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Evaluation of Existing Aircraft Operator Data Bases

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Final Report

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16. Abstract This report has been prepared in conjunction with the requirement to research existing sources of aircraft operator information. The research determined the availability of aircraft operator information, assessed the factors involved in its acquisition, and evaluated the feasibility of using these data in an International Aircraft Operators Information System for the Federal Aviation Administration (FAA). This evaluation was completed as part of the first phase of a two-phase program to develop an operational aircraft operator information system. The system will include an operator data base and will use existing data from commercial data suppliers. Results of the search for available aircraft operator data from data suppliers, manufacturers, and other organizations indicate there are a number of data suppliers capable of providing more detail and better scope than those now available to the FAA. (KR) (—)			
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EXECUTIVE SUMMARY

This report is prepared in conjunction with the requirement to research existing sources of aircraft operator information. The research determined the availability of aircraft operator information, assessed the factors involved in its acquisition, and evaluated the feasibility of using these data in an International Aircraft Operators Information System for the Federal Aviation Administration (FAA).

This effort was completed as part of the first phase of a two phase program to develop an International Aircraft Operator Information System. The system will include an operator data base and will use existing data from commercial data suppliers. As a result of the research performed during the first phase, a number of sources in the private sector have been found which provide operator and owner information. Eight of these sources responded with detailed information in response to a request for proposal. Contracts were issued to three of these companies: Lundkvist Aviation Research, Bucher Publications, and Forecast International. The contracts permitted a detailed evaluation of the content and structure of each firm's data and technical assistance.

Comparisons were made for an inventory of the aircraft operator data provided by the three separate data suppliers for 10 different models of aircraft. The models were selected to represent a broad range of air carrier, commuter/regional, corporate, and rotorcraft aircraft models. Each of the data suppliers provided good coverage for the air carrier aircraft. The data provided by Lundkvist Aviation Research were the most complete and recorded the history of each airplane (no rotorcraft). The information provided by Bucher Publications consisted of all commercial aircraft, 3,000 pounds and above. Forecast International supplied similar information including the addresses of the operators of aircraft and extensive engine information.

Commercial data suppliers are a viable source for the names and addresses of operators. Results of the search for available operator data from data suppliers, manufacturers, and other organizations indicate there are a number of data suppliers capable of providing the data in more detail and better scope than those now available to the FAA. However, no single supplier has all the information needed to obtain the desired coverage. Multiple sources of aircraft operator information are recommended. Areas where desirable information is not presently available are identified.

INTRODUCTION

The Federal Aviation Administration (FAA) has a continuing need to distribute timely airworthiness safety information to the operators and owners of aircraft with a United States Type Certificate. Timely notification of maintenance and repair issues and required modifications is one of the basic tenets of our eminence as a world leader in aviation safety. The FAA's Aviation Standards National Field Office (AVN) carries out this responsibility by reference to a United States Civil Aircraft registration list and several air carrier listings. The lists are not all-inclusive and considerable manual cross-checking is required. These manual processing methods are laborious, time consuming, and error-prone.

The major complicating factor regarding the timely distribution of airworthiness information is the fact that the U.S. Civil Aircraft Registry correctly records only the legal owner of the aircraft, which may or may not be the operator. The registered owner of turbine powered and large piston powered aircraft is often a financial institution. Further, subleasing practices often result in tiers of operators of an aircraft. The current operator, therefore, may not receive important airworthiness information. The methods presently employed by the FAA are not adequate to meet demands for current aircraft operator data.

This program (see reference 1) began with this 10 month effort (Phase I) during which a Master Requirements and Implementation Plan was developed and the evaluation of existing data bases was completed. Also included in Phase I was a feasibility demonstration in which a data supplier from the private sector provided aircraft operator data to selected FAA offices on a telephone call-in basis. An examination of the logs of the telephone calls contributed to the determination of the requirements of the FAA for aircraft operator data. Phase II will consist of the development, testing, and operation of an International Aircraft Operator Information System. At the end of the second phase (a 23 month effort), an operational system will be delivered to the FAA.

The FAA contracted with The National Institute for Aviation Research of The Wichita State University (WSU) to develop a Master Requirements and Implementation Plan, as well as to locate and to evaluate sources of aircraft operator data for the creation of an International Aircraft Operator Information System. Operator information was sought for all categories of civil aircraft. This report provides an evaluation of the sources of that information and was prepared as a part of the requirements of the contract.

SEARCH METHODS

As a result of the research performed during this first phase of the contract, a number of sources have been found in the private sector which provide aircraft operator and owner information. An extensive effort was made to locate these sources using phone calls, placing a notice in the *Commerce Business Daily*, seeking referrals from manufacturers, actual purchase and evaluation of the data of three vendors, and operation of a feasibility demonstration by a fourth data supplier.

INITIAL TELEPHONE SURVEY RESULTS.

The initial search for suppliers of aircraft operator data began with a review of indexes of the aviation industry (see reference 2). Using these as a starting point, referrals were obtained that resulted in prospective sources. Initial contacts were made by telephone, letter, and fax to obtain information describing the services of data suppliers. The full name, address, and telephone numbers are listed in Appendices A and B. The summaries included below are descriptions of the initial information obtained from data suppliers and aircraft manufacturers.

1. AERORESEARCH. Mr. Harry Smith, the owner, said in a telephone conversation that he no longer maintained a data base. Initially he had developed a data base of general aviation aircraft for subscription and resale to brokers. The data base is now inactive. Mr. Smith said he had difficulty maintaining up-to-date information because of the low rate of activity in used aircraft. In addition, used aircraft brokers and dealers would not provide information because they did not want the owners to be known by anyone but themselves.

His data base contained fewer than 12,500 aircraft. He estimated that at any one time there are from 17,000 to 18,000 aircraft on the market and in a "for sale" status. Information on many of the aircraft is difficult to obtain because corporations keep their ownership of aircraft private. Others register their aircraft out of state to avoid local taxes. Mr. Smith employs three people on a part-time basis.

2. AIR CLAIMS. Air Claims is the U.S. representative of Aviation Information Services, which is listed later. Mr. Fred Reardon indicated his data base was based on that of the London home office. Their data covers the active jet aircraft of the world, but "not necessarily the turboprops." This firm also tracks aircraft through foreign registries. They have data for a total of 9,100 aircraft. In addition to the 8,750 free world aircraft they have 350 aircraft from eastern block countries. Further, their data are available in hardcopy and on floppy diskette.

3. AMSTAT. In a telephone conversation, Ms. Debbie Hohorst, the Director of Research, said that this company does market research and tracks the owners and operators of turbine powered corporate aircraft up to the Boeing 737. She said they maintain a data base of 11,000 aircraft worldwide that includes the names and addresses of operators. They provide hardcopy versions of their data base and do not routinely give out an owner's list. Their primary interest is finding aircraft for sale.

On inquiry as to the content of their data base, she estimated that as many as 10 percent of the registered aircraft are registered with shelter organizations in Wilmington, Delaware. The largest of these shelter organizations is the Corporate Trust Center. Other aircraft are often registered in the states of Wyoming, Oregon, Nevada, and North Carolina apparently to avoid high sales and property taxes. Ms. Hohorst stated that Amstat has approximately 19 employees who work continuously tracking aircraft information and are meticulous in searching for operator information.

4. ANACOMP. This organization is a contractor for the FAA to provide U.S. Airman and Aircraft Registry reports and information to the general public in the form of Microfiche. The administrator is Ms. Laurie Turner who sent information on the types of data provided. She said that her organization receives requests for as many as 15 different reports. They cover the U.S. Civil Aircraft Registry, associated reference reports, and a weekly report of documents filed for recording in the FAA Aircraft Registry. This last report is followed by many of the data suppliers. The company would not, however, provide the names and addresses of their customers.

5. AVIATAS. A description of this company was given by Mr. Bob Minich, who conducts aircraft appraisals ranging from air carrier to commuter/regionals. Their data list totals about 7,000 aircraft. They are not the direct source for the data but use another service, whose name he did not reveal. Their main business is technical inspection for value purposes and inspection of maintenance capabilities of smaller operators. They also do future value forecasting.

6. AVIATION DATA SERVICES. Mr. John Zimmerman gave a description of his services in a visit to the office of Aviation Data Services. His company maintains a data base of operator information for turbine-powered aircraft located worldwide. The company's data monitoring activities are divided, with a separate individual responsible for turbojet and turboprop airplanes. Updates to their data are made continuously. Their electronic data base of operator information, at the time of the visit, was made up of 55,605 turbine powered airplanes and rotorcraft. They provide data on floppy diskettes, magnetic tape, or hardcopy. Historical data and older electronic data are maintained in printed form.

7. AVIATION INFORMATION SERVICES. A telephone call for information was made to Mr. Paul Hayes, Director of Accident Investigation. This firm is part of Airclaims and employs about 30 people. Aircraft in their data base were described as the more expensive turbine-powered aircraft. They also have a number of foreign aircraft registries.

