UNITED STATES AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

THE VALIDITY OF AIRCRAFT NORS
RATE AS AN INDICATOR OF
MISSION CAPABILITY

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LSSR 30-77B

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(14)

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: AFIT-LSSR-30-77B	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE VALIDITY OF AIRCRAFT NORS RATE AS AN INDICATOR OF MISSION CAPABILITY.	5. TYPE OF REPORT & PERIOD COVERED: (9) Master's Thesis
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): (10) Michael R./Barnes, Captain, USAF; Dick D./Brashear, Captain, USAF	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Graduate Education Division, School of Systems and Logistics, Air Force Institute of Technology, WPAFB, OH	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Department of Research and Administrative Management, AFIT/LSGR, WPAFB, OH 45433	12. REPORT DATE: (11) Sep[redacted]77
	13. NUMBER OF PAGES: (12) 156p.
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

012 250

18. SUPPLEMENTARY NOTES

APPROVED FOR PUBLIC RELEASE AFR 190-17.

JERRAL F. ..., Capt, USAF

Director of ...

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

NORS
NORS CANCELLATIONS
NORS RATE
MISSION CAPABILITY
OPERATIONAL CAPABILITY

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: Paul F. Tully, Major, USAF

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The purpose of this study was to determine if there was a relationship between NORS rates and mission capability. In order to determine if a relationship existed, linear regressions were utilized between the variables NORS rate and NORS cancellation rate. These two variables were regressed to determine the coefficient of determination, r^2. A value for r^2 of greater than or equal to .8 would have indicated a significant relationship existing between NORS rate and mission capability. The data for this study was provided by SAC and ADCOM although MAC and TAC were contacted but were unable to provide relevant data. Using the primary weapon systems of the two commands, B-52, C-135, FB-111, F-106 and B-57, the regression model was employed using the NORS rate and cancellation rate on a by month, by base, by weapon system basis to determine if, in fact, a relationship existed. The results of this research effort proved that no significant relationship exists between NORS rate and mission capability. The tests proved, in fact, that a very small relationship existed between NORS rate and mission capability.

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LSSR 30-77B

THE VALIDITY OF AIRCRAFT NORS RATE AS AN INDICATOR OF MISSION CAPABILITY

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

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September 1977

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MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

DATE: 7 September 1977

Paul D. Tully

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ACKNOWLEDGEMENTS

The authors wish to thank the many people who helped make this final product possible; however, a few people will be singled out for their special contributions.

Major Paul F. Tully, our thesis chairman, deserves a great deal of credit for his guidance, wisdom and inspiration. His personal warmness and professional manner gave impetus toward this research effort.

We also express our gratitude for all the people in HQ AFLC, SAC, and ADCOM who provided the data needed to conduct this research. We also thank the people in the Business Research Management Center who provided the coordination in obtaining our data.

We especially impart our deepest and warmest thanks to our wives, Anne and Jeanne, who endured this year with understanding and patience.

Finally, we thank our typists, Linda Pearson, Marianne Zambo, and Phyllis Reynolds who, jointly, organized and put all the pieces together for us.

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CHAPTER I

INTRODUCTION

Overview

In order for the reader to appreciate the ambiguity surrounding the subject of Not Operationally Ready-Supply (NORS),[1] a typical feeling among many Air Force personnel might be summed up in the following quote:

> Whenever the subject of NORS arises, I get badly confused about 60 seconds into the conversation, and, because I'm confused, I naturally assume that the entire Air Force is confused. . . . The result is that the "fog" count gets very high and very little real communication occurs [5:2].
>
> – Former SAC Staff Officer

Misunderstandings frequently occur when talking about NORS rates because they are utilized for different purposes (5:2). Some examples of possible different interpretations of NORS rates are as follows:

1. To supply personnel, NORS might reflect a priority requisition required to relieve a specific NORS condition.

2. To maintenance/operations personnel, NORS might reflect the current operational limitations of

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[1]As defined in this paper, NORS represents the amount of grounding hours against an airframe because of lack of spare parts. The NORS rate is based on a ratio of grounding hours versus twenty-four hour possession per airframe.

a specific aircraft (i.e., Tail #456 is grounded because of lack of parts).

3. To logistics personnel at an Air Logistics Center (ALC), NORS might reflect the historical support problems associated with a particular item. For instance, National Stock Number (NSN) 1560008941682 accumulated 700 NORS hours during the month of January.

4. Finally, NORS sometimes reflects historical operational limitations for a specific weapon system. As an example, the NORS rate at Base A, for the B-2 bomber, was 5 percent during the month of January.

It is this last interpretation or meaning that the authors chose to examine. The specific impact that aircraft NORS rates have on an organization's ability to complete its assigned mission was researched to provide insight into questions like the following:

1. To what degree does a specific NORS rate reflect an operational limitation on an organization?

2. Will twice as many aircraft missions be cancelled due to NORS if, at a particular base, the NORS rate doubles from 5 percent to 10 percent?

3. Is the NORS rate an accurate indicator of mission capability limitations?

This study attempted to provide at least a partial answer to these and other questions relating to the true value and meaning of the NORS rate as an indicator of limitations on a unit's capability to perform its assigned mission.

Problem Statement

Presently, there is no demonstrated relationship between NORS rate and its impact on mission capability. If a specific relationship can be demonstrated between NORS rate and mission capability, then logistics managers and commanders at all levels would have a better understanding of the impact that specific NORS rates would have on their organizations. They might then be better able to determine how many additional sorties, if any, are likely to be cancelled when the NORS rate fluctuates.

NORS rates were designed to be indicators of the impact of supply support on mission capability (18:11). The current unofficial Air Force standard of 5 percent for aircraft NORS implies that any figure below 5 percent would not adversely affect mission capability and any figure above 5 percent would cause a degradation in unit mission capability. A study which revealed the actual relationship between NORS rate and mission capability would be beneficial in determining the probable impact upon a unit's mission capability for any specific NORS rate experienced by that unit. Using this relationship, aircraft missions might then be scheduled more effectively to meet operational requirements.

Background

NORS Definition

Traditionally, the aircraft NORS rate has been utilized to measure the effectiveness of logistic support (14:1-1). As a consequence, commanders at all levels are interested in the NORS rate and its impact upon their units (2; 4; 12). Over the years, numerous studies have been performed by the various agencies within the Department of Defense to specify more precisely, what the NORS rate actually indicates (4).

The NORS rate obtained from the daily aircraft status inputs generally by maintenance (14:1-1), "attempts to relate the impact supply is having on the operational mission [14:2-1]." In other words, what effect does detrimental supply support have on mission capability?[2]

According to Air Force Manual 67-1, Vol. I, Part One, "an aerospace vehicle is NORS when it is not capable of performing any of the primary missions assigned to the unit due to lack of parts [16:1-31]." The NORS rate of a weapon system is defined by the ratio of NORS hours accumulated during a specified time period divided by the possessed aircraft hours for the same time period (8:1). For example, consider Base A, with weapon system B-2, during the month of January. If three B-2s are

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[2]Mission capability is defined in this study as: the ability of an aircraft to perform its scheduled mission.

located at Base A for the entire month of January, the number of possessed hours used would be 3(B-2s)x31(days) x24(hours) or 2,232 hours. Further, if one B-2 was NORS for two days, and another NORS for three days during January, the total NORS hours charged to the B-2s during the month would be 2(days)x24(hours)+3(days)x24(hours) or 120 hours. The NORS rate for the month of January would then be computed as 120/2,232 = .054 or 5.4 percent.

Factors Affecting NORS Rates

As a result of the various studies conducted on NORS rates and the amount of management concern over what NORS rates were really depicting, it has been shown that NORS rates are *highly susceptible to manipulation and suppression* (17:16-19; 2:4-5; 14:2-2). Examples of how NORS rates might be manipulated are provided by the following:

1. The consolidation of several NORS items on one aircraft would result in a lower NORS rate than several aircraft grounded for single items.

2. The accomplishment of unscheduled maintenance while an aircraft is NORS would result in that aircraft being reported in a NORM (Not Operationally Ready Due to Maintenance) status.

3. Removing serviceable assets from an aircraft in NORM status to return a NORS aircraft to an OR status (i.e., cannibalization) would result in a lower NORS rate.

These are but a few of the many ways NORS rates might be manipulated by various Air Force organizations. The following items, although by no means all encompassing, also have a varying impact upon the magnitude of NORS rates (3:4-5).

1. War readiness spares kit (WRSK) withdrawals
2. Supply/maintenance cooperation
3. Management of due-in-from-maintenance assets (DIFM)
4. Base repair capability
5. Management of stock levels
6. Aggressive supply follow-up on requisitions
7. Age of aircraft
8. Deficiencies in NORS reporting system
9. Cannibalization policy
10. Mission essentiality of weapon system
11. Dispersal pattern of aircraft

Current NORS Standards

Commanders at all levels operate on the premise that the current Air Force NORS rate standard is 5 percent (4). Although adherence persists, the NORS rate standard of 5 percent was deleted from AFM 65-110, *Standard Aerospace Vehicle and Equipment Inventory, Status, and Utilization Reporting*, in late 1973 (4). Even though officially deleted, General Crow's[3] letter to the various Major Air Commands (MAJCOMs) indicated the 5 percent NORS rate would still be used as a "management indicator of the logistics systems capability to support an operational unit's materiel requirements" until such time as an Ad Hoc Group, under the direction of AF/LG, could determine what the NORS rate standard should be (2:1). As of the date of this writing, the authors were unable to find any published material delineating a new NORS rate standard. However, the unpublished conclusion and recommendation of the Ad Hoc Group mentioned previously was to continue the 5 percent NORS rate standard (11:1).

Prior to its deletion from AFM 65-110, the 5 percent NORS rate standard was based on standards of aircraft operational categories as follows (17:4):

1. Operationally ready (OR) aircraft capable of performing at least one of their primary missions--*71 percent.*

2. Not operationally ready due to maintenance (NORM) aircraft--*24 percent.*

3. NORS aircraft--*5 percent.*

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[3]Lieutenant General Duward L. Crow, former Assistant Vice Chief of Staff, United States Air Force, January 1974.

These standards set objectives for all operational levels to follow and ". . . deviations from the standards served as management indicators of potential problems [17:4]."

Proposed NORS Standards

When senior Air Force personnel became increasingly dissatisfied with the across-the-board (5 percent) approach to NORS rate standards, the Operations Analysis Office at Headquarters, Air Force Logistics Command (AFLC), developed a new method of setting NORS rate standards in 1970 (8:1). In essence, their new method allowed for a variable standard for different types of aircraft. It took into account three variables that have significant impact on NORS rates (age of aircraft, mission essentiality, and dispersal pattern); however, their new method has yet to be adopted (8:1-17).

Headquarters, USAF, in recognition of the amount of NORS rate manipulation, asked the various MAJCOMs in its "Supply Support Improvement Program Project 75-2, Airframe NORS Indicator," to conduct an evaluation of current NORS reporting with a view towards establishing a more realistic appraisal of supply impact on aircraft availability for operational missions (12:1). MAJCOM replies to this request indicated various amounts of dissatisfaction with the current method of computing NORS rates (13:1; 15:1; 9:1).

Because of the increasing concern over the validity of NORS rates as management indicators of supply support effectiveness, another attempt is currently being made to improve the NORS rate standard. The "Dynamic NORS Support Concept" that Air Force Logistics Command hopes to implement soon (10:1-30) again establishes variable NORS rate standards for different weapon systems. The factors included in the calculation of the new NORS rate standard were the same factors considered six years earlier by the Operations Analysis Office at Headquarters AFLC. Under the new "Dynamic NORS Support Concept," weapon system age, mission essentiality, and dispersal pattern, will combine[4] to form the numerical support objective which will be the new NORS rate standard for the weapon system. As a result of the computation, older and established weapon systems such as the B-52 will have a lower NORS standard (3 percent) than newer weapon systems such as the F-15 (21.8 percent) (10.25).

The variable NORS rate standards computed under the Dynamic NORS Concept will also determine, in part, which organizations receive priority in satisfying their requirements from AFLC depots for NORS support. Those units that are experiencing NORS rates above their

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[4]The mathematical computations which were employed in determining the numerical support objective are fully delineated in the unpublished briefing entitled, "Dynamic NORS Support Concept," which is available at HQ AFLC, Wright-Patterson Air Force Base, Ohio.

respective standards will receive priority over units that have rates equal to or below their respective NORS rate standards. In other words, a B-52 unit with a 4 percent NORS rate (3 percent standard) will receive priority over an F-15 unit with a 15 percent NORS rate (21.8 percent standard) (10:1-30).

Usefulness of NORS

The various studies previously mentioned in this review have shown that NORS rates, when taken alone, do not appear to be totally valid indicators of the effect of supply support on the operational mission. The reasons for this are the many factors mentioned earlier (cannibalization policy, NORS consolidation, etc.) that allow maintenance organizations to manipulate NORS rates. This should lead one to be highly suspect of the NORS rate as a reliable and accurate management indicator of supply performance.

Due to the amount of manipulation that NORS rates are subjected to, it would seem highly unlikely that they could be used in an across-the-board approach to measure not only supply performance, but limitations on mission capability. The factors affecting individual NORS rates are present in varying amounts from base to base and from MAJCOM to MAJCOM. Thus, a given NORS rate at one base may not equate to a given NORS rate at another base. However, if a relationship can be established between NORS rates and mission capability, NORS rates would be useful as tools in evaluating a unit's ability to meet its assigned mission. Stated another way, if the NORS rate for a particular unit went from 5 percent to 10 percent, would that necessarily mean that the unit's mission cancellation rate due to NORS would be doubled?

Objective

The objective of this thesis is to identify and describe the relationship (if any) between NORS rate and mission capability. In order to accomplish this objective, a research question was developed to serve as a guide for the research effort.

Research Question

To what extent are aircraft NORS rate and mission capability related?

In order to discover the answer to this broad research question, the following investigative questions served as guidelines in the research effort.

1. What relationship exists between NORS rate and mission capability at each specific base surveyed?

2. What relationship exists between NORS rate and mission capability within each weapon system surveyed?

3. What relationship exists between NORS rate and mission capability within each Major Air Command (MAJCOM) surveyed?

4. What relationship exists between NORS rate and mission capability within a weapon system when the unit assigned (U/A) aircraft vary? (As an example, what relationship exists at X AFB, with twenty-three EC-135 assigned as opposed to Y AFB, with three EC-135 assigned?)

The existence and direction of any relationship between NORS rate and mission capability was tested through the use of appropriate statistical techniques. In order to measure the impact that NORS rate has on mission capability, the authors elected to measure the specific number of missions that were cancelled because of NORS conditions as the best measure of mission impact. Because bases which schedule and fly more missions will probably have more cancellations than other bases, the number of cancellations at each base was divided by the total number of scheduled missions to come up with a *NORS Cancellation Rate*. This rate, the percent of scheduled missions which were cancelled, was used as the measure of impact which NORS rates have on mission capability. (NORS CANCELLATIONS ÷ TOTAL SCHEDULED = NORS CANCELLATION RATE.)

The authors feel that the only true indicator of the degree of NORS rate impact on mission capability is to determine how many missions were cancelled as the result of a NORS condition, all other factors held constant.

Scope

The aircraft considered in this study were operational aircraft[5] of the United States Air Force assigned to operational bases[6] within the Continental United States (CONUS). Aircraft assigned to overseas bases were not considered due to the inaccessibility of data. The operational aircraft selected to produce data for this study were chosen because they provided a broad spectrum of NORS rates for analysis.

In the search for data pertinent to this report, i.e., sorties scheduled, sorties flown, and supply cancellations, the authors contacted the following major command headquarters: Military Airlift Command (MAC), Strategic Air Command (SAC), Tactical Air Command (TAC), Air Training Command (ATC), and Aerospace Defense Command (ADCOM). Of these five major air commands, only two, SAC and ADCOM, possessed and maintained information feasible to this study.

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[5]For purposes of this study, an operational aircraft is defined as one whose primary mission is to engage in direct combat with enemy forces or to perform a direct support mission.

[6]An operational base is defined as an Air Force base which supports one or more squadrons of operational aircraft assigned and located at that base.

Only a peacetime environment will be considered in this study because of the lack of available data from a combat environment. Such a restriction in scope may limit the generalizability of the research results. Based upon their experience in a combat environment, it is the authors' opinion that the results of this study may not be applicable to the combat environment. Other factors, such as mission essentiality, may have an overriding effect on the NORS rate and mission capability thereby degrading any relationship that might be discovered in this research. For example, a more liberal cannibalization policy might be condoned in a combat environment as opposed to a peacetime environment. The results of such a policy could be an artificial reduction in the NORS rate (14:17).

As previously mentioned there are many factors which can influence NORS rates; however, it is not within the scope of this study to examine those factors and their influence on the NORS rate. This study examined only the overall NORS rate, however determined, and its relationship to mission capability. If a significant relationship can be established between the two variables, then future research efforts could direct attention to the relative importance of the various factors that determine the specific NORS rate.

CHAPTER II

METHODOLOGY AND DATA

This chapter describes the population of aircraft which were selected for this study, the manner in which the data was collected, the data sources, and the methodology used in conducting the research.

Population

In order to conduct this study on a workable scale and due to the availability of necessary data, attention will be focused on the aircraft assigned to the Strategic Air Command (SAC) and the Aerospace Defense Command (ADCOM). The aircraft in SAC to be studied are the B-52 (all models except F), C-135 (all configurations and models) and the FB-111. The aircraft assigned to ADCOM under consideration in this study are the F-106, and B-57. B-52F aircraft were excluded because of the exclusive nature of their mission (training). The sample was composed of the total population of each respective weapon system during the months data was gathered. Since data from all the aircraft listed above will be used, the sample consists of a census of the population.

The results obtained from this study allow the authors and subsequent readers to make inferences and generalizations about the impact NORS has on mission capability for the selected aircraft in the two major commands involved. No conclusions were or should be drawn pertaining to the impact of NORS on mission capability in any other major command or for any other types of aircraft.

Data

This section describes, in specific detail, the data gathered for this study.

The data essential to this study are:

1. The aircraft NORS rate of each type of weapon system broken down by base and by month.

2. The number of aircraft missions scheduled for each weapon system broken down by base and by month.

3. The number of aircraft mission cancellations due to NORS for each weapon system broken down by base and by month.[7]

This data was collected from calendar years (CY) 1975-1976 in order to have up-to-date information with which to conduct a meaningful and useful study. Due to the availability of data, the information received from ADCOM included only CY 1976 data. Information gathered from SAC included June 1975 through December 1976 data with the

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[7]Since the authors are only concerned about the impact NORS has on mission cancellations, all other factors contributing to mission cancellations were not considered in this study.

exception of April 1976 for KC-135 aircraft. In April 1976 a conversion from computer printout (Weekly Aerospace Vehicle Status Report A-G033B-SWR-WI-MWO) to microfich (Monthly Aerospace Vehicle Status/Utilization Report A-G033B-MSU-M3-MM1) resulted in the loss of credibility for data obtained on KC-135 aircraft for that month. Therefore, the authors elected not to include that data in this research effort (6). In summary, F-106 and B-57 data was examined for a twelve-month period; however, B-52 and C-135 aircraft were examined over a range of fourteen to nineteen months. This range was due partly to the conversion and missing information in the reports mentioned above because of erroneous inputs/computer errors.

Data Sources

The data employed in this research effort was provided by Headquarters, Strategic Air Command (HQ/SAC/LGY), and Headquarters, Aerospace Defense Command (HQ/ADCOM/LGR). The original data source is at base level and is forwarded to the respective MAJCOM Headquarters according to prescribed reporting procedures for the MAJCOM. The particular office in each Headquarters consolidated and forwarded the data which was requested by the authors.

The data utilized in this study is limited to that which is forwarded to HQ/SAC and HQ/ADCOM from their respective units and is assumed to be accurate and consistent because it was prepared and reported in accordance with standard command specified procedures.

Variables of Interest

In order to specify the procedure to be followed in this study, the authors have defined the following variables:

1. NORS Cancellations. The number of aircraft missions cancelled by weapon system, by base, by month, due to a NORS condition. This variable is measured on a ratio scale.

2. Scheduled Missions. The number of aircraft missions scheduled for each weapon system by base, by month. This variable is measured on a ratio scale.

3. NORS Cancellation Rate. A ratio which is formulated by dividing the value for NORS CANCELLATIONS by the value of SCHEDULED MISSIONS. This ratio is the percentage of aircraft which did not meet their assigned mission. This variable is measured on a ratio scale.

4. NORS Rate. A ratio of aircraft grounding hours versus a twenty-four hour possession per airframe. This variable is measured on a ratio scale.

For example, suppose March Air Force Base (SAC) scheduled 250 B-52 missions in July 1976. Because of various conditions such as NORS, NORM, bad weather, etc., only 230 missions were actually flown. Of the twenty missions *not* flown, NORS was the cause of ten cancellations. Therefore, 10÷250x100 = 4% of March's assigned missions in July 1976 was not met and thus the impact or effect of NORS on mission capability for March Air Force Base in July 1976 was 4 percent.

Methodology

NORS rates at each selected base were compared with the respective NORS cancellation rates during the same time period and analyzed for any relationship. Also, NORS rates for each weapon system were compared with the respective NORS cancellation rates to determine if a relationship exists over an entire weapon system. As an example, data for the B-52 aircraft was analyzed together to determine if an overall relationship exists.

The techniques selected to provide the required analysis were scattergrams accompanied by correlation and regression analysis.

Following is a synopsis of the techniques selected and an explanation of how they were applied to the data collected for this research.

Scattergrams

Scattergrams are scaled graphic representations of the sample space with the data points plotted in order to ease the identification of patterns (7:21). By identifying the correct pattern (linear, hyperbolic, power, exponential, etc.), the selection of the appropriate regression model was simplified. To further demonstrate how the data was analyzed, the following example is provided (see Figure 1). The data which appear in Figure 1, when plotted would appear as shown in the scattergram (see Figure 2). The scattergram indicates that the data in this example exhibits a linear relationship (a linear relationship was demonstrated for purposes of simplicity, in reality, a curvilinear relationship would probably be more likely to appear). Keeping this in mind, the next technique in our methodology, correlation analysis, can be explained.

Correlation Analysis

Bivariate correlation provides a single number which summarizes the relationship between two variables measured on at least an interval scale (7:276). The number (Pearson's correlation coefficient) indicates the degree to which variation or change in one variable is related to variation or change in another variable. If the value of the correlation coefficient r is close to zero, there is little or no linear relationship between the two variables. If the value of r approaches +1 or -1, there is a strong linear relationship (7:279). Pearson's correlation coefficient is determined by the following formula.

Item	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1. Missions Scheduled	100	100	100	100	100	100	100	100	100	100	100	100
2. Missions Cancelled Due to NORS	9	3	7	6	1	4	7	7	0	1	8	2
3. #1/#1 (NORS Cancellation Rate)	.09	.03	.07	.06	.01	.04	.07	.07	.00	.01	.08	.02
4. NORS Rate (%)	8	2	5	4	1	2	6	5	0	1	7	1

Fig. 1. Example of Hypothetical Data (Minct AFB (SAC) B-52H Aircraft)

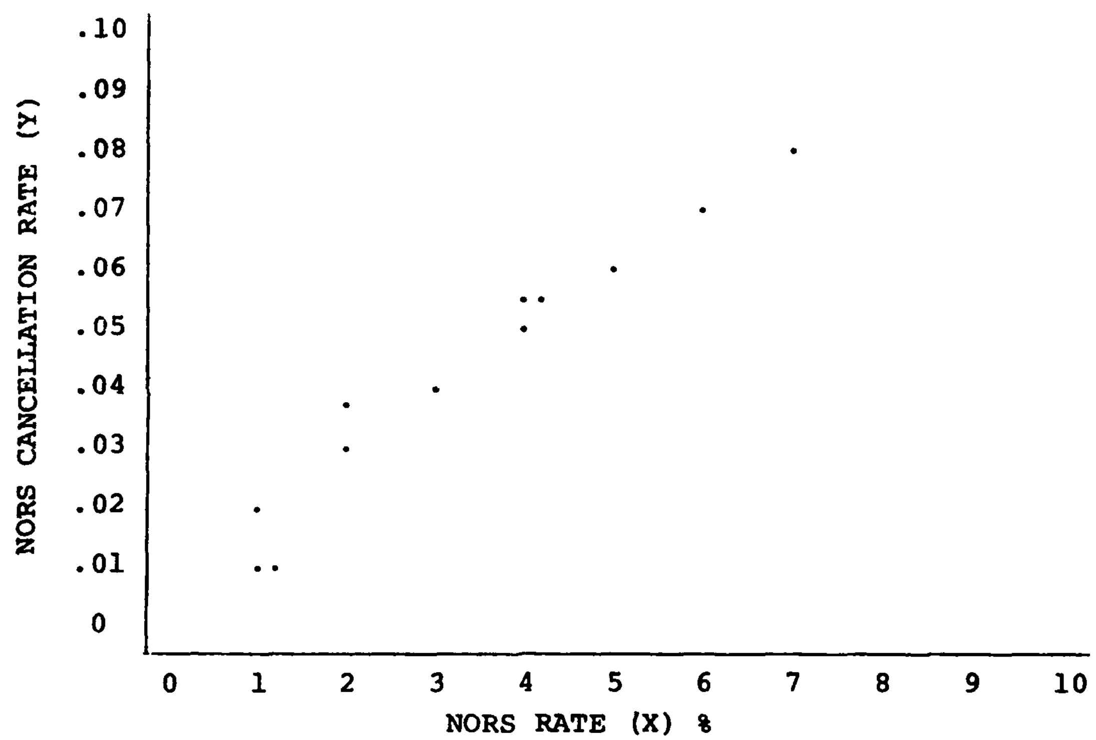

Fig. 2. Scattergram of Hypothetical Data (Minot AFB--B-52H)

$$r = \frac{\sum_i (X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_i (X_i-\bar{X})^2 \cdot \sum (Y_i-\bar{Y})^2}}$$

where: X_i = NORS rate/month

$\bar{X}$ = Average NORS rate

Y_i = NORS cancellation rate/month

$\bar{Y}$ = Average NORS cancellation rate

X and Y are random variables

(X,Y) are distributed joint bivariate normal

Accordingly, the sample provided earlier would have an r of .973. By squaring r we get another statistic denoted by r^2. Actually, r^2 is a more easily interpreted measure of association when our concern is with strength of relationship rather than direction (7:270). The values of r^2 will range from 0 to a maximum of 1.0. In the preceding example r^2 would equal .9483 (indicating a strong linear relationship between the two variables). For the purposes of this study an r^2 of .8 or higher will indicate a *significant* relationship. The authors selected .8 as a measure of significance in order to be fairly certain that a strong relationship does exist between the variables in question. With an r^2 of .8 or higher, managers would be able to use NORS rates as a fairly accurate predictor of mission cancellations. Any value of r^2 less than .8 would not be of much value in predicting mission cancellations. In such cases, other methods of prediction such as averaging might yield better results.

After determining that a significant relationship does exist ($r^2 \geq .8$), it would be beneficial to construct an equation that would "best" fit the data depicted on the scattergram shown earlier. The most common statistical technique used for fitting a line to a scattergram is least-squares regression (7:278). The benefit obtained by the construction of such a line in this study was as an aid in determining the probable NORS cancellation rate, given a specific NORS rate. As a prediction of future events, this would be quite helpful in determining the possible number of NORS cancellations given a specified NORS rate.

After determining that a significant relationship exists the next procedural step is to mathematically describe the relationships between NORS rate and mission capability. The best technique for describing the relationship, as mentioned above, is regression analysis.

Regression Analysis

Regression analysis is a general statistical technique which one can use to analyze the relationship between a dependent and independent variable(s) (7:321).

Regression is accomplished by building an equation that mathematically describes the relationship between the variables under study. The essence of regression analysis is to find a mathematical equation that will generate a curve to minimize the errors in prediction from the curve. The criterion used for measuring how well the generated curve fits the original data is the coefficient of determination, r^2. This statistic is the ratio of explained variation divided by total variation.

The most common type of regression is linear regression in which a straight line yields the highest value of r^2. However, a curvilinear relationship might provide a better explanation (higher value of r^2), and therefore should be considered when analyzing the data portrayed in a scattergram. In this study, depending upon the apparent relationship depicted in the scattergrams, appropriate linear or curvilinear regression models will be utilized.

Continuing with the example provided earlier, it appeared that the variables expressed a linear relationship. The general form for a linear equation used in regression analysis is as follows (1:2):

$$Y = A + BX + e$$

where:

Y = In this example is the expected NORS cancellation rate given a NORS rate of X.

$$B = \frac{N\Sigma XY - \Sigma X \cdot \Sigma Y}{N\Sigma X^2 - \Sigma (X)^2}$$

$$A = \frac{\Sigma Y - B\Sigma X}{N}$$

N = The size of the sample

X = The independent variable (NORS rate)

Y = The dependent variable (NORS cancellation rate)

e = The error

Using the example provided earlier, the linear expression determined is Y=.006+1.133X. In other words, by substituting various NORS rates into this equation, the resulting Y (NORS cancellation rate) could be determined. As mentioned earlier, the accuracy of this prediction is determined by the value of r^2. Because of the duality concept (19:391-457) of correlation/regression analysis, the r^2 obtained in correlation analysis is equivalent to the r^2 determined in regression analysis by the following formula.

$$\text{Total Variation} = \frac{N\Sigma Y^2 - (\Sigma Y)^2}{N}$$

$$\text{Explained Variation} = A\Sigma Y + B\Sigma XY - \frac{(\Sigma Y)^2}{N}$$

$$r^2 = \frac{\text{Explained Variation}}{\text{Total Variation}}$$

The significance of r^2 can be best demonstrated by the realization that by selecting a value of $r^2 \geq .8$, the resulting NORS cancellation rate determined by the linear regression equation should be at *least* 80 percent accurate when compared to actual value.

The following chapter will be the presentation of data in which various groupings are made in order to see if there exists a significant value for the coefficient of determination, r^2, for the regression analysis models considered in this study.

CHAPTER III

PRESENTATION OF DATA

This chapter consists of an analysis of the regression models used in the research effort and a presentation of data obtained from these models to describe the direction and strength of relationship between NORS rate and NORS cancellation rate.

Regression Model Analysis

As was mentioned in Chapter II, a curvilinear relationship might provide a better explanation (higher value of r^2), and therefore should be considered when analyzing the data portrayed in a scattergram. The equations selected for the regression models in the study were:

Linear equation: $Y = A+BX$

Power equation: $Y = A+BX^2$

The first regression model utilized, the linear model, is shown in Figure 3. This example demonstrates a linear relationship between NORS rate and NORS cancellation rate and illustrates a perfect fit (r^2=1.00). A detailed explanation of the workings of the model was presented in Chapter II.

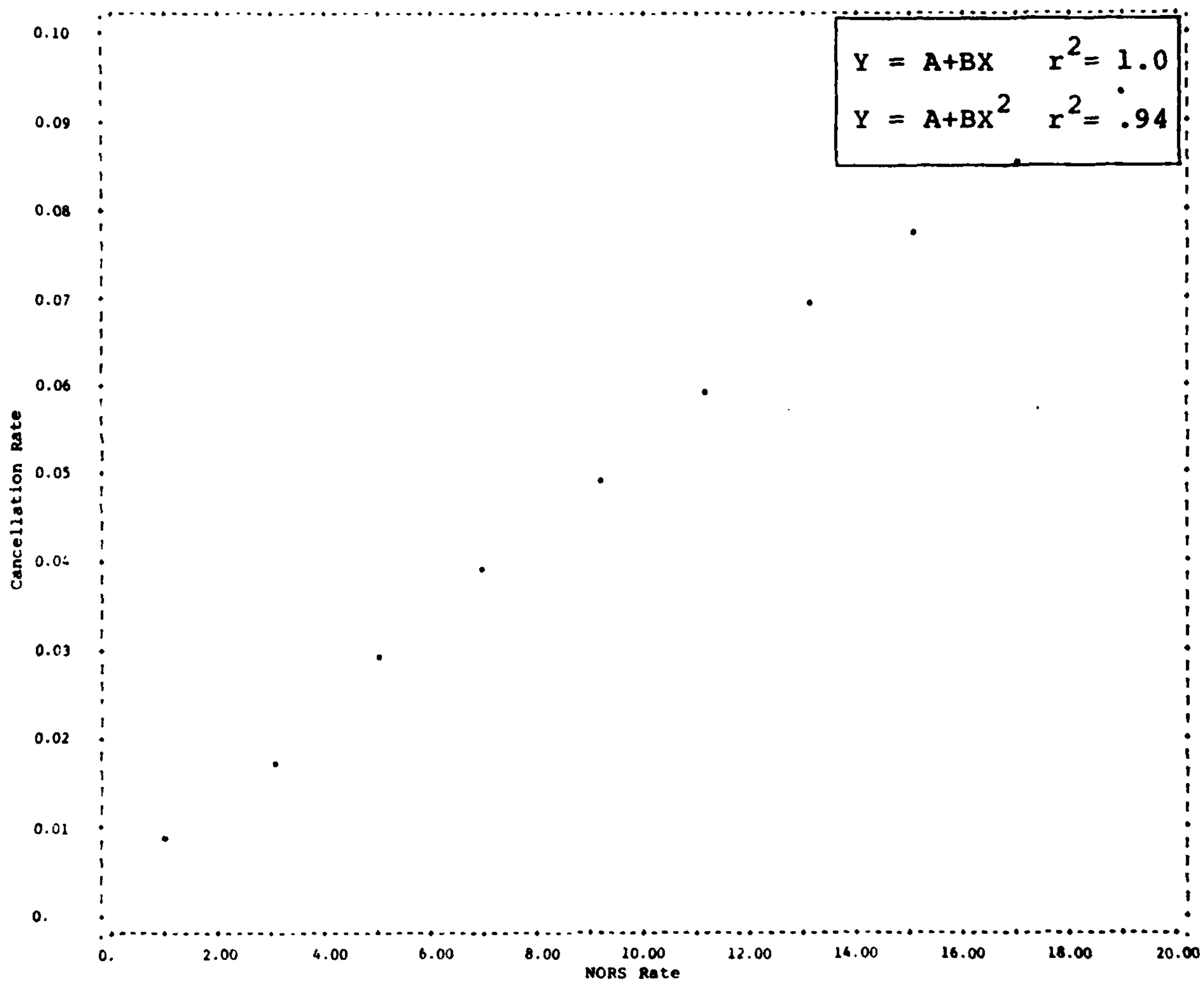

Fig. 3. Linear Regression Model

The power curve model, $Y=A+BX^2$, is shown in Figure 4. This model was selected in order to see if a given change in NORS rate caused a relatively larger change in NORS cancellations. There are infinitely many power models that could have been used; however, their use would not be within the scope of this study. The results obtained from using both the linear and power models mentioned above should sufficiently describe the relationship between the two variables and allow conclusions to be drawn from the results.[8]

To demonstrate the difference between the linear model and the power model and each model's ability to differentiate between sample data, regressions were run using both models against the data used in constructing the model curves. The r^2 values shown below verify that the model's designed data does equate to a perfect fit ($r^2=1.00$).

<u>Linear test data results</u>

Linear model	$r^2 = 1.000$
Power model	$r^2 = .9398$

<u>Power test data results</u>

Linear model	$r^2 = .9404$
Power model	$r^2 = 1.000$

---

[8]Another power model, $Y=AX^B$, was utilized in the data manipulation portion of this study; however, the results were not significantly different from the $Y=A+BX^2$ model to warrant its inclusion.

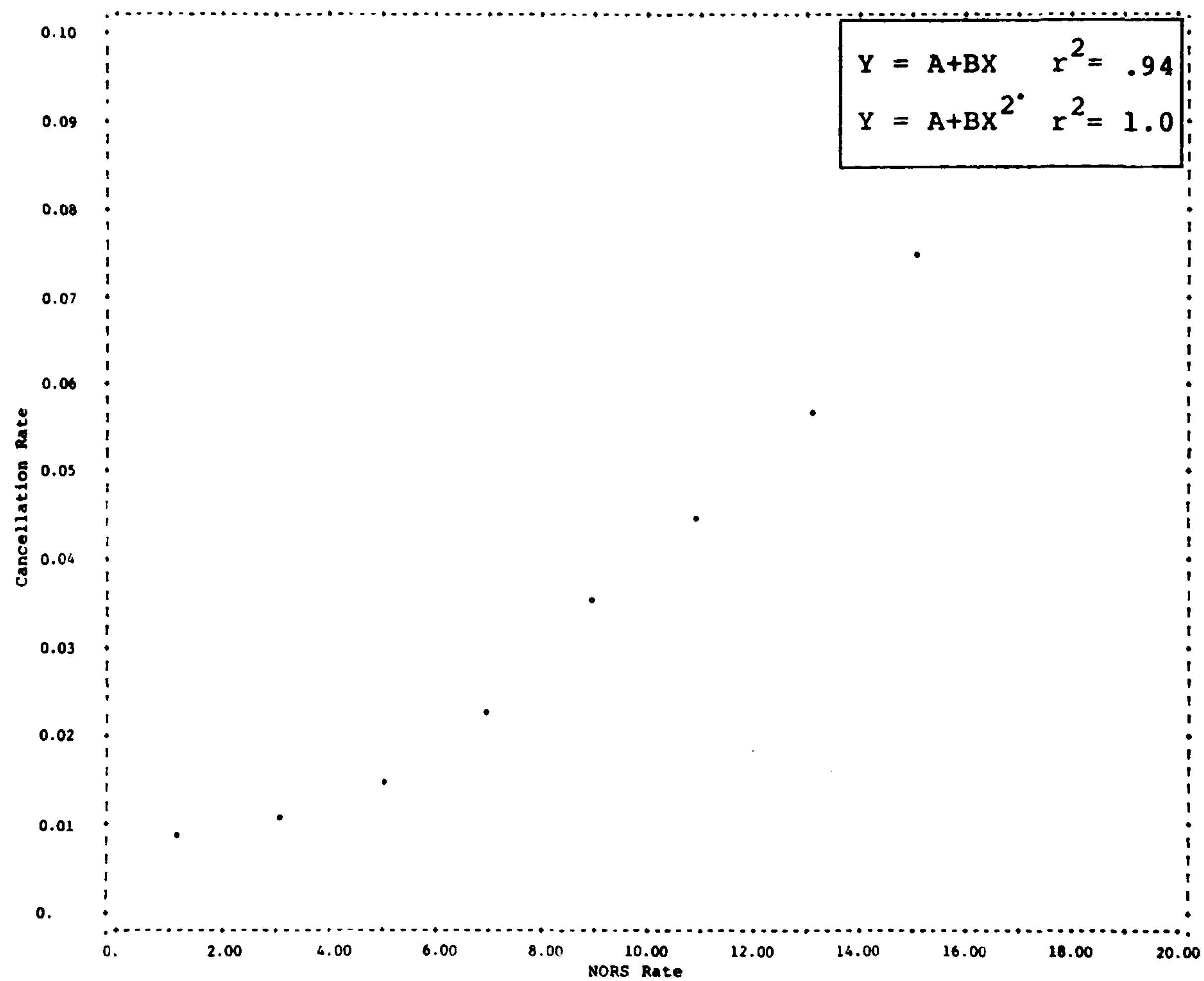

Fig. 4. Power Regression Model

Direction of Relationship

In order to determine and describe the relationship between NORS rate and NORS cancellation rate, it is first necessary to determine if the two variables are directly or indirectly related. Intuition dictates that the two variables should be related directly; however, the authors first investigated the direction (direct or indirect) before attempting to describe the strength of the relationship.

The regression method discussed in Chapter II gives a statistic that describes the slope of the model line when applied to sample data. The statistic given by the regression methodology is the B regression coefficient. If the sign of the B value is negative, the slope of the curve is negative which indicates some degree of indirect relationship. Likewise, if the sign of the B value is positive, the slope of the curve is positive and a direct relationship exists.

The size of the B value is also important in that it differentiates between model lines with relatively little slope (i.e., the smaller the B value, the closer the model line approaches a constant value for Y). As an example, a regression equation Y=A+BX with a B value of .001 and an A value of 2 would approximate a constant value for Y of 2, over the range of X values 0 to 20. While another regression with a B value of 1.0 and the same A value would represent an entirely different relationship, even though both regressions exhibited positive slopes. With this in mind, Tables 1 through 6 present the reader with a brief summary of the relative frequency and magnitude of positive and negative B coefficients obtained in this study. All of the tables came out with approximately 75 percent or higher positive B coefficients (with the exception of Table 6 where the sample size was very small (2)).

