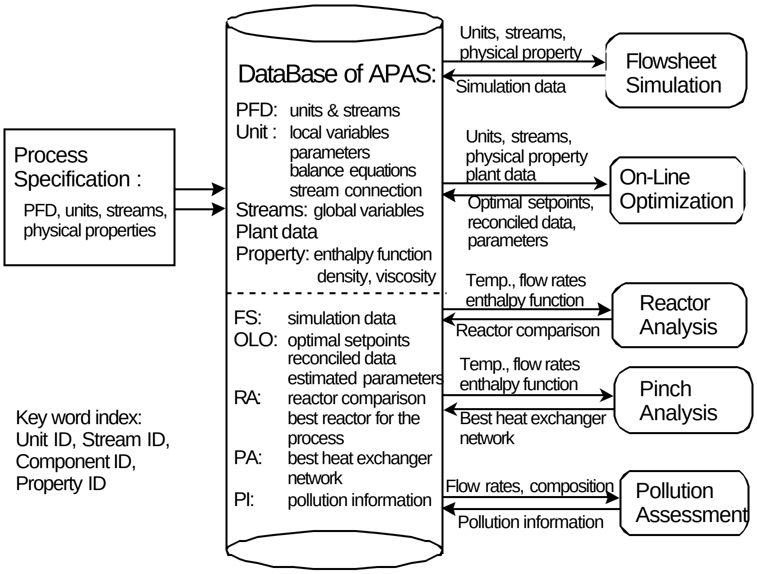
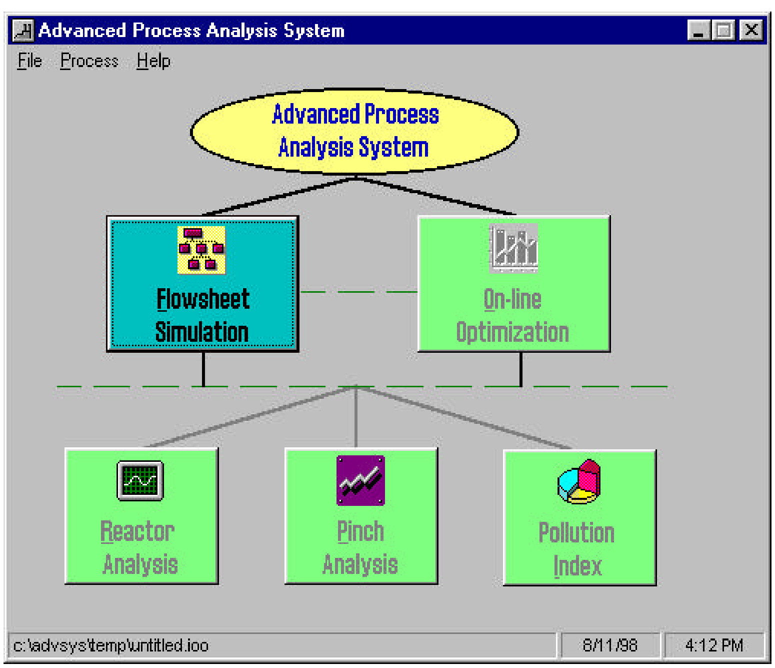


Mineral Processing Research Institute

Louisiana State University

Advanced Process Analysis System

User's Manual
and
Tutorial
for the Alkylation Process



Derya Ozyurt
Ralph W. Pike
Jack R. Hopper
Janardhana R. Punuru
Carl L. Yaws

May 1,2001

TABLE OF CONTENTS

Disclaimer

The Mineral Processing Research Institute(MPRI) makes no warranties, express or implied, including without limitation the implied warranties of merchantability and fitness for particular purpose, regarding the MPRI software. MPRI does not warrant, guarantee or make any representation regarding the use or the results of the use of the MPRI software in terms of its correctness, accuracy, reliability, currentness or otherwise. The entire risk as to the results and performance of the MPRI software is assumed by you.

In no event will MPRI, its director, officers, employees or agents be liable to you for any consequential, incidental or indirect damages (including damage for loss of business profits, business interruption, loss of business information, and the like) arising out of the use or inability to use the MPRI software even if MPRI has been advised of the possibility of such damages.

I. INTRODUCTION AND METHODOLOGY

An Advanced Process Analysis System is a powerful tool for use by process and plant engineers to perform comprehensive and in-depth evaluations of economic, environmental, safety and hazard analysis projects. This system is based on chemical engineering fundamentals such as stoichiometry, thermodynamics, fluid dynamics, heat transfer, mass transfer, reactor design and optimization. It helps to identify pollutants in chemical processes and petroleum refineries and develop innovative, economically viable designs to eliminate their generation. It aims at waste minimization and pollution prevention in chemical plants, in addition to increased profit and improved efficiency of operations.

The framework of the Advanced Process Analysis System is shown in Figure 1. The main components of this system are an on-line optimization program, a flowsheeting program for process material and energy balances, a chemical reactor analysis program, a heat exchanger network design program, and a pollution assessment module. A Windows interface is used to integrate these programs into one user-friendly application.

The Advanced Process Analysis System methodology to identify and eliminate the causes of energy inefficiency and pollutant generation is based on the onion skin diagram shown in Figure 2. Having an accurate description of the process from on-line optimization, an evaluation of the best types of chemical reactors is done first to modify and improve the process. Then the separation units are evaluated. This is followed by the pinch analysis to determine the best configuration for the heat exchanger network and determine the utilities needed for the process. Not shown in The diagram is the pollution Assessment, which is used to identify and minimize emissions. The following gives a detailed description of the Advanced Process Analysis System and its components, and how they are used together to control and modify the process to maximize the profit and minimize the wastes and emissions. The Motiva Alkylation process will be used to demonstrate the use and capabilities of the Advanced Process Analysis System. This will follow the description of the programs and the components.

A. Flowsheeting

The first step towards implementing the Advanced Process Analysis System is the development of the process model using Flowsim. As described earlier, process model is a set of constraint equations, which are the material and energy balances, rate equations and equilibrium relations that describe the material and energy transport and the chemical reactions of the process. These form a mathematical model of relationships between the various plant units and process streams. Formulation of the process model can be divided into two important steps.

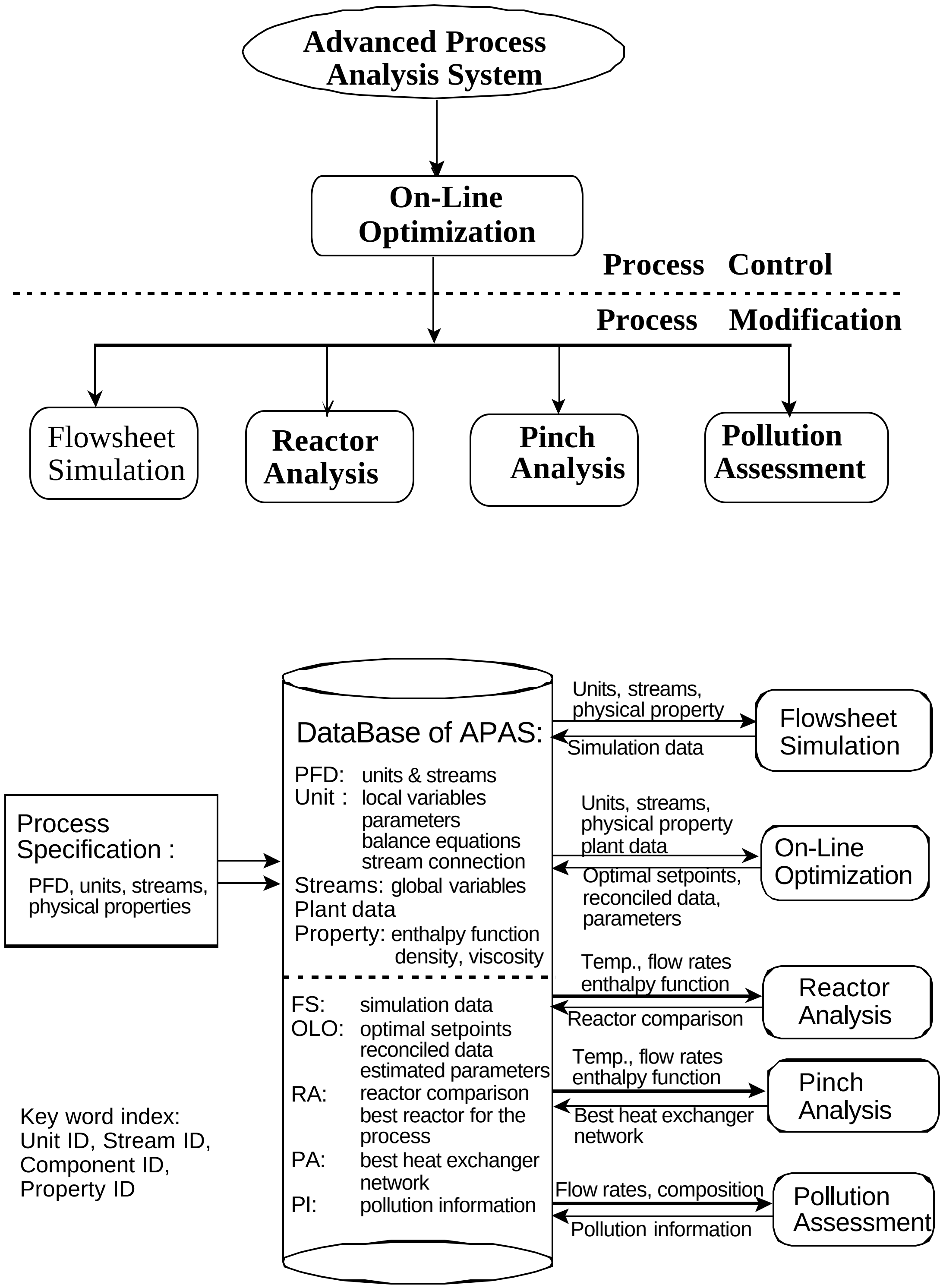


Figure 1: The Framework of the Advanced Process Analysis System

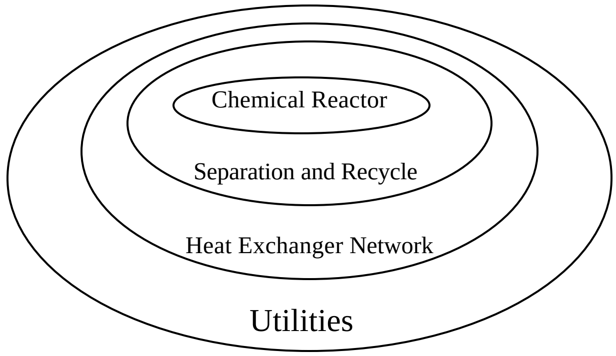


Figure 2: The 'Onion Skin' Diagram for Organization of a Chemical Process and Hierarchy of Analysis.

A-1. Formulation of Constraints for Process Units

The formulation of constraints can be classified into empirical and mechanistic methods. The process models used in Advanced Process Analysis System belong to the type of mechanistic models because they are based on conservation laws as well as the physical and chemical attributes of its constituents.

A typical chemical plant includes hundreds of process units such as heat exchangers, reactors, distillation columns, absorption towers and others. The constraints for these units are either based on conservation laws (mass and energy balances) or they are based on some other laws of nature which include models for chemical phase equilibrium, kinetic models etc. Mathematically, the constraints fall into two types: equality constraints and inequality constraints. Equality constraints deal with the exact relationships such as material and energy balances in the model. The inequality constraints recognize the various bounds involved. Examples of inequality constraints are upper limits on the temperature of certain streams or upper limits on the capacity of certain units.

A-2. Classification of Variables and Determination of Parameters

After the constraints are formulated, the variables in the process are divided into two groups, measured variables and unmeasured variables. The measured variables are the variables which are directly measured from the distributed control systems (DCS) and the plant control laboratory. The remaining variables are the unmeasured variables. For redundancy, there must be more measured variables than the degree of freedom.

The parameters in the model can also be divided into two types. The first type of parameters is the constant parameters, which do not change with time. Examples of these are reaction activation energy, heat exchanger areas etc. The other type of parameters is the time-varying parameters such as catalyst deactivation and heat exchanger fouling factors. These are treated as parameters because they change very slowly with time. They are related to the equipment conditions and not the operating conditions.

A-3. Flowsim Interface

Flowsim is used to develop the process model, and it has a graphical user interface with interactive capabilities. Process units are represented as rectangular shapes whereas the process streams are represented as lines with arrows between these units. Each process unit and stream included in the flowsheet must have a name and a description. Process information is divided into the following six categories; equality constraints, inequality constraints, unmeasured variables, measured variables, parameters and constants.

The information in the first five categories is further classified by associating it with either a unit or a stream in the flowsheet. For example, for a unit that is a heat exchanger, the relevant information includes the mass balance and heat transfer equations, limitations on the flowrates and temperatures if any, the heat transfer coefficient parameter and all the intermediate variables defined for that exchanger.

For a stream, the information includes its temperature, pressure, total flowrate, molar flowrates of individual components etc. Also, information not linked to any one unit or stream is called the ‘Global Data’. For example, the overall daily profit of the process is a global unmeasured variable.

The sixth category of constants can be grouped into different sets based on their physical significance. For example, constants related to heat exchangers can be placed in one group and those related to reactors into another group.

Flowsim also has a seventh category of information called as the ‘enthalpy coefficients’. This stores the list of all the chemical components in the process and their enthalpy coefficients for multiple temperature ranges. All of this process information is entered with the help of the interactive, user-customized graphic screens of Flowsim. The formulation of process models and the classification of process information for the Alkylation process is given in section II. The next step of Advanced Process Analysis System is on-line optimization.

B. The Online Optimization Program

Once the process model has been developed using Flowsim, the next step is to conduct on-line optimization. On-line optimization is the use of an automated system which adjusts the operation of a plant based on product scheduling and production control to maximize profit and minimize emissions by providing setpoints to the distributed control system. As shown in Figure 3, it includes three important steps: combined gross error detection and data reconciliation, simultaneous data reconciliation and parameter estimation and plant economic optimization. In combined gross error detection and data reconciliation, a set of accurate plant measurements is generated from plant’s Distributed Control System (DCS). This set of data is used for estimating the parameters in plant models. Parameter estimation is necessary to have the plant model match the current performance of the plant. Then the economic optimization is conducted to optimize the economic model using this current plant model as constraints and this generates the optimal set points for the Distributed Control System.

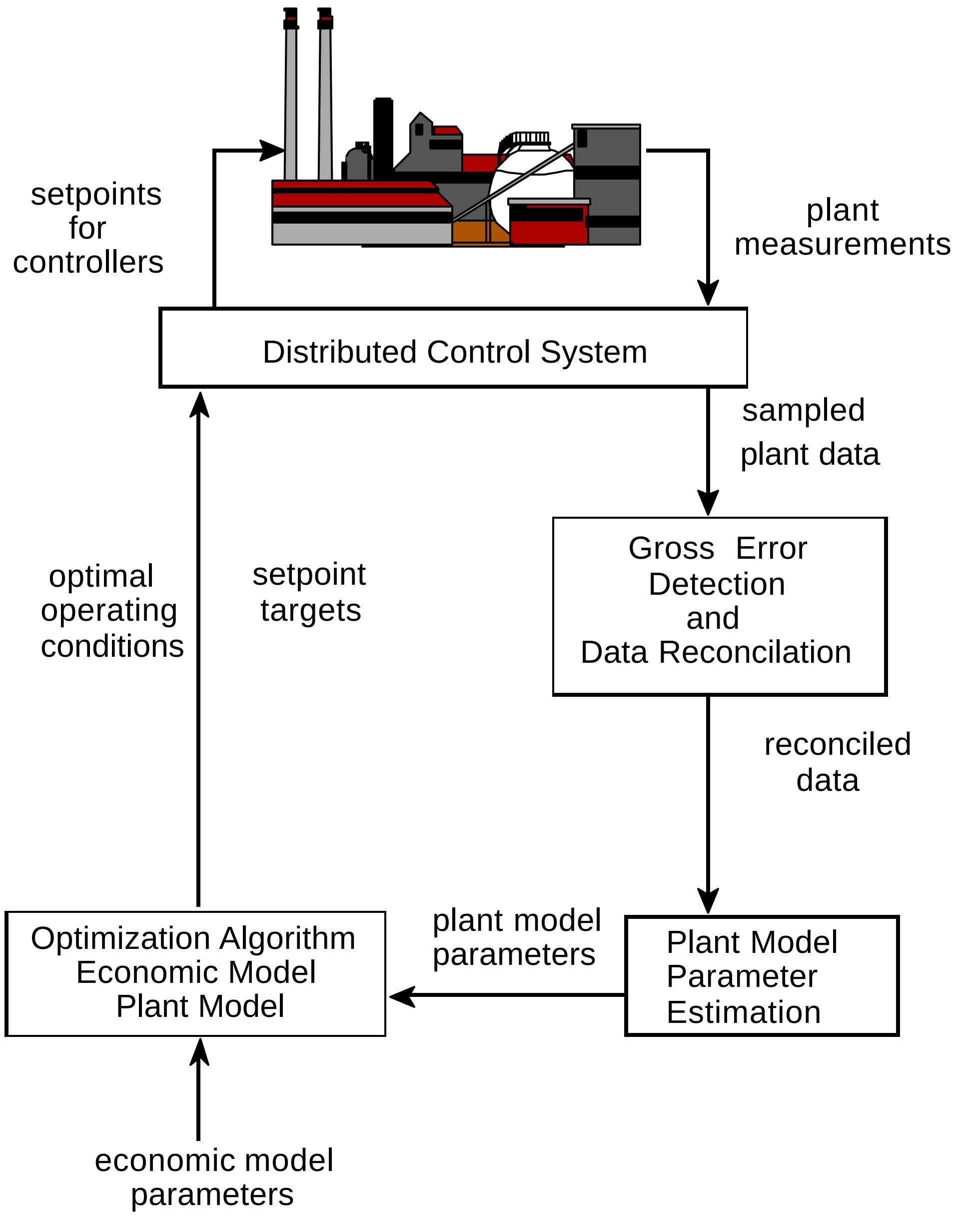


Figure 3: Simplified Structure of Online Optimization

Each of the above three-optimization problems in on-line optimization has a similar mathematical statement as following:

Optimize: *Objective function*
Subject to: *Constraints from plant model.*

where the objective function is a joint distribution function for data validation or parameter estimation and a profit function (economic model) for plant economic optimization. The constraint equations describe the relationship among variables and parameters in the process, and they are material and energy balances, chemical reaction rates, thermodynamic equilibrium relations, and others.

To perform data reconciliation, there has to be more measurements than necessary to be able to rectify errors in instruments. For redundancy, the number of measurements to determine the unmeasured variables is given by the degree of freedom, which is calculated using the following equation.

Degree of freedom = Total number of variables – Total number of equality constraints + Number of chemical reactions

Also, the unmeasured variables have to be determined by the measured variables, called observability. If an unmeasured variable can not be determined by a measured variable, it is unobservable. This is called the 'observability and redundancy criterion', which needs to be satisfied.

B-1. Combined Gross Error Detection and Data Reconciliation

The process data from distributed control system is subject to two types of errors, random error and gross error, and the gross error must be detected and rectified before the data is used to estimate plant parameters. Combined gross error detection and data reconciliation algorithms can be used to detect and rectify the gross errors in measurements for on-line optimization. These algorithms are measurement test method using a normal distribution, Tjoa-Biegler's method using a contaminated Gaussian distribution, and robust statistical method using robust functions. The theoretical performance of these algorithms has been evaluated by Chen, 1998.

Based on Chen's study, the Tjao-Biegler's method is the best for chemical processes and is used to perform combined gross error detection and data reconciliation. When gross errors are in the range of $-\sigma$ to σ, it detects and rectifies gross errors in plant data sampled from distributed control system. This step generates a set of measurements containing only random errors. Then, this set of measurements is used for simultaneous parameter estimation and data reconciliation using the least squares method. This step provides the reconciled data and the updated parameter values in the plant model for economic optimization. Finally, optimal set points are generated for the distributed control system from the economic optimization using the updated plant and economic models. This optimal procedure can be used for any process to conduct on-line optimization.

B-2. Simultaneous Data Reconciliation and Parameter Estimation

The general methodology for this is similar to the methodology of combined gross error detection and data reconciliation. The difference is that the parameters in plant model are considered as variables along with process variables in simultaneous data reconciliation and parameter estimation rather than being constants in data reconciliation. Both process variables and parameters are simultaneously estimated. Based on Chen's study, the least squares algorithm is used to carry out the combined gross error detection and data reconciliation. The data set produced by the parameter estimation is free of any gross errors, and the updated values of parameters represent the current state of the process. These parameter values are now used in the economic optimization step.

B-3. Plant Economic Optimization

The objective of plant economic optimization is to generate a set of optimal operating set points for the distributed control system. This set of optimal set points will maximize the plant profit, satisfy the current constraints in plant model, meet the requirements for the demand of the product and availability of raw materials, and meet the restriction on pollutant emission. This optimization can be achieved by maximizing the economic model (objective function) subject to the process constraints. The objective function can be different depending on the goals of the optimization. The objectives can be to maximize plant profit, optimize plant configuration for energy conservation, minimize undesired by-products, minimize the waste/pollutant emission, or a combination of these objectives. The result of the economic optimization is a set of optimal values for all the measured and unmeasured variables in the process. These are then sent to the distributed control system (DCS) to provide set points for the controllers.

The on-line optimization program of the Advanced Process Analysis System retrieves the process model and the flowsheet diagram from Flowsim. Additional information needed to run online optimization includes plant data and standard deviation for measured variables; initial guess values, bounds and scaling factors for both measured and unmeasured variables; and the economic objective function. The program then constructs the three optimization and uses GAMS (General Algebraic Modeling System) to solve them. Results of all three problems can be viewed using the graphical interface of Flowsim.

The Alkylation process will be used to demonstrate the use and capabilities of the on-line optimization program. This is described in Section VI.

C. The Chemical Reactor Analysis Program

Having optimized the process operating conditions for the most current state of the plant, the next step in the Advanced Process Analysis System is to evaluate modifications to improve the process and reduce emission and energy consumption. First, the chemical reactors in the process are examined. The reactors are the key units of chemical plants. The performance of reactors significantly affects the economic and environmental aspects of the plant operation. The formulation of constraints in these types of units is very important and complicated owing to the various types of reactors and the complex reaction kinetics. Unlike a heat exchanger whose constraints are similar regardless of types of equipment, there is a great variation in deriving the constraints for reactors.

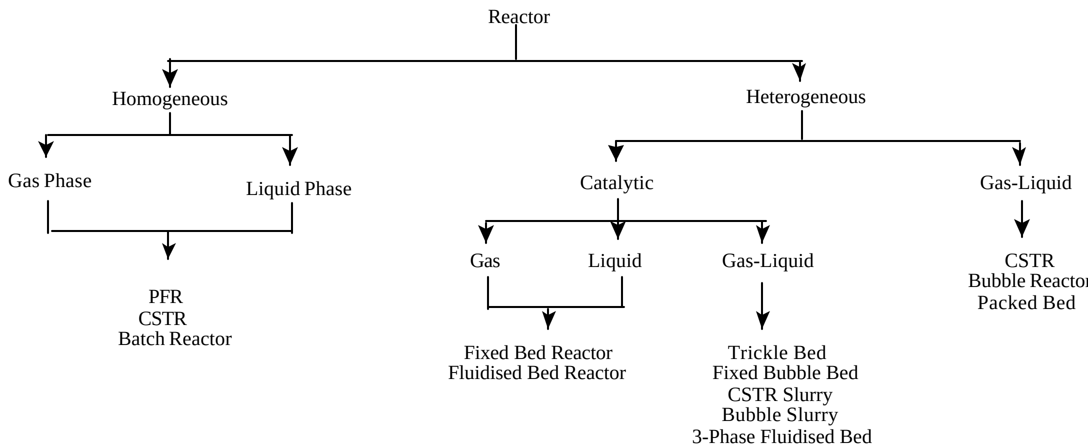


Figure 4: The Reactor Analysis Program Outline

The chemical reactor analysis program of the Advanced Process Analysis System is a comprehensive, interactive computer simulation that can be used for modeling various types of reactors such as Plug Flow, CSTR and Batch reactors. This is shown in Figure 4. Reaction phases included are homogeneous gas, homogeneous liquid, catalytic liquid, gas-liquid etc. The options for energy model include isothermal, adiabatic and non-adiabatic.

The kinetic data needed for the reactor system includes the number of reactions taking place in the reactor and the number of chemical species involved. For each reaction, the stoichiometry and reaction rate expressions also need to be supplied. The physical properties for the chemical species can be retrieved from Flowsim.

The feed stream for the reactor is obtained from Flowsim and its temperature, pressure, flowrate and composition are retrieved using the results from on-line optimization. Finally, the dimensions of the reactor and heat transfer coefficients are supplied. All of this data is used with various types of reactors to predict their performance and select the best one. The reactant concentration, conversion, temperature and pressure are calculated as function of reactor length or space-time. The results can be viewed in both tabular and graphical form.

As the operating process conditions change, the performance of the reactors also can vary to a significant extent. The reactor design program provides a tool to develop an understanding of these relationships. It provides a wide range of different types of reactors, which can be examined and compared to decide the best reactor configuration for economic benefits and waste reduction.

The Alkylation process will be used to demonstrate the use and capabilities of the chemical reactor analysis program. This is described in Section IX.

D. The Heat Exchanger Network Program

The optimization of the chemical reactors is followed by the heat exchanger network optimization as shown in the onion skin diagram in Figure 2. Most chemical processes require the heating and cooling of certain process streams before they enter another process unit or are released into the environment. This heating or cooling requirement can be satisfied by matching of these streams with one another and by supplying external source of heating or cooling. These external sources are called as utilities, and they add to the operating cost of the plant. The Heat Exchanger Network program aims at minimizing the use of these external utilities by increasing energy recovery within the process. It also synthesizes a heat exchanger network that is feasible and has a low investment cost.

There are several ways of carrying out the above optimization problem. Two of the most important ones are the pinch analysis and the mathematical programming methods. Pinch analysis is based on thermodynamic principles whereas the mathematical methods are based on mass and energy balance constraints. The Heat Exchanger Network Program (abbreviated as THEN) is based on the method of pinch analysis (Knopf, 1989).

The first step in implementation of THEN is the identification of all the process streams, which are important for energy integration. These important streams usually include streams entering or leaving heat exchangers, heaters and coolers. The flowsheeting diagram of Flowsim can be an important aid in selection of these streams.

The next step in this optimization task involves retrieval of the necessary information related to these streams. Data necessary to perform heat exchanger network optimization includes the temperature, the flowrate, the film heat transfer coefficient and the enthalpy data. The enthalpy data can be in the form of constant heat capacities for streams with small temperature variations. For streams with large variations, it can be entered as temperature-dependent enthalpy coefficients. The film heat transfer coefficients are needed only to calculate the areas of heat exchangers in the new network proposed by THEN.

The temperature and flowrates of the various process streams are automatically retrieved from the results of online optimization. The set points obtained after the plant economic optimization are used as the source data. The physical properties such as the heat capacities, enthalpy coefficients and film heat transfer coefficients are retrieved from the Flowsim.

The third step in the heat exchanger network optimization is classification of streams into hot streams and cold streams. A hot stream is a stream that needs to be cooled to a lower temperature whereas a cold stream is a stream that needs to be heated to a higher temperature. Usually, streams entering a cooler or the hot side of a heat exchanger are the hot streams whereas streams entering through a heater or the cold side of a heat exchanger are the cold streams. The final step in this problem requires the specification of the minimum approach temperature. This value is usually based on experience.

Having completed all of the above four steps, the heat exchanger network optimization is now performed using THEN. Thermodynamic principles are applied to determine the minimum amount of external supply of hot and cold utilities. The Composite Curves and the Grand Composite Curve are constructed for the process. These curves show the heat flows at various temperature levels. Illustrations of the composite curves are given in Figure 5. A new network of heat exchangers, heaters and coolers is proposed, which features the minimum amount of external utilities. This network drawn in a graphical format is called the Network Grid Diagram. An example of a network grid diagram is given in Figure 6. Detailed information about the network can be viewed using the interactive features of the user interface.

The amount for minimum hot and cold utilities calculated by the Heat Exchanger Network Program is compared with the existing amount of utilities being used in the process. If the existing amounts are greater than the minimum amounts, the process has potential for reduction in operating cost. The network grid diagram synthesized by THEN can be used to construct a heat exchanger network that achieves the target of minimum utilities. The savings in operating costs are compared with the cost of modification of the existing network, and a decision is made about the implementation of the solution proposed by THEN.

The Alkylation process will be used to demonstrate the use and capabilities of the THEN program. This is described in Section VII.

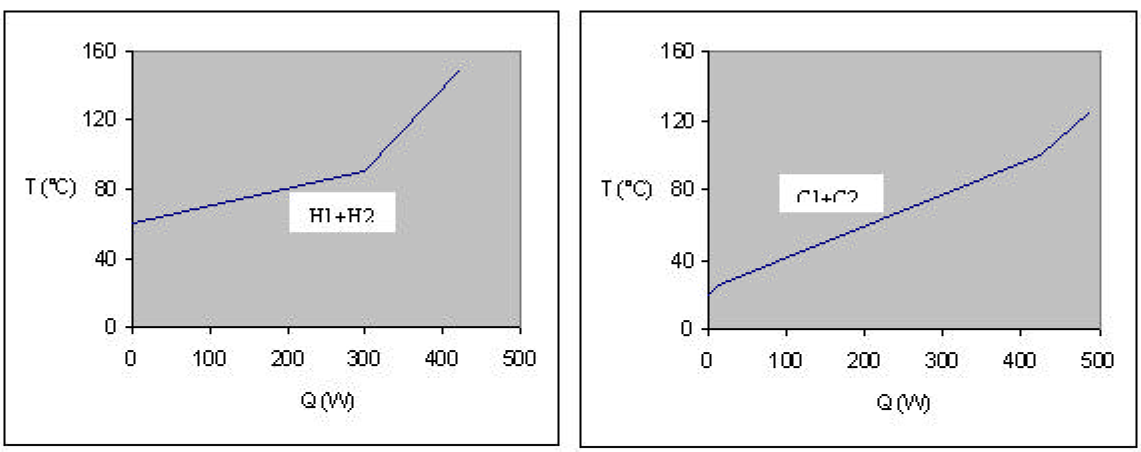


Figure 5: The Composite Curves for Hot Streams (on the left side) and Cold Streams (on the right side) for The Simple Process.

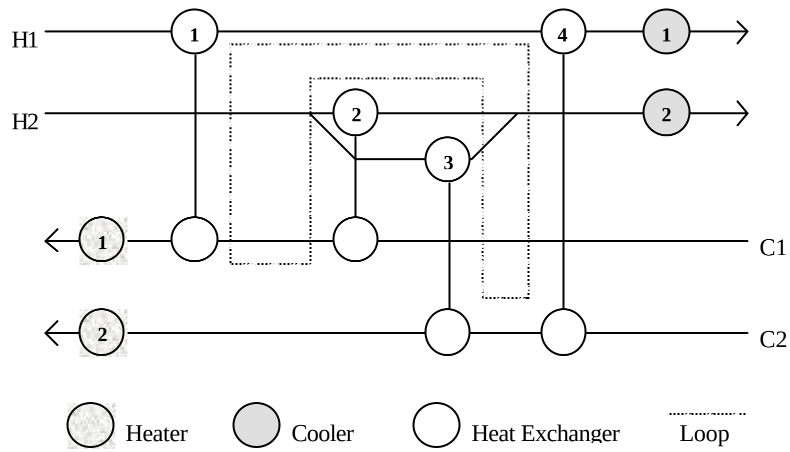


Figure 6: The Grid Diagram

E. The Pollution Assessment Program

The final step in the Advanced Process Analysis System is the assessment of the pollution impact of the process on the environment. This has become an important issue in the design and optimization of chemical processes because of growing environmental awareness

The pollution assessment module of the Advanced Process Analysis System is called 'The Pollution Assessment Program'. It is based on the Waste Reduction Algorithm (Hilaly, 1994) and the Environmental Impact Theory (Cabezas et. al., 1997).

E-1. Waste Reduction Algorithm

The WAR algorithm is based on the generic pollution balance of a process flow diagram.

Pollution Accumulation = Pollution Inputs + Pollution Generation - Pollution Output (I.1)

It defines a quantity called as the 'Pollution Index' to measure the waste generation in the process. This pollution index is defined as:

$$I = \text{wastes/products} = -(G\text{Out} + G\text{Fugitive}) / GP_n \qquad \text{(I.2)}$$

This index is used to identify streams and parts of processes to be modified. Also, it allows comparison of pollution production of different processes. The WAR algorithm can be used to minimize waste in the design of new processes as well as modification of existing processes.

E-2. The Environmental Impact Theory

The Environmental Impact Theory (Cabezas et. al., 1997) is a generalization of the WAR algorithm. It describes the methodology for evaluating potential environmental impacts, and it can be used in the design and modification of chemical processes. The environmental impacts of a chemical process are generally caused by the energy and material that the process takes from and emits to the environment. The potential environmental impact is a conceptual quantity that can not be measured. But it can be calculated from related measurable quantities.

The generic pollution balance equation of the WAR algorithm is now applied to the conservation of the Potential Environmental Impact in a process. The flow of impact $\dot{I}$, in and out of the process is related to mass and energy flows but is not equivalent to them. The conservation equation can be written as

$$\frac{dI_{sys}}{dt} = \dot{I}_{in} - \dot{I}_{out} + \dot{I}_{gen} \qquad \text{(I.3)}$$

where I_{sys} is the potential environmental impact content inside the process, $\dot{I}_{in}$ is the input rate of impact, $\dot{I}_{out}$ is the output rate of impact and $\dot{I}_{gen}$ is the rate of impact generation inside the process by chemical reactions or other means. At steady state, equation I.3 reduces to

$$0 = \dot{I}_{in} - \dot{I}_{out} + \dot{I}_{gen} \qquad \text{(I.4)}$$

Application of this equation to chemical processes requires an expression that relates the conceptual impact quantity $\dot{I}$ to measurable quantities. The input rate of impact can be written as

$$\dot{I}_{in} = \sum_j \dot{I}_j = \sum_j \dot{M}_j^{in} \sum_k x_{kj} \Psi_k \qquad \text{(I.5)}$$

where the subscript 'in' stands for input streams. The sum over j is taken over all the input streams. For each input stream j, a sum is taken over all the chemical species present in that stream. M_j is the mass flow rate of the stream j and the x_{kj} is the mass fraction of chemical k in that stream. Q_k is the characteristic potential impact of chemical k.

The output streams are further divided into two different types: Product and Non-product. All non-product streams are considered as pollutants with positive potential impact and all product streams are considered to have zero potential impact. The output rate of impact can be written as

$$\dot{I}_{out} = \sum_j \dot{I}_j = \sum_j \dot{M}_j^{out} \sum_k x_{kj} \Psi_k \tag{I.6}$$

where the subscript 'out' stands for non-product streams. The sum over j is taken over all the non-product streams. For each stream j, a sum is taken over all the chemical species.

Knowing the input and output rate of impact from the equations I.5 and I.6, the generation rate can be calculated using equation I.4. Equations I.5 and I.6 need values of potential environmental impacts of chemical species. The potential environmental impact of a chemical species (Ψ_k) is calculated using the following expression

$$\Psi_k = \sum_l a_l \Psi^s_{k,l} \tag{I.7}$$

where the sum is taken over the categories of environmental impact. "$_l$ is the relative weighting factor for impact of type l independent of chemical k. $Q^s_{k,l}$ is the potential environmental impact of chemical k for impact of type l. Values of $Q^s_{k,l}$ for a number of chemical species can be obtained from the report on environmental life cycle assessment of products (Heijungs, 1992).

There are nine different categories of impact. These can be subdivided into four physical potential impacts (acidification, greenhouse enhancement, ozone depletion and photochemical oxidant formation), three human toxicity effects (air, water and soil) and two ecotoxicity effects (aquatic and terrestrial). The relative weighting factor "$_l$ allows the above expression for the impact to be customized to specific or local conditions. The suggested procedure is to initially set values of all relative weighting factors to one and then allow the user to vary them according to local needs. More information on impact types and choice of weighting factors can be obtained from the report on environmental life cycle assessment of products (Heijungs, 1992).

To quantitatively describe the pollution impact of a process, the conservation equation is used to define two categories of Impact Indexes. The first category is based on generation of potential impact within the process. These are useful in addressing the questions related to the internal environmental efficiency of the process plant, i.e., the ability of the process to produce desired products while creating a minimum of environmental impact. The second category measures the emission of potential impact by the process. This is a measure of the external environmental efficiency of the process i.e. the ability to produce the desired products while inflicting on the environment a minimum of impact.

Within each of these categories, three types of indexes are defined which can be used for comparison of different processes. In the first category (generation), the three indexes are as follows.

1) $\dot{I}^{NP}_{gen}$ This measures the the total rate at which the process generates potential environmental impact due to nonproducts. This can be calculated by subtracting the input rate of impact ($\dot{I}_{in}$) from the output rate of impact ($\dot{I}_{out}$).

Total rate of Impact generated based on Potential Environmemtal Impact is:

$$\dot{I}^{NP}_{gen} = \dot{I}^{NP}_{out} - \dot{I}^{NP}_{in} \qquad \text{(I.8)}$$

where $\dot{I}_{in}$ is calculated using equation I.5 and $\dot{I}_{out}$ is calculated using Equation I.6.

2) $\hat{I}^{NP}_{gen}$ This measures the potential impact created by all nonproducts in manufacturing a unit mass of all the products. This can be obtained from dividing $\dot{I}^{NP}_{gen}$ by the rate at which the process outputs products.

Specific Impact generated based on Potential Environmental Impact is:

$$\hat{I}^{NP}_{gen} = \frac{\dot{I}^{NP}_{gen}}{\sum_p \dot{P}_p} = \frac{\dot{I}^{NP}_{out} - \dot{I}^{NP}_{in}}{\sum_p \dot{P}_p} \qquad \text{(I.9)}$$

where $\sum_p \dot{P}_p$ is the total rate of output of products

3) $\hat{M}^{NP}_{gen}$ This is a measure of the mass efficiency of the process, i.e., the ratio of mass converted to an undesirable form to mass converted to a desirable form. This can be calculated from $\hat{I}^{NP}_{gen}$ by assigning a value of 1 to the potential impacts of all non-products.

Rate of Generation of Pollutants per Unit Product is

$$\hat{M}^{NP}_{gen} = \frac{\sum_j \dot{M}^{(out)}_j \sum_k x^{NP}_{kj} - \sum_j \dot{M}^{(in)}_j \sum_k x^{NP}_{kj}}{\sum_p \dot{P}_p} \qquad \text{(I.10)}$$

The indexes in the second category (emission) are as follows.

4) $\dot{I}_{out}^{NP}$ This measures the the total rate at which the process outputs potential environmental impact due to nonproducts. This is calculated using equation I.6.

5) $\hat{I}_{out}^{NP}$ This measures the potential impact emitted in manufacturing a unit mass of all the products. This is obtained from dividing $\dot{I}_{out}^{NP}$ by the rate at which the process outputs products.

Specific Impact Emission based on Potential Environmental Impact is:

$$\hat{I}_{out}^{NP} = \frac{\dot{I}_{out}^{NP}}{\sum_p \dot{P}_p} \qquad \text{(I.11)}$$

6) $\hat{M}_{out}^{NP}$ This is the amount of pollutant mass emitted in manufacturing a unit mass of product. This can be calculated from $\hat{I}_{out}^{NP}$ by assigning a value of 1 to the potential impacts of all non-products.

Rate of Emission of Pollutants per Unit Product is:

$$\hat{M}_{out}^{NP} = \frac{\sum_j \dot{M}_j^{(out)} \sum_k x_{kj}^{NP}}{\sum_p \dot{P}_p} \qquad \text{(I.12)}$$

Indices 1 and 4 can be used for comparison of different designs on an absolute basis whereas indices 2, 3, 5 and 6 can be used to compare them independent of the plant size. Higher values of indices mean higher pollution impact and suggest that the plant design is inefficient from environmental safety point of view.

E-3. Steps in Using the Pollution Index Program

The first step in performing pollution analysis is the selection of relevant streams. Environmental impact of a chemical process is caused by the streams that the process takes from and emits to the environment. Therefore, only these input and output streams are considered in performing the pollution Assessment analysis. Other streams, which are completely internal to the process, are excluded. In the Pollution Index Program, this selection of input-output streams is automatically done based on the plant information entered in Flowsim.

The next step in the pollution index analysis is the classification of the output streams into product and non-product streams. All streams which are either sold as product or which are used up in a subsequent process in the production facility are considered as product streams. All other output streams, which are released into the environment, are considered as non-product streams. All non-product streams are considered as pollutant streams whereas all product streams are considered to have zero environmental impact.

Pollution index of a stream is a function of its composition. The composition data for the streams is retrieved from the results of on-line optimization performed earlier. This can be either in terms of the molar flowrates or fractions. Additional data such as the specific environmental impact potential values for the chemical species is available in the report on environmental life cycle assessment of products.

The last piece of information required is the relative weighting factors for the process plant. These values depend on the location of the plant and its surrounding conditions. For example, the weighting factor for photochemical oxidation is higher in areas that suffer from smog.

Having finished all of the above prerequisite steps, the pollution index program is now called to perform the analysis. Mass balance constraints are solved for the process streams involved, and the equations of the Environmental Impact Theory are used to calculate the pollution index values. The pollution indices of the six types discussed earlier are reported for the process. Three of these are based on internal environmental efficiency whereas the other three are based on external environmental efficiency. Higher the values of these indices, higher is the environmental impact of the process.

The pollution Assessment program also calculates pollution indices for each of the individual process streams. These values help in identification of the streams that contribute more to the overall pollution impact of the process. Suitable process modifications can be done to reduce the pollutant content of these streams.

Every run of on-line optimization for the process is followed by the pollution index calculations. The new pollution index values are compared with the older values. The comparison shows how the change in process conditions affects the environmental impact. Thus, the pollution Assessment program can be used in continuous on-line monitoring of the process.

The Alkylation process will be used to demonstrate the use and capabilities of the pollution Assessment program. This is described in section VIII.

F. Windows Interface

An important part of the advanced process analysis system is development of the Graphical User Interface (GUI). It was necessary to have a programming language, which could integrate all of above applications into one program. It should also be able to exchange information between these programs without the intervention of the process engineer.

There are four competitive object-oriented, rapid applications development tools with GUI windows that have the above capabilities. These are Microsoft's Visual Basic, Borland's Delphi32, IBM's Visual Age and Powersoft's Powerbuilder.

We have chosen Visual Basic as the interface development language. It is integrated with Windows 95 and Windows NT, has a low cost and can link applications over a local area network. Also, Visual Basic supports the Object Linking and Embedding technology in OLE2. This feature allows the programs to exchange information regardless of the physical or logical location or data type and format.

Visual Basic 5.0 was used to develop windows interface for Flowsim, the on-line optimization program, the chemical reactor design program, THEN, the heat exchanger network design program, and the pollution Assessment program. As mentioned earlier, sharing of process, economic and environmental data is the key to integration of these programs into one package. Storing the output data of all these programs in different files had many disadvantages. Both storage and retrieval of data would be inefficient. Also, exchange of information between the programs would require reading data from a number of files thus reducing the speed.

As a result, it was decided to use a database to store all of the necessary information to be shared by the component programs as shown in Figure 1. A database is nothing but a collection of information in form of tables. The information in a table is related to a particular subject or purpose. A number of database formats are in use in industry. We have chosen Microsoft Access as the database system for this project.

A table in Microsoft Access consists of rows and columns, which are called *Records* and *Fields* respectively in the database terminology. Each *Field* can store information of a particular kind e.g. a table 'Stream Data' can have a field called 'Temperature' which stores all the stream temperatures. Another table can have a field called 'Prices' which has the prices of all the reactants and products. Each *Record* is a data entry, which fills all the fields of a table. So, the Stream Data table in the above example can have a record for stream S1, which has values for temperatures, pressure, flowrates etc. entered in the respective fields.

Microsoft Access is an interactive database system. Using Access, you can store data in tables according to the subject. This makes tracking of data very efficient. Also, you can specify relationships between different tables. Consequently, it is easy to bring together information related to various topics. Microsoft Access takes full advantage of the graphical power of windows. Also, it is fully compatible with Microsoft's Visual Basic and Microsoft Excel, which is a significant advantage for this application.

G. Summary

The Advanced Process Analysis System offers a combination of powerful process design and modification tools. The Visual Basic interface integrates all of these into one system and makes the application very user-friendly. The best way to understand the application of the Advanced Process Analysis System is apply it to an actual process. The Alkylation process is used for this purpose. This process incorporates four reactor pairs and four acid settlers. The next section gives a detailed description of the Alkylation process.

II. DESCRIPTION OF ALKYLATION PROCESS

Motiva Alkylation process plant is a 15,000 BPD STRATCO Effluent Refrigerated Alkylation Plant. The heart of the process is the STRATCO reactor or contactor, which contacts the reactants in a high velocity propeller stream and removes heat from the exothermic reaction.

In the STRATCO Effluent Refrigerated Alkylation process, light olefins (propylene, butylenes) are reacted with isobutane in the presence of sulfuric acid catalyst to form hydrocarbon, mainly in the iC_7 to iC_8 range, called alkylate. The alkylate product is a mixture of gasoline boiling range branched hydrocarbons which is blended with the refinery gasoline pool to increase the gasoline octane.

Process flow diagrams representing Motiva alkylation process are shown in Figures 7, 8 and 9. These were prepared from P&ID's of the plant. The reaction section of the process is shown in Figure 7. The refrigeration, depropanizer and deisobutanizer sections are shown in Figure 8. The saturate deisobutanizer section of the alkylation process is shown in Figure 9.

The process has four reactor pairs and four acid settlers as shown in Figure 7. In the reaction section there are three feed streams, the olefin feed (HC01), the isobutane feed (HC03) and the recycled olefin/isobutane mixture (HC32). The olefin feed contains the light olefins that are reacted with isobutane in the alkylation unit's STRATCO stirred reactors. The isobutane stream is in excess to fully react with all of the olefins being charged to the unit. The process units are described in this section.

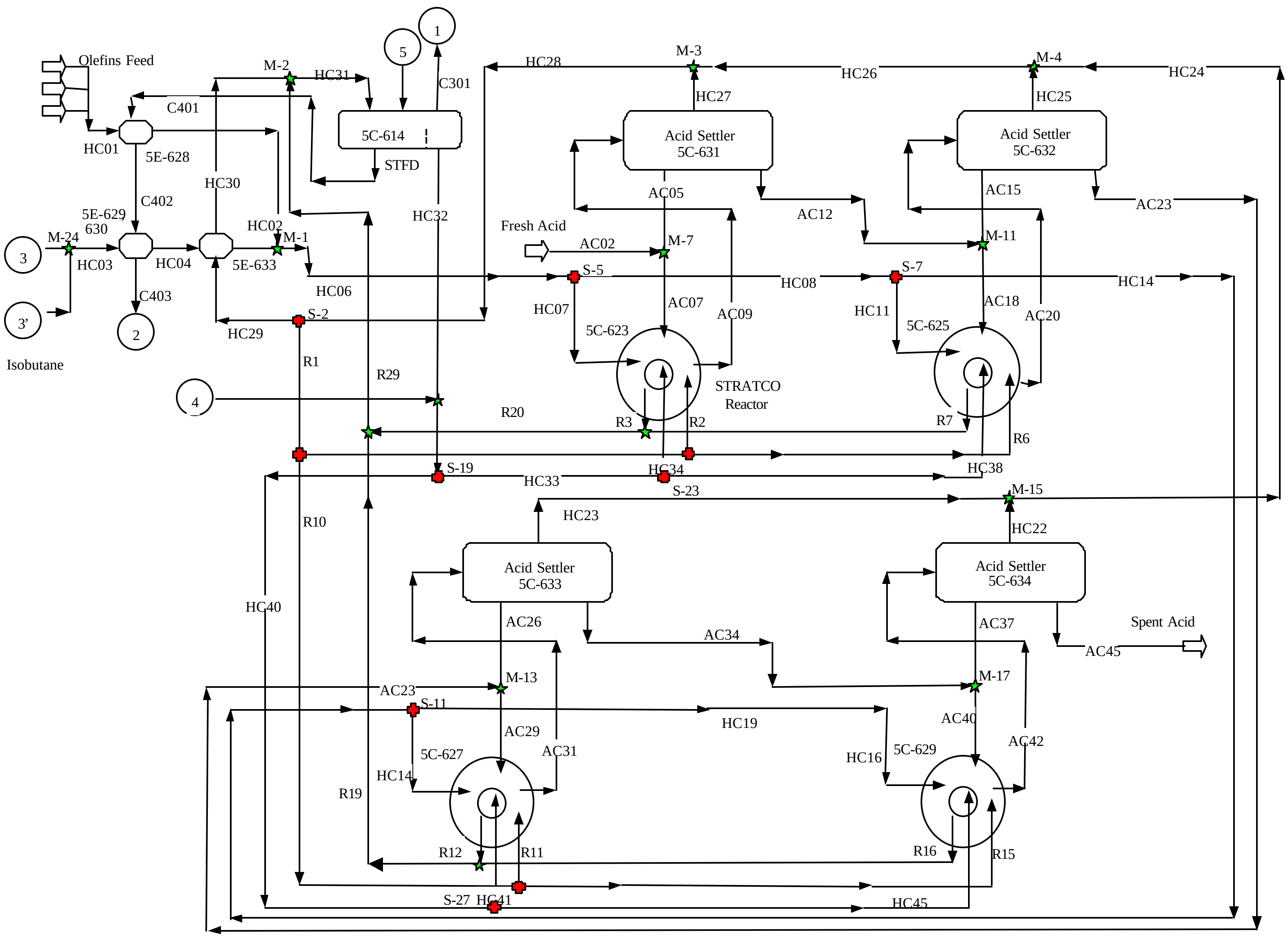


Figure 7. Reaction Section of the Alkylation Process

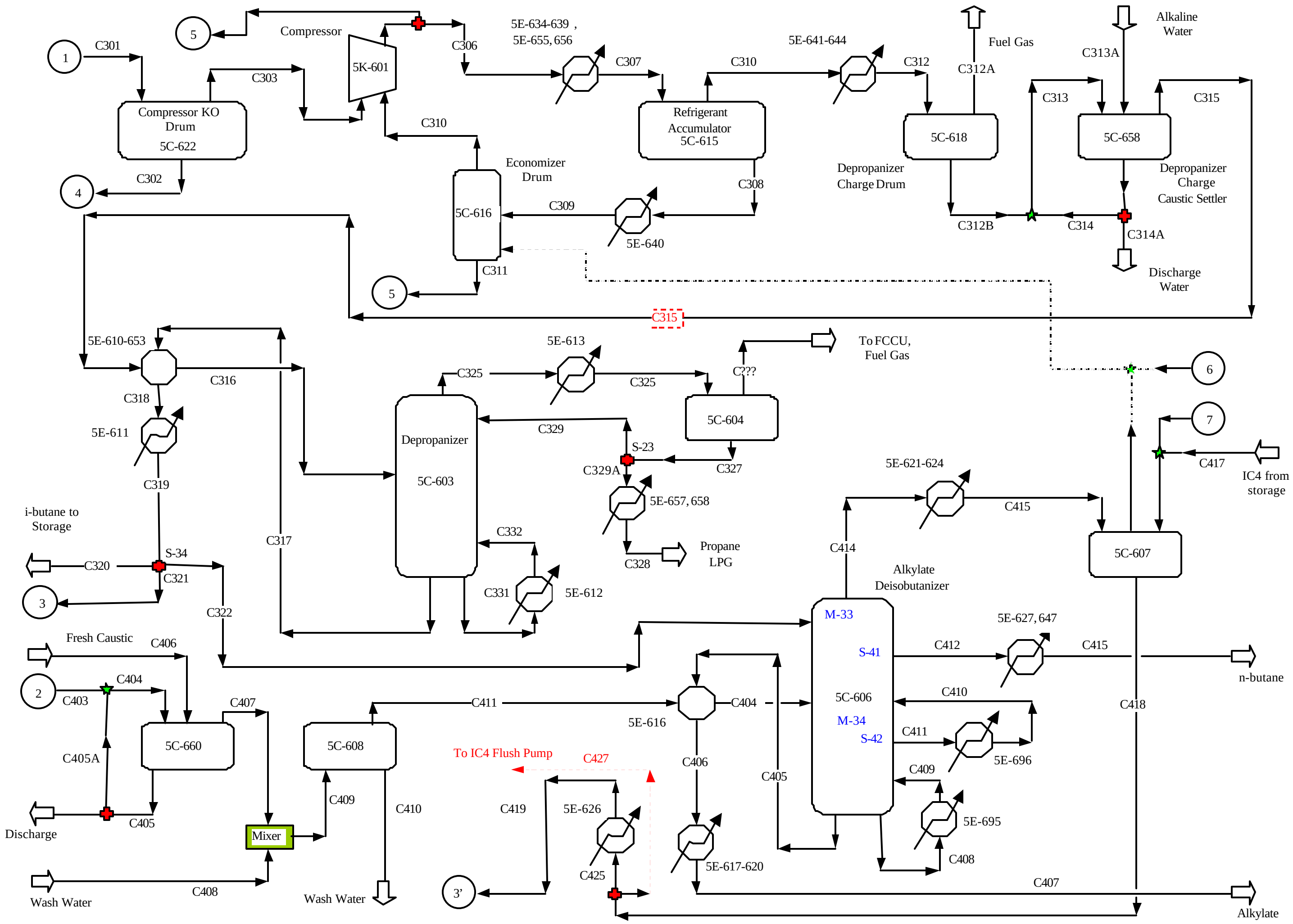


Figure 8. Refrigeration, Depropanizer and Deisobutanizer sections of the Alkylation process

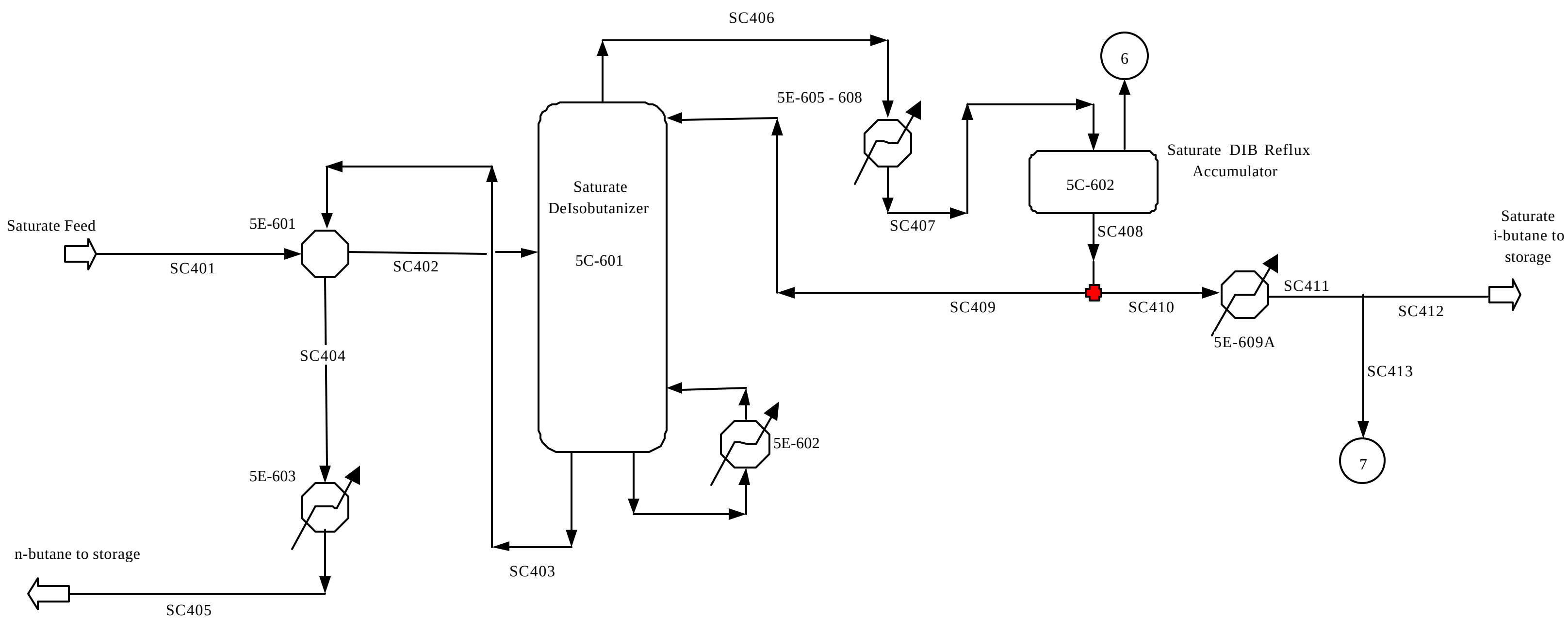


Figure 9. Saturate Deisobutanizer Section of the Alkylation Process

A. STRATCO Contactor

The two feed streams (HC01 and HC03) are cooled by exchanging heat with the net Contactor effluent stream (5E-628, 5E-628, 5E-630) from the suction trap/flash drum (5C-614) as shown in Figure 7. The two streams are then combined and fed to the STRATCO Contactors (5C-623 to 5C-630). The recycled olefin/isobutane stream is fed to the Contactors separately (HC34, HC38, HC41, HC45).

The STRATCO Contactor, in which the alkylation reaction occurs, is a horizontal pressure vessel containing a mixing impeller, an inner circulation tube and a tube bundle to remove the heat generated by the alkylation reaction as shown in Figure 10. The feed is injected into the suction side of the impeller inside the circulation tube. The impeller rapidly disperses the hydrocarbon feed with acid catalyst to form an emulsion. The emulsion is circulated by the impeller at high rates within the Contactor. The sulfuric acid present within the reaction zone serves as a catalyst to the alkylation reaction. The acid absorbs a small amount of hydrocarbon from side reactions and feed contaminants which reduces the sulfuric acid concentration. In order to maintain the desired spent acid strength (89.0 wt% H_2SO_4) in the last two of the eight Contactors, fresh acid (98.5 wt% H_2SO_4) is continuously charged to the first two Contactors, and an equivalent amount of 89.0 wt% spent acid is withdrawn from the acid settler.

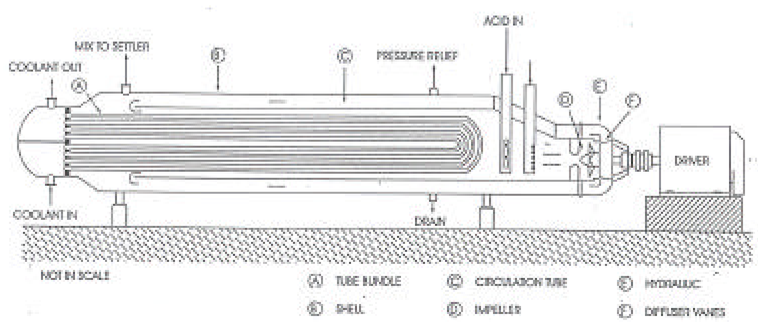


Figure 10. STRATCO Effluent Refrigeration Reactor (Yongkeat, 1996)

The hydrocarbon and acid are separated in four settlers 5C-631 to 5C-634 and the acid-free hydrocarbon phase (HC22, HC23, HC25, HC27) flows from the top of the acid settler through a backpressure control valve. Part of it goes into the tube side of the contactor tube bundle (R1). The backpressure control valve is set at a pressure (60.0 psig) to maintain the contents of the settler in the liquid phase. As the hydrocarbon stream passes through the control valve, its pressure is reduced to about 5.0 psig, flashing a portion of the stream's lighter components, thereby, cooling the stream to a temperature of about 30 °F. When the two-phase stream passes through the tube bundle, additional vapor is generated as a result of absorbing heat generated by the alkylation reaction.

B. Refrigeration Section

As shown in Figure 7, the second portion (HC29) of the hydrocarbon effluent from the settler goes to the isobutane chiller (5E-633) and is used to reduce the temperature of the isobutane feed stream. It then combines with the Contactor effluent stream leaving the tube bundle and flows into the suction trap side of the suction trap/flash drum (5C-614), where the liquid and vapor portions of this stream are separated. The suction trap/flash drum is a two-compartment vessel with a common vapor space. The net Contactor effluent is accumulated on one side of a separation baffle and is pumped to the effluent treating section. The cold refrigerant condensate is accumulated on the other side of the baffle. This effluent recycle stream consists mostly of isobutane and is returned to the Contactor by the effluent recycle pump. The vapor portions of both of these streams combine and flow to the suction of the refrigeration compressor (5K-601) shown in Figure 8.

The compressor driven by an electric motor, increases the pressure of the refrigerant vapor to allow condensing by cooling water. The vapor is condensed in two steps to provide a higher concentration of propane in the depropanizer feed.

Liquid generated by the first bank of condensers (e.g. 5E-634-639) is separated from the propane-rich vapor in the refrigerant accumulator (5C-615), further cooled by the refrigerant cooler, and then flashed across a control valve. Vapor and liquid are separated in an economizer (5C-616). The economizer vapor returns to an intermediate stage of the compressor (5K-601) to be recompressed, while the liquid is returned to the suction trap/flash drum (5C-614).

The remaining vapor portion of the compressor discharge stream (C310) flows from the separator to the "total condenser" (5E-641-644). Liquid from the total condenser is accumulated in the Depropanizer Charge Drum (5C-618), and ultimately fed to the Depropanizer (5C-603) for stripping of propane before being sent to the Alkylate Deisobutanizer (5C-606).

C. Depropanizer (5C-603)

The depropanizer feed stream is pumped from the charge drum to the depropanizer feed caustic wash (5C-658) to neutralize acidic components. The neutralized stream then flows to the depropanizer feed/bottoms exchanger (5E-610-5E-653) before entering the tower, as shown in Figure 8.

The overhead propane vapor from the depropanizer (C325) is totally condensed by cooling water and collected in the depropanizer reflux accumulator drum (5C-604). A part of the liquid is refluxed to the column's top tray (C329), and the rest is further cooled and sent to the LPG section (C328). The depropanizer bottoms product (C317) temperature is reduced in the feed/bottoms exchanger (5E610-653). The stream then enters a water-cooled exchanger (5E-611) before it is split into three portions, one each for the Alkylate Deisobutanizer, the Contactor (3) and storage.

D. Alkylate Deisobutanizer (5C-606)

The net effluent from the suction trap/flash drum (5C-614) is heated in the feed/effluent exchangers (5E-628; 5E-629, 5E-630) as shown in Figure 7 and then treated with caustic to remove any traces of acid (5C-660 and 5C-608 in Figure 8). The treated net effluent is fed to the alkylate deisobutanizer (DIB) tower (5C-606) to strip isobutane from alkylate as shown in Figure 8. Two steam-fired thermosiphon reboilers (5E-695, 5E-696) supply the majority of the heat to the lower portion of the column by vaporizing liquid side draws (C411) from the column as well as the DIB bottoms liquid (C408). A portion of the depropanizer bottoms is fed to the column as the reflux (C322).

Normal butane is removed as a vapor side-draw (C412). The vapor is condensed and cooled by cooling water (5E-627, 5E-647). The normal butane product (C415) can be used for vapor pressure blending or sold. The rate of the normal butane product will vary depending on the desired deisobutanizer alkylate product Reid Vapor Pressure (RVP).

The overhead isobutane vapor is condensed by cooling water and accumulated in the isobutane accumulator pot (5C-607). Make-up isobutane (C417) from storage is added to the pot and the combined stream (C418) is sent to the Contactors to react with the olefins (3') .

The deisobutanizer bottoms (C405) is the alkylate product. It is cooled by the deisobutanizer feed/effluent exchanger (5E-616) and also a heat exchanger with cooling water (5E-617-5E-620). The cooled alkylate (C407) is removed as a product and sent to storage.

E. Saturate Deisobutanizer (5C-601)

Another source for isobutane is the saturate deisobutanizer (SatDIB) column (Figure 9), which strips isobutane from saturate feed coming from reformer unit of the refinery (SC401). The saturate feed, containing mainly C_4's, flows to the SatDIB feed/bottoms exchanger (5E-601) before entering the tower, as shown in Figure 8. The overhead isobutane vapor is condensed by cooling water and a fraction of it (stream SC413) is accumulated in the isobutane accumulator pot (5C-607, Figure 8). The saturate deisobutanizer bottoms (SC403) are mainly n-butane product. It is cooled by the SatDIB feed/bottoms exchanger (5E-601) and also by a heat exchanger with cooling water (5E-603). The cooled n-butane (SC405) is sent to storage.

III. PROCESS MODEL FOR ALKYLATION PROCESS

A process model of a chemical engineering process is a set of constraint equations, which represents a mathematical model of relationships between the various plant units and process streams. Before the constraint equations are formulated, it is important to note that in order to have an accurate model of the process, it is essential to include the key process units such as reactors, heat exchangers and absorbers. These units affect the economic and pollution performance of the process to a significant extent. Certain other units are not so important and can be excluded from the model without compromising the accuracy. For the Alkylation process, The equipment in the Alkylation plant can be categorized according to their functions as Reaction Zone, Separation Zone, Heat Transfer Zone, Miscellaneous.

Reaction Zone:

- STRATCO Contactor
- Acid settler

Separation Zone:

- Depropanizer
- Alkylate Deisobutanizer
- Saturate Deisobutanizer
- Suction Trap Flash Drum
- Economizer
- Compressor

Heat Transfer Zone:

- Heat Exchangers
- Condensers
- Reboilers

Miscellaneous:

- Mixers
- Splitters
- Reflux Accumulators

The alkylation process involves mixtures of a variety of components. The components and compositions of streams vary widely from one section to the other. For record keeping, all the hydrocarbon streams in the plant are composed of the following components:

1. C_3- Propane and lower
2. C_4= Butenes
3. iC_4 iso-butane
4. nC_4 normal-butane

5. iC_5 iso-pentane
6. nC_5 normal-pentane
7. iC_6 iso-hexane
8. iC_7 iso-heptane
9. iC_8 iso-octane
10. iC_9+ iso-nonane and higher

All the sulfuric acid streams in the plant are composed of:

11. H_2SO_4 sulfuric acid
12. Water and impurities

The streams carrying the reaction products from the contactors to the acid settlers contain all of the twelve components.

A. STRATCO Contactor (5C-623)

The sulfuric acid alkylation reaction mechanism for pure propylene and pure butylene feeds is based on the Schmering carbonium ion mechanism with modification introduced to account for iC_9 and iC_{10} formation. The parameters that affect the performance of the contactor are:

1. Operating Temperature
2. Acid Strength
3. Isobutane Concentration
4. Olefin Space Velocity

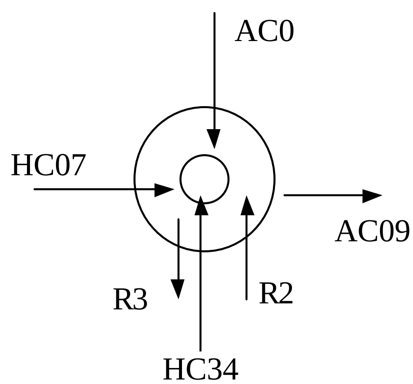


Figure 11: Contactor 5C-623

The contactor was modeled as of a Continuously Stirred Tank Reactor (CSTR) with heat exchange. The intense mixing provided by the propellers ensures that there is no spatial variation in concentration, temperature, or reaction rate throughout the vessel. The composition and temperature of the exit stream were the same as those inside the reactor.

Referring to Figures 7 and 11, the material and energy balance equations for the contactor 5C-623 are as follows:

Description

Inlet streams: HC07 (isobutane- olefin mixture), HC34 (effluent recycle-mainly isobutane), and AC07 (sulfuric acid catalyst)
Outlet streams: AC09
Coolant streams: R2 (in), R3 (out)

Material Balance

Overall:

Mass flowrate in – Mass flowrate out = 0 (III.1)

$$F_{HC07} + F_{HC34} + F_{AC07} - F_{AC09} = 0 \quad (III.2)$$

$$F_{R2} - F_{R3} = 0 \quad (III.3)$$

where, F_X is the total mass flow rate (metric ton/min) of stream X.

Component:

Mass flowrate in – Mass flowrate out + Mass generation rate = 0 (III.4)

$$F^i_{HC07} + F^i_{HC34} - F^i_{AC09} + r^i V^a_{5C623} MW^i = 0 \quad (III.5)$$

for the hydrocarbon components. Here, r^i is the reaction rate of component i, in terms of moles of i produced per unit time, per unit volume of the acid catalyst (metric ton moles/(m^3·min)), and MW^i is the molecular weight of component i. The quantity V^a_{5C623}, shown in the material balance equations, is the volume of acid in the contactor, and is typically 60 % of the total contactor volume.

Considering the degradation of the catalyst, the material balance equation for the acid component can be written as

$$F^i_{AC07} - F^i_{AC09} - R^a_{5C623} = 0 \quad (III.6)$$

where, R^a_{5C623} is the rate of degradation of the acid (metric ton/min). The acid degradation rate can be related to the volumetric flowrate of butylenes into the contactor as follows (Graves 1999),

$$R^a_{5C623} = 0.121 Q^{C4=}_{HC07} \quad (III.7)$$

The total mass flow rates are calculated as the sum of the component flow rates.

$$\sum F^i_X - F_X = 0 \quad (III.8)$$

The subscripts to the process variables like mass flow rates, specific enthalpies and stream temperatures indicate the stream names, and their superscripts indicate the component. The subscripts to the process parameters indicate the process unit they represent.

The material in the contactor is a two-phase mixture, consisting of a hydrocarbon phase and an acid phase. Since the reaction model assumes that all the reactions occur in the acid phase, the concentrations shown in the reaction model equations are those in the acid phase.

The olefin feed to the process is composed of about 45% lv butylenes (1-BUT + C2B + T2B) and about 3.5% lv propylene among other paraffins. Because of the low presence of propylene and the non-participation of paraffins in the alkylation reaction, the reaction mechanism of alkylation of isobutane with pure butylene was adopted. The reaction rate terms in Equation III.5 is evaluated.

Alkylation of isobutane with olefins is an exothermic reaction. The reaction mixture must be maintained in a particular temperature range (0-10 °C) in order to obtain the desired yields. Higher operating temperatures result in oxidation and polymerization reactions, decreasing the yields. Lower temperatures result in decreased effectiveness due to the increase in acid viscosity and decrease in solubility of hydrocarbons in the acid phase. Therefore, the temperature in the contactor is maintained by recycling the cold refrigerant condensate from the Suction Trap Flash Drum, which consists mostly of isobutane, and by circulating a part of the flashed, acid-free effluent from the settlers, through the contactor tube bundle. When the two-phase stream passes through the tube bundle, additional vapor is generated.

The tube bundle in the contactor, is effectively, a partial boiler, which vaporizes a portion of the coolant. This can be modeled by assuming that the two-phases in the coolant mixture are in equilibrium with each other throughout the tube bundle. The component mass balance for the two-phase coolant stream can be written as

$$(F^i_{R2l} + F^i_{R2v}) - (F^i_{R3l} + F^i_{R3v}) = 0 \qquad \text{(III.9)}$$

$$K_i = \frac{y_i}{x_i} \quad \text{where,} \quad \sum x_i = 1, \quad \sum y_i = 1 \qquad \text{(III.10)}$$

In the above equation, y_i is the mole fraction of component i in the vapor phase, and x_i is that in the liquid phase.

The model can be simplified by assuming that all the vapor generation in the tube bundle, due to transfer of heat from the contactor, occurs at a point outside the tube bundle; i.e. after the coolant has passed through it. This is the same as considering the partial boiler to be equivalent to a heater followed by an isothermal flash operation. Then, the mole fractions can be written as

$$y_i = \frac{F^i_{R3v}/MW^i}{\sum F^i_{R3v}/MW^i} \quad \text{and} \quad x_i = \frac{F^i_{R3l}/MW^i}{\sum F^i_{R3l}/MW^i} \qquad \text{(III.11)}$$

Energy Balance

Overall:

Energy in + Energy generated - Energy out = 0 (III.12)

$$h_{HC07} + h_{HC34} + h_{AC07} + h_{R2} + H_{5C623} - h_{AC09} - h_{R3} = 0 \qquad \text{(III.13)}$$

where, h_X is the enthalpy of stream X in (MJ/min), and H_{5C623} is the heat generated in the contactor by the exothermic reaction (MJ/min).
The stream enthalpies are calculated from the component specific enthalpies, as

$$h_X = \sum F_X^i h_X^i \text{ for single phase streams, and} \qquad \text{(III.14)}$$

$$h_X = \left(\sum F_X^i h_X^i\right)_l + \left(\sum F_X^i h_X^i\right)_v \qquad \text{(III.15)}$$

for two-phase streams (R2 and R3)

where, h_X^i is the specific enthalpy of the component i in stream X in (MJ/metric ton).
Heat Transfer:

Energy in – Energy out – Energy transferred out = 0 (III.16)

$$h_{R2} - h_{R3} - U_{5C623} A_{5C623} \Delta T_{lm} = 0 \qquad \text{(III.17)}$$

where, U_{5C623} is the overall heat transfer coefficient (MJ/m^2·°C·min), A_{5C623} is the area of heat transfer (m^2), and ΔT_{lm} is the log mean temperature difference in the contactor 5C-623 (°C).

$$\Delta T_{lm} = \frac{\left(T_{5C623} - T_{R2}\right) - \left(T_{5C623} - T_{R3}\right)}{\ln \dfrac{\left(T_{5C623} - T_{R2}\right)}{\left(T_{5C623} - T_{R3}\right)}} \qquad \text{(III.18)}$$

The mass and energy balance equations for contactor 5C-623 are summarized in Table A.1 in Appendix A.

E. Acid Settler (5C-631)

The acid settler separates the emulsion from the contactor into the acid and hydrocarbon phases. One acid settler is provided to each pair of contactors. The inputs to the settler are the effluents from the contactor pair and the outputs are the separated acid and hydrocarbon streams.

The material and energy balance equations for the acid settler (5C-631) are as shown in Table A.2 Appendix A. The mass flow rate of each component coming in is equal to the mass flow rate of each component leaving of the settler. Since there is no heat transferred from or into the settler, the temperatures of the various input and output streams can be assumed to be equal. We also assume that the separation of the two phases in the settler is complete, so that there is no acid component in the output hydrocarbon stream and vice-versa.

C Depropanizer (5C-603)

The Depropanizer was modeled using Smith-Brinkley Group method (Smith, 1963; Perry *et al.*, 1984). This method can be applied to absorption, extraction processes and distillation. The equation, which applies to the distillation process is, for each component i,

$$f = \frac{\left(1+S_{n,i}^{N-M}\right)+R\left(1-S_n\right)}{\left(1+S_{n,i}^{N-M}\right)+R\left(1-S_n\right)+hS_n^{N-M}\left(1-S_m^{M+1}\right)} \qquad \text{(III.19)}$$

where R is the external-reflux ratio F_{C329}/F_{C328} and f = (F^i_{C317}/F^i_{C316}), is the fraction of i leaving in the bottoms product. The quantity S is the stripping factor (for each component) and is defined for each group of stages in the column by $S_{n,i}=K_iV/L$ and $S_{m,i}=K'_iV'/L'$. K is the equilibrium ratio y/x for each component and V, L are the vapor and liquid molar flow rates in the column. The K_i, V and L values are the effective values for the top column section; K'_i, V' and L' are the effective values for the section below the feed stage. The quantity h depends on whether K or K' is used for the feed stage. If the feed is mostly liquid, the feed stage is grouped with the lower stages and

$$h_i = \frac{K'_i L}{K_i L'}\left(\frac{1-S_n}{1-S_m}\right)_i \qquad \text{(III.20)}$$

If the feed is mostly vapor,

$$h_i = \frac{L}{L'}\left(\frac{1-S_n}{1-S_m}\right)_i \qquad \text{(III.21)}$$

The following four specifications for the column are necessary:

1. N, the total number of equilibrium stages
2. M, the number of stages below the feed stage
3. The reflux rate or the maximum vapor rate at some point in the column
4. The distillate rate D

Specification of D and L (or V), along with specifications of the feed stream variables fixes the assumed phase rates in both sections of the column. Determination of separation factors S_n and S_m then depends upon estimation of individual K values. If ideal solutions are assumed, K values are functions of only temperature and column specified pressure. Estimation of K values and, in turn, S_n and S_m values for each component reduces to estimation of the effective temperature in each column section or group of stages.

The effective temperature is assumed to be the arithmetic average for simplicity.

$$T_n = \left(T_N + T_{M+1}\right)/2 \qquad \text{(III.22)}$$

$$T_m = \left(T_{M+1} + T_1\right)/2 \qquad \text{(III.23)}$$

The feed enters the column at the (M+1)th stage. The material and energy balance equations for the depropanizer are shown in Table A. in 3 Appendix A. The Saturate Deisobutanizer column is modeled in a similar way.

D. Alkylate Deisobutanizer (5C-606)

The alkylate deisobutanizer column has two feed streams, two product streams, two side streams and two reboilers, one of which is used as a side reboiler. One of the feed streams is fed to the column, at the top tray, in place of the reflux. There was no readily available short cut method to model such a distillation column as it is, therefore, the column was divided into three reasonable sections (C-606A, C-606C and C-606D) which can be modeled using Smith Brinkley Method and by employing equilibrium stage assumption. General Smith-Brinkley Method is used for a classical distillation column with recycle and reboiler streams, however the model of deisobutanizer requires the derivation of the Method for the rectifying and stripping sections separately. Derivations can be found in (Smith, 1963) – Design of Equilibrium Stage Processes in Table A.4 in Appendix A.

F. Suction Trap/Flash Drum (5C-614)

The suction trap/flash drum (STFD) splits the hydrocarbon effluent from the settlers based on volatility. It is a two-compartment vessel, with a common vapor space. The net contactor effluent is accumulated on one side of the baffle and the cold refrigerant condensate on the other. The vapors from the two compartments combine, and flow out from the top.

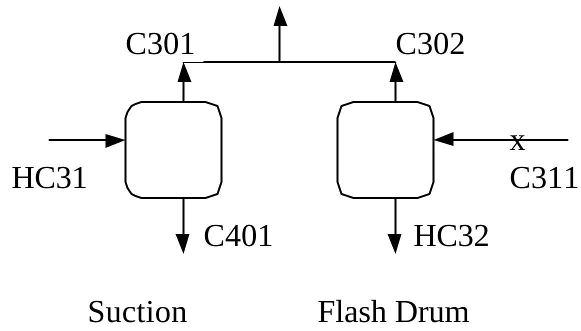


Figure 12: STFD 5C-614

The STFD is modeled as two separate units – suction trap and flash drum, with the vapor streams from the two units combining in a mixer, as shown in Figure 12. The suction trap acts as the separating vessel for the two-phase contactor from the contactor tube bundles and from the isobutane chiller (5E-633). The liquid and vapor streams leave the vessel as two separate streams. In the Flash drum, the cold condensate from the economizer is flashed and separated. This unit is modeled as an equilibrium stage with adiabatic flash. The material and energy balance equations for the two units are as follows:

Suction Trap:

Overall material balance: $$\left(F_{HC31l} + F_{HC31v}\right) - \left(F_{C401} + F_{C301}\right) = 0 \qquad \text{(III.24)}$$

$$F_{HC31l} - F_{C401} = 0 \qquad \text{(III.25)}$$

Component material balance: $$\left(F^i_{HC31l} + F^i_{HC31v}\right) - \left(F^i_{C401} + F^i_{C301}\right) = 0 \qquad \text{(III.26)}$$

$$F^i_{HC31l} - F^i_{C401} = 0 \qquad \text{(III.27)}$$

Energy balance: $$T_{HC31} = T_{C301} = T_{C401} \qquad \text{(III.28)}$$

Flash Drum

Overall material balance: $$F_{C311} - F_{HC32} - F_{C302} = 0 \qquad \text{(III.29)}$$

Component material balance: $$F^i_{C311} - F^i_{HC32} - F^i_{C302} = 0 \qquad \text{(III.30)}$$

$$K_i = \frac{y_i}{x_i}, \text{ where, } \sum x_i = 1, \ \sum y_i = 1 \qquad \text{(III.31)}$$

Energy balance: $$h_{C311} - h_{HC32} - h_{C302} = 0 \qquad \text{(III.32)}$$

The flash operation has been described, in detail, in the contactor modeling section. The Suction Trap Flash Drum model described above is summarized in Table A.5 in Appendix A.

F. Economizer (5C-616)

The Economizer separates the vapor and liquid phases generated when the liquid portion of the propane-rich vapor, in the Depropanizer section, is flashed. This unit is modeled the same way as the flash drum of STFD, i.e. assuming an adiabatic flash operation, where the two phases generated are in equilibrium with each other. The mass and enthalpy balances are:

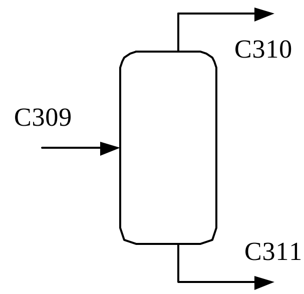


Figure 13. Economizer 5C-616

Overall material balance:

$$F_{C309} - F_{C310} - F_{C311} = 0 \qquad \text{(III.33)}$$

Component material balance:

$$F^{i}_{C309} - F^{i}_{C310} - F^{i}_{C311} = 0 \qquad \text{(III.34)}$$

$$K_i = \frac{y_i}{x_i}, \text{ where, } \sum x_i = 1,\ \sum y_i = 1 \qquad \text{(III.35)}$$

In the above equation, K_i is the distribution coefficient or the K-factor, y_i is the mole fraction of component i in the vapor phase, and x_i is that in the liquid phase.
Enthalpy balance:

$$h_{C309} - h_{C310} - h_{C311} = 0 \qquad \text{(4.36)}$$

where, h_X is the enthalpy of stream X.

G Compressor (5K-601)

The combined vapor stream from Suction Trap and the Flash Drum is rich in propane, and is sent to the depropanizer section. The vapor is compressed in the Refrigeration compressor (5K-601), to allow condensing by cooling water. The compressor was assumed to operate under adiabatic conditions, and hence the calculations were based on the following formulas (Perry *et al.*, 1984):
Adiabatic head is expressed as

$$H_{ad} = \frac{k}{k-1} R T_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{(k-1)}{k}} - 1 \right] \qquad \text{(III.37)}$$

where H_{ad} = adiabatic head, ft; R = gas constant, (ft·lbf)/(lb·°R) = 1545/molecular weight; T_1 = inlet gas temperature, °R; p_1 = absolute inlet pressure, lbf/in^2;
p_2 = Absolute discharge pressure, lbf/in^2, k = ratio of specific heat capacities (c_p/c_v).

The work expended on the gas during compression is equal to the product of the adiabatic head and the weight of the gas handled. Therefore, the adiabatic power is as follows:

$$hp_{ad} = \frac{WH_{ad}}{550} = \frac{k}{k-1} \frac{WRT_1}{550} \left[\left(\frac{p_2}{p_1} \right)^{\frac{(k-1)}{k}} - 1 \right] \qquad \text{(III.38)}$$

or

$$hp_{ad} = 4.36 \times 10^{-3} \frac{k}{k-1} Q_1 p_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{(k-1)}{k}} - 1 \right] \qquad \text{(III.39)}$$

where hp_{ad} = power, hp; W = mass flow, lb/s; and Q_1 = volume rate of gas flow, ft^3/min.
Adiabatic discharge temperature is:

$$T_2 = T_1 \left(\frac{p_2}{p_1} \right)^{\frac{(k-1)}{k}} \qquad \text{(III.40)}$$

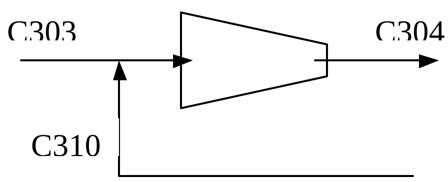


Figure 14: Compressor 5K-601

The constraint equations, for the compressor, are developed using the above formulas.
Overall material balance:

$$F_{C303} + F_{C310} - F_{C304} = 0 \tag{III.41}$$

Component material balance:

$$F^{i}_{C303} + F^{i}_{C310} - F^{i}_{C304} = 0 \tag{III.42}$$

Enthalpy balance:

$$h_{C303} + h_{C310} + hp_{ad} - h_{C304} = 0 \tag{III.43}$$

$$T_2 = T_1\left(\frac{p_2}{p_1}\right)^{\frac{(k-1)}{k}} \tag{III.44}$$

where hp_{ad} is the compressor as given in Equations (III.38, III.39). The constraints of the compressor are summarized in Table A.7 in Appendix A.

H. Olefin Feed Effluent Exchanger (5E-628)

The olefin feed effluent exchanger cools the olefin feed by exchanging heat with the alkylate effluent stream from the suction trap/flash drum. The material and energy balance equations for this exchanger are shown in Table A.8 in Appendix A Since no mass transfer is involved in this unit, the masses of the two streams are conserved. The heat transferred between the streams can be accounted for as shown in the energy balance equations.

This concludes the description of the main units in the Alkylation. The following describes the validation of the alkylation process model.

Model Validation

The validation of the above described model by solving the data validation problem using a set of plant data (steady state operation point #1) and then comparing the results of the model with the plant data. The model predicted out of the 125 plant variables 88 within the accuracy of the measurements. The remaining 37 variables (Table III.1), especially FC316, FC322, x5C417, xx5C412, xx7C414 are found within the range of possible process values. The discrepancy in the variable xx1C322 can be accounted by the model assumption that the propane purge from the drum 5C-618 occurs infrequently.

Table III.1. Plant vs. Model Data

Variable Name	Plant Data	Reconciled Data From Data Validation	Gross Error
FAC02	0.1125	0.1600	4.2235
FAC12	0.1259	0.1600	2.7085
FAC23	0.1253	0.1600	2.7653
FAC45	0.1040	0.1600	5.3846
FC308	2.1990	3.1032	4.1120
FC316	0.6581	1.8000	17.3515
FC322	0.4427	1.5619	25.2812
FC328	0.0942	0.0535	2.6399
FC403	3.8766	2.2834	4.1097
FC412	0.0324	0.0418	2.8968
FSC411	2.7287	1.3525	5.0436
FstmE612	0.1425	0.0889	3.7607
x1C417	0.0372	0.0255	3.1309
x2SC402	0.0136	0.0084	3.7929
x2SC408	0.0221	0.0002	9.9048
x3C325	0.0017	0.0000	10.0000
x3SC403	0.0103	0.0212	10.5665
x4C316	0.0580	0.0796	3.7155
x4SC408	0.0331	0.0088	7.3475
x5C316	0.0020	0.0060	19.8000
x5C417	0.0009	0.0295	286.2300
x5HC32	0.0096	0.0306	22.0134
x6SC402	0.0167	0.0666	29.8204
x6SC403	0.0250	0.0950	27.9946
x7HC32	0.0197	0.0497	15.2312
x7SC402	0.0022	0.0032	4.3956
x7SC408	0.0022	0.0000	10.0000
xx1C322	0.0027	0.1167	428.5338
xx1C414	0.0330	0.0800	14.2498
xx2HC01	0.4525	0.1291	7.1481
xx3C407	0.0003	0.0000	7.4194
xx3HC01	0.3558	0.0125	9.6498
xx4C407	0.1124	0.0853	2.4068
xx5C407	0.0803	0.1506	8.7555
xx5C412	0.0022	0.0581	255.6751
xx5C414	0.0021	0.0011	4.8325
xx7C414	0.0015	0.0080	44.4218

IV. GETTING STARTED WITH THE ADVANCED PROCESS ANALYSIS SYSTEM

Upon running the Advanced Process Analysis System, the first window presented to the user is the ‘Advanced Process Analysis Desk’. This is shown in Figure 15.

By default, the Advanced Process Analysis System opens a new model named ‘untitled.ioo’ in the program directory. The complete filename for this new model is shown in the bottom left corner of the window. The bottom right corner shows the date and the time the program was started. The file menu provides various options such as opening a new or an existing model. This is shown in Figure 16. The ‘Recent Models’ item in the file menu maintains a list of last four recently used models for easy access.

The Advanced Process Analysis Desk has five buttons leading to the five component programs, which were described in earlier sections. All of these can also be called using the process menu at the top. This is shown in Figure 17.

When a new model is opened, only the ‘Flowsheet Simulation’ button is available. This is because the development of the process model using Flowsim is the first step in the implementation of the Advanced Process Analysis System. Until the flowsheet simulation part is completed, buttons for the other four programs remain dimmed and unavailable.

To implement the Advanced Process Analysis System for the Motiva Alkylation process described in earlier section, the first step is to develop the process model using the Flowsim program. The ‘Flowsheet Simulation’ button should be now clicked to open the Flowsim program.

V. USING FLOWSIM

Upon clicking the ‘Flowsheet Simulation’ button in Figure 17, the Flowsim window is displayed with the ‘General Information’ box. In the space for model name, let us enter ‘Alkyl’. In the process description box, let us enter ‘Alkylation Process’. The ‘General Information’ box with this information is shown in Figure 18.

On clicking the ‘OK’ button, the main screen of ‘Flowsim’ is displayed. This is the screen where the user draws the flowsheet diagram. The ‘Model’ menu shown in Figure 19 provides the various commands used to draw the flowsheet diagram. The menu commands are divided into two groups. The first group has commands for drawing the flowsheet diagram whereas the second group has commands for entering various kinds of process information.

The ‘Add Unit’ command should be used to draw a process unit. The ‘Add Stream’ command should be used to draw a process stream between two process units. The program requires that every stream be drawn between two units. However, the input and output streams of a process only have one unit associated with them. To solve this problem, the Flowsim program provides an additional type of unit called ‘Environment I/O’. This can be drawn using the command ‘Add Environment I/O’ in Figure 19. The ‘Lock’ option makes the diagram read-only and does not allow any changes. The diagram can be unlocked by clicking on the command again.

