

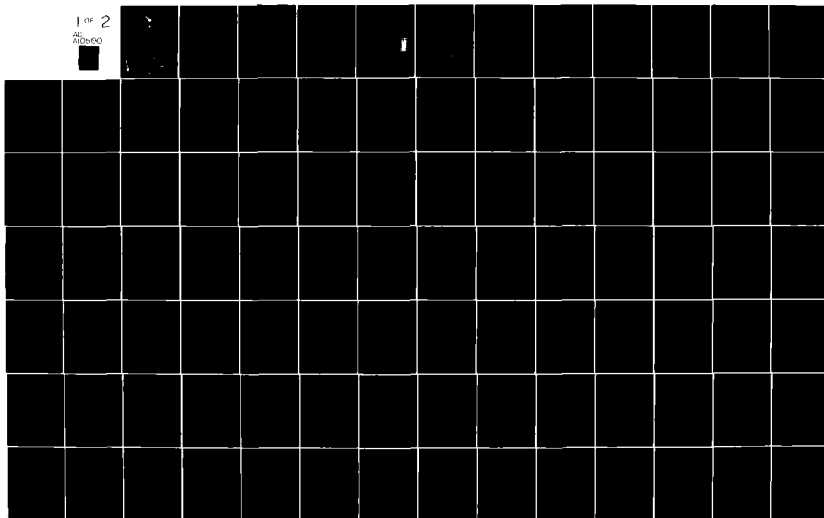
AD-A105 190

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/8 15/5
AN EXAMINATION OF SELECTED FORECASTING MODELS FOR PROJECTING LO--ETC(U)
JUN 81 W J MAGOWAN, T J RICHARDSON
AFIT-LSSR-25-81

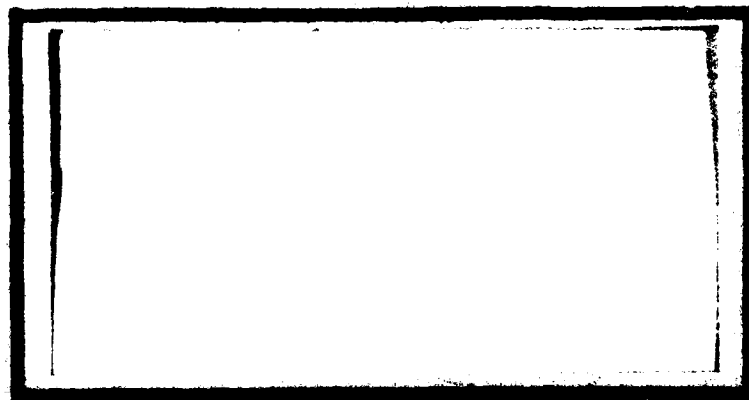
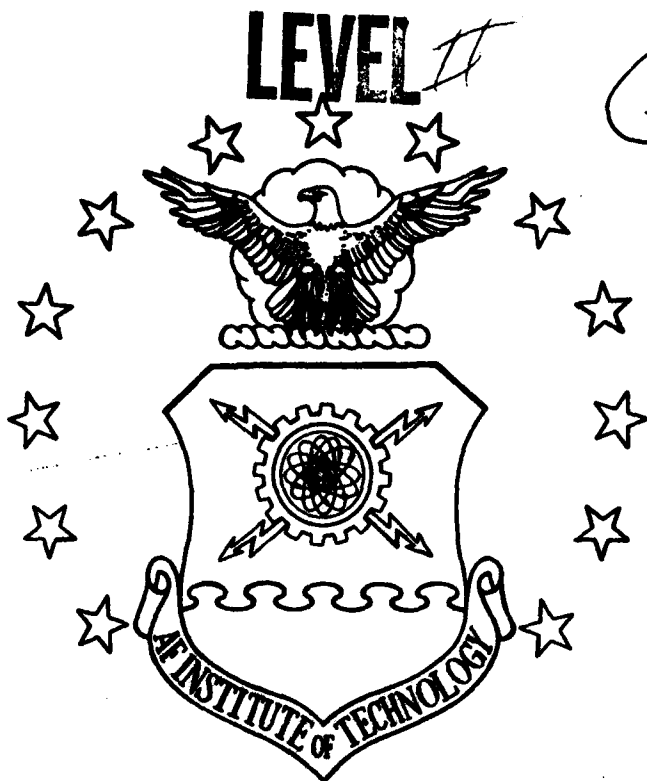
UNCLASSIFIED

NL

1 OF 2
AD
A105-00



AD A105190



UNITED STATES AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

This document has been approved
for public release and sale; its
distribution is unlimited.

DTIC
ELECTRONIC

OCT 8 1981

62 10 6 81

AN EXAMINATION OF SELECTED FORECASTING
MODELS FOR PROJECTING LOGAIR
UTILIZATION REQUIREMENTS FOR THE
5Q ROUTE

Captain William J. Magowan, Jr., USA
Captain Thomas J. Richardson, USAF

LSSR 25-81

Accession Form

NAME	_____
DATE	_____
TIME	_____
LOCATION	_____
DESCRIPTION	_____

Classification /
Priority Codes
Remarks /

A

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/LSH, Wright-Patterson AFB, Ohio 45433.

1. Did this research contribute to a current Air Force project?

- a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

- a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Can you estimate what this research would have cost if it had been accomplished under contract or if it had been done in-house in terms of manpower and/or dollars?

a. Man-years _____ \$ _____ (Contract).

b. Man-years _____ \$ _____ (In-house).

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

- a. Highly b. Significant c. Slightly d. Of No
Significant Significant Significance

5. Comments:

Name and Grade

Position

Organization

Location

FOLD DOWN ON OUTSIDE - SEAL WITH TAPE

AFIT/LSH
WRIGHT-PATTERSON AFB OH 45433
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. \$300



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 73236 WASHINGTON D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

AFIT/DAA

Wright-Patterson AFB OH 45433



FOLD IN

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER LSSR-25-81	2. GOVT ACCESSION NO. AD-A205190	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AN EXAMINATION OF SELECTED FORECASTING MODELS FOR PROJECTING LOGAIR UTILIZATION REQUIREMENTS FOR THE 50 ROUTE		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis
6. AUTHOR(s) William J. Magowan, Jr., USA Thomas J. Richardson, Captain, USAF		7. PERFORMING ORG. REPORT NUMBER
8. PERFORMING ORGANIZATION NAME AND ADDRESS School of Systems and Logistics Air Force Institute of Technology, WPAFB OH		9. CONTRACT OR GRANT NUMBER(s)
10. CONTROLLING OFFICE NAME AND ADDRESS Department of Communication and Humanities AFIT/LSH, WPAFB OH 45433		11. REPORT DATE June 1981
12. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES 134
14. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		15. SECURITY CLASS. (of this report) UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		17. DECLASSIFICATION/DOWNGRADING SCHEDULE
18. SUPPLEMENTARY NOTES 7. AUG 1981 APPROVED FOR PUBLIC RELEASE AFR 190-17 Air Force Institute of Technology (ATC) Wright-Patterson AFB, OH 45433 FREDRIC C. LYNCH, Major, USAF Director of Public Affairs		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) LOGAIR FORECASTING AIRLIFT FORECASTING FORECASTING MODELS FOR LOGAIR TRANSPORTATION FORECASTING MODELS--AIRLIFT AIR CARGO FORECASTING MODELS FREDRIC C. LYNCH, Major, USAF Director of Public Affairs		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Thesis Chairman: Thomas C. Harrington, Major, USAF		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 68 IS OBSOLETE

UNCLASSIFIED 042350
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

LOGAIR is an extensive, high speed transportation network utilizing a combination of military and civilian, air and surface transportation systems to reduce inventory levels and to reduce pipeline times of priority cargo between suppliers and user organizations. This study analyzed the historical data of a single branch of the LOGAIR system (the 5Q route) in an attempt to find a more consistent, reliable, and accurate means of forecasting daily, weekly, and annual LOGAIR base-level airlift requirements. An algorithm was first developed to convert the raw data into a usable format. This data was then analyzed using a number of relatively uncomplicated forecasting methods which are common to most user station computer systems. The models analyzed included the simple moving average, weighted moving average, exponential smoothing, and regression analysis methods. The models were then compared using the mean absolute deviation and tracking signal criteria to identify the best forecasting method. An examination was also conducted to detect any seasonal trends. The results indicated that very little correlation exists between the weight and time variables in the LOGAIR system; however, when these two parameters were considered, the simple moving average provided the best forecast.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

LSSR 25-81

AN EXAMINATION OF SELECTED FORECASTING MODELS FOR
PROJECTING LOGAIR UTILIZATION REQUIREMENTS
FOR THE 5Q ROUTE

A Thesis

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University

In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Logistics Management

By

William J. Magowan, Jr., BS
Captain, USA

Thomas J. Richardson, BS
Captain, USAF

June 1981

Approved for public release;
distribution unlimited

This thesis, written by

Captain William J. Magowan, Jr.

and

Captain Thomas J. Richardson

has been accepted by the undersigned on behalf of the
faculty of the School of Systems and Logistics in partial
fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

DATE: 17 June 1981


COMMITTEE CHAIRMAN

TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	vii
Chapter	
I. INTRODUCTION	1
Overview	1
Background	2
Problem Statement	14
Justification of Research	15
Research Objective	18
Research Questions	18
II. METHODOLOGY	19
Scope and Delimitation	19
Research Design	21
Data Source	21
Variables	21
Model Determination	22
Model Analysis	28
Limitations and Assumptions	30
III. DATA COLLECTION	31
Overview	31
Data Source Identification	31

Chapter	Page
Sample Data	32
Algorithm Development	33
Program Development	34
Nature and Limitations of Data	36
IV. RESULTS AND CONCLUSIONS	38
Overview	38
Faulty Records	38
Statistical Analysis	39
Simple Moving Average	40
Weighted Moving Average	41
Linear Regression	41
Exponential Smoothing	42
Mean Absolute Deviation	43
The Tracking Signal	44
Seasonal Analysis	45
Summary	45
V. RECOMMENDATIONS FOR FURTHER RESEARCH	48
Overview	48
Record Format	48
Use of the Algorithm	49
Data Trail	49
Variable Analysis	50
Relation to LOGAIR System	51
Summary	51

	Page
APPENDICES	52
A. SAMPLE DATA	53
B. PROGRAM AND ACTUAL DATA	59
C. SIMPLE MOVING AVERAGE	90
D. WEIGHTED MOVING AVERAGE	94
E. LINEAR REGRESSION	101
F. EXPONENTIAL SMOOTHING	106
G. MADS AND TRACKING SIGNAL	110
H. SEASONAL ANALYSIS	126
SELECTED BIBLIOGRAPHY	130
A. REFERENCES CITED	131
B. RELATED SOURCES	132

LIST OF TABLES

Table	Page
1. Composition of LOGAIR Traffic	3
2. Alphabetical Listing of LOGAIR "On-Line" Stations	5
3. Homestead AFB Florida HST	11
4. Schedule of Utilization of Allocations Requested	20
5. Algorithm Logic	35
6. Seasonal Analysis	46

LIST OF FIGURES

Figure		Page
1.	United States Air Force Logistic Airlift Route Structure	7
2.	5Q Feeder Route: (Warner Robins-Florida) . . .	8
3.	Off-line Service Provided by the 5Q Feeder Route	10

CHAPTER I

INTRODUCTION

Overview

The movement of repair parts from the supply or maintenance depot to user is a matter of critical importance throughout the Department of Defense. To aid in meeting this need, the United States Air Force has contracted commercial airlines to transport priority parts from its depots to installations throughout the Continental United States. This system of contract air freight is called Logistical Airlift (LOGAIR).¹

In any major transportation system, including LOGAIR, requirements projection is a significant factor contributing to overall management efficiency and effectiveness. However, Air Force policies and procedures have still not been fully developed to provide a standardized and reliable method for accurately forecasting cargo movement requirements. In addition, Air Force bases utilizing LOGAIR have developed their own independent forecasting

¹The United States Air Force's system of contract air freight is "LOGAIR." It is closely paralleled in structure and service by the United States Navy's system, "QUICKTRANS." The systems support and complement one another with independent, nonredundant routes (13:5).

techniques. As a result, daily, annual, and long-range forecasts of LOGAIR usage are often inaccurate and inconsistent (13:2). The purpose of this study is to investigate the problems associated with current forecasting procedures and to establish a methodology for developing an accurate model with which to forecast LOGAIR usage requirements for the 5Q route.²

The plan of development of this chapter is to first review the LOGAIR system. The review provides a general background and understanding of the concepts, vocabulary, and abbreviations used throughout the paper. Second, the problem statement is delineated. Third, an extensive justification of the stated problem is provided. Next, a specific statement of the research objective of this study is stated. Finally, the research questions pertinent to the stated problem are individually addressed.

Background

LOGAIR is an extensive, high speed transportation network utilizing a combination of aircraft and surface transportation modes (government and civilian trucks, buses, and autos) to reduce inventory levels and to reduce pipeline times between supplier and user organizations. It

²The LOGAIR 5Q route is the Florida feeder route flown from the Warner Robins ALC. It is described in detail in the background section of this paper (9:8).

is designed to insure operational readiness of the U.S. Air Force's first-line weapon systems through faster delivery of needed assets (13:2).

First-line weapon systems are those systems considered essential to the U.S. national defense and include tactical aircraft (A-7D, A-10, F-4, F-15, F-16, F-111), strategic aircraft (C-5 and C-141) and two legs of the strategic triad--the nuclear strike bomb force (B-52 and the supporting KC-135) and the Intercontinental Ballistic Missiles (Titan and Minuteman). These systems depend on LOGAIR to transport the large volume of spare parts necessary to maintain combat-ready status. As a result, a majority of the cargo is classified as high priority cargo by the Uniform Material Movement and Issue Priority System (UMMIPS) (17:7). The priority composition of LOGAIR traffic for FY 79 is shown in Table 1.

TABLE 1
COMPOSITION OF LOGAIR TRAFFIC

Priority Mix of Cargo	Percent of Transported Weight
999/Mission Capable--999/MICAP	13.9
Transportation Priority 1--TP1(01-03)	42.7
Transportation Priority 2--TP2(04-08)	39.8
Transportation Priority 3--TP3(09-15)	3.6

The LOGAIR system provides two general types of service; "on-line" and "off-line." The first, on-line service, is provided to those stations served directly by a LOGAIR flight. There are fifty-six on-line stations which are designated as either Air Force Logistics Center (AFLC) stations or as customer stations (see Table 2).

On-line service links these stations via nine trunk routes and seven feeder routes which are operated five, six, or seven days per week, as needed to meet requirements. Trunk routes are the core of the LOGAIR system and provide service to the Air Logistics Centers (ALCs), Wright-Patterson AFB, and the Aerial Ports of Embarkation (APOEs) (see Legend, Figure 1). The feeder routes are round-robin routes originating from the ALCs. They service a number of sequential customer stations and terminate at the originating ALC. An example of a feeder route (taken from the overall LOGAIR system in Figure 1) is the Warner Robins-Florida, 5Q³ route (see Figure 2). All of the on-line routes have been developed to ensure the fastest service (shortest intransit time) by considering the least number of transfers and the minimum hold time at transfer points (17:10).

Off-line support includes service to activities that are not part of the LOGAIR route structure, but which

³LOGAIR flight numbers are assigned by contractor, aircraft type, and flight route (16:6).

TABLE 2

ALPHABETICAL LISTING OF LOGAIR "ON-LINE" STATIONS

Station	Ident	Command
Barksdale AFB LA	BAD	SAC
Blythville AFB AR	BYH	SAC
Cannon AFB NM	CVS	TAC
Carswell AFB TX	FWH	SAC
Charleston AFB SC	CHS	MAC
Columbus AFB MS	CBM	ATC
Davis-Monthan AFB AZ	DMA	TAC
Dover AFB DE	DOV	MAC
Duluth Int'l Aprt MN	DLH	TAC
Dyess AFB TX	DYS	SAC
Eglin AFB FL	VPS	AFSC
Ellsworth AFB SD	RCA	SAC
England AFB LA	AEX	TAC
Fairchild AFB WA	SKA	SAC
F. E. Warren AFB WY	FEW	SAC
Grand Forks AFB ND	RDR	SAC
Griffiss AFB NY	RME	SAC
*Hill AFB UT	HIF	AFLC
Holloman AFB NM	HMN	TAC
Homestead AFB FL	HST	TAC
Jacksonville NAS FL	NIP	NAVY
Kessler AFB MS	BIX	ATC
*Kelly AFB TX	SKF	AFLC
Key West NAS FL	NQX	NAVY
K. I. Sawyer AFB MI	SAW	SAC
Kirtland AFB NM	ABQ	MAC
Langley AFB VA	LFI	TAC
Little Rock AFB AR	LRF	MAC

*AFLC stations.

TABLE 2--Continued

Station	Ident	Command
Loring AFB ME	LIZ	SAC
Luke AFB AZ	LUF	TAC
MacDill AFB FL	MCF	TAC
Malmstrom AFB MT	GFA	SAC
McChord AFB WA	TCM	MAC
*McClellan AFB CA	MCC	AFLC
McGuire AFB NJ	WRI	MAC
Minot AFB ND	MIB	SAC
Moody AFB GA	VAD	TAC
Mountain Home AFB ID	MUO	TAC
Nellis AFB NV	LSV	TAC
Norton AFB CA	SBD	MAC
Offutt AFB NE	OFF	SAC
Patrick AFB FL	COF	AFSC
Pease AFB NH	PSM	SAC
Peterson AFB CO	COS	SAC
Plattsburgh AFB NY	PBG	SAC
*Robins AFB GA	WRB	AFLC
Scott AFB IL	BLV	MAC
Selfridge ANG MI	MTC	ANG
Seymour-Johnson AFB NC	GSB	TAC
Shaw AFB SC	SSC	TAC
*Tinker AFB OK	TIK	AFLC
Travis AFB CA	SUU	MAC
Tyndall AFB FL	PAM	TAC
Whiteman AFB MO	SZL	SAC
*Wright-Patterson AFB OH	FFO	AFLC
Wurtsmith AFB MI	OSC	SAC

Log/IR

UNITED STATES AIR FORCE LOGISTIC AIRLIFT ROUTE STRUCTURE

EFFECTIVE 1 FEBRUARY 1960

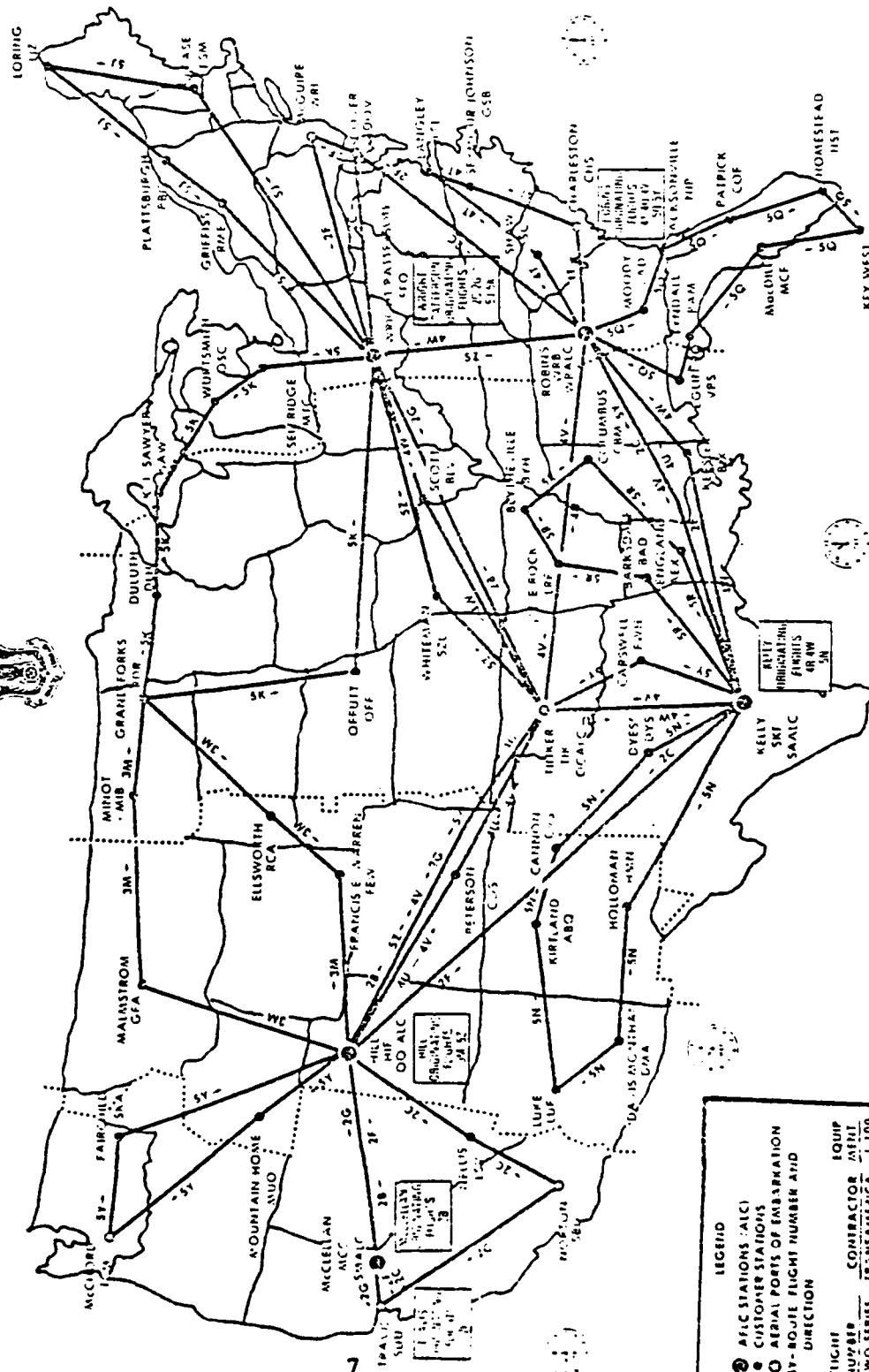


Fig. 1. United States Air Force Logistic Airlift Route Structure

LEGEND			
●	AFLC STATIONS (ALC)	FLIGHT NUMBER	EQUIP
○	CUSTOMER STATIONS	CONTRACTOR	AMT
○	AERIAL PORTS OF EMBARKATION	TWO SERIES	TRANSAMERICA
SY	ROUTE FLIGHT NUMBER AND DIRECTION	THREE SERIES	TRANSAMERICA
		FOUR SERIES	TRANSAMERICA
		FIVE SERIES	TRANSAMERICA

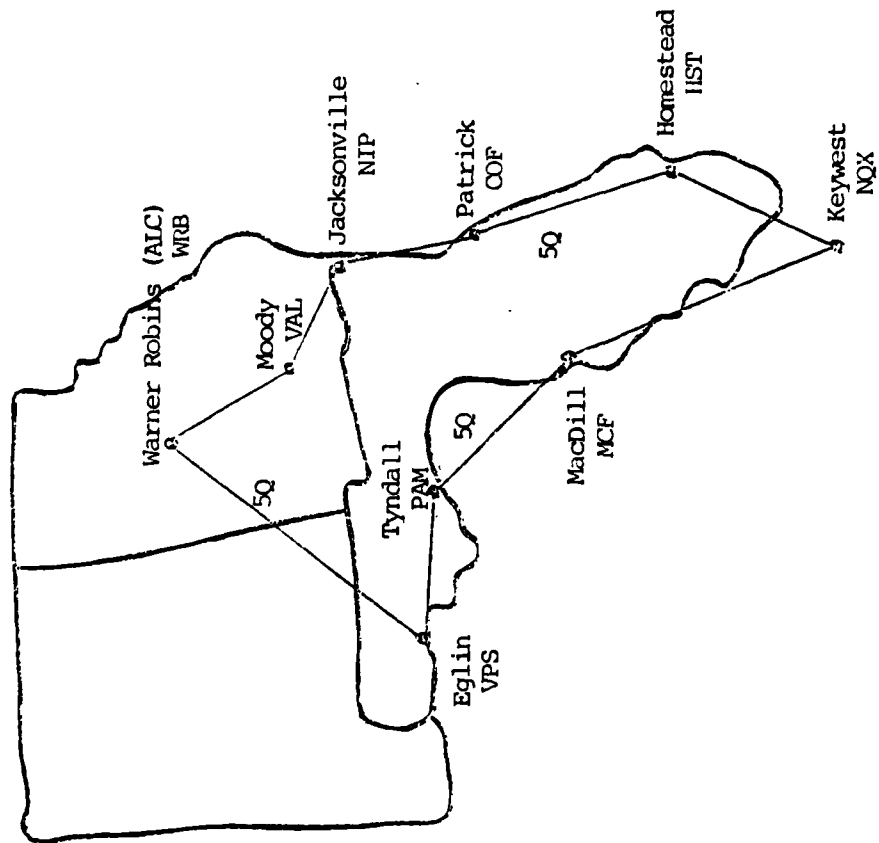


Fig. 2. 5Q Feeder Route: (Warner Robins-Florida)

are serviced by a LOGAIR station. There are over 900 off-line points and/or activities that ship and receive cargo via the LOGAIR system (14:90-170). To illustrate off-line support, Figure 3 shows the FY 80 LOGAIR feeder route on-line bases on the 5Q route. The number of off-line points, supported by each base via commercial transportation modes or government truck are shown in circles. These include other Air Force bases, guard and reserve units, radar sites, and contractor facilities (15:18). As an example, Homestead AFB Florida is listed as having thirteen off-line points. These individual points are listed in Table 3, with less than truck load (LTL) service available to each. All thirteen of these stations transport their shipments to Homestead AFB where they are then absorbed into the LOGAIR system.

