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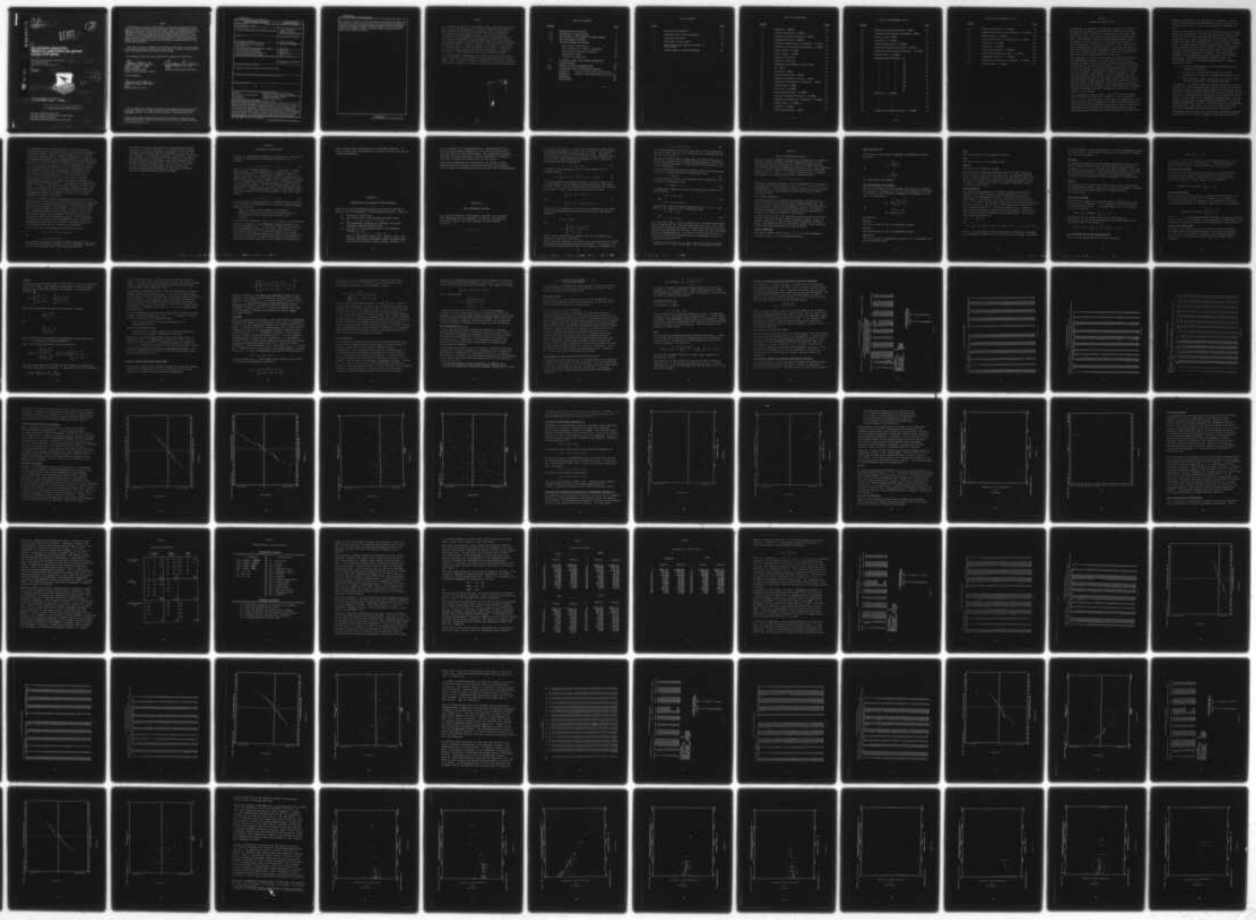

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Recent DOD experience shows that a prime factor in the evaluation of alternative weapon systems for performing a particular mission is Life Cycle Cost (LCC). Since 70% of the system LCC is determined by the end of the conceptual phase, it is important that techniques to predict LCC be available during that phase. Since system definition is not complete enough in this phase to perform detailed analysis using accounting models, the major tool which can be used is parametric estimating models. This report describes a model which relates the available design parameters to LCC via various cost estimating relationships (CERs).

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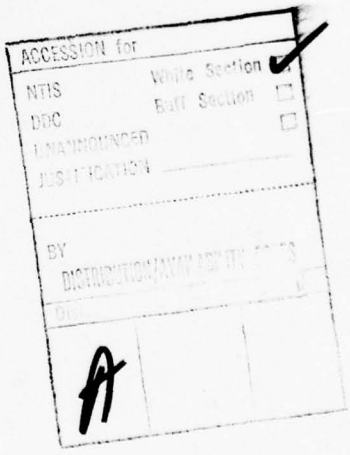
This document is Volume II of the Final Report which describes the mathematical and statistical techniques used to obtain the cost estimating relationships and parametric estimating relationships needed to develop the Avionic Laboratory Predictive Operations and Support (ALPOS) Cost Model. The Air Force Program Monitor was Lt Thomas G. James, Jr., System Evaluation Group (AFAL/AAA-3), Avionic Systems Engineering Branch.

PREFACE

This document is Volume II of the Final Report concerning the development of the Avionics Laboratory Predictive Operations and Support Model (ALPOS) by the Logistics Engineering Group, Westinghouse Integrated Logistics Support Division. This volume presents a discussion of the mathematical and statistical techniques used to obtain the cost-estimating relationships and parametric estimating relationships needed to develop the ALPOS Model, by means of Multiple Regression Analysis. Volume I presents a discussion of the "Design of the Experiment" and the development of the model, in addition to the model's source program listing and documentation. Volume III presents the consolidated data base used to develop the model.

The author wishes to acknowledge the technical contributions made by John P. Turek and E. Louis Wienecke in the development of the ALPOS Model. Also, the author wishes to acknowledge the computer programming assistance of Theresa B. Wallace of Westinghouse Logistics Engineering.



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SECTION I

INTRODUCTION AND OVERVIEW

Much research has been done in Government, Business, and Industry to obtain the capability to predict future occurrences (events). The need for such a capability is demonstrated by the time, money and, in some cases, lives, which can be saved using these predictions. For instance, studies are made to predict such things as the number of red blood cells in a blood sample based upon the packed-cell volume of the blood, the average grade a student makes on a standardized test based upon their I.Q.s, the death rate of males being exposed to the environmental conditions of a coal mine for over a 10 year period, the cost of a piece of avionics equipment based upon its physical characteristics, etc.

Past experience is usually the only means of predicting the future. The approaches to prediction can take forms ranging from hard objective evidence (which is rarely the case) to pure speculation. As an example of hard objective evidence, if you drop an apple from a cliff, most people will agree with the prediction that the apple will hit the ground. Accounting type models are useful estimating tools but require a large amount of detailed information. Such things as estimating the cost of a piece of equipment early in the conceptual/preliminary design phase, however, does not usually have the luxury of hard objective evidence or such detailed information on which to base decisions. Other approaches to prediction, such as the subjective approach, relies on the opinions of qualified experts in the field of study. And then of course, there is the "crystal ball" approach.

Once an estimate is made, however, there is an obvious question, "How accurate is the estimate?" Because of certain constraints (such as time, money and scope of the study) some approaches to estimation are the only ones possible, but there is a major drawback in that the merits of future predictions usually cannot be quantified. Mathematicians and statisticians have developed (and are still developing) many techniques for estimating purposes with particular

emphasis on quantifying the reliability of estimates. A major area of statistics that has been used for over a century is that of Regression Analysis. This is the approach to estimation we take.

Inherent in the interpretation of the words prediction or estimate is the term uncertainty. It would be nice to make "exact" predictions, but this is rarely the case when dealing with a mass of statistical data. Thus, statisticians do not profess to estimate exactly, but that their predictions are "on the average" reasonably close. The basic concept of Regression Analysis is then to estimate the average value of a given variable (called the dependent variable) in terms of the known values of one or more other variables (called independent variables). Regression Analysis expresses the relationships of these variables by determining the form of a mathematical equation connecting them. In other words, there are three major questions that are asked in Regression Analysis:

(1) Is there a relationship between the dependent and the independent variables?;

(2) If there is a relationship, how can it be "best" expressed in the form of a mathematical equation?; and

(3) What statistics, plots, techniques, etc., can be used to verify the accuracy of the equation obtained?

For instance, if a study is made to estimate the average weight of a female in a given university based upon her height, the procedure would be to select a "representative sample" of the females in the university, record both their heights and weights (the data) and try to fit the "best" mathematical relationship that connects weight to height. In many cases, as in estimating equipment costs, one independent variable does not provide enough information to accurately predict the dependent variable. Considering additional independent variables can, in most cases, lead to more accurate estimates, since more information should lead to better predictions.

The purpose of this study is to estimate the Operations and Maintenance (O&M) cost of avionics equipment, based upon the physical

characteristics of the equipment in addition to any current information available (such as the type of aircraft in which the equipment is used and the equipment's avionics area) early in the conceptual/preliminary design phase. The tool used to estimate avionics O&M costs is a computer model developed by the Logistics Engineering Section of Westinghouse for the Air Force Avionics Laboratory (AFAL), and is called the Avionics Laboratory Predictive Operations and Support (ALPOS) Model. The ALPOS model is highly dependent on the six estimating relationships obtained for the logistics, support and cost parameters: Maintenance Manhours per Operating Hour (MMH/OH); Mean Time Between Failure (MTBF); Mean Time Between Maintenance Actions (MTBMA); Logistic Support Costs per Operating Hour (LSC/OH); Training Cost per Operating Hour (TRAIN/OH); and the fraction Not Repairable this Station (NRTS). The approach was to collect data consisting of 21 independent variables covering a wide spectrum of avionics equipment, develop Cost-Estimating Relationships (CERs), i.e. Regression equations where the dependent variable is cost (LSC/OH, TRAIN/OH), and Parametric Estimating Relationships (PERs), Regression equations where the dependent variable is a parameter which drives cost (MTBF, MTBMA, MMH/OH, NRTS) by means of Multiple Regression Analyses. Other parameters which drive O&M cost, such as spares cost and support equipment cost, are not estimated using regressions, since there are many other subjective variables affecting these parameters that cannot easily be quantified. The relationships obtained for MTBMA and NRTS, however, are used in conjunction with an Expected Back Order (EBO) criteria to estimate the quantity of spares and hence spares cost. The interested reader is referred to Vol.I of this report for a look at "The Design of the Experiment" and the development of the ALPOS model, in addition to the approaches used to estimate spares costs and support equipment costs. This volume is mainly devoted to the Multiple Regression Analysis techniques used to obtain the estimating relationships for MMH/OH, MTBF, MTBMA, LSC/OH, TRAIN/OH and NRTS.

Since the six parameters considered are major drivers of Operations and Maintenance Cost, much emphasis has been placed on finding the most up to date approach to the subject of Regression Analysis.

The major reference noted throughout this report is a book written in 1971 by C. Daniel and F. S. Wood entitled Fitting Equations to Data [1], out of which evolved a most powerful computer program called "The Linear Least-Squares Curve-Fitting Program" (LLSCFP). As will be seen, the sophistication of the approach and techniques used in [1] is far beyond that of any standard statistics books and many advanced textbooks on Regression Analysis. The innovative use of "interior" statistics, "Indicator" variables and computerized plots are extremely helpful in leading a qualified statistician in the direction of obtaining the "best" estimating relationships that can be obtained from a given set of multifactor data.

The proposals presented in [1] have been successfully discussed in seminars at many distinguished worldwide universities as well as the Bell Telephone Laboratories and the National Cancer Institute. The LLSCFP has also been the most sought after program in both the SHARE (IBM) and VIM (CDC) libraries of computer programs, and has also been converted to run in East Germany and Russia. These techniques have been applied in a wide range of areas including studies by government agencies of variables for pollution control, searches for influential variables which cause cancer, studies to estimate hospital costs, studies in the conservation of energy and the evaluation of moon rocks at the Johnson Space Center. In addition a Bureau of Labor Statistics study has shown that the coefficients estimated by the LLSCFP are accurate to 15 digits. It is felt then that the proposals and techniques presented in [1] are the "state of the art" in Regression Analysis.

A word of caution however, is in order, in that the LLSCFP is not idiot proof and the cost analyst must remember that Regression Analysis is highly dependent on the "goodness" of the data and maybe to a greater extent on the assumed functional form of the equation. For if the assumed functional form is incorrect then the statistics will be misleading, giving the wrong values of the coefficients to be estimated, making uninfluential variables seem influential and possibly even dropping the most influential variables. Many examples

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[1] Fitting Equations to Data, Computer Analysis of Multifactor Data for Scientist and Engineers, C. Daniel and F. S. Wood with the assistance of J. W. Gorman, Wiley, (1971).

in Regression Analysis have an assured form of the estimating relationship based on a previous study or on technical knowledge of the process studied. However, there has been no previous study devoted to developing CERs for avionics equipment in as many as 21 independent variables, nor is enough known about avionics equipment that will lend to technical knowledge of the correct functional form. We must not stop here, but, should simultaneously consider all variables which are "assumed" to have an influential effect on the dependent variable, and let statistics and techniques lead the analyst in the direction of obtaining the equations that yield the best possible predictions. Many functional forms can be quite complicated, and for a given range of interest, transformations (such as, the square, the natural logarithm, the exponential, the square root, etc.) are often used to estimate these cases. To assist in obtaining the "best" possible equations, three forms or transformations of the independent variables (namely the variable, its square and its natural logarithm) and two forms of the dependent variable (the dependent variable and its natural logarithm) are used in this report.

It is to be emphasized that the independent variables are not considered one at a time or in pairs or any other grouping, but that they have all been considered simultaneously to determine their compound effect on the parameters to be estimated. It can be easily shown that a dependent variable can be highly correlated to one variable and no apparent correlation exists between another variable, but the compound effect of both variables (or many variables) has a significant effect on the dependent variable. Hence the practice of using scatter diagrams of the dependent variable versus each independent variable should not be used in determining the form of the equation when multiple variables are considered.

Thus, in this study such complicated functional forms as:

$$y = b_0 + b_1 x_1 + b_2 x_2^2 + b_3 \ln x_3 + \ldots$$

and

$$y = b_0 e^{b_1 x_1} e^{b_2 x_2^2} x_3^{b_3} \ldots .$$

are considered as means of estimating advanced equipment costs. Here y stands for the dependent variable, x_i's the independent variables, b_i's are the constants, and e the exponential function.

To assist in verifying the accuracy of the equations obtained, there are over thirty statistics, five types of plots, several techniques and different tabular arrangements of the data that are available in the computer printouts of the LLSCFP. This document includes a brief discussion of the concepts of Regression Analysis including the statistics, plots and techniques used to estimate advanced equipment costs. Also given, as an example, are the procedures and approaches utilized to obtain the parametric estimating relationship for the support parameter Mean Time Between Maintenance Actions (MTBMA).

SECTION II

THE METHOD OF LEAST-SQUARES

The form of the equations considered throughout this report can be written (or transformed) into the linear equation in $(\kappa + 1)$ - unknowns

$$y = \beta_0 + \beta_1 x_1 + \ldots + \beta_\kappa x_\kappa \quad , \tag{1}$$

where y is the dependent variable, $x_1, \ldots, x_\kappa$ and the κ - independent variables, β_0 (the constant) and κ - coefficient $\beta_1, \ldots, \beta_\kappa$ make up the unknown $(\kappa + 1)$ population parameters. Also it is assumed that there are N observations (pieces of equipment) in the sample indexed by j. Thus y_j represents the (observed) jth observation of the dependent variable and x_{ij} the jth observation of the ith independent variable. Regression Analysis requires that the analyst find statistics $b_0, b_1, \ldots, b_\kappa$ which "best" approximates the unknown $(\kappa + 1)$ population parameters (where we have taken a sample from the population of all avionics equipment), and whose fitted equation

$$Y = b_0 + b_1 x_1 + \ldots + b_\kappa x_\kappa \tag{2}$$

gives the "best" possible prediction. The method most widely used by statisticians to accomplish this is called the <u>method of least-squares</u>, which says:

> "Find the values of the constants in the assumed equation that minimize the sum of the squared deviations of the observed values from those estimated by the equation."

In other words, minimize $Q = \sum_{j=1}^{N} (y_j - Y_j)^2$, where Y_j is the estimate of the jth observation of the dependent variable obtained by (2). Once the estimates $b_0, b_1, \ldots, b_\kappa$ are found, substituting the values of the independent variables in (2) yields the estimate of the the dependent variable Y. We thus find ourselves in an area of statistics called "Inductive Statistics" which uses the concepts of "Statistical Inference" to make generalizations (or estimates) of population parameters based upon a given sample of the population,

and to quantify the reliability of the estimates obtained. In order to make these generalizations, however, the data must satisfy certain assumptions.

SECTION III

ASSUMPTIONS OF THE METHOD OF LEAST-SQUARES

There are four major assumptions which the data must satisfy in order to use the techniques of least-squares estimation. They are:

A1. The data is "good" data.

A2. The correct form of the equation has been chosen.
e.g., $y = \beta_0 + \beta_1 x_1 + \ldots + \beta_K x_K$

A3. The independent variables are constant, non-random variables, measured without error.

A4. All error is in the observations of the dependent variable y_j, i.e.

$$y_j = \beta_0 + \beta_1 x_1 + \ldots + \beta_K x_K + e_j$$

where e_j represents random error. Morever, the e_j are normally distributed independent random variables with mean zero and constant, though unknown, variance $\sigma^2(y)$.

If all the above four assumptions hold or "approximately" hold, then the least-squares approach will give the best estimates of the coefficients in the relationships. Past experiences, however, indicate that slight departure from the assumptions of normality and equal variances has little effect on the results.

Since these assumptions are the basis for the method of least-squares estimation and hence Regression Analysis, much emphasis must be placed in determining how close the data fits the assumptions.

SECTION IV

ONE INDEPENDENT VARIABLE

Very often in practice a relationship connecting two variables (one independent and one dependent) is desired. The equation most widely used is the linear equation (in two unknowns β_0 and β_1),

$$y = \beta_0 + \beta_1 x_1 \quad .$$

If all pairs of values of x_1 and y, when plotted in a scatter diagram on ordinary graph paper, fall on or near a straight line, equation (3) is the correct form of the relationship to be used. According to the least-squares cirteria, we must use the data to calculate statistics b_0 and b_1 which estimate the parameters β_0 and β_1, and whose fitted equation can be expressed by

$$y = b_0 + b_1 x_1 \tag{4}$$

In addition, the statistics b_0 and b_1 must be chosen so as to minimize Q where:

$$Q = \sum_{j=1}^{N} (y_j - Y_j)^2 = \sum_{j=1}^{N} (y_j - b_0 - b_1 x_{1j})^2 \quad . \tag{5}$$

By the techniques of differential calculus, the way to find b_0 and b_1 which minimize Q is to take partial derivatives of Q with respect to both b_0 and b_1, set the results equal to 0 and solve the equations for b_0 and b_1. Thus, taking partial derivatives we obtain

$$\sum_{j=1}^{N} (y_j - b_0 - b_1 x_{1j}) = 0$$

and

$$\sum_{j=1}^{N} (y_j - b_0 - b_1 x_{1j})(x_{1j}) = 0 \quad . \tag{6}$$

Solving the first equation of (4) for b_0 and substituting the results into the second equation yields the following linear least-squares estimates:

$$b_0 = \bar{y} - b_1 \bar{x}_1$$

and

$$b_1 = \frac{\sum_{j=1}^{N} (x_{1j} - \bar{x}_1)(y_j - \bar{y})}{\sum_{j=1}^{N} (x_{1j} - \bar{x}_1)^2} \quad , \tag{7}$$

where $\bar{y}$ and $\bar{x}_1$ represent the arithmetic mean of the dependent and independent variables respectively.

Scatter diagrams, however, do not always give an indication of an linear relationship, but show some evidence of curvature. For instance, the graph might indicate that the form of the equation is a parabola, i.e.,

$$y = \beta_o + \beta_1 x_1 + \beta_1 x_1^2 \qquad (8)$$

If a linear equation is fitted to data that is better represented by a curvilinear equation, then assumption A2 is volidated and the results can be spurious.

The use of a special type of graph paper (for which either one or both of the variables are calibrated logarithmically) called semi-log or log-log graph paper, is also helpful in choosing other forms of the relationship.

If in a scatter diagram plotted on semi-log paper, the observations fall near a straight line, then the exponential curve,

$$y = \beta_o e^{\beta_1 x_1} \quad , \qquad (9)$$

is the appropriate choice. If a straight line is obtained on log-log paper, the geometric curve,

$$y = \beta_o x_1^{\beta_1} \quad , \qquad (10)$$

is appropriate. Taking the natural logarithm of both sides of (9) and (10) yields

$$\ln y = \ln \beta_o + \beta_1 x_1$$

and (11)

$$\ln y = \ln \beta_o + \beta_1 \ln x_1$$

respectively. Using the simple transformation $y' = \ln y$, $x' = \ln x_1$ and $\beta_o' = \ln \beta_o$, equation (11) is transformed into

$$y' = \beta_0' + \beta_1 x_1$$

and (12)

$$y' = \beta_0' + \beta_1 x_1' \quad ,$$

which are both similar in form to equation (3), and whose coefficients can be estimated by (5). Thus, any functional forms (e.g. (8) or (9)) which can be linearized by simple transformations fall under the realm of least-square estimation techniques. Many other plots of linearizable equations (see [1] and [2]) are also useful in finding the correct functional relationship to be used when only one independent variable is considered to be influential.

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[2] "Fitting Curves to Data," A. E. Horel, Chemical Business Handbook (edited by J. H. Perry), McGraw-Hill, 1954, Section 20, pp. 55-77.

SECTION V

MULTIPLE REGRESSION ANALYSIS

When two or more independent variables are considered in a regression exercise, scatter diagrams and other graphical methods are often useless when trying to determine the form of the assumed equation. For instance, if the two independent variables x_1 and x_2 are considered, an x_1 - y scatter diagram might indicate a high linear relationship whereas the x_2 - y and x_1 - x_2 scatter diagram may show no apparent correlation, even though the true form after equation is

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \quad .$$

Therefore, graphical techniques are not considered as an alternative to finding the correct form of the equation to be tested (as required by assumption A2). If the correct form is not known, the analyst should try several forms of the equation, and let the statistics verify the correct form.

THE "GLOBAL" STATISTICS

As stated previously, in addition to estimating the coefficients, a means is needed to determine how "good" these estimates are. The statistics used to verify the "goodness of fit" of the relationships will be briefly defined with some general comments. The capital letters correspond to the respective names of these statistics as listed in the computer printouts of the LLSCFP.

We initially begin with a few elementary statistics which are quite helpful. They are the sums, means, maximums, minimums, ranges and standard deviations of the variables (both independent and dependent). With these statistics, the analyst can get a good indication of the distributional properites of the variables.

SUMS OF VARIABLES

The computer LLSCFP lists the sum, $\sum_{j=1}^{N} x_{ij}$, for each independent variable and $\sum_{j=1}^{N} y_j$ for the dependent variable.

MEANS OF VARIABLES

The arithmetic mean of each independent and dependent variable denoted by

$$\bar{x}_i = \frac{\sum_{j=1}^{N} x_{ij}}{N}$$

and

$$\bar{y} = \frac{\sum_{j=1}^{N} y_j}{N}$$

are listed under this heading.

ROOT MEAN SQUARES OF VARIABLES

The root mean squares of the variables (also called the standard deviation) is a statistic that can give an indication of the spread or variation of each variable, independent and dependent, in the data and is denoted by

$$S_{x_i}^2 = \frac{\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)^2}{N - 1}$$

and

$$S_y^2 = \frac{\sum_{j=1}^{N} (y_j - \bar{y})^2}{N - 1}$$

respectively.

MAX X(I)

The maximum value of the ith independent variable.

MIN X(I)

The minimum value of the ith independent variable.

RANGE X(I)

The range of the ith independent variable, i.e., the maximum value minus the minimum value.

MAX Y

The maximum value of the dependent variable.

MIN Y

The minimum value of the dependent value.

RANGE Y

The range of the dependent variable.

Many times these elementary statistics can give a quick indication that something is wrong with the data (e.g., an impossible maximum value). Recall Assumption A1 specifies that the data is "good" data. The simple statistics can be helpful in pinpointing which particular variables are causing such things as outliers (impossible values) to develop in the results.

COEFFICIENT B(I)

The least-squares estimates of a multiple regression equation are obtained in a similar fashion as those estimated for the linear-equation in one independent variable. The partial derivative of Q with respect to the constant b_o is taken and set to zero and solved for b_o. This result is then substituted into Q where partial derivatives of Q with respect to each of the κ - coefficients are taken and set to zero, thereby yielding a $\kappa \times \kappa$ system of equation in κ - unknowns. This system of equations is then solved by the methods of determinants to determine the desired estimates of the coefficients. The linear-least squares estimates are:

$$b_0 = \bar{y} - \sum_{i=1}^{\kappa} b_i \bar{x}_i$$

and

$$b_i = \sum_{j=1}^{N} y_j \{c_{i1} (x_{1j} - \bar{x}_1) + c_{i2} (x_{2j} - \bar{x}_2) + \ldots + c_{i\kappa} (x_{\kappa j} - \bar{x}_\kappa)\}$$

where c_{ij} is the element of the inverse matrix (obtained by the method of determinants) belonging to the ith row of the jth column. The LLSCFP

lists the constant b_0 and a coefficient b_i for each independent variable. The coefficient b_i can be used to determine the influence of variable x_i on the fitted equation.

RESIDUAL

The residual is defined as the difference between the observed value of the dependent value and the value estimated by the prediction equation, i.e., $y_j - Y_j$. Note that this simple statistic is the basis for least-squares analysis. Once the prediction equation is obtained, the residuals show how well the equation estimates the dependent variable for each observation (piece of equipment) in the data base.

FITTED Y

The statistic Y_j is called the fitted y-value of the jth observation of the dependent variable. This is the value of the dependent variable estimated by the prediction equation for each observation in the data base.

TOTAL SUM OF SQUARES

The total sum of squares in an initial step is trying to get a grip on the error of prediction. It is a measure of the total variation in the dependent variable. It is proportional to S_y^2, the variance of y and is defined:

$$\text{TOTAL SUM OF SQUARES} = \sum_{j=1}^{N} (y_j - \bar{y})^2 \quad .$$

The total sum of the squares can be partitioned into two useful sums, the sum of the squares due to the fitted equation and the residual sum of the squares, i.e.

$$\sum_{j=1}^{N} (y_j - \bar{y})^2 = \sum_{j=1}^{N} (Y_j - \bar{y})^2 + \sum_{j=1}^{N} (y_i - Y_j)^2$$

SUM OF SQUARES DUE TO THE FITTED EQUATION

The sum of the squares due to the fitted equation,

$$SSFE = \sum_{j=1}^{N} (Y_j - \bar{y})^2$$

is that part of the total variation in the dependent variable y that can be attributed to the fitted equation. A large SSFE indicates that the equation used is accounting for most of the variation.

RESIDUAL SUM OF SQUARES

The residual sum of the squares is that part of the total variation that cannot be attributed to the fitted equation (such things as experimental error, chance, function bias, i.e., having the wrong form of the equation, or other biases), and is defined as

$$\text{RESIDUAL SUM OF SQUARES} = \sum_{j=1}^{N} (y_j - Y_j)^2$$

RESIDUAL MEAN SQUARE

Recall Assumption A4 states that the y-observations have the same constant though unknown variance $\sigma^2(y)$, and hence, we need a means of estimating this variance of prediction. One estimate of $\sigma^2(y)$ called the residual mean square (or variance), denoted by $S^2(y)$, is defined as

$$\text{RESIDUAL MEAN SQUARE} = \frac{\sum_{j=1}^{N} (y_j - Y_j)^2}{N - \kappa - 1}$$

where $N - \kappa - 1$ is the RESIDUAL DEGREES OF FREEDOM. The degrees of freedom of a statistic is the number of independent bits of observations minus the number of parameters estimated in the calculation of the statistic.

RESIDUAL ROOT MEAN SQUARE

The square root of the residual mean square is called the RESIDUAL ROOT MEAN SQUARE (or standard deviation). This can be interpreted in a similar way as the standard deviation of the prediction equation. The residual root mean square is also called the Standard Error of Estimate.

STANDARD ERROR OF THE COEFFICIENT

Since each of the coefficients obtained by the method of least-squares are only estimates, the accuracy and importance of each estimate must be shown. From the equation which calculates b_i, it can be shown that the variance of the b_i, denoted by $S^2(b_i)$ can be written in the form

$$S^2(b_i) = S^2(y)\ C_{ii} \quad ,$$

where C_{ii} is the ith diagonal element of the inverse matrix. The square root of the variance of b_i, $S(b_i)$, is called the standard error of the coefficient and is calculated by the formula

$$\text{S.E.COEF.} = S(y)\ (C_{ii})^{\frac{1}{2}} \quad .$$

The standard error of the coefficient gives an indication of the "inherent" precision of the coefficient estimated. If a coefficient is large, say 1,000 with a standard error of .1, we could say that the coefficient is estimated with great precision. However, a coefficient of say .2 with a standard error of .1 is obviously not as precise an estimate. Therefore, a means of determining the relative accuracy of each coefficient is needed.

T-VALUE

The statistic used to measure the relative accuracy of each of the coefficients is called the T-VALUE (denoted by t_i) and is defined by

$$\text{T-VALUE} = \frac{b_i}{S(b_i)} = \frac{\text{COEF B(I)}}{\text{S.E.COEF.}}$$

The LLSCFP lists a T-VALUE for each coefficient. The larger the coefficients t_i - value (as compared with the other t-values), the more chance variable x_i will be in the final fitted equation.

RELATIVE INFLUENCE OF EACH INDEPENDENT VARIABLE

A statistic called the relative influence of x_i, describes the fraction of the total change in Y that can be accounted for by the accompanying total change in the ith independent variable and is defined as

$$\text{REL.INF.X(I)} = \frac{b_i w_i}{w_y} \quad ,$$

where $b_i \equiv$ COEF B(I) is the coefficient, w_i = RANGE X(I) is the range of the independent variable and w_y is the range of the dependent variable.

MULTIPLE CORRELATION COEFFICIENT SQUARED

The total sum of the squares, sum of squares due to the fitted equation and residual sum of the squares will have different values for different equations. The most widely used statistic which gives a relative measure of the "goodness of fit" of the assumed equation is the multiple correlation coefficient squared (denoted by R_y^2) where

$$\text{MULT.CORREL.COEF.SQUARED} = \frac{\text{SSFE}}{\text{TOTAL SUM OF SQUARES}} .$$

The multiple correlation coefficient squared (also called the coefficient of determination) is defined as that fraction of the total sum of the squares that can be attributed to the fitted equation. If $R_y^2 = 1$ we are fortunate to have a "perfect" fit and if $R_y^2 = 0$ the fitted equation does not fit the data at all. In most cases the multiple correlation coefficient squared will fall between the values of 0 and 1, and here interpretation is necessary.

For instance, if a straight line is fitted to a pair of data points when the correct form of the equation should be exponential (i.e., a logged dependent variable), a low R_y^2 does not indicate that there is "no" relationship between the data, but that the relationship used does not adequately represent the data. Thus the multiple correlation coefficient squared measures the degree of the relationship relative to the equation used. Sometimes, however, a large R_y^2 such as .90 can occur when the wrong form of the equation is chosen (examples will be given). Therefore a specific value of R_y^2 that indicates a "good" fit is not given. Although the multiple correlation coefficient squared is the most widely used statistic that measures the accuracy of the relationships, it means very little to this analyst when considered alone. It should be considered in conjunction with all other statistics, graphical representations of goodness of fit, and techniques used to determine the stability of the equations.

F-VALUE

A statistic used to determine the "significance" of R_y^2 is the statistic called the F-VALUE. The F-VALUE is usually used to judge the equivalence of two independent estimates of variance. It can be easily be shown that

$$R_y^2 = \frac{\sum_{j=1}^{N} (Y_j - \bar{y})^2}{\sum_{j=1}^{N} (y_j - \bar{y})^2} = 1 - \frac{\sum_{j=1}^{N} (y_j - Y_j)^2}{\sum_{j=1}^{N} (y_j - \bar{y})^2}$$

and therefore indicates that the two estimates of variance

$$\frac{\sum_{j=1}^{N} (Y_j - \bar{y})^2}{\kappa}$$

and

$$\frac{\sum_{j=1}^{N} (y_j - Y_j)^2}{N - \kappa - 1}$$

should be helpful in determining the significance of R_y^2, where κ and $N - \kappa - 1$ are degrees of freedom respectively.

Hence, the F-VALUE is defined by the variance ratio,

$$\text{F-VALUE} = \frac{\dfrac{\sum_{j=1}^{N} (Y_j - \bar{y})^2}{\kappa}}{\dfrac{\sum_{j=1}^{N} (y_j - Y_j)^2}{N - \kappa - 1}} = \left(\frac{N - \kappa - 1}{\kappa}\right) \frac{\sum_{j=1}^{N} (Y_j - \bar{y})^2}{\sum_{j=1}^{N} (y_j - Y_j)^2} ,$$

which indicates that the larger SSFE is with respect to RESIDUAL SUM OF SQUARES, the larger the F-VALUE. An equivalent form of the F-VALUE is

$$\text{F-VALUE} = \left(\frac{N - \kappa - 1}{\kappa}\right) \frac{R_y^2}{(1 - R_y^2)} .$$

If R_y^2 is close to 1 then $1 - R_y^2$ is close to 0 and the F-VALUE is large. Of course the question must be answered, "How large is large enough?" This question can be answered by performing the statistical hypothesis test called the F-Test.

In performing a statistical test, a level of significance is usually assumed, denoted by the Greek letter α. The level of significance is the amount of risk that the analyst is willing to take in rejecting a true hypothesis. The values of α which are usually assumed are .05 (The test would be called "probably significant" and further experimentation may be in order.) and .01 (The test is called "highly significant."). Throughout this report $\alpha = .01$ is the assumed level of significance.

The F-Test compares the F-VALUE with values from an F-Table (in most standard statistics books) with κ and $N - \kappa - 1$ degrees of freedom, to give a joint test of the hypothesis that:

> "all the coefficients of the fitted equation are 0" (indicating a bad fit).

against the alternative that

> "the equation as a whole produces a significant reduction in the total sum of square" (indicating a good fit).

Suppose for a given fit the F-VALUE = 10.8 where there are $N = 15$ observations and $\kappa = 3$ independent variables ($\alpha = .01$). From an F-table, a value (based on $\kappa = 3$ numerator degrees of freedom and $N - \kappa - 1 = 11$ denominator degrees) of 6.22 can be extracted. Since 10.8 is greater than 6.22 the fit is considered significant. The larger the F-VALUE is with respect to its associated tabular value, the more significant the fit.

SIMPLE "LINEAR" CORRELATION COEFFICIENT

A statistic (similar to the multiple correlation coefficient squared) which gives an indication of how any two variables are linearly related is the simple "linear" correlation coefficient

$$r_{12} = \left(\frac{\sum_{j=1}^{N} (x_{1j} - \bar{x}_1)(x_{2j} - \bar{x}_2)}{\sum_{j=1}^{N} (x_{1j} - \bar{x}_1)^2 \sum_{j=1}^{N} (x_{2j} - \bar{x}_2)^2} \right)^{\frac{1}{2}}$$

which is a measure of the linear interdependence between any two variables. The simple linear correlation coefficient is a number between -1 and +1, where $r_{12} = 1$ indicates positive linear correlation, $r_{12} = -1$ indicates a negative linear correlation, and $r_{12} = 0$ indicates that there is no linear relationship between the two variables. Again, note that $r_{12} = 0$ does not indicate that there is "no" correlation between the variables, but that no linear correlation exists.

R(I) SQRD

There are obviously many problems in which more than two independent variables are assumed to be influential, and it is very informative to see how all the independent variables are linearly related to each other. A statistic (which is a generalization of r_{12}) that gives an indication of how the ith independent variable is linearly related to all the other (κ - 1) - independent variables, is the squared multiple "linear" correlation coefficient R_i^2. Here with variable x_i as the dependent variable and the remaining (κ - 1) independent variables, we fit a simple linear equation and calculate the multiple correlation coefficient squared which is R_i^2. Thus R_i^2 measures the degree of linear dependence of x_i or the other $x_{i'}$, $i' \neq i$, where $R_i^2 = 1$ indicates that a strong linear relationship between x_i and the other $x_{i'}$'s. If only two independent variables are considered then

$$R_1^2 = r_{12}^2 = r_{21}^2 = R_2^2$$

It can be shown that C_{ii} (the element of the inverse matrix in the ith row and jth column) may be written as

$$C_{ii} = \frac{1}{\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)^2 (1 - R_i^2)}$$

This leads to a relationship between the standard error of the coefficient b_i, $s(b_i)$ (S.E.COEF) and the squared multiple linear correlation coefficient, R_i^2 (R(I)SQUARED), namely

$$s(b_i) = \frac{s(y)}{\sqrt{\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)^2 \ (1 - R_i^2)}} \quad .$$

With the form of the equation chosen, $s(y)$ and $\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)^2$ are constant and determined by the data, and R_i^2 therefore determines the size of $s(b_i)$. If R_i^2 is close to 1, then $1 - R_i^2$ is close to 0 which increases the size of the standard error of the coefficient, $s(b_i)$. A large $s(b_i)$ will result in a small t_i-value, thus possibly dropping x_i from the set of influential variables to be used in the final prediction equations. Some independent variables are simply uninfluential in their effect on the dependent variable and will be dropped (by using a technique called the Cp-search technique), while other independent variables may be so highly correlated (linearly) to the remaining independent variables that their effects on the dependent variable can be explained by the remaining variables.

THE D-STATISTIC

Many times the statistics and plots will indicate some form of lack of fit of the assumed equation. This lack of fit may be caused by having the wrong form of the equation, sometimes called function bias. For instance, we may be fitting a straight line to a set of paired data when actually a parabola is the correct form, i.e., a squared term is needed in the equation. If the statistics and plots indicate that curvature in a particular variable x_i is needed, x_i^2 can be used as an additional independent variable. Usually $(x_i - \bar{x}_i)$ and $(x_i - \bar{x}_i)^2$ can be used as independent variables to reduce the high correlation between x_i and x_i^2, resulting in an unwanted large R_i^2. Sometimes, however, the mean $\bar{x}$ does not sufficiently reduce the high correlation between a variable and its square. A

statistic d_i (called the d-statistic) due to O. Dykstra [1], which requires that the covariance between $(x_i - \bar{x})$ and $(x_i - d_i)^2$ to be zero, can be used to reduce such high correlations. This reduces to solving

$$\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)\,(x_{ij} - d_i)^2 = 0$$

for d_i, which yields

$$d_i = \frac{\sum_{j=1}^{N} x_{ij}^2\,(x_{ij} - \bar{x})}{2\sum_{j=1}^{N} (x_{ij} - \bar{x}_i)^2} \quad .$$

In this case we use $(x_i - \bar{x})$ and $(x_i - d_i)^2$ as the independent variables. If $\bar{x}_i$ is used instead of d_i, a large R_i^2 for either the variable or its square may occur, thereby possibly dropping the variable and/or its square as being uninfluential variables, when in fact both may be influential variables. Through this report, the d_i-statistic is used if there is an indication of curvature in the relationships.

THE CP-STATISTIC, $P = \kappa + 1$

In many cases when multiple variables are considered, not enough previous work has been done in the area of study to be sure that all the independent variables are influential, but that possibly a subset collection of the variables fit the data "better" or as "good" as the initial set. If there are $\kappa = 18$ independent variables, then there are $2^{18} = 262{,}144$ possible combinations of variables whose equation must be compared.

A major innovative statistic due to C. Mallows ([1] and [3]) called the C_p-statistic, is used as a measure of "goodness of fit" to compare all the possible 2^{κ} combinations of equations for the "set" of equations which best fits the data. The C_p-statistic represents the "total squared error (random squared error and bias squared error)" and is defined as

---

[3] "Choosing Variables in a Linear Regression: A Graphical Aid," C. L. Mallows, presented at the Central Regional Meeting of the Institute of Mathematical Statistics, Manhattan, Kansas, May 7-9, 1964.

$$C_p = \frac{\text{RESIDUAL SUM OF SQUARES}}{\text{RESIDUAL MEAN SQUARE}} - N + 2p \quad .$$

A C_p-statistic is calculated for each equation. Note that for every variable dropped, the C_p-statistic can decrease by at most 2 units. For the derivation of C_p see [1] and [3].

PRECISION OF X(I)

This statistic is a new statistic not now in the statistical cannon. A paper to be published in the near future by F. S. Wood will introduce it and, hence will not be discussed here.

THE "INTERIOR" or "LOCAL" STATISTICS

All the previous statistics discussed fall under the heading of "global" statistics in that they are statistics of the entire set of data. The "global" statistics are helpful in determining how the independent variables influence the fitted equations, but they do not describe how the observations (the interior of the data) in multifactor space affect the fit. Four innovative "interior" statistics which have been developed (see [1]) can assist in such things as detecting outliers; indicating observations which may influence the form of the equation (possibly introducing curvature); detecting those observations which have the largest effect on the assumed equation, finding those observations which are taken approximately under the same x_i-conditions (called nearby neighbors) and in testing the validity of the "global" statistics. These nearby neighbors are used to obtain a less biased estimate of our error of prediction, $\sigma^2(y)$. The interior statistics defined are weighted by the b_i - values so as to reduce the effects of uninfluential factors.

WSS DISTANCE (Weighted Squared Standardized Distance)

An observation whose points are at the extreme ends of the independent variables are usually far from the "centroid" of all the observations of the data. For instance, a piece of equipment may have a much larger (or smaller) weight than all the rest of the data. A statistic called the Weighted Squared Standardized Distance (WSS DISTANCE), defined by

$$\text{WSS DISTANCE} = \sum_{i=1}^{K} \frac{b_i (x_{ij} - \bar{x}_i)}{s(y)}^2 ,$$

is useful in detecting those observations which are far from the centroid of all the observations. These observations (with large WSS DISTANCE) may indicate that outliers are present or possibly that curvature is needed in the equation.

COMPONENT EFFECTS, C_{ij}

The statistic C_{ij}, where

$$C_{ij} = b_i (x_{ij} - \bar{x}_i) ,$$

may be defined as the component effects of x_i (the ith independent variable) on y_j (the fitted value of observation j). A nice tabular arrangement (See "COMPONENTS EFFECTS" TABLE) of the components effects assists the analyst in determining the influence that each particular observation has on the fitted equation. This is helpful in the analysis of trade studies.

WSSD

In some cases the observations may have nearly the same x_i - values (for instance similar pieces of equipment) and can be considered as being "close" to each other in multidimensional factor space (nearby neighbors). The statistic

$$WSSD_{jj'} = \sum_{i=1}^{K} \frac{b_i (x_{ij} - x_{ij'})^2}{S(y)} = \frac{1}{S^2(y)} \sum_{i=1}^{K} (C_{ij} - C_{ij'})^2$$

measures the (squared) distance in "effect space" between two observations j and j'.

This statistic is also helpful in detection of what is known as "Nested Data." If the analyst determines that his data is nested, additional things must be considered to find the correct form of the equations (See [1]).

CUMULATIVE STANDARD DEVIATION ESTIMATED FROM NEAR NEIGHBORS

Recall that as a "global" estimate of random error of prediction, the residual mean square (variance) or the residual root mean square (standard deviation) was used. Sometimes the inner characteristics of the data may indicate that these are not very good estimates. The statistic WSSD identifies those near neighbors which are used to obtain a less biased running estimate, S_n, of S(y) called the standard deviation estimated from near neighbors where

$$S_n = \frac{.886 \ (\sum_n \Delta_n d)}{n} \quad .$$

Here $\Delta_n d$ is the absolute value of the differences of the residuals of the neighboring observations, and the value .886 = 1/1.28 is used since the expected value of the range for pairs of independent observations from a normal distribution is 1.128. If the residual root mean square is close to the successive estimates of cumulative standard deviation S_n, there is then no evidence of lack of fit of the proposed equation.

STATISTICAL PRINTOUTS AND TABLES

The statistics are printed out in an orderly manner which the analyst can use to further evaluate the fit of an equation. A partial printout of the statistics on the equation obtained for the fit of the dependent variable MAINTENANCE MANHOURS PER OPERATING HOUR, where Y1 = MMH/OH, is shown in Figures 1 to 4. Figure 1 shows many of the global statistics, including the coefficients b_i, $S(b_i)$, t_i and the relative influence of x_i for each independent variable x_i. In addition R_y^2, the F-VALUE and the residual root mean square are displayed.

OBSERVATIONS ORDERED BY COMPUTER INPUT AND BY RESIDUALS

As shown in Figure 2, under the heading "ORDERED BY COMPUTER INPUT," the residuals are listed in the order in which the observations were given to the computer. The Work Unit Code (WUC) of each piece of

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR IS Y1 MIN Y = 8,336D-04 MAX Y = 4,563D-01 RANGE Y = 4,554D-01

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

Y1 = B(0) + B(1)X5 + B(2)X6 + B(3)X7 + B(4)X13 + B(5)X18 + B(6)X9M
+ B(7)X13M + B(8)X14M + B(9)X15M + B(10)X16M + B(11)X21M
+ B(12)X9DSQ + B(13)X13DSQ + B(14)X14DSQ + B(15)X15DSQ
+ B(16)X16DSQ + B(17)X21DSQ + B(18)LNX8 + B(19)LNX18

Y1 = MMH/OH (MAINTENANCE MANHOURS PER OPERATING HOUR)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		-1,951150-01							
1	X5	-4,512210-02	2,320-02	1,9	0,2678	-2,134D-01	5,326D-01	7,460D-01	0,07
2	X6	-7,747450-02	2,690-02	2,9	0,4116	-2,317D-01	5,783D-01	8,100D-01	0,14
3	X7	-6,499260-02	2,530-02	2,6	0,3296	-2,057D-01	6,043D-01	8,100D-01	0,12
4	X13	1,622920-03	3,510-04	4,6	0,7724	0,0	1,000D 02	1,000D 02	0,35
5	X18	-3,346950-04	1,400-04	2,4	0,5777	0,0	1,000D 02	1,000D 02	0,07
6	X9M	-8,613690-05	1,220-05	5,4	0,9634	-1,488D 03	6,762D 03	8,170D 03	1,19
7	X13M	4,628710-03	6,610-04	7,0	0,9672	-3,388D 01	1,387D 02	1,725D 02	1,75
8	X14M	1,872280-03	3,490-04	5,4	0,9117	-6,272D 01	3,730D 01	1,000D 02	0,41
9	X15M	1,209830-03	3,440-04	3,5	0,8817	-1,698D 01	8,490D 01	1,000D 02	0,26
10	X16M	1,543680-03	4,070-04	3,8	0,7162	-3,438D 00	9,657D 01	1,000D 02	0,34
11	X21M	1,249280-03	5,390-04	2,3	0,6835	-4,830D 00	5,617D 01	6,100D 01	0,17
12	X9DSQ	1,781120-08	2,450-09	7,0	0,8466	0,181D 04	2,394D 07	2,388D 07	0,89
13	X13DSQ	-1,292830-05	5,210-06	2,5	0,8362	1,840D 00	1,195D 04	1,195D 04	0,34
14	X14DSQ	-3,335810-05	8,140-06	5,4	0,5764	4,000D-02	2,561D 03	2,561D 03	0,19
15	X15DSQ	3,568220-05	7,930-06	4,5	0,4176	5,476D 01	2,873D 03	2,818D 03	0,22
16	X16DSQ	-8,386870-05	3,910-05	2,1	0,4329	1,750D 03	2,517D 03	7,673D 02	0,14
17	X21DSQ	5,781680-05	2,760-05	2,1	0,4833	6,288D 01	1,161D 03	1,098D 03	0,14
18	LNX9	7,478670-02	1,830-02	4,1	0,9689	3,491D 00	9,012D 00	5,611D 00	0,92
19	LNX18	-4,981970-02	1,970-02	2,5	0,9672	1,823D-01	5,157D 00	4,975D 00	0,54

NO. OF OBSERVATIONS	63
NO. OF IND. VARIABLES	19
RESIDUAL DEGREES OF FREEDOM	43
F-VALUE	28,5
RESIDUAL ROOT MEAN SQUARE	0,03915483
RESIDUAL MEAN SQUARE	0,00099927
RESIDUAL SUM OF SQUARES	0,03999842
TOTAL SUM OF SQUARES	0,39298338
MULT. CORREL. COEF. SQUARED	,9885

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-3
7	-2
8	-2
9	-2
10	-2
11	-2
12	-7
13	-4
14	-4
15	-4
16	-3
17	-3
18	1
19	1

FIGURE 1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR IS Y1

IDENT.	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL
71B2A	1	19.	0.034	0.031	0.003
7353A	2	8.	0.031	0.067	-0.036
71L8A	3	9.	0.051	0.100	-0.049
71M5A	4	23.	0.058	-0.003	0.060
71PKA	5	9.	0.049	0.073	-0.024
71P8A	6	7.	0.026	0.061	-0.034
71710	7	82.	0.003	-0.035	0.038
724GA	8	89.	0.002	0.028	-0.026
71G5A	9	20.	0.032	0.023	0.009
71FAA	10	53.	0.034	0.042	-0.008
71F8A	11	35.	0.019	0.002	0.017
71CAA	12	55.	0.005	-0.016	0.021
710A0	13	6.	0.055	0.055	-0.001
714BE	15	42.	0.011	0.027	-0.016
714DA	17	34.	0.211	0.176	0.035
7308A	18	233.	0.176	0.209	-0.033
71ACC	19	91.	0.015	0.036	-0.021
73C8Q	20	142.	0.004	-0.009	0.013
73CEN	21	63.	0.005	0.031	-0.026
73CFK	22	527.	0.456	0.422	0.034
730AM	24	64.	0.077	0.056	0.021
73E8A	25	75.	0.009	0.023	-0.014
73EHF	26	30.	0.070	0.066	0.004
71CAA	27	29.	0.224	0.179	0.044
72EAA	28	227.	0.168	0.186	-0.019
72ECA	29	94.	0.031	0.049	-0.018
728PA	31	69.	0.208	0.188	0.019
71JAA	32	27.	0.090	0.033	0.057
71LAA	33	16.	0.105	0.095	0.010
720NA	34	36.	0.067	0.071	-0.004
72AC8	35	17.	0.037	0.087	-0.050
71716	36	44.	0.011	0.016	-0.005
7131D	37	29.	0.171	0.179	-0.008
72RF8	38	63.	0.026	0.029	-0.003
72A8P	39	43.	0.005	0.031	-0.026
75938	40	82.	0.008	-0.018	0.026
74BDA	41	18.	0.065	0.067	-0.003
74BFA	42	78.	0.050	0.044	0.006
74810	43	49.	0.004	0.019	-0.014
76A10	44	23.	0.012	0.029	-0.017
76GAA	45	49.	0.048	0.051	-0.003
74FF8	46	66.	0.050	0.049	0.001
74FAA	47	603.	0.237	0.242	-0.005
74FHA	48	58.	0.083	0.080	0.003
74FUA	49	218.	0.174	0.190	-0.016
77EC8	50	16.	0.046	0.074	-0.028
77EE0	51	78.	0.001	-0.007	0.008
770CA	52	13.	0.024	0.017	0.007
77D80	53	78.	0.001	-0.007	0.009
73CRA	54	42.	0.003	0.007	-0.004
73CGA	55	44.	0.017	0.012	0.005
71NA8	56	7.	0.143	0.105	0.038
710UA	57	7.	0.094	0.105	-0.012
63AAP	58	6.	0.109	0.097	0.012
65AAP	59	25.	0.062	0.079	-0.017
638AA	60	19.	0.052	0.107	-0.055
63CAA	61	19.	0.168	0.107	0.061
659AA	62	20.	0.052	0.054	-0.002
6188A	63	27.	0.079	0.064	0.015
658AA	64	19.	0.054	0.053	0.002
63AA9	65	8.	0.089	0.092	-0.003
63121	67	19.	0.120	0.106	0.014
63AAA	68	49.	0.030	0.025	0.005

OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEG
61	0.168	0.107	0.061	1
4	0.058	-0.003	0.060	2
32	0.090	0.033	0.057	3
27	0.224	0.179	0.044	4
7	0.003	-0.035	0.038	5
56	0.143	0.105	0.038	6
17	0.211	0.176	0.035	7
22	0.456	0.422	0.034	8
40	0.008	-0.018	0.026	9
24	0.077	0.056	0.021	10
12	0.005	-0.016	0.021	11
31	0.206	0.188	0.018	12
11	0.019	0.002	0.017	13
63	0.075	0.060	0.015	14
67	0.120	0.106	0.014	15
28	0.004	-0.009	0.013	16
58	0.109	0.097	0.012	17
33	0.105	0.095	0.010	18
53	0.001	-0.007	0.009	19
9	0.032	0.023	0.009	20
51	0.001	-0.007	0.008	21
52	0.024	0.017	0.007	22
42	0.050	0.044	0.006	23
68	0.030	0.025	0.005	24
55	0.017	0.012	0.005	25
26	0.070	0.066	0.004	26
48	0.083	0.080	0.003	27
1	0.034	0.031	0.003	28
64	0.054	0.053	0.002	29
46	0.050	0.049	0.001	30
13	0.065	0.065	-0.001	31
62	0.052	0.054	-0.002	32
41	0.065	0.067	-0.003	33
38	0.026	0.029	-0.003	34
66	0.089	0.092	-0.003	35
45	0.048	0.051	-0.003	36
34	0.067	0.071	-0.004	37
54	0.093	0.097	-0.004	38
47	0.237	0.242	-0.005	39
36	0.011	0.016	-0.005	40
10	0.034	0.042	-0.008	41
37	0.171	0.179	-0.008	42
57	0.094	0.105	-0.012	43
25	0.009	0.023	-0.014	44
43	0.004	0.019	-0.014	45
15	0.011	0.027	-0.016	46
49	0.174	0.190	-0.016	47
59	0.062	0.079	-0.017	48
44	0.012	0.029	-0.017	49
29	0.031	0.049	-0.018	50
28	0.168	0.186	-0.019	51
19	0.015	0.036	-0.021	52
5	0.049	0.073	-0.024	53
8	0.002	0.028	-0.026	54
21	0.005	0.031	-0.026	55
39	0.005	0.031	-0.026	56
50	0.046	0.074	-0.028	57
18	0.176	0.209	-0.033	58
6	0.026	0.061	-0.034	59
2	0.031	0.067	-0.036	60
3	0.051	0.100	-0.049	61
35	0.037	0.087	-0.050	62
60	0.052	0.107	-0.055	63

FIGURE 2

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR IS Y1 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.03

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.05	0.0	37	27	0.05	0.20	0.01	-0.03	7	1
2	0.09	0.0	61	60	0.12	6.02	0.01	-0.02	40	2
3	0.05	0.0	57	56	0.05	33.34	0.01	-0.02	12	3
4	0.05	0.0	53	51	0.00	93.63	0.00	-0.01	29	4
5	0.05	0.20	7	40	0.01	0.0	0.00	-0.01	53	5
6	0.04	0.70	28	18	0.01	82.38	0.05	-0.01	51	6
7	0.05	1.18	44	32	0.07	40.81	0.04	-0.00	4	7
8	0.05	1.94	3	56	0.09	32.62	0.02	0.00	11	8
9	0.05	1.94	3	57	0.04	67.43	0.01	0.01	54	9
10	0.05	2.17	54	36	0.00	70.94	0.01	0.01	55	10
11	0.05	2.19	58	56	0.03	36.17	0.01	0.02	36	11
12	0.04	2.19	58	57	0.02	74.74	0.02	0.02	52	12
13	0.04	2.98	55	43	0.02	78.37	0.00	0.02	43	13
14	0.04	3.51	25	8	0.01	30.27	0.02	0.02	25	14
15	0.04	3.60	5	50	0.00	31.47	0.00	0.02	9	15
16	0.04	3.70	6	2	0.00	24.23	0.02	0.03	60	16
17	0.04	4.05	66	3	0.05	14.53	0.01	0.03	15	17
18	0.03	4.56	66	57	0.01	92.09	0.02	0.03	8	18
19	0.04	4.64	3	67	0.06	67.24	0.01	0.03	38	19
20	0.04	4.93	3	61	0.11	5.98	0.02	0.03	44	20
21	0.04	5.04	61	27	0.02	21.84	0.03	0.03	1	21
22	0.04	5.04	60	27	0.10	21.71	0.00	0.03	39	22
23	0.04	5.04	61	37	0.07	59.45	0.00	0.03	21	23
24	0.04	5.04	60	37	0.05	32.10	0.00	0.03	32	24
25	0.04	5.04	1	32	0.05	41.56	0.01	0.04	19	25
26	0.04	5.92	7	12	0.02	184.75	0.01	0.04	10	26
27	0.04	5.98	44	1	0.02	95.53	0.02	0.04	42	27
28	0.04	6.02	40	12	0.01	107.01	0.02	0.05	29	28
29	0.04	6.11	58	3	0.06	51.77	0.00	0.05	46	29
30	0.04	6.18	67	37	0.02	88.48	0.01	0.05	45	30
31	0.04	6.85	66	58	0.02	7.51	0.00	0.05	64	31
32	0.04	7.29	36	25	0.01	55.94	0.02	0.05	62	32
33	0.04	7.45	17	27	0.01	47.28	0.01	0.06	24	33
34	0.04	7.45	17	37	0.04	14.77	0.05	0.06	63	34
35	0.04	7.49	25	15	0.00	9.23	0.03	0.06	6	35
36	0.04	7.51	67	60	0.07	25.20	0.00	0.07	13	36
37	0.04	7.51	67	61	0.05	48.71	0.04	0.07	26	37
38	0.04	7.51	64	62	0.00	7.93	0.03	0.07	2	38
39	0.04	7.93	2	41	0.03	42.38	0.00	0.07	41	39
40	0.04	7.96	15	1	0.02	38.02	0.02	0.07	34	40
41	0.04	8.29	13	2	0.04	3.09	0.00	0.07	5	41
42	0.04	8.51	15	44	0.00	65.40	0.01	0.07	59	42
43	0.04	8.59	9	15	0.02	112.08	0.02	0.08	59	43
44	0.04	8.75	50	66	0.02	106.16	0.03	0.08	48	44
45	0.04	8.84	2	5	0.01	23.90	0.03	0.09	35	45
46	0.04	9.16	57	67	0.03	21.29	0.01	0.09	66	46
47	0.04	9.16	56	67	0.02	16.86	0.00	0.09	33	47
48	0.04	9.23	6	13	0.03	6.11	0.06	0.10	58	48
49	0.04	9.47	6	41	0.03	1.94	0.04	0.10	3	49
50	0.04	9.75	41	5	0.02	0.0	0.05	0.11	57	50
51	0.04	10.59	36	9	0.01	9.16	0.02	0.11	56	51
52	0.04	10.59	57	60	0.04	7.51	0.05	0.11	67	52
53	0.04	10.59	56	60	0.09	0.0	0.12	0.11	61	53
54	0.04	10.59	57	61	0.07	13.63	0.09	0.11	60	54
55	0.04	10.59	56	61	0.02	7.45	0.04	0.18	17	55
56	0.04	11.39	41	50	0.03	0.0	0.05	0.18	37	56
57	0.04	11.60	67	13	0.02	155.57	0.06	0.18	27	57
58	0.04	13.51	7	28	0.03	116.17	0.04	0.19	28	58
59	0.04	13.63	61	17	0.03	81.93	0.03	0.19	31	59
60	0.04	13.63	60	17	0.09	123.98	0.02	0.19	49	60
61	0.04	13.91	40	28	0.01	241.03	0.03	0.21	18	61
62	0.04	14.12	37	31	0.03	267.78	0.04	0.24	47	62
63	0.04	14.12	27	31	0.03	5.92	0.02	0.42	22	63

FIGURE 3

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR 11 Y1

COMPONENT EFFECT OF EACH VARIABLE ON EACH OBSERVATION (IN UNITS OF Y)
(VARIABLES ORDERED BY THEIR RELATIVE INFLUENCE --- OBSERVATIONS ORDERED BY INFLUENCE OF MOST INFLUENTIAL VARIABLE)