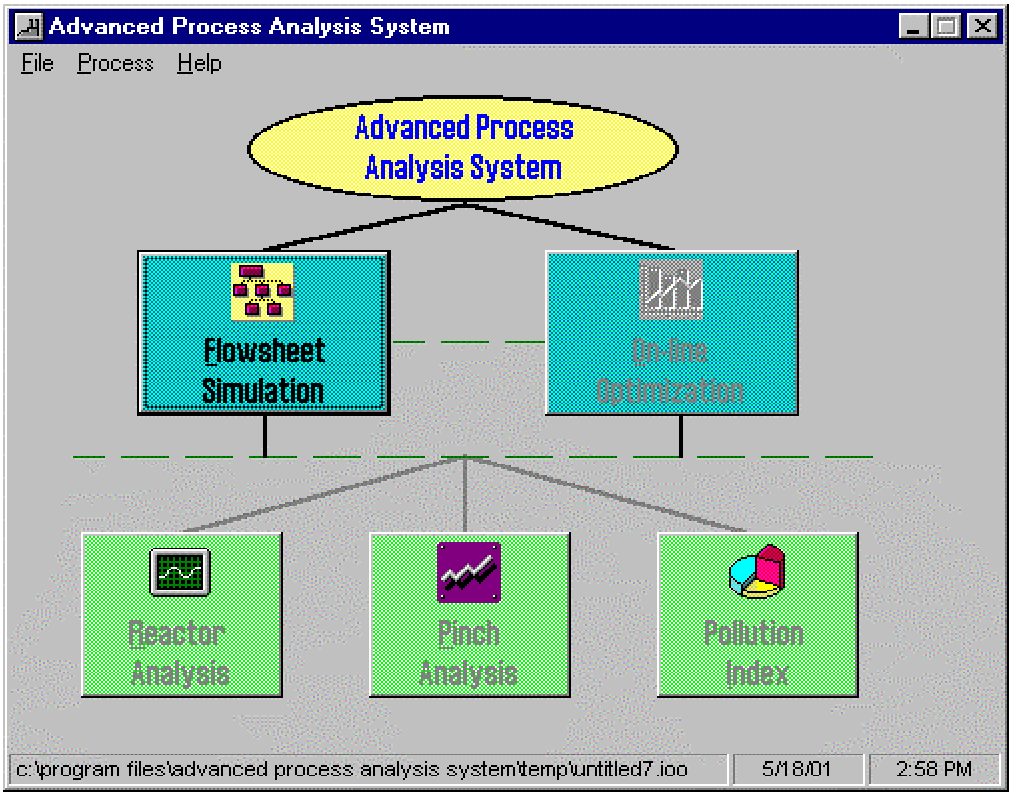


Figure 15. Advanced Process Analysis Desk

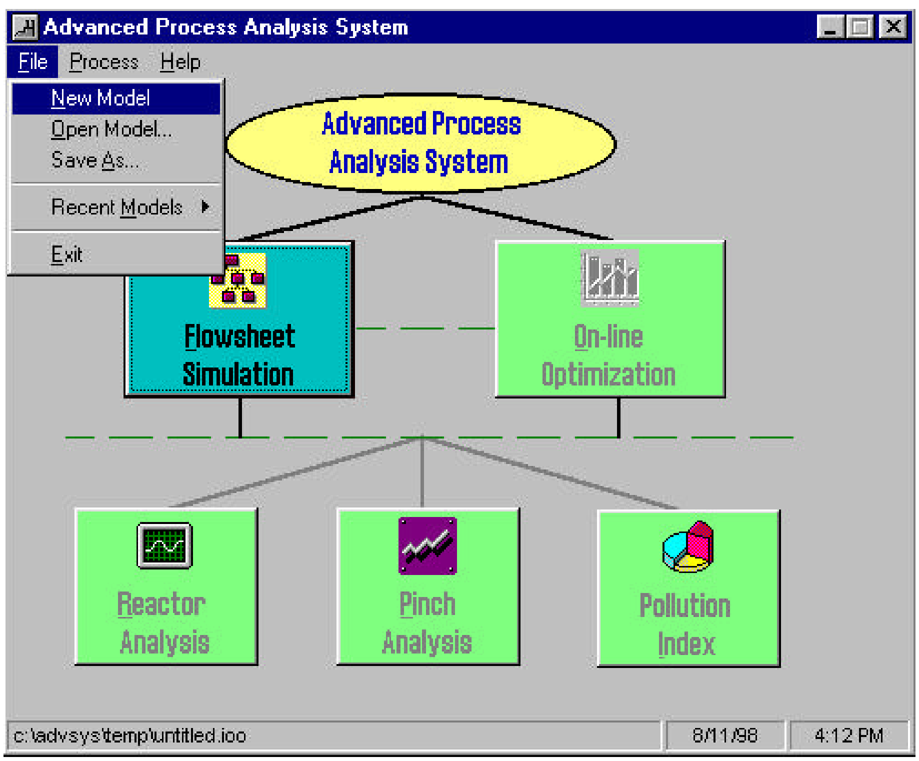


Figure 16. The File Menu of the Advanced Process Analysis Desk

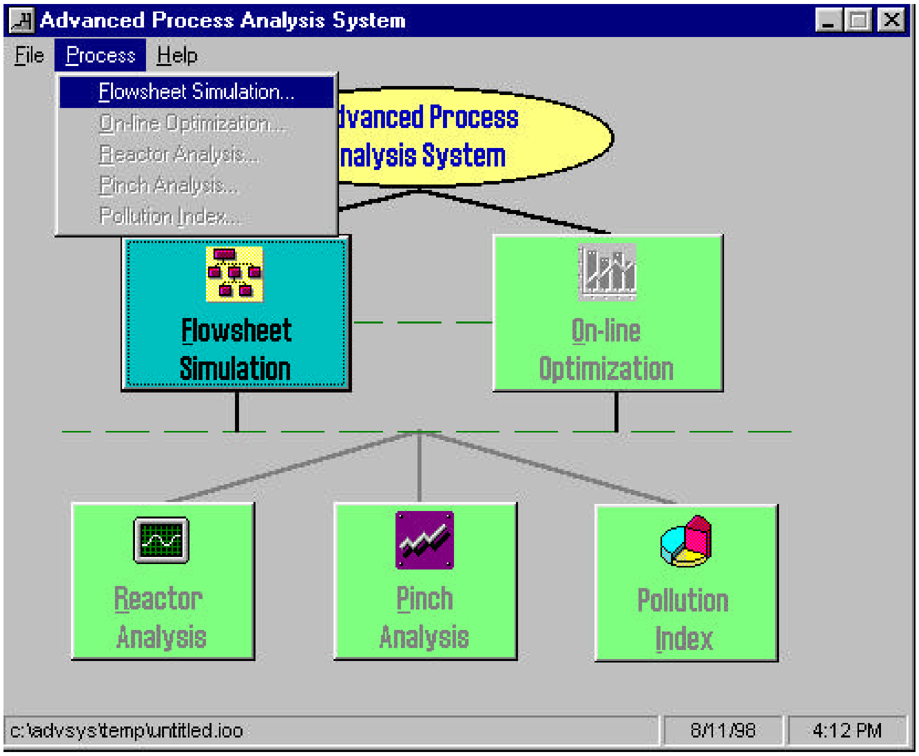


Figure 17. The Process Menu of the Advanced Process Analysis Desk

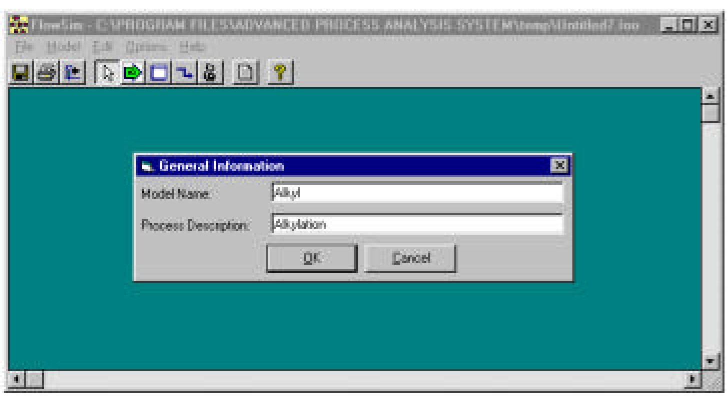


Figure 18. General Information Box

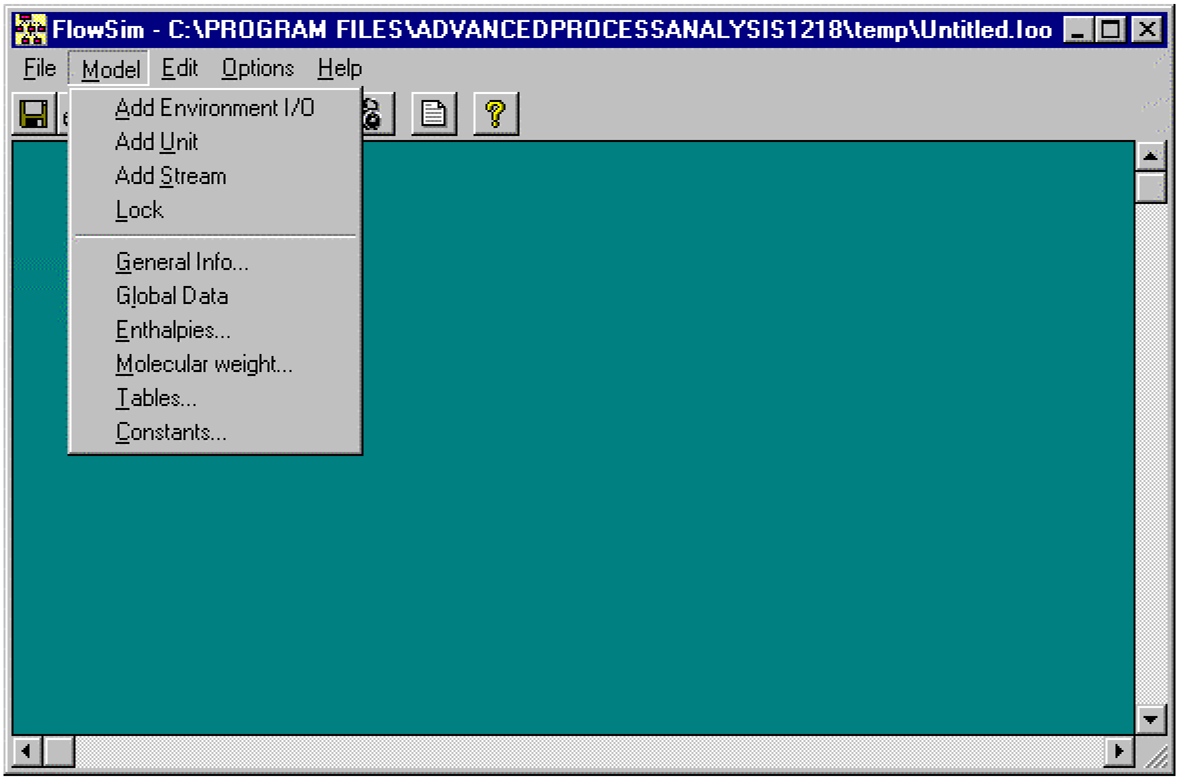


Figure 19. The Model Menu

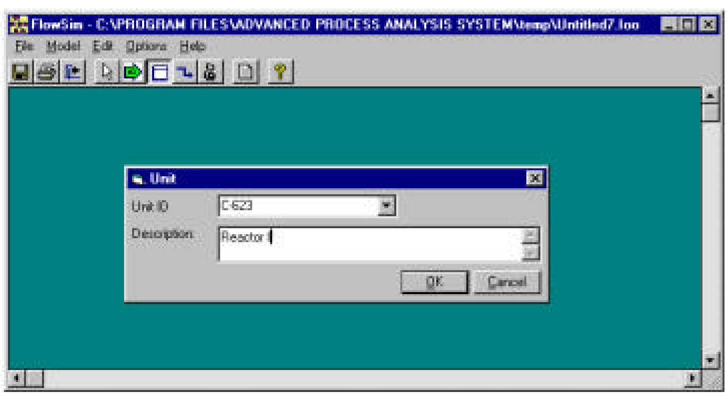


Figure 20. The Unit Window

Now, let us use these commands to draw the flowsheet diagram for the Motiva Alkylation process. Although Flowsim allows the units and streams to be drawn in any order, it is recommended that while drawing a process model, one should start with the feed and then add units and streams in order. Let us draw the Unit C-623 (Reactor I) which is one of the main reactors of the process. Select the 'Add Unit' command from the 'Model' menu. The mouse cursor changes to a hand. The cursor can now be dragged to draw a rectangle.

Once, the mouse button is released, a small input window appears on the screen as shown in Figure 20. For every process unit that is drawn in Flowsim, the user is required to enter a unique Unit ID and description. For the Reactor I, let us enter 'C-623' as the unit ID and 'Reactor I' as the description.

Now, let us draw the another Unit in the flowsheet diagram. Let us enter the Unit ID '5C-631' and description 'Settler I'. With these two units, the screen looks like in Figure 21.

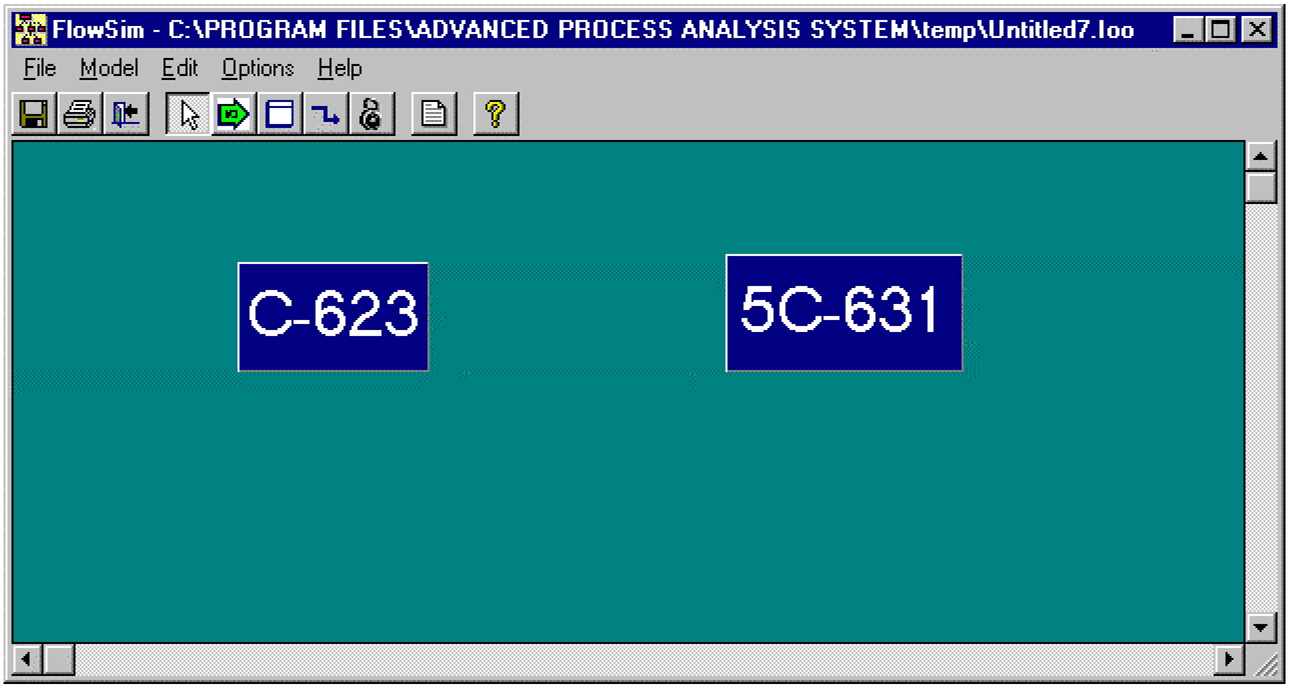


Figure 21 . Flowsheet Screen with two Units

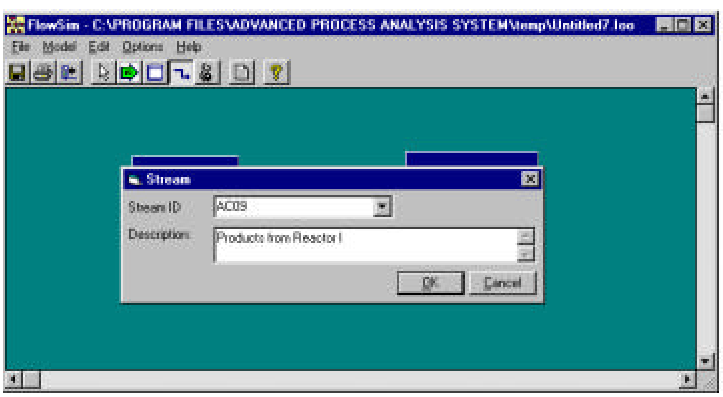


Figure 22. The Stream Window

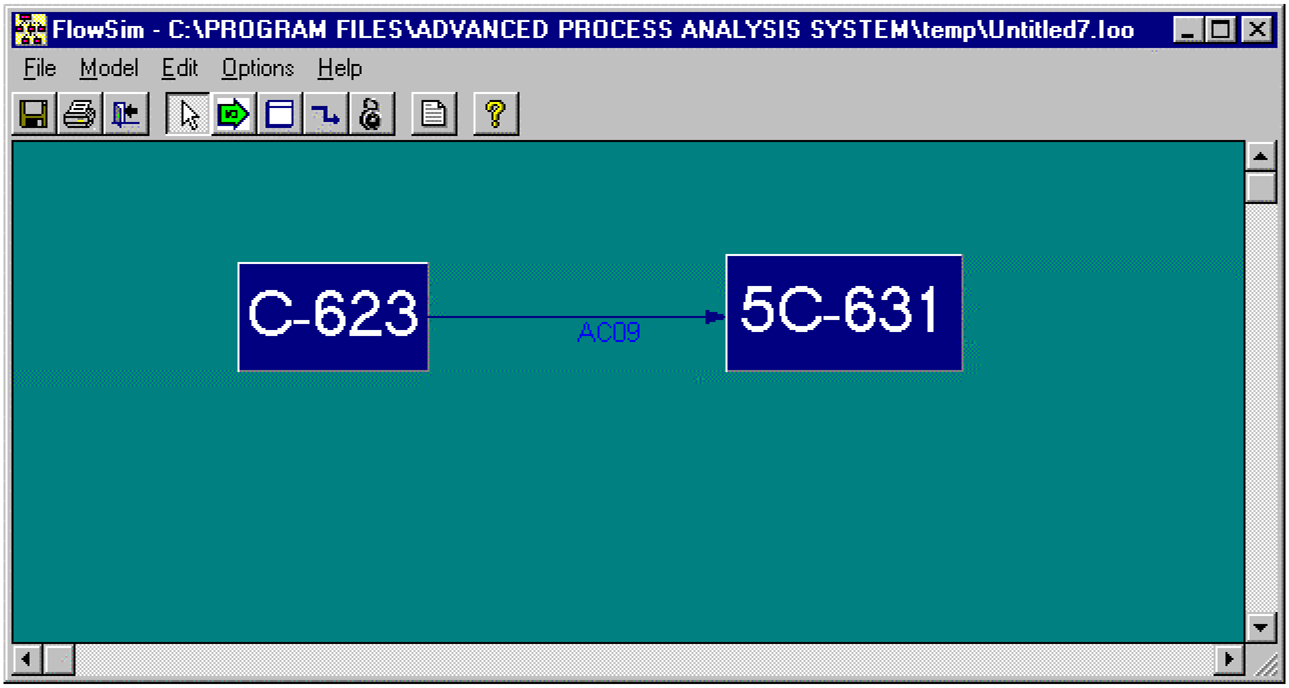


Figure 23. Flowsim Screen with two Units and a Stream

Now, let us add the stream that leaves the unit C-623 and enters the unit 5C-631. To do this, select the 'Add stream' command from the 'Model' menu. The cursor changes to a small circle. Position the cursor on the unit C-623 and drag the cursor to the unit 5C-631. The program now displays a small box shown in Figure 22. Let us enter the stream ID 'AC09' and the description 'Products from Reactor I' With the S-2, M-3 and HC28 stream, the Flowsim screen looks as shown in Figure 23. In this way, the entire process flow diagram for the Alkylation process can be drawn using the Model menu commands. After drawing the complete diagram, the Flowsim screen looks as shown in Figure 24.

The 'Edit' menu at the top of the Flowsim screen provides various options for editing the diagram. It is shown in Figure 25. To use the Edit commands, a unit in the flowsheet diagram has to be selected first by clicking on it. The cut, copy and paste commands can be used for both units as well as streams. The 'Delete' command can be used to permanently remove a unit or a stream from the diagram. The 'Rename' command can be used to change the unit ID for a unit or to change the stream ID for a stream. The 'Properties' command can be used to change the appearance of a unit or a stream.

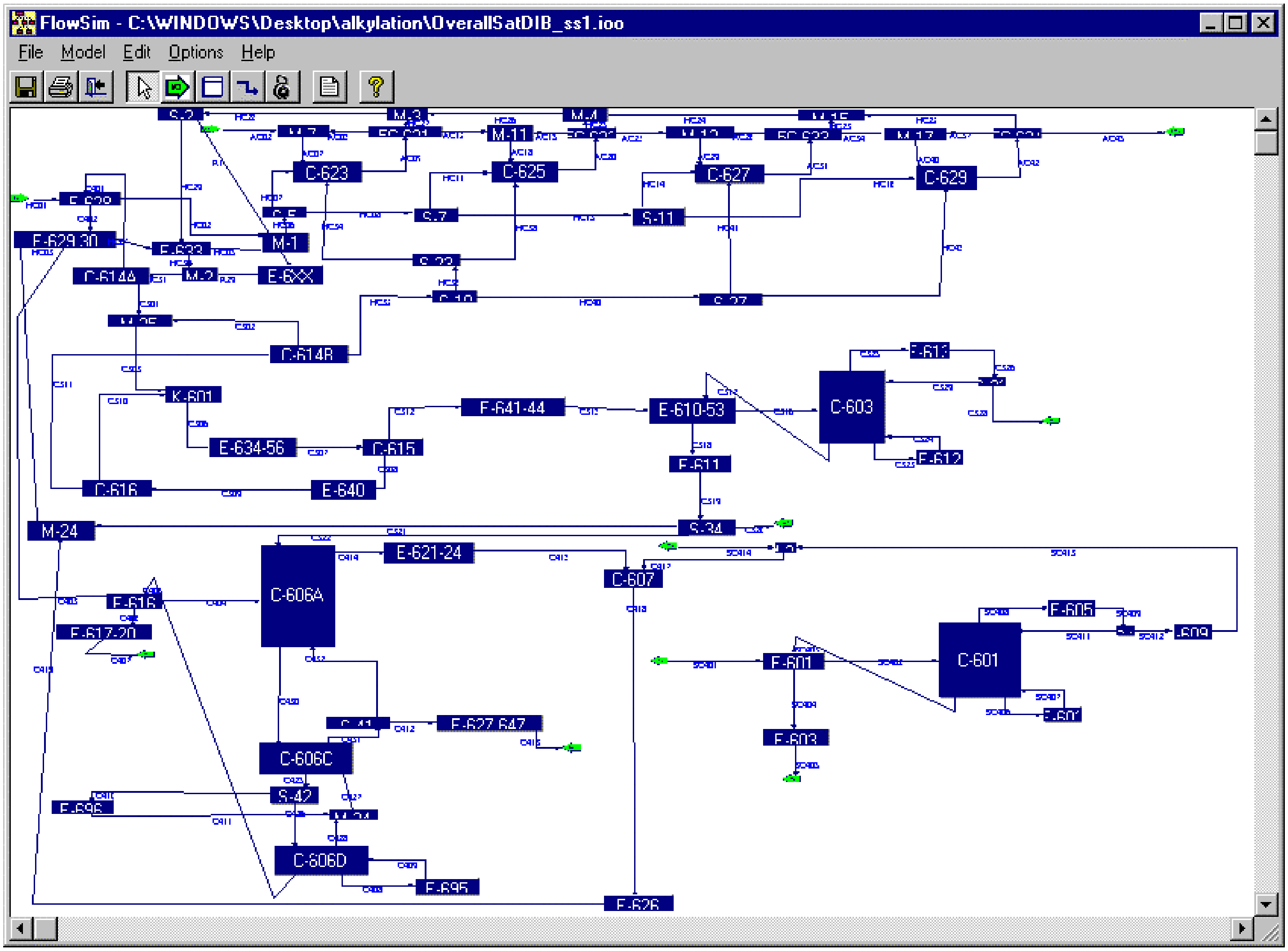


Figure 24. The Flowsim Screen with the Complete Process Diagram for Sulfuric Acid Process Model

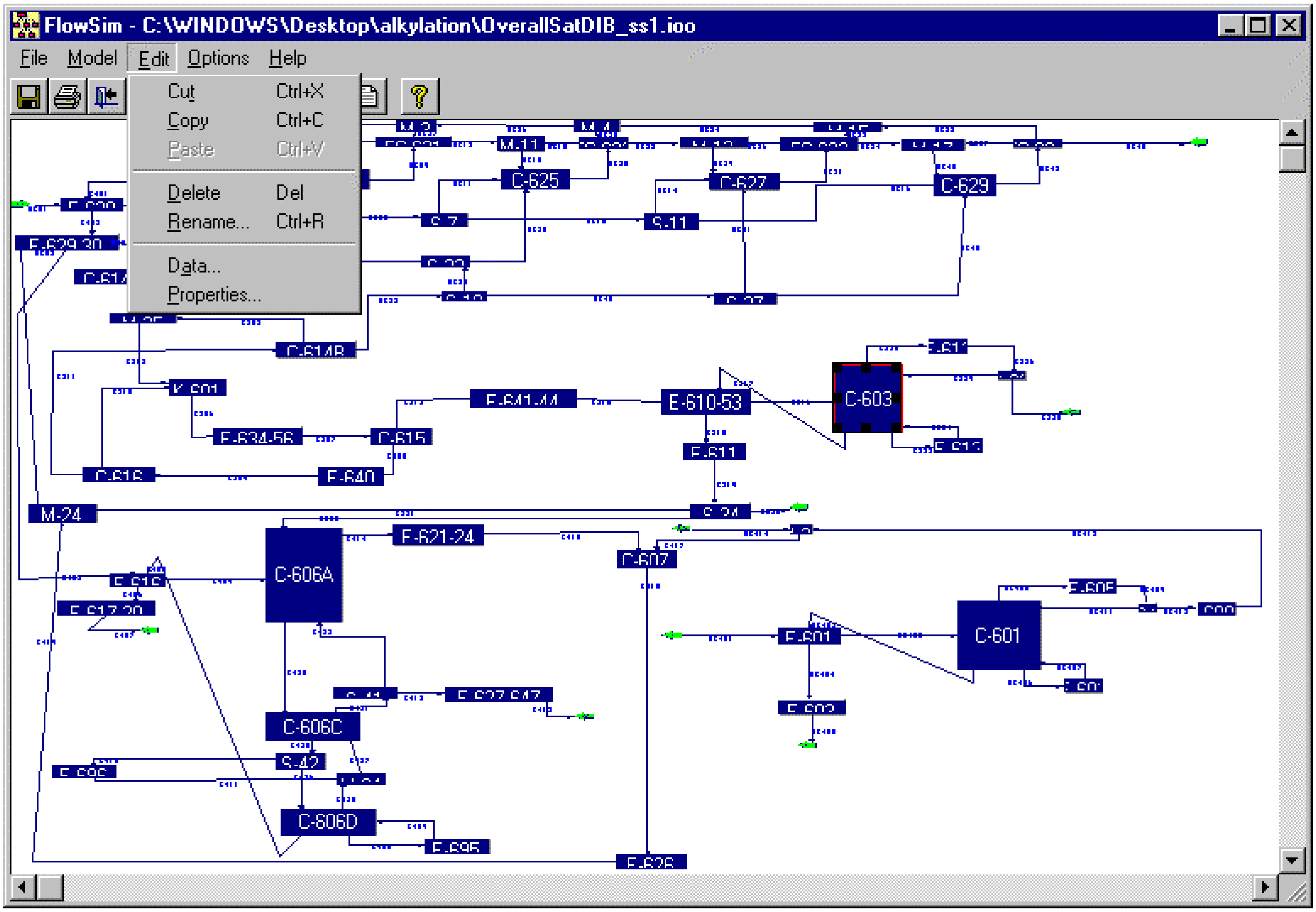


Figure 25. The Edit Menu

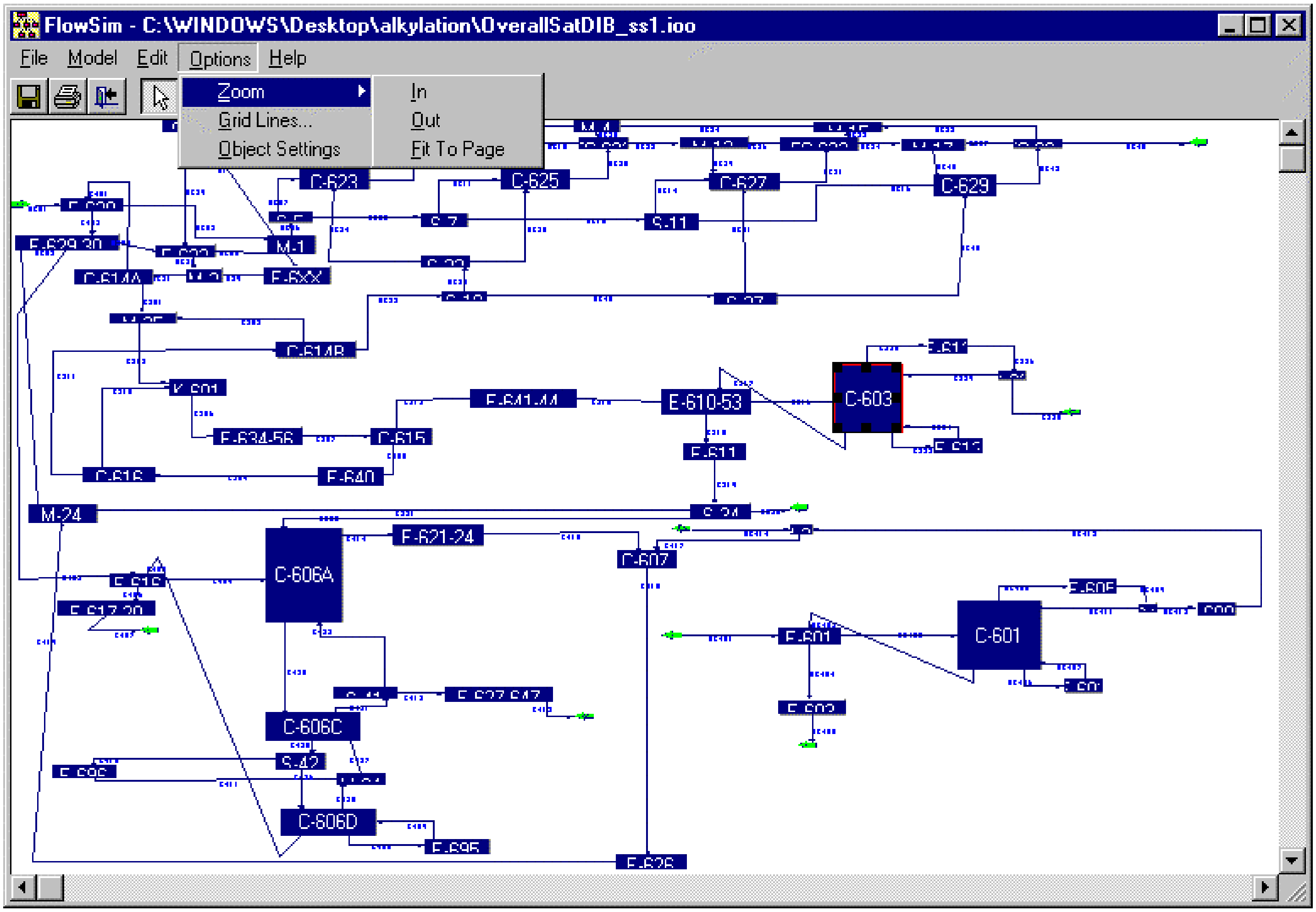


Figure 26. The Options Menu

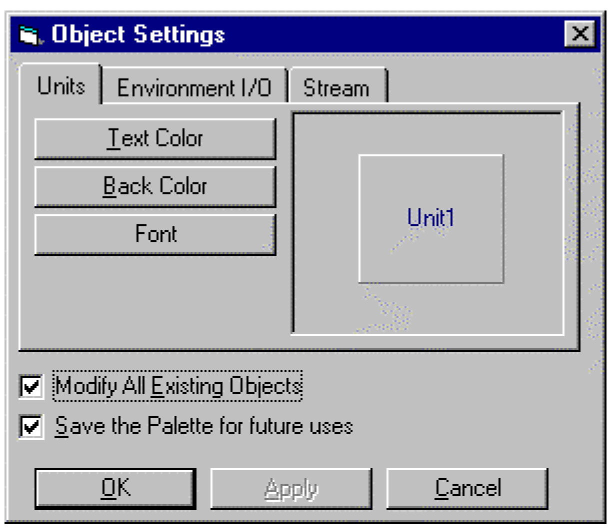


Figure 27. Object Settings Window

The 'Options' menu in the Flowsim screen is shown in Figure 26. The zoom option can be used to change the magnification by zooming in and out. The 'zoom to fit' option will automatically select the appropriate magnification so that the diagram occupies the entire screen. 'Grid Lines' command can be used to display grid lines on the FlowSim screen and to change the spacing between the grid lines. The 'Object settings' command is useful to change the appearance of all the units and streams in the FlowSim screen. The object settings window is shown in Figure 27. To change settings for all the streams, click on the streams tab. To change settings for all the environment I/O units, click on the 'Environment I/O' tab. If you want the changes to remain effective even after you close the application, you must select 'Save the palette for future uses' box.

Once you have drawn a stream, the data associated with the stream can be entered by clicking on the data option in the edit menu or by double clicking on the stream. Let us enter the data associated with the stream HC32. When you double click on this stream, a data form is opened. This is shown in Figure 28.

To enter the measured variables associated with the stream, the 'add' button should be clicked. When the 'add' button is clicked, the caption of the Refresh button changes to 'Cancel'. Then the information about the variable such as the name of the variable, the plant data, the standard deviation of the plant data should be entered. The description, initial point, scaling factor, lower and upper bounds and the unit of the variable are optional.

The changes can be recorded to the model by clicking on the 'Update' button or can be cancelled by clicking on the 'Cancel' button. When the update button is clicked, the caption of the cancel button reverts back to 'Refresh'. The Stream Data Window with the information appears as shown in Figure 28. In this way, all the other measured variables associated with the stream 'HC32' can be entered.

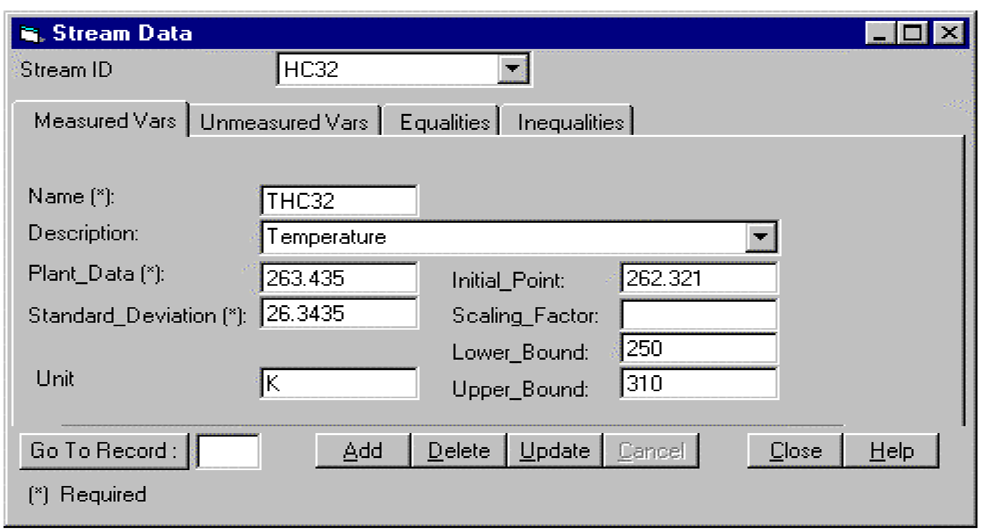


Figure 28. Stream Data Window

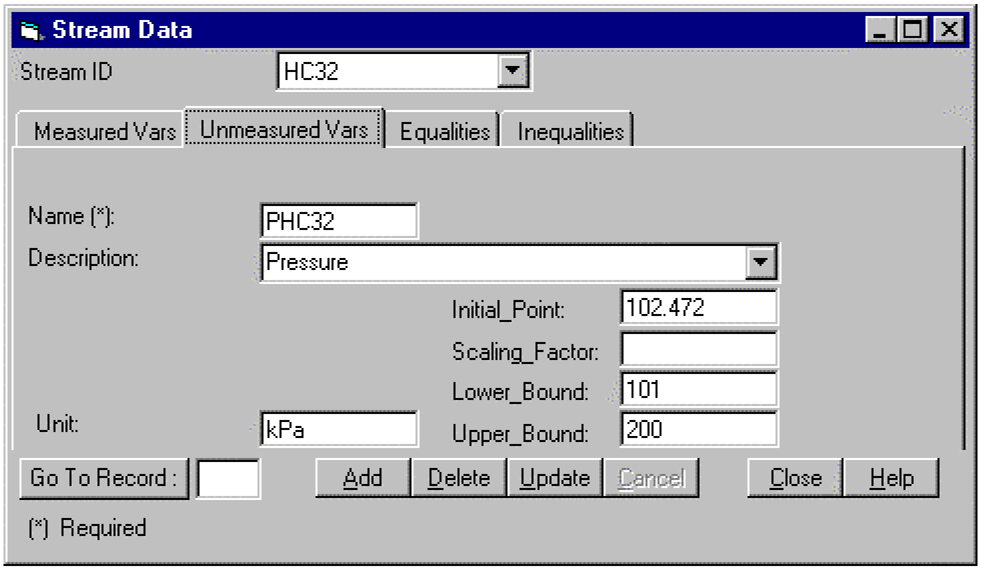


Figure 29 .Unmeasured Variables Tab in the Stream Data Window

To enter the unmeasured variables associated with the stream, click on the ‘Unmeasured Vars’ tab. As explained above for the measured variables, click on the add button in the stream data window. Enter the name, initial point of the unmeasured variable. The bounds, scaling factor, description and unit of the variable are optional. The Stream Data window with the unmeasured variable data is shown in Figure 29.

To move to a particular variable, enter the record number in the box adjacent to ‘Go to Record’ button. Then press ‘enter’ or click on the ‘Go to Record’ button to move to that variable. To delete a variable, first move to that variable and then click ‘Delete’. To return to the main screen, click on the ‘close’ button.

To enter the data associated with a unit, double click on the unit. When you double click on the unit, a data form similar to the one shown in Figure 28 is opened. The measured variables, unmeasured variables are entered in the same way as for the streams.

Let us proceed to enter the equality constraints for the unit S-2. Click on the Equalities tab in the Unit Data window to enter the equality constraints.

Let us enter the overall material balance equation for the S-2. This equation is given in Appendix A. Click on the add button on the Unit Data window. Enter the equation in the box provided and click ‘Update’. Note the use of ‘=e=’ in place of ‘=’ as required by the GAMS programming language. The screen now looks as shown in Figure 30a.

Let us enter another material balance equation for S-2. This equation is also given in Appendix A. The Equality constraints tab in the Unit Data window for S-2 with this equation is shown in Figure 30.b.

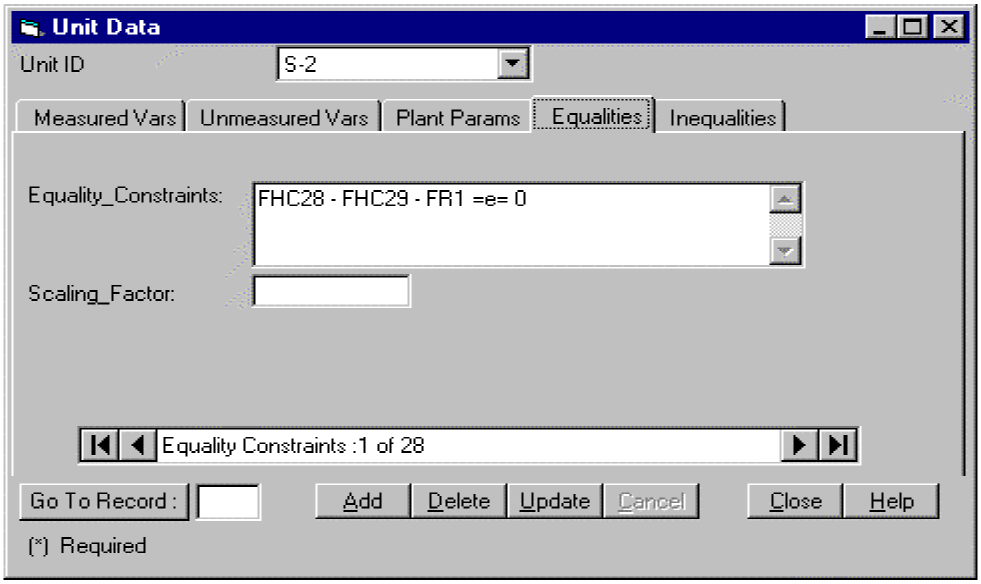


Figure 30.a. Equality Constraints Tab in the Unit Data Window

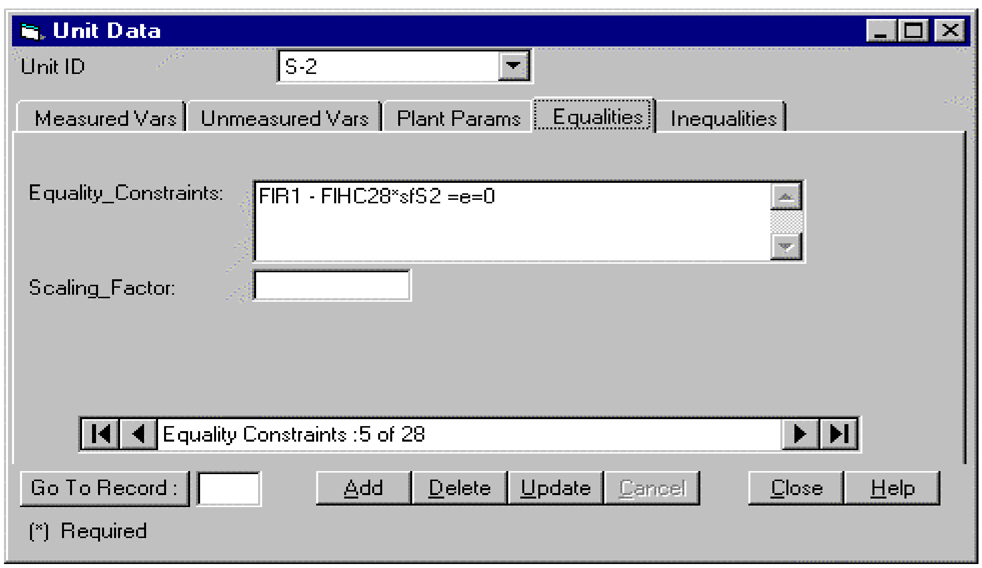


Figure 30.b. Equality Constraints Tab in the Unit Data Window

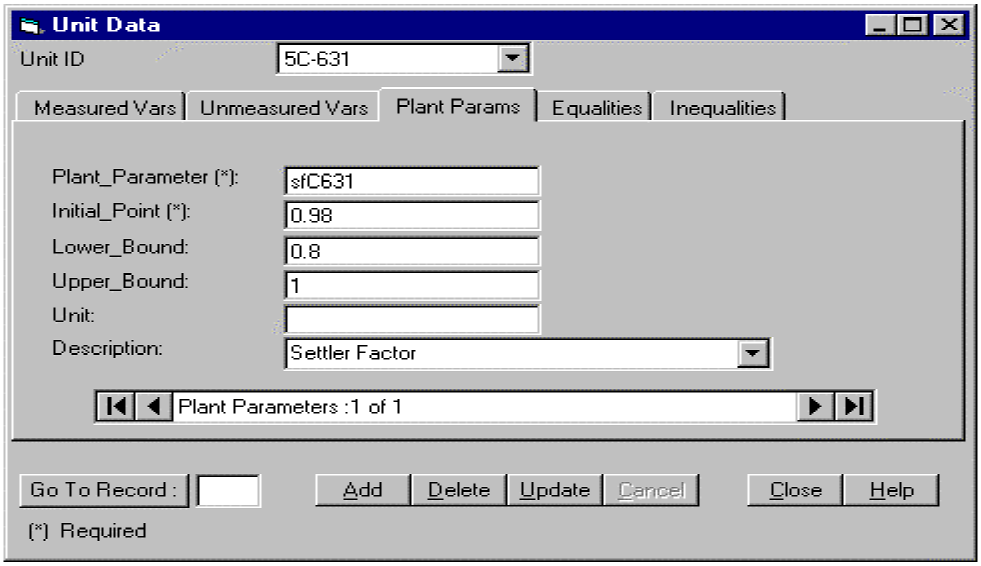


Figure 31. Plant Parameters tab in the Unit Data window

Unit Data window has an extra tab for entering the parameters in the model, which are associated with that particular unit. Let us enter the parameter for the 5C-631 unit. Double click on the unit to open the Unit Data window. In the Unit Data window, click on the 'Plant Params' tab. Click on the 'Add' button. The parameter name and the initial point are required. Enter 'sfC631' as the parameter name. This is the settler factor for Settler I (5C-631). The bounds, description and the unit of the parameter are optional. The Unit Data window with the parameter information is shown in Figure 31.

A. Global Data

If there are variables, parameters and equations that do not belong to either a unit or a stream, then they can be entered in the Global Data window. This includes the economic model and the equations to evaluate emissions and energy use. To enter this global data, double click on the background of the flowsheet diagram or click on the 'Global Data' option in the Model menu.

The Global Data window in Figure 32.a shows an equation that calculates the cost for the Alkylation process when the process is optimized. Other equality constraints can be added in this window in a similar way. For the Alkylation process, let us enter another equation that defines the profit function for the whole process. Click on the 'add' button and enter the equation as shown in Figure 32.b. The variable 'Profit' will be used later to specify the objective function for economic optimization. As seen in Figure 32.b, the profit function is equal to the 'Earnings' less the 'Cost' and the 'Utilities'. This profit fumction can be entered in the ' Economic Eqn' section of the Global Data window.

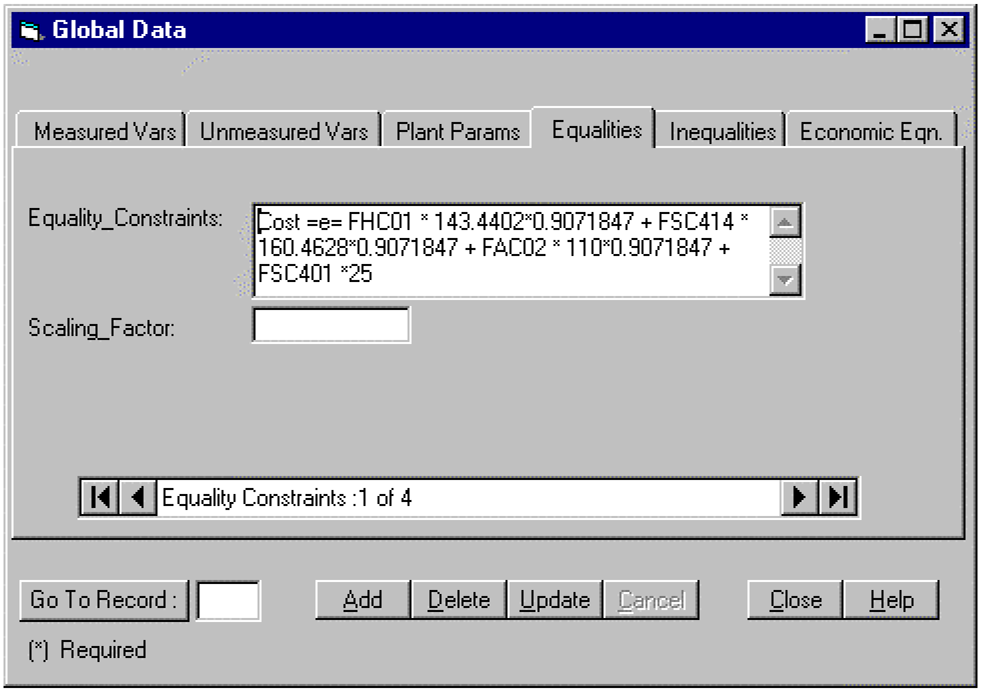


Figure 32.a Equalities Tab in the Global Data Window

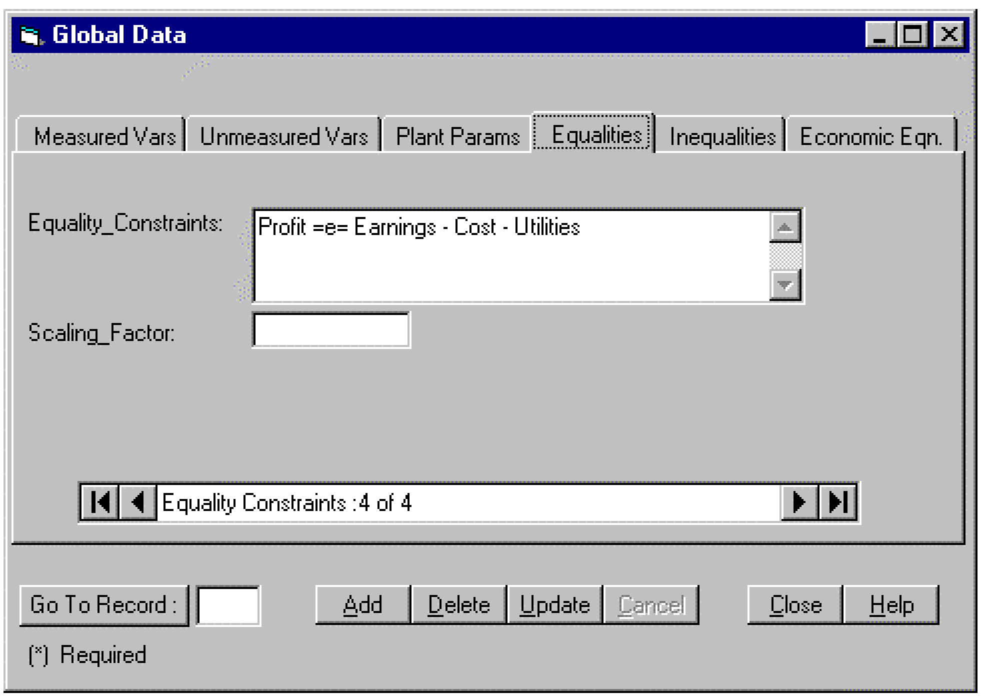


Figure 32.b. The Economic Equations Tab of Global Data

B. Tables

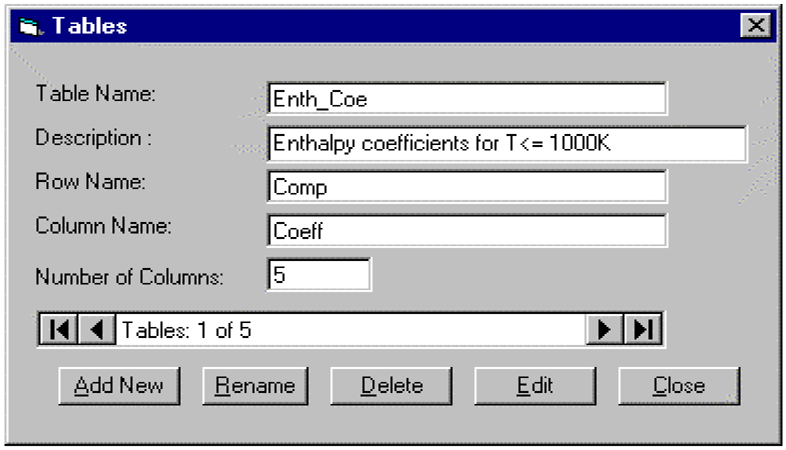


Figure 33. Tables Window

If there are constant coefficients used in the constraints equations, they can be defined as a table. These constant coefficients are grouped in sets, and they can be defined using concise names to refer their values in the equations before an equation definition. Along with constant coefficients enthalpy coefficients for streams can also be entered in this section.

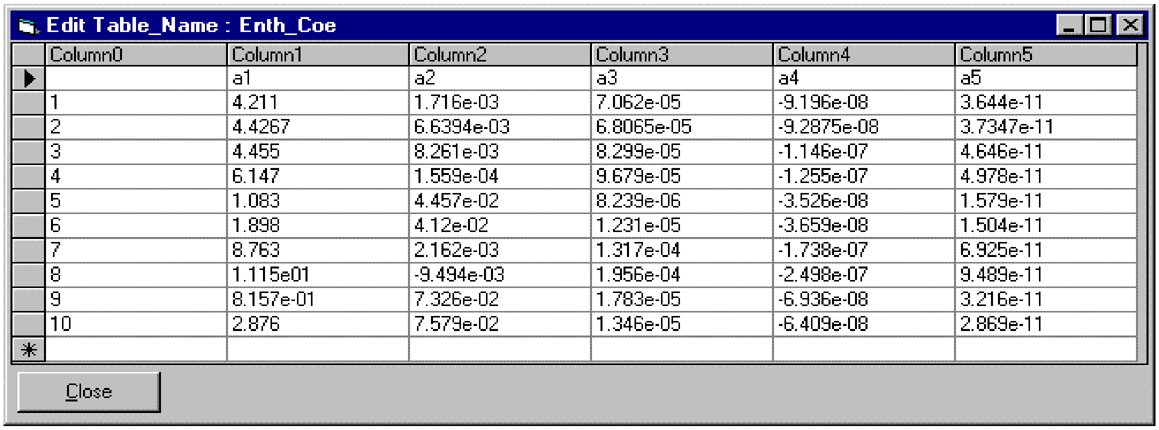
The enthalpy of a stream usually is expressed as a polynomial function of temperature. This function appears repeatedly in the plant model with the same coefficients, which have different numerical values for each chemical component. An example is:

$$h_i = a_{0i} + a_{1i}T + a_{2i}T^2 + a_{3i}T^3 + a_{4i}T^4 + a_{5i}T^5$$

where there are six coefficients, a_{0i} to a_{5i}, for component i.

Let us create a new table for the Alkylation model. Click on the 'Tables' option in the model menu to open the Tables window, which is shown in Figure 33. Then click on the 'Add New' button in the tables window to activate the window. As soon as 'Add New' button is clicked, the caption of the 'Add New' button changes to 'Save' and that of 'Delete' changes to 'Cancel'. Then the general information of a table: the name of the table, rows and columns as well as the number of columns, must be entered from in the window. The name of the table stands for the name of the coefficient group. The names of rows and columns are the set names of the sub-components. After entering the table information, the 'Save' button should be clicked to save the changes.

To enter data in a table, click on the 'Edit' button. The Edit Table window is opened names and numerical values of constant coefficients. The edit table window for the table 'Enth_Coe' is shown in Figure 34. Clicking the 'Close' button will update the table and close the 'Edit table' window. An existing table can be edited or deleted by selecting the table and then clicking 'Edit' or 'Delete'.



Edit Table_Name : Enth_Coe

Column0	Column1	Column2	Column3	Column4	Column5
	a1	a2	a3	a4	a5
1	4.211	1.716e-03	7.062e-05	-9.196e-08	3.644e-11
2	4.4267	6.6394e-03	6.8065e-05	-9.2875e-08	3.7347e-11
3	4.455	8.261e-03	8.299e-05	-1.146e-07	4.646e-11
4	6.147	1.559e-04	9.679e-05	-1.255e-07	4.978e-11
5	1.083	4.457e-02	8.239e-06	-3.526e-08	1.579e-11
6	1.898	4.12e-02	1.231e-05	-3.659e-08	1.504e-11
7	8.763	2.162e-03	1.317e-04	-1.738e-07	6.925e-11
8	1.115e01	-9.494e-03	1.956e-04	-2.498e-07	9.489e-11
9	8.157e-01	7.326e-02	1.783e-05	-6.936e-08	3.216e-11
10	2.876	7.579e-02	1.346e-05	-6.409e-08	2.869e-11

Close

Figure 34. Edit Table Window

C. Constant Properties

The Constant Property window is where a list of constants is stored. Clicking on the 'Constants' option in the model menu opens the Constant Property window as shown in Figure 35. To create a set of constant properties, click on the 'Add New' button in Constant Property window to activate the window. As soon as 'Add New' button is clicked, the caption of the 'Add New' button changes to 'Save' and that of 'Delete' changes to 'Cancel'. Then the general information of a constant property: the name and an optional description must be entered in the Constant Property window.

After entering the constant property information, the 'Save' button should be clicked to save the changes.

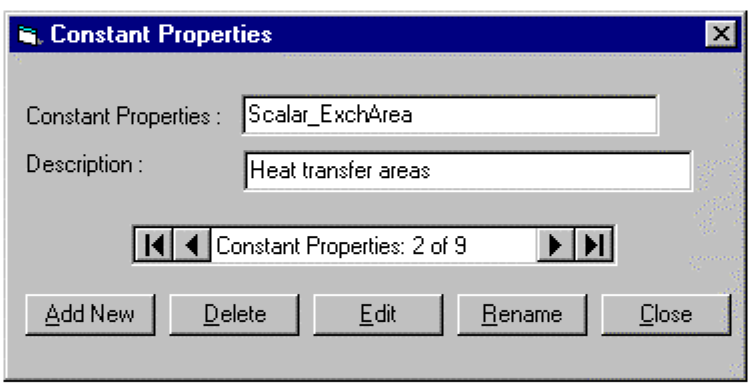


Figure 35. Constant Properties Window

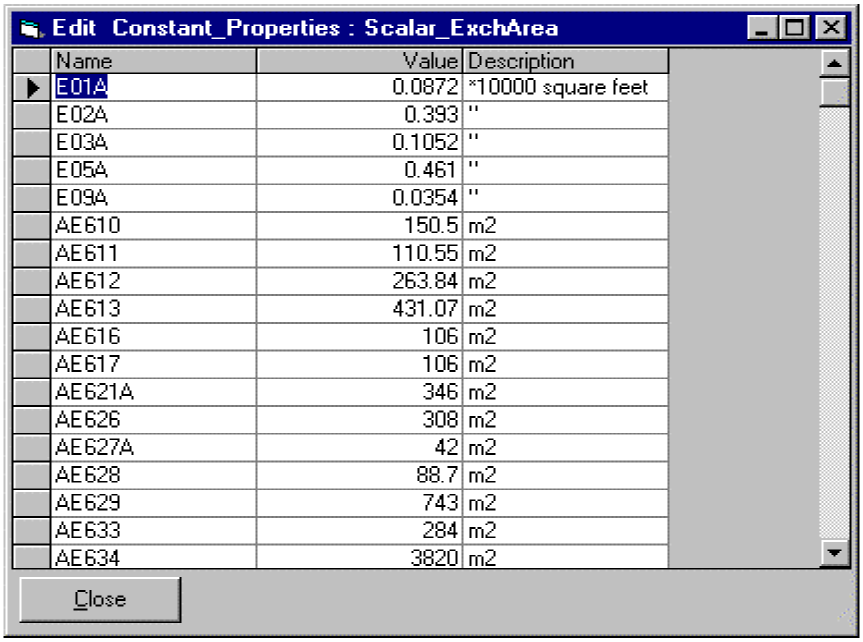


Figure 36. Edit Constant Property Window

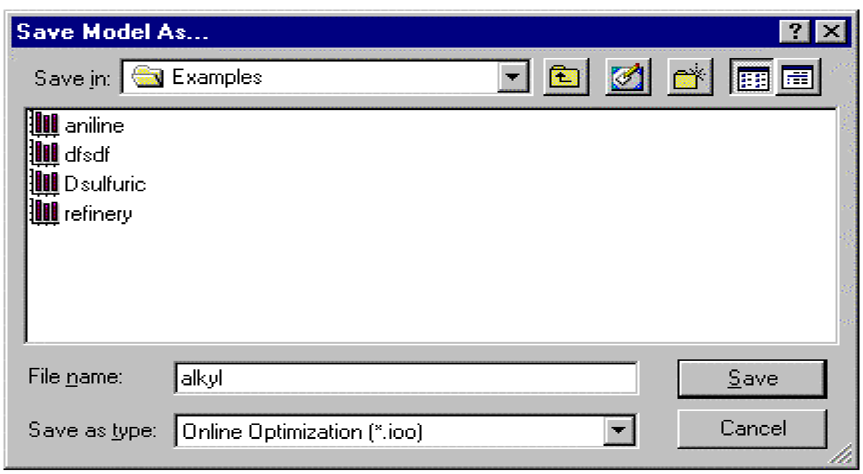


Figure 37. Save Model As Dialog Box

To enter the data in the constant property window, click on the ‘Edit’ button. The Edit Constant Property window is opened for entering the numerical values of the constants. The name of the constant, the corresponding numerical value and an optional description. The Edit Constant Property window is shown in Figure 36.

After entering all of the above information, the model is complete. Save the changes by clicking on the ‘Save’ option in the File menu. If you click ‘Exit’ without saving the model, a message is displayed asking whether you want to save the changes or not. The ‘Print’ option in the File menu when clicked, prints the flowsheet diagram. When ‘Exit’ button is clicked, Flowsim window is closed and the user is taken back to the Advanced Process Analysis Desk.

The development of the process model using Flowsim has been completed. The equations, parameters and constants have been stored in the database as shown in Figure 1. Save the model using the ‘Save As’ option in the File menu shown in Figure 19. A ‘Save Model As’ dialog box shown in Figure 37 is opened. Save the model as ‘Alkyl.ioo’ in the ‘Examples’ subdirectory of the program folder.

The process model developed above needs to be validated to make sure that it is representing the actual process accurately and it does not have any mistakes. This can be done by using the model to carry out a simulation and then comparing the results with the design data for the process. If the design data is not available, an alternative solution is to use the combined gross error detection and data reconciliation step of on-line optimization to check the model validity. The plant operating data obtained from the distributed control system can be used for this purpose. The reconciled data obtained is compared with the plant data and if the values agree within the accuracy of the data, the model is an accurate description of the actual process. For the Alkylation process, this strategy is used to validate the model. The combined gross error detection and data reconciliation is the first step of on-line optimization and will be explained in the next section.

The next step of the Advanced Process Analysis System is on-line optimization. The ‘On-line Optimization’ button in Figure 15 should be now clicked to open the On-line Optimization program.

VI. USING ONLINE OPTIMIZATION PROGRAM

Upon clicking the ‘On-line Optimization’ button, On-line Optimization main window is displayed with the Model Description window as shown in Figure 38.

The model name and the description were entered in the Flowsim program. This Model Description window also includes the Optimization Objective and Model Type. The optimization objective can be selected from the drop-down list of ‘Optimization Objective’ . The five selections are: ‘On-line Optimization (All)’, ‘Data Validation’, ‘Parameter Estimation’, ‘Economic Optimization’ and ‘Parameter Estimation and Economic Optimization’. Let us choose the ‘Online Optimization (All)’ option for the optimization objective. The model type of the plant model must be specified as either ‘Linear’ or ‘Nonlinear’ from the drop-down list. Let us choose ‘Nonlinear’ as the model type for the Alkylation model.

When you click on the View menu in the Model Description window, a pull down menu is displayed as shown in Figure 39. The View menu includes commands for the All Information mode, The

Online Optimization Algorithms and Flow sheet diagram. The ‘All Information’ mode is used to switch between windows. The ‘All Information’ mode displays the different windows combined together into one switchable window. The Flowsheet diagram option is used to view the flowsheet diagram, which is drawn using the flowsheet simulation program.

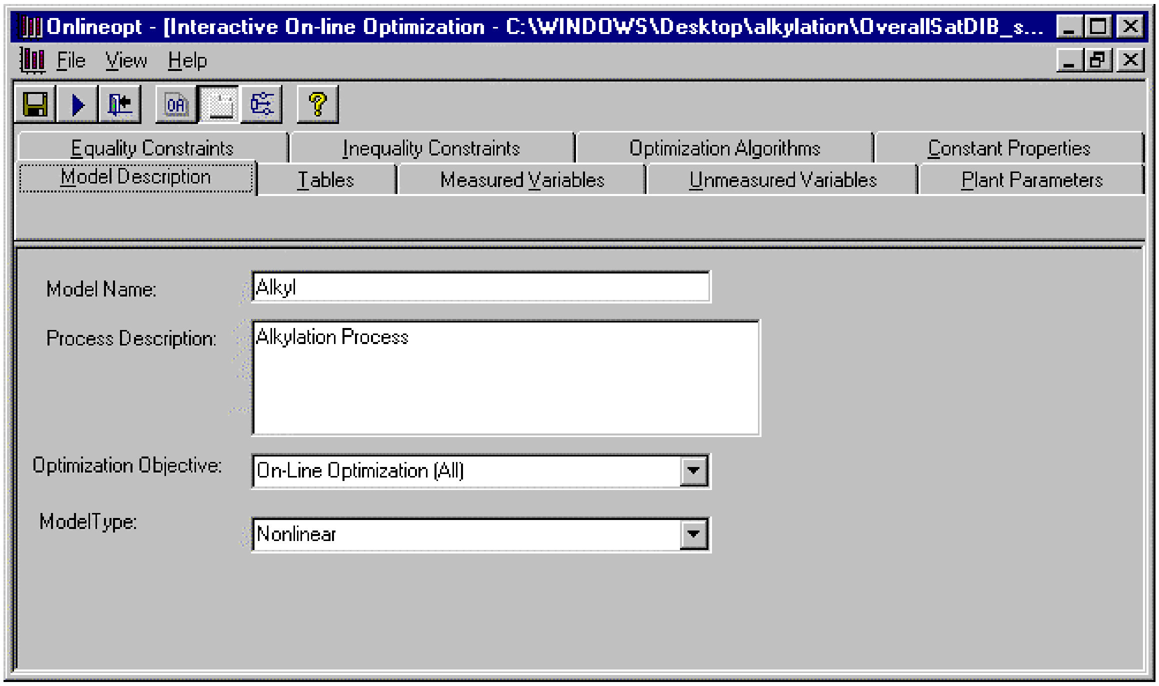


Figure 38. Model Description Window

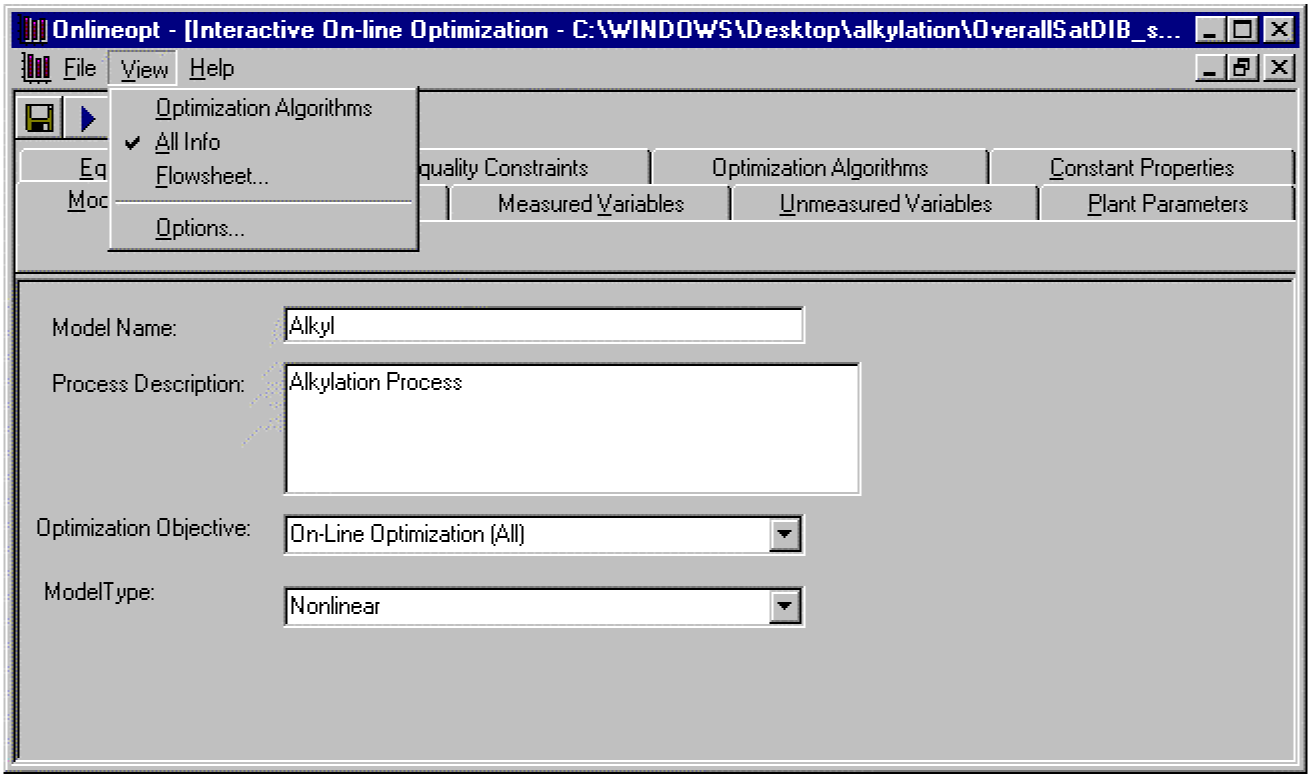


Figure 39. View Menu

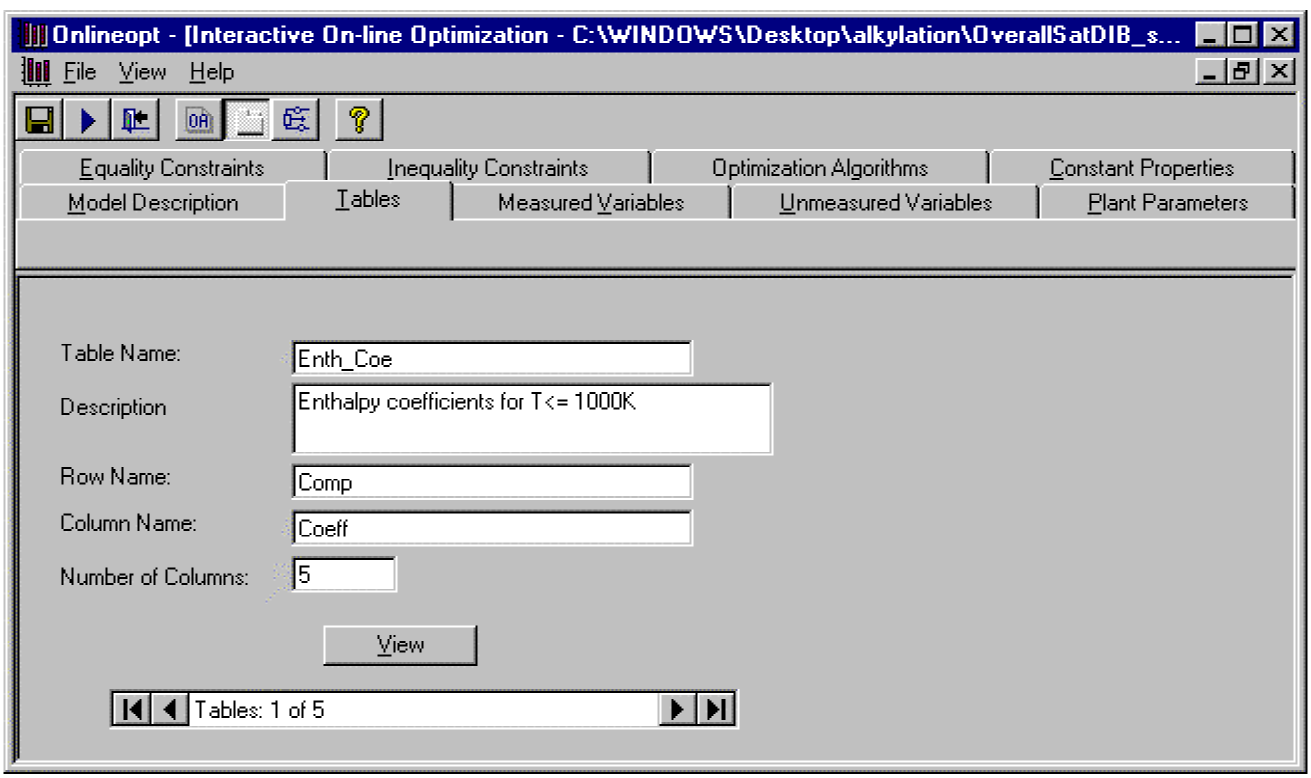
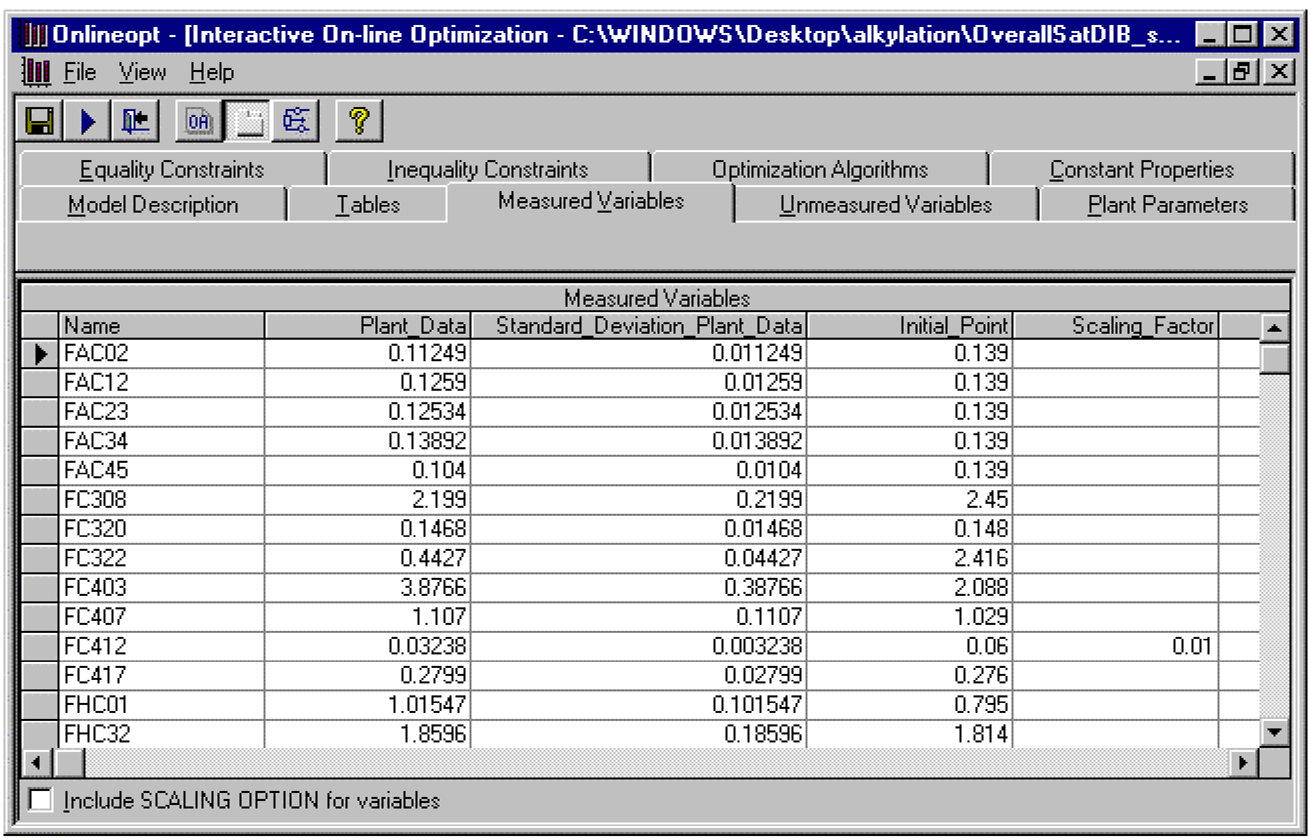


Figure 40. Tables Window

When the information for the Model Description window is completed, you can proceed to the Tables window by clicking on the Tables tab in the All-Information mode. The tables window is shown in Figure 40, which contains information about the tables which were entered in Flowsim program.

Let us proceed to the Measured Variables window by clicking the Measured Variables tab. The Measured Variables window has a table with twelve columns which display the name, plant data, standard deviation, initial point, scaling factor, lower and upper bounds, stream number, process unit ID, the unit and a short description of the measured variables. The Measured Variables window lists all the measured variables that are associated with all the units and streams in the process model and the global measured variables that were entered in the Flowsim program. The column 'Process Unit ID' has the name of the process unit and the column 'Stream Number' has the name of the stream with which the variable is associated. The Measured Variables window is shown in Figure 41. In this window, information can only be viewed. All of the data entered in Flowsim can only be viewed using the screens of on-line optimization. To change the data, the user has to go back to Flowsim program.

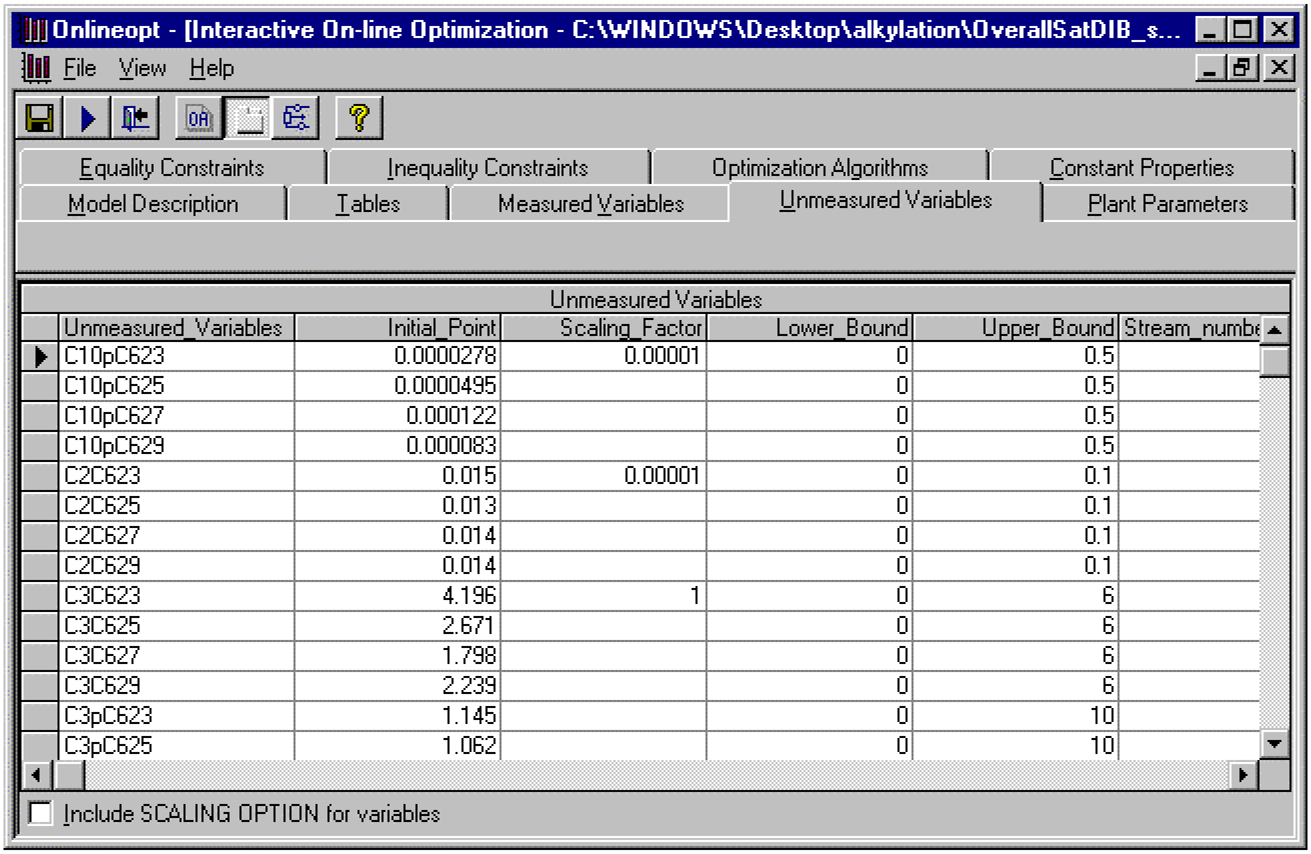
Then proceed to the Unmeasured variables window by clicking on the Unmeasured Variables tab. The Unmeasured variables window has nine columns for displaying the name, initial point, scaling factor, lower and upper bounds, stream number, process unitID, unit and description of the unmeasured variables. The Unmeasured Variables window lists all the unmeasured variables, which were entered in the Flowsim program. The Unmeasured Variables window is shown in Figure 42.



Measured Variables

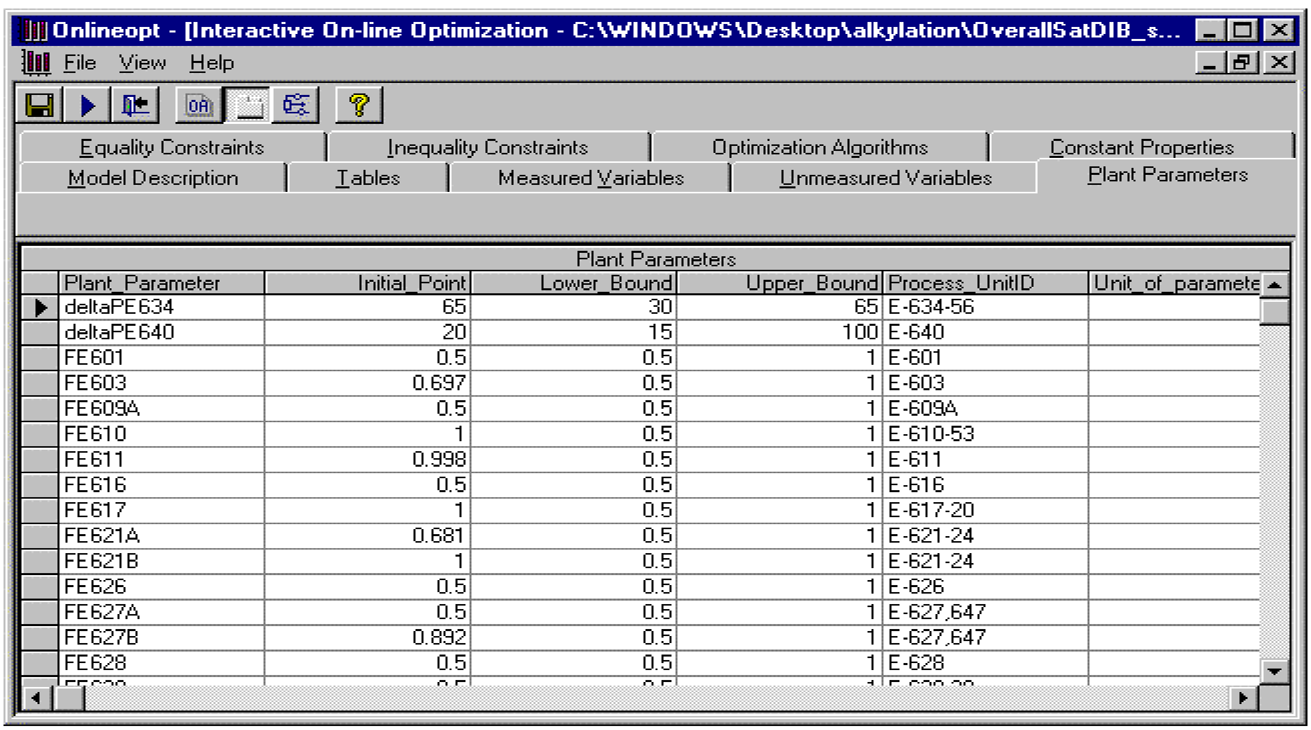
Name	Plant_Data	Standard_Deviation_Plant_Data	Initial_Point	Scaling_Factor
FAC02	0.11249	0.011249	0.139	
FAC12	0.1259	0.01259	0.139	
FAC23	0.12534	0.012534	0.139	
FAC34	0.13892	0.013892	0.139	
FAC45	0.104	0.0104	0.139	
FC308	2.199	0.2199	2.45	
FC320	0.1468	0.01468	0.148	
FC322	0.4427	0.04427	2.416	
FC403	3.8766	0.38766	2.088	
FC407	1.107	0.1107	1.029	
FC412	0.03238	0.003238	0.06	0.01
FC417	0.2799	0.02799	0.276	
FHC01	1.01547	0.101547	0.795	
FHC32	1.8596	0.18596	1.814	

Figure 41. Measured Variables Window



Unmeasured_Variables	Initial_Point	Scaling_Factor	Lower_Bound	Upper_Bound	Stream_numbe
C10pC623	0.0000278	0.00001	0	0.5	
C10pC625	0.0000495		0	0.5	
C10pC627	0.000122		0	0.5	
C10pC629	0.000083		0	0.5	
C2C623	0.015	0.00001	0	0.1	
C2C625	0.013		0	0.1	
C2C627	0.014		0	0.1	
C2C629	0.014		0	0.1	
C3C623	4.196	1	0	6	
C3C625	2.671		0	6	
C3C627	1.798		0	6	
C3C629	2.239		0	6	
C3pC623	1.145		0	10	
C3pC625	1.062		0	10	

Figure 42. Unmeasured Variables Window



Plant_Parameter	Initial_Point	Lower_Bound	Upper_Bound	Process_UnitID	Unit_of_paramete
deltaPE634	65	30	65	E-634-56	
deltaPE640	20	15	100	E-640	
FE601	0.5	0.5	1	E-601	
FE603	0.697	0.5	1	E-603	
FE609A	0.5	0.5	1	E-609A	
FE610	1	0.5	1	E-610-53	
FE611	0.998	0.5	1	E-611	
FE616	0.5	0.5	1	E-616	
FE617	1	0.5	1	E-617-20	
FE621A	0.681	0.5	1	E-621-24	
FE621B	1	0.5	1	E-621-24	
FE626	0.5	0.5	1	E-626	
FE627A	0.5	0.5	1	E-627,647	
FE627B	0.892	0.5	1	E-627,647	
FE628	0.5	0.5	1	E-628	

Figure 43. Plant Parameters Window

Optimization programs need to have all the variables in the same numerical range, and it may be necessary to scale the variables by adjusting the scaling factors. For the Alkylation model, the unmeasured variables should be scaled. To scale variables using Scaling Option provided by the system, the scale factors must be entered in the Flowsim program and the icon 'Include Scaling Option for variables' at the bottom of Figure 42 should be checked. A description of scaling factors and their use is given in Section X.

Let us proceed to the Plant Parameters window by clicking on Plant Parameters tab. The Plant Parameters window lists all the parameters entered in the Unit and the Global Data window of the Flowsim program. The Plant Parameters window is shown in Figure 43.

Then proceed to the Equality Constraints window. This window has four columns for displaying the constraints, scaling factor, process unitID and stream number. All the equality constraints entered in the Flowsim program are listed in this window. The equality constraints window is shown in Figure 44. The next step is the Inequality Constraints window, which is similar to the Equality Constraints window. The Inequality Constraints window has three columns for displaying the constraints, process unitID and stream number. Scaling factors are not available for inequality constraints.

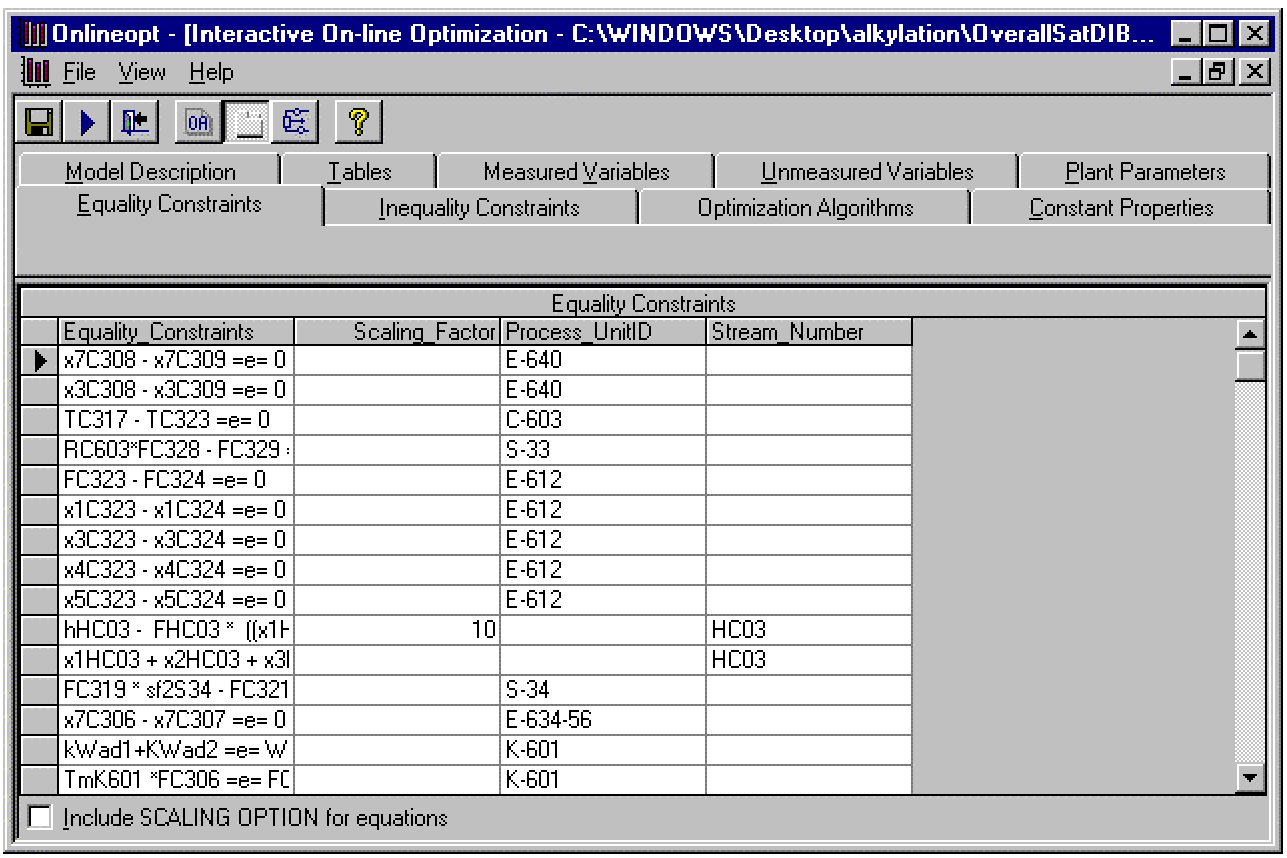


Figure 44. Equality Constraints Window

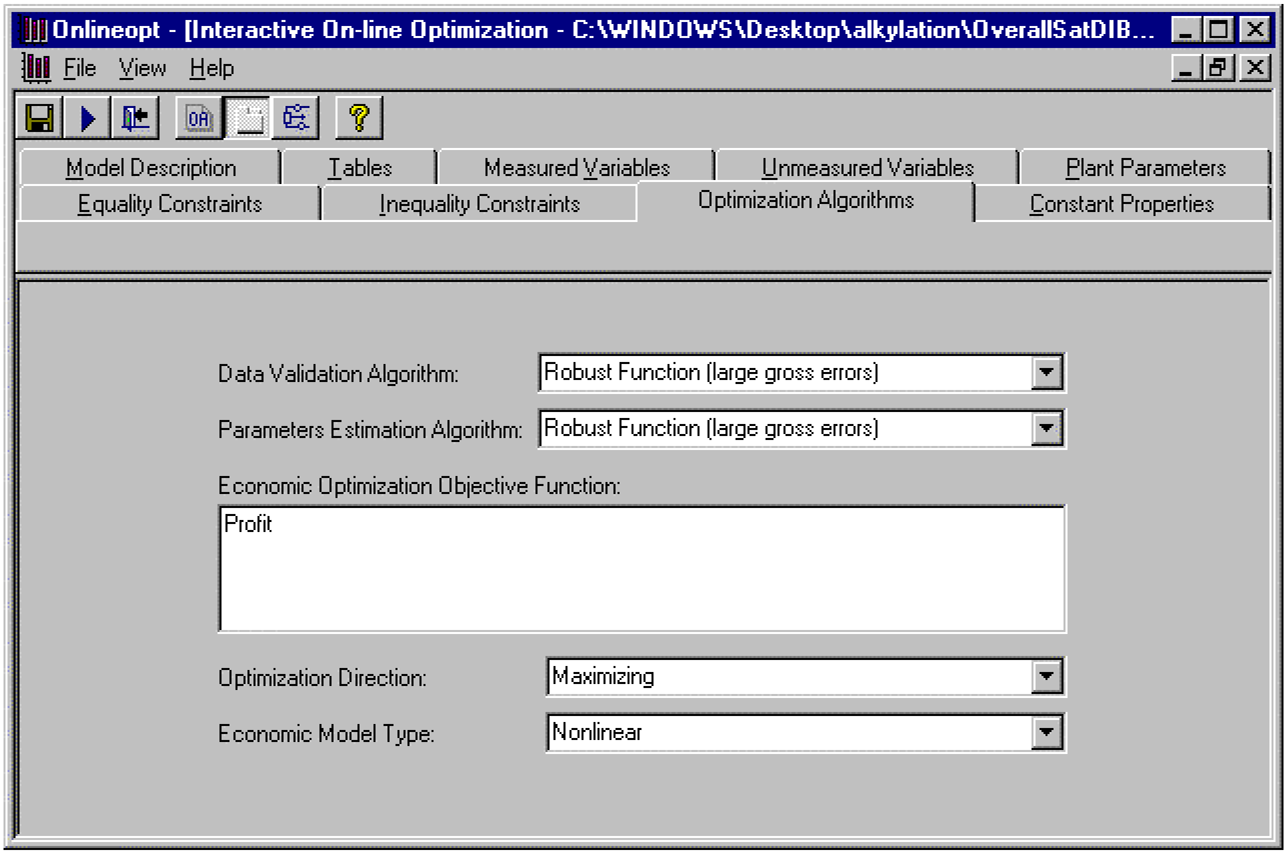


Figure 45. Optimization Algorithms Window

Let us proceed to the Optimization Algorithm window shown in Figure 45. This window includes the algorithms for Data Validation and Parameter Estimation, the Objective function for Economic Optimization, the Optimization direction and the Economic Model type. The options for Alkylation model are 'Robust Function (large gross errors)' for data validation and 'Robust Function (large gross errors)' for Parameter Estimation. In the Economic Optimization for the Alkylation process, the objective function is 'profit' defined in Section V in a global equality constraints(Figure 31.b). Let us choose the optimization direction to be 'Maximizing' and the Economic Model type to be 'NonLinear'.

The next step is the Constant Properties window. The constant properties window is shown in Figure 46-A.

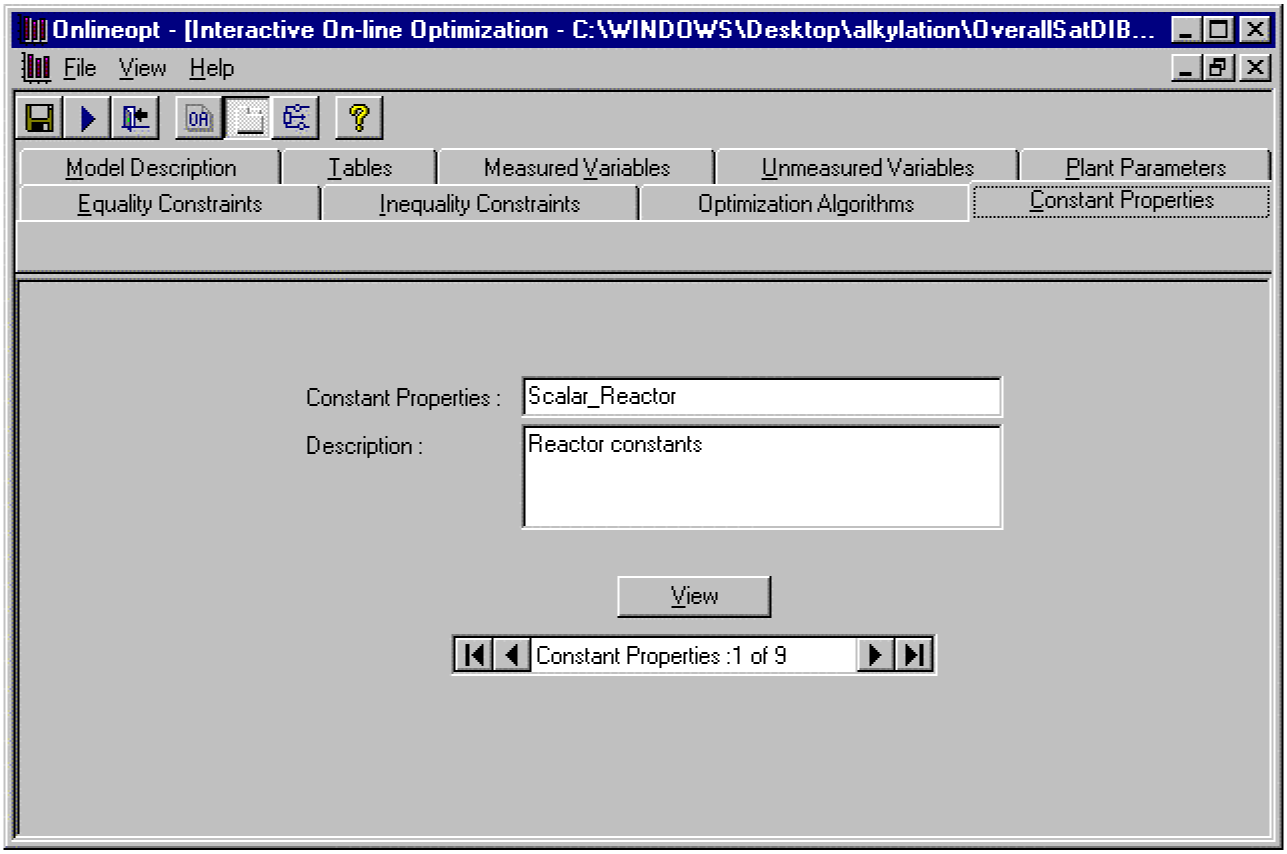
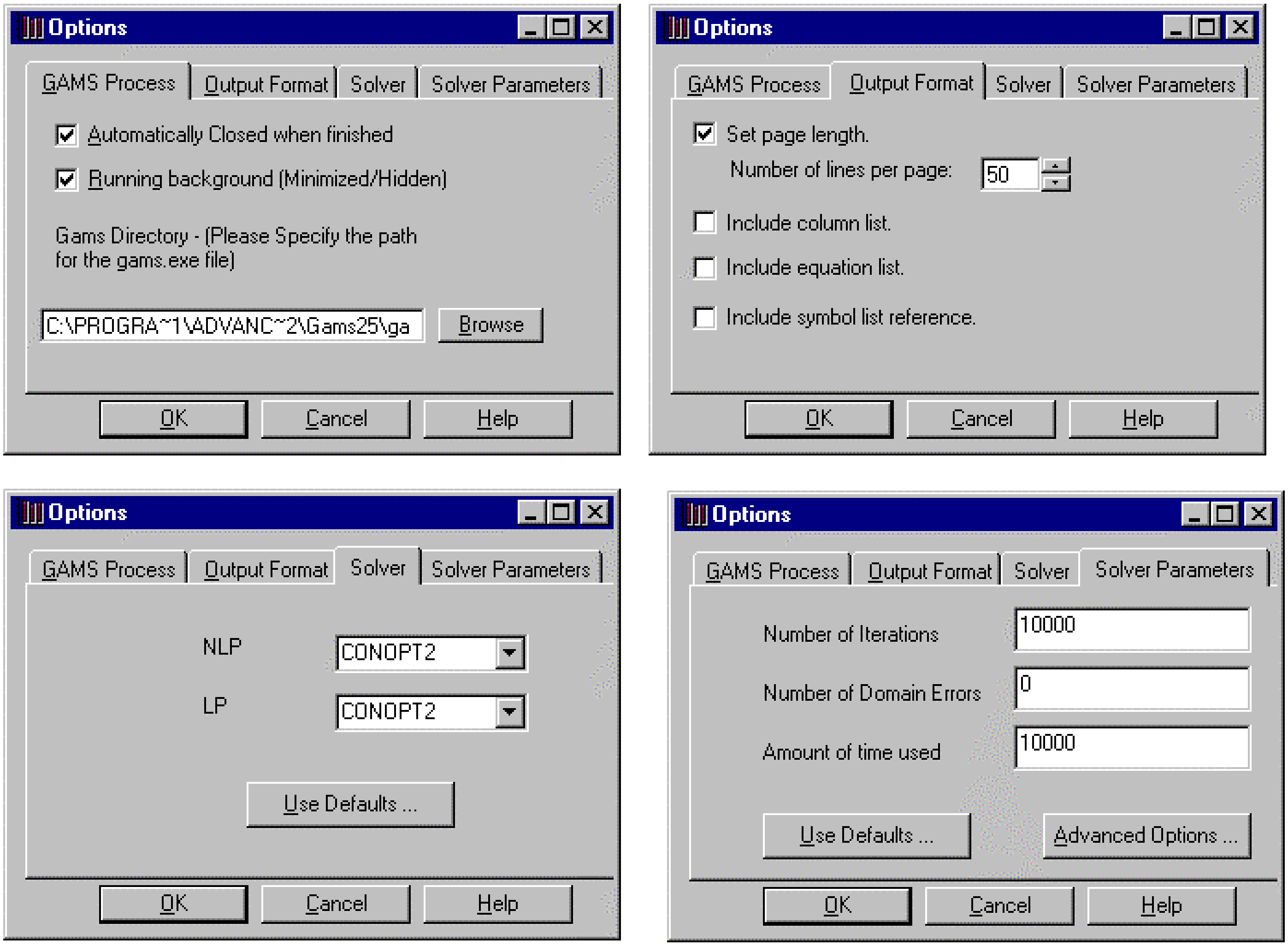


Figure 46-A. Constant Properties Window



Fingure 46-B. Options

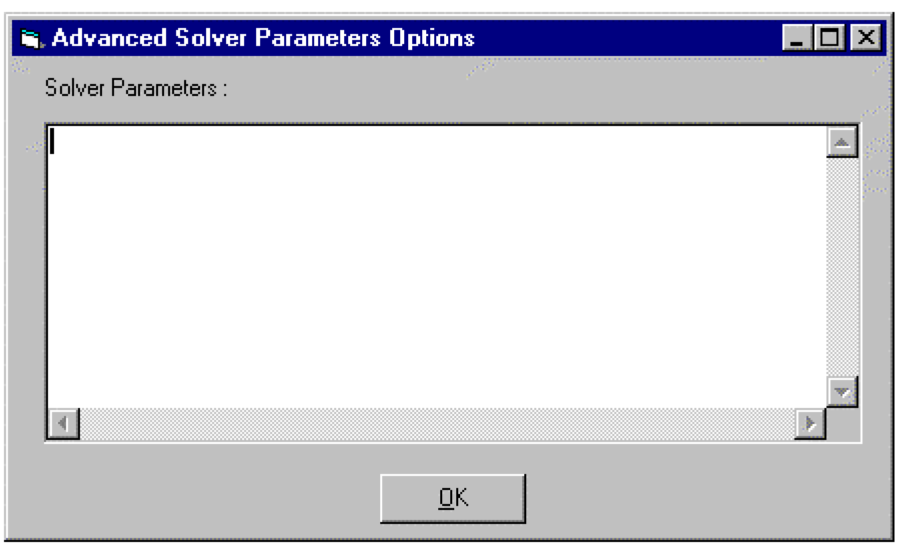


Figure 46-C. Advaced Parameters Options Window

Clicking on the 'Options' item in 'View' menu, opens the Options window as shown in Figure 46-B. General GAMS Process options are set in the 'GAMS Process' tab as shown in the first window of Figure 46-B. The format for the GAMS output can be specified in the 'Output Format' tab as shown in second window of Figure 46-B. LP and NLP values for the Solver can be set in the 'Solver' tab as shown in the third window of Figure 46-B. The default values are CONOPT for both LP and NLP. These default values can be restored by clicking on the 'Use Defaults…' button. The LP and NLP values for Alkylation process are CONOPT2 and CONOPT2. Solver Parameters like Number of Iterations, Number of Domain Errors and Amount of Time Used can be specified in the 'Solver Parameters' tab as shown in the fourth window of Figure 46-B. The recommended values for Solver Parameters of the Alkylation process are Number of iterations 5000, Domain Errors 0, and Amount of time used 5000 sec. The default values can be restored by clicking on the 'Use Defaults…' button. Other advanced options can be set by clicking on the 'Advanced Options' button, which brings up the window shown in Figure 46-C . For the alkylation process advanced options are specified by providing CONOPT2.OPT file and adding the following line in gamsprm95.txt " OPTFILE =1".