Only the B coefficients associated with the linear models are presented in Tables 1 through 6 because the B coefficients obtained with the power model were somewhat smaller in absolute value because of the relatively larger size of X after it has been squared (i.e., $Y=A+BX^2$). Almost identical results were obtained with both the linear and power models except for the relative size of the B coefficient as mentioned above. As the reader can see, the average positive slope for all observations in this study was approximately .33. In other words, the NORS cancellation rate increases at a rate approximately one third as fast as the NORS rate. If NORS rate increased 9 percent, we might expect an average increase in NORS cancellations of 3 percent.

TABLE 1

SUMMARY OF B COEFFICIENTS AT ALL BASES, BOTH COMMANDS

	Linear
Number of Negative Slopes	12
Number of Positive Slopes	56
Percent Positive	82
Average Negative Slope	.067
Average Positive Slope	.33

TABLE 2

SUMMARY OF B COEFFICIENTS AT ADCOM (F-106 AND B-57)

	Linear
Number of Negative Slopes	0
Number of Positive Slopes	8
Percent Positive	100
Average Negative Slope	0
Average Positive Slope	.33

TABLE 3

SUMMARY OF B COEFFICIENTS AT SAC (B-52, C-135, FB-111)

	Linear
Number of Negative Slopes	12
Number of Positive Slopes	45
Percent Positive	79
Average Negative Slope	.067
Average Positive Slope	.34

TABLE 4

SUMMARY OF B COEFFICIENTS AT SAC (B-52--ALL MODELS)

	Linear
Number of Negative Slopes	3
Number of Positive Slopes	15
Percent Positive	83
Average Negative Slope	.08
Average Positive Slope	.36

TABLE 5

SUMMARY OF B COEFFICIENTS AT SAC (C-135--ALL MODELS)

	Linear
Number of Negative Slopes	8
Number of Positive Slopes	28
Percent Positive	78
Average Negative Slope	.06
Average Positive Slope	.33

TABLE 6

SUMMARY OF B COEFFICIENTS AT SAC (FB-111)

	Linear
Number of Negative Slopes	1
Number of Positive Slopes	1
Percent Positive	50
Average Negative Slope	.06
Average Positive Slope	.1

Strength of Relationship

Tables 7 through 12 present various summaries of the values of r^2 grouped according to weapon system, command, base, and by the relative number of aircraft at each base (i.e., bases with zero to ten aircraft, eleven to twenty aircraft and greater than twenty aircraft were grouped). These tables represent a consolidation of the information contained in Appendices A through E for ease of reader identification and understanding. While there may be other possible groupings, the authors selected these as the best examples from which conclusions may be drawn as they relate to the four investigative questions of the research question itself.

First, is there a relationship between NORS rate and mission capability at each base? Second, is there a relationship between NORS rate and mission capability for each type of weapon system surveyed? Third, is there a relationship between NORS rate and mission capability within each MAJCOM surveyed? Fourth, is there a relationship between NORS rate and mission capability when the number of aircraft varies from base to base? Tables 7 through 12 represent the authors' attempts to summarize the data so as to best answer these questions.

By looking at Table 7, the values of r^2 for Carswell, Castle and Ellsworth, for each of the two respective types of aircraft at ease base, were about

TABLE 7

PRESENTATION OF DATA FOR TWO WEAPONS SYSTEMS AT THE SAME BASE (r^2)

Model Used		Linear A + BX	Power $A + BX^2$	Average No. of Aircraft
Base: Carswell				
Type Aircraft:	B-52D	.00	.00	31
	KC-135A	.00	.00	14
Base: Barksdale				
Type Aircraft:	B-52G	.13	.13	26
	KC-135A	.07	.04	28
Base: Castle				
Type Aircraft:	B-52G	.14	.08	14
	KC-135A	.14	.08	26
Base: Blytheville				
Type Aircraft:	B-52G	.24	.33	13
	KC-135A	.00	.00	13
Base: Ellsworth				
Type Aircraft:	B-52G	.03	.04	12
	KC-135A	.04	.02	12
Base: Wurtsmith				
Type Aircraft:	B-52H	.11	.13	14
	KC-135A	.14	.10	15
Base: Fairchild				
Type Aircraft:	B-52G	.00	.01	13
	KC-135A	.27	.33	32
Base: Warner-Robins				
Type Aircraft:	B-52G	.10	.08	10
	KC-135A	.05	.05	13

identical. However, there was a distinct difference between the number of each type of aircraft at the individual base. For example, Ellsworth had 12 B-52Gs and 12 KC-135As and the r^2 for each type of aircraft was almost identical, whereas Carswell had 31 B-52Ds and 14 KC-135As and the values for r^2 were identical for each type of aircraft. By the same token, Fairchild had a distinctly different number of aircraft, 13 B-52Gs and 32 KC-135As, and the values of r^2 for each type were widely dispersed. Blythville had the same number of each type of aircraft, 13 B-52Gs and 13 KC-135As, and the values of r^2 for each type were also distinctly different.

Table 8 reflects low values of r^2 for both SAC and ADCOM, with the exception of the F-106 aircraft in ADCOM which shows relatively high values of r^2. The values of r^2 for both the linear and power models were essentially the same for SAC when comparing each of the three types of weapon systems. The values of r^2 in ADCOM, for both the linear and power models, were the same for the B-57 but were clearly different for the F-106. The reader might note that the total number of each type of aircraft, or the range of aircraft, was from 19 to 538. Also, it should be pointed out that the command values for r^2 were greater than any of the values of r^2 for the seven F-106 ADCOM bases studied. The significance of this point will be addressed in Chapter IV.

TABLE 8

PRESENTATION OF DATA BY COMMAND AND WEAPON SYSTEM (r^2)

Model Used		Linear A + BX	Power A + BX^2	Average No. of Aircraft
Command: SAC				
Weapon System:	B-52	.01	.01	294
	C-135	.30	.29	538
	FB-111	.02	.01	55
Command: ADCOM				
Weapon System:	F-106	.69	.76	225
	B-57	.02	.02	19

In looking at just the SAC KC-135A aircraft, Table 9 depicts the average values of the coefficient of determination, r^2, for the linear and power models to be .07 and .08, respectively. These values were quite low compared to the established criteria of $r^2 \geq .8$. The range of values in the linear model extended from .00 to .31 and the range of values using the power model was from .00 to .36. The upper limit for the value of r^2 for both models occurred at Kincheloe AFB, Michigan. The number of KC-135A aircraft ranged from 2 (Offutt) to 38 (Grissom).

Table 10 reflects the average values of r^2 for both the linear and power models for each model of B-52s. Again, the average values were relatively low when compared to the established criteria of $r^2 \geq .8$. The r^2 values for the B-52D averaged .07 and .05 when looking at

TABLE 9

PRESENTATION OF DATA BY WEAPON SYSTEM (r^2)

Model Used	Linear A + BX	Power A + BX^2	Average No. of Aircraft
Weapon System: KC-135A			
Base:			
Altus	.04	.01	16
Barksdale	.07	.04	28
Blytheville	.00	.00	14
Carswell	.00	.00	14
Castle	.14	.08	26
Dyess	.01	.00	14
Ellsworth	.04	.02	12
Fairchild	.27	.33	32
Grand Forks	.04	.05	15
Grissom	.26	.28	38
Kincheloe	.31	.36	15
K. I. Sawyer	.20	.22	18
Loring	.00	.01	28
March	.15	.17	13
Mather	.01	.00	14
McConnell	.04	.06	27
Minot	.00	.01	14
Offutt	.04	.02	2
Pease	.00	.01	19
Plattsburgh	.00	.00	17
Rickenbacker	.00	.00	14
Seymour Johnson	.05	.04	13
Travis	.07	.04	15
Warner Robins	.05	.05	13
Wurtsmith	.14	.10	15
Average	.07	.07	

TABLE 10

PRESENTATION OF DATA BY WEAPON SYSTEM (r^2)

Model Used	Linear A + BX	Power A + BX^2	Average No. of Aircraft
Weapon System: B-52D			
Base:			
Carswell	.00	.00	32
Dyess	.15	.07	16
March	.07	.08	17
Average	.07	.05	
Weapon System: B-52H			
Base:			
Bastle	.49	.69	7
Grand Forks	.13	.15	14
Kincheloe	.06	.01	14
K. I. Sawyer	.01	.03	13
Minot	.10	.08	15
Wurtsmith	.11	.13	14
Average	.15	.18	
Weapon System: B-52G			
Base:			
Barksdale	.13	.13	26
Blytheville	.24	.33	13
Castle	.14	.08	14
Ellsworth	.03	.04	12
Fairchild	.00	.01	13
Loring	.36	.41	11
Mather	.25	.19	11
Seymour Johnson	.00	.02	12
Warner Robins	.10	.08	10
Average	.14	.14	

the linear and power models, respectively. There were only three bases which possess B-52D aircraft with Carswell possessing 32 aircraft and Dyess owns 16 aircraft. The third base, March AFB, has 17 B-52Ds. The B-52H average values of r^2 for both the linear and power models were greater than the B-52D and B-52G values. Castle AFB had the highest values at .49 and .69 and they also possessed the least number of aircraft.

When comparing the average values of r^2 for bases which had 10 aircraft or less, of any particular type, the values of r^2 for both the linear and power models were significantly lower than the established criteria of $r^2 \geq .8$, as Table 11 indicates. For the linear model, the range of r^2 values was from .00 (Ellsworth and Grissom) to .52 (Ellsworth). The .00 value at Ellsworth was for the EC-135A and the .52 at Ellsworth was for the EC-135C. For the power model, the range of values was from .00 (Ellsworth, Grissom and Offutt) to .69 (Castle). As previously mentioned in Table 10, Castle, with the B-52H, had the highest values at .49 and .69 respectively. Ellsworth, with the EC-135, had the second largest values of .52 and .54 respectively. Also note that all of the ADCOM bases studied had greater than 10 aircraft on the average.

Table 12 presents the r^2 values for those bases possessing 11 to 20 aircraft. The average values were

TABLE 11

PRESENTATION OF DATA BY AVERAGE NUMBER OF AIRCRAFT (0-10) (r^2)

Model Used	Linear A + BX	Power A + BX^2	Average No. of Aircraft
Command: SAC Base: Castle Type Aircraft: B-52H	.49	.69	7
Command: SAC Base: Warner Robins Type Aircraft: B-52G	.10	.08	10
Command: SAC Base: Offutt Type Aircraft: RC-135M	.02	.01	2
Command: SAC Base: Offutt Type Aircraft: KC-135V	.17	.12	3
Command: SAC Base: Offutt Type Aircraft: RC-135U	.05	.00	1
Command: SAC Base: Grissom Type Aircraft: EC-135G	.00	.00	1
Command: SAC Base: Ellsworth Type Aircraft: EC-135C	.52	.54	3
Command: SAC Base: Offutt Type Aircraft: EC-135C	.05	.03	8
Command: SAC Base: Ellsworth Type Aircraft: EC-135A	.00	.00	3

TABLE 11--Continued

Model Used	Linear $A + BX$	Power $A + BX^2$	Average No. of Aircraft
Command: SAC Base: Grissom Type Aircraft: EC-135L	.17	.19	4
Command: SAC Base: Ellsworth Type Aircraft: EC-135G	.49	.43	3
Command: SAC Base: Offutt Type Aircraft: KC-135A	.04	.02	2
Average	.175	.176	

TABLE 12

PRESENTATION OF DATA BY AVERAGE NUMBER OF AIRCRAFT (11-20) (r^2)

Model Used	Linear A + BX	Power A + BX^2	Average No. of Aircraft
Command: ADCOM Base: Castle Type Aircraft: F-106	.45	.53	15
Command: ADCOM Base: Griffins Type Aircraft: F-106	.69	.68	17
Command: ADCOM Base: Langley Type Aircraft: F-106	.28	.27	15
Command: ADCOM Base: McChord Type Aircraft: F-106	.13	.15	17
Command: ADCOM Base: Minot Type Aircraft: F-106	.41	.43	17
Command: ADCOM Base: K. I. Sawyer Type Aircraft: F-106	.13	.15	17
Command: ADCOM Base: Malstrom Type Aircraft: B-57	.02	.02	19
Command: SAC Base: Dyess Type Aircraft: B-52D	.15	.07	16
Command: SAC Base: March Type Aircraft: B-52D	.07	.09	17
Command: SAC Base: Grand Forks Type Aircraft: B-52H	.13	.15	14

TABLE 12--Continued

Model Used	Linear $A + BX$	Power $A + BX^2$	Average No. of Aircraft
Command: SAC Base: Kincheloe Type Aircraft: B-52H	.06	.01	14
Command: SAC Base: K. I. Sawyer Type Aircraft: B-52H	.01	.03	13
Command: SAC Base: Minot Type Aircraft: B-52H	.11	.13	14
Command: SAC Base: Blytheville Type Aircraft: B-52G	.24	.33	12
Command: SAC Base: Castle Type Aircraft: B-52G	.14	.08	14
Command: SAC Base: Ellsworth Type Aircraft: B-52G	.03	.04	12
Command: SAC Base: Fairchild Type Aircraft: B-52G	.00	.01	13
Command: SAC Base: Loring Type Aircraft: B-52G	.36	.41	11
Command: SAC Base: Mather Type Aircraft: B-52G	.25	.19	11
Command: SAC Base: Seymour Johnson Type Aircraft: B-52G	.00	.02	12
Command: SAC Base: Beale Type Aircraft: KC-135Q	.22	.23	16

TABLE 12--Continued

Model Used	Linear A + BX	Power $A + BX^2$	Average No. of Aircraft
Command: SAC Base: Plattsburgh Type Aircraft: KC-135Q	.01	.02	16
Command: SAC Base: Altus Type Aircraft: KC-135A	.04	.01	17
Command: SAC Base: Barksdale Type Aircraft: KC-135A	.07	.04	28
Command: SAC Base: Blytheville Type Aircraft: KC-135A	.00	.00	13
Command: SAC Base: Carswell Type Aircraft: KC-135A	.00	.00	13
Command: SAC Base: Dyess Type Aircraft: KC-135A	.01	.00	13
Command: SAC Base: Ellsworth Type Aircraft: KC-135A	.04	.02	12
Command: SAC Base: Grand Forks Type Aircraft: KC-135A	.04	.05	15
Command: SAC Base: Kincheloe Type Aircraft: KC-135A	.31	.36	15
Command: SAC Base: K. I. Sawyer Type Aircraft: KC-135A	.20	.22	13
Command: SAC Base: March Type Aircraft: KC-135A	.15	.17	13

TABLE 12--Continued

Model Used	Linear A + BX	Power $A + BX^2$	Average No. of Aircraft
Command: SAC Base: Mather Type Aircraft: KC-135A	.01	.00	15
Command: SAC Base: Minot Type Aircraft: KC-135A	.00	.01	14
Command: SAC Base: Pease Type Aircraft: KC-135A	.00	.01	19
Command: SAC Base: Plattsburgh Type Aircraft: KC-135A	.00	.00	17
Command: SAC Base: Rickenbacker Type Aircraft: KC-135A	.00	.00	14
Command: SAC Base: Travis Type Aircraft: KC-135A	.07	.04	15
Command: SAC Base: Warner Robins Type Aircraft: KC-135A	.05	.05	13
Command: SAC Base: Wurtsmith Type Aircraft: KC-135A	.14	.10	15
Average	.024	.126	

.124 and .126, respectively, as opposed to .175 and .176, respectively, for bases possessing ten or less aircraft (see Table 10). The range of values was from .00 at several bases to .69 at Griffiss, utilizing the linear model. The range of r^2 values for the power model was from .00 at several bases to .68 at Griffiss. Griffiss had the highest values of r^2 in either model at .69 and .68 while possessing 17 F-106 aircraft. In any case, the r^2 values are all significantly lower than $r^2 \geq .8$ as Table 12 clearly indicates.

For those bases possessing greater than 20 aircraft, Table 13 depicts the average values of r^2 to be .13 and .13 for the two respective models. For the linear model the range of values was from .00 (Carswell and Loring) to .35 (Tyndall). The range of values for the power model was from .00 (Carswell) to .36 (Tyndall). Tyndall, with the F-106, had the highest values of r^2 for the two models at .35 and .36, respectively, while Carswell, with the B-52D, had the lowest values of r^2 at .00 for both the linear and power models. Grissom had the greatest number of aircraft, 37 KC-135As, and the respective values of r^2 were .26 and .28. Again, none of the values even approached the established criteria of $r^2 \geq .8$.

TABLE 13

PRESENTATION OF DATA BY AVERAGE NUMBER OF AIRCRAFT (>20) (r^2)

Model Used	Linear $A + BX$	Power $A + BX^2$	Average No. of Aircraft
Command: ADCOM Base: Tyndall Type Aircraft: F-106	.35	.36	28
Command: SAC Base: Pease Type Aircraft: FB-111	.16	.16	25
Command: SAC Base: Plattsburgh Type Aircraft: FB-111	.01	.01	30
Command: SAC Base: Carswell Type Aircraft: B-52D	.00	.00	32
Command: SAC Base: Barksdale Type Aircraft: B-52G	.13	.13	25
Command: SAC Base: Barksdale Type Aircraft: KC-135A	.07	.04	28
Command: SAC Base: Castle Type Aircraft: KC-135A	.14	.08	26
Command: SAC Base: Fairchild Type Aircraft: KC-135A	.27	.33	32
Command: SAC Base: Grissom Type Aircraft: KC-135A	.26	.28	37

TABLE 13--Continued

Model Used	Linear A + BX	Power $A + BX^2$	Average No. of Aircraft
Command: SAC Base: Loring Type Aircraft: 135A	.00	.01	28
Command: SAC Base: McConnell Type Aircraft: KC-135A	.04	.06	27
Average:	.13	.13	

Summary

In summary, Tables 7 through 13 appear to demonstrate that no matter how one groups or compares the types, numbers, or commands of the aircraft, or however grouped, the values of r^2 may vary differently but *all* values are consistently lower than the established criteria of $r^2 \geq .8$. In Chapter IV the meanings of these results and their implications are discussed in detail.

CHAPTER IV

ANALYSIS OF DATA

The objective of this research was *"To identify and describe the relationship (if any) between NORS rate and mission capability."* In meeting this objective, several findings were derived from an analysis of the data presented in Chapter III and the accompanying scattergrams in Appendices A through E. Tables 14 and 15 provide a concise summary of the data presented in Chapter III.

The first major finding was that NORS rate and mission capability (as indicated by NORS cancellation rate) was not significantly ($r^2 \geq .8$) related to one another when all other factors were held constant (i.e., number of aircraft, MAJCOM, etc.). In other words, an increase or decrease in aircraft NORS rate, by itself, does not appear to present a beneficial or detrimental impact upon mission capability. This was most aptly demonstrated by many of the SAC bases in which the NORS rate varied and the NORS cancellation rate remained almost constant near zero. The following bases/weapon systems demonstrated this fact.

Carswell, B52D
K. I. Sawyer, B-52H
Fairchild, B-52G
Seymour Jounson, B-52G
Ellsworth, EC-135A

TABLE 14

STRENGTH OF RELATIONSHIP

Command	Weapon System	Regression Model Linear (r^2)	Regression Model Power (r^2)
SAC	FB-111	.02	.01
SAC	B-52	.01	.01
SAC	C-135	.30	.29
ADCOM	F-106	.69	.76
ADCOM	B-57	.02	.02

Number U/A Aircraft/Base	Average r^2 (Linear)	Average r^2 (Power)
0-10	.175	.176
11-20	.124	.126
>20	.130	.130

TABLE 15

DIRECTION OF RELATIONSHIP

	Average Pos. Slope	Average Neg. Slope	Percent Positive
F-106, B-57 (ADCOM)	.33	0	100
B-52, C-135, FB-111 (SAC)	.34	.067	79
All bases, both commands	.33	.067	82

Plattsburgh, KC-135Q
Blytheville, KC-135A
Carswell, KC-135A
Dyess, KC-135A
Loring, KC-135A
Mather, KC-135A
Minot, KC-135A
Pease, KC-135A
Plattsburgh, KC-135A

The second major finding of this study was that there appeared to be a significantly different relationship between NORS rate and NORS cancellation rate when comparisons were made among the various weapon systems. Using Table 14 as the basis for comparison, one sees the range of r^2 values extending from a low of .01 for the B-52 linear/power regression models and FB-111 power regression model to a high of .76 for the F-106 power regression model. Essentially, the FB-111, B-52, and B-57 *all* demonstrated a negligible relationship between NORS rate and NORS cancellation rate when those weapon systems were considered as a whole. However, the C-135 weapon system demonstrated a much stronger relationship and the F-106 demonstrated the *strongest relationship* found in this research effort. Nevertheless, none of the r^2 values for any of the individual weapon systems was equal to or greater than the prescribed value of .8 which indicated a relatively weak relationship.

When comparing the overall r^2 values for each weapon system with the individual r^2 values for each base with the same weapon system, the authors noted that the r^2 values for the F-106, as a weapon system, were greater than any of the individual F-106 bases. The relationships, therefore, at each base, must have been somewhat closely related to each other in order for the overall F-106 average to be larger in value than the individual bases. None of the other weapon systems exhibited similar behavior although the overall C-135 average r^2 values for the respective regression models of .3 and .29 were much stronger than the average C-135 base r^2 values.

The above leads the authors to conclude the possibility that, where a relationship does exist at base level, the stronger that relationship will be when viewing that weapon system as a whole. As a hypothetical example, if the average r^2 value for each base with weapon system X were in the .8 range, one might expect the overall weapon system X average r^2 value to be in the .85 to .90 range. Conversely, an average r^2 value of .5 for each base with weapon system X might have an overall weapon system average in the .45 to .5 range. Further studies should be performed in order to prove this conclusively because these results could have possibly been the result of chance and not the reasons stated above.

The third major finding of this study was that NORS rates were no better at predicting the impact on mission capability (indicated by the number of cancelled missions) when the number of aircraft under study varied.

In Chapter III the average r^2 value for each base with ten or less (0-10) aircraft was compared with r^2 values for bases with eleven to twenty (11-20) aircraft and then compared with the r^2 values for bases with more than twenty (>20) aircraft. The results were as follows:

	(0-10)	(11-20)	(>20)
r^2 (linear/base)	.175/.175	.124/.126	.13/.13

While those bases with ten or less aircraft had a slightly higher r^2 value than the rest, the difference is so small that the authors concluded that the relationship between NORS rate and mission capability did not appear to be affected by the number of aircraft assigned.

The fourth finding of this study relates to the direction of the relationship between NORS rates and mission capability. While NORS rates have been utilized as a direct measure of impact on mission capability in the past, no proof had been offered verifying this relationship. Table 15 tends to at least support the theory that even though NORS rates are subjected to manipulation, they still vary directly with the NORS cancellation rate.

Another aspect to be considered in the direction of the relationship is that the average positive slopes for both commands approximated .33. However, the authors feel that additional analysis should be conducted to determine if this relationship existed only by chance.

As it now stands, a change in the NORS rate would result in a corresponding change in the NORS cancellation rate of one-third. If this relationship could be substantiated, it would be of benefit to logistics planners in determining the impact which varying NORS rates might have on mission capability.

While logic dictates that NORS rates and NORS cancellation rates should vary directly, approximately 20 percent of the scattergrams in Appendices A through E had negative slopes (indirect relationship). Table 15 indicates that these slopes were of very low magnitude (.067 average). This led the authors to conclude that many of these slopes would have been positive if additional data had been gathered (instead of 12-18 months, perhaps 36 or more months would reduce the impact of one month's extreme fluctuations).

These findings indicate that NORS cancellation rates are not strongly influenced by the aircraft NORS rate except for the F-106 aircraft when viewed command-wide. The findings also possibly indicate that even though there was a weak relationship, a change in NORS rates would result in a corresponding change in the NORS cancellation rate of approximately one-third. However, the authors were unable to determine the range over which this relationship holds true due to the relatively small amount of data available to them.

These findings also indicated that to examine NORS rates in isolation would yield the following result: The NORS rate at Base A in SAC cannot be equated with the NORS rate at Base B in ADCOM. Their relative impact on the mission capability of each base is entirely different. Therefore, caution must be exercised by anyone who attempts to relate a 5 percent NORS standard in SAC with a 5 percent NORS standard in ADCOM and the relative impact these NORS standards have on the individual bases.

Summary

In summary, the analysis presented in this chapter has demonstrated a weak relationship between NORS rate and NORS cancellation rate when comparing bases, weapon systems, MAJCOMs, and selected numbers of unit assigned aircraft with each other. Chapter V will provide the reader with a summary of the major findings of this thesis along with recommendations for further study.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Introduction

This chapter includes a brief summary of the major findings of this study and also provides recommendations for further study in the area of NORS analysis. The findings will be summarized by answering the investigative questions initially posed in Chapter I which served as guides throughout the research effort.

Summary

The major finding of the study in relation to the original research questions are:

1. *What relationship exists between NORS rate and mission capability at each base surveyed?*

As presented in the findings of Chapter IV, the relationship between NORS rates and mission capability is considered to be quite weak when individual bases are considered.

2. *What relationship exists between NORS rate and mission capability within each weapon system surveyed?*

None of the weapon systems demonstrated a relationship between NORS rates and mission capability strong enough to be considered useful; i.e., $r^2 \geq .8$.

3. *What relationship exists between NORS rates and mission capability within each Major Air Command (MAJCOM) surveyed?*
The findings demonstrate that the relationship between NORS rate and mission capability for both commands was not high enough to be considered significant; however, the relationship demonstrated in ADCOM was much stronger than the relationship in SAC.

4. *What relationship exists between NORS rates and mission capability within a weapon system when the unit assigned (U/A) aircraft vary?*
The difference in the relationship between NORS rates and mission capability was so small when the unit assigned aircraft varied, that the authors concluded the relationship was not affected by the number of aircraft assigned.

Conclusion

In answering the research question posed in Chapter I, *To what extent are aircraft NORS rate and mission capability related?*, the findings of this study indicate there is little relationship between NORS rate and mission capability. Unless further studies are successful in revealing a substantial relationship, caution should be exercised by anyone attempting to associate a specific NORS rate with a specific level of mission or operational capability.

Recommendations

The authors' first recommendation is that an analysis of NORS rates and NORS cancellation rates be accomplished using data extending for a greater length of time. Because of the relative short length of time covered in this study (18 months or less), the regression equations were moderately influenced by a relative few data elements at extreme points in the scattergrams. As an example, one extreme data point out of 18 would lower the r^2 value of a relationship from one of significance ($r^2 \geq .8$) to one that is not significant ($r^2 < .8$). To alleviate this problem, a study that represents three (3) years (36 months) of data would lower the possible effect of one extreme fluctuation in data and render more accurate results.

Besides conducting a more lengthy study into the relationship between NORS rates and NORS cancellation rates, the authors also recommend a study be accomplished to include not only NORS rates, but cannibalization rates and commodity hours[9] as variables potentially affecting mission capability. Even though studies concerning the relationship between NORS rates and cannibalization rates

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[9]Commodity hours relate themselves to individual NORS *items* instead of NORS airframes as reported by maintenance, and are those hours accumulated for each individual item reported to repair a NORS reportable weapon system.

have found little relationship (5:19-21), the possibility exists that all three variables (NORS rate, cannibalization rate, and commodity hours) could together be accurate predictors of mission or operational capability. A standard technique such as multiple linear regression could be utilized on all three variables to compute the strength and direction of any relationship and then each variable could be examined to determine which one was the best "descriptor." Such a study would provide beneficial insight into the relationship between these variables and might clear up many conflicting opinions concerning the value of these measures.

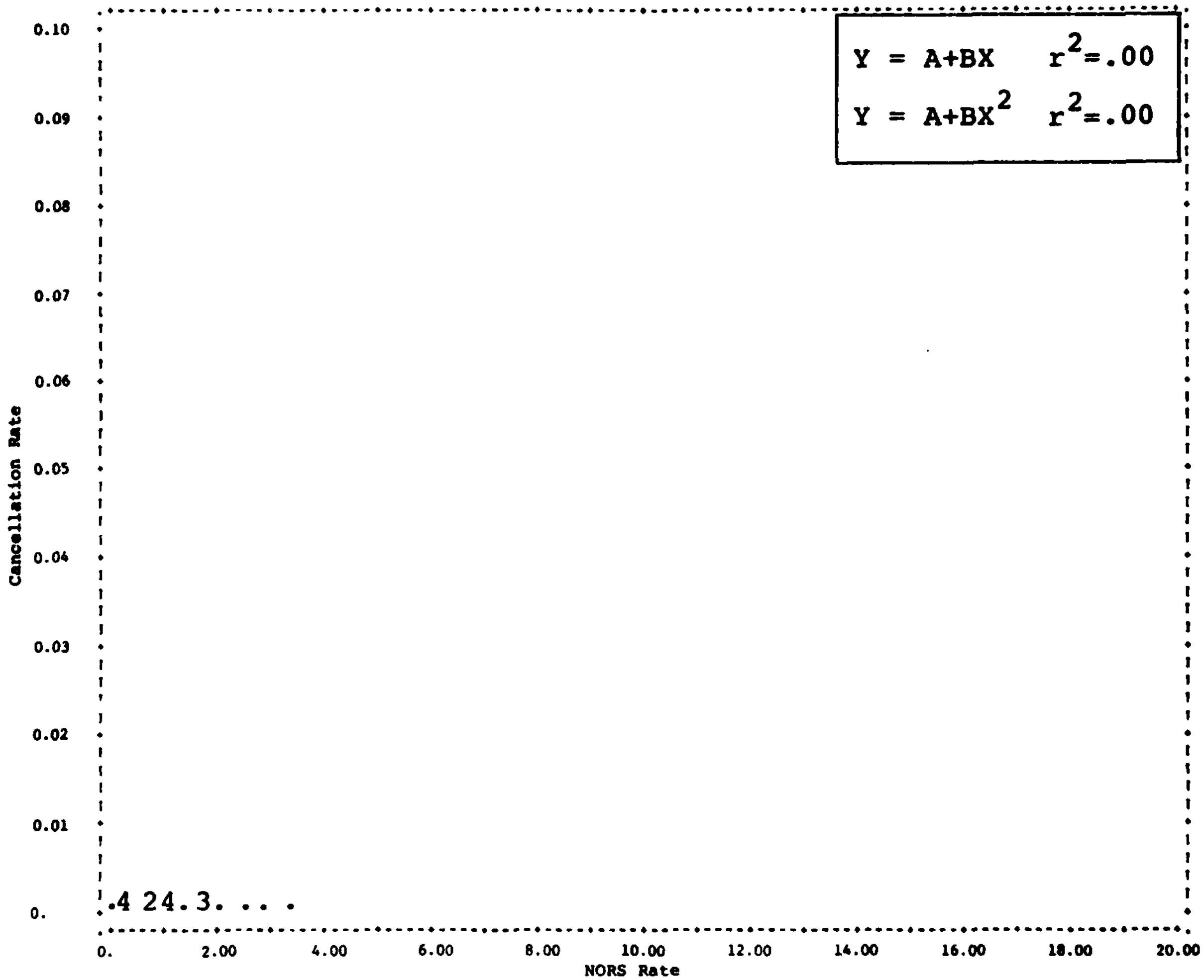
The final recommendation is that prior to the implementation of the Dynamic NORS Support Concept, AFLC should determine if there is a better "descriptor" than NORS rates of the relative impact supply support is having upon a unit's mission capability. One other alternative available might be the Commodity Hour Ratios (14:2-1 to 2-5) utilized by Headquarters SAC *along with* NORS rates as the primary indicators and measurements of logistics support.

The foregoing recommendations should not be construed as being all conclusive but should provide a starting point from which further studies could be made.

APPENDICES

APPENDIX A

B-52 SCATTERGRAMS (ALL MODELS)



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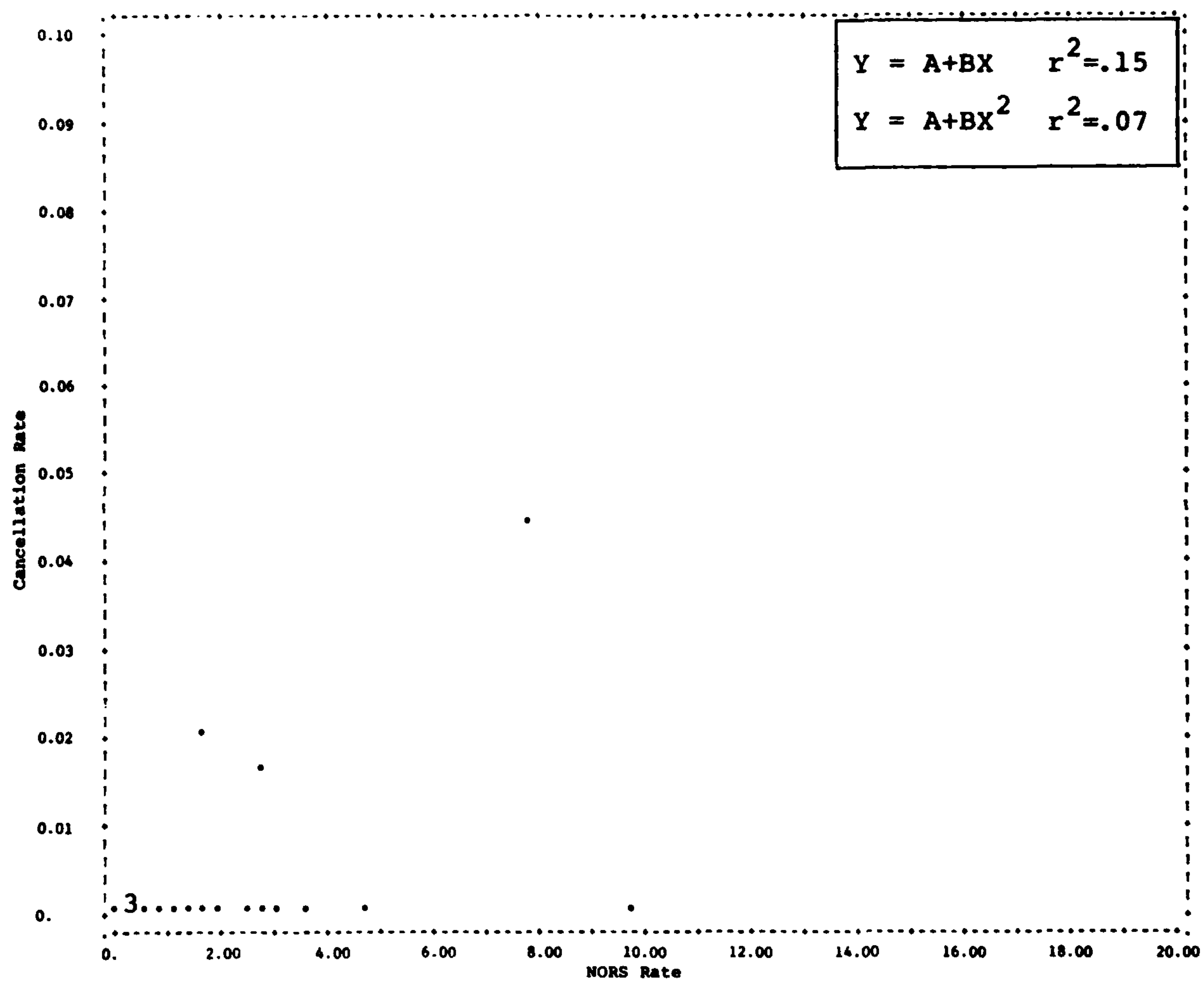

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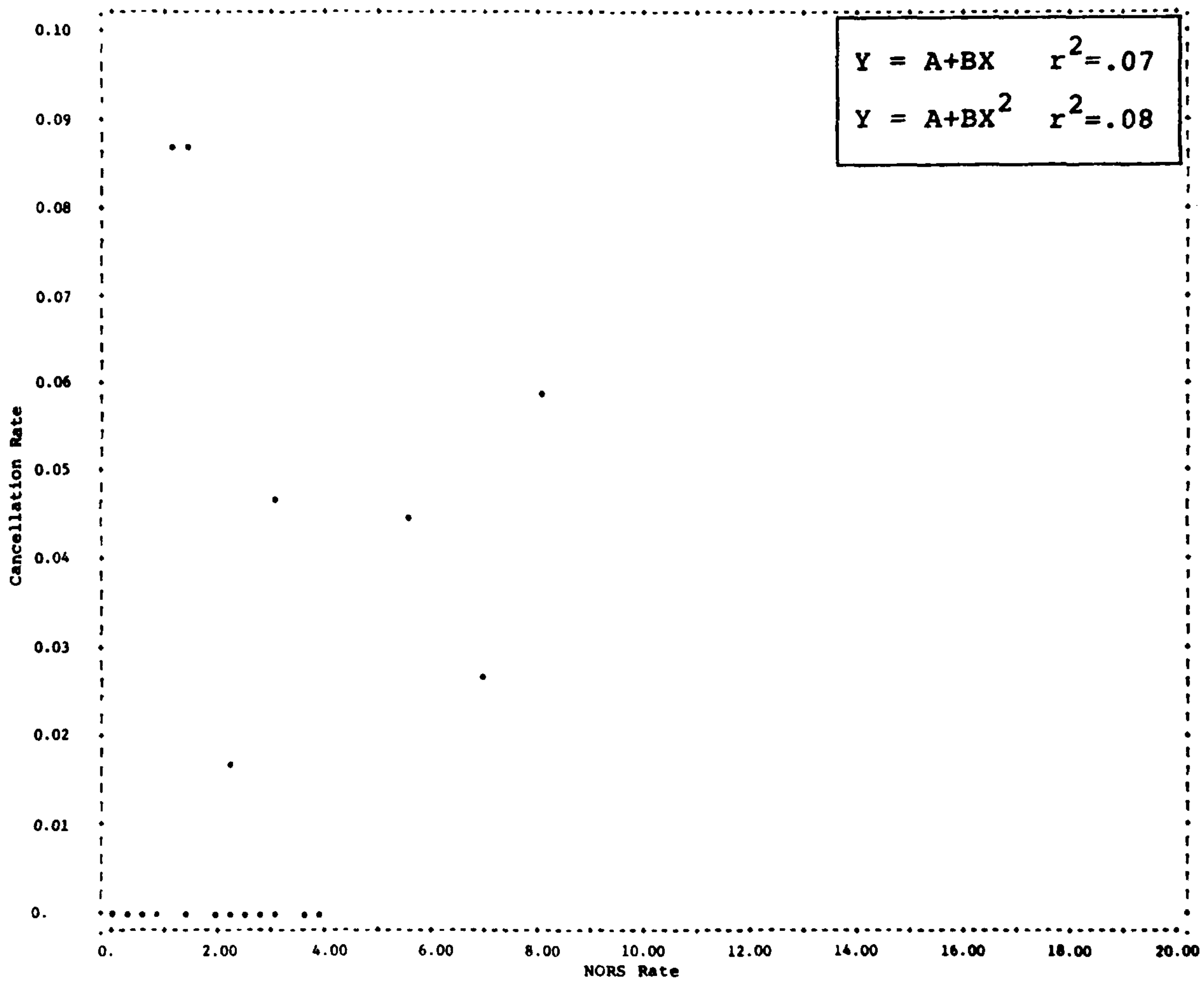

