c) capacity considerations—inventory current locations of substantial high-density demand and methods for accommodating the demand, formulate alternatives for accommodating various levels of high-density demand, apply alternatives to existing terminals as appropriate, and evaluate concepts for potential application to future terminals.

9. Systemwide Effect of Capacity Changes at One Airport

Landside capacity restraint at one airport will affect other airports in the system. Where will the effect occur? How big will it be? Can it be offset by changes in operating procedures? The proposed research should quantify the effect of landside constraints on the actual demand at large airports; predict the quantitative effect of a constraint at one airport on other airports in the system; quantify the cost of the constraint relative to the system and the cost of removing the constraint; and identify adjustments that might be made to the system to offset the effect of a constraint at one airport in the system.

10. Expansion of Low- and Medium-Density Airports to Accommodate Wide-Bodied Aircraft and High Peak Hours

Low- and medium-density airports need assistance in efforts to expand existing terminals and facilities to meet the needs of wide-bodied aircraft and high peak-hour operations that exceed the original design capabilities of terminals and landside facilities. The research proposed should establish through the collection of data the number and types of airports in this category and develop and provide operators having similar terminal designs modification data and methods that are best suited for wide-bodied aircraft and high peak-hour operations and that directly affect terminal design, curbside activity, baggage claim operation, parking facilities, and traffic flow.

COMMUNITY ATTITUDES

11. Community Attitudes

Community attitudes directly and indirectly affect airports and thus airside, landside, and off-airport characteristics and operations. Today, this attitude appears negative in many localities. The proposed research should survey community attitudes toward airports, airlines, and direct or indirect community-related services affected by the airport system. The survey should seek attitudes about the following but not necessarily

be limited to them: noise; air and water quality; solid wastes; levels of service; accessibility and traffic considerations; terminal function and comfort levels; amenities such as hotels, restaurants, shops; airport-airline labor disputes; management, operations, and legislative policies as they affect the general public; transportation alternatives; socioeconomic concerns; and methods for improving community and airport relations and for maintaining community support of aviation.

12. Influence of Increased Social Awareness on Implementation of Airport Expansion Programs

In recent years, communities have become increasingly apprehensive regarding major public works that affect the community and its environment. As a result, special interest groups have formed to oppose public works through public opinion campaigns, lawsuits, or other delaying tactics. New airports or additions to existing airports have particularly been the target of such opposition resulting either in considerable delay or in cancellation of airport expansions. The proposed research should recognize the need for airport planners to be more responsive to community goals and attitudes but should seek to understand why certain projects are accepted by the communities and why others, which appear well planned and worthy of support, meet with extreme opposition. A review of a number of recent public work projects should be made to determine whether social awareness is a long-term and increasing trend. At the same time, through case studies, an endeavor should be made to establish general guidelines to airport planners on the method of presenting and explaining their projects and on the consultation mechanisms to be set up to ensure, on the one hand, a better compliance with community goals and objectives and, on the other hand, better acceptance of the project by the community.

COMPETITIVE MODES

13. Effect of Intermodal Competition on Short-Haul Air Traffic

Short-haul air travel has a tendency to peak and to cause severe constraints on airport landside facilities. A trend has developed in the last few years, accentuated by the energy crisis, to improve public intercity ground transportation to discourage the use of private automobiles. Such a trend could have serious effects on airports by cutting down short-haul air traffic, thereby relieving airport landside capacity. A study should be made of the development or rehabilitation of effective rail links between city pairs and the effect that such intermodal competition could have on the growth of short-haul air traffic. The need for flexibility in airport landside facility design to adapt to changing traffic patterns should also be studied, especially in regard to road access and parking.

CONCESSIONS

14. Impact of Concessions and Consumer Services on Landside Capacity

Concession and consumer services are provided to serve the needs and desires of passengers and to develop revenues. Concessions are frequently located to force passengers through concession areas so that impulse purchases are increased. What impact do concessions have on landside capacity? The proposed research should answer the following questions: What type of concessions and consumer services are needed to serve the requirements and convenience of passengers? Do speciality concessions

that rely on impulse buying produce significant net revenues? Can added capacity be achieved by eliminating them? To what extent do kiosks and island displays impede traffic flow? Do concession signing and displays interfere with necessary graphics? To what extent does this cause confusion? Is there an ideal location for necessary concessions where they can be easily recognized without interfering with traffic flow? Can the size of concession areas be reduced by improved operating procedures (fast food service versus dining rooms)?

ENERGY CONSERVATION

15. Constraining Effects of Policies to Conserve Energy

If national policies for conservation of energy are to be effective, all major fuel users must examine areas of potential energy savings. From 30 to 60 percent of all energy expended at an airport is expended on the landside. Nevertheless, in the development of alternatives for the improvement of landside capacity, little or no thought is given to the energy requirements implicit in the choice of construction materials and methods, in the manner in which the facilities will be operated and maintained, and in the way in which the operating users, concessionaires, and the public will consume energy in the expanded or improved facilities. Because of the complexity of the relations among the many factors involved, airport sponsors and planners need a standardized and practical approach to the analyses of consumption of energy at airport landside facilities.

The proposed research program covers all airport landside facilities from the terminal apron to the ultimate connection with the nearest major link in the surface transportation network. The research would investigate the energy required to accomplish a project, the average annual rate of consumption required if the sponsor is to operate and maintain the facilities adequately, and the forecast consumption of energy by the permanent and transient elements of the landside population. First-, second-, and third-order effects of various choices would be investigated (e.g., x-gallons of jet aviation fuel burned in aircraft apron maneuvering require the consumption of y-units of energy for transporting the fuel to the airport and of z-units of energy in the manufacturing of the jet fuel and the transportation fuel).

The product of the research should be a procedure that can be readily and inexpensively applied through the use of computer programs. The theoretical framework would likely take the form of an input-output analysis. Architects, engineers, and planners experienced and competent in their own disciplines should not need to master a great body of new knowledge to use the procedure. The results of applying the procedures should include the following for each alternative under consideration for at least a 20-year period: net impacts on national energy resources of various kinds; net impacts on atmospheric pollution, both locally and nationally; and specific impacts of the major elements of total consumption.

