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IMPACT OF EXTERNAL ENVIRONMENTAL FACTORS ON MINUTEMAN III  
INERTIAL GUIDANCE SYSTEM (NS-20) FAILURES

Gerald L. Clemons, et al

Air Force Institute of Technology  
Wright-Patterson Air Force Base, Ohio

August 1975

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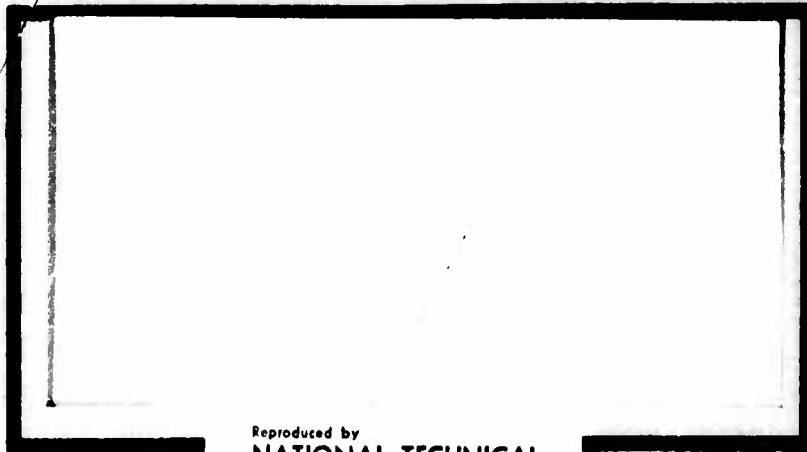
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IMPACT OF EXTERNAL ENVIRONMENTAL  
FACTORS ON MINUTEMAN III  
INERTIAL GUIDANCE SYSTEM  
(NS-20) FAILURES

Gerald L. Clemons, Major, USAF  
Chris A. Schell, Captain, USAF

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This study is a preliminary search to determine if a relationship exists between Minuteman III Guidance System (NS-20) failures and the external environmental factors of temperature, wind speed, wind direction, humidity, and barometric pressure. Multiple regression analysis was used to determine what degree of relationship, if any, existed between NS-20 failures and several combinations of environmental factors. The search was extended to determine whether or not a relationship existed between external environmental factors and the failure of subcomponents of the NS-20, i.e., the Digital Computer Unit (DCU) and the Pendulous Integrating Gyroscopic Assembly (PIGA). Environmental conditions existing at the time of failure and prior to the time of failure were included. The strongest relationship was found to exist between failures of the DCU and a limited combination of environmental factors existing at the time of failure (humidity, barometric pressure, wind speed, and wind direction), and the rate-of-temperature change existing prior to the time of failure. The researchers concluded the relationship was significant enough to warrant further study.

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IMPACT OF EXTERNAL ENVIRONMENT FACTORS ON MINUTEMAN III  
INERTIAL GUIDANCE SYSTEM (NS-20) FAILURES

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

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Major, USAF

Chris A. Schell, BA  
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August 1975

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This thesis, written by

Major Gerald L. Clemons

and

Captain Chris A. Schell

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

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## CHAPTER I

### INTRODUCTION

#### Statement of the Problem

Environmental control is an important part of the Minuteman weapon system. Critical temperature and humidity ranges should be maintained for the operation of the electronic equipment and the missile (7:1). The failure rate for the Minuteman III missile guidance set (NS-20) seems to be greater during the spring and fall months. Hence there is reason to believe the environmental control system for the Minuteman III weapon system is not protecting the missile and its electronic equipment from changes in the external environment (15). If there is a relationship between changes in external environmental conditions and the failure rate of the NS-20 guidance system, then action could be initiated to correct the problem and possibly reduce the number of NS-20 failures.

#### Definitions

Chiller Unit--a component of the environmental control system which cools a brine solution. The brine solution then cools a sodium dichromate solution which in turn cools selected components within the NS-20 guidance system (4:24).

Digital Computer Unit (DCU)--converts sensor data to stabilization and sensing signals. Converts inertial measuring unit velocity and angular attitude signals to control signals for staging, thrust termination, pre-arming, re-entry system disconnect and other flight functions. Monitors guidance control systems to provide proper response to status request messages and executes the operational ground program (25:1-4).

Failure Rate--the number of NS-20 failures that normally occur within a specified period of time. Therefore, any given failure rate may vary according to a function of time. See Chapter I, Failure Rate and Time Between Successive Failures.

Flight Control Group--the first, second and third stage motor control systems. Also includes the Propulsion System Rocket Engine for the Minuteman III missile (6:54).

Gyro Stabilized Platform--provides information concerning missile attitude acceleration and velocity to digital computer unit (25:1-3).

Missile Guidance Control System--the complete guidance control system consisting of the missile guidance set (NS-20) and the flight control group (25:1-2).

Missile Guidance Set Control--interpreting medium between gyro stabilized platform and digital computer unit (25:1-2).

Missile Guidance Set (NS-20)--consists of the missile guidance set control, gyro stabilized platform, digital computer unit, battery power supply, and the control and discrete amplifier assembly (25:1-2).

Pendulous Integrating Gyro Accelerometer (PIGA)--a device located in the gyro unit which detects changes in acceleration. This information is then sent to the on-board computer which then calculates the missile's velocity and the distance it has travelled (9:5).

Retest OK (RTOK)--a term used by the depot to identify a missile guidance set (NS-20) that gave failure indications and shutdown at the missile site, but functioned properly when analyzed at the depot (19).

Time Between Successive Failures (TBSF)--the time period between one NS-20 failure and the next. As the TBSF decreases/increases, the failure rate increases/decreases. See Chapter I, Failure Rate and Time Between Successive Failures.

#### Justification of Research

The Minuteman III guidance and control system consists of a missile guidance set (NS-20) and a flight control group (6:49-50). The guidance and control system performs both ground and in-flight functions. On the ground, the system maintains operational readiness of the site through self-testing, spatial orientation to the launch point, and automatic adjustment of navigation parameters. The

guidance and control system also processes remote commands and provides status reports on missile and launch facility equipment. During the boost phase, the guidance system performs inertial navigation, flight control, staging, and thrust termination. The primary component of the guidance and control system is the missile guidance set (NS-20). The missile guidance set is a cylindrical missile body section located forward of the propulsion system rocket engine (see Figure 1(6:54)). Additionally, the missile guidance set houses the gyro-stabilized platform, missile guidance set control, digital control unit, amplifier assembly, and the battery power supply as shown in Figure 2.

When the NS-20 fails, the missile maintenance officer becomes involved. His job is to take whatever action is necessary to return the missile to alert status. Approximately 60 to 75 manhours are required to remove and replace the NS-20 (21). Only 20 to 25 manhours are required for the actual removal and replacement of the NS-20. The remainder of the time is spent in preparation and travel to and from the missile site (21). To support this task, two specially equipped vehicles are required: a maintenance van and a payload transporter (6:63-64).

The removal and replacement procedure is accomplished by a missile maintenance team composed of five highly trained technicians (21). This procedure requires

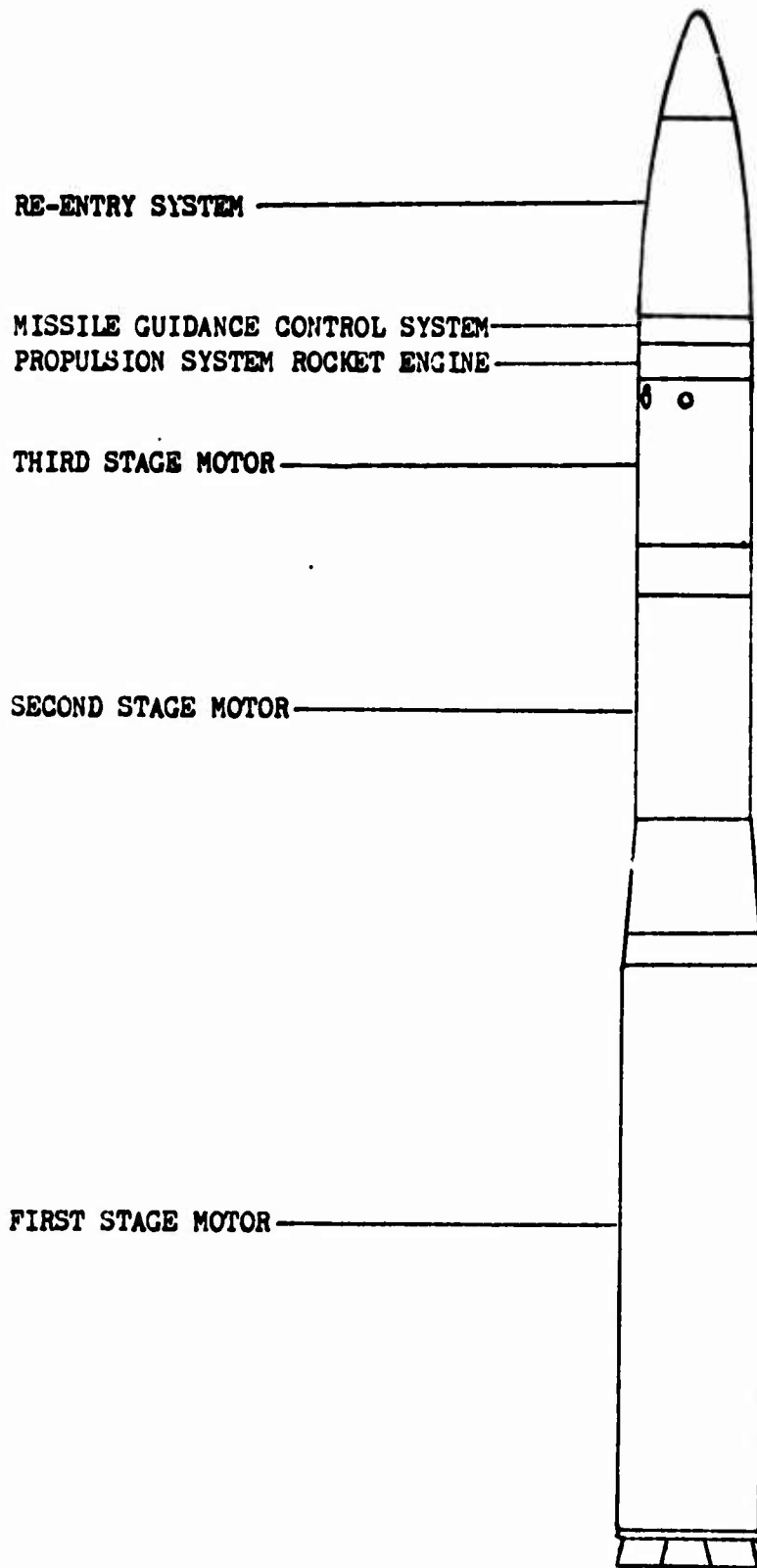


Figure 1. Missile Component Location

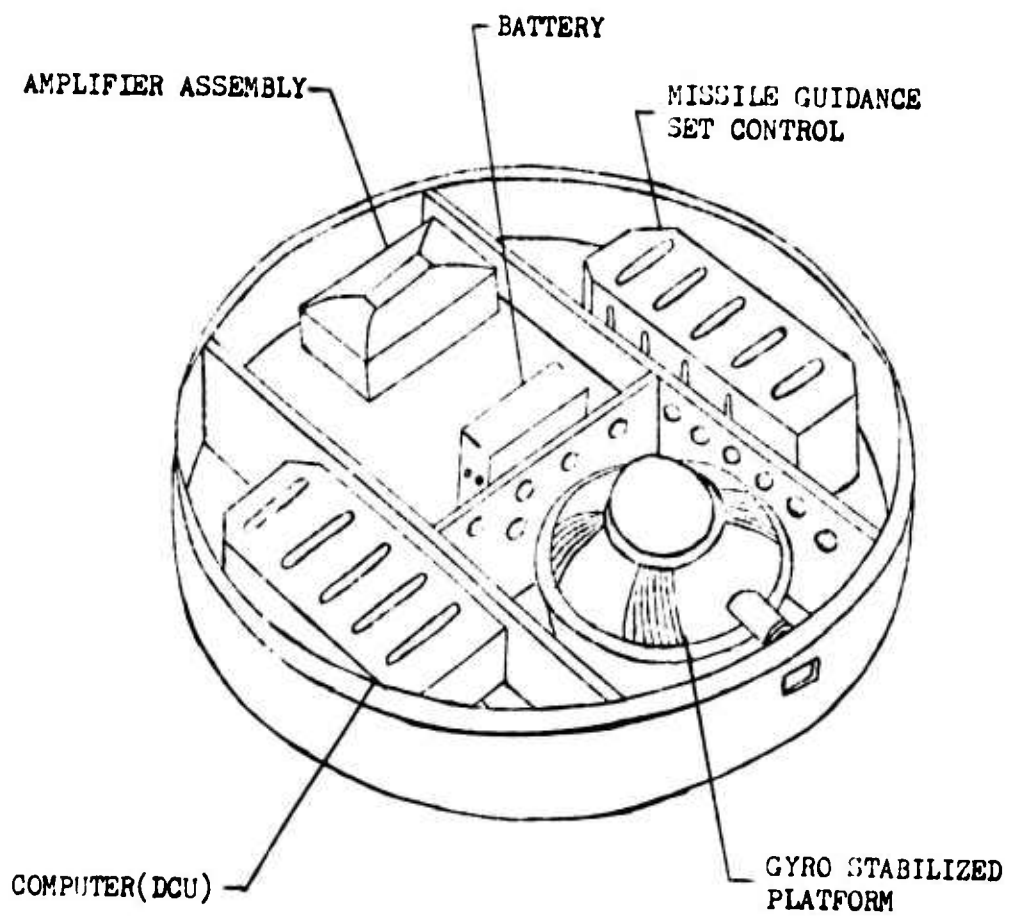


Figure 2. NS-20 Missile Guidance Set

the following sequence: (1) remove the re-entry system (warhead), (2) remove the defective NS-20 guidance system, (3) install the new NS-20 guidance system, and (4) replace the re-entry system.

The maintenance officer's task is complicated by the manner in which the Minuteman missile sites are deployed. The squadrons are dispersed over large areas. For example, the average site at Grand Forks AFB, North Dakota is approximately 75 surface miles from the support base (see Figure 3).

Another complicating factor is that all Minuteman units are either involved in or scheduled for a major modification program (1:3-3). These programs create many problems for unit maintenance personnel. One is the efficient use of test and support equipment. Since only a limited number of certain equipment items are available, maintenance organizations share these items with contractors performing weapon system modifications. At times the combined requirements of the contractor and the maintenance organization exceed available supply. Therefore, neither is able to perform in an efficient manner. The payload transporter is one of the items that is frequently in short supply (3:5).

If the failure rate of the NS-20 could be reduced, then the workload of the Minuteman maintenance organization might also be reduced as well as its requirement for

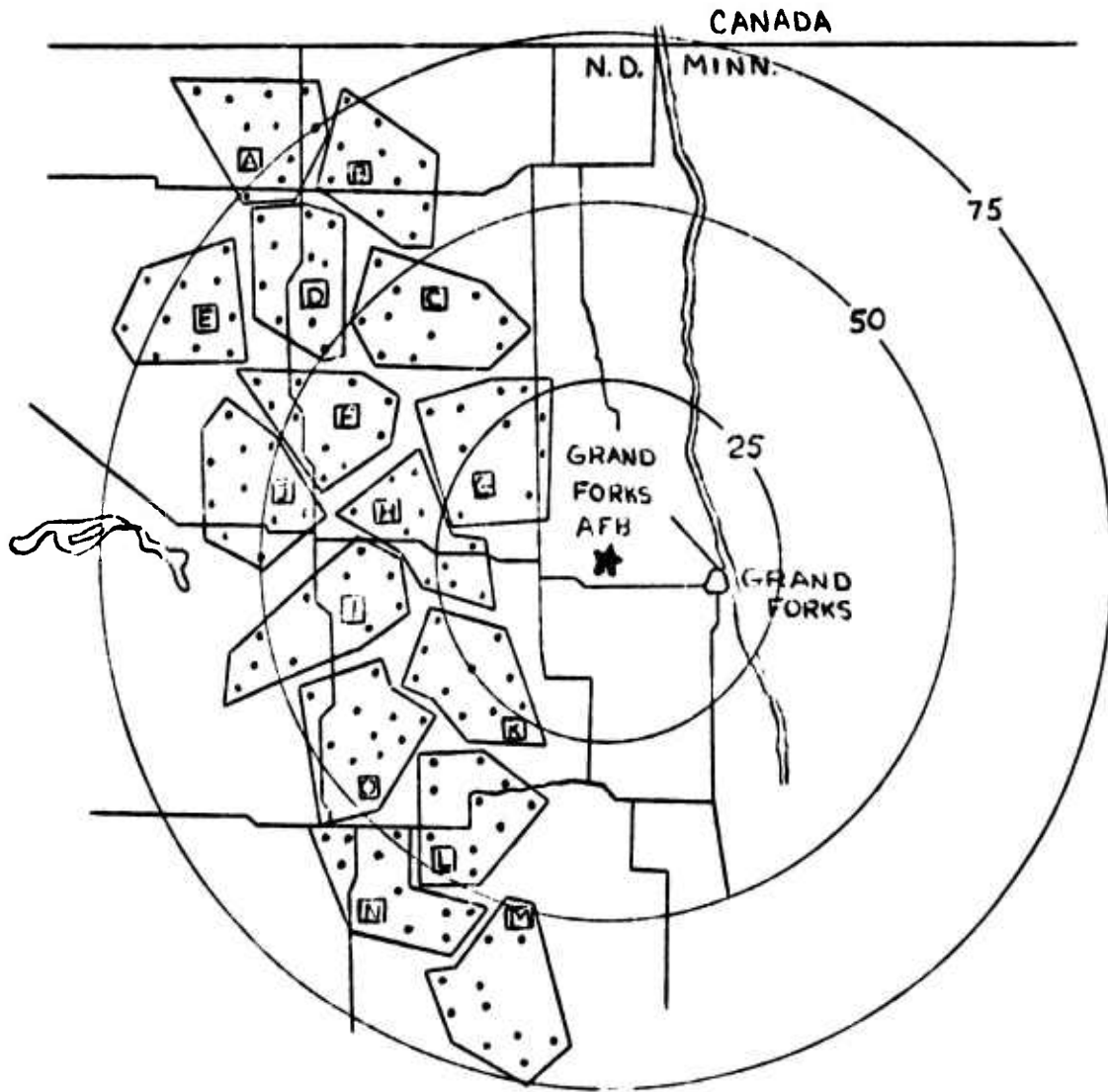


Figure 3. Wing VI Layout

critical equipment items. Reducing the NS-20 failure rate has been the goal of organizations within the Strategic Air Command (SAC), Air Force Systems Command (AFSC), and Air Force Logistics Command (AFLC) (19). While analyzing the failure data, several personnel (12; 15; 19; 20; 23; 27) have noticed that the NS-20 failure rate appears to increase during the spring and fall months.

Mr. Keith Gwylliam (15), Logistics Specialist, Ogden Air Logistics Center (ALC), believes that there is a trend toward more guidance and control system failures during the fall and spring months than at other times. He stated that the Ogden ALC anticipated an increase of failures during these times. He also thought an attempt had been made to correlate Minuteman II guidance and control system (NS-17) failures with the weather, but he was unsure of the specific details or outcome. Mr. Gwylliam indicated the Ogden ALC would be interested in a study attempting a correlation between NS-20 failures and environmental conditions.

Mr. A. Neukuckatz (19), TRW Representative, Reliability and Quality Assurance Division, Space and Missile Systems Organization, MNDR, was aware of a study that had been accomplished on the NS-17 guidance system. He did not know whether a copy was available or not, but he did remember that the study had failed to find any correlation between NS-17 failures and outside air temperature. He was

aware of several other informal studies that had also failed to find a correlation between NS-17/NS-20 failures and such things as holidays, seasons, maintenance manning levels, Santa Anna winds, etc. The studies were not documented since they consisted of scanning available data or scratch pad computations. Mr. Neukuckatz conducted a search of the TRW technical library, but failed to find any studies related to external environmental effects on guidance and control system failures. He stated that he would be glad to furnish any data the authors might require.

Mr. Robert Wallan (27), Reliability Engineer, Ogden ALC, generally agreed with Mr. Gwylliam. He offered to supply any data that might be required to support a study and recommended other sources of information.

Major Paul Pirtle (20), SAMSO/MNNG, could only recall one study in the area of environmental factors versus guidance and control system failures. It was an informal attempt to correlate NS-17 failures with the seasons. (The same study referred to by Mr. Gwylliam.) He also reported that the attempt had produced inconclusive results. Major Pirtle stated that there was a study in progress to determine the effect on Minuteman guidance systems of seismic phenomena caused by earth crustal movement due to changes in barometric pressure. However, the objective of this study was to examine accuracy rather than failure impact. He was also aware of another informal study that attempted

to correlate gyroscopic reliability with burn-in time. Again the study had inconclusive results. Major Pirtle indicated that the gyros are extremely sensitive indicators of temperature change. Slight changes in temperature will result in measurable changes in gyro bias. However, he believes this would have more of an accuracy rather than a reliability impact. Major Pirtle expressed doubt that a correlation could be found between outside air temperature changes and guidance and control failures. He believes the thermal mass of a Minuteman launcher would negate any effects of outside temperature changes.

Mr. Carroll Turbin (23), Autonetics Representative, Hq. SAC, could only recall the NS-17 study (referred to by Mr. Gwylliam and Major Pirtle) and a study conducted to determine intransit effects. He made several inquiries to autonetics personnel and to the Autonetics Technical Library. He was unable to locate any formal studies that related to environmental effects.

Lieutenant Colonel Vern Dede (12), SAC Directorate of Missile Maintenance, reported that he had requested CMSgt John Murphy, SAC Operational Engineering Squadron, F. E. Warren AFB, Wyoming, to attempt to correlate seasonal variations and transportation environmental effects with NS-17 failures. He indicated that CMSgt Murphy did not discover any correlations. Lt Col. Dede was also aware of a study in progress attempting to correlate fluctuations

in the earth's magnetic field with guidance and control system failures; the theory being that fluctuations cause spikes and surges in the commercial power serving Minuteman launch facilities. These spikes and surges may in turn have an effect on guidance and control system performance.

The belief that some NS-20 failures may be related to environmental factors appears to be based on the fact that the NS-20 is very sensitive to temperature. During ground operations the overall temperature within the NS-20 is maintained between 66 and 69 degrees Fahrenheit (8:7). Certain components, such as the gyro stabilized platform are maintained at  $71.2 \pm 1$  degree Fahrenheit. Temperatures beyond these parameters may result in the NS-20 shutting down (4:30). The external temperature of the NS-20, i.e., the launcher temperature, is maintained between 60 and 80 degrees Fahrenheit (4:17-24).

#### Scope

The scope of this study is limited to NS-20 failures that occurred at Grand Forks AFB during calendar year 1973. A major modification program was in progress at Grand Forks during all of 1974; therefore that time period was not included in the study (1:3-3). F. E. Warren AFB, Wyoming, and the 564SMS, Malmstrom AFB, Montana, were not selected since they have only recently received Minuteman IIIs, and sufficient data is not available (1:3-3). Minot AFB,

North Dakota, was not considered since the 91st Strategic Missile Wing is in the process of a major modification program that will change the launcher structure, environmental control system, and the ground electronics system (2:125).

#### Summary

There are several theories concerning the impact of seasonal variations on the NS-20 guidance system. The impact is viewed as ranging from negligible to being responsible for some NS-20 failures (12; 15; 19; 20; 23; 27). Although there is conflicting belief on the degree of impact, the preponderance of opinion supports the concept that there may be a relationship between failures and seasonal changes. Seasonal variations in NS-20 failures, if they do exist, may be caused by any one or a combination of factors, e.g., temperature, wind speed, wind direction, humidity, barometric pressure, maintenance penetrations of the launchers for annual or semi-annual targeting changes, or maintenance manning levels. Several informal, undocumented studies have failed to discover a relationship between any of the above factors and NS-20 failures. If the environmental control and monitoring system is performing as it should, then there should be no relationship between NS-20 failures and environmental conditions. However, the belief that a relationship exists between external environmental factors and NS-20 failures still persists.

Therefore, the concept of external environmental conditions versus NS-20 failures appears to be an important candidate for study.

### Failure Rate and Time Between Successive Failures

Throughout this study the term "Time Between Successive Failures" will be used instead of failure rate. The failure rate of an item refers to the number of failures that normally occur within a specified period of time. Time Between Successive Failures (TBSF) refers to the time period between one failure and the next. Thus, as the TBSF decreases/increases, the failure rate increases/decreases.

### Objective

This research was designed to provide enough new knowledge to address conflicting opinion about whether different seasons and hence external environmental factors are related to the time between successive NS-20 failures.

### Limitations

This study will be limited to determining whether or not there is a relationship between the TBSF of NS-20s and the external environmental factors of temperature, wind speed, wind direction, humidity and barometric pressure.

### Research Hypothesis

There is a relationship between external environmental factors and the TBSF of NS-20 guidance systems.

### Overview

Chapter II will present an overview of the research design. It contains a general description of NS-20 failures and external environmental conditions to be analyzed, statistical methods, and criteria used to determine the significance of results.

## CHAPTER II

### RESEARCH METHODOLOGY

#### Introduction

The relationship between the TBSF of NS-20s and external environmental conditions was examined through the use of multiple regression analysis. Multiple regression analysis was chosen since it provides a means by which the relationship between a dependent variable (TBSF) and one or more independent variables (environmental conditions) may be measured (26:232). The significance of the resulting measurement then becomes a matter of judgement. Criteria by which significance is evaluated was established by obtaining the opinions of personnel familiar with both statistical methods and the TBSF of NS-20s (26:221). The net result of the collective opinions is a criteria test by which the findings of the study were judged as significant or insignificant in terms of practical importance, rather than via the use of statistical significance alone.

#### Research Design

NS-20 failure modes were considered as three distinct groups. The first group contained all NS-20 failures that occurred at Grand Forks during 1973. The second group contained only those NS-20 failures that

occurred as the result of DCU malfunctions. The third group contained only those NS-20 failures that occurred as the result of PIGA malfunctions. The last two groupings (DCU and PIGA caused failures) were selected for separate analysis together since they caused approximately 66 percent of all the NS-20 failures at Grand Forks during 1973. Also, any relationship that might exist between the failure of a particular NS-20 component and environmental conditions, could possibly be obscured when NS-20 failures are analyzed as a whole.

Environmental conditions were considered in three distinct groups (A, B, and C). Group A contained the conditions that existed at the time of failure. These conditions were temperature, wind speed, wind direction, humidity, and barometric pressure. Groups B and C differed from Group A in that different temperature variables were considered. Group B used an average temperature existing for a given time prior to failure. Group C used an average rate-of-temperature change that occurred for a given time period prior to the time of failure.

Group B and C analysis was conducted due to the possibility of a delay effect of temperature on failure modes caused by the mass of Minuteman launchers. Therefore, to account for any possible delayed effect, temperature conditions were considered for several hours prior to the time of failure. The search for a relationship between

average temperature conditions (environmental Group B) and NS-20 failures covered a 72-hour period preceding the time of failure. An average was computed in six-hour periods up to the 72 hour limit. The result was twelve averages representing the average temperature during the six hours preceding failure, twelve hours preceding failure, eighteen hours preceding failure, and etc. Each average was analyzed separately to determine if a relationship exists between a particular time period/average temperature condition and the TBSF.

