NUREG/CR-1723
ORNL/NUREG/TM-412
Dist. Category R2

Contract No. W-7405-eng-26

Engineering Physics Division

A NONLINEAR SENSITIVITY AND UNCERTAINTY ANALYSIS IN SUPPORT OF THE BLOWDOWN HEAT TRANSFER PROGRAM

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Manuscript Completed - September 10, 1980

Date Published - November 1980

PREPARED FOR THE U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH
Washington, DC 20555
UNDER INTERAGENCY AGREEMENT DOE 40-551-75
NRC FIN No. B0125

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for the
DEPARTMENT OF ENERGY

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ABSTRACT

A nonlinear uncertainty analysis methodology based on the use of first and second order sensitivity coefficients is presented. As a practical demonstration, an uncertainty analysis of several responses of interest is performed for Test 177, which is part of a series of tests conducted at the Thermal-Hydraulic Test Facility (THTF) of the ORNL Engineering Technology Division Pressurized Water Reactor-Blowdown Heat Transfer (PWR-BDHT) program. These space- and time-dependent responses are: mass flow rate, temperature, pressure, density, enthalpy, and water quality - in several volumetric regions of the experimental facility.

The analysis shows that, over parts of the transient, the responses behave as linear functions of the input parameters; in these cases, their standard deviations are of the same order of magnitude as those of the input parameters. Otherwise, the responses exhibit nonlinearities and their standard deviations are considerably larger. The analysis also shows that the degree of nonlinearity of the responses is highly dependent on their volumetric locations.

I. INTRODUCTION

The purpose of this report is to present a nonlinear uncertainty analysis methodology based on the use of first and second order sensitivity coefficients and to illustrate its use in a practical application. The methods described in this report are new, although a general treatment of nonlinear uncertainty analysis has been studied.[1]

As a practical application, the methodology is employed to perform a sensitivity and uncertainty analysis of Test 177, which is one of a series of tests conducted at the THTF[2] facility of the Engineering Technology Division's PWR-BDHT[2] program. Using a locally modified version of the RELAP4 code (RLPSFLUX)[3] to model the experimental facility, sensitivity coefficients of a set of system responses to various input parameters have been determined. These coefficients have in turn been used to compute the uncertainty in the responses due to experimental uncertainties in the input parameters.

Since the uncertainty analysis of Test 177 presented here is only intended to serve as an illustration of the practical application of this methodology, rather crude estimates of the standard deviations of the input parameters were employed. Consequently, the calculated response uncertainties can be used to provide only a qualitative description of the physical behavior of the system. This is clearly not a limitation inherent to the methodology, but rather a reminder that a good uncertainty analysis must be based on credible estimates of the uncertainties in the basic data.

In Test 177 of the BDHT program, a bundle of electrically heated rods is subjected to a double-ended break simulating a LOCA with conditions (such as temperature and water pressure) approximatin those of a nuclear fuel bundle. The RELAP4 model of the test section of the

experimental facility is diagrammed in Fig. 1, with the bundle of heated rods contained in volumes 18 through 28. The calculations are bounded hydrodynamically by conditions calculated from data acquired in instrumented spool pieces located at junctions 36 and 38. A set of boundary condition heat fluxes, calculated by the ORINC code[4] from measured temperatures, are applied to the bundle as shown. The input parameters considered are the inlet and outlet mass flow rate, the enthalpy of the water at the inlet, and the heat fluxes. The system responses are the mass flow rate, temperature, pressure, enthalpy, density and water quality in various regions of the facility. Note that both the responses and the input parameters are the time-dependent quantities.

For each response, the following have been calculated:

1) First and second order sensitivity coefficients (with respect to each input parameter),
2) The expectation value of the response, and
3) The variance and standard deviation of the nominal and expectation value of the response (using sensitivity coefficients, and the variance of each parameter).

The uncertainty analysis methodology is described in Sections II and III and its limitations and advantages are discussed in Section IV. The procedures followed in the analysis are outlined in Section V, the pertinent results are presented in Section VI and the conclusions are summarized in Section VII.

II. SENSITIVITY COEFFICIENTS

The following nomenclature is adopted here for the purposes of sensitivity and uncertainty analysis:

$\bar{\sigma}_0$ = The vector whose components $\sigma_1, \ldots, \sigma_N$, are the set of nominal values of the N input parameters,

$\bar{\sigma}$ = The vector whose components $\sigma_1 + \Delta\sigma_1, \ldots, \sigma_N + \Delta\sigma_N$, are the set of perturbed values of the N input parameters,

$R(\bar{\sigma}_0)$ = The nominal value of the response

$R(\bar{\sigma})$ = The value of the response calculated using the set of perturbed parameters.

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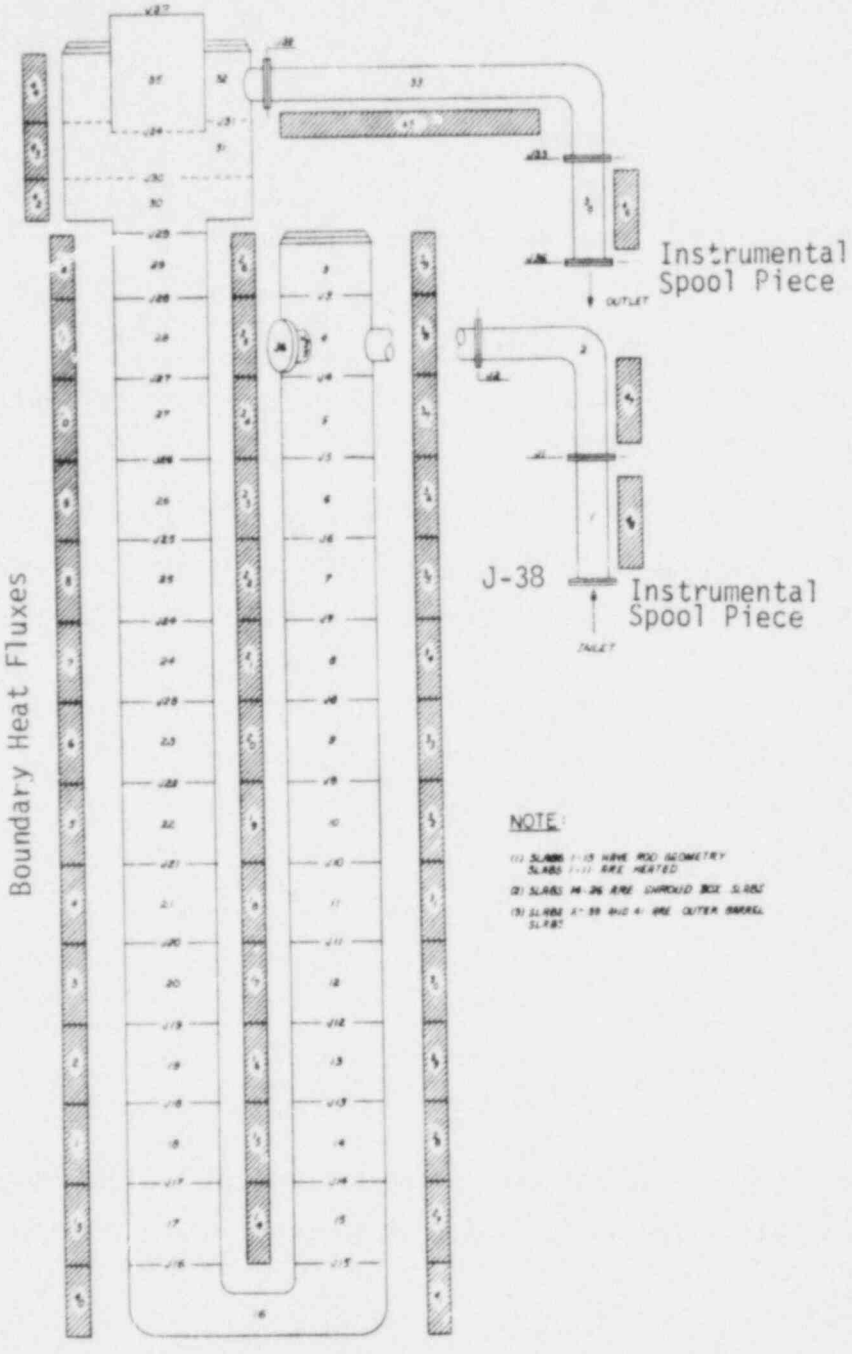

Fig. 1. THTF (11 axial nodes) single-channel test section model (core model).

Assuming the responses to be nonlinear functionals of the input parameters, the following second-order approximation is employed to represent the change ΔR in a response $R(\bar{\sigma})$ due to changes $\Delta\sigma_i$ in the parameters σ_i:

$$\Delta R = R(\bar{\sigma}) - R(\bar{\sigma}_o) \approx \sum_{i=1}^{N} \frac{\partial R}{\partial \sigma_i} \Delta\sigma_i + \frac{1}{2} \sum_{i=1}^{N} \sum_{j=i}^{N} \frac{\partial^2 R}{\partial \sigma_i \partial \sigma_j} \Delta\sigma_i \Delta\sigma_j \qquad (1)$$

The derivatives $\frac{\partial R}{\partial \sigma_i}$ and $\frac{\partial^2 R}{\partial \sigma_i \partial \sigma_j}$ are the required first and second order sensitivity coefficients, respectively. The second derivative will be termed a "mixed derivative", when $i \neq j$.

The first and second order derivatives, but not the mixed derivatives, are obtained by running the RELAP code twice for each input parameter. In the first run, the parameter σ_i is changed by $(+\Delta\sigma_i)$ giving a change in the response denoted by $\Delta R_{1,i}$ while in the second run σ_i is changed by $(-\Delta\sigma_i)$ with the corresponding response change denoted by $\Delta R_{2,i}$. For such runs, Eq. (1) shows that $\Delta R_{1,i}$ and $\Delta R_{2,i}$ are given by

$$\Delta R_{1,i} \approx \frac{\partial R}{\partial \sigma_i} \Delta\sigma_i + \frac{1}{2} \frac{\partial^2 R}{\partial \sigma_i^2} \Delta\sigma_i^2 \qquad (2)$$

and

$$\Delta R_{2,i} \approx - \frac{\partial R}{\partial \sigma_i} \Delta\sigma_i + \frac{1}{2} \frac{\partial^2 R}{\partial \sigma_i^2} \Delta\sigma_i^2 \qquad (3)$$

respectively. The system consisting of Eqs. (2) and (3) can be solved for the sensitivity coefficients, to obtain

$$\frac{\partial R}{\partial \sigma_i} \approx \frac{\Delta R_{1,i} - \Delta R_{2,i}}{2\Delta\sigma_i} , \qquad (4)$$

and

$$\frac{\partial^2 R}{\partial \sigma_i^2} \approx \frac{\Delta R_{1,i} + \Delta R_{2,i}}{\Delta\sigma_i^2} , \qquad (5)$$

respectively. For N input parameters this procedure requires 2N+1 RELAP runs, i.e. 2N runs using perturbed parameter values and 1 run using the reference values of the parameters.

The mixed derivatives are obtained in a similar manner, but by changing two input parameters at a time. Thus, changing the parameter σ_i by $+\Delta\sigma_i$ and the parameter σ_j by $+\Delta\sigma_j$ and running RELAP once gives a change in response denoted by $\Delta R_{3,ij}$. Then, according to Eq. (1), we have

$$\Delta R_{3,ij} \approx \frac{\partial R}{\partial \sigma_i}\Delta\sigma_i + \frac{\partial R}{\partial \sigma_j}\Delta\sigma_j + \frac{1}{2}\frac{\partial^2 R}{\partial \sigma_i^2}\Delta\sigma_i^2 + \frac{1}{2}\frac{\partial^2 R}{\partial \sigma_j^2}\Delta\sigma_j^2 + \frac{\partial^2 R}{\partial\sigma_i\partial\sigma_j}\Delta\sigma_i\Delta\sigma_j \tag{6}$$

$$= \Delta R_{1,i} + \Delta R_{1,j} + \frac{\partial^2 R}{\partial\sigma_i\partial\sigma_j}\Delta\sigma_i\Delta\sigma_j, \quad j\neq 1 \quad .$$

Equation (6) can therefore be used to obtain the mixed derivatives in terms of known quantities, i.e.

$$\frac{\partial^2 R}{\partial\sigma_i\partial\sigma_j} = \frac{\Delta R_{3,ij} - (\Delta R_{1,i} + \Delta R_{1,j})}{\Delta\sigma_i\Delta\sigma_j} \quad . \tag{7}$$

To compute all of the mixed derivatives for N input parameters would require $\frac{1}{2}N(N-1)$ RELAP runs. Hence to compute all of the first and second order derivatives would require $\frac{1}{2}N(N+3)+1$ runs.

III. NONLINEAR UNCERTAINTY ANALYSIS

The starting point for nonlinear uncertainty analysis is the Taylor expansion of the response around the nominal value $\bar{\sigma}_0$ of the input parameters. The second order approximation is given by

$$R \equiv R(\bar{\sigma}_0) + \sum_{i=1}^{N}\frac{\partial R}{\partial\sigma_i}\delta\sigma_i + \frac{1}{2}\sum_{i,j=1}^{N}\frac{\partial^2 R}{\partial\sigma_i\partial\sigma_j}\delta\sigma_i\,\delta\sigma_j \tag{8}$$

$$= R(\bar{\sigma}_0) + \sum_{i=1}^{N} S_i\,\delta\sigma_i + \frac{1}{2}\sum_{i,j=1}^{N} Q_{i,j}\,\delta\sigma_i\,\delta\sigma_j$$

where $R(\bar{\sigma}_o)$ is the nominal value of the response, and $\delta\sigma_i$ $(i=1,\ldots,N)$ are the variations in the input parameters.

The variance of R relative to $R(\bar{\sigma}_c)$ is given by:

$$\begin{aligned} \mathrm{var}[R(\bar{\sigma}_o)] = \langle [R-R(\bar{\sigma}_o)]^2 \rangle &= \sum_{i=1}^{N} S_i^2 \langle \delta\sigma_i^2 \rangle \\ &+ \sum_{\substack{i,j=1 \\ i\neq j}}^{N} S_i S_j \langle \delta\sigma_i \delta\sigma_j \rangle + \sum_{i,j,k=1}^{N} S_k Q_{ij} \langle \delta\sigma_k \delta\sigma_i \delta\sigma_j \rangle \\ &+ \frac{1}{4} \sum_{i,j=1}^{N} Q_{ij}^2 \langle (\delta\sigma_i \delta\sigma_j)^2 \rangle \\ &+ \frac{1}{4} \sum_{\substack{i,j,k,m=1 \\ i,j\neq k,m}}^{N} Q_{ij} Q_{km} \langle \delta\sigma_i \delta\sigma_j \delta\sigma_k \delta\sigma_m \rangle \end{aligned} \tag{9}$$

where

$$\langle [R-R(\bar{\sigma}_o)]^2 \rangle = \int \cdots \int [R-R(\bar{\sigma}_o)]^2 \, f(\sigma_1,\ldots,\sigma_N) \, d\sigma_1 \ldots d\sigma_N \quad , \tag{10}$$

$$\langle \delta\sigma_i^2 \rangle = \mathrm{Var}(\sigma_i) \quad , \tag{10a}$$

$$\langle \delta\sigma_i \delta\sigma_j \rangle = \mathrm{Cov}(\sigma_i \sigma_j) \quad , \tag{10b}$$

and $f(\sigma_1,\ldots,\sigma_N)$ is the joint continuous probability density function (p.d.f).

