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SOLVENT REFINED COAL (SRC) PROCESS

Annual Technical Progress Report for Period January--December 1979

Volume 2--Part 2

November 1980

Work Performed Under Contract No. AC05-76ET10104

**Pittsburg & Midway Coal Mining Company
Englewood, Colorado**

U. S. DEPARTMENT OF ENERGY

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SOLVENT REFINED COAL (SRC) PROCESS

ANNUAL TECHNICAL PROGRESS REPORT
FOR THE PERIOD
JANUARY, 1979 THROUGH DECEMBER, 1979
VOLUME II - Part 2

THE PITTSBURG & MIDWAY COAL MINING CO.
Englewood, Colorado 80111

November 1980

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
DIVISION OF COAL CONVERSION AND UTILIZATION
UNDER CONTRACT DEAC-0179-ET10104
(formerly EX-76-C-01-0496)

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ABSTRACT

This report summarizes the progress of research and development tasks of the Solvent Refined Coal (SRC) project by the Pittsburgh & Midway Coal Mining Co. for the Department Of Energy for the period January 1, 1979 through December 31, 1979. A set of statistically designed, simulated recycle SRC-II experiments utilizing a bench-scale unit was completed; the objective was to study the effects of principle operating variables over wide ranges of conditions. Using data from four pilot plants, models have been developed which predict yields as a function of operating variables, describe unsteady state, three-phase convection, backmixing and generation of heat by reaction of hydrogen in the liquid phase of SRC-II reactors. A substantial amount of preparatory work was completed on a bench-scale reactor and laboratory which permits determining the effects of heavy media separation on response to coal liquefaction. Laboratory tests were completed to measure the effects of corrosion-erosion of coal slurries on various steels; the metal losses were found to be dependent on type of steel and conditions. A measure of coal reactivity was determined by correlating the effects of coal properties on product yields from a process development unit.

A P P E N D I X 3

Second-Order Models for the SRC Yields
from Kentucky and Powhatan Coals

Gulf Science & Technology Company
Pittsburgh, PA

SECOND ORDER MODELS FOR THE SRC
YIELDS FROM KENTUCKY AND POWHATAN COALS

G. L. Jones

Chemicals and Minerals Division
Report No. 627RK015
Project No. 238-8610-260
File No. FT07-30-30
September 17, 1979

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September 26, 1979

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I. SUMMARY AND CONCLUSIONS

This report discusses the effects on SRC yields of seven process variables (reactor temperature, SRT, hydrogen partial pressure, recycle ash and coal concentrations, gas velocity and coal type) predicted by second-order regression models developed from a data base containing pilot plant data with both Kentucky and Powhatan coals. These regression models are the same as those discussed previously in Report No. 627RK002 ("A Sequel Report: Second-Order Models for the SRC Yields from Kentucky Coals"); the only difference being the addition of a coal level term which defines the particular coal. Only a single coal term was added primarily because it was felt that the behavior of the two coals with respect to the remaining six variables would be nearly the same. The only effect of coal type in the model is a shift in each yield by a constant factor. Although some differences were found between the models developed from the Kentucky data base (1) (which we call Kentucky models) and the pooled coal models, the general conclusions of the previous report are confirmed by the new models and the assumption of similar behavior of the two coals appears to be justified. The algebraic forms of these yield models are shown in Section 2 of Part V next to the statistics for each yield.

In some respects the dependence of the yields (MAF coal basis) on variables such as pressure and temperature are clearer than in the previous models. The principal trends which emerge are the following:

- 1) The Powhatan coals yield more middle distillate, naphthas and light gases, less SRC and heavy distillate and consume more hydrogen than the Kentucky coals. Thus hydrocracking mechanisms may be more effective or important with Powhatan coals.
- 2) As reactor temperature or SRT increase, SRC and heavy distillate shift to middle distillate, naphthas and lighter gases and more hydrogen is consumed. Total distillate yield increases. This appears consistent with a thermally controlled hydrocracking process.

- 3) Increased recycle ash appears to favor the formation of heavy distillate from SRC and hydrogen while middle distillate (which may act as a solvent) is reduced. The lighter gases and naphthas are not affected. The increase in heavy distillate exceeds the drop in middle distillate and the total distillate yield increases. This result appears consistent with a liquid phase hydrogenation reaction catalyzed by recycle ash.
- 4) Increasing pressure reduces the yields of SRC, heavy distillate and middle distillate, produces more naphthas and light gases and consumes more hydrogen. The only exception to this effect is at high recycle ash where heavy distillate yield increases somewhat. This may result from catalytically hydrogenating SRC to produce heavy distillate at a somewhat faster rate than the hydrocracking of heavy distillate to produce lighter gases and naphthas.
- 5) Increased inlet coal concentration clearly increases SRC yields, decreases total, middle and heavy distillates, and results in a decrease in hydrogen consumption when all these yields are expressed on a moisture- and ash-free coal basis. Apparently the increased coal concentration exceeds the capacity of the catalytic hydrogenating and hydrocracking mechanisms to produce lighter products from the additional coal.
- 6) Increased linear superficial gas velocity increases SRC, middle distillate and light gas yields, decreases heavy distillate yield and hydrogen consumption and has no net effect on total distillate. It is known that higher gas velocity increases gas holdup at the expense of liquid and solid holdups. The velocity variable was included in the models primarily to compare differences between pilot plants. The models should not be applied to higher velocity conditions outside the data base. The correlation effect of velocity should not be used for scaleup.

- 7) A quantitative analysis of the effect of coal type on yields must await more experimental data which would allow continuous variables such as coal pyrite content to be introduced into the correlation.
- 8) The trends mentioned above confirm the findings from the Kentucky models that a reduction in reactor pressure would result in improved yields of middle and heavy distillate provided recycle ash and/or reactor temperature were increased. A similar statement can be made for reactor SRT. A reduction in these variables could result in potential savings in reactor capital and operating costs due to less severe operating conditions.
- 9) Although there are some differences between the predictions of the pooled coal and the Kentucky models, the use of the level variable for coal produces a surprising degree of similarity between the models. The differences in these predictions are probably attributable to differences in the coals (particularly in the pressure dependence) which cannot be accounted for by a coal level term.

II. INTRODUCTION

This report describes the second-order regression models for the yields and hydrogen consumption discussed previously in several reports.⁽¹⁻³⁾ These models were obtained by similar regression techniques using SAS (Statistical Analysis System) on a data base which was expanded to include both Kentucky (79 runs) and Powhatan coal data (29 runs). The variables chosen were the same as those used previously⁽¹⁾ with the addition of a term (NCOAL) which was assigned the value +1 for Powhatan coal and the value -1 for Kentucky coal data. The models are termed "full second order" in that they contain all possible combinations of linear, squared and cross products of the five significant variables (slurry residence time, reactor temperature,

hydrogen partial pressure, recycle ash concentration and feed MF coal concentration) as well as a linear term for superficial gas velocity and a level term for coal type.

The majority of the data are with Kentucky coal and the models developed previously for this coal are thought to have a sound, theoretical and experimental basis. However, the most recent data are being generated with Powhatan coal and current interest is focused on this coal because of its use in the planned Demonstration Plant. For these reasons models of the pooled coal data were developed to see how well the teachings of the models for Kentucky coal apply to the pooled coal models. An additional objective for this work was to see if any new insights about the effects of the process variables could be obtained from the larger data base for two coals. This work provides a first step in the development of kinetic models which will be useful in the hydrodynamic, reaction and thermal models already developed.^(4,5)

The underlying assumption in the use of a coal variable expressed as a level is that the behavior of the two coals with respect to the other variables would be the same for both coals. Therefore, the predictions of the pooled models are compared to those of the Kentucky coal alone.⁽¹⁾ Although there are some differences in behavior which become clear when one compares contour plots in Part V, Section 5 with those in (1), much of the results are strikingly similar. The differences, particularly in the dependence on pressure may be due to actual differences in coal which cannot be accounted for by the use of the coal level or due to statistical bias in the data for the two coals. Scatter plots of the model predictions vs experimental data indicate no apparent bias in the data. Therefore the use of a coal level as a correlating factor appears to be acceptable, until a model can be developed based on more quantitative continuous coal properties.

The data analyses were not limited to the models under discussion. Other forms of the models were developed to account for coal and for additional variables such as recycle SRC and recycle distillate. Other models were developed which treated coal as a "class" rather than a level. The

models using coal as a class are equivalent to those with coal expressed as a level with the addition of a large number of second and third order interaction terms between coal and the other variables. The two types of models gave a slightly better fit to the data but did not add any new information. It was felt that the added number of terms greatly overconstrained the model and that the simpler second order models were adequate to describe the data. Various unconstrained models were developed by stepwise regression in which the least significant terms were dropped from the models. These models were thought to be unsatisfactory because they lacked dependence on variables which other data showed were important. These models were also found to depend on the particular kind of coding of the variables. This problem did not occur in the fully constrained models containing all 22 terms which were finally chosen and are discussed further in this report.

III. DISCUSSION OF THE RESULTS

A. Regression Models and Statistics

Models were developed for the following responses (yields):

<u>Yield (MAF Coal Basis)</u>	<u>Symbol</u>
hydrogen consumption	(SHY)
light gases (C ₁ -C ₄)	(SC1C4)
by-products (SO ₂ , CO ₂ , H ₂ S, CO)	(SBY)
water	(SHW)
naphthas	(SNAP)
middle distillate (350-550°F)	(SMD)
heavy distillate (550-850°F)	(SHD)
SRC (>850°F, pyridine soluble)	(SSRC)
IOM (>850°F, pyridine insoluble)	(SIOM)
Total Distillate (middle + heavy)	(SDIST)

in terms of the following variables:

	<u>Variable</u>	<u>Symbol</u>	<u>Range</u>
1.	Temperature	(T)	413-465°C (775-869°F)
2.	Inlet hydrogen partial pressure	(PH2)	6.9-17.7 mPa (1000-2567 psia)
3.	Nominal slurry residence time	(SRT)	0.13-1.59 hr
4.	Inlet moisture free coal in feed slurry	(CIN)	23.4-50.0g/100g feed
5.	Recycle ash concentration	(RASH)	0-12.7g/100g MF coal
6.	Superficial gas velocity	(V)	0.43-6.06 cm/sec
7.	Coal type	(NCOAL)	-1(Kentucky) +1 (Powhatan)

Variables 1-5 above appear as linear, squared and crossed product terms in each model. Variables 6 and 7 appear only as linear terms.

Each model response consists of the sum of the following terms:

Response = intercept + sum of 5 linear terms + sum of 5 squared
terms + sum of 10 coupled terms + coal term + velocity term.
= total of 22 terms (coefficients) + intercept term

The terms in the models are summarized in Table 2. The mean values of the yields and those of the variables are indicated. The variables are listed in the left-most column and the coefficients of each variable in each model are tabulated. In the regression each variable is expressed as a difference between a particular run value and its mean value for all the data. Each squared term and each crossed product term are expressed as the square of the difference from the mean and the products of the differences from the mean of each variables. For example: $RASH = RASH - MRASH$ where $MRASH$ is the mean ash level. $RASH^2$ is actually $(RASH-MRASH)^2$. $TPH2$ is $(T-TM)(PH2-PH2M)$ where TM and $PH2M$ are again the mean values of T and $PH2$ respectively. This pattern is repeated with the other variables. The mean values of the variables are summarized in Part V, Section 2 (Statistical Regression Data Summary) and in Table 2.

The intercept value for each model is very close to the mean value of each yield. This is interesting in that the mean response is predicted (approximately) when all the variables are at their mean values. It does not necessarily follow that the intercept and the mean of each response should be equal because the intercept term is adjusted in the model just as the coefficients are to produce the best least squares fit to the data.

The magnitude of the model coefficient determines the relative weighting given each term and the sign determines the dependence (increasing or decreasing) of the yield on each term.

At the bottom of Table 2 are statistics from the regression indicating the "goodness of fit" of the model ($\bar{S}$) and the degree to which the model "explains the data" (R^2 value). One can see that the best models from the standpoint of R^2 are for SRC, ClC4 and total distillate. The poorest model is for naphtha due to the higher level of error in the data. The models for middle and heavy distillate are not as good at fitting the data as that for total distillate because of the error inherent in measuring the distillate split in each run. The yields of by-products, water and IOM are generally not considered important at present except from the standpoint that higher yields of NH_3 and H_2S indicate greater removal of heteroatoms from the coal. The hydrogen consumption model is adequate but not highly precise. In addition to these statistics, the significance values or so-called F or T statistics are also generated for each variable in the models. These data are summarized for each model in Section 2 of Model Output (IV).

The algebraic form of each model (except BY, HW and IOM) is shown next to the statistics and the lists of predicted and experimental values for each run in Section 2 of Part V. Also shown are residuals for each run as well as sums and squares of residuals.

Section 3 of Model Output contains the scatter plots of the data in which the horizontal axis represents the model predictions and the vertical axis represents the experimental values. These scatter plots are similar to those in (1) with the addition of more runs (points) and a plot for total

distillate. In general the degree of scatter agrees with the R^2 and $\pm S$ values of each model and the distributions of points about the 45° line indicate no significant bias or pattern of the data or models except perhaps in the split between SRC I and SRC II runs in those yields for which recycle ash is significant.

B. Regression Data Base

A great deal could be said about the data base in Section 1 of Part IV. This data base is similar to that in the report on Kentucky coal.⁽¹⁾ The terms in the data base are not completely defined by the Glossary, although this does define the variables and responses of interest. The data base is included primarily as a reference for the data and not as a tool for analysis at present.

C. Analysis of Effects of Single Variables About the Design Point

Section 4 of Model Output contains single variable plots for the principle yields (HY, ClC4, NAP, MD, HD, SRC, DIST) versus the primary variables (T, PH2, CI, RASH, SRT, V) where all the other terms in the model are evaluated at a common set of basis values. The basis values are the present central operating points for the Demonstration Plant which are summarized in Table 1. These single variable curves provide a useful measure of the effects of the variables about the operating point without considering the complexity of interactive effects.

Nonlinear effects are, of course, included. These plots show that nonlinear effects are often quite significant. The high probability of significant nonlinear effects suggests that experiments must be designed to take these into account. However where curvature is predicted and a minimum or maximum in the yield happens to coincide with the mean value of the variables, these curves are suspect. This is particularly true when the data are sparse at values beyond the max or min values of the curves. In several cases the overall change in a response for one variable is not large when the

other variables are at their basis values. Yet there may be significant effects for this variable when all values of the other variables are considered. Therefore the effects of the variables interpreted from the single variable plots may not always agree exactly with those from the contour plots discussed later in which interactive effects are considered.

Recycle Ash: RASH (g/100g MF coal)

Hydrogen consumption, middle and heavy distillate yields increase significantly with increasing recycle ash for some values of ash. SRC decreases most for lower values of ash and shows no particular effect at high levels. Total distillate appears to increase most for low to moderate ash levels and then appears to be insensitive to ash at higher levels. The apparent decline in some yields at the highest levels is probably due to the curvature caused by sparcity of data at these levels.

Yields of ClC4 and naphtha do not appear to change significantly although some variation around the mean is apparent. This variation is discounted for reasons mentioned above.

SRT: SRT (hrs)

Increasing SRT appears to increase hydrogen consumption and yields of ClC4, naphtha, middle and total distillate and decreases the yields of heavy distillate and SRC. The effect of SRT on distillates and SRC occurs over the entire range of SRT although curiously the effect appears absent at lower SRT for total distillate and at higher SRT for naphthas.

Average Reactor Temperature: T (°C)

The effects of temperature are very nearly the same as those of SRT. This appears to agree with our understanding concerning the combined effects of time and temperature on the thermal degradation of heavier products to lighter products.

Inlet Coal Concentration: CI (g/100g SF)

Increasing inlet coal concentration decreases the yields of ClC4, naphthas, middle and heavy distillate and increases SRC. The reasons for this are discussed in more detail later. In general these results agree with previous findings. The increase in ClC4 yield for very high coal levels is probably not real but is caused by uncertainty in the model at high coal levels.

Inlet Hydrogen Partial Pressure: PH2 (mPa)

Increasing inlet hydrogen partial pressure increases the production of light gases and naphthas and drives down the yield of middle distillate. This is probably caused by increased level of vapor phase hydrocracking at the higher pressures. There is a decrease in SRC yield and a corresponding increase in heavy distillate yield (and total distillate yield) as pressure increases. This is probably due to catalytically controlled hydrogenation of SRC to heavy distillate. The increase in total distillate is not very large over the entire range of pressure variation. This is due to the nearly equal opposing effects of pressure on middle and heavy distillate. It is also interesting to note that these effects are almost exactly linear and very little curvature is observed over the entire range of pressure.

Superficial Gas Velocity: V (cm/sec)

Increasing gas velocity tends to decrease hydrogen consumption and increase the yield of SRC. This trend is consistent with the effect of gas velocity on slurry holdup. Yields of ClC4 and naphthas are affected very little. There does appear to be a shift from heavy distillate to middle distillate yields but very little effect on total distillate yields.

D. Analysis of Pairs of Variables (Interactive Effects)
Over the Entire Range of the Data

Section 5 of Part V contains the contour plots for selected pairs of variables for each of the significant responses. All other variables are assigned their basis values.

The contour plots are identical for the two coals. The only effect of the coal is to shift the levels of the contours. Therefore there are two sets of levels for the various ranges of each yield at the bottom of each contour plot. These contour plots have been summarized in Table 3 to make detailed comparisons of the interactions of the variables without resorting to individual contour plots. Each "figure" in Table 3 shows the approximate lines of steepest ascent for both the Kentucky models (in red) and the pooled models (in black). Some figures do not contain Kentucky model lines because no contour plots were generated for these combinations of variables or responses. From Table 3, Table 4 was constructed to abstract further the qualitative effects of the variables on the significant yields. In Table 4, the responses indicated are for an increase in each variable. The responses in parentheses are for the Kentucky models which differ from those of the pooled models. The following discussion refers primarily to Tables 3 and 4.

Temperature

Table 3 shows that there is a high level of agreement between the models for this variable except for naphtha which is not considered a precise model for reasons discussed earlier. The effect of T appears to be a classical kinetic effect in which high boilers such as SRC and heavy distillate are hydrocracked to produce middle distillate, naphthas and light gas as the temperature is increased. The net effect, however, is to increase total distillate so the overall effect of temperature appears to be beneficial. This points out the importance of maintaining an adequately high temperature in the reactor while maintaining temperature uniformity via quench or by other means.

SRT

The effect of SRT appears to agree with that of temperature in that the two represent a classical reaction response in which the yield increases with the product of time and temperature. For the Kentucky models,^(1,2) the effect of SRT was judged to be nil for SRC, HD and MD while in the pooled

models SRT either increases or decreases the yield. Referring to Table 3 one can see that the effects of SRT agree quite well for the two models except for the naphtha yield.

Recycle Ash

There is general agreement in all responses on the effect of recycle ash. These results further confirm the principles shown earlier⁽¹⁻³⁾ that recycle ash catalyzes the hydrogenation of SRC to the next lower molecular weight products (heavy distillate) with a correspondingly increased consumption of hydrogen. Although middle distillate is probably produced by a similar mechanism by the hydrogenation of heavy distillate or SRC, the net yields of MD decrease with increasing ash. The yield of MD may be reduced by a higher level of complexing between MD and coal or reactive SRC. This reaction may be catalyzed at higher recycle ash levels. Naphtha yields may be increased by hydrocracking of the higher molecular weight species including middle distillate at the higher ash levels. There may be possible effects of ash on holdups and vapor liquid equilibrium which may indirectly alter the yields.

Inlet Coal Concentration

There is general agreement between the models on the effect of increased coal concentration. Tables 3 and 4 show that only SRC increases and all other yields including hydrogen consumption decrease. One would suspect that increased coal concentration would increase production of all coal products as well as SRC. Apparently the added production of these products due to increased dissolved coal content in the slurry is not compensated when expressing the yield on an MF coal basis. When expressed on a slurry feed basis, most yields increase with coal concentration. But the hydrocracking and/or hydrogen transfer processes are apparently not efficient enough to produce much more distillate and light gases as the coal feed increases and consequently the net yields decrease.

Linear Velocity

There is also general agreement between the models on the effects of linear velocity. In this case the effects were judged to be insignificant for the Kentucky coals,⁽¹⁾ but now appear to be somewhat significant for HY, ClC4 and NAP. One interpretation of the effect of velocity from a hydrodynamic point of view is that as gas velocity increases, gas holdup increases and this in turn decreases liquid and solid holdups. This change increases the importance of vapor phase reactions over those in the liquid phase which may be catalyzed by ash. The net result is that SRC yield increases and heavy distillate yield and hydrogen consumption decrease. Middle distillate yield may increase due to the reduced association (loss) of middle distillate with coal or reactive SRC because of the reduced liquid holdup. SRC yields may increase by this mechanism as well. A second cause for increased middle distillate (which does not exclude the first) may be due to the increased level of backmixing and thermal dispersion by the increased gas flow. This may tend to increase the effective residence time of the distillate within the reactor causing a shift downward in the boiling point of the distillate.

Inlet Hydrogen Partial Pressure

The greatest level of disagreement is apparent in the responses to pressure. The Kentucky coal models appeared to show very little effect of pressure and the pooled models appear to show some effect. However, the increased role of pressure is consistent with the other variable effects discussed above. The interpretation of the effect of pressure for the pooled models also confirms previous findings regarding the potential benefits of decreased pressure in increasing distillate yields provided this is compensated by an increase in temperature or recycle ash.

Increased pressure generally decreases the higher boiling components (SRC, HD, MD) (presumably by some hydrogen transfer process), increases the production of light gases and naphthas and consumes more hydrogen. One exception to this trend is in the heavy distillate yield which increases with

pressure at high ash concentrations. The overall effect of pressure is most clearly seen in the total distillate yield (which always increases with increasing pressure.) The sometimes opposing effect of pressure on middle and heavy distillate is most probably caused by the different rates of loss by vapor phase hydrocracking reactions to produce lighter products and of gain by hydrogenation of SRC. Perhaps the former effects are primarily thermal cracking to produce gases in the vapor phase while the latter effects are primarily catalytic liquid phase reactions which are favored by high recycle ash concentrations. The latter effect would then tend to produce heavy distillate from SRC at a slightly faster rate than its loss by thermal cracking and the net effect would be an increase in HD with ash. Middle distillate may be thermally cracked in the vapor phase as well as complexed with coal or reactive SRC in the liquid phase to a greater extent than heavy distillate. Consequently, it may be lost more rapidly to produce lighter gases by the first mechanism or to produce heavy distillate by the second as pressure increases.

Table 1

Basis Values for Correlations

(Used to Compute Single Variable and Contour Plots)

Temperature	455°C
Inlet Hydrogen Partial Pressure	12.55 mPa
Hydrogen purity	91%
Total Pressure	13.79 mPa
Gas Superficial Velocity	1.53 cm/sec (since this value is not specified, the mean value from the data was used)
SRT	1 hr
Inlet MF Coal Conc	30g/100g feed
Recycle Ash Conc	10.17g/100g MF coal
Coal Type	Powhatan (Curves for both coals were computed)

Table 2

Slope Values of Variables for Full Second-Order Models

Variables	Responses in Wt% of MAF Coal	SHY Hydrogen	SCIC ₂ Light Gases	SNAP Naphthas	SMD Middle Distillate	SHD Heavy Distillate	SSRC SRC	SDIST Total Distillate*	SHW Water	SIOM Insoluble Org. Matter	SBY ByProducts
	Intercept	3.777	10.769	9.1881	10.5531	14.6704	39.458	25.2236	7.4177	6.112	4.379
	Mean Value	4.047	13.075	9.346	12.341	11.223	40.573	23.564	7.360	6.075	4.144
T	453.74(°C)	.05813	.54964	.12810	.34533	-.31117	-.76243	.03417	.04996	.12885	.03675
PH ₂	12.402 (mPa)	.15904	.15698	.33953	-.14151	1.36378	-1.47754	1.22221	.23988	-.59246	.01258
SRT	.8578 (hr)	2.2240	9.22225	4.68260	8.05199	-2.25395	-15.84815	5.79804	-1.39221	-.13605	.28383
CIN	32.796(g/100g SF)	-.06719	.30341	-.13994	-.29239	-.14728	.66738	-.43966	.08904	.03850	.020
RASH	5.0166(g/100gSF)	.07763	.15323	-.22163	-.08916	1.31652	-1.50601	1.23237	.25626	.06373	.11301
V	1.5345 cm/sec	-.1525	.04650	-.06295	1.32803	-1.03487	.38242	.29315	-.45085	-.26023	.12345
NCQAL	-.4630	.23126	1.71363	.24991	3.57601	-2.43092	-1.34758	1.14508	-.43977	-.25308	-.29220
T ²		.00121	.00865	.00048	.00196	-.00977	-.00344	-.00781	.00379	.00155	.00040
(PH ₂) ²		.03462	.03291	-.08700	.02516	-.01170	.01638	.01347	.06172	-.00441	-.01288
SRT ²		.25808	4.69011	-6.68374	3.84229	-1.39237	-1.41633	2.44992	3.55292	.26736	-1.79154
CIN ²		-.00162	.03320	-.00526	-.00416	.00783	-.01128	.00367	-.00769	-.00314	.00619
RASH ²		-.01101	.01724	.01330	.03537	-.15379	.12513	-.11842	.02186	-.01184	-.02489
T*PH ₂		.00144	-.01803	-.00727	.03002	.02560	.00214	.05562	-.00787	-.01330	.00188
T*SRT		.01601	.56594	-.11352	.01561	.29214	-.95640	.30775	.21903	.05107	.01932
T*CIN		-.05403	-.01245	.00209	-.02711	.03881	-.00116	-.01171	-.00520	.00379	.00078
T*RASH		.05363	-.30297	.00183	.08534	-.05509	-.00822	.03028	-.03399	.00914	-.00340
PH ₂ *SRT		.25339	.13026	.07608	-.14476	.11168	-.52822	-.03308	.79692	-.47976	.03231
PH ₂ *CIN		-.00780	-.01040	-.01224	.05341	.01293	-.06536	.06635	.00092	-.00352	-.01086
PH ₂ *RASH		.02766	.13435	.07555	-.27839	.17365	-.12465	-.10474	.04785	-.01036	-.00506
SRT*CIN		.07858	-.26799	.26826	-.44053	.03909	.23594	-.40144	.13436	.01756	.01119
SRT*RASH		-.01076	-.96436	.73532	.35223	-1.43300	2.58849	-1.08077	-1.27094	.15792	.03627
CIN*RASH		-.01576	.02406	-.04425	-.02690	-.03698	.08570	-.06389	.00115	.00217	-.01409
R ² Correlation Coefficient		.8219	.9091	.4542	.776	.7602	.9688	.888	.7801	.4035	.7572
±S Standard Deviation		.6421	1.875	2.263	3.6612	3.708	3.322	3.786	1.0199	1.076	.5483

*Sum of Middle and Heavy Distillate

Boiling Range
 SMD = 350-550°F
 SHD = 550-850°F
 SSRC = >850°F (pyridine solubles)
 SIOM = >850 (pyridine insolubles)

Table 3

Significant Effects of Variable Pairs on SRC Yields

Coal Type					Color Code			
Kentucky and Powhatan Pooled					Black			
Kentucky Only					Red			
Lines indicate direction of steepest ascent for each yield.								
Variable Pair	Y X	Hydrogen Cons. SHY	Cl-C4 SClC4	Naphtha SNAP	Mid. Dist. SMD	Heavy Dist. SHD	SRC SSRC	Total Dist. SDIST
T • SRT Y • X								
T • PH2								
T • RASH								
T • CIN								
SRT • CIN								
SRT • RASH								
PH2 • RASH								
PH2 • SRT								
PH2 • CIN								
CIN • RASH								
RASH • V								
CIN • V								
PH2 • V								

Table 4

Summary of Effects of Variables Predicted
From Full Second Order Pooled Coal Models
(Effects are for increases in variable)

<u>Response</u>	<u>Avg. Tem- perature</u> <u>Tavg</u>	<u>SRT</u>	<u>Recycle Ash Conc</u> <u>Rash</u>	<u>Inlet Hydrogen Partial Press</u> <u>PH₂</u>	<u>Inlet Coal Conc.</u> <u>CIN</u>	<u>Linear Gas Velocity</u> <u>V</u>	<u>Coal Type</u> <u>NCOAL*</u>
SHY	inc	inc	inc	inc (nil)**	dec	dec (nil)	inc
SC1C4	inc	inc	nil	inc (dec)	nil (dec)	inc (nil)	inc
SNAP	inc (dec)	inc (dec)	inc	inc (dec)	dec	dec (nil)	inc
SMD	inc	inc (nil)	dec	dec (nil)	dec	inc	inc
SHD	dec	dec (nil)	inc	dec (except at high ash) (nil)	dec	dec	dec
SSRC	dec	dec (nil)	dec	dec (nil)	inc	inc	dec
SDIST	inc	inc	inc	inc	dec	nil	inc

*NCOAL = +1 for Powhatan coal, -1 for Kentucky coal. NCOAL increases as coal type changes from Kentucky to Powhatan.

** (effects in parentheses are those for the Kentucky coal models which differ from the pooled coal models.)

IV. REFERENCES

1. Carr, N. L., Jones, G. L., McMahon, M., "Second-Order Models for the SRC Yields from Kentucky Coal," R. N. 627RK001, June 18, 1979.
2. Carr, N. L., Jones, G. L., McMahon, M., "A Sequel Report: Second-Order Models for the SRC Yields from Kentucky Coal," R. N. 627RK002, June 18, 1979.
3. Carr, N. L., Jones, G. L., McMahon, M., "Statistical Analysis of Eleven Powhatan SRC-II Runs on P-99," R.N. 627RK004, June 29, 1979.
4. Shah, Y. T., Parulekar S., "A Model for the SRC-II Coal Liquefaction Reactor," Ref. 624RJ041, October 1978.
5. Parulekar, S. J., Shah, Y. T., "A Model for an Adiabatic SRC-II Coal Liquefaction Reactor," R. N. 627RK003, April 1979. (Not yet issued.)

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TERMS

XXX
 CODE DESIGNATES ONE OF THE FOUR SRC PILOT PLANTS
THOSE BEGINNING WITH FTL ARE FT. LEWIS RUNS
THOSE BEGINNING WITH MER ARE MERRIAM RUNS
THOSE BEGINNING WITH MRI ARE HYDROCARBON RESEARCH INSTITUTE RUNS
THOSE BEGINNING WITH PNN ARE P-99 RUNS
 RUN.....A SPECIFIC RUN FOR EACH OF THE PILOT PLANTS
 COAL.....KENTUCKY COAL ONLY
 MODE.....SRC-I OR SRC-II
 TAVG.....AVERAGE REACTOR TEMPERATURE, DEG C
 TPRMT.....PREHEATER TEMPERATURE, DEG C
 PTOT.....TOTAL AVERAGE REACTOR PRESSURE IN MPA
 GASRT.....GAS RATE PER COAL RATE IN MSCF/TON OF COAL
 PUR.....GAS PURITY(HYDROGEN CONCENTRATION) IN PER CENT
 DIA.....REACTOR DIAMETER IN CM
 LEN.....REACTOR LENGTH IN CM
 SRT.....NOMINAL SLURRY RESIDENCE TIME(HRS)
 CIN.....INLET COAL CONCENTRATION(G COAL/100 G SLURRY FEED)
 RMD.....RECYCLE MIDDLE DISTILLATE
 RHD.....RECYCLE HEAVY DISTILLATE
 RSRC.....RECYCLE SRC
 RASH.....RECYCLE ASH
 RIOM.....RECYCLE IOM
 TOTSOL.....TOTAL SOLIDS IN THE SLURRY FEED
 DHY.....NET HYDROGEN CONSUMPTION BASED ON 1 G OF MOISTURE FREE COAL
 DC1C4.....NET YIELD OF C1-C4 BASED ON 1 G OF MOISTURE FREE COAL
 DBY.....NET YIELD OF BYPRODUCTS BASED ON 1 G OF MOISTURE FREE COAL
 DHW.....NET YIELD OF WATER BASED ON 1 G OF MOISTURE FREE COAL
 DNAP.....NET YIELD OF NAPHTHA BASED ON 1 G OF MOISTURE FREE COAL
 NAPHTHA.....C5-380F
 DMD.....NET YIELD OF MIDDLE DISTILLATE BASED ON 1 G OF MOISTURE FREE COAL
 MIDDLE DISTILLATE.....380-550F
 DHD.....NET YIELD OF HEAVY DISTILLATE BASED ON 1 G OF MOISTURE FREE COAL
 HEAVY DISTILLATE.....550-850F
 DSRC.....NET YIELD OF SRC BASED ON 1 G OF MOISTURE FREE COAL
 DIOM.....NET YIELD OF IOM BASED ON 1 G OF MOISTURE FREE COAL
 IOM.....INSOLUBLE ORGANIC MATTER
 DASH.....NET YIELD OF ASH BASED ON 1 G OF MOISTURE FREE COAL
 PH2.....INLET HYDROGEN PARTIAL PRESSURE IN THE REACTOR(MPA)
 V.....GAS LINEAR VELOCITY (CM/SEC)
 NCOAL.....WEIGHTING FACTOR FOR COAL TYPE, KENTUCKY(-1) OR POWHATAN(+1)
 SHY.....NET HYDROGEN CONSUMPTION PER 100 G OF MAF COAL
 SC1C4.....NET YIELD OF C1-C4 PER 100 G OF MAF COAL
 SBY.....NET YIELD OF BYPRODUCTS PER 100 G OF MAF COAL
 SHW.....NET YIELD OF WATER PER 100 G OF MAF COAL
 SNAP.....NET YIELD OF NAPHTHA PER 100 G OF MAF COAL
 SMD.....NET YIELD OF MIDDLE DISTILLATE PER 100 G OF MAF COAL
 SHD.....NET YIELD OF HEAVY DISTILLATE PER 100 G OF MAF COAL
 SSRC.....NET YIELD OF SRC PER 100 G OF MAF COAL
 SIOM.....NET YIELD OF IOM PER 100 G OF MAF COAL
 SOIST.....VALUE FOR COMBINED MIDDLE AND HEAVY DISTILLATE
 SUMIN.....TOTAL MASS OF COAL AND HYDROGEN IN
 SUMOUT.....SUM OF THE NET YIELDS
 MTAVG.....MEAN VALUE FOR TEMPERATURE

GLOSSARY

10:53 THURSDAY, AUGUST 30, 1979

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TERMS

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MPH2.....MEAN VALUE FOR THE AVERAGE HYDROGEN PARTIAL PRESSURE  
MGASRT.....MEAN VALUE FOR THE GAS RATE  
MSRT.....MEAN VALUE FOR THE NOMINAL SLURRY RESIDENCE TIME  
MCIN.....MEAN VALUE FOR THE INLET COAL CONCENTRATION  
MRASH.....MEAN VALUE FOR THE RECYCLE ASH CONCENTRATION  
MV.....MEAN VALUE FOR THE GAS LINEAR VELOCITY  
MNCOAL.....MEAN VALUE OF THE WEIGHTING FACTOR, NCOAL  
VTAVG.....DEVIATION OF THE TEMPERATURE FROM ITS MEAN VALUE  
VPH2.....DEVIATION OF THE H2 PARTIAL PRESSURE FROM ITS MEAN VALUE  
VGASRT.....DEVIATION OF THE GAS RATE FROM ITS MEAN VALUE  
VSRT.....DEVIATION OF THE SLURRY RESIDENCE TIME FROM ITS MEAN VALUE  
VRASH.....DEVIATION OF THE RECYCLE ASH FROM ITS MEAN VALUE  
VV.....DEVIATION OF THE GAS LINEAR VELOCITY FROM ITS MEAN VALUE  
VNCOAL.....DEVIATION OF THE WEIGHTING FACTOR NCOAL FROM ITS MEAN VALUE  
VTP.....CROSS PRODUCT OF VTAVG AND VPH2  
VTS.....CROSS PRODUCT OF VTAVG AND VSRT  
VTC.....CROSS PRODUCT OF VTAVG AND VCIN  
VTR.....CROSS PRODUCT OF VTAVG AND VRASH  
VPS.....CROSS PRODUCT OF VPH2 AND VSRT  
VPC.....CROSS PRODUCT OF VPH2 AND VCIN  
VPR.....CROSS PRODUCT OF VPH2 AND VRASH  
VSC.....CROSS PRODUCT OF VSRT AND VCIN  
VSR.....CROSS PRODUCT OF VSRT AND VRASH  
VCR.....CROSS PRODUCT OF VCIN AND VRASH  
XXXXXXXXXXXXXX  
XXXXXXXXXXXXXX  
OBSERVATIONS CORRESPOND TO RUNS IN THE DATA BASE  
XXXXXXXXXXXXXX
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SECTION 1. DATA SUMMARY

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STATISTICAL ANALYSIS SYSTEM

9:48 MONDAY, JULY 16, 1979 1

OBS	CODE	RUN	COAL	MODE	TAVG	TPRMT	PTOT	PHYQUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RHD	RSRC	RASH
1	FTLS1	MBR1	KENT	1	450.0	400.0	10.71	4.18	14.769	94.80	61.00	914.4	0.525	37.3	16.9	45.80	0.00	0.0
2	FTLS2	MBR2	KENT	1	447.0	374.0	10.37	5.81	21.535	97.10	61.00	914.4	0.926	38.4	16.7	44.90	0.00	0.0
3	FTLS3	MBR3	KENT	1	461.0	403.0	10.42	4.99	19.498	93.48	61.00	497.0	0.350	37.5	16.8	45.70	0.00	0.0
4	FTLS4	MBR4	KENT	1	445.0	399.0	10.44	6.14	18.869	93.83	61.00	497.0	0.348	38.6	16.5	44.90	0.00	0.0
5	FTLS5	MBR5	KENT	1	451.0	406.0	10.36	5.08	15.398	91.96	61.00	497.0	0.275	38.1	16.7	45.20	0.00	0.0
6	FTLS6	MBR6	KENT	1	462.0	412.0	10.33	4.29	13.789	90.71	61.00	497.0	0.274	38.4	16.6	45.00	0.00	0.0
7	FTLS7	MBR7	KENT	1	452.0	403.0	10.25	4.57	13.816	91.37	61.00	497.0	0.274	38.4	16.7	44.90	0.00	0.0
8	FTLS8	MBR8	KENT	1	447.0	393.0	10.34	5.58	18.014	94.10	61.00	497.0	0.346	39.1	16.4	44.50	0.00	0.0
9	FTLS9	MBR9	KENT	1	457.0	403.0	10.29	4.89	16.082	92.50	61.00	497.0	0.303	39.3	16.4	44.30	0.00	0.0
10	FTLS10	MBR10	KENT	1	448.0	407.0	7.18	2.94	22.354	96.03	61.00	497.0	0.367	38.0	16.7	45.30	0.00	0.0
11	FTLS11	MBR11	KENT	1	451.0	402.0	8.80	4.50	22.118	94.21	61.00	497.0	0.366	38.4	16.7	44.90	0.00	0.0
12	MERS1	GUI20	KENT	1	450.0	402.0	9.53	5.96	20.670	100.00	1.75	184.0	0.367	39.1	0.0	60.90	0.00	0.0
13	MERS2	GUI22	KENT	1	453.0	402.0	9.34	3.55	12.880	100.00	1.75	184.0	0.283	38.9	0.0	61.10	0.00	0.0
14	MERS3	GUI23	KENT	1	453.0	400.0	9.34	3.74	13.530	100.00	1.75	184.0	0.288	39.1	0.0	60.90	0.00	0.0
15	MERS4	GUI27	KENT	1	446.0	395.5	9.83	5.51	18.060	100.00	1.75	184.0	0.353	39.3	0.0	60.70	0.00	0.0
16	MERS5	GUI31	KENT	1	447.0	397.9	9.83	5.51	19.130	100.00	1.75	184.0	0.358	39.5	0.0	60.50	0.00	0.0

OBS	RIOM	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DHD	DSRC	DIOM	DASH	PH2	X	SHY
1	0.0000	0.3730	0.0250	0.0540	0.0330	0.0490	0.0660	0.0800	0.0010	0.5830	0.0660	0.0930	10.1531	110.254	2.75634
2	0.0000	0.3840	0.0270	0.0550	0.0260	0.0530	0.1020	0.1040	-0.0280	0.5750	0.0480	0.0920	10.0693	110.132	2.97357
3	0.0000	0.3750	0.0210	0.0790	0.0390	0.0720	0.1520	-0.0420	-0.0290	0.5860	0.0710	0.0880	9.7406	109.649	2.30263
4	0.0000	0.3860	0.0200	0.0370	0.0210	0.0480	0.0430	0.0580	0.0210	0.6400	0.0580	0.0930	9.7959	110.254	2.20507
5	0.0000	0.3810	0.0200	0.0290	0.0200	0.0560	0.0260	0.0690	0.0090	0.6730	0.0630	0.0930	9.5271	110.254	2.20507
6	0.0000	0.3840	0.0200	0.0590	0.0250	0.0540	0.0360	0.0500	0.0190	0.6590	0.0650	0.1010	9.3703	111.235	2.22469
7	0.0000	0.3840	0.0190	0.0370	0.0280	0.0550	0.0370	0.0600	0.0090	0.6560	0.0570	0.0980	9.3654	110.865	2.10643
8	0.0000	0.3910	0.0240	0.0370	0.0220	0.0500	0.0510	0.0520	0.0320	0.6300	0.0540	0.0960	9.7299	110.619	2.65487
9	0.0000	0.3930	0.0210	0.0590	0.0240	0.0500	0.0500	0.0510	-0.0010	0.6420	0.0590	0.0970	9.5182	110.742	2.32558
10	0.0000	0.3800	0.0360	0.0460	0.0280	0.0630	0.0150	0.0630	-0.0090	0.6540	0.0630	0.1130	6.8950	112.740	4.05862
11	0.0000	0.3660	0.0290	0.0540	0.0280	0.0700	0.0560	0.0280	0.0090	0.6110	0.0610	0.1130	8.2905	112.740	3.26945
12	0.0000	0.3910	0.0160	0.0290	0.0300	0.0640	0.1190	0.0460	0.0000	0.5620	0.0530	0.1130	9.9300	112.740	1.80383
13	0.0000	0.3890	0.0180	0.0340	0.0310	0.0850	0.0960	0.0020	0.0000	0.5980	0.0580	0.1130	9.3400	112.740	2.02931
14	0.0000	0.3910	0.0180	0.0440	0.0310	0.0660	0.0960	0.0000	-0.0290	0.6510	0.0670	0.0910	9.3400	110.011	1.98020
15	0.0000	0.3930	0.0175	0.0330	0.0280	0.0560	0.0540	0.0350	0.0420	0.6140	0.0550	0.0960	9.8300	110.619	1.93584
16	0.0000	0.3950	0.0144	0.0470	0.0340	0.0470	0.0380	0.0690	0.0070	0.6100	0.0540	0.0960	9.8300	110.619	1.59292

OBS	SC1C4	SBY	SHW	SNAP	SMD	SHD	SSRC	SIOM	SDIST	RDIST	L	V	SUMIN	SUMOUT	DUM
1	5.9537	3.63837	5.4024	7.2767	8.8203	0.1103	64.2778	7.2767	8.9305	62.70	914.4	2.26598	102.756	102.756	1
2	6.0573	2.86344	5.8370	11.2335	11.4537	-3.0837	63.3260	5.2863	8.3700	61.60	914.4	1.98348	102.974	102.974	1
3	8.6623	4.27632	7.8947	16.6667	-4.6053	-3.1798	64.2544	7.7851	-7.7851	62.50	497.0	2.55862	102.303	101.754	1
4	4.0794	2.31533	5.2922	4.7409	6.3947	2.3153	70.5623	6.3947	8.7100	61.40	497.0	2.50270	102.205	102.095	1
5	3.1974	2.20507	6.1742	2.8666	7.6075	0.9923	74.2007	6.9460	8.5998	61.90	497.0	2.59216	102.205	104.190	1
6	6.5628	2.78027	6.0067	4.0044	5.5617	2.1135	73.3037	7.2303	7.6752	61.60	497.0	2.39070	102.225	107.564	1
7	4.1020	3.10421	6.0976	4.1020	6.6519	0.9978	72.7273	6.3193	7.6497	61.60	497.0	2.38124	102.106	104.102	1
8	4.0929	2.43363	5.5310	5.6416	5.7522	3.5398	69.6903	5.9735	9.2920	60.90	497.0	2.46463	102.655	102.655	1
9	6.5338	2.65761	5.5371	5.5371	5.6478	-0.1107	71.0963	6.5338	5.5371	60.70	497.0	2.57290	102.326	103.433	1
10	5.1860	3.15671	7.1026	1.6911	7.1026	-1.0147	73.7317	7.1026	6.0879	62.00	497.0	4.04121	104.059	104.059	1
11	6.0879	3.15671	7.8918	6.3134	3.1567	1.0147	68.8839	6.8771	4.1714	61.60	497.0	3.31955	103.269	103.382	1
12	3.2694	3.38219	7.2153	13.4160	5.1860	0.0000	63.3596	5.9752	5.1860	60.90	184.0	1.03212	101.804	101.804	1
13	3.8331	3.49493	9.5829	10.8230	0.2255	0.0000	67.4183	6.5389	0.2255	61.10	184.0	0.88584	102.029	101.917	1
14	4.8405	3.41034	7.2607	10.5611	0.0000	-3.1903	71.6172	7.3707	-3.1903	60.90	184.0	0.91909	101.980	101.870	1
15	3.6504	3.09735	6.1947	5.9735	3.8717	4.6460	67.9204	6.0841	8.5177	60.70	184.0	0.94667	101.936	101.438	1
16	5.1991	3.76106	5.1991	4.2035	7.6327	0.7743	67.4779	5.9735	8.4071	60.50	184.0	0.99517	101.593	100.221	1

STATISTICAL ANALYSIS SYSTEM

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OBS	CODE	RUN	COAL	MODE	TAVG	TPRMT	PTOT	PHYOUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RMD	RSRC	RASH
17	MERS6	GUA4	KENT	1	460.0	400.0	13.89	11.67	58.70	100.00	1.75	377.9	1.000	35.0	0.0	65.00	0.00	0.00
18	MERS7	GUB4	KENT	1	461.0	404.0	13.89	10.42	44.69	100.00	1.75	377.9	1.000	45.0	0.0	55.00	0.00	0.00
19	MERS8	GUC4	KENT	1	459.0	401.0	13.89	10.14	42.63	100.00	1.75	377.9	1.000	50.0	0.0	50.00	0.00	0.00
20	MERS9	GU213	KENT	1	456.0	400.0	13.89	11.67	57.10	100.00	1.75	377.9	0.977	30.0	0.0	70.00	0.00	0.00
21	MERS10	GU214	KENT	1	456.0	401.0	13.89	9.86	38.70	100.00	1.75	377.9	0.993	45.0	0.0	55.00	0.00	0.00
22	MERS11	GU234	KENT	1	455.0	400.0	13.89	11.39	52.70	100.00	1.75	377.9	1.032	30.0	0.0	70.00	0.00	0.00
23	MFRS12	GU235A	KENT	1	455.0	400.0	13.89	9.58	36.70	100.00	1.75	377.9	1.084	45.0	0.0	55.00	0.00	0.00
24	MERS13	GU235B	KENT	1	455.0	401.0	13.89	9.58	35.30	100.00	1.75	377.9	1.044	45.0	0.0	55.00	0.00	0.00
25	HRIS1	HR1A	KENT	1	441.1	432.8	10.45	7.11	28.60	100.00	2.07	299.7	0.700	24.4	0.0	75.60	0.00	0.00
26	HRIS2	HR1B	KENT	1	426.7	415.0	10.45	7.21	28.40	100.00	2.07	299.7	0.716	24.9	0.0	75.10	0.00	0.00
27	HRIS3	HR1C	KENT	1	426.7	417.8	17.17	12.02	31.40	100.00	2.07	299.7	0.710	24.8	0.0	75.20	0.00	0.00
28	HRIS4	HR1D	KENT	1	440.6	436.7	17.24	10.34	28.20	100.00	2.07	299.7	0.671	23.4	0.0	76.60	0.00	0.00
29	HRIS5	HR1E	KENT	1	412.8	408.9	10.45	7.21	28.90	100.00	2.07	299.7	0.701	24.2	0.0	75.80	0.00	0.00
30	HRIS6	HR1F	KENT	1	440.6	429.4	10.48	6.81	27.50	100.00	2.07	299.7	0.367	25.5	0.0	74.50	0.00	0.00
31	HRIS7	HR1G	KENT	1	426.7	415.6	10.55	7.07	27.60	100.00	2.07	299.7	0.357	24.8	0.0	75.20	0.00	0.00
32	HRIS8	HR1H	KENT	1	426.7	415.6	17.65	11.65	26.90	100.00	2.07	299.7	0.359	24.9	0.0	75.10	0.00	0.00

OBS	RIOM	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DHD	DSRC	DICM	DASH	PH2	X	SHY
17	0.0000	0.3500	0.0194	0.1386	0.0403	0.0749	0.1068	0.0466	0.1029	0.3431	0.0440	0.1131	13.8900	112.752	2.18739
18	0.0000	0.4500	0.0205	0.1290	0.0423	0.0924	0.0910	0.0615	0.1049	0.3361	0.0444	0.1132	13.8900	112.765	2.31168
19	0.0000	0.5000	0.0265	0.1386	0.0451	0.0855	0.1235	0.0524	0.1285	0.3310	0.0448	0.1132	13.8900	112.765	2.98827
20	0.0000	0.3000	0.0240	0.1050	0.0360	0.0610	0.1060	0.1210	0.0320	0.4270	0.0410	0.0950	13.8900	110.497	2.65193
21	0.0000	0.4500	0.0380	0.1050	0.0360	0.0680	0.1030	0.1050	0.0660	0.4140	0.0440	0.0970	13.8900	110.742	4.20819
22	0.0000	0.3000	0.0410	0.0990	0.0230	0.0940	0.1070	0.1410	0.0410	0.3940	0.0430	0.0990	13.8900	110.988	4.55050
23	0.0000	0.4500	0.0420	0.1040	0.0350	0.0840	0.0690	0.1130	0.1190	0.3710	0.0460	0.1010	13.8900	111.235	4.67186
24	0.0000	0.4500	0.0420	0.0970	0.0350	0.0900	0.0910	0.0860	0.1000	0.3920	0.0470	0.1040	13.8900	111.607	4.68750
25	0.0000	0.2440	0.0197	0.0579	0.0240	0.0238	0.0482	0.0742	0.1102	0.5429	0.0510	0.0876	10.4500	109.601	2.15914
26	0.0000	0.2490	0.0182	0.0453	0.0241	0.0183	0.0347	0.0576	0.0708	0.6271	0.0562	0.0840	10.4500	109.170	1.98690
27	0.0000	0.2480	0.0207	0.0462	0.0250	0.0392	0.0370	0.0730	0.0521	0.5807	0.0450	0.0786	17.1700	108.530	2.24658
28	0.0000	0.2340	0.0249	0.0603	0.0307	0.0385	0.0530	0.0868	0.1079	0.5227	0.0447	0.0803	17.2400	108.731	2.70740
29	0.0000	0.2420	0.0180	0.0291	0.0226	0.0240	0.0320	0.0609	0.0953	0.6164	0.0569	0.0827	10.4500	109.016	1.96228
30	0.0000	0.2550	0.0197	0.0496	0.0247	0.0391	0.0420	0.0716	0.0921	0.5646	0.0515	0.0845	10.4800	109.230	2.15183
31	0.0000	0.2480	0.0148	0.0338	0.0216	0.0393	0.0381	0.0349	0.0537	0.6572	0.0569	0.0795	10.5500	108.637	1.60782
32	0.0000	0.2490	0.0163	0.0328	0.0215	0.0356	0.0350	0.0403	0.0660	0.6456	0.0571	0.0820	17.6500	108.932	1.77560

OBS	SC1C4	SBY	SHW	SNAP	SMD	SHD	SSRC	SIOM	SDIST	RDIST	L	V	SUMIN	SUMOUT	DUM
17	15.6275	4.54392	8.4451	12.0419	5.2543	11.6022	38.6853	4.9611	16.8565	65.00	377.9	1.43335	102.187	101.161	1
18	14.5467	4.76996	10.4195	10.2616	6.9350	11.8290	37.9003	5.0068	18.7641	55.00	377.9	1.40495	102.312	101.669	1
19	15.6292	5.08570	9.6414	13.9265	5.9089	14.4903	37.3252	5.0519	20.3992	50.00	377.9	1.48504	102.988	107.059	1
20	11.6022	3.97750	6.7403	11.7127	13.3702	3.5359	47.1823	4.5304	16.9061	70.00	377.9	1.21656	102.652	102.652	1
21	11.6279	3.98671	7.5305	11.4064	11.6279	7.3090	45.8472	4.8726	18.9369	55.00	377.9	1.21687	104.208	104.208	1
22	10.9878	2.55272	10.4329	11.8757	15.6493	4.5505	43.7292	4.7725	20.1998	70.00	377.9	1.06152	104.550	104.550	1
23	11.5684	3.89321	9.3437	7.6752	12.5695	13.2369	41.2681	5.1168	25.8065	55.00	377.9	1.05566	104.672	104.672	1
24	10.8259	3.90625	10.0446	10.1562	9.5982	11.1607	43.7500	5.2455	20.7589	55.00	377.9	1.05430	104.687	104.687	1
25	6.3459	2.63043	2.6085	5.2828	8.1324	12.0780	59.5024	5.5897	20.2104	75.00	299.7	0.71427	102.159	102.170	1
26	4.9454	2.63100	1.9978	3.7882	6.2882	7.7293	68.4607	6.1354	14.0175	75.10	299.7	0.69337	101.987	101.976	1
27	5.0141	2.71326	4.2544	4.0156	7.9227	5.6544	63.0237	4.8839	13.5772	75.20	299.7	0.46863	102.247	97.482	1
28	6.5565	3.33805	4.1861	5.7627	9.4379	11.7321	56.8338	4.8603	21.1699	76.00	299.7	0.42680	102.707	102.707	1
29	3.1724	2.46375	2.6164	3.4885	6.6390	10.3892	67.1972	6.2030	17.0282	75.80	299.7	0.68651	101.962	102.169	1
30	5.4178	2.69758	4.2709	4.5877	7.8209	10.0601	61.6712	5.6253	17.8809	74.50	299.7	1.36415	102.152	102.152	1
31	3.6719	2.34655	4.2694	4.1391	3.7914	5.8338	71.3960	6.1814	9.6252	75.20	299.7	1.33326	101.608	101.630	1
32	3.5730	2.34205	3.8780	3.8126	4.3900	7.1895	70.3268	6.2200	11.5795	75.10	299.7	0.77551	101.776	101.732	1

STATISTICAL ANALYSIS SYSTEM

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OBS	CODE	RUN	COAL	MODE	TAVG	TPRHT	PTOT	PHYOUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RMD	MSRC	RASH
33	HRIS9	HRIS	KENT	1	441.1	418.3	17.37	11.12	27.10	100.00	2.07	299.70	0.360	25.1	0.0	74.90	0.00	0.00
34	HRIS10	HRIS	KENT	1	440.6	433.9	6.89	5.03	37.60	100.00	2.07	299.70	0.721	25.1	0.0	74.90	0.00	0.00
35	PNN1	P99_15	KENT	2	460.0	391.0	13.80	8.76	91.01	85.21	15.20	304.80	1.060	33.2	22.4	25.60	12.30	3.90
36	PNN2	P99_16	KENT	2	460.0	390.0	15.17	9.36	71.13	85.84	15.20	304.80	1.000	29.6	20.5	23.30	16.90	5.90
37	PNN3	P99_17	KENT	2	465.0	389.0	13.76	8.00	64.16	84.52	15.20	304.80	1.040	32.8	21.8	24.80	12.30	4.40
38	PNN4	P99_18	KENT	2	460.0	389.0	15.19	9.11	75.30	83.97	15.20	304.80	1.330	32.7	22.6	25.70	12.10	4.10
39	PNN5	P99_20	KENT	2	460.0	403.0	13.80	7.83	57.74	83.97	15.20	304.80	0.660	29.8	18.4	20.80	20.50	5.30
40	PNN6	P99_21	KENT	2	460.0	380.0	17.24	10.62	73.04	84.69	15.20	304.80	0.660	29.6	18.2	20.70	20.70	7.40
41	PNN7	P99_22	KENT	2	460.0	380.0	17.24	11.13	97.97	85.28	15.20	304.80	1.220	29.6	21.1	24.00	13.50	7.50
42	PNN8	P99_23	KENT	2	460.0	386.0	13.80	8.98	84.55	85.31	15.20	304.80	1.210	29.7	20.2	23.00	14.20	6.80
43	FTLL1	77SR_1	KENT	2	461.0	427.0	13.29	10.22	72.63	93.95	61.00	914.40	0.997	26.1	2.5	35.30	22.40	8.60
44	FTLL2	77SR_2	KENT	2	459.0	429.0	13.29	10.13	78.69	90.54	61.00	914.40	0.984	24.2	2.7	35.70	22.30	10.30
45	FTLL3	77SR_3	KENT	2	459.0	430.0	13.18	10.11	87.83	92.20	61.00	914.40	0.823	24.6	6.1	25.00	27.80	10.60
46	FTLL4	77SR_4	KENT	2	461.0	429.0	13.20	9.35	86.20	90.40	61.00	914.40	0.799	29.9	6.2	22.20	26.30	9.20
47	FTLL5	77SR_5	KENT	2	458.0	429.0	13.28	9.82	87.65	91.80	61.00	914.40	0.780	30.6	10.9	30.70	20.20	5.10
48	FTLL6	77SR_6	KENT	2	459.0	428.0	13.24	9.69	80.20	90.98	61.00	914.40	0.956	33.5	12.9	23.00	19.80	6.00