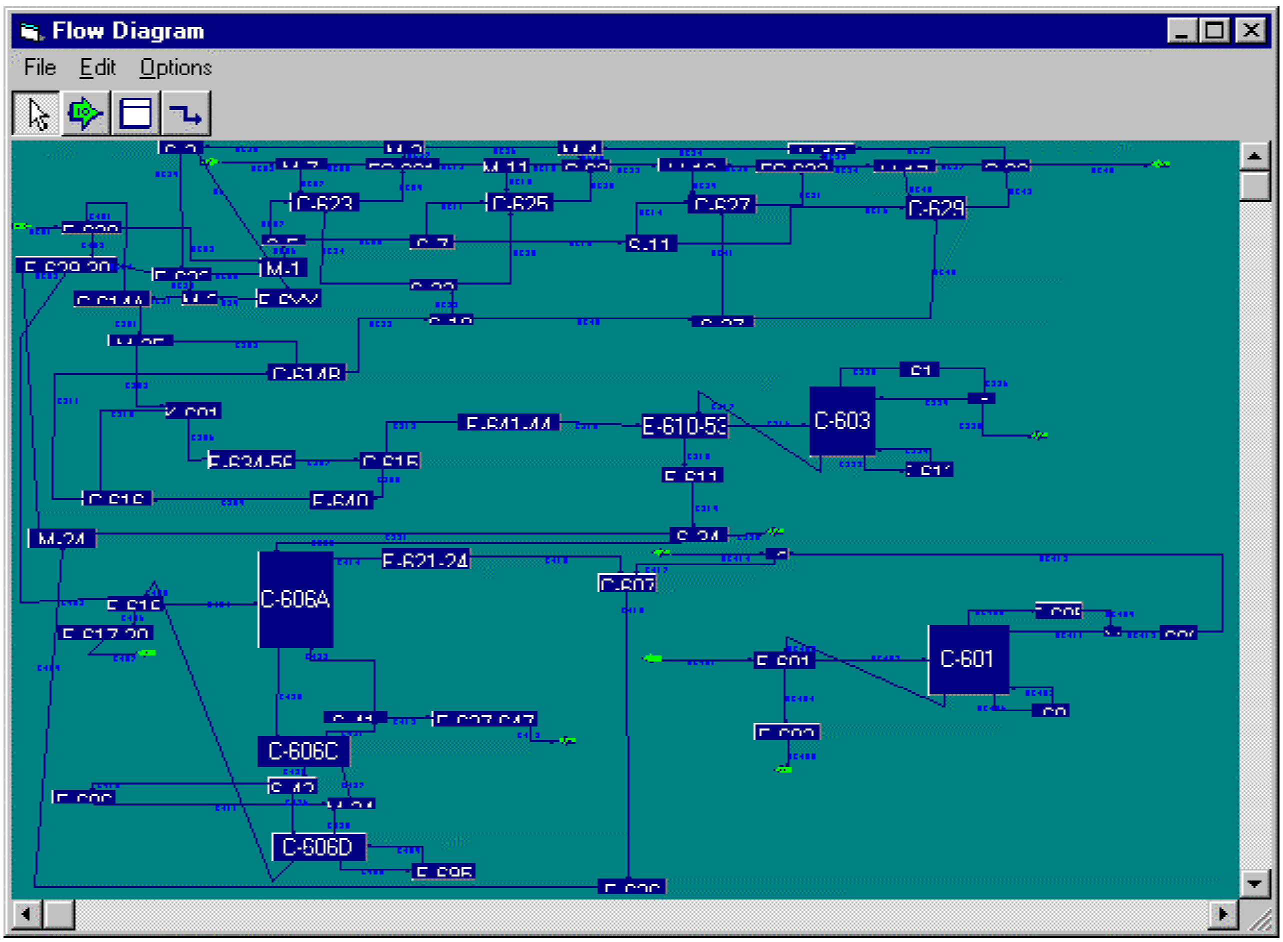


Figure 47. Flowsheet Diagram Window

The flowsheet diagram can be viewed by clicking on the 'FlowSheet Diagram' option in the view menu as shown in Figure 39. The flowsheet cannot be edited in the On-line Optimization program. The flowsheet diagram is shown in Figure 47. Double clicking on a unit opens a data form, which displays all the measured variables, unmeasured variables and plant parameters that are associated with that unit. Similarly double clicking on a stream opens a data form, which displays the measured and unmeasured variables, associated with the stream. The global data can be viewed by double clicking on the background of the flowsheet.

After entering the required information, let us proceed to execute the model. To execute the model, click on the 'Execute' option in the File menu or click on the 'Execute' button in the toolbar. Once the 'Execute' option is clicked the Model Summary and Execute window as shown in Figure 48 is opened. This window gives the summary of the contact process.

When the 'Execute' button in the 'Model Execute and Summary' window is clicked, the program first extracts the model information from the database. Based on this information, it generates the GAMS input files and calls the GAMS solver. The progress of GAMS program execution is shown in Figure 49. This window is automatically closed as soon as the execution is over. When the execution of the program is completed, it displays the results of on-line optimization results in the Output window.

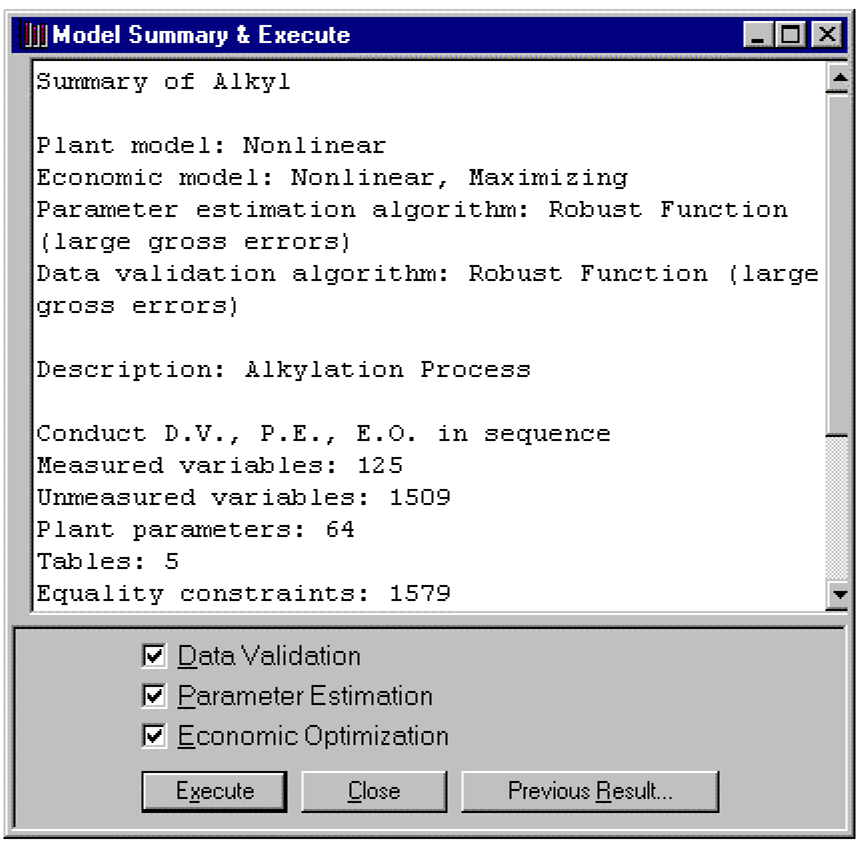


Figure 48. Model Execution and Summary Window

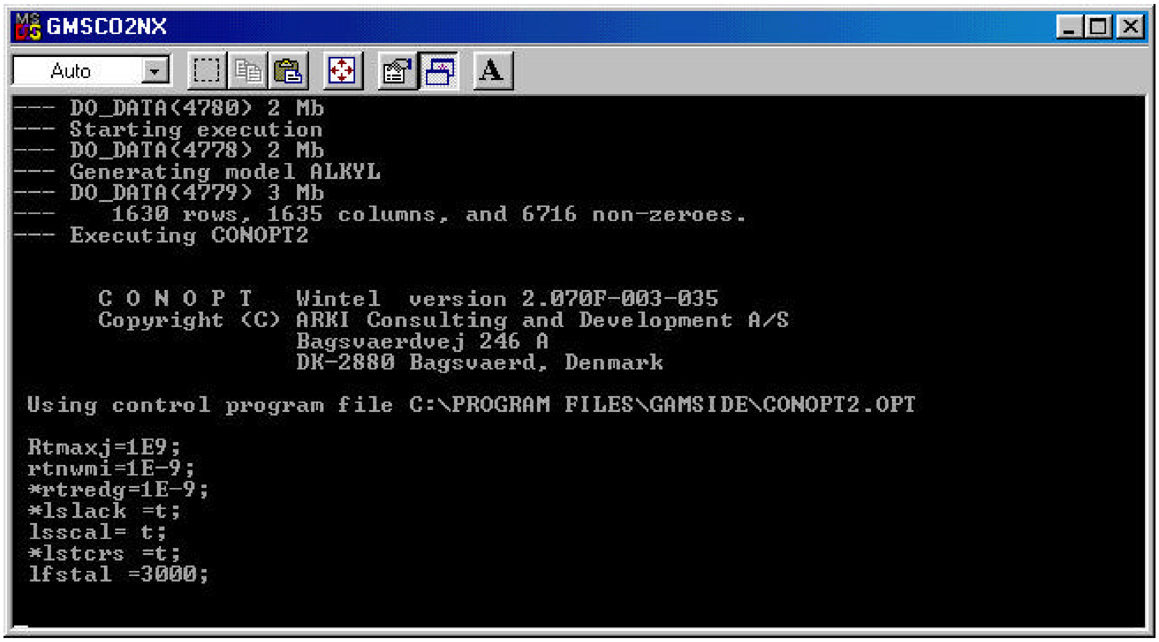


Figure 49. GAMS Program Execution Window

A GAMS licensed software is required to execute this program. This Alkylation plant has 1,579 equality constraints and 50 inequality constraints, and the free or demonstration version is limited to 300 constraint equations. The results for the optimization case are included. And can be seen by clicking on the button "Previous Results" in Figure 48. A licensed version can be obtained from the GAMS Development Corporation(www.gams.com).

After the three programs have been executed, three detailed GAMS output files will be generated by GAMS for the three optimization problems. These files give detailed solutions of the optimization problems for Data Validation, Parameter Estimation and Economic Optimization. Also, a final report is generated by Interactive On-line Optimization system. In the final report, the estimated values of parameters, the reconciled values of process variables, the optimal set points and profit from Economic Optimization are shown. The Output Window with the Final Report is shown in Figure 50. The View menu in the Output window has three options namely Final Report, Full output and Flowsheet.

The Final Report options has five options namely the Economic Objective, Measured Variables, Unmeasured Variables, Plant Parameters and the Stream number as shown in Figure 51. The Economic Objective value is shown in Figure 50.

When the option 'Measured Variables' in the Final Report menu is clicked, the system opens a spreadsheet data form which includes the optimal setpoints from economic optimization, reconciled value from Data Validation, reconciled value from Parameter Estimation and the plant data as shown in Figure 52. Clicking on "Plant parameters" in Final Report menu, the system opens a spreadsheet data form that includes the estimated values of plant parameters as shown in Figure 53.

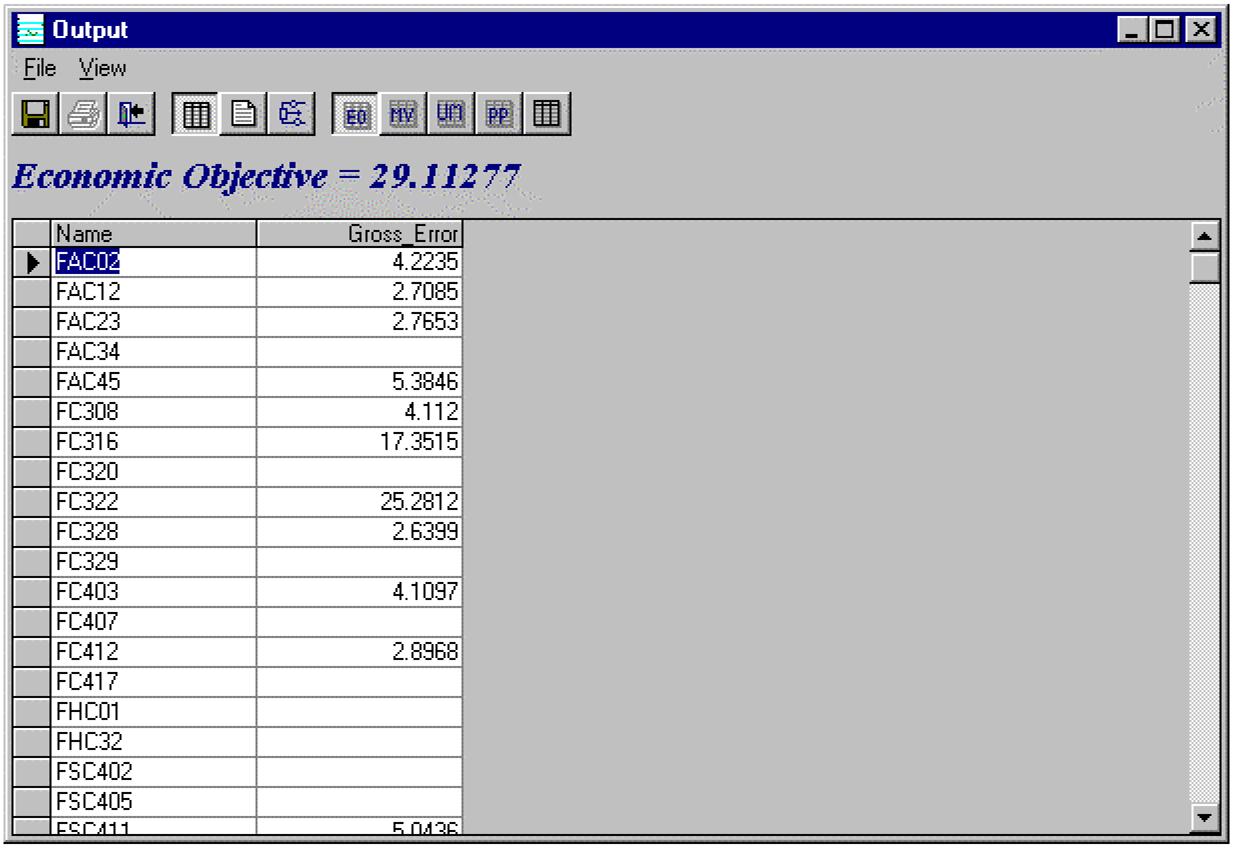


Figure 50. Final Report in the Output Window

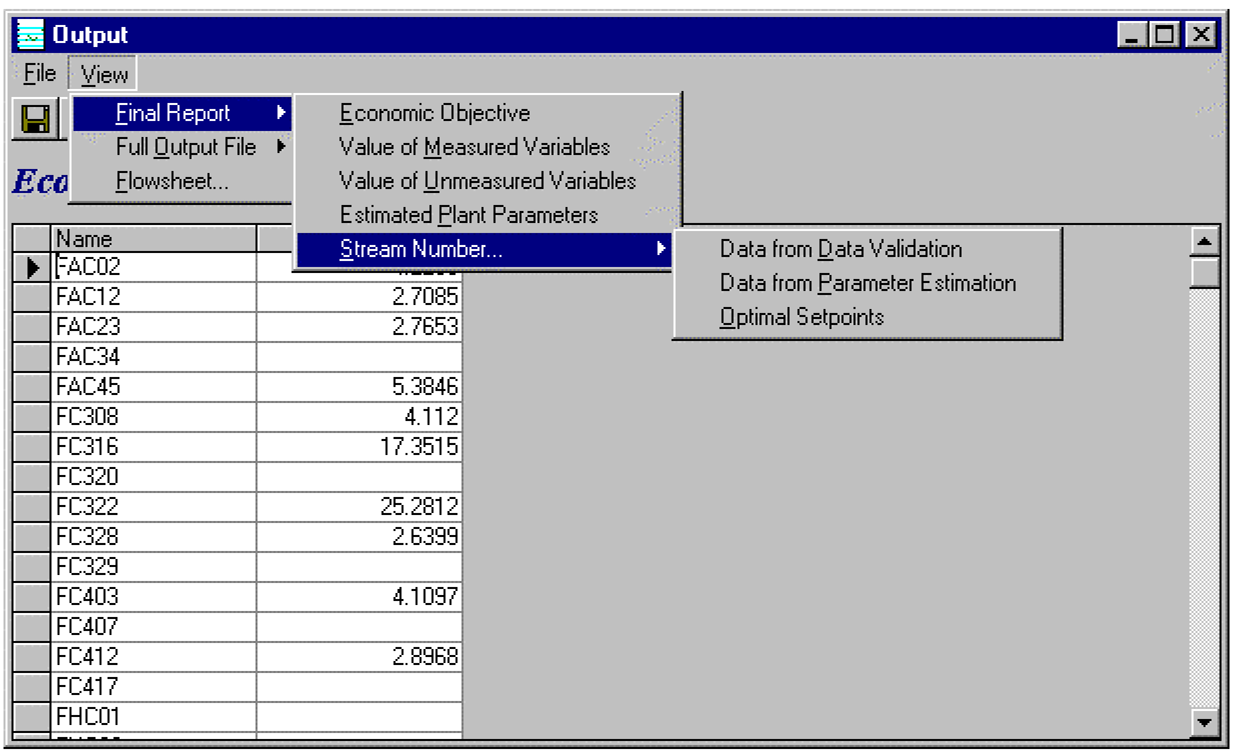


Figure 51. View Menu in the Output Window

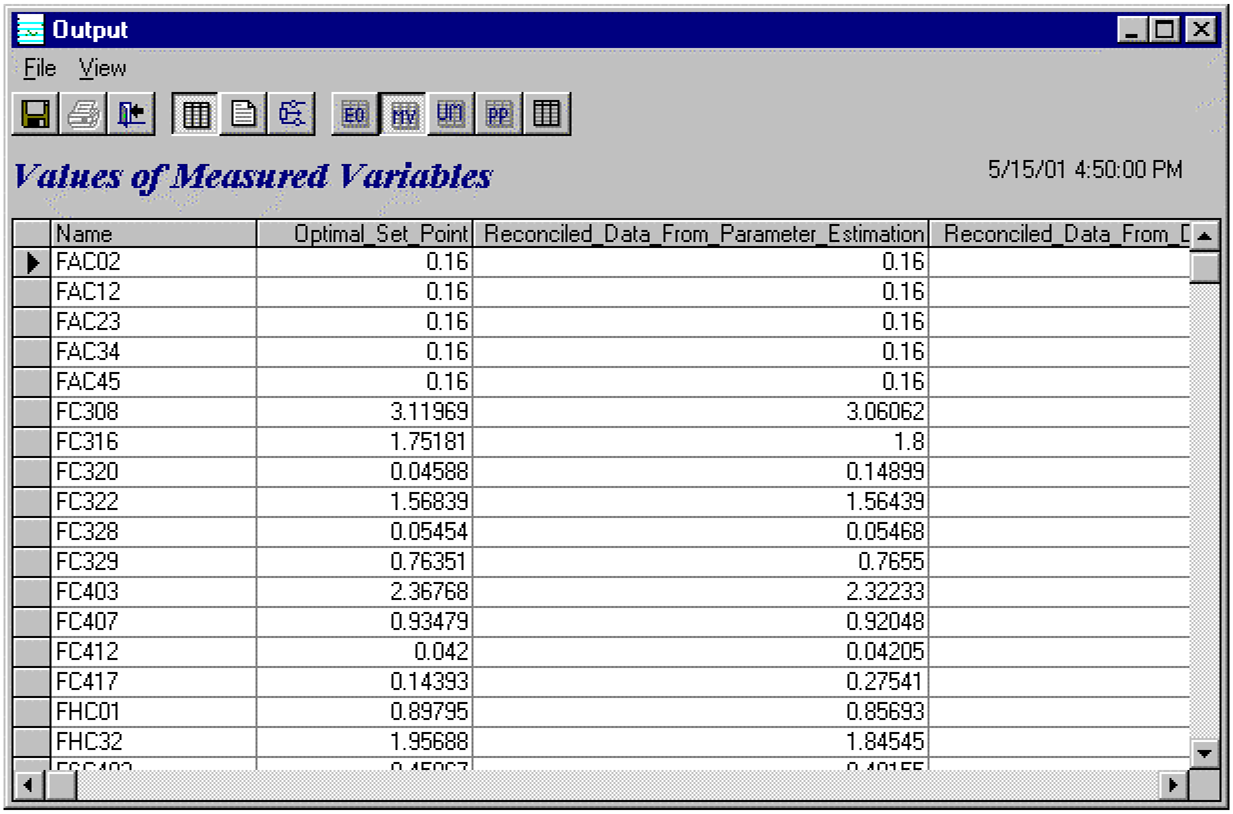


Figure 52. Optimal Set points and Reconciled Data in Final Report for Measured Variables

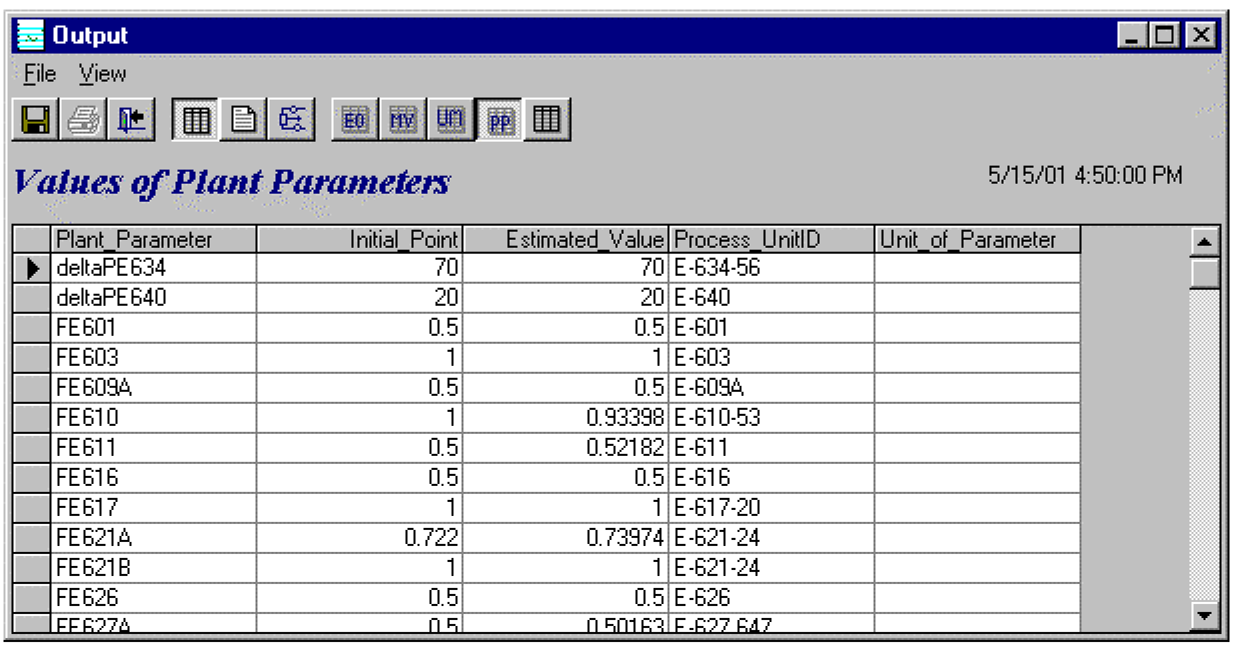
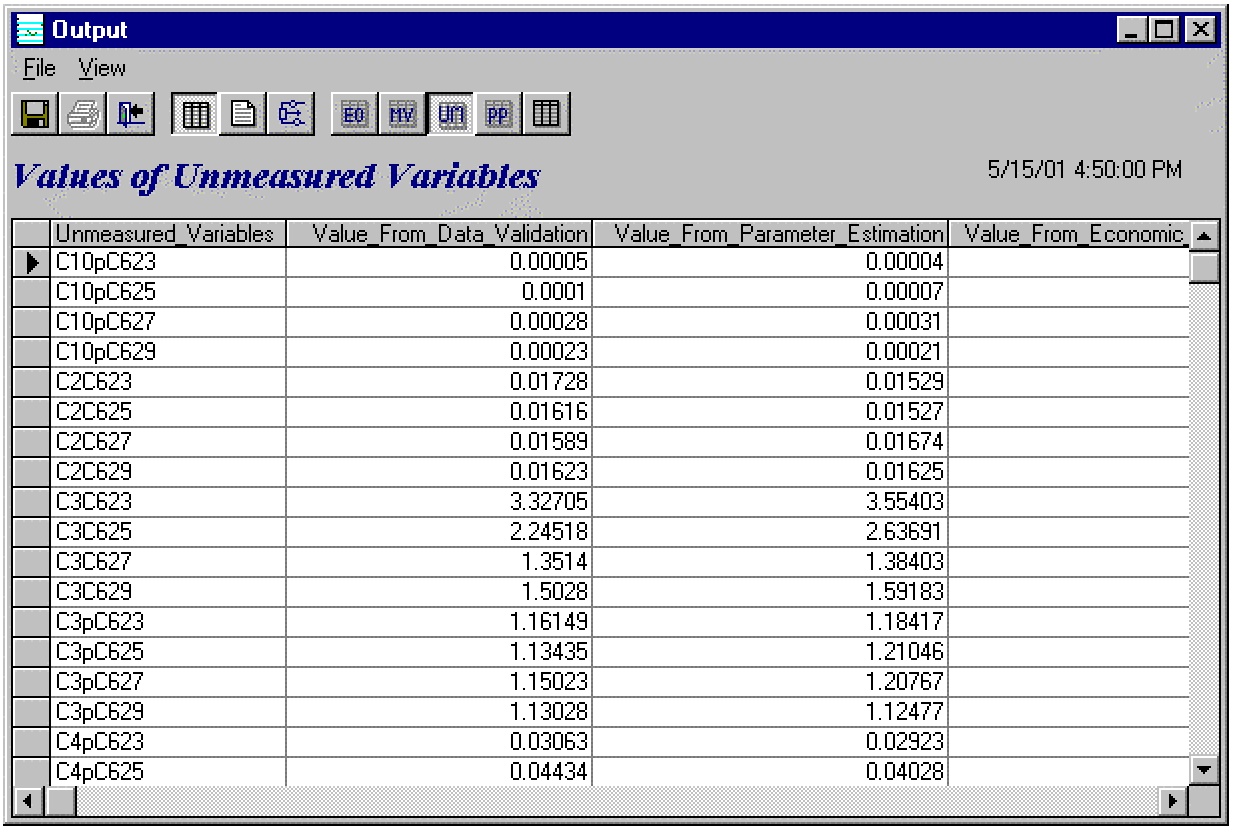
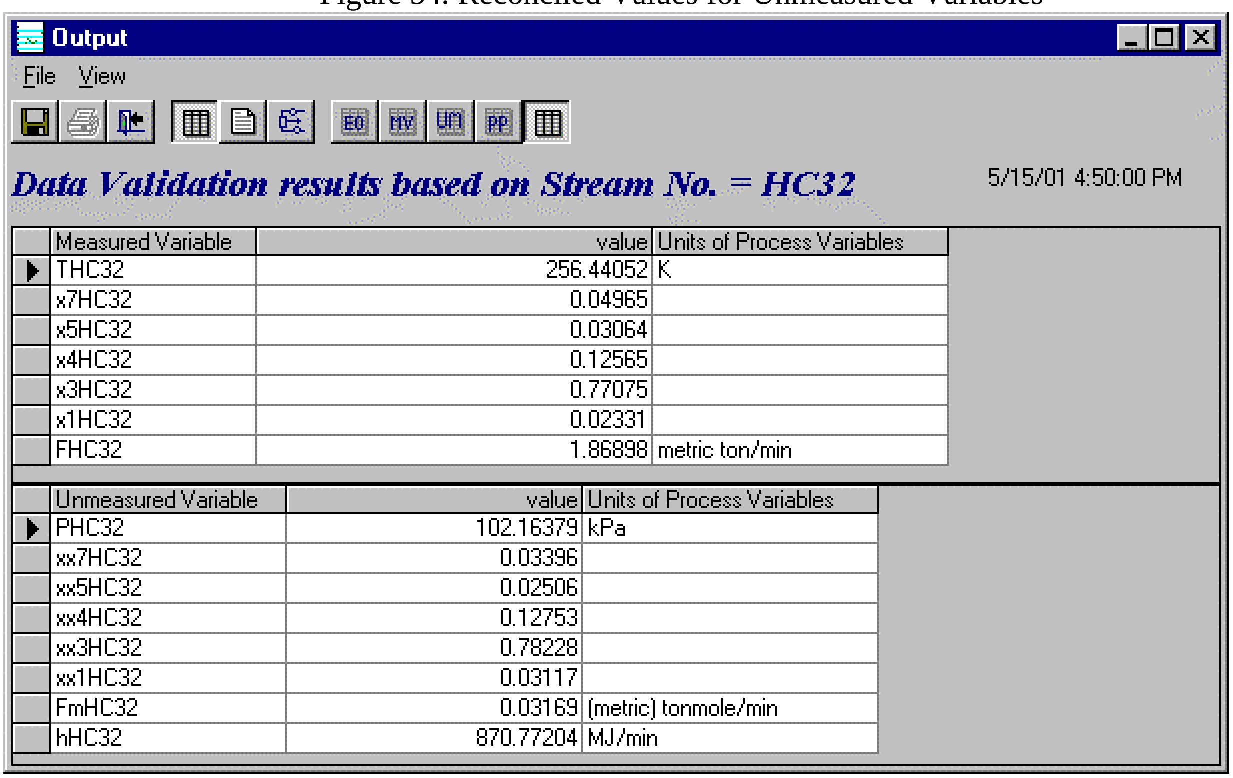


Figure 53. Estimated Values of Plant parameters in Final Report



Unmeasured_Variables	Value_From_Data_Validation	Value_From_Parameter_Estimation	Value_From_Economic_
C10pC623	0.00005	0.00004	
C10pC625	0.0001	0.00007	
C10pC627	0.00028	0.00031	
C10pC629	0.00023	0.00021	
C2C623	0.01728	0.01529	
C2C625	0.01616	0.01527	
C2C627	0.01589	0.01674	
C2C629	0.01623	0.01625	
C3C623	3.32705	3.55403	
C3C625	2.24518	2.63691	
C3C627	1.3514	1.38403	
C3C629	1.5028	1.59183	
C3pC623	1.16149	1.18417	
C3pC625	1.13435	1.21046	
C3pC627	1.15023	1.20767	
C3pC629	1.13028	1.12477	
C4pC623	0.03063	0.02923	
C4pC625	0.04434	0.04028	

Figure 54. Reconciled Values for Unmeasured Variables



Measured Variable	value	Units of Process Variables
THC32	256.44052	K
x7HC32	0.04965	
x5HC32	0.03064	
x4HC32	0.12565	
x3HC32	0.77075	
x1HC32	0.02331	
FHC32	1.86898	metric ton/min

Unmeasured Variable	value	Units of Process Variables
PHC32	102.16379	kPa
xx7HC32	0.03396	
xx5HC32	0.02506	
xx4HC32	0.12753	
xx3HC32	0.78228	
xx1HC32	0.03117	
FmHC32	0.03169	(metric) tonmole/min
hHC32	870.77204	MJ/min

Figure 55. Information based on Stream Number

Clicking on the “Unmeasured Variables”, the system opens a spreadsheet data form which includes the unmeasured variables and their reconciled values as shown in Figure 54.

Three options are available in the ‘Stream Number’ menu as shown in Figure 51. The three options are Data from Data Validation, Data from Parameter Estimation and Optimal Setpoints. Let us click the ‘Data from Data Validation’ option. An input box appears. Let us enter ‘AC09’ and click ‘Ok’. The Measured Variables and Unmeasured variables which are associated with the stream ‘AC09’ with their reconciled values from Data Validation are displayed as shown in Figure 55.

When the ‘Full Output file’ option in the view menu is selected, three buttons are displayed in the toolbar each corresponding to the three optimization problems. Clicking a button will open the corresponding output file for viewing. Let us click on ‘Economic Optimization’ option in the Full output menu. The front part of full output file is shown in Figure 56 and the entire file is shown in Appendix B.

The user can use the ‘Find’ and ‘Goto’ options in the Edit menu to search for a particular phrase or go to a particular section in the Full output file.The Final Report can be exported as Excel files using the ‘Export’ option in the file menu. The Full Output files can also be exported as text files using the ‘Export’ option.

Flowsheet can be viewed in results , in a window similar to the one shown in Figure 46. Double clicking on a stream or unit opens the corresponding data window. The Data window for stream ‘s06’ is shown in Figure 57. As seen in this figure, the values of the measured variables obtained as a result of on-line optimization are displayed in the data window.

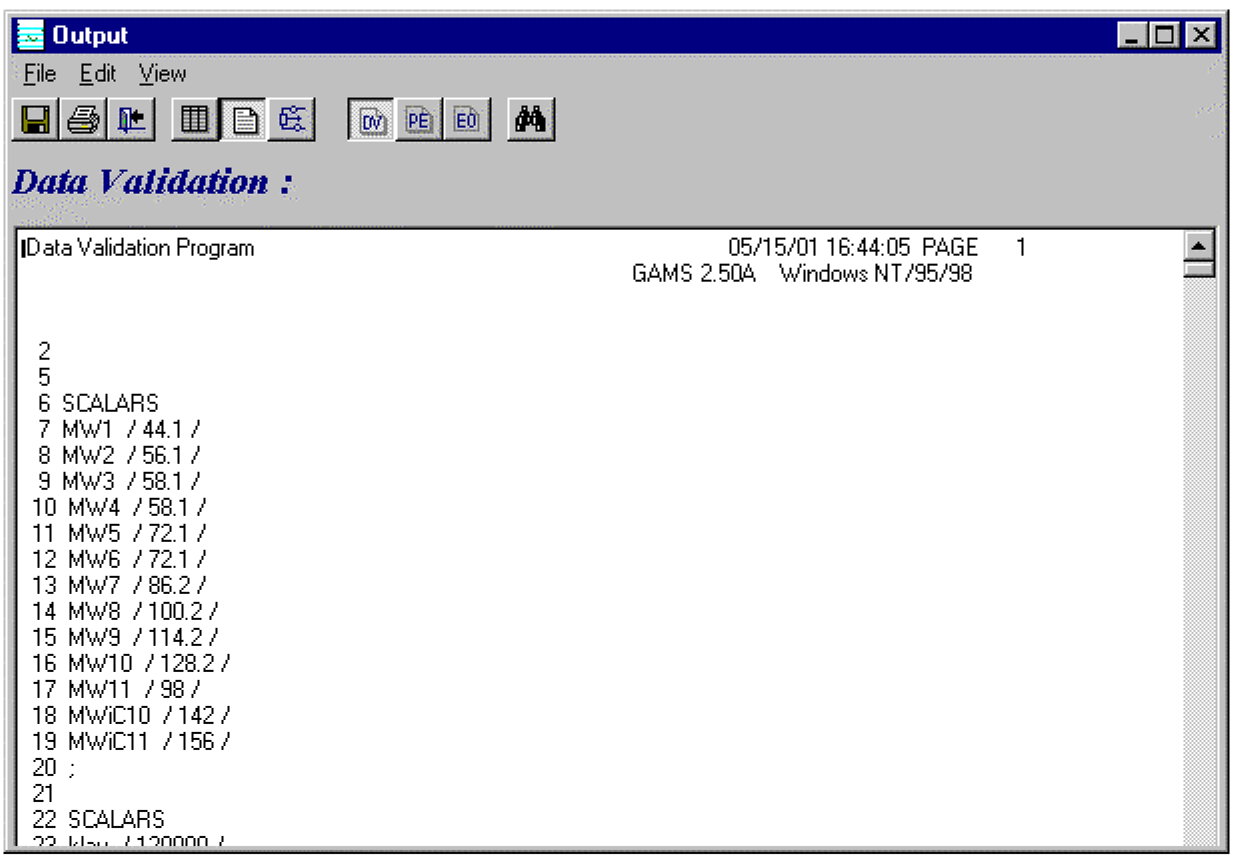


Figure 56. Full Output File of Gams Programs

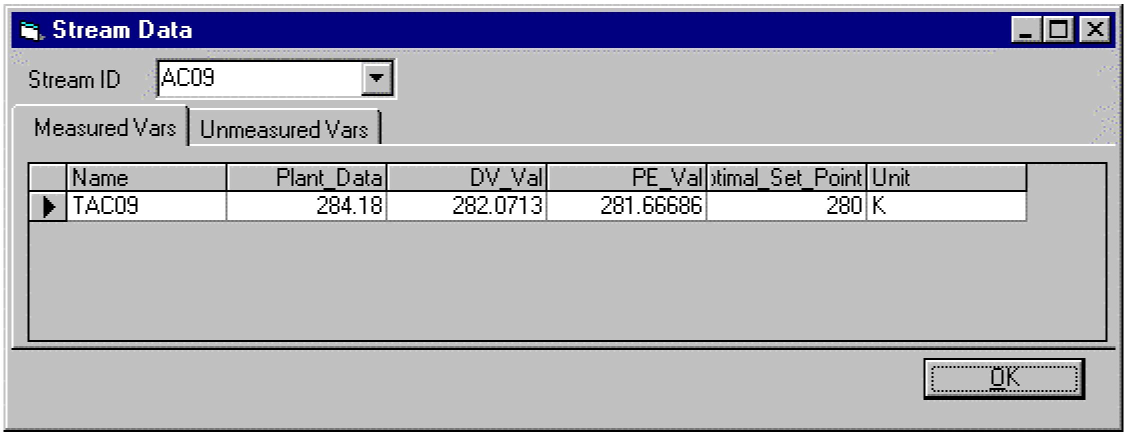
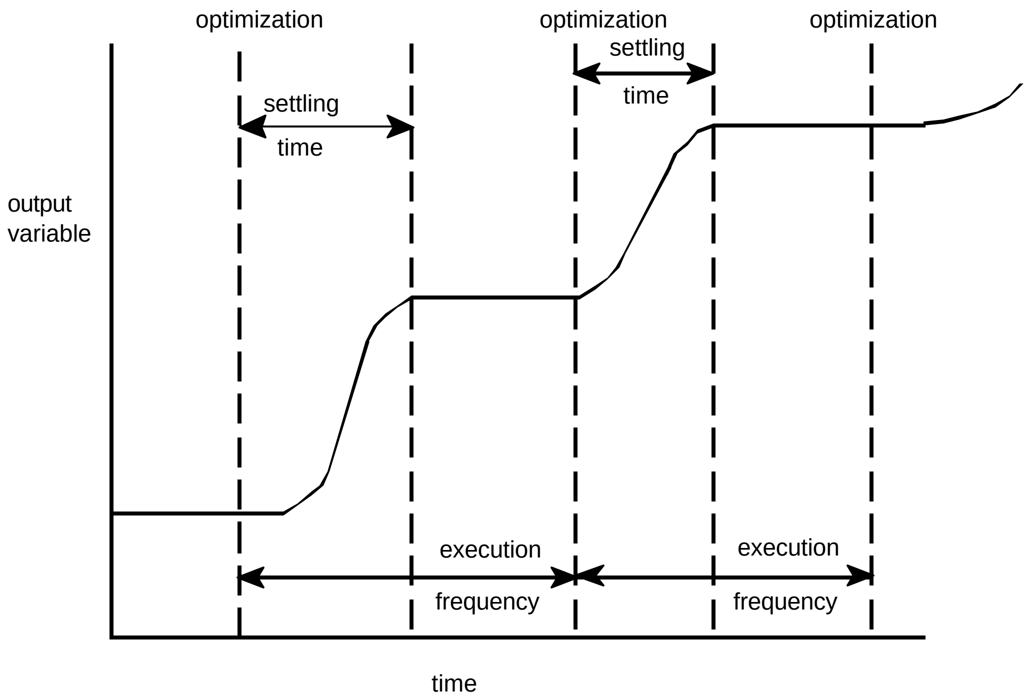


Figure 57. Stream Data Window

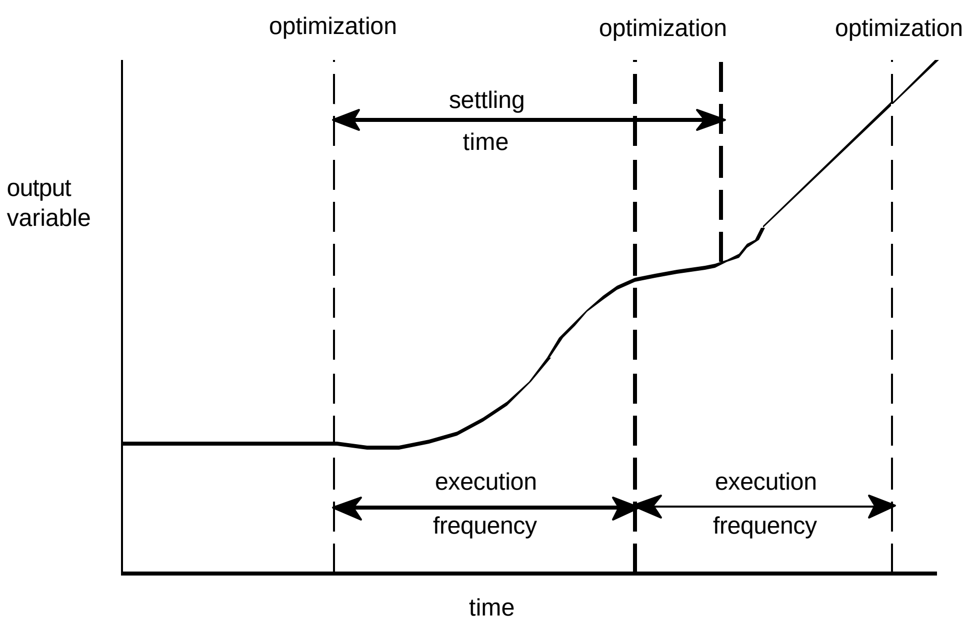
Clicking the 'Close' option in the file menu of the Output window returns the user to the main screen, which was shown in Figure 38. The model information can be exported as Excel files using the 'Export' option in the file menu of the main window. Save the optimization results using the 'Save' option in the file menu. The results including the full output files are stored along with the Alkylation model. When the 'Exit' button is clicked, the Interactive On-line Optimization main window is closed and the user is taken back to the Advanced Process Analysis Desk.

Steady-State Detection and Execution Frequency

On-line optimization executes economic optimization and generates a set of optimal set point. Then these set points are transferred to the coordinator program or the operators as an Excel spreadsheet file. These optimal set points can be sent directly to Distributed Control System or they can be viewed by operators before they are sent to the DCS. Before the optimal set points are implemented, the steady state detection program is run to ensure the process is at steady state. The following gives detailed information about steady-state detection and execution frequency.



a. Time between optimizations is longer than settling time



b. Time between optimizations is less than settling time

Figure 58. Comparison of Time between Optimizations and Process Settling Time after Darby and White (1988).

The execution frequency for optimization is the time between conducting on-line optimization of the process, and it has to be determined for each of the units in the process. It depends on the settling time, i.e., the time required for the units in the process to move from one set of steady-state operating condition to another. This settling time can be estimated from the time constant determined by process step testing. The time period between two on-line optimization executions must be longer than the settling time to ensure that the units have returned to steady state operations before the optimization is conducted again. This is illustrated in Figure 58, after Darby and White (1988). The figure shows that execution frequency for optimization in Figure 58a was satisfactory for the process but the execution frequency in Figure 58b was too rapid for the process. In Figure 58a, the process has returned to steady-state operations and held that position until the next optimization. However, in Figure 58b, the process did not have enough time to return to steady-state operations before the optimization altered the operating conditions. The process would continue on an unsteady state path, and operator intervention would be required. The settling time for an ethylene plant is four hours according to Darby and White (1988), and this time for the sulfuric acid contact process is twelve-hour according to Hertwig (1997).

As shown in Figure 58, it is necessary to make sure that the process is operating at steady state before the plant data is taken from distributed control system for conducting on-line optimization. Steady state plant data is required for steady state process models.

The time series horizontal screening method has been used in industry to detect steady state. In this method, the measured values for key process variables are observed for a time period. If the measured values remain within the bounds of two standard deviations, then the process is said to be operating at steady state. This requires the use of a coordinator program or operator action for identifying steady state and exchanging data between the on-line optimization program and the distributed control system. Excel spreadsheet files are widely used to transfer the data. The use of an Excel spreadsheet is the industry standard way of selecting and manipulating data from a DCS. Therefore, the on-line optimization program is capable of importing the identified steady state values for the measured process variables if they are stored in an Excel spreadsheet.

To transfer this steady state data to the on-line optimization program, return to the Declaration Window for Measured Variables, which is shown in Figure 41 and pull down the File menu. This is shown in Figure 60 and then select Import Plant Data. This action brings up the window shown in Figure 61, and in this window the name of the Excel file is designated which contains the steady state plant data that was selected with the Excel time series program. Clicking the Open button will replace the plant data currently in the program. Now having the new data in place, the on-line optimization program can be executed to generate the new set of optimal points for the distributed control system.

The execution of the on-line optimization program generates the set points for the distributed control system. These values can be exported from the on-line optimization program using the same procedure as importing data.

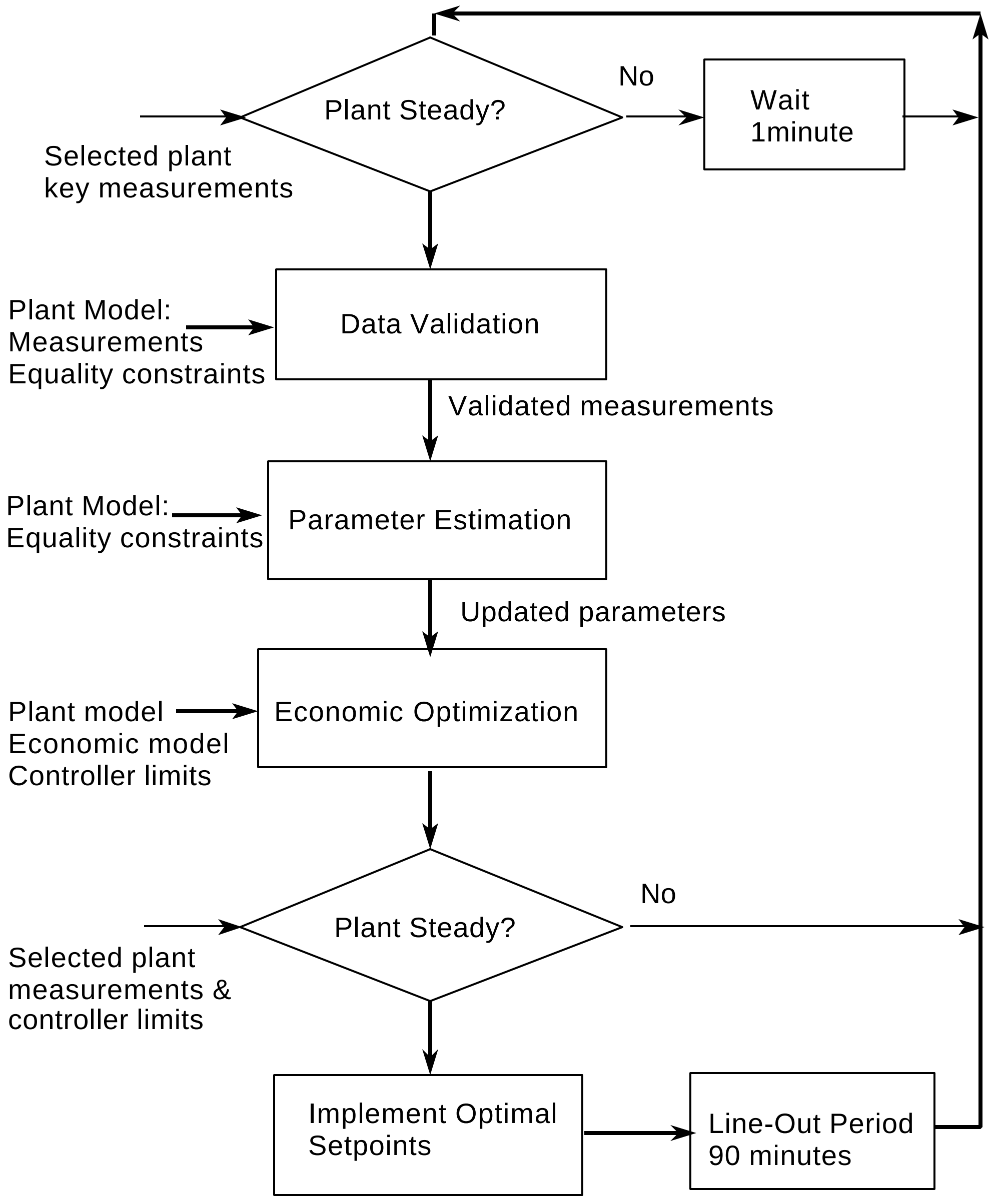


Figure 59. Implementation Procedure for On-Line Optimization, after Kelly, et al. (1996)

The file menu in these windows has a line Export Plant Data which, when clicked, gives a screen similar to the one in Figure 61 to specify the Excel file to transfer this data.

The on-line optimization program requires the standard deviation of the measured variables as shown in Figure 41. This information can be transferred to the on-line optimization program using the same procedure as was used for the measured variables. However, it is not necessary to use the current plant data to evaluate the standard deviation, and the Excel program can be used with any data set to determine appropriate values of the standard deviation.

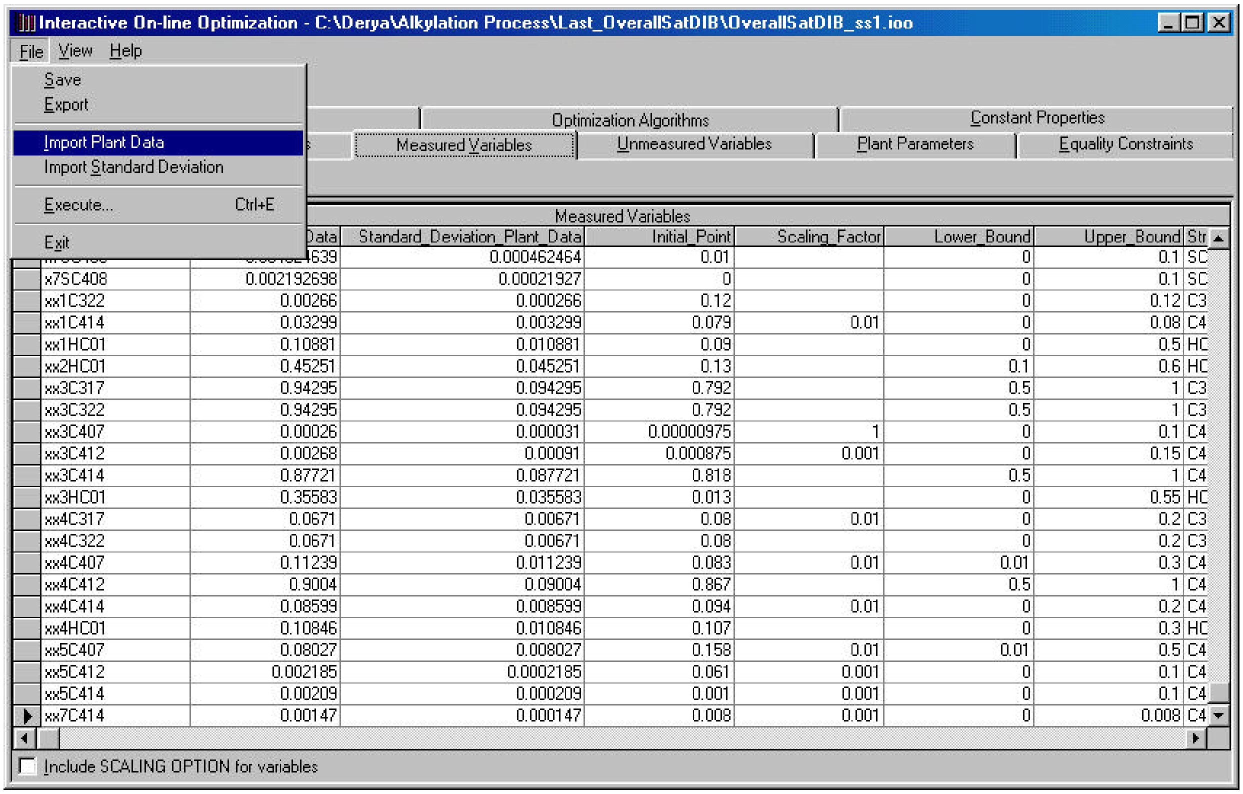


Figure 60. The Import Option in the File menu of On-line Optimization

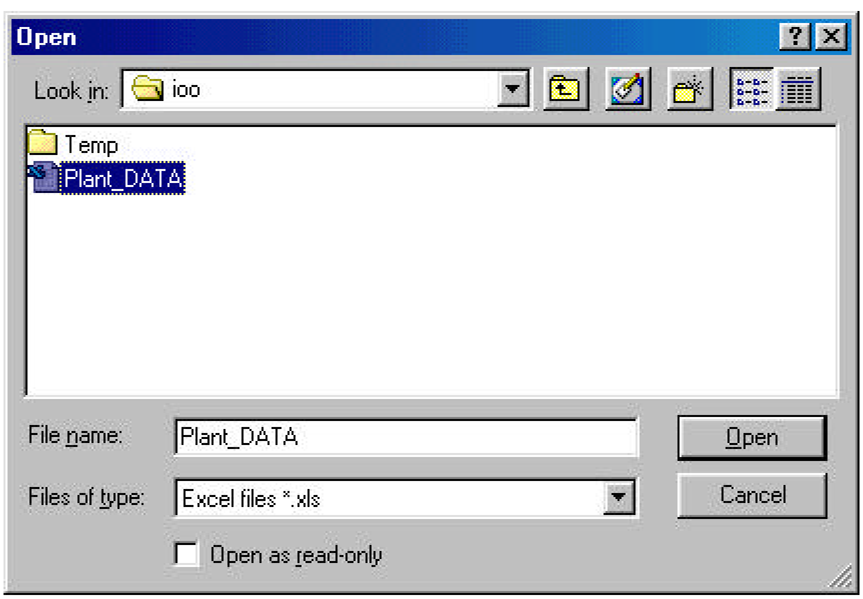


Figure 61. The Dialog Box that opens when Import is clicked

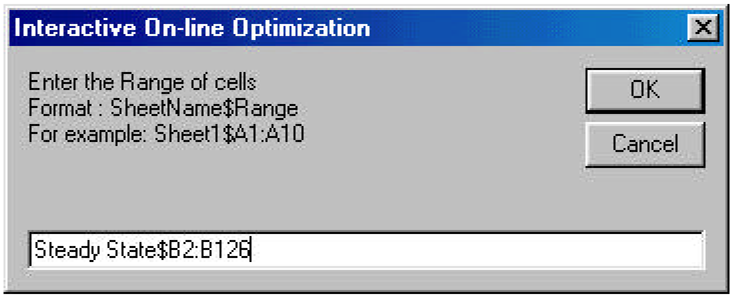


Figure 62. The Screen to enter the Excel Sheet Name and Range

This concludes the description of steady-state detection and execution frequency of on-line optimization. The next step of Advanced Process Analysis System is the heat exchanger network optimization. Click the 'Pinch Analysis' button in Advanced Process Analysis Desk to open the heat exchanger network (THEN) program.

VII. USING THE HEAT EXCHANGER NETWORK (THEN) PROGRAM

Upon clicking the 'Pinch Analysis' button on the Advanced Process Analysis Desk, the 'Heat Exchanger Network Model Information' window is displayed. This window is shown in Figure 63. Since we are using the THEN program for the first time, click the 'New Model' button.

Once the 'New Model' button is clicked, the 'Welcome Screen' of the Heat Exchanger Network program is displayed. This screen is shown in Figure 64. The message at the center confirms that you are working on the process model 'Alkylation.ioo' in the 'Examples'

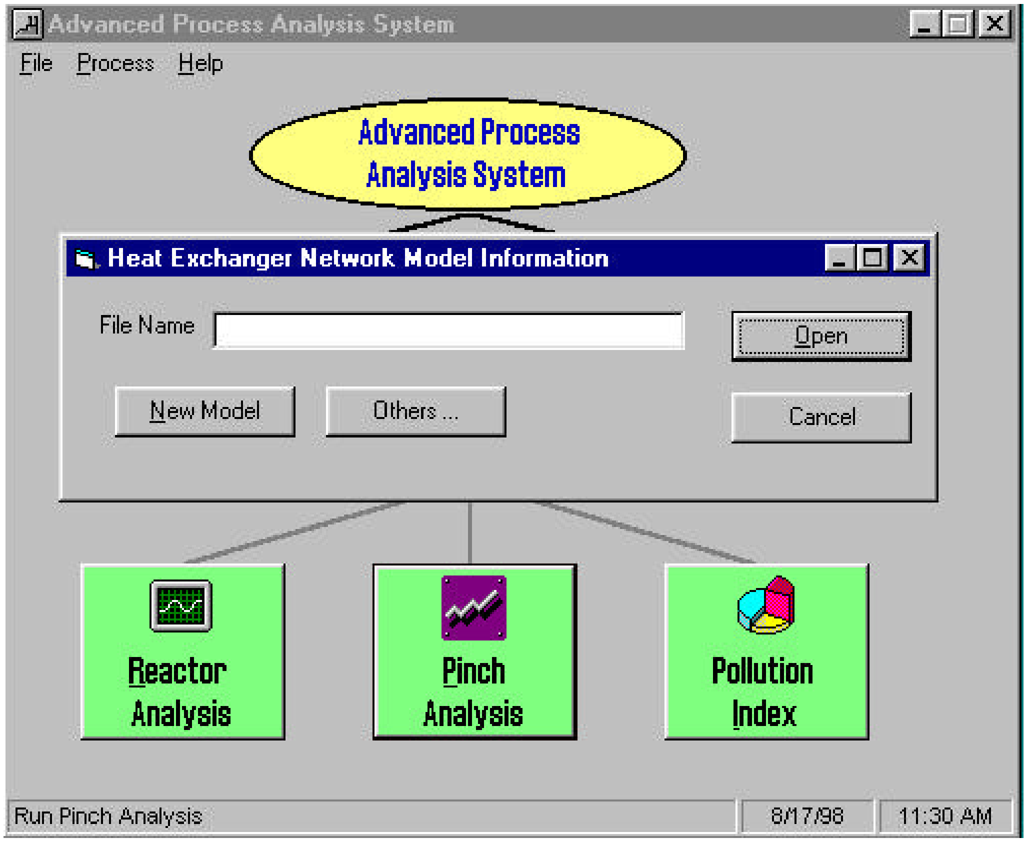


Figure 63. The Heat Exchanger Network Model Information Window

subdirectory. The HEN model you are working on is an untitled new model. A HEN model is an input file created by the heat exchanger network program to apply pinch analysis to the process model. A HEN model is stored as a file with 'hen' extension (e.g. sample.hen).

The menu at the top of the background window is the 'main menu' of THEN. It is available at all times during the execution of the program. The 'Help' button can be used to access online help. The 'About' button gives the copyright information. The 'Exit' button can be used to quit the program at any time and go back to the Advanced Process Analysis Desk.

Click on the 'Proceed' button on the welcome screen. The 'Stream List' window is now displayed on the screen. This is shown in Figure 65. The box in the center shows the list of all the process streams and their descriptions. This list has been automatically retrieved by the program based on the information in the flowsheet diagram. Scroll up and down in the box to see the entire list. There is a check box available to the left of each stream name in the list. If a process stream is important for heat integration, the check box for that stream needs to be selected. For the Alkylation model, the following streams are determined to be important; C306, C307, C308, C309, C312, C315, C316, C317, C318, C319, C323, C324, C325, C326, C401, C402, C403, C404, C405, C406, C407, C408, C409, C410, C411, C412, C413, C414, C415, C418, C419, HC01, HC02, HC03, HC04, HC05, HC29, HC30, SC401, SC402, SC403, SC404, SC405, SC406, SC407, SC408, SC409, SC412, SC413. Select all of these streams in the list by clicking on their checkboxes.

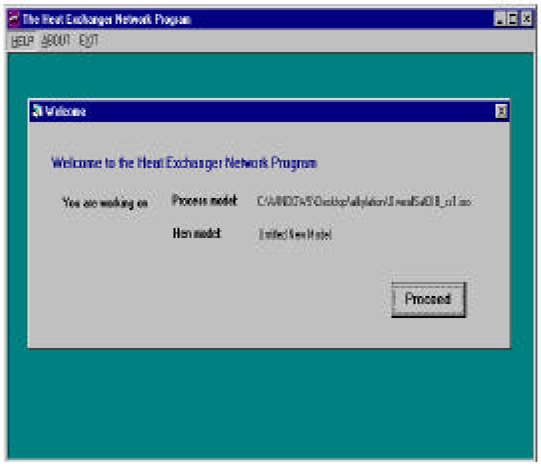


Figure 64. The Welcome Screen of THEN

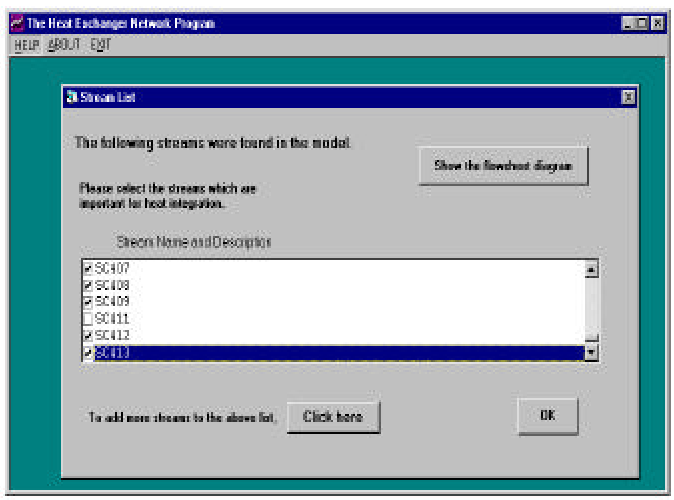


Figure 65. The Stream List Window

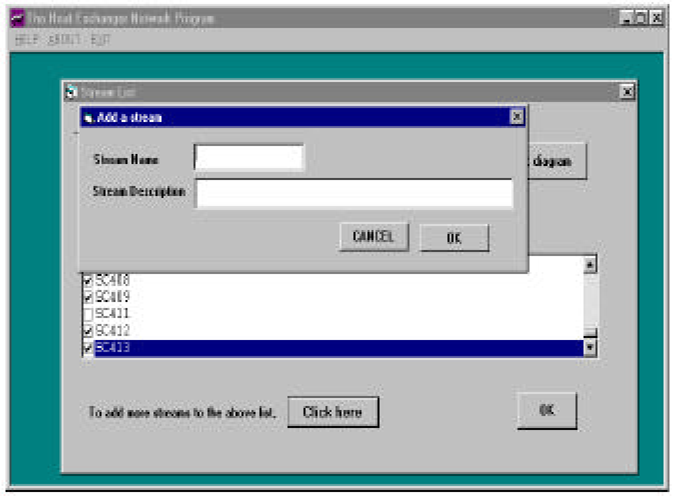


Figure 66. The Add Stream Window

The button 'Show the flowsheet diagram' at the top of the stream list window can be used to view the flowsheet diagram at any time. In addition to the streams listed, new streams can also be added. To add a stream, click the 'Click here' button at the bottom of the window. A small window shown in Figure 66 is displayed. A stream name and a description must be entered. Clicking the 'OK' button will add the stream to the list. For the Alkylation model, we do not want to add any stream. So, click the 'Cancel' button to go back to the 'Stream List' window.

Having selected all the important streams in the Stream List window, click the 'OK' button to continue. The next window displayed on the screen is the 'Retrieving Stream Data' window shown in Figure 67. A vertical line divides this window into two parts. The left side of the screen displays a list. This list contains all the streams, which were selected earlier in the 'Stream List' window. As can be seen from the Figure 67, all the forty streams that were chosen as the important streams are present in the list.

The heat exchanger network program needs certain information for each stream in order to apply pinch analysis. This information includes temperature, flowrate, enthalpies and film heat transfer coefficient. The values of all of these variables have to be retrieved for each of the selected streams. The values for temperature and flowrate are automatically retrieved by the program from the results of economic optimization carried out earlier during Advanced Process Analysis System. The values for enthalpies and film heat transfer coefficients have to be entered by the user. To understand how the data is retrieved, let us enter the data for the stream C306.

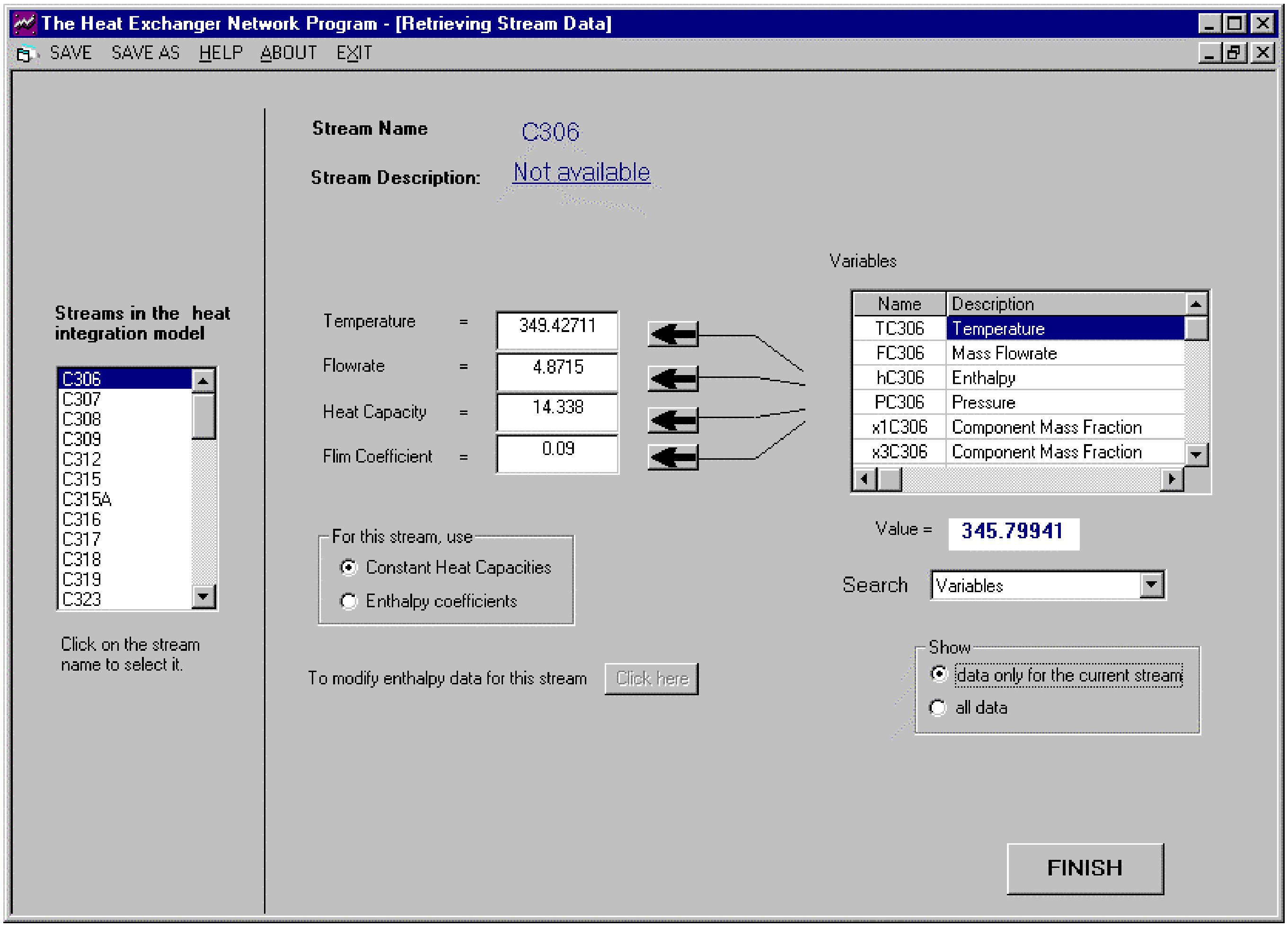


Figure 67. The Retrieving Stream Data Window

Click on the stream C306 in the list on the left side of the screen. On the right side of the screen, the stream name and stream description labels now show 'C306' and 'not Available' respectively. The description of the stream is shown as 'not available' it is no description is given while entering stream details. As can be seen in Figure 67, the temperatures and flowrate values for stream C306 have been automatically retrieved and displayed. The heat capacity and film coefficient values are initialized to the defaults, which are 0 and 100 respectively.

The enthalpy data for any stream can be entered as either constant heat capacity coefficients or temperature-dependent enthalpy coefficients. For the alkylation process constant heat capacity coefficients are used for all the streams. To enter these coefficients for stream C306, select the 'Constant Heat Capacities' option. This view is shown in Figure 67.

Now, the temperature, flowrate and enthalpy coefficients data for stream C306 have been entered and can be seen in the Figure 67. The final piece of information is the film heat transfer coefficient value. For the Alkylation process model, an average film coefficient value of 0.09 MJ/m^2-K.min is estimated for all the process streams. Change the default value of 100 to 0.09 as the film coefficient for stream C306. This completes the data retrieval for stream C306.

This procedure should be repeated for all the streams listed on left side of the screen. For each of the streams, the temperature and flowrate will be automatically retrieved. The enthalpy coefficients should be calculated as done for stream C306. The film heat transfer coefficient values for all the streams should be 0.09. The data retrieval part for Alkylation model is now complete and the 'Finish' button at the bottom of the screen should now be clicked.

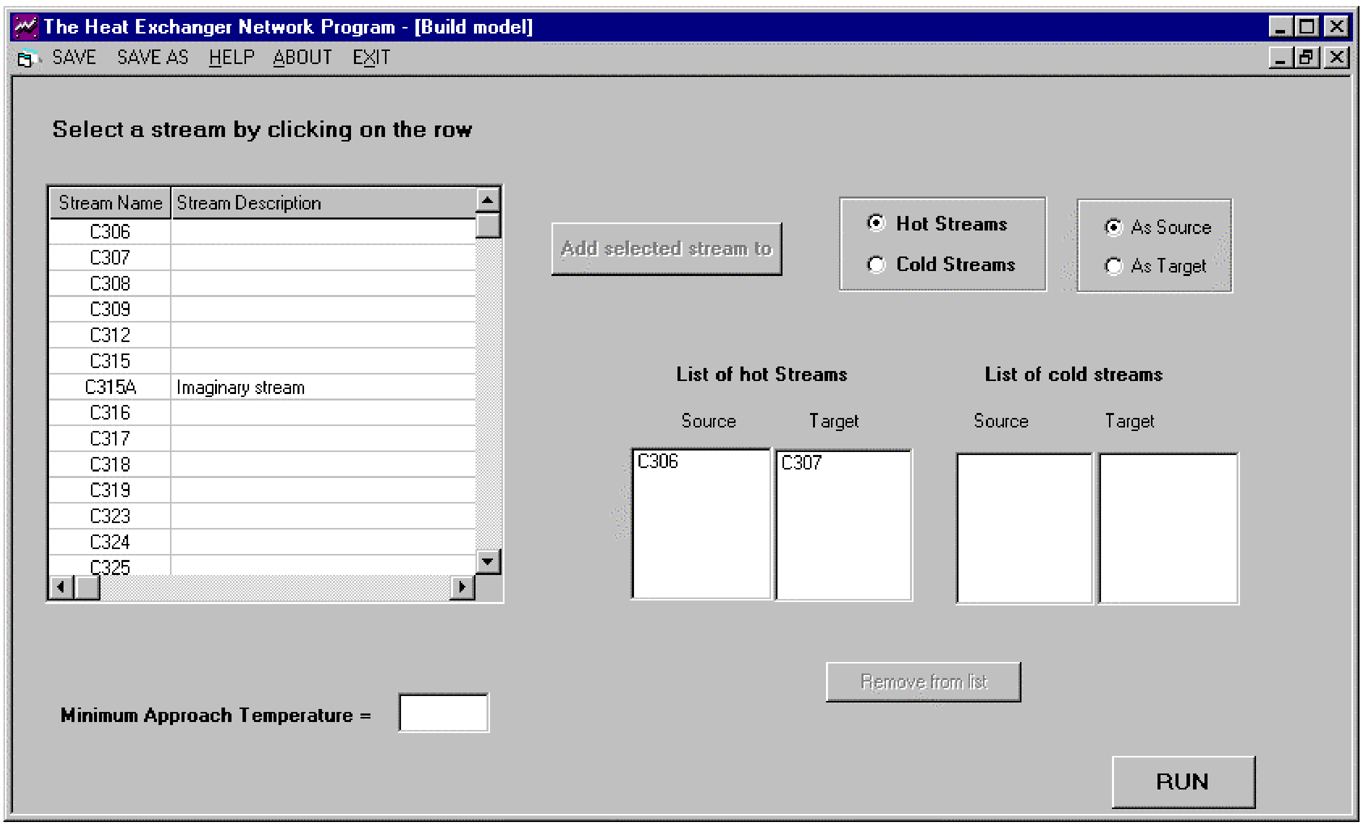


Figure 68. The Build Model Window

When the ‘Finish’ button is clicked, the ‘Build Model’ window appears on the screen. This is shown in Figure 68. In this ‘Build Model’ window, the final step of dividing process streams into pairs of hot and cold streams is performed. This classification of streams constitutes the THEN model. In a THEN model, a hot stream is a stream that needs to be cooled and a cold stream is a stream that needs to be heated.

The table on the left side of the screen shows the list of process streams selected earlier in the program for heat integration. It shows the stream names as well as the descriptions. The two pairs of lists on the right side of the screen display the hot and cold streams in the stream model. Let us build the stream model for the Alkylation process.

From our knowledge of the Motiva Alkylation process, we know that stream C306 enters the refrigerant partial condenser and the stream C307 is the outlet stream from the condenser. Therefore, streams C306 and C306 are the source and targets respectively of a hot stream. To enter the hot stream, first select the stream C306 in the table. The button ‘Add selected stream to’ now becomes enabled. Select the ‘Hot Streams’ option and the ‘As source’ option. Now click the ‘Add selected stream to’ button. The stream C306 gets added to the list of hot streams as the source. Now click on the stream C307 in the table. Keep the ‘Hot Streams’ option and select ‘As target’ option this time. Now, C306 and C307 are both added to the hot streams list as source and target respectivey. These two constitute one hot stream. The screen view now is shown in Figure 68.

Repeat this procedure for all the other streams. The hot stream pairs for the Alkylation process are C306-C307, C308-C309, C312-C315A, C317-C318, C318-C319, C325-C326, C405-C406, C406-C407, C412-C413, C414-C415, C418-C419, HC01-HC02, HC03-HC04, HC04-HC05, SC403-SC404, SC404-SC405, SC408-SC409 and SC412-SC413. The cold stream pairs are C315-C316, C323-C324, C401-C402, C402-C403, C403-C404, C408-C409, C410-C411, HC29-HC30, SC401-SC402 and SC406-SC407. In all of these pairs, the first stream is the source and the second stream is the target. Once, we have entered all of these streams, the THEN model for the Alkylation process is complete. The ‘Build Model’ window with all the hot and cold streams is shown in Figure 69. The last piece of information needed is the minimum approach temperature between the streams. There is no fixed recommended value for this. We will enter an approach tempearture of 13 °C to ensure that there is sufficient driving force for heat exchange between the streams.

The input part of the program is now over. Let us save the information entered so far by clicking the ‘Save’ button. The program displays the ‘Save As’ window shown in Figure70. Save the model as ‘Alkylation.hen’ in the ‘Examples’ subdirectory of the program folder.

Now, click the ‘Run’ button on the ‘Build Model’ window. The program uses all of the information entered above and appiles concepts of pinch analysis to the Alkylation process. The next window that appears on the screen is the ‘Output Window’ shown in Figure 71.

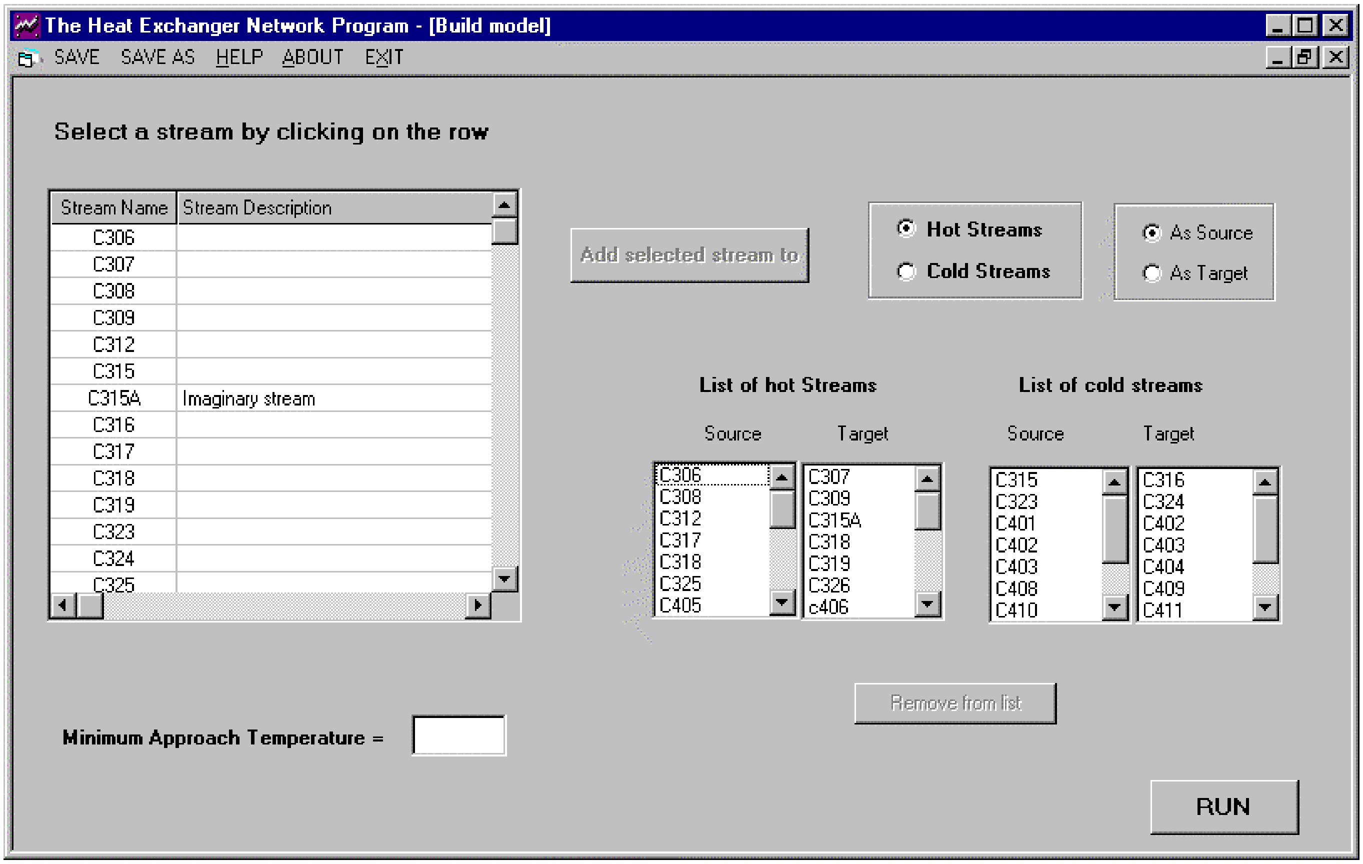


Figure 69. The Build Model Window with all the Hot and Cold Streams

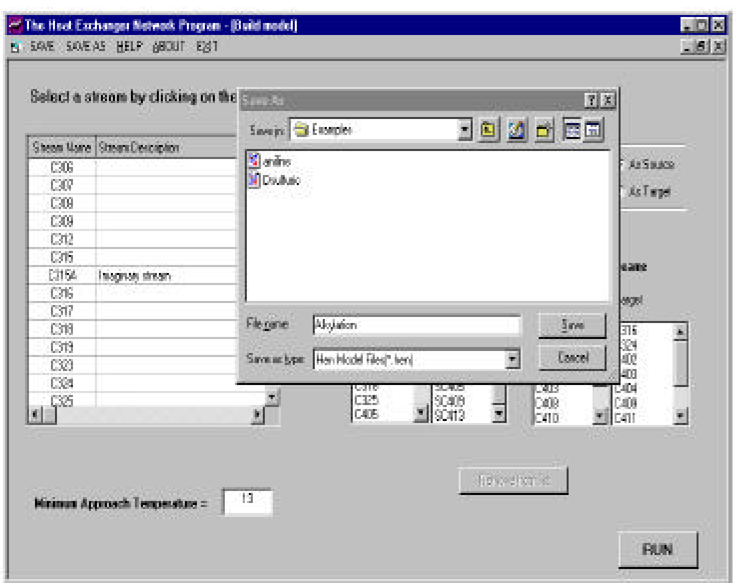


Figure 70.The Save As Window

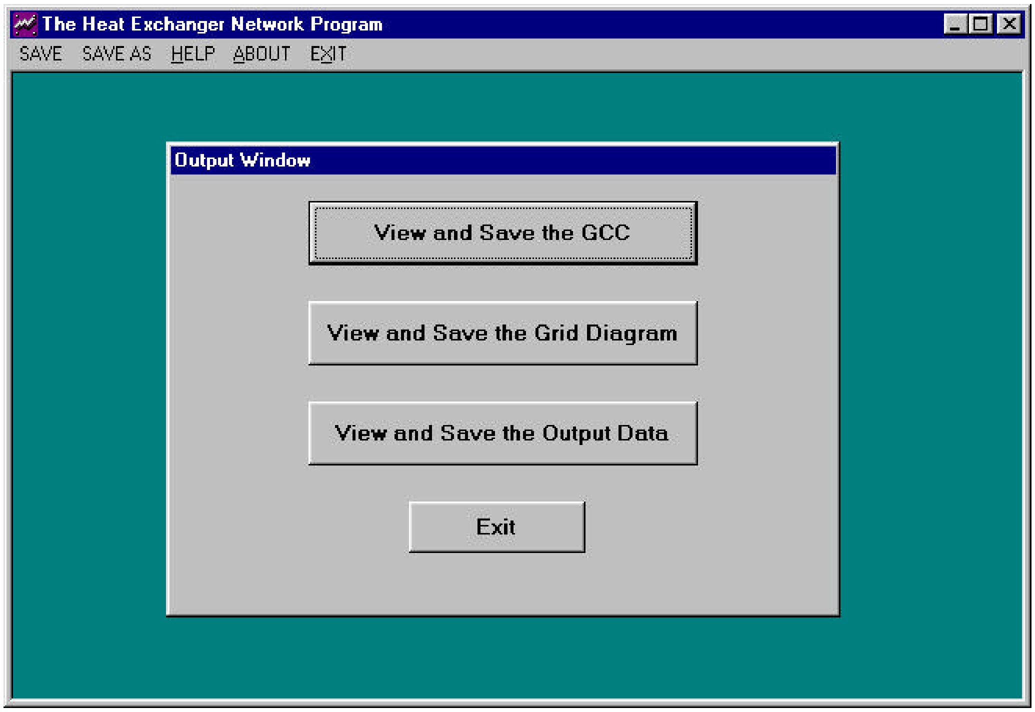


Figure 71. The Output Window

Clicking the first button ‘View and save the GCC’ on the 'Output Window' displays the 'Grand Composite Curve' on the screen. This is shown in Figure 72. It is a plot of enthalpy flows in the system versus temperature. The units for temperature and enthalpy are the same as for the input data entered. The temperatures are in Kelvin and enthalpies are in KJ/s. As seen in Figure 72, the curve touches the temperature-axis at 343.113 K. The amount of cold utility is the enthalpy coordinate of the lowest point of the curve. This is about 4000 MJ/min as seen in the diagram. The amount of hot utility is the enthalpy coordinate of the highest point of the curve. This is about 1700 MJ/min as seen in the diagram. The exact amounts of the hot and cold utilities can be seen in the output file, which is explained later.

The menu bar at the top of the diagram provides options for viewing and printing the diagram. Clicking the 'View' button displays the commands to turn off the grid and show the data points. The 'Print Options' button can be used to set the number of copies and change the printer orientation. Clicking the 'Print' button will print the diagram to the default system printer. Click the 'Save' button to save the diagram in 'Windows Metafile’ format. The 'Help' button will display a brief description about the Grand Composite Curve. Closing the window brings the user back to the 'Output Window'.

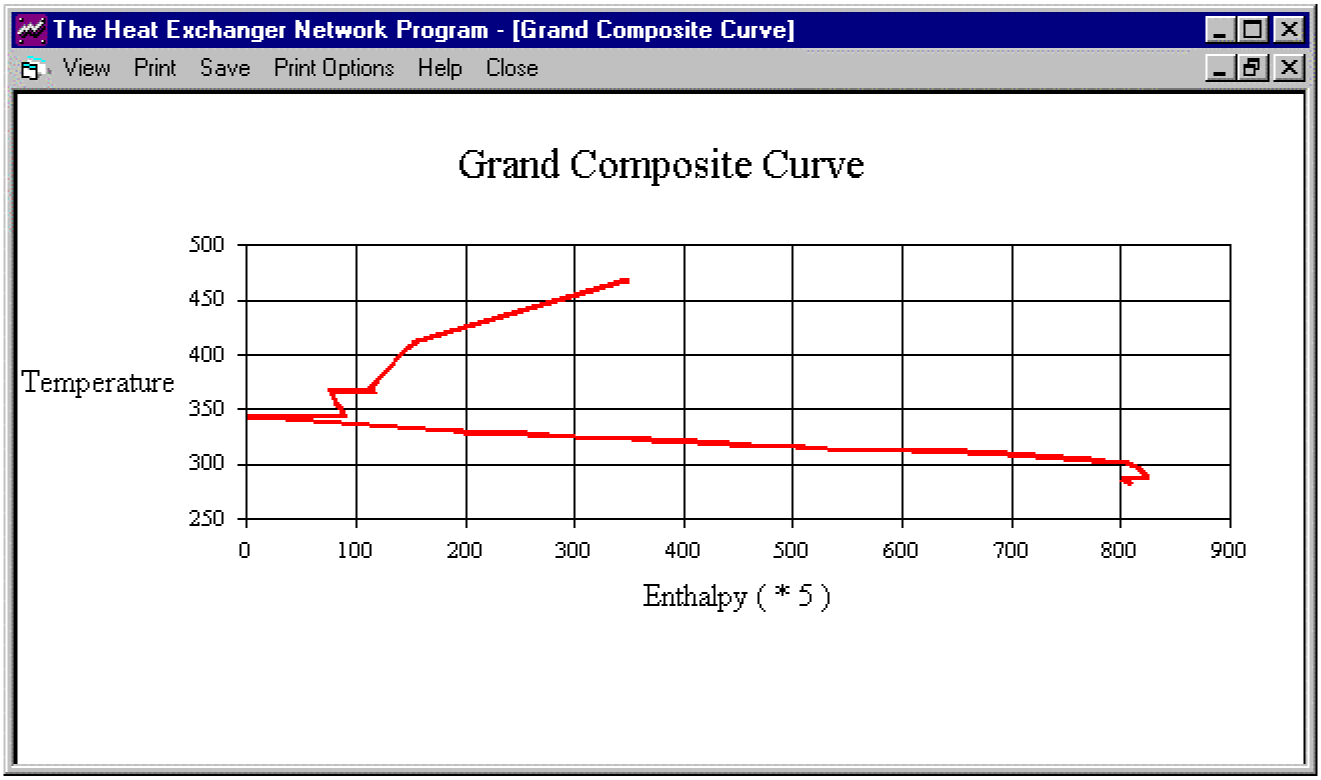


Figure 72. The Grand Composite Curve

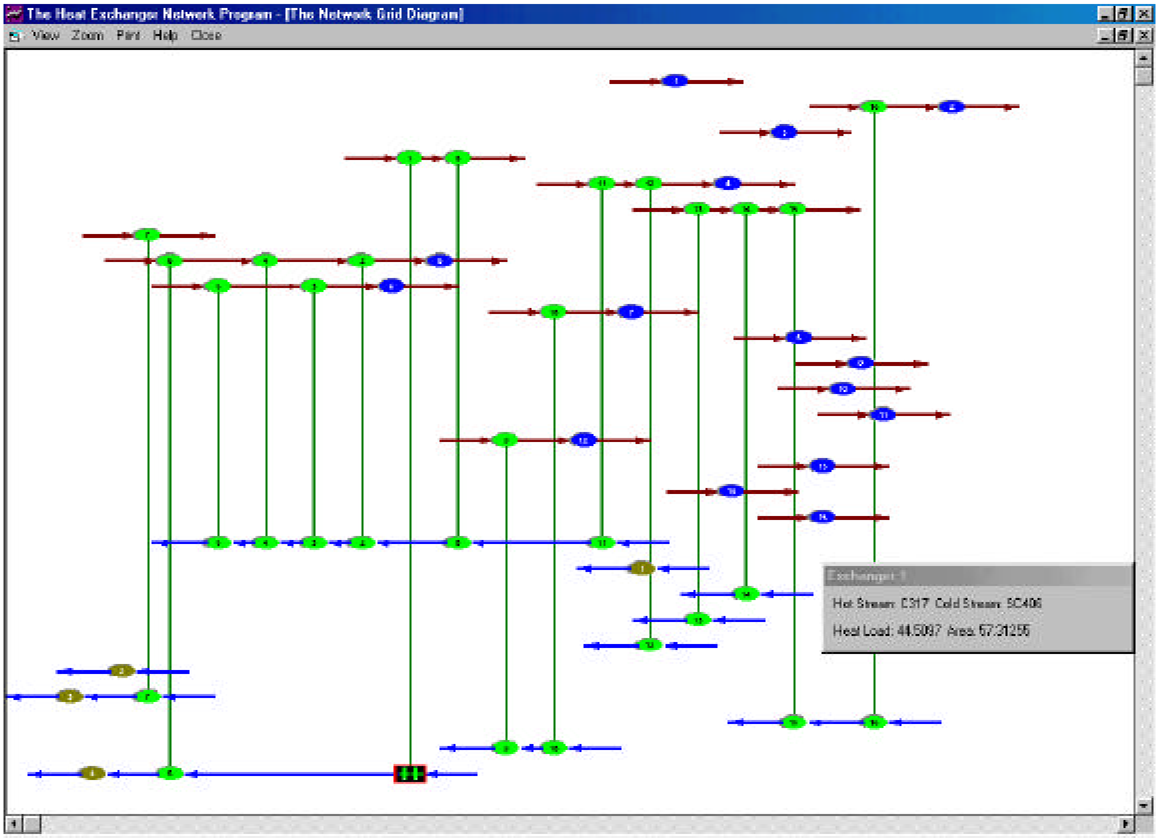


Figure 73. The Network Grid Diagram

The second button 'View and save the Grid Diagram' on the 'Output Window' displays the 'Network Grid Diagram'. This is shown in Figure 73. It is a graphical representation of the network solution designed by the program. It shows the arrangement of heat exchangers, heaters and coolers in the system. Red lines going from left to right represent hot streams and blue lines going from right to left represent cold streams. A red circle on a blue line means a heater and a blue circle on a red line is a cooler. Green circles joined by a vertical green line represent a heat exchanger between the streams on which the two circles lie

The network grid diagram offers a very convenient way of understanding the solution network. Clicking on a unit in the diagram displays a small box, which shows all the necessary information for that unit. For example, clicking on a green circle will display the relevant information for the heat exchanger that it represents. This information includes the names of the hot and cold streams flowing through it, the heat exchange load of the exchanger and its area. Clicking on a heater or a cooler will show the name of the stream flowing through it and its heat load. Similarly, clicking on a horizontal line will display the temperature, mass flowrate and average heat capacity of that stream. In Figure 73, the heat exchanger with index 1 has been selected by clicking, and the box at the bottom right side is showing the information for that heat exchanger.