The search for a relationship between TBSF and rate-of-temperature change conditions (environmental group C) covered a twelve-hour period preceding the time of failure. The rate-of-temperature change was computed in one-hour increments from the time of failure up to the twelve hour limit. The result was twelve rates representing the rate-of-temperature change for one hour preceding failure, two hours preceding failure, three hours preceding failure, and etc. Each rate of change was analyzed separately to determine if a relationship existed between a particular time period/rate-of-temperature change condition and TBSF. Figure 4 is a summary of the combinations of variables that were analyzed. Each of the dependent variables was regressed with the three groups of independent variables making a total of nine different combinations.

<u>Group</u>	<u>Dependent Variables (Failures)</u>	<u>Independent Variables (Environmental Conditions)</u>
1	TBSF (all causes)	Group A
2	TBSF (due to DCU malfunctions)	1. Temperature at time of failure (TOF). 2. Wind speed at TOF. 3. Wind direction at TOF. 4. Humidity at TOF. 5. Barometric Pressure at TOF.
3	TBSF (due to PIGA malfunctions)	Group B 1. Average temperature prior to failure. 2. Wind speed at TOF. 3. Wind direction at TOF. 4. Humidity at TOF. 5. Barometric pressure at TOF.
		Group C 1. Rate-of-temperature change prior to failure. 2. Wind speed at TOF. 3. Wind direction at TOF. 4. Humidity at TOF. 5. Barometric pressure at TOF.

Figure 4. Variable Combinations

When significant trends or relationships were noted during the analysis, additional time periods were considered.

To maintain a conservative approach, the NS-20 failures that occurred at Grand Forks during 1973 were defined as a census of a finite population. In this context, statistical F and t-tests were not considered appropriate. Main effects were identified by data analysis consisting of descriptive statistics using simple coefficients of mathematical relationships through regression analysis or  $R^2$ ; and the application of a practical criteria test rather than a statistical test. For those individuals who wish to assume the census is a representative sample from a process population, the results of F tests are included in Appendices A, B, and C.

#### Multiple Regression Analysis

As stated previously, multiple regression analysis was used to analyze the relationship between TBSF and external environmental conditions. The general form of the relationship is:

$$Y_m = \text{TBSF}$$

$$X_i = \text{Environmental Conditions}$$

$$Y_m = B_0 + B_1X_1 + B_2X_2 \dots B_nX_n$$

The relationship was estimated by least squares methods for linear relationships (26:232). Once a regression relationship has been established, it may be used to derive

estimates of the dependent variable ( $Y_m$ ) based on the values of the independent variable(s) ( $X_i$ ). The relationship may also be used to determine the effects of the independent variables on the dependent variable (28:3). The major advantage of multiple regression analysis is that the effect of each independent variable can be measured in the context of the combined relationship with all other independent variables (18:10).

Multiple regression analysis yields an index called the coefficient of determination or  $R^2$ . The term  $R^2$  represents the proportion of the total variability in the dependent variable, i.e., TBSF, explained by the linear regression (30:342). Total variability is equal to the explained variability plus the unexplained variability. Thus,

$$R^2 = \frac{\text{Explained Variability}}{\text{Total Variability}} \quad (29:492)$$

For example, if the total variability of the TBSF was equal to 15,672 and a linear regression resulted in an explained variability of 5,934 then:

$$R^2 = \frac{5,934}{15,672} = .378$$

This may be interpreted as meaning that 37.8 percent of the variance in the TBSF is explained by the particular combination of environmental factors (independent variables) used in the equation. Since the numerator cannot

exceed the denominator,  $R^2$  will always be between zero and one. If  $R^2$  equals zero, then the regression explains none of the variability, and there would be no observed relationship between the dependent variables and independent variables in the regression equation. If  $R^2$  equals one, then the regression explains the variability perfectly. However, when the value of  $R^2$  falls somewhere between zero and one, the significance or importance of the relationship in practical terms, between the variables becomes a matter of judgement (16:221).

#### Criteria Test

To construct a decision rule to use as a test of the research hypothesis, it was necessary to determine what should be considered a significant relationship in terms of practical importance between TBSF and environmental conditions. Therefore, the researchers contacted several individuals closely associated with reliability and quality control of the NS-20 missile guidance set who were also knowledgeable about regression analysis. The following is a brief description of the opinions of the personnel contacted.

Both Lt. Col. W. Goodwin (14) and Mr. Neukuckatz (19), MNDR, SAMSO, declined to give any specific quantitative answers. Their reasons were that too many variables were involved to assign any significance to a specific relationship without first examining the factors being compared, the method of comparison, and the size of the

population. Lt. Col. Goodwin indicated that any findings considered insignificant by the researchers might upon further analysis by MNDR be considered significant, and conversely, findings considered significant by the researchers might be considered insignificant by MNDR.

Mr. R. Wallan (27), Ogden ALC, indicated the degree of significance depends upon the size of the population being considered. He indicated that for small populations the coefficient of determination would have to be .9 or better before he would consider the relationship significant. However, for large populations, he would consider the relationship significant if the coefficient of determination was .4 or higher.

Mr. R. Genet (13), Aerospace Guidance and Metrology Center (AGMC), Newark AFS, Ohio, agreed with Mr. Wallan's comments. However, he indicated that AGMC might assign differing degrees of significance to the researchers' findings after they had a chance to review the completed study.

As a result of the interviews, the establishment of a decision rule was delayed until after data analysis. The results of data analysis would be presented to several qualified individuals with a request for their opinion to aid in establishing a decision rule for the criteria test. The criteria test would then be applied to determine

support or nonsupport for the research hypothesis; i.e., a predicted relationship between external environmental factors and the TBSF of NS-20s.

## CHAPTER III

### DATA CONVERSION AND PROCESSING

#### Introduction

Evaluation of the research hypothesis was accomplished through the use of multiple regression analysis. During the analysis, TBSF of failure groups 1, 2, and 3 was compared with environmental groupings A, B, and C. See Figure 4, page 19. The temperature conditions examined were "temperature at failure," "average temperature prior to failure," and "average rate-of-temperature change prior to failure." These conditions are explained in detail in this chapter under the section titled "Environmental Variables." To complete the analysis, it was necessary to know the hourly weather observations at Grand Forks from 30 December 1972 to 28 December 1973. It was also necessary to know the date, time and cause of failure for every NS-20 that failed at Grand Forks during calendar year 1973. Following is a discussion of the source, validity, and collection of NS-20 failure data, environmental data, and the processing that was necessary to prepare both sets of data for use in multiple regression analysis.

## NS-20 Failure Data

### Universe

The universe of NS-20 guidance systems have been operationally deployed on Minuteman III missiles since February 1970 (2:80). NS-20s are presently operationally deployed on 500 Minuteman IIIs: 150 at Minot AFB, North Dakota; 150 at Grand Forks AFB, North Dakota; 200 at F. E. Warren AFB, Wyoming; and 50 in the 564th Strategic Missile Squadron (SMS), Malmstrom AFB, Montana (2:80-82).

### Population

The population census consisted of all NS-20 failures that occurred at Grand Forks AFB during calendar year 1973. The population consisted of 160 failures distributed throughout calendar year 1973. See Figure 5. The population was divided into two major groupings.

Non-Stratified Population. The "non-stratified population" consisted of all 165 NS-20 failures, less five induced failures for a total of 160. An induced failure is caused by operation under conditions outside specification limits or by physical mishandling and was not considered appropriate to the objectives of this study.

Stratified Population. Two causes of failure were included in the stratified population: Pendulous Integrating Gyro Accelerometer (PIGA) failures and Digital Computer Unit (DCU) failures. To achieve any statistically

<u>Month</u>	<u>Number Failures</u>	<u>PIGA</u>	<u>DCU</u>	<u>RTOK</u>	<u>GT-TI-B</u>	<u>MGSC</u>	<u>GCA</u>	<u>GSP</u>	<u>P92</u>	<u>Induced</u>
Jan	19	4	5	3	3	3	1			
Feb	10	5		2	2		1			
Mar	16	7	4	4			1			
Apr	20	11	2	2	1	1		1	2	
May	12	7	1		2					2
Jun	17	10	3	1	1		1	1		
Jul	19	8	4	2	1	2		1		1
Aug	21	12	6					1		2
Sep	10	5	2	1	1	1				
Oct	3	1	1				1			
Nov	10	4	3	1	2					
Dec	<u>8</u>	<u>4</u>	<u>1</u>	<u>3</u>	—	—	—	—	—	—
Total	165	78	32	19	13	7	5	4	2	5

PIGA . . . . . Pendulous Integrating Gyro Accelerometer  
 DCU . . . . . Digital Computer Unit  
 RTOK . . . . . Retest OK  
 GT-TI-B . . . . . Gyro Compass  
 MGSC . . . . . Missile Guidance Set Control  
 GSP . . . . . Gyro Stabilized Platform  
 GCA . . . . . Gyro Compass Assembly  
 P92 . . . . . Amplifier Assembly  
 Induced . . . . . See "non-stratified population"

TOTAL FAILURES USED IN STUDY = 165 - (five induced failures)  
 = 160 Failures

Figure 5. Population of NS-20 Failure Data  
 Grand Forks AFB, Calendar Year 1973

meaningful results, a stratified grouping should contain at least thirty observations (17). PIGA failures and DCU failures consisted of seventy-eight and thirty-two observations respectively. Other causes of failure in the data consisted of less than twenty observations each, and therefore were not included in the stratified population. However, they were included in analysis of non-stratified population information described above (see Figure 5, page 27).

#### Data Source and Validity

NS-20 failure data was obtained from the Reliability and Quality Assurance Division, (MNDR), Space and Missile Systems Organization (SAMSO), Norton AFB, California. MNDR received the information on NS-20 failures from individual missile wings (19). The data was transmitted in the form of a "Not Repairable This Station" (NRTS) message. Each Minuteman wing transmitted a NRTS message every time a failed NS-20 was replaced (2:80-82). All failed NS-20s were repaired at the depot (15). Source data for the NRTS message was accumulated by automatic equipment in the missile complex. The automatic equipment recorded the cause of failure as well as the date and time of failure (21). The NRTS message contained the date and time of failure and cause of failure (19). Any questionable data in the message was resolved by a telephone call from MNDR to the wing concerned (19).

After the failed NS-20 was received and analyzed by the depot at Newark AFS, Ohio, all agencies concerned were notified of the depot's findings, that is, what the depot determined was the actual cause of failure (19). Cause of failure, time and date of failure information from both the wings and the depot was consolidated on an "MNDR file" and maintained at MNDR for reliability and quality control analysis (19). Since SAMSO used the MNDR data file to conduct Minuteman reliability and quality control studies (19), it was assumed that it accurately reflected the date and time of failure and cause of failure as determined by the depot. Figure 6 is an example of the data received from MNDR.

### Environmental Data

#### Universe

Environmental data was collected at the Minuteman deployment area described previously. Common data included temperature, humidity, dew point, wind speed, wind direction, barometric pressure, cloud cover, visibility, rain and snow fall, and storm activity. Both ground level and upper atmosphere conditions were recorded. The observations were normally made hourly; however, when weather conditions were changing rapidly or were unusually turbulent, special observations were recorded.

<u>MO/DAY</u>	<u>TIME</u>	<u>SILO</u>	<u>FFI</u>	<u>FAILURE VERIFICATION/ HARDWARE REPAIRED</u>
3-01	0300	044	DCU	FFV/D37
3-04	1100	I35	DCU	FFV/D37
3-08	1513	043	PIG	FFV/PIGA
3-11	1617	B17	GCA	FFNV/RTOK
3-12	2042	G15	PIG	FFV/PIGA
3-16	0700	A05	PIG	FFNV/RTOK
3-16	0530	I40	PIG	FFV/PIGA
3-17	2144	D33	PIG	FFV/PIGA
3-21	1638	E43	PIG	FFV/PIGA
3-22	0137	G18	PIG	FFV/PIGA

Figure 6. Sample NS-20 Failure Data

### Population

The environmental data for this study was a population census of all the hourly observations of ground level temperature, barometric pressure, dew point, wind speed, and wind direction taken by Detachment 15, 3rd Weather Wing, Grand Forks AFB, North Dakota, from 30 December 1972 through 28 December 1973.

### Data Source and Validity

The data was extracted from copies of original daily logs maintained by Detachment 15, 3rd Weather Wing (see Figure 7). The logs contained the following pertinent data: ground level temperature, barometric pressure, dew point, wind direction, and wind speed. According to Lt. Clark (9), Detachment 15, observations were taken hourly within plus or minus five minutes of the hour. Temperature readings were in degrees Fahrenheit and accurate to within plus or minus one degree. Barometric pressure was recorded in inches of mercury. Dew point was in degrees Fahrenheit and accurate to within plus or minus three degrees. Wind direction was rounded to the nearest ten degrees, i.e., a wind direction of 276 would be recorded as 280 degrees. Wind speed was in knots and represented a one minute average that included all peaks and lulls.

Since weather observations were not available for individual missile sites (11), it was assumed that the data collected at Grand Forks AFB was representative of

**FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS  
(ABRIDGED FORM FOR USE AT AWS STATIONS)**

STATION E

LATITUDE **47°56'N**      LONGITUDE **97°24'W**

TYPE	TIME (LST)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRES (mb) (6)	TEMP (°F) (7)	DEW POINT (°F) (8)	WIND		ALSTG (inches) (12)	
								TRUE DIRECTION (9)	SPEED (knots) (10)		
R	0058		220-13			47	34	17	17	620	972
R	0156		220-13			47	33	17	15	622	969
R	0258		220-13		047	45	33	16	12		966
R	0356		220-13			44	33	16	14		963

**FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS  
(ABRIDGED FORM FOR USE AT AWS STATIONS)**

STATION E

LATITUDE **47°56'N**      LONGITUDE **97°24'W**

TYPE	TIME (LST)	SYNOPTIC DATA			STATION PRESSURE COMPUTATION				SUMMARY OF THE DAY						
		PRECIP (inches) (14)	SNOW FALL (inches) (15)	SNOW DEPTH (inches) (16)	TIME (LST) (17)	AT THERM (18)	QBSRD BAR (19)	IQIAL CORR (20)	SEA PRESS (21)	BAROGRAPH (22)	BAR CORR (23)	PRECIP (inches) (24)	SNOW FALL (inches) (25)	SNOW DEPTH (inches) (26)	ACTIV TIME (LST) (27)
R	0554	0	0	0								0	0	0	CONTD
R	1150	0	0	0								0	0	0	1637
R	1750	0	0	0								0	0	0	
R	2300	0	0	0								35	19	1255	

PREVIOUS EDITION WILL BE USED

AWS FORM SEP 70 10

Figure 7. Sample Weather Data

conditions throughout the missile complex. This assumption was based on two reasons: first, the opinion of Detachment 15 weather personnel was that weather conditions were fairly consistent throughout the missile complex at Grand Forks AFB (11); and second, the 150 missile sites were distributed from fifteen to one hundred miles north and south of Grand Forks AFB, and as a result differences tend to average out (11).

#### Data Processing--Step One

##### General

The data was prepared and entered into the computer in a two-step process. The first step was to enter the NS-20 failure data (date, time and cause of failure), and the environmental conditions existing at the time of failure (temperature, wind speed, wind direction, humidity, and barometric pressure). The second step was to enter the hourly temperature readings from 72 hours preceding time of failure up to the time of failure. Figure 8 is an example of an entry for the first step in the data input process. Each part of the entry will be described in the following paragraphs.

##### Processing of NS-20 Data

The raw data identified the date and time of each failure (to the nearest minute) and the cause of failure as

Card	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Columns	1 - 7	9 - 16	19 - 22	25 - 28	31 - 33	36 - 37	40 - 44	47 - 48	51	54
Data	TBSF	Time of Failure	Time of Observ.	Temp.	Wind Direction	Wind Speed	Pressure	Humidity	PIGA Fail.	DCU Fail.
Entry	24.00	250.25	250	10	340	5	30.21	55	1	0

The above entry is for an NS-20 that failed at 1015, 11 January 1973, due to a PIGA malfunction. The previous failure occurred 24.00 hours before or at 1015, 10 January 1973. The environmental data was recorded at 1000, 11 January 1973. Items 4 through 8 are the environmental conditions that existed at the time of failure.

Figure 8. Sample Data Entry

determined by the depot (19). The raw data was processed into usable information as follows:

Date and Time of Failure. See Item 2, Figure 8, page 34. The time was converted to decimal form. The date was converted into hours in the following manner:

$$[(\text{Julian Date} - 1) * 24] + \text{Time of Day}$$

Thus the date and time of each failure was converted into "Year Hours." Example: An NS-20 that failed at 1015, 11 January 1973, would have been converted as follows:

$$[(011 - 1) * 24] + 1025 = 250.25$$

Time Between Successive Failures. See Item 1, Figure 8, page 34. This data input was obtained by subtracting the time of the previous failure from the time of the current failure. This data was used in the multiple regression analysis as the dependent variable.

Cause of Failure. See Items 9 and 10, Figure 8, page 34. The only "causes of failure" that were explicitly coded were PIGA and DCU failures. This was accomplished by entering a "1" or an "0" in the appropriate column. For example, a PIGA failure would be represented by a "1" in column 51 and a "0" in column 54. A DCU failure would be represented by an "0" in column 51 and a "1" in column 54.

All other failures were coded by entering a "0" in both columns 51 and 54.

### Environmental Data

The environmental data was processed as follows:

Date and Time of Observation. See Item 3, Figure 8, page 34. The time was rounded to the nearest hour. This meant a maximum of a five minute change. The resulting date/time group was then converted to year hours in the same manner as for NS-20 failure data.

Temperature. See Item 4, Figure 8, page 34. Temperature data was used as it appeared on the logs. When entered in the computer, the temperature readings required four columns. The first column indicated whether or not the reading was above or below zero, and the next three columns contained the degrees. Example: a temperature reading of 15 degrees below zero would appear as indicated in line a below, and a reading of 110 degrees above zero would appear as indicated in line b.

	Columns 19-22 (temperature)
a . . . . .	-15
b . . . . .	110

Wind Direction and Speed. See Items 5 and 6, Figure 8, page 34. Wind data was used as it appeared on

the logs. A wind reading of 280 degrees at 6 knots would appear as indicated below.

Columns 31-32  
(direction)

280

Columns 36-37  
(speed)

06

Barometric Pressure. See Item 7, Figure 8, page 34. Pressure readings were modified from the manner in which they appeared on the log. For example, a pressure reading of 30.21 inches appeared on the log as 021; a pressure reading of 29.68 inches appeared on the log as 968. The log readings were converted to the normal form of 30.27, 29.68, etc.

Humidity. See Item 8, Figure 8, page 34. To obtain the relative humidity readings it was necessary to convert the dew point readings on the logs into humidity readings. The conversion was accomplished by the use of a "Relative Humidity (percent) From Temperature and Temperature-Dewpoint Depression" conversion chart (see Figure 9). To obtain this conversion from the chart it required the following:

1. Convert the temperature and time of failure and the dew point temperature to degrees Centigrade that equate to degrees in Fahrenheit.
2. Obtain the difference between the temperature at the time of failure and the dew point temperature (degree Centigrade).

TEMPERATURE\*

DEW POINT DEPRESSION

	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40
1	88	95	94	94	91	91	91	87	93	93	92	92	82	91	91	91	90
2	87	89	89	89	88	88	87	87	86	86	85	85	84	83	83	82	81
3	84	85	84	84	83	83	82	81	80	79	79	78	77	76	75	74	73
4	81	80	79	78	78	77	76	75	74	73	73	71	70	69	68	67	66
5	77	78	75	74	73	72	71	70	69	68	67	66	64	63	62	60	59
6	72	71	70	69	68	67	66	65	64	63	61	60	59	57	56	54	53
7	67	67	66	65	64	63	62	61	59	58	57	57	54	52	51	49	47
8	64	63	62	61	60	59	57	56	54	53	52	50	49	47	46	44	42
9	61	60	59	57	56	55	54	52	51	49	48	46	45	43	41	39	38
10	58	56	55	54	53	51	50	48	47	45	44	42	41	39	37	35	34
11	54	53	52	50	49	48	46	45	43	42	40	39	37	35	33	32	31
12	51	50	49	47	46	45	43	41	40	38	37	35	34	32	30	28	27
13	48	47	46	44	43	42	40	38	37	35	34	32	30	29	27	25	24
14	46	44	43	41	40	39	37	36	34	32	31	29	28	26	24	23	22
15	43	42	40	39	37	36	34	33	31	30	28	27	25	24	22	20	19
16	40	39	38	36	35	33	32	30	29	27	26	24	23	21	20	16	
17	38	37	35	34	32	31	29	28	27	25	23	22	21	19	18	14	
18	36	34	33	32	30	29	27	26	24	23	21	20	19	17	16	12	
19	34	32	31	30	28	27	25	24	22	21	20	18	17	15	14	11	
20	32	30	29	28	26	25	23	22	21	19	18	16	15	14	12	09	
21	30	28	27	26	24	23	22	20	19	17	16	15	14	12	09		
22	28	27	25	24	23	21	20	19	17	16	15	13	12	11	08		
23	26	25	24	22	21	19	18	17	16	15	13	12	11	10	07		
24	25	23	22	21	19	18	17	16	14	13	12	11	10	09	06		
25	23	22	21	19	18	17	16	14	13	12	11	10	09	08	06		
26	22	20	19	18	17	16	14	13	12	11	10	09	08	06			
27	20	19	18	17	16	14	13	12	11	10	09	08	07	06			
28	19	17	17	15	14	13	12	11	10	09	08	07	06	04			
29	18	17	16	14	13	12	11	10	09	08	07	06	04				
30	17	16	15	14	12	11	10	09	08	07	06	05	04				

\*Both scales are in degrees centigrade

Figure 9. Dewpoint/Humidity Conversion Chart (18:424)

3. Using the temperature at the time of failure in Centigrade (across the top) and the difference from Step 2 (left side), enter Figure 9 (page 38) and obtain the humidity. A dew point reading of 25 degrees Fahrenheit would appear as indicated below.

Columns 47-48 (humidity)  
(86 percent)

#### Data Processing--Step Two

##### Follow-on Input of Temperature Data

The second step of the data input process was to enter the hourly temperature readings for the 72 hours immediately preceding the time of each failure. Figure 10 is an example of the entries for this step in the data input process.

	(1)	(2)	(3)
Card Columns	1 - 3	6 - 7	10 - 13
Data	Julian Date	Time	Temp.
Entry	025	10	15

Figure 10. Sample Temperature Input

##### Date/Time of Temperature Readings

See Items 1 and 2, Figure 10. The data in columns 1 through 7 was processed and entered in exactly the same manner as described in the paragraph titled "Date and Time of Observation."

##### Temperature Data

See Item 3, Figure 10. The data in columns 10 through 13 was processed and entered in exactly the same

manner as described in the paragraph titled "Temperature."

### Environmental Variables

After the environmental data was processed and entered into the computer, it was used to compute the following variables for each failure.

- $T_1$  - Temperature at time of failure.
- $T2_n$  - Average temperature preceding failure (see below).
- $T3_n$  - Average rate-of-temperature change preceding failure (see below).
- WS - Wind speed at time of failure.
- WD - Wind direction at time of failure.
- H - Relative humidity at time of failure.
- P - Barometric pressure at time of failure.

$T2_n$ --Average Temperature Prior to Failure. Average temperature prior to failure was computed in six-hour increments from the time of failure, up to 72 hours preceding the time of failure, where  $n = 6, 12, 18, 24...72$ . Smaller time intervals were not selected due to the large number of calculations involved. The computations resulted in twelve groups of data representing the average temperature prior to failure in six-hour increments ranging from six to 72 hours preceding each failure.

$T3_n$ --Average Rate-of-Temperature Change Prior to Failure. The average rate-of-temperature change prior to failure was computed in one-hour increments from one hour up to twelve hours preceding the time of failure where

$n = 1 - 12$ . The computations resulted in twelve groups of data representing the average rate-of-temperature change from one to twelve hours preceding each failure. The average rate-of-temperature change was computed by dividing the absolute total change in temperature for a period by the number of hours in the period. Example: Assume a failure occurred at 1000 and the following temperatures were observed during the preceding four hours.

<u>Time</u>	<u>Temperature</u>	<u>Change (absolute)</u>
1000	+015	- (time of failure)
0900	+023	7
0800	+030	7
0700	+025	5
0600	+020	<u>5</u>
		$24 \div 4 = 6$ degrees per hour

Therefore, for this failure  $T3_4 = 6$ .

### Dependent Variables

Three dependent variables were computed for use in the multiple regression equations. The computation and classification of these variables is described below.

TBSF (All Causes)--Group 1. This variable represents TBSF for all NS-20 failures in the total or non-stratified population. The procedure for computing TBSF was to round the time of failure to the nearest tenth of an hour; then convert the rounded time to "year-hours" as described in the section titled "Date and Time of Failure;" and finally to compute TBSF as described in the

section titled "Time Between Successive Failures." TBSF meets the criteria for multiple regression analysis (interval level data), since it is a measure of time. Time satisfies the criteria of ratio level data since it can be conceptually measured as having an absolute zero as well as equal units (16:179). Therefore, TBSF of all NS-20 failures is at least interval level data. However, the criteria have not been met for F-tests since by definition the data is a population and not a representative sample of a process population.

TBSF (Due to DCU Failures)--Group 2. This variable represents one stratum of the stratified population; i.e., the TBSF for all NS-20 failures due to DCU malfunctions. Since its computation was the same as TBSF (all causes), it also meets the data level criteria for multiple regression analysis.

TBSF (Due to PIGA Failures)--Group 3. This variable represents the other stratum of the stratified population; i.e., the TBSF for all NS-20 failures due to PIGA malfunctions. Since its computation was the same as TBSF (all causes), it also meets the data level criteria for multiple regression analysis.

#### Independent Variables

Seven independent variables were computed for use in the multiple regression equations. The computation

and classification of these variables is described below.

Temperature at Time of Failure (T1). The time of each temperature reading was rounded to the nearest hour; then the time was converted to "year-hours" as described in the section titled "Date and Time of Failure." The temperature at time of failure was then determined by selecting the year-hour of a temperature observation that came closest to the year-hour of an individual failure. Temperature at Time of Failure meets the criteria or interval level or better data for multiple regression analysis since any data that allows a determination of differences in magnitude is classified as interval data (16:179).

Wind Speed at Time of Failure (WS). The computation and data level classification of this variable was the same as for "Temperature at Time of Failure."

Wind Direction at Time of Failure (WD). The computation and data level classification of this variable was the same as for "Temperature at Time of Failure."

Humidity at Time of Failure (H). The computation and data level classification of this variable was the same as for "Temperature at Time of Failure."

Barometric Pressure at Time of Failure (BP). The computation and data level classification of this variable was the same as for "Temperature at Time of Failure."

Average Temperature Prior to Failure ( $T2_n$ ). This variable was computed as described in the section titled " $T2_n$ --Average Temperature Prior to Failure." The  $T2_n$  variable was considered as interval level data since it allows a determination of differences in magnitude (16:179).

Average Rate-of-Temperature Change Prior to Failure ( $T3_n$ ). This variable was computed as described in the section titled " $T3_n$ --Average Rate-of-Temperature Change Prior to Failure." The  $T3_n$  variable was considered as interval level data since it allows a determination of differences in magnitude (16:179).

### Summarization of Data

#### Introduction

The data was arrayed in two types of files, intermediate and final. The intermediate files consisted of raw data with minimum changes. The final files were in a format that was readily used by the BMD02R Multiple Regression Program. The BMD02R program is described in Chapter IV, "Data Analysis." Files were arrayed and entered into the computer as follows.

### Intermediate Files

These files were used as vehicles to initially enter and process the raw data. After being checked and verified, the intermediate files served as a data source for the creation of the final files.

