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16. Abstract

The annual expenditures and revenues of 15 general aviation airports in Texas were surveyed to gain a better understanding of the operating and maintenance costs of smaller airports. The airports selected were among those considered by the staff of the Texas Aeronautics Commission to be well managed. The survey included five basic transport airports, five general utility airports and five basic utility facilities. Eight of the airports are located in east Texas and seven in west Texas. The operating and maintenance expenditures and revenue collections for each airport's most recent fiscal year were obtained during visits with the airport management. Additional information was obtained through follow-up phone calls and mail surveys.

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THE OPERATION AND MAINTENANCE OF TEXAS GENERAL AVIATION AIRPORTS: COST AND REVENUE EXPERIENCE

prepared in support of the
Texas Aeronautical Facilities Plan

by
Kenneth C. Kaemmerle
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sponsored by the
Texas Aeronautics Commission
in cooperation with the
U.S. Department of Transportation,
Federal Aviation Administration

February 1989

Texas Transportation Institute
The Texas A&M University System
College Station, Texas

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ABSTRACT

The annual expenditures and revenues of 15 general aviation airports in Texas were surveyed to gain a better understanding of the operating and maintenance costs of smaller airports. The airports selected were among those considered by the staff of the Texas Aeronautics Commission to be well managed. The survey included five basic transport airports, five general utility airports and five basic utility facilities. Eight of the airports are located in east Texas and seven in west Texas. The operating and maintenance expenditures and revenue collections for each airport's most recent fiscal year were obtained during visits with the airport management. Additional information was obtained through follow-up phone calls and mail surveys.

The expenditures and revenues reported by the 15 airports were organized by cost and revenue center. Capital costs were not included. Average expenditures and revenues were calculated by cost/revenue center based on data furnished by the 15 airports. Average expenditures and revenues by cost/revenue centers were also determined for airports with similar layout design and comparable levels of aviation activity (numbers of based aircraft). Using the averages developed from the survey data, it was proposed that estimates could be made of annual expenditures and revenues for other airports, given an airport's design and activity characteristics.

In 1973 the Texas Aeronautics Commission recommended adequate expenditures levels for general aviation airports. The 1973 levels were adjusted to 1988 dollars and compared with the recent study. The comparison showed that the total recommended expenditures were comparable with the survey findings, although there were large differences in some cost centers. This comparison indicated that the averages developed from the survey data were reasonable estimates of adequate spending levels. A similar comparison of revenue data was not possible because data comparable to the survey findings were not available.

TABLE OF CONTENTS

page

I. Design of the Study 1
Airports Studied 1
Scope of the Study 2
Airport Budgeting and Accounting Practices 4
II. Results of the Survey 6
Cost Centers 7
Revenue Centers 16
III. Application of the Survey Findings 22
Selection of Related Characteristics 22
Estimating Annual Maintenance Costs 22
Estimated Annual Revenue 24
IV. Conclusions and Recommendations 25
Adequate Annual Operating and Maintenance Expenditures 25
Adequate AnnualAirport Revenue 29
V. Appendix 30

LIST OF TABLES

page

Table 1 Airports Included in the Study....2

Table 2 Study Airports Grouped by Number of Based Aircraft....2

Table 3 Average Annual Administration Expenses by Reporting Airports....7

Table 4 Average Annual Runway and Taxiway Maintenance Expenses by Reporting Airports....8

Table 5 Average Annual Runway and Taxiway Maintenance Expenses by Pavement Area of Reporting Airports....9

Table 6 Average Annual Building Maintenance Expenses by Reporting Airports....10

Table 7 Average Annual Grounds Maintenance Expenses by Reporting Airports....10

Table 8 Average Annual Grounds Maintenance Expenses by Acreage of Reporting Airports....11

Table 9 Average Annual Lighting Maintenance Expenses by Reporting Airports....12

Table 10 Average Annual Lighting Maintenance Expenses by Total Runway Length of Reporting Airports....12

Table 11 Average Annual Roadways and Parking Facilities Maintenance Expenses by Reporting Airports....13

Table 12 Average Annual Non-Aviation Equipment Maintenance Expenses by Reporting Airports....13

Table 13 Average Annual Aviation Equipment Maintenance Expenses by Reporting Airports....14

Table 14 Average Annual Line Service Expenses by Reporting Airports....15

Table 15 Average Annual Utility Expenses by Reporting Airports....15

Table 16 Average Annual Insurance Expenses by Reporting Airports....16

Table 17 Average Annual Land Lease Revenue by Reporting Airports....17

Table 18 Average Annual Fuel Flowage Fee Revenue by Reporting Airports....18

Table 19 Average Annual Fuel Sale Revenue by Reporting Airports....19

Table 20 Average Annual Hangar Rental Revenue by Reporting Airports....19

Table 21 Average Annual Tie-down Revenue by Reporting Airports....20

Table 22 Average Annual Concession Revenue by Reporting Airports....21

Table 23 Estimated Annual Expenses by Airport Cost Center....23

Table 24 Estimated Annual Revenue by Airport Revenue Center....24

Table 25 Comparison of Adequate to Actual Expenditures by Cost Center....26

Table 26 Comparison of Expenditure Recommendation by Cost Center....27

I. DESIGN OF THE STUDY

Millions of dollars are spent annually on the capital improvement of general aviation airports in Texas. Many of these dollars go toward rehabilitating runways, taxiways and aprons that have deteriorated over the years. In some cases, pavement may require rehabilitation before the end of its useful life because the pavement has not been adequately maintained. In these instance, dollars spent to reconstruct prematurely deteriorated pavement are dollars that can't be spent on airport improvements. Adequately maintaining all parts of an airport's physical plant is an important strategy in proper airport management.

One reason often given for failure to adequately maintain an airport is a lack of maintenance dollars. There is no question that budgets for small general aviation airports do not contain unlimited dollars. However, adequate maintenance is an implicit part of the responsibility for owning and operating an airport. Allowing capital improvements to deteriorate for lack of maintenance is not an acceptable management practice. Airport budgets must contain adequate amounts for ongoing maintenance of the airport property.

Little information is available about local airport budgeting practices. This study has been designed to answer several basic questions about airport finances: how much is being budgeted for airport operation and maintenance and what are adequate expenditures for these purposes? Related to these questions is how much money airports have available for operation and maintenance To answer these questions, the expenses and revenues of 15 general aviation airports in Texas were studied in detail.

Airports Studied

The airports selected for study are considered by the Texas Aeronautics Commission (TAC) and Texas Transportation Institute (TTI) staffs to be among the best managed in the state. All are publicly owned and, with one exception, are managed by an employee of the owning municipality. The exception is an airport managed by a fixed base operator (FBO). The 15 airports were also selected based on their design class and their location. Airports from both east and west Texas are included in the event expenses vary by region. Airports were grouped into three design classes: 1) those with a basic transport or extended utility design; 2) general utility airports; and 3) basic utility airports. A brief description of the design classifications is included in the Appendix. Table 1 identifies the airports selected for the study.