If the input parameters are uncorrelated, we have:

$$f(\sigma_1,\ldots,\sigma_N) = f_1(\sigma_1) \ldots f_N(\sigma_N) \quad . \tag{11}$$

Hence, the quantities $\langle \delta\sigma_i \delta\sigma_j \rangle$, $\langle \delta\sigma_i \delta\sigma_j \delta\sigma_k \rangle$, and $\langle \delta\sigma_i \delta\sigma_j \delta\sigma_k \delta\sigma_m \rangle$ are all equal to zero for $ij \neq km$, $im \neq jk$, and $ik \neq jm$. Thus for uncorrelated input parameters, Eq. (9) can be simplified and written as

$$\begin{aligned} \mathrm{var}[R(\bar{\sigma}_o)] = & \sum_{i=1}^{N} S_i^2 \langle \delta\sigma_i^2 \rangle + \frac{1}{4} \sum_{i=1}^{N} Q_{ii}^2 \langle \delta\sigma_i^4 \rangle \\ & + \frac{1}{4} \sum_{\substack{i,j=1 \\ i \neq j}}^{N} Q_{ij}^2 \langle (\delta\sigma_i \delta\sigma_j)^2 \rangle + \frac{1}{4} \sum_{\substack{i,j=1 \\ i \neq j}}^{N} Q_{ii} Q_{jj} \langle (\delta\sigma_i \delta\sigma_j)^2 \rangle \\ & + \frac{1}{4} \sum_{\substack{i,j=1 \\ i \neq j}}^{N} Q_{ij} Q_{ji} \langle (\delta\sigma_i \delta\sigma_j)^2 \rangle \end{aligned} \tag{12}$$

However, since $Q_{ij} = Q_{ji}$, and since

$$\begin{aligned} \langle (\delta\sigma_i \delta\sigma_j)^2 \rangle &= \int \cdots \int \delta\sigma_i^2 f_i(\sigma_i)\, d\sigma_i \int \delta\sigma_j^2 f_j(\sigma_j)\, d\sigma_j \\ &= \mathrm{var}(\sigma_i)\ \mathrm{var}(\sigma_j) \quad , \end{aligned} \tag{13}$$

equation (12) becomes

$$\begin{aligned} \mathrm{var}[R(\bar{\sigma}_o)] = & \sum_{i=1}^{N} S_i^2\ \mathrm{var}(\sigma_i) + \sum_{i>j} Q_{ij}^2\ \mathrm{var}(\sigma_i)\ \mathrm{var}(\sigma_j) \\ & + \frac{1}{2} \sum_{i>j} Q_{ii} Q_{jj}\ \mathrm{var}(\sigma_i)\ \mathrm{var}(\sigma_j) + \frac{1}{4} \sum_{i=1}^{N} Q_{ii}^2 \langle \delta\sigma_i^4 \rangle \ . \end{aligned} \tag{14}$$

If the p.d.f. are normal distribution functions, it can be shown that

$$\langle \delta\sigma_i^4 \rangle = 3 \langle \delta\sigma_i^2 \rangle^2 = 3[\mathrm{var}(\sigma_i)]^2 \tag{15}$$

For nonlinear problems, the expectation value of $R = \langle R \rangle = \bar{R}$ is not equal to $R(\bar{\sigma}_o)$; in fact, it can readily be shown that for a second order expansion the following relationship holds:

$$\bar{R} = \langle R \rangle = R(\bar{\sigma}_o) + \frac{1}{2} \sum_{i,j=1}^{N} Q_{ij} \langle \delta\sigma_i \delta\sigma_j \rangle \quad . \tag{16}$$

If the input parameters are uncorrelated, Eq. (16) reduces to

$$\bar{R} = R(\bar{\sigma}_o) + \frac{1}{2} \sum_{i=1}^{N} Q_{ii} \, \mathrm{var}(\sigma_i) \quad . \tag{17}$$

Taking into account Eq. (16), the variance of R relative to $\bar{R}$ can be determined as

$$\mathrm{var}(\bar{R}) = \langle (R - \bar{R})^2 \rangle = \mathrm{var}[R(\bar{\sigma}_o)]$$

$$- \frac{1}{4} \sum_{i,j=1}^{N} Q_{ij}^2 \langle \delta\sigma_i \delta\sigma_j \rangle \langle \delta\sigma_i \delta\sigma_j \rangle \tag{18}$$

$$- \frac{1}{4} \sum_{\substack{i,j,k,m=1 \\ ij \neq km}}^{N} Q_{ij} Q_{km} \langle \delta\sigma_i \delta\sigma_j \rangle \langle \delta\sigma_k \delta\sigma_m \rangle \quad .$$

For the case of uncorrelated input parameters Eq. (18) can also be simplified, to obtain

$$\mathrm{var}(\bar{R}) = \mathrm{var}[R(\bar{\sigma}_o)] - \frac{1}{4} \sum_{i=1}^{N} Q_{ii}^2 [\mathrm{var}(\sigma_i)]^2 \tag{19}$$

$$- \frac{1}{2} \sum_{i>j}^{N} Q_{ii} Q_{jj} \, \mathrm{var}(\sigma_i) \, \mathrm{var}(\sigma_j)$$

A simple comparison between Eqs. (19) and (14) reveals that $\mathrm{var}(\bar{R}) < \mathrm{var}[R(\bar{\sigma}_o)]$.

Thus, for uncorrelated input parameters, the variance of the response is dependent on the sensitivity coefficients and on the variances of the input parameters [of Eqs. (14) and (19)]. It should also be noted [c.f.Eq.(14)] that even if the input parameters are uncorrelated, the mixed derivatives Q_{ij} are still contributing to the variance of the response.

IV. ADVANTAGES AND LIMITATIONS OF THE METHODOLOGY

Since the methodlogy is based on a second order Taylor series expansion of the response about the nominal value of the input parameter, all sensitivity coefficients higher than second order are assumed to be negligible. For responses which behave linearly (or weakly nonlinearly) as functions of the input parameters, this is an adequate approximation. However, for responses which exhibit a strong nonlinearity the inclusion of only a single nonlinear term in the expansion is insufficient for a valid uncertainty analysis. (A number of such cases are presented and discussed in Section VI of this report). The above mentioned assumption also leads to loss of accuracy in systems where the uncertainties in the input parameters are very large (>100% of the parameter value), because the higher order derivatives in the expansion would be multiplied by large numbers and would give rise to non-negligible contributions.

A major factor in determing the practical usefulness of a methodology is the incurred cost. For this methodology, the cost is mainly determined by the number of computer runs needed to calculate all of the sensitivity coefficients. As has been shown in Section II, this number is $\frac{1}{2}N(N+3) + 1$, (where N is the number of independent input parameters); therefore, it is practical to employ this method only when N is not too large. However, this limitation is less severe as compared to those commonly used uncertainty analysis methods which are based on variations of the Factorial Stratified Sampling (FSS) approach.[5] The number of computer runs needed in the FSS approach is I^N, where I is the number of levels (intervals) associated with each input parameter. Even in the simplest case (i.e. when I = 2), the number of computer runs required

in methods utilizing the FSS approach quickly surpasses the number required in the new methodology as the number of input parameters increases. Comparatively, only the adjoint uncertainty analysis method[6] requires fewer computer runs than the methodology presented here.

In the application presented in this work, the number of input parameters is small (N = 12), but they are all time dependent. In order to correctly predict the time dependence of the response uncertainties, each input parameter at each time step should be treated as an independent parameter. However, this would lead to a total number of NK (where K is the number of time steps) independent parameters. Since there are 401 time steps in the Test 177 data, this problem would clearly be too large to address. However, the standard deviations of the input parameters are time independent (or at least constant over large time intervals). Therefore, sensitivity coefficients can be obtained from Eqs. 4, 5 and 7 by taking $\Delta\sigma_i$ (for each input parameter i) to be equal to the standard deviation (of the parameter i) for all time steps. Time dependent sensitivity coefficients for each parameter can thus be generated while reducing the number of independent parameters from NK to N. The uncertainty analysis is then applied to each time step independently, using the sensitivity coefficients calculated for that time step. Finally, it should be mentioned that in addition to the approximations discussed above, the present uncertainty analysis of Test 177 is based on the assumption that the input parameters are not correlated. This limitation is not inherent to the methodology, but has been necessitated due to the lack of data to describe such correlations.

In summary, the methodology presented in Sections II and III is accurate to second order and can easily be implemented in the analysis of complicated computer codes. In practice, however, it cannot be applied to problems involving a large number of input parameters and has not yet been employed to analyze problems involving correlated input parameters.

V. PROCEDURE

The 12 input parameters considered in this study are listed in Table 1 along with their 4-character identifiers (RELAP nomenclature) and their respective standard deviations. Also listed is the (percent) ratio of the standard deviation to the nominal value of the parameter at time zero. Table 2 lists the 21 system responses for which sensitivities were calculated. The responses in regions 27, 23 and 19 are near the top, middle and bottom of the heated core, respectively.

A fairly automated and general system was developed for producing sensitivity coefficients and response variances. This sytem consists of: (i) the RELAP code, (ii) several auxiliary codes[7,8] for manipulating the input to and output from RELAP, and (iii) several interactive programs[9] to perform the sensitivity and uncertainty analysis. The steps followed in generating the sensitivities and variances for each response are outlined below.

(1) Make the appropriate change in the input parameter. If the parameter is one of the heat fluxes, the REDSEL[7] program is used. If the parameter is the inlet enthalpy or the inlet or outlet mass flow, the interactive program RLPCRE[9] (on the PDP-10) is used.

(2) Run the RELAP code and use the REDPLOT program[8] to produce a card-image file containing the 21 desired responses.

(3) Produce an unformatted (binary) file on the PDP-10 from the card image file of step 2.

(4) Calculate the first and second order sensitivity coefficients by using the two response files corresponding to positive and negative parameter changes, and the file with the reference response values and place them in a binary file on the PDP-10 for later use.

(5) Calculate the expectation value of each response and the standard deviation of the nominal and expectation value of the response by using the sensitivity coefficients (for all the input parameters) generated in step 4.

Table 1. Input Parameters

Parameter	Identifier	Standard Deviation[10]	Standard Deviation/ Parameter at t=0 (%)
Inlet mass flux	JW38	45 $\frac{lb}{sec\text{-}ft^2}$	6.5
Outlet mass flux	JW36	75 $\frac{lb}{sec\text{-}ft^2}$ for $0 \leq t \leq 1.55$ sec	11.0
		85 $\frac{lb}{sec\text{-}ft^2}$ for $1.55 < t \leq 2.7$ sec	
		30 $\frac{lb}{sec\text{-}ft^2}$ for $t > 2.7$ sec	
Inlet enthalpy	JH38	8 $\frac{Btu}{lb}$	1.5
Heat flux #3	FR03	25000 $\frac{Btu}{hr\text{-}ft^2}$ for $0 \leq t \leq 0.5$ sec	7.1
		7900 $\frac{Btu}{hr\text{-}ft^2}$ for $t > 0.5$ sec	

Heat fluxes #4 through #11 have the same standard deviation as #3, and have the identifiers FR04, FR05, FR06, FR07, FR08, FR09, FR10 and FR11, respectively.

Table 2. System Responses

Response(s)	Identifier(s)
Pressure in volumes 27, 23, 19, 32	AP27, AP23, AP19, AP32
Temp. in volumes 27, 23, 19, 2, 16	AT27, AT23, AT19, AT02, AT16
Water density in volumes 27, 23, 19	AR27, AR23, AR19
Enthalpy in volumes 27, 23, 19	AH27, AH23, AH19
Water quality in volumes 27, 23, 19	AX27, AX23, AX19
Mass flow through junctions 27, 23, 19	JW27, JW23, JW19

VI. RESULTS

The nominal and expectation values of each of the responses specified in Table 1 as well as their standard deviations are listed in Appendix A as functions of time. (Expectation values are labeled "average".) All these quantities have been calculated according to the formalism outlined in Section III of this report; however, the contributions due to the terms containing mixed derivative have been considered to be negligible.

It has been found that, if the calculated nominal and expectation values of a response differ by a small amount only, the second order derivatives are small and the response is linear with respect to changes in the respective input parameters. In most of such cases, it has also been found that the first order derivatives are small. Although "pathological" cases could be found such that the first and second order derivatives are both small while the mixed derivative is large, this was assumed not to be the case in the present analysis. The validity of this assumption has been confirmed by calculating the mixed derivatives for several of those cases which were judged to be most likely "pathological" (in the above sense); these mixed derivatives have been found to be quite small.

For comparison purposes, the resonse is considered "linear" with respect to the input parameters if the expectation value is within 10% of the nominal value. This criterion is intended to serve merely as a guideline regarding the behvaior of the response. Conclusions based onthe numerical results presented in the Appendix can now be drawn for each of the responses.

Pressure

For all volumes considered, the pressure can be considered to be a "linear" function of the input parameters. The nominal and expectation values do not differ by more than 10%; most of the time, in fact, the difference is below 3%. It is a general trend of all of the responses that the departure from linearity is time - and position - dependent. For example, a slight nonlinearity can be noticed at 1.55 seconds into

the transient. At this point in time, the difference between nominal and expectation values reaches 9.5% for the volume at the middle of the heated core, while the difference immediately before and after this point is 1-2%. The position effects are also noticeable, with differences between the nominal and the expectation values being lower at the top and bottom of the heated core than in the middle.

The ratio between the standard deviation and the value of a response is a relative measure of the uncertainty of the response. For the pressure, which can be considered to be a linear response, the calculated values of the standard deviations of the nominal and expectation values, respectively, differ also by a small amount only. As will be seen later, this is not so for non-linear cases. However the time variation of the standard deviation is markedly in contrast to the time variation of the difference between the nominal and expectation values of the response; the values of the standard deviation ranging from about 2% of the response value in the middle to about 10% of the response value at the ends of that portion of the transient we have analyzed. Due to the essentially linear behavior of the response, the calculated standard deviation of the pressure is considered to be quite accurate.

Temperature

The temperature in a volume shows larger variations both in time and position than the pressure. Thus, consider the response to be the temperature at the top of the heated core, i.e. in volume 27. This response may be considered as linear up to about 2.4 seconds into the transient. After this point, the expectation value departs rapidly from the nominal value, becoming too high by a factor of two at 2.75 seconds. As with the pressure, the standard deviations of the nominal and expectation values are very close over the range where the temperature behaves linearly, but the time variation is different. The ratio between the standard deviation and the resonse value ranges from very low (.25%) at the beginning of the transient to about 2% at the limit of linearity. Beyond this point, the standard deviation

approaches the value of the response itself; at the same time, the expectation value of the response becomes significantly lower than the nominal value of the response. The latter effect is apparently due to the fact that the omission of the mixed derivative has resulted in an underestimation of the standard deviation.

The spatial behavior of the temperature is similar to that displayed by the pressure. Thus, the temperature is somewhat more non-linear in the middle of the heated core than at the top and bottom; in time the departure from linearity becomes pronounced at 1.3 seconds into the transient in volumes 19 and 23, and at 2.1 seconds in volume 16. Beyond this point, the responses show the same trend as in volume 27. Outside of the heated core the temperature in volume 2 is linear at all times.

Density

Unlike the pressure and temperature responses, the water density in volume 27 displays a very pronounced variation in time. The difference between the nominal and expectation value varies between a low of 2% and a high of 15% for times greater than 0.25 seconds, at which point in time flow reversal takes place in the system. Before this point in time, the inlet flow is still into the system and the response is very linear, with differences less than .4%. Similarly, the ratio between the values of the standard deviation and the response is very low before 0.25 seconds, but thereafter increases in time, approaching 100% at 2.75 seconds.

The behavior of density as a function of position is also different than that of the pressure and temperature responses. The non-linearity of this response becomes more pronounced towards the bottom of the heated core. At 2.75 seconds, for example, the difference between the nominal and the expectation values is 9% at the top of the core, 18% in the middle and 22% at the bottom. It is therefore apparent that the water density can no longer be considered to be a linear response after the point of flow reversal.