Information about the grid diagram can be obtained as online help by clicking the 'Help' button in the menu bar at the top of the diagram. Other buttons in the menu bar are to set the view and print options. The 'Zoom' button allows the user to change the zoom of the diagram. The 'View' button can be used to display the printer lines. The 'Print' button will open the printer dialog box and print the diagram to the selected printer. Closing the window will take the user back to the 'Output Window'.

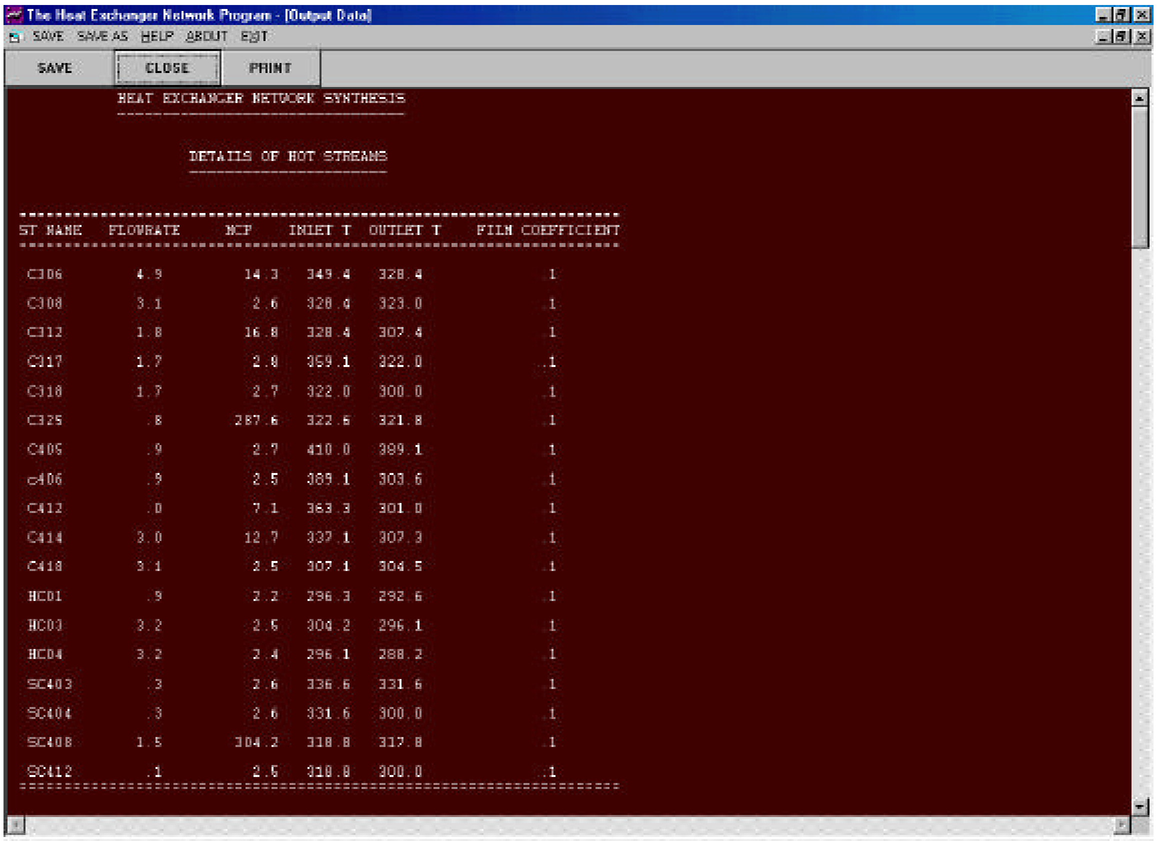


Figure 74. The Ouput Data Window

The third button in the output window, the ‘View and save the Output Data’ button shows the output text file in a window as shown in Figure 74. Using horizontal and vertical scroll bars, the user can see the entire output text. The 'Print' button at the top of the window prints output file to the default printer. On clicking the ‘Save’ button, the program opens the 'Save as' window and requests the user to specify the filename. Let us save the output as file 'out.dat' in the Examples subdirectory of the program folder. Click the 'Close' button to go back to the Output Menu window.

The execution of the THEN program is complete. The results have been displayed in the form grand composite curve, network grid diagram and the output data file. Let us look at the results more closely and interpret the solution generated by THEN.

Using the Results from THEN

The Grand Composite Curve (GCC): The GCC for the Alkylation process is shown in Figure 72. It is a plot of temperature on Y-axis versus the enthalpy flow on X-axis. If the curve touches the temperature-axis except at its endpoints, it is a pinched process, and the temperature corresponding to that point is the pinch temperature. If the curve touches the X-axis at its uppermost point, the process is 'below the pinch'. If it touches at the lowermost point, it is an 'above the pinch' process. In Figure 72, the GCC meets the temperature axis at 343.113 K. Hence it is a pinched process.

Also, the GCC can be used to determine the minimum amount of hot and cold utilities needed by the process. To find the amount of hot utility required, locate the topmost point of the curve and read its X coordinate which is equal to the amount of hot utility. Similarly, to get the amount of cold utility required, locate the bottommost point of the curve and read its X coordinate. For the Alkylation process, from Figure 72, it can be seen that the amount of hot utility is 1800 MJ/min and the amount of cold utility is about 4000 MJ/min.

The Network Grid Diagram:

The network grid diagram for the Alkylation process is shown in Figure 73. Let us examine this diagram to understand the new heat exchanger network structure for this process. The 18 horizontal red lines at the top running from left to right represent the hot streams C306, C308, C312, C317, C318, C325, C405, C406, C412, C414, C418, HC01, HC03, HC04, SC403, SC404, SC408 and SC412. The 10 horizontal blue lines at the bottom running from right to the left represent the cold streams C315, C323, C401, C402, C403, C408, C410, HC29, SC401 and SC406. The blue circles (numbered 1-15) on streams indicate that these streams require coolers. The red circles (numbered 1-4) in the diagram indicate the presence of heaters. There are 16 pairs of green circles (numbered 1-16) joined by vertical green lines. These represent the 16 heat exchangers in the process. Each exchanger exchanges heat between the two streams on which the two circles lie. For example, heat exchanger 1 (the pair of green circles with number 1) is exchanging heat between the hot stream C317 and cold stream SC406. Thus, it can been seen from the grid diagram that the Alkylation process needs 16 heat exchangers, 4 heaters and 15 coolers in the new network solution.

The Output Data File:

Now, let us examine the output data generated by THEN. The complete output file for the above problem is given in Table VII.1. In Table VII.1, the first two sections 'Details of hot stream' and 'Details of cold stream' list a summary of the input information entered by the user. This consists of the data for hot and cold streams followed by the specified minimum approach temperature for the matches. The input summary is followed by the results for the simple process.

This is followed by a matrix of values which is the solution array generated by THEN for the problem above the pinch. These values can help in understanding the matches made by the program to arrive at the solution. However, the most important part of the output is the Heat Exchangers, Heaters and Coolers summary tables, which follow.

The heat exchanger summary above the pinch shows that there should be 7 heat exchangers, each between streams SC406-C317, C315-C406, C315-C412, C315-C406, C315-C412, SC406-C406, C410-C405. For exchanger 1 between SC406 and C317, the heat transfer rate will be 44.5 MJ/min. Also, it gives the inlet and outlet temperatures for both the streams. Note that the area of the heat exchanger (57.313 m^2) has been calculated using the film heat transfer coefficient supplied in the data.

Table VII.1. THEN Solution for the Alkylation Process - Output Data File

HEAT EXCHANGER NETWORK SYNTHESIS

DETAILS OF HOT STREAMS

ST NAME	FLOWRATE	MCP	INLET T	OUTLET T	FILM COEFFICIENT
C306	4.9	14.3	349.4	328.4	.1
C308	3.1	2.6	328.4	323.0	.1
C312	1.8	16.8	328.4	307.4	.1
C317	1.7	2.8	359.1	322.0	.1
C318	1.7	2.7	322.0	300.0	.1
C325	.8	287.6	322.6	321.8	.1
C405	.9	2.7	410.0	389.1	.1
c406	.9	2.5	389.1	303.6	.1
C412	.0	7.1	363.3	301.0	.1
C414	3.0	12.7	337.1	307.3	.1
C418	3.1	2.5	307.1	304.5	.1
HC01	.9	2.2	296.3	292.6	.1
HC03	3.2	2.5	304.2	296.1	.1
HC04	3.2	2.4	296.1	288.2	.1
SC403	.3	2.6	336.6	331.6	.1
SC404	.3	2.6	331.6	300.0	.1
SC408	1.5	304.2	318.8	317.8	.1
SC412	.1	2.5	318.8	300.0	.1

DETAILS OF COLD STREAMS

ST NAME	FLOWRATE	MCP	INLET T	OUTLET T	FILM COEFFICIENT
C315	1.8	2.7	307.4	345.2	.1
C323	.8	237.6	359.1	360.1	.1
C401	2.4	2.3	282.6	283.9	.1
C402	2.4	2.3	283.9	295.8	.1
C403	2.4	2.3	295.8	305.2	.1
C408	3.2	5.4	405.0	461.0	.1
C410	.9	8.2	363.3	403.8	.1
HC29	1.2	111.1	280.0	281.0	.1
SC401	.5	2.6	319.6	323.2	.1
SC406	1.5	306.9	336.6	337.6	.1

MINIMUM DELTA T FOR THE MATCHES IS 13.00 DEG

PINCH LOCATED
PINCH TEMPERATURE = 343.112700

ALL STRMS EXHAUSTED

.0	.0	.0	.0	10.0	1.0	1.0	2.0	6.0	7.0
.0	.0	.0	.0	451.3	2.4	2.3	190.4	17.3	7.0
.0	.0	.0	.0	343.3	358.4	344.9	365.6	411.5	377.3
.0	.0	.0	.0	349.6	.0	.0	190.4	969.8	232.3
4.0	4.7	352.6	.0	44.5	.0	.0	.0	.0	.0
8.0	2.4	382.6	.0	57.2	33.7	.0	.0	.0	.0
9.0	.3	356.8	.0	.0	.0	.0	.0	.0	.0
7.0	2.5	403.5	.0	.0	.0	.0	.0	.0	52.4

HEAT EXCHANGER SUMMARY ABOVE THE PINCH

HEX	CS	HS	HEAT	THIN	THOUT	TCIN	TCOUT	CPH	CPC	AREA
1.	SC406	C317	.445E+02	359.07	349.61	336.61	336.71	.47E+01	.45E+03	57.313
2.	C315	c406	.236E+01	350.61	349.61	336.61	337.61	.24E+01	.24E+01	4.040
3.	C315	C412	.230E+01	357.31	349.61	336.61	337.61	.30E+00	.23E+01	3.176
4.	C315	c406	.337E+02	364.88	350.61	337.61	351.88	.24E+01	.24E+01	57.652
5.	C315	C412	.180E+01	363.33	357.31	337.61	338.39	.30E+00	.23E+01	1.800
6.	SC406	c406	.572E+02	389.08	364.88	336.71	336.84	.24E+01	.45E+03	32.604
7.	C410	C405	.524E+02	410.00	389.08	363.33	370.77	.25E+01	.70E+01	45.467

HEATER SUMMARY ABOVE THE PINCH

HEATER	CNO	HEAT	TCIN	TCOUT	CPC
1.0	2.0	190.4	359.1	360.1	190.4
2.0	6.0	969.8	405.0	461.0	17.3
3.0	7.0	232.3	370.8	403.8	7.0
4.0	10.0	349.6	336.8	337.6	451.3

ALL STRMS EXHAUSTED

.0	.0	.0	.0	1.0	3.0	4.0	5.0	8.0	9.0
.0	.0	.0	.0	4.7	5.4	5.4	5.5	136.7	1.2
.0	.0	.0	.0	313.9	289.1	290.4	302.3	286.5	326.1
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4.0	4.7	315.5	.0	130.2	.0	.0	.0	.0	.0
8.0	2.4	343.1	108.8	.0	.0	.0	.0	.0	.0
9.0	.3	343.1	14.5	.0	.0	.0	.0	.0	.0
1.0	69.8	342.9	1468.5	.0	.0	.0	.0	.0	.0
2.0	8.1	319.4	23.9	.0	.0	.0	.0	20.1	.0
3.0	29.4	321.9	619.3	.0	.0	.0	.0	.0	.0
5.0	4.5	302.5	40.6	6.3	.0	.0	52.1	.0	.0
6.0	235.3	315.3	.0	.0	7.1	64.5	.0	116.6	.0
10.0	38.0	330.5	1130.5	.0	.0	.0	.0	.0	3.0
11.0	7.8	300.6	20.6	.0	.0	.0	.0	.0	.0
12.0	1.9	289.8	7.1	.0	.0	.0	.0	.0	.0
13.0	8.0	297.7	64.9	.0	.0	.0	.0	.0	.0
14.0	7.9	289.6	62.0	.0	.0	.0	.0	.0	.0
15.0	.8	328.7	3.0	.0	.0	.0	.0	.0	.0
16.0	.8	325.1	25.4	.0	.0	.0	.0	.0	.0
17.0	447.3	312.3	447.3	.0	.0	.0	.0	.0	.0
18.0	.4	312.3	6.8	.0	.0	.0	.0	.0	.0

HEAT EXCHANGER SUMMARY BELOW PINCH

HEX	CS	HS	HEAT	THIN	THOUT	TCIN	TCOUT	CPH	CPC	AREA
8.	C315	C317	.130E+03	349.61	321.95	308.72	336.61	.47E+01	.47E+01	20.532
9.	SC401	SC403	.120E+01	336.61	335.15	322.15	323.17	.82E+00	.12E+01	2.017
10.	SC401	C414	.300E+01	337.09	337.01	319.60	322.15	.38E+02	.12E+01	4.133
11.	C315	C318	.633E+01	321.95	320.55	307.36	308.72	.45E+01	.47E+01	10.639
12.	C403	C318	.521E+02	320.55	309.00	295.81	305.25	.45E+01	.55E+01	81.476
13.	C402	C325	.645E+02	322.60	322.33	283.92	295.81	.24E+03	.54E+01	44.466
14.	C401	C325	.713E+01	322.33	322.30	282.60	283.92	.24E+03	.54E+01	4.056
15.	HC29	C325	.117E+03	322.30	321.80	280.15	281.00	.24E+03	.14E+03	62.499
16.	HC29	C308	.201E+02	328.40	325.93	280.00	280.15	.81E+01	.14E+03	9.486

COOLER SUMMARY BELOW THE PINCH

COOLER	CNO	HEAT	THIN	THOUT	CPH
1.0	1.0	1468.5	349.4	328.4	69.8
2.0	2.0	23.9	325.9	323.0	8.1
3.0	3.0	619.3	328.4	307.4	29.4
4.0	5.0	40.6	309.0	300.0	4.5
5.0	8.0	108.8	349.6	303.6	2.4
6.0	9.0	14.5	349.6	301.0	.3
7.0	10.0	1130.5	337.0	307.3	38.0
8.0	11.0	20.6	307.1	304.5	7.8
9.0	12.0	7.1	296.3	292.6	1.9
10.0	13.0	64.9	304.2	296.1	8.0
11.0	14.0	62.0	296.1	288.2	7.9
12.0	15.0	3.0	335.2	331.6	.8
13.0	16.0	25.4	331.6	300.0	.8
14.0	17.0	447.3	318.8	317.8	447.3
15.0	18.0	6.8	318.8	300.0	.4

```
=======================================================
LOOP#           HEAT EXCHANGERS INVOLVED
=======================================================
 1            5  3
 2            4  1  6  8
 5            2  1  6  8
=======================================================

THE MINIMUM HOT UTILITY REQUIREMENT IS:    1742.152000

THE MINIMUM COLD UTILITY REQUIREMENT IS:    4043.175000
```

Next comes the heater summary above the pinch. It shows that we need 4 heaters in the system, for streams C323, C408, C410 and SC406. The heat load for the heater on the stream C323 is 190.4 MJ/min. Stream C323 enters the heater at 359 K and leaves at 360 K and as vapor. Similarly, the other heaters have heat loads of 969.8, 232.3 and 349.6 MJ/min respectively.

The heat exchanger summary below the pinch shows that there should be 9 heat exchangers (numbered 8-16). The cooler summary below the pinch describes the 15 coolers required for the heat integration of the Alkylation Process.

Next comes the information about the loops identified in the network. A loop is any path in the heat exchanger network that starts at some point and returns to the same point. For the Alkylation process, there are three loops in the network.

Finally, the last two lines of output give the minimum hot and cold utilities needed for this process. Thus, for the Alkylation process, 4043.175 MJ/min of heat needs to be removed by use of external cold utilities. The hot utility requirement for the process is 1742.152 MJ/min.

Note that just above the printout of the solution array is a message which says if all the streams were exhausted or not. If the message is ‘all streams exhausted’, THEN has successfully generated the heat exchanger network. If the message is ‘Error- not all streams exhausted’, THEN has failed to solve the problem. In this case, the order of the streams in the input data should be changed. For example, the data for stream C408 should be entered before stream C306. The program uses a solution method that is sensitive to the order in which the stream data is entered.

To summarize, the Alkylation process is a “pinched” process, and it needs 16 heat exchangers, 4 heaters and 15 coolers for maximum energy utilization. The minimum amount of cold utility is 4043.175 MJ/min and the minimum amount of hot utility is 1742.15 MJ/min.

This concludes the implementation of the Heat Exchanger Network program in the Advanced Process Analysis System. The next step of the Advanced Process Analysis System is calculation of pollution indices. Click on the ‘Pollution Index’ button in the Advanced Process Analysis Desk to call the pollution index program.

VIII. USING THE POLLUTION ASSESSMENT PROGRAM

Upon clicking the 'Pollution Assessment' button in the Advanced Process Analysis Desk, the first window presented to the user is the 'Process' window shown in Figure 75.

The table 'Stream List' shows the list of all input and output streams in the process. This list is automatically retrieved based on the flowsheet diagram drawn by the user. The total molar flowrates of the streams are also retrieved and are shown in the second column of the table. The third column gives the type of the stream. As discussed in Section I, the streams important for pollution Assessment calculations are the input and output streams, and the output streams are further divided into product and non-product streams. In the table shown in Figure 75, the classification of streams into input and output is automatically done. The further classification of output streams into product and non-product needs to be done by the user. By default, all output streams are assumed to be products.

Calculation of pollution indices requires the composition of the process streams. The composition can be specified either in terms of molar flowrates or mole fractions. These values can be conveniently retrieved from the results of on-line optimization. Let us retrieve the values for the first stream in the list, C320. Click on the stream, C320 in the table 'Stream List' in Figure 75. Choose the radio button with the option 'Flowrates of components' to specify the composition. Now, let us retrieve the flowrates of the individual components in stream C320 as described below.

In Figure 75, the table 'Variables' on the right-hand side at the top shows the names and descriptions of all the measured and unmeasured variables in the Alkylation process model. Select the radio button for the option 'data only for the current stream'. When this option is selected, the table 'Variables' only shows the variables that are associated with that stream. The screen view now is shown In Figure 76 The variables associated with stream C320 can be seen in the table 'Variables' in Figure 76. Stream C320 is the depropanizer bottoms, and it contains components 1 (propane and lower hydrocarbons), 3 (isobutane), 4 (n-butane), 5 (i-pentane), 7 (i-hexane). In the 'Variables' table, x1C320, x3C320, x4C320, x5C320 and x7C320 are the mass fractions of these 5 components. Let us enter these values in the 'Components Data' table as described below.

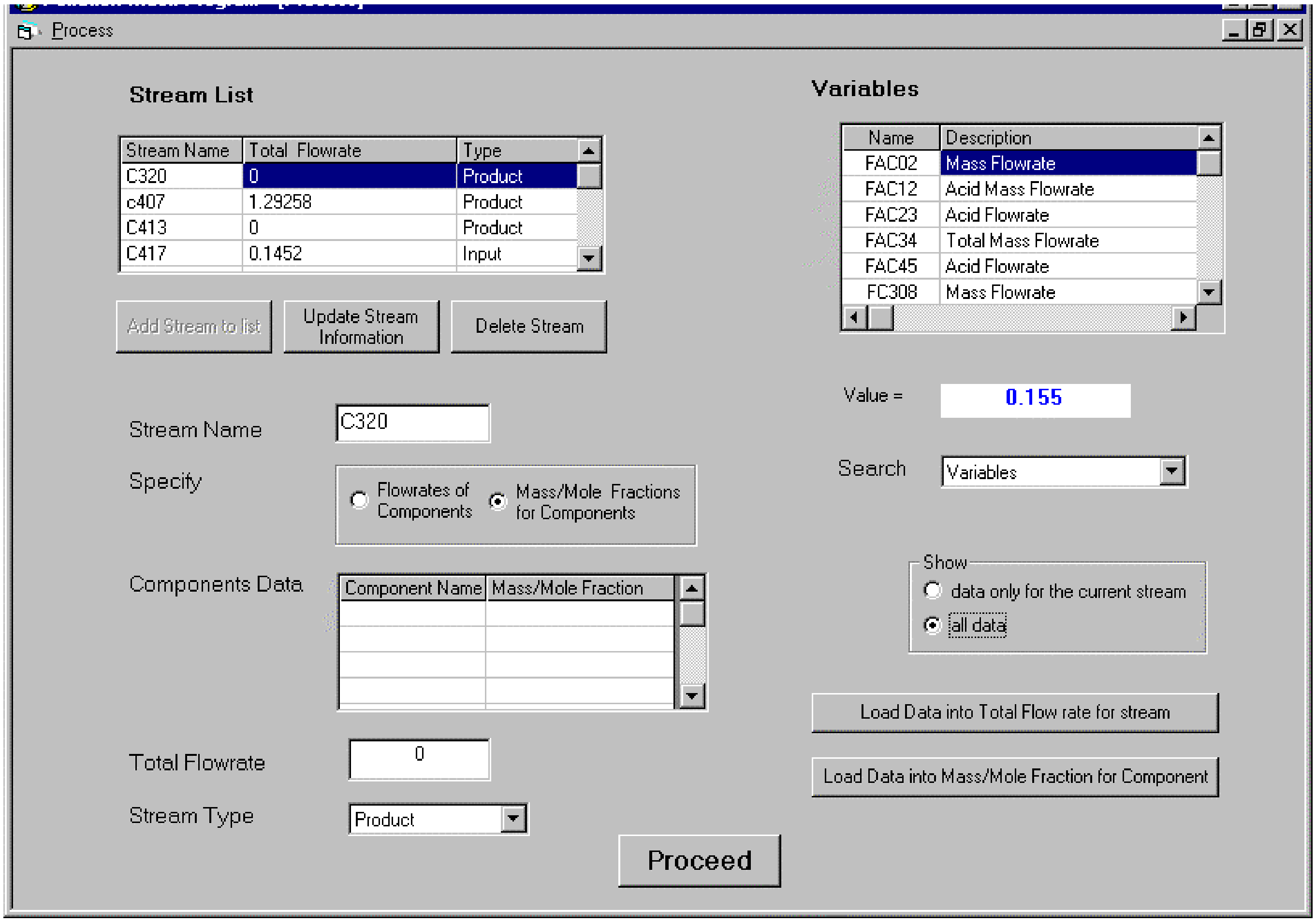


Figure 75. The Process Window of the Pollution Assessment Program

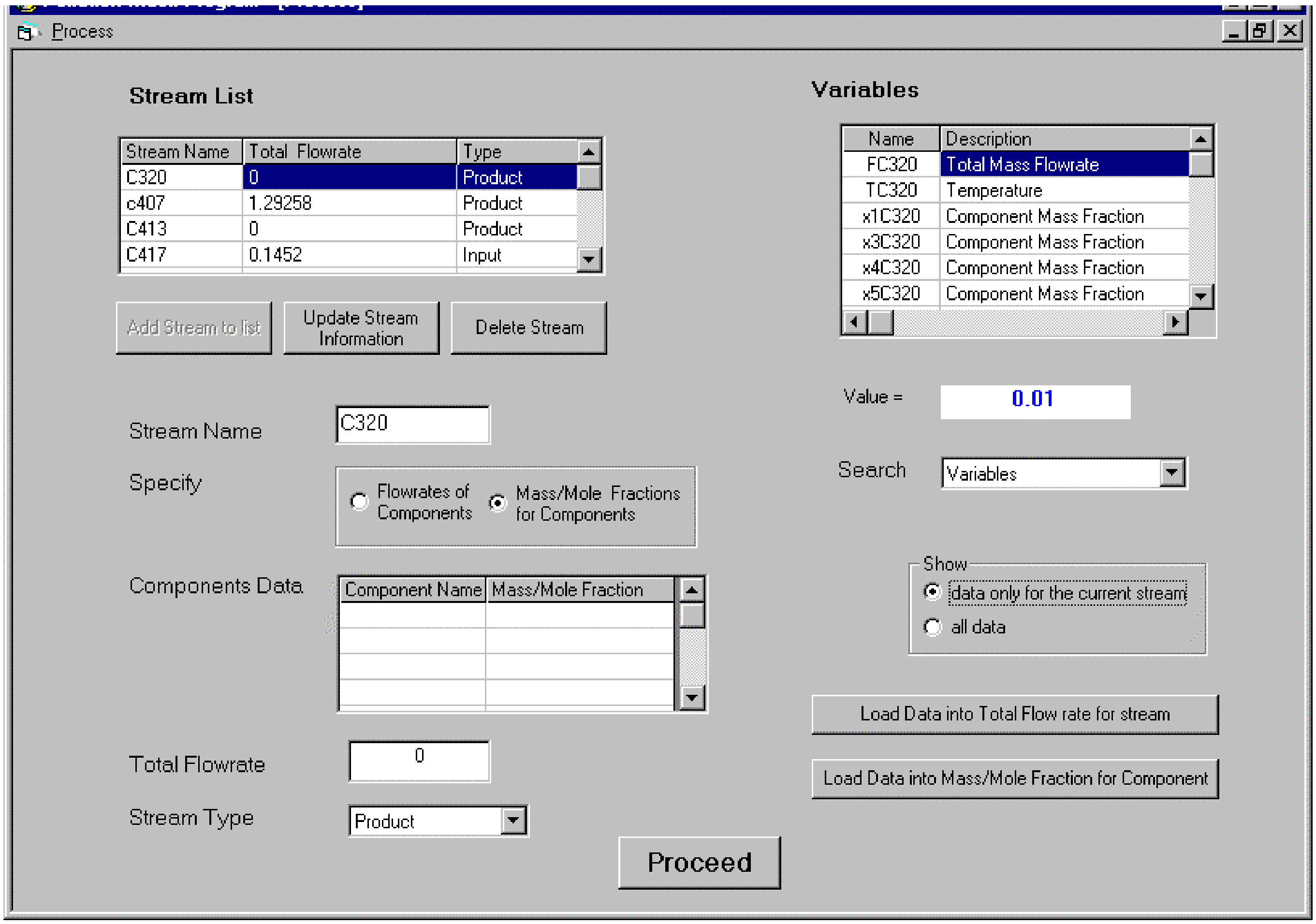


Figure 76. The Process Screen with Stream C320

In the 'Component Data' table, enter 1 in the first row of the component name column. Now click on the variable x1C320 in the 'Variables' table. The value field below the 'Variables' table now shows the value of x1C320 obtained as a result of economic optimization. To take this value as the mass fraction of component 1, click the button 'Load Data into Mass/Mole Fraction for Component'. The next component in stream C320 is component 3. Enter '3' in the second row of the 'Components Data' table. Click on the variable 'x3C320' in the 'Variables' table and then click the button 'Load Data into Mass/Mole Fraction for Component'. For components 4, 5 and 7 of the stream C320 repeat the same procedure and the composition of stream C320 is now completely specified. The stream type of stream C320 is 'product' as correctly determined by the program. The screen view now is shown in Figure 77 The above changes made to the composition data for stream C320 need to be updated. Click on the 'Update Stream Information' button to save the changes.

Repeat the same procedure for all the other streams in the table 'Stream List'. Click on each stream in the table. Enter the component names and retrieve their flowrates from the 'Variables' table. If you do not see the required variable in the table, choose the 'all data' option. For the output streams, change the default type from 'product' to 'non-product' wherever necessary. In the Alkylation process, the stream AC45 is the non-product stream. For each stream, after the changes are done, click the 'Update Stream Information' button.

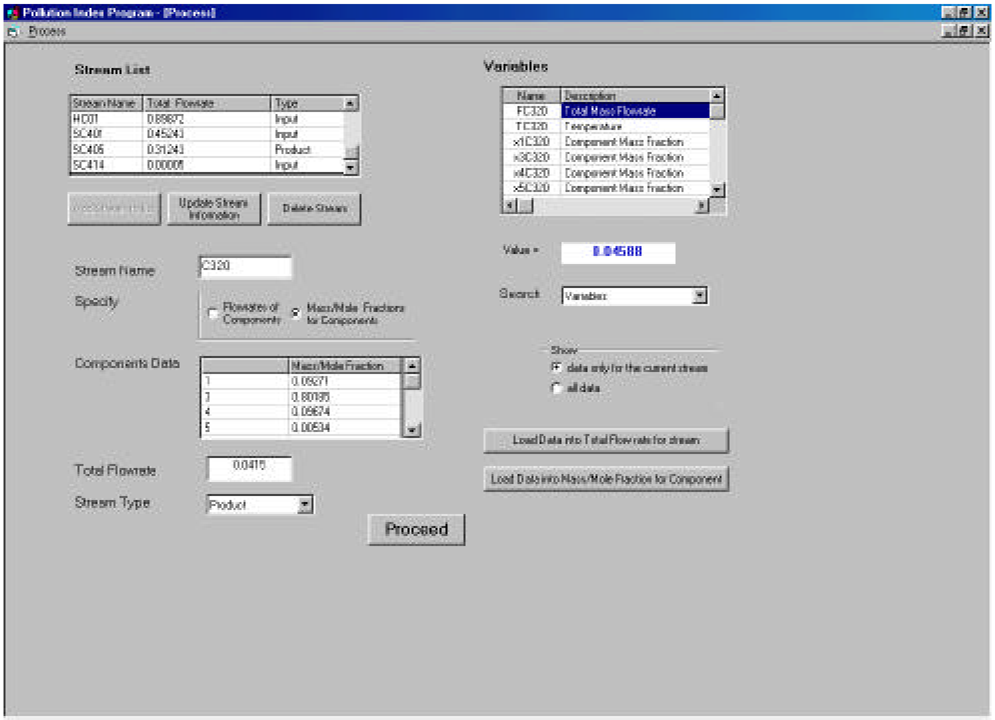


Figure 77. The Composition Data for Stream C320.

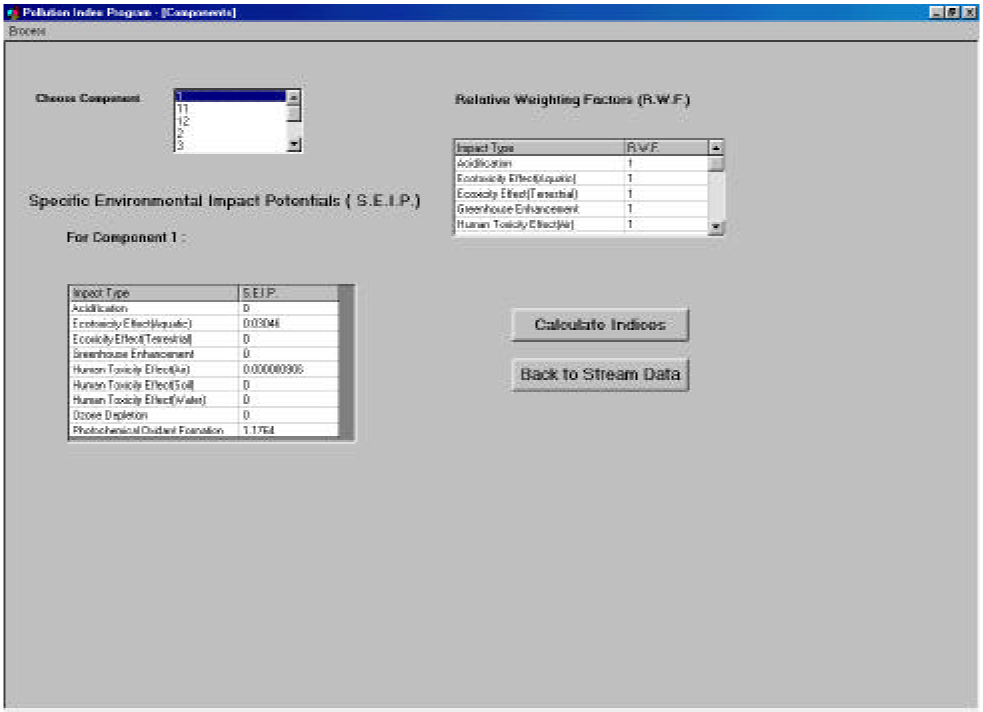


Figure 78. The Components Window

When the composition information for all the streams in table 'Stream List' has been entered, click the 'Proceed' button. The 'Components' window is now displayed on the screen. This is shown in Figure 78 This window is used to enter the specific environmental impact potentials of the various components in the process. As discussed in Section I, there are nine categories of environmental impacts. The specific environmental impact potential values have to be entered for each component for each of the nine types of impact.

The final piece of information needed is the relative weighting factors. For the Alkylation process, let us keep the default values of one for all the weighting factors. All of the information necessary for the calculation of pollution indices has been entered in the program. Now, click on the 'Calculate Indices' button to view the values of the six pollution indices defined earlier in Section I.

The program uses the data entered by the user to evaluate these indices and then displays the 'Index Calculations' window shown in Figure 79. The indices on the left-hand side are the indices based on the generation of potential environmental impacts, and the indices on the right-hand side are the indices based on the emission of impacts. These indices are calculated based on the equations in the page A-1150. Each index is accompanied by a Help button. Clicking on the 'Help' displays more information about that particular index at the bottom of the screen. The program also calculates the pollution index values for each of the individual streams. To see these values, click on the 'Show WAR algorithm' button. The program now displays the 'Waste Reduction Algorithm' window shown in Figure 80.

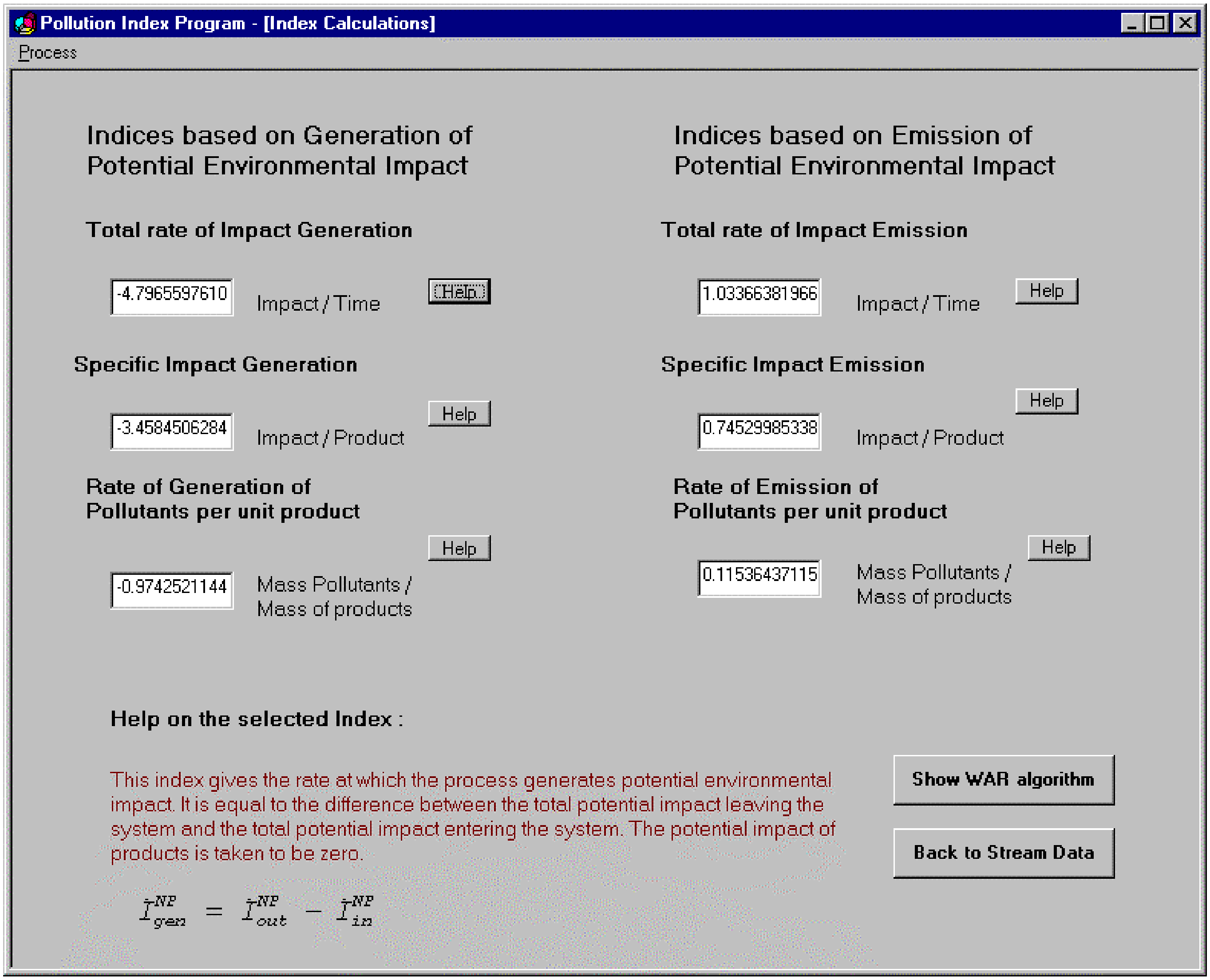


Figure 79. The Index Calculations Window

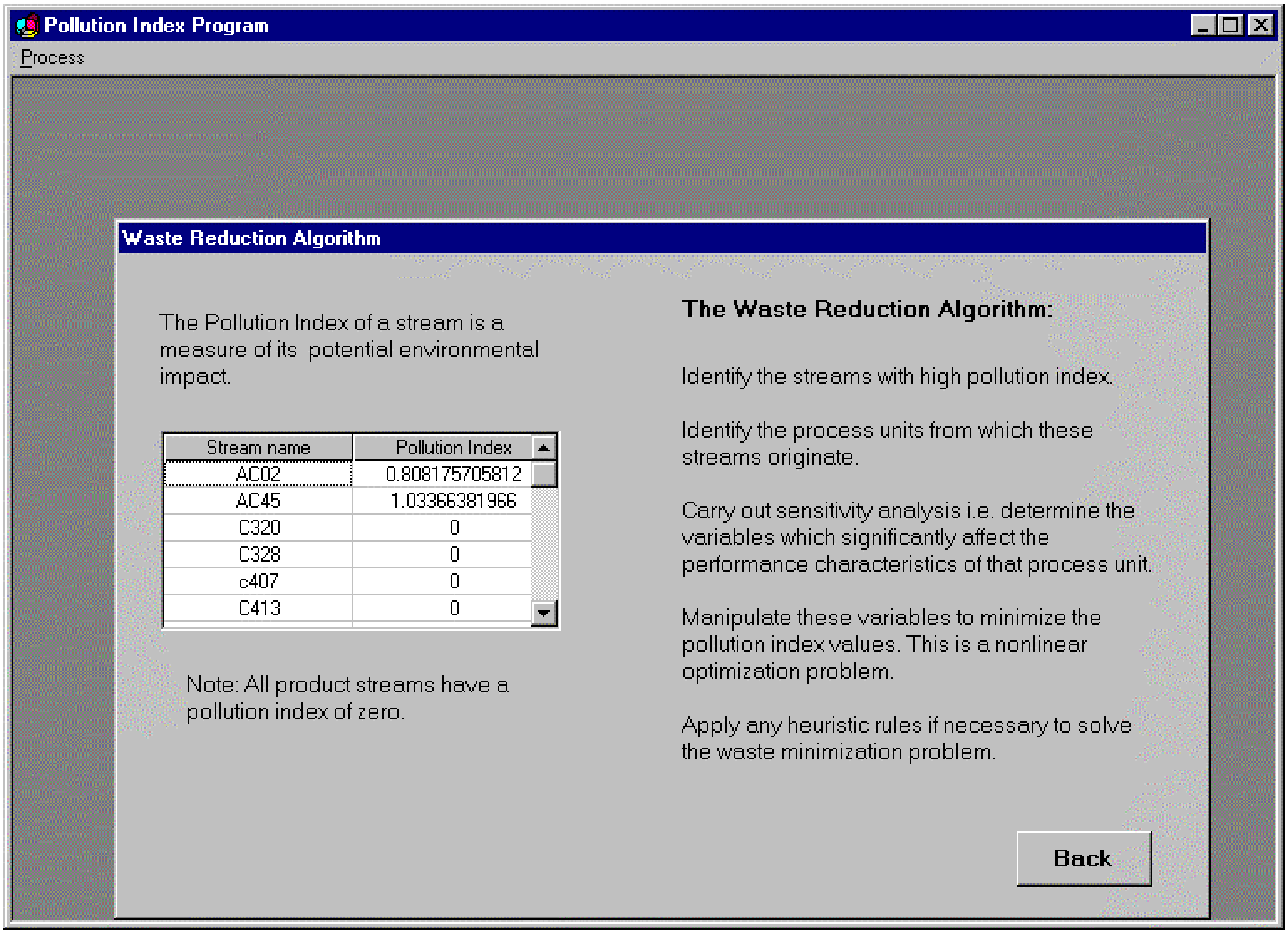


Figure 80. The Waste Reduction Algorithm Window

In Figure 80 the table on the left-hand side shows the pollution index values for all the input and output streams in the contact process. A comparison of these values can help in identifying streams with high pollution content. In Figure 80 it can be seen that the pollution index values are zero for all the streams except streams AC02, AC45, HC01, SC401 and SC414. This shows that these streams are the main source of pollutant emission into the environment and need special attention.

The right side of the 'Waste Reduction Algorithm' window shows the important steps of WAR algorithm, which gives a systematic way of approaching the waste minimization problem. The back button can be used to go back to the previous screens and make changes in the data. Click on the back button till you reach the process screen shown in Figure 75 Let us save the information entered so far by clicking on the 'save' button in the 'process' menu. The program displays the 'Save the model as' dialog box shown in Figure 81. The pollution Assessment program stores the model as a file with '.pnd' extension. Let us save this model as 'Alkylation.pnd' in the Examples subdirectory of the program folder.

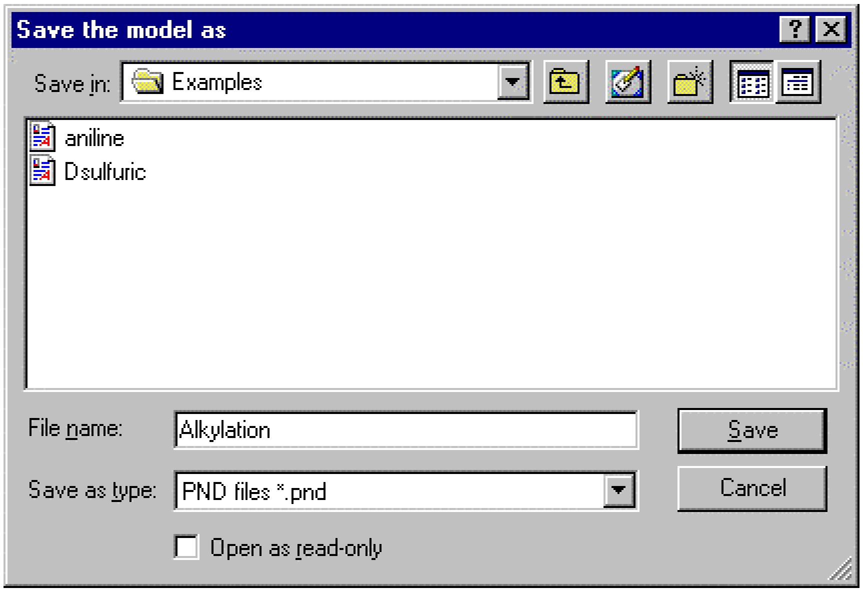


Figure 81.The Save As Window

This concludes the implementation of the Pollution Index program in the Advanced Process Analysis System. Click the 'Exit' button in the process menu to return to the Advanced Process Analysis Desk. The next section explains the use of the Chemical Reactor Analysis program.

IX. USING CHEMICAL REACTOR ANALYSIS PROGRAM

The Reactor Analysis program can be used to predict the performance of reactors in the Alkylation process. The chemical reactor program is an integral part of the Advanced Process Analysis System, and the reactor feed flowrates and compositions are provided to the program from the database. This Chemical Reactor Analysis for Alkylation process is not shown in this manual. This will demonstrate how the reactor analysis program is integrated in the Advanced Process Analysis System.

X. OPTIMIZATION SOLVER-GAMS

A. Compilation Output (Brooke, et al., 1996)

The compilation output is produced during the initial check of the program, and it is often referred to as a compilation. It includes two or three parts: the echo print of the program, an explanation of any errors detected, and the symbol reference maps. The echo print of the program is always the first part of the output file. If errors had been detected, the explanatory messages would be found at the end of the echo print. The echo print of the GAMS program for the economic optimization of the contact process is included in the GAMS output file in Appendix B.

The symbol reference maps follow the echo print, and they include the symbol cross-reference and the symbol-listing map. These are extremely useful if one is looking into a model written by someone else, or if one is trying to make some changes in their own model after spending time away from it. The symbol cross reference lists the identifiers (symbols) in the model in alphabetical order, identifies their type, shows the line numbers where the symbols appear, and classifies each appearance. The complete list of data types is given in Table X.1. Next in the listing is a list of references to the symbols, grouped by reference type and identified by the line number in the output file. The actual references can then be found by referring to the echo print of the program, which has line numbers on it. The complete list of reference types is given in Table X.2. The symbol reference maps do not appear in the output files by default. However, it can be included in the output files by changing the default setting in Output File Format Specification window.

Table X.1 A List of Data Types

Entry in symbol reference table	GAMS data type
SET	set
PARAM	parameter
VAR	variable
EQU	equation
MODEL	model

B. Execution Output

The execution output follows the compilation output and is also found in the GAMS output file. If a display statement is present in the GAMS program, then data requested by the display statement is produced in the execution output while GAMS performs data manipulations. Also, if errors are detected because of illegal data operations, a brief message indicating the cause and the line number of the offending statement, will appear in the execution output. The execution output will be shown in the GAMS output file if a display statement is present in the GAMS program (which requests the display of the value of a variable) or if an execution error is encountered.

Table X.2 A List of Reference Types

Reference	Description
DECLARED	This is where the identifier is declared as to type. This must be the first appearance of the identifier.
DEFINED	This is the line number where an initialization (a table or a data list between slashes) or symbol definition (equation) starts for the symbol.
ASSIGNED	This is when values are replaced because the identifier appears on the left of an assignment statement.
IMPL-ASN	This is an "implicit assignment": an equation or variable will be updated as a result of being referred to implicitly in a solve statement.
CONTROL	This refers to the use of a set as the driving index in an assignment, equation, loop or other indexed operation (sum, prod, smin or smax).
REF	This is a reference: the symbol has been referenced on the right of an assignment in a display, in an equation, or in a model or solve statement.

C. Output produced by a Solve Statement (Brooke, et al., 1996)

The output triggered by a solve statement includes the equation listing, the column listing, the model statistics, solver report, the solution listing, report summary, and file summary as shown in the GAMS output file in Section X. All of the output produced as a result of a SOLVE statement is labeled with a subtitle identifying the model, its type, and the line number of the solve statement.

The first list in the output produced by the SOLVE statement is the Equation Listing, which is marked with that subtitle in the output file. The Equation Listing is an extremely useful debugging aid. It shows the variables that appear in each constraint, and what the individual coefficients and right-hand-side value evaluate to after the data manipulations have been made. Normally, the first three equations in every block are listed. Most of the listing is self-explanatory. The name, text, and type of constraints are shown. The four dashes are useful for mechanical searching. All terms that depend on variables are collected on the left, and all the constant terms are combined into one number on the right, with any necessary sign changes made. For example, a equation "x + 5y - 10z +20 =e= 0" is rearranged as: "x + 5y - 10z =e= -20". Four places of decimals are shown if necessary, but trailing zeroes following the decimal point are suppressed. E-format is used to prevent small numbers being displayed as zero. By default, the equation listing will not appear in the output file unless specified by the user in the Output File Format Specification Window.

The general format in the equation listing was described above. However, the nonlinear terms in an equation are treated differently from the linear terms. If the coefficient of a variable in the Equation Listing is enclosed in parentheses, then the variable corresponding to this coefficient is nonlinear in the constraint equation, and the value of the coefficient depends on the activity levels of one or more of the variables. This coefficient is not algebraic, but it is the partial derivative of each variable evaluated at their current level values (initial points).

For an equation: $x + 2y^3 + 10$ =e= 0 with current level values $x = 2$ and $y = 1$, this equation is listed in the equation listing as: x + (6) y =e= -12, where the coefficient of y is the partial derivative of the equation with respect to y evaluated at y=1, i.e., $6y^2 = 6$. The right hand side coefficient, -12, is the sum of constant in the equation, 10, and the constant, 2, from the linearization of the nonlinear term $2y^3$ using Taylor expansion evaluated at y = 1. x in this equation is linear, and its coefficient is shown as 1 without the parentheses.

Next, the column listing gives the individual coefficients sorted by column rather than by row. The default shows the first three entries for each variable, along with their bound and level values. The format for the coefficients is the same as in the equation listing, with the nonlinear ones enclosed in parentheses and the trailing zeroes dropped. The order in which the variables appear is the order in which they were declared.

The final information generated while a model is being prepared for solution is the statistics block to provide details on the size and nonlinearity of the model. The status for the solver (the state of the program) and the model (what the solution looks like) are characterized in solver status and model status. The model status and solver status are listed in Table X.3 and Table X.4, respectively.

The next section is the solver report, which is the solve summary particular to the solver program that has been used. Also, there will be diagnostic messages in plain language if anything unusual was detected, and specific performance details as well. In case of serious trouble, the GAMS listing file will contain additional messages printed by the solver, which may help, identify the cause of the difficulty.

Solution listing is a row-by-row then column-by-column listing of the solutions returned to GAMS by the solver program. Each individual equation and variable is listed with four pieces of information. The four columns associated with each entry are listed in Table X.5. For variables, the values in the LOWER and UPPER columns refer to the lower and upper bounds. For equations, they are obtained from the (constant) right-hand-side value and from the relational type of the equation. EPS means very small or close to zero. It is used with non-basic variables whose marginal values are very close to, or actually, zero, or in nonlinear problems with super-basic variables whose marginal values are zero or very close to it. A superbasic variable is the one between its bounds at the final point but not in the basis.

For models that do not reach an optimal solution, some constraints may be marked with the flags shown in Table X.6. The final part of solution listing is the report summary marked with four asterisks. It shows the count of rows or columns that have been marked INFES, NOPT, UNBND. The sum of infeasibilities will be shown if the reported solution is infeasible. The error count is only shown if the problem is nonlinear. The last piece of the output file is the file summary, which gives the names of the input and output disk files. If work files have been used, they will be named here as well.

D. Error Reporting

The last part in the output file is error reporting. All the comments and descriptions about errors have been collected into this section for easy reference. Errors are grouped into the three phases of GAMS modeling in the on-line optimization system: compilation, execution and model generation (which includes the solution that follows). They will be illustrated in the section, “Error Reporting”.

Table X.3 A List of Model Status in GAMS Output Files

Model status	Meaning
1. Optimal	This means that the solution is optimal. It only applies to linear problems or relaxed mixed integer problems (RMIP).
2. Locally Optimal	This message means that a local optimal for nonlinear problems, since all that can guarantee for general nonlinear problems is a local optimum.
3. Unbounded	That means that the solution is unbounded. It is reliable if the problem is linear, but occasionally it appears for difficult nonlinear problem that lack some strategically paced bounds to limit the variables to sensible values.
4. Infeasible	This means that he linear problem is infeasible.
5. Locally Infeasible	This message means that no feasible point could be found for the nonlinear problem from the given starting point. It does not necessarily mean that no feasible point exists.
6. Intermediate Infeasible	The current solution is not feasible, the solver program stopped, either because of a limit (iteration or resource), or some sort of difficulty.
7. Intermediate Nonoptimal	This is again an incomplete solution, but it appears to be feasible.
8. Integer Solution	An integer solution has been found to a MIP (mixed integer problem).
9. Intermediate Noninteger	This is an incomplete solution to a MIP. An integer solution has not yet been found.
10. Integer	There is no integer solution to a MIP. This message should be reliable.
11.Error Unknown, Error no Solution	There is no solution in either of these cases.

Table X.4 A List of Solver Status in GAMS Output Files

Solver status	Meaning
1. Normal Completion	This means that the solver terminated in a normal way: i.e., it was not interrupted by an iteration or resource limit or by internal difficulties. The model status describes the characteristics of the accompanying solution.
2. Iteration Interrupt	This means that the solver was interrupted because it used too many iterations. Use option iterlim to increase the iteration limit if everything seems normal.
3. Resource Interrupt	This means that the solver was interrupted because it used too much time. Use option reslim to increase the time limit if everything seems normal.
4. Terminated by Solver	This means that the solver encountered difficulty and was unable to continue. More detail will appear following the message.
5. Evaluation Error Limit	Too many evaluations of nonlinear terms at undefined values. You should use bounds to prevent forbidden operations, such as division by zero. The rows in which the errors occur are listed just before the solution.
6. Unknown Error Preprocessor(s) Error Setup Failure Error Solver Failure Error Internal Solver Error Error Post-Processor	All these messages announce some sort of unanticipated failure of GAMS, a solver, or between the two. Check the output thoroughly for hints as to what might have gone wrong.

Table X.5 A List of Solution Listing Types

Heading in listing file	Description
LOWER	Lower Bound (.lo)
LEVEL	Level Value (.l)
UPPER	Upper Bound (.up)
MARGINAL	Marginal (.m)

Table X.6 A List of Constraint Flags

Flag	Description
INFES	The row or column is infeasible. This mark is make for any entry whose LEVEL value is not between the UPPER and LOWER bounds.
NOPT	The row or column is non-optimal. This mark is made for any non-basic entries for which the marginal sign is incorrect, or superbasic ones for which the marginal value is too large.
UNBND	The row or column that appears to cause the problem to be unbounded.

E. GAMS Input Model (Brooke et al., 1996)

The basic components of a GAMS input model include:

- Sets
- Data (Parameters, Tables, Scalar)
- Variables
- Assignment of bounds and/or initial values
- Equations
- Model and Solve statements
- Display/Put statement

The overall content of GAMS output file is:

- Echo Print
- Reference Maps
- Equation Listings
- Status Reports
- Results

E-1. Format for Entering System Information

The GAMS input code generated by the interactive on-line optimization system is based on the information provided by the user. Although the user usually does not need to consider the format of the GAMS program, there are some regulations about the format related to GAMS that must be followed to properly enter information about the plant. The input must be in correct format for an accurate GAMS input file to be generated automatically by the on-line optimization system.

Most of the characters and words are allowable for the input information, however, the letters in the input information are case insensitive. A few characters are not allowed for the input because they are illegal or ambiguous on some machines. Generally, all unprintable and control characters are illegal. Most of the uncommon punctuation characters are not part of the language, but can be used freely. In Table X.7, a full list of legal characters is given.

Besides characters, there are some reserved words and non-alphanumeric symbols with predefined meanings in GAMS, which can not be used, in input information. The reserved words and non-alphanumeric symbols are listed in Table X.8 and Table X.9, respectively.

Table X.7 A List of Full Set of Legal Characters for GAMS

A to Z	alphabet	a to z	alphabet	0 to 9	Numerals
&	ampersand	“ ”	double quote	#	pound sign
*	asterisk	=	equals	?	question mark
@	at	>	greater than	;	semicolon
\	back slash	<	less than	‘	single quote
:	Colon	-	minus	/	slash
,	comma	( )	parenthesis		space
$	Dollar	[ ]	square brackets	_	underscore
.	Dot	{ }	braces	!	exclamation mark
+	Plus	%	percent	^	circumflex

Table X.8 A List of All Reserved Words for GAMS

abort	ge	Not	smin	if
acronym	gt	Option	sos1	then
acronyms	inf	Options	sos2	else
alias	integer	Or	sum	semicont
all	le	Ord	system	semiint
and	loop	Parameter	table	file
assign	lt	Parameters	using	files
binary	maximizing	Positive	variable	putpage
card	minimizing	Prod	variables	puttl
display	model	Scalar	xor	free
eps	models	Scalars	yes	no
eq	na	Set	repeat	solve
equation	ne	Sets	until	for
equations	Negative	Smax	while	

In the on-line optimization system, numeric values are entered in a style similar to that used in other computer languages. Blanks cannot be used in a number because the system treats a blank as a separator. The common distinction between real and integer data types does not exist. If a number is entered without a decimal point, it is still stored as a real number. In addition, the system uses an extended range arithmetic that contains special symbols for infinity (INF), negative infinity (-INF), undefined (UNDF), epsilon (EPS), and not available (NA) as shown in Table X.10. One cannot enter UNDF; it is only produced by an operation that does not have a proper result, such as division by zero. All other special symbols can be entered and used as if they were ordinary numbers.

Table X.9 A List of Non-alphanumeric Symbols for GAMS

=l=	--
=g=	++
=e=	**
=n=	

GAMS uses a small range of numbers to ensure that the system will behave in the same way on a wide variety of machines. A general rule is to avoid using or creating numbers with absolute values greater than 1.0e+20. A number up to 10 significant digits can be entered on all machines, and some machines can even support more than that. However, if a number is too large, it may be treated by the system as undefined (UNDF), and all values derived from it in a model may be unusable. It is recommended to always use INF (or -INF) explicitly for arbitrarily large numbers. When an attempted arithmetic operation is illegal or has undefined results because of the value of arguments (division by zero is the normal example), an error is reported and the result is set to undefined (UNDF). Afterwards, UNDF is treated as a proper data value and does not trigger any additional error messages. Thus, the system will not solve a model if an error has been detected, but it will terminate with an error condition.

The string definition such as the variable's name in the system has to start with a letter followed by more letters or digits. It can only contain alphanumeric characters and up to 10 characters long. The comment to describe the set or element must not exceed 80 characters. Basically, there are five possible types of variables that may be used which are listed in Table X.11.

The type of mathematical programming problem must be known before the problem is solved. The on-line optimization system can only solve linear and nonlinear optimization problems. However, GAMS can solve a large number of optimization problems, which are summarized in Table X.12.

As the interactive on-line optimization system writes all the required GAMS input files for the user, most of the components in the GAMS input model are automatically formulated from the information provided in the input windows. If the user can follow the explicit rules introduced above, the GAMS input file can be generated automatically. After the user enters all the plant information through the input windows, the GAMS source codes will be generated.

Table X.10 A List of Special Symbols for GAMS

Special symbol	Description
INF	Plus infinity. A very large positive number
-INF	Minus infinity. A very large negative number
NA	Not available. Used for missing data. Any operation that uses the value NA will produce the result NA
UNDF	Undefined. The result of an undefined or illegal operation. The user cannot directly set a value to UNDF
EPS	Very close to zero, but different from zero.

Table X.11 A List of Types of Variables for GAMS

Keyword	Default Lower Bound	Default Upper Bound	Description
Free (default)	-inf	+inf	No bounds on variables. Both bounds can be changed from the default values by the user
Positive	0	+inf	No negative values are allowed for variables. The upper bound can be changed from the default value by the user
Negative	-inf	0	No positive values are allowed for variables. The user can change the lower bound from the default value.
Binary	0	1	Discrete variable that can only take values of 0 or 1
Integer	0	100	D Discrete variable that can only take integer values between the bounds. Bounds can be changed from the default value by the user

The on-line optimization system will then forward these source codes to the GAMS software. This initiates the execution of GAMS and also creates output files so the user can view the execution in the output window. The execution and the output has been discussed in the previous sections.

Table X.13 A List of Types of Models for GAMS

Model Type	Description
LP	Linear programming. No nonlinear terms or discrete (binary or integer) variables.
NLP	Nonlinear programming. There are general nonlinear terms involving only "smooth" functions in the model, but no discrete variables.
DNLP	Nonlinear programming with discontinuous derivatives. Same as NLP, but "non-smooth" functions can appear as well. More difficult to solve than NLP. Not recommended to use.
RMIP	Relaxed mixed integer programming. Can contain discrete variables but the integer and binary variables can be any values between their bounds.
MIP	Mixed integer programming. Like RMIP but the discrete requirements are enforced: the discrete variables must assume integer values between their bounds.
RMINLP	Relaxed mixed integer nonlinear programming. Can contain both discrete variables and general nonlinear terms. The discrete requirements are relaxed. Same difficulty as NLP.
MINLP	Mixed integer nonlinear programming. Characteristics are the same as for RMINLP, but the discrete requirements are enforced.
MCP	Mixed Complementarily Problem
CNS	Constrained Nonlinear System

E-2. Equation Formulation

Besides the rules introduced above, the equations as the main part of the input information have their own specific requirements. The mathematical definitions of equations can be written in one or multiple lines. Blanks can be inserted to improve readability, and expressions can be arbitrarily complicated. The standard arithmetic operations for the equations are listed in Table X.14. The arithmetic operations listed in Table X.14 are in order of precedence, which determines the order of evaluation in an equation without parentheses. The relational operators in the equations are:

=L= Less than: left hand side (lhs) must be less than or equal to right hand side (rhs)
=G= Greater than: lhs must be greater than or equal to rhs
=E= Equality: lhs must equal to rhs
=N= No relationships enforced between lhs and rhs. This type is rarely used.

Additionally, GAMS provides the numerical relationships and logical operators used to generate logical conditions for evaluating values of True or False. A result of zero is treated as a logical value of False, while a non-zero result is treated as a logical value of True. A complete numerical relationship operators and logical operators are listed in the Table X.15 and Table X.16, respectively.

Table X.14 A List of Standard Arithmetic Operators

Operator	Description
**	Exponentiation
*, /	Multiplication and division
+, -	Addition and subtraction (unary and binary)

Table X.15 A List of Numerical Relationship Operators

Operator	Description
lt, <	Strictly less than
le, <=	Less than or equal to
eq, =	Equal to
ne, <>	Not equal to
ge, >=	Greater than or equal to
gt, >	Strictly greater than

Table X.17 A List of Logical Operators

Operator	Description
not	Not
And	And
Or	Inclusive or
Xor	Exclusive or

Table X.18 The Truth Table Generated by the Logical Operators

Operands		Results			
A	b	a and b	a or b	a xor b	not a
0	0	0	0	0	1
0	non-zero	0	1	1	1
Non-zero	0	0	1	1	0
Non-zero	non-zero	1	1	0	0

Table X.19 The Operator Precedence Order in case of Mixed Logical Conditions

Operation	Operator
Exponentiation	**
Numerical Operators	
Multiplication, Division	*, /
Unary operators - Plus, Minus	+, -
Binary operators - Addition, Subtraction	+, -
Numerical Relationship Operators	<, <=, =, <>, >=, >
Logical Operators	
Not	not
And	and
Or, xor	or, xor

The functions of the logical operators are expressed in Table X.18. For the mixed logical conditions, the default operator precedence order used by GAMS in the absence of parenthesis is shown in Table X.19 in decreasing order. For the formulation of equations, variables can appear on the left or right-hand side of an equation or on both sides. The system can automatically convert the equation to its standard form (variables on the left, no duplicate appearances) before calling the GAMS solver. For the convenience of input, the system also provides several special notations, such as summation (sum) and product (prod), minimum value (smin), maximum value (smax).

E-3. Functions Predefined in the System

There are two types of functions based on the type of argument: exogenous or endogenous. For exogenous arguments, the arguments are known, and examples are parameters and variable attributes. The expression is evaluated once when the model is set up. All functions except the random distribution functions, uniform and normal, are allowed. With endogenous arguments, the arguments are variables, and are, therefore, unknown. The function will be evaluated many times at intermediate points while the model is being solved. The occurrence of any function with endogenous arguments implies that the model is not linear and the use of the functions of "uniform" and "normal" are forbidden in an equation definition. Some built-in functions are listed in Table X.20.

E-4. Scaling Option for Variables and Equations

To facilitate the translation between a natural model (no scaling) to a well scaled model, GAMS introduces the concept of a scale factor for variables and equations with a scaling option. This feature is incorporated in the interactive on-line optimization system to provide a well-scaled optimization problem for GAMS to solve. To use the scaling option in the interactive on-line optimization, the user must highlight the scaling option in the variable declaration and the equations declaration windows. Then, the user must enter the values of the scale factors for the variables and equations that need to be scaled. The following describes how the scale factor is incorporated in the GAMS program and how to determine the value of a scale factor.

The scale factor on a variable V^s is used to relate the variable as seen by user (in natural model) V^u to the variable as seen by the optimization algorithm (in well scaled model) V^a as follows:

$$V^u = V^a \ V^s$$

This means that the scaled variable V^a will become around 1 if the scale factor V^s is chosen to represent the order of magnitude of the user variable V^u.

If the approximate expected value for a variable in the model is known, then the magnitude of this variable value is used as the scale factor of the variable. The scale factor can be specified by users through the Measured or Unmeasured Variables window. If the approximate expected values for some of the variables in the model are not available, these values can be found in the column list of the corresponding GAMS output file. The scale factor will not change the values of variables in the solution seen by users. GAMS uses the scale factor to scale variables and transfer the model into a well scaled model for optimization algorithm. When the optimal solution is found, GAMS will rescale the variables and transfer them back to user's notation. The effect of scaling can only be viewed in the Column and Equation lists of the GAMS output files.

The scale factor for an equation is dependent on the order of magnitude of the equation coefficients. It is slightly different from the determination of scale factor for a variable that is dependent on the magnitude of the variable. An equation usually contains several terms, and it has several coefficients that may not be in the same order.

If the equation is linear, the coefficients of this equation is known. If the equation is nonlinear, then the equation is linearized first using the initial values. However, the linearized coefficients must be obtained from the equation list. Users can obtain the values of the linearized equation coefficients for nonlinear constraints from the equation list of the corresponding GAMS output file. To appropriately assign the scale factor for an equation, users need to carefully select the value of the scale factor based on the coefficients shown in equation list of the GAMS output file so that all coefficients will be in the range of 0.01 to 100 after scaling.

The column (variables) and equation lists are very important for nonlinear problems when scaling the variables and equations. It provides initial values of all variables and linearized constraint coefficients, which can be used to determine the scale factors for both variables and equations. It is suggested that the user turn off the scaling option for both variables and equations before GAMS is initiated.

Table X.20 A List of Functions Predefined in the On-line Optimization System

Function	Description	Classification	Exogenous Classification	Endogenous model type
Abs	Absolute value	Non-smooth	Legal	DNLP
Arctan	Arctangent	Smooth	Legal	NLP
Ceil	Ceiling	Smooth	Legal	Illegal
Cos	Cosine	Discontinuous	Legal	NLP
Errorf	Error function	Smooth	Legal	NLP
Exp	Exponential	Smooth	Legal	NLP
Floor	Floor	Discontinuous	Legal	Illegal
Log	Natural log	Smooth	Legal	NLP
Log10	Common log	Smooth	Legal	NLP
Mapval	Mapping function	Discontinuous	Legal	Illegal
Max	Largest value	Non-smooth	Legal	DNLP
Min	Smallest value	Non-smooth	Legal	DNLP
Mod	Remainder	Discontinuous	Legal	Illegal
Normal	Normal random	Illegal	Illegal	Illegal
Power	Integer power	Smooth	Legal	NLP
Round	Rounding	Discontinuous	Legal	Illegal
Sign	Sign	Discontinuous	Legal	Illegal
Sin	Sine	Smooth	Legal	NLP
Sqr	Square	Smooth	Legal	NLP
Sqrt	Square root	Smooth	Legal	NLP
Trunc	Truncation	Discontinuous	Legal	Illegal
Uniform	Uniform random	Illegal	Illegal	Illegal

After the program ends, if the solution is correct and there was no difficulty in searching for an optimal solution, then the scaling option is not necessary. If the solution is not correct or some difficulty was encountered while searching for an optimal solution, then the scaling option must be incorporated in the program. In this case, users may instruct the system to include the column and equation lists in the output file. To do this, the user must change the default setting for the output files in window 12, the

Output File Format Specification window. This will run the optimization program without the scaling option. Based on the values of variables in column list without scaling, users can decide the values of scale factors for variables, enter them in the Measured Variables and Unmeasured variables windows, and highlight the icon "Include Scaling Option for variables" to scale the variables first. After the system executes the program, a new equation list, which incorporates the scale information of variables, is generated and can be used for equation scaling. Based on the linearized coefficients in this new equation list, users can determine the scale factors for the equations and enter them in the Equality Constraints and Inequality Constraints windows. Also, users must highlight the icon "Include Scaling Option for Equations" to add the Scaling Option in the programs.

E-5. Error Reporting

During compiling, executing, and solving the optimization problem, GAMS checks the input source code for program syntax, rearranges the information in the source code, and solves the optimization problem. At every step, GAMS records any error encountered and reports it in the GAMS output file. The following describes error reporting during solving the optimization problems.

Compilation Errors

The first type of error is a compilation error. When the GAMS compiler encounters an error in the input file, it inserts a coded error message inside the echo print on the line immediately following the scene of the offense. The message includes a $-symbol and an error number printed below the offending symbol (usually to the right). This error number is printed on a separate line starting with four asterisks (****). If more than one error occurs on a line, the $-signs may be suppressed and the error number is squeezed. GAMS programs are generated by the system, and no serious compilation errors are expected to appear. The most common error will be a spelling error, i.e., the variables defined in the equations may be mistyped and mismatch while declaring the variables. This will result in "variable undefined error". GAMS will not list more than 10 errors on any single line. At the end of the echo print, a list of all error numbers encountered, together with a description of the probable cause of each error, will be printed. The error messages are self-explanatory and will not be listed here. Checking the first error is recommended because it has the highest priority.

Execution Errors

The second type of error is an execution error. Execution errors are usually caused by illegal arithmetic operations such as division by zero or taking the log of a negative number. GAMS prints a message on the output file with the line number of the offending statement and continues execution. A GAMS program should never abort with an unintelligible message from the computer's operating system if an invalid operation is attempted. GAMS has rigorously defined an extended algebra that contains all operations including illegal ones. The model library problem [CRAZY] contains all non-standard operations and should be executed to study its exceptions. GAMS arithmetic is defined over the closed interval [-INF, INF] and contains values EPS (small but not zero), NA (not available), and UNDF (the result of an illegal operation). The results of illegal operations are propagated through the entire system and can be displayed with standard display statements. The model cannot be solved if errors have been detected previously.

Solve Errors

The last type of error is a solve error. The execution of a solve statement can trigger additional errors called MATRIX errors, which report on problems encountered during transformation of the model into a format required by the solver. Problems are most often caused by illegal or inconsistent bounds, or an extended range value being used as a matrix coefficient. Some solve statement require the evaluation of nonlinear functions and the computation of derivatives. Since these calculations are not carried out by the system but by other subsystems not under its direct control, errors associated with these calculations are reported in the solution report.

If the solver returns an intermediate solution because of evaluation errors, then a solution will still be attempted. The only fatal error in the system that can be caused by a solver program is the failure to return any solution at all. If this happens as mentioned above, all possible information is listed on the GAMS output file, but the solution will not be given.

XII. Acknowledgments

We gratefully acknowledge the Gulf Coast Hazardous Substance Research Center and the Environmental Protection Agency for support of this work. Also, the assistance of Ms. Gayathri Srinivasan, Mr. Tai Lee, Mr. Huitao Liu, and Ms. Qing Chen in Visual Basic programming was invaluable in developing the program.

XIII. References

Brooke, A., D. Kendrick, and A. Meeraus, 1996, *GAMS User's Guide*, Release 2.25, GAMS Development Corporation, Washington, D.C.

Cabezas, H., J. C. Bare and S. K. Mallick, 1997, "Pollution Prevention with Chemical Process Simulators: The Generalized Waste Reduction Algorithm," *Computers Chem. Engng.*, Vol. 21, Supp. p. S305-S310.

Chen, X., 1998, *The Optimal Implementation of On-line Optimization for Chemical and Refinery Processes*, Ph. D. Dissertation, Louisiana State University, Baton Rouge, LA.

Darby, M. L., and D. C. White, 1988, "On-Line Optimization of Complex Process Units," Chemical Engineering Progress, Vol. 84, No. 8 p. 51-59.

Felder, R. M. and R. W. Rousseau, 1986, Elementary Principles of Chemical Engineering, Second Ed., John Wiley and Sons, New Year, p. 423.

Harris, J. L. and J. R. Norman, 1972, "Temperature-Dependent Kinetic Equation for Catalytic Oxidation of Sulfur Dioxide," *Ind. Eng. Chem. Process Des. Develop.*, Vol. 11, p. 564.

Heijungs, R. (Final Ed.); Guinee, J. B., Huppes, G., Lankreijer, R. M., Udo de Haes, H. A. and Wegener, S. A., 1992, *Environmental Life Cycle Assessment of Products Guide - October 1992*, Center of Environmental Science, Leiden.

Hertwig, T., 1997, Private Communication.

Hilaly, A. K. and Sikdar, S. K., 1994, "Pollution Balance: A New Methodology for Minimizing Waste Production in Manufacturing Processes," *J. Air and Waste Manage. Assoc.*, Vol. 44, p. 1303-1308.

Kelly, D. N., F. C. Fatora, and S. L. Davenport, 1996, "Implementation of a Closed Loop Real Time Optimization System on a Large Scale Ethylene Plant," Private Communication.

Knopf, F. C., Pethe, Singh, Bhargava and Dhooper, 1989, *THEN User's Manual*.

McBride, B. J., S. Gordon and M. A. Reno, 1993, *Coefficients for Calculating Thermodynamic and Transport Properties of Individual Species*, NASA Technical Memorandum 4513.

Telang, K. S., R. W. Pike, F. C. Knopf, J. R. Hopper, J. Saleh, S. Waghchoure, S. C. Hedge and T. A. Hertwig,, 1999, "An Advanced Process Analysis System for Improving Chemical and Refinery Processes," *Computers and Chemical Engineering*, Vol. 23, p. S727-730

APPENDIX A

CONSTRAINT EQUATIONS FOR SULFURIC ACID PROCESS

In this section, the constraint equations are listed for each of the units in the Motiva Alkylation process shown in Figure 9. The Alkylation Process Model, “Alkyl”, has 1,579 equality constraints and 50 inequality constraints to describe 76 process units and 110 streams. The material and energy balances as well as reaction rate equation for the units in the reactor system are shown in Tables A.1 through A.9.

Table A.1. Constraint equations for **Reactor (5C-623)**

Material Balances	
Overall	$F_{HC07} + F_{HC34} + F_{AC07} - F_{AC09} = 0$ $F_{R2} - F_{R3} = 0$
Species	$F^{i}_{HC07} + F^{i}_{HC34} - F^{i}_{AC09} + r^{i} V^{a}_{5C623} MW^{i} = 0$ $F^{i'}_{AC07} - F^{i'}_{AC09} - R^{a}_{5C623} = 0$ $R^{a}_{5C623} = 0.121 Q^{C4=}_{HC07}$ where, *i*= 1,2,3,4,5,6,7,8,9,10 and *i'*= 11
Energy Balances	
	$h_{HC07} + h_{HC34} + h_{AC07} + h_{R2} + H_{5C623} - h_{AC09} - h_{R3} = 0$ $h_{R2} - h_{R3} - U_{5C623} A_{5C623} \Delta T_{lm} = 0$

Table A.2. Constraint Equations of **acid settler(5C-631)**

Material Balances	
	$F^{i}_{AC09} - F^{i}_{HC27} = 0 \qquad i=1,2,3,4,5,7$
	$F^{11}_{AC09} + F^{12}_{AC09} - F_{AC05} - F_{AC12} = 0$
	$F^{11}_{AC05} - s_{C631} F^{11}_{AC09} = 0$
	$F^{12}_{AC05} - s_{C631} F^{12}_{AC09} = 0$
	$x^{11}_{AC05} - x^{11}_{AC12} = 0$
Energy Balances	
	$T_{AC09} = T_{HC27}$; $T_{AC09} = T_{AC12}$; $T_{AC09} = T_{AC05}$

Table A.3. Constraint equations for **Depropanizer (5C-603)**

Material Balances	
Overall	$F_{C316} + F_{C329} - F_{C317} - F_{C325} = 0$
Species	$F^{i}_{C316} + F^{i}_{C329} - F^{i}_{C317} - F^{i}_{C325} = 0$ where i=1,3,4,5
Smith- Brinkley Method Equations	
	$K_i = f(P_{C603}, T_n)$ $K_i^{'} = f(P_{C603}, T_m)$ $S_{n,i} = \frac{K_i F_{C325}}{F_{C329}}$ $S_{m,i} = \frac{K_i^{'} V^{'}}{L^{'}}$ $f_i = \frac{\left(1+S_{n,i}^{N-M}\right)+R\left(1-S_{n,i}\right)}{\left(1+S_{n,i}^{N-M}\right)+R\left(1-S_{n,i}\right)+h_i S_{n,i}^{N-M}\left(1-S_{m,i}^{M+1}\right)}$ $f_i = \frac{F^{i}_{C317}}{F^{i}_{C316}}$ $h_i = \frac{K'_i L}{K_i L'}\left(\frac{1-S_n}{1-S_m}\right)_i$ where i=1,3,4,5,7 $x^{i}_{C317} - x^{i}_{C323} = 0$, where i=1,3,4,5 $T_{C317} - T_{C323} = 0$

Table A.4. Constraint Equations for **Alkylate Deisobutanizer (5C-606)**

Material Balances	
Overall	$F_{C404}+F_{C432}+F_{C322}-F_{C414}-F_{C430}=0$
	$F_{C430}+F_{C427}-F_{C431}-F_{C425}=0$
	$F_{C426}-F_{C428}-F_{C405}=0$
	$F_{C427}-F_{C431}=0$
	$F_{C425}-F_{C430}=0$
Species	$F^{i}_{C404}+F^{i}_{C432}+F^{i}_{C322}-F^{i}_{C414}-F^{i}_{C430}=0$
	$F^{i}_{C430}+F^{i}_{C427}-F^{i}_{C431}-F^{i}_{C425}=0$
	$F^{i}_{C426}-F^{i}_{C428}-F^{i}_{C405}=0$
	where i=1,3,4,5
Smith- Brinkley Method Equations	
	$K_{i,C606A}=f(P_{C606A},T_{n,C606A})$
	$K^{'}_{i,C606A}=f(P_{C606A},T_{m,C606A})$
	$K_{i,C606C}=f(P_{C606C},T_{C425})$
	$K^{'}_{i,C606D}=f(P_{C606D},T_{m,C606D})$
	$S_{m,i,C606A}=\frac{K^{'}_{i,C606A}V^{'}_{C606A}}{L^{'}_{C606A}}$
	$S_{n,i,C606A}=\frac{K_{i,C606A}F_{C414}}{F_{C322}}$
	$S_{m,i,C606D}=\frac{K_{i,C428}F_{C428}}{F_{C426}}$

Table A.5. Constraint Equations for **Alkylate Deisobutanizer (5C-606)**

Smith- Brinkley Method Equations

$$f_{i,C606A} = \frac{\left(1 - S_{n,i,C606A}^{N-M}\right) + q_{i,C606A}^{S}\left(S_{n,i,C606A}^{N-M} - S_{n,i,C606A}\right) + q_{i,C606A}^{F} h_{i,C606A} S_{n,i,C606A}^{N-M}\left(1 - S_{m,i,C606A}^{M}\right)}{\left(1 - S_{n,i,C606A}^{N-M}\right) + h_{i,C606A} S_{n,i,C606A}^{N-M}\left(1 - S_{m,i,C606A}^{M+1}\right)}$$

$$f_{i,C606A} = \frac{F_{C430}^{i}}{(F_{C404}^{i} + F_{C322}^{i} + F_{C432}^{i})}$$

$$h_{i,C606A} = \frac{F_{C322}}{L'_{C606A}}\left(\frac{1 - S_{n,C606A}}{1 - S_{m,C606A}}\right)_i$$

$$x_{i,C606D}^{M} = \frac{F_{C428} K'_{i,C606D}\left(S_{m,i,C606D}^{M_D - 1} - 1\right) + F_{C426}\left(S_{m,i,C606D} - 1\right)}{F_{C426}^{2}\left(S_{m,i,C606D} - 1\right)}$$

where i=1,3,4,5,7

$xx_{C425}^{i} K_{C606C}^{i} - xx_{C431}^{i} = 0$, where i=1,3,4,5

$x_{C408}^{i} - x_{C405}^{i} = 0$, where i=1,3,4,5

$$L'_{C606A} = F_{C322} + q_{C606A} F_{C404}$$

$$V'_{C606A} = F_{C432}$$

$$T_{C431} - T_{C425} = 0$$

Table A.6. Constraint Equations for the **suction trap/flash drum model(5c-614)**

Material Balances	
Overall	$\left(F_{HC31l}+F_{HC31v}\right)-\left(F_{C401}+F_{C301}\right)=0$
	$F_{HC31l}-F_{C401}=0$
	$F_{C311}-F_{HC32}-F_{C302}=0$
Species	$\left(F^{i}_{HC31l}+F^{i}_{HC31v}\right)-\left(F^{i}_{C401}+F^{i}_{C301}\right)=0$
	$F^{i}_{HC31l}-F^{i}_{C401}=0$
	$F^{i}_{C311}-F^{i}_{HC32}-F^{i}_{C302}=0$, where i=1,3,4,5,7
	$K_i=\frac{y_i}{x_i}$, where, $\sum x_i=1$, $\sum y_i=1$
Energy Balances	
	$T_{HC31}=T_{C301}=T_{C401}$
	$h_{C311}-h_{HC32}-h_{C302}=0$

table A.7. Constraint Equations for the **suction trap/flash drum model(5C-614)**

Material Balances	
Overall	$F_{C309} - F_{C310} - F_{C311} = 0$
Component material balance:	$F^i_{C309} - F^i_{C310} - F^i_{C311} = 0$ $K_i = \frac{y_i}{x_i}$, where, $\sum x_i = 1$, $\sum y_i = 1$ In the above equation, K_i is the distribution coefficient or the K-factor, y_i is the mole fraction of component i in the vapor phase, and x_i is that in the liquid phase.
Enthalpy balance:	$h_{C309} - h_{C310} - h_{C311} = 0$ where, h_X is the enthalpy of stream X.