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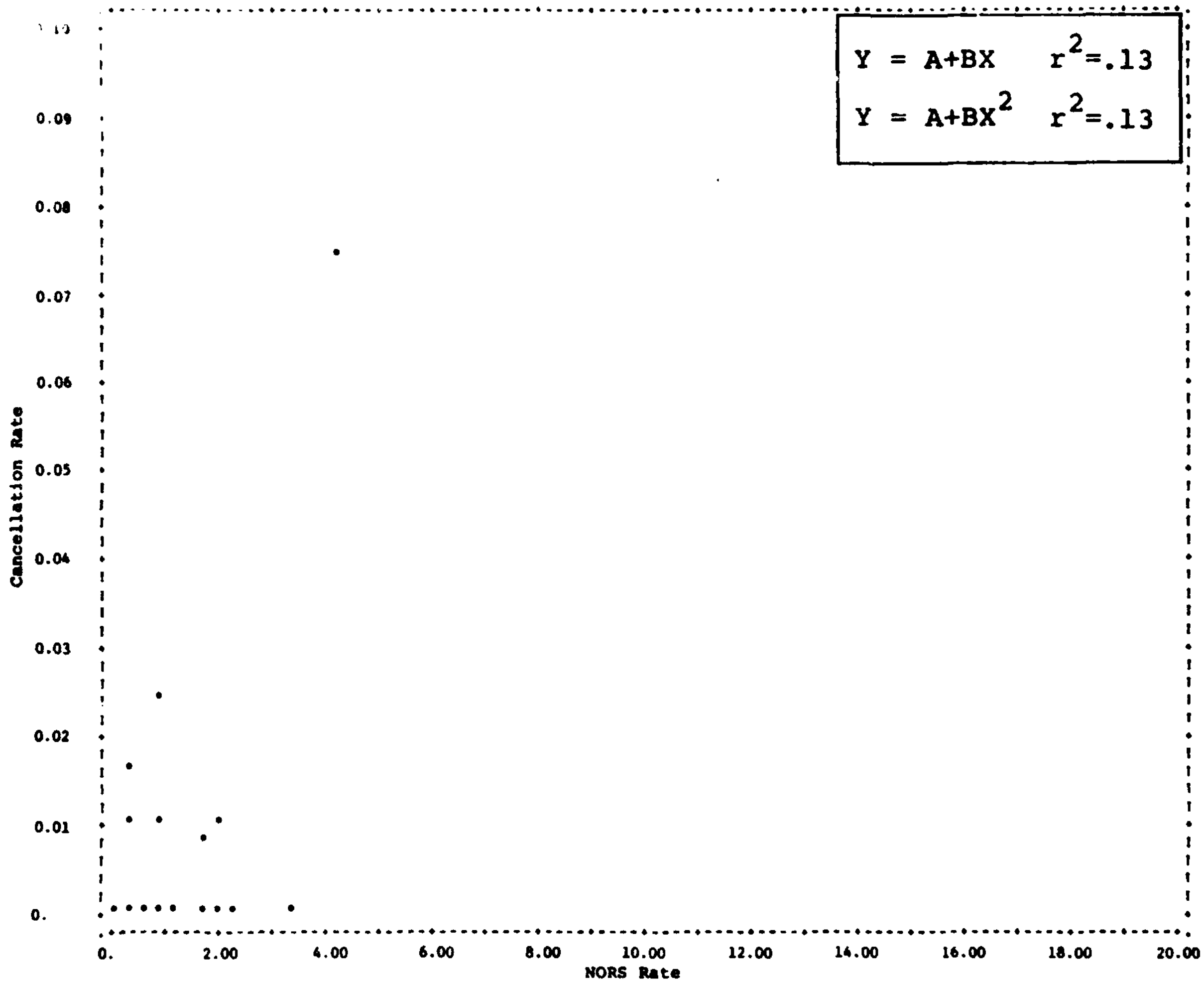

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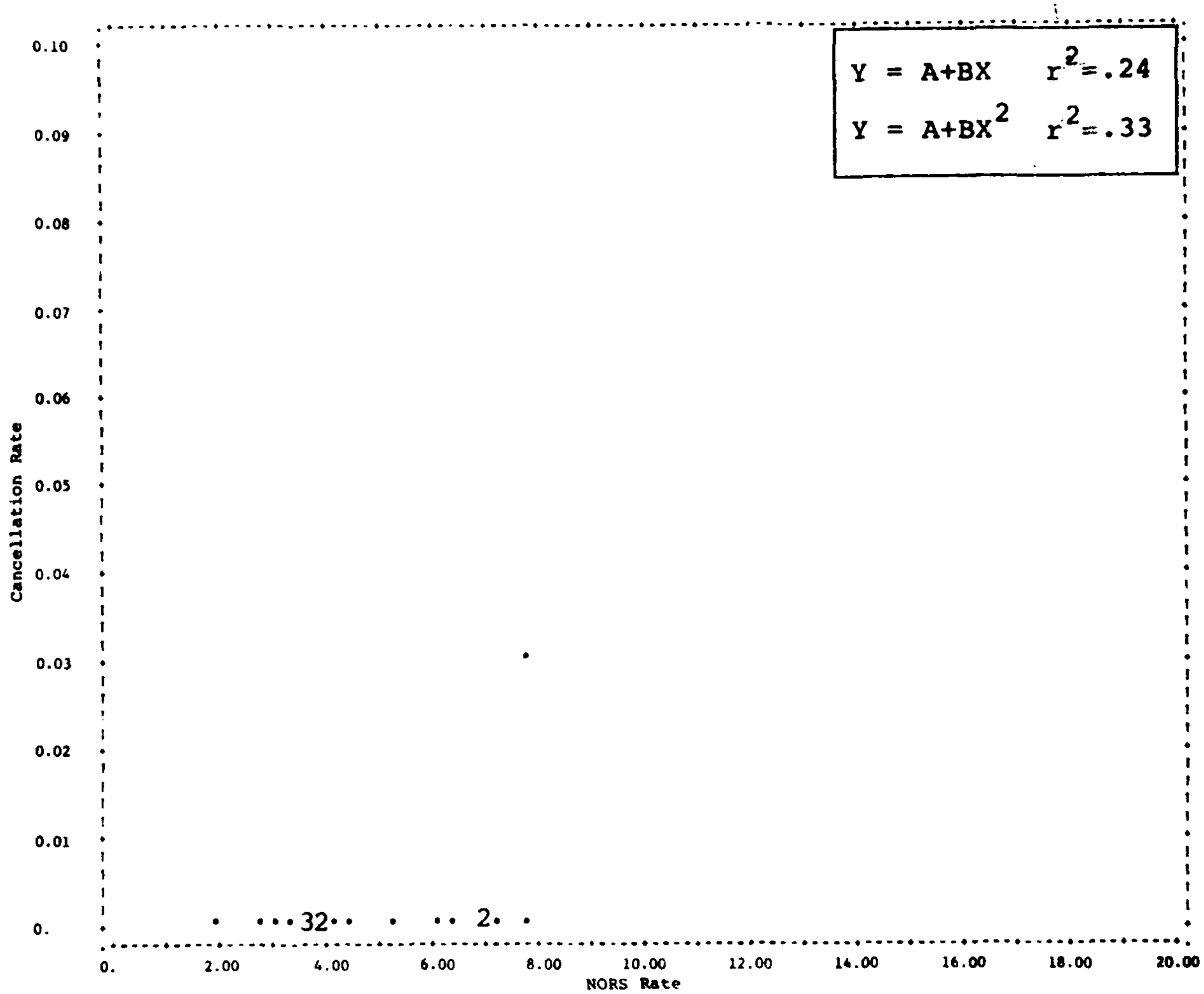

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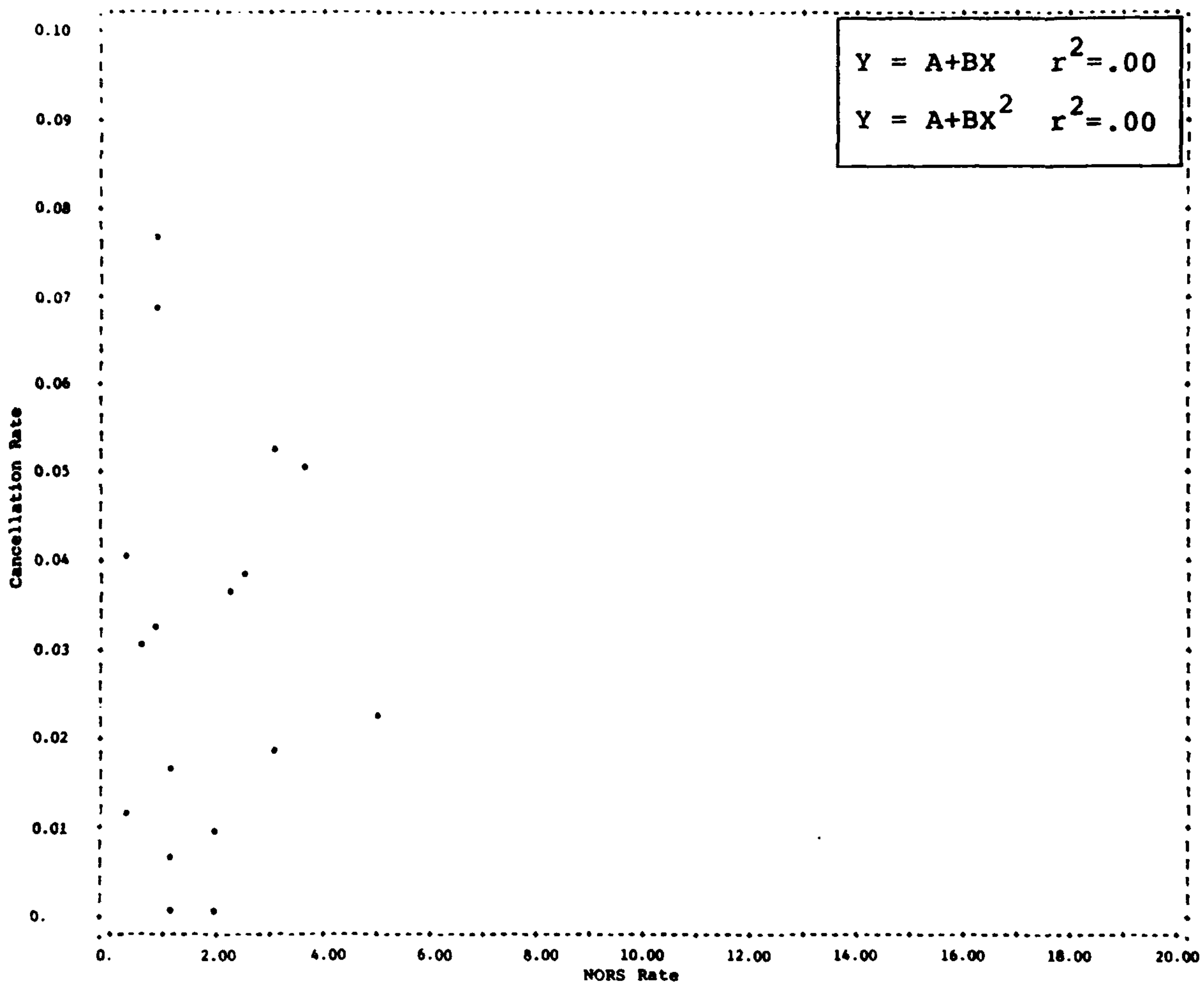

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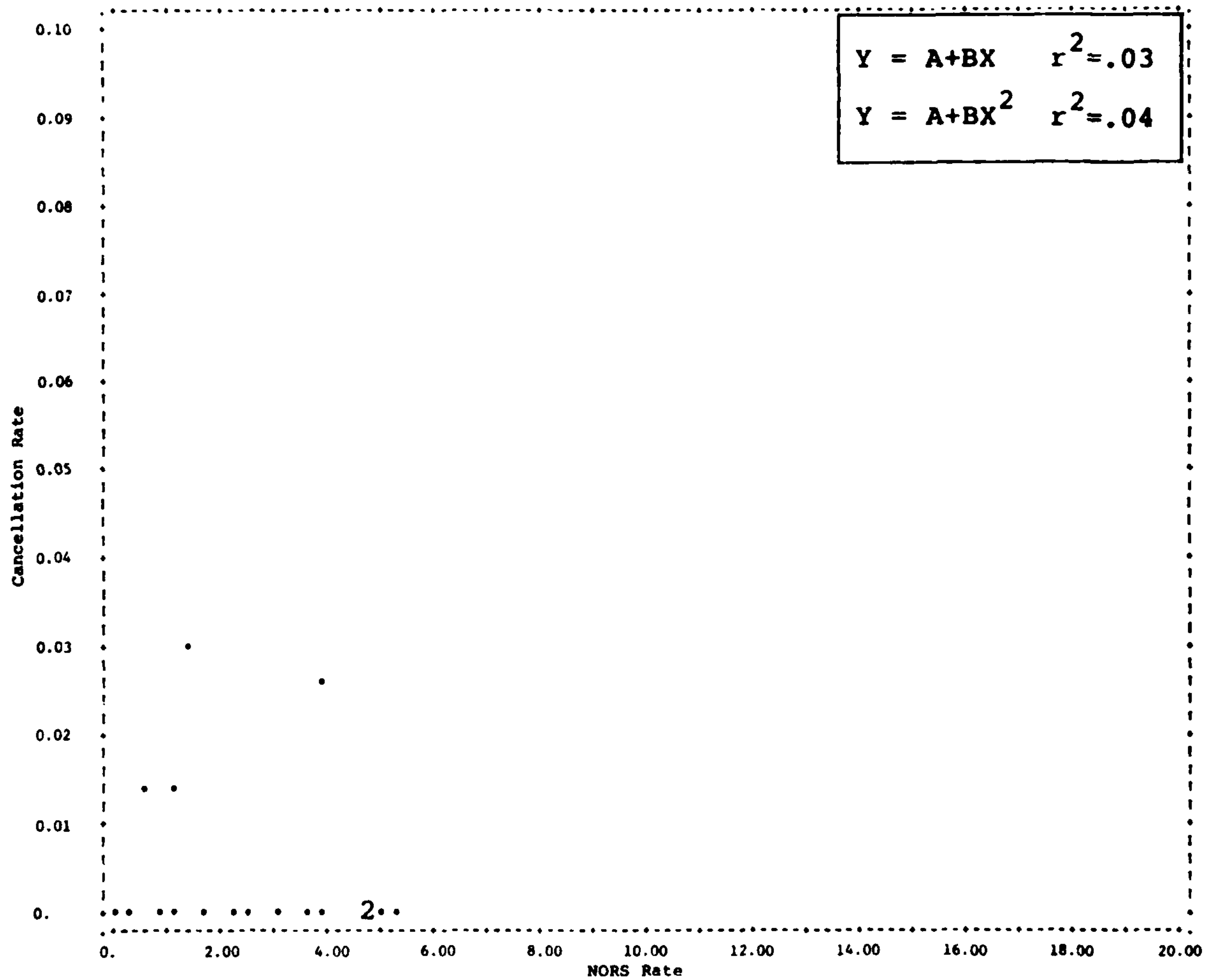

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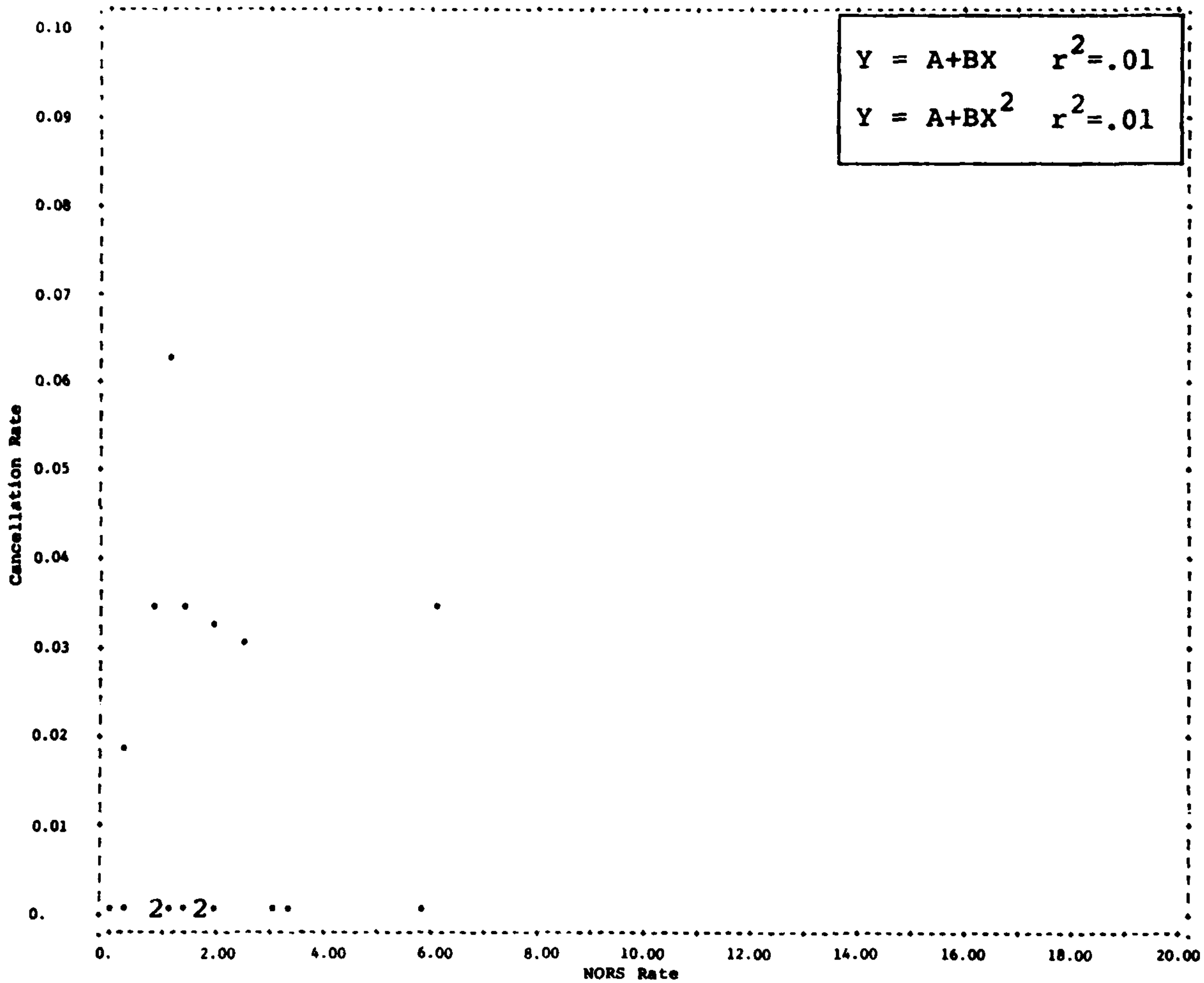

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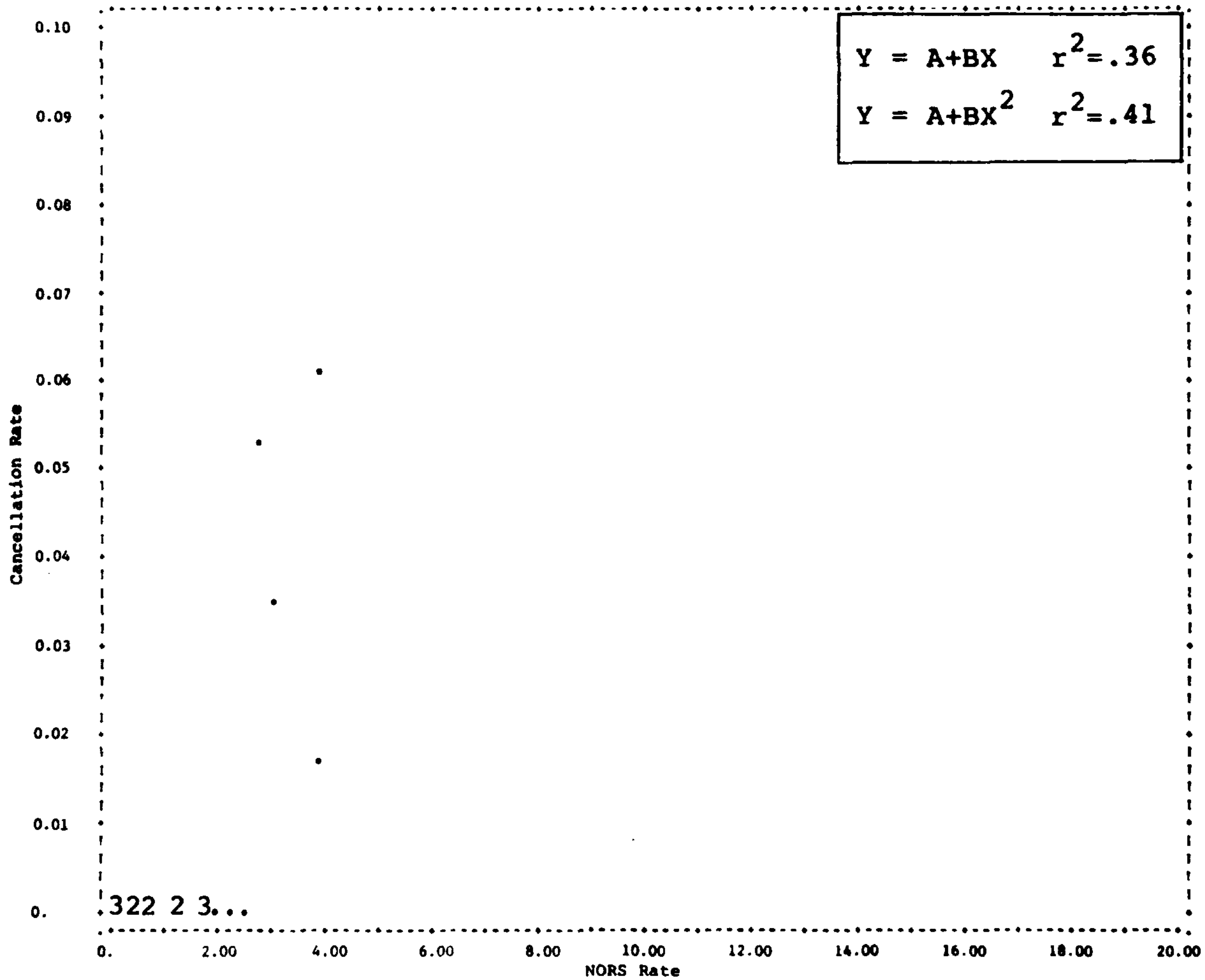

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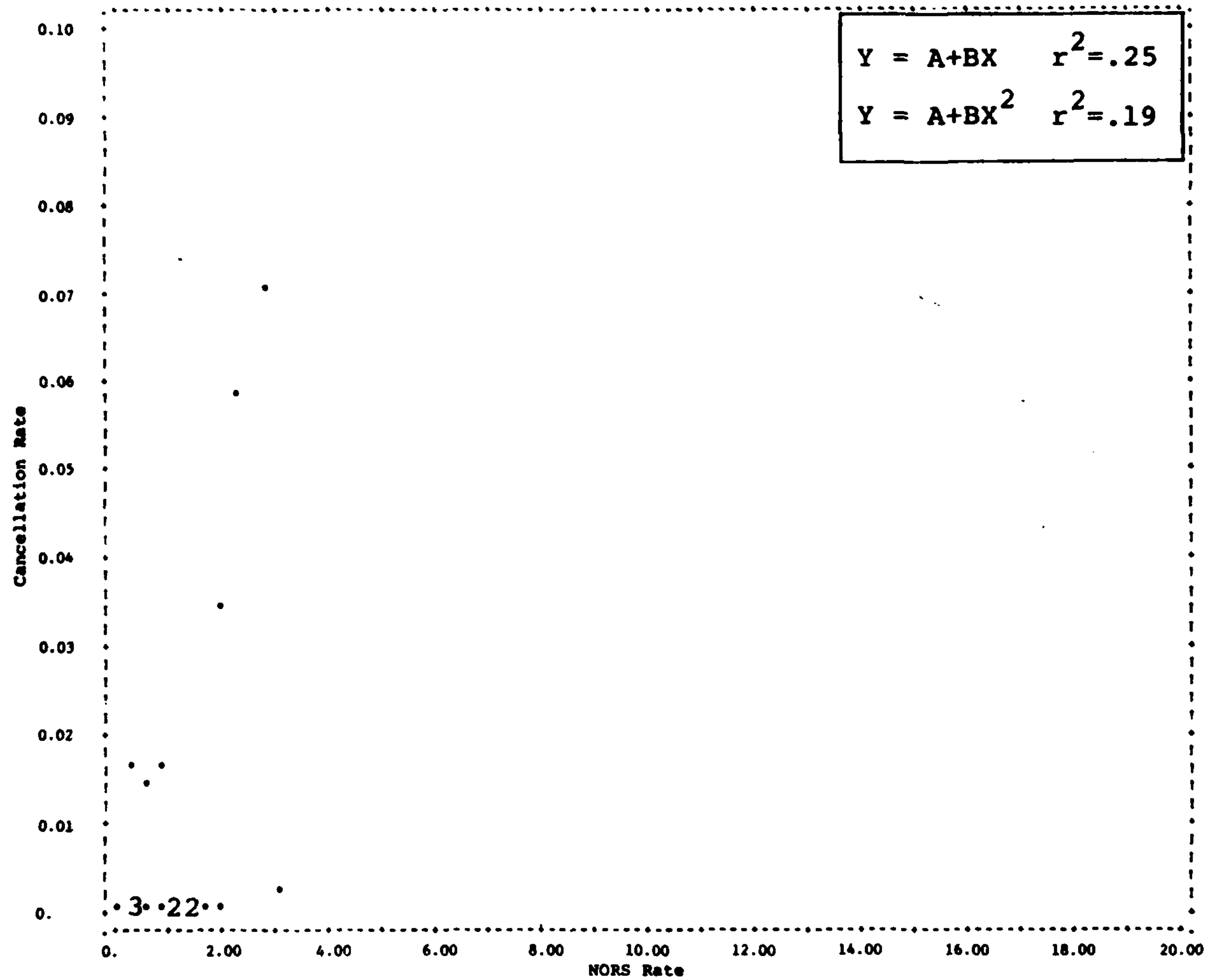

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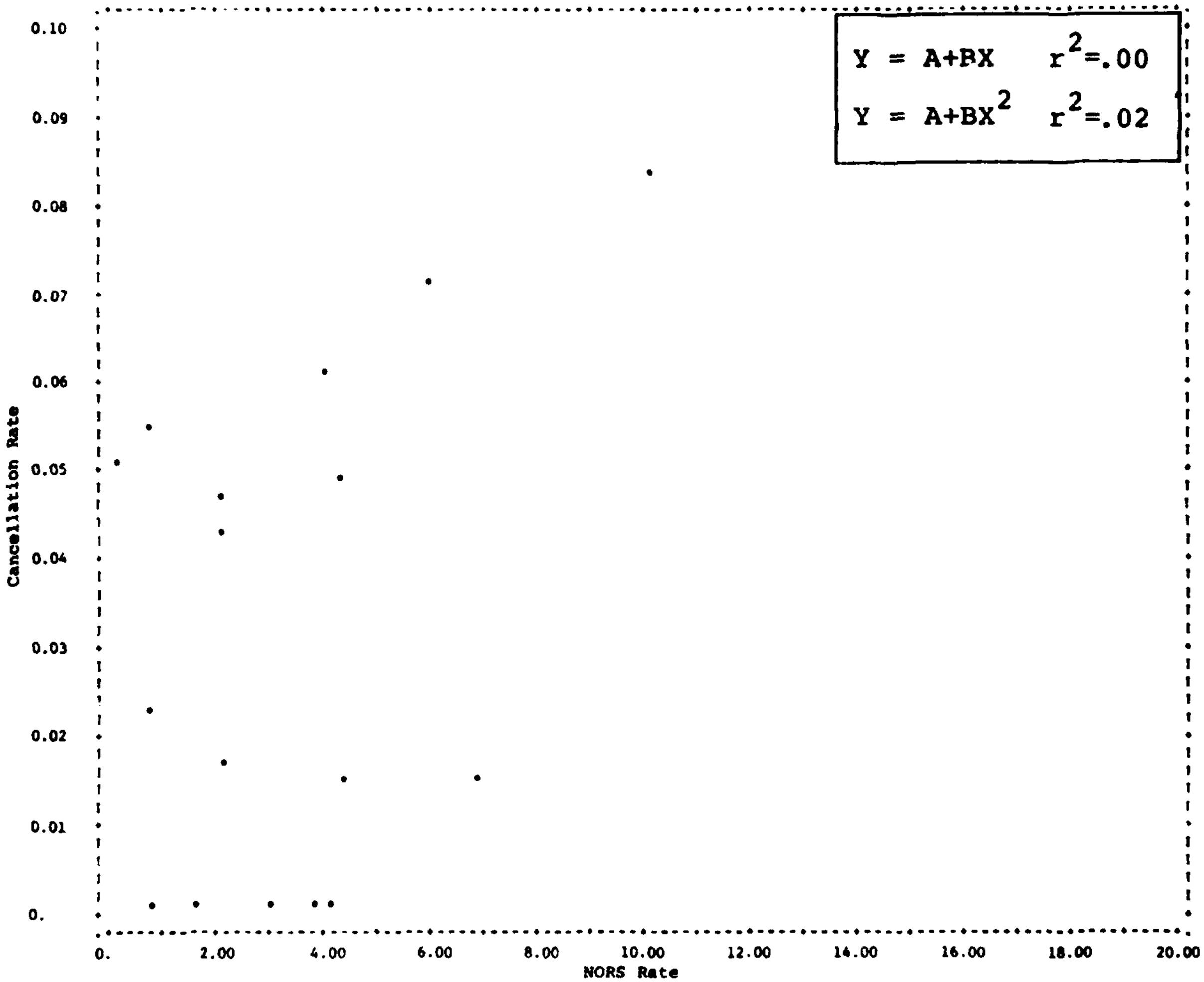

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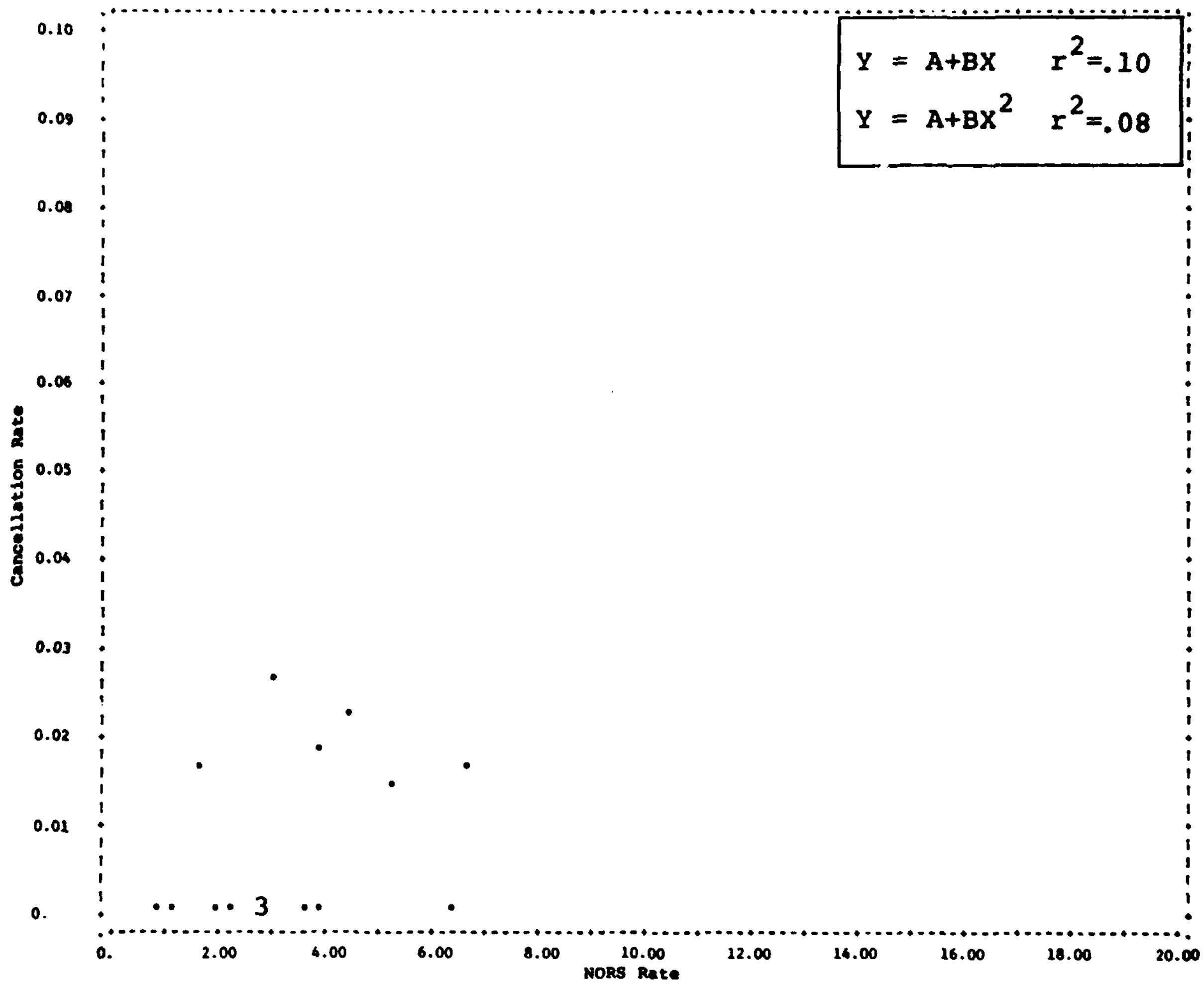

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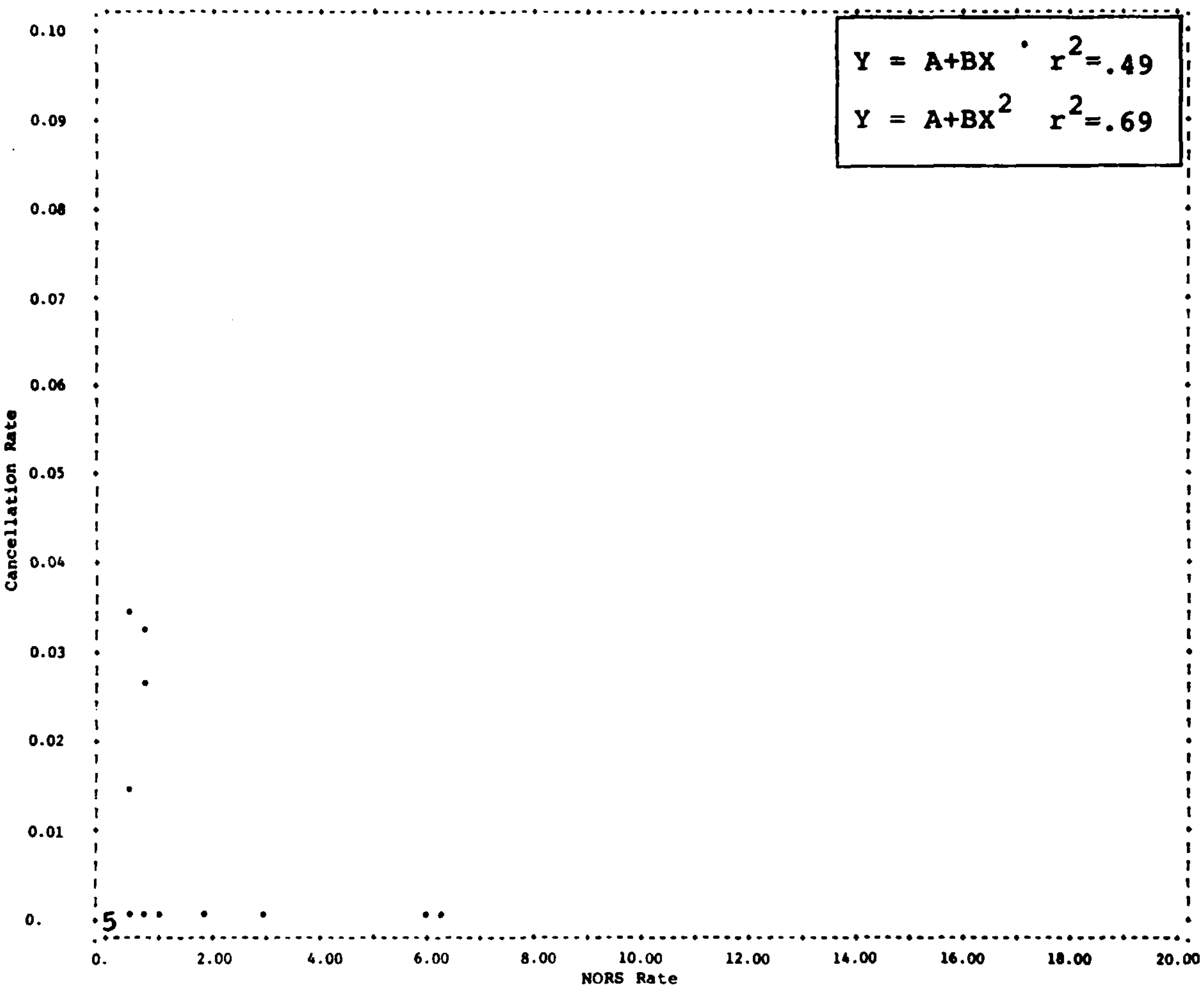

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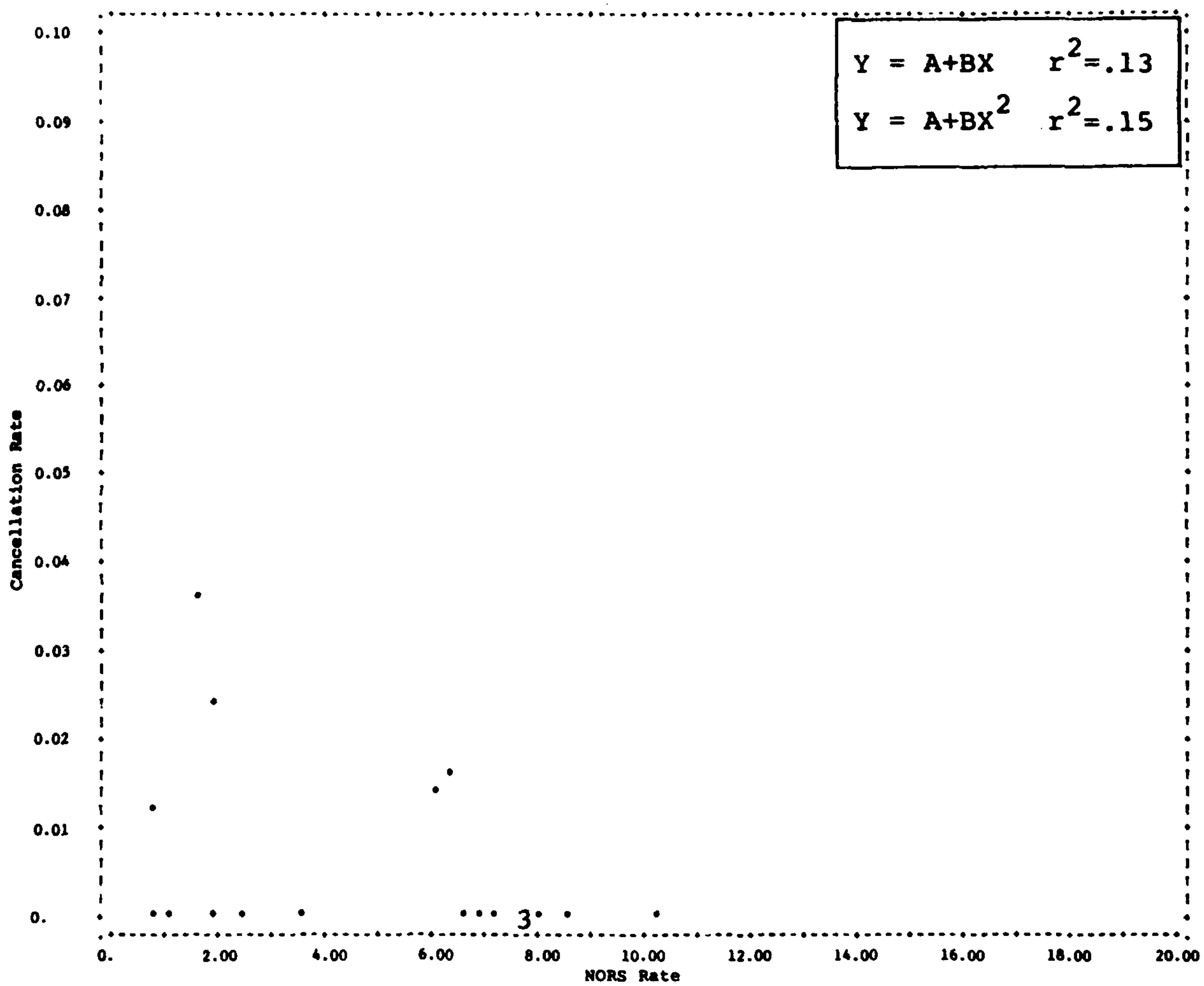