Since the majority of the airlift provided on the complex routing network is for the movement of high priority traffic, LOGAIR serves the purpose much more aptly than alternative commercial methods. It provides not only more frequent but more reliable service to the desired destinations. In addition, the LOGAIR contracts require that the contractors grant the government the right to divert any trip to a route or area of operation as dictated by government needs (8:F-5). This type of flexibility could only be achieved through a system such as LOGAIR.

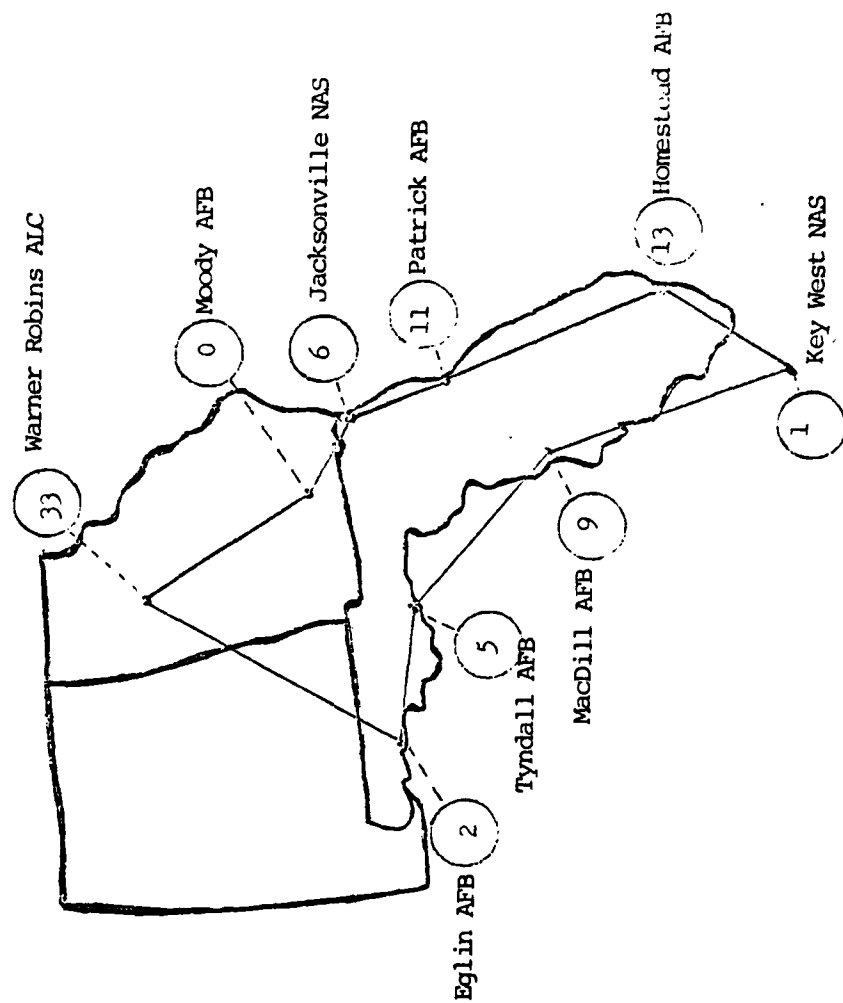


Fig. 3. Off-line Service Provided by the 5Q Feeder Route

TABLE 3
HOMESTEAD AFB FLORIDA HST

Off-Line Point	Method of Service	Frequency
Boca Raton FL	LTL	As Required
Boynton Beach FL	LTL	As Required
Ft. Lauderdale FL	LTL	As Required
Hialeah FL	LTL	As Required
Hollywood FL	LTL	As Required
Miami FL (And Greater Miami Area)	LTL	As Required
Opa Loca FL	LTL	As Required
Pompano Beach FL	LTL	As Required
Pratt & Whitney, West Palm Beach FL	LTL	As Required
Richmond Air Field FL	LTL	As Required
TUSA Logistical Support Facility FL	LTL	As Required
United FL	LTL	As Required
West Palm Beach FL	LTL	As Required

In addition to the high priority cargo movement, a great deal of hazardous material is transported by LOGAIR that could not be easily transported by other commercial means. The LOGAIR contracts state that the contractor shall transport hazardous materials in accordance with FAA or DOT Rules and Regulations or under Department of Transportation Exemption 7573 (DOTE 7573) (8:F-5). This exemption allows the contractor to transport explosives, chemical products, fuels, and classified material without the tremendous delays and bureaucratic headaches which would be encountered if these materials were transported by other means.

The contracts also serve to explain why these materials and spare parts are not transported on DOD aircraft. The first and foremost reason is due to the limited number of capable and available DOD aircraft. With the strategic airlift requirements, continuation training requirements, aircrew proficiency requirements, and periodic depot and maintenance requirements, Military Airlift Command's (MAC's) resources are currently 100 percent committed. In addition, if the United States were to enter into a foreign conflict, the MAC forces would be required to support the conflict, thus stalling the CONUS airlift system. The LOGAIR contracts alleviate this problem by requiring that the contractors allocate their contractually committed aircraft to the Department of Defense to

meet varying defense emergency needs for the civil airlift augmentation of the military airlift capability. The contractual commitment of the aircraft includes the supporting resources required to provide the contract airlift services. This clause in the contract makes LOGAIR the only active portion of the Civil Reserve Air Fleet (CRAF) and provides an extremely valuable and essential function which could not be achieved through other commercial or government transportation means (2).

The restricted routing, priority shipment movements, diversion flexibility, hazardous cargo shipment, and CRAF commitment all clearly show that the LOGAIR service is necessary and that "such necessity arises from genuine considerations of national defense" as stated in Justification for Negotiation exception 16 (18:J-200). However, emphasis must be placed on the need to negotiate with a particular contractor or contractors. In the case of LOGAIR, with its routes structured as they are and with the airlift requirements for frequent transport of oversized cargo (aircraft engines such as the F-100 engine for the F-16), the field of competitive contractors is greatly narrowed. Few modern aircraft lend themselves to cost-efficient operation synchronous with the current LOGAIR mission profile. The Lockheed Electra Freighter (L-188) and the Lockheed Hercules Air Freighter (L-100-30) are turbo prop aircraft which are more efficient in short haul,

low altitude service, characteristic of the LOGAIR system. They also have the required airlift capabilities and are not so outdated as to make maintenance prohibitive. As a result, these two aircraft types are the most logical alternatives for LOGAIR service. Unfortunately, only three companies, Hawaiian Airlines, Inc., Zantop International Airlines, and Transamerica Airlines, offer contract service with these aircraft (18:37). Thus, the need to negotiate with "a particular contractor or contractors" as stated in Justification for Authority to Negotiate (JAN) exception 16 becomes apparent (8:J200).

This review of LOGAIR highlighted the major features of the system and offered some explanation of why it exists. Further examination reveals that the overall LOGAIR system, with all of its complexities, is relatively well administered. The contracts provide a sound legal and administrative framework and the system is frequently reviewed and revised. However, even with constant monitoring there are still a number of problems in the system. As stated earlier, the purpose of this study is to examine one of these specific problems.

Problem Statement

At the present time, there does not exist a consistent, reliable or accurate means of forecasting daily, weekly, or annual LOGAIR base-level airlift requirements.

A need exists to examine the current data and, if necessary, to develop standard procedures for use by all LOGAIR stations to accurately forecast future requirements.

Justification of Research

Logistics Airlift has been the focal issue for a multitude of studies, audits, investigations and inquiries in recent years. The Defense Logistics Studies Information Exchange (DLSIE) alone lists more than twenty documents and studies germane to this particular topic. The organizations performing these studies include the U.S. General Accounting Office, the U.S. Office of Scientific Research, the Logistics Management Institute, Air Force Logistics Command, Air Command and Staff College, and the Air Force Institute of Technology. These reports cover many aspects of the LOGAIR system and address a variety of specific issues. Among the issues addressed are: Various Alternatives to the Logistical Airlift System, Present and Future Service Under the Changing Logistics Concept, The Feasibility of Developing and Solving a Model to Determine LOGAIR Routing Structures, A Computer-Assisted Method for Determining LOGAIR Route Structures, and an endless variety of additional topics.

Careful analysis and review of the material indicates that an overwhelming majority of the information is directed toward a relatively small area of concentration.

A preponderance of the studies centered upon establishing a computer model to create a more cost-effective route structure. Interest in this area was generated at the Secretary of the Air Force level in 1972 and continues to pervade the School of Systems and Logistics. Two Air Force Institute of Technology theses were written on the subject in 1980 alone (4; 6).

A second area of emphasis addresses alternate air carriers. These studies advocate possibilities ranging from the utilization of USAF C-130 aircraft in an organic military operation to deleting LOGAIR in favor of standard commercial air carriers utilized as needed for supplemental airlift.

Throughout this extensive literature review, only two sources were found that address LOGAIR forecasting and its associated problems. The first was a 1969 U.S. General Accounting Office study entitled "Management of the Logistics Airlift System Contracted for by the Air Force." Findings of this report indicated that annual LOGAIR cargo capacity requirements were not forecast accurately. More capacity was scheduled on some routes than was needed and other routes required more capacity than was scheduled. The report also made recommendations for reducing the cost of day-to-day operations (6:8). The second source which addressed LOGAIR forecasting was prepared by the Air Force Audit Agency in 1978 and is entitled "Effectiveness of the

Operational Support Provided by the Logistics Airlift (LOGAIR) System." The audit evaluated the management effectiveness and efficiency of the LOGAIR system in providing logistics support to selected CONUS bases. Projecting requirements was a specific area of concern and was addressed to a great extent in the audit findings:

Daily, annual, and long range forecasts of LOGAIR requirements developed by bases have contained many inaccuracies. The annual forecasts of LOGAIR requirements submitted by most bases were rehashes of historical data originally provided by AFLC. This condition resulted because AFR 76-1, USAF Logistics Airlift (LOGAIR) Traffic Regulation, did not provide a uniform technique for forecasting LOGAIR annual and long-range requirements. Also, AFLCR 75-5, Airlift Requirements, provided general guidance only, and other MAJCOMs had not issued LOGAIR forecasting implementing instructions. Consequently each base developed its own technique, which led to inconsistent forecasting, exclusion of some airlift requirements, and duplication of other requirements. Inaccurate requirements can result in an ineffective route structure and procurement of too little or too much airlift capability [7:5].

Detailed evaluation of AFR 76-1 (including Change 2, May 80) and AFLCR 75-5 (30 November 79) revealed that the required guidance and techniques for forecasting LOGAIR requirements still have not been implemented. In addition, personal interviews were conducted with Mr. Jim Henderson, Traffic Manager, Airlift Branch AFLC (5) and Mr. Jack Fisher, Data Automation Center, Financial Systems Branch, Transportation Management Group, AFLC (3) to determine if a feasible solution to the forecasting problem had been derived. Results of both the literature review and of these interviews indicated that simple heuristic methods

of forecasting requirements are still being used and that changes are still needed.

Research Objective

The objective of this research is to examine the current LOGAIR forecasting system and, if necessary, develop a model to accurately forecast the daily, weekly, and annual, base-level LOGAIR usage requirements for the 5Q (Florida-Warner Robins) feeder route.

Research Questions

1. What is the current system of forecasting daily, weekly, and annual LOGAIR usage requirements?
2. What problems are being experienced with the current system?
3. Does a forecasting model exist that can be readily adapted to the LOGAIR situation?
4. Is sufficient current data available to use in a forecasting model?
5. Is the 5Q route representative of all of the LOGAIR feeder routes and the LOGAIR system at large?
6. If more than one forecasting model is available, which one provides the most valid and reliable representation of the actual 5Q route usage requirements?

CHAPTER II

METHODOLOGY

Scope and Delimitation

The research methodology required that the problem first be reduced in scope and size to a manageable level. With 56 on-line stations and over 900 off-line stations, the LOGAIR system was too large and complex to deal with in its entirety. AFLC estimated fiscal year (FY) 1978 utilization at 13.4 million plane miles flown and the transportation of over 125,000 tons of cargo at an estimated cost of \$49.1 million. If each of these stations were to operate 365 days per year handling just ten pieces of cargo per day, this would amount to approximately 3.5 million shipments per year. To analyze the data for the intended three years of this study would entail examining well over 10.4 million shipments.

To reduce the magnitude of this problem to one which better met the time and budget constraints of this study, it was determined that only the on-line routes would be studied. The problem was further reduced by limiting the study to the Florida Air Force base on the 5Q route.

The 5Q route was selected for this study for a number of reasons. First, it is generally a representative

feeder route in terms of number of stations supported and number of air miles flown. Second, the Air Force Audit Agency identified four (more than twice as many as any other route) of the bases on the 5Q route as having substantial deviations in the amount of allocation requested and the actual cargo shipped (see Table 4), thus indicating a clear need to study these bases and effect either a remedy or an explanation. Third, the data for this study was arranged by route location and the geographic proximity of the Florida bases to one another facilitated data acquisition. Fourth, the 5Q route has been relatively unaffected by recent funding cutbacks in the LOGAIR program.

TABLE 4
SCHEDULE OF UTILIZATION OF ALLOCATIONS REQUESTED

Base	LOGAIR Flight Number	Allocation Requested	Pounds Shipped	Percent of Request Utilized
Homestead	5Q	60,375	87,544	145.0
MacDill	5Q	156,000	56,580	36.3
Tyndall	5Q	7,200	72,754	1010.0
Eglin	5Q	91,269	76,143	83.4

A number of assumptions were made to further narrow the scope of this study. These will be addressed in the latter portion of the research design section.

Research Design

Data Source

The data for this study was based on actual, daily LOGAIR usage over the three-year period from 1977 through 1979. The data was initially recorded on a mandatory traffic record called a Flight Data Record, AF Form 295A. It provides the information necessary for computing aircraft space and weight utilization; preparing aircraft weight and balance reports; communicating arrival and departure messages; and preparing the Monthly Station Traffic Summary, AF Form 295 (12:p.3-3). This data is also programmed into the MILSTAMP 0004 computer record system and is retained on computer tape at HQ AFLC/LOTSL, Wright-Patterson AFB, Ohio. To facilitate computer analysis, the data for this study was extracted from the MILSTAMP 0004 system. Daily data was attained and cumulated to attain the weekly figures needed. The data was collected only for the pertinent bases on the 5Q route; specifically Eglin, Tyndall, MacDill, Homestead, and Patrick AFBs.

Variables

The variables of concern were the initial on-line shipment station, date of shipment, weight of cargo shipped and the destination station. This data, if available in the anticipated format, was to be stripped from the MILSTAMP 0004 computer record and stored on a file in the

ASD Control Data Computer (CDC) system for future analysis. If the data was not in the correct format, then an algorithm would be developed to extract the information. If data was missing or incomplete, as a last recourse, the data would have been fabricated using a random number generator to provide a data base to test the proposed forecasting models.

Model Determination

The purpose of this study was to identify a readily available and uncomplicated method for forecasting LOGAIR usage. The forecasting method was to be within existing USAF limitations and capabilities and was not to entail any extensive training or schooling for the potential base level user. As a result, the study was confined to those forecasting models common to most Air Force bases through the COPPER IMPACT⁴ system.

Within the COPPER IMPACT system, the study centered upon the statistical forecast development approach rather than upon a subjective or judgmental approach. The statistical approach involves quantitative analysis and is formulated on the assumption that historical performance is

⁴COPPER IMPACT is a comprehensive computer program package produced and owned by the General Electric Company. It is a versatile, user-oriented system for statistical data analysis which provides the capability to manage data via conventional, on-line operations. It allows the user to transform, select, sort and manipulate large volumes of data and to perform a large variety of statistical analyses quickly and with no programming (4:1).

indicative of future expectations. After the development of a statistical forecast however, the judgmental approach would be utilized to modify the forecast to reflect the expected influence of factors such as weapon systems changes, base closures, unit moves, and special projects or programs which might cause deviations in historical trends.

It has been recognized that the most common and relatively uncomplicated methods for developing a forecast from past data include simple moving average, weighted moving average, exponential smoothing, and regression analysis (1:231). As a result, data from each of the bases studied was analyzed using at least one of these forecasting methods. A total of five separate methods were tested. Each of these methods was available through the COPPER IMPACT system and, together, they provided an in-depth analysis of any weight versus time correlation or relationship in existence within the LOGAIR system.

The simple moving average was used to remove random fluctuations in the data in an attempt to detect any general trends in both daily and weekly LOGAIR usage. The moving average technique generates the next period's forecast by averaging the actual demand for the last n time periods and the choice of n being determined by experimentation. In this study, n was tested using 3, 4, 5, 7, and 10 point periods. The objective of the moving average was

to include a sufficient number of time periods so that random fluctuations were cancelled, but few enough periods so irrelevant information from the distant past was eliminated. Mathematically, the simple moving average is stated:

$$\hat{Y}_t = \sum_{i=1}^n \frac{Y_{t-i}}{n},$$

where,

$\hat{Y}_t$ = forecast demand for period t ;

Y_{t-i} = actual demand in i , the period preceding t ;
and

n = number of time periods included in the moving average.

The weighted moving average method was used to "weight" the data to provide additional emphasis to specified portions of the data. A 15-term weighted moving average (Spencer Smoothing) method and a 13-term weighted moving average (Henderson Smoothing) method were both tested. Both methods include complex smoothing weight parameters developed from polynomial curves to account for irregular fluctuations in the data.⁵ Spencer smoothing is one method of eliminating the irregular component which is based on the assumption that the underlying movements of

⁵For a detailed discussion of Henderson and Spencer weights, see Computerized Economic Analysis by Salzman (11:74-93).

the series are not distributed. Henderson smoothing is a program which computes and prints Henderson moving average weights for any odd-length smoothing specified from 3 to 99 terms. Henderson's basic formula for developing weights for any number of odd terms minimizes the sums of the squares of the third differences of the weights. The number of terms is represented by $2m-3$. The first weight has $x=m-2$; the second has $x=m-3$; and so on to the middle-term weight where $x=m-m=0$ (11:88). Mathematically, this relationship is expressed as:

$$w(i) = \frac{315[(m-1)^2-x^2](m^2-x^2)[(m+1)^2-x^2][(3m^2-16)-11x^2]}{8m(m^2-1)(4m^2-1)(4m^2-9)(4m^2-25)}$$

where,

$i = 1, \dots, m-1;$

$x = m-2, \dots, 0;$

w = weight of odd terms; and

m = middle term.

The exponential smoothing method was used to apply emphasis to the situation in which the past data was not given equal weight. The weight given to past data decreases geometrically with increasing time and more recent data is weighted more heavily than older, less applicable data. The exponential smoothing model assumes that some value (although possibly very little) remains in any datum and

appropriate weightings provide more accurate information than a model which totally eliminates old data (12:402).

Exponential smoothing uses a smoothing constant alpha (α) to determine the level of smoothing and the speed of reaction to differences between forecasts and actual occurrences. Any value between 0 and 1 can be assigned as the smoothing constant. This arbitrary value is determined by the situation and intuition as to what constitutes a good response rate (1:234). In this study, the COPPER IMPACT system performs a preliminary analysis of the data and calculates an optimum value of α . The general exponential smoothing relationship is expressed mathematically as,

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

where,

F_t is the exponentially smoothed forecast for period t ;

F_{t-1} is the exponentially smoothed forecast for the prior period;

A_{t-1} is the actual demand in the prior period; and

α is the smoothing constant between 0 and 1.

Linear Regression Analysis was also used in an attempt to accurately forecast LOGAIR usage. It is a computationally more difficult model which "regresses" one variable on another variable. The variable to be predicted (future LOGAIR shipments) was the dependent variable,

while the variable used in predicting (time) was the independent variable. Regression analysis by the least squares method was used to fit a straight line to a plot of data. The line fitted by this method produces a smaller sum of squared deviations about the line than the sum of the deviations about any other line (11:398). Mathematically, the expression for linear regression analysis is,

$$y = a+bx$$

where,

y = the dependent variable,

a = the y intercept,

b = the slope of the line, and

x = independent variable.

Seasonal demand patterns for the use of LOGAIR were also examined in the study. Although there was not an existing program within the COOPER IMPACT system to perform exponential smoothing with seasonal analysis, this LOGAIR traffic characteristic was considered important enough to merit further study. To facilitate this study, ten weeks of data from the 1977 records were randomly selected and plotted. These points were then compared to corresponding points in each of the subsequent years. This data was then carefully scrutinized to detect any obvious seasonal fluctuations. If any significant trends

had been identified, it would have justified the creation of a computer program to specifically examine the exponential smoothing with seasonal analysis option.