Table A.8. Constraint equations for **Compressor (5K-601)**

Material Balances	
Overall	$F_{C303} + F_{C310} - F_{C304} = 0$
Species	$F^{i}_{C303} + F^{i}_{C310} - F^{i}_{C304} = 0$ where i=1,3,4,5
Energy Balances	
	$h_{C303} + h_{C310} + hp_{ad} - h_{C304} = 0$ $T_2 = T_1\left(\frac{p_2}{p_1}\right)^{\frac{(k-1)}{k}}$ $hp_{ad} = \frac{k}{k-1}\frac{8.314F_{C306}T_{C303}}{55}\left[\left(\frac{p_2}{p_1}\right)^{\frac{(k-1)}{k}} - 1\right]$

Table A.9. Constraint equations for **Olefin Feed Effluent Exchanger (5E-628)**

Material Balances	
Overall	$F_{HC01} + F_{HC02} = 0$ $F_{C401} + F_{C402} = 0$
Species	$x^i_{HC01} + x^i_{HC02} = 0$ $x^i_{C401} + x^i_{C402} = 0$ where i= 1,2,3,4,5
Energy Balances	
	$(h_{HC02} - h_{HC01}) - (h_{C401} - h_{C402}) = 0$ $(h_{HC01} - h_{HC02}) - U_{5E628} A_{5E628} \Delta T_{lm} = 0$ $\Delta T_{lm} = \frac{(T_{HC02} - T_{C401}) - (T_{HC01} - T_{C402})}{\ln \frac{(T_{HC02} - T_{C401})}{(T_{HC01} - T_{C402})}}$

APPENDIX B
Full Output File for Economic Optimization of Online Optimization for Motiva Alkylation Process

```
Economic Optimization Program                                    05/15/01 16:49:39  PAGE      1
                                                        GAMS 2.50A  Windows NT/95/98


 SCALARS
 MW1   / 44.1 /
 MW2   / 56.1 /
 MW3   / 58.1 /
 MW4   / 58.1 /
 MW5   / 72.1 /
 MW6   / 72.1 /
 MW7   / 86.2 /
 MW8   / 100.2 /
 MW9   / 114.2 /
 MW10   / 128.2 /
 MW11   / 98 /
 MWiC10   / 142 /
 MWiC11   / 156 /
 ;

 SCALARS
 klav   / 120000 /
 Vr   / 87.06 /
 k1   / 6770 /
 k2   / 13797000000 /
 k3   / 4970000000 /
 k4   / 1929700000 /
 k5   / 1420300000 /
 k6   / 5370200000 /
 k7   / 4290200000 /
 k8   / 4720300000 /
 k9   / 1210000 /
 k10   / 396000000000000 /
 k11   / 401000000000000 /
 k12   / 19971000 /
 k13   / 4.02E+16 /
 k14   / 96770000 /
 k15   / 8.45E+15 /
 k16   / 8.006E+16 /
 k17   / 213740000 /
 k18   / 3780100000 /
 k19   / 1.231E+15 /
 VaC623   / 46.1 /
 Ha   / 0.53 /
 ;
 SCALARS
 AE601   / 81 /
 AE602   / 365 /
_Economic Optimization Program                                   05/15/01 16:49:39  PAGE      2
                                                        GAMS 2.50A  Windows NT/95/98


 AE603   / 98 /
 AE605   / 428 /
 AE609A   / 33 /
 AE610   / 150.5 /
 AE611   / 110.55 /
 AE612   / 263.84 /
 AE613   / 431.07 /
 AE616   / 106 /
 AE617   / 106 /
 AE621A   / 346 /
 AE626   / 308 /
 AE627A   / 42 /
 AE628   / 88.7 /
 AE629   / 743 /
 AE633   / 284 /
 AE634   / 3820 /
 AE640   / 282.42 /
 AE641   / 133.8 /
 AE695A   / 310 /
 AE696A   / 393 /
 ContrA   / 2.2 /
 AE6XX   / 7360 /
 AE621B   / 115 /
 AE627B   / 41 /
 AE696B   / 131 /
 AE695B   / 103 /
 ;
 SCALARS
 E01MTD   / 40.2 /
 E02MTD   / 114.5 /
```

```
E03MTD  / 24.3 /
E05MTD  / 27.1 /
E09MTD  / 19.9 /
E10MTD  / 35.8 /
E11MTD  / 19.8 /
E12MTD  / 75.5 /
E13MTD  / 21.5 /
E16MTD  / 140.2 /
E17MTD  / 29.1 /
E21MTD  / 25.6 /
E26MTD  / 15.4 /
E27MTD  / 44.5 /
E28MTD  / 36.1 /
E29MTD  / 16.4 /
E33MTD  / 20.4 /
E34MTD  / 19.3 /
```



```
E40MTD  / 13.6 /
E41MTD  / 15.7 /
E95MTD  / 59.2 /
E96MTD  / 70.4 /
;
SCALARS
C06AN  / 9 /
C06BN  / 34 /
C06CN  / 2 /
C06DN  / 9 /
C03N  / 40 /
C03M  / 21 /
C01N  / 60 /
C01M  / 41 /
;
SCALARS
R  / 0.0083144 /
H298_1  /-12590 /
H298_2  /-64.95 /
H298_3  /-16240 /
H298_4  /-15130 /
H298_5  /-18490 /
H298_6  /-17650 /
H298_7  / 28980 /
H298_8  / 33220 /
H298_9  /-26940 /
H298_10  /-4454 /
b_1  /-14380 /
b_2  /-2115 /
b_3  /-18460 /
b_4  /-17590 /
b_5  /-20810 /
b_6  /-20090 /
b_7  /-542.63 /
b_8  /-26770 /
b_9  /-30480 /
b_10  /-8684 /
kK601  / 1.12 /
WK601  / 460 /
hsteam  / 1946.60928 /
hwatin  / 112 /
hsteam397  / 1736 /
;
SCALARS
C03Kn1  / 1.3 /
C03Kn2  / 0.65 /
```



```
C03Kn3  / 0.62 /
C03Kn4  / 0.46 /
C03Kn5  / 0.22 /
C03Kn6  / 0.18 /
C03Kn7  / 0.1 /
C03Kn8  / 0.045 /
C03Kn9  / 0.02 /
C03Kn10  / 0.005 /
C03Km1  / 1.75 /
C03Km2  / 0.93 /
C03Km3  / 0.9 /
C03Km4  / 0.7 /
C03Km5  / 0.35 /
C03Km6  / 0.3 /
C03Km7  / 0.18 /
C03Km8  / 0.07 /
C03Km9  / 0.035 /
C03Km10  / 0.012 /
C01Kn1  / 1.8 /
C01Kn2  / 0.75 /
C01Kn3  / 0.8 /
C01Kn4  / 0.6 /
```

```
C01Kn5  / 0.26 /
C01Kn6  / 0.22 /
C01Kn7  / 0.09 /
C01Kn8  / 0.04 /
C01Kn9  / 0.018 /
C01Kn10  / 0.005 /
C01Km1  / 2.1 /
C01Km2  / 0.85 /
C01Km3  / 1 /
C01Km4  / 0.7 /
C01Km5  / 0.35 /
C01Km6  / 0.28 /
C01Km7  / 0.15 /
C01Km8  / 0.05 /
C01Km9  / 0.025 /
C01Km10  / 0.008 /
K1C616  / 3.5 /
K2C616  / 1.7 /
K3C616  / 1.4 /
K4C616  / 0.95 /
K5C616  / 0.4 /
K6C616  / 0.3 /
K7C616  / 0.13 /
K8C616  / 0.04 /
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 5
GAMS 2.50A Windows NT/95/98

```
K9C616  / 0.015 /
K10C616  / 0.0045 /
C14K1  / 3.4 /
C14K2  / 1.2 /
C14K3  / 1.1 /
C14K4  / 0.75 /
C14K5  / 0.23 /
C14K6  / 0.16 /
C14K7  / 0.05 /
C14K8  / 0.011 /
C14K9  / 0.004 /
C14K10  / 0.0008 /
K1C615  / 2.2 /
K2C615  / 1.2 /
K3C615  / 1 /
K4C615  / 0.7 /
K5C615  / 0.3 /
K6C615  / 0.25 /
K7C615  / 0.13 /
K8C615  / 0.045 /
K9C615  / 0.02 /
K10C615  / 0.006 /
RK1  / 5 /
RK2  / 2 /
RK3  / 1.7 /
RK4  / 1.35 /
RK5  / 0.41 /
RK6  / 0.3 /
RK7  / 0.1 /
RK8  / 0.03 /
RK9  / 0.01 /
RK10  / 0.003 /
K1M3  / 3.71 /
K2M3  / 1.05 /
K3M3  / 1.25 /
K4M3  / 0.82 /
K5M3  / 0.28 /
K6M3  / 0.24 /
K7M3  / 0.068 /
K8M3  / 0.025 /
K9M3  / 0.0075 /
K10M3  / 0.0025 /
C06Am  / 0.9 /
C06Bm  / 1.2 /
C06Cm  / 1.1 /
C06Dm  / 2.9 /
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 6
GAMS 2.50A Windows NT/95/98

```
;
SCALARS
AC07dens  / 115.37 /
AC08dens  / 115.37 /
AC18dens  / 115.05 /
AC19dens  / 115.05 /
AC29dens  / 114.6 /
AC30dens  / 114.6 /
AC40dens  / 114.3 /
AC41dens  / 114.3 /
HCdens1  / 0.002055 /
HCdens2  / 0.002543 /
HCdens3  / 0.002301 /
HCdens4  / 0.002389 /
```

```
HCdens5  / 0.002568 /
HCdens6  / 0.002589 /
HCdens7  / 0.002702 /
HCdens8  / 0.00281 /
HCdens9  / 0.002902 /
HCdens10  / 0.00296 /
;
SCALARS
wat1  / 1.0861707 /
wat2  / 0.000563134 /
wat3  / 0.000000834491 /
wat4  / 11426.6 /
wat5  / 1018240 /
;
SCALARS
KdiC4  / 0.0007 /
KdiC5  / 0.00056 /
KdiC6  / 0.00047 /
KdiC7  / 0.000407 /
KdiC8  / 0.000356 /
KdiC9  / 0.000317 /
;

* The following are the Measured Variables
VARIABLES
FAC02, FAC12, FAC23, FAC34, FAC45, FC308, FC316, FC320,
FC322, FC328, FC329, FC403, FC407, FC412, FC417, FHC01,
FHC32, FSC402, FSC405, FSC411, FSC413, FstmE612, PC302, PC310,
PC601, PC603, QHC07, QHC11, QHC14, QHC16, QHC34, QHC38,
QHC41, QHC45, TAC09, TAC12, TAC23, TAC31, TAC34, TAC42,
TAC45, TC303, TC306, TC307, TC308, TC315, TC316, TC317,
TC321, TC324, TC325, TC404, TC405, TC407, TC408, TC410,
```


```
TC414, TC418, TC419, THC32, TSC402, TSC403, TSC405, TSC408,
TSC413, x11AC12, x11AC23, x11AC34, x11AC45, x1C316, x1C325, x1C417,
x1HC32, x1SC402, x1SC403, x1SC408, x2SC402, x2SC403, x2SC408, x3C316,
x3C325, x3C417, x3HC32, x3SC402, x3SC403, x3SC408, x4C316, x4C417,
x4HC32, x4SC402, x4SC403, x4SC408, x5C316, x5C417, x5HC32, x5SC402,
x5SC403, x5SC408, x6SC402, x6SC403, x6SC408, x7HC32, x7SC402, x7SC403,
x7SC408, xx1C322, xx1C414, xx1HC01, xx2HC01, xx3C317, xx3C322, xx3C407,
xx3C412, xx3C414, xx3HC01, xx4C317, xx4C322, xx4C407, xx4C412, xx4C414,
xx4HC01, xx5C407, xx5C412, xx5C414, xx7C414;

VARIABLE ObjVar objective or profit function;
* The following are the Unmeasured Variables
VARIABLES
C10pC623, C10pC625, C10pC627, C10pC629, C2C623, C2C625, C2C627, C2C629,
C3C623, C3C625, C3C627, C3C629, C3pC623, C3pC625, C3pC627, C3pC629,
C4pC623, C4pC625, C4pC627, C4pC629, C5pC623, C5pC625, C5pC627, C5pC629,
C7pC623, C7pC625, C7pC627, C7pC629, C8pC623, C8pC625, C8pC627, C8pC629,
C9pC623, C9pC625, C9pC627, C9pC629, CHXC623, CHXC625, CHXC627, CHXC629,
CiC10pC623, CiC10pC625, CiC10pC627, CiC10pC629, CiC11pC623, CiC11pC625, CiC11pC627, CiC11pC629,
CiC4eC623, CiC4eC625, CiC4eC627, CiC4eC629, CiC5eC623, CiC5eC625, CiC5eC627, CiC5eC629,
CiC8eC623, CiC8eC625, CiC8eC627, CiC8eC629, Cost, dTE601, dTE602, dTE603,
dTE605, dTE609A, dTE610, dTE611, dTE612, dTE613, dTE616, dTE617,
dTE621A, dTE621B, dTE626, dTE627A, dTE627B, dTE628, dTE629, dTE633,
dTE634, dTE640, dTE641, dTE695A, dTE695B, dTE696A, dTE696B, dTE6XX,
Earnings, f1C601, f1C603, f1C606A, f2C601, f3C601, f3C603, f3C606A,
f4C601, f4C603, f4C606A, f5C601, f5C603, f5C606A, f6C601, f7C601,
f7C603, f7C606A, FAC05, FAC07, FAC09, FAC15, FAC18, FAC20,
FAC26, FAC29, FAC31, FAC37, FAC40, FAC42, FC301, FC302,
FC303, FC306, FC307, FC309, FC310, FC311, FC312, FC315,
FC317, FC318, FC319, FC321, FC323, FC324, FC325, FC326,
FC401, FC402, FC404, FC405, FC406, FC408, FC409, FC410,
FC411, FC413, FC414, FC415, FC418, FC419, FC425, FC426,
FC427, FC428, FC430, FC431, FC432, FcwE603, FcwE605, FcwE609A,
FcwE611, FcwE613, FcwE617, FcwE621A, FcwE621B, FcwE626, FcwE627A, FcwE627B,
FcwE634, FcwE640, FcwE641A, FcwE641B, FHC02, FHC03, FHC04, FHC05,
FHC06, FHC07, FHC08, FHC11, FHC14, FHC15, FHC16, FHC22,
FHC23, FHC24, FHC25, FHC26, FHC27, FHC28, FHC29, FHC30,
FHC31, FHC33, FHC34, FHC38, FHC40, FHC41, FHC45, FlHC28,
FlHC29, FlHC30, FlHC31, FlR1, FlR29, FmC302, FmC308, FmC310,
FmC311, FmC312, FmC317, FmC322, FmC323, FmC325, FmC405, FmC407,
FmC408, FmC409, FmC412, FmC414, FmC425, FmC427, FmC428, FmC430,
FmC431, FmC432, FmHC01, FmHC32, FmlHC28, FmlHC29, FmlHC30, FmlR1,
FmlR29, FmSC403, FmSC406, FmSC408, FmvHC28, FmvHC29, FmvHC30, FmvR1,
FmvR29, FR1, FR29, FSC401, FSC403, FSC404, FSC406, FSC407,
FSC408, FSC409, FSC412, FSC414, FstmE602, FstmE695A, FstmE695B, FstmE696A,
FstmE696B, FvHC28, FvHC29, FvHC30, FvHC31, FvR1, FvR29, h1C601,
```


```
h1C603, h1C606A, h2C601, h3C601, h3C603, h3C606A, h4C601, h4C603,
h4C606A, h5C601, h5C603, h5C606A, h6C601, h7C601, h7C603, h7C606A,
hAC02, hAC05, hAC07, hAC09, hAC12, hAC15, hAC18, hAC20,
hAC23, hAC26, hAC29, hAC31, hAC34, hAC37, hAC40, hAC42,
hacAC09, hacAC20, hacAC31, hacAC42, hC301, hC302, hC303, hC306,
hC307, hC308, hC309, hC310, hC311, hC312, hC312liq, hC315,
```

```
hC316, hC317, hC318, hC319, hC321, hC322, hC323, hC324,
hC325, hC326, hC329, hC401, hC402, hC403, hC404, hC405,
hC406, hC407, hC408, hC408vap, hC409, hC410, hC410vap, hC411,
hC412, hC412liq, hC413, hC414, hC414liq, hC415, hC417, hC418,
hC419, hC425, hC426, hC427, hC428, hC430, hC431, hC432,
hC623, hC625, hC627, hC629, hHC01, hHC02, hHC03, hHC04,
hHC05, hHC06, hHC07, hHC11, hHC14, hHC16, hHC29, hHC30,
hHC31, hHC32, hHC34, hHC38, hHC41, hHC45, hlHC29, hlHC30,
hlHC31, hlR1, hlR29, hR1, hR29, hSC401, hSC402, hSC403,
hSC404, hSC405, hSC406, hSC407, hSC408, hSC409, hSC411, hSC412,
hSC413, hSC414, hvHC29, hvHC30, hvHC31, hvR1, hvR29, K1C323,
K1C325, K1C408, K1C414, K1C428, K1C430, K1C601, K1C603, K1C606A,
K1C606C, K1C614B, K1C615_A, K1C616_A, K1E633, K1E6XX, K1SC406, K1SC408,
K2C601, K2E633, K2E6XX, K2SC406, K2SC408, K3C323, K3C325, K3C408,
K3C414, K3C428, K3C430, K3C601, K3C603, K3C606A, K3C606C, K3C614B,
K3C615_A, K3C616_A, K3E633, K3E6XX, K3SC406, K3SC408, K4C323, K4C325,
K4C408, K4C414, K4C428, K4C430, K4C601, K4C603, K4C606A, K4C606C,
K4C614B, K4C615_A, K4C616_A, K4E633, K4E6XX, K4SC406, K4SC408, K5C323,
K5C325, K5C408, K5C414, K5C428, K5C430, K5C601, K5C603, K5C606A,
K5C606C, K5C614B, K5C615_A, K5C616_A, K5E633, K5E6XX, K5SC406, K5SC408,
K6C601, K6SC406, K6SC408, K7C323, K7C325, K7C408, K7C414, K7C428,
K7C430, K7C601, K7C603, K7C606A, K7C614B, K7C615_A, K7C616_A, K7E633,
K7E6XX, K7SC406, K7SC408, Kp1C601, Kp1C603, Kp1C606A, Kp1C606D, Kp2C601,
Kp3C601, Kp3C603, Kp3C606A, Kp3C606D, Kp4C601, Kp4C603, Kp4C606A, Kp4C606D,
Kp5C601, Kp5C603, Kp5C606A, Kp5C606D, Kp6C601, Kp7C601, Kp7C603, Kp7C606A,
Kp7C606D, kWad1, kWad2, LpC601, LpC603, LpC606A, PC303, PC306,
PC307, PC308, PC309, PC311, PC312, PHC30, PHC32, PR29,
Profit, Q2HC07, Q2HC11, Q2HC14, Q2HC16, qFp1C606A, qFp3C606A, qFp4C606A,
qFp5C606A, qFp7C606A, qS1C606A, qS3C606A, qS4C606A, qS5C606A, qS7C606A, r10C623,
r10C625, r10C627, r10C629, r2C623, r2C625, r2C627, r2C629, r3C623,
r3C625, r3C627, r3C629, r4C623, r4C625, r4C627, r4C629, r5C623,
r5C625, r5C627, r5C629, r7C623, r7C625, r7C627, r7C629, r8C623,
r8C625, r8C627, r8C629, r9C623, r9C625, r9C627, r9C629, rho2HC07,
rho2HC11, rho2HC14, rho2HC16, rhoAC09, rhoAC20, rhoAC31, rhoAC42, riC10C623,
riC10C625, riC10C627, riC10C629, riC11C623, riC11C625, riC11C627, riC11C629, sf1S34,
sf2S34, sfS11, sfS19, sfS2, sfS23, sfS27, sfS41, sfS42,
sfS5, sfS7, Sm1C601, Sm1C603, Sm1C606A, Sm1C606D, Sm2C601, Sm3C601,
Sm3C603, Sm3C606A, Sm3C606D, Sm4C601, Sm4C603, Sm4C606A, Sm4C606D, Sm5C601,
Sm5C603, Sm5C606A, Sm5C606D, Sm6C601, Sm7C601, Sm7C603, Sm7C606A, Sm7C606D,
Sn1C601, Sn1C603, Sn1C606A, Sn2C601, Sn3C601, Sn3C603, Sn3C606A, Sn4C601,
```



```
Sn4C603, Sn4C606A, Sn5C601, Sn5C603, Sn5C606A, Sn6C601, Sn7C601, Sn7C603,
Sn7C606A, TAC02, TAC05, TAC07, TAC15, TAC18, TAC20, TAC26,
TAC29, TAC37, TAC40, TC301, TC302, TC309, TC310, TC311,
TC312, TC318, TC319, TC320, TC322, TC323, TC326, TC328,
TC329, TC401, TC402, TC403, TC406, TC409, TC411, TC412,
TC413, TC415, TC417, TC425, TC426, TC427, TC428, TC430,
TC431, TC432, TcwotE609A, TcwotE621A, TcwotE621B, TcwotE627A, TcwotE627B, TcwotE641A,
TcwotE641B, TcwoutE603, TcwoutE605, TcwoutE611, TcwoutE613, TcwoutE617, TcwoutE626, TcwoutE634,
TcwoutE640, THC01, THC02, THC03, THC04, THC05, THC06, THC07,
THC11, THC14, THC16, THC22, THC23, THC24, THC25, THC26,
THC27, THC28, THC29, THC30, THC31, THC34, THC38, THC41,
THC45, TmC601, TmC603, TmC606A, TmC606D, TmK601, TnC601, TnC603,
TnC606A, TR1, TR29, TSC401, TSC404, TSC406, TSC407, TSC409,
TSC411, TSC412, TSC414, Utilities, VFC614B, VFC615, VFC616, VFM3,
VpC601, VpC603, VpC606A, x10AC09, x10AC20, x10AC31, x10AC42, x11AC02,
x11AC05, x11AC07, x11AC09, x11AC15, x11AC18, x11AC20, x11AC26, x11AC29,
x11AC31, x11AC37, x11AC40, x11AC42, x12AC02, x12AC05, x12AC07, x12AC09,
x12AC12, x12AC15, x12AC18, x12AC20, x12AC23, x12AC26, x12AC29, x12AC31,
x12AC34, x12AC37, x12AC40, x12AC42, x12AC45, x1AC09, x1AC20, x1AC31,
x1AC42, x1C301, x1C302, x1C303, x1C306, x1C307, x1C308, x1C309,
x1C310, x1C311, x1C312, x1C315, x1C317, x1C318, x1C319, x1C320,
x1C321, x1C322, x1C323, x1C324, x1C326, x1C328, x1C329, x1C401,
x1C402, x1C403, x1C404, x1C405, x1C406, x1C407, x1C408, x1C409,
x1C410, x1C411, x1C412, x1C413, x1C414, x1C415, x1C418, x1C419,
x1C425, x1C426, x1C427, x1C428, x1C430, x1C431, x1C432, x1HC01,
x1HC02, x1HC03, x1HC04, x1HC05, x1HC06, x1HC07, x1HC08, x1HC11,
x1HC14, x1HC15, x1HC16, x1HC22, x1HC23, x1HC24, x1HC25, x1HC26,
x1HC27, x1HC28, x1HC29, x1HC30, x1HC31, x1HC33, x1HC34, x1HC38,
x1HC40, x1HC41, x1HC45, x1R1, x1R29, x1SC401, x1SC404, x1SC405,
x1SC406, x1SC407, x1SC409, x1SC411, x1SC412, x1SC413, x1SC414, x2AC09,
x2AC20, x2AC31, x2AC42, x2C301, x2C417, x2C418, x2C419, x2HC01,
x2HC02, x2HC03, x2HC04, x2HC05, x2HC06, x2HC07, x2HC08, x2HC11,
x2HC14, x2HC15, x2HC16, x2HC22, x2HC23, x2HC24, x2HC25, x2HC26,
x2HC27, x2HC28, x2HC29, x2HC30, x2HC31, x2R1, x2R29, x2SC401,
x2SC404, x2SC405, x2SC406, x2SC407, x2SC409, x2SC411, x2SC412, x2SC413,
x2SC414, x3AC09, x3AC20, x3AC31, x3AC42, x3C301, x3C302, x3C303,
x3C306, x3C307, x3C308, x3C309, x3C310, x3C311, x3C312, x3C315,
x3C317, x3C318, x3C319, x3C320, x3C321, x3C322, x3C323, x3C324,
x3C326, x3C328, x3C329, x3C401, x3C402, x3C403, x3C404, x3C405,
x3C406, x3C407, x3C408, x3C409, x3C410, x3C411, x3C412, x3C413,
x3C414, x3C415, x3C418, x3C419, x3C425, x3C426, x3C427, x3C428,
x3C430, x3C431, x3C432, x3HC01, x3HC02, x3HC03, x3HC04, x3HC05,
x3HC06, x3HC07, x3HC08, x3HC11, x3HC14, x3HC15, x3HC16, x3HC22,
x3HC23, x3HC24, x3HC25, x3HC26, x3HC27, x3HC28, x3HC29, x3HC30,
x3HC31, x3HC33, x3HC34, x3HC38, x3HC40, x3HC41, x3HC45, x3R1,
x3R29, x3SC401, x3SC404, x3SC405, x3SC406, x3SC407, x3SC409, x3SC411,
```

```
x3SC412, x3SC413, x3SC414, x4AC09, x4AC20, x4AC31, x4AC42, x4C301,
x4C302, x4C303, x4C306, x4C307, x4C308, x4C309, x4C310, x4C311,
x4C312, x4C315, x4C317, x4C318, x4C319, x4C320, x4C321, x4C322,
x4C323, x4C324, x4C325, x4C326, x4C328, x4C329, x4C401, x4C402,
x4C403, x4C404, x4C405, x4C406, x4C407, x4C408, x4C409, x4C410,
x4C411, x4C412, x4C413, x4C414, x4C415, x4C418, x4C419, x4C425,
x4C426, x4C427, x4C428, x4C430, x4C431, x4C432, x4HC01, x4HC02,
x4HC03, x4HC04, x4HC05, x4HC06, x4HC07, x4HC08, x4HC11, x4HC14,
x4HC15, x4HC16, x4HC22, x4HC23, x4HC24, x4HC25, x4HC26, x4HC27,
x4HC28, x4HC29, x4HC30, x4HC31, x4HC33, x4HC34, x4HC38, x4HC40,
x4HC41, x4HC45, x4R1, x4R29, x4SC401, x4SC404, x4SC405, x4SC406,
x4SC407, x4SC409, x4SC411, x4SC412, x4SC413, x4SC414, x5AC09, x5AC20,
x5AC31, x5AC42, x5C301, x5C302, x5C303, x5C306, x5C307, x5C308,
x5C309, x5C310, x5C311, x5C312, x5C315, x5C317, x5C318, x5C319,
x5C320, x5C321, x5C322, x5C323, x5C324, x5C325, x5C326, x5C328,
x5C329, x5C401, x5C402, x5C403, x5C404, x5C405, x5C406, x5C407,
x5C408, x5C409, x5C410, x5C411, x5C412, x5C413, x5C414, x5C415,
x5C418, x5C419, x5C425, x5C426, x5C427, x5C428, x5C430, x5C431,
x5C432, x5HC01, x5HC02, x5HC03, x5HC04, x5HC05, x5HC06, x5HC07,
x5HC08, x5HC11, x5HC14, x5HC15, x5HC16, x5HC22, x5HC23, x5HC24,
x5HC25, x5HC26, x5HC27, x5HC28, x5HC29, x5HC30, x5HC31, x5HC33,
x5HC34, x5HC38, x5HC40, x5HC41, x5HC45, x5R1, x5R29, x5SC401,
x5SC404, x5SC405, x5SC406, x5SC407, x5SC409, x5SC411, x5SC412, x5SC413,
x5SC414, x6SC401, x6SC404, x6SC405, x6SC406, x6SC407, x6SC409, x6SC411,
x6SC412, x6SC413, x6SC414, x7AC09, x7AC20, x7AC31, x7AC42, x7C301,
x7C302, x7C303, x7C306, x7C307, x7C308, x7C309, x7C310, x7C311,
x7C312, x7C315, x7C316, x7C317, x7C318, x7C319, x7C320, x7C321,
x7C322, x7C323, x7C324, x7C325, x7C326, x7C328, x7C329, x7C401,
x7C402, x7C403, x7C404, x7C405, x7C406, x7C407, x7C408, x7C409,
x7C410, x7C411, x7C412, x7C413, x7C414, x7C415, x7C417, x7C418,
x7C419, x7C425, x7C426, x7C427, x7C428, x7C430, x7C431, x7C432,
x7HC01, x7HC02, x7HC03, x7HC04, x7HC05, x7HC06, x7HC07, x7HC08,
x7HC11, x7HC14, x7HC15, x7HC16, x7HC22, x7HC23, x7HC24, x7HC25,
x7HC26, x7HC27, x7HC28, x7HC29, x7HC30, x7HC31, x7HC33, x7HC34,
x7HC38, x7HC40, x7HC41, x7HC45, x7R1, x7R29, x7SC401, x7SC404,
x7SC405, x7SC406, x7SC407, x7SC409, x7SC411, x7SC412, x7SC413, x7SC414,
x8AC09, x8AC20, x8AC31, x8AC42, x9AC09, x9AC20, x9AC31, x9AC42,
xAC02, xAC05, xAC07, xAC09, xAC12, xAC15, xAC18, xAC20,
xAC23, xAC26, xAC29, xAC31, xAC34, xAC37, xAC40, xAC42,
xiC10AC09, xiC10AC20, xiC10AC31, xiC10AC42, xiC11AC09, xiC11AC20, xiC11AC31, xiC11AC42,
xM1C606D, xM3C606D, xM4C606D, xM5C606D, xM7C606D, xx1C302, xx1C308, xx1C310,
xx1C311, xx1C312, xx1C323, xx1C325, xx1C405, xx1C408, xx1C425, xx1C428,
xx1C430, xx1C431, xx1HC28, xx1HC29, xx1HC30, xx1HC32, xx1R1, xx1R29,
xx1SC406, xx1SC408, xx2HC28, xx2HC29, xx2HC30, xx2R1, xx2R29, xx2SC406,
xx2SC408, xx3C302, xx3C308, xx3C310, xx3C311, xx3C312, xx3C323, xx3C325,
xx3C405, xx3C408, xx3C425, xx3C428, xx3C430, xx3C431, xx3C432, xx3HC28,
```