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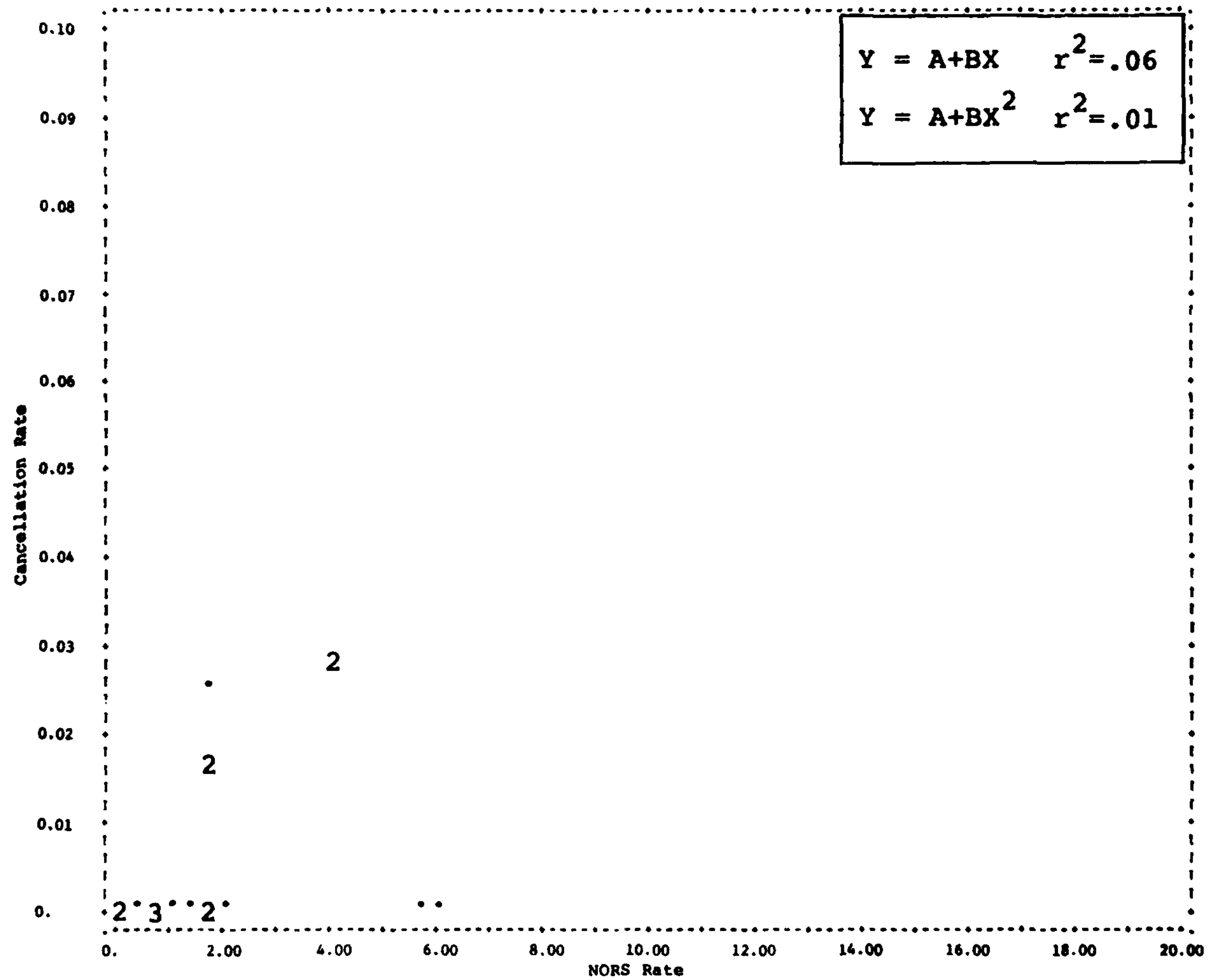

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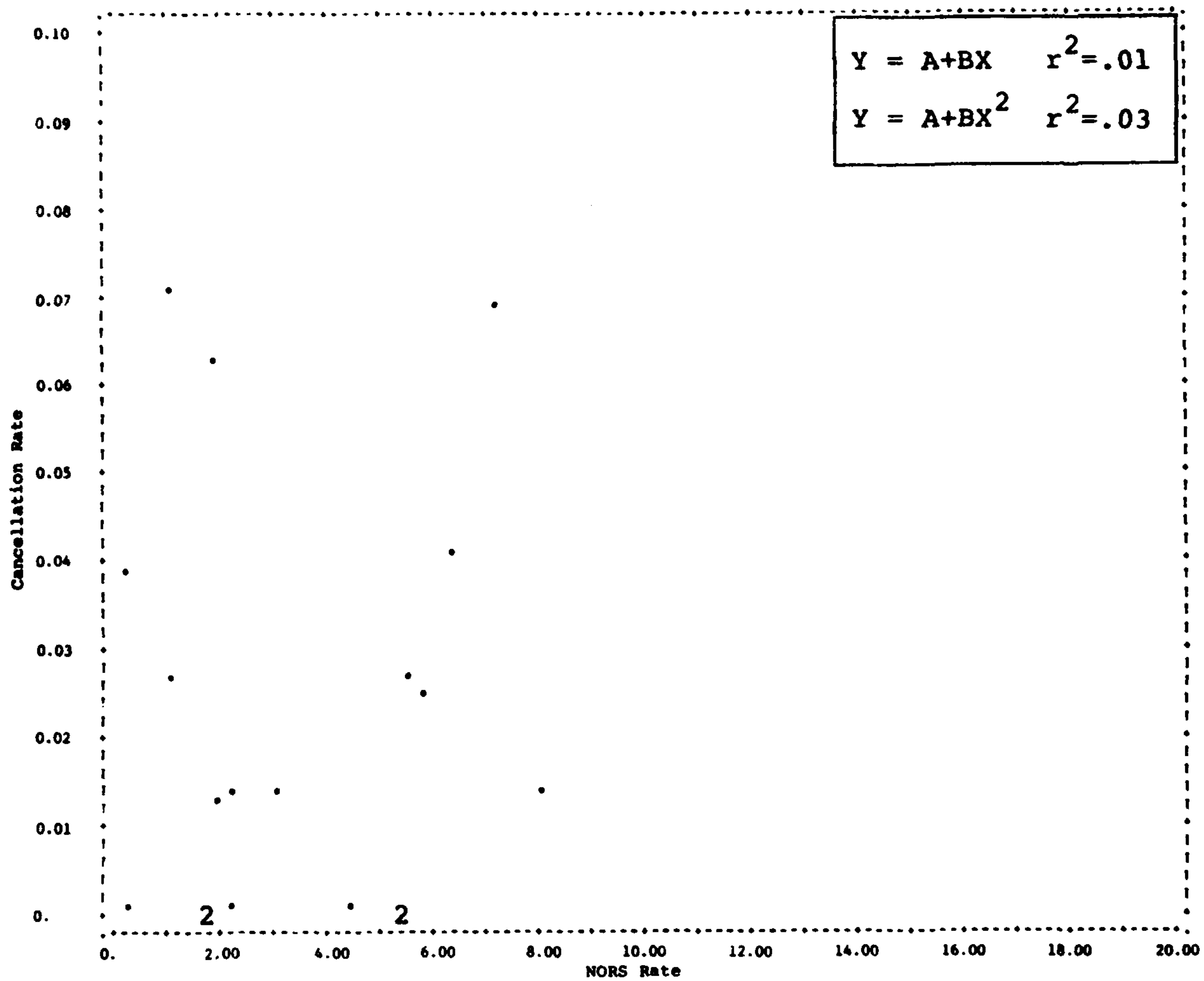

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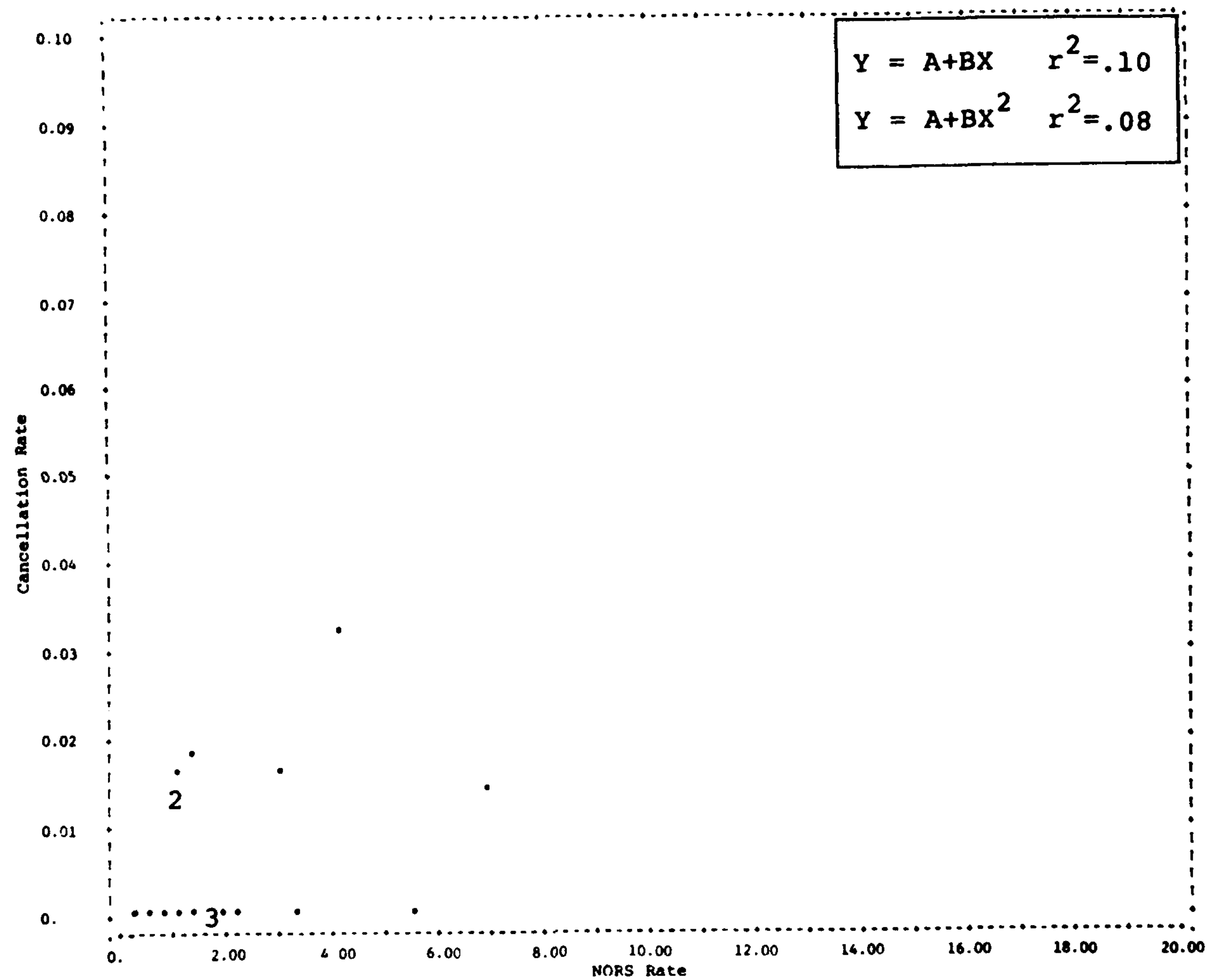

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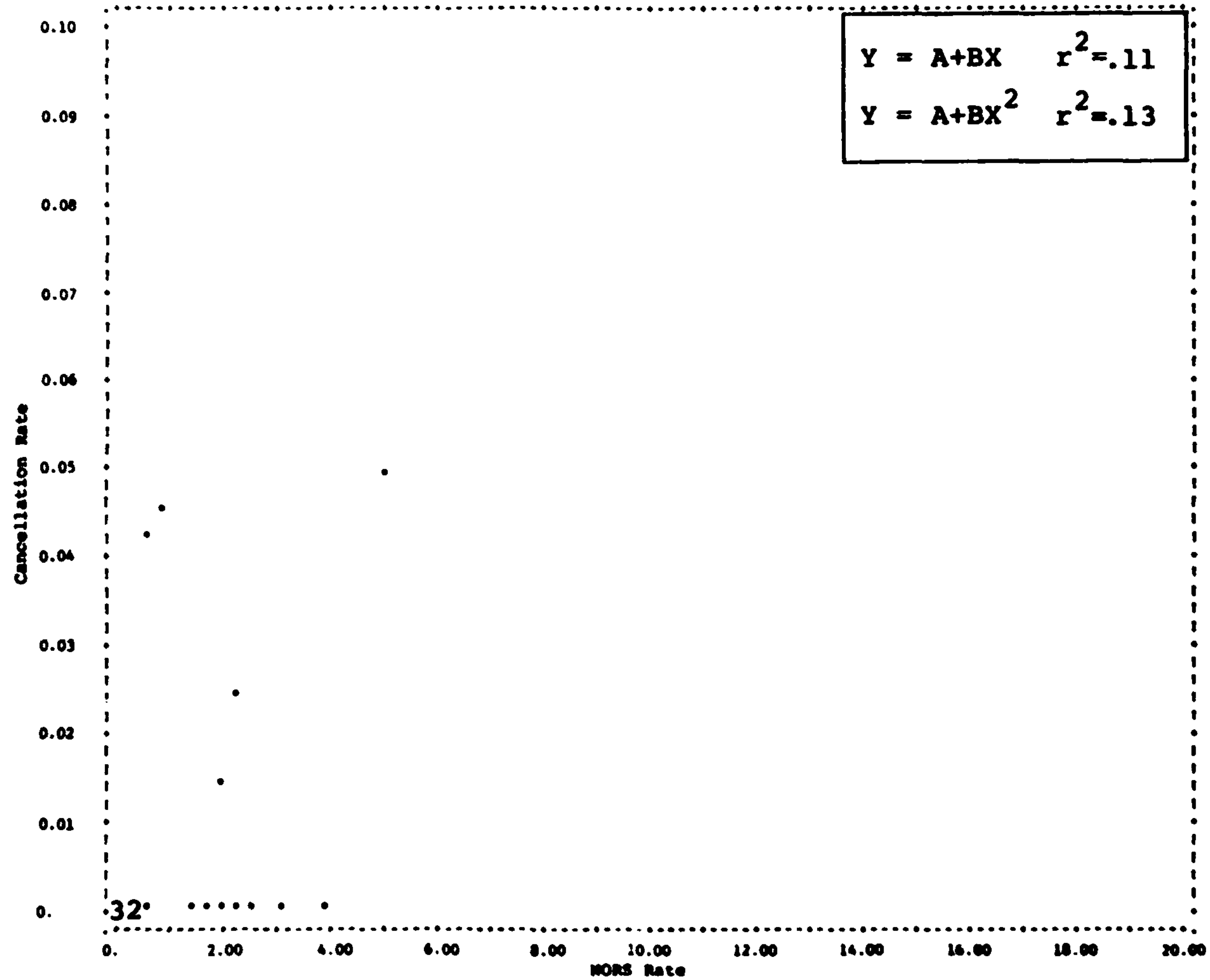

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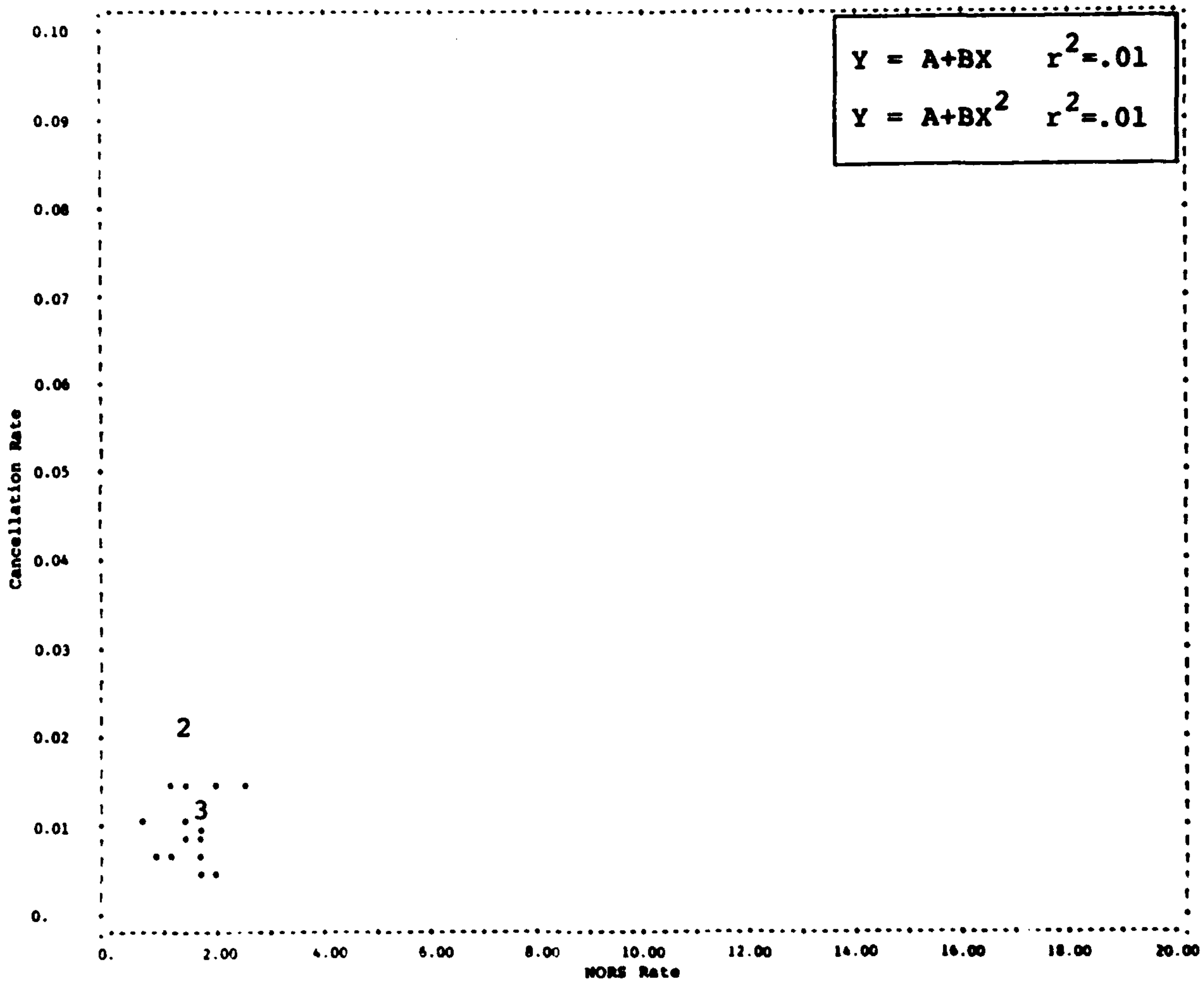

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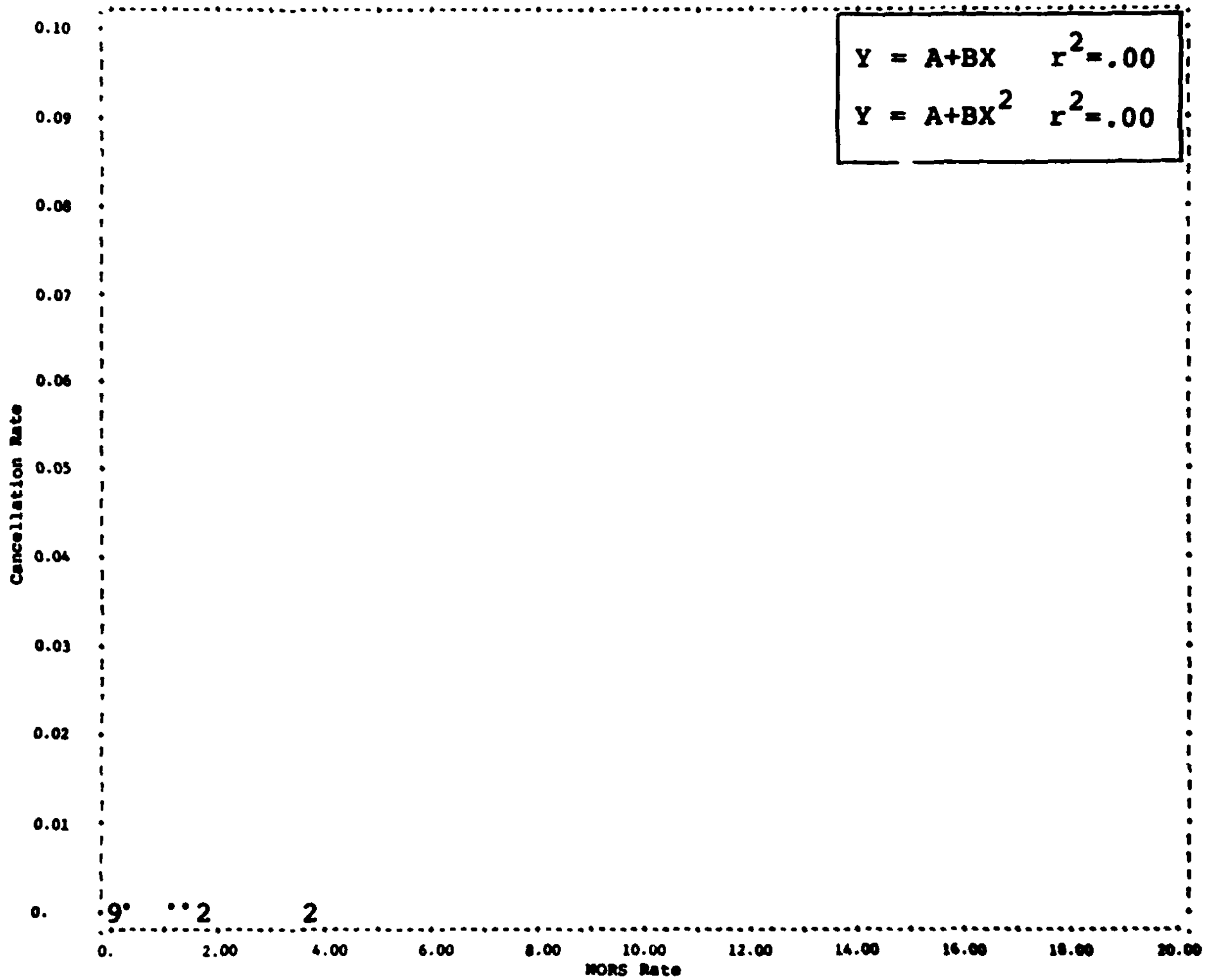
APPENDIX B

C-135 SCATTERGRAMS (ALL MODELS)



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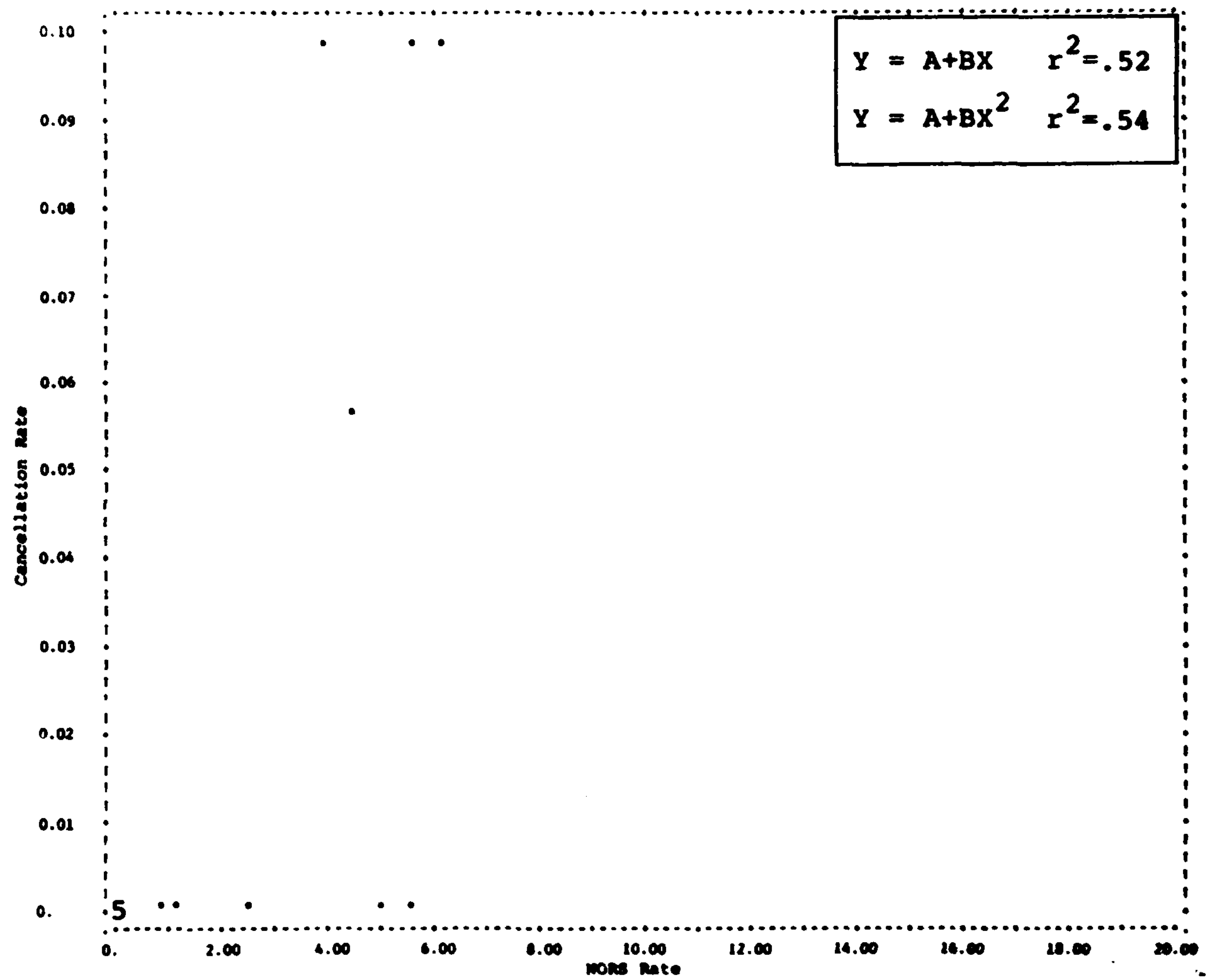

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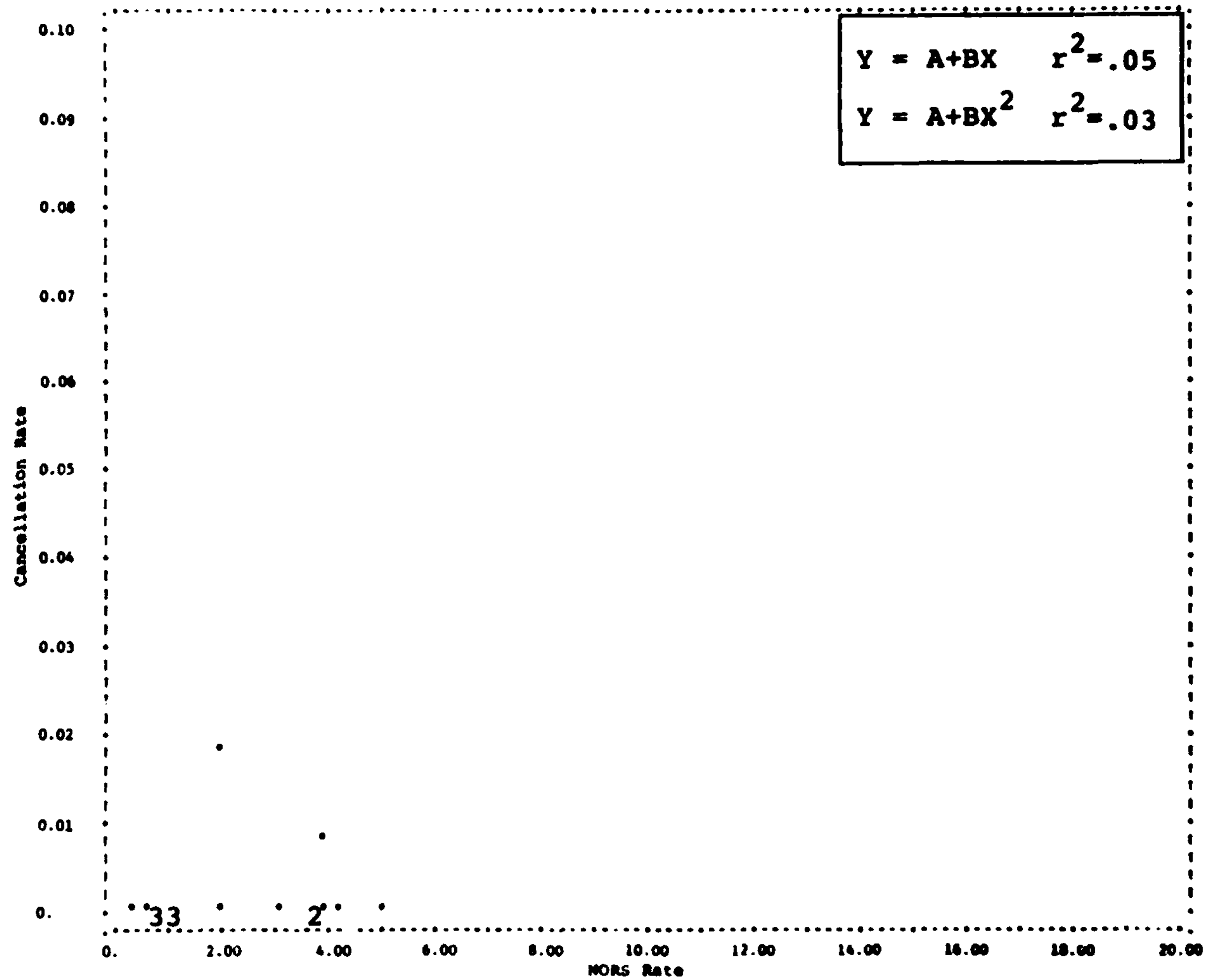

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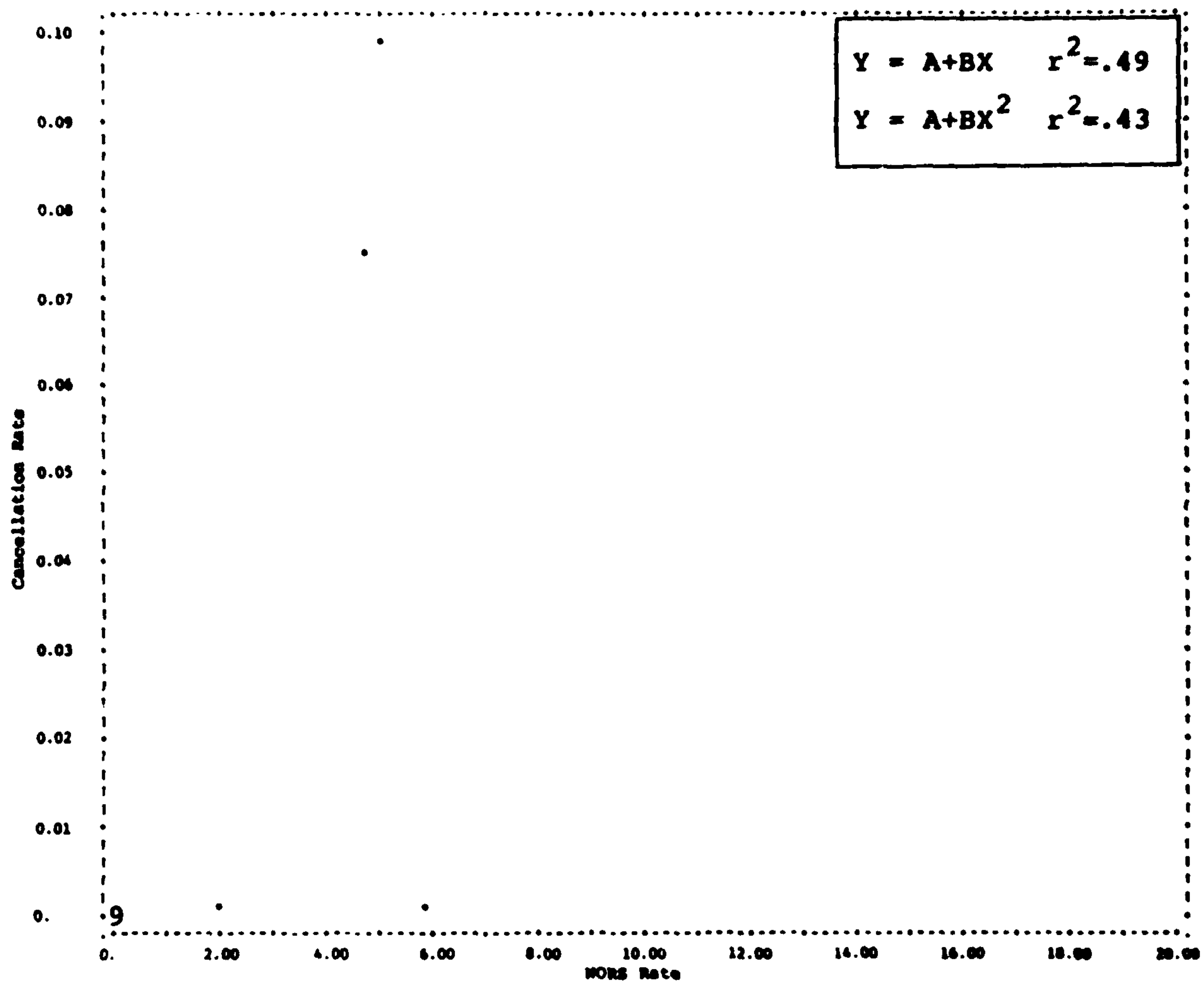

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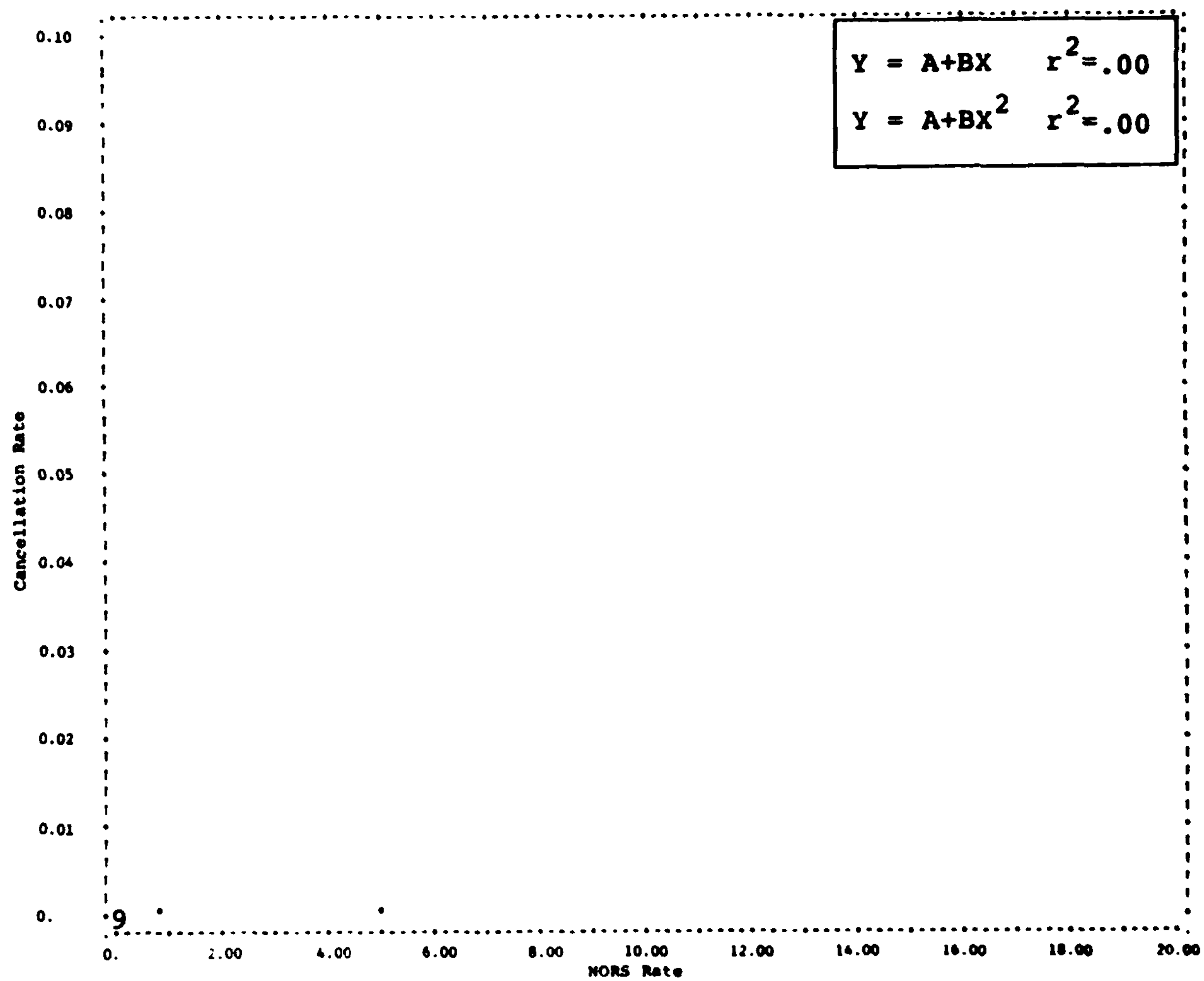

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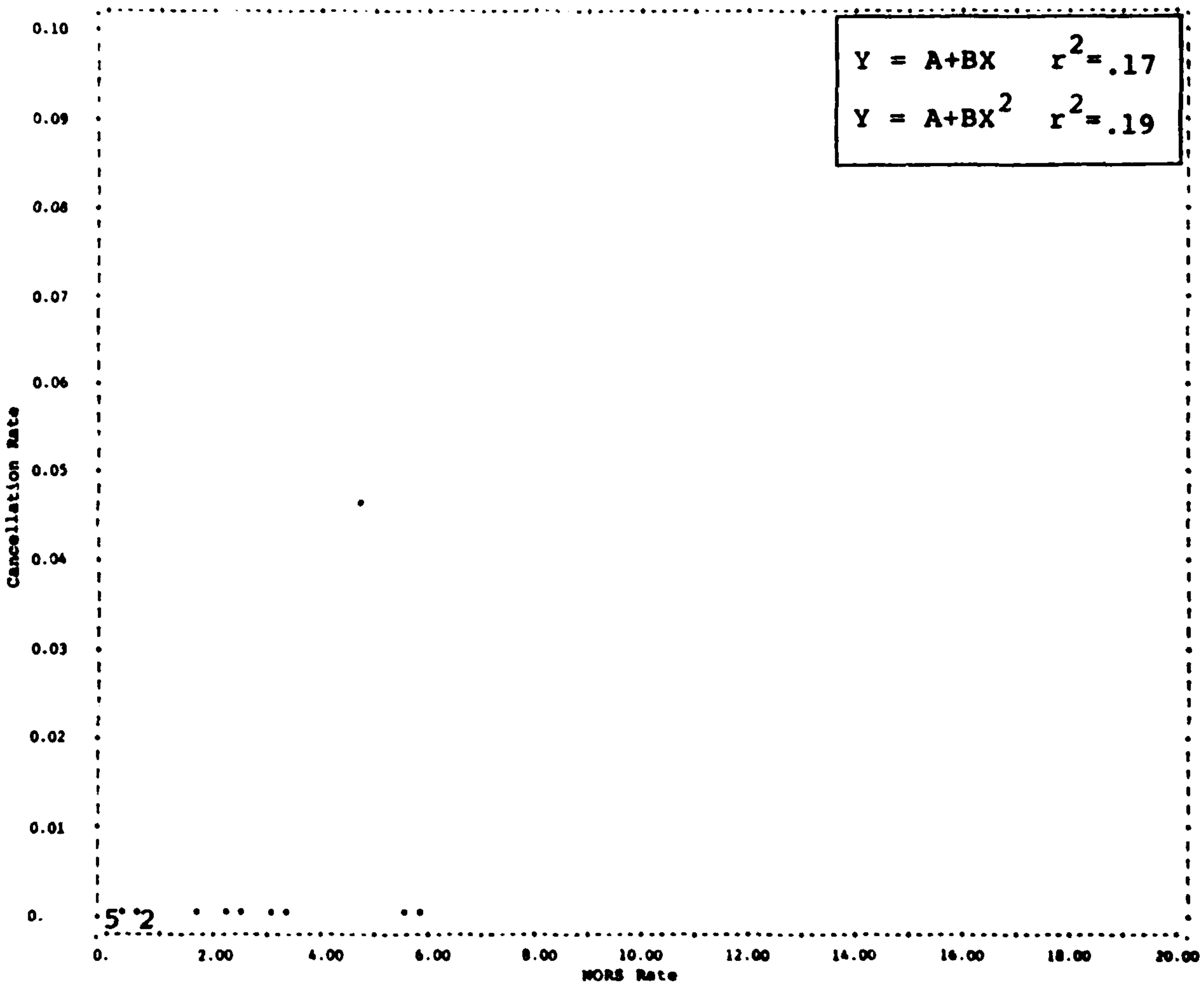