8. AVIATION RESEARCH. The manager for this company is Ms. Vicki Grissom. They use their data to buy and sell aircraft. Their data consist of 13,000 to 15,000 airplanes and includes both turbojets and turboprops with the names of owners and operators. Data are collected by tracking lease arrangements.

Information in a brochure from Aviation Research showed a screen print-out of a transaction report for turbojets. This consisted of the following information: name and address of the owner, name and address of the seller, registration number, manufacturer, model, and serial number. Also included were the bill of sale date and the owner of the security agreement. Further, there were provisions for change of address, certificate of repossession, notice of name change, letter of de-registration, or termination of lease.

9. BEECHCRAFT. An inquiry was made by telephone to Ms. Shelley Huffman of Beechcraft Customer Service. She indicated that they use the U.S. registry to notify FAA registered owners and back up these mailings with their own personal list. This company has manufactured a large number of the world's airplanes. The size of their data base was not given.

Mr. Ernie Murray of Beechcraft, who works in the area of aircraft statistics and budgets, was also called. He said that some of the data they receive from data suppliers are only 10 to 20 percent accurate. He confirmed that they use the U.S. civil aircraft registry and spend up to one-half man days a week entering changes to maintain their files. Further, he pointed out that the registry can be as much as 90 days behind actual events. Manufacturers issue service instructions to those owners and operators on their listing - at least those they know about. When asked about other sources of operators of piston aircraft, he felt that virtually nothing in the way of a listing of operators exists.

10. BELL TEXTRON. An inquiry was made of Mr. Bob Davis, Manager of Customer Support, specifically to obtain the serial number sequence for the Bell Jet Ranger II helicopter. In discussing his company's data base, which is used for marketing purposes, he said there were several methods used to maintain current operator lists. For instance, when the buyer and seller gives notification of the sale of equipment, the company immediately corrects their records. In addition, dealers and company representatives, such as field service personnel, supply data. They are, therefore, able to maintain customer lists for sales and marketing purposes. They safeguard customer listings and restrict the release of their

names. Personally, he had no opinion on the accuracy of their aircraft operator data beyond the currency of the names of the customers.

11. BOEING COMMERCIAL AIRPLANES. An initial contact at Boeing Commercial Airplanes was made through Ms. Starr Tavenner, Director of Industry Communication. She said that they send service bulletins to owners and operators of Boeing airplanes. Alert service bulletins are used when the problem is more immediate and has a higher priority. There are thousands of service bulletins on some air carrier aircraft. For example, there are over 3,000 service bulletins on the Model 707 alone.

The Customer Support Group at Boeing states that they have extensive mailing lists which are automated in such a way that they can handle a large mailing in a matter of hours. In some cases, service bulletins may also be issued by the FAA as airworthiness directives. In turn, the airlines keep Boeing informed about their actions. Because of the size of their aircraft, they receive regular owner-operator reports. These data are stored in an extensive aircraft information computer system.

For more information on the Boeing data base of aircraft owners and operators, a call was made to Ms. Kay Martin of Boeing Customer Support Services. She said they have over 100 field service offices around the world to support Boeing commercial airplanes. They use special forms to indicate an airplane status change, the number of flight hours, and the number of take-offs and landings. In addition, Boeing Customer Services uses a number of basic sources to detect ownership or to find an unrecorded aircraft. Follow-up inquiries are made after any contact with an owner or operator. Typically these contacts are purchases and requests for service. Other sources are contracts, requests for configuration changes, software changes, sales contracts, and purchases of spares. Only one to two percent of the owners or operators of the airplanes they follow are unknown. Another source for their data is the U.S. registry and the registries of foreign countries. They deal with 105 regulatory agencies and are involved in an international notification process.

It was determined that Boeing also maintains an extensive data base of all of the turbojet aircraft in the world. These data are maintained by a Mr. William Frankoeur in Marketing Research. This source has a record of more than 10,000 commercial turbojet airplanes located all over the world and includes operator information. In a telephone conversation, he said he had a listing for every turbojet aircraft ever made with an accuracy of 99 percent. These are maintained in electronic files. However, there are no turboprop aircraft listed in these files. He gets some information directly from the company's data base for Boeing aircraft, which he estimates make up 60 percent of the world's airline fleet.

He indicated that he freely exchanges information with commercial data suppliers. He recommended sources for data on operators of commercial aircraft. These were Lundkvist Aviation Research, Federal Express, Bucher Publications, and Aviation Data Services. His contention is that the owners of commercial jets are most difficult to locate. The data he receives are condensed and segmented by operator. These are major airlines, national airlines, and others. This latter category consists of private owners, government agencies, manufacturers, and brokers. In addition, there are some military airplanes listed under the names of dummy companies. He further stated that he has information no longer available from other sources.

Electronic data files are not available outside the company, but the data is published each March as the *World Jet Inventory*. This document is available free of charge as a public courtesy. Boeing segments their data into categories of operator, airline (major, national, and others), model type, region, and others not airlines. This latter category includes private operators, government agencies, manufacturers, and brokers.

12. CESSNA AIRCRAFT. A contact at Cessna arranged referral to Mr. Pat Boyarski, manager of customer support for all Cessna Aircraft products except for those sold under the Citation name. They have an owner's advisory service which is maintained based on customer contacts and uses the U.S. registry. They estimated that they have a list of 120,000 aircraft of which 12-14 percent are multi-engine aircraft. Of these aircraft, Mr. Boyarski estimated that 80 percent of the owners are also the operators.

Jet aircraft is a separate division at Cessna. Several telephone conversations were held with Mr. Floyd Curtis at Cessna who was manager of customer support of the Citation jets. He suggested that the only way he knew to locate operators was to send a letter to the owner of the aircraft and request verification.

Cessna has a subscription program called CESCO with a membership of about 85 percent of the Citation jets, which amounts to a listing of the owners and operators of 1,500 airplanes. This is an active group of airplanes. As many as one hundred of these airplanes may be listed for sale at any time and about 150 change hands during a year.

13. FGL ASSOCIATES. Mr. Frank Lefebvre, president, described the content of his files by telephone. He had a list of corporate aircraft, but no air carrier or commuter/regional aircraft. His company tracks aircraft for currency by monitoring notices of bills of sale followed by a phone call to the company. In addition, he also tracks city and state registration lists. His listing, which also emphasizes non-commercial operators, contains 6,000 domestic companies. Long range plans are to include international operators.

His files are maintained on a personal computer with output on magnetic tape or floppy diskette. Two files are maintained, a file by company name and a file by aircraft. He estimated that they have 90 percent of the serial numbers. He further stated that all files undergo continuous revision and are completely updated using telephone calls every 7 months. His staff consists of 15 people, 3 of which are full-time. His service is on an annual basis for 8,500 to 17,000 names. A price was not available. Each month a basic new file is provided that is a revision of existing data. He appeared to be agreeable to maintaining additional aircraft categories for the FAA. He sent information and a diskette for our review.

14. FEDERAL EXPRESS. Mr. Phil Blum of Federal Express said his department keeps track of the commercial jet market for airplanes with 100 seats or more. In doing this he provides airplane market intelligence for the company in a joint effort with Lundkvist Aviation Research in San Diego. Federal Express sells a directory of all the aircraft in the world fleet. He stated that he has people that he can call on all over the world. He said that the data he has obtained from other data suppliers is not accurate enough for his standards. His conclusions emphasized that data suppliers need a flexible data collection approach, that foreign contacts are necessary, and that they are needed in every country.

15. FORECAST INTERNATIONAL. Initially, contact was made with Forecast International by a telephone call to Ms. Donna Seminara of customer service who described a number of capabilities of this firm. Special studies, custom research, and aircraft forecasting were some capabilities mentioned. They have access to extensive information stored in electronic data bases. She stated that they receive information from 260 military and civilian information sources worldwide. Their civil aircraft inventory, at that time, used information from Data Resources Incorporated (DRI) according to the World Aviation Directory (see reference 2).

16. INSURED AIRCRAFT TITLE. The following information is the result of a telephone conversation with Mr. Larry Smith of Insured Aircraft Title Company of Oklahoma City. This company has the entire listing of U.S. Type Certificated aircraft registered in the United States. These are available as computer print-outs and on floppy diskettes. Because of the large number of disks, subsets of the data are often provided, on request, instead of the entire data set. For the most part, there are no phone numbers or names of principals within the organizations. One of his company's functions is also to provide mailing lists for sales of aircraft. The charge for any subset of the data involves a \$50 setup charge and 2.75 cents for each name.

According to Mr. Smith there are 294,396 civil aircraft in the most current registry (June 1989). Of these, 224,549 are fixed wing aircraft and 11,574 are rotorcraft.