_Economic Optimization Program   05/15/01 16:49:39 PAGE   11
GAMS 2.50A Windows NT/95/98

```
xx3HC29, xx3HC30, xx3HC32, xx3R1, xx3R29, xx3SC406, xx3SC408, xx4C302,
xx4C308, xx4C310, xx4C311, xx4C312, xx4C323, xx4C325, xx4C405, xx4C408,
xx4C409, xx4C425, xx4C427, xx4C428, xx4C430, xx4C431, xx4C432, xx4HC28,
xx4HC29, xx4HC30, xx4HC32, xx4R1, xx4R29, xx4SC406, xx4SC408, xx5C302,
xx5C308, xx5C310, xx5C311, xx5C312, xx5C323, xx5C325, xx5C405, xx5C408,
xx5C425, xx5C428, xx5C430, xx5C431, xx5HC28, xx5HC29, xx5HC30, xx5HC32,
xx5R1, xx5R29, xx5SC406, xx5SC408, xx6SC406, xx6SC408, xx7C302, xx7C308,
xx7C310, xx7C311, xx7C312, xx7C323, xx7C325, xx7C405, xx7C408, xx7C425,
xx7C428, xx7C430, xx7C431, xx7HC28, xx7HC29, xx7HC30, xx7HC32, xx7R1,
xx7R29, xx7SC406, xx7SC408, y1HC28, y1HC29, y1HC30, y1HC31, y1R1,
y1R29, y2HC28, y2HC29, y2HC30, y2HC31, y2R1, y2R29, y3HC28,
y3HC29, y3HC30, y3HC31, y3R1, y3R29, y4HC28, y4HC29, y4HC30,
y4HC31, y4R1, y4R29, y5HC28, y5HC29, y5HC30, y5HC31, y5R1,
y5R29, y7HC28, y7HC29, y7HC30, y7HC31, y7R1, y7R29, yy1HC28,
yy1HC29, yy1HC30, yy1R1, yy1R29, yy2HC28, yy2HC29, yy2HC30, yy2R1,
yy2R29, yy3HC28, yy3HC29, yy3HC30, yy3R1, yy3R29, yy4HC28, yy4HC29,
yy4HC30, yy4R1, yy4R29, yy5HC28, yy5HC29, yy5HC30, yy5R1, yy5R29,
yy7HC28, yy7HC29, yy7HC30, yy7R1, yy7R29;

 * The following are the Parameters in the Model
SCALARS
deltaPE634      / 70 /
deltaPE640      / 20 /
FE601       / 0.5 /
FE603       / 1 /
FE609A      / 0.5 /
FE610       / 0.93398 /
FE611       / 0.52182 /
FE616       / 0.5 /
FE617       / 1 /
FE621A      / 0.73974 /
FE621B      / 1 /
FE626       / 0.5 /
FE627A      / 0.50163 /
FE627B      / 0.52572 /
FE628       / 0.5 /
FE629       / 0.5 /
FE634       / 1 /
FE640       / 0.75692 /
FE641       / 0.5 /
```

```
hstmE602      / 2145 /
hstmE612      / 2145 /
hstmE695      / 1920 /
hstmE696      / 2145 /
PC606A      / 900 /
PC606C      / 890 /
```



```
PC606D      / 900 /
PE633      / 145 /
qC601      / 1 /
qC603      / 0.99037 /
qC606A      / 0.5 /
RC601      / 9.22101 /
RC603      / 14 /
sfC631      / 0.97742 /
sfC632      / 0.9815 /
sfC633      / 0.99131 /
sfC634      / 0.98926 /
Tcwin      / 290 /
UE601      / 0.008 /
UE602      / 0.01596 /
UE603      / 0.02513 /
UE605      / 0.04982 /
UE609A      / 0.04 /
UE610      / 0.08981 /
UE611      / 0.1 /
UE612      / 0.013 /
UE613      / 0.02563 /
UE616      / 0.01 /
UE617      / 0.05255 /
UE621A      / 0.114 /
UE621B      / 0.07589 /
UE626      / 0.01 /
UE627A      / 0.01 /
UE627B      / 0.01 /
UE628      / 0.01435 /
UE629      / 0.01 /
UE633      / 0.0177 /
UE634      / 0.02059 /
UE640      / 0.01 /
UE641      / 0.08735 /
UE695A      / 0.03291 /
UE695B      / 0.03883 /
UE696A      / 0.01216 /
UE696B      / 0.01 /
UE6XX      / 0.02855 /
;

VARIABLES
ObjVar Objective function using ' ' algorithm;

SETS
Coeff /a1,a2,a3,a4,a5/
```



```
Comp /1, 2, 3, 4, 5, 6, 7, 8, 9, 10/
;
TABLE Enth_Coe(Comp,Coeff)
             a1           a2           a3           a4
1            4.211        1.716e-03    7.062e-05    -9.196e-08
2            4.4267       6.6394e-03   6.8065e-05   -9.2875e-08
3            4.455        8.261e-03    8.299e-05    -1.146e-07
4            6.147        1.559e-04    9.679e-05    -1.255e-07
5            1.083        4.457e-02    8.239e-06    -3.526e-08
6            1.898        4.12e-02     1.231e-05    -3.659e-08
7            8.763        2.162e-03    1.317e-04    -1.738e-07
8            1.115e01     -9.494e-03   1.956e-04    -2.498e-07
9            8.157e-01    7.326e-02    1.783e-05    -6.936e-08
10           2.876        7.579e-02    1.346e-05    -6.409e-08
+            a5
1            3.644e-11
2            3.7347e-11
3            4.646e-11
4            4.978e-11
5            1.579e-11
6            1.504e-11
7            6.925e-11
8            9.489e-11
9            3.216e-11
10           2.869e-11
TABLE Enth_Form(Comp,Coeff)
             a1           a2           a3
1            -80.697      -9.05e-02    4.2104e-05
2            21.822       -8.5458e-02  3.8902e-05
3            -106.746     -1.0929e-01  5.2693e-05
4            -98.186      -1.0974e-01  5.2254e-05
5            -121.118     -1.3184e-01  6.5174e-05
```

```
6              -113.399        -1.3001e-01     6.2902e-05
7              -137.114        -1.4707e-01     7.2785e-05
8              -151.825        -1.7028e-01     8.4061e-05
9              -167.368        -1.9025e-01     9.4496e-05
10             -184.627        -2.0407e-01     1.0198e-04
TABLE Enth_gas(Comp,Coeff)
               a1              a2              a3              a4
1              28.277          1.16e-01        1.9597e-04      -2.3271e-07
2              30.11           1.71e-01        1.01e-04        -1.812e-07
3              6.772           3.4147e-01      -1.0271e-04     -3.685e-08
4              20.056          2.815e-01       -1.314e-05      -9.4571e-08
5              -0.881          4.75e-01        -2.479e-04      6.751e-08
6              26.671          3.234e-01       4.282e-05       -1.664e-07
7              -7.197          6.009e-01       -3.409e-04      9.521e-08
```



```
8              -3.249          6.663e-01       -3.383e-04      6.0489e-08
9              -3.367          7.5824e-01      -3.8216e-04     5.736e-08
10             51.299          5.356e-01       1.696e-04       -4.023e-07
+              a5
1              6.867e-11
2              5.732e-11
3              2.043e-11
4              3.415e-11
5              -8.534e-12
6              5.604e-11
7              -1.029e-11
8              2.5385e-12
9              8.0178e-12
10             1.3567e-10
TABLE Enth_liq(Comp,Coeff)
               a1              a2              a3              a4
1              59.642          3.283e-1        -1.5377e-03     3.6539e-06
2              50              5.1e-01         -2.02e-03       2.56e-06
3              71.791          4.8472e-01      -2.0519e-03     4.0634e-06
4              62.873          5.8913e-01      -2.3558e-03     4.2257e-06
5              91.474          4.4852e-01      -1.6859e-03     3.1342e-06
6              80.641          6.2195e-01      -2.2682e-03     3.7423e-06
7              110.129         5.0521e-01      -1.7675e-03     3.066e-06
8              118.184         7.1284e-01      -2.3129e-03     3.4493e-06
9              134.965         8.1458e-01      -2.5182e-03     3.5416e-06
10             129.481         1.1045          -3.2083e-03     4.0849e-06
TABLE Enth_Vap(Comp,Coeff)
               a1              a2              a3
1              26.89           369.82          0.365
2              33.39           419.59          0.393
3              31.954          408.14          0.392
4              33.02           425.18          0.377
5              37.692          460.43          0.395
6              39.854          469.65          0.398
7              42.78           497.5           0.384
8              49.917          530.37          0.408
9              59.503          559.64          0.481
10             59.521          586.75          0.397

EQUATIONS
* The Constraints
EQU1, EQU2, EQU3, EQU4, EQU5, EQU6,
EQU7, EQU8, EQU9, EQU10, EQU11, EQU12,
EQU13, EQU14, EQU15, EQU16, EQU17, EQU18,
EQU19, EQU20, EQU21, EQU22, EQU23, EQU24,
EQU25, EQU26, EQU27, EQU28, EQU29, EQU30,
```



```
EQU31, EQU32, EQU33, EQU34, EQU35, EQU36,
EQU37, EQU38, EQU39, EQU40, EQU41, EQU42,
EQU43, EQU44, EQU45, EQU46, EQU47, EQU48,
EQU49, EQU50, EQU51, EQU52, EQU53, EQU54,
EQU55, EQU56, EQU57, EQU58, EQU59, EQU60,
EQU61, EQU62, EQU63, EQU64, EQU65, EQU66,
EQU67, EQU68, EQU69, EQU70, EQU71, EQU72,
EQU73, EQU74, EQU75, EQU76, EQU77, EQU78,
EQU79, EQU80, EQU81, EQU82, EQU83, EQU84,
EQU85, EQU86, EQU87, EQU88, EQU89, EQU90,
EQU91, EQU92, EQU93, EQU94, EQU95, EQU96,
EQU97, EQU98, EQU99, EQU100, EQU101, EQU102,
EQU103, EQU104, EQU105, EQU106, EQU107, EQU108,
EQU109, EQU110, EQU111, EQU112, EQU113, EQU114,
EQU115, EQU116, EQU117, EQU118, EQU119, EQU120,
EQU121, EQU122, EQU123, EQU124, EQU125, EQU126,
EQU127, EQU128, EQU129, EQU130, EQU131, EQU132,
EQU133, EQU134, EQU135, EQU136, EQU137, EQU138,
EQU139, EQU140, EQU141, EQU142, EQU143, EQU144,
EQU145, EQU146, EQU147, EQU148, EQU149, EQU150,
EQU151, EQU152, EQU153, EQU154, EQU155, EQU156,
EQU157, EQU158, EQU159, EQU160, EQU161, EQU162,
EQU163, EQU164, EQU165, EQU166, EQU167, EQU168,
EQU169, EQU170, EQU171, EQU172, EQU173, EQU174,
```

```
EQU175, EQU176, EQU177, EQU178, EQU179, EQU180,
EQU181, EQU182, EQU183, EQU184, EQU185, EQU186,
EQU187, EQU188, EQU189, EQU190, EQU191, EQU192,
EQU193, EQU194, EQU195, EQU196, EQU197, EQU198,
EQU199, EQU200, EQU201, EQU202, EQU203, EQU204,
EQU205, EQU206, EQU207, EQU208, EQU209, EQU210,
EQU211, EQU212, EQU213, EQU214, EQU215, EQU216,
EQU217, EQU218, EQU219, EQU220, EQU221, EQU222,
EQU223, EQU224, EQU225, EQU226, EQU227, EQU228,
EQU229, EQU230, EQU231, EQU232, EQU233, EQU234,
EQU235, EQU236, EQU237, EQU238, EQU239, EQU240,
EQU241, EQU242, EQU243, EQU244, EQU245, EQU246,
EQU247, EQU248, EQU249, EQU250, EQU251, EQU252,
EQU253, EQU254, EQU255, EQU256, EQU257, EQU258,
EQU259, EQU260, EQU261, EQU262, EQU263, EQU264,
EQU265, EQU266, EQU267, EQU268, EQU269, EQU270,
EQU271, EQU272, EQU273, EQU274, EQU275, EQU276,
EQU277, EQU278, EQU279, EQU280, EQU281, EQU282,
EQU283, EQU284, EQU285, EQU286, EQU287, EQU288,
EQU289, EQU290, EQU291, EQU292, EQU293, EQU294,
EQU295, EQU296, EQU297, EQU298, EQU299, EQU300,
EQU301, EQU302, EQU303, EQU304, EQU305, EQU306,
```



```
EQU307, EQU308, EQU309, EQU310, EQU311, EQU312,
EQU313, EQU314, EQU315, EQU316, EQU317, EQU318,
EQU319, EQU320, EQU321, EQU322, EQU323, EQU324,
EQU325, EQU326, EQU327, EQU328, EQU329, EQU330,
EQU331, EQU332, EQU333, EQU334, EQU335, EQU336,
EQU337, EQU338, EQU339, EQU340, EQU341, EQU342,
EQU343, EQU344, EQU345, EQU346, EQU347, EQU348,
EQU349, EQU350, EQU351, EQU352, EQU353, EQU354,
EQU355, EQU356, EQU357, EQU358, EQU359, EQU360,
EQU361, EQU362, EQU363, EQU364, EQU365, EQU366,
EQU367, EQU368, EQU369, EQU370, EQU371, EQU372,
EQU373, EQU374, EQU375, EQU376, EQU377, EQU378,
EQU379, EQU380, EQU381, EQU382, EQU383, EQU384,
EQU385, EQU386, EQU387, EQU388, EQU389, EQU390,
EQU391, EQU392, EQU393, EQU394, EQU395, EQU396,
EQU397, EQU398, EQU399, EQU400, EQU401, EQU402,
EQU403, EQU404, EQU405, EQU406, EQU407, EQU408,
EQU409, EQU410, EQU411, EQU412, EQU413, EQU414,
EQU415, EQU416, EQU417, EQU418, EQU419, EQU420,
EQU421, EQU422, EQU423, EQU424, EQU425, EQU426,
EQU427, EQU428, EQU429, EQU430, EQU431, EQU432,
EQU433, EQU434, EQU435, EQU436, EQU437, EQU438,
EQU439, EQU440, EQU441, EQU442, EQU443, EQU444,
EQU445, EQU446, EQU447, EQU448, EQU449, EQU450,
EQU451, EQU452, EQU453, EQU454, EQU455, EQU456,
EQU457, EQU458, EQU459, EQU460, EQU461, EQU462,
EQU463, EQU464, EQU465, EQU466, EQU467, EQU468,
EQU469, EQU470, EQU471, EQU472, EQU473, EQU474,
EQU475, EQU476, EQU477, EQU478, EQU479, EQU480,
EQU481, EQU482, EQU483, EQU484, EQU485, EQU486,
EQU487, EQU488, EQU489, EQU490, EQU491, EQU492,
EQU493, EQU494, EQU495, EQU496, EQU497, EQU498,
EQU499, EQU500, EQU501, EQU502, EQU503, EQU504,
EQU505, EQU506, EQU507, EQU508, EQU509, EQU510,
EQU511, EQU512, EQU513, EQU514, EQU515, EQU516,
EQU517, EQU518, EQU519, EQU520, EQU521, EQU522,
EQU523, EQU524, EQU525, EQU526, EQU527, EQU528,
EQU529, EQU530, EQU531, EQU532, EQU533, EQU534,
EQU535, EQU536, EQU537, EQU538, EQU539, EQU540,
EQU541, EQU542, EQU543, EQU544, EQU545, EQU546,
EQU547, EQU548, EQU549, EQU550, EQU551, EQU552,
EQU553, EQU554, EQU555, EQU556, EQU557, EQU558,
EQU559, EQU560, EQU561, EQU562, EQU563, EQU564,
EQU565, EQU566, EQU567, EQU568, EQU569, EQU570,
EQU571, EQU572, EQU573, EQU574, EQU575, EQU576,
EQU577, EQU578, EQU579, EQU580, EQU581, EQU582,
```



```
EQU583, EQU584, EQU585, EQU586, EQU587, EQU588,
EQU589, EQU590, EQU591, EQU592, EQU593, EQU594,
EQU595, EQU596, EQU597, EQU598, EQU599, EQU600,
EQU601, EQU602, EQU603, EQU604, EQU605, EQU606,
EQU607, EQU608, EQU609, EQU610, EQU611, EQU612,
EQU613, EQU614, EQU615, EQU616, EQU617, EQU618,
EQU619, EQU620, EQU621, EQU622, EQU623, EQU624,
EQU625, EQU626, EQU627, EQU628, EQU629, EQU630,
EQU631, EQU632, EQU633, EQU634, EQU635, EQU636,
EQU637, EQU638, EQU639, EQU640, EQU641, EQU642,
EQU643, EQU644, EQU645, EQU646, EQU647, EQU648,
EQU649, EQU650, EQU651, EQU652, EQU653, EQU654,
EQU655, EQU656, EQU657, EQU658, EQU659, EQU660,
EQU661, EQU662, EQU663, EQU664, EQU665, EQU666,
EQU667, EQU668, EQU669, EQU670, EQU671, EQU672,
EQU673, EQU674, EQU675, EQU676, EQU677, EQU678,
```

```
EQU679, EQU680, EQU681, EQU682, EQU683, EQU684,
EQU685, EQU686, EQU687, EQU688, EQU689, EQU690,
EQU691, EQU692, EQU693, EQU694, EQU695, EQU696,
EQU697, EQU698, EQU699, EQU700, EQU701, EQU702,
EQU703, EQU704, EQU705, EQU706, EQU707, EQU708,
EQU709, EQU710, EQU711, EQU712, EQU713, EQU714,
EQU715, EQU716, EQU717, EQU718, EQU719, EQU720,
EQU721, EQU722, EQU723, EQU724, EQU725, EQU726,
EQU727, EQU728, EQU729, EQU730, EQU731, EQU732,
EQU733, EQU734, EQU735, EQU736, EQU737, EQU738,
EQU739, EQU740, EQU741, EQU742, EQU743, EQU744,
EQU745, EQU746, EQU747, EQU748, EQU749, EQU750,
EQU751, EQU752, EQU753, EQU754, EQU755, EQU756,
EQU757, EQU758, EQU759, EQU760, EQU761, EQU762,
EQU763, EQU764, EQU765, EQU766, EQU767, EQU768,
EQU769, EQU770, EQU771, EQU772, EQU773, EQU774,
EQU775, EQU776, EQU777, EQU778, EQU779, EQU780,
EQU781, EQU782, EQU783, EQU784, EQU785, EQU786,
EQU787, EQU788, EQU789, EQU790, EQU791, EQU792,
EQU793, EQU794, EQU795, EQU796, EQU797, EQU798,
EQU799, EQU800, EQU801, EQU802, EQU803, EQU804,
EQU805, EQU806, EQU807, EQU808, EQU809, EQU810,
EQU811, EQU812, EQU813, EQU814, EQU815, EQU816,
EQU817, EQU818, EQU819, EQU820, EQU821, EQU822,
EQU823, EQU824, EQU825, EQU826, EQU827, EQU828,
EQU829, EQU830, EQU831, EQU832, EQU833, EQU834,
EQU835, EQU836, EQU837, EQU838, EQU839, EQU840,
EQU841, EQU842, EQU843, EQU844, EQU845, EQU846,
EQU847, EQU848, EQU849, EQU850, EQU851, EQU852,
EQU853, EQU854, EQU855, EQU856, EQU857, EQU858,
```



```
EQU859, EQU860, EQU861, EQU862, EQU863, EQU864,
EQU865, EQU866, EQU867, EQU868, EQU869, EQU870,
EQU871, EQU872, EQU873, EQU874, EQU875, EQU876,
EQU877, EQU878, EQU879, EQU880, EQU881, EQU882,
EQU883, EQU884, EQU885, EQU886, EQU887, EQU888,
EQU889, EQU890, EQU891, EQU892, EQU893, EQU894,
EQU895, EQU896, EQU897, EQU898, EQU899, EQU900,
EQU901, EQU902, EQU903, EQU904, EQU905, EQU906,
EQU907, EQU908, EQU909, EQU910, EQU911, EQU912,
EQU913, EQU914, EQU915, EQU916, EQU917, EQU918,
EQU919, EQU920, EQU921, EQU922, EQU923, EQU924,
EQU925, EQU926, EQU927, EQU928, EQU929, EQU930,
EQU931, EQU932, EQU933, EQU934, EQU935, EQU936,
EQU937, EQU938, EQU939, EQU940, EQU941, EQU942,
EQU943, EQU944, EQU945, EQU946, EQU947, EQU948,
EQU949, EQU950, EQU951, EQU952, EQU953, EQU954,
EQU955, EQU956, EQU957, EQU958, EQU959, EQU960,
EQU961, EQU962, EQU963, EQU964, EQU965, EQU966,
EQU967, EQU968, EQU969, EQU970, EQU971, EQU972,
EQU973, EQU974, EQU975, EQU976, EQU977, EQU978,
EQU979, EQU980, EQU981, EQU982, EQU983, EQU984,
EQU985, EQU986, EQU987, EQU988, EQU989, EQU990,
EQU991, EQU992, EQU993, EQU994, EQU995, EQU996,
EQU997, EQU998, EQU999, EQU1000, EQU1001, EQU1002,
EQU1003, EQU1004, EQU1005, EQU1006, EQU1007, EQU1008,
EQU1009, EQU1010, EQU1011, EQU1012, EQU1013, EQU1014,
EQU1015, EQU1016, EQU1017, EQU1018, EQU1019, EQU1020,
EQU1021, EQU1022, EQU1023, EQU1024, EQU1025, EQU1026,
EQU1027, EQU1028, EQU1029, EQU1030, EQU1031, EQU1032,
EQU1033, EQU1034, EQU1035, EQU1036, EQU1037, EQU1038,
EQU1039, EQU1040, EQU1041, EQU1042, EQU1043, EQU1044,
EQU1045, EQU1046, EQU1047, EQU1048, EQU1049, EQU1050,
EQU1051, EQU1052, EQU1053, EQU1054, EQU1055, EQU1056,
EQU1057, EQU1058, EQU1059, EQU1060, EQU1061, EQU1062,
EQU1063, EQU1064, EQU1065, EQU1066, EQU1067, EQU1068,
EQU1069, EQU1070, EQU1071, EQU1072, EQU1073, EQU1074,
EQU1075, EQU1076, EQU1077, EQU1078, EQU1079, EQU1080,
EQU1081, EQU1082, EQU1083, EQU1084, EQU1085, EQU1086,
EQU1087, EQU1088, EQU1089, EQU1090, EQU1091, EQU1092,
EQU1093, EQU1094, EQU1095, EQU1096, EQU1097, EQU1098,
EQU1099, EQU1100, EQU1101, EQU1102, EQU1103, EQU1104,
EQU1105, EQU1106, EQU1107, EQU1108, EQU1109, EQU1110,
EQU1111, EQU1112, EQU1113, EQU1114, EQU1115, EQU1116,
EQU1117, EQU1118, EQU1119, EQU1120, EQU1121, EQU1122,
EQU1123, EQU1124, EQU1125, EQU1126, EQU1127, EQU1128,
EQU1129, EQU1130, EQU1131, EQU1132, EQU1133, EQU1134,
```



```
EQU1135, EQU1136, EQU1137, EQU1138, EQU1139, EQU1140,
EQU1141, EQU1142, EQU1143, EQU1144, EQU1145, EQU1146,
EQU1147, EQU1148, EQU1149, EQU1150, EQU1151, EQU1152,
EQU1153, EQU1154, EQU1155, EQU1156, EQU1157, EQU1158,
EQU1159, EQU1160, EQU1161, EQU1162, EQU1163, EQU1164,
EQU1165, EQU1166, EQU1167, EQU1168, EQU1169, EQU1170,
EQU1171, EQU1172, EQU1173, EQU1174, EQU1175, EQU1176,
EQU1177, EQU1178, EQU1179, EQU1180, EQU1181, EQU1182,
```

```
EQU1183, EQU1184, EQU1185, EQU1186, EQU1187, EQU1188,
EQU1189, EQU1190, EQU1191, EQU1192, EQU1193, EQU1194,
EQU1195, EQU1196, EQU1197, EQU1198, EQU1199, EQU1200,
EQU1201, EQU1202, EQU1203, EQU1204, EQU1205, EQU1206,
EQU1207, EQU1208, EQU1209, EQU1210, EQU1211, EQU1212,
EQU1213, EQU1214, EQU1215, EQU1216, EQU1217, EQU1218,
EQU1219, EQU1220, EQU1221, EQU1222, EQU1223, EQU1224,
EQU1225, EQU1226, EQU1227, EQU1228, EQU1229, EQU1230,
EQU1231, EQU1232, EQU1233, EQU1234, EQU1235, EQU1236,
EQU1237, EQU1238, EQU1239, EQU1240, EQU1241, EQU1242,
EQU1243, EQU1244, EQU1245, EQU1246, EQU1247, EQU1248,
EQU1249, EQU1250, EQU1251, EQU1252, EQU1253, EQU1254,
EQU1255, EQU1256, EQU1257, EQU1258, EQU1259, EQU1260,
EQU1261, EQU1262, EQU1263, EQU1264, EQU1265, EQU1266,
EQU1267, EQU1268, EQU1269, EQU1270, EQU1271, EQU1272,
EQU1273, EQU1274, EQU1275, EQU1276, EQU1277, EQU1278,
EQU1279, EQU1280, EQU1281, EQU1282, EQU1283, EQU1284,
EQU1285, EQU1286, EQU1287, EQU1288, EQU1289, EQU1290,
EQU1291, EQU1292, EQU1293, EQU1294, EQU1295, EQU1296,
EQU1297, EQU1298, EQU1299, EQU1300, EQU1301, EQU1302,
EQU1303, EQU1304, EQU1305, EQU1306, EQU1307, EQU1308,
EQU1309, EQU1310, EQU1311, EQU1312, EQU1313, EQU1314,
EQU1315, EQU1316, EQU1317, EQU1318, EQU1319, EQU1320,
EQU1321, EQU1322, EQU1323, EQU1324, EQU1325, EQU1326,
EQU1327, EQU1328, EQU1329, EQU1330, EQU1331, EQU1332,
EQU1333, EQU1334, EQU1335, EQU1336, EQU1337, EQU1338,
EQU1339, EQU1340, EQU1341, EQU1342, EQU1343, EQU1344,
EQU1345, EQU1346, EQU1347, EQU1348, EQU1349, EQU1350,
EQU1351, EQU1352, EQU1353, EQU1354, EQU1355, EQU1356,
EQU1357, EQU1358, EQU1359, EQU1360, EQU1361, EQU1362,
EQU1363, EQU1364, EQU1365, EQU1366, EQU1367, EQU1368,
EQU1369, EQU1370, EQU1371, EQU1372, EQU1373, EQU1374,
EQU1375, EQU1376, EQU1377, EQU1378, EQU1379, EQU1380,
EQU1381, EQU1382, EQU1383, EQU1384, EQU1385, EQU1386,
EQU1387, EQU1388, EQU1389, EQU1390, EQU1391, EQU1392,
EQU1393, EQU1394, EQU1395, EQU1396, EQU1397, EQU1398,
EQU1399, EQU1400, EQU1401, EQU1402, EQU1403, EQU1404,
EQU1405, EQU1406, EQU1407, EQU1408, EQU1409, EQU1410,
```



```
EQU1411, EQU1412, EQU1413, EQU1414, EQU1415, EQU1416,
EQU1417, EQU1418, EQU1419, EQU1420, EQU1421, EQU1422,
EQU1423, EQU1424, EQU1425, EQU1426, EQU1427, EQU1428,
EQU1429, EQU1430, EQU1431, EQU1432, EQU1433, EQU1434,
EQU1435, EQU1436, EQU1437, EQU1438, EQU1439, EQU1440,
EQU1441, EQU1442, EQU1443, EQU1444, EQU1445, EQU1446,
EQU1447, EQU1448, EQU1449, EQU1450, EQU1451, EQU1452,
EQU1453, EQU1454, EQU1455, EQU1456, EQU1457, EQU1458,
EQU1459, EQU1460, EQU1461, EQU1462, EQU1463, EQU1464,
EQU1465, EQU1466, EQU1467, EQU1468, EQU1469, EQU1470,
EQU1471, EQU1472, EQU1473, EQU1474, EQU1475, EQU1476,
EQU1477, EQU1478, EQU1479, EQU1480, EQU1481, EQU1482,
EQU1483, EQU1484, EQU1485, EQU1486, EQU1487, EQU1488,
EQU1489, EQU1490, EQU1491, EQU1492, EQU1493, EQU1494,
EQU1495, EQU1496, EQU1497, EQU1498, EQU1499, EQU1500,
EQU1501, EQU1502, EQU1503, EQU1504, EQU1505, EQU1506,
EQU1507, EQU1508, EQU1509, EQU1510, EQU1511, EQU1512,
EQU1513, EQU1514, EQU1515, EQU1516, EQU1517, EQU1518,
EQU1519, EQU1520, EQU1521, EQU1522, EQU1523, EQU1524,
EQU1525, EQU1526, EQU1527, EQU1528, EQU1529, EQU1530,
EQU1531, EQU1532, EQU1533, EQU1534, EQU1535, EQU1536,
EQU1537, EQU1538, EQU1539, EQU1540, EQU1541, EQU1542,
EQU1543, EQU1544, EQU1545, EQU1546, EQU1547, EQU1548,
EQU1549, EQU1550, EQU1551, EQU1552, EQU1553, EQU1554,
EQU1555, EQU1556, EQU1557, EQU1558, EQU1559, EQU1560,
EQU1561, EQU1562, EQU1563, EQU1564, EQU1565, EQU1566,
EQU1567, EQU1568, EQU1569, EQU1570, EQU1571, EQU1572,
EQU1573, EQU1574, EQU1575, EQU1576, EQU1577, EQU1578,
EQU1579,
INEQU1, INEQU2, INEQU3, INEQU4, INEQU5, INEQU6,
INEQU7, INEQU8, INEQU9, INEQU10, INEQU11, INEQU12,
INEQU13, INEQU14, INEQU15, INEQU16, INEQU17, INEQU18,
INEQU19, INEQU20, INEQU21, INEQU22, INEQU23, INEQU24,
INEQU25, INEQU26, INEQU27, INEQU28, INEQU29, INEQU30,
INEQU31, INEQU32, INEQU33, INEQU34, INEQU35, INEQU36,
INEQU37, INEQU38, INEQU39, INEQU40, INEQU41, INEQU42,
INEQU43, INEQU44, INEQU45, INEQU46, INEQU47, INEQU48,
INEQU49, INEQU50, ObjName;

ObjName..ObjVar=E=
Profit;

EQU1..x7C308 - x7C309 =e= 0;
EQU2..x3C308 - x3C309 =e= 0;
EQU3..TC317 - TC323 =e= 0;
EQU4..RC603*FC328 - FC329 =e= 0;
```

```
EQU5..FC323 - FC324 =e= 0;
EQU6..x1C323 - x1C324 =e= 0;
EQU7..x3C323 - x3C324 =e= 0;
EQU8..x4C323 - x4C324 =e= 0;
EQU9..x5C323 - x5C324 =e= 0;
EQU10..hHC03 -  FHC03 *  ((x1HC03/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC03,ORD(Coeff))))
+(x2HC03/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC03,ORD(Coeff))))
+(x3HC03/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC03,ORD(Coeff))))
+(x4HC03/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC03,ORD(Coeff))))
+(x5HC03/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC03,ORD(Coeff))))
+(x7HC03/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC03,ORD(Coeff))))) =e= 0;
EQU11..x1HC03 + x2HC03 + x3HC03 + x4HC03 + x5HC03 + x7HC03 =e= 1;
EQU12..FC319 * sf2S34 - FC321  =e= 0;
EQU13..x7C306 - x7C307 =e= 0;
EQU14..kWad1+KWad2 =e= WK601;
EQU15..TmK601 *FC306 =e= FC303*(TC303*(PC310/PC303)**((kK601-1)/kK601)) + FC310*TC310;
EQU16..TC306 =e= TmK601*(PC306/PC310)**((kK601-1)/kK601);
EQU17..x3C306 - x3C307 =e= 0;
EQU18..PC307=e=PC306-deltaPE634;
EQU19..dTE634**3 =e= ((TC306-TcwoutE634)*(TC307-Tcwin)*
((TC306-TcwoutE634)+(TC307-Tcwin))/2);
EQU20..xx1C312 + xx3C312 + xx4C312 + xx5C312 + xx7C312 =e= 1;
EQU21..K3C615_A * xx3C308 - xx3C312 =e= 0;
EQU22..FC312 =e= VFC615*FC307;
EQU23..(hC308 - hC309) - UE640*AE640*FE640*dTE640 =e= 0;
EQU24..x4C308 - x4C309 =e= 0;
EQU25..x5C308 - x5C309 =e= 0;
EQU26..TC310 - TC311 =e= 0;
EQU27..K4C616_A=e=0.13332*EXP(15.6782-2154.90/(TC310-34.42))/PC310;
EQU28..PC310 -PC311 =e= 0;
EQU29..K5C616_A=e=0.13332*EXP(15.5338-2348.67/(TC310-40.05))/PC310;
EQU30..K7C616_A=e=0.13332*EXP(15.7588-2633.90/(TC310-46.30))/PC310;
EQU31..PC307 - PC312 =e= 0;
EQU32..PC307 - PC308 =e= 0;
EQU33..x7C317 - x7C323 =e= 0;
EQU34..LpC603=e=FC329 + qC603*FC316;
EQU35..VpC603=e=LpC603 - FC317;
EQU36..TnC603=e=(TC325+TC316)/2;
EQU37..x1C326 - x1C329 =e= 0;
EQU38..x3C326 - x3C329 =e= 0;
EQU39..x4C326 - x4C329 =e= 0;
EQU40..x5C326 - x5C329 =e= 0;
EQU41..x7C326 -x7C329 =e= 0;
EQU42..x1C403 + x3C403 + x4C403 + x5C403 + x7C403 =e= 1;
EQU43..x1C404 + x3C404 + x4C404 + x5C404 + x7C404 =e= 1;
EQU44..x1C405 + x3C405 + x4C405 + x5C405 + x7C405 =e= 1;
```



```
EQU45..x1C406 + x3C406 + x4C406 + x5C406 + x7C406 =e= 1;
EQU46..x1C407 + x3C407 + x4C407 + x5C407 + x7C407 =e= 1;
EQU47..x1C408 + x3C408 + x4C408 + x5C408 + x7C408 =e= 1;
EQU48..x1C409 + x3C409 + x4C409 + x5C409 + x7C409 =e= 1;
EQU49..x1C410 + x3C410 + x4C410 + x5C410 + x7C410 =e= 1;
EQU50..x1C411 + x3C411 + x4C411 + x5C411 + x7C411 =e= 1;
EQU51..x1C412 + x3C412 + x4C412 + x5C412 + x7C412 =e= 1;
EQU52..x1C413 + x3C413 + x4C413 + x5C413 + x7C413 =e= 1;
EQU53..x1C414 + x3C414 + x4C414 + x5C414 + x7C414 =e= 1;
EQU54..x1C415 + x3C415 + x4C415 + x5C415 + x7C415 =e= 1;
EQU55..x1C417+ x3C417 + x4C417 + x5C417 + x7C417 =e= 1;
EQU56..x1C418 + x2C418 + x3C418 + x4C418 + x5C418 + x7C418 =e= 1;
EQU57..x1C419 + x2C419 + x3C419 + x4C419 + x5C419 + x7C419 =e= 1;
EQU58..x1C303 + x3C303 + x4C303 + x5C303 + x7C303 =e= 1;
EQU59..x1C306 + x3C306 + x4C306 + x5C306 + x7C306 =e= 1;
EQU60..x1C307 + x3C307 + x4C307 + x5C307 + x7C307 =e= 1;

EQU61..x1C308 + x3C308 + x4C308 +x5C308 + x7C308=e= 1;
EQU62..x1C309 + x3C309 + x4C309 + x5C309 + x7C309 =e= 1;
EQU63..x1C310 + x3C310 + x4C310 + x5C310 + x7C310 =e= 1;
EQU64..x1C311 + x3C311 + x4C311 + x5C311 + x7C311 =e= 1;
EQU65..x1C312 + x3C312 + x4C312 + x5C312 + x7C312 =e= 1;
EQU66..x1C315 + x3C315 + x4C315 + x5C315 + x7C315 =e= 1;
EQU67..x1C316 + x3C316 + x4C316 + x5C316 + x7C316 =e= 1;
EQU68..x1C317 + x3C317 + x4C317 + x5C317 + x7C317 =e= 1;
EQU69..x1C318 + x3C318 + x4C318 + x5C318 + x7C318 =e= 1;
EQU70..x1C319 + x3C319 + x4C319 + x5C319 + x7C319 =e= 1;
EQU71..x1C320 + x3C320 + x4C320 + x5C320 + x7C320 =e= 1;
EQU72..x1C321 + x3C321 + x4C321 + x5C321 + x7C321 =e= 1;
EQU73..x1C322 + x3C322 + x4C322 + x5C322 + x7C322 =e= 1;
EQU74..x1C323 + x3C323 + x4C323 + x5C323 + x7C323 =e= 1;
EQU75..x1C324 + x3C324 + x4C324 + x5C324 + x7C324 =e= 1;
EQU76..(hC406 - hC407) - FcwE617*4.197*(TcwoutE617 - Tcwin) =e= 0;
EQU77..(hC406 - hC407) - UE617*AE617*FE617*dTE617 =e= 0;
EQU78..(hC405 - hC406) - (hC404 - hC403) =e= 0;
EQU79..(hC405 - hC406) - UE616*AE616*dTE616*FE616 =e= 0;
EQU80..(hC408vap - hC408) - FstmE695A * hstmE695 =e= 0;
EQU81..(hC408vap - hC408) - UE695A*AE695A*dTE695A =e= 0;
EQU82..(hC410vap - hC410) - FstmE696A * hstmE696 =e= 0;
EQU83..(hC410vap - hC410) - UE696A*AE696A*dTE696A =e= 0;
EQU84..(hC412 - hC412liq) - FcwE627A*4.197*(TcwotE627A - Tcwin) =e= 0;
EQU85..(hC412 - hC412liq) - UE627A*FE627A*AE627A*dTE627A =e= 0;
```

```
EQU86..(hC414 - hC414liq) - FcwE621A*4.197*(TcwotE621A - Tcwin) =e= 0;
EQU87..(hC414 - hC414liq) - UE621A*FE621A*AE621A*dTE621A =e= 0;
EQU88..(hC418 - hC419) - FcwE626*4.197*(TcwoutE626 - Tcwin) =e= 0;
EQU89..(hC418 - hC419) - UE626*AE626*FE626*dTE626 =e= 0;
EQU90..FC306 - FC307 =e= 0;
```



```
EQU91..x1C306 - x1C307 =e= 0;
EQU92..FC414 - FC415 =e= 0;
EQU93..x1C414 - x1C415 =e= 0;
EQU94..x3C414 - x3C415 =e= 0;
EQU95..x4C414 - x4C415 =e= 0;
EQU96..x5C414 - x5C415 =e= 0;
EQU97..FC418 - FC419 =e= 0;
EQU98..x1C418 - x1C419 =e= 0;
EQU99..x3C418 - x3C419 =e= 0;
EQU100..x4C418 - x4C419 =e= 0;
EQU101..x5C418 - x5C419 =e= 0;
EQU102..hC431 -  FC431*
((x3C431/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC431,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                              ((1-TC431/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C431/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC431,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                              ((1-TC431/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C431/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC431,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                              ((1-TC431/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C431/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC431,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-TC431/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU103..hC412 -  FC412 *
((x3C412/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC412,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                              ((1-TC412/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C412/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC412,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                              ((1-TC412/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C412/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC412,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                              ((1-TC412/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C412/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC412,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-TC412/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU104..TmC603=e=(TC317+TC316)/2;
EQU105..K1C603*PC603 =e= 0.1333*10**(21.4469-1.4627E3/TnC603-5.261*LOG10(TnC603)+3.282E-11*TnC603+3.7349E-6*TnC603**2);
EQU106..Kp1C603*PC603 =e= 0.1333*10**(21.4469-1.4627E3/TmC603-5.261*LOG10(TmC603)+3.282E-11*TmC603+3.7349E-6*TmC603**2);
EQU107..K3C603*PC603 =e= 0.1333*10**(31.2541-1.9532E3/TnC603-8.806*LOG10(TnC603)+8.9246E-11*TnC603+5.7501E-6*TnC603**2);
EQU108..Kp3C603*PC603 =e= 0.1333*10**(31.2541-1.9532E3/TmC603-8.806*LOG10(TmC603)+8.9246E-11*TmC603+5.7501E-6*TmC603**2);
EQU109..K4C603*PC603 =e= 0.1333*10**(27.0441-1.9049E3/TnC603-7.1805*LOG10(TnC603)-6.6845E-11*TnC603+4.219E-6*TnC603**2);
EQU110..Kp4C603*PC603 =e= 0.1333*10**(27.0441-1.9049E3/TmC603-7.1805*LOG10(TmC603)-6.6845E-11*TmC603+4.219E-6*TmC603**2);
EQU111..K5C603*PC603 =e= 0.1333*10**(29.2963-2.1762E3/TnC603-7.883*LOG10(TnC603)-4.6512E-11*TnC603+3.8997E-6*TnC603**2);
EQU112..Kp5C603*PC603 =e= 0.1333*10**(29.2963-2.1762E3/TmC603-7.883*LOG10(TmC603)-4.6512E-11*TmC603+3.8997E-6*TmC603**2);
EQU113..K7C603*PC603 =e= 0.1333*10**(33.0162-2.583E3/TnC603-9.042*LOG10(TnC603)-1.371E-12*TnC603+3.634E-6*TnC603**2);
EQU114..Kp7C603*PC603 =e= 0.1333*10**(33.0162-2.583E3/TmC603-9.042*LOG10(TmC603)-1.371E-12*TmC603+3.634E-6*TmC603**2);
EQU115..Sn1C603 *FC329 =e= K1C603*FC325;
EQU116..Sm1C603*LpC603=e= Kp1C603*VpC603;
EQU117..Sn3C603 *FC329 =e= K3C603*FC325;
EQU118..Sm3C603*LpC603=e= Kp3C603*VpC603;
EQU119..Sn4C603 *FC329 =e= K4C603*FC325;
EQU120..(hC306 - hC307) - FcwE634*4.197*(TcwoutE634 - Tcwin) =e= 0;
```



```
EQU121..(hC306 - hC307) - UE634*AE634*FE634*dTE634 =e= 0;
EQU122..(hC312liq - hC315) - FcwE641B*4.197*(TcwotE641B - Tcwin) =e= 0;
EQU123..(hC312liq - hC315) - UE641*AE641*FE641*dTE641 =e= 0;
EQU124..(hC325 - hC326) - FcwE613*4.197*(TcwoutE613 - Tcwin) =e= 0;
EQU125..(hC325 - hC326) - UE613*AE613*dTE613 =e= 0;
EQU126..(hC324 - hC323) - FstmE612 * hstmE612 =e= 0;
EQU127..(hC324 - hC323) - UE612*AE612*dTE612 =e= 0;
EQU128..FC325 - FC326 =e= 0;
EQU129..FC405 - FC406 =e= 0;
EQU130..hC409 -  FC409 *
((x1C408/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC408,ORD(Coeff))))
 +(x3C408/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC408,ORD(Coeff))))
 +(x4C408/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC408,ORD(Coeff))))
 +(x5C409/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC409,ORD(Coeff))))
 +(x7C409/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC409,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-TC409/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU131..hC428 -  FC428 *
((x3C428/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC428,ORD(Coeff))))
 +(x4C428/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC428,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                              ((1-TC428/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C428/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC428,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                              ((1-TC428/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C428/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC428,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-TC428/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU132..Sm4C603*LpC603=e= Kp4C603*VpC603;
EQU133..Sn5C603 *FC329 =e= K5C603*FC325;
EQU134..Sm5C603*LpC603=e= Kp5C603*VpC603;
EQU135..Sn7C603 *FC329 =e= K7C603*FC325;
EQU136..Sm7C603*LpC603=e= Kp7C603*VpC603;
EQU137..f1C603*((1-Sn1C603**(40-17))/1E2+ RC603*(1-Sn1C603) /1E2+  h1C603*Sn1C603**(40-17)*(1-Sm1C603**(17+1))/1E2) =e=
                                (1-Sn1C603**(40-17))/1E2+ RC603*(1-Sn1C603)/1E2;
EQU138..f3C603*((1-Sn3C603**(40-17))+ RC603*(1-Sn3C603) +  h3C603*Sn3C603**(40-17)*(1-Sm3C603**(17+1))) =e=  (1-Sn3C603**(40-1
                                          7))+ RC603*(1-Sn3C603);
```

```
EQU139..f4C603*((1-Sn4C603**(40-17))+ RC603*(1-Sn4C603) +  h4C603*Sn4C603**(40-17)*(1-Sm4C603**(17+1))) =e=  (1-Sn4C603**(40-1
                                                                    7))+ RC603*(1-Sn4C603);
EQU140..f5C603*((1-Sn5C603**(40-17))+ RC603*(1-Sn5C603) +  h5C603*Sn5C603**(40-17)*(1-Sm5C603**(17+1))) =e=  (1-Sn5C603**(40-1
                                                                    7))+ RC603*(1-Sn5C603);
EQU141..f7C603*((1-Sn7C603**(40-17))+ RC603*(1-Sn7C603) +  h7C603*Sn7C603**(40-17)*(1-Sm7C603**(17+1))) =e=  (1-Sn7C603**(40-1
                                                                    7))+ RC603*(1-Sn7C603);
EQU142..f1C603 * x1C316 * FC316 =e= x1C317 * FC317;
EQU143..f3C603 * x3C316 * FC316 =e= x3C317 * FC317;
EQU144..f4C603 * x4C316 * FC316 =e= x4C317 * FC317;
EQU145..f5C603 * x5C316 * FC316 =e= x5C317 * FC317;
EQU146..f7C603 * x7C316 * FC316 =e= x7C317 * FC317;
EQU147..h1C603*K1C603*LpC603*(1-Sm1C603) =e= Kp1C603*FC329*(1-Sn1C603);
EQU148..h3C603*K3C603*LpC603*(1-Sm3C603) =e= Kp3C603*FC329*(1-Sn3C603);
```



```
EQU149..h4C603*K4C603*LpC603*(1-Sm4C603) =e= Kp4C603*FC329*(1-Sn4C603);
EQU150..h5C603*K5C603*LpC603*(1-Sm5C603) =e= Kp5C603*FC329*(1-Sn5C603);
EQU151..h7C603*K7C603*LpC603*(1-Sm7C603) =e= Kp7C603*FC329*(1-Sn7C603);
EQU152..K1C323*PC603 =e= 0.1333*10**(21.4469-1.4627E3/TC323-5.261*LOG10(TC323)+3.282E-11*TC323+3.7349E-6*TC323**2);
EQU153..K3C323*PC603 =e= 0.1333*10**(31.2541-1.9532E3/TC323-8.806*LOG10(TC323)+8.9246E-11*TC323+5.7501E-6*TC323**2);
EQU154..K4C323*PC603 =e= 0.1333*10**(27.0441-1.9049E3/TC323-7.1805*LOG10(TC323)-6.6845E-11*TC323+4.219E-6*TC323**2);
EQU155..K5C323*PC603 =e= 0.1333*10**(29.2963-2.1762E3/TC323-7.883*LOG10(TC323)-4.6512E-11*TC323+3.8997E-6*TC323**2);
EQU156..K7C323*PC603 =e= 0.1333*10**(33.0162-2.583E3/TC323-9.042*LOG10(TC323)-1.371E-12*TC323+3.634E-6*TC323**2);
EQU157..K1C323*xx1C323+K3C323*xx3C323+K4C323*xx4C323+K5C323*xx5C323+K7C323*xx7C323 =e= 1;
EQU158..FmC323 - FC323 * (x1C323/MW1 + x3C323/MW3 + x4C323/MW4 + x5C323/MW5 + x7C323/MW7)=e= 0;
EQU159..xx1C323 * MW1 * FmC323 - FC323 *x1C323=e= 0;
EQU160..xx3C323 * MW3 * FmC323 - FC323 *x3C323=e= 0;
EQU161..xx4C323 * MW4 * FmC323 - FC323 *x4C323=e= 0;
EQU162..xx5C323 * MW5 * FmC323 - FC323 *x5C323=e= 0;
EQU163..xx1C323+xx3C323+xx4C323+xx5C323+xx7C323 =e= 1;
EQU164..dTE613*2  =e=
(TC325-TcwoutE613) + (TC326-Tcwin);
EQU165..x1C325 -x1C326 =e=0;
EQU166..x3C325 -x3C326 =e=0;
EQU167..x4C325 -x4C326 =e=0;
EQU168..FC418 - FC417 - FC415  =e= 0;
EQU169..(hC317 - hC318) - (hC316 - hC315) =e= 0;
EQU170..(hC317 - hC318) - UE610*AE610*dTE610*FE610 =e= 0;
EQU171..(hC318 - hC319) - FcwE611*4.197*(TcwoutE611 - Tcwin) =e= 0;
EQU172..(hC318 - hC319) - UE611*AE611*FE611*dTE611 =e= 0;
EQU173..FC317 - FC318 =e= 0;
EQU174..FC318 - FC319 =e= 0;
EQU175..x1C318 - x1C319 =e= 0;
EQU176..x3C318 - x3C319 =e= 0;
EQU177..x4C318 - x4C319 =e= 0;
EQU178..x5C318 - x5C319 =e= 0;
EQU179..x1C405 - x1C406 =e= 0;
EQU180..x5C325 -x5C326 =e=0;
EQU181..x1C325 + x3C325 +x4C325 +x5C325 +x7C325  =e= 1;
EQU182..x1C326 + x3C326 +x4C326 +x5C326 +x7C326  =e= 1;
EQU183..TC325-TC326 =e= 0;
EQU184..x1C326 -x1C328 =e= 0;
EQU185..x3C326 -x3C328 =e= 0;
EQU186..x4C326 -x4C328 =e= 0;
EQU187..x5C326 -x5C328 =e= 0;
EQU188..x7C326 -x7C328 =e= 0;
EQU189..K1C325*PC603 =e= 0.1333*10**(21.4469-1.4627E3/TC325-5.261*LOG10(TC325)+3.282E-11*TC325+3.7349E-6*TC325**2);
EQU190..K3C325*PC603 =e= 0.1333*10**(31.2541-1.9532E3/TC325-8.806*LOG10(TC325)+8.9246E-11*TC325+5.7501E-6*TC325**2);
EQU191..K4C325*PC603 =e= 0.1333*10**(27.0441-1.9049E3/TC325-7.1805*LOG10(TC325)-6.6845E-11*TC325+4.219E-6*TC325**2);
EQU192..K5C325*PC603 =e= 0.1333*10**(29.2963-2.1762E3/TC325-7.883*LOG10(TC325)-4.6512E-11*TC325+3.8997E-6*TC325**2);
EQU193..K7C325*PC603 =e= 0.1333*10**(33.0162-2.583E3/TC325-9.042*LOG10(TC325)-1.371E-12*TC325+3.634E-6*TC325**2);
```



```
EQU194..xx1C325/K1C325+xx3C325/K3C325+xx4C325/K4C325+xx5C325/K5C325+xx7C325/K7C325 =e= 1;
EQU195..FmC325 - FC325 * (x1C325/MW1 + x3C325/MW3 + x4C325/MW4 + x5C325/MW5 + x7C325/MW7)=e= 0;
EQU196..xx1C325 * MW1 * FmC325 - FC325 *x1C325=e= 0;
EQU197..xx3C325 * MW3 * FmC325 - FC325 *x3C325=e= 0;
EQU198..xx4C325 * MW4 * FmC325 - FC325 *x4C325=e= 0;
EQU199..xx5C325 * MW5 * FmC325 - FC325 *x5C325=e= 0;
EQU200..xx1C325+xx3C325+xx4C325+xx5C325+xx7C325 =e= 1;
EQU201..hC309-hC310-hC311=e=0;
EQU202..FAC07*x11AC07 - FAC09*x11AC09 - 0.06*2.02*FHC07*x2HC07/(rho2HC07/1000) =e= 0;
EQU203..1000*FAC09*xiC11AC09 -riC11C623 * VaC623 * MWiC11 =e= 0;
EQU204..1000*FAC09*xiC10AC09 - riC10C623*VaC623*MWiC10 =e= 0;
EQU205..FHC07 +FHC34 + FAC07 =e= FAC09;
EQU206..1000*FAC09*x10AC09 - r10C623*VaC623*MW10 =e= 0;
EQU207..1000*FAC09*x9AC09 - r9C623*VaC623*MW9 =e= 0;
EQU208..1000*FAC09*x8AC09 - r8C623*VaC623*MW8 =e= 0;
EQU209..1000*(FHC07*x7HC07 + FHC34*x7HC34 - FAC09*x7AC09)  + r7C623*VaC623*MW7 =e= 0;
EQU210..FC326 - FC328 - FC329 =e= 0;
EQU211..TC326 - TC328 =e= 0;
EQU212..TC326 - TC329 =e= 0;
EQU213..1000*(FHC07*x5HC07 + FHC34*x5HC34 - FAC09*x5AC09)  + r5C623*VaC623*MW5 =e= 0;
EQU214..1000*(FHC07*x4HC07 + FHC34*x4HC34 - FAC09*x4AC09)  + r4C623*VaC623*MW4 =e= 0;
EQU215..1000*(FHC07*x3HC07 + FHC34*x3HC34 - FAC09*x3AC09)  - r3C623*VaC623*MW3 =e= 0;
EQU216..FHC07*x1HC07 + FHC34*x1HC34 - FAC09*x1AC09 =e= 0;
EQU217..r4C623 =e= k2/1E12*C4pC623*C3C623;
EQU218..r5C623 =e= k3/1E12*C5pC623*C3C623;
```

```
EQU219..r7C623 =e= k4/1E14*C7pC623 * C3C623;
EQU220..r9C623 =e=  k6/1E12*C9pC623 * C3C623;
EQU221..r10C623 =e= k7/1E12*C10pC623 * C3C623;
EQU222..riC10C623  =e= k8/1E12* CiC10pC623 * C3C623;
EQU223..r8C623 =e= k5/1E12*C8pC623*C3C623;
EQU224..riC11C623 =e=k18/1E12*CiC11pC623*C3C623;
EQU225..-r3C623 + r4C623 + r5C623 + r7C623 + r8C623 + r9C623 + r10C623 + riC10C623+ riC11C623 =e= 0;
EQU226..1000*(FHC07*x2HC07 - FAC09*x2AC09) - r2C623*VaC623*MW2 =e= 0;
EQU227..-r2C623 + k1/1E6*C2C623*CHXC623 + k11/(1E9*1E6)*C3pC623 *C2C623 + k15/(1E12*1E6)*C8pC623*C2C623 + k19/(1E14*1E6)
                                                                   *C7pC623*C2C623=e=0;
EQU228..k9/1E9*C3pC623 - k10/(1E6*1E9)*CiC4eC623*C3pC623 =e= 0;
EQU229..k13/(1E11*1E9)*CiC8eC623*C3pC623 +k17/1E12*CiC11pC623 - k14/1E11*CiC5eC623*CHXC623 - k16/(1E11*1E9)*CiC5eC623*C3pC623
                                                                          =e= 0;
EQU230..k12/1E12*C9pC623 - k13/(1E11*1E9)*CiC8eC623*C3pC623 =e=0;
EQU231..k1/1E6*C2C623*CHXC623 - k2/1E12*C4pC623*C3C623 =e= 0;
EQU232..r3C623 - k9/1E9*C3pC623 - k10/(1E6*1E9)*CiC4eC623*C3pC623 - k11/(1E6*1E9)*C3pC623*C2C623 - k13/(1E11*1E9)
                               *CiC8eC623*C3pC623 - k16/(1E11*1E9) * CiC5eC623*C3pC623 =e= 0;
EQU233..k14/1E11*CiC5eC623*CHXC623 - k3/1E12*C5pC623*C3C623 =e=0;
EQU234..k17/1E12*CiC11pC623 - k4/1E14*C7pC623*C3C623 - k19/(1E6*1E14)*C7pC623*C2C623 =e= 0;
EQU235..C2C623 /1E6=e= rhoAC09*x2AC09/MW2;
EQU236..C3C623 =e= rhoAC09*x3AC09/MW3;
```



```
EQU237..CHXC623 =e= rhoAC09*x11AC09/MW11;
EQU238..FAC09*x1AC09 - FHC27*x1HC27 =e=0;
EQU239..FAC09*x2AC09 - FHC27*x2HC27 =e=0;
EQU240..FAC09*x3AC09 - FHC27*x3HC27 =e=0;
EQU241..FAC09*x4AC09 - FHC27*x4HC27 =e=0;
EQU242..FAC09*x5AC09 - FHC27*x5HC27 =e=0;
EQU243..x11AC05 - x11AC12 =e=0;
EQU244..FAC05*x11AC05 - sfC631*FAC09*x11AC09 =e=0;
EQU245..FAC05*x12AC05 - sfC631*FAC09*x12AC09 =e=0;
EQU246..FAC09*(x11AC09 + x12AC09) - FAC05 - FAC12 =e=0;
EQU247..FAC09*(x7AC09+x8AC09+x9AC09+x10AC09+xiC10AC09+xiC11AC09) - FHC27*x7HC27 =e= 0;
EQU248..x11AC07 + x12AC07 =e= 1;
EQU249..K3C616_A * xx3C311 - xx3C310 =e= 0;
EQU250..FC310 =e= VFC616*FC309;
EQU251..FC309 - FC310 - FC311 =e= 0;
EQU252..FC309 * x1C309 - FC311 * x1C311 - FC310 * x1C310 =e= 0;
EQU253..FC309 * x3C309 - FC310 * x3C310 - FC311 * x3C311 =e= 0;
EQU254..FC309 * x4C309 - FC310 * x4C310 - FC311 * x4C311 =e= 0;
EQU255..FC309 * x5C309 - FC310 * x5C310 - FC311 * x5C311 =e= 0;
EQU256..K1C616_A* xx1C311 - xx1C310 =e= 0;
EQU257..K7C616_A * xx7C311 - xx7C310 =e= 0;
EQU258..K4C616_A * xx4C311 - xx4C310 =e= 0;
EQU259..x1AC09 + x2AC09 + x3AC09 + x4AC09 + x5AC09 +x7AC09 + x8AC09 + x9AC09 + x10AC09 + x11AC09 + x12AC09 + xiC10AC09 +
                                                                      xiC11AC09 =e= 1;
EQU260..FAC07 -FAC05 - FAC02 =e= 0;
EQU261..FAC07*x11AC07 -FAC05*x11AC05 - FAC02*x11AC02 =e= 0;
EQU262..x11AC05+x12AC05 =e=1;
EQU263..x11AC02+x12AC02 =e=1;
EQU264..k13/(1E11*1E9)*C3pC623*CiC8eC623 - k5/1E12*C8pC623*C3C623 -k15/(1E6*1E12)*C8pC623*C2C623 =e= 0;
EQU265..k11/(1E6*1E9)*C2C623*C3pC623 + k10/(1E6*1E9)*C3pC623*CiC4eC623 - k6/1E12*C9pC623*C3C623 - k12/1E12*C9pC623 =e= 0;
EQU266..k16/(1E11*1E9)*CiC5eC623*C3pC623 - k7/1E12*C10pC623*C3C623 =e= 0;
EQU267..k19/(1E6*1E14)*C7pC623*C2C623 - k8/1E12*CiC10pC623*C3C623 =e= 0;
EQU268..k15/(1E6*1E12)*C8pC623*C2C623 - k18/1E12*CiC11pC623*C3C623 - k17/1E12*CiC11pC623 =e= 0;
EQU269..x7C325 -x7C326 =e=0;
EQU270..TC323 - TC324 =e= 0;
EQU271..dTE612 =e= 414.6 - TC323;
EQU272..K1C615_A*PC308 =e= 0.1333*10**(21.4469-1.4627E3/TC308-5.261*LOG10(TC308)+3.282E-11*TC308+3.7349E-6*TC308**2);
EQU273..K3C615_A*PC308 =e= 0.1333*10**(31.2541-1.9532E3/TC308-8.806*LOG10(TC308)+8.9246E-11*TC308+5.7501E-6*TC308**2);
EQU274..K4C615_A=e=0.13332*EXP(15.6782-2154.90/(TC308-34.42))/PC308;
EQU275..K5C615_A=e=0.13332*EXP(15.5338-2348.67/(TC308-40.05))/PC308;
EQU276..K7C615_A=e=0.13332*EXP(15.7588-2633.90/(TC308-46.30))/PC308;
EQU277..K1C616_A*PC310 =e= 0.1333*10**(21.4469-1.4627E3/TC310-5.261*LOG10(TC310)+3.282E-11*TC310+3.7349E-6*TC310**2);
EQU278..K3C616_A*PC310 =e= 0.1333*10**(31.2541-1.9532E3/TC310-8.806*LOG10(TC310)+8.9246E-11*TC310+5.7501E-6*TC310**2);
EQU279..x11AC12+x12AC12 =e=1;
EQU280..FAC18 -FAC12 - FAC15 =e= 0;
EQU281..FAC18*x11AC18 -FAC12*x11AC12 - FAC15*x11AC15 =e= 0;
```



```
EQU282..x11AC15+x12AC15 =e=1;
EQU283..x11AC18 + x12AC18 =e= 1;
EQU284..1000*(FHC11*x7HC11 + FHC38*x7HC38 - FAC20*x7AC20)  + r7C625*VaC623*MW7 =e= 0;
EQU285..r10C625 =e= k7/1E12*C10pC625 * C3C625;
EQU286..r9C625 =e=  k6/1E12*C9pC625 * C3C625;
EQU287..r7C625 =e= k4/1E14*C7pC625 * C3C625;
EQU288..r5C625 =e= k3/1E12*C5pC625*C3C625;
EQU289..K5C616_A * xx5C311 - xx5C310 =e= 0;
EQU290..FmC310 - FC310 * (x1C310/MW1 + x3C310/MW3 +x4C310/MW4 + x5C310/MW5 + x7C310/MW7)=e= 0;
EQU291..xx1C310*MW1*FmC310 - FC310 * x1C310 =e= 0;
EQU292..xx3C310 * MW3 * FmC310 - FC310 * x3C310 =e= 0;
EQU293..xx4C310 * MW4 * FmC310 - FC310 * x4C310 =e= 0;
EQU294..xx5C310 * MW5 * FmC310 - FC310 * x5C310 =e= 0;
EQU295..xx1C310 + xx3C310 + xx4C310 + xx5C310 + xx7C310 =e=1
;
EQU296..FmC311 - FC311 * (x1C311/MW1 + x3C311/MW3 + x4C311/MW4 + x5C311/MW5 + x7C311/MW7 )=e= 0;
EQU297..xx1C311 * MW1 * FmC311 - FC311 * x1C311 =e= 0;
```

```
EQU298..xx3C311 * MW3 * FmC311 - FC311 * x3C311 =e= 0;
EQU299..xx4C311 * MW4 * FmC311 - FC311 * x4C311 =e= 0;
EQU300..xx5C311 * MW5 * FmC311 - FC311 * x5C311 =e= 0;
EQU301..xx1C311+ xx3C311 + xx4C311 + xx5C311 + xx7C311 =e= 1;
EQU302..FC306 * x1C306 - FC303 * x1C303 - FC310 * x1C310  =e= 0;
EQU303..FC306 * x3C306 - FC303 * x3C303 - FC310 * x3C310  =e= 0;
EQU304..FC306 * x4C306 - FC303 * x4C303 - FC310 * x4C310  =e= 0;
EQU305..FC306 * x5C306 - FC303 * x5C303 - FC310 * x5C310  =e= 0;
EQU306..r4C625 =e= k2/1E12*C4pC625*C3C625;
EQU307..FHC11*x1HC11 + FHC38*x1HC38 - FAC20*x1AC20 =e= 0;
EQU308..1000*(FHC11*x3HC11 + FHC38*x3HC38 - FAC20*x3AC20)  - r3C625*VaC623*MW3 =e= 0;
EQU309..FAC18*x11AC18 - FAC20*x11AC20 - 0.06*2.02*FHC11*x2HC11/(rho2HC11/1000) =e= 0;
EQU310..1000*(FHC11*x5HC11 + FHC38*x5HC38 - FAC20*x5AC20)  + r5C625*VaC623*MW5 =e= 0;
EQU311..riC11C625 =e=k18/1E12*CiC11pC625*C3C625;
EQU312..1000*FAC20*x8AC20 - r8C625*VaC623*MW8 =e= 0;
EQU313..1000*FAC20*x9AC20 - r9C625*VaC623*MW9 =e= 0;
EQU314..1000*FAC20*x10AC20 - r10C625*VaC623*MW10 =e= 0;
EQU315..FHC11 +FHC38 + FAC18 =e= FAC20;
EQU316..1000*FAC20*xiC10AC20 - riC10C625*VaC623*MWiC10 =e= 0;
EQU317..1000*FAC20*xiC11AC20 -riC11C625 * VaC623 * MWiC11 =e= 0;
EQU318..1000*(FHC11*x4HC11 + FHC38*x4HC38 - FAC20*x4AC20)  + r4C625*VaC623*MW4 =e= 0;
EQU319..r3C625 - k9/1E9*C3pC625 - k10/(1E6*1E9)*CiC4eC625*C3pC625 - k11/(1E6*1E9)*C3pC625*C2C625 - k13/(1E11*1E9)
                                   *CiC8eC625*C3pC625 - k16/(1E11*1E9) * CiC5eC625*C3pC625 =e= 0;
EQU320..k19/(1E6*1E14)*C7pC625*C2C625 - k8/1E12*CiC10pC625*C3C625 =e= 0;
EQU321..k16/(1E11*1E9)*CiC5eC625*C3pC625 - k7/1E12*C10pC625*C3C625 =e= 0;
EQU322..k11/(1E6*1E9)*C2C625*C3pC625 + k10/(1E6*1E9)*C3pC625*CiC4eC625 - k6/1E12*C9pC625*C3C625 - k12/1E12*C9pC625 =e= 0;
EQU323..k13/(1E11*1E9)*C3pC625*CiC8eC625 - k5/1E12*C8pC625*C3C625 -k15/(1E6*1E12)*C8pC625*C2C625 =e= 0;
EQU324..CHXC625 =e= rhoAC20*x11AC20/MW11;
EQU325..C3C625 =e= rhoAC20*x3AC20/MW3;
```



```
EQU326..C2C625/1E6 =e= rhoAC20*x2AC20/MW2;
EQU327..riC10C625  =e= k8/1E12* CiC10pC625 * C3C625;
EQU328..k14/1E11*CiC5eC625*CHXC625 - k3/1E12*C5pC625*C3C625 =e=0;
EQU329..r8C625 =e= k5/1E12*C8pC625*C3C625;
EQU330..k1/1E6*C2C625*CHXC625 - k2/1E12*C4pC625*C3C625 =e= 0;
EQU331..k12/1E12*C9pC625 - k13/(1E11*1E9)*CiC8eC625*C3pC625 =e=0;
EQU332..k13/(1E11*1E9)*CiC8eC625*C3pC625 +k17/1E12*CiC11pC625 - k14/1E11*CiC5eC625*CHXC625 - k16/(1E11*1E9)*CiC5eC625*C3pC625
                                                                              =e= 0;
EQU333..k9/1E9*C3pC625 - k10/(1E6*1E9)*CiC4eC625*C3pC625 =e= 0;
EQU334..-r2C625 + k1/1E6*C2C625*CHXC625 + k11/(1E9*1E6)*C3pC625 *C2C625 + k15/(1E12*1E6)*C8pC625*C2C625 + k19/(1E14*1E6)
                                                                      *C7pC625*C2C625=e=0;
EQU335..1000*(FHC11*x2HC11 - FAC20*x2AC20) - r2C625*VaC623*MW2 =e= 0;
EQU336..-r3C625 + r4C625 + r5C625 + r7C625 + r8C625 + r9C625 + r10C625 + riC10C625+ riC11C625 =e= 0;
EQU337..k15/(1E6*1E12)*C8pC625*C2C625 - k18/1E12*CiC11pC625*C3C625 - k17/1E12*CiC11pC625 =e= 0;
EQU338..k17/1E12*CiC11pC625 - k4/1E14*C7pC625*C3C625 - k19/(1E6*1E14)*C7pC625*C2C625 =e= 0;
EQU339..x1HC08 + x2HC08 + x3HC08 + x4HC08 + x5HC08 + x7HC08 =e= 1;
EQU340..FC307 - FC308 - FC312 =e= 0;
EQU341..FC307 * x1C307 - FC308 * x1C308 - FC312 * x1C312 =e= 0;
EQU342..FC307 * x3C307 - FC308 * x3C308 - FC312 * x3C312 =e= 0;
EQU343..FC307 * x4C307 - FC308 * x4C308 - FC312 * x4C312 =e= 0;
EQU344..FC307 * x5C307 - FC308 * x5C308 - FC312 * x5C312 =e= 0;
EQU345..x1AC20 + x2AC20 + x3AC20 + x4AC20 + x5AC20 +x7AC20 + x8AC20 + x9AC20 + x10AC20 + x11AC20 + x12AC20 + xiC10AC20 +
                                                                        xiC11AC20 =e= 1;
EQU346..FAC20*(x7AC20+x8AC20+x9AC20+x10AC20+xiC10AC20+xiC11AC20) - FHC25*x7HC25 =e= 0;
EQU347..FAC20*(x11AC20 + x12AC20) - FAC15 - FAC23 =e=0;
EQU348..FAC15*x12AC15 - sfC632*FAC20*x12AC20 =e=0;
EQU349..FAC15*x11AC15 - sfC632*FAC20*x11AC20 =e=0;
EQU350..x11AC15 - x11AC23 =e=0;
EQU351..FAC20*x5AC20 - FHC25*x5HC25 =e=0;
EQU352..FAC20*x4AC20 - FHC25*x4HC25 =e=0;
EQU353..FAC20*x3AC20 - FHC25*x3HC25 =e=0;
EQU354..FAC20*x2AC20 - FHC25*x2HC25 =e=0;
EQU355..FAC20*x1AC20 - FHC25*x1HC25 =e=0;
EQU356..dTE641**3 - ((TC312-TcwotE641B)*(TC315-Tcwin)*
((TC312-TcwotE641B)+(TC315-Tcwin))/2) =e= 0;
EQU357..dTE611**3  =e= ((TC318-TcwoutE611)*(TC319-Tcwin)*
((TC318-TcwoutE611)+(TC319-Tcwin))/2);
EQU358..dTE610**3  =e=  ((TC317-TC316)*(TC318-TC315)*
((TC317-TC316)+(TC318-TC315))/2);
EQU359..x11AC23+x12AC23 =e=1;
EQU360..x11AC29 + x12AC29 =e= 1;
EQU361..x11AC26+x12AC26 =e=1;
EQU362..x1AC31 + x2AC31 + x3AC31 + x4AC31 + x5AC31 +x7AC31 + x8AC31 + x9AC31 + x10AC31 + x11AC31 + x12AC31 + xiC10AC31 +
                                                                        xiC11AC31 =e= 1;
EQU363..Q2HC14 - FHC14 * x2HC14/(rho2HC14/1000) =e= 0;
EQU364..QHC14 - FHC14/0.575 =e= 0;
```



```
EQU365..x1HC14 + x2HC14 + x3HC14 + x4HC14 + x5HC14 + x7HC14 =e= 1;
EQU366..QHC41 - FHC41/0.575 =e= 0;
EQU367..x1HC41 +x3HC41 + x4HC41 + x5HC41 + x7HC41 =e= 1;
EQU368..FAC29 -FAC23 - FAC26 =e= 0;
EQU369..FAC29*x11AC29 -FAC23*x11AC23 - FAC26*x11AC26 =e= 0;
EQU370..FAC31*x1AC31 - FHC23*x1HC23 =e=0;
EQU371..FAC31*x2AC31 - FHC23*x2HC23 =e=0;
EQU372..FAC31*x3AC31 - FHC23*x3HC23 =e=0;
EQU373..FAC31*x4AC31 - FHC23*x4HC23 =e=0;
```

```
EQU374..K1C615_A * xx1C308 - xx1C312 =e= 0;
EQU375..K7C615_A * xx7C308 - xx7C312 =e= 0;
EQU376..K4C615_A * xx4C308 - xx4C312 =e= 0;
EQU377..K5C615_A * xx5C308 - xx5C312 =e= 0;
EQU378..TC312 - TC308 =e= 0;
EQU379..TC312 - TC307 =e= 0;
EQU380..FmC312 - FC312 * (x1C312/MW1 + x3C312/MW3 + x4C312/MW4 + x5C312/MW5 + x7C312/MW7)=e= 0;
EQU381..xx1C312 * MW1 * FmC312 - FC312 * x1C312 =e= 0 ;
EQU382..xx3C312 * MW3 * FmC312 - FC312 * x3C312 =e= 0 ;
EQU383..xx4C312 * MW4 * FmC312 - FC312 * x4C312 =e= 0 ;
EQU384..xx5C312 * MW5 * FmC312 - FC312 * x5C312 =e= 0 ;
EQU385..FmC308 - FC308 * (x1C308/MW1 + x3C308/MW3 + x4C308/MW4 + x5C308/MW5 + x7C308/MW7)=e= 0;
EQU386..xx1C308 * MW1 * FmC308 - FC308 *x1C308=e= 0;
EQU387..xx3C308 * MW3 * FmC308 - FC308 *x3C308=e= 0;
EQU388..xx4C308 * MW4 * FmC308 - FC308 *x4C308=e= 0;
EQU389..xx5C308 * MW5 * FmC308 - FC308 *x5C308=e= 0;
EQU390..xx1C308+ xx3C308+ xx4C308+ xx5C308+ xx7C308=e=1;
EQU391..FC306 - FC303 - FC310  =e= 0;
EQU392..1000*kWad1=e= kK601/(kK601 -1)*FC303*8314/55.5*TC303*((PC310/PC303)**((kK601 -1)/kK601) -1);
EQU393..1000*kWad2=e= kK601/(kK601 -1)*FC306*8314/55.5*TmK601*((PC306/PC310)**((kK601 -1)/kK601) -1);
EQU394..hC307 -  FC307 *  ((x1C307/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC307,ORD(Coeff))))
+(x3C307/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC307,ORD(Coeff))))
+(x4C307/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC307,ORD(Coeff))))
+(x5C307/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC307,ORD(Coeff))))
+(x7C307/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC307,ORD(Coeff))))) =e= 0;
EQU395..x4C306 - x4C307 =e= 0;
EQU396..x5C306 - x5C307 =e= 0;
EQU397..FC312 - FC315 =e= 0;
EQU398..x1C312 - x1C315 =e= 0;
EQU399..FC315 - FC316 =e= 0;
EQU400..x1C315 - x1C316 =e= 0;
EQU401..x3C315 - x3C316 =e= 0;
EQU402..PC309=e=PC308-deltaPE640;
EQU403..dTE640**3=e= ((TC308-TcwoutE640)*(TC309-Tcwin)*
((TC308-TcwoutE640)+(TC309-Tcwin))/2);
EQU404..x3C405 - x3C406 =e= 0;
EQU405..FC406 - FC407 =e= 0;
```



```
EQU406..x1C406 - x1C407 =e= 0;
EQU407..FC410 - FC411 =e= 0;
EQU408..x3C312 -  x3C315 =e= 0;
EQU409..x4C312 - x4C315 =e= 0;
EQU410..x5C312 -  x5C315 =e= 0;
EQU411..FAC31*x5AC31 - FHC23*x5HC23 =e=0;
EQU412..x11AC26 - x11AC34 =e=0;
EQU413..FAC26*x11AC26 - sfC633*FAC31*x11AC31 =e=0;
EQU414..FAC26*x12AC26 - sfC633*FAC31*x12AC31 =e=0;
EQU415..FAC31*(x11AC31 + x12AC31) - FAC26 - FAC34 =e=0;
EQU416..FAC31*(x7AC31+x8AC31+x9AC31+x10AC31+xiC10AC31+xiC11AC31) - FHC23*x7HC23 =e= 0;
EQU417..FAC29*x11AC29 - FAC31*x11AC31 - 0.06*2.02*FHC14*x2HC14/(rho2HC14/1000) =e= 0;
EQU418..1000*(FHC14*x7HC14 + FHC41*x7HC41 - FAC31*x7AC31)  + r7C627*VaC623*MW7 =e= 0;
EQU419..1000*FAC31*xiC11AC31 -riC11C627 * VaC623 * MWiC11 =e= 0;
EQU420..1000*FAC31*xiC10AC31 - riC10C627*VaC623*MWiC10 =e= 0;
EQU421..FHC14 +FHC41 + FAC29 =e= FAC31;
EQU422..1000*FAC31*x10AC31 - r10C627*VaC623*MW10 =e= 0;
EQU423..1000*FAC31*x9AC31 - r9C627*VaC623*MW9 =e= 0;
EQU424..1000*FAC31*x8AC31 - r8C627*VaC623*MW8 =e= 0;
EQU425..r3C627 - k9/1E9*C3pC627 - k10/(1E6*1E9)*CiC4eC627*C3pC627 - k11/(1E6*1E9)*C3pC627*C2C627 - k13/(1E11*1E9)
                              *CiC8eC627*C3pC627 - k16/(1E11*1E9) * CiC5eC627*C3pC627 =e= 0;
EQU426..1000*(FHC14*x5HC14 + FHC41*x5HC41 - FAC31*x5AC31)  + r5C627*VaC623*MW5 =e= 0;
EQU427..k19/(1E6*1E14)*C7pC627*C2C627 - k8/1E12*CiC10pC627*C3C627 =e= 0;
EQU428..1000*(FHC14*x3HC14 + FHC41*x3HC41 - FAC31*x3AC31)  - r3C627*VaC623*MW3 =e= 0;
EQU429..FHC14*x1HC14 + FHC41*x1HC41 - FAC31*x1AC31 =e= 0;
EQU430..r4C627 =e= k2/1E12*C4pC627*C3C627;
EQU431..r5C627 =e= k3/1E12*C5pC627*C3C627;
EQU432..r7C627 =e= k4/1E14*C7pC627 * C3C627;
EQU433..r9C627 =e=  k6/1E12*C9pC627 * C3C627;
EQU434..r10C627 =e= k7/1E12*C10pC627 * C3C627;
EQU435..riC11C627 =e=k18/1E12*CiC11pC627*C3C627;
EQU436..k14/1E11*CiC5eC627*CHXC627 - k3/1E12*C5pC627*C3C627 =e=0;
EQU437..k15/(1E6*1E12)*C8pC627*C2C627 - k18/1E12*CiC11pC627*C3C627 - k17/1E12*CiC11pC627 =e= 0;
EQU438..-r3C627 + r4C627 + r5C627 + r7C627 + r8C627 + r9C627 + r10C627 + riC10C627+ riC11C627 =e= 0;
EQU439..1000*(FHC14*x2HC14 - FAC31*x2AC31) - r2C627*VaC623*MW2 =e= 0;
EQU440..-r2C627 + k1/1E6*C2C627*CHXC627 + k11/(1E9*1E6)*C3pC627 *C2C627 + k15/(1E12*1E6)*C8pC627*C2C627 + k19/(1E14*1E6)
                                              *C7pC627*C2C627=e=0;
EQU441..k9/1E9*C3pC627 - k10/(1E6*1E9)*CiC4eC627*C3pC627 =e= 0;
EQU442..k13/(1E11*1E9)*CiC8eC627*C3pC627 +k17/1E12*CiC11pC627 - k14/1E11*CiC5eC627*CHXC627 - k16/(1E11*1E9)*CiC5eC627*C3pC627
                                                   =e= 0;
EQU443..k12/1E12*C9pC627 - k13/(1E11*1E9)*CiC8eC627*C3pC627 =e=0;
EQU444..1000*(FHC14*x4HC14 + FHC41*x4HC41 - FAC31*x4AC31)  + r4C627*VaC623*MW4 =e= 0;
EQU445..r8C627 =e= k5/1E12*C8pC627*C3C627;
EQU446..k17/1E12*CiC11pC627 - k4/1E14*C7pC627*C3C627 - k19/(1E6*1E14)*C7pC627*C2C627 =e= 0;
EQU447..riC10C627  =e= k8/1E12* CiC10pC627 * C3C627;
EQU448..C2C627/1E6 =e= rhoAC31*x2AC31/MW2;
```



```
EQU449..C3C627 =e= rhoAC31*x3AC31/MW3;
```

```
EQU450..CHXC627 =e= rhoAC31*x11AC31/MW11;
EQU451..k13/(1E11*1E9)*C3pC627*CiC8eC627 - k5/1E12*C8pC627*C3C627 -k15/(1E6*1E12)*C8pC627*C2C627 =e= 0;
EQU452..k11/(1E6*1E9)*C2C627*C3pC627 + k10/(1E6*1E9)*C3pC627*CiC4eC627 - k6/1E12*C9pC627*C3C627 - k12/1E12*C9pC627 =e= 0;
EQU453..x4C315 - x4C316 =e= 0;
EQU454..x5C315 - x5C316 =e= 0;
EQU455..x1C317 - x1C318 =e= 0;
EQU456..x3C317 - x3C318 =e= 0;
EQU457..x4C317 - x4C318 =e= 0;
EQU458..x5C317 - x5C318 =e= 0;
EQU459..FC319 - FC320 - FC321 - FC322 =e= 0;
EQU460..FC319 * x1C319 - FC320 * x1C320 - FC321 * x1C321 - FC322 * x1C322 =e= 0;
EQU461..FC319 * x3C319 - FC320 * x3C320 - FC321 * x3C321 - FC322 * x3C322 =e= 0;
EQU462..FC319 * x4C319 - FC320 * x4C320 - FC321 * x4C321 - FC322 * x4C322 =e= 0;
EQU463..FC319 * x5C319 - FC320 * x5C320 - FC321 * x5C321 - FC322 * x5C322 =e= 0;
EQU464..FC319 * sf1S34 - FC320  =e= 0;
EQU465..x1C319 - x1C320 =e= 0;
EQU466..x3C319 - x3C320 =e= 0;
EQU467..x4C319 - x4C320 =e= 0;
EQU468..k16/(1E11*1E9)*CiC5eC627*C3pC627 - k7/1E12*C10pC627*C3C627 =e= 0;
EQU469..k1/1E6*C2C627*CHXC627 - k2/1E12*C4pC627*C3C627 =e= 0;
EQU470..x1HC23+x2HC23+x3HC23+x4HC23+x5HC23+x7HC23 =e=1;
EQU471..x11AC34+x12AC34 =e=1;
EQU472..x1HC22+x2HC22+x3HC22+x4HC22+x5HC22+x7HC22 =e=1;
EQU473..x11AC37+x12AC37 =e=1;
EQU474..x11AC40 + x12AC40 =e= 1;
EQU475..x1AC42 + x2AC42 + x3AC42 + x4AC42 + x5AC42 +x7AC42 + x8AC42 + x9AC42 + x10AC42 + x11AC42 + x12AC42 + xiC10AC42 +
                                                                      xiC11AC42 =e= 1;
EQU476..x11AC45+x12AC45 =e=1;
EQU477..Q2HC16 - FHC16 * x2HC16/(rho2HC16/1000) =e= 0;
EQU478..QHC16 - FHC16/0.575 =e= 0;
EQU479..x1HC16 + x2HC16 + x3HC16 + x4HC16 + x5HC16 + x7HC16 =e= 1;
EQU480..FAC40 -FAC34 - FAC37 =e= 0;
EQU481..FAC40*x11AC40 -FAC34*x11AC34 - FAC37*x11AC37 =e= 0;
EQU482..FAC42*(x7AC42+x8AC42+x9AC42+x10AC42+xiC10AC42+xiC11AC42) - FHC22*x7HC22 =e= 0;
EQU483..FAC42*(x11AC42 + x12AC42) - FAC37 - FAC45 =e=0;
EQU484..FAC37*x12AC37 - sfC634*FAC42*x12AC42 =e=0;
EQU485..FAC37*x11AC37 - sfC634*FAC42*x11AC42 =e=0;
EQU486..x11AC37 - x11AC45 =e=0;
EQU487..FAC42*x5AC42 - FHC22*x5HC22 =e=0;
EQU488..FAC42*x4AC42 - FHC22*x4HC22 =e=0;
EQU489..FAC42*x3AC42 - FHC22*x3HC22 =e=0;
EQU490..FAC42*x2AC42 - FHC22*x2HC22 =e=0;
EQU491..FAC42*x1AC42 - FHC22*x1HC22 =e=0;
EQU492..r3C629 - k9/1E9*C3pC629 - k10/(1E6*1E9)*CiC4eC629*C3pC629 - k11/(1E6*1E9)*C3pC629*C2C629 - k13/(1E11*1E9)
                                              *CiC8eC629*C3pC629 - k16/(1E11*1E9) * CiC5eC629*C3pC629 =e= 0;
```



```
EQU493..FAC40*x11AC40 - FAC42*x11AC42 - 0.06*2.02*FHC16*x2HC16/(rho2HC16/1000) =e= 0;
EQU494..r9C629 =e=  k6/1E12*C9pC629 * C3C629;
EQU495..r7C629 =e= k4/1E14*C7pC629 * C3C629;
EQU496..x5C319 - x5C320 =e= 0;
EQU497..x1C319 - x1C321 =e= 0;
EQU498..x3C319 - x3C321 =e= 0;
EQU499..x4C319 - x4C321 =e= 0;
EQU500..x5C319 - x5C321 =e= 0;
EQU501..FC308 - FC309 =e= 0;
EQU502..x1C308 - x1C309 =e= 0;
EQU503..(hC308 - hC309) - FcwE640*4.197*(TcwoutE640 - Tcwin) =e= 0;
EQU504..FC316 + FC329 - FC317 - FC325 =e= 0;
EQU505..FC316 * x1C316 + FC329*x1C329 - FC317 * x1C317 - FC325*x1C325 =e= 0;
EQU506..r5C629 =e= k3/1E12*C5pC629*C3C629;
EQU507..r4C629 =e= k2/1E12*C4pC629*C3C629;
EQU508..FHC16*x1HC16 + FHC45*x1HC45 - FAC42*x1AC42 =e= 0;
EQU509..1000*(FHC16*x3HC16 + FHC45*x3HC45 - FAC42*x3AC42)  - r3C629*VaC623*MW3 =e= 0;
EQU510..riC11C629 =e=k18/1E12*CiC11pC629*C3C629;
EQU511..1000*(FHC16*x5HC16 + FHC45*x5HC45 - FAC42*x5AC42)  + r5C629*VaC623*MW5 =e= 0;
EQU512..k14/1E11*CiC5eC629*CHXC629 - k3/1E12*C5pC629*C3C629 =e=0;
EQU513..1000*FAC42*x8AC42 - r8C629*VaC623*MW8 =e= 0;
EQU514..1000*FAC42*x9AC42 - r9C629*VaC623*MW9 =e= 0;
EQU515..1000*FAC42*x10AC42 - r10C629*VaC623*MW10 =e= 0;
EQU516..FHC16 +FHC45 + FAC40 =e= FAC42;
EQU517..1000*FAC42*xiC10AC42 - riC10C629*VaC623*MWiC10 =e= 0;
EQU518..1000*FAC42*xiC11AC42 -riC11C629 * VaC623 * MWiC11 =e= 0;
EQU519..1000*(FHC16*x7HC16 + FHC45*x7HC45 - FAC42*x7AC42)  + r7C629*VaC623*MW7 =e= 0;
EQU520..k19/(1E14*1E6)*C7pC629*C2C629 - k8/1E12*CiC10pC629*C3C629 =e= 0;
EQU521..1000*(FHC16*x4HC16 + FHC45*x4HC45 - FAC42*x4AC42)  + r4C629*VaC623*MW4 =e= 0;
EQU522..k16/(1E11*1E9)*CiC5eC629*C3pC629 - k7/1E12*C10pC629*C3C629 =e= 0;
EQU523..k11/(1E6*1E9)*C2C629*C3pC629 + k10/(1E6*1E9)*C3pC629*CiC4eC629 - k6/1E12*C9pC629*C3C629 - k12/1E12*C9pC629 =e= 0;
EQU524..k13/(1E11*1E9)*C3pC629*CiC8eC629 - k5/1E12*C8pC629*C3C629 -k15/(1E6*1E12)*C8pC629*C2C629 =e= 0;
EQU525..CHXC629 =e= rhoAC42*x11AC42/MW11;
EQU526..C3C629 =e= rhoAC42*x3AC42/MW3;
EQU527..C2C629/1E6 =e= rhoAC42*x2AC42/MW2;
EQU528..riC10C629  =e= k8/1E12* CiC10pC629 * C3C629;
EQU529..r10C629 =e= k7/1E12*C10pC629 * C3C629;

EQU530..r8C629 =e= k5/1E12*C8pC629*C3C629;
EQU531..k1/1E6*C2C629*CHXC629 - k2/1E12*C4pC629*C3C629 =e= 0;
EQU532..k12/1E12*C9pC629 - k13/(1E11*1E9)*CiC8eC629*C3pC629 =e=0;
EQU533..k13/(1E11*1E9)*CiC8eC629*C3pC629 +k17/1E12*CiC11pC629 - k14/1E11*CiC5eC629*CHXC629 - k16/(1E11*1E9)*CiC5eC629*C3pC629
                                                                             =e= 0;
```

```
EQU534..k9/1E9*C3pC629 - k10/(1E6*1E9)*CiC4eC629*C3pC629 =e= 0;
EQU535..-r2C629 + k1/1E6*C2C629*CHXC629 + k11/(1E9*1E6)*C3pC629 *C2C629 + k15/(1E12*1E6)*C8pC629*C2C629 + k19/(1E14*1E6)
                                                            *C7pC629*C2C629=e=0;
EQU536..1000*(FHC16*x2HC16 - FAC42*x2AC42) - r2C629*VaC623*MW2 =e= 0;
```



```
EQU537..-r3C629 + r4C629 + r5C629 + r7C629 + r8C629 + r9C629 + r10C629 + riC10C629+ riC11C629 =e= 0;
EQU538..k15/(1E6*1E12)*C8pC629*C2C629 - k18/1E12*CiC11pC629*C3C629 - k17/1E12*CiC11pC629 =e= 0;
EQU539..k17/1E12*CiC11pC629 - k4/1E14*C7pC629*C3C629 - k19/(1E6*1E14)*C7pC629*C2C629 =e= 0;
EQU540..FC316 * x3C316 + FC329*x3C329 - FC317 * x3C317 - FC325*x3C325 =e= 0;
EQU541..FC316 * x4C316 + FC329*x4C329 - FC317 * x4C317 - FC325*x4C325 =e= 0;
EQU542..FC316 * x5C316 + FC329*x5C329 - FC317 * x5C317 - FC325*x5C325 =e= 0;
EQU543..x1C317 - x1C323 =e= 0;
EQU544..x3C317 - x3C323 =e= 0;
EQU545..x4C317 - x4C323 =e= 0;
EQU546..x5C317 - x5C323 =e= 0;
EQU547..FHC03 - FC419 - FC321 =e= 0;
EQU548..FHC03 * x1HC03 - FC419 * x1C419 - FC321 * x1C321 =e= 0;
EQU549..FHC03 * x3HC03 - FC419 * x3C419 - FC321 * x3C321 =e= 0;
EQU550..FHC03 * x4HC03 - FC419 * x4C419 - FC321 * x4C321 =e= 0;
EQU551..FHC03 * x5HC03 - FC419 * x5C419 - FC321 * x5C321 =e= 0;
EQU552..hHC03 - hC419 - hC321 =e= 0;
EQU553..FHC24 -FHC23 - FHC22 =e= 0;
EQU554..FHC24*x1HC24 -FHC23*x1HC23 - FHC22*x1HC22 =e= 0;
EQU555..FHC24*x3HC24 -FHC23*x3HC23 - FHC22*x3HC22 =e= 0;
EQU556..FHC24*x4HC24 -FHC23*x4HC23 - FHC22*x4HC22 =e= 0;
EQU557..FHC24*x5HC24 -FHC23*x5HC23 - FHC22*x5HC22 =e= 0;
EQU558..FHC24*x7HC24 -FHC23*x7HC23 - FHC22*x7HC22 =e= 0;
EQU559..x1HC24+x2HC24+x3HC24+x4HC24+x5HC24+x7HC24 =e=1;
EQU560..x1HC25+x2HC25+x3HC25+x4HC25+x5HC25+x7HC25 =e=1;
EQU561..FHC26 -FHC25 - FHC24 =e= 0;
EQU562..FHC26*x1HC26 -FHC25*x1HC25 - FHC24*x1HC24 =e= 0;
EQU563..FHC26*x3HC26 -FHC25*x3HC25 - FHC24*x3HC24 =e= 0;
EQU564..FHC26*x4HC26 -FHC25*x4HC25 - FHC24*x4HC24 =e= 0;
EQU565..FHC26*x5HC26 -FHC25*x5HC25 - FHC24*x5HC24 =e= 0;
EQU566..FHC26*x7HC26 -FHC25*x7HC25 - FHC24*x7HC24 =e= 0;
EQU567..x1HC26+x2HC26+x3HC26+x4HC26+x5HC26+x7HC26 =e=1;
EQU568..x1HC27+x2HC27+x3HC27+x4HC27+x5HC27+x7HC27 =e=1;
EQU569..FHC28 -FHC27 - FHC26 =e= 0;
EQU570..FlHC28*x1HC28 + FvHC28*y1HC28 - FHC27*x1HC27 - FHC26*x1HC26 =e= 0;
EQU571..FlHC28*x3HC28  + FvHC28*y3HC28 - FHC27*x3HC27 - FHC26*x3HC26 =e= 0;
EQU572..FlHC28*x4HC28  + FvHC28*y4HC28 - FHC27*x4HC27 - FHC26*x4HC26 =e= 0;
EQU573..FlHC28*x5HC28  + FvHC28*y5HC28 - FHC27*x5HC27 - FHC26*x5HC26 =e= 0;
EQU574..FlHC28*x7HC28  + FvHC28*y7HC28 - FHC27*x7HC27 - FHC26*x7HC26 =e= 0;
EQU575..x1HC28+x2HC28+x3HC28+x4HC28+x5HC28+x7HC28 =e=1;
EQU576..FHC28 - FHC29 - FR1 =e= 0;
EQU577..FR1 - FHC28*sfS2 =e=0;
EQU578..FlHC28 - FlHC29 - FlR1 =e= 0;
EQU579..FvHC28 - FvHC29 - FvR1 =e= 0;
EQU580..FlR1 - FlHC28*sfS2 =e=0;
EQU581..FvR1 - FvHC28*sfS2 =e=0;
EQU582..FHC15 - FHC14 - FHC16 =e= 0;
```



```
EQU583..FHC15*sfS11 - FHC14 =e= 0;
EQU584..x1HC15 - x1HC14 =e= 0;
EQU585..x2HC15 - x2HC16 =e= 0;
EQU586..x2HC15 - x2HC14 =e= 0;
EQU587..LpC606A=e=FC322 + qC606A*FC404;
EQU588..VpC606A=e=FC432;
EQU589..TnC606A=e=(TC414+TC404)/2;
EQU590..TmC606A=e=(TC430+TC404)/2;
EQU591..FC418 * x1C418 - FC417 * x1C417 - FC415 * x1C415  =e= 0;
EQU592..FC418 * x3C418 - FC417 * x3C417 - FC415 * x3C415  =e= 0;
EQU593..FC418 * x4C418 - FC417 * x4C417 - FC415 * x4C415  =e= 0;
EQU594..FC418 * x5C418 - FC417 * x5C417 - FC415 * x5C415  =e= 0;
EQU595..hC418 - hC417 - hC415  =e= 0;
EQU596..x4C405 - x4C406 =e= 0;
EQU597..x5C405 - x5C406 =e= 0;
EQU598..FC403 - FC404 =e= 0;
EQU599..x1C403 - x1C404 =e= 0;
EQU600..x3C403 - x3C404 =e= 0;
EQU601..x4C403 - x4C404 =e= 0;
EQU602..x5C403 - x5C404 =e= 0;
EQU603..x3C406 - x3C407 =e= 0;
EQU604..x4C406 - x4C407 =e= 0;
EQU605..x5C406 - x5C407 =e= 0;
EQU606..FC431 - FC412 - FC432 =e= 0;
EQU607..FC432 - sfS41 * FC431 =e= 0;
EQU608..x1C431 - x1C412 =e= 0;
EQU609..x3C431 - x3C412 =e= 0;
EQU610..x4C431 - x4C412 =e= 0;
EQU611..x5C431 - x5C412 =e= 0;
EQU612..TC319 - TC320 =e= 0;
EQU613..TC319 - TC321 =e= 0;
EQU614..TC319 - TC322 =e= 0;
EQU615..x1C431 - x1C432 =e= 0;
EQU616..x3C431 - x3C432 =e= 0;
```

```
EQU617..x4C431 - x4C432 =e= 0;
EQU618..x5C431 - x5C432 =e= 0;
EQU619..FC430 + FC427 - FC431 - FC425 =e= 0;
EQU620..FC430 * x1C430 + FC427 * x3C427 - FC431 * x1C431 - FC425 * x1C425 =e= 0;
EQU621..FC430 * x3C430 + FC427 * x3C427 - FC431 * x3C431 - FC425 * x3C425 =e= 0;
EQU622..FC430 * x4C430 + FC427 * x4C427 - FC431 * x4C431 - FC425 * x4C425 =e= 0;
EQU623..FC430 * x5C430 + FC427 * x5C427 - FC431 * x5C431 - FC425 * x5C425 =e= 0;
EQU624..x3HC15 - x3HC14 =e= 0;
EQU625..x4HC15 - x4HC14 =e= 0;
EQU626..x5HC15 - x5HC14 =e= 0;
EQU627..x3HC15 - x3HC16 =e= 0;
EQU628..x4HC15 - x4HC16 =e= 0;
```


```
EQU629..x5HC15 - x5HC16 =e= 0;
EQU630..x1HC15 - x1HC16 =e= 0;
EQU631..x1HC15 + x2HC15 + x3HC15 + x4HC15 + x5HC15 + x7HC15 =e= 1;
EQU632..FHC08 - FHC11 - FHC15 =e= 0;
EQU633..FHC08*sfS7 - FHC11 =e= 0;
EQU634..x1HC08 - x1HC11 =e= 0;
EQU635..x2HC08 - x2HC11 =e= 0;
EQU636..x3HC08 - x3HC11 =e= 0;
EQU637..x4HC08 - x4HC11 =e= 0;
EQU638..x5HC08 - x5HC11 =e= 0;
EQU639..x1HC08 - x1HC15 =e= 0;
EQU640..x2HC08 - x2HC15 =e= 0;
EQU641..x3HC08 - x3HC15 =e= 0;
EQU642..x4HC08 - x4HC15 =e= 0;
EQU643..x5HC08 - x5HC15 =e= 0;
EQU644..Q2HC11 - FHC11 * x2HC11/(rho2HC11/1000) =e= 0;
EQU645..QHC11 - FHC11/0.575 =e= 0;
EQU646..x1HC11 + x2HC11 + x3HC11 + x4HC11 + x5HC11 + x7HC11 =e= 1;
EQU647..FHC06 - FHC07 - FHC08 =e= 0;
EQU648..FHC06*sfS5 - FHC07 =e= 0;
EQU649..x1HC06 - x1HC07 =e= 0;
EQU650..FC425 - FC410 - FC426 =e= 0;
EQU651..FC426 - sfS42 * FC425 =e= 0;
EQU652..x1C425 - x1C410 =e= 0;
EQU653..x3C425 - x3C410 =e= 0;
EQU654..x4C425 - x4C410 =e= 0;
EQU655..x5C425 - x5C410 =e= 0;
EQU656..x1C425 - x1C426 =e= 0;
EQU657..x3C425 - x3C426 =e= 0;
EQU658..x4C425 - x4C426 =e= 0;
EQU659..x5C425 - x5C426 =e= 0;
EQU660..x1C410 - x1C411 =e= 0;
EQU661..x3C410 - x3C411 =e= 0;
EQU662..x4C410 - x4C411 =e= 0;
EQU663..x5C410 - x5C411 =e= 0;
EQU664..hC427 - hC428 - hC411 =e= 0;
EQU665..FC427 * x1C427 - FC428 * x1C428 - FC411 * x1C411 =e= 0;
EQU666..FC427 * x3C427 - FC428 * x3C428 - FC411 * x3C411 =e= 0;
EQU667..FC427 * x4C427 - FC428 * x4C428 - FC411 * x4C411 =e= 0;
EQU668..FC427 * x5C427 - FC428 * x5C428 - FC411 * x5C411 =e= 0;
EQU669..FC426 - FC428 - FC405 =e= 0;
EQU670..x2HC06 - x2HC07 =e= 0;
EQU671..x3HC06 - x3HC07 =e= 0;
EQU672..x4HC06 - x4HC07 =e= 0;
EQU673..x5HC06 - x5HC07 =e= 0;
EQU674..x1HC06 - x1HC08 =e= 0;
```


```
EQU675..x2HC06 - x2HC08 =e= 0;
EQU676..x3HC06 - x3HC08 =e= 0;
EQU677..x4HC06 - x4HC08 =e= 0;
EQU678..x5HC06 - x5HC08 =e= 0;
EQU679..x1HC07 + x2HC07 + x3HC07 + x4HC07 + x5HC07 + x7HC07 =e= 1;
EQU680..QHC07 - FHC07/0.575 =e= 0;
EQU681..Q2HC07 - FHC07 * x2HC07/(rho2HC07/1000) =e= 0;
EQU682..x1HC06 + x2HC06 + x3HC06 + x4HC06 + x5HC06 + x7HC06 =e= 1;
EQU683..FHC06 -FHC02 - FHC05 =e= 0;
EQU684..FHC06*x1HC06 - FHC02*x1HC02 - FHC05*x1HC05 =e= 0;
EQU685..FHC06*x2HC06 - FHC02*x2HC02 - FHC05*x2HC05 =e= 0;
EQU686..FHC06*x3HC06 - FHC02*x3HC02 - FHC05*x3HC05 =e= 0;
EQU687..FHC06*x4HC06 - FHC02*x4HC02 - FHC05*x4HC05 =e= 0;
EQU688..FHC06*x5HC06 - FHC02*x5HC02 - FHC05*x5HC05 =e= 0;
EQU689..FHC40 - FHC41 - FHC45 =e= 0;
EQU690..FHC40*sfS27 - FHC41 =e= 0;
EQU691..x1HC40 - x1HC41 =e= 0;
EQU692..x3HC40 - x3HC41 =e= 0;
EQU693..x4HC40 - x4HC41 =e= 0;
EQU694..x5HC40 - x5HC41 =e= 0;
EQU695..x1HC40 - x1HC45 =e= 0;
EQU696..x3HC40 - x3HC45 =e= 0;
EQU697..x4HC40 - x4HC45 =e= 0;
EQU698..x1HC32 - x1HC33 =e= 0;
EQU699..FC426 * x1C426- FC428 * x1C428 - FC405 * x1C405 =e= 0;
EQU700..FC426 * x3C426- FC428 * x3C428 - FC405 * x3C405 =e= 0;
```

```
EQU701..FC426 * x4C426- FC428 * x4C428 - FC405 * x4C405 =e= 0;
EQU702..FC426 * x5C426- FC428 * x5C428 - FC405 * x5C405 =e= 0;
EQU703..FC408 - FC409 =e= 0;
EQU704..x1C408 - x1C409 =e= 0;
EQU705..x3C408 - x3C409 =e= 0;
EQU706..x4C408 - x4C409 =e= 0;
EQU707..x5C408 - x5C409 =e= 0;
EQU708..x5HC40 - x5HC45 =e= 0;
EQU709..FHC32 - FHC33 - FHC40 =e= 0;
EQU710..x1HC45 +x3HC45 + x4HC45 + x5HC45 + x7HC45 =e= 1;
EQU711..QHC45 - FHC45/0.575 =e= 0;
EQU712..x1HC40 +x3HC40 + x4HC40 + x5HC40 + x7HC40 =e= 1;
EQU713..FHC32*sfS19 - FHC33 =e= 0;
EQU714..x3HC32 - x3HC33 =e= 0;
EQU715..x4HC32 - x4HC33 =e= 0;
EQU716..x5HC32 - x5HC33 =e= 0;
EQU717..x1HC32 - x1HC40 =e= 0;
EQU718..x3HC32 - x3HC40 =e= 0;
EQU719..x4HC32 - x4HC40 =e= 0;
EQU720..x5HC32 - x5HC40 =e= 0;
```



```
EQU721..x1HC33 +x3HC33 + x4HC33 + x5HC33 + x7HC33 =e= 1;
EQU722..FHC33 - FHC34 - FHC38 =e= 0;
EQU723..FHC33*sfS23 - FHC34 =e= 0;
EQU724..x1HC33 - x1HC34 =e= 0;
EQU725..x3HC33 - x3HC34 =e= 0;
EQU726..x4HC33 - x4HC34 =e= 0;
EQU727..x5HC33 - x5HC34 =e= 0;
EQU728..x1HC33 - x1HC38 =e= 0;
EQU729..x3HC33 - x3HC38 =e= 0;
EQU730..x4HC33 - x4HC38 =e= 0;
EQU731..x5HC33 - x5HC38 =e= 0;
EQU732..x1HC34 +x3HC34 + x4HC34 + x5HC34 + x7HC34 =e= 1;
EQU733..QHC34 - FHC34/0.575 =e= 0;
EQU734..QHC38 - FHC38/0.575 =e= 0;
EQU735..x1HC38 +x3HC38 + x4HC38 + x5HC38 + x7HC38 =e= 1;
EQU736..FC412 - FC413 =e= 0;
EQU737..x1C412 - x1C413 =e= 0;
EQU738..x3C412 - x3C413 =e= 0;
EQU739..x4C412 - x4C413 =e= 0;
EQU740..x5C412 - x5C413 =e= 0;
EQU741..x1C319 - x1C322 =e= 0;
EQU742..x3C319 - x3C322 =e= 0;
EQU743..x4C319 - x4C322 =e= 0;
EQU744..x5C319 - x5C322 =e= 0;
EQU745..hC414liq -  FC414 *  ((x1C414/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC414,ORD(Coeff))))
 +(x3C414/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC414,ORD(Coeff))))
 +(x4C414/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC414,ORD(Coeff))))
 +(x5C414/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC414,ORD(Coeff))))
 +(x7C414/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC414,ORD(Coeff))))) =e= 0;
EQU746..dTE621A*2  =e=
(TC414-TcwotE621A) + (TC414-Tcwin);
EQU747..(hC414liq - hC415) - FcwE621B*4.197*(TcwotE621B - Tcwin) =e= 0;
EQU748..(hC414liq - hC415) - UE621B*FE621B*AE621B*dTE621B =e= 0;
EQU749..dTE621B**3 =e= ((TC414-TcwotE621B)*(TC415-Tcwin)*
((TC414-TcwotE621B)+(TC415-Tcwin))/2);
EQU750..hC412liq -  FC412 *  ((x1C412/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC412,ORD(Coeff))))
 +(x3C412/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC412,ORD(Coeff))))
 +(x4C412/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC412,ORD(Coeff))))
 +(x5C412/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC412,ORD(Coeff))))
 +(x7C412/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC412,ORD(Coeff))))) =e= 0;
EQU751..dTE627A*2  =e=
(TC412-TcwotE621A) + (TC412-Tcwin);
EQU752..(hC412liq - hC413) - FcwE627B*4.197*(TcwotE627B - Tcwin) =e= 0;
EQU753..(hC412liq - hC413) - UE627B*FE627B*AE627B*dTE627B =e= 0;
EQU754..dTE627B **3 =e= ((TC412-TcwotE627B)*(TC413-Tcwin)*
((TC412-TcwotE627B)+(TC413-Tcwin))/2);
```



```
EQU755..hC411 -  FC411 *
((x1C411/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC411,ORD(Coeff))))
 +(x3C411/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC411,ORD(Coeff))))
 +(x4C411/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC411,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                                ((1-TC411/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C411/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC411,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                                ((1-TC411/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C411/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC411,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                            ((1-TC411/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU756..hC410vap -  FC410 *
((x1C410/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC410,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                                                ((1-TC410/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(x3C410/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC410,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                                ((1-TC410/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C410/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC410,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                                ((1-TC410/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C410/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC410,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                                ((1-TC410/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
```

```
+(x7C410/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC410,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
    ((1-TC410/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU757..dTE696A =e= 414.6 - TC410;
EQU758..(hC411 - hC410vap) - FstmE696B * hstmE696 =e= 0;
EQU759..(hC411 - hC410vap) - UE696B*AE696B*dTE696B =e= 0;
EQU760..dTE696B*2  =e=
(414.6-TC410) + (414.6-TC411);
EQU761..dTE626**3 =e= ((TC418-TcwoutE626)*(TC419-Tcwin)*
((TC418-TcwoutE626)+(TC419-Tcwin))/2);
EQU762..dTE617 **3=e= ((TC406-TcwoutE617)*(TC407-Tcwin)*
((TC406-TcwoutE617)+(TC407-Tcwin))/2);
EQU763..dTE616**3 =e= ((TC405-TC404)*(TC406-TC403)*
((TC405-TC404)+(TC406-TC403))/2);
EQU764..hC408vap -  FC408 *
((x1C408/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC408,ORD(Coeff)))
)
+(x3C408/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC408,ORD(Coeff))))
+(x4C408/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC408,ORD(Coeff))))
+(x5C408/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC408,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
    ((1-TC408/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C408/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC408,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
    ((1-TC408/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU765..dTE695A =e= 481 - TC408;
EQU766..(hC409 - hC408vap) - FstmE695B * hstmE695 =e= 0;
EQU767..(hC409 - hC408vap) - UE695B*AE695B*dTE695B =e= 0;
EQU768..dTE695B*2  =e=
(481-TC408) + (481-TC409);
EQU769..hvR1 -  FvR1*((y1R1/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TR1,ORD(Coeff)))+ Enth_Vap("1","a1")
```



```
    *1000 * ((1-TR1/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(y3R1/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TR1,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 * ((1-TR1/Enth_Vap(
    "3","a2"))**Enth_Vap("3","a3")))
+(y4R1/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TR1,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 * ((1-TR1/Enth_Vap("
    4","a2"))**Enth_Vap("4","a3")))
+(y5R1/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TR1,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 * ((1-TR1/Enth_Vap("
    5","a2"))**Enth_Vap("5","a3")))
+(y7R1/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TR1,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 * ((1-TR1/Enth_Vap("
    7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU770..y1R1 + y2R1 + y3R1 + y4R1 + y5R1 + y7R1 =e= 1;
EQU771..hlR1 -  FlR1* ((x1R1/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TR1,ORD(Coeff))))
+(x3R1/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TR1,ORD(Coeff))))
+(x4R1/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TR1,ORD(Coeff))))
+(x5R1/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TR1,ORD(Coeff))))
+(x7R1/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TR1,ORD(Coeff)))))  =e= 0;
EQU772..x1R1 + x2R1 + x3R1 + x4R1  + x5R1 + x7R1 =e= 1;
EQU773..hR1 - hlR1 - hvR1 =e= 0;
EQU774..hvHC29 -  FvHC29*((y1HC29/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC29,ORD(Coeff)))+ Enth_Vap("1",
    "a1")*1000 * ((1-THC29/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(y3HC29/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC29,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
    ((1-THC29/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(y4HC29/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC29,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
    ((1-THC29/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(y5HC29/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC29,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
    ((1-THC29/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(y7HC29/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC29,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
    ((1-THC29/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU775..hHC29 - hlHC29 - hvHC29 =e= 0;
EQU776..FHC29 - FlHC29 - FvHC29 =e= 0;
EQU777..hlHC29 - FlHC29*((x1HC29/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC29,ORD(Coeff))))
+(x3HC29/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC29,ORD(Coeff))))
+(x4HC29/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC29,ORD(Coeff))))
+(x5HC29/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC29,ORD(Coeff))))
+(x7HC29/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC29,ORD(Coeff))))) =e= 0;
EQU778..xx7HC32 * MW7 * FmHC32 - FHC32 * x7HC32 =e= 0;
EQU779..xx5HC32 * MW5 * FmHC32 - FHC32 * x5HC32 =e= 0;
EQU780..FR1 - FlR1 -FvR1 =e= 0;
EQU781..hC303 -  FC303 *
((x1C303/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC303,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
    ((1-TC303/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C303/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC303,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
    ((1-TC303/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C303/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC303,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
    ((1-TC303/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C303/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC303,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
    ((1-TC303/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
```



```
+(x7C303/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC303,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
    ((1-TC303/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU782..hC306 -  FC306 *
((x1C306/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC306,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
    ((1-TC306/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C306/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC306,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
    ((1-TC306/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C306/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC306,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
    ((1-TC306/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C306/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC306,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
```

```
((1-TC306/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C306/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC306,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
((1-TC306/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU783..hC308 - FC308* ((x1C308/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC308,ORD(Coeff))))
+(x3C308/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC308,ORD(Coeff))))
+(x4C308/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC308,ORD(Coeff))))
+(x5C308/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC308,ORD(Coeff))))
+(x7C308/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC308,ORD(Coeff))))) =e= 0;
EQU784..hC310 - FC310 *
((x1C310/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC310,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
((1-TC310/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C310/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC310,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
((1-TC310/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C310/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC310,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
((1-TC310/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C310/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC310,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
((1-TC310/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C310/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC310,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
((1-TC310/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU785..hC311 - FC311 * ((x1C311/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC311,ORD(Coeff))))
+(x3C311/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC311,ORD(Coeff))))
+(x4C311/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC311,ORD(Coeff))))
+(x5C311/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC311,ORD(Coeff))))
+(x7C311/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC311,ORD(Coeff))))) =e= 0;
EQU786..hC312 - FC312*
((x1C312/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC312,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
((1-TC312/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C312/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC312,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
((1-TC312/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C312/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC312,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
((1-TC312/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C312/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC312,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
((1-TC312/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C312/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC312,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
((1-TC312/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU787..hC315 - FC315 * ((x1C315/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC315,ORD(Coeff))))
```


```
+(x3C315/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC315,ORD(Coeff))))
+(x4C315/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC315,ORD(Coeff))))
+(x5C315/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC315,ORD(Coeff))))
+(x7C315/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC315,ORD(Coeff))))) =e= 0;
EQU788..hC316 - FC316 * ((x1C316/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC316,ORD(Coeff))))
+(x3C316/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC316,ORD(Coeff))))
+(x4C316/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC316,ORD(Coeff))))
+(x5C316/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC316,ORD(Coeff))))
+(x7C316/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC316,ORD(Coeff))))) =e= 0;
EQU789..hC317 - FC317 * ((x1C317/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC317,ORD(Coeff))))
+(x3C317/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC317,ORD(Coeff))))
+(x4C317/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC317,ORD(Coeff))))
+(x5C317/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC317,ORD(Coeff))))
+(x7C317/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC317,ORD(Coeff))))) =e= 0;
EQU790..hC318 - FC318 * ((x1C318/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC318,ORD(Coeff))))
+(x3C318/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC318,ORD(Coeff))))
+(x4C318/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC318,ORD(Coeff))))
+(x5C318/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC318,ORD(Coeff))))
+(x7C318/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC318,ORD(Coeff))))) =e= 0;
EQU791..hC319 - FC319 * ((x1C319/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC319,ORD(Coeff))))
+(x3C319/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC319,ORD(Coeff))))
+(x4C319/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC319,ORD(Coeff))))
+(x5C319/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC319,ORD(Coeff))))
+(x7C319/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC319,ORD(Coeff))))) =e= 0;
EQU792..hC403 - FC403 * ((x1C403/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC403,ORD(Coeff))))
+(x3C403/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC403,ORD(Coeff))))
+(x4C403/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC403,ORD(Coeff))))
+(x5C403/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC403,ORD(Coeff))))
+(x7C403/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC403,ORD(Coeff))))) =e= 0;
EQU793..xx4HC32 * MW4 * FmHC32 - FHC32 * x4HC32 =e= 0;
EQU794..xx3HC32 * MW3 * FmHC32 - FHC32 * x3HC32 =e= 0;
EQU795..FmHC32 - FHC32 * (x1HC32/MW1 + x3HC32/MW3 + x4HC32/MW4 + x5HC32/MW5 + x7HC32/MW7) =e= 0;
EQU796..hHC32 - FHC32 * ((x1HC32/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC32,ORD(Coeff))))
+(x3HC32/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC32,ORD(Coeff))))
+(x4HC32/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC32,ORD(Coeff))))
+(x5HC32/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC32,ORD(Coeff))))
+(x7HC32/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC32,ORD(Coeff))))) =e= 0;
EQU797..x1HC32 + x3HC32 + x4HC32 + x5HC32 + x7HC32 =e= 1;
EQU798..xx1HC32 + xx3HC32 + xx4HC32 + xx5HC32 + xx7HC32 =e= 1;
EQU799..hC302 - FC302 *
((x1C302/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC302,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
((1-TC302/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C302/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC302,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
((1-TC302/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C302/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC302,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
((1-TC302/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
```


```
+(x5C302/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC302,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
((1-TC302/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
```

```
+(x7C302/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC302,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                          ((1-TC302/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU800..xx7C302 * MW7 * FmC302 - FC302 * x7C302 =e= 0;
EQU801..xx5C302 * MW5 * FmC302 - FC302 * x5C302 =e= 0;
EQU802..xx4C302 * MW4 * FmC302 - FC302 * x4C302 =e= 0;
EQU803..xx3C302 * MW3 * FmC302 - FC302 * x3C302 =e= 0;
EQU804..FmC302 - FC302 * (x1C302/MW1 + x3C302/MW3 + x4C302/MW4 + x5C302/MW5 + x7C302/MW7) =e= 0;
EQU805..x1C302 + x3C302 + x4C302 + x5C302 + x7C302 =e= 1;
EQU806..xx1C302 + xx3C302 + xx4C302 + xx5C302 + xx7C302 =e= 1;
EQU807..x1C301 + x2C301 + x3C301 + x4C301 + x5C301 + x7C301 =e= 1;
EQU808..hC301 -  FC301 *
((x1C301/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC301,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                                              ((1-TC301/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C301/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC301,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                              ((1-TC301/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C301/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC301,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                              ((1-TC301/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C301/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC301,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                              ((1-TC301/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C301/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC301,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                          ((1-TC301/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU809..hC303 - hC302 - hC301 =e= 0;
EQU810..FC303 * x5C303 - FC302 * x5C302 - FC301 * x5C301 =e= 0;
EQU811..FC303 * x4C303 - FC302 * x4C302 - FC301 * x4C301 =e= 0;
EQU812..FC303 * x3C303 - FC302 * x3C302 - FC301 * x3C301 =e= 0;
EQU813..FC303 * x1C303 - FC302 * x1C302 - FC301 * x1C301 =e= 0;
EQU814..FC303 - FC302 - FC301 =e= 0;
EQU815..x1HC02 + x2HC02 + x3HC02 + x4HC02 + x5HC02 + x7HC02 =e= 1;
EQU816..hHC02 - FHC02 * ((x1HC02/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC02,ORD(Coeff))))
+(x2HC02/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC02,ORD(Coeff))))
+(x3HC02/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC02,ORD(Coeff))))
+(x4HC02/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC02,ORD(Coeff))))
+(x5HC02/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC02,ORD(Coeff))))
+(x7HC02/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC02,ORD(Coeff))))) =e= 0;
EQU817..x1HC05 + x2HC05 + x3HC05 + x4HC05 + x5HC05 + x7HC05 =e= 1;
EQU818..hHC05 -  FHC05 *  ((x1HC05/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC05,ORD(Coeff))))
+(x2HC05/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC05,ORD(Coeff))))
+(x3HC05/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC05,ORD(Coeff))))
+(x4HC05/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC05,ORD(Coeff))))
+(x5HC05/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC05,ORD(Coeff))))
+(x7HC05/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC05,ORD(Coeff))))) =e= 0;
EQU819..x1HC04 + x2HC04 + x3HC04 + x4HC04 + x5HC04 + x7HC04 =e= 1;
EQU820..hHC04 -  FHC04 * ((x1HC04/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC04,ORD(Coeff))))
+(x2HC04/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC04,ORD(Coeff))))
```



```
+(x3HC04/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC04,ORD(Coeff))))
+(x4HC04/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC04,ORD(Coeff))))
+(x5HC04/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC04,ORD(Coeff))))
+(x7HC04/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC04,ORD(Coeff))))) =e= 0;
EQU821..hC402 -  FC402 *  ((x1C402/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC402,ORD(Coeff))))
+(x3C402/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC402,ORD(Coeff))))
+(x4C402/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC402,ORD(Coeff))))
+(x5C402/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC402,ORD(Coeff))))
+(x7C402/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC402,ORD(Coeff))))) =e= 0;
EQU822..x1C402 + x3C402 + x4C402 + x5C402 + x7C402 =e= 1;
EQU823..FHC01 - FHC02 =e= 0;
EQU824..FC401 - FC402 =e= 0;
EQU825..(hHC02 - hHC01) - (hC401 - hC402) =e= 0;
EQU826..(hHC01 - hHC02) - UE628*AE628*FE628*dTE628 =e= 0;
EQU827..x1HC01 - x1HC02 =e= 0;
EQU828..x2HC01 - x2HC02 =e= 0;
EQU829..x3HC01 - x3HC02 =e= 0;
EQU830..x4HC01 - x4HC02 =e= 0;
EQU831..x5HC01 - x5HC02 =e= 0;
EQU832..hC321 -  FC321 *  ((x1C321/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC321,ORD(Coeff))))
+(x3C321/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC321,ORD(Coeff))))
+(x4C321/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC321,ORD(Coeff))))
+(x5C321/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC321,ORD(Coeff))))
+(x7C321/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC321,ORD(Coeff))))) =e= 0;
EQU833..FmC322 - FC322 * (x1C322/MW1 + x3C322/MW3 + x4C322/MW4 + x5C322/MW5 + x7C322/MW7)=e= 0;
EQU834..hC323 -  FC323 *  ((x1C323/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC323,ORD(Coeff))))
+(x3C323/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC323,ORD(Coeff))))
+(x4C323/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC323,ORD(Coeff))))
+(x5C323/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC323,ORD(Coeff))))
+(x7C323/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC323,ORD(Coeff))))) =e= 0;
EQU835..hC326 -  (FC326/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC326,ORD(Coeff))))
=e= 0;
EQU836..hC329 - (FC329/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC329,ORD(Coeff))))
=e= 0;
EQU837..x1C401 - x1C402 =e= 0;
EQU838..x3C401 - x3C402 =e= 0;
EQU839..x4C401 - x4C402 =e= 0;
EQU840..x5C401 - x5C402 =e= 0;
EQU841..(hC403 - hC402) - UE629*AE629*FE629*dTE629 =e= 0;
EQU842..(hC402 - hC403) - (hHC04 - hHC03) =e= 0;
EQU843..FHC03 - FHC04 =e= 0;
EQU844..FC402 - FC403 =e= 0;
EQU845..x5C402 - x5C403 =e= 0;
EQU846..x4C402 - x4C403 =e= 0;
```

```
EQU847..x3C402 - x3C403 =e= 0;
EQU848..x1C402 - x1C403 =e= 0;
```



```
EQU849..x5HC03 - x5HC04 =e= 0;
EQU850..x4HC03 - x4HC04 =e= 0;
EQU851..x3HC03 - x3HC04 =e= 0;
EQU852..x2HC03 - x2HC04 =e= 0;
EQU853..x1HC03 - x1HC04 =e= 0;
EQU854..FHC04 - FHC05 =e= 0;
EQU855..THC29 - THC30 =e= 0;
EQU856..(FlHC29*x5HC29 + FvHC29*y5HC29) - (FlHC30*x5HC30 + FvHC30*y5HC30) =e= 0;
EQU857..(FlHC29*x4HC29 + FvHC29*y4HC29) - (FlHC30*x4HC30 + FvHC30*y4HC30) =e= 0;
EQU858..(FlHC29*x3HC29 + FvHC29*y3HC29) - (FlHC30*x3HC30 + FvHC30*y3HC30) =e= 0;
EQU859..(FlHC29*x1HC29 + FvHC29*y1HC29) - (FlHC30*x1HC30 + FvHC30*y1HC30) =e= 0;
EQU860..(hHC04 - hHC05) - UE633*AE633*dTE633 =e= 0;
EQU861..(hHC04 - hHC05) - (hHC30 - hHC29) =e= 0;
EQU862..(FlHC29 + FvHC29) - (FlHC30 + FvHC30) =e= 0;
EQU863..x5HC04 - x5HC05 =e= 0;
EQU864..x4HC04 - x4HC05 =e= 0;
EQU865..x3HC04 - x3HC05 =e= 0;
EQU866..x2HC04 - x2HC05 =e= 0;
EQU867..x1HC04 - x1HC05 =e= 0;
EQU868..dTE628 **3=e= ((THC02-TC401)*(THC01-TC402)*
 ((THC02-TC401)+(THC01-TC402))/2);
EQU869..dTE629 **3=e= ((THC03-TC403)*(THC04-TC402)*
 ((THC03-TC403)*(THC04-TC402))/2);
EQU870..hC309 -  FC309 *  ((x1C309/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC309,ORD(Coeff))))
 +(x3C309/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC309,ORD(Coeff))))
 +(x4C309/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC309,ORD(Coeff))))
 +(x5C309/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC309,ORD(Coeff))))
 +(x7C309/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC309,ORD(Coeff))))) =e= 0;
EQU871..THC34 - THC32 =e=0;
EQU872..hHC34 -  FHC34 *  ((x1HC34/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC34,ORD(Coeff))))
 +(x3HC34/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC34,ORD(Coeff))))
 +(x4HC34/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC34,ORD(Coeff))))
 +(x5HC34/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC34,ORD(Coeff))))
 +(x7HC34/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC34,ORD(Coeff))))) =e= 0;
EQU873..hHC38 -  FHC38 *  ((x1HC38/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC38,ORD(Coeff))))
 +(x3HC38/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC38,ORD(Coeff))))
 +(x4HC38/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC38,ORD(Coeff))))
 +(x5HC38/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC38,ORD(Coeff))))
 +(x7HC38/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC38,ORD(Coeff))))) =e= 0;
EQU874..THC38 - THC32 =e=0;
EQU875..THC32 - THC41 =e= 0;
EQU876..hHC41 -  FHC41 *  ((x1HC41/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC41,ORD(Coeff))))
 +(x3HC41/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC41,ORD(Coeff))))
 +(x4HC41/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC41,ORD(Coeff))))
 +(x5HC41/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC41,ORD(Coeff))))
 +(x7HC41/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC41,ORD(Coeff))))) =e= 0;
```



```
EQU877..THC32 - THC45 =e=0;
EQU878..hHC45 -  FHC45 *  ((x1HC45/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC45,ORD(Coeff))))
 +(x3HC45/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC45,ORD(Coeff))))
 +(x4HC45/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC45,ORD(Coeff))))
 +(x5HC45/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC45,ORD(Coeff))))
 +(x7HC45/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC45,ORD(Coeff))))) =e= 0;
EQU879..hHC06 - FHC06 *  ((x1HC06/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC06,ORD(Coeff))))
 +(x2HC06/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC06,ORD(Coeff))))
 +(x3HC06/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC06,ORD(Coeff))))
 +(x4HC06/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC06,ORD(Coeff))))
 +(x5HC06/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC06,ORD(Coeff))))
 +(x7HC06/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC06,ORD(Coeff))))) =e= 0;
EQU880..hHC06 -hHC02 - hHC05 =e= 0;
EQU881..THC06 - THC07 =e= 0;
EQU882..hHC07 -  FHC07 *  ((x1HC07/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC07,ORD(Coeff))))
 +(x2HC07/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC07,ORD(Coeff))))
 +(x3HC07/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC07,ORD(Coeff))))
 +(x4HC07/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC07,ORD(Coeff))))
 +(x5HC07/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC07,ORD(Coeff))))
 +(x7HC07/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC07,ORD(Coeff))))) =e= 0;
EQU883..THC06 -THC11 =e=0;
EQU884..hHC11 -  FHC11 *  ((x1HC11/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC11,ORD(Coeff))))
 +(x2HC11/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC11,ORD(Coeff))))
 +(x3HC11/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC11,ORD(Coeff))))
 +(x4HC11/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC11,ORD(Coeff))))
 +(x5HC11/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC11,ORD(Coeff))))
 +(x7HC11/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC11,ORD(Coeff))))) =e= 0;
EQU885..THC06 -THC14 =e=0;
EQU886..hHC14 -  FHC14 *  ((x1HC14/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC14,ORD(Coeff))))
 +(x2HC14/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC14,ORD(Coeff))))
 +(x3HC14/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC14,ORD(Coeff))))
 +(x4HC14/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC14,ORD(Coeff))))
 +(x5HC14/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC14,ORD(Coeff))))
 +(x7HC14/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC14,ORD(Coeff))))) =e= 0;
EQU887..THC06 -THC16 =e=0;
EQU888..hHC16 -  FHC16 *  ((x1HC16/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC16,ORD(Coeff))))
```

```
 +(x2HC16/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC16,ORD(Coeff))))
 +(x3HC16/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC16,ORD(Coeff))))
 +(x4HC16/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC16,ORD(Coeff))))
 +(x5HC16/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC16,ORD(Coeff))))
 +(x7HC16/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC16,ORD(Coeff))))) =e= 0;
EQU889..hC432 -  FC432 *
((x3C432/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC432,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                        ((1-TC432/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C432/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC432,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                        ((1-TC432/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
```



```
 +(x5C432/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC432,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                        ((1-TC432/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C432/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC432,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                     ((1-TC432/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
 EQU890..x1C432 + x3C432 + x4C432 + x5C432 + x7C432 =e= 1;
 EQU891..FmC432 - FC432 * (x1C432/MW1 + x3C432/MW3 + x4C432/MW4 + x5C432/MW5 + x7C432/MW7)=e= 0;
 EQU892..xx3C432 * FmC432 * MW3 - FC432 * x3C432 =e= 0;
 EQU893..xx4C432 * FmC432 * MW4 - FC432 * x4C432 =e= 0;
 EQU894..x1C430 + x3C430 + x4C430 + x5C430 + x7C430 =e= 1;
 EQU895..FmC430 - FC430 * (x1C430/MW1 + x3C430/MW3 + x4C430/MW4 + x5C430/MW5 + x7C430/MW7)=e= 0;
 EQU896..xx3C430 * FmC430 * MW3 - FC430 * x3C430 =e= 0;
 EQU897..hC430 -  FC430 *  ((x1C430/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC430,ORD(Coeff))))
 +(x3C430/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC430,ORD(Coeff))))
 +(x4C430/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC430,ORD(Coeff))))
 +(x5C430/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC430,ORD(Coeff))))
 +(x7C430/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC430,ORD(Coeff))))) =e= 0;
 EQU898..xx4C430 * FmC430 * MW4 - FC430 * x4C430 =e= 0;
 EQU899..xx1HC28 + xx2HC28 + xx3HC28 + xx4HC28 + xx5HC28 + xx7HC28 =e= 1;
 EQU900..FmlHC28 - FlHC28 * (x1HC28/MW1 + x2HC28/MW2 + x3HC28/MW3 + x4HC28/MW4 + x5HC28/MW5 + x7HC28/MW7)=e= 0;
 EQU901..yy1HC28 + yy2HC28 + yy3HC28 + yy4HC28 + yy5HC28 + yy7HC28 =e= 1;
 EQU902..FmvHC28 - FvHC28 * (y1HC28/MW1 + y2HC28/MW2 + y3HC28/MW3 + y4HC28/MW4 + y5HC28/MW5 + y7HC28/MW7)=e= 0;
 EQU903..y1HC28+y2HC28+y3HC28+y4HC28+y5HC28+y7HC28 =e=1;
 EQU904..xx1HC28 * MW1 * FmlHC28 - FlHC28 * x1HC28 =e= 0 ;
 EQU905..xx3HC28 * MW3 * FmlHC28 - FlHC28 * x3HC28 =e= 0 ;
 EQU906..xx4HC28 * MW4 * FmlHC28 - FlHC28 * x4HC28 =e= 0;
 EQU907..xx5HC28 * MW5 * FmlHC28 - FlHC28 * x5HC28 =e= 0;
 EQU908..xx7HC28 * MW7 * FmlHC28 - FlHC28 * x7HC28 =e= 0;
 EQU909..yy7HC28 * MW7 * FmvHC28 - FvHC28 * y7HC28 =e= 0;
 EQU910..yy5HC28 * MW5 * FmvHC28 - FvHC28 * y5HC28 =e= 0;
 EQU911..yy4HC28 * MW4 * FmvHC28 - FvHC28 * y4HC28 =e= 0;
 EQU912..yy3HC28 * MW3 * FmvHC28 - FvHC28 * y3HC28 =e= 0;
 EQU913..yy1HC28 * MW1 * FmvHC28 - FvHC28 * y1HC28 =e= 0;
 EQU914..FHC28 - FlHC28 - FvHC28 =e= 0;
 EQU915..FvHC28 - VFM3* FHC28 =e= 0;
 EQU916..xx1HC28 * K1M3 =e= yy1HC28;
 EQU917..K1C606A*PC606A =e= 0.1333*10**(21.4469-1.4627E3/TnC606A-5.261*LOG10(TnC606A)+3.282E-11*TnC606A+3.7349E-6*TnC606A**2);
 EQU918..xx2HC28 * K2M3 =e= yy2HC28;
 EQU919..xx3HC28 * K3M3 =e= yy3HC28;
 EQU920..xx4HC28 * K4M3 =e= yy4HC28;
 EQU921..xx5HC28 * K5M3 =e= yy5HC28;
 EQU922..xx7HC28 * K7M3 =e= yy7HC28;
EQU923..hC427 -  FC427 *
((x3C427/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC427,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                        ((1-TC427/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C427/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC427,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                        ((1-TC427/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
```



```
 +(x5C427/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC427,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                        ((1-TC427/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C427/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC427,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                     ((1-TC427/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
 EQU924..x1C427 + x3C427 + x4C427 + x5C427 + x7C427 =e= 1;
 EQU925..FmC427 - FC427 * (x1C427/MW1 + x3C427/MW3 + x4C427/MW4 + x5C427/MW5 + x7C427/MW7)=e= 0;
 EQU926..xx4C427 * FmC427 * MW4 - FC427 * x4C427 =e= 0;
 EQU927..K3C606A*PC606A =e= 0.1333*10**(31.2541-1.9532E3/TnC606A-8.806*LOG10(TnC606A)+8.9246E-11*TnC606A+5.7501E-6*TnC606A**2);
 EQU928..Kp3C606A*PC606A =e= 0.1333*10**(31.2541-1.9532E3/TmC606A-8.806*LOG10(TmC606A)+8.9246E-11*TmC606A+5.7501E-6*TmC606A**2)
;
 EQU929..K4C606A*PC606A =e= 0.1333*10**(27.0441-1.9049E3/TnC606A-7.1805*LOG10(TnC606A)-6.6845E-11*TnC606A+4.219E-6*TnC606A**2);
 EQU930..Kp4C606A*PC606A =e= 0.1333*10**(27.0441-1.9049E3/TmC606A-7.1805*LOG10(TmC606A)-6.6845E-11*TmC606A+4.219E-6*TmC606A**2)
;
 EQU931..K5C606A*PC606A =e= 0.1333*10**(29.2963-2.1762E3/TnC606A-7.883*LOG10(TnC606A)-4.6512E-11*TnC606A+3.8997E-6*TnC606A**2);
 EQU932..Kp5C606A*PC606A =e= 0.1333*10**(29.2963-2.1762E3/TmC606A-7.883*LOG10(TmC606A)-4.6512E-11*TmC606A+3.8997E-6*TmC606A**2)
;
 EQU933..K7C606A*PC606A =e= 0.1333*10**(33.0162-2.583E3/TnC606A-9.042*LOG10(TnC606A)-1.371E-12*TnC606A+3.634E-6*TnC606A**2);
 EQU934..Kp7C606A*PC606A =e= 0.1333*10**(33.0162-2.583E3/TmC606A-9.042*LOG10(TmC606A)-1.371E-12*TmC606A+3.634E-6*TmC606A**2);
 EQU935..Sn1C606A *FC322 =e= K1C606A*FC414;
 EQU936..Sm1C606A*LpC606A=e= Kp1C606A*VpC606A;
 EQU937..Sn3C606A *FC322 =e= K3C606A*FC414;
 EQU938..Sm3C606A*LpC606A=e= Kp3C606A*VpC606A;
 EQU939..Sn4C606A *FC322 =e= K4C606A*FC414;
 EQU940..Sm4C606A*LpC606A=e= Kp4C606A*VpC606A;
 EQU941..Sn5C606A *FC322 =e= K5C606A*FC414;
 EQU942..Sm5C606A*LpC606A=e= Kp5C606A*VpC606A;
 EQU943..Sn7C606A *FC322 =e= K7C606A*FC414;
 EQU944..Sm7C606A*LpC606A=e= Kp7C606A*VpC606A;
```

```
EQU945..f1C606A*((1-Sn1C606A**(56-47))/1E20+  h1C606A*Sn1C606A**(56-47)*(1-Sm1C606A**(47+1))/1E20) =e=  (1-Sn1C606A**(56-47))
              /1E20+ qS1C606A*(Sn1C606A**(56-47)-Sn1C606A)/1E20+qFp1C606A*h1C606A*Sn1C606A**(56-47)*(1-Sm1C606A**47)/1E20
;
EQU946..f3C606A*((1-Sn3C606A**(56-47))/1E10+  h3C606A*Sn3C606A**(56-47)*(1-Sm3C606A**(47+1))/1E10) =e=  (1-Sn3C606A**(56-47))
              /1E10+ qS3C606A*(Sn3C606A**(56-47)-Sn3C606A)/1E10+qFp3C606A*h3C606A*Sn3C606A**(56-47)*(1-Sm3C606A**47)/1E10
;
EQU947..f4C606A*((1-Sn4C606A**(56-47))+  h4C606A*Sn4C606A**(56-47)*(1-Sm4C606A**(47+1))) =e=  (1-Sn4C606A**(56-47))+
                        qS4C606A*(Sn4C606A**(56-47)-Sn4C606A)+qFp4C606A*h4C606A*Sn4C606A**(56-47)*(1-Sm4C606A**47)
;
EQU948..f5C606A*((1-Sn5C606A**(56-47))+  h5C606A*Sn5C606A**(56-47)*(1-Sm5C606A**(47+1))) =e=  (1-Sn5C606A**(56-47))+
                        qS5C606A*(Sn5C606A**(56-47)-Sn5C606A)+qFp5C606A*h5C606A*Sn5C606A**(56-47)*(1-Sm5C606A**47)
;
EQU949..f7C606A*((1-Sn7C606A**(56-47))+  h7C606A*Sn7C606A**(56-47)*(1-Sm7C606A**(47+1))) =e=  (1-Sn7C606A**(56-47))+
                        qS7C606A*(Sn7C606A**(56-47)-Sn7C606A)+qFp7C606A*h7C606A*Sn7C606A**(56-47)*(1-Sm7C606A**47)
;
EQU950..f1C606A * (x1C404 * FC404 + x1C322 * FC322 + x1C432 * FC432) =e= x1C430 * FC430;
EQU951..f3C606A * (x3C404 * FC404 + x3C322 * FC322 + x3C432 * FC432) =e= x3C430 * FC430;
EQU952..f4C606A * (x4C404 * FC404 + x4C322 * FC322 + x4C432 * FC432) =e= x4C430 * FC430;
```



```
EQU953..f5C606A * (x5C404 * FC404 + x5C322 * FC322 + x5C432 * FC432) =e= x5C430 * FC430;
EQU954..f7C606A * (x7C404 * FC404 + x7C322 * FC322 + x7C432 * FC432) =e= x7C430 * FC430;
EQU955..h1C606A*LpC606A*(1-Sm1C606A) =e= FC322*(1-Sn1C606A);
EQU956..h3C606A*LpC606A*(1-Sm3C606A) =e= FC322*(1-Sn3C606A);
EQU957..h4C606A*LpC606A*(1-Sm4C606A) =e= FC322*(1-Sn4C606A);
EQU958..Kp1C606A*PC606A =e= 0.1333*10**(21.4469-1.4627E3/TmC606A-5.261*LOG10(TmC606A)+3.282E-11*TmC606A+3.7349E-6*TmC606A**2);
EQU959..FmC414 - FC414 * (x1C414/MW1 + x3C414/MW3 + x4C414/MW4 + x5C414/MW5 + x7C414/MW7 )=e= 0;
EQU960..xx3C414 * FmC414 * MW3 - FC414 * x3C414 =e= 0;
EQU961..hC322 -  FC322 *  ((x1C322/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC322,ORD(Coeff))))
+(x3C322/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC322,ORD(Coeff))))
+(x4C322/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC322,ORD(Coeff))))
+(x5C322/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC322,ORD(Coeff))))
+(x7C322/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC322,ORD(Coeff))))) =e= 0;
EQU962..xx3C322 * FmC322 * MW3 - FC322 * x3C322 =e= 0;
EQU963..FC427 -FC431 =e= 0;
EQU964..TC431 - TC425 =e= 0;
EQU965..x1C428 + x3C428 + x4C428 + x5C428 + x7C428 =e= 1;
EQU966..FmC428 - FC428 * (x1C428/MW1 + x3C428/MW3 + x4C428/MW4 + x5C428/MW5 + x7C428/MW7)=e= 0;
EQU967..xx4C428 * FmC428 * MW4 - FC428 * x4C428 =e= 0;
EQU968..x1C425 + x3C425 + x4C425 + x5C425 + x7C425 =e= 1;
EQU969..FmC425 - FC425 * (x1C425/MW1 + x3C425/MW3 + x4C425/MW4 + x5C425/MW5 + x7C425/MW7)=e= 0;
EQU970..xx4C425 * FmC425 * MW4 - FC425 * x4C425 =e= 0;
EQU971..x1C408 - x1C405 =e= 0;
EQU972..x3C408 - x3C405 =e= 0;
EQU973..x4C408 - x4C405 =e= 0;
EQU974..x5C408 - x5C405 =e= 0;
EQU975..xM1C606D * FC426**2 *(Sm1C606D-1)=e=  FC405 * x1C405 * (FC428*Kp1C606D*(Sm1C606D**(13-1)-1) + FC426*(Sm1C606D-1));
EQU976..h5C606A*LpC606A*(1-Sm5C606A) =e= FC322*(1-Sn5C606A);
EQU977..h7C606A*LpC606A*(1-Sm7C606A) =e= FC322*(1-Sn7C606A);
EQU978..FC404 * x1C404 + FC432*x1C432 + FC322*x1C322- FC414 * x1C414 - FC430*x1C430 =e= 0;
EQU979..FC404 * x3C404 + FC432*x3C432 + FC322*x3C322- FC414 * x3C414 - FC430*x3C430 =e= 0;
EQU980..FC404 * x4C404 + FC432*x4C432 + FC322*x4C322- FC414 * x4C414 - FC430*x4C430 =e= 0;
EQU981..FC404 * x5C404 + FC432*x5C432 + FC322*x5C322- FC414 * x5C414 - FC430*x5C430 =e= 0;
EQU982..qS1C606A*(FC404 * x1C404 + FC432*x1C432 + FC322*x1C322) =e= FC322*x1C322;
EQU983..qS3C606A*(FC404 * x3C404 + FC432*x3C432 + FC322*x3C322) =e= FC322*x3C322;
EQU984..qS5C606A*(FC404 * x5C404 + FC432*x5C432 + FC322*x5C322) =e= FC322*x5C322;
EQU985..qS4C606A*(FC404 * x4C404 + FC432*x4C432 + FC322*x4C322) =e= FC322*x4C322;
EQU986..xAC02 * (2* x11AC02/98.08 + (1-x11AC02)/360)*98.08 - x11AC02 =e= 0;
EQU987..hAC02*(80.06*xAC02 + 360*(1- xAC02)) /1E2- FAC02 * 4.184E3* (-145.8407 * x11AC02 /1E2+ 9.739e-03 * (TAC02-273) /1E2+
                        8.024e-03 * (TAC02-273) * x11AC02 /1E2+ 83.615 * x11AC02 * x11AC02/1E2 + 65.3921/1E2) =e= 0;
EQU988..xAC05 * (2* x11AC05/98.08 + (1-x11AC05)/360) - x11AC05/98.08 =e= 0;
EQU989..hAC05*(80.06*xAC05 + 360*(1- xAC05))/1E2 - FAC05 * 4.184E3* (-145.8407 * x11AC05/1E2 + 9.739e-03 * (TAC05-273)/1E2 +
                        8.024e-03 * (TAC05-273) * x11AC05/1E2 + 83.615 * x11AC05 * x11AC05/1E2 + 65.3921/1E2) =e= 0;
EQU990..hAC07*(80.06*xAC07 + 360*(1- xAC07))/1E2 - FAC07 * 4.184E3* (-145.8407 * x11AC07/1E2 + 9.739e-03 * (TAC07-273) /1E2+
                        8.024e-03 * (TAC07-273) * x11AC07/1E2 + 83.615 * x11AC07 * x11AC07/1E2 + 65.3921/1E2) =e= 0;
EQU991..xAC07 * (2* x11AC07/98.08 + (1-x11AC07)/360) - x11AC07/98.08 =e= 0;
```



```
EQU992..hAC09 -  FAC09 *  ((x1AC09/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TAC09,ORD(Coeff))))
+(x3AC09/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TAC09,ORD(Coeff))))
+(x4AC09/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TAC09,ORD(Coeff))))
+(x5AC09/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TAC09,ORD(Coeff))))
+(x7AC09/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TAC09,ORD(Coeff))))
+(x8AC09/MW8)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("8",Coeff) *POWER(TAC09,ORD(Coeff))))
+(x9AC09/MW9)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("9",Coeff) *POWER(TAC09,ORD(Coeff))))
+ 3 * (x10AC09/MW10)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("10",Coeff) *POWER(TAC09,ORD(Coeff))))) - hacAC09 =e= 0;
EQU993..xAC09 * (2* x11AC09/98.08 + (1-x11AC09)/360) - x11AC09/98.08 =e= 0;
EQU994..hacAC09*(80.06*xAC09 + 360*(1- xAC09))/1E2 - FAC09 * 4.184E3* (-145.8407 * x11AC09/1E2 + 9.739e-03 * (TAC09-273)
                   /1E2+ 8.024e-03 * (TAC09-273) * x11AC09 /1E2+ 83.615 * x11AC09 * x11AC09 /1E2+ 65.3921/1E2) =e= 0;
EQU995..xAC12 * (2* x11AC12/98.08 + (1-x11AC12)/360) - x11AC12/98.08 =e= 0;
EQU996..hAC12*(80.06*xAC12 + 360*(1- xAC12)) /1E2- FAC12 * 4.184E3* (-145.8407 * x11AC12 /1E2+ 9.739e-03 * (TAC12-273) /1E2+
                        8.024e-03 * (TAC12-273) * x11AC12 /1E2+ 83.615 * x11AC12 * x11AC12 /1E2+ 65.3921/1E2) =e= 0;
EQU997..hAC15*(80.06*xAC15 + 360*(1- xAC15))/1E2 - FAC15 * 4.184E3* (-145.8407 * x11AC15 /1E2+ 9.739e-03 * (TAC15-273) /1E2+
                        8.024e-03 * (TAC15-273) * x11AC15 /1E2+ 83.615 * x11AC15 * x11AC15/1E2 + 65.3921/1E2) =e= 0;
EQU998..xAC15 * (2* x11AC15/98.08 + (1-x11AC15)/360) - x11AC15/98.08 =e= 0;
EQU999..hAC18*(80.06*xAC18 + 360*(1- xAC18))/1E2 - FAC18 * 4.184E3* (-145.8407 * x11AC18 /1E2+ 9.739e-03 * (TAC18-273)/1E2 +
                        8.024e-03 * (TAC18-273) * x11AC18/1E2 + 83.615 * x11AC18 * x11AC18/1E2 + 65.3921/1E2) =e= 0;
EQU1000..xAC18 * (2* x11AC18/98.08 + (1-x11AC18)/360) - x11AC18/98.08 =e= 0;
```

```
EQU1001..hacAC20*(80.06*xAC20 + 360*(1- xAC20))/1E2 - FAC20 * 4.184E3* (-145.8407 * x11AC20/1E2 + 9.739e-03 * (TAC20-273)
                    /1E2+ 8.024e-03 * (TAC20-273) * x11AC20 /1E2+ 83.615 * x11AC20 * x11AC20 /1E2+ 65.3921/1E2) =e= 0;
EQU1002..hAC20 -  FAC20 *  ((x1AC20/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TAC20,ORD(Coeff))))
+(x3AC20/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TAC20,ORD(Coeff))))
+(x4AC20/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TAC20,ORD(Coeff))))
+(x5AC20/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TAC20,ORD(Coeff))))
+(x7AC20/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TAC20,ORD(Coeff))))
+(x8AC20/MW8)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("8",Coeff) * POWER(TAC20,ORD(Coeff))))
+(x9AC20/MW9)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("9",Coeff) *POWER(TAC20,ORD(Coeff))))
+ 3 * (x10AC20/MW10)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("10",Coeff) *POWER(TAC20,ORD(Coeff))))) - hacAC20 =e= 0;
EQU1003..xAC20 * (2* x11AC20/98.08 + (1-x11AC20)/360) - x11AC20/98.08 =e= 0;
EQU1004..hAC23*(80.06*xAC23 + 360*(1- xAC23))/1E2 - FAC23 * 4.184E3* (-145.8407 * x11AC23 /1E2+ 9.739e-03 * (TAC23-273) /1E2+
                      8.024e-03 * (TAC23-273) * x11AC23 /1E2+ 83.615 * x11AC23 * x11AC23 /1E2+ 65.3921/1E2) =e= 0;
EQU1005..xAC23 * (2* x11AC23/98.08 + (1-x11AC23)/360) - x11AC23/98.08 =e= 0;
EQU1006..hAC26*(80.06*xAC26 + 360*(1- xAC26))/1E2 - FAC26 * 4.184E3* (-145.8407 * x11AC26 /1E2+ 9.739e-03 * (TAC26-273)/1E2 +
                      8.024e-03 * (TAC26-273) * x11AC23 /1E2+ 83.615 * x11AC26 * x11AC26 /1E2+ 65.3921/1E2) =e= 0;
EQU1007..xAC26 * (2* x11AC26/98.08 + (1-x11AC26)/360) - x11AC26/98.08 =e= 0;
EQU1008..hAC29*(80.06*xAC29 + 360*(1- xAC29))/1E2 - FAC29 * 4.184E3* (-145.8407 * x11AC29 /1E2+ 9.739e-03 * (TAC29-273) /1E2+
                      8.024e-03 * (TAC29-273) * x11AC29/1E2 + 83.615 * x11AC29 * x11AC29 /1E2+ 65.3921/1E2) =e= 0;
EQU1009..xAC29 * (2* x11AC29/98.08 + (1-x11AC29)/360) - x11AC29/98.08 =e= 0;
EQU1010..hacAC31*(80.06*xAC31 + 360*(1- xAC31))/1E2 - FAC31 * 4.184E3* (-145.8407 * x11AC31/1E2 + 9.739e-03 * (TAC31-273)
                    /1E2+ 8.024e-03 * (TAC31-273) * x11AC31/1E2 + 83.615 * x11AC31 * x11AC31/1E2 + 65.3921/1E2) =e= 0;
EQU1011..hAC31 -  FAC31 *  ((x1AC31/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TAC31,ORD(Coeff))))
+(x3AC31/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TAC31,ORD(Coeff))))
+(x4AC31/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TAC31,ORD(Coeff))))
+(x5AC31/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TAC31,ORD(Coeff))))
```



```
+(x7AC31/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TAC31,ORD(Coeff))))
+(x8AC31/MW8)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("8",Coeff) *POWER(TAC31,ORD(Coeff))))
+(x9AC31/MW9)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("9",Coeff) *POWER(TAC31,ORD(Coeff))))
+ 3 * (x10AC31/MW10)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("10",Coeff) *POWER(TAC31,ORD(Coeff))))) - hacAC31 =e= 0;
EQU1012..xAC31 * (2* x11AC31/98.08 + (1-x11AC31)/360) - x11AC31/98.08 =e= 0;
EQU1013..hAC34*(80.06*xAC34 + 360*(1- xAC34)) /1E2- FAC34 * 4.184E3* (-145.8407 * x11AC34 /1E2+ 9.739e-03 * (TAC34-273) /1E2+
                      8.024e-03 * (TAC34-273) * x11AC34/1E2 + 83.615 * x11AC34 * x11AC34 /1E2+ 65.3921/1E2) =e= 0;
EQU1014..xAC34 * (2* x11AC34/98.08 + (1-x11AC34)/360) - x11AC34/98.08 =e= 0;
EQU1015..qS7C606A*(FC404 * x7C404 + FC432*x7C432 + FC322*x7C322) =e= FC322*x7C322;
EQU1016..qFp1C606A*(FC404 * x1C404 + FC432*x1C432 + FC322*x1C322) =e= FC432*x1C432;
EQU1017..qFp3C606A*(FC404 * x3C404 + FC432*x3C432 + FC322*x3C322) =e= FC432*x3C432;
EQU1018..xM3C606D * FC426**2 * (Sm3C606D-1)=e=  FC405 * x3C405 * (FC428*Kp3C606D*(Sm3C606D**(13-1)-1) + FC426*(Sm3C606D-1));
EQU1019..FmC409 - FC409 * (x1C409/MW1 + x3C409/MW3 + x4C409/MW4 + x5C409/MW5 + x7C409/MW7)=e= 0;
EQU1020..xx4C409 * FmC409 * MW4 - FC409 * x4C409 =e= 0;
EQU1021..FmC408 - FC408 * (x1C408/MW1 + x3C408/MW3 + x4C408/MW4 + x5C408/MW5 + x7C408/MW7)=e= 0;
EQU1022..xx1C408 * FmC408 * MW1 - FC408 * x1C408 =e= 0;
EQU1023..xx3C408 * FmC408 * MW3 - FC408 * x3C408 =e= 0;
EQU1024..xx4C408 * FmC408 * MW4 - FC408 * x4C408 =e= 0;
EQU1025..xx5C408 * FmC408 * MW5 - FC408 * x5C408 =e= 0;
EQU1026..xx1C408 + xx3C408 + xx4C408 + xx5C408 + xx7C408 =e= 1;
EQU1027..FmC405 - FC405 * (x1C405/MW1 + x3C405/MW3 + x4C405/MW4 + x5C405/MW5 + x7C405/MW7)=e= 0;
EQU1028..xx1C405 * FmC405 * MW1 - FC405 * x1C405 =e= 0;
EQU1029..xx3C405 * FmC405 * MW3 - FC405 * x3C405 =e= 0;
EQU1030..xx4C405 * FmC405 * MW4 - FC405 * x4C405 =e= 0;
EQU1031..xx5C405 * FmC405 * MW5 - FC405 * x5C405 =e= 0;
EQU1032..xx7C405 * FmC405 * MW7 - FC405 * x7C405 =e= 0;
EQU1033..FC427 - FC428 - FC411 =e= 0;
EQU1034..hAC37*(80.06*xAC37 + 360*(1- xAC37)) /1E2- FAC37 * 4.184E3* (-145.8407 * x11AC37/1E2 + 9.739e-03 * (TAC37-273)/1E2 +
                      8.024e-03 * (TAC37-273) * x11AC37 /1E2+ 83.615 * x11AC37 * x11AC37/1E2 + 65.3921/1E2) =e= 0;
EQU1035..xAC37 * (2* x11AC37/98.08 + (1-x11AC37)/360) - x11AC37/98.08 =e= 0;
EQU1036..hAC40*(80.06*xAC40 + 360*(1- xAC40))/1E2 - FAC40 * 4.184E3* (-145.8407 * x11AC40 /1E2+ 9.739e-03 * (TAC40-273)/1E2 +
                      8.024e-03 * (TAC40-273) * x11AC40/1E2 + 83.615 * x11AC40 * x11AC40/1E2 + 65.3921/1E2) =e= 0;
EQU1037..hacAC42*(80.06*xAC42 + 360*(1- xAC42))/1E2 - FAC42 * 4.184E3* (-145.8407 * x11AC42/1E2 + 9.739e-03 * (TAC42-273)/1E2
                     +8.024e-03 * (TAC42-273) * x11AC42/1E2 + 83.615 * x11AC42 * x11AC42/1E2 + 65.3921/1E2) =e= 0;
EQU1038..xAC40 * (2* x11AC40/98.08 + (1-x11AC40)/360) - x11AC40/98.08 =e= 0;
EQU1039..xAC42 * (2* x11AC42/98.08 + (1-x11AC42)/360) - x11AC42/98.08 =e= 0;
EQU1040..hAC42 -  FAC42 *  ((x1AC42/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TAC42,ORD(Coeff))))
+(x3AC42/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TAC42,ORD(Coeff))))
+(x4AC42/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TAC42,ORD(Coeff))))
+(x5AC42/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TAC42,ORD(Coeff))))
+(x7AC42/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TAC42,ORD(Coeff))))
+(x8AC42/MW8)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("8",Coeff) *POWER(TAC42,ORD(Coeff))))
+(x9AC42/MW9)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("9",Coeff) *POWER(TAC42,ORD(Coeff))))
+ 3 * (x10AC42/MW10)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("10",Coeff) *POWER(TAC42,ORD(Coeff))))) - hacAC42 =e= 0;
EQU1041..x1HC28 -x1HC29 =e= 0;
EQU1042..x2HC28 -x2HC29 =e= 0;
```



```
EQU1043..x3HC28 -x3HC29 =e= 0;
EQU1044..x4HC28 -x4HC29 =e= 0;
EQU1045..x5HC28 -x5HC29 =e= 0;
EQU1046..x1HC28 -x1R1 =e= 0;
EQU1047..x2HC28 -x2R1 =e= 0;
EQU1048..x3HC28 -x3R1 =e= 0;
EQU1049..x4HC28 -x4R1 =e= 0;
EQU1050..x5HC28 -x5R1 =e= 0;
EQU1051..y1HC28 -y1HC29 =e= 0;
EQU1052..y2HC28 -y2HC29 =e= 0;
EQU1053..y3HC28 -y3HC29 =e= 0;
EQU1054..y4HC28 -y4HC29 =e= 0;
```

```
EQU1055..y5HC28 -y5HC29 =e= 0;
EQU1056..y1HC28 -y1R1 =e= 0;
EQU1057..y2HC28 -y2R1 =e= 0;
EQU1058..y3HC28 -y3R1 =e= 0;
EQU1059..y4HC28 -y4R1 =e= 0;
EQU1060..TC425 - TC410 =e= 0;
EQU1061..TC425 - TC426 =e= 0;
EQU1062..TC432 - TC431 =e= 0;
EQU1063..TC431 - TC412 =e= 0;
EQU1064..y5HC28 -y5R1 =e= 0;
EQU1065..THC28 -TR1 =e= 0;
EQU1066..THC28 -THC29 =e= 0;
EQU1067..x1HC29 + x2HC29 + x3HC29 + x4HC29 + x5HC29 + x7HC29 =e= 1;
EQU1068..y1HC29 + y2HC29 + y3HC29 + y4HC29 + y5HC29 + y7HC29 =e= 1;
EQU1069..hvHC30 -  FvHC30*((y1HC30/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC30,ORD(Coeff)))+ Enth_Vap("1",
                         "a1")*1000 * ((1-THC30/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(y3HC30/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC30,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                         ((1-THC30/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(y4HC30/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC30,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                         ((1-THC30/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(y5HC30/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC30,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                         ((1-THC30/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(y7HC30/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC30,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-THC30/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1070..hHC30 - hlHC30 - hvHC30 =e= 0;
EQU1071..FHC30 - FlHC30 - FvHC30 =e= 0;
EQU1072..hlHC30 - FlHC30*((x1HC30/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC30,ORD(Coeff))))
 +(x3HC30/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC30,ORD(Coeff))))
 +(x4HC30/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC30,ORD(Coeff))))
 +(x5HC30/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC30,ORD(Coeff))))
 +(x7HC30/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC30,ORD(Coeff))))) =e= 0;
EQU1073..x1HC30 + x2HC30 + x3HC30 + x4HC30 + x5HC30 + x7HC30 =e= 1;
EQU1074..y1HC30 + y2HC30 + y3HC30 + y4HC30 + y5HC30 + y7HC30 =e= 1;
EQU1075..hvR29 -  FvR29*((y1R1/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TR29,ORD(Coeff)))+ Enth_Vap("1","a1")
```



```
                         *1000 * ((1-TR29/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(y3R29/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TR29,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 * ((1-TR29/Enth_V
                         ap("3","a2"))**Enth_Vap("3","a3")))
 +(y4R29/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TR29,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 * ((1-TR29/Enth_Va
                         p("4","a2"))**Enth_Vap("4","a3")))
 +(y5R29/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TR29,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 * ((1-TR29/Enth_Va
                         p("5","a2"))**Enth_Vap("5","a3")))
 +(y7R29/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TR29,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 * ((1-TR29/Enth_Va
                         p("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1076..y1R29 + y2R29 + y3R29 + y4R29 + y5R29 + y7R29 =e= 1;
EQU1077..hlR29 -  FlR29* ((x1R29/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TR29,ORD(Coeff))))
 +(x3R29/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TR29,ORD(Coeff))))
 +(x4R29/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TR29,ORD(Coeff))))
 +(x5R29/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TR29,ORD(Coeff))))
 +(x7R29/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TR29,ORD(Coeff)))))  =e= 0;
EQU1078..x1R29 + x2R29 + x3R29 + x4R29  + x5R29 + x7R29 =e= 1;
EQU1079..hR29 - hlR29 - hvR29 =e= 0;
EQU1080..FR29 - FlR29 -FvR29 =e= 0;
EQU1081..hvHC31 -  FvHC31*((y1HC31/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC31,ORD(Coeff)))+ Enth_Vap("1",
                         "a1")*1000 * ((1-THC31/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(y3HC31/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC31,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                         ((1-THC31/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(y4HC31/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC31,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                         ((1-THC31/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(y5HC31/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC31,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                         ((1-THC31/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(y7HC31/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC31,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                         ((1-THC31/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1082..hHC31 - hlHC31 - hvHC31 =e= 0;
EQU1083..FHC31 - FlHC31 - FvHC31 =e= 0;
EQU1084..hlHC31 - FlHC31*((x1HC31/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(THC31,ORD(Coeff))))
 +(x3HC31/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC31,ORD(Coeff))))
 +(x4HC31/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC31,ORD(Coeff))))
 +(x5HC31/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(THC31,ORD(Coeff))))
 +(x7HC31/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC31,ORD(Coeff))))) =e= 0;
EQU1085..x1HC31 + x2HC31 + x3HC31 + x4HC31 + x5HC31 + x7HC31 =e= 1;
EQU1086..y1HC31 + y2HC31 + y3HC31 + y4HC31 + y5HC31 + y7HC31 =e= 1;
EQU1087..qFp4C606A*(FC404 * x4C404 + FC432*x4C432 + FC322*x4C322) =e= FC432*x4C432;
EQU1088..qFp5C606A*(FC404 * x5C404 + FC432*x5C432 + FC322*x5C322) =e= FC432*x5C432;
EQU1089..qFp7C606A*(FC404 * x7C404 + FC432*x7C432 + FC322*x7C322) =e= FC432*x7C432;
EQU1090..K1C430*PC606A =e= 0.1333*10**(21.4469-1.4627E3/TC430-5.261*LOG10(TC430)+3.282E-11*TC430+3.7349E-6*TC430**2);
EQU1091..K3C430*PC606A =e= 0.1333*10**(31.2541-1.9532E3/TC430-8.806*LOG10(TC430)+8.9246E-11*TC430+5.7501E-6*TC430**2);
EQU1092..K4C430*PC606A =e= 0.1333*10**(27.0441-1.9049E3/TC430-7.1805*LOG10(TC430)-6.6845E-11*TC430+4.219E-6*TC430**2);
EQU1093..K5C430*PC606A =e= 0.1333*10**(29.2963-2.1762E3/TC430-7.883*LOG10(TC430)-4.6512E-11*TC430+3.8997E-6*TC430**2);
EQU1094..K7C430*PC606A =e= 0.1333*10**(33.0162-2.583E3/TC430-9.042*LOG10(TC430)-1.371E-12*TC430+3.634E-6*TC430**2);
EQU1095..K1C430*xx1C430+K3C430*xx3C430+K4C430*xx4C430+K5C430*xx5C430+K7C430*xx7C430 =e= 1;
```



```
EQU1096..xx1C430+xx3C430+xx4C430+xx5C430+xx7C430 =e= 1;
EQU1097..xx1C430 * FmC430 * MW1 - FC430 * x1C430 =e= 0;
EQU1098..xx5C430 * FmC430 * MW5 - FC430 * x5C430 =e= 0;
EQU1099..xx1C414+xx3C414+xx4C414+xx5C414+xx7C414 =e= 1;
```

```
EQU1100..K1C414*PC606A =e= 0.1333*10**(21.4469-1.4627E3/TC414-5.261*LOG10(TC414)+3.282E-11*TC414+3.7349E-6*TC414**2);
EQU1101..K3C414*PC606A =e= 0.1333*10**(31.2541-1.9532E3/TC414-8.806*LOG10(TC414)+8.9246E-11*TC414+5.7501E-6*TC414**2);
EQU1102..K4C414*PC606A =e= 0.1333*10**(27.0441-1.9049E3/TC414-7.1805*LOG10(TC414)-6.6845E-11*TC414+4.219E-6*TC414**2);
EQU1103..K5C414*PC606A =e= 0.1333*10**(29.2963-2.1762E3/TC414-7.883*LOG10(TC414)-4.6512E-11*TC414+3.8997E-6*TC414**2);
EQU1104..K7C414*PC606A =e= 0.1333*10**(33.0162-2.583E3/TC414-9.042*LOG10(TC414)-1.371E-12*TC414+3.634E-6*TC414**2);
EQU1105..xx1C414/K1C414+xx3C414/K3C414+xx4C414/K4C414+xx5C414/K5C414+xx7C414/K7C414 =e= 1;
EQU1106..xx1C414 * FmC414 * MW1 - FC414 * x1C414 =e= 0;
EQU1107..xx4C414 * FmC414 * MW4 - FC414 * x4C414 =e= 0;
EQU1108..xx7C414 * FmC414 * MW7 - FC414 * x7C414 =e= 0;
EQU1109..FC425 - FC430 =e=0;
EQU1110..x1C431 + x3C431 + x4C431 + x5C431 + x7C431 =e= 1;
EQU1111..FmC431 - FC431 * (x1C431/MW1 + x3C431/MW3 + x4C431/MW4 + x5C431/MW5 + x7C431/MW7)=e= 0;
EQU1112..xx4C431 * FmC431 * MW4 - FC431 * x4C431 =e= 0;
EQU1113..xx1C425*K1C606C =e= xx1C431;
EQU1114..xx3C425*K3C606C =e= xx3C431;
EQU1115..xx4C425*K4C606C =e= xx4C431;
EQU1116..xx5C425*K5C606C =e= xx5C431;
EQU1117..xx1C431 * FmC431 * MW1 - FC431 * x1C431 =e= 0;
EQU1118..xx3C431 * FmC431 * MW3 - FC431 * x3C431 =e= 0;
EQU1119..xx5C431 * FmC431 * MW5 - FC431 * x5C431 =e= 0;
EQU1120..xx1C431+ xx3C431+ xx4C431+ xx5C431+ xx7C431 =e= 1;
EQU1121..xx1C425 * FmC425 * MW1 - FC425 * x1C425 =e= 0;
EQU1122..xx3C425 * FmC425 * MW3 - FC425 * x3C425 =e= 0;
EQU1123..xx5C425 * FmC425 * MW5 - FC425 * x5C425 =e= 0;
EQU1124..xx1C425 + xx3C425 +xx4C425 +xx5C425 +xx7C425 =e=1 ;
EQU1125..K1C606C*PC606C =e= 0.1333*10**(21.4469-1.4627E3/TC425-5.261*LOG10(TC425)+3.282E-11*TC425+3.7349E-6*TC425**2);
EQU1126..K3C606C*PC606C =e= 0.1333*10**(31.2541-1.9532E3/TC425-8.806*LOG10(TC425)+8.9246E-11*TC425+5.7501E-6*TC425**2);
EQU1127..K4C606C*PC606C =e= 0.1333*10**(27.0441-1.9049E3/TC425-7.1805*LOG10(TC425)-6.6845E-11*TC425+4.219E-6*TC425**2);
EQU1128..K5C606C*PC606C =e= 0.1333*10**(29.2963-2.1762E3/TC425-7.883*LOG10(TC425)-4.6512E-11*TC425+3.8997E-6*TC425**2);
EQU1129..xM4C606D * FC426**2 *(Sm4C606D-1)=e=  FC405 * x4C405 * (FC428*Kp4C606D*(Sm4C606D**(13-1)-1) + FC426*(Sm4C606D-1));
EQU1130..xM5C606D * FC426**2 *(Sm5C606D-1)=e=  FC405 * x5C405 * (FC428*Kp5C606D*(Sm5C606D**(13-1)-1) + FC426*(Sm5C606D-1));
EQU1131..xM7C606D * FC426**2 * (Sm7C606D-1)=e=  FC405 * x7C405 * (FC428*Kp7C606D*(Sm7C606D**(13-1)-1) + FC426*(Sm7C606D-1));
EQU1132..xM1C606D + xM3C606D + xM4C606D + xM5C606D + xM7C606D =e=1;
EQU1133..xx3C428 * FmC428 * MW3 - FC428 * x3C428 =e= 0;
EQU1134..xx1C428 * FmC428 * MW1 - FC428 * x1C428 =e= 0;
EQU1135..xx5C428 * FmC428 * MW5 - FC428 * x5C428 =e= 0;
EQU1136..xx1C428 + xx3C428 + xx4C428 + xx5C428 + xx7C428 =e=1;
EQU1137..K1C428*PC606D =e= 0.1333*10**(21.4469-1.4627E3/TC428-5.261*LOG10(TC428)+3.282E-11*TC428+3.7349E-6*TC428**2);
EQU1138..K3C428*PC606D =e= 0.1333*10**(31.2541-1.9532E3/TC428-8.806*LOG10(TC428)+8.9246E-11*TC428+5.7501E-6*TC428**2);
EQU1139..K4C428*PC606D =e= 0.1333*10**(27.0441-1.9049E3/TC428-7.1805*LOG10(TC428)-6.6845E-11*TC428+4.219E-6*TC428**2);
EQU1140..K5C428*PC606D =e= 0.1333*10**(29.2963-2.1762E3/TC428-7.883*LOG10(TC428)-4.6512E-11*TC428+3.8997E-6*TC428**2);
EQU1141..K7C428*PC606D =e= 0.1333*10**(33.0162-2.583E3/TC428-9.042*LOG10(TC428)-1.371E-12*TC428+3.634E-6*TC428**2);
```



```
EQU1142..xM1C606D*K1C428 =e= xx1C428;
EQU1143..xM3C606D*K3C428 =e= xx3C428;
EQU1144..xM4C606D*K4C428 =e= xx4C428;
EQU1145..xM5C606D*K5C428 =e= xx5C428;
EQU1146..Kp1C606D*PC606D =e= 0.1333*10**(21.4469-1.4627E3/TmC606D-5.261*LOG10(TmC606D)+3.282E-11*TmC606D+3.7349E-6*TmC606D**2)
;
EQU1147..Kp3C606D*PC606D =e= 0.1333*10**(31.2541-1.9532E3/TmC606D-8.806*LOG10(TmC606D)+8.9246E-11*TmC606D+5.7501E-6*TmC606D**2
);
EQU1148..Kp4C606D*PC606D =e= 0.1333*10**(27.0441-1.9049E3/TmC606D-7.1805*LOG10(TmC606D)-6.6845E-11*TmC606D+4.219E-6*TmC606D**2
);
EQU1149..Kp5C606D*PC606D =e= 0.1333*10**(29.2963-2.1762E3/TmC606D-7.883*LOG10(TmC606D)-4.6512E-11*TmC606D+3.8997E-6*TmC606D**2
);
EQU1150..Kp7C606D*PC606D =e= 0.1333*10**(33.0162-2.583E3/TmC606D-9.042*LOG10(TmC606D)-1.371E-12*TmC606D+3.634E-6*TmC606D**2);
EQU1151..TmC606D * 2 =e= TC428 + TC405;
EQU1152..Sm1C606D*FC426 =e= K1C428 *  FC428;
EQU1153..Sm3C606D*FC426 =e= K3C428 *  FC428;
EQU1154..Sm4C606D*FC426 =e= K4C428 *  FC428;
EQU1155..Sm5C606D*FC426 =e= K5C428 *  FC428;
EQU1156..Sm7C606D*FC426 =e= K7C428 *  FC428;
EQU1157..K1C408*PC606D =e= 0.1333*10**(21.4469-1.4627E3/TC408-5.261*LOG10(TC408)+3.282E-11*TC408+3.7349E-6*TC408**2);
EQU1158..K3C408*PC606D =e= 0.1333*10**(31.2541-1.9532E3/TC408-8.806*LOG10(TC408)+8.9246E-11*TC408+5.7501E-6*TC408**2);
EQU1159..K4C408*PC606D =e= 0.1333*10**(27.0441-1.9049E3/TC408-7.1805*LOG10(TC408)-6.6845E-11*TC408+4.219E-6*TC408**2);
EQU1160..K2E6XX*PR29 =e=1.05*PE633;
EQU1161..K3E6XX*PR29 =e= 1.25*PE633;
EQU1162..K4E6XX*PR29 =e=0.82*PE633;
EQU1163..K5E6XX*PR29 =e=0.28*PE633;
EQU1164..K7E6XX*PR29 =e=0.068*PE633;
EQU1165..hC623 =e= hAC09 - hAC07 - hHC07 - hHC34 ;
EQU1166..hC625 =e= hAC20 - hAC18 - hHC11 - hHC38;
EQU1167..hC627 =e= hAC31 - hAC29 - hHC14 - hHC41;
EQU1168..hC629 =e= hAC42 - hAC40 - hHC16 - hHC45;
EQU1169..FHC30 + FR29 =e= FHC31;
EQU1170..FvHC30 + FvR29 =e= FvHC31;
EQU1171..FvHC30*y1HC30 + FvR29*y1R29 =e= FvHC31*y1HC31;
EQU1172..FvHC30*y3HC30 + FvR29*y3R29 =e= FvHC31*y3HC31;
EQU1173..FvHC30*y4HC30 + FvR29*y4R29 =e= FvHC31*y4HC31;
EQU1174..FvHC30*y5HC30 + FvR29*y5R29 =e= FvHC31*y5HC31;
EQU1175..FvHC30*y7HC30 + FvR29*y7R29 =e= FvHC31*y7HC31;
EQU1176..FlHC30*x1HC30 + FlR29*x1R29 =e= FlHC31*x1HC31;
EQU1177..FlHC30*x3HC30 + FlR29*x3R29 =e= FlHC31*x3HC31;
EQU1178..FlHC30*x4HC30 + FlR29*x4R29 =e= FlHC31*x4HC31;
EQU1179..FlHC30*x5HC30 + FlR29*x5R29 =e= FlHC31*x5HC31;
EQU1180..FlHC30*x7HC30 + FlR29*x7R29 =e= FlHC31*x7HC31;
EQU1181..FC301 - FvHC31 =e= 0;
EQU1182..x1C301 - y1HC31 =e=0;
EQU1183..x7C301 - y7HC31 =e=0;
```

```
EQU1184..x3C301 - y3HC31 =e=0;
EQU1185..x4C301 - y4HC31 =e=0;
EQU1186..x5C301 - y5HC31 =e=0;
EQU1187..FC401 - FlHC31 =e= 0;
EQU1188..x1C401 - x1HC31 =e=0;
EQU1189..x3C401 - x3HC31 =e=0;
EQU1190..x4C401 - x4HC31 =e=0;
EQU1191..x5C401 - x5HC31 =e=0;
EQU1192..x7C401 - x7HC31 =e=0;
EQU1193..THC32 - TC302 =e= 0;
EQU1194..K4C614B=e=0.13332*EXP(15.6782-2154.90/(TC302-34.42))/PC302;
EQU1195..PC302 -PHC32 =e= 0;
EQU1196..K5C614B=e=0.13332*EXP(15.5338-2348.67/(TC302-40.05))/PC302;
EQU1197..K7C614B=e=0.13332*EXP(15.7588-2633.90/(TC302-46.30))/PC302;
EQU1198..hC311-hC302-hHC32=e=0;
EQU1199..K3C614B * xx3HC32 - xx3C302 =e= 0;
EQU1200..K1C614B * xx1HC32 - xx1C302 =e= 0;
EQU1201..K4C614B * xx4HC32 - xx4C302 =e= 0;
EQU1202..K5C614B * xx5HC32 - xx5C302 =e= 0;
EQU1203..x1C426 + x3C426 + x4C426 + x5C426 +  x7C426 =e= 1;
EQU1204..K5C408*PC606D =e= 0.1333*10**(29.2963-2.1762E3/TC408-7.883*LOG10(TC408)-4.6512E-11*TC408+3.8997E-6*TC408**2);
EQU1205..K7C408*PC606D =e= 0.1333*10**(33.0162-2.583E3/TC408-9.042*LOG10(TC408)-1.371E-12*TC408+3.634E-6*TC408**2);
EQU1206..K1C408*xx1C408+K3C408*xx3C408+K4C408*xx4C408+K5C408*xx5C408+K7C408*xx7C408 =e= 1;
EQU1207..dTE633*2 =e= (THC05-THC30) + (THC04-THC29);
EQU1208..xx1HC29 + xx2HC29 + xx3HC29 + xx4HC29 + xx5HC29 + xx7HC29 =e= 1;
EQU1209..yy1HC29 + yy2HC29 + yy3HC29 + yy4HC29 + yy5HC29 + yy7HC29 =e= 1;
EQU1210..FmlHC29 - FlHC29 * (x1HC29/MW1 + x2HC29/MW2 + x3HC29/MW3 + x4HC29/MW4 + x5HC29/MW5 + x7HC29/MW7)=e= 0;
EQU1211..FmvHC29 - FvHC29 * (y1HC29/MW1 + y2HC29/MW2 + y3HC29/MW3 + y4HC29/MW4 + y5HC29/MW5 + y7HC29/MW7)=e= 0;
EQU1212..xx1HC29 * MW1 * FmlHC29 - FlHC29 * x1HC29 =e= 0;
EQU1213..xx3HC29 * MW3 * FmlHC29 - FlHC29 * x3HC29 =e= 0;
EQU1214..xx4HC29 * MW4 * FmlHC29 - FlHC29 * x4HC29 =e= 0;
EQU1215..xx5HC29 * MW5 * FmlHC29 - FlHC29 * x5HC29 =e= 0;
EQU1216..xx7HC29 * MW7 * FmlHC29 - FlHC29 * x7HC29 =e= 0;
EQU1217..yy7HC29 * MW7 * FmvHC29 - FvHC29 * y7HC29 =e= 0;
EQU1218..yy5HC29 * MW5 * FmvHC29 - FvHC29 * y5HC29 =e= 0;
EQU1219..yy4HC29 * MW4 * FmvHC29 - FvHC29 * y4HC29 =e= 0;
EQU1220..yy3HC29 * MW3 * FmvHC29 - FvHC29 * y3HC29 =e= 0;
EQU1221..yy1HC29 * MW1 * FmvHC29 - FvHC29 * y1HC29 =e= 0;
EQU1222..yy7R1 * MW7 * FmvR1 - FvR1 * y7R1 =e= 0;
EQU1223..yy5R1 * MW5 * FmvR1 - FvR1 * y5R1 =e= 0;
EQU1224..yy4R1 * MW4 * FmvR1 - FvR1 * y4R1 =e= 0;
EQU1225..yy3R1 * MW3 * FmvR1 - FvR1 * y3R1 =e= 0;
EQU1226..yy1R1 * MW1 * FmvR1 - FvR1 * y1R1 =e= 0;
EQU1227..xx7R1 * MW7 * FmlR1 - FlR1 * x7R1 =e= 0;
EQU1228..xx5R1 * MW5 * FmlR1 - FlR1 * x5R1 =e= 0;
EQU1229..xx4R1 * MW4 * FmlR1 - FlR1 * x4R1 =e= 0;
```



```
EQU1230..xx3R1 * MW3 * FmlR1 - FlR1 * x3R1 =e= 0;
EQU1231..xx1R1 * MW1 * FmlR1 - FlR1 * x1R1 =e= 0;
EQU1232..FmvR1 - FvR1 * (y1R1/MW1 + y2R1/MW2 + y3R1/MW3 + y4R1/MW4 + y5R1/MW5 + y7R1/MW7)=e= 0;
EQU1233..FmlR1 - FlR1 * (x1R1/MW1 + x2R1/MW2 + x3R1/MW3 + x4R1/MW4 + x5R1/MW5 + x7R1/MW7)=e= 0;
EQU1234..xx1R1 + xx2R1 + xx3R1 + xx4R1 + xx5R1 + xx7R1 =e= 1;
EQU1235..yy1R1 + yy2R1 + yy3R1 + yy4R1 + yy5R1 + yy7R1 =e= 1;
EQU1236..K1E633*PHC30 =e= 3.71*PE633;
EQU1237..K2E633*PHC30 =e= 1.05*PE633;
EQU1238..K3E633*PHC30 =e=1.25*PE633;
EQU1239..K4E633*PHC30 =e=0.82*PE633;
EQU1240..K5E633*PHC30 =e= 0.28*PE633;
EQU1241..K7E633*PHC30 =e= 0.068*PE633;
EQU1242..yy1HC30 * MW1 * FmvHC30 - FvHC30 * y1HC30 =e= 0;
EQU1243..yy3HC30 * MW3 * FmvHC30 - FvHC30 * y3HC30 =e= 0;
EQU1244..yy4HC30 * MW4 * FmvHC30 - FvHC30 * y4HC30 =e= 0;
EQU1245..yy5HC30 * MW5 * FmvHC30 - FvHC30 * y5HC30 =e= 0;
EQU1246..yy7HC30 * MW7 * FmvHC30 - FvHC30 * y7HC30 =e= 0;
EQU1247..xx1HC30 * MW1 * FmlHC30 - FlHC30 * x1HC30 =e= 0;
EQU1248..xx3HC30 * MW3 * FmlHC30 - FlHC30 * x3HC30 =e= 0;
EQU1249..xx4HC30 * MW4 * FmlHC30 - FlHC30 * x4HC30 =e= 0;
EQU1250..xx5HC30 * MW5 * FmlHC30 - FlHC30 * x5HC30 =e= 0;
EQU1251..xx7HC30 * MW7 * FmlHC30 - FlHC30 * x7HC30 =e= 0;
EQU1252..FmlHC30 - FlHC30 * (x1HC30/MW1 + x2HC30/MW2 + x3HC30/MW3 + x4HC30/MW4 + x5HC30/MW5 + x7HC30/MW7)=e= 0;
EQU1253..FmvHC30 - FvHC30 * (y1HC30/MW1 + y2HC30/MW2 + y3HC30/MW3 + y4HC30/MW4 + y5HC30/MW5 + y7HC30/MW7)=e= 0;
EQU1254..xx1HC30 + xx2HC30 + xx3HC30 + xx4HC30 + xx5HC30 + xx7HC30 =e= 1;
EQU1255..yy1HC30 + yy2HC30 + yy3HC30 + yy4HC30 + yy5HC30 + yy7HC30 =e= 1;
EQU1256..hC404 -  FC404 *  ((x1C404/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC404,ORD(Coeff))))
 +(x3C404/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC404,ORD(Coeff))))
 +(x4C404/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC404,ORD(Coeff))))
 +(x5C404/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC404,ORD(Coeff))))
 +(x7C404/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC404,ORD(Coeff))))) =e= 0;
EQU1257..hC405 -  FC405 *  ((x1C405/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC405,ORD(Coeff))))
 +(x3C405/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC405,ORD(Coeff))))
 +(x4C405/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC405,ORD(Coeff))))
 +(x5C405/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC405,ORD(Coeff))))
 +(x7C405/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC405,ORD(Coeff))))) =e= 0;
EQU1258..hC406 -  FC406 *  ((x1C406/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC406,ORD(Coeff))))
 +(x3C406/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC406,ORD(Coeff))))
```

```
+(x4C406/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC406,ORD(Coeff))))
+(x5C406/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC406,ORD(Coeff))))
+(x7C406/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC406,ORD(Coeff))))) =e= 0;
EQU1259..hC407 -  FC407 *  ((x1C407/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC407,ORD(Coeff))))
+(x3C407/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC407,ORD(Coeff))))
+(x4C407/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC407,ORD(Coeff))))
+(x5C407/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC407,ORD(Coeff))))
+(x7C407/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC407,ORD(Coeff))))) =e= 0;
```



```
EQU1260..hC408 -  FC408 *  ((x1C408/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC408,ORD(Coeff))))
+(x3C408/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC408,ORD(Coeff))))
+(x4C408/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC408,ORD(Coeff))))
+(x5C408/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC408,ORD(Coeff))))
+(x7C408/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC408,ORD(Coeff))))) =e= 0;
EQU1261..hC410 -  FC410 *  ((x1C410/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC410,ORD(Coeff))))
+(x3C410/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC410,ORD(Coeff))))
+(x4C410/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC410,ORD(Coeff))))
+(x5C410/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC410,ORD(Coeff))))
+(x7C410/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC410,ORD(Coeff))))) =e= 0;
EQU1262..hC413 -  FC413 *  ((x1C413/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC413,ORD(Coeff))))
+(x3C413/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC413,ORD(Coeff))))
+(x4C413/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC413,ORD(Coeff))))
+(x5C413/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC413,ORD(Coeff))))
+(x7C413/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC413,ORD(Coeff))))) =e= 0;
EQU1263..hC414 -  FC414 *
((x1C414/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC414,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                                                   ((1-TC414/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
+(x3C414/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC414,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                                   ((1-TC414/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
+(x4C414/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC414,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                                   ((1-TC414/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
+(x5C414/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC414,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                                   ((1-TC414/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
+(x7C414/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC414,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                                               ((1-TC414/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1264..hC415 -  FC415 *  ((x1C415/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC415,ORD(Coeff))))
+(x3C415/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC415,ORD(Coeff))))
+(x4C415/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC415,ORD(Coeff))))
+(x5C415/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC415,ORD(Coeff))))
+(x7C415/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC415,ORD(Coeff))))) =e= 0;
EQU1265..hC417 -  FC417 *  ((x1C417/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC417,ORD(Coeff))))
+(x3C417/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC417,ORD(Coeff))))
+(x4C417/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC417,ORD(Coeff))))
+(x5C417/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC417,ORD(Coeff))))
+(x7C417/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC417,ORD(Coeff))))) =e= 0;
EQU1266..hC418 -  FC418 *  ((x1C418/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC418,ORD(Coeff))))
+(x3C418/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC418,ORD(Coeff))))
+(x4C418/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC418,ORD(Coeff))))
+(x5C418/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC418,ORD(Coeff))))
+(x7C418/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC418,ORD(Coeff))))) =e= 0;
EQU1267..hC419 -  FC419 *  ((x1C419/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC419,ORD(Coeff))))
+(x3C419/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC419,ORD(Coeff))))
+(x4C419/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC419,ORD(Coeff))))
+(x5C419/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC419,ORD(Coeff))))
+(x7C419/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC419,ORD(Coeff))))) =e= 0;
```



```
EQU1268..hC425 -  FC425 * ((x1C425/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC425,ORD(Coeff))))
+(x3C425/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC425,ORD(Coeff))))
+(x4C425/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC425,ORD(Coeff))))
+(x5C425/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC425,ORD(Coeff))))
+(x7C425/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC425,ORD(Coeff))))) =e= 0;
EQU1269..hC426 -  FC426 *  ((x1C426/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC426,ORD(Coeff))))
+(x3C426/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC426,ORD(Coeff))))
+(x4C426/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC426,ORD(Coeff))))
+(x5C426/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC426,ORD(Coeff))))
+(x7C426/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC426,ORD(Coeff))))) =e= 0;
EQU1270..yy7R29 * MW7 * FmvR29 - FvR29 * y7R29 =e= 0;
EQU1271..yy5R29 * MW5 * FmvR29 - FvR29 * y5R29 =e= 0;
EQU1272..yy4R29 * MW4 * FmvR29 - FvR29 * y4R29 =e= 0;
EQU1273..yy3R29 * MW3 * FmvR29 - FvR29 * y3R29 =e= 0;
EQU1274..yy1R29 * MW1 * FmvR29 - FvR29 * y1R29 =e= 0;
EQU1275..xx7R29 * MW7 * FmlR29 - FlR29 * x7R29 =e= 0;
EQU1276..xx5R29 * MW5 * FmlR29 - FlR29 * x5R29 =e= 0;
EQU1277..xx4R29 * MW4 * FmlR29 - FlR29 * x4R29 =e= 0;
EQU1278..xx3R29 * MW3 * FmlR29 - FlR29 * x3R29 =e= 0;
EQU1279..xx1R29 * MW1 * FmlR29 - FlR29 * x1R29 =e= 0;
EQU1280..yy1R29 + yy2R29 + yy3R29 + yy4R29 + yy5R29 + yy7R29 =e= 1;
EQU1281..xx1R29 + xx2R29 + xx3R29 + xx4R29 + xx5R29 + xx7R29 =e= 1;
EQU1282..FmlR29 - FlR29 * (x1R29/MW1 + x2R29/MW2 + x3R29/MW3 + x4R29/MW4 + x5R29/MW5 + x7R29/MW7)=e= 0;
EQU1283..FmvR29 - FvR29 * (y1R29/MW1 + y2R29/MW2 + y3R29/MW3 + y4R29/MW4 + y5R29/MW5 + y7R29/MW7)=e= 0;
EQU1284..yy1HC30 =e= K1E633*xx1HC30;
EQU1285..yy3HC30 =e= K3E633*xx3HC30;
EQU1286..yy4HC30 =e= K4E633*xx4HC30;
EQU1287..yy5HC30 =e= K5E633*xx5HC30;
EQU1288..yy7HC30 =e= K7E633*xx7HC30;
EQU1289..yy1R29 =e= K1E6XX*xx1R29;
```

```
EQU1290..yy3R29 =e= K3E6XX*xx3R29;
EQU1291..yy4R29 =e= K4E6XX*xx4R29;
EQU1292..yy5R29 =e= K5E6XX*xx5R29;
EQU1293..yy7R29 =e= K7E6XX*xx7R29;
EQU1294..TR1-TR29 =e= 0;
EQU1295..(FlHC29*x7HC29 + FvHC29*y7HC29) - (FlHC30*x7HC30 + FvHC30*y7HC30) =e= 0;
EQU1296..(hC623+hC625+hC627+hC629) - (hR29 - hR1) =e= 0;
EQU1297..(FlR1*x7R1 + FvR1*y7R1) - (FlR29*x7R29 + FvR29*y7R29) =e= 0;
EQU1298..(FlR1*x5R1 + FvR1*y5R1) - (FlR29*x5R29 + FvR29*y5R29) =e= 0;
EQU1299..(FlR1*x1R1 + FvR1*y1R1) - (FlR29*x1R29 + FvR29*y1R29) =e= 0;
EQU1300..(FlR1*x3R1 + FvR1*y3R1) - (FlR29*x3R29 + FvR29*y3R29) =e= 0;
EQU1301..(FlR1*x4R1 + FvR1*y4R1) - (FlR29 *x4R29+ FvR29*y4R29) =e= 0;
EQU1302..(FlR1 + FvR1) - (FlR29 + FvR29) =e= 0;
EQU1303..(hC623+hC625+hC627+hC629) - UE6XX*AE6XX*dTE6XX =e= 0;
EQU1304..K1E6XX*PR29 =e= 3.71*PE633;
EQU1305..FC418 * x2C418 - FC417 * x1C417 =e= 0;
```



```
EQU1306..FC302 =e= VFC614B*FC311;
EQU1307..FC311 - FC302 - FHC32 =e= 0;
EQU1308..K1C614B*PC302 =e= 0.1333*10**(21.4469-1.4627E3/TC302-5.261*LOG10(TC302)+3.282E-11*TC302+3.7349E-6*TC302**2);
EQU1309..K3C614B*PC302 =e= 0.1333*10**(31.2541-1.9532E3/TC302-8.806*LOG10(TC302)+8.9246E-11*TC302+5.7501E-6*TC302**2);
EQU1310..FC311*x1C311 - FC302*x1C302 - FHC32*x1HC32 =e= 0;
EQU1311..FC311*x3C311 - FC302*x3C302 - FHC32*x3HC32 =e= 0;
EQU1312..FC311*x4C311 - FC302*x4C302 - FHC32*x4HC32 =e= 0;
EQU1313..FC311*x7C311 - FC302*x7C302 - FHC32*x7HC32 =e= 0;
EQU1314..hHC01 -  FHC01 *  ((x1HC01/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff)*POWER(THC01,ORD(Coeff))))
+(x2HC01/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) * POWER(THC01,ORD(Coeff))))
+(x3HC01/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(THC01,ORD(Coeff))))
+(x4HC01/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(THC01,ORD(Coeff))))
+(x5HC01/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff)*POWER(THC01,ORD(Coeff))))
+(x7HC01/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(THC01,ORD(Coeff))))) =e= 0;
EQU1315..x1HC01 + x2HC01 + x3HC01 + x4HC01 + x5HC01 + x7HC01 =e=1;
EQU1316..hC401 -  FC401 *  ((x1C401/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC401,ORD(Coeff))))
+(x3C401/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC401,ORD(Coeff))))
+(x4C401/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC401,ORD(Coeff))))
+(x5C401/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC401,ORD(Coeff))))
+(x7C401/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC401,ORD(Coeff))))) =e= 0;
EQU1317..x1C401 + x3C401 + x4C401 + x5C401 + x7C401 =e= 1;
EQU1318..TAC09=e=TAC05;
EQU1319..TAC09=e=TAC12;
EQU1320..TAC09=e=THC27;
EQU1321..hAC02 + hAC05 =e= hAC07;
EQU1322..FHC27*THC27 + FHC26*THC26 =e= FHC28*THC28;
EQU1323..TAC20 - TAC15 =e= 0;
EQU1324..TAC20 - TAC23 =e= 0;
EQU1325..TAC20 - THC25 =e= 0;
EQU1326..hAC12 + hAC15 - hAC18 =e=0;
EQU1327..FHC26*THC26 -FHC25 *THC25 - FHC24 *THC24 =e= 0;
EQU1328..hAC23 + hAC26 - hAC29 =e= 0;
EQU1329..TAC31 - TAC26 =e= 0;
EQU1330..TAC31 - TAC34 =e= 0;
EQU1331..TAC31 - THC23 =e= 0;
EQU1332..FHC24*THC24 -FHC23 *THC23 - FHC22 *THC22 =e= 0;
EQU1333..hAC34 + hAC37 - hAC40 =e= 0;
EQU1334..TAC42 =e= TAC37;
EQU1335..TAC42 =e= TAC45;
EQU1336..TAC42 =e= THC22;
EQU1337..hHC30 + hR29 =e= hHC31;
EQU1338..(hC312 - hC312liq) - FcwE641A*4.197*(TcwotE641A - Tcwin) =e= 0;
EQU1339..hC312liq -  FC312*
((x1C312/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC312,ORD(Coeff))))
+(x3C312/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC312,ORD(Coeff))))
+(x4C312/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC312,ORD(Coeff))))
```



```
+(x5C312/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC312,ORD(Coeff))))
+(x7C312/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC312,ORD(Coeff))))) =e= 0;
EQU1340..THC31 =e= TC401;
EQU1341..THC31 - TC301 =e=0;
EQU1342..xx4C407 * FmC407 * MW4 - FC407 * x4C407 =e= 0;
EQU1343..FmC407 - FC407 * (x1C407/MW1 + x3C407/MW3 + x4C407/MW4 + x5C407/MW5 + x7C407/MW7 )=e= 0;
EQU1344..xx5C407 * FmC407 * MW5 - FC407 * x5C407 =e= 0;
EQU1345..xx3C407 * FmC407 * MW3 - FC407 * x3C407 =e= 0;
EQU1346..FmC412 - FC412 * (x1C412/MW1 + x3C412/MW3 + x4C412/MW4 + x5C412/MW5 + x7C412/MW7 )=e= 0;
EQU1347..xx4C412 * FmC412 * MW4 - FC412 * x4C412 =e= 0;
EQU1348..xx3C412 * FmC412 * MW3 - FC412 * x3C412 =e= 0;
EQU1349..xx5C412 * FmC412 * MW5 - FC412 * x5C412 =e= 0;
EQU1350..xx4C322 * FmC322 * MW4 - FC322 * x4C322 =e= 0;
EQU1351..xx1C322 * FmC322 * MW1 - FC322 * x1C322 =e= 0;
EQU1352..FmC317 - FC317 * (x1C317/MW1 + x3C317/MW3 + x4C317/MW4 + x5C317/MW5 + x7C317/MW7 )=e= 0;
EQU1353..xx4C317 * FmC317 * MW4 - FC317 * x4C317 =e= 0;
EQU1354..xx3C317 * FmC317 * MW3 - FC317 * x3C317 =e= 0;
EQU1355..FmHC01 - FHC01 * (x1HC01/MW1 + x2HC01/MW2+ x3HC01/MW3 + x4HC01/MW4 + x5HC01/MW5 + x7HC01/MW7)=e= 0;
EQU1356..xx1HC01 * MW1 * FmHC01 - FHC01 *x1HC01=e= 0;
EQU1357..xx2HC01 * MW2 * FmHC01 - FHC01 *x2HC01=e= 0;
EQU1358..xx3HC01 * MW3 * FmHC01 - FHC01 *x3HC01=e= 0;
EQU1359..xx4HC01 * MW4 * FmHC01 - FHC01 *x4HC01=e= 0;
```

```
EQU1360..x2C418 - x2C419 =e= 0;
EQU1361..FHC03 * x2HC03 - FC419 * x2C419 =e= 0;
EQU1362..FC417 - FSC414 - FSC413 =e= 0;
EQU1363..FC417 * x1C417- FSC414* x1SC414 - FSC413* x1SC413 =e= 0;
EQU1364..hC417 - hSC414 - hSC413 =e= 0;
EQU1365..FC417 * x2C417- FSC414* x2SC414 - FSC413* x2SC413 =e= 0;
EQU1366..FC417 * x3C417- FSC414* x3SC414 - FSC413* x3SC413 =e= 0;
EQU1367..FC417 * x4C417- FSC414* x4SC414 - FSC413* x4SC413 =e= 0;
EQU1368..FC417 * x5C417- FSC414* x5SC414 - FSC413* x5SC413 =e= 0;
EQU1369..(hSC404 - hSC405) - UE603*AE603*FE603*dTE603 =e= 0;
EQU1370..x3SC409 - x3SC412 =e= 0;
EQU1371..x6SC409 - x6SC412 =e= 0;
EQU1372..x6SC409 - x6SC411 =e= 0;
EQU1373..x2SC409 - x2SC411 =e= 0;
EQU1374..x1SC409 - x1SC411 =e= 0;
EQU1375..x3SC409 - x3SC411 =e= 0;
EQU1376..x4SC409 - x4SC411 =e= 0;
EQU1377..x2SC409 - x2SC412 =e= 0;
EQU1378..x7SC409 - x7SC411 =e= 0;
EQU1379..x1SC409 - x1SC412 =e= 0;
EQU1380..x4SC409 - x4SC412 =e= 0;
EQU1381..x5SC409 - x5SC412 =e= 0;
EQU1382..FSC409 - FSC411 - FSC412 =e= 0;
EQU1383..TSC409 - TSC412 =e= 0;
```



```
EQU1384..TSC409 - TSC411 =e= 0;
EQU1385..x7SC409 - x7SC412 =e= 0;
EQU1386..x5SC409 - x5SC411 =e= 0;
EQU1387..RC601*FSC412 - FSC411 =e= 0;
EQU1388..x3SC412 - x3SC413 =e= 0;
EQU1389..dTE609A**3  =e= ((TSC412-TcwotE609A)*(TSC413-Tcwin)*
((TSC412-TcwotE609A)+(TSC413-Tcwin))/2);
EQU1390..x4SC412 - x4SC413 =e= 0;
EQU1391..x1SC412 - x1SC413 =e= 0;
EQU1392..x2SC412 - x2SC413 =e= 0;
EQU1393..x6SC412 - x6SC413 =e= 0;
EQU1394..FSC412 - FSC413 =e= 0;
EQU1395..(hSC412 - hSC413) - UE609A*AE609A*FE609A*dTE609A =e= 0;
EQU1396..(hSC412 - hSC413) - FcwE609A*4.197*(TcwotE609A - Tcwin) =e= 0;
EQU1397..x5SC412 - x5SC413 =e= 0;
EQU1398..(hSC408 - hSC409) - FcwE605*4.197*(TcwoutE605 - Tcwin) =e= 0;
EQU1399..x3SC408 -x3SC409 =e=0;
EQU1400..x7SC408 -x7SC409 =e=0;
EQU1401..FSC408 - FSC409=e= 0;
EQU1402..TSC408 - TSC409 =e=0;
EQU1403..(hSC408 - hSC409) - UE605*AE605*dTE605 =e= 0;
EQU1404..dTE605*2  =e=
(TSC408-TcwoutE605) + (TSC409-Tcwin);
EQU1405..x1SC408 -x1SC409 =e=0;
EQU1406..x5SC408 -x5SC409 =e=0;
EQU1407..x4SC408 -x4SC409 =e=0;
EQU1408..x2SC408 -x2SC409 =e=0;
EQU1409..x6SC408 -x6SC409 =e=0;
EQU1410..x5SC404 - x5SC405 =e= 0;
EQU1411..x6SC404 - x6SC405 =e= 0;
EQU1412..(hSC404 - hSC405) - FcwE603*4.197*(TcwoutE603 - Tcwin) =e= 0;
EQU1413..x4SC404 - x4SC405 =e= 0;
EQU1414..x3SC404 - x3SC405 =e= 0;
EQU1415..x1SC404 - x1SC405 =e= 0;
EQU1416..dTE603**3  =e= ((TSC404-TcwoutE603)*(TSC405-Tcwin)*
((TSC404-TcwoutE603)+(TSC405-Tcwin))/2);
EQU1417..FSC404 - FSC405 =e= 0;
EQU1418..x2SC404 - x2SC405 =e= 0;
EQU1419..TSC407 - TSC406 =e= 0;
EQU1420..x3SC407 - x3SC406 =e= 0;
EQU1421..x4SC407 - x4SC406 =e= 0;
EQU1422..dTE602 =e= 414.6 - TSC406;
EQU1423..x6SC407 - x6SC406 =e= 0;
EQU1424..x1SC407 - x1SC406 =e= 0;
EQU1425..(hSC407 - hSC406) - UE602*AE602*dTE602 =e= 0;
EQU1426..(hSC407 - hSC406) - FstmE602 * hstmE602 =e= 0;
```



```
EQU1427..x2SC407 - x2SC406 =e= 0;
EQU1428..FSC407 - FSC406 =e= 0;
EQU1429..x5SC407 - x5SC406 =e= 0;
EQU1430..x3SC401 - x3SC402 =e= 0;
EQU1431..x4SC401 - x4SC402 =e= 0;
EQU1432..x5SC403 - x5SC404 =e= 0;
EQU1433..x3SC403 - x3SC404 =e= 0;
EQU1434..x2SC403 - x2SC406 =e= 0;
EQU1435..Sm4C601*LpC601=e= Kp4C601*VpC601;
EQU1436..f4C601 * x4SC402 * FSC402 =e= x4SC403 * FSC403;
EQU1437..x1SC403 - x1SC406 =e= 0;
EQU1438..K3C601*PC601 =e= 0.1333*10**(31.2541-1.9532E3/TnC601-8.806*LOG10(TnC601)+8.9246E-11*TnC601+5.7501E-6*TnC601**2);
EQU1439..K6C601*PC601 =e= 0.1333*10**(33.3239-2.4227E3/TnC601-9.2354*LOG10(TnC601)+9.0199E-11*TnC601+4.1050E-6*TnC601**2);
EQU1440..K1C601*PC601 =e= 0.1333*10**(21.4469-1.4627E3/TnC601-5.261*LOG10(TnC601)+3.282E-11*TnC601+3.7349E-6*TnC601**2);
```

```
EQU1441..K2C601*PC601 =e= 0.1333*10**(33.9868-2.0916E3/TnC601-10.048*LOG10(TnC601)+3.0198E-3*TnC601+2.9122E-6*TnC601**2);
EQU1442..x5SC403 - x5SC406 =e= 0;
EQU1443..Kp3C601*PC601 =e= 0.1333*10**(31.2541-1.9532E3/TmC601-8.806*LOG10(TmC601)+8.9246E-11*TmC601+5.7501E-6*TmC601**2);
EQU1444..x3SC403 - x3SC406 =e= 0;
EQU1445..Kp1C601*PC601 =e= 0.1333*10**(21.4469-1.4627E3/TmC601-5.261*LOG10(TmC601)+3.282E-11*TmC601+3.7349E-6*TmC601**2);
EQU1446..FSC402 * x5SC402 + FSC411*x5SC411 - FSC403 * x5SC403 - FSC408*x5SC408 =e= 0;
EQU1447..Sn7C601 *FSC411 =e= K7C601*FSC408;
EQU1448..FSC402 * x4SC402 + FSC411*x4SC411 - FSC403 * x4SC403 - FSC408*x4SC408 =e= 0;
EQU1449..FSC402 * x3SC402 + FSC411*x3SC411 - FSC403 * x3SC403 - FSC408*x3SC408 =e= 0;
EQU1450..FSC402 * x1SC402 + FSC411*x1SC411 - FSC403 * x1SC403 - FSC408*x1SC408 =e= 0;
EQU1451..FSC402 + FSC411 - FSC403 - FSC408 =e= 0;
EQU1452..x4SC403 - x4SC406 =e= 0;
EQU1453..TSC403 - TSC406 =e= 0;
EQU1454..Kp4C601*PC601 =e= 0.1333*10**(27.0441-1.9049E3/TmC601-7.1805*LOG10(TmC601)-6.6845E-11*TmC601+4.219E-6*TmC601**2);
EQU1455..K5C601*PC601 =e= 0.1333*10**(29.2963-2.1762E3/TnC601-7.883*LOG10(TnC601)-4.6512E-11*TnC601+3.8997E-6*TnC601**2);
EQU1456..Kp5C601*PC601 =e= 0.1333*10**(29.2963-2.1762E3/TmC601-7.883*LOG10(TmC601)-4.6512E-11*TmC601+3.8997E-6*TmC601**2);
EQU1457..K7C601*PC601 =e= 0.1333*10**(33.0162-2.583E3/TnC601-9.042*LOG10(TnC601)-1.371E-12*TnC601+3.634E-6*TnC601**2);
EQU1458..Kp2C601*PC601 =e= 0.1333*10**(33.9868-2.0916E3/TmC601-10.048*LOG10(TmC601)+3.0198E-3*TmC601+2.9122E-6*TmC601**2);
EQU1459..x6SC403 - x6SC406 =e= 0;
EQU1460..x7SC403 - x7SC406 =e= 0;
EQU1461..LpC601=e=FSC411 + qC601*FSC402;
EQU1462..Sn1C601 *FSC411 =e= K1C601*FSC408;
EQU1463..K4C601*PC601 =e= 0.1333*10**(27.0441-1.9049E3/TnC601-7.1805*LOG10(TnC601)-6.6845E-11*TnC601+4.219E-6*TnC601**2);
EQU1464..Kp7C601*PC601 =e= 0.1333*10**(33.0162-2.583E3/TmC601-9.042*LOG10(TmC601)-1.371E-12*TmC601+3.634E-6*TmC601**2);
EQU1465..TmC601=e=(TSC403+TSC402)/2;
EQU1466..TnC601=e=(TSC408+TSC402)/2;
EQU1467..VpC601=e=LpC601 - FSC403;
EQU1468..x1SC413 + x2SC413 + x3SC413 +x4SC413 +x5SC413 + x6SC413 + x7SC413=e= 1;
EQU1469..hSC413 -  FSC413 *  ((x1SC413/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC413,ORD(Coeff))))
 +(x2SC413/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC413,ORD(Coeff))))
 +(x3SC413/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC413,ORD(Coeff))))
 +(x4SC413/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC413,ORD(Coeff))))
```



```
 +(x5SC413/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC413,ORD(Coeff))))
 +(x6SC413/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC413,ORD(Coeff))))
 +(x7SC413/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC413,ORD(Coeff))))) =e= 0;
EQU1470..hSC414 -  FSC414 *  ((x1SC414/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC414,ORD(Coeff))))
 +(x2SC414/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC414,ORD(Coeff))))
 +(x3SC414/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC414,ORD(Coeff))))
 +(x4SC414/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC414,ORD(Coeff))))
 +(x5SC414/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC414,ORD(Coeff))))
 +(x6SC414/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC414,ORD(Coeff))))
 +(x7SC414/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC414,ORD(Coeff))))) =e= 0;
EQU1471..x1SC414 + x2SC414 + x3SC414 +x4SC414 +x5SC414 + x6SC414 + x7SC414=e= 1;
EQU1472..hSC412 -  FSC412 *  ((x1SC412/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC412,ORD(Coeff))))
 +(x2SC412/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC412,ORD(Coeff))))
 +(x3SC412/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC412,ORD(Coeff))))
 +(x4SC412/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC412,ORD(Coeff))))
 +(x5SC412/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC412,ORD(Coeff))))
 +(x6SC412/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC412,ORD(Coeff))))
 +(x7SC412/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC412,ORD(Coeff))))) =e= 0;
EQU1473..x1SC412 + x2SC412 + x3SC412 +x4SC412 +x5SC412 + x6SC412 + x7SC412 =e= 1;
EQU1474..hSC411 -  FSC411 *  ((x1SC411/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC411,ORD(Coeff))))
 +(x2SC411/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC411,ORD(Coeff))))
 +(x3SC411/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC411,ORD(Coeff))))
 +(x4SC411/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC411,ORD(Coeff))))
 +(x5SC411/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC411,ORD(Coeff))))
 +(x6SC411/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC411,ORD(Coeff))))
 +(x7SC411/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC411,ORD(Coeff))))) =e= 0;
EQU1475..hSC409 -  FSC409 *  ((x1SC409/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC409,ORD(Coeff))))
 +(x2SC409/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC409,ORD(Coeff))))
 +(x3SC409/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC409,ORD(Coeff))))
 +(x4SC409/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC409,ORD(Coeff))))
 +(x5SC409/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC409,ORD(Coeff))))
 +(x6SC409/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC409,ORD(Coeff))))
 +(x7SC409/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC409,ORD(Coeff))))) =e= 0;
EQU1476..x1SC409 + x2SC409 + x3SC409 +x4SC409 +x5SC409 + x6SC409 +x7SC409 =e= 1;
EQU1477..xx1SC408 * MW1 * FmSC408 - FSC408 *x1SC408=e= 0;
EQU1478..K6SC408*PC601 =e= 0.1333*10**(33.3239-2.4227E3/TSC408-9.2354*LOG10(TSC408)+9.0199E-11*TSC408+4.1050E-6*TSC408**2);
EQU1479..xx6SC408 * MW6 * FmSC408 - FSC408 *x6SC408=e= 0;
EQU1480..xx2SC408 * MW2 * FmSC408 - FSC408 *x2SC408=e= 0;
EQU1481..xx1SC408+xx2SC408+xx3SC408+xx4SC408+xx5SC408+xx6SC408+xx7SC408 =e= 1;
EQU1482..xx5SC408 * MW5 * FmSC408 - FSC408 *x5SC408=e= 0;
EQU1483..K2SC408*PC601 =e= 0.1333*10**(33.9868-2.0916E3/TSC408-10.048*LOG10(TSC408)+3.0198E-3*TSC408+2.9122E-6*TSC408**2);
EQU1484..xx3SC408 * MW3 * FmSC408 - FSC408 *x3SC408=e= 0;
EQU1485..K3SC408*PC601 =e= 0.1333*10**(31.2541-1.9532E3/TSC408-8.806*LOG10(TSC408)+8.9246E-11*TSC408+5.7501E-6*TSC408**2);
EQU1486..FmSC408 - FSC408 * (x1SC408/MW1 + x2SC408/MW2 + x3SC408/MW3 + x4SC408/MW4 + x5SC408/MW5 + x6SC408/MW6 + x7SC408/MW7)
                                                                                                  =e= 0;
EQU1487..xx1SC408/K1SC408+xx2SC408/K2SC408+xx3SC408/K3SC408+xx4SC408/K4SC408+xx5SC408/K5SC408+xx6SC408/K6SC408+xx7SC408/K7SC40
```



```
                                                                                                  8 =e= 1;
EQU1488..K7SC408*PC601 =e= 0.1333*10**(33.0162-2.583E3/TSC408-9.042*LOG10(TSC408)-1.371E-12*TSC408+3.634E-6*TSC408**2);
EQU1489..K5SC408*PC601 =e= 0.1333*10**(29.2963-2.1762E3/TSC408-7.883*LOG10(TSC408)-4.6512E-11*TSC408+3.8997E-6*TSC408**2);
EQU1490..K4SC408*PC601 =e= 0.1333*10**(27.0441-1.9049E3/TSC408-7.1805*LOG10(TSC408)-6.6845E-11*TSC408+4.219E-6*TSC408**2);
EQU1491..K1SC408*PC601 =e= 0.1333*10**(21.4469-1.4627E3/TSC408-5.261*LOG10(TSC408)+3.282E-11*TSC408+3.7349E-6*TSC408**2);
EQU1492..x1SC408 + x2SC408 + x3SC408 +x4SC408 +x5SC408 + x6SC408 +x7SC408  =e= 1;
```

```
EQU1493..xx4SC408 * MW4 * FmSC408 - FSC408 *x4SC408=e= 0;
EQU1494..x1SC407 + x2SC407 + x3SC407 + x4SC407 + x5SC407 + x6SC407 + x7SC407 =e= 1;
EQU1495..xx1SC406+xx2SC406+xx3SC406+xx4SC406+xx5SC406+xx6SC406+xx7SC406 =e= 1;
EQU1496..K7SC406*PC601 =e= 0.1333*10**(33.0162-2.583E3/TSC406-9.042*LOG10(TSC406)-1.371E-12*TSC406+3.634E-6*TSC406**2);
EQU1497..K1SC406*xx1SC406+K2SC406*xx2SC406+K3SC406*xx3SC406+K4SC406*xx4SC406+K5SC406*xx5SC406+K6SC406*xx6SC406+K7SC406*xx7SC40
                                                                 6 =e= 1;
EQU1498..FmSC406 - FSC406 * (x1SC406/MW1 + x2SC406/MW2 + x3SC406/MW3 + x4SC406/MW4 + x5SC406/MW5 + x6SC406/MW6 + x7SC406/MW7)
                                                                 =e= 0;
EQU1499..xx2SC406 * MW2 * FmSC406 - FSC406 *x2SC406=e= 0;
EQU1500..xx6SC406 * MW6 * FmSC406 - FSC406 *x6SC406=e= 0;
EQU1501..K2SC406*PC601 =e= 0.1333*10**(33.9868-2.0916E3/TSC406-10.048*LOG10(TSC406)+3.0198E-3*TSC406+2.9122E-6*TSC406**2);
EQU1502..K6SC406*PC601 =e= 0.1333*10**(33.3239-2.4227E3/TSC406-9.2354*LOG10(TSC406)+9.0199E-11*TSC406+4.1050E-6*TSC406**2);
EQU1503..xx1SC406 * MW1 * FmSC406 - FSC406 *x1SC406=e= 0;
EQU1504..xx3SC406 * MW3 * FmSC406 - FSC406 *x3SC406=e= 0;
EQU1505..xx4SC406 * MW4 * FmSC406 - FSC406 *x4SC406=e= 0;
EQU1506..K5SC406*PC601 =e= 0.1333*10**(29.2963-2.1762E3/TSC406-7.883*LOG10(TSC406)-4.6512E-11*TSC406+3.8997E-6*TSC406**2);
EQU1507..xx5SC406 * MW5 * FmSC406 - FSC406 *x5SC406=e= 0;
EQU1508..x1SC406 + x2SC406 + x3SC406 + x4SC406+ x5SC406 + x6SC406 + x7SC406 =e= 1;
EQU1509..K4SC406*PC601 =e= 0.1333*10**(27.0441-1.9049E3/TSC406-7.1805*LOG10(TSC406)-6.6845E-11*TSC406+4.219E-6*TSC406**2);
EQU1510..K3SC406*PC601 =e= 0.1333*10**(31.2541-1.9532E3/TSC406-8.806*LOG10(TSC406)+8.9246E-11*TSC406+5.7501E-6*TSC406**2);
EQU1511..K1SC406*PC601 =e= 0.1333*10**(21.4469-1.4627E3/TSC406-5.261*LOG10(TSC406)+3.282E-11*TSC406+3.7349E-6*TSC406**2);
EQU1512..hSC406 -  FSC406 *  ((x1SC406/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC406,ORD(Coeff))))
 +(x2SC406/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC406,ORD(Coeff))))
 +(x3SC406/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC406,ORD(Coeff))))
 +(x4SC406/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC406,ORD(Coeff))))
 +(x5SC406/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC406,ORD(Coeff))))
 +(x6SC406/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff)*POWER(TSC406,ORD(Coeff))))
 +(x7SC406/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC406,ORD(Coeff))))) =e= 0;
EQU1513..x1SC405 + x2SC405 + x3SC405 + x4SC405 + x5SC405 + x6SC405 + x7SC405 =e= 1;
EQU1514..hSC405 -  FSC405 *  ((x1SC405/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff)*POWER(TSC405,ORD(Coeff))))
 +(x2SC405/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC405,ORD(Coeff))))
 +(x3SC405/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC405,ORD(Coeff))))
 +(x4SC405/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC405,ORD(Coeff))))
 +(x5SC405/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC405,ORD(Coeff))))
 +(x6SC405/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC405,ORD(Coeff))))
 +(x7SC405/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC405,ORD(Coeff))))) =e= 0;
EQU1515..x1SC404 + x2SC404 + x3SC404 + x4SC404 + x5SC404 + x6SC404 + x7SC404 =e= 1;
EQU1516..hSC404 -  FSC404 *  ((x1SC404/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC404,ORD(Coeff))))
 +(x2SC404/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC404,ORD(Coeff))))
 +(x3SC404/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC404,ORD(Coeff))))
```



```
 +(x4SC404/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC404,ORD(Coeff))))
 +(x5SC404/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC404,ORD(Coeff))))
 +(x6SC404/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff)*POWER(TSC404,ORD(Coeff))))
 +(x7SC404/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC404,ORD(Coeff))))) =e= 0;
EQU1517..x1SC403 + x2SC403 + x3SC403 + x4SC403 + x5SC403 + x6SC403 + x7SC403 =e= 1;
EQU1518..FmSC403 - FSC403* (x1SC403/MW1 + x2SC403/MW2 + x3SC403/MW3 + x4SC403/MW4 + x5SC403/MW5 + x6SC403/MW6 + x7SC403/MW7 )
                                                                 =e= 0;
EQU1519..hSC403 -  FSC403 *  ((x1SC403/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC403,ORD(Coeff))))
 +(x2SC403/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC403,ORD(Coeff))))
 +(x3SC403/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC403,ORD(Coeff))))
 +(x4SC403/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC403,ORD(Coeff))))
 +(x5SC403/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC403,ORD(Coeff))))
 +(x6SC403/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC403,ORD(Coeff))))
 +(x7SC403/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC403,ORD(Coeff))))) =e= 0;
EQU1520..x1SC402 + x2SC402 + x3SC402 + x4SC402 + x5SC402 + x6SC402 + x7SC402 =e= 1;
EQU1521..hSC402 -  FSC402 *  ((x1SC402/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC402,ORD(Coeff))))
 +(x2SC402/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff)*POWER(TSC402,ORD(Coeff))))
 +(x3SC402/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC402,ORD(Coeff))))
 +(x4SC402/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC402,ORD(Coeff))))
 +(x5SC402/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC402,ORD(Coeff))))
 +(x6SC402/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC402,ORD(Coeff))))
 +(x7SC402/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC402,ORD(Coeff))))) =e= 0;
EQU1522..x1SC401 + x2SC401 + x3SC401 + x4SC401 + x5SC401 + x6SC401 + x7SC401 =e= 1;
EQU1523..hSC401 -  FSC401 *  ((x1SC401/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC401,ORD(Coeff))))
 +(x2SC401/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC401,ORD(Coeff))))
 +(x3SC401/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC401,ORD(Coeff))))
 +(x4SC401/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC401,ORD(Coeff))))
 +(x5SC401/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC401,ORD(Coeff))))
 +(x6SC401/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC401,ORD(Coeff))))
 +(x7SC401/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC401,ORD(Coeff))))) =e= 0;
EQU1524..VpC601=e=FSC406;
EQU1525..VpC603=e=FC323;
EQU1526..Cost =e= FHC01 * 143.4402*0.9071847 + FSC414 * 160.4628*0.9071847 + FAC02 * 110*0.9071847 + FSC401 *25;
EQU1527..Earnings =e= FC407 * 214.1463*0.9071847;
EQU1528..Utilities =e= (FstmE612 +FstmE602+ (FstmE696A+FstmE696B)) * 1.25*0.9071847 + (FstmE695A+ FstmE695B)* 1.8*0.9071847 +
                                                        0.67e-3 *22.35* WK601;
EQU1529..Profit =e= Earnings - Cost - Utilities;
EQU1530..hSC408 -  FSC408 *
((x1SC408/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC408,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                                          ((1-TSC408/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(x3SC408/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC408,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                                          ((1-TSC408/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4SC408/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC408,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                                          ((1-TSC408/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5SC408/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC408,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                                          ((1-TSC408/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
```

```
 +(x7SC408/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC408,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                    ((1-TSC408/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1531..hC325 -  FC325 *
((x1C325/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC325,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                    ((1-TC325/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(x3C325/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC325,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                    ((1-TC325/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C325/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC325,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                    ((1-TC325/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C325/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC325,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                    ((1-TC325/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C325/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC325,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                    ((1-TC325/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1532..hSC407 -  FSC407 *
((x1SC407/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TSC407,ORD(Coeff))))
 +(x2SC407/MW2)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("2",Coeff) *POWER(TSC407,ORD(Coeff))))
 +(x3SC407/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TSC407,ORD(Coeff))))
 +(x4SC407/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TSC407,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                    ((1-TSC407/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5SC407/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TSC407,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                    ((1-TSC407/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x6SC407/MW6)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("6",Coeff) *POWER(TSC407,ORD(Coeff)))+ Enth_Vap("6","a1")*1000 *
                    ((1-TSC407/Enth_Vap("6","a2"))**Enth_Vap("6","a3")))
 +(x7SC407/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TSC407,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                    ((1-TSC407/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1533..hC324 -  FC324 *
((x1C324/MW1)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("1",Coeff) *POWER(TC324,ORD(Coeff)))+ Enth_Vap("1","a1")*1000 *
                    ((1-TC324/Enth_Vap("1","a2"))**Enth_Vap("1","a3")))
 +(x3C324/MW3)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("3",Coeff) * POWER(TC324,ORD(Coeff)))+ Enth_Vap("3","a1")*1000 *
                    ((1-TC324/Enth_Vap("3","a2"))**Enth_Vap("3","a3")))
 +(x4C324/MW4)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("4",Coeff) *POWER(TC324,ORD(Coeff)))+ Enth_Vap("4","a1")*1000 *
                    ((1-TC324/Enth_Vap("4","a2"))**Enth_Vap("4","a3")))
 +(x5C324/MW5)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("5",Coeff) *POWER(TC324,ORD(Coeff)))+ Enth_Vap("5","a1")*1000 *
                    ((1-TC324/Enth_Vap("5","a2"))**Enth_Vap("5","a3")))
 +(x7C324/MW7)*(SUM(Coeff,1/ORD(Coeff)* Enth_liq("7",Coeff) *POWER(TC324,ORD(Coeff)))+ Enth_Vap("7","a1")*1000 *
                    ((1-TC324/Enth_Vap("7","a2"))**Enth_Vap("7","a3")))) =e= 0;
EQU1534..x1SC403 - x1SC404 =e= 0;
EQU1535..FSC403 - FSC404 =e= 0;
EQU1536..x1SC401 - x1SC402 =e= 0;
EQU1537..FSC401 - FSC402 =e= 0;
EQU1538..(hSC403 - hSC404) - (hSC402 - hSC401) =e= 0;
EQU1539..(hSC403 - hSC404) - UE601*AE601*dTE601*FE601 =e= 0;
EQU1540..dTE601**3  =e=  ((TSC403-TSC402)*(TSC404-TSC401)*
((TSC403-TSC402)+(TSC404-TSC401))/2);
EQU1541..x2SC401 - x2SC402 =e= 0;
EQU1542..x6SC403 - x6SC404 =e= 0;
```



```
EQU1543..x2SC403 - x2SC404 =e= 0;
EQU1544..x6SC401 - x6SC402 =e= 0;
EQU1545..x4SC403 - x4SC404 =e= 0;
EQU1546..x5SC401 - x5SC402 =e= 0;
EQU1547..FSC402 * x2SC402 + FSC411*x2SC411 - FSC403 * x2SC403 - FSC408*x2SC408 =e= 0;
EQU1548..h6C601*K6C601*LpC601*(1-Sm6C601) =e= Kp6C601*FSC411*(1-Sn6C601);
EQU1549..h2C601*K2C601*LpC601*(1-Sm2C601) =e= Kp2C601*FSC411*(1-Sn2C601);
EQU1550..f6C601 * x6SC402 * FSC402 =e= x6SC403 * FSC403;
EQU1551..Sn4C601 *FSC411 =e= K4C601*FSC408;
EQU1552..Sn2C601 *FSC411 =e= K2C601*FSC408;
EQU1553..Sm1C601*LpC601=e= Kp1C601*VpC601;
EQU1554..Sn3C601 *FSC411 =e= K3C601*FSC408;
EQU1555..Sn6C601 *FSC411 =e= K6C601*FSC408;
EQU1556..Sn5C601 *FSC411 =e= K5C601*FSC408;
EQU1557..f2C601 * x2SC402 * FSC402 =e= x2SC403 * FSC403;
EQU1558..f6C601*((1-Sn6C601**(60-37))+ RC601*(1-Sn6C601) +  h6C601*Sn6C601**(60-37)*(1-Sm6C601**(37+1))) =e=  (1-Sn6C601**(60-
                    37))+ RC601*(1-Sn6C601);
EQU1559..f2C601*((1-Sn2C601**(60-37))+ RC601*(1-Sn2C601) +  h2C601*Sn2C601**(60-37)*(1-Sm2C601**(37+1))) =e=  (1-Sn2C601**(60-
                    37))+ RC601*(1-Sn2C601);
EQU1560..Sm6C601*LpC601=e= Kp6C601*VpC601;
EQU1561..Sm2C601*LpC601=e= Kp2C601*VpC601;
EQU1562..Sm3C601*LpC601=e= Kp3C601*VpC601;
EQU1563..f7C601 * x7SC402 * FSC402 =e= x7SC403 * FSC403;
EQU1564..Sm7C601*LpC601=e= Kp7C601*VpC601;
EQU1565..f3C601*((1-Sn3C601**(60-37))+ RC601*(1-Sn3C601) +  h3C601*Sn3C601**(60-37)*(1-Sm3C601**(37+1))) =e=  (1-Sn3C601**(60-
                    37))+ RC601*(1-Sn3C601);
EQU1566..f4C601*((1-Sn4C601**(60-37))+ RC601*(1-Sn4C601) +  h4C601*Sn4C601**(60-37)*(1-Sm4C601**(37+1))) =e=  (1-Sn4C601**(60-
                    37))+ RC601*(1-Sn4C601);
EQU1567..f5C601*((1-Sn5C601**(60-37))+ RC601*(1-Sn5C601) +  h5C601*Sn5C601**(60-37)*(1-Sm5C601**(37+1))) =e=  (1-Sn5C601**(60-
                    37))+ RC601*(1-Sn5C601);
EQU1568..f7C601*((1-Sn7C601**(60-37))+ RC601*(1-Sn7C601) +  h7C601*Sn7C601**(60-37)*(1-Sm7C601**(37+1))) =e=  (1-Sn7C601**(60-
                    37))+ RC601*(1-Sn7C601);
EQU1569..f1C601 * x1SC402 * FSC402 =e= x1SC403 * FSC403;
EQU1570..f3C601 * x3SC402 * FSC402 =e= x3SC403 * FSC403;
EQU1571..FSC402 * x6SC402 + FSC411*x6SC411 - FSC403 * x6SC403 - FSC408*x6SC408 =e= 0;
EQU1572..f5C601 * x5SC402 * FSC402 =e= x5SC403 * FSC403;
EQU1573..Kp6C601*PC601 =e= 0.1333*10**(33.3239-2.4227E3/TmC601-9.2354*LOG10(TmC601)+9.0199E-11*TmC601+4.1050E-6*TmC601**2);
EQU1574..h1C601*K1C601*LpC601*(1-Sm1C601) =e= Kp1C601*FSC411*(1-Sn1C601);
EQU1575..h3C601*K3C601*LpC601*(1-Sm3C601) =e= Kp3C601*FSC411*(1-Sn3C601);
```

```
EQU1576..h4C601*K4C601*LpC601*(1-Sm4C601) =e= Kp4C601*FSC411*(1-Sn4C601);
EQU1577..h5C601*K5C601*LpC601*(1-Sm5C601) =e= Kp5C601*FSC411*(1-Sn5C601);
EQU1578..h7C601*K7C601*LpC601*(1-Sm7C601) =e= Kp7C601*FSC411*(1-Sn7C601);
EQU1579..Sm5C601*LpC601=e= Kp5C601*VpC601;

INEQU1..sf1S34 + sf2S34 =l= 1;
INEQU2..TC306 - TcwoutE634 =g= 8;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 69
GAMS 2.50A Windows NT/95/98