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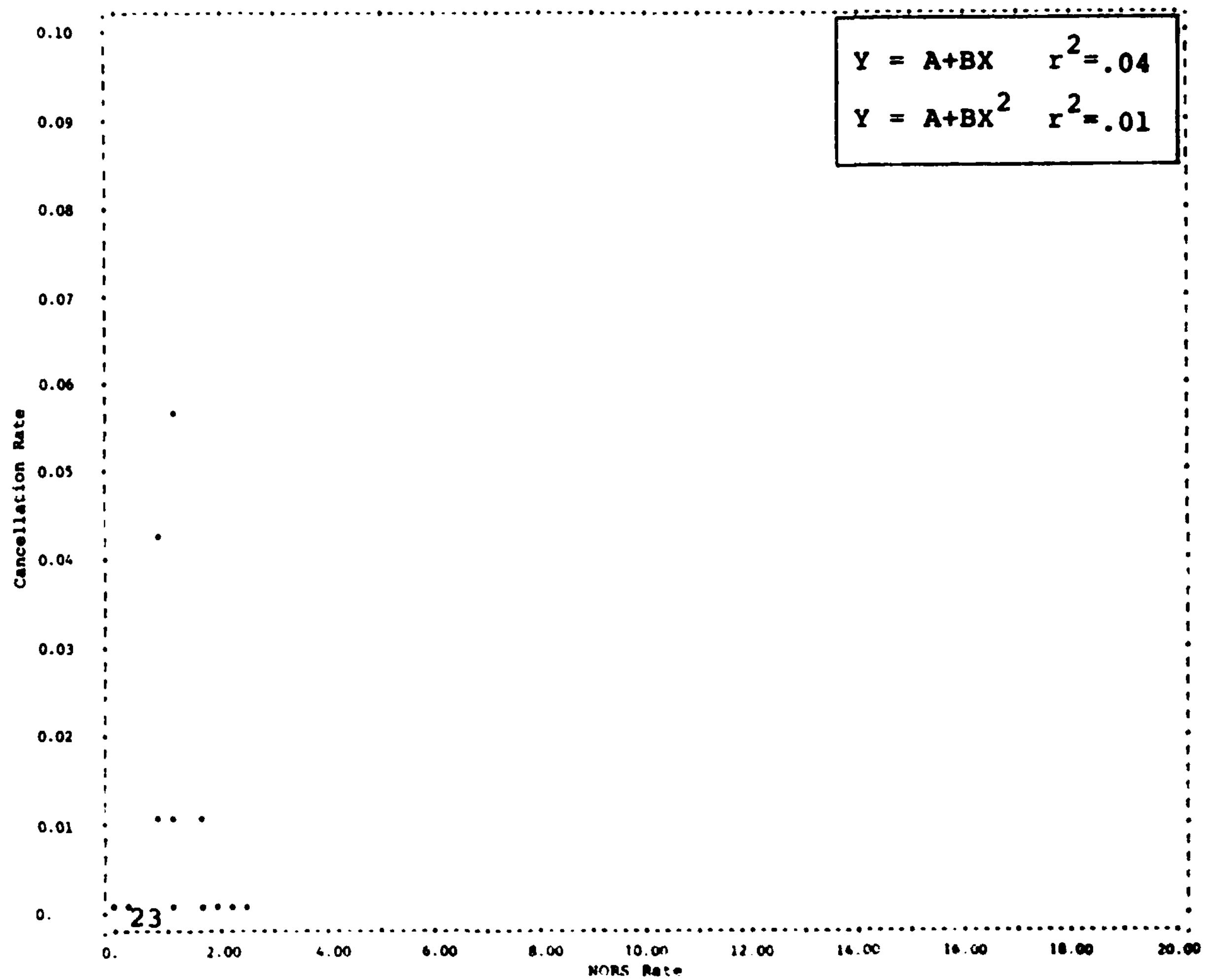

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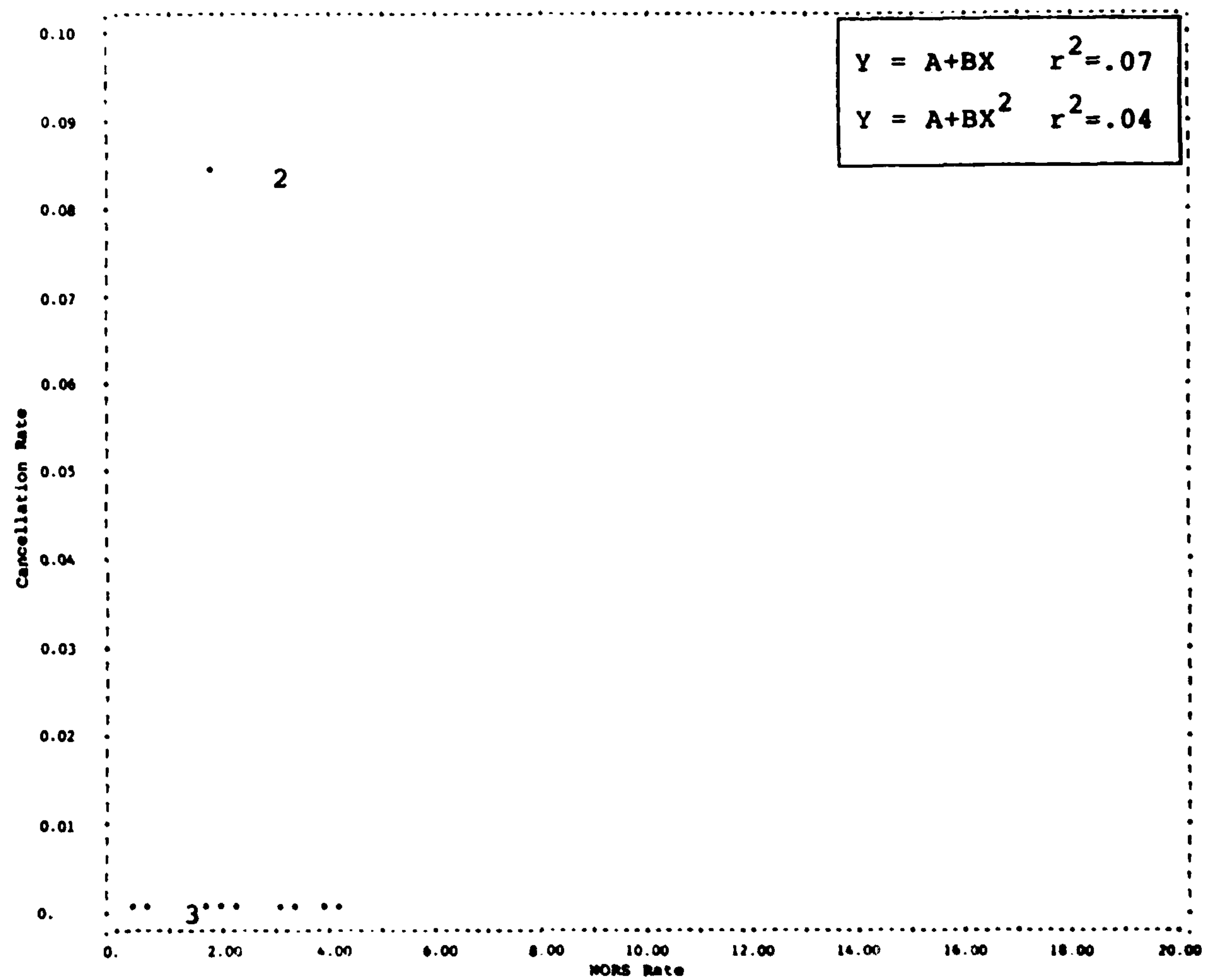

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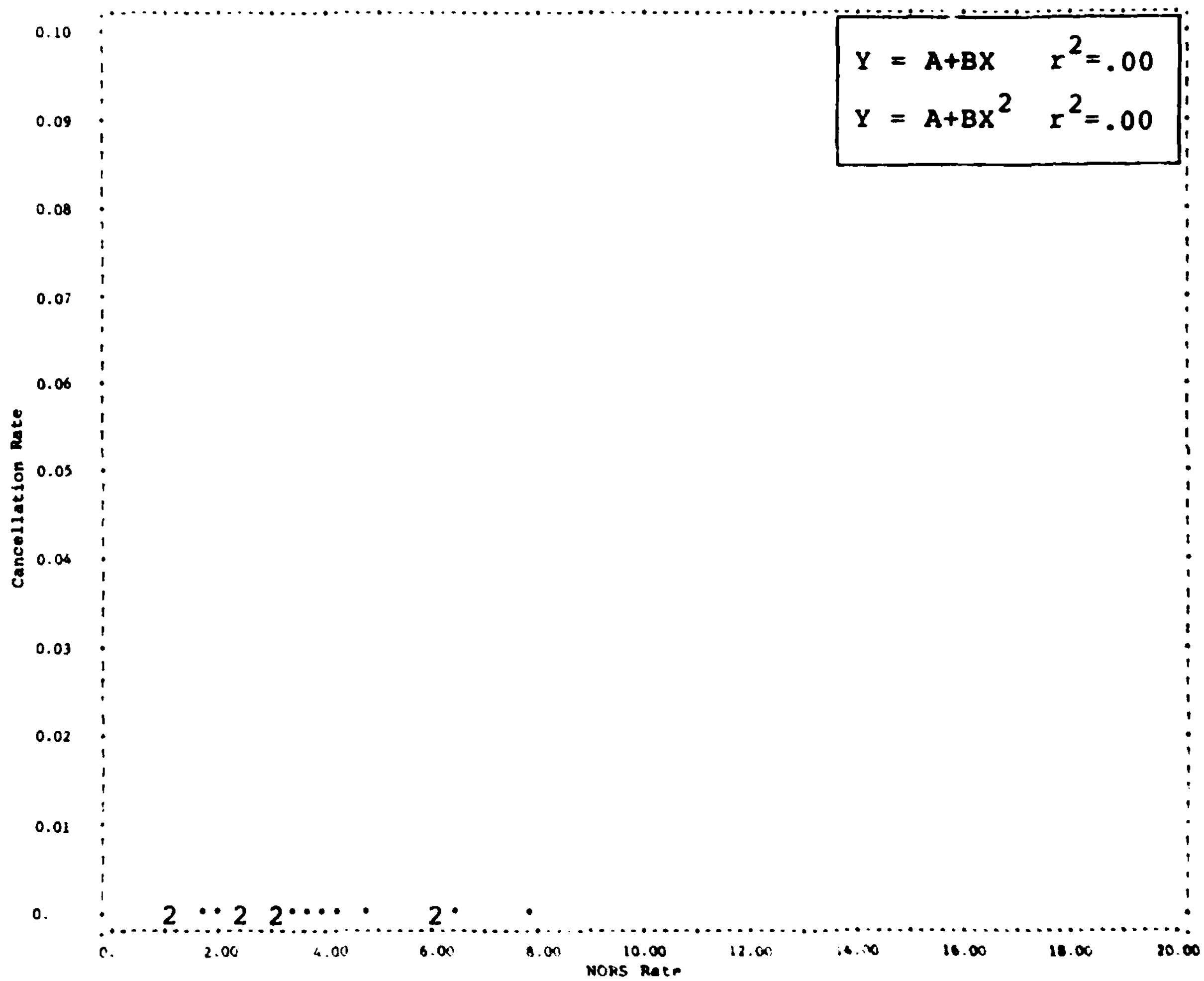

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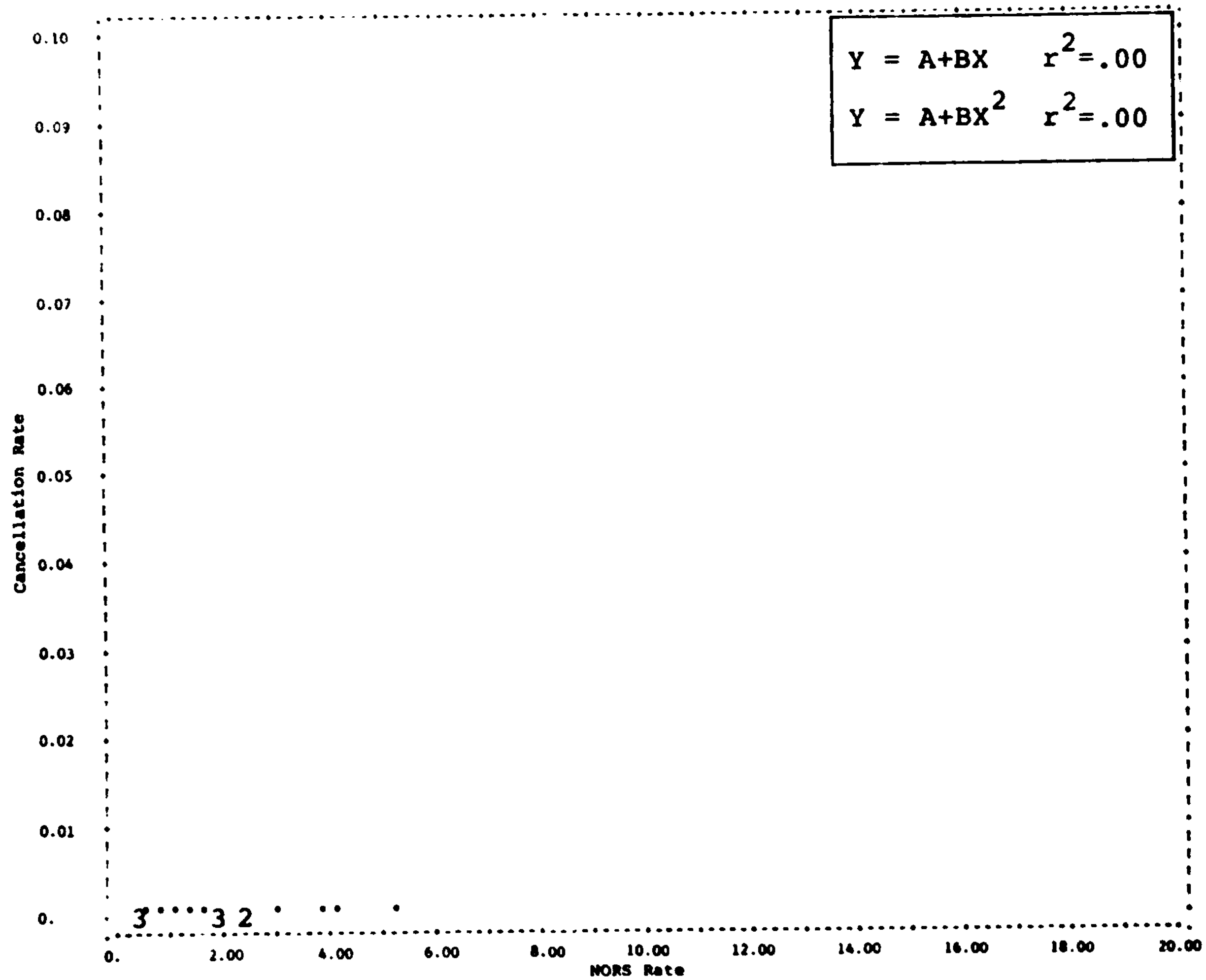

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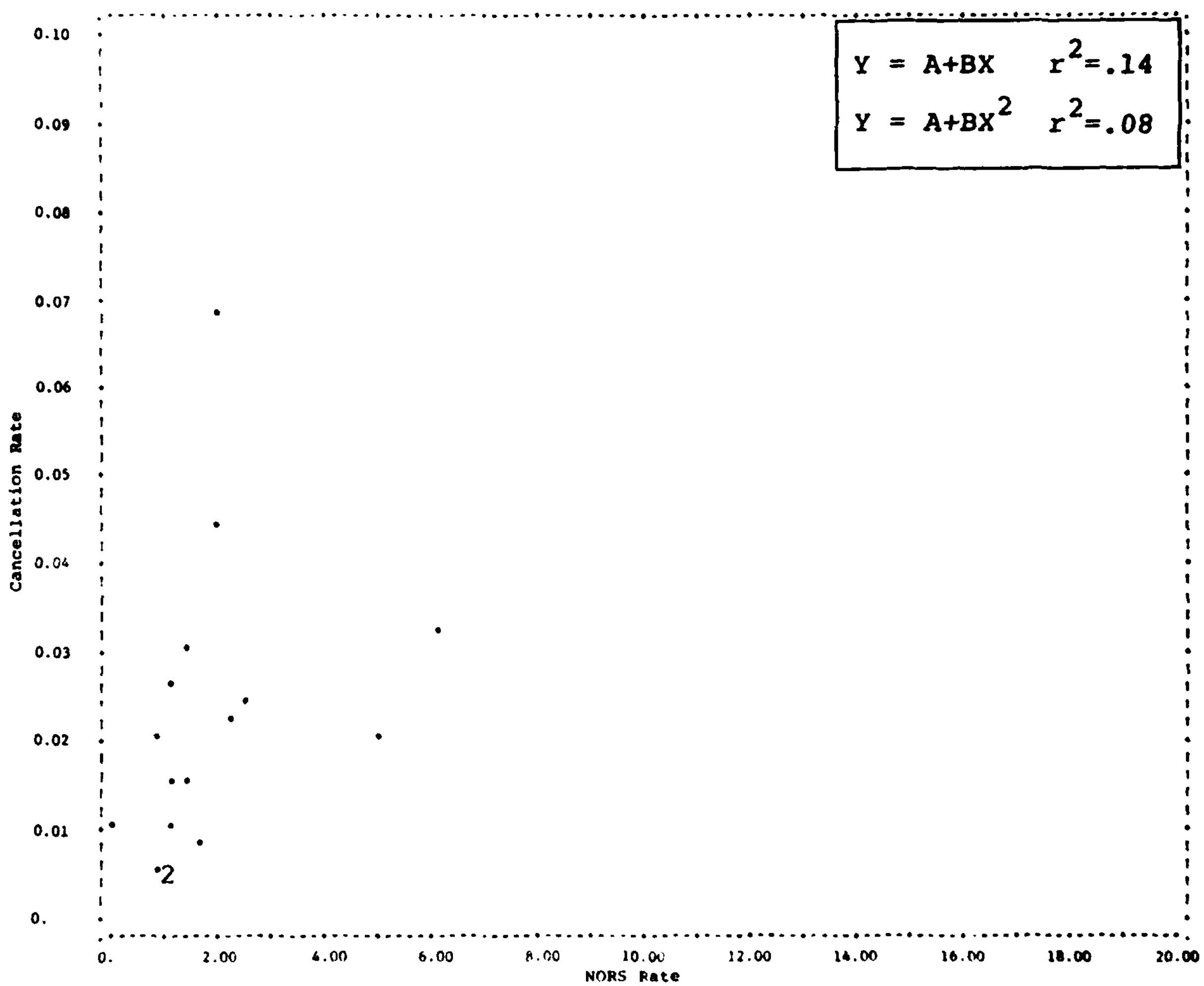

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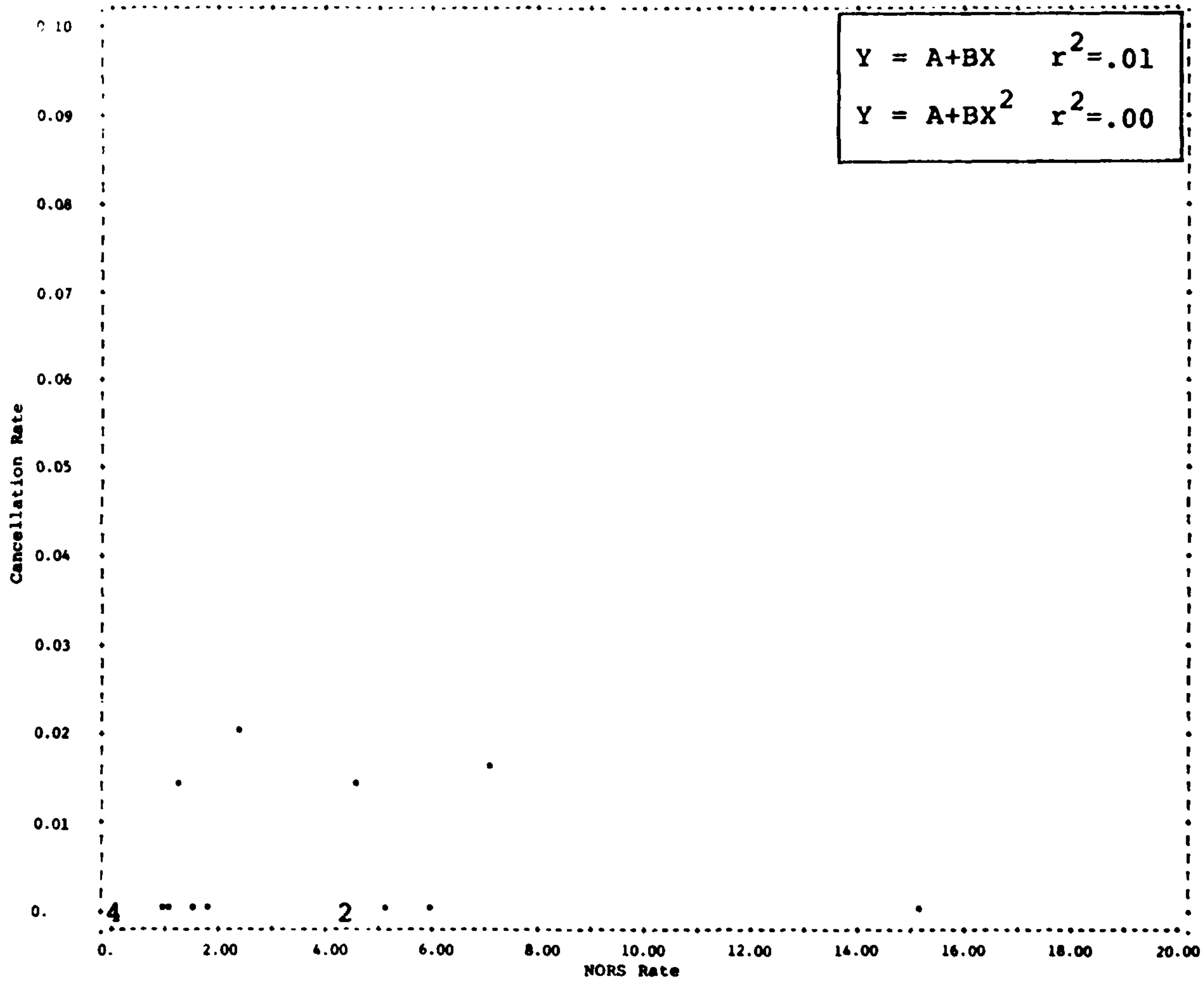

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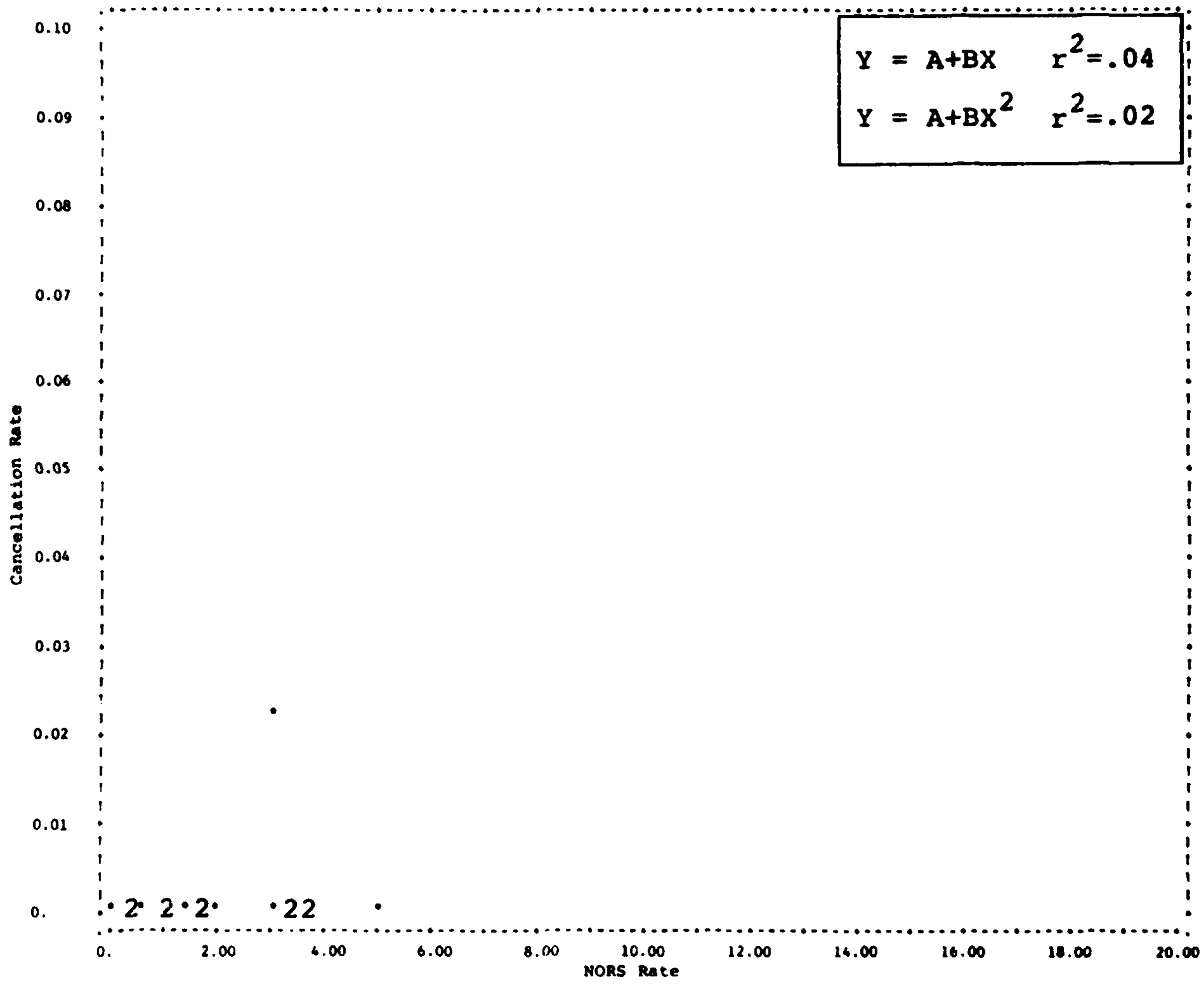

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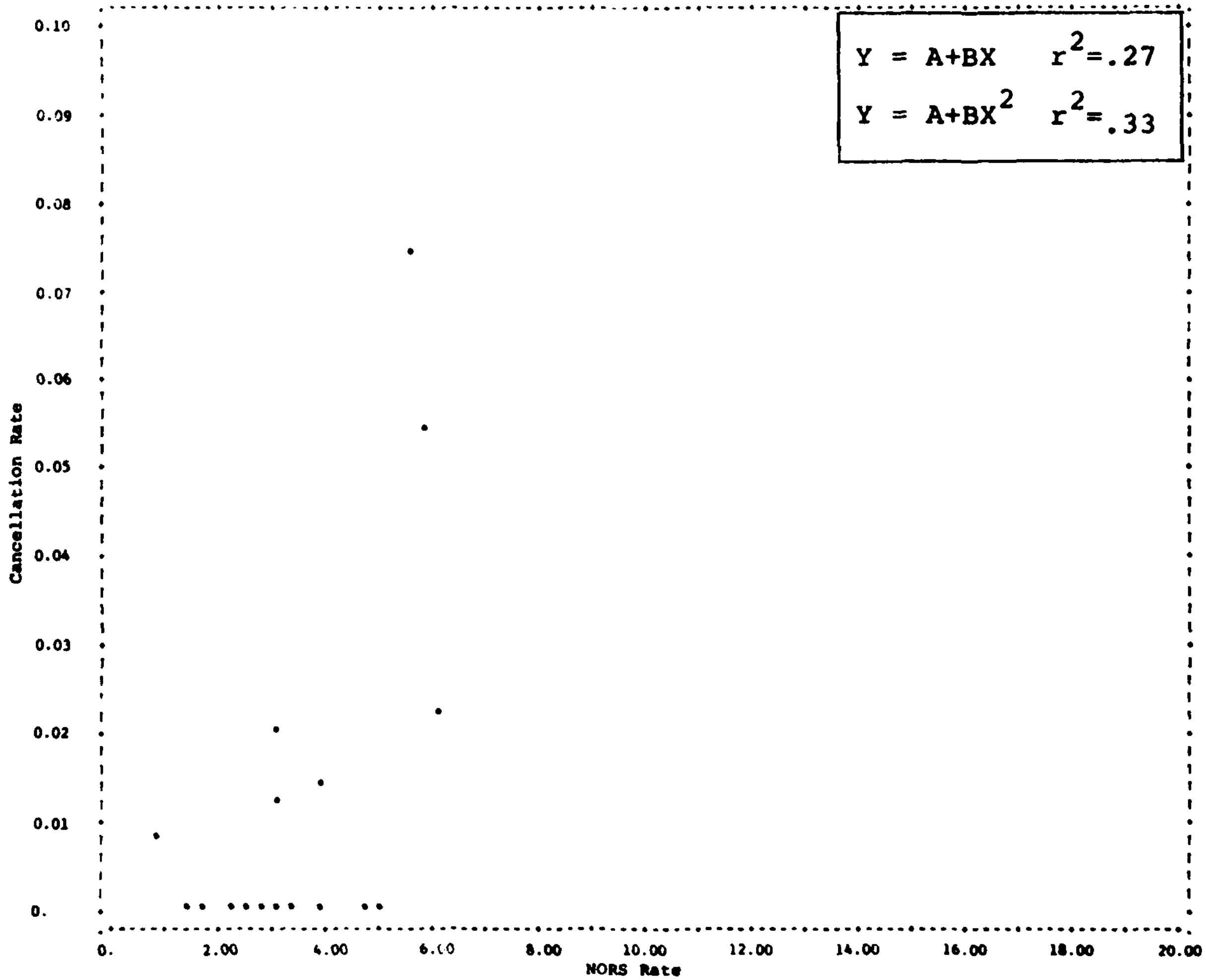

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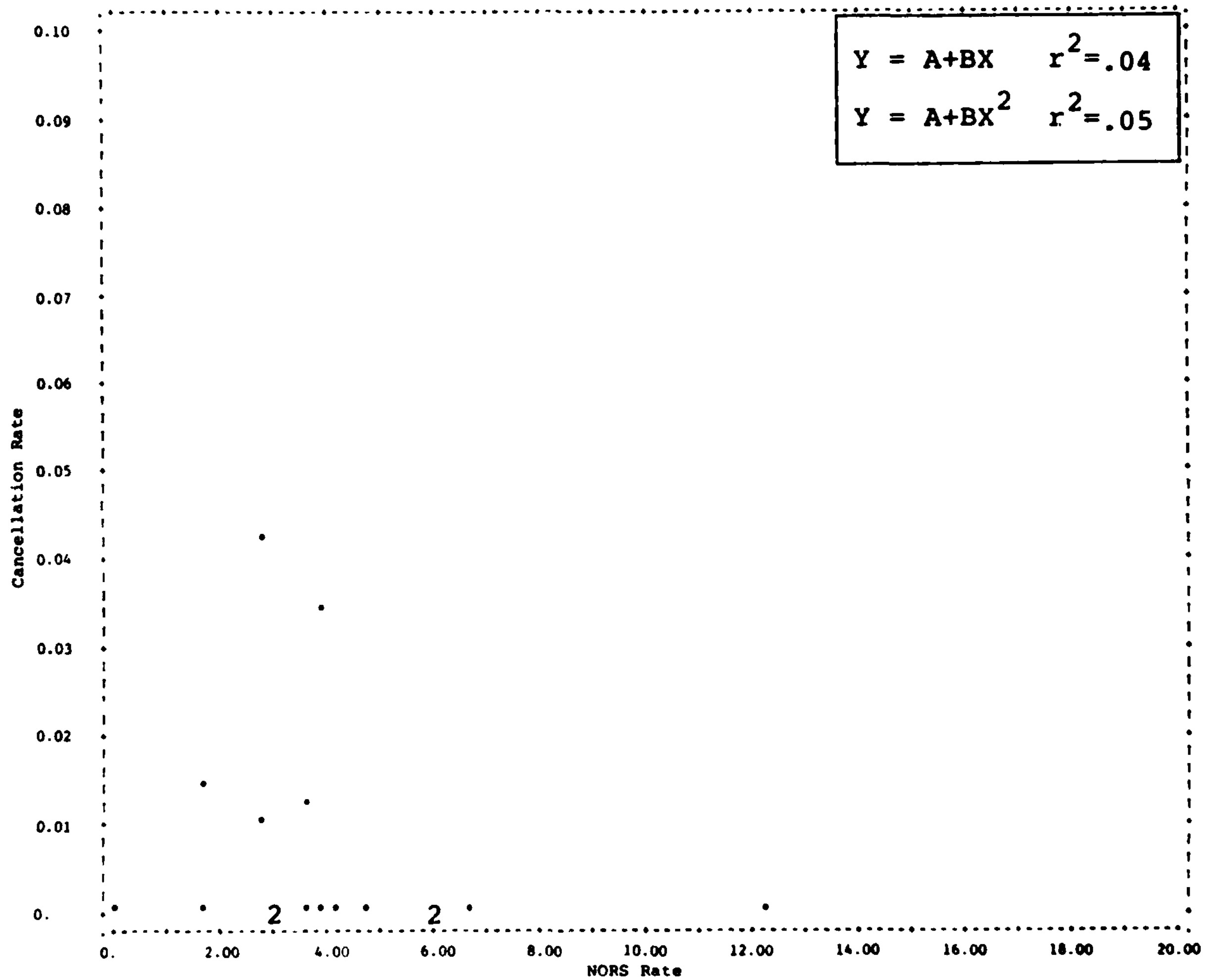

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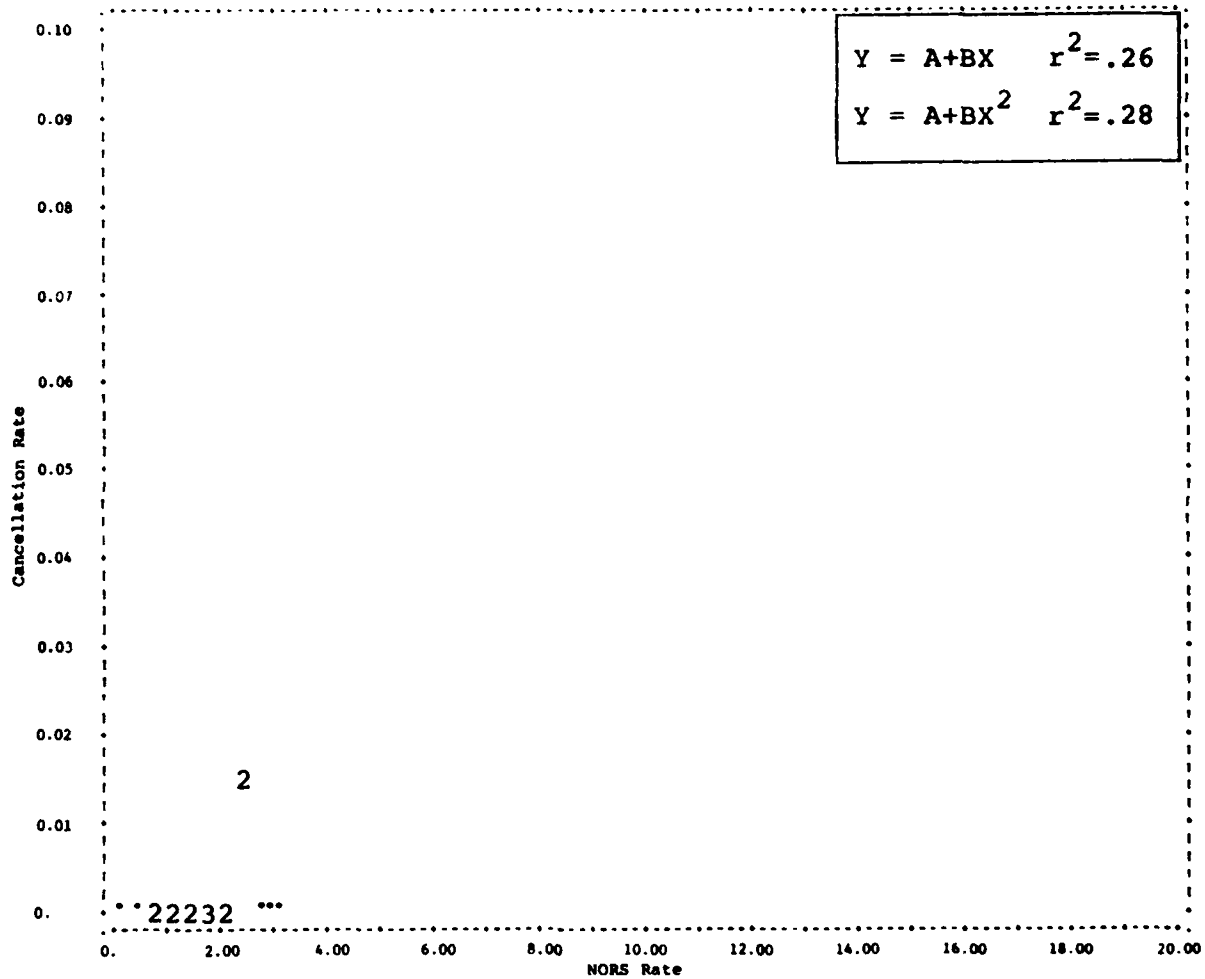

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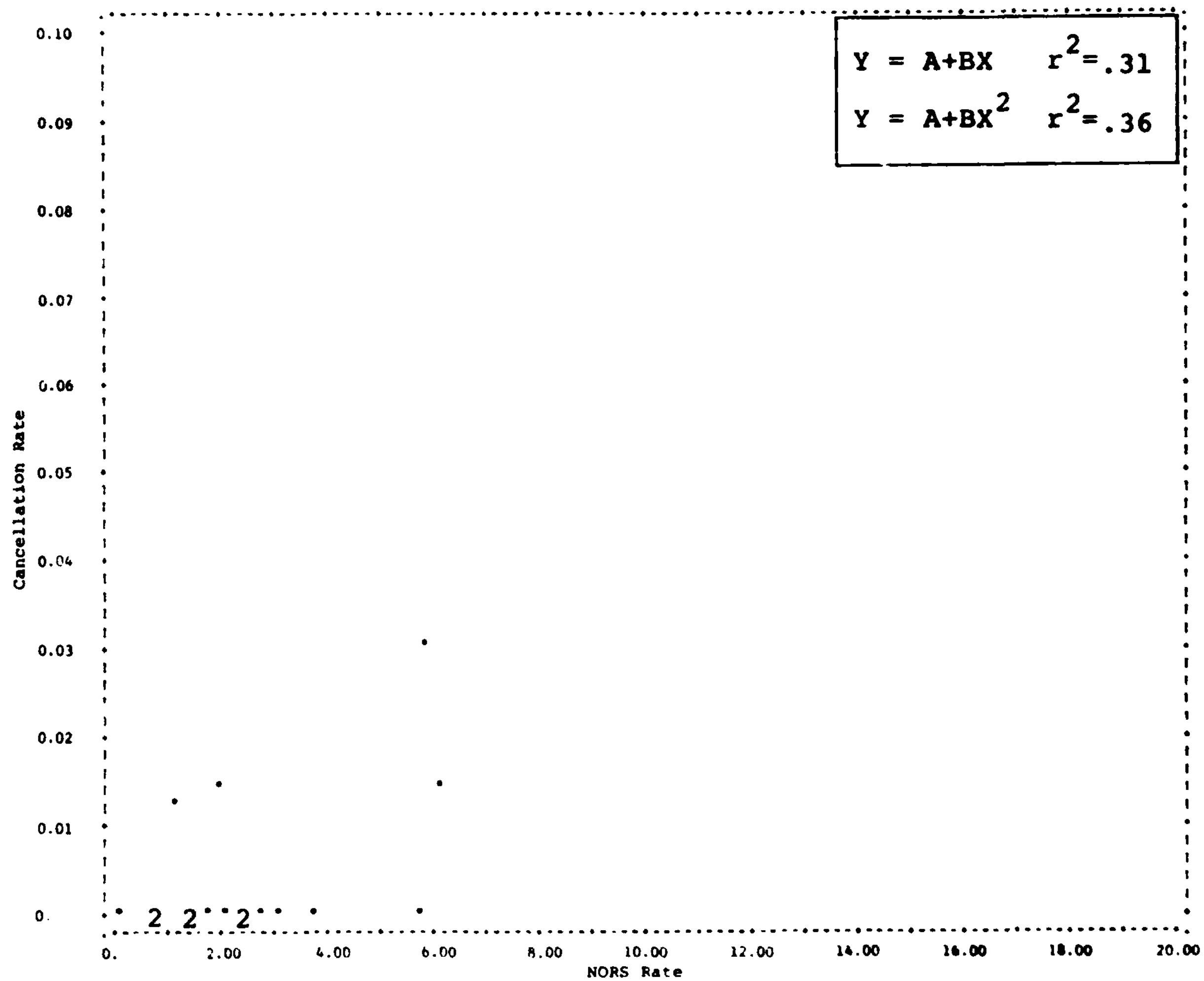