Model Analysis

To compare the effectiveness of each of these models, a number of tests were performed. The mean absolute deviation (MAD) was calculated to determine which, if any, of the previously described time series analyses provided the most accurate forecast of LOGAIR usage. The MAD is an objective function frequently employed to measure forecast error. This forecast error is the numerical difference between forecast and actual demand. Each technique was tested on the basis of the historical data, and the technique with the smallest MAD was to be selected as the forecast instrument (3-394). The MAD is described mathematically as,

$$MAD = \frac{\sum_{i=1}^n |\hat{Y}_i - Y_i|}{n}$$

where,

$\hat{Y}_i$ = forecast demand for period i ,

Y_i = actual demand for period i , and

n = number of periods.

The tracking signal, which measures whether the forecast average is keeping pace with any genuine upward or downward changes in usage (as differentiated from random changes) was then calculated (1:243). It was calculated by dividing the arithmetic sum of forecast deviations by the mean absolute deviation. The tracking signal is indicated mathematically by the equation,

$$\text{Tracking Signal} = \frac{\text{RSFE}}{\text{MAD}} ,$$

where,

RSFE = running sum of forecast errors, and

MAD = mean absolute error.

Acceptable limits for the tracking signal depend on the size of the demand being forecast and the amount of personnel time available to investigate large deviations (1:243).

The sum of the actual forecast errors in an ideal forecasting model would be expected to be zero. That is, random errors that result in overestimates of actual usage should be offset by errors that are underestimates. In the ideal situation, the tracking signal would be zero, indicating an unbiased model, neither leading nor lagging the actual demands (1:243).

Limitations and Assumptions

A number of limitations and assumptions had to be made concerning the significance of the 5Q route. First, it was assumed that the LOGAIR data in the MILSTAMP 0004 system was representative of the actual LOGAIR usage experienced at the respective bases. It was also assumed that the actual traffic within the 5Q route had remained free of external influences brought about by major funding cuts and system alterations. It was further assumed that no major weapons system or mission changes had occurred, thereby altering the demand patterns for LOGAIR usage.

CHAPTER III

DATA COLLECTION

Overview

At the outset, it must be recognized that the quality of the output of a system is directly contingent upon the quality of the input to that system. With this in mind, a distinction should be made clear between data and information. Data can be defined as the raw facts, figures, or observed characteristics about some occurrence from which conclusions may be drawn (9:6). However, until some analysis is made, data provides little usable information. Thus, the output of data analysis is information and this is useful in generating forecasts and making decisions (1:227).

Data Source Identification

The first step in this investigation involved the specification of the problem to be studied. From this specification came an identified need for a particular type of data and data format to study and analyze the problem (9:8). To develop and test a forecasting model for daily and weekly LOGAIR requirements, it was obvious that a history of previous actual requirements for the bases being studied would be useful. Further research

indicated that this data would be either partially or totally available on magnetic tape from the computerized files of the MILSTAMP 0004 system (see Appendix A). A three-year history was selected to insure a long enough time period for the collection of sufficient data to detect any trends within the system. The three-year history was, at the same time, of short enough duration to minimize the effects of major system and funding changes.

Sample Data

A sample of 100 records was then retrieved to allow examination of the record format and to insure that the desired data could be stripped from the overall LOGAIR historical files. An example of the raw data, the corresponding record layout (AFLC Form 7404), and a detailed data element description by position/block number are included in Appendix A.

Examination of this data indicated that the departure base, arrival base, and shipment weight were clearly identified. However, a potential difficulty was discovered concerning the "Flight Departure Hour/Date" element contained in data blocks 15 through 17. The hour of flight departure was identified by an alphabetic hour identifier in column 15 and the date was identified by only the last two characters of the Julian date in blocks 16 and 17. As an example, the first record in the raw data

sample identifies the hour and date of departure only by the three-character identifier "W51." This information was of little use since it not only failed to identify the year in which the flight occurred, but also failed to indicate whether it was the 51st, 151st, 251st, or 351st day of that year.

Further examination of the file indicated that each shipment was identified by a transportation control number (TCN) in blocks 30-44. Within each TCN, blocks 36-39 identified the four-digit Julian date on which the TCN was filed. Once again, referring to the first record in the raw data sample, the date on which the TCN was filed is "7217." This indicates that the TCN was filed on the 217th day of 1977.

Algorithm Development

Since over 56 percent of the LOGAIR shipments are at least transportation priority 1 (TP1), and over 96 percent of the shipments are transportation priority 2 (TP2) or higher (see Table 1, page 3), it seemed a logical assumption that a minimum of time would be allowed between the issuance of the TCN and the actual cargo shipment date. As a result, an algorithm was developed to translate the relationship between the "Flight Departure Hour/Date" element and the TCN shipment date into a Julian flight departure date. This date could then be used to compile

the remaining data for this study. The prevailing logic behind this algorithm is depicted in Table 5 and centers on the assumption that the actual shipment date will either be the same, or fall shortly after, the TCN date. Without accurate shipment dates available in the data base, the forecasting models would be inaccurate from the outset.

Program Development

Once the algorithm for determining the departure date was complete, a computer program then had to be written which included the algorithm and the capability to examine the entire magnetic tape file of data previously collected from the MILSTAMP 0004 system. This data then had to be sorted and compiled to provide the total weight shipped per base per day for each of the 5Q bases being studied. The program which provided date determination, data sorting and compilation is included in Appendix B.

This program was then verified using a dummy data deck consisting of 48 different combinations of bases, dates and weights. The dummy deck is included in Appendix B. The program ran as expected and correctly sorted and computed the desired data.

The actual data from the magnetic computer tape file was then run and the computer program provided a breakdown of total weight carried per base per day. This data is also contained in Appendix B. Observation of the

TABLE 5
ALGORITHM LOGIC

Given card columns (CC) 16-17 represent the day of shipment (example: 51) and CC 36-39 represent the four-digit Julian date of the Transportation Control Number (TCN) requisition date (example: 7217), the algorithm logic for every type of situation is illustrated as follows:

Case 1

If CC 16-17 is less than CC 38-39 and CC 37 is equal to 0, then the new shipment date is CC 16-17 + 100.

Example	CC 16-17	CC 36-39	New Shipment Date
	51	7052	7151

Case 2

If CC 16-17 is less than CC 38-39 and CC 37 is equal to 1, then the new shipment date is CC 16-17 + 200.

Example	CC 16-17	CC 36-39	New Shipment Date
	51	7152	7251

Case 3

If CC 16-17 is less than CC 38-39 and CC 37 is equal to 2, then the new shipment date is CC 16-17 + 300.

Example	CC 16-17	CC 36-39	New Shipment Date
	51	7252	7351

Case 4

If CC 16-17 is less than CC 38-39 and CC 37 is equal to 3, then the new shipment date is CC 16-17 + 1000.

Example	CC 16-17	CC 36-39	New Shipment Date
	51	7352	8151

Case 5

If CC 16-17 is greater than CC 38-39, then the new shipment date is CC 16-17 + CC 36-37.

Example	CC 16-17	CC 36-39	New Shipment Date
	52	7251	7252

Case 6

If CC 16-17 is equal to CC 38-39, then the new shipment date is CC 16-17 + CC 36-37.

Example	CC 16-17	CC 36-39	New Shipment Date
	51	7251	7251

data output indicates several serious deficiencies exist within the original data base. According to the data depicted, MacDill (MCF) for instance, failed to ship any cargo for the first 734 days of the study. Shipments gradually increased from that point and assumed a normal pattern by day 776. VPS, on the other hand, experienced normal shipments until day 403, at which time shipments declined rapidly. Then from day 433 until day 957, VPS reported zero shipments with the rare exception of an occasional small (less than 515 pounds) load. Finally, all of the bases reflected a large preponderance of zero records for the final sixty days of the study.

In an attempt to isolate the cause of the zero records, each step of the data extraction and manipulation process from the AFLC system to the CDC system was reevaluated. No discrepancies were detected during this test. As a result, the data for VPS and MCF was declared invalid and was deleted from further study.

Nature and Limitations of Data

These trends clearly indicate that the single greatest factor in determining the validity of any of the forecasting models in this study was the validity of the data used to generate the forecast. Therefore, a great deal of effort was expended to becoming thoroughly acquainted with the nature and limitations of the data.

The potential limitations were many and included imperfect or improper methods of data collection, recording, and classification; as well as errors of omission or commission when data was transferred from one record to another in its journey from the individual bases to the ALCs, to AFLC, to the MILSTAMP 0004 system, and finally to the data file for this study. As a result, all of the statistically-based conclusions in this study must be viewed with the nature and limitations of the data in mind.

CHAPTER IV

RESULTS AND CONCLUSIONS

Overview

Although the current method of forecasting LOGAIR usage is reportedly plagued with a number of inaccuracies and problems, a better method still has not been proposed. In accordance with AFCE 75-5, prior fiscal year reports (RCS:LOG-LO(M)7926) still provide a baseline from which to forecast the future LOGAIR needs, with allowances being made for weapons systems changes, base closures, unit moves, funding changes, or special projects.

The primary problems being experienced result primarily from a lack of reliable and accurate data from which to construct forecasts. This problem was identified in the 1978 Summary of Audit Report and it continues to be a major issue.

Faulty Records

There are a number of possible reasons for the large number of zero records from MacDill (MCF) and Eglin (VPS). First, the data may not have been entered into the system. Second, the computer system may have stripped this data from the files through an inadvertent programming error. Third, the record search which was used in this study may

have been in error and, finally, the data may have been altered in the records transfer process. Individuals interviewed by telephone at each of the bases refute the conclusion that the data was not entered into the system. The additional checks performed in the MILSTAMP 0004 system and the dummy run with the algorithm clearly indicate that the errors were not introduced at this level or in the transfer process. The possibility that the data was inadvertently stripped from the files would provide a logical explanation. However, this fails to account for the fact that the data starts and stops and appears to do so gradually, not abruptly as might be expected.

Possible solutions to this problem include a more detailed and stringent examination of the data files than that which is called for on a quarterly basis, as required by AFLCR-75-5. The AFLC should also consider more closely monitoring the initial data input to the system. As a final resort, the data could be compared to AFSC Form 295, historical data, on a regular basis.

Statistical Analysis

The overall conclusion from the statistical analysis of each of the forecasting methods indicates that weight of the goods shipped in the LOGAIR system is random and fails to display any significant trends or patterns. This further

indicates that there is very little correlation between the weight of goods shipped and time of shipment.

Simple Moving Average

The first statistical analysis undertaken with the aid of the computer was a simple moving average forecast. It was calculated using 3, 4, 5, 7 and 10 point periods. A total of thirty tests were performed using both daily and weekly data from the three bases with usable data. The computer was used to calculate the moving averages for the years of 1977 and 1978. These forecasts were then analyzed in comparison with the actual figures for the corresponding years. A ratio was then calculated by dividing the forecast quantity by the actual quantity shipped. To illustrate this method, the results of the four point moving average for the weekly data at Patrick AFB are included (see Appendix C). The ratios ranged in value from a low of .3 to a high of 747. Further, there were no obvious trends in the ratios. Ideally, the ratios should be reasonably consistent from day to day and close to a value of one. A ratio approaching one would indicate that the actual value was very close to the forecast value and would have established the validity of the forecasting method. A number consistently greater than one would indicate a tendency to overforecast and, conversely, a number less than one would indicate a trend to underforecast. In this test,

the wide range and dispersion of the ratios indicates that there is very little correlation between the forecast values and the actual shipments.

Weighted Moving Average

The data was also evaluated using the Spencer 15-term weighted moving average and the Henderson 13-term weighted moving average forecasting methods. These methods closely approximate the four-point moving average with the primary difference occurring in the relative importance placed on different portions of the data. The ratio of forecast weight to actual weight was also calculated in each of the tests (see Appendix D) with approximately the same amount of dispersion. The Spencer and Henderson Methods further indicate the random nature of the weights and the ratios illustrate that neither method produces an accurate forecast.

Linear Regression

The COPPER IMPACT model for regression analysis was run for both the daily and the weekly data from the three bases having usable data for 1977 and 1978. This analysis was performed to determine the strength of the linear relationship between the forecast weight and the actual weight by regressing weight with time. The regression model provides two analytical tools to evaluate the data. The coefficient of correlation, r , provides a measure of the linear

correlation between weight and time. Values for r fall within the range $-1 \leq r \leq 1$. When r is $+1$ or -1 , all the points fall exactly on the fitted line. When r equals zero there is no linear correlation between time and weight (7:342-344). Any other value of r suggests the degree to which the points tend to be linearly related. The linear regression for the weekly data at Patrick AFB produced the highest r value with r equal to only .1420 (see Appendix E), indicating very little linear correlation. The interpretation of r as a descriptive statistic is usually in terms of the second analytical tool provided by the regression model, r^2 , the coefficient of determination. This term is equal to the ratio of the reduction in the sum of squares of deviations obtained by using the linear model to the total sum of squares of deviations about the sample mean, which would be the predictor of weight if time were ignored (7:345). The value of r^2 for Patrick AFB was .0202. This means that the variability in forecast weight and actual weight shipped is reduced only 2.02 percent when time is considered. Thus, the linear regression model also suggests that there is very little relation between weight and time in forecasting LOGAIR usage.

Exponential Smoothing

An exponential smoothing model was also used to analyze the weight/time relationship in LOGAIR forecasting.

The same data was tested by exponential smoothing. For this model, the computer program conducts a preliminary analysis of the data and calculates the optimum alpha (α) value to use as the smoothing constant. It also determines the most suitable type of smoothing; type 1 for random data, type 2 for a linear relationship, and type 3 for a curvilinear relationship. The computer program also provides an evaluation of the smoothed absolute deviation per data point. The results of the exponential smoothing model for weekly Patrick AFB data are once again included as an example (see Appendix F). The optimum smoothing constant was calculated to be .5, indicating that there was no significant trend in the data which smoothing could eliminate. The type of smoothing was type 1, indicating random data and very little trend information. The smoothed absolute deviation per data point of 3189.2 also indicates that very little correlation exists in the variables.

Mean Absolute Deviation

To determine which, if any, of the preceding techniques would provide the best forecasts, the mean absolute deviation (MAD) would normally be the appropriate measure for analysis.⁶ In this study, none of the forecasts justify any further analysis. However, the MADs were calculated on

⁶Since none of the above techniques provides a reliable forecast, the MAD is included only to illustrate the technique as it would normally be applied to differentiate among the models.

a weekly basis for Patrick AFB to demonstrate the technique (see Appendix G). Ideally, the MAD would equal "0" indicating that no deviations exist and that the forecast is indeed a good one. The MADs in this study were very high, ranging from 2220 to 4228, indicating very large differences between the forecast values and the actual weights. This further confirms the contention that weight and time are not positively correlated and provides little forecasting information.

The Tracking Signal

The tracking signal, like the MAD, is a useful tool for differentiating among several different forecasts. It indicates whether the forecast average is keeping pace with any genuine upward or downward changes in demand. The sum of the actual forecast errors in a perfect forecasting model would be expected to be zero; meaning that the random errors that result in overestimates should be offset by errors that are underestimates. The tracking signal would then be zero, indicating an unbiased model (1:243). If in this study all of the forecasts were fairly even, the tracking signal could be used to weigh the economic advantages of consistently overforecasting or underforecasting. For demonstration purposes, tracking signals are computed for the weekly forecasts for Patrick AFB (see Appendix G).

Seasonal Analysis

In many government programs which are affected by the budget process, there are pronounced seasonal trends brought about by economic as well as environmental factors. As a result, it was deemed necessary to examine the data for seasonal trends. Since there was not an existing program within COPPER IMPACT to accomplish this task, an analysis was conducted manually. Ten random one-week periods were selected from the 1977 data and were then compared to the corresponding weeks in each of the next two years. This data was presented in graphic form to facilitate examination (see Appendix H). Analysis of this data is illustrated in Table 6 and indicates that there was little seasonal correlation; however, if there had been enough significant evidence to pursue the investigation, an exponential smoothing model with seasonal analysis would have been developed to provide further statistical evidence.

Summary

Each of these five tests clearly indicates that time and weight are very poorly related and provide very little information for forecasting LOGAIR requirements. The tests also indicate that weight shipped is random over time. The simple moving average did provide the best results; however, these results were still not good

TABLE 6
SEASONAL ANALYSIS

<u>Week 4</u>		<u>Week 9</u>	
4	Valley	9	Peak
56	Increasing	61	Valley
108	Increasing	113	Plateau
<u>Week 13</u>		<u>Week 18</u>	
13	Plateau	18	Valley
65	Valley	70	Valley
117	Peak	122	Increasing
<u>Week 21</u>		<u>Week 24</u>	
21	Valley	24	Peak
73	Decreasing	76	Valley
125	Peak	128	Valley
<u>Week 30</u>		<u>Week 37</u>	
30	Valley	37	Increasing
82	Valley	89	Peak
134	Peak	141	Valley
<u>Week 44</u>		<u>Week 50</u>	
44	Valley	50	Valley
96	Decreasing	102	Increasing
148	Valley	154	Valley

according to the statistical analysis, which suggests the need for continued investigation to find a consistent, reliable, and accurate means of forecasting daily and weekly LOGAIR base level requirements.

CHAPTER V

RECOMMENDATIONS FOR FURTHER RESEARCH

Overview

This study, in attempting to establish a relationship upon which to base LOGAIR forecasting, has answered one question; specifically, whether weight of previous shipments over time furnishes a reliable forecast base. However, as is often the case in research, the solution to this question has surfaced several other issues equally worthy of additional investigation.

Record Format

The first area recommended for additional emphasis concerns the computer record format in which the LOGAIR historical data is currently stored. Under the present system, MILSTAMP 0004, there is provision for identifying only the last two characters of the Julian date. As a result, the exact Julian date and year in which a shipment was made, is exceedingly difficult to ascertain. A new format for all subsequent LOGAIR data entering the MILSTAMP 0004 system would be of tremendous benefit. A study of the present record layout and subsequent redesign, to include a four-character Julian shipment date, would greatly facilitate data recall and would also greatly simplify the

quarterly review of assigned allocations and use, versus LOGAIR forecasted needs, as required by AFLC Regulation 75-5. This information would also be of great value in any future routing structure or forecasting model studies.

Use of the Algorithm

Additional study concerning the existing data would also be of great benefit. A procedure or method of translating the data currently in the MILSTAMP 0004 system into a readily available format would be of significant value. The algorithm outlined in Table 5, page 35, and subsequently incorporated into the data extraction program (see Appendix B) could be used as is or slightly modified to greatly facilitate the study of LOGAIR historical data. The algorithm would also greatly simplify the quarterly reviews of assigned LOGAIR allocations versus forecasted needs, as currently required by AFLC Regulation 75-5. In addition, the extraction of historical data for future studies would be simplified through the inclusion of this algorithm in AFR 76-1 and AFLCR 75-5.

Data Trail

A study of the data trail from the base level user, to the ALC, to AFLC and into the MILSTAMP 0004 system would also be of tremendous benefit. This study should center upon contrasting AF Form 295, Monthly Station Traffic

Summary, data with that data which is currently on record in the MILSTAMP 0004 system. This would help to insure the accuracy and maintenance of the system and would be of value in determining the cause of faulty records such as the extensive zero records found for MacDill AFB and Eglin AFB in this study.

Variable Analysis

Once it has been determined that the data within the MILSTAMP 0004 system is accurate and complete, another research project should be conducted to find a variable which is positively related to LOGAIR utilization. A reliable forecasting model could then be developed and tested following the same methodology used in this study. An apparent variable of interest for potential study should be operational mission time. This would address parameters such as Air Force aircraft, mission flying hours, or strategic missile alert time, and relate them to LOGAIR utilization.

Multivariate regression analysis offers another field of potential study in which a number of factors are combined to cause a synergistic effect reflecting a combined forecasting efficiency that surpasses any of the individual forecasts alone.

Relation to LOGAIR System

This study dealt only with the 5Q route and made the assumption that the route was representative of other feeder routes as well as the LOGAIR system as a whole. These assumptions should serve as the basis for an in-depth analysis of the continuity of the subsystems within LOGAIR. Further studies should analyze the impact of any proposed forecasting models, not only upon the feeder route for which they were designed, but also for the other feeder routes and upon the system as a whole. It may well prove that different models work better on some routes than others.

Summary

There is a great deal of latitude for improvement in the LOGAIR system. These improvements will require extensive time, effort, and study; however, the potential savings in not only dollars but also in reduced inventory levels and reduced pipeline times, justify this need.

APPENDICES

APPENDIX A
SAMPLE DATA



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AFB OHIO 45433

REPLY TO
ATTN OF

LMVTF

22 JAN 1981

SUBJECT

DAR-LOG-LOZ-D80-235-AFIT Study (Request for LOGAIR Historical Data)

TO:

AFIT/LSMDT (Capt T.J. Richardson)

1. Data Automation Requirement DAR-LOG-LOZ-D80-235 is complete. Attached are the record format, partial listing of the magnetic tape, and the magnetic tape containing the LOGAIR Historical Data.