Table 1
AIRPORTS INCLUDED IN THE STUDY

Basic Transport or Extended Utility	General Utility	Basic Utility
Bay City Municipal	Arlington Municipal	Caldwell Municipal
Montgomery County	Georgetown Municipal	Commerce Municipal
Kerrville Louis Schreiner	Mexia/Limestone County	LaPorte Municipal
Odessa Schlemeyer	Midland Airpark	Levelland Municipal
Wilbarger County	Mid Valley Municipal	Seymour Cooper Municipal

Airports were not selected based on their level of aviation activity. However, it is reasonable to assume that the expenses and revenues of a busy airport would be greater than for a less busy facility. For this reason, the analysis will also airport activity. The number of based aircraft reported in the airport's most recent Master Record will represent the airport's activity level. Table 2 shows the 15 airports grouped according to the number of based aircraft.

Table 2
STUDY AIRPORTS GROUPED BY NUMBER OF BASED AIRCRAFT

150 or More Aircraft	40-150 Aircraft	Less than 40 aircraft
Arlington Municipal	Bay City Municipal	Mexia/Limestone County
Georgetown Municipal	Kerrville Louis Schreiner	Caldwell Municipal
Montgomery County	Midland Airpark	Commerce Municipal
LaPorte Municipal	Wilbarger County	Levelland Municipal
Odessa Schlemeyer	Mid Valley Municipal	Seymour Cooper Municipal

The most notable difference between Tables 1 and 2 is the inclusion of LaPorte Municipal Airport, a basic utility facility, among the busiest airports in the study.

Scope of the Study

A member of the TTI staff collected information during a visit to each airport. Airport managers were notified prior to the visit that expense and revenue data from the airport's most recently completed fiscal year were desired. This was generally fiscal year 1987-88 ending in the fall of 1988. Each manager was informed that this information would be grouped with data from other airports before being published. They were mailed copies of the study's initial tabulation of expenses and revenues for their airports. The managers' comments and corrections were taken into account in preparing the final tables.

Cost Centers

Expenses reported included the costs of activities performed by the airport staff as well as services provided and billed to the airport by vendors or the municipal government. Many of the maintenance and administrative duties for smaller airports are performed by the municipal staff but are not charged to the airport. In these cases the airport managers were asked to estimate the value of these services. One contracts with an FBO to manage the airport. In this case the FBO manager estimated the value of his contract and allocated the value to the different cost centers. The cost centers used in this study were:

Administration
Maintenance of Runways/Taxiways/Aprons
Maintenance of Buildings
Maintenance of Grounds
Maintenance of Lighting
Maintenance of Roads/Auto Parking
Maintenance of Non-Aviation Equipment
Maintenance of Aviation Equipment
Line Service
Utilities
Insurance
Leases (property or equipment leased *to* the airport)

Revenue Centers

General aviation airports are limited in their sources of revenue. Most comes from two sources: property rental and fuel sales. One of the airports in the study recovered no revenue from its operation. In this case the sole source of operating revenue was a contribution from the general fund of the municipality owning the airport. Concession fees, a major source of revenue at large airports, were notably absent from small airport revenues. The revenue centers for which data were collected included:

Land lease income
Fuel flowage fee revenue (from sales by others)
Net income from airport fuel sales (from sales by the airport owner)
Hangar rentals
Based aircraft tie-downs
Transient aircraft tie-downs
Food service concessions
Vending concessions
Telephone concessions
Auto rental concessions
Terminal advertising concessions
Investment Interest (from airport bank account or CDs)

Reporting Problems

Organizing the data into these expense/revenue centers resulted in some difficulty since the majority of the airports do not budget to expense/revenue centers in the detail requested. This was true more for expenses than revenues and more for wages than purchases. To resolve this problem, managers were asked to estimate the amount of time each airport employee spent working in each of the cost centers. A portion of the employee's total annual wages/salary was then allocated to the cost center based on the percent of the employee's annual hours charged to the cost center. Managers were asked to include benefits with wage/salary costs in their report.

Airport Budgeting and Accounting Practices

Publicly-owned gneral aviation airports in the state of Texas are financially organized either as a municipal enterprise or as a part of the municipal government.

Airports Operated as a Municipal Enterprise

As a municipal enterprise, airport accounts are kept separately from those of the municipality owning the airport. The airport is operated as a small business which happens to be owned by the municipality. Any shortfall in funds for the operation and improvement of the airport is made up with "contributions" from the municipality. The enterprise system is often used where a municipal service collects revenueas in the case of municipally owned power utilities.

Airports Operated as Part of Municipal Government

An airport can also be organized as a part of the municipal government in the same way other municipal services such as public safety and streets and highways. The budget for the airport is part of the municipal budget, and the airport is a cost center in the municipal accounts. There is no deficit *per se* in the airport operation because airport expenses and revenues are not balanced separately from other city accounts. Texas law does require that any airport revenue be accounted for separately by maintaining an "airport fund" on the municipal books.

Airports that are operated as an enterprise are likely to have better records of airport expenses because services provided to the airport by the municipality are billed to the airport. For example, time spent by the municipal staff on airport management would be charged to the airport account, as would maintenance performed on the airport property by the municipality. Where the airport is a line item in the municipal budget, the cost of services provided to the airport may not appear in the airport account, having been accounted for in the budget of another department. (This was

found to be the case in a recent study by the city of Arlington which identified the cost of "indirect" services provided the airport by the city.)

The majority of the airports included in this survey are operated as municipal departments. An effort has been made to account for all airport expenses. It must be recognized, however, that there is the potential for underaccounting where services are provided by the municipality to the airport.