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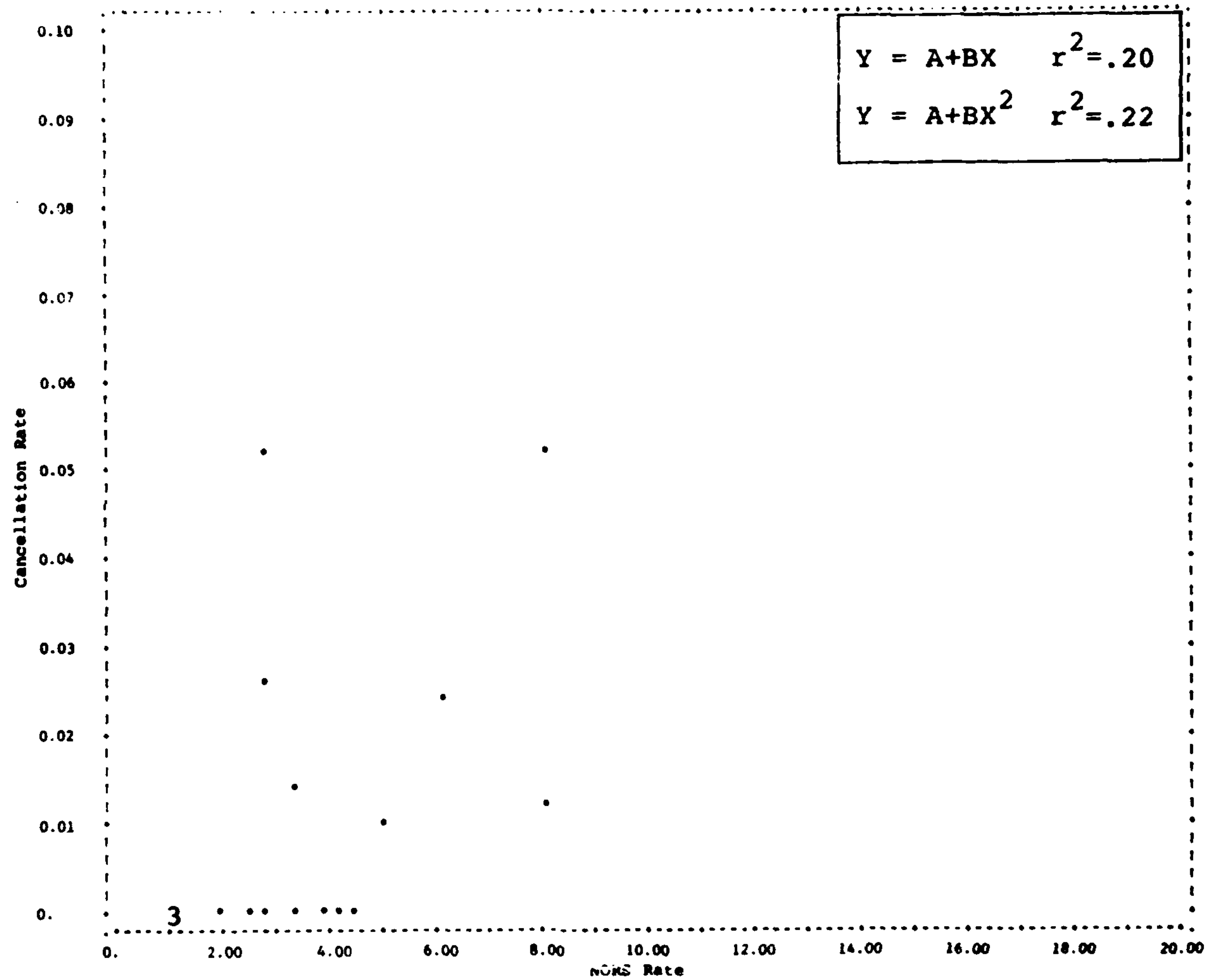

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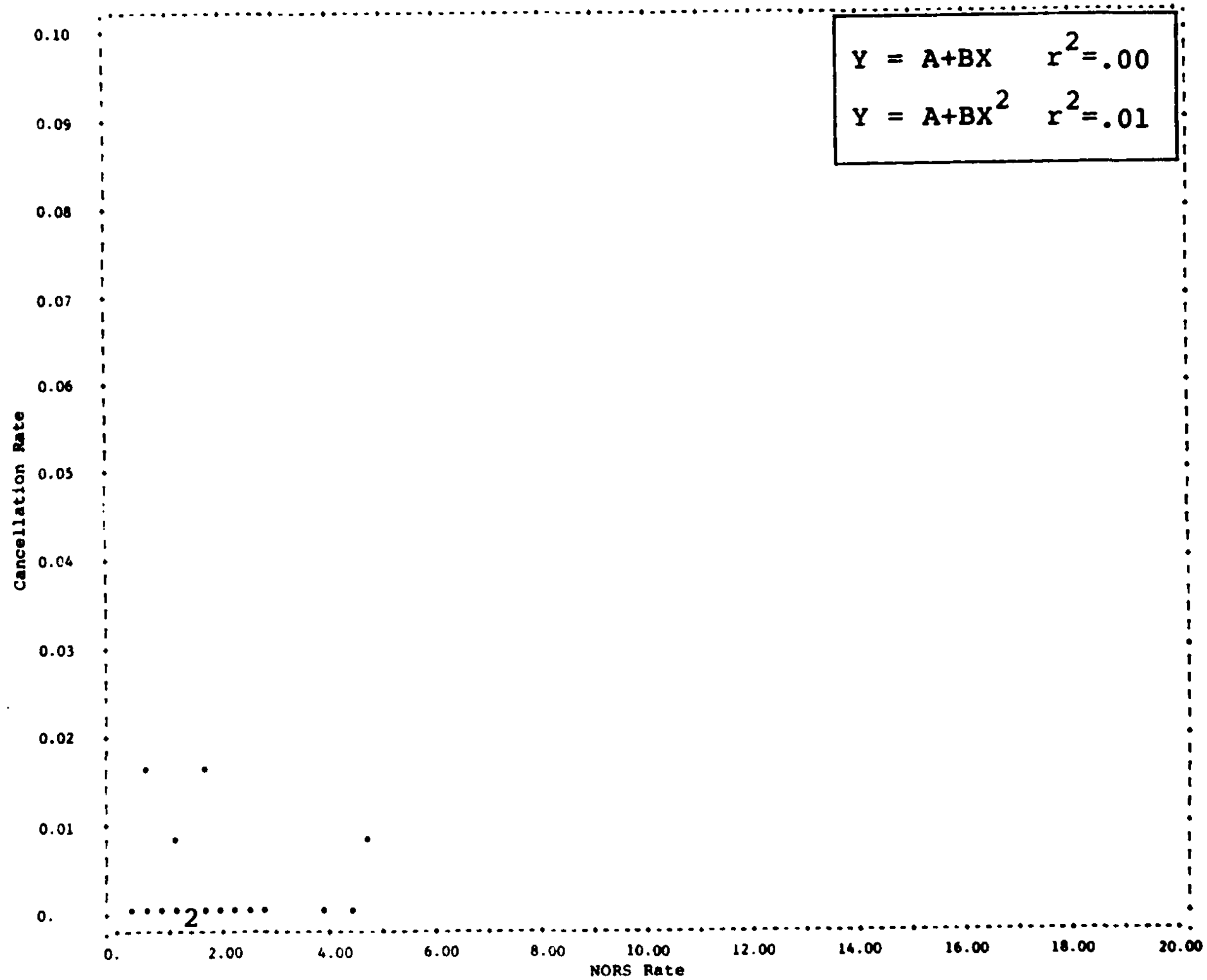

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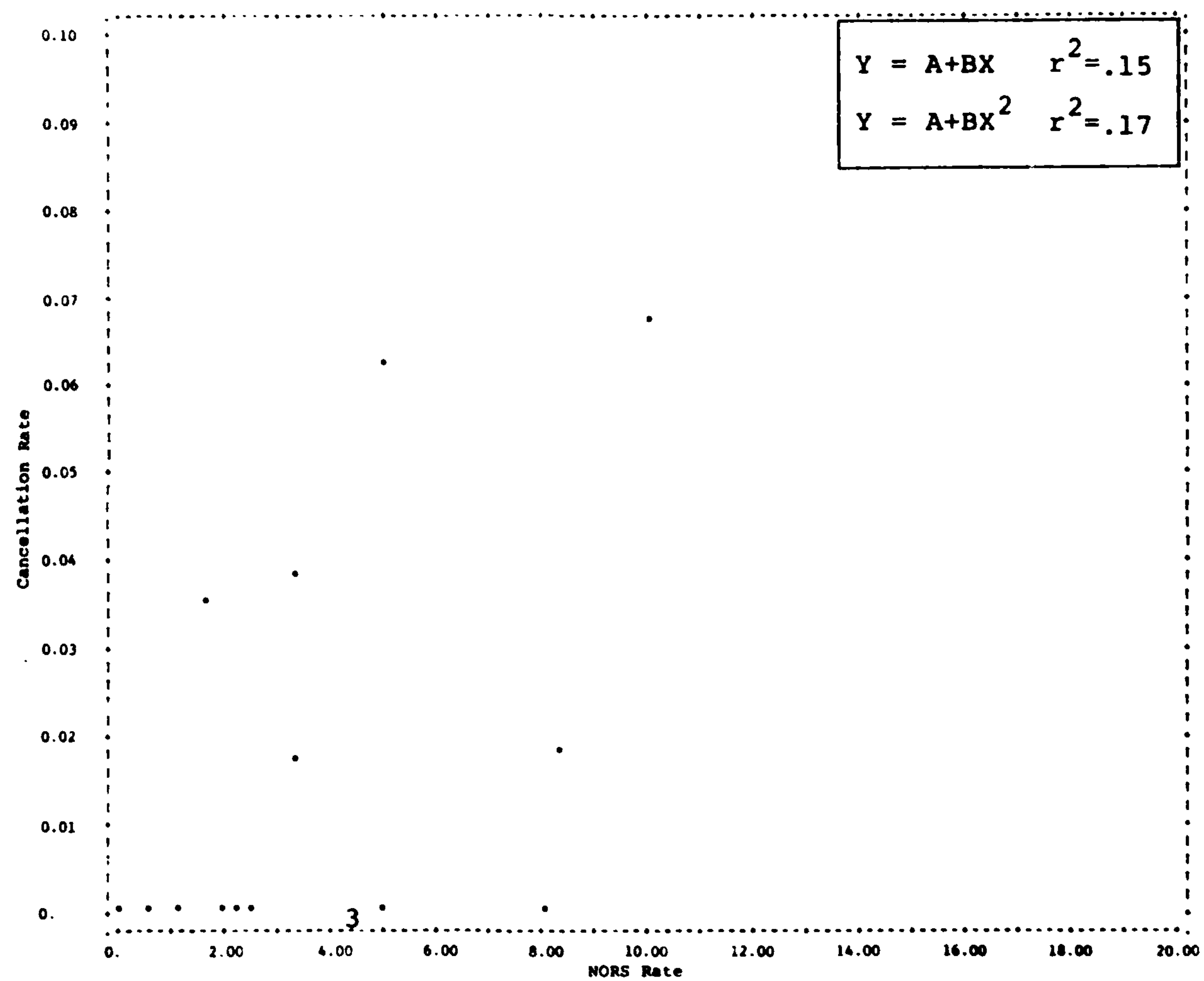

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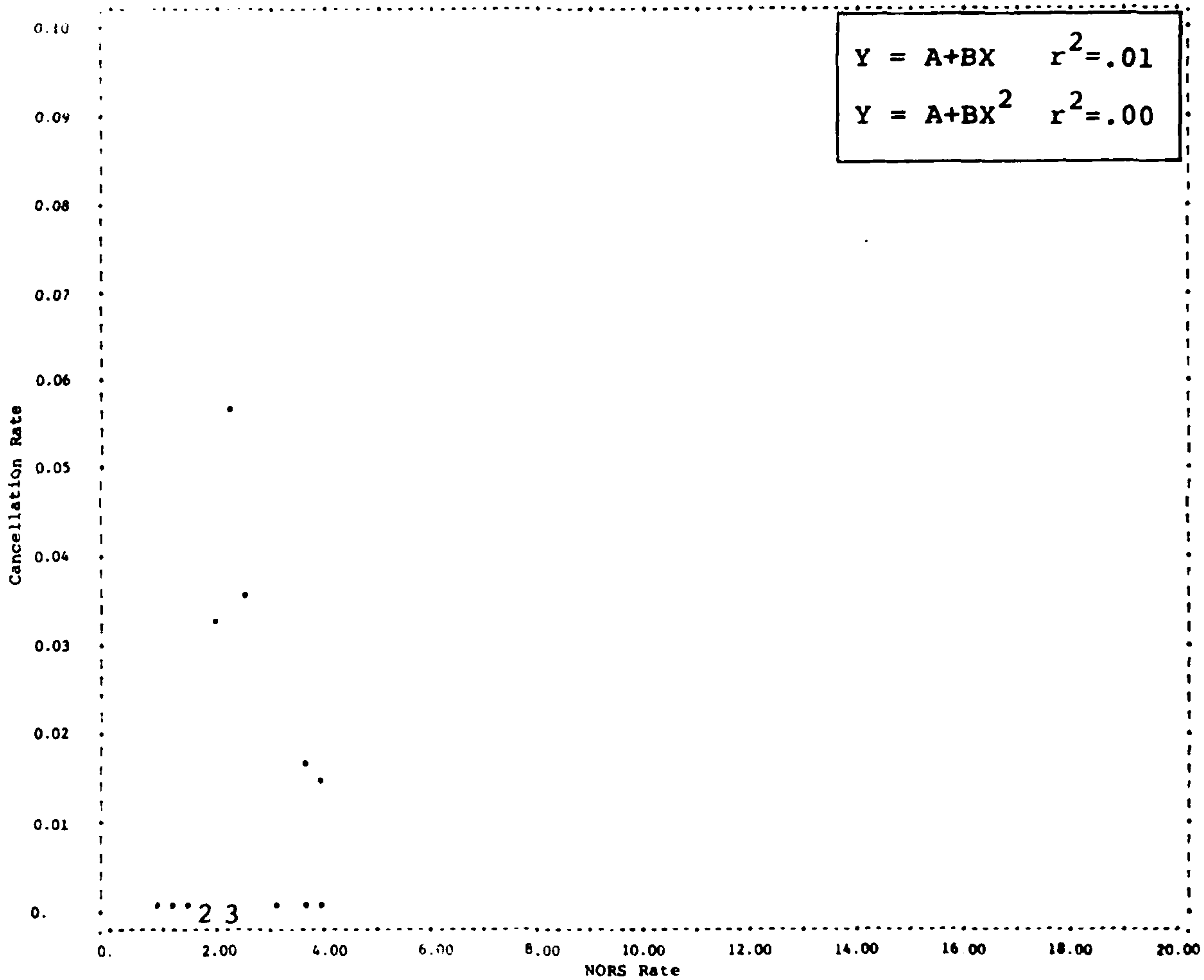

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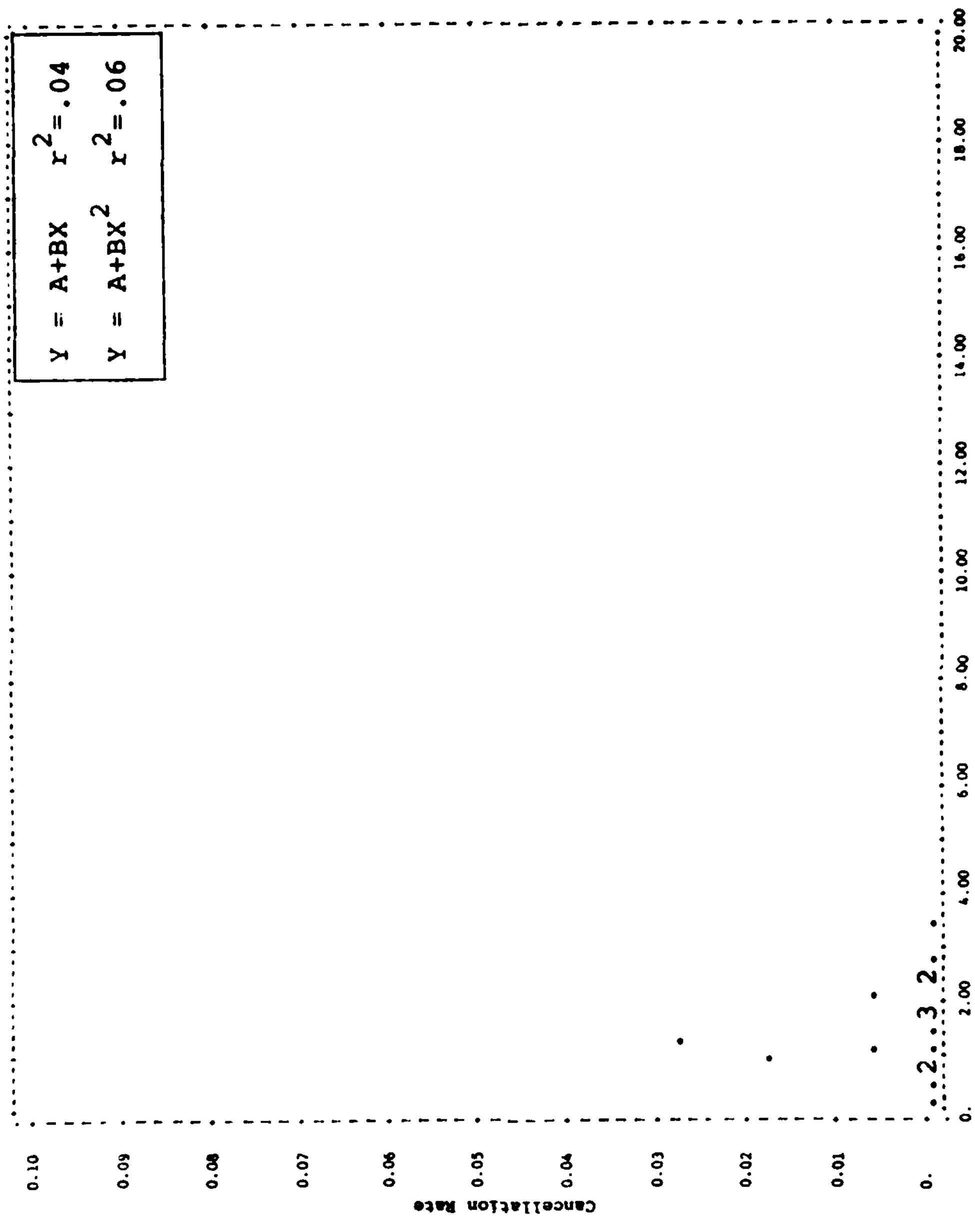

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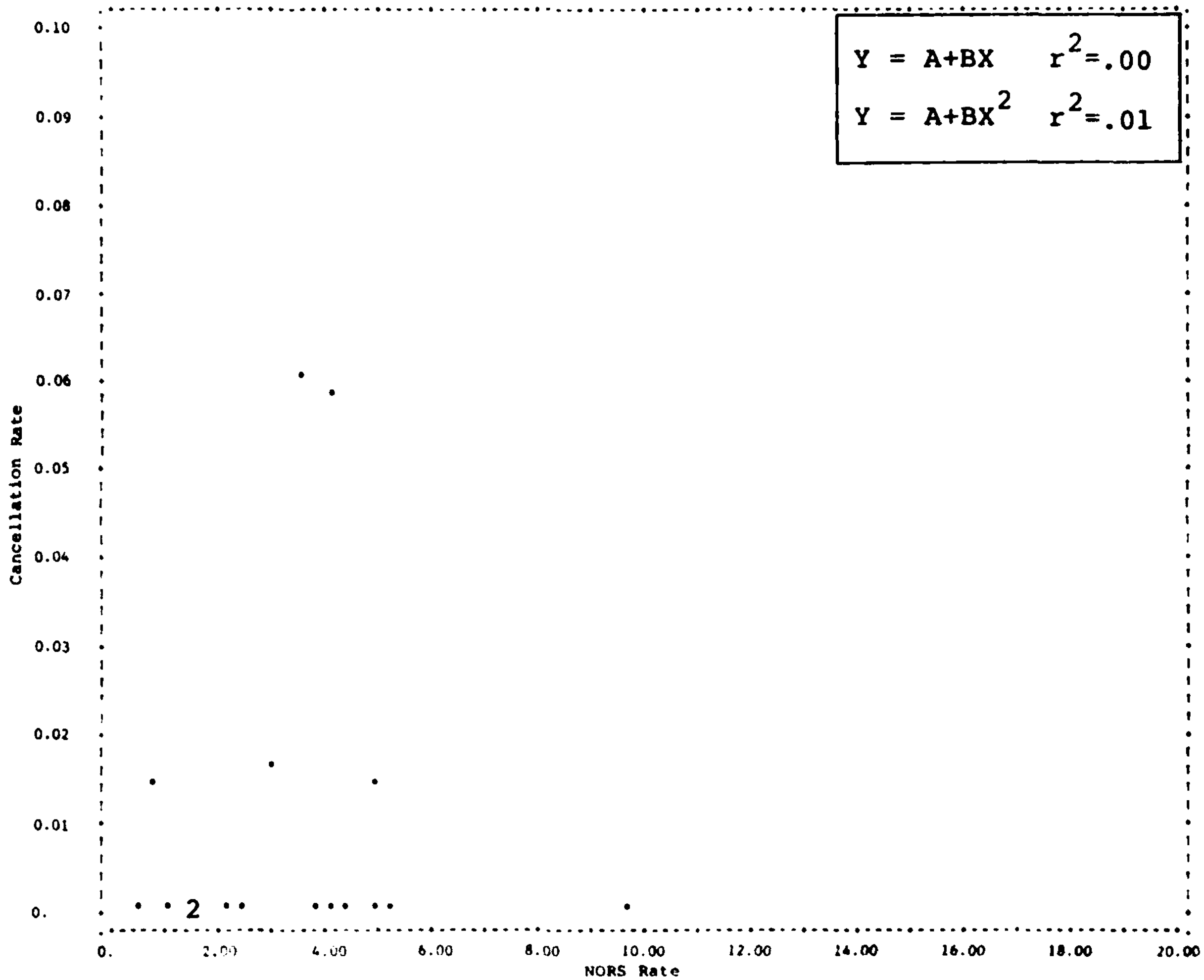

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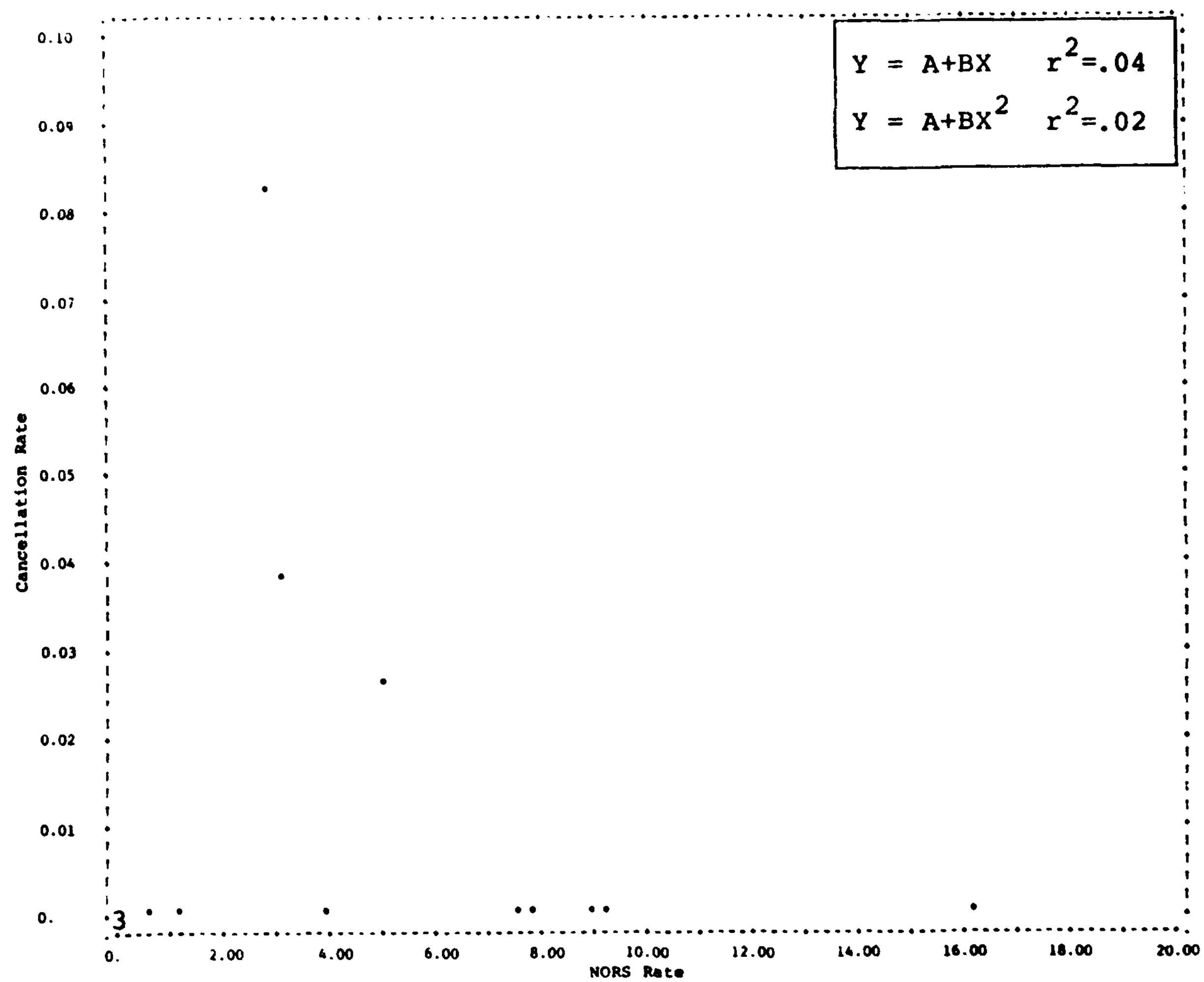

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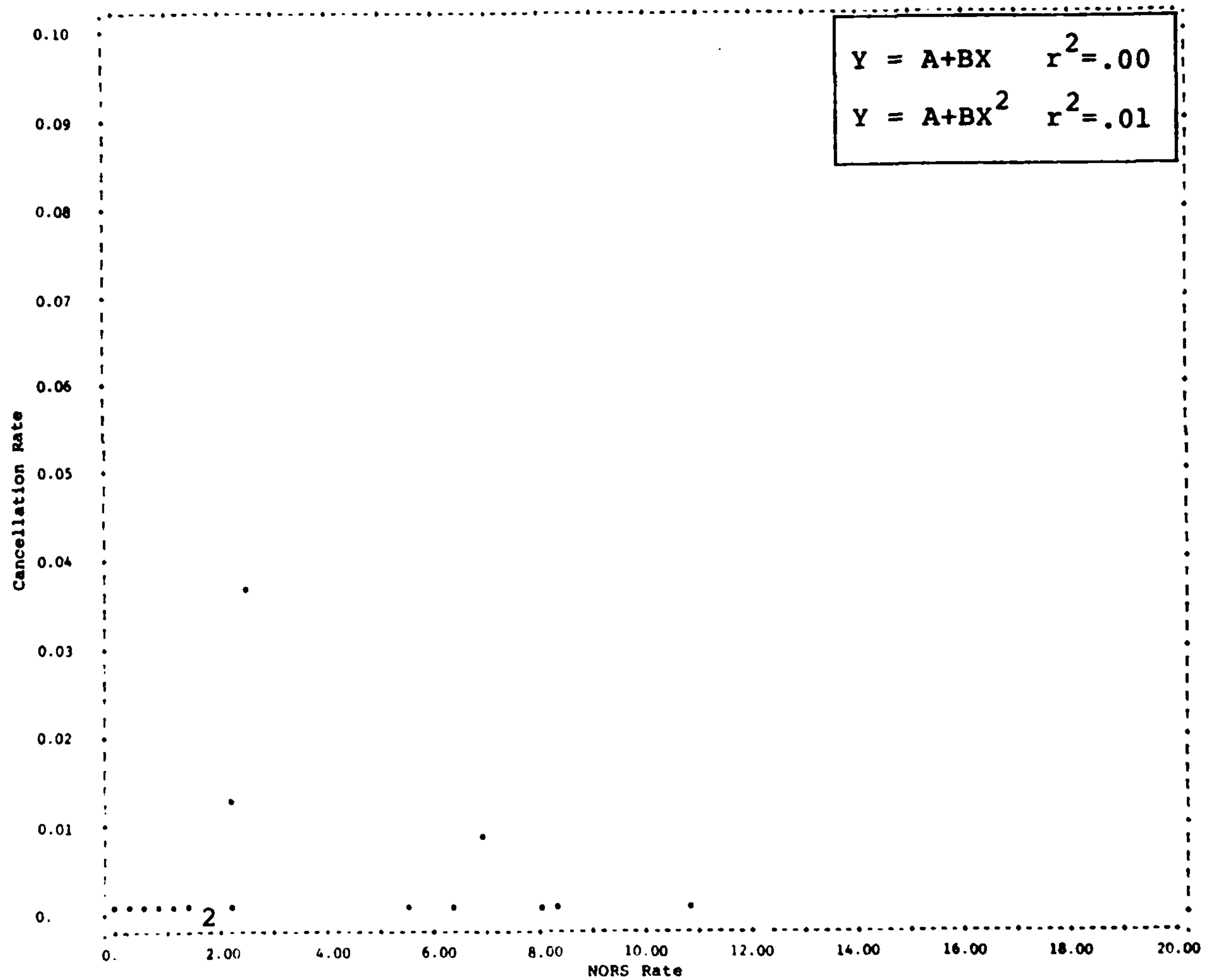

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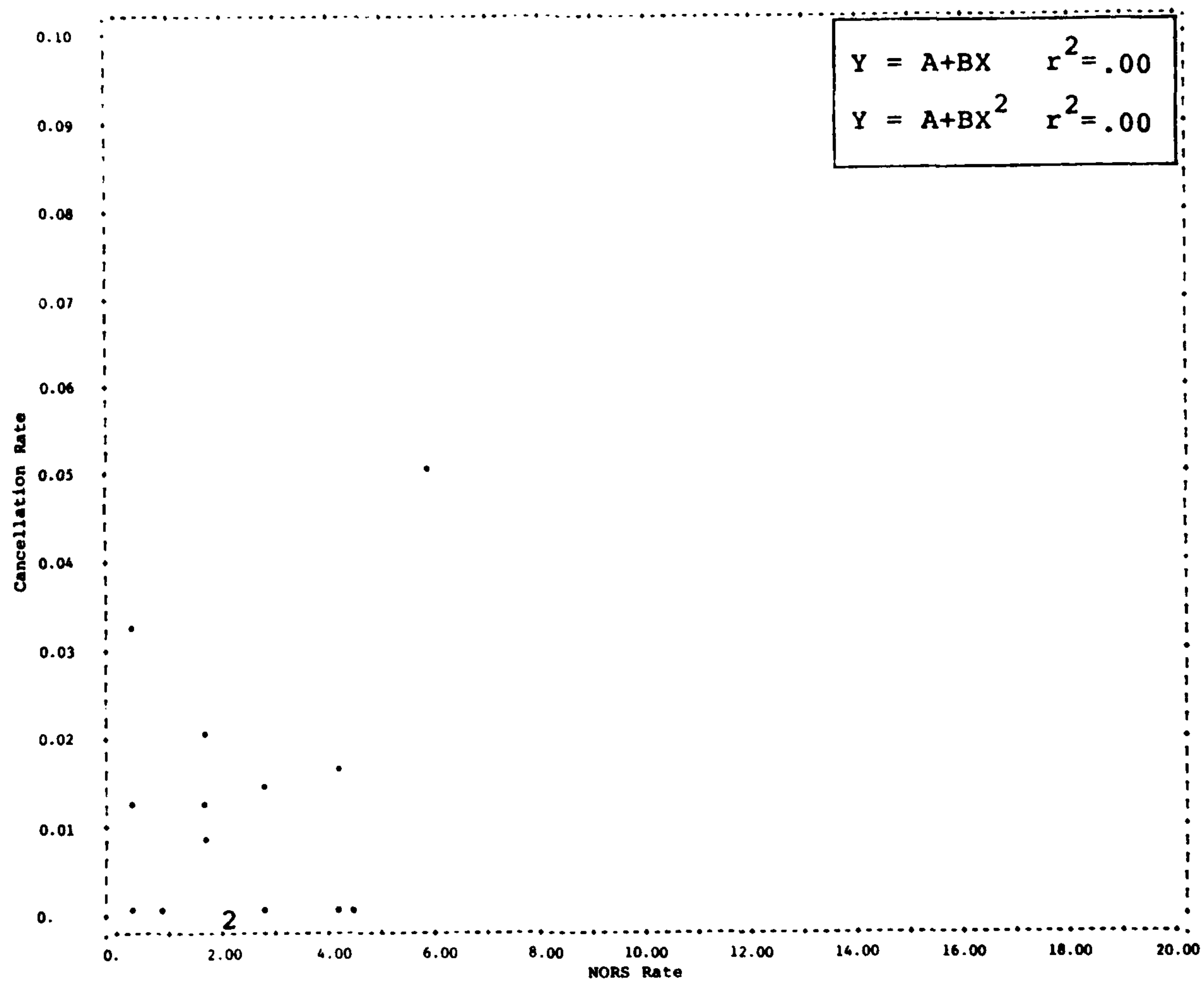

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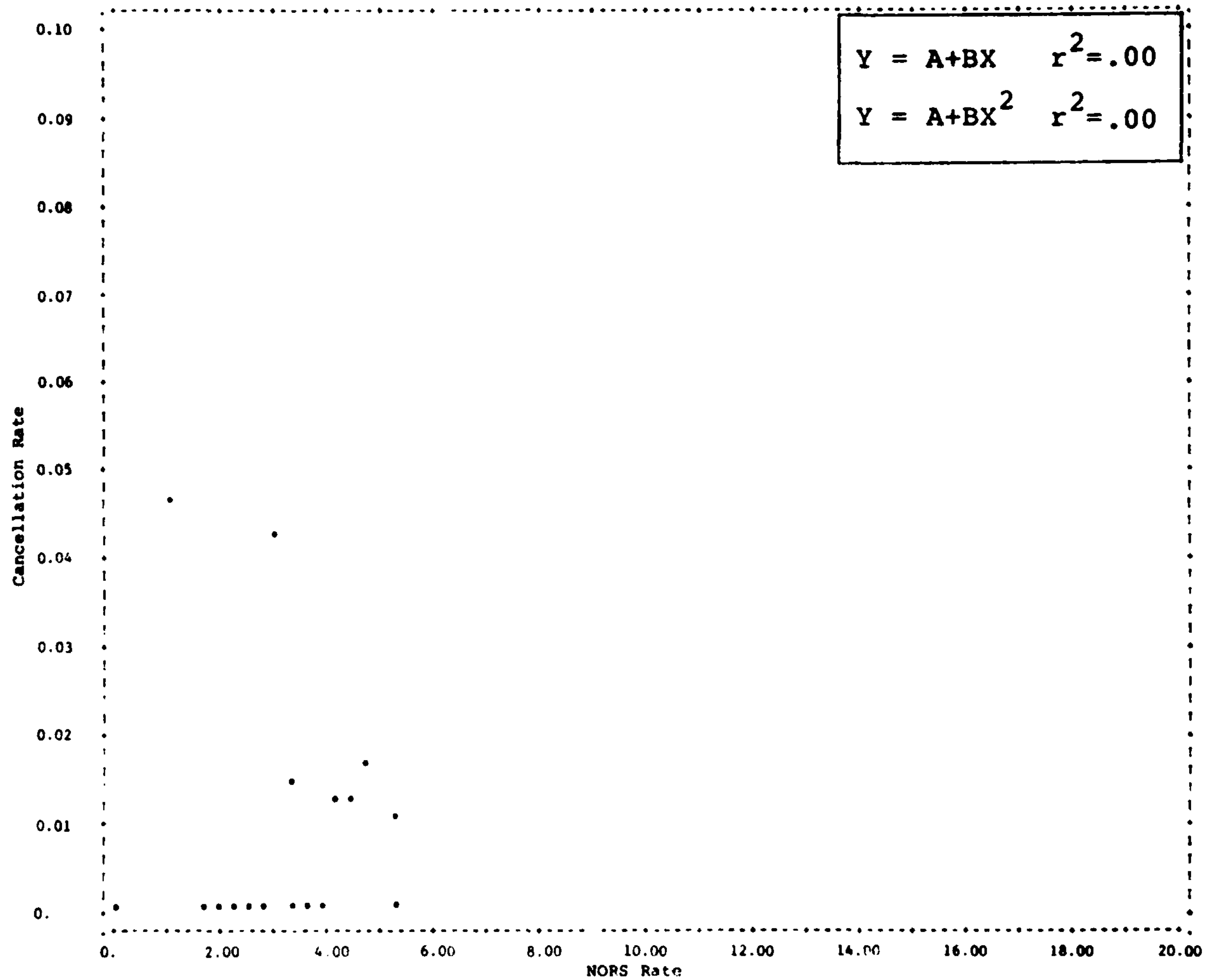