2. The magnetic tape format is:

9 TRACK BINARY 1600 DENSITY
UNLABELED CYBER TAPE
TAPE BLOCK SIZE - 5120 CHARACTERS
RECORD LENGTH - 100 CHARACTERS
RECORD COUNT - 109,295
SEQUENCE - STATION, POSITIONS 1-3
YEAR, POSITION 27

3. If there are any questions, contact Willie McDaniel, extension 74271.

FOR THE COMMANDER

John C. Peters

JOHN C. PETERS, Chief
Financial Systems Branch
Dir of Distr & Maint Systems

3 Atch

1. Record Format
2. Listing
3. Magnetic Tape

Cy to: AFLC/LMDFT
AFLC/LOZMA

[illegible]

INPUT /OUTPUT RECORD			SYSTEM NUMBER		PAGE 1 OF 2 PAGES	
TITLE			INPUT OUTPUT	FILE NUMBER	RUN NUMBER	SEQUENCE OF FILE
LOGAIR HISTORICAL DATA						
DATA RECORD LENGTH 100		TAPE RECORD LENGTH/ BLOCKING FACTOR				
REMARKS						
NO.	DATA ELEMENT NAME		POSITION OR BLOCK	STRUCTURE LENGTH CHARAC		
1	STATION		1	3	AN	
2	DESTINATION		4	3	AN	
3	FLIGHT NUMBER		7	2	AN	
4	SHIPPER AAC		9	6	AN	
5	FLIGHT DEPARTURE HOUR/DATE		15	3	AN	
6	COMMODITY		18	1	AN	
7	SPECIAL HANDLING		19	1	AN	
8	FILLER		20	1	A	
9	POE		21	3	AN	
10	POD		24	3	AN	
11	YEAR		27	1	N	
12	MANIFEST REFERENCE		28	2	AN	
13	TCN		30	17	AN	
14	CONSIGNEE AAC		47	6	AN	
15	PRIORITY		53	1	AN	
16	RDD/NORS		54	3	AN	
17	PROJECT		57	3	AN	
18	HOUR/DATE RECEIVED		60	3	AN	
19	ORIGIN		63	1	AN	
20	TAC		64	4	AN	
21	PIECES		68	4	N	
22	WEIGHT		72	5	N	

APPENDIX B
PROGRAM AND ACTUAL DATA

ALGORITHM PROGRAM

```

PROGRAM BILLTOM (INPUT,OUTPUT,TAPES,TAPE7)
DIMENSION IHIST(195,5)
INTEGER EOF
REAL MCF
DATA COF,HST,MCF,PAM,VPS/3HCOF,3H4ST,3HMCF,3HPAM,3HVPS/
CALL LIMERR(10.0)
NERR=NUMERR(N)
DO 20 I=1,195
DO 10 J=1,5
IHIST(I,J)=0
10 CONTINUE
20 CONTINUE
IRAD=0
ICOUNT=0
30 ICOUNT=ICOUNT+1
31 CONTINUE
READ(5,40)BASE,IDAY,IYEAR,ITCN,IRANT,CODE
40 FORMAT(A3,12X,I2,9X,I1,9X,I3,32X,I4,41)
NERRX=NUMERR(N)
IF(NERR.EQ.NERRX)GO TO 45
NERR=NERRX
GO TO 31
45 CONTINUE
IF(EOF(5).NE.4)GO TO 80
IF(CODE.EQ."<")IALPHA=0
IF(CODE.EQ."A")IALPHA=1
IF(CODE.EQ."B")IALPHA=2
IF(CODE.EQ."C")IALPHA=3
IF(CODE.EQ."D")IALPHA=4
IF(CODE.EQ."E")IALPHA=5
IF(CODE.EQ."F")IALPHA=6
IF(CODE.EQ."G")IALPHA=7
IF(CODE.EQ."H")IALPHA=8
IF(CODE.EQ."I")IALPHA=9
IWT=IRANT*10+IALPHA
IF(IWT.EQ.0)IRAD=IRAD+1
IF(IWT.EQ.0)GO TO 30
J=5
IF(BASE.EQ.COF)J=1
IF(BASE.EQ.HST)J=2
IF(BASE.EQ.MCF)J=3
IF(BASE.EQ.PAM)J=4
IF(BASE.EQ.VPS)J=5
IF(J.GT.5)GO TO 31
IF(IYEAR.EQ.7)I4=7000
IF(IYEAR.EQ.8)I4=8000
IF(IYEAR.EQ.9)I4=9000
ITCN=ITCN-300

```

```

      I3=1000
      I2=300
      IF(MTCN,GE.0)GO TO 50
      MTCN=ITCN-200
      I3=300
      I2=200
      IF(MTCN,GE.0)GO TO 50
      MTCN=ITCN-100
      I3=200
      I2=100
      IF(MTCN,GE.0)GO TO 50
      MTCN=ITCN
      I3=100
      I2=0
50  IF(IDAY,GE.MTCN)GO TO 60
      IDATE=IDAY+I3+I4
      GO TO 70
60  IDATE=IDAY+I2+I4
70  IF(IDATE.LE.7365)I=IDATE-7000
      IF(IDATE.GT.7365.AND.IDATE.LE.8365)I=IDATE-8000+365
      IF(IDATE.GT.8365)I=IDATE-9000+730
      IF(I.GT.1095)GO TO 30
      IHIST(I,J)=IHIST(I,J)+IWT
      GO TO 30
80  CONTINUE
      DO 90 I=1,1095
      WRITE(7,900)I,(IHIST(I,J),J=1,5)
900  FORMAT(5X,I4,5X,5(I5,5X))
      90  CONTINUE
      WRITE(7,910)IRAD
910  FORMAT(15X,"ZERO RECORDS",I5)
      STOP
      END

```

Column 1-3 (Base)	Column 16-17 (Ship Rate)	Column 27 (Year)	Column 37-39 (TCN)	Column 72-75 (Weight)	Computed Date	Computer Weight Printout
COF	12	7	364	0010	377	0010
COF	12	7	312	0010	312}	
COF	12	7	311	0010	312}	0020
COF	12	7	312	0000	312	0000
COF	11	7	264	0010	311	0010
COF	11	7	211	0010	211}	
COF	11	7	210	0010	211}	0020
COF	11	7	211	0000	211	0000
COF	10	7	164	0010	210	0010
COF	10	7	110	0010	110}	
COF	10	7	109	0010	110}	0020
COF	10	7	110	0000	110	0000
COF	09	7	064	0010	109	0010
COF	09	7	009	0010	009}	
COF	09	7	008	0010	009}	0020
COF	09	7	009	0000	009	0000
HST	12	8	364	0010	742	0010
HST	12	8	312	0010	677}	
HST	12	8	311	0010	677}	0020
HST	12	8	312	0000	677	0000
HST	11	8	264	0010	676	0010
HST	11	8	211	0010	576}	
HST	11	8	210	0010	576}	0020
HST	11	8	211	0000	576	0000
HST	10	8	164	0010	575	0010
HST	10	8	110	0010	475}	
HST	10	8	109	0010	475}	0020
HST	10	8	110	0000	475	0000
HST	09	8	064	0010	474	0010
HST	09	8	009	0010	374}	
HST	09	8	008	0010	374}	0020
HST	09	8	009	0000	374	0000
MCF	12	9	364	0010	1107 (1980)	Out of bounds
MCF	12	9	312	0010	1042}	
MCF	12	9	311	0010	1042}	0020
MCF	12	9	312	0000	1042	0000
PAM	11	9	264	0010	1041	0010
PAM	11	9	211	0010	941}	
PAM	11	9	210	0010	941}	0020
PAM	11	9	211	0000	941	0000

Column 1-3 (Base)	Column 16-17 (Ship Rate)	Column 27 (Year)	Column 37-39 (TCN)	Column 72-75 (Weight)	Computed Date	Computer Weight Printout
VPS	10	9	164	0010	940	0010
VPS	10	9	110	0010	840}	0020
VPS	10	9	109	0010	840}	
VPS	10	9	110	0000	840	0000
VPS	09	9	064	0010	839	0010
VPS	09	9	009	0010	739}	0020
VPS	09	9	008	0010	739}	
VPS	09	9	009	0000	739	0000

ACTUAL DATA

Day	Patrick (COF)	Homestead (HST)	MacDill (MCF)	Tyndall (PAM)	Eglin (VPS)
1		0	0	0	0
2		0	0	0	0
3		11	0	0	0
4	15	3254	0	1437	15
5	104	2976	0	3168	524
6	1019	17445	0	577	430
7	1500	5442	0	1444	0
8	143	12123	0	0	0
9	3	3553	0	370	1553
10	10	15238	0	1252	1249
11	2	0	0	1063	1745
12	54	3493	0	0	1994
13	0	1357	0	3222	4129
14	919	1752	0	3644	0
15	3	1	0	3872	0
16	371	0	0	0	2535
17	1325	4494	0	874	1870
18	0	0	0	0	2352
19	649	4798	0	3744	4129
20	0	1324	0	0	4725
21	1198	1539	0	935	0
22	0	107	0	2253	24
23	1020	1	0	982	2915
24	0	0	0	0	1891
25	75	12924	0	3278	3950
26	412	653	0	3140	8410
27	433	17495	0	2973	4525
28	182	27774	0	4819	3144
29	671	0	0	1795	2327
30	0	2003	0	9291	2043
31	0	3500	0	0	1519
32	359	0	0	0	6170
33	154	0	0	6150	2734
34	664	0	0	3259	5235
35	590	0	0	5037	57
36	0	0	0	6147	0
37	3	0	0	3876	2211
38	985	0	0	3204	7174
39	0	0	0	1654	12374
40	222	2513	0	1821	9373
41	334	7533	0	2001	11145
42	975	7435	0	0	0
43	0	7145	0	2941	0
44	0	755	0	2263	1593
45	11	4044	0	0	4413

46	326	2772	0	4286	5132
47	305	3721	0	4820	7425
48	1054	3542	0	3815	5200
49	815	17538	0	509	43
50	365	3139	0	43	5
51	0	2430	0	0	0
52	0	4775	0	0	7433
53	0	5021	0	2370	5302
54	0	3498	0	1431	10507
55	779	7425	0	2641	17800
56	57	1230	0	3778	0
57	4700	0	0	0	0
58	0	14635	0	2276	4531
59	470	3306	0	4052	15013
60	592	3315	0	601	11733
61	932	3075	0	2455	4333
62	1044	3807	0	2173	15755
63	2545	3472	0	844	0
64	77	3430	0	0	24
65	17	437	0	1756	10203
66	1114	2523	0	1441	3353
67	410	4412	0	3182	5344
68	345	3244	0	1549	12553
69	294	0	0	0	23154
70	0	0	0	5063	53
71	374	14042	0	0	4340
72	0	5753	0	3092	9153
73	713	2435	0	1212	5798
74	90	13933	0	8129	12532
75	325	4572	0	0	12035
76	1	3005	0	3760	20353
77	193	3125	0	0	3451
78	2632	0	0	4345	4745
79	0	0	0	1058	5574
80	122	3475	0	1697	7297
81	750	4184	0	2055	8574
82	0	0	0	1772	5345
83	379	7538	0	1017	5435
84	575	4011	0	3011	14721
85	41	1100	0	8	2985
86	0	900	0	2915	7030
87	22	2851	0	1199	14301
88	2204	1955	0	4659	10500
89	1003	0	0	712	15073
90	291	59438	0	1853	27410
91	89	3173	0	1919	5355
92	50	4285	0	3872	5640
93	2	5932	0	3307	5543
94	0	0	0	2159	5277
95	147	5235	0	283	5515

95	335	5792	0	1722	12511
97	625	1742	0	3212	8151
98	1344	12437	0	0	1155
99	519	5455	0	5	5353
100	449	155	0	2900	3305
101	502	7221	0	1628	3577
102	2930	47	0	2503	5135
103	1798	5514	0	3915	6437
104	11	1934	0	1143	17535
105	1480	5453	0	6801	1499
106	811	4651	0	5256	3330
107	934	224	0	4154	40
108	3634	849	0	1791	4427
109	1723	2248	0	1380	6335
110	1031	5978	0	1081	8125
111	61	22417	0	2481	14332
112	2193	3144	0	912	3571
113	505	5984	0	4	3092
114	0	13557	0	1251	4134
115	438	3249	0	1605	3815
116	647	7422	0	2189	8515
117	20	5198	0	1560	7544
118	2875	3721	0	2451	12539
119	245	28	0	1902	3937
120	0	5613	0	14	7300
121	1083	4446	0	2807	1392
122	159	7	0	2631	19659
123	413	3117	0	3387	5393
124	154	3537	0	2266	7929
125	55	5285	0	8270	12393
126	213	5819	0	1570	74
127	117	4131	0	309	2953
128	0	9	0	1586	13876
129	1431	1742	0	1146	11992
130	830	5853	0	1332	14362
131	211	7259	0	1713	11111
132	405	3725	0	1826	9735
133	293	5034	0	1997	3653
134	834	1555	0	0	3353
135	0	7	0	900	6257
136	67	7147	0	1867	5012
137	120	1311	0	3946	10929
138	1125	3755	0	1729	3269
139	195	2447	0	4337	19529
140	555	125	0	4321	5754
141	717	0	0	6196	5300
142	7	0	0	1727	8312
143	0	2794	0	3557	5994
144	2132	1999	0	3151	5051
145	972	5313	0	2491	7451

146	404	4374	0	6915	11333
147	1524	1297	0	999	1055
148	4551	234	0	1800	5042
149	1992	12	0	10	4220
150	1	0	0	0	5200
151	14	12740	0	8919	9237
152	1982	1513	0	0	15529
153	2452	2575	0	7538	5034
154	276	5377	0	6694	44143
155	3786	1614	0	405	2
156	1700	90	0	800	5955
157	1710	5319	0	1800	7135
158	1392	15090	0	4306	15193
159	1954	3873	0	1780	11572
160	4944	3745	0	6344	15721
161	1802	5554	0	3410	8243
162	1806	4115	0	2480	10272
163	0	3510	0	2480	4955
164	1102	0	0	2035	9559
165	423	4251	0	6338	9127
166	4069	5803	0	4180	10035
167	1734	13559	0	4102	13501
168	2100	7465	0	6934	1309
169	172	595	0	1764	3031
170	5	145	0	56	449
171	1098	2557	0	2396	3449
172	656	7019	0	6154	3934
173	8924	3123	0	8514	9469
174	6523	5634	0	2729	8091
175	140	9	0	0	15529
176	2500	7819	0	8447	4145
177	1315	4797	0	6968	3294
178	1625	5485	0	294	11590
179	454	12928	0	6355	8551
180	7892	4544	0	2658	14333
181	3982	0	0	2883	7412
182	0	12943	0	2001	13079
183	457	0	0	1300	2352
184	0	5512	0	0	5353
185	0	0	0	0	0
186	633	17739	0	1757	7052
187	209	7191	0	6582	18435
188	4	3819	0	1155	5915
189	2223	4	0	0	6344
190	3600	891	0	7115	2547
191	1315	1457	0	1897	2303
192	0	0	0	0	12904
193	273	5734	0	3217	9724
194	0	0	0	0	3055
195	572	47659	0	6195	11432

195	669	7853	L	4329	14725
197	138	3117	C	2286	3492
198	.	5735	L	432	2373
199	2375	3173	C	3756	5934
200	116	3519	L	5320	8353
201	455	7097	C	7483	5839
202	452	0	C	12960	13221
203	963	4544	C	7853	5955
204	18	0	C	5582	0
205	0	5	C	287	3151
206	254	1592	C	993	7154
207	1	9828	C	3200	14397
208	245	2904	C	4705	3331
209	0	0	C	0	5937
210	221	2773	C	5089	3133
211	1463	5070	C	5898	0
212	653	125	C	351	7043
213	939	2867	C	4493	5735
214	335	5140	L	6314	10346
215	632	5022	C	0	8045
216	0	0	C	0	17772
217	2313	365	C	7401	2159
218	0	0	C	1545	3349
219	0	0	C	4381	10922
220	168	1993	C	1858	9924
221	577	3	C	2795	21035
222	1855	0	C	1137	12011
223	725	5351	C	2512	14707
224	796	5974	C	2153	5465
225	3657	2183	L	1379	2143
226	492	945	C	53	1550
227	1197	1183	L	4954	5339
228	1412	2852	C	1231	10735
229	1630	1237	C	1263	15091
230	374	1713	L	1112	7255
231	1412	2534	C	2505	13509
232	6	1380	C	1380	55
233	0	0	L	26	2174
234	279	2514	L	3169	7737
235	1049	2405	C	5153	5305
236	0	1305	C	4389	5429
237	0	0	C	7413	15543
238	2080	4298	C	1560	5579
239	6733	4100	L	5607	2858
240	735	142	C	2200	3929
241	977	1215	C	2775	3874
242	890	2157	C	5653	5304
243	615	1241	C	4198	8938
244	524	0	L	0	11501
245	928	2953	C	4798	4155

246		1627	C	2890	3537
247		50	C	0	545
248		72	C	0	3253
249	914	2433	C	896	4857
250	367	7860	C	1890	7413
251	1217	5343	C	1624	7075
252	321	1079	C	2399	2575
253	523	105	C	0	8755
254	1445	0	C	8	4312
255	0	1744	C	1288	3122
256	691	595	C	1472	3853
257	978	2734	C	5294	4931
258	115	921	C	2534	12455
259	735	+153	C	5350	0
260	0	0	C	0	1953
261	210	0	C	0	2479
262	5	2533	C	1286	2533
263	6923	3530	C	4018	4327
264	8204	1392	C	3837	4352
265	3192	3914	C	2523	10174
266	1492	1391	C	15620	8395
267	0	833	C	2014	4135
268	37	7	C	74	1353
269	50	0	C	2008	2351
270	1433	4135	C	5014	9453
271	895	1874	C	1151	6951
272	197	3533	C	3615	14331
273	100	3825	C	2276	5
274	0	0	C	2113	5593
275	0	12	C	0	7312
276	0	0	C	1603	4029
277	0	3	C	334	13314
278	0	0	C	0	9445
279	0	0	C	5482	9513
280	0	14	C	2159	1992
281	0	0	C	0	3429
282	0	25	C	0	75
283	0	0	C	0	3454
284	0	0	C	0	8535
285	0	0	C	1780	9445
286	0	0	C	0	17451
287	0	12239	C	0	2090
288	52	0	C	0	0
289	0	0	C	0	4155
290	11	974	C	0	4314
291	0	0	C	0	4409
292	0	0	C	0	5950
293	0	0	C	0	21035
294	0	0	C	0	4033
295	0	0	C	0	3522

296		1	0	0	0
297		0	0	0	0
298		1	0	0	0
299		757	0	0	2274
300		3	0	0	4505
301	1930	171	0	4	9343
302		0	0	0	6730
303		223	0	0	0
304		49	0	0	747
305		0	0	0	5125
306		0	0	62	24
307		0	0	400	5335
308		20	0	129	2239
309		0	0	14	9454
310		52	0	0	0
311		1	0	0	17
312	73	10	0	0	1151
313	15	0	0	341	4113
314	2	13	0	235	4511
315		29	0	14	5133
316	40	0	0	42	805+
317	70	0	0	0	7
318	0	1	0	0	0
319	25	1	0	209	1531
320	0	17	0	2	4254
321	0	15	0	231	3701
322	0	15	0	54	1059
323	0	115	0	96	8234
324	0	3	0	145	0
325	0	0	0	554	1151
326	0	10	0	115	0
327	0	0	0	32	5341
328	0	0	0	209	534
329	0	0	0	13	8373
330	0	0	0	0	7
331	0	13	0	0	335
332	14	7	0	0	36
333	0	0	0	2	3695
334	261	0	0	5	1549
335	0	453	0	0	3547
336	0	257	0	488	4532
337	0	745	0	37	535
338	204	57	0	0	214
339	0	5	0	89	1331
340	0	1	0	42	1035
341	0	17	0	0	3033
342	2	1	0	0	3140
343	0	41	0	0	5533
344	0	1	0	3	44
345	0	6	0	56	215

346		25		330	2292
347	173	0		2730	1474
348		342		199	425
349		1		162	3513
350		55		0	9173
351		0		0	0
352		0		0	1375
353		0		121	8915
354		8		341	653
355		1045		43	9842
356		119		0	2575
357		157		0	0
358		0		0	2520
359		0		17	19
360		0		0	14
361		0		0	29
362	3	325		22	4293
363		5		20	3223
364		0		0	4335
365		0		0	155
366	2151	0		3575	4
367	20	0		163	0
368		2943		1732	1359
369	434	2135		3178	3352
370	815	2234		1829	2212
371	1923	3275		1785	3255
372	44	911		976	5
373	241	0		1040	4
374	932	1551		393	1390
375	2013	2232		1216	530
376	1189	3211		7251	555
377	2554	2011		1418	0
378	102	5340		2628	239
379	185	3821		4146	0
380	1	2010		10348	0
381	15	946		15694	330
382	1368	1911		1631	732
383	26	1535		3747	3
384	352	1995		5311	329
385	109	3131		910	452
386	951	479		71	48
387	2050	4525		459	3
388	494	2935		2927	175
389	105	4795		4750	71
390	308	3177		3253	1174
391	1521	5114		3312	0
392	1213	5545		2555	379
393	2414	413		312	595
394	2910	2		0	531
395	345	3677		2026	351

396	599	2591	C	407	329
397	65	3327	C	2945	1333
398	124	11573	C	13333	70
399	2735	752	C	4352	53
400	441	5707	C	2921	2
401	5	0	C	0	0
402	0	5218	C	2215	12
403	38	3733	C	2683	275
404	139	1159	C	1471	0
405	433	1651	C	7877	0
406	8	3537	C	8309	0
407	1321	10513	C	3369	0
408	254	22	C	3933	0
409	102	4359	C	3975	7
410	864	3450	C	1461	4
411	83	3343	C	2215	0
412	723	2212	C	3157	8
413	858	3939	C	2768	0
414	1262	1954	C	999	0
415	0	4	C	1660	0
416	903	1	C	0	0
417	853	5453	C	2774	0
418	1187	4344	C	2497	0
419	6	2023	C	1135	0
420	471	3517	C	2059	38
421	3	20100	C	3883	0
422	136	32	C	1366	0
423	25	4140	C	2586	0
424	0	5835	C	1646	0
425	104	3901	C	2237	0
426	1921	212	C	1430	0
427	574	3977	C	2392	0
428	221	5497	C	1180	23
429	746	3832	C	5	0
430	29	5873	C	1922	0
431	439	3375	C	2656	0
432	2271	2137	C	4175	13
433	509	2933	C	3405	0
434	22	2707	C	4206	0
435	510	2973	C	1771	0
436	96	7175	C	0	0
437	707	2937	C	1023	0
438	623	3573	C	0	0
439	382	7571	C	6280	0
440	809	4825	C	6769	0
441	345	152	C	2768	0
442	927	112	C	1152	0
443	3125	2575	C	0	0
444	117	2151	C	1142	0
445	1879	2595	C	2959	0

446	237	2574	0	2423	0
447	287	3583	0	1098	0
448	695	1445	0	4259	0
449		5225	0	1420	0
450	5	0	0	0	0
451	932	2150	0	1840	0
452	1187	4134	0	5248	0
453	778	2752	0	2135	0
454	97	3274	0	4661	0
455	410	3052	0	3575	0
456	21	4394	0	5230	0
457	5	2115	0	0	0
458	185	2424	0	1418	0
459	133	2155	0	1451	0
460	2047	1148	0	1323	0
461	169	1906	0	2075	0
462	2770	2535	0	3387	0
463	134	2035	0	2	0
464	5	1	0	5	0
465	855	12812	0	2166	0
466	451	3712	0	2117	0
467	594	1982	0	2224	0
468	313	4158	0	1417	0
469	1824	4723	0	3425	0
470	35	34	0	927	0
471	5	0	0	0	0
472	1722	2923	0	0	0
473	1731	2384	0	0	0
474	365	3954	0	2447	0
475	26	5312	0	2149	0
476	559	3332	0	3038	0
477	1475	23	0	0	0
478	0	4389	0	0	0
479	45	1344	0	2294	0
480	15	971	0	2512	0
481	430	1414	0	1649	0
482	88	2057	0	1460	0
483	0	45	0	3744	0
484	0	153	0	1243	0
485	10	3702	0	535	0
486	94	5112	0	8391	0
487	71	4254	0	8156	0
488	71	3055	0	6921	0
489	0	7151	0	4365	0
490	440	4933	0	7630	0
491	555	2325	0	2238	0
492	5	2049	0	0	0
493	221	2531	0	762	0
494	543	827	0	2831	0
495	85	5252	0	3715	0