Intermediate File CLSC1. This file contained the raw NS-20 failure data and the environmental conditions existing at the time of failure. The only changes to the data were: converting the dates to Julian days, the hours to decimal form, and rounding the time of the weather observation to the nearest hour. The conversions were accomplished manually and the data was input from worksheets created from basic documents. The file was constructed as indicated in Figure 11.

<u>Julian</u> <u>Date</u>	<u>TOF*</u>	<u>TOWO**</u>	<u>Temp</u>	<u>Dew</u> <u>Point</u>	<u>Wind</u> <u>Dir</u>	<u>Wind</u> <u>Speed</u>	<u>Press</u>	<u>PIGA</u> <u>Fail.</u>	<u>DCU</u> <u>Fail.</u>
002,	8.9,	9,	014,	007,	160,	15,	29.80,	0,	0

\*TOF . . . . Time of Failure  
 \*\*TOWO . . . Time of Weather Observation

Figure 11. File CLSC1

Intermediate File CLSC2. This file was a further refinement of file CLSC1. It contained the same data as CLSC1 with the addition of time between Successive Failures; and dew point converted to relative humidity. The file

was created by computer program MOD1 listed in Appendix D. The file appeared as previously indicated in Figure 8 on page 34.

Intermediate File TEMP. This file contained all the required temperature data for each NS-20 failure, that is, it contained the temperature at time of failure, and the hourly temperature readings for a 72 hour period preceding each failure. The only changes to the data were: converting dates to Julian days and rounding the time to the nearest hour. The file appeared as indicated in Figure 12.

<u>Julian Date</u>	<u>TOWO*</u>	<u>Temp</u>
002,	9,	014

\*Time of Weather Observation.

Figure 12. File TEMP

### Final Files

The final files contained all of the variables in a compatible format that were needed to conduct the multiple regression analysis on the BMD02R Program. Each of the final files is briefly described below. All of the files except File T1 were created by computer program MOD2 listed in Appendix D. File T1 was created by program MOD1.

File T1--All NS-20 Failures. This file contained all the NS-20 failures. The failures were listed in chronological sequence. The entry for each file contained: TBSF, temperature, wind speed, wind direction, humidity, and pressure at time of failure; and the cause of failure (PIGA, DCU or other).

File T1D--NS-20 Failures Due to DCU Malfunctions. This file was identical to File T1, except that it contained only DCU-caused failures.

File T1P--NS-20 Failures Due to PIGA Malfunctions. This file was identical to File T1, except that it contained only PIGA-caused failures.

File T2A and T2B--Average Temperature Prior to All NS-20 Failures. These files contained the same data as File T1 with the exception of the temperature at the time of failure. In addition, they contained the average temperature computations for the twelve six-hour periods preceding each failure. File T2A contained the data for periods one through six; that is, the average temperature existing during the 6, 12, 18, 24, 30, and 36 hour time periods preceding each NS-20 failure. File T2B contained the average temperature data for periods seven through twelve, i.e., for the six-hour increments going from 42 to 72 hours prior to the time of failure.

File T2DA and T2DB--Average Temperature Prior to DCU-Caused Failures. These files were identical to File T2A and T2B, except that they contained only those NS-20 failures caused by DCU malfunctions.

Files T2PA and T2PB--Average Temperature Prior to PIGA-Caused Failures. These files were identical to files T2A and T2B, except that they contained only those NS-20 failures caused by PIGA malfunctions.

Files T3A and T3B--Average Rate-of-Temperature Change Prior to All NS-20 Failures. These files contained the same data as File T1 with the exception of the temperature at time of failure. In addition, they contained the average rate-of-temperature change computations for the twelve-hour periods preceding each failure. File T3A contained the data for hours one through six preceding each failure; that is, the average rate-of-temperature change occurring during hours one through six. File T3B contained the data for hours seven through twelve.

Files T3DA and T3DB--Average Rate-of-Temperature Change Prior to DCU-Caused Failures. These files were identical to Files T3A and T3B, except that they contained only those NS-20 failures caused by DCU malfunctions.

Files T3PA and T3PB--Average Rate-of-Temperature Change Prior to PIGA-Caused Failures. These files were

identical to Files T3A and T3B, except that they contained only those NS-20 failures caused by PIGA malfunctions.

#### Assumptions

a. It was assumed the weather data collected at Grand Forks AFB was representative of conditions throughout the missile complex.

b. The time period considered, 1 January through 31 December 1973, was of sufficient length of yield sufficient data to meet the objectives of this study.

c. The data collected yielded valid information.

#### Limitations

The conclusions derived from the research apply only to the population census of NS-20 failures at Grand Forks AFB for Calendar Year 1973.

#### Summary

At this point the data was ready for use in the BMD02R Multiple Linear Regression Program. Chapter IV consists of an analysis of the data that was produced by the BMD02R program.

## CHAPTER IV

### DATA ANALYSIS AND TESTING OF HYPOTHESIS

#### Introduction

A total of 159 multiple regression equations were computed. Seventy-five equations were originally planned, however, additional equations were necessary to allow an investigation of a relationship between the average rate-of-temperature change variable and the stratified population. Each one of the regression equations was an attempt to find a relationship between TBSF and external environmental conditions. The following paragraphs present generalized descriptions of the equations.

#### Analysis of NS-20 Non-Stratified Population

The non-stratified population included all NS-20 failures that occurred at Grand Forks during 1973. Twenty-five equations were computed in an attempt to find a relationship between the non-stratified population and environmental conditions (see Figure 13). One equation (see Equation 1 below) consisted of a prediction of TBSF in terms of environmental conditions that existed at the time of failure, i.e., temperature, wind speed, wind direction, humidity, and pressure.

DEPENDENT VARIABLES (TBSF)	INDEPENDENT VARIABLES (ENVIRONMENTAL CONDITIONS)			TOTAL R <sup>2</sup> EQUATIONS
	GROUP A*	GROUP B**	GROUP C***	
GROUP ONE FAILURES (Non-Strat Population)	TEMP, WS, WD, H, P (T <sub>1</sub> )	TEMP, WS, WD, H, P (T <sub>2</sub> ) n=1,12...72	TEMP, WS, WD, H, P (T <sub>3</sub> ) n=1,2...12	25
	#Equations=1 Appendix A-1	#Equations=12 Appendix A-2 Eqs. 1-12	#Equations=12 Appendix A-3, Eqs. 1-12	
GROUP TWO FAILURES (Stratified Population)	TEMP, WS, WD, H, P (T <sub>1</sub> )	TEMP, WS, WD, H, P (T <sub>2</sub> ) n=6,12...72	TEMP, WS, WD, H, P (T <sub>3</sub> ) n=1,2...72	85
DCU Stratum	#Equations=1 Appendix B-1	#Equations=12 Appendix B-2, Eqs. 1-12	#Equations=72 Appendix B-3, Eqs. 1-72	
GROUP THREE FAILURES (Stratified Population)	TEMP, WS, WD, H, P (T <sub>1</sub> )	TEMP, WS, WD, H, P (T <sub>2</sub> ) n=6,12...72	TEMP, WS, WD, H, P (T <sub>3</sub> ) n=1,2...36	49
PIGA Stratum	#Equations=1 Appendix C-1	#Equations=12 Appendix C-2, Eqs. 1-12	#Equations=36 Appendix C-3, Eqs. 1-36	
TOTAL R <sup>2</sup> EQUATIONS	3	36	120	159

\*These regression equations attempt to predict TBSF in terms of environmental conditions existing at the time of failure, i.e., temperature, wind direction, wind speed, humidity and pressure.

\*\*These regression equations attempt to predict TBSF in terms of average temperature conditions existing prior to the time of failure, in addition to conditions existing at the time of failure, i.e., wind direction, wind speed, humidity and pressure. Twelve time periods were selected: 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66 and 72 hours preceding time to failure.

\*\*\*These regression equations attempt to predict TBSF in terms of the average rate-of-temperature change conditions existing prior to the time of failure, in addition to conditions existing at the time of failure, i.e., wind direction, wind speed, humidity and pressure. Up to 72 time periods were selected: 1, 2, 3...72 hours prior to time of failure.

Figure 13. Summary of Multiple Regression Equations

Twelve equations (see Equation 2 below) consisted of predictions of TBSF in terms of "average temperature conditions prior to failure" and the environmental conditions existing at time of failure. The last twelve equations (see Equation 3 below) consisted of predictions of TBSF in terms of "average rate-of-temperature change" conditions prior to failure and the environmental conditions existing at the time of failure.

### Variables

$Y_m$  = TBSF of NS-20 Non-Stratified Population.

$X_1$  = Wind Speed at the time of failure (TOF).

$X_2$  = Wind Direction at TOF.

$X_3$  = Barometric Pressure at TOF.

$X_4$  = Humidity at TOF.

$X_5$  = Temperature at TOF.

$X_{6n}$  = Average Temperature Conditions Existing Prior to Failure (computed in 12 six-hour periods).  
 $n = 6, 12, 18...72.$

$X_{7n}$  = Average Rate-of-Temperature change Conditions Existing Prior to Failure (computed in twelve one-hour periods).  
 $n = 1, 2, 3...12.$

$b_0$  = Constant.

$b_1...b_n$  = Coefficient of the Independent Variables  
 $X_1...X_n.$

### Equations

$$(1) \quad Y_m = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

$$(2) \quad Y_m = b_0 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_{6n}X_{6n}$$

$$(3) \quad Y_m = b_0 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_{7n}X_{7n}$$

### Analysis of NS-20 Stratified Population

The stratified population consisted of thirty-one DCU-caused failures and seventy-seven PIGA-caused failures. Each cause of failure (DCU and PIGA) was grouped separately, and then each group was analyzed in exactly the same manner as for the non-stratified population. A total of 134 equations were computed in an attempt to find a relationship between the TBSF of the groups of the stratified population and the environmental conditions. During analysis of the DCU group,  $Y_m$  in equations 1, 2, and 3 above was set equal to the TBSF due to DCU malfunctions. During analysis of the PIGA group,  $Y_m$  was set equal to the TBSF due to PIGA malfunctions.

### Computation of Equations

The actual computation of the multiple regression equations was accomplished by using the BMD02R Multiple Linear Regression Program. This computer program was developed by the Health Sciences Computing Facility of the University of California at Los Angeles. The BMD02R program computes a sequence of multiple linear regression equations in a stepwise manner. At each step one variable is added to the regression equation. The variable

added is the one which makes the greatest reduction in the error of the sum of squares (26:232); that is, the variable that will increase the  $R^2$  value (coefficient of determination) more than any of the other available independent variables; i.e., environmental factors.  $R^2$  is the proportion of the total variation in the dependent variable explained by the regression equation (29:492). See section titled "Criteria Test," Chapter II, for a detailed explanation of  $R^2$ .

#### BMD02R Output

A summarization of the BMD02R program output is presented in Figure 14. A brief explanation of the meaning of each item in Figure 14 follows:

(1) DF means degrees of freedom. The top figure represents upper degrees of freedom; the bottom figure represents lower degrees of freedom for the F ratio (2) discussed below. For the F to remove values (6) the upper degree of freedom is always one and the lower degree of freedom is the same as for the F ratio.

(2) F Ratio represents the statistical significance of the ability of the equation to predict the value of the dependent variable when all five independent variables are considered.

(3) SS/PS are symbols entered by the authors to indicate whether the F-Ratio is statistically significant (SS) at the .05 level or practically significant (PS) in

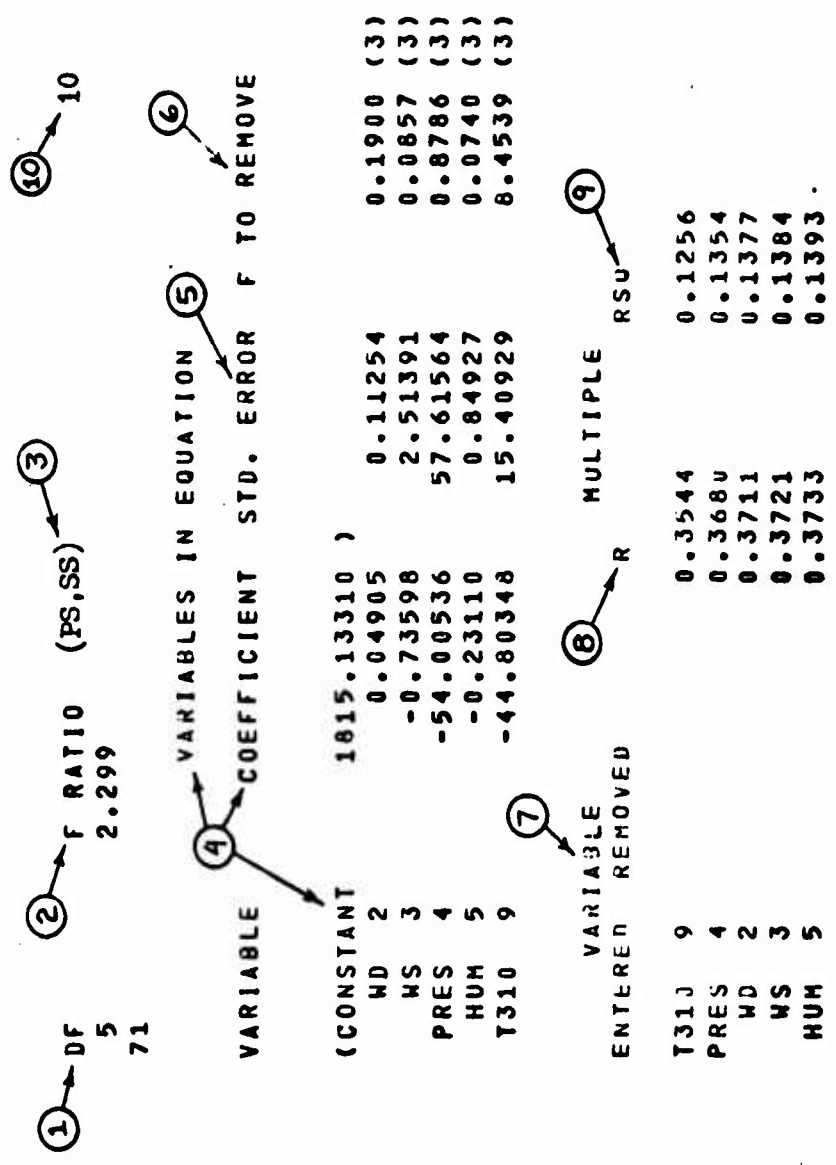


Figure 14. Sample BMD02R Output

accordance with the criteria rule established in the section titled "Decision Rule." The absence of either or both SS and PS indicates that the equation is not statistically significant or of practical significance. The F-ratio and statistical test was included for the convenience of those individuals who wish to consider the data as a representative sample of a process population in which case the use of a statistical test is appropriate.

(4) Variables in Equation. Displays variables in the regression equation. The general form of the equation is:

$$Y_m = b_0 + b_1X_1 + b_2X_2 \dots b_nX_n$$

$$Y_m = \text{TBSF}$$

$$b_0 = \text{Constant}$$

$$b_1 - b_n = \text{Coefficients for independent variables}$$

$$X_1 - X_n = \text{Independent variables of wind speed, wind direction, humidity, pressure, and temperature condition}$$

Example: In Figure 14, the equation would appear as follows:

$$Y_m = 1815.3310 - .04905X_1 - .73598X_2 - 54.00536X_3 \\ - .23110X_4 - 44.80348X_5$$

where  $X_1$  = wind direction;  $X_2$  = wind speed;  $X_3$  = pressure;  $X_4$  = humidity; and  $X_5$  = temperature condition.

The variables representing wind speed, wind direction, humidity, and pressure are self-explanatory; however, the temperature variables are somewhat complex. Therefore, the temperature variables are defined as follows:  $T_1$  represents temperature existing at the time of failure.  $T_{2n}$  represents the average temperature existing for a specific time prior to failure, i.e.,  $T_{26}$  represents the average temperature that existed during the six-hour period immediately preceding failure, etc.  $n = 6, 12, 18, \dots, 72$ .  $T_{3n}$  represents the average rate-of-temperature change that existed for a specific time prior to failure; i.e.,  $T_{39}$  represents the average rate-of-temperature change that existed for nine hours preceding failure;  $T_{310}$  represents temperature change for ten hours preceding failure, etc.  $n = 1, 2, 3 \dots, 72$ .

(5) Standard Error. A measure of the variation of the sample around the expected value of that sample, i.e., standard deviation.

(6) F to Remove represents the statistical significance of the relationship between that independent variable and the dependent variable with all other variables being held constant.

(7) Variable Entered/Removed represents variables entered in the regression equation. In this study no variables were removed.

(8) R is the correlation coefficient of the equation after each independent variable is added to the equation.

(9) RSQ is the coefficient of determination or  $R^2$  of the equation after each independent variable is added to the equation.

(10) An equation number entered by the researchers to assist the reader in identifying specific equations.

#### Analysis of the Output

The total output of the BMD02R consisted of 159 multiple regression equations outlined in Figure 14 on page 55. The equations were grouped for analysis as indicated:

1. Group one contains twenty-five equations produced as the result of regressing TBSF (Group 1, non-stratified population) against environmental Groups A, B, and C. See Figure 13, page 51.

2. Group two contains eighty-five equations as the result of regressing TBSF (Group 2, stratified population) DCU strata, against environmental groups A, B, and C. See Figure 13, page 51.

3. Group three contains forty-nine equations produced as the result of regressing TBSF (Group 3, stratified population) PIGA strata, against environmental Groups A, B, and C. See Figure 13, page 51.

Due to the large number of equations involved, the summary results are listed in the following appendices.

Appendix A - Failure Group One equations versus Environmental Groups A, B, and C.

Appendix B - Failure Group Two equations versus Environmental Groups A, B, and C.

Appendix C - Failure Group Three Equations versus Environmental Groups A, B, and C.

Throughout the analysis that follows, the term "inverse relationship" is used several times. The term is used to describe the relationship between the dependent variable and one or more independent variables. The term is defined below for the various situations under which the term might be used. An inverse relationship between the TBSF and a particular environmental condition would mean that as the condition (temperature, humidity, barometric pressure, wind speed, average temperature or average rate-of-temperature change) INCREASED/DECREASED, TBSF would do the opposite; i.e., DECREASE/INCREASE. Some of the regression equations indicated that an inverse relationship existed between wind direction and TBSF. This occurred since wind direction was measured from zero to 360 degrees, and for each failure mode a mean wind direction was computed. During the computation of a regression equation, the BMD02R program may have noted that as wind direction varied from, for example, a mean of 180 degrees toward 200 degrees, i.e., INCREASED, the TBSF DECREASED. Therefore, it would indicate that an inverse

relationship existed. A direct relationship means the dependent and independent variables both move in the same direction.

#### Analysis of Group One Equations

This group is analyzed as indicated in Figure 15. The first equation regresses Group One failures against environmental Group A. The next twelve equations regress Group One failures against environmental Group B. The last twelve equations regress Group One failures against environmental Group C.

#### Failure Group One vs. Environmental Group A

See Appendix A-1. This regression indicated an inverse relationship between temperature/pressure at time of failure and TBSF. That is, as temperature/pressure decreased, the TBSF increased. The other variables (wind speed, wind direction, and humidity) were indicated as having a direct relationship with TBSF. Temperature contributed the most to  $R^2$  (.0085), followed by wind speed (.0029), wind direction (.0020), humidity (.0002), and pressure (.0001). The total  $R^2$  value was a rather low .0136, which may be interpreted as meaning that the environmental conditions at time of failure explained 1.36 percent of the variance in the TBSF.

DEPENDENT VARIABLES (TBSF)	INDEPENDENT VARIABLES (ENVIRONMENTAL CONDITIONS)			TOTAL EQS.
	GROUP A	GROUP B	GROUP C	
GROUP ONE FAILURES (Non-strat Population)	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P T(2 <sub>n</sub> ) n=6,12...72	TEMP, WS, WD, H, P (T3 <sub>n</sub> ) n=1,2...12	25
	#Equations = 1 See Appendix A-1.	#Equations = 12. See Appendix A-2, Eqs. 1-12.	#Equations = 12. See Appendix A-3, Eqs. 1-12.	

Figure 15. Group One Equations vs. Environmental Groups A, B, and C

### Failure Group One vs. Environmental Group B

See Appendix A-2. All twelve regression equations in this grouping indicated an inverse relationship between: (1) average temperature conditions existing prior to failure and TBSF; and (2) barometric pressure existing at time of failure and TBSF. With the exception of the first equation, humidity was indicated as having a direct relationship with TBSF. Wind speed and wind direction were indicated as having a direct relationship in all equations. The major contributors to  $R^2$  were the average temperature and barometric pressure variables. The combined contribution of these two variables ranged from 68 to 80 percent of the total  $R^2$  (.0117-.0155) with an average contribution of 74 percent.

The values of the twelve  $R^2$ s are plotted in Figure 16. The range of  $R^2$  was from .0117 in the twelfth equation to a high of .0155 in the second equation. This may be interpreted as meaning that environmental conditions at the time of failure plus average temperature conditions existing prior to failure explain from 1.17 to 1.55 percent of the variance in TBSF.

### Failure Group One vs. Environmental Group C

See Appendix A-3. The inverse relationships indicated in these equations were between TBSF and (1) pressure for all equations, (2) the rate-of-temperature change variable for equations two through twelve, and (3) humidity

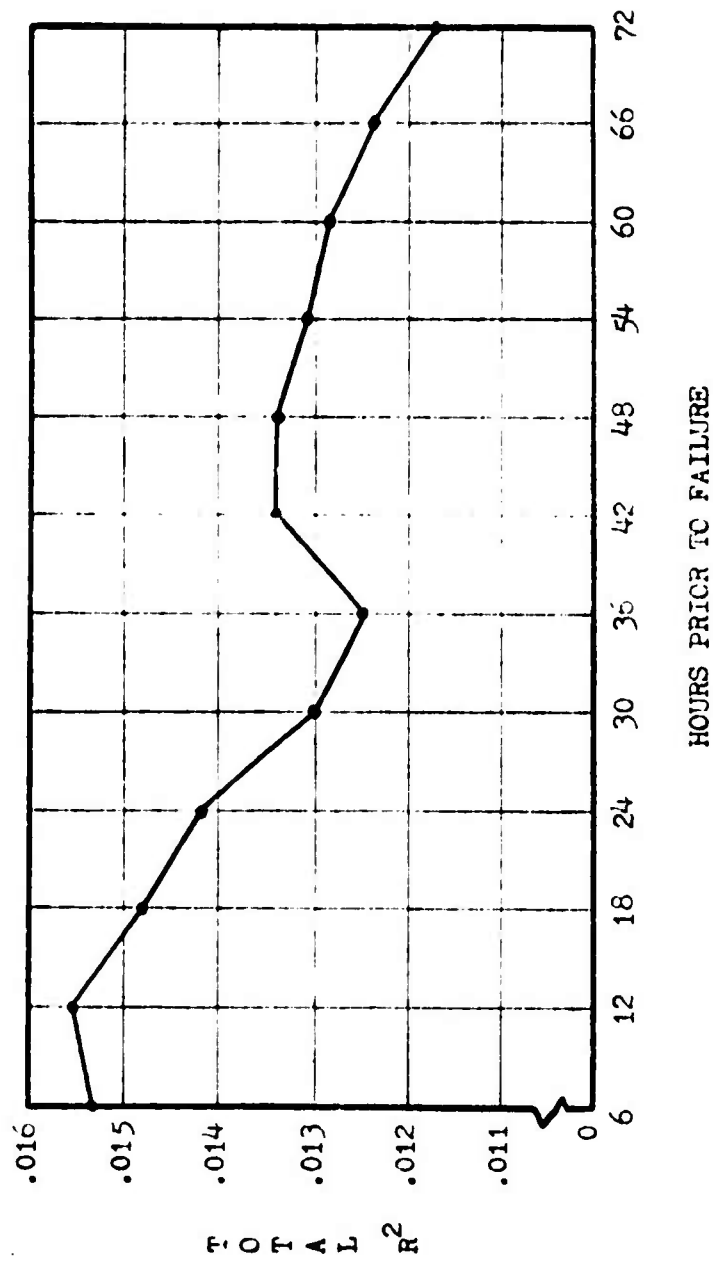


Figure 16. Failure Group One vs. Environmental Group B

for equations three through twelve, and (4) wind speed for equations nine through twelve. With the exception of equation one, the average rate-of-temperature change variable was the major contributor to  $R^2$ ; the contribution for equations two through twelve ranged from 58 to 85 percent, with an average contribution of 74 percent. The value of  $R^2$  for equations one through twelve is plotted on the graph in Figure 17. The value of  $R^2$  ranged from .0065 in equation one, to a high of .0520 in equation twelve. This may be interpreted as meaning that from .65 to 5.2 percent of the variance in TBSF is explained by environmental conditions at time of failure, plus the average rate-of-temperature change variable.

#### Summary of Group One Analysis

The equations in this group indicated an inverse relationship between TBSF for all NS-20 failures and (1) the temperature variables, and (2) pressure. In all cases the temperature variable was the major contributor to  $R^2$ . The highest  $R^2$  value (.0520) obtained in this group was in equation twelve where group one failures were regressed against environmental Group C.

#### Analysis of Group Two Equations

This group is analyzed as indicated in Figure 18. The first equation regresses the group two failures against environmental Group A. The next twelve equations

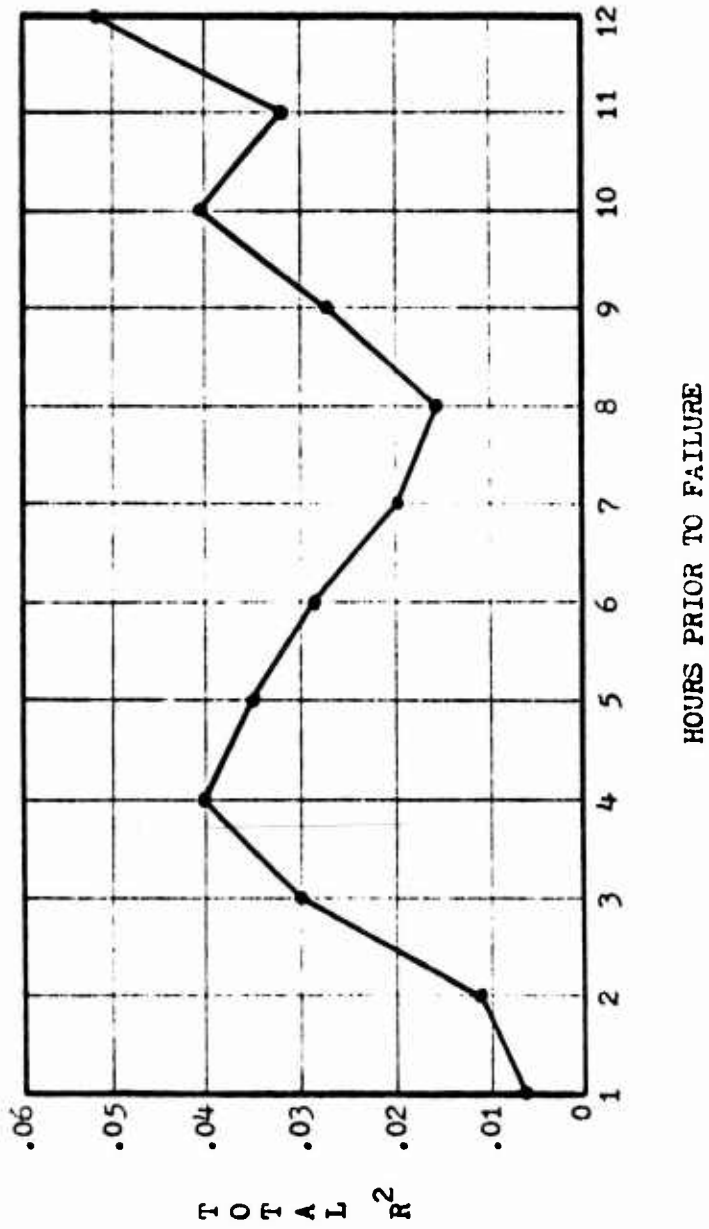


Figure 17. Failure Group One vs. Environmental Group C

DEPENDENT VARIABLES (TBSF)	INDEPENDENT VARIABLES (ENVIRONMENTAL CONDITIONS)			TOTAL EQS.
	GROUP A	GROUP B	GROUP C	
GROUP TWO FAILURES (Stratified Population) DCU Stratum	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P (T2) n=6,12...72	TEMP, WS, WD, H, P (T3) n=1,2...72	85
	#Equations = 1 See Appendix B-1	#Equations = 12 See Appendix B-2, Eqs. 1-12.	#Equations = 72 See Appendix B-3, Eqs. 1-72	

Figure 18. Group Two Equations vs. Environmental Groups A, B, and C

regress group two failures against environmental Group B. The last 72 equations regress Group two failures against environmental Group C.