Mr. Smith also said his organization will do everything short of manual manipulation to correct the U.S. registry data. This eliminates many inconsistencies without large labor costs. His company's contribution is in the form of data formatting, elimination of duplications and errors, keeping lists, and grouping. He says they are able to provide a service because the registry acts independently and as a recording agency only.

17. JETNET. Mr. John Huber was the first contact at Jetnet. He said their primary business is tracking sales data on executive aircraft to find those available for sale. Their basic data are for aircraft defined as "middle-size and up". Part of these aircraft are from foreign registries, which he uses to update his records. This company consists of 23 researchers. In order to quickly supply names and available aircraft to dealers, each dealer is supplied with a HP Vector CS Computer and a 3 foot in diameter satellite disk.

In a return call, Ms. Mary Ann Huber further described the capabilities of her company. Her employees number 23 people. They follow the registries of 45 foreign countries. She described her data base as consisting of 14,000 corporate and private aircraft. These are "jets and turboprops, but no piston-powered aircraft". They use extensive phone inquiries to locate the operators of these aircraft. To maintain currency, each owner is contacted monthly. Further, they have developed a unique 17 step process to locate the operators of hard to find aircraft. If the information is not listed on the registry their procedure is to inquire at other possible sources until they either locate the operator or have completed all of the possible steps. In this way they locate operators and owners not available through a single source.

18. LEARJET. A call to Learjet customer services resulted in contact with Ms. Sharon McDonald who described their mailing list as essentially the same as the registry and for Learjet employees use only. In response to inquiries about the sources for their data she mentioned they had used Aviation Data Services on occasion.

19. LUNDKVIST AVIATION RESEARCH. Mr. Bo-Goran Lundkvist of Lundkvist Aviation Research indicated in a telephone conversation that he had a data base of all air carrier and corporate airplanes with all air carriers down to those with 15 to 18 passenger seats and all executive jet airplanes. For 32,000 active airplanes, he indicated he had information on current operators. Data available included the most current operator, line number, type of airplanes, type of engine, date of last transaction, and code indicators for the operator. Later examination of his data showed that a sequence of individual records and status codes are retained. These represent a history of each airplane. There is no address or telephone number for the operator or owner. Mr. Lundkvist does all of the resource work and has contacts throughout the world.

20. PIPER AIRCRAFT. Piper Aircraft maintains their own file of owners of Piper airplanes. Ms. Susie Luther, Director of Customer Service, provided some information about their aircraft data. They have used other firms to develop special computer programs, but maintain their files using their own information on owners and airmen. Piper extracts changes to the registry involving Piper aircraft using a custom computer program. The registry tape is run monthly using data provided by the FAA through Myriad Systems. They use a data base management program developed by SMS associates of Fort Lauderdale. This custom program extracts the monthly changes to the aircraft of interest from the tape.

21. WORLD AIRCRAFT REGISTRIES. A telephone conversation was held with owner Mr. Lee Wonnacott, who has a data base of 45,000 to 50,000 aircraft including the cabin class twins. Some categories have 55-60 percent of the operators listed and some categories have only 15-25 percent. He felt that there were some real problems with the registry and that as many as 15 to 20 percent of the addresses are "bad". A larger problem, according to him, is accounting for airlines and owners of aircraft that have several lease agreements.

He priced his services at \$650 per year by modem. His only condition was that there be no access by other data suppliers. He said that his world aircraft registries sell for about 12.5 cents for each record. To protect his data base, he said he would "hold back some codes". Further, he stated that his data is unique in having fax numbers.

PROPOSAL INFORMATION RECEIVED.

Operator information was sought for all categories of aircraft with a U.S. Type Certificate, not just those operating in the U.S. civil fleet. These aircraft included those certificated under reciprocal agreement. Also included were U.S. manufactured aircraft of foreign registry operating in the United States, public service aircraft, and transitional aircraft that are not listed on the U.S. Registry. Competitive bids were requested from data suppliers to obtain data for detailed evaluation, receive technical advice, and provide for operation of a feasibility demonstration.

Requests for proposals were solicited after preparation of a bid package for the data subcontractors. A draft of the bid specifications was prepared by WSU staff and a meeting was held with Mr. Gary Frings, Program Manager, Flight Safety Research Branch (ACD-230) and Mr. James Vaughan, Branch Manager, Engineering and Manufacturing (AVN-110) of the FAA to review and modify these specifications. A full set of specifications was completed as well as a short version for inclusion in the *Commerce Business Daily* (CBD). At the time of the announcement, a basic bid package was sent to known potential bidders. Later, a complete bid package was

sent to all known data suppliers and any organizations which responded to the announcement. Names and addresses of companies which were sent bid packages are listed in Appendix A.

The paragraphs below summarize the information received from the data suppliers. (November 1, 1989) in their responses to the request for bids.

AIRTRACK. This company responded with a bid on both parts of the request for proposal (RFP). They listed four personnel as members of the company. Sample data provided with the bid listed the owner only and did not list the operator. The data did, however, provide for a contact name. The data consisted of the manufacturer, model, and series code similar to that used by the Civil Registry. Price for access to the data was \$500 for the basic service and \$50 a month for revisions and updates. Categories listed were corporate jet, cabin class piston-powered twin-engined aircraft, and turbine and piston-powered helicopters. A sample data disk was provided.

The table of the aircraft available from Airtrack shown below summarizes the number of aircraft by category that they provided in their response to the request for proposal.

TABLE 1. AIRCRAFT BY CATEGORY - AIRTRACK

Category	Number
Corporate Jets	12,542
Piston Twins	14,396
Helicopters	16,886
Total	43,824

AVIATION DATA SERVICES. The aircraft categories available in electronic files were: air carrier aircraft worldwide, all corporate jets and turboprop aircraft worldwide, and all civilian helicopters worldwide. The cost quoted for access and file maintenance was \$262,640. The contents of the electronic data file included the name and address of the operator, the name and address of the owner, aircraft designators, and other information. They use various codes to indicate data sources and times of entry. The personnel section listed 13 key personnel, three of whom were directly involved in the day-to-day research activities. The response states hardcopy data on all multi-engine and single-engine piston aircraft used by airlines, brokers, dealers, manufacturers, and travel clubs. The response also states to have 80 percent of all civil aircraft of record worldwide in hard copy. This company was selected to provide service for the feasibility demonstration.

TABLE 2. AIRCRAFT BY CATEGORY - AVIATION DATA SERVICES

Category	Number
Turbine Air carrier	27,360
Turbine Fixed Wing	14,505
Corporate Helicopter	18,776
Total	60,641

BUCHER PUBLICATIONS. The information provided in the bid response did not break out aircraft by categories. The information provided did, however provide a list of aircraft with total numbers and operators. In addition to Mr. Bucher, the personnel description listed an editor, manager of research, two part-time editors, and a data processing expert on staff. No price was quoted for an examination copy of the data base, except for a consulting fee and expenses. The data base is divided into an airline and fleet data base. Also provided in the data, were a single company name and extensive country codes. In addition, the data format also listed IATA Code, ICAO code, telex and fax number. This company was selected to provide data for detailed evaluation.

TABLE 3. AIRCRAFT BY CATEGORY - BUCHER PUBLICATIONS

Category	Number
Air Carrier	11,945
Other Commercial Aircraft	25,109
Total	37,054

EXECUTIVE AIRCRAFT HISTORIANS. This company's response to the RFP listed four personnel, none of whom were full-time. The response offered operator information on a proposed format for air carrier aircraft and a proposed review of European registers. There were no provisions for owners. The cost for approximately 16,000 aircraft on electronic data files, and other aircraft on hardcopy was \$30,500.

TABLE 4. AIRCRAFT BY CATEGORY - EXECUTIVE AIRCRAFT HISTORIANS

Category	Number
Turbojet Powered Air carrier	7,000
Turboprop Powered Air carrier	6,500
Piston Powered Air carrier	2,500
Other	24,000
Total	40,000

FORECAST INTERNATIONAL. This company delivered a complete two volume proposal. The cost for access to their data base was \$33,000 for 47,552 aircraft. The response listed six key personnel and a staff of twelve research and editorial professionals, five management information system professionals, and operations people. Data input, however, was primarily the responsibility of a single individual. In addition, the company maintained forecasting and engine data bases. The sample of the original data format provided by Forecast International listed operator addresses but no owner addresses. Aircraft information for their data base was collected by using extensive published sources and an annual mailing inquiry. Their proposal addressed the problem in filling gaps in data. This company was selected to provide data for further evaluation.