OBS	RIDM	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DHD	DSRC	DIDM	DASH	PH2	X	SHY
33	0.0000	0.2510	0.0199	0.0490	0.0247	0.0399	0.0441	0.0596	0.0948	0.5719	0.0519	0.0841	17.3700	109.182	2.17273
34	0.0000	0.2510	0.0186	0.0732	0.0244	0.0450	0.0619	0.0445	0.0530	0.5776	0.0537	0.0851	6.8900	109.302	2.03301
35	0.0280	0.3990	0.0493	0.1720	0.0444	0.0794	0.0572	0.1613	0.1214	0.2509	0.0679	0.0919	11.7590	110.120	5.42892
36	0.0370	0.3920	0.0468	0.1536	0.0385	0.0790	0.1019	0.1620	0.1135	0.2484	0.0580	0.0919	13.0219	110.120	5.15362
37	0.0390	0.4110	0.0476	0.1714	0.0423	0.0790	0.1051	0.1386	0.1035	0.2353	0.0804	0.0919	11.6300	110.120	5.24171
38	0.0280	0.3960	0.0502	0.1986	0.0425	0.0839	0.0655	0.1422	0.1124	0.2501	0.0632	0.0919	12.7550	110.120	5.52803
39	0.0530	0.4040	0.0401	0.1427	0.0409	0.0783	0.0497	0.1316	0.1197	0.2928	0.0926	0.0919	11.5879	110.120	4.41581
40	0.0340	0.4040	0.0463	0.1474	0.0402	0.0843	0.0775	0.1477	0.1658	0.2494	0.0422	0.0919	14.6006	110.120	5.09856
41	0.0430	0.4140	0.0589	0.2161	0.0463	0.0791	0.1005	0.1985	0.1029	0.1697	0.0539	0.0919	14.7023	110.120	6.48607
42	0.0610	0.4260	0.0527	0.2110	0.0438	0.0755	0.0770	0.1749	0.1208	0.1742	0.0832	0.0924	11.7728	110.181	5.80652
43	0.0510	0.4080	0.0414	0.1685	0.0572	0.0534	0.0833	0.2032	0.1011	0.2349	0.0525	0.0870	12.4860	109.529	4.53450
44	0.0480	0.3930	0.0365	0.1628	0.0552	0.0472	0.0934	0.1989	0.1504	0.2038	0.0522	0.1100	12.0328	112.360	4.10112
45	0.0590	0.4110	0.0406	0.1479	0.0687	0.0514	0.1389	0.1606	0.1118	0.2102	0.0541	0.0980	12.1520	110.865	4.50111
46	0.0620	0.4530	0.0388	0.1398	0.0568	0.0830	0.0622	0.1813	0.0938	0.2598	0.0649	0.0970	11.9328	110.742	4.29679
47	0.0250	0.3820	0.0326	0.1151	0.0435	0.0652	0.0824	0.1576	0.1151	0.3126	0.0471	0.0940	12.1910	110.375	3.59823
48	0.0480	0.4430	0.0325	0.1293	0.0542	0.0479	0.1175	0.1690	0.0000	0.3426	0.0759	0.0960	12.0458	110.619	3.59513

OBS	SC1C4	SBY	SHW	SNAP	SMD	SHD	SSRC	SIOM	SDIST	RDIST	L	V	SUMIN	SUMOUT	DUM
33	5.3499	2.69680	4.3564	4.8149	6.5073	10.3505	62.4413	5.6666	16.8577	74.90	299.70	0.81444	102.173	102.184	1
34	8.0009	2.66696	4.9186	6.7658	4.8639	5.7930	63.1326	5.8695	10.6569	74.90	299.70	1.42142	102.033	102.011	1
35	18.9406	4.44886	8.7435	6.2989	17.7624	13.3686	27.6291	7.4772	31.1309	48.00	304.80	1.61447	105.429	104.669	1
36	16.9144	4.23962	8.6995	11.2212	17.8394	12.4986	27.3538	6.3870	30.3381	43.00	304.80	1.08479	105.154	105.154	1
37	18.8746	4.65808	8.6995	11.5736	15.2626	11.3974	25.9112	8.8537	26.6601	46.60	304.80	1.15724	105.242	105.231	1
38	21.8698	4.68010	9.2391	7.2129	15.6591	12.3775	27.5410	6.9596	28.0366	48.30	304.80	0.95262	105.528	105.539	1
39	15.7141	4.50391	8.6224	5.4730	14.4918	13.1814	32.2431	10.1971	27.6732	39.20	304.80	1.47658	104.416	104.427	1
40	16.2317	4.42683	9.2831	8.5343	16.2647	18.2579	27.4639	4.6471	34.5226	38.90	304.80	1.48511	105.099	105.110	1
41	23.7969	5.09856	8.7105	11.0671	21.8588	11.3314	18.6874	5.9355	33.1902	45.10	304.80	1.07764	106.486	106.486	1
42	23.2481	4.82591	8.3186	8.4839	19.2706	13.3098	19.1935	9.1670	32.5804	43.20	304.80	1.17542	105.807	105.818	1
43	18.4556	6.26506	5.8488	9.1238	22.2563	11.0734	25.7284	5.7503	33.3297	37.80	914.40	3.35921	104.535	104.502	1
44	18.2921	6.20225	5.3034	10.4944	22.3483	16.8989	22.8989	5.8652	39.2472	38.40	914.40	3.40981	104.101	108.303	1
45	16.3969	7.61641	5.6984	15.3991	17.8049	12.3947	23.3038	5.9978	30.1996	31.10	914.40	4.66421	104.501	104.612	1
46	15.4817	6.29014	9.1916	6.8882	20.0775	10.3876	28.7708	7.1872	30.4651	28.40	914.40	5.73797	104.297	104.275	1
47	12.7042	4.80132	7.1965	9.0949	17.3951	12.7042	34.5033	5.1987	30.0993	41.60	914.40	6.05484	103.598	103.598	1
48	14.3031	5.99558	5.2987	12.9978	18.6947	0.0000	37.8982	8.3960	18.6947	35.90	914.40	4.97037	103.595	103.584	1

STATISTICAL ANALYSIS SYSTEM

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OBS	CODE	RUN	COAL	MODE	TAVG	TPRHT	PTOT	PHYOUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RHD	RSRC	RASH
49	FTLL7	77SR_7	KENT	2	461	428.0	13.34	9.67	82.11	89.8	61.00	914.40	0.932	29.5	6.9	26.50	23.90	8.20
50	MERL1	GUR134	KENT	2	461	399.5	13.89	10.28	52.20	100.0	1.75	189.00	0.955	35.0	0.0	32.70	19.20	8.40
51	MERL2	GUR138	KENT	2	455	389.0	13.20	9.81	44.50	100.0	1.75	377.90	1.010	40.0	0.0	34.70	17.30	5.50
52	MERL3	GUR139	KENT	2	455	403.0	13.20	9.31	39.80	100.0	1.75	377.90	1.040	45.0	0.0	24.30	22.70	5.40
53	MERL4	GUR140	KENT	2	455	401.0	13.20	8.38	39.80	100.0	1.75	377.90	1.490	45.1	0.0	32.60	14.30	5.00
54	MERL5	GUR141	KENT	2	455	399.0	13.20	9.24	45.00	100.0	1.75	377.90	1.590	40.1	0.0	30.86	18.55	6.50
55	MERL6	GUR145	KENT	2	455	419.0	13.20	10.36	51.40	100.0	1.75	377.90	1.020	35.0	0.0	28.98	24.50	6.76
56	MERL7	GUR145	KENT	2	454	421.0	13.20	10.20	50.30	100.0	1.75	377.90	0.980	35.0	0.0	29.85	23.30	6.89
57	MERL8	GUR146	KENT	2	463	406.0	13.20	9.93	47.80	100.0	1.75	377.90	1.080	40.0	0.0	38.44	18.56	5.25
58	MERL9	GUR147	KENT	2	455	400.0	13.20	9.21	38.40	100.0	1.75	377.90	0.990	45.0	0.0	43.11	8.55	2.01
59	MERL10	GUR148	KENT	2	455	438.0	13.20	10.14	48.30	100.0	1.75	377.90	1.040	35.0	0.0	26.50	26.67	7.10
60	MERL11	GUR152	KENT	2	455	401.0	13.20	11.11	78.90	100.0	1.75	377.90	0.970	30.0	0.0	30.00	25.30	9.60
61	MERL12	GUR153	KENT	2	455	398.0	13.20	10.30	50.00	100.0	1.75	377.90	0.990	45.0	0.0	42.80	9.20	2.00
62	MERL13	GUR154	KENT	2	455	387.0	13.20	10.51	58.60	100.0	1.75	377.90	1.000	40.0	0.0	32.50	19.50	5.20
63	MERL14	GUR155	KENT	2	455	401.0	13.20	11.22	82.90	100.0	1.75	377.90	1.000	30.0	0.0	24.20	31.90	9.50
64	MERL15	GUR158	KENT	2	455	401.0	13.20	9.11	41.80	100.0	1.75	377.90	1.480	45.0	0.0	44.98	7.09	2.39

OBS	R10M	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DWD	DSRC	DIOM	DASH	PH2	X	SHY
49	0.0500	0.4270	0.0433	0.1660	0.0478	0.0541	0.1281	0.1768	0.0776	0.2354	0.0595	0.0980	11.9793	110.865	4.80044
50	0.0470	0.4810	0.0472	0.1692	0.0422	0.0789	0.1000	0.1044	0.1945	0.2130	0.0520	0.0932	13.8900	110.278	5.20512
51	0.0250	0.4800	0.0291	0.1054	0.0441	0.0673	0.1004	0.0726	0.1421	0.3370	0.0510	0.1090	13.2000	112.233	3.26599
52	0.0260	0.4800	0.0332	0.1153	0.0383	0.0689	0.0822	0.0485	0.1184	0.4150	0.0430	0.0980	13.2000	110.865	3.68071
53	0.0300	0.4800	0.0514	0.2105	0.0413	0.0973	0.0823	0.0564	0.1113	0.2900	0.0620	0.1000	13.2000	111.111	5.71111
54	0.0399	0.5059	0.0452	0.1394	0.0267	0.0921	0.1069	0.0770	0.1697	0.2683	0.0577	0.0940	13.2000	110.375	4.98896
55	0.0476	0.4652	0.0265	0.0843	0.0349	0.0825	0.0730	0.0714	0.1768	0.3420	0.0654	0.0943	13.2000	110.412	2.93695
56	0.0496	0.4675	0.0303	0.1023	0.0436	0.0909	0.0791	0.0734	0.1592	0.3070	0.0652	0.0906	13.2000	109.963	3.33187
57	0.0375	0.4900	0.0327	0.1189	0.0437	0.0765	0.0648	0.0663	0.1534	0.3340	0.0675	0.0945	13.2000	110.436	3.61126
58	0.0133	0.4834	0.0325	0.1140	0.0375	0.0707	0.0778	0.0484	0.1249	0.4000	0.0530	0.0940	13.2000	110.375	3.58720
59	0.0473	0.4683	0.0286	0.1051	0.0321	0.0776	0.0725	0.0651	0.1814	0.3340	0.0592	0.0889	13.2000	109.757	3.13906
60	0.0510	0.4470	0.0373	0.1088	0.0559	0.0751	0.0885	0.1036	0.2094	0.2470	0.0493	0.0937	13.2000	110.339	4.11563
61	0.0100	0.4800	0.0268	0.0817	0.0453	0.0690	0.0618	0.0598	0.1302	0.4160	0.0466	0.0928	13.2000	110.229	2.95414
62	0.0280	0.4800	0.0322	0.0955	0.0454	0.0702	0.0761	0.0630	0.1612	0.3500	0.0568	0.0935	13.2000	110.314	3.55212
63	0.0440	0.4390	0.0360	0.1000	0.0537	0.0660	0.0842	0.0803	0.1845	0.3111	0.0431	0.0929	13.2000	110.241	3.96869
64	0.0104	0.4843	0.0410	0.1422	0.0383	0.0990	0.1009	0.0870	0.1477	0.2790	0.0410	0.0940	13.2000	110.375	4.52539

OBS	SC1C4	SBY	SHM	SNAP	SMD	S-1D	SSRC	SIOM	SDIST	RDIST	L	V	SUMIN	SUMOUT	DUM
49	18.4035	5.29933	5.9978	14.2018	19.6009	8.6031	26.0976	6.59645	28.2040	33.40	914.40	4.34161	104.800	104.800	1
50	18.6590	4.65373	8.7009	11.5278	11.5130	21.4491	23.4892	5.73445	32.9621	32.70	189.00	0.66843	105.205	105.227	1
51	11.8294	4.94945	7.5533	11.2682	8.1481	15.9484	37.8227	5.72391	24.0965	34.70	377.90	1.28500	103.266	103.244	1
52	12.7827	4.24612	7.6386	9.1131	5.3769	13.1264	46.0089	5.32151	18.5033	24.30	377.90	1.25564	103.681	103.614	1
53	23.4000	4.58885	10.8111	9.1444	6.2667	12.3667	32.2222	6.88889	18.6333	32.60	377.90	0.87837	105.711	105.689	1
54	15.3863	2.94702	10.1556	11.7991	8.4989	18.7307	29.6137	6.36865	27.2296	30.86	377.90	0.82749	104.989	103.510	1
55	9.3077	3.35337	9.1390	8.0601	7.8834	19.5208	37.7608	7.33135	27.4042	28.98	377.90	1.28598	102.937	102.827	1
56	11.3042	4.75437	9.9956	8.6980	8.0713	17.5060	33.7585	7.16956	25.5773	29.85	377.90	1.30803	103.332	101.298	1
57	13.0315	4.32606	8.4484	7.5563	7.3219	16.9409	36.8857	7.45445	24.2628	38.44	377.90	1.30501	103.611	102.065	1
58	12.5828	4.13907	7.8035	8.5872	5.3422	13.7859	44.1501	5.84989	19.1280	43.11	377.90	1.27266	103.587	102.241	1
59	11.5355	3.52321	8.5172	7.9574	7.1452	16.9100	36.6590	6.49764	27.0552	26.50	377.90	1.18518	103.139	101.745	1
60	12.0049	6.16794	8.2864	9.7650	11.4311	23.1049	27.2537	5.43970	34.5360	30.00	377.90	1.77922	104.116	103.454	1
61	9.0057	4.99339	7.6058	6.8122	6.5917	14.3519	45.8554	5.13668	20.9436	42.80	377.90	1.65711	102.954	100.353	1
62	10.5350	5.00827	7.7441	8.3949	6.9498	17.7827	38.6100	5.60397	24.7325	32.50	377.90	1.70908	103.552	100.629	1
63	11.0241	5.91996	7.2759	9.2823	8.8524	20.3395	34.2961	4.75141	29.1919	24.20	377.90	1.81334	103.969	101.742	1
64	15.6954	4.22737	10.9272	11.1369	9.6026	16.3024	30.7947	4.52539	25.9051	44.98	377.90	0.92668	104.525	103.212	1

STATISTICAL ANALYSIS SYSTEM

9:48 MONDAY, JULY 16, 1979

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OBS	CODE	RUN	COAL	MODE	TAVG	TPRHT	PTOT	PHYOUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RHD	RSRC	RASH
65	MERL16	GUR16C	KENT	2	465	400	13.89	11.31	71.6	100	1.75	377.90	0.680	30	0.0	25.12	26.2	10.77
66	MERL17	GUR17C	KENT	2	455	406	13.89	10.00	50.0	100	1.75	377.90	1.020	30	0.0	25.93	25.3	10.78
67	MERL18	GUR177	KENT	2	455	405	13.89	9.17	38.4	100	1.75	377.90	0.990	30	0.0	24.60	26.3	10.25
68	MERL19	GUR17E	KENT	2	455	400	14.48	11.03	60.1	100	1.75	377.90	1.030	30	0.0	30.00	23.4	10.76
69	MERL20	GUR179	KENT	2	455	405	11.72	9.05	61.9	100	1.75	377.90	1.060	30	0.0	17.80	33.8	11.02
70	MERL21	GUR180	KENT	2	455	409	13.89	10.70	60.8	100	1.75	377.90	1.040	30	0.0	19.80	30.9	11.21
71	MERL22	GUR21C	KENT	2	455	401	13.89	10.45	58.2	100	1.75	377.90	0.996	30	4.8	19.10	27.1	12.70
72	MERL23	GURA219	KENT	2	455	400	13.89	10.42	58.2	100	1.75	377.90	0.998	30	32.5	32.60	0.0	3.70
73	MERL24	GURB219	KENT	2	455	400	13.89	10.79	59.9	100	1.75	377.90	1.026	30	32.5	32.50	0.3	3.20
74	MERL25	GURC219	KENT	2	455	400	13.89	10.70	59.0	100	1.75	377.90	1.010	30	30.0	30.00	0.5	6.50
75	MERL26	GURD219	KENT	2	455	400	13.89	10.65	57.9	100	1.75	377.90	0.990	30	27.6	27.60	0.0	11.00
76	MERL27	DOER237	KENT	2	454	391	13.89	10.63	54.6	100	2.80	157.00	1.070	30	0.0	25.40	26.9	12.20
77	MERL28	DOER238	KENT	2	455	402	13.89	10.25	53.7	100	2.80	157.00	1.052	30	0.0	24.30	29.8	10.60
78	MERL29	DOE266	KENT	2	463	402	13.89	10.14	25.6	100	1.75	83.82	0.133	30	35.0	21.00	11.1	1.80
79	MERL30	DOE267	KENT	2	463	403	13.89	10.14	18.9	100	1.75	83.82	0.130	40	30.0	14.60	12.2	1.90

OBS	RIOM	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DHD	DSRC	DIOM	DASH	PH2	X	SHY	SC1C4
65	0.0789	0.4868	0.046	0.1686	0.044	0.0944	0.0924	0.0941	0.191	0.209	0.063	0.086	13.89	109.409	5.03282	18.4464
66	0.0794	0.4872	0.052	0.1460	0.041	0.1040	0.1150	0.0840	0.190	0.214	0.067	0.091	13.89	110.011	5.72057	16.0616
67	0.0883	0.490E	0.044	0.1410	0.039	0.0930	0.1030	0.0650	0.187	0.241	0.081	0.094	13.89	110.375	4.85651	15.5629
68	0.0585	0.4661	0.057	0.1580	0.044	0.0950	0.1080	0.0890	0.221	0.200	0.050	0.082	14.48	108.932	6.20915	17.2113
69	0.0734	0.4836	0.054	0.1440	0.045	0.0840	0.0810	0.0790	0.195	0.276	0.060	0.090	11.72	109.890	5.93407	15.8242
70	0.0810	0.4931	0.052	0.1440	0.040	0.0820	0.1030	0.0850	0.195	0.248	0.065	0.090	13.89	109.890	5.71429	15.8242
71	0.0650	0.4900	0.056	0.1610	0.044	0.1040	0.1000	0.1120	0.177	0.210	0.051	0.097	13.89	110.742	6.20155	17.8295
72	0.0120	0.3450	0.043	0.1200	0.039	0.0620	0.1140	0.0980	0.115	0.364	0.029	0.102	13.89	111.359	4.78842	13.3630
73	0.0150	0.3470	0.048	0.1320	0.046	0.0650	0.1230	0.0670	0.137	0.345	0.031	0.102	13.89	111.359	5.34521	14.6993
74	0.0300	0.3950	0.050	0.1200	0.039	0.0730	0.1730	0.0270	0.178	0.316	0.022	0.102	13.89	111.359	5.56793	13.3630
75	0.0380	0.448C	0.048	0.1270	0.039	0.0760	0.1480	0.0830	0.139	0.321	0.013	0.102	13.89	111.359	5.34521	14.1425
76	0.0550	0.4770	0.041	0.1460	0.038	0.0890	0.0740	0.1220	0.199	0.225	0.046	0.102	13.89	111.359	4.56570	16.2584
77	0.0530	0.4590	0.054	0.1260	0.036	0.0710	0.0690	0.1220	0.201	0.280	0.050	0.099	13.89	110.988	5.99334	13.9845
78	0.0110	0.3290	0.022	0.0390	0.031	0.0620	0.0480	0.0810	0.020	0.586	0.057	0.098	13.89	110.865	2.43902	4.3237
79	0.0130	0.4320	0.016	0.0350	0.029	0.0540	0.0420	0.0790	0.071	0.538	0.070	0.098	13.89	110.865	1.77384	3.8803

OBS	SBY	SHW	SNAP	SMD	SHD	SSRC	SIGN	SDIST	RDIST	L	V	SUMIN	SUMOUT	DUM
65	4.81400	10.3282	10.1094	10.2954	20.8972	22.8665	6.89278	31.1926	25.12	377.90	2.21883	105.033	104.650	1
66	4.51045	11.4411	12.6513	9.2409	20.9021	23.5424	7.37074	30.1430	25.93	377.90	1.01898	105.721	105.721	1
67	4.30464	10.2649	11.3687	7.1744	20.6402	26.6004	8.94040	27.8146	24.60	377.90	0.80629	104.857	104.857	1
68	4.79303	10.3486	11.7647	9.6950	24.0741	21.7865	5.44662	33.7691	30.00	377.90	1.16350	106.209	105.120	1
69	4.94505	9.2308	8.9011	8.6813	21.4286	30.3297	6.59341	30.1099	17.80	377.90	1.43865	105.934	105.934	1
70	4.39560	9.0110	11.3187	9.3407	21.4286	27.2527	7.14286	30.7692	19.80	377.90	1.21525	105.714	105.714	1
71	4.87265	11.5172	11.0742	12.4031	19.6013	23.2558	5.64784	32.0044	23.90	377.90	1.21468	106.202	106.202	1
72	4.34298	6.9042	12.6949	10.9131	12.8062	40.5345	3.22940	23.7194	65.10	377.90	1.21224	104.788	104.788	1
73	5.12249	7.2383	13.6971	7.4610	15.2561	38.4187	3.45212	22.7171	65.00	377.90	1.21360	105.345	105.345	1
74	4.34298	8.1292	19.2650	3.0067	19.8218	35.1893	2.44989	22.8285	60.00	377.90	1.21430	105.568	105.568	1
75	4.34298	8.4633	16.4811	9.2428	15.4788	35.7461	1.44766	24.7216	55.20	377.90	1.21574	105.345	105.345	1
76	4.23163	9.9109	8.2405	13.5857	22.1604	25.0557	5.12249	35.7461	25.40	157.00	0.44008	104.566	104.566	1
77	3.99556	7.8801	7.6582	13.5405	22.3085	31.0766	5.54939	35.8491	24.30	157.00	0.44084	105.993	105.993	1
78	3.43681	6.8736	5.3215	8.9800	2.2173	64.9667	6.31929	11.1973	56.00	83.82	0.89722	102.439	102.439	1
79	3.21508	5.5667	4.6563	8.7583	7.8714	59.6452	7.76053	16.6297	44.60	83.82	0.90359	101.774	101.774	1

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OBS	CODE	RUN	COAL	MODE	TAVG	TPRHT	PTOT	PHYDUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RWD	RSRC	RASH	RIOM
1	FTLL8	78SR-22	POWH	2	456.1	408.9	13.80	9.17	63.25	85.60	61.00	497.0	0.91	29.2	1.9	28.2	25.5	10.2	0.050
2	FTLL9	78SR-23	POWH	2	455.6	418.3	13.80	9.37	73.56	85.60	61.00	497.0	0.86	27.1	3.2	26.9	26.6	11.0	0.052
3	FTLL10	78SR-24	POWH	2	456.1	413.9	13.80	9.09	75.45	86.00	61.00	497.0	0.88	27.9	8.3	21.8	25.1	11.3	0.056
4	FTLL11	78SR-25	POWH	2	460.0	406.1	13.80	8.83	70.15	84.70	61.00	497.0	0.97	30.9	6.7	21.1	24.7	10.7	0.059
5	FTLL12	78SR-26	POWH	2	458.3	412.2	13.80	9.39	75.30	85.70	61.00	497.0	0.96	30.3	6.6	25.2	23.3	9.6	0.050
6	FTLL13	78SR-27	POWH	2	456.1	402.2	13.80	9.90	78.10	85.90	61.00	497.0	0.95	30.2	1.5	27.6	27.0	9.1	0.046
7	FTLL14	78SR-28	POWH	2	456.1	399.4	13.80	10.08	100.31	85.50	61.00	497.0	0.97	30.6	1.6	29.5	25.1	9.2	0.040
8	FTLL15	78SR-29	POWH	2	455.0	401.7	13.80	10.09	93.65	86.00	61.00	497.0	0.97	31.3	2.3	25.5	27.0	9.4	0.045
9	FTLL16	78SR-30	POWH	2	455.0	398.3	13.80	9.35	77.32	83.20	61.00	497.0	0.93	29.6	2.3	27.3	26.9	9.6	0.043
10	MERL31	DOER276	POWH	2	457.0	401.0	12.51	9.04	49.90	100.00	2.80	157.0	1.01	30.0	7.2	28.3	22.4	8.2	0.039
11	MERL32	DOER277	POWH	2	455.0	400.0	12.51	9.25	49.50	100.00	2.80	157.0	1.00	30.0	8.1	28.5	22.1	7.4	0.039
12	MERL33	DOER278	POWH	2	455.0	400.0	12.51	10.18	70.90	100.00	2.80	157.0	1.01	30.0	3.0	33.8	21.3	8.0	0.039
13	MERL34	DOER279	POWH	2	455.0	400.0	12.51	10.09	71.30	100.00	2.80	157.0	1.02	30.0	7.4	28.3	20.7	9.3	0.043
14	MERL35	DOER280	POWH	2	455.0	397.0	12.51	9.37	50.00	100.00	2.80	157.0	1.01	30.0	4.1	30.6	21.3	9.7	0.043
15	MERL36	DOER281	POWH	2	455.0	399.0	12.51	10.21	71.50	100.00	2.80	157.0	1.02	30.0	11.5	22.7	19.8	10.2	0.058
16	MERL37	DOER296	POWH	2	455.0	401.0	12.51	9.05	49.80	100.00	2.80	157.0	1.01	30.0	4.4	30.2	21.6	9.6	0.042

OBS	TOTSOL	DHY	DC1C4	DBY	DHW	DNAP	DMD	DHD	DSRC	DIOM	DASH	PH2	X	SHY	SC1C4
1	0.444	0.03954	0.1323	0.0270	0.0559	0.1061	0.2587	0.0195	0.2725	0.0550	0.1124	11.8128	112.663	4.49977	14.9054
2	0.433	0.04059	0.1544	0.0406	0.0653	0.0711	0.1999	0.1094	0.2444	0.0565	0.1176	11.8128	113.327	4.59995	17.4977
3	0.448	0.04869	0.1903	0.0425	0.0602	0.1117	0.2163	0.0575	0.2266	0.0540	0.1147	11.8680	112.956	5.49983	21.4955
4	0.475	0.04616	0.1926	0.0417	0.0604	0.0990	0.2055	0.0515	0.2459	0.0630	0.1124	11.6886	112.663	5.20054	21.6990
5	0.449	0.04146	0.1500	0.0335	0.0662	0.1300	0.2675	0.0071	0.2479	0.0556	0.1179	11.8266	113.366	4.70015	17.0049
6	0.439	0.03489	0.1396	0.0357	0.0447	0.0926	0.2635	0.0537	0.2720	0.0510	0.1053	11.8542	111.769	3.89963	15.6030
7	0.438	0.04050	0.1584	0.0414	0.0522	0.0535	0.2077	0.1584	0.2358	0.0432	0.0999	11.7990	111.099	4.49950	17.5980
8	0.452	0.03946	0.1482	0.0342	0.0561	0.0775	0.1793	0.1499	0.2473	0.0438	0.1232	11.8680	114.051	4.50046	16.9024
9	0.435	0.03876	0.1524	0.0335	0.0502	0.0719	0.2147	0.0846	0.2784	0.0529	0.1191	11.4816	113.520	4.40005	17.3005
10	0.421	0.05100	0.1423	0.0450	0.0640	0.1220	0.1580	0.1190	0.2600	0.0460	0.0950	12.5100	110.497	5.63536	15.6906
11	0.413	0.04900	0.1360	0.0410	0.0530	0.1170	0.1380	0.1390	0.2800	0.0498	0.0940	12.5100	110.375	5.40839	15.0110
12	0.419	0.04800	0.1503	0.0450	0.0590	0.1190	0.2040	0.0800	0.2510	0.0460	0.0940	12.5100	110.375	5.29801	16.5563
13	0.436	0.05300	0.1550	0.0380	0.0650	0.0870	0.1250	0.1350	0.2700	0.0568	0.1220	12.5100	113.895	6.03645	17.6538
14	0.440	0.04600	0.1373	0.0360	0.0750	0.0910	0.1900	0.0830	0.2630	0.0530	0.1190	12.5100	113.507	5.22134	15.5505
15	0.460	0.04100	0.1360	0.0390	0.0680	0.1400	0.0650	0.1770	0.2290	0.0680	0.1190	12.5100	113.507	4.65380	15.4370
16	0.438	0.05300	0.1350	0.0360	0.0700	0.1000	0.2020	0.0960	0.2500	0.0500	0.1140	12.5100	112.867	5.98194	15.2370

OBS	SBY	SHY	SNAP	SMD	SHD	SSRC	SIOM	SDIST	RDIST	SU4IN	SUNOUT	L	V	DUM
1	3.04191	6.29788	11.9536	29.1460	2.1969	30.7008	6.19648	31.3429	30.1	104.500	104.439	497.0	1.86438	1
2	4.60109	7.40027	8.0576	22.6541	12.3980	27.6972	6.40299	35.0521	30.1	104.600	106.709	497.0	2.12789	1
3	4.80063	6.79595	12.6172	24.4324	6.4950	25.5958	6.09963	30.9274	30.1	105.500	108.336	497.0	2.19743	1
4	4.69806	6.80487	11.1537	23.1523	5.8022	27.7039	7.09779	28.9545	27.8	105.201	108.112	497.0	2.06378	1
5	3.79776	7.50482	14.7376	30.3254	0.8049	28.1034	6.30314	31.1303	31.8	104.700	108.582	497.0	2.18982	1
6	3.99016	4.99609	10.3498	29.4512	6.0028	30.4013	5.70023	35.4532	29.1	103.900	106.494	497.0	2.28070	1
7	4.59949	5.79536	5.9438	23.0752	17.5980	26.1971	4.79947	40.6733	31.1	104.500	105.610	497.0	2.90688	1
8	3.90055	6.39627	9.8390	20.4494	17.0963	28.2048	4.99544	37.5456	27.8	104.500	106.786	497.0	2.77178	1
9	3.80293	5.69872	8.1621	24.3728	9.6038	31.6040	6.00522	33.9766	29.6	104.400	106.550	497.0	2.25725	1
10	4.97238	7.07182	13.4807	17.4586	13.1492	28.7293	5.08287	30.6077	35.5	105.635	105.635	157.0	0.47504	1
11	4.52539	5.84589	12.5139	15.2318	15.3422	30.9051	5.40839	30.5740	36.6	105.408	105.188	157.0	0.47465	1
12	4.96689	6.51214	13.1347	22.5166	8.8308	27.7042	5.07726	31.3466	36.8	105.298	105.298	157.0	0.67312	1
13	4.32802	7.40319	9.9089	14.2369	15.3759	30.7517	6.37813	29.6128	35.7	106.036	106.036	157.0	0.67028	1
14	4.08627	8.51305	10.5292	21.5664	9.4211	29.8524	6.01589	30.9875	34.7	105.221	105.335	157.0	0.47469	1
15	4.42679	7.71650	15.6910	7.3780	20.0903	25.9932	7.71850	27.4688	34.2	104.654	104.654	157.0	0.67216	1
16	4.06321	7.90668	11.2867	22.7991	10.8352	28.2167	5.64334	33.6343	34.6	105.982	105.982	157.0	0.47279	1

STATISTICAL ANALYSIS SYSTEM

9:48 MONDAY, JULY 16, 1979 8

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	RANGE	SUM	VARIANCE UNCORRECTED SS	CORRECTED SS	STD ERROR OF MEAN
SHY	4.0465891	1.35626985	1.5925204	6.4860698	4.8931495	437.0316	1.839468	1965.3	0.13050713
SC1C4	13.0751360	5.54445598	3.1723536	23.7969387	20.6245850	1412.1147	30.740992	21752.9	0.53351553
SBY	4.1440912	0.99182128	2.2050717	7.6164080	5.4113363	447.5618	0.983709	1960.0	0.09543805
SHW	7.3596394	1.93856784	1.9976166	11.5171650	9.5193484	794.8411	3.758045	6251.9	0.18653878
SNAP	9.3403923	3.33428879	1.6910936	19.2650334	17.5739398	1008.7624	11.117482	10611.8	0.32084209
SND	12.3409839	6.90146144	-4.6052632	30.3253599	34.9306231	1332.8263	47.630170	21544.8	0.66409344
SHD	11.2232374	6.74885671	-3.1903190	24.0740741	27.2643931	1212.1096	45.547067	18477.3	0.64940904
SSRC	40.5728826	16.77357482	18.6873692	74.2006615	55.5132923	4381.8713	281.352812	207889.9	1.61403799
SIOM	6.0754419	1.24166885	1.4476615	10.1971149	8.7494534	656.1477	1.541742	4151.4	0.11947964
SDIST	23.5642213	10.08865378	-7.7850877	40.6732585	48.4583462	2544.9359	101.780935	70860.0	0.97078116
TAVG	453.7398148	8.30801819	412.8000000	465.0000000	52.2000000	49003.9000	69.023166	22242406.0	0.79943942
PH2	12.4025540	1.89587523	6.8900000	17.6500000	10.7600000	1339.4758	3.594343	16997.5	0.18243068
SRT	0.8578333	0.30103623	0.1300000	1.5900000	1.4600000	92.6460	0.090623	89.2	0.02896722
CIN	32.7962963	5.97184869	23.4000000	50.0000000	26.6000000	3542.0000	35.662977	119980.4	0.57464141
RASH	5.0165741	4.16912397	0.0000000	12.7000000	12.7000000	541.7900	17.381595	4577.8	0.40117414
RDIST	44.3691667	16.65341850	17.8000000	76.6000000	58.8000000	4791.8700	277.336348	242286.3	1.60247594
V	1.5344827	1.09661493	0.4267959	6.0548440	5.6280480	165.7241	1.202564	383.0	0.10552182
RSRC	14.3668519	11.57024904	0.0000000	33.8000000	33.8000000	1551.6200	133.870663	36616.1	1.11334773
NCOAL	-0.4629630	0.89050994	-1.0000000	1.0000000	2.0000000	-50.0000	0.793008	108.0	0.08568936
DUM	1.0000000	0.00000000	1.0000000	1.0000000	0.0000000	108.0000	0.000000	108.0	0.00000000

VARIABLE	C.V.	SKEWNESS	T	PR>|T|
SHY	33.516	-0.29855976	31.01	0.0001
SC1C4	42.405	-0.37704286	24.51	0.0001
SBY	23.933	0.26189714	43.42	0.0001
SHW	26.341	-0.22116524	39.45	0.0001
SNAP	35.658	0.08762910	29.11	0.0001
SND	55.923	0.45379015	18.58	0.0001
SHD	60.133	-0.29836127	17.28	0.0001
SSRC	41.342	0.83729441	25.14	0.0001
SIOM	20.438	-0.12090976	50.85	0.0001
SDIST	42.813	-0.84455380	24.27	0.0001
TAVG	1.831	-2.48044765	567.57	0.0001
PH2	15.286	-0.17847573	67.99	0.0001
SRT	35.093	-0.75690316	29.61	0.0001
CIN	18.209	0.81193213	57.07	0.0001
RASH	83.107	0.07714817	12.50	0.0001
RDIST	37.034	0.52048491	27.69	0.0001
V	71.465	2.03692913	14.54	0.0001
RSRC	80.534	-0.22107273	12.90	0.0001
NCOAL	-192.350	1.05938876	-5.40	0.0001
DUM	0.000	.	.	.

STATISTICAL ANALYSIS SYSTEM

9:48 MONDAY, JULY 16, 1979 7

OBS	CODE	RUN	COAL	MODE	TAVG	TPRHT	PTOT	PHYOUT	GASRT	PUR	DIA	LEN	SRT	CIN	RMD	RMD	RSRC	RASH	RIOM
17	MERL38	DOER297	POWH	2	455	400	13.45	9.44	52.20	94.90	2.80	157.0	1.01	30.0	4.0	30.5	21.9	9.4	0.042
18	MERL39	DOER298	POWH	2	455	400	14.34	9.25	57.10	90.00	2.80	157.0	1.05	30.0	4.4	28.8	22.5	9.8	0.045
19	PNN10	P99-35	POWH	2	454	388	13.79	9.10	61.39	85.01	15.20	304.8	0.99	29.5	2.9	26.3	28.5	4.7	0.081
20	PNN11	P99-36	POWH	2	454	380	13.79	9.14	45.91	93.99	15.20	304.8	0.99	29.5	2.8	26.1	29.4	4.5	0.080
21	PNN12	P99-37	POWH	2	455	383	13.80	7.92	41.92	85.24	15.20	304.8	0.99	29.5	3.1	27.1	27.7	5.0	0.076
22	PNN13	P99-45	POWH	2	455	396	13.80	9.03	51.78	90.17	15.24	304.8	0.99	29.4	3.0	27.8	25.4	4.9	0.095
23	PNN14	P99-46	POWH	2	455	389	13.79	9.07	50.83	90.13	15.24	304.8	1.00	29.7	3.2	29.2	24.6	4.1	0.092
24	PNN15	P99-47	POWH	2	450	388	13.79	9.25	50.16	89.79	15.24	304.8	0.99	29.5	3.2	29.4	24.8	3.9	0.092
25	PNN16	P99-48	POWH	2	450	388	13.79	8.63	60.12	85.52	15.24	304.8	1.00	30.0	3.0	27.9	22.8	5.2	0.111
26	PNN17	P99-49	POWH	2	457	393	13.79	8.83	51.03	89.83	15.24	304.8	1.00	29.4	3.9	27.9	24.2	4.9	0.097
27	PNN18	P99-50	POWH	2	455	390	13.80	9.69	55.48	93.88	15.24	304.8	1.00	29.4	6.1	23.8	25.0	4.5	0.112
28	PNN19	P99-51	POWH	2	455	389	15.86	10.19	51.02	90.21	15.24	304.8	1.00	29.4	3.7	26.2	25.5	4.3	0.110
29	PNN20	P99-52	POWH	2	457	392	13.79	8.83	51.21	90.10	15.24	304.8	1.00	29.5	7.5	25.0	23.3	4.9	0.098

OBS	TOTSQL	DMY	DC1C4	DBY	DMW	DNAP	DMD	DHD	DSRC	DIOM	DASH	PH2	X	SHY	SC1C4
17	0.436	0.0470	0.1330	0.0390	0.0690	0.0970	0.1710	0.1110	0.2630	0.0510	0.1138	12.7640	112.740	5.29876	14.9944
18	0.443	0.0460	0.1320	0.0470	0.0430	0.0920	0.2150	0.0990	0.2560	0.0510	0.1110	12.9060	112.486	5.17435	14.8481
19	0.423	0.0426	0.1672	0.0396	0.0585	0.0890	0.1355	0.1408	0.2627	0.0548	0.0947	11.7229	110.461	4.70562	18.4690
20	0.420	0.0434	0.1652	0.0397	0.0594	0.0944	0.1392	0.1290	0.2594	0.0532	0.0947	12.9612	110.461	4.79399	18.2481
21	0.421	0.0428	0.1652	0.0414	0.0629	0.0946	0.1303	0.1195	0.2772	0.0618	0.0947	11.7631	110.461	4.72771	18.2481
22	0.438	0.0380	0.1422	0.0382	0.0615	0.0925	0.1285	0.0944	0.2952	0.0636	0.1219	12.4435	113.882	4.32753	16.1941
23	0.430	0.0380	0.1450	0.0359	0.0578	0.0781	0.1405	0.0983	0.3055	0.0550	0.1219	12.4289	113.882	4.32753	16.5129
24	0.426	0.0345	0.1295	0.0345	0.0566	0.0751	0.1353	0.1147	0.3160	0.0508	0.1219	12.3820	113.882	3.92894	14.7478
25	0.463	0.0431	0.1528	0.0360	0.0692	0.0920	0.1586	0.1122	0.2441	0.0569	0.1213	11.7932	113.804	4.90497	17.3893
26	0.440	0.0442	0.1725	0.0385	0.0725	0.0935	0.1340	0.0797	0.2709	0.0616	0.1211	12.3876	113.779	5.02901	19.6268
27	0.451	0.0461	0.1681	0.0358	0.0718	0.0803	0.1497	0.1299	0.2402	0.0493	0.1211	12.9554	113.779	5.24519	19.1262
28	0.446	0.0467	0.1633	0.0359	0.0712	0.0812	0.1621	0.1288	0.2360	0.0472	0.1211	14.3073	113.779	5.31346	18.5800
29	0.442	0.0447	0.1734	0.0361	0.0705	0.0748	0.1450	0.1041	0.2584	0.0614	0.1211	12.4248	113.779	5.08590	19.7292

OBS	SBY	SHW	SNAP	SND	SHD	SSRC	SDOM	SDIST	RDIST	SUMIN	SUNOUT	L	V	DUM
17	4.39684	7.77903	10.9357	19.2785	12.5141	29.6505	5.74972	31.7926	34.5	105.299	105.299	157.0	0.46094	1
18	5.28684	4.83690	10.3487	24.1845	11.1361	28.7964	5.73678	35.3206	33.2	105.174	105.174	157.0	0.45490	1
19	4.37424	6.46155	9.8310	14.5674	15.5529	29.0180	6.05324	30.5203	29.2	104.706	104.728	304.8	1.02835	1
20	4.38529	6.56136	10.4275	15.3761	14.2494	28.6535	5.87651	29.6255	28.9	104.794	103.778	304.8	0.76904	1
21	4.57307	6.94757	10.4496	14.3930	13.2000	30.6197	6.82647	27.5931	30.2	104.728	105.258	304.8	0.70266	1
22	4.35030	7.00376	10.5341	14.6339	10.7505	33.6180	7.24291	25.3844	30.8	104.328	104.328	304.8	0.86499	1
23	4.08837	6.58239	8.8942	16.0005	11.1946	34.7910	6.26352	27.1951	32.4	104.328	104.328	304.8	0.84982	1
24	3.92894	6.44574	8.5526	15.4083	13.0623	35.9868	5.73522	28.4706	32.6	103.929	103.918	304.8	0.83561	1
25	4.09596	7.87527	10.4700	18.0494	12.7689	27.7797	6.47548	30.8183	30.9	104.905	104.905	304.8	1.02226	1
26	4.38048	8.24855	10.6383	15.2463	9.0682	30.8226	7.03876	24.3145	31.8	105.029	105.840	304.8	0.84687	1
27	4.07327	8.16930	9.1364	17.0327	14.7798	27.3296	5.63928	31.8125	29.9	105.245	105.257	304.8	0.91753	1
28	4.08465	8.10104	9.2388	18.4435	14.6547	26.8517	5.37035	33.0982	29.9	105.313	105.325	304.8	0.73418	1
29	4.10741	8.02139	8.5166	16.4979	11.8444	29.4004	6.93601	28.3422	32.5	105.086	105.097	304.8	0.85275	1

SECTION 2. STATISTICAL REGRESSION DATA SUMMARY

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GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	161.77573581	7.35344254	17.83	0.0001	0.821935	15.8682
ERROR	85	35.04733137	0.41232155		STD DEV		SHY MEAN
CORRECTED TOTAL	107	196.82306719			0.64212269		4.04658912

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	48.24318279	117.00	0.0001	1	2.12730528	5.16	0.0256
VPH2	1	14.64146770	35.51	0.0001	1	1.15811538	2.81	0.0974
VSRT	1	53.15822576	130.38	0.0001	1	5.82637698	14.13	0.0003
VCIN	1	18.58965034	46.06	0.0001	1	3.41379572	8.28	0.0051
VRASH	1	9.52373197	23.10	0.0001	1	0.99879190	2.42	0.1233
VTAVG2	1	0.38488764	0.93	0.3367	1	0.36026591	0.87	0.3526
VPH22	1	1.17113299	2.84	0.0956	1	1.37292763	3.33	0.0716
VSRT2	1	0.39448030	0.96	0.3308	1	0.02155944	0.05	0.8197
VCIN2	1	0.59354728	1.44	0.2335	1	0.06708641	0.16	0.6877
VRASH2	1	0.00022782	0.00	0.9813	1	0.60840533	1.48	0.2278
VV	1	2.27063353	5.51	0.0213	1	1.19242198	2.89	0.0927
VNCOAL	1	0.70621770	1.71	0.1942	1	1.45824453	3.54	0.0635
VTP	1	0.35871605	0.87	0.3536	1	0.02369261	0.06	0.8111
VTS	1	0.63243741	1.53	0.2189	1	0.04004642	0.10	0.7561
VTC	1	4.76903985	11.57	0.0010	1	0.35233679	0.85	0.3579
VTR	1	0.09656942	0.23	0.6297	1	0.09059477	0.22	0.6405
VPS	1	2.78783994	6.76	0.0110	1	0.56175166	1.36	0.2464
VPC	1	0.04077096	0.10	0.7539	1	0.13431603	0.33	0.5697
VPR	1	0.94490308	2.29	0.1338	1	0.63971458	1.55	0.2163
VSC	1	0.05586384	0.14	0.7137	1	0.40199183	0.97	0.3263
VSR	1	0.17244967	0.42	0.5196	1	0.00093382	0.00	0.9622
VCR	1	1.23975977	3.01	0.0865	1	1.23975977	3.01	0.0865

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	3.77709604	17.82	0.0001	0.21193893
VTAVG	0.05813173	2.27	0.0256	0.02559272
VPH2	0.15904099	1.68	0.0974	0.09489671
VSRT	2.22405798	3.76	0.0003	0.59164995
VCIN	-0.06718913	-2.88	0.0051	0.02335061
VRASH	0.07763035	1.56	0.1233	0.04987835
VTAVG2	0.00120869	0.93	0.3526	0.00129307
VPH22	0.03461881	1.82	0.0716	0.01897171
VSRT2	0.25808436	0.23	0.8197	1.12865425
VCIN2	-0.00161674	-0.40	0.6877	0.00400813
VRASH2	-0.01101325	-1.21	0.2278	0.00906645
VV	-0.15251092	-1.70	0.0927	0.08968173
VNCOAL	0.23126231	1.88	0.0635	0.12297241
VTP	0.00143513	0.24	0.8111	0.00598692

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHY

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTS	0.01601427	0.31	0.7561	0.05138582
VTC	-0.00403468	-0.92	0.3579	0.00436486
VTR	0.00363015	0.47	0.6405	0.00774445
VPS	0.25339141	1.17	0.2464	0.21708895
VPC	-0.00780123	-0.57	0.5697	0.01366838
VPR	0.02766471	1.25	0.2163	0.02221013
VSC	0.07858128	0.99	0.3263	0.07958451
VSR	-0.01076007	-0.05	0.9622	0.22610079
VCK	-0.01576359	-1.73	0.0865	0.00909085

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	2.75633958	2.41401469	0.34232489	1.94252522	2.88550417
2	2.97356828	3.27653560	-0.30296732	2.34843431	4.20463690
3	2.30263158	2.33282508	-0.03019351	1.68428553	2.98136464
4	2.20507166	2.21567171	-0.01060005	1.67274258	2.75860084
5	2.20507166	2.12646446	0.07860721	1.73643158	2.51649734
6	2.22469410	2.32275352	-0.09805941	1.60254753	3.04295953
7	2.10643015	2.21118016	-0.10475000	1.83353427	2.58882605
8	2.65486725	2.21280183	0.44206543	1.75137281	2.67423085
9	2.32558140	2.16522972	0.16035167	1.68041749	2.65004196
10	4.05862458	3.23422318	0.82440140	2.34973236	4.11871399
11	3.26944753	2.64905714	0.62039043	2.17828362	3.11983066
12	1.80383315	2.37058891	-0.56675577	1.98446225	2.75671558
13	2.02931229	2.45162098	-0.42230869	2.00952196	2.89372001
14	1.98019802	2.44970759	-0.46950957	2.00802830	2.89138689
15	1.93584071	2.43691080	-0.50107009	1.90993053	2.96389106
16	1.59292035	2.42247063	-0.82955027	1.93570330	2.90923795
17	2.18739429	3.77774451	-1.59035021	3.11196222	4.44352679
18	2.31168245	3.42256561	-1.11088316	2.75307951	4.09205172
19	2.98827244	3.10334749	-0.11507505	2.26752125	3.93917371
20	2.65193370	3.55297635	-0.90104265	2.87430273	4.23164997
21	4.20819491	3.39220341	0.81599150	2.84130442	3.94310240
22	4.55049945	3.65633051	0.89416893	2.95703181	4.35562921
23	4.67185762	3.75674526	0.91511236	3.16711245	4.34637806
24	4.68750000	3.60733275	1.08016725	3.02332131	4.19134419
25	2.15914073	2.01888967	0.14025106	1.27396230	2.76381703
26	1.98689956	1.81227006	0.17462950	1.10642286	2.51811727
27	2.24658129	2.52527367	-0.27869239	1.51114729	3.53940006
28	2.70740459	2.78987119	-0.08246660	1.83559529	3.74414709
29	1.96229061	1.87708104	0.08519956	0.72110040	3.03306169
30	2.15182960	1.72044875	0.43138085	0.94154391	2.49935359
31	1.60782164	1.47850612	0.12931572	0.58127182	2.37574041
32	1.77559913	1.81942759	-0.04382846	0.75071239	2.88814280
33	2.17272628	2.07296101	0.09976527	1.17574247	2.97017954
34	2.03300967	2.80146920	-0.76846013	1.64060487	3.96233353
35	5.42891752	4.28014896	1.14876856	3.82936924	4.73092868

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SKY

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	5.15361744	5.00515553	0.14846191	4.62966898	5.38064208
37	5.24171347	4.75128883	0.49042464	4.10388409	5.39869357
38	5.52802555	5.31229525	0.21573030	4.64527282	5.97931769
39	4.41581324	3.87540307	0.54041017	3.21664408	4.53416206
40	5.09855743	4.87856566	0.21999176	4.24030084	5.51683048
41	6.48606982	6.49014419	-0.00407438	5.77821345	7.20207494
42	5.80652270	5.18422556	0.62229714	4.60632188	5.76212924
43	4.53450164	5.32545187	-0.79095022	4.75123393	5.89966980
44	4.10112360	5.32163567	-1.22051208	4.63969872	6.00357262
45	4.50110865	4.90132506	-0.40021641	4.26289957	5.53975054
46	4.29678848	3.94603440	0.35075409	3.37312075	4.51894804
47	3.59823400	3.22450958	0.37372441	2.54268712	3.90633204
48	3.59513274	3.64047936	-0.04534661	3.08594200	4.19501671
49	4.80044346	4.52700598	0.27343748	4.05852263	4.99548934
50	5.20511689	4.88054887	0.32456803	4.31456294	5.44653480
51	3.26599327	3.72355982	-0.45756656	3.29615841	4.15096124
52	3.68070953	3.31491562	0.36579392	2.45971133	4.17011991
53	5.71111111	5.03031406	0.68079705	4.28456381	5.77606431
54	4.98896247	5.62426392	-0.63530145	4.78751468	6.46101316
55	2.93695484	4.25170557	-1.31475073	3.87463871	4.62877244
56	3.33186717	4.08408941	-0.75222225	3.66991553	4.49826330
57	3.61126449	4.32131665	-0.71005216	3.69244076	4.95019254
58	3.58719647	3.34377832	0.24341814	2.92550691	3.76204974
59	3.13906267	4.32951338	-1.19045071	3.95694532	4.70208145
60	4.11563500	4.74391689	-0.62828189	4.41544707	5.07238671
61	2.95414462	3.28537756	-0.33123293	2.86532388	3.70543123
62	3.55212355	3.63350106	-0.08137750	3.22110612	4.04589599
63	3.96869143	4.80130406	-0.83261262	4.48602180	5.11658631
64	4.52538631	5.16393051	-0.63854419	4.32595516	6.00190585
65	5.03282276	5.39954567	-0.36672291	4.44478374	6.35430760
66	5.72057206	5.32977619	0.39079587	4.97453866	5.68501372
67	4.85651214	5.26595532	-0.40944318	4.91545532	5.61645531
68	6.20915033	5.63128423	0.57786610	5.16003855	6.10252991
69	5.93406593	4.44325862	1.49080731	3.78259015	5.10392710
70	5.71428571	5.36293773	0.35134798	4.96784657	5.75802889
71	6.20155039	5.27620505	0.92534534	4.66947314	5.88293696
72	4.78841871	4.41909905	0.36931966	4.04909459	4.78910351
73	5.34521158	4.38869027	0.95652131	4.01272494	4.76465560
74	5.56792873	4.90776350	0.66016523	4.50553678	5.30999023
75	5.34521158	5.23536911	0.10984248	4.85587075	5.61486746
76	4.56570156	5.46904553	-0.90334397	4.93409270	6.00399835
77	5.99334073	5.48848479	0.50485594	5.12085939	5.85611019
78	2.43902439	2.56823797	-0.12921358	1.53436896	3.60210698
79	1.77383592	1.27462409	0.49921183	0.15525698	2.39399119
80	4.49977467	4.81714591	-0.31737124	4.45621407	5.17807776
81	4.59995467	4.95444554	-0.35449087	4.44014704	5.46874404
82	5.49983057	4.93383542	0.56599514	4.46296534	5.40470551
83	5.20054078	4.99495111	0.20558968	4.36757822	5.62232400
84	4.70014738	4.91922651	-0.21907914	4.54175271	5.29670031

GENERAL LINEAR MODELS PROCEDURE

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DEPENDENT VARIABLE: SHY

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	3.89963116	4.69257847	-0.79294731	4.39487789	4.99027904
86	4.49950006	4.57320760	-0.07370754	4.21047272	4.93594248
87	4.50045620	4.43269071	0.06776549	4.03698213	4.82839930
88	4.40004541	4.53747969	-0.13743428	4.14147785	4.93348152
89	5.63535912	5.35254908	0.28281004	5.04078205	5.66431610
90	5.40838852	5.10048990	0.30789863	4.80679509	5.39418471
91	5.29801325	5.13234961	0.16566364	4.85671709	5.40798212
92	6.03644647	5.21551476	0.82093171	4.94080615	5.49022338
93	5.22133939	5.23602191	-0.01468252	4.94591062	5.52613320
94	4.65380250	5.23615425	-0.58235175	4.92895014	5.54335837
95	5.98194131	5.23375533	0.74818598	4.94630179	5.52120896
96	5.29875986	5.32092286	-0.02216299	5.04095114	5.60089457
97	5.17435321	5.47733677	-0.30298357	5.15697192	5.79770162
98	4.70562245	4.51133874	0.19428370	4.17605404	4.84662345
99	4.79399094	4.77482944	0.01916151	4.42942097	5.12023790
100	4.72771457	4.67655325	0.05116132	4.35171457	5.00139193
101	4.32752534	4.77851992	-0.45099458	4.46172465	5.09531517
102	4.32752534	4.67023205	-0.34270671	4.33371182	5.00675228
103	3.92893748	4.28658393	-0.35764645	3.87103585	4.70213200
104	4.90497326	5.05308946	-0.14811620	4.63090047	5.47527844
105	5.02901354	4.94778690	0.08122664	4.61209072	5.28348307
106	5.24519285	4.85174557	0.39344728	4.50166655	5.20182459
107	5.31346001	5.23727393	0.07618607	4.74717612	5.72737175
108	5.08590283	4.94953451	0.13636833	4.61651832	5.28255070

SUM OF RESIDUALS	0.00000000
SUM OF SQUARED RESIDUALS	35.04733137
SUM OF SQUARED RESIDUALS - ERROR SS	-0.00000000
FIRST ORDER AUTOCORRELATION	0.35820580
DURBIN-WATSON D	1.28110263

$SHYMD = 3.77710 + 0.05813 * VTAVG + 0.15904 * VPH2 + 2.22406 * VSRT - 0.06719 * VCIN$
 $+ 0.07763 * VRASH + 0.00121 * VTAVG2 + 0.03462 * VPH22 + 0.25808 * VSRT2$
 $- 0.00162 * VCIN2 - 0.01101 * VRASH2 - 0.15251 * VV + 0.23126 * VMCQAL + 0.00144 * VTP$
 $+ 0.01601 * VTS - 0.00403 * VTC + 0.00363 * VTR + 0.25339 * VPS - 0.00780 * VPC$
 $+ 0.02766 * VPR + 0.07858 * VSC - 0.01076 * VSR - 0.01576 * VCR;$

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SC1C4

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	2990.40369247	135.92744057	38.66	0.0001	0.909135	14.3415
ERROR	85	298.88246563	3.51626430		STD DEV		SC1C4 MEAN
CORRECTED TOTAL	107	3289.28615810			1.87517047		13.07513596

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	1156.45181283	328.89	0.0001	1	190.17592439	54.08	0.0001
VPH2	1	222.89708736	63.39	0.0001	1	1.12827011	0.32	0.5726
VSRT	1	1029.38771814	292.75	0.0001	1	100.17969613	28.49	0.0001
VCIN	1	325.74216162	92.64	0.0001	1	69.61561927	19.80	0.0001
VRASH	1	12.26896360	3.49	0.0652	1	3.89116437	1.11	0.2958
VTAVG2	1	25.25709799	7.18	0.0088	1	18.47223958	5.25	0.0244
VPH22	1	4.17139772	1.19	0.2792	1	1.24073195	0.35	0.5541
VSRT2	1	0.21619849	0.06	0.8048	1	7.12001008	2.02	0.1584
VCIN2	1	23.53785562	6.69	0.0114	1	28.29575451	8.05	0.0057
VRASH2	1	6.41382890	1.82	0.1804	1	1.49080083	0.42	0.5167
VV	1	6.36952521	1.81	0.1819	1	0.11086690	0.03	0.8595
VNCOAL	1	71.97623278	20.44	0.0001	1	80.07327451	22.77	0.0001
VTP	1	0.28234009	0.08	0.7776	1	3.73944149	1.06	0.3054
VTSC	1	63.35552018	18.02	0.0001	1	50.01381950	14.22	0.0003
VTC	1	11.25879471	3.20	0.0771	1	3.35499077	0.95	0.3314
VTR	1	0.55564721	0.19	0.6670	1	0.06049211	0.02	0.8960
VPS	1	9.80536778	2.79	0.0986	1	0.14845180	0.04	0.8377
VPC	1	0.32605199	0.01	0.9316	1	0.23861538	0.07	0.7951
VPR	1	11.89707657	3.38	0.0693	1	15.08648421	4.29	0.0414
VSC	1	0.30063762	0.09	0.7707	1	4.67528737	1.33	0.2521
VSR	1	5.34385555	1.52	0.2211	1	7.50081093	2.13	0.1478
VCR	1	2.88851652	0.82	0.3673	1	2.88851652	0.82	0.3673