Failure Group Two vs. Environmental Group A

See Appendix B-1. This regression indicated an inverse relationship between temperature at the time of failure and TBSF of DCU malfunctions. All other variables (wind speed, wind direction, and humidity) were indicated as having a direct relationship with the TBSF of DCUs. The major contributors to  $R^2$  (.2338) were wind speed (.1063) and pressure (.0993); wind direction, humidity and temperature contributed .0248, .0033 and .0001 respectively. The total  $R^2$  value was .2338, which may be interpreted as meaning that the environmental conditions at the time of failure explained 23.38 percent of the variance in TBSF of DCUs.

Failure Group Two vs. Environmental Group B

See Appendix B-2. There were no inverse relationships in this group of equations; all variables indicated a direct relationship with TBSF of DCUs. In each equation, wind speed and barometric pressure were major contributors to  $R^2$ . Wind speed and pressure combined accounted for 83 to 84 percent of the total  $R^2$  (.2155-.2174) in every equation. The contributions to  $R^2$  for wind speed (.1063), barometric pressure (.0737), wind direction

(.0317) and humidity (.0035) remained constant throughout all twelve equations. The variance in the  $R^2$  values plotted in Figure 19 was due to the variation in the contribution of the average temperature variable. In all twelve equations, the average temperature variable contributed the least to the  $R^2$  value. The  $R^2$  value ranged from .2155 in equation 1, 2, and 4, to a high of .2174 in equation 5. This may be interpreted as meaning that environmental conditions at time of failure plus average temperature conditions prior to failure explained from 21.55 to 21.74 percent of the variance in TBSF of DCUs.

#### Failure Group Two vs. Environmental Group C

See Appendix B-3. The original plan for this grouping was to compute twelve equations. However, equations ten, eleven, and twelve seemed to indicate that an increasingly significant relationship was developing between the average rate-of-temperature change variable and TBSF of DCUs. Therefore, an additional twelve equations were computed to investigate the effect of the rate-of-change in temperature on the TBSF up to twenty-four hours preceding the time of failure. However, again the last equations 21, 22, 23, and 24 indicated that a relationship was developing between the average rate-of-temperature change variable and TBSF. Therefore, another twelve equations were computed, and again the last equations 33, 34, 35, and 36 indicated that a relationship was

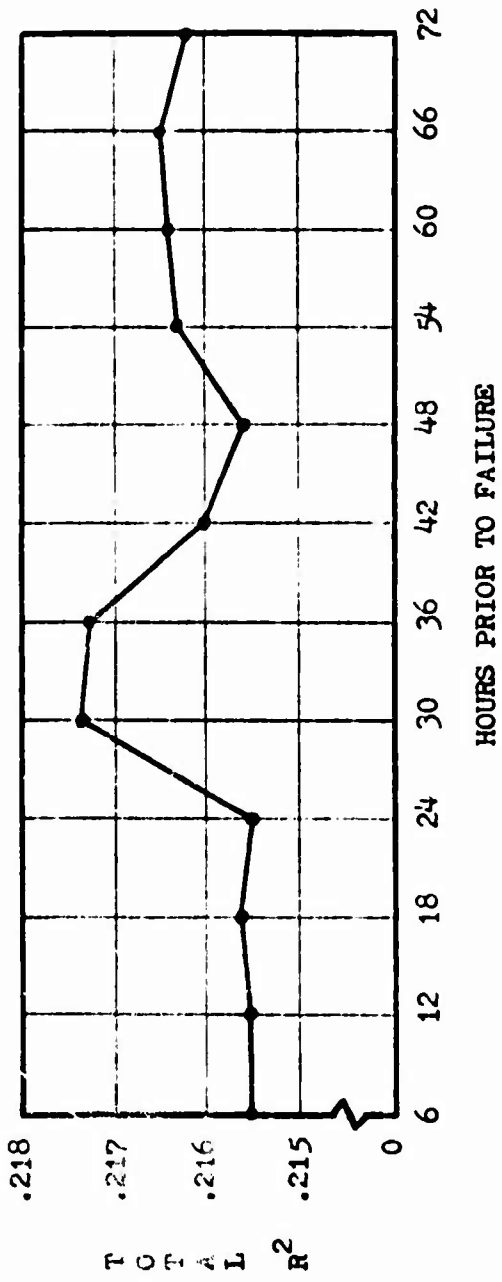


Figure 19. Failure Group Two vs. Environmental Group B

developing. Therefore, the relationship between the rate-of-temperature change and TBSF was computed at one hour intervals for 72 hours prior to the time of failure.

At the 37 hour point the  $R^2$  value fell sharply and remained at a relatively low level for equations 37 through 72. See Figure 20. The cycling phenomena remains a mystery. Since the peaks of the cycles fell at nearly twelve hour intervals and were fairly sharply defined, graphs were drawn to see if DCU failures were related to time of day or time of year. No obvious relationship was noted through an inspection of these graphs depicted in Figures 21 and 22. A regression analysis was not accomplished to formally determine if a relationship existed between DCU failures and the time of day or the time of year because the inspection of Figures 21 and 22 indicates no obvious relationship exists.

The equations indicated that an inverse relationship existed between the rate-of-temperature change variable and the TBSF of DCUs. All equations, except 26, 58, 59, and 60, indicated that an inverse relationship existed between humidity and TBSF. The equations indicated the other variables (pressure, wind speed, and wind direction) had a direct relationship with TBSF. The major contributor to  $R^2$  depended upon the time period involved. Figure 23 indicates what percentage of  $R^2$  was attributable to the rate-of-temperature change variable. The time

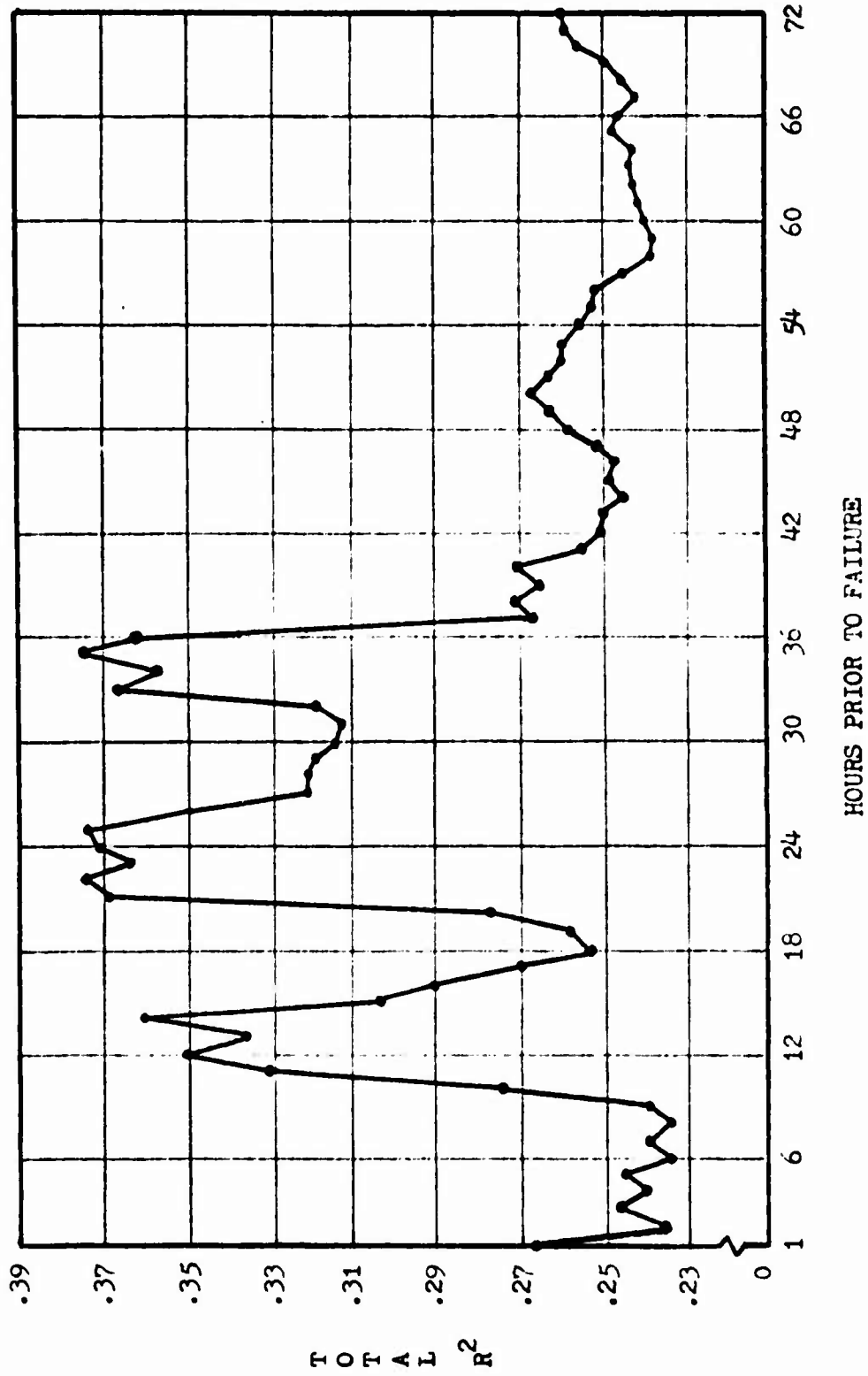
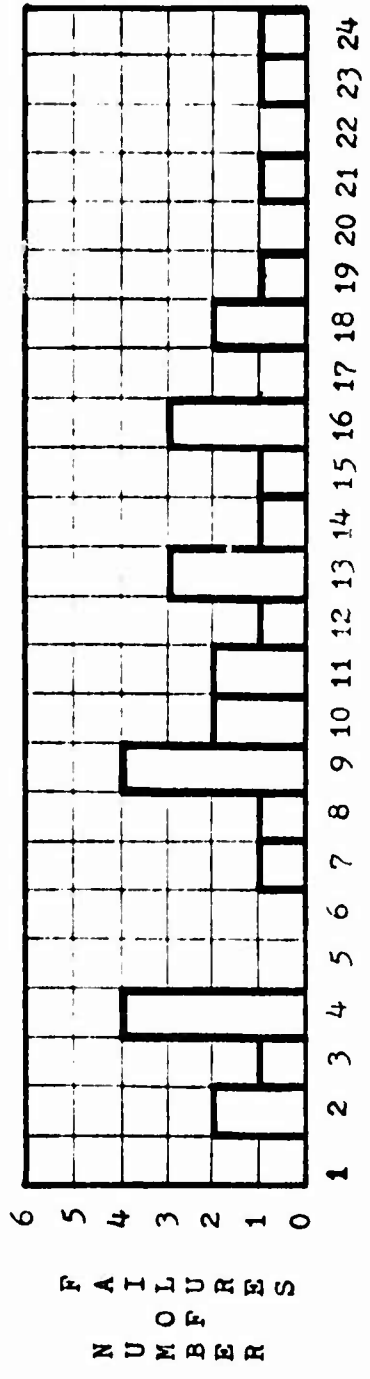


Figure 20. Failure Group Two vs. Environmental Group C



HOUR OF FAILURE

Figure 21. Time of Day vs. DCU Failure Rate

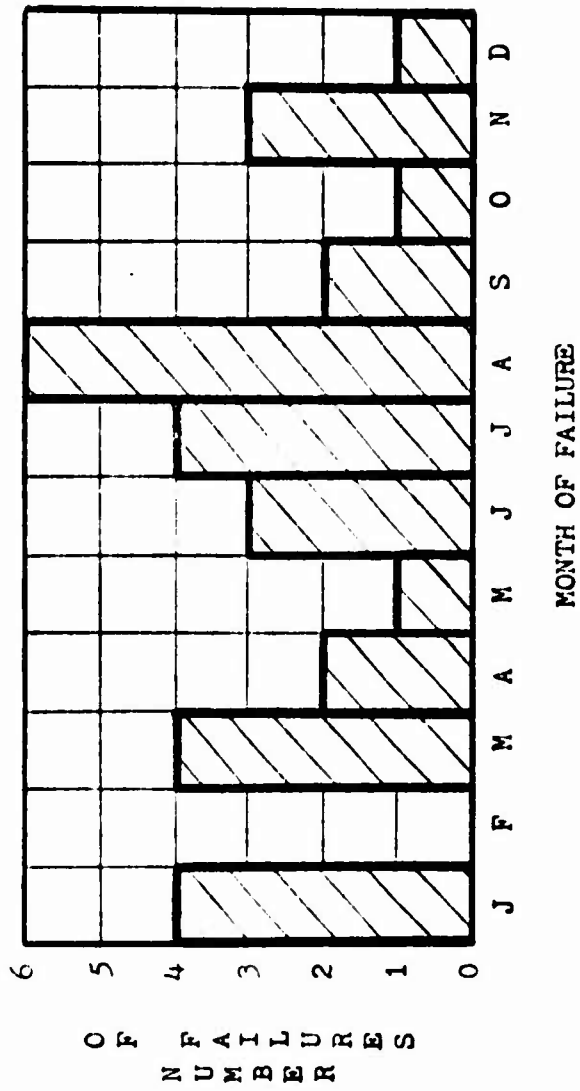


Figure 22. Month of Failure vs. DCU Failure Rate

Variable	% Contribution to R <sup>2</sup>	Variable	% Contribution to R <sup>2</sup>
T31	19	T321	42
T32	2	T322	45
T33	7	T323	49
T34	15	T324	53
T35	15	T325	61
T36	9	T326	49
T37	9	T327	18
T38	8	T328	18
T39	9	T329	16
T310	14	T330	15
T311	36	T331	15
T312	36	T332	16
T313	36	T333	38
T314	42	T334	38
T315	38	T335	50
T316	37	T336	51
T317	15	T337	12
T318	13	.	for hours
T319	14	.	38-72 the
T320	17	.	contribution
		T372	to R <sup>2</sup> ranged
			from 3 to 13%

Figure 23. Contribution of Average Rate-of-Temperature Change Variable to R<sup>2</sup> for DCU Failures

periods where the rate-of-change variable contributed the most to  $R^2$  were very clearly defined.

When the rate-of-temperature change variable became the major contributor to  $R^2$ , humidity normally became the second major contributor. During the time periods when the rate-of-temperature change variable was not a major contributor, wind speed and pressure contributed the most to  $R^2$ .

The maximum  $R^2$  values for the three cycles noted in Figures 20 and 23 (pages 71 and 74 respectively), occurred at 14, 22, and 35 hours prior to the time of failure. The  $R^2$  values for these periods were .3607, .3741 and .3738 respectively. In each case the average rate-of-temperature change variable and humidity at the time of failure were the major contributors to the  $R^2$  value. Average rate-of-temperature change combined with humidity amounted to 78, 77, and 85 percent respectively of the total  $R^2$  values of .3607, .3741, and .3738. The contribution of the average rate-of-temperature change variable alone equaled 42, 45, and 50 percent respectively of the total  $R^2$  value.

Since the total  $R^2$  value in equation 35 equaled .3738, it may be interpreted as meaning that the average rate-of-temperature change variable (computed at 35 hours prior to failure), plus environmental conditions at time of failure, explained 37.38 percent of the variance in

TBSF of DCUs. The TBSF for DCUs displayed more sensitivity to the average rate-of-temperature change variable and environmental conditions at time of failure than any other group analyzed.

#### Summary of Group Two Analysis

This group consistently indicated a greater sensitivity to external environmental conditions than any other group. When regressed against environmental Groups A and C, an inverse relationship was indicated between the temperature variable and TBSF. Wind speed and pressure were major contributors in all equations except where temperature variable T3 was dominant in the regression against environmental Group C. The highest  $R^2$  value (.3741) was obtained during the Group two versus environmental Group C regression in equation 22.

#### Analysis of Group Three Equations

This group is analyzed as indicated in Figure 24. The first equation regresses the group three failures against environmental Group A. The next twelve equations regress group three failures against environmental Group B. The last 36 equations regress group three failures against environmental Group C.

#### Failure Group Three vs. Environmental Group A

See Appendix C-1. This regression indicated an inverse relationship between temperature/pressure at time

DEPENDENT VARIABLES (TBSF)	INDEPENDENT VARIABLES (ENVIRONMENTAL CONDITIONS)			TOTAL EQS.
	GROUP A	GROUP B	GROUP C	
GROUP THREE FAILURES (Stratified Population) PIGA Stratum	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P (T2 <sub>n</sub> ) n=6,12...72	TEMP, WS, WD, H, P (T3 <sub>n</sub> ) n=1,2...36	49
	#Equations = 1 Appendix C-1	#Equations = 12 Appendix C-2, Eqs. 1-12	#Equations = 36 Appendix C-3, Eqs. 1-36	

Figure 24. Group Three Equations vs. Environmental Groups A, B, and C

of failure and TBSF due to PIGA malfunctions. The other variables (wind speed, wind direction and humidity) indicated a direct relationship with the TBSF of PIGAs. The major contributors to  $R^2$  (.0485) were humidity (.0315), and temperature (.0138); pressure, wind direction and wind speed contributed .0032, .0000, and .0000 respectively. The total  $R^2$  value was fairly low .0485, which may be interpreted as meaning that environmental conditions at time of failure explained 4.85 percent of the variance in the TBSF.

#### Failure Group Three vs. Environmental Group B

See Appendix C-2. All twelve regression equations in this grouping indicated an inverse relationship between the TBSF due to PIGA malfunctions and wind speed, barometric pressure and the average temperature variable. An inverse relationship was indicated between TBSF and wind direction for the first six equations. The last six equations indicated a direct relationship between TBSF and wind direction. All equations indicated a direct relationship between humidity and TBSF. The major contributors to  $R^2$  were the average temperature variable, pressure and humidity. The combined contribution of these three variables accounted for more than 99 percent of  $R^2$  (.0777-.0951) in all twelve equations.

Total  $R^2$  values are plotted on the graph in Figure 25. The values of  $R^2$  ranged from .0777 in equation eight

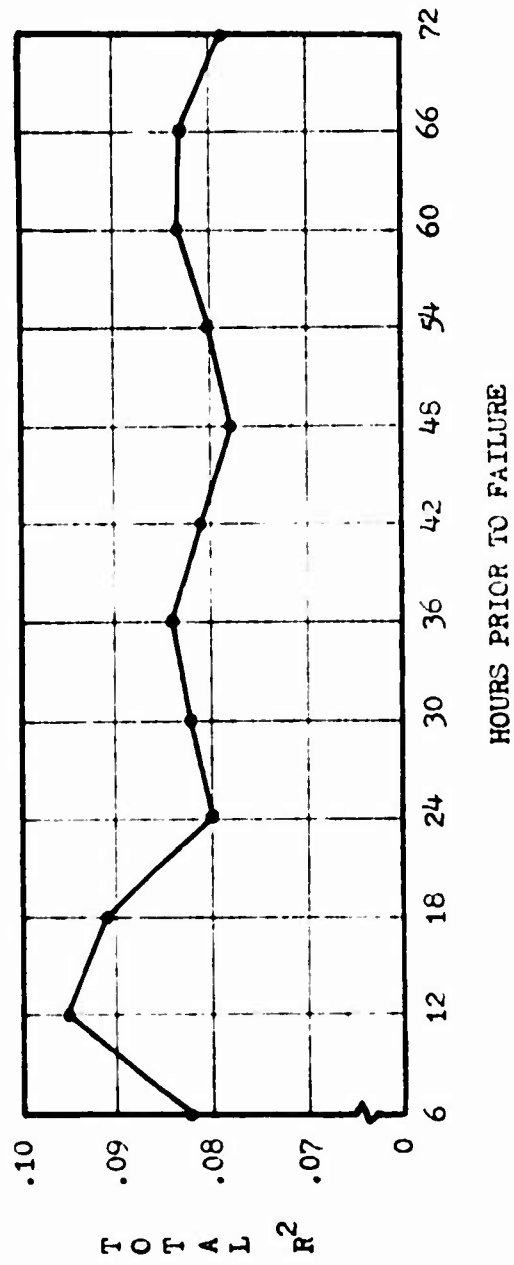


Figure 25. Failure Group Three vs. Environmental Group B

to a high of .0951 in equation two. This may be interpreted as meaning that from 7.77 to 9.51 percent of the variance in TBSF of PIGAs is explained by environmental conditions at time of failure, plus the average temperature variable.

#### Failure Group Three vs. Environmental Group C

See Appendix C-3. The original plan for this grouping was to compute twelve equations. However, equations nine, ten, eleven, and twelve indicated that a relationship was developing between TBSF and the average rate-of-temperature change variable. Of further interest was the fact that the average rate-of-temperature change variable contributed from 88 to 94 percent of the  $R^2$  value in equations nine, ten, eleven, and twelve. Based on experience with the DCU failure rate analysis, an additional twenty-four equations were computed to determine if the relationship would continue to develop.

All of the equations indicated that an inverse relationship existed between TBSF and (1) the average rate-of-temperature change variable, (2) barometric pressure, and (3) wind speed (except equation thirteen). An inverse relationship was indicated between TBSF and wind direction in equations three, four, and twenty-four. All equations indicated a direct relationship between TBSF and humidity.

The average rate-of-temperature change variable was the major contributor to  $R^2$  in equations three through twenty-four. In equation three it contributed 56 percent of the total  $R^2$  value. In equations four through twenty-four, the average rate-of-temperature change variable contribution to  $R^2$  ranged from 76 to 94 percent, with an average contribution of 85 percent. In equation one, two, and twenty-five through thirty-six, humidity was the major contributor to  $R^2$ . The contribution ranged from 53 to 97 percent with an average contribution of 88 percent. The most significant  $R^2$  values occurred in equations twelve (.1610) and seventeen through twenty-two (.1414, .1500, .1554, .1584, .1358, and .1342, respectively). After equation twenty-two, the  $R^2$  value dropped very sharply to a value of .0336 in equation twenty-five. See Figure 26. The value of  $R^2$  remained at approximately the .0336 level through equation thirty-six. The total  $R^2$  values are plotted on the graph in Figure 26. It was interesting that environmental conditions at the time of failure contributed very little to  $R^2$  in this group of equations.

Since the  $R^2$  value of the average rate-of-temperature change variable equaled .1518 in equation twelve, it may be interpreted as meaning that the average rate-of-temperature change variable (when computed at twelve hours prior to failure) explained 15.18 percent of the variance in TBSF of PIGAs.

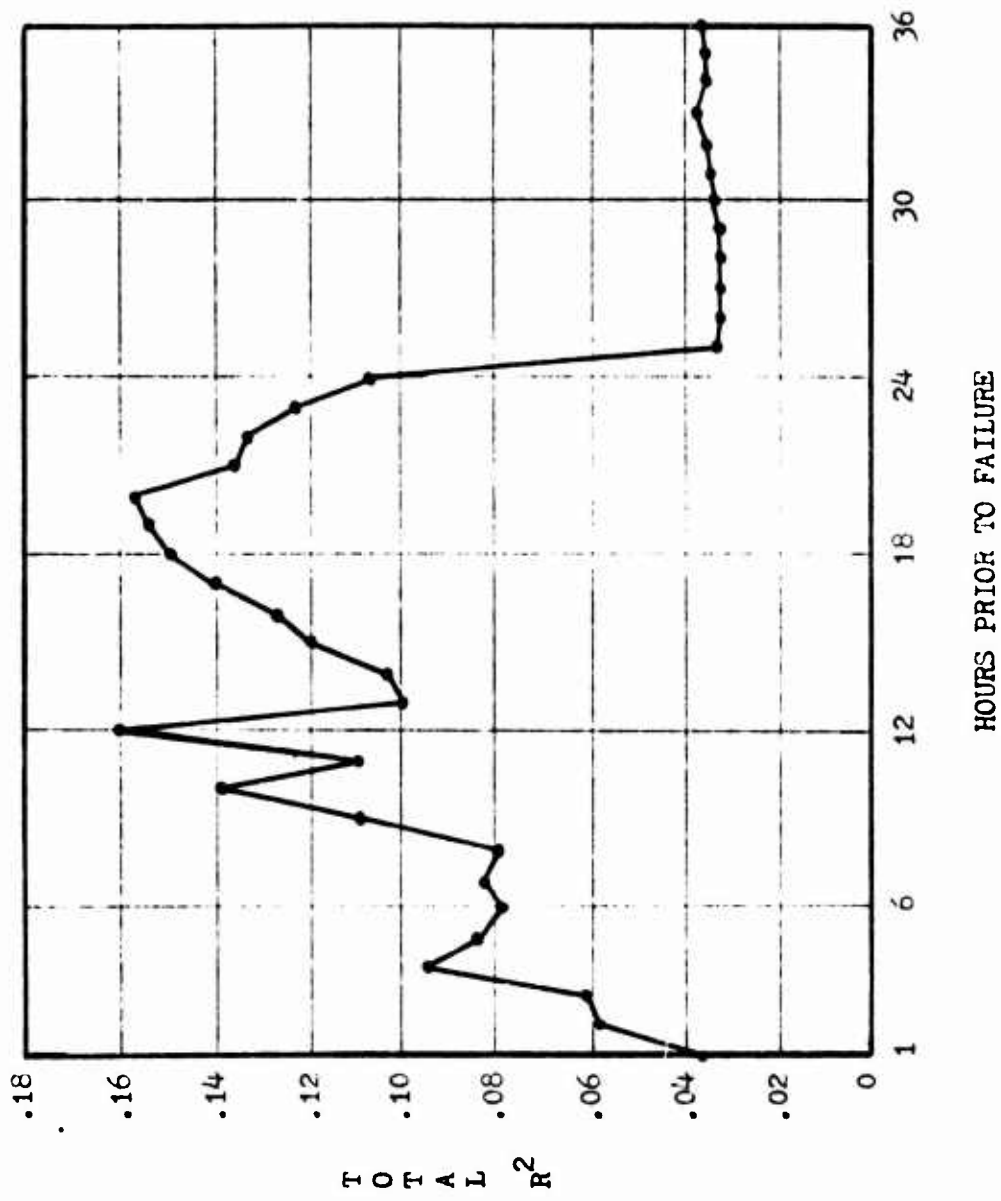


Figure 26. Failure Group Three vs. Environmental Group C

### Summary of Group Three Analysis

The TBSF for this group displayed little sensitivity to external environmental conditions with the exception of the T3 variable. Temperature, pressure and wind speed were generally indicated as having an inverse relationship with TBSF. With the exception of the Group three versus environmental Group A regression, the temperature variable was the major contributor to  $R^2$ . The highest  $R^2$  (.1610) value was obtained in equation twelve during the regression against environmental Group C.