ENVIRONMENT

16. Constraint of Environmental Statutes on Landside Capacity Development

If landside capacity at many airports, especially the large hubs, soon limits the full maturing of the airside capacity or operationally constrains the airside capacity where it has essentially matured, what impact will compliance with environmental statutes have on developing landside capacity to meet the desired level of airside capacity? The environmental analysis process is becoming more sophisticated and quantitative. Increased interest is being paid to impacts of those components associated with landside capacity, such as automobile access, parking facilities, and garages. Future

regulations, such as indirect pollution source review and parking management programs, may seriously impact the traditional approach of building more access roads and parking structures to solve landside capacity problems.

The proposed research should focus on the application of the environmental statutes to specific airports anticipating major landside development in the future. Such an analysis could provide an early warning system in terms of both particular expansion projects and overall development of the air transport system. This research would assist in the development of alternative solutions to solve landside capacity problems within the context of the environmental statutes. In addition, this research may encourage greater flexibility in the administration of the environmental statutes as applied to landside development.

Other questions to be answered include the following: What are the implications for airside capacity if landside development is constrained by environmental factors? Are airport sponsors or their consultants adequately prepared to foresee potential constraints? Is there sufficient opportunity for aviation interests to provide input to the environmental decision-making process? Are existing federal, state, and local institutional arrangements appropriate if federal funds are used in landside development? What methods or design approaches are needed to mitigate any adverse effects? How should costs of environmental constraints be allocated, especially those associated with off-airport systems? Should airside and landside development projects be separated to forestall backlash to landside projects?

FINANCING AND FUNDING

17. Evaluation of Financial Needs and Capabilities of Air Carrier Airports

Recent analyses have shown marked similarities in airport revenue and expense characteristics and airport passenger enplanement levels. For example, airports are typically unable to support operating expenses, debt service, and new capital improvement projects with self-generated funds unless they enplane more than 2 million passengers annually. Airports enplaning fewer than 100,000 passengers per year are generally unable to generate sufficient revenues to meet even their operating expenses. There are similar patterns in income source and airport size; larger airports rely most heavily on concession revenues, and smaller airports derive a larger relative proportion of income from airside activities. The economic capabilities of their respective sponsors may have implications for future development of adequate airport landside capacity.

The proposed research would survey 150 large, medium, small, and nonhub facilities to determine the capability of each to meet present and future revenue requirements. Airports will be categorized by passenger enplanement levels or other suitable measures of similarity; and revenue and expense, debt service, and new capital improvement requirements of each category will be identified. The financial posture of each airport sponsor will be examined and categorized by airport class. Once the revenue potential and financial requirements of airports and sponsors are identified, alternative federal, state, and local policy option will be developed to provide the most efficient levels of landside capacity consistent with the national goals.

18. Criteria for Economic and Financial Performance of Airport Landside Capacity

The rapidly rising costs of landside investment and the uncertain outlook for air transport demand make it increasingly important that the resources used to provide landside capacity be minimized. Obvious biases toward establishing more capacity than needed must be countered by the development of performance criteria. This problem will be

accentuated if federal funds become available for the terminal area or if airport head taxes are imposed. This study will develop criteria necessary to measure airport landside economic and financial performance. Each of the revenue areas on the landside will be examined from the standpoint of costs, revenues, and return on investment, taking into account the appropriate allocation of the non-revenue-producing portions of the landside. The approach will be to examine a sufficient number of airports in each category to permit the development of sound criteria. The study will examine alternative economic and financial objectives.

19. Airport Cash-Flow Model

Analytic tools are required to support more effective and efficient use of resources devoted to meeting landside capacity needs. One of these tools is an airport cash-flow model to permit the financial effects of any policy, investment, or operating decision to be analyzed in advance of the decisions being implemented. The proposed research will develop such a model in sufficient detail to permit timely analysis of the financial effects of any policy, investment, or operating decision.

20. Uniform Code of Accounts for Airports

Current accounting methods and terms differ from one airport to another, and to measure or compare their financial performance on a systematic basis is difficult if not impossible. Uniform accounting is important as a management tool but is particularly important to ensure efficient use of federal funds designated for expansion of improvement of landside capacity. This study will examine current codes of accounts used at airports and will develop a uniform system of accounts that will permit comparison of performance among airports and will provide management with consistent measures of performance.

21. Factors Affecting Efficiency of Resource Use in Airport Landside Capacity

Inflation, the uncertain outlook for air travel growth, and the traditional tendency of airport operators to build expensive monuments place burdens on resources to provide airport landside capacity. A study should be made of all significant input markets related to airport landside development to determine the degree to which competition sets input prices and to ensure that such input prices are kept to a minimum through appropriate purchasing practices on the part of airport operators. In addition, all barriers to the efficient allocation of resources to landside development should be identified, and the most effective means of dismantling or overcoming these barriers should be developed. This should be accomplished in such a way as not to impair unduly the ability of air carriers and concessionaires to compete effectively in their respective markets. A study should also be undertaken to quantify as precisely as possible the burden on interstate commerce imposed through the misallocation of resources to airport landside development and operation.

22. Airport Service Pricing Options

Historically, the provision of adequate airport landside capacity has been accomplished with capital investment or increased levels of operating expense. The number of airport employees, parking spaces, loading gates, and terminal floor space, for example, typically follows or precedes passenger demand. In addition to investment strategies, however, there are numerous noncapital, or pricing, options that may be used to more efficiently allocate scarce landside resources and more accurately signal the

requirement for expansion of existing facilities. The proposed research will survey 50 large, medium, small, and nonhub facilities to identify present and future costs of airport landside services and the value of each to the consumer. Alternative airport service pricing options will then be developed. These pricing options will relate to alternative airport financial objectives (i.e., deficit operation, breakeven, profit center), landside pricing strategies, estimated service price elasticities of demand, value of service versus cost-based pricing strategies, and innovative pricing concepts (e.g., baggage charges and other direct pricing schedules). Finally, the revenue potential of each alternative pricing strategy will be estimated by using projected passenger enplanement levels.

23. Cost-Benefit Analysis of Airport Landside Research

The air transportation industry is a relatively healthy transportation industry serving predominantly the higher income passenger. What are the national benefits and to whom do they accrue of investing federal funds in additional landside research? What is the magnitude of national landside congestion? Who will benefit by research aimed at reducing landside congestion? What are the magnitudes of the possible improvements versus costs?

24. Federal Landside Participation Policy

The U.S. Congress and the Federal Aviation Administration, through the Airport Development Aid Program (ADAP) revenue collection process, have deprived the airport owner-operator of certain sources of local revenue production that could be used in the development of local operations and facilities improvement programs. It is now incumbent on the Congress and the FAA to establish policies and procedures for the disbursement of these funds that will ensure maximum benefit to the airport owner-operator and to the national aviation industry. Application of ADAP funds to airport landside improvements can improve airport landside capacity. Guidelines are required to assist in the preparation of new legislation and agency policies and procedures to direct ADAP funds to landside improvements.