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	10.76890181	17.40	0.0001	0.61891853
VTAVG	0.54963720	7.35	0.0001	0.07473759
VPH2	0.15697833	0.57	0.5726	0.27712385
VSRT	9.22224528	5.34	0.0001	1.72777653
VCIN	-0.30341261	-4.45	0.0001	0.06819005
VRASH	0.15322648	1.05	0.2958	0.14565815
VTAVG2	0.00865492	2.29	0.0244	0.00377610
VPH22	0.03290996	0.59	0.5541	0.05540247
VSRT2	4.69011198	1.42	0.1584	3.29597314
VCIN2	0.03320355	2.84	0.0057	0.01170482
VRASH2	0.01723967	0.65	0.5167	0.02647646
VV	0.04650363	0.18	0.8595	0.26189470
VNCOAL	1.71369481	4.77	0.0001	0.35911243
VTP	-0.01802971	-1.03	0.3054	0.01748341

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SCIC4

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTs	0.56593984	3.77	0.0003	0.15006037
VTC	-0.01245081	-0.98	0.3314	0.01274656
VTR	-0.00296635	-0.13	0.8960	0.02261587
VPS	0.13026041	0.21	0.8377	0.63395796
VPC	-0.01039797	-0.26	0.7951	0.03991535
VPR	0.13434672	2.07	0.0414	0.06485953
VSC	-0.26793672	-1.15	0.2521	0.23240810
VSR	-0.96435776	-1.46	0.1478	0.66027496
VCR	0.02406156	0.91	0.3673	0.02654772

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	5.95369350	4.85744910	1.09624439	3.48057338	6.23432482
2	6.05726372	7.09427052	-1.03700180	4.38396583	9.80457522
3	8.66228070	7.31764705	1.34463366	5.42373761	9.21155649
4	4.07938258	3.43101955	0.64836303	1.84552089	5.01651822
5	3.19735391	4.07097469	-0.87362078	2.93197407	5.20997532
6	6.56284761	7.16330564	-0.60045803	5.06011091	9.26650036
7	4.10199557	4.41253697	-0.31054140	3.30970966	5.51536425
8	4.09292035	3.81489113	0.27802922	2.46739463	5.16238763
9	6.53377630	5.80070791	0.73306839	4.38492616	7.21648966
10	5.18602025	6.17272999	-0.98670970	3.58977958	8.75568040
11	6.08793687	5.67506723	0.41286963	4.30028228	7.04985219
12	3.26944758	4.16938238	-0.89993480	3.04178895	5.29697580
13	3.83314543	4.69856324	-0.86541781	3.40751552	5.98961097
14	4.84048405	4.76762271	0.07286134	3.47780070	6.05744472
15	3.65044248	3.62891827	0.02152421	2.08999454	5.16784200
16	5.19911504	3.81915628	1.37995876	2.39766513	5.24064743
17	15.62746646	14.07987075	1.54759570	12.13560791	16.02413359
18	14.54668471	13.88926223	0.65742248	11.93418324	15.84434121
19	15.62922869	14.91010004	0.71912865	12.46926329	17.35093679
20	11.60220994	13.63676358	-2.03455364	11.65485457	15.61867259
21	11.62790698	11.04252543	0.58538154	9.43375263	12.65129824
22	10.98775134	13.89919320	-2.91140186	11.85705344	15.94133296
23	11.56840934	11.76091141	-0.19250207	10.03902548	13.48279734
24	10.82585266	11.21563103	-0.38973817	9.51016098	12.92110108
25	6.34590092	7.53461023	-1.18870930	5.35922253	9.70999792
26	4.94541485	3.32832869	1.61708616	1.26706554	5.38959184
27	5.01410856	4.23171063	0.78239834	1.27018958	7.19323167
28	6.55648581	7.14426845	-0.58778264	4.35752687	9.93101003
29	3.17235365	3.32870064	-0.15634700	-0.04707290	6.70447418
30	5.41780448	4.80717434	0.61063014	2.53256330	7.08178538
31	3.67191744	4.25038572	-0.57846829	1.63022093	6.87055051
32	3.57298475	4.87584462	-1.30285987	1.75490957	7.99677967
33	5.34992903	3.89598467	1.45394436	1.27586590	6.51610344
34	8.00087441	8.65729414	-0.65641973	5.26725894	12.04732934
35	18.94064530	16.37979979	2.56084551	15.06340210	17.69619748

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SC1C4

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	16.91443674	17.28604539	-0.37160866	16.18952395	18.38256683
37	18.87457328	20.25394881	-1.37937553	18.36335333	22.14454429
38	21.86583812	21.03244750	0.83739063	19.08456308	22.98033191
39	15.71412840	12.58968772	3.12444068	10.66593478	14.51344067
40	16.23169254	14.33964371	1.89204883	12.47573924	16.20354818
41	23.79693866	21.32407744	2.47286122	19.24504873	23.40310616
42	23.24812693	19.82201857	3.42610836	18.13438483	21.50965231
43	18.45564074	20.38669599	-1.93105525	18.70982561	22.06356638
44	18.29213483	19.74836233	-1.45622750	17.75692353	21.73980113
45	16.39689579	18.05386225	-1.65696647	16.18948861	19.91823590
46	15.48172757	15.61499334	-0.13326576	13.94193182	17.28805485
47	12.70419426	12.57078738	0.13340688	10.57968292	14.56189183
48	14.30309735	14.12861095	0.17448640	12.50921313	15.74800877
49	18.40354767	17.67470315	0.72884452	16.30660610	19.04280021
50	18.65902073	16.10837809	2.55064264	14.45554738	17.76120880
51	11.82940516	11.51938147	0.31002370	10.27125471	12.76750822
52	12.78270510	13.15445262	-0.37174752	10.65702671	15.65187852
53	23.40000000	17.78807518	5.61192482	15.61028443	19.96586593
54	15.38631347	18.09361563	-2.70730216	15.65008342	20.53714784
55	9.30771779	12.08638552	-2.77866773	10.98524913	13.18752190
56	11.30415659	11.17185258	0.13230401	9.96235374	12.38135142
57	13.03147432	17.41446322	-4.38298890	15.57797695	19.25094949
58	12.58278146	11.48156319	1.10121827	10.26009847	12.70302791
59	11.53550653	12.33732845	-0.80182192	11.24932977	13.42532714
60	12.00485490	13.87281132	-1.86795641	12.91359135	14.83203129
61	9.00573192	11.49625179	-2.49051986	10.26958238	12.72292119
62	10.53502482	11.35756638	-0.82254156	10.15326255	12.56187022
63	11.02414287	14.08038711	-3.05624424	13.15967837	15.00109586
64	15.69536424	17.88071211	-2.18534787	15.43359934	20.32782488
65	18.44638930	18.93116784	-0.48477834	16.14300693	21.71932875
66	16.06160616	15.18301488	0.87859128	14.14562603	16.22040373
67	15.56291391	14.78968639	0.77322751	13.76613240	15.81324039
68	17.21132898	15.88640171	1.32492727	14.51023793	17.26256548
69	15.82417582	13.33403512	2.49014071	11.40470597	15.26336426
70	15.82417582	15.46522625	0.35894957	14.31145410	16.61899840
71	17.82945736	15.76139799	2.06805938	13.98957808	17.53321790
72	13.36302895	13.46116186	-0.09813291	12.38064960	14.54167412
73	14.69933185	13.80894059	0.89039125	12.71102098	14.90686021
74	13.36302895	14.01037061	-0.64734165	12.83576069	15.18498052
75	14.14253898	15.06969520	-0.92715622	13.96145822	16.17793217
76	16.25835189	15.26724552	0.99110638	13.70503979	16.82945124
77	13.98446171	15.32759307	-1.34313136	14.25402830	16.40115783
78	4.32372506	5.57892784	-1.25520279	2.55975303	8.59810266
79	3.88026608	3.95149842	-0.07123234	0.68264625	7.22035059
80	14.90536278	16.89591822	-1.99055544	15.84190042	17.94993601
81	17.49773345	17.41705765	0.08067580	15.91516809	18.91894722
82	21.49553824	17.53627029	3.95926795	16.16120334	18.91133724
83	21.69896350	19.33471814	2.36424536	17.50262104	21.66881524
84	17.00487473	18.28828152	-1.28340679	17.18595678	19.39060626

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SC1C4

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	15.60299542	16.71251876	-1.10952334	15.84315324	17.58188428
86	17.59804466	16.70657162	0.89147305	15.64728848	17.76585475
87	16.90237226	15.77138854	1.13098372	14.61581334	16.92696374
88	17.30048814	15.85215000	1.44833814	14.69571845	17.00858155
89	15.69060773	18.25139604	-2.56078830	17.34095273	19.16183935
90	15.01103753	16.72024831	-1.70921078	15.86258069	17.57791592
91	16.55829139	16.85273751	-0.29644612	16.04781665	17.65765838
92	17.65375854	17.03075620	0.62300234	16.22853336	17.83297904
93	15.55251078	16.98303087	-1.43252008	16.13582810	17.83023363
94	15.43700341	17.12395657	-1.68695317	16.22683816	18.02107498
95	15.23702032	16.97197712	-1.73495680	16.13253543	17.81141881
96	14.99436302	17.15059046	-2.15622744	16.33299797	17.96818295
97	14.84814398	17.63849237	-2.79034838	16.70294107	18.57404366
98	18.46901580	16.12916461	2.33985118	15.15004334	17.10828588
99	18.24509455	16.31057856	1.93751599	15.30189320	17.31926393
100	18.24309455	16.76518526	1.48290929	15.81656919	17.71380133
101	16.19405535	16.94759552	-0.75354018	16.02246841	17.87272264
102	16.51292563	16.95519940	-0.44227377	15.97247808	17.93792873
103	14.74775083	13.72055032	1.02720051	12.50703851	14.93406213
104	17.38532514	20.30340521	-2.91408007	19.07050814	21.53631027
105	19.62680624	18.48380827	1.14299797	17.50348540	19.46413114
106	19.12518045	17.17321153	1.95296893	16.15088691	18.19553615
107	18.58004324	17.40141754	1.17862569	15.97020048	18.83263461
108	19.72520696	18.42843221	1.30077475	17.45593562	19.40092880

SUM OF RESIDUALS	0.00000000
SUM OF SQUARED RESIDUALS	298.88246563
SUM OF SQUARED RESIDUALS - ERROR SS	0.00000000
FIRST ORDER AUTOCORRELATION	0.15581113
DURBIN-WATSON D	1.68020444

SC1C4ND=10.76890+0.54964*VTAVG+0.15698*VPH2+9.22225*VSRT-0.30341*VCIN
+0.15323*VRASH+0.00865*VTAVG2+0.03291*VPH22+4.69011*VSRT2
+0.03320*VCIN2+0.01724*VRASH2+0.04650*VV+1.71369*VNCOAL-0.01803*VTP
+0.56594*VTS-0.01245*VTC-0.00297*VTR+0.13026*VPS-0.01040*VPC
+0.13435*VPR-0.26799*VSC-0.96436*VSR+0.02406*VCR;

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SBY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	79.70395950	3.62290725	12.05	0.0001	0.757233	13.2307
ERROR	85	25.55295157	0.30062296		STD DEV		SBY MEAN
CORRECTED TOTAL	107	105.25691107			0.54829094		4.14409116

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	37.28699105	124.03	0.0001	1	0.85041335	2.83	0.0963
VPH2	1	4.78094928	15.90	0.0001	1	0.00724183	0.02	0.8770
VSRT	1	8.31834673	27.67	0.0001	1	0.09489216	0.32	0.5757
VCIN	1	4.33760286	14.43	0.0003	1	3.72655404	12.40	0.0007
VRASH	1	3.62382802	12.05	0.0008	1	1.75847409	5.85	0.0177
VTAVG2	1	1.52802565	5.08	0.0267	1	0.03920163	0.13	0.7189
VPH22	1	0.08055880	0.27	0.6060	1	0.18998743	0.63	0.4288
VSRT2	1	4.16361488	13.85	0.0004	1	1.03888803	3.46	0.0665
VCIN2	1	4.04336421	13.45	0.0004	1	0.98380534	3.27	0.0740
VRASH2	1	1.13168404	3.76	0.0557	1	3.10784929	10.34	0.0018
VV	1	4.46975840	14.87	0.0002	1	0.78133697	2.60	0.1106
VNCOAL	1	2.10126366	6.99	0.0098	1	2.32794503	7.74	0.0066
VTP	1	0.22735299	0.76	0.3869	1	0.04084137	0.14	0.7134
VT5	1	0.15586235	0.52	0.4735	1	0.05827329	0.19	0.6609
VTC	1	0.78191182	2.60	0.1105	1	0.01324165	0.04	0.8343
VTR	1	0.89234256	2.97	0.0885	1	0.07936629	0.26	0.6087
VPS	1	0.23315562	0.78	0.3810	1	0.00913479	0.03	0.8620
VPC	1	0.27122467	0.90	0.3449	1	0.26024070	0.87	0.3548
VPR	1	0.00115845	0.00	0.9506	1	0.02139634	0.07	0.7903
VSC	1	0.22956561	0.76	0.3847	1	0.00814472	0.03	0.8697
VSR	1	0.05450033	0.18	0.6713	1	0.01060773	0.04	0.8514
VCR	1	0.99089755	3.30	0.0730	1	0.99089755	3.30	0.0730

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	4.37867515	24.20	0.0001	0.18096884
VTAVG	0.03675474	1.68	0.0963	0.02185292
VPH2	-0.01257643	-0.16	0.8770	0.08102970
VSRT	0.28383240	0.56	0.5757	0.50519365
VCIN	-0.07019950	-3.52	0.0007	0.01993845
VRASH	0.10300588	2.42	0.0177	0.04258975
VTAVG2	0.00039871	0.36	0.7189	0.00110411
VPH22	-0.01287807	-0.79	0.4288	0.01619942
VSRT2	-1.79154318	-1.86	0.0665	0.96372690
VCIN2	0.00619125	1.81	0.0740	0.00342243
VRASH2	-0.02489139	-3.22	0.0018	0.00774159
VV	0.12345399	1.61	0.1106	0.07657677
VNCOAL	-0.29219720	-2.78	0.0066	0.10500277
VTP	0.00188424	0.37	0.7134	0.00511207

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SBY

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VT5	0.01931790	0.44	0.6609	0.04387694
VTC	0.00078221	0.21	0.8343	0.00372703
VTR	-0.00339774	-0.51	0.6087	0.00661277
VPS	0.03231239	0.17	0.8620	0.18536630
VPC	-0.01085892	-0.93	0.3548	0.01167106
VPR	-0.00505444	-0.27	0.7903	0.01896462
VSC	0.01118532	0.16	0.8697	0.06795503
VSR	0.03626563	0.19	0.8514	0.19306126
VCR	-0.01409291	-1.82	0.0730	0.00776243

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	3.63836825	3.23275947	0.40560877	2.83016755	3.63535140
2	2.86343612	3.33155329	-0.46811717	2.53907307	4.12403352
3	4.27631579	3.50269614	0.77361965	2.94892601	4.05646627
4	2.31532525	2.90860319	-0.59327795	2.44501091	3.37219548
5	2.20507166	2.96364750	-0.75857583	2.63060912	3.29668587
6	2.78086763	3.44053073	-0.65966309	2.82556657	4.05549488
7	3.10421286	3.00141524	0.10279762	2.67895377	3.32387670
8	2.43362832	3.02264838	-0.58902007	2.62864680	3.41664996
9	2.65780731	3.39225024	-0.73444293	2.97828238	3.80621810
10	3.15670800	3.09431814	0.06238986	2.33907570	3.84956058
11	3.15670800	3.23170494	-0.07499693	2.82972434	3.63368553
12	3.38218715	3.00023944	0.38194770	2.67053648	3.32994241
13	3.49492672	2.92549388	0.56943284	2.54799765	3.30299010
14	3.41034103	2.96086096	0.44948008	2.58372313	3.33799879
15	3.09734513	2.82682757	0.27051757	2.37685357	3.27680156
16	3.76105195	2.90000328	0.86105867	2.48436601	3.31564054
17	4.54391701	3.75264792	0.79126909	3.18415470	4.32114114
18	4.76995940	4.62376154	0.14619786	4.05210573	5.19541736
19	5.08570140	5.34647604	-0.26077464	4.63278696	6.06016511
20	3.97790055	3.55486058	0.42303997	2.97535979	4.13436136
21	3.98671056	4.23825695	-0.25154599	3.76785942	4.70865448
22	2.55271920	3.45656230	-0.90384310	2.85945033	4.05367427
23	3.89321468	4.11756722	-0.22435253	3.61409595	4.62103849
24	3.90625000	4.13451452	-0.22826452	3.63584317	4.63318586
25	2.63042525	2.98714711	-0.35672186	2.35107408	3.62322015
26	2.63100437	2.57752254	0.05348182	1.97481898	3.18022610
27	2.71326243	2.61151439	0.10174803	1.74557970	3.47744909
28	3.33804501	3.34681136	-0.00876635	2.53198136	4.16164137
29	2.46375232	2.46515284	-0.00144053	1.47813269	3.45225300
30	2.69797925	2.67085002	0.02712922	2.00576455	3.33593549
31	2.34655079	2.46697438	-0.12042359	1.70085063	3.23309812
32	2.34204793	2.30322176	0.03882617	1.39067515	3.21576835
33	2.69680056	2.75864973	-0.06184877	1.99253944	3.52476002
34	2.66695814	2.41964461	0.24731353	1.42841441	3.41087481
35	4.44884925	4.64137309	-0.19252384	4.25646465	5.02628152

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SBY

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	4.23962119	5.12730711	-0.88768593	4.80668945	5.44792478
37	4.65807730	4.91038640	-0.25230910	4.35758526	5.46318754
38	4.68010131	4.39976387	0.28033744	3.83021172	4.96931603
39	4.50390926	4.88490954	-0.38100028	4.32241331	5.44740577
40	4.42682524	5.01954629	-0.59272105	4.47454947	5.56454311
41	5.09855743	5.09743522	0.00112220	4.48953710	5.70533335
42	4.82591450	5.04661942	-0.22070492	4.55316333	5.54007552
43	6.26506024	6.09456393	0.17049631	5.60425499	6.58487287
44	6.20224719	6.39734959	-0.19510239	5.81506233	6.97963684
45	7.61640798	6.39366865	1.22273933	5.84853465	6.93880265
46	6.29014396	5.59858116	0.69156281	5.10938591	6.08777640
47	4.80132450	5.40227945	-0.60095495	4.82008996	5.98446894
48	5.99557522	5.19812572	0.79744950	4.72462148	5.67162995
49	5.29933481	5.61696007	-0.31762526	5.21693499	6.01698515
50	4.65372739	4.43482127	0.21890612	3.95154142	4.91810113
51	4.94949495	4.31087300	0.63862195	3.94592666	4.67581934
52	4.24611973	4.49900652	-0.25288679	3.76877104	5.22924200
53	4.58888889	4.04739481	0.54149408	3.41061914	4.68417049
54	2.94701987	3.55676151	-0.60974164	2.84228429	4.27123873
55	3.85337308	4.45057268	-0.59719960	4.12860563	4.77253973
56	4.79436991	4.41736011	0.37700980	4.06370839	4.77101183
57	4.82606295	4.71347956	0.11258339	4.17649969	5.25045942
58	4.13907285	4.52948665	-0.39041380	4.17233617	4.88663714
59	3.52321370	4.42572180	-0.90250810	4.10759615	4.74384745
60	6.16793556	4.98436954	1.18356602	4.70389818	5.26484091
61	4.99338624	4.57617425	0.41721200	4.21750194	4.93484656
62	5.00827358	4.36966219	0.63861139	4.01752947	4.72179492
63	5.91996472	4.99762211	0.92234261	4.72841124	5.26683298
64	4.22737307	4.03415345	0.19321962	3.31862929	4.74967760
65	4.81400438	4.88019488	-0.06619050	4.06494986	5.69543989
66	4.51045105	4.72775820	-0.21730716	4.42443062	5.03108578
67	4.30463576	4.77461441	-0.46997865	4.47533208	5.07389674
68	4.79302832	4.71888889	0.07413943	4.31650514	5.12127265
69	4.94505495	4.76810513	0.17694981	4.20397845	5.33223181
70	4.39560440	4.68135425	-0.28574985	4.34399675	5.01871175
71	4.87264673	4.36975545	0.50289128	3.85168372	4.88782718
72	4.34298441	4.57477618	-0.23179177	4.25883952	4.89071283
73	5.12249443	4.45989240	0.66260203	4.13886592	4.78091888
74	4.34298441	4.94159326	-0.59860885	4.59814289	5.28504362
75	4.34298441	4.71730947	-0.37432506	4.39326624	5.04135270
76	4.23162584	4.37056061	-0.13893477	3.91377907	4.82734214
77	3.99556049	4.67910511	-0.68354462	4.36519986	4.99301035
78	3.43680710	3.28538073	0.15142637	2.40258834	4.16817311
79	3.21507761	3.14033486	0.07474275	2.18453800	4.09613172
80	3.04191077	4.50484900	-1.46293823	4.19665920	4.81303880
81	4.60108794	4.83760878	-0.23652084	4.39846341	5.27675416
82	4.80063255	4.65190234	0.14873022	4.24983929	5.05396539
83	4.69806219	4.26159163	0.43647056	3.72589513	4.79728812
84	3.79775536	4.47964755	-0.68189219	4.15733303	4.80196207

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SBY

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	3.99016430	4.49466282	-0.50449852	4.24046447	4.74886117
86	4.59948895	4.50589833	0.09359061	4.19616897	4.81562769
87	3.90054745	4.34622416	-0.44567671	4.00833946	4.68410886
88	3.80292882	4.51594458	-0.71301576	4.17780949	4.85407968
89	4.97237569	4.37321844	0.59915725	4.10700914	4.63942775
90	4.52538631	4.31375149	0.21163482	4.06297355	4.56452943
91	4.96688742	4.34235936	0.62452806	4.10700432	4.57771440
92	4.32801822	4.29162686	0.03639136	4.05706071	4.52619301
93	4.08626561	4.23671945	-0.15045384	3.98900138	4.48443752
94	4.42678774	4.20890276	0.21788498	3.94658959	4.47121592
95	4.06320542	4.24524083	-0.18203542	3.99979207	4.49068960
96	4.39684329	4.25899903	0.13784426	4.01993887	4.49805920
97	5.28683915	4.21624522	1.07059393	3.94269446	4.48979597
98	4.37424058	4.12121412	0.25302646	3.83492371	4.40750453
99	4.38528665	4.09350592	0.29178073	3.79857111	4.38844073
100	4.57306970	4.16853703	0.40453267	3.89116620	4.44590787
101	4.35030179	4.20968466	0.14061713	3.93918189	4.48018744
102	4.08837262	4.03470144	0.05367119	3.74735605	4.32204682
103	3.92893748	3.81515579	0.11378168	3.46033070	4.16998089
104	4.09696142	4.37887462	-0.28191320	4.01837903	4.73937020
105	4.38047559	4.28147215	0.09900344	3.99483040	4.56811391
106	4.07327341	4.16044408	-0.08717067	3.86152122	4.45936695
107	4.08465127	4.10627061	-0.02161934	3.68778953	4.52475168
108	4.10740699	4.27291162	-0.16550463	3.98855823	4.55726500
SUM OF RESIDUALS			0.00000000		
SUM OF SQUARED RESIDUALS			25.55295157		
SUM OF SQUARED RESIDUALS - ERROR SS			-0.00000000		
FIRST ORDER AUTOCORRELATION			0.10375729		
DURBIN-WATSON D			1.78575513		

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHW

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	313.69766611	14.25898482	13.71	0.0001	0.780127	13.8577
ERROR	85	88.41317884	1.04015505		STD DEV		SHW MEAN
CORRECTED TOTAL	107	402.11084495			1.01987992		7.35963943

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	144.92837070	139.33	0.0001	1	1.57131145	1.51	0.2224
VPH2	1	20.26554234	19.48	0.0001	1	2.63459555	2.53	0.1152
VSRT	1	20.31099090	19.53	0.0001	1	2.28303844	2.19	0.1422
VCIN	1	30.35798442	29.19	0.0001	1	5.99526417	5.76	0.0185
VRASH	1	6.86041913	6.60	0.0120	1	10.88333209	10.46	0.0017
VTAVG2	1	0.00101990	0.00	0.9751	1	3.54653569	3.41	0.0683
VPH22	1	5.78811453	5.56	0.0206	1	4.36326607	4.19	0.0436
VSRT2	1	3.25380830	3.13	0.0805	1	4.08586654	3.93	0.0507
VCIN2	1	6.68420272	6.43	0.0131	1	1.51713250	1.46	0.2305
VRASH2	1	13.94728959	13.41	0.0004	1	2.39745667	2.30	0.1327
VV	1	5.37135421	5.16	0.0256	1	10.42068571	10.02	0.0022
VNCOAL	1	13.23099588	12.72	0.0006	1	5.27316946	5.07	0.0269
VTP	1	2.03810793	1.96	0.1652	1	0.71197331	0.68	0.4104
VTS	1	1.53085084	1.47	0.2284	1	7.49107344	7.20	0.0088
VTC	1	0.43170854	0.42	0.5212	1	0.58447506	0.56	0.4556
VTR	1	3.72598494	3.58	0.0618	1	7.94062083	7.63	0.0070
VPS	1	6.07422520	5.84	0.0178	1	5.55638563	5.34	0.0232
VPC	1	2.36599123	2.27	0.1352	1	0.00188710	0.00	0.9661
VPR	1	1.55425571	1.49	0.2249	1	1.91364588	1.84	0.1786
VSC	1	10.61385095	10.20	0.0020	1	1.17529655	1.13	0.2908
VSR	1	14.35595076	13.80	0.0004	1	13.02810177	12.53	0.0007
VCR	1	0.00664739	0.01	0.9365	1	0.00664739	0.01	0.9365

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	7.41774833	22.04	0.0001	0.33662143
VTAVG	0.04996081	1.23	0.2224	0.04064877
VPH2	0.23987784	1.59	0.1152	0.15072392
VSRT	-1.39220576	-1.48	0.1422	0.93971434
VCIN	0.08903985	2.40	0.0185	0.03708765
VRASH	0.25625655	3.23	0.0017	0.07922150
VTAVG2	0.00379232	1.85	0.0683	0.00205377
VPH22	0.06171550	2.05	0.0436	0.03013266
VSRT2	3.55291646	1.98	0.0507	1.79263531
VCIN2	-0.00768839	-1.21	0.2305	0.00636609
VRASH2	0.02186223	1.52	0.1327	0.01440019
VV	-0.45085210	-3.17	0.0022	0.14244099
VNCOAL	-0.43976995	-2.25	0.0269	0.19531641
VTP	-0.00786715	-0.83	0.4104	0.00950899

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHW

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTS	0.21932681	2.68	0.0088	0.08161581
VTC	-0.00519679	-0.75	0.4556	0.00693268
VTR	-0.03398598	-2.76	0.0070	0.01230047
VPS	0.79692215	2.31	0.0232	0.34480118
VPC	0.00052469	0.04	0.9661	0.02170942
VPR	0.04784801	1.36	0.1786	0.03527622
VSC	0.13436441	1.06	0.2908	0.12640363
VSR	-1.27093881	-3.54	0.0007	0.35911464
VCR	0.00115428	0.08	0.9365	0.01443894

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	5.40242558	5.76372995	-0.36130437	5.01486583	6.51259408
2	5.83708441	6.20465741	-0.36765301	4.73055926	7.67875557
3	7.89473684	7.21372706	0.68100978	6.18365527	8.24379885
4	5.29217200	5.57952054	-0.28734855	4.71718921	6.44185187
5	6.17420066	6.17394415	0.00025652	5.55445708	6.79343121
6	6.00667408	7.56248006	-1.55580598	6.41858083	8.70637929
7	6.09756098	6.45038271	-0.35282173	5.85056983	7.05019559
8	5.53097345	5.70188232	-0.17090887	4.96899715	6.43476748
9	5.53709356	6.60894184	-1.07184328	5.83891725	7.37896643
10	7.10259301	7.46400214	-0.36140913	6.05917027	8.86883402
11	7.89177001	6.72229648	1.16947353	5.97456949	7.47002346
12	7.21533258	6.36929470	0.84603788	5.75601185	6.98257755
13	9.58286359	7.17332129	2.40954230	6.47113785	7.87550473
14	7.26072607	7.13646144	0.12426463	6.43494465	7.83797823
15	6.19469027	6.25827583	-0.06358557	5.42127598	7.09527568
16	5.19911504	6.26106859	-1.06195354	5.48793873	7.03419845
17	8.44514601	9.81924345	-1.37409743	8.76178513	10.87670177
18	10.41948579	9.66403351	0.75545229	8.60069243	10.72737459
19	9.64140731	8.43149575	1.20991156	7.10395758	9.75903392
20	6.74033149	8.22531179	-1.48498030	7.14737823	9.30324536
21	7.53045404	8.62093250	-1.09047846	7.74594268	9.49592232
22	10.43285239	8.42360609	2.00924630	7.31291383	9.53429835
23	9.34371524	9.35785928	-0.01414404	8.42134876	10.29436981
24	10.04464286	8.97648840	1.06815445	8.04890626	9.90407055
25	2.60850504	3.53436982	-0.92586478	2.35120580	4.71753383
26	1.99781659	2.27349681	-0.27568022	1.15240360	3.39459002
27	4.25439549	4.12441201	0.12998348	2.51368067	5.73514334
28	4.18614766	4.22107699	-0.03492934	2.70540585	5.73674813
29	2.61637414	2.27858070	0.33779344	0.44254302	4.11461837
30	4.27089022	4.33680070	-0.06591047	3.09967044	5.57393095
31	4.26941679	4.01072442	0.25869437	2.58565215	5.43579670
32	3.87799564	4.39834084	-0.52034520	2.70090638	6.09577530
33	4.35637078	3.76348601	0.59288477	2.33843877	5.18853326
34	4.91857134	4.97262425	-0.05405392	3.12882986	6.81641865
35	8.74353045	8.35112159	0.39240886	7.63515065	9.06709253

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHW

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	8.69948244	8.19552649	0.50395595	7.59914327	8.79190970
37	8.69948244	9.24076473	-0.54128229	8.21249536	10.26903410
38	9.23907059	9.86880416	-0.62973358	8.80937611	10.92823221
39	8.62239841	8.21561924	0.40677917	7.16931597	9.26192251
40	9.28311860	9.53973566	-0.25661706	8.52598317	10.55348815
41	8.71049444	9.15055819	-0.44006375	8.01980253	10.28131385
42	8.31864257	7.33347663	0.98516594	6.41559541	8.25135785
43	5.84884995	6.36868393	-0.51983399	5.45665676	7.28071111
44	5.30337079	5.88547684	-0.58210605	4.80236015	6.96859353
45	5.69844789	6.84397815	-1.14553026	5.82997049	7.85798582
46	9.19158361	6.71008160	2.48150201	5.80012602	7.62003718
47	7.19646799	5.78309331	1.41337468	4.70015847	6.86602816
48	5.29867257	6.39968848	-1.10101592	5.51891986	7.28045710
49	5.99778271	6.28863346	-0.29085076	5.54454393	7.03272299
50	8.70092633	9.40492243	-0.70399610	8.50597011	10.30387475
51	7.55331089	8.45225616	-0.89894528	7.77341686	9.13109546
52	7.63858093	8.28725796	-0.64867703	6.92894171	9.64557421
53	10.81111111	10.27147772	0.53963340	9.08700672	11.45594872
54	10.16556291	9.78664002	0.37892289	8.45763583	11.11564422
55	9.10897648	8.41732129	0.69165519	7.81842807	9.01621451
56	9.99560150	8.48503134	1.51057015	7.82720124	9.14286144
57	8.44837107	9.22412892	-0.77575785	8.22528882	10.22296902
58	7.80353201	8.05338212	-0.24985011	7.38904394	8.71772030
59	8.51717704	8.47535788	0.04181915	7.88361008	9.06710569
60	8.28643937	8.43518378	-0.14874441	7.91347698	8.95689058
61	7.60582011	7.88039216	-0.27457205	7.21322322	8.54756109
62	7.74407060	8.22373601	-0.47966541	7.56873141	8.87874061
63	7.27593430	8.21987079	-0.94393650	7.71910973	8.72063186
64	10.92715232	11.71659547	-0.78944315	10.38564386	13.04754709
65	10.32822757	10.06596183	0.26226574	8.54951874	11.58240493
66	11.44114411	9.34301283	2.09813128	8.77879103	9.90723463
67	10.26490066	9.44895683	0.81594383	8.89225963	10.00565404
68	10.34858388	9.71418345	0.63440043	8.96570654	10.46266036
69	9.23076923	7.39377276	1.83699647	6.34443667	8.44310885
70	9.01098901	9.26019966	-0.24921065	8.63267856	9.88772077
71	11.51716501	10.17984733	1.33731768	9.21617839	11.14351627
72	6.90423163	7.98098217	-1.07675055	7.39330614	8.56865821
73	7.23830735	8.04973925	-0.81143190	7.45259559	8.64688291
74	8.12917595	8.26546639	-0.13629044	7.62661191	8.90432087
75	8.46325167	9.53332335	-1.07007168	8.93056821	10.13607849
76	9.91091314	9.84661545	0.06429769	8.99695284	10.69627807
77	7.88013319	9.34909590	-1.46896272	8.76519851	9.93299329
78	6.87361419	6.98697011	-0.11335592	5.34488167	8.62905855
79	5.98669623	6.13272845	-0.14603222	4.35484386	7.91061304
80	6.29788193	7.18478712	-0.88690520	6.61152107	7.75805318
81	7.40027199	7.51129488	-0.11102290	6.69443741	8.32815235
82	6.79995482	7.51043739	-0.71048257	6.76255703	8.25831775
83	6.80486706	6.64547174	0.15939532	5.64901885	7.64192463
84	7.50481805	6.58342582	0.92139223	5.98388627	7.18296537

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHW

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	4.99608807	6.58713169	-1.59104362	6.11429552	7.05996787
86	5.79935563	6.22985792	-0.43050229	5.65372812	6.80598772
87	6.39826642	6.50053605	-0.10226963	5.87203430	7.12903781
88	5.69871722	6.67080221	-0.97208498	6.04183469	7.29976972
89	7.07182320	7.22692209	-0.15509889	6.73174426	7.72209993
90	5.84988962	7.13422540	-1.28433577	6.66775155	7.60069924
91	6.51214128	7.09441464	-0.58227336	6.65662905	7.53220024
92	7.40318907	7.27342125	0.12976782	6.83710307	7.70973943
93	8.51305335	7.50612771	1.00692564	7.04534556	7.96690986
94	7.71850170	7.46715710	0.25134461	6.97922650	7.95508769
95	7.90067720	7.48452969	0.41614751	7.02796868	7.94109070
96	7.77903044	7.59548508	0.18354536	7.15080756	8.04016261
97	4.83689539	7.54369870	-2.70680331	7.03486497	8.05253242
98	6.46194632	6.25618894	0.20575738	5.72365809	6.78871978
99	6.56136087	6.74943368	-0.18807280	6.20082332	7.29804404
100	6.94797305	6.53155115	0.41642190	6.01561167	7.04749063
101	7.00375811	6.63950148	0.36425663	6.13633733	7.14266564
102	6.58239380	6.67639172	-0.09399792	6.14189850	7.21088494
103	6.44573511	6.01033705	0.43539806	5.35032435	6.67034975
104	7.87527029	7.07290110	0.80236918	6.40234067	7.74346153
105	8.24894755	6.86465286	1.38429469	6.33146848	7.39783724
106	8.16930254	6.78510892	1.38419362	6.22908035	7.34113749
107	8.10103539	7.48059878	0.62043661	6.70217913	8.25901843
108	8.02139037	6.88814367	1.13324670	6.35921590	7.41707144

SUM OF RESIDUALS	0.00000000
SUM OF SQUARED RESIDUALS	88.41317884
SUM OF SQUARED RESIDUALS - ERROR SS	-0.00000000
FIRST ORDER AUTOCORRELATION	0.13285122
DURBIN-WATSON D	1.72042714

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SNAP

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	540.63775220	24.57444328	3.22	0.0001	0.454481	29.5818
ERROR	85	648.93279662	7.63450349		STD DEV		SNAP MEAN
CORRECTED TOTAL	107	1189.57054882			2.76306053		9.34039228

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	273.64187223	35.84	0.0001	1	10.33071182	1.35	0.2480
VPH2	1	40.39170942	5.29	0.0239	1	5.27824965	0.69	0.4080
VSRT	1	118.32320994	15.50	0.0002	1	25.82740412	3.38	0.0694
VCIN	1	12.47381188	1.63	0.2046	1	14.80964342	1.94	0.1673
VRASH	1	5.14885703	0.67	0.4138	1	8.14081666	1.07	0.3047
VTAVG2	1	3.74474063	0.49	0.4856	1	0.05619254	0.01	0.9318
VPH22	1	8.36743424	1.10	0.2981	1	8.67099512	1.14	0.2896
VSRT2	1	17.82919656	2.34	0.1302	1	14.45949393	1.89	0.1724
VCIN2	1	0.30349542	0.04	0.8424	1	0.71112426	0.09	0.7610
VRASH2	1	23.33959236	3.06	0.0840	1	0.95510537	0.13	0.7244
VV	1	2.38709514	0.31	0.5775	1	0.20313932	0.03	0.8708
VNCOAL	1	0.94498070	0.12	0.7258	1	1.70290115	0.22	0.6379
VTP	1	0.90876655	0.12	0.7309	1	0.60874491	0.08	0.7783
VTS	1	0.29232214	0.04	0.8453	1	2.01248149	0.26	0.6090
VTC	1	2.08185407	0.27	0.6029	1	0.09409008	0.01	0.9119
VTR	1	4.92241500	0.64	0.4242	1	0.02301841	0.00	0.9563
VPS	1	5.87272675	0.77	0.3829	1	0.05064300	0.01	0.9353
VPC	1	0.56821091	0.07	0.7857	1	0.33065060	0.04	0.8356
VPR	1	8.03257239	1.05	0.3079	1	4.77151983	0.62	0.4314
VSC	1	0.00820270	0.00	0.9739	1	4.68470260	0.61	0.4356
VSR	1	1.28437687	0.17	0.6827	1	4.36100181	0.57	0.4519
VCR	1	9.77030926	1.28	0.2611	1	9.77030926	1.28	0.2611

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	9.18806821	10.07	0.0001	0.91197540
VTAVG	0.12810423	1.16	0.2480	0.11012572
VPH2	0.33952997	0.83	0.4080	0.40834153
VSRT	4.68260143	1.84	0.0694	2.54587580
VCIN	-0.13994345	-1.39	0.1673	0.10047793
VRASH	-0.22162573	-1.03	0.3047	0.21462704
VTAVG2	-0.00047736	-0.09	0.9318	0.00556408
VPH22	-0.08700072	-1.07	0.2896	0.08163545
VSRT2	-6.68373857	-1.38	0.1724	4.85661086
VCIN2	-0.00526377	-0.31	0.7610	0.01724703
VRASH2	0.01379891	0.35	0.7244	0.03901302
VV	-0.06294815	-0.16	0.8708	0.38590140
VNCOAL	0.24991044	0.47	0.6379	0.52915157
VTP	-0.00727450	-0.28	0.7783	0.02576177

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SNAP

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTs	-0.11352192	-0.51	0.6090	0.22111370
VTC	0.00208509	0.11	0.9119	0.01878203
VTR	0.00182983	0.05	0.9563	0.03332444
VPS	0.07608156	0.08	0.9353	0.93413599
VPC	-0.01224107	-0.21	0.8356	0.05881520
VPR	0.07555469	0.79	0.4314	0.09557041
VSC	0.26825728	0.78	0.4356	0.34245295
VSR	0.73532140	0.76	0.4519	0.97291404
VCR	-0.04425278	-1.13	0.2611	0.03911802

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	7.27673649	8.39689635	-1.12015985	6.36807230	10.42572040
2	11.23348018	9.72058981	-1.51289037	5.72696040	13.71421921
3	16.66666667	9.06216928	-7.60449739	6.27149691	11.85284164
4	4.74090408	5.65807399	-0.91716991	3.32184437	7.99430360
5	2.86659316	6.16467874	-3.29808558	4.48636324	7.84299424
6	4.00444939	8.45555896	-4.45150957	5.35690508	11.55501284
7	4.10199557	6.29630612	-2.19431056	4.67129198	7.92132026
8	5.64159292	5.99727893	-0.35568601	4.01174511	7.98281276
9	5.53709856	7.62377515	-2.08667659	5.53762312	9.70992718
10	1.69109357	4.68094465	-2.98985108	0.87497158	8.48691773
11	6.31341601	6.38102234	-0.06760633	4.35527903	8.40676565
12	13.41600902	6.99725648	-6.41875254	5.33574946	8.65876349
13	10.82299887	6.64276753	-4.18023134	4.74041088	8.54512418
14	10.56105611	6.67130360	-3.88975250	4.77075304	8.57185416
15	5.97345133	5.96208146	0.01136987	3.69447994	8.22968298
16	4.20353962	6.20374238	-2.00020255	4.10917756	8.29830719
17	12.04194385	11.07531576	-0.96662809	8.21044775	13.94018378
18	10.26161479	11.58006509	-1.31845030	8.69925950	14.46087068
19	13.92647722	11.14294996	-2.78352726	7.54638113	14.73951879
20	11.71270718	10.20777659	-1.50493059	7.28743701	13.12811617
21	11.40642303	11.01168052	0.39474251	8.64115650	13.38220454
22	11.87569367	10.03439850	-1.84129518	7.02530900	13.04348799
23	7.67519466	11.07115907	-3.39596441	8.53396306	13.60835509
24	10.15625030	11.01197645	-0.85572645	8.49896921	13.52498369
25	5.28277071	7.34071209	-2.05794138	4.13528199	10.54614220
26	3.78820961	5.25359235	-1.46538275	2.21632458	8.29086013
27	4.01562839	5.22883251	-1.21320412	0.86503624	9.59262877
28	5.76274872	6.45558701	-0.69283828	2.34932799	10.56184602
29	3.48844836	2.83122235	0.65727650	-2.14297427	7.80541897
30	4.58765732	5.80077971	-1.21312270	2.44914418	9.15241525
31	4.13905436	3.08115455	1.05790031	-0.77965385	6.94196295
32	3.81263617	2.56888085	1.24375531	-2.02981168	7.16757338
33	4.81493613	4.79415062	0.02078550	0.93341003	8.65489122
34	6.76576675	4.54490614	2.22086061	-0.45030501	9.54011728
35	6.29886576	10.25987126	-3.96100550	8.32016149	12.19958104

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SNAP

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	11.22123114	10.78829467	0.43293647	9.17257218	12.40401716
37	11.57361524	10.67871020	0.89490504	7.89292095	13.46449946
38	7.21286202	10.22261413	-3.00975211	7.35240973	13.09281853
39	5.47296553	8.89091434	-3.41794881	6.05626762	11.72556106
40	8.53430239	9.55673094	-1.02242855	6.81027084	12.30319103
41	11.06706310	11.84555353	-0.77849043	8.78210823	14.90899884
42	8.48391362	10.50946930	-2.02555569	8.02274383	12.99619478
43	9.12376780	11.51390550	-2.39013770	9.04303981	13.98477119
44	10.49438202	11.88603712	-1.39165510	8.95165540	14.82041884
45	15.39911308	11.06462681	4.33448627	8.31747538	13.81177823
46	6.88815061	9.21523860	-2.32708800	6.74998529	11.68049192
47	9.09492274	9.15806838	-0.06314564	6.22417932	12.09195743
48	12.99778761	9.46057376	3.53721385	7.07439381	11.84675372
49	14.20177384	10.37430505	3.82746879	8.35841635	12.39019375
50	11.02779003	10.03185555	0.99593448	7.59641228	12.46729881
51	11.26823793	8.77130861	2.49692932	6.93219594	10.61042128
52	9.11308204	7.85929263	1.25378941	4.17933978	11.53924549
53	9.14444444	9.18504202	-0.04059758	5.97607103	12.39401302
54	11.79911700	9.44543778	2.35367922	5.84489719	13.04597837
55	8.06006404	9.55720521	-1.49714117	7.93468260	11.17972782
56	8.69804267	9.24197761	-0.54393494	7.45978311	11.02417211
57	7.15626726	10.01329048	-2.85702323	7.30723106	12.71934991
58	8.58719647	9.71874239	-1.13154592	7.91891618	11.51856860
59	7.95741411	9.62324444	-1.66583032	8.02008021	11.22640867
60	9.76497848	10.63111107	-0.86613259	9.21770206	12.04452008
61	6.81216931	9.70139250	-2.88922319	7.89389720	11.50888780
62	8.39492554	8.80463993	-0.40971439	7.03010026	10.57917959
63	9.28232830	10.77514549	-1.49281719	9.41848270	12.13180828
64	11.13686534	9.92363923	1.21322611	6.31782269	13.52945577
65	10.10940919	10.12174455	-0.01233536	6.01339415	14.23009495
66	12.65126513	11.63918195	1.01208317	10.11059123	13.16777268
67	11.36865342	11.32653270	0.04212072	9.81832762	12.83473778
68	11.76470588	11.97897539	-0.21426950	9.95120038	14.00675039
69	8.90109890	10.26279797	-1.36169907	7.41993473	13.10566121
70	11.31868132	11.87938019	-0.56069887	10.17929887	13.57946151
71	11.07419712	12.06325522	-0.98905810	9.45248157	14.67402888
72	12.69487751	10.20925165	2.48562585	8.61711866	11.80138465
73	13.69710468	10.18501531	3.51208937	8.56723261	11.80279801
74	19.26503341	10.58768164	8.67735177	8.85689591	12.31846737
75	16.48106904	11.50233555	4.97873349	9.86935023	13.13532087
76	8.24053452	12.35684997	-4.11631545	10.05494247	14.65875747
77	7.35815760	11.80295279	-4.44479518	10.22105691	13.38484866
78	5.32150776	6.87280249	-1.55129473	2.42405349	11.32155149
79	4.65631929	4.58956580	0.06775349	-0.22808236	9.40521396
80	11.95358269	10.20033212	1.75325058	8.64723867	11.75342556
81	8.05757026	10.53933333	-2.48176307	8.32630159	12.75236507
82	12.61719191	10.57134103	2.04585088	8.54518219	12.59749986
83	11.15367283	10.44308811	0.71058472	7.74349612	13.14268010
84	14.73755810	10.40294059	4.33461751	8.77866695	12.02721423

P99
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GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SNAP

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	10.34983793	10.10262502	0.24721292	8.82161539	11.38363364
86	5.94378402	10.02876845	-4.08498443	8.46791554	11.58962036
87	8.83895985	9.77291085	-0.93395099	8.07017274	11.47564895
88	8.16210594	9.72300451	-1.56089757	8.01900157	11.42700445
89	13.48066298	11.01851698	2.46214600	9.67698130	12.36005366
90	12.91390728	10.68594667	2.22796061	9.42217888	11.94971846
91	13.13465784	10.76837438	2.36628345	9.58232185	11.95442392
92	9.90888383	10.97913211	-1.07024828	9.79705311	12.16120611
93	10.32917140	11.00224502	-0.67307363	9.75389317	12.25059687
94	15.89103292	11.12518725	4.76584567	9.80328178	12.44708971
95	11.28668172	10.98713435	0.29954737	9.75021943	12.22405027
96	10.93573944	11.12758657	-0.19184813	9.92286541	12.33230773
97	10.34870541	11.49177623	-1.14306982	10.11324298	12.87030948
98	9.83099525	10.10928376	-0.27828851	8.66655222	11.55201730
99	10.42748260	10.57902684	-0.15154424	9.09273165	12.06532303
100	10.44957473	10.24987605	0.19969867	8.85209188	11.64766023
101	10.53410773	10.53698135	-0.00287362	9.17380311	11.90015460
102	8.89420339	10.52368299	-1.62947959	9.07563298	11.97173299
103	8.55255566	9.97714787	-1.42459122	8.18904326	11.76525548
104	10.47001252	10.76222625	-0.29221373	8.94554271	12.57890979
105	10.63829787	10.73970874	-0.10141087	9.29520464	12.18421284
106	9.13642153	10.68838013	-1.55195960	9.18198552	12.19477373
107	9.23882125	10.84305343	-1.60423218	8.73415750	12.95194936
108	8.51063330	10.74720722	-2.23656892	9.31423513	12.18017930

SUM OF RESIDUALS 0.00000000
 SUM OF SQUARED RESIDUALS 648.93279662
 SUM OF SQUARED RESIDUALS - ERROR SS -0.00000000
 FIRST ORDER AUTOCORRELATION 0.31951577
 DURBIN-WATSON D 1.35440993

SNAPMD=9.1E807+0.12810*VTAVG+0.33953*VPH2+4.68260*VSRT-0.12994*VCIN
 -0.22163*VFASH-0.00048*VTAVG2-0.08700*VPH22-6.68374*VSRT2-0.00526*VCIN2
 +0.01380*VFASH2-0.06295*VV+0.24991*VNCOAL-0.00727*VTP-0.11352*VTS
 +0.00209*VTC+0.00183*VTR+0.07608*VPS-0.01224*VPC+0.07555*VPR+0.26826*VSC
 +0.73532*VSR-0.04425*VCR;

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SMD

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	3957.03020711	179.86500941	13.42	0.0001	0.776432	29.6673
ERROR	85	1139.39792173	13.40468214		STD DEV		SMD MEAN
CORRECTED TOTAL	107	5096.42818885			3.66124052		12.34098392

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	601.61304815	44.88	0.0001	1	75.07154119	5.60	0.0202
VPH2	1	39.75516679	2.97	0.0887	1	0.91759347	0.07	0.7942
VSRT	1	526.68285414	39.29	0.0001	1	76.36823403	5.70	0.0192
VCIN	1	1342.69786406	100.17	0.0001	1	64.64801017	4.82	0.0308
VRASH	1	70.84517401	5.29	0.0240	1	1.17381522	0.09	0.7680
VTAVG2	1	2.82865232	0.21	0.6471	1	0.94351244	0.07	0.7914
VPH22	1	41.77894919	3.12	0.0811	1	0.72528186	0.05	0.8166
VSRT2	1	42.47908816	3.17	0.0786	1	4.77851925	0.36	0.5521
VCIN2	1	31.81957133	2.37	0.1271	1	0.44407553	0.03	0.8560
VRASH2	1	16.83739224	1.26	0.2656	1	6.27407426	0.47	0.4957
VV	1	72.73968967	5.43	0.0222	1	90.41504860	6.75	0.0111
VNCOAL	1	842.64058810	62.86	0.0001	1	348.67219198	26.01	0.0001
VTP	1	0.28225000	0.02	0.8850	1	10.36603663	0.77	0.3817
VT	1	30.50733858	2.28	0.1351	1	0.03802693	0.00	0.9576
VTC	1	105.67761229	7.88	0.0062	1	15.90178981	1.19	0.2792
VTR	1	49.49301789	3.69	0.0580	1	50.06625883	3.73	0.0566
VPS	1	26.46766835	1.97	0.1636	1	0.18333428	0.01	0.9072
VPC	1	2.45135269	0.18	0.6700	1	6.29678523	0.47	0.4950
VPR	1	67.13295112	5.01	0.0278	1	64.78030654	4.83	0.0306
VSC	1	38.52508310	2.87	0.0937	1	12.63354589	0.94	0.3344
VSR	1	0.16340119	0.01	0.9123	1	1.00066487	0.07	0.7853
VCR	1	3.61149373	0.27	0.6051	1	3.61149373	0.27	0.6051

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	10.55312427	8.73	0.0001	1.20842858
VTAVG	0.34533136	2.37	0.0202	0.14592396
VPH2	-0.14156579	-0.26	0.7942	0.54107991
VSRT	8.05198928	2.39	0.0192	3.37345619
VCIN	-0.29238687	-2.20	0.0308	0.13314000
VRASH	-0.08415771	-0.30	0.7680	0.28439522
VTAVG2	0.00195604	0.27	0.7914	0.00737278
VPH22	0.02516180	0.23	0.8166	0.10817244
VSRT2	3.84228502	0.60	0.5521	6.43533512
VCIN2	-0.00415961	-0.18	0.8560	0.02285347
VRASH2	0.03536665	0.68	0.4957	0.05169487
VV	1.32802518	2.60	0.0111	0.51134523
VNCOAL	3.57600685	5.10	0.0001	0.70116131
VTP	0.03001869	0.88	0.3817	0.03413608

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SMD

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTS	0.015E0526	0.05	0.9576	0.29299049
VTC	-0.02710660	-1.09	0.2792	0.02488745
VTR	0.08533851	1.93	0.0566	0.04415712
VPS	-0.14475766	-0.12	0.9072	1.23779284
VPC	0.05341443	0.69	0.4950	0.07793409
VPR	-0.27839060	-2.20	0.0306	0.12663721
VSC	-0.44052762	-0.97	0.3344	0.45377313
VSR	0.35223167	0.27	0.7853	1.28917635
VCR	-0.02690481	-0.52	0.6051	0.05183399

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	8.82028666	6.93729612	1.98299054	4.14896818	9.52562405
2	11.45374449	8.47518827	2.97855622	3.18336146	13.76701509
3	-4.60526316	3.23581125	-7.84107441	-0.46201680	6.93363931
4	6.39470783	8.17523293	-1.78052510	5.07957200	11.27089386
5	7.60749724	5.94033294	1.76716430	3.61645234	8.06421354
6	5.56173526	1.78072523	3.78101003	-2.32572902	5.88717948
7	6.65188470	4.98164748	1.67023722	2.82839476	7.13490021
8	5.75221239	7.35422757	-1.60201518	4.72326208	9.98519305
9	5.64784053	3.63107554	2.01676499	0.86678419	6.39536689
10	7.10259101	5.57921732	1.52337569	0.53604773	10.62238691
11	3.15670800	5.11327826	-1.95657026	2.42903251	7.79752402
12	5.18602029	4.64869221	0.53732809	2.44708398	6.85030044
13	0.22547914	2.56867056	-2.34319142	0.04792041	5.08942071
14	0.00000000	2.59067124	-2.59067124	0.07231428	5.10902820
15	3.87168142	5.85455516	-1.98287375	2.84983106	8.85927926
16	7.63274336	5.55622284	2.07652052	2.78078398	8.33166171
17	5.25425640	11.82147300	-6.56721660	8.02533074	15.61761526
18	6.93504736	7.74133934	-0.80629197	3.92407871	11.55859996
19	5.90888888	6.50462152	-0.59573563	1.73892659	11.27031644
20	13.37016575	12.65460360	0.71556215	8.78495779	16.52424940
21	11.62790598	9.21942919	2.40847778	6.07832588	12.36053251
22	15.64927858	12.86693731	2.78234127	8.87969191	16.85418271
23	12.56952169	9.55651250	3.01300919	6.19455761	12.91846739
24	9.59821429	9.46275471	0.13541958	6.13289157	12.79269785
25	8.13239807	6.13460140	1.99779667	1.88719152	10.38201128
26	6.28820961	6.45843621	-0.17022660	2.43385270	10.48301972
27	7.92272629	6.77718596	1.14554033	0.99486322	12.55950869
28	9.43786017	8.34386234	1.09399783	2.90279374	13.78493094
29	6.63904938	6.50460288	0.13444650	-0.08654125	13.09574702
30	7.82086292	4.88740367	2.93345924	0.44626179	9.32854555
31	3.79141771	4.66311772	-0.87170002	-0.45271235	9.77894780
32	4.38997821	5.28229239	-0.89231417	-0.81128365	11.37586842
33	6.50726062	8.19549484	-1.68823423	3.07975462	13.31123507
34	4.86391955	6.39782247	-1.53390291	-0.22116733	13.01681226
35	17.76236097	11.81851042	5.94385056	9.24826487	14.38875596

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SMD

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	17.83944500	13.45783173	4.38161326	11.31689106	15.59877240
37	15.26263627	13.07620210	2.18643417	9.38484450	16.76755971
38	15.65906838	14.41341957	1.24564881	10.61020624	18.21663290
39	14.49179606	10.70220397	3.78959209	6.94610695	14.45830099
40	16.26472855	10.26481543	5.99991313	6.62557160	13.90405926
41	21.85882612	15.66715792	6.19166820	11.60788743	19.72642841
42	19.27060379	17.32679148	1.94381231	14.03171344	20.62186951
43	22.25629792	21.46257252	0.79372540	18.18850976	24.73663527
44	22.34831461	23.07967912	-0.73136451	19.19142654	26.96793170
45	17.80487805	22.33817891	-4.53330086	18.69801902	25.97833879
46	20.07751938	21.34861461	-1.27109523	18.08198863	24.61524060
47	17.39514349	16.39187862	1.00326487	12.50427884	20.27947840
48	18.69469027	16.05819292	2.63649734	12.89634445	19.22004140
49	15.60088692	20.70540589	-1.10451897	18.03421816	23.37659362
50	11.51301279	10.78392457	0.72908823	7.55679889	14.01105024
51	8.14814815	7.07277542	1.07537272	4.63582779	9.50972306
52	5.37694013	4.97446317	0.40247696	0.09827883	9.85064752
53	6.26666667	7.15341340	-0.88674674	2.90131161	11.40551520
54	8.49889625	11.17308020	-2.67418396	6.40212243	15.94403797
55	7.88340510	9.01956955	-1.13616445	6.86961827	11.16952083
56	8.07125577	8.21557216	-0.14431639	5.85404492	10.57709940
57	7.32192159	9.36268382	-2.04076223	5.77697359	12.94839405
58	5.34216336	6.74397357	-1.40181021	4.35908313	9.12886401
59	7.14520909	9.04430222	-1.89909314	6.92000210	11.16860235
60	11.43109346	11.52822683	-0.09713338	9.65536510	13.40108857
61	6.59171076	7.26146622	-0.66975546	4.86641372	9.65651872
62	6.94980695	7.67075357	-0.72094662	5.31936950	10.02213765
63	8.85238673	11.90219302	-3.04980629	10.10452384	13.69986221
64	9.60264901	8.25739019	1.34525882	3.47944143	13.03533894
65	10.29540481	17.82502769	-7.52962288	12.38118787	23.26886752
66	9.24092409	10.20678711	-0.96586302	8.18130188	12.23227235
67	7.17439294	9.49325423	-2.31886129	7.49478134	11.49172712
68	9.69498911	9.46523032	0.22975879	6.77829243	12.15216820
69	8.68131868	15.50159756	-6.82027888	11.73461310	19.26858203
70	9.34065934	10.79003966	-1.44938032	8.53731788	13.04276143
71	12.40310078	10.57296770	1.83013307	7.11351751	14.03241789
72	10.91314031	10.96380741	-0.05066710	8.85412441	13.07349041
73	7.46102450	11.42379381	-3.96276931	9.28012323	13.56746439
74	3.08668151	10.36679199	-7.36011047	8.07338481	12.66019916
75	9.24276169	10.13284573	-0.8908404	7.96903066	12.29666080
76	13.58574610	9.28907648	4.29666962	6.23889465	12.33925831
77	13.54051054	9.81083232	3.72967823	7.71471419	11.90695045
78	8.98004435	8.02199351	0.95805083	2.12710271	13.91688431
79	8.75831486	7.23364118	1.52467368	0.85125932	13.61602304
80	29.14601172	21.96563493	7.18037679	19.90768195	24.02358791
81	22.65412511	22.91797858	-0.26385346	19.98556309	25.85039406
82	24.43239580	23.49665959	0.93573621	20.81186324	26.18145894
83	23.15232087	26.05169868	-2.89937782	22.47455823	29.62883913
84	30.32535994	23.71031205	6.61504789	21.55884053	25.86258386