TABLE 5. AIRCRAFT BY CATEGORY - FORECAST INTERNATIONAL

Category	Number
Air carrier	18,783
Corporate	17,733
General Aviation	4,461
Helicopters	6,575
Total	47,522

JETNET. This company follows aircraft in an active, unique segment of the corporate aircraft group. The cost to access 12,525 aircraft was \$30,000. This included monthly updates for a 6 month period. The categories that were listed were corporate turbojet aircraft and turboprop aircraft. The staff was listed as 27 research personnel. Updating information was continuous and a complete cycle of their worldwide data for each airplane was made every 30 days. In addition to the owner and operator names and addresses, they maintain the name of the chief operating officer and pilot. Further, they contact 1,200 aircraft dealers and brokers, charter

companies, manufacturers, fixed base operators, and aircraft management companies biweekly. Estimation of the temporary gaps in their information at any given time was at 6 to 7 percent of these aircraft, but, that these gaps are addressed within two weeks. Within the last two years, they began maintaining a file history of aircraft transactions with cycle, equipment, and avionics information on each airplane.

TABLE 6. AIRCRAFT BY CATEGORY - JETNET

Category	Number
Corporate Jet	6,030
Corporate Turboprop	6,495
Total	12,525

LUNDKVIST AVIATION RESEARCH. The response to the RFP from this company was to bid only the first part to provide data for evaluation and technical advice. The cost for 27,050 aircraft and 5 months of revisions was \$28,800. His files were made up of approximately 175,000 historical records for these aircraft. Addresses of the owner and operator are not included, however, the name of the operator is given. Mr. Lundkvist has been in the business for over 22 years. He updates his data continuously with these incorporated revisions published as a new version each month. This company was selected to provide data for further evaluation.

TABLE 7. AIRCRAFT BY CATEGORY - LUNDKVIST AVIATION RESEARCH

Category	Number
Large Air carrier	10,800
Commuter/Air Taxi	5,500
Corporate Jets	6,900
Turboprop Aircraft	3,100
Large Piston Twin-engined	400
Others (Multi-engine Piston)	350
Total	27,050

WORLD AIRCRAFT REGISTRIES. This company has a system for access to a subset of the company files by modem. There was no direct quote for costs of accessing data files, but, the response restricted any data provided from being held in electronic form.

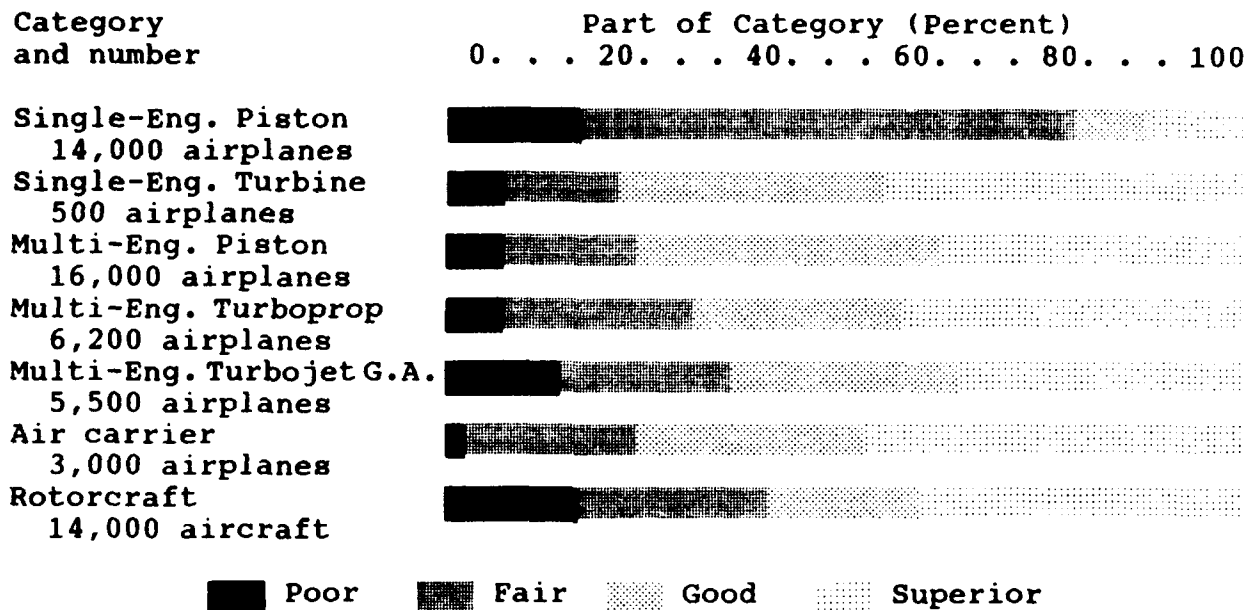
This restricted access to viewing these files. An extensive evaluation of the quality of their data subset data was provided. Quality was based on whether mail to an aircraft owner or company contact was deliverable. World Aircraft Registries employs three support personnel in addition to the owner.

TABLE 8. AIRCRAFT BY ENGINE CATEGORY -
WORLD AIRCRAFT REGISTRIES

Category	Number
ME Air carrier	3,000
ME General Aviation Turbojet	5,500
ME General Aviation Turboprop	6,200
ME General Aviation Piston-powered	16,000
SE General Aviation Turbine-powered	500
SE General Aviation Piston-powered	<u>14,000</u>
Total	45,200

ME indicates multi-engine aircraft
SE indicates single-engine aircraft

World Aircraft Registries provided information on the effectiveness of the address information in mailings to owners and operators of seven different categories of aircraft (Figure 1). This effectiveness is probably better than most. It does indicate the categories and relative gaps that exist in notification by mail.



The ratings are defined as follows:

Poor -

Where mail is known to be undeliverable, with no contact name or phone number available.

Fair -

Where mail is known to be deliverable but there is no contact name or telephone number on file.

Good -

Where mail is known to be deliverable and a name for a contact or telephone number is on file.

Superior -

Where mail is known deliverable and both a contact name and telephone or fax number are on file.

FIGURE 1. EFFECTIVENESS OF MAIL DELIVERY

DISCUSSIONS WITH DATA SUPPLIERS.

On site visits were made to three of the selected data suppliers by FAA Technical Center and WSU personnel. Each of these visits extended over a span of 2 days.

BUCHER PUBLICATIONS. Bucher Publications is located in Zurich, Switzerland. Representing the company were Mr. Frank Bucher, president, and Mr. Ronald Harman, a computer systems consultant from England. Mr. Bucher maintains a detailed data base of aircraft operator information for commercially operated aircraft worldwide and has worked full-time at developing this company since 1986. The manager of the data collection is Mr. U. Klee, who was not available during the visit. Their main product is an annual directory *JP Airline Fleets International*. This book is sold to aviation enthusiasts and companies worldwide, including Dornier and McDonnell-Douglas. Additionally, this book is sold to leasing companies, parts manufacturers, and dealers.

The data base contents are obtained from aircraft registries, aviation magazines, foreign correspondents, inquiries to airlines, and manufacturer's production lists. The data base contains listings for commercial operators, including smaller aircraft with gross weight above 3,000 pounds. Larger aircraft operated for dignitaries and governments are also included. Data base coverage includes eastern block countries, with the exception of some of the Russian fleet. Airplanes operated in Mongolia and China are also included. Mr. Bucher feels that as a private company located in a neutral country, they can obtain information not available to others, including that of other governments. An electronic copy of his complete data base was provided for evaluation.

Bucher Publications expects to begin a monthly update service beginning in 1990. Data accuracy is obtained by management of exceptions. Multiple sources are compared and differences resolved by noting information that is different from one source to another. All corrections and entries to the data are entered by a single individual, Mr. Klee. Versions of the data base exist in three different locations for security purposes.

FORECAST INTERNATIONAL. Forecast International is located in Newtown, Connecticut. Discussions with the company president and staff centered on the quantity, quality, and structure of their aircraft operator data base as well as a review of their capabilities, personnel, and facilities. Discussions also covered the subject of aircraft operator data, which was not available, as well as methods of improving the breadth and accuracy of the data available.

The capabilities of this company were impressive, especially in data processing, its viability, and in its other interests of technical forecasting and publishing. At the time of the visit,

Forecast International had just purchased the assets of another firm (DMS). The president, Mr. Edward Nebinger, said he had plans to hire additional staff members. He expressed an interest in providing the data requested, in participating in the feasibility demonstration, and, at some time, in administering the data base.

LUNDKVIST AVIATION RESEARCH. Lundkvist Aviation Research (LAR) is located in Poway, California, which is near San Diego. Program history and goals were discussed. Mr. Lundkvist then proceeded to describe the unique structure of the LAR data base. Mr. Lundkvist explained that multiple records for each aircraft provide a historical record but, in some cases, only the most current record is required. His approach to building his data base was to complete one aircraft model at a time. Some aircraft models are not covered because the data for them are incomplete.

He indicated that his aircraft data collection was aided by a large network of correspondents located in Europe, Australia, and Africa who have a personal interest in aviation. They supply information that may be included in his monthly magazine (Reference 3). Some of these data are also put into his electronic data base. He suggested that an advertisement in this magazine might provide access to other sources of aircraft operator data.