The proposed research will identify and categorize current and projected needs of each airport in the national system of airports and establish a system of needs priorities encompassing both airside and landside. It will review past, current, and projected ADAP funds generation; fund application and collection ratio performance; current procedures for application of ADAP funds; and legislation, regulations, and orders governing application of ADAP funds. It will recommend formulas for fund applications responsive to individual airport need, project priority, and airport contribution to the national program; procedures for establishing project eligibility that will ensure that funds are based on maximum application-collection ratios; and new and revised legislation, regulations, and orders required to implement revised fiscal programs.

25. Use of ADAP Funds to Balance Airport Development

The Airport Development Aid Program favors the airside elements of the airport much more than the landside elements. Therefore, the FAA should study the implications of a policy that in effect would permit the FAA to withhold funds for airside projects if by not doing so the capacity of the airside would far exceed the capacity of the landside. In addition, the FAA proposes that ADAP funds not be used for acquiring land for new airports that will be developed in the future and for approach and departure paths of runways beyond those that are currently eligible. Studies are needed to determine whether these revisions are justified. Included in the studies should be a consideration of the priorities that FAA field offices assign to purchase of land for airside and landside facilities.

26. Development of Measures for Cost of Capital

A basic decision faced by airport managers concerns the means to be employed in raising the capital necessary to provide the capacity called for in the airport plan. Historically airport landside capacity has been financed without the direct aid of the federal government. Therefore, the cost of capital must be minimized, and alternative sources and costs must be identified. This study would identify and define all alternative sources of capital that can be employed for landside capacity developments, analyze costs and benefits of each alternative source, and develop precise measures for cost of capital.

FORECASTING AND SIMULATION

27. Forecasting Methodology and Monitoring System for Airport Landside Capacity

In planning the establishment or expansion of airport landside capacity, better forecasts are needed of the future demands that will be placed on the various elements of the airport landside system and of technological developments that will affect landside requirements. These forecasts must be regularly updated and continually monitored so that they provide early warning of any impending mismatch between airport airside and landside capacity. This study would list, identify, and define all measures that are relevant to a determination of the requirements for the various elements of airport landside capacity; develop relations or methodologies for forecasting these measures; recommend a feasible data collection system to provide a base for the required forecasts; develop a system for monitoring and updating these forecasts to ensure early warning of airport landside capacity requirements or of any impending imbalance between landside and airside capacity; ensure compatibility among data, definitions, and forecasts of airside activity; and concentrate on measures of the characteristics, peaking, and mix of demand that are important to determining landside needs and methodological differences among airport types.

28. Effect of Forecast Variability in Landside Development

The level of airport activity at any future time is characterized by random variables that describe things such as peak passenger boardings, gate requirements, aircraft operation, and loads. The difference between requirements and the ability of a specific landside complex to satisfy requirements implies a cost. These costs not only depend on initial facility design but also change over time as requirements change or as capacity is adjusted. This dependence of costs on initial design concept and time should be taken into account in the landside development decision-making process. The proposed research will develop a methodology to take into account the effect of forecast landside requirements or their determinants and the uncertainty associated with these forecasts on the present value of all costs assigned to a landside expansion alternative during the planning period. Requirement forecasts will be specified in probabilistic terms, and the expected present value of an alternative will be calculated with respect to these distributions for a specified development or expansion policy.

29. Conversion of Forecast Demand Factors to Daily Peaking

Level of service is dependent on magnitudes and duration of peaking. Therefore, peaking values are necessary to determine future estimates of level of service at a given airport. The present techniques derive these values from the forecast yearly enplanements, which are obtained through various analysis methods. The adequacy of the

present methods should be investigated, and conversion improved where possible. A combination of the demand factors may range from simplified rules of thumb to some form of modeling. The existing models should be identified, and present data should be used to determine how well the forecasting of peaking may be effected. If no model is reasonably accurate, a conversion model should be developed. Causal relations should be identified where possible.

30. Sensitivity Analysis of Demand Factors on Level of Service

To determine the amount of emphasis to be given to improvement of forecasting of demand factors, a sensitivity analysis should be conducted to determine how critical the various factors are in influencing level of service. Through the use of a validated model, changes in level of service may be determined, based on input values of the demand and service factors. The purpose would be to eliminate unnecessary refinements in forecasting techniques. The analysis should be performed before any investigation of forecasting method improvements.

31. Development of Airport Landside Simulation Capability

The ability to estimate landside capacity and to properly allocate landside investments can be significantly improved by proper simulation (computer-based) tools suitably validated and suitably supplied with input data. Such tools should be further developed and made available to all. An attempt should also be made to develop an analysis tool for better understanding the flow of people, baggage, and vehicles. The goal should be to design a methodology that is adaptable to a wide variety of airport situations. Concentrated development of a few tools should produce more results than limited effort on many different tools.

32. Application of Econometric Techniques to Demand Forecast

The uncertainties and errors of demand factor forecasting as exhibited in quantities such as yearly enplanements appear to be large. The reasons for this should be investigated. A study should be conducted to determine the extent of application of present-day econometric techniques. These techniques include correlation methods or time series analysis. An indication of the applicability of such methods should be provided in order to determine the degree of flexibility.

33. Calibration of Airport Planning Models

Models are useful when they represent up-to-date and real-life experience; they are dangerous when their basis is not clearly traceable to relevant conditions. Research should be undertaken to collect the set of models that represent functions of the elements of landside service (and their interdependence) and that have been found useful in planning expansions of or new airport facilities; process the data collected for airport management tools in the daily accounting by function and cost of maintenance and repair activities such that the landside service activities are reported; and use the service activity data to update the empirical elements in the planning models and to calibrate the models.

INFORMATION

34. Survey and Data Collection Requirements

Planning and providing for future airport capacity must begin with the adoption of a forecast or a workable range of forecasts. To develop such forecasts, airport and airline management require current information on many airport activities, including passenger, aircraft, ground vehicles, and cargo. These data are expensive to obtain and maintain. For example, a constant and critical need is an up-to-date profile of the air passenger and his or her trip to and from the airport, local origination and destination, mode of access and egress, trip purpose, baggage, use of curbside space and parking lots, and use of airport facilities. These data can be used to calibrate and improve the forecast and facility planning models, which are now available. Collected over a period of time, they become increasingly more valuable as trends can be discerned and projected. ADAP planning funds for individual airports should provide sufficient money for periodic surveys and other data collection activities vital to the forecasting and planning process. These requirements should be outlined, and a study should be conducted to determine the form or forms in which these data should be compiled to satisfy the needs of all the users.