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SMD

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	29.45121270	21.62178261	7.82943008	19.92436027	23.31920496
86	23.07521387	22.61733111	0.45788276	20.54905764	24.68556457
87	20.44936131	21.27115098	-0.82178965	19.01490877	23.52739315
88	24.37280054	21.70787030	2.66493024	19.44995610	23.96578451
89	17.45856354	19.33423138	-1.87566784	17.55660530	21.11185746
90	15.23178808	17.55128892	-2.31950084	15.87676654	19.22587130
91	22.51655629	18.11471208	4.40184421	16.54311690	19.68630726
92	14.23690205	18.72408786	-4.48718581	17.15776053	20.29041519
93	21.56640182	18.52007692	3.04632490	16.86592699	20.17422684
94	7.37797957	19.14115858	-11.76317902	17.38954916	20.89276801
95	22.79909707	18.47255111	4.32654596	16.83355455	20.11154766
96	19.27846674	17.99201094	1.28645580	16.39567460	19.58834727
97	24.18447694	18.39884745	5.78562949	16.57219843	20.22549647
98	14.96741412	17.62378552	-2.65637141	15.71206682	19.53550423
99	15.37611841	16.99976659	-1.62364817	15.03032445	18.96920872
100	14.39301889	17.67120301	-3.27818412	15.81904522	19.52336079
101	14.63386858	17.69720325	-3.06333468	15.89098728	19.50349923
102	16.00045553	17.58916208	-1.58870655	15.67039871	19.50792545
103	15.41826785	15.83867791	-0.43041006	13.46931540	18.20804042
104	18.04939115	20.23642449	-2.18703333	17.82919695	22.64365201
105	15.24633064	18.67023684	-3.42390620	16.75617203	20.58430166
106	17.03265445	17.74505563	-0.71240122	15.74898312	19.74112824
107	18.44350893	17.44807058	0.99543835	14.65364203	20.24249913
108	16.49789510	18.62898759	-2.13109249	16.73023346	20.52777172

SUM OF RESIDUALS 0.00000000
 SUM OF SQUARED RESIDUALS 1139.39798173
 SUM OF SQUARED RESIDUALS - ERROR SS -0.00000000
 FIRST ORDER AUTOCORRELATION 0.12328349
 DUNBIN-WATSON D 1.74691281

SMDMD=10.55312+0.34533*VTAYG-0.14157*VPH2+8.05199*VSRT-0.29239*VCIN
 -0.08416*VRASH+0.00196*VTAYG2+0.02516*VPH22+3.84229*VSRT2
 -0.08416*VCIN2+0.03537*VRASH2+1.32803*VV+3.57601*VNCOL+0.03002*VTP
 +0.01561*VTS-0.02711*VTC+0.08534*VTR-0.14476*VPS+0.05341*VPC
 -0.27839*VPR-0.44053*VSC+0.35223*VSR-0.02690*VCR;

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHD

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	3705.02275985	168.41012545	12.25	0.0001	0.760233	33.0361
ERROR	85	1168.51339771	13.74721644		STD DEV		SHD MEAN
CORRECTED TOTAL	107	4873.53615756			3.70772389		11.22323737

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	228.87359121	16.65	0.0001	1	60.95206984	4.43	0.0382
VPH2	1	1381.27834065	100.48	0.0001	1	85.15720378	6.19	0.0148
VSRT	1	783.78602605	57.01	0.0001	1	5.98406663	0.44	0.5112
VCIN	1	87.83676463	6.39	0.0133	1	16.40203413	1.19	0.2778
VRASH	1	419.05663012	30.48	0.0001	1	287.25638110	20.90	0.0001
VTAVG2	1	0.00622724	0.00	0.9831	1	23.53021729	1.71	0.1943
VPH22	1	14.52187922	1.06	0.3070	1	0.15671828	0.01	0.9152
VSRT2	1	4.07455115	0.30	0.5876	1	0.62751027	0.05	0.8313
VCIN2	1	7.02369710	0.51	0.4767	1	1.57239072	0.11	0.7360
VRASH2	1	43.45900854	3.16	0.0790	1	118.63080124	8.63	0.0043
VV	1	69.73779597	5.08	0.0268	1	54.90357063	3.99	0.0489
VNCOAL	1	417.51044223	30.37	0.0001	1	161.12519740	11.72	0.0010
VTP	1	79.33318165	5.77	0.0185	1	7.54053875	0.55	0.4610
VTS	1	0.03538499	0.00	0.9597	1	13.32709151	0.97	0.3276
VTC	1	65.75791560	4.78	0.0315	1	32.60256790	2.37	0.1273
VTR	1	29.64618553	2.16	0.1457	1	20.86488810	1.52	0.2214
VPS	1	7.12554594	0.52	0.4735	1	0.10911831	0.01	0.9292
VPC	1	4.55370256	0.33	0.5664	1	0.36912840	0.03	0.8702
VPR	1	26.42513638	1.92	0.1692	1	25.20532692	1.83	0.1793
VSC	1	0.99519162	0.07	0.7885	1	0.09948655	0.01	0.9324
VSH	1	27.06202500	1.97	0.1642	1	16.56250327	1.20	0.2755
VCR	1	6.82353647	0.50	0.4830	1	6.82353647	0.50	0.4830

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	14.67043278	11.99	0.0001	1.22377087
VTAVG	-0.31116632	-2.11	0.0382	0.14777662
VPH2	1.36377853	2.49	0.0148	0.54794950
VSRT	-2.25395387	-0.66	0.5112	3.41628583
VCIN	-0.14727504	-1.09	0.2778	0.13483035
VRASH	1.31652430	4.57	0.0001	0.28800592
VTAVG2	-0.00976823	-1.31	0.1943	0.00746639
VPH22	-0.01169629	-0.11	0.9152	0.10954581
VSRT2	-1.39236574	-0.21	0.8313	6.51703859
VCIN2	0.00782716	0.34	0.7360	0.02314362
VRASH2	-0.15378639	-2.94	0.0043	0.05235119
VV	-1.03487107	-2.00	0.0489	0.51783731
VNCOAL	-2.43092420	-3.42	0.0010	0.71006331
VTP	0.02560275	0.74	0.4610	0.03456947

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SMO

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTS	0.29214129	0.98	0.3276	0.29671031
VTC	0.03881307	1.54	0.1273	0.02520342
VTR	-0.05309099	-1.23	0.2214	0.04471774
VPS	0.11167823	0.09	0.9292	1.25350795
VPC	0.01291266	0.16	0.8702	0.07892354
VPR	0.17365178	1.35	0.1793	0.12824500
VSC	0.03909243	0.09	0.9324	0.45953426
VSR	-1.43304287	-1.10	0.2755	1.30554383
VCR	-0.03698207	-0.70	0.4830	0.05249208

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	0.11025358	1.92403465	-1.81378108	-0.79842448	4.64649380
2	-3.08370044	3.03493854	-6.11863898	-2.32407368	8.39395077
3	-3.17582456	-0.58320572	-2.59661885	-4.32798166	3.16157023
4	2.31532525	0.05482236	2.26050289	-3.08014130	3.18978602
5	0.99228225	-0.03736811	1.02965036	-2.28948326	2.21474703
6	2.11345440	-1.23914221	3.35260161	-5.39773230	2.91944787
7	0.99778271	0.05993793	0.93784478	-2.12065265	2.24052850
8	3.53982301	0.21963440	3.32018861	-2.44473401	2.88400281
9	-0.11074197	-0.04680389	-0.06393808	-2.84619089	2.75258310
10	-1.01465614	-2.32508320	1.31042706	-7.43228124	2.78211483
11	1.01465614	-0.94502060	1.95967674	-3.66334573	1.77330453
12	0.00800000	2.19063677	-2.19063677	-0.03892323	4.42019678
13	0.00800000	1.62746862	-1.62746862	-0.92528515	4.18022239
14	-3.19031503	1.63305682	-4.82337585	-0.91727338	4.18338701
15	4.64601770	1.68056052	2.96545718	-1.36231177	4.72343281
16	0.77433628	1.76319985	-0.98886357	-1.04747618	4.57387588
17	11.60220594	7.62002853	3.98218142	3.77569017	11.46436688
18	11.82904826	12.22371520	-0.39466694	8.35799037	16.08944004
19	14.49330221	13.83538727	0.65491494	9.00918674	18.66158779
20	3.53591160	6.80362644	-3.26771484	2.88485133	10.72240155
21	7.30897010	10.24997085	-2.94100076	7.06898787	13.43095384
22	4.55349545	7.34122231	-2.79072287	3.30335456	11.37909007
23	13.23692592	10.43007408	2.80685584	7.02543557	13.83471259
24	11.16371429	10.21660704	0.94410725	6.84442721	13.58878687
25	12.07303555	9.27200038	2.80603556	4.97066509	13.57333568
26	7.72925764	9.65560361	-1.92634597	5.57992370	13.73128352
27	5.65443690	7.65458413	-2.00014524	1.79884862	13.51031965
28	11.73208655	10.15055879	1.58152776	4.64040999	15.66070758
29	10.38218565	7.75202174	2.63716391	1.07719597	14.42684751
30	10.06307646	7.51673941	2.54633705	3.01921248	12.01426635
31	5.83378599	10.01215490	-4.17836891	4.83137388	15.19293592
32	7.18454248	7.64722289	-0.46268040	1.47628238	13.81816340
33	10.35347454	8.03736385	2.31611109	2.85667382	13.21805388
34	5.79298284	7.76475511	-1.97177227	1.06173015	14.46778007
35	13.3657174	11.64734471	1.72122704	9.04446714	14.25022227

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHD

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	12.49862350	15.45978674	-2.96116324	13.29166454	17.62790894
37	11.39742319	10.22446423	1.17295896	6.48624089	13.96268757
38	12.37749147	13.82018048	-1.44268901	9.96868128	17.67167967
39	13.18136769	12.67623185	0.50513584	8.87244715	16.48801654
40	18.25790111	19.98797076	-1.73006965	16.30252283	23.67341869
41	11.33135117	18.41214653	-7.08079536	14.30133925	22.52295381
42	13.30982812	12.81932490	0.49050322	9.48241232	16.15623748
43	11.07338445	12.33943933	-1.26605488	9.02380884	15.65506981
44	16.89887640	13.05957511	3.83930129	9.12195700	16.99719323
45	12.39467849	13.24191172	-0.84723323	9.55553610	16.92828734
46	10.38759690	9.43016638	0.95743052	6.12206708	12.73826568
47	12.70419426	9.66788702	3.03630724	5.73093000	13.60484404
48	0.00000000	10.56875437	-10.56875437	7.36676284	13.77074590
49	8.60310421	10.18573405	-1.58262984	7.48063273	12.89083537
50	21.44905161	18.22029583	3.22875578	14.95219834	21.48839332
51	15.94837262	16.84108324	-0.89271063	14.37319594	19.30897054
52	13.12638581	17.00275900	-3.87637319	12.06466627	21.94085173
53	12.36666667	16.06598240	-3.69931574	11.75989562	20.37206918
54	18.73068433	15.08723118	3.64345314	10.25570099	19.91876137
55	19.52081263	17.86222386	1.65858877	15.68497665	20.03947108
56	17.50604794	18.38565206	-0.87960412	15.99414271	20.77716142
57	16.94091662	15.96171965	0.97919697	12.33048498	19.59295431
58	13.78587196	13.20785776	0.57801420	10.79268858	15.62302694
59	19.90999890	18.02730525	1.88269365	15.87603486	20.17857564
60	23.10493214	19.35419483	3.75073731	17.45755511	21.25083455
61	14.35185185	12.79329081	1.55856104	10.36783055	18.21875107
62	17.78268064	16.18452652	1.59815412	13.80328911	18.86574394
63	20.33954360	19.06494836	1.27459524	17.24445584	20.88944088
64	16.30242826	14.86115792	1.44127034	10.02254798	19.69976785
65	20.89715536	14.37782787	6.51932750	8.86487266	19.89078307
66	20.90209021	20.92625809	-0.02416788	18.87505715	22.97765903
67	20.64017660	21.60532720	-0.96515060	19.58148156	23.62917284
68	24.07407407	22.05682426	2.01724981	19.33577282	24.77787570
69	21.42857143	14.70868690	6.71988453	10.89387653	18.52349726
70	21.42857143	20.30064766	1.12792377	18.01932517	22.58197015
71	19.60132890	19.71420663	-0.11287772	16.21083501	23.21757824
72	12.80623608	15.83093201	-3.02469593	13.69446432	17.96739969
73	15.25612472	14.89428690	0.36183783	12.72340012	17.06517367
74	19.82182628	19.64687154	0.17495474	17.32434710	21.96939598
75	15.47884187	20.95241550	-5.47357363	18.76112848	23.14370252
76	22.16035635	20.75060297	1.40975338	17.66169582	23.03951012
77	22.30854606	21.26046705	1.04807901	19.13773645	23.30319764
78	2.21729450	4.89663808	-2.67934318	-1.07309467	10.86637084
79	7.87139690	8.71393402	-0.84253712	2.25052098	15.17734705
80	2.19693556	11.16181383	-8.96487828	9.07773294	13.24589473
81	12.39800544	12.15914628	0.23885916	9.18950064	15.12879192
82	6.49497346	11.06616247	-4.57118901	8.34727975	13.78504518
83	5.80216314	6.25838257	-0.45621944	2.63582650	9.88093865
84	0.80489740	8.77081110	-7.96591370	6.59121419	10.95040801

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SHD

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	6.00201185	10.55783739	-4.55582554	8.83886445	12.27681033
86	17.59804466	9.50925180	8.08879286	7.41475989	11.60374370
87	17.09625912	10.25189231	6.84436681	7.96700471	12.53677991
88	9.60381428	10.75557366	-1.15175938	8.46899282	13.04215451
89	13.14917127	12.87298446	0.27618681	11.07278952	14.67317941
90	15.34216336	13.87953032	1.46263304	12.18368732	15.57537332
91	8.83002208	13.81151615	-4.98149408	12.21996789	15.40306442
92	15.37585421	13.77250856	1.60334566	12.18629502	15.35872209
93	9.42111237	13.96935533	-4.54824296	12.29420420	15.64450646
94	20.09080590	13.48338385	6.60742206	11.70953587	15.25723183
95	10.83521445	13.99872036	-3.16350591	12.33891499	15.65852573
96	12.51409245	14.59833789	-2.08424545	12.98173436	16.21494143
97	11.13610799	14.45578929	-3.32368131	12.60994901	16.30962958
98	15.55285541	10.47742458	5.07543083	8.54143456	12.41341460
99	14.24942008	12.05004264	2.19937744	10.05559633	14.04448895
100	13.20004418	10.78856775	2.41147643	8.91289484	12.66424066
101	10.75048400	11.44755953	-0.69707553	9.61833069	13.27678837
102	11.19462476	10.32262309	0.87200167	8.37949896	12.26574722
103	13.06229359	11.59185115	1.47044244	9.19240704	13.99129525
104	12.76886309	8.21744362	4.55141948	5.77965375	10.65523348
105	9.06815337	10.48955390	-1.42140053	8.55118798	12.42791982
106	14.77983843	11.51242198	3.26741645	9.49100714	13.53383682
107	14.65468199	13.05351404	1.60116795	10.22360723	15.88342085
108	11.84435089	10.52925887	1.31509202	8.60636765	12.45215010

SUM OF RESIDUALS 0.00000000
 SUM OF SQUARED RESIDUALS 1168.51339771
 SUM OF SQUARED RESIDUALS - ERROR SS -0.00000000
 FIRST ORDER AUTOCORRELATION 0.03040245
 DURBIN-WATSON D 1.93503028

SHDMD=14.67043-0.31117*VTAVG+1.36378*VPH2-2.25395*VSRT-0.14728*VCIN
 +1.31652*VRASH-0.00977*VTAVG2-0.01170*VPH22-1.39237*VSRT2+0.00783*VCIN2
 -0.15379*VRASH2-1.03487*VV-2.43092*VNCOAL+0.02560*VTP+0.29214*VTS
 +0.03881*VTC-0.05509*VTR+0.11168*VPS+0.01293*VPC+0.17365*VPR+0.03909*VSC
 -1.43380*VSR-0.03698*VCR;

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SSRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	29166.64419948	1325.75655452	120.12	0.0001	0.968839	8.1881
ERROR	85	938.10672574	11.03654971		STD DEV		SSRC MEAN
CORRECTED TOTAL	107	30104.75092522			3.32213030		40.57288263

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	10151.35989119	919.79	0.0001	1	365.93189612	33.16	0.0001
VPH2	1	4539.82212931	411.34	0.0001	1	99.95701721	9.06	0.0034
VSRT	1	8841.57895164	801.12	0.0001	1	295.84437893	26.81	0.0001
VCIN	1	3397.81935126	307.87	0.0001	1	336.81229685	30.52	0.0001
VRASH	1	1248.07633309	113.09	0.0001	1	375.89365518	34.06	0.0001
VTAVG2	1	78.26859299	7.09	0.0093	1	2.92233212	0.26	0.6082
VPH22	1	81.49069260	7.38	0.0080	1	0.30733259	0.03	0.8679
VSRT2	1	145.88990596	13.22	0.0005	1	0.64929572	0.06	0.8089
VCIN2	1	61.26266888	5.55	0.0208	1	3.26653291	0.30	0.5878
VRASH2	1	95.16398924	8.62	0.0043	1	78.53271630	7.12	0.0091
VV	1	14.81502246	1.34	0.2498	1	7.49732463	0.68	0.4121
VNCOAL	1	55.94813731	5.07	0.0269	1	49.51395420	4.49	0.0371
VTP	1	27.99515165	2.54	0.1149	1	0.05275042	0.00	0.9450
VTS	1	199.27529625	18.06	0.0001	1	142.83189488	12.94	0.0005
VTC	1	39.23544111	3.56	0.0628	1	0.02899854	0.00	0.9592
VTR	1	0.00119748	0.00	0.9917	1	0.46456274	0.04	0.8379
VPS	1	7.18235253	0.65	0.4221	1	2.44117006	0.22	0.6393
VPC	1	29.39617795	2.66	0.1064	1	9.42944932	0.85	0.3579
VPR	1	13.53356850	1.23	0.2713	1	12.98685940	1.18	0.2811
VSC	1	4.74726525	0.43	0.5137	1	3.62395571	0.33	0.5681
VSR	1	97.13731432	8.80	0.0039	1	54.04112787	4.90	0.0296
VCR	1	36.64076852	3.32	0.0720	1	36.64076852	3.32	0.0720

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	39.45500742	35.98	0.0001	1.09650190
VTAVG	-0.76242738	-5.76	0.0001	0.13240824
VPH2	-1.47754187	-3.01	0.0034	0.49096419
VSRT	-15.84814642	-5.18	0.0001	3.06100103
VCIN	0.66738163	5.52	0.0001	0.12080835
VRASH	-1.50600542	-5.84	0.0001	0.25805406
VTAVG2	-0.00344245	-0.51	0.6082	0.00668990
VPH22	0.01637920	0.17	0.8679	0.09815333
VSRT2	-1.41632909	-0.24	0.8089	5.83928362
VCIN2	-0.01128152	-0.54	0.5878	0.02073674
VRASH2	0.12512511	2.67	0.0091	0.04690680
VV	0.38241869	0.82	0.4121	0.46398358
VNCOAL	-1.34757670	-2.12	0.0371	0.63621858
VTP	0.00214140	0.07	0.9450	0.03097434

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SSRC

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTs	-0.95539423	-3.60	0.0005	0.26585322
VTC	-0.00115755	-0.05	0.9592	0.02258233
VTR	-0.00322043	-0.21	0.8379	0.04006722
VPS	-0.52822472	-0.47	0.6393	1.12314640
VPC	-0.06536456	-0.92	0.3579	0.07071570
VPR	-0.12464795	-1.08	0.2811	0.11490786
VSC	0.23594020	0.57	0.5681	0.41174390
VSR	2.58848670	2.21	0.0296	1.16977068
VCR	0.08569161	1.82	0.0720	0.04703304

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	64.277839C3	64.85190043	-0.57406140	62.41256992	67.29123094
2	63.32599119	58.38626994	4.93972125	53.58458098	63.18795890
3	64.25438556	66.37228955	-2.11790358	63.01696052	69.72761858
4	70.56229327	70.39082971	0.17146357	67.58189407	73.19976534
5	74.20066152	70.97805890	3.22260263	68.96015784	72.99595995
6	73.30367075	68.98909642	4.31457433	65.26298883	72.71520400
7	72.72727213	70.97285257	1.75442016	69.01903771	72.92666743
8	69.69026549	70.17877503	-0.48850955	67.79149397	72.56605610
9	71.09634551	69.33007512	1.76627039	66.82181706	71.83833319
10	73.73167962	73.04996307	0.68171675	68.47390028	77.62602588
11	68.88387824	70.65259719	-1.76871895	68.21697076	73.08822361
12	63.35963923	68.34589062	-4.98625139	66.34819903	70.34358222
13	67.41826381	70.13293543	-2.71467162	67.84566138	72.42020948
14	71.61715172	70.06123493	1.55592679	67.77613240	72.34633745
15	67.92035358	69.59360740	-1.67325342	66.86718587	72.32002892
16	67.47787611	69.34953651	-1.87166040	66.83116344	71.86790958
17	38.68530838	40.20431200	-1.51900363	36.75977479	43.64884922
18	37.90031574	39.31886953	-1.41855378	35.85516997	42.78256908
19	37.32521425	40.35159945	-3.02638520	36.02731117	44.67588774
20	47.18232044	43.53017272	3.65214772	40.01893998	47.04140546
21	45.84717608	43.95636122	1.89081486	41.10619215	46.80653029
22	43.72918979	42.55725681	1.17193298	38.93931675	46.17519687
23	41.26807564	42.17865847	-0.91058284	39.12809347	45.22922348
24	43.75000000	43.31929943	0.43070057	40.29781749	46.34078137
25	59.50241122	59.68779799	-0.18538677	55.83379032	63.54180566
26	68.46069869	66.06191669	2.39878200	62.41009684	69.71373654
27	63.02365965	64.17308040	-1.14942075	58.92632607	69.41983472
28	56.83375014	58.94752271	-2.11377257	54.01041499	63.88463043
29	67.19720920	70.33476407	-3.13755487	64.35410273	76.31542541
30	61.67121791	66.08084383	-4.40962591	62.05104794	70.11063971
31	71.39598045	67.28134933	4.11463112	62.63935599	71.92334266
32	70.32679739	66.57648311	3.75031427	61.04730429	72.10566194
33	62.44131455	65.29505000	-2.85373544	60.65313819	69.93696180
34	63.13258260	61.73532620	1.39725660	55.72939831	67.74125409
35	27.62911574	33.33038195	-5.70126621	30.99819684	35.66256705

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SSRC

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	27.35381566	27.55252901	-0.19871335	25.60988584	29.49517217
37	25.91124326	28.00980675	-2.09856349	24.66034886	31.35926464
38	27.54101971	24.20875540	3.33226431	20.75780205	27.65970875
39	32.24314503	37.91215148	-5.66900645	34.50395045	41.32035251
40	27.46393569	29.46243288	-1.99849719	26.16026190	32.76460386
41	18.68736923	19.10385267	-0.41648344	15.42055860	22.78714674
42	19.19347730	24.68992439	-5.49644708	21.70004199	27.67980678
43	25.72836802	21.92395689	3.80441113	18.95314330	24.69477047
44	22.89887640	21.10470306	1.79417334	17.57658694	24.63281919
45	23.30376940	23.11409275	0.18967665	19.81109056	26.41709494
46	28.77076412	30.23862730	-1.46786318	27.27456167	33.20269292
47	34.50331126	38.78411573	-4.28080447	35.25659195	42.31163951
48	37.89823009	35.31024122	2.58798887	32.44124844	38.17923400
49	26.09756098	27.42614239	-1.32858141	25.00236453	29.84992024
50	23.48919277	27.91927831	-4.43008555	24.99105442	30.84750221
51	37.82267116	39.09129541	-1.26862426	36.88006194	41.30252888
52	46.00886918	41.02545890	4.98341028	36.60091490	45.45000289
53	32.22222222	33.84449595	-1.62227373	29.98623094	37.70276096
54	29.61368653	30.98406211	-1.37037557	26.65499842	35.31312579
55	37.76084796	35.08726729	2.67358067	33.13644810	37.03808649
56	33.75852210	36.42466802	-2.66614591	34.28188938	38.56746668
57	36.88569851	29.97121335	6.91448516	26.711761760	33.22480910
58	44.15011038	43.61936213	0.53074825	41.45536423	45.78336003
59	36.65898365	34.62810584	2.03087780	32.70056195	36.55564974
60	27.25366876	29.73914728	-2.48547851	28.03975313	31.43854142
61	45.85537919	43.77619747	2.07918172	41.60297873	45.94941620
62	38.61003861	39.56697220	-0.95693359	37.43337725	41.70056715
63	34.29610848	29.58857282	4.70753565	27.95740677	31.21973888
64	30.79470199	32.12600793	-1.33130595	27.79060078	36.46141508
65	22.86652079	22.44359145	0.42292933	17.50396918	27.38321373
66	23.54235424	27.52861570	-3.98626147	25.69073430	29.36649711
67	26.60044150	27.68555017	-1.08510867	25.87217918	29.49892115
68	21.78649237	26.34055559	-4.55406322	23.90248639	28.77862480
69	30.32967033	32.16901638	-1.83934605	28.75093632	35.58709644
70	27.25274725	27.53359353	-0.28084628	25.48952262	29.57766445
71	23.25581395	27.88923438	-4.63342043	24.75020425	31.02826451
72	40.53452116	34.92770769	5.60681347	33.01342706	36.84198832
73	38.41870824	35.25168308	3.16702517	33.30656285	37.19680330
74	35.18930958	30.38603027	4.80327930	28.30504231	32.46701824
75	35.74610245	27.69529035	8.05081210	25.73189145	29.65868925
76	25.05567929	28.44833349	-3.39265421	25.68066461	31.21600238
77	31.07658158	27.18022915	3.89635242	25.27825699	29.08220131
78	64.96674058	60.79110233	4.17563825	55.44220617	66.13999848
79	59.64523282	61.13149097	-1.48625815	55.34025599	66.92272595
80	30.70076611	27.95247340	2.74829271	26.08513147	29.81981533
81	27.69718948	25.66925666	2.02793282	23.00844641	28.33006692
82	25.59584322	26.09099835	-0.49515513	23.65487233	28.52712437
83	27.70392068	26.39829823	1.30562246	23.15247851	29.64411794
84	28.10338964	27.22565292	0.87773672	25.27272839	29.17857745

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SSRC

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	30.40123182	29.35964888	1.04160293	27.81944164	30.89985313
86	26.19708921	29.96294157	-3.76585236	28.08627135	31.83961179
87	28.20483577	31.53100702	-3.32617125	29.48374176	33.57827229
88	31.60404132	30.27764697	1.32639435	28.22866456	32.32642938
89	28.72928177	26.28314568	2.44613609	24.67016630	27.89612506
90	30.90507726	28.83877791	2.06629935	27.31929816	30.35825767
91	27.70419426	28.37211295	-0.66791869	26.94608154	29.79814435
92	30.75176843	27.69363230	3.05807613	26.27238082	29.11488377
93	29.85244041	27.58869929	2.26374112	26.08775949	29.08963908
94	25.99318956	27.54577384	-1.55258429	25.95640142	29.13514627
95	28.21670429	27.60957276	0.60713153	26.12238280	29.09676271
96	29.65050733	27.17022089	2.48028643	25.72173990	28.61870189
97	28.79640045	26.54299976	2.25340069	24.88553803	28.20046149
98	29.01800508	33.87162686	-4.85362178	32.13697174	35.60627898
99	28.65348503	32.49470354	-3.84121851	30.70767143	34.28173265
100	30.61968408	32.37959055	-1.75990646	30.69898271	34.06019838
101	33.61803895	31.60395449	2.01408446	29.96496367	33.24294831
102	34.79102608	32.89687784	1.89414824	31.15583354	34.63792214
103	35.98678966	37.69464059	-1.70785093	35.54473240	39.84454878
104	27.77967452	27.80763313	-0.02795861	25.62336704	29.99189922
105	30.82261918	29.66656069	1.15605849	27.92977977	31.40334162
106	27.32961657	31.40594468	-4.07632811	29.59475170	33.21713766
107	26.85174650	30.04832065	-3.19657415	27.51271575	32.58392456
108	29.40038685	29.69619110	-0.29580425	27.97327554	31.41910666

SUM OF RESIDUALS	0.00000000
SUM OF SQUARED RESIDUALS	938.10672574
SUM OF SQUARED RESIDUALS - ERROR SS	0.00000000
FIRST ORDER AUTOCORRELATION	0.02014029
DURBIN-WATSON D	1.95928381

SSRCMD=39.45501-0.76243*VTAVG-1.47754*VPH2-15.84815*VSRT+0.66733*VCIN
 -1.50601*VRASH-0.00344*VTAVG2+0.01638*VPH22-1.41633*VSRT2-0.01128*VCIN2
 +0.12513*VRASH2+0.38242*VV-1.34758*VNCOAL+0.00214*VTP-0.95540*VTS
 -0.00116*VTC-0.00822*VTR-0.52822*VPS-0.06536*VPC-0.12465*VPR
 +0.23294*VSC+2.58849*VSR+0.08570*VCR;

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SION

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	66.55629500	3.02528614	2.61	0.0009	0.403454	17.7106
ERROR	85	98.41004892	1.15776528		STD DEV		SION MEAN
CORRECTED TOTAL	107	164.96634392			1.07599502		6.07544187

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	3.68510264	3.18	0.0780	1	10.45211034	9.03	0.0035
VPH2	1	18.62971547	16.09	0.0001	1	16.07155819	13.88	0.0003
VSRT	1	1.85550542	1.60	0.2090	1	0.02180088	0.02	0.8912
VCIN	1	1.22959829	1.06	0.3057	1	1.12080852	0.97	0.3280
VRASH	1	0.35232268	0.30	0.5826	1	0.67308322	0.58	0.4479
VTAVG2	1	11.49898128	9.93	0.0022	1	0.59580492	0.51	0.4751
VPH22	1	1.30564182	1.13	0.2913	1	0.02226408	0.02	0.8900
VSRT2	1	3.50577983	3.03	0.0855	1	0.02313618	0.02	0.8879
VCIN2	1	1.52724028	1.32	0.2540	1	0.25357006	0.22	0.6410
VRASH2	1	3.34489981	2.89	0.0928	1	0.70337132	0.61	0.4379
VV	1	1.08670358	0.94	0.3354	1	3.47181530	3.00	0.0870
VNCOAL	1	0.25256714	0.22	0.6416	1	1.74642458	1.51	0.2228
VTP	1	10.12130884	8.74	0.0040	1	2.03349936	1.76	0.1886
VTS	1	1.90528508	1.65	0.2030	1	0.40726995	0.35	0.5547
VTC	1	0.64888262	0.56	0.4561	1	0.31166597	0.27	0.6052
VTR	1	1.33439788	1.15	0.2861	1	0.57386101	0.50	0.4833
VPS	1	3.80206800	3.28	0.0735	1	2.01377809	1.74	0.1908
VPC	1	0.08737129	0.08	0.7842	1	0.02741940	0.02	0.8781
VPR	1	0.07936788	0.07	0.7941	1	0.08976885	0.08	0.7813
VSC	1	0.00229596	0.00	0.9646	1	0.02008012	0.02	0.8955
VSR	1	0.27774717	0.24	0.6255	1	0.20114651	0.17	0.6779
VCR	1	0.02351204	0.02	0.8870	1	0.02351204	0.02	0.8870

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	6.11228969	17.21	0.0001	0.35514278
VTAVG	0.12885472	3.00	0.0035	0.04288532
VPH2	-0.59246424	-3.73	0.0003	0.15901695
VSRT	-0.13604539	-0.14	0.8912	0.99141863
VCIN	0.03849869	0.98	0.3280	0.03912826
VRASH	0.06372773	0.76	0.4479	0.08358037
VTAVG2	0.00155437	0.72	0.4751	0.00216677
VPH22	-0.00440850	-0.14	0.8900	0.03179059
VSRT2	0.26735529	0.14	0.8879	1.89126841
VCIN2	-0.00314321	-0.47	0.6410	0.00671636
VRASH2	-0.01184163	-0.78	0.4379	0.01519251
VV	-0.26023413	-1.73	0.0870	0.15027828
VNCOAL	-0.25308395	-1.23	0.2228	0.20606297
VTP	-0.01329558	-1.33	0.1886	0.01003219

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SION

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTB	0.05107007	0.59	0.5547	0.08610642
VTC	0.00379487	0.52	0.6052	0.00731412
VTR	0.00913642	0.70	0.4833	0.01297725
VPS	-0.47976163	-1.32	0.1908	0.36377259
VPC	-0.00352475	-0.15	0.8781	0.02290390
VPR	-0.01036325	-0.28	0.7813	0.03721717
VSC	0.01756280	0.13	0.8955	0.13335852
VSR	0.15792116	0.42	0.6779	0.37887359
VCR	0.00217086	0.14	0.8870	0.01523339

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	7.27673649	6.28202543	0.99471106	5.49195784	7.07209302
2	5.28634361	6.00900736	-0.72266345	4.45380213	7.56421199
3	7.78506772	7.60870121	0.17638651	6.52195355	8.69544887
4	6.39470783	5.84363177	0.55107606	4.93385386	6.75340967
5	6.94597574	6.46408312	0.48189263	5.81051108	7.11765516
6	7.23025584	7.90239552	-0.67213968	6.69555748	9.10923355
7	6.31929047	6.65678553	-0.33749507	6.02397018	7.28960089
8	5.97345133	6.02868701	-0.05523568	5.25547756	6.80189645
9	6.53377630	7.16170915	-0.62793285	6.34931682	7.97410149
10	7.18254301	6.34387999	0.75871302	4.86175246	7.82600752
11	6.87711387	6.59862556	0.27848820	5.80975778	7.38749355
12	5.97519729	6.65076034	-0.67556305	6.00373389	7.29778680
13	6.53885515	7.16010217	-0.62120702	6.41928378	7.90092064
14	7.37073707	7.15028980	0.22044807	6.41017386	7.89040414
15	6.08407080	6.30063976	-0.21656896	5.41758711	7.18369242
16	5.97345133	6.37283453	-0.39938330	5.55716618	7.18880308
17	4.96110046	5.20928836	-0.24818850	4.09364793	6.32493000
18	5.00676590	5.38784723	-0.38108133	4.26599976	6.50969470
19	5.05187190	4.85640116	0.19547074	3.45582014	6.25698219
20	4.53038674	4.75537841	-0.22499167	3.61813556	5.89262127
21	4.87264673	4.78738330	0.08526373	3.86425012	5.71051589
22	4.77247503	4.64638238	0.12609205	3.47457901	5.81818696
23	5.11675644	4.59214455	0.52465179	3.60410611	6.58018318
24	5.24553571	4.64261857	0.60291704	3.66399976	5.62123758
25	5.58965366	5.77531672	-0.18566306	4.52705359	7.02357994
26	6.13537118	5.63916432	0.49620686	4.45638712	6.82194152
27	4.84387237	5.07579099	-0.19191802	3.37643455	6.77814623
28	4.86028053	4.08806540	0.77221512	2.48900009	5.68713071
29	6.28298703	6.19682471	0.00616231	4.25976589	8.13388354
30	5.62534134	5.94443023	-0.31908889	4.63923149	7.24962898
31	6.18142314	6.08993917	0.09148397	4.58645759	7.59342075
32	6.22004357	6.73437018	-0.51432661	4.94354078	8.52819966
33	5.66655748	5.26679401	0.39976348	3.76333883	6.77024918
34	5.86944393	6.43581750	-0.56632366	4.49057526	8.38105993
35	7.47715009	7.47158719	0.00556290	6.71622261	8.22695177

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIOM

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	6.38696179	6.67538708	-0.28842529	6.04619010	7.30458407
37	8.85365048	8.59194540	0.26170508	7.50709933	9.67679148
38	6.95958595	6.90265628	0.05692967	5.78493714	8.02037542
39	10.19711486	7.38727633	2.80983852	6.28340412	8.49114855
40	4.64706530	5.68531134	-1.03824604	4.61578089	6.75484180
41	5.93546966	5.42680301	0.50866666	4.23383171	6.61977430
42	9.16703394	7.86515778	1.30187616	6.89677355	8.83354200
43	5.75027382	6.50550935	-0.75523552	5.54330126	7.46771743
44	5.86516854	6.29061919	-0.42545065	5.14790802	7.43333035
45	5.99778271	5.75867884	0.23910387	4.68887917	6.82847851
46	7.18715393	6.54087460	0.64627933	5.58085210	7.50089710
47	5.19867550	5.64686459	-0.44818909	4.50434528	6.78938390
48	8.39601770	6.50360599	1.89241171	5.57437635	7.43283563
49	6.59645233	6.96808686	-0.37163454	6.18305658	7.75311715
50	5.73445082	6.85535651	-1.12090570	5.90694268	7.80377034
51	5.72390572	6.12288449	-0.39897877	5.40669458	6.83907440
52	5.32150776	6.03305298	-0.71154522	4.60000043	7.46610553
53	6.88888889	6.07034676	0.81854212	4.82070465	7.31998888
54	6.36865342	6.40929906	-0.04064564	5.00717135	7.81142678
55	7.33134592	6.13642483	1.19492109	5.50457973	6.76826992
56	7.16956235	5.98719219	1.18237016	5.29316743	6.68121694
57	7.45444506	7.48314703	-0.02870197	6.42934947	8.53694460
58	5.84988962	5.54047265	0.30941697	4.83958173	6.24136357
59	6.49764022	6.18046462	0.31717560	5.55615809	6.80477115
60	5.43969988	5.78148249	-0.34178261	5.23107072	6.33189427
61	5.13668430	5.43856915	-0.30188484	4.73469172	6.14244658
62	5.60397132	5.98510109	-0.38112977	5.29405729	6.67614488
63	4.75140558	5.78365753	-1.03225195	5.25534395	6.31197111
64	4.52538631	5.47730780	-0.95192149	4.07312552	6.88149008
65	6.89277899	6.71477147	0.17800752	5.11489173	8.31465121
66	7.37073707	5.43611778	1.93461930	4.84085177	6.03138378
67	8.94039735	5.51629766	3.42409969	4.92897026	6.10362506
68	5.44662309	4.95451909	0.49210400	4.16486002	5.74417816
69	6.59340659	6.97474994	-0.38134335	5.86767803	8.08182185
70	7.14285714	5.36299963	1.77985751	4.70095151	6.02504776
71	5.64784053	5.22082501	0.42701552	4.20413377	6.23751625
72	3.22939866	5.21788733	-1.98848866	4.59787660	5.83789806
73	3.45211581	5.13194880	-1.67983299	4.50194953	5.76194807
74	2.44988864	5.41805051	-2.96816187	4.74404544	6.09205559
75	1.44766147	5.36609765	-3.91843618	4.73017815	6.00201715
76	5.12249443	5.32447220	-0.20197777	4.42806006	6.22088435
77	5.54938957	5.60103371	-0.05164414	4.98500953	6.21705788
78	6.31929047	6.73736543	-0.41807497	5.00492718	8.46980369
79	7.76053215	7.09831835	0.66221380	5.22261227	8.97402443
80	6.19648490	6.28579527	-0.08931037	5.68098738	6.89060317
81	6.40299184	5.84579348	0.55719836	4.98399146	6.70759549
82	6.09962725	5.95956000	0.14006724	5.17053031	6.74858970
83	7.09779180	7.30064156	-0.20284976	6.24936255	8.35192057
84	6.30314023	6.74934745	-0.44620722	6.11682046	7.38187444

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SION

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	5.70023472	6.28331393	-0.58307922	5.75446170	6.78216616
86	4.79946673	6.20819826	-1.40873154	5.60036906	6.81602747
87	4.99543796	6.04579893	-1.05036098	5.38271620	6.70888166
88	6.00522193	6.27962380	-0.27440187	5.61604969	6.94319792
89	5.08287293	6.44704311	-1.36417018	5.92461995	6.96946626
90	5.40838852	6.10199142	-0.69360290	5.60985158	6.59413125
91	5.07726269	6.07029163	-0.99302893	5.60841850	6.53216475
92	6.37813212	6.08475908	0.29337304	5.62443412	6.54508405
93	6.01589103	6.12413735	-0.10824631	5.63800237	6.61027232
94	7.71858170	6.06767744	1.65082427	5.55290027	6.58245460
95	5.64334086	6.12639616	-0.48305530	5.64471457	6.60807774
96	5.74971815	5.94941826	-0.19970010	5.48027400	6.41856251
97	5.73678290	5.85973690	-0.12295400	5.32290649	6.39656731
98	6.05324202	6.13337857	-0.08013655	5.57154719	6.69520995
99	5.87658503	5.38671194	0.48979308	4.80791634	5.96550755
100	6.82646636	6.35336149	0.47310487	5.80903436	6.89768862
101	7.24291083	5.84768360	1.39522723	5.31683471	6.37853250
102	6.26352352	5.79773468	0.46578884	5.23383296	6.36163640
103	5.78521808	5.25214812	0.53306997	4.55582067	5.94847556
104	6.47547513	7.04037152	-0.56489639	6.33291600	7.74782705
105	7.00876095	6.14735382	0.86140713	5.58483295	6.70987469
106	5.60928433	5.45479454	0.15448979	4.86817257	6.04141651
107	5.37034930	4.57845844	0.79189086	3.75720914	5.39970774
108	6.98600523	6.12750830	0.85849694	5.56947824	6.68553836
SUM OF RESIDUALS			0.00000000		
SUM OF SQUARED RESIDUALS			98.41004892		
SUM OF SQUARED RESIDUALS - ERROR SS			-0.00000000		
FIRST ORDER AUTO-CORRELATION			0.31562426		
DURBIN-WATSON D			1.35674559		

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SDIST

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	9672.41779295	439.65535423	30.68	0.0001	0.888147	16.0652
ERROR	85	1218.14225517	14.33108535		STD DEV		SDIST MEAN
CORRECTED TOTAL	107	10890.56004812			3.78564200		23.56422129

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
VTAVG	1	1572.62770100	109.74	0.0001	1	0.73479669	0.05	0.8214
VPH2	1	1889.70375750	131.86	0.0001	1	68.39546538	4.77	0.0317
VSRT	1	2595.46952024	181.11	0.0001	1	39.59753012	2.76	0.1001
VCIN	1	2117.62282603	147.76	0.0001	1	146.17634833	10.20	0.0020
VRASH	1	834.50573668	58.23	0.0001	1	251.70495091	17.56	0.0001
VTAVG2	1	2.56943884	0.18	0.6731	1	15.05013112	1.05	0.3084
VPH22	1	105.56374972	7.37	0.0080	1	0.20771555	0.01	0.9045
VSRT2	1	72.86585833	5.08	0.0267	1	1.94275366	0.14	0.7136
VCIN2	1	68.74250126	4.80	0.0313	1	0.34522690	0.02	0.8770
VRASH2	1	114.39765300	7.98	0.0059	1	70.34120785	4.91	0.0294
VV	1	0.03057169	0.00	0.9633	1	4.40575244	0.31	0.5807
VNCOAL	1	73.87746225	5.16	0.0257	1	35.75150231	2.49	0.1179
VTP	1	89.07942453	6.22	0.0146	1	35.58882647	2.48	0.1188
VT5	1	28.46474199	1.99	0.1624	1	14.78889991	1.03	0.3126
VTC	1	4.71252996	0.33	0.5679	1	2.96583854	0.21	0.6503
VTR	1	2.52904245	0.18	0.6755	1	6.28977045	0.44	0.5095
VPS	1	6.12711979	0.43	0.5150	1	0.00957363	0.00	0.9794
VPC	1	13.68718993	0.96	0.3312	1	9.71505923	0.68	0.4126
VPR	1	9.32039074	0.65	0.4222	1	9.16957554	0.64	0.4260
VSC	1	27.13644011	1.89	0.1724	1	10.49083002	0.73	0.3946
VSR	1	23.01973139	1.61	0.2085	1	9.42105167	0.66	0.4197
VCR	1	20.36340554	1.42	0.2366	1	20.36340554	1.42	0.2366

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	25.22355705	20.19	0.0001	1.24948851
VTAVG	0.03416504	0.23	0.8214	0.15088216
VPH2	1.22221274	2.18	0.0317	0.55946470
VSRT	5.79803540	1.66	0.1001	3.48807934
VCIN	-0.43966190	-3.19	0.0020	0.13766382
VRASH	1.23236659	4.19	0.0001	0.29405839
VTAVG2	-0.00781220	-1.02	0.3084	0.00762329
VPH22	0.01346551	0.12	0.9045	0.11184792
VSRT2	2.44991928	0.37	0.7136	6.65399467
VCIN2	-0.00366755	0.16	0.8770	0.02362999
VRASH2	-0.11841973	-2.22	0.0294	0.05348135
VV	0.29315412	0.55	0.5807	0.52871970
VNCOAL	1.14508265	1.58	0.1179	0.72498535
VTP	0.05562143	1.58	0.1188	0.03529595

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SCIST

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
VTS	0.30774655	1.02	0.3126	0.30294570
VTC	0.01170647	0.45	0.6503	0.02573307
VTR	0.03024753	0.66	0.5095	0.04565749
VPS	-0.03307542	-0.03	0.9794	1.27985051
VPC	0.06634709	0.82	0.4126	0.08058213
VPR	-0.10473682	-0.80	0.4260	0.13094008
VSC	-0.40143519	-0.86	0.3946	0.46919141
VSR	-1.08077120	-0.81	0.4197	1.33297993
VCR	-0.06388587	-1.19	0.2366	0.05359521

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
1	8.93054024	8.76133078	0.16920946	5.98165894	11.54100261
2	8.37004415	11.51012682	-3.14008276	6.03849453	16.98175911
3	-7.78508772	2.65260554	-10.43769326	-1.17086717	6.47607824
4	8.71003318	8.23005529	0.47997779	5.02921012	11.43090046
5	8.59977949	5.80296483	2.79681466	3.50352131	8.10240835
6	7.67519466	8.54158302	7.13361164	-3.70440017	4.78756620
7	7.64966741	5.04158541	2.60808200	2.81516955	7.26800127
8	9.29203540	7.57386197	1.71817343	4.85350165	10.29422229
9	5.53709856	3.58427165	1.95282691	0.72605532	6.44248798
10	6.08793687	3.25413412	2.83380275	-1.96039209	8.46866032
11	4.17136415	4.16825766	0.00310649	1.39280671	6.94370861
12	5.18602029	6.83932898	-1.65330869	4.56291460	9.11574336
13	0.22547914	4.19613918	-3.97066004	1.58973909	6.80253928
14	-3.19031903	4.22372805	-7.41404709	1.61980247	6.82765364
15	8.51769912	7.53511568	0.98258343	4.42829719	10.64193417
16	8.40707965	7.31942269	1.08765695	4.44968008	10.18916530
17	16.85646634	19.44150152	-2.58503518	15.51637410	23.36662895
18	18.76409562	19.96505454	-1.20095891	16.01809119	23.91201789
19	20.39918809	28.34000878	0.05917931	15.41238527	25.26763229
20	16.90607735	19.45823004	-2.55215269	15.45710156	23.45935851
21	18.93687708	15.46940005	-0.53252297	16.22156845	22.71723164
22	20.19977802	20.20815963	-0.00838160	16.06543576	24.33088349
23	25.80645161	19.98658658	5.81986503	16.51039932	23.46277384
24	20.75892857	19.67940174	1.07952683	16.23635529	23.12244820
25	20.21043402	15.40660179	4.80383223	11.01487359	19.79832998
26	14.01746725	16.11403982	-2.09657257	11.95270917	20.27537046
27	13.57716518	14.43177009	-0.85460491	8.45297583	20.41056435
28	21.16994672	18.49442113	2.67552559	12.86847612	24.12036613
29	17.02823504	14.25662463	2.77161041	7.44152687	21.07172239
30	17.88093918	12.40414309	5.47679629	7.81210027	16.99618590
31	9.62520369	14.67527262	-5.05006893	9.38561708	19.96492816
32	11.57952070	12.42951527	-1.34999458	6.62889196	19.23013859
33	16.85773556	16.23285869	0.62487687	10.94329606	21.52242133
34	10.65690239	14.16257758	-3.50567518	7.31868802	21.00646714
35	31.13093272	23.46585512	7.66507760	20.80827788	26.12343237

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SCIST

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
36	30.33806849	28.91761847	1.42045002	26.70393301	31.13130393
37	26.64005946	23.30066633	3.35939313	19.48388393	27.11744873
38	28.03655985	28.23360005	-0.19704020	24.30116129	32.16603881
39	27.67316375	23.37843581	4.29472793	19.49471428	27.26215734
40	34.52262967	30.25278619	4.26984348	26.48988828	34.01568410
41	33.19017729	34.07930445	-0.88912716	29.88210823	38.27650067
42	32.58043191	30.14611638	2.43431553	26.73907832	33.55315444
43	33.32968237	33.80201184	-0.47232948	30.41670312	37.18732057
44	39.24719101	36.13925423	3.10793678	32.11888676	40.15962170
45	30.19955654	35.58009063	-5.38053409	31.81624554	39.34393572
46	30.44511628	30.77878099	-0.31366471	27.40116172	34.15640026
47	30.09933775	26.05976564	4.03957211	22.04007316	30.07945812
48	18.69469027	26.62694730	-7.93225703	23.35786566	29.89622893
49	28.20399113	30.89113994	-2.68714881	28.12919071	33.65308918
50	32.96206440	29.00422039	3.95784401	25.66744358	32.34099721
51	24.09652076	21.91385867	0.18266210	21.39410852	26.43360881
52	18.50332594	21.97722217	-3.47389623	16.93535503	27.01908931
53	18.63333333	23.21939581	-4.58606247	18.82281628	27.61597534
54	27.22958057	26.26031139	0.96926918	21.32724621	31.19337657
55	27.40421773	26.88179341	0.52242432	24.65879117	29.10479565
56	25.57730372	26.60122423	-1.02392051	24.15945711	29.04299134
57	24.26283821	25.32440347	-1.06156525	21.61685812	29.03194881
58	19.12803532	19.95183133	-0.82379601	17.48590718	22.41775549
59	27.05520799	27.07160747	-0.01639948	24.87512797	29.26808698
60	34.53602560	30.88242167	3.65360393	28.94592392	32.81891942
61	20.94356261	20.05475703	0.88880558	17.57832553	22.53118853
62	24.73248759	23.85528010	0.87720749	21.42400079	26.28655940
63	29.19193033	30.96714138	-1.77521105	29.10839106	32.82589169
64	25.90507726	23.11854810	2.78652916	18.17825440	28.05884181
65	31.19256018	32.20285556	-1.01029538	26.57404517	37.83166595
66	30.14301430	31.13304520	-0.99003090	29.03873811	33.22735229
67	27.81456954	31.09858143	-3.28401189	29.03220451	33.16495835
68	33.76906318	31.52205458	2.24700860	28.74382003	34.30028913
69	30.10989011	30.21028446	-0.10039435	26.31530555	34.10526337
70	30.76923077	31.09068732	-0.32145655	28.76142265	33.41995198
71	32.00442968	30.28717433	1.71725535	26.71017908	33.86416958
72	23.71937639	26.79473942	-3.07536302	24.61337369	28.97610514
73	22.71714922	26.31808071	-3.60093149	24.10157258	28.53458884
74	22.82850780	30.01366352	-7.18515573	27.64233105	32.38499600
75	24.72160356	31.08526123	-6.36365767	28.84792414	33.32259832
76	35.74610245	30.03967945	5.70642300	26.88585867	33.19350023
77	35.84905660	31.07129936	4.77775724	28.90395942	33.23863931
78	11.19733925	12.91863160	-1.72129235	6.82344443	19.01381876
79	16.62971175	15.94757520	0.68213655	9.34833302	22.54681737
80	31.34294727	33.12444876	-1.78450149	30.99957074	35.25532678
81	35.05213055	35.07712486	-0.02499431	32.04507188	38.10917784
82	30.92736925	34.56282205	-3.63545280	31.78680180	37.33884230
83	28.95448400	32.31008125	-3.35559725	28.61139688	36.00876563
84	31.13025734	32.48112315	-1.35086581	30.25572184	34.70652446

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SDIST

OBSERVATION	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	LOWER 95% CL FOR MEAN	UPPER 95% CL FOR MEAN
85	35.45322454	32.17962000	3.27360454	30.42452271	33.93471729
86	40.67325853	32.12658291	8.54667562	29.98807509	34.26509072
87	37.54562044	31.52304327	6.02257717	29.19013857	33.85594797
88	33.97661483	32.46344397	1.51317086	30.12881044	34.79807749
89	30.60773481	32.20721584	-1.59948104	30.36918966	34.04524203
90	30.57395143	31.43081924	-0.85686781	29.69933797	33.16230051
91	31.34657837	31.92622824	-0.57964987	30.30123346	33.55122301
92	29.61275626	32.49659642	-2.88384015	30.87704848	34.11614436
93	30.98751419	32.48943225	-1.50191806	30.77907768	34.19978681
94	27.46878547	32.62454243	-5.15575696	30.81341690	34.43566797
95	33.63431151	32.47127146	1.16304005	30.77658515	34.16595778
96	31.79255919	32.59034883	-0.79778964	30.93977225	34.24092542
97	35.32058493	32.85863674	2.46194818	30.96992192	34.74735157
98	30.52026952	28.10121010	2.41905942	26.12453510	30.07788511
99	29.62553850	29.04980923	0.57572927	27.01344947	31.08616899
100	27.59306307	28.45977076	-0.86670768	26.54468043	30.37486108
101	25.38435258	29.14476278	-3.76041020	27.27709255	31.01243301
102	27.19508029	27.91178517	-0.71670488	25.92782613	29.89574421
103	28.47056144	27.43052906	1.04003238	24.98066045	29.88039767
104	30.81825424	28.45386810	2.36438614	25.96484789	30.94288831
105	24.31448401	29.15979074	-4.84530673	27.18068991	31.13889157
106	31.81249289	29.25747766	2.55501523	27.19358262	31.32137269
107	33.09819092	30.50158462	2.59660630	27.61220710	33.39096215
108	28.34224599	29.15824647	-0.81600048	27.19494553	31.12154740

SUM OF RESIDUALS 0.00000000
 SUM OF SQUARED RESIDUALS 1218.14225517
 SUM OF SQUARED RESIDUALS - ERROR SS -0.00000000
 FIRST ORDER AUTOCORRELATION 0.19150152
 DURBIN-WATSON D 1.61653604

SDISTND=25.22356+0.03417*VTAVG+1.22221*VPH2+5.79804*VSRT-0.43965*VCIN
 +1.23237*VRASH-0.00781*VTAVG2+0.01347*VPH22+2.44992*VSRT2+0.00357*VCIN2
 -0.11842*VRASH2+0.29315*VV+1.14508*VNCOAL+0.05562*VTP+0.30775*VFS
 +0.01171*VTC+0.03025*VTR-0.03308*VPS+0.06638*VPC-0.10474*VPR-.43144*VSC
 -1.08077*VSR-0.06389*VCR;

SECTION 3. PARITY (SCATTER) PLOTS

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PARITY PLOT FOR C1-C4, I II KENT POWH

9:48 MONDAY, JULY 16, 1979 50

PARITY PLOT FOR WATER. 1 11 NENT POWH

9:48 MONDAY, JULY 16, 1979 52

PARITY PLOT FOR HEAVY DIS(550-850) I II KEN POW

9:48 MONDAY, JULY 16, 1979 55

PARITY PLOT FOR SRC(850+) I II KENT POWH

9:48 MONDAY, JULY 16, 1979 56

98

72
64
56
48
SSRC
40
32
24
16

18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72

PSSRC

SECTION 4. SINGLE VARIABLE PLOTS

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SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF HYDROGEN CONSUMPTION VS. TEMPERATURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15147 TUESDAY, AUGUST 28, 1979

PLOT OF SHYND+TAVG LEGEND: A = 1 OBS. B = 2 OBS. ETC.

36

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF C1-C4 VS. TEMPERATURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:47 TUESDAY, AUGUST 28, 1979 ²

PLOT OF SC1C4MD*TAVG LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Kentucky

POWHERMAN

22.5

SC1C4MD

27.5

20.0

25.0

17.5

22.5

15.0

20.0

12.5

17.5

SC1C4MD

15.0

10.0

12.5

7.5

10.0

5.0

7.5

2.5

5.0

0.0

2.5

0.0

412.80

418.02

423.24

428.46

433.68

438.90

444.12

449.34

454.55

459.78

465.00

TAVG

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF NAPHTHA VS. TEMPERATURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:47 TUESDAY, AUGUST 28, 1979

3

PLOT OF SNAPMD*TAGV LEGEND: A = 1 OBS., B = 2 OBS., ETC.