AVIATION DATA SERVICES. Aviation Data Services is located in Wichita, Kansas. Representatives of this company indicated that they maintain electronic files on turbine air carriers, turbine fixed wing airplanes, and corporate helicopters. They also maintain extensive paper files on the world's civil aircraft. Discussions were held concerning Aviation Data Service's ability to support the 24 hour per day telephone call-in service. This service relied on the electronic and paper files and on the knowledge and research skills of Aviation Data Service personnel.

DETAILED ANALYSIS

Data provided by Lundkvist Aviation Research, Forecast International, and Bucher Publications were evaluated for content by comparing the electronic data available from each of the data suppliers for 10 selected aircraft models. The FAA Aircraft Registry data base was also used.

EVALUATION TECHNIQUE.

Initially, the data bases of each of the three data suppliers were inventoried for 5 selected aircraft types. Manufacturers of the selected aircraft were contacted to determine the number and serial number range of the aircraft delivered. A master list was created from this information. A listing of current airplanes by model was compiled from the data provided by the data suppliers. The first 5 aircraft types on this list were the Boeing 757, the Cessna 550 Citation, the De Havilland DHC 6-300 Twin Otter, the Bell 206B Jet Ranger, and the Douglas DC-6. Thus, the study included a current air carrier airplane, a corporate jet airplane, a commuter/regional airplane, a commercial helicopter, and an older piston-powered air carrier aircraft.

The serial number and operator name for each aircraft were compared to the master list. The active aircraft were selected to exclude those which were awaiting delivery, on order, or in production. Each of the data suppliers had a status code which was used to eliminate undelivered aircraft from current ones.

The evaluation was made by model. Operators for each aircraft were compared side-by-side from the data base of each of the three data suppliers. A count of the number of active aircraft was made, which was followed by a list of exceptions. The exceptions list contained those aircraft of one data supplier not available in the data base of another data supplier.

MODEL COMPARISON.

In this section the results of a careful comparison of the contents of the data bases are discussed. The number following the aircraft model is the number of aircraft compared. At the end of this section a table is given (Table 9) which summarizes these results.

BOEING 757 (256). The comparison was made for the Boeing Model 757 using Boeing production line number designation as a reference because the serial numbers for this model were not consecutive. Serial numbers provided by Boeing were part of a block of serial numbers which included various other Boeing Models. Both Lundkvist Aviation Research and Forecast International provided line numbers which were numbered consecutively. The data from Bucher Publications had the fuselage number, which is identical to the line number.

Complete files of Lundkvist Aviation Research were selected for the last transaction file. When these files were further compared for active aircraft, consecutive line numbers were obtained for 256 aircraft which agreed with those given by Boeing. Using the line numbers from Lundkvist Aviation Research as the standard, lists from Forecast International were compared for the same serial numbers with very good agreement for number of airplanes delivered, serial numbers, and operator names. For the last two aircraft by serial number, Lundkvist Aviation Research data showed they were in the possession of the broker and gave the name of the buyer, while Forecast International listed the buyer. All delivered airplanes listed by Forecast International or Bucher Publications were also listed by Lundkvist Aviation Research.

A review of the U.S. FAA aircraft registry data for the Boeing 757 indicated that, as expected, foreign owners are not listed. In addition, approximately 16 U.S. aircraft were not listed after being sold. These aircraft were sold for leaseback to the airlines. They were dropped from the registry when notified that the airplanes were for sale, and were not relisted. *This is an example of a deficiency in relying on the existing FAA registry for distribution of airworthiness safety information.*

CESSNA MODEL 550 AND 551 (613). For the Cessna Model 550 and 551, instead of a comparison with a standard list of serial numbers, it was also necessary to rely on manufacturer's line numbers to assure continuity because the serial numbers were not consecutive.

The analysis also covered the single pilot Model 551 version of the Citation Model 550. The Model 550 and Model 551 were sometimes converted to the other model. Each conversion resulted in a change in the serial number. Historical sequence data provided in Lundkvist Aviation Research files with line numbers were useful in following these changes (according to Mr. Lundkvist, the Cessna Citation and the Fairchild Merlin are the only two models of aircraft known to have non-singular serial numbers). The data from Lundkvist Aviation Research listed 577 active Cessna Citation airplanes, including some that were not known to the manufacturer. Forecast International had 61 Citation aircraft listed. For smaller airplanes, such as the Cessna Citation, the Bucher Publications data was also less complete. Many of the 613 Citation airplanes that were delivered are not commercially operated, but are part of the corporate and general aviation fleet. Therefore, Bucher Publications listed only 115 of these airplanes.

DE HAVILLAND DHC 6-300 TWIN OTTER (614). For analysis of the De Havilland DHC 6-300 Twin Otter, blocks of applicable serial numbers were obtained from the manufacturer. These made up a master list for this model. Lundkvist Aviation Research had records for 611 airplanes and Forecast International had serial numbers for 365, including one not on the master list. Bucher Publications' data showed 324 active airplanes.

BELL JET RANGER II (1507). For the Bell Jet Ranger II helicopter, Bucher Publications listed 670 of the 1570 helicopters of this model that have been made. The majority of these operators were located in foreign countries. A total of 217 were U.S. registered aircraft. The Forecast International data base had 499 helicopters, of these, 108 were U.S. registered. Lundkvist Aviation Research does not maintain data on helicopters.

DOUGLAS DC-6 (175). The inventory of the Douglas DC-6, as expected, showed that a large majority of these aircraft have been retired since production ceased in 1951. Serial numbers for these airplanes were obtained from a listing of McDonnell-Douglas aircraft (see reference 4). A total of 188 airplanes were initially built as the DC-6 and military versions C-118 and R6D-1. Twelve are shown to be active by Lundkvist Aviation Research, 4 are shown to be active by Forecast International, and 5 are shown to be active by Bucher Publications.

After a detailed analysis of these first 5 aircraft models, the comparisons were extended to include 5 additional models. The other airplanes selected were the Beechcraft Model 1900, the Falcon F20, the CASA Model 212, the Lockheed L1011, and the Convair-Allison Model 580. A summary of the results of the inventory for each of the aircraft follows.

BEECHCRAFT MODEL 1900 (74). The inventory was selected to include the basic model consisting of only the first 74 delivered. Data from Lundkvist Aviation Research listed 73 of these as active with 67 having U.S. registration numbers. The information from the data base of Forecast International had to be selected by serial number because some model numbers were not clearly defined as a 1900 aircraft. The names of the owners of all but 6 of the aircraft were the same as the operators. Bucher Publications listed 66 of this model and Forecast International listed 68.

FALCON F20 (487). A comparison of the operator data provided by Bucher Publications with the data from Forecast International was striking. The Forecast International data was similar to the data provided by Bucher Publications, except that foreign address numbers and United States zip codes were missing from the Forecast International data. The Bucher Publications data was more complete in terms of number of aircraft than the information provided by Forecast International. The Forecast International data base had only 53 Falcons. Lundkvist Aviation Research had historical records for 411 of the Falcons.

CASA 212 (448). In a telephone call, the U.S. representative for CASA said 448 of the Model 212 airplanes were produced. There were no records in the Lundkvist Aviation Research data base to indicate that the latest of these had been delivered. Lundkvist Aviation Research had records for 376 of these and listed 349 as active. A large number of the aircraft were contained in the Lundkvist

Aviation Research data base, but not in the Bucher Publications (137) or Forecast International (53) data bases. The missing aircraft were primarily in the military of foreign countries. Only 42 of the CASA model 212 airplanes had U.S. registration numbers.

CONVAIR 580 (175). Evaluating the data for the Model CV-580 airplane presented still another unique problem in accounting. This airplane is a turboprop conversion of two Convair piston-powered transports, the Model 340 and 440. The production list was obtained from Allison, the engine manufacturer who did the conversions, and retained their original Model 340 and 440 serial numbers. Lundkvist Aviation Research had data for 158 and listed 140 of these as still active airplanes. Bucher Publications listed 43 and Forecast International listed 35.

LOCKHEED L1011 (250). Lundkvist Aviation Research had a listing for 243 active aircraft of the total of 250 model L1011 units delivered by the manufacturer. For the data comparison of Model L1011 aircraft, the Bucher Publications data listed 191 active aircraft and Forecast International listed 169. The Bucher Publications data, on the other hand, did not have 52 recent transactions listed in the Lundkvist Aviation Research data.

SPECIAL COMPARISON.

A line-by-line comparison has been made to include an analysis of operator and owner data provided by the subcontractor for the feasibility demonstration. Aviation Data Services provided a listing of U.S. registered SAAP 340 commuter airplanes in response to an inquiry from the FAA in Brussels, Belgium. The names of the owners and operators provided by the subcontractor agreed with those of Lundkvist Aviation Research except for the name of one operator. This difference was minor. The Lundkvist Aviation Research data, probably correctly, listed an airplane owned by Air Midwest as leased to another airline. The agreement between data from Lundkvist Aviation Research and the data provided by Aviation Data Services was good. The same data from Bucher Publications was missing four corporate aircraft.