SEQ.	OBSV.	VARIABLES													
		7	6	18	12	19	8	4	13	10	9	15	14	11	16
		17	2	3	1	5									
		X10M	X9M	LNX9	X9DSQ	LNX10	X14M	X13	X10DSQ	X16M	X15M	X15DSQ	X14DSQ	X21M	X16DSQ
		X21DSQ	X6	X7	X5	X18									
1	47	0.64	-0.26	0.14	-0.03	-0.10	-0.12	-0.01	-0.13	-0.01	-0.02	0.01	-0.03	0.07	-0.00
		0.03	-0.02	-0.00	0.01	-0.01									
2	22	0.38	-0.45	0.17	0.30	-0.08	0.02	-0.01	-0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.01	-0.00	0.01	-0.00									
3	49	0.35	-0.15	0.11	-0.10	-0.08	-0.12	-0.01	-0.00	-0.01	0.10	0.03	-0.03	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	0.02									
4	18	0.25	-0.33	0.16	0.07	-0.07	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.01									
5	28	0.24	-0.33	0.16	0.07	-0.07	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.01									
6	42	0.29	0.00	0.04	-0.04	-0.06	-0.12	-0.01	0.02	-0.01	-0.02	0.01	-0.03	-0.00	-0.00
		0.00	-0.00	-0.00	0.01	-0.01									
7	31	0.19	-0.07	0.08	-0.09	-0.06	0.01	0.04	0.02	-0.01	-0.02	0.00	0.04	-0.00	-0.00
		-0.01	-0.00	0.01	-0.00	-0.01									
8	29	0.13	-0.19	0.12	-0.09	-0.05	0.07	-0.01	0.02	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.02									
9	17	0.12	-0.02	0.06	-0.06	-0.05	0.07	-0.01	0.02	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.02									
10	27	0.12	-0.02	0.06	-0.06	-0.05	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.02									
11	37	0.12	-0.02	0.06	-0.06	-0.05	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.02									
12	24	0.11	-0.11	0.10	-0.10	-0.05	-0.04	-0.01	0.02	-0.01	0.05	-0.07	0.05	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.02									
13	60	0.06	-0.02	0.06	-0.06	-0.04	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.04	0.01	0.01	0.01									
14	61	0.06	-0.02	0.06	-0.06	-0.04	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.04	0.01	0.01	0.01									
15	63	0.06	-0.03	0.06	-0.07	-0.04	0.07	-0.01	0.02	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	-0.04	0.01	0.01	-0.00									
16	67	0.06	-0.02	0.06	-0.06	-0.04	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	-0.04	-0.00	0.01									
17	50	0.05	-0.02	0.06	-0.06	-0.03	0.04	0.01	0.02	-0.01	-0.01	-0.01	0.01	-0.01	-0.00
		0.00	0.01	-0.00	-0.02	-0.01									
18	41	0.04	-0.01	0.05	-0.06	-0.03	-0.00	-0.01	0.02	-0.01	0.03	-0.07	0.05	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	0.00									
19	46	0.03	-0.06	0.08	-0.09	-0.03	-0.12	0.15	0.02	-0.01	-0.02	0.01	-0.03	0.06	-0.00
		-0.00	-0.00	-0.00	0.01	-0.01									
20	66	0.03	0.02	0.02	-0.02	-0.03	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	-0.04	-0.00	-0.01									
21	3	0.02	-0.00	0.04	-0.05	-0.03	0.02	-0.01	0.02	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	0.01									
22	5	0.02	-0.00	0.05	-0.05	-0.03	0.02	-0.01	0.02	-0.01	-0.02	0.00	0.03	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	-0.01									
23	34	0.02	-0.00	0.05	-0.05	-0.03	-0.09	0.13	0.02	-0.01	-0.02	0.00	0.00	0.00	-0.00
		-0.01	-0.00	0.01	-0.00	-0.01									
24	2	0.01	0.03	0.02	-0.01	-0.02	0.02	-0.01	0.01	-0.01	0.01	-0.06	0.03	-0.00	-0.00
		-0.01	-0.00	-0.00	-0.00	-0.00									
25	6	0.01	0.01	0.03	-0.03	-0.02	0.04	-0.01	0.01	-0.01	-0.00	-0.03	0.01	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	-0.00									
26	56	0.00	0.00	0.04	-0.04	-0.02	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	0.01	-0.00	-0.01									
27	57	0.00	0.00	0.04	-0.04	-0.02	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	0.01	-0.00	-0.01									
28	48	0.00	-0.03	0.06	-0.07	-0.02	-0.12	-0.01	0.01	0.15	-0.02	0.01	-0.03	0.07	-0.00
		0.02	-0.00	-0.00	0.01	-0.01									

FIGURE 4

29	33	-0.01	0.01	0.03	-0.03	-0.02	-0.06	0.00	0.01	-0.01	-0.02	0.01	0.04	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	-0.01									
30	35	-0.02	0.07	-0.05	0.04	-0.22	0.07	-0.01	0.01	-0.01	-0.02	0.00	-0.03	-0.00	-0.00
		-0.01	-0.00	0.01	-0.00	-0.01									
31	4	-0.02	-0.02	0.06	-0.06	-0.02	-0.07	-0.01	0.01	-0.01	0.07	-0.04	0.03	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	0.01									
32	13	-0.02	0.04	0.01	-0.00	-0.01	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	0.02	-0.00
		-0.03	-0.00	-0.00	-0.00	-0.01									
33	58	-0.03	0.02	0.02	-0.02	-0.01	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	0.01	-0.00	-0.01									
34	62	-0.03	-0.03	0.00	-0.07	-0.01	0.02	-0.01	0.01	0.01	-0.02	0.00	0.03	0.00	0.06
		-0.01	-0.04	0.01	0.01	-0.01									
35	64	-0.03	-0.03	0.06	-0.07	-0.01	0.02	-0.01	0.01	0.01	-0.02	0.00	0.03	0.00	0.06
		-0.01	0.02	-0.04	-0.00	-0.01									
36	52	-0.04	0.01	0.03	-0.03	-0.01	0.07	-0.01	0.01	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	0.01	-0.00	-0.02	-0.01									
37	45	-0.05	0.06	-0.03	0.02	-0.01	-0.12	0.15	0.00	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	-0.01									
38	1	-0.08	0.07	-0.04	0.04	0.01	0.04	-0.01	-0.00	-0.01	-0.00	-0.03	0.01	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	-0.01									
39	44	-0.09	0.06	-0.03	0.02	0.02	0.07	-0.01	-0.01	-0.01	-0.02	0.01	-0.04	0.00	-0.00
		-0.01	-0.00	-0.00	0.01	-0.01									
40	9	-0.10	0.06	-0.02	0.02	0.02	0.05	-0.01	-0.01	-0.01	-0.01	-0.03	-0.00	0.01	-0.00
		-0.03	-0.03	-0.00	-0.00	0.01									
41	38	-0.10	0.07	-0.05	0.04	0.02	-0.12	-0.01	-0.01	0.15	-0.02	0.01	-0.03	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.01									
42	59	-0.10	0.07	-0.06	0.04	0.02	0.02	-0.01	-0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
		0.00	0.02	0.01	-0.00	-0.01									
43	10	-0.10	0.09	-0.13	0.07	0.02	-0.03	0.07	-0.01	-0.01	-0.02	0.00	0.05	0.02	-0.00
		-0.03	-0.00	-0.00	-0.00	-0.01									
44	11	-0.10	0.07	-0.05	0.04	0.02	-0.06	-0.01	-0.01	-0.01	0.06	-0.05	0.04	0.02	-0.00
		-0.03	-0.00	-0.00	-0.00	0.01									
45	32	-0.10	0.06	-0.04	0.03	0.03	0.07	-0.01	-0.01	-0.01	-0.02	0.00	-0.03	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	-0.01									
46	55	-0.11	0.04	0.01	-0.01	0.03	-0.12	-0.01	-0.01	-0.01	0.10	0.03	-0.03	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	0.02									
47	26	-0.11	0.06	-0.04	0.03	0.03	0.07	-0.01	-0.01	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.01									
48	43	-0.11	0.06	-0.02	0.02	0.04	-0.12	-0.01	-0.01	-0.01	0.10	0.03	-0.03	0.00	-0.00
		-0.01	-0.00	-0.00	0.01	0.02									
49	21	-0.11	0.08	-0.09	0.05	0.04	-0.12	-0.01	-0.01	-0.01	0.10	0.03	-0.03	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.02									
50	39	-0.12	0.07	-0.06	0.04	0.05	-0.06	-0.01	-0.02	-0.01	0.06	-0.05	0.04	-0.01	-0.00
		0.00	-0.00	0.01	-0.00	0.02									
51	60	-0.12	0.08	-0.09	0.06	0.05	-0.05	0.06	-0.02	-0.01	-0.02	0.01	0.05	-0.01	-0.00
		0.00	0.02	-0.04	-0.00	-0.01									
52	51	-0.12	0.08	-0.10	0.06	0.05	-0.12	-0.01	-0.02	-0.01	0.10	0.03	-0.03	-0.01	-0.00
		0.00	0.01	-0.00	-0.02	0.02									
53	53	-0.12	0.08	-0.10	0.06	0.05	-0.12	-0.01	-0.02	-0.01	0.10	0.03	-0.03	-0.01	-0.00
		0.00	0.01	-0.00	-0.02	0.02									
54	54	-0.12	0.07	-0.07	0.05	0.05	0.07	-0.01	-0.02	-0.01	-0.00	-0.03	-0.03	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	-0.01									
55	15	-0.13	0.08	-0.08	0.05	0.05	0.06	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00
		-0.01	0.01	-0.00	0.01	-0.01									
56	36	-0.13	0.08	-0.08	0.05	0.05	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.04	-0.00	-0.00
		-0.01	-0.00	0.01	-0.00	-0.01									
57	12	-0.13	0.08	-0.10	0.06	0.06	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.04	0.01	-0.00
		-0.03	-0.00	-0.00	-0.00	-0.01									
58	7	-0.14	0.09	-0.10	0.07	0.09	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.04	-0.00	-0.00
		0.00	-0.00	-0.00	-0.00	-0.01									
59	40	-0.14	0.09	-0.10	0.07	0.09	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	-0.00	-0.00	0.01	-0.01									
60	25	-0.15	0.09	-0.13	0.07	0.09	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	0.01	-0.00	0.01	-0.01									
61	19	-0.15	0.09	-0.17	0.07	0.11	0.07	-0.01	-0.03	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
		0.00	0.01	-0.00	0.01	0.02									
62	8	-0.16	0.09	-0.13	0.07	0.14	0.06	-0.01	-0.03	-0.01	-0.02	-0.00	-0.03	-0.01	-0.00
		0.00	-0.00	-0.00	-0.00	-0.01									
63	20	-0.16	0.09	-0.25	0.08	0.15	0.07	-0.01	-0.03	-0.01	-0.02	0.01	-0.04	-0.00	-0.00
		-0.01	0.01	-0.00	0.01	0.02									

FIGURE 4(CONT.)

equipment is given in the first column for identification purposes. The third column shows the WSS DISTANCE for each observation. Here those observations far from the centroid of all observations can be easily spotted (observation 47 and 22). Under the heading "ORDERED BY RESIDUALS," the residuals are listed in the order of the magnitude of the residuals. This gives an indication of which observations are fitted the best (or worst). As can be seen, observations 46 and 13 are fitted best and 61 is fitted worst.

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS

The cumulative estimates, S_n, of the standard deviation are printed in the second column of Figure 3. The $WSSD_{jj}$, of the observations in columns 4 and 5 are printed in the third column. Also the observations are ordered by their increasing fitted y values. At the top of Figure 3 is the residual root mean square = .03. The cumulative standard deviation column indicates that the standard deviation estimated from near neighbors is approximately .03, hence there is no evidence of lack of fit.

"COMPONENT EFFECTS" TABLE

The component effect, C_{ij}, of each variable on each observation is printed in tabular form (Figure 4) where the variables are ordered by their decreasing relative influences in columns, and the observations are ordered by their decreasing effects on the most influential variables in rows. Here the analyst can see which particular observations are most influential in their effects on the fitted equation. In addition this table can be used to determine the importance of high correlation among the independent variables.

STATISTICAL PLOTS

As with any endeavor dealing with Deductive Reasoning, the conclusions are dependent on the validity of the assumptions. Thus the analyst must have some means of verifying the degree to which the assumptions are satisfied. In addition to the number of statistics and statistical tables, there are five types of computerized plots that can be used to determine how close the data and fitted equations satisfy the assumptions. These plots give the analyst much insight

into the fit that the statistics alone cannot. The plots are used to determine (1) whether the assumptions of the method of least-squares are "nearly" satisfied, (2) just how well (or bad) the equation fits the data, and (3) to obtain further insights into the distributional properties of the data and how these properties affect the fit.

CUMULATIVE DISTRIBUTION OF RESIDUALS

When κ independent variables are fitted to data with normally distributed error (Assumption A3), it can be shown that the residuals also have a Normal distribution. Therefore, the graph of the residual versus cumulative frequency should be "nearly" a straight line. This plot is helpful in determining whether the data satisfies Assumptions A1, A2 and A4. Figure 5 is a plot for the initial fit of ln(MTBF). Obviously there is an observation whose residual is separated from the rest of the data. This observation may be an outlier (violating Assumption A1) or may indicate that some form of curvature is needed in the equation (Assumption A2). After investigation it was determined that the point was indeed an outlier. Figure 6 is the cumulative frequency plot for the fitted equation obtained, with ln (MTBF) as the dependent variable. There is no indication here of deficiencies in the fit.

RESIDUALS VS FITTED Y

The plot of the residuals versus the fitted values of the dependent variable is also helpful in checking Assumption A1, A2 and A4. This plot may show whether there is some dependence of the magnitude of the residuals on the magnitude of the fitted values. Daniel and Wood [1], gives four common defects that may be revealed by such plots. Recall Assumption A3 states that the variance of the error is constant. The plot of residual versus fitted Y should then show an equal scatter about the 0-residual line. Figure 7 is a plot for the initial fit of ln(MTBF). As in the cumulative frequency plot, (Figure 5) one observation is separated from the remainder of the data. Both the cumulative frequency plot and the plot of residual vs. fitted y are necessary to determine whether a point is an outlier. Again, if this observation is at the extreme ends of the ranges of the dependent variable, curvature may be the solution. Figure 8 is a plot of

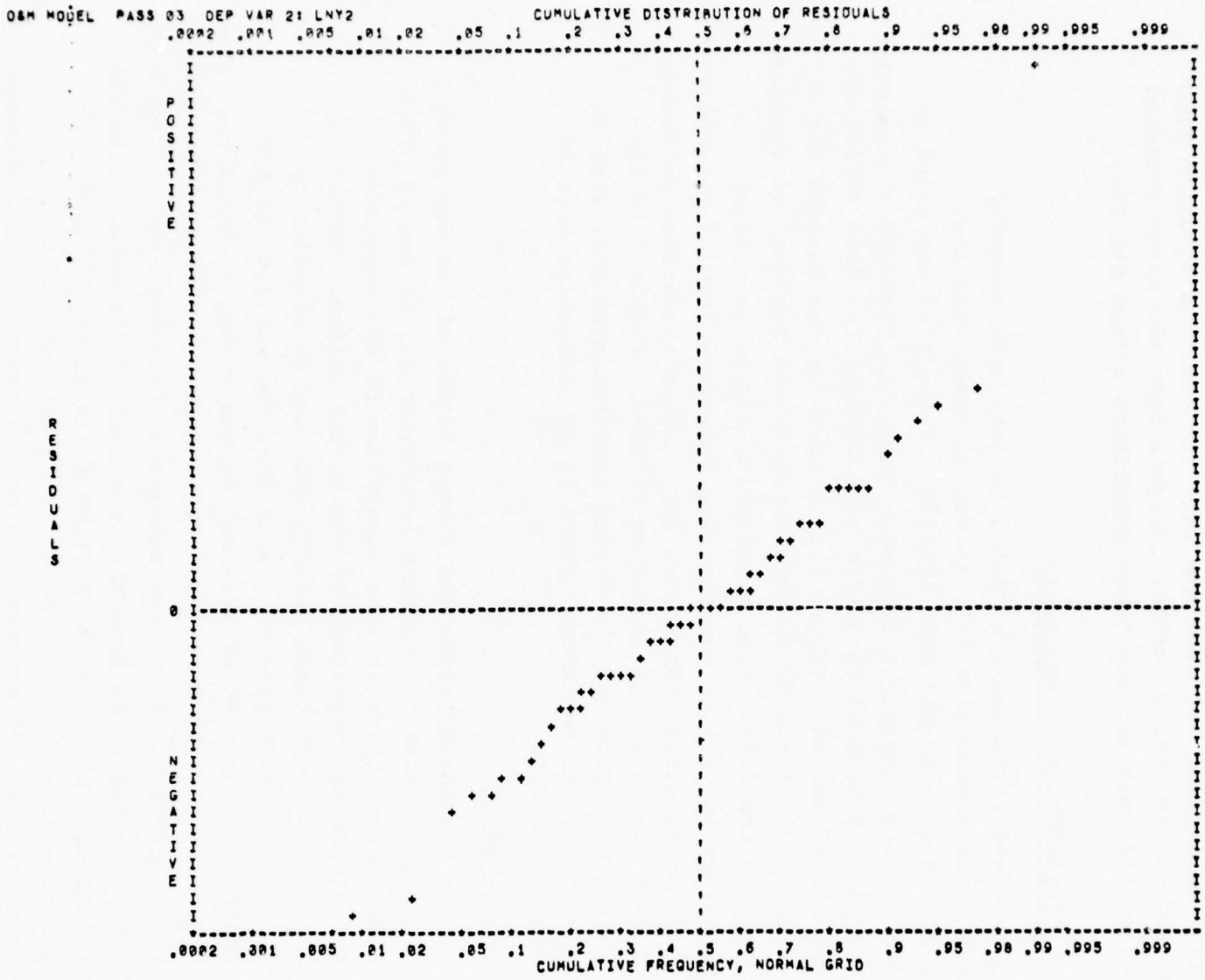

O&M MODEL PASS 03 DEP VAR 2: LNY2
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 5

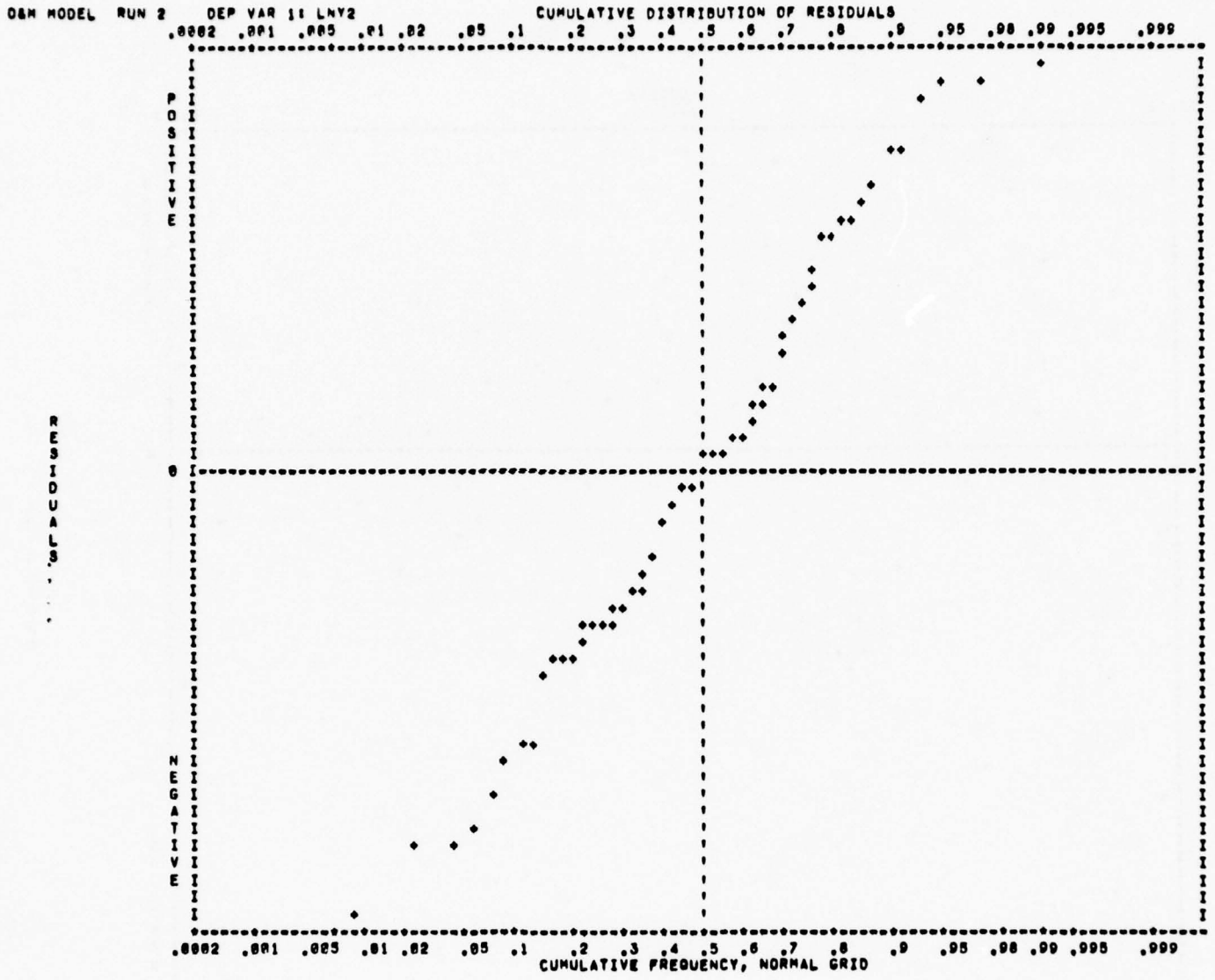

O&M MODEL RUN 2 DEP VAR IS LNY2
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 6

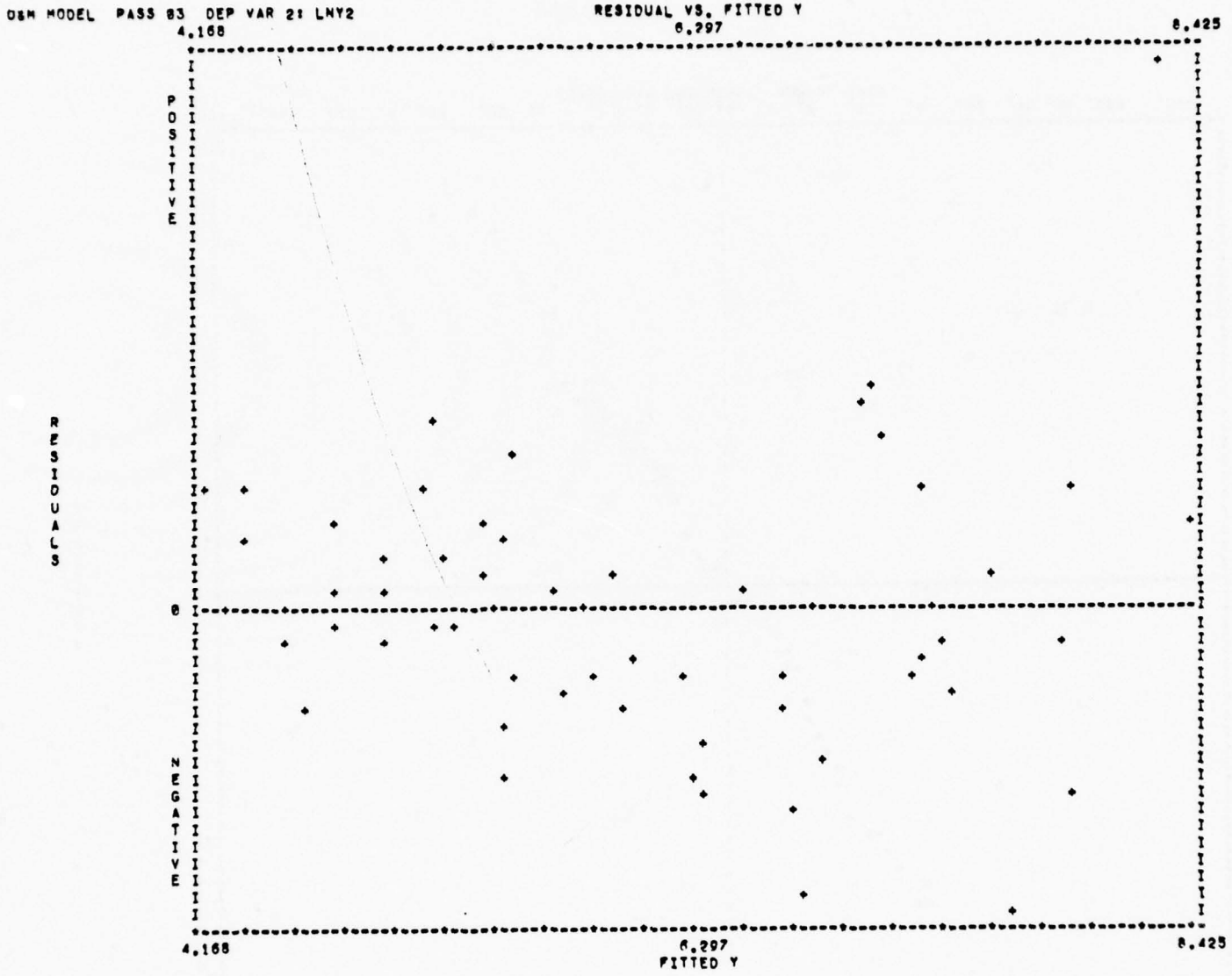

O&M MODEL PASS 03 DEP VAR 2: LNY2
RESIDUAL VS. FITTED Y
4.168
6.297
8.425
POSITIVE
RESIDUALS
0
NEGATIVE
4.168
6.297
8.425
FITTED Y

FIGURE 7

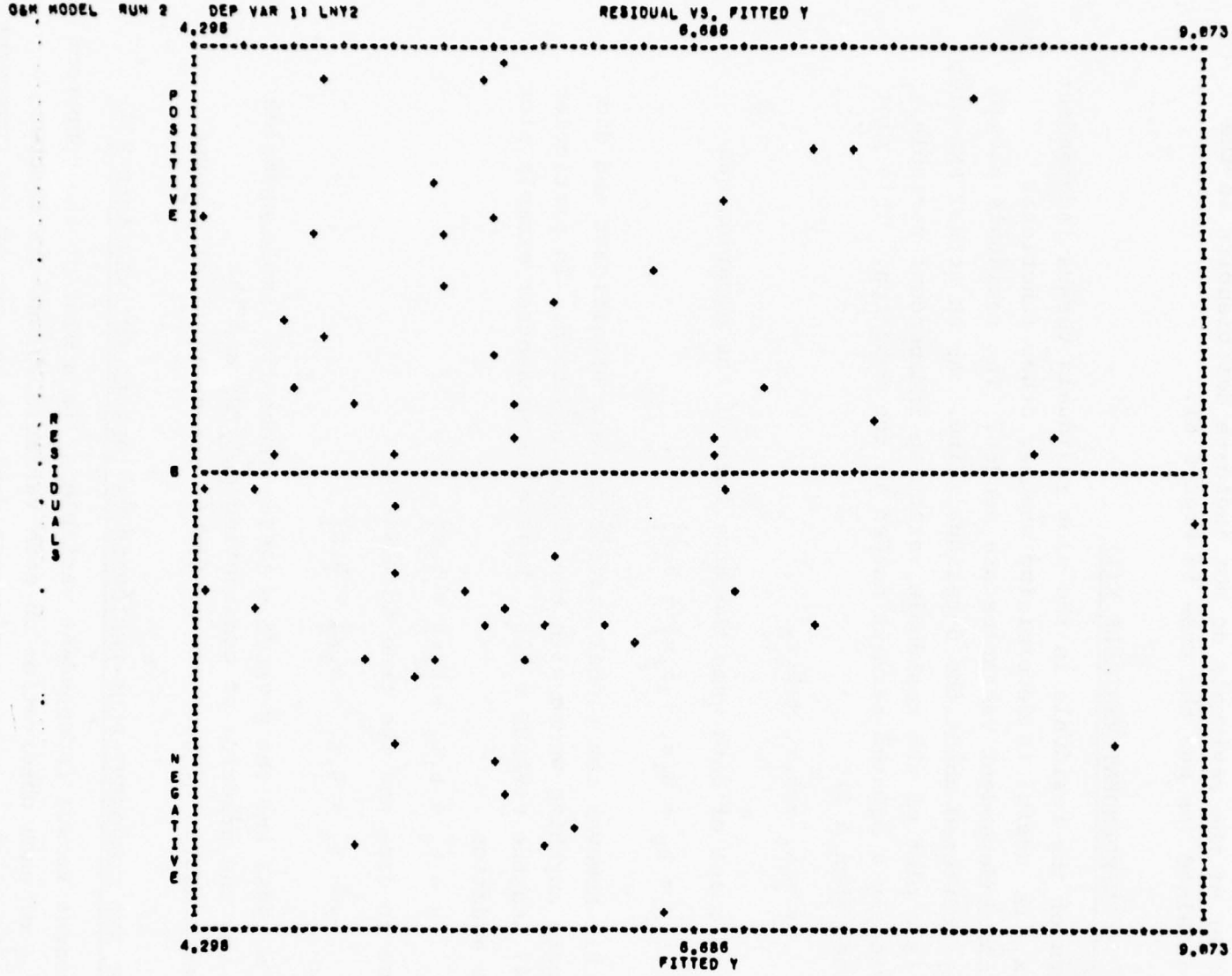

O&M MODEL RUN 2 DEP VAR IS LNY2
RESIDUAL VS. FITTED Y
4.298
6.686
9.073
POSITIVE
0
NEGATIVE
RESIDUALS
4.298
6.686
9.073
FITTED Y

FIGURE 8

residuals versus fitted Y for the equation obtained for ln(MTBF). The equal scatter of the residuals do not indicate deficiencies in tne equation obtained (as was the case in Figure 6).

RESIDUALS VS INDEPENDENT VARIABLE X(I)

The pattern of the residuals in the plot residuals versus independent variable x_i is useful in determining whether other functional forms of the independent variables are needed. The residuals should be equally scattered about the 0-residual line. As an actual example, Figure 9 is a plot of the residuals versus an independent variable x_1 where obviously a squared term is needed in the equation. This plot was obtained when a fit

$$y = b_0 + b_1x_1 + b_2x_2$$

was made to a set of data when the true form of the equation was

$$y = b_0 + b_1x_1 + b_2x_2 + b_1x_1^2 \quad .$$

For this fit however the "global" statistics were significant and did not indicate anything wrong with the fitted equation. In particular $R_y^2 = .9047$ and the F-VALUE = 228. Figure 10 is another example plot where the equation

$$y = b_0 + b_1x_1 + b_2x_2^2 + b_3x_1^3$$

was fitted to data and the true form was

$$y = b_0 + b_1x_1 + b_2x_2^2 + b_3x_1^4$$

Here, $R_y^2 = .9963$ and the F-VALUE = 3267. These two simple examples indicate why the practice of considering <u>only</u> R_y^2 and the F-VALUE as measures of "goodness of fit" is not statistically sound.

COMPONENT AND COMPONENT-PLUS-RESIDUALS VS INDEPENDENT VARIABLE X(I)

The component versus independent variable x_i is a plot of the component effect C_{ij} of each observation on each variable versus the independent variable. The component-plus-residuals is the sum of the component effects of each observation and its residual. As stated in [1],

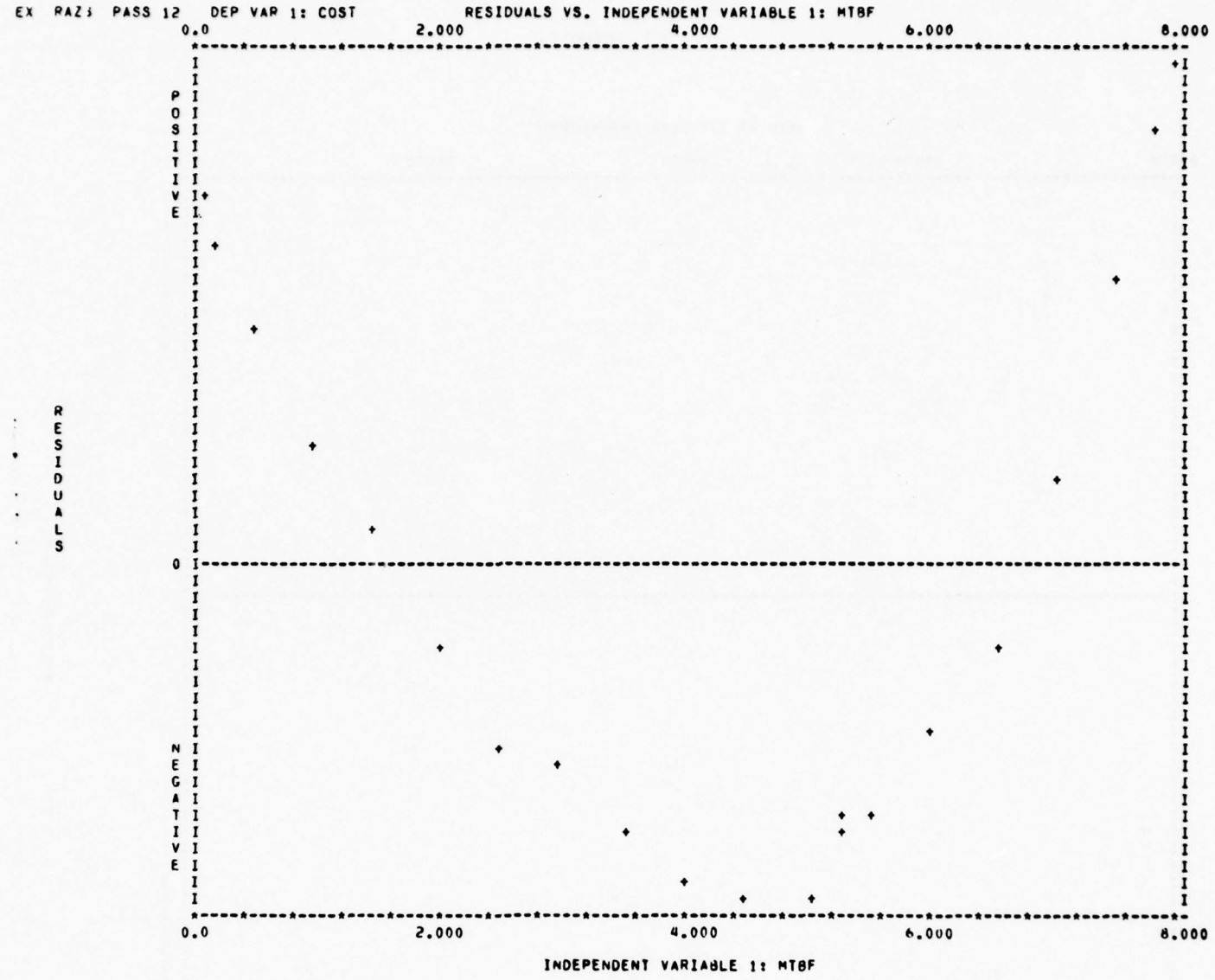

EX RAZ; PASS 12 DEP VAR 1: COST
RESIDUALS VS. INDEPENDENT VARIABLE 1: MTBF
0.0
2.000
4.000
6.000
8.000
POSITIVE
RESIDUALS
0
NEGATIVE
INDEPENDENT VARIABLE 1: MTBF

FIGURE 9

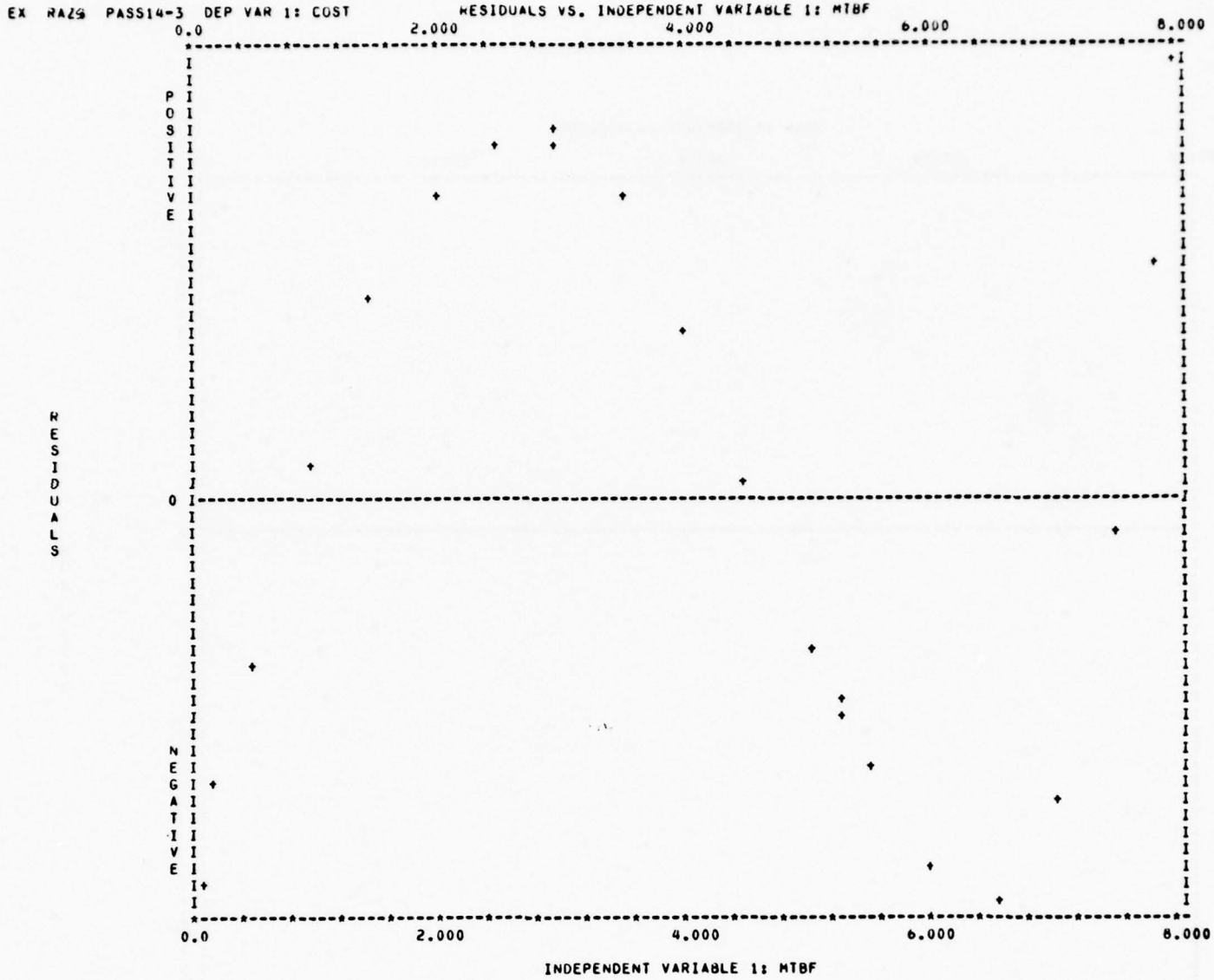

EX RA2S PASS14-3 DEP VAR 1: COST
RESIDUALS VS. INDEPENDENT VARIABLE 1: MTBF
0.0
2.000
4.000
6.000
8.000
POSITIVE
RESIDUALS
0
NEGATIVE
0.0
2.000
4.000
6.000
8.000
INDEPENDENT VARIABLE 1: MTBF

FIGURE 10

"Component-plus residual plots are used as an aid
(1) to choose the appropriate form of the equation,
(2) to observe the distribution of the observations
over the range of each independent variable and
(3) to estimate the influence of each observation
on each component of the equation."

Observations at the extreme ends of the ranges of the independent variables usually control the estimates of the statistics. The component-plus-residuals plots can be used (with indicator variables and the C_p-search technique) to determine if these extreme points are compatible with the remainder of the data. If it is determined that these extreme values are not compatible with the rest of the data, then either curvature should be introduced in that independent variable or other subjective information (introduced by indicator variables) about the points in question should be considered.

Figure 11 is a plot for the training cost equation obtained, where the independent variable is the % power supply. As can be seen from the graph, only one observation extends the range of % power supply by over 3,000%. It was later found out that introducing curvature in the % power supply had a significant impact on the fit. The residuals should be equally scattered about the component line.

CP VS P

The C_p-plot (developed by Mallows [3]), is a plot of the C_p-statistic for an equation versus P where $P = \kappa + 1$. For those equations with negligible bias, the C_p-statistic will fall near line $C_p = p$. Obviously the analyst would like to choose the equations with smallest total squared errors (C_p) and with the least amount of bias. Figure 12 is an example of a C_p-plot for the NRTS equation obtained where it can be seen that the C_p-statistic 1 is on the line $C_p = p$ which indicates that there is no evidence of function bias. The C_p-statistic 2 is about the same as 1 but is above the line $C_p = p$ and indicates that more is present in equation 2 than equation 1.

STATISTICAL TECHNIQUES

There are two techniques utilized that are helpful in finding the subset collection of variables which best fits the data and in determining the stability of the equations obtained.

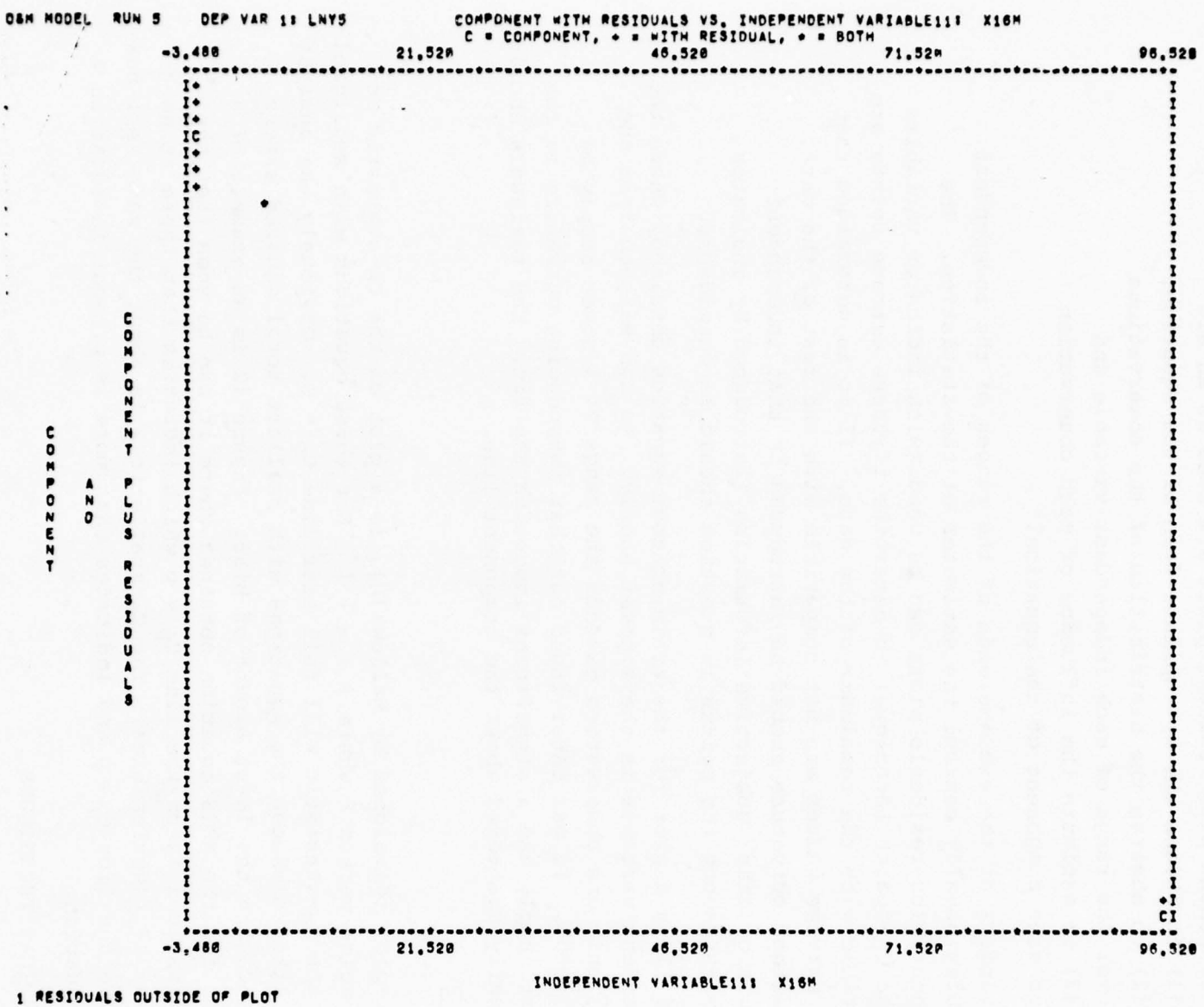

O&M MODEL RUN 5 DEP VAR 1: LNY5
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE111 X16M
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
-3,480
21,520
46,520
71,520
96,520
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE111 X16M
1 RESIDUALS OUTSIDE OF PLOT

FIGURE 11

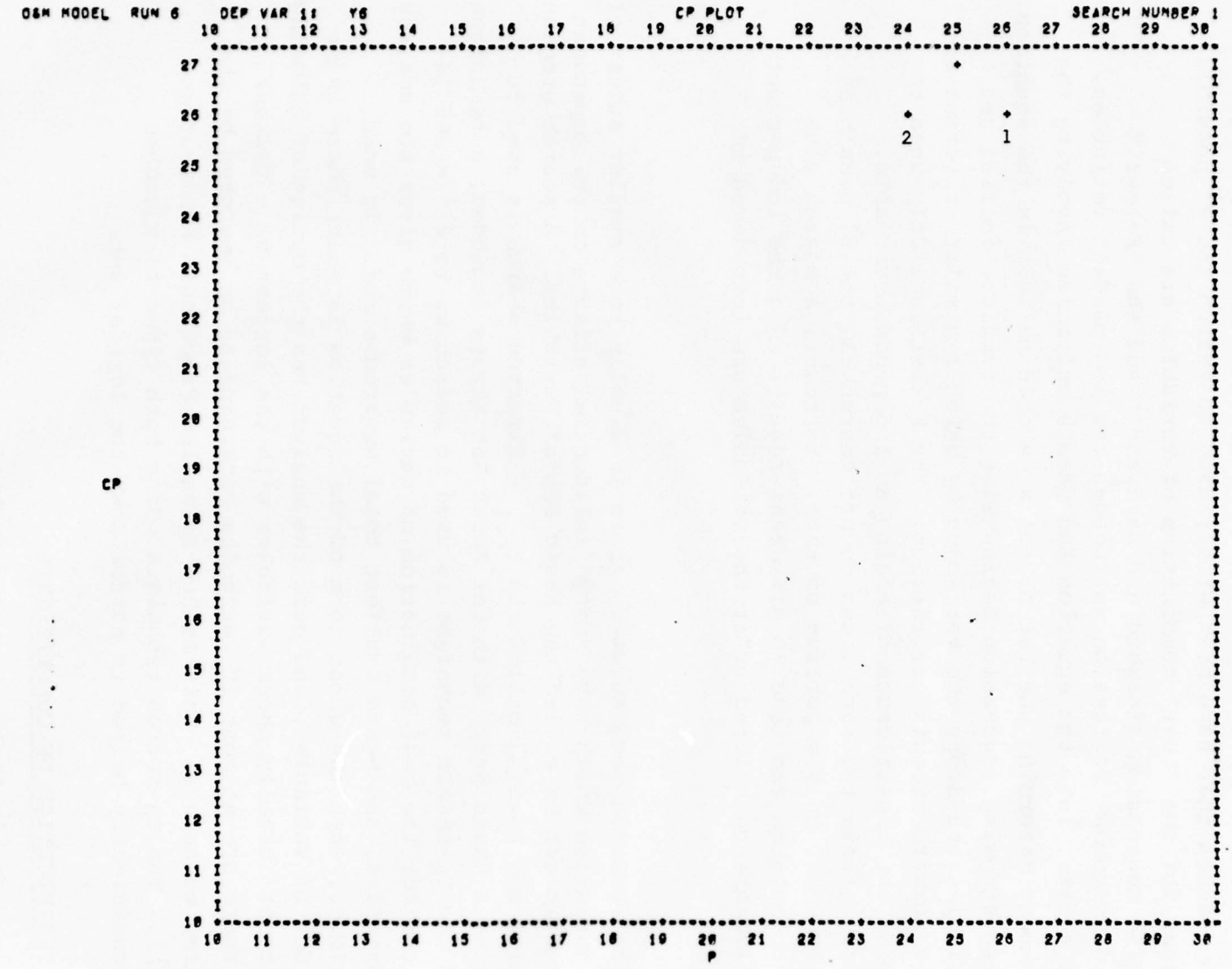


FIGURE 12

CP-SEARCH TECHNIQUE

Two approaches that have been widely used to search the 2^K possible equations for the "best" combination of variables are called "Stepwise Regression (forward and backward)" and the "F-test." Forward stepwise regression introduces the independent variables, one at a time, into the equation and uses a criterion involving the t_i values to determine whether or not x_i should be left in the equation. Backward stepwise regression begins with the complete initial set of variables and drops the variables by using a similar criterion as that of forward stepwise regression. The F-test is widely used to determine the significance of adding an independent variable. Obviously, these two techniques do not search all the 2^K possible equations, but only a portion of them. Moreover, a search with these techniques can lead to different results when the independent variables are correlated or if the variables are introduced in different orders.

With the equation form assumed, there is usually some smaller subset of these variables which have "very" influential effects on the dependent This subset can be called the Basic Set of Variables. A search proposed by Daniel and Wood [1] called the $t_{K,i}$ - directed search is used to determine a Basic Set. With the Basic Set always included, a technique called the C_p-search technique is used to search up to $2^{18} = 262,144$ equations for the best combination of variables which gives the smallest C_p-statistics, and hence smallest total squared error. In some cases (e.g., when the wrong form of the equation is used) there is no Basic Set of Variables, and here the analyst has the option of choosing a basic set (usually those variables with the largest t_i - values) until there are at most 18 variables remaining to be searched by the C_p-search technique. This method is called Fractional Replication (See [1]). The C_p-search technique using both types of searches have consistently helped to narrow down the initial set.

CROSS VERIFICATION OF COEFFICIENTS

Once a presumably final equation is obtained, the analyst must determine the stability of the obtained equations coefficients. There

may be a few observations in the data base (such as those with large WSS DISTANCE and large residuals) that are not compatible with the rest of the data and may be controlling the estimates of the fitted coefficients. A way to determine stability is to drop those observations, run another regression and determine the effects on the least-squares estimates of the coefficients. This technique is called cross verification of coefficients with a second sample of data and provides a rigorous test of the data, the model and the fitted coefficients.

Component-plus-residual plots of the second sample of data (where residuals are calculated using the initial coefficients) may point out those observations which may indicate that other forms of curvature are needed.

SECTION VI

AN EXAMPLE,

MEAN TIME BETWEEN MAINTENANCE ACTIONS (MTBMA)

The data (a year's worth of data) was chosen from existing data systems to determine the CER's and PER's used to estimate O&M cost and is shown in Appendix A. There are 64 pieces of avionics equipment (observations), called LRU's, on which the study is based. Each observation can be identified by its observation number and Work Unit Code (WUC). Also associated with each is a total of 27 variables, of which 21 are independent variables and 6 are dependent variables. The independent variables are of two types, quantitative and qualitative. The usual types of variables in a regression exercise are quantitative (i.e., variables that may take on values over a given range) such as weight or other physical characteristics of the equipment. Many times additional (qualitative) information is available, such as certain characteristics of the equipment or a certain class in which the equipment belongs, which should not be discarded, but should be introduced into the regression, since more information should lead to a better fit. "Indicator" variables (variables which take on the value of 0 or 1) are used to introduce qualitative information into the regressions. A "1" indicates that the observation is in a certain class and a "0" indicates that it is not.

The type of aircraft in which a piece of equipment is used and the equipment avionics areas are the two qualitative classes used in

this study. There are three types of aircraft: Fighters, Bombers and Cargo and three areas of avionics: Navigation, Sensory, and Communications. Table 1 shows the observation numbers of each piece of equipment and the class to which it belongs. For instance, observation 9 is a piece of navigations equipment that is used in a fighter. Since there is no sensory equipment used in cargo type aircraft, no observations are present there. The numbers in parenthesis indicates the quantity of observations in each category. Thus 18 LRUs are used in bombers and 16 LRUs are sensory type equipment. The numbers in the corners of the inner rectangles indicate the number of observations which fall in the respective interactive classes. There are 4 observations which are used in fighters in addition to being communications equipment. Table 2 lists the names of all the variables and their associated variable names used in the computer printouts of the regressions. Also, listed are the units in which the variables are expressed. The quantitative independent variables and the dependent variables are defined in Volume I of this report. The indicator variables (qualitative independent variables) need some further clarification.

BOMBER and CARGO are indicator variables used to represent equipment that is used in bomber and cargo type aircrafts respectively. SENS and COMM are indicator variables indicating that the avionics areas of the equipment are sensory and communications respectively. It is noted that there is no indicator variable for fighter aircraft or navigation equipment. Using indicator variables in this fashion, that is having a "baseline" of each class or category, can be very informative. Without loss of generality, fighters are chosen as the "baseline" for the aircraft types and navigation equipment are chosen as the "baseline" for the avionics area. We can then find those members of a certain class that are significantly different from the baseline. As an example, if the indicator variable BOMBER is significant enough to be in the final equations for MTBMA, this may be interpreted to mean that the MTBMA for equipment used in bombers is statistically significantly different from the MTBMA for equipment used in fighters (the baseline). Conversely if COMM does not remain, this indicates that the MTBMA for communications equipment behaves in a similar

TABLE 1.

Qualitative Categories

	FIGHTERS (29)			BOMBERS (18)			CARGO (17)		
NAVIGATIONS (35)	1	6	11	15	21	27	33	38	
	2	7	12	17	22	28	34	39	
	3	8	13	18	24	29	35		
	4	9		19	25	31	36		
	5	10		20	26	32	37		
			13		10			12	
SENSORY (16)	40	45	54	56					
	41	46	55	51					
	42	47		52					
	43	48		53					
	44	49							
			12		4			0	
COMMUNICATIONS (13)	56			60		64			
	57			61		65			
	58			62		66			
	59			63		67			
						68			
			4		4			5	

TABLE 2.

Variables Used in the Regressions

Independent Variables

"Indicator"	Quantitative
X1M = (BOMBER - $\overline{\text{BOMBER}}$)	X8 = Unit price
X2M = (CARGO - $\overline{\text{CARGO}}$)	X9 = Volume
X3M = (SENS - $\overline{\text{SENS}}$)	X10 = Weight
X4M = (COMM - $\overline{\text{COMM}}$)	X11 = Components Count
X5 = X1 × X3	X12 = Components density
X6 = X1 × X4	X13 = % Digital
X7 = X2 × X4	X14 = % Analog
	X15 = % Electro-mechanical
	X16 = % Power supply
	X17 = % Transmitter
	X18 = % Solid state
	X19 = Power Dissipation
	X20 = Utilization factor
	X21 = % BIT/FIT

Dependent Variables

Y1 = Maintenance Manhours per Operating Hour (MMH/OH)
Y2 = Mean Time Between Failure (MTBF)
Y3 = Mean Time Between Maintenance Actions (MTBMA)
Y4 = Logistics Support Cost per Operating Hour (LSC/OH)
Y5 = Training Cost per Operating Hour (TRAIN/OH)
Y6 = Not Repairable This Station (NRTS)

manner as that of navigation equipment (the baseline). There also exists the possibility that communications equipment used in cargo type aircraft might have a significantly different effect on the dependent variable from that of navigations equipment used in fighters.

Three indicator variables (which are products of the four initial indicator variables) that can be used to determine the effects of such interactions are: BOMBER x SENS, BOMBER x COMM and CARGO x COMM. In the regressions however, the 7 indicator variables used are the ones shown in Table 2, where the bar above the variables indicate the mean. This is done in order to reduce the sometimes high correlation between the indicator variables and their products. If any of the three interactive variables X5, X6 and X7 are significant, then the analysis of the MTBMA example (above paragraph) will have quite a different interpretation. If interactions prove to be significant (as was the case in all regressions equations obtained in this study), the interpretation of how the levels with which the two classes (aircraft type, avionics area) compare with their baseline should not be used, but the analyst should find a means of interpreting which specific interactions are significantly different from which others.

Returning to Appendix A, we see three lines of information associated with each observation. The first line lists the 7 indicator variables, the second the (quantitative) independent variables and the third line are the 6 dependent variables. Thus observation 2 is a piece of navigation equipment used in a fighter with weight = 36.60, % solid state = 73. and MTBMA = 274.

Initially 85 LRUs were considered for the study. Many of the observations were dropped from the analysis because of the lack of data or the difficulty in obtaining the necessary data. Other observations, such as equipment which had not been in the Air Force inventory long enough to experience "good" data, were discarded so as not to introduce bias in the results. In addition a couple of the observations had missing dependent variable data and were omitted for that particular fit. Once all the data has been collected, there should be a panel of qualified experts on the studied equipment to determine the validity

of each data element in the data base. This was done to a limited extent in this study (because of time constraints).

Many times the statistics, plots, tables and techniques indicate that some observations do not behave like the remainder of the data. Besides other possible subjective variables, curvature may be causing this instability. In addition to the variables shown in Table 3, two transformations of the independent variable (the square and natural logarithm) and a transformation of the dependent variable (natural logarithm) are introduced into the regressions when curvature is indicated. The natural logarithm transformation is considered for those variables whose range is contained in the positive real numbers.

Since the LLSCFP allows six card columns to identify the names of the variables, alphanumeric representations consisting of six letters or less are used in computer printouts. Using X8 as an example, the transformed independent variables are of the form

$$X8M = (X8 - \overline{X8}) \quad ,$$

$$X8DSQ = (X8 - d8)^2 \quad ,$$

and

$$LNX8 = \ln X8$$

where the bar indicates the mean, d8 is the d-statistic of variable X8 and ln is the natural logarithm. Table 3 shows the d-statistic and mean for each of the variables used in the regressions.

Before beginning any regressions, the data must be critically analyzed for outliers (impossible values) and for what is known as "Nested Data." The data is said to be "Nested" if some of the observations have all or nearly all the same or approximate x_i-values. Obviously outliers would have a significant impact on the fitted coefficients, thereby yielding the incorrect relationships. If the equations are fitted without checking to determine whether or not the data are nested, the wrong factors may be significant. The analysis of "Nested Data" was first introduced into the statistical literature by Daniel and Wood ([1], Chapter 8).

Since there is human intervention in the development, collection and analysis of data, outliers might not immediately become apparent.

TABLE 3

D-Statistic and Mean

MTTH/OH

I	MEAN(I)	DSTAT(I)
8	27173.650	133726.400
9	1438.048	3307.065
10	34.981	64.404
11	909.889	2948.044
12	0.924	2.489
13	7.556	43.028
14	62.683	49.183
15	16.000	46.378
16	3.429	49.827
17	10.492	40.395
18	61.297	51.914
19	368.968	723.684
20	1.657	1.681
21	4.825	26.957

MTBF

I	MEAN(I)	DSTAT(I)
8	27536.100	133828.600
9	1483.726	3337.016
10	36.221	65.088
11	940.016	2965.510
12	0.924	2.489
13	7.677	43.038
14	61.677	48.615
15	16.258	46.403
16	3.484	49.829
17	11.065	40.258
18	61.044	52.254
19	382.419	729.178
20	1.645	1.679
21	4.694	27.148

MTBMA

I	MEAN(I)	DSTAT(I)
8	27536.100	133828.600
9	1483.726	3337.016
10	36.221	65.088
11	940.016	2965.510
12	0.924	2.489
13	7.677	43.038
14	61.677	48.615
15	16.258	46.403
16	3.484	49.829
17	11.065	40.258
18	61.044	52.254
19	382.419	729.178
20	1.645	1.679
21	4.694	27.148

LSC/OH

I	MEAN(I)	DSTAT(I)
8	26943.220	133606.300
9	1457.984	3311.530
10	35.570	64.314
11	927.746	2956.742
12	0.933	2.501
13	7.556	43.028
14	63.349	48.895
15	14.937	46.991
16	3.429	49.827
17	10.889	40.172
18	61.138	51.898
19	374.159	722.249
20	1.639	1.681
21	4.556	27.288

TABLE 3

D-Statistic and Mean (Con't.)

	TRAIN/OH			NRTS	
I	MEAN(I)	DSTAT(I)	I	MEAN(I)	DSTAT(I)
8	26950.100	133922.500	8	27288.080	133763.300
9	1445.145	3305.984	9	1475.339	3321.284
10	34 955	64.418	10	36.005	64.594
11	889.468	2982.834	11	936.758	2961.209
12	0.904	2.522	12	0.938	2.505
13	7.677	43.038	13	7.677	43.038
14	62.516	49.242	14	63.468	49.468
15	15.823	46.514	15	14.468	45.651
16	3.484	49.828	16	3.484	49.828
17	10.661	40.474	17	11.065	40.258
18	61.108	51.989	18	62.108	52.151
19	372.097	723.719	19	378.529	723.518
20	1.646	1.680	20	1.645	1.679
21	4.839	26.952	21	4.694	27.149

However, the computerized plots of an initial regression may point them out. Figures 13 - 17 show summary computer printouts of an initial run (Pass 03) after fitting the equation

$$y = b_0 + \sum_{i=1}^{21} b_i x_i \quad ,$$

where Y = ln MTBMA and x_i = Xi, i = 1, 2, ..., 21, are the 21 independent variables. The statistics (Figure 13) are not significant and the stars, *, indicate error is too large to be printed out in the space provided. The cumulative standard deviation table (Figure 15) shows that there is a serious lack of fit. The cumulative distribution plot (Figure 16) and the fitted value plot (Figure 17) indicate that there is a single oversized residual (possibly an outlier). Since there is also the possibility of curvature, a fit is made with Y = ln Y3 = ln MTBMA with printouts shown in Figure 18-22. The statistics using the natural logarithm are greatly improved but Figures 21 and 22 also (although not as profound as before) indicate that an oversized residual is present.