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN.REG. MODEL
PLOT OF YIELD OF MIDDLE DISTILLATE VS. TEMPERATURE
FOR BASIS CONDITIONS, SEE TABLE 1

15:47 TUESDAY, AUGUST 26, 1979

PLOT OF SHOWN*TAGC LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

POWHATAN

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF HEAVY DISTILLATE VS. TEMPERATURE
 FOR BASIS CONDITIONS. SEE TABLE 1

5
 15:47 TUESDAY, AUGUST 28, 1979

PLOT OF SHDND*TAGV LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

POWMTAN

SINGLE-VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF YIELD OF SRC VS. TEMPERATURE
FOR BASIS CONDITIONS, SEE TABLE 1

15:47 TUESDAY, AUGUST 28, 1979

Kentucky

PLOT OF SSRCHD-TAVG - LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWHATAN

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF TOTAL DISTILLATE VS. TEMPERATURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:47 TUESDAY, AUGUST 26, 1979

7

Kentucky

PLOT OF SDISTND+TAVG. LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF HYDROGEN CONSUMPTION VS. PRESSURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:35 TUESDAY, AUGUST 26, 1979

PLOT OF SHYNDOPH2 LEGEND: A = 1 OBS., B = 2 OBS. ETC.

POWHA7A7

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF C1-C4 VS. PRESSURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:35 TUESDAY, AUGUST 28, 1979

2

PLOT OF SC1C4ND*PH2 LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

POWHATAN

100

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL

PLOT OF YIELD OF NAPHTHA VS. PRESSURE

15:35 TUESDAY, AUGUST 28, 1979

FOR BASIS CONDITIONS, SEE TABLE 1

Kentucky

PLOT OF SNAPNO*PH2

LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POMHATW

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN.REG. MODEL
 PLOT OF YIELD OF MIDDLE DISTILLATE VS. PRESSURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:35 TUESDAY, AUGUST 28, 1979

PLOT OF SHDND*PH2 LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

POWHA7W

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF HEAVY DISTILLATE VS. PRESSURE
 FOR BASIS CONDITIONS. SEE TABLE 1

15:35 TUESDAY, AUGUST 28, 1979

5

PLOT OF SHDND*PH2 LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWHATAN

Kentucky

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF SRC VS. PRESSURE
 FOR BASIS CONDITIONS, SEE TABLE 1

15:35 TUESDAY, AUGUST 28, 1979

6

PLOT OF SSRCHD*PM2 LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22-TERM LIN. REG. MODEL
 PLOT OF YIELD OF TOTAL DISTILLATE VS. PRESSURE
 FOR BASIS CONDITIONS. SEE TABLE 1

15:35 TUESDAY, AUGUST 28, 1979

7

PLOT OF SDISTND*PH2 LEGEND: A = 1 OBS., B = 2 OBS., ETC.

POWRATAN

Kentucky

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF HYDROGEN CONSUMPTION VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

1
 15:31 TUESDAY, AUGUST 28, 1979

PLOT OF SHYND*SRT LEGEND: A = 1 OBS. B = 2 OBS. ETC.

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF C1-C4 VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

15:31 TUESDAY, AUGUST 28, 1979

2

Kentucky

PLOT OF SC1CAND*SRT LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWHA/TW

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF NAPHTHA VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

15:31 TUESDAY, AUGUST 28, 1979

PLOT OF SNAPND+SRT LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky
 SNAPND

Penetration
 SNAPND

POWNATAN

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF HEAVY DISTILLATE VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

15:31 TUESDAY, AUGUST 28, 1979

5

Kentucky

SHDND

26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6

PLOT OF SHDND+SRT

LEGEND: A = 1 OBS, B = 2 OBS, ETC.

POWHATAN

SHDND

21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6

0.130 0.276 0.422 0.568 0.714 0.860 1.006 1.152 1.298 1.444 1.590

SRT

109

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF SRC VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

15:31 TUESDAY, AUGUST 28, 1979

PLOT OF SSRCHD*SRT LEGEND: A = 1 OBS, B = 2 OBS, ETC.

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF TOTAL DISTILLATE VS. SRT
 FOR BASIS CONDITIONS, SEE TABLE 1

15:31 TUESDAY, AUGUST 28, 1979

7

Kentucky

PLOT OF SDISTMD*SRT LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF HYDROGEN CONSUMPTION VS. COAL CONCENTRATION
FOR BASIS CONDITIONS. SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

Kentucky

PLOT OF SHYND+CIN LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POW HATAN

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL

PLOT OF YIELD OF C1-C4 VS. COAL CONCENTRATION

FOR BASIS CONDITIONS, SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

2

PLOT OF SC1C4ND+CIN LEGEND: A = 1 OBS. B = 2 OBS. ETC.

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF NAPHTHA VS. COAL CONCENTRATION
 FOR BASIS CONDITIONS, SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

3

PLOT OF SNAPND*CIH LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN.REG. MODEL
 PLOT OF YIELD OF MIDDLE DISTILLATE VS. COAL CONCENTRATION
 FOR BASIS CONDITIONS, SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

Powhatan

PLOT OF SMOHD+CIN LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Kentucky

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL

PLOT OF YIELD OF HEAVY DISTILLATE VS. COAL CONCENTRATION
FOR BASIS CONDITIONS. SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

5

PLOT OF SHDND+CIN: LEGEND: A = 1 OBS, B = 2 OBS, ETC.

116

Kentucky

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF SRC VS. COAL CONCENTRATION
 FOR BASIS CONDITIONS, SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979

6

Kentucky

PLOT OF SSRCHD*CN

LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF YIELD OF TOTAL DISTILLATE VS. COAL CONCENTRATION
FOR BASIS CONDITIONS, SEE TABLE 1

15:43 TUESDAY, AUGUST 28, 1979 7

Kentucky

PLOT OF SDISTMD*CIN LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF HYDROGEN CONSUMPTION VS. RECYCLE ASH
 FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979

KENTUCKY

PLOT OF SHYND * RASH LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWATAN

120

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF YIELD OF C1-C4 VS. RECYCLE ASH
FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979²

POWHATAN

KENTUCKY

PLOT OF SC1C4ND+RASH LEGEND: A = 1 OBS. B = 2 OBS. ETC.

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF NAPHTHA VS. RECYCLE ASH
 FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979 ³

Kentucky

PLOT OF SNAPMD+RASH LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN.REG. MODEL
 PLOT OF YIELD OF MIDDLE DISTILLATE VS. RECYCLE ASH
 FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF HEAVY DISTILLATE VS. RECYCLE ASH
 FOR BASIS CONDITIONS. SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979

5

Kentucky

PLOT OF SHOND+RASH

LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Powhatan

SHOND

SHOND

20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

0.00 1.27 2.54 3.81 5.08 6.35 7.62 8.89 10.16 11.43 12.70

RASH

123

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF SRC VS. RECYCLE ASH
 FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979⁶

Kentucky

PLOT OF SSRCOND RASH LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Powhatan

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF TOTAL DISTILLATE VS. RECYCLE ASH
 FOR BASIS CONDITIONS, SEE TABLE 1

15:11 TUESDAY, AUGUST 28, 1979

7

KENTUCKY

PLOT OF SDISTMD*RASH LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWHATAN

126

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF HYDROGEN CONSUMPTION VS. GAS VELOCITY
FOR BASIS CONDITIONS, SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

PLOT OF SHYMD V LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWMTAN

Kentucky

V

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF C1-C4 VS. GAS VELOCITY
 FOR BASIS CONDITIONS. SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

2

PLOT OF SC1C4ND*V LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Kentucky

SC1C4ND

13.850

13.825

13.800

13.775

13.750

13.725

13.700

13.675

13.650

13.625

13.600

13.575

DownHATAN

SC1C4ND

17.275

17.250

17.225

17.200

17.175

17.150

17.125

17.100

17.075

17.050

17.025

17.000

0.426800

1.102165

1.777530

2.452894

3.128259

3.803624

4.478989

5.154354

5.829718

V

105

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL

PLOT OF YIELD OF NAPHTHA VS. GAS VELOCITY
FOR BASIS CONDITIONS, SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

3

Kentucky

PLOT OF SNAPMDV LEGEND: A = 1 OBS, B = 2 OBS, ETC.

POWHATAN

PLOT OF YIELD OF MIDDLE DISTILLATE VS. GAS VELOCITY
FOR BASIS CONDITIONS. SEE TABLE 1

1

PLOT OF SNOWD*V LEGEND: A = 1 OBS, B = 2 OBS, ETC.

130

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
PLOT OF YIELD OF HEAVY DISTILLATE VS. GAS VELOCITY
FOR BASIS CONDITIONS. SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

5

POWHATAN

PLOT OF SHOND% LEGEND: A = 1 OBS. B = 2 OBS. ETC.

entucky

SHND

SHOND

0

5

7

8

9

10

11

12

13

14

0.426800

1.102165

1.777530

2.452894

3.128259

3.803624

4.478989

5.154354

5.829718

V

SINGLE VARIABLE PLOT: FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF SRC VS. GAS VELOCITY
 FOR BASIS CONDITIONS. SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

6

PLOT OF SSRCHD*V LEGEND: A = 1 OBS. B = 2 OBS. ETC.

Kentucky

SSRCHD
 32.75
 32.50
 32.25
 32.00
 31.75
 31.50
 31.25
 31.00
 30.75
 30.50
 30.25
 30.00

Powhatan

SSRCHD
 29.75
 29.50
 29.25
 29.00
 28.75
 28.50
 28.25
 28.00
 27.75
 27.50
 27.25
 27.00

0.426800 1.102165 1.777530 2.452894 3.128259 3.803624 4.478989 5.154354 5.829718

V

SINGLE VARIABLE PLOT, FULLY CONSTRAINED 22 TERM LIN. REG. MODEL
 PLOT OF YIELD OF TOTAL DISTILLATE VS. GAS VELOCITY
 FOR BASIS CONDITIONS, SEE TABLE 1

15:55 TUESDAY, AUGUST 28, 1979

Kentucky

PLOT OF SOISTMD*V LEGEND: A = 1 OBS. B = 2 OBS. ETC.

POWHATAN

SECTION 5. CONTOUR PLOTS

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CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS, SEE TABLE 1

15:15 FRIDAY, AUGUST 24, 1979

CONTOUR PLOT OF TAVG*PH2

SYMBOL	PCWHATAN	SHYMD	SYMBOL	PCWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.536913 -	2.912430	=====	4.414496 -	5.165530	XXXXXX	6.667596 -	7.418629	##### 8.920696 - 9.296212
.....	2.912430 -	3.663463	++++++	5.165530 -	5.916563	000000	7.418629 -	8.169663	
-----	3.663463 -	4.414496	000000	5.916563 -	6.667596	000000	8.169663 -	8.920696	
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.074393 -	2.449910	=====	3.951976 -	4.703010	XXXXXX	6.205076 -	6.956109	##### 8.458176 - 8.833692
.....	2.449910 -	3.200943	++++++	4.703010 -	5.454043	000000	6.956109 -	7.707143	
-----	3.200943 -	3.951976	000000	5.454043 -	6.205076	000000	7.707143 -	8.458176	

CONTOUR PLOT, FULLY CONTRAINED 22-TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

15:15 FRIDAY, AUGUST 24, 1979

2

CONTOUR PLOT OF TAVG*PM2

POWHATAN				POWHATAN				POWHATAN			
SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	-4.019570 - -2.126092	+++++	9.234776 - 13.021731	#####	24.382599 - 28.169555	.....	-4.019570 - -2.126092	.....	20.955219 - 24.742175	.....	20.955219 - 24.742175
.....	-2.126092 - 1.660864	000000	13.021731 - 16.808687	#####	28.169555 - 30.063033	.....	-2.126092 - 1.660864	.....	24.742175 - 26.635653	.....	24.742175 - 26.635653
-----	1.660864 - 5.447820	XXXXXX	16.808687 - 20.595643			-----	1.660864 - 5.447820				
=====	5.447820 - 9.234776	888888	20.595643 - 24.382599			=====	5.447820 - 9.234776				
SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	-7.446950 - -5.553472	+++++	5.807396 - 9.594351	#####	20.955219 - 24.742175	.....	-7.446950 - -5.553472	.....	20.955219 - 24.742175	.....	20.955219 - 24.742175
.....	-5.553472 - -1.766516	000000	9.594351 - 13.381307	#####	24.742175 - 26.635653	.....	-5.553472 - -1.766516	.....	24.742175 - 26.635653	.....	24.742175 - 26.635653
-----	-1.766516 - 2.020440	XXXXXX	13.381307 - 17.168263			-----	-1.766516 - 2.020440				
=====	2.020440 - 5.807396	888888	17.168263 - 20.595643			=====	2.020440 - 5.807396				

CONTOUR PLOT OF TAVG*PH2

SYMBOL	POWHATAN	SNAPMD	SYMBOL	POWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	-3.357132	-2.424855	++++++	3.168801	5.033353	000000	10.627010 - 12.491562
.....	-2.424855	-0.560303	000000	5.033353	6.897906	000000	12.491562 - 13.423838
-----	-0.560303	1.304249	XXXXXX	6.897906	8.762458		
=====	1.304249	3.168801	000000	8.762458	10.627010		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-3.856952	-2.924675	++++++	2.668981	4.533533	000000	10.127190 - 11.991742
.....	-2.924675	-1.060123	000000	4.533533	6.398086	000000	11.991742 - 12.924018
-----	-1.060123	0.804429	XXXXXX	6.398086	8.262638		
=====	0.804429	2.668981	000000	8.262638	10.127190		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF M100LE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*PH2

SYMBOL	POWHATAN	SNDND	SYMBOL	POWHATAN	SNDND	SYMBOL	SNDND
.....	-28.435042 -	-24.722541	+++++	-2.447541 -	4.977459	#####	27.252460 - 34.677460
.....	-24.722541 -	-17.297541	000000	4.977459 -	12.402459	#####	34.677460 - 38.389960
-----	-17.297541 -	-9.872541	XXXXXX	12.402459 -	19.827460		
#####	-9.872541 -	-2.447541	#####	19.827460 -	27.252460		
SYMBOL	KENTUCKY	SNDND	SYMBOL	KENTUCKY	SNDND	SYMBOL	SNDND
.....	-35.587062 -	-31.874561	+++++	-9.599561 -	-2.174561	#####	20.100440 - 27.525440
.....	-31.874561 -	-24.449561	000000	-2.174561 -	5.250439	#####	27.525440 - 31.237940
-----	-24.449561 -	-17.024561	XXXXXX	5.250439 -	12.675440		
#####	-17.024561 -	-9.599561	#####	12.675440 -	20.100440		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*PH2

PH2

SYMBOL	POWHATAN	SHDMD	SYMBOL	POWHATAN	SHDMD	SYMBOL	SHDMD
.....	-10.650163 -	-8.266184	+++++	6.037695 -	10.805654	000000	25.109532 - 29.877492
.....	-8.266184 -	-3.498224	000000	10.805654 -	15.573614	000000	29.877492 - 32.261472
-----	-3.498224 -	1.269735	XXXXXX	15.573614 -	20.341573		
=====	1.269735 -	6.037695	000000	20.341573 -	25.109532		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	-5.788323 -	-3.404344	+++++	10.899535 -	15.667494	000000	29.971372 - 34.739332
.....	-3.404344 -	1.363616	000000	15.667494 -	20.435454	000000	34.739332 - 37.123312
-----	1.363616 -	6.131575	XXXXXX	20.435454 -	25.203413		
=====	6.131575 -	10.899535	000000	25.203413 -	29.971372		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*PM2

PM2				PM2			
SYMBOL	POW HATAN	SSRCMD	SYMBOL	POW HATAN	SSRCMD	SYMBOL	SSRCMD
.....	6.961402 -	10.689473	+++++	33.057896 -	40.514037	#####	62.882460 - 70.338601
.....	10.689473 -	18.145614	CC0000	40.514037 -	47.970178	#####	70.338601 - 74.066672
-----	18.145614 -	25.601755	XXXXXX	47.970178 -	55.426319		
=====	25.601755 -	33.057896	GGGGGG	55.426319 -	62.882460		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD
.....	9.656562 -	13.384633	+++++	35.753056 -	43.209197	#####	65.577620 - 73.033761
.....	13.384633 -	20.840774	000000	43.209197 -	50.665338	#####	73.033761 - 76.761832
-----	20.840774 -	28.296915	XXXXXX	50.665338 -	58.121479		
=====	28.296915 -	35.753056	GGGGGG	58.121479 -	65.577620		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1.

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CONTOUR PLOT OF TAVG*PH2

SYMBOL	POWHATAN	SDISTMD	SYMBOL	POWHATAN	SDISTMD	SYMBOL	SDISTMD
.....	1.855102 -	4.010142	+++++	16.940379 -	21.250459	000000	34.180696 - 38.490776
.....	4.010142 -	9.320221	000000	21.250459 -	25.560538	000000	38.490776 - 40.645815
-----	8.320221 -	12.630300	XXXXXX	25.560538 -	29.870617		
=====	12.630300 -	16.940379	000000	29.870617 -	34.180696		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD
.....	-0.435058 -	1.719982	+++++	14.650219 -	18.960299	000000	31.890536 - 36.200616
.....	1.719982 -	6.030061	000000	18.960299 -	23.270378	000000	36.200616 - 38.355655
-----	6.030061 -	10.340140	XXXXXX	23.270378 -	27.580457		
=====	10.340140 -	14.650219	000000	27.580457 -	31.890536		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*SRT

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	2.150436 -	2.461799	=====	3.707251 -	4.329977	XXXXXX	5.575428 -	6.198154	#####	7.443606 -	7.754969
.....	2.461799 -	3.084525	+++++	4.329977 -	4.952702	BBBBBB	6.198154 -	6.820880			
-----	3.084525 -	3.707251	000000	4.952702 -	5.575428	#####	6.820880 -	7.443606			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	1.687916 -	1.999279	=====	3.244731 -	3.867457	XXXXXX	5.112908 -	5.735634	#####	6.981086 -	7.292449
.....	1.999279 -	2.622005	+++++	3.867457 -	4.490182	BBBBBB	5.735634 -	6.358360			
-----	2.622005 -	3.244731	000000	4.490182 -	5.112908	#####	6.358360 -	6.981086			

CONTOUR PLOT, FULLY CONTAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG+SRT

SYMBOL	POWHATAN	SC1C4ND
.....	-4.379731	-2.162115
.....	-2.162115	2.273117
-----	2.273117	6.708350
=====	6.708350	11.143582
SYMBOL	KENTUCKY	SC1C4ND
.....	-7.807111	-5.589495
.....	-5.589495	-1.154263
-----	-1.154263	3.280970
=====	3.280970	7.716202

SYMBOL	POWHATAN	SC1C4ND
+++++	11.143582	15.578814
00000	15.578814	20.014046
xxxxxx	20.014046	24.449278
00000	24.449278	28.884511
SYMBOL	KENTUCKY	SC1C4ND
+++++	7.716202	12.151434
00000	12.151434	16.586666
xxxxxx	16.586666	21.021898
00000	21.021898	25.457131

SYMBOL	SC1C4ND
00000	28.884511 - 33.319743
00000	33.319743 - 35.537369
SYMBOL	SC1C4ND
00000	25.457131 - 29.892363
00000	29.892363 - 32.109979

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*SRT

SYMBOL	POUGHATAN	SNAPMD	SYMBOL	POUGHATAN	SNAPMD	SYMBOL	SNAPMD
.....	-8.828011	-7.620244	+++++	-0.373645	2.041888	#####	9.288487 - 11.704020
.....	-7.620244	-5.204711	000000	2.041888	4.457421	#####	11.704020 - 12.911787
-----	-5.204711	-2.789178	XXXXXX	4.457421	6.872954		
=====	-2.789178	-0.373645	888888	6.872954	9.288487		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-9.327831	-8.120064	+++++	-0.873465	1.542068	#####	8.788667 - 11.204200
.....	-8.120064	-5.704531	000000	1.542068	3.957601	#####	11.204200 - 12.411967
-----	-5.704531	-3.288998	XXXXXX	3.957601	6.373134		
=====	-3.288998	-0.873465	888888	6.373134	8.729557		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*SRT

SYMBOL	POW HATAN	SMDMD	SYMBOL	POW HATAN	SMDMD	SYMBOL	SMDMD
.....	-20.492355	-17.189291	+++++	2.629090	9.235217	#####	29.053598 - 35.659725
.....	-17.189291	-10.583164	000000	9.235217	15.841344	#####	35.659725 - 38.962788
-----	-10.583164	-3.977037	XXXXXX	15.841344	22.447471		
=====	-3.977037	2.629090	888888	22.447471	29.053598		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	-27.644375	-24.341311	+++++	-4.522930	2.083197	#####	21.901578 - 28.507705
.....	-24.341311	-17.735184	000000	2.083197	8.689324	#####	28.507705 - 31.810768
-----	-17.735184	-11.129057	XXXXXX	8.689324	15.295451		
=====	-11.129057	-4.522930	888888	15.295451	21.901578		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*SRT

SYMBOL	POWHATAN	SHDMD	SYMBOL	POWHATAN	SHDMD	SYMBOL	SHDMD
.....	-0.424736 -	1.958463	+++++	16.257479 -	21.023817	#####	35.322832 - 40.089171
.....	1.958453 -	6.724802	000000	21.023817 -	25.790156	#####	40.089171 - 42.472340
-----	6.724802 -	11.491140	XXXXXX	25.790156 -	30.556494		
=====	11.491140 -	16.257479	#####	30.556494 -	35.322832		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	4.437134 -	6.820303	+++++	21.119319 -	25.885657	#####	40.184672 - 44.951011
.....	6.820303 -	11.586642	000000	25.885657 -	30.651996	#####	44.951011 - 47.334180
-----	11.586642 -	16.352980	XXXXXX	30.651996 -	35.418334		
=====	16.352980 -	21.119319	#####	35.418334 -	40.184		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF S R C
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*SRT

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD
.....	6.942026	- 11.174636	+++++	36.570286	- 45.035502	.....	70.431151 - 78.896368
.....	11.174636	- 19.639853	000000	45.035502	- 53.500718	.....	78.896368 - 83.128976
-----	19.639853	- 28.105069	XXXXXX	53.500718	- 61.965935		
=====	28.105069	- 36.570286	000000	61.965935	- 70.431151	SYMBOL	SSRCMD
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD		
.....	9.637188	- 13.869796	+++++	39.265446	- 47.730662	.....	73.126311 - 81.591528
.....	13.869796	- 22.335013	000000	47.730662	- 56.195878	.....	81.591528 - 85.824136
-----	22.335013	- 30.800229	XXXXXX	56.195878	- 64.661095		
=====	30.800229	- 39.265446	000000	64.661095	- 73.126311		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG+SRT

SYMBOL	PCWHATAN	SDISTMD	SYMBOL	PCWHATAN	SDISTMD	SYMBOL	SDISTMD
.....	5.345052 -	7.189105	+++++	18.253428 -	21.941536	#####	33.005859 - 36.693967
.....	7.189105 -	10.877213	000000	21.941536 -	25.629644	#####	36.693967 - 38.538020
-----	10.877213 -	14.565321	XXXXXX	25.629644 -	29.317751		
=====	14.565321 -	18.253428	#####	29.317751 -	33.005859		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD
.....	3.054892 -	4.898945	+++++	15.963268 -	19.651376	#####	30.715699 - 34.403807
.....	4.898945 -	8.587053	000000	19.651376 -	23.339484	#####	34.403807 - 36.247860
-----	8.587053 -	12.275161	XXXXXX	23.339484 -	27.027591		
=====	12.275161 -	15.963268	#####	27.027591 -	30.715699		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINIAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN:
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*CIN

CIN

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	1.706139	2.020748	=====	3.279183	3.908400	XXXXXX	5.166835 - 5.796052	=====	7.054487 - 7.369096
.....	2.020748	2.649965	++++++	3.908400	4.537617	000000	5.796052 - 6.425270		
-----	2.649965	3.279183	000000	4.537617	5.166835	000000	6.425270 - 7.054487		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	1.243619	1.958228	=====	2.816663	3.445880	XXXXXX	4.704315 - 5.333532	=====	6.591967 - 6.906576
.....	1.958228	2.187445	++++++	3.445880	4.075097	000000	5.333532 - 5.962750		
-----	2.187445	2.816663	000000	4.075097	4.704315	000000	5.962750 - 6.591967		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG+CIN

SYMBOL	POWHATAN	SC1C4ND	SYMBOL	POWHATAN	SC1C4ND	SYMBOL	SC1C4ND
.....	4.095969 -	5.569581	+++++	14.411259 -	17.358485	#####	26.200162 - 29.147388
.....	5.569581 -	8.516807	000000	17.358485 -	20.305710	#####	29.147388 - 30.621001
-----	8.516807 -	11.464033	XXXXXX	20.305710 -	23.252936		
=====	11.464033 -	14.411259	888888	23.252936 -	26.200162		
SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	SC1C4ND
.....	0.6685836 -	2.1422015	+++++	10.9838789 -	13.9311047	#####	22.7727820 - 25.7200078
.....	2.1422015 -	5.0894273	000000	13.9311047 -	16.8783305	#####	25.7200078 - 27.1936297
-----	5.0894273 -	8.0365531	XXXXXX	16.8783305 -	19.8255563		
=====	8.0365531 -	10.9838789	888888	19.8255563 -	22.7727820		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*CIN

SYMBOL	PCW HATAN	SNAPMD	SYMBOL	PCW HATAN	SNAPMD	SYMBOL	SNAPMD
.....	-4.5110273	-3.4953189	+++++	2.5989318	4.6303487	#####	10.7245993 - 12.7560162
.....	-3.4953189	-1.4639020	000000	4.6303487	6.6617656	#####	12.7560162 - 13.7717247
-----	-1.4639020	0.5675149	xxxxxx	6.6617656	8.6931825		
=====	0.5675149	2.5989318	#####	8.6931825	10.7245993		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-5.01084732	-3.99513887	+++++	2.09911179	4.13052868	#####	10.22477935 - 12.25619623
.....	-3.99513887	-1.96372158	000000	4.13052868	6.16194557	#####	12.25619623 - 13.27190468
-----	-1.96372198	0.06769491	xxxxxx	6.16194557	8.19336246		
=====	0.06769491	2.09911179	#####	8.19336246	10.22477935		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1.

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CONTOUR PLOT OF TAVG+CIN

SYMBOL	POWHATAN	SMDMD	SYMBOL	POWHATAN	SMDMD	SYMBOL	SMDMD
.....	-17.821828 -	-14.892390	+++++	2.684241 -	8.543118	#####	26.119748 - 31.978625
.....	-14.892390 -	-9.033513	000000	8.543118 -	14.401995	#####	31.978625 - 34.908064
-----	-9.033513 -	-3.174636	XXXXXX	14.401995 -	20.260871		
=====	-3.174636 -	2.684241	888888	20.260871 -	26.119748		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	-24.973848 -	-22.044410	+++++	-4.467779 -	1.391098	#####	18.967728 - 24.826605
.....	-22.044410 -	-16.185533	000000	1.391098 -	7.249975	#####	24.826605 - 27.756044
-----	-16.185533 -	-10.326656	XXXXXX	7.249975 -	13.108851		
=====	-10.326656 -	-4.467779	888888	13.108851 -	18.967728		

CONTOUR PLOT OF TAVG*CIN

SYMBOL	PCWHATAN	SHDMD	SYMBOL	PCWHATAN	SHDMD	SYMBOL	SHDMD
.....	-11.819560 -	-9.073633	+++++	7.401930 -	12.893784	■■■■■■■	29.369347 - 34.861201
.....	-9.073633 -	-3.581779	000000	12.893784 -	18.385638	■■■■■■■	34.861201 - 37.607128
-----	-3.581779 -	1.910075	xxxxxx	18.385638 -	23.877493		
=====	1.910075 -	7.401930	000000	23.877493 -	29.369347		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	-6.957720 -	-4.211793	+++++	12.263770 -	17.755624	■■■■■■■	34.231187 - 39.723041
.....	-4.211793 -	1.280061	000000	17.755624 -	23.247478	■■■■■■■	39.723041 - 42.468968
-----	1.280061 -	6.771915	xxxxxx	23.247478 -	28.739333		
=====	6.771915 -	12.263770	000000	28.739333 -	34.231187		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG* $\bar{CIN}$

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD
.....	8.739324	- 12.811918	+++++	37.247483	- 45.392671	#####	69.828236 - 77.973424
.....	12.811918	- 20.957106	000000	45.392671	- 53.537860	#####	77.973424 - 82.046019
-----	20.957106	- 29.102295	XXXXXX	53.537860	- 61.683048		
=====	29.102295	- 37.247483	888888	61.683048	- 69.828236		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD
.....	11.43448	- 15.50708	=====	31.79745	- 39.94264	XXXXXX	56.23302 - 64.37821
.....	15.50708	- 23.65227	+++++	39.94264	- 48.08783	888888	64.37821 - 72.52340
-----	23.65227	- 31.79745	000000	48.08783	- 56.23302	#####	72.52340 - 80.65858
							##### 80.66858 - 84.74118

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG+CIN

SYMBOL	POW HATAN	SDISTMD	SYMBOL	POW HATAN	SDISTMD	SYMBOL	SDISTMD
.....	-13.9137585 -	-10.9831895	+++++	6.6002242 -	12.4613621	.....	30.0447758 - 35.9059137
.....	-10.9831895 -	-5.1220516	000000	12.4613621 -	18.3225000	.....	35.9059137 - 38.8364827
-----	-5.1220516 -	0.7390863	XXXXXX	18.3225000 -	24.1836379		
=====	0.7390863 -	6.6002242	888888	24.1836379 -	30.0447758		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD
.....	-16.203918 -	-13.273350	+++++	4.310064 -	10.171202	.....	27.754616 - 33.615754
.....	-13.273350 -	-7.412212	00COCO	10.171202 -	16.032340	.....	33.615754 - 36.546323
-----	-7.412212 -	-1.551074	XXXXXX	16.032340 -	21.893478		
=====	-1.551074 -	4.310064	888888	21.893478 -	27.754616		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG*RASH

SYMBOL	PCWHATAN	SHYND	SYMBOL	PCWHATAN	SHYND	SYMBOL	SHYND	SYMBOL	SHYND
.....	2.811055 - 3.006473		=====	3.788149 - 4.178987		XXXXXX	4.960663 - 5.351501	=====	6.133177 - 6.328595
.....	3.006473 - 3.397311		+++++	4.176987 - 4.569825		oooooo	5.351501 - 5.742339		
-----	3.397311 - 3.788149		000000	4.569825 - 4.960663		000000	5.742339 - 6.133177		
SYMBOL	KENTUCKY	SHYND	SYMBOL	KENTUCKY	SHYND	SYMBOL	SHYND	SYMBOL	SHYND
.....	2.348535 - 2.543963		=====	3.325629 - 3.716467		XXXXXX	4.498143 - 4.888981	=====	5.670657 - 5.866075
.....	2.543963 - 2.934791		+++++	3.716467 - 4.107305		oooooo	4.888981 - 5.279819		
-----	2.934791 - 3.325629		000000	4.107305 - 4.498143		000000	5.279819 - 5.670657		

CONTOUR PLOT. FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG+RASH

SYMBOL	POWHATAN	SC1C4ND	SYMBOL	POWHATAN	SC1C4ND	SYMBOL	SC1C4ND
.....	3.151328	- 4.429618	+++++	12.099362	- 14.655943	.....	22.325686 - 24.882268
.....	4.429618	- 6.986199	000000	14.655943	- 17.212524	.....	24.882268 - 26.160558
-----	6.986199	- 9.542781	XXXXXX	17.212524	- 19.769105		
-----	9.542781	- 12.099362	000000	19.769105	- 22.325686		
SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	SC1C4ND
.....	-0.276052	- 1.002238	+++++	8.671982	- 11.228563	.....	18.898306 - 21.454888
.....	1.002238	- 3.558819	000000	11.228563	- 13.785144	.....	21.454888 - 22.733178
-----	3.558819	- 6.115401	XXXXXX	13.785144	- 16.341725		
-----	6.115401	- 8.671982	000000	16.341725	- 18.898306		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG+RASH

SYMBOL	POWHATAN	SNAPMD	SYMBOL	POWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	5.217620 -	5.638356	+++++	8.162772 -	9.004244	#####	11.528660 - 12.370132
.....	5.638356 -	6.479828	000000	9.004244 -	9.845716	#####	12.370132 - 12.790868
-----	6.479828 -	7.321300	xxxxxx	9.845716 -	10.687188		
=====	7.321300 -	8.162772	#####	10.687188 -	11.528660		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	4.717800 -	5.138536	+++++	7.662952 -	8.504424	#####	11.028840 - 11.870312
.....	5.138536 -	5.980008	000000	8.504424 -	9.345896	#####	11.870312 - 12.291048
-----	5.980008 -	6.821480	xxxxxx	9.345896 -	10.187368		
=====	6.821480 -	7.662952	#####	10.187368 -	11.028840		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG+RASH

SYMBOL	POW HATAN	SMDMD	SYMBOL	POW HATAN	SMDMD	SYMBOL	SMDMD
.....	-21.8049472	-18.7019908	++++++	-0.0842527	6.1216601	000000	24.7393982
.....	-18.7019908	-12.4960781	000000	6.1216601	12.3275728	000000	30.9453109
-----	-12.4960781	-6.2901654	XXXXXX	12.3275728	18.5334855		34.0482673
=====	-6.2901654	-0.0842527	000000	18.5334855	24.7393982		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	-28.956967	-25.854011	++++++	-7.236273	-1.030360	000000	17.587378
.....	-25.854011	-19.648098	000000	-1.030360	5.175553	000000	23.793291
-----	-19.648098	-13.442185	XXXXXX	5.175553	11.381465		26.865247
=====	-13.442185	-7.236273	000000	11.381465	17.587378		

NOTE:

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG-RASH

SYMBOL	POW-HATAN	SHDND	SYMBOL	POW-HATAN	SHDND	SYMBOL	SHDND
.....	-11.0404827 -	-8.8470925	+++++	4.3132488 -	8.7000292	#####	21.8603705 - 26.2471510
.....	-8.8470925 -	-4.4603121	000000	8.7000292 -	13.0868097	#####	26.2471510 - 28.4405412
-----	-4.4603121 -	-0.0735316	XXXXXX	13.0868097 -	17.4735901		
=====	-0.0735316 -	4.3132488	000000	17.4735901 -	21.8603705		
SYMBOL	KENTUCKY	SHDND	SYMBOL	KENTUCKY	SHDND	SYMBOL	SHDND
.....	-6.1786427 -	-3.9852525	+++++	9.1750888 -	13.5618692	#####	26.7222105 - 31.1089910
.....	-3.9852525 -	0.4015279	000000	13.5618692 -	17.9486497	#####	31.1089910 - 33.3023812
-----	0.4015279 -	4.7883084	XXXXXX	17.9486497 -	22.3354301		
=====	4.7883084 -	9.1750888	000000	22.3354301 -	26.7222105		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SR 2
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG-RASH

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	16.94553	- 20.02000	=====	32.31787	- 38.46681	XXXXXX	50.76468 - 56.91362	#####	69.21149 - 72.28596
.....	20.02000	- 26.16894	++++++	38.46681	- 44.61574	#####	56.91362 - 63.06255		
-----	26.16894	- 32.31787	000000	44.61574	- 50.76468	#####	63.06255 - 69.21149		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	19.64069	- 22.71516	=====	35.01303	- 41.16197	XXXXXX	53.45984 - 59.60878	#####	71.90665 - 74.98112
.....	22.71516	- 28.86410	++++++	41.16197	- 47.31090	#####	59.60878 - 65.75771		
-----	28.86410	- 35.01303	000000	47.31090	- 53.45984	#####	65.75771 - 71.90665		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR EASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF TAVG+RASH

SYMBOL	PEW HATAN	SDISTMD	SYMBOL	PEW HATAN	SDISTMD	SYMBOL	SDISTMD
.....	6.636594	- 8.174290	+++++	17.400463	- 20.475854	#####	29.702027 - 32.777418
.....	8.174290	- 11.249681	000000	20.475854	- 23.551245	#####	32.777418 - 34.315113
-----	11.249681	- 14.325072	XXXXXX	23.551245	- 26.626636		
=====	14.325072	- 17.400463	#####	26.626636	- 29.702027		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD
.....	4.346434	- 5.984130	+++++	15.110303	- 18.185694	#####	27.411867 - 30.487258
.....	5.984130	- 9.959521	000000	18.185694	- 21.261085	#####	30.487258 - 32.024953
-----	8.959521	- 12.034912	XXXXXX	21.261085	- 24.336476		
=====	12.034912	- 15.110303	#####	24.336476	- 27.411867		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*V

SYMBOL	POWHDATAN	SHYMD	SYMBOL	POWHDATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.558964	- 2.773901	=====	3.633649	- 4.063523	XXXXXX	4.923271 - 5.353145	#####	6.212893 - 6.427830
.....	2.773901	- 3.203775	+++++	4.063523	- 4.493357	#####	5.353145 - 5.783019		
-----	3.203775	- 3.633649	000000	4.493397	- 4.923271	#####	5.783019 - 6.212893		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.096444	- 2.311381	=====	3.171129	- 3.601003	XXXXXX	4.460751 - 4.890625	#####	5.750373 - 5.965310
.....	2.311381	- 2.741255	+++++	3.601003	- 4.030877	#####	4.890625 - 5.320499		
-----	2.741255	- 3.171129	000000	4.030877	- 4.460751	#####	5.320499 - 5.750373		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1 C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLCT. OF TAVG*V

SYMBOL	POWRATAN	SC1C4MD	SYMBOL	POWRATAN	SC1C4MD	SYMBOL	SC1C4MD
.....	4.075248 -	5.277072	+++++	12.488018 -	14.891667	#####	22.102613 - 24.506261
.....	5.277072 -	7.680721	000000	14.891667 -	17.295315	#####	24.506261 - 25.708085
-----	7.680721 -	10.084370	XXXXXX	17.295315 -	19.698964		
=====	10.084370 -	12.488018	#####	19.698964 -	22.102613		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD
.....	0.6478682 -	1.8496924	+++++	9.0606382 -	11.4642668	#####	18.6752326 - 21.0788812
.....	1.8496924 -	4.2533410	000000	11.4642668 -	13.8679354	#####	21.0788812 - 22.2807054
-----	4.2533410 -	6.6569896	XXXXXX	13.8679354 -	16.2715840		
=====	6.6569896 -	9.0606382	#####	16.2715840 -	18.6752326		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*V

SYMBOL	POWHATAN	SMDMD	SYMBOL	POWHATAN	SMDMD	SYMBOL	SMDMD
.....	-14.835383 -	-12.015674	+++++	4.926608 -	10.574035	#####	27.516317 - 33.163745
.....	-12.015674 -	-6.368247	000000	10.574035 -	16.221463	#####	33.163745 - 35.987458
-----	-6.368247 -	-0.720819	XXXXXX	16.221463 -	21.868890		
=====	-0.720819 -	4.926608	000000	21.868890 -	27.516317		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	-21.991408 -	-19.167694	+++++	-2.225412 -	3.422015	#####	20.364297 - 26.011725
.....	-19.167694 -	-13.520267	000000	3.422015 -	9.069443	#####	26.011725 - 28.835438
-----	-13.520267 -	-7.972819	XXXXXX	9.069443 -	14.716870		
=====	-7.972819 -	-2.225412	000000	14.716870 -	20.364297		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*V

SYMBOL	POWATAN	SHDMD	SYMBOL	POWATAN	SHDMD	SYMBOL	SHDMD
.....	-0.6400105 -	0.8382945	+++++	9.7081248 -	12.6647349	000000	21.5345652 - 24.4911753
.....	0.8382945 -	3.7949046	000000	12.6647349 -	15.6213450	000000	24.4911753 - 25.9694804
-----	3.7949046 -	6.7515147	XXXXXX	15.6213450 -	18.5779551		
=====	6.7515147 -	9.7081248	000000	18.5779551 -	21.5345652		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	4.221829 -	5.700135	+++++	14.569965 -	17.526575	000000	26.396405 - 29.353015
.....	5.700135 -	8.656745	000000	17.526575 -	20.483185	000000	29.353015 - 30.831320
-----	8.656745 -	11.613355	XXXXXX	20.483185 -	23.439795		
=====	11.613355 -	14.569965	000000	23.439795 -	26.396405		

NOTE :

CONTOUR PLOT, FULLY-CONSTRAINED 22-TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF S R C
 FCA BASIS CONDITIONS, SEE TABLE I

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CONTOUR PLOT OF TAVG*V

SYMBOL	PCWHATAN	SSRCMD	SYMBOL	PCWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	16.60739 -	19.20992	=====	29.62126 -	34.82693	XXXXXX	45.23826 - 50.44393	#####	60.85527 - 63.45810
.....	19.20992 -	24.41555	+++++	34.82693 -	40.03259	#####	50.44393 - 55.54960		
-----	24.41555 -	29.62126	000000	40.03259 -	45.23826	#####	55.54960 - 60.85527		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	19.30225 -	21.90508	=====	32.31642 -	37.52209	XXXXXX	47.93342 - 53.13909	#####	63.55043 - 66.15326
.....	21.90508 -	27.11075	+++++	37.52209 -	42.72775	#####	53.13909 - 58.34476		
-----	27.11075 -	32.31642	000000	42.72775 -	47.93342	#####	58.34476 - 63.55043		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF TAVG*V

SYMBOL	POWHATAN	SDISTMD	SYMBOL	POWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	10.61763 -	11.99150	=====	17.48695 -	20.23474	XXXXXX	25.73023 -	28.47797	##### 33.97347 - 35.34734
.....	11.99150 -	14.73925	++++++	20.23474 -	22.98248	#####	28.47797 -	31.22572	
-----	14.73925 -	17.48699	000000	22.98248 -	25.73023	#####	31.22572 -	33.97347	
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	8.327466 -	9.701339	++++++	17.944577 -	20.692323	#####	28.935561 -	31.683307	
.....	9.701339 -	12.449085	000000	20.692323 -	23.440069	#####	31.683307 -	33.057180	
-----	12.449085 -	15.196831	XXXXXX	23.440069 -	26.187815				
=====	15.196831 -	17.944577	#####	26.187815 -	28.935561				

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*SRT

POWHATAN		POWHATAN		POWHATAN		POWHATAN	
SYMBOL	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	3.298858 - 3.685066	+++++	6.002314 - 6.774730	.....	9.091979 - 9.864395		
.....	3.685066 - 4.457482	000000	6.774730 - 7.547147	.....	9.864395 - 10.250603		
-----	4.457482 - 5.225898	XXXXXX	7.547147 - 8.319563				
=====	5.225898 - 6.002314	888888	8.319563 - 9.091979				
KENTUCKY		KENTUCKY		KENTUCKY		KENTUCKY	
SYMBOL	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.836338 - 3.222546	=====	4.767378 - 5.539794	XXXXXX	7.084627 - 7.851043	.....	9.401875 - 9.788083
.....	3.222546 - 3.994962	+++++	5.539794 - 6.312210	888888	7.851043 - 8.629459		
-----	3.994962 - 4.767378	000000	6.312210 - 7.084627	888888	8.629459 - 9.401875		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2+SHT

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SYMBOL	POWHATAN	SC1C4ND	SYMBOL	POWHATAN	SC1C4ND	SYMBOL	SC1C4ND	SYMBOL	SC1C4ND		
.....	10.96814 -	11.98569	=====	16.05589 -	18.09099	XXXXXX	22.16119 -	24.19629	#####	28.26649 -	29.28404
.....	11.98569 -	14.02079	+++++	18.09099 -	20.12609	000000	24.19629 -	26.23139			
-----	14.02079 -	16.05589	000000	20.12609 -	22.16119	000000	26.23139 -	28.26649			
	SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	KENTUCKY	SC1C4ND	SYMBOL	SC1C4ND	SYMBOL	SC1C4ND	
	.....	7.540758 -	8.558309	+++++	14.663610 -	16.698710	000000	22.804011 -	24.839112		
	.....	8.558309 -	10.593409	000000	16.698710 -	18.733811	000000	24.839112 -	25.856662		
	-----	10.593409 -	12.628509	XXXXXX	18.733811 -	20.768911					
	=====	12.628509 -	14.663610	000000	20.768911 -	22.804011					

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2*SRT

SYMBOL	PELOHATAN	SNAPMD	SYMBOL	PELOHATAN	SNAPMD	SYMBOL	SNAPMD
.....	-5.620299	-4.535318	+++++	1.974571	4.144534	#####	10.654423 - 12.824385
.....	-4.535318	-2.365355	000000	4.144534	6.314497	#####	12.824385 - 13.909367
-----	-2.365355	-0.195392	XXXXXX	6.314497	8.484460		
=====	-0.195392	1.974571	888888	8.484460	10.654423		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-6.120119	-5.035138	+++++	1.474751	3.644714	#####	10.154603 - 12.324565
.....	-5.035138	-2.865175	000000	3.644714	5.814677	#####	12.324565 - 13.409547
-----	-2.865175	-0.695212	XXXXXX	5.814677	7.984640		
=====	-0.695212	1.474751	888888	7.984640	10.154603		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*SRT

SYMBOL	PCWHATAN	SMDMD
.....	4.600698 -	6.562872
.....	6.562872 -	10.487218
-----	10.487218 -	14.411565
=====	14.411565 -	18.335912
SYMBOL	KENTUCKY	SMDMD
.....	-2.551322 -	-0.589148
.....	-0.589148 -	3.335198
-----	3.335198 -	7.255545
=====	7.255545 -	11.183892

SYMBOL	PCWHATAN	SMDMD
++++++	18.335912 -	22.260259
000000	22.260259 -	26.184605
XXXXXX	26.184605 -	30.108952
000000	30.108952 -	34.033299
SYMBOL	KENTUCKY	SMDMD
++++++	11.183892 -	15.108239
000000	15.108239 -	19.032585
XXXXXX	19.032585 -	22.956932
000000	22.956932 -	26.881279

SYMBOL	SMDMD
000000	34.033299 - 37.957646
000000	37.957646 - 39.919819
SYMBOL	SMDMD
000000	26.881279 - 30.805626
000000	30.805626 - 32.767799

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2*SRT

SYMBOL	PCWHATAN	SHDMD	SYMBOL	PCWHATAN	SHDMD	SYMBOL	SHDMD
.....	-7.284473	-5.128031	+++++	7.810618	12.123501	#####	25.062151 - 29.375034
.....	-5.128031	-0.815148	000000	12.123501	16.436384	#####	29.375034 - 31.531475
-----	-0.815148	3.497735	XXXXXX	16.436384	20.749268		
=====	3.497735	7.810618	000000	20.749268	25.062151		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	-2.422533	-0.266191	+++++	12.672458	16.985341	#####	29.923991 - 34.236874
.....	-0.266191	4.046692	000000	16.985341	21.298224	#####	34.236874 - 36.393315
-----	4.046692	8.359575	XXXXXX	21.298224	25.611108		
=====	8.359575	12.672458	000000	25.611108	29.923991		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS. SEE TABLE 1

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SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	12.41439	- 13.96800	=====	20.18241	- 23.28962	XXXXXX	29.50403 - 32.61124	#####	38.82565 - 40.37926
.....	13.96800	- 17.07520	+++++	23.28962	- 26.39683	000000	32.61124 - 35.71845		
-----	17.07520	- 20.18241	000000	26.39683	- 29.50403	000000	35.71845 - 38.82565		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	15.10955	- 16.66316	=====	22.87757	- 25.98478	XXXXXX	32.19919 - 35.30640	#####	41.52081 - 43.07442
.....	16.66316	- 19.77036	+++++	25.98478	- 29.09199	000000	35.30640 - 38.41361		
-----	19.77036	- 22.87757	000000	29.09199	- 32.19919	000000	38.41361 - 41.52081		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2+SRT

SYMBOL	POWHATAN	SDISTMD	SYMBOL	POWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	29.37702 -	29.88632	=====	31.93203 -	32.95403	xxxxxx	34.99804 -	36.02004	=====	38.06405 -	38.57505
.....	29.88802 -	30.91002	++++++	32.95403 -	33.97603	888888	36.02004 -	37.04205			
-----	30.91002 -	31.93203	000000	33.97603 -	34.99804	888888	37.04205 -	38.06405			
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	27.08685 -	27.59785	=====	29.64187 -	30.66387	xxxxxx	32.70788 -	33.72988	=====	35.77389 -	36.28489
.....	27.59785 -	28.61985	++++++	30.66387 -	31.68587	888888	33.72988 -	34.75189			
-----	28.61985 -	29.64187	000000	31.68587 -	32.70788	888888	34.75189 -	35.77389			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*CIN

SYMBOL	POULIATAN	SHYMD	SYMBOL	POULIATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	1.406293	- 1.834833	=====	3.548996	- 4.406078	XXXXXX	6.120240 - 6.977322	#####	8.691485 - 9.120025
.....	1.834833	- 2.691915	+++++	4.406078	- 5.263159	#####	6.977322 - 7.834403		
-----	2.691915	- 3.548996	000000	5.263159	- 6.120240	#####	7.834403 - 8.691485		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD		
.....	0.9437726	- 1.3723133	+++++	3.9435576	- 4.8006390	#####	7.3718832 - 8.2289646		
.....	1.3723133	- 2.2293948	000000	4.8006390	- 5.6577204	#####	8.2289646 - 8.6575053		
-----	2.2293948	- 3.0864762	XXXXXX	5.6577204	- 6.5148018				
=====	3.0864762	- 3.9435576	#####	6.5148018	- 7.3718832				

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*CIN

CIN

SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	12.12082 -	12.96225	=====	16.32794 -	18.01079	XXXXXX	21.37649 - 23.05934	000000	26.42504 - 27.26646
.....	12.96225 -	14.64509	++++++	18.01079 -	19.69364	000000	23.05934 - 24.74219		
-----	14.64509 -	16.32794	000000	19.69364 -	21.37649	000000	24.74219 - 25.42504		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	8.693441 -	9.54865	++++++	14.583412 -	16.266261	000000	21.314808 - 22.997657		
.....	9.534865 -	11.211714	000000	16.266261 -	17.949110	000000	22.997657 - 23.839082		
-----	11.211714 -	12.90563	XXXXXX	17.949110 -	19.631959				
=====	12.900563 -	14.583412	000000	19.631959 -	21.314808				

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2+CIN

SYMBOL	POWHATAN	SNAPMD	SYMBOL	POWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	-2.6963902 -	-1.7315249	+++++	4.0548669 -	5.9837975	#####	11.7705893 - 13.6995199
.....	-1.7319245 -	0.1970057	OCOCOC	5.9837975 -	7.9127281	#####	13.6995199 - 14.6639852
-----	0.1970057 -	2.1259363	XXXXXX	7.9127281 -	9.8416587		
=====	2.1259363 -	4.0548669	#####	9.8416587 -	11.7705893		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-3.196210 -	-2.231745	+++++	3.555047 -	5.483977	#####	11.270769 - 13.199700
.....	-2.231745 -	-0.302814	OCOCOC	5.483977 -	7.412908	#####	13.199700 - 14.164165
-----	-0.302814 -	1.626116	XXXXXX	7.412908 -	9.341839		
=====	1.626116 -	3.555047	#####	9.341839 -	11.270769		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2+CIN

SYMBOL	POWHATAN	SMDND	SYMBOL	POWHATAN	SMDND	SYMBOL	SMDND
.....	5.708546 -	7.362701	+++++	17.287633 -	20.595944	000000	30.520876 - 33.829187
.....	7.362701 -	10.671012	000000	20.595944 -	23.904255	000000	33.829187 - 35.483342
-----	10.671012 -	13.579322	xxxxxx	23.904255 -	27.212565		
=====	13.579322 -	17.287633	000000	27.212565 -	30.520876		
SYMBOL	KENTUCKY	SMDND	SYMBOL	KENTUCKY	SMDND	SYMBOL	SMDND
.....	-1.443474 -	0.210681	+++++	10.135613 -	13.443924	000000	23.368856 - 26.677167
.....	0.210681 -	3.518992	000000	13.443924 -	16.752235	000000	26.677167 - 28.331322
-----	3.518992 -	6.827302	xxxxxx	16.752235 -	20.060545		
=====	6.827302 -	10.135613	000000	20.060545 -	23.368856		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*CIN

SYMBOL	POWATAN	SHDMD	SYMBOL	POWATAN	SHDMD	SYMBOL	SHDMD
.....	-5.1533130 -	-3.3867185	+++++	7.2128485 -	10.7460375	000000	21.3456046 - 24.8787936
.....	-3.3867185 -	0.1464705	000000	10.7460375 -	14.2792266	000000	24.8787936 - 26.6453881
-----	0.1464705 -	3.6796595	XXXXXX	14.2792266 -	17.8124156		
=====	3.6796595 -	7.2128485	000000	17.8124156 -	21.3456046		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	-0.291473 -	1.475121	+++++	12.074689 -	15.607878	000000	26.207445 - 29.740634
.....	1.475121 -	5.008310	GCCCCO	15.607878 -	19.141067	000000	29.740634 - 31.507228
-----	5.008310 -	8.541500	XXXXXX	19.141067 -	22.674256		
=====	8.541500 -	12.074689	000000	22.674256 -	26.207445		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF S R C
 FOR BASIS CONDITIONS, SEE TABLE 1

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SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	11.61900 -	14.67037	=====	26.87585 -	32.97859	XXXXXX	45.18407 -	51.28582	##### 63.49230 - 66.54367
.....	14.67037 -	20.77311	+++++	32.97859 -	39.08133	#####	51.28682 -	57.38956	
-----	20.77311 -	26.87585	000000	39.08133 -	45.18407	#####	57.38956 -	53.49230	
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	14.31416 -	17.36553	=====	29.57101 -	35.67375	XXXXXX	47.87923 -	53.98198	##### 66.18746 - 69.23883
.....	17.36553 -	23.46827	+++++	35.67375 -	41.77649	#####	53.98198 -	59.08472	
-----	23.46827 -	29.57101	000000	41.77649 -	47.87923	#####	60.08472 -	56.18746	

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2*CIN

SYMBOL	POWILLATAN	SDISTMD	SYMBOL	POWILLATAN	SDISTMD	SYMBOL	SDISTMD
.....	7.593521	- 9.365933	+++++	20.000407	- 23.545232	#####	34.179706 - 37.724531
.....	9.365933	- 12.910758	000000	23.545232	- 27.090057	#####	37.724531 - 39.496943
-----	12.910758	- 16.455583	XXXXXX	27.090057	- 30.634882		
=====	16.455583	- 20.000407	000000	30.634882	- 34.179706		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD
.....	5.303361	- 7.075773	+++++	17.710247	- 21.255072	#####	31.889546 - 35.434371
.....	7.075773	- 10.620598	000000	21.255072	- 24.799897	#####	35.434371 - 37.206783
-----	10.620598	- 14.165423	XXXXXX	24.799897	- 28.344722		
=====	14.165423	- 17.710247	000000	28.344722	- 31.889546		

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POWHATAN			POWHATAN			POWHATAN			POWHATAN		
SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD
.....	3.605769 -	3.871925	=====	4.936549 -	5.468861	XXXXXX	6.533485 -	7.065797	8.130420	8.396576	
.....	3.871925 -	4.404237	+++++	5.468861 -	6.001173	000000	7.065797 -	7.598108			
-----	4.404237 -	4.936549	000000	6.001173 -	6.533485	000000	7.598108 -	8.130420			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD
.....	3.143249 -	3.409405	=====	4.474029 -	5.006341	XXXXXX	6.070965 -	6.603277	7.667900	7.934056	
.....	3.409405 -	3.941717	+++++	5.006341 -	5.538653	000000	6.603277 -	7.135588			
-----	3.941717 -	4.474029	000000	5.538653 -	6.070965	000000	7.135588 -	7.667900

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SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	
.....	11.51757 -	12.27767	=====	15.31807 -	16.83827	XXXXXX	19.87867 -	21.39887	##### 24.43927 -	25.19937
.....	12.27767 -	13.79787	++++++	16.83827 -	18.35847	000000	21.39887 -	22.91907		
-----	13.75767 -	15.31807	000000	18.35847 -	19.87867	#####	22.91907 -	24.43927		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	
.....	8.090188 -	8.850288	++++++	13.410889 -	14.931090	#####	19.491691 -	21.011891		
.....	8.850288 -	10.370488	000000	14.931090 -	16.451290	#####	21.011891 -	21.771991		
-----	10.370488 -	11.890689	XXXXXX	16.451290 -	17.971490					
=====	11.890689 -	13.410839	000000	17.971490 -	19.491691					

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2#RASH

SYMBOL	PCWHATAN	SNAPMD	SYMBOL	PCWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	3.382339 -	3.979527	+++++	7.562658 -	8.757035	.....	12.340165 - 13.534542
.....	3.975527 -	5.173904	000000	8.757035 -	9.951412	.....	13.534542 - 14.131730
-----	5.173904 -	6.368281	XXXXXX	9.951412 -	11.145788		
=====	6.368281 -	7.562658	888888	11.145788 -	12.340165		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	2.882519 -	3.475707	+++++	7.062838 -	8.257215	.....	11.840345 - 13.034722
.....	3.475707 -	4.678084	000000	8.257215 -	9.451592	.....	13.034722 - 13.631910
-----	4.678084 -	5.868461	XXXXXX	9.451592 -	10.645968		
=====	5.868461 -	7.062838	888888	10.645968 -	11.840345		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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RASH				RASH				RASH			
SYMBOL	PCWHATAN	SMDMD	SYMBOL	PCWHATAN	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD
.....	9.09749 -	10.61245	=====	16.67229 -	19.70221	xxxxxx	25.76205 -	28.79197	=====	34.85180 -	36.36676
.....	10.61245 -	13.64237	+++++	19.70221 -	22.73213	oooooo	28.79197 -	31.82188			
-----	13.64237 -	16.67229	000000	22.73213 -	25.76205	oooooooo	31.82188 -	34.85180			
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD
.....	1.945470 -	3.460429	+++++	12.550187 -	15.580107	=====	24.669865 -	27.699784			
.....	3.460429 -	6.490349	000000	15.580107 -	18.610026	=====	27.699784 -	29.214744			
-----	6.490349 -	9.520268	xxxxxx	18.610026 -	21.639945						
=====	9.520268 -	12.550187	oooooo	21.639945 -	24.669865						