### Testing of Hypothesis

#### Introduction

The researchers desired a conservative approach to testing for support of the research hypothesis. Defining the data as being derived from a representative sample of a process population would have been tenuous. Therefore, the data, by definition, was a census of a small information finite population. As such, a statistical test was considered inappropriate as the first step in research hypothesis testing because conducting a statistical test on a population census and/or non-representative sample of an ill defined population, would violate the assumptions underlying the appropriate use of such tests. Those readers willing to assume the data was collected from a representative sample of an indeterminate population may

refer to Appendices A, B, and C for the results of statistical testing.

#### Construction of Decision Rule

To construct a decision rule it was necessary to present the results of the data analysis in Chapter IV to several individuals familiar with statistical methods and the NS-20 guidance system. Each individual was asked to specify a level of  $R^2$  at which he would consider the results of the study to be of practical significance in terms of decision making and potential follow-up studies. Only personnel within the School of Systems and Logistics had access to the total study. Personnel outside the school gave their opinions based on an oral description of the research design and data analysis. The following paragraphs are brief summaries of interviews conducted by the authors.

Captain Steven Henderson, Quantitative Studies Department, School of Systems and Logistics. Captain Henderson believed that since the NS-20 is environmentally protected within the Minuteman silo, there should be no relationship between NS-20 failure rates and external environmental conditions. Therefore, in his opinion, any value of  $R^2$  above zero would warrant further study (17).

Lieutenant Colonel Joseph Boyett, Management Studies Department, School of Systems and Logistics. In Lieutenant Colonel Boyett's experience with multiple

regression, almost any combination of variables would produce some value of  $R^2$ . Under the circumstances of this study, it was his opinion that any value of  $R^2$  above .15 would warrant further study (10).

Mr. Robert Wallen, MER Ogden Air Logistics Center. Mr. Wallen believed that an  $R^2$  value of .15 or higher should be considered significant. However, the  $R^2$  value would have to range from .3 to .4 before the results could be considered of practical significance and warrant further study (27).

Mr. Russell Genet, AGMC. Mr. Genet believed any variable would produce an  $R^2$  of some value. Considering the circumstances surrounding Minuteman NS-20 failures, it was his opinion that an  $R^2$  value of .35 would be considered of practical significance and the results would warrant further study (13).

#### Decision Rule

Based on the background and experience of the above individuals, the most conservative estimates were selected as a basis for the decision rule. Therefore, any  $R^2$  value that exceeded .35 was considered as being of practical significance. However, the reader should apply his own judgement in analyzing the results.

### Testing of Hypothesis

The research hypothesis stated that a relationship existed between the TBSF of NS-20s and external environmental conditions. The search for a relationship consisted of the computation of 159 regression equations. These equations were the results of a regression analysis of the failure groups and environmental groups listed in Figure 27. Based on the decision rule established (Figure 27), the only multiple regression equations that produced  $R^2$  values of practical significance were those where group two failures were regressed against environmental Group C. However, out of the 72 equations that were computed in regressing group two failures against environmental Group C, only eleven produced a significant  $R^2$  value. The variables that were contained in the eleven equations are listed in Figure 28. The contribution to  $R^2$  of each variable is in parenthesis. The equations are listed in Appendix B-3.

The research hypothesis that a relationship exists between the TBSF of NS-20s and external environmental conditions is supported. However, it is supported for only very limited combinations of independent variables, that include the variable "average rate-of-temperature change." Without the stepwise regression of other independent variables of wind speed, wind direction, pressure and humidity, the average rate-of-temperature change variable contributed an average of approximately 52 percent to the total  $R^2$ .

DEPENDENT VARIABLES (TBSF)	INDEPENDENT VARIABLES (ENVIRONMENTAL CONDITIONS)			TOTAL EQS.
	GROUP A	GROUP B	GROUP C	
GROUP ONE FAILURES (Non-strat Population)	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P (T2) <sub>n</sub> n=6,12...72	TEMP, WS, WD, H, P (T3) <sub>n</sub> n=1,2...12	25
	#Equations = 1 Appendix A-1	#Equations = 12 Appendix A-2	#Equations = 12 Appendix A-3	
GROUP TWO FAILURES (Stratified Population) DCU Stratum	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P (T2) <sub>n</sub> n=6,12...72	TEMP, WS, WD, H, P (T3) <sub>n</sub> n=1,2...72	85
	#Equations = 1 Appendix B-1	#Equations = 12 Appendix B-2	#Equations = 72 Appendix B-3	
GROUP THREE FAILURES (Stratified Population) PIGA Stratum	TEMP, WS, WD, H, P (T1)	TEMP, WS, WD, H, P (T2) <sub>n</sub> n=6,12...72	TEMP, WS, WD, H, P (T3) <sub>n</sub> n=1,2...36	49
	#Equations = 1 Appendix C-1	#Equations = 12 Appendix C-2	#Equations = 36 Appendix C-3	
TOTAL EQUATIONS	3	36	120	159

Figure 27. Summary of Multiple Regression Equations

TEMPERATURE VARIABLE*	VARIABLES FOR CONDITIONS AT TIME OF FAILURE			TOTAL R <sup>2</sup>	
T312(.128)**	H(.124)	WD(.042)	P(.054)	WS(.002)	.350
T314(.153)	H(.130)	WD(.039)	P(.039)	WS(.001)	.360
T321(.155)	H(.108)	WD(.064)	P(.043)	WS(.000)	.368
T322(.167)	H(.119)	WD(.056)	P(.032)	WS(.000)	.374
T323(.178)	H(.117)	WD(.048)	P(.020)	WS(.001)	.363
T324(.198)	H(.117)	WD(.034)	P(.021)	WS(.001)	.371
T325(.227)	H(.093)	WD(.026)	P(.026)	WS(.000)	.313
T333(.139)	H(.130)	WD(.065)	P(.023)	WS(.009)	.366
T334(.136)	H(.127)	WD(.060)	P(.023)	WS(.011)	.356
T335(.187)	H(.131)	WD(.038)	P(.014)	WS(.003)	.374
T336(.184)	H(.123)	WD(.037)	P(.014)	WS(.005)	.361

\*T312 represents the average rate-of-temperature change condition existing for twelve hours prior to failure; T314, 14 hours; T321, 21 hours, through 36 hours for T336.

\*\*Contribution to R<sup>2</sup> is in parenthesis after each variable.

Figure 28. Equations Producing R<sup>2</sup> Values of .35 and Above

Humidity contributed an average of 33 percent. Due to the relationship between humidity and temperature (see Chapter III, "Environmental Variables"), there was concern that the relationship might be responsible for the large contribution to  $R^2$  by humidity and the rate-of-temperature change variables. However, inspection of the data failed to reveal any obvious interaction between humidity and the rate-of-temperature change during the periods when practically significant  $R^2$  values were achieved. The inspection consisted of a search for patterns in the correlation between humidity and the rate-of-temperature change; for evidence of multicollinearity between the two variables; and for variations in the mean and standard deviation of each average rate-of-temperature change variable. Although no relationships were obvious through inspection, it should not be concluded they do not exist. The relationship between the variables may be so complex that the only means of identifying them may be through the use of multiple regression or other mathematical techniques.

Since the stepwise addition of the independent variables may have created some association by chance, the findings of limited support should be accepted with caution. In general, the analysis indicated a lack of support in terms of practical significance except under some very limited conditions for DCU failures.

**Overview**

Chapter V contains conclusions, recommendations and a brief critique of this study.

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine if a relationship existed between external environmental conditions and the TBSF of NS-20s at Grand Forks AFB, North Dakota. The study of environmental conditions versus NS-20 failures evolved as the result of the opinions of various maintenance and depot personnel that there seemed to be more NS-20 failures at certain times of the year. The preponderance of opinion was that the number of failures increased during spring and fall months. Several informal, undocumented studies had been conducted to determine if a relationship existed between the seasons of the year and failures of Minuteman guidance systems. None of the studies found a relationship.

If a seasonal variation in NS-20 failures existed, then it was possibly due to changes in external environmental conditions. Therefore this study was an attempt to determine if a relationship existed between the environmental conditions of temperature, wind speed, wind direction, humidity, barometric pressure and the failures of NS-20s. If a relationship between one or a combination of these environmental factors and NS-20 failures could be

found, it would be more meaningful than finding a relationship between the seasons and NS-20 failures. It was not the purpose of this study to determine why any particular relationship existed, but to simply determine if a relationship did exist. Therefore, the general approach was to conduct a search for a relationship through the use of multiple regression analysis. The search included examining both environmental conditions at the time of failure and prior to failure for all NS-20 failures and for specific NS-20 failure modes, i.e., DCU and PIGA malfunctions. The following paragraphs contain the conclusions and recommendations as a result of this study.

#### Conclusions

Under the criteria rule established in Chapter IV, the following conclusions are drawn from this study.

No relationship of practical importance existed between the TBSF of all NS-20 failures, non-stratified population, and any one or a combination of the following: (1) environmental conditions of temperature, wind speed, wind direction, humidity, and barometric pressure existing at the time of failure; (2) the average temperature conditions existing up to seventy-two hours prior to time of failure; and (3) the average rate-of-temperature change conditions existing up to twelve hours prior to time of failure.

No relationship of practical importance existed between the TBSF of NS-20s due to the stratum of PIGA malfunctions and any one or a combination of the following: (1) the environmental conditions of temperature, wind speed, wind direction, humidity and barometric pressure existing at the time of failure; (2) the average temperature conditions existing up to seventy-two hours prior to time of failure; and (3) the average rate-of-temperature change conditions existing up to thirty-six hours prior to the time of failure.

No relationship of practical importance existed between the TBSF of NS-20s due to the stratum of DCU malfunctions and any one or a combination of the following: (1) the environmental conditions of temperature, wind speed, wind direction, humidity and barometric pressure; and (2) the average temperature conditions existing for up to seventy-two hours prior to the time of failure.

A relationship of practical importance did exist between the TBSF of NS-20s due to the stratum of DCU malfunctions and a combination of environmental conditions existing at the time of failure; i.e., wind speed, wind direction, humidity, and barometric pressure, and the average rate-of-temperature change existing prior to failure. The specific combination is listed in Figure 28 on page 88.

The research hypothesis was supported. A relationship did exist between external environmental conditions and the NS-20 failure rate for DCU malfunctions. However, the relationship was for a very limited combination of environmental variables and DCU failures. Since DCU failures were the only category of NS-20 failures that indicated a significant sensitivity to environmental conditions, the possibility that their failure was related to the seasons of the year was examined. An inspection of Figure 22 on page 73, revealed that no obvious relationship existed between DCU-induced NS-20 failures and the seasons of the year.

#### Recommendations

One of the problems in using multiple regression analysis is knowing where to start. There seems to be no limit to the numbers, types, and combinations of variables that can be entered into the regression. Also, once the results of the regression equation are obtained, it can be very difficult to interpret their meaning or to determine precisely what the equation is measuring. This study should be considered as a preliminary and incomplete survey of the subject. If time permitted, or if this study could be replicated, the following changes should be made:

- (1) select a longer time period for analysis, i.e., three to four years so as to permit a time series analysis and provide a larger data base;
- (2) use a different combination

of variables in the regression equations; that is, combine all of the average rate-of-temperature change variables into one equation, rather than consider each one in a separate equation; (3) possibly re-define the average rate-of-temperature change variable and establish it as the total rate-of-temperature change variable and thus regress the total change in temperature change for the time periods used in this study against the TBSF; (4) conduct additional regressions, i.e., regress the failure rate against the time of day and the time of year; and (5) control the order in which the variables are considered in the regression equation rather than allowing the BMD02R program to establish the sequence by selecting the variables that contribute the most to  $R^2$ . When the researchers control the sequence in which independent variables are entered into the regression equation, a more precise analysis of the contribution of each variable is possible.

Therefore, additional studies conducted to more precisely define the relationships found in this study are recommended. If such relationships exist by trend, then additional studies should be conducted to determine why the relationships exist. Regression analysis provides a mathematical relationship. With enough equations and variables, by chance alone, some relationships may occur. However, these mathematical models should not

be interpreted as cause and effect relationships between dependent and independent variables.

The regression analysis indicated a possible relationship of practical significance associated with rate-of-temperature change and humidity. An inspection of the data was conducted to determine if a reasonable inference could be rendered about a possible cause and effect relationship. The inspection revealed that no obvious relationship exists.

## APPENDICES

The appendices contain summaries of the 159 multiple regression equations. They also contain the computed programs to convert the raw data to usable form. Appendix A contains the equations from regressing the TBSF of failure group one against environmental groups A, B, and C. Appendix B contains the equations from regressing the TBSF of failure group three against environmental groups A, B, and C. Appendix D contains the computer programs to convert the raw data into usable form.

For readers who wish to consider this study as a representative sample of a process population, F-distribution values for given alpha levels (statistical significance) are included in Figure 29. The values in Figure 29 correspond to the appropriate upper and lower degrees of freedom of the equations included in each appendix. The terms SS and PS will be found next to the "F Ratio" on some equations. SS means the  $R^2$  was statistically significant at the .05 level of confidence. PS means the  $R^2$  was of practical significance; i.e.,  $R^2 = .35$  and above. If no symbol is present, the equation was not significant in either a statistical or practical sense. A detailed description of the BMD02R output is given in Chapter IV.

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F-VALUES FOR APPENDIX A

<u>ALPHA LEVEL</u>	<u>CONFIDENCE LEVEL</u>	<u>F-RATIO DF* = 5/153</u>	<u>F TO REMOVE DF = 1/153</u>
.10	90	1.85	2.71
.05	95	2.21	3.84
.025	97.5	2.57	5.02
.01	99	3.02	6.63

F-VALUES FOR APPENDIX B

		<u>DF = 5/25</u>	<u>DF = 1/25</u>
.10	90	2.09	2.92
.05	95	2.60	4.24
.025	97.5	3.13	5.69
.01	99	3.85	7.77

F-VALUES FOR APPENDIX C

		<u>DF = 5/71</u>	<u>DF = 1/71</u>
.10	90	1.94	2.78
.05	95	2.36	3.99
.025	97.5	2.78	5.29
.01	99	3.33	7.07

\*Degrees of freedom: upper = 5; lower = 153

Figure 29. F-Distribution Values for Appendices  
A, B, and C

## APPENDIX A

### FAILURE GROUP ONE (ALL NS-20 FAILURES) VERSUS ENVIRONMENTAL GROUPS A, B, AND C

This appendix is divided into three sub-appendices. Appendices A-1, A-2, and A-3 contain respectively the equations that resulted from regressing the TBSF of all NS-20 failures against environmental groups A, B, and C. The appropriated F-distribution values for each sub-appendix are listed in Figure 29 on page 99.

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**APPENDIX A-1**  
**FAILURE GROUP ONE (ALL NS-20 FAILURES)**  
**VERSUS ENVIRONMENTAL GROUP A**

DF            F RATIO  
 5             0.421  
 153

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	95.23852 )		
TEMP 2	-0.21627	0.23883	0.6200 (3)
WD 3	0.02223	0.03975	0.3127 (3)
WS 4	0.48955	0.82263	0.3297 (3)
PRES 5	-1.43679	24.34966	0.0035 (3)
HUM 6	0.04109	0.30879	0.0177 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
TEMP	2	0.0919	0.0085
WS	4	0.1064	0.0113
WD	3	0.1155	0.0134
HUM	6	0.1164	0.0135
PRES	5	0.1165	0.0136

**APPENDIX A-2**  
**FAILURE GROUP ONE (ALL NS-20 FAILURES)**  
**VERSUS ENVIRONMENTAL GROUP B**

DF 5 F RATIO 1  
 153 0.477

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	571.52090 )		
WD 2	0.01969	0.03979	0.2447 (3)
WS 3	0.35206	0.07248	0.1706 (3)
PRES 4	-17.05960	24.16365	0.4984 (3)
HUM 5	-0.01151	0.29974	0.0015 (3)
T26 6	-0.23659	0.23833	1.4460 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T26	6	0.0830	0.0069
PRES	4	0.1105	0.0122
WD	2	0.1189	0.0141
WS	3	0.1238	0.0153
HUM	5	0.1236	0.0153

DF 5 F RATIO 2  
 153 0.481

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	506.82722 )		
WD 2	0.02113	0.03964	0.2041 (3)
WS 3	0.34832	0.05263	0.1669 (3)
PRES 4	-16.90694	24.00445	0.4983 (3)
HUM 5	0.02278	0.29060	0.0061 (3)
T212 7	-0.29109	0.24018	1.4689 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T212	7	0.0814	0.0066
PRES	4	0.1108	0.0123
WD	2	0.1200	0.0144
WS	3	0.1243	0.0154
HUM	5	0.1244	0.0155

DF  
5  
153

F RATIO  
0.461

3

106

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		544.74858 )		
WD	2	0.02230	0.03957	0.3175 (3)
WS	3	0.33695	0.85399	0.1557 (3)
PRES	4	-16.27670	24.00797	0.4596 (3)
HUM	5	0.03221	0.20932	0.0124 (3)
T218	8	-0.26953	0.24749	1.3686 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T218	8	0.0784	0.0061
PRES	4	0.1072	0.0115
WD	2	0.1176	0.0138
WS	3	0.1215	0.0148
HUM	5	0.1218	0.0148

DF  
5  
153

F RATIO  
0.442

4

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		519.33992 )		
WD	2	0.02231	0.03959	0.3176 (3)
WS	3	0.33772	0.85447	0.1562 (3)
PRES	4	-15.43065	23.86801	0.4180 (3)
HUM	5	0.02923	0.29076	0.0101 (3)
T224	9	-0.28309	0.25068	1.2753 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T224	9	0.0770	0.0059
PRES	4	0.1043	0.0109
WD	2	0.1150	0.0132
WS	3	0.1191	0.0142
HUM	5	0.1194	0.0142

DF            F RATIO            5  
 5            0.403  
 153

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	474.67377 )		
WD 2	0.02273	0.03961	0.3294 (3)
WS 3	0.33890	0.82563	0.1569 (3)
PRES 4	-13.99611	23.72602	0.3471 (3)
HUM 5	0.03620	0.29065	0.0157 (3)
T230 10	-0.25832	0.24840	1.0814 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T230	10	0.0719	0.0052
PRES	4	0.0978	0.0096
WD	2	0.1092	0.0120
WS	3	0.1136	0.0129
HUM	5	0.1140	0.0130

DF            F RATIO            6  
 5            0.388  
 153

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	450.24450 )		
WD 2	0.02336	0.03958	0.3483 (3)
WS 3	0.33331	0.82683	0.1513 (3)
PRES 4	-13.22277	23.60370	0.3138 (3)
HUM 5	0.04600	0.28923	0.0253 (3)
T236 11	-0.24659	0.24585	1.0060 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T236	11	0.0696	0.0048
PRES	4	0.0947	0.0090
WD	2	0.1073	0.0115
WS	3	0.1112	0.0124
HUM	5	0.1119	0.0125

DF  
5  
153

F RATIO  
0.417

7

108

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		472.18948 )		
WD	2	0.02388	0.03952	0.3652 (3)
WS	3	0.31689	0.85751	0.1366 (3)
PRES	4	-13.92327	23.48929	0.3514 (3)
HUM	5	0.04255	0.20876	0.0217 (3)
T242	6	-0.26348	0.24561	1.1508 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T242	6	0.0743	0.0055
PRES	4	0.0995	0.0099
WD	2	0.1120	0.0125
WS	3	0.1154	0.0133
HUM	5	0.1160	0.0134

DF  
5  
153

F RATIO  
0.416

8

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		461.74673 )		
WD	2	0.02418	0.03950	0.3748 (3)
WS	3	0.31556	0.85770	0.1354 (3)
PRES	4	-13.57374	23.32363	0.3387 (3)
HUM	5	0.03969	0.20944	0.0188 (3)
T248	7	-0.26103	0.24371	1.1471 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T248	7	0.0748	0.0056
PRES	4	0.0991	0.0098
WD	2	0.1119	0.0125
WS	3	0.1153	0.0133
HUM	5	0.1159	0.0134

DF  
5  
153

F RATIO  
0.400

9

109

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	447.79590 )		
WD 2	0.02426	0.03951	0.3772 (3)
WS 3	0.31581	0.85806	0.1355 (3)
PRES 4	-13.12219	23.22661	0.3192 (3)
HUM 5	0.04070	0.28959	0.0197 (3)
T254 8	-0.25344	0.24123	1.1038 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T254	8	0.0740	0.0055
PRES	4	0.0976	0.0095
WD	2	0.1107	0.0122
WS	3	0.1141	0.0130
HUM	5	0.1147	0.0131

DF  
5  
153

F RATIO  
0.400

10

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	436.21175 )		
WD 2	0.02437	0.03951	0.3804 (3)
WS 3	0.31459	0.85857	0.1343 (3)
PRES 4	-12.75647	23.15303	0.3036 (3)
HUM 5	0.04604	0.28866	0.0254 (3)
T260 9	-0.24755	0.23965	1.0669 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T260	9	0.0730	0.0053
PRES	4	0.0962	0.0093
WD	2	0.1096	0.0120
WS	3	0.1129	0.0127
HUM	5	0.1136	0.0129

DF  
5  
153

F RATIO  
0.385

11

110

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	417.05602 )		
WD 2	0.02458	0.03951	0.3870 (3)
WS 3	0.31521	0.80929	0.1346 (3)
PRES 4	-12.16586	23.00828	0.2777 (3)
HUM 5	0.04883	0.23868	0.0286 (3)
T266 10	-0.23778	0.23891	0.9905 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T266	10	0.0708	0.0050
PRES	4	0.0933	0.0087
WD	2	0.1072	0.0115
WS	3	0.1106	0.0122
HUM	5	0.1110	0.0124

DF  
5  
153

F RATIO  
0.361

12

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	391.65424 )		
WD 2	0.02462	0.03953	0.3879 (3)
WS 3	0.32205	0.80966	0.1403 (3)
PRES 4	-11.31981	23.02950	0.2416 (3)
HUM 5	0.05103	0.23929	0.0311 (3)
T272 11	-0.22280	0.23833	0.8739 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T272	11	0.0672	0.0045
PRES	4	0.0889	0.0079
WD	2	0.1035	0.0107
WS	3	0.1071	0.0115
HUM	5	0.1080	0.0117

APPENDIX A-3  
FAILURE GROUP ONE (ALL NS-20 FAILURES)  
VERSUS ENVIRONMENTAL GROUP C

DF F RATIO 1  
 5 0.201  
 153

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	33.90859 )		
WD 2	0.02814	0.04014	0.4915 (3)
WS 3	0.46278	0.86001	0.2896 (3)
PRES 4	-0.00254	19.74655	0.0000 (3)
HUM 5	0.13553	0.23872	0.2204 (3)
T31 6	0.76251	2.71149	0.0791 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WD	2	0.0581	0.0034
WS	3	0.0694	0.0048
HUM	5	0.0776	0.0060
T31	6	0.0809	0.0065
PRES	4	0.0889	0.0065

DF F RATIO 2  
 5 0.328  
 153

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	139.90463 )		
WD 2	0.02516	0.03953	0.4051 (3)
WS 3	0.36753	0.86485	0.1264 (3)
PRES 4	-3.03160	19.99411	0.0230 (3)
HUM 5	0.03763	0.29615	0.0161 (3)
T32 7	-2.88298	3.42600	0.7081 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T32	7	0.0790	0.0062
WD	2	0.0963	0.0093
WS	3	0.1013	0.0103
PRES	4	0.1025	0.0105
HUM	5	0.1030	0.0106

DF	F RATIO	3
5	0.953	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	231.12872 )		
WD 2	0.02303	0.03915	0.3460 (3)
WS 3	0.14658	0.89605	0.0293 (3)
PRES 4	-7.13107	19.92787	0.1293 (3)
HUM 5	-0.08650	0.29680	0.0849 (3)
T33 8	-7.46569	3.82339	3.6128 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T33	8	0.1609	0.0259
WD	2	0.1680	0.0285
PRES	4	0.1711	0.0293
HUM	5	0.1732	0.0300
WS	3	0.1738	0.0302

DF	F RATIO	4
5	1.279	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	324.46729 )		
WD 2	0.02736	0.03892	0.4944 (3)
WS 3	0.00316	0.39907	0.0000 (3)
PRES 4	-8.24032	19.71053	0.1748 (3)
HUM 5	-0.17502	0.30352	0.3325 (3)
T34 9	-9.70350	4.16167	5.4365 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T34	9	0.1841	0.0339
WD	2	0.1932	0.0373
HUM	5	0.1973	0.0389
PRES	4	0.2003	0.0401
WS	3	0.2003	0.0401

DF 5 F RATIO 1.100 5  
153

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	319.57935 )		
WD 2	0.02879	0.03904	0.5436 (3)
WS 3	0.02176	0.80325	0.0006 (3)
PRES 4	-8.10911	19.81233	0.1675 (3)
HUM 5	-0.17248	0.30872	0.3121 (3)
T35 10	-9.54471	4.47671	4.5458 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T35	10	0.1679	0.0282
WD	2	0.1788	0.0320
HUM	5	0.1031	0.0335
PRES	4	0.1368	0.0347
WS	3	0.1368	0.0347

DF 5 F RATIO 0.920 6  
153

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	315.31972 )		
WD 2	0.03039	0.03920	0.0011 (3)
WS 3	0.07120	0.86482	0.0068 (3)
PRES 4	-8.05735	19.94693	0.1632 (3)
HUM 5	-0.15809	0.31312	0.2549 (3)
T36 11	-9.20059	4.81516	3.6510 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T36	11	0.1498	0.0224
WD	2	0.1631	0.0266
HUM	5	0.1670	0.0279
PRES	4	0.1707	0.0292
WS	3	0.1709	0.0292

DF  
5  
153

F RATIO  
0.638

7

115

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		266.01449 )		
WD	2	0.03149	0.03947	0.6368 (3)
WS	3	0.09092	0.07778	0.0107 (3)
PRES	4	-6.54189	20.05839	0.1064 (3)
HUM	5	-0.13477	0.32566	0.1710 (3)
T37	6	-0.11810	5.41123	2.2507 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
T37	6	0.1190	0.0142
WD	2	0.1362	0.0185
HUM	5	0.1396	0.0195
PRES	4	0.1427	0.0204
WS	3	0.1430	0.0204

DF  
5  
153

F RATIO  
0.488

8

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		250.26311 )		
WD	2	0.03092	0.03959	0.6100 (3)
WS	3	0.11814	0.88764	0.0177 (3)
PRES	4	-6.14235	20.24609	0.0920 (3)
HUM	5	-0.10207	0.33213	0.0944 (3)
T38	7	-7.26148	5.91993	1.5046 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
T38	7	0.0999	0.0100
WD	2	0.1193	0.0142
WS	3	0.1217	0.0148
HUM	5	0.1229	0.0151
PRES	4	0.1253	0.0157

DF	F RATIO	9
5	0.839	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	338.54329 )		
WD 2	0.03083	0.03927	0.6164 (3)
WS 3	-0.10302	0.89577	0.0132 (3)
PRES 4	-8.57284	20.08933	0.1821 (3)
HUM 5	-0.20797	0.33172	0.3930 (3)
T39 8	-11.03259	6.12203	3.2476 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T39	8	0.1402	0.0196
WD	2	0.1539	0.0237
HUM	5	0.1598	0.0255
PRES	4	0.1631	0.0266
WS	3	0.1634	0.0267

DF	F RATIO	10
5	1.292	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	474.21698 )		
WD 2	0.03315	0.03902	0.7217 (3)
WS 3	-0.26799	0.89056	0.0906 (3)
PRES 4	-12.73125	20.12684	0.4001 (3)
HUM 5	-0.27749	0.32358	0.7354 (3)
T310 9	-14.49117	6.17890	5.5003 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T310	9	0.1750	0.0306
WD	2	0.1873	0.0351
HUM	5	0.1948	0.0379
PRES	4	0.1999	0.0400
WS	3	0.2013	0.0405

DF	F RATIO	11
5	1.006	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	398.93908 )		
WD 2	0.03030	0.03913	0.5994 (3)
WS 3	-0.11097	0.88472	0.0157 (3)
PRES 4	-10.49511	20.14883	0.2713 (3)
HUM 5	-0.20801	0.32097	0.4200 (3)
T311 10	-12.61530	6.24822	4.0765 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T311	10	0.1561	0.0244
WD	2	0.1684	0.0283
HUM	5	0.1735	0.0301
PRES	4	0.1781	0.0317
WS	3	0.1784	0.0318

DF	F RATIO	12
5	1.679	
153		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	458.63345 )		
WD 2	0.02943	0.03869	0.5786 (3)
WS 3	-0.31929	0.87839	0.1321 (3)
PRES 4	-11.96850	19.76428	0.3667 (3)
HUM 5	-0.29710	0.31400	0.8953 (3)
T312 11	-17.22164	6.32164	7.4216 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T312	11	0.2054	0.0422
HUM	5	0.2145	0.0460
WD	2	0.2225	0.0495
PRES	4	0.2263	0.0512
WS	3	0.2281	0.0520

## APPENDIX B

### FAILURE GROUP TWO (DCU FAILURES) VERSUS ENVIRONMENTAL GROUPS A, B, AND C

This appendix is divided into three sub-appendices. Appendices B-1, B-2, and B-3 contain respectively the equations that resulted from regressing the TBSF due to DCU failures against environmental groups A, B, and C. The appropriate F-distribution values for each appendix are listed in Figure 29 on page 99.