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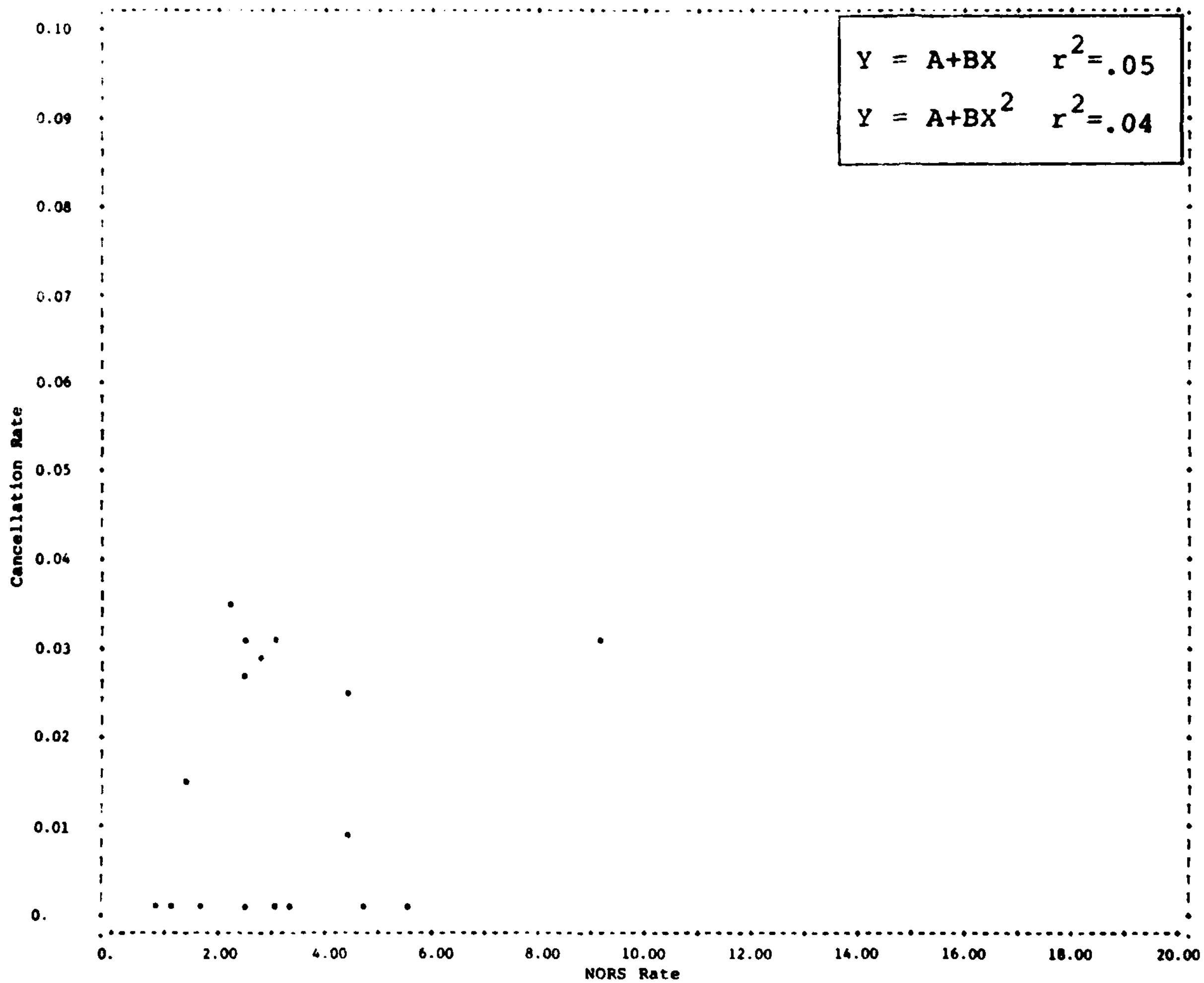

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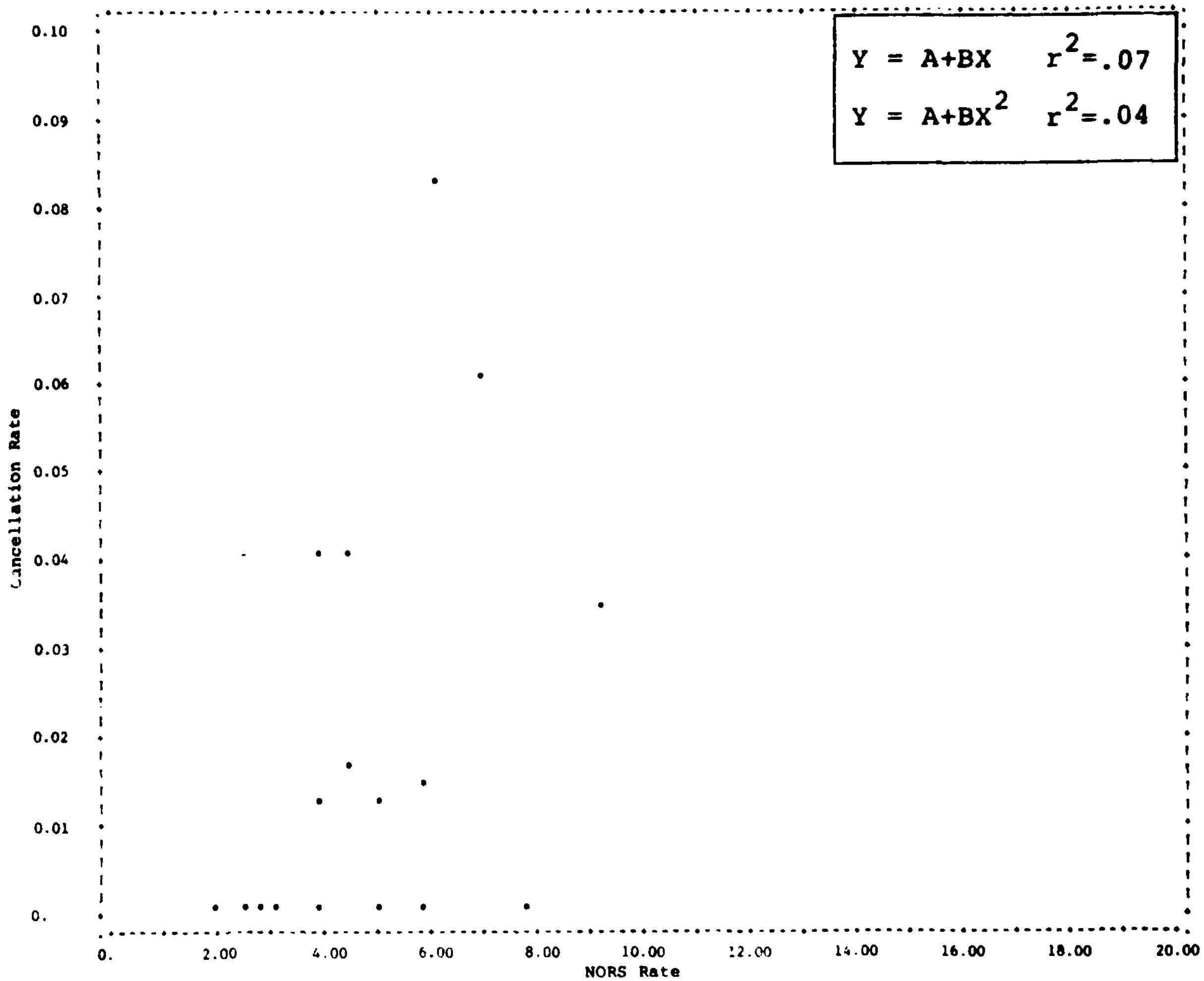

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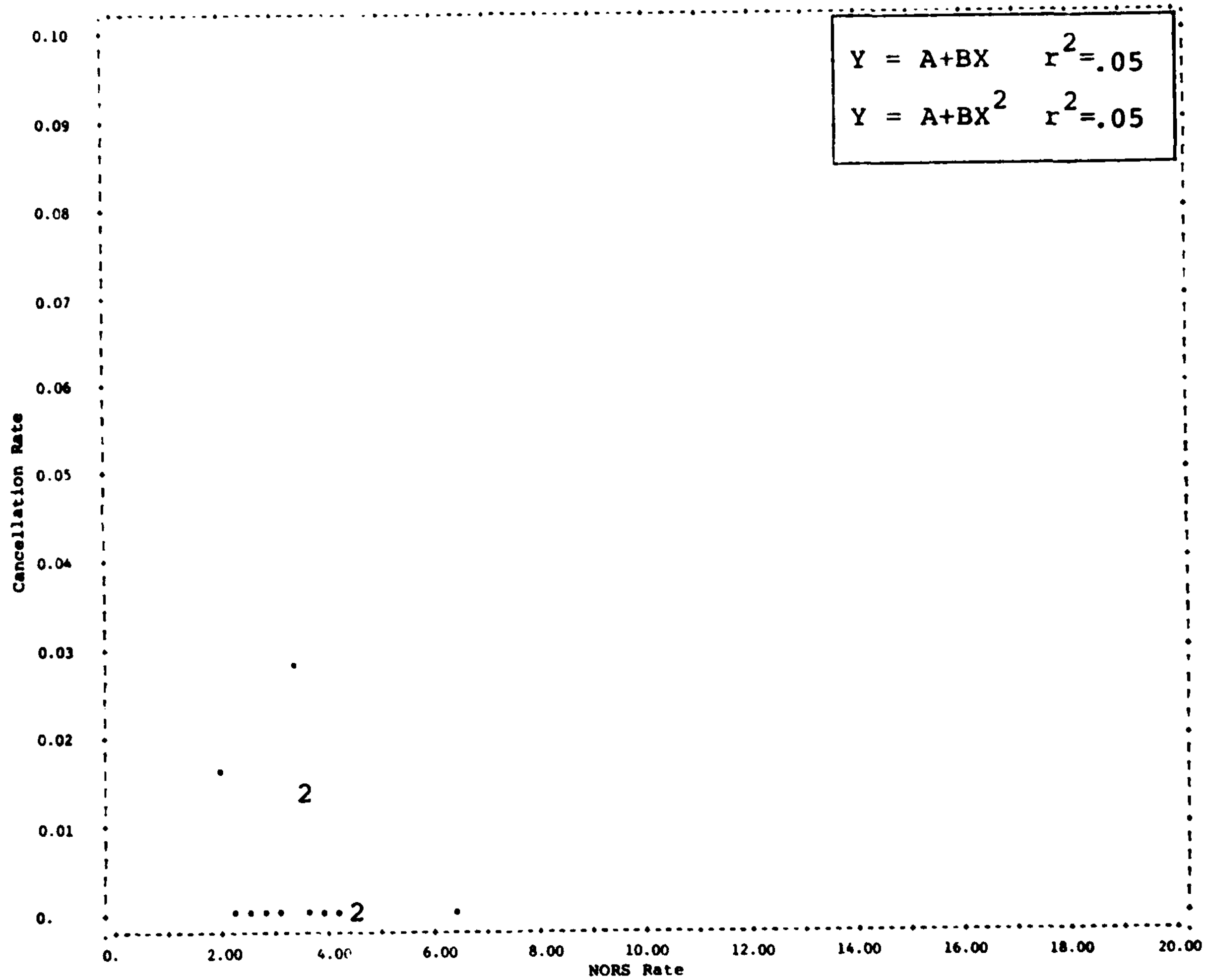

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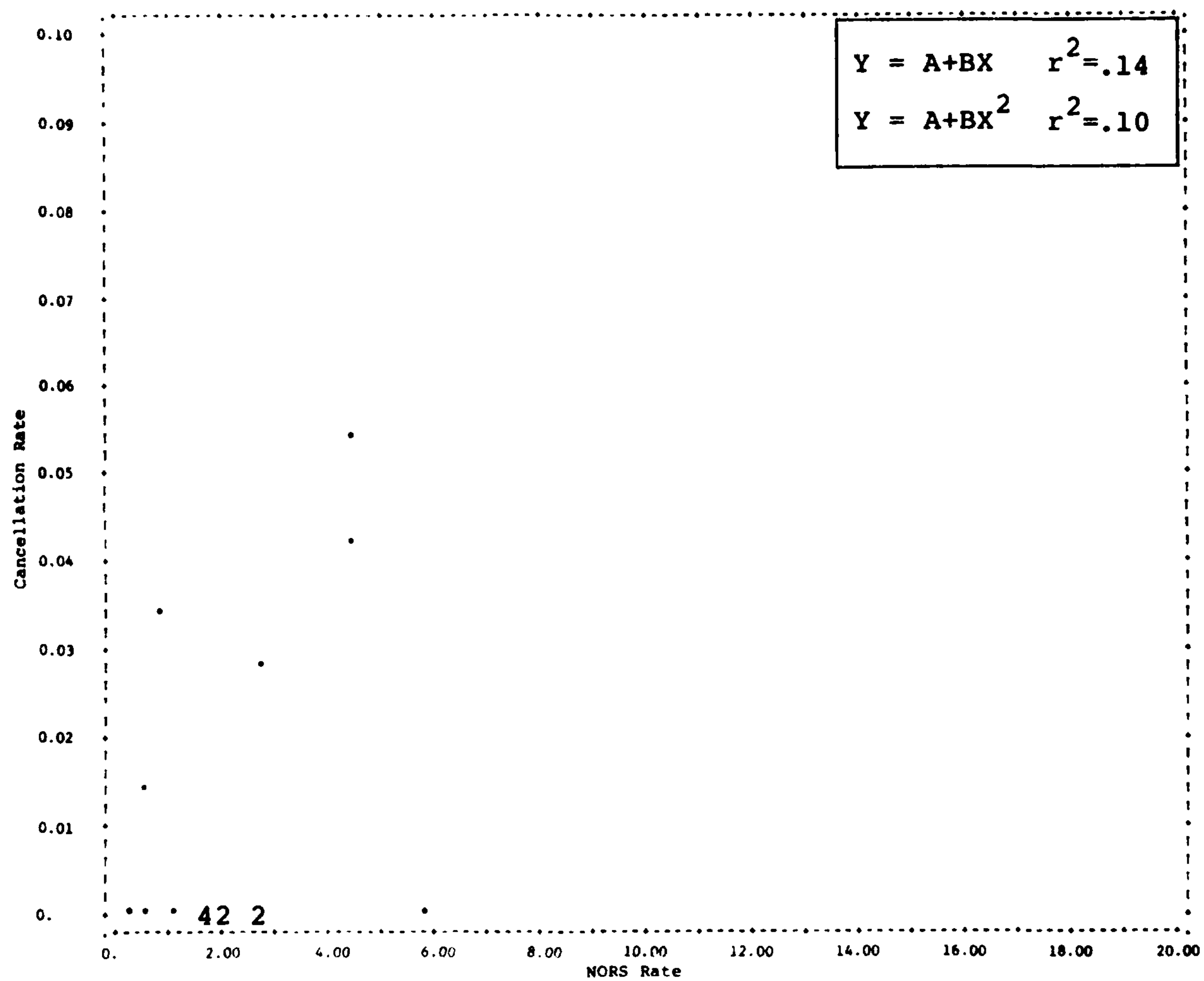

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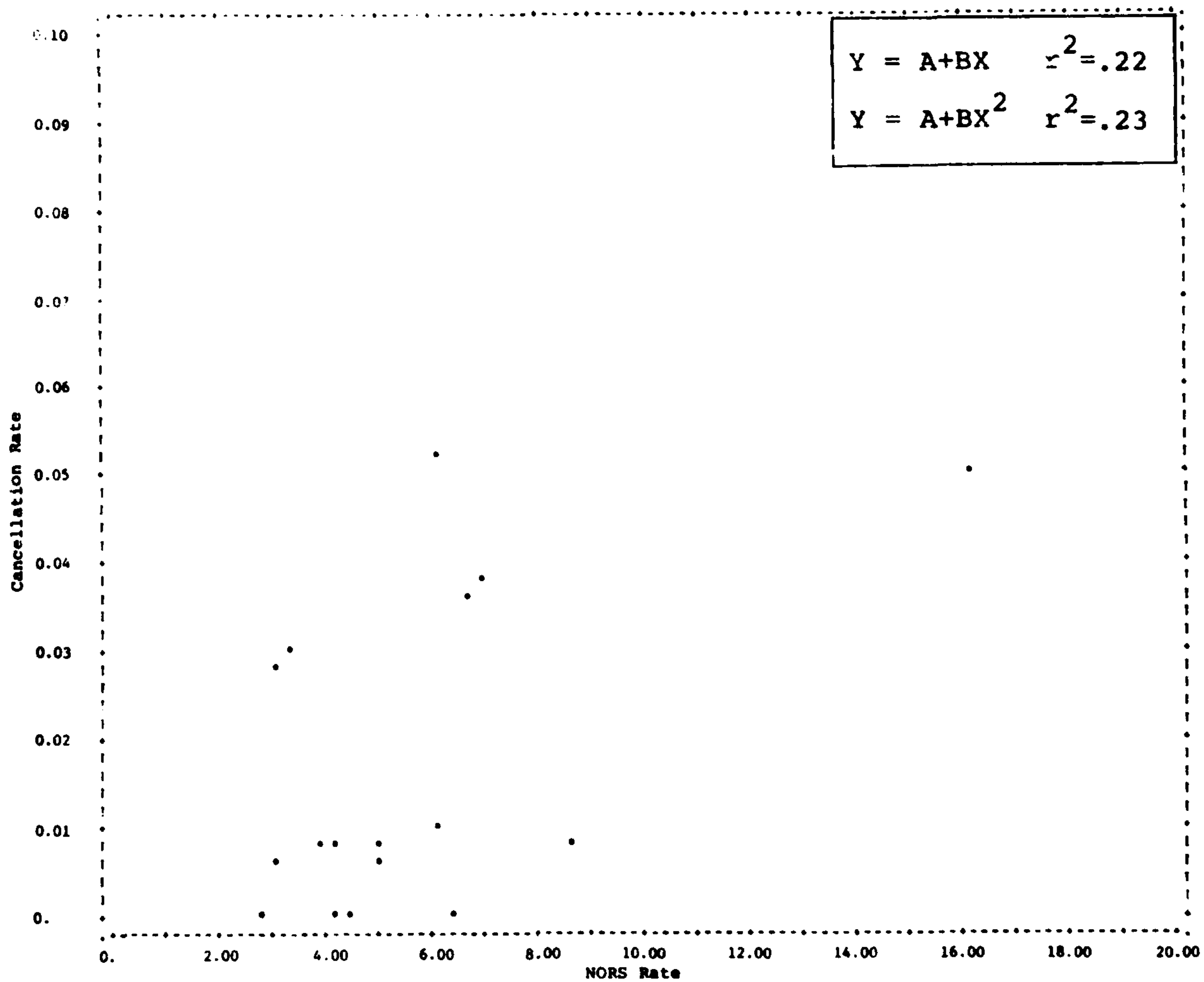

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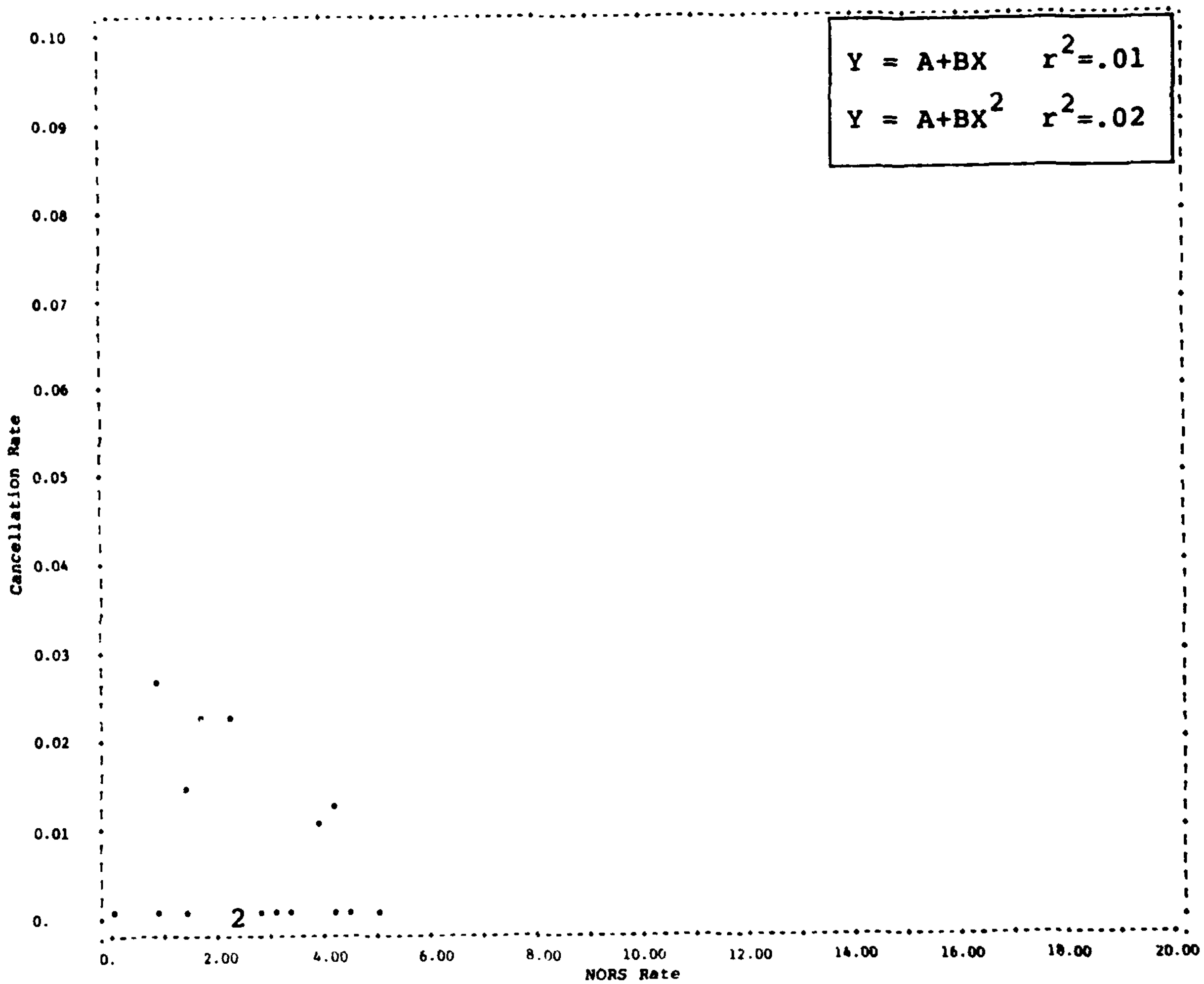

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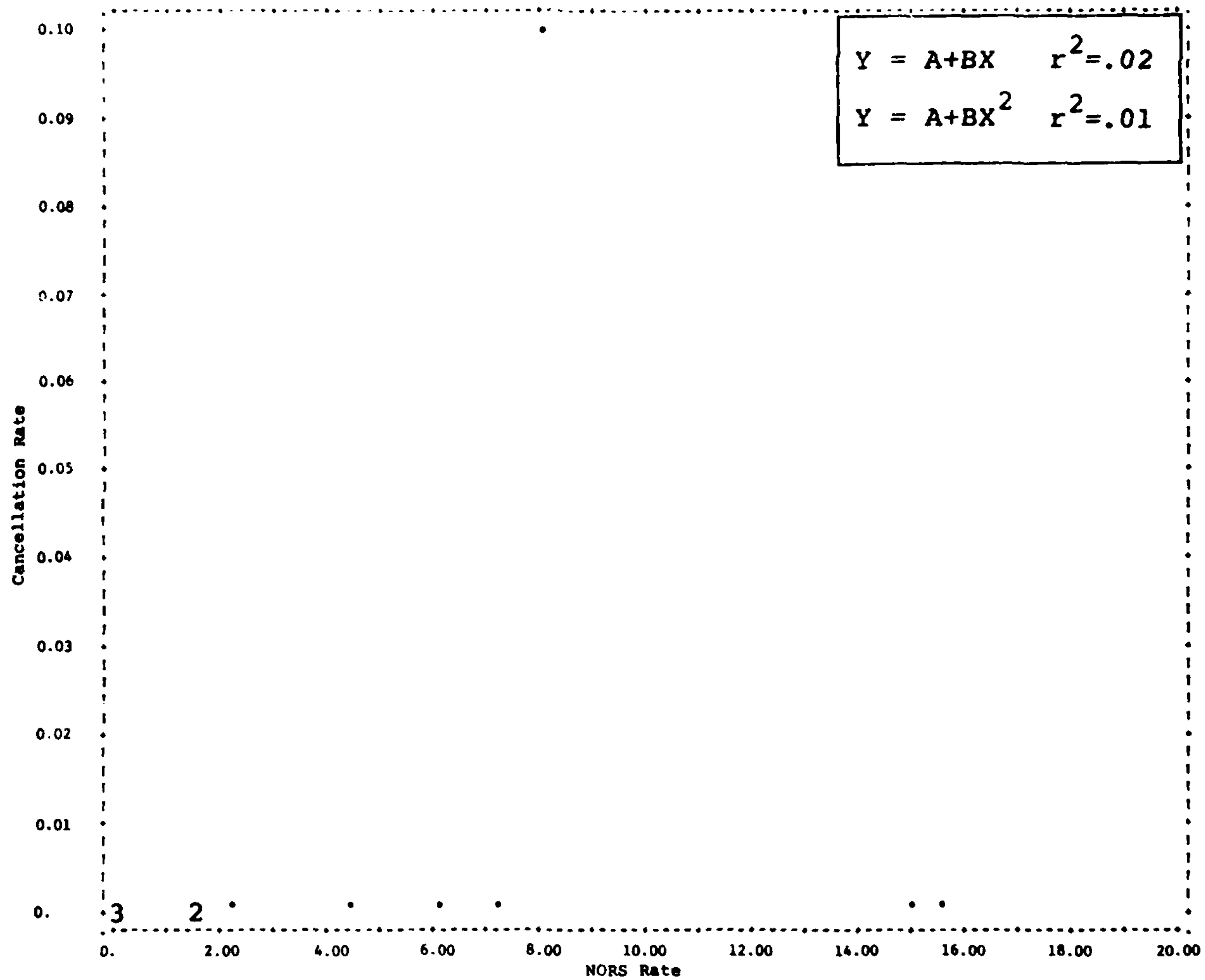

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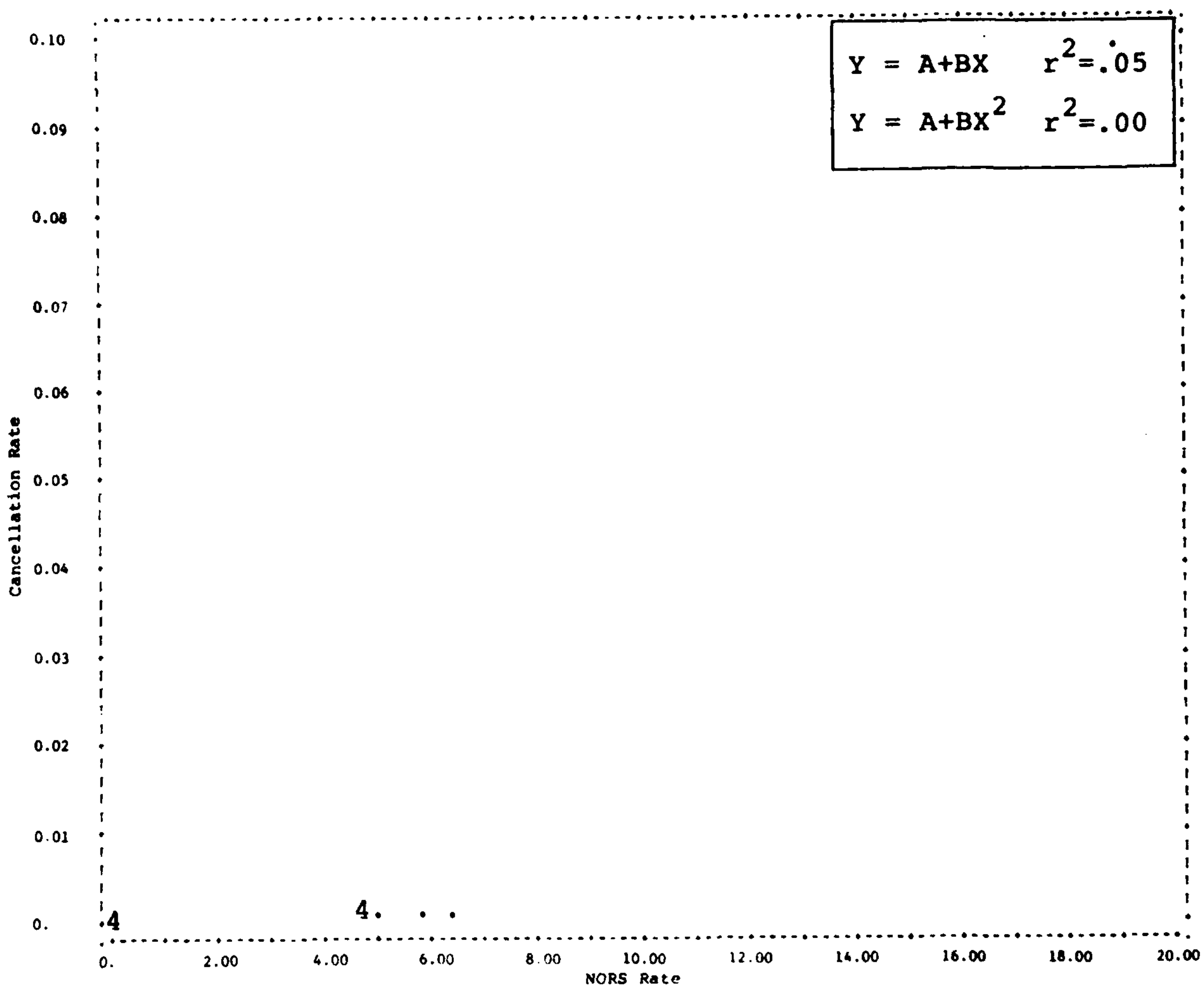

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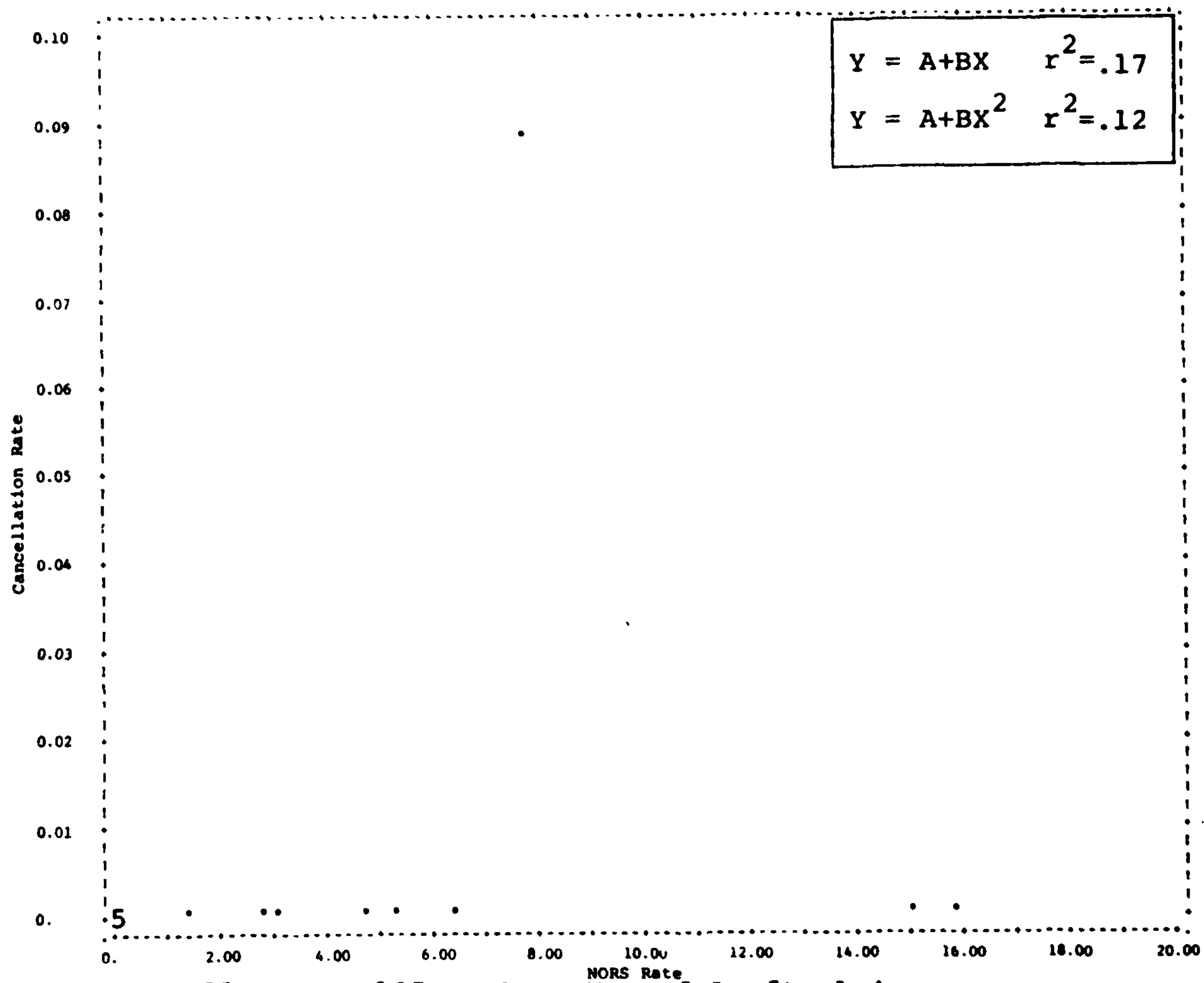

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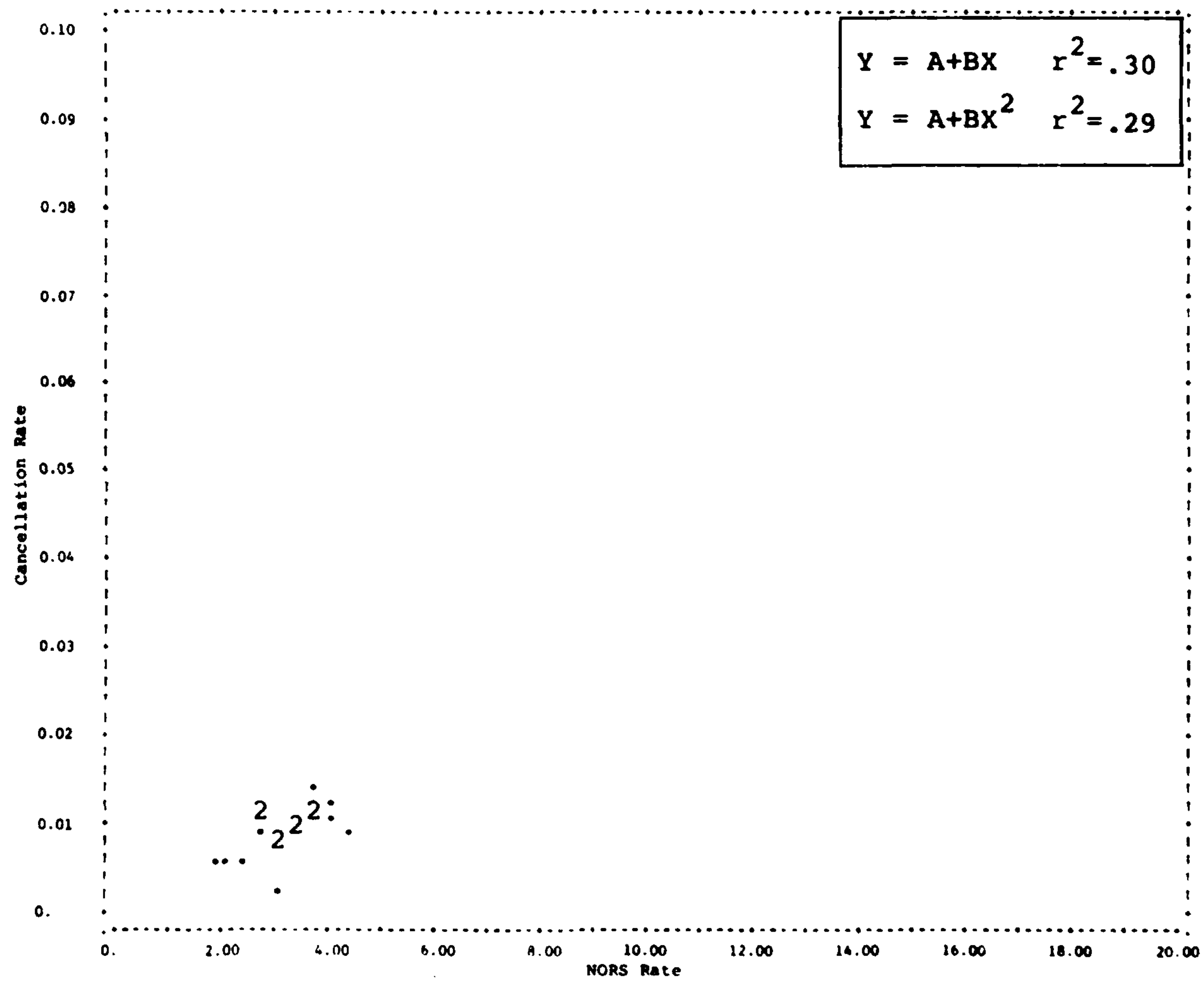

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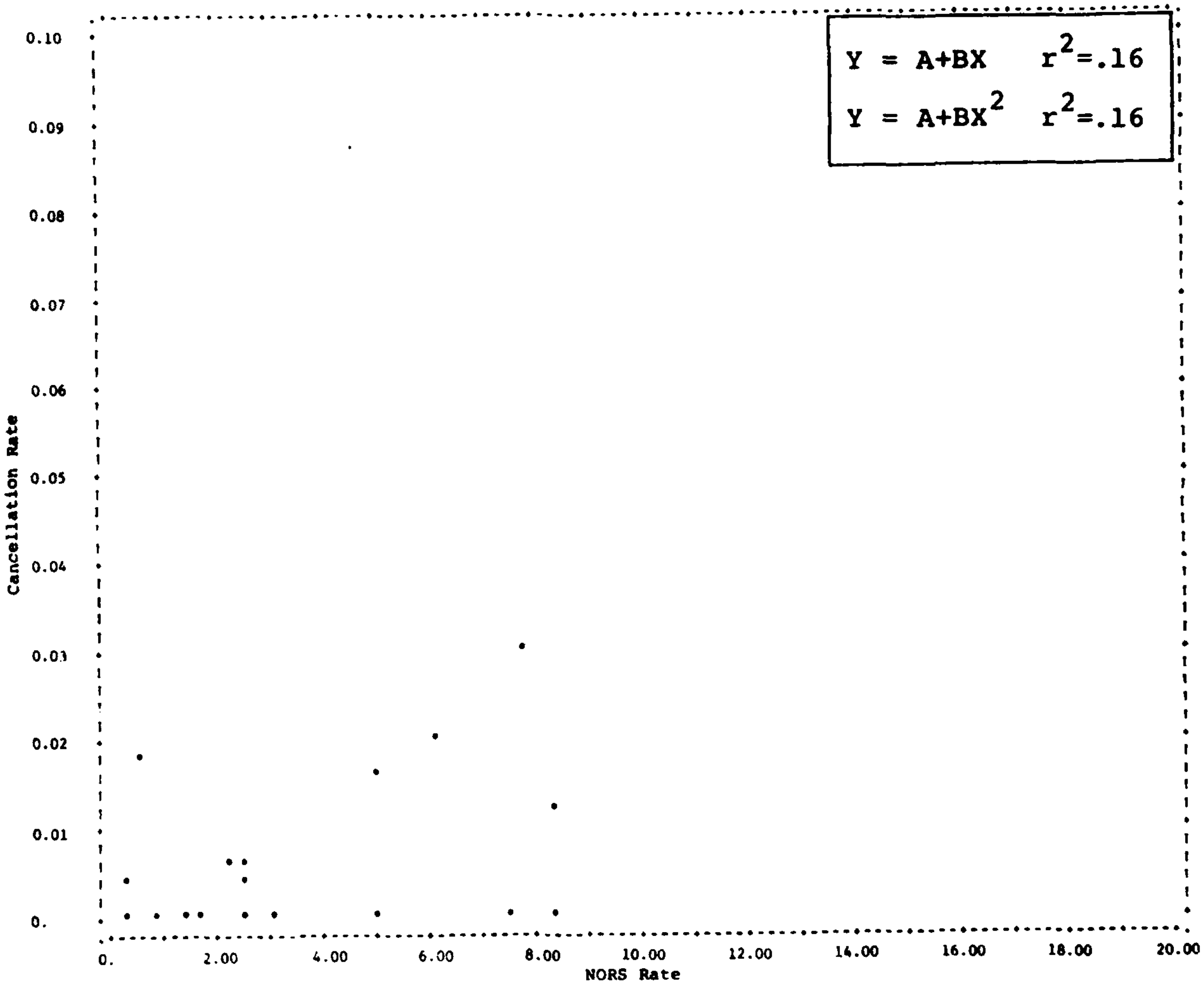
APPENDIX C