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF PH2+RASH

SYMBOL	POWHATAN	SHDND	SYMBOL	POWHATAN	SHDND	SYMBOL	SHDND
.....	-5.393445	-3.703112	+++++	6.438884	9.819550	#####	19.961547 - 23.342212
.....	-3.703112	-0.322447	000000	9.819550	13.200216	#####	23.342212 - 25.032545
-----	-0.322447	3.058219	xxxxxx	13.200216	16.580881		
=====	3.058219	6.438884	#####	16.580881	19.961547		
SYMBOL	KENTUCKY	SHDND	SYMBOL	KENTUCKY	SHDND	SYMBOL	SHDND
.....	-0.531625	1.158728	+++++	11.300724	14.681390	#####	24.823387 - 28.204052
.....	1.158728	4.536393	000000	14.681390	18.062056	#####	28.204052 - 29.894385
-----	4.536393	7.920059	xxxxxx	18.062056	21.442721		
=====	7.920059	11.300724	#####	21.442721	24.823387		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS; SEE TABLE 1

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SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD	
.....	16.50205 -	18.18080	=====	24.89576 -	28.25325	XXXXXX	34.96822 -	38.32570	##### 45.04067 -	46.71941
.....	18.18080 -	21.53828	++++++	28.25325 -	31.61073	#####	38.32570 -	41.68318		
-----	21.53828 -	24.89576	000000	31.61073 -	34.96822	#####	41.68318 -	45.04067		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD	
.....	19.15721 -	20.87596	=====	27.59092 -	30.94841	XXXXXX	37.66338 -	41.02086	##### 47.73583 -	49.41457
.....	20.87596 -	24.23344	++++++	30.94841 -	34.30589	#####	41.02086 -	44.37834		
-----	24.23344 -	27.59092	000000	34.30589 -	37.66338	#####	44.37834 -	47.73583		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2#RASH

SYMBOL	POWHATAN	SDISTMD	SYMBOL	POWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	11.19340 -	12.61383	=====	18.29556 -	21.13642	XXXXXX	26.81814 -	29.65900	##### 35.34073 - 36.76116
.....	12.61383 -	15.45469	++++++	21.13642 -	23.97728	#####	29.65900 -	32.49987	
-----	15.45469 -	18.29556	000000	23.97728 -	26.81814	#####	32.49987 -	35.34073	
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	8.90324 -	10.32367	=====	16.00540 -	18.84626	XXXXXX	24.52798 -	27.36834	##### 33.05057 - 34.47100
.....	10.32367 -	13.16453	++++++	18.84626 -	21.68712	#####	27.36834 -	30.20971	
-----	13.16453 -	16.00540	000000	21.68712 -	24.52798	#####	30.20971 -	33.05057	

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2+V

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	3.374871 -	3.642868	=====	4.714858 -	5.250853	XXXXXX	6.322843 -	6.858838	=====	7.930828 -	8.198825
.....	3.642868 -	4.178863	++++++	5.250853 -	5.786848	000000	6.858838 -	7.394833			
-----	4.178863 -	4.714658	000000	5.786848 -	6.322843	000000	7.394833 -	7.930828			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	2.912351 -	3.180348	=====	4.252338 -	4.788333	XXXXXX	5.860323 -	6.396318	=====	7.468308 -	7.736305
.....	3.180348 -	3.716343	++++++	4.788333 -	5.324328	000000	6.396318 -	6.932313			
-----	3.716343 -	4.252338	000000	5.324328 -	5.860323	000000	6.932313 -	7.468308			

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*V

SYMBOL	POWHATAN	SC1C4MD	SYMBOL	POWHATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	13.05244	- 13.59931	=====	15.78679	- 16.88054	xxxxxx	19.06802 - 20.16176	=====	22.34925 - 22.89612
.....	13.59931	- 14.69305	+++++	16.88054	- 17.97428	=====	20.16176 - 21.25551		
-----	14.69305	- 15.78679	000000	17.97428	- 19.06802	=====	21.25551 - 22.34925		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD		
.....	9.625058	- 10.171929	+++++	13.453157	- 14.546900	=====	17.828127 - 18.921870		
.....	10.171929	- 11.265672	000000	14.546900	- 15.640642	=====	18.921870 - 19.468741		
-----	11.265672	- 12.359415	xxxxxx	15.640642	- 16.734385				
=====	12.359415	- 13.453157	=====	16.734385	- 17.828127				

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*V

SYMBOL	POWHATAN	SNAPMD	SYMBOL	POWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	3.722293 -	4.216819	+++++	7.183977 -	8.173030	#####	11.140187 - 12.129240
.....	4.216819 -	5.205872	000000	8.173030 -	9.162082	#####	12.129240 - 12.623766
-----	5.205872 -	6.194924	XXXXXX	9.162082 -	10.151135		
=====	6.194924 -	7.183977	000000	10.151135 -	11.140187		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	3.222473 -	3.716999	+++++	6.684157 -	7.673210	#####	10.640367 - 11.629420
.....	3.716999 -	4.706052	000000	7.673210 -	8.662262	#####	11.629420 - 12.123946
-----	4.706052 -	5.695104	XXXXXX	8.662262 -	9.651315		
=====	5.695104 -	6.684157	000000	9.651315 -	10.640367		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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SYMBOL	POWHATAN	SMDMD	SYMBOL	POWHATAN	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD		
.....	10.15723 -	11.62316	=====	17.48689 -	20.41875	XXXXXX	26.28248 -	29.21434	=====	35.07807 -	36.54400
.....	11.62316 -	14.55502	++++++	20.41875 -	23.35061	000000	29.21434 -	32.14520			
-----	14.55502 -	17.48689	000000	23.35061 -	26.28248	000000	32.14620 -	35.07807			
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD		
.....	3.005210 -	4.471141	++++++	12.266731 -	16.198595	000000	24.994185 -	27.926048			
.....	4.471141 -	7.403005	000000	16.198595 -	19.130458	000000	27.926048 -	29.391979			
-----	7.403005 -	10.334868	XXXXXX	19.130458 -	22.062321						
=====	10.334868 -	13.266731	000000	22.062321 -	24.994135						

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*V

SYMBOL	POWHATAN	SHDMD	SYMBOL	POWHATAN	SHDMD	SYMBOL	SHDMD
.....	-5.11066836	-3.39577503	+++++	6.89358498	10.32337165	=====	20.61273166 - 24.04251832
.....	-3.39577503	0.03401164	000000	10.32337165	13.75315832	=====	24.04251832 - 25.75741166
-----	0.03401164	3.46379831	XXXXXX	13.75315832	17.18294499		
=====	3.46379831	6.89358498	000000	17.18294499	20.61273166		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	-0.248828	1.466065	+++++	11.755425	15.185212	=====	25.474572 - 28.904358
.....	1.466065	4.895852	000000	15.185212	18.614998	=====	28.904358 - 30.619252
-----	4.895852	8.325638	XXXXXX	18.614998	22.044785		
=====	8.325638	11.755425	000000	22.044785	25.474572		

CONTOUR PLOT. FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*V

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	17.27799 -	16.62574	=====	24.01673 -	26.71223	XXXXXX	32.10323 -	34.79873	■■■■■■	40.18973 -	41.53748
.....	18.62574 -	21.32123	+++++	26.71223 -	29.40773	000000	34.79873 -	37.49423			
-----	21.32123 -	24.01673	UC000U	29.40773 -	32.10323	■■■■■■■■	37.49423 -	40.18973			
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	19.97315 -	21.32090	=====	26.71189 -	29.40739	XXXXXX	34.79839 -	37.49389	■■■■■■■■	42.88489 -	44.23264
.....	21.32090 -	24.01639	+++++	29.40739 -	32.10289	000000	37.49389 -	40.18939			
-----	24.01639 -	26.71189	000000	32.10289 -	34.79839	■■■■■■■■	40.18939 -	42.89489			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF PH2*V

SYMBOL	PCWHATAN	SDISTMD	SYMBOL	PCWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	29.75103	- 30.18696	=====	31.93068	- 32.80255	xxxxxx	34.54627 - 35.41814	#####	37.16186 - 37.59780
.....	30.18696	- 31.05682	++++++	32.80255	- 33.67441	#####	35.41814 - 36.29000		
-----	31.05682	- 31.93068	uuuuuu	33.67441	- 34.54627	#####	36.29000 - 37.16186		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	27.46087	- 27.89680	=====	29.64052	- 30.51239	xxxxxx	32.25611 - 33.12798	#####	34.87170 - 35.30764
.....	27.89680	- 28.76866	++++++	30.51239	- 31.38425	#####	33.12798 - 33.99984		
-----	28.76866	- 29.64052	uuuuuu	31.38425	- 32.25611	#####	33.99984 - 34.87170		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*CIN

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	
.....	-1.2399342 -	-0.7844363	+++++	1.9485510 -	2.8595468	.....	5.5925342 -	6.5035300
.....	-0.7844363 -	0.1265595	00000	2.8595468 -	3.7705426	.....	6.5035300 -	6.9590279
-----	0.1265595 -	1.0375552	XXXXXX	3.7705426 -	4.6815384			
=====	1.0375552 -	1.9485510	000000	4.6815384 -	5.5925342			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	
.....	-1.7024542 -	-1.2469563	+++++	1.4860310 -	2.3970268	.....	5.1300142 -	6.0410100
.....	-1.2469563 -	-0.3359605	000000	2.3970268 -	3.3080226	.....	6.0410100 -	6.4965079
-----	-0.3359605 -	0.5750352	XXXXXX	3.3080226 -	4.2190184			
=====	0.5750352 -	1.4860310	000000	4.2190184 -	5.1300142			

CONTOUR PLOT OF SRT*CIN

CIN

SYMBOL	POWATAN	SC1C4MD	SYMBOL	POWATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	
.....	13.98479 -	14.79354	=====	18.02855 -	19.64606	XXXXXX	22.88106 -	24.49857	27.73358 -	28.54233
.....	14.79354 -	16.41105	++++++	19.64606 -	21.26356	888888	24.49857 -	26.11607		
-----	16.41105 -	18.02855	000000	21.26356 -	22.88106	888888	26.11607 -	27.73358		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD	
.....	10.55741 -	11.36616	=====	14.60117 -	16.21868	XXXXXX	19.45368 -	21.07119	24.30620 -	25.11495
.....	11.36616 -	12.98367	++++++	16.21868 -	17.83618	888888	21.07119 -	22.68869		
-----	12.98367 -	14.60117	000000	17.83618 -	19.45368	888888	22.68869 -	24.30620		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*CIN

SYMBOL	POW/ATAN	SNAPMD	SYMBOL	POW/ATAN	SNAPMD	SYMBOL	SNAPMD
.....	-11.7886356 -	-10.3944928	+++++	-2.0296363 -	0.7586492	#####	9.1235057 - 11.9117912
.....	-10.3944928 -	-7.6062073	000000	0.7586492 -	3.5469347	#####	11.9117912 - 13.3059339
-----	-7.6062073 -	-4.6179218	xxxxxx	3.5469347 -	6.3352202		
=====	-4.6179218 -	-2.0296363	000000	6.3352202 -	9.1235057		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-12.2884556 -	-10.8943126	+++++	-2.5294563 -	0.2586292	#####	8.6236857 - 11.4119712
.....	-10.8943126 -	-8.1060273	000000	0.2586292 -	3.0471147	#####	11.4119712 - 12.8061139
-----	-8.1060273 -	-5.3177418	xxxxxx	3.0471147 -	5.8354002		
=====	-5.3177418 -	-2.5294563	000000	5.8354002 -	8.6236857		

CONTOUR PLCT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLCT OF SRT*CIN

SYMBOL	POUGHATAN	SMOED	SYMBOL	POUGHATAN	SMOED	SYMBOL	SMOED
.....	7.618583 -	9.077484	+++++	17.830887 -	20.748688	#####	29.502091 - 32.419892
.....	9.077484 -	11.995285	00000	20.748688 -	23.666489	#####	32.419892 - 33.878792
-----	11.995285 -	14.913086	xxxxxx	23.666489 -	26.584290		
=====	14.913086 -	17.830887	66666	26.584290 -	29.502091		
SYMBOL	KENTUCKY	SMOED	SYMBOL	KENTUCKY	SMOED	SYMBOL	SMOED
.....	0.4665632 -	1.9254637	+++++	10.6788667 -	13.5966677	#####	22.3500707 - 25.2678717
.....	1.9254637 -	4.6432647	00000	13.5966677 -	16.5144687	#####	25.2678717 - 26.7267722
-----	4.6432647 -	7.7610657	xxxxxx	16.5144687 -	19.4322697		
=====	7.7610657 -	10.6788667	66666	19.4322697 -	22.3500707		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF SRT*CIN

SYMBOL	PCWHATAN	SHDMD	SYMBOL	PCWHATAN	SHDMD	SYMBOL	SHDMD
.....	3.417692	- 4.507700	+++++	11.047747	- 13.227762	#####	19.767809 - 21.947825
.....	4.507700	- 6.687715	000000	13.227762	- 15.407778	#####	21.947825 - 23.037833
-----	6.687715	- 8.867731	XXXXXX	15.407778	- 17.587794		
=====	8.867731	- 11.047747	888888	17.587794	- 19.767809		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	8.279532	- 9.369540	+++++	15.909587	- 18.089602	#####	24.629649 - 26.809665
.....	9.369540	- 11.549555	000000	18.089602	- 20.269618	#####	26.809665 - 27.899673
-----	11.549555	- 13.729571	XXXXXX	20.269618	- 22.449634		
=====	13.729571	- 15.909587	888888	22.449634	- 24.629649		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF S R C
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT+CIN

CIN

SYMBOL	DEWHATAN	SSRCMD	SYMBOL	DEWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	15.00801 -	16.80092	=====	23.97253 -	27.55834	xxxxxxx	34.72996 -	38.31576	#####	45.48738 -	47.28028
.....	16.80092 -	20.33672	+++++	27.55834 -	31.14415	#####	38.31576 -	41.90157			
-----	20.33672 -	23.97253	000000	31.14415 -	34.72996	#####	41.90157 -	45.48738			
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	17.70317 -	19.49608	=====	26.66769 -	30.25350	xxxxxxx	37.42512 -	41.01092	#####	48.18254 -	49.97544
.....	19.49608 -	23.08188	+++++	30.25350 -	33.83931	#####	41.01092 -	44.59673			
-----	23.08188 -	26.66769	000000	33.83931 -	37.42512	#####	44.59673 -	48.18254			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF SRT*CIN

SYMBOL	PCWHATAN	SDISTMD	SYMBOL	PCWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	15.34866	- 16.85812	=====	22.89595	- 25.91486	XXXXXX	31.95268 - 34.97160	#####	41.00942 - 42.51888
.....	16.85812	- 19.87703	++++++	25.91486	- 28.93377	#####	34.97160 - 37.99051		
-----	19.87703	- 22.89595	000000	28.93377	- 31.95268	#####	37.99051 - 41.00942		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	13.05850	- 14.56796	=====	20.60579	- 23.62470	XXXXXX	29.66252 - 32.68144	#####	38.71926 - 40.22872
.....	14.56796	- 17.58687	++++++	23.62470	- 26.64361	#####	32.68144 - 35.70035		
-----	17.58687	- 20.60579	000000	26.64361	- 29.66252	#####	35.70035 - 38.71926		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF SRT#RASH

RASH

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.073588	- 2.317571	=====	3.293505	- 3.781472	XXXXXX	4.757406 - 5.245373	#####	6.221307 - 6.465291
.....	2.317571	- 2.805538	++++++	3.781472	- 4.269439	#####	5.245373 - 5.733340		
-----	2.805538	- 3.293505	000000	4.269439	- 4.757406	#####	5.733340 - 6.221307		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	1.611068	- 1.855051	=====	2.830985	- 3.318952	XXXXXX	4.294886 - 4.782853	#####	5.758787 - 6.002771
.....	1.855051	- 2.343018	++++++	3.318952	- 3.806919	#####	4.782853 - 5.270820		
-----	2.343018	- 2.830985	000000	3.806919	- 4.294886	#####	5.270820 - 5.758787		

CONTOUR PLOT OF SRT*RASH

SYMBOL	POUGHATON	SC1C4MD	SYMBOL	POUGHATON	SC1C4MD	SYMBOL	SC1C4MD
.....	6.254509 -	7.553337	+++++	15.346307 -	17.943963	888888	25.736933 - 28.334590
.....	7.553337 -	10.150994	000000	17.943963 -	20.541620	888888	29.334590 - 29.633418
-----	10.150994 -	12.748650	XXXXXX	20.541620 -	23.139276		
=====	12.748650 -	15.346307	888888	23.139276 -	25.736933		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD
.....	2.927129 -	4.125957	+++++	11.918927 -	14.516583	888888	22.309553 - 24.907210
.....	4.125957 -	6.723614	000000	14.516583 -	17.114240	888888	24.907210 - 26.206038
-----	6.723614 -	9.321270	XXXXXX	17.114240 -	19.711896		
=====	9.321270 -	11.918927	888888	19.711896 -	22.309553		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*RASH

SYMBOL	PCWHAHAN	SNAPMD	SYMBOL	PCWHAHAN	SNAPMD	SYMBOL	SNAPMD
.....	-0.2476443 -	0.5316783	+++++	5.2076133 -	6.7662583	#####	11.4421933 - 13.0008384
.....	0.5316783 -	2.0903233	000000	6.7662583 -	8.3249033	#####	13.0008384 - 13.7801609
-----	2.0903233 -	3.6489683	xxxxxx	8.3249033 -	9.8835483		
=====	3.6489683 -	5.2076133	000000	9.8835483 -	11.4421933		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	-0.74746425 -	0.03185826	+++++	4.70779330 -	6.26643831	#####	10.94237335 - 12.50101836
.....	0.03185826 -	1.59050327	000000	6.26643831 -	7.82508332	#####	12.50101836 - 13.28034087
-----	1.59050327 -	3.14914828	xxxxxx	7.82508332 -	9.38372633		
=====	3.14914828 -	4.70779330	000000	9.38372633 -	10.94237335		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF SRT-RASH

SYMBOL	LOW HATAN	SMDMD	SYMBOL	LOW HATAN	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD
.....	12.06812 -	13.12978	=====	17.37643 -	19.49975	XXXXXX	23.74639 -	25.86971	##### 30.11636 - 31.17802
.....	13.12978 -	15.25310	+++++	19.49975 -	21.62307	000000	25.86971 -	27.99304	
-----	15.25310 -	17.37643	000000	21.62307 -	23.74639	000000	27.99304 -	30.11636	
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD
.....	4.916100 -	5.977761	+++++	12.347727 -	14.471049	000000	20.841016 -	22.964338	
.....	5.977761 -	8.101083	000000	14.471049 -	16.594372	000000	22.964338 -	24.025999	
-----	8.101083 -	10.224405	XXXXXX	16.594372 -	18.717694				
=====	10.224405 -	12.347727	000000	18.717694 -	20.841016				

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT#RASH

SYMBOL	POWATAN	SHMD	SYMBOL	POWATAN	SHMD	SYMBOL	SHMD
.....	-4.0607170 -	-2.6431538	+++++	5.8619665 -	8.6970189	#####	17.2021763 - 20.0372287
.....	-2.6431908 -	0.1918616	000000	8.6970189 -	11.5320714	#####	20.0372287 - 21.4547549
-----	0.1918616 -	3.0269141	XXXXXX	11.5320714 -	14.3671238		
=====	3.0269141 -	5.8619665	000000	14.3671238 -	17.2021763		
SYMBOL	KENTUCKY	SHMD	SYMBOL	KENTUCKY	SHMD	SYMBOL	SHMD
.....	0.801123 -	2.218649	+++++	10.723807 -	13.558859	#####	22.064016 - 24.899069
.....	2.218649 -	5.053702	000000	13.558859 -	16.393911	#####	24.899069 - 26.316595
-----	5.053702 -	7.688754	XXXXXX	16.393911 -	19.228964		
=====	7.688754 -	10.723807	000000	19.228964 -	22.064016		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF
 SRC
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT#RASH

SYMBOL	POUGHATAN	SSRCMD	SYMBOL	POUGHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	19.93565	- 22.61037	=====	33.30844	- 38.65748	XXXXXX	49.35556 - 54.70459	#####	65.40267 - 68.07719
.....	22.61037	- 27.95941	++++++	38.65748	- 44.00652	000000	54.70459 - 60.05363		
-----	27.95941	- 33.30844	000000	44.00652	- 49.35556	000000	60.05363 - 65.40267		
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	22.63101	- 25.30553	=====	36.00360	- 41.35264	XXXXXX	52.05072 - 57.39975	#####	68.09783 - 70.77235
.....	25.30553	- 30.65457	++++++	41.35264	- 46.70168	000000	57.39975 - 62.74879		
-----	30.65457	- 36.00360	000000	46.70168	- 52.05072	000000	62.74879 - 68.09783		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*RASH

SYMBOL	POUGHATAN	SDISTMD	SYMBOL	POUGHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	10.17148	- 11.61069	=====	17.36756	- 20.24599	XXXXXX	26.00286 - 28.88129	#####	34.63816 - 36.07739
.....	11.61069	- 14.48913	+++++	20.24599	- 23.12443	000000	28.88129 - 31.75973		
-----	14.48913	- 17.36756	000000	23.12443	- 26.00286	000000	31.75973 - 34.63816		
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	7.801317	- 9.320534	+++++	17.955634	- 20.834267	000000	29.469567 - 32.348001		
.....	9.320534	- 12.198967	000000	20.834267	- 23.712701	#####	32.348001 - 33.787217		
-----	12.198967	- 15.077401	XXXXXX	23.712701	- 26.591134				
=====	15.077401	- 17.955634	000000	26.591134	- 29.469567				

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

SYMBOL	POUGHATAN	SHYMD	SYMBOL	POUGHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	2.756719 -	2.972049	=====	3.833366 -	4.264024	XXXXXX	5.125341 -	5.555999	#####	6.417316 -	6.632643
.....	2.972049 -	3.402707	+++++	4.264024 -	4.694682	#####	5.555999 -	5.986658			
-----	3.402707 -	3.833366	000000	4.694682 -	5.125341	#####	5.986658 -	6.417316			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	2.294199 -	2.509529	=====	3.370846 -	3.801504	XXXXXX	4.662821 -	5.093479	#####	5.954796 -	6.170125
.....	2.509529 -	2.940187	+++++	3.801504 -	4.232162	#####	5.093479 -	5.524138			
-----	2.940187 -	3.370846	000000	4.232162 -	4.662821	#####	5.524138 -	5.954796			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

SYMBOL	FOUR HATAN	SC1C4MD	SYMBOL	FOUR HATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	14.33755 -	14.84334	=====	16.86648 -	17.87805	XXXXXX	19.90120 - 20.91277	#####	22.93591 - 23.44170
.....	14.84334 -	15.85491	++++++	17.87805 -	18.88963	#####	20.91277 - 21.92434		
-----	15.85491 -	16.86648	000000	18.88963 -	19.90120	#####	21.92434 - 22.93591		
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD
.....	10.91017 -	11.41596	=====	13.43910 -	14.45067	XXXXXX	16.47382 - 17.48539	#####	19.50853 - 20.01432
.....	11.41596 -	12.42753	++++++	14.45067 -	15.46225	#####	17.48539 - 18.49696		
-----	12.42753 -	13.43910	000000	15.46225 -	16.47382	#####	18.49696 - 19.50853		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF : NAPHTHA
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

SYMBOL	POUGHATAN	SNAPMD	SYMBOL	POUGHATAN	SNAPMD	SYMBOL	SNAPMD
.....	0.6830701 -	1.3264132	+++++	5.1864716 -	6.4731577	000000	10.3332161 -
.....	1.3264132 -	2.1130993	UDC000	6.4731577 -	7.7598438	000000	11.6199022 -
-----	2.6130993 -	3.8997854	XXXXXX	7.7598438 -	9.0465299		12.2632453
=====	3.8997854 -	5.1864716	000000	9.0465299 -	10.3332161		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	0.1832501 -	0.6265932	+++++	4.6866510 -	5.9733377	000000	9.8333961 -
.....	0.6265932 -	2.1132793	000000	5.9733377 -	7.2600238	000000	11.1200822 -
-----	2.1132793 -	3.3999654	XXXXXX	7.2600238 -	8.5467099		11.7634253
=====	3.3999654 -	4.6866510	000000	8.5467099 -	9.8333961		

CONTOUR PLOT, FULLY CONTAIGNED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

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SYMBOL	POUNDRAN	SMDMD	SYMBOL	POUNDRAN	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD		
.....	10.79189 -	12.14422	=====	17.55356 -	20.25824	XXXXXX	25.66758 -	28.37225	#####	33.78159 -	35.13392
.....	12.14422 -	14.84889	+++++	20.25824 -	22.96291	#####	28.37225 -	31.07692			
-----	14.84889 -	17.55356	000000	22.96291 -	25.66758	#####	31.07692 -	33.78159			
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD	SYMBOL	SMDMD		
.....	3.639668 -	4.992203	+++++	13.106215 -	15.810886	#####	23.924897 -	26.629568			
.....	4.992203 -	7.696874	000000	15.810886 -	18.515556	#####	26.629568 -	27.981903			
-----	7.696874 -	10.401545	XXXXXX	18.515556 -	21.220227						
=====	10.401545 -	13.106215	#####	21.220227 -	23.924897						

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

SYMBOL	PCWHATAN	SHDMD	SYMBOL	PCWHATAN	SHDMD	SYMBOL	SHDMD
.....	1.517085 -	2.625676	+++++	9.277221 -	11.494402	.....	18.145947 - 20.363128
.....	2.625676 -	4.842858	000000	11.494402 -	13.711584	.....	20.363128 - 21.471719
-----	4.842858 -	7.060039	XXXXXX	13.711584 -	15.928765		
=====	7.060039 -	9.277221	888888	15.928765 -	18.145947	SYMBOL	SHDMD
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD		
.....	6.378925 -	7.487516	+++++	14.139061 -	16.356242	.....	23.007787 - 25.224968
.....	7.487516 -	9.704698	000000	16.356242 -	18.573424	.....	25.224968 - 26.333559
-----	9.704698 -	11.921879	XXXXXX	18.573424 -	20.790605		
=====	11.921879 -	14.139061	888888	20.790605 -	23.007787		

CONTOUR PLOT OF SRT*V

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	23.92455 -	24.41867	=====	26.39518 -	27.38343	XXXXXX	29.35994 -	30.34819	##### 32.32470 - 32.81883
.....	24.41867 -	25.40693	++++++	27.38343 -	28.37169	000000	30.34819 -	31.33645	
-----	25.40693 -	26.39518	000000	28.37169 -	29.35994	000000	31.33645 -	32.32470	
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	26.61971 -	27.11363	=====	29.09034 -	30.07859	XXXXXX	32.05510 -	33.04335	##### 35.01986 - 35.51399
.....	27.11363 -	28.10209	++++++	30.07859 -	31.06685	000000	33.04335 -	34.03161	
-----	28.10209 -	29.09034	(X)0000	31.06685 -	32.05510	000000	34.03161 -	35.01986	

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF SRT*V

SYMBOL	POUNHATAN	SDISTMD	SYMBOL	POUNHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	31.92122 -	32.18399	=====	33.23507 -	33.76062	XXXXXX	34.81170 -	35.33724	##### 36.38833 - 36.65110
.....	32.18399 -	32.70953	++++++	33.76062 -	34.28616	#####	35.33724 -	35.86278	
-----	32.70953 -	33.23507	000000	34.28616 -	34.81170	#####	35.86278 -	36.38333	
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD
.....	29.63106 -	29.89383	=====	30.94491 -	31.47046	XXXXXX	32.52154 -	33.04708	##### 34.09817 - 34.36094
.....	29.89383 -	30.41937	++++++	31.47046 -	31.99600	#####	33.04708 -	33.57262	
-----	30.41937 -	30.94491	000000	31.99600 -	32.52154	#####	33.57262 -	34.09317	

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF CIN+RASH

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD
.....	0.8209798	- 1.1165062	+++++	2.8896645	- 3.4807173	#####	5.2538756 - 5.8449284
.....	1.1165062	- 1.7075590	000000	3.4807173	- 4.0717701	#####	5.8449284 - 6.1404548
-----	1.7075590	- 2.2986117	xxxxxx	4.0717701	- 4.6628228		
=====	2.2986117	- 2.8896645	#####	4.6628228	- 5.2538756		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD
.....	0.3564598	- 0.6534862	+++++	2.4271445	- 3.0181973	#####	4.7913556 - 5.3824084
.....	0.6534862	- 1.2450390	000000	3.0181973	- 3.6092501	#####	5.3824084 - 5.6779348
-----	1.2450390	- 1.8360917	xxxxxx	3.6092501	- 4.2003028		
=====	1.8360917	- 2.4271445	#####	4.2003028	- 4.7913556		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL.
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF CIN+RASH

SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	PCWHATAN	SC1C4MD	SYMBOL	PCWHATAN	SC1C4MD
.....	14.05559	14.59659	=====	16.76057	17.84256	xxxxxx	20.00654	21.03853	#####	23.25251	23.79351
.....	14.59659	15.67858	+++++	17.84256	18.92455	000000	21.08853	22.17052			
-----	15.67858	16.76057	000000	18.92455	20.00654	#####	22.17052	23.25251			
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD
.....	10.62621	11.16921	=====	13.33319	14.41518	xxxxxx	16.57916	17.66115	#####	19.82513	20.36613
.....	11.16921	12.25120	+++++	14.41518	15.49717	000000	17.66115	18.74314			
-----	12.25120	13.33319	000000	15.49717	16.57916	#####	18.74314	19.82513			

CONTOUR PLOT OF CIN+RASH

SYMBOL	POWHATAN	SNAPMD	SYMBOL	POWHATAN	SNAPMD	SYMBOL	SNAPMD
.....	0.982690 -	1.711614	+++++	6.085162 -	7.543011	.....	11.916558 - 13.374407
.....	1.711614 -	3.169464	CCGUUU	7.543011 -	9.000860	.....	13.374407 - 14.103332
-----	3.169464 -	4.627313	XXXXXX	9.000860 -	10.458709		
=====	4.627313 -	6.085162	666666	10.458709 -	11.916558		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	0.482870 -	1.211794	+++++	5.585342 -	7.043191	.....	11.416738 - 12.874587
.....	1.211794 -	2.669644	UUUUUU	7.043191 -	8.501040	.....	12.874587 - 13.603512
-----	2.669644 -	4.127493	XXXXXX	8.501040 -	9.958889		
=====	4.127493 -	5.585342	666666	9.958889 -	11.416738		

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CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF CIN+RASH

SYMBOL	POWHATAN	SMDMD	SYMBOL	POWHATAN	SMDMD	SYMBOL	SMDMD
.....	8.331333 -	9.265207	+++++	14.868450 -	16.736198	000000	22.339441 - 24.207188
.....	9.265207 -	11.132955	000000	16.736198 -	18.603945	000000	24.207188 - 25.141062
-----	11.132955 -	13.000702	XXXXXX	18.603945 -	20.471693		
=====	13.000702 -	14.868450	000000	20.471693 -	22.339441		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	1.179313 -	2.113187	+++++	7.716430 -	9.584178	000000	15.187421 - 17.055168
.....	2.113187 -	3.980935	000000	9.584178 -	11.451925	000000	17.055168 - 17.989042
-----	3.980935 -	5.848682	XXXXXX	11.451925 -	13.319673		
=====	5.848682 -	7.716430	000000	13.319673 -	15.187421		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF CIN#RASH

SYMBOL	PCWHATAN	SHDMD	SYMBOL	PCWHATAN	SHDMD	SYMBOL	SHDMD
.....	1.099228 -	1.894975	+++++	6.669452 -	8.260945	888888	13.035422 - 14.626915
-----	1.894975 -	3.486467	000000	8.260945 -	9.852437	888888	14.626915 - 15.422661
-----	3.486467 -	5.077960	XXXXXX	9.852437 -	11.443930		
=====	5.077960 -	6.669452	888888	11.443930 -	13.035422		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	5.961008 -	6.756815	+++++	11.531292 -	13.122785	888888	17.897262 - 19.488755
.....	6.756815 -	8.348307	000000	13.122785 -	14.714277	888888	19.488755 - 20.284501
-----	8.348307 -	9.939800	XXXXXX	14.714277 -	16.305770		
=====	9.939800 -	11.531292	888888	16.305770 -	17.897262		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF CINRASH

SYMBOL	POWHATAN	SSRCMD	SYMBOL	POWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	18.59127 -	20.48568	=====	28.06432 -	31.85354	XXXXXX	39.43198 -	43.22120	■■■■■■■	50.79964 -	52.69425
.....	20.48568 -	24.27510	+++++	31.85354 -	35.64276	RRRRRR	43.22120 -	47.01042			
-----	24.27510 -	28.06432	000000	35.64276 -	39.43198	RRRRRR	47.01042 -	50.79964			
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	21.28043 -	23.18104	=====	30.75948 -	34.54870	XXXXXX	42.12714 -	45.91636	■■■■■■■	53.49480 -	55.38941
.....	23.18104 -	25.97076	+++++	34.54870 -	38.33792	RRRRRR	45.91636 -	49.70558			
-----	25.97076 -	28.75948	000000	38.33792 -	42.12714	RRRRRR	49.70558 -	53.49480			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF CIN+HASH

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SYMBOL	PCWHATAN	SDISTMD	SYMBOL	PCWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	13.56658 -	14.97527	=====	20.61004 -	23.42743	XXXXXX	29.06220 -	31.87958	#####	37.51435 -	38.92305
.....	14.97527 -	17.79266	++++++	23.42743 -	26.24481	000000	31.87958 -	34.69697			
-----	17.79266 -	20.61004	000000	26.24481 -	29.06220	000000	34.69697 -	37.51435			
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	11.27642 -	18.68511	=====	18.68511 -	21.13727	XXXXXX	26.77204 -	29.58942	#####	35.22419 -	36.63289
.....	12.68511 -	18.50250	++++++	21.13727 -	23.95465	000000	29.58942 -	32.40661			
-----	18.50250 -	18.31986	000000	23.95465 -	26.77204	000000	32.40661 -	35.22419			

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF CIN*V

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	1.034631 -	1.313957	=====	2.431263 -	2.989916	XXXXXX	4.107222 -	4.665875	#####	5.783181 -	6.062507
.....	1.313957 -	1.872610	+++++	2.989916 -	3.548569	000000	4.665875 -	5.224528			
-----	1.872610 -	2.431263	000000	3.548569 -	4.107222	#####	5.224528 -	5.783181			
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD		
.....	0.5721106 -	0.8514370	+++++	2.5273959 -	3.0860489	#####	4.7620078 -	5.3206607			
.....	0.8514370 -	1.4100700	000000	3.0860489 -	3.6447019	#####	5.3206607 -	5.5999872			
-----	1.4100900 -	1.9687430	XXXXXX	3.6447019 -	4.2033548						
=====	1.9687430 -	2.5273959	000000	4.2033548 -	4.7620078						

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF CIN*V

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE 1

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CONTOUR PLOT OF CIN#V

SYMBOL	POUGHATAN	SNAPMD	SYMBOL	POUGHATAN	SNAPMD	SYMBOL	SNAPMD
.....	2.596240 -	3.163191	+++++	6.564893 -	7.698793	#####	11.100495 - 12.234395
.....	3.163191 -	4.297291	UUUUUU	7.698793 -	8.832694	#####	12.234395 - 12.801346
-----	4.297291 -	5.430992	XXXXXX	8.832694 -	9.966594		
=====	5.430992 -	6.564893	BBBBBB	9.966594 -	11.100495		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD
.....	2.096420 -	2.663371	+++++	6.065073 -	7.198973	#####	10.600675 - 11.734575
.....	2.663371 -	3.797271	UUUUUU	7.198973 -	8.332874	#####	11.734575 - 12.301526
-----	3.797271 -	4.931172	XXXXXX	8.332874 -	9.466774		
=====	4.931172 -	6.065073	BBBBBB	9.466774 -	10.600675		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

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CONTOUR PLOT OF CIN*V

SYMBOL	PCWHATAN	SMDMD	SYMBOL	PCWHATAN	SMDMD	SYMBOL	SMDMD
.....	6.890405 -	8.130376	+++++	15.570204 -	18.050146	#####	25.489974 - 27.969916
.....	8.130376 -	10.610319	000000	18.050146 -	20.530089	#####	27.969916 - 29.209888
-----	10.610319 -	13.090261	xxxxxx	20.530089 -	23.010031		
=====	13.090261 -	15.570204	000000	23.010031 -	25.489974		
SYMBOL	KENTUCKY	SMDMD	SYMBOL	KENTUCKY	SMDMD	SYMBOL	SMDMD
.....	-0.2616148 -	0.9783565	+++++	8.4181840 -	10.8981265	#####	18.3379539 - 20.8178964
.....	0.9783565 -	3.4582590	000000	10.8981265 -	13.3780690	#####	20.8178964 - 22.0578677
-----	3.4582590 -	5.9382415	xxxxxx	13.3780690 -	15.8580115		
=====	5.9382415 -	8.4181840	000000	15.8580115 -	18.3379539		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

5
 9:10 MONDAY, AUGUST 27, 1979

CONTOUR PLOT OF CIN*V

SYMBOL	POW-HATAN	SHDMD	SYMBOL	POW-HATAN	SHDMD	SYMBOL	SHDMD	
.....	4.720311 -	5.376003	+++++	9.310158 -	10.621542	.....	14.555697 -	15.867082
.....	5.376003 -	6.687388	000000	10.621542 -	11.932927	.....	15.867082 -	16.522774
-----	6.687388 -	7.998773	xxxxxx	11.932927 -	13.244312			
=====	7.998773 -	9.310156	888888	13.244312 -	14.555697			
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD	
.....	9.582151 -	10.237843	+++++	14.171998 -	15.483382	.....	19.417537 -	20.728922
.....	10.237843 -	11.549228	000000	15.483382 -	16.794767	.....	20.728922 -	21.384614
-----	11.549228 -	12.860613	xxxxxx	16.794767 -	18.106152			
=====	12.860613 -	14.171998	888888	18.106152 -	19.417537			

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF S R C
 FOR BASIS CONDITIONS. SEE TABLE 1

9:10 MONDAY, AUGUST 27, 1979

CONTOUR PLOT OF CIN+V

SYMBOL	POWATAN	SSRCMD	SYMBOL	POWATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	19.09730 -	20.76099	=====	27.41695 -	30.74493	XXXXXX	37.40090 -	40.72888	##### 47.38484 - 49.04883
.....	20.76099 -	24.06897	++++++	30.74493 -	34.07292	#####	40.72888 -	44.05686	
-----	24.06897 -	27.41695	UUUUUU	34.07292 -	37.40090	#####	44.05686 -	47.38484	
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD
.....	21.79216 -	23.45615	=====	30.11211 -	33.44009	XXXXXX	40.09606 -	43.42404	##### 50.08000 - 51.74399
.....	23.45615 -	26.78413	++++++	33.44009 -	36.76808	#####	43.42404 -	46.75202	
-----	26.78413 -	30.11211	UUUUUU	36.76808 -	40.09606	#####	46.75202 -	50.08000	

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

7
 9:10 MONDAY, AUGUST 27, 1979

CONTOUR PLOT OF CIN*V

SYMBOL	POUGHATAN	SDISTMD	SYMBOL	POUGHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	17.55109 -	18.76670	=====	23.72916 -	26.20039	XXXXXX	31.14285 -	33.61408	=====	38.55654 -	39.79216
.....	18.76670 -	21.25793	+++++	26.20039 -	28.67162	000000	33.61408 -	36.08531			
-----	21.25793 -	23.72916	000000	28.67162 -	31.14285	000000	36.08531 -	38.55654			
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	15.26093 -	16.49654	=====	21.43900 -	23.91023	XXXXXX	28.85269 -	31.32392	=====	36.26638 -	37.50200
.....	16.49654 -	18.96777	+++++	23.91023 -	26.38146	000000	31.32392 -	33.79515			
-----	18.96777 -	21.43900	000000	26.38146 -	28.95269	000000	33.79515 -	36.26638			

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET CONSUMPTION OF HYDROGEN
 FOR BASIS CONDITIONS. SEE TABLE 1

1
 9:14 MONDAY, AUGUST 27, 1979

SYMBOL	POWHATAN	SHYMD	SYMBOL	POWHATAN	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	3.076064	- 3.196913	=====	3.680310	- 3.922008	XXXXXX	4.405404 - 4.647102	=====	5.130499 - 5.251348
.....	3.196913	- 3.436811	+++++	3.922008	- 4.163706	XXXXXX	4.647102 - 4.888801		
-----	3.436811	- 3.680310	000000	4.163706	- 4.405404	XXXXXX	4.888801 - 5.130499		
SYMBOL	KENTUCKY	SHYMD	SYMBOL	KENTUCKY	SHYMD	SYMBOL	SHYMD	SYMBOL	SHYMD
.....	2.613544	- 2.734393	=====	3.217790	- 3.459488	XXXXXX	3.942884 - 4.184582	=====	4.667979 - 4.788828
.....	2.734393	- 2.976091	+++++	3.459488	- 3.701136	XXXXXX	4.184582 - 4.426281		
-----	2.976091	- 3.217790	000000	3.701136	- 3.942884	XXXXXX	4.426281 - 4.667979		

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF C1-C4
 FOR BASIS CONDITIONS, SEE TABLE 1

2
 9:14 MONDAY, AUGUST 27, 1979

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CONTOUR PLOT OF RASH*V

V

SYMBOL	POWHATAN	SC1C4MD	SYMBOL	POWHATAN	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD		
.....	16.70597 -	16.76661	=====	17.00914 -	17.13040	XXXXXX	17.37294 -	17.49420	=====	17.73673 -	17.79737
.....	16.76661 -	16.88787	++++++	17.13040 -	17.25167	000000	17.49420 -	17.61547			
-----	16.88787 -	17.00914	000000	17.25167 -	17.37294	000000	17.61547 -	17.73673			
SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	KENTUCKY	SC1C4MD	SYMBOL	SC1C4MD	SYMBOL	SC1C4MD		
.....	13.27859 -	13.33923	=====	13.58176 -	13.70302	XXXXXX	13.94556 -	14.06682	=====	14.30935 -	14.36999
.....	13.33923 -	13.46049	++++++	13.70302 -	13.82429	000000	14.06682 -	14.18809			
-----	13.46049 -	13.58176	000000	13.82429 -	13.94556	000000	14.18809 -	14.30935			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF NAPHTHA
 FOR BASIS CONDITIONS. SEE TABLE I

3
 9:14 MONDAY, AUGUST 27, 1979

SYMBOL	POWATAN	SNAPMD	SYMBOL	POWATAN	SNAPMD	SYMBOL	SNAPMD	SYMBOL	SNAPMD
.....	10.21500	- 10.29261	=====	10.60303	- 10.75823	xxxxxx	11.06865 - 11.22386	#####	11.53428 - 11.61188
.....	10.29261	- 10.44782	+++++	10.75823	- 10.91344	#####	11.22386 - 11.37907		
-----	10.44782	- 10.60303	000000	10.91344	- 11.06865	#####	11.37907 - 11.53428		
SYMBOL	KENTUCKY	SNAPMD	SYMBOL	KENTUCKY	SNAPMD	SYMBOL	SNAPMD	SYMBOL	SNAPMD
.....	9.715185	- 9.792789	+++++	10.258415	- 10.413624	#####	10.879250 - 11.034458		
.....	9.792789	- 9.947998	000000	10.413624	- 10.568832	#####	11.034458 - 11.112063		
-----	9.947998	- 10.103206	xxxxxx	10.568832	- 10.724041				
=====	10.103206	- 10.258415	#####	10.724041	- 10.879250				

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CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF MIDDLE DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

9:14 MONDAY, AUGUST 27, 1979

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CONTOUR PLOT OF RASH*V

SYMBOL	POWHATAN	SMDND	SYMBOL	POWHATAN	SMDND	SYMBOL	POWHATAN	SMDND	SYMBOL	POWHATAN	SMDND
.....	16.91119 -	17.51069	=====	19.90870 -	21.10771	XXXXXX	23.50572 -	24.70473	■■■■■■	27.10274 -	27.70224
.....	17.51069 -	18.70970	++++++	21.10771 -	22.30671	000000	24.70473 -	25.90373			
-----	18.70970 -	19.90870	000000	22.30671 -	23.50572	■■■■■■	25.90373 -	27.10274			
SYMBOL	KENTUCKY	SMDND	SYMBOL	KENTUCKY	SMDND	SYMBOL	KENTUCKY	SMDND	SYMBOL	KENTUCKY	SMDND
.....	9.759166 -	10.358669	++++++	13.955688 -	15.154695	■■■■■■	18.751714 -	19.950721			
.....	10.358669 -	11.557675	000000	15.154695 -	16.353701	■■■■■■	19.950721 -	20.550224			
-----	11.557675 -	12.756682	XXXXXX	16.353701 -	17.552708						
=====	12.756682 -	13.955688	000000	17.552708 -	18.751714						

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF HEAVY DISTILLATE
 FOR BASIS CONDITIONS. SEE TABLE 1

5
 9:14 MONDAY, AUGUST 27, 1979

CONTOUR PLOT OF RASH*V

SYMBOL	PCSHATAN	SHDMD	SYMBOL	PCSHATAN	SHDMD	SYMBOL	SHDMD
.....	-3.013056	-2.617255	+++++	3.357550	5.349151	BBBBBB	11.323956 - 13.315558
.....	-2.617255	-0.625653	UUUUUU	5.349151	7.340753	BBBBBB	13.315558 - 14.311359
-----	-0.625653	1.365948	XXXXXX	7.340753	9.332355		
=====	1.365948	3.357550	BBBBBB	9.332355	11.323956		
SYMBOL	KENTUCKY	SHDMD	SYMBOL	KENTUCKY	SHDMD	SYMBOL	SHDMD
.....	1.248784	2.244585	+++++	8.219390	10.210991	BBBBBB	16.185796 - 18.177398
.....	2.244585	4.236127	UUUUUU	10.210991	12.202593	BBBBBB	18.177398 - 19.173199
-----	4.236127	6.227743	XXXXXX	12.202593	14.194195		
=====	6.227743	8.219390	BBBBBB	14.194195	16.185796		

CONTOUR PLOT, FULLY CONSTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF SRC
 FOR BASIS CONDITIONS, SEE TABLE 1

9:14 MONDAY, AUGUST 27, 1979

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SYMBOL	PCWHATAN	SSRCMD	SYMBOL	PCWHATAN	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	27.44540 -	28.35422	=====	31.98749 -	33.80413	xxxxxx	37.43740 -	39.25403	#####	42.88730 -	43.79562
.....	28.35422 -	30.17086	+++++	33.80413 -	35.62076	#####	39.25403 -	41.07067			
-----	30.17086 -	31.98749	000000	35.62076 -	37.43740	#####	41.07067 -	42.88730			
SYMBOL	KENTUCKY	SSRCMD	SYMBOL	KENTUCKY	SSRCMD	SYMBOL	SSRCMD	SYMBOL	SSRCMD		
.....	30.14106 -	31.04936	=====	34.68205 -	36.49929	xxxxxx	40.13256 -	41.94919	#####	45.58246 -	46.49078
.....	31.04936 -	32.86602	+++++	36.49929 -	38.31592	#####	41.94919 -	43.76583			
-----	32.86602 -	34.68265	000000	38.31592 -	40.13256	#####	43.76583 -	45.58246			

CONTOUR PLOT, FULLY CONTRAINED 22 TERM LINEAR REGRESSION MODEL
 LINES INDICATE CONSTANT LEVELS OF NET YIELD OF TOTAL DISTILLATE
 FOR BASIS CONDITIONS, SEE TABLE 1

7
 9:14 MONDAY, AUGUST 27, 1979

CONTOUR PLOT OF RASH*V

SYMBOL	POWHATAN	SDISTMD	SYMBOL	POWHATAN	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	19.66950 -	20.47755	=====	23.70973 -	25.32582	XXXXXX	28.55799 -	30.17408	=====	33.40626 -	34.21431
.....	20.47755 -	22.09364	+++++	25.32582 -	26.94190	888888	30.17408 -	31.79017			
-----	22.09364 -	23.70973	000000	26.94190 -	28.55799	888888	31.79017 -	33.40626			
SYMBOL	KENTUCKY	SDISTMD	SYMBOL	KENTUCKY	SDISTMD	SYMBOL	SDISTMD	SYMBOL	SDISTMD		
.....	17.37934 -	18.18739	=====	21.41957 -	23.03566	XXXXXX	26.26783 -	27.88392	888888	31.11610 -	31.92415
.....	18.18739 -	19.80348	+++++	23.03566 -	24.65174	888888	27.88392 -	29.50001			
-----	19.80348 -	21.41957	000000	24.65174 -	26.26783	888888	29.50001 -	31.11610			

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APPENDIX 4

GULF SCIENCE AND TECHNOLOGY COMPANY
Pittsburgh, PA 15230

A MODEL FOR AN ADIABATIC COUNTERCURRENT FLOW SRC-II LIQUEFACTION REACTOR

by

Gary L. Jones

Chemicals and Minerals Division

Report No.: 6270RK016

Project No.: 238-8500

August, 1979

Approved:

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10/12/79

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10/16/79

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A MODEL FOR AN ADIABATIC COUNTER-CURRENT FLOW
SRC-II COAL LIQUEFACTION REACTOR

I. Summary and Conclusions

This report contains the results of a study of a countercurrent flow SRC-II reactor model in which the temperature profile and hydrogen consumption are compared to that predicted by a cocurrent flow reactor model under similar flow conditions. The simulation models show that for identical gas and slurry inlet conditions the temperature rise and hydrogen consumption are nearly identical for the two reactor types. The thermal response of the reactors with respect to inlet coal and recycle ash concentrations and reactor pressure is also similar. A principle advantage of the countercurrent reactor is in the ability to control the reactor temperature by reducing the inlet gas temperature without the need for introducing quench gas. The cocurrent reactor requires preheated gas introduced with the slurry in order to sustain reaction. Reactor temperature is controlled by injecting quench gas at one or more quench points. The simulations show that at design flow conditions a flatter temperature profile will exist in the countercurrent reactor when inlet gas is not preheated.

As slurry velocity is reduced below design levels, the temperature of the countercurrent reactor can be controlled near desired levels by reducing inlet gas temperature without the need for quench. The temperature profile becomes flatter as the inlet gas temperature is lowered. Under the same reduced slurry flow conditions, the temperature rises to unacceptable levels in the cocurrent reactor. High quench rates would be required to reduce the temperature rise.

This favorable characteristic of the countercurrent reactor could minimize high temperature upsets during startup when slurry velocity is low. Relatively modest design modifications would be required to accomplish countercurrent flow operation.

Independent models of the transient thermal and hydrogen consumption responses for cocurrent and countercurrent flow systems were developed in a manner similar to that by S. Parulekar and Y. T. Shah⁽¹⁾. The parameters in the cocurrent flow model were adjusted so that the temperature profile and hydrogen consumption would fit experimental data from the Ft. Lewis pilot plant for a set of basis conditions. These parameters were then assumed to be valid for both models at the conditions which are proposed for the Demonstration Plant. The cocurrent and countercurrent reactor models are described in detail. The predicted reactor responses at a number of reactor conditions of variable gas flow rate, slurry flow rate, inlet temperature, total pressure, recycle ash concentration and inlet coal concentration are summarized and the performance of the two reactor systems is compared. The predictions of the cocurrent flow models compare quite well with the limited pilot plant data. The time required to reach the steady state for the same conditions is nearly equal for the two reactors. This time does change significantly with reactor conditions, particularly slurry flow rate. Empirical yield models of principle gaseous, liquid and solid products obtained from statistical regression of the pilot plant data are used to compare yields for the two reactor types. In general, the yields of the two reactors and the hydrogen consumption are very similar.

The steady state behavior of the reactor systems is discussed from the standpoint of an overall energy balance on the reactor. The steady state behavior of the partially backmixed reactor is compared to that of the limiting cases of the plug flow reactor and the continuous stirred-tank reactor (CSTR). The sensitivity of the steady state model predictions to the model parameters is discussed.

The countercurrent flow reactor appears to offer the advantage of a "built in" quench point at the bottom of the reactor column which might lead to a simplification in the quench recycle and hydrogen preheat systems. The reduction in hydrogen preheating requirements could provide energy savings. The disengagement zone above the slurry could double as an effective vapor/liquid separator and allow the elimination of the first separator. The slurry outlet line may serve as the slurry let down system thus simplifying this

system over that for the current concept. There would also appear to be fewer solids accumulation problems because of the slurry flowing from the reactor bottom.

II. Introduction

The current Demonstration Plant reactor design calls for an adiabatic reactor in which vapor and slurry are introduced together and flow cocurrently upward through the reactor. The present design calls for a number of quench points to control the temperature rise and reduce the potential for deleterious high temperature effects. In order to promote reaction, hydrogen introduced with the slurry is preheated to the slurry temperature. A modified adiabatic reactor design has been proposed in which hydrogen gas is introduced at the bottom of the reactor and flows upward while the slurry is introduced at the top and flows downward. This countercurrent flow design would offer the advantage of effectively eliminating the need for one quench point and might offer some advantages in temperature control over the cocurrent flow design. Unlike the cocurrent model, the countercurrent reactor would be effectively decoupled from the preheater by a disengagement space at the top of the reactor in which slurry level could be independently controlled to prevent carry over of slurry by the upward movement of gas. Although little data exist in this area, it was felt that the countercurrent flow of gas would provide better axial mixing and therefore more uniform contact of slurry and gas.

Figure 1 shows a schematic representation of the cocurrent flow reactor. Although the details of the flow are poorly understood, the temperature profile appears to be intermediate between that in a perfectly mixed CSTR (Continuous Stirred Tank Reactor) in which the inlet temperature jumps abruptly to the temperature in the reactor and the plug flow reactor in which the temperature varies continuously from the inlet temperature along the length of the reactor. The inference from this data is that heat is dispersed along the reactor axis by the partial backmixing of the fluid phase. In the absence of quenching by hydrogen, the temperature jumps abruptly to nearly

two-thirds of the ultimate temperature and the remaining one-third of the overall temperature rise occurs along the length of the reactor as shown in Figure 2. This behavior indicates a high level of backmixing which places the thermal behavior closer to that of a CSTR than to that of a plug flow reactor.

The high level of backmixing is presumably caused by macro turbulence caused by bubbles of vapor and gas moving and reacting with the slurry. Independent indirect radioactive tracer measurements indicate that the gas flows primarily as a plug and it is assumed to be dispersed uniformly across the flow area.

The size of the coal solids is sufficiently small (ca. 3μ) that it is fair to assume the solids and liquid form a single continuous flowing phase. Solids and liquids are treated separately in the energy balance because of their different thermal properties. However, only one energy balance is used to define the temperature for all three phases.

The velocity, density and heat capacity of the liquid, solid and vapor phases are assumed to take on some constant average value along the reactor axis. The composition of the liquid phase is approximated by a heavy oil, that of the solid phase by an organo-silicate and the vapor by a mixture of gases and oil vapor with a molecular weight of about 25.

The liquefaction reactions occurring are complex. However, there is strong evidence that the primary heat generation occurs by the hydrogenolysis of the coal liquids; this consumes hydrogen. Therefore, the details of the liquefaction reactions need not be considered in the present versions of the models. The thermal behavior can be linked to the consumption of hydrogen through a reaction rate term. The details of the liquid composition are not specified; only the kinetics of the hydrogen consumption and a lumped parameter value of the heat of reaction are provided. Analysis of reaction data indicate that the hydrogen reaction rate is weakly dependent on hydrogen partial pressure and strongly dependent on the local temperature. The former dependence is approximated by a power term and the latter dependence by a

linear temperature term. The details of the reaction rate expression will be discussed in another section.

In order to compare the effect of the two reactor temperature profiles and other conditions on primary yields, empirical models of yields of C_1 - C_4 , naphthas, middle and heavy distillates and SRC obtained from regression of pilot plant data are incorporated in the model.

Because of the intimate mixing of the fluid and gas phases, these are assumed to be in thermal equilibrium (i.e., the temperature of all three phases is assumed to be equal at each point in the reactor). The temperature is assumed to vary with time and axial distance but not with radial position in the reactor. The holdups of the three phases in the cocurrent flow reactor are calculated from various empirical relationships developed for different systems. These approximations for the slurry plus vapor have been determined to be reasonable via indirect methods applied to Ft. Lewis data.

The thermal behavior of the highly backmixed reactor (HBR) is controlled by the so-called thermal Peclet Number (Pe) which is the ratio of convective heat transfer to the diffusive heat transfer rates. This parameter is derived and discussed in the section on material and energy balances. As the Peclet Number decreases, the degree of backmixing increases and the temperature profile approaches that of a CSTR, a flat profile. The profile approaches that of a plug flow reactor as Pe increases. For intermediate values of Pe (values of .1 to 1.5), the degree of axial dispersion of heat is significant and the reactor is said to be highly backmixed. Because the degree of backmixing of the fluid (mass) and of heat are found to be very nearly equal, these processes are represented by the same value of Pe. Thus the axial dispersion model is applicable for both heat and mass.

For an adiabatic reactor, conditions may exist which may lead to high temperature rises due to the dominant exothermic hydrocracking reactions. The temperature rise in the cocurrent reactor is normally controlled by a series of quench points in which cool hydrogen or hydrogen diluted with a recycle gas is introduced at points along the axis (Figure 1). Another method

Upflow or Cocurrent Flow
Reactor Concept and Temperature Profile

*for emergency
draining only*

Countercurrent Flow
Reactor Concept and Temperature Profile

Comparison of Reactor Concepts
Figure 1

Schematic Representation of Reactor Temperature for Three Reactor Types

Figure 2

of controlling the temperature rise and at the same time simplifying the design of the reactor would be to introduce gas and draw liquid off at the bottom of the reactor and to introduce slurry at the top of the reactor. In such a reactor the inlet port would serve as a quench point and the cool gas would reduce the destabilizing effect of the backmixing of high temperature liquid toward the reactor inlet. This would in theory lessen the likelihood of thermal transients. This countercurrent flow reactor concept is shown in Figure 1.