```
INEQU3..TC308 - TcwoutE640 =g= 10;
INEQU4..TC317-TC316 =g=10;
INEQU5..TC318-TC315 =g=10;
INEQU6..TC319-Tcwin =g=10;
INEQU7..TC318-TcwoutE611 =g=10;
INEQU8..414.6-TC323 =g=10;
INEQU9..414.6-TC324 =g=10;
INEQU10..TC326-Tcwin =g=10;
INEQU11..TC325-TcwoutE613 =g=10;
INEQU12..TC405-TC404 =g=10;
INEQU13..TC406-TC403 =g=10;
INEQU14..TC407-Tcwin =g=10;
INEQU15..TC406-TcwoutE617 =g=10;
INEQU16..TC414-Tcwin =g=10;
INEQU17..TC414-TcwotE621A =g=10;
INEQU18..TC415-Tcwin =g=10;
INEQU19..TC414-TcwotE621B =g=10;
INEQU20..TC419-Tcwin =g=10;
INEQU21..TC418-TcwoutE626 =g=10;
INEQU22..THC01-TC402 =g=10;
INEQU23..THC02-TC401 =g=10;
INEQU24..TC412-Tcwin =g=8;
INEQU25..TC412-TcwotE627A =g=8;
INEQU26..TC413-TcwotE627B =g=8;
INEQU27..THC04-TC402 =g=8;
INEQU28..THC03-TC403 =g=8;
INEQU29..THC05-THC29 =g=8;
INEQU30..THC04-THC30 =g=8;
INEQU31..TC307-Tcwin =g=8;
INEQU32..TC308-TcwoutE640 =g=10;
INEQU33..TC308-Tcwin =g=10;
INEQU34..TC308-TcwotE641A =g=10;
INEQU35..TC309-TcwotE641B =g=10;
INEQU36..481-TC408 =g=10;
INEQU37..481-TC409 =g=10;
INEQU38..414.6-TC410 =g=10;
INEQU39..414.6-TC411 =g=10;
INEQU40..TSC404-TSC401 =g=10;
INEQU41..TSC403-TSC402 =g=10;
INEQU42..414.6-TSC407 =g=10;
INEQU43..414.6-TSC406 =g=10;
INEQU44..TSC404-TcwoutE603 =g=10;
INEQU45..TSC405-Tcwin =g=10;
INEQU46..TSC408-TcwoutE605 =g=10;
INEQU47..TSC409-Tcwin =g=10;
INEQU48..TSC412 - TcwotE609A =g= 10;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 70
GAMS 2.50A Windows NT/95/98

```
INEQU49..TSC413 - Tcwin =g=10;
INEQU50..f1C601=l=0.0001;

FAC02.L=0.155; FAC12.L=0.155; FAC23.L=0.155;
FAC34.L=0.155; FAC45.L=0.155; FC308.L=3.196;
FC316.L=1.7; FC320.L=0.043; FC322.L=1.5;
FC328.L=0.047; FC329.L=0.665; FC403.L=2.302;
FC407.L=0.911; FC412.L=0.042; FC417.L=0.139;
FHC01.L=0.87; FHC32.L=1.943; FSC402.L=0.484;
FSC405.L=0.344; FSC411.L=1.273; FSC413.L=0.139;
FstmE612.L=0.142; PC302.L=101.847; PC310.L=261.214;
PC601.L=625; PC603.L=1703.728; QHC07.L=1.739;
QHC11.L=1.743; QHC14.L=1.739; QHC16.L=1.739;
QHC34.L=1.079; QHC38.L=0.581; QHC41.L=0.857;
QHC45.L=0.862; TAC09.L=280.004; TAC12.L=280.004;
TAC23.L=280; TAC31.L=280.105; TAC34.L=280.105;
TAC42.L=281.963; TAC45.L=281.963; TC303.L=280.411;
TC306.L=349.007; TC307.L=328.661; TC308.L=328.661;
TC315.L=308.238; TC316.L=345.659; TC317.L=359;
TC321.L=301.113; TC324.L=359; TC325.L=322.937;
TC404.L=305; TC405.L=410; TC407.L=302.95;
TC408.L=405; TC410.L=363.414; TC414.L=336.829;
TC418.L=305.918; TC419.L=303.525; THC32.L=259.254;
TSC402.L=324.98; TSC403.L=336.03; TSC405.L=301.256;
TSC408.L=318.852; TSC413.L=300; x11AC12.L=0.971;
x11AC23.L=0.944; x11AC34.L=0.917; x11AC45.L=0.89;
x1C316.L=0.119; x1C325.L=1; x1C417.L=0.02;
x1HC32.L=0.023; x1SC402.L=0.006; x1SC403.L=0.0000081;
x1SC408.L=0.02; x2SC402.L=0.009; x2SC403.L=0.012;
x2SC408.L=0.00031; x3C316.L=0.79; x3C325.L=0.00000166;
x3C417.L=0.967; x3HC32.L=0.774; x3SC402.L=0.293;
```

```
x3SC403.L=0.021; x3SC408.L=0.967; x4C316.L=0.08;
x4C417.L=0.013; x4HC32.L=0.127; x4SC402.L=0.562;
x4SC403.L=0.784; x4SC408.L=0.013; x5C316.L=0.006;
x5C417.L=0; x5HC32.L=0.03; x5SC402.L=0.052;
x5SC403.L=0.073; x5SC408.L=0; x6SC402.L=0.071;
x6SC403.L=0.1; x6SC408.L=0; x7HC32.L=0.046;
x7SC402.L=0.007; x7SC403.L=0.01; x7SC408.L=0;
xx1C322.L=0.12; xx1C414.L=0.079; xx1HC01.L=0.09;
xx2HC01.L=0.13; xx3C317.L=0.792; xx3C322.L=0.792;
xx3C407.L=0.00000975; xx3C412.L=0.000875; xx3C414.L=0.818;
xx3HC01.L=0.013; xx4C317.L=0.08; xx4C322.L=0.08;
xx4C407.L=0.083; xx4C412.L=0.867; xx4C414.L=0.094;
xx4HC01.L=0.107; xx5C407.L=0.158; xx5C412.L=0.061;
xx5C414.L=0.001; xx7C414.L=0.008;
FAC02.LO=0.09; FAC12.LO=0.01; FAC23.LO=0.01;
```



```
FAC34.LO=0.01; FAC45.LO=0.01; FC308.LO=1;
FC316.LO=0.1; FC320.LO=0.01; FC322.LO=0.1;
FC328.LO=0.01; FC329.LO=0.1; FC403.LO=0.1;
FC407.LO=0.75; FC412.LO=0.01; FC417.LO=0.1;
FHC01.LO=0.795; FHC32.LO=0.5; FSC402.LO=0.1;
FSC405.LO=0; FSC411.LO=0.1; FSC413.LO=0.1;
FstmE612.LO=0.05; PC302.LO=101; PC310.LO=230;
PC601.LO=600; PC603.LO=1600; QHC07.LO=0.1;
QHC11.LO=0.1; QHC14.LO=0.1; QHC16.LO=0.1;
QHC34.LO=0.1; QHC38.LO=0.1; QHC41.LO=0.1;
QHC45.LO=0.1; TAC09.LO=280; TAC12.LO=280;
TAC23.LO=280; TAC31.LO=280; TAC34.LO=280;
TAC42.LO=280; TAC45.LO=280; TC303.LO=260;
TC306.LO=320; TC307.LO=300; TC308.LO=270;
TC315.LO=300; TC316.LO=335; TC317.LO=300;
TC321.LO=250; TC324.LO=359; TC325.LO=300;
TC404.LO=305; TC405.LO=410; TC407.LO=298;
TC408.LO=405; TC410.LO=345; TC414.LO=300;
TC418.LO=301; TC419.LO=298; THC32.LO=250;
TSC402.LO=310; TSC403.LO=320; TSC405.LO=300;
TSC408.LO=300; TSC413.LO=295; x11AC12.LO=0.88;
x11AC23.LO=0.88; x11AC34.LO=0.88; x11AC45.LO=0.88;
x1C316.LO=0.01; x1C325.LO=0.5; x1C417.LO=0.02;
x1HC32.LO=0; x1SC402.LO=0; x1SC403.LO=0;
x1SC408.LO=0; x2SC402.LO=0; x2SC403.LO=0;
x2SC408.LO=0; x3C316.LO=0.5; x3C325.LO=0;
x3C417.LO=0.35; x3HC32.LO=0.1; x3SC402.LO=0.2;
x3SC403.LO=0; x3SC408.LO=0.5; x4C316.LO=0.001;
x4C417.LO=0.001; x4HC32.LO=0; x4SC402.LO=0.48;
x4SC403.LO=0.5; x4SC408.LO=0; x5C316.LO=0;
x5C417.LO=0; x5HC32.LO=0; x5SC402.LO=0;
x5SC403.LO=0; x5SC408.LO=0; x6SC402.LO=0;
x6SC403.LO=0; x6SC408.LO=0; x7HC32.LO=0;
x7SC402.LO=0; x7SC403.LO=0; x7SC408.LO=0;
xx1C322.LO=0; xx1C414.LO=0; xx1HC01.LO=0;
xx2HC01.LO=0.1; xx3C317.LO=0.5; xx3C322.LO=0.5;
xx3C407.LO=0; xx3C412.LO=0; xx3C414.LO=0.5;
xx3HC01.LO=0; xx4C317.LO=0; xx4C322.LO=0;
xx4C407.LO=0.01; xx4C412.LO=0.5; xx4C414.LO=0;
xx4HC01.LO=0; xx5C407.LO=0.01; xx5C412.LO=0;
xx5C414.LO=0; xx7C414.LO=0;
FAC02.UP=0.16; FAC12.UP=0.9; FAC23.UP=0.9;
FAC34.UP=0.9; FAC45.UP=0.9; FC308.UP=6;
FC316.UP=1.8; FC320.UP=1.5; FC322.UP=1.6;
FC328.UP=1; FC329.UP=3; FC403.UP=5;
FC407.UP=5; FC412.UP=1; FC417.UP=2;
```



```
FHC01.UP=1.5; FHC32.UP=5; FSC402.UP=4;
FSC405.UP=3; FSC411.UP=3.2; FSC413.UP=0.5;
FstmE612.UP=1; PC302.UP=187; PC310.UP=360;
PC601.UP=625; PC603.UP=1800; QHC07.UP=5;
QHC11.UP=5; QHC14.UP=5; QHC16.UP=5;
QHC34.UP=5; QHC38.UP=5; QHC41.UP=5;
QHC45.UP=5; TAC09.UP=300; TAC12.UP=300;
TAC23.UP=300; TAC31.UP=300; TAC34.UP=300;
TAC42.UP=300; TAC45.UP=300; TC303.UP=300;
TC306.UP=368; TC307.UP=330; TC308.UP=350;
TC315.UP=320; TC316.UP=370; TC317.UP=420;
TC321.UP=350; TC324.UP=385; TC325.UP=360;
TC404.UP=325; TC405.UP=440; TC407.UP=350;
TC408.UP=440; TC410.UP=369; TC414.UP=368;
TC418.UP=350; TC419.UP=310; THC32.UP=310;
TSC402.UP=340; TSC403.UP=350; TSC405.UP=360;
TSC408.UP=330; TSC413.UP=350; x11AC12.UP=0.999;
x11AC23.UP=0.999; x11AC34.UP=0.999; x11AC45.UP=0.999;
x1C316.UP=0.5; x1C325.UP=1; x1C417.UP=0.2;
x1HC32.UP=0.1; x1SC402.UP=0.1; x1SC403.UP=0.1;
x1SC408.UP=0.1; x2SC402.UP=0.1; x2SC403.UP=0.1;
x2SC408.UP=0.1; x3C316.UP=1; x3C325.UP=0.1;
x3C417.UP=1; x3HC32.UP=1; x3SC402.UP=0.42;
```

```
x3SC403.UP=0.1; x3SC408.UP=1; x4C316.UP=0.2;
x4C417.UP=0.4; x4HC32.UP=0.5; x4SC402.UP=0.7;
x4SC403.UP=1; x4SC408.UP=0.1; x5C316.UP=0.01;
x5C417.UP=0.15; x5HC32.UP=2.5; x5SC402.UP=0.1;
x5SC403.UP=0.1; x5SC408.UP=0.1; x6SC402.UP=0.1;
x6SC403.UP=0.12; x6SC408.UP=0.1; x7HC32.UP=2;
x7SC402.UP=0.1; x7SC403.UP=0.1; x7SC408.UP=0.1;
xx1C322.UP=0.12; xx1C414.UP=0.08; xx1HC01.UP=0.5;
xx2HC01.UP=0.6; xx3C317.UP=1; xx3C322.UP=1;
xx3C407.UP=0.1; xx3C412.UP=0.15; xx3C414.UP=1;
xx3HC01.UP=0.55; xx4C317.UP=0.2; xx4C322.UP=0.2;
xx4C407.UP=0.3; xx4C412.UP=1; xx4C414.UP=0.2;
xx4HC01.UP=0.3; xx5C407.UP=0.5; xx5C412.UP=0.1;
xx5C414.UP=0.1; xx7C414.UP=0.008;

C10pC623.L=0.0000338; C10pC625.L=0.0000735; C10pC627.L=0.000214;
C10pC629.L=0.000152; C2C623.L=0.015; C2C625.L=0.015;
C2C627.L=0.015; C2C629.L=0.015; C3C623.L=3.85;
C3C625.L=2.584; C3C627.L=1.5; C3C629.L=1.801;
C3pC623.L=1.173; C3pC625.L=1.198; C3pC627.L=1.215;
C3pC629.L=1.19; C4pC623.L=0.027; C4pC625.L=0.041;
C4pC627.L=0.071; C4pC629.L=0.058; C5pC623.L=0.000408;
C5pC625.L=0.00091; C5pC627.L=0.003; C5pC629.L=0.002;
```



```
C7pC623.L=0.0000378; C7pC625.L=0.000179; C7pC627.L=0.001;
C7pC629.L=0.000743; C8pC623.L=0.001; C8pC625.L=0.003;
C8pC627.L=0.01; C8pC629.L=0.007; C9pC623.L=0.419;
C9pC625.L=0.625; C9pC627.L=1.074; C9pC629.L=0.895;
CHXC623.L=13.606; CHXC625.L=14.201; CHXC627.L=14.702;
CHXC629.L=14.035; CiC10pC623.L=0; CiC10pC625.L=0;
CiC10pC627.L=0; CiC10pC629.L=0; CiC11pC623.L=0.0000132;
CiC11pC625.L=0.000042; CiC11pC627.L=0.000202; CiC11pC629.L=0.000121;
CiC4eC623.L=0.003; CiC4eC625.L=0.003; CiC4eC627.L=0.003;
CiC4eC629.L=0.003; CiC5eC623.L=0.000594; CiC5eC625.L=0.00085;
CiC5eC627.L=0.001; CiC5eC629.L=0.001; CiC8eC623.L=0.018;
CiC8eC625.L=0.026; CiC8eC627.L=0.044; CiC8eC629.L=0.037;
Cost.L=148.943; dTE601.L=10.516; dTE602.L=78.57;
dTE603.L=10.825; dTE605.L=22.741; dTE609A.L=10;
dTE610.L=13.533; dTE611.L=16.018; dTE612.L=55.6;
dTE613.L=25; dTE616.L=98.994; dTE617.L=33.53;
dTE621A.L=28.414; dTE621B.L=25.722; dTE626.L=11.674;
dTE627A.L=55; dTE627B.L=31.592; dTE628.L=10.806;
dTE629.L=16.246; dTE633.L=11.452; dTE634.L=19.324;
dTE640.L=25.062; dTE641.L=16.152; dTE695A.L=76;
dTE695B.L=48; dTE696A.L=51.186; dTE696B.L=30.593;
dTE6XX.L=1; Earnings.L=176.97; f1C601.L=0.001;
f1C603.L=0.765; f1C606A.L=0.001; f2C601.L=0.99;
f3C601.L=0.05; f3C603.L=1; f3C606A.L=0.000997;
f4C601.L=0.994; f4C603.L=1; f4C606A.L=0.898;
f5C601.L=1; f5C603.L=1; f5C606A.L=0.989;
f6C601.L=1; f7C601.L=1; f7C603.L=1;
f7C606A.L=0.999; FAC05.L=6.653; FAC07.L=6.808;
FAC09.L=8.428; FAC15.L=8.574; FAC18.L=8.729;
FAC20.L=10.065; FAC26.L=18.057; FAC29.L=18.212;
FAC31.L=19.705; FAC37.L=14.803; FAC40.L=14.958;
FAC42.L=16.454; FC301.L=3.643; FC302.L=0.428;
FC303.L=4.071; FC306.L=4.896; FC307.L=4.896;
FC309.L=3.196; FC310.L=0.825; FC311.L=2.371;
FC312.L=1.7; FC315.L=1.7; FC317.L=1.653;
FC318.L=1.653; FC319.L=1.653; FC321.L=0.11;
FC323.L=0.712; FC324.L=0.712; FC325.L=0.712;
FC326.L=0.712; FC401.L=2.302; FC402.L=2.302;
FC404.L=2.302; FC405.L=0.911; FC406.L=0.911;
FC408.L=3.271; FC409.L=3.271; FC410.L=0.833;
FC411.L=0.833; FC413.L=0.042; FC414.L=2.883;
FC415.L=2.883; FC418.L=3.023; FC419.L=3.023;
FC425.L=3.767; FC426.L=2.934; FC427.L=2.856;
FC428.L=2.023; FC430.L=3.767; FC431.L=2.856;
FC432.L=2.814; FcwE603.L=0.199; FcwE605.L=0.949;
FcwE609A.L=0.083; FcwE611.L=2.139; FcwE613.L=1.618;
```



```
FcwE617.L=1.551; FcwE621A.L=5.225; FcwE621B.L=6.898;
FcwE626.L=0.724; FcwE627A.L=0.55; FcwE627B.L=0.536;
FcwE634.L=7.241; FcwE640.L=0.4; FcwE641A.L=4.111;
FcwE641B.L=0.881; FHC02.L=0.87; FHC03.L=3.132;
FHC04.L=3.132; FHC05.L=3.132; FHC06.L=4.002;
FHC07.L=1; FHC08.L=3.002; FHC11.L=1.002;
FHC14.L=1; FHC15.L=2; FHC16.L=1;
FHC22.L=1.496; FHC23.L=1.493; FHC24.L=2.989;
FHC25.L=1.336; FHC26.L=4.325; FHC27.L=1.62;
FHC28.L=5.945; FHC29.L=0.679; FHC30.L=0.679;
FHC31.L=5.945; FHC33.L=0.954; FHC34.L=0.62;
FHC38.L=0.334; FHC40.L=0.989; FHC41.L=0.493;
FHC45.L=0.496; FlHC28.L=3.019; FlHC29.L=0.345;
FlHC30.L=0.198; FlHC31.L=2.302; FlR1.L=2.675;
FlR29.L=2.105; FmC302.L=0.007; FmC308.L=0.055;
```

```
FmC310.L=0.015; FmC311.L=0.04; FmC312.L=0.03;
FmC317.L=0.029; FmC322.L=0.027; FmC323.L=0.013;
FmC325.L=0.016; FmC405.L=0.011; FmC407.L=0.011;
FmC408.L=0.04; FmC409.L=0.04; FmC412.L=0.000684;
FmC414.L=0.05; FmC425.L=0.056; FmC427.L=0.045;
FmC428.L=0.032; FmC430.L=0.058; FmC431.L=0.047;
FmC432.L=0.046; FmHC01.L=0.012; FmHC32.L=0.033;
FmlHC28.L=0.047; FmlHC29.L=0.005; FmlHC30.L=0.003;
FmlR1.L=0.042; FmlR29.L=0.032; FmSC403.L=0.006;
FmSC406.L=0.023; FmSC408.L=0.024; FmvHC28.L=0.051;
FmvHC29.L=0.006; FmvHC30.L=0.008; FmvR1.L=0.045;
FmvR29.L=0.055; FR1.L=5.266; FR29.L=5.266;
FSC401.L=0.484; FSC403.L=0.344; FSC404.L=0.344;
FSC406.L=1.412; FSC407.L=1.412; FSC408.L=1.412;
FSC409.L=1.412; FSC412.L=0.139; FSC414.L=0;
FstmE602.L=0.401; FstmE695A.L=0.409; FstmE695B.L=0.1;
FstmE696A.L=0.111; FstmE696B.L=0.019; FvHC28.L=2.926;
FvHC29.L=0.334; FvHC30.L=0.481; FvHC31.L=3.643;
FvR1.L=2.592; FvR29.L=3.162; h1C601.L=1.083;
h1C603.L=-0.308; h1C606A.L=0.988; h2C601.L=0.551;
h3C601.L=3.047; h3C603.L=0.237; h3C606A.L=-65;
h4C601.L=0.576; h4C603.L=0.303; h4C606A.L=0;
h5C601.L=0.893; h5C603.L=0.4; h5C606A.L=0.484;
h6C601.L=0.919; h7C601.L=0.963; h7C603.L=0.466;
h7C606A.L=0.548; hAC02.L=9.363; hAC05.L=345.67;
hAC07.L=355.032; hAC09.L=1238.893; hAC12.L=8.054;
hAC15.L=381.455; hAC18.L=389.509; hAC20.L=1095.317;
hAC23.L=6.896; hAC26.L=712.123; hAC29.L=719.019;
hAC31.L=1498.7; hAC34.L=6.108; hAC37.L=550.6;
hAC40.L=556.708; hAC42.L=1479.085; hacAC09.L=400.225;
hacAC20.L=404.239; hacAC31.L=725.831; hacAC42.L=698.262;
```



```
hC301.L=3202.309; hC302.L=362.16; hC303.L=3564.469;
hC306.L=4694.871; hC307.L=3144.814; hC308.L=2047.223;
hC309.L=2011.834; hC310.L=732.158; hC311.L=1279.676;
hC312.L=1592.117; hC312liq.L=1097.591; hC315.L=1007.31;
hC316.L=1177.087; hC317.L=1206.034; hC318.L=1036.258;
hC319.L=948.614; hC321.L=63.005; hC322.L=861.064;
hC323.L=519.83; hC324.L=824.202; hC325.L=576.997;
hC326.L=469.229; hC329.L=437.948; hC401.L=1191.06;
hC402.L=1195.852; hC403.L=1256.207; hC404.L=1308.674;
hC405.L=732.132; hC406.L=679.665; hC407.L=494.768;
hC408.L=2583.757; hC408vap.L=3369.113; hC409.L=3561.113;
hC410.L=589.132; hC410vap.L=826.439; hC411.L=866.516;
hC412.L=41.665; hC412liq.L=30.115; hC413.L=23.373;
hC414.L=2726.349; hC414liq.L=1918.758; hC415.L=1687.138;
hC417.L=79.433; hC418.L=1766.572; hC419.L=1748.594;
hC425.L=2663.701; hC426.L=2074.569; hC427.L=2889.353;
hC428.L=2022.838; hC430.L=2637.618; hC431.L=2855.907;
hC432.L=2814.242; hC623.L=54.051; hC625.L=10;
hC627.L=10; hC629.L=151.308; hHC01.L=454.527;
hHC02.L=449.735; hHC03.L=1811.6; hHC04.L=1751.245;
hHC05.L=1699.117; hHC06.L=2148.851; hHC07.L=536.914;
hHC11.L=538.109; hHC14.L=536.914; hHC16.L=536.914;
hHC29.L=469.914; hHC30.L=522.042; hHC31.L=4393.369;
hHC32.L=917.516; hHC34.L=292.895; hHC38.L=157.699;
hHC41.L=232.767; hHC45.L=234.155; hlHC29.L=177.154;
hlHC30.L=100.685; hlHC31.L=1191.06; hlR1.L=1374.506;
hlR29.L=1077.84; hR1.L=3645.969; hR29.L=3871.327;
hSC401.L=298.275; hSC402.L=301.683; hSC403.L=223.217;
hSC404.L=219.81; hSC405.L=193.288; hSC406.L=915.321;
hSC407.L=1775.662; hSC408.L=921.092; hSC409.L=872.425;
hSC411.L=786.391; hSC412.L=86.033; hSC413.L=79.433;
hSC414.L=0; hvHC29.L=292.759; hvHC30.L=421.357;
hvHC31.L=3202.309; hvR1.L=2271.462; hvR29.L=2793.488;
K1C323.L=2.018; K1C325.L=1; K1C408.L=7.956;
K1C414.L=2.523; K1C428.L=4.259; K1C430.L=3.799;
K1C601.L=2.666; K1C603.L=1.267; K1C606A.L=1.812;
K1C606C.L=4.173; K1C614B.L=2.98; K1C615_A.L=2.404;
K1C616_A.L=2.852; K1E633.L=4.427; K1E6XX.L=3.982;
K1SC406.L=3.576; K1SC408.L=2.493; K2C601.L=0.784;
K2E633.L=1.253; K2E6XX.L=1.127; K2SC406.L=1.122;
K2SC408.L=0.723; K3C323.L=0.887; K3C325.L=0.401;
K3C408.L=3.836; K3C414.L=1.052; K3C428.L=1.897;
K3C430.L=1.668; K3C601.L=1.067; K3C603.L=0.525;
K3C606A.L=0.723; K3C606C.L=1.851; K3C614B.L=0.93;
K3C615_A.L=0.981; K3C616_A.L=1.021; K3E633.L=1.492;
K3E6XX.L=1.342; K3SC406.L=1.488; K3SC408.L=0.989;
```



```
K4C323.L=0.673; K4C325.L=0.29; K4C408.L=3.023;
K4C414.L=0.776; K4C428.L=1.45; K4C430.L=1.266;
K4C601.L=0.769; K4C603.L=0.386; K4C606A.L=0.52;
K4C606C.L=1.413; K4C614B.L=0.58; K4C615_A.L=0.708;
K4C616_A.L=0.686; K4E633.L=0.978; K4E6XX.L=0.88;
K4SC406.L=1.096; K4SC408.L=0.709; K5C323.L=0.308;
K5C325.L=0.12; K5C408.L=1.509; K5C414.L=0.335;
```

```
K5C428.L=0.673; K5C430.L=0.579; K5C601.L=0.317;
K5C603.L=0.165; K5C606A.L=0.213; K5C606C.L=0.653;
K5C614B.L=0.162; K5C615_A.L=0.272; K5C616_A.L=0.225;
K5E633.L=0.334; K5E6XX.L=0.301; K5SC406.L=0.472;
K5SC408.L=0.289; K6C601.L=0.247; K6SC406.L=0.375;
K6SC408.L=0.224; K7C323.L=0.12; K7C325.L=0.04;
K7C408.L=0.674; K7C414.L=0.12; K7C428.L=0.268;
K7C430.L=0.226; K7C601.L=0.105; K7C603.L=0.058;
K7C606A.L=0.071; K7C614B.L=0.039; K7C615_A.L=0.103;
K7C616_A.L=0.068; K7E633.L=0.081; K7E6XX.L=0.073;
K7SC406.L=0.168; K7SC408.L=0.095; Kp1C601.L=3.197;
Kp1C603.L=1.79; Kp1C606A.L=2.282; Kp1C606D.L=6.131;
Kp2C601.L=0.979; Kp3C601.L=1.311; Kp3C603.L=0.775;
Kp3C606A.L=0.939; Kp3C606D.L=2.859; Kp4C601.L=0.958;
Kp4C603.L=0.584; Kp4C606A.L=0.688; Kp4C606D.L=2.23;
Kp5C601.L=0.406; Kp5C603.L=0.263; Kp5C606A.L=0.292;
Kp5C606D.L=1.082; Kp6C601.L=0.32; Kp7C601.L=0.141;
Kp7C603.L=0.1; Kp7C606A.L=0.102; Kp7C606D.L=0.462;
kWad1.L=171.048; kWad2.L=288.952; LpC601.L=1.757;
LpC603.L=2.365; LpC606A.L=2.651; PC303.L=101;
PC306.L=870; PC307.L=800; PC308.L=800;
PC309.L=780; PC311.L=261.214; PC312.L=800;
PHC30.L=121.513; PHC32.L=101.847; PR29.L=135.084;
Profit.L=20; Q2HC07.L=0.035; Q2HC11.L=0.035;
Q2HC14.L=0.035; Q2HC16.L=0.035; qFp1C606A.L=0.007;
qFp3C606A.L=0.00098; qFp4C606A.L=0.865; qFp5C606A.L=0.6;
qFp7C606A.L=0.278; qS1C606A.L=0.796; qS3C606A.L=0.509;
qS4C606A.L=0.046; qS5C606A.L=0.027; qS7C606A.L=0.008;
r10C623.L=0; r10C625.L=0; r10C627.L=0.00000137;
r10C629.L=0.00000117; r2C623.L=0.009; r2C625.L=0.009;
r2C627.L=0.009; r2C629.L=0.009; r3C623.L=0.01;
r3C625.L=0.01; r3C627.L=0.01; r3C629.L=0.01;
r4C623.L=0.001; r4C625.L=0.001; r4C627.L=0.001;
r4C629.L=0.001; r5C623.L=0.00000781; r5C625.L=0.0000117;
r5C627.L=0.0000201; r5C629.L=0.0000167; r7C623.L=0;
r7C625.L=0; r7C627.L=0; r7C629.L=0;
r8C623.L=0.00000817; r8C625.L=0.0000121; r8C627.L=0.0000203;
r8C629.L=0.000017; r9C623.L=0.009; r9C625.L=0.009;
r9C627.L=0.009; r9C629.L=0.009; rho2HC07.L=650;
```



```
rho2HC11.L=650; rho2HC14.L=650; rho2HC16.L=650;
rhoAC09.L=1700; rhoAC20.L=1700; rhoAC31.L=1700;
rhoAC42.L=1700; riC10C623.L=0; riC10C625.L=0;
riC10C627.L=0; riC10C629.L=0; riC11C623.L=0;
riC11C625.L=0; riC11C627.L=0.00000114; riC11C629.L=0;
sf1S34.L=0.026; sf2S34.L=0.066; sfS11.L=0.5;
sfS19.L=0.491; sfS2.L=0.886; sfS23.L=0.65;
sfS27.L=0.499; sfS41.L=0.985; sfS42.L=0.779;
sfS5.L=0.25; sfS7.L=0.334; Sm1C601.L=2.57;
Sm1C603.L=0.539; Sm1C606A.L=2.422; Sm1C606D.L=2.936;
Sm2C601.L=0.787; Sm3C601.L=1.054; Sm3C603.L=0.233;
Sm3C606A.L=0.997; Sm3C606D.L=1.308; Sm4C601.L=0.77;
Sm4C603.L=0.176; Sm4C606A.L=0.73; Sm4C606D.L=1;
Sm5C601.L=0.326; Sm5C603.L=0.079; Sm5C606A.L=0.31;
Sm5C606D.L=0.464; Sm6C601.L=0.257; Sm7C601.L=0.113;
Sm7C603.L=0.03; Sm7C606A.L=0.108; Sm7C606D.L=0.185;
Sn1C601.L=2.958; Sn1C603.L=1.358; Sn1C606A.L=3.483;
Sn2C601.L=0.87; Sn3C601.L=1.184; Sn3C603.L=0.562;
Sn3C606A.L=1.39; Sn4C601.L=0.853; Sn4C603.L=0.413;
Sn4C606A.L=1; Sn5C601.L=0.351; Sn5C603.L=0.177;
Sn5C606A.L=0.41; Sn6C601.L=0.274; Sn7C601.L=0.117;
Sn7C603.L=0.062; Sn7C606A.L=0.136; TAC02.L=276;
TAC05.L=280.004; TAC07.L=279.99; TAC15.L=280;
TAC18.L=280.063; TAC20.L=280; TAC26.L=280.105;
TAC29.L=280.224; TAC37.L=281.963; TAC40.L=281.981;
TC301.L=282.932; TC302.L=259.254; TC309.L=324.429;
TC310.L=288.704; TC311.L=288.704; TC312.L=328.661;
TC318.L=321.965; TC319.L=301.113; TC320.L=301.113;
TC322.L=301.113; TC323.L=359; TC326.L=322.937;
TC328.L=322.937; TC329.L=322.937; TC401.L=282.932;
TC402.L=283.85; TC403.L=295.279; TC406.L=388.5;
TC409.L=461; TC411.L=404.6; TC412.L=363.414;
TC413.L=301; TC415.L=305.99; TC417.L=299.989;
TC425.L=363.414; TC426.L=363.414; TC427.L=375.65;
TC428.L=365.245; TC430.L=358.683; TC431.L=363.414;
TC432.L=363.414; TcwotE609A.L=308.852; TcwotE621A.L=326.829;
TcwotE621B.L=298; TcwotE627A.L=295; TcwotE627B.L=293;
TcwotE641A.L=318.661; TcwotE641B.L=314.429; TcwoutE603.L=321.814;
TcwoutE605.L=302.221; TcwoutE611.L=299.764; TcwoutE613.L=305.874;
TcwoutE617.L=318.399; TcwoutE626.L=295.918; TcwoutE634.L=341.007;
TcwoutE640.L=311.08; THC01.L=295.504; THC02.L=292.932;
THC03.L=303.279; THC04.L=295.426; THC05.L=288.522;
THC06.L=289.396; THC07.L=289.396; THC11.L=289.396;
THC14.L=289.396; THC16.L=289.396; THC22.L=281.963;
THC23.L=280.105; THC24.L=281.035; THC25.L=280;
THC26.L=280.715; THC27.L=280.004; THC28.L=280.522;
```

```
THC29.L=280.522; THC30.L=280.522; THC31.L=282.932;
THC34.L=259.254; THC38.L=259.254; THC41.L=259.254;
THC45.L=259.254; TmC601.L=330.505; TmC603.L=352.33;
TmC606A.L=331.841; TmC606D.L=387.623; TmK601.L=306.796;
TnC601.L=321.916; TnC603.L=334.298; TnC606A.L=320.914;
TR1.L=280.522; TR29.L=280.522; TSC401.L=322.219;
TSC404.L=332.219; TSC406.L=336.03; TSC407.L=336.03;
TSC409.L=318.852; TSC411.L=318.852; TSC412.L=318.852;
TSC414.L=320; Utilities.L=8.027; VFC614B.L=0.181;
VFC615.L=0.347; VFC616.L=0.258; VFM3.L=0.492;
VpC601.L=1.412; VpC603.L=0.712; VpC606A.L=2.814;
x10AC09.L=0; x10AC20.L=0; x10AC31.L=0;
x10AC42.L=0; x11AC02.L=0.998; x11AC05.L=0.971;
x11AC07.L=0.972; x11AC09.L=0.784; x11AC15.L=0.944;
x11AC18.L=0.944; x11AC20.L=0.819; x11AC26.L=0.917;
x11AC29.L=0.917; x11AC31.L=0.848; x11AC37.L=0.89;
x11AC40.L=0.89; x11AC42.L=0.809; x12AC02.L=0.002;
x12AC05.L=0.029; x12AC07.L=0.028; x12AC09.L=0.023;
x12AC12.L=0.029; x12AC15.L=0.056; x12AC18.L=0.056;
x12AC20.L=0.049; x12AC23.L=0.056; x12AC26.L=0.083;
x12AC29.L=0.083; x12AC31.L=0.077; x12AC34.L=0.083;
x12AC37.L=0.11; x12AC40.L=0.11; x12AC42.L=0.1;
x12AC45.L=0.11; x1AC09.L=0.009; x1AC20.L=0.007;
x1AC31.L=0.004; x1AC42.L=0.004; x1C301.L=0.068;
x1C302.L=0.069; x1C303.L=0.068; x1C306.L=0.072;
x1C307.L=0.072; x1C308.L=0.048; x1C309.L=0.048;
x1C310.L=0.094; x1C311.L=0.031; x1C312.L=0.119;
x1C315.L=0.119; x1C317.L=0.094; x1C318.L=0.094;
x1C319.L=0.094; x1C320.L=0.094; x1C321.L=0.094;
x1C322.L=0.094; x1C323.L=0.094; x1C324.L=0.094;
x1C326.L=1; x1C328.L=1; x1C329.L=1;
x1C401.L=0.015; x1C402.L=0.015; x1C403.L=0.015;
x1C404.L=0.015; x1C405.L=0; x1C406.L=0;
x1C407.L=0; x1C408.L=0; x1C409.L=0;
x1C410.L=0.0001; x1C411.L=0.0001; x1C412.L=0.000463;
x1C413.L=0.000463; x1C414.L=0.061; x1C415.L=0.061;
x1C418.L=0.059; x1C419.L=0.059; x1C425.L=0.0001;
x1C426.L=0.0001; x1C427.L=0.000132; x1C428.L=0.000145;
x1C430.L=0.0000468; x1C431.L=0.000463; x1C432.L=0.000463;
x1HC01.L=0.055; x1HC02.L=0.055; x1HC03.L=0.06;
x1HC04.L=0.06; x1HC05.L=0.06; x1HC06.L=0.059;
x1HC07.L=0.059; x1HC08.L=0.059; x1HC11.L=0.059;
x1HC14.L=0.059; x1HC15.L=0.059; x1HC16.L=0.059;
x1HC22.L=0.047; x1HC23.L=0.047; x1HC24.L=0.047;
x1HC25.L=0.05; x1HC26.L=0.048; x1HC27.L=0.045;
x1HC28.L=0.019; x1HC29.L=0.019; x1HC30.L=0.012;
```



```
x1HC31.L=0.015; x1HC33.L=0.023; x1HC34.L=0.023;
x1HC38.L=0.023; x1HC40.L=0.023; x1HC41.L=0.023;
x1HC45.L=0.023; x1R1.L=0.019; x1R29.L=0.015;
x1SC401.L=0.006; x1SC404.L=0.0000081; x1SC405.L=0.0000081;
x1SC406.L=0.0000081; x1SC407.L=0.0000081; x1SC409.L=0.02;
x1SC411.L=0.02; x1SC412.L=0.02; x1SC413.L=0.02;
x1SC414.L=0.1; x2AC09.L=0; x2AC20.L=0;
x2AC31.L=0; x2AC42.L=0; x2C301.L=0;
x2C417.L=0.00031; x2C418.L=0.000922; x2C419.L=0.000922;
x2HC01.L=0.1; x2HC02.L=0.1; x2HC03.L=0.000889;
x2HC04.L=0.000889; x2HC05.L=0.000889; x2HC06.L=0.022;
x2HC07.L=0.022; x2HC08.L=0.022; x2HC11.L=0.022;
x2HC14.L=0.022; x2HC15.L=0.022; x2HC16.L=0.022;
x2HC22.L=0; x2HC23.L=0; x2HC24.L=0;
x2HC25.L=0; x2HC26.L=0; x2HC27.L=0;
x2HC28.L=0; x2HC29.L=0; x2HC30.L=0;
x2HC31.L=0; x2R1.L=0; x2R29.L=0;
x2SC401.L=0.009; x2SC404.L=0.012; x2SC405.L=0.012;
x2SC406.L=0.012; x2SC407.L=0.012; x2SC409.L=0.00031;
x2SC411.L=0.00031; x2SC412.L=0.00031; x2SC413.L=0.00031;
x2SC414.L=0.1; x3AC09.L=0.132; x3AC20.L=0.088;
x3AC31.L=0.051; x3AC42.L=0.062; x3C301.L=0.781;
x3C302.L=0.71; x3C303.L=0.774; x3C306.L=0.78;
x3C307.L=0.78; x3C308.L=0.775; x3C309.L=0.775;
x3C310.L=0.812; x3C311.L=0.762; x3C312.L=0.79;
x3C315.L=0.79; x3C317.L=0.813; x3C318.L=0.813;
x3C319.L=0.813; x3C320.L=0.813; x3C321.L=0.813;
x3C322.L=0.813; x3C323.L=0.813; x3C324.L=0.813;
x3C326.L=0.00000166; x3C328.L=0.00000166; x3C329.L=0.00000166;
x3C401.L=0.51; x3C402.L=0.51; x3C403.L=0.51;
x3C404.L=0.51; x3C405.L=0.00000694; x3C406.L=0.00000694;
x3C407.L=0.00000694; x3C408.L=0.00000694; x3C409.L=0.00000694;
x3C410.L=0.000406; x3C411.L=0.000406; x3C412.L=0.000834;
x3C413.L=0.000834; x3C414.L=0.83; x3C415.L=0.83;
x3C418.L=0.837; x3C419.L=0.837; x3C425.L=0.000406;
x3C426.L=0.000406; x3C427.L=0.000533; x3C428.L=0.000586;
x3C430.L=0.000634; x3C431.L=0.000834; x3C432.L=0.000834;
x3HC01.L=0.01; x3HC02.L=0.01; x3HC03.L=0.836;
x3HC04.L=0.836; x3HC05.L=0.836; x3HC06.L=0.656;
x3HC07.L=0.656; x3HC08.L=0.656; x3HC11.L=0.656;
x3HC14.L=0.656; x3HC15.L=0.656; x3HC16.L=0.656;
```

```
x3HC22.L=0.677; x3HC23.L=0.677; x3HC24.L=0.677;
x3HC25.L=0.665; x3HC26.L=0.673; x3HC27.L=0.684;
x3HC28.L=0.568; x3HC29.L=0.568; x3HC30.L=0.446;
x3HC31.L=0.51; x3HC33.L=0.774; x3HC34.L=0.774;
x3HC38.L=0.774; x3HC40.L=0.774; x3HC41.L=0.774;
```



```
x3HC45.L=0.774; x3R1.L=0.568; x3R29.L=0.516;
x3SC401.L=0.293; x3SC404.L=0.021; x3SC405.L=0.021;
x3SC406.L=0.021; x3SC407.L=0.021; x3SC409.L=0.967;
x3SC411.L=0.967; x3SC412.L=0.967; x3SC413.L=0.967;
x3SC414.L=0.5; x4AC09.L=0.02; x4AC20.L=0.014;
x4AC31.L=0.008; x4AC42.L=0.01; x4C301.L=0.105;
x4C302.L=0.073; x4C303.L=0.101; x4C306.L=0.099;
x4C307.L=0.099; x4C308.L=0.108; x4C309.L=0.108;
x4C310.L=0.084; x4C311.L=0.117; x4C312.L=0.08;
x4C315.L=0.08; x4C317.L=0.082; x4C318.L=0.082;
x4C319.L=0.082; x4C320.L=0.082; x4C321.L=0.082;
x4C322.L=0.082; x4C323.L=0.082; x4C324.L=0.082;
x4C325.L=0; x4C326.L=0; x4C328.L=0;
x4C329.L=0; x4C401.L=0.104; x4C402.L=0.104;
x4C403.L=0.104; x4C404.L=0.104; x4C405.L=0.059;
x4C406.L=0.059; x4C407.L=0.059; x4C408.L=0.059;
x4C409.L=0.059; x4C410.L=0.527; x4C411.L=0.527;
x4C412.L=0.826; x4C413.L=0.826; x4C414.L=0.095;
x4C415.L=0.095; x4C418.L=0.092; x4C419.L=0.092;
x4C425.L=0.527; x4C426.L=0.527; x4C427.L=0.676;
x4C428.L=0.738; x4C430.L=0.641; x4C431.L=0.826;
x4C432.L=0.826; x4HC01.L=0.085; x4HC02.L=0.085;
x4HC03.L=0.091; x4HC04.L=0.091; x4HC05.L=0.091;
x4HC06.L=0.09; x4HC07.L=0.09; x4HC08.L=0.09;
x4HC11.L=0.09; x4HC14.L=0.09; x4HC15.L=0.09;
x4HC16.L=0.09; x4HC22.L=0.105; x4HC23.L=0.105;
x4HC24.L=0.105; x4HC25.L=0.102; x4HC26.L=0.104;
x4HC27.L=0.106; x4HC28.L=0.109; x4HC29.L=0.109;
x4HC30.L=0.096; x4HC31.L=0.104; x4HC33.L=0.127;
x4HC34.L=0.127; x4HC38.L=0.127; x4HC40.L=0.127;
x4HC41.L=0.127; x4HC45.L=0.127; x4R1.L=0.109;
x4R29.L=0.105; x4SC401.L=0.562; x4SC404.L=0.784;
x4SC405.L=0.784; x4SC406.L=0.784; x4SC407.L=0.784;
x4SC409.L=0.013; x4SC411.L=0.013; x4SC412.L=0.013;
x4SC413.L=0.013; x4SC414.L=0.1; x5AC09.L=0.006;
x5AC20.L=0.004; x5AC31.L=0.002; x5AC42.L=0.003;
x5C301.L=0.019; x5C302.L=0.005; x5C303.L=0.017;
x5C306.L=0.015; x5C307.L=0.015; x5C308.L=0.021;
x5C309.L=0.021; x5C310.L=0.006; x5C311.L=0.026;
x5C312.L=0.006; x5C315.L=0.006; x5C317.L=0.006;
x5C318.L=0.006; x5C319.L=0.006; x5C320.L=0.006;
x5C321.L=0.006; x5C322.L=0.006; x5C323.L=0.006;
x5C324.L=0.006; x5C325.L=0; x5C326.L=0;
x5C328.L=0; x5C329.L=0; x5C401.L=0.054;
x5C402.L=0.054; x5C403.L=0.054; x5C404.L=0.054;
x5C405.L=0.14; x5C406.L=0.14; x5C407.L=0.14;
```



```
x5C408.L=0.14; x5C409.L=0.14; x5C410.L=0.099;
x5C411.L=0.099; x5C412.L=0.072; x5C413.L=0.072;
x5C414.L=0.001; x5C415.L=0.001; x5C418.L=0.001;
x5C419.L=0.001; x5C425.L=0.099; x5C426.L=0.099;
x5C427.L=0.086; x5C428.L=0.08; x5C430.L=0.088;
x5C431.L=0.072; x5C432.L=0.072; x5HC01.L=0.15;
x5HC02.L=0.15; x5HC03.L=0.001; x5HC04.L=0.001;
x5HC05.L=0.001; x5HC06.L=0.034; x5HC07.L=0.034;
x5HC08.L=0.034; x5HC11.L=0.034; x5HC14.L=0.034;
x5HC15.L=0.034; x5HC16.L=0.034; x5HC22.L=0.033;
x5HC23.L=0.033; x5HC24.L=0.033; x5HC25.L=0.033;
x5HC26.L=0.033; x5HC27.L=0.032; x5HC28.L=0.049;
x5HC29.L=0.049; x5HC30.L=0.058; x5HC31.L=0.054;
x5HC33.L=0.03; x5HC34.L=0.03; x5HC38.L=0.03;
x5HC40.L=0.03; x5HC41.L=0.03; x5HC45.L=0.03;
x5R1.L=0.049; x5R29.L=0.054; x5SC401.L=0.052;
x5SC404.L=0.073; x5SC405.L=0.073; x5SC406.L=0.073;
x5SC407.L=0.073; x5SC409.L=0; x5SC411.L=0;
x5SC412.L=0; x5SC413.L=0; x5SC414.L=0;
x6SC401.L=0.071; x6SC404.L=0.1; x6SC405.L=0.1;
x6SC406.L=0.1; x6SC407.L=0.1; x6SC409.L=0;
x6SC411.L=0; x6SC412.L=0; x6SC413.L=0;
x6SC414.L=0.1; x7AC09.L=0.02; x7AC20.L=0.015;
x7AC31.L=0.008; x7AC42.L=0.01; x7C301.L=0.027;
x7C302.L=0.144; x7C303.L=0.039; x7C306.L=0.033;
x7C307.L=0.033; x7C308.L=0.048; x7C309.L=0.048;
x7C310.L=0.005; x7C311.L=0.064; x7C312.L=0.005;
x7C315.L=0.005; x7C316.L=0.005; x7C317.L=0.005;
x7C318.L=0.005; x7C319.L=0.005; x7C320.L=0.005;
x7C321.L=0.005; x7C322.L=0.005; x7C323.L=0.005;
x7C324.L=0.005; x7C325.L=0; x7C326.L=0;
x7C328.L=0; x7C329.L=0; x7C401.L=0.316;
x7C402.L=0.316; x7C403.L=0.316; x7C404.L=0.316;
```

```
x7C405.L=0.801; x7C406.L=0.801; x7C407.L=0.801;
x7C408.L=0.801; x7C409.L=0.801; x7C410.L=0.374;
x7C411.L=0.374; x7C412.L=0.101; x7C413.L=0.101;
x7C414.L=0.012; x7C415.L=0.012; x7C417.L=0.00031;
x7C418.L=0.011; x7C419.L=0.011; x7C425.L=0.374;
x7C426.L=0.374; x7C427.L=0.238; x7C428.L=0.181;
x7C430.L=0.271; x7C431.L=0.101; x7C432.L=0.101;
x7HC01.L=0.6; x7HC02.L=0.6; x7HC03.L=0.01;
x7HC04.L=0.01; x7HC05.L=0.01; x7HC06.L=0.139;
x7HC07.L=0.139; x7HC08.L=0.139; x7HC11.L=0.139;
x7HC14.L=0.139; x7HC15.L=0.139; x7HC16.L=0.139;
x7HC22.L=0.138; x7HC23.L=0.139; x7HC24.L=0.139;
x7HC25.L=0.15; x7HC26.L=0.142; x7HC27.L=0.131;
```



```
x7HC28.L=0.255; x7HC29.L=0.255; x7HC30.L=0.389;
x7HC31.L=0.316; x7HC33.L=0.046; x7HC34.L=0.046;
x7HC38.L=0.046; x7HC40.L=0.046; x7HC41.L=0.046;
x7HC45.L=0.046; x7R1.L=0.255; x7R29.L=0.31;
x7SC401.L=0.007; x7SC404.L=0.01; x7SC405.L=0.01;
x7SC406.L=0.01; x7SC407.L=0.01; x7SC409.L=0;
x7SC411.L=0; x7SC412.L=0; x7SC413.L=0;
x7SC414.L=0.1; x8AC09.L=0.00000448; x8AC20.L=0.00000554;
x8AC31.L=0.00000475; x8AC42.L=0.00000478; x9AC09.L=0.005;
x9AC20.L=0.005; x9AC31.L=0.002; x9AC42.L=0.003;
xAC02.L=0.5; xAC05.L=0.498; xAC07.L=0.498;
xAC09.L=0.482; xAC12.L=0.498; xAC15.L=0.496;
xAC18.L=0.496; xAC20.L=0.485; xAC23.L=0.496;
xAC26.L=0.494; xAC29.L=0.494; xAC31.L=0.488;
xAC34.L=0.494; xAC37.L=0.492; xAC40.L=0.492;
xAC42.L=0.484; xiC10AC09.L=0; xiC10AC20.L=0;
xiC10AC31.L=0; xiC10AC42.L=0; xiC11AC09.L=0;
xiC11AC20.L=0; xiC11AC31.L=0; xiC11AC42.L=0;
xM1C606D.L=0.0000485; xM3C606D.L=0.000334; xM4C606D.L=0.55;
xM5C606D.L=0.104; xM7C606D.L=0.346; xx1C302.L=0.093;
xx1C308.L=0.063; xx1C310.L=0.12; xx1C311.L=0.042;
xx1C312.L=0.151; xx1C323.L=0.12; xx1C325.L=1;
xx1C405.L=0; xx1C408.L=0; xx1C425.L=0.000153;
xx1C428.L=0.000207; xx1C430.L=0.0000689; xx1C431.L=0.00064;
xx1HC28.L=0.027; xx1HC29.L=0.027; xx1HC30.L=0.018;
xx1HC32.L=0.031; xx1R1.L=0.027; xx1R29.L=0.023;
xx1SC406.L=0.0000111; xx1SC408.L=0.026; xx2HC28.L=0;
xx2HC29.L=0; xx2HC30.L=0; xx2R1.L=0;
xx2R29.L=0; xx2SC406.L=0.013; xx2SC408.L=0.000319;
xx3C302.L=0.729; xx3C308.L=0.779; xx3C310.L=0.791;
xx3C311.L=0.774; xx3C312.L=0.764; xx3C323.L=0.792;
xx3C325.L=0.00000126; xx3C405.L=0.00000975; xx3C408.L=0.00000975;
xx3C425.L=0.000473; xx3C428.L=0.000633; xx3C430.L=0.000709;
xx3C431.L=0.000875; xx3C432.L=0.000875; xx3HC28.L=0.621;
xx3HC29.L=0.621; xx3HC30.L=0.515; xx3HC32.L=0.784;
xx3R1.L=0.621; xx3R29.L=0.578; xx3SC406.L=0.021;
xx3SC408.L=0.961; xx4C302.L=0.075; xx4C308.L=0.109;
xx4C310.L=0.082; xx4C311.L=0.119; xx4C312.L=0.077;
xx4C323.L=0.08; xx4C325.L=0; xx4C405.L=0.083;
xx4C408.L=0.083; xx4C409.L=0.083; xx4C425.L=0.613;
xx4C427.L=0.746; xx4C428.L=0.797; xx4C430.L=0.716;
xx4C431.L=0.867; xx4C432.L=0.867; xx4HC28.L=0.12;
xx4HC29.L=0.12; xx4HC30.L=0.11; xx4HC32.L=0.129;
xx4R1.L=0.12; xx4R29.L=0.117; xx4SC406.L=0.814;
xx4SC408.L=0.012; xx5C302.L=0.004; xx5C308.L=0.017;
xx5C310.L=0.005; xx5C311.L=0.021; xx5C312.L=0.005;
```



```
xx5C323.L=0.005; xx5C325.L=0; xx5C405.L=0.158;
xx5C408.L=0.158; xx5C425.L=0.093; xx5C428.L=0.07;
xx5C430.L=0.079; xx5C431.L=0.061; xx5HC28.L=0.044;
xx5HC29.L=0.044; xx5HC30.L=0.054; xx5HC32.L=0.025;
xx5R1.L=0.044; xx5R29.L=0.049; xx5SC406.L=0.061;
xx5SC408.L=0; xx6SC406.L=0.084; xx6SC408.L=0;
xx7C302.L=0.1; xx7C308.L=0.033; xx7C310.L=0.003;
xx7C311.L=0.044; xx7C312.L=0.003; xx7C323.L=0.004;
xx7C325.L=0; xx7C405.L=0.759; xx7C408.L=0.759;
xx7C425.L=0.293; xx7C428.L=0.132; xx7C430.L=0.204;
xx7C431.L=0.071; xx7HC28.L=0.188; xx7HC29.L=0.188;
xx7HC30.L=0.303; xx7HC32.L=0.031; xx7R1.L=0.188;
xx7R29.L=0.234; xx7SC406.L=0.007; xx7SC408.L=0;
y1HC28.L=0.077; y1HC29.L=0.077; y1HC30.L=0.062;
y1HC31.L=0.068; y1R1.L=0.077; y1R29.L=0.069;
y2HC28.L=0; y2HC29.L=0; y2HC30.L=0;
y2HC31.L=0; y2R1.L=0; y2R29.L=0;
y3HC28.L=0.789; y3HC29.L=0.789; y3HC30.L=0.771;
y3HC31.L=0.781; y3R1.L=0.789; y3R29.L=0.783;
y4HC28.L=0.1; y4HC29.L=0.1; y4HC30.L=0.108;
y4HC31.L=0.105; y4R1.L=0.1; y4R29.L=0.104;
y5HC28.L=0.015; y5HC29.L=0.015; y5HC30.L=0.022;
y5HC31.L=0.019; y5R1.L=0.015; y5R29.L=0.018;
y7HC28.L=0.019; y7HC29.L=0.019; y7HC30.L=0.037;
y7HC31.L=0.027; y7R1.L=0.019; y7R29.L=0.026;
```

```
yy1HC28.L=0.1; yy1HC29.L=0.1; yy1HC30.L=0.081;
yy1R1.L=0.1; yy1R29.L=0.09; yy2HC28.L=0;
yy2HC29.L=0; yy2HC30.L=0; yy2R1.L=0;
yy2R29.L=0; yy3HC28.L=0.777; yy3HC29.L=0.777;
yy3HC30.L=0.768; yy3R1.L=0.777; yy3R29.L=0.775;
yy4HC28.L=0.098; yy4HC29.L=0.098; yy4HC30.L=0.108;
yy4R1.L=0.098; yy4R29.L=0.103; yy5HC28.L=0.012;
yy5HC29.L=0.012; yy5HC30.L=0.018; yy5R1.L=0.012;
yy5R29.L=0.015; yy7HC28.L=0.013; yy7HC29.L=0.013;
yy7HC30.L=0.025; yy7R1.L=0.013; yy7R29.L=0.017;
C10pC623.LO=0; C10pC625.LO=0; C10pC627.LO=0;
C10pC629.LO=0; C2C623.LO=0; C2C625.LO=0;
C2C627.LO=0; C2C629.LO=0; C3C623.LO=0;
C3C625.LO=0; C3C627.LO=0; C3C629.LO=0;
C3pC623.LO=0; C3pC625.LO=0; C3pC627.LO=0;
C3pC629.LO=0; C4pC623.LO=0; C4pC625.LO=0;
C4pC627.LO=0; C4pC629.LO=0; C5pC623.LO=0;
C5pC625.LO=0; C5pC627.LO=0; C5pC629.LO=0;
C7pC623.LO=0; C7pC625.LO=0; C7pC627.LO=0;
C7pC629.LO=0; C8pC623.LO=0; C8pC625.LO=0;
C8pC627.LO=0; C8pC629.LO=0; C9pC623.LO=0;
```



```
C9pC625.LO=0; C9pC627.LO=0; C9pC629.LO=0;
CHXC623.LO=2.5; CHXC625.LO=2.5; CHXC627.LO=2.5;
CHXC629.LO=2.5; CiC10pC623.LO=0; CiC10pC625.LO=0;
CiC10pC627.LO=0; CiC10pC629.LO=0; CiC11pC623.LO=0;
CiC11pC625.LO=0; CiC11pC627.LO=0; CiC11pC629.LO=0;
CiC4eC623.LO=0; CiC4eC625.LO=0; CiC4eC627.LO=0;
CiC4eC629.LO=0; CiC5eC623.LO=0; CiC5eC625.LO=0;
CiC5eC627.LO=0; CiC5eC629.LO=0; CiC8eC623.LO=0;
CiC8eC625.LO=0; CiC8eC627.LO=0; CiC8eC629.LO=0;
Cost.LO=-10000; dTE601.LO=5; dTE602.LO=5;
dTE603.LO=5; dTE605.LO=5; dTE609A.LO=5;
dTE610.LO=5; dTE611.LO=5; dTE612.LO=10;
dTE613.LO=4; dTE616.LO=10; dTE617.LO=5;
dTE621A.LO=5; dTE621B.LO=5; dTE626.LO=5;
dTE627A.LO=5; dTE627B.LO=5; dTE628.LO=5;
dTE629.LO=5; dTE633.LO=5; dTE634.LO=5;
dTE640.LO=5; dTE641.LO=5; dTE695A.LO=5;
dTE695B.LO=5; dTE696A.LO=10; dTE696B.LO=10;
dTE6XX.LO=1; Earnings.LO=-10000; f1C601.LO=0;
f1C603.LO=0; f1C606A.LO=0; f2C601.LO=0.5;
f3C601.LO=0.05; f3C603.LO=0; f3C606A.LO=0;
f4C601.LO=0.95; f4C603.LO=0; f4C606A.LO=0;
f5C601.LO=0.5; f5C603.LO=0.5; f5C606A.LO=0.5;
f6C601.LO=0.5; f7C601.LO=0.5; f7C603.LO=0.5;
f7C606A.LO=0.5; FAC05.LO=0.1; FAC07.LO=0.1;
FAC09.LO=0.01; FAC15.LO=0.1; FAC18.LO=0.1;
FAC20.LO=0.01; FAC26.LO=0.1; FAC29.LO=0.1;
FAC31.LO=0.01; FAC37.LO=0.1; FAC40.LO=0.1;
FAC42.LO=0.01; FC301.LO=1; FC302.LO=0.1;
FC303.LO=2; FC306.LO=0.1; FC307.LO=0.0001;
FC309.LO=0.0001; FC310.LO=0.0001; FC311.LO=0;
FC312.LO=0.0001; FC315.LO=0.0001; FC317.LO=0.1;
FC318.LO=0.0001; FC319.LO=0.0001; FC321.LO=0;
FC323.LO=0.5; FC324.LO=0.5; FC325.LO=0.5;
FC326.LO=0.01; FC401.LO=0.1; FC402.LO=0.1;
FC404.LO=0; FC405.LO=0.1; FC406.LO=0;
FC408.LO=0; FC409.LO=0; FC410.LO=0.1;
FC411.LO=0; FC413.LO=0; FC414.LO=0.1;
FC415.LO=0; FC418.LO=0.1; FC419.LO=0.0001;
FC425.LO=1; FC426.LO=0; FC427.LO=0;
FC428.LO=0; FC430.LO=1; FC431.LO=0;
FC432.LO=1; FcwE603.LO=0.1; FcwE605.LO=0.1;
FcwE609A.LO=0.01; FcwE611.LO=0.1; FcwE613.LO=0.1;
FcwE617.LO=1; FcwE621A.LO=0.1; FcwE621B.LO=0.1;
FcwE626.LO=0.1; FcwE627A.LO=0.1; FcwE627B.LO=0.1;
FcwE634.LO=4; FcwE640.LO=0.4; FcwE641A.LO=0.1;
```



```
FcwE641B.LO=0.1; FHC02.LO=0.01; FHC03.LO=1;
FHC04.LO=1; FHC05.LO=1; FHC06.LO=1;
FHC07.LO=1; FHC08.LO=1; FHC11.LO=1;
FHC14.LO=1; FHC15.LO=1; FHC16.LO=1;
FHC22.LO=1; FHC23.LO=1; FHC24.LO=1;
FHC25.LO=1; FHC26.LO=1; FHC27.LO=1;
FHC28.LO=1; FHC29.LO=0; FHC30.LO=0;
FHC31.LO=0; FHC33.LO=0; FHC34.LO=0;
FHC38.LO=0; FHC40.LO=0; FHC41.LO=0;
FHC45.LO=0; FlHC28.LO=1; FlHC29.LO=0;
FlHC30.LO=0; FlHC31.LO=0; FlR1.LO=0;
FlR29.LO=0; FmC302.LO=0; FmC308.LO=0.0001;
FmC310.LO=0; FmC311.LO=0; FmC312.LO=0;
FmC317.LO=0.001; FmC322.LO=0; FmC323.LO=0;
FmC325.LO=0.01; FmC405.LO=0; FmC407.LO=0;
FmC408.LO=0; FmC409.LO=0; FmC412.LO=0;
FmC414.LO=0.0001; FmC425.LO=0; FmC427.LO=0;
```

```
FmC428.LO=0; FmC430.LO=0; FmC431.LO=0;
FmC432.LO=0; FmHC01.LO=0; FmHC32.LO=0;
FmlHC28.LO=0.01; FmlHC29.LO=0; FmlHC30.LO=0;
FmlR1.LO=0; FmlR29.LO=0; FmSC403.LO=0.001;
FmSC406.LO=0; FmSC408.LO=0; FmvHC28.LO=0;
FmvHC29.LO=0; FmvHC30.LO=0; FmvR1.LO=0;
FmvR29.LO=0; FR1.LO=0; FR29.LO=0;
FSC401.LO=0.1; FSC403.LO=0.1; FSC404.LO=0.1;
FSC406.LO=0; FSC407.LO=0; FSC408.LO=0.05;
FSC409.LO=0.05; FSC412.LO=0.102; FSC414.LO=0;
FstmE602.LO=0.1; FstmE695A.LO=0; FstmE695B.LO=0.1;
FstmE696A.LO=0.01; FstmE696B.LO=0.01; FvHC28.LO=0;
FvHC29.LO=0; FvHC30.LO=0; FvHC31.LO=0;
FvR1.LO=0; FvR29.LO=0; h1C601.LO=0.8;
h1C603.LO=-3; h1C606A.LO=0; h2C601.LO=0.395;
h3C601.LO=0.5; h3C603.LO=0; h3C606A.LO=-65;
h4C601.LO=0.45; h4C603.LO=0; h4C606A.LO=-10;
h5C601.LO=0.5; h5C603.LO=0; h5C606A.LO=-5;
h6C601.LO=0.5; h7C601.LO=0.5; h7C603.LO=0;
h7C606A.LO=0; hAC02.LO=0; hAC05.LO=10;
hAC07.LO=10; hAC09.LO=10; hAC12.LO=0;
hAC15.LO=10; hAC18.LO=10; hAC20.LO=10;
hAC23.LO=0; hAC26.LO=10; hAC29.LO=10;
hAC31.LO=10; hAC34.LO=0; hAC37.LO=10;
hAC40.LO=10; hAC42.LO=10; hacAC09.LO=10;
hacAC20.LO=10; hacAC31.LO=10; hacAC42.LO=10;
hC301.LO=10; hC302.LO=0; hC303.LO=0.0001;
hC306.LO=0.0001; hC307.LO=0.0001; hC308.LO=0.0001;
hC309.LO=0.0001; hC310.LO=0.0001; hC311.LO=0.001;
```



```
hC312.LO=0.0001; hC312liq.LO=0; hC315.LO=0.0001;
hC316.LO=0.0001; hC317.LO=0.0001; hC318.LO=0.0001;
hC319.LO=0.0001; hC321.LO=0; hC322.LO=0.0001;
hC323.LO=0; hC324.LO=0.0001; hC325.LO=0.0001;
hC326.LO=0.0001; hC329.LO=0.0001; hC401.LO=0;
hC402.LO=10; hC403.LO=0.0001; hC404.LO=0.0001;
hC405.LO=0.0001; hC406.LO=0.0001; hC407.LO=0.0001;
hC408.LO=0.0001; hC408vap.LO=10; hC409.LO=0.0001;
hC410.LO=0.0001; hC410vap.LO=10; hC411.LO=10;
hC412.LO=0.0001; hC412liq.LO=1; hC413.LO=0.0001;
hC414.LO=0.0001; hC414liq.LO=10; hC415.LO=0.0001;
hC417.LO=0.0001; hC418.LO=0.0001; hC419.LO=0.0001;
hC425.LO=10; hC426.LO=10; hC427.LO=0;
hC428.LO=10; hC430.LO=10; hC431.LO=10;
hC432.LO=10; hC623.LO=10; hC625.LO=10;
hC627.LO=10; hC629.LO=10; hHC01.LO=0;
hHC02.LO=0; hHC03.LO=1; hHC04.LO=10;
hHC05.LO=10; hHC06.LO=10; hHC07.LO=10;
hHC11.LO=10; hHC14.LO=10; hHC16.LO=10;
hHC29.LO=20; hHC30.LO=20; hHC31.LO=100;
hHC32.LO=0; hHC34.LO=0; hHC38.LO=0;
hHC41.LO=0; hHC45.LO=0; hlHC29.LO=0;
hlHC30.LO=0; hlHC31.LO=20; hlR1.LO=0;
hlR29.LO=10; hR1.LO=0; hR29.LO=20;
hSC401.LO=10; hSC402.LO=10; hSC403.LO=10;
hSC404.LO=10; hSC405.LO=10; hSC406.LO=0.1;
hSC407.LO=10; hSC408.LO=10; hSC409.LO=10;
hSC411.LO=10; hSC412.LO=10; hSC413.LO=10;
hSC414.LO=0; hvHC29.LO=10; hvHC30.LO=10;
hvHC31.LO=20; hvR1.LO=0; hvR29.LO=10;
K1C323.LO=1; K1C325.LO=0.5; K1C408.LO=1;
K1C414.LO=1; K1C428.LO=0; K1C430.LO=1;
K1C601.LO=1.5; K1C603.LO=1; K1C606A.LO=1;
K1C606C.LO=1; K1C614B.LO=2; K1C615_A.LO=0.5;
K1C616_A.LO=0.5; K1E633.LO=1; K1E6XX.LO=1;
K1SC406.LO=2; K1SC408.LO=1.5; K2C601.LO=0.5;
K2E633.LO=0.2; K2E6XX.LO=0.2; K2SC406.LO=0.5;
K2SC408.LO=0.5; K3C323.LO=0.5; K3C325.LO=0.01;
K3C408.LO=1; K3C414.LO=0.5; K3C428.LO=0;
K3C430.LO=1; K3C601.LO=0.5; K3C603.LO=0.5;
K3C606A.LO=0.5; K3C606C.LO=1; K3C614B.LO=0.6;
K3C615_A.LO=0.1; K3C616_A.LO=0.1; K3E633.LO=0.3;
K3E6XX.LO=0.3; K3SC406.LO=1; K3SC408.LO=0.7;
K4C323.LO=0.5; K4C325.LO=0.03; K4C408.LO=1;
K4C414.LO=0.5; K4C428.LO=0; K4C430.LO=0.5;
K4C601.LO=0.2; K4C603.LO=0.1; K4C606A.LO=0.1;
```



```
K4C606C.LO=1; K4C614B.LO=0.5; K4C615_A.LO=0.05;
K4C616_A.LO=0.05; K4E633.LO=0.2; K4E6XX.LO=0.2;
K4SC406.LO=0.8; K4SC408.LO=0.5; K5C323.LO=0.1;
K5C325.LO=0.1; K5C408.LO=0.5; K5C414.LO=0.1;
K5C428.LO=0; K5C430.LO=0.2; K5C601.LO=0.1;
K5C603.LO=0.01; K5C606A.LO=0.1; K5C606C.LO=0.1;
K5C614B.LO=0.05; K5C615_A.LO=0.002; K5C616_A.LO=0.002;
K5E633.LO=0.05; K5E6XX.LO=0.05; K5SC406.LO=0.1;
K5SC408.LO=0.2; K6C601.LO=0.1; K6SC406.LO=0;
```

```
K6SC408.LO=0.1; K7C323.LO=0.1; K7C325.LO=0.001;
K7C408.LO=0.1; K7C414.LO=0.05; K7C428.LO=0;
K7C430.LO=0; K7C601.LO=0.01; K7C603.LO=0.01;
K7C606A.LO=0.05; K7C614B.LO=0.001; K7C615_A.LO=0.001;
K7C616_A.LO=0.011; K7E633.LO=0.01; K7E6XX.LO=0.01;
K7SC406.LO=0.1; K7SC408.LO=0.05; Kp1C601.LO=1;
Kp1C603.LO=1; Kp1C606A.LO=1; Kp1C606D.LO=1;
Kp2C601.LO=0.5; Kp3C601.LO=1; Kp3C603.LO=0.5;
Kp3C606A.LO=0.5; Kp3C606D.LO=1; Kp4C601.LO=0.5;
Kp4C603.LO=0.2; Kp4C606A.LO=0.1; Kp4C606D.LO=1;
Kp5C601.LO=0.1; Kp5C603.LO=0.1; Kp5C606A.LO=0.1;
Kp5C606D.LO=1; Kp6C601.LO=0.1; Kp7C601.LO=0.01;
Kp7C603.LO=0.01; Kp7C606A.LO=0.05; Kp7C606D.LO=0.1;
kWad1.LO=50; kWad2.LO=105; LpC601.LO=1;
LpC603.LO=1; LpC606A.LO=0.5; PC303.LO=101;
PC306.LO=650; PC307.LO=600; PC308.LO=600;
PC309.LO=580; PC311.LO=260; PC312.LO=600;
PHC30.LO=101; PHC32.LO=101; PR29.LO=101;
Profit.LO=10; Q2HC07.LO=0; Q2HC11.LO=0;
Q2HC14.LO=0; Q2HC16.LO=0; qFp1C606A.LO=0;
qFp3C606A.LO=0; qFp4C606A.LO=0; qFp5C606A.LO=0;
qFp7C606A.LO=0; qS1C606A.LO=0; qS3C606A.LO=0;
qS4C606A.LO=0; qS5C606A.LO=0; qS7C606A.LO=0;
r10C623.LO=0; r10C625.LO=0; r10C627.LO=0;
r10C629.LO=0; r2C623.LO=0; r2C625.LO=0;
r2C627.LO=0; r2C629.LO=0; r3C623.LO=0;
r3C625.LO=0; r3C627.LO=0; r3C629.LO=0;
r4C623.LO=0; r4C625.LO=0; r4C627.LO=0;
r4C629.LO=0; r5C623.LO=0; r5C625.LO=0;
r5C627.LO=0; r5C629.LO=0; r7C623.LO=0;
r7C625.LO=0; r7C627.LO=0; r7C629.LO=0;
r8C623.LO=0; r8C625.LO=0; r8C627.LO=0;
r8C629.LO=0; r9C623.LO=0; r9C625.LO=0;
r9C627.LO=0; r9C629.LO=0; rho2HC07.LO=610;
rho2HC11.LO=610; rho2HC14.LO=610; rho2HC16.LO=610;
rhoAC09.LO=1500; rhoAC20.LO=1500; rhoAC31.LO=1500;
rhoAC42.LO=1500; riC10C623.LO=0; riC10C625.LO=0;
```


```
riC10C627.LO=0; riC10C629.LO=0; riC11C623.LO=0;
riC11C625.LO=0; riC11C627.LO=0; riC11C629.LO=0;
sf1S34.LO=0.0001; sf2S34.LO=0; sfS11.LO=0.1;
sfS19.LO=0.1; sfS2.LO=0.1; sfS23.LO=0.1;
sfS27.LO=0.1; sfS41.LO=0.0001; sfS42.LO=0.0001;
sfS5.LO=0.1; sfS7.LO=0.1; Sm1C601.LO=1;
Sm1C603.LO=0.05; Sm1C606A.LO=0.1; Sm1C606D.LO=1;
Sm2C601.LO=0.5; Sm3C601.LO=0.5; Sm3C603.LO=0.001;
Sm3C606A.LO=0.1; Sm3C606D.LO=1; Sm4C601.LO=0.4;
Sm4C603.LO=0.01; Sm4C606A.LO=0.1; Sm4C606D.LO=0.5;
Sm5C601.LO=0.1; Sm5C603.LO=0.01; Sm5C606A.LO=0.05;
Sm5C606D.LO=0.1; Sm6C601.LO=0.1; Sm7C601.LO=0.01;
Sm7C603.LO=0.001; Sm7C606A.LO=0.001; Sm7C606D.LO=0.1;
Sn1C601.LO=1; Sn1C603.LO=1; Sn1C606A.LO=1;
Sn2C601.LO=0.5; Sn3C601.LO=0.5; Sn3C603.LO=0.5;
Sn3C606A.LO=1; Sn4C601.LO=0.5; Sn4C603.LO=0.2;
Sn4C606A.LO=0.8; Sn5C601.LO=0.1; Sn5C603.LO=0.1;
Sn5C606A.LO=0.3; Sn6C601.LO=0.1; Sn7C601.LO=0.01;
Sn7C603.LO=0.01; Sn7C606A.LO=0.1; TAC02.LO=276;
TAC05.LO=273; TAC07.LO=273; TAC15.LO=273;
TAC18.LO=273; TAC20.LO=280; TAC26.LO=273;
TAC29.LO=273; TAC37.LO=273; TAC40.LO=273;
TC301.LO=200; TC302.LO=250; TC309.LO=270;
TC310.LO=200; TC311.LO=270; TC312.LO=300;
TC318.LO=250; TC319.LO=250; TC320.LO=250;
TC322.LO=250; TC323.LO=300; TC326.LO=300;
TC328.LO=300; TC329.LO=300; TC401.LO=260;
TC402.LO=270; TC403.LO=280; TC406.LO=298;
TC409.LO=400; TC411.LO=300; TC412.LO=330;
TC413.LO=250; TC415.LO=250; TC417.LO=275;
TC425.LO=300; TC426.LO=300; TC427.LO=360;
TC428.LO=300; TC430.LO=300; TC431.LO=300;
TC432.LO=350; TcwotE609A.LO=298; TcwotE621A.LO=298;
TcwotE621B.LO=298; TcwotE627A.LO=295; TcwotE627B.LO=293;
TcwotE641A.LO=295; TcwotE641B.LO=295; TcwoutE603.LO=296.836;
TcwoutE605.LO=298; TcwoutE611.LO=295; TcwoutE613.LO=298;
TcwoutE617.LO=295; TcwoutE626.LO=295; TcwoutE634.LO=295;
TcwoutE640.LO=295; THC01.LO=295; THC02.LO=275;
THC03.LO=290; THC04.LO=280; THC05.LO=270;
THC06.LO=273; THC07.LO=273; THC11.LO=273;
THC14.LO=273; THC16.LO=273; THC22.LO=273;
THC23.LO=273; THC24.LO=273; THC25.LO=273;
THC26.LO=273; THC27.LO=273; THC28.LO=270;
THC29.LO=270; THC30.LO=250; THC31.LO=260;
THC34.LO=250; THC38.LO=250; THC41.LO=250;
THC45.LO=250; TmC601.LO=315; TmC603.LO=350;
```


```
TmC606A.LO=327; TmC606D.LO=370; TmK601.LO=273;
```

```
TnC601.LO=310; TnC603.LO=320; TnC606A.LO=310;
TR1.LO=270; TR29.LO=260; TSC401.LO=280;
TSC404.LO=310; TSC406.LO=320; TSC407.LO=320;
TSC409.LO=308; TSC411.LO=308; TSC412.LO=308;
TSC414.LO=275; Utilities.LO=-10000; VFC614B.LO=0.1;
VFC615.LO=0.001; VFC616.LO=0.05; VFM3.LO=0;
VpC601.LO=1; VpC603.LO=0.01; VpC606A.LO=0.1;
x10AC09.LO=0; x10AC20.LO=0; x10AC31.LO=0;
x10AC42.LO=0; x11AC02.LO=0.97; x11AC05.LO=0.89;
x11AC07.LO=0.89; x11AC09.LO=0; x11AC15.LO=0.89;
x11AC18.LO=0.89; x11AC20.LO=0; x11AC26.LO=0.89;
x11AC29.LO=0.89; x11AC31.LO=0; x11AC37.LO=0.89;
x11AC40.LO=0.89; x11AC42.LO=0; x12AC02.LO=0.002;
x12AC05.LO=0.001; x12AC07.LO=0.001; x12AC09.LO=0;
x12AC12.LO=0.001; x12AC15.LO=0.001; x12AC18.LO=0.001;
x12AC20.LO=0; x12AC23.LO=0.001; x12AC26.LO=0.001;
x12AC29.LO=0.001; x12AC31.LO=0; x12AC34.LO=0.001;
x12AC37.LO=0.001; x12AC40.LO=0.001; x12AC42.LO=0;
x12AC45.LO=0.001; x1AC09.LO=0; x1AC20.LO=0;
x1AC31.LO=0; x1AC42.LO=0; x1C301.LO=0;
x1C302.LO=0; x1C303.LO=0.05; x1C306.LO=0;
x1C307.LO=0; x1C308.LO=0; x1C309.LO=0;
x1C310.LO=0; x1C311.LO=0; x1C312.LO=0;
x1C315.LO=0.0001; x1C317.LO=0; x1C318.LO=0.0001;
x1C319.LO=0.0001; x1C320.LO=0; x1C321.LO=0.0001;
x1C322.LO=0; x1C323.LO=0; x1C324.LO=0;
x1C326.LO=0.4; x1C328.LO=0.4; x1C329.LO=0.4;
x1C401.LO=0; x1C402.LO=0; x1C403.LO=0;
x1C404.LO=0; x1C405.LO=0; x1C406.LO=0;
x1C407.LO=0; x1C408.LO=0; x1C409.LO=0;
x1C410.LO=0.0001; x1C411.LO=0; x1C412.LO=0;
x1C413.LO=0; x1C414.LO=0; x1C415.LO=0;
x1C418.LO=0; x1C419.LO=0.0001; x1C425.LO=0;
x1C426.LO=0; x1C427.LO=0; x1C428.LO=0;
x1C430.LO=0; x1C431.LO=0; x1C432.LO=0;
x1HC01.LO=0.001; x1HC02.LO=0; x1HC03.LO=0.0001;
x1HC04.LO=0; x1HC05.LO=0; x1HC06.LO=0;
x1HC07.LO=0; x1HC08.LO=0; x1HC11.LO=0;
x1HC14.LO=0; x1HC15.LO=0; x1HC16.LO=0;
x1HC22.LO=0; x1HC23.LO=0; x1HC24.LO=0;
x1HC25.LO=0; x1HC26.LO=0; x1HC27.LO=0;
x1HC28.LO=0; x1HC29.LO=0; x1HC30.LO=0;
x1HC31.LO=0; x1HC33.LO=0; x1HC34.LO=0;
x1HC38.LO=0; x1HC40.LO=0; x1HC41.LO=0;
x1HC45.LO=0; x1R1.LO=0; x1R29.LO=0;
```



```
x1SC401.LO=0; x1SC404.LO=0; x1SC405.LO=0;
x1SC406.LO=0; x1SC407.LO=0; x1SC409.LO=0;
x1SC411.LO=0; x1SC412.LO=0; x1SC413.LO=0;
x1SC414.LO=0; x2AC09.LO=0; x2AC20.LO=0;
x2AC31.LO=0; x2AC42.LO=0; x2C301.LO=0;
x2C417.LO=0; x2C418.LO=0; x2C419.LO=0;
x2HC01.LO=0.1; x2HC02.LO=0.1; x2HC03.LO=0;
x2HC04.LO=0; x2HC05.LO=0; x2HC06.LO=0;
x2HC07.LO=0; x2HC08.LO=0; x2HC11.LO=0;
x2HC14.LO=0; x2HC15.LO=0; x2HC16.LO=0;
x2HC22.LO=0; x2HC23.LO=0; x2HC24.LO=0;
x2HC25.LO=0; x2HC26.LO=0; x2HC27.LO=0;
x2HC28.LO=0; x2HC29.LO=0; x2HC30.LO=0;
x2HC31.LO=0; x2R1.LO=0; x2R29.LO=0;
x2SC401.LO=0; x2SC404.LO=0; x2SC405.LO=0;
x2SC406.LO=0; x2SC407.LO=0; x2SC409.LO=0;
x2SC411.LO=0; x2SC412.LO=0; x2SC413.LO=0;
x2SC414.LO=0; x3AC09.LO=0; x3AC20.LO=0;
x3AC31.LO=0; x3AC42.LO=0; x3C301.LO=0.5;
x3C302.LO=0.45; x3C303.LO=0.5; x3C306.LO=0;
x3C307.LO=0; x3C308.LO=0; x3C309.LO=0.2;
x3C310.LO=0; x3C311.LO=0; x3C312.LO=0;
x3C315.LO=0.0001; x3C317.LO=0.5; x3C318.LO=0.0001;
x3C319.LO=0.0001; x3C320.LO=0.0001; x3C321.LO=0.0001;
x3C322.LO=0; x3C323.LO=0.5; x3C324.LO=0.5;
x3C326.LO=0; x3C328.LO=0; x3C329.LO=0;
x3C401.LO=0; x3C402.LO=0; x3C403.LO=0.0001;
x3C404.LO=0.0001; x3C405.LO=0; x3C406.LO=0;
x3C407.LO=0; x3C408.LO=0; x3C409.LO=0;
x3C410.LO=0.0001; x3C411.LO=0.0001; x3C412.LO=0;
x3C413.LO=0; x3C414.LO=0.5; x3C415.LO=0;
x3C418.LO=0.0001; x3C419.LO=0.0001; x3C425.LO=0;
x3C426.LO=0.0001; x3C427.LO=0; x3C428.LO=0;
x3C430.LO=0; x3C431.LO=0; x3C432.LO=0;
x3HC01.LO=0.01; x3HC02.LO=0; x3HC03.LO=0.1;
x3HC04.LO=0.1; x3HC05.LO=0.1; x3HC06.LO=0.3;
x3HC07.LO=0.3; x3HC08.LO=0.3; x3HC11.LO=0.3;
x3HC14.LO=0.3; x3HC15.LO=0.3; x3HC16.LO=0.3;
x3HC22.LO=0.1; x3HC23.LO=0.1; x3HC24.LO=0.1;
x3HC25.LO=0.1; x3HC26.LO=0.1; x3HC27.LO=0.1;
x3HC28.LO=0.1; x3HC29.LO=0.1; x3HC30.LO=0.1;
x3HC31.LO=0.1; x3HC33.LO=0.1; x3HC34.LO=0.1;
x3HC38.LO=0.1; x3HC40.LO=0.1; x3HC41.LO=0.1;
```

```
x3HC45.LO=0.1; x3R1.LO=0; x3R29.LO=0.1;
x3SC401.LO=0.2; x3SC404.LO=0; x3SC405.LO=0;
x3SC406.LO=0; x3SC407.LO=0; x3SC409.LO=0.5;
```



```
x3SC411.LO=0.5; x3SC412.LO=0.5; x3SC413.LO=0.5;
x3SC414.LO=0.5; x4AC09.LO=0; x4AC20.LO=0;
x4AC31.LO=0; x4AC42.LO=0; x4C301.LO=0;
x4C302.LO=0; x4C303.LO=0.05; x4C306.LO=0;
x4C307.LO=0; x4C308.LO=0; x4C309.LO=0;
x4C310.LO=0; x4C311.LO=0; x4C312.LO=0;
x4C315.LO=0.0001; x4C317.LO=0; x4C318.LO=0.0001;
x4C319.LO=0.0001; x4C320.LO=0.0001; x4C321.LO=0.0001;
x4C322.LO=0; x4C323.LO=0.01; x4C324.LO=0.01;
x4C325.LO=0; x4C326.LO=0; x4C328.LO=0;
x4C329.LO=0; x4C401.LO=0.001; x4C402.LO=0.001;
x4C403.LO=0.0001; x4C404.LO=0.0001; x4C405.LO=0.0001;
x4C406.LO=0; x4C407.LO=0.01; x4C408.LO=0;
x4C409.LO=0; x4C410.LO=0.0001; x4C411.LO=0;
x4C412.LO=0.5; x4C413.LO=0.0001; x4C414.LO=0.01;
x4C415.LO=0.0001; x4C418.LO=0.0001; x4C419.LO=0.0001;
x4C425.LO=0; x4C426.LO=0.0001; x4C427.LO=0;
x4C428.LO=0; x4C430.LO=0.5; x4C431.LO=0.0001;
x4C432.LO=0.5; x4HC01.LO=0; x4HC02.LO=0;
x4HC03.LO=0; x4HC04.LO=0; x4HC05.LO=0;
x4HC06.LO=0; x4HC07.LO=0; x4HC08.LO=0;
x4HC11.LO=0; x4HC14.LO=0; x4HC15.LO=0;
x4HC16.LO=0; x4HC22.LO=0; x4HC23.LO=0;
x4HC24.LO=0; x4HC25.LO=0; x4HC26.LO=0;
x4HC27.LO=0; x4HC28.LO=0; x4HC29.LO=0;
x4HC30.LO=0; x4HC31.LO=0; x4HC33.LO=0;
x4HC34.LO=0; x4HC38.LO=0; x4HC40.LO=0;
x4HC41.LO=0; x4HC45.LO=0; x4R1.LO=0;
x4R29.LO=0.01; x4SC401.LO=0.5; x4SC404.LO=0.48;
x4SC405.LO=0.48; x4SC406.LO=0.7; x4SC407.LO=0.7;
x4SC409.LO=0; x4SC411.LO=0; x4SC412.LO=0;
x4SC413.LO=0; x4SC414.LO=0; x5AC09.LO=0;
x5AC20.LO=0; x5AC31.LO=0; x5AC42.LO=0;
x5C301.LO=0; x5C302.LO=0; x5C303.LO=0;
x5C306.LO=0; x5C307.LO=0; x5C308.LO=0;
x5C309.LO=0; x5C310.LO=0; x5C311.LO=0;
x5C312.LO=0; x5C315.LO=0.0001; x5C317.LO=0;
x5C318.LO=0.0001; x5C319.LO=0.0001; x5C320.LO=0;
x5C321.LO=0.0001; x5C322.LO=0; x5C323.LO=0.002;
x5C324.LO=0.002; x5C325.LO=0; x5C326.LO=0;
x5C328.LO=0; x5C329.LO=0; x5C401.LO=0;
x5C402.LO=0; x5C403.LO=0.0001; x5C404.LO=0;
x5C405.LO=0; x5C406.LO=0; x5C407.LO=0;
x5C408.LO=0; x5C409.LO=0; x5C410.LO=0.0001;
x5C411.LO=0; x5C412.LO=0; x5C413.LO=0;
x5C414.LO=0; x5C415.LO=0; x5C418.LO=0;
```



```
x5C419.LO=0.0001; x5C425.LO=0; x5C426.LO=0.0001;
x5C427.LO=0; x5C428.LO=0; x5C430.LO=0;
x5C431.LO=0; x5C432.LO=0; x5HC01.LO=0;
x5HC02.LO=0; x5HC03.LO=0; x5HC04.LO=0;
x5HC05.LO=0; x5HC06.LO=0; x5HC07.LO=0;
x5HC08.LO=0; x5HC11.LO=0; x5HC14.LO=0;
x5HC15.LO=0; x5HC16.LO=0; x5HC22.LO=0;
x5HC23.LO=0; x5HC24.LO=0; x5HC25.LO=0;
x5HC26.LO=0; x5HC27.LO=0; x5HC28.LO=0;
x5HC29.LO=0.01; x5HC30.LO=0; x5HC31.LO=0;
x5HC33.LO=0; x5HC34.LO=0; x5HC38.LO=0;
x5HC40.LO=0; x5HC41.LO=0; x5HC45.LO=0;
x5R1.LO=0; x5R29.LO=0.01; x5SC401.LO=0.008;
x5SC404.LO=0; x5SC405.LO=0; x5SC406.LO=0.01;
x5SC407.LO=0.01; x5SC409.LO=0; x5SC411.LO=0;
x5SC412.LO=0; x5SC413.LO=0; x5SC414.LO=0;
x6SC401.LO=0; x6SC404.LO=0; x6SC405.LO=0;
x6SC406.LO=0; x6SC407.LO=0; x6SC409.LO=0;
x6SC411.LO=0; x6SC412.LO=0; x6SC413.LO=0;
x6SC414.LO=0; x7AC09.LO=0; x7AC20.LO=0;
x7AC31.LO=0; x7AC42.LO=0; x7C301.LO=0;
x7C302.LO=0; x7C303.LO=0; x7C306.LO=0;
x7C307.LO=0; x7C308.LO=0; x7C309.LO=0;
x7C310.LO=0; x7C311.LO=0; x7C312.LO=0;
x7C315.LO=0; x7C316.LO=0; x7C317.LO=0;
x7C318.LO=0; x7C319.LO=0; x7C320.LO=0;
x7C321.LO=0; x7C322.LO=0; x7C323.LO=0;
x7C324.LO=0; x7C325.LO=0; x7C326.LO=0;
x7C328.LO=0; x7C329.LO=0; x7C401.LO=0;
x7C402.LO=0; x7C403.LO=0.0001; x7C404.LO=0.0001;
x7C405.LO=0.0001; x7C406.LO=0.001; x7C407.LO=0.01;
x7C408.LO=0; x7C409.LO=0; x7C410.LO=0.0001;
x7C411.LO=0; x7C412.LO=0; x7C413.LO=0;
x7C414.LO=0; x7C415.LO=0; x7C417.LO=0.0001;
x7C418.LO=0.0001; x7C419.LO=0; x7C425.LO=0.2;
```

```
x7C426.LO=0.0001; x7C427.LO=0; x7C428.LO=0;
x7C430.LO=0; x7C431.LO=0; x7C432.LO=0;
x7HC01.LO=0; x7HC02.LO=0; x7HC03.LO=0;
x7HC04.LO=0; x7HC05.LO=0; x7HC06.LO=0;
x7HC07.LO=0; x7HC08.LO=0; x7HC11.LO=0;
x7HC14.LO=0; x7HC15.LO=0; x7HC16.LO=0;
x7HC22.LO=0; x7HC23.LO=0; x7HC24.LO=0;
x7HC25.LO=0; x7HC26.LO=0; x7HC27.LO=0;
x7HC28.LO=0; x7HC29.LO=0.1; x7HC30.LO=0.1;
x7HC31.LO=0.1; x7HC33.LO=0; x7HC34.LO=0;
x7HC38.LO=0; x7HC40.LO=0; x7HC41.LO=0;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 93
GAMS 2.50A Windows NT/95/98