FB-111 SCATTERGRAMS



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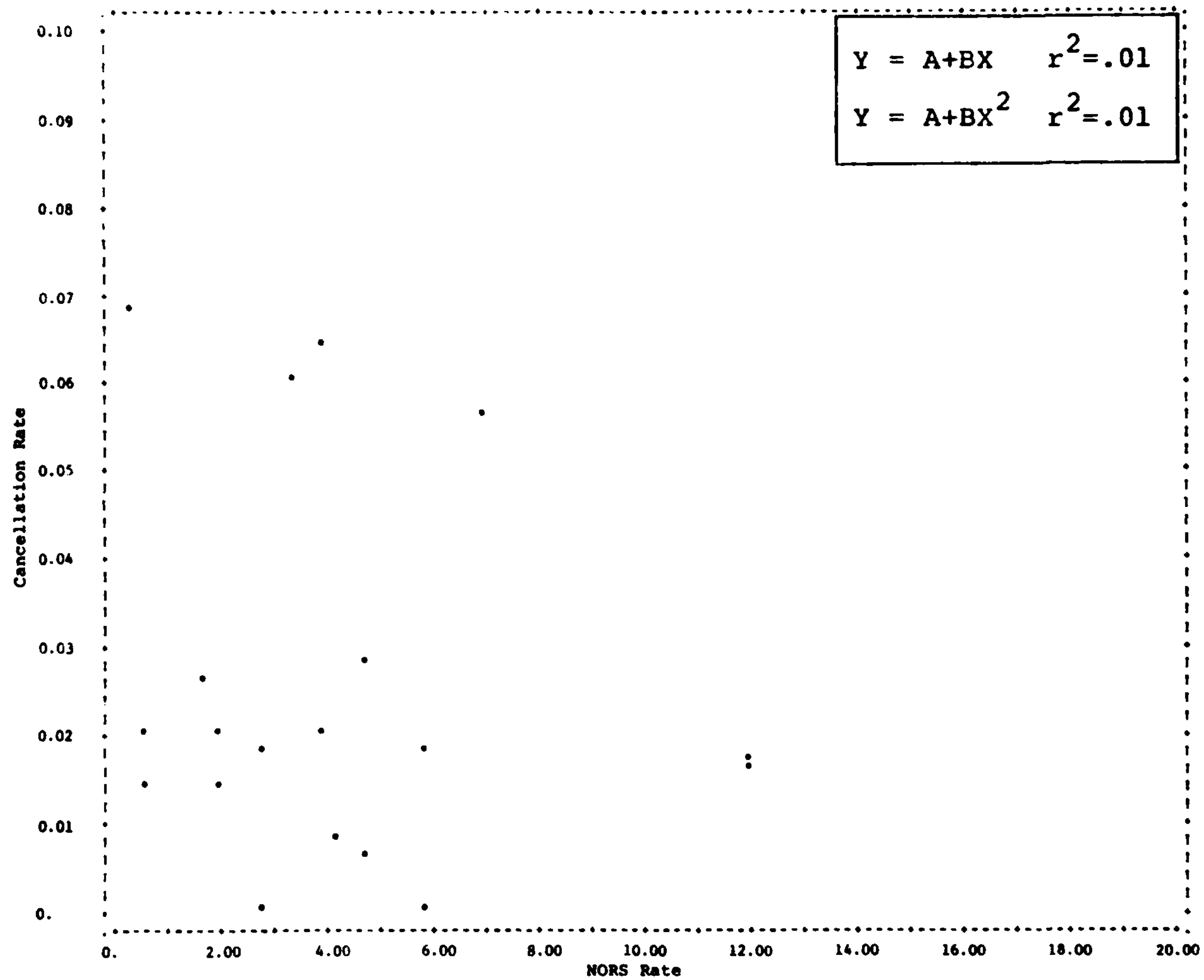

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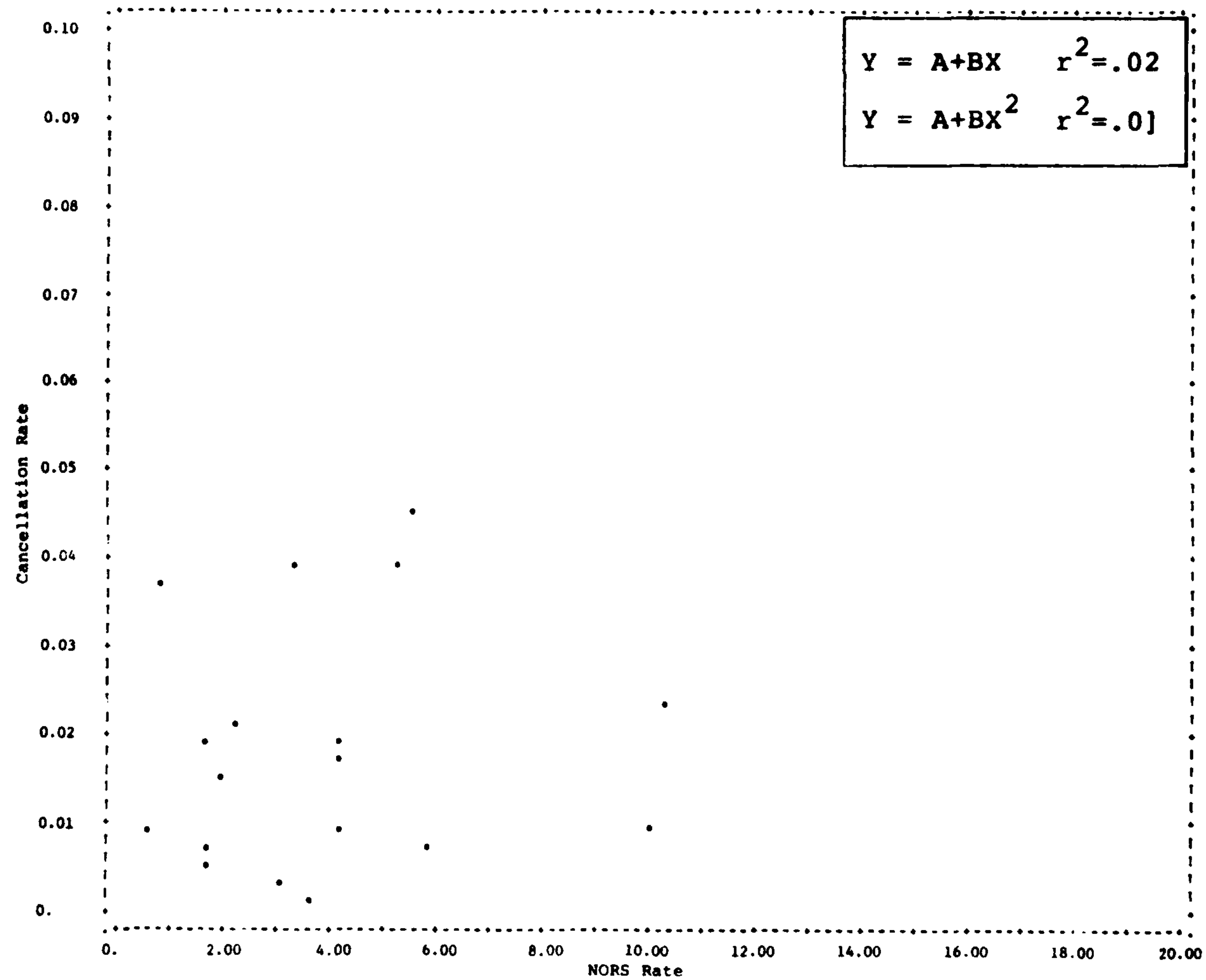

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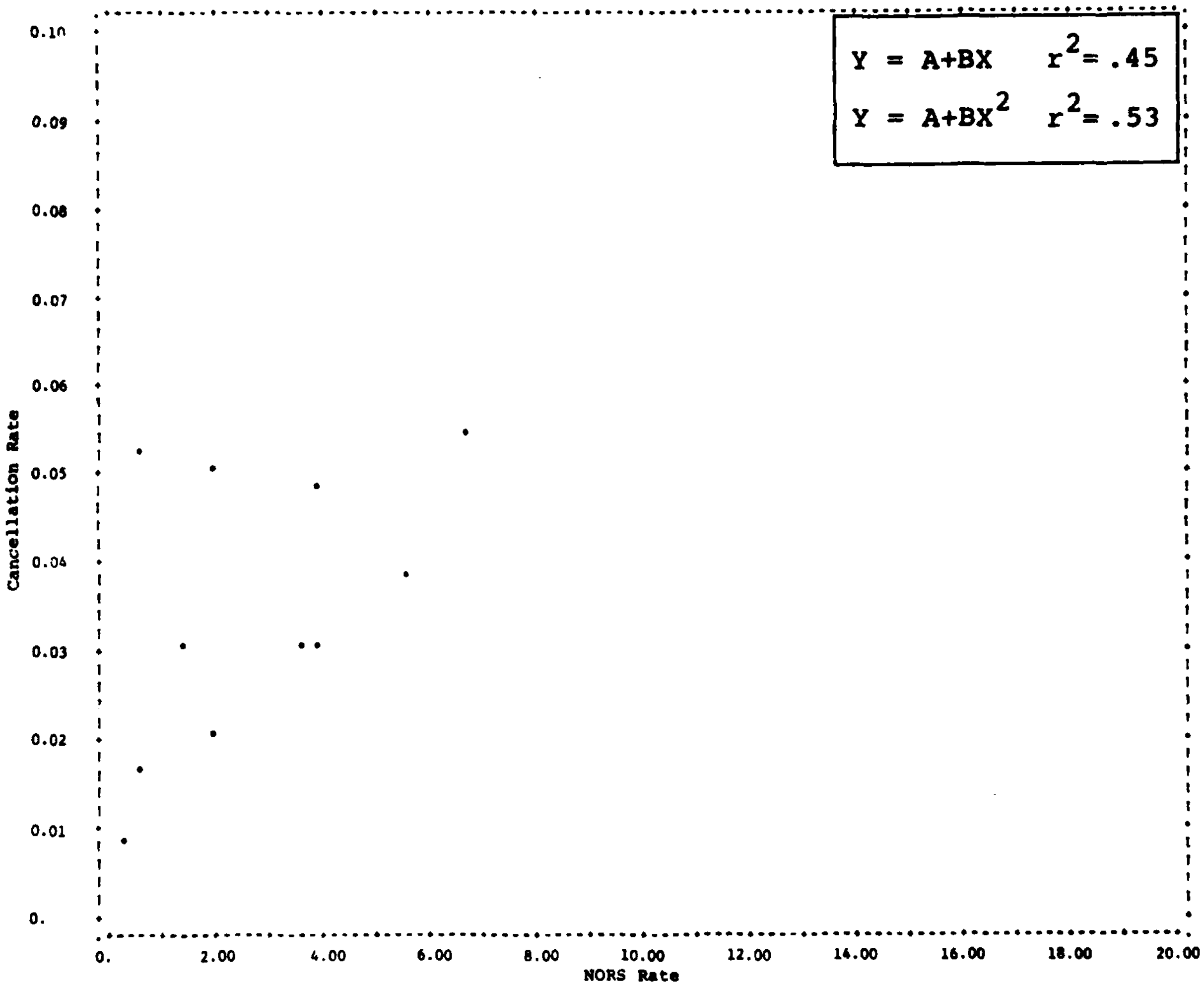
APPENDIX D

F-106 SCATTERGRAMS



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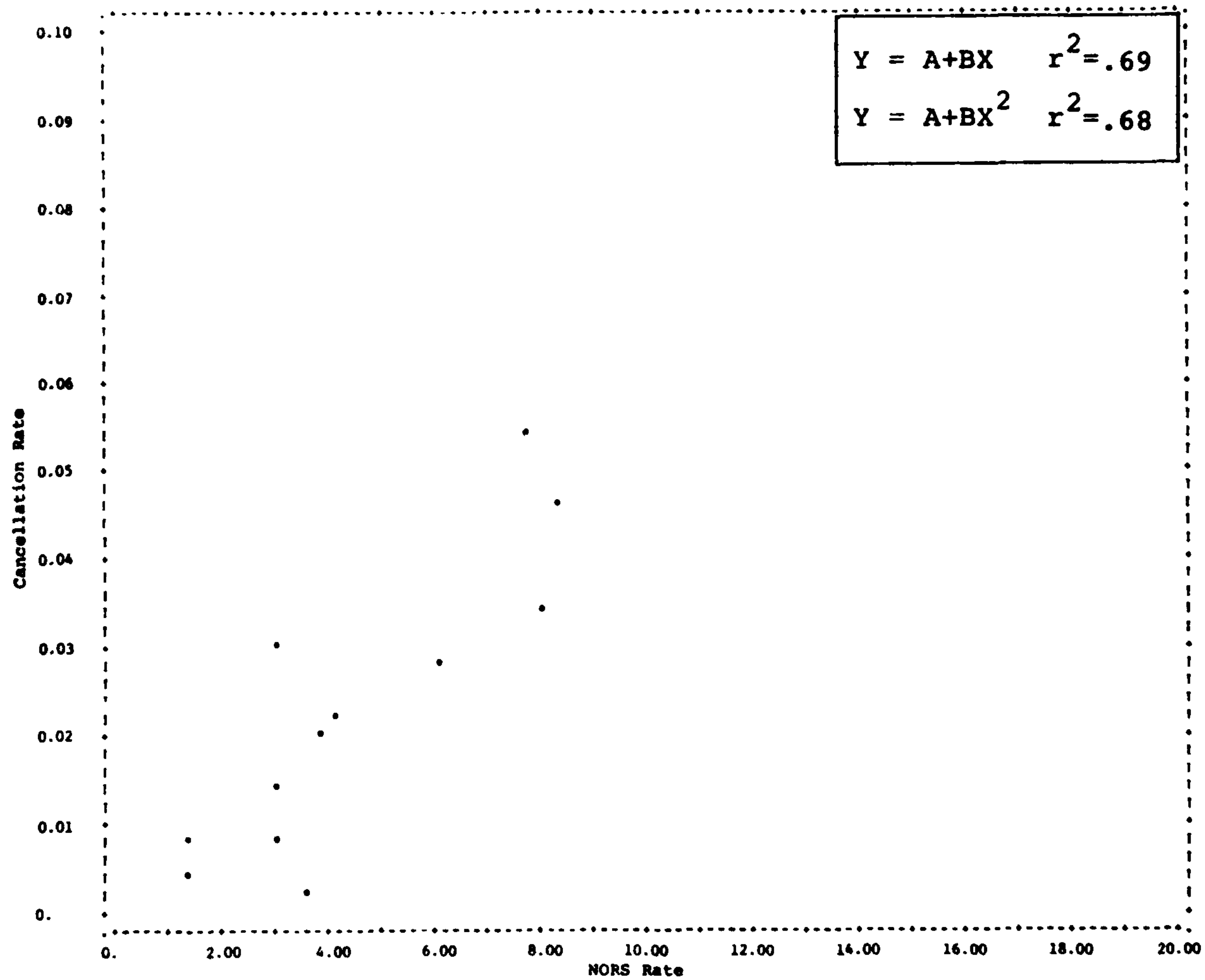

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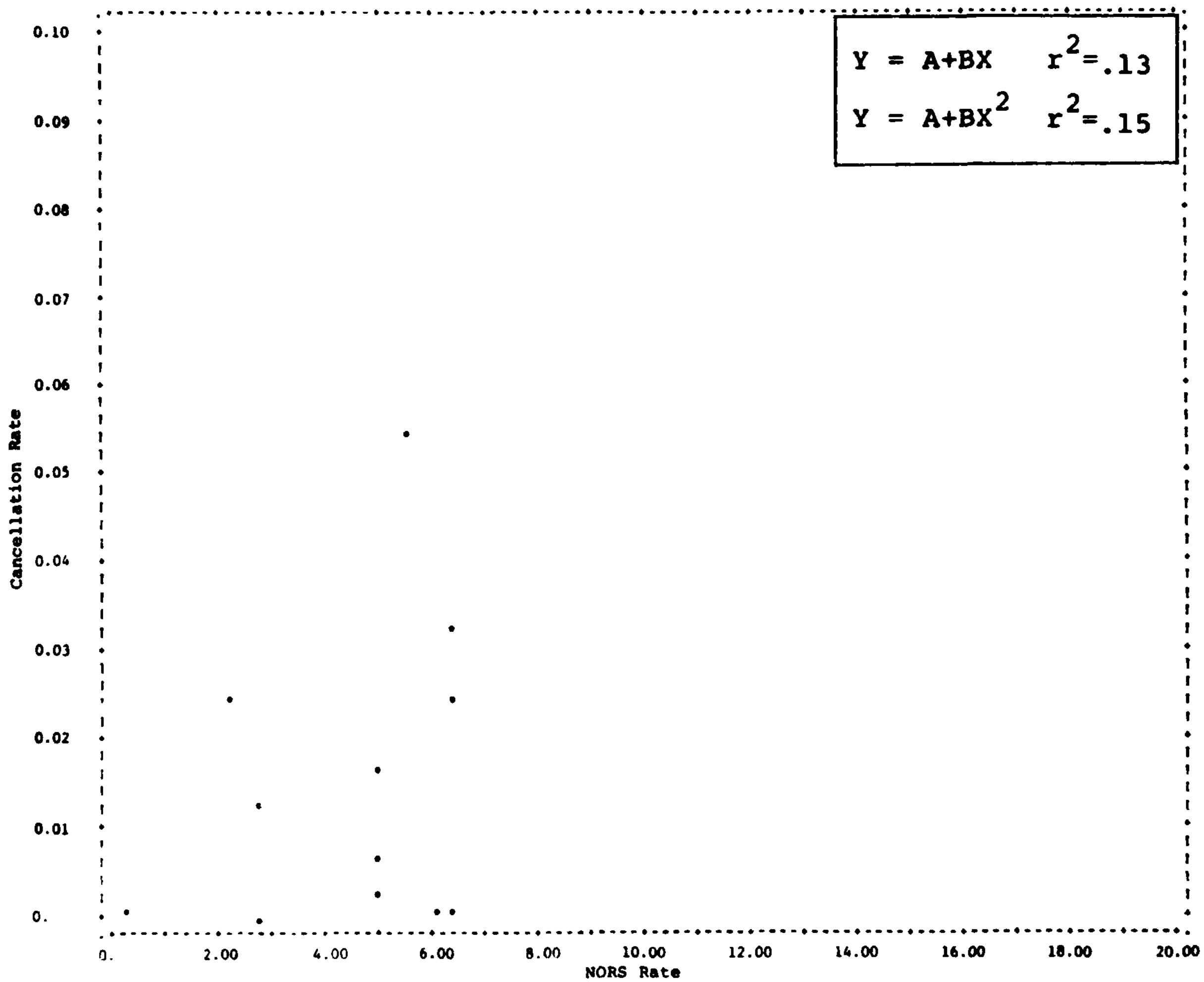

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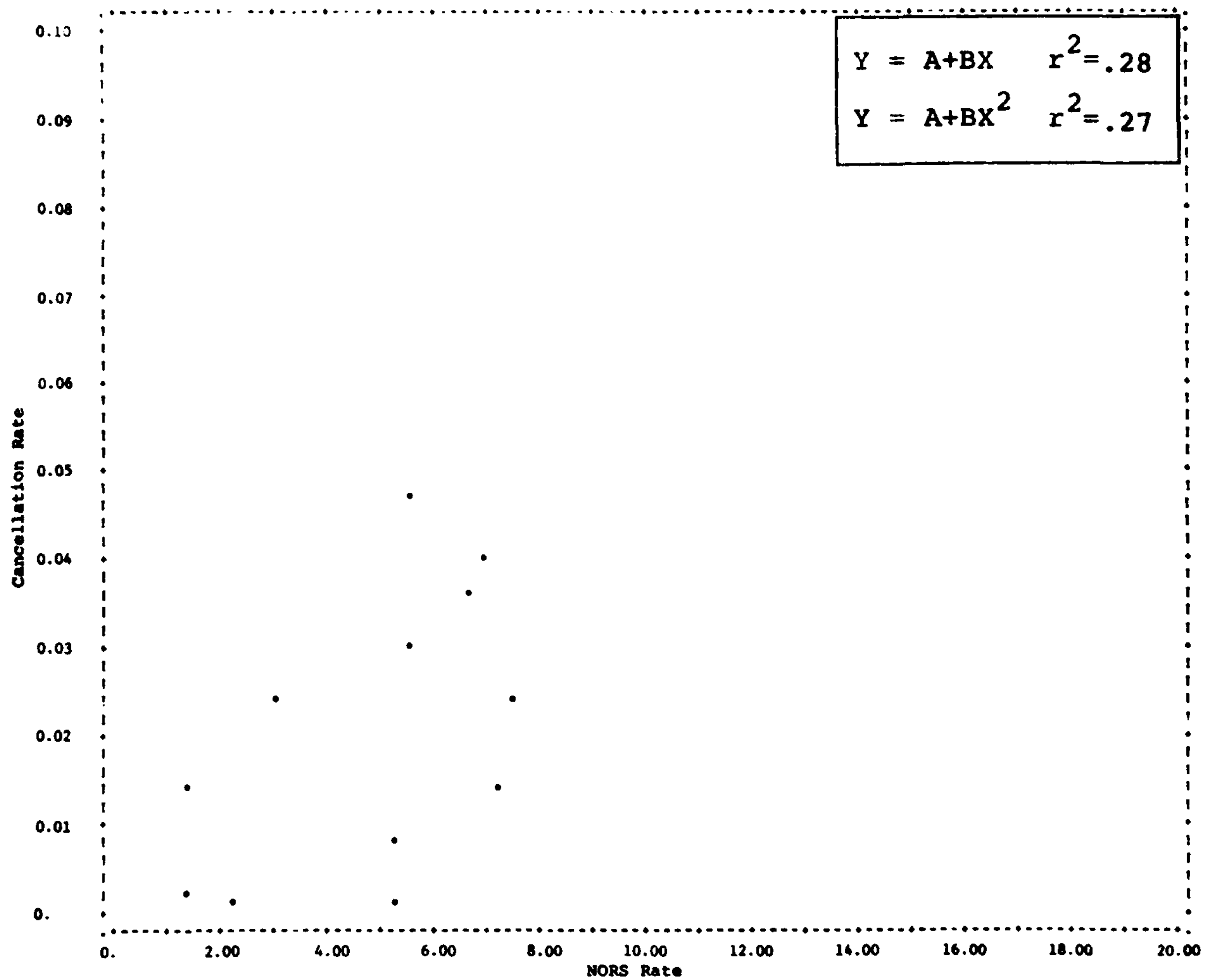

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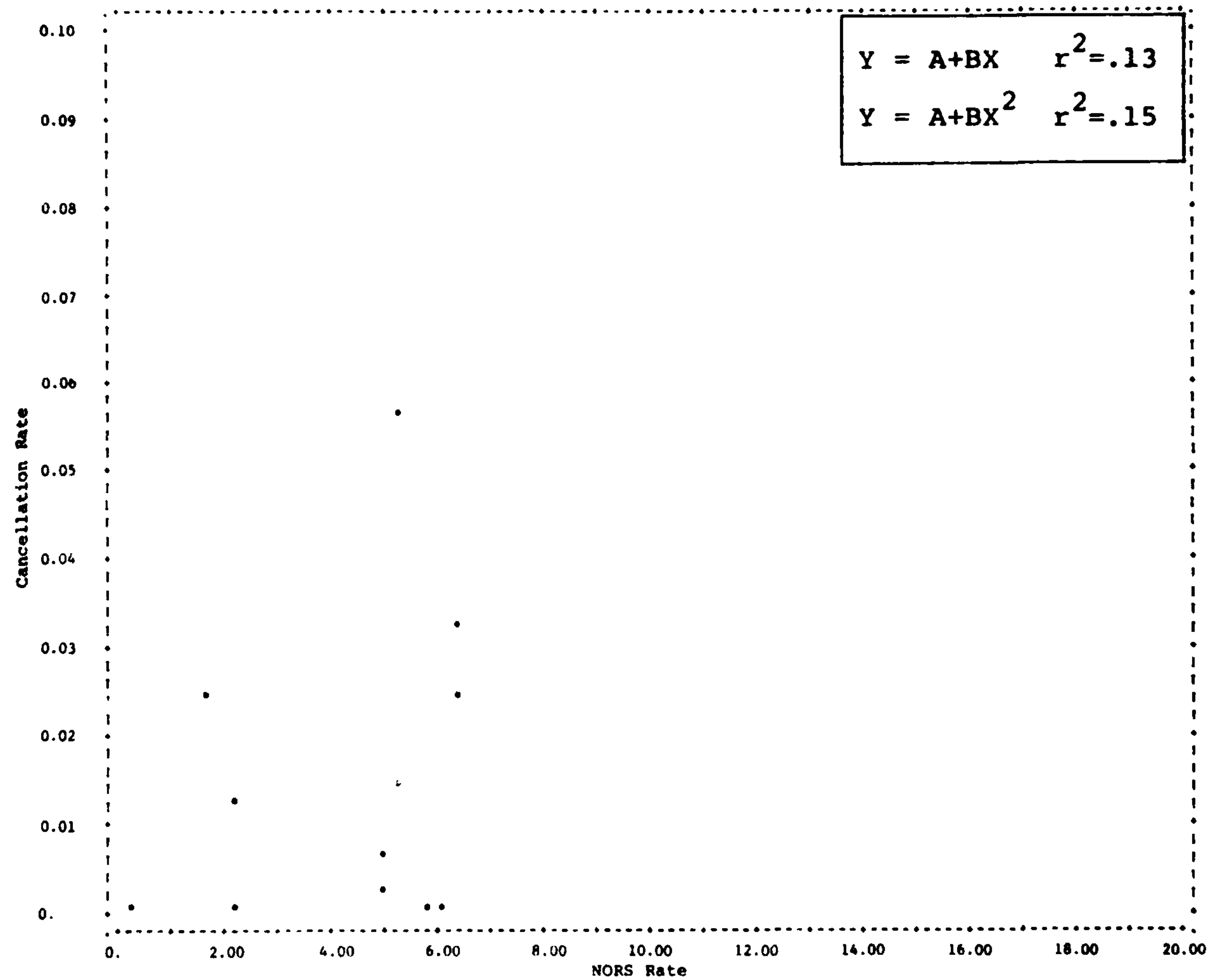

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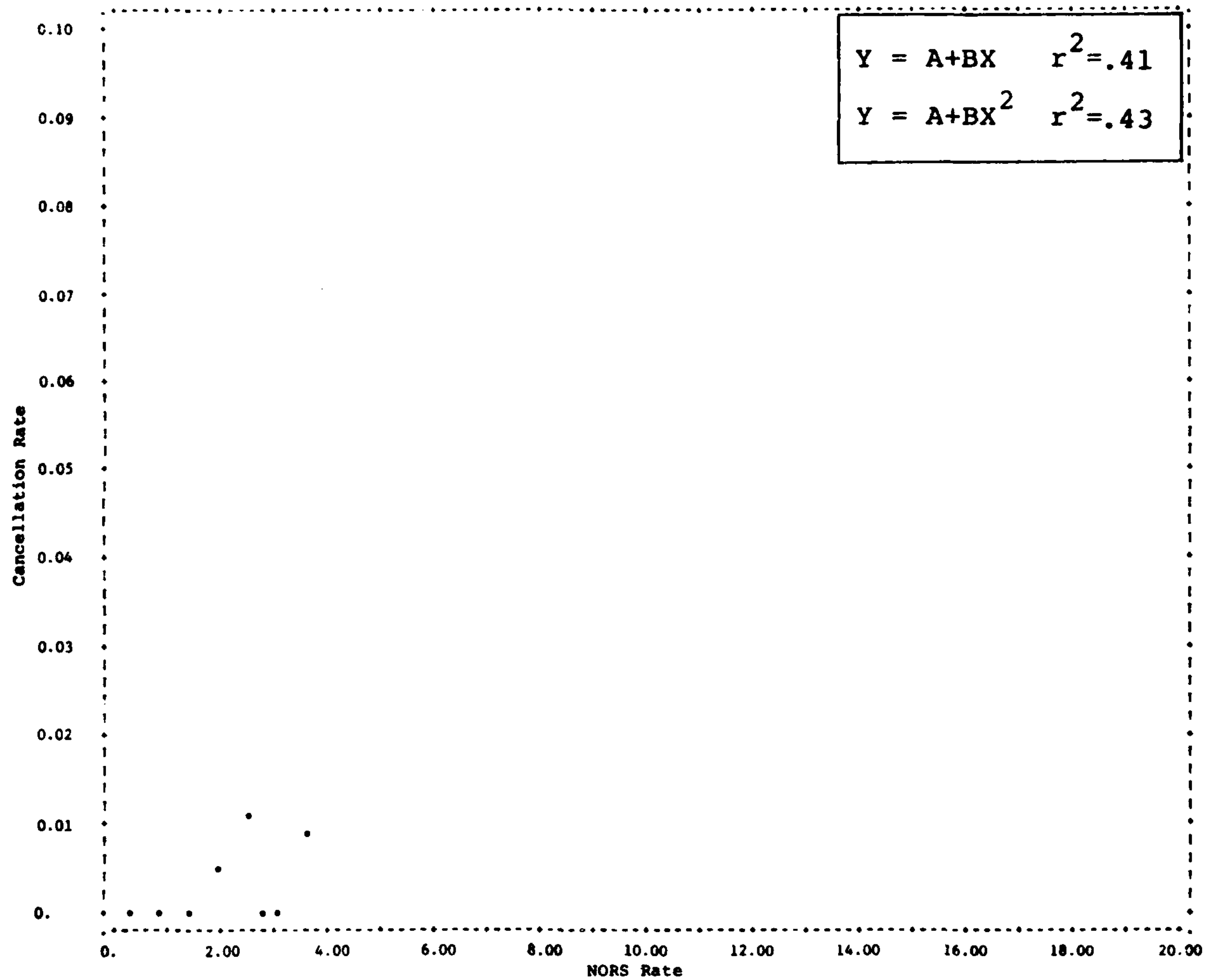

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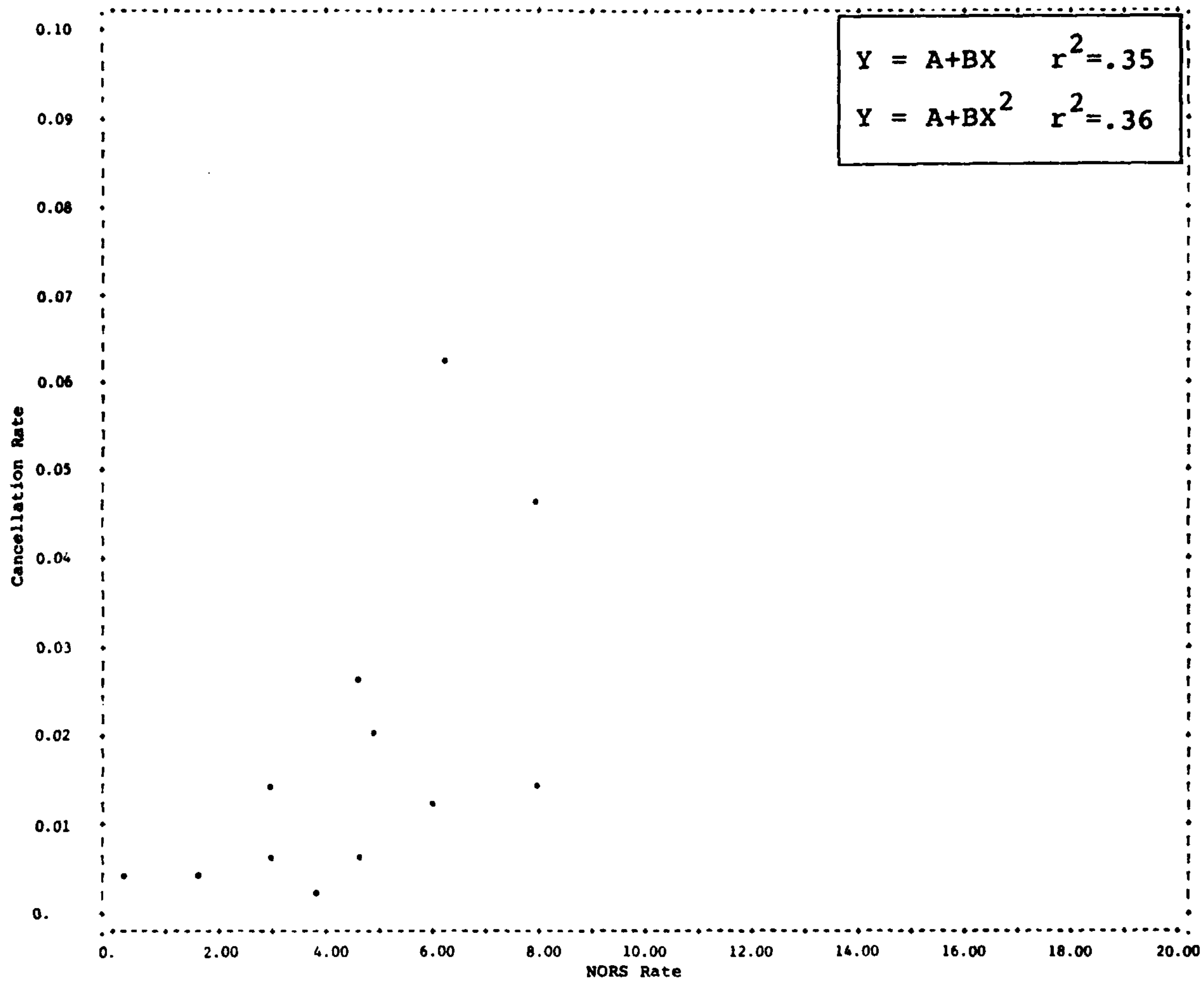

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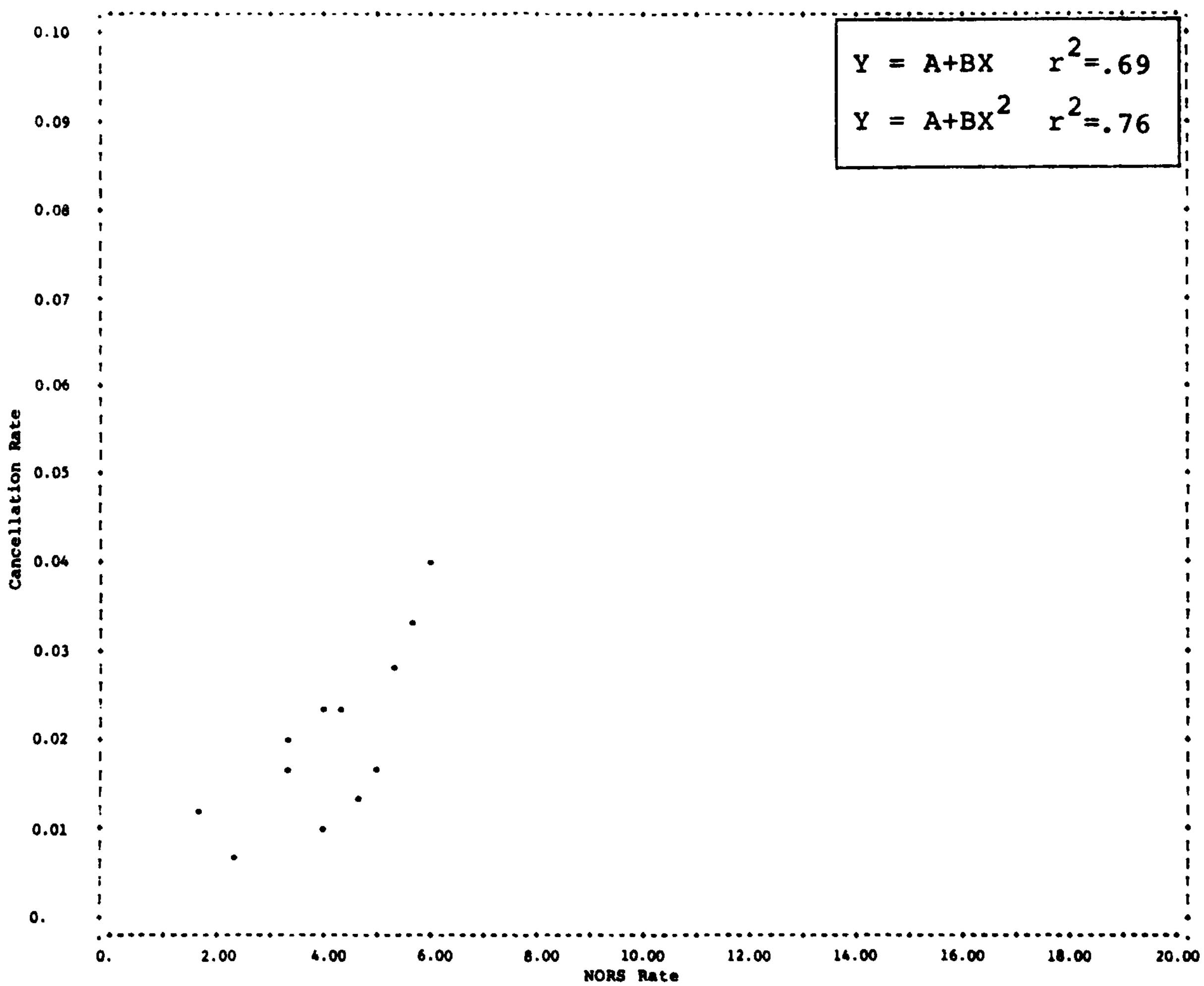

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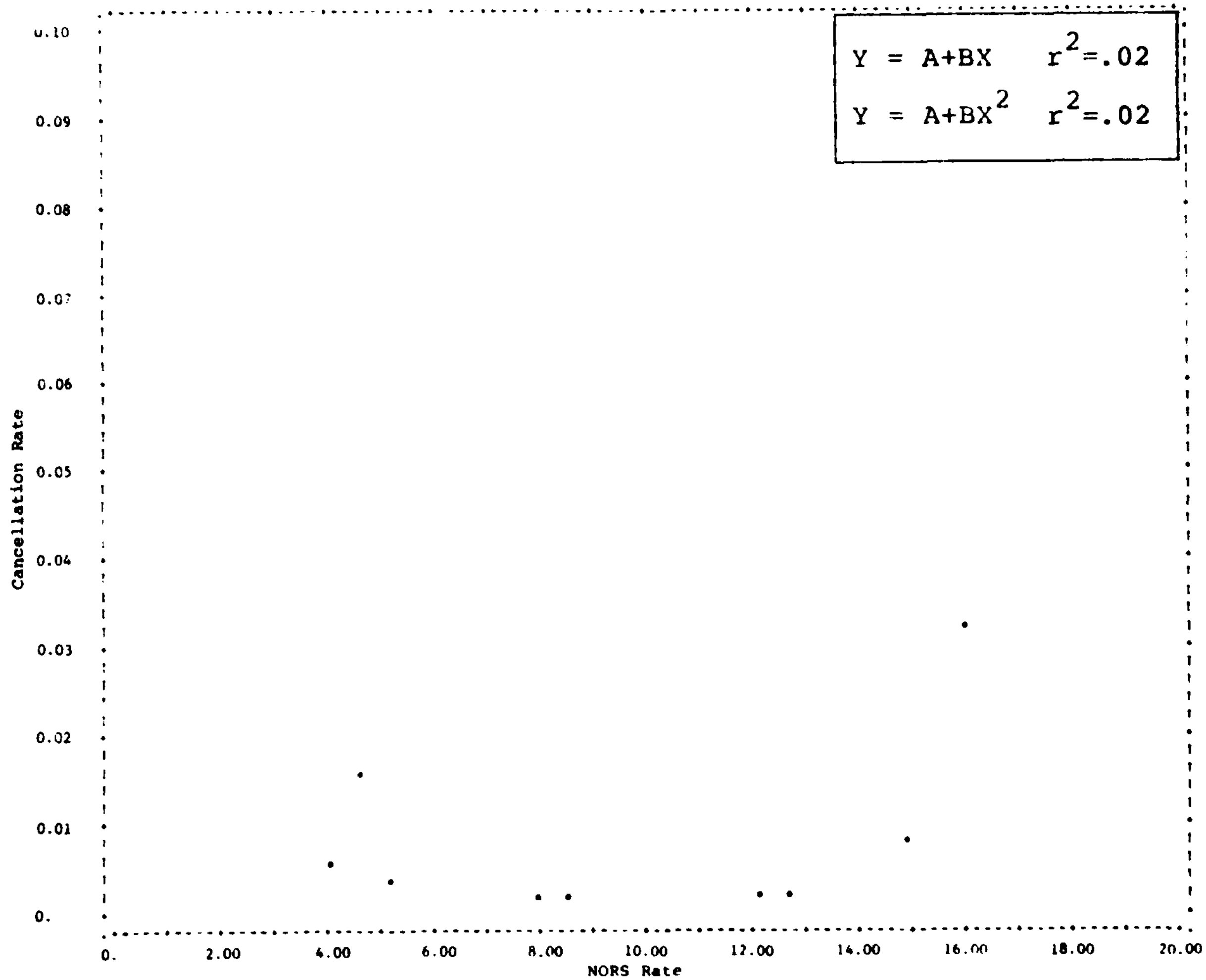
APPENDIX E

B-57 SCATTERGRAM



ADCOM, Malstrom, B-57, Avg. No. of Arcft. 16-22.

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