Enthalpy

Up to the time of flow reversal (i.e. at 0.25 seconds) the enthalpy behaves linearly with respect to the input parameters. After flow reversal takes place the code calculates the functions which determine the enthalpy internally regardless of the values of the input parameters. Thus the results presented for the enthalpy represent, in fact the average change in the enthalpy due to the changes in the input parameters in the first 0.25 seconds. They should not be interpreted as "standard deviation" in the usual sense.

Water Quality

The spatial variation of the water quality is roughly similar for all three volumes (i.e. volumes 27, 23 and 19). In time the departure from linearity occurs at about 1.4 seconds for all three volumes. It should be noted, however, that the absolute magniude of the standard deviation is quite large, being about the same order (of magnitude) as the absolute magnitude of the response itself.

Junction Mass Flow Rates

The mass flow rate in all volumes considered is clearly linear up through 0.15 seconds, but becomes markedly non-linear at all later times. This phenomenon is undoubtedly related to the flow reversal at 0.25 seconds. The standard deviations are about 10% of the response values in the linear range, and 100% or more in the non-linear range. The effects of position (in the heated core) are negligible.

VII. SUMMARY AND CONCLUSIONS

The sensitivity coefficients of a set of system responses to variations in several input parameters have been calculated and used to determine the standard deviations of the responses due to the uncertainties in the parameters. It has been shown that each response can be considered to be linear over only a portion of the transient; the approximate equality between the nominal and expectation values of the response has been used here as the criterion to define linear

behavior. For most of the responses the position in the system at which the response is calculated has been found to influence their behavior.

Over the time range when a particular response can be considered linear, the standard deviation of the response has been found to be of about the same order of magnitude as the standard deviations of the individual input parameters. However, when the response becomes nonlinear, its estimated standard deviation has, in most instances, been found to be much larger than the standard deviations of the input parameters. It is also noted that the standard deviations of the responses are in general underestimated due to the omission of the mixed derivative terms. Additional investigations of the contribution arising from the mixed derivative term would clearly be required to obtain more accurate values for the standard deviations of markedly nonlinear responses.

ACKNOWLEDGEMENTS

This work was initiated by W. G. Craddick. The authors thank W. G. Craddick, F. G. Perey, E. M. Oblow, J. J. Wagschal and C. R. Weisbin for reviewing and criticizing earlier drafts of this report. Thanks are also due C. B. Mullins for his help in performing this work.

Special thanks are due Ann Houston for typing this report.

REFERENCES

1. F. G. Perey, "Introduction to Probability Theory and Applications to Neutron and Reactor Physics Problems," lecturer's notes, unpublished, 1979.

2. "Project Description, ORNL PWR Blowdown Heat Transfer Separate-Effects Program — Thermal-Hydraulic Test Facility (THTF)," ORNL/NUREG/TM-218, November 1978.

3. S. B. Cliff, "RLPSFLUX - RELAP with Surface Flux Modifications," ORNL/NUREG/CSD-5, September 1978.

4. L. J. Ott and R. A. Hedrick, "ORINC — A One-Dimensional Implicit Approach to the Inverse Heat Conduction Problem," ORNL/NUREG-23, November 1977.

5. R. H. Myres, "Response Surface Methodology," Allyn and Bacon, Inc., Boston, 1971.

6. D. G. Cacuci, C. F. Weber, E. M. Oblow and J. H. Marable, *Nucl. Sci. Eng.*, 75, 88 (1980).

7. J. W. Teague, II, "REDSEL-RELAP Plot Tape and Engineering Units Tape Data Selection Routine," K/CSP/INF-79/7, April 1979.

8. L. J. Schlemper, internal memorandum, "Additions to REDPLOT Input Data," September 16, 1977.

9. M. A. Bjerke to Y. Ronen, internal memorandum, "Codes and Files on the PDP-10 for RELAP Sensitivity Analysis," March 26, 1980.

10. C. B. Mullins, private communication, 1980.

POOR ORIGINAL

Appendix

Standard Deviations of Nominal and Expectation Average Responses

RESPONSE = AP27 *

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	2.267E+03	2.267E+03	0.0E+00	0.0E+00
0.05	2.276E+03	2.273E+03	1.4E+02	1.4E+02
0.10	2.243E+03	2.231E+03	2.8E+02	2.8E+02
0.15	1.999E+03	2.027E+03	4.1E+02	4.1E+02
0.20	1.468E+03	1.564E+03	5.2E+02	4.3E+02
0.25	1.377E+03	1.317E+03	4.9E+01	3.2E+01
0.30	1.371E+03	1.336E+03	3.2E+01	2.3E+01
0.35	1.362E+03	1.351E+03	2.0E+01	2.0E+01
0.40	1.360E+03	1.355E+03	1.2E+01	1.2E+01
0.45	1.363E+03	1.348E+03	1.8E+01	1.4E+01
0.50	1.358E+03	1.352E+03	1.9E+01	1.9E+01
0.55	1.363E+03	1.347E+03	2.1E+01	1.8E+01
0.60	1.358E+03	1.371E+03	2.3E+01	2.1E+01
0.65	1.358E+03	1.359E+03	2.2E+01	2.2E+01
0.70	1.355E+03	1.354E+03	2.3E+01	2.3E+01
0.75	1.355E+03	1.338E+03	2.7E+01	2.4E+01
0.80	1.350E+03	1.354E+03	2.9E+01	2.9E+01
0.85	1.345E+03	1.349E+03	2.9E+01	2.9E+01
0.90	1.346E+03	1.332E+03	3.5E+01	3.1E+01
0.95	1.337E+03	1.346E+03	3.5E+01	3.5E+01
1.00	1.334E+03	1.341E+03	3.4E+01	3.4E+01
1.05	1.332E+03	1.329E+03	3.9E+01	3.9E+01
1.10	1.326E+03	1.336E+03	4.0E+01	3.9E+01
1.15	1.326E+03	1.317E+03	4.5E+01	4.4E+01
1.20	1.320E+03	1.322E+03	4.5E+01	4.5E+01
1.25	1.316E+03	1.316E+03	4.7E+01	4.8E+01
1.30	1.314E+03	1.311E+03	5.0E+01	5.0E+01
1.35	1.310E+03	1.308E+03	5.0E+01	5.0E+01
1.40	1.308E+03	1.285E+03	5.9E+01	5.7E+01
1.45	1.298E+03	1.279E+03	6.3E+01	6.2E+01
1.50	1.286E+03	1.266E+03	6.7E+01	6.6E+01
1.55	1.257E+03	1.339E+03	8.8E+01	7.1E+01
1.60	1.263E+03	1.285E+03	6.2E+01	6.1E+01
1.65	1.253E+03	1.273E+03	5.8E+01	5.7E+01
1.70	1.255E+03	1.211E+03	6.6E+01	6.0E+01
1.75	1.242E+03	1.236E+03	6.2E+01	6.1E+01
1.80	1.235E+03	1.212E+03	6.7E+01	6.5E+01
1.85	1.223E+03	1.225E+03	6.7E+01	6.7E+01
1.90	1.215E+03	1.227E+03	6.7E+01	6.7E+01
1.95	1.211E+03	1.205E+03	6.8E+01	6.8E+01
2.00	1.206E+03	1.193E+03	7.1E+01	7.1E+01
2.05	1.199E+03	1.183E+03	7.4E+01	7.4E+01
2.10	1.191E+03	1.189E+03	7.6E+01	7.6E+01
2.15	1.185E+03	1.179E+03	7.7E+01	7.7E+01
2.20	1.180E+03	1.169E+03	8.0E+01	8.0E+01
2.25	1.176E+03	1.163E+03	8.3E+01	8.3E+01
2.30	1.170E+03	1.156E+03	8.6E+01	8.5E+01
2.35	1.164E+03	1.156E+03	8.6E+01	8.6E+01
2.40	1.157E+03	1.158E+03	8.7E+01	8.7E+01
2.45	1.155E+03	1.147E+03	8.8E+01	8.8E+01
2.50	1.153E+03	1.142E+03	9.0E+01	9.0E+01
2.55	1.150E+03	1.136E+03	9.3E+01	9.3E+01
2.60	1.146E+03	1.135E+03	9.4E+01	9.4E+01
2.65	1.141E+03	1.134E+03	9.5E+01	9.5E+01
2.70	1.139E+03	1.131E+03	9.8E+01	9.8E+01
2.75	1.136E+03	1.125E+03	9.9E+01	9.8E+01

*See Table 2 (p. 12) for definition of AP27 and subsequent identifiers.

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AT27

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.855E+02	5.855E+02	0.0E+00	0.0E+00
0.05	5.851E+02	5.850E+02	9.9E-01	9.9E-01
0.10	5.844E+02	5.842E+02	2.0E+00	2.0E+00
0.15	5.831E+02	5.831E+02	2.9E+00	2.9E+00
0.20	5.811E+02	5.805E+02	3.8E+00	3.2E+00
0.25	5.830E+02	5.824E+02	1.5E+00	1.5E+00
0.30	5.843E+02	5.810E+02	3.1E+00	2.2E+00
0.35	5.834E+02	5.824E+02	1.9E+00	1.9E+00
0.40	5.832E+02	5.828E+02	1.2E+00	1.1E+00
0.45	5.836E+02	5.821E+02	1.7E+00	1.4E+00
0.50	5.831E+02	5.835E+02	1.8E+00	1.8E+00
0.55	5.835E+02	5.820E+02	2.0E+00	1.8E+00
0.60	5.830E+02	5.844E+02	2.2E+00	2.0E+00
0.65	5.831E+02	5.831E+02	2.1E+00	2.1E+00
0.70	5.828E+02	5.827E+02	2.3E+00	2.3E+00
0.75	5.828E+02	5.812E+02	2.6E+00	2.3E+00
0.80	5.823E+02	5.827E+02	2.8E+00	2.8E+00
0.85	5.819E+02	5.822E+02	2.8E+00	2.8E+00
0.90	5.819E+02	5.794E+02	3.5E+00	3.0E+00
0.95	5.811E+02	5.819E+02	3.4E+00	3.3E+00
1.00	5.808E+02	5.814E+02	3.3E+00	3.3E+00
1.05	5.806E+02	5.802E+02	3.8E+00	3.8E+00
1.10	5.800E+02	5.809E+02	3.9E+00	3.8E+00
1.15	5.800E+02	5.790E+02	4.4E+00	4.3E+00
1.20	5.794E+02	5.794E+02	4.8E+00	4.5E+00
1.25	5.790E+02	5.789E+02	4.7E+00	4.7E+00
1.30	5.788E+02	5.784E+02	5.0E+00	5.0E+00
1.35	5.784E+02	5.781E+02	4.9E+00	4.9E+00
1.40	5.782E+02	5.757E+02	5.9E+00	5.7E+00
1.45	5.772E+02	5.751E+02	6.3E+00	6.2E+00
1.50	5.761E+02	5.737E+02	6.8E+00	6.6E+00
1.55	5.731E+02	5.812E+02	8.8E+00	7.1E+00
1.60	5.737E+02	5.747E+02	6.2E+00	6.2E+00
1.65	5.727E+02	5.746E+02	5.9E+00	5.8E+00
1.70	5.729E+02	5.682E+02	6.8E+00	6.2E+00
1.75	5.715E+02	5.707E+02	6.3E+00	6.3E+00
1.80	5.702E+02	5.682E+02	7.0E+00	6.8E+00
1.85	5.696E+02	5.695E+02	6.9E+00	7.0E+00
1.90	5.687E+02	5.697E+02	7.0E+00	7.0E+00
1.95	5.683E+02	5.674E+02	7.2E+00	7.2E+00
2.00	5.678E+02	5.661E+02	7.5E+00	7.5E+00
2.05	5.671E+02	5.650E+02	7.9E+00	7.8E+00
2.10	5.662E+02	5.656E+02	8.1E+00	8.1E+00
2.15	5.656E+02	5.646E+02	8.3E+00	8.3E+00
2.20	5.651E+02	5.634E+02	8.6E+00	8.6E+00
2.25	5.646E+02	5.628E+02	9.0E+00	8.9E+00
2.30	5.640E+02	5.619E+02	9.3E+00	9.3E+00
2.35	5.633E+02	5.620E+02	9.4E+00	9.3E+00
2.40	5.626E+02	5.622E+02	9.5E+00	9.5E+00
2.45	5.624E+02	5.795E+02	1.5E+01	1.3E+01
2.50	5.621E+02	6.110E+02	4.5E+01	3.8E+01
2.55	5.618E+02	6.513E+02	8.6E+01	7.3E+01
2.60	5.613E+02	7.611E+02	1.9E+02	1.6E+02
2.65	5.608E+02	8.474E+02	2.8E+02	2.4E+02
2.70	5.606E+02	9.690E+02	4.0E+02	3.5E+02
2.75	5.603E+02	1.079E+03	5.1E+02	4.4E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AR27

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.439E+01	4.439E+01	0.0E+00	0.0E+00
0.05	4.442E+01	4.442E+01	7.1E-02	7.1E-02
0.10	4.444E+01	4.448E+01	1.3E-01	1.3E-01
0.15	4.432E+01	4.434E+01	1.8E-01	1.8E-01
0.20	4.396E+01	4.415E+01	2.4E-01	2.1E-01
0.25	4.368E+01	4.336E+01	3.6E-01	3.2E-01
0.30	4.196E+01	3.825E+01	3.7E+00	2.9E+00
0.35	3.762E+01	3.692E+01	2.6E+00	2.6E+00
0.40	3.420E+01	3.369E+01	2.2E+00	2.2E+00
0.45	3.116E+01	3.012E+01	2.4E+00	2.3E+00
0.50	2.759E+01	2.859E+01	2.2E+00	2.2E+00
0.55	2.484E+01	2.399E+01	2.1E+00	2.0E+00
0.60	2.169E+01	2.244E+01	2.0E+00	1.9E+00
0.65	1.907E+01	1.924E+01	1.9E+00	1.9E+00
0.70	1.664E+01	1.703E+01	1.6E+00	1.6E+00
0.75	1.476E+01	1.423E+01	1.6E+00	1.6E+00
0.80	1.264E+01	1.337E+01	1.6E+00	1.5E+00
0.85	1.109E+01	1.170E+01	1.3E+00	1.3E+00
0.90	1.003E+01	9.269E+00	1.4E+00	1.3E+00
0.95	8.546E+00	9.249E+00	1.3E+00	1.3E+00
1.00	7.626E+00	7.668E+00	1.1E+00	1.1E+00
1.05	6.793E+00	7.061E+00	1.1E+00	1.1E+00
1.10	6.150E+00	6.400E+00	9.9E-01	9.8E-01
1.15	5.603E+00	5.968E+00	9.9E-01	9.6E-01
1.20	5.170E+00	5.678E+00	9.7E-01	9.1E-01
1.25	4.952E+00	4.918E+00	8.8E-01	8.8E-01
1.30	4.611E+00	4.900E+00	1.1E+00	1.1E+00
1.35	4.333E+00	4.560E+00	1.0E+00	1.0E+00
1.40	4.179E+00	5.029E+00	1.3E+00	1.2E+00
1.45	4.123E+00	6.175E+00	2.2E+00	1.9E+00
1.50	4.469E+00	5.128E+00	1.5E+00	1.4E+00
1.55	5.451E+00	4.116E+00	2.1E+00	2.0E+00
1.60	6.049E+00	4.512E+00	3.3E+00	3.3E+00
1.65	5.616E+00	6.736E+00	3.0E+00	3.0E+00
1.70	6.384E+00	6.235E+00	2.7E+00	2.8E+00
1.75	6.205E+00	9.235E+00	4.1E+00	3.6E+00
1.80	6.850E+00	7.213E+00	3.4E+00	3.4E+00
1.85	7.420E+00	7.431E+00	3.7E+00	3.7E+00
1.90	7.882E+00	7.442E+00	4.6E+00	4.6E+00
1.95	7.867E+00	8.585E+00	4.8E+00	4.8E+00
2.00	7.796E+00	9.279E+00	4.9E+00	4.8E+00
2.05	8.240E+00	8.586E+00	4.8E+00	4.8E+00
2.10	8.481E+00	8.593E+00	5.2E+00	5.2E+00
2.15	8.886E+00	7.793E+00	5.5E+00	5.5E+00
2.20	8.773E+00	8.998E+00	5.8E+00	5.8E+00
2.25	8.737E+00	9.253E+00	6.0E+00	6.0E+00
2.30	8.833E+00	8.736E+00	6.0E+00	6.0E+00
2.35	8.931E+00	8.675E+00	6.2E+00	6.2E+00
2.40	9.165E+00	8.019E+00	6.5E+00	6.4E+00
2.45	9.041E+00	8.515E+00	6.7E+00	6.7E+00
2.50	8.750E+00	9.200E+00	6.9E+00	6.9E+00
2.55	8.650E+00	8.830E+00	7.0E+00	7.0E+00
2.60	8.546E+00	8.508E+00	7.0E+00	7.0E+00
2.65	8.485E+00	8.488E+00	7.1E+00	7.1E+00
2.70	8.488E+00	8.324E+00	7.3E+00	7.3E+00
2.75	8.149E+00	8.892E+00	7.5E+00	7.5E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AH27