The countercurrent flow concept may also offer potential for reducing the volume of hydrogen recycle because the bottom feed hydrogen doubles as a quench also. Energy may be saved by reducing or eliminating hydrogen preheating. The more uniform temperature profile which results may reduce the degree of temperature rise as slurry velocity is reduced. The natural flow of slurry from the bottom rather than the top of the reactor may improve the efficiency of draining the reactor after emergency shutdown or when maintenance is required. Also, the tendency of solids to accumulate at the reactor bottom by gravity separation would be eliminated.

We may determine the behavior of the countercurrent flow reactor from experience with the cocurrent flow reactor. As presently visualized, the hydrogen gas will be bubbled up from the bottom and the slurry fed in near the top of the reactor (Figure 1). Slurry product is removed from the bottom. A vapor disengagement space would be required at the top of the reactor in order to prevent flooding of the reactor by gas, a condition which exists when gas flow rate exceeds a certain critical level (flooding velocity). The mixing and thermal characteristics and the holdup of the countercurrent system are assumed to be the same as those for the cocurrent system for want of better data at this time.

A model was developed for the countercurrent flow reactor along the same lines as that of the cocurrent reactor model developed by Y. T. Shah and S. Parulekar⁽¹⁾ and independently by the author. The discussion of these models follows.

III. Objectives

The principal objective of this work was to assess the feasibility of the countercurrent flow concept for the adiabatic SRC-II liquefaction reactor by comparing its behavior and performance with that of the present cocurrent flow model under a variety of reactor conditions around certain basis conditions which were chosen to be those of the Ft. Lewis Pilot Plant and the proposed Demonstration Plant.

The thermal behavior of the countercurrent flow reactor with cool inlet hydrogen will be compared to that of the cocurrent flow reactor without quench at various slurry velocities and gas velocities to determine if there is a reduced sensitivity to slurry turndown and to assess the concept.

Models for the co- and countercurrent flow reactors with quench injection are being developed and will be discussed in a subsequent report.

IV. Discussion of Results

A. General Characteristics

The models were used to predict the steady state temperature and hydrogen consumption profiles for a number of operating conditions. These conditions are summarized in Table 1 and the results are shown in Figures 3a-8b. The first 13 cases in Table 1 compare the cocurrent and countercurrent flow reactors for variable U_g , U_s , PT, CI, RASH, TG_{in} , T_{in} with the same inlet gas temperature for both types of reactor. The reactor dimensions and base conditions are those of the Ft. Lewis pilot plant. These results were intended to study the effects of the above variables on the thermal response of both systems and to see if there were any unexpected differences between the systems.

Figures 9 and 10 show the axial profiles at the Ft. Lewis and Demonstration Plant basis conditions. In general, the thermal behavior of the countercurrent reactor is essentially the same as that of the cocurrent

reactor for the same inlet gas temperature. The countercurrent reactor shows a slightly lower temperature and hydrogen consumption because of the slight quenching effect at the slurry outlet. However, as the inlet hydrogen temperature is reduced, the quenching effect is increased, the differences between the two reactors becomes more pronounced and the advantages of the countercurrent flow system more obvious. The differences between the thermal behavior of the two systems increases as the temperature rise and hydrogen consumption increase. These increase as U_g decreases and PT , CI , $RASH$ and U_g increase.

A second set of cases was run for the Demo Plant dimensions and basis conditions as indicated in Tables 1 and 2.

The inlet slurry temperature T_{in} was set at the same level as that of the Ft. Lewis runs. The results of these runs are shown in Figures 11a through 16b.

These runs were made while varying the principal variables about the basis levels for the cocurrent and countercurrent flow reactors with equal inlet gas temperatures. Again, the behavior of the two reactor systems is similar for equal inlet temperatures. The dependence of the thermal characteristics of the Demo Plant are completely consistent with those seen in the Ft. Lewis runs.

An additional series of runs was made in which inlet gas temperature was reduced to 600, 500, 400 and 300°K (620.6, 440.6, 260.6, 80.6°F) for each of 3 slurry velocities: 1.8, 1.2 (basis value) and 0.6 cm/sec. These runs were intended to compare the thermal response of the two systems as slurry velocity was reduced and to demonstrate the magnitude of the quenching effect of the countercurrent system. These last results are summarized in Table 5, shown in Figures 17a through 17c and discussed in Section J.

B. Effect of Slurry Velocity

(Ft. Lewis Plant) (Ref. Table 2)

The effect of slurry velocity (U_s) is not linear. In fact, it appears that as U_s decreases (and SRT increases) by 50%, an unacceptably high temperature rise results. The hydrogen consumption also increases to very high levels because of the high residence time and temperature. Note that the countercurrent temperature rise and hydrogen consumption are somewhat lower (by 15°F and 3.4%) at the lower slurry velocity but this difference is small when the inlet gas temperature is the same as the inlet slurry. Note that the time predicted by the model to reach a steady state temperature rise for both types of flow increases dramatically as U_s decreases. This could have implications for the control of process operating conditions, particularly during startup. Although the time to achieve a steady state is based on a somewhat arbitrary definition* in the model, the same definition applies in all cases and a change in this time should therefore signify a change in the underlying thermal response.

C. Effect of Gas Velocity

(Ft. Lewis Plant) Ref. Table 2

The effect of varying gas velocity is to increase the temperature rise and hydrogen consumption as gas velocity decreases. This behavior is born out by the regression analysis of the pilot plant data. The consumption of hydrogen increases because the effective gas residence time or hydrogen/slurry contact time increases. The temperature rise increases because the degree of backmixing decreases (Pe increases) and a larger fraction of the total temperature rise occurs within the reactor. The average reactor temperature may actually be somewhat lower at the lower gas velocity, under these inlet conditions.

*Defined as the time required to reach 99.99% of steady state.

D. Effect of Reactor Pressure

(Ft. Lewis Plant) (Ref. Table 2)

Total reactor pressure does not have a very strong effect on the maximum temperature rise or on hydrogen consumption (Cases 0, 5, 6). The latter increases linearly 6.1% more as PT decreases by 3 MPA (from 17 MPA to 14 MPA). However, the consumption expressed in g/100g MF coal first increases slightly as PT decreases from 17 to 14 MPA and then decreases by .3 as PT decreases further to 11 MPA. This results from a decrease in hydrogen density at a fixed temperature which in turn increases the relative amount of hydrogen consumed. The countercurrent reactor shows a slightly lower temperature rise and about the same hydrogen consumption under these cases.

E. Effect of Recycle Ash Concentration

(Ft. Lewis Plant) (Ref. Table 2)

Cases 0, 7 and 8 show the effect of varying recycle ash concentration. As recycle ash increases from 4% to 9%, temperature and hydrogen consumption decline by 3.3°K and 1.3% respectively for both cocurrent and countercurrent flow. The decline is only 2.9°F and 1.2% as recycle ash is increased further from 9% to 14%. These effects are caused by an increase in solid holdup and a corresponding increase in convective heat transfer rate as recycle ash increases. This can be clearly seen in Eq. (11). This effect definitely goes counter to the teachings of the general regression models for hydrogen consumption. These results indicate that (1) either the positive effect of recycle ash in increasing hydrogen consumption and temperature is underestimated in the reaction rate term, or (2) the effect of ash on liquid and gas holdups is overestimated in the holdup calculations. Better reaction models are being developed to understand this effect.

F. Effect of Inlet Gas and Slurry Temperature

(Ft. Lewis Plant) (Ref. 2)

Cases 0, 9 and 10 show that as inlet gas and slurry temperature increase by a total of 40°C (72°F), the temperature rise increases by 44.2°F for the cocurrent flow and by 43°F for the countercurrent flow reactor. The corresponding hydrogen consumption increases by almost 2X because of the increase in reactor temperature (increased reaction rate) and the decrease in inlet hydrogen density (ideal gas law). These results are consistent with the regression models.

G. Effect of Inlet MF Coal Concentration

(Ft. Lewis Plant) (Ref. Table 2)

Cases 0, 11 and 12 illustrate the effects of varying inlet MF coal concentrations from 20 to 40%. As coal concentration increases from 20 to 30%, temperature rise increases from 61 to 74.4°C (134°F) for the cocurrent and by a corresponding amount for the countercurrent reactor. Relative hydrogen consumption jumps by 5.6% from 25.1% to 30.7%. An additional increase in coal concentration by 10% increases the temperature rise by 35°F for the cocurrent and by 31.5°F for the countercurrent flow reactor. The corresponding hydrogen consumption increases by nearly 15%. This effect is apparently caused by the increased reaction rate (Eq. 7) in which the exponent on the coal concentration term N_c is 1.84. The hydrogen consumption based on moisture free coal (g/g MF coal) first decreases and then increases slightly (with a net overall decrease) because the relative change in hydrogen consumption is exceeded by the relative change in coal concentration (CI) as CI decreases from .4 to .3 g/g slurry but the relative change is reversed as CI decreases from .3 to .2 g/g slurry. These results are in general agreement with the empirical correlation models.

H. Comparison of Effect of Conditions for Ft. Lewis
and Demonstration Plants (Ref. Tables 2, 3 and 4)

The basis conditions for the Demo Plant (Case 13) lead to slightly lower overall temperature rise (60°F vs 72.3°F) and a lower level of hydrogen consumption (26% vs 30.4% and 3.63 vs 4.36 g/100 MF coal) than the Ft. Lewis pilot at the basis conditions summarized in Table 4. Table 6 shows that the Peclet Number (which relates to the degree of backmixing) is .98 for the Demo Plant compared to .94 for Ft. Lewis. Therefore, the Demo Plant exhibits only slightly less backmixing (more plug flow) than the Ft. Lewis reactor. One would desire the values of this principle dimensionless parameter to be equal for the two reactors. The different conditions on coal and ash concentration and total pressure may account for most of the difference in predicted temperature rise between the Ft. Lewis and the Demo Plant simulation.

I. Effects of Slurry Velocity, Gas Velocity
and Other Variables Around the Demonstration
Plant Basis Conditions (Ref. Table 4)

The effects of slurry velocity, gas velocity, recycle ash, total pressure, inlet coal concentration and inlet gas or slurry temperature around the Demo Plant basis conditions and the differences between countercurrent and cocurrent flow are consistent with the effects seen at the Ft. Lewis conditions. These effects are summarized in Table 3 and are shown in Figures 11a and 16b. Also shown in Table 3 are the yields of C₁-C₄, naphthas, middle and heavy distillates and SRC respectively, based on empirical models of the yields from linear regression of the pilot plant data (Table 7). These results show no differences between cocurrent and countercurrent flow systems provided the temperature profiles are similar, as one would expect for equal inlet gas temperature.

Figures 9 and 10 which show axial temperature profiles for the two reactors at the basis conditions for both co- and countercurrent flow indicate the differences in temperature characteristics noted above.

J. Effects of Reduced Inlet Gas Temperature and
Slurry Velocity (Ref. Table 5)

Table 5 summarizes the overall effects of variable inlet gas temperature at several different slurry velocities for the Demonstration Plant. All other conditions are at their basis values.

Figures 17a,b,c illustrate the effects of lowering the feed gas temperature. The upper curves, which are for cocurrent and countercurrent flow with no quenching, become progressively higher as slurry velocity decreases while the cooled countercurrent reactor shows a slower temperature rise and a flatter axial profile at the lower velocity. Table 5 shows that the yield structure changes significantly as U_L and inlet gas temperature change. At present, direct yield comparisons cannot be made with quenched cocurrent flow. The expressions used to compute the various yields are summarized in Table 7. These are obtained from a linear regression of pilot plant data for two coals (Powhatan and Kentucky) and both SRC-I and II modes. These models will be discussed further in a forthcoming report. The yields shown are for Powhatan coal. Because the yield structure changes with coal type and the model kinetic expression is based on a regression model for Kentucky coal, correction factors to shift from one coal yield to another are also indicated. The yields of products are also summarized in Tables 2 and 3 showing the effects of various differences in reactor conditions on these yields.

The effect of cooling the inlet gas is to decrease the yields of lighter product (C_1 - C_4 , naphthas and MD) and to increase the yields of HD and SRC at each value of U_L . The reduction or increase in yields are much more pronounced at lower U_L than at higher U_L . The predictions may be less accurate at lower U_L (higher SRT) where little data are available. In particular, the indicated negative yields of C_1 - C_4 and naphthas at low temperature and high SRT are incorrect. Note also that the effect of cool gas on the temperature rise is more pronounced at lower U_L than it is at higher

U_L . Therefore, the stabilizing effect of countercurrent flow could be beneficial for cases where slurry turndown is required such as during reactor startup when the reactor is partially full or during an emergency shutdown.

Table 1

Summary of Model Assumptions and Conditions

1. Liquids and solid particles are treated as one continuous flowing phase.
2. Enthalpy of gas, liquid and solids are included separately in the energy balance. However, the enthalpy balance is written on the combined three phase system.
3. The reactor is adiabatic (no wall heat losses). This assumption can be dropped if it is deemed necessary to add wall heat losses.
4. The gas phase flows as a plug uniformly distributed across the flow area.
5. Radial concentration, temperature or velocity gradients are assumed small because of the high level of turbulence in the reactor.
6. Liquid/solid phase (slurry) is partially backmixed.
7. The dispersion of heat is the same as the dispersion of mass. Both occur by physical backmixing of the slurry phase.
8. The thermal dispersion coefficients, enthalpies and convective heat transfer terms are each lumped together for the three phases.
9. Vapor and liquid/solid phases are in local thermal equilibrium at each point in the reactor (i.e., equal temperatures).
10. All heat generation is assumed to occur proportionally to the consumption of hydrogen.

11. The only material balance is on hydrogen.
12. All liquid, solid, vapor properties, superficial velocities and holdups are assumed constant with respect to time and axial position, but do depend on various conditions of the process (gas velocity, mineral content, vessel dimensions, settling velocity).
13. The vapor phase contains heavier hydrocarbons which increase the average molecular weight to about 25. The hydrogen concentration decreases and the proportion of heavier hydrocarbons in the gas phase probably increases along the length of the reactor. However, the model does not currently compute the composition of these heavier components.
14. The dependence of the reaction rate expression on coal concentration, recycle ash concentration, hydrogen partial pressure, temperature, and slurry residence time is determined by a statistical fit to pilot plant data. This reaction model may not be adequate for large excursions in some of the reactor variables.
15. The heat of reaction, thermal dispersion (Peclet Number) and reaction rate preexponential factor are adjusted to fit the temperature profile and overall hydrogen consumption of the Ft. Lewis Pilot Plant at certain basis conditions (Table 4).
16. The model so fit is assumed to apply to the Demonstration Plant scale reactor.

V. Materials and Energy Balance Models

A. General Considerations and Model Assumptions

For the reasons discussed in the previous section the energy balance is related to the hydrogen balance by the reaction rate term. The energy balance on the combined three phase system contains contributions from each phase based on their respective volume fractions or based on their superficial velocities.

The following is not meant to be a rigorous derivation of the material and energy balances but is meant to represent the important steps involved and the underlying assumptions. Primary emphasis is placed on the analysis of the dependence of the steady state solution on the system parameters and the means by which these parameters may be estimated to produce an acceptable fit to certain pilot plant data.

B. Model Description

Writing an enthalpy balance on all three phases over the volume element and taking the limit as the length ΔX goes to zero we obtain:

$$1) \quad \frac{\partial}{\partial t} \left[(\rho C_{ph})_{l,s,g}^T \right] = \frac{\partial^2}{\partial x^2} \left[D_{l,s,g}^T \right] - \frac{\partial}{\partial x} \left[(\rho C_{pU})_{l,s,g}^T \right] + DHR \cdot RXN$$

where $\rho C_{ph}T$ is the enthalpy of each phase per unit reactor volume (i.e., $(\rho C_{ph})_l$ refers to liquid, s, g refer to solid and vapor), D is the thermal dispersion coefficient for each phase (i.e., D_l refers to liquid phase), $\rho C_{pU}T$ is the enthalpy flux through the reactor (again $(\rho C_{pU})_l$ refers to the liquid phase), $DHR \cdot RXN$ is the rate of heat generation by reaction per unit reactor volume and subscript l, s, g represents the sum of the subscripted quantity for the three phases. DHR is the heat of reaction (cal/g hydrogen consumed) and RXN is the reaction rate (g hydrogen consumed per unit volume of

reactor). Equation 1 is true for both cocurrent and countercurrent flow. The holdups (volume fractions) of the phases are given by h_l , h_s and h_g . Term 1 represents the rate of change with time of the quantity of heat in the reactor, term 2 represents the dispersion of heat throughout the reactor volume, term 3 represents the convection of heat through the reactor volume and term 4 represents the rate of heat generation by reaction.

It is fair to assume that at the relatively high temperatures of the reactor the vapor phase behaves as an ideal gas. Therefore, the density and the temperature of the vapor phase are inversely proportional to each other. Further, for reasons mentioned earlier, the density of the liquid and solid phases and the holdup (h), heat capacity (C_p), velocity (U), and dispersion coefficients of all these phases are assumed constant. Equation 1 may be greatly simplified by removing these terms from the derivatives and by cancelling out the vapor terms from terms 1 and 3. Then Equation 1 may be rewritten:

$$(2) \quad (\rho C_p h)_{l,s} \frac{\partial T}{\partial t} = D_{l,s,g} \frac{\partial^2 T}{\partial x^2} - (\rho C_p U)_{l,s} \frac{\partial T}{\partial x} + DHR \quad RXN$$

(1)
(2)
(3)
(4)

Because the fluid is assumed to be well mixed across the flow area, the above terms do not depend on radial position. The same assumptions hold for the balance on hydrogen which follows.

The holdups of each phase (h) and the thermal dispersion coefficients are consistent with those used previously by Y. T. Shah and S. Parulekar⁽¹⁾ and no attempt will be made here to justify these expressions. The same expressions are assumed to apply for the countercurrent reactor for lack of better data. These are:

$$\text{Gas Holdup: } h_g = \frac{0.18 \ln U_g - .05}{S_l^{0.1} \text{ DIAM}^{.08}} \quad (\text{dimensionless})$$

where S_L is the surface tension of the liquid, ($S_L^{0.1} = 1.25$), DIAM is the reactor diameter (cm) and U_g is the superficial gas velocity (cm/sec).

$$\text{Solid hold up: } h_s = (1-h_g) \frac{\rho_{SL}}{\rho_s} (2 \text{ ASMF} + \text{ORG} + \text{ASSF})$$

where ρ_{SL} = slurry density = 1.15 g/cc

ASMF = moisture free ash concentration in the recycle stream
(g/g slurry feed)

ASSF = ASMF CI

ORG = .0595 CIMAF + ASSF = organic solids concentration in feed coal
(g/g feed)

ρ_s = Solids density (g/cm³)

where CIMAF = (1-ASMF) CI, CIMAF = moisture and ash free coal concentration in the feed (g/g feed) and CI = inlet moisture free coal concentration (g MF coal/g feed). The factor 2 in the expression for h_s takes into account the amount of organic solids recycled with the recycle ash.

$$\text{Liquid holdup: } h_l = 1-h_s-h_g$$

The velocity of each phase in Eqs. 1 and 2 is the superficial velocity based on total reactor flow area. The vapor velocity and liquid velocities are simply specified independently. Generally these are in the range of 1-6 cm/sec for the vapor and 0.15 to 0.45 cm/sec for the liquid for the Ft. Lewis pilot plant. These values are increased by a factor of 4 for the Demonstration Plant. The solid phase is assumed to flow along with the liquid and is highly influenced by the liquid velocity. The expression used is:

$$U_s = U_l (1-T_1(1-h_g))$$

where U_L is the liquid superficial velocity (cm/sec) and T_1 is the ratio of the terminal settling velocity of the solids (U_T) and the liquid velocity. The terminal velocity is given by:

$$U_T = \frac{981 D_p^2 (\rho_s - \rho_l)}{18 \text{ PMU}}$$

where D_p is the average coal solid particle diameter (~.003 cm); PMU is the fluid viscosity and the remaining term is the difference between the solid density (1.5 g/cc) and the liquid density (0.9 g/cc).

The value of the heat capacities assumed are $C_{p_g} = 0.89$, $C_{p_l} = 0.63$, $C_{p_s} = 0.27$, all units are cal/g°C. The density of the vapor phase is defined as follows from the ideal gas law assuming an average molecular weight of the vapor of 25. This value was determined independently from a vapor-liquid equilibrium calculation by J. L. Stephenson

$$\rho_v = \frac{.2405 \text{ PT}}{\text{TG}_{in}} \quad \frac{\text{g}}{\text{cc}}$$

where PT is the average reactor pressure (mPa) and TG_{in} is the inlet gas temperature (°K). For the countercurrent flow model the inlet slurry temperature and inlet gas temperature are different. For the cocurrent flow reactor the inlet slurry and gas temperatures are assumed to be equal. PT is nominally 13.8 to 14.0 mPa and TG_{in} is nominally 690 to 730°K for both Ft. Lewis and the Demo plant.

The dispersion coefficients of the phases are assumed to be lumped together into an effective coefficient which is related to the sum of the phase density times heat capacity terms and an empirical expression which depends on reactor diameter and superficial gas velocity.

$$D_{g,l,s} = (\rho C_p)_{g,l,s} \quad \text{m} \quad \text{EZL}$$

where m is a parameter which is adjusted to fit the temperature profile to experimental data. A value of $m = 0.237$ produced the desired temperature profile. EZL is given by:

$$EZL = 2.7 \text{ DIAM}^{1.4} |U_g|^{0.3}$$

and the term ρC_p is used instead of the more logical ρC_{ph} because the above correlation was based on superficial and not the actual velocities of each phase. The absolute value of U_g is required because U_g will change sign for the countercurrent reactor.

For values of m less than 0.15, the temperature profile approaches that of a plug flow reactor (high Pe and low dispersion). For values of m above 0.15, the temperature profile flattens out as in the CSTR.

The hydrogen balance is obtained directly from the standard references⁽³⁾ in terms of the mass density of hydrogen (P_H):

$$3) \quad \frac{\partial P_H}{\partial t} + \frac{U_g}{h_g} \frac{\partial P_H}{\partial x} = - \frac{RXN}{h_g}$$

(1) (2) (3)

Equation 3) equates the rate of change of mass of hydrogen per unit volume of gas (Term 1) plus the flux of mass through the reactor (Term 2) to the rate of reaction per unit volume of gas (Term 3). The absence of a dispersion term indicates that the gas flows as a plug down the reactor. U_g is positive for the cocurrent reactor and negative for the countercurrent reactor. h_g is the average gas holdup in the reactor. Note: the symbols P and ρ both refer to density.

The boundary conditions for equations 2 and 3 are obtained as follows. As with the energy balance within the reactor, an energy balance is taken across the boundary at the slurry inlet, and as the thickness of the boundary shrinks, the capacity and reaction terms become zero. The result is

a relationship between the convective flux (Term 2) and the diffusive flux (Term 1) of heat across the boundary.

$$4) \quad D_{g,l,s} \frac{\partial T}{\partial x} \Big|_{x=0^+} = (\rho C_p U)_{l,s} (T \Big|_{x=0^+} - T_{in}) \quad (1) \quad (2)$$

where $x = 0^+$ is a point just inside the reactor. It is assumed that the temperature gradient at the left of the boundary ($x = 0^-$) is zero and the inlet slurry temperature is T_{in} . Equation 4 results in a discontinuity in temperature across the boundary (see Fig. 18).

Reactor and Slurry Temperature Profile at Slurry
Inlet Boundary

Figure 18

The remaining quantities in 4) are as defined previously. Equation 4 applies to the slurry inlet of cocurrent and countercurrent reactors alike.

At the slurry outlet the temperature gradient is taken to be zero for the cocurrent reactor. For the countercurrent flow reactor the exit of the slurry corresponds to the inlet of the gas stream which acts as a "built in" quench point. For modeling purposes, the exit boundary is treated as a mixing zone in which local thermodynamic equilibrium between the slurry and the upflowing gas (mostly hydrogen) phase is achieved. There is a transfer of heat between the slurry and inlet gas which is proportional to the temperature difference between the two phases. Thus, even if hydrogen is introduced at the inlet slurry temperature, the effect is to quench the slurry and vapor slightly at the outlet and throughout the reactor due to the high level of backmixing. For lower inlet gas temperatures the quenching effect is increased. A thermal sink term is introduced into the energy balance (Eq. 2) for countercurrent flow. This term is the amount of convected enthalpy of the system needed to raise the inlet hydrogen up to the slurry temperature at the exit. The term is

$$P_H C_{pH} U_g (T_{g_{in}} - T)$$

where P_H is the hydrogen density at the inlet temperature and average reactor pressure. C_{pH} is taken to be the same as C_{pg} . U_g is again the superficial gas velocity.

$T_{g_{in}}$ is the inlet temperature of the hydrogen and T is the slurry temperature at the right boundary. The above condition is imposed in addition to the zero gradient boundary condition which results when backmixing and reaction cease beyond the outlet of the reactor. This term is introduced only into the last "element" in the finite differences form of the energy balance which is discussed later.

At the inlet the hydrogen density is specified as a constant. For the cocurrent flow this condition becomes

$$5) \quad P_H = P_{H0}, \quad x = 0$$

For countercurrent flow the inlet is at the other end of the reactor. Thus:

$$P_H = P_{H0}, \quad x = L$$

Although it is not necessary to do so because of the nature of Eq. 3 and the plug flow of gas, a zero gradient boundary condition is imposed on the hydrogen density at the hydrogen outlet. This condition becomes

$$6) \quad \frac{\partial P_H}{\partial x} = 0, \quad x = L \quad \text{for cocurrent flow}$$

$$\frac{\partial P_H}{\partial x} = 0, \quad x = 0 \quad \text{for countercurrent flow}$$

Finally, the reaction rate expression (RXN) is specified. At present no completely satisfactory rate expression has been obtained from analysis of the pilot plant data. The best model of the rate expression has been obtained by modifying an empirical expression for the hydrogen consumption derived from a statistical regression of pilot plant data. The regression model, which has the units of a yield (g hydrogen consumed/g MF coal), is first modified from a form in which the variables are a sum of linear and higher order terms into a more theoretically satisfying (but not necessarily more correct form) in which the various terms are coupled together into a product. Although previous versions of the model have used temperature in the form of an Arrhenius rate term ($\exp(E/RT)$), this was not found to be justified by the results of statistical analysis of the data. The present version of RXN contains a linear dependence on temperature in place of the exponential term mentioned above. Unconstrained regression models consistently show no more than a positive linear dependence on temperature over the range of the data and no significant second order dependence.

A further consideration which will be discussed in more detail later is the dominant effect this temperature dependent term has on the steady state behavior of the system. The modified nonlinear model is divided by the mean

slurry residence time (SRT) (which is simply the reactor length (L) divided by the superficial liquid velocity (U_L)) to convert it to a rate. It is then multiplied by the slurry density (P_{SL}) and the total slurry holdup (h_{sl}) which is just the sum of the liquid and solid holdups ($h_L + h_S$). The final result is the following expression.

$$7) \text{RXNH}_2 = .01 P_{SL} h_{sl} ZK \left[\frac{.43}{3600 \text{SRTM}} \left(\frac{CI}{CIM} \right)^{N_C} \left(1 + B \left(\frac{ASR}{ASRM} - 1 \right) \right) \left(\frac{PH2}{PH2M} \right)^{N_P} \left(1 + B_T (T - TM) \right) + \frac{.6}{\text{SRT}} \right]$$

where SRTM, CIM, ASRM, PH2M, TM are the mean values of SRT, CI, ASR, PH2 and T in the original regression data base and SRT, CI, ASR, PH2 and T are the actual nominal slurry residence time (hr), inlet coal concentration (%), recycle ash concentration (%), local hydrogen partial pressure in the reactor (mPa) and local temperature (deg K). The hydrogen partial pressure is actually expressed by means of the ideal gas law in terms of the gas density (P_H) and the local temperature (T). Thus the reaction rate term is dependent on temperature in two terms and on hydrogen mass density in one term.

The constants N_C , N_P , B, B_T are fitting parameters which are determined by a technique developed by the author and discussed in a forthcoming report. These values are 1.84, .1873, .3277 and .0338, respectively. The parameter ZK is a fitting parameter used to fit the hydrogen consumption and maximum temperature rise to pilot plant data (Ft. Lewis) at certain base conditions. The value of ZK = 1.7 produced a good fit to the data.

The variables x, t, T and P_H in the above equations are normalized in the customary fashion by dividing each by some characteristic value as follows:

$$\bar{x} = x/L$$

$$\bar{t} = t/\text{SRT}$$

$$\bar{T} = T/T_{in}$$

$$\bar{H} = P_H/P_{H0}$$

where P_{H0} and T_{in} are the inlet hydrogen density and slurry temperature and $\bar{x}$, $\bar{t}$, $\bar{T}$ and $\bar{H}$ are dimensionless quantities. Equations and boundary conditions (1-7) are reexpressed in terms of dimensionless quantities and the terms are collected and summarized below. For simplicity the overbar notation is dropped from the dimensionless variables.

Cocurrent and Countercurrent Flow:

$$8) \quad \frac{\partial T}{\partial t} = \frac{(\rho C_p U)_{l,s} SRT}{(\rho C_p h)_{l,s} Pe L} \frac{\partial^2 T}{\partial x^2} - p \frac{\partial T}{\partial x} + RXN$$

$$\text{where } Pe = \frac{(\rho C_p U)_{l,s} L}{(\rho C_p)_{g,l,s} EZL m} = \text{thermal Peclet Number}$$

$$p = \frac{(\rho C_p U)_{l,s} SRT}{(\rho C_p h)_{l,s} L} = \begin{array}{l} \text{dimensionless ratio of} \\ \text{convective heat transport} \\ \text{to heat holdup} \end{array}$$

$$RXN = \frac{DHR \cdot RXNH_2}{(\rho C_p h)_{l,s} T_{in} SRT} = \begin{array}{l} \text{dimensionless reaction} \\ \text{rate expression} \end{array}$$

$$\frac{1}{Pe} \frac{\partial T}{\partial x} = T - 1 \text{ at } x = 0 \quad \begin{array}{l} \text{for cocurrent and} \\ \text{countercurrent flow} \end{array}$$

$$\frac{\partial T}{\partial x} = 0 \text{ at } x = 1 \quad \text{for cocurrent flow}$$

For countercurrent flow the same boundary condition obtains at the exit.

$$\frac{\partial T}{\partial x} = 0 \quad \text{at } x = 1$$

However, the equation at the right boundary point contains a "sink" term defined above. The form of Eq. 8 at the right boundary is as follows.

$$\frac{\partial T}{\partial t} = \frac{(\rho C_p U)_{l,s} \text{SRT}}{(\rho C_p h)_{l,s} \text{Pe } L} \frac{\partial^2 T}{\partial x^2} + \frac{\rho_H C_{pH} U_g \text{SRT}}{(\rho C_p h)_{l,s} L} \left(T - \frac{T_{G_{in}}}{T_{in}} \right) + \text{RXN}$$

where all the terms are as defined previously and U_g is negative indicating that the gas flow is upward (opposite to that of the slurry). The second term on the right hand side is the enthalpy lost from the slurry to heat up the incoming gas.

The hydrogen balance is written similarly:

$$\frac{\partial H}{\partial t} + q \frac{\partial H}{\partial x} = -r \quad \text{RXN}$$

9)

$$\text{where } q = \frac{\text{SRT}}{L} \frac{U_g}{h_g} \quad r = \frac{\text{SRT}}{P_H} \frac{1}{h_g}$$

and U_g is positive for cocurrent flow and negative for countercurrent flow. The boundary conditions are

$$x = 0, \quad H = H_0 \text{ for cocurrent flow and}$$

$$x = 1, \quad H = H_0 \text{ for countercurrent flow and}$$

H0 is always equal to 1 because the density is made dimensionless by dividing by its inlet value. At the gas exit

$$\frac{\partial H}{\partial x} = 0 \text{ at } x = 1 \text{ for cocurrent flow}$$

$$\frac{\partial H}{\partial x} = 0 \text{ at } x = 0 \text{ for countercurrent flow}$$

The initial temperature profile is specified to be an idealized case in which the temperature everywhere in the reactor is equal to the inlet temperature. A similar initial condition is assumed for hydrogen. These are equivalent to assuming the reactor is initially filled with hot slurry and hydrogen gas but no reaction has yet taken place.

Initial condition:

At $t=0$, $T=1$ and $H=H_0$ for all x .

The terms in equations 8 and 9 are approximated by central differences and the resulting systems of implicit linear finite difference equations are solved for the temperature and hydrogen density profiles at time increments until a steady state is achieved. Because the reaction rate term may be nonlinear in temperature, it is important to evaluate this term at the most correct temperature i.e., the average temperature over the time increment at a given point. In order to do this, the entire solution is recalculated iteratively using updated values of T and H in the reaction term until the calculated and guessed values agree. Then the process is begun again at the next time step. This procedure led to a large improvement in the maximum allowable size of the time increment. It was also necessary in order to reach steady state profiles for large SRT conditions. The finite difference equations and solution technique used are summarized in Appendix 1. Appendix 2 is a listing of the computer code. The solution techniques and algorithms were identical for the two types of flow systems.

C. Steady State Analysis

In order to understand how the system approaches a steady state and to provide a check on the calculations, overall material and energy balances

were also computed. These overall balances also provided the best estimates of the model parameters to reduce the need for trial and error calculations. The forms of the balance equations were analyzed to study the dependence of the steady state on the form of the reaction term (RXN) and on the effects of important variables such as U_L , U_G and parameters such as B_T . The difference between the mass of hydrogen flowing into and out of the reactor was compared to the sum of all the hydrogen consumption terms within the reactor. The same procedure was used for the energy balance. In this case the net amount of heat flowing out of the system was computed and compared to the total heat generated by reaction and the heat held up in the reactor. These balances are obtained several ways. The expressions used in the model to compute the overall material and energy balances are summarized below.

The mass of hydrogen flowing out of the reactor in time $DT \cdot SRT$ where DT is a dimensionless time increment is:

$$DHIN = P_H U_G \text{ AREA } DT \text{ SRT } (1-H_N)$$

H_N is the dimensionless hydrogen density at the end of the reactor for the cocurrent flow reactor. H_N is replaced with H_1 for the countercurrent flow reactor.

The total amount of hydrogen reacted is given by the sum of all the individual reaction terms:

$$SUMRXN = \sum_{i=1}^N DT \text{ SRT } DL \text{ L AREA RXN}_i;$$

where DL is the dimensionless axial increment, N is the number of increments and RXN is now the point reaction rate given by Eq. 7. The values of $DHIN$ and $SUMRXN$ are summed at each time step to calculate a cumulative material balance for the entire simulation time. These two values always agree indicating no systematic or round-off error in the computation. The overall energy balance is derived similarly. The net heat flowing out in one time step is

$$DTIN = T_{in} (Cp\rho U)_{s,l,g} \quad DT \quad SRT \quad AREA$$

The total heat generated by reaction is:

$$SUMTMP = DHR \quad SUMRXN$$

DTIN and SUMTMP are summed at each time step to calculate cumulative heat balance terms. These terms approach each other in value as the steady state is reached. At any time step SUMRXN is somewhat higher than DTIN and the difference is stored as heat in the system which causes the reactor temperature to rise. As the steady state is reached, these incremental heat terms become equal.

For the purposes of analysis and to estimate the model parameters, the system equations 2 and 3 are integrated over the reactor length as follows.

At steady state, terms 1 in equations 2 and 3 are zero. Term 2 in Equation 2, when integrated across the inlet boundary and separately along the length of the reactor, produces a series of four terms which are either zero because of the boundary conditions or cancel out as follows:

$$\begin{aligned} \int_0^1 \frac{\partial^2 T}{\partial x^2} dx &= \int_{0-}^{0+} \frac{\partial^2 T}{\partial x^2} dx + \int_{0+}^1 \frac{\partial^2 T}{\partial x^2} dx \\ &= \left. \frac{\partial T}{\partial x} \right|_{0+} - \left. \frac{\partial T}{\partial x} \right|_{0-} + \left. \frac{\partial T}{\partial x} \right|_1 - \left. \frac{\partial T}{\partial x} \right|_{0+} \\ &= 0 \end{aligned}$$

Because $\left. \frac{\partial T}{\partial x} \right|_{0-} = \left. \frac{\partial T}{\partial x} \right|_1 = 0$ and the remaining two terms cancel, the above

integral is zero. The diffusion term does not remain in the integrated balance expression. This is so because this term cannot contribute to the overall energy balance in any net way. However, the diffusion does affect the

temperature profile in the reactor and the temperature in turn enters into the overall energy balance through the reaction rate term. The convection term 3 in equation 2 can be integrated directly. The reaction rate term presents a special problem. For the case of a CSTR, the temperature profile is flat; and, if RXN is assumed to be approximately independent of hydrogen density, this term may be expressed simply in its present form but evaluated at the average reactor temperature. This approximation is also justified for a highly backmixed reactor. As the flow approaches that of a plug flow reactor, the temperature profile is not readily known and must be approximated in some way (i.e., a straight line). In principle the reaction rate term may then be integrated along the length of the reactor. This produces a more accurate but somewhat more complex expression for the average reaction rate. The final form of the overall energy balance determined by this method is

$$\frac{T_{in}(\rho C_p U)_{l,s}(T_N - 1)}{L} = \int_0^1 (a + bT) dx$$

$$\text{where } a = .01 P_{SL} h_{SL}^{1.7} \left[\frac{.43}{3600 SRTM} \left(\frac{CI}{CIM} \right)^{N_C} \left(1 + B \left(\frac{ASR}{ASRM} - 1 \right) \right) \left(\frac{PH2}{PH2M} \right)^N \right. \\ \left. \cdot (1 - B_T TM) + \frac{.6}{SRT} \right] DHR$$

$$b = .01 P_{SL} h_{SL}^{1.7} DHR \left[\left(\frac{.43}{3600 SRTM} \right) \left(\frac{CI}{CIM} \right)^{N_C} \left(1 + B \left(\frac{ASR}{ASRM} - 1 \right) \right) \left(\frac{PH2}{PH2M} \right)^N B_T T_{in} \right]$$

P_{SL} = slurry density

h_{SL} = slurry holdup

If T is assumed to be constant as in a CSTR, $T_N = T$ and we obtain an expression for the steady state temperature in the vessel:

$$T_N = \frac{a + \frac{T_{in}(\rho C_p U)_{l,s}}{L}}{-b + \frac{T_{in}(\rho C_p U)_{l,s}}{L}}$$

The general expression which describes the steady state temperature for all reactor types including CSTR, partially backmixed and plug flow is given by

$$10) \quad \frac{T_{in} (\rho C_p U)_{l,s} (T_N - 1)}{L \text{ DHR}} = \int_0^1 \text{RXN} \, dx$$

where RXN is the general reaction rate term which may take on different forms for different reactor conditions. For a CSTR, RXN is constant and equation 10 becomes an algebraic equation relating the average reactor temperature to the system variables and parameters. As the level of backmixing decreases (Pe decreases), T and RXN become more strongly dependent on x and the integral term becomes harder to approximate.

Eq. 10 expresses the equality between the net heat flowing out of the reactor and the cumulative heat generated by reaction. Rearranging Equation 10 into a more convenient form (Eq. 11), the separate terms may be plotted as shown in Figure 19

Dimensionless Steady State Temperature Tss

Figure 19

$$11) \quad T_{ss} = 1 + \frac{L}{(\rho C_p U)_{l,s}} \frac{DHR}{T_{in}} \int_0^1 RXN \, dx$$

For a CSTR approximation to Ft. Lewis reactor conditions, the right hand side of Eq. 11 becomes:

$$\begin{aligned} T_{ss} &= 1.0 + .0474 T_{ss} \text{ or} \\ T_{ss} &= 1.05 \end{aligned}$$

This corresponds to a temperature rise of 34.5°C (94.1°F) for the Ft. Lewis reactor basis conditions.

One can see from Fig. 4 and Eq. 11 that the steady state temperature will increase as U_l decreases, L , DHR , recycle ash, total pressure, slurry holdup increase and as inlet coal concentration increases but will not change much as inlet slurry temperature increases, because both numerator (RXN) and denominator in the right hand side term will increase as T_{in} increases. Because of the form of Eq. 11, the intercept and the slope of the reaction line (2) are equal. As the slope decreases, so does the intercept; and the steady state temperature decreases.

If RXN were independent of temperature ($B_T=0$), the slope of line (2) would be zero. As the temperatures dependence of RXN increases or as the dependence of temperature on axial distance x increases, (as in a partially backmixed or plug flow reactor), the slope of line (2) increases and the steady state temperature rise increases. However, because the temperature near the slurry inlet undergoes a corresponding decrease, the average reactor temperature will, in general, decrease.

The cases in which RXN is independent of temperature or has at most a linear dependence on temperature assures the existence of only one steady state. Also, provided the value of the slope of the reaction line (2) is less than 1 (which will generally be the case), the steady state temperature will be a relatively low value near the inlet temperature.

However, for those conditions which cause the slope of (2) to exceed 1, no steady state exists and temperature runaway results. One such condition is when the liquid flow is reduced to only 4 to 5% of its design value. One can see from studying equations 11 and 7 that this is practically the only such condition which might lead to excessive reactor temperatures. For the actual backmixed reactor and for the more correct expression for RXN given by equation 7, one can see that as T increases H will decrease and the net effect may well be a steady state at a somewhat higher temperature and hydrogen consumption level, but temperature runaway will not occur. Computer simulations would be necessary to study this more realistic but complex case.

If RXN is made to depend on temperature by an Arrhenius reaction rate term, multiple steady states may result. This situation is shown in Fig. 20.

Figure 20 (Ref. 2)

Normally, of the three steady states shown, 2 are stable (points 1 and 3) and one is unstable (point 2) and the reactor will approach the lower stable steady state under most conditions. Again, as the slurry velocity decreases, the slope and intercept of line (2) will increase and the steady

state temperature will increase rapidly. At some lower level of U_L , there may be no intersection of the lines at a reasonable T_{ss} and no acceptable steady state will exist. This series of conditions is shown schematically in Figure 21.

Figure 21 (Ref. 2)

One can see from the above analysis that the particular form of RXN determines the steady state temperature profile in the reactor. As the temperature dependence of RXN increases, the sensitivity of the steady state temperature to changes in U_L , SRT and other variables will increase. As better kinetic models are developed, the predictions of the hydrodynamic models will improve as well.

D. Reactor Scaling Considerations

The relationships in Figure 4 and Eq. 11 can also provide information for the choice of operating conditions for larger reactor dimensions which lead to the same steady state temperature rise. For example, in the simple case in which the reaction rate term is constant and the inlet temperature is fixed, the temperature rise is fixed for reactors of different length provided

L/U_L is approximately constant. This intuitively obvious result is, of course, the condition of constant SRT for different sized reactors. Clearly a more detailed analysis would be required to fully investigate the scaling possibilities for the more general case of a partially backmixed reactor and for the more general reaction rate term involving hydrogen density and temperature. However, the results of these simulations show that temperature profiles and hydrogen consumption can be scaled to larger reactors provided SRT and Pe are held constant.

Table 2. FT. LEWIS REACTOR SIMULATION RESULTS
Effects of Process Variables on Thermal Response and Hydrogen Consumption

	Case 0	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
UL (cm/sec)	.3	.15	.45	.3									
(ft/min)	(.59)	(.295)	(.885)	(.59)									
UG (cm/sec)	3.0	4.5				1.5	3.0						
(ft/min)	(5.9)	(8.85)				(2.95)	(5.9)						
CI (gm/gmSF)	.30											.40	.20
Feed Temp. (°C)	417									400	440	417	
(°F)	(782.6)									(752)	(824)	(782.6)	
Gas Temp. (°C)	417									400	440	417	
(°F)	(782.6)									(752)	(824)	(782.6)	
PT (MPa)	14					11	17	14					
(PSIA)	(2030)					(1595)	(2466)	(2030)					
ASMF (g/gSF)	.09							.04	.14	.09			
S.S. Temp. Rise (°F)													
Co-Counter	74 72	178 153	64 63	70 67	81 80	73 71	76 73	78 75	72 70	55 54	100 97	110 105	61 60
S.S. H ₂ Consumption (%)													
Co-Counter	30.7 30.7	36.7 33.3	39.5 39.9	19.2 19.2	66.7 67.3	38.1 38.3	25.8 25.8	32.0 32.1	29.5 29.6	22.2 22.3	42.4 42.5	45.1 44.6	25.1 25.3
S.S. H ₂ Consumption Co-Counter (g/100 g MFC)	4.39 4.35	10.50 9.43	3.77 3.76	4.12 4.07	4.77 4.77	4.29 4.26	4.48 4.43	4.59 4.54	4.22 4.19	3.26 3.24	5.87 5.82	4.84 4.73	5.40 5.38
S.S. time (HRS)													
Co-Counter	6 6	25 27	3 3	6 6	6 6	6 6	6 6	7 7	6 6	6 6	6 6	9 9	5 5
Temp. Rise @ Inlet °F													
Temp. Rise within													
Reactor, °F	(47/27)	(142/36)	(34/30)	(47/23)	(47/34)	(47/26)	(49/27)	(50/28)	(45/27)	(36/19)	(65/35)	(70/40)	(40/21)
(Upper-Co, Lower-Counter)	(47/25)	(122/31)	(34/29)	(45/22)	(47/33)	(45/26)	(47/26)	(49/26)	(45/25)	(34/20)	(61/36)	(67/38)	(38/22)

*SF refers to slurry feed

**MFC refers to moisture free coal

Table 3. 'DEMO' PLANT REACTOR SIMULATION RESULTS
Effects of Process Variables on Thermal Response and Hydrogen Consumption

	Case 0	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
UL (cm/sec)	1.2	.6	1.8	1.2									
(ft/min)	(2.36)	(1.18)	(3.54)	(2.36)									
UG (cm/sec)	12.0			18.0	6.0	12.0							
(ft/min)	(23.6)			(35.4)	(11.8)	(23.6)							
CI (GM/GM SF)	.30											.40	.20
Feed Temp. (°C)	417									400	440	417	
(°F)	(782.6)									(752)	(824)	(782.6)	
Gas Temp. (°C)	417									400	440	417	
(°F)										(752)	(824)	(782.6)	
PT (MPA)	13.79					10.79	16.79	13.79					
(PSIA)	(2000)					(1564.9)	(2435)	(2000)					
ASMF (g/g SF)	.10							.05	.15	.10			
S.S. Temp. Rise (°F)													
Co-	62	126	54	58	68	61	63	62	60	45	85	86	52
Counter	60	111	53	56	67	59	61	62	58	43	82	83	51
S.S. H ₂ Consumption													
Co- (%)	25.9	26.5	34.0	16.2	56.6	32.4	21.6	27.0	25.0	18.2	36.7	36.0	21.8
Counter	26.0	25.6	34.3	16.2	57.1	32.6	21.7	27.0	25.1	18.2	37.9	35.7	22.0
S.S. H ₂ Consumption													
Co- (g/100 g MFC)	3.651	7.470	3.198	3.431	3.988	3.578	3.714	3.793	3.527	2.625	5.004	3.805	4.611
Counter	3.626	6.869	3.195	3.393	3.984	3.562	3.680	3.763	3.526	2.608	4.967	3.734	4.599
S.S. time (HRS)													
Co-	6	24	3	6	6	6	6	6	5	6	6	8	5
Counter	6	24	3	6	6	6	6	6	6	6	6	8	5
Temp. Rise @ Inlet °F													
Temp. Rise within													
Reactor °F	(39/23)	(39/27)	(29/25)	(38/20)	(39/29)	(39/22)	(40/23)	(40/24)	(38/22)	(27/17)	(53/31)	(54/32)	(33/19)
(Upper-Co,													
Lower-Counter)	(39/21)	(88/23)	(27/26)	(38/18)	(39/28)	(38/21)	(39/22)	(39/23)	(38/20)	(27/16)	(52/30)	(52/31)	(33/18)

Table 3 (con't)

	Case 0	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
Predicted Yields*													
(g/100 g MFC)													
(Counter C ₁ -C ₄)	13.2	42.3	10.3	12.5	14.0	12.7	13.6	12.2	14.3	2.2	27.9	14.7	16.7
Current) NAP	8.4	11.5	6.6	8.2	8.7	8.4	8.5	8.6	8.3	4.7	13.5	10.0	7.8
MD	18.7	48.8	12.5	22.4	15.3	21.7	15.6	21.5	16.2	-2.0	46.4	20.3	22.0
HD	19.6	24.4	17.7	19.7	19.5	8.7	30.6	14.6	24.6	21.3	17.5	19.0	19.9
SRC	43.4	6.5	45.3	50.3	36.1	45.3	41.5	49.5	43.1	63.2	16.8	46.3	35.8

*Via empirical models at average temperature, pressure and SRT.

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Table 4

BASIS CONDITIONS FOR MODEL STUDIES

	<u>Ft. Lewis Reactor Studies</u>	<u>Demo Plant Reactor Studies</u>
Diameter	60 cm (1.97 ft)	335 cm (11.0 ft)
Length	900 cm (29.53 ft)	3962 cm (123.0 ft)
Gas Velocity	3.0 cm/sec (5.905 ft/min)	12.0 cm/sec (23.62 ft/min)
Slurry Velocity	.3 cm/sec (.590 ft/min)	1.2 cm/sec (2.36 ft/min)
Total Pressure	14 MPA (2030 psia)	13.79 MPA (2000 psia)
Feed Temperature	690°K (783°F)	690°K (783°F)
Gas Temperature	690°K (783°F)	690°K (783°F)
Recycle Ash Conc.	.09 g/g Slurry	.10 g/g Slurry
Coal Concentration	.30 g/g Slurry	.30 g/g Slurry
Slurry Residence Time (SRT)	.834 hr	.869 hr

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Table 5. DEMO PLANT REACTOR RESULTS
EFFECTS OF VARIABLE INLET GAS TEMPERATURE AND SLURRY VELOCITY

	Case 13	Case 14	Case 15	Case 16	Case 17	Case 18	Case 19	Case 20	Case 21	Case 22	Case 23	Case 24	
UL (cm/sec)	1.2	→ 0.6							→ 1.8	→			
(ft/min)	(2.36)												
UG (cm/sec)	12.0	→											
(ft/min)	(23.62)												
CI (g/g SF)	.30	→											
Feed Temp. (°C)	417	→											
(°F)	(782.6)												
Gas Temp. (°C)	327	227	127	27	327	227	127	27	327	227	127	27	
(°F)	(620.6)	(440.6)	(260.6)	(80.6)									
PT (MPA)	13.79	→											
(PSIA)	(2000)												
ASMF (g/gSF)	.10	→											
S.S. Temp Rise (°F)	55	46	34	temp drops from inlet	89	54	temperature drops	50	45	38	27		
S. S. H ₂ Consumption %	22.1%	17.7%	13.4%	9.0%	18.6%	11.9%	5.4%	5.5%	29.6%	24.4%	19.1%	13.9%	
(g/100 g MFC)	3.544	3.414	3.220	2.899	5.974	4.598	2.625	0.316	3.171	3.132	3.073	2.972	
S. S. Time (Hr)	27.5	27.5	27.5	27.5	55.0	55.0	55.0	55.0	18.3	18.3	18.3	18.3	
Temp Rise @ Inlet	(36/19)	(32/14)	(26/7)	(18/-5)	(72/17)	(47/7)	(11/-6)	-	(27/33)	(26/19)	(24/14)	(21/6)	
Temp Rise within Reactor													
(°F)													

MFC refers to moisture free coal
 SF refers to slurry feed

Table 5 (con't)

		Case 13	Case 14	Case 15	Case 16	Case 17	Case 18	Case 19	Case 20	Case 21	Case 22	Case 23	Case 24
Predicted Yields*													
(g/100gMF coal)	C ₁ -C ₄	12.2	10.7	8.5	4.8	32.5	17.8	-3.2	-34.6	10.1	9.6	8.8	7.6
(Counter-current	NAP	8.0	7.7	6.8	5.6	9.5	6.7	2.6	-3.6	6.4	6.2	5.8	5.2
flow)	MD	16.8	14.0	9.8	3.0	39.7	25.8	6.0	-23.7	11.6	10.1	8.0	4.4
	HD	19.8	20.0	20.3	20.9	25.2	26.3	27.9	30.2	17.8	17.9	18.1	18.4
	SRC	45.1	47.8	51.8	58.4	21.9	45.2	78.4	128.1	46.0	47.0	48.6	51.1

*Yield Predictions based on Powhatan coal correlation. Yields can be corrected to Kentucky coal yields by the following adjustments:

To change Powhatan yields to Kentucky yields:

<u>Yield</u>	<u>Add to Powhatan yield</u>	
C ₁ -C ₄	-2.3870	-2.39
Naphthas	0	
Middle Distillate	-6.415	-6.42
Heavy Distillate	0	
SRC	0	

SF refers to slurry feed

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Table 6

Values of Peclet Number (Pe) Defined by Eq.8
For Several Cases Shown in Tables 2, 3, 4

<u>Ft. Lewis</u>				<u>Demonstration Plant</u>			
<u>Case</u>	<u>Pe</u>	<u>U_l</u>	<u>U_g</u>	<u>Case</u>	<u>Pe</u>	<u>U_l</u>	<u>U_g</u>
0	.941	.30	3.0	0	.984	1.2	12.0
1	.470	.15	3.0	1	.492	0.6	12.0
2	1.350	.45	3.0	2	1.480	1.8	12.0
3	.833	.30	4.5	3	.871	1.2	18.0
4	1.158	.3	1.5	4	1.211	1.2	6.0

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Table 7

Yields from "Second Order Models"*

$$\begin{aligned}
 YDC1C4 &= 30.38727 - 211.3156 \quad VSRT - 1.314 \quad VCIN + 1.1945 \quad VCOAL \\
 &\quad + .01578VCIN2 + .4855 \quad VTS + .01108 \quad VPR \\
 YDNAP &= 54.92379 + .12887 \quad VTAVG - 4.75446 \quad VSRT2 + .0248 \quad VTS \\
 YDMD &= 5.2235 - 33.684 \quad VRASH + .8244 \quad VV + 3.2079 \quad VNCOAL + \\
 &\quad .084 \quad VTR + .51469 \quad VPH2 - .16066 \quad VPR - .0754 \quad VCR \\
 YDHD &= -7.637 + .77319 \quad VPH2 + 7.29676 \quad VSRT - .00672 \quad VTR \\
 &\quad + .28854 \quad VPR \\
 YDSRC &= 69.94148 + 269.50221 \quad VSRT + .36536 \quad VCIN + .95626 \quad VV \\
 &\quad + .1487 \quad VRASH2 - .65885 \quad VTS - .019935 \quad VTR - .0201 \quad VPC \\
 &\quad + .2625 \quad VSR + .11293 \quad VCR
 \end{aligned}$$

where YDC1C4, YDNAP etc., are the yields of C₁-C₄, naphthas, middle distillate (350-550°F), heavy distillate (550-850°F), and SRC (>850°) respectively in g/100gMFcoal. The terms in the expressions are:

VSRT, VSRT2 = SRT and SRT² = slurry residence time (HR)
 VCIN, VCIN2 = CI and CI² = inlet coal concentration (g/g slurry feed)
 VTAVG = average reactor temperature (°C)
 VV = superficial linear gas velocity (cm/sec)
 VRASH, VRASH2 = RASH, RASH² = recycle ash conc. (g/gSF)
 VPH2=PH2 = hydrogen partial pressure (mPa), (total pressure, P_T, was used)
 VNCOAL = coal parameter = +1 for Powhattan, -1 for Kentucky
 VTS = TAVG SRT (°C hr)
 VPR = PH2 RASH, VTR = TAVG RASH, VPS = PH2 SRT, VPC=PH2 CIN,
 VSR = SRT RASH, VCR = CIN RASH

*These models are second order in the primary variables but include a linear gas velocity term and a coal level term. The linear gas velocity term present in the yields of SRC and MD make the predictions of these yield models highly suspect for the Demo Plant simulations because the value of VV in these cases lie outside the data base used to derive the models. The values of VSRT and VTAVG used above are the average SRT and the average of the inlet and outlet slurry temperatures, respectively. Other data such as VCI and VRASH are fixed by the inlet conditions.