In Figures 14 and 19, under the heading "ORDERED BY RESIDUALS", we immediately see that observation 36 with WUC 7171A is the culprit. In addition Figure 13 shows that the maximum value of the dependent variable, MTBMA is 31,490 hours, and hence there is an observation (piece of equipment) in data base with such a large MTBMA. On investigating the data collection system (AFM 66-1 "6-LOG") from which the MTBMAs were extracted, it was found that observation 36 with MTBMA = 31,490 was a subassembly of an LRU (called an SRU) and not a LRU. Since the study is based on LRUs, leaving this particular observation in would bias the results, and therefore another observation with WUC 71716 was used in its place.

In addition to impossible values and discrepancies in the data systems, outliers may be caused by simple keypunch errors. If those errors are profound, the computerized plots should reflect the discrepancies. In many of the regressions considered throughout this report, the plots were helpful in detecting those observations which

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 03 DEP VAR 11 Y3 MIN Y = 4.5500 01 MAX Y = 3.149D 04 RANGE Y = 3.145D 04

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		2.673150 04							
1	X1M	8.324450 02	2.580 03	0.3	0.7650	-2.7400-01	7.2600-01	1.0000 00	0.03
2	X2M	3.818310 03	3.970 03	1.2	0.9338	-2.7400-01	7.2620-01	1.0000 00	0.12
3	X3M	1.773290 03	1.970 03	0.9	0.5809	-2.5800-01	7.4200-01	1.0020 00	0.06
4	X4M	-8.275970 02	1.810 03	0.3	0.4288	-2.1000-01	7.9000-01	1.0020 00	0.02
5	X5	1.367830 03	3.620 03	0.4	0.3464	-2.9330-01	5.3870-01	7.4200-01	0.03
6	X6	2.997650 02	3.920 03	0.1	0.3871	-2.1650-01	5.7350-01	7.9000-01	0.01
7	X7	-4.356990 03	3.680 03	1.2	0.4912	-2.1650-01	5.7350-01	7.9000-01	0.11
8	X8	8.719080-03	1.710-02	0.5	0.7129	1.5800 02	3.2400 05	3.2380 05	0.09
9	X9	7.517230-01	9.310-01	0.8	0.8548	3.2000 01	8.2000 03	8.1700 03	0.20
10	X10	-8.104820 01	6.210 01	1.3	0.9198	1.2000 00	1.7370 02	1.7250 02	0.44
11	X11	-8.033540-01	7.640-01	1.1	0.6490	9.2000 00	7.6380 03	7.6290 03	0.19
12	X12	-3.616930 02	8.140 02	0.4	0.5792	4.9230-03	6.6740 00	6.6690 00	0.08
13	X13	-2.299210 02	5.830 02	0.4	0.9982	0.0	1.0000 02	1.0020 02	0.73
14	X14	-2.174840 02	5.640 02	0.4	0.9993	0.0	1.0000 02	1.0020 02	0.69
15	X15	-2.178420 02	5.680 02	0.4	0.9991	0.0	1.0000 02	1.0020 02	0.69
16	X16	-2.589950 02	5.720 02	0.5	0.9969	0.0	1.0000 02	1.0020 02	0.82
17	X17	-2.227860 02	5.660 02	0.4	0.9975	0.0	1.0000 02	1.0020 02	0.64
18	X18	9.259120 00	2.290 01	0.4	0.6589	0.0	1.0000 02	1.0020 02	0.03
19	X19	-2.243640 00	2.050 00	1.1	0.5659	7.0000 00	1.6400 03	1.6330 03	0.12
20	X20	-6.396220 02	2.430 03	0.3	0.8297	3.0020-01	2.3000 00	2.2000 00	0.04
21	X21	9.462110 01	6.910 01	1.4	0.5878	0.0	6.1000 01	6.1000 01	0.18

NO. OF OBSERVATIONS 62
NO. OF IND. VARIABLES 21
RESIDUAL DEGREES OF FREEDOM 40
F-VALUE 0.7
RESIDUAL ROOT MEAN SQUARE 4395.193101804
RESIDUAL MEAN SQUARE **********
RESIDUAL SUM OF SQUARES **********
TOTAL SUM OF SQUARES **********
MULT. CORREL. COEF. SQUARED .2661

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 13

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

OSM MODEL PASS 03 DEP VAR 11 Y3

IDENT.	OBSV.	MSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL
71R2P	1	2.	163,300	455,076	-291,776
7353W	2	1.	273,700	-1981,442	2255,142
71L3P	3	2.	161,000	-653,140	814,140
71M8P	4	13.	119,600	-852,412	972,012
71P4P	5	2.	133,400	103,695	29,705
71P8P	6	2.	476,100	-1964,718	1540,618
7171P	7	5.	2520,800	2425,657	95,143
724GP	8	5.	3539,700	2178,915	1360,785
71G5P	9	3.	94,300	1833,298	-1738,998
71F4P	10	6.	529,300	720,595	-191,595
71F8P	11	9.	736,000	2519,294	-1783,294
71DAP	13	2.	213,900	3275,983	-3062,083
71ARE	15	4.	999,700	3220,515	-2220,815
71ADA	17	5.	97,500	-1675,340	1772,840
73C4A	18	4.	120,900	-2852,378	2971,278
73C4Q	20	5.	3703,700	2575,211	1128,689
73CEN	21	27.	1781,800	1893,899	-112,899
73CFK	22	5.	45,500	-199,192	244,692
73DAM	24	6.	232,700	-185,953	418,653
73EBA	25	5.	648,700	2947,053	-2298,353
73EBF	26	5.	113,100	2037,185	-1924,085
71CAP	27	2.	69,600	2042,760	-1973,160
72E44	28	4.	133,200	1711,361	-1578,161
72ECA	29	6.	330,000	1049,236	-719,236
72PP0	31	4.	72,000	274,860	-202,860
71JAP	32	5.	289,200	5514,997	-5225,797
71LAP	33	9.	152,800	2752,083	-2591,283
720NP	34	25.	127,200	3454,185	-3326,985
72AC0	35	5.	284,400	3565,671	-3281,271
7171A	36	6.	31494,000	7641,036	23852,964
7131D	37	2.	104,400	2038,226	-1933,826
72RF0	38	43.	272,400	110,770	161,630
72R50	39	10.	1485,600	4667,614	-3182,014
75932	40	5.	1308,700	3334,955	-2025,255
74B00	41	2.	126,500	-164,551	291,051
74RF0	42	28.	117,300	-1814,057	1931,357
74R10	43	27.	1265,000	2192,601	-927,601
76A10	44	5.	381,800	1804,687	-1422,887
76GA0	45	34.	151,400	-2041,986	2243,386
74FF0	46	37.	151,800	-2042,345	2194,145
74FA0	47	35.	104,100	838,676	-734,576
74FH0	48	44.	195,500	9,795	185,795
74FU0	49	30.	195,500	-1118,392	1313,822
77EC0	50	2.	345,800	2350,205	-2004,405
77EE0	51	28.	7529,600	4802,395	2727,205
770CA	52	5.	837,200	3635,926	-2798,726
770B0	53	28.	6878,300	4802,395	2075,905
73CR0	54	4.	904,700	904,700	-0,000
73CG0	55	27.	913,830	3966,056	-3052,226
71NA0	56	2.	78,200	-625,747	723,947
71QU0	57	2.	119,600	-625,747	745,347
63AA0	58	2.	124,200	909,330	-785,130
65AA0	59	2.	319,700	983,865	-664,165
63RAA	60	2.	61,100	-733,893	794,993
63CAA	61	2.	78,000	-733,893	811,893
65BAA	62	2.	249,600	2525,114	-2275,514
61RAA	63	5.	172,000	-495,728	668,628
65RAA	64	2.	189,600	2256,897	-2067,297
63AF0	65	3.	55,200	-1200,233	1255,433
63AA0	66	2.	139,200	1024,791	-885,591
63121	67	2.	118,400	-1002,110	1112,510
63AAA	68	7.	342,000	-242,945	584,945

OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
30	31494,000	7641,036	23852,964	1
18	120,900	-2859,378	2971,278	2
51	7529,600	4802,395	2727,205	3
2	273,700	-1981,442	2255,142	4
45	151,400	-2981,986	2243,386	5
46	151,800	-2042,345	2194,145	6
53	6878,300	4802,395	2075,905	7
42	117,300	-1814,057	1931,357	8
17	97,500	-1675,340	1772,840	9
6	476,100	-1964,718	1540,818	10
8	3539,700	2178,915	1360,785	11
49	195,500	-1118,322	1313,822	12
65	55,200	-1200,233	1255,433	13
20	3703,700	2575,211	1128,689	14
67	118,400	-1002,110	1112,510	15
4	119,600	-852,412	972,012	16
3	151,000	-853,140	814,140	17
61	78,000	-733,893	811,893	18
60	61,100	-733,893	794,993	19
57	119,500	-825,747	745,347	20
56	78,200	-825,747	723,947	21
63	172,900	-495,728	668,628	22
68	342,000	-242,945	584,945	23
24	232,700	-185,953	418,653	24
41	126,500	-164,551	291,051	25
22	45,500	-199,192	244,692	26
48	195,500	9,795	185,795	27
38	272,400	110,770	161,630	28
7	2520,800	2425,657	95,143	29
5	133,400	103,695	29,705	30
54	904,700	904,700	-0,000	31
21	1781,800	1893,899	-112,899	32
10	529,000	720,595	-191,595	33
31	72,000	274,860	-202,860	34
1	163,300	455,076	-291,776	35
59	319,700	983,865	-664,165	36
29	330,000	1049,236	-719,236	37
47	128,100	838,676	-710,576	38
58	124,200	909,330	-785,130	39
66	139,200	1024,791	-885,591	40
43	1265,000	2192,601	-927,601	41
44	381,800	1804,687	-1422,887	42
28	133,200	1711,361	-1578,161	43
9	94,300	1833,298	-1738,998	44
11	736,000	2519,294	-1783,294	45
26	113,100	2037,185	-1924,085	46
37	104,400	2038,226	-1933,826	47
27	69,600	2042,760	-1973,160	48
50	345,800	2350,205	-2004,405	49
40	1308,700	3334,955	-2026,255	50
64	189,600	2256,897	-2067,297	51
15	999,700	3220,515	-2220,815	52
62	249,600	2525,114	-2275,514	53
25	648,700	2947,053	-2298,353	54
33	152,800	2752,083	-2591,283	55
52	837,200	3635,926	-2798,726	56
55	913,830	3966,056	-3052,226	57
13	213,900	3275,983	-3062,083	58
39	1485,600	4667,614	-3182,014	59
35	284,400	3565,671	-3281,271	60
34	127,200	3454,185	-3326,985	61
32	289,200	5514,997	-5225,797	62

FIGURE 14

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 03 DEP VAR IS Y3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 4395.19

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	718.45	0.0	53	51	651.30	45.04	727.89	-2858.38	18	1
2	382.27	0.0	57	56	41.40	2.99	49.24	-2081.99	45	2
3	241.27	0.0	61	60	16.99	44.73	61.00	-2042.34	46	3
4	246.65	0.00	37	27	39.33	36.75	323.79	-1981.44	2	4
5	196.87	0.00	65	67	142.92	45.94	158.52	-1814.06	42	5
6	794.47	0.04	20	25	3427.04	4.01	517.41	-1675.34	17	6
7	880.53	0.05	8	7	1265.64	42.63	58.39	-1200.23	65	7
8	4782.30	0.06	32	36	29078.76	38.90	227.00	-1118.32	49	8
9	4959.70	0.12	55	51	5770.43	3.23	428.31	-1064.72	6	9
10	5029.73	0.12	55	53	5128.13	23.11	140.50	-1002.11	67	10
11	4584.62	0.12	58	59	120.96	22.21	160.12	-852.41	4	11
12	4297.53	0.12	7	20	1033.55	0.0	16.90	-733.89	61	12
13	4245.93	0.16	26	8	3284.87	0.23	19.15	-733.89	60	13
14	3951.33	0.17	3	56	112.19	0.17	68.79	-653.14	3	14
15	3692.97	0.17	3	57	68.79	0.0	41.40	-625.75	57	15
16	3469.61	0.18	61	56	107.95	2.98	35.32	-625.75	56	16
17	3271.43	0.18	60	56	91.35	18.84	83.68	-495.73	63	17
18	3093.76	0.18	61	57	66.55	16.18	340.25	-242.94	68	18
19	2933.82	0.18	60	57	49.65	13.82	173.96	-199.19	22	19
20	2892.14	0.22	25	40	272.09	1.99	127.60	-185.95	24	20
21	2668.82	0.23	61	3	2.25	49.50	105.26	-164.55	41	21
22	2548.47	0.23	60	3	19.15	51.62	156.09	9.71	48	22
23	2442.35	0.25	25	15	97.54	50.47	131.93	103.70	5	23
24	2493.70	0.30	20	15	3329.50	50.85	364.49	110.77	38	24
25	2416.08	0.30	44	26	501.20	6.49	88.92	274.86	31	25
26	2355.95	0.39	40	52	772.44	10.44	100.18	455.98	1	26
27	2275.83	0.47	15	40	174.55	43.91	538.98	720.59	10	27
28	2226.95	0.62	1	54	291.78	56.70	730.58	838.68	47	28
29	2137.02	0.74	9	26	185.99	3.45	785.13	904.70	54	29
30	2077.42	0.83	44	9	316.11	0.12	120.96	909.33	58	30
31	2021.23	1.13	67	3	298.37	1.69	221.43	983.86	59	31
32	1974.51	1.21	35	52	482.57	4.30	166.35	1024.79	66	32
33	1922.44	1.26	17	6	232.92	4.30	858.92	1049.24	29	33
34	1868.95	1.40	27	64	94.14	7.15	155.27	1711.36	28	34
35	1819.76	1.40	37	64	133.47	0.83	316.11	1804.69	44	35
36	1822.34	1.40	15	35	1080.48	39.01	1626.10	1833.30	9	36
37	1759.84	1.41	64	62	208.22	49.06	1811.19	1893.90	21	37
38	1722.75	1.41	67	60	317.52	4.58	9.74	2037.18	26	38
39	1687.28	1.41	67	61	328.62	0.00	39.33	2038.23	37	39
40	1647.68	1.44	58	66	180.46	4.69	3333.95	2042.76	27	40
41	1641.28	1.45	40	35	1255.01	46.44	2288.39	2178.92	8	41
42	1599.32	1.64	59	62	271.11	42.42	1139.78	2192.60	43	42
43	1577.58	1.69	59	66	221.43	2.59	62.89	2256.90	64	43
44	1626.14	1.76	8	58	3355.19	1.97	2099.55	2358.28	58	44
45	1591.84	1.85	62	15	74.78	22.28	1878.44	2425.66	7	45
46	1597.61	1.97	58	7	2099.55	16.35	492.22	2519.29	11	46
47	1576.43	1.99	24	41	127.60	2.65	3434.28	2525.11	62	47
48	1615.60	2.07	58	28	3133.09	21.93	3719.97	2575.01	28	48
49	1593.74	2.24	1	58	493.35	28.92	292.93	2752.98	33	49
50	1558.96	2.28	5	1	321.48	8.25	97.54	2947.85	25	50
51	1554.34	2.32	6	60	745.82	2.57	861.27	3228.51	15	51
52	1539.92	2.32	6	61	728.92	3.42	1935.82	3275.98	13	52
53	1511.34	2.56	62	25	22.84	41.27	1388.72	3334.96	48	53
54	1538.96	2.57	15	13	861.27	39.18	45.71	3454.18	34	54
55	1474.93	2.59	64	58	62.89	1.21	482.57	3565.87	35	55
56	1495.31	2.62	7	62	2378.66	49.33	253.52	3635.91	52	56
57	1535.20	2.65	62	28	3424.22	6.58	129.79	3966.86	55	57
58	1521.92	2.65	29	44	703.65	6.51	5257.92	4667.61	39	58
59	1589.28	2.72	66	28	692.57	0.0	651.30	4802.39	53	59
60	1486.26	2.85	60	63	126.36	49.28	7953.28	4802.39	51	60
61	1463.28	2.98	57	63	76.72	8.06	29078.76	5515.98	32	61
62	1440.31	2.98	56	63	35.32	47.11	777.13	7641.84	36	62

FIGURE 15

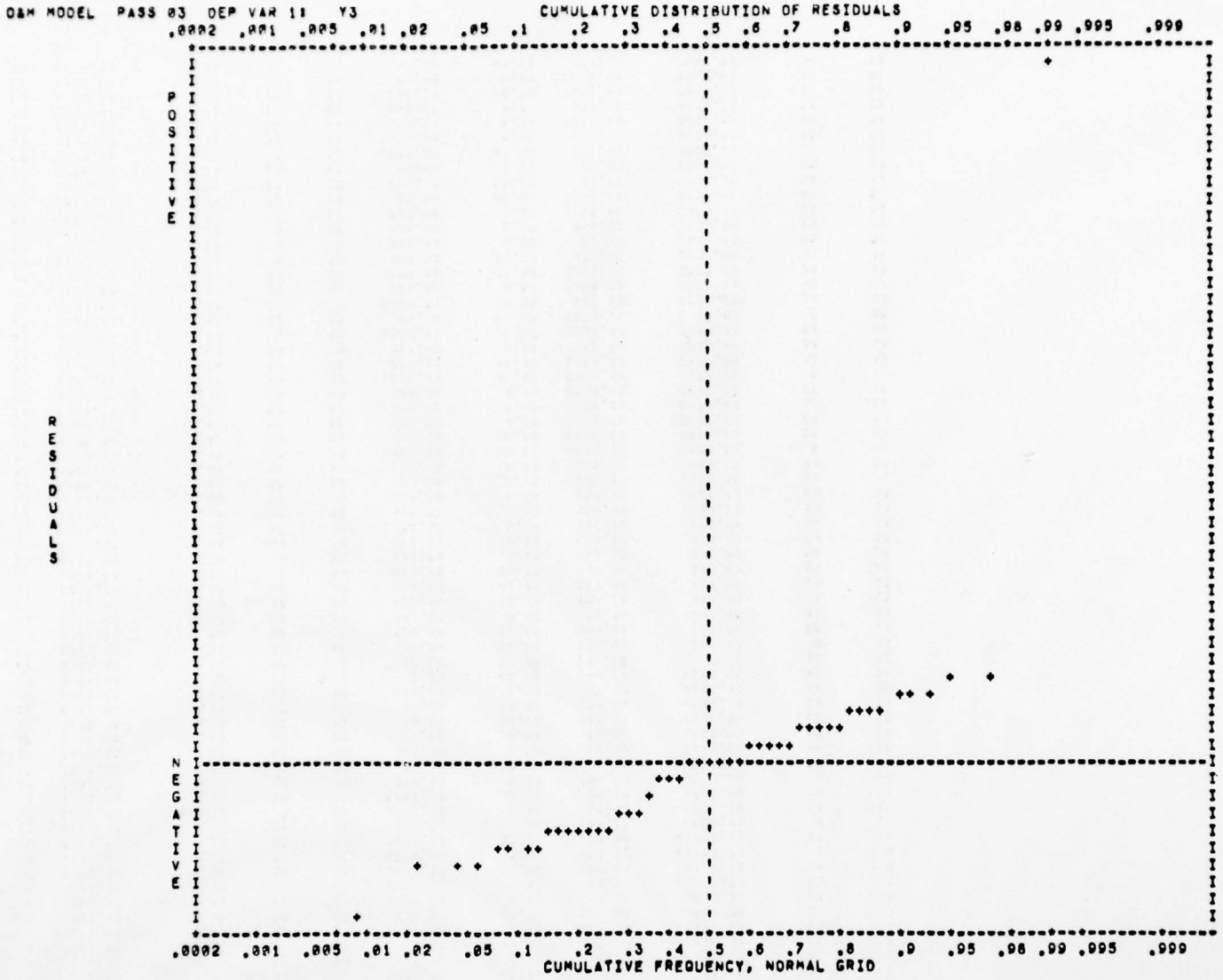

O&M MODEL PASS 03 DEP VAR 11 Y3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 16

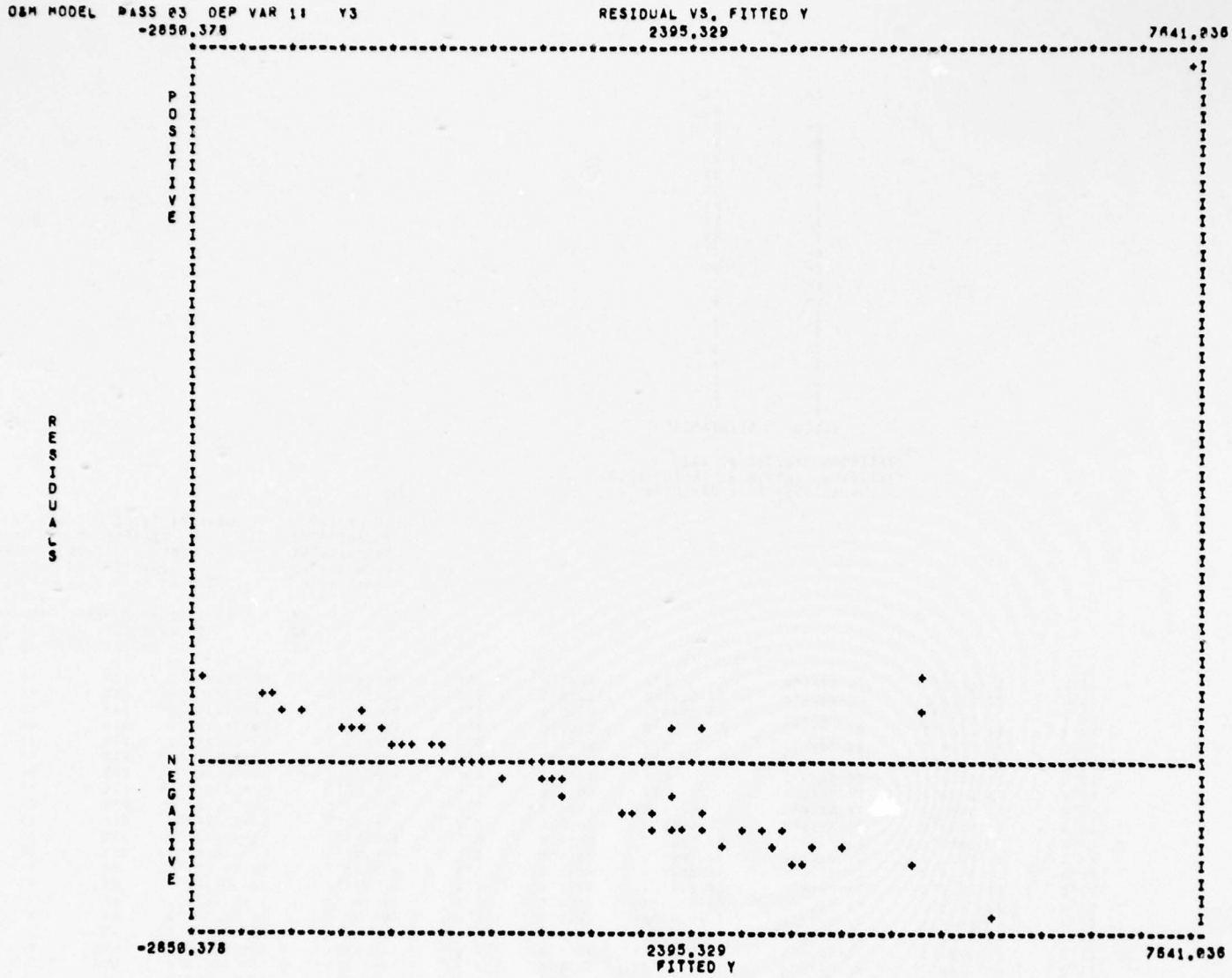

O&M MODEL PASS 03 DEP VAR 11 Y3
RESIDUAL VS. FITTED Y
-2858.378
2395.329
7641.036
POSITIVE
RESIDUALS
NEGATIVE
-2858.378
2395.329
7641.036
FITTED Y

FIGURE 17

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 03 DEP VAR 21 LNY3 MIN Y = 3.810D 00 MAX Y = 1.038D 01 RANGE Y = 6.540D 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		7.793620 00							
1	X1M	5.858270-01	5.540-01	1.1	0.7550	-2.740D-01	7.260D-01	1.000D 00	0.09
2	X2M	8.83353D-01	6.580-01	1.3	0.8338	-2.740D-01	7.260D-01	1.000D 00	0.14
3	X3M	7.255930-01	4.230-01	1.7	0.5809	-2.580D-01	7.420D-01	1.000D 00	0.11
4	X4M	-7.656890-01	3.890-01	2.0	0.4288	-2.100D-01	7.900D-01	1.000D 00	0.12
5	X5	6.779220-01	7.730-01	0.9	0.3464	-2.930D-01	5.387D-01	7.420D-01	0.08
6	X6	1.743210-01	8.270-01	0.2	0.3871	-2.165D-01	5.735D-01	7.900D-01	0.02
7	X7	-7.315130-01	7.690-01	0.9	0.4012	-2.165D-01	5.735D-01	7.900D-01	0.09
8	X8	2.858460-05	3.670-06	0.8	0.7129	1.580D 02	3.240D 05	3.238D 05	0.14
9	X9	2.923130-04	1.930-04	1.5	0.8540	3.000D 01	8.200D 03	8.170D 03	0.36
10	X10	-4.144290-02	1.330-02	3.1	0.9190	1.200D 00	1.737D 02	1.725D 02	1.09
11	X11	-2.385990-04	1.540-04	1.5	0.8490	9.000D 00	7.638D 03	7.629D 03	0.28
12	X12	7.253570-02	1.750-01	0.4	0.5792	4.923D-03	6.674D 00	6.669D 00	0.07
13	X13	-1.829370-02	1.250-01	0.1	0.9982	0.0	1.000D 02	1.000D 02	0.28
14	X14	-9.377110-03	1.210-01	0.1	0.9993	0.0	1.000D 02	1.000D 02	0.14
15	X15	-8.489350-04	1.220-01	0.0	0.9991	0.0	1.000D 02	1.000D 02	0.01
16	X16	-2.073120-02	1.220-01	0.2	0.9969	0.0	1.000D 02	1.000D 02	0.32
17	X17	5.427980-04	1.210-01	0.0	0.9975	0.0	1.000D 02	1.000D 02	0.01
18	X18	2.775790-03	4.910-03	0.6	0.6599	0.0	1.000D 02	1.000D 02	0.04
19	X19	-6.610770-04	4.490-04	1.5	0.5659	7.000D 00	1.640D 03	1.633D 03	0.17
20	X20	-1.941290-01	5.210-01	0.2	0.8297	3.000D-01	2.330D 00	2.000D 00	0.03
21	X21	2.934980-02	1.480-02	2.0	0.5878	0.0	6.100D 01	6.100D 01	0.27

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	21
RESIDUAL DEGREES OF FREEDOM	40
F-VALUE	4.0
RESIDUAL ROOT MEAN SQUARE	0.94294949
RESIDUAL MEAN SQUARE	0.88915375
RESIDUAL SUM OF SQUARES	35.56614993
TOTAL SUM OF SQUARES	199.98282818
MULT. CORREL. COEF. SQUARED	.6764

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 18

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS #3 DEP VAR 2: LNY3

IDENT	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
	ORDERED BY COMPUTER INPUT					ORDERED BY RESIDUALS				
71R2A	1	1.	5.096	5.833	-0.738	36	10.358	7.517	2.840	1
7353A	2	0.	5.612	5.168	0.444	8	8.172	6.460	1.712	2
71L8A	3	0.	5.981	5.075	0.907	7	7.832	6.388	1.445	3
71M6A	4	1.	4.784	5.685	-0.901	20	8.217	6.820	1.397	4
71PKA	5	0.	4.893	5.339	-0.446	6	6.186	5.068	1.118	5
71P8A	6	0.	6.186	5.068	1.118	29	5.799	4.894	0.905	6
7171A	7	3.	7.832	6.368	1.465	18	4.795	4.010	0.785	7
724GA	8	3.	8.172	6.460	1.712	63	5.153	4.440	0.712	8
71G5A	9	1.	4.546	6.268	-1.721	47	4.683	4.066	0.617	9
71FAA	10	2.	6.271	5.966	0.305	45	5.484	4.516	0.568	10
71F8A	11	2.	6.681	6.846	-0.245	51	8.927	8.402	0.525	11
710AA	13	1.	5.366	6.367	-1.001	49	5.276	4.757	0.519	12
71ABE	15	2.	6.907	6.891	0.016	67	4.704	4.235	0.469	13
714DA	17	2.	4.980	4.514	0.466	2	5.612	5.168	0.444	14
730BA	18	9.	4.795	4.010	0.785	53	8.836	8.402	0.435	15
73C8Q	20	3.	8.217	6.820	1.397	21	7.485	7.117	0.368	16
73CEN	21	2.	7.485	7.117	0.368	38	5.607	5.256	0.351	17
73CFK	22	10.	3.818	4.429	-0.612	10	6.271	5.966	0.305	18
73DAM	24	2.	5.450	5.687	-0.237	40	7.177	6.944	0.232	19
73E9A	25	3.	8.475	8.837	-0.362	57	4.784	4.555	0.229	20
73E8F	25	2.	4.728	6.350	-1.622	39	7.304	7.094	0.209	21
71CAA	27	2.	4.243	5.117	-0.874	42	4.765	4.557	0.207	22
72EAA	28	9.	4.892	4.781	0.111	49	5.023	4.831	0.191	23
72ECA	29	4.	5.799	4.894	0.905	59	5.767	5.599	0.169	24
72BPA	31	5.	4.277	4.415	-0.138	28	4.892	4.781	0.111	25
71JAA	32	2.	5.667	7.061	-1.394	17	4.580	4.514	0.066	26
71LAA	33	2.	5.088	5.728	-0.648	15	6.907	6.891	0.016	27
72DNA	34	3.	4.846	5.351	-0.505	3	5.981	5.075	0.907	28
724CA	35	1.	5.659	6.041	-0.390	54	6.808	6.808	-0.000	29
7171A	36	3.	10.358	7.517	2.840	66	4.936	4.948	-0.012	30
7131D	37	2.	4.648	5.116	-0.467	68	5.035	5.869	-0.834	31
72RFA	38	7.	5.607	5.256	0.351	24	5.450	5.687	-0.237	32
72R8A	39	2.	7.304	7.094	0.209	43	7.143	7.184	-0.041	33
7593A	40	3.	7.177	6.944	0.232	61	4.357	4.468	-0.111	34
74BDA	41	1.	4.840	5.572	-0.732	65	4.011	4.145	-0.134	35
74BFA	42	5.	4.765	4.557	0.207	31	4.277	4.415	-0.138	36
7481A	43	2.	7.143	7.184	-0.041	56	4.359	4.555	-0.196	37
7641A	44	2.	5.945	6.425	-0.480	58	4.822	5.023	-0.201	38
76GAA	45	5.	5.284	4.516	0.768	11	6.681	6.846	-0.245	39
74FF8	46	10.	5.023	4.831	0.191	62	5.520	5.766	-0.246	40
74FAA	47	42.	4.683	4.066	0.617	64	5.245	5.534	-0.289	41
74FM8	48	9.	5.276	5.584	-0.309	48	5.276	5.584	-0.309	42
74FU8	49	13.	5.276	4.757	0.519	60	4.113	4.468	-0.355	43
77EC8	50	1.	5.846	6.363	-0.517	25	6.475	6.837	-0.362	44
77EE0	51	3.	8.927	8.402	0.525	35	5.659	6.041	-0.390	45
77DCA	52	1.	6.730	7.172	-0.442	52	6.730	7.172	-0.442	46
77D8A	53	3.	8.836	8.402	0.435	5	4.893	5.339	-0.446	47
73C9A	54	2.	6.808	6.808	-0.000	37	4.648	5.116	-0.467	48
73CGA	55	2.	6.818	7.591	-0.773	44	5.945	6.425	-0.480	49
71NAA	56	1.	4.359	4.555	-0.196	34	4.846	5.351	-0.505	50
71QUA	57	1.	4.784	4.555	0.229	50	5.846	6.363	-0.517	51
63AAA	58	1.	4.822	5.023	-0.201	22	3.818	4.429	-0.612	52
65AAA	59	2.	5.767	5.599	0.169	33	5.080	5.728	-0.648	53
638AA	60	1.	4.113	4.468	-0.355	41	4.840	5.572	-0.732	54
63CAA	61	1.	4.357	4.468	-0.111	1	5.796	5.833	-0.738	55
658AA	62	1.	5.520	5.766	-0.246	55	6.818	7.591	-0.773	56
61B8A	63	1.	5.153	4.440	0.712	27	4.243	5.117	-0.874	57
65BAA	64	1.	5.245	5.534	-0.289	4	4.784	5.685	-0.901	58
63AFA	65	2.	4.011	4.145	-0.134	13	5.366	6.367	-1.001	59
63AA8	66	1.	4.936	4.948	-0.012	32	5.667	7.061	-1.394	60
63121	67	2.	4.784	4.235	0.469	26	4.728	6.350	-1.622	61
63AAA	68	4.	5.035	5.869	-0.834	9	4.546	6.268	-1.721	62

FIGURE 10

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

D&M MODEL PASS #3 DEP VAR 21: LNY3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.94

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD				ORDERED BY FITTED Y				
		WSSD	OBSV.	OBSV.	DEL RESIDUALS	WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.10	0.0	53	51	0.09	22.28	0.17	4.01	18	1
2	0.28	0.0	57	56	0.42	37.15	0.75	4.07	47	2
3	0.28	0.0	61	60	0.24	0.01	0.60	4.14	65	3
4	0.32	0.00	37	27	0.41	4.07	0.61	4.23	67	4
5	0.39	0.01	65	67	0.60	12.04	0.47	4.41	31	5
6	0.37	0.02	7	8	0.25	13.85	1.32	4.43	22	6
7	0.38	0.06	25	15	0.38	0.09	0.82	4.44	63	7
8	0.48	0.06	6	3	1.11	0.0	0.24	4.47	61	8
9	0.65	0.09	20	25	1.76	1.14	0.42	4.47	69	9
10	0.70	0.09	63	69	1.07	9.17	0.50	4.51	17	10
11	0.72	0.09	63	61	0.82	6.56	0.34	4.52	45	11
12	0.73	0.14	43	55	0.73	0.0	0.42	4.56	57	12
13	0.79	0.17	20	15	1.38	5.70	0.40	4.56	56	13
14	0.77	0.18	44	54	0.48	3.51	0.31	4.56	42	14
15	0.77	0.20	6	2	0.67	5.56	0.41	4.76	49	15
16	0.79	0.22	1	9	0.98	18.34	0.09	4.78	28	16
17	0.80	0.24	2	5	0.89	12.11	0.71	4.83	46	17
18	0.78	0.29	3	2	0.44	3.83	0.92	4.89	29	18
19	0.92	0.43	9	7	3.19	1.55	0.19	4.95	68	19
20	0.99	0.45	8	25	2.07	0.85	1.32	5.02	58	20
21	0.95	0.54	8	20	0.31	0.06	1.11	5.05	6	21
22	0.92	0.55	7	20	0.07	1.78	0.47	5.07	3	22
23	0.92	0.59	9	13	0.72	0.00	0.41	5.12	37	23
24	1.22	0.60	26	7	3.09	2.27	1.32	5.12	27	24
25	0.98	0.63	9	26	0.10	7.81	0.09	5.17	2	25
26	0.95	0.71	5	41	0.29	8.06	0.80	5.26	38	26
27	0.98	0.74	55	51	1.30	4.56	0.06	5.34	5	27
28	0.99	0.76	55	53	1.21	5.58	0.47	5.35	34	28
29	1.01	0.77	7	54	1.46	4.22	0.25	5.49	24	29
30	1.00	0.79	43	51	0.57	2.87	0.44	5.53	64	30
31	0.98	0.79	43	53	0.48	9.73	0.42	5.57	41	31
32	0.98	0.79	59	1	0.91	12.39	0.48	5.58	48	32
33	1.01	0.79	8	54	1.71	2.09	1.07	5.60	59	33
34	1.02	0.85	58	8	1.32	2.77	0.25	5.68	4	34
35	1.04	0.85	32	39	1.60	3.58	0.40	5.73	33	35
36	1.02	0.89	60	56	0.16	1.70	0.49	5.77	62	36
37	1.00	0.89	51	57	0.34	3.13	0.79	5.83	1	37
38	0.99	0.89	50	57	0.58	2.37	0.34	5.87	66	38
39	1.04	0.90	39	36	2.63	2.98	0.79	5.97	10	39
40	1.03	0.98	15	21	0.35	1.84	1.33	6.04	35	40
41	1.02	1.00	25	49	0.59	0.63	0.19	6.27	9	41
42	1.00	1.00	56	3	0.21	3.35	1.10	6.35	26	42
43	1.03	1.02	7	44	1.95	2.11	0.49	6.36	50	43
44	1.01	1.04	15	49	0.22	1.72	2.47	6.37	13	44
45	1.01	1.04	21	55	1.14	1.02	1.95	6.37	7	45
46	1.04	1.05	8	11	1.96	1.13	2.19	6.43	44	46
47	1.02	1.06	54	15	0.02	0.70	1.71	6.46	8	47
48	1.01	1.08	63	17	0.65	1.24	1.40	6.81	54	48
49	1.00	1.08	21	43	0.41	0.09	1.76	6.82	20	49
50	0.99	1.08	54	25	0.36	1.42	0.12	6.84	25	50
51	0.97	1.09	4	1	0.16	1.29	0.26	6.85	11	51
52	0.96	1.09	11	15	0.26	1.04	0.22	6.89	15	52
53	0.96	1.11	20	40	1.17	1.79	1.63	6.94	40	53
54	0.99	1.13	44	8	2.19	0.85	1.60	7.06	32	54
55	0.98	1.14	61	17	0.18	1.72	0.16	7.09	39	55
56	0.97	1.14	60	17	0.42	2.67	0.81	7.12	21	56
57	0.97	1.15	26	44	1.14	2.47	0.40	7.17	52	57
58	0.96	1.18	59	62	0.42	2.75	2.88	7.18	43	58
59	0.98	1.20	10	9	2.03	2.73	3.61	7.52	36	59
60	0.99	1.24	54	20	1.40	0.76	1.21	7.59	55	60
61	0.98	1.37	41	4	0.17	0.0	0.09	8.40	53	61
62	0.97	1.39	13	44	0.52	7.92	0.92	8.48	51	62

FIGURE 20

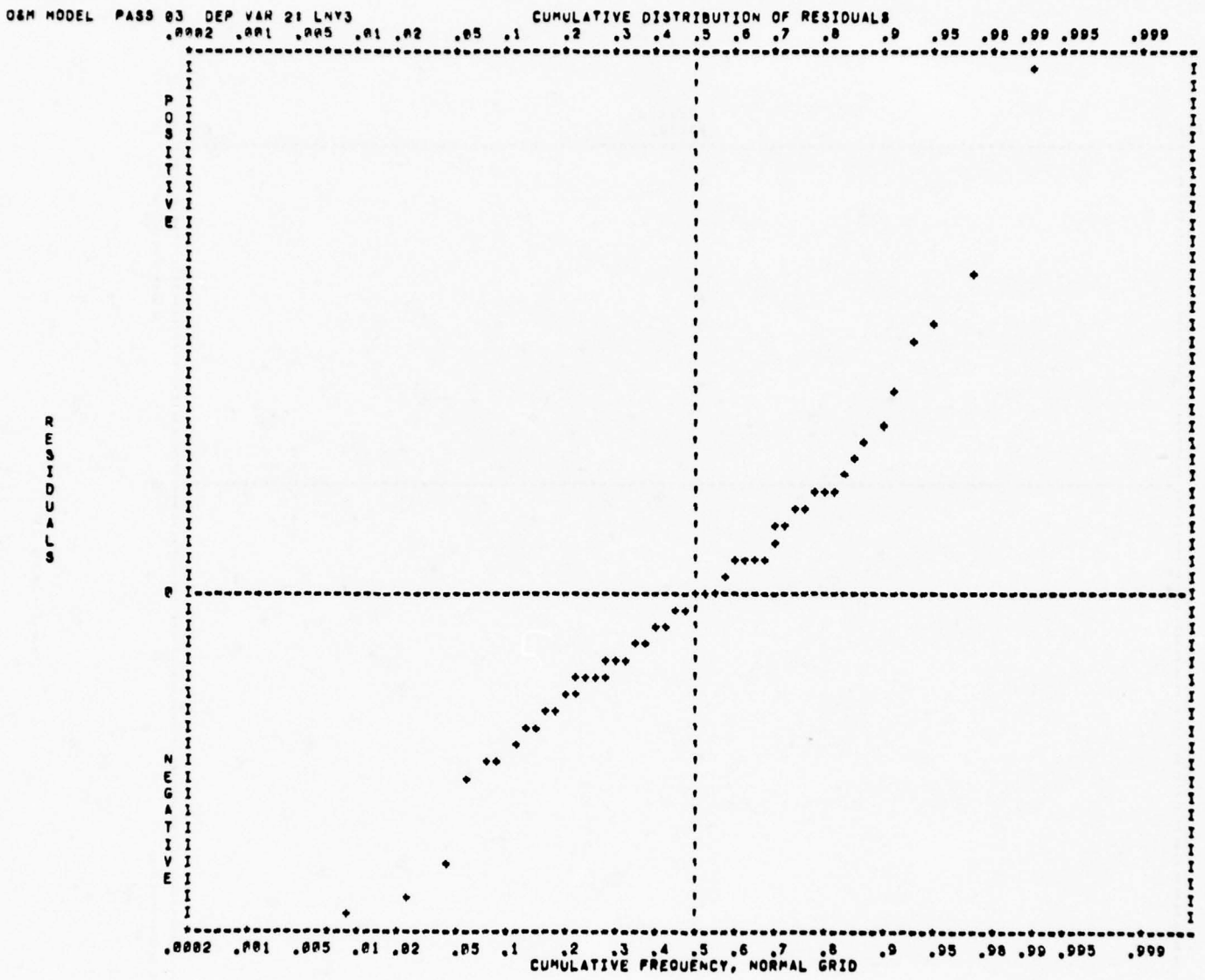

O&M MODEL PASS 03 DEP VAR 21 LNY3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 21

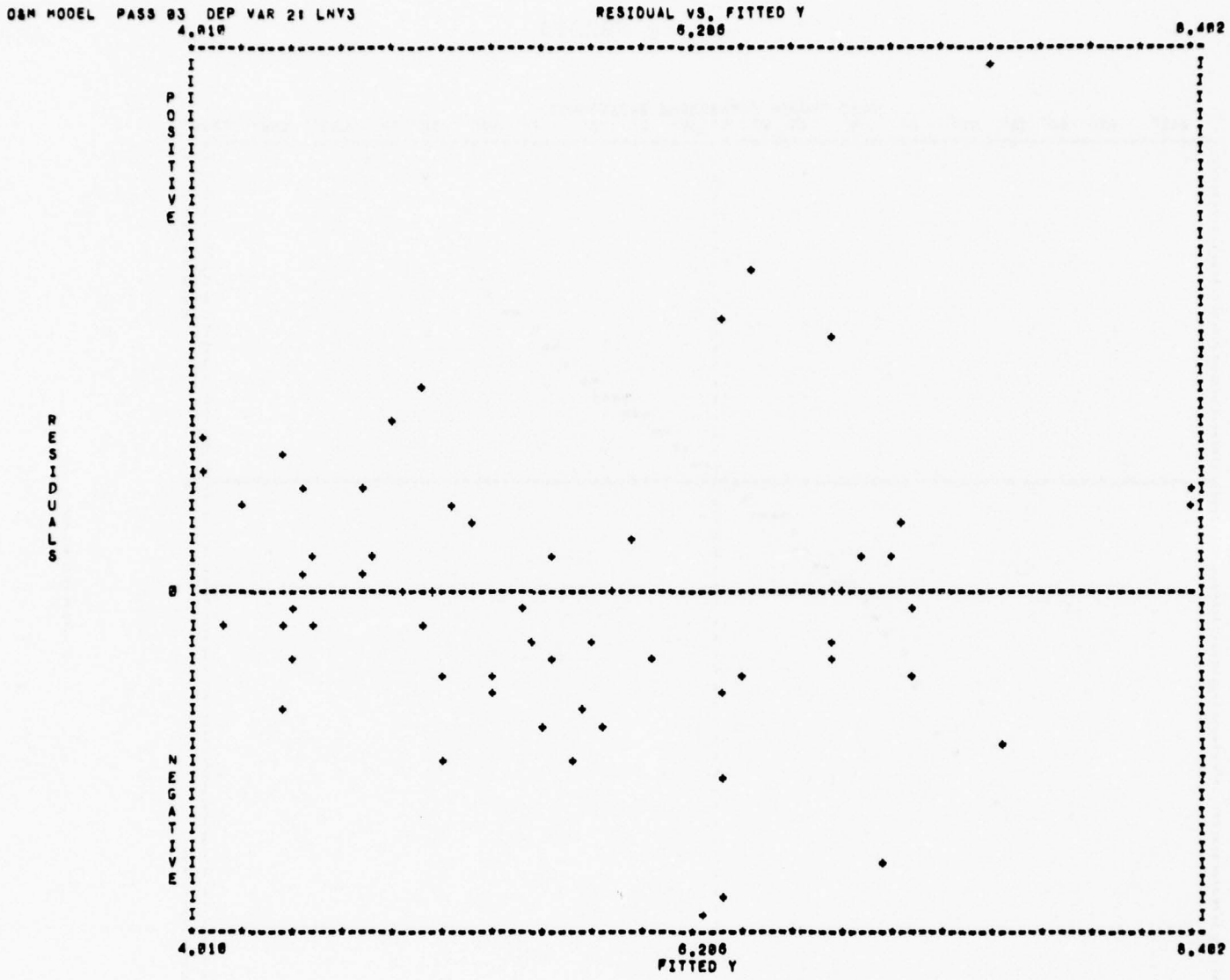

O&M MODEL PASS 03 DEP VAR 21 LNY3
RESIDUAL VS. FITTED Y
4,818
6,286
8,482
POSITIVE
RESIDUALS
0
NEGATIVE
4,818
6,286
8,482
FITTED Y

FIGURE 22

had not been in the Air Force inventory long enough to experience "good" data. These observations were dropped from the analysis in order to reduce bias.

As a means of determining whether the data are "nested", a computer program was written to sort the data table by each independent variable, x_i. For instance, Table 4 is a printout of the data ranked by the unit price. As can be seen there are only a few observations with the same x_i values, and hence no evidence of serious nesting exists. If it is determined that the data are nested, two fittings must be made: one on the nested data "within plots" and one "among plots". (See [1], Chapter 8).

After the data has been critically examined, and alternate LRUs considered where necessary, we are now ready to begin the regressions. As before, a fit is made (Pass 3) where Y3 is the dependent variable (see Figures 23-27). Note that the statistics in Figure 23 have been greatly improved over that of Figure 13, which indicates the power of an outlier in the data. The fitted values plot (Figure 27), however, shows a strange trend in the residuals, that possibly the natural logarithm function can straighten out. Figures 28-32 show the results of fitting the same independent variable but with ln Y3 as the dependent variable. Here the statistics are slightly better than those of Figure 23, but the cumulative distribution plot shows an approximate straight line and the trend in the fitted values plot has disappeared.

The anxious analyst might feel at this point that the use of the natural logarithm transformation in the dependent variable is the appropriate form to use the equation. It might be, however, that other transformation (curvature) in the independent variables are needed in the equation to determine the correct form of the dependent variable. Consequently, both forms of the dependent variable should be fitted simultaneously, analyzing the statistics, plots and tables at each stage and introducing curvature whenever the statistics indicate. In developing several of the fitted equations such as MMH/OH, LSC/OH, and TRAIN/OH, the statistics did not definitely

TABLE 4

RANKED BY INDEPENDENT VARIABLE X(8)

OBSER. NO.	X(8)	X(9)	X(10)	X(11)	X(12)	X(13)	X(14)	X(15)	X(16)	X(17)	X(18)	X(19)	X(20)	X(21)	DEP. VAR.
	UPRICE	VOLUME	WEIGHT	CCOUNT	CDENS	DIGTAL	ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT	MTBMA
19	153.	86.	2.60	78.	0.91	0.00	100.00	0.00	0.00	0.00	0.00	17.	1.30	0.00	0.
20	158.	30.	1.20	38.	1.27	0.00	100.00	0.00	0.00	0.00	0.00	34.	1.30	4.00	3724.
51	835.	222.	8.50	9.	0.04	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00	7530.
53	835.	222.	8.50	9.	0.04	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00	6878.
7	840.	91.	4.00	12.	0.13	0.00	100.00	0.00	0.00	0.00	100.00	22.	2.30	1.00	2521.
15	1100.	280.	7.50	214.	0.76	0.00	93.00	7.00	0.00	0.00	93.00	7.	1.30	4.00	1222.
35	1208.	294.	7.50	214.	0.73	0.00	100.00	0.00	0.00	0.00	100.00	22.	1.20	4.00	1387.
25	1347.	132.	3.40	120.	0.91	0.00	100.00	0.00	0.00	0.00	85.00	34.	1.30	0.00	849.
38	1602.	399.	14.00	328.	0.82	0.00	0.00	0.00	100.00	0.00	30.00	860.	1.20	0.00	272.
29	2851.	4243.	63.38	4363.	1.03	0.00	100.00	0.00	0.00	0.00	0.00	160.	1.20	0.00	339.
8	2855.	133.	1.25	84.	0.63	0.00	97.00	3.00	0.00	0.00	97.00	87.	2.30	0.00	3542.
33	2185.	368.	9.00	88.	0.24	0.00	33.00	67.00	0.00	0.00	0.00	850.	1.20	0.00	1486.
6	2241.	1276.	36.50	756.	0.59	0.00	86.00	14.00	0.00	0.00	68.00	289.	2.30	0.00	476.
26	2598.	464.	11.50	177.	0.38	0.00	100.00	0.00	0.00	0.00	37.00	132.	1.30	0.00	113.
44	2652.	563.	15.00	911.	1.63	0.00	100.00	0.00	0.00	0.00	100.00	335.	2.30	6.00	382.
17	2744.	1732.	60.00	924.	0.53	0.00	100.00	0.00	0.00	0.00	0.00	17.	1.30	0.00	98.
37	2745.	1734.	60.00	924.	0.53	0.00	75.00	0.00	0.00	25.00	0.00	500.	1.20	0.00	124.
21	2782.	256.	10.50	20.	0.07	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00	1781.
40	3015.	94.	4.00	128.	1.15	0.00	100.00	0.00	0.00	0.00	100.00	7.	2.30	0.00	1309.
27	3265.	1734.	60.00	924.	0.53	0.00	75.00	0.00	0.00	25.00	0.00	500.	1.20	0.00	70.
29	3720.	5478.	87.50	321.	0.05	0.00	75.00	0.00	0.00	25.00	25.00	1640.	1.20	0.00	133.
62	3846.	1484.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	500.	1.30	0.00	61.
61	3846.	1682.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	507.	1.30	0.00	78.
67	3846.	1682.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	500.	1.20	0.00	110.
64	3914.	1844.	29.00	1236.	0.67	0.00	76.00	1.00	8.00	15.00	97.50	90.	1.20	5.00	190.
62	3914.	1844.	29.00	1236.	0.67	0.00	76.00	1.00	8.00	15.00	97.50	90.	1.30	5.00	250.
65	4063.	1682.	51.00	1186.	0.71	0.00	75.00	0.00	0.00	25.00	23.00	502.	1.20	0.00	55.
68	4208.	242.	9.00	1615.	6.67	44.00	37.00	0.00	0.00	19.00	100.00	35.	1.20	0.00	342.
24	5720.	3060.	58.00	156.	0.05	0.00	43.00	57.00	0.00	0.00	0.00	225.	1.30	0.00	233.
63	5864.	1869.	49.00	1376.	0.74	0.00	100.00	0.00	0.00	0.00	70.00	382.	1.30	0.00	173.
18	5928.	5478.	90.00	321.	0.05	0.00	75.00	0.00	0.00	25.00	25.00	1640.	1.30	0.00	121.
32	6247.	479.	12.80	1013.	2.11	0.00	99.00	1.00	0.00	0.00	99.00	175.	1.20	0.00	289.
43	6257.	577.	11.00	35.	0.06	0.00	0.00	100.00	0.00	0.00	0.00	434.	2.30	5.00	1265.
3	6681.	1444.	40.00	491.	0.34	0.00	75.00	0.00	0.00	25.00	27.00	212.	2.30	0.00	161.
56	7191.	1367.	36.00	1674.	1.22	0.00	75.00	0.00	0.00	25.00	97.60	256.	2.30	0.00	78.
57	7191.	1367.	36.00	1674.	1.22	0.00	75.00	0.00	0.00	25.00	97.60	256.	2.30	0.00	129.
5	8418.	1473.	40.00	689.	0.47	0.00	74.00	1.00	0.00	25.00	95.80	77.	2.30	0.00	133.
12	8632.	220.	6.50	150.	0.75	0.00	100.00	0.00	0.00	0.00	100.00	20.	2.30	13.00	0.
50	9741.	1780.	45.00	946.	0.54	11.00	84.00	5.00	0.00	0.00	94.70	350.	1.30	0.00	346.
58	9865.	1120.	29.00	790.	0.71	0.00	75.00	0.00	0.00	25.00	97.00	150.	2.30	0.00	124.
10	10000.	142.	13.90	412.	2.90	49.00	49.00	2.00	0.00	0.00	98.00	384.	2.30	19.00	529.
41	10127.	1599.	43.70	1126.	0.70	0.00	61.00	39.00	0.00	0.00	61.00	212.	2.30	0.00	127.
66	10712.	1122.	41.00	790.	0.71	0.00	75.00	0.00	0.00	25.00	97.00	152.	1.20	0.00	139.
1	13721.	443.	17.70	410.	0.93	0.00	86.00	14.00	0.00	0.00	86.00	200.	2.30	0.00	163.
59	14271.	377.	14.00	982.	2.60	0.00	75.00	0.00	0.00	25.00	100.00	64.	2.30	0.00	329.
42	15258.	1377.	78.50	399.	0.29	0.00	0.00	0.00	0.00	100.00	98.00	900.	2.30	1.00	117.
35	16793.	432.	31.00	592.	1.37	0.00	99.00	1.00	0.00	0.00	99.00	851.	1.20	4.00	284.
11	16880.	424.	13.90	61.	0.14	0.00	33.00	67.00	0.00	0.00	33.00	175.	2.30	17.00	736.
22	18724.	8200.	118.00	561.	0.06	0.00	75.00	0.00	0.00	25.00	66.50	152.	1.30	0.00	45.
45	19274.	551.	25.70	1319.	2.39	100.00	0.00	0.00	0.00	0.00	100.00	1300.	0.30	0.00	161.
9	23337.	584.	14.00	421.	0.72	0.00	89.00	11.00	0.00	0.00	34.00	172.	2.30	13.00	94.
54	24642.	307.	8.00	529.	1.72	0.00	98.00	12.00	0.00	0.00	98.60	300.	0.80	0.00	905.
52	31698.	1223.	26.40	1457.	1.19	0.00	100.00	0.00	0.00	0.00	100.00	145.	1.30	0.00	837.
33	34862.	1254.	32.00	2743.	2.18	55.00	33.00	0.00	0.00	12.00	99.60	265.	1.20	0.00	161.
4	36913.	1676.	38.60	78.	0.05	0.00	24.00	76.00	0.00	0.00	24.00	820.	2.30	0.00	129.
2	41234.	998.	36.60	2176.	2.18	0.00	73.00	27.00	0.00	0.00	73.00	175.	2.30	4.00	274.
55	43912.	944.	12.00	53.	0.06	0.00	0.00	100.00	0.00	0.00	0.00	60.	0.80	0.00	914.
48	46759.	1866.	35.00	932.	0.50	0.00	0.00	0.00	100.00	0.00	100.00	1620.	2.30	59.00	196.
13	57100.	866.	29.80	32.	0.04	0.00	75.00	0.00	0.00	25.00	93.00	70.	2.30	18.00	214.
34	100450.	1511.	39.86	1244.	0.69	87.00	12.00	1.00	0.00	0.00	98.70	850.	1.20	6.00	127.
47	156200.	5330.	173.70	1558.	0.29	0.00	0.00	0.00	0.00	100.00	99.00	270.	2.30	61.00	198.
46	238700.	2278.	41.00	7638.	3.35	100.00	0.00	0.00	0.00	0.00	100.00	1300.	2.30	51.00	152.
31	253382.	2475.	75.00	4595.	1.82	30.00	69.00	1.00	0.00	0.00	99.60	707.	1.20	4.00	72.
49	324200.	3656.	110.00	18.	0.00	0.00	0.00	100.00	0.00	0.00	0.00	400.	2.30	0.00	196.