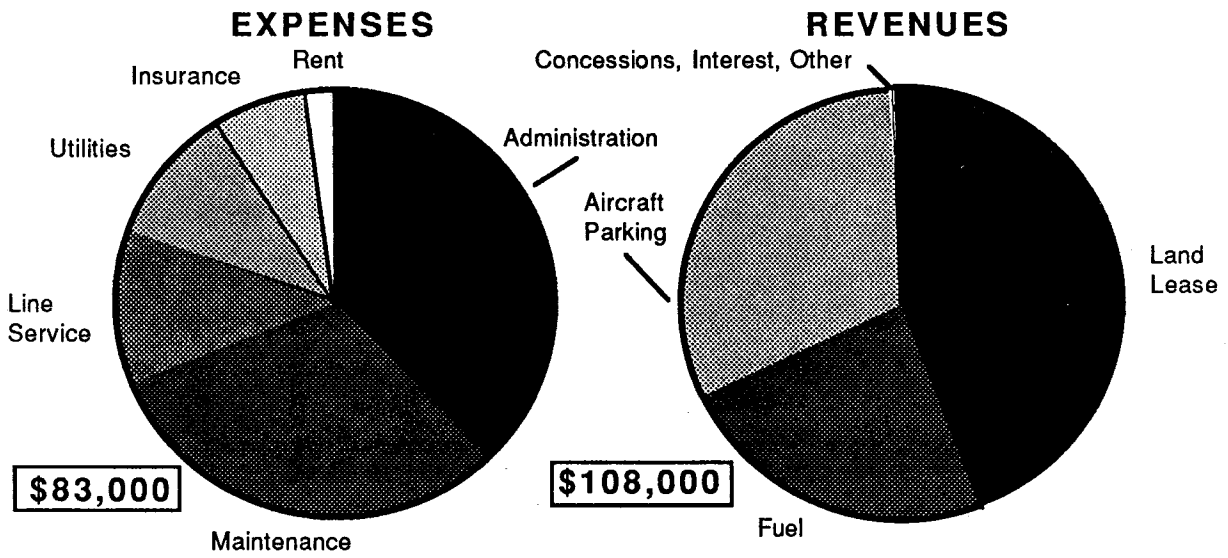
Debt Service and Depreciation

Interest paid on bonds issued for airport improvements (debt service) can be a major part of an airport's budget. Because this study did not address capital expenses, the question of debt service was not raised in the survey. However, debt service on income producing property (hangars, fuel systems, etc.) is an expense that must be considered when evaluating airport revenue. Depreciation reflects the capital investment in the airport. Depreciation is not an operating cost and was not included in this study.

II. RESULTS OF THE SURVEY

Average expenditures for the 15 surveyed airports were $83,000 during their most recent fiscal years. Revenues averaged $108,000 giving the average airport a comfortable surplus in operating funds. Actually, eight airports reported revenues exceeding their reported expenses. Figure 1 shows the relative proportion of expenses and revenues that the average airport reported for each cost/revenue center. Labor accounted for an average of 52 percent of total expenses. The averages shown in Figure 1 are for total expenses and revenues in each cost/revenue center, divided by 15 airports. It should be noted that not all airports had expenses in each of the cost centers identified or revenues from all of the possible sources investigated.

Figure 1
AVERAGE EXPENSES AND REVENUES FOR 15 STUDY AIRPORTS



To examine expenditures and revenues in greater detail, the airports were sorted into three groups to reflect common characteristics. Three groupings of the 15 airports were used. The first group identified the average for all airports that reported an expenditure or revenue for the particular cost/revenue center. The second group segregated the airports in the first group by their number of based aircraft. Airport design was the determining factor for the third group. Each table indicates the number of airports that make up the average shown. Analyzing the data by airport characteristics also establishes the differences among airports and prevents identification of data from any single airport.

Cost Centers

The following tables show the average expenditures for each of the cost centers for which at least four airports reported expenses.

Administration

Administrative expenses are those associated with managing the airport including wages, salaries and benefits of bookkeepers, clerical and administrative staff. Also included in this cost center are office supplies, purchased administrative services and equipment, travel costs and professional development expenses. In cases where municipal staffs perform all or part of the administrative duties, this cost center was difficult to analyze. Individuals who had other responsibilities in addition to the airport estimated the time they spent on airport matters. The cost including benefits of additional clerical and professional assistance provided by the municipal staff may have been overlooked. The nine airports with managers averaged $48,591 spent on administration compared to $5,655 by airports managed by municipal staffs.

Table 3 shows that the average airport expended $31,416 on airport administration. The range in administrative expenditures was from $660 to $150,000 annually The amount spent to manage an airport declined significantly as the activity level (number of based aircraft) dropped. There was little difference in the amount spent on administration between the basic transport and general utility airports. Variation in the amount of annual administrative expenditures appears more closely related to the number of based aircraft than to airport design.

Table 3
AVERAGE ANNUAL ADMINISTRATION EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	15	$31,416
150+ Based Aircraft	5	64,230
40-149 Based Aircraft	5	23,813
<40 Based Aircraft	5	6,207
Basic Transport Airports	5	42,846
General Utility Airports	5	49,010
Basic Utility Airports	5	2,393

Airport Maintenance

Expenditures for airport maintenance are of particular interest in this study. For this reason, maintenance expenditures have been broken down into greater detail than have other expenditures. The following discussion and tables describe the expenditures reported by the 15 study airports for the various activities required to maintain an airport.

Maintenance of Runways, Taxiways and Aprons. This cost center includes the labor, material and equipment charges for the preventive maintenance of airside pavements. Preventive maintenance includes herbicide treatment, pavement patching, crack filling and pavement markings. The work can be performed by the airport personnel, municipal employees or contractors (including FBO personnel).

The findings of the survey are shown in Table 4. Four of the 15 airports reported no expenses in this area. The 11 airports reporting expenses spent an average of $7,851 a year on pavement maintenance. The highest expenditure was $40,000; the lowest was only $57. When drawing conclusions, consideration must be given to the fact that the cost data reported were for the most recent year. Pavement maintenance expenses can vary from year to year. The expenditures reported in the survey may not reflect an average year.

Table 4
AVERAGE ANNUAL RUNWAY AND TAXIWAY MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	11	$7,851
150+ Based Aircraft	4	8,471
40-149 Based Aircraft	4	12,700
<40 Based Aircraft	3	557
Basic Transport Airports	4	4,226
General Utility Airports	3	20,533
Basic Utility Airports	4	1,964

Airport design and activity were not a factor in the annual maintenance of pavement. It would be expected that the basic transport airports with more pavement would have higher annual expenses for pavement maintenance. However, the airports in the 40-149 based aircraft group and those in

the general utility design class spent significantly more than the airports in the other groups.. Expenses at the smallest airports in both groups were the least.

The airport design standard may not adequately reflect the amount of pavement on an airport. A general utility airport with three runways could have more pavement than a basic transport airport with one runway. Pavement maintenance costs per square footage of runway pavement, therefore, were also examined. (Runway square footage is being used to represent total pavement area, including taxiways, and aprons.) Table 5 presents these findings.

Table 5
AVERAGE ANNUAL RUNWAY AND TAXIWAY MAINTENANCE EXPENSES BY PAVEMENT AREA OF REPORTING AIRPORTS

	Number Reporting	Average Expenditure per 1,000 Sq. Ft.
All Airports	11	$9.52
>750,000 Sq. Ft.	5	8.11
300-749,000 Sq. Ft.	4	17.76
<300,000 Sq. Ft.	2	2.68

Table 5 supports the findings of Table 4 that the largest and smallest airports spent less on pavement maintenance than did the medium-sized airports. Expenditures per 1,000 square feet at airports with 300-749,000 square feet of pavement were more than twice those of the larger airports. The largest airports averaged 1.125 million square feet of pavement, the medium-sized airports averaged 400,000 square feet, and the smallest airports averaged 185,000 square feet of pavement. Expenditures by the medium-sized airports are, therefore, greater both in terms of dollar amount and in rate of expenditure. Although expressing pavement maintenance expenses as a rate does not explain the difference in expenditures between airports, it does present a reasonable alternative for describing pavement maintenance expenses.