35. Existing Airline Data

A variety of information collection and survey activity has been undertaken by the airlines, but much of the information remains closely guarded. Ways of making this information more available and of supplementing it should be investigated. The ability to simulate and analyze the operations on the airport landside operations is critically dependent on the availability of appropriate data such as detailed processing times, passenger profiles, and visitor and passenger ratios. Time series data on such factors are also important for forecasting purposes. Provision should be made for collecting and supplementing available information.

36. Airport Management Information Support

A considerable body of experience has been developed by various airport sponsors, operators, and transportation planners with respect to the development and operation of landside capacity. This experience could benefit their counterparts in other communities were it readily accessible. However, existing channels of communication are inadequate. A preliminary survey of existing channels including trade journals, industry organizations, governmental mechanisms, training programs, and professional societies should be undertaken to identify the scope and limitations of their utility as information sources. The results of such a survey, coupled with information on needs for information obtained via survey or derived from analysis of existing channels, would support recommendations on ways to improve or supplement information sources. Possible factors are budget constraints, travel constraints, internal circulation of information, lack of immediacy, lack of forum, need for extensive computerized data base, need for brief format to highlight information availability, and storage considerations. Depending on findings and recommendations, materials, workshops, documents, videotapes, newsletters, computerized information retrieval systems, or other information support products could be developed as a separate task.

INTERGOVERNMENTAL RELATIONS

37. Jurisdictional Cooperation in Intermodal and Multimodal Planning

Current revisions to ADAP; compounding constraints on airport operations and activities; limiting factors concerning airport development, expansion, access, and land acquisition; changing role of state departments of transportation and airport managers; and the need for more effective intermodal planning have made it necessary (a) to ensure that all decision makers (e.g., federal agencies, state departments of transportation, local planning agencies, airport sponsors, consultants, and local elected officials) realize the impact of their interrelated roles and responsibilities in each facet of airport planning; (b) to identify voids that exist in understanding the vital role intermodal planning can play in strengthening the interface between the different multimodal planning agencies, the airport sponsor, and other decision makers from the local to federal levels; and (c) to seek ways and workable solutions for coping with the changing role of the state departments of transportation and responsibilities of the airport sponsors.

The proposed research project should (a) seek ways to increase the understanding of decision makers and their application of the various intermodal cooperation and coordination techniques (including case histories); (b) strengthen the on-airport and off-airport interface by stressing the need for conducting intermodal planning in conjunction with areawide land use planning, capital improvement programs, legislative regulations, and multimodal transportation planning in accordance with local, regional, state, and federal goals and objectives; (c) seek and recommend ways of resolving the questions around the current and future role of airport managers; (d) investigate the virtually untapped potential function of the airport manager as a vital link in coordinating the efforts of the local, state, and federal planning agencies; and (e) address the problem of multijurisdictional planning by reporting what cooperation and coordination efforts could be or have been implemented by airport sponsors, regional transportation planning agencies, state departments of transportation, or other public or private concerns.

38. Influence of Urban Development Patterns on Airside and Landside Capacities and Operations

Urban development patterns constrain expansion of airport boundaries. At the same time, they tend to impose greater demands on the services provided within those boundaries. It is hypothesized that different land use patterns predetermine the selection of access alternatives and, hence, air transportation service. Research is proposed that tests this hypothesis and that makes the results available to transportation planners and the public.

LEVELS OF SERVICE

39. Criteria for Airport Landside Level of Service

The landside system is a complex network of processes and interconnecting flows. The kinds of passenger demand imposed on this system are highly variable and fluctuate widely. These complex, dynamic characteristics of an airport landside system are a major contributor to the difficulty of establishing unambiguous level-of-service criteria. For example, during airport planning, airport consultants, architectural and engineering firms, and airlines typically use their own proprietary criteria that are generally based on individual system experience and are localized to the needs of a particular airport. Severe aviation system constraints and conflicting priorities have created the

need for more emphasis on the systematic treatment of level-of-service considerations. This need includes the requirement for a range of criteria that will permit a more discriminating trade-off of airport development options. The ability to reach general agreement on an acceptable range of criteria or standards is complicated by the overlapping infrastructure of public and private decision makers.

Because of the proprietary nature of this subject and the overlapping infrastructure of responsibilities, a multifirm study team under the auspices of the Transportation Research Board is recommended. The individuals assigned to the study team should interact on an anonymous basis, thus increasing the likelihood of objective results. The work environment would have to be intense and intimate to ensure full treatment of the complex relations and subjective judgments that accompany level-of-service considerations. Maximum support of the results could be ensured if the funding was shared by all interested parties. The Transportation Research Board would assume the responsibility for selecting a study team, allocating the funds, and administering the project. Results would be published by the Transportation Research Board.

40. Policy Studies of Level-of-Service Implementation Alternatives

The implementation of airport landside levels of service is currently the management prerogative of a complex, localized infrastructure of decision makers in the public and private sectors. The problem of peak-hour level-of-service "balance" between adjoining landside segments is especially troublesome. Peak-hour imbalances between airport airside and airport landside segments are forecast to become serious at many major hub airports in the next decade. These conditions raise a basic policy question: What is the best way to balance, improve, or maintain landside level of service in the future? This question is accentuated by the possibility of federally funded landside grants that will affect landside service. The major policy questions are, (a) Who should be responsible for providing and balancing airport landside level of service? (b) What are the problems in establishing and imposing level-of-service standards? (c) What degree of authority is needed to achieve the desired standards? and (d) How should balanced level-of-service standards be implemented?

The possible alternatives within and among the 4 stated policy issues are numerous. They form a large matrix of policy alternatives that must all be evaluated in terms of their advantages and disadvantages. As a minimum, the following policy alternatives, grouped according to the 4 major policy issues noted above, should be treated both singularly and in combination: (a) airport sponsor, airport operator, airlines, concessionaires, ground transport operators, local government, state government, federal government, or joint responsibility; (b) potential conflict between level of service and other desirable airport system performance goals (safety, efficiency, environment); differentiation of aviation system jurisdiction (local, intrastate, and national), the question of whether a level-of-service standard should be established for the entire landside or for major landside segments, legal implications, and financial implications; (c) do nothing, suggest, encourage, induce, regulate, or impose through statutory authority; and (d) provide data and analysis models by means of user handbooks, hold educational conferences, distribute FAA advisory circulars, provide federal grants for level-of-service improvement, undertake pilot projects, impose federal grant penalties, certify airport, or impose legal penalties and fines.