Figure 3-A

TEMPERATURE RISE vs. SLURRY VELOCITY
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 3-B

HYDROGEN CONSUMPTION vs. SLURRY VELOCITY
FT. LEWIS SIMULATION

(Ref. to Tables 2, 4)

figure 4-A

TEMPERATURE RISE vs. GAS VELOCITY
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 4-B

HYDROGEN CONSUMPTION vs. GAS VELOCITY
FT. LEWIS SIMULATION

(Ref. Table 4)

Figure 5-A

OVERALL TEMPERATURE RISE vs. TOTAL PRESSURE
FT. LEWIS SIMULATION

(Ref. Table 2, 4)

Figure 5-B

HYDROGEN CONSUMPTION vs. TOTAL PRESSURE
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 6-A

OVERALL TEMPERATURE RISE vs. SLURRY FEED TEMPERATURE
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 6-B

HYDROGEN CONSUMPTION vs. SLURRY FEED TEMPERATURE
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 7-A

OVERALL TEMPERATURE RISE vs. INLET SLURRY COAL CONCENTRATION
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 7-B

HYDROGEN CONSUMPTION vs. INLET SLURRY COAL CONCENTRATION
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 8-A

OVERALL TEMPERATURE RISE vs. RECYCLE ASH CONCENTRATION
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 8-B

HYDROGEN CONSUMPTION vs. RECYCLE ASH CONCENTRATION
FT. LEWIS SIMULATION

(Ref. Tables 2, 4)

Figure 9

AXIAL TEMPERATURE PROFILE (°K)
FT. LEWIS BASIS CONDITIONS

(Ref. Table 2)

Figure 10

AXIAL TEMPERATURE PROFILE (°K)
DEMONSTRATION PLANT BASIS CONDITIONS

(Ref. Table 2)

Figure 11-A

OVERALL TEMPERATURE RISE vs. SLURRY VELOCITY
DEMONSTRATION PLANT SIMULATION

(Ref. Table 3, 4)

Figure 11-B

HYDROGEN CONSUMPTION vs. SLURRY VELOCITY
DEMONSTRATION PLANT SIMULATION

(Ref. Tables 3, 4)

Figure 12-A

OVERALL TEMPERATURE RISE vs. SUPERFICIAL GAS VELOCITY
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 12-B

HYDROGEN CONSUMPTION vs. SUPERFICIAL GAS VELOCITY
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 13-A

OVERALL TEMPERATURE RISE vs. TOTAL PRESSURE
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 13-B

HYDROGEN CONSUMPTION vs. TOTAL PRESSURE
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 14-A

OVERALL TEMPERATURE RISE vs. SLURRY FEED TEMPERATURE
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 14-B

HYDROGEN CONSUMPTION vs. SLURRY FEED TEMPERATURE
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 15-A

OVERALL TEMPERATURE RISE vs. INLET COAL CONCENTRATION
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 15-B

HYDROGEN CONSUMPTION vs. INLET COAL CONCENTRATION
DEMONSTRATION PLANT SIMULATIONS

(Ref. Tables 3, 4)

Figure 16-A

OVERALL TEMPERATURE RISE vs. RECYCLE ASH CONCENTRATION
DEMONSTRATION PLANT SIMULATION

(Ref. Tables 3, 4)

Figure 16-B

HYDROGEN CONSUMPTION vs. RECYCLE ASH CONCENTRATION
DEMONSTRATION PLANT SIMULATIONS

Figure 17-A

AXIAL TEMPERATURE PROFILES
FOR DEMONSTRATION PLANT

Slurry Velocity = 0.6 cm/sec (1.18 ft/min)

(Ref. to Table 5)

Figure 17-B

AXIAL TEMPERATURE PROFILES
FOR DEMONSTRATION PLANT

Slurry Velocity = 1.2 cm/sec (2.36 ft/min)

(Ref. to Table 5)

Figure 17-C

AXIAL TEMPERATURE PROFILES
FOR DEMONSTRATION PLANT

Slurry Velocity = 1.8 cm/sec (3.54 ft/min)

(Ref. to Table 5)

VI. Areas of Future Work

The area in the countercurrent model where data are most lacking is in the effect of flows and reactor dimensions on slurry mixing, dispersion and heat transfer and phase holdups (gas, liquid, solid). Very little literature exists on these and experimental data would be very helpful.

The models are being modified to include quench points to allow a direct comparison of the quenched cocurrent flow and the countercurrent flow with cooled inlet gas. Also, comprehensive kinetic models of liquid, solid and gas species will be incorporated to determine the effects of thermal history, flow changes and other reactor conditions on these yields. Additional simulations could be run investigating the transient behavior of the reactors for changes in major variables such as slurry or gas velocity or reactor pressure excursions. These studies may be part of a more detailed analysis of thermal stability of the system.

The kinetic models mentioned previously should be improved (particularly the hydrogen consumption) to take into account the effect of coal type. The temperature and pressure dependence of these models should be studied more closely because the system thermal behavior is critically dependent on these.

VII. Nomenclature

<u>Computer Symbol</u>	<u>Model Symbol</u>	<u>Definition</u>	<u>Units</u>
DENG	ρ_g	density of vapor in reactor	g/cc
DENS	ρ_s	density of solid in reactor	g/cc
DENL	ρ_l	density of liquid in reactor	g/cc
DENH	-	inlet hydrogen density	g/cc
CPG	C_{p_g}	heat capacity of vapor	cal/g°C
CPL	C_{p_l}	heat capacity of solid	cal/g°C
CPS	C_{p_s}	heat capacity of liquid	cal/g°C
EG	h_g	holdup of vapor	cc/cc reactor
ES	h_s	holdup of solid	cc/cc reactor
EL	h_l	holdup of liquid	cc/cc reactor
TMP	T	local reactor temperature	°K
DIFF,EZL	D_g	dispersion coefficient of vapor	cm ² /sec
DIFF,EZL	D_l	dispersion coefficient of liquid	cm ² /sec
DIFF,EZL	D_s	dispersion coefficient of solid	cm ² /sec
UG	U_g	superficial velocity of vapor	cm/sec
US	U_s	superficial velocity of solid	cm/sec
UL	U_l	superficial velocity of liquid	cm/sec
DHR	DHR	heat of reaction *	cal/g
RXNH2	RXNH2	reaction rate expression	cal/cm ³ sec
RXN	RXN	normalized reaction rate expression	dimensionless
X	x	axial distance	cm
T	t	time	sec
ESL	h_{sl}, h_{SL}	slurry hold up	-
DIAM	DIAM	reactor diameter	cm
DENSL	ρ_{sl}, ρ_{SL}	slurry density	g/cm ³
ASMF	ASMF	moisture free recycle ash concentration based on coal	g/100g MF coal
ORG	ORG	estimated organic content of slurry	g/100g slurry

Nomenclature (con't)

<u>Computer Symbol</u>	<u>Model Symbol</u>	<u>Definition</u>	<u>Units</u>
ASSF	ASSF	ash times coal concentrations	-
CI	CI	inlet moisture free coal concentration in feed coal	g/100g slurry
CIMAF	CIMAF	moisture and ash free coal concentration in feed slurry	g/g slurry
TI	TI	ratio of terminal velocity to superficial liquid velocity	-
UT	U_T	terminal solids settling velocity	cm/sec
DP	D_p	coal particle diameter	cm
PMU	PMU	slurry viscosity	poise
PT	P_T	total reactor pressure	MPa
TGIN	$T_{g_{in}}$	inlet hydrogen temperature	deg K
PET	Pe	Thermal Peclet Number	-
TEMP	T_{in}	inlet slurry temperature	deg. K
SRTM	SRTM	mean values from data base of slurry residence time	hr
CIM	CIM	moisture free coal concentration	g/100g slurry
ASRM	ASRM	recycle ash concentration	g/100g MF coal
PH2M	PH2M	hydrogen partial pressure	mPa
TMPM	T_M	reactor temperature	deg. K
SRT	SRT	slurry residence time	hr
CI	CI	inlet coal concentration (MF)	g/100g slurry
BH2	B	ash parameters in RXN expression	-
B_T	B_T	temperature parameter in RXN	-
TMP	T, T	reactor temperature	dimensionless
-	T	reactor temperature	deg K

Nomenclature (con't)

<u>Computer Symbol</u>	<u>Model Symbol</u>	<u>Definition</u>	<u>Units</u>
ZKH2	ZK	parameter to fit hydrogen consumption to data	-
ZNH2	N_p	pressure dependence parameter in RXN	-
ZNCH2	N_c	concentration dependence parameter in RXN	-
-	$\bar{x}, x$	dimensionless distance	-
TIME	$\bar{t}, t$	dimensionless time	-
RXNH2	RXN, RXNH2	dimensionless reactor rate expression	-
-	p, q, r	dimensionless quantities in heat and material balances	-
H2, H2T	$\bar{H}, H$	dimensionless hydrogen mass concentration	-
I	I, i	axial counter	-
NDIST	N, NDIST	number of axial steps	-
ZL	L, ZL	length of reactor	cm
AREA	AREA	reactor area	cm ²
H (NDIST)	H_N	outlet hydrogen concentration	-
DTIN	DTIN	heat flowing in one time step	cal
DHIN	DHIN	net mass flowing in one time step	g
SUMTMP	SUMTMP	total heat generated by reaction in one time step	cal
SUMRXN	SUMRXN	total mass of hydrogen consumed by reaction in one time step	g
-	$\bar{T}_{ss}, T_{ss}$	steady state dimensionless temperature	-
-	ρ_H, P_H	hydrogen mass concentration in reactor	g/cc
DENH	P_{H0}	hydrogen mass concentration in inlet gas	-

Nomenclature (con't)

<u>Computer Symbol</u>	<u>Model Symbol</u>	<u>Definition</u>	<u>Units</u>
-	Q	dimensionless heat term associated with either convection of heat or reaction	-
P1	P1	approximately average hydrogen partial pressure in the reactor	mPa
m	m	an adjustable parameter in the Peclet number	-
	p,q,r	ratios of transport terms	-
H0	H0	dimensionless inlet hydrogen concentration	-
CPH	CP _H	heat capacity of inlet gas from countercurrent flow	cal/g°C

VIII. References

1. S. J. Parulekar, Y. T. Shah, "Model for the SRC-II Coal Liquefaction Reactor" Report No. 624RJ041, October 1978.
2. R. Aris, Introduction To The Analysis of Chemical Reactor, Prentice-Hall, Inc., 1965.
3. R. B. Bird, W. E. Stewart, E. L. Lightfoot, Transport Phenomenon, John Wiley, 1960.

IX. Appendices

Appendix 1

Finite Difference Equations and Solution Algorithm

Used In the Computer Code

Equations 8 and 9 plus boundary conditions along with Eq. 7 for the reaction rate and subsidiary equations describe the dimensionless temperature $\bar{T}$ and hydrogen density $\bar{H}$ profiles in the reactor as a function of time. The terms in these equations are approximated by the following finite difference approximations. For clarity the differential terms in the equations are expressed directly in terms of computer code variables which are defined in the Nomenclature. Thus:

$$\frac{\partial \bar{T}}{\partial t} = \frac{\text{TMP}(I) - \text{TMPO}(I)}{DT}$$

$$\frac{\partial \bar{T}}{\partial x} = \frac{\text{TMP}(I + 1) - \text{TMP}(I - 1)}{2 \text{ DL}}$$

$$\frac{\partial^2 \bar{T}}{\partial x^2} = \frac{\text{TMP}(I + 1) + \text{TMP}(I - 1) - 2 \text{ TMP}(I)}{\text{DL}^2}$$

$$\frac{\partial \bar{H}}{\partial t} = \frac{\text{H2}(I) - \text{H2O}(I)}{DT}$$

$$\frac{\partial \bar{H}}{\partial x} = \frac{\text{H2}(I + 1) - \text{H2}(I - 1)}{2 \text{ DL}}$$

where $\text{H2}(I)$ and $\text{TMP}(I)$ are the latest values of $\bar{H}$ and $\bar{T}$, $\text{H2O}(I)$ and $\text{TMPO}(I)$ are the "old" values of $\bar{H}$ and $\bar{T}$ at the previous time step and subscript I is the axial location. $I = 1$ refers to a point just inside the reactor at the slurry inlet (bottom of the reactor for cocurrent, and top of the reactor for countercurrent flow) and $I = \text{NDIST} - 1$ is a point just inside the reactor at the slurry outlet (top for cocurrent, bottom for countercurrent). NDIST is

defined as 1.0 divided by the axial increment DL plus 1. $I = 0$ refers to a feed condition and $I = \text{NDIST}$ refers to a point just outside the exit end of the reactor for both cocurrent and countercurrent flow. Thus the boundary conditions on the slurry are unchanged for the two types of flow but the boundary conditions on the hydrogen are reversed. The countercurrent flow reactor does contain an additional sink (quench) term at the exit end due to the cooling effect of the incoming hydrogen. This term is not present in the cocurrent flow reactor where both gas and slurry enter at the same temperature.

Because the reaction term (RXN) contains nonlinear terms in $\bar{H}$ and $\bar{T}$, it cannot be evaluated at the latest time as are the other terms. Instead, the reaction rate is evaluated at an average $\bar{T}$ (TAVG(I)) and $\bar{H}$ (HAVG(I)) where HAVG and TAVG are the average of the values of $\bar{H}$ and $\bar{T}$ at the old time step and the latest time step. Of course, at this point the values of $\bar{H}$ and $\bar{T}$ at the latest time step are not known; they are set at their old values. The general procedure, which will be shown in more detail later, is to iterate on the latest solutions for $\bar{H}$ and $\bar{T}$ using updated values of TAVG and HAVG each time until the successive values of $\bar{H}$ and $\bar{T}$ don't change significantly. Then the iterative process is repeated at the next time step. The profiles of $\bar{H}$ and $\bar{T}$ are calculated at each iteration step by solving the series of NDIST linear equations for each variable. These are obtained as follows. At the slurry inlet the so-called Dankwerts boundary condition applies for $\bar{T}$. The finite difference approximation of the condition is

$$\frac{\text{TMP}(1) - \text{TMP}(0)}{2 \text{ DL} \cdot \text{PE}} = \text{TMP}(1) - \text{TMP}(0) \quad \text{Dankwerts B. C.}$$

The inlet temperature is specified $\text{TMP}(0) = 1$ Left Inlet Condition

The following boundary conditions are written in the differential form on the left followed by the form as they appear in the computer code.

For $\bar{H}$ the condition at the slurry inlet is:

$$\bar{H} = 1 \text{ or } H_2(0) = H_{20} \quad \text{for cocurrent flow}$$

$$\frac{\partial \bar{H}}{\partial x} = 0 \text{ or } H_2(2) = H_2(0) = H_{20} \quad \text{for countercurrent flow}$$

$$H_{20} = 1$$

At the slurry outlet, the boundary conditions are

$$\frac{\partial \bar{T}}{\partial x} = 0 \text{ or } TMP(NDIST + 1) = TMP(NDIST - 1) \text{ co- or countercurrent flow}$$

$$\frac{\partial \bar{H}}{\partial x} = 0 \text{ or } H_2(NDIST + 1) = H_2(NDIST - 1) \text{ for cocurrent flow}$$

$$\bar{H} = H_{20} = H_2(NDIST) \text{ for countercurrent flow}$$

$$H_{20} = 1$$

The sink term applicable at $I = NDIST$ and described previously in Section III will be discussed later.

Equations 8 and 9 become with these approximations:

TEMPERATURE:

$$\frac{(\rho C_p)_{l,s,q} \frac{EZL}{DL} \frac{SRT}{DL} \frac{DT}{DL}}{(\rho C_{ph})_{l,s} \frac{(ZL}{DL})^2} (TMP(I + 1) - 2 TMP(I) + TMP(I - 1)) -$$

$$\frac{(\rho C_{pu})_{l,s} \frac{SRT}{DL} \frac{DT}{DL}}{2 (\rho C_{ph})_{l,s} \frac{ZL}{DL}} (TMP(I + 1) - TMP(I - 1)) =$$

$$TMP(I) - TMP_0(I) - \frac{RXN}{(\rho C_{ph})_{l,s}} \frac{SRT}{TEMP} \frac{DT}{DL} \frac{DHR}{DL}$$

for $I = 2$ to $NDIST - 1$ (within reactor - both co- and countercurrent flow)

HYDROGEN:

$$\frac{DT}{2ZL} \frac{SRT}{DL} \frac{UG}{HG} \left(H_2(I + 1) - H_2(I - 1) \right) = H_2(I) - H_2O(I) + \frac{RXN}{P_H} \frac{SRT}{HG} \frac{DT}{HG}$$

for I = 2 to NDIST-1.

These terms are defined completely in the Nomenclature and and RXN is defined in Section III (Material and Energy Balances) and later on in this Appendix.

To simplify further the presentation, the groups of terms are defined as in the computer code.

$$C1 = \frac{EZL}{(ZL \quad DL)^2} \frac{SRT}{DL} \frac{DT}{DL}$$

$$C2 = \frac{(\rho CpU)_{l,s}}{2 \quad ZL} \frac{SRT}{DL} \frac{DT}{S6}$$

$$C3 = ZK \quad C9 \quad DHR$$

C4 is defined later.

$$C5 = \frac{(\rho Cph)_{l,s}}{S6}$$

$$C7 = \frac{DT}{ZL} \frac{SRT}{DL} \frac{UG}{HG}$$

$$C8 = \frac{ZK}{DENH} \frac{SRT}{HG} \frac{DT}{HG}$$

$$C9 = \frac{SRT}{TEMP} \frac{DT}{S6}$$

$$PET = \frac{(\rho Cp)_{l,s}}{DIFF} \frac{ZL}{S6}$$

$$DIFF = M \quad EZL$$

$$S6 = (\rho Cp)_{s,l,g} = \rho_s Cp_s + \rho_l Cp_l + \rho_g Cp_g$$

The summation convention used in S6 is shown above and applied to other terms. The numbers ZK and M are assigned the values 1.7 and .235 respectively to fit the profiles to experimental data. DHR is given the value 2730 cal/g to fit the correct experimental thermal behavior.

The coefficients of the systems of equations for $\bar{T}$ and $\bar{H}$ are ATMP(I), BTMP(I), CTMP(I), DTMP(I) and AH(I), BH(I), CH(I) and DH(I), respectively. These are summarized as follows:

For both cocurrent and countercurrent flow:

I = 2 to NDIST-1

AH(I) = -C7	BH(I) = 1	CH(I) = C7
ATMP(I) = C1 + C2	BTMP(I) = -C5-2C1	CTMP(I) = C1-C2
DH(I) = H20 (I) - C8 RXNH2		
DTMP(I) = -C5 TMPO(I) - C3 RXNH2		

For Cocurrent flow:

I = 1

AH(1) = 0	BH(1) = 1	CH(1) = 0	DH(1) = 1
ATMP(1) = 0	BTMP(1) = $\frac{-1}{DL} - 1$	CTMP(1) = $\frac{1}{DL \cdot PET}$	DTMP(1) = -1

I= NDIST

AH(NDIST) = -2C7	BH(NDIST) = 1 + 2C7	CH(NDIST) = 0
ATMP(NDIST) = 2C1	BTMP(NDIST) = -C5-2C1	CTMP(NDIST) = 0
DH(NDIST) = H20(NDIST) - C8 RXNH2		
DTMP(NDIST) = -TMPO(NDIST) C5-C3 RXNH2		

For countercurrent Flow:

$$I = 1$$

$$AH(1) = 0 \quad BH(1) = 1 - 2C7 \quad CH(1) = 2C7 \quad DH(1) = H2O(1) - C8 \cdot RXNH2$$

$$ATMP(1) = 0 \quad BTMP(1) = \frac{-1}{DL \cdot PET} \quad CTMP(1) = \frac{1}{DL \cdot PET}$$

$$DTMP(1) = -TMPO(1) \cdot C5 - C3 \cdot RXNH2$$

$$I = NDIST$$

$$AH(NDIST) = -C7 \quad BH(NDIST) = 1 \quad CH(NDIST) = C7$$

$$DH(NDIST) = H2O(NDIST) - C8 \cdot RXNH2 - C7$$

$$ATMP(NDIST) = 2C1 \quad BTMP(NDIST) = -2C1 - C4 - C5 \cdot TMP(NDIST) = 0$$

$$DTMP(NDIST) = -C3 \cdot RXNH2 - C4 \cdot TG_{in}/TEMP - TMPO(NDIST) \cdot C5$$

where

$$C4 = \frac{DENH \cdot CPG \cdot UG \cdot SRT \cdot DT}{DL \cdot ZL \cdot S6}$$

$DENH = P_H$ = density of hydrogen feed defined by the ideal gas law

$$DENH = \frac{PT \cdot 2000 \cdot 2}{TG_{in} \cdot 14.7 \cdot 82.06 \cdot 13.79} \quad \frac{g}{cm^3}$$

where PT is the total reactor pressure and TGIN is the temperature of the inlet hydrogen. TEMP is the inlet temperature of the slurry feed. The various numbers are left in the expression above to show how the units are converted to give those of density.

$$RXNH2 = CRXN(1 + BT(TEMP \cdot TAVG(I) - TMPM)) \cdot (TAVG(I) \cdot H2AVG(I))^{ZNH2} + C11$$

where

$$CRXN = .43 \frac{(.01 \cdot DENSL \cdot ESL)}{3600} \left(\frac{C1MAF}{CIM} \right)^{ZNCH2} \left(1 + BH2 \cdot (ASF - ASRM) \right) \frac{1}{SRTM} \left(\frac{P1}{PH2M} \right)^{ZNH2}$$

ZNH2 = .1873; ZNCH2 = 1.84; BT = .0338 (Regression parameters)

CIM = .296; SRTM = 0.78; PH2M = 12.59 (mean values of the variables)

C11 = 0.6 · 01 · ESL · DENSL/SRT

$P1 = PT \left(\frac{2}{25} \right)$ (actual average hydrogen partial pressure)

ESL = slurry holdup = ES + EL = solid holdup + liquid holdup

The terms in the above expressions are defined in the Nomenclature. CRXN and C11 are obtained directly from the expression RXN in Section III. The term RXNH2 above is defined in terms of H2AVG(I) and TAVG(I) as mentioned earlier.

C4 above comes from the introduction of hydrogen gas at the exit of the reactor which acts as a heat sink in the countercurrent case. A similar approach could be used for other quenches should they be incorporated into later versions of the program. At each time step the solutions are obtained by a standard solution technique called the Thomas Algorithm defined in (1).

Before the steady state is reached the "new" solutions will differ from the "old" solutions at each time step. On the first iteration at each time step the solutions are simply saved in order to compare them to those at the next time step. In the second iteration the solutions are again obtained by the Thomas Algorithm but RXNH2 is evaluated at H2AVG(I) and TAVG(I) defined as:

$$H2AVG(I) = \frac{H2T(I) + H2O(I)}{2}$$

$$TAVG(I) = \frac{TMPT(I) + TMPO(I)}{2}$$

where H2O and TMPO do not change since they are the values of H2 and TMP at the last time step. H2T and TMPT are temporary new solutions which do change at each iteration until 'correct' solutions are obtained. The above averages

are used to generate better values of $H_2T(I)$ and $TMPT(I)$ after each succeeding iteration, which are compared at one point in the reactor. This point is chosen to be $I = NDIST$ for both cocurrent and countercurrent flow until convergence is found.

Although the choice of convergence criterion is arbitrary, the exact values do not seem to make much difference. If the convergence condition is satisfied, it is assumed that a correct temperature and concentration have been obtained. If the condition is not satisfied, the next iteration is begun or, if the maximum number of iterations is exceeded, the next time step in the computation is begun. This latter situation does not generally occur unless the tolerance for convergence is too small or the solution is diverging (i.e., the steady state is not being reached). The number of iterations also depends on the degree of nonlinearity of the reaction rate term. This is particularly true when RXN includes an Arrhenius reaction rate term. If RXN were expressed only in terms of $\bar{T}$ or $(TMP(I))$ and not in terms of $\bar{H}$ or $\bar{T}$ to a power, the entire equation system can be solved implicitly and there is no need for the internal iteration scheme. A simpler approach is to assume that the reaction rate can be evaluated at the old time step and used to calculate $\bar{H}$ and $\bar{T}$ at the latest time step. This is a valid approach provided the reaction rate is not changing rapidly with time, i.e., when the time steps are very small or the reaction rate is very small. However, for the coal system under consideration the reaction rate is relatively rapid at first and it is definitely not small. In order to reach a steady state in the fewest number of iterations, it is also necessary to use relatively long time steps (i.e., .1 SRT) but to set the number of iterations in the iteration scheme to a relatively high value to assure internal convergence at each time step. As time progresses, the number of iterations decreases rapidly. A second consideration is the accuracy of the solution. Evaluating the reaction rate term systematically at the previous time step will lead to a slower reaction rate, slower thermal response and hydrogen consumption and a slower approach to a steady state. This may not be as accurate as the solution predicted by the iteration scheme.

The form of the equations is summarized below.

$$\begin{aligned}
 I=1 \quad & BT(1) \cdot TMP(2) + CT(1) \cdot TMP(1) & = DT(1) \\
 I=2 \quad & AT(2) \cdot TMP(1) + BT(2) \cdot TMP(2) + CT(2) \cdot TM(3) & = DT(2) \\
 & : & : \\
 I=I \quad & AT(I) \cdot TMP(I - 1) + BT(I) \cdot TMP(I) + CT(I) \cdot TMP(I+ 1) & = DT(I) \\
 & : & : \\
 I=NDIST-1 \quad & AT(NDIST-1) \cdot TMP(NDIST-2) + BT(NDIST-1) \cdot TMP(NDIST-1) \\
 & + CT(NDIST-1) \cdot TMP(NDIST) & = DT(NDIST-1) \\
 I=NDIST \quad & AT(NDIST) \cdot TMP(NDIST-1) + BT(NDIST) \cdot TMP(NDIST) & = DT(NDIST)
 \end{aligned}$$

A similar set of equations is obtained for $\bar{H}$ with a corresponding set of coefficients. Note the equation for $\bar{T}$ naturally requires a pair of boundary conditions to completely specify the second order differential term. However, this is not the case with $\bar{H}$. The additional boundary condition imposed on $\bar{H}$ does provide the added advantage of increased accuracy and stability for the system without quench addition. When quench addition is included in later versions of the model, the hydrogen balance requires a different set of finite difference approximations and a different solution algorithm.

APPENDIX 2

COMPILER OPTIONS - NAME= MAIN.OPT=02.LINECNT=56.SIZE=0250X.

SOURCE=ENCDC,NOLIST,NOOCLK,LOAD,MAP,NOEDIT,ID,XREF

```

      ISN 0002      IMPLICIT REAL*8(A-H,O-Z)
      ISN 0003      DIMENSION AH(101),BH(101),CH(101),DH(101),H2(101),ATMP(101),
      16TMP(101),CTMP(101),DTMP(101),TMP(101)
      ISN 0004      DIMENSION TMM(101),H2O(101),RXN(101),TNP(101),H2T(101)
      ISN 0005      DIMENSION TAVG(101),H2AVG(101),TCONV(300),TMPRIZ(300),HYDCMP(300)
      C BASIC DATA
      C REACTOR LENGTH - ZL, DIAMETER-CM-DIAM-CM
      C DENSITY-SOLID-DENS, LIQUID-DENL, GAS-DENG (G/CC)
      C HEAT CAPACITY-SOLID-CPS, LIQUID-CPL, GAS-CPG (CAL/CM K)
      C DENSITY OF SLURRY-DENSL (G/CC)
      C PARTICLE DIAMETER-DP (CM)
      C INLET COAL CONCENTRATION-C1 (G COAL/100 G SLURRY FEED)
      C VELOCITY(SUPERFICIAL) OF GAS-VG, OF LIQUID-VL (CM/SEC)
      C FLUID VISCOSITY-PMU- .004
      C RECYCLE ASH CONCENTRATION-ASHF (G/100 G SLURRY FEED)
      C.....TEMPERATURE AT INLET-TEMP-DEG K
      C TOTAL PRESSURE-PT (MPA)
      C AREA IS THE REACTOR FLOW AREA IN CM**2
      ISN 0006      ZL=3962
      ISN 0007      DIAM=335
      ISN 0008      DENS=1.5
      ISN 0009      DENL=0.9
      ISN 0010      TEMP=690.
      ISN 0011      UG=12.0
      ISN 0012      TGIN=TEMP
      ISN 0013      TGCC=400
      ISN 0014      ICC=1
      ISN 0015      ITM=16
      ISN 0016      IF(ICC.EQ.1) GO TO 114
      93 ISN 0018      113 CONTINUE
      ISN 0019      DENSL=1.15
      ISN 0020      CPS=.28
      ISN 0021      CPL=.63
      ISN 0022      CPG=.69
      ISN 0023      PMU=.004
      ISN 0024      DP=.0003
      ISN 0025      ASHF=.10
      ISN 0026      C1=.30
      ISN 0027      PT=13.79
      ISN 0028      AREA=DIAM**2*3.14159/4.
      ISN 0029      DENH=PT*2000.*2./((TGIN*14.7*82.06*13.79)
      ISN 0030      DENG=25.*DENH*TGIN/(2*TEMP)
      C.....DENG REFERS TO TOTAL VAPOR PHASE DENSITY INCLUDING VAPOR-
      C.....IZED OILS, ETC. DENH REFERS TO HYDROGEN DENSITY ONLY
      ISN 0031      100 FORMAT(2X,'BASIC DATA FOR COCURRENT OR COUNTER CURRENT FLOW')
      ISN 0032      101 FORMAT(2X,'DENSITIES IN GM/CC OF SOLIDS LIQUID,GAS,SLURRY'//
      1 5(2X,F10.5))
      ISN 0033      WRITE(6,101) DENS,DENL,DENG,DENSL,DENH
      ISN 0034      WRITE(6,102) DIAM,ZL
      ISN 0035      102 FORMAT(2X,'REACTION DIAMETER AND LENGTH IN CMS'//2X,2(2X,F10.5))
      ISN 0036      WRITE(6,103) CPS,CPL,CPG
      ISN 0037      103 FORMAT(2X,'HEAT CAPACITIES OF SOLID,LIQUID,GAS IN CL/GM DEG K')//
      1 2X,3(2X,F10.5))
      ISN 0038      UL=1.8
      C.....CONSTANTS USED IN HYDROGEN CONSUMPTION REACTION
      ISN 0039      GH2=.3277
      ISN 0040      ZNH2=.1873
  
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ISN 0041      ZKHZ=1.84
ISN 0042      HT=.033E
ISN 0043      HO=1.0
ISN 0044      IT=0
ISN 0045      700 C1M=29.6365/100.
ISN 0046      PH2M=12.5914
ISN 0047      ASRM=4.4078/100.
ISN 0048      SRTM=.78
ISN 0049      YMPM=726.333
C MOISTURE FREE ASH CONCENTRATION
  ASSF=ASMF*CI
C MOISTURE AND ASH FREE COAL CONCENTRATION-CIMAF
  CIMAF=CI*(1.-ASMF)
C NOMINAL SLURRY RESIDENCE TIME-SRT (HRS)
  912 SRT=ZL/UL
ISN 0052      870 WRITE(6,730) UL,UG,SRT
ISN 0053      730 FORMAT(2X,'LIQUID AND GAS LINEAR VELOCITIES AND
ISN 0054      1 SRT IN CGS UNITS',/3(2X,F12.5)/)
C TERMINAL SETTLING VELOCITY OF SOLIDS-UT (CM/SEC)
  UT=961*UP**2*(DENS-DENL)/(18*PMU)
C RATIO OF UT TO UL-T1
  T1=UT/UL
ISN 0056      C DISPERSION COEFFICIENT FOR SINGLE PHASE-EZL
  EZL=2.7*UIAM**1.4*DABS(UG)**0.3
ISN 0057      WRITE(6,104) EZL
ISN 0058      104 FORMAT(2X,'THERMAL DISPERSION COEFFICIENT CM**2/SEC',2X,F14.5)
ISN 0059      C GAS HOLDUP-VOL FRAC-EG
  EG=(0.15*DLOG(DABS(UG))-0.04)/DIAM**0.08
ISN 0060      C SOLID VELOCITY-US
  US=UL*(1-T1*(1-EG))
ISN 0061      C BREAK UP PARTITION COEFFICIENT-ZKS
  ZKS=.0595
ISN 0062      ZIO1=ZKS+ASSF/CIMAF
ISN 0063      ORGO=ZIO1*CIMAF
ISN 0064      C SOLID HOLD UP-VOL FRAC-ES
  ES=(1.-EG)*DENSL*(2*ASMF+ORGO+ASSF)
ISN 0065      C LIQUID HOLDUP-EL
  EL=1-ES-EG
ISN 0066      WRITE(6,105) EG,EL,ES
ISN 0067      105 FORMAT(2X,'HOLDUPS OF GAS,LIQUID,SOLID'//2X,3(2X,F10.5))
ISN 0068      C VARIOUS THERMODYNAMIC SUMS FOR THE SLURRY
  SUMD=0.45*(EZL)*(DENS*CPS+DENL*CPL+DENG*CPG)
  PE=ZL*(DENG*CPG+UG+DENL*CPL+UL+DENS*CPS+US)/SUMD
ISN 0069      WRITE(6,1112) PE,EZL
ISN 0070      1112 FORMAT(2X,'PLECLET NO. AND EZL COMPUTED FROM S. PARULEKAR S
ISN 0071      1FORMULAS',2(2X,F12.5))
ISN 0072      S1=DENG*CPG+UG +DENL*CPL*UL +DENS*CPS*US
ISN 0073      S3=DENG*DABS(UG)
ISN 0074      S4=1.00/(SRTM*3600.)
ISN 0075      FSL=ES*EL
ISN 0076      S2=0.01*DENSL*ES_*ZL
ISN 0077      106 FORMAT(2X,' SIX ENTHALPY COEFFICIENTS'//2X,6(2X,F10.5))
ISN 0078      DHR=2730.
ISN 0079      ZKH2=1.70
ISN 0080      WRITE(6,1003) ZKH2,DHR
ISN 0081      1003 FORMAT(2X,'THE VALUES OF ZKH2 AND DHR ARE',2X,2(1X,F16.4)/)
ISN 0082      C EFFECTIVE DIFFUSION COEFFICIENT-DIFF (CM**2/SEC)
  DIFF=0.23*EZL
ISN 0083      EZL=DIFF
ISN 0084      C DIMENSIONLESS LENGTH AND TIME INCREMENTS

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ISN 0085      701 DL=0.01
ISN 0086      DT=0.10
ISN 0087      S4=DENG*CPG*UG+DENL*CPL*UL+DENS*CPS*US
ISN 0088      S5=DENG*CPG*EG+DENL*CPL*EL+DENS*CPS*ES
ISN 0089      S6=DENG*CPG+DENL*CPL+DENS*CPS
C S1THRUUGH S5 ARE VARIOUS THERMODYNAMIC QUANTITIES USED IN THE MODEL
ISN 0090      WRITE(6,106) S1,S2,S3,S4,S5,S6
C THERMAL PECLET NUMBER
ISN 0091      PET=(DENL*CPL*UL+DENS*CPS*US)*ZL/(S6*DIFF)
ISN 0092      107 FORMAT(2X,'LENGTH AND TIME INCREMENTS AND PECLET NUMBER'//
              1 2X,4(2X,F12.4))
C C1THROUGH CRXN ARE VARIOUS CONSTANTS USED IN THE MODEL
ISN 0093      C1=EZL*SRT*DT/(ZL*DL)**2
ISN 0094      C2=(DENS*CPS*US+CPL*DENL*UL)*SRT*DT/(2*ZL*DL*S6)
ISN 0095      702 C9=SRT*DT/(TEMP*S6)
ISN 0096      C4=DENH*CPG*DABS(UG)*SRT*DT/(DL*ZL*S6)
ISN 0097      C5=(DENL*CPL*EL+DENS*CPS*ES)/S6
ISN 0098      R=UG/UL
ISN 0099      C7=0.5*DT*SRT*UG/(ZL*DL*EG)
ISN 0100      CH=ZKH2*SRT*DT/(DENH*EG)
ISN 0101      WRITE(6,107) DL,DT,PE
ISN 0102      800 CONTINUE
ISN 0103      C3=ZKH2*C9*DH
ISN 0104      C11=0.6+0.01*ESL=DENSL/SRT
ISN 0105      P1=P1*2/25.
ISN 0106      803 CRXN=0.43*(.01*DENSL*CSL/3600)*((CINAF/CIN)**ZNCH2)* (1.+BH2
              1*(ASSF-ASRM))*(1./SRTM)*(P1/PH2M)**ZNH2
C MAXIMUM NUMBER OF LENGTH AND TIME INCREMENTS
ISN 0107      NDIST=1./DL+1
ISN 0108      LTIME=300
ISN 0109      WRITE(6,108) LTIME,NDIST
ISN 0110      108 FORMAT(2X,'MAX NUMBER OF TIME AND DISTANCE STEPS'//
              1 2X,2(2X,15))
              NDIST1=NDIST-1
ISN 0111      C VARIOUS CONSTANTS IN INTEGRATION
ISN 0112      WRITE(6,110) C1,C2,C3,C4,C5,C7,C8,CRXN
ISN 0113      110 FORMAT(2X,'SYSTEM CONSTANTS C1 THRU C8 AND CRXN'//
              12X,6(2X,F14.9),E14.7,2X,F14.9)
C THERMODYNAMIC QUANTITIES ARE SPECIFIED. THESE ARE
C AMBTMP=AMBIENT TEMPERATURE, TGIN=INLET GAS TEMP, LPRNT=MAX NO. OF
C TIME STEPS BETWEEN PRINCIPLE PRINTOUTS, LIT=THE INTERNAL TEMP ITER
C ATION COUNTER, DHIN, DTIN=INCREMENTAL HYDROGEN AND ENTHALPY FLOWING
C INTO THE SYSTEM, HIN, HOUT, TIN, TOUT = HYDROGEN MASS INTO AND OUT
C AND ENTHALPY FLOWING INTO AND OUT OF THE REACTOR
ISN 0114      AMBTMP=273.+30.
ISN 0115      LPRNT=30
ISN 0116      LIT=0
ISN 0117      DHIN=DENH*DABS(UG)*AREA*DT*SRT
ISN 0118      HIN=0.
ISN 0119      HOUT=0.
ISN 0120      DTIN=TEMP*(CPS*DENS*US +CPL*DENL*UL)*DT*SRT*AREA
ISN 0121      TIN=0.
ISN 0122      TOUT=0.
C THIS STEP DETERMINES WHETHER THE COCURRENT OR THE COUNTER-
C CURRENT MODELS IS EXECUTED
ISN 0123      IF( ICC.EQ. 1) GO TO 115
C COCURRENT FLOW MODEL INCLUDES HYDROGEN CONSUMPTION AND ADIABATIC TEMP. RISE
C THIS LOOP ESTABLISHED THE INITIAL VALUES FOR THE ARRAYS USED IN THE
C TRIDIAGONAL MATRIX AND THE INITIAL VALUES OF THE HYDROGEN AND TEMP.
ISN 0125      DO 1 I=1,NDIST

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ISN 0126      AH(I)=-C7
ISN 0127      BH(I)=1.0
ISN 0128      CH(I)=C7
ISN 0129      ATMP(I)=C1+C2
ISN 0130      BTMP(I)=-C5-2.*C1
ISN 0131      CTMP(I)=C1-C2
ISN 0132      TMPQ(I)=1.
ISN 0133      TMP(I)=TMPQ(I)
ISN 0134      TAVG(I)=TMP(I)
ISN 0135      H2O(I)=1.
ISN 0136      H2(I)=1.
ISN 0137      H2AVG(I)=H2(I)
ISN 0138      TMT(I)=TMPQ(I)
ISN 0139      H2T(I)=H2O(I)
ISN 0140      1 CONTINUE
ISN 0141      H2O(I)=H0
ISN 0142      TMPQ(I)=1.0
ISN 0143      ATMP(NDIST)=2.*C1
ISN 0144      BTMP(NDIST)=-C5-2.*C1
ISN 0145      CTMP(NDIST)=0.0
ISN 0146      AH(NDIST)=-2.*C7
ISN 0147      BH(NDIST)=1.+2.*C7
ISN 0148      CH(NDIST)=0.
ISN 0149      AH(I)=0.
ISN 0150      HH(I)=1.
ISN 0151      CH(I)=0.
ISN 0152      ATMP(I)=0.
ISN 0153      DTMP(I)=-1./(DL*PET)-1.
ISN 0154      CTMP(I)=1./(DL*PET)
ISN 0155      1001 FORMAT(10I1X,F11.6))

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ISN 0156
ISN 0157
ISN 0158
ISN 0159
ISN 0160

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TIME=0.
SUMRXN=0.
ACCN=0.
ACCMH=0.
H2RACT=0.

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ISN 0161

HTGEN=0.

ISN 0162

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C THE COUNTER WHICH SPECIFIES THE MAXIMUM NUMBER OF TIME STEPS
C WHICH PASS BEFORE EXITING THE MODEL

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ICONVM=5

ISN 0163

```

C BEGIN TIME STEPS
DO 2 LT=1,LTIME

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ISN 0164

IT=0

ISN 0165

IF(TMP(NDIST) .GT. 1.5) GO TO 910

ISN 0167

```

C INCREMENT TIME
TIME=TIME+DT *SRT/3600
C BEGIN THE AXIAL DISTANCE DO LOOP

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LIT=LIT+1

ISN 0168

112 CONTINUE

ISN 0169

IF(H2T(I) .GT. 1.E-10)GO TO 999

ISN 0170

RXNH2=0.

ISN 0171

RXN(I)=RXNH2

ISN 0172

GO TO 958

ISN 0173

999 RXNH2=CRXNH*(1.+BT*(TEMP*TAVG(I)-TMPN))

1 *(TAVG(I)*H2AVG(I))*ZNH2 +C11

ISN 0174

RXN(I)=RXNH2

ISN 0175

998 DTMP(I)=-1.

ISN 0176

DH(I)=H0

ISN 0177

DO 3 I=2,NDIST

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ISN 0180      TAVG(I)=0.5*(TMP(I)+TMP0(I))
ISN 0181      H2AVG(I)=0.5*(H2(I)+H20(I))
ISN 0182      C SKIP THE HYDROGEN CONSUMPTION REACTION IF HYDROGEN IS SMALL
ISN 0184      IF( H2(I) .GT. 1.E-10)GO TO 9
ISN 0185      RXNH2=0.
ISN 0186      RXN(I)=RXNH2
ISN 0187      GO TO 13
ISN 0188      9 RXNH2=CRXN*(H2AVG(I)+TAVG(I))*ZNH2*(1.+BT*(TEMP*TAVG(I)-TMPN))
ISN 0189      1 +C11
ISN 0190      RXN(I)=RXNH2
ISN 0191      C CALCULATE THE NORMALIZED HYDROGEN MASS CONCENTRATION AND TEMPERATURE
ISN 0192      13 DH(I)=H20(I)-C6*RXNH2
ISN 0193      DTMP(I)=-TMP0(I)+C5-C3*RXNH2
ISN 0194      3 CONTINUE
ISN 0195      CALL THOMAS(NDIST,AM,BH,CH,DH,H2)
ISN 0196      CALL THOMAS(NDIST,ATMP,BTMP,CTMP,DTMP,TMP)
ISN 0197      IF(IT .EQ. ITM .OR. DABS(TMPT(NDIST)-TMP(NDIST)) .LT. 1.E-10)
ISN 0198      1 GO TO 109
ISN 0199      IT=IT+1
ISN 0200      DO 8 I=1,NDIST
ISN 0201      TMPT(I)=(TMP(I)+TMPT(I))/2.
ISN 0202      IF( H2(I) .LT. 0.) H2(I)=0.
ISN 0203      H2T(I)=(H2(I)+H2T(I))/2.
ISN 0204      8 CONTINUE
ISN 0205      GO TO 112
ISN 0206      109 SUMTMP=0.
ISN 0207      ACCMT=0.
ISN 0208      ACCMH=0.
ISN 0209      WRITE(6,120) IT,TIME,TMP(NDIST),TMPT(NDIST),H2(NDIST),H2T(NDIST)
ISN 0210      120 FORMAT(2X,'IT,TIME,TMPTMPT H2 AND H2T AT NDIST ARE',I5,5(F12.6)
ISN 0211      /)
ISN 0212      DELT=TMP(NDIST)-TMP0(NDIST)
ISN 0213      TCONV(LT) = DELT
ISN 0214      IF( LT .EQ. 1) GO TO 1114
ISN 0215      IF(DABS(TCONV(LT)-TCONV(LT-1)) .GT. 1.E-7 )GO TO 1114
ISN 0216      ICONV=ICONV+1
ISN 0217      IF( ICONV .EQ. ICONVM) GO TO 515
ISN 0218      1114 DELH=H2(NDIST)-H20(NDIST)
ISN 0219      IF( LT .EQ. 1) GO TO 709
ISN 0220      IF( DELT .LT. DELTO) GO TO 709
ISN 0221      WRITE(6,710) DT, DELT,DELTO,DELH,DELHO
ISN 0222      710 FORMAT(2X,'DT DELT DELTO DELH DELHO ARE',5(2X,F10.5))
ISN 0223      709 DELTO=DELT
ISN 0224      DELHO=DELH
ISN 0225      SUMTMP=0.
ISN 0226      ACCMT=0.
ISN 0227      ACCMH=0.
ISN 0228      DO 111 I=1,NDIST
ISN 0229      SUMTMP=SUMTMP+RXN(I)
ISN 0230      ACCMT=ACCMT+TMP(I)-1.
ISN 0231      ACCMH=ACCMH+H2(I) -1.
ISN 0232      IF (H2(I) .LT. 0.) H2(I)=0.
ISN 0233      H2AVG(I)=0.5*(H2(I)+H20(I))
ISN 0234      TAVG(I)=0.5*(T4F(I)+TMP0(I))
ISN 0235      H2T(I)=H2(I)
ISN 0236      H20(I)=H2T(I)
ISN 0237      TMPT(I)=TMP(I)
ISN 0238      TMP0(I)=TMP(I)
ISN 0239      111 CONTINUE
ISN 0240      SUMRXN=SUMRXN+SUMTMP*DT*SRT*DL*ZL*AREA

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ISN 0244      ACCMT=ACCMT+AREA*DL*ZL*SS
ISN 0245      ACCMH=ACCMH+AREA*DL*ZL*DENVH*EG
ISN 0246      IT=0
ISN 0247      HTGEN2=SUMRXN*DHR
ISN 0248      HIN=HIN+DHIN
ISN 0249      HUUT=HOUT+DHIN*H2(NDIST)
ISN 0250      H2RACT=HIN-HUUT
ISN 0251      TIN=TIN+DTIN
ISN 0252      TOUT=TOUT+DTIN*TMP(NDIST)
ISN 0253      HTGEN=TOUT-TIN
ISN 0254      HTBAL=HTGEN -HTGEN2-ACCMT
ISN 0255      HGBAL=H2RACT -SUMRXN
ISN 0256      TMPRIZ(LT)=(TMP(NDIST)-1. )*TMP*1.8
ISN 0257      HYDCMP(LT)=(HU-H2(NDIST))*DENVH*UG/(UL*DENSL*CIM)

C  PRINT THE TIME, TEMPERATURE RISE AND HYDROGEN CONSUMPTION AND
C  T-E HYDROGEN MASS DISTRIBUTION IN THE REACTOR
      WRITE(6,5)TIME,TMPRIZ(LT),HYDCMP(LT)
      IF(LIT.LT.LPRNT) GO TO 2
      LIT=0
      WRITE(6,900)
900  FORMAT(2X,'TOTAL MATERIAL AND ENERGY BALANCES'/)
      WRITE(6,901)
901  FORMAT(2X,'H2 IN, H2OUT AND APPROXIMATE H2 REACTED'/)
      WRITE(6,902) HIN,HOUT,H2RACT,SUMRXN,CCMH,HGBAL
902  FORMAT(6(2X,E14.5))

ISN 0263      WRITE(6,903)
ISN 0269      903  FORMAT(2X,'HEAT IN, HEAT OUT, HEAT GENERATED'/)
ISN 0270      WRITE(6,902)TIN,TOUT,HTGEN,HTGEN2,ACCMT,HTBAL
ISN 0271      WRITE(6,7)
ISN 0272      WRITE(6,6)(TMP(I),I=1,NDIST)
ISN 0273      WRITE(6,6)(H2(I),I=1,NDIST)
ISN 0274      5  FORMAT(22X,'TIME IS',2X,F10.5,2X,'TEMPRISE IS',F10.5,2X,'HYDROGEN
          1CDMP IS',F10.5,2X,/)
          6  FORMAT(2X,10F10.5)
          7  FORMAT(2X,'HYDROGEN CONC & TEMPERATURE DISTRIBUTION
          1 COCURRENT FLOW MODEL'//)
          2  CONTINUE
C  PLOT THE FINAL AXIAL DISTRIBUTIONS OF HYDROGEN AND TEMPERATURE
ISN 0278      910 CONTINUE
ISN 0279      515 CONTINUE
ISN 0280      DO 1200 I=1,NDIST
ISN 0281      TMP(I)=(TMP(I)*TEMP-273.)*1.8+32.
ISN 0282      H2(I)=H2(I)*UG*DENVH*100/(UL*DENSL*CIM)
ISN 0283      1200 CONTINUE
ISN 0284      WRITE(6,7)
ISN 0285      WRITE(6,6) (H2(I), I=1,NDIST)
ISN 0286      WRITE(6,6) (TMP(I), I=1,NDIST)
ISN 0287      VTAVG=((TMP(1)+TMP(NDIST))/2.-32.)/1.8
ISN 0288      VNCUAL=1.
ISN 0289      VSRT=SRT/3600.
ISN 0290      VSRT2=VSRT**2
ISN 0291      VCIN=CINAF*100.
ISN 0292      VCIN2=VCIN**2
ISN 0293      VPH2=PT
ISN 0294      VPH22=VPH2**2
ISN 0295      VRASH=AS4F*100.
ISN 0296      VRASH2=VRASH**2
ISN 0297      VV=DABS(UG)
ISN 0298      VPR=VPH2*VRASH
ISN 0299      VTS=VTAVG*VSRT

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1SN 0300      VTR=VTAVG*VRASH
1SN 0301      VPS=VPH2*VSRT
1SN 0302      VPC=VPH2*VCIN
1SN 0303      VSR=VSRT*VRASH
1SN 0304      VCR=VCIN*VRASH
1SN 0305      YDHYD=-9.5554+.0265286*VTAVG+.28745*VNCOAL+1.44118*VSRT2+
1 0.042*VPR-0.014118*VCR
1SN 0306      YDC1C4=30.38727-211.3156*VSRT-1.314*VCIN+1.1934*VNCOAL
1 +.01578*VCIN2+.4855*VTS+.01108*VPR
1SN 0307      YDNAP=-54.92379+.12887*VTAVG-4.75446*VSRT2+.0248*VTS
1SN 0308      YDMO=5.2235-33.684*VRASH+.8244*VV+3.2079*VNCOAL+
1 .084*VTR +.51469*VPS-.16066*VPR-.07544*VCR
1SN 0309      YDHD=-7.637+.77319*VPH2+7.28676*VSRT-.00672*VTR+.28854*VPR
1SN 0310      YDSRC=69.94148+269.50221*VSRT+.36536*VCIN+.95626*VV+.1487*
1 VRASH2-.65886*VTS-.019935*VTR-.0201*VPC+2.625*VSR+.11293*VCR
1SN 0311      950 FORMAT(2X,'YIELDS OF HYDROGEN, C1C4,NAPHTHA, MD,HD,C5SRC ARE',/)
1SN 0312      951 FORMAT(2X,6(2X,F10.4))
1SN 0313      WRITE(6,950)
1SN 0314      WRITE(6,951) YDHYD,YDC1C4,YDNAP,YDMO,YDHD,YDSRC

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C COUNTERCURRENT FLOW MODEL
C RESET TIME, HYDROGEN CONSUMPTION TO ZERO AND CHANGE THE SIGN
C ON THE GAS VELOCITY TO COMPUTE THE COUNTER CURRENT FLOW CASE

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1SN 0315      114 ICC=1
1SN 0316      ICONV=0
1SN 0317      UG=-UG
1SN 0318      TGIN=YGCC
1SN 0319      GO TO 113
1SN 0320      115 CONTINUE
1SN 0321      TIME=0.

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```

C RESET THE PRINT PARAMETER TO ZERO
LIT=0
IT=0

```

```

C INITIALIZE THE HYDROGEN AND TEMPERATURE DISTRIBUTIONS

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99 1SN 0324      DO 1100 I=1,NDIST
1SN 0325      AH(I)=-C7
1SN 0326      BH(I)=1.
1SN 0327      CH(I)=C7
1SN 0328      ATMP(I)=C1+C2
1SN 0329      HTMP(I)=-C5-2.*C1
1SN 0330      CTMP(I)=C1-C2
1SN 0331      TMPO(I)=1.
1SN 0332      H2O(I)=1.
1SN 0333      TMPT(I)=TMPO(I)
1SN 0334      H2T(I)=H2O(I)
1SN 0335      H2(I)=H2O(I)
1SN 0336      TMP(I)=TMPO(I)
1SN 0337      H2AVG(I)=H2(I)
1SN 0338      TAVG(I)=TMP(I)
1SN 0339      1100 CONTINUE
1SN 0340      ATMP(NDIST)=2.*C1
1SN 0341      BTMP(NDIST)=-2.*C1-C4-C5
1SN 0342      CTMP(NDIST)=0.
1SN 0343      H2O(NDIST)=H0
1SN 0344      TMPO(1)=1.
1SN 0345      AH(1)=0.
1SN 0346      CH(1)=2.*C7
1SN 0347      BH(1)=1.-2.*C7
1SN 0348      ATMP(1)=0.
1SN 0349      BTMP(1)=-1./(DL*PET)-1.
1SN 0350      CTMP(1)=1./(DL*PET)

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ISN 0351      H2RACT=0.
ISN 0352      HTGEN=0.
ISN 0353      SUMRXN=0.
ISN 0354      HIN=0.
ISN 0355      HOUT=0.
ISN 0356      TIN=0.
ISN 0357      TOUT=0.
ISN 0358      TIME=0.

C   THE HYDROGEN AND TEMPERATURE ARE NORMALIZED WITH RESPECT TO THE
C   INLET GAS DENSITY AND THE INLET TEMPERATURE RESPECTIVELY
C   RECALCULATE THE SYSTEM PARAMETERS BECAUSE OF THE CHANGE IN SIGN OF
C   GAS VELOCITY
C   GO THROUGH THE SAME SEQUENCE OF STEPS AS IN THE COCURRENT FLOW CASE

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C   THE EXCEPTION HERE IS THAT THE GAS COORDINATE SYSTEM IS REVERSED

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ISN 0359      DO 12 LT=1,LTIME
ISN 0360      IT=0
ISN 0361      IF( TMP(NDIST) .GT. 1.5) GO TO 1111
ISN 0363      LIT=LIT+1
ISN 0364      TIME=TIME+DT *SRT/3600
ISN 0365      116 CONTINUE
ISN 0366      I=NDIST
ISN 0367      IF(H2I(NDIST) .GT. 1.E-10)GO TO 899
ISN 0369      RXNH2=0.
ISN 0370      GO TO 898
ISN 0371      899 RXNH2=CRXN*(1.+BT*(TEMP*TAVG(I)-TMPN))
          1*(TAVG(I)*H2AVG(I))*ZNH2+C11
ISN 0372      898 DH(NDIST)=H2D(NDIST)-C8*RXNH2-C7
ISN 0373      DTMP(NDIST)=-C3*RXNH2-C4*TGIN/TEMP-TMP0(NDIST)*C5
ISN 0374      RXN(NDIST)=RXNH2
ISN 0375      DO 11 I=1,NDIST1
ISN 0376      IF( H2I(I) .GT. 1.E-10)GO TO 15
ISN 0378      RXNH2=C.
ISN 0379      GO TO 16
ISN 0380      15 RXNH2=CRXN*(H2AVG(I)*TAVG(I))*ZNH2*(1.+BT*(TEMP*TAVG(I)-
          1 TMPN))+C11
ISN 0381      16 DH(I)=H2D(I)-C8*RXNH2
ISN 0382      DTMP(I)=-TMP0(I)*C5-C3*RXNH2
ISN 0383      RXN(I)=RXNH2
ISN 0384      11 CONTINUE
ISN 0385      RXNH2=CRXN*(H2AVG(I)*TAVG(I) )**ZNH2*(1.+BT*(TEMP*TAVG(I)-
          1 TMPN))+C11
ISN 0386      RXN(I)=RXNH2
ISN 0387      DTMP(I)=-1.
ISN 0388      CALL THOMAS(NDIST,AH,BH,CH,DH,H2)
ISN 0389      CALL THOMAS(NDIST,ATMP,BTMP,CTMP,DTMP,TMP)
ISN 0390      IF( IT .EQ. ITM .OR. DABS(TMP(NDIST)-TMP(NDIST)) .LT. 1.E-10)
          1 GO TO 117
ISN 0392      IT=IT+1
ISN 0393      DO 24 I=1,NDIST
ISN 0394      IF( H2(I) .LT. 0.) H2(I)=0.
ISN 0396      H2T(I)=(H2(I)+H2T(I))/2.
ISN 0397      TMP(I)=(TMP(I)+TMP(I))/2.
ISN 0398      24 CONTINUE
ISN 0399      GO TO 116
ISN 0400      117 SUMTMP=0.
ISN 0401      DELT=DABS(TMP(NDIST)-TMP0(NDIST))
ISN 0402      TCONV(LT) = DELT
ISN 0403      IF( LT .EQ. 1) GO TO 1115
ISN 0405      IF( DABS( TCONV(LT)-TCONV(LT-1)) .GT. 1.E-7 ) GO TO 1115
ISN 0407      TCONV=I CONV+1

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1SN 0468      VCIN=VCIMAF*100.
1SN 0469      VCIN2=VCIN**2
1SN 0470      VPH2=PT
1SN 0471      VPH22=VPH2**2
1SN 0472      VRASH=ASMF*100.
1SN 0473      VRASH2=VRASH**2
1SN 0474      VV=DABS(UG)
1SN 0475      VPR=VPH2*VRASH
1SN 0476      VTS=VTAVG*VSRT
1SN 0477      VTR=VTAVG*VRASH
1SN 0478      VPS=VPH2*VSRT
1SN 0479      VPC=VPH2*VCIN
1SN 0480      VSR=VSRT*VRASH
1SN 0481      VCR=VCIN*VRASH
1SN 0482      YDHYD=-9.5554+.0265288*VTAVG+.28745*VNCOAL+1.44118*VSRT2+
1 0.042*VPH-0.014118*VCR
1SN 0483      YDC1C4=30.38727-211.3156*VSRT-1.314*VCIN+1.1934*VNCOAL
1 +.01578*VCIN2+.4855*VTS+.01E08*VPR
1SN 0484      YDNAP=-54.92379+.12887*VTAVG-4.75446*VSRT2+.0248*VTS
1SN 0485      YDMD=5.2235-33.684*VRASH+.8244*VV+3.2079*VNCOAL+
1 .084*VTR +.51469*VPS-.16066*VPR-.07544*VCR
1SN 0486      YDHU=-7.637+.77319*VPH2+7.28676*VSRT-.00072*VTR+.28854*VPR
1SN 0487      YDSRC=69.94148+269.50221*VSRT+.36536*VCIN+.95626*VV+.1487*
1 VRASH2-.65886*VTS-.019935*VTR-.0201*VPC+2.625*VSR+.11293*VCR
1SN 0488      WRITE(6,950)
1SN 0489      WRITE(6,951) YDHYD,YDC1C4,YDNAP,YDMD,YDHD,YDSRC
1SN 0490      WRITE(6,952) VTAVG,VNCOAL,VCIN,VSRT,VPH2,VRASH,VSRT2,VCIN2,VTS,
1 VPS,VSR,VPC,VCR,VV,VCR,VTR,VRASH2,VPH22
1SN 0491      952 FORMAT(2X,'TERMS IN YIELD EXPRESSIONS',8F10.5/28X,8F10.5/
1 26X,2F10.5)
1SN 0492      STOP
1SN 0493      END

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