Maintenance of Buildings. Included in this cost center are the labor and materials required for maintenance of airport-owned buildings including hangars and terminal. Expenses can be expected to vary with the number of buildings owned by each airport. However, the number of buildings at each airport was not reported. Respondents stated that the maintenance of buildings leased to FBOs was generally the responsibility of the lessee. As can be seen in Table 6, the busier airports and the larger facilities reported higher expenses for maintaining buildings. Expenditures ranged from a high of $32,000 to only $68 a year. Without more information about the number of

buildings on each airport, airport design will be used to reflect the variation in building maintenance costs among airports.

Table 6
AVERAGE ANNUAL BUILDING MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	10	$6,308
150+ Based Aircraft	4	11,841
40-149 Based Aircraft	2	4,097
<40 Based Aircraft	4	1,907
Basic Transport Airports	4	10,681
General Utility Airports	3	5,402
Basic Utility Airports	3	1,383

Maintenance of Grounds. As shwon in Table 7, all 15 airports reported expenses for maintenance of the airport grounds (labor and materials required for mowing, landscaping and fencing). The busier and larger airports had higher expenses in this cost center. The most spent was approximately $24,000 compared to the lowest expenditure of $815.

Table 7
AVERAGE ANNUAL GROUNDS MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	15	$7,746
150+ Based Aircraft	5	14,156
40-149 Based Aircraft	5	7,082
<40 Based Aircraft	5	1,907
Basic Transport Airports	5	11,109
General Utility Airports	5	8,639
Basic Utility Airports	5	3,490

As with pavement maintenance, expenditures were examined in greater detail by grouping airports according to their acreage in Table 8. The medium-sized airports, again, spent proportionately

more than the other airports. The larger total expenses by basic transport airports are due, in this instance, to their greater acreage. Some economy of scale can be expected in maintenance of grounds, which may in part provide a reason for the lower rate of expenditure among the airports with the most land. Lacking a better explanation of the variation in cost per acre, airport design will be used to explain the difference in expenditures among airports.

Table 8
AVERAGE ANNUAL GROUNDS MAINTENANCE EXPENSES BY ACREAGE OF REPORTING AIRPORTS

	Number Reporting	Average Expenditure per Acre
All Airports	15	$24.05
>600 Acres	5	11.11
150-559 Acres	4	37.55
<150 Acres	6	23.50

Maintenance of Lighting. This cost center consists of labor and materials required for maintaining airside lighting including runway/taxiway lights and beacons. Only one airport did not report expenditures in this area. Differences among the airports in the annual cost of lighting maintenance could be expected to be related to the amount of runway lighting on the airport since all of the airports have beacons. Runway lighting is generally a function of runway length. Basic transport airports have the longest runways and basic utility airports the shortest. Table 9 shows that basic transport airports had the highest annual expenditure in this cost center. The reported expenditures ranged from $120 to $9,280.

Table 10 looks at lighting expenses in terms of annual cost per linear foot of runway. Examined in this manner, the airports with the most runway length (sum of all usable runways) spent less than the airports with the least amount of runway. This again may be due to economy of scale, although opportunities for such economy in lighting maintenance would appear to be limited. A more probable explanation is that busier airports have more on-field lighting overall. The average lighting expenditure per linear foot of runway for airports with more than 150 based aircraft was $0.84 compared to $0.32 for airports with 40-149 based aircraft and $0.22 for airport with less than 40 based aircraft. Among the three measures of variation in expenditures for airport lighting (activity, design, runway length), airport design appears to be a reasonable medium between runway length and airport activity for explaining variation in costs.

Table 9
AVERAGE ANNUAL LIGHTING MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	14	$3,085
150+ Based Aircraft	5	6,222
40-149 Based Aircraft	5	1,746
<40 Based Aircraft	4	835
Basic Transport Airports	5	5,056
General Utility Airports	5	2,026
Basic Utility Airports	4	1,899

Table 10
AVERAGE ANNUAL LIGHTING MAINTENANCE EXPENSES BY TOTAL RUNWAY LENGTH OF REPORTING AIRPORTS

	Number Reporting	Average Expenditure per Linear Foot
All Airports	14	$0.48
>8,000 Feet	5	0.33
5,000-7,999 Feet	4	0.59
<5,000 Feet	5	0.53

Maintenance of Roads/Auto Parking. Only five of the 15 airports reported any expenditures on roadways and parking facilities (landside pavements) in their most recent fiscal year. It is suspected that many of the publicly-owned airports receive assistance from their municipal highway maintenance crews with this activity. The five airports spent an average of only $899 on landside pavement maintenance as shown in Table 11. Expenditures per airport ranged from $16 to $12,000. Too few airports reported expenditures to draw any conclusions about expenditure patterns by group. The average reported expenditure for all airports will be used to represent expenditures in this cost center.

Table 11
AVERAGE ANNUAL ROADWAYS AND PARKING FACILITY MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	5	$899
150+ Based Aircraft	1	16
40-149 Based Aircraft	3	4,430
<40 Based Aircraft	1	181
Basic Transport Airports	3	4,430
General Utility Airports	1	16
Basic Utility Airports	1	181

Maintenance of Non-aviation Equipment. This cost center includes expenditures for labor and materials required to maintain airport-owned vehicles and service equipment. The more an airport relied on its own staff to perform maintenance, the greater the expenditures in this cost center. Seven of the airports reported expenditures ranging from $98 to $33,600. Table 12 shows that the busier and larger airports reported higher expenditures. The number of based aircraft is used to portray the variation in reported airport expenditures on non-aviation equipment.

Table 12
AVERAGE ANNUAL MAINTENANCE OF NON-AVIATION EQUIPMENT EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	7	$6,270
150+ Based Aircraft	3	13,070
40-149 Based Aircraft	3	1,313
<40 Based Aircraft	1	740
Basic Transport Airports	4	9,389
General Utility Airports	3	2,112
Basic Utility Airports	0	0

Maintenance of Aviation Equipment. Expenses in this cost center are for the labor and materials required to maintain airport-owned non-directional beacons (NDBs), radios and visual navaids. The surveyed airports reported that this maintenance is generally performed by contractors. NDB maintenance can be a large part of this cost center. Of the seven airports reporting expenditures on aviation equipment maintenance, six maintain NDBs. The presence of an NDB appears more significant in explaining the variation in expenditures among the airports than either activity or size (Table 13). Reported expenditures ranged from $1,000 to $12,000. Aviation equipment maintenance expenses will be represented by the average annual expenditure reported.