41. Establishment of Level-of-Service Values

Numerical values should be established for the level of service of various landside segments. In addition, a performance target should be set for each segment. Research is proposed to (a) accumulate data on each landside segment as defined in order to evaluate each segment; (b) weight each segment in order of importance in the overall landside movement; (c) review candidate numerical values with airport operators,

airlines ground transportation operators, concessionaires, and others; and (d) distribute final results to all airports and thereafter notify them of results of other research that specifically affects a landside segment.

42. Attitudinal Surveys Regarding Airport Landside Services

Attitudinal surveys on passenger preferences in the airport landside are rare. If valid level-of-service measures are to be developed, information is needed on what people want or value in the airport landside. The development of the appropriate survey questions is crucial to the validity of the survey results. The proposed research would (a) determine the information professional planners and decision makers require and the form in which it should be prepared so as to be useful in the future planning of landside facilities and in determining the priorities for development of facilities; (b) develop an attitudinal survey form to be used in surveying airline passengers in the airport landside (this part of the program should be accomplished by a multidisciplinary team, which should include specialists in human factors, sociology, psychology, airport planning and operations, traffic engineering, urban design, and market research); (c) develop a specific program and procedures for conducting the passenger survey, including how the surveys are to be conducted, the sample required, and the airports in which surveys should be made; and (d) conduct surveys in selected airport landsides and analyze survey results.

43. Composite Measures of Walk, Serve, and Delay Time

Single-point measures of service level fail to capture the trade-offs inherent in airport layouts and the difference in passengers' perceived disutility for waiting, walking, or serving times. The disutilities are not linear with time duration, nor does the relative importance remain constant for different airports, times of day, seasons, or days of the week. Human factors research should be reviewed to identify existing utility measures and models of aggregating different forms of disutility. Level-of-service criteria should be developed that express the human trade-offs under varying conditions and the expected reliability (variability) of such trade-offs or composite measures as a function of factors such as passenger characteristics, trip purpose, and peak and off-peak expectations.

MARKETING

44. Impact of Airline Marketing Practices on Airport Capacity Requirements

Innovative marketing alternatives have been introduced by several airlines. These include "no-frill" service, demand scheduling, off-peak pricing, and various tour options. Additional alternatives have been proposed. In general, the objective of such strategies is to increase aircraft load factors and, consequently, airline revenues. Similarly, wide-bodied jet service has been increased in an attempt to meet high-density demand at lower unit costs, thereby increasing profits. These market innovations may alter airport passenger demand profiles and have a significant impact on landside capacity requirements. The proposed research will identify recent and possible future airline market actions that may impact airport passenger demand. These will include no-frill service, use of wide-bodied jets, and charter-affinity tours. The impact of each of these on airline load factors, scheduling practices, and fleet mixes will be estimated, based on industry statistics and interviews with appropriate airline, government, and airport officials. Passenger demand profiles at a representative sample of large, medium, small, and nonhub airports will be developed, and potential

airport landside deficiencies will be identified.

MANAGEMENT

45. Management Training

Formalized university programs are needed, comparable to those at Texas A&M and the University of California, Berkeley, in which airport managers may acquire or add to their knowledge of business and airport management. The proposed research would identify those elements common to airport and fundamental to business management; establish ongoing academic courses; review impediments to attendance and suggest methods for overcoming them; and evaluate advisability of establishing several courses at many universities or all courses at one university.

PASSENGER AND BAGGAGE PROCESSING

46. Common, Nonrestrictive, and Automated Passenger and Baggage-Processing Facilities

At individual terminals, each airline furnishes the staff and equipment required to process passengers and baggage. These individual services are based on the innate competitive environment in which the carriers operate. As a result, there is a duplication of service involving a large superfluous staff and individual facilities that are used only while the activity of the individual airline peaks. The European airports have found through the use of common and shared facilities that level of service and capacity can be improved and can be far more cost effective. A feasibility study should be made at several terminals in the United States to determine the increase in the level-of-service capacity and improvement in cost effectiveness through the use of shared services and facilities. The common and shared services and facilities have the following functions: (a) automated passenger processing—common and standardized check-in (ticket, boarding pass, seat assignment, and baggage tags), security check, boarding, and baggage claim; and (b) automated baggage handling—common and standardized procedure at origin, during transfer (interline, on-line), and at destination.

The feasibility study would determine the following: (a) technical—the capability of offering common and standardized services that would be sufficiently automated to reduce the labor intensity of the normal competitive passenger processing and baggage-handling activities; (b) institutional—the acceptability of a shared facility on the part of the carriers and the ability of the carriers to attain their own identity and to ensure that the design service level is realized; (c) social—the acceptability of shared service and facilities to the passengers and other users of the terminal; and (d) economic—the potential savings to the carriers, the airport operator, and the passenger.

47. International Passenger and Baggage Processing

The function of the federal inspection agencies as it relates to airport passengers is to collect duties on legally imported articles and to prevent the entry of certain undesirable persons, diseases, plants, animals, and other goods. A system of inspection and passenger and import declarations and payments is employed to carry out these functions. The benefits to the public provided by these inspection agencies are not commensurate with the payments required of the public. These payments take many forms including direct taxation, inconvenience and costs of delays, cost of procedural requirements, and creation of monopolistic enterprise through excessive regulations. Airport landside capacity can be increased by expediting the inspection processes by reducing

storage facilities and by introducing cost-effective procedures. The research proposed would (a) review legislation, regulations, and orders governing the activities of the inspection agencies, define existing goals and objectives, and review in a similar manner the activities and composition of the various agencies in other nations performing like functions; (b) devise methodology and evaluate effectiveness of performance of inspection agencies with respect to goals and objectives, cost, public benefit, and comparative performance of those agencies performing a like function in other nations; and (c) recommend improvements to the services provided by the inspection agencies including areas of administration, operation, law, budget, and further study and research identified in the proposed study program.