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 11 Y3 MIN Y = 4.550D 01 MAX Y = 7.530D 03 RANGE Y = 7.4840 03

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		-4.299690 03							
1	X1M	1.165540 03	6.290 02	1.9	0.7650	-2.740D-01	7.260D-01	1.000D 00	0.16
2	X2M	5.475220 02	7.480 02	0.7	0.8338	-2.740D-01	7.260D-01	1.000D 00	0.07
3	X3M	7.871970 02	4.880 02	1.6	0.5809	-2.580D-01	7.420D-01	1.000D 00	0.11
4	X4M	-3.189210 02	4.420 02	0.7	0.4288	-2.100D-01	7.900D-01	1.000D 00	0.04
5	X5	2.646990 03	8.790 02	3.0	0.3464	-2.030D-01	5.370D-01	7.400D-01	0.26
6	X6	3.929750 01	9.320 02	0.0	0.3871	-2.165D-01	5.735D-01	7.900D-01	0.00
7	X7	-2.974560 02	8.960 02	0.3	0.4012	-2.165D-01	5.735D-01	7.900D-01	0.03
8	X8	3.278670-03	4.160-03	0.8	0.7129	1.580D 02	3.240D 05	3.238D 05	0.14
9	X9	2.472110-01	2.290-01	1.1	0.8548	3.000D 01	8.200D 03	8.170D 03	0.27
10	X10	-3.585770 01	1.520 01	2.4	0.9190	1.200D 00	1.737D 02	1.725D 02	0.83
11	X11	-1.457730-01	1.860-01	0.8	0.6498	0.000D 00	7.638D 03	7.629D 03	0.15
12	X12	-4.891180 01	1.990 02	0.2	0.5792	4.923D-03	6.674D 00	6.669D 00	0.24
13	X13	6.323970 01	1.420 02	0.4	0.9962	0.0	1.000D 02	1.000D 02	0.64
14	X14	5.839790 01	1.380 02	0.4	0.9993	0.0	1.000D 02	1.000D 02	0.78
15	X15	6.577430 01	1.390 02	0.5	0.9991	0.0	1.000D 02	1.000D 02	0.88
16	X16	5.439250 01	1.390 02	0.4	0.9969	0.0	1.000D 02	1.000D 02	0.73
17	X17	8.923820 01	1.380 02	0.6	0.9975	0.0	1.000D 02	1.000D 02	1.07
18	X18	-6.856420 00	5.580 00	1.2	0.6589	0.0	1.000D 02	1.000D 02	2.09
19	X19	-5.165490-01	5.910-01	1.0	0.5659	7.000D 00	1.640D 03	1.633D 03	0.11
20	X20	2.228960 02	5.920 02	0.4	0.8297	3.000D-01	2.320D 00	2.000D 00	0.06
21	X21	1.736950 01	1.680 01	1.0	0.5878	0.0	6.100D 01	6.100D 01	0.14

NO. OF OBSERVATIONS 62
NO. OF IND. VARIABLES 21
RESIDUAL DEGREES OF FREEDOM 40
F-VALUE 3.1
RESIDUAL ROOT MEAN SQUARE 1071.42220661
RESIDUAL MEAN SQUARE 1147945.54481105
RESIDUAL SUM OF SQUARES **********
TOTAL SUM OF SQUARES 121154112.61904668
MULT. CORREL. COEF. SQUARED .6210

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 23

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR IS Y3

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71920	1	3.	163,300	446,671	-283,371	8	3539,700	884,357	2655,343	1
73530	2	2.	273,700	-54,505	328,205	51	7529,600	5025,225	2504,375	2
71LR0	3	3.	161,000	730,310	-569,310	20	3703,700	1821,117	1882,583	3
71M60	4	19.	119,600	1024,125	-904,525	53	6878,300	5025,225	1853,075	4
71P40	5	3.	133,400	313,513	-180,113	7	2520,800	815,326	1705,474	5
71P60	6	3.	476,100	-16,234	492,334	31	72,000	-830,499	902,499	6
7171R	7	8.	2520,800	815,326	1705,474	45	181,400	-633,851	795,251	7
724G0	8	7.	3539,700	884,357	2655,343	63	172,900	-525,095	697,995	8
71G50	9	4.	94,300	1228,501	-1134,201	47	178,100	-523,558	631,658	9
71FA0	10	9.	529,000	704,416	-175,416	40	1308,700	810,725	497,975	10
71F80	11	14.	736,000	1750,639	-1014,639	6	476,100	-16,234	492,334	11
710A0	13	3.	213,900	1133,682	-919,782	35	284,400	-159,326	443,726	12
71ARE	15	6.	999,700	1087,586	-87,886	22	45,500	-342,230	387,730	13
71ADA	17	8.	97,500	-12,269	109,569	18	122,900	-253,972	376,872	14
73CBA	18	9.	122,900	-253,972	376,872	29	330,200	-2,824	332,824	15
73CB0	20	9.	3703,700	1821,117	1882,583	2	273,700	-54,505	328,205	16
73CEN	21	41.	1781,000	2255,880	-474,880	36	1387,200	1099,735	287,465	17
73CFK	22	14.	45,500	-342,230	387,730	57	119,600	-113,388	232,988	18
73DAM	24	18.	232,700	851,404	-618,704	48	195,500	-16,594	212,094	19
73EBA	25	9.	648,700	1117,751	-469,051	66	139,200	-61,715	200,915	20
73EBF	26	8.	113,100	1217,331	-1104,231	56	78,200	-113,388	191,588	21
71CAR	27	4.	69,500	402,280	-332,680	28	133,200	-58,301	191,501	22
72EAA	28	8.	133,200	-58,301	191,501	17	97,500	-12,069	109,569	23
72ECA	29	8.	330,000	-2,824	332,824	65	55,200	-35,778	90,978	24
72RR0	31	6.	72,000	-832,499	902,499	67	110,400	41,964	68,436	25
71JA0	32	7.	289,200	652,227	-363,027	44	381,800	324,678	57,122	26
71LA0	33	12.	160,800	471,780	-310,980	41	125,500	111,276	15,224	27
720N0	34	31.	127,200	497,729	-370,529	54	904,700	904,700	0,000	28
72AC0	35	6.	284,400	-159,326	443,726	49	195,500	241,153	-45,653	29
71716	36	8.	1387,200	1099,735	287,465	15	999,700	1087,586	-87,886	30
7131D	37	4.	104,400	400,575	-296,175	42	117,300	259,120	-141,820	31
72RF0	38	38.	272,400	448,556	-176,156	64	189,600	332,501	-142,901	32
72R80	39	15.	1485,600	1792,068	-306,468	46	151,800	302,372	-150,572	33
75933	40	8.	1308,700	810,725	497,975	58	124,200	298,442	-174,242	34
74B00	41	4.	125,500	111,276	15,224	10	529,000	704,416	-175,416	35
74BF0	42	60.	117,300	259,120	-141,820	38	272,400	448,556	-176,156	36
74810	43	49.	1265,200	2054,305	-789,305	5	133,400	313,513	-180,113	37
76A10	44	8.	381,800	324,678	57,122	61	78,000	265,386	-187,386	38
76GA0	45	44.	181,400	-633,851	795,251	60	61,100	265,386	-204,286	39
74FF0	46	45.	151,800	302,372	-150,572	68	342,000	559,428	-217,428	40
74FA0	47	81.	178,100	-523,558	631,658	59	319,700	570,034	-250,334	41
74FH0	48	39.	195,500	-16,594	212,094	1	163,300	446,671	-283,371	42
74FU0	49	47.	195,500	241,153	-45,653	37	104,400	400,575	-296,175	43
77EC0	50	6.	345,800	2531,318	-2185,518	62	249,600	555,923	-306,323	44
77EE0	51	43.	7529,600	5025,225	2504,375	39	1485,600	1792,068	-306,468	45
77DCA	52	9.	837,200	3009,133	-2171,933	33	160,800	471,780	-310,980	46
77D80	53	43.	6878,300	5025,225	1853,075	27	69,600	402,280	-332,680	47
73CR0	54	7.	904,700	904,700	0,000	32	289,200	652,227	-363,027	48
73CG0	55	40.	913,830	1995,804	-1081,974	34	127,200	497,729	-370,529	49
71NA0	56	3.	78,200	-113,388	191,588	25	648,700	1117,751	-469,051	50
71QU0	57	3.	119,600	-113,388	232,988	21	1781,000	2255,880	-474,880	51
63AA0	58	3.	124,200	298,442	-174,242	3	161,000	730,310	-569,310	52
65AA0	59	4.	319,700	570,034	-250,334	24	232,700	851,404	-618,704	53
638AA	60	4.	61,100	265,386	-204,286	43	1265,200	2054,305	-789,305	54
63CAA	61	4.	78,000	265,386	-187,386	4	119,600	1024,125	-904,525	55
65BAA	62	3.	249,600	555,923	-306,323	13	213,900	1133,682	-919,782	56
61B8A	63	7.	172,900	-525,095	697,995	11	736,000	1750,639	-1014,639	57
658AA	64	2.	189,500	332,501	-142,901	55	913,830	1995,804	-1081,974	58
63AF0	65	4.	55,200	-35,778	90,978	26	113,100	1217,331	-1104,231	59
63AA0	66	3.	139,200	-61,715	200,915	9	94,300	1228,501	-1134,201	60
63121	67	3.	110,400	41,964	68,436	52	837,200	3009,133	-2171,933	61
63AAA	68	9.	342,000	559,428	-217,428	50	345,800	2531,318	-2185,518	62

FIGURE 24

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 11 Y3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 1071.42

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	719,85	0,0	53	51	651,38	36,28	187,25	-832,50	31	1
2	368,75	0,0	61	60	16,90	67,30	97,26	-633,85	45	2
3	251,27	0,0	57	56	41,40	186,85	66,34	-525,10	63	3
4	295,87	0,00	37	27	36,50	55,11	243,93	-523,56	47	4
5	374,37	0,07	7	8	949,87	1,62	12,86	-342,23	22	5
6	365,82	0,15	55	43	292,67	13,29	68,85	-253,97	18	6
7	413,71	0,18	25	26	635,18	5,80	219,74	-159,33	35	7
8	774,27	0,19	26	23	2986,81	0,0	41,40	-113,39	57	8
9	686,78	0,24	58	5	5,87	0,41	9,33	-113,39	56	9
10	651,97	0,36	15	25	381,16	4,81	9,41	-61,72	66	10
11	612,82	0,39	66	65	109,94	11,77	136,70	-58,38	28	11
12	564,71	0,41	57	66	32,97	7,11	237,23	-54,58	2	12
13	522,05	0,41	56	66	9,33	49,83	121,12	-35,78	65	13
14	671,44	0,43	8	38	2387,88	58,74	282,24	-16,59	48	14
15	778,88	0,45	32	7	2968,58	3,79	382,77	-16,23	8	15
16	822,31	0,49	15	26	1916,35	2,43	221,26	-12,07	17	16
17	799,21	0,58	11	39	708,17	6,31	262,39	-0,82	29	17
18	785,35	0,79	48	54	497,97	11,35	53,21	41,96	67	18
19	749,85	0,87	56	65	100,61	31,38	60,88	111,28	41	19
20	779,28	1,00	40	7	1207,58	96,51	96,17	241,15	49	20
21	855,29	1,07	48	8	2157,37	51,33	45,57	259,12	42	21
22	817,99	1,13	58	64	31,34	0,0	16,98	265,39	61	22
23	797,73	1,15	59	3	319,98	2,35	38,84	265,39	58	23
24	771,51	1,19	5	27	152,57	58,89	23,67	298,44	58	24
25	745,77	1,19	5	37	116,96	58,24	29,54	302,37	46	25
26	724,26	1,21	2	6	164,13	7,28	237,23	313,51	5	26
27	698,76	1,31	5	64	37,21	4,88	208,02	324,68	44	27
28	729,84	1,39	36	9	1421,67	2,37	153,27	332,50	64	28
29	737,45	1,44	32	40	861,00	0,00	36,50	400,57	37	29
30	819,56	1,47	8	54	2655,34	7,34	49,31	402,28	27	30
31	797,74	1,61	33	68	93,55	48,89	197,21	446,67	1	31
32	763,57	1,62	22	18	12,86	41,96	134,82	448,56	38	32
33	748,88	1,70	50	52	13,58	5,94	59,55	471,78	33	33
34	774,45	1,70	7	54	1705,47	42,23	64,21	497,73	34	34
35	771,47	1,78	55	21	607,09	14,08	88,98	555,92	62	35
36	834,15	1,79	8	15	2743,23	11,66	32,91	559,43	68	36
37	824,98	1,81	43	21	314,42	5,62	112,69	570,03	59	37
38	807,73	1,85	54	36	287,46	16,21	187,61	652,23	32	38
39	808,42	1,89	35	25	756,52	15,26	393,89	704,42	10	39
40	795,27	1,99	67	61	255,82	8,14	1267,29	730,31	3	40
41	778,24	1,94	54	15	87,89	1,00	1207,58	810,73	40	41
42	796,28	2,04	36	26	1391,70	27,66	2324,18	815,33	7	42
43	777,95	2,09	61	5	7,27	25,71	3274,95	851,40	24	43
44	760,88	2,09	63	5	24,17	1,47	2655,34	884,36	8	44
45	753,18	2,19	15	36	375,35	33,72	994,52	994,70	54	45
46	748,26	2,35	54	25	469,95	34,74	816,64	1024,12	4	46
47	732,45	2,35	61	58	13,14	2,19	375,35	1087,59	15	47
48	717,88	2,35	60	58	38,24	1,89	756,52	1099,74	36	48
49	710,98	2,35	44	1	340,49	7,92	458,73	1117,75	25	49
50	700,87	2,37	64	27	189,78	7,62	184,45	1133,68	13	50
51	692,45	2,37	64	37	153,27	2,51	29,97	1217,33	26	51
52	681,86	2,43	17	29	221,26	21,12	119,56	1228,50	9	52
53	669,62	2,51	26	9	29,97	0,58	798,17	1750,64	11	53
54	662,42	2,52	63	35	254,27	32,31	2189,95	1792,97	39	54
55	710,92	2,73	9	28	3816,78	69,23	2984,56	1821,12	20	55
56	699,32	2,75	62	59	55,99	2,15	292,67	1995,80	55	56
57	699,93	2,75	25	9	665,15	1,81	314,42	2054,30	43	57
58	692,54	3,06	64	1	148,47	60,94	1710,64	2235,88	21	58
59	680,72	3,16	28	65	100,52	1,70	13,58	2531,32	50	59
60	672,14	3,18	68	10	42,01	68,18	4025,01	3009,13	52	60
61	662,08	3,35	6	29	161,51	0,0	651,38	5025,22	53	61
62	704,44	3,76	21	51	2979,26	9,52	284,58	5025,22	51	62

FIGURE 25

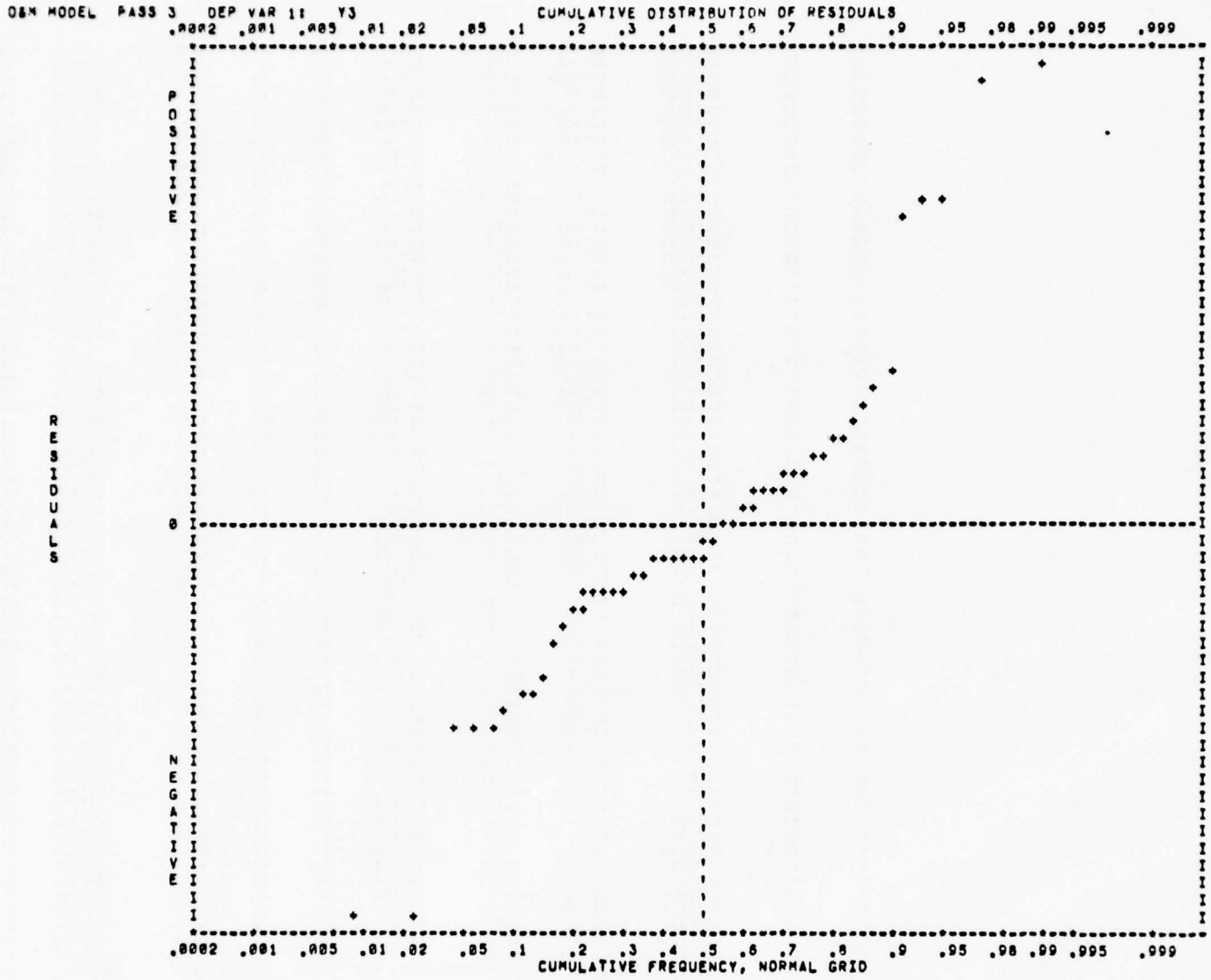

O&M MODEL PASS 3 DEP VAR IS Y3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 26

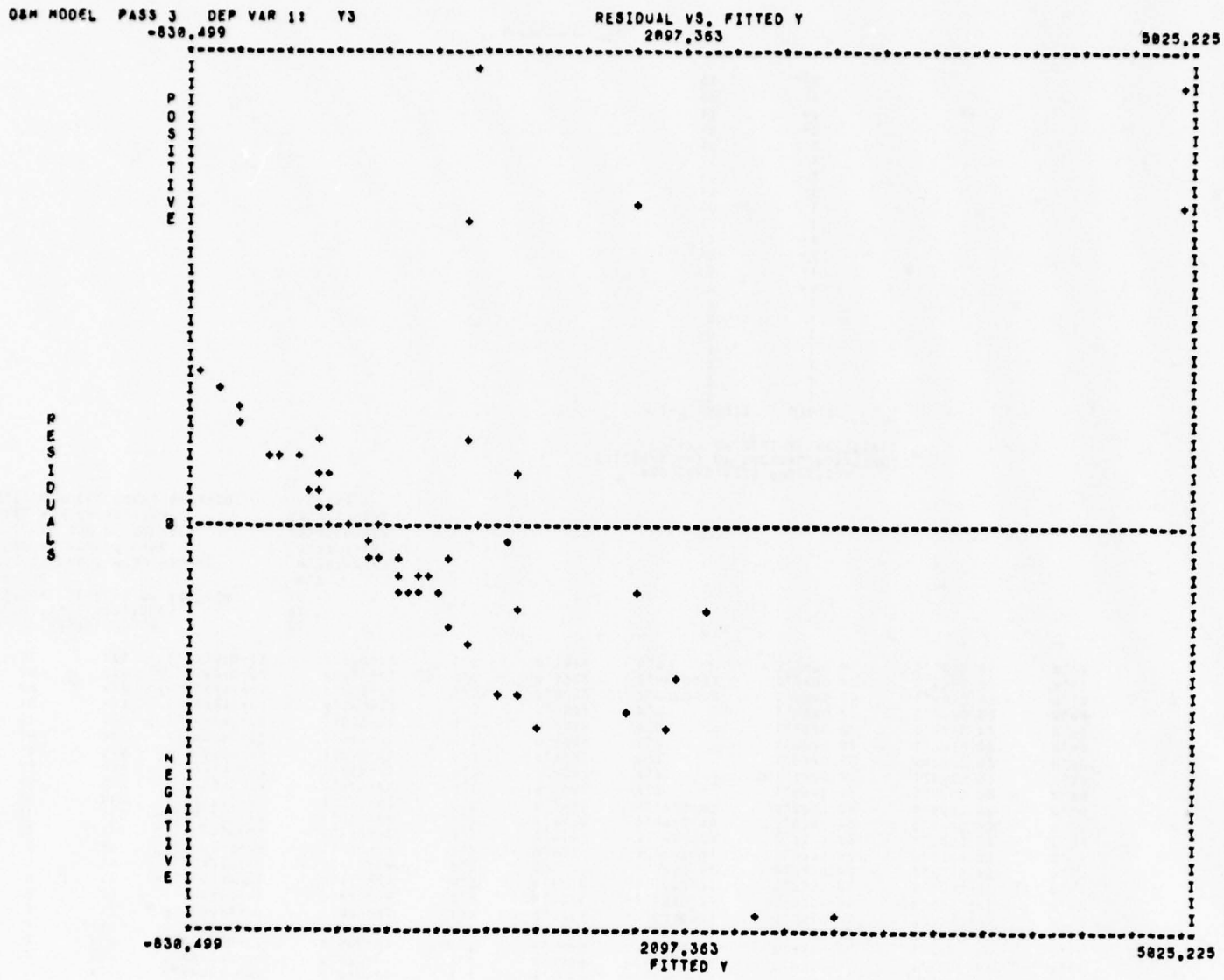

O&M MODEL PASS 3 DEP VAR 1: Y3
RESIDUAL VS. FITTED Y
-830.499
2097.363
5025.225
POSITIVE
RESIDUALS
0
NEGATIVE
-830.499
2097.363
5025.225
FITTED Y

FIGURE 27

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 21: LNY3 MIN Y = 3.818D 00 MAX Y = 8.927D 00 RANGE Y = 5.109D 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		4.576270 00							
1	X1M	6.20354D-01	4.69D-01	1.3	0.7650	-2.740D-01	7.260D-01	1.000D 00	0.12
2	X2M	5.44125D-01	5.57D-01	1.0	0.8338	-2.742D-01	7.262D-01	1.000D 00	0.11
3	X3M	6.23232D-01	3.58D-01	1.7	0.5809	-2.580D-01	7.420D-01	1.000D 00	0.12
4	X4M	-7.33589D-01	3.29D-01	2.2	0.4286	-2.100D-01	7.900D-01	1.000D 00	0.14
5	X5	8.19589D-01	6.54D-01	1.2	0.3454	-2.033D-01	5.387D-01	7.420D-01	0.12
6	X6	1.48248D-01	6.94D-01	0.2	0.3871	-2.165D-01	5.735D-01	7.900D-01	0.02
7	X7	-3.10583D-01	6.57D-01	0.5	0.4012	-2.165D-01	5.735D-01	7.900D-01	0.05
8	X8	2.29421D-06	3.10D-06	0.7	0.7129	1.580D 02	3.248D 05	3.238D 05	0.15
9	X9	2.37990D-04	1.64D-04	1.5	0.8549	3.000D 01	8.200D 03	8.170D 03	0.36
10	X10	-3.67551D-02	1.13D-02	3.3	0.9193	1.200D 00	1.737D 02	1.725D 02	1.24
11	X11	-1.70429D-04	1.39D-04	1.2	0.6498	9.000D 00	7.638D 03	7.629D 03	0.25
12	X12	1.04976D-01	1.48D-01	0.7	0.5792	4.923D-03	6.674D 00	6.669D 00	0.14
13	X13	1.22188D-02	1.06D-01	0.1	0.9992	0.0	1.000D 02	1.000D 02	0.24
14	X14	1.92315D-02	1.02D-01	0.2	0.9993	0.0	1.000D 02	1.000D 02	0.38
15	X15	2.85670D-02	1.03D-01	0.3	0.9991	0.0	1.000D 02	1.000D 02	0.56
16	X16	1.16589D-02	1.04D-01	0.1	0.9969	0.0	1.000D 02	1.000D 02	0.23
17	X17	2.95870D-02	1.03D-01	0.3	0.9975	0.0	1.000D 02	1.000D 02	0.58
18	X18	1.12508D-03	4.14D-03	0.3	0.6589	0.0	1.000D 02	1.000D 02	0.02
19	X19	-4.81948D-04	3.73D-04	1.3	0.5659	7.000D 00	1.640D 03	1.633D 03	0.15
20	X20	-1.46657D-02	4.41D-01	0.0	0.8297	3.000D-01	2.300D 00	2.000D 00	0.01
21	X21	2.13287D-02	1.25D-02	1.7	0.5878	0.0	6.100D 01	6.100D 01	0.25

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	21
RESIDUAL DEGREES OF FREEDOM	40
F-VALUE	4.9
RESIDUAL ROOT MEAN SQUARE	0.79780443
RESIDUAL MEAN SQUARE	0.63649191
RESIDUAL SUM OF SQUARES	25.45967650
TOTAL SUM OF SQUARES	99.47129240
MULT. CORREL. COEF. SQUARED	.7186

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 28

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 21 LNY3

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71929	1	2.	5.096	5.833	-0.737	8	8.172	6.326	1.846	1
73538	2	1.	5.612	5.368	0.245	7	7.832	6.201	1.632	2
71L80	3	1.	5.081	5.218	-0.137	20	8.217	6.741	1.476	3
71M6A	4	6.	4.784	5.880	-1.095	29	5.799	4.786	1.014	4
71PKA	5	1.	4.893	5.361	-0.467	6	6.166	5.156	1.009	5
71PB8	6	1.	6.166	5.156	1.009	47	4.683	3.925	0.758	6
7171A	7	4.	7.832	6.201	1.632	63	5.153	4.437	0.715	7
724GA	8	4.	8.172	6.326	1.846	18	4.795	4.280	0.515	8
71G5A	9	2.	4.546	6.205	-1.659	39	7.304	6.796	0.507	9
71FA8	10	3.	6.271	5.964	0.307	51	8.927	8.425	0.502	10
71F8A	11	5.	6.631	6.768	-0.165	40	7.177	6.683	0.494	11
71DAA	13	1.	5.366	6.144	-0.779	45	5.084	4.666	0.418	12
714BE	15	3.	6.947	6.672	0.236	53	8.836	8.425	0.411	13
714DA	17	3.	4.580	4.686	-0.106	36	7.235	6.839	0.396	14
730BA	18	18.	4.795	4.280	0.515	49	5.276	4.898	0.378	15
73C8Q	20	5.	8.217	6.741	1.476	67	4.704	4.343	0.361	16
73CEN	21	14.	7.485	7.154	0.331	21	7.485	7.154	0.331	17
73CFK	22	19.	3.818	4.415	-0.597	38	5.627	5.291	0.316	18
73DAM	24	4.	5.459	5.595	-0.145	19	6.271	5.964	0.307	19
73EBA	25	4.	6.475	6.648	-0.173	28	4.892	4.597	0.295	20
73EBF	26	3.	4.728	6.265	-1.537	2	5.612	5.368	0.245	21
71CA8	27	2.	4.243	4.947	-0.704	15	6.907	6.672	0.236	22
72EAA	28	10.	4.892	4.597	0.295	59	5.767	5.556	0.212	23
72ECA	29	5.	5.799	4.786	1.014	57	4.784	4.609	0.176	24
728P8	31	5.	4.277	4.300	-0.023	66	4.936	4.836	0.100	25
71JA8	32	3.	5.667	6.557	-0.890	54	6.808	6.808	-0.000	26
71LA8	33	2.	5.080	5.491	-0.411	35	5.650	5.654	-0.004	27
72DNA	34	4.	4.845	5.044	-0.198	42	4.765	4.772	-0.006	28
72ACA	35	2.	5.650	5.654	-0.004	31	4.277	4.300	-0.023	29
71716	36	4.	7.235	6.839	0.396	43	7.143	7.170	-0.027	30
71310	37	2.	4.648	4.945	-0.298	62	5.520	5.562	-0.042	31
72RFA	38	8.	5.607	5.291	0.316	46	5.023	5.075	-0.052	32
72R8A	39	6.	7.304	6.796	0.507	64	5.245	5.334	-0.089	33
75932	40	4.	7.177	6.683	0.494	17	4.580	4.686	-0.106	34
74BDA	41	1.	4.840	5.601	-0.761	68	5.835	5.952	-0.118	35
746FA	42	18.	4.765	4.772	-0.008	3	5.081	5.218	-0.137	36
74818	43	13.	7.143	7.170	-0.027	58	4.822	4.960	-0.138	37
76A1A	44	3.	5.945	6.272	-0.327	24	5.450	5.595	-0.145	38
76GAA	45	6.	5.084	4.666	0.418	11	6.601	6.766	-0.165	39
74FFA	46	10.	5.023	5.075	-0.052	25	6.475	6.648	-0.173	40
74FAA	47	58.	4.683	3.925	0.758	34	4.846	5.044	-0.198	41
74FHA	48	8.	5.276	5.581	-0.306	61	4.357	4.571	-0.215	42
74FUA	49	25.	5.276	4.898	0.378	55	4.359	4.609	-0.249	43
77EC8	50	2.	5.846	6.382	-0.536	65	4.011	4.266	-0.255	44
77EED	51	14.	8.927	8.425	0.502	37	4.648	4.946	-0.298	45
770CA	52	3.	6.730	7.107	-0.377	48	5.276	5.581	-0.306	46
770B8	53	14.	8.836	8.425	0.411	44	5.945	6.272	-0.327	47
73CRA	54	3.	6.808	6.808	-0.000	52	6.730	7.107	-0.377	48
73CGA	55	13.	6.818	7.386	-0.569	33	5.080	5.491	-0.411	49
71NA8	56	1.	4.359	4.609	-0.249	60	4.113	4.571	-0.459	50
710U8	57	1.	4.784	4.609	0.176	5	4.893	5.361	-0.467	51
63AA8	58	2.	4.822	4.960	-0.138	50	5.846	6.382	-0.536	52
65AA8	59	3.	5.767	5.556	0.212	55	6.818	7.386	-0.569	53
638AA	60	2.	4.113	4.571	-0.459	22	3.818	4.415	-0.597	54
63CAA	61	2.	4.357	4.571	-0.215	27	4.243	4.947	-0.704	55
65RAA	62	2.	5.520	5.562	-0.042	1	5.096	5.833	-0.737	56
618HA	63	3.	5.153	4.437	0.715	41	4.840	5.601	-0.761	57
65RAA	64	2.	5.245	5.334	-0.089	13	5.366	6.144	-0.779	58
63AFA	65	2.	4.011	4.266	-0.255	32	5.667	6.557	-0.890	59
63AAA	66	2.	4.936	4.836	0.100	4	4.784	5.880	-1.095	60
63121	67	2.	4.704	4.343	0.361	26	4.728	6.265	-1.537	61
63AAA	68	4.	5.835	5.952	-0.118	9	4.546	6.205	-1.659	62

FIGURE 29

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 2: LNY3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.80

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	WSSD	DEL RESIDUALS	ORDERED BY FITTED Y: FITTED Y	OBSV.	SEQ.
1	0.10	0.0	53	51	0.09	49.13	1.01	3.92	47	1
2	0.28	0.0	57	56	0.42	7.82	0.77	4.27	65	2
3	0.29	0.0	61	60	0.24	5.84	0.54	4.28	18	3
4	0.32	0.00	37	27	0.41	4.60	0.38	4.30	31	4
5	0.39	0.01	65	67	0.62	15.98	0.96	4.34	67	5
6	0.39	0.02	3	5	0.33	15.83	1.31	4.41	22	6
7	0.59	0.04	25	20	1.65	1.24	0.93	4.44	63	7
8	0.55	0.04	7	8	0.21	0.0	0.24	4.57	61	8
9	0.55	0.09	43	55	0.54	7.70	0.75	4.57	60	9
10	0.54	0.14	25	15	0.41	10.09	0.12	4.60	28	10
11	0.62	0.20	15	20	1.24	0.0	0.42	4.61	57	11
12	0.61	0.27	49	54	0.49	8.70	0.57	4.61	56	12
13	0.84	0.50	7	9	3.29	12.71	0.52	4.67	45	13
14	1.06	0.52	9	8	3.50	21.93	0.10	4.69	17	14
15	1.14	0.70	8	25	2.02	22.98	1.02	4.77	42	15
16	1.14	0.80	8	15	1.61	4.69	0.91	4.79	29	16
17	1.31	0.82	7	26	3.17	30.56	0.28	4.84	66	17
18	1.41	0.85	8	32	2.74	24.65	0.68	4.90	49	18
19	1.35	0.87	66	58	0.24	0.00	0.41	4.95	37	19
20	1.32	0.91	11	39	0.67	3.45	0.57	4.95	27	20
21	1.43	0.93	26	8	3.38	6.74	0.06	4.96	58	21
22	1.44	1.00	9	44	1.33	5.12	0.15	5.04	34	22
23	1.38	1.04	9	26	0.12	12.63	1.06	5.07	46	23
24	1.41	1.09	7	44	1.96	1.23	1.15	5.16	6	24
25	1.36	1.11	61	56	0.03	8.44	0.45	5.22	3	25
26	1.31	1.11	60	58	0.21	7.35	0.41	5.29	38	26
27	1.28	1.11	61	57	0.39	1.81	0.38	5.33	64	27
28	1.26	1.11	60	57	0.63	1.95	0.71	5.36	5	28
29	1.22	1.14	58	3	0.00	3.30	0.66	5.37	2	29
30	1.18	1.16	21	51	0.17	4.18	0.62	5.49	33	30
31	1.15	1.16	21	53	0.08	1.61	0.25	5.56	59	31
32	1.13	1.21	44	32	0.56	10.60	0.25	5.56	62	32
33	1.15	1.21	6	5	1.48	13.11	0.16	5.58	48	33
34	1.18	1.22	44	8	2.17	2.50	0.62	5.59	24	34
35	1.17	1.22	25	40	0.67	4.50	0.76	5.60	41	35
36	1.17	1.23	6	3	1.15	1.33	0.73	5.65	35	36
37	1.18	1.24	63	60	1.17	7.82	0.36	5.83	1	37
38	1.17	1.24	63	61	0.93	12.08	0.98	5.88	4	38
39	1.16	1.24	26	32	0.65	2.62	0.42	5.95	68	39
40	1.15	1.25	67	60	0.82	2.60	1.09	5.96	10	40
41	1.14	1.25	67	61	0.58	2.93	2.41	6.14	13	41
42	1.13	1.26	43	51	0.53	9.60	3.29	6.20	7	42
43	1.11	1.26	43	53	0.44	1.04	0.12	6.21	9	43
44	1.11	1.26	55	51	1.07	1.34	1.21	6.27	26	44
45	1.11	1.26	55	53	0.98	1.22	2.17	6.27	44	45
46	1.12	1.26	20	36	1.08	5.93	2.38	6.33	8	46
47	1.11	1.27	40	20	0.98	4.49	0.35	6.38	50	47
48	1.11	1.27	21	55	0.90	1.42	0.72	6.56	32	48
49	1.10	1.28	21	43	0.36	0.14	0.41	6.65	25	49
50	1.09	1.33	35	1	0.73	1.35	0.26	6.67	15	50
51	1.10	1.34	26	44	1.21	1.27	0.98	6.68	40	51
52	1.08	1.35	15	40	0.26	9.55	1.64	6.74	20	52
53	1.08	1.36	32	15	1.13	0.91	0.67	6.77	11	53
54	1.09	1.40	32	40	1.38	7.68	0.51	6.80	39	54
55	1.08	1.41	54	36	0.40	1.41	0.40	6.81	54	55
56	1.08	1.42	32	25	0.72	2.65	0.77	6.84	36	56
57	1.05	1.47	64	59	0.30	20.55	0.71	7.11	52	57
58	1.09	1.55	32	20	2.37	1.28	0.36	7.15	21	58
59	1.10	1.58	20	54	1.48	0.09	0.54	7.17	43	59
60	1.08	1.61	59	62	0.25	1.26	0.98	7.39	55	60
61	1.07	1.62	44	25	0.15	0.0	0.09	8.42	53	61
62	1.07	1.72	13	9	0.88	30.87	0.24	8.42	51	62

FIGURE 30

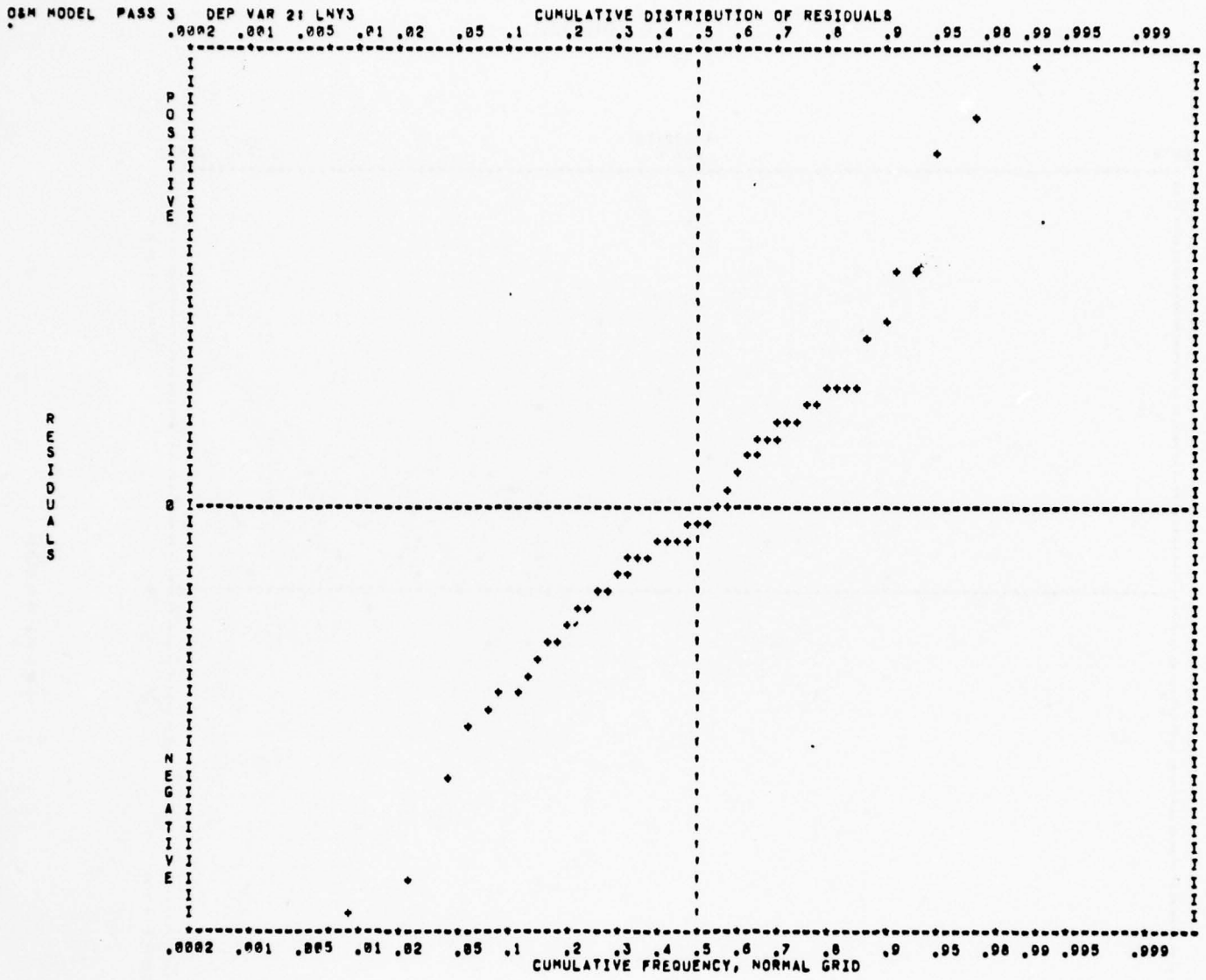

O&M MODEL PASS 3 DEP VAR 21 LNY3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 31

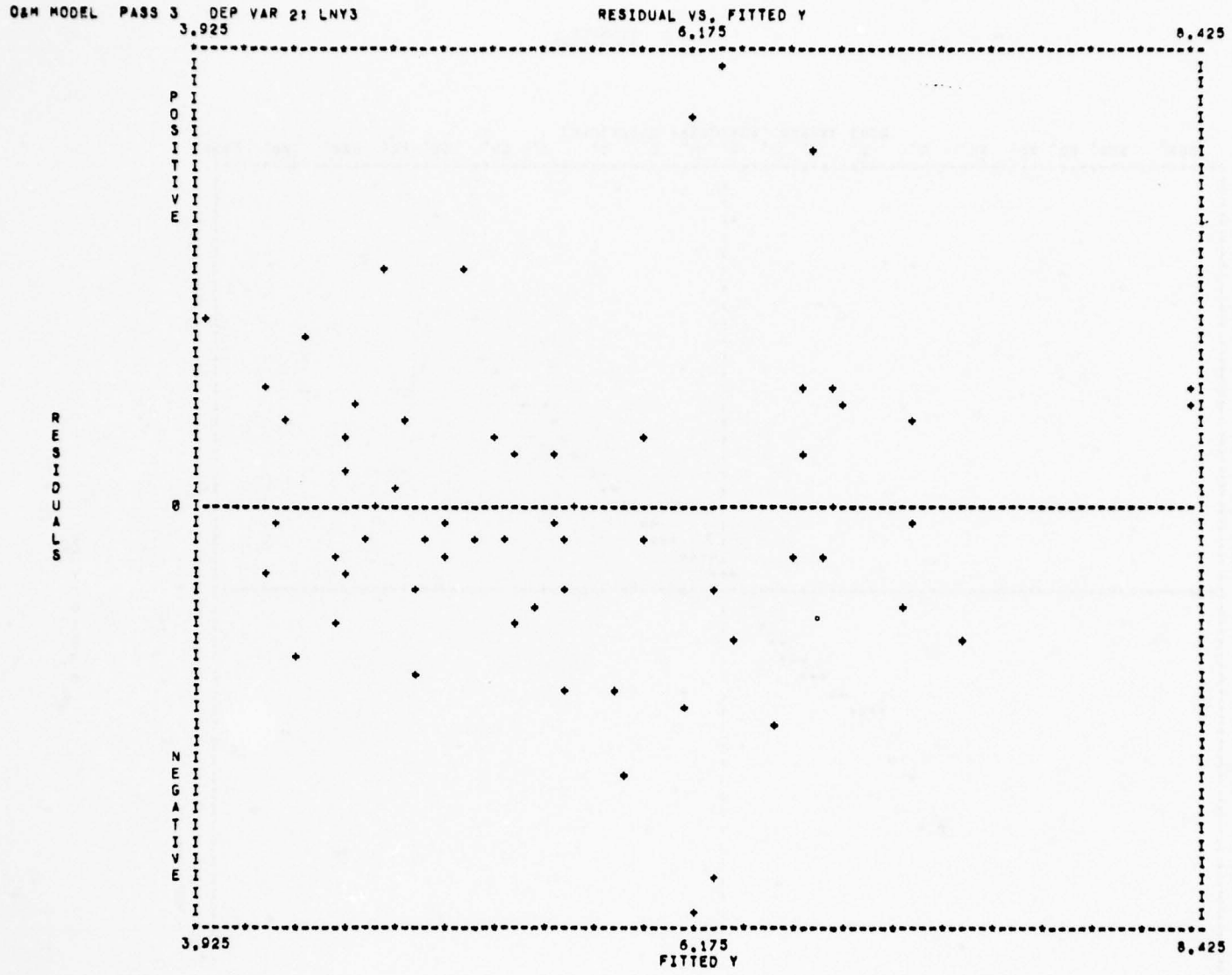

O&M MODEL PASS 3 DEP VAR 2: LNY3
RESIDUAL VS. FITTED Y
3.925
6.175
8.425
POSITIVE
RESIDUALS
0
NEGATIVE
3.925
6.175
8.425
FITTED Y

FIGURE 32

pointout which form of the dependent variable was appropriate until the final iterations were made.

After much analysis in the MTBMA fit, it was discovered that ln MTBMA is the more appropriate form of the dependent to be used. We will then proceed with the sketch of the ln MTBMA fit. Figures 33-42 are component-plus-residual plots for the ten independent variables X8, X9, X10, X11, X12, X16, X17, X19, X20 and X21. Figure 33 shows that there are 5 observations which extend the range of X8 by 300%. It must be determined whether these observations behave like the rest of the data (thereby extending the range of variable X8) or whether they are not consistant with the remainder of the data (possibly indicating curvature). Table 5 shows the ten independent together with the observations which extend the respectives ranges. These observations numbers can be obtained by using the component-plus-residual plots and the tables of data ranked by each independent variable.

Indicator variables in conjunction with the C_p-search technique can be used to determine the effects of such extended observations (see [4]). The approach is to define indicator variables, X22 through X31, denoting those observations which extend the variables shown in Table 5, then multiply these indicator variables by each of their respective independent variables, and use the C_p-search technique to determine if any of these interactions are significant. If any of these products prove to be significant, then curvature will be introduced in the variables, since we have assumed that 7 initial indicator variables sufficiently describes all qualitative information about the observations. This is displayed in Figure 43, where for instance X22 is an indicator variable indicating observations 49, 31, 46, 47 and 34 and X22X8 is the product of X22 and X8.

There are 31 independent variables shown, of which only one belongs to the "basic set," and leaves 30 variables to be searched. The approach

[4] "The Use of Individual Effects and Residuals in Fitting Equations to Data," F. S. Wood, Technometrics, 15, No. 4, (1973), pp. 677-695.

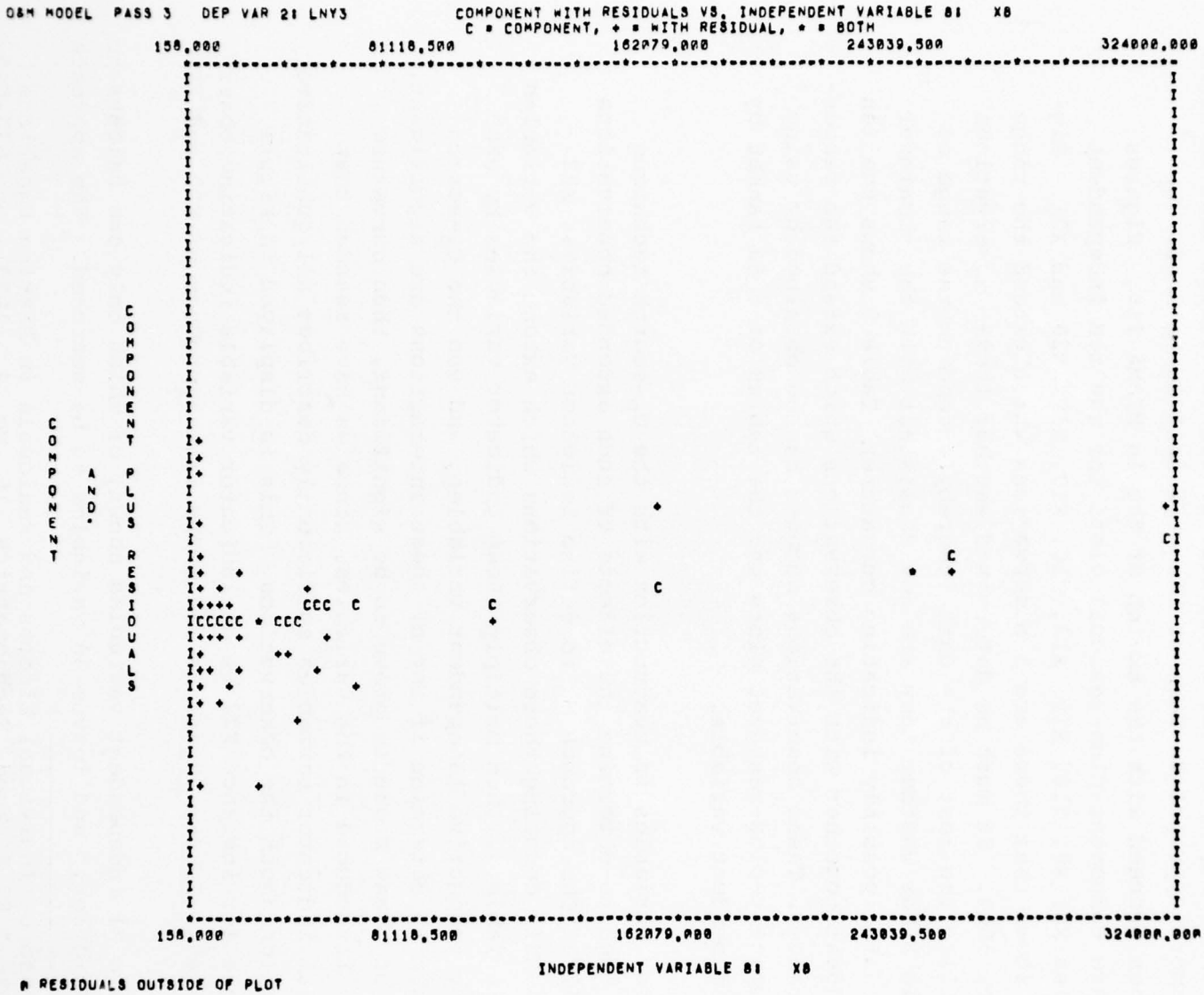

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE 8: X8
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
158.000
81118.500
162079.000
243039.500
324000.000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE 8: X8
* RESIDUALS OUTSIDE OF PLOT

FIGURE 33

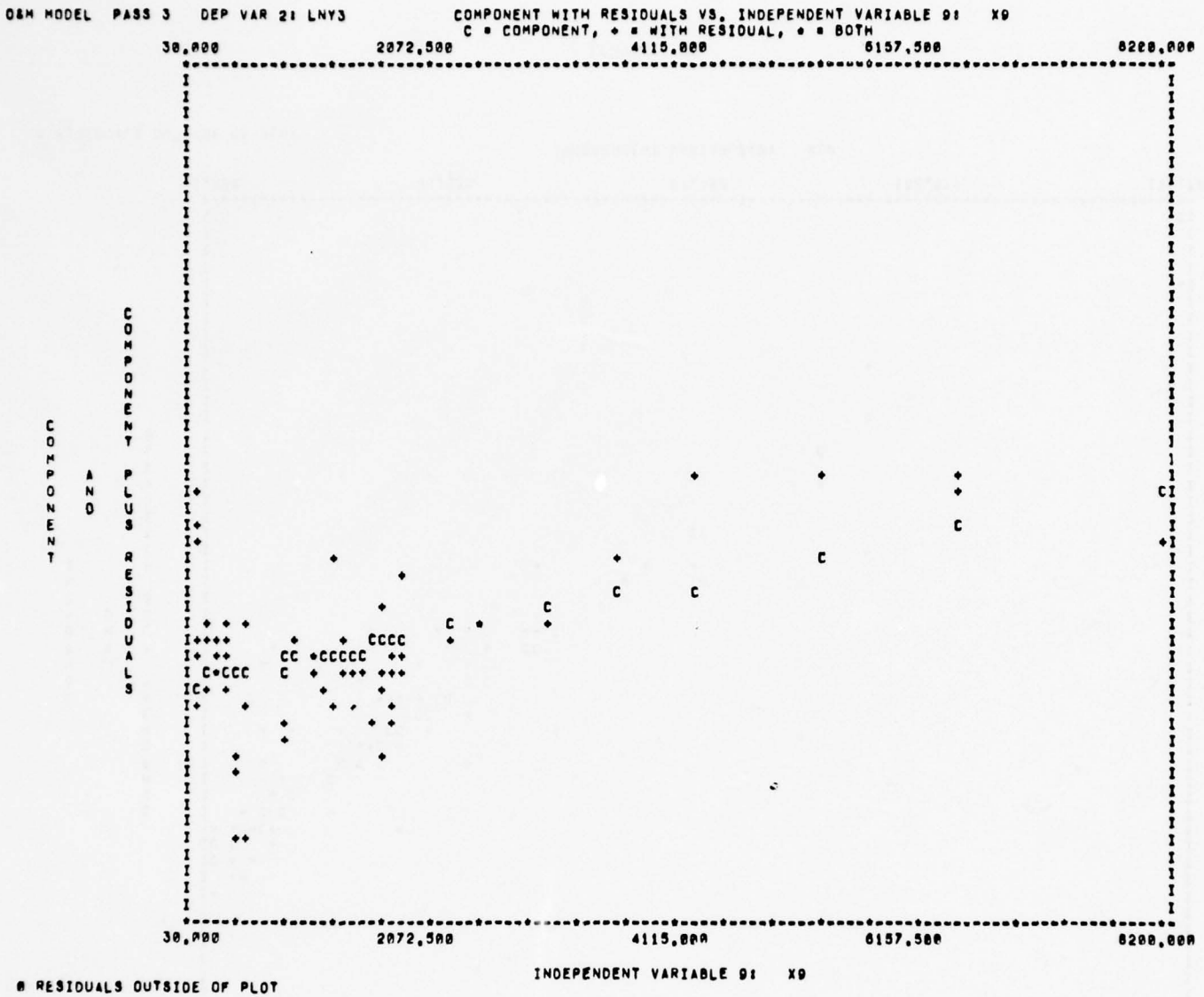

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE 9: X9
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
30.000
2072.500
4115.000
6157.500
8200.000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE 9: X9
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 34

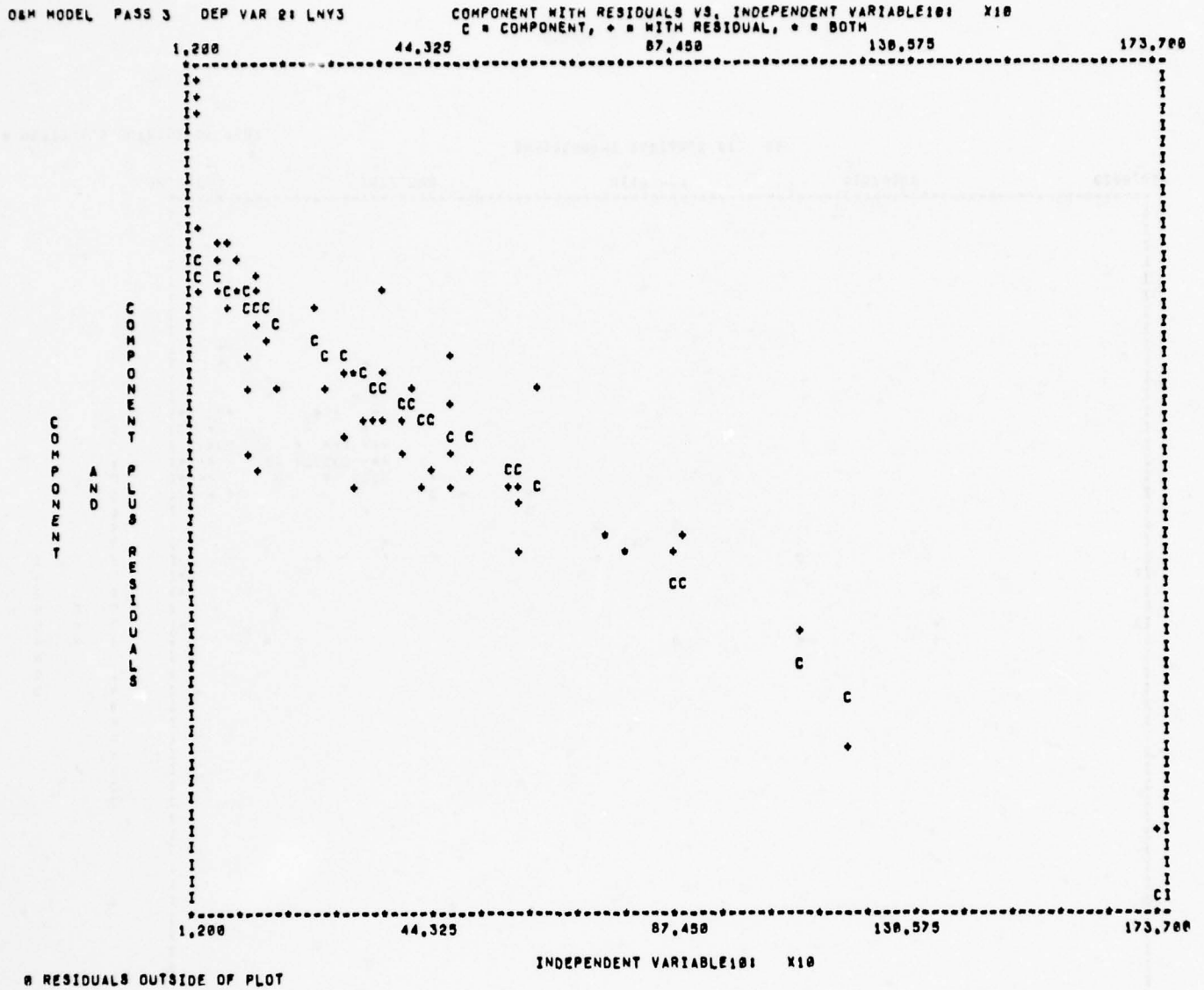

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE10: X10
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
1,200
44,325
87,450
130,575
173,700
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE10: X10
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 35

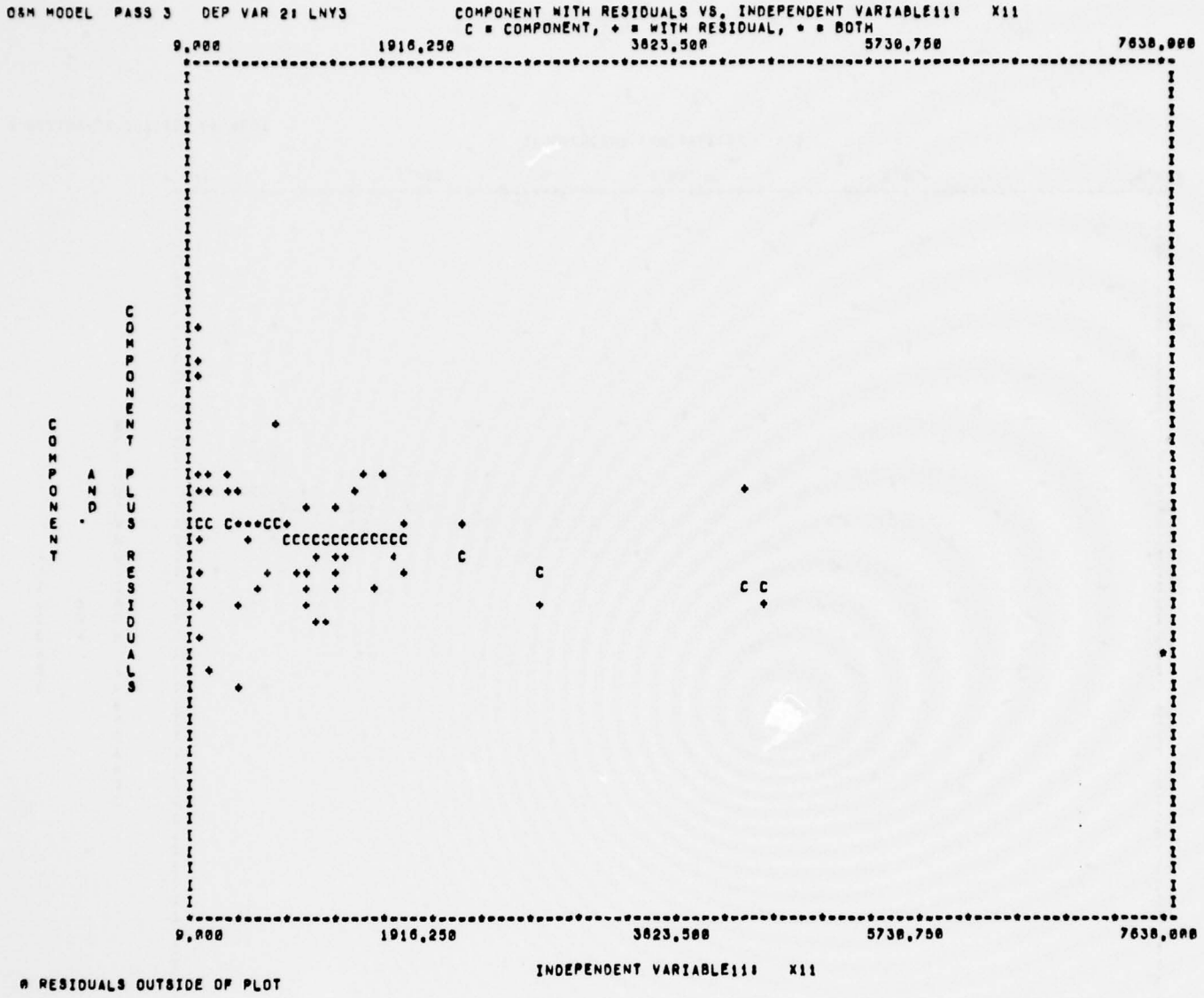

O&M MODEL PASS 3 DEP VAR 21 LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE11: X11
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
9,000
1916,250
3823,500
5730,750
7638,000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE11: X11
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 36

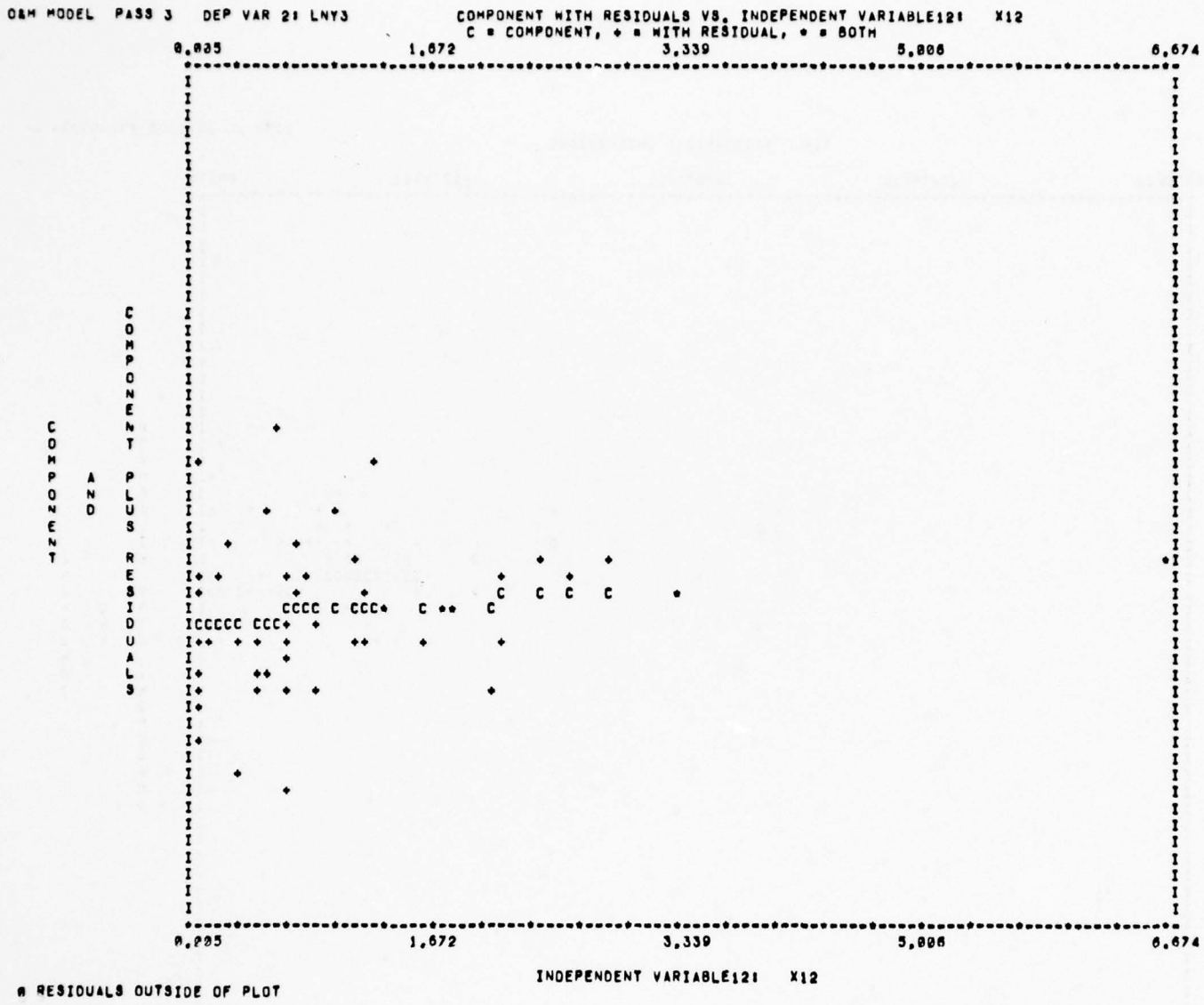

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE12: X12
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
0.035
1.672
3.339
5.006
6.674
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE12: X12
RESIDUALS OUTSIDE OF PLOT