Table 13
AVERAGE ANNUAL AVIATION EQUIPMENT MAINTENANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	7	$3,490
150+ Based Aircraft	3	5,339
40-149 Based Aircraft	2	969
<40 Based Aircraft	2	3,239
Basic Transport Airports	3	1,278
General Utility Airports	3	6,466
Basic Utility Airports	1	1,200

Line Services

Expenses are incurred in this cost center only if the airport operator sells fuel. Line service costs are those associated with the fueling and parking of aircraft and do not include the bulk purchase price of the fuel. Labor is the major expense although the costs of maintaining the fueling system may be included. Fuel is sold by five of the fifteen airports. The most spent by an airport on line service was $88,000. The lowest line service expenditure was $3,600. The assumption that the busier the airport, the more fuel is sold and, consequently, the higher line service costs is supported by Table 14. Aircraft activity is the better choice to represent variation in line service costs.

Table 14
AVERAGE ANNUAL LINE SERVICE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	5	$29,113
150+ Based Aircraft	2	60,269
40-149 Based Aircraft	2	10,731
<40 Based Aircraft	1	3,569
Basic Transport Airports	2	10,731
General Utility Airports	3	41,369
Basic Utility Airports	0	0

Utilities

All 15 airports reported expenses for utilities. In some cases, electricity and water costs were reported together. Telephone expenses were identified by 13 of the airports. Total utility expenses including gas, electricity, water and telephone are shown in Table 15. Expenses were greater at the busier and larger airports. Electricity cost averaged 74 percent of the average total utility costs of the airports in the study. The highest reported utility costs were $34,000 and the lowest, $1,464.

Table 15
AVERAGE ANNUAL UTILITY EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	15	$8,721
150+ Based Aircraft	5	14,423
40-149 Based Aircraft	5	7,378
<40 Based Aircraft	5	4,091
Basic Transport Airports	5	12,621
General Utility Airports	5	9,387
Basic Utility Airports	5	4,153

Insurance

Insurance premiums were reported by all but one of the 15 airports. The airport not reporting expenses in this cost center is self-insured. Although there is a cost to the municipality to include the airport under its self-insurance plan, the cost evidently has not been charged to the airport in

this case. The remaining airports all carried liability insurance. Airports without buildings or equipment on the airport tended not to carry property insurance. Insufficient information was collected to determine reasons for the variation in premium amounts. However, liability coverage for the larger airports was generally around $5,000,000 and $1,000,000 for the smaller airports. Annual insurance premiums ranged from $1,340 to $18,000. Table 16 shows that insurance costs increased with airport activity and size.

Table 16
AVERAGE ANNUAL INSURANCE EXPENSES BY REPORTING AIRPORTS

	Number Reporting	Average Expenditure
All Airports	14	$6,004
150+ Based Aircraft	4	9,412
40-149 Based Aircraft	5	6,507
<40 Based Aircraft	5	4,091
Basic Transport Airports	5	8,229
General Utility Airports	5	6,574
Basic Utility Airports	5	2,511

Lease Payments

Lease payments were made by three of the study airports for the use (rent) of land, buildings and/or equipment for airport purposes. Lease expenses are not shown in a table. Payments averaged $8,000 at each of the three airports. Because lease payments depend on circumstances peculiar to each airport, they will not be considered further.

Revenue Centers

Revenues collected by the study airports are shown in the following tables where at least three airports reported revenue in the particular revenue center.

Lease Income

The lease of airport property is the major source of income for most of the airports in the study. Income reported in this revenue center is for leases of one year or more. Leased property may include land and buildings for aviation or other purposes. "Other purposes" may include land

leased for farming or buildings leased for storage. Hangar "rentals" have not been intentionally included in lease income but in a few cases could not be extricated from a larger lease. The preference was to show month-to-month rentals under "hangar rental" below.

The larger and busier airports received more income from leases than did the smaller less busy facilities. One airport collected no lease payments at all. This particular airport charges only a token fee for the land on which owners construct their own hangars. The highest reported revenue from this source was $421,000. A low collection of $180 was also reported. The opportunity to lease land for FBO uses and other private operations decreases as the airport activity declines as can be seen in the relatively low lease revenue for the smaller airports in Table 17. Based aircraft groups will be used to differentiate the level of revenue from land leases among airports.

An unsuccessful attempt was made to determine an average rental fee. A lack of information about the amount of property leased made it difficult to calculate a per-square-foot charge. Also, some of the lease agreements call for the lessee to perform various services, such as maintenance of the leased property or maintenance of other airport property, in return for considerations in the lease payment. Leases were most frequently for 10 or 20 years with a review of the lease payment every five years.

Table 17
AVERAGE ANNUAL LAND LEASE REVENUE BY REPORTING AIRPORTS

	Number Reporting	Average Revenue
All Airports	14	$51,546
150+ Based Aircraft	5	111,058
40-149 Based Aircraft	5	30,271
<40 Based Aircraft	4	3,749
Basic Transport Airports	5	93,389
General Utility Airports	5	46,489
Basic Utility Airports	4	5,564

Fuel Revenues

Airport fuel revenues may come from a fuel flowage fee paid to the airport operator by an on-field fuel vendor or from the net revenues from fuel sales made by the airport. The net sale is the difference between the wholesale and retail price of fuel. A fuel flowage fee is an amount per

gallon sold paid by an on airport vendor (an FBO) to the airport operator. In some cases, airports may derive revenue from both (two of the 15 airports), especially if aircraft operators are permitted to purchase bulk fuel for their own aircraft.

Fuel Flowage Fee. Table 18 shows the average revenue collected by the seven airports that impose a fuel flowage fee. Four of the airports levy a $0.04 per gallon fee, and the remaining three charge $0.03, $0.05 and $0.06 per gallon, respectively. The average annual revenue from this source is very similar for the first two levels of airport activity. This can be explained in part by the presence of an aircraft manufacturer at one of the airports in the 40-149 based aircraft group. Revenue collected from fuel flowage fees ranged from $2,000 to $25,000.

Table 18
AVERAGE ANNUAL FUEL FLOWAGE FEE REVENUE BY REPORTING AIRPORTS

	Number Reporting	Average Revenue
All Airports	7	$9,459
150+ Based Aircraft	4	9,764
40-149 Based Aircraft	3	9,054
<40 Based Aircraft	0	0
Basic Transport Airports	3	15,739
General Utility Airports	4	4,750
Basic Utility Airports	0	0

Fuel Sales. Five airports sell fuel and collect average annual *net* revenue of $64,555. The net price is defined here as the difference between the wholesale and retail price. The costs of line service personnel and fueling facilities have not been deducted from the revenue. Airports selling fuel netted from $6,000 to $84,000. The amount of fuel sold is definitely related to the level of activity as shown in Table 19[1]. Therefore, the based aircraft is used to represent variation in fuel sales. Airport design is used to reflect differences in fuel flowage revenue.