48. Passenger Information Systems for Airport Terminals

Airport terminal capacity is increasingly affected by passenger confusion over processing routes through the airport terminal. This confusion has resulted from the following factors: increasing air travel by the unsophisticated family and recreational segments of the market, differences in passenger processing systems at major airports among individual airlines, increasing size and complexity of major airport terminal complexes, and terminal concept variations. The research proposed would analyze current and proposed passenger processing systems to determine areas of commonality and procedures subject to increased standardization; survey public information systems in use at railroad and rapid transit terminals and large shopping complexes for applicability to airport terminals; develop recommendations for increasing the standardization of airline processing procedures in those areas that directly affect public circulation within the terminal complex; develop alternative systems and subsystems for effectively communicating information to travelers as to the locations of processing stations and preferred route through the terminal complex; compile, describe, and state applicability and cost in terms of passenger unit processed at existing public information systems; recommend additional research that may be required for development and implementation of devices for simple and effective display of information to users.

49. Potential and Limitations of Automation for Airport Baggage Processing

Automation has failed in airport-baggage, transit, and other systems for 2 reasons: (a) Automating a facility requires expert judgments about the types of loads, and these estimates are often wrong; and (b) the degradation of performance under extreme loads is not understood. The potential of automation for landside airport facilities should be explored. The proposed research would review current failures, develop a procedure to analyze actual performance under loads, develop an analysis framework for tracing out propagation of delays due to likely extremes of traffic, explore means of using redundancy as a way to allow graceful degradation of performance when failure occurs, make cost estimates of discrepancies of scale due to complexity, develop a procedure for the analysis of a proposed system for particular situations, and prepare policy recommendations for particular situations.

SECURITY

50. Present and Future Impact of Airport Security Regulations on Airport Landside Capacity

Present FAA security regulations are designed to eliminate all aircraft hijackings. The existence of such regulations requires that landside capacity be used to house

equipment, operating personnel, and support facilities for such personnel. It also requires that such facilities be planned for in new airports. A further impact is the potential queuing that may exist during certain peak times and its spillover effects into other airport facilities. The existence of the security regulations imposes certain costs on the operators of airports. To what extent do enplaning passengers arrive earlier because of security provisions? What facilities must be used to provide the service? What are the benefits of the security system relative to the costs?

The institution of the security regulations has nearly eliminated hijacking. The costs imposed, however, should be examined to determine whether the objective should be zero incidence or some higher level of incidence.

The proposed research would document, by major airport, the space used by security equipment and personnel, the space used by support facilities for such personnel, the impact of the security system on passenger queuing (by time period), the impact of the security system on the consumption of other airport landside capacity (e.g., lines extending into the lobby), the extent that the arrival pattern of passengers is influenced by the knowledge that a security system must be negotiated, and the impact on the utilization of baggage facilities.

Based on the findings of such case studies, conclusions can be drawn as to whether such systems are a bottleneck on landside capacity. The system costs can be identified and compared to system benefits. The fact that the 30,000 employees nationwide are unionized should be accounted for.

The output of the research not only would show the extent that security impacts capacity but also would suggest alternative methods (more capacity efficiency) of processing passengers and suggest alternative security levels and show their capacity effects. A further output would be the investigation of security technology and the demand for security in the future.

SURFACE TRANSPORTATION AND PARKING

51. Improving Ground Transportation Service by Low-Cost Techniques

The supply of ground transportation services for transporting 3 segments of the airport population—passengers, visitors, and employees—between the airport and their local origins or destinations varies widely among airports. Although the feasibility of certain high-capital ground systems, such as fixed-rail, has been extensively analyzed, the less glamorous, low-capital systems or approaches have received less attention. Recent developments in urban transportation services generally suggest that there is considerable potential for increased utilization and productivity of existing airport access capacity. At the same time improved ground transportation can be responsive to environmental and energy concerns.

The following program is proposed to evaluate opportunities for and constraints on the development and implementation of improved ground transportation other than the automobile or high-capital systems and to document and disseminate information on both technical and managerial issues: (a) investigation of the applicability of recently developed techniques giving priority to high-occupancy vehicles on existing roadways and giving consideration to factors such as institutional and regulatory barriers at the state and local levels, the estimated potential increase in off- and on-airport capacity associated with various mixes of ground transportation services, and secondary impacts; (b) evaluation of the current role of the airport sponsor with respect to the provision of ground transportation services to passengers and to employees to determine whether changes are needed in existing industry practices, including an examination of revenue structure, contracted levels of service, operational aspects (e.g., signing, curb location), and consumer preferences; (c) exploration of the potential benefits of a more fully integrated intermodal service for the air traveler and use of carrier computer capability to provide information on and ticketing for ground transportation

services at either end of an air trip, including scheduling of ground service vehicles; (d) analysis of the long-run implications for ground transportation service requirements of the trend toward mass air travel at relatively lower fares; and (e) development of model contracts, legislation, or other legal materials to assist in the implementation of improved ground transportation services, including ownership, funding, insurance and liability issues, impact on bondholders, and labor relations.

52. Alternative Transport Systems for Airport Access

The feasibility and potential benefits should be examined of using alternative transport systems as vehicular connectors to supplement constrained landside and off-airport capacities. The research proposed would (a) evaluate existing alternative transport vehicles and systems as they relate to serving airport access needs, including demand analysis, level of service, technical feasibility, modal-split behavior, economic considerations, and resultant impact on existing surface accessibility; (b) identify conditions required to sustain airport access service by alternative connector vehicles and analyze various large airports to determine the applicability of these concepts; (c) investigate the existence of political or financial barriers to alternative access concepts and recommend government policies or procedures that will enhance the use of these concepts; and (d) investigate the advisability and effectiveness of making more available the cost- and energy-efficient methods and modes of ground transportation that promote multipassenger movement to more segments of the airport use, both urban and suburban, passenger and employee (more and better use of such low-cost service would reduce demand on existing and future parking and highway facilities now used by single-passenger vehicles).

53. Automated Guideway Transit Systems in Airport Landside Capacity Improvement

During the last 15 years, many new transportation concepts have emerged based on the application of automation to ground transportation. These concepts may be generally characterized by the use of unmanned electrically propelled vehicles that operate under automatic control on separate protected roadways or guideways. Although the initial impetus for the development of automated guideway transit (AGT) technology was provided by the desire to develop less labor-intensive solutions to urban transit problems, the major application of automated transit has developed in airport applications. This phenomenon is probably the result of a number of factors: intraairport transportation problems are relatively self-contained, capital cost of an automated transit system is a relatively low percentage of total facility cost, airport authorities are generally more comfortable with high-technology systems, airport operations demand a high level of transit service over long periods of operation, the airport fabric may more easily integrate AGT than conventional solutions, AGT permits increased flexibility in developing airport terminal configurations, and a more cost-effective solution may be provided by AGT than by more conventional transit modes.