496	37	24		2564	
497	1636	3352		3317	
498	76	1467		3983	
499	2424	110		156	
500	257	2031		2810	
501	250	3353		3477	
502	1399	+190		2028	
503	1133	7138		1555	
504	1189	7343		2462	
505	53	0		2619	
506	2886	+597		0	
507	466	4379		2253	
508	63	5110		2167	
509	5	+549		7526	
510	821	2486		2631	
511	153	1542		6806	
512	465	34		1656	
513	0	172		4	
514	18	339		0	
515	299	5297		973	
516	537	2633		1779	
517	25	2748		24	
518	5	3151		120	
519	0	0		0	
520	0	2511		0	
521	40	3345		2	
522	151	2092		1695	
523	0	0		116	
524	234	0		6	
525	0	3984		0	
526	0	344		73	
527	0	4		0	
528	0	0		4	
529	2	0		0	
530	0	0		252	
531	0	0		0	
532	0	4		0	
533	0	0		221	
534	0	52		0	
535	0	4095		2	
536	0	171		0	
537	0	795		0	
538	0	10805		0	
539	0	0		0	
540	0	732		0	
541	0	657		0	
542	0	2779		0	
543	1874	2810		1030	
544	0	1953		0	
545	33	2138		2081	

546		1374	C	0	C
547	3351	17	C	4417	C
548	1622	526	C	0	C
549	3378	4593	C	676	C
550	4121	0	C	0	C
551	7	1522	C	1613	C
552	1084	4635	C	346	C
553	1473	4193	C	800	C
554	3417	3119	C	5267	C
555	316	2851	C	0	C
556	333	12543	C	2697	C
557	541	178	C	5523	C
558	719	3592	C	11531	C
559	5	5011	C	5171	C
560	908	3159	C	2887	C
561	264	11318	C	3017	C
562	1534	5139	C	0	C
563	189	2532	C	637	C
564	234	1397	C	3742	C
565	582	1762	C	1669	C
566	8597	4297	C	661	C
567	528	2756	C	955	C
568	1607	1	C	872	C
569	2377	7	C	3987	C
570	1461	4149	C	4634	C
571	1452	349	C	2622	C
572	716	291	C	2868	C
573	827	1137	C	1565	C
574	1413	4737	C	0	C
575	0	0	C	440	C
576	3578	859	C	0	C
577	243	3733	C	1570	C
578	4105	3430	C	2289	C
579	5300	2357	C	3559	C
580	395	4379	C	1212	C
581	514	5953	C	1179	C
582	531	1319	C	12	C
583	0	840	C	460	C
584	2741	2248	C	4715	C
585	67	13105	C	1410	C
586	355	12731	C	1917	C
587	423	3162	C	2120	C
588	1131	4962	C	3555	C
589	573	5414	C	2195	C
590	0	5350	C	3987	C
591	6	3819	C	1847	C
592	10835	1993	C	3680	C
593	1376	1722	C	1851	C
594	1430	1047	C	7778	C
595	904	2452	C	3554	C

596	5495	537	0	3188	0
597	.	2	0	121	0
598	193	513	0	1965	0
599	1081	1875	0	4526	0
600	189	4270	0	2308	0
601	3935	3814	0	6297	0
602	2371	1859	0	1846	0
603	2248	1728	0	3872	0
604	2538	2	0	8	0
605	522	1497	0	47	0
606	2168	2421	0	4188	0
607	3272	2045	0	3897	0
608	1397	3991	0	2985	0
609	552	359	0	1498	0
610	3727	5481	0	12796	0
611	0	0	0	3632	0
612	117	7	0	1409	0
613	101	2938	0	754	0
614	71	2914	0	11	0
615	508	5735	0	2849	0
616	1035	5178	0	1398	0
617	867	7523	0	2244	0
618	5	4704	0	0	0
619	333	5153	0	2580	0
620	263	5933	0	3218	0
621	2413	5115	0	1632	0
622	875	5215	0	5305	0
623	2843	3703	0	2493	0
624	413	4917	0	219	0
625	0	16	0	311	0
626	252	2553	0	2217	0
627	139	3035	0	2443	0
628	1487	2427	0	2781	0
629	429	5931	0	1417	0
630	45	13733	0	4997	0
631	254	1972	0	0	0
632	1	113	0	0	0
633	106	3439	0	1150	0
634	735	12739	0	2951	0
635	689	2493	0	1694	0
636	864	715	0	1475	0
637	83	2837	0	2519	0
638	1563	4133	0	5	0
639	1911	12773	0	0	0
640	.	2343	0	0	0
641	1643	3575	0	0	0
642	3139	2101	0	0	0
643	3251	5113	0	0	0
644	197	2924	0	0	0
645	2746	11439	0	0	0

646	43	394	0	716	0
647	8513	1	0	6	0
648	1977	1	0	6	0
649	231	2331	0	1416	0
650	911	3177	0	260	0
651	711	1915	0	5250	0
652	1153	2535	0	3081	0
653	1736	4931	0	0	0
654	1345	47	0	2194	0
655	12	31749	0	1337	0
656	2793	3999	0	4432	0
657	2728	1	0	3278	0
658	1217	2071	0	2933	0
659	3518	5737	0	1611	0
660	7358	7129	0	1565	0
661	770	7193	0	335	0
662	944	1	0	1116	0
663	4693	3917	0	1785	0
664	353	3743	0	0	0
665	2606	144	0	5643	0
666	102	5132	0	1088	0
667	653	5435	0	922	0
668	4757	11657	0	2333	0
669	5943	361	0	4826	0
670	1043	3477	0	4530	0
671	1718	3579	0	4010	0
672	235	7015	0	8005	0
673	443	4613	0	2415	0
674	32	294	0	7622	0
675	2809	2550	0	1783	0
676	770	4790	0	3473	0
677	1060	5202	0	2472	0
678	710	1559	0	3336	0
679	863	2586	0	3036	0
680	364	3672	0	1923	0
681	76	3147	0	703	0
682	5	3	0	0	0
683	5	1141	0	2497	0
684	210	3955	0	0	0
685	1447	5733	0	3787	0
686	401	0	0	5389	0
687	13	7925	0	1357	0
688	572	5039	0	2213	0
689	1905	7675	0	1267	0
690	1580	4329	0	2474	0
691	267	3142	0	9	0
692	2217	2055	0	6498	0
693	1058	4093	0	6529	0
694	242	5759	0	724	0
695		823	0	4640	0

696	1651	4	0	146	0
697	792	4535	0	1720	0
698	582	5776	0	2825	0
699	2103	7	0	959	0
700	71	5223	0	1893	3
701	925	4096	0	1452	0
712	1882	133	0	1305	0
713	255	117	0	1158	0
714	1	4013	0	1227	0
705	1205	3520	0	2138	0
706	621	2459	0	2240	0
707	1723	1437	0	2769	0
708	21	3775	0	3296	0
709	1354	2594	0	6665	0
710	1105	1332	0	690	0
711	776	5054	0	4012	0
712	1065	4041	0	1883	0
713	1052	3501	0	3776	0
714	34	1409	0	1114	0
715	456	5070	0	5250	0
716	512	0	0	2275	0
717	0	0	0	1673	0
718	0	2875	0	0	0
719	99	1492	0	3422	0
720	2532	2231	0	3353	0
721	2010	2952	0	3314	0
722	454	3372	0	1725	0
723	1321	12532	0	3672	0
724	821	0	0	3	0
725	137	0	0	0	0
726	66	1513	0	167	0
727	2447	1157	0	1674	0
728	666	1806	0	2211	0
729	23	2375	0	3168	0
730	598	0	0	0	0
731	1	4	0	5	0
732	245	0	0	0	0
733	0	2573	0	1048	0
734	433	2155	3	1503	0
735	23	405	0	304	0
736	129	353	0	196	0
737	925	0	0	0	0
738	1	13	0	55	0
739	12	7521	0	18	0
740	0	72	0	14	0
741	1147	0	0	114	0
742	191	15	0	290	0
743	0	490	102	3102	0
744	64	1	0	0	0
745	0	322	0	25	0

746		37	33	11	
747	52	52	0	0	
748	7	2575	144	5	
749		95	0	0	
750	115	150	50	0	
751	365	0	0	0	
752	25	30	0	0	
753	0	0	0	446	
754	154	0	0	139	
755	173	2	0	152	
756	0	0	0	1860	
757	22	19	0	0	
758		0	0	0	
759	1075	0	0	0	
760	164	5	0	0	
761	0	4	43	212	
762	340	4753	2	4049	
763	2600	3397	7	6839	
764	6	19	1	1179	
765	55	2	17	5	
766	2331	17398	0	2348	
767	858	3151	0	7482	
768	713	5214	135	7146	
769	213	21797	5	3908	
770	593	11945	0	10339	
771	6	52	0	2250	
772	1325	177	0	33	
773	3152	5191	0	1987	
774	295	5438	0	1744	
775	174	3611	0	4747	
776	1525	1585	962	1961	
777	933	4307	1463	2655	
778	0	4025	1352	0	
779	5	1350	2334	0	
780	0	1	0	0	
781	13	3153	2	6158	
782	419	0	3417	2450	
783	1205	0	3645	0	
784	185	0	2931	1620	
785	74	0	898	3229	
786	55	277	49	3392	
787	231	0	0	0	
788	521	0	1527	3325	
789	71	0	2543	909	
790	2297	0	6165	1681	
791	144	0	2817	887	
792	517	0	3850	4069	
793	250	0	0	45	
794	283	0	0	3573	
795	1026	0	2753	6632	

796	759	0	2066	6118	0
797	742	0	2074	5770	1
798	8-	0	2395	1235	0
799	1504	0	5311	2504	0
800	1354	0	0	3	0
801	1457	31	117	1542	0
802	643	0	1313	5240	0
803	152	0	2202	11005	0
804	586	591	1680	1922	0
805	3553	0	2759	1151	0
806	0	0	1593	6137	0
807	2645	129	0	4155	0
808	46	0	4	7345	0
809	984	685	1829	3663	0
810	77	11	3006	2750	0
811	1685	1654	2458	2442	0
812	907	0	8005	4442	0
813	676	1732	4623	1313	0
814	1230	5	0	11696	0
815	881	7	39	2974	0
816	1203	0	1860	3539	0
817	491	13	2622	5202	0
818	365	55	35	4745	0
819	2449	0	3563	0	0
820	892	0	1345	0	0
821	0	1375	37	0	0
822	0	0	4603	0	0
823	0	2	1784	0	0
824	0	1158	5789	0	0
825	0	0	0	0	0
826	20	29	3547	0	0
827	0	0	2692	32	0
828	0	0	995	3	0
829	0	5	0	358	0
830	0	4	742	0	0
831	0	75	2919	50	0
832	1429	0	10126	262	0
833	57	1275	196	83	0
834	0	0	175	36	0
835	0	1595	1	32	0
836	1	35	0	107	0
837	2	9	14	0	0
838	0	0	13	0	0
839	0	0	0	48	0
840	17	0	430	57	0
841	0	0	823	407	0
842	0	0	0	499	0
843	184	0	3	105	0
844	0	35	0	302	0
845	0	0	0	0	0

846		9	139	16	
847	66	5	0	675	
848		15	0	0	
849	0	0	0	0	
850	674	7	0	5	
851	689	1523	58	7192	
852	1127	11557	0	2613	
853	561	1539	17	3863	
854	239	4162	8	7325	
855	420	3571	178	11	
856	867	952	2	0	
857	279	3925	0	3134	
858	39	4414	0	650	
859	344	2531	119	2922	
860	95	5291	96	1489	
861	6459	2875	0	1856	
862	2037	4913	9	1122	
863	0	751	14	0	
864	355	5603	0	1829	
865	2069	2927	881	3847	
866	706	4911	4016	0	
867	910	5454	0	647	
868	78	5032	5325	5693	253
869	1354	0	2716	3730	0
870	0	0	0	0	0
871	951	3416	33	5972	0
872	4253	2395	3840	3042	31
873	477	2149	0	2564	2
874	6	17315	1894	5339	9
875	824	0	2037	3719	0
876	6	23165	100	0	0
877	0	2942	2176	0	0
878	0	4297	1	0	0
879	153	3009	13	1719	0
880	965	2235	1065	3986	25
881	4993	2212	4702	0	351
882	130	0	3263	2503	0
883	950	3455	2498	4645	0
884	0	500	2353	495	0
885	1690	2299	110	2573	0
886	607	743	2007	1494	0
887	9014	4535	5076	2161	0
888	225	961	3566	3350	2
889	2578	3795	3395	3615	0
890	625	2735	1029	998	0
891	5	7132	1467	50	0
892	1220	5631	1	1569	23
893	1232	2931	3126	537	0
894	1111	3246	1938	1615	0
895	2275	5950	3300	4632	0

896	81	5175	3152	1971	0
897		2491	3961	63	0
898	1265	J	2096	40	0
899	3157	7243	0	1601	0
900	715	5333	2442	1460	171
901	214	2932	2061	1219	0
902		5411	4973	1781	73
903	2973	5381	6610	2252	0
904	1872	5592	2930	1276	3
905	331	22534	6410	0	0
906	3789	7214	4501	2241	0
907	6	3872	2436	2741	0
908	5	7717	2489	2385	0
909	301	4685	15015	1663	0
910	217	4157	2745	1136	0
911	1795	23878	2755	0	0
912	0	1	0	0	0
913	1065	4567	2	2941	0
914	892	5733	4625	1431	0
915	545	10320	2681	1	0
916	103	12435	2	1479	0
917	1140	5857	195	3583	0
918	5866	2795	1807	2199	0
919	1315	5	13953	120	0
920	704	2110	0	1780	0
921	365	5995	845	3356	0
922	652	5539	3416	1516	0
923	377	1555	1842	5774	0
924	725	2513	1365	1705	0
925	55	3	2018	0	0
926	5	2	2322	0	0
927	11	2142	58	847	0
928	1241	3454	2079	4614	0
929	71	3059	6926	3410	0
930	2063	14719	1343	2806	0
931	146	25373	2658	2304	0
932	1742	7595	6754	1	0
933	495	4035	1111	0	0
934	4	4235	0	5144	0
935	921	5539	2138	1430	515
936	50	1432	2448	3350	0
937	1115	11759	866	1377	0
938	1385	1723	2563	2512	0
939		5856	2053	0	0
940	5	4794	5125	750	0
941	751	1651	0	2256	0
942	330	2539	1732	1541	0
943	110	3974	2950	2017	0
944	0	5059	1159	5225	0
945	533	4637	3316	3753	0

AD-A105 190 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/8 15/5
AN EXAMINATION OF SELECTED FORECASTING MODELS FOR PROJECTING LO--ETC(U)
JUN 81 W J MAGOWAN, T J RICHARDSON
UNCLASSIFIED AFIT-LSSR-25-81

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
AN EXAMINATION OF SELECTED FORECASTING MODELS FOR PROJECTING LO--ETC(U)
JUN 81 W J MASOWAN, T J RICHARDSON
AFIT-LSSR-25-81

NL

AL
A0519C

END
DATE
FILMED
10 8
DTIC

946	533	7132	1798	167	0
947	353	1135	34	0	0
948	272	2759	1726	7132	0
949	466	3721	2166	1262	0
950	391	1495	1897	8956	0
951	1509	253	2175	3098	0
952	37	9532	1191	4115	0
953	1539	1	1703	4756	0
954		7	1783	83	0
955	67	7	0	2082	0
956	112	7	7059	2477	0
957	2179	15	5438	1783	5513
958	1172	0	6568	2993	2542
959	300	0	3435	2561	4355
960	525	7	7479	1303	5935
961	6	7	0	0	0
962	393	0	316	2073	0
963	210	2217	3031	0	2535
964	111	2871	1243	2326	10145
965	688	2235	3188	3058	8355
966	193	9235	2318	2552	2339
967	0	5035	3193	0	5553
968	6	14215	16	0	2331
969	132	2551	6239	2566	2084
970	597	4044	0	2730	5735
971	131	0	1671	1918	2174
972	417	3453	3	1646	3799
973	141	7	5623	2456	3044
974	2393	11177	3024	0	11575
975	0	0	1293	3872	0
976	0	5492	0	0	0
977	0	3454	22	2467	0
978	212	5775	0	4744	2259
979	98	8083	2178	5047	4552
980	133	1755	3660	3718	2495
981	0	7	3225	2372	9992
982	6	691	2620	89	515
983	208	5174	110	4162	0
984	17	4234	3241	510	1335
985	141	11944	2700	0	10539
986	7	7377	997	2863	0
987	52	5213	2890	3039	12
988	2502	11099	2056	0	13441
989	0	7721	1758	0	3
990	314	12155	0	3074	0
991	83	21732	2477	2098	3037
992	137	12774	0	2851	2653
993	193	5195	1	2542	3924
994	81	2575	0	0	9555
995	591	1712	0	1521	4455

996						
997						53
998	10	5637		4709	3245	
999	191	5779	3249	2436	52	
1000	821	7397		0	11355	
1001			5793	4161	4345	
1002	113	3335	3977	1517	4012	
1003		14347	5187	315	5013	
1004		17913		1405		
1005		7715		20		
1006		3422	7538	5240		
1007		17174	2670	6320		
1008		13992	2040	2812		
1009		11934		2647		
1010		7704	3563	1128		
1011			4			
1012		237				
1013		32	1			
1014		4372	6970	9138		
1015	315	5419	830	5888		
1016	10	1546	2490	4122		
1017	35	5113	4418	3315		
1018		376		1176		
1019		10	1	1496		
1020		2900		4660		
1021		3474		9352		
1022		1559	38	6688		
1023		5344		10620		
1024		3995	32	3564		
1025		23433		110		
1026		11357		0		
1027		4687		9870		
1028		31567		12212		
1029		3315		14950		
1030		4120		11634		
1031		3221		13852		
1032		13072		78		
1033		14652		12524		
1034		4839		6718		
1035		3799		5124		
1036		0		0		
1037		0		0		
1038		0		0		
1039		0		0		
1040		0		0		
1041		0		0		
1042		0		0		
1043		0		0		
1044		0	2	0		
1045		0	0	0		
		0	0	2		

1046					
1047					
1048					
1049					
1050					
1051					
1052					
1053					
1054		20			
1055					
1056					
1057					
1058					
1059					
1060					
1061					
1062	20				
1063		34			
1064					
1065	25				
1066		15			
1067		19			
1068		223			
1069		1333			
1070					
1071					
1072		23			
1073					
1074					
1075		48			
1076		11			
1077		854			
1078					
1079		12			
1080		3915			
1081		19			
1082					
1083		118			
1084					
1085		35			
1086					
1087	120				
1088		7			
1089					
1090					
1091		213			
1092		947			
1093					
1094	6				
1095					

<u>Week</u>	<u>COF</u>	<u>HST</u>	<u>PAM</u>
1	2742	29039	6646
2	1614	39018	9581
3	3543	12746	9425
4	2043	47855	17445
5	2438	10503	27533
6	2520	9607	18713
7	5459	35177	18634
8	1201	32939	10263
9	10292	36629	12401
10	2257	14492	12991
11	2555	46882	16193
12	4539	19308	14955
13	4451	75468	13266
14	2514	36138	14555
15	11736	25890	18895
16	10386	46513	17055
17	4732	58159	10968
18	2087	34873	20947
19	3292	33716	9911
20	2903	16061	17100
21	5756	15236	25036
22	13761	23552	25121
23	17298	35284	18845
24	26844	35714	28549
25	17530	19091	21613
26	17762	44377	29607
27	7228	32295	10795
28	6430	59908	16353
29	5543	34108	40030
30	689	17102	19856
31	12207	19585	24457
32	4124	13311	16421
33	10180	12223	12498
34	4216	9732	19139
35	11511	11719	25231
36	2799	15034	9701
37	4595	10221	15946
38	20026	17810	27284
39	2719	14200	16185
40	0	29	11688
41	0	12264	1780
42	63	934	0
43	1930	928	4
44	0	297	591
45	90	112	604
46	135	49	548

<u>Week</u>	<u>COF</u>	<u>HST</u>	<u>PAM</u>
47	0	119	1174
48	275	730	495
49	206	875	168
50	170	1040	3500
51	0	1320	505
52	3	331	59
53	5344	10638	12262
54	7074	15256	14932
55	2091	15360	41787
56	6653	27642	14409
57	9201	21439	26140
58	1406	22444	25476
59	4215	37835	20888
60	4696	17414	11074
61	4090	49197	15540
62	4237	26443	17549
63	3565	32379	18631
64	7118	21547	13069
65	3412	21497	18939
66	5330	17199	14884
67	4156	29427	11377
68	4389	23999	8561
69	2053	16171	11659
70	686	28576	37244
71	3189	16370	15507
72	7422	25582	16481
73	4454	22663	24002
74	1514	14433	4556
75	425	16823	1819
76	2	352	315
77	0	15919	223
78	1911	12266	3911
79	15076	15641	8032
80	6240	31370	33066
81	11928	29170	10680
82	9846	10474	16588
83	14435	20780	10249
84	5357	38166	14189
85	15133	27797	24895
86	13273	13008	20251
87	12727	12543	16487
88	5522	24147	22849
89	7605	39445	17472
90	2771	29512	14385
91	3331	29954	8889
92	13377	33567	5
93	15220	20475	7646

<u>Week</u>	<u>COF</u>	<u>HST</u>	<u>PAM</u>
94	10975	65300	17155
95	25248	28900	12055
96	15375	49746	25694
97	6975	22704	24137
98	2513	28217	14359
99	7818	30708	20362
100	5531	22100	12877
101	6611	15776	12299
102	5410	22766	21436
103	5719	15621	19287
104	5915	20567	9652
105	1327	7610	6028
106	2405	7971	689
107	123	3511	3144
108	835	192	2597
109	3601	8193	11100
110	4444	53416	32337
111	7395	21454	15377
112	1832	8539	10228
113	3994	200	13423
114	3771	0	27442
115	9273	662	23367
116	7040	2398	30944
117	7309	1785	29471
118	912	2565	0
119	1496	1360	798
120	29	1741	280
121	250	44	2004
122	3310	19006	20998
123	8504	23518	10882
129	6155	30571	13138
125	7865	21305	24366
126	6153	42780	8208
127	15165	15943	18534
128	6622	28159	11373
129	8325	26791	8416
130	6522	62924	11442
131	5552	63848	9435
132	10008	21664	16551
133	3592	55795	13981
134	5729	36667	13814
135	1757	29459	15549
136	7086	25016	24728
137	5399	16	16665
138	2131	16662	11314
139	1417	35308	11316
140	2836	44647	19848

<u>Week</u>	<u>COF</u>	<u>HST</u>	<u>PAM</u>
141	966	35601	13051
142	4620	74062	12086
143	1140	42474	13138
144	6	75042	19552
145	361	16816	22464
146	0	22768	36956
147	0	87684	62628
148	0	45660	24444
149	0	0	0
150	0	0	2
151	0	20	3
152	46	94	2617
153	0	1687	2668
154	6	939	5600
155	0	4068	5550
156	1206	1172	138