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APPENDIX B-1  
FAILURE GROUP TWO (DCU FAILURES)  
VERSUS ENVIRONMENTAL GROUP A

DF            F RATIO  
 5            1.526  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11969.23804 )		
TEMP 2	-0.15156	2.43933	0.0039 (3)
WD 3	0.32698	0.34501	0.8982 (3)
WS 4	14.43098	7.46908	3.7330 (3)
PRES 5	400.74868	274.51771	2.1311 (3)
HUM 6	0.63772	3.23695	0.0388 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	4	0.3260	0.1063
PRES	5	0.4534	0.2056
WD	3	0.4800	0.2304
HUM	6	0.4835	0.2337
TEMP	2	0.4836	0.2338

APPENDIX B-2  
FAILURE GROUP TWO (DCU FAILURES)  
VERSUS ENVIRONMENTAL GROUP B

DF                    F RATIO                    1  
 5                    1.374  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11470.84839 )		
WD 2	0.35163	0.35318	0.9912 (3)
WS 3	15.09865	7.71213	3.8329 (3)
PRES 4	302.50310	279.80133	1.8688 (3)
HUM 5	0.99200	2.99619	0.1096 (3)
T26 6	0.26609	2.45339	0.0118 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T26	6	0.4642	0.2155

DF                    F RATIO                    2  
 5                    1.373  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11471.04565 )		
WD 2	0.35007	0.35886	0.9516 (3)
WS 3	15.07951	7.70542	3.8298 (3)
PRES 4	302.64048	284.18671	1.8129 (3)
HUM 5	0.94847	2.81614	0.1134 (3)
T212 7	0.26156	2.55275	0.0105 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T212	7	0.4642	0.2155

DF	F RATIO	3
5	1.374	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11508.02966 )		
WD 2	0.34894	0.35755	0.9524 (3)
WS 3	15.13811	7.75622	3.8093 (3)
PRES 4	383.72797	279.97529	1.8785 (3)
HUM 5	0.97372	2.85029	0.1184 (3)
T218 8	0.31204	2.65789	0.0138 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T218	8	0.4645	0.2156

DF	F RATIO	4
5	1.374	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11441.56213 )		
WD 2	0.35049	0.35603	0.9691 (3)
WS 3	15.14413	7.88226	3.6914 (3)
PRES 4	381.49496	275.70351	1.9147 (3)
HUM 5	0.97853	2.92618	0.1118 (3)
T224 9	0.29743	2.75045	0.0117 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T224	9	0.4642	0.2155

DF	F RATIO	5
5	1.389	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	12096.72241 )		
WD 2	0.33286	0.35761	0.8664 (3)
WS 3	15.76130	8.05877	3.8348 (3)
PRES 4	402.07244	277.19088	2.1040 (3)
HUM 5	1.24607	2.92558	0.1814 (3)
T230 10	0.73133	2.73788	0.0714 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T230	10	0.4662	0.2174

DF	F RATIO	6
5	1.388	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	12094.49646 )		
WD 2	0.32912	0.36317	0.8213 (3)
WS 3	15.86687	8.26811	3.6827 (3)
PRES 4	402.11712	278.91732	2.0765 (3)
HUM 5	1.21084	2.87559	0.1773 (3)
T236 11	0.71603	2.75506	0.0675 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T236	11	0.4661	0.2173

DF            F RATIO            7  
 5            1.377  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11671.88000 )		
WD 2	0.33966	0.36686	0.8572 (3)
WS 3	15.48507	8.35420	3.4357 (3)
PRES 4	388.76892	277.51385	1.9625 (3)
HUM 5	1.05797	2.88828	0.1342 (3)
T242 6	0.45251	2.79585	0.0262 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T242	6	0.4647	0.2160

DF            F RATIO            8  
 5            1.375  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11508.10547 )		
WD 2	0.34396	0.36763	0.8754 (3)
WS 3	15.35022	8.40482	3.3356 (3)
PRES 4	383.55877	274.46516	1.9529 (3)
HUM 5	1.00751	2.90822	0.1200 (3)
T248 7	0.35565	2.78302	0.0163 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T248	7	0.4644	0.2156

DF	F RATIO	9
5	1.380	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11751.34680 )		
WD 2	0.33422	0.36910	0.8199 (3)
WS 3	15.66540	6.47026	3.4205 (3)
PRES 4	391.17283	273.70270	2.0426 (3)
HUM 5	1.10754	2.88310	0.1476 (3)
T254 8	0.53316	2.75359	0.0375 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T254	8	0.4651	0.2163

DF	F RATIO	10
5	1.381	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11788.00964 )		
WD 2	0.33265	0.37003	0.8082 (3)
WS 3	15.71444	8.50800	3.4115 (3)
PRES 4	392.35667	274.28170	2.0463 (3)
HUM 5	1.11026	2.85680	0.1510 (3)
T260 9	0.55705	2.76731	0.0405 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T260	9	0.4652	0.2164

DF  
5  
25

F RATIO  
1.381

11

128

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11795.20264 )		
WD 2	0.33206	0.36990	0.8059 (3)
WS 3	15.73076	8.49577	3.4284 (3)
PRES 4	392.55364	273.54086	2.0595 (3)
HUM 5	1.11727	2.85662	0.1530 (3)
T266 10	0.57304	2.78411	0.0424 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T266	10	0.4653	0.2165

DF  
5  
25

F RATIO  
1.379

12

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11683.69312 )		
WD 2	0.33625	0.36858	0.8323 (3)
WS 3	15.59831	8.44262	3.4135 (3)
PRES 4	389.02855	272.20783	2.0425 (3)
HUM 5	1.08151	2.86586	0.1424 (3)
T272 11	0.49724	2.74789	0.0327 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
HUM	5	0.4638	0.2151
T272	11	0.4649	0.2162

APPENDIX B-3  
FAILURE GROUP TWO (DCU FAILURES)  
VERSUS ENVIRONMENTAL GROUP C

DF                      F RATIO                      1  
 5                      1.825  
 25

VARIABLES IN EQUATION

VARIABLE                      COEFFICIENT      STD. ERROR      F TO REMOVE

(CONSTANT                      12403.68164 )  
 WD 2                      0.19889                      0.35090                      0.3213 (3)  
 WS 3                      11.58521                      7.36196                      2.4764 (3)  
 PRES 4                      420.35905                      235.63884                      3.1823 (3)  
 HUM 5                      -0.13154                      2.45109                      0.0029 (3)  
 T31 6                      -33.43836                      31.21701                      1.1474 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
T31	6	0.5060	0.2561
WD	2	0.5170	0.2673
HUM	5	0.5171	0.2674

DF                      F RATIO                      2  
 5                      1.546  
 25

VARIABLES IN EQUATION

VARIABLE                      COEFFICIENT      STD. ERROR      F TO REMOVE

(CONSTANT                      12205.87097 )  
 WD 2                      0.30412                      0.34452                      0.7792 (3)  
 WS 3                      13.85239                      7.42048                      3.4849 (3)  
 PRES 4                      409.67033                      240.35886                      2.9050 (3)  
 HUM 5                      0.46636                      2.58540                      0.0325 (3)  
 T32 7                      -9.02035                      31.51344                      0.0819 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T32	7	0.4850	0.2352
HUM	5	0.4860	0.2362

DF  
5  
25

F RATIO  
1.638

3

131

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		12261.56763 )		
WD	2	0.30755	0.33667	0.8345 (3)
WS	3	13.50298	7.09607	3.6210 (3)
PRES	4	413.73078	238.79049	3.0019 (3)
HUM	5	-0.08794	2.67602	0.0011 (3)
T33	8	-22.54445	34.25118	0.4332 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T33	8	0.4967	0.2467
HUM	5	0.4968	0.2468

DF  
5  
25

F RATIO  
1.578

4

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		12360.81921 )		
WD	2	0.32890	0.33767	0.9488 (3)
WS	3	13.62233	7.26381	3.5170 (3)
PRES	4	416.50857	240.36741	3.0026 (3)
HUM	5	-0.02895	2.95079	0.0001 (3)
T34	9	-18.76373	41.82407	0.2013 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T34	9	0.4897	0.2398
HUM	5	0.4897	0.2398

DF  
5  
25

F RATIO  
1.632

5

132

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11912.37134 )		
WD 2	0.34050	0.33713	1.0201 (3)
WS 3	13.05679	7.30825	3.1919 (3)
PRES 4	403.20482	238.95172	2.8473 (3)
HUM 5	-0.51757	3.08433	0.0282 (3)
T35 10	-27.00525	42.11830	0.4111 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T35	10	0.4953	0.2453
HUM	5	0.4961	0.2461

DF  
5  
25

F RATIO  
1.526

6

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	12176.20557 )		
WD 2	0.32596	0.34664	0.8842 (3)
WS 3	14.49412	7.41073	3.8253 (3)
PRES 4	407.41218	243.56631	2.7979 (3)
HUM 5	0.69100	3.11949	0.0491 (3)
T36 11	-1.98797	47.98270	0.0017 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
HUM	5	0.4835	0.2337
T36	11	0.4835	0.2338

DF  
5  
25

F RATIO  
1.576

7

133

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8874.11255 )		
WD 2	0.37144	0.33675	1.2166 (3)
WS 3	10.82752	8.31243	1.6967 (3)
PRES 4	305.44662	252.82656	1.4596 (3)
HUM 5	-1.53568	3.51154	0.1913 (3)
T37 6	-50.20396	55.95606	0.8050 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T37	6	0.4835	0.2338
HUM	5	0.4895	0.2396

DF  
5  
25

F RATIO  
1.527

8

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9897.68823 )		
WD 2	0.39413	0.34041	1.3405 (3)
WS 3	10.92027	8.62483	1.6031 (3)
PRES 4	338.53461	246.79499	1.8816 (3)
HUM 5	-1.14839	3.43339	0.1119 (3)
T38 7	-45.83669	58.55040	0.6129 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T38	7	0.4801	0.2305
HUM	5	0.4837	0.2339

DF	F RATIO	9
5	1.578	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9699.21802 )		
WD 2	0.42455	0.34375	1.5254 (3)
WS 3	8.33184	10.04340	0.6882 (3)
PRES 4	334.33417	245.80939	1.8500 (3)
HUM 5	-1.55325	3.51645	0.1951 (3)
T39 8	-62.17752	68.96743	0.8128 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T39	8	0.4437	0.2339
HUM	5	0.4497	0.2399

DF	F RATIO	10
5	1.891	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10495.67847 )		
WD 2	0.35965	0.32876	1.1967 (3)
WS 3	6.67518	8.91892	0.5601 (3)
PRES 4	363.47253	237.35262	2.3451 (3)
HUM 5	-1.82850	2.94769	0.3848 (3)
T310 9	-80.86333	56.56562	2.0436 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T310	9	0.4673	0.2184
WD	2	0.5131	0.2633
HUM	5	0.5239	0.2744

DF	F RATIO	11
5	2.364	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9642.53760 )		
WD 2	0.33682	0.31826	1.1200 (3)
WS 3	3.07085	8.91629	0.1186 (3)
PRES 4	341.76632	229.96889	2.2086 (3)
HUM 5	-3.27479	3.03726	1.1625 (3)
T311 10	-122.02665	61.78735	3.9004 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T311	10	0.3423	0.1172
HUM	5	0.4797	0.2301
PRES	4	0.5356	0.2869
WD	2	0.5638	0.3178
WS	3	0.5666	0.3211

DF	F RATIO	(PS,SS)	12
5	2.690		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9259.74036 )		
WD 2	0.38996	0.31147	1.5675 (3)
WS 3	2.12348	8.56757	0.0614 (3)
PRES 4	330.86786	225.26571	2.1573 (3)
HUM 5	-3.68982	2.94137	1.5737 (3)
T312 11	-140.78954	61.87227	5.1778 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T312	11	0.3571	0.1275
HUM	5	0.5017	0.2517
PRES	4	0.5530	0.3058
WD	2	0.5901	0.3482
WS	3	0.5914	0.3498

DF	F RATIO	13
5	2.527	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9702.16760 )		
WD 2	0.33384	0.31484	1.1244 (3)
WS 3	4.46107	8.17637	0.2977 (3)
PRES 4	343.22371	227.39371	2.2782 (3)
HUM 5	-3.25605	2.71335	1.2491 (3)
T313 6	-122.77874	57.64129	4.5371 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T313	6	0.3500	0.1225
HUM	5	0.4943	0.2443
PRES	4	0.5448	0.2968
WD	2	0.5725	0.3278
WS	3	0.5794	0.3357

DF	F RATIO	(PS,SS)	14
5	2.821		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-7512.20691 )		
WD 2	0.38114	0.30870	1.5243 (3)
WS 3	1.34296	8.57112	0.0245 (3)
PRES 4	272.32750	226.36658	1.4473 (3)
HUM 5	-3.83543	2.90735	1.7403 (3)
T314 7	-133.56136	55.97444	5.6935 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T314	7	0.3905	0.1525
HUM	5	0.5316	0.2827
WD	2	0.5669	0.3214
PRES	4	0.6001	0.3601
WS	3	0.6006	0.3607

DF  
5  
25

F RATIO  
2.181

15

137

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		-6086.90063 )		
WD	2	0.47137	0.32792	2.0662 (3)
WS	3	4.27367	8.95498	0.2278 (3)
PRES	4	219.18761	247.05230	0.7871 (3)
HUM	5	-2.63553	2.96747	0.7888 (3)
TJ15	8	-107.01721	60.00799	3.1805 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ15	8	0.3378	0.1141
HUM	5	0.4645	0.2158
WD	2	0.5307	0.2816
PRES	4	0.5453	0.2974
WS	3	0.5511	0.3037

DF  
5  
25

F RATIO  
2.040

16

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		-6685.83057 )		
WD	2	0.45994	0.33092	1.9318 (3)
WS	3	5.03403	9.08601	0.3070 (3)
PRES	4	237.53960	248.26248	0.9155 (3)
HUM	5	-2.21573	2.94252	0.5670 (3)
TJ16	9	-97.52298	60.16815	2.6271 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ16	9	0.3292	0.1083
WD	2	0.4528	0.2050
HUM	5	0.5131	0.2632
PRES	4	0.5301	0.2811
WS	3	0.5383	0.2898

DF  
5  
25

F RATIO  
1.835

17

138

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-7809.10669 )		
WD 2	0.49349	0.34432	2.0541 (3)
WS 3	6.66004	9.16293	0.5283 (3)
PRES 4	274.95858	248.10474	1.2282 (3)
HUM 5	-2.43706	3.33101	0.5353 (3)
T317 10	-94.07183	69.66588	1.8234 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T317	10	0.5028	0.2528
HUM	5	0.5182	0.2685

DF  
5  
25

F RATIO  
1.697

18

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9120.29688 )		
WD 2	0.45801	0.34426	1.7701 (3)
WS 3	7.43564	9.53203	0.6085 (3)
PRES 4	316.53554	245.02683	1.6689 (3)
HUM 5	-1.83006	3.29415	0.3086 (3)
T318 11	-81.78881	72.22358	1.2824 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T318	11	0.4942	0.2442
HUM	5	0.5034	0.2534

DF	F RATIO	19
5	1.740	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9242.25525 )		
WD 2	0.45441	0.34130	1.7727 (3)
WS 3	7.13067	9.42388	0.5725 (3)
PRES 4	321.46496	243.09021	1.7488 (3)
HUM 5	-2.04168	3.31493	0.3793 (3)
T319 6	-86.04441	71.43304	1.4509 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T319	6	0.4969	0.2469
HUM	5	0.5081	0.2502

DF	F RATIO	20
5	1.915	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8478.42981 )		
WD 2	0.49252	0.34024	2.0954 (3)
WS 3	5.71962	9.25378	0.3820 (3)
PRES 4	298.25800	241.69522	1.5228 (3)
HUM 5	-2.53767	3.24000	0.6134 (3)
T320 7	-104.39118	71.38833	2.1383 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
WD	2	0.4601	0.2117
T320	7	0.5092	0.2592
HUM	5	0.5263	0.2770

DF  
5  
25

F RATIO (PS,SS)  
2.916

21

140

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-7606.58032 )		
WD 2	0.49511	0.31152	2.5260 (3)
WS 3	0.24721	8.72222	0.0008 (3)
PRES 4	275.27952	224.62795	1.5018 (3)
HUM 5	-3.37636	2.73849	1.5201 (3)
T321 8	-159.46048	64.74995	6.0650 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T321	8	0.3931	0.1545
HUM	5	0.5120	0.2622
WD	2	0.5707	0.3256
PRES	4	0.6069	0.3683
WS	3	0.6069	0.3684

DF  
5  
25

F RATIO (PS,SS)  
2.989

22

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-6203.98969 )		
WD 2	0.46508	0.30811	2.2785 (3)
WS 3	-0.39028	8.78169	0.0020 (3)
PRES 4	229.65233	227.17914	1.0219 (3)
HUM 5	-3.77376	2.80630	1.8083 (3)
T322 9	-163.88809	65.03493	6.3504 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T322	9	0.4007	0.1670
HUM	5	0.5352	0.2864
WD	2	0.5852	0.3425
PRES	4	0.6116	0.3741
WS	3	0.6117	0.3741

DF	F RATIO	(PS,SS)	23
5	2.851		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-5564.53522 )		
WD 2	0.41940	0.30895	1.8427 (3)
WS 3	1.89664	8.37645	0.0513 (3)
PRES 4	206.42898	232.26236	0.7899 (3)
HUM 5	-3.29763	2.74810	1.4399 (3)
T323 10	-149.62436	62.07831	5.8093 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T323	10	0.4214	0.1776
HUM	5	0.5423	0.2941
WD	2	0.5850	0.3423
PRES	4	0.6015	0.3618
WS	3	0.6026	0.3631

DF	F RATIO	(PS,SS)	24
5	2.950		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-5602.67047 )		
WD 2	0.35564	0.30610	1.3499 (3)
WS 3	1.49466	8.33994	0.0321 (3)
PRES 4	208.88063	230.04665	0.8245 (3)
HUM 5	-3.38793	2.72651	1.5440 (3)
T324 11	-158.92526	63.83888	6.1975 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T324	11	0.4452	0.1982
HUM	5	0.5616	0.3154
WD	2	0.5908	0.3490
PRES	4	0.6085	0.3702
WS	3	0.6091	0.3711

DF	F RATIO	(PS,SS)	25
5	2.977		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-5847.94592 )		
WD 2	0.31222	0.30620	1.0398 (3)
WS 3	-0.44046	8.81443	0.0025 (3)
PRES 4	217.33734	228.65071	0.9036 (3)
HUM 5	-3.09465	2.64484	1.3691 (3)
T325 6	-160.42488	63.89925	6.3031 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T325	6	0.4761	0.2267
HUM	5	0.5650	0.3193
PRES	4	0.5891	0.3471
WD	2	0.6108	0.3731
WS	3	0.6109	0.3732

DF	F RATIO	(SS)	26
5	2.679		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-7495.62506 )		
WD 2	0.35472	0.31145	1.2972 (3)
WS 3	4.64297	7.90763	0.3447 (3)
PRES 4	269.11807	229.03855	1.3806 (3)
HUM 5	-2.64882	2.66131	0.9906 (3)
T326 7	-144.09188	63.58581	5.1352 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T326	7	0.4140	0.1714
HUM	5	0.5268	0.2775
WD	2	0.5588	0.3123
PRES	4	0.5830	0.3399
WS	3	0.5907	0.3489

DF	F RATIO	27
5	2.152	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9272.17041 )		
WD 2	0.35911	0.32272	1.2382 (3)
WS 3	6.99781	8.08827	0.7485 (3)
PRES 4	326.45296	234.18752	1.9432 (3)
HUM 5	-2.37714	2.89987	0.6720 (3)
T327 8	-130.19232	74.36352	3.0651 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T327	8	0.4843	0.2345
WD	2	0.5311	0.2821
HUM	5	0.5485	0.3009

DF	F RATIO	28
5	2.157	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9260.66760 )		
WD 2	0.36745	0.32261	1.2973 (3)
WS 3	6.94603	8.09367	0.7365 (3)
PRES 4	326.21613	234.10291	1.9418 (3)
HUM 5	-2.43632	2.91633	0.6979 (3)
T328 9	-131.57553	74.88831	3.0869 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T328	9	0.4828	0.2331
WD	2	0.5309	0.2819
HUM	5	0.5490	0.3014

DF	F RATIO	29
5	2.129	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9016.71265 )		
WD 2	0.39731	0.32390	1.5046 (3)
WS 3	7.05471	8.11504	0.7557 (3)
PRES 4	317.04607	235.21345	1.8169 (3)
HUM 5	-2.29710	2.89038	0.6316 (3)
T329 10	-120.73350	69.97517	2.9769 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T329	10	0.4778	0.2283
WD	2	0.5300	0.2909
HUM	5	0.5465	0.2987

DF	F RATIO	30
5	2.081	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9203.87341 )		
WD 2	0.40520	0.32540	1.5506 (3)
WS 3	7.40547	8.10165	0.8355 (3)
PRES 4	322.68541	235.71748	1.8740 (3)
HUM 5	-2.17013	2.88669	0.5652 (3)
T330 11	-118.45199	70.95879	2.7866 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T330	11	0.4739	0.2246
WD	2	0.5271	0.2779
HUM	5	0.5421	0.2938

DF	F RATIO	31
5	2.064	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9133.78101 )		
WD 2	0.39975	0.32556	1.5077 (3)
WS 3	7.61421	8.06880	0.8905 (3)
PRES 4	320.30370	236.20638	1.8388 (3)
HUM 5	-2,19629	2.91196	0.5689 (3)
T331 6	-117.42099	71.19150	2.7204 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T331	6	0.4730	0.2237
WD	2	0.5254	0.2761
HUM	5	0.5405	0.2922

DF	F RATIO	32
5	2.130	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8785.51758 )		
WD 2	0.39767	0.32390	1.5074 (3)
WS 3	7.30692	8.05435	0.8271 (3)
PRES 4	309.27338	235.81466	1.7201 (3)
HUM 5	-2.32563	2.90027	0.6430 (3)
T332 7	-120.69716	69.93281	2.9787 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4242	0.1800
T332	7	0.4774	0.2279
WD	2	0.5298	0.2807
HUM	5	0.5465	0.2987

DF	F RATIO	(PS,SS)	33
5	2.885		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-6926.75641 )		
WD 2	0.47065	0.31061	2.2960 (3)
WS 3	4.66237	7.65740	0.3707 (3)
PRES 4	251.13825	227.01345	1.2238 (3)
HUM 5	-3.32265	2.73901	1.4716 (3)
T333 8	-152.77494	62.67364	5.9420 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T333	8	0.3722	0.1385
HUM	5	0.5187	0.2690
WD	2	0.5778	0.3338
PRES	4	0.5970	0.3565
WS	3	0.6049	0.3659

DF	F RATIO	(PS,SS)	34
5	2.769		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-7074.32367 )		
WD 2	0.45163	0.31203	2.0949 (3)
WS 3	5.02737	7.70486	0.4257 (3)
PRES 4	255.35047	228.60174	1.2471 (3)
HUM 5	-3.18218	2.75709	1.3321 (3)
T334 9	-144.71181	61.78270	5.4862 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T334	9	0.3681	0.1355
HUM	5	0.5126	0.2628
WD	2	0.5682	0.3228
PRES	4	0.5877	0.3454
WS	3	0.5970	0.3564

DF	F RATIO	(PS,SS)	35
5	2.985		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-5186.03345 )		
WD 2	0.37288	0.30546	1.4902 (3)
WS 3	2.93139	7.94083	0.1363 (3)
PRES 4	194.78881	230.99890	0.7111 (3)
HUM 5	-3.51490	2.74283	1.6422 (3)
TJ35 10	-164.05202	65.18371	6.3341 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ35	10	0.4319	0.1865
HUM	5	0.5638	0.3178
WD	2	0.5966	0.3560
PRES	4	0.6086	0.3704
WS	3	0.6114	0.3738

DF	F RATIO	(PS,SS)	36
5	2.829		
25			

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-5362.27240 )		
WD 2	0.36456	0.30844	1.3970 (3)
WS 3	3.41803	8.01591	0.1818 (3)
PRES 4	199.46091	233.56082	0.7293 (3)
HUM 5	-3.23179	2.74118	1.3900 (3)
TJ36 11	-154.44959	64.55168	5.7248 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ36	11	0.4285	0.1836
HUM	5	0.5533	0.3061
WD	2	0.5854	0.3426
PRES	4	0.5973	0.3567
WS	3	0.6011	0.3614

DF  
5  
25

F RATIO  
1.825

37

148

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10110.89648 )		
WD 2	0.40571	0.34013	1.4228 (3)
WS 3	9.45425	0.32668	1.2892 (3)
PRES 4	349.06415	241.93596	2.0817 (3)
HUM 5	-1.27043	2.98941	0.1806 (3)
T337 6	-87.30335	81.47028	1.1483 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T337	6	0.5119	0.2621
HUM	5	0.5171	0.2674

DF  
5  
25

F RATIO  
1.855

38

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9530.49487 )		
WD 2	0.42016	0.34162	1.5126 (3)
WS 3	8.95794	8.43986	1.1265 (3)
PRES 4	330.22354	245.07655	1.8156 (3)
HUM 5	-1.36028	2.97883	0.2085 (3)
T338 7	-91.85213	81.66284	1.2651 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T338	7	0.5143	0.2646
HUM	5	0.5202	0.2706

DF	F RATIO	39
5	1.805	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9358.50806 )		
WD 2	0.40705	0.34152	1.4205 (3)
WS 3	9.24459	8.55286	1.1683 (3)
PRES 4	324.04794	249.58388	1.6857 (3)
HUM 5	-1.28044	3.04106	0.1773 (3)
T339 8	-87.93041	84.90698	1.0725 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T339	8	0.5099	0.2600
HUM	5	0.5150	0.2652

DF	F RATIO	40
5	1.851	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9418.10767 )		
WD 2	0.42210	0.34229	1.5207 (3)
WS 3	8.96285	8.45646	1.1234 (3)
PRES 4	326.42002	246.25687	1.7570 (3)
HUM 5	-1.33196	2.97037	0.2011 (3)
T340 9	-91.65600	81.97088	1.2503 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T340	9	0.5142	0.2644
HUM	5	0.5198	0.2702