AGT systems are currently in operation at Dallas-Fort Worth, Seattle, Tampa, and Houston airports, two are under construction at Miami and Hartford airports, and one is decommissioned at Love Field. Further research is needed to determine ways for reducing the risk involved in the deployment of AGT systems at airports, develop the analytical tools required to establish the cost and service characteristics of AGT systems, and perform cost-benefit studies to establish whether AGT is a feasible intra-airport transit solution.

The following items identify possible research projects: evaluate performance of systems integrated with existing facilities and identify economic and operational characteristics, develop innovative methods of using AGT in airport complexes, develop analytical methods required to accurately project performance of systems in new applications affecting reliability and other hardware limitations, develop network

configurations required to provide fleet size management and fail-safe operational performance, evaluate existing system hardware and identify major strengths and weaknesses and areas where further development is required, and evaluate traffic flow patterns in a number of areas and perform airport deployability studies for a number of AGT systems.

54. Busways for Airport Accessibility

Busways are under consideration as a primary means of airport access. However, the dispersed origins and destinations of originating and terminating passengers and the relatively high cost of implementation of exclusive rights-of-way will impede the use of this concept as a means of airport access for all but a few of the high demand areas. Nevertheless, many communities are examining busways as part of their regional transportation planning. In such planning, airport access represents only one of a large group of transportation objectives. From an airport planning viewpoint, it would be useful to examine these busway plans to determine the priority placed on airport access by regional planning authorities, to identify the modifications to the plans that would improve access, to estimate the cost of these modifications and their impact on the regional system, and to generalize to the extent possible the results to other communities. Such a study would provide a framework for future planning of airport access.

55. Intermodal Ticketing

Considerable confusion exists at most major airports with regard to the availability of alternative collective ground transport to major activity centers within the metropolitan area. Because of energy and pollution constraints, a greater effort should be undertaken to promote and encourage the use of collective ground transport services. One solution to this problem may be in the development and implementation of an intermodal ticket that would not only inform the traveler that such ground transport services exist but also simplify the ticketing procedures and fleet requirements for the ground transport carriers. The resultant impact on ground access-egress and curbside facilities in terms of providing additional capacity would be substantial at many major airports in this country. The research proposed would (a) document the existing and proposed opportunities for implementation of intermodal ticketing for the air to major activity center trip utilizing collective ground transport services; (b) analyze and evaluate the consequences to landside capacity if such a system were implemented at a selected number of airports currently experiencing capacity problems in the ground access-egress area; (c) evaluate the potential benefits and obstacles to implementation of such a system from the standpoint of the air carriers and the ground transport operators; and (d) identify the procedures that would be required to initiate such an intermodal ticketing system and analyze the relative costs and benefits to be derived from fleet utilization and availability, reduction in ground access congestion, and simplification or complication of selling, collecting, and monitoring tickets.

56. Curbside Use at Airports

One of the traffic bottlenecks at airports is at the curbside where people and baggage enter and leave the terminal. The complexity of merging people and vehicles and the randomness of their arrival partially explain this problem. Control of curbside is generally under the airport manager's jurisdiction, but economic incentives for high service are less direct than for airlines because of their visibility at ticketing or baggage areas.

An analysis of vehicle behavior in diverging and merging, at curbside lanes, and in maneuvering lanes is needed to more accurately characterize levels of service and throughput rate as functions of demand level. This should be studied at several airports

under several load conditions to explicitly define vehicle movement and timing of movements. A detailed simulative model should be developed of curbside vehicle movements. A demonstration should be carried out at airports contemplating curbside modifications to evaluate effect of such modifications. Improved ideal designs of curbside should be developed and evaluated by a panel of experts and also by simulation.

Requirements should be developed for curbside under the following types of policies: free curbside use; exclusive curbside use by taxis, limousines, buses, and intraterminal shuttle; paid public curbside use; and mixed curbside use.

57. Manual for Uniform Traffic Control Devices for the Airport Landside

A manual is needed that would standardize the signals, signing, and pavement markings at all airports. This would increase the level of service throughout the landside system by minimizing confusion and delay time. The manual would be used by designers in specifying traffic control device location, function, size, shape, color, legend, and warrant. It would be similar to the Federal Highway Administration's Manual for Uniform Traffic Control Devices. The research proposed includes a survey of present airport traffic control devices and an evaluation of their adequacy in maintaining free flow throughout the landside system, including access-egress between airport boundary and terminal area, intraairport circulation system, and intraterminal pedestrian activities; demonstration projects to measure delay and level of service at various airports before and after introduction of alternative traffic control devices; data collection activities, including traffic counts, time-lapse photography, personal observations, travel time studies, and attitudinal surveys; investigation of state of the art in traffic control devices, including the Manual for Uniform Traffic Control Devices and IOTA's recent signing recommendations; specific and detailed definition of requirements for traffic control devices for various elements of the airport landside system; development of a uniform manual to be used nationwide that would standardize the design, selection, and use of traffic control devices; and a study of human-factor effects of alternative signing elements.

58. Ground Transportation Information

The number of ground transportation options at major airports is often large, far exceeding the air traveler's knowledge. Consequently, many travelers either opt for the simplest (but most expensive) solution of taxi or rental car or else try out public transportation systems, with mixed success. An information guide is needed that identifies all connecting travel modes and their locations, departure-arrival times, destinations, routes, schedules, and fares. The research proposed would review present intermodal information guides (e.g., the Swiss National Time Table) to determine state of the art; identify the various connecting modes of transportation at a given airport and their related information parameters that would assist a traveler in selecting a connecting mode (e.g., departure time, routes, location, departure-arrival at airport, destinations, schedules, and fares); develop media alternatives for information distribution (e.g., handbook, brochure, cathode-ray tube with passenger input and with or without hard copy output, maps); investigate alternative signing or marking schemes to direct a passenger to a connecting mode (e.g., special trailblazer signs or painted color, letter-coded or number-coded lines); study human-factors effect of the various information guide and system alternatives; include a demonstration project at one airport where alternative guides and systems would be developed and tested and time and delay studies, attitudinal surveys, and personal observations would be conducted to evaluate the effectiveness and user acceptance of the alternatives; analyze benefits and costs of the alternative guides and systems.