[1] A linear regression equation could be used to estimate the dollar amount of fuel sales from the number of based aircraft. The equation developed from the data in this study is Fuel Sales ($) = -5030 + 663 x No. Based Aircraft. The R^2 for this equation is .935. However, the equation is based on sales from only 5 airports. The equation must therefore be used with caution.

Table 19
AVERAGE ANNUAL FUEL SALE REVENUE BY REPORTING AIRPORTS

	Number Reporting	Average Revenue
All Airports	5	$64,555
150+ Based Aircraft	2	126,549
40-149 Based Aircraft	2	31,841
<40 Based Aircraft	1	5,997
Basic Transport Airports	2	31,841
General Utility Airports	3	86,356
Basic Utility Airports	0	0

Hangar Rentals

Hangar rentals are a source of revenue for ten of the airports in the study. The rental fees reported here are generally for T-hangars of various sizes. Monthly rental fees ranged from a low of $15 to a high of $375; annual collections were from $900 to $153,000 The variation in the rent appears to be due to demand at the airport, size of the hangar and the hangar's condition. Table 20 illustrates that income from hangar rental increases with airport activity, as would be expected.

Table 20
Average Annual Hangar Rental Revenue by Reporting Airports

	Number Reporting	Average Revenue
All Airports	10	$44,062
150+ Based Aircraft	4	79,543
40-149 Based Aircraft	3	31,576
<40 Based Aircraft	3	9,240
Basic Transport Airports	4	49,433
General Utility Airports	4	54,017
Basic Utility Airports	2	13,410

Aircraft Tie-down Fees

Few airports charge tie-down fees for aircraft parking on the airport in other than a hangar. Based aircraft owners may be charged a monthly tie-down fee and transient operators may pay an

overnight tie-down fee. Table 21 shows that of the six airports reporting revenue in this category, one collected a tie-down fee from transient users. Revenue from tie-downs is significant only for the busiest airports. The most collected was $43,000. The lowest annual revenue was $280. Airport size does not determine whether or not a tie-down fee is charged. The based aircraft group will be used to explain the variation among airports in the amount of tie-down fees collected.

Table 21
AVERAGE ANNUAL TIE-DOWN REVENUE BY REPORTING AIRPORTS

	Number Reporting	Average Revenue
All Airports	6	$9,092
150+ Based Aircraft	4	14,698
40-149 Based Aircraft	2	311
<40 Based Aircraft	0	0
Basic Transport Airports	2	676
General Utility Airports	3	16,762
Basic Utility Airports	1	7,776

Concession Fees

Providers of services on the airport normally pay a fee to the airport owner based on the concession operator's revenues. Potential sources of concession fees include food service, vending machines, public telephones, auto rental and terminal advertising space. Airport owners might also derive revenue by managing these services themselves. Table 22 shows that only four airports reported any revenue from concessions (three from vending machines, two from pay phones on the airport, and one from auto rentals). Concession revenue is not a major source of income for general aviation airports. Collections ranged from $53 to $1,400. The relationship between airport activity, airport size and concession revenue is not significant considering the small number of airports with income from concessions. However, airport design will be used as a measure of the variation in concession revenue among airports.

Table 22
AVERAGE ANNUAL CONCESSION REVENUE BY REPORTING AIRPORTS

	Number Reporting	Average Revenue
All Airports	4	$761
150+ Based Aircraft	1	289
40-149 Based Aircraft	3	918
<40 Based Aircraft	0	0
Basic Transport Airports	3	918
General Utility Airports	1	289
Basic Utility Airports	0	0

Other Income

All revenue from municipal airport operations must be placed in a separate airport fund that may be used only for airport purposes (Section 46d-11, Texas Statutues). Money in this fund should be in an interest-bearing account. The interest is a source of income for airport operations or improvements. Three airports reported interest income averaging $2,400. One airport reported income of $2,700 a year in miscellaneous user fees.

III. APPLICATION OF THE SURVEY FINDINGS

With the following reservations, the preceding data can be used to make a rough estimate of annual expenses and revenues that might be expected for a general aviation airport in Texas. The data are from 15 airports which were selected because they were believed to be well-managed. They may not be, however, representative of an "average" general aviation airport. The costs and revenues reported in this study are for each airport's most recent fiscal year which may not have been an average year. The cost and revenue centers used in this study were devised by the authors. Expenses and revenues reported by each of the airports were allocated to one of the centers based on the judgement of the airport operator and the authors. For airports that do not keep records according to the cost/revenue centers used in this study (i.e., in most cases), some misallocation may have resulted. Finally, it should be recalled that all expenditures may not have been fully accounted for at airports that operate as part of a municipal budget.

Selection of Related Characteristics

In Section II, expenditures and revenues were related to airport characteristics: levels of aviation activity (number of based aircraft), the design of an airport (basic transport, general utility and basic utility), or to a unit of measurement (acres, square feet, linear feet). For each center the characteristic that best explained the variation among the airports was identified. For example, the number of based aircraft would appear to explain the variation in administrative costs (Table 3). Table 3 suggests that as an airport gets busier, administrative responsibilities will increase. The design of an airport does not present a logical relationship to the variation in this case.

Where a logical relationship between expenditures and airport activity level or design was not apparent, an alternative relationship was investigated, usually a rate (cost per square foot, acre or linear foot). Only in the case of pavement maintenance did a rate have a better relationship to the variation in expenses. The use of the average-cost-for-all-airports is also possible where there is no alternative measure that can better explain the variation, or where insufficient data made use of the grouped values untenable. This was the case with maintenance of parking and roadway pavements and with aviation equipment maintenance costs (Tables 11 and 13).

Estimating Annual Maintenance Costs

Table 23 shows the average expenditures in each cost center and the airport characteristic (of the characteristics investigated) that is most closely related to the variation in expenditure level. Using Table 23, annual operating and maintenance costs can be estimated.