APPENDIX C
SIMPLE MOVING AVERAGE

"4-POINT" SMOOTHING TO DESEASONALIZE THE VARIABLE A

INDEX	104 VALUES FOR RAW DATA	4-POINT MOVING AVERAGE	RATIO
1	2742		
2	1614		
3	3543	2447.500	0.691
4	2843	2522.750	1.235
5	2438	2875.500	1.179
6	2528	3009.750	1.194
7	5459	3886.250	0.712
8	1201	4835.125	4.026
9	10292	4439.250	0.431
10	2257	4493.500	1.991
11	2555	4180.625	1.636
12	4539	3482.625	0.767
13	4451	4662.375	1.047
14	2514	6540.875	2.602
15	11736	7306.875	0.623
16	10386	7280.625	0.702
17	4732	6179.750	1.306
18	2087	4188.875	2.007
19	3292	3381.500	1.027
20	2903	4968.750	1.712
21	5756	8178.750	1.421
22	13761	12922.125	0.939
23	17298	17306.500	1.005
24	26844	19358.375	0.721
25	17530	18599.750	1.061
26	17762	14789.250	0.833
27	7228	10739.125	1.486
28	6430	7106.625	1.105
29	5543	5594.875	1.009
30	689	5929.000	8.605
31	12207	6220.375	0.510
32	4124	7240.875	1.756
33	10180	7594.750	0.746
34	4216	7342.125	1.741
35	11511	6478.375	0.563
36	2799	7756.500	2.771
37	4595	8633.750	1.879
38	20026	7184.875	0.359
39	2719	6260.625	2.303
40	0	3190.275	

41	0	596.375	
42	63	498.250	7.989
43	1930	509.500	0.264
44	0	529.750	
45	90	297.500	3.306
46	135	90.625	0.671
47	0	139.500	
48	275	158.375	0.576
49	206	162.750	0.790
50	170	128.750	0.757
51	0	737.000	
52	3	2242.250	747.417
53	5344	3366.625	0.630
54	7074	4459.250	0.630
55	2091	5772.625	2.761
56	6653	5546.250	0.834
57	9201	5103.250	0.555
58	1406	5124.125	3.644
59	4215	4240.625	1.006
60	4696	3955.625	0.842
61	4090	4228.250	1.034
62	4237	4449.750	1.050
63	3565	4667.750	1.309
64	7118	4719.625	0.663
65	3412	4930.125	1.445
66	5330	4662.875	0.875
67	4156	4151.875	0.999
68	4389	3401.500	0.775
69	2053	2700.125	1.315
70	686	2950.375	4.312
71	3189	3637.625	1.141
72	7422	4041.250	0.544
73	4454	3799.250	0.853
74	1514	2526.250	1.669
75	425	1042.000	2.452
76	2	534.875	267.437
77	0	2415.875	
78	1911	5027.300	2.631
79	15376	7297.750	0.484
80	6240	9780.625	1.567

81	11928	10692.375	0.896
82	9846	10501.875	1.067
83	14435	10792.125	0.748
84	5357	11621.125	2.169
85	15133	11836.000	0.782
86	13273	11643.125	0.877
87	12727	10722.750	0.843
88	5522	8469.000	1.534
89	7635	5981.750	0.787
90	2771	5789.125	2.089
91	3331	7722.875	2.318
92	13377	9700.250	0.725
93	15220	13465.375	0.835
94	10975	16454.750	1.499
95	25248	15673.875	0.621
96	15375	13585.500	0.884
97	6975	10349.000	1.484
98	2513	6939.750	2.762
99	7818	5663.750	0.724
100	5531	5980.375	1.081
101	6611	6080.125	0.920
102	5410	5865.750	1.084
103	5719		
104	5915		

APPENDIX D
WEIGHTED MOVING AVERAGE

"13-TERM" SMOOTHING WITH HENDERSON WEIGHTS FOR THE VARIABLE A

INDEX	104 VALUES FOR RAW DATA	HENDERSON SMOOTHING	RATIO
1	2742	2214.644	0.808
2	1614	2432.705	1.507
3	3543	2405.893	0.679
4	2043	2510.464	1.229
5	2438	2859.276	1.173
6	2528	3403.824	1.351
7	5459	3952.613	0.724
8	1281	4388.447	3.654
9	10292	4436.147	0.431
10	2257	4155.755	1.841
11	2555	3982.357	1.559
12	4539	4370.948	0.963
13	4451	5254.464	1.181
14	2514	6283.967	2.500
15	11736	6915.065	0.589
16	10386	6667.127	0.642
17	4732	5481.933	1.158
18	2087	4120.722	1.974
19	3292	3753.715	1.140
20	2903	5211.936	1.795
21	5756	8735.252	1.518
22	13761	13328.873	0.969
23	17298	17194.221	0.994
24	26844	19086.453	0.711
25	17530	18295.755	1.044
26	17762	15323.399	0.863
27	7228	11317.153	1.566
28	6430	7840.186	1.219
29	5543	5738.156	1.035
30	689	5287.861	7.675
31	12287	5977.496	0.490
32	4124	6578.161	1.595
33	10180	7014.953	0.689
34	4216	7426.321	1.762
35	11511	7905.066	0.687
36	2799	8177.268	2.921
37	4595	7971.577	1.735
38	20026	7125.179	0.356
39	2719	5489.303	2.019
40	0	3558.102	
41	0	1717.740	
42	63	426.468	6.769

(43	1938	-168.825	-0.083
44	8	-4.238	
(45	98	308.087	3.334
46	135	233.804	1.726
(47	8	39.888	
48	275	-178.416	-0.649
(49	206	-128.693	-0.556
50	170	298.979	1.712
51	8	971.313	
(52	3	2073.899	691.300
53	5344	3427.580	0.641
54	7074	4656.311	0.658
(55	2891	5452.655	2.608
56	6653	5692.409	0.856
(57	9281	5458.213	0.592
58	1406	4899.962	3.485
59	4215	4426.285	1.850
(60	4696	4186.627	0.892
61	4670	4145.289	1.014
(62	4237	4311.296	1.018
63	3565	4673.994	1.311
64	7118	4936.731	0.694
(65	3412	4895.683	1.435
66	5330	4527.815	0.849
(67	4156	3906.937	0.940
68	4389	3368.393	0.767
69	2053	3182.611	1.550
(70	686	3348.189	4.881
71	3189	3632.475	1.139
72	7422	3649.883	0.492
73	4454	3016.122	0.677
74	1514	2027.705	1.339
(75	425	1237.573	2.912
76	2	1260.501	630.250
77	8	2381.433	
(78	1911	4646.083	2.431
79	15076	7201.397	0.478
(80	6240	9240.868	1.481
81	11928	10501.341	0.880
82	9846	11241.963	1.142
83	14435	11631.048	0.806
84	5357	11914.929	2.224

(85	15133	12023.801	0.795
86	13273	11401.438	0.859
87	12727	9789.488	0.769
(88	5522	8027.481	1.454
89	7605	6508.055	0.856
90	2771	6103.423	2.203
(91	3331	7476.993	2.245
92	13377	10517.764	0.786
(93	15220	13647.542	0.897
94	10975	15559.041	1.418
95	25249	15507.265	0.614
(96	15375	13655.151	0.888
97	6975	10754.144	1.542
(98	2513	7991.058	3.180
99	7818	6147.303	0.786
100	5531	5413.714	0.979
(101	6611	5541.553	0.838
102	5410	5785.417	1.069
103	5719	5907.384	1.033
(104	5915	6004.114	1.015

"15-TERM" SMOOTHING WITH SPENCER WEIGHTS FOR THE VARIABLE A

INDEX	104 VALUES FOR RAW DATA	SPENCER SMOOTHING	RATIO
1	2742	2440.627	0.890
2	1614	2397.119	1.485
3	3543	2390.953	0.675
4	2043	2555.905	1.251
5	2438	2885.666	1.184
6	2520	3367.217	1.336
7	5459	3932.892	0.720
8	1201	4313.625	3.592
9	10292	4313.703	0.419
10	2257	4202.344	1.862
11	2555	4163.250	1.629
12	4539	4457.238	0.982
13	4451	5264.597	1.183
14	2514	6240.578	2.482
15	11736	6702.797	0.571
16	10386	6400.194	0.616
17	4732	5386.263	1.136
18	2087	4256.372	2.348
19	3292	4090.613	1.243
20	2903	5691.697	1.961
21	5756	9007.978	1.565
22	13761	13173.656	0.957
23	17298	16874.400	0.976
24	26344	18621.891	0.694
25	17530	17944.809	1.024
26	17762	15169.988	0.854
27	7228	11491.887	1.590
28	6430	8126.722	1.264
29	5543	6081.459	1.097
30	689	5526.500	8.021
31	12207	5789.576	0.474
32	4124	6468.644	1.569
33	10160	7067.319	0.634
34	4216	7491.100	1.777
35	11511	7803.797	0.678
36	2799	8114.516	2.899
37	4595	7922.303	1.724
38	20026	6978.434	0.348
39	2719	5497.706	2.022
40	0	3533.244	

41	0	1735.834	
42	63	552.731	8.774
43	1930	71.734	0.037
44	0	-13.478	
45	90	109.219	1.214
46	135	156.306	1.158
47	0	-9.906	
48	275	-110.575	-0.402
49	206	-48.078	-0.233
50	170	277.516	1.632
51	0	1042.466	
52	3	2163.591	721.197
53	5344	3403.491	0.637
54	7074	4567.328	0.646
55	2091	5381.578	2.574
56	6653	5611.241	0.843
57	9201	5381.003	0.585
58	1406	4972.491	3.537
59	4215	4494.666	1.066
60	4696	4195.241	0.893
61	4090	4200.338	1.027
62	4237	4389.916	1.036
63	3565	4646.344	1.303
64	7118	4855.100	0.682
65	3412	4823.209	1.414
66	5330	4463.859	0.837
67	4156	3956.450	0.952
68	4389	3473.812	0.791
69	2053	3254.344	1.585
70	686	3356.331	4.893
71	3189	3568.847	1.119
72	7422	3462.594	0.467
73	4454	2917.366	0.655
74	1514	2054.756	1.357
75	425	1335.853	3.143
76	2	1403.275	701.637
77	0	2634.325	
78	1911	4706.394	2.463
79	15076	7024.547	0.466
80	6240	9103.147	1.459

(81	11928	10467.412	0.878
82	9846	11218.809	1.139
(83	14435	11667.703	0.808
84	5357	12007.809	2.242
85	15133	11867.094	0.784
(86	13273	11140.819	0.839
87	12727	9813.591	0.771
(88	5522	8025.353	1.453
89	7605	6601.116	0.868
90	2771	6488.200	2.341
(91	3331	7935.075	2.382
92	13377	10486.425	0.784
93	15220	13367.322	0.878
(94	10975	15240.403	1.389
95	25248	15194.709	0.602
(96	15375	13496.541	0.878
97	6975	10854.713	1.556
(98	2513	8152.443	3.244
99	7818	6258.429	0.801
100	5531	5469.989	0.989
(101	6611	5364.177	0.811
102	5410	5565.473	1.329
(103	5719	5801.006	1.014
104	5915	5867.079	0.992

APPENDIX E
LINEAR REGRESSION

PARAMETER	EXPECTED VALUE	STANDARD ERROR	NON-SIMULTANEOUS 95.00% CONFIDENCE LIMITS	
A	4632.2	1102.3	2445.8	6818.6
B	26.407	18.221	-9.7354	62.549

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F-RATIO
REGRESSION	1	0.65430E+08	0.65430E+08	2.100
ERROR	102	0.31777E+10	0.31154E+08	
TOTAL	103	0.32431E+10		A 84.966% VALUE

0.0202 = INDEX OF DETERMINATION
 0.0106 = "ADJUSTED" INDEX OF DETERMINATION
 0.1420 = CORRELATION COEFFICIENT

5581.5 = STANDARD ERROR OF ESTIMATE
 92.735% OF MEAN OF A

TYPE 1 FOR CONFIDENCE LIMITS ON ESTIMATED A
 OR 2 FOR PREDICTION LIMITS ON OBSERVATIONS OF A
 OR 3 FOR RESIDUALS AND PERCENT DIFFERENCE
 OR 0 FOR NO TABULATION. WHICH --??

TIME	A OBSERVED	A ESTIMATED	NON-SIMULTANEOUS 95.00% PREDICTION LIMITS	
1	2742	4658.6	-6620.2	15937.
2	1614	4685.0	-6587.8	15958.
3	3543	4711.4	-6555.6	15979.
4	2043	4737.8	-6523.5	15999.
5	2438	4764.2	-6491.6	16020.
6	2520	4790.7	-6459.7	16041.
7	5459	4817.1	-6428.0	16062.
8	1201	4843.5	-6396.3	16083.
9	10292	4869.9	-6364.8	16105.
10	2257	4896.3	-6333.4	16126.

11	2555	4922.7	-6382.1	16147.
12	4539	4949.1	-6270.9	16169.
13	4451	4975.5	-6239.8	16191.
14	2514	5001.9	-6208.9	16213.
15	11736	5028.3	-6178.1	16235.
16	10386	5054.7	-6147.3	16257.
17	4732	5081.1	-6116.7	16279.
18	2087	5107.5	-6086.2	16301.
19	3292	5133.9	-6055.9	16324.
20	2903	5160.3	-6025.6	16346.
21	5756	5186.8	-5995.5	16369.
22	13761	5213.2	-5965.4	16392.
23	17298	5239.6	-5935.5	16415.
24	26844	5266.0	-5905.7	16438.
25	17530	5292.4	-5876.0	16461.
26	17762	5318.8	-5846.5	16484.
27	7228	5345.2	-5817.0	16507.
28	6430	5371.6	-5787.7	16531.
29	5543	5398.0	-5758.5	16554.
30	689	5424.4	-5729.4	16578.
31	12207	5450.8	-5700.4	16602.
32	4124	5477.2	-5671.5	16626.
33	10180	5503.6	-5642.8	16650.
34	4216	5530.0	-5614.1	16674.
35	11511	5556.5	-5585.6	16699.
36	2799	5582.9	-5557.2	16723.
37	4595	5609.3	-5528.9	16747.
38	20026	5635.7	-5500.8	16772.
39	2719	5662.1	-5472.7	16797.
40	0	5688.5	-5444.8	16822.
41	0	5714.9	-5417.0	16847.
42	63	5741.3	-5389.3	16872.
43	1930	5767.7	-5361.7	16897.
44	0	5794.1	-5334.2	16922.
45	90	5820.5	-5306.9	16948.
46	135	5846.9	-5279.6	16973.
47	0	5873.3	-5252.5	16999.
48	275	5899.7	-5225.5	17025.
49	206	5926.1	-5198.6	17051.
50	170	5952.6	-5171.9	17077.

51	0	5979.8	-5145.2	17103.
52	3	6005.4	-5118.7	17129.
53	5344	6031.8	-5092.3	17156.
54	7074	6058.2	-5066.0	17182.
55	2091	6084.6	-5039.8	17209.
56	6453	6111.0	-5013.8	17236.
57	9281	6137.4	-4987.9	17263.
58	1406	6163.8	-4962.0	17290.
59	4215	6190.2	-4936.3	17317.
60	4696	6216.6	-4910.7	17344.
61	4090	6243.0	-4885.3	17371.
62	4237	6269.4	-4859.9	17399.
63	3565	6295.8	-4834.7	17426.
64	7118	6322.3	-4809.6	17454.
65	3412	6348.7	-4784.6	17482.
66	5330	6375.1	-4759.7	17510.
67	4156	6401.5	-4734.9	17538.
68	4389	6427.9	-4710.3	17566.
69	2053	6454.3	-4685.7	17594.
70	686	6480.7	-4661.3	17623.
71	3139	6507.1	-4637.0	17651.
72	7422	6533.5	-4612.8	17680.
73	4454	6559.9	-4588.8	17709.
74	1514	6586.3	-4564.8	17737.
75	425	6612.7	-4541.0	17766.
76	2	6639.1	-4517.3	17796.
77	0	6665.5	-4493.7	17825.
78	1911	6691.9	-4470.2	17854.
79	15076	6718.4	-4446.8	17884.
80	6240	6744.8	-4423.6	17913.
81	11928	6771.2	-4400.5	17943.
82	9846	6797.6	-4377.4	17973.
83	14435	6824.0	-4354.5	18003.
84	5357	6850.4	-4331.8	18033.
85	15133	6876.8	-4309.1	18063.
86	13273	6903.2	-4286.5	18093.
87	12727	6929.6	-4264.1	18123.
88	5522	6956.0	-4241.8	18154.
89	7605	6982.4	-4219.6	18184.
90	2771	7008.8	-4197.5	18215.

91	3331	7035.2	-4175.5	18246.
92	13377	7061.6	-4153.6	18277.
93	15228	7088.1	-4131.9	18308.
94	18975	7114.5	-4110.2	18339.
95	25248	7140.9	-4088.7	18370.
96	15375	7167.3	-4067.3	18402.
97	6975	7193.7	-4046.0	18433.
98	2513	7220.1	-4024.8	18465.
99	7818	7246.5	-4003.8	18497.
100	5531	7272.9	-3982.8	18529.
101	6411	7299.3	-3962.0	18561.
103	5410	7352.1	-3920.6	18625.
103	5719	7352.1	-3920.6	18625.
104	5915	7378.5	-3900.1	18657.

5581.5 = STANDARD ERROR OF ESTIMATE
92.735% OF MEAN OF A

APPENDIX F
EXPONENTIAL SMOOTHING

OPTIMUM
 ALPHA
 0.50000

TYPE OF
 SMOOTHING
 1

SMOOTHED
 ABSOLUTE
 DEVIATION
 PER DATA POINT
 3189.2

-----FORECAST-----					
TIME	RESIDUE	COMPOSITE	ACTUAL	ERROR	% ERROR
6	2716.4	1516.1	2520.0	1003.9	66.22
7	3219.3	3632.7	5459.0	1826.3	50.27
8	4131.5	3069.3	1201.0	-1868.3	-60.87
9	3197.3	3749.8	10292.	6542.2	174.47
10	6468.4	5544.4	2257.0	-3287.4	-59.29
11	4824.7	5515.3	2555.0	-2960.3	-53.67
12	3344.6	2558.6	4539.0	1980.4	77.40
13	4334.8	5163.5	4451.0	-712.48	-13.80
14	3978.5	3330.7	2514.0	-816.70	-24.52
15	3570.2	4537.0	11736.	7199.0	158.67
16	7169.7	6660.0	10386.	3726.0	55.95
17	9032.7	10130.	4732.0	-5405.6	-53.32
18	6329.9	5958.3	2087.0	-3871.3	-64.97
19	4394.2	5637.3	3292.0	-2345.3	-41.60
20	3221.6	2988.1	2903.0	-85.110	-2.85
21	3179.0	4560.2	5756.0	1195.8	26.22
22	3776.9	3681.6	13761.	10079.	273.78
23	8816.6	10336.	17298.	6962.1	67.36
24	12298.	12340.	26844.	14504.	117.53
25	19549.	21207.	17530.	-3676.9	-17.34
26	17711.	17892.	17762.	-129.90	-0.73
27	17646.	19442.	7228.0	-12214.	-62.82
28	11539.	11858.	6430.0	-5428.3	-45.78
29	8825.1	10759.	5543.0	-5215.8	-48.48
30	6217.2	6674.4	689.00	-5985.4	-89.68

31	3224.5	5296.3	12207.	6910.7	130.48
32	6679.9	7275.1	4124.0	-3151.1	-43.31
33	5104.3	7314.2	10180.	2865.8	39.18
34	6537.2	7270.6	4216.0	-3054.6	-42.01
35	5009.9	7357.9	11511.	4153.1	56.44
36	7086.4	7957.9	2799.0	-5158.9	-64.83
37	4506.9	6993.1	4595.0	-2398.1	-34.29
38	3307.9	4317.5	26026.	15708.	363.83
39	11162.	13786.	2719.0	-11067.	-80.28
40	5628.4	6776.2	0.00000	-6776.2	-100.00
41	2240.3	5002.7	0.00000	-5002.7	-100.00
42	-261.05	1024.8	63.000	-961.83	-93.85
43	-741.97	2158.6	1930.0	-228.58	-10.59
44	-856.26	567.75	0.00000	-567.75	-100.00
45	-1140.1	1898.5	90.000	-1808.5	-95.26
46	-2044.4	-482.27	135.00	617.27	-127.99
47	-1735.8	1441.0	0.00000	-1441.0	-100.00
48	-2456.3	-756.03	275.00	1031.0	-136.37
49	-1940.8	1374.1	206.00	-1168.1	-85.01
50	-2524.8	-686.47	170.00	856.47	-124.76
51	-2096.6	1356.4	0.00000	-1356.4	-100.00
52	-2774.8	-798.33	3.0000	801.33	-100.38
53	-2374.2	1217.0	5344.0	4127.0	339.11
54	-310.65	1804.0	7074.0	5270.0	292.14
55	2324.4	6053.6	2091.0	-3962.6	-65.46
56	343.85	2595.8	6653.0	4057.2	156.30
57	2371.7	6239.1	9201.0	2961.9	47.47
58	3852.6	6243.5	1406.0	-4837.5	-77.48
59	1433.9	5439.4	4215.0	-1224.4	-22.51
60	821.69	3350.7	4696.0	1345.3	40.15
61	1494.4	5638.0	4090.0	-1548.0	-27.46
62	720.36	3387.5	4237.0	849.54	25.08
63	1145.1	5426.9	3565.0	-1861.9	-34.31
64	214.19	3019.4	7118.0	4098.6	135.74
65	2263.5	6683.4	3412.0	-3271.4	-48.95
66	627.80	3571.1	5330.0	1758.9	49.25
67	1507.2	6065.2	4156.0	-1909.2	-31.48

68	552.62	3634.1	4389.0	754.93	20.77
69	930.08	5626.2	2053.0	-3573.2	-63.51
70	-856.52	2363.1	606.00	-1677.1	-70.97
71	-1695.1	3139.2	3189.0	49.808	1.59
72	-1670.1	1687.6	7422.0	5734.4	339.81
73	1197.1	6169.4	4454.0	-1715.4	-27.81
74	339.36	3835.2	1514.0	-2321.2	-60.52
75	-821.23	4289.3	425.00	-3864.3	-90.09
76	-2753.4	880.58	2.0000	-878.58	-99.77
77	-3192.7	2056.0	0.00000	-2056.0	-100.00
78	-4220.6	-448.56	1911.0	2359.6	-526.03
79	-3040.8	2345.9	15076.	12730.	542.66
80	3324.2	7234.4	6240.0	-994.40	-13.75
81	2827.0	8351.9	11928.	3576.1	42.82
82	4615.1	8663.4	9846.0	1182.6	13.65
83	5206.4	10869.	14435.	3565.6	32.80
84	6989.2	11176.	5357.3	-5818.6	-52.07
85	4079.9	9881.0	15133.	5252.0	53.15
86	6705.9	11030.	13273.	2242.6	20.33
87	7827.2	13766.	12727.	-1039.4	-7.55
88	7387.5	11770.	5522.0	-6248.2	-53.08
89	4183.4	10261.	7605.0	-2655.7	-25.88
90	2855.5	7456.3	2771.0	-4685.3	-62.84
91	512.87	6728.3	3331.0	-3397.3	-50.49
92	-1185.8	3553.1	13377.	9823.9	276.49
93	3726.1	10080.	15220.	5140.3	51.00
94	6296.3	11173.	10975.	-198.32	-1.77
95	6197.1	12689.	25248.	12559.	98.98
96	12477.	17492.	15375.	-2116.9	-12.10
97	11418.	18048.	6975.0	-11073.	-61.35
98	5881.7	11035.	2513.0	-8522.0	-77.23
99	1620.7	8388.7	7818.0	-570.67	-6.80
100	1335.4	6626.8	5531.0	-1095.8	-16.54
101	787.50	7693.6	6611.0	-1002.6	-14.07
102	246.22	5675.7	5410.0	-265.74	-4.68
103	113.35	7157.5	5719.0	-1438.5	-20.10
104	-605.92	4961.7	5915.0	953.28	19.21