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.930E+02	5.930E+02	0.0E+00	0.0E+00
0.05	5.924E+02	5.924E+02	9.3E-01	9.3E-01
0.10	5.916E+02	5.916E+02	1.8E+00	1.8E+00
0.15	5.907E+02	5.909E+02	2.6E+00	2.6E+00
0.20	5.901E+02	5.927E+02	3.2E+00	2.8E+00
0.25	5.931E+02	5.929E+02	2.1E+00	2.1E+00
0.30	5.968E+02	5.971E+02	2.6E+00	2.6E+00
0.35	6.012E+02	6.013E+02	3.1E+00	3.1E+00
0.40	6.063E+02	6.070E+02	3.7E+00	3.7E+00
0.45	6.125E+02	6.132E+02	4.5E+00	4.4E+00
0.50	6.202E+02	6.204E+02	5.2E+00	5.2E+00
0.55	6.289E+02	6.304E+02	6.3E+00	6.2E+00
0.60	6.400E+02	6.400E+02	7.0E+00	7.0E+00
0.65	6.528E+02	6.538E+02	8.7E+00	8.7E+00
0.70	6.676E+02	6.665E+02	9.5E+00	9.5E+00
0.75	6.831E+02	6.877E+02	1.3E+01	1.2E+01
0.80	7.048E+02	7.004E+02	1.5E+01	1.5E+01
0.85	7.260E+02	7.208E+02	1.7E+01	1.6E+01
0.90	7.453E+02	7.605E+02	2.4E+01	2.2E+01
0.95	7.775E+02	7.690E+02	2.8E+01	2.7E+01
1.00	8.048E+02	8.074E+02	3.0E+01	3.0E+01
1.05	8.360E+02	8.356E+02	3.7E+01	3.7E+01
1.10	8.646E+02	8.685E+02	4.2E+01	4.2E+01
1.15	8.959E+02	8.870E+02	4.9E+01	4.9E+01
1.20	9.233E+02	9.055E+02	5.4E+01	5.4E+01
1.25	9.385E+02	9.627E+02	6.1E+01	5.9E+01
1.30	9.669E+02	9.755E+02	7.8E+01	7.8E+01
1.35	9.923E+02	1.009E+03	8.9E+01	9.0E+01
1.40	1.008E+03	9.68bE+02	1.2E+02	1.3E+02
1.45	1.010E+03	8.908E+02	1.8E+02	1.7E+02
1.50	9.694E+02	9.746E+02	1.2E+02	1.3E+02
1.55	8.819E+02	1.089E+03	2.0E+02	1.6E+02
1.60	8.499E+02	1.116E+03	2.6E+02	2.1E+02
1.65	8.705E+02	9.507E+02	1.6E+02	1.5E+02
1.70	8.311E+02	9.587E+02	1.9E+02	1.8E+02
1.75	8.354E+02	8.500E+02	1.6E+02	1.6E+02
1.80	8.054E+02	9.192E+02	1.9E+02	1.8E+02
1.85	7.810E+02	9.255E+02	1.9E+02	1.7E+02
1.90	7.643E+02	9.806E+02	2.5E+02	2.2E+02
1.95	7.638E+02	9.355E+02	2.2E+02	2.0E+02
2.00	7.644E+02	9.31UE+02	2.3E+02	2.2E+02
2.05	7.502E+02	9.383E+02	2.3E+02	2.2E+02
2.10	7.417E+02	9.633E+02	2.6E+02	2.4E+02
2.15	7.307E+02	1.005E+03	3.0E+02	2.6E+02
2.20	7.320E+02	1.001E+03	3.1E+02	2.8E+02
2.25	7.316E+02	1.017E+03	3.3E+02	3.0E+02
2.30	7.280E+02	1.041E+03	3.5E+02	3.1E+02
2.35	7.242E+02	1.080E+03	3.9E+02	3.5E+02
2.40	7.176E+02	1.131E+03	4.4E+02	3.8E+02
2.45	7.197E+02	1.154E+03	4.7E+02	4.1E+02
2.50	7.254E+02	1.172E+03	4.9E+02	4.3E+02
2.55	7.209E+02	1.210E+03	5.2E+02	4.6E+02
2.60	7.283E+02	1.281E+03	5.9E+02	5.2E+02
2.65	7.285E+02	1.338E+03	6.5E+02	5.7E+02
2.70	7.278E+02	1.415E+03	7.2E+02	6.3E+02
2.75	7.356E+02	1.465E+03	7.7E+02	6.8E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AX<7

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.05	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.10	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.15	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.20	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.25	0.000E+00	5.549E-04	5.5E-04	4.8E-04
0.30	3.034E-03	1.134E-02	8.0E-03	6.0E-03
0.35	1.265E-02	1.513E-02	6.6E-03	6.5E-03
0.40	2.182E-02	2.410E-02	6.7E-03	6.5E-03
0.45	3.175E-02	3.626E-02	8.6E-03	8.0E-03
0.50	4.596E-02	4.530E-02	9.8E-03	9.8E-03
0.55	5.999E-02	5.580E-02	1.2E-02	1.1E-02
0.60	7.994E-02	7.738E-02	1.3E-02	1.3E-02
0.65	1.018E-01	1.033E-01	1.7E-02	1.7E-02
0.70	1.278E-01	1.260E-01	1.8E-02	1.8E-02
0.75	1.542E-01	1.648E-01	2.4E-02	2.3E-02
0.80	1.922E-01	1.837E-01	2.8E-02	2.9E-02
0.85	2.290E-01	2.193E-01	3.1E-02	3.1E-02
0.90	2.619E-01	2.912E-01	4.5E-02	4.1E-02
0.95	3.181E-01	3.018E-01	5.0E-02	5.0E-02
1.00	3.647E-01	3.675E-01	5.4E-02	5.4E-02
1.05	4.181E-01	4.166E-01	6.5E-02	6.5E-02
1.10	4.672E-01	4.716E-01	7.3E-02	7.3E-02
1.15	5.202E-01	5.042E-01	8.5E-02	8.5E-02
1.20	5.670E-01	5.350E-01	9.4E-02	9.3E-02
1.25	5.928E-01	6.318E-01	1.0E-01	1.0E-01
1.30	6.409E-01	6.525E-01	1.3E-01	1.3E-01
1.35	6.840E-01	7.093E-01	1.5E-01	1.5E-01
1.40	7.110E-01	6.416E-01	2.0E-01	2.1E-01
1.45	7.146E-01	5.128E-01	2.9E-01	2.8E-01
1.50	6.461E-01	6.536E-01	2.1E-01	2.1E-01
1.55	5.017E-01	8.393E-01	3.4E-01	2.7E-01
1.60	4.480E-01	8.841E-01	4.4E-01	3.5E-01
1.65	4.831E-01	6.093E-01	2.6E-01	2.5E-01
1.70	4.175E-01	6.258E-01	3.1E-01	3.0E-01
1.75	4.258E-01	4.431E-01	2.6E-01	2.7E-01
1.80	3.770E-01	5.924E-01	3.2E-01	3.0E-01
1.85	3.384E-01	5.677E-01	3.0E-01	2.8E-01
1.90	3.120E-01	6.557E-01	4.0E-01	3.5E-01
1.95	3.116E-01	5.843E-01	3.6E-01	3.3E-01
2.00	3.13AE-01	5.765E-01	3.7E-01	3.6E-01
2.05	2.910E-01	5.891E-01	3.8E-01	3.5E-01
2.10	2.784E-01	6.272E-01	4.2E-01	3.8E-01
2.15	2.614E-01	6.943E-01	4.8E-01	4.3E-01
2.20	2.643E-01	6.883E-01	5.0E-01	4.5E-01
2.25	2.643E-01	7.129E-01	5.3E-01	4.8E-01
2.30	2.593E-01	7.499E-01	5.6E-01	5.0E-01
2.35	2.541E-01	8.111E-01	6.2E-01	5.6E-01
2.40	2.488E-01	8.895E-01	7.0E-01	6.1E-01
2.45	2.482E-01	8.944E-01	7.1E-01	6.3E-01
2.50	2.578E-01	8.718E-01	6.9E-01	6.1E-01
2.55	2.606E-01	8.762E-01	6.9E-01	6.1E-01
2.60	2.634E-01	8.738E-01	6.8E-01	6.1E-01
2.65	2.645E-01	8.701E-01	6.8E-01	6.1E-01
2.70	2.637E-01	8.789E-01	6.9E-01	6.1E-01
2.75	2.766E-01	8.586E-01	6.7E-01	6.0E-01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AP23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	2.276E+03	2.276E+03	0.0E+00	0.0E+00
0.05	2.285E+03	2.282E+03	1.4E+02	1.4E+02
0.10	2.252E+03	2.242E+03	2.8E+02	2.8E+02
0.15	2.001E+03	2.028E+03	4.1E+02	4.1E+02
0.20	1.470E+03	1.918E+03	5.0E+02	4.3E+02
0.25	1.382E+03	1.272E+03	8.8E+01	5.7E+01
0.30	1.367E+03	1.377E+03	1.4E+01	1.4E+01
0.35	1.355E+03	1.400E+03	3.9E+01	2.6E+01
0.40	1.363E+03	1.350E+03	1.7E+01	1.5E+01
0.45	1.366E+03	1.352E+03	1.8E+01	1.5E+01
0.50	1.359E+03	1.369E+03	1.9E+01	1.8E+01
0.55	1.365E+03	1.347E+03	2.2E+01	1.9E+01
0.60	1.359E+03	1.370E+03	2.2E+01	2.1E+01
0.65	1.360E+03	1.349E+03	2.4E+01	2.3E+01
0.70	1.355E+03	1.360E+03	2.3E+01	2.3E+01
0.75	1.357E+03	1.343E+03	2.5E+01	2.3E+01
0.80	1.350E+03	1.354E+03	2.9E+01	2.9E+01
0.85	1.345E+03	1.354E+03	3.0E+01	2.9E+01
0.90	1.348E+03	1.320E+03	3.7E+01	3.2E+01
0.95	1.337E+03	1.346E+03	3.5E+01	3.4E+01
1.00	1.338E+03	1.336E+03	3.4E+01	3.4E+01
1.05	1.332E+03	1.327E+03	3.9E+01	3.9E+01
1.10	1.327E+03	1.333E+03	3.9E+01	3.9E+01
1.15	1.326E+03	1.315E+03	4.5E+01	4.4E+01
1.20	1.320E+03	1.323E+03	4.6E+01	4.6E+01
1.25	1.316E+03	1.316E+03	4.7E+01	4.7E+01
1.30	1.313E+03	1.316E+03	5.1E+01	5.1E+01
1.35	1.309E+03	1.309E+03	5.0E+01	5.0E+01
1.40	1.304E+03	1.282E+03	6.0E+01	5.8E+01
1.45	1.298E+03	1.283E+03	6.1E+01	6.1E+01
1.50	1.285E+03	1.269E+03	6.6E+01	6.6E+01
1.55	1.253E+03	1.372E+03	1.1E+02	7.2E+01
1.60	1.264E+03	1.280E+03	6.2E+01	6.2E+01
1.65	1.251E+03	1.277E+03	5.9E+01	5.7E+01
1.70	1.256E+03	1.210E+03	6.6E+01	6.0E+01
1.75	1.240E+03	1.243E+03	6.2E+01	6.2E+01
1.80	1.234E+03	1.215E+03	6.5E+01	6.5E+01
1.85	1.222E+03	1.226E+03	6.6E+01	6.6E+01
1.90	1.216E+03	1.214E+03	6.6E+01	6.6E+01
1.95	1.211E+03	1.205E+03	6.9E+01	6.9E+01
2.00	1.208E+03	1.196E+03	7.1E+01	7.1E+01
2.05	1.199E+03	1.181E+03	7.4E+01	7.3E+01
2.10	1.190E+03	1.190E+03	7.6E+01	7.6E+01
2.15	1.186E+03	1.176E+03	7.7E+01	7.7E+01
2.20	1.180E+03	1.168E+03	8.0E+01	8.0E+01
2.25	1.175E+03	1.164E+03	8.3E+01	8.2E+01
2.30	1.170E+03	1.155E+03	8.5E+01	8.5E+01
2.35	1.163E+03	1.156E+03	8.5E+01	8.5E+01
2.40	1.157E+03	1.157E+03	8.7E+01	8.7E+01
2.45	1.156E+03	1.145E+03	8.8E+01	8.8E+01
2.50	1.152E+03	1.143E+03	9.0E+01	9.0E+01
2.55	1.150E+03	1.136E+03	9.3E+01	9.3E+01
2.60	1.145E+03	1.135E+03	9.3E+01	9.3E+01
2.65	1.141E+03	1.133E+03	9.5E+01	9.5E+01
2.70	1.139E+03	1.128E+03	9.7E+01	9.7E+01
2.75	1.136E+03	1.125E+03	9.8E+01	9.8E+01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AT23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.615E+02	5.615E+02	0.0E+00	0.0E+00
0.05	5.618E+02	5.618E+02	1.0E+00	1.0E+00
0.10	5.621E+02	5.621E+02	2.0E+00	2.0E+00
0.15	5.621E+02	5.623E+02	2.8E+00	2.8E+00
0.20	5.623E+02	5.652E+02	3.7E+00	3.1E+00
0.25	5.679E+02	5.666E+02	2.4E+00	2.3E+00
0.30	5.745E+02	5.747E+02	2.7E+00	2.7E+00
0.35	5.815E+02	5.811E+02	2.8E+00	2.8E+00
0.40	5.836E+02	5.823E+02	1.6E+00	1.4E+00
0.45	5.839E+02	5.825E+02	1.7E+00	1.5E+00
0.50	5.832E+02	5.842E+02	1.9E+00	1.8E+00
0.55	5.837E+02	5.820E+02	2.1E+00	1.8E+00
0.60	5.831E+02	5.842E+02	2.1E+00	2.0E+00
0.65	5.833E+02	5.822E+02	2.3E+00	2.2E+00
0.70	5.828E+02	5.832E+02	2.2E+00	2.2E+00
0.75	5.830E+02	5.816E+02	2.4E+00	2.2E+00
0.80	5.823E+02	5.826E+02	2.8E+00	2.8E+00
0.85	5.818E+02	5.827E+02	2.9E+00	2.9E+00
0.90	5.821E+02	5.794E+02	3.6E+00	3.1E+00
0.95	5.811E+02	5.819E+02	3.4E+00	3.3E+00
1.00	5.809E+02	5.809E+02	3.3E+00	3.3E+00
1.05	5.806E+02	5.800E+02	3.8E+00	3.8E+00
1.10	5.801E+02	5.806E+02	3.8E+00	3.8E+00
1.15	5.800E+02	5.788E+02	4.4E+00	4.3E+00
1.20	5.794E+02	5.796E+02	4.5E+00	4.5E+00
1.25	5.790E+02	5.789E+02	4.6E+00	4.6E+00
1.30	5.787E+02	5.789E+02	5.1E+00	5.1E+00
1.35	5.783E+02	5.964E+02	1.7E+01	1.5E+01
1.40	5.782E+02	6.567E+02	6.5E+01	4.1E+01
1.45	5.801E+02	7.261E+02	1.2E+02	6.5E+01
1.50	6.054E+02	6.370E+02	8.1E+01	8.3E+01
1.55	5.948E+02	6.995E+02	1.2E+02	9.9E+01
1.60	6.785E+02	8.271E+02	2.0E+02	1.2E+02
1.65	5.876E+02	7.591E+02	1.6E+02	1.3E+02
1.70	5.730E+02	7.819E+02	1.9E+02	1.4E+02
1.75	5.714E+02	7.629E+02	1.8E+02	1.4E+02
1.80	5.708E+02	7.501E+02	1.6E+02	1.4E+02
1.85	5.695E+02	7.120E+02	1.4E+02	1.2E+02
1.90	5.688E+02	7.303E+02	1.6E+02	1.4E+02
1.95	5.684E+02	7.147E+02	1.4E+02	1.2E+02
2.00	5.677E+02	7.201E+02	1.5E+02	1.3E+02
2.05	5.671E+02	7.030E+02	1.3E+02	1.1E+02
2.10	5.661E+02	7.082E+02	1.4E+02	1.2E+02
2.15	5.657E+02	7.119E+02	1.4E+02	1.2E+02
2.20	5.651E+02	7.155E+02	1.5E+02	1.3E+02
2.25	5.645E+02	7.195E+02	1.5E+02	1.3E+02
2.30	5.640E+02	7.234E+02	1.6E+02	1.3E+02
2.35	5.633E+02	7.434E+02	1.8E+02	1.5E+02
2.40	5.626E+02	7.668E+02	2.0E+02	1.7E+02
2.45	5.624E+02	8.076E+02	2.4E+02	2.1E+02
2.50	5.621E+02	8.847E+02	3.2E+02	2.7E+02
2.55	5.618E+02	1.003E+03	4.4E+02	3.8E+02
2.60	5.613E+02	1.126E+03	5.6E+02	4.8E+02
2.65	5.608E+02	1.315E+03	7.5E+02	6.5E+02
2.70	5.606E+02	1.567E+03	1.0E+03	8.7E+02
2.75	5.603E+02	1.939E+03	1.4E+03	1.2E+03