FIGURE 37

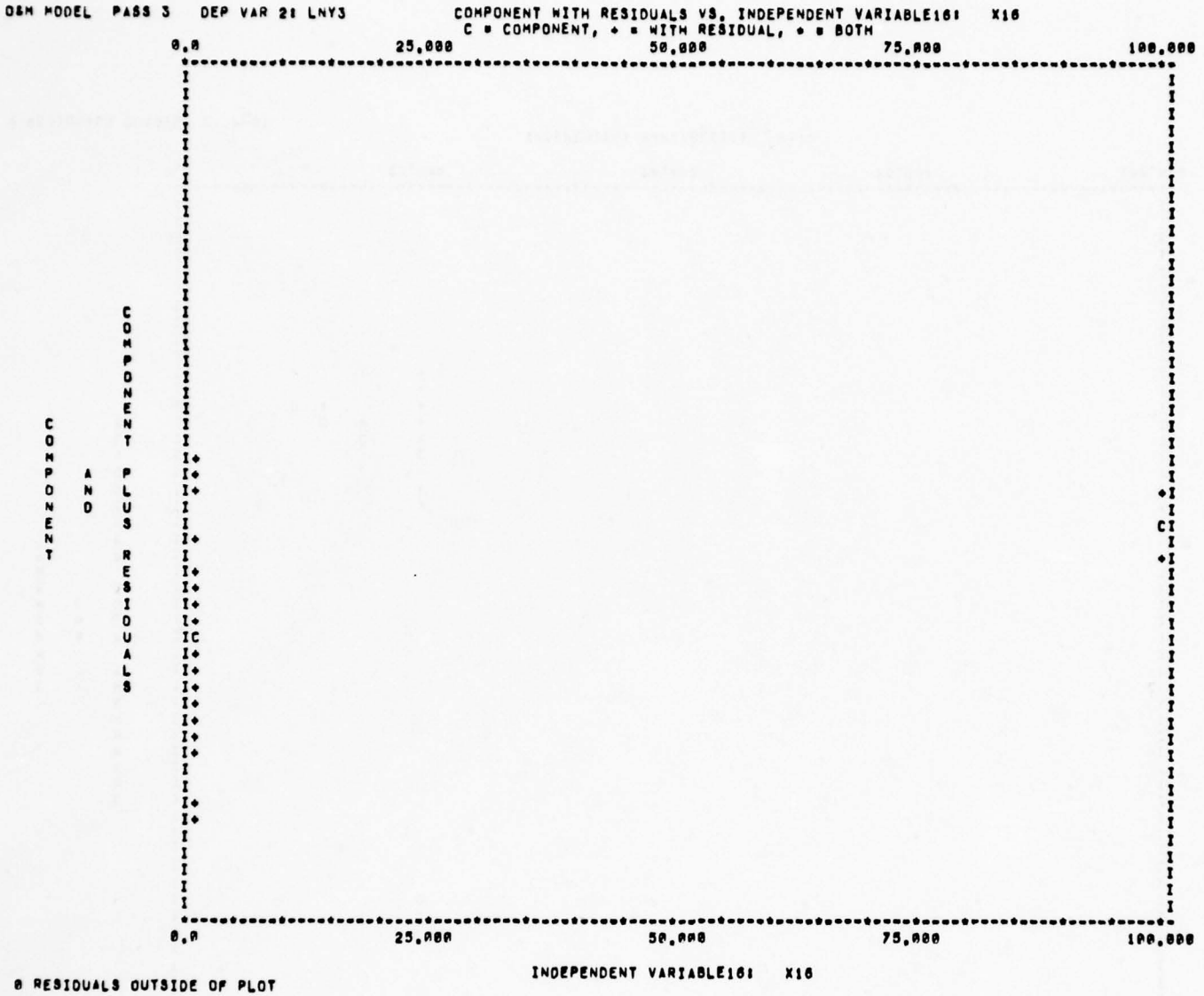

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE16: X16
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
0.0
25,000
50,000
75,000
100,000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE16: X16
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 38

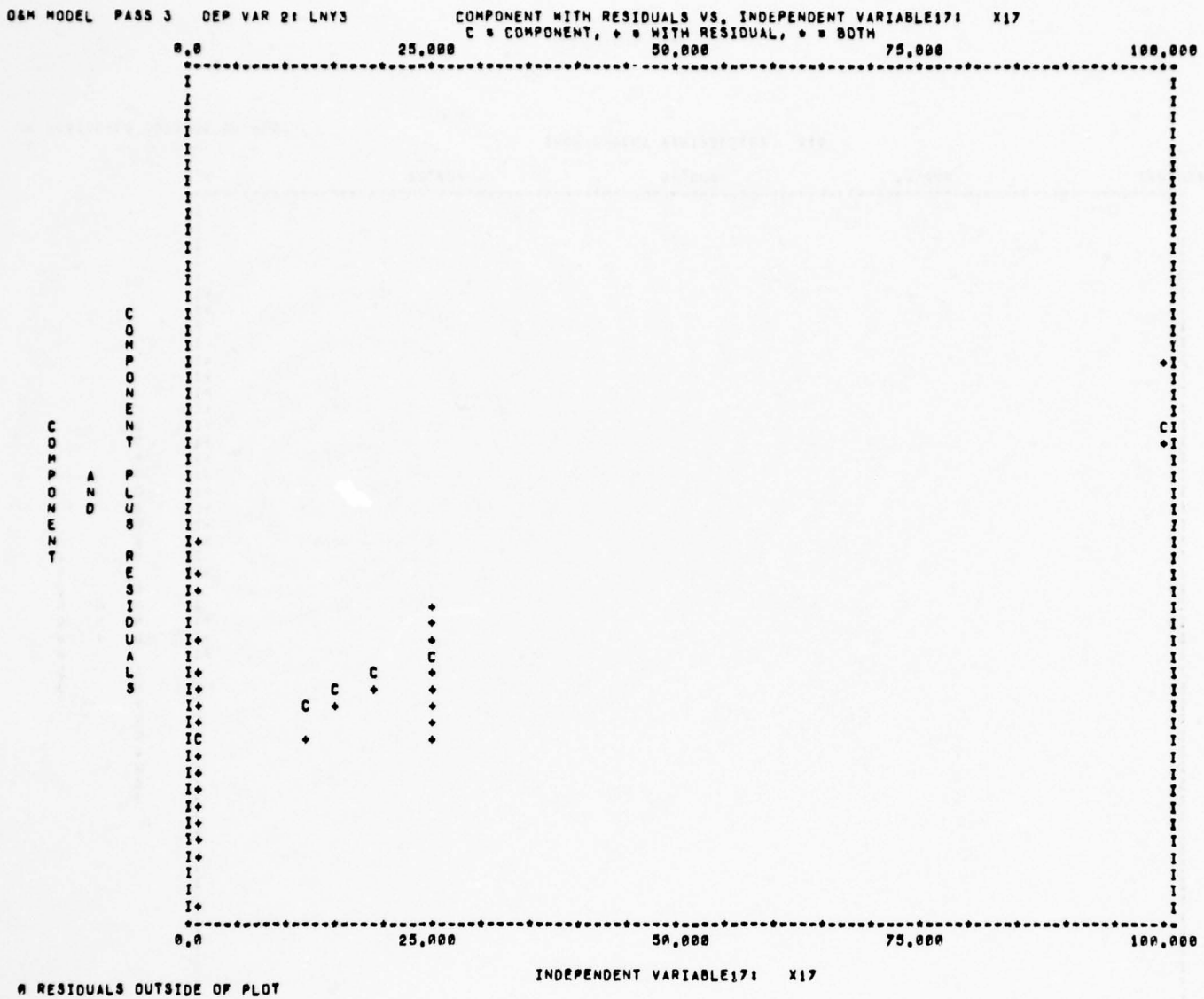

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE17: X17
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
0.0
25,000
50,000
75,000
100,000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE17: X17
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 39

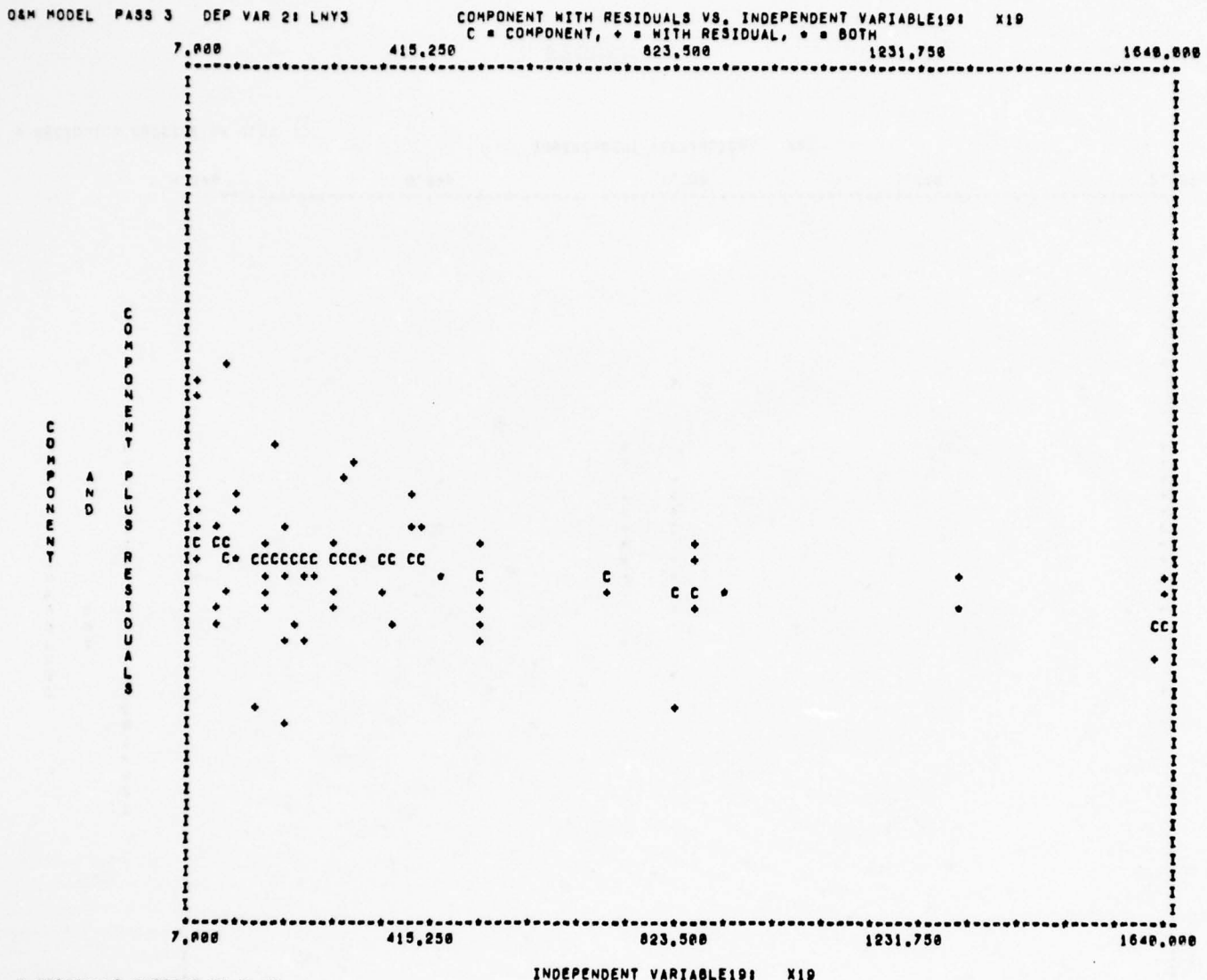

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE19: X19
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
7.000
415.250
823.500
1231.750
1640.000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE19: X19
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 40

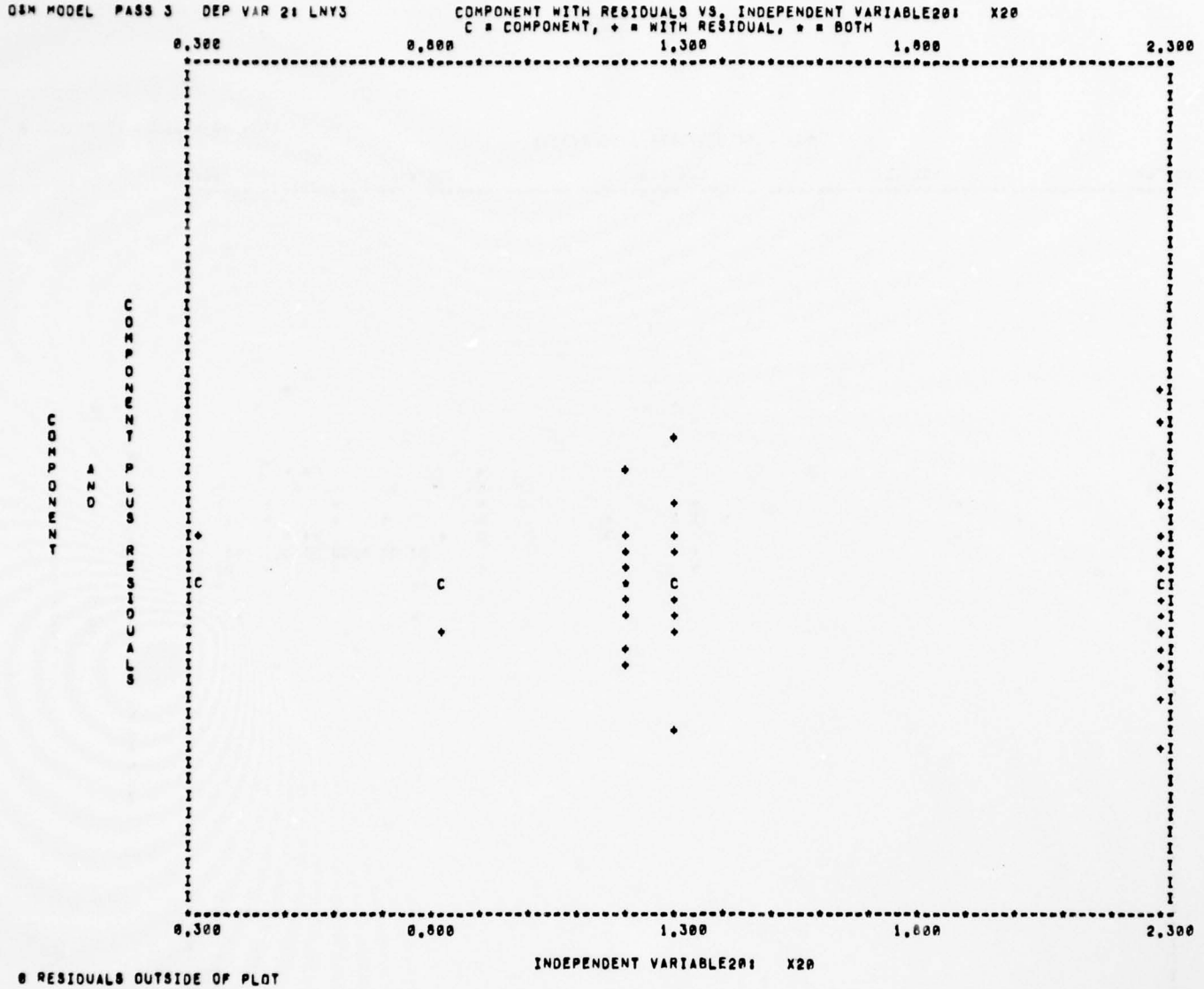
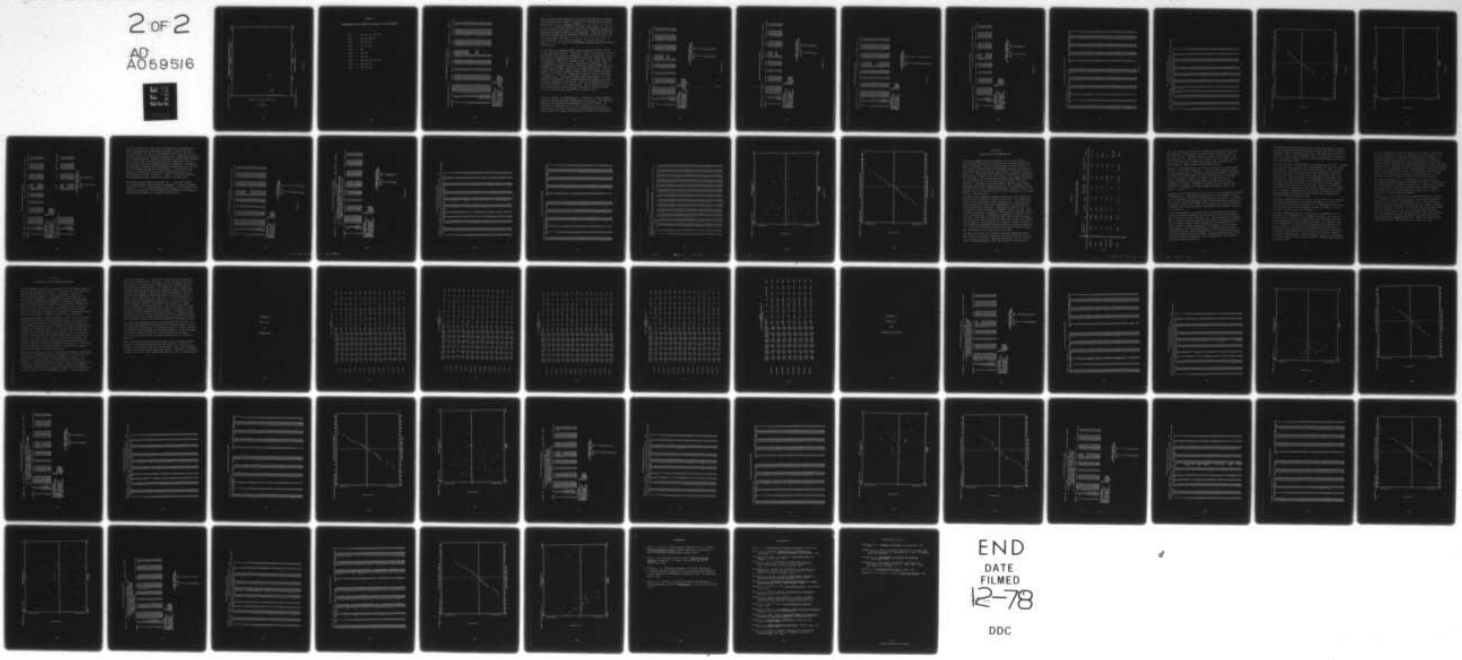

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE20: X20
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
0.300
0.800
1.300
1.800
2.300
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE20: X20
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 41

AD-A059 516 WESTINGHOUSE ELECTRIC CORP HUNT VALLEY MD F/G 15/5
THE AVIONICS LABORATORY PREDICTIVE OPERATIONS AND SUPPORT (ALPO--ETC(U).
APR 78 E E FELTUS F33615-77-C-1105
UNCLASSIFIED AFAL-TR-78-49-VOL-2 NL

2 OF 2
AD
A059516



END
DATE
FILMED
12-78
DDC

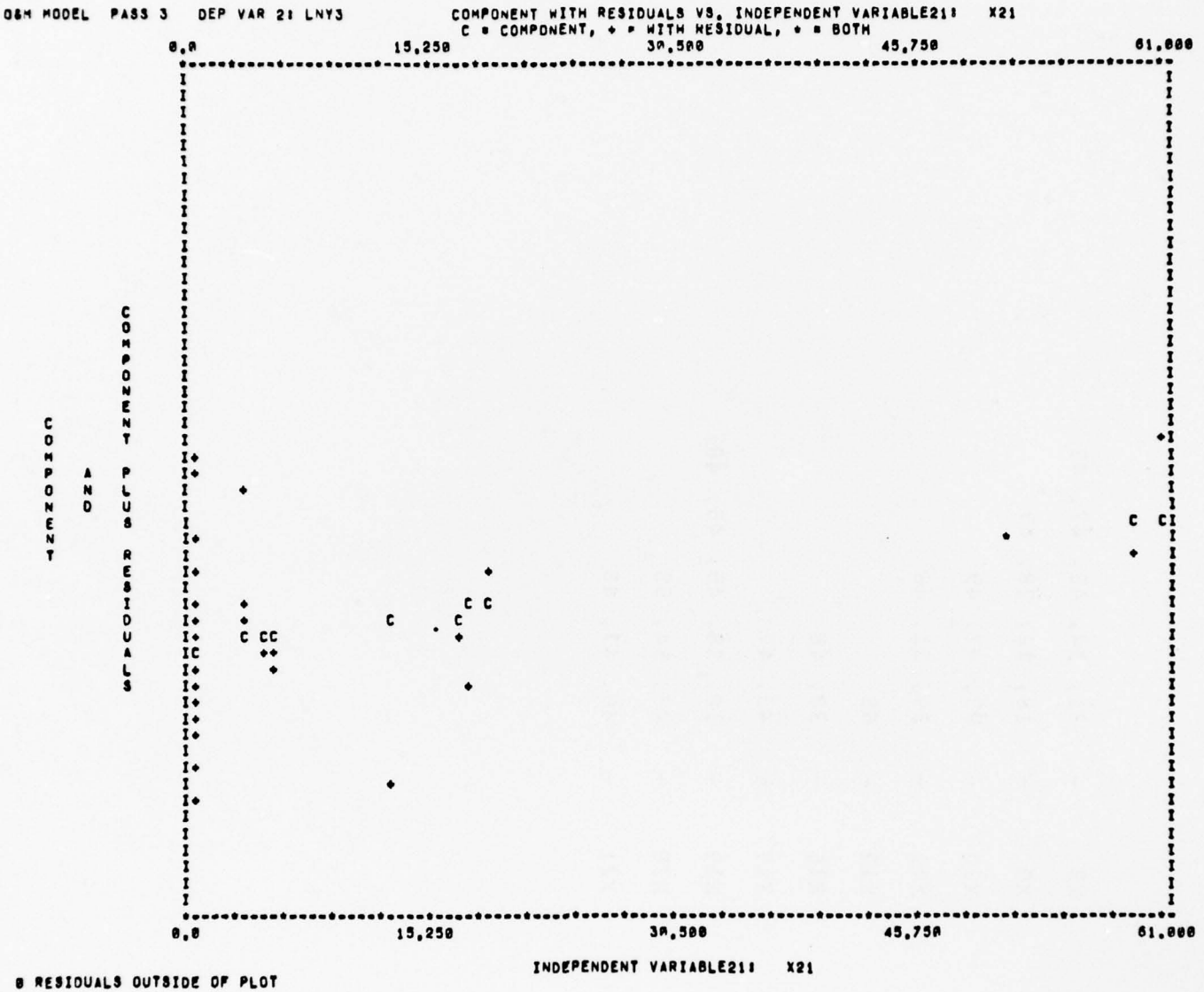

O&M MODEL PASS 3 DEP VAR 2: LNY3
COMPONENT WITH RESIDUALS VS. INDEPENDENT VARIABLE21: X21
C = COMPONENT, + = WITH RESIDUAL, * = BOTH
0.0
15,250
30,500
45,750
61,000
COMPONENT AND COMPONENT PLUS RESIDUALS
INDEPENDENT VARIABLE21: X21
0 RESIDUALS OUTSIDE OF PLOT

FIGURE 42

TABLE 5

OBSERVATIONS THAT EXTEND THE RANGES OF THE VARIABLES

X8	-	31, 34, 46, 47, 49
X9	-	18, 22, 28, 47
X10	-	22, 47, 49
X11	-	29, 31, 46
X12	-	68
X16	-	38, 48
X17	-	42, 47
X19	-	18, 28, 45, 46, 48
X20	-	45, 54, 55
X21	-	46, 47, 48

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 31 DEP VAR IS Y3 MIN Y = 4.550D 01 MAX Y = 7.530D 03 RANGE Y = 7.484D 03

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		-1.742670 04							
1	X1M	2.323820 02	1.970 03	0.1	0.9797	-2.740D-01	7.260D-01	1.000D 00	0.03
2	X2M	5.696550 01	2.120 03	0.0	0.9826	-2.740D-01	7.260D-01	1.000D 00	0.01
3	X3M	5.361760 02	5.050 02	1.1	0.6826	-2.580D-01	7.420D-01	1.000D 00	0.07
4	X4M	4.279940 02	6.980 02	0.6	0.8024	-2.100D-01	7.900D-01	1.000D 00	0.06
5	X5	3.281990 03	8.790 02	3.7	0.4584	-2.033D-01	5.387D-01	7.420D-01	0.33
6	X6	1.097330 03	9.960 02	1.1	0.5481	-2.165D-01	5.735D-01	7.900D-01	0.12
7	X7	-4.167470 01	9.810 02	0.0	0.5796	-2.165D-01	5.735D-01	7.900D-01	0.00
8	X8	-7.588970-03	1.890-02	0.4	0.9883	1.580D 02	3.240D 05	3.238D 05	0.33
9	X9	-4.257710-01	6.490-01	0.7	0.9859	3.000D 01	8.200D 03	8.170D 03	0.46
10	X10	-1.314520 01	2.940 01	0.4	0.9819	1.200D 00	1.737D 02	1.725D 02	0.30
11	X11	-4.926670-01	5.490-01	0.9	0.9659	9.000D 00	7.638D 03	7.629D 03	0.59
12	X12	4.423960-01	3.890 02	0.0	0.9876	4.923D-03	6.674D 00	6.669D 00	0.00
13	X13	2.182440 02	1.670 02	1.3	0.9989	0.0	1.000D 02	1.000D 02	2.92
14	X14	2.072710 02	1.630 02	1.3	0.9996	0.0	1.000D 02	1.000D 02	2.77
15	X15	2.182990 02	1.630 02	1.3	0.9994	0.0	1.000D 02	1.000D 02	2.91
16	X16	2.052840 02	2.200 02	0.9	0.9990	0.0	1.000D 02	1.000D 02	2.74
17	X17	2.035810 02	1.610 02	1.3	0.9984	0.0	1.000D 02	1.000D 02	2.72
18	X18	-8.678320 00	6.770 00	1.3	0.8001	0.0	1.000D 02	1.000D 02	0.12
19	X19	-2.048140 00	9.610-01	2.1	0.9008	7.000D 00	1.640D 03	1.633D 03	0.45
20	X20	-1.842230 02	1.930 03	0.1	0.9865	3.000D-01	2.300D 03	2.000D 00	0.35
21	X21	-4.432810 01	4.630 01	1.0	0.9542	0.0	6.100D 01	6.100D 01	0.36
22	X22X8	9.968170-03	2.020-02	0.5	0.9992	0.0	3.240D 05	3.240D 05	0.43
23	X23X9	4.949140-01	3.470-01	1.4	0.9523	0.0	8.200D 03	8.200D 03	0.54
24	X24X10	-2.771020 00	2.570 01	0.1	0.9727	0.0	1.737D 02	1.737D 02	0.06
25	X25X11	4.509770-01	5.030-01	0.9	0.9598	0.0	7.638D 03	7.638D 03	0.46
26	X25X12	-1.975820 02	3.410 02	0.6	0.8099	0.0	6.674D 00	6.674D 00	0.18
27	X27X16	8.137390 00	1.430 02	0.1	0.9976	0.0	1.000D 02	1.000D 02	0.11
28	X28X17	2.294330 01	2.430 01	0.9	0.9151	0.0	1.000D 02	1.000D 02	0.31
29	X29X19	1.364290 00	1.530 00	0.9	0.9604	0.0	1.640D 03	1.640D 03	0.30
30	X30X20	-2.314280 03	4.170 03	0.6	0.9604	0.0	8.300D-01	8.300D-01	0.26
31	X31X21	4.821240 01	6.120 01	0.8	0.9723	0.0	6.100D 01	6.100D 01	0.39

NO. OF OBSERVATIONS 62
NO. OF IND. VARIABLES 31
RESIDUAL DEGREES OF FREEDOM 30
F-VALUE 3.1
RESIDUAL ROOT MEAN SQUARE 983.10709583
RESIDUAL MEAN SQUARE 966499.56186898
RESIDUAL SUM OF SQUARES **********
TOTAL SUM OF SQUARES 121154112.61004668
MULT. CORREL. COEF. SQUARED .7607

FIGURE 43

used to search these variables is to utilize the fractional replication technique twice, where 12 variables are searched at each stage. First of all, the 12 variables numbered 3, 7, 9, 12, 16, 17, 18, 21, 23, 26, 27, 31 have the smallest t_i-values (see Figure 43). The CP search technique indicated that none of the 12 variables searched are significant enough to remain in the equations. These variables are therefore dropped and the remaining variables are fitted (Figure 44). Next, the twelve variables 1, 2, 3, 5, 6, 8, 9, 10, 12, 13, 16, 19 are put through the C_p search technique. This time only variables 3, 6, 10, 12, and 13 are significant and the results are printed in Figure 45.

We note that the variables X22X8, X24X10, X28X17 and X29X19 remain in the resulting equation. Therefore, curvature in the form of squares and natural logarithms for variables X8, X10, X17 and X19 are introduced into the regressions as shown in Figure 46. Since X17 is the % transmitter, there is no logarithm used. In this pass, there are two variables in the basic set. Since there are obviously some variables of negligible influence (see the T-VALUE and REL. INF. X(I)) a search must be made. Again, using a double fractional factorial search, the C_p-search technique admits only the 12 variables shown in Figure 47. (Pass 39). Additional outputs of Pass 39 are shown in Figures 48-51. Since the residual route mean square = .43, the cumulative estimates of the standard deviation indicates that there is little evidence of lack of fit. There are no observations far from the "centroid" of all observations. The cumulative distribution of residuals plot is now a straight line and the fitted y values have a nice even scatter about the 0 - residual line.

There is, however, one observation, 9, which has a larger (smaller) residual than all the other observations (Figure 48). This observation may be controlling the estimates of the coefficients. To determine if observation 9 is in fact controlling some of the coefficients, a cross verification of coefficients is performed as shown in Figure 52, where the statistics at the top are calculated

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 33 DEP VAR 11 Y3 MIN Y = 4.5500 01 MAX Y = 7.5300 03 RANGE Y = 7.484D 03

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		2.142250 03							
1	X1M	7.483330 02	8.910 02	0.8	0.9154	-2.7400-01	7.2600-01	1.0000 00	0.10
2	X2M	1.200810 02	9.830 02	0.1	0.9305	-2.7400-01	7.2600-01	1.0000 00	0.02
3	X4M	-2.959780 02	3.830 02	0.5	0.4589	-2.1000-01	7.9000-01	1.0000 00	0.03
4	X5	3.574270 03	7.350 02	4.9	0.3251	-2.0330-01	5.3870-01	7.4200-01	0.35
5	X6	7.423490 02	7.130 02	1.0	0.2440	-2.1650-01	5.7350-01	7.9000-01	0.08
6	X8	-3.024390-02	1.210-02	2.5	0.9752	1.5800 02	3.2400 05	3.2238D 05	1.31
7	X10	-2.461830 01	8.130 00	3.0	0.7965	1.2000 00	1.7370 02	1.7250 02	0.57
8	X11	-2.251420-01	3.060-01	0.7	0.9057	9.0000 00	7.6380 03	7.6290 03	0.23
9	X13	-4.472350 00	1.490 01	0.4	0.7837	0.0	1.0000 02	1.0000 02	0.06
10	X14	-3.451950 00	8.170 00	0.4	0.8478	0.0	1.0000 02	1.0000 02	0.05
11	X15	1.284760 01	8.430 00	1.4	0.8192	0.0	1.0000 02	1.0000 02	0.15
12	X19	-1.043490 00	6.970-01	1.5	0.8382	7.0000 00	1.6400 03	1.6330 03	0.23
13	X20	3.710240 01	8.650 02	0.8	0.9425	3.0000-01	2.3000 00	2.0000 00	0.01
14	X22X8	2.922980-02	1.190-02	2.4	0.9760	0.0	3.2400 05	3.2430 05	1.27
15	X24X10	1.242070 01	8.390 00	1.5	0.7882	0.0	1.7370 02	1.7370 02	0.29
16	X25X11	2.692130-01	2.880-01	0.9	0.8930	0.0	7.6380 03	7.6380 03	0.27
17	X28X17	1.930000 01	1.100 01	1.8	0.6475	0.0	1.0000 02	1.0000 02	0.26
18	X29X19	1.501860 00	6.150-01	2.4	0.7989	0.0	1.6400 03	1.6400 03	0.33
19	X30X20	7.777310 02	1.910 03	0.4	0.8391	0.0	8.3000-01	8.3000-01	0.09

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	19
RESIDUAL DEGREES OF FREEDOM	42
F-VALUE	9.5
RESIDUAL ROOT MEAN SQUARE	910.81636039
RESIDUAL MEAN SQUARE	829222.15581297
RESIDUAL SUM OF SQUARES	**********
TOTAL SUM OF SQUARES	12115412.61004660
MULT. CORREL. COEF. SQUARED	.7125

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	-5
7	-2
8	-3
9	-2
10	-2
11	-2
12	-3
13	1
14	-5
15	-2
16	-4
17	-2
18	-3
19	1

FIGURE 44

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 34" DEP VAR 11 LNY3 MIN Y = 3.818D 00 MAX Y = 8.927D 00 RANGE Y = 5.109D 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		6.635980D 00							
1	X4M	-5.238320D-01	2.190-01	2.4	0.2343	-2.100D-01	7.900D-01	1.000D 00	0.19
2	X5	1.435030D 00	4.370-01	3.3	0.1327	-2.930D-01	5.387D-01	7.420D-01	0.21
3	X8	-1.901260D-05	6.650-06	2.9	0.9630	1.580D 02	3.240D 05	3.238D 05	1.21
4	X10	-3.571470D-02	4.900-03	7.3	0.7454	1.200D 00	1.737D 02	1.725D 02	1.21
5	X14	9.117480D-03	4.070-03	2.2	0.7210	0.0	1.000D 02	1.000D 02	0.18
6	X15	1.847840-02	3.910-03	4.7	0.6170	0.0	1.000D 02	1.000D 02	0.36
7	X19	-7.418110-04	4.060-04	1.8	0.7630	7.000D 00	1.640D 03	1.633D 03	0.24
8	X20	-2.459780D-01	1.530-01	1.6	0.1575	3.000D-01	2.300D 00	2.000D 00	0.19
9	X22X8	1.951840-05	6.320-06	3.1	0.9610	0.0	3.240D 05	3.240D 05	1.24
10	X24X10	1.428590-02	5.040-03	2.8	0.7224	0.0	1.737D 02	1.737D 02	0.49
11	X28X17	2.636640-02	6.750-03	3.9	0.5720	0.0	1.000D 02	1.000D 02	0.52
12	X29X19	1.316130-03	3.490-04	3.8	0.7044	0.0	1.640D 03	1.640D 03	0.42

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	12
RESIDUAL DEGREES OF FREEDOM	49
F-VALUE	15.9
RESIDUAL ROOT MEAN SQUARE	0.61431588
RESIDUAL MEAN SQUARE	0.37738390
RESIDUAL SUM OF SQUARES	18.49181129
TOTAL SUM OF SQUARES	98.47129040
MULT. CORREL. COEF. SQUARED	.7956

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	-5
4	-2
5	-2
6	-2
7	-3
8	1
9	-5
10	-2
11	-2
12	-3

FIGURE 45

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 35 DEP VAR 11 LNY3 MIN Y = 3.8180 00 MAX Y = 8.9270 00 RANGE Y = 5.1090 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		3.172190 00							
1	X1M	-1.278570-01	3.270-01	0.4	0.8391	-2.7470-01	7.2690-01	1.0080 00	0.03
2	X2M	-2.957250-02	3.880-01	0.1	0.8886	-2.7490-01	7.2690-01	1.0080 00	0.01
3	X3M	2.495890-01	2.280-01	1.0	0.6312	-2.5840-01	7.4280-01	1.0080 00	0.04
4	X4M	-1.637590-01	2.530-01	0.6	0.5761	-2.1930-01	7.9280-01	1.0220 00	0.03
5	X5	1.733460 00	4.360-01	4.0	0.5078	-2.2330-01	5.3870-01	7.4280-01	0.25
6	X6	5.932830-01	4.180-01	1.4	0.4347	-2.1650-01	5.7350-01	7.9080-01	0.09
7	X7	-2.699470-01	4.050-01	0.7	0.4579	-2.1650-01	5.7350-01	7.9080-01	0.04
8	X9	2.175770-05	1.450-04	0.2	0.9379	3.2980 01	8.2980 03	8.1720 03	0.03
9	X11	2.125230-06	1.140-04	0.0	0.8252	9.0020 00	7.6380 03	7.6290 03	0.00
10	X12	3.546370-02	1.930-01	0.3	0.7124	4.9230-03	6.6740 00	6.6690 00	0.05
11	X13	9.675790-02	6.660-02	1.5	0.9985	0.0	1.0000 02	1.0000 02	1.89
12	X14	9.787530-02	6.410-02	1.5	0.9994	0.0	1.0000 02	1.0000 02	1.98
13	X15	1.175840-01	6.460-02	1.8	0.9992	0.0	1.0000 02	1.0000 02	2.38
14	X16	9.451130-02	6.490-02	1.5	0.9974	0.0	1.0000 02	1.0000 02	1.85
15	X18	7.431070-03	3.070-03	2.4	0.7867	0.0	1.0000 02	1.0000 02	0.15
16	X20	-1.862210-01	3.050-01	0.6	0.5813	3.0000-01	2.3000 00	2.0000 00	0.07
17	X21	1.717630-02	1.190-02	1.4	0.8483	0.0	6.1930 01	6.1940 01	0.21
18	X8M	1.683670-06	3.740-06	0.4	0.9339	-2.7380 04	2.9650 05	3.2380 05	0.11
19	X10M	1.339110-02	1.220-02	1.1	0.9769	-3.5000 01	1.3750 02	1.7250 02	0.45
20	X17M	9.657330-02	6.490-02	1.5	0.9978	-1.1190 01	8.8990 01	1.0080 02	1.89
21	X19M	8.209900-05	4.580-04	0.2	0.9938	-3.7500 02	1.2580 03	1.6330 03	0.03
22	X8DSQ	-7.284920-12	2.920-11	0.2	0.8161	5.9050 08	3.6170 10	3.5660 10	0.05
23	X10DSQ	-1.223820-04	8.930-05	1.4	0.8672	2.9580 00	1.1790 04	1.1790 04	0.28
24	X17DSQ	1.498990-04	1.530-04	1.0	0.7439	2.3410 02	3.5640 03	3.3380 03	0.12
25	X19DSQ	4.808520-07	6.880-07	0.7	0.8173	4.8400 02	8.2990 05	8.2940 05	0.08
26	LNX8	-3.671710-01	1.570-01	2.3	0.9391	5.2630 00	1.2690 01	7.6260 00	0.55
27	LNX10	-9.152840-01	2.530-01	3.6	0.9491	1.8230-01	5.1570 00	4.9750 00	0.89
28	LNX19	-1.859230-01	1.610-01	0.7	0.9183	1.9460 00	7.4920 00	5.4570 00	0.11

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	28
RESIDUAL DEGREES OF FREEDOM	33
F-VALUE	14.0
RESIDUAL ROOT MEAN SQUARE	0.46124574
RESIDUAL MEAN SQUARE	0.21274763
RESIDUAL SUM OF SQUARES	7.02967195
TOTAL SUM OF SQUARES	90.47129840
MULT. CORREL. COEF. SQUARED	.9224

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-3
9	-4
10	1
11	1
12	1
13	1
14	1
15	-2
16	1
17	-2
18	-5
19	-1
20	1
21	-3
22	-10
23	-4
24	-3
25	-6
26	1

FIGURE 46

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 39 DEP VAR 1: LNY3 MIN Y = 3.818D 00 MAX Y = 8.927D 00 RANGE Y = 5.109D 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		1.003760 01							
1	X3M	2.992270-01	1.690-01	1.8	0.3674	-2.589D-01	7.429D-01	1.000D 00	0.06
2	X5	1.689440 00	3.270-01	5.2	0.2300	-2.033D-01	5.387D-01	7.423D-01	0.25
3	X8	6.529480-01	3.320-01	2.0	0.2117	-2.165D-01	5.735D-01	7.900D-01	0.19
4	X15	1.745490-02	3.130-03	5.6	0.7252	0.0	1.000D 02	1.000D 02	0.34
5	X18	5.665520-03	2.450-03	2.3	0.7244	0.0	1.000D 02	1.000D 02	0.11
6	X21	7.840460-03	6.410-03	1.2	0.5373	0.0	6.100D 01	6.100D 01	0.09
7	X10M	1.497940-02	5.330-03	2.8	0.8935	-3.590D 01	1.375D 02	1.725D 02	0.48
8	X10DSQ	-8.732620-05	6.380-05	1.4	0.7486	2.958D 00	1.179D 04	1.179D 04	0.20
9	X17DSQ	2.020770-04	1.010-04	2.0	0.4788	2.341D 02	3.564D 03	3.330D 03	0.13
10	X19DSQ	7.634990-07	3.410-07	2.2	0.3479	4.840D 02	8.299D 05	8.294D 05	0.12
11	LNX8	-2.377390-01	6.260-02	3.8	0.6618	5.063D 00	1.269D 01	7.626D 00	0.35
12	LNX10	-1.015570 00	1.830-01	5.5	0.9148	1.823D-01	5.157D 00	4.975D 00	0.99

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	12
RESIDUAL DEGREES OF FREEDOM	49
F-VALUE	36.3
RESIDUAL ROOT MEAN SQUARE	0.43229090
RESIDUAL MEAN SQUARE	0.18987542
RESIDUAL SUM OF SQUARES	9.15689566
TOTAL SUM OF SQUARES	98.4712904A
MULT. CORREL. COEF. SQUARED	.8988

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-2
7	-2
8	-4
9	-4
10	-6
11	1
12	1

FIGURE 47

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 39 DEP VAR 11 LNY3

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71R20	1	1.	5.096	5.753	-0.658	54	6.808	5.986	0.821	1
73530	2	2.	5.612	5.352	0.260	29	5.799	5.051	0.748	2
71L80	3	3.	5.081	4.682	0.399	52	6.732	6.162	0.568	3
71M60	4	8.	4.784	5.760	-0.975	35	5.659	5.094	0.557	4
71P40	5	3.	4.893	5.155	-0.262	6	6.166	5.671	0.495	5
71P80	6	2.	6.166	5.671	0.495	21	7.485	7.029	0.456	6
71710	7	21.	7.832	7.618	0.214	13	5.366	4.916	0.449	7
724G0	8	51.	8.172	8.476	-0.305	10	6.271	5.871	0.400	8
71G50	9	3.	4.546	5.560	-1.013	3	5.081	4.682	0.399	9
71FA0	10	3.	6.271	5.871	0.400	39	7.304	6.913	0.390	10
71F80	11	7.	6.691	6.619	-0.018	59	5.767	5.397	0.370	11
710A0	13	3.	5.366	4.916	0.449	15	6.907	6.548	0.359	12
71A8E	15	11.	6.907	6.548	0.359	10	4.795	4.437	0.358	13
714DA	17	8.	4.580	4.554	0.025	67	4.794	4.491	0.303	14
730BA	18	15.	4.795	4.437	0.358	24	5.450	5.186	0.264	15
73C80	20	57.	8.217	8.037	0.180	2	5.612	5.352	0.260	16
73CEN	21	18.	7.485	7.029	0.456	34	4.846	4.598	0.248	17
73CFK	22	23.	3.818	3.949	-0.131	36	7.235	6.991	0.244	18
730AM	24	9.	5.450	5.186	0.264	33	5.080	4.849	0.231	19
73EBA	25	24.	6.475	6.981	-0.506	46	5.023	4.792	0.230	20
73ERF	26	5.	4.728	5.411	-0.683	7	7.832	7.618	0.214	21
71CA0	27	7.	4.243	4.458	-0.215	20	8.217	8.037	0.180	22
72EAA	28	14.	4.892	5.126	-0.234	63	5.153	4.981	0.172	23
72ECA	29	8.	5.799	5.051	0.748	37	4.648	4.499	0.149	24
728P0	31	14.	4.277	4.256	0.020	43	7.143	7.004	0.139	25
71JA0	32	4.	5.667	6.025	-0.358	55	6.818	6.710	0.107	26
71LA0	33	2.	5.080	4.849	0.231	66	4.936	4.833	0.103	27
720N0	34	5.	4.846	4.598	0.248	49	5.276	5.176	0.099	28
72AC0	35	2.	5.650	5.094	0.557	44	5.945	5.865	0.080	29
71716	36	10.	7.235	6.991	0.244	62	5.520	5.469	0.051	30
71310	37	7.	4.648	4.499	0.149	40	7.177	7.148	0.029	31
72RF0	38	4.	5.607	5.656	-0.049	17	4.580	4.554	0.025	32
72R80	39	12.	7.304	6.913	0.390	31	4.277	4.256	0.020	33
7593G	40	21.	7.177	7.148	0.029	47	4.693	4.693	-0.000	34
74B0A	41	4.	4.840	5.543	-0.702	11	6.691	6.619	-0.018	35
748F0	42	13.	4.755	5.111	-0.347	38	5.607	5.656	-0.049	36
74810	43	17.	7.143	7.004	0.139	51	8.927	8.997	-0.070	37
76A10	44	4.	5.945	5.865	0.080	45	5.284	5.178	-0.094	38
76GA0	45	2.	5.084	5.178	-0.094	57	4.784	4.885	-0.100	39
74FF0	46	8.	5.023	4.792	0.230	61	4.357	4.481	-0.124	40
74FA0	47	52.	4.683	4.693	-0.009	22	3.816	3.949	-0.131	41
74FH0	48	5.	5.276	5.647	-0.372	64	5.245	5.389	-0.144	42
74FU0	49	36.	5.276	5.176	0.099	58	4.822	4.972	-0.150	43
77EC0	50	8.	5.846	6.165	-0.319	53	8.836	8.997	-0.161	44
77EE0	51	25.	8.927	8.997	-0.070	27	4.243	4.458	-0.215	45
77DCA	52	6.	6.730	6.162	0.568	28	4.892	5.126	-0.234	46
77DB0	53	25.	8.836	8.997	-0.161	68	5.835	6.094	-0.259	47
73CR0	54	9.	6.808	5.986	0.821	5	4.893	5.155	-0.262	48
73CG0	55	17.	6.818	6.710	0.107	8	8.172	8.476	-0.305	49
71MA0	56	2.	4.359	4.885	-0.525	50	5.846	6.165	-0.319	50
710U0	57	2.	4.784	4.885	-0.100	42	4.765	5.111	-0.347	51
83AA0	58	1.	4.822	4.972	-0.150	32	5.667	6.025	-0.358	52
85AA0	59	3.	5.767	5.397	0.370	65	4.011	4.379	-0.368	53
63BAA	60	6.	4.113	4.481	-0.369	60	4.113	4.481	-0.369	54
63CAA	61	6.	4.357	4.481	-0.124	48	5.276	5.647	-0.372	55
65BAA	62	2.	5.520	5.469	0.051	25	6.475	6.981	-0.506	56
61BBA	63	5.	5.153	4.981	0.172	56	4.359	4.885	-0.525	57
65BAA	64	1.	5.245	5.389	-0.144	1	5.096	5.753	-0.658	58
63AF0	65	5.	4.011	4.379	-0.368	26	4.728	5.411	-0.683	59
63AA0	66	3.	4.936	4.833	0.103	41	4.840	5.543	-0.702	60
63121	67	5.	4.794	4.491	0.303	4	4.784	5.760	-0.975	61
63AAA	68	7.	5.835	6.094	-0.259	9	4.546	5.560	-1.013	62

FIGURE 18

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 39 DEP VAR 11 LNY3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.43

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV	OBSV	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.09	0.0	53	51	0.09	7.52	0.15	3.95	22	1
2	0.26	0.0	57	56	0.42	8.20	0.39	4.20	31	2
3	0.25	0.0	61	60	0.24	2.01	0.67	4.36	65	3
4	0.28	0.01	27	37	0.36	6.80	0.05	4.40	67	4
5	0.36	0.21	65	67	0.67	5.09	0.57	4.44	10	5
6	0.40	0.21	66	56	0.63	2.08	0.09	4.46	27	6
7	0.37	0.21	66	57	0.27	0.0	0.24	4.46	61	7
8	0.42	0.34	10	32	0.76	2.11	0.52	4.48	60	8
9	0.38	0.39	57	58	0.05	2.18	0.12	4.50	37	9
10	0.38	0.39	56	58	0.37	8.85	0.22	4.55	17	10
11	0.37	0.44	33	13	0.22	3.74	0.15	4.60	34	11
12	0.35	0.51	65	27	0.15	45.10	0.41	4.68	3	12
13	0.36	0.63	67	27	0.52	36.27	0.24	4.69	47	13
14	0.41	0.83	1	10	1.06	5.96	0.13	4.79	46	14
15	0.41	0.83	33	58	0.38	1.14	0.13	4.83	66	15
16	0.42	0.94	25	40	0.53	1.09	0.33	4.85	33	16
17	0.41	0.95	9	1	0.36	0.0	0.42	4.88	57	17
18	0.43	1.04	58	35	0.71	1.96	0.97	4.89	56	18
19	0.42	1.07	43	21	0.32	1.25	0.69	4.92	13	19
20	0.44	1.09	33	56	0.76	5.20	0.32	4.97	58	20
21	0.43	1.09	33	57	0.33	3.51	0.56	4.98	63	21
22	0.43	1.10	3	66	0.30	7.31	0.19	5.05	29	22
23	0.41	1.14	66	33	0.13	9.63	0.99	5.09	35	23
24	0.42	1.25	13	58	0.60	7.70	0.11	5.11	42	24
25	0.41	1.32	32	68	0.10	7.35	0.33	5.13	28	25
26	0.40	1.51	13	35	0.11	34.84	0.35	5.16	5	26
27	0.41	1.55	35	5	0.82	40.38	0.19	5.18	49	27
28	0.40	1.60	55	43	0.93	13.20	0.36	5.18	45	28
29	0.43	1.72	59	9	1.38	6.37	0.00	5.19	24	29
30	0.43	1.96	37	3	0.25	3.66	0.40	5.35	2	30
31	0.42	1.87	66	13	0.35	3.79	0.51	5.39	64	31
32	0.43	1.96	57	13	0.55	3.26	1.05	5.40	59	32
33	0.44	1.96	56	13	0.97	7.26	0.73	5.41	26	33
34	0.44	2.05	44	32	0.44	5.39	0.75	5.47	62	34
35	0.44	2.08	27	60	0.15	11.55	0.31	5.54	41	35
36	0.43	2.08	27	61	0.09	9.33	0.64	5.56	9	36
37	0.42	2.09	40	7	0.19	14.13	0.32	5.65	48	37
38	0.42	2.11	61	37	0.27	6.43	0.54	5.66	38	38
39	0.42	2.11	60	37	0.52	4.42	1.15	5.67	6	39
40	0.42	2.16	68	15	0.62	9.33	0.32	5.75	1	40
41	0.42	2.16	3	33	0.17	17.32	1.95	5.76	4	41
42	0.43	2.18	60	3	0.77	2.24	0.32	5.87	44	42
43	0.42	2.18	37	17	0.12	3.87	0.42	5.87	10	43
44	0.41	2.19	27	17	0.24	3.67	1.18	5.99	54	44
45	0.41	2.24	44	10	0.32	1.32	0.10	6.03	32	45
46	0.40	2.26	36	7	0.03	12.22	0.83	6.09	68	46
47	0.41	2.32	10	68	0.66	2.58	0.89	6.16	52	47
48	0.42	2.44	67	60	0.67	29.95	0.68	6.17	50	48
49	0.41	2.44	64	62	0.19	12.39	0.38	6.55	15	49
50	0.41	2.44	67	61	0.43	4.26	0.12	6.62	11	50
51	0.41	2.45	34	66	0.15	7.14	0.28	6.71	55	51
52	0.40	2.45	65	61	0.24	15.73	0.99	6.91	39	52
53	0.42	2.48	5	2	0.52	4.64	0.75	6.98	25	53
54	0.41	2.56	52	50	0.89	21.75	0.11	6.99	36	54
55	0.41	2.61	38	44	0.13	1.07	0.32	7.00	43	55
56	0.42	2.64	29	28	0.98	23.84	0.43	7.03	21	56
57	0.43	2.69	9	38	0.96	2.09	0.19	7.15	40	57
58	0.42	2.75	61	17	0.15	11.70	0.03	7.62	7	58
59	0.42	2.75	60	17	0.39	4.77	0.48	8.04	20	59
60	0.43	2.79	38	1	0.61	41.47	0.14	8.48	8	60
61	0.42	2.80	34	46	0.02	0.0	0.00	9.00	53	61
62	0.42	2.90	22	18	0.49	11.22	0.24	9.80	51	62

FIGURE 49

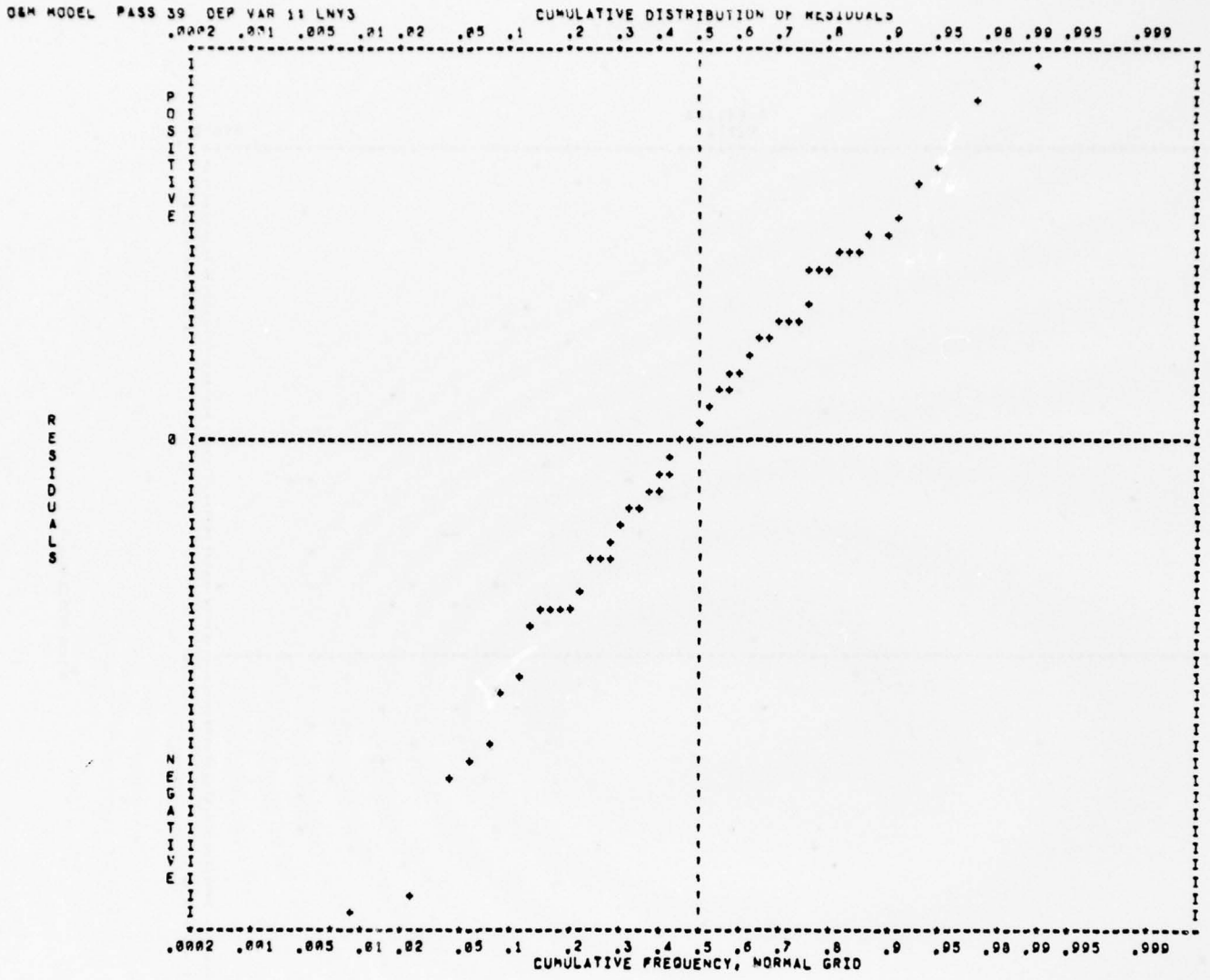

O&M MODEL PASS 39 DEP VAR 11 LNY3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 50

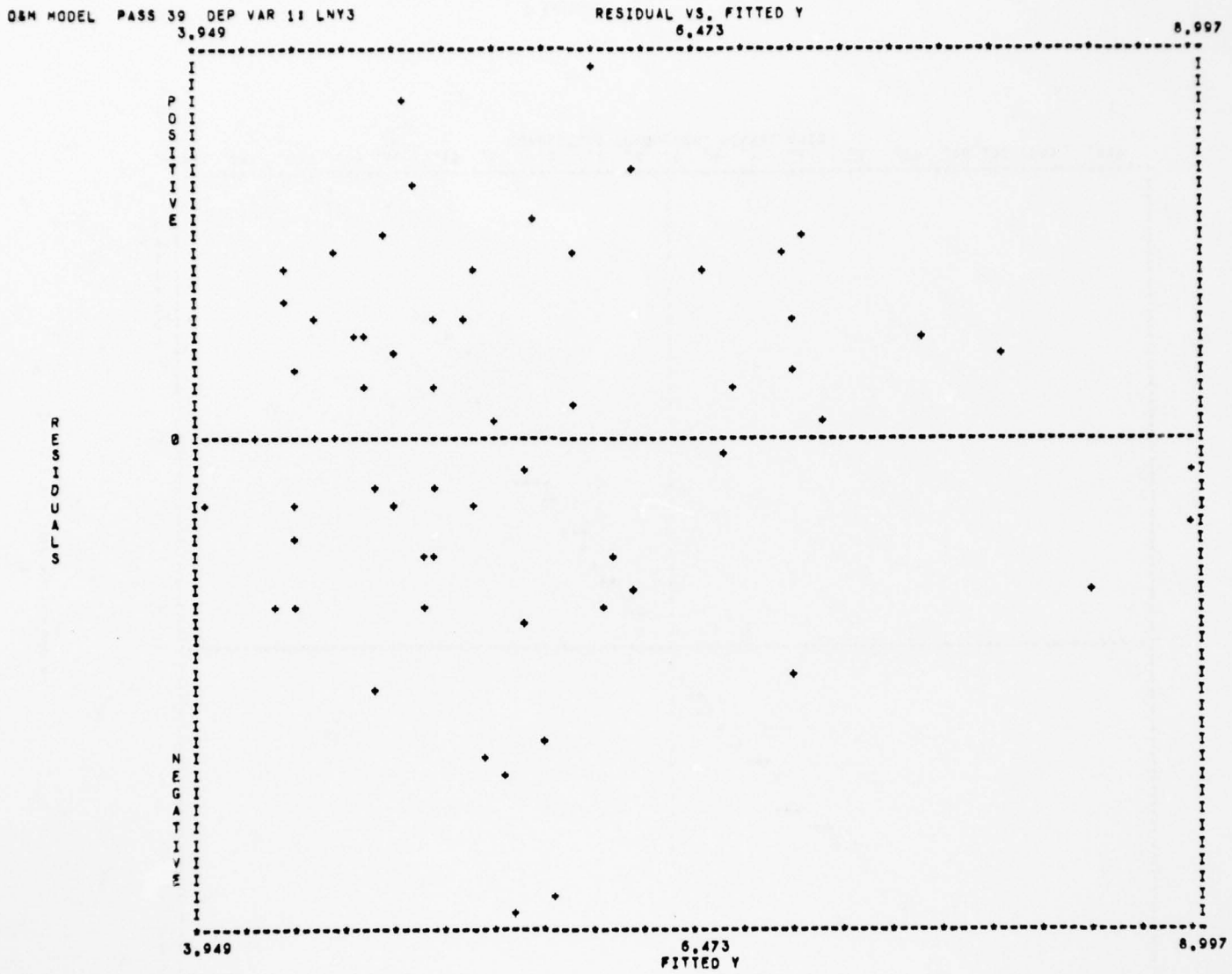

Q&M MODEL PASS 39 DEP VAR 11 LNY3
RESIDUAL VS. FITTED Y
3,949
6,473
8,997
POSITIVE
RESIDUALS
0
NEGATIVE
3,949
6,473
8,997
FITTED Y

FIGURE 51

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 39 DEP VAR 1: LNY3 MIN Y = 3.810D 00 MAX Y = 8.927D 00 RANGE Y = 5.109D 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		1.003760 01							
1	X3M	2.922270-01	1.600-01	1.8	0.3874	-2.580D-01	7.420D-01	1.000D 00	0.26
2	X5	1.689440 00	3.270-01	5.2	0.2300	-2.033D-01	5.387D-01	7.420D-01	0.25
3	X6	6.529480-01	3.320-01	2.0	0.2117	-2.163D-01	5.735D-01	7.900D-01	0.10
4	X15	1.745490-02	3.130-03	5.6	0.7052	0.0	1.000D 02	1.000D 02	0.34
5	X18	5.665500-03	2.450-03	2.3	0.7044	0.0	1.000D 02	1.000D 02	0.11
6	X21	7.840460-03	6.410-03	1.2	0.5373	0.0	6.100D 01	6.100D 01	0.09
7	X10M	1.427940-02	5.330-03	2.6	0.8935	-3.500D 01	1.375D 02	1.725D 02	0.48
8	X10DSQ	-8.732620-05	6.480-05	1.4	0.7486	2.958D 00	1.179D 04	1.179D 04	0.29
9	X17DSQ	2.022770-04	1.010-04	2.0	0.4788	2.341D 02	3.564D 03	3.338D 03	0.13
10	X19DSQ	7.634990-07	3.410-07	2.2	0.3479	4.840D 02	8.299D 05	8.294D 05	0.12
11	LNX8	-2.377390-01	6.260-02	3.8	0.6618	5.063D 00	1.269D 01	7.626D 00	0.35
12	LNX10	-1.015570 00	1.830-01	5.5	0.9148	1.823D-01	5.157D 00	4.975D 00	0.99

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	12
RESIDUAL DEGREES OF FREEDOM	49
F-VALUE	36.3
RESIDUAL ROOT MEAN SQUARE	0.43229090
RESIDUAL MEAN SQUARE	0.18687542
RESIDUAL SUM OF SQUARES	9.15689566
TOTAL SUM OF SQUARES	90.47129040
MULT. CORREL. COEF. SQUARED	.8988

IND.VAR(I)	NAME	COEF.B(I)	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
*** COEFFICIENTS FROM PREVIOUS FIT ***						
0		9.413860 00				
1	X3M	2.497780-01	-2.588D-01	7.420D-01	1.000D 00	0.25
2	X5	1.826890 00	-2.033D-01	5.387D-01	7.420D-01	0.26
3	X6	6.989660-01	-2.165D-01	5.735D-01	7.900D-01	0.11
4	X15	1.468770-02	0.0	1.000D 02	1.000D 02	0.29
5	X18	3.826420-03	0.0	1.000D 02	1.000D 02	0.06
6	X21	6.658120-03	0.0	6.100D 01	6.100D 01	0.08
7	X10M	1.958120-02	-3.500D 01	1.375D 02	1.725D 02	0.36
8	X10DSQ	-5.552360-05	2.958D 00	1.179D 04	1.179D 04	0.13
9	X17DSQ	2.458520-04	2.341D 02	3.564D 03	3.338D 03	0.16
10	X19DSQ	9.816790-07	4.840D 02	8.299D 05	8.294D 05	0.15
11	LNX8	-1.768740-01	5.063D 00	1.269D 01	7.626D 00	0.26
12	LNX10	-9.659400-01	1.823D-01	5.157D 00	4.975D 00	0.94

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-2
7	-2
8	-4
9	-4
10	-6
11	1
12	1

FIGURE 52

using the entire set of data and the statistics at the bottom are those calculated with observation 9 omitted. Here we note that the coefficient, for X18 has decreased by nearly 50%, and the coefficient for X21 has decreased by nearly 15%. Sometimes the effects of the observations on a certain coefficient are lying hidden beneath other effects, and hence the effects on the coefficients for X21 may be larger than the statistics indicate. Therefore, in addition to considering curvature for the previous variables X8, X10, X17 and X19, we consider curvature for X18 and X21. If curvature is not needed in variable X21, the C_p search technique should omit it. This exercise is shown in Figure 53. Again a fractional factorial search performed twice, yields the results in Figures 54-59.