These data also illustrated the pervasiveness of fleet leasing. These 97 Saab 340 airplanes were part of the fleets of 14 different operators. Only six of these operators, however, were also owners of some or all of the aircraft in their fleet. The other owners were financial institutions and leasing companies.

RESULTS OF DETAILED EVALUATION.

Data base selection techniques were conducted on a personal computer to establish the status and to count the number of aircraft of each of the active models in the data bases of each of the three data suppliers. This method also produced a side-by-side

comparison of the names of the operators for each aircraft as well as a listing of exceptions, i.e. those aircraft in one of the data bases, but not in the other.

Lundkvist Aviation Research had the most complete records for all active air carrier airplanes. Their data did not list helicopters, operators and owners addresses, or telephone numbers. However, the completeness of their airplane data for each of the models permitted it to be used as the standard by which to measure the other data suppliers. The historical records and line numbers provided by Lundkvist Aviation Research were useful in tracking the conversion of aircraft with serial number changes, as was the case with the Cessna 550-551.

Analysis of the data provided by Bucher Publications indicated that it was also consistent and correct in detail for those aircraft covered. These data were limited to commercially operated (and some corporate and public) aircraft of 3,000 pounds and above. It does not provide either the name or address of the owner. The operator names and addresses are very complete.

The coverage of the data of Forecast International was similar to that of Bucher Publications. Their data base is still under development and lacks the accuracy and consistency of the other two data suppliers. The data provided by Aviation Data Service during the feasibility demonstration were comparable with that of the other three data suppliers.

In summary, comparisons have been made using an inventory of aircraft operator data provided by three separate data suppliers for 10 different models of aircraft. Aircraft models selected for comparison ranged from the Lockheed L1011 air carrier airplane to the Citation II corporate jet. Results of the inventory are shown in Table 9 for each of the three data suppliers. The aircraft models that were selected represent a broad range of aircraft.

Comparison of Number of Aircraft

Manu. Model	Boeing 757	Cessna 550/51	De Hav DHC6-3	Bell 206B	Dougl DC-6	Beech 1900	Falcon F20	CASA 212	Convair 580	Lockheed L1011
Delivered	256	613	614	1507	175	74	487	448	175	250
Lundkvist	256	577	524	none	12	73	411	349	140	243
Forecast	256	61	369	499	4	68	53	71	35	169
Bucher	253	115	324	670	5	66	137	80	43	191

Table 9 Inventory of Active Aircraft by Data Supplier

DISCUSSION OF RESULTS

Results of the research of available aircraft operator data indicate that there are a number of data suppliers in the private sector who are capable of providing the data in more detail and better scope than is presently available to the FAA. Combined with analysis, this leads to a number of conclusions about the availability, acquisition, and development of operator data for the International Aircraft Operators Information System.

AVAILABILITY OF AIRCRAFT OPERATOR DATA.

Data availability and cost of electronic data files have been addressed. Emphasis on electronic data files is consistent with the need to develop the data base as an electronic filing system. Data in electronic form is essential to employ modern data base management techniques, to provide rapid and flexible access, and to minimize the costs of implementation, operation, and maintenance.

No single supplier has been found with all of the aircraft operator data necessary to provide the coverage required by the FAA. Each has developed a collection of information for particular categories of aircraft that fit the criteria of what was practically possible and economically rewarding. The work involved in finding and recording the data is labor intensive. The skills and knowledge of at least one person in each company who has had experience with this aircraft data is very important. This fact limits the size of the data base a company can effectively maintain in the present market for this information.

Commercial availability of aircraft operator data reflects its economic importance. Air carrier aircraft comprise about seven percent of the active fleet of U.S. registered aircraft and compared to the information available for piston-powered aircraft there are extensive sources of operator data available for this relatively small portion of the universe. The operators of these aircraft, however, are more visible. Many are commercial operators and large corporations. The air carrier aircraft have a greater market potential in terms of their individual value and their capacity to operate efficiently over a longer range. Their reporting requirements are more strict. And lastly, this segment of the universe of aircraft is more volatile, with as many as 15 percent of the aircraft of certain classes changing operators in a given year.

The piston-powered general aviation aircraft universe is, on the other hand, much larger. Because of the large numbers, it remains an important part of the responsibility of the FAA. *Approximately one third of the airworthiness directives issued in 1988 were for aircraft certified under Part 23 (under 12,500 pounds gross weight) of the Federal Aviation Regulations, (FAR).*

There is a need for increased emphasis on the coverage of U.S. registered general aviation aircraft. This category is essentially a neglected one, compared to the data available for air carrier aircraft. There appears to be several reasons for this:

1. There is less information available on this category aircraft.
2. The universe is very large with no assurances that this category can be developed to any degree of completeness.
3. The operators of this category are diverse and not easily located.
4. Commercially, there is a much smaller demand for operator information in this category of aircraft.

Suggestions for the improvement of the coverage of operator information are listed later in the data development section.

ACQUISITION OF OPERATOR DATA.

Data suppliers have been identified who are interested in supplying aircraft operator information to the FAA. Each has data that represents value in a labor intensive business. The costs of the development of their data has been paid by the private sector.

Suppliers all have some characteristics in common that relate to their ability to effectively and economically provide data for the use of the FAA and other government offices. Commercial data suppliers represent a resource that can obtain aircraft operator data not readily available to the government.

Most of the data suppliers are small firms. Their data collection is usually centralized around an individual and, therefore, is consistent within itself. They often find they are most effective when they cover a segment of the universe of aircraft thoroughly with continuous updates to their data. They maintain low operating costs by calling on individuals in other locations, who provide specific information as an avocation or as a part-time job. Each data supplier discussed his company with pride in his accomplishments and had personal satisfaction in what he was doing.

DATA ACCURACY. An in-depth analysis has been completed for three data suppliers. This allows judgements about the accuracy of the data supplied by each. In a side-by-side comparison, data from Lundkvist Aviation Research were often used as a standard. In addition to being more complete, the information was also more accurate. In fact, it became evident that the commercial data were often more accurate than information from the manufacturer. The data from Bucher Publications had correct operator addresses, which are an important part of this system. The addresses had the complete numbers and format for both foreign and U.S. operators.

The accuracy of the data from Forecast International was similar to that of Bucher Publications. Forecast International was the only data supplier to provide the address of the owner.

DATA INTEGRITY. The manner and consistency in which data follows a given form is related to its ability to support data base functions. The form of the data from each of the three data suppliers was consistent within itself. Data items were assigned blocks in the record for each aircraft and this format was followed in a manner consistent with good practice (see Appendix C). Both the data from Lundkvist Aviation Research and Bucher Publications reflect the consistency that is attained when a single person makes all of the data entries.

Because of its excellent management information system Forecast International has the potential to provide good owner and operator data. Occasional inconsistencies were noted in the recording of the complete model number and serial number. Consistent data are necessary for the efficient operation of a computer based information system.

PROTECTION OF VENDOR'S DATA. Provisions are already in place to protect vendor's data when purchased by the FAA. A description of the FAA Regulations that apply to the rights of the public to have access to government records is described in the Public Availability of Information (see reference 5). The policy of the FAA is that all records of the FAA - except those that the agency specifically determines must not be disclosed in the national interest, for the protection of private rights, or for the efficient conduct of public business - are available for public inspection and copying.

Paragraph 3 of that document lists the records that may be withheld from disclosure. This includes the records described under the following paragraph:

"Those containing information the government has received or obtained from anyone, including an individual, a foreign nation, an international organization, a State or local government, a corporation, or any other organization, with the understanding, expressed or implied, that the information will be retained on a privileged or confidential basis. The following are examples of the types of records that fall under this exemption:

Commercial information such as research data, formulas, designs, drawings and other technical data and reports."

This represents only part of the information the agency must shield from the disclosure under the privacy doctrine.

DATA DEVELOPMENT.

Special steps are recommended to develop the data base of aircraft operator information desired to meet the requirements of the FAA. Data integrity and completeness can be obtained and improved by using available commercial data and the following program efforts:

1. Segmentation of the universe of aircraft into categories and seeking completeness and accuracy for the aircraft data within each category.
2. Advertising for operator data and emphasizing those categories, such as piston-powered twin-engine and single-engine general aviation aircraft, for which data have not been found.
3. Selection of an alternate supplier, if necessary, for corporate aircraft. The scope of this category would include all of the turbine aircraft available worldwide.
4. Make provisions for acquiring, changing, and updating data on a continuous basis. Establish standards for data suppliers.

UPDATE CYCLES. The most desirable data base would be updated and corrected on a continuing basis. The Lundkvist Aviation Letter for example, lists several thousand registration changes, aircraft casualties, and sightings from around the world each month. These sightings provide a unique reference as to the currency of data.