APPENDIX G
MADS AND TRACKING SIGNAL

"4" POINT" SMOOTHING WITH UNWEIGHTED MOVING AVERAGE

<u>Week</u>	<u>Actual Data (A_t)</u>	<u>Forecast (F_t)</u>	<u>$A_t - F_t$</u>	<u>$\Sigma(A_t - F_t)$</u>
1	2742	-	-	-
2	1614	-	-	-
3	3543	2447.500	1095.500	1095.500
4	2043	2522.750	-479.750	615.750
5	2438	2875.500	-437.500	178.250
6	2520	3009.750	-489.750	-311.500
7	5459	3886.250	1572.750	1261.250
8	1201	4835.125	-3634.125	-2372.875
9	10292	4439.250	5852.750	3479.875
10	2257	4493.500	-2236.500	1243.375
11	2555	4180.625	-1625.625	-382.250
12	4539	3482.625	1056.375	674.125
13	4451	4662.375	-211.375	462.750
14	2514	6540.875	-4026.875	-3564.125
15	11736	7306.875	4429.125	865.000
16	10386	7288.625	3097.375	3962.375
17	4732	6179.750	-1447.750	2514.625
18	2087	4188.875	-2101.875	412.750
19	3292	3381.500	-89.500	323.250
20	2903	4968.750	-2065.750	-1742.500
21	5756	8178.750	-2422.750	-4165.250
22	13761	12922.125	838.875	-3326.375
23	17298	17386.500	-88.500	-3414.875
24	26844	19358.375	7485.625	4070.750
25	17530	18599.750	-1069.750	3001.000
26	17762	14789.250	2972.750	5973.750
27	7228	10739.125	-3511.125	2462.625
28	6430	7106.625	-676.625	1786.000
29	5543	5594.875	-51.875	1734.125
30	689	5929.000	-5240.000	-3505.875
31	12207	6220.375	5986.625	2480.750
32	4124	7240.875	-3116.875	-636.125
33	10180	7594.750	2585.250	1949.125
34	4216	7342.125	-3126.125	-1177.000
35	11511	6478.375	5032.625	3855.625
36	2799	7756.500	-4957.500	-1101.875
37	4595	8633.750	-4038.750	-5140.625
38	20026	7184.875	12841.125	7700.500
39	2719	6260.625	-3541.625	4158.875
40	0	3190.875	-3190.875	968.000
41	0	596.875	-596.875	371.125
42	63	498.250	-435.250	-64.125

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
43	1930	509.500	1420.500	1356.375
44	0	529.750	-529.750	826.625
45	90	297.500	-207.500	619.125
46	135	90.625	44.375	663.500
47	0	139.500	-139.500	524.000
48	275	158.375	116.625	640.625
49	206	162.750	43.250	683.875
50	170	128.750	41.250	725.125
51	0	737.000	-737.000	-11.875
52	3	2242.250	-2239.250	-2251.125
53	5344	3366.625	1977.375	-273.750
54	7074	4459.250	2614.750	2341.000
55	2091	5772.625	-3681.625	-1340.625
56	6653	5546.250	1106.750	-233.875
57	9201	5103.250	4097.750	3863.875
58	1406	5124.125	-3718.125	145.750
59	4215	4240.625	-25.625	120.125
60	4696	3955.625	740.375	860.500
61	4090	4228.250	-138.250	722.250
62	4237	4449.750	-212.750	509.500
63	3565	4667.750	-1102.750	-593.250
64	7118	4719.625	2398.375	1805.125
65	3412	4930.125	-1518.125	287.000
66	5330	4662.875	667.125	954.125
67	4156	4151.875	4.125	958.250
68	4389	3401.500	987.500	1945.750
69	2053	2700.125	-647.125	1298.625
70	686	2958.375	-2272.375	-973.750
71	3189	3637.625	-448.625	-1422.375
72	7422	4041.250	3380.750	1958.375
73	4454	3799.250	654.750	2613.125
74	1514	2526.250	-1012.250	1600.875
75	425	1042.000	-617.000	983.875
76	2	534.875	-532.875	451.000
77	0	2415.875	-2415.875	-1964.875
78	1911	5027.000	-3116.000	-5080.875
79	15076	7297.750	7778.250	2697.375
80	6240	9780.625	-3540.625	-843.250
81	11928	10692.375	1235.625	392.375
82	9846	10501.875	-655.875	-263.500
83	14435	10792.125	3642.875	3379.375
84	5357	11621.125	-6264.125	-2884.750
85	15133	11836.000	3297.000	412.250
86	13273	11643.125	1629.875	2042.125
87	12727	10722.750	2004.250	4046.375
88	5522	8469.000	-2947.000	1099.375

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
89	7605	5981.750	1623.250	2722.625
90	2771	5789.125	-3018.125	-295.500
91	3331	7722.875	-4391.875	-4687.375
92	13377	9700.250	3676.750	-1010.625
93	15220	13465.375	1754.625	744.000
94	10975	16454.750	-5479.750	-4735.750
95	25248	15673.875	9574.125	4838.375
96	15375	13585.500	1789.500	6627.875
97	6975	10349.000	-3374.000	3253.875
98	2513	6939.750	-4426.750	-1172.875
99	7818	5663.750	2154.250	981.375
100	5531	5980.375	-449.750	531.625
101	6611	6080.125	530.875	1062.500
102	5410	5865.750	-455.750	606.750
103	5719	-	-	-
104	5915	-	-	-

$$\Sigma |A_t - F_t| = 230960.52$$

$$MAD = \frac{\Sigma |A_t - F_t|}{n} = \frac{230960.52}{104} = 2220.77$$

$$T.S. = \frac{\Sigma (A_t - F_t)}{MAD} = \frac{606.75}{230960.52} = .2732$$

"13 TERM" SMOOTHING WITH HENDERSON WEIGHTS

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma (A_t - F_t)$
1	2742	2214.644	527.356	527.356
2	1614	2432.705	-818.705	-291.349
3	3543	2405.893	1137.107	845.758
4	2043	2510.464	-467.464	378.294
5	2438	2859.276	-421.276	-42.982
6	2520	3403.824	-883.824	-926.806
7	5459	3952.613	1506.387	579.581
8	1201	4388.447	-3187.447	-2607.866
9	10292	4436.147	5855.853	3247.987
10	2257	4155.755	-1898.755	1349.232
11	2555	3982.357	-1427.357	-78.125
12	4539	4370.948	168.052	89.927
13	4451	5254.464	-803.464	-713.537
14	2514	6283.967	-3769.967	-4483.504
15	11736	6915.065	4820.935	337.431
16	10386	6667.127	3718.873	4056.304
17	4732	5481.933	-749.933	3306.371
18	2087	4120.722	-2033.722	1272.649
19	3292	3753.715	-461.715	810.934
20	2903	5211.936	-2308.936	-1498.002
21	5756	8735.252	-2979.252	-4477.254
22	13761	13328.873	432.127	-4045.127
23	17298	17194.221	103.779	-3941.348
24	26844	19086.453	7757.547	3816.199
25	17530	18295.755	-765.755	3050.444
26	17762	15323.399	2438.601	5489.045
27	7228	11317.153	-4089.153	1399.892
28	6430	7840.186	-1410.186	-10.294
29	5543	5738.156	-195.156	-205.450
30	689	5287.861	-4598.861	-4804.311
31	12207	5977.496	6229.504	1425.193
32	4124	6578.161	-2454.161	-1028.968
33	10180	7014.953	3165.047	2136.079
34	4216	7426.821	-3210.821	-1074.742
35	11511	7905.066	3605.934	2531.192
36	2799	8177.268	-5378.268	-2847.076
37	4595	7971.577	-3376.577	-6223.653
38	20026	7125.179	12900.821	6677.168
39	2719	5489.303	-2770.303	3906.865
40	0	3558.102	-3558.102	348.763
41	0	1717.740	-1717.740	-1368.977
42	63	426.468	-363.468	-1732.445

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
43	1930	-160.825	2090.825	358.380
44	0	-4.238	4.238	362.618
45	90	300.087	-210.087	152.531
46	135	233.004	-98.004	54.527
47	0	39.088	-39.088	15.439
48	275	-178.416	453.416	468.855
49	206	-120.693	326.693	795.548
50	170	290.979	-120.979	674.569
51	0	971.313	-971.313	-296.744
52	3	2073.899	-2070.899	-2367.643
53	5344	3427.580	1916.420	-451.223
54	7074	4656.311	2417.689	1966.466
55	2091	5452.655	-3361.655	-1395.189
56	6653	5692.409	960.591	-434.598
57	9201	5450.213	3750.787	3316.189
58	1406	4899.962	-3493.962	-177.773
59	4215	4426.205	-211.205	-388.978
60	4696	4186.627	509.373	120.395
61	4090	4145.289	-55.289	65.106
62	4237	4311.296	-74.296	-9.190
63	3565	4673.994	-1108.994	-1118.184
64	7118	4936.731	2181.269	1063.085
65	3412	4895.683	-1483.683	-420.598
66	5330	4527.015	802.985	382.387
67	4156	3906.937	249.063	631.450
68	4389	3368.303	1020.697	1652.147
69	2053	3182.611	-1129.611	522.536
70	686	3348.189	-2662.189	-2139.653
71	3189	3632.475	-443.475	-2583.128
72	7422	3649.883	3772.117	1188.989
73	4454	3016.122	1437.878	2626.867
74	1514	2027.705	-513.705	2113.162
75	425	1237.573	-812.573	1300.589
76	2	1260.501	-1258.501	42.088
77	0	2381.433	-2381.433	-2339.345
78	1911	4686.083	-2775.083	-5114.428
79	15076	7201.397	7874.603	2760.175
80	6240	9240.868	-3000.868	-240.693
81	11928	10501.341	1426.659	1185.966
82	9846	11241.963	-1395.963	-209.997
83	14435	11631.048	2803.952	2593.955
84	5357	11914.929	-6557.929	-3963.974
85	15133	12023.801	3109.199	-854.775
86	13273	11401.438	1871.562	1016.787
87	12727	9789.488	2937.512	3954.299
88	5522	8027.481	-2505.481	1448.818

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
89	7605	6508.055	1095.945	2545.763
90	2771	6103.423	-3332.423	-786.660
91	3331	7476.993	-4145.993	-4932.653
92	13377	10517.764	2859.236	-2073.417
93	15220	13647.542	1572.458	-500.959
94	10975	15559.041	-4584.041	-5085.000
95	25248	15507.265	9740.735	4655.735
96	15375	13655.151	1719.849	6375.584
97	6975	10754.144	-3779.144	2596.440
98	2513	7991.858	-5478.858	-2882.418
99	7818	6147.303	1670.697	-1211.721
100	5531	5413.714	117.286	-1094.435
101	6611	5541.553	1069.447	-24.988
102	5410	5785.417	-375.417	-400.405
103	5719	5907.384	-188.384	-588.789
104	5915	6004.114	-89.114	-677.903

$$\Sigma |A_t - F_t| = 237346.23$$

$$MAD = \frac{\Sigma |A_t - F_t|}{n} = \frac{237346.23}{104} = 2282.18$$

$$T.S. = \frac{\Sigma (A_t - F_t)}{MAD} = \frac{-677.903}{2282.18} = -.297$$

"15 TERM" SMOOTHING WITH SPENCER WEIGHTS

<u>Week</u>	<u>Actual Data (A_t)</u>	<u>Forecast (F_t)</u>	<u>A_t-F_t</u>	<u>Σ(A_t-F_t)</u>
1	2742	2440.627	301.373	301.373
2	1614	2397.119	-783.119	-481.746
3	3543	2390.953	1152.047	670.301
4	2043	2555.905	-512.905	157.396
5	2438	2885.666	-447.666	-290.270
6	2520	3367.217	-847.217	-1137.487
7	5459	3932.892	1526.108	388.621
8	1201	4313.625	-3112.625	-2724.004
9	10292	4313.703	5978.297	3254.293
10	2257	4202.344	-1945.344	1308.949
11	2555	4163.250	-1608.250	-299.301
12	4539	4457.238	81.762	-217.539
13	4451	5264.597	-813.597	-1031.136
14	2514	6240.578	-3726.578	-4757.714
15	11736	6702.797	5033.203	275.489
16	10386	6400.194	3985.806	4261.295
17	4732	5386.263	-654.263	3607.032
18	2087	4256.872	-2169.872	1437.160
19	3292	4090.613	-798.613	638.547
20	2903	5691.697	-2788.697	-2150.150
21	5756	9007.978	-3251.978	-5402.128
22	13761	13173.656	587.344	-4814.784
23	17298	16874.400	423.600	-4391.184
24	26844	18621.891	8222.109	3830.925
25	17530	17944.809	-414.809	3416.116
26	17762	15169.988	2592.012	6008.128
27	7228	11491.887	-4263.887	1744.241
28	6430	8126.722	-1696.722	47.519
29	5543	6081.459	-538.459	585.978
30	689	5526.500	162.500	748.478
31	12207	5789.578	6417.422	7165.900
32	4124	6468.644	-2344.694	4821.256
33	10180	7067.319	3112.681	7933.937
34	4216	7491.100	-3275.100	4658.837
35	11511	7803.797	3707.203	8366.040
36	2799	8114.516	-5315.516	3050.524
37	4595	7922.303	-3327.303	-276.779
38	20026	6978.434	13047.566	12770.787
39	2719	5497.706	-2778.706	9992.081
40	0	3553.244	-3553.244	6438.837
41	0	1735.834	-1735.834	4703.003
42	63	552.731	-489.731	4213.272

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
43	1930	71.734	1858.266	6071.538
44	0	-13.478	13.478	6085.016
45	90	109.219	-99.219	5985.797
46	135	156.306	-21.306	5964.491
47	0	-9.906	9.906	5974.397
48	275	-110.575	385.575	6359.972
49	206	-48.078	254.078	6614.050
50	170	277.516	-107.516	6506.534
51	0	1042.466	-1042.466	5464.068
52	3	2163.591	-2160.591	3303.477
53	5344	3403.491	1940.509	5243.986
54	7074	4567.328	2506.672	7750.658
55	2091	5381.578	-3290.578	4460.080
56	6653	5611.241	1041.759	5501.839
57	9201	5381.003	3819.997	9321.836
58	1406	4972.491	-3566.491	5754.839
59	4215	4494.666	-279.666	5475.173
60	4696	4195.241	500.759	5975.932
61	4090	4200.338	-110.338	5865.594
62	4237	4389.916	-152.916	5712.678
63	3565	4646.344	-1081.344	4631.334
64	7118	4855.100	2262.900	6894.234
65	3412	4823.209	-1411.209	5483.025
66	5330	4463.859	866.141	6349.166
67	4156	3956.450	199.550	6548.716
68	4389	3473.812	915.188	7463.904
69	2053	3254.344	-1201.344	6262.560
70	686	3356.331	-2670.331	3592.229
71	3189	3568.847	-379.847	3212.382
72	7422	3462.594	3959.406	7171.788
73	4454	2917.366	1536.634	8708.422
74	1514	2054.756	-540.756	8167.666
75	425	1335.853	-910.853	7256.813
76	2	1403.275	-1401.275	5855.538
77	0	2634.325	-2634.325	3221.213
78	1911	4706.394	-2795.394	425.819
79	15076	7024.547	8051.453	8477.272
80	6240	9103.147	-2863.147	5614.125
81	11928	10467.412	1460.588	7074.713
82	9846	11210.809	-1364.809	5709.904
83	14435	11667.703	2767.297	8477.201
84	5357	12007.809	-6650.809	1826.392
85	15133	11867.094	3265.906	5092.298
86	13273	11140.819	2132.181	7224.479
87	12727	9813.591	2913.409	10137.888
88	5522	8025.353	-2503.353	7634.535

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
89	7605	6601.116	1003.884	8638.419
90	2771	6488.200	-3717.200	4921.219
91	3331	7935.075	-4604.075	317.144
92	13377	10486.425	2890.575	3207.719
93	15220	13367.022	1852.978	5060.697
94	10975	15240.403	-4265.403	795.294
95	25248	15194.709	10053.291	10848.585
96	15375	13496.541	1878.459	12727.044
97	6975	10854.713	-3879.713	8847.331
98	2513	8152.443	-5639.443	3207.888
99	7818	6258.429	1559.571	4767.459
100	5531	5469.989	61.011	4828.470
101	6611	5364.177	1246.823	6075.293
102	5410	5565.473	-155.473	5919.820
103	5719	5801.006	-82.006	5837.814
104	5915	5867.079	47.921	5885.735

$$\Sigma |A_t - F_t| = 238177.52$$

$$MAD = \frac{\Sigma |A_t - F_t|}{n} = \frac{238177.52}{104} = 2290.17$$

$$T.S. = \frac{\Sigma (A_t - F_t)}{MAD} = \frac{5885.735}{2290.17} = 2.57$$

SIMPLE LINEAR REGRESSION

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
1	2742	4658.6	-1916.6	-1916.6
2	1614	4685.0	-3071.0	-4987.6
3	3543	4711.4	-1168.4	-6156.0
4	2043	4737.8	-2694.8	-8850.8
5	2438	4764.2	-2326.2	-11177.0
6	2520	4790.7	-2270.7	-13447.7
7	5459	4817.1	641.9	-12805.8
8	1201	4843.5	-3642.5	-16448.3
9	10292	4869.9	5422.1	-11026.2
10	2257	4896.3	-2639.3	-13665.5
11	2555	4922.7	-2367.7	-16033.2
12	4539	4949.1	-410.1	-16443.3
13	4451	4975.5	-524.5	-16497.8
14	2514	5001.9	-2487.9	-18985.7
15	11736	5028.3	6707.7	-12278.0
16	10386	5054.7	5331.7	-6946.3
17	4732	5081.1	-349.1	-7295.4
18	2087	5107.5	-3020.5	-10315.9
19	3292	5133.9	-1841.9	-12157.8
20	2903	5160.3	-2257.3	-14415.1
21	5756	5186.8	569.2	-13845.9
22	13761	5213.2	8547.8	-5298.1
23	17298	5239.6	12058.4	6760.3
24	26844	5266.0	21578.0	28338.3
25	17530	5292.4	12237.6	40575.9
26	17762	5318.8	12443.2	53019.1
27	7228	5345.2	1882.8	54901.9
28	6430	5371.6	1058.4	55960.3
29	5543	5398.0	145.0	55815.3
30	689	5424.4	-4735.4	51079.9
31	12207	5450.8	6756.2	57836.1
32	4124	5477.2	-1353.2	56482.9
33	10180	5503.6	4676.4	61159.3
34	4216	5530.0	-1314.0	59845.3
35	11511	5556.5	5954.5	65799.8
36	2799	5582.9	-2783.9	63015.9
37	4595	5609.3	-1014.3	62001.6
38	20026	5635.7	14390.3	76391.9
39	2719	5662.1	-2943.7	73448.2
40	0	5688.5	-5688.5	67759.7
41	0	5714.9	-5714.9	62044.8
42	63	5741.3	-5678.3	56366.5

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
43	1930	5767.7	-3837.7	52528.8
44	0	5794.1	-5794.1	46734.7
45	90	5820.5	-5730.5	41004.2
46	135	5846.9	-5711.9	35292.3
47	0	5873.3	-5873.3	29419.0
48	275	5899.7	-5624.7	23794.3
49	206	5926.1	-5720.1	18074.2
50	170	5952.6	-5782.6	12291.6
51	0	5979.0	-5979.0	6312.6
52	3	6005.4	-6002.4	310.2
53	5344	6031.8	-687.8	-377.6
54	7074	6058.2	1015.8	638.2
55	2091	6084.6	-3993.6	-3355.4
56	6653	6111.0	542.0	-2813.4
57	9201	6137.4	3063.6	250.2
58	1406	6163.8	-4757.8	-4507.6
59	4215	6190.2	-1948.8	-6456.4
60	4696	6216.6	-1520.6	-7977.0
61	4090	6243.0	-2153.0	-10130.0
62	4237	6269.4	-2032.4	-12162.4
63	3565	6295.8	-2730.8	-14893.2
64	7118	6322.3	795.7	-14097.5
65	3412	6348.7	-2936.7	-17034.2
66	5330	6375.1	-1045.1	-18079.3
67	4156	6401.5	-2245.5	-20324.8
68	4389	6427.9	-2038.9	-22363.7
69	2053	6454.3	-4401.3	-26765.0
70	686	6480.7	-5794.7	-32559.7
71	3189	6507.1	-3318.1	-35877.8
72	7422	6533.5	888.5	-34989.3
73	4454	6559.9	-2105.9	-37095.2
74	1514	6586.3	-5072.3	-42167.5
75	425	6612.7	-6187.7	-48355.2
76	2	6639.1	-6637.1	-54992.3
77	0	6665.5	-6665.5	-61657.8
78	1911	6691.9	-4780.9	-66438.7
79	15076	6718.4	8357.6	-58081.1
80	6240	6744.8	-504.8	-58585.9
81	11928	6771.2	5156.8	-53429.1
82	9846	6797.6	3048.4	-50380.7
83	14435	6824.0	7611.0	-42769.7
84	5357	6850.4	-1493.4	-44263.1
85	15133	6876.8	8256.2	-36006.9
86	13273	6903.2	6369.8	-29637.1
87	12727	6929.6	5797.4	-23839.7
88	5522	6956.0	-1434.0	-25273.7