The statistics are highly significant, R_y^2 = .9183 and F-VALUE = 41.5, the residuals are now evenly distributed, (indicating constant variance of $\sigma^2(y)$), the cumulative distribution is a straight line (indicating normality) and the cumulative estimates of the standard indicates that there is no evidence of lack of fit.

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 41 DEP VAR 21 LNY3 MIN Y = 3.8180 00 MAX Y = 8.9270 00 RANGE Y = 5.1090 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		1.980720D 00							
1	X1M	2.181080-02	3.160-01	0.1	0.8453	-2.7400-01	7.2600-01	1.0000 00	0.00
2	X2M	-8.240857D-02	3.630-01	0.2	0.8824	-2.7400-01	7.2600-01	1.0000 00	0.02
3	X3M	1.446340-01	2.230-01	0.6	0.6774	-2.5800-01	7.4200-01	1.0000 00	0.03
4	X4M	-1.242770-01	2.420-01	0.5	0.6823	-2.1000-01	7.9000-01	1.0000 00	0.02
5	X5	1.660340 00	4.160-01	4.0	0.5146	-2.0330-01	5.3670-01	7.4200-01	0.24
6	X6	8.456690-01	4.290-01	2.0	0.5182	-2.1650-01	5.7350-01	7.9000-01	0.13
7	X7	2.228530-01	4.550-01	0.5	0.5145	-2.1650-01	5.7350-01	7.9000-01	0.03
8	X8	-4.969950-05	1.560-04	0.3	0.9521	3.0000 01	8.2000 03	8.1700 03	0.08
9	X11	1.042430-04	1.230-04	0.8	0.8658	9.0000 00	7.6380 03	7.6290 03	0.16
10	X12	-9.957230-03	1.220-01	0.1	0.7242	4.9230-03	6.674D 00	6.6690 00	0.01
11	X13	1.016210-01	6.330-02	1.6	0.9985	0.0	1.0000 02	1.0000 02	1.99
12	X14	1.033720-01	6.120-02	1.7	0.9994	0.0	1.0000 02	1.0000 02	2.02
13	X15	1.219940-01	6.160-02	2.0	0.9992	0.0	1.0000 02	1.0000 02	2.39
14	X16	1.052140-01	6.190-02	1.7	0.9974	0.0	1.0000 02	1.0000 02	2.06
15	X20	-6.578370-04	3.000-01	0.0	0.8898	3.0000-01	2.3000 00	2.0000 00	0.00
16	X8M	2.379550-07	3.690-06	0.1	0.9392	-2.738D 04	2.965D 05	3.238D 05	0.02
17	X11M	1.750530-02	1.350-02	1.3	0.9838	-3.5000 01	1.375D 02	1.725D 02	0.59
18	X17M	9.866670-02	6.080-02	1.6	0.9978	-1.1100 01	8.8900 01	1.0000 02	1.93
19	X18M	6.834960-03	2.960-03	2.3	0.7943	-6.1000 01	3.9000 01	1.0000 02	0.13
20	X19M	2.679310-04	4.430-04	0.6	0.9978	-3.750D 02	1.2580 03	1.6330 03	0.09
21	X21M	-1.872190-03	1.390-02	0.1	0.9902	-4.690D 00	5.631D 01	6.1320 01	0.22
22	X8DSQ	-1.514650-11	2.790-11	0.5	0.8188	5.0050 08	3.617D 10	3.566D 10	0.11
23	X10DSQ	-1.224590-05	9.650-05	0.1	0.8983	2.9580 00	1.179D 04	1.179D 04	0.02
24	X17DSQ	1.219970-04	1.490-04	0.8	0.7579	2.341D 02	3.564D 03	3.330D 03	0.08
25	X18DSQ	2.212340-04	1.070-04	2.1	0.6233	7.726D 01	2.726D 03	2.649D 03	0.11
26	X19DSQ	7.831790-07	6.770-07	1.2	0.8395	4.840D 02	8.299D 05	8.294D 05	0.13
27	X21DSQ	-6.989420-04	4.850-04	1.4	0.6131	7.939D 01	1.139D 03	1.059D 03	0.14
28	LNX8	-3.338680-01	1.500-01	2.2	0.9396	5.063D 00	1.269D 01	7.626D 00	0.50
29	LNX10	-8.266980-01	2.530-01	3.3	0.9544	1.823D-01	5.157D 00	4.975D 00	0.81
30	LNX19	-5.284230-02	1.550-01	0.3	0.9282	1.946D 00	7.402D 00	5.457D 00	0.05

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	30
RESIDUAL DEGREES OF FREEDOM	31
F-VALUE	14.8
RESIDUAL ROOT MEAN SQUARE	0.43680387
RESIDUAL MEAN SQUARE	0.19079762
RESIDUAL SUM OF SQUARES	5.91472622
TOTAL SUM OF SQUARES	92.47129340
MULT. CORREL. COEF. SQUARED	.9346

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-3
9	-3
10	1
11	1
12	1
13	1
14	1
15	1
16	-5
17	-1
18	1
19	-2
20	-3
21	-1
22	-10

FIGURE 53

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 3 DEP VAR 1: LNY3 MIN Y = 3.8180 00 MAX Y = 8.9270 00 RANGE Y = 5.1090 00

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

LNY3 = B(0) + B(1)X3M + B(2)X4M + B(3)X5 + B(4)X6 + B(5)X10 + B(6)X11
+ B(7)X15 + B(8)X18M + B(9)X18DSQ + B(10)X19DSQ + B(11)X21DSQ
+ B(12)LNX8 + B(13)LNX10

LNY3 = LN(MTBMA) MTBMA (MEAN TIME BETWEEN MAINTENANCE ACTIONS)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		9.858660 00							
1	X3M	3.155280-01	1.480-01	2.1	0.4053	-2.580D-01	7.420D-01	1.000D 00	0.06
2	X4M	-3.135960-01	1.450-01	2.2	0.2875	-2.100D-01	7.900D-01	1.000D 00	0.06
3	X5	1.45371D 00	2.980-01	4.9	0.2353	-2.930D-01	5.387D-01	7.420D-01	0.21
4	X6	8.311760-01	3.040-01	2.7	0.2261	-2.165D-01	5.735D-01	7.900D-01	0.13
5	X10	1.176660-02	3.370-03	3.5	0.7898	1.200D 00	1.737D 02	1.725D 02	0.42
6	X11	8.266690-05	5.060-05	1.6	0.3614	9.000D 00	7.638D 03	7.629D 03	0.12
7	X15	1.768380-02	2.720-03	6.5	0.6786	0.0	1.000D 02	1.000D 02	0.35
8	X18M	6.508370-03	2.120-03	3.1	0.6748	-6.100D 01	3.900D 01	1.000D 02	0.13
9	X18DSQ	1.864360-04	6.710-05	2.8	0.2325	7.726D 01	2.726D 03	2.649D 03	0.10
10	X19DSQ	7.326610-07	2.830-07	2.6	0.2173	4.840D 02	6.299D 05	6.294D 05	0.12
11	X21DSQ	-4.839340-04	3.240-04	1.5	0.3814	7.039D 01	1.139D 03	1.059D 03	0.10
12	LNX8	-2.838050-01	5.850-02	4.9	0.6802	5.063D 00	1.269D 01	7.626D 00	0.42
13	LNX10	-8.398660-01	1.110-01	7.5	0.8181	1.823D-01	5.157D 00	4.975D 00	0.02

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	13
RESIDUAL DEGREES OF FREEDOM	48
F-VALUE	41.5
RESIDUAL ROOT MEAN SQUARE	0.39249151
RESIDUAL MEAN SQUARE	0.15404959
RESIDUAL SUM OF SQUARES	7.39438816
TOTAL SUM OF SQUARES	98.47129040
MULT. CORREL. COEF. SQUARED	.9183

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	-2
6	-4
7	-2
8	-2
9	-4
10	-6
11	-3
12	1
13	1

FIGURE 54

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 3 DEP VAR 11 LNY3 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.39

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.09	0.0	53	51	0.09	10.95	0.15	4.03	22	1
2	0.26	0.0	57	56	0.42	0.01	0.07	4.08	65	2
3	0.26	0.0	61	60	0.24	3.71	0.63	4.10	67	3
4	0.36	0.01	65	67	0.07	0.0	0.24	4.38	61	4
5	0.35	0.02	27	37	0.36	8.44	0.63	4.38	60	5
6	0.35	0.26	66	57	0.32	14.11	0.60	4.43	10	6
7	0.31	0.39	57	58	0.03	13.23	0.85	4.51	31	7
8	0.33	0.39	56	58	0.46	30.69	0.55	4.54	63	8
9	0.35	0.70	35	33	0.57	35.06	0.38	4.62	47	9
10	0.38	0.78	61	63	0.64	6.14	0.24	4.64	3	10
11	0.43	0.78	60	63	0.89	12.74	0.29	4.64	34	11
12	0.45	1.00	10	32	0.66	6.33	0.28	4.66	17	12
13	0.44	1.40	13	33	0.29	6.25	0.22	4.74	66	13
14	0.44	1.63	21	43	0.44	6.30	0.57	4.79	42	14
15	0.45	1.66	1	10	0.67	0.02	0.36	4.83	27	15
16	0.44	1.66	25	40	0.26	6.01	0.11	4.88	37	16
17	0.43	1.76	32	68	0.16	0.0	0.42	4.91	57	17
18	0.42	1.81	35	13	0.28	0.39	0.46	4.91	56	18
19	0.40	1.83	17	37	0.15	10.79	0.07	4.91	58	19
20	0.41	1.85	17	27	0.50	24.30	0.35	5.04	46	20
21	0.39	1.94	36	7	0.09	26.10	0.15	5.10	26	21
22	0.39	1.98	5	64	0.34	13.56	0.36	5.11	28	22
23	0.41	2.09	59	1	0.85	5.36	0.31	5.14	48	23
24	0.45	2.32	6	5	1.28	3.23	0.02	5.16	2	24
25	0.44	2.39	32	44	0.20	1.81	0.28	5.18	35	25
26	0.43	2.54	40	7	0.21	1.40	0.29	5.18	13	26
27	0.44	2.60	50	52	0.77	14.72	0.34	5.18	33	27
28	0.45	2.64	2	33	0.55	17.50	0.21	5.22	24	28
29	0.44	2.80	2	13	0.27	24.43	0.45	5.25	49	29
30	0.43	2.88	3	66	0.25	11.05	0.36	5.27	41	30
31	0.43	2.90	10	44	0.46	6.13	0.50	5.33	9	31
32	0.45	3.01	6	64	0.94	6.56	1.05	5.37	45	32
33	0.46	3.02	68	15	0.59	12.82	1.39	5.39	6	33
34	0.46	3.15	15	25	0.59	15.28	0.10	5.40	4	34
35	0.45	3.17	48	33	0.24	6.82	0.87	5.40	8	35
36	0.44	3.23	2	35	0.02	3.62	0.53	5.41	59	36
37	0.44	3.34	45	5	0.23	6.49	0.36	5.41	64	37
38	0.44	3.50	10	68	0.50	15.09	0.17	5.41	38	38
39	0.44	3.62	59	64	0.53	14.91	0.85	5.44	29	39
40	0.43	3.65	63	3	0.17	5.55	0.31	5.58	1	40
41	0.42	3.69	48	13	0.95	12.81	0.01	5.70	62	41
42	0.41	3.71	64	62	0.01	23.24	0.91	6.01	50	42
43	0.42	3.71	67	60	0.87	4.44	0.56	6.06	54	43
44	0.43	3.71	67	61	0.63	7.50	0.42	6.08	10	44
45	0.42	3.72	65	60	0.21	7.81	1.08	6.12	52	45
46	0.42	3.72	65	61	0.04	1.76	0.16	6.14	32	46
47	0.41	3.78	64	1	0.32	4.51	0.03	6.15	68	47
48	0.41	3.93	31	34	0.44	15.16	0.47	6.22	44	48
49	0.41	3.95	36	40	0.12	16.20	0.08	6.41	11	49
50	0.40	3.96	39	21	0.05	29.25	0.24	6.63	15	50
51	0.42	4.00	54	32	1.22	37.44	0.35	6.78	55	51
52	0.42	4.03	3	17	0.52	18.06	0.59	6.79	25	52
53	0.41	4.10	34	66	0.01	3.96	0.05	7.03	39	53
54	0.41	4.20	44	15	0.56	25.15	0.26	7.15	21	54
55	0.42	4.27	38	1	0.68	3.95	0.12	7.16	36	55
56	0.43	4.37	41	6	1.20	28.84	0.06	7.23	40	56
57	0.44	4.40	45	59	0.64	32.26	0.26	7.25	43	57
58	0.44	4.41	25	36	0.39	12.04	0.01	7.68	7	58
59	0.44	4.42	32	15	0.75	7.36	0.24	8.07	20	59
60	0.44	4.44	54	18	0.56	42.94	0.09	8.26	8	60
61	0.44	4.51	60	44	0.83	0.0	0.85	9.02	53	61
62	0.43	4.59	46	48	0.15	11.60	0.02	9.02	51	62

FIGURE 55

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 3 DEP VAR IS LNY3

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71B2A	1	1.	5.096	5.584	-0.488	6	6.166	5.393	0.772	1
7353A	2	3.	5.612	5.162	0.450	54	6.808	6.062	0.746	2
71L8A	3	3.	5.081	4.638	0.444	63	5.153	4.537	0.616	3
71M6A	4	10.	4.784	5.397	-0.613	52	6.730	6.122	0.608	4
71PKA	5	2.	4.893	5.405	-0.512	67	4.784	4.100	0.684	5
71P8A	6	2.	6.166	5.393	0.772	35	5.650	5.181	0.469	6
71710	7	20.	7.832	7.677	0.155	2	5.612	5.162	0.450	7
724GA	8	43.	8.172	8.263	-0.091	3	5.081	4.638	0.444	8
71G5A	9	4.	4.546	5.330	-0.784	29	5.799	5.437	0.362	9
71FA0	10	3.	6.271	6.085	0.186	18	4.795	4.434	0.361	10
71F8A	11	9.	6.601	6.406	0.195	59	5.767	5.407	0.360	11
71DAA	13	4.	5.366	5.181	0.184	21	7.485	7.153	0.332	12
71ABE	15	10.	6.907	6.629	0.278	39	7.304	7.025	0.278	13
71ADA	17	8.	4.580	4.641	-0.061	15	6.907	6.629	0.278	14
73DBA	18	14.	4.795	4.434	0.361	24	5.450	5.217	0.233	15
73C8Q	20	53.	8.217	8.072	0.145	34	4.846	4.640	0.206	16
73CEN	21	20.	7.485	7.153	0.332	66	4.936	4.738	0.198	17
73CFK	22	28.	3.818	4.035	-0.217	11	6.601	6.406	0.195	18
73DAM	24	9.	5.450	5.217	0.233	38	5.607	5.415	0.192	19
73E8A	25	22.	6.475	6.787	-0.312	10	6.271	6.085	0.186	20
73E8F	26	6.	4.728	5.099	-0.371	13	5.366	5.181	0.184	21
71CA0	27	7.	4.243	4.828	-0.585	7	7.832	7.677	0.155	22
72EAA	28	13.	4.892	5.111	-0.220	28	8.217	8.072	0.145	23
72ECA	29	8.	5.799	5.437	0.362	48	5.276	5.139	0.136	24
728P0	31	16.	4.277	4.514	-0.237	36	7.235	7.162	0.073	25
71JA0	32	3.	5.667	6.141	-0.474	47	4.683	4.621	0.062	26
71LA0	33	3.	5.080	5.182	-0.102	55	6.818	6.781	0.037	27
72DN0	34	6.	4.846	4.640	0.206	49	5.276	5.254	0.021	28
72AC0	35	2.	5.650	5.181	0.469	46	5.923	5.940	-0.017	29
71716	36	18.	7.235	7.162	0.073	42	4.765	4.785	-0.020	30
71310	37	7.	4.648	4.877	-0.229	61	4.357	4.382	-0.025	31
72RF0	38	5.	5.607	5.415	0.192	40	7.177	7.227	-0.050	32
72R8P	39	13.	7.324	7.025	0.278	65	4.011	4.075	-0.064	33
75930	40	18.	7.177	7.227	-0.050	17	4.580	4.661	-0.081	34
74BD0	41	4.	4.840	5.265	-0.425	51	8.927	9.016	-0.089	35
74BF0	42	10.	4.765	4.785	-0.020	58	4.822	4.911	-0.090	36
74B1B	43	20.	7.143	7.251	-0.108	8	8.172	8.263	-0.091	37
76A1A	44	4.	5.945	6.223	-0.278	33	5.080	5.182	-0.102	38
76GA0	45	3.	5.084	5.366	-0.282	43	7.143	7.251	-0.108	39
74FF0	46	11.	5.923	5.940	-0.017	57	4.784	4.907	-0.123	40
74FA0	47	42.	4.683	4.621	0.062	50	5.846	6.007	-0.161	41
74FH0	48	5.	5.276	5.139	0.136	64	5.245	5.414	-0.169	42
74FU0	49	39.	5.276	5.254	0.021	62	5.520	5.696	-0.176	43
77EC0	50	7.	5.846	6.007	-0.161	53	8.836	9.016	-0.180	44
77EE0	51	28.	8.927	9.016	-0.089	22	3.818	4.035	-0.217	45
77DCA	52	7.	6.730	6.122	0.608	26	4.892	5.111	-0.220	46
77D80	53	26.	8.836	9.016	-0.180	37	4.648	4.877	-0.229	47
73CR0	54	8.	6.808	6.062	0.746	31	4.277	4.514	-0.237	48
73CG0	55	21.	6.818	6.781	0.037	60	4.113	4.382	-0.269	49
71NA0	56	2.	4.359	4.907	-0.548	44	5.945	6.223	-0.278	50
710U0	57	2.	4.784	4.907	-0.123	45	5.084	5.366	-0.282	51
63AA0	58	2.	4.822	4.911	-0.090	25	6.475	6.787	-0.312	52
65AA0	59	4.	5.767	5.407	0.360	68	5.835	6.147	-0.313	53
638AA	60	6.	4.113	4.382	-0.269	26	4.728	5.099	-0.371	54
63CAA	61	6.	4.357	4.382	-0.025	41	4.840	5.265	-0.425	55
659AA	62	4.	5.520	5.696	-0.176	32	5.667	6.141	-0.474	56
6188A	63	6.	5.153	4.537	0.616	1	5.096	5.584	-0.488	57
658AA	64	2.	5.245	5.414	-0.169	5	4.893	5.405	-0.512	58
63AF0	65	5.	4.011	4.075	-0.064	58	4.359	4.907	-0.548	59
63AA0	66	3.	4.936	4.738	0.198	27	4.243	4.828	-0.585	60
63121	67	5.	4.784	4.180	0.604	4	4.784	5.397	-0.613	61
63AAA	68	7.	5.835	6.147	-0.313	9	4.546	5.330	-0.784	62

FIGURE 56

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 3 DEP VAR 11 LNY3

COMPONENT EFFECT OF EACH VARIABLE ON EACH OBSERVATION (IN UNITS OF Y)
(VARIABLES ORDERED BY THEIR RELATIVE INFLUENCE --- OBSERVATIONS ORDERED BY INFLUENCE OF MOST INFLUENTIAL VARIABLE)

SEQ.	OBSV.	VARIABLES 13 LNX1R	12 LNX8	5 X1R	7 X15	3 X5	4 X6	8 X18M	6 X11	10 X19DSQ	11 X21DSQ	9 X18DSQ	1 X3M	2 X4M
1	20	2.51	1.10	-0.41	-0.29	-0.26	-0.13	-0.40	-0.07	0.14	0.06	0.10	-0.08	0.07
2	8	2.46	0.38	-0.41	-0.23	0.11	0.04	0.23	-0.07	0.09	-0.04	0.04	-0.08	0.07
3	25	1.64	0.52	-0.39	-0.29	-0.26	-0.13	0.16	-0.07	0.14	-0.04	-0.12	-0.08	0.07
4	7	1.50	0.63	-0.38	-0.29	0.11	0.04	0.25	-0.08	0.16	-0.01	0.09	-0.08	0.07
5	40	1.50	0.27	-0.38	-0.29	-0.29	0.04	0.25	-0.07	0.17	-0.04	0.09	0.23	0.07
6	15	0.97	0.55	-0.34	-0.16	-0.26	-0.13	0.21	-0.06	0.17	0.06	-0.02	-0.08	0.07
7	36	0.97	0.51	-0.34	-0.29	0.11	0.04	0.25	-0.06	0.16	0.06	0.09	-0.08	0.07
8	54	0.92	-0.33	-0.33	-0.08	-0.29	0.04	0.24	-0.03	-0.08	-0.04	0.07	0.23	0.07
9	51	0.87	0.63	-0.33	1.48	0.79	-0.13	-0.40	-0.08	0.08	-0.04	0.18	0.23	0.07
10	53	0.87	0.63	-0.33	1.48	0.79	-0.13	-0.40	-0.08	0.08	-0.04	0.18	0.23	0.07
11	39	0.82	0.36	-0.32	0.93	0.11	0.04	-0.40	-0.07	-0.20	-0.04	0.18	-0.08	0.07
12	68	0.82	0.17	-0.32	-0.29	0.11	-0.19	0.25	0.06	0.14	-0.04	0.09	-0.08	-0.25
13	21	0.69	0.29	-0.30	1.48	-0.26	-0.13	-0.40	-0.08	0.08	-0.04	0.18	-0.08	0.07
14	43	0.65	0.06	-0.30	1.48	-0.29	0.04	-0.40	-0.07	-0.15	0.08	0.18	0.23	0.07
15	26	0.61	0.31	-0.29	-0.29	-0.26	-0.13	-0.16	-0.06	0.05	-0.04	-0.29	-0.08	0.07
16	55	0.58	-0.49	-0.28	1.48	-0.29	0.04	-0.40	-0.07	0.12	-0.04	0.18	0.23	0.07
17	32	0.52	0.06	-0.28	-0.27	0.11	0.04	0.25	0.01	0.01	-0.04	0.08	-0.08	0.07
18	10	0.45	-0.08	-0.26	-0.25	0.11	0.04	0.24	-0.04	-0.13	0.29	0.06	-0.08	0.07
19	11	0.45	-0.25	-0.26	0.00	0.11	0.04	-0.18	-0.07	0.01	0.27	-0.26	-0.08	0.07
20	9	0.45	-0.31	-0.26	-0.09	0.11	0.04	-0.18	-0.04	0.01	0.23	-0.27	-0.08	0.07
21	38	0.45	0.45	-0.26	-0.29	0.11	0.04	-0.20	-0.05	-0.20	-0.04	-0.24	-0.08	0.07
22	59	0.45	-0.17	-0.26	-0.29	0.11	-0.19	0.25	0.20	0.11	-0.04	0.09	-0.08	-0.25
23	44	0.39	0.30	-0.25	-0.29	-0.29	0.04	0.25	-0.02	-0.10	0.10	0.09	0.23	0.07
24	1	0.25	-0.16	-0.22	-0.04	0.11	0.04	0.16	-0.04	-0.01	-0.04	-0.12	-0.08	0.07
25	45	-0.04	-0.25	-0.13	-0.29	-0.29	0.04	0.25	0.03	0.03	-0.04	0.09	0.23	0.07
26	52	-0.08	-0.42	-0.12	-0.29	0.79	-0.13	0.25	0.04	0.04	-0.04	0.09	0.23	0.07
27	58	-0.16	-0.47	-0.08	-0.29	0.11	-0.19	0.23	-0.01	0.03	-0.04	0.04	-0.08	-0.25
28	62	-0.16	0.19	-0.08	-0.27	-0.26	0.47	0.24	0.02	0.09	0.08	0.05	-0.08	-0.25
29	64	-0.16	0.19	-0.08	-0.27	0.11	-0.19	0.24	0.02	0.09	0.08	0.05	-0.08	-0.25
30	13	-0.19	-0.57	-0.08	-0.29	0.11	0.04	0.21	-0.08	0.11	0.28	-0.02	-0.08	0.07
31	4	-0.21	-0.44	-0.07	1.06	0.11	0.04	-0.24	-0.07	-0.21	-0.04	-0.18	-0.08	0.07
32	35	-0.22	-0.22	-0.06	-0.27	0.11	0.04	0.25	-0.03	-0.20	0.06	0.08	-0.08	0.07
33	33	-0.25	-0.43	-0.05	-0.29	0.11	0.04	0.25	0.15	-0.06	-0.04	0.09	-0.08	0.07
34	48	-0.32	-0.51	-0.01	-0.29	-0.29	0.04	0.25	-0.00	0.37	-0.16	0.09	0.23	0.07
35	56	-0.34	0.02	-0.00	-0.29	0.11	-0.19	0.24	0.06	-0.05	-0.04	0.05	-0.08	-0.25
36	57	-0.34	0.02	-0.00	-0.29	0.11	-0.19	0.24	0.06	-0.05	-0.04	0.05	-0.08	-0.25
37	6	-0.36	0.35	0.00	-0.04	0.11	0.04	0.05	-0.02	-0.07	-0.04	-0.29	-0.08	0.07
38	2	-0.36	-0.47	0.00	0.19	0.11	0.04	0.08	0.10	0.01	0.06	-0.25	-0.08	0.07
39	34	-0.43	-0.73	0.04	-0.27	0.11	0.04	0.24	0.01	-0.20	0.10	0.07	-0.08	0.07
40	3	-0.43	0.04	0.04	-0.29	0.11	0.04	-0.22	-0.04	-0.02	-0.04	-0.21	-0.08	0.07
41	5	-0.43	-0.02	0.04	-0.27	0.11	0.04	0.23	-0.02	0.10	-0.04	0.02	-0.08	0.07
42	46	-0.45	-0.97	0.06	-0.29	-0.29	0.04	0.25	0.55	0.03	0.06	0.09	0.23	0.07
43	66	-0.45	-0.09	0.06	-0.29	0.11	-0.19	0.23	-0.01	0.03	-0.04	0.04	-0.08	-0.25
44	41	-0.51	-0.08	0.09	0.40	-0.29	0.04	-0.08	0.02	-0.02	-0.04	-0.32	0.23	0.07
45	50	-0.53	-0.06	0.10	-0.20	0.79	-0.13	0.22	0.00	-0.11	-0.04	0.00	0.23	0.07
46	60	-0.60	0.20	0.15	-0.29	-0.26	0.47	-0.25	0.02	-0.17	-0.04	-0.17	-0.08	-0.25
47	61	-0.60	0.20	0.15	-0.29	-0.26	0.47	-0.25	0.02	-0.17	-0.04	-0.17	-0.08	-0.25
48	63	-0.60	0.08	0.15	-0.29	-0.26	0.47	0.06	0.04	-0.12	-0.04	-0.27	-0.08	-0.25
49	67	-0.60	0.20	0.15	-0.29	0.11	-0.19	-0.25	0.02	-0.17	-0.04	-0.17	-0.08	-0.25
50	65	-0.64	0.18	0.17	-0.29	0.11	-0.19	-0.25	0.02	-0.17	-0.04	-0.17	-0.08	-0.25
51	24	-0.75	0.09	0.26	0.72	-0.26	-0.13	-0.40	-0.06	-0.03	-0.04	0.18	-0.08	0.07
52	17	-0.77	0.29	0.28	-0.29	-0.26	-0.13	-0.40	-0.00	0.15	-0.04	0.18	-0.08	0.07
53	27	-0.77	0.24	0.28	-0.29	0.11	0.04	-0.40	-0.00	-0.17	-0.04	0.18	-0.08	0.07
54	37	-0.77	0.29	0.28	-0.29	0.11	0.04	-0.40	-0.00	-0.17	-0.04	0.18	-0.08	0.07
55	29	-0.82	0.34	0.32	-0.29	0.11	0.04	-0.40	0.28	0.02	-0.04	0.18	-0.08	0.07
56	31	-0.96	-0.99	0.46	-0.27	0.11	0.04	0.25	0.29	-0.21	0.06	0.09	-0.08	0.07
57	42	-1.00	-0.19	0.50	-0.29	-0.29	0.04	0.24	-0.04	-0.19	-0.01	0.06	0.23	0.07
58	28	-1.09	0.21	0.60	-0.29	0.11	0.04	-0.23	-0.05	0.40	-0.04	-0.19	-0.08	0.07
59	18	-1.11	0.28	0.63	-0.29	-0.26	-0.13	-0.23	-0.05	0.40	-0.04	-0.19	-0.08	0.07
60	49	-1.28	-1.96	0.87	1.48	-0.29	0.04	-0.40	-0.08	-0.13	-0.04	0.18	0.23	0.07
61	22	-1.34	-0.25	0.96	-0.29	-0.26	-0.13	0.04	-0.03	0.03	-0.04	-0.29	-0.08	0.07
62	47	-1.67	-0.85	1.62	-0.29	-0.29	0.04	0.25	0.05	-0.08	-0.22	0.08	0.23	0.07

FIGURE 57

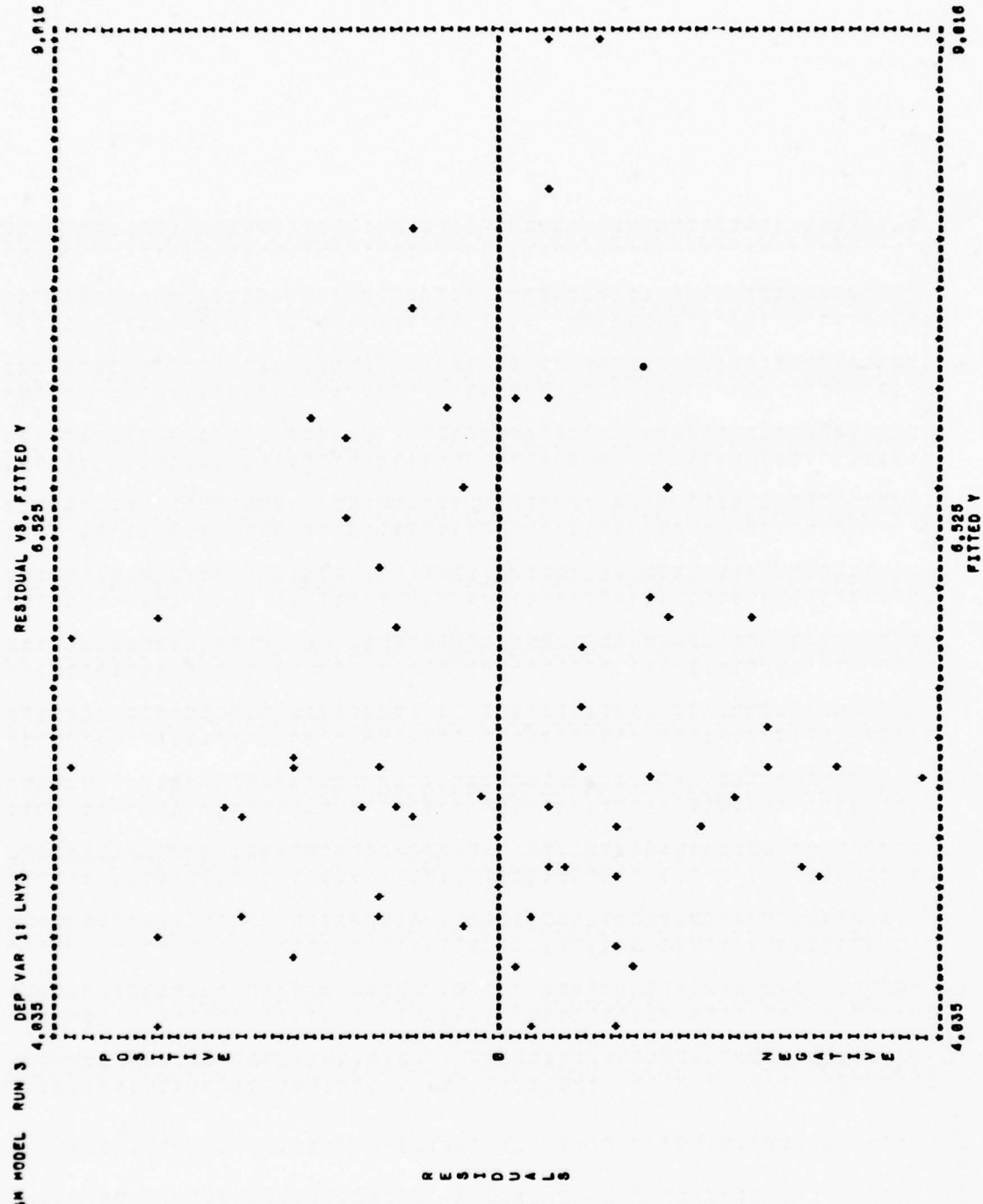

O&M MODEL RUN 3 DEP VAR 11 LNY3
RESIDUAL VS. FITTED Y
9.816
6.525
4.835
POSITIVE
0
NEGATIVE
RESIDUALS
6.525
FITTED Y

FIGURE 58

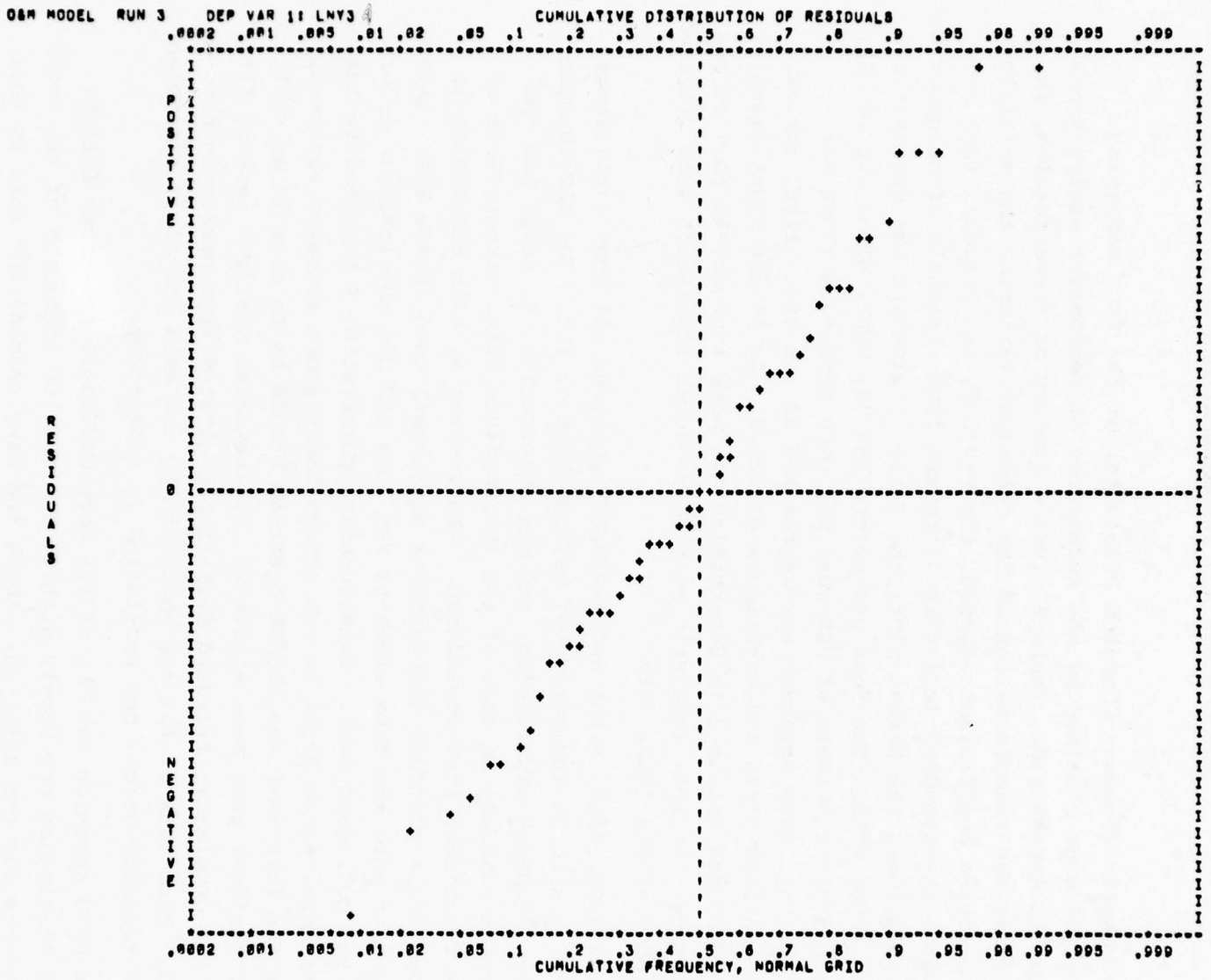

O&M MODEL RUN 3 DEP VAR IS LNY3
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

FIGURE 59

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

The results (Summary Computer Printouts) of the five remaining relationships obtained by the techniques of regression analysis are shown in Appendix B. Table 6 gives a summary of these results, indicating the transformation of the dependent variable, the multiple correlation coefficient squared, the F-VALUE, the residual root mean square, the standard deviation estimated from residuals of neighboring observations, the Normal plot, the Fitted Y plot and the observations with large WSSD. The four parameters MMH/OH, MTBF, MTBMA and LSC/OH, are the major drivers of O&M cost and were therefore given more attention. Each equation was approached as the statistics, tables, computerized plots and techniques directed. As in the MTBMA example, the WSSD was not used in determining the most appropriate form of the equation, but this statistic as well as other statistics were utilized in many of the other fits.

The MMH/OH, MTBF, MTBMA and TRAIN/OH equations all show significant results with no indication of serious lack of fit. The LSC/OH equation, although significant, had one observation, 4, which had the largest residual in each of the intermediate fits, irregardless of the functional form considered. Observation 4, with WUC 71H60, is a Gyroscope platform (navigations equipment) used in the F4E. Investigation into the data elements for this LRU did not indicate errors in the collected data. Consequently, observation 4 remained in the data base, since there is not enough known about avionics equipment and the form that the LSC/OH equation should be to deem it an outlier. The residual root mean square of .52 indicates a slight lack of fit as the cumulative standard deviation estimated from near neighbors is .57. This lack of fit may be caused by the data and other variables and transformations not considered in this study.

The NRTS equation was one of the more difficult equations fitted. The statistics are barely significant and the stability of the coefficients was not attained. Among the many reasons for this is that NRTS is highly dependent on many other factors not considered in

TABLE 6

Summary Results of the Regressions

	Transf. of Dep. Var.	R^2_y	F-VALUE	RRMS	Cum. Std. Deviation	Normal Plot	Fitted Values Plot	WSSD
MMH/OH	None	.9005	20.5	.03	.03	OK	OK	47, 22
MTBF	ln	.9089	33.5	.42	.47	OK	OK	22
MTBMA	ln	.9183	41.5	.39	.40	OK	OK	None
LSC/OH	ln	.9283	25.3	.52	.57	4 high	4 high	45
TRAIN/OH	ln	.8599	11.7	.75	.76	OK	OK	38, 45, 46, 48
NRTS	None	.8200	6.6	15.15	7.10	20 high	20 high	None

this study (most are subjective). Leaving out influential variables can make other collections of variables appear significant when in fact they are not. Although there is a serious lack of fit in the NRTS equation, 15.5 versus 7.1, the results are still useful, since only large differences in NRTS cause significant changes in the total number of spares estimated by the EBO routine.

Because of time constraints, one area not touched upon in this study is that of "prediction intervals." The prediction intervals depend on the standard error or variance of the fitted equation. The formula for computing this variance is rather complicated and is dependent on the residual mean square, the number of observations, the ith diagonal elements of the inverse matrix and the spread of the independent variables. Although the LLSCFP does not compute this variance, we recommend the simple bounds suggested by Daniel and Wood ([1], page 55).

Another area not discussed is that of error in the independent variables (Assumption A3). Some notable contributions on the subject of error in the independent variables has been made for the case of one independent variable (See Bibliography; Acton, Hocking and Leslie, Mandansky). It appears, however, that there are no results now in the statistical literature that lend to practical applications when multiple variables are considered.

As previous experience indicates, many of the logistics, cost and support parameters considered in this study are difficult parameters to estimate, especially Field MTBF, i.e., the value actually achieved. MTBF is usually the major cost and risk driver in resource, warranty and maintenance models. MTBF is estimated from MIL-STD-217B and other reliability documents based on the proposed, detailed system configuration. But the configuration and other parameters which define MTBF are not usually well defined in the early proposal phase. Previous predictions for Field MTBF in the conceptual phase were off by several orders of magnitude, which indicates the risk involved when using these predictions.

The estimating relationships obtained in this study were put through critical statistical examinations and covered a wide range of possible functional forms. Although the results, statistical and validation (Volume I), were quite encouraging, there are still areas for improvement that warrant further study to increase the prediction capability of the equations obtained.

The first and major recommendation is to expand the data base. Although the data base used indicated that relationships did exist, more data would lend to convergence of the "true" functional forms. By expanding the data base we mean more data, more independent variables, extending the ranges of the variables and expanding to newer technology areas. Other variables, not considered in this study, that may have an influential effect on the dependent variable, should be introduced into the regressions, so as to reduce bias and improve the prediction capability of the equations. Some of the variables may not have been experienced over a range adequate enough to display their influence. Extending the ranges of the variables and using newer equipment in the data base will enhance the capability of predicting advanced equipment costs.

The second recommendation is to refine the data base. This includes investigation into other Data Collection Systems to obtain more sound and up-to-date data. Moreover, it is recommended that a panel of qualified experts on the studied equipment be formed, to determine the validity of each data element.

The third recommendation is to consider more transformation of the variables. The transformations considered covered a wide range of possible forms, but there are many other transformations that may better approximate the more complicated cases. For instance, some of the independent variables were percentages which covered a wide range of values. The Inverse Sine transformation can be used to weigh more heavily the small percentages which have small variance. In addition cross products of the variables can also be considered as viable transformations. Again there must be more data available to give the analyst the flexibility needed to consider many different functional forms.

The fourth recommendation is to consider other subset collections of the final collection of variables obtained for each equation. The C_p-search technique, in addition to finding those collections of variables which have the smallest total squared error, finds other subsets of these variables and ranks them according to their C_p-values. Sometimes these subcollections have approximately the same C_p-statistic and variance of prediction as the final collection. This will greatly enhance the flexibility of the use of the equations and the ALPOS model, in that some of the values of the more difficult to obtain variables may not be needed to make satisfactory predictions.

The fifth recommendation is to investigate the possibilities of considering Non-linear Regression Analysis as a means of determining the correct functional form of the equations. Although the relationships considered in this study covered a wide range of possible functional forms, Non-linear Regression Analyses can be used to approximate even more complicated cases.

Although many Logisticians feel that predicting Logistics costs by the techniques of Regression Analysis is not a viable approach to take (usually because of inconsistencies in the data collection systems), the statistics and validation results, however, indicate the great possibilities ahead. We feel that this study has significantly contributed to the art of estimating advanced avionics equipment costs early in the conceptual phase. The stage has been set, the statistics defined, the approach outlined, the results displayed and the recommendations made. There is a light shining across the horizon. The challenge is to reach that light.

SECTION VIII

A TECHNICAL NOTE ON REGRESSION ANALYSIS

The name Regression Analysis is associated with the names Analysis of Variance and Analysis of Covariance. There is not a very acute distinction between these three types of analyses. According to Scheffé (see Bibliography), the distinction can be made that in the analysis of variance all independent variables are qualitative, in regression analysis all independent variables are quantitative, whereas in the Analysis of Covariance the independent variables are both qualitative and quantitative. According to this slight difference, we might say that the analyses presented in this report fall under the realm of analysis of covariance. Regression analysis, however, can be used to consider all three types of problems.

Analysis of variance is used to determine if significant differences exist between the means of different populations. For instance, we may want to know if there is a significant difference between the average MTBF of equipment used in fighters and that of equipment used in bomber or cargo type aircraft. If the statistics indicate that a significant difference exists, the problem is then to find which aircraft type is "more" significantly different from the "baseline." Analysis of variance depends on different methods of comparison to determine the "least" and/or "most" significant differences. Two notable procedures that have been developed are Tukey's method and Scheffé's Method for Multiple Comparisons (See Guenther). Some recent approaches have been the Least Significant Difference and Duncan's Multiple Range Test (See Adler and Roessler).

The problem of finding the "most" significant differences becomes more difficult to disentangle when more categories are used (such as the avionics area) and interactions are considered. However, if an analysis of variance problem is solved using the statistics and techniques presented on regression analysis, much more information can be obtained. The procedure is to consider indicator (independent) variables to represent the qualitative classes (with an assumed baseline) and make a fit on the dependent variable. If the statistics

are not significant (i.e., a bad fit), we can say that there is no significant differences in the means. If the statistics indicate a significant fit, then there are some classes or interactions with significantly different means. If interactions are not among the variables admitted by the C_p-search technique (usually admits those variables with largest t-values and relative influence), then the variable which causes the most significant drop in the C_p-values gives a good indication of the class which is "most" different. If interactions prove significant, another fit is to be made with different indicator variables representing the interactive classes (with an assumed interactive baseline), and use the statistics and C_p-search technique to determine which specific interactive classes are significantly different from which others. In addition, useful information can be extracted from other statistics, tables and computerized plots, such as the coefficients of the indicator variables, the "Component Effects" Table and the component-plus-residual plots.

There are also elementary statistical hypothesis type problems, such as testing the hypothesis that the mean of a certain sample is equal to a specified value against the alternative that it is not, that can be handled by the techniques of regression analysis, if the variables are properly defined (again more information can be obtained). Thus, we see the wide range of possible applications of Regression Analysis.

Many examples in standard statistics books as well as some advanced books on statistical hypothesis testing, analysis of variance and analysis of covariance, have been investigated. Using the approaches outlined, above, the results have been similar. The author is planning a paper in the near future showing the results of these investigations.

APPENDIX A

DATA USED

IN

REGRESSIONS

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA

	BOMBER UPRICE MMH/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOMSEN CDENS TRA/OH	ROMCOM DIGTAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT
1 71B20	0.	0.	0.	0.	0.	0.	0.							
	13721.	443.	17.70	410.	0.93	0.00	86.00	14.00	0.00	0.00	86.00	200.	2.30	0.00
	0.034	244.	163.	0.593	0.240	13.00								
2 73530	0.	0.	0.	0.	0.	0.	0.							
	41034.	998.	36.50	2176.	2.18	0.00	73.00	27.00	0.00	0.00	73.00	175.	2.30	4.00
	0.031	400.	274.	0.694	0.000	16.00								
3 71L80	0.	0.	0.	0.	0.	0.	0.							
	6681.	1444.	40.00	491.	0.34	0.00	75.00	0.00	0.00	25.00	27.00	212.	2.30	0.00
	0.051	271.	161.	0.840	0.336	27.00								
4 71M60	0.	0.	0.	0.	0.	0.	0.							
	36913.	1676.	30.50	78.	0.05	0.00	24.00	76.00	0.00	0.00	24.00	820.	2.30	0.00
	0.058	209.	128.	6.068	2.253	16.00								
5 71PK0	0.	0.	0.	0.	0.	0.	0.							
	8410.	1473.	40.00	589.	0.47	0.00	74.00	1.00	0.00	25.00	95.80	77.	2.30	0.00
	0.049	191.	133.	1.115	0.338	11.00								
6 71P80	0.	0.	0.	0.	0.	0.	0.							
	2241.	1276.	36.50	758.	0.59	0.00	86.00	14.00	0.00	0.00	88.00	289.	2.30	0.00
	0.026	672.	476.	0.407	0.136	5.00								
7 71710	0.	0.	0.	0.	0.	0.	0.							
	840.	91.	4.00	12.	0.13	0.00	100.00	0.00	0.00	0.00	100.00	20.	2.30	1.00
	0.003	4239.	2521.	0.055	0.020	9.00								
8 724G0	0.	0.	0.	0.	0.	0.	0.							
	2055.	133.	1.25	84.	0.63	0.00	97.00	3.00	0.00	0.00	97.00	87.	2.30	0.00
	0.002	4653.	3540.	0.039	0.015	4.00								
9 71G50	0.	0.	0.	0.	0.	0.	0.							
	23327.	584.	14.00	421.	0.72	0.00	89.00	11.00	0.00	0.00	34.00	172.	2.30	13.00
	0.032	228.	94.	0.517	0.114	0.00								
10 71FA0	0.	0.	0.	0.	0.	0.	0.							
	10080.	142.	13.90	412.	2.90	49.00	49.00	2.00	0.00	0.00	98.00	384.	2.30	19.00
	0.034	803.	529.	0.473	0.021	24.00								
11 71FB0	0.	0.	0.	0.	0.	0.	0.							
	18600.	424.	13.90	61.	0.14	0.00	33.00	67.00	0.00	0.00	33.00	175.	2.30	17.00
	0.019	945.	736.	0.000	0.213	94.00								
12 71CA0	0.	0.	0.	0.	0.	0.	0.							
	8632.	200.	6.50	150.	0.75	0.00	100.00	0.00	0.00	0.00	100.00	20.	2.30	13.00
	0.005	0.	0.	0.078	0.004	100.00								
13 71DA0	0.	0.	0.	0.	0.	0.	0.							
	57100.	866.	29.80	32.	0.04	0.00	75.00	0.00	0.00	25.00	93.00	70.	2.30	18.00
	0.064	382.	214.	1.817	0.164	11.00								
15 7148E	1.	0.	0.	0.	0.	0.	0.							
	1100.	280.	7.50	214.	0.76	0.00	93.00	7.00	0.00	0.00	93.00	7.	1.30	4.00
	0.011	1288.	1000.	0.168	0.056	0.00								

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER UPRICE MMM/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOMSEN CDENS TRA/OH	BOMCOM DIGTAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT
17 71ADA	1.	0.	0.	0.	0.	0.	0.							
	2744.	1732.	60.00	924.	0.53	0.00	100.00	0.00	0.00	0.00	0.00	17.	1.30	0.00
	0.211	116.	98.	3.501	0.696	4.00								
18 73D8A	1.	0.	0.	0.	0.	0.	0.							
	5928.	6478.	90.00	321.	0.05	0.00	75.00	0.00	0.00	25.00	25.00	1640.	1.30	0.00
	0.176	147.	121.	3.008	0.870	8.00								
19 71ACC	1.	0.	0.	0.	0.	0.	0.							
	153.	86.	2.60	78.	0.91	0.00	100.00	0.00	0.00	0.00	0.00	17.	1.30	0.00
	0.015	0.	0.	0.228	0.041	3.00								
20 73C8Q	1.	0.	0.	0.	0.	0.	0.							
	158.	30.	1.20	36.	1.27	0.00	100.00	0.00	0.00	0.00	0.00	34.	1.30	4.00
	0.004	3704.	3704.	0.095	0.008	100.00								
21 73CEN	1.	0.	0.	0.	0.	0.	0.							
	2762.	256.	10.50	20.	0.07	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00
	0.005	3213.	1781.	0.364	0.097	100.00								
22 73CFK	1.	0.	0.	0.	0.	0.	0.							
	18720.	8200.	118.00	561.	0.06	0.00	75.00	0.00	0.00	25.00	66.50	152.	1.30	0.00
	0.456	60.	45.	8.891	2.015	3.00								
24 73DAH	1.	0.	0.	0.	0.	0.	0.							
	5720.	3050.	58.00	156.	0.05	0.00	43.00	57.00	0.00	0.00	0.00	225.	1.30	0.00
	0.077	361.	233.	1.307	0.443	18.00								
25 73EBA	1.	0.	0.	0.	0.	0.	0.							
	1347.	132.	3.40	120.	0.91	0.00	100.00	0.00	0.00	0.00	86.00	34.	1.30	0.00
	0.009	1102.	649.	0.150	0.037	8.00								
26 73E8F	1.	0.	0.	0.	0.	0.	0.							
	2590.	464.	11.50	177.	0.38	0.00	100.00	0.00	0.00	0.00	37.00	130.	1.30	0.00
	0.070	150.	113.	1.333	0.393	24.00								
27 71CA0	0.	1.	0.	0.	0.	0.	0.							
	3255.	1734.	60.00	924.	0.53	0.00	75.00	0.00	0.00	25.00	0.00	500.	1.20	0.00
	0.224	84.	70.	3.556	1.067	4.00								
28 72EAA	0.	1.	0.	0.	0.	0.	0.							
	3700.	6478.	87.50	321.	0.05	0.00	75.00	0.00	0.00	25.00	25.00	1640.	1.20	0.00
	0.168	166.	133.	3.113	0.937	16.00								
29 72ECA	0.	1.	0.	0.	0.	0.	0.							
	2951.	4243.	63.38	4363.	1.03	0.00	100.00	0.00	0.00	0.00	0.00	160.	1.20	0.00
	0.031	583.	330.	0.488	0.151	6.00								
31 728P0	0.	1.	0.	0.	0.	0.	0.							
	253380.	2475.	75.00	4505.	1.82	30.00	69.00	1.00	0.00	0.00	99.60	707.	1.20	4.00
	0.206	144.	72.	26.631	6.029	34.00								
32 71JA0	0.	1.	0.	0.	0.	0.	0.							
	6247.	479.	12.80	1013.	2.11	0.00	99.00	1.00	0.00	0.00	99.00	175.	1.20	0.00
	0.090	314.	289.	0.900	0.357	2.00								

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER UPRICE MMH/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOMSEN CDENS TRA/OH	BOMCOM DIGTAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT
33 71L42	0.	1.	0.	0.	0.	0.	0.							
	34862.	1260.	32.00	2743.	2.18	55.00	33.00	0.00	0.00	12.00	99.60	265.	1.20	0.00
	0.105	186.	161.	3.123	0.776	17.00								
34 72CN0	0.	1.	0.	0.	0.	0.	0.							
	100450.	1511.	39.86	1044.	0.69	87.00	12.00	1.00	0.00	0.00	98.70	850.	1.20	6.00
	0.067	373.	127.	3.928	0.172	8.00								
35 72AC0	0.	1.	0.	0.	0.	0.	0.							
	16793.	432.	31.00	592.	1.37	0.00	99.00	1.00	0.00	0.00	99.00	851.	1.20	4.00
	0.037	557.	284.	0.817	0.115	30.00								
36 71716	0.	1.	0.	0.	0.	0.	0.							
	1268.	294.	7.50	214.	0.73	0.00	100.00	0.00	0.00	0.00	100.00	20.	1.20	4.00
	0.011	1723.	1387.	0.150	0.003	4.00								
37 71310	0.	1.	0.	0.	0.	0.	0.							
	2745.	1734.	60.00	924.	0.53	0.00	75.00	0.00	0.00	25.00	0.00	500.	1.20	0.00
	0.171	122.	104.	2.665	0.526	5.00								
38 72RF0	0.	1.	0.	0.	0.	0.	0.							
	1622.	399.	14.00	328.	0.82	0.00	0.00	0.00	100.00	0.00	30.00	860.	1.20	0.00
	0.026	395.	272.	0.377	0.057	4.00								
39 72R80	0.	1.	0.	0.	0.	0.	0.							
	2185.	368.	9.00	88.	0.24	0.00	33.00	67.00	0.00	0.00	0.00	860.	1.20	0.00
	0.005	2573.	1486.	0.076	0.016	9.00								
40 75930	0.	0.	1.	0.	0.	0.	0.							
	3015.	94.	4.00	108.	1.15	0.00	100.00	0.00	0.00	0.00	100.00	7.	2.30	0.00
	0.008	5853.	1329.	0.094	0.024	0.00								
41 748D0	0.	0.	1.	0.	0.	0.	0.							
	10120.	1609.	43.70	1126.	0.70	0.00	61.00	39.00	0.00	0.00	61.00	212.	2.30	0.00
	0.064	193.	127.	1.223	0.452	5.00								
42 74BF0	0.	0.	1.	0.	0.	0.	0.							
	15258.	1377.	78.50	399.	0.29	0.00	0.00	0.00	0.00	100.00	98.00	900.	2.30	1.00
	0.050	168.	117.	0.765	0.307	25.00								
43 74810	0.	0.	1.	0.	0.	0.	0.							
	5267.	577.	11.00	35.	0.06	0.00	0.00	100.00	0.00	0.00	0.00	430.	2.30	5.00
	0.004	2139.	1265.	0.211	0.068	93.00								
44 75A10	0.	0.	1.	0.	0.	0.	0.							
	2552.	564.	15.00	911.	1.63	0.00	100.00	0.00	0.00	0.00	100.00	335.	2.30	6.00
	0.012	1513.	382.	0.102	0.125	0.00								
45 75GA0	0.	0.	1.	0.	0.	0.	0.							
	19274.	551.	25.00	1319.	2.39	100.00	0.00	0.00	0.00	0.00	100.00	1300.	0.30	0.00
	0.248	398.	161.	2.260	0.629	46.00								
46 74FF0	0.	0.	1.	0.	0.	0.	0.							
	238700.	2278.	41.00	7638.	3.35	100.00	0.00	0.00	0.00	0.00	100.00	1300.	2.30	51.00
	0.050	235.	152.	0.722	0.034	50.00								