The best choice for an FAA information system is to make an update of the data from a data supplier each month. Lundkvist Aviation Research provides this choice. Their service provides the complete data base with changes incorporated. Monthly updates will also be available from Bucher Publications as of June, 1990.

COLLECTION ETHICS. The question of any problems with data collection ethics was discussed with each of the selected data suppliers in face-to-face meetings. Each discussion concluded that it was not an issue. There was no indication that the data suppliers, who often knew each other, were aware of any improper collection practices.

EFFECTS OF PENDING CHANGES TO REGISTRY PROCEDURES. Recent recommended changes to the procedures for improving the registration of U.S. aircraft, if implemented, would improve the currency of the U.S. registry. Pending changes to the registry, which improve disclosure, would aid in the collection of operator information.

The Notice of Proposed Rule Making (NPRM) described in Reference 6 amends the Federal Aviation Act of 1958 to "authorize and direct the administrator of the FAA to modify the aircraft registration system to more effectively serve the needs of buyers and sellers of aircraft, drug enforcement officials, and other users of the system." Seven abuses of the registry system were listed and proposed changes were outlined to locate owners evading identification, to provide more timely and accurate notice of transfer of ownership of aircraft, and to make changes in the practice of allowing temporary operation of an aircraft with a certificate of registration.

These changes, if implemented, would also improve the effectiveness of the collection of data by commercial data suppliers. This is true especially if a responsible individual is named in the registration as required by pending registry regulations. The data suppliers and manufacturers with current data follow the updates and registration changes on a daily or weekly basis.

CONCLUDING REMARKS

A number of existing commercial data bases of operator and owner information exist which could be utilized to provide the FAA with more accurate operator data to aid in the distribution of maintenance alert and airworthiness directives to aircraft operators and owners.

The universe of aircraft, which is a logical part of an international aircraft operators information system, is extremely large. The exact size is unknown, but is a population of well over 300,000 aircraft. A large number of the aircraft in the general aviation fleet are not presently a part of any commercial data base of operators. General aviation aircraft represent the largest segment of this universe based on estimates of the both the number of aircraft and the number of hours flown. Except for some high performance piston-powered and turbine-powered aircraft, information on these aircraft is not compiled in commercially available data bases. The only reference generally available is the U.S. Civil Aircraft Registry. The manufacturers do, however, maintain their own data bases of the aircraft they have manufactured and sold.

The operators of the commercial fleet including air carrier aircraft are well documented. This is a volatile market and it is difficult to follow the ownership of a small part of the universe of jet aircraft. Operator information for these aircraft is commercially available.

SUGGESTED SOLUTIONS AND OPTIONS.

Solutions to the problems of obtaining and developing a effective information system for notification of owners and operators of relevant safety information are related to sustaining sources for the data and developing data completeness.

DATA SOURCE LONGEVITY. Companies which supply operator and owner information are all small companies, most have fewer than 20 employees and gross incomes of less than \$500,000 per year. The conclusion is, it would be risky to rely on any single company to provide all the data to an important information system. While these companies are stable and have survived the most current downturn in the aviation industry, they may be more susceptible to adverse factors than most larger companies. All of the companies selected in Phase I for further evaluation, incidently, were also involved in a primary business of publishing.

These companies used their publishing to sustain their operations. Each of the selected companies that supplied data was apparently in good financial condition. In addition, each of these data suppliers had plans to expand.

DATA COMPLETENESS. Interest on the part of the FAA in purchasing aircraft operator data has increased the efforts of companies to further develop their data bases. Each of the three data suppliers was interested in expanding and maintaining the completeness of his data base. Continued sources of these data would more likely be assured if there was a stable demand, fair opportunity to compete, and use of multiple sources of operator information.

SUMMARY

The U.S. Civil Aircraft Registry maintains data for only the owners of U.S. registered aircraft. In order to provide operator data to the FAA, sources were sought for private suppliers of aircraft operator data which could support an International Aircraft Operator Information System. The initial search began with a review of the indexes of the aviation industry and proceeded with telephone contacts and other referrals. Competitive bids were sought from data suppliers to obtain data for detailed evaluation, receive technical advice, and provide for the operation of a feasibility demonstration. After careful evaluation, three data suppliers were selected as subcontractors to supply data: Bucher Publications, Forecast International, and Lundkvist Aviation Research. The entire data base of these companies was provided. Aviation Data Services was selected to supply the feasibility demonstration. All of the data suppliers were visited in order to evaluate their capabilities and to seek their advice on how to best use their data to meet program objectives.

Data supplied by the subcontractors were evaluated for accuracy and content by comparing the data for ten representative aircraft models. A list of serial numbers for each aircraft model was obtained and operator names and addresses, along with other information for each aircraft, were prepared for side-by-side comparisons. This permitted a test for both the completeness and accuracy of the data bases. Other computer reports were also prepared for this purpose.

Results of the research indicate that there are several private companies which could supply portions of the data required to operate an International Aircraft Operator Information System. However, there is no single data supplier which would be able, at the present time, to supply all of the operator information required by the FAA. Each company has its own unique capabilities and specialties. Most of the data suppliers are small firms with fewer than 30 employees. Their data collection is usually centralized around a single individual and is, therefore, consistent within itself. This limits the size of the data base that a small company can maintain.

Lundkvist Aviation Research was found to have the most complete records for all of the larger airplanes. Their electronic data included a complete history of each airplane. A separate record is created each time a significant activity occurs in the life of the airplane. Their data included the name of the operator of the aircraft but no addresses or telephone numbers. Their data did not include helicopters.

Bucher Publications had electronic data for all of the commercial aircraft with gross weight of 3,000 pounds and above. Also included were some public and corporate aircraft. These data included the full names and addresses of the aircraft operators.

The coverage of the data of Forecast International was similar to that of Bucher Publications. Forecast International's data included full names, addresses, and telephone numbers of both the owners and operators. Their data base is still under development and lacked the completeness of the other data suppliers.

The feasibility demonstration contract did not provide access to the actual data files of the subcontractor and hence it was not possible to evaluate the aircraft operator data base of Aviation Data Services as thoroughly as the others. An examination of the telephone logs of the responses to the call-in service indicates that their data base is comparable with the other three.

There were some significant gaps in the data. None of the three data suppliers provided the operators of non-commercial turbojet aircraft. Improvements in the existing data bases are anticipated which should close this gap. More significantly, no suitable supplier of operator data for single-engined general aviation aircraft was identified. This category represents a large number of aircraft. It is anticipated that the requirement for general aviation operator data will result in a market for these data and the companies which presently keep general aviation data will add operators to their data bases.

Potential problems with protection of the vendor's data and data collection ethics were addressed. No problems of collection ethics were discovered. Limited license agreements and modern data base security systems can assure that a vendor's proprietary data are protected.

CONCLUSIONS

1. A number of commercial data bases have been found, each which could meet a portion of the FAA's aircraft operator data requirements as identified in the *International Aircraft Operator Information System Master Requirements and Implementation Plan* (see reference 7).
2. No single data supplier has been found which could meet all of these requirements, multiple suppliers are required. The utilization of multiple suppliers would permit the FAA to make use of the best features of each company as well as protect the FAA from being dependent on a single supplier.
3. The research carried out in Phase I of this effort has shown that the technical data processing problems associated with using multiple suppliers are manageable.
4. Gaps still exist in the data needed to develop the required information system. This program has already resulted in the creation of some of the missing data and the existence of a market for this data should have the result of closing all of the remaining gaps.
5. Phase I has shown that it is possible to make use of several competing data suppliers to provide information to the FAA. Possible problems associated with collection ethics and the use of proprietary data have been satisfactorily resolved.

REFERENCES

1. John J. Hutchinson and Frank H. Macheers, "Program Plan-International Aircraft Operators Data Base." Report DOT/FAA/CT-89/34, December, 1989.
2. *World Aviation Directory*, New York: McGraw-Hill, Volume 1, 1989.
3. *Aviation Letter*, Poway, California: Lundkvist Aviation Research, February, 1990.
4. Francellon, Rene. *McDonnell Douglas Aircraft Since 1920*, New York: Putnam Publishing Group, 1979.
5. *Public Availability of Information*, Order 1200.2, Department of Transportation, Federal Aviation Administration, April 7, 1969.
6. *Drug Enforcement Assistance; Notice of Proposed Rulemaking*, Federal Register, March 12, 1990.
7. John J. Hutchinson, Frank H. Macheers, Gary Ott, Raj Sunderraman, and John Ellis; "International Aircraft Operator Data Base Master Requirements and Implementation Plan." Report DOT/FAA/CT-90/17, August, 1990.

APPENDIX A

ORGANIZATIONS RECEIVING REQUEST FOR PROPOSAL

Copies of the request for proposal followed by copies of the FAA contract with WSU and other related information were sent to the following companies.