DF	F RATIO	41
5	1.714	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10221.96338 )		
WD 2	0.40710	0.34831	1.3660 (3)
WS 3	10.17406	8.60871	1.3967 (3)
PRES 4	350.67531	247.01758	2.0154 (3)
HUM 5	-0.85702	3.01035	0.0810 (3)
T341 10	-71.08031	83.55979	0.7236 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T341	10	0.5029	0.2529
HUM	5	0.5053	0.2553

DF	F RATIO	42
5	1.671	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10148.68079 )		
WD 2	0.39757	0.34954	1.2937 (3)
WS 3	10.82916	8.52613	1.6132 (3)
PRES 4	346.94997	252.06776	1.8945 (3)
HUM 5	-0.64183	2.99931	0.0458 (3)
T342 11	-61.17206	81.68842	0.5608 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T342	11	0.4992	0.2492
HUM	5	0.5005	0.2505

DF	F RATIO	
5	1.664	43
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10154.74292 )		
WD 2	0.39809	0.35065	1.2889 (3)
WS 3	10.93991	8.51525	1.6506 (3)
PRES 4	346.89722	252.91247	1.8813 (3)
HUM 5	-0.59471	2.94999	0.0396 (3)
T343 6	-59.82579	81.92356	0.5333 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T343	6	0.4985	0.2485
HUM	5	0.4997	0.2497

DF	F RATIO	
5	1.629	44
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10406.23621 )		
WD 2	0.38598	0.35063	1.2118 (3)
WS 3	11.29540	8.66348	1.6999 (3)
PRES 4	354.60892	253.88762	1.9508 (3)
HUM 5	-0.46650	3.05305	0.0233 (3)
T344 7	-53.95984	85.49606	0.3983 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T344	7	0.4950	0.2450
HUM	5	0.4957	0.2457

DF  
5  
25

F RATIO  
1.657

45

152

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10775.92761 )		
WD 2	0.39732	0.35137	1.2787 (3)
WS 3	10.94509	8.59772	1.6206 (3)
PRES 4	351.00084	251.92172	1.9413 (3)
HUM 5	-0.59647	3.02600	0.0389 (3)
T345 8	-61.16173	86.10862	0.5045 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T345	8	0.4977	0.2477
HUM	5	0.4989	0.2489

DF  
5  
25

F RATIO  
1.646

46

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10324.96667 )		
WD 2	0.38744	0.34876	1.2342 (3)
WS 3	11.11930	8.57916	1.6798 (3)
PRES 4	352.26337	252.61868	1.9445 (3)
HUM 5	-0.51615	3.00438	0.0295 (3)
T346 9	-57.70427	84.67111	0.4645 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T346	9	0.4968	0.2468
HUM	5	0.4977	0.2477

DF            F RATIO  
5            1.672  
25

47

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10170.16370 )		
WD 2	0.39878	0.34996	1.2985 (3)
WS 3	10.50688	8.78262	1.4312 (3)
PRES 4	347.82140	251.64732	1.9104 (3)
HUM 5	-0.63081	2.98846	0.0446 (3)
T347 10	-64.04284	85.41138	0.5622 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T347	10	0.4992	0.2492
HUM	5	0.5006	0.2506

DF            F RATIO  
5            1.736  
25

48

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9584.48743 )		
WD 2	0.42338	0.35160	1.4500 (3)
WS 3	9.64761	8.78457	1.2061 (3)
PRES 4	329.98383	252.65937	1.7057 (3)
HUM 5	-0.93977	2.99904	0.0982 (3)
T348 11	-79.36220	88.19145	0.8098 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T348	11	0.5048	0.2549
HUM	5	0.5077	0.2578

DF 5 F RATIO 1.785 49  
25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8975.05664 )		
WD 2	0.43416	0.35038	1.5354 (3)
WS 3	9.05090	8.79933	1.0580 (3)
PRES 4	310.60344	255.79864	1.4744 (3)
HUM 5	-1.11889	2.90691	0.1403 (3)
T349 6	-87.89530	88.02591	0.9970 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T349	6	0.5089	0.2590
HUM	5	0.5129	0.2631

DF 5 F RATIO 1.818 50  
25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8865.95020 )		
WD 2	0.44347	0.35036	1.6021 (3)
WS 3	8.78679	8.73995	1.0107 (3)
PRES 4	307.73227	254.12073	1.4664 (3)
HUM 5	-1.30165	3.02248	0.1855 (3)
T350 7	-93.59868	88.28971	1.1239 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T350	7	0.5111	0.2613
HUM	5	0.5164	0.2667

DF  
5  
25

F RATIO  
1.786

51

155

VARIABLES IN EQUATION

VARIABLE      COEFFICIENT    STD. ERROR    F TO REMOVE

(CONSTANT		-9002.40344	)		
WD	2	0.43133		0.34944	1.5236 (3)
WS	3	9.06044		8.78939	1.0626 (3)
PRES	4	312.05768		255.19252	1.4953 (3)
HUM	5	-1.29969		3.10352	0.1754 (3)
T351	8	-89.73219		89.76843	0.9992 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T351	8	0.5079	0.2580
HUM	5	0.5130	0.2632

DF  
5  
25

F RATIO  
1.752

52

VARIABLES IN EQUATION

VARIABLE      COEFFICIENT    STD. ERROR    F TO REMOVE

(CONSTANT		-9030.66638	)		
WD	2	0.42820		0.35165	1.4828 (3)
WS	3	9.23285		8.93940	1.0667 (3)
PRES	4	312.47562		258.29160	1.4636 (3)
HUM	5	-1.19923		3.13607	0.1462 (3)
T352	9	-85.25391		91.44084	0.8693 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T352	9	0.5051	0.2551
HUM	5	0.5094	0.2595

DF  
5  
25

F RATIO  
1.756

53

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9040.64795 )		
WD 2	0.42804	0.35120	1.4855 (3)
WS 3	9.25662	8.89083	1.0840 (3)
PRES 4	312.94828	257.68509	1.4749 (3)
HUM 5	-1.22094	3.13922	0.1513 (3)
T353 10	-86.61677	92.12625	0.8840 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T353	10	0.5054	0.2554
HUM	5	0.5098	0.2599

DF  
5  
25

F RATIO  
1.718

54

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9478.40125 )		
WD 2	0.41458	0.35051	1.3990 (3)
WS 3	9.95214	8.73453	1.2982 (3)
PRES 4	326.22462	256.06399	1.6231 (3)
HUM 5	-0.94224	3.06192	0.0947 (3)
T354 11	-76.52773	89.09350	0.7378 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T354	11	0.5029	0.2529
HUM	5	0.5057	0.2557

DF	F RATIO	55
5	1.696	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9488.70447 )		
WD 2	0.41396	0.35282	1.3766 (3)
WS 3	10.07978	8.85192	1.2967 (3)
PRES 4	326.20931	258.70080	1.5900 (3)
HUM 5	-0.87855	3.09359	0.0807 (3)
T355 6	-74.26577	91.75977	0.6550 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T355	6	0.5009	0.2509
HUM	5	0.5033	0.2533

DF	F RATIO	56
5	1.682	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9508.84473 )		
WD 2	0.40821	0.35242	1.3416 (3)
WS 3	10.35983	8.78934	1.3893 (3)
PRES 4	326.41705	260.68745	1.5679 (3)
HUM 5	-0.81001	3.09808	0.0684 (3)
T356 7	-70.43656	90.96487	0.5996 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T356	7	0.4996	0.2496
HUM	5	0.5017	0.2517

DF	F RATIO	57
5	1.624	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10158.52588 )		
WD 2	0.40319	0.36066	1.2497 (3)
WS 3	10.99891	9.05258	1.4762 (3)
PRES 4	346.39918	259.67389	1.7795 (3)
HUM 5	-0.45419	3.07396	0.0218 (3)
T357 8	-56.63714	92.07285	0.3784 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T357	8	0.4945	0.2445
HUM	5	0.4951	0.2452

DF	F RATIO	58
5	1.562	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11170.48682 )		
WD 2	0.37649	0.36652	1.0551 (3)
WS 3	12.64590	8.66255	2.1311 (3)
PRES 4	376.95922	254.63775	2.1915 (3)
HUM 5	0.16590	2.85033	0.0034 (3)
T358 9	-30.69139	81.48115	0.1419 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T358	9	0.4878	0.2380
HUM	5	0.4879	0.2381

DF	F RATIO	59
5	1.559	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	11175.58838 )		
WD 2	0.37444	0.36666	1.0429 (3)
WS 3	12.71815	8.67160	2.1510 (3)
PRES 4	377.01344	255.81788	2.1720 (3)
HUM 5	0.18410	2.85994	0.0041 (3)
T359 10	-29.66450	81.98505	0.1309 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T359	10	0.4374	0.2376
HUM	5	0.4876	0.2377

DF	F RATIO	60
5	1.581	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10871.78870 )		
WD 2	0.38838	0.36580	1.1273 (3)
WS 3	12.11540	8.76554	1.9104 (3)
PRES 4	367.75674	255.71781	2.0682 (3)
HUM 5	0.03433	2.83824	0.0001 (3)
T360 11	-37.09714	80.19133	0.2140 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T360	11	0.4901	0.2402
HUM	5	0.4901	0.2402

DF  
5  
25

F RATIO  
1.599

61

160

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10560.26196 )		
WD 2	0.39876	0.36583	1.1882 (3)
WS 3	11.77310	8.72542	1.8206 (3)
PRES 4	357.93980	257.90084	1.9263 (3)
HUM 5	-0.05460	2.81272	0.0004 (3)
T361 6	-43.37643	81.59054	0.2826 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T361	6	0.4922	0.2423
HUM	5	0.4922	0.2423

DF  
5  
25

F RATIO  
1.606

62

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10464.46655 )		
WD 2	0.40489	0.36746	1.2141 (3)
WS 3	11.71768	8.63733	1.8405 (3)
PRES 4	354.92918	258.18075	1.8899 (3)
HUM 5	-0.10807	2.82587	0.0015 (3)
T362 7	-45.23054	81.23239	0.3100 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T362	7	0.4930	0.2431
HUM	5	0.4931	0.2431

DF  
5  
25

F RATIO  
1.610

63

161

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		10395.83508 )		
WD	2	0.40660	0.36704	1.2272 (3)
WS	3	11.64967	8.62709	1.8235 (3)
PRES	4	352.80016	258.57347	1.8616 (3)
HUM	5	-0.15385	2.84750	0.0029 (3)
T363	8	-46.05396	80.58486	0.3266 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T363	8	0.4935	0.2435
HUM	5	0.4935	0.2436

DF  
5  
25

F RATIO  
1.604

64

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		10335.98975 )		
WD	2	0.40275	0.36673	1.2061 (3)
WS	3	11.71504	8.68205	1.8207 (3)
PRES	4	350.73155	261.64496	1.7962 (3)
HUM	5	-0.15109	2.84304	0.0027 (3)
T364	9	-45.20994	82.26275	0.3020 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T364	9	0.4927	0.2428
HUM	5	0.4928	0.2429

DF	F RATIO	65
5	1.645	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9817.12781 )		
WD 2	0.42578	0.36837	1.3360 (3)
WS 3	11.11652	8.59738	1.6719 (3)
PRES 4	334.43501	262.64554	1.6214 (3)
HUM 5	-0.33441	2.84850	0.0138 (3)
T365 10	-55.38683	81.67797	0.4598 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T365	10	0.4971	0.2472
HUM	5	0.4976	0.2476

DF	F RATIO	66
5	1.641	
25		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9963.80078 )		
WD 2	0.42658	0.37005	1.3289 (3)
WS 3	11.16309	8.61008	1.6809 (3)
PRES 4	335.86055	262.60688	1.6357 (3)
HUM 5	-0.30384	2.83893	0.0115 (3)
T366 11	-54.54125	81.81361	0.4444 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T366	11	0.4968	0.2468
HUM	5	0.4971	0.2471

DF  
5  
25

F RATIO  
1.595

67

163

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	10382.64392 )		
WD 2	0.40156	0.36979	1.1792 (3)
WS 3	11.92450	8.64502	1.9026 (3)
PRES 4	351.92786	263.69996	1.7811 (3)
HUM 5	-0.08405	2.87195	0.0009 (3)
T367 6	-43.12258	83.51263	0.2666 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T367	6	0.4917	0.2418
HUM	5	0.4917	0.2418

DF  
5  
25

F RATIO  
1.624

68

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9943.36072 )		
WD 2	0.41958	0.37100	1.2791 (3)
WS 3	11.42286	8.61671	1.7574 (3)
PRES 4	338.20259	265.07110	1.6279 (3)
HUM 5	-0.26230	2.87880	0.0083 (3)
T368 7	-52.35504	84.94462	0.3799 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T368	7	0.4949	0.2449
HUM	5	0.4952	0.2452

DF  
5  
25

F RATIO  
1.662

69

164

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9592.44763 )		
WD 2	0.42813	0.36544	1.3725 (3)
WS 3	10.92855	8.55277	1.6327 (3)
PRES 4	327.03312	263.78175	1.5371 (3)
HUM 5	-0.41506	2.85100	0.0212 (3)
T369 8	-60.35477	83.40685	0.5236 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T369	8	0.4988	0.2488
HUM	5	0.4994	0.2494

DF  
5  
25

F RATIO  
1.724

70

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-9197.02429 )		
WD 2	0.44838	0.36333	1.5229 (3)
WS 3	10.12663	8.55675	1.4006 (3)
PRES 4	315.50148	260.18251	1.4704 (3)
HUM 5	-0.63358	2.82404	0.0503 (3)
T370 9	-72.98417	83.59055	0.7623 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T370	9	0.5049	0.2549
HUM	5	0.5064	0.2564

DF                    F RATIO                    71                    165  
 5                    1.750  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8890.67969 )		
WD 2	0.45275	0.36129	1.5704 (3)
WS 3	9.68379	8.65318	1.2524 (3)
PRES 4	305.98003	261.43475	1.3698 (3)
HUM 5	-0.75707	2.84251	0.0709 (3)
T371 10	-78.65624	84.79306	0.8605 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T371	10	0.5071	0.2571
HUM	5	0.5091	0.2592

DF                    F RATIO                    72  
 5                    1.759  
 25

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	-8906.60950 )		
WD 2	0.45046	0.35909	1.5737 (3)
WS 3	9.55369	8.66878	1.2146 (3)
PRES 4	306.79160	259.99551	1.3924 (3)
HUM 5	-0.82185	2.86194	0.0825 (3)
T372 11	-79.76182	84.26525	0.8960 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
WS	3	0.3260	0.1063
PRES	4	0.4534	0.2056
WD	2	0.4800	0.2304
T372	11	0.5077	0.2578
HUM	5	0.5101	0.2602

## APPENDIX C

### FAILURE GROUP THREE (PIGA FAILURES) VERSUS ENVIRONMENTAL GROUPS A, B, AND C

This appendix is divided into three sub-appendices. Appendices C-1, C-2, and C-3 contain respectively the equations that resulted from regressing TBSF of PIGA failures against environmental groups A, B, and C. The appropriate F-distribution values for the appendix are listed in Figure 29 on page 99.

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APPENDIX C-1  
FAILURE GROUP THREE (PIGA FAILURES)  
VERSUS ENVIRONMENTAL GROUP A

DF            F RATIO  
 5            0.724  
 71

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1054.85475 )		
TEMP 2	-0.78608	0.70918	1.2286 (3)
WD 3	0.00164	0.11911	0.0002 (3)
WS 4	0.00924	2.64379	0.0000 (3)
PRES 5	-32.06063	67.97261	0.2225 (3)
HUM 6	0.85904	0.80180	1.1479 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	6	0.1776	0.0315
TEMP	2	0.2129	0.0453
PRES	5	0.2203	0.0485
WD	3	0.2203	0.0485
WS	4	0.2203	0.0485

APPENDIX C-2  
FAILURE GROUP THREE (PIGA FAILURES)  
VERSUS ENVIRONMENTAL GROUP B



DF  
5  
71

F RATIO  
1.413

3

172

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		2824.02975 )		
WD	2	-0.00340	0.11554	0.0009 (3)
WS	3	-0.29910	2.58784	0.0134 (3)
PRES	4	-90.08183	64.54742	1.9477 (3)
HUM	5	0.88233	0.75427	1.3684 (3)
T218	8	-1.44492	0.70599	4.1889 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T218	8	0.1872	0.0350
PRES	4	0.2667	0.0711
HUM	5	0.3005	0.0903
WS	3	0.3008	0.0905
WD	2	0.3008	0.0905

DF  
5  
71

F RATIO  
1.238

4

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		2620.05472 )		
WD	2	-0.00513	0.11638	0.0019 (3)
WS	3	-0.37704	2.60116	0.0210 (3)
PRES	4	-83.41908	64.65270	1.6648 (3)
HUM	5	0.87137	0.76001	1.3145 (3)
T224	9	-1.32370	0.72383	3.3443 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T224	9	0.2412	0.0582
PRES	4	0.2826	0.0799
WS	3	0.2831	0.0801
WD	2	0.2831	0.0802

DF  
5  
71

F RATIO  
1.269

5

173

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2610.55334 )		
WD 2	-0.00613	0.11629	0.0028 (3)
WS 3	-0.35825	2.59886	0.0190 (3)
PRES 4	-83.04681	64.29249	1.6685 (3)
HUM 5	0.86639	0.75933	1.3019 (3)
T230 10	-1.35017	0.72210	3.4961 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T230	10	0.2450	0.0600
PRES	4	0.2860	0.0818
WS	3	0.2864	0.0820
WD	2	0.2864	0.0820

DF  
5  
71

F RATIO  
1.295

6

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2599.24710 )		
WD 2	-0.00341	0.11604	0.0009 (3)
WS 3	-0.36288	2.59649	0.0195 (3)
PRES 4	-82.74196	64.01663	1.6706 (3)
HUM 5	0.90486	0.75653	1.4306 (3)
T236 11	-1.36802	0.71903	3.6199 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T236	11	0.2480	0.0615
PRES	4	0.2886	0.0833
WS	3	0.2891	0.0836
WD	2	0.2891	0.0836

DF	F RATIO	7
5	1.254	
71		

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2558.16379 )		
WD 2	0.00072	0.11603	0.0000 (3)
WS 3	-0.44689	2.59832	0.0296 (3)
PRES 4	-81.45021	64.09270	1.6150 (3)
HUM 5	0.91565	0.75721	1.4623 (3)
T242 6	-1.34230	0.72578	3.4205 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T242	6	0.2444	0.0598
PRES	4	0.2841	0.0807
WS	3	0.2848	0.0811
WD	2	0.2848	0.0811

DF	F RATIO	8
5	1.196	
71		

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2460.44983 )		
WD 2	0.00123	0.11625	0.0001 (3)
WS 3	-0.46500	2.60292	0.0319 (3)
PRES 4	-78.24568	63.90881	1.4990 (3)
HUM 5	0.90103	0.75955	1.4072 (3)
T248 7	-1.28740	0.72588	3.1455 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T248	7	0.2405	0.0578
PRES	4	0.2780	0.0773
WS	3	0.2788	0.0777
WD	2	0.2788	0.0777

DF	F RATIO	9
5	1.241	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2501.35641 )		
WD 2	0.00165	0.11605	0.0002 (3)
WS 3	-0.46302	2.59911	0.0317 (3)
PRES 4	-79.52203	63.79876	1.5536 (3)
HUM 5	0.88447	0.75913	1.3575 (3)
T254 8	-1.32550	0.72300	3.3611 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T254	8	0.2446	0.0598
PRES	4	0.2828	0.0800
WS	3	0.2835	0.0804
WD	2	0.2835	0.0804

DF	F RATIO	10
5	1.283	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2517.20111 )		
WD 2	0.00248	0.11585	0.0005 (3)
WS 3	-0.47651	2.59536	0.0337 (3)
PRES 4	-80.04234	63.57387	1.5852 (3)
HUM 5	0.90365	0.75692	1.4253 (3)
T260 9	-1.35605	0.71842	3.5628 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T260	9	0.1785	0.0319
HUM	5	0.2489	0.0619
PRES	4	0.2871	0.0824
WS	3	0.2879	0.0829
WD	2	0.2879	0.0829

DF  
5  
71

F RATIO  
1.280

11

176

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2514.02057 )		
WD 2	0.00392	0.11581	0.0011 (3)
WS 3	-0.51284	2.59525	0.0390 (3)
PRES 4	-79.93315	63.57885	1.5806 (3)
HUM 5	0.90083	0.75715	1.4155 (3)
T266 10	-1.35421	0.71913	3.5462 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T266	10	0.1782	0.0318
HUM	5	0.2485	0.0618
PRES	4	0.2866	0.0821
WS	3	0.2875	0.0826
WD	2	0.2875	0.0827

DF  
5  
71

F RATIO  
1.218

12

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2456.60211 )		
WD 2	0.00483	0.11603	0.0017 (3)
WS 3	-0.54417	2.60022	0.0438 (3)
PRES 4	-78.06499	63.69222	1.5022 (3)
HUM 5	0.88875	0.75959	1.3690 (3)
T272 11	-1.30615	0.72466	3.2487 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T272	11	0.2430	0.0591
PRES	4	0.2800	0.0784
WS	3	0.2810	0.0790
WD	2	0.2811	0.0790

APPENDIX C-3  
FAILURE GROUP THREE (PIGA FAILURES)  
VERSUS ENVIRONMENTAL GROUP C

DF                    F RATIO                    1  
 5                    0.544  
 71

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1133.44734 )		
WD 2	0.01618	0.11900	0.0185 (3)
WS 3	-0.60320	2.66370	0.0513 (3)
PRES 4	-36.26862	61.03413	0.3531 (3)
HUM 5	1.02284	0.78509	1.6974 (3)
T31 6	-0.31050	7.43099	0.0017 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
PRES	4	0.1894	0.0359
WS	3	0.1913	0.0366
WD	2	0.1920	0.0368
T31	6	0.1920	0.0369

DF                    F RATIO                    2  
 5                    0.896  
 71

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1758.50124 )		
WD 2	0.00361	0.11750	0.0009 (3)
WS 3	-0.98981	2.64494	0.1400 (3)
PRES 4	-55.54537	61.74038	0.8094 (3)
HUM 5	0.70618	0.80274	0.7739 (3)
T32 7	-12.41461	9.52821	1.6976 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T32	7	0.2196	0.0482
PRES	4	0.2397	0.0575
WS	3	0.2436	0.0593
WD	2	0.2436	0.0593

DF	F RATIO	3
5	0.942	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1707.51265 )		
WD 2	-0.00393	0.11784	0.0011 (3)
WS 3	-0.95904	2.63671	0.1323 (3)
PRES 4	-53.56109	61.12783	0.7678 (3)
HUM 5	0.65966	0.80768	0.6671 (3)
TJJ 8	-15.18723	10.96601	1.9180 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJJ	8	0.1870	0.0350
HUM	5	0.2276	0.0518
PRES	4	0.2458	0.0604
WS	3	0.2493	0.0622
WD	2	0.2494	0.0622

DF	F RATIO	4
5	1.489	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1829.22655 )		
WD 2	-0.00024	0.11511	0.0000 (3)
WS 3	-0.94825	2.58273	0.1348 (3)
PRES 4	-56.46777	59.51976	0.9001 (3)
HUM 5	0.36740	0.81058	0.2054 (3)
T34 9	-24.39908	11.43076	4.5561 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T34	9	0.2758	0.0761
PRES	4	0.2989	0.0893
HUM	5	0.3053	0.0932
WS	3	0.3081	0.0949
WD	2	0.3081	0.0949

DF	F RATIO	5
5	1.304	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1722.78915 )		
WD 2	0.01418	0.11553	0.0151 (3)
WS 3	-0.83202	2.59577	0.1027 (3)
PRES 4	-53.30288	59.78079	0.7950 (3)
HUM 5	0.47257	0.80761	0.3424 (3)
T35 10	-23.08766	12.06475	3.6620 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T35	10	0.2525	0.0637
PRES	4	0.2771	0.0768
HUM	5	0.2873	0.0826
WS	3	0.2496	0.0839
WD	2	0.2900	0.0841

DF	F RATIO	6
5	1.214	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1680.98135 )		
WD 2	0.02077	0.11588	0.0321 (3)
WS 3	-0.62404	2.60046	0.0576 (3)
PRES 4	-51.80682	59.91484	0.7477 (3)
HUM 5	0.36857	0.84027	0.1924 (3)
T36 11	-23.42303	13.03604	3.2285 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T36	11	0.2492	0.0621
PRES	4	0.2728	0.0744
HUM	5	0.2785	0.0776
WS	3	0.2799	0.0783
WD	2	0.2806	0.0787

DF  
5  
71

F RATIO  
1.270

7

181

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		1564.63295 )		
WD	2	0.03164	0.11589	0.0745 (3)
WS	3	-0.62801	2.59502	0.0586 (3)
PRES	4	-47.67544	59.46504	0.6428 (3)
HUM	5	0.26846	0.85554	0.0985 (3)
TJ7	6	-25.41512	13.50745	3.5403 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ7	6	0.2630	0.0692
PRES	4	0.2812	0.0791
HUM	5	0.2043	0.0808
WD	2	0.2861	0.0818
WS	3	0.2874	0.0826

DF  
5  
71

F RATIO  
1.222

8

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		1552.88611 )		
WD	2	0.03047	0.11608	0.0689 (3)
WS	3	-0.69059	2.60021	0.0705 (3)
PRES	4	-46.94122	59.55610	0.6212 (3)
HUM	5	0.20177	0.88311	0.0522 (3)
TJ8	7	-27.40142	15.19314	3.2699 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ8	7	0.2593	0.0673
PRES	4	0.2763	0.0763
WS	3	0.2787	0.0777
WD	2	0.2803	0.0786
HUM	5	0.2815	0.0793

DF	F RATIO	9
5	1.740	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1645.36797 )		
WD 2	0.03138	0.11410	0.0756 (3)
WS 3	-0.98003	2.56212	0.1463 (3)
PRES 4	-50.08212	58.57197	0.7311 (3)
HUM 5	-0.11328	0.88234	0.0165 (3)
T39 8	-37.64660	15.63229	5.7628 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T39	8	0.3132	0.0981
PRES	4	0.3261	0.1063
WS	3	0.3286	0.1080
WD	2	0.3301	0.1089
HUM	5	0.3304	0.1092

DF	F RATIO	10
5	2.299	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1815.13310 )		
WD 2	0.04905	0.11254	0.1900 (3)
WS 3	-0.73598	2.51391	0.0857 (3)
PRES 4	-54.00536	57.61564	0.8786 (3)
HUM 5	-0.23110	0.84927	0.0740 (3)
T310 9	-44.80348	15.40929	8.4539 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T310	9	0.3544	0.1256
PRES	4	0.3680	0.1354
WD	2	0.3711	0.1377
WS	3	0.3721	0.1384
HUM	5	0.3733	0.1393

DF	F RATIO	11
5	1.732	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1615.25581 )		
WD 2	0.04881	0.11475	0.1809 (3)
WS 3	-0.17452	2.56306	0.0046 (3)
PRES 4	-48.37769	58.52149	0.6834 (3)
HUM 5	0.04267	0.84994	0.0025 (3)
T311 10	-38.32069	16.01817	5.7232 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
T311	10	0.3100	0.0961
PRES	4	0.3260	0.1063
WD	2	0.3295	0.1086
WS	3	0.3296	0.1087
HUM	5	0.3297	0.1087