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
89	7605	6982.4	622.6	-24651.1
90	2771	7008.8	-4237.8	-28888.9
91	3331	7035.2	-3704.2	-32593.1
92	13337	7061.6	6275.4	-26317.7
93	15220	7088.1	8131.9	-18185.8
94	10975	7114.5	3860.5	-14325.3
95	25248	7140.9	18107.1	3781.8
96	15375	7167.3	8207.7	11989.5
97	6975	7193.7	-218.7	11770.8
98	2513	7220.1	-4707.1	7063.7
99	7818	7246.5	571.5	7635.2
100	5531	7272.9	-1741.9	5893.2
101	6611	7299.3	-688.3	5205.0
102	5410	7352.1	-1942.1	3262.9
103	5719	7352.1	-1633.1	1629.8
104	5915	7378.5	-1463.5	166.3

$$\Sigma |A_t - F_t| = 439715.1$$

$$MAD = \frac{\Sigma |A_t - F_t|}{n} = \frac{439715.1}{104} = 4228.03$$

$$T.S. = \frac{\Sigma (A_t - F_t)}{MAD} = \frac{166.3}{4228.03} = .039$$

EXPONENTIAL SMOOTHING

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma (A_t - F_t)$
1	2742	-	-	-
2	1614	-	-	-
3	3543	-	-	-
4	2043	-	-	-
5	2438	-	-	-
6	2520	1516.1	1003.90	1003.90
7	5459	3632.7	1826.30	2830.20
8	1201	3069.3	-1868.30	961.90
9	10292	3749.8	6542.20	7504.10
10	2257	5544.4	-3287.40	4216.70
11	2555	5515.3	-2960.30	1256.40
12	4539	2558.6	1980.40	3236.80
13	4451	5163.5	-712.50	2524.30
14	2514	3330.7	-816.70	1707.60
15	11736	4537.0	7199.00	8906.60
16	10386	6660.0	3726.00	12632.60
17	4732	10138.0	-5405.60	7227.00
18	2087	5958.3	-3871.30	3355.70
19	3292	5637.3	-2345.30	1010.40
20	2903	2988.1	-85.10	925.30
21	5756	4560.2	1195.90	2121.10
22	13761	3681.6	10079.40	12200.50
23	17298	10336.0	6962.00	19162.50
24	26844	12340.0	14504.00	33666.50
25	17530	21207.0	-3677.00	29989.50
26	17762	17892.0	-130.00	29859.50
27	7228	19442.0	-12214.00	17645.50
28	6430	11858.0	-5428.00	12217.50
29	5543	10759.0	-5216.00	7001.50
30	689	6674.4	-5985.40	1016.10
31	12207	5296.3	6910.70	7926.80
32	4124	7275.1	-3151.10	4775.70
33	10180	7314.2	2865.80	7641.50
34	4216	7270.6	-3054.60	4586.90
35	11511	7357.9	4153.10	8740.00
36	2799	7957.9	-5158.90	3581.10
37	4595	6993.1	-2398.10	1183.00
38	20026	4317.5	15708.50	16891.50
39	2719	13786.0	-11067.00	5824.50
40	0	6776.2	-6676.20	-851.70
41	0	5002.7	-5002.70	-5854.40
42	63	1024.8	-961.83	-6816.23

Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
43	1930	2158.6	-228.60	-7044.83
44	0	567.7	-567.75	-7612.58
45	90	1898.5	-1808.50	-9421.08
46	135	-482.2	617.27	-8803.81
47	0	1441.0	-1441.00	-10244.81
48	275	-756.0	1031.03	-9213.78
49	206	1374.1	-1168.10	-10381.88
50	170	-686.4	856.47	-9525.41
51	0	1356.4	-1356.40	-10881.81
52	3	-798.3	801.33	-10080.48
53	5344	1217.0	4127.00	-5953.48
54	7074	1804.0	5270.00	-683.48
55	2091	6053.6	-3962.60	-4646.08
56	6653	2595.8	4057.20	-588.88
57	9201	6239.1	2961.90	2373.02
58	1406	6243.5	-4837.50	-2464.48
59	4215	5439.4	-1224.40	-3688.88
60	4646	3350.7	1345.30	-2343.58
61	4090	5638.0	-1548.00	-3891.58
62	4237	3387.5	849.50	-3042.08
63	3565	5426.9	-1861.90	-4903.98
64	7118	3019.4	4098.60	-805.38
65	3412	6683.4	-3271.40	-4076.78
66	5330	3571.1	1758.90	-2317.88
67	4156	6065.2	-1909.20	-4227.08
68	4389	3634.1	754.90	-3472.18
69	2053	5626.2	-3573.20	-7045.38
70	686	2363.1	-1677.10	-8722.48
71	3189	3139.2	49.80	-8672.68
72	7422	1687.6	5734.40	-2938.28
73	4454	6169.4	-1715.40	-4653.68
74	1514	3835.2	-2321.20	-6974.88
75	425	4289.3	-3864.30	-10839.18
76	2	880.5	-878.58	-11717.76
77	0	2056.0	-2056.00	-13773.76
78	1911	-448.5	2359.56	-11414.20
79	15076	2345.9	12730.10	1315.90
80	6240	7234.4	-994.40	321.50
81	11928	8351.9	3576.10	3897.60
82	9846	8663.4	1182.60	5080.20
83	14435	10869.0	3566.00	8646.20
84	5357	11176.0	-5819.00	2827.20
85	15133	9881.0	5252.00	8079.20
86	13273	11030.0	2243.00	10322.20
87	12727	13766.0	-1039.00	9283.20
88	5522	11770.0	-6248.00	3035.20

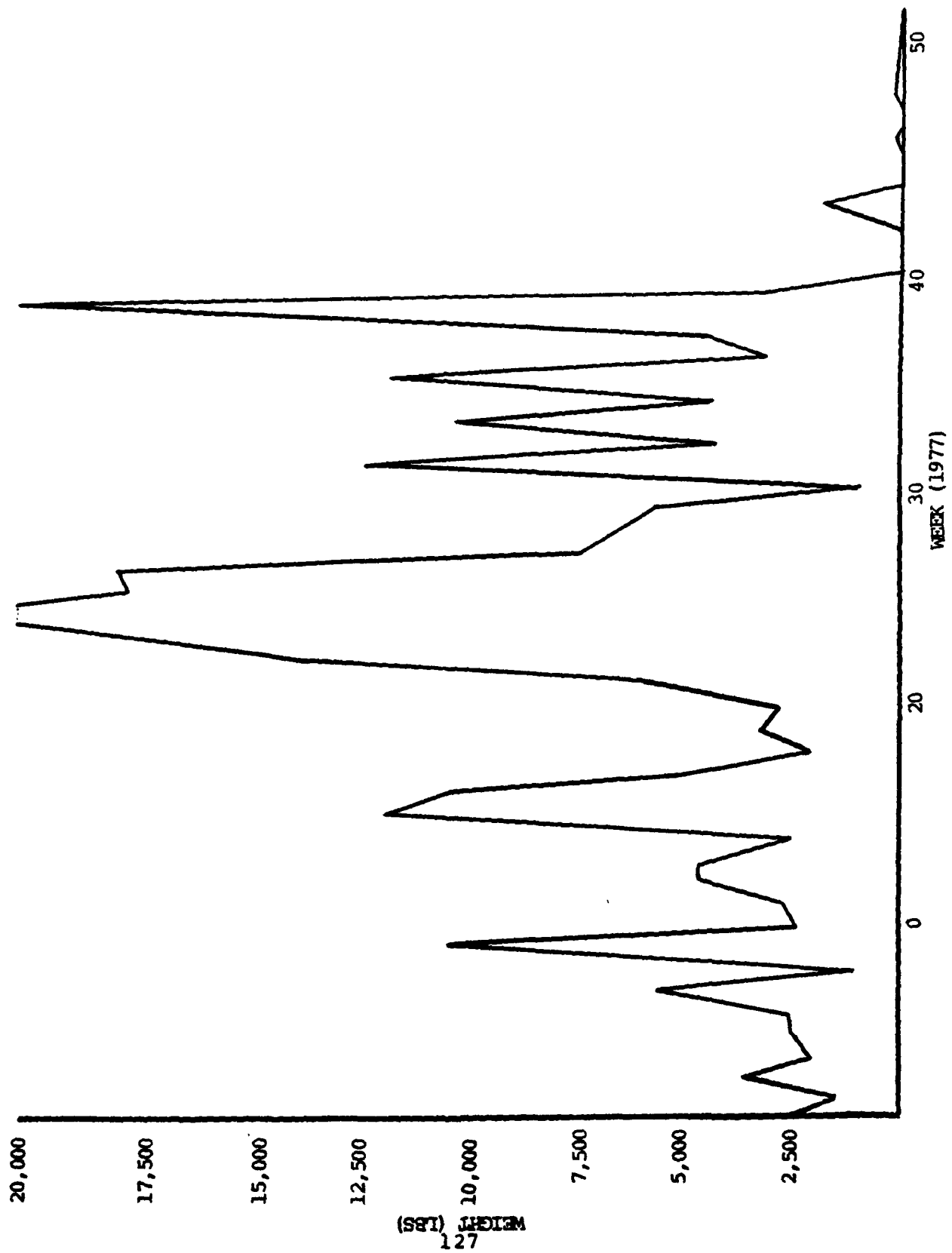
Week	Actual Data (A_t)	Forecast (F_t)	$A_t - F_t$	$\Sigma(A_t - F_t)$
89	7605	10261.0	-2656.00	379.20
90	2771	7456.3	-4685.30	-4306.10
91	3331	6728.3	-3397.30	-7703.40
92	13377	3553.1	9823.90	2120.50
93	15220	10080.0	5140.00	7260.50
94	10975	11173.0	-198.00	7062.50
95	25248	12689.0	12559.00	19621.50
96	15375	17492.0	-2117.00	17504.50
97	6975	18048.0	-11073.00	6431.50
98	2513	11035.0	-8522.00	-2090.50
99	7818	8388.7	-570.70	-2661.20
100	5531	6626.8	-1095.80	-3757.00
101	6611	7693.6	-1082.60	-4839.60
102	5410	5675.7	-265.70	-5105.30
103	5719	7157.5	-1438.50	-6543.80
104	5915	4961.7	953.30	-5590.50

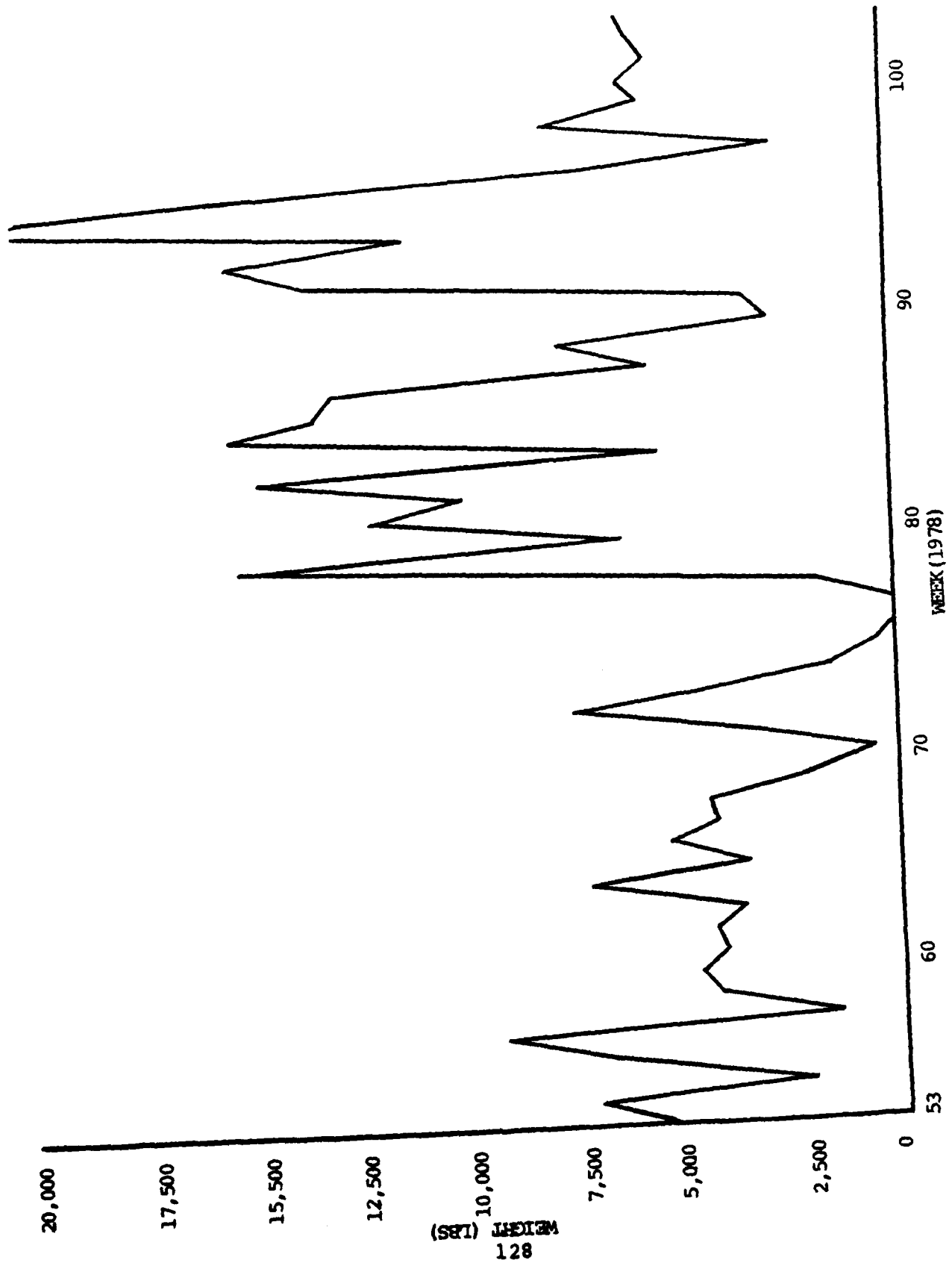
$$\Sigma |A_t - F_t| = 362303.11$$

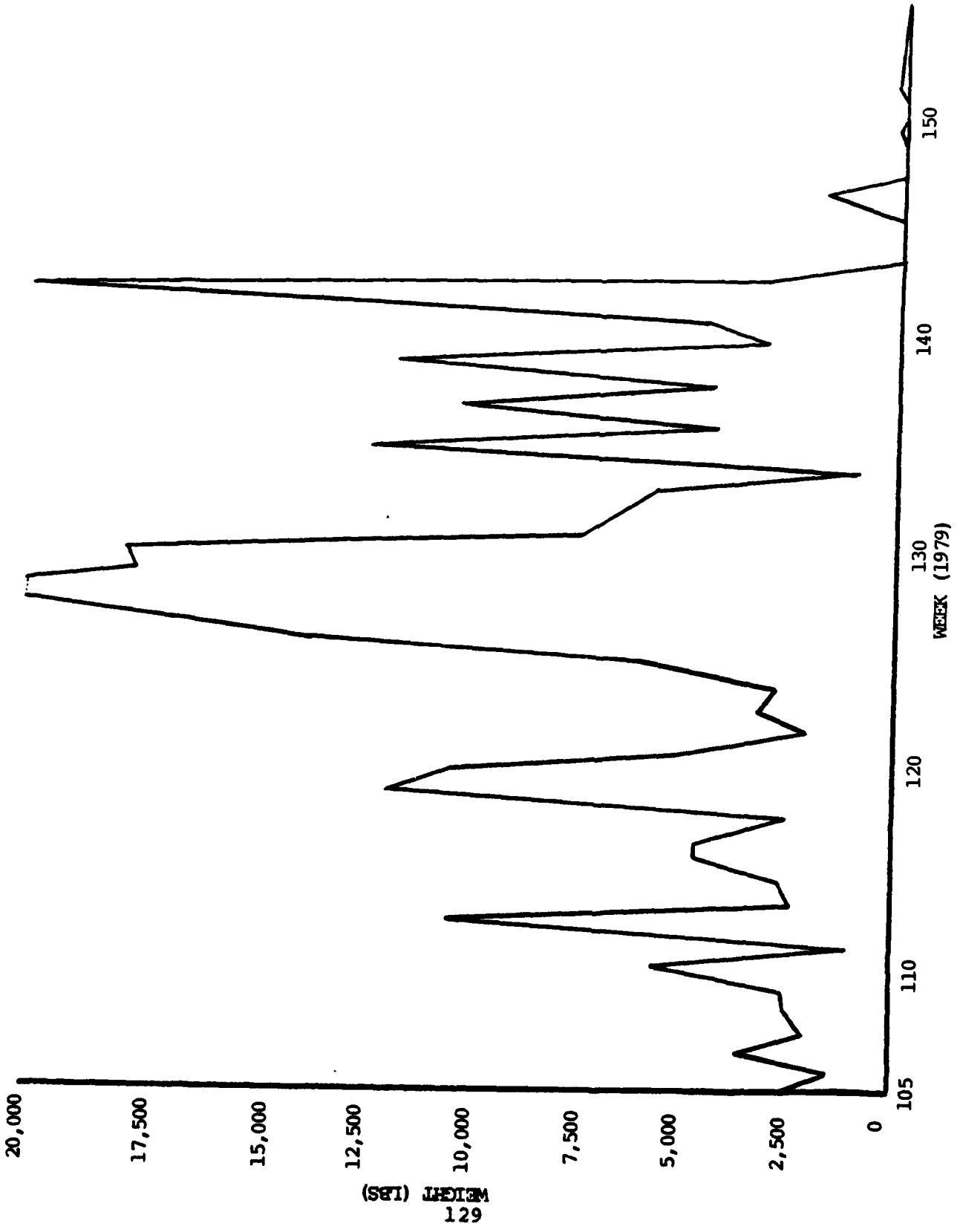
$$MAD = \frac{\Sigma |A_t - F_t|}{n} = \frac{362303.11}{104} = 3483.68$$

$$T.S. = \frac{\Sigma (A_t - F_t)}{MAD} = \frac{-5590.5}{3483.68} = -1.605$$

APPENDIX H
SEASONAL ANALYSIS







SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. Chase, Richard B., and Nicholas J. Aquilano. Production and Operations Management: A Life Cycle Approach. Homewood IL: Richard D. Irwin, Inc., 1977.
2. Cieply, John M., and Norm Cohen. HQ, Air Force Contract Maintenance Center, Maintenance Contract Administration Branch, Wright-Patterson AFB OH. Personal interview. 25 August 1980.
3. Fisher, Jack. Data Automation Center, Financial Systems Branch, Transportation Management Group, Air Force Logistics Command, Wright-Patterson AFB OH. Personal interview. 9 October 1980.
4. Forster, Captain John R., USA, and others. "A Study to Determine the Role of Competition in Contracting for the Movement of Air Freight Within the Domestic Market." Unpublished master's thesis. LSSR 9-80. AFIT/SL, Wright-Patterson AFB OH, June 1980.
5. Henderson, J. Traffic Management Specialist, LOGAIR Requirements Branch, Directorate of Distribution, Air Force Logistics Command, Wright-Patterson AFB OH. Personal interview. 9 October 1980.
6. "Management of the Logistics Airlift System Contracted for by the Air Force." Unpublished report No. 23865, U.S. General Accounting Office, Washington DC, December 1968.
7. Mendenhall, William, and James E. Reinmuth. Statistics for Management and Economics. North Scituate MA: Duxbury Press, 1974.
8. Military Airlift Command. Contracts F11626-80-C-0004 and Amendment P00003; F11626-80-C-0005 and Amendment P00003; F11626-80-C-0006 and Amendment P00003; 01 February 1980.
9. Neter John, William Wasserman, and G. A. Whitmore. Applied Statistics. Boston: Allyn and Bacon, Inc., 1977.

10. Payne, Captain Milton O., Jr., USAF, and Captain Darryl A. Scott, USAF. "The LOGAIR Route Structure: An Exploration of the Single-Hub Concept." Unpublished master's thesis. LSSR 40-80. AFIT/SL, Wright-Patterson AFB OH, June 1980.
11. Salzman, Lawrence. Computerized Economic Analysis. New York: McGraw-Hill Book Company, 1968.
12. Tersine, Richard J. Production/Operations Management: Concepts, Structure, & Analysis. New York: Elsevier North Holland, Inc., 1980.
13. USAF, Air Force Audit Agency. "Summary Report of Audit: Effectiveness of the Operational Support Provided by Logistics Airlift (LOGAIR) System." Unpublished report No. 87339, Air Force Audit Agency, Washington DC, 30 August 1978.
14. U.S. Department of the Air Force. Air Logistics Command. FY-80 LOGAIR Flight Schedules and Routing Guide. HQ AFLC: Wright-Patterson AFB OH, 1 February 1980.
15. _____. Air Force Logistics Command. Headquarters Operating Instructions 70-I. Unpublished Operating Instructions, 20 April 1976.
16. _____. USAF Logistical Airlift Briefing--LOGAIR Briefing Test. HQ AFLC: Wright-Patterson AFB OH, October 1977.
17. _____. USAF Logistics Airlift (LOGAIR) Traffic Regulation. AFR 76-1. Washington: Government Printing Office, 25 July 1977.
18. U.S. Department of Defense. Armed Services Procurement Regulation. 1976 edition. Washington: Government Printing Office, 1 October 1976.

B. RELATED SOURCES

Alexander, Major E. J., USAF, and others. "High Speed Transportation--Its Present and Future Service Under Changing Logistics Concepts." Unpublished master's thesis. LD 03564. AFIT/SL, Wright-Patterson AFB OH, June 1961. ADA 266746.

Boudreaux, Major Elsie J., USAF, and Major John B. Olansen, USAF. "The Design of LOGAIR Feeder Routes." Unpublished master's thesis. LSSR 37-77A. AFIT/SL, Wright-Patterson AFB OH, June 1977. ADA 044170.

Kelsey, Colonel David S., USAF, and Major Robert S. Tripp, USAF. "Logistics Support Alternatives: An Evaluation of LOGAIR Options." Unpublished report No. LD 43831A, Air Force Logistics Command, Wright-Patterson AFB OH, January 1979.

Kipp, Robert. History of the AMC Contract Airlift System (LOGAIR) 1949-1955. Wright-Patterson AFB OH, HQ, Air Materiel Command, March 1956.

McClish, Captain Paul S., USAF, and Major Robert S. Tripp, USAF. "Air Force Logistics Command (AFLC) Initiatives to Improve Support Readiness: An Evaluation of Transportation Alternatives." Unpublished report No. XRS 79-9A. Air Force Logistics Command, Wright-Patterson AFB OH, May 1977.

McPherson, Captain Michael F., USAF, and Captain Brian O'Hara, USAF. "A Computer-Assisted Method for Determining LOGAIR Route Structures." Unpublished master's thesis. SLSR 17-76A. AFIT/SL, Wright-Patterson AFB OH, June 1976. ADA 030288.

Palamatier, Lieutenant Commander Phillip E., USN, and Major Gary T. Prescott, USAF. "The Feasibility of Developing and Solving a Model to Determine LOGAIR Routine Structures." Unpublished master's thesis. SLSR 30-75B. AFIT/SL, Wright-Patterson AFB OH, August 1975. ADA 066341.

U.S. Department of the Air Force. Air Force Logistics Command. AFLC Logistical Airlift Briefing--LOGAIR Briefing Test. HQ AFLC: Wright-Patterson AFB OH, October 1977.

_____. Airlift Requirements Regulation. AFLC Regulation 75-5. HQ AFLC: Wright-Patterson AFB OH, October 1977.

_____. FY 80 Cargo Shipments Table. HQ AFLC: Wright-Patterson AFB OH, 1980.

. FY 80 LOGAIR Flight Schedules and Routing Guide.
HQ AFLC: Wright-Patterson AFB OH, 1 February 1980.

Van Valkenburgh, Major Nicholas, USAF. "LOGAIR Mark 2--
An Alternative Logistics Airlift System." Unpublished
research study No. 2470-79. Air Command and Staff
College, Maxwell AFB AL, April 1979. ADA 039213C.

END

DATE
FILMED

10-81

DTIC