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AR23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.614E+01	4.614E+01	0.0E+00	0.0E+00
0.05	4.613E+01	4.612E+01	5.3E-02	5.3E-02
0.10	4.608E+01	4.607E+01	1.0E-01	1.0E-01
0.15	4.589E+01	4.588E+01	1.6E-01	1.6E-01
0.20	4.544E+01	4.543E+01	2.0E-01	1.9E-01
0.25	4.493E+01	4.492E+01	1.6E-01	1.6E-01
0.30	4.441E+01	4.439E+01	2.2E-01	2.2E-01
0.35	4.380E+01	4.322E+01	7.3E-01	6.6E-01
0.40	3.812E+01	3.729E+01	3.9E+00	3.8E+00
0.45	3.191E+01	3.103E+01	3.2E+00	3.2E+00
0.50	2.644E+01	2.671E+01	3.2E+00	3.2E+00
0.55	2.236E+01	2.162E+01	2.7E+00	2.7E+00
0.60	1.869E+01	1.887E+01	2.4E+00	2.4E+00
0.65	1.585E+01	1.549E+01	2.1E+00	2.1E+00
0.70	1.334E+01	1.321E+01	1.9E+00	1.9E+00
0.75	1.134E+01	1.114E+01	1.6E+00	1.6E+00
0.80	9.695E+00	9.631E+00	1.5E+00	1.5E+00
0.85	8.348E+00	8.287E+00	1.3E+00	1.3E+00
0.90	7.204E+00	7.230E+00	1.2E+00	1.2E+00
0.95	6.314E+00	6.366E+00	1.0E+00	1.0E+00
1.00	5.595E+00	5.686E+00	9.4E-01	9.4E-01
1.05	5.022E+00	5.050E+00	8.7E-01	8.7E-01
1.10	4.546E+00	4.645E+00	8.1E-01	8.1E-01
1.15	4.208E+00	4.216E+00	7.8E-01	7.8E-01
1.20	3.921E+00	3.987E+00	7.3E-01	7.3E-01
1.25	3.660E+00	3.886E+00	7.1E-01	7.0E-01
1.30	3.490E+00	3.662E+00	6.7E-01	6.6E-01
1.35	3.338E+00	3.400E+00	6.4E-01	6.3E-01
1.40	3.186E+00	3.010E+00	6.8E-01	6.7E-01
1.45	3.006E+00	2.921E+00	6.8E-01	7.0E-01
1.50	2.761E+00	3.272E+00	8.7E-01	8.3E-01
1.55	2.757E+00	3.089E+00	8.5E-01	8.3E-01
1.60	2.901E+00	2.665E+00	9.9E-01	9.9E-01
1.65	2.801E+00	3.070E+00	1.1E+00	1.1E+00
1.70	3.005E+00	2.916E+00	1.1E+00	1.1E+00
1.75	3.003E+00	3.726E+00	1.4E+00	1.3E+00
1.80	3.203E+00	3.608E+00	1.4E+00	1.4E+00
1.85	3.424E+00	3.716E+00	1.6E+00	1.6E+00
1.90	3.665E+00	3.877E+00	2.0E+00	2.0E+00
1.95	3.799E+00	4.391E+00	2.3E+00	2.2E+00
2.00	3.919E+00	4.728E+00	2.4E+00	2.4E+00
2.05	4.171E+00	4.722E+00	2.5E+00	2.5E+00
2.10	4.363E+00	4.943E+00	2.8E+00	2.8E+00
2.15	4.596E+00	4.926E+00	3.0E+00	3.0E+00
2.20	4.689E+00	5.445E+00	3.3E+00	3.2E+00
2.25	4.804E+00	5.662E+00	3.5E+00	3.4E+00
2.30	4.948E+00	5.641E+00	3.5E+00	3.5E+00
2.35	5.068E+00	5.752E+00	3.7E+00	3.7E+00
2.40	5.180E+00	5.713E+00	3.8E+00	3.8E+00
2.45	5.198E+00	5.727E+00	3.9E+00	3.9E+00
2.50	5.141E+00	5.700E+00	4.0E+00	4.0E+00
2.55	5.018E+00	5.546E+00	4.0E+00	4.0E+00
2.60	4.817E+00	5.422E+00	4.0E+00	4.0E+00
2.65	4.560E+00	5.229E+00	3.9E+00	3.9E+00
2.70	4.303E+00	5.028E+00	3.8E+00	3.8E+00
2.75	4.079E+00	4.804E+00	3.8E+00	3.8E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AM23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.615E+02	5.615E+02	0.0E+00	0.0E+00
0.05	5.620E+02	5.620E+02	1.0E+00	1.0E+00
0.10	5.624E+02	5.625E+02	2.0E+00	2.0E+00
0.15	5.630E+02	5.632E+02	2.8E+00	2.8E+00
0.20	5.646E+02	5.650E+02	3.6E+00	3.6E+00
0.25	5.722E+02	5.708E+02	3.2E+00	3.1E+00
0.30	5.813E+02	5.817E+02	3.7E+00	3.7E+00
0.35	5.911E+02	5.912E+02	4.2E+00	4.2E+00
0.40	6.007E+02	6.013E+02	4.9E+00	4.9E+00
0.45	6.114E+02	6.125E+02	6.2E+00	6.1E+00
0.50	6.235E+02	6.263E+02	8.5E+00	8.3E+00
0.55	6.382E+02	6.410E+02	1.0E+01	1.0E+01
0.60	6.550E+02	6.592E+02	1.3E+01	1.3E+01
0.65	6.746E+02	6.799E+02	1.6E+01	1.6E+01
0.70	6.976E+02	7.056E+02	2.1E+01	2.0E+01
0.75	7.245E+02	7.318E+02	2.4E+01	2.4E+01
0.80	7.530E+02	7.643E+02	3.0E+01	2.9E+01
0.85	7.850E+02	8.009E+02	3.8E+01	3.7E+01
0.90	8.235E+02	8.284E+02	4.1E+01	4.1E+01
0.95	8.597E+02	8.750E+02	4.8E+01	4.7E+01
1.00	8.994E+02	9.124E+02	5.5E+01	5.5E+01
1.05	9.388E+02	9.565E+02	6.4E+01	6.3E+01
1.10	9.780E+02	9.958E+02	7.1E+01	7.0E+01
1.15	1.012E+03	1.036E+03	8.0E+01	7.9E+01
1.20	1.044E+03	1.068E+03	8.6E+01	8.4E+01
1.25	1.078E+03	1.078E+03	8.8E+01	8.8E+01
1.30	1.103E+03	1.111E+03	9.2E+01	9.2E+01
1.35	1.126E+03	1.141E+03	9.5E+01	9.5E+01
1.40	1.152E+03	1.159E+03	9.7E+01	9.7E+01
1.45	1.183E+03	1.131E+03	1.0E+02	1.0E+02
1.50	1.211E+03	1.139E+03	1.2E+02	1.2E+02
1.55	1.202E+03	1.192E+03	1.2E+02	1.2E+02
1.60	1.186E+03	1.195E+03	1.8E+02	1.8E+02
1.65	1.195E+03	1.156E+03	1.6E+02	1.6E+02
1.70	1.162E+03	1.166E+03	1.7E+02	1.7E+02
1.75	1.159E+03	1.182E+03	2.0E+02	2.0E+02
1.80	1.112E+03	1.154E+03	2.1E+02	2.1E+02
1.85	1.069E+03	1.162E+03	2.3E+02	2.2E+02
1.90	1.031E+03	1.201E+03	2.8E+02	2.6E+02
1.95	1.011E+03	1.159E+03	2.8E+02	2.7E+02
2.00	9.936E+02	1.141E+03	2.9E+02	2.8E+02
2.05	9.634E+02	1.154E+03	3.1E+02	2.9E+02
2.10	9.406E+02	1.170E+03	3.3E+02	3.1E+02
2.15	9.181E+02	1.196E+03	3.6E+02	3.3E+02
2.20	9.083E+02	1.179E+03	3.7E+02	3.4E+02
2.25	8.973E+02	1.180E+03	3.8E+02	3.5E+02
2.30	8.845E+02	1.193E+03	4.0E+02	3.7E+02
2.35	8.737E+02	1.210E+03	4.2E+02	3.9E+02
2.40	8.640E+02	1.237E+03	4.5E+02	4.1E+02
2.45	8.623E+02	1.260E+03	4.8E+02	4.3E+02
2.50	8.648E+02	1.301E+03	5.2E+02	4.7E+02
2.55	8.720E+02	1.366E+03	5.8E+02	5.2E+02
2.60	8.848E+02	1.428E+03	6.3E+02	5.7E+02
2.65	9.032E+02	1.525E+03	7.1E+02	6.4E+02
2.70	9.250E+02	1.655E+03	8.3E+02	7.4E+02
2.75	9.458E+02	1.861E+03	1.0E+03	9.1E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AX23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.05	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.10	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.15	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.20	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.25	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.30	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.35	0.000E+00	1.189E-03	1.2E-03	9.7E-04
0.40	1.145E-03	1.519E-02	9.6E-03	9.3E-03
0.45	2.916E-02	3.408E-02	1.1E-02	1.1E-02
0.50	5.143E-02	5.395E-02	1.5E-02	1.5E-02
0.55	7.557E-02	8.388E-02	1.9E-02	1.8E-02
0.60	1.058E-01	1.104E-01	2.3E-02	2.3E-02
0.65	1.388E-01	1.497E-01	2.9E-02	2.8E-02
0.70	1.789E-01	1.918E-01	3.7E-02	3.6E-02
0.75	2.248E-01	2.392E-01	4.3E-02	4.2E-02
0.80	2.745E-01	2.929E-01	5.3E-02	5.1E-02
0.85	3.298E-01	3.555E-01	6.6E-02	6.4E-02
0.90	3.957E-01	4.059E-01	7.1E-02	7.1E-02
0.95	4.578E-01	4.826E-01	8.2E-02	8.1E-02
1.00	5.265E-01	5.459E-01	9.5E-02	9.4E-02
1.05	5.926E-01	6.211E-01	1.1E-01	1.1E-01
1.10	6.594E-01	6.834E-01	1.2E-01	1.2E-01
1.15	7.178E-01	7.569E-01	1.4E-01	1.3E-01
1.20	7.718E-01	8.111E-01	1.4E-01	1.4E-01
1.25	8.287E-01	8.273E-01	1.5E-01	1.5E-01
1.30	8.705E-01	8.824E-01	1.5E-01	1.5E-01
1.35	9.101E-01	9.072E-01	1.5E-01	1.5E-01
1.40	9.551E-01	9.185E-01	1.6E-01	1.3E-01
1.45	1.000E+00	6.482E-01	2.8E-01	1.5E-01
1.50	1.000E+00	8.198E-01	1.5E-01	8.8E-02
1.55	1.000E+00	7.787E-01	1.8E-01	1.0E-01
1.60	1.000E+00	6.869E-01	3.2E-01	2.0E-01
1.65	1.000E+00	6.164E-01	3.2E-01	2.1E-01
1.70	9.666E-01	5.460E-01	2.9E-01	2.1E-01
1.75	9.517E-01	5.444E-01	3.8E-01	2.8E-01
1.80	8.831E-01	7.091E-01	2.7E-01	2.5E-01
1.85	8.117E-01	7.458E-01	2.5E-01	2.5E-01
1.90	7.488E-01	7.844E-01	2.9E-01	2.9E-01
1.95	7.167E-01	7.321E-01	3.0E-01	3.0E-01
2.00	6.880E-01	6.954E-01	3.1E-01	3.1E-01
2.05	6.388E-01	7.339E-01	3.3E-01	3.3E-01
2.10	6.021E-01	7.539E-01	3.6E-01	3.5E-01
2.15	5.658E-01	7.903E-01	3.9E-01	3.7E-01
2.20	5.501E-01	7.662E-01	4.0E-01	3.8E-01
2.25	5.326E-01	7.524E-01	4.1E-01	3.9E-01
2.30	5.124E-01	7.677E-01	4.3E-01	4.1E-01
2.35	4.954E-01	7.725E-01	4.4E-01	4.2E-01
2.40	4.802E-01	7.918E-01	4.6E-01	4.3E-01
2.45	4.777E-01	7.866E-01	4.6E-01	4.3E-01
2.50	4.820E-01	7.808E-01	4.6E-01	4.3E-01
2.55	4.938E-01	7.736E-01	4.5E-01	4.2E-01
2.60	5.148E-01	7.601E-01	4.3E-01	4.1E-01
2.65	5.446E-01	7.422E-01	4.0E-01	3.9E-01
2.70	5.797E-01	7.181E-01	3.8E-01	3.7E-01
2.75	6.131E-01	7.030E-01	3.6E-01	3.6E-01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AT19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.356E+02	5.356E+02	0.0E+00	0.0E+00
0.05	5.358E+02	5.358E+02	6.2E-01	6.2E-01
0.10	5.359E+02	5.359E+02	1.2E+00	1.2E+00
0.15	5.354E+02	5.355E+02	1.7E+00	1.7E+00
0.20	5.340E+02	5.361E+02	2.2E+00	1.9E+00
0.25	5.354E+02	5.343E+02	1.2E+00	9.6E-01
0.30	5.374E+02	5.379E+02	1.2E+00	1.2E+00
0.35	5.402E+02	5.404E+02	1.5E+00	1.5E+00
0.40	5.437E+02	5.439E+02	2.2E+00	2.2E+00
0.45	5.481E+02	5.477E+02	2.9E+00	2.9E+00
0.50	5.528E+02	5.532E+02	3.7E+00	3.7E+00
0.55	5.585E+02	5.586E+02	4.5E+00	4.5E+00
0.60	5.647E+02	5.645E+02	5.2E+00	5.2E+00
0.65	5.712E+02	5.709E+02	5.7E+00	5.7E+00
0.70	5.781E+02	5.766E+02	5.8E+00	5.7E+00
0.75	5.830E+02	5.770E+02	5.8E+00	5.0E+00
0.80	5.823E+02	5.821E+02	2.8E+00	2.8E+00
0.85	5.816E+02	5.833E+02	3.1E+00	3.0E+00
0.90	5.822E+02	5.793E+02	3.5E+00	3.1E+00
0.95	5.811E+02	5.814E+02	3.3E+00	3.3E+00
1.00	5.810E+02	6.794E+02	3.4E+00	3.2E+00
1.05	5.806E+02	5.797E+02	3.9E+00	3.8E+00
1.10	5.802E+02	5.793E+02	3.9E+00	3.8E+00
1.15	5.800E+02	5.786E+02	4.5E+00	4.4E+00
1.20	5.793E+02	6.797E+02	4.6E+00	4.6E+00
1.25	5.790E+02	5.790E+02	4.6E+00	4.6E+00
1.30	5.786E+02	5.795E+02	5.1E+00	5.1E+00
1.35	5.783E+02	5.779E+02	5.0E+00	5.0E+00
1.40	5.782E+02	6.426E+02	5.4E+01	4.7E+01
1.45	5.771E+02	7.281E+02	1.4E+02	1.2E+02
1.50	6.154E+02	7.461E+02	1.5E+02	1.3E+02
1.55	6.572E+02	7.590E+02	1.6E+02	1.4E+02
1.60	6.788E+02	7.500E+02	1.6E+02	1.6E+02
1.65	6.880E+02	7.743E+02	1.7E+02	1.6E+02
1.70	6.964E+02	7.348E+02	1.5E+02	1.5E+02
1.75	6.951E+02	6.959E+02	1.5E+02	1.5E+02
1.80	6.838E+02	6.830E+02	1.5E+02	1.5E+02
1.85	6.607E+02	7.112E+02	1.5E+02	1.5E+02
1.90	6.364E+02	7.395E+02	1.7E+02	1.6E+02
1.95	6.198E+02	7.510E+02	1.8E+02	1.7E+02
2.00	6.038E+02	7.831E+02	1.9E+02	1.9E+02
2.05	5.761E+02	8.679E+02	2.7E+02	2.1E+02
2.10	5.661E+02	8.571E+02	2.7E+02	2.2E+02
2.15	5.657E+02	8.217E+02	2.5E+02	2.2E+02
2.20	5.651E+02	8.198E+02	2.5E+02	2.2E+02
2.25	5.645E+02	8.172E+02	2.5E+02	2.1E+02
2.30	5.639E+02	8.135E+02	2.5E+02	2.1E+02
2.35	5.632E+02	8.135E+02	2.5E+02	2.1E+02
2.40	5.626E+02	8.127E+02	2.5E+02	2.1E+02
2.45	5.624E+02	8.114E+02	2.5E+02	2.1E+02
2.50	5.620E+02	8.132E+02	2.5E+02	2.1E+02
2.55	5.617E+02	8.172E+02	2.5E+02	2.2E+02
2.60	5.613E+02	8.243E+02	2.6E+02	2.2E+02
2.65	5.607E+02	8.375E+02	2.7E+02	2.3E+02
2.70	5.606E+02	8.568E+02	2.9E+02	2.5E+02
2.75	5.603E+02	8.879E+02	3.2E+02	2.8E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AP19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	2.285E+03	2.285E+03	0.0E+00	0.0E+00
0.05	2.293E+03	2.291E+03	1.4E+02	1.4E+02
0.10	2.260E+03	2.251E+03	2.8E+02	2.8E+02
0.15	2.001E+03	2.029E+03	4.1E+02	4.1E+02
0.20	1.471E+03	1.582E+03	4.9E+02	4.9E+02
0.25	1.389E+03	1.435E+03	1.2E+02	8.4E+01
0.30	1.358E+03	1.416E+03	4.6E+01	2.8E+01
0.35	1.354E+03	1.399E+03	4.1E+01	3.1E+01
0.40	1.360E+03	1.374E+03	1.7E+01	1.4E+01
0.45	1.369E+03	1.335E+03	3.1E+01	2.1E+01
0.50	1.358E+03	1.376E+03	2.2E+01	1.9E+01
0.55	1.362E+03	1.362E+03	1.7E+01	1.7E+01
0.60	1.359E+03	1.365E+03	1.9E+01	1.9E+01
0.65	1.359E+03	1.351E+03	2.4E+01	2.4E+01
0.70	1.355E+03	1.359E+03	2.3E+01	2.3E+01
0.75	1.357E+03	1.345E+03	2.7E+01	2.6E+01
0.80	1.349E+03	1.349E+03	2.9E+01	2.9E+01
0.85	1.342E+03	1.360E+03	3.2E+01	3.1E+01
0.90	1.348E+03	1.320E+03	3.6E+01	3.2E+01
0.95	1.337E+03	1.341E+03	3.4E+01	3.4E+01
1.00	1.336E+03	1.320E+03	3.5E+01	3.3E+01
1.05	1.332E+03	1.324E+03	3.9E+01	3.9E+01
1.10	1.328E+03	1.320E+03	4.0E+01	3.9E+01
1.15	1.326E+03	1.313E+03	4.5E+01	4.5E+01
1.20	1.319E+03	1.324E+03	4.6E+01	4.6E+01
1.25	1.316E+03	1.317E+03	4.6E+01	4.6E+01
1.30	1.312E+03	1.322E+03	5.2E+01	5.2E+01
1.35	1.309E+03	1.306E+03	5.1E+01	5.1E+01
1.40	1.308E+03	1.280E+03	6.1E+01	5.9E+01
1.45	1.297E+03	1.285E+03	6.0E+01	6.0E+01
1.50	1.284E+03	1.273E+03	6.6E+01	6.6E+01
1.55	1.274E+03	1.367E+03	1.0E+02	7.0E+01
1.60	1.265E+03	1.272E+03	6.1E+01	6.2E+01
1.65	1.250E+03	1.280E+03	5.9E+01	5.7E+01
1.70	1.256E+03	1.207E+03	6.8E+01	6.1E+01
1.75	1.239E+03	1.246E+03	6.2E+01	6.2E+01
1.80	1.234E+03	1.213E+03	6.5E+01	6.4E+01
1.85	1.222E+03	1.226E+03	6.5E+01	6.6E+01
1.90	1.217E+03	1.204E+03	6.7E+01	6.6E+01
1.95	1.212E+03	1.204E+03	6.9E+01	6.9E+01
2.00	1.204E+03	1.197E+03	7.1E+01	7.1E+01
2.05	1.199E+03	1.182E+03	7.3E+01	7.3E+01
2.10	1.189E+03	1.191E+03	7.6E+01	7.6E+01
2.15	1.186E+03	1.174E+03	7.7E+01	7.7E+01
2.20	1.180E+03	1.169E+03	8.0E+01	8.0E+01
2.25	1.175E+03	1.164E+03	8.2E+01	8.2E+01
2.30	1.169E+03	1.155E+03	8.5E+01	8.5E+01
2.35	1.163E+03	1.156E+03	8.5E+01	8.5E+01
2.40	1.157E+03	1.155E+03	8.6E+01	8.6E+01
2.45	1.156E+03	1.143E+03	8.7E+01	8.7E+01
2.50	1.152E+03	1.143E+03	9.0E+01	9.0E+01
2.55	1.149E+03	1.136E+03	9.3E+01	9.2E+01
2.60	1.145E+03	1.134E+03	9.3E+01	9.3E+01
2.65	1.140E+03	1.132E+03	9.4E+01	9.4E+01
2.70	1.139E+03	1.127E+03	9.7E+01	9.7E+01
2.75	1.136E+03	1.124E+03	9.8E+01	9.8E+01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AR19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.780E+01	4.780E+01	0.0E+00	0.0E+00
0.05	4.779E+01	4.779E+01	4.9E-02	4.9E-02
0.10	4.776E+01	4.776E+01	1.0E-01	1.0E-01
0.15	4.764E+01	4.764E+01	1.5E-01	1.5E-01
0.20	4.738E+01	4.751E+01	1.9E-01	1.7E-01
0.25	4.723E+01	4.720E+01	5.8E-02	5.6E-02
0.30	4.709E+01	4.709E+01	7.3E-02	7.3E-02
0.35	4.690E+01	4.691E+01	1.1E-01	1.1E-01
0.40	4.666E+01	4.665E+01	1.6E-01	1.5E-01
0.45	4.636E+01	4.638E+01	2.1E-01	2.0E-01
0.50	4.603E+01	4.601E+01	2.6E-01	2.6E-01
0.55	4.564E+01	4.560E+01	3.4E-01	3.4E-01
0.60	4.515E+01	4.518E+01	4.0E-01	4.0E-01
0.65	4.466E+01	4.464E+01	4.5E-01	4.5E-01
0.70	4.410E+01	4.233E+01	2.1E+00	1.9E+00
0.75	4.118E+01	3.694E+01	6.7E+00	6.3E+00
0.80	3.404E+01	3.484E+01	7.8E+00	7.8E+00
0.85	2.724E+01	2.966E+01	7.4E+00	7.3E+00
0.90	2.194E+01	2.465E+01	6.0E+00	5.8E+00
0.95	1.848E+01	1.909E+01	4.2E+00	4.2E+00
1.00	1.524E+01	1.644E+01	4.1E+00	4.0E+00
1.05	1.276E+01	1.383E+01	3.5E+00	3.4E+00
1.10	1.051E+01	1.186E+01	3.1E+00	3.0E+00
1.15	8.907E+00	9.487E+00	2.7E+00	2.6E+00
1.20	7.398E+00	7.907E+00	2.2E+00	2.2E+00
1.25	5.937E+00	7.382E+00	2.2E+00	2.1E+00
1.30	5.128E+00	5.707E+00	1.7E+00	1.7E+00
1.35	4.388E+00	4.645E+00	1.4E+00	1.4E+00
1.40	3.729E+00	3.745E+00	1.3E+00	1.3E+00
1.45	3.198E+00	3.248E+00	1.2E+00	1.2E+00
1.50	2.676E+00	3.210E+00	1.2E+00	1.1E+00
1.55	2.342E+00	3.211E+00	1.1E+00	1.0E+00
1.60	2.283E+00	2.824E+00	9.2E-01	8.6E-01
1.65	2.201E+00	2.642E+00	8.0E-01	7.6E-01
1.70	2.182E+00	2.553E+00	7.3E-01	6.9E-01
1.75	2.150E+00	2.814E+00	8.7E-01	7.6E-01
1.80	2.182E+00	2.834E+00	8.9E-01	7.8E-01
1.85	2.250E+00	2.873E+00	9.3E-01	8.4E-01
1.90	2.355E+00	2.936E+00	1.0E+00	9.3E-01
1.95	2.435E+00	3.105E+00	1.1E+00	1.0E+00
2.00	2.521E+00	3.209E+00	1.2E+00	1.1E+00
2.05	2.694E+00	2.903E+00	1.2E+00	1.2E+00
2.10	2.813E+00	3.102E+00	1.3E+00	1.3E+00
2.15	2.945E+00	3.308E+00	1.5E+00	1.5E+00
2.20	3.035E+00	3.653E+00	1.7E+00	1.7E+00
2.25	3.144E+00	3.857E+00	1.9E+00	1.9E+00
2.30	3.280E+00	3.953E+00	2.0E+00	2.0E+00
2.35	3.427E+00	4.151E+00	2.2E+00	2.2E+00
2.40	3.607E+00	4.278E+00	2.4E+00	2.4E+00
2.45	3.746E+00	4.573E+00	2.7E+00	2.6E+00
2.50	3.862E+00	4.901E+00	2.9E+00	2.9E+00
2.55	4.004E+00	5.012E+00	3.1E+00	3.0E+00
2.60	4.132E+00	5.120E+00	3.2E+00	3.2E+00
2.65	4.245E+00	5.236E+00	3.3E+00	3.3E+00
2.70	4.341E+00	5.294E+00	3.5E+00	3.4E+00
2.75	4.374E+00	5.350E+00	3.6E+00	3.5E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AH19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.295E+02	5.295E+02	0.0E+00	0.0E+00
0.05	5.297E+02	5.297E+02	6.2E-01	6.2E-01
0.10	5.299E+02	5.299E+02	1.2E+00	1.2E+00
0.15	5.295E+02	5.297E+02	1.7E+00	1.7E+00
0.20	5.285E+02	5.300E+02	2.1E+00	1.8E+00
0.25	5.304E+02	5.292E+02	1.4E+00	1.2E+00
0.30	5.329E+02	5.334E+02	1.5E+00	1.5E+00
0.35	5.364E+02	5.366E+02	1.9E+00	1.9E+00
0.40	5.408E+02	5.411E+02	2.8E+00	2.8E+00
0.45	5.463E+02	5.460E+02	3.7E+00	3.7E+00
0.50	5.525E+02	5.529E+02	4.8E+00	4.8E+00
0.55	5.598E+02	5.601E+02	5.9E+00	5.9E+00
0.60	5.680E+02	5.680E+02	6.9E+00	6.9E+00
0.65	5.769E+02	5.765E+02	7.8E+00	7.8E+00
0.70	5.864E+02	5.864E+02	8.8E+00	8.8E+00
0.75	5.960E+02	5.955E+02	9.1E+00	9.1E+00
0.80	6.052E+02	6.103E+02	1.3E+01	1.3E+01
0.85	6.189E+02	6.243E+02	1.8E+01	1.8E+01
0.90	6.375E+02	6.373E+02	2.0E+01	2.0E+01
0.95	6.528E+02	6.504E+02	2.4E+01	2.4E+01
1.00	6.768E+02	6.764E+02	3.1E+01	3.1E+01
1.05	6.999E+02	7.050E+02	3.8E+01	3.8E+01
1.10	7.323E+02	7.316E+02	4.6E+01	4.6E+01
1.15	7.654E+02	7.844E+02	6.5E+01	6.4E+01
1.20	8.087E+02	8.342E+02	7.6E+01	7.5E+01
1.25	8.728E+02	8.522E+02	9.0E+01	9.0E+01
1.30	9.236E+02	9.518E+02	1.1E+02	1.1E+02
1.35	9.865E+02	1.038E+03	1.4E+02	1.3E+02
1.40	1.068E+03	1.126E+03	1.7E+02	1.6E+02
1.45	1.145E+03	1.176E+03	1.7E+02	1.7E+02
1.50	1.223E+03	1.184E+03	1.7E+02	1.7E+02
1.55	1.269E+03	1.219E+03	1.6E+02	1.6E+02
1.60	1.284E+03	1.264E+03	1.4E+02	1.4E+02
1.65	1.295E+03	1.296E+03	1.3E+02	1.3E+02
1.70	1.302E+03	1.277E+03	1.3E+02	1.3E+02
1.75	1.302E+03	1.241E+03	1.4E+02	1.3E+02
1.80	1.293E+03	1.231E+03	1.4E+02	1.3E+02
1.85	1.275E+03	1.231E+03	1.4E+02	1.4E+02
1.90	1.253E+03	1.212E+03	1.6E+02	1.6E+02
1.95	1.237E+03	1.188E+03	1.8E+02	1.7E+02
2.00	1.220E+03	1.171E+03	1.9E+02	1.9E+02
2.05	1.193E+03	1.180E+03	2.0E+02	2.0E+02
2.10	1.166E+03	1.181E+03	2.1E+02	2.2E+02
2.15	1.136E+03	1.193E+03	2.4E+02	2.4E+02
2.20	1.118E+03	1.170E+03	2.5E+02	2.5E+02
2.25	1.092E+03	1.169E+03	2.7E+02	2.7E+02
2.30	1.065E+03	1.181E+03	2.9E+02	2.8E+02
2.35	1.039E+03	1.190E+03	3.1E+02	3.0E+02
2.40	1.011E+03	1.211E+03	3.3E+02	3.2E+02
2.45	9.922E+02	1.206E+03	3.5E+02	3.3E+02
2.50	9.765E+02	1.204E+03	3.6E+02	3.4E+02
2.55	9.594E+02	1.216E+03	3.8E+02	3.6E+02
2.60	9.441E+02	1.226E+03	4.0E+02	3.7E+02
2.65	9.309E+02	1.239E+03	4.2E+02	3.9E+02
2.70	9.215E+02	1.256E+03	4.4E+02	4.1E+02
2.75	9.173E+02	1.274E+03	4.6E+02	4.2E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AX19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.05	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.10	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.15	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.20	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.25	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.30	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.35	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.40	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.45	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.50	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.55	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.60	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.65	0.000E+00	0.000E+00	0.0E+00	0.0E+00
0.70	0.000E+00	3.499E-03	3.5E-03	3.0E-03
0.75	4.750E-03	1.782E-02	1.7E-02	1.5E-02
0.80	2.223E-02	3.082E-02	2.5E-02	2.4E-02
0.85	4.705E-02	5.228E-02	3.2E-02	3.2E-02
0.90	7.755E-02	7.421E-02	3.6E-02	3.6E-02
0.95	1.057E-01	1.178E-01	4.2E-02	4.2E-02
1.00	1.445E-01	1.488E-01	5.4E-02	5.4E-02
1.05	1.867E-01	1.964E-01	6.6E-02	6.6E-02
1.10	2.424E-01	2.419E-01	8.0E-02	8.1E-02
1.15	2.990E-01	3.320E-01	1.1E-01	1.1E-01
1.20	3.732E-01	4.146E-01	1.3E-01	1.3E-01
1.25	4.818E-01	4.453E-01	1.5E-01	1.5E-01
1.30	5.679E-01	6.137E-01	1.9E-01	1.9E-01
1.35	6.742E-01	7.586E-01	2.3E-01	2.3E-01
1.40	8.059E-01	8.004E-01	2.2E-01	2.2E-01
1.45	9.414E-01	7.469E-01	2.5E-01	2.3E-01
1.50	1.000E+00	7.719E-01	2.2E-01	1.8E-01
1.55	1.000E+00	8.867E-01	1.1E-01	9.8E-02
1.60	1.000E+00	9.765E-01	2.4E-02	2.0E-02
1.65	1.000E+00	1.000E+00	0.0E+00	0.0E+00
1.70	1.000E+00	1.000E+00	0.0E+00	0.0E+00
1.75	1.000E+00	1.000E+00	0.0E+00	0.0E+00
1.80	1.000E+00	1.000E+00	0.0E+00	0.0E+00
1.85	1.000E+00	9.592E-01	4.1E-02	3.5E-02
1.90	1.000E+00	8.789E-01	1.2E-01	1.0E-01
1.95	1.000E+00	8.174E-01	1.8E-01	1.6E-01
2.00	1.000E+00	7.515E-01	2.4E-01	2.0E-01
2.05	1.000E+00	5.768E-01	3.6E-01	2.5E-01
2.10	9.688E-01	6.355E-01	3.4E-01	2.7E-01
2.15	9.192E-01	6.738E-01	3.0E-01	2.7E-01
2.20	8.848E-01	6.379E-01	3.2E-01	2.9E-01
2.25	8.472E-01	6.378E-01	3.1E-01	2.9E-01
2.30	8.047E-01	6.601E-01	3.0E-01	2.9E-01
2.35	7.621E-01	6.737E-01	3.0E-01	2.9E-01
2.40	7.169E-01	7.090E-01	3.1E-01	3.1E-01
2.45	6.869E-01	7.105E-01	3.2E-01	3.2E-01
2.50	6.617E-01	6.945E-01	3.3E-01	3.3E-01
2.55	6.343E-01	7.089E-01	3.5E-01	3.4E-01
2.60	6.100E-01	7.189E-01	3.6E-01	3.6E-01
2.65	5.891E-01	7.265E-01	3.7E-01	3.6E-01
2.70	5.740E-01	7.356E-01	3.8E-01	3.7E-01
2.75	5.675E-01	7.352E-01	3.9E-01	3.8E-01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = JW27