Aircraft Technical Publications

Attn: Mary Venturoni
101 S. Hill Dr.
Brisbane, CA 94005-1251
Phone: (415) 465-1705 Fax: (415) 468-1596

Airtract, Inc.

Attn: Glenn Wonnacott
200 S. 1st
Folkston, GA 31537
Phone: (912) 496-3504 Fax: (912) 496-7513

Amstat Corporation

Attn: Debbie Hohorst
P.O. Box 8908
227 E. Bergen Place
Red Bank, NJ 07701
Phone: (201) 530-6400 Fax: (201) 530-6360

AOPA Airsafety Foundation

Attn: John Carson
421 Aviation Way
Fredrick, MD 21701
Phone: (301) 695-2000 Fax: (301) 695-2375

ARC Professional Services Group

Attn: James R. Hefner
333 Salem Place
Suite 240
Fairview Heights, IL 62208
Phone: (618) 632-3365

Aviation Data Services, Inc.

Attn: John Zimmerman
P.O. Box 913
Wichita, KS 67201
Phone: (316) 262-1491 Fax: (316) 262-5333

Aviation Information Services, LTD

Attn: Paul Hayes
Cardinal Point, Newhall Road
Heathrow Airport Hounslow, TW6 2AS
England
Phone: (01) 897-1066 Fax: (01) 897-0300

Bucher Publications
Attn: Frank E. Bucher
P.O. Box 44
CH-8058 Zurich Airport
Switzerland
Phone: (01) 810-0311 Fax: (01) 810-8545

Executive Aircraft Historians
Attn: Alan S. Mawman
1 Thompson Drive
Thatcham, Berks RG13 4FJ
England
Phone: (06) 356-6929

Failure Analysis Associates
149 Commonwealth Drive
Menlow Park, CA 94025
Phone: (415) 326-9400 Fax: (415) 326-8072

FGL Associates
Attn: Frank G. Lefebvre
190 Lexington Avenue
Hackensack, NJ 07601
Phone: (201) 488-5442 Fax: (201) 489-7449

Forecast International
Attn: Ed Nebinger
22 Commerce Road
Newtown, CT 06470
Phone: (203) 426-0800 Fax: (203) 426-1964

Greco Systems
372 Coogan Way
El Cajon, CA 92020
Phone: (619) 442-0205 Fax: (619) 447-8982

Insured Aircraft Title Service, Inc.
Attn: Larry Smith
P.O. Box 19527
6449 S. Denning
Oklahoma City, OK 73144
Phone: (505) 681-6668 Fax: (405) 681-9299

Jack Faucett Associates
4550 Montgomery Avenue
Suite 300 North
Bethesda, MD 20814
Phone: (301) 469-3001

Jetnet, Inc.

Attn: Mary Ann Huber

258 Genessee Street

Utica, NY 13502

Phone: (315) 797-4420 Fax: (315) 797-4798

Lundkvist Aviation Research

Attn: Bo-Goran Lundkvist

13960 Carriage Road

Poway, CA 92064

Phone: (619) 679-0450 Fax: (619) 679-0607

NYMA

Attn: Kelly Webb

7501 Greenway Center Drive

Suite 1200

Greenbelt, MD 20770

Phone: (301) 345-0832 Fax: (301) 441-1012

The Washington Consulting Group

Attn: Teresa Stith

1625 Eye Street NW

Suite 214

Washington, DC 20006

Phone: (202) 457-0223 Fax: (202) 785-5141

Universal Energy Systems, Inc.

Attn: Imogene Hoffer

4401 Dayton-Xenia Road

Dayton, OH 45432-1894

Phone: (515) 426-6900 Fax: (513) 429-5413

World Aircraft Registries, Inc.

Attn: Lee Wonnacott

P.O. Box 66

Folkston, GA 31567-0066

Phone: (912) 496-3551 Fax: (912) 496-3244

APPENDIX B

OTHER ORGANIZATIONS CONTACTED

The following companies and organizations were contacted during the first phase of the program. They are listed here because each is involved in distribution of information and services related to aviation safety and most have other information related to aircraft operations and safety issues.

Aero Research Associates Inc.
Attn: Jennifer Roantree
1 Sintsink Drive East
Port Washington, NY 11050
(516) 883-5972

Air Britain Historians
Attn: Donald M. Hannah
England
(44) 7-783-3677

ANACOMP Inc.
Attn: Laurie Turner
1220 Soverign Row
Oklahoma City, OK
(405) 949-9090

Automated Sciences Group Inc.
Attn: Carolyn Frank
700 Roeder Road
Silver Springs, MD
(301) 587-8750

Aviation Advisory Services Ltd
Attn: John Fricker
Building 142
Oakland Airport
Oakland, CA
(415) 569-6985

Aviation Research
Attn: Vicki Grissom
6728 S. Meridian
Bethany, OK
(405) 681-0090

Aviation Research and Support Information Ltd
Attn: Andrew Murray
Rugby, England
(44) 78-854-0898

Browcom Publishers Ltd.
Attn: Bits Emma
Feltham, Mddx England
(44) 1-890-8933

Computerized Aviation Consultant Ltd. Inc.
Attn: Dr. George Radnoti
274 E. Lake Blvd
Mahopac, NY
(914) 628-4730

DATAQUEST
Attn: Carole Bender
1290 Ridder Park Drive
San Jose, CA
(408) 437-8000

Fu Associates
Attn: Barry Riegelhaupt
2030 Clarndn Blvd
Arlington, VA
(703) 243-2992

International Civil Aviation Organization
Attn: Statistics Section
Mohammed Murtaza
Montreal, Quebec
(514) 286-6292

Myriad Systems
Attn: Jane Bettes
3750 N. Interstate 44
Oklahoma City, OK
(405) 946-3395

TAI Inc.
Attn: Juan O'Calahan
181 Harbor Drive
Stamford, CT
(203) 323-2211

APPENDIX C

DATA STRUCTURE

The items in the table list the name and field size for each of the three data bases. The field size, in parenthesis, represents the width in characters.

REFERENCE LIST	FORECAST INTERNATIONAL	LUNDKVIST AVIATION RESEARCH	BUCHER PUBLICATIONS
MFG_CODE	ACMFG (30)	MFR (03)	*TYPE (40)[FL]
SERIES_CODE		TYPE (40)	*TYPE (40)[FL]
AIRFRAME_SERIAL	SERIAL-NUM(15)	CN (12)	SERIAL (15)[FL]
REGISTRATION-NO	REG-NUM (15)	REG (10)	EXREG (11)[FL]
OWNER_NAME	OWNER (50)	OWNER (40)	
OWNER_ADDR1	OW_ADD1 (30)		
OWNER-ADDR2	OW_ADD2 (35)		
OWNER_ADDR3	OW_POB (14)		
OWNER_CITY	OW_CITY (30)		
OWNER_STATE	OW_STATE (15)		
OWNER_ZIP	OW_ZIP (15)		
OWNER-COUNTRY	OWN_CTRY (30)		
OWNER_STATUS		OWC (01)	
OPERATOR_NAME	OPERATOR (50)	OPERATOR(40)	COMPANY (30)[AL]
OPERATOR_ADDR1	OP-ADD1 (30)		*ADD1 (30)[AL]
OPERATOR_ADDR2	OP-ADD2 (35)		*ADD2 (30)[AL]
OPERATOR_ADDR3	OP-POB (15)		*ADD3 (30)[AL]
OPERATOR_CITY	OP_CITY (30)		*ADD4 (30)[AL]
OPERATOR_STATE	OP_STATE (15)		
OPERATOR_ZIP	OP_ZIP (15)		
OPERATOR_COUNTRY	OP_CTRY (30)		COUNTRY (03) *
OPERATOR_TELEX	OP_TELEX (30)		TELEX (16)[AL]
OPERATOR_FAX	OP_FAX (40)		FAX (16)[AL]

APPENDIX C

DATA STRUCTURE (continued)

REFERENCE LIST	FORECAST INTERNATIONAL	LUNDKVIST AVIATION RESEARCH	BUCHER PUBLICATIONS
YEAR_MFG			YEAR (04)[FL]
AIRCRAFT_STATUS	PHASE (02)	C2 (01)	
ENGINES_TYPE	ENG_DESIG (25)	ENGTYPE (15)	*POWERED (20)[FL]
ENGINE_MFG	ENG_MFG (30)	ENGMFR (03)	*POWERED (20)[FL]
ENGINE_COUNT	ENG-QTY (02)		*POWERED (20)[FL]
IATA_2		L1 (02)	IATA (02)[AL]
IATA_3		L2 (03)	ICAO (03)[AL]
COMMENTS		REMARKS (34)	TEXTMEMO(10)[AL]
REMARKS			REMARKS (40)[FL]

* REQUIRED INFORMATION IS A PART OF ANOTHER ITEM
 [FL] INDICATES FLEET DATA BASE
 [AL] INDICATES AIRLINE DATA BASE