59. Off-Airport Parking

The value of off-airport parking to landside transportation capacity is not known. Several advantages appear possible: reduced on-airport parking demand, reduced trips onto airport, and reduced patron parking charges. Apparent disadvantages are loss of airport revenue and probable inconvenience to parkers. Long-term public parking and employee parking appear to be suitable types for off-airport parking served by shuttle transportation. Suitable studies should be made of existing and planned off-airport parking operations to determine demand characteristics, transportation shuttle needs, and the financial requirements for construction and operation. The studies should include a variety of off-airport schemes, such as those at the Cleveland and Los Angeles airports.

60. Airport Access Links to Major Transportation Corridors

On-airport transportation systems should be coordinated with major regional systems. The research proposed would inventory factors that influence effective interjurisdictional coordination of airport-oriented transportation facilities (the inventory would include physical, political, and financial elements, and emphasis would be given to areas where effective coordination is critical); inventory existing or potential sources of funds to support such systems; and develop processes or propose federal policies to encourage interjurisdictional coordination, including coordinated scheduling of interrelated projects.

TERMINAL DESIGN

61. Terminal Design to Increase Service Reliability

Complex systems are composed of a series of elements with differing degrees or ranges of service variability. At times these elements combine to produce wide variations in service. Good service systems are usually characterized by their consistency and limited service time variability; poor service systems tend to exhibit wide service time variability. The research proposed would identify the elements in the typical terminal system and establish their degrees of variability and service sensitivity under differing demand conditions; show how combined system variability tends to produce inconsistent service; and recommend terminal planning, design, and operations procedures to reduce individual element and combined system variability to improve service consistency.

62. Methodologies for Forecasting Passenger Volumes for Designing Airport Terminals

There is a significant deficiency in the documentation of applicable methodologies for determining passenger volumes for the sizing and design of airport terminal facilities. The purpose of the proposed research is to document alternative strategies that can be applied in developing design passenger volumes and related baggage quantities from standard forecasts of passenger enplanement and the total number of passengers that use the terminal. The research would identify essential planning base data, their sources, and method of collection; document methods for collecting information on subjects such as passenger profile (originations, transfers, charter, trip purpose); describe methods for the calculation of parameters such as average number of seats per departure, board factors, fleet composition, design peak period; explore the question of forecasting a range of volumes and the selection of a design level from these ranges through public policy input; list quantitative and qualitative factors that will

improve the process of sizing terminal area facilities; and describe and develop a meaningful strategy for monitoring and updating the selected design demand level.

TERMINALS, OFF-AIRPORT

63. Off-Airport Terminals for Passengers and Cargo

Off-airport terminals are facilities for the processing of passengers and visitors arriving and departing by ground transportation in both directions between their local originations and the airport. The link between the off-airport and on-airport terminal is served by public transportation. Off-airport processing may include one or all of the following: ground transportation, passenger ticketing, and baggage handling. The facility may include private automobile parking, curb frontage for arriving and departing vehicles, platforms for vehicular fixed guideway, and station stops. The technology to design and construct the facility exists. Program development will follow known methodology applied for the development of similar facilities on the airport and at other locations. A study is needed to identify and illustrate with actual examples the main facility components and combinations.

The volumes of historical and forecast demand need to be identified. The financial aspects need to be identified and expressed in cost per user and cost per air passenger. The political aspects, which are multitudinal and may include federal, state, local, city, and county governments, should be assessed.

TRAFFIC PEAKING

64. Methodologies for Assessing and Evaluating Economic, Legal, and Political Implications of Peaking of Domestic and International Air Traffic at Airports

Peaking refers to the highest concentration of traffic (aircraft, passenger, vehicles, cargo, baggage) that the airport has to handle or process within a particular period of time. Peaking of traffic at airports affects airlines, airport authorities, designers, operators, inspection services, common services, contractors, concessionaires, travelers, greeters, well-wishers, and the general public. Peaking of traffic flows is, in part, a national and international problem. The problem cannot be eliminated in its entirety by unilateral action of one level of government; therefore, studies of peaking problems must be undertaken in a national and international context. To study the problems of peaking at airports requires that the nature and extent of the peaking be identified and that the economic penalties due to peaking and the legal and political implications be estimated.

This proposed research project requires several in-depth studies in the following areas: (a) statistical analysis and collection of data—comprehensive review of existing traffic data system, feasibility study of a common traffic data book, assessment of a method to forecast peaks, systematic analysis of traffic data to understand nature and cause of peaks, and analysis of socioeconomic forces that motivate the behavior of air-traveler preferences according to time of day, day of week, month, or season of year; (b) development of a relationship between use of airports and economic penalties—estimate of overall economic impacts of peaking to all interests at airports, methodology for assessing the adverse operational effects of peaking at a given airport, and methodology for assessing the interaction of traffic among major airports to develop relations among uses of major airports on the same network; and (c) development of methods for actively managing traffic flows—formulation of objectives, consideration of alternative approaches, development of evaluation procedures, examination of the legal and political implications, and development of governmental organization and

legislative authority to implement selected approach.

USER CHARACTERISTICS

65. Characteristics of Airport Population

The characteristics and behavior patterns of an airport population significantly affect landside capacity requirements. Nationwide standards or norms regarding airport population characteristics and behavior are seldom applicable to a specific airport because of the influence of local conditions, e.g., resident characteristics, types of visitors attracted to the area, type of airline service offered, and physical and operational characteristics of the airport itself. The characteristics of airport populations need to be related to local conditions in a manner that will permit local planners to understand their own specific capacity demands and how best to provide for it.

A study of the characteristics of an airport population is proposed. Characteristics are defined to include 2 general categories: type of individual and behavior patterns. The characteristics included in each category should be limited to those specifically affecting the individual's use of the capacity of one or more functional components of the airport. Individual characteristics could include items such as purpose of being at the airport, size of party, access mode, frequency of airport usage, age, handicaps, and resident origin. Behavior patterns could include time of arrival, time of departure, services and facilities used, time spent in using each, and changes in behavior anticipated on next visit. The study of these characteristics should indicate future trends of change in these patterns because of either internal or external forces.

A study of this type limited to one specific airport could produce meaningful results for that airport but with limited applicability to other airports. A multiairport survey should include a stratified sample of a wide variety of airport and community types. These results should be cross tabulated with the corresponding airport and community characteristics in an effort to provide cause and effect relations that will make the results more universally applicable.