Table 23
ESTIMATED ANNUAL EXPENSES BY AIRPORT COST CENTER

Cost Center	Related Characteristic	Estimated Annual Expenditure for Group 1	Group 2	Group 3
Administration	Based Aircraft	$64,000	$24,000	$6,000
Maintenance of Pavement	per 1,000 Sq. Ft. of Runway	$9.50	$9.50	$9.50
Maintenance of Buildings	Airport Design	$10,500	$5,500	$1,500
Maintenance of Grounds	Airport Design	$11,000	$8,500	$3,500
Maintenance of Lighting	Airport Design	$5,000	$2,000	$2,000
Maintenance of Parking/Roads	Average	$900	$900	$900
Maintenance of Non-Av Equipment	Based Aircraft	$13,000	$1,500	$750
Maintenance of Av-Equipment	Average			
with an NDB		$3,500	$3,500	$3,500
without an NDB		$1,500	$1,500	$1,500
Line Service	Based Aircraft	$60,000	$11,000	$3,500
Utilities	Airport Design	$12,500	$9,000	$4,000
Insurance	Based Aircraft	$9,500	$6,500	$4,000

Group 1 = 150+ Based Aircraft or Basic Transport Design
Group 2 = 40-149 Based Aircraft or General Utility Design
Group 3 = Less than 40 Based Aircraft or Basic Utility Design

For example, annual operating and maintenance costs for a general utility airport with a 60 x 3,700 foot runway, an NDB and 35 based aircraft for which the owner provides line services can be estimated from Table 23 as follows:

Administration	$6,000	
Maintenance of Pavements	2,100	(60 x 3,7000÷1,000 x $9.50)
Maintenance of Buildings	5,500	
Maintenance of Grounds	8,500	
Maintenance of Lighting	2,000	
Maintenance of Parking/Roads	900	
Maintenance of Non-Av Equipment	750	
Maintenance of Av-Equipment	3,500	
Line Service	3,500	
Utilities	9,000	
Insurance	4,000	
Total Estimated Annual Expenses	$45,750	

Estimated Annual Revenue

Annual revenue can be estimated in the same way as expenses by creating a table similar to Table 23 from the data in Tables 17-22. The reservations that apply to the use of such a table for estimating expenses also apply to estimating revenue. In addition, the variability in revenue from land leases makes it difficult to relate lease income to a characteristic of the airport. However, given these reservations, the following table for estimating annual revenue was created.

Table 24
ESTIMATED ANNUAL REVENUE BY AIRPORT REVENUE CENTER

Revenue Center	Related Characteristic	Estimated Annual Revenue for Group 1	Group 2	Group 3
Land Lease	Based Aircraft	$111,000	$30,000	$3,750
Fuel Flowage Fee	Airport Design	$15,750	$4,750	$0
Fuel Sales	Based Aircraft	$126,500	$32,000	$6,000
Hangar Rental	Based Aircraft	$79,500	$31,500	$9,000
Tie-downs	Based Aircraft	$15,000	$500	$0
Concessions	Airport Design	$900	$300	$0

Group 1 = 150+ Based Aircraft or Basic Transport Design
Group 2 = 40-149 Based Aircraft or General Utility Design
Group 3 = Less than 40 Based Aircraft or Basic Utility Design

Annual revenues for the airport used in the previous example can be calculated from Table 24 as follows:

Land Leases	$3,750
Fuel Flowage Fee	Not Applicable
Fuel Sales	6,000
Hangar Rental	9,000
Tie-down Rental	0
Concessions	300
Total Estimated Annual Revenue	$19,050

IV. CONCLUSIONS AND RECOMMENDATIONS

The estimates of annual operating and maintenance expenditures shown in Table 23 are based on actual expenditures by the 15 surveyed airports. Whether these expenditure levels are adequate still remains to be answered. This study did not identify what would be adequate for the operation and maintenance of the different types of airports. However, a study made by the TAC staff in 1973 may help answer the question.

Adequate Annual Operating and Maintenance Expenditures

A study prepared by the TAC in 1973 entitled "Operation and Maintenance Costs for Utility Airports," had much the same objective as this study. The authors stated that the purpose of the study was "to provide airport sponsors with a means of estimating costs which will be incurred in the operation and maintenance of their airport." The authors of the study, engineers with the TAC, were familiar with the maintenance practices and needs of general aviation airports in Texas.

The costs identified in the 1973 TAC study can be compared to the costs reported in this study. Several adjustments must be made first. The 1973 report identified costs for three classes of airports: general utility, improved basic utility and basic utility. There are no estimates for a basic transport airport design. The general utility and improved basic utility classifications are comparable to the general utility and basic utility design classes used in this report. However, in terms of *activity*, the basic transport airports in this study are similar to general utility airports. Since it has been shown that many costs vary with activity, the average expenditures for basic transport and general utility airports have been combined and are presented below under general utility airport costs.

The expenditures in the TAC report are in 1973 dollars. They have been adjusted to estimate current expenditures using the consumer price index (CPI) prepared by the U.S. Bureau of Labor Statistics. More cost centers have been identified in this study than were included in the 1973 TAC report. In addition, the cost centers used in the TAC report are not identical to those used in the present study. For comparison purposes, the 1973 cost centers have been converted to the cost centers used here. Only those found in both studies will be compared. The 1973 estimated costs are shown in Table 25 and are compared to the actual average costs reported in this survey.

Table 25
COMPARISON OF ADEQUATE TO ACTUAL EXPENDITURES BY COST CENTER

	Annual Expenditures			
	General Utility Airports		Basic Utility Airports	
Cost Center	Adequate (1)	Actual (2)	Adequate (1)	Actual (2)
Administration	$67,000	$46,000	$25,500	$ 2,400
Maintenance of Pavements	7,000	7,850	2,800	1,600
Maintenance of Buildings	4,000	5,875	2,000	800
Maintenance of Grounds	5,500	9,850	3,750	3,500
Maintenance of Lighting	8,000	3,550	3,800	1,500
Maintenance of Non-Av Equipment	3,000	1,250	2,200	0
Maintenance of Av Equipment	1,750	2,325	650	250
Utilities	4,800	11,000	2,400	4,150
Total	$101,050	$87,700	$43,100	$14,200

(1) Venhizen, D., Lyons, C. J. and Karpenko, W. O., "Texas Airport System Plan, Technical Note: Operation and Maintenance Cost for Utility Airports," Austin:Texas Aeronautics Commission, October 1973. Costs from this report were inflated by the Consumer Price Index June 1973-June 1988.
(2) Average expenditures reported in this study by *all* airports of this design class. Basic and general utility airport expenditures have been combined under "general utility" in this table. Tables in the text show only averages for those airports that reported an expenditure in the respective cost center.

Table 25 shows that the basic transport/general utility airports in this study spent close to the total amount recommended in the 1973 TAC study for comparable cost centers. Much of the difference is in the administration cost center. The TAC report also recommended spending more on airport lighting than the airports in this study reported spending. There also is a large difference in utility expenditures. It is possible that some of the utility costs identified in this study were included among other cost centers in the 1973 study, such as airport lighting. With the exceptions noted, the recommended expenditures and actual expenditures are in line with the recommended 1973 figures.