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER UPRICE MMH/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOMSEN CDENS TRA/OH	BOMCOM DIGTAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT
47 74FA0	0.	0.	1.	0.	0.	0.	0.							
	156200.	5330.	173.70	1558.	0.29	0.00	0.00	0.00	0.00	100.00	99.00	270.	2.30	61.00
	0.237	177.	108.	3.825	0.156	15.00								
48 74FH0	0.	0.	1.	0.	0.	0.	0.							
	46759.	1866.	35.00	932.	0.50	0.00	0.00	0.00	100.00	0.00	100.00	1620.	2.30	59.00
	0.083	347.	196.	1.202	0.077	18.00								
49 74FU0	0.	0.	1.	0.	0.	0.	0.							
	324000.	3656.	110.00	18.	0.00	0.00	0.00	100.00	0.00	0.00	0.00	400.	2.30	0.00
	0.174	262.	196.	0.413	0.173	10.00								
50 77EC0	1.	0.	1.	0.	1.	0.	0.							
	9701.	1760.	45.00	946.	0.54	11.00	84.00	5.00	0.00	0.00	94.70	350.	1.30	0.00
	0.046	445.	345.	1.305	0.228	9.00								
51 77EE0	1.	0.	1.	0.	1.	0.	0.							
	835.	222.	8.50	9.	0.04	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00
	0.000	7884.	7530.	0.006	0.006	0.00								
52 77DCA	1.	0.	1.	0.	1.	0.	0.							
	31698.	1223.	26.40	1457.	1.19	0.00	100.00	0.00	0.00	0.00	100.00	145.	1.30	0.00
	0.224	959.	837.	0.484	0.189	17.00								
53 77D80	1.	0.	1.	0.	1.	0.	0.							
	835.	222.	8.50	9.	0.04	0.00	0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00
	0.001	8066.	6878.	0.014	0.004	75.00								
54 73CR0	0.	0.	1.	0.	0.	0.	0.							
	24642.	307.	8.00	529.	1.72	0.00	98.00	12.00	0.00	0.00	98.60	300.	0.83	0.00
	0.203	906.	905.	0.063	0.017	10.00								
55 73CG0	0.	0.	1.	0.	0.	0.	0.							
	43912.	900.	12.00	53.	0.06	0.00	0.00	100.00	0.00	0.00	0.00	60.	0.83	0.00
	0.017	914.	914.	0.157	0.172	67.00								
56 71NA0	0.	0.	0.	1.	0.	0.	0.							
	7191.	1367.	36.00	1674.	1.22	0.00	75.00	0.00	0.00	25.00	97.60	256.	2.30	0.00
	0.143	122.	78.	2.366	0.953	4.80								
57 71GU0	0.	0.	0.	1.	0.	0.	0.							
	7191.	1367.	36.00	1674.	1.22	0.00	75.00	0.00	0.00	25.00	97.60	256.	2.30	0.00
	0.093	295.	128.	1.552	0.522	5.20								
58 63AA0	0.	0.	0.	1.	0.	0.	0.							
	9865.	1120.	29.00	790.	0.71	0.00	75.00	0.00	0.00	25.00	97.00	150.	2.30	0.00
	0.109	182.	124.	1.794	0.110	6.70								
59 65AA0	0.	0.	0.	1.	0.	0.	0.							
	14271.	377.	14.00	982.	2.60	0.00	75.00	0.00	0.00	25.00	100.00	64.	2.30	0.00
	0.052	492.	320.	1.985	0.060	17.20								
60 63BAA	1.	0.	0.	1.	0.	1.	0.							
	3845.	1680.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	500.	1.30	0.00
	0.252	78.	61.	3.423	0.803	2.00								

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER UPRICE MMH/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOMSEN CDENS TRA/OH	BOMCOM DIGTAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POWDIS	UFACT	BITFIT
61 63CAA	1.	0.	0.	1.	0.	1.	0.							
	3846.	1680.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	500.	1.30	0.00
	0.168	96.	78.	2.766	0.688	2.00								
62 65BAA	1.	0.	0.	1.	0.	1.	0.							
	3914.	1844.	29.00	1236.	0.67	0.00	76.00	1.00	8.00	15.00	97.50	90.	1.30	5.00
	0.052	305.	250.	0.788	0.206	5.70								
63 61BBA	1.	0.	0.	1.	0.	1.	0.							
	5864.	1969.	49.00	1378.	0.74	0.00	100.00	0.00	0.00	0.00	70.00	380.	1.30	0.00
	0.074	203.	173.	1.203	0.295	5.40								
64 65BAA	0.	1.	0.	1.	0.	0.	1.							
	3914.	1844.	29.00	1235.	0.67	0.00	76.00	1.00	8.00	15.00	97.50	90.	1.20	5.00
	0.054	254.	190.	0.825	0.255	3.00								
65 63AF0	0.	1.	0.	1.	0.	0.	1.							
	4083.	1680.	51.00	1186.	0.71	0.00	75.00	0.00	0.00	25.00	23.00	502.	1.20	0.00
	0.000	74.	55.	6.142	0.000	2.60								
66 63AA0	0.	1.	0.	1.	0.	0.	1.							
	10712.	1120.	41.00	790.	0.71	0.00	75.00	0.00	0.00	25.00	97.00	150.	1.20	0.00
	0.089	180.	139.	1.308	0.258	1.80								
67 63121	0.	1.	0.	1.	0.	0.	1.							
	3846.	1680.	49.00	1153.	0.69	0.00	75.00	0.00	0.00	25.00	23.00	500.	1.20	0.00
	0.120	126.	110.	1.603	0.439	8.10								
68 63AAA	0.	1.	0.	1.	0.	0.	1.							
	4208.	242.	9.00	1615.	6.67	44.00	37.00	0.00	0.00	19.00	100.00	35.	1.20	0.00
	0.030	360.	342.	0.357	0.100	0.00								

APPENDIX B

RESULTS OF

THE

REGRESSION ANALYSES

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR IS Y1 MIN Y = 8.336D-04 MAX Y = 4.563D-01 RANGE Y = 4.554D-01

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

Y1 = B(0) + B(1)X5 + B(2)X6 + B(3)X7 + B(4)X13 + B(5)X18 + B(6)X9M
+ B(7)X13M + B(8)X14M + B(9)X15M + B(10)X16M + B(11)X21M
+ B(12)X9DSQ + B(13)X18DSQ + B(14)X14DSQ + B(15)X15DSQ
+ B(16)X16DSQ + B(17)X21DSQ + B(18)LNX8 + B(19)LNX18

Y1 = MMH/OH (MAINTENANCE MANHOURS PER OPERATING HOUR)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		-1.951150-01							
1	X5	-4.512210-02	2.320-02	1.9	0.2678	-2.134D-01	5.326D-01	7.460D-01	0.07
2	X6	-7.747450-02	2.690-02	2.9	0.4116	-2.317D-01	5.783D-01	8.100D-01	0.14
3	X7	-6.499260-02	2.530-02	2.6	0.3296	-2.057D-01	6.043D-01	8.100D-01	0.12
4	X13	1.622920-03	3.51D-04	4.6	0.7724	0.0	1.000D 02	1.000D 02	0.36
5	X18	-3.346350-04	1.40D-04	2.4	0.5777	0.0	1.000D 02	1.000D 02	0.07
6	X9M	-6.613690-05	1.220-05	5.4	0.9634	-1.408D 03	6.762D 03	8.170D 03	1.19
7	X13M	4.628710-03	6.61D-04	7.0	0.9672	-3.380D 01	1.387D 02	1.725D 02	1.75
8	X14M	1.872880-03	3.49D-04	5.4	0.9117	-6.278D 01	3.738D 01	1.000D 02	0.41
9	X15M	1.209820-03	3.44D-04	3.5	0.8817	-1.698D 01	8.448D 01	1.000D 02	0.26
10	X16M	1.543680-03	4.07D-04	3.8	0.7162	-3.432D 00	9.657D 01	1.000D 02	0.34
11	X21M	1.249280-03	5.39D-04	2.3	0.6835	-4.830D 00	5.617D 01	6.100D 01	0.17
12	X9DSQ	1.781180-08	2.45D-09	7.0	0.8466	6.101D 04	2.394D 07	2.388D 07	0.89
13	X18DSQ	-1.292830-05	5.21D-06	2.5	0.8382	1.049D 00	1.195D 04	1.195D 04	0.34
14	X14DSQ	-3.335810-05	8.14D-06	5.4	0.5764	4.000D-02	2.581D 03	2.581D 03	0.19
15	X15DSQ	3.568020-05	7.93D-06	4.5	0.4176	5.476D 01	2.873D 03	2.818D 03	0.22
16	X16DSQ	-8.386870-05	3.91D-05	2.1	0.4329	1.750D 03	2.517D 03	7.673D 02	0.14
17	X21DSQ	5.781680-05	2.76D-05	2.1	0.4833	6.288D 01	1.161D 03	1.098D 03	0.14
18	LNX9	7.478670-02	1.83D-02	4.1	0.9669	3.481D 00	9.812D 00	6.611D 00	0.92
19	LNX18	-4.981970-02	1.97D-02	2.5	0.9672	1.023D-01	5.157D 00	4.975D 00	0.54

NO. OF OBSERVATIONS	63
NO. OF IND. VARIABLES	19
RESIDUAL DEGREES OF FREEDOM	43
F-VALUE	20.5
RESIDUAL ROOT MEAN SQUARE	0.03215483
RESIDUAL MEAN SQUARE	0.00099927
RESIDUAL SUM OF SQUARES	0.03999842
TOTAL SUM OF SQUARES	0.39298338
MULT. CORREL. COEF. SQUARED	.9085

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-3
7	-2
8	-2
9	-2
10	-2
11	-2
12	-7
13	-4
14	-4
15	-4
16	-3
17	-3
18	1
19	1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR IS Y1

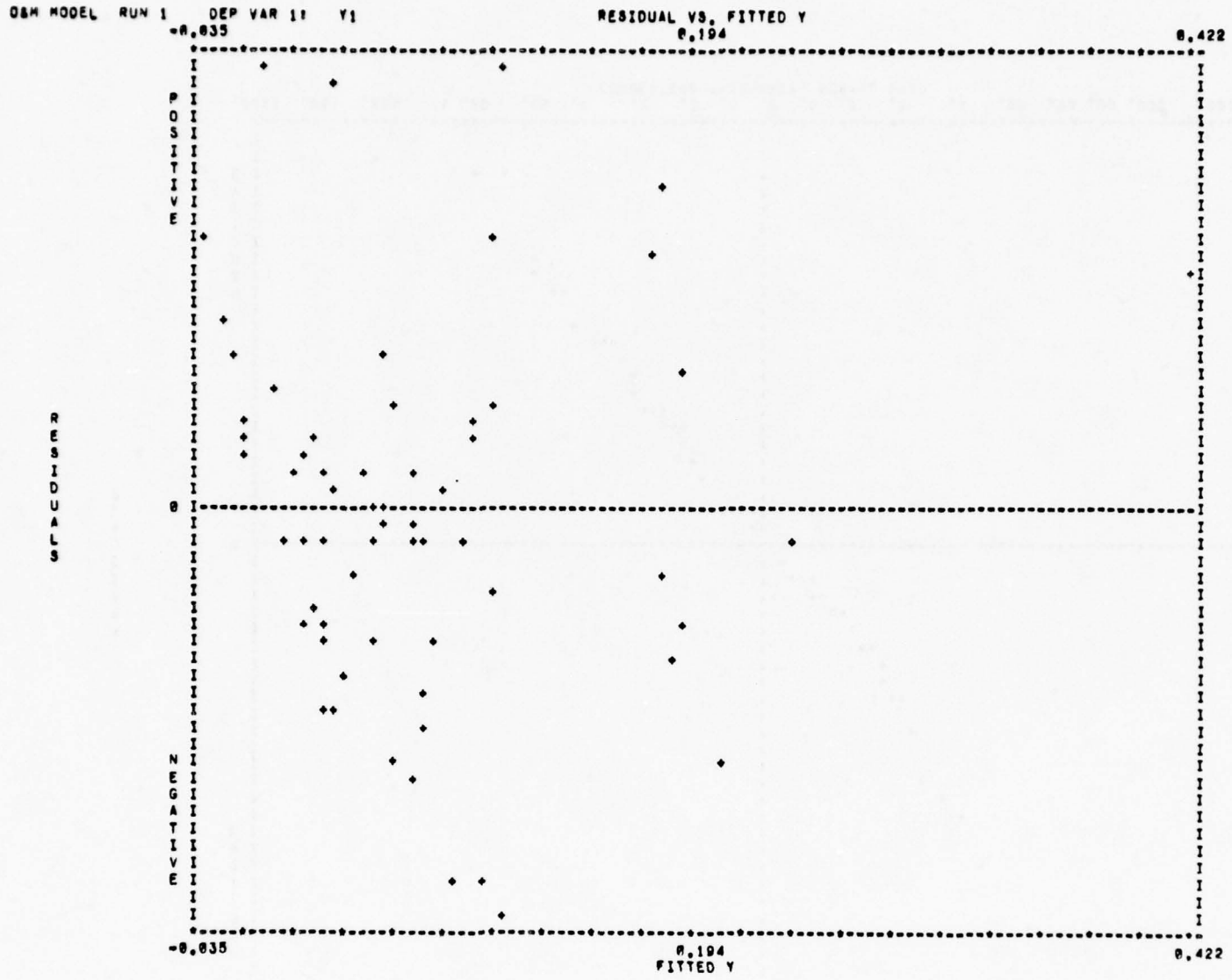
ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71882A	1	19.	0.034	0.031	0.003	61	0.168	0.107	0.061	1
73530	2	8.	0.031	0.067	-0.036	4	0.058	-0.003	0.060	2
71L93	3	9.	0.051	0.100	-0.049	32	0.090	0.033	0.057	3
71M53	4	23.	0.058	-0.003	0.060	27	0.224	0.179	0.044	4
71P40	5	9.	0.049	0.073	-0.024	7	0.003	-0.035	0.038	5
71P59	6	7.	0.026	0.061	-0.034	56	0.143	0.105	0.038	6
71710	7	82.	0.003	-0.035	0.038	17	0.211	0.176	0.035	7
724GA	8	89.	0.002	0.028	-0.026	22	0.456	0.422	0.034	8
71G58	9	20.	0.032	0.023	0.009	40	0.008	-0.018	0.026	9
71FAP	10	53.	0.034	0.042	-0.008	24	0.077	0.056	0.021	10
71F98	11	35.	0.019	0.002	0.017	12	0.005	-0.016	0.021	11
71CA2	12	55.	0.005	-0.016	0.021	31	0.206	0.188	0.018	12
71DA0	13	6.	0.055	0.055	-0.001	11	0.019	0.002	0.017	13
71A9E	15	42.	0.011	0.027	-0.016	53	0.075	0.060	0.015	14
71ADA	17	34.	0.211	0.176	0.035	07	0.120	0.106	0.014	15
73D8A	18	233.	0.176	0.209	-0.033	20	0.004	-0.009	0.013	16
71ACC	19	91.	0.015	0.036	-0.021	58	0.109	0.097	0.012	17
73C8Q	20	142.	0.004	-0.009	0.013	33	0.105	0.095	0.010	18
73CEN	21	63.	0.005	0.031	-0.026	53	0.091	-0.007	0.009	19
73CFK	22	527.	0.456	0.422	0.034	9	0.032	0.023	0.009	20
73DAM	24	64.	0.077	0.056	0.021	01	0.001	-0.007	0.008	21
73E8A	25	75.	0.009	0.023	-0.014	52	0.024	0.017	0.007	22
73E9F	26	30.	0.070	0.066	0.004	42	0.050	0.044	0.006	23
71CAR	27	29.	0.224	0.179	0.044	08	0.030	0.025	0.005	24
72EAA	28	227.	0.168	0.186	-0.019	55	0.017	0.012	0.005	25
72ECA	29	94.	0.031	0.049	-0.018	20	0.070	0.066	0.004	26
728PR	31	69.	0.206	0.188	0.018	46	0.083	0.080	0.003	27
71JAR	32	27.	0.090	0.033	0.057	1	0.034	0.031	0.003	28
71LA8	33	16.	0.105	0.095	0.010	64	0.054	0.053	0.002	29
72D48	34	36.	0.067	0.071	-0.004	46	0.050	0.049	0.001	30
72AC3	35	17.	0.037	0.087	-0.050	13	0.065	0.265	-0.001	31
71716	36	44.	0.211	0.016	-0.005	62	0.052	0.054	-0.002	32
71310	37	29.	0.171	0.179	-0.008	41	0.065	0.067	-0.003	33
72RF3	38	63.	0.026	0.029	-0.003	38	0.026	0.029	-0.003	34
72R6R	39	43.	0.005	0.031	-0.026	60	0.089	0.092	-0.003	35
75930	40	82.	0.008	-0.018	0.026	45	0.048	0.051	-0.003	36
748DR	41	18.	0.065	0.067	-0.003	34	0.067	0.071	-0.004	37
748FR	42	78.	0.050	0.044	0.006	54	0.093	0.097	-0.004	38
74810	43	49.	0.004	0.019	-0.014	47	0.237	0.242	-0.005	39
76A10	44	23.	0.012	0.029	-0.017	36	0.011	0.016	-0.005	40
76GAR	45	49.	0.048	0.051	-0.003	10	0.034	0.042	-0.008	41
74FF8	46	66.	0.050	0.049	0.001	37	0.171	0.179	-0.008	42
74FA8	47	883.	0.237	0.242	-0.005	57	0.094	0.105	-0.012	43
74FMR	48	58.	0.083	0.080	0.003	25	0.009	0.023	-0.014	44
74FUR	49	218.	0.174	0.198	-0.016	43	0.004	0.019	-0.014	45
77EC8	50	16.	0.046	0.074	-0.028	15	0.011	0.027	-0.016	46
77EE0	51	78.	0.001	-0.007	0.008	49	0.174	0.198	-0.016	47
77DCA	52	13.	0.024	0.017	0.007	59	0.062	0.079	-0.017	48
77D80	53	78.	0.001	-0.007	0.009	44	0.012	0.029	-0.017	49
73CR8	54	42.	0.003	0.007	-0.004	29	0.031	0.049	-0.018	50
73CG8	55	44.	0.017	0.012	0.005	28	0.168	0.186	-0.019	51
71NA8	56	7.	0.143	0.106	0.038	19	0.015	0.036	-0.021	52
710UR	57	7.	0.094	0.105	-0.012	5	0.049	0.073	-0.024	53
634AP	58	6.	0.109	0.097	0.012	8	0.002	0.028	-0.026	54
65AAP	59	25.	0.262	0.279	-0.017	21	0.005	0.031	-0.026	55
638AA	60	19.	0.052	0.107	-0.055	39	0.005	0.031	-0.026	56
63CAA	61	19.	0.168	0.107	0.061	58	0.046	0.074	-0.028	57
658AA	62	20.	0.052	0.054	-0.002	18	0.176	0.209	-0.033	58
6188A	63	27.	0.075	0.060	0.015	6	0.026	0.061	-0.034	59
658AA	64	19.	0.054	0.053	0.002	2	0.031	0.067	-0.036	60
63AAR	66	8.	0.089	0.092	-0.003	3	0.051	0.100	-0.049	61
63121	67	19.	0.120	0.106	0.014	35	0.037	0.087	-0.050	62
63AAA	68	49.	0.030	0.025	0.005	60	0.052	0.107	-0.055	63

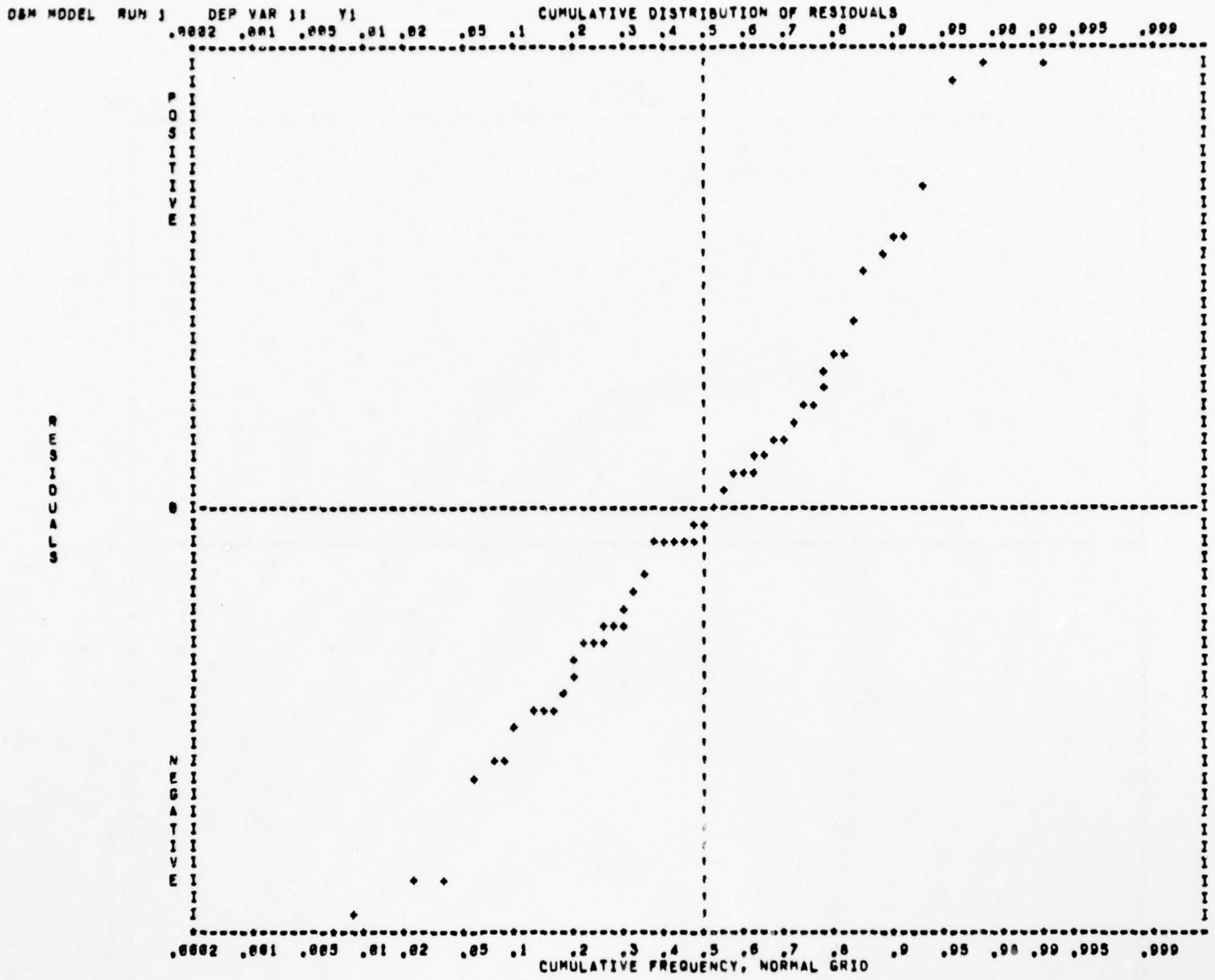
LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 1 DEP VAR 1: Y1 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.03

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	ORDERED BY MSSD: MSSD	OBSV.	OBSV.	DEL RESIDUALS	MSSD	DEL RESIDUALS	ORDERED BY FITTED Y: FITTED Y	OBSV.	SEQ.
1	0.06	0.0	37	27	0.05	0.20	0.01	-0.03	7	1
2	0.09	0.0	51	60	0.12	6.02	0.01	-0.02	40	2
3	0.05	0.0	57	56	0.05	33.34	0.01	-0.02	12	3
4	0.06	0.0	53	51	0.00	93.53	0.00	-0.01	29	4
5	0.05	0.20	7	40	0.01	0.0	0.00	-0.01	53	5
6	0.04	0.70	28	18	0.01	80.38	0.05	-0.01	51	6
7	0.05	1.18	44	32	0.07	42.61	0.04	-0.00	4	7
8	0.05	1.94	3	56	0.09	32.62	0.02	0.00	11	8
9	0.05	1.94	3	57	0.04	67.43	0.01	0.01	54	9
10	0.05	2.17	54	36	0.00	79.94	0.01	0.01	55	10
11	0.05	2.19	58	56	0.03	38.17	0.01	0.02	36	11
12	0.04	2.19	58	57	0.02	74.74	0.02	0.02	52	12
13	0.04	2.98	55	43	0.02	78.37	0.00	0.02	43	13
14	0.04	3.51	25	8	0.01	30.27	0.02	0.02	25	14
15	0.04	3.69	5	58	0.00	31.47	0.00	0.02	9	15
16	0.04	3.70	6	2	0.00	24.23	0.02	0.03	68	16
17	0.04	4.05	66	3	0.05	14.53	0.01	0.03	15	17
18	0.03	4.56	66	57	0.01	92.09	0.02	0.03	0	18
19	0.04	4.64	3	67	0.06	67.24	0.01	0.03	38	19
20	0.04	4.93	3	61	0.11	5.98	0.02	0.03	44	20
21	0.04	5.04	61	27	0.02	21.84	0.03	0.03	1	21
22	0.04	5.04	60	27	0.10	21.71	0.00	0.03	39	22
23	0.04	5.04	61	37	0.07	59.45	0.06	0.03	21	23
24	0.04	5.04	60	37	0.05	32.10	0.08	0.03	32	24
25	0.04	5.04	1	32	0.05	41.56	0.01	0.04	19	25
26	0.04	5.92	7	12	0.02	164.75	0.01	0.04	10	26
27	0.04	5.98	44	1	0.02	95.53	0.02	0.04	42	27
28	0.04	6.02	40	12	0.01	107.01	0.02	0.05	29	28
29	0.04	6.11	58	3	0.06	51.77	0.00	0.05	46	29
30	0.04	6.18	67	37	0.02	86.48	0.01	0.05	45	30
31	0.04	6.85	66	58	0.02	7.51	0.00	0.05	64	31
32	0.04	7.29	36	25	0.01	55.94	0.02	0.05	62	32
33	0.04	7.45	17	27	0.01	47.28	0.01	0.06	24	33
34	0.04	7.45	17	37	0.24	14.77	0.05	0.06	63	34
35	0.04	7.49	25	15	0.00	9.23	0.03	0.06	6	35
36	0.04	7.51	67	60	0.07	25.20	0.00	0.07	13	36
37	0.04	7.51	67	61	0.05	48.71	0.04	0.07	26	37
38	0.04	7.51	64	62	0.00	7.93	0.03	0.07	2	38
39	0.04	7.93	2	41	0.03	42.38	0.00	0.07	41	39
40	0.04	7.96	15	1	0.02	38.02	0.02	0.07	34	40
41	0.04	8.29	13	2	0.04	3.68	0.00	0.07	5	41
42	0.04	8.51	15	44	0.00	65.48	0.01	0.07	50	42
43	0.04	8.59	9	15	0.02	112.08	0.02	0.08	59	43
44	0.04	8.75	50	66	0.02	105.16	0.05	0.08	48	44
45	0.04	8.84	2	5	0.01	23.90	0.05	0.09	35	45
46	0.04	9.16	57	67	0.03	21.29	0.01	0.09	66	46
47	0.04	9.16	56	67	0.02	16.86	0.00	0.09	33	47
48	0.04	9.23	6	13	0.03	6.11	0.06	0.10	58	48
49	0.04	9.47	6	41	0.03	1.94	0.04	0.10	3	49
50	0.04	9.75	41	5	0.02	0.0	0.05	0.11	57	50
51	0.04	10.59	36	9	0.01	9.16	0.02	0.11	56	51
52	0.04	10.59	57	60	0.04	7.51	0.05	0.11	67	52
53	0.04	10.59	56	60	0.09	0.0	0.12	0.11	61	53
54	0.04	10.59	57	61	0.07	13.63	0.09	0.11	60	54
55	0.04	10.59	56	61	0.02	7.45	0.04	0.18	17	55
56	0.04	11.39	41	58	0.03	0.0	0.05	0.18	37	56
57	0.04	11.60	67	17	0.02	155.57	0.06	0.18	27	57
58	0.04	13.51	7	20	0.03	116.17	0.04	0.19	28	58
59	0.04	13.63	61	17	0.03	81.93	0.03	0.19	31	59
60	0.04	13.63	60	17	0.09	123.98	0.02	0.19	49	60
61	0.04	13.91	40	20	0.01	241.03	0.03	0.21	18	61
62	0.04	14.12	37	31	0.03	287.78	0.04	0.24	47	62
63	0.04	14.12	27	31	0.03	5.92	0.02	0.42	22	63


O&M MODEL RUN 1 DEP VAR 1: Y1
RESIDUAL VS. FITTED Y
-0.035
0.194
0.422
POSITIVE
RESIDUALS
0
NEGATIVE
-0.035
0.194
FITTED Y
0.422


O&M MODEL RUN 1 DEP VAR 11 Y1
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 2 DEP VAR IS LNY2 MIN Y = 4.091D 00 MAX Y = 8.995D 00 RANGE Y = 4.904D 00

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

LNY2 = B(0) + B(1)X3M + B(2)X4M + B(3)X5 + B(4)X6 + B(5)X15 + B(6)X9M
+ B(7)X18M + B(8)X9DSQ + B(9)X13DSQ + B(10)X18DSQ + B(11)X21DSQ
+ B(12)LNX8 + B(13)LNX9 + B(14)LNX10

LNY2 = LN(MTBF) MTBF (MEAN TIME BETWEEN FAILURE)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		1.36551D 01							
1	X3M	3.462810-01	1.66D-01	2.1	0.4524	-2.588D-01	7.420D-01	1.000D 00	0.07
2	X4M	-4.582430-01	1.59D-01	2.9	0.3118	-2.198D-01	7.930D-01	1.000D 00	0.09
3	X5	1.153740 00	3.24D-01	3.6	0.2530	-2.933D-01	5.387D-01	7.420D-01	0.17
4	X6	6.347630-01	3.27D-01	1.9	0.2250	-2.165D-01	5.735D-01	7.900D-01	0.18
5	X15	1.72434D-02	2.85D-03	6.1	0.6588	0.0	1.000D 02	1.000D 02	0.35
6	X9M	3.79188D-04	9.66D-05	3.9	0.8823	-1.454D 03	6.715D 03	8.170D 03	0.63
7	X18M	9.889450-03	2.37D-03	4.2	0.6977	-6.100D 01	3.900D 01	1.000D 02	0.28
8	X9DSQ	-6.188970-08	2.67D-08	2.3	0.7498	7.673D 04	2.365D 07	2.357D 07	0.38
9	X13DSQ	2.097260-04	1.18D-04	1.8	0.2238	8.464D-01	3.240D 03	3.239D 03	0.14
10	X18DSQ	1.883490-04	7.71D-05	2.4	0.3245	7.726D 01	2.726D 03	2.649D 03	0.18
11	X21DSQ	-5.826640-04	3.43D-04	1.7	0.2768	7.939D 01	1.139D 03	1.059D 03	0.13
12	LNX8	-2.385660-01	6.07D-02	3.9	0.6555	5.963D 00	1.269D 01	7.626D 00	0.37
13	LNX9	-6.250550-01	2.16D-01	2.9	0.9522	3.481D 00	9.812D 00	6.611D 00	0.72
14	LNX10	-4.638980-01	1.62D-01	2.9	0.8953	1.823D-01	5.157D 00	4.975D 00	0.47

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	14
RESIDUAL DEGREES OF FREEDOM	47
F-VALUE	33.5
RESIDUAL ROOT MEAN SQUARE	0.42296907
RESIDUAL MEAN SQUARE	0.17890283
RESIDUAL SUM OF SQUARES	8.40843324
TOTAL SUM OF SQUARES	92.28672250
MULT. CORREL. COEF. SQUARED	.9089

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	-2
6	-4
7	-2
8	-7
9	-4
10	-4
11	-3
12	1
13	1
14	1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 2 DEP VAR IS LNY2 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.42

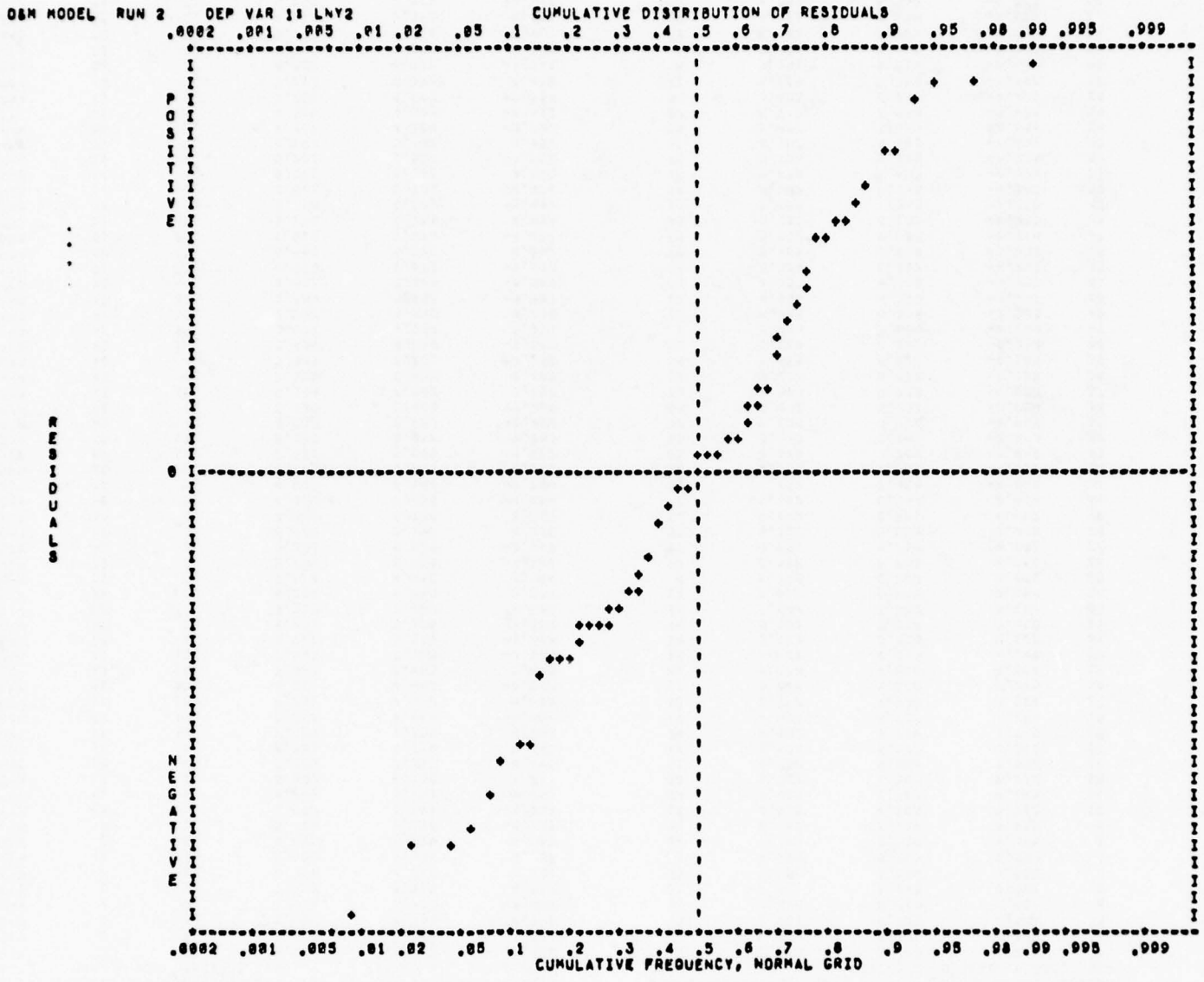
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

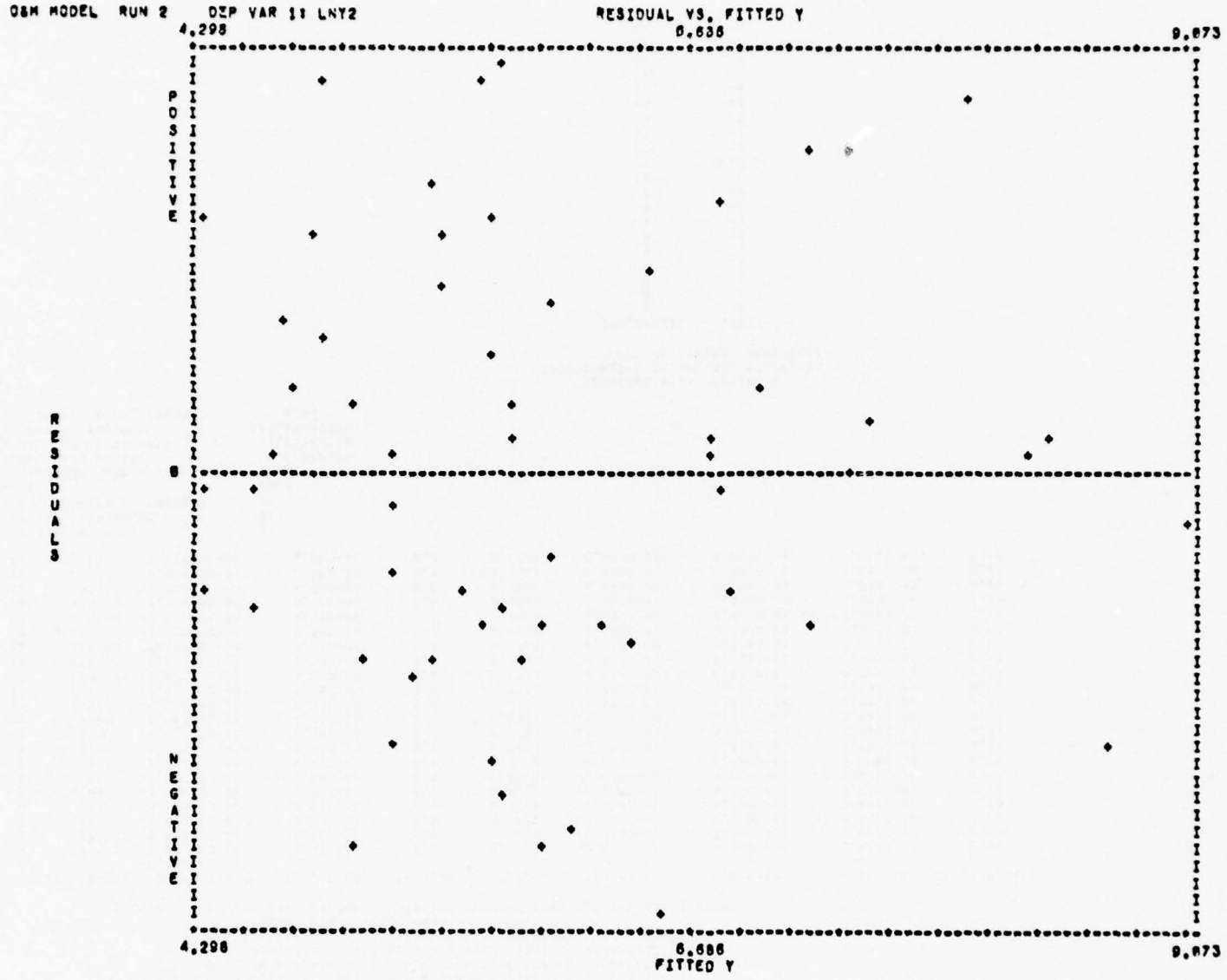
NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.22	0.0	53	51	0.02	53.38	0.17	4.38	22	1
2	0.28	0.0	57	56	0.52	0.00	0.49	4.35	65	2
3	0.25	0.0	61	60	0.21	1.90	0.47	4.36	67	3
4	0.32	0.00	65	67	0.49	0.0	0.21	4.59	61	4
5	0.32	0.01	27	37	0.34	3.43	0.27	4.59	60	5
6	0.38	0.14	66	58	0.17	24.55	0.21	4.71	17	6
7	0.32	0.25	58	56	0.42	26.07	0.09	4.74	18	7
8	0.29	0.25	58	57	0.09	9.50	0.26	4.81	31	8
9	0.27	0.79	15	36	0.15	3.69	0.25	4.89	63	9
10	0.26	0.93	1	32	0.16	26.39	0.44	4.93	3	10
11	0.32	1.06	35	1	0.90	27.19	0.11	4.95	47	11
12	0.35	1.38	60	63	0.65	0.04	0.78	5.08	66	12
13	0.38	1.66	50	52	0.67	0.01	0.34	5.10	27	13
14	0.44	1.72	32	44	1.27	0.57	0.26	5.14	37	14
15	0.46	1.76	40	7	0.65	2.65	0.01	5.26	58	15
16	0.51	1.79	3	27	1.34	2.91	0.08	5.27	33	16
17	0.52	1.81	42	48	0.64	0.0	0.52	5.28	57	17
18	0.55	1.87	3	37	1.01	32.69	0.38	5.28	56	18
19	0.59	1.98	6	5	1.29	49.96	0.18	5.29	28	19
20	0.60	1.98	67	60	0.68	12.55	0.04	5.37	26	20
21	0.59	1.98	67	61	0.47	4.77	0.83	5.45	42	21
22	0.57	1.98	65	60	0.19	3.84	0.08	5.48	2	22
23	0.55	1.98	65	61	0.02	2.23	0.11	5.50	34	23
24	0.55	1.96	48	46	0.57	11.68	0.52	5.53	48	24
25	0.55	1.99	35	45	0.55	27.44	0.88	5.63	9	25
26	0.54	2.03	64	5	0.32	10.64	0.94	5.69	29	26
27	0.52	2.22	7	8	0.94	7.17	0.47	5.71	46	27
28	0.51	2.23	34	48	0.11	5.42	0.24	5.73	13	28
29	0.51	2.27	15	25	0.42	15.88	0.04	5.75	59	29
30	0.51	2.47	17	3	0.63	3.30	1.22	5.76	41	30
31	0.50	2.65	66	33	0.16	3.66	0.97	5.78	6	31
32	0.48	2.65	58	33	0.01	2.83	0.32	5.78	64	32
33	0.48	2.69	45	32	0.52	14.58	0.62	5.82	5	33
34	0.48	2.69	1	45	0.36	26.71	0.07	5.84	24	34
35	0.48	2.71	21	43	0.47	54.14	0.45	5.85	38	35
36	0.47	2.75	65	17	0.88	36.28	0.06	5.89	49	36
37	0.47	2.75	67	17	0.41	16.65	0.48	5.99	62	37
38	0.48	2.76	39	21	0.88	29.48	0.52	6.00	4	38
39	0.47	2.77	32	54	0.81	5.49	0.43	6.03	68	39
40	0.47	2.86	34	46	0.68	1.86	0.98	6.04	35	40
41	0.47	2.91	33	58	0.43	2.69	0.36	6.12	1	41
42	0.46	2.91	33	57	0.88	10.76	0.04	6.25	45	42
43	0.46	2.96	5	62	0.38	1.86	0.67	6.41	50	43
44	0.46	2.96	44	15	0.34	0.52	1.15	6.58	52	44
45	0.45	3.04	2	34	0.98	2.77	0.81	6.53	32	45
46	0.45	3.06	42	34	0.75	13.65	0.04	6.78	54	46
47	0.45	3.11	45	54	0.29	13.31	0.42	6.79	11	47
48	0.45	3.18	40	8	0.61	25.58	0.53	6.84	44	48
49	0.45	3.23	25	36	0.27	33.21	0.16	6.86	55	49
50	0.47	3.30	41	6	1.22	4.98	0.35	6.89	10	50
51	0.47	3.34	54	44	0.46	2.27	0.42	7.01	15	51
52	0.46	3.43	61	17	0.98	15.17	0.84	7.26	25	52
53	0.46	3.43	60	17	0.27	2.76	0.88	7.29	39	53
54	0.45	3.48	57	42	0.37	23.18	0.57	7.44	21	54
55	0.45	3.48	56	42	0.15	25.48	0.11	7.46	36	55
56	0.45	3.53	2	9	0.71	31.18	0.56	7.56	43	56
57	0.45	3.64	36	7	0.92	1.76	0.65	8.01	40	57
58	0.46	3.66	6	64	0.97	2.22	0.84	8.33	7	58
59	0.45	3.69	63	3	0.25	12.88	0.52	8.39	8	59
60	0.45	3.86	9	13	0.41	35.53	0.39	8.88	20	60
61	0.45	4.06	39	43	0.46	0.0	0.82	9.07	53	61
62	0.45	4.20	63	66	0.30	53.52	0.66	9.07	51	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 2 DEP VAR IS LNY2

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT,	OBSV,	MSS DISTANCE	OBS, Y	FITTED Y	RESIDUAL	OBSV,	OBS, Y	FITTED Y	ORDERED RESID,	SEQ
71R20	1	3,	5,496	6,117	-0,620	6	6,510	5,779	0,730	1
73530	2	2,	5,992	5,483	0,509	29	6,369	5,685	0,683	2
71L80	3	3,	5,604	4,930	0,673	3	5,604	4,930	0,673	3
71M60	4	9,	5,344	6,003	-0,659	40	8,675	8,010	0,665	4
71PK0	5	2,	5,252	5,816	-0,564	21	8,011	7,443	0,568	5
71P80	6	2,	6,510	5,779	0,730	39	7,853	7,289	0,563	6
71710	7	20,	8,352	8,334	0,018	2	5,992	5,483	0,509	7
724G0	8	22,	8,445	8,390	0,055	44	7,322	6,837	0,485	8
71G50	9	3,	5,428	5,626	-0,198	59	6,199	5,747	0,452	9
71FA0	10	12,	6,698	6,891	-0,203	67	4,836	4,385	0,452	10
71F80	11	9,	6,852	6,788	0,064	34	5,922	5,497	0,425	11
710A0	13	3,	5,945	5,730	0,215	63	5,312	4,893	0,420	12
71A8E	15	8,	7,161	7,013	0,148	52	6,866	6,500	0,366	13
71ADA	17	6,	4,751	4,710	0,041	48	5,850	5,532	0,318	14
730BA	18	33,	4,990	4,736	0,254	35	6,322	6,038	0,285	15
73C80	20	45,	8,217	8,684	-0,467	18	4,990	4,736	0,254	16
73CEN	21	20,	8,011	7,443	0,568	47	5,177	4,948	0,229	17
73CFK	22	59,	4,991	4,298	-0,207	13	5,945	5,730	0,215	18
730AM	24	13,	5,890	5,835	0,055	31	4,970	4,806	0,164	19
73E8A	25	16,	7,005	7,280	-0,275	15	7,161	7,013	0,148	20
73E8F	26	4,	5,007	5,372	-0,364	38	5,978	5,853	0,125	21
71CA0	27	5,	4,431	5,100	-0,669	66	5,193	5,078	0,115	22
72EAA	28	33,	5,110	5,292	-0,183	43	7,664	7,562	0,102	23
72ECA	29	17,	6,369	5,685	0,683	11	6,852	6,788	0,064	24
728P0	31	11,	4,970	4,806	0,164	8	8,445	8,390	0,055	25
71JA0	32	3,	5,751	6,533	-0,782	24	5,890	5,835	0,055	26
71LA0	33	3,	5,226	5,270	-0,045	17	4,751	4,710	0,041	27
720N0	34	5,	5,922	5,497	0,425	57	5,322	5,282	0,040	28
72AC0	35	4,	6,322	6,038	0,285	54	6,809	6,781	0,027	29
71716	36	8,	7,452	7,456	-0,004	7	8,352	8,334	0,018	30
71810	37	6,	4,807	5,141	-0,334	36	7,452	7,456	-0,004	31
72RF0	38	5,	5,978	5,853	0,125	61	4,566	4,588	-0,022	32
72RB0	39	11,	7,853	7,289	0,563	65	4,389	4,352	-0,042	33
7593R	40	19,	8,675	8,010	0,665	55	6,818	6,861	-0,043	34
748D0	41	4,	5,264	5,756	-0,492	33	5,226	5,270	-0,045	35
748F0	42	4,	5,123	5,449	-0,326	58	5,292	5,257	-0,054	36
74810	43	16,	7,664	7,562	0,102	53	8,995	9,073	-0,077	37
76A10	44	4,	7,322	6,837	0,485	51	8,973	9,073	-0,100	38
76GA0	45	4,	5,987	6,251	-0,265	68	5,886	6,028	-0,142	39
74FF0	46	18,	5,458	5,714	-0,256	28	5,110	5,292	-0,183	40
74FA0	47	29,	5,177	4,948	0,229	9	5,428	5,626	-0,198	41
74FH0	48	5,	5,858	5,532	0,318	10	6,688	6,891	-0,203	42
74FU0	49	31,	5,569	5,893	-0,324	22	4,891	4,298	-0,207	43
77EC0	50	6,	6,097	6,405	-0,309	60	4,357	4,588	-0,232	44
77EED	51	25,	8,973	9,073	-0,100	64	5,539	5,782	-0,243	45
770CA	52	5,	6,866	6,500	0,366	46	5,458	5,714	-0,256	46
770B0	53	25,	8,995	9,073	-0,077	62	5,722	5,986	-0,264	47
73CR0	54	7,	6,809	6,781	0,027	45	5,987	6,251	-0,265	48
73CG0	55	16,	6,818	6,861	-0,043	25	7,005	7,280	-0,275	49
71NA0	56	3,	4,803	5,282	-0,479	50	6,097	6,406	-0,309	50
710U0	57	3,	5,322	5,282	0,040	49	5,569	5,893	-0,324	51
63AA0	58	2,	5,282	5,257	-0,054	42	5,123	5,449	-0,326	52
65AA0	59	5,	6,199	5,747	0,452	37	4,807	5,141	-0,334	53
638AA	60	5,	4,357	4,588	-0,232	26	5,007	5,372	-0,364	54
63CAA	61	5,	4,566	4,588	-0,022	20	8,217	8,684	-0,467	55
658AA	62	5,	5,722	5,986	-0,264	56	4,803	5,282	-0,479	56
6188A	63	5,	5,312	4,893	0,420	41	5,264	5,756	-0,492	57
658AA	64	4,	5,539	5,782	-0,243	5	5,252	5,816	-0,564	58
63AF0	65	4,	4,389	4,352	-0,042	1	5,496	6,117	-0,620	59
63AA0	66	3,	5,193	5,078	0,115	4	5,344	6,003	-0,659	60
63121	67	4,	4,836	4,385	0,452	27	4,431	5,100	-0,669	61
63AAA	68	9,	5,886	6,028	-0,142	32	5,751	6,533	-0,782	62


O&M MODEL RUN 2 DEP VAR IS LNY2
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
CUMULATIVE FREQUENCY, NORMAL GRID


O&M MODEL RUN 2 DEP VAR IS LNY2
RESIDUAL VS. FITTED Y
4.298
6.686
9.073
POSITIVE
0
NEGATIVE
RESIDUALS
4.298
6.686
9.073
FITTED Y

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 4 DEP VAR IS LNY4 MIN Y = -5.069D 00 MAX Y = 3.282D 00 RANGE Y = 8.352D 00

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

LNY4 = B(0) + B(1)X1M + B(2)X2M + B(3)X3M + B(4)X5 + B(5)X6 + B(6)X7
+ B(7)X16 + B(8)X14M + B(9)X18M + B(10)X20M + B(11)X8DSQ
+ B(12)X10DSQ + B(13)X14DSQ + B(14)X15DSQ + B(15)X17DSQ
+ B(16)X18DSQ + B(17)X19DSQ + B(18)X20DSQ + B(19)X21DSQ
+ B(20)LNX8 + B(21)LNX9

LNY4 = LN(LSC/OH) LSC/OH (LOGISTICS SUPPORT COST PER OPERATING HOUR)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	B(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		-8.151080 00							
1	X1M	3.861110 00	6.410-01	6.0	0.9483	-2.860D-01	7.140D-01	1.000D 00	0.46
2	X2M	3.665330 00	6.530-01	5.6	0.9484	-2.700D-01	7.300D-01	1.000D 00	0.44
3	X3M	-4.852710-01	2.600-01	1.9	0.6622	-2.540D-01	7.460D-01	1.000D 00	0.06
4	X5	-2.566630 00	4.210-01	6.1	0.3318	-2.134D-01	5.326D-01	7.460D-01	0.23
5	X6	-1.662620 00	4.760-01	3.5	0.4443	-2.271D-01	5.669D-01	7.940D-01	0.16
6	X7	-7.672530-01	4.340-01	1.8	0.3980	-2.144D-01	5.796D-01	7.940D-01	0.07
7	X16	1.273560-02	4.930-03	2.6	0.4192	0.0	1.000D 02	1.000D 02	0.15
8	X14M	2.259670-02	3.750-03	6.0	0.7676	-6.333D 01	3.667D 01	1.000D 02	0.27
9	X18M	-7.429990-03	2.580-03	3.0	0.6028	-6.110D 01	3.889D 01	1.000D 02	0.09
10	X20M	2.385030 00	4.580-01	5.2	0.9327	-1.340D 00	6.660D-01	2.000D 00	0.57
11	X8DSQ	-9.223840-11	1.840-11	5.0	0.4883	5.125D 08	3.625D 10	3.574D 10	0.39
12	X10DSQ	-1.528640-04	5.250-05	2.9	0.5202	8.464D-01	1.197D 04	1.197D 04	0.22
13	X14DSQ	-1.671050-03	1.850-04	5.8	0.8576	4.880D-02	2.621D 03	2.621D 03	0.34
14	X15DSQ	1.224180-03	2.080-04	5.8	0.7188	6.400D 01	2.809D 03	2.745D 03	0.48
15	X17DSQ	7.100250-04	2.170-04	3.3	0.8366	2.310D 02	3.576D 03	3.345D 03	0.28
16	X18DSQ	-1.616510-04	1.080-04	1.5	0.4652	8.372D 01	2.688D 03	2.605D 03	0.05
17	X19DSQ	-1.115680-06	4.280-07	2.7	0.3924	2.250D 02	8.427D 05	8.425D 05	0.11
18	X20DSQ	5.849960 00	7.670-01	6.5	0.8716	1.459D-01	1.910D 00	1.764D 00	1.06
19	X21DSQ	1.700420-03	4.780-04	3.6	0.4818	6.823D 01	1.138D 03	1.070D 03	0.22
20	LNX8	4.602930-01	8.280-02	5.6	0.7431	5.838D 00	1.269D 01	7.658D 00	0.42
21	LNX9	2.355630-01	1.080-01	2.2	0.7328	3.491D 00	9.812D 00	6.611D 00	0.16

NO. OF OBSERVATIONS	63
NO. OF IND. VARIABLES	21
RESIDUAL DEGREES OF FREEDOM	41
F-VALUE	25.3
RESIDUAL ROOT MEAN SQUARE	0.52289749
RESIDUAL MEAN SQUARE	0.27342179
RESIDUAL SUM OF SQUARES	11.21029323
TOTAL SUM OF SQUARES	156.45152270
MULT. CORREL. COEF. SQUARED	.9283

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	-2
8	-2
9	-2
10	1
11	-10
12	-4
13	-3
14	-3
15	-3
16	-4
17	-6
18	1
19	-3
20	1
21	1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 4 DEP VAR 11 LNY4 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.52

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

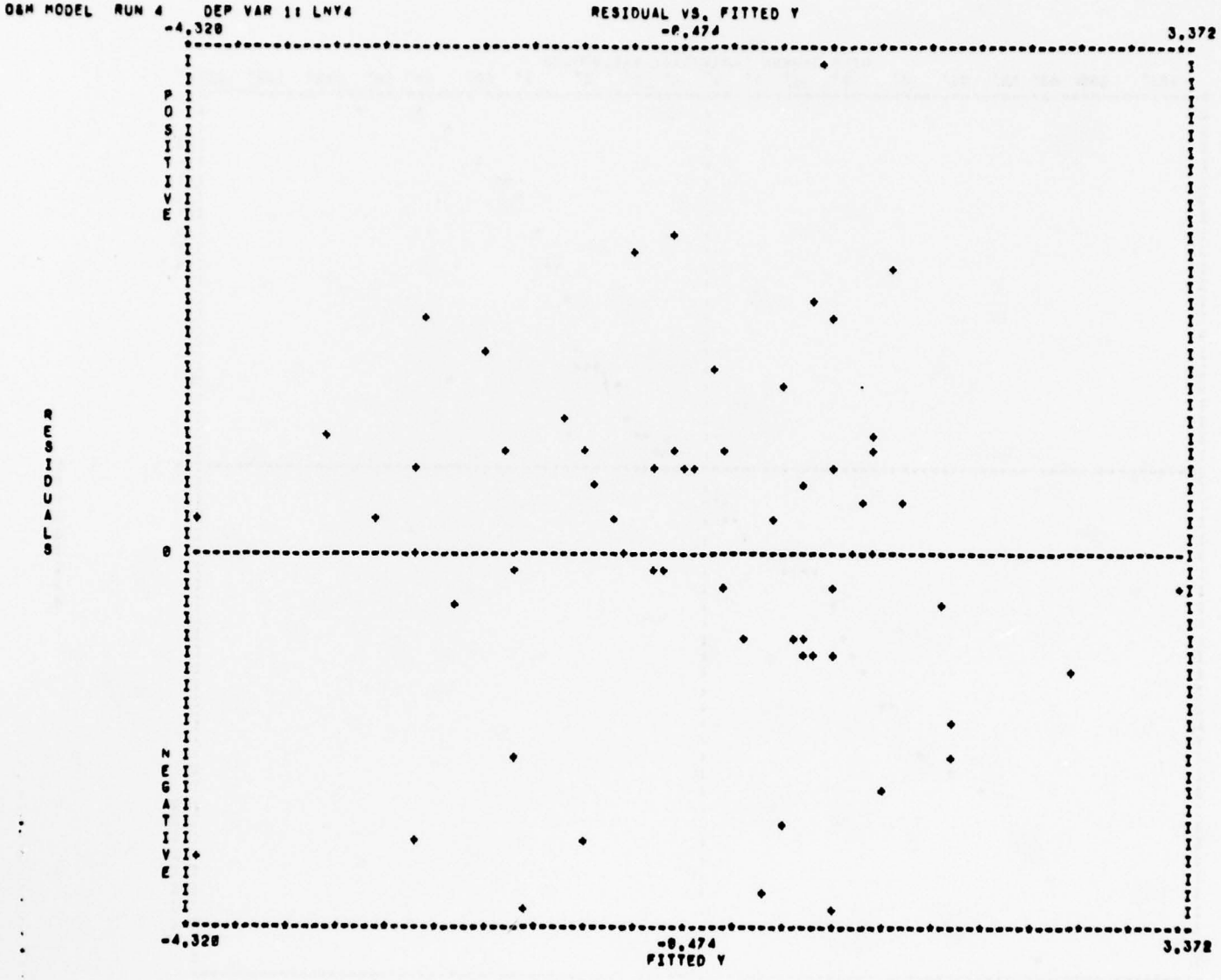
NO.	CUMULATIVE STD DEV	ORDERED BY WSSD WSSD	OBSV.	OBSV.	DEL RESIDUALS	WSSD	ORDERED BY FITTED Y DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.23	0.0	61	60	0.21	0.0	0.00	-4.32	53	1
2	0.35	0.0	57	56	0.42	109.95	1.03	-4.32	51	2
3	0.52	0.0	53	51	0.00	74.64	0.22	-3.19	7	3
4	0.75	0.00	67	65	1.30	121.45	0.13	-2.82	54	4
5	0.84	0.02	37	27	0.20	91.16	0.91	-2.55	20	5
6	0.58	0.17	58	56	0.26	5.66	0.69	-2.53	8	6
7	0.53	0.17	58	57	0.16	80.65	0.58	-2.53	12	7
8	0.60	1.52	7	8	0.99	80.59	0.69	-2.45	36	8
9	0.55	2.04	5	59	0.17	90.70	0.63	-2.22	40	9
10	0.57	2.22	57	3	0.65	115.58	0.25	-1.97	19	10
11	0.62	2.22	56	3	1.07	62.00	0.31	-1.80	43	11
12	0.60	2.27	40	44	0.37	88.60	0.44	-1.79	55	12
13	0.63	2.37	58	3	0.81	87.17	0.46	-1.78	44	13
14	0.65	2.44	27	67	0.89	136.93	0.83	-1.74	15	14
15	0.64	2.45	27	65	0.41	159.19	1.20	-1.70	39	15
16	0.64	2.51	37	67	0.69	116.02	0.11	-1.34	21	16
17	0.62	3.35	18	22	0.20	133.48	0.93	-1.20	38	17
18	0.59	3.37	6	1	0.12	143.83	0.83	-1.19	25	18
19	0.59	3.83	8	40	0.57	100.23	0.85	-1.16	68	19
20	0.58	4.57	1	9	0.24	68.76	0.89	-0.98	6	20
21	0.56	4.57	15	25	0.66	127.77	0.74	-0.88	49	21
22	0.59	5.66	8	12	0.69	88.53	0.54	-0.84	32	22
23	0.61	6.00	66	28	0.85	20.66	0.24	-0.72	1	23
24	0.59	6.96	12	40	0.12	128.53	0.02	-0.71	18	24
25	0.58	6.96	7	12	0.30	100.45	0.02	-0.66	52	25
26	0.57	7.27	26	63	0.29	32.08	0.25	-0.62	9	26
27	0.57	7.94	35	29	0.61	123.86	0.55	-0.54	46	27
28	0.56	8.31	33	31	0.35	23.83	0.58	-0.50	50	28
29	0.57	9.53	19	15	0.53	113.84	0.01	-0.43	62	29
30	0.56	9.56	59	13	0.26	108.87	0.25	-0.37	64	30
31	0.55	11.51	34	33	0.28	60.46	0.53	-0.22	41	31
32	0.56	11.72	52	50	0.83	47.61	0.33	-0.16	42	32
33	0.58	13.33	65	33	1.13	98.96	0.46	-0.11	5	33
34	0.57	13.55	67	33	0.17	7.94	0.61	0.03	35	34
35	0.55	16.08	34	31	0.07	109.19	0.91	0.13	29	35
36	0.54	19.51	10	9	0.00	106.42	0.33	0.23	26	36
37	0.53	20.86	1	10	0.24	25.24	1.05	0.29	59	37
38	0.53	21.15	64	35	0.41	126.35	0.43	0.38	2	38
39	0.54	23.12	21	25	1.03	118.16	0.02	0.42	63	39
40	0.57	23.58	4	58	1.27	44.80	0.38	0.44	48	40
41	0.57	23.51	43	44	0.75	127.76	0.33	0.47	13	41
42	0.56	23.71	6	10	0.12	140.14	0.04	0.47	24	42
43	0.57	23.77	2	13	0.79	6.00	0.85	0.51	66	43
44	0.57	23.83	50	52	0.58	104.21	0.59	0.53	28	44
45	0.59	24.23	4	56	1.01	23.58	1.27	0.61	4	45
46	0.60	24.23	4	57	1.43	0.17	0.19	0.66	58	46
47	0.62	25.24	59	2	1.05	0.0	0.42	0.66	57	47
48	0.63	25.25	39	68	1.00	105.77	0.37	0.68	56	48
49	0.64	25.35	13	4	1.06	104.33	1.43	0.71	17	49
50	0.63	25.49	48	43	0.38	329.27	0.89	0.71	3	50
51	0.63	27.59	12	43	0.26	359.68	0.99	0.82	45	51
52	0.62	27.59	15	21	0.37	0.02	0.20	0.89	37	52
53	0.61	30.72	41	5	0.20	109.19	0.29	0.99	27	53
54	0.61	32.08	9	46	0.25	0.0	0.21	1.02	61	54
55	0.61	32.66	65	34	0.85	113.84	0.82	1.02	60	55
56	0.61	33.61	67	34	0.45	0.00	1.38	1.08	67	56
57	0.60	35.43	1	46	0.92	157.56	0.57	1.12	65	57
58	0.60	35.86	68	32	0.60	107.79	0.28	1.22	47	58
59	0.59	37.12	38	68	0.09	11.51	0.28	1.52	34	59
60	0.59	37.46	53	28	0.15	118.81	0.08	1.58	33	60
61	0.59	37.46	51	28	0.95	3.35	0.28	1.62	16	61
62	0.60	40.46	59	48	0.84	118.39	0.23	2.58	22	62
63	0.59	41.63	52	62	0.85	109.95	0.23	3.37	31	63