DF	F RATIO (SS)	12
5	2.724	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1432.90985 )		
WD 2	0.03975	0.11080	0.1287 (3)
WS 3	-0.09058	2.48656	0.0013 (3)
PRES 4	-42.76517	56.59479	0.5710 (3)
HUM 5	-0.12986	0.80493	0.0260 (3)
T312 11	-52.45069	16.18428	10.5031 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSU
T312	11	0.3896	0.1518
PRES	4	0.3989	0.1591
WD	2	0.4008	0.1607
HUM	5	0.4012	0.1610
WS	3	0.4012	0.1610

DF	F RATIO	13
5	1.576	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1620.57211 )		
WD 2	0.02369	0.11457	0.0427 (3)
WS 3	0.09767	2.54912	0.0014 (3)
PRES 4	-48.84676	58.80122	0.6887 (3)
HUM 5	0.19085	0.83609	0.0521 (3)
T313 6	-37.32138	16.73187	4.9754 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T313	6	0.2954	0.0873
PRES	4	0.3142	0.0987
HUM	5	0.3152	0.0994
WD	2	0.3161	0.0999
WS	3	0.3161	0.0999

DF	F RATIO	14
5	1.631	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1699.06680 )		
WD 2	0.01555	0.11433	0.0185 (3)
WS 3	0.05832	2.54181	0.0005 (3)
PRES 4	-51.31786	58.85963	0.7602 (3)
HUM 5	0.18660	0.83151	0.0504 (3)
T314 7	-38.08312	16.63937	5.2383 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T314	7	0.2997	0.0898
PRES	4	0.3197	0.1022
HUM	5	0.3206	0.1028
WD	2	0.3210	0.1030
WS	3	0.3210	0.1030

DF	F RATIO	15
5	1.933	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1919.25145 )		
WD 2	0.01178	0.11326	0.0108 (3)
WS 3	-0.35940	2.54342	0.0200 (3)
PRES 4	-58.04435	58.55134	0.9828 (3)
HUM 5	0.15971	0.81145	0.0307 (3)
T315 8	-45.27481	17.50001	6.6932 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T315	8	0.3233	0.1045
PRES	4	0.3447	0.1188
HUM	5	0.3456	0.1194
WS	3	0.3460	0.1197
WD	2	0.3462	0.1198

DF	F RATIO	16
5	2.087	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1964.83034 )		
WD 2	0.02065	0.11272	0.0336 (3)
WS 3	-0.23826	2.53316	0.0088 (3)
PRES 4	-59.67387	58.30429	1.0475 (3)
HUM 5	0.13079	0.80557	0.0264 (3)
T316 9	-43.82656	16.07494	7.4332 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T316	9	0.3345	0.1119
PRES	4	0.3567	0.1272
WD	2	0.3572	0.1276
HUM	5	0.3578	0.1280
WS	3	0.3579	0.1281

DF 5 F RATIO 2.338 17  
71

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1947.40683 )		
WD 2	0.01973	0.11186	0.0311 (3)
WS 3	-0.26466	2.51298	0.0111 (3)
PRES 4	-60.26433	57.80609	1.0869 (3)
HUM 5	0.13257	0.79067	0.0281 (3)
T317 10	-46.36037	15.76844	8.6440 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T317	10	0.3534	0.1249
PRES	4	0.3748	0.1404
HUM	5	0.3753	0.1409
WD	2	0.3758	0.1412
WS	3	0.3760	0.1414

DF 5 F RATIO 2.506 (SS) 18  
71

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2194.42236 )		
WD 2	0.01353	0.11129	0.0148 (3)
WS 3	-0.29453	2.49973	0.0139 (3)
PRES 4	-67.09804	57.81768	1.3468 (3)
HUM 5	0.13001	0.78253	0.0276 (3)
T318 11	-47.20909	15.35506	9.4525 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T318	11	0.3610	0.1303
PRES	4	0.3863	0.1492
HUM	5	0.3869	0.1497
WD	2	0.3871	0.1498
WS	3	0.3873	0.1500

DF F RATIO (SS) 19  
 5 2.613  
 71

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2314.95639 )		
WD 2	0.00129	0.11104	0.0001 (3)
WS 3	-0.34291	2.49114	0.0189 (3)
PRES 4	-70.99449	57.81731	1.5078 (3)
HUM 5	0.12741	0.77786	0.0268 (3)
T319 6	-48.08175	15.22953	9.9675 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T319	6	0.3662	0.1341
PRES	4	0.3934	0.1547
HUM	5	0.3939	0.1552
WS	3	0.3942	0.1554
WD	2	0.3942	0.1554

DF F RATIO (SS) 20  
 5 2.672  
 71

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2104.35968 )		
WD 2	0.01236	0.11075	0.0124 (3)
WS 3	-0.55236	2.48550	0.0494 (3)
PRES 4	-64.16117	57.32303	1.2528 (3)
HUM 5	0.21397	0.76580	0.0781 (3)
T320 7	-48.06366	15.00990	10.2536 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T320	7	0.3730	0.1391
PRES	4	0.3954	0.1564
HUM	5	0.3970	0.1576
WS	3	0.3978	0.1582
WD	2	0.3980	0.1584

DF	F RATIO	21
5	2.231	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2162.46866 )		
WD 2	0.01080	0.11224	0.0093 (3)
WS 3	-0.23219	2.52186	0.0085 (3)
PRES 4	-66.47549	58.36760	1.2962 (3)
HUM 5	0.23899	0.78260	0.0933 (3)
TJ21 8	-44.11151	15.47244	8.1281 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ21	8	0.3386	0.1147
PRES	4	0.3664	0.1343
HUM	5	0.3682	0.1356
WD	2	0.3683	0.1357
WS	3	0.3685	0.1358

DF	F RATIO	22
5	2.202	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2098.38150 )		
WD 2	0.01258	0.11233	0.0125 (3)
WS 3	-0.09731	2.52794	0.0015 (3)
PRES 4	-64.57113	58.35436	1.2253 (3)
HUM 5	0.30200	0.77640	0.1513 (3)
TJ22 9	-43.43796	15.36969	7.9875 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
TJ22	9	0.3356	0.1126
PRES	4	0.3635	0.1321
HUM	5	0.3662	0.1341
WD	2	0.3664	0.1342
WS	3	0.3664	0.1342

DF  
5  
71

F RATIO  
2.014

23

189

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	2123.80475 )		
WD 2	0.00721	0.11302	0.0041 (3)
WS 3	-0.09194	2.54249	0.0013 (3)
PRES 4	-45.47188	58.83518	1.2383 (3)
HUM 5	0.32757	0.78249	0.1752 (3)
T323 10	-42.85586	16.10206	7.0834 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T323	10	0.3189	0.1017
PRES	4	0.3491	0.1219
HUM	5	0.3524	0.1242
WD	2	0.3524	0.1242
WS	3	0.3524	0.1242

DF  
5  
71

F RATIO  
1.520

24

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	1872.69897 )		
WD 2	-0.00317	0.11509	0.0008 (3)
WS 3	-0.24410	2.58007	0.0090 (3)
PRES 4	-57.64856	59.52780	0.9379 (3)
HUM 5	0.45199	0.77415	0.3239 (3)
T324 11	-35.77776	16.49621	4.7039 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
T324	11	0.2750	0.0756
PRES	4	0.3033	0.0920
HUM	5	0.3108	0.0966
WS	3	0.3109	0.0967
WD	2	0.3110	0.0967

DF  
5  
71

F RATIO  
0.493

25

190

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	144.67148 )		
WD 2	0.01976	0.11882	0.0277 (3)
WS 3	-0.13335	2.66118	0.0025 (3)
PRES 4	-3.72426	63.37144	0.0035 (3)
HUM 5	1.04906	0.80870	1.6828 (3)
T325 6	-6.10183	18.54740	0.1082 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T325	6	0.1819	0.0331
WD	2	0.1830	0.0335
PRES	4	0.1831	0.0335
WS	3	0.1832	0.0336

DF  
5  
71

F RATIO  
0.485

26

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	133.78300 )		
WD 2	0.02026	0.11885	0.0291 (3)
WS 3	-0.14163	2.66152	0.0028 (3)
PRES 4	-2.79898	63.44954	0.0019 (3)
HUM 5	1.06474	0.80859	1.7339 (3)
T326 7	-4.95578	18.55408	0.0713 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T326	7	0.1805	0.0326
WD	2	0.1817	0.0330
WS	3	0.1817	0.0330
PRES	4	0.1818	0.0330

DF  
5  
71

F RATIO  
0.490

27

191

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	164.28665 )		
WD 2	0.01980	0.11886	0.0277 (3)
WS 3	-0.15177	2.66060	0.0033 (3)
PRES 4	-3.73968	63.67872	0.0034 (3)
HUM 5	1.05382	0.80930	1.6955 (3)
T327 8	-5.71453	18.56845	0.0947 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T327	8	0.1814	0.0329
WD	2	0.1825	0.0333
PRES	4	0.1825	0.0333
WS	3	0.1827	0.0334

DF  
5  
71

F RATIO  
0.478

28

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	102.77015 )		
WD 2	0.02037	0.11911	0.0292 (3)
WS 3	-0.15709	2.66170	0.0035 (3)
PRES 4	-1.88509	64.03831	0.0009 (3)
HUM 5	1.08083	0.81542	1.7569 (3)
T328 9	-3.52623	18.89105	0.0348 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T328	9	0.1791	0.0321
WD	2	0.1803	0.0325
WS	3	0.1804	0.0325
PRES	4	0.1804	0.0326

DF  
5  
71

F RATIO  
0.479

29

192

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		111.25024 )		
WD	2	0.02045	0.11898	0.0295 (3)
WS	3	-0.15942	2.66161	0.0036 (3)
PRES	4	-2.12857	63.88496	0.0011 (3)
HUM	5	1.07404	0.81802	1.7239 (3)
T329	10	-3.96149	19.24368	0.0424 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T329	10	0.1794	0.0322
WD	2	0.1806	0.0326
WS	3	0.1807	0.0326
PRES	4	0.1807	0.0327

DF  
5  
71

F RATIO  
0.502

30

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT		219.26339 )		
WD	2	0.01932	0.11878	0.0265 (3)
WS	3	-0.16738	2.65970	0.0040 (3)
PRES	4	-5.59018	63.85397	0.0071 (3)
HUM	5	1.02055	0.82024	1.5481 (3)
T330	11	-7.40251	19.09813	0.1502 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T330	11	0.1833	0.0336
WD	2	0.1844	0.0340
PRES	4	0.1846	0.0341
WS	3	0.1847	0.0341

DF	F RATIO	31
5	0.509	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	246.44584 )		
WD 2	0.01884	0.11877	0.0252 (3)
WS 3	-0.17589	2.65924	0.0044 (3)
PRES 4	-6.20837	63.83772	0.0095 (3)
HUM 5	1.00786	0.81976	1.5116 (3)
T331 6	-8.32440	19.20732	0.1878 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T331	6	0.1847	0.0341
WD	2	0.1857	0.0345
PRES	4	0.1859	0.0346
WS	3	0.1861	0.0346

DF	F RATIO	32
5	0.525	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	278.28741 )		
WD 2	0.01719	0.11886	0.0209 (3)
WS 3	-0.17984	2.65788	0.0046 (3)
PRES 4	-7.13178	63.55908	0.0126 (3)
HUM 5	0.99337	0.81438	1.4879 (3)
T332 7	-9.83559	19.25021	0.2611 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T332	7	0.1874	0.0351
WD	2	0.1882	0.0354
PRES	4	0.1886	0.0356
WS	3	0.1887	0.0356

DF                    F RATIO                    33  
 5                    0.554  
 71

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	351.93229 )		
WD 2	0.01538	0.11882	0.0168 (3)
WS 3	-0.16685	2.65488	0.0039 (3)
PRES 4	-9.36139	63.55312	0.0217 (3)
HUM 5	0.95995	0.81366	1.3919 (3)
T333 8	-12.29062	19.35848	0.4031 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T333	8	0.1923	0.0370
PRES	4	0.1930	0.0373
WD	2	0.1936	0.0375
WS	3	0.1938	0.0375

DF                    F RATIO                    34  
 5                    0.532  
 71

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	286.64770 )		
WD 2	0.01674	0.11885	0.0198 (3)
WS 3	-0.16003	2.65677	0.0036 (3)
PRES 4	-7.36361	63.36509	0.0135 (3)
HUM 5	0.98929	0.81091	1.4884 (3)
T334 9	-10.56074	19.32493	0.2986 (3)

VARIABLE		MULTIPLE	
ENTERED	REMOVED	R	RSQ
HUM	5	0.1776	0.0315
T334	9	0.1887	0.0356
WD	2	0.1896	0.0359
PRES	4	0.1900	0.0361
WS	3	0.1901	0.0361

DF	F RATIO	35
5	0.533	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	311.34687 )		
WD 2	0.01544	0.11906	0.0168 (3)
WS 3	-0.16146	2.65670	0.0037 (3)
PRES 4	-8.15198	63.71486	0.0164 (3)
HUM 5	0.98412	0.81334	1.4640 (3)
T335 10	-10.88829	19.78335	0.3029 (3)

VARIABLE	MULTIPLE		
ENTERED	REMOVED	R	RSQ
HUM 5		0.1776	0.0315
T335 10		0.1889	0.0357
WD 2		0.1896	0.0360
PRES 4		0.1901	0.0361
WS 3		0.1902	0.0362

DF	F RATIO	36
5	0.546	
71		

## VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT	334.69469 )		
WD 2	0.01519	0.11894	0.0163 (3)
WS 3	-0.11635	2.65632	0.0019 (3)
PRES 4	-8.85839	63.57877	0.0194 (3)
HUM 5	0.97095	0.81235	1.4286 (3)
T336 11	-11.80108	19.52817	0.3652 (3)

VARIABLE	MULTIPLE		
ENTERED	REMOVED	R	RSQ
HUM 5		0.1776	0.0315
T336 11		0.1910	0.0365
PRES 4		0.1918	0.0368
WD 2		0.1924	0.0370
WS 3		0.1924	0.0370

**APPENDIX D**  
**COMPUTER PROGRAMS USED TO CONVERT**  
**RAW DATA TO USABLE FORM**

## **APPENDIX D**

### **COMPUTER PROGRAMS USED TO CONVERT RAW DATA INTO USABLE FORM**

**This appendix is divided into two sub-appendices. Appendices D-1 and D-2 contain respectively computer programs MOD1 and MOD2.**

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**APPENDIX D-1**  
**COMPUTER PROGRAM MOD1**

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0110C REFERENCE SECTIONS TITLED "INTERMEDIATE FILE",
0120C "CLSC2", AND "FINAL FILES"
0130C THIS PROGRAM WAS USED TO PROCESS THE RAW
0140C DATA FOR INPUT TO FILES CLSC2 AND T1
0150 DIMENSION A(14),B(3),M(7)
0160 CALL ATTACH (13,"75349/CLSC1".3,0..)
0170 CALL ATTACH (14,"75349/CLSC2".3,0..)
0180 CALL ATTACH (15,"75349/T1".3,0..)
0190 CALL FMEDIA (14,5)
0200 CALL FMEDIA (15,5)
0210C LINES 200 THROUGH 300 READ IN THE RAW DATA
0220C FROM FILE CLSC1 (VARIABLES A(1) THROUGH A(10)).
0230C VARIABLE B(2) IS THE RESULT OF CONVERTING
0240C TIME OF NS-20 FAILURE TO "YEAR HOURS".
0250C VARIABLE M(1) IS THE RESULT OF CONVERTING TIME
0260C OF WEATHER OBSERVATION TO "YEAR HOURS".
0270C VARIABLES M(2) THROUGH M(7) REPRESENT TEMP,WD,
0280C NS,PIGA FAILURES,DDJ FAILURES AND HUMIDITY
0290C RESPECTIVELY. VARIABLE B(3) EQUALS PRESSURE.
0300 DO 10 J=1,160
0310 READ(13,141)(A(I),I=1,10)
0320 141 FORMAT(V)
0330 B(2)=(A(1)-1)*24+A(2)
0340 B(1)=(A(1)-1)*24+A(3)
0350 M(2)=A(4)
0360 M(3)=A(5)
0370 M(4)=A(7)
0380 B(3)=A(8)
0390 M(5)=A(9)
0400 M(6)=A(10)
0410C LINES 330 THROUGH 390 WERE USED TO CONVERT
0420C DEWPOINT TO HUMIDITY
0430 C=(A(4)-32)*5./9.
0440 D=(A(5)-32)*5./9.
0450 E=C-D
0460 PRINT 11,C,E
0470 11 FORMAT(F7.2,2X,F7.2)
0480 READ,M(7)
0490 IF(B(2).LE.32.0) GO TO 5
0500C LINE 420 WAS USED TO COMPUTE TIME BETWEEN
0510C SUCCESSIVE FAILURES
0520 B(1)=B(2)-TF
0530C LINES 440 THROUGH 460 WROTE THE DATA INTO FILE T1
0540 WRITE(15,143)B(1),(M(K),K=2,4),B(3),M(7),M(5),M(6)
0550 143 FORMAT(F7.2,2X,I4,2X,I3,2X,I2,2X,
0560 &F5.2,2X,I2,2X,I1,2X,I1)
0570C LINES 480 THROUGH 500 WROTE THE DATA INTO FILE CLSC2
0580 WRITE(14,142)B(1),B(2),(M(K),K=1,4),B(3),M(7),M(5),M(6)
0590 142 FORMAT(F7.2,2X,F7.2,2X,I4,2X,I4,2X,I3,2X,
0600 &I2,2X,F5.2,2X,I2,2X,I1,2X,I1)
0610 5 TF=B(2)
0620 10 CONTINUE
0630 STOP

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**APPENDIX D-2**  
**COMPUTER PROGRAM MOD2**

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0010C REFERENCE SECTION TITLED "FINAL FILES".
0020C THIS PROGRAM WAS USED TO CREATE FINAL FILES
0030C T2A,T2B,T2PA,T2PB,T2DA,T2DB,T3A,T3B,T3PA,T3PB,
0040C T3DA,T3DB,TIP,AND TID.
0050C INTERMEDIATE FILES CLSC2 AND TEMP
0060C WERE SOURCES OF DATA.
0070 DIMENSION A(3),C(10),D(17),E(12),F(12),G(12),T(8760)
0080 INTEGER NY,WZ
0090 CALL ATTACH (11,"75849/TEMP1",3,1,,)
0100 CALL ATTACH (12,"75849/CLSC2",3,0,,)
0110 CALL ATTACH (13,"75849/T2A",3,0,,)
0120 CALL ATTACH (14,"75849/T2B",3,0,,)
0130 CALL ATTACH (15,"75849/T2PA",3,0,,)
0140 CALL ATTACH (16,"75849/T2PB",3,0,,)
0150 CALL ATTACH (17,"75849/T2DA",3,0,,)
0160 CALL ATTACH (18,"75849/T2DB",3,0,,)
0170 CALL ATTACH (19,"75849/T3A",3,0,,)
0180 CALL ATTACH (20,"75849/T3B",3,0,,)
0190 CALL ATTACH (21,"75849/T3PA",3,0,,)
0200 CALL ATTACH (22,"75849/T3PB",3,0,,)
0210 CALL ATTACH (23,"75849/T3DA",3,0,,)
0220 CALL ATTACH (24,"75849/T3DB",3,0,,)
0230 CALL ATTACH (25,"75849/TIP",3,0,,)
0240 CALL ATTACH (26,"75849/TID",3,0,,)
0250 CALL FMEDIA (13,5)
0260 CALL FMEDIA (14,5)
0270 CALL FMEDIA (15,5)
0280 CALL FMEDIA (16,5)
0290 CALL FMEDIA (17,5)
0300 CALL FMEDIA (18,5)
0310 CALL FMEDIA (19,5)
0320 CALL FMEDIA (20,5)
0330 CALL FMEDIA (21,5)
0340 CALL FMEDIA (22,5)
0350 CALL FMEDIA (23,5)
0360 CALL FMEDIA (24,5)
0370 CALL FMEDIA (25,5)
0380 CALL FMEDIA (26,5)
0390C LINES 410 THROUGH 430 READ IN TEMP DATA FOR ALL
0400C FAILURES AND CONVERT DATE/TIMES TO "YEAR HOURS".
0410 DO 10 I=1,6391
0420 READ(11,101)A(1),A(2),A(3)
0430 101 FORMAT (V)
0440 B=(A(1)-1)*24+A(2)
0450C T(B) EQUALS THE TEMPERATURE FOR A GIVEN
0460C YEAR HOUR.
0470 T(B)=A(3)
0480 10 CONTINUE
0490C LINES 510 THROUGH 530 READ IN ALL THE DATA
0500C CONTAINED IN THE FILE CLSC2.
0510 DO 11 J=1,159
0520 READ(12,102)(C(K),K=1,10)
0530 102 FORMAT (V)

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0540C LINES 570 THROUGH 620 SET VARIABLES D(1) - D(5)
0550C EQUAL TO THSF,WD,WS,PRESS,AND HUMIDITY.
0560C F(1) EQUALS TEMP AT FAILURE.
0570 D(1)=C(1)
0580 D(2)=C(5)
0590 D(3)=C(6)
0600 D(4)=C(7)
0610 D(5)=C(8)
0620 F(1)=C(4)
0630C LINES 660 THROUGH 1060 COMPUTE THE AVERAGE
0640C TEMPERATURE IN SIX HOUR INCREMENTS FROM SIX HOURS
0650C TO 72 HOURS PRECEDING FAILURE.
0660 DO 12 K=1,6
0670 F(1)=F(1)+T(C(3)-K)
0680 12 CONTINUE
0690 F(2)=F(1)
0700 DO 13 L=7,12
0710 F(2)=F(2)+T(C(3)-L)
0720 13 CONTINUE
0730 F(3)=F(2)
0740 DO 14 M=13,18
0750 F(3)=F(3)+T(C(3)-M)
0760 14 CONTINUE
0770 F(4)=F(3)
0780 DO 15 N=19,24
0790 F(4)=F(4)+T(C(3)-N)
0800 15 CONTINUE
0810 F(5)=F(4)
0820 DO 16 II=25,30
0830 IF ((C(3)-II).GT.0.) GO TO 30
0840 Z=T(8760+(C(3)-II))
0850 GO TO 31
0860 30 Z=T(C(3)-II)
0870 31 F(5)=F(5)+Z
0880 16 CONTINUE
0890 F(6)=F(5)
0900 DO 17 IJ=31,36
0910 IF ((C(3)-IJ).GT.0.) GO TO 32
0920 Z=T(8760+(C(3)-IJ))
0930 GO TO 33
0940 32 Z=T(C(3)-IJ)
0950 33 F(6)=F(6)+Z
0960 17 CONTINUE
0970 F(7)=F(6)
0980 DO 18 IK=37,42
0990 IF ((C(3)-IK).GT.0.) GO TO 34
1000 Z=T(8760+(C(3)-IK))
1010 GO TO 35
1020 34 Z=T(C(3)-IK)
1030 35 F(7)=F(7)+Z
1040 18 CONTINUE
1050 F(8)=F(7)
1060 DO 19 IL=43,48

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1070 IF ((C(3)-IL).GT.0.) GO TO 36
1080 Z=T(8760+(C(3)-IL))
1090 GO TO 37
1100 36 Z=T(C(3)-IL)
1110 37 F(8)=F(8)+Z
1120 19 CONTINUE
1130 F(9)=F(8)
1140 DO 20 IM=49,54
1150 IF ((C(3)-IM).GT.0.) GO TO 38
1160 Z=T(8760+(C(3)-IM))
1170 GO TO 39
1180 38 Z=T(C(3)-IM)
1190 37 F(9)=F(9)+Z
1200 20 CONTINUE
1210 F(10)=F(9)
1220 DO 21 IN=55,60
1230 IF ((C(3)-IN).GT.0.) GO TO 40
1240 Z=T(8760+(C(3)-IN))
1250 GO TO 41
1260 40 Z=T(C(3)-IN)
1270 41 F(10)=F(10)+Z
1280 21 CONTINUE
1290 F(11)=F(10)
1300 DO 22 JJ=61,66
1310 IF ((C(3)-JJ).GT.0.) GO TO 42
1320 Z=T(8760+(C(3)-JJ))
1330 GO TO 43
1340 42 Z=T(C(3)-JJ)
1350 43 F(11)=F(11)+Z
1360 22 CONTINUE
1370 F(12)=F(11)
1380 DO 23 JK=67,72
1390 IF ((C(3)-JK).GT.0.) GO TO 44
1400 Z=T(8760+(C(3)-JK))
1410 GO TO 45
1420 44 Z=T(C(3)-JK)
1430 45 F(12)=F(12)+Z
1440 23 CONTINUE
1450 D(6)=F(1)/7.
1460 D(7)=F(2)/13.
1470 D(8)=F(3)/19.
1480 D(9)=F(4)/25.
1490 D(10)=F(5)/31.
1500 D(11)=F(6)/37.
1510 D(12)=F(7)/43.
1520 D(13)=F(8)/49.
1530 D(14)=F(9)/55.
1540 D(15)=F(10)/61.
1550 D(16)=F(11)/67.
1560 D(17)=F(12)/73.
1570C LINES 1600 THROUGH 1660 COMPUTE THE AVERAGE
1580C RATE OF TEMPERATURE CHANGE FROM ONE HOUR
1590C TO 12 HOURS PRIOR TO FAILURE.

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1600 E(1)=ABS(C(4)-T(C(3)-1))
1610 DO 24 JL=2,12
1620 E(JL)=E(JL-1)+ABS(T(C(3)-(JL-1))-T(C(3)-JL))
1630 24 CONTINUE
1640 DO 25 JM=1,12
1650 G(JM)=E(JM)/JM
1660 25 CONTINUE
1670C LINES 169 THROUGH 1930 WRITE THE DATA
1680C COMPUTES ABOVE INTO THE FINAL FILES.
1690 WRITE(13,103)(D(JM),JM=1,11)
1700 WRITE(14,103)(D(JN),JN=1,5),(D(KK),KK=12,17)
1710 103 FORMAT(F6.2,1X,F4.0,1X,F3.0,1X,F5.2,1X,
1720 &F3.0,1X,6(F5.1,1X))
1730 WRITE(19,103)(D(KL),KL=1,5),(G(KM),KM=1,6)
1740 WRITE(20,103)(D(KN),KN=1,5),(G(KA),KA=7,12)
1750 I=C(9)
1760 IF(I.LT.1) GO TO 1
1770 IF(C(2).LE.67.5) GO TO 60
1780 D(1)=C(2)-NW
1790 WRITE(25,106)D(1),C(4),(D(WY),WY=2,5)
1800 106 FORMAT(F6.2,2X,F4.0,2X,F4.0,2X,F3.0,2X
1810 &F5.2,2X,F3.0)
1820 WRITE(15,103)(D(KB),KB=1,11)
1830 WRITE(16,103)(D(KC),KC=1,5),(D(KD),KD=12,17)
1840 WRITE(21,103)(D(KE),KE=1,5),(G(KF),KF=1,6)
1850 WRITE(22,103)(D(KG),KG=1,5),(G(KH),KH=7,12)
1860 60 NW=C(2)
1870 GO TO 11
1880 1 JW=C(10)
1890 IF(JW.LT.1) GO TO 11
1900 IF(C(2).LE.526.30) GO TO 61
1910 D(1)=C(2)-WX
1920 WRITE(26,106)D(1),C(4),(D(WZ),WZ=2,5)
1930 WRITE(17,103)(D(LA),LA=1,11)
1940 WRITE(18,103)(D(LB),LB=1,5),(D(LC),LC=12,17)
1950 WRITE(23,103)(D(LD),LD=1,5),(G(LE),LE=1,6)
1960 WRITE(24,103)(D(LF),LF=1,5),(G(LG),LG=7,12)
1970 61 WX=C(2)
1980 11 CONTINUE
1990 STOP
2000 END

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