The differences between the expenditures recommended for basic service airports and those reported in the study are more difficult to explain. All of the expenses may not have been reported for the smaller airports operating on a municipal budget as suggested earlier. This might explain the large difference in recommended and actual administration expenditures. However, with the exception of expenditures for maintenance of grounds and utility costs, most expenditures reported by the basic service airports in the study are generally half of those recommended by the TAC study.

It is also of interest as to whether the cost estimating methodology presented in Table 23 is comparable to the recommendation of the 1973 TAC report for cost centers used in both studies. Again, it is difficult to compare the studies due to questions about the characteristics of the airports. Table 23 used both airport design and airport activity to estimate cost. The TAC study uses only the airport design. Assuming that the "general utility" airport the TAC study had in mind included a 4,200 x 75 foot runway and had at least 150 based aircraft, the two sets of recommendations can be compared as shown in Table 26. To compare costs for a basic utility airport, a facility with a 3,200 x 60 foot runway and 50 based aircraft has been assumed.

Table 26
COMPARISON OF EXPENDITURE RECOMMENDATION BY COST CENTER

	Recommended Annual Expenditures			
	Basic Transport/General Utility		Basic Utility	
Cost Center	1973 Study (1)	1989 Study(2)	1973 Study (1)	1989 Study(2)
Administration	$67,000	$64,000	$25,500	$ 24,000
Maintenance of Pavements	7,000	3,000	2,800	1,825
Maintenance of Buildings	4,000	5,500	2,000	1,500
Maintenance of Grounds	5,500	8,500	3,750	3,500
Maintenance of Lighting	8,000	2,000	3,800	2,000
Maintenance of Non-Av Equipment	3,000	13,000	2,200	1,500
Maintenance of Av Equipment	1,750	3,500	650	3,500
Utilities	4,800	9,000	2,400	4,000
Total	$101,050	$108,500	$43,100	$41,825

(1) Venhizen, D., Lyons, C. J. and Karpenko, W. O., "Texas Airport System Plan, Technical Note: Operation and Maintenance Cost for Utility Airports," Austin:Texas Aeronautics Commission, October 1973. Costs from this report were inflated by the Consumer Price Index June 1973-June 1988.
(2) Table 23, above.

Table 26 shows that once the characteristics of the airports have been defined, the two estimates of cost are very similar. The estimates produced by Table 23 are reasonable if the assumptions used in making the comparison can be accepted and the recommendations of the 1973 TAC study are considered valid.

The comparison also supports the conclusion that the basic utility airports in the study are not spending adequate amounts for operation and maintenance of the airports as shown in Table 25.

Managers of the smaller airports in the study agree that their airports have a difficult time getting adequate funding for maintaining their facilities, from both users and from the municipality owning the airport.

Table 25 suggests that the basic utility/general utility airports in the study are spending adequate amounts of money on maintenance of runways, taxiways and aprons. However, the use of averages in this case can be misleading. Although the average is useful for identifying what should be spent, it overstates what is actually being spent by many airports. Four airports in the study reported spending nothing during the past fiscal year on airside pavement maintenance. The range in expenditures for the airports that did report pavement maintenance expenses was from $57 to $40,000. The *median* expenditure for the 15 airports was $1,467.

The amount estimated to be adequate for annual pavement maintenance by the TAC report is based only on pavement crack sealing and pavement edge sterilization. Therefore, it can be concluded that the majority of the airports surveyed for this study are not spending adequate amounts for maintenance of airside pavements. If this is the case, the concern for premature pavement deterioration stated at the outset of this study is real.

Programmed Maintenance

Perhaps the most important conclusion to be drawn from this study is that many, if not most of the airports do not appear to have a comprehensive maintenance plan for their airports. There is no evidence that the lack of a plan is intentional. It is more likely that limited financial resources are devoted to the the most pressing needs. However, regular maintenance can prevent many needs from becoming "pressing."

Most of the state's general aviation airports, especially the smaller airports with little management manpower, might benefit from preparing an airport maintenance program. Such a program would evaluate the present condition of the airport's facilities and identify the maintenance activities necessary to preserve the public's investment in the airport. A program of this type would also be useful in identifying the timing for major reconstruction of facilities and would also be helpful to airport managers in preparing and justifying annual budgets. The development of a maintenance program should be preceded by an audit of the airport's financial operation to determine what is being spent and what financial resources are available to the airport.

Adequate Annual Airport Revenue

A comparison of adequate to actual revenues, similar to the comparison of maintenance expenditures, is not possible. Airports of identical design will have many of the same expenses whether they are located in an urban area with high activity levels or in a rural area where the airport is used less. This is the reason Table 24 has related most revenue sources to the activity measure of based aircraft. What the airport operator can collect for the use of the airport will vary considerably depending on the demand for fuel, and hangars and tie-down rentals. Land leases are also dependent on demand, especially FBO leases. The value of the lease to the FBO will be based on economic return the FBO gets from use of the property.

An objective of all airports should be to cover their operating and maintenance expenses with airport generated revenues. Over half of the airports in this study indicated that they were able to meet this objective. However, only half of those covering their expenses with revenue were located in rural areas.

Several airport managers inquired about the rents and fees charged by other airports. As noted previously, the many conditions attached to land leases made it difficult to compare their dollar amounts. Monthly rentals on T-hangars ranged from $15 to $375, depending on size and, according to one airport operator, the hangar's condition. Rent on a medium-sized hangar averaged about $100 per month. The monthly tie-down fees reported ranged from a low of $12 to a high of $40.

An airport sponsor may choose to pay for airport costs from general fund revenues as opposed to airport generated revenue. This is a policy decision each community must make for itself. However, if general fund contributions to the airport are inadequate to properly maintain the facility, the result will be accelerated deterioration of the public's investment in the airport.

V. APPENDIX

Texas Aeronautical Facilities Plan Minimum Design Standards

	Basic Transport	General Utility	Basic Utility
Design Aircraft	Business jet	Light twin–turbo prop	Light twin–piston
Land Requirements			
- landing area	136 acres	51 acres	36 acres
- approach area	124 acres	30 acres	21 acres
- building area	24 acres	24 acres	12 acres
Runways			
- length[1]	5,000 feet	3,800 feet	3,200 feet
- width	75 feet	60 feet	60 feet
- strength[2]	30,000 pounds	12,500 pounds	12,500 pounds
- lighting	medium intensity	medium intensity	low intensity
Taxiways	full parallel	partial parallel	stub with turnarounds
Approach			
- type	nonprecision	nonprecision	visual
- visibility minimums	600 feet - 1 mile	no minimum	not applicable
Services	terminal, restrooms, telephone, avgas, Jet A, attended 12 hours	terminal, restrooms, telephone, avgas	telephone

[1]Runway length is for sea level and increases at higher altitudes; see AC 150/5300-12, 150/5325-4 and 150/5300-4B.
[2]Single-wheel landing gear.