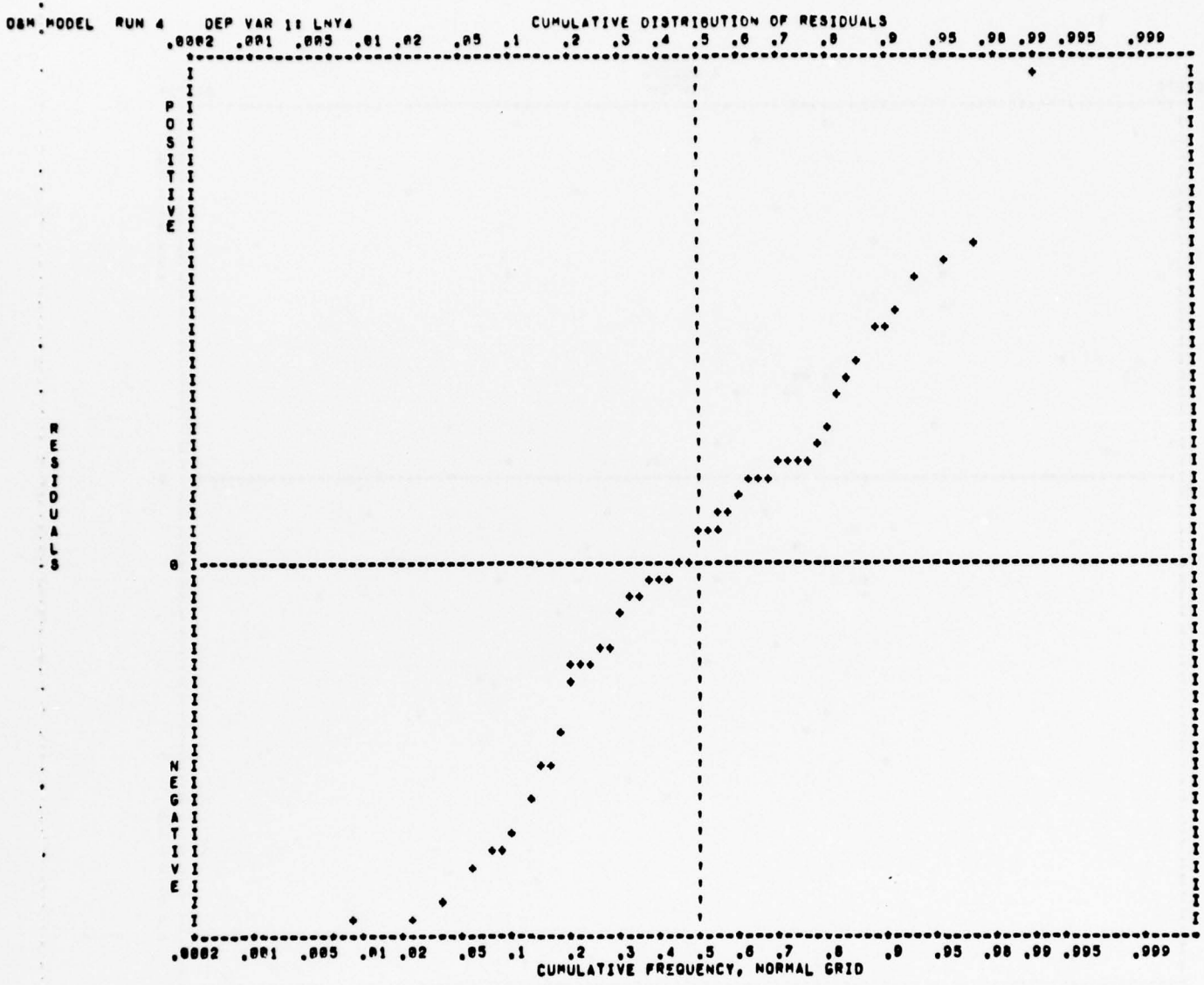
LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 4 DEP VAR IS LNY4

IDENT.	OBSV.	HSS DISTANCE	ORDERED BY COMPUTER INPUT ORS. Y	FITTED Y	RESIDUAL
71B2P	1	24.	-0.522	-0.720	0.198
73530	2	40.	-0.366	0.295	-0.661
71LR0	3	24.	-0.174	0.714	-0.887
71H60	4	36.	1.803	0.611	1.192
71PK0	5	24.	0.109	-0.113	0.222
71P80	6	25.	-0.900	-0.901	0.001
71710	7	31.	-2.910	-3.189	0.280
724G0	8	26.	-3.237	-2.529	-0.708
71G50	9	26.	-0.659	-0.621	-0.038
71FA0	10	33.	-0.749	-0.711	-0.039
71CA0	12	29.	-2.547	-2.528	-0.019
71DA0	13	33.	0.597	0.467	0.130
7148E	15	45.	-1.782	-1.740	-0.042
714DA	17	47.	1.253	0.706	0.547
73D8A	18	45.	1.191	1.620	-0.519
71ACC	19	59.	-1.479	-1.972	0.493
73C8Q	20	60.	-2.351	-2.549	0.198
73CEN	21	53.	-1.010	-1.337	0.327
73CFK	22	45.	2.185	2.502	-0.317
73CAM	24	69.	0.268	0.469	-0.201
73E8A	25	49.	-1.895	-1.192	-0.703
73E8F	26	47.	0.287	0.230	0.057
71CA0	27	43.	1.271	0.985	0.286
72EAA	28	44.	1.135	0.531	0.604
72ECA	29	46.	-0.717	0.134	-0.850
72BP0	31	52.	3.282	3.372	-0.090
71JA0	32	43.	-0.105	-0.841	0.735
71LA0	33	48.	1.139	1.577	-0.438
72DN0	34	54.	1.368	1.524	-0.156
72AC0	35	44.	-0.202	0.035	-0.237
71710	36	47.	-1.898	-2.453	0.557
7131D	37	43.	0.980	0.893	0.088
72RF0	38	55.	-0.976	-1.198	0.222
72R80	39	61.	-2.569	-1.698	-0.871
7593P	40	38.	-2.357	-2.222	-0.135
74BD0	41	48.	0.201	-0.223	0.424
74BF0	42	41.	-0.268	-0.159	-0.110
7481P	43	35.	-1.556	-1.801	0.245
76410	44	29.	-2.281	-1.776	-0.504
76GA0	45	294.	0.815	0.815	0.000
74FFP	46	41.	-0.326	-0.543	0.217
74FA0	47	66.	1.341	1.222	0.119
74FM0	48	43.	0.184	0.435	-0.251
74FU0	49	69.	-0.884	-0.879	-0.006
77EC0	50	47.	0.266	-0.500	0.766
77EE0	51	63.	-5.069	-4.320	-0.750
770CA	52	55.	-0.726	-0.664	-0.062
77D80	53	63.	-4.274	-4.320	0.046
73CR0	54	50.	-2.757	-2.822	0.064
73CG0	55	58.	-1.852	-1.788	-0.064
71NA0	56	24.	0.861	0.682	0.179
710U0	57	24.	0.439	0.682	-0.242
63AA0	58	24.	0.585	0.664	-0.080
65AA0	59	25.	0.685	0.295	0.391
6394A	60	47.	1.231	1.021	0.210
63CAA	61	47.	1.018	1.021	-0.004
658AA	62	45.	-0.238	-0.427	0.189
6188A	63	49.	0.185	0.420	-0.235
65RAA	64	42.	-0.192	-0.379	0.177
63AF0	65	43.	1.815	1.121	0.694
63AA0	66	43.	0.268	0.512	-0.244
63121	67	43.	0.472	1.079	-0.607
63AAA	68	49.	-1.031	-1.161	0.130

OBSV.	OBS. Y	FITTED Y	ORDERED BY RESIDUALS ORDERED RESID.	SEQ
4	1.803	0.611	1.192	1
50	0.266	-0.500	0.766	2
32	-0.105	-0.841	0.735	3
65	1.815	1.121	0.694	4
28	1.135	0.531	0.604	5
36	-1.896	-2.453	0.557	6
17	1.253	0.706	0.547	7
19	-1.479	-1.972	0.493	8
41	0.201	-0.223	0.424	9
59	0.685	0.295	0.391	10
21	-1.010	-1.337	0.327	11
27	1.271	0.985	0.286	12
7	-2.910	-3.189	0.280	13
43	-1.556	-1.801	0.245	14
38	-0.976	-1.198	0.222	15
5	0.109	-0.113	0.222	16
46	-0.326	-0.543	0.217	17
60	1.231	1.021	0.210	18
20	-2.351	-2.549	0.198	19
1	-0.522	-0.720	0.198	20
62	-0.238	-0.427	0.189	21
56	0.861	0.682	0.179	22
64	-0.192	-0.370	0.177	23
68	-1.031	-1.161	0.130	24
13	0.597	0.467	0.130	25
47	1.341	1.222	0.119	26
37	0.980	0.893	0.088	27
6	-0.900	-0.981	0.081	28
54	-2.757	-2.822	0.064	29
26	0.287	0.230	0.057	30
53	-4.274	-4.320	0.046	31
45	0.815	0.815	0.000	32
61	1.018	1.021	-0.004	33
49	-0.884	-0.879	-0.006	34
12	-2.547	-2.528	-0.019	35
9	-0.659	-0.621	-0.038	36
10	-0.749	-0.711	-0.039	37
15	-1.782	-1.740	-0.042	38
52	-0.726	-0.664	-0.062	39
55	-1.852	-1.788	-0.064	40
58	0.585	0.664	-0.080	41
31	3.282	3.372	-0.090	42
42	-0.268	-0.159	-0.110	43
40	-2.357	-2.222	-0.135	44
34	1.368	1.524	-0.156	45
24	0.268	0.469	-0.201	46
63	0.185	0.420	-0.235	47
35	-0.202	0.035	-0.237	48
57	0.439	0.682	-0.242	49
66	0.268	0.512	-0.244	50
48	0.184	0.435	-0.251	51
22	2.185	2.502	-0.317	52
33	1.139	1.577	-0.438	53
44	-2.281	-1.776	-0.504	54
18	1.191	1.620	-0.519	55
67	0.472	1.079	-0.607	56
2	-0.366	0.295	-0.661	57
25	-1.895	-1.192	-0.703	58
8	-3.237	-2.529	-0.708	59
51	-5.069	-4.320	-0.750	60
29	-0.717	0.134	-0.850	61
39	-2.569	-1.698	-0.871	62
3	-0.174	0.714	-0.887	63


O&M MODEL RUN 4 DEP VAR IS LNY4
RESIDUAL VS. FITTED Y
-4.328
-8.474
3.372
POSITIVE
RESIDUALS
0
NEGATIVE
-4.328
-8.474
3.372
FITTED Y


O&M MODEL RUN 4 DEP VAR IS LNY4
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
RESIDUALS
0
NEGATIVE
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 8 DEP VAR IS LNY5 MIN Y = -5.7930 00 MAX Y = 1.7970 00 RANGE Y = 7.5890 00

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

LNY5 = B(0) + B(1)X17 + B(2)X37 + B(3)X4M + B(4)X5 + B(5)X6 + B(6)X13
+ B(7)X17 + B(8)X11M + B(9)X14M + B(10)X15M + B(11)X16M
+ B(12)X19DSQ + B(13)X11DSQ + B(14)X14DSQ + B(15)X15DSQ
+ B(16)X16DSQ + B(17)X18DSQ + B(18)X19DSQ + B(19)X20DSQ
+ B(20)X21DSQ + B(21)LNX8

LNY5 = LN(TRAIN/OH) TRAIN/OH (TRAINING COST PER OPERATING HOUR)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		3.174600 00							
1	X1M	7.479470-01	2.990-01	2.5	0.5861	-2.9800-01	7.1900-01	1.0000 00	0.10
2	X3M	-7.172710-01	3.350-01	2.1	0.5781	-2.5800-01	7.4200-01	1.0000 00	0.09
3	X4M	-1.379650 00	3.390-01	4.0	0.4942	-1.9400-01	8.9600-01	1.0900 00	0.18
4	X5	-2.249680 00	5.920-01	3.8	0.3038	-2.1520-01	5.2680-01	7.4200-01	0.22
5	X6	-1.382970 00	6.170-01	2.2	0.3034	-2.3370-01	5.7230-01	8.0600-01	0.15
6	X13	-2.253940-01	8.740-02	2.6	0.9977	0.0	1.0000 02	1.0000 02	2.97
7	X17	-2.845140-01	8.750-02	2.3	0.9969	0.0	1.0000 02	1.0000 02	2.69
8	X11M	2.388180-04	1.240-04	1.9	0.6114	-8.8900 02	6.7490 03	7.6290 03	0.24
9	X14M	-2.284370-01	8.560-02	2.4	0.9991	-4.2500 01	3.7500 01	1.0000 02	2.75
10	X15M	-2.977420-01	8.690-02	2.4	0.9988	-1.5800 01	8.4200 01	1.0000 02	2.74
11	X16M	-2.188390-01	8.640-02	2.5	0.9961	-3.4800 00	9.6520 01	1.0000 02	2.88
12	X18DSQ	-3.894090-04	6.710-05	4.8	0.3852	1.2540 00	1.1920 04	1.1920 04	0.49
13	X11DSQ	-1.614110-07	4.320-08	3.7	0.5195	5.7600 04	2.1670 07	2.1610 07	0.46
14	X14DSQ	-4.981710-04	1.890-04	2.6	0.7196	4.0000-02	2.5810 03	2.5810 03	0.17
15	X15DSQ	4.949610-04	2.320-04	2.1	0.5306	5.6250 01	2.8620 03	2.8060 03	0.18
16	X16DSQ	-1.428490-03	8.770-04	1.6	0.3011	1.7460 03	2.5220 03	7.7650 02	0.15
17	X18DSQ	-4.954750-04	1.480-04	3.4	0.3968	8.1360 01	2.7020 03	2.6210 03	0.17
18	X19DSQ	-1.398320-06	6.210-07	2.3	0.4119	2.8980 02	8.3910 05	8.3880 05	0.15
19	X20DSQ	1.512220 00	6.420-01	2.4	0.6218	1.4750-01	1.9150 00	1.7680 00	0.35
20	X21DSQ	1.939530-03	6.680-04	2.9	0.4485	6.3040 01	1.1680 03	1.0970 03	0.28
21	LNX8	3.649860-01	8.820-02	4.1	0.5257	5.0300 00	1.2690 01	7.6580 00	0.37

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	21
RESIDUAL DEGREES OF FREEDOM	40
F-VALUE	11.7
RESIDUAL ROOT MEAN SQUARE	0.75929222
RESIDUAL MEAN SQUARE	0.56293842
RESIDUAL SUM OF SQUARES	22.51753698
TOTAL SUM OF SQUARES	168.76786708
MULT. CORREL. COEF. SQUARED	.8599

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-4
9	1
10	1
11	1
12	-4
13	-7
14	-4
15	-3
16	-3
17	-4
18	-6
19	1
20	-3
21	1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 5 DEP VAR 1: LNY5 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.75

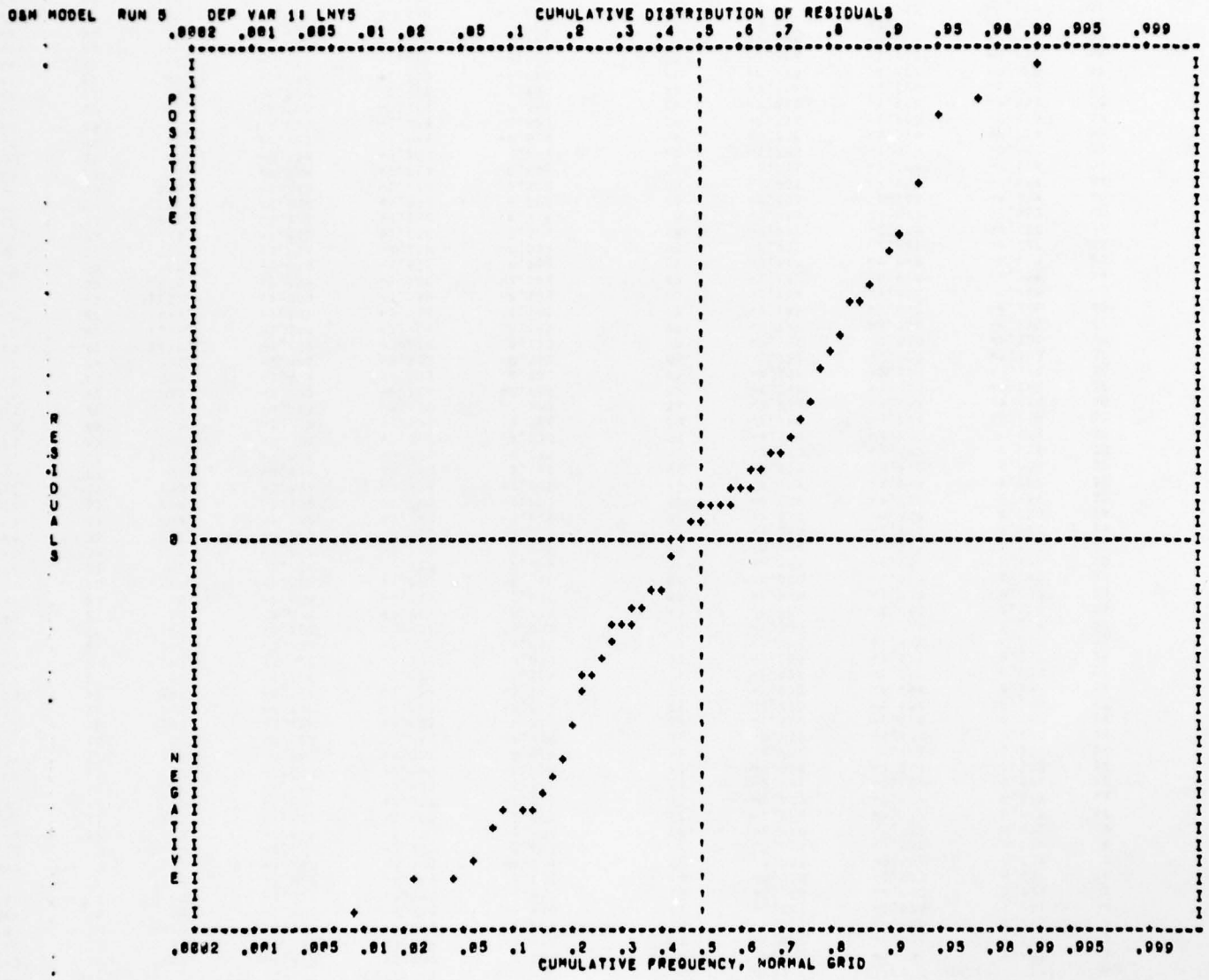
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

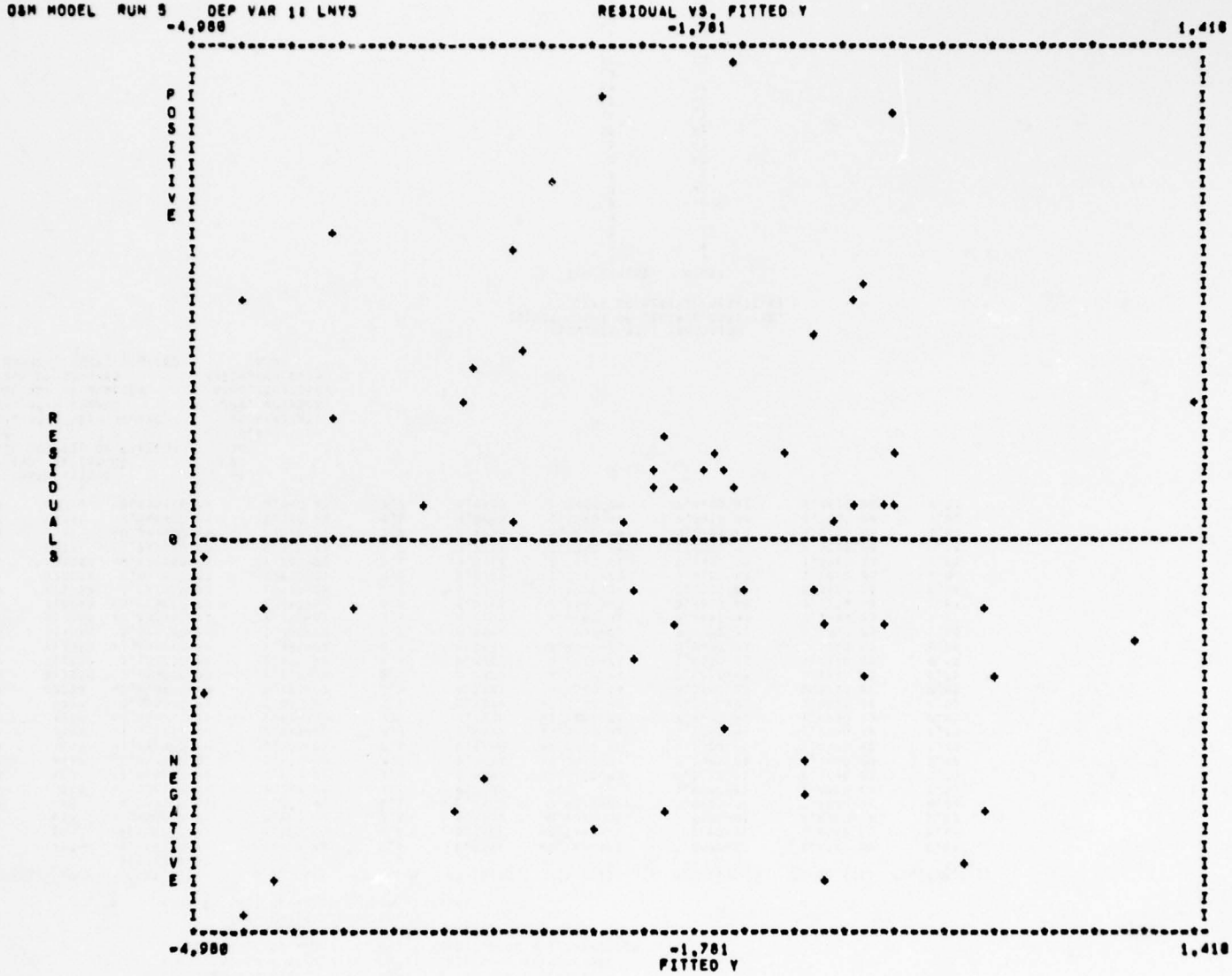
NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	WSSD	DEL RESIDUALS	ORDERED BY FITTED Y: FITTED Y	OBSV.	SEQ.
1	0.17	0.0	61	60	0.15	0.0	0.48	-4.98	53	1
2	0.42	0.0	57	56	0.60	1542.14	0.77	-4.98	51	2
3	0.43	0.0	53	51	0.40	0.36	1.89	-4.63	7	3
4	0.50	0.01	37	27	0.64	2.99	0.95	-4.62	36	4
5	0.58	0.17	58	66	0.83	6.62	0.81	-4.53	20	5
6	0.69	0.28	20	19	1.11	7.78	1.93	-4.46	12	6
7	0.89	0.36	7	36	1.89	22.13	0.90	-4.08	19	7
8	0.91	1.16	56	67	0.97	13.99	0.32	-4.06	54	8
9	0.95	1.31	27	5	1.17	3.25	0.57	-4.04	40	9
10	0.92	1.39	37	5	0.53	1652.49	0.36	-3.94	8	10
11	0.85	1.78	38	12	0.14	1356.23	0.95	-3.58	46	11
12	0.79	2.25	18	22	0.12	1284.26	1.23	-3.31	39	12
13	0.74	2.72	7	19	0.16	1621.74	0.11	-3.26	38	13
14	0.78	2.83	7	20	0.94	1143.73	1.25	-3.18	43	14
15	0.84	2.58	7	12	1.75	424.00	1.61	-3.12	10	15
16	0.85	2.99	36	28	0.95	11.69	0.84	-2.93	44	16
17	0.86	3.14	3	16	0.81	456.47	0.56	-2.89	15	17
18	0.85	3.15	3	22	0.68	558.87	0.52	-2.88	68	18
19	0.92	3.23	36	19	2.06	780.76	1.98	-2.64	11	19
20	0.91	3.25	48	8	0.57	4.19	2.21	-2.41	25	20
21	0.94	3.33	29	17	1.42	20.32	1.26	-2.35	32	21
22	0.92	3.83	67	60	0.52	1481.74	0.45	-2.23	9	22
23	0.90	3.83	67	61	0.37	1624.83	0.22	-2.17	48	23
24	0.88	3.83	64	62	0.29	1532.84	0.33	-2.15	21	24
25	0.90	3.83	12	40	1.36	885.25	0.94	-2.02	47	25
26	0.90	3.97	12	8	0.78	8.46	1.03	-2.00	13	26
27	0.96	4.19	25	32	2.21	104.15	1.13	-1.98	59	27
28	0.95	4.40	67	3	0.74	1547.73	0.15	-1.97	52	28
29	0.94	4.44	19	40	0.57	1512.08	0.41	-1.91	55	29
30	0.94	4.58	57	27	0.67	1268.80	0.25	-1.89	35	30
31	0.91	4.58	56	27	0.86	928.49	0.23	-1.74	34	31
32	0.90	4.63	57	5	0.50	22.87	0.01	-1.69	50	32
33	0.91	4.63	56	5	1.10	75.83	0.83	-1.65	1	33
34	0.90	4.65	37	56	0.58	0.17	0.83	-1.60	58	34
35	0.87	4.65	37	57	0.83	5.79	1.25	-1.57	66	35
36	0.87	4.69	20	40	0.54	21.38	1.32	-1.53	28	36
37	0.85	4.74	26	17	0.36	3.83	0.29	-1.51	64	37
38	0.88	4.91	44	25	1.74	78.75	0.48	-1.43	62	38
39	0.89	5.19	27	67	1.83	9.28	1.06	-1.19	26	39
40	0.87	5.21	5	67	0.14	1550.60	0.12	-1.16	29	40
41	0.88	5.22	19	8	1.14	1553.88	0.49	-1.07	49	41
42	0.87	5.39	52	35	0.57	8.31	0.88	-1.03	63	42
43	0.88	5.79	66	28	1.25	36.35	1.64	-0.97	17	43
44	0.92	5.93	58	28	2.08	1334.20	0.77	-0.95	6	44
45	0.92	6.62	20	12	0.81	1141.78	0.30	-0.92	42	45
46	0.92	6.74	61	3	1.11	379.83	0.88	-0.85	24	46
47	0.93	6.74	60	3	1.26	4.85	0.83	-0.75	37	47
48	0.92	7.55	5	61	0.50	0.0	0.68	-0.74	57	48
49	0.95	7.78	12	19	1.93	4.58	0.06	-0.74	56	49
50	0.94	7.97	26	63	0.45	1.31	1.17	-0.69	27	50
51	0.93	8.01	61	18	0.38	1385.81	0.53	-0.67	5	51
52	0.92	8.01	60	18	0.45	1403.27	0.39	-0.58	45	52
53	0.92	8.31	63	17	0.88	696.66	1.56	-0.55	67	53
54	0.92	8.34	15	25	0.90	899.88	1.19	-0.47	4	54
55	0.92	8.46	13	59	1.83	0.0	0.15	-0.47	61	55
56	0.93	9.20	26	29	1.86	6.74	1.26	-0.47	60	56
57	0.94	9.58	15	32	1.38	3.14	0.81	-0.38	3	57
58	0.93	9.66	29	63	0.62	184.46	0.66	0.07	18	58
59	0.92	10.78	54	8	0.25	467.69	0.45	0.08	41	59
60	0.92	11.69	44	15	0.84	428.89	0.18	0.17	33	60
61	0.91	13.99	54	48	0.32	139.83	0.71	1.03	22	61
62	0.91	15.85	58	64	0.76	1542.14	1.18	1.42	31	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 5 DEP VAR 11 LNY5

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	MSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71B20	1	59.	-1.427	-1.652	0.225	28	-0.065	-1.531	1.466	1
71L80	3	55.	-1.090	-0.978	-1.012	32	-1.031	-2.350	1.319	2
71M60	4	410.	0.812	-0.469	1.282	4	0.812	-0.469	1.282	3
71PK0	5	50.	-1.086	-0.674	-0.412	11	-1.545	-2.635	1.091	4
71P80	6	60.	-1.992	-0.960	-1.032	19	-3.189	-4.085	0.895	5
71710	7	146.	-3.913	-4.632	0.720	44	-2.276	-2.933	0.657	6
724G0	8	121.	-4.189	-3.943	-0.246	27	0.065	-0.691	0.756	7
71G50	9	74.	-2.174	-2.233	0.059	7	-3.913	-4.632	0.720	8
71FA0	10	196.	-3.878	-3.124	-0.754	56	-0.048	-0.739	0.692	9
71F80	11	288.	-1.545	-2.635	1.091	17	-0.362	-0.972	0.610	10
71CA0	12	146.	-5.487	-4.457	-1.031	60	-2.302	-2.877	0.575	11
71DA0	13	57.	-1.885	-2.083	0.198	43	-2.681	-3.182	0.501	12
71ABE	15	95.	-2.875	-2.892	0.016	38	-2.866	-3.261	0.395	13
71ADA	17	145.	-0.362	-0.972	0.610	31	1.797	1.418	0.379	14
73D8A	18	56.	-0.139	0.066	-0.206	40	-3.719	-4.043	0.325	15
71ACC	19	149.	-3.189	-4.085	0.895	52	-1.668	-1.958	0.301	16
73C80	20	149.	-4.747	-4.528	-0.219	26	-0.935	-1.188	0.253	17
73CEN	21	862.	-2.327	-2.154	-0.173	60	-0.220	-0.468	0.248	18
73CFK	22	56.	0.701	1.028	-0.327	1	-1.427	-1.652	0.225	19
730AH	24	179.	-0.815	-0.853	0.038	66	-1.355	-1.571	0.217	20
73E8A	25	146.	-3.300	-2.413	-0.887	58	-1.479	-1.691	0.212	21
73E8F	26	146.	-0.935	-1.188	0.253	13	-1.885	-2.083	0.198	22
71CA8	27	55.	0.065	-0.691	0.756	47	-1.657	-2.015	0.158	23
72EAA	28	56.	-0.065	-1.531	1.466	55	-1.760	-1.910	0.150	24
72ECA	29	147.	-1.893	-1.883	-0.010	64	-1.366	-1.513	0.147	25
728P0	31	81.	1.797	1.418	0.379	37	-0.638	-0.754	0.116	26
71JA0	32	136.	-1.031	-2.350	1.319	45	-0.464	-0.578	0.115	27
71LA0	33	294.	-0.253	0.170	-0.424	46	-3.386	-3.498	0.112	28
720N0	34	794.	-1.760	-1.744	-0.016	61	-0.375	-0.468	0.093	29
72AC0	35	136.	-2.159	-1.895	-0.265	57	-0.650	-0.739	0.089	30
71716	36	145.	-5.793	-4.624	-1.169	9	-2.174	-2.233	0.059	31
71310	37	55.	-0.638	-0.754	0.116	24	-0.815	-0.853	0.038	32
72RF0	38	1132.	-2.866	-3.261	0.395	15	-2.875	-2.892	0.016	33
72R8A	39	286.	-4.150	-3.314	-0.836	54	-4.064	-4.064	0.000	34
75933	40	145.	-3.719	-4.043	0.325	34	-1.760	-1.744	-0.016	35
748D0	41	62.	-0.793	0.077	-0.870	51	-5.034	-4.980	-0.054	36
748F0	42	923.	-1.182	-0.916	-0.266	62	-1.580	-1.433	-0.147	37
74810	43	862.	-2.681	-3.182	0.501	21	-2.327	-2.154	-0.173	38
76A10	44	145.	-2.976	-2.933	0.857	63	-1.221	-1.027	-0.193	39
76GA0	45	1112.	-0.464	-0.578	0.115	18	-0.139	0.066	-0.206	40
74FF0	46	1120.	-3.386	-3.498	0.112	20	-4.747	-4.528	-0.219	41
74FA0	47	944.	-1.657	-2.015	0.158	8	-4.189	-3.943	-0.246	42
74FH0	48	1132.	-2.564	-2.169	-0.395	35	-2.159	-1.895	-0.265	43
74FU0	49	865.	-1.755	-1.069	-0.685	42	-1.182	-0.916	-0.266	44
77EC0	50	60.	-1.479	-1.691	0.212	67	-0.823	-0.548	-0.275	45
77EE0	51	866.	-5.034	-4.980	-0.054	22	0.701	1.028	-0.327	46
77DCA	52	148.	-1.668	-1.968	0.301	48	-2.564	-2.169	-0.395	47
77D80	53	866.	-5.438	-4.980	-0.458	5	-1.086	-0.674	-0.412	48
73CR0	54	116.	-4.064	-4.064	0.000	33	-0.253	0.170	-0.424	49
73CG0	55	863.	-1.760	-1.910	0.150	53	-5.438	-4.980	-0.458	50
71NA0	56	57.	-0.048	-0.739	0.692	58	-2.211	-1.601	-0.610	51
710U0	57	57.	-0.650	-0.739	0.089	49	-1.755	-1.069	-0.685	52
63AA0	58	56.	-2.211	-1.601	-0.610	10	-3.878	-3.124	-0.754	53
65AA0	59	56.	-2.811	-1.976	-0.834	29	-1.893	-1.883	-0.010	54
63BAA	60	59.	-0.220	-0.468	0.248	59	-2.811	-1.976	-0.834	55
63CAA	61	59.	-0.375	-0.468	0.093	39	-4.150	-3.314	-0.836	56
65BAA	62	46.	-1.580	-1.433	-0.147	41	-0.793	0.077	-0.870	57
6188A	63	149.	-1.221	-1.027	-0.193	25	-3.300	-2.413	-0.887	58
65BAA	64	45.	-1.366	-1.513	0.147	3	-1.090	-0.978	-1.012	59
63AAA	66	56.	-1.355	-1.571	0.217	12	-5.487	-4.457	-1.031	60
63121	67	57.	-0.823	-0.548	-0.275	6	-1.992	-0.960	-1.032	61
63AAA	68	200.	-2.302	-2.877	0.575	36	-5.793	-4.624	-1.169	62


O&M MODEL RUN 5 DEP VAR 11 LNY5
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID


O&M MODEL RUN 5 DEP VAR IS LNY5
RESIDUAL VS. FITTED Y
-4,988
-1,781
1,418
POSITIVE
RESIDUALS
0
NEGATIVE
-4,988
-1,781
1,418
FITTED Y

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 6 DEP VAR IS Y6 MIN Y = 0.0 MAX Y = 1.0000 02 RANGE Y = 1.0000 02

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

Y6 = B(0) + B(1)X1M + B(2)X2M + B(3)X3M + B(4)X5 + B(5)X16 + B(6)X9M
+ B(7)X12M + B(8)X13M + B(9)X14M + B(10)X17M + B(11)X20M
+ B(12)X9DSQ + B(13)X11DSQ + B(14)X12DSQ + B(15)X13DSQ
+ B(16)X14DSQ + B(17)X15DSQ + B(18)X17DSQ + B(19)X19DSQ
+ B(20)X20DSQ + B(21)X21DSQ + B(22)LNX8 + B(23)LNX9
+ B(24)LNX11 + B(IK)LNX19

Y6 = NRTS (NOT REPAIRABLE THIS STATION)

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		2.639340 02							
1	X1M	6.354140 01	2.41D 01	2.6	0.9681	-2.7420-01	7.2600-01	1.0000 00	0.64
2	X2M	4.130390 01	2.35D 01	1.8	0.9662	-2.7400-01	7.2600-01	1.0000 00	0.41
3	X3M	-1.455390 01	7.220 00	2.0	0.6132	-2.4200-01	7.5800-01	1.0000 00	0.15
4	X5	2.787270 01	1.33D 01	2.1	0.3412	-2.8770-01	5.5030-01	7.5800-01	0.21
5	X16	-1.525190 00	2.290-01	6.7	0.7738	0.0	1.0000 02	1.0000 02	1.53
6	X9M	1.908980-02	4.52D-03	4.2	0.9317	-1.4450 03	6.7250 03	8.1700 03	1.56
7	X12M	-2.845490 01	5.80D 00	4.9	0.9993	-9.3310-01	5.7360 00	6.6690 00	1.99
8	X13M	-1.416960 00	2.33D-01	6.1	0.8698	-7.4800 00	9.2320 01	1.0000 02	1.42
9	X14M	-1.652870 00	2.24D-01	7.4	0.9427	-8.3500 01	3.6500 01	1.0000 02	1.65
10	X17M	-3.491970-01	1.870-01	1.9	0.7276	-1.1100 01	8.8900 01	1.0000 02	0.35
11	X20M	3.114550 01	1.58D 01	2.0	0.9520	-1.3500 00	6.5000-01	2.0000 00	0.62
12	X9DSQ	-2.919790-06	9.72D-07	3.0	0.7541	6.8120 04	2.3800 07	2.3740 07	0.89
13	X11DSQ	3.129250-06	1.23D-06	2.5	0.7678	4.7520 04	2.1870 07	2.1830 07	0.68
14	X12DSQ	3.171950 00	1.470 00	2.2	0.7423	9.3650-03	1.7350 01	1.7340 01	0.55
15	X13DSQ	-4.194610-02	1.34D-02	3.1	0.9238	8.4640-01	3.2490 03	3.2390 03	1.36
16	X14DSQ	5.327760-02	1.46D-02	3.7	0.9889	2.5900-01	2.5500 03	2.5500 03	1.36
17	X15DSQ	-3.352580-02	1.39D-02	2.4	0.9495	4.4890 01	2.9480 03	2.9440 03	0.97
18	X17DSQ	-5.156210-02	1.48D-02	3.5	0.9795	2.5600 02	3.4610 03	3.2250 03	1.66
19	X19DSQ	3.632510-05	1.44D-05	2.5	0.5611	2.8920 02	8.3910 05	8.3880 05	0.30
20	X20DSQ	1.841890 02	3.45D 01	5.3	0.9465	1.4750-01	1.9150 00	1.7680 00	1.84
21	X21DSQ	-9.880560-02	1.58D-02	6.2	0.5613	6.7880 01	1.1430 03	1.8760 03	1.85
22	LNX8	6.981490 00	2.590 00	2.7	0.7717	5.8390 00	1.2690 01	7.6580 00	0.53
23	LNX9	-6.344820 01	1.07D 01	5.9	0.9768	3.4810 00	9.8120 00	5.6110 00	3.56
24	LNX11	3.840490 01	6.340 00	6.1	0.9883	2.1970 00	8.9410 00	6.7440 00	2.59
25	LNX19	8.038810 00	2.540 00	2.4	0.6782	1.9460 00	7.4820 00	5.4570 00	0.33

NO. OF OBSERVATIONS	62
NO. OF IND. VARIABLES	25
RESIDUAL DEGREES OF FREEDOM	36
P-VALUE	0.0
RESIDUAL ROOT MEAN SQUARE	15.14933080
RESIDUAL MEAN SQUARE	229.50222367
RESIDUAL SUM OF SQUARES	8262.08005210
TOTAL SUM OF SQUARES	45910.96919355
MULT. CORREL. COEF. SQUARED	.8200

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	-2
6	-3
7	1
8	-2
9	-2
10	-2
11	1
12	-7
13	-7
14	1
15	-3
16	-3
17	-3
18	-3
19	-8
20	1
21	-3

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 6 DEP VAR 1: Y6 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 15.15

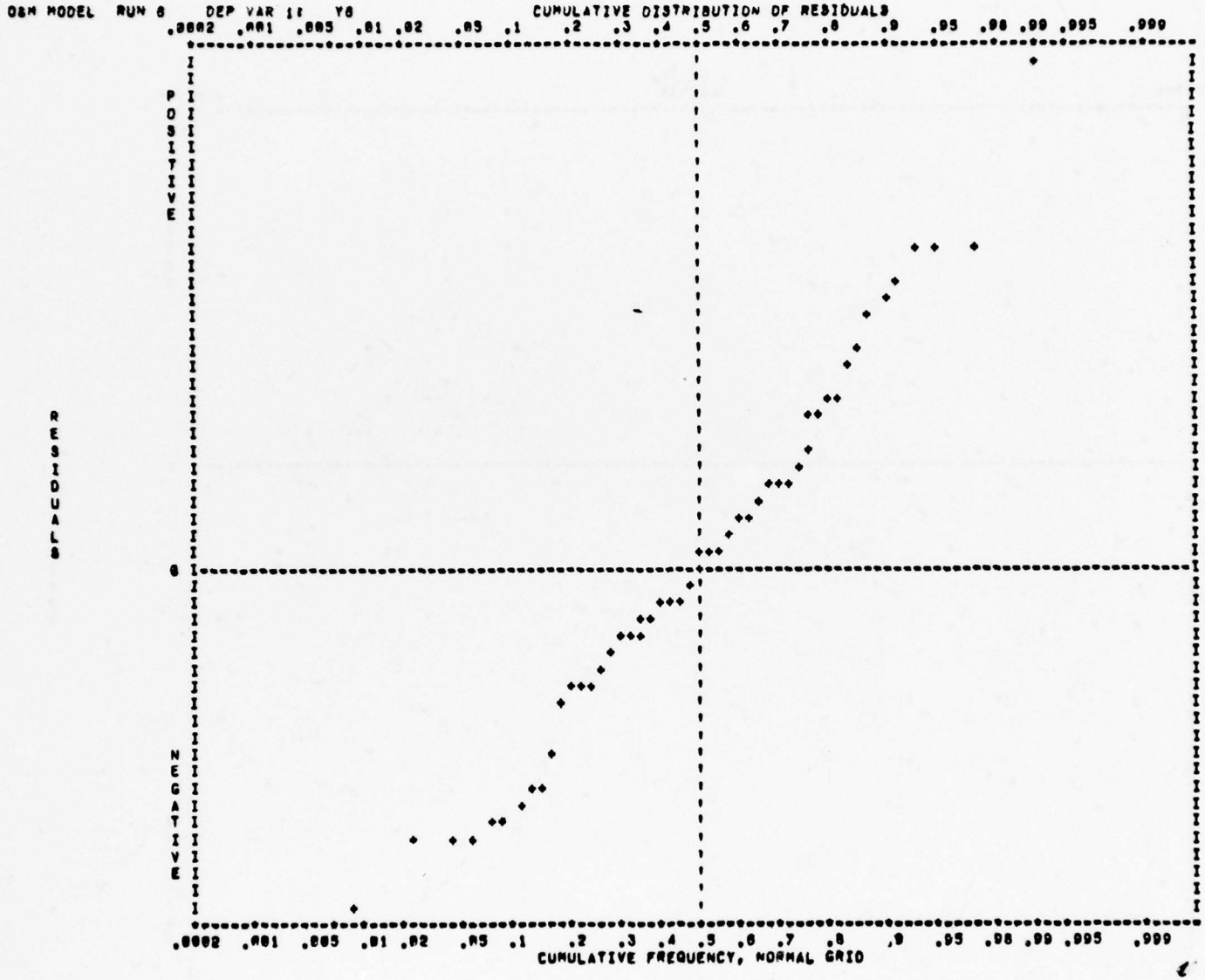
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

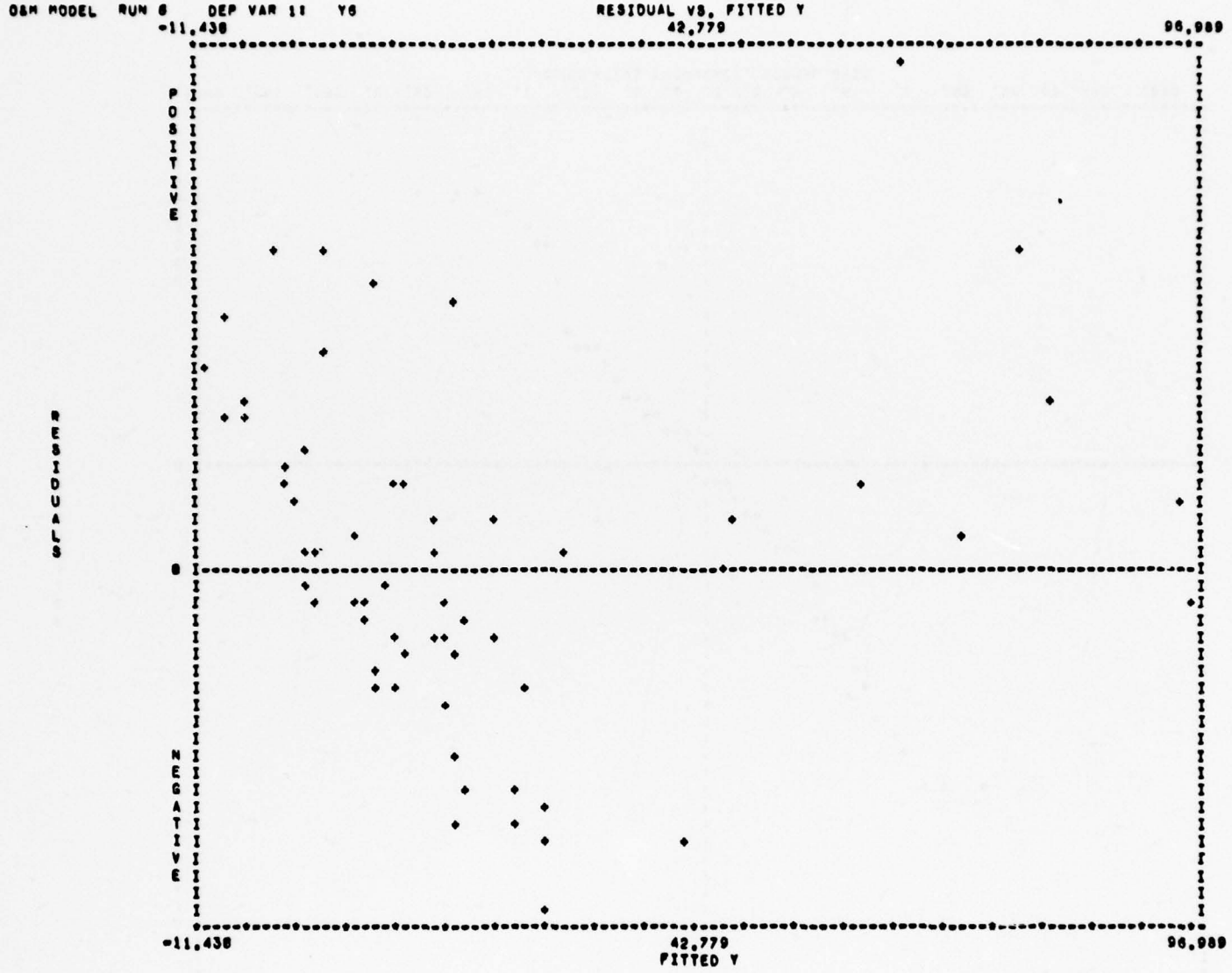
NO.	CUMULATIVE STD DEV	ORDERED BY WSSD: WSSD	OBSV.	OBSV.	DEL RESIDUALS	ORDERED BY FITTED Y: WSSD	DEL RESIDUALS	FITTED Y	OBSV.	SEQ.
1	0.0	0.0	61	60	0.0	207.17	3.12	-11.43	32	1
2	0.23	0.0	57	56	0.40	665.20	6.16	-7.55	7	2
3	1.01	0.01	37	27	2.21	215.39	0.92	-7.39	22	3
4	2.46	0.01	67	65	5.84	33.79	1.25	-5.31	6	4
5	2.65	0.48	27	67	2.95	68.04	10.63	-5.03	41	5
6	2.36	0.49	37	67	0.74	116.12	14.21	-2.69	24	6
7	2.50	0.60	27	65	2.88	104.54	1.66	-1.47	37	7
8	2.93	0.62	37	65	5.10	104.54	0.55	-0.81	17	8
9	3.23	2.16	5	58	4.85	0.44	2.95	-0.26	27	9
10	3.01	6.79	65	64	0.66	0.01	5.84	0.69	67	10
11	3.44	6.80	67	64	6.71	272.19	2.72	1.22	65	11
12	3.36	6.80	61	62	2.09	314.79	0.76	1.35	68	12
13	3.29	6.80	60	62	2.09	109.98	2.61	2.11	44	13
14	3.16	7.47	53	21	1.38	153.19	20.75	2.58	64	14
15	4.61	13.76	57	3	21.38	139.85	7.10	2.75	26	15
16	5.90	13.76	56	3	21.78	124.59	11.81	3.84	59	16
17	7.32	17.11	3	66	25.73	291.48	5.81	6.65	58	17
18	7.19	19.63	57	66	4.36	294.58	8.79	6.66	38	18
19	7.06	19.63	56	66	3.96	0.0	0.40	7.96	57	19
20	7.02	24.48	55	43	5.50	259.82	4.84	7.96	56	20
21	6.93	27.43	25	8	4.27	232.60	26.61	7.99	40	21
22	6.68	31.09	66	61	1.34	17.11	25.73	8.38	3	22
23	6.61	33.50	36	15	4.36	152.51	5.67	8.91	66	23
24	6.40	33.79	6	41	1.25	243.38	7.89	9.44	34	24
25	6.24	36.16	54	1	2.22	184.56	10.62	10.36	28	25
26	6.78	41.09	59	56	17.31	76.52	3.48	10.37	63	26
27	7.26	41.09	59	57	16.91	0.0	0.0	10.45	61	27
28	7.09	41.51	15	19	2.30	6.80	2.89	10.45	68	28
29	7.13	42.75	43	21	6.92	120.82	11.21	12.07	62	29
30	7.28	49.95	1	36	10.17	273.25	1.71	12.16	33	30
31	7.19	51.16	2	1	3.70	312.13	8.30	14.87	48	31
32	7.14	52.98	0	37	4.83	108.98	5.93	15.17	54	32
33	7.75	53.72	44	26	23.36	63.23	5.67	15.24	2	33
34	7.58	54.24	64	59	1.85	67.89	1.97	15.92	5	34
35	7.58	55.20	6	17	6.49	56.20	6.82	15.95	1	35
36	7.59	56.29	1	58	8.82	112.37	27.00	16.47	58	36
37	7.72	56.66	2	58	10.52	275.42	23.16	16.77	31	37
38	7.76	58.82	53	43	8.22	148.12	7.19	16.93	13	38
39	7.63	61.61	36	19	2.87	33.50	4.36	17.12	36	39
40	7.60	63.23	2	5	5.67	41.51	2.30	17.48	15	40
41	7.70	63.68	4	39	10.88	610.72	11.59	18.19	19	41
42	7.58	63.89	32	6	2.12	80.85	7.15	18.60	47	42
43	7.44	65.89	63	62	1.39	204.69	8.36	21.44	42	43
44	7.42	65.86	41	27	5.79	196.41	10.42	21.80	52	44
45	7.35	65.95	41	37	3.58	167.23	2.53	23.22	18	45
46	7.33	67.46	50	56	5.50	271.91	9.43	23.75	29	46
47	7.30	67.46	50	57	5.10	100.40	8.09	24.32	4	47
48	7.20	67.89	5	1	1.97	399.70	2.55	26.41	49	48
49	7.30	68.04	41	24	10.63	27.43	4.27	26.96	25	49
50	7.72	70.11	8	35	24.10	140.84	4.83	27.23	8	50
51	7.73	71.06	62	2	7.12	154.01	10.27	27.48	39	51
52	8.02	74.08	25	35	19.83	204.64	19.08	29.13	35	52
53	7.95	76.52	63	60	3.48	396.63	18.21	42.21	10	53
54	7.88	76.52	63	61	3.48	211.59	2.68	46.08	45	54
55	8.01	78.65	52	29	12.95	349.11	2.49	47.32	46	55
56	8.01	80.05	47	42	7.15	378.38	29.03	61.83	55	56
57	8.21	81.34	2	31	16.48	217.82	31.75	65.88	28	57
58	8.32	82.86	15	52	12.68	215.76	18.38	72.55	53	58
59	8.45	82.58	64	59	13.66	165.64	10.16	79.16	12	59
60	8.33	86.46	5	13	1.01	42.75	6.92	82.32	43	60
61	8.58	88.42	44	59	16.26	157.01	6.74	96.25	21	61
62	8.44	88.78	58	13	3.84	360.61	3.84	96.99	11	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL RUN 6 DEP VAR 11 Y6

ORDERED BY COMPUTER INPUT						ORDERED BY RESIDUALS				
IDENT.	OBSV.	NSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
71820	1	26.	13,000	15,948	-2,948	20	100,000	65,800	34,200	1
73530	2	57.	16,000	15,244	0,756	26	24,000	2,747	21,253	2
71L80	3	35.	27,000	8,379	18,621	12	100,000	79,163	20,837	3
71M60	4	70.	16,000	24,322	-8,322	24	18,000	-2,686	20,686	4
71PK0	5	37.	11,000	15,917	-4,917	3	27,000	8,379	18,621	5
71P80	6	24.	6,000	-5,306	11,306	31	34,000	16,766	17,234	6
71710	7	212.	9,000	-7,549	16,549	7	9,000	-7,549	16,549	7
724G0	8	108.	4,000	27,230	-23,230	59	17,200	3,043	14,157	8
71FA0	10	162.	24,000	42,214	-18,214	32	2,000	-11,430	13,430	9
71F8P	11	96.	94,000	96,989	-2,989	6	6,000	-5,306	11,306	10
71CA0	12	92.	100,000	79,163	20,837	43	93,000	82,324	10,676	11
710A0	13	89.	11,000	16,930	-5,930	22	3,000	-7,385	10,385	12
71ABE	15	58.	0.0	17,482	-17,482	41	5,000	-5,055	10,055	13
71ADA	17	61.	4,000	-0,811	4,811	67	8,100	0,886	7,214	14
73D8A	18	155.	8,000	23,215	-15,215	37	5,000	-1,471	6,471	15
71ACC	19	161.	3,000	18,187	-15,187	28	16,000	10,357	5,643	16
73C80	20	264.	100,000	65,800	34,200	55	67,000	61,829	5,171	17
73CE0	21	169.	100,000	96,245	3,755	33	17,000	12,162	4,838	18
73CFK	22	214.	3,000	-7,385	10,385	17	4,000	-0,811	4,811	19
73DAH	24	105.	18,000	-2,686	20,686	27	4,000	-0,260	4,260	20
73E8A	25	119.	8,000	26,960	-18,960	21	100,000	96,245	3,755	21
73E8F	26	59.	24,000	2,747	21,253	42	25,000	21,442	3,558	22
71CA0	27	45.	4,000	-0,260	4,260	48	18,000	14,869	3,131	23
72EAA	28	158.	16,000	10,357	5,643	46	50,000	47,317	2,683	24
72ECA	29	136.	6,000	23,750	-17,750	53	75,000	72,547	2,453	25
728P0	31	116.	34,000	16,766	17,234	50	9,000	6,655	2,345	26
71JA0	32	54.	2,000	-11,430	13,430	65	2,000	1,224	1,376	27
71L40	33	113.	17,000	12,162	4,838	35	30,000	29,132	0,868	28
720N0	34	112.	8,000	9,443	-1,443	2	16,000	15,244	0,756	29
72AC0	35	49.	30,000	29,132	0,868	64	3,000	2,500	0,500	30
71710	36	66.	4,000	17,128	-13,128	45	46,000	46,000	0,000	31
71310	37	46.	5,000	-1,471	6,471	68	0.0	1,345	-1,345	32
72RF0	38	177.	4,000	6,661	-2,661	34	6,000	9,443	-1,443	33
72R80	39	81.	9,000	27,482	-18,482	44	0.0	2,106	-2,106	34
75930	40	139.	0.0	7,093	-7,093	38	4,000	6,661	-2,661	35
74B00	41	62.	5,000	-5,055	10,055	57	5,200	7,956	-2,756	36
746F0	42	132.	25,000	21,442	3,558	1	13,000	15,948	-2,948	37
74810	43	120.	93,000	82,324	10,676	11	94,000	96,989	-2,989	38
78A10	44	50.	0.0	2,106	-2,106	56	4,800	7,956	-3,156	39
76GA0	45	307.	46,000	46,000	0,000	47	15,800	18,595	-3,595	40
74FF0	46	268.	50,000	47,317	2,683	52	17,000	21,798	-4,798	41
74FA0	47	234.	15,000	18,595	-3,595	5	11,000	15,917	-4,917	42
74FH0	48	187.	18,000	14,869	3,131	63	5,400	10,373	-4,973	43
74FU0	49	189.	10,000	26,407	-16,407	54	10,000	15,171	-5,171	44
77EC0	50	42.	9,000	6,655	2,345	13	11,000	16,930	-5,930	45
770CA	52	61.	17,000	21,798	-4,798	62	5,700	12,067	-6,367	46
77DB0	53	213.	75,000	72,547	2,453	66	1,800	8,913	-7,113	47
73CR0	54	66.	10,000	15,171	-5,171	40	0.0	7,993	-7,993	48
73CG0	55	113.	67,000	61,829	5,171	4	16,000	24,322	-8,322	49
71NA0	56	46.	4,800	7,956	-3,156	60	2,000	10,453	-8,453	50
710U0	57	46.	5,200	7,956	-2,756	61	2,000	10,453	-8,453	51
63AA0	58	32.	6,700	16,466	-9,766	58	6,700	16,466	-9,766	52
65AA0	59	56.	17,200	3,043	14,157	36	4,000	17,128	-13,128	53
63AAA	60	52.	2,000	10,453	-8,453	19	3,000	18,187	-15,187	54
63CAA	61	52.	2,000	10,453	-8,453	18	8,000	23,215	-15,215	55
65AAA	62	48.	5,700	12,067	-6,367	49	10,000	26,407	-16,407	56
6186A	63	67.	5,400	10,373	-4,973	15	0.0	17,482	-17,482	57
658AA	64	43.	3,000	2,500	0,500	20	6,000	23,750	-17,750	58
63AF0	65	47.	2,600	1,224	1,376	18	24,000	42,214	-18,214	59
63AA0	66	35.	1,000	8,913	-7,113	39	9,000	27,482	-18,482	60
63121	67	47.	8,100	0,886	7,214	25	8,000	26,960	-18,960	61
63AAA	68	240.	0.0	1,345	-1,345	8	4,000	27,230	-23,230	62


O&M MODEL RUN 8 DEP VAR IS Y8
CUMULATIVE DISTRIBUTION OF RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
POSITIVE
0
NEGATIVE
RESIDUALS
.0002 .001 .005 .01 .02 .05 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .98 .99 .995 .999
CUMULATIVE FREQUENCY, NORMAL GRID


O&M MODEL RUN 6 DEP VAR 11 Y6
RESIDUAL VS. FITTED Y
-11,438
42,779
96,989
POSITIVE
RESIDUALS
0
NEGATIVE
-11,438
42,779
96,989
FITTED Y

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