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.612E+01	4.612E+01	0.0E+00	0.0E+00
0.05	4.621E+01	4.605E+01	4.1E+00	4.1E+00
0.10	4.609E+01	4.586E+01	3.1E+00	3.1E+00
0.15	3.507E+01	3.471E+01	3.0E+00	3.0E+00
0.20	2.478E+01	-2.411E+01	4.1E+01	3.9E+01
0.25	8.188E+00	-3.001E+01	3.2E+01	2.2E+01
0.30	7.912E+00	3.586E+01	2.3E+01	1.6E+01
0.35	2.436E+01	2.103E+01	7.3E+00	8.2E+00
0.40	1.872E+01	2.800E+01	8.6E+00	7.5E+00
0.45	2.259E+01	-5.759E-01	1.9E+01	1.1E+01
0.50	1.899E+01	1.725E+01	6.2E+00	6.1E+00
0.55	1.727E+01	1.628E+01	5.3E+00	5.7E+00
0.60	1.428E+01	2.172E+01	6.7E+00	5.1E+00
0.65	1.626E+01	-1.299E+00	1.4E+01	7.4E+00
0.70	9.196E+00	1.425E+01	5.0E+00	3.8E+00
0.75	9.653E+00	7.816E+00	4.4E+00	4.3E+00
0.80	6.312E+00	6.138E+00	2.7E+00	2.6E+00
0.85	4.975E+00	1.268E+01	6.5E+00	4.8E+00
0.90	5.878E+00	2.388E+00	5.1E+00	4.6E+00
0.95	4.626E+00	4.851E+00	1.8E+00	2.1E+00
1.00	2.890E+00	9.377E+00	5.4E+00	3.1E+00
1.05	2.836E+00	2.778E+00	2.9E-01	3.1E-01
1.10	8.452E-01	9.328E+00	6.6E+00	3.6E+00
1.15	1.432E+00	8.912E-01	1.5E+00	1.7E+00
1.20	2.303E-01	3.906E+00	3.0E+00	2.0E+00
1.25	-7.882E-01	5.068E+00	4.9E+00	3.3E+00
1.30	1.029E+00	-8.088E-02	1.5E+00	1.7E+00
1.35	-1.608E-01	-1.623E+00	2.0E+00	2.2E+00
1.40	-8.113E-01	-8.872E+00	5.4E+00	4.3E+00
1.45	-2.745E+00	1.951E+00	4.0E+00	2.7E+00
1.50	-4.500E+00	6.043E-01	6.2E+00	6.9E+00
1.55	-1.110E+01	1.681E+01	2.3E+01	1.6E+01
1.60	1.897E+00	-1.208E+01	1.2E+01	9.4E+00
1.65	-1.627E+00	-9.029E+00	5.8E+00	5.8E+00
1.70	-4.687E+00	-8.664E+00	5.7E+00	7.[illegible]+00
1.75	-1.651E+00	-8.158E+00	7.2E+00	6.[illegible]00
1.80	-5.905E+00	1.013E+01	1.3E+01	7.[illegible]
1.85	-3.464E+00	-1.136E+01	8.6E+00	6.9[illegible]
1.90	-4.456E+00	-4.123E+00	5.3E+00	5.5E+00
1.95	6.357E-03	-1.591E+01	1.3E+01	8.5E+00
2.00	-5.367E+00	4.237E+00	8.0E+00	5.7E+00
2.05	-3.879E+00	-6.431E+00	4.5E+00	4.4E+00
2.10	-4.650E+00	8.089E-01	6.3E+00	5.2E+00
2.15	-3.788E+00	-4.797E+00	4.3E+00	4.2E+00
2.20	-1.837E+00	-1.328E+01	1.0E+01	7.4E+00
2.25	-3.198E+00	2.250E-01	3.5E+00	2.9E+00
2.30	-3.218E+00	-1.934E+00	2.7E+00	2.6E+00
2.35	-3.716E+00	-3.297E+00	4.0E+00	4.0E+00
2.40	-4.330E+00	1.429E+00	4.3E+00	5.4E+00
2.45	-4.543E-01	-1.161E+01	9.8E+00	7.0E+00
2.50	-1.332E+00	-4.750E+00	4.7E+00	4.5E+00
2.55	-2.022E+00	-5.977E-01	2.1E+00	1.9E+00
2.60	-1.903E+00	-2.705E+00	2.6E+00	2.5E+00
2.65	-2.489E+00	-3.621E+00	3.5E+00	3.5E+00
2.70	-1.449E+00	-5.505E+00	5.7E+00	5.5E+00
2.75	2.130E-01	-6.939E+00	6.7E+00	5.5E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = J=23

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.612E+01	4.612E+01	0.0E+00	0.0E+00
0.05	4.633E+01	4.618E+01	4.1E+00	4.1E+00
0.10	4.594E+01	4.586E+01	3.0E+00	3.0E+00
0.15	3.347E+01	3.315E+01	2.9E+00	2.9E+00
0.20	2.202E+01	-2.342E+01	3.9E+01	2.9E+01
0.25	6.163E+00	-4.067E+01	3.9E+01	2.6E+01
0.30	-3.999E+00	-2.073E+01	1.4E+01	9.2E+00
0.35	-1.068E+01	9.746E+00	1.7E+01	1.1E+01
0.40	-5.944E+00	9.682E+00	1.3E+01	9.4E+00
0.45	1.218E+00	-3.656E+00	4.6E+00	3.5E+00
0.50	-1.029E-01	6.362E+00	5.6E+00	3.9E+00
0.55	1.968E+00	-1.082E+00	3.3E+00	3.0E+00
0.60	-2.023E-01	7.788E+00	6.7E+00	4.9E+00
0.65	2.943E+00	-4.144E+00	6.0E+00	4.7E+00
0.70	-4.288E-01	3.406E+00	3.8E+00	3.5E+00
0.75	1.731E+00	-5.039E+00	5.5E+00	3.3E+00
0.80	2.308E-01	1.850E+00	2.9E+00	1.9E+00
0.85	-8.923E-01	3.408E+00	3.6E+00	2.6E+00
0.90	9.834E-01	-3.732E+00	4.3E+00	3.1E+00
0.95	2.971E-01	-7.855E-01	1.4E+00	1.5E+00
1.00	-3.638E-01	3.026E+00	2.8E+00	1.8E+00
1.05	-1.270E-01	3.792E-01	4.4E-01	3.4E-01
1.10	-9.035E-01	4.172E+00	4.0E+00	2.2E+00
1.15	-5.142E-01	-5.073E-01	8.8E-01	1.0E+00
1.20	-1.152E+00	1.589E+00	2.2E+00	1.8E+00
1.25	-1.688E+00	2.439E+00	3.4E+00	2.3E+00
1.30	-5.316E-01	-5.088E-01	7.8E-01	1.0E+00
1.35	-1.041E+00	-3.317E+00	1.8E+00	1.2E+00
1.40	-1.268E+00	-3.916E+00	2.5E+00	1.9E+00
1.45	-2.202E+00	-3.828E-02	1.9E+00	1.4E+00
1.50	-2.940E+00	1.288E+00	3.8E+00	3.2E+00
1.55	-5.557E+00	1.436E+01	1.5E+01	7.2E+00
1.60	8.207E-02	-6.761E+00	8.9E+00	4.2E+00
1.65	-1.253E+00	-5.689E+00	3.7E+00	2.6E+00
1.70	-2.462E+00	-3.989E+00	2.1E+00	2.2E+00
1.75	-1.552E+00	-3.967E+00	2.9E+00	2.7E+00
1.80	-3.532E+00	1.174E+00	5.3E+00	2.8E+00
1.85	-2.577E+00	-4.282E+00	3.1E+00	3.0E+00
1.90	-2.792E+00	-3.610E+00	3.0E+00	3.0E+00
1.95	-1.331E+00	-5.894E+00	4.1E+00	3.3E+00
2.00	-3.388E+00	1.287E+00	3.9E+00	2.6E+00
2.05	-2.827E+00	-4.006E+00	2.3E+00	2.3E+00
2.10	-3.265E+00	-1.222E+00	3.3E+00	3.0E+00
2.15	-2.783E+00	-4.475E+00	3.1E+00	2.9E+00
2.20	-2.024E+00	-7.690E+00	5.3E+00	4.0E+00
2.25	-2.929E+00	-2.050E+00	2.0E+00	2.0E+00
2.30	-3.123E+00	-2.911E+00	2.1E+00	2.1E+00
2.35	-3.531E+00	-3.658E+00	3.1E+00	3.1E+00
2.40	-3.900E+00	-2.490E+00	3.6E+00	3.6E+00
2.45	-2.257E+00	-8.101E+00	5.8E+00	4.6E+00
2.50	-2.672E+00	-4.461E+00	3.4E+00	3.3E+00
2.55	-2.854E+00	-2.650E+00	2.3E+00	2.3E+00
2.60	-2.703E+00	-3.383E+00	2.6E+00	2.6E+00
2.65	-2.807E+00	-3.698E+00	3.0E+00	3.0E+00
2.70	-2.204E+00	-4.619E+00	3.9E+00	3.7E+00
2.75	-1.536E+00	-5.041E+00	4.1E+00	3.7E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AT02

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.304E+02	5.304E+02	0.0E+00	0.0E+00
0.05	5.304E+02	5.304E+02	5.7E-01	5.7E-01
0.10	5.303E+02	5.302E+02	1.2E+00	1.2E+00
0.15	5.292E+02	5.293E+02	1.9E+00	1.9E+00
0.20	5.271E+02	5.286E+02	2.3E+00	2.1E+00
0.25	5.268E+02	5.280E+02	1.4E+00	1.4E+00
0.30	5.266E+02	5.271E+02	1.3E+00	1.2E+00
0.35	5.267E+02	5.268E+02	1.1E+00	1.1E+00
0.40	5.267E+02	5.269E+02	1.0E+00	1.0E+00
0.45	5.268E+02	5.265E+02	9.5E-01	9.4E-01
0.50	5.267E+02	5.269E+02	8.6E-01	8.5E-01
0.55	5.267E+02	5.269E+02	7.8E-01	7.7E-01
0.60	5.268E+02	5.267E+02	7.0E-01	6.9E-01
0.65	5.269E+02	5.267E+02	6.3E-01	6.3E-01
0.70	5.268E+02	5.269E+02	5.6E-01	5.6E-01
0.75	5.268E+02	5.267E+02	5.0E-01	5.0E-01
0.80	5.268E+02	5.267E+02	4.5E-01	4.5E-01
0.85	5.268E+02	5.269E+02	4.1E-01	4.1E-01
0.90	5.268E+02	5.269E+02	3.6E-01	3.6E-01
0.95	5.268E+02	5.268E+02	3.3E-01	3.3E-01
1.00	5.268E+02	5.267E+02	3.2E-01	3.0E-01
1.05	5.268E+02	5.268E+02	2.9E-01	2.8E-01
1.10	5.269E+02	5.267E+02	2.8E-01	2.6E-01
1.15	5.269E+02	5.267E+02	2.6E-01	2.5E-01
1.20	5.269E+02	5.269E+02	2.4E-01	2.4E-01
1.25	5.269E+02	5.269E+02	2.2E-01	2.2E-01
1.30	5.269E+02	5.269E+02	2.3E-01	2.3E-01
1.35	5.269E+02	5.268E+02	2.3E-01	2.2E-01
1.40	5.269E+02	5.267E+02	2.6E-01	2.4E-01
1.45	5.269E+02	5.268E+02	2.3E-01	2.3E-01
1.50	5.268E+02	5.268E+02	2.4E-01	2.5E-01
1.55	5.267E+02	5.273E+02	4.6E-01	2.8E-01
1.60	5.268E+02	5.268E+02	2.3E-01	2.4E-01
1.65	5.268E+02	5.269E+02	2.2E-01	2.0E-01
1.70	5.268E+02	5.266E+02	2.7E-01	2.3E-01
1.75	5.268E+02	5.268E+02	2.3E-01	2.3E-01
1.80	5.268E+02	5.266E+02	2.5E-01	2.4E-01
1.85	5.267E+02	5.267E+02	2.3E-01	2.3E-01
1.90	5.267E+02	5.267E+02	2.4E-01	2.4E-01
1.95	5.267E+02	5.267E+02	2.5E-01	2.5E-01
2.00	5.267E+02	5.267E+02	2.6E-01	2.6E-01
2.05	5.267E+02	5.266E+02	2.7E-01	2.6E-01
2.10	5.267E+02	5.267E+02	2.7E-01	2.7E-01
2.15	5.267E+02	5.266E+02	2.8E-01	2.8E-01
2.20	5.267E+02	5.267E+02	2.9E-01	2.9E-01
2.25	5.267E+02	5.267E+02	3.0E-01	3.0E-01
2.30	5.267E+02	5.267E+02	3.0E-01	3.0E-01
2.35	5.267E+02	5.267E+02	3.1E-01	3.1E-01
2.40	5.267E+02	5.268E+02	3.1E-01	3.1E-01
2.45	5.268E+02	5.268E+02	3.1E-01	3.2E-01
2.50	5.268E+02	5.269E+02	3.4E-01	3.4E-01
2.55	5.268E+02	5.269E+02	3.5E-01	3.5E-01
2.60	5.268E+02	5.270E+02	3.8E-01	3.8E-01
2.65	5.269E+02	5.271E+02	4.2E-01	4.1E-01
2.70	5.269E+02	5.272E+02	4.7E-01	4.6E-01
2.75	5.270E+02	5.273E+02	5.2E-01	5.2E-01

POOR ORIGINAL

Appendix (Cont.)

RESPONSE # JW19

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	4.612E+01	4.612E+01	0.0E+00	0.0E+00
0.05	4.620E+01	4.603E+01	4.1E+00	4.1E+00
0.10	4.567E+01	4.559E+01	2.9E+00	2.9E+00
0.15	3.211E+01	3.185E+01	2.9E+00	2.9E+00
0.20	1.978E+01	-2.430E+01	3.0E+01	2.8E+01
0.25	4.326E+00	-4.312E+01	3.9E+01	2.7E+01
0.30	-6.239E+00	-2.222E+01	1.3E+01	9.3E+00
0.35	-1.324E+01	-3.844E+00	9.3E+00	7.2E+00
0.40	-1.882E+01	-6.306E+00	7.8E+00	5.0E+00
0.45	-1.553E+01	-2.013E+01	4.9E+00	3.6E+00
0.50	-1.662E+01	-1.657E+01	3.1E+00	3.2E+00
0.55	-1.888E+01	-1.713E+01	2.8E+00	2.6E+00
0.60	-1.905E+01	-1.593E+01	3.8E+00	3.3E+00
0.65	-2.051E+01	-1.741E+01	3.6E+00	3.0E+00
0.70	-2.078E+01	-1.115E+01	9.0E+00	7.8E+00
0.75	-1.136E+01	-2.486E+01	1.1E+01	7.7E+00
0.80	-1.215E+01	-7.327E+00	4.2E+00	2.9E+00
0.85	-1.214E+01	-4.695E+00	6.6E+00	5.3E+00
0.90	-5.621E+00	-1.809E+01	1.1E+01	7.3E+00
0.95	-6.204E+00	-8.031E+00	3.0E+00	3.1E+00
1.00	-5.231E+00	-6.740E+00	2.0E+00	1.7E+00
1.05	-4.750E+00	-2.578E+00	1.9E+00	1.3E+00
1.10	-4.152E+00	-2.688E+00	2.1E+00	2.0E+00
1.15	-3.460E+00	-3.245E+00	9.6E-01	1.3E+00
1.20	-3.431E+00	2.548E-01	3.2E+00	2.2E+00
1.25	-3.650E+00	8.963E-01	3.8E+00	2.6E+00
1.30	-1.961E+00	-2.717E+00	1.2E+00	1.4E+00
1.35	-2.304E+00	-3.956E+00	1.4E+00	1.1E+00
1.40	-2.329E+00	-4.177E+00	1.9E+00	1.4E+00
1.45	-2.963E+00	1.084E+00	3.1E+00	1.7E+00
1.50	-3.378E+00	1.028E+00	3.7E+00	2.8E+00
1.55	-4.641E+00	1.034E+01	1.1E+01	5.6E+00
1.60	-5.204E-01	-5.273E+00	4.1E+00	3.0E+00
1.65	-1.226E+00	-5.370E+00	3.5E+00	2.4E+00
1.70	-1.854E+00	-3.197E+00	1.5E+00	1.5E+00
1.75	-1.351E+00	-2.612E+00	1.6E+00	1.5E+00
1.80	-2.443E+00	-1.665E+00	3.1E+00	1.5E+00
1.85	-1.923E+00	-2.861E+00	1.6E+00	1.5E+00
1.90	-1.877E+00	-2.978E+00	1.8E+00	1.7E+00
1.95	-1.172E+00	-3.791E+00	2.3E+00	1.9E+00
2.00	-2.343E+00	7.373E-01	2.8E+00	1.5E+00
2.05	-2.048E+00	-2.679E+00	1.3E+00	1.2E+00
2.10	-2.347E+00	-8.968E-01	2.0E+00	1.8E+00
2.15	-1.964E+00	-3.478E+00	2.1E+00	1.8E+00
2.20	-1.610E+00	-4.793E+00	3.0E+00	2.3E+00
2.25	-2.200E+00	-1.989E+00	1.2E+00	1.2E+00
2.30	-2.416E+00	-2.383E+00	1.4E+00	1.4E+00
2.35	-2.794E+00	-2.758E+00	2.2E+00	2.2E+00
2.40	-3.044E+00	-2.819E+00	2.8E+00	2.6E+00
2.45	-2.044E+00	-6.728E+00	4.6E+00	3.7E+00
2.50	-2.477E+00	-4.196E+00	2.8E+00	2.6E+00
2.55	-2.888E+00	-2.973E+00	2.0E+00	2.0E+00
2.60	-3.017E+00	-3.634E+00	2.5E+00	2.5E+00
2.65	-3.376E+00	-4.155E+00	3.0E+00	2.9E+00
2.70	-2.785E+00	-5.590E+00	4.1E+00	3.8E+00
2.75	-2.265E+00	-6.156E+00	4.5E+00	3.9E+00

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AT16

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	5.304E+02	5.304E+02	0.0E+00	0.0E+00
0.05	5.304E+02	5.304E+02	5.3E-01	5.3E-01
0.10	5.303E+02	5.302E+02	1.1E+00	1.1E+00
0.15	5.292E+02	5.293E+02	1.6E+00	1.6E+00
0.20	5.271E+02	5.287E+02	1.9E+00	1.7E+00
0.25	5.268E+02	5.260E+02	6.3E-01	4.3E-01
0.30	5.267E+02	5.272E+02	4.0E-01	3.1E-01
0.35	5.271E+02	5.273E+02	3.4E-01	3.4E-01
0.40	5.278E+02	5.280E+02	8.4E-01	6.3E-01
0.45	5.289E+02	5.288E+02	9.9E-01	9.8E-01
0.50	5.303E+02	5.306E+02	1.4E+00	1.4E+00
0.55	5.322E+02	5.325E+02	1.8E+00	1.8E+00
0.60	5.346E+02	5.347E+02	2.4E+00	2.4E+00
0.65	5.373E+02	5.374E+02	3.0E+00	3.0E+00
0.70	5.406E+02	5.411E+02	3.8E+00	3.8E+00
0.75	5.445E+02	5.448E+02	4.6E+00	4.6E+00
0.80	5.487E+02	5.489E+02	5.3E+00	5.3E+00
0.85	5.533E+02	5.540E+02	6.3E+00	6.3E+00
0.90	5.585E+02	5.588E+02	7.1E+00	7.1E+00
0.95	5.640E+02	5.638E+02	7.8E+00	7.8E+00
1.00	5.696E+02	5.692E+02	8.4E+00	8.4E+00
1.05	5.751E+02	5.703E+02	7.8E+00	7.3E+00
1.10	5.802E+02	5.677E+02	1.1E+01	8.7E+00
1.15	5.800E+02	5.738E+02	6.6E+00	5.6E+00
1.20	5.792E+02	5.798E+02	4.6E+00	4.6E+00
1.25	5.738E+02	5.792E+02	4.5E+00	4.5E+00
1.30	5.784E+02	5.801E+02	5.3E+00	5.2E+00
1.35	5.783E+02	5.771E+02	5.1E+00	5.1E+00
1.40	5.782E+02	5.748E+02	6.3E+00	6.0E+00
1.45	5.770E+02	5.765E+02	6.0E+00	6.0E+00
1.50	5.757E+02	5.746E+02	6.6E+00	6.6E+00
1.55	5.731E+02	5.789E+02	7.4E+00	6.6E+00
1.60	5.740E+02	5.737E+02	6.2E+00	6.3E+00
1.65	5.724E+02	5.753E+02	6.0E+00	5.7E+00
1.70	5.731E+02	6.213E+02	5.0E+01	4.5E+01
1.75	5.712E+02	6.638E+02	9.1E+01	7.9E+01
1.80	5.707E+02	7.731E+02	1.7E+02	1.1E+02
1.85	6.003E+02	6.464E+02	9.1E+01	9.2E+01
1.90	6.176E+02	6.105E+02	9.0E+01	9.5E+01
1.95	6.246E+02	6.117E+02	8.9E+01	9.0E+01
2.00	6.275E+02	6.023E+02	8.9E+01	8.9E+01
2.05	6.275E+02	6.044E+02	9.2E+01	9.2E+01
2.10	6.202E+02	6.239E+02	8.8E+01	9.1E+01
2.15	6.103E+02	6.278E+02	9.2E+01	9.7E+01
2.20	6.001E+02	6.358E+02	1.0E+02	1.1E+02
2.25	5.863E+02	6.784E+02	1.3E+02	1.2E+02
2.30	5.667E+02	8.018E+02	2.0E+02	1.5E+02
2.35	5.632E+02	7.497E+02	1.8E+02	1.5E+02
2.40	5.626E+02	7.458E+02	1.8E+02	1.5E+02
2.45	5.624E+02	7.473E+02	1.8E+02	1.6E+02
2.50	5.620E+02	7.498E+02	1.8E+02	1.6E+02
2.55	5.617E+02	7.507E+02	1.8E+02	1.6E+02
2.60	5.612E+02	7.510E+02	1.9E+02	1.6E+02
2.65	5.607E+02	7.519E+02	1.9E+02	1.6E+02
2.70	5.606E+02	7.527E+02	1.9E+02	1.6E+02
2.75	5.603E+02	7.556E+02	1.9E+02	1.6E+02

POOR ORIGINAL

Appendix (Cont.)

RESPONSE = AP32

TIME	NOMINAL RESPONSE	AVERAGE RESPONSE	NOMINAL STDDEV	AVERAGE STDDEV
0.00	2.261E+03	2.261E+03	0.0E+00	0.0E+00
0.05	2.270E+03	2.267E+03	1.4E+02	1.4E+02
0.10	2.237E+03	2.227E+03	2.8E+02	2.8E+02
0.15	1.999E+03	2.027E+03	4.1E+02	4.1E+02
0.20	1.467E+03	1.973E+03	5.2E+02	4.3E+02
0.25	1.361E+03	1.383E+03	1.9E+01	1.3E+01
0.30	1.357E+03	1.363E+03	1.2E+01	1.2E+01
0.35	1.357E+03	1.361E+03	1.2E+01	1.1E+01
0.40	1.356E+03	1.383E+03	1.3E+01	1.2E+01
0.45	1.357E+03	1.361E+03	1.5E+01	1.5E+01
0.50	1.357E+03	1.359E+03	1.7E+01	1.7E+01
0.55	1.356E+03	1.364E+03	1.7E+01	1.6E+01
0.60	1.357E+03	1.354E+03	2.1E+01	2.1E+01
0.65	1.356E+03	1.351E+03	2.0E+01	1.9E+01
0.70	1.353E+03	1.356E+03	2.5E+01	2.5E+01
0.75	1.349E+03	1.360E+03	2.5E+01	2.4E+01
0.80	1.349E+03	1.344E+03	2.9E+01	2.9E+01
0.85	1.345E+03	1.345E+03	3.0E+01	3.0E+01
0.90	1.339E+03	1.352E+03	3.2E+01	3.0E+01
0.95	1.338E+03	1.338E+03	3.4E+01	3.4E+01
1.00	1.333E+03	1.337E+03	3.5E+01	3.5E+01
1.05	1.331E+03	1.331E+03	3.9E+01	3.9E+01
1.10	1.326E+03	1.332E+03	4.0E+01	3.9E+01
1.15	1.326E+03	1.316E+03	4.5E+01	4.4E+01
1.20	1.321E+03	1.319E+03	4.5E+01	4.5E+01
1.25	1.316E+03	1.316E+03	4.8E+01	4.8E+01
1.30	1.314E+03	1.308E+03	4.8E+01	4.8E+01
1.35	1.310E+03	1.301E+03	4.9E+01	4.9E+01
1.40	1.307E+03	1.293E+03	5.6E+01	5.6E+01
1.45	1.298E+03	1.272E+03	6.6E+01	6.5E+01
1.50	1.287E+03	1.271E+03	6.6E+01	6.5E+01
1.55	1.282E+03	1.320E+03	7.7E+01	6.9E+01
1.60	1.263E+03	1.266E+03	5.7E+01	5.8E+01
1.65	1.256E+03	1.264E+03	5.7E+01	5.7E+01
1.70	1.251E+03	1.229E+03	6.0E+01	5.8E+01
1.75	1.244E+03	1.221E+03	6.4E+01	6.2E+01
1.80	1.236E+03	1.218E+03	6.7E+01	6.6E+01
1.85	1.223E+03	1.225E+03	6.7E+01	6.7E+01
1.90	1.216E+03	1.213E+03	6.6E+01	6.6E+01
1.95	1.210E+03	1.209E+03	6.9E+01	6.9E+01
2.00	1.207E+03	1.187E+03	7.2E+01	7.1E+01
2.05	1.199E+03	1.186E+03	7.5E+01	7.4E+01
2.10	1.191E+03	1.185E+03	7.5E+01	7.5E+01
2.15	1.184E+03	1.184E+03	7.8E+01	7.8E+01
2.20	1.180E+03	1.169E+03	8.0E+01	8.0E+01
2.25	1.176E+03	1.161E+03	8.3E+01	8.2E+01
2.30	1.170E+03	1.157E+03	8.6E+01	8.6E+01
2.35	1.164E+03	1.155E+03	8.6E+01	8.6E+01
2.40	1.157E+03	1.160E+03	8.7E+01	8.7E+01
2.45	1.155E+03	1.148E+03	8.9E+01	8.8E+01
2.50	1.153E+03	1.139E+03	9.0E+01	9.0E+01
2.55	1.149E+03	1.136E+03	9.3E+01	9.3E+01
2.60	1.145E+03	1.136E+03	9.4E+01	9.4E+01
2.65	1.141E+03	1.134E+03	9.5E+01	9.5E+01
2.70	1.137E+03	1.135E+03	9.8E+01	9.8E+01
2.75	1.136E+03	1.123E+03	9.8E+01	9.8E+01

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