```
x7HC45.LO=0; x7R1.LO=0; x7R29.LO=0.1;
x7SC401.LO=0; x7SC404.LO=0; x7SC405.LO=0;
x7SC406.LO=0; x7SC407.LO=0; x7SC409.LO=0;
x7SC411.LO=0; x7SC412.LO=0; x7SC413.LO=0;
x7SC414.LO=0; x8AC09.LO=0; x8AC20.LO=0;
x8AC31.LO=0; x8AC42.LO=0; x9AC09.LO=0;
x9AC20.LO=0; x9AC31.LO=0; x9AC42.LO=0;
xAC02.LO=0.4; xAC05.LO=0.4; xAC07.LO=0.4;
xAC09.LO=0.4; xAC12.LO=0.4; xAC15.LO=0.4;
xAC18.LO=0.4; xAC20.LO=0.4; xAC23.LO=0.4;
xAC26.LO=0.4; xAC29.LO=0.4; xAC31.LO=0.4;
xAC34.LO=0.4; xAC37.LO=0.4; xAC40.LO=0.4;
xAC42.LO=0.4; xiC10AC09.LO=0; xiC10AC20.LO=0;
xiC10AC31.LO=0; xiC10AC42.LO=0; xiC11AC09.LO=0;
xiC11AC20.LO=0; xiC11AC31.LO=0; xiC11AC42.LO=0;
xM1C606D.LO=0; xM3C606D.LO=0; xM4C606D.LO=0;
xM5C606D.LO=0; xM7C606D.LO=0; xx1C302.LO=0;
xx1C308.LO=0; xx1C310.LO=0; xx1C311.LO=0;
xx1C312.LO=0; xx1C323.LO=0; xx1C325.LO=0.4;
xx1C405.LO=0; xx1C408.LO=0; xx1C425.LO=0;
xx1C428.LO=0; xx1C430.LO=0; xx1C431.LO=0;
xx1HC28.LO=0.01; xx1HC29.LO=0; xx1HC30.LO=0.01;
xx1HC32.LO=0; xx1R1.LO=0; xx1R29.LO=0;
xx1SC406.LO=0; xx1SC408.LO=0; xx2HC28.LO=0;
xx2HC29.LO=0; xx2HC30.LO=0; xx2R1.LO=0;
xx2R29.LO=0; xx2SC406.LO=0; xx2SC408.LO=0;
xx3C302.LO=0.5; xx3C308.LO=0; xx3C310.LO=0;
xx3C311.LO=0; xx3C312.LO=0; xx3C323.LO=0.5;
xx3C325.LO=0; xx3C405.LO=0; xx3C408.LO=0;
xx3C425.LO=0; xx3C428.LO=0; xx3C430.LO=0;
xx3C431.LO=0; xx3C432.LO=0; xx3HC28.LO=0.2;
xx3HC29.LO=0.1; xx3HC30.LO=0.1; xx3HC32.LO=0.3;
xx3R1.LO=0.1; xx3R29.LO=0.1; xx3SC406.LO=0;
xx3SC408.LO=0.5; xx4C302.LO=0; xx4C308.LO=0;
xx4C310.LO=0; xx4C311.LO=0; xx4C312.LO=0;
xx4C323.LO=0.08; xx4C325.LO=0; xx4C405.LO=0.0001;
xx4C408.LO=0; xx4C409.LO=0.0001; xx4C425.LO=0;
xx4C427.LO=0; xx4C428.LO=0; xx4C430.LO=0.5;
xx4C431.LO=0.0001; xx4C432.LO=0.5; xx4HC28.LO=0.01;
xx4HC29.LO=0.01; xx4HC30.LO=0.01; xx4HC32.LO=0;
xx4R1.LO=0; xx4R29.LO=0.01; xx4SC406.LO=0.6;
xx4SC408.LO=0; xx5C302.LO=0; xx5C308.LO=0;
xx5C310.LO=0; xx5C311.LO=0; xx5C312.LO=0;
xx5C323.LO=0.001; xx5C325.LO=0; xx5C405.LO=0.0001;
xx5C408.LO=0; xx5C425.LO=0; xx5C428.LO=0;
xx5C430.LO=0; xx5C431.LO=0; xx5HC28.LO=0.01;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 94
GAMS 2.50A Windows NT/95/98

```
xx5HC29.LO=0; xx5HC30.LO=0; xx5HC32.LO=0;
xx5R1.LO=0; xx5R29.LO=0; xx5SC406.LO=0;
xx5SC408.LO=0; xx6SC406.LO=0; xx6SC408.LO=0;
xx7C302.LO=0; xx7C308.LO=0; xx7C310.LO=0;
xx7C311.LO=0; xx7C312.LO=0; xx7C323.LO=0.002;
xx7C325.LO=0; xx7C405.LO=0.0001; xx7C408.LO=0;
xx7C425.LO=0; xx7C428.LO=0; xx7C430.LO=0;
xx7C431.LO=0; xx7HC28.LO=0.1; xx7HC29.LO=0;
xx7HC30.LO=0.1; xx7HC32.LO=0; xx7R1.LO=0.1;
xx7R29.LO=0.1; xx7SC406.LO=0; xx7SC408.LO=0;
y1HC28.LO=0.05; y1HC29.LO=0.05; y1HC30.LO=0.05;
y1HC31.LO=0.05; y1R1.LO=0; y1R29.LO=0.05;
y2HC28.LO=0; y2HC29.LO=0; y2HC30.LO=0;
y2HC31.LO=0; y2R1.LO=0; y2R29.LO=0;
y3HC28.LO=0.2; y3HC29.LO=0.1; y3HC30.LO=0.1;
y3HC31.LO=0.1; y3R1.LO=0.1; y3R29.LO=0.1;
y4HC28.LO=0; y4HC29.LO=0; y4HC30.LO=0.01;
y4HC31.LO=0; y4R1.LO=0; y4R29.LO=0;
y5HC28.LO=0; y5HC29.LO=0; y5HC30.LO=0;
y5HC31.LO=0; y5R1.LO=0; y5R29.LO=0;
y7HC28.LO=0.01; y7HC29.LO=0; y7HC30.LO=0;
y7HC31.LO=0; y7R1.LO=0; y7R29.LO=0;
yy1HC28.LO=0.1; yy1HC29.LO=0.1; yy1HC30.LO=0.05;
yy1R1.LO=0.1; yy1R29.LO=0.05; yy2HC28.LO=0;
yy2HC29.LO=0; yy2HC30.LO=0; yy2R1.LO=0;
yy2R29.LO=0; yy3HC28.LO=0.1; yy3HC29.LO=0.1;
yy3HC30.LO=0.1; yy3R1.LO=0.1; yy3R29.LO=0.1;
```

```
yy4HC28.LO=0.01; yy4HC29.LO=0.01; yy4HC30.LO=0.01;
yy4R1.LO=0; yy4R29.LO=0.01; yy5HC28.LO=0.001;
yy5HC29.LO=0; yy5HC30.LO=0; yy5R1.LO=0;
yy5R29.LO=0; yy7HC28.LO=0; yy7HC29.LO=0;
yy7HC30.LO=0; yy7R1.LO=0; yy7R29.LO=0;
C10pC623.UP=0.5; C10pC625.UP=0.5; C10pC627.UP=0.5;
C10pC629.UP=0.5; C2C623.UP=0.1; C2C625.UP=0.1;
C2C627.UP=0.1; C2C629.UP=0.1; C3C623.UP=6;
C3C625.UP=6; C3C627.UP=6; C3C629.UP=6;
C3pC623.UP=10; C3pC625.UP=10; C3pC627.UP=10;
C3pC629.UP=10; C4pC623.UP=1; C4pC625.UP=1;
C4pC627.UP=1; C4pC629.UP=1; C5pC623.UP=0.1;
C5pC625.UP=0.1; C5pC627.UP=0.1; C5pC629.UP=0.1;
C7pC623.UP=0.1; C7pC625.UP=0.1; C7pC627.UP=0.1;
C7pC629.UP=0.1; C8pC623.UP=0.1; C8pC625.UP=0.1;
C8pC627.UP=0.1; C8pC629.UP=0.1; C9pC623.UP=10;
C9pC625.UP=10; C9pC627.UP=10; C9pC629.UP=10;
CHXC623.UP=15; CHXC625.UP=15; CHXC627.UP=15;
CHXC629.UP=15; CiC10pC623.UP=1; CiC10pC625.UP=1;
```



```
CiC10pC627.UP=1; CiC10pC629.UP=1; CiC11pC623.UP=0.1;
CiC11pC625.UP=0.1; CiC11pC627.UP=0.1; CiC11pC629.UP=0.1;
CiC4eC623.UP=0.1; CiC4eC625.UP=0.1; CiC4eC627.UP=0.1;
CiC4eC629.UP=0.1; CiC5eC623.UP=0.1; CiC5eC625.UP=0.1;
CiC5eC627.UP=0.1; CiC5eC629.UP=0.1; CiC8eC623.UP=0.3;
CiC8eC625.UP=0.3; CiC8eC627.UP=0.3; CiC8eC629.UP=0.3;
Cost.UP=10000; dTE601.UP=50; dTE602.UP=90;
dTE603.UP=50; dTE605.UP=50; dTE609A.UP=20;
dTE610.UP=50; dTE611.UP=50; dTE612.UP=90;
dTE613.UP=30; dTE616.UP=120; dTE617.UP=50;
dTE621A.UP=50; dTE621B.UP=40; dTE626.UP=50;
dTE627A.UP=55; dTE627B.UP=50; dTE628.UP=60;
dTE629.UP=80; dTE633.UP=50; dTE634.UP=20;
dTE640.UP=50; dTE641.UP=50; dTE695A.UP=90;
dTE695B.UP=60; dTE696A.UP=90; dTE696B.UP=90;
dTE6XX.UP=50; Earnings.UP=10000; f1C601.UP=0.1;
f1C603.UP=1; f1C606A.UP=1; f2C601.UP=1;
f3C601.UP=1; f3C603.UP=1; f3C606A.UP=1;
f4C601.UP=1; f4C603.UP=1; f4C606A.UP=1;
f5C601.UP=1; f5C603.UP=1; f5C606A.UP=1;
f6C601.UP=1; f7C601.UP=1; f7C603.UP=1;
f7C606A.UP=1; FAC05.UP=20; FAC07.UP=20;
FAC09.UP=20; FAC15.UP=20; FAC18.UP=20;
FAC20.UP=20; FAC26.UP=20; FAC29.UP=20;
FAC31.UP=20; FAC37.UP=20; FAC40.UP=20;
FAC42.UP=20; FC301.UP=6; FC302.UP=5;
FC303.UP=6; FC306.UP=15; FC307.UP=15;
FC309.UP=10; FC310.UP=3; FC311.UP=8;
FC312.UP=5; FC315.UP=5; FC317.UP=3;
FC318.UP=3; FC319.UP=3; FC321.UP=5;
FC323.UP=3; FC324.UP=3; FC325.UP=3;
FC326.UP=3; FC401.UP=5; FC402.UP=5;
FC404.UP=5; FC405.UP=2; FC406.UP=5;
FC408.UP=10; FC409.UP=10; FC410.UP=10;
FC411.UP=10; FC413.UP=1; FC414.UP=5;
FC415.UP=10; FC418.UP=5; FC419.UP=10;
FC425.UP=10; FC426.UP=5; FC427.UP=10;
FC428.UP=5; FC430.UP=10; FC431.UP=10;
FC432.UP=5; FcwE603.UP=20; FcwE605.UP=15;
FcwE609A.UP=1; FcwE611.UP=20; FcwE613.UP=15;
FcwE617.UP=25; FcwE621A.UP=10; FcwE621B.UP=20;
FcwE626.UP=20; FcwE627A.UP=10; FcwE627B.UP=30;
FcwE634.UP=60; FcwE640.UP=50; FcwE641A.UP=30;
FcwE641B.UP=10; FHC02.UP=5; FHC03.UP=10;
FHC04.UP=10; FHC05.UP=10; FHC06.UP=12;
FHC07.UP=5; FHC08.UP=5; FHC11.UP=5;
```



```
FHC14.UP=5; FHC15.UP=5; FHC16.UP=5;
FHC22.UP=6; FHC23.UP=6; FHC24.UP=6;
FHC25.UP=6; FHC26.UP=6; FHC27.UP=10;
FHC28.UP=12; FHC29.UP=12; FHC30.UP=12;
FHC31.UP=12; FHC33.UP=1; FHC34.UP=1;
FHC38.UP=1; FHC40.UP=1; FHC41.UP=1;
FHC45.UP=1; FIHC28.UP=10; FIHC29.UP=12;
FIHC30.UP=12; FIHC31.UP=12; FIR1.UP=10;
FIR29.UP=12; FmC302.UP=0.1; FmC308.UP=0.5;
FmC310.UP=0.8; FmC311.UP=0.5; FmC312.UP=0.1;
FmC317.UP=0.1; FmC322.UP=1; FmC323.UP=0.4;
FmC325.UP=1; FmC405.UP=0.1; FmC407.UP=0.1;
FmC408.UP=2; FmC409.UP=0.2; FmC412.UP=0.1;
FmC414.UP=0.1; FmC425.UP=2; FmC427.UP=0.2;
FmC428.UP=0.1; FmC430.UP=0.2; FmC431.UP=1;
FmC432.UP=0.1; FmHC01.UP=0.1; FmHC32.UP=0.1;
FmIHC28.UP=0.2; FmIHC29.UP=0.1; FmIHC30.UP=0.1;
FmIR1.UP=0.2; FmIR29.UP=0.1; FmSC403.UP=0.1;
FmSC406.UP=0.1; FmSC408.UP=1; FmvHC28.UP=0.2;
```

```
FmvHC29.UP=0.1; FmvHC30.UP=0.1; FmvR1.UP=0.2;
FmvR29.UP=0.1; FR1.UP=12; FR29.UP=12;
FSC401.UP=5; FSC403.UP=3; FSC404.UP=3;
FSC406.UP=3; FSC407.UP=3; FSC408.UP=3.2;
FSC409.UP=3.2; FSC412.UP=1; FSC414.UP=0.5;
FstmE602.UP=1; FstmE695A.UP=10; FstmE695B.UP=10;
FstmE696A.UP=10; FstmE696B.UP=10; FvHC28.UP=8;
FvHC29.UP=12; FvHC30.UP=12; FvHC31.UP=12;
FvR1.UP=12; FvR29.UP=12; h1C601.UP=2;
h1C603.UP=1; h1C606A.UP=10; h2C601.UP=5;
h3C601.UP=6; h3C603.UP=1; h3C606A.UP=-35;
h4C601.UP=2; h4C603.UP=1; h4C606A.UP=1;
h5C601.UP=1.5; h5C603.UP=1.5; h5C606A.UP=2;
h6C601.UP=3; h7C601.UP=1.5; h7C603.UP=1.5;
h7C606A.UP=1; hAC02.UP=10000; hAC05.UP=10000;
hAC07.UP=10000; hAC09.UP=10000; hAC12.UP=10000;
hAC15.UP=10000; hAC18.UP=10000; hAC20.UP=10000;
hAC23.UP=10000; hAC26.UP=10000; hAC29.UP=10000;
hAC31.UP=10000; hAC34.UP=10000; hAC37.UP=10000;
hAC40.UP=10000; hAC42.UP=10000; hacAC09.UP=10000;
hacAC20.UP=10000; hacAC31.UP=10000; hacAC42.UP=10000;
hC301.UP=10000; hC302.UP=5000; hC303.UP=10000;
hC306.UP=10000; hC307.UP=10000; hC308.UP=10000;
hC309.UP=10000; hC310.UP=5000; hC311.UP=10000;
hC312.UP=10000; hC312liq.UP=10000; hC315.UP=10000;
hC316.UP=10000; hC317.UP=10000; hC318.UP=10000;
hC319.UP=10000; hC321.UP=5000; hC322.UP=5000;
```


```
hC323.UP=10000; hC324.UP=10000; hC325.UP=10000;
hC326.UP=5000; hC329.UP=5000; hC401.UP=5000;
hC402.UP=10000; hC403.UP=10000; hC404.UP=10000;
hC405.UP=5000; hC406.UP=5000; hC407.UP=5000;
hC408.UP=10000; hC408vap.UP=10000; hC409.UP=10000;
hC410.UP=10000; hC410vap.UP=10000; hC411.UP=10000;
hC412.UP=5000; hC412liq.UP=1000; hC413.UP=5000;
hC414.UP=10000; hC414liq.UP=10000; hC415.UP=5000;
hC417.UP=5000; hC418.UP=10000; hC419.UP=10000;
hC425.UP=10000; hC426.UP=5000; hC427.UP=10000;
hC428.UP=10000; hC430.UP=10000; hC431.UP=10000;
hC432.UP=10000; hC623.UP=5000; hC625.UP=5000;
hC627.UP=5000; hC629.UP=5000; hHC01.UP=5000;
hHC02.UP=5000; hHC03.UP=10000; hHC04.UP=10000;
hHC05.UP=10000; hHC06.UP=10000; hHC07.UP=5000;
hHC11.UP=5000; hHC14.UP=5000; hHC16.UP=5000;
hHC29.UP=10000; hHC30.UP=10000; hHC31.UP=10000;
hHC32.UP=5000; hHC34.UP=5000; hHC38.UP=5000;
hHC41.UP=5000; hHC45.UP=5000; hlHC29.UP=10000;
hlHC30.UP=10000; hlHC31.UP=10000; hlR1.UP=10000;
hlR29.UP=10000; hR1.UP=10000; hR29.UP=10000;
hSC401.UP=10000; hSC402.UP=10000; hSC403.UP=10000;
hSC404.UP=10000; hSC405.UP=10000; hSC406.UP=10000;
hSC407.UP=10000; hSC408.UP=10000; hSC409.UP=5000;
hSC411.UP=5000; hSC412.UP=10000; hSC413.UP=10000;
hSC414.UP=500; hvHC29.UP=10000; hvHC30.UP=10000;
hvHC31.UP=10000; hvR1.UP=10000; hvR29.UP=10000;
K1C323.UP=3; K1C325.UP=2; K1C408.UP=15;
K1C414.UP=4; K1C428.UP=10; K1C430.UP=6;
K1C601.UP=3; K1C603.UP=3; K1C606A.UP=3;
K1C606C.UP=7; K1C614B.UP=3.5; K1C615_A.UP=4;
K1C616_A.UP=5; K1E633.UP=5.5; K1E6XX.UP=5.5;
K1SC406.UP=5; K1SC408.UP=3.5; K2C601.UP=1;
K2E633.UP=1.5; K2E6XX.UP=1.5; K2SC406.UP=1.2;
K2SC408.UP=1; K3C323.UP=1.5; K3C325.UP=1.5;
K3C408.UP=6; K3C414.UP=3; K3C428.UP=5;
K3C430.UP=5; K3C601.UP=2; K3C603.UP=1;
K3C606A.UP=3; K3C606C.UP=5; K3C614B.UP=1.5;
K3C615_A.UP=2; K3C616_A.UP=2; K3E633.UP=2;
K3E6XX.UP=3; K3SC406.UP=2; K3SC408.UP=1.5;
K4C323.UP=1; K4C325.UP=1; K4C408.UP=5;
K4C414.UP=2; K4C428.UP=5; K4C430.UP=3;
K4C601.UP=1; K4C603.UP=1; K4C606A.UP=3;
K4C606C.UP=4; K4C614B.UP=1; K4C615_A.UP=1.5;
K4C616_A.UP=1.5; K4E633.UP=1.5; K4E6XX.UP=1.5;
K4SC406.UP=1.5; K4SC408.UP=1; K5C323.UP=0.6;
```


```
K5C325.UP=0.6; K5C408.UP=3; K5C414.UP=2;
K5C428.UP=2; K5C430.UP=1.5; K5C601.UP=0.5;
K5C603.UP=0.5; K5C606A.UP=1; K5C606C.UP=1.2;
K5C614B.UP=0.8; K5C615_A.UP=1; K5C616_A.UP=1;
K5E633.UP=1; K5E6XX.UP=1; K5SC406.UP=0.6;
K5SC408.UP=0.6; K6C601.UP=1; K6SC406.UP=0.5;
K6SC408.UP=0.5; K7C323.UP=0.3; K7C325.UP=0.2;
K7C408.UP=1; K7C414.UP=1; K7C428.UP=2;
K7C430.UP=1; K7C601.UP=0.5; K7C603.UP=0.5;
K7C606A.UP=0.5; K7C614B.UP=0.1; K7C615_A.UP=1;
K7C616_A.UP=1; K7E633.UP=0.1; K7E6XX.UP=0.1;
```

```
K7SC406.UP=0.3; K7SC408.UP=0.2; Kp1C601.UP=5;
Kp1C603.UP=3; Kp1C606A.UP=5; Kp1C606D.UP=12;
Kp2C601.UP=1.5; Kp3C601.UP=2; Kp3C603.UP=1.5;
Kp3C606A.UP=3; Kp3C606D.UP=5; Kp4C601.UP=1.5;
Kp4C603.UP=1; Kp4C606A.UP=3; Kp4C606D.UP=5;
Kp5C601.UP=1; Kp5C603.UP=0.5; Kp5C606A.UP=1;
Kp5C606D.UP=5; Kp6C601.UP=1; Kp7C601.UP=1;
Kp7C603.UP=0.3; Kp7C606A.UP=0.5; Kp7C606D.UP=5;
kWad1.UP=300; kWad2.UP=355; LpC601.UP=5;
LpC603.UP=10; LpC606A.UP=5; PC303.UP=140;
PC306.UP=900; PC307.UP=850; PC308.UP=800;
PC309.UP=780; PC311.UP=400; PC312.UP=850;
PHC30.UP=140; PHC32.UP=200; PR29.UP=140;
Profit.UP=10000; Q2HC07.UP=1; Q2HC11.UP=1;
Q2HC14.UP=1; Q2HC16.UP=1; qFp1C606A.UP=1;
qFp3C606A.UP=0.1; qFp4C606A.UP=1; qFp5C606A.UP=1;
qFp7C606A.UP=1; qS1C606A.UP=1; qS3C606A.UP=1;
qS4C606A.UP=0.5; qS5C606A.UP=0.55; qS7C606A.UP=0.16;
r10C623.UP=0.1; r10C625.UP=0.1; r10C627.UP=0.1;
r10C629.UP=0.1; r2C623.UP=0.832; r2C625.UP=0.832;
r2C627.UP=0.832; r2C629.UP=0.832; r3C623.UP=0.15;
r3C625.UP=0.15; r3C627.UP=0.15; r3C629.UP=0.15;
r4C623.UP=0.03; r4C625.UP=0.03; r4C627.UP=0.03;
r4C629.UP=0.03; r5C623.UP=0.3; r5C625.UP=0.3;
r5C627.UP=0.3; r5C629.UP=0.3; r7C623.UP=0.05;
r7C625.UP=0.05; r7C627.UP=0.05; r7C629.UP=0.05;
r8C623.UP=0.1; r8C625.UP=0.1; r8C627.UP=0.1;
r8C629.UP=0.1; r9C623.UP=0.1; r9C625.UP=0.1;
r9C627.UP=0.1; r9C629.UP=0.1; rho2HC07.UP=650;
rho2HC11.UP=650; rho2HC14.UP=650; rho2HC16.UP=650;
rhoAC09.UP=1700; rhoAC20.UP=1700; rhoAC31.UP=1700;
rhoAC42.UP=1700; riC10C623.UP=0.3; riC10C625.UP=0.3;
riC10C627.UP=0.3; riC10C629.UP=0.3; riC11C623.UP=0.1;
riC11C625.UP=0.1; riC11C627.UP=0.1; riC11C629.UP=0.1;
sf1S34.UP=1; sf2S34.UP=1; sfS11.UP=0.8;
```



```
sfS19.UP=0.8; sfS2.UP=1; sfS23.UP=0.8;
sfS27.UP=0.8; sfS41.UP=1; sfS42.UP=1;
sfS5.UP=0.5; sfS7.UP=0.8; Sm1C601.UP=5;
Sm1C603.UP=1; Sm1C606A.UP=5; Sm1C606D.UP=5;
Sm2C601.UP=1; Sm3C601.UP=2; Sm3C603.UP=0.5;
Sm3C606A.UP=5; Sm3C606D.UP=10; Sm4C601.UP=1.5;
Sm4C603.UP=0.5; Sm4C606A.UP=5; Sm4C606D.UP=5;
Sm5C601.UP=0.6; Sm5C603.UP=0.5; Sm5C606A.UP=5;
Sm5C606D.UP=5; Sm6C601.UP=1; Sm7C601.UP=0.2;
Sm7C603.UP=0.2; Sm7C606A.UP=5; Sm7C606D.UP=5;
Sn1C601.UP=5; Sn1C603.UP=3; Sn1C606A.UP=20;
Sn2C601.UP=1.5; Sn3C601.UP=1.5; Sn3C603.UP=1.5;
Sn3C606A.UP=15; Sn4C601.UP=1; Sn4C603.UP=1;
Sn4C606A.UP=10; Sn5C601.UP=0.8; Sn5C603.UP=0.4;
Sn5C606A.UP=10; Sn6C601.UP=1; Sn7C601.UP=0.5;
Sn7C603.UP=0.5; Sn7C606A.UP=5; TAC02.UP=290;
TAC05.UP=300; TAC07.UP=300; TAC15.UP=300;
TAC18.UP=300; TAC20.UP=300; TAC26.UP=300;
TAC29.UP=300; TAC37.UP=300; TAC40.UP=300;
TC301.UP=300; TC302.UP=290; TC309.UP=350;
TC310.UP=310; TC311.UP=310; TC312.UP=369;
TC318.UP=365; TC319.UP=400; TC320.UP=400;
TC322.UP=400; TC323.UP=420; TC326.UP=360;
TC328.UP=360; TC329.UP=375; TC401.UP=300;
TC402.UP=305; TC403.UP=320; TC406.UP=400;
TC409.UP=461; TC411.UP=418; TC412.UP=405;
TC413.UP=350; TC415.UP=400; TC417.UP=350;
TC425.UP=410; TC426.UP=410; TC427.UP=405;
TC428.UP=405; TC430.UP=400; TC431.UP=405;
TC432.UP=400; TcwotE609A.UP=320; TcwotE621A.UP=355;
TcwotE621B.UP=325; TcwotE627A.UP=360; TcwotE627B.UP=310;
TcwotE641A.UP=360; TcwotE641B.UP=325; TcwoutE603.UP=350;
TcwoutE605.UP=320; TcwoutE611.UP=350; TcwoutE613.UP=320;
TcwoutE617.UP=350; TcwoutE626.UP=310; TcwoutE634.UP=360;
TcwoutE640.UP=330; THC01.UP=370; THC02.UP=302;
THC03.UP=360; THC04.UP=310; THC05.UP=300;
THC06.UP=300; THC07.UP=300; THC11.UP=300;
THC14.UP=300; THC16.UP=300; THC22.UP=290;
THC23.UP=290; THC24.UP=290; THC25.UP=290;
THC26.UP=290; THC27.UP=290; THC28.UP=290;
THC29.UP=290; THC30.UP=300; THC31.UP=310;
THC34.UP=310; THC38.UP=310; THC41.UP=310;
THC45.UP=310; TmC601.UP=360; TmC603.UP=375;
TmC606A.UP=370; TmC606D.UP=400; TmK601.UP=333;
TnC601.UP=340; TnC603.UP=375; TnC606A.UP=370;
TR1.UP=290; TR29.UP=300; TSC401.UP=350;
```



```
TSC404.UP=365; TSC406.UP=360; TSC407.UP=400;
TSC409.UP=360; TSC411.UP=375; TSC412.UP=360;
TSC414.UP=320; Utilities.UP=10000; VFC614B.UP=0.8;
```

```
VFC615.UP=0.6; VFC616.UP=1; VFM3.UP=0.55;
VpC601.UP=5; VpC603.UP=3; VpC606A.UP=10;
x10AC09.UP=0.1; x10AC20.UP=0.1; x10AC31.UP=0.1;
x10AC42.UP=0.1; x11AC02.UP=0.998; x11AC05.UP=0.999;
x11AC07.UP=0.999; x11AC09.UP=1; x11AC15.UP=0.999;
x11AC18.UP=0.999; x11AC20.UP=1; x11AC26.UP=0.999;
x11AC29.UP=0.999; x11AC31.UP=1; x11AC37.UP=0.999;
x11AC40.UP=0.999; x11AC42.UP=1; x12AC02.UP=0.03;
x12AC05.UP=0.11; x12AC07.UP=0.11; x12AC09.UP=0.1;
x12AC12.UP=0.12; x12AC15.UP=0.11; x12AC18.UP=0.11;
x12AC20.UP=0.1; x12AC23.UP=0.12; x12AC26.UP=0.11;
x12AC29.UP=0.11; x12AC31.UP=0.1; x12AC34.UP=0.12;
x12AC37.UP=0.11; x12AC40.UP=0.11; x12AC42.UP=0.1;
x12AC45.UP=0.12; x1AC09.UP=0.1; x1AC20.UP=0.1;
x1AC31.UP=0.1; x1AC42.UP=0.1; x1C301.UP=0.2;
x1C302.UP=0.2; x1C303.UP=0.22; x1C306.UP=0.5;
x1C307.UP=0.5; x1C308.UP=0.4; x1C309.UP=0.5;
x1C310.UP=0.5; x1C311.UP=0.2; x1C312.UP=1;
x1C315.UP=1; x1C317.UP=0.3; x1C318.UP=0.3;
x1C319.UP=0.1; x1C320.UP=0.1; x1C321.UP=0.1;
x1C322.UP=0.15; x1C323.UP=0.2; x1C324.UP=0.3;
x1C326.UP=1; x1C328.UP=1; x1C329.UP=1;
x1C401.UP=0.2; x1C402.UP=0.2; x1C403.UP=0.2;
x1C404.UP=0.2; x1C405.UP=0.01; x1C406.UP=0.01;
x1C407.UP=0.01; x1C408.UP=1; x1C409.UP=0.01;
x1C410.UP=1; x1C411.UP=0.1; x1C412.UP=0.05;
x1C413.UP=0.1; x1C414.UP=0.25; x1C415.UP=0.2;
x1C418.UP=0.3; x1C419.UP=0.2; x1C425.UP=0.1;
x1C426.UP=0.1; x1C427.UP=1; x1C428.UP=0.1;
x1C430.UP=0.1; x1C431.UP=0.1; x1C432.UP=0.1;
x1HC01.UP=0.3; x1HC02.UP=0.3; x1HC03.UP=0.2;
x1HC04.UP=0.2; x1HC05.UP=0.2; x1HC06.UP=0.2;
x1HC07.UP=0.2; x1HC08.UP=0.2; x1HC11.UP=0.2;
x1HC14.UP=0.2; x1HC15.UP=0.2; x1HC16.UP=0.2;
x1HC22.UP=0.5; x1HC23.UP=0.5; x1HC24.UP=0.5;
x1HC25.UP=0.5; x1HC26.UP=0.5; x1HC27.UP=0.5;
x1HC28.UP=0.2; x1HC29.UP=0.2; x1HC30.UP=0.2;
x1HC31.UP=0.1; x1HC33.UP=0.1; x1HC34.UP=0.1;
x1HC38.UP=0.1; x1HC40.UP=0.1; x1HC41.UP=0.1;
x1HC45.UP=0.1; x1R1.UP=0.1; x1R29.UP=0.2;
x1SC401.UP=0.1; x1SC404.UP=0.1; x1SC405.UP=0.1;
x1SC406.UP=0.1; x1SC407.UP=0.1; x1SC409.UP=0.1;
x1SC411.UP=0.1; x1SC412.UP=0.1; x1SC413.UP=0.1;
```



```
x1SC414.UP=0.1; x2AC09.UP=1; x2AC20.UP=1;
x2AC31.UP=1; x2AC42.UP=1; x2C301.UP=0.01;
x2C417.UP=0.1; x2C418.UP=0.1; x2C419.UP=0.1;
x2HC01.UP=0.7; x2HC02.UP=1; x2HC03.UP=0.1;
x2HC04.UP=0.1; x2HC05.UP=0.1; x2HC06.UP=0.15;
x2HC07.UP=0.15; x2HC08.UP=0.15; x2HC11.UP=0.15;
x2HC14.UP=0.15; x2HC15.UP=0.15; x2HC16.UP=0.15;
x2HC22.UP=0.1; x2HC23.UP=0.1; x2HC24.UP=0.1;
x2HC25.UP=0.1; x2HC26.UP=0.1; x2HC27.UP=0.1;
x2HC28.UP=0.1; x2HC29.UP=0.1; x2HC30.UP=0.1;
x2HC31.UP=0.1; x2R1.UP=0.1; x2R29.UP=0.1;
x2SC401.UP=0.1; x2SC404.UP=0.1; x2SC405.UP=0.1;
x2SC406.UP=0.1; x2SC407.UP=0.1; x2SC409.UP=0.1;
x2SC411.UP=0.1; x2SC412.UP=0.1; x2SC413.UP=0.1;
x2SC414.UP=0.1; x3AC09.UP=0.7; x3AC20.UP=0.7;
x3AC31.UP=0.7; x3AC42.UP=0.7; x3C301.UP=1;
x3C302.UP=1; x3C303.UP=0.8; x3C306.UP=1;
x3C307.UP=1; x3C308.UP=1; x3C309.UP=0.8;
x3C310.UP=1; x3C311.UP=1; x3C312.UP=1;
x3C315.UP=1; x3C317.UP=1; x3C318.UP=1;
x3C319.UP=1; x3C320.UP=1; x3C321.UP=1;
x3C322.UP=1; x3C323.UP=0.95; x3C324.UP=0.95;
x3C326.UP=0.5; x3C328.UP=0.5; x3C329.UP=0.5;
x3C401.UP=1; x3C402.UP=0.8; x3C403.UP=1;
x3C404.UP=1; x3C405.UP=0.1; x3C406.UP=0.01;
x3C407.UP=0.01; x3C408.UP=1; x3C409.UP=0.01;
x3C410.UP=0.1; x3C411.UP=0.2; x3C412.UP=0.1;
x3C413.UP=0.1; x3C414.UP=1; x3C415.UP=1;
x3C418.UP=1; x3C419.UP=1; x3C425.UP=0.1;
x3C426.UP=0.1; x3C427.UP=1; x3C428.UP=0.3;
x3C430.UP=0.1; x3C431.UP=0.1; x3C432.UP=0.1;
x3HC01.UP=0.6; x3HC02.UP=0.5; x3HC03.UP=1;
x3HC04.UP=1; x3HC05.UP=1; x3HC06.UP=1;
x3HC07.UP=1; x3HC08.UP=1; x3HC11.UP=1;
x3HC14.UP=1; x3HC15.UP=1; x3HC16.UP=1;
x3HC22.UP=0.9; x3HC23.UP=0.9; x3HC24.UP=0.9;
x3HC25.UP=0.9; x3HC26.UP=0.9; x3HC27.UP=0.9;
x3HC28.UP=0.6; x3HC29.UP=0.6; x3HC30.UP=0.6;
x3HC31.UP=0.6; x3HC33.UP=1; x3HC34.UP=1;
x3HC38.UP=1; x3HC40.UP=1; x3HC41.UP=1;
x3HC45.UP=1; x3R1.UP=0.6; x3R29.UP=0.6;
x3SC401.UP=0.4; x3SC404.UP=0.1; x3SC405.UP=0.1;
x3SC406.UP=0.1; x3SC407.UP=0.1; x3SC409.UP=1;
x3SC411.UP=1; x3SC412.UP=1; x3SC413.UP=1;
x3SC414.UP=1; x4AC09.UP=0.2; x4AC20.UP=0.2;
```

```
x4AC31.UP=0.2; x4AC42.UP=0.2; x4C301.UP=0.5;
```



```
x4C302.UP=0.5; x4C303.UP=0.2; x4C306.UP=0.8;
x4C307.UP=0.8; x4C308.UP=0.5; x4C309.UP=0.4;
x4C310.UP=0.3; x4C311.UP=0.5; x4C312.UP=1;
x4C315.UP=0.3; x4C317.UP=0.2; x4C318.UP=0.3;
x4C319.UP=0.3; x4C320.UP=0.3; x4C321.UP=0.3;
x4C322.UP=0.4; x4C323.UP=0.25; x4C324.UP=0.25;
x4C325.UP=0.1; x4C326.UP=0.1; x4C328.UP=0.1;
x4C329.UP=0.1; x4C401.UP=0.5; x4C402.UP=0.5;
x4C403.UP=0.3; x4C404.UP=0.3; x4C405.UP=0.2;
x4C406.UP=0.2; x4C407.UP=0.3; x4C408.UP=0.2;
x4C409.UP=0.3; x4C410.UP=1; x4C411.UP=1;
x4C412.UP=1; x4C413.UP=1; x4C414.UP=0.25;
x4C415.UP=0.3; x4C418.UP=0.3; x4C419.UP=0.3;
x4C425.UP=1; x4C426.UP=1; x4C427.UP=1;
x4C428.UP=1; x4C430.UP=1; x4C431.UP=1;
x4C432.UP=1; x4HC01.UP=0.25; x4HC02.UP=0.25;
x4HC03.UP=0.3; x4HC04.UP=0.5; x4HC05.UP=0.5;
x4HC06.UP=0.4; x4HC07.UP=0.4; x4HC08.UP=0.4;
x4HC11.UP=0.4; x4HC14.UP=0.4; x4HC15.UP=0.4;
x4HC16.UP=0.4; x4HC22.UP=0.5; x4HC23.UP=0.5;
x4HC24.UP=0.5; x4HC25.UP=0.5; x4HC26.UP=0.5;
x4HC27.UP=0.5; x4HC28.UP=0.5; x4HC29.UP=0.3;
x4HC30.UP=0.3; x4HC31.UP=0.3; x4HC33.UP=0.5;
x4HC34.UP=0.5; x4HC38.UP=0.5; x4HC40.UP=0.5;
x4HC41.UP=0.5; x4HC45.UP=0.5; x4R1.UP=0.3;
x4R29.UP=0.3; x4SC401.UP=0.7; x4SC404.UP=1;
x4SC405.UP=1; x4SC406.UP=1; x4SC407.UP=1;
x4SC409.UP=0.1; x4SC411.UP=0.1; x4SC412.UP=0.1;
x4SC413.UP=0.1; x4SC414.UP=0.1; x5AC09.UP=0.1;
x5AC20.UP=0.1; x5AC31.UP=0.1; x5AC42.UP=0.1;
x5C301.UP=0.2; x5C302.UP=0.1; x5C303.UP=0.1;
x5C306.UP=0.6; x5C307.UP=0.6; x5C308.UP=0.2;
x5C309.UP=0.2; x5C310.UP=0.1; x5C311.UP=0.2;
x5C312.UP=0.4; x5C315.UP=0.1; x5C317.UP=0.1;
x5C318.UP=0.1; x5C319.UP=0.1; x5C320.UP=0.1;
x5C321.UP=0.1; x5C322.UP=0.1; x5C323.UP=0.1;
x5C324.UP=0.1; x5C325.UP=0.01; x5C326.UP=0.01;
x5C328.UP=0.01; x5C329.UP=0.01; x5C401.UP=0.5;
x5C402.UP=0.5; x5C403.UP=0.2; x5C404.UP=0.2;
x5C405.UP=0.2; x5C406.UP=0.2; x5C407.UP=0.2;
x5C408.UP=0.2; x5C409.UP=0.3; x5C410.UP=1;
x5C411.UP=1; x5C412.UP=0.1; x5C413.UP=0.3;
x5C414.UP=0.1; x5C415.UP=0.1; x5C418.UP=0.1;
x5C419.UP=0.1; x5C425.UP=1; x5C426.UP=1;
x5C427.UP=1; x5C428.UP=0.4; x5C430.UP=0.1;
x5C431.UP=0.2; x5C432.UP=0.1; x5HC01.UP=0.15;
```



```
x5HC02.UP=0.15; x5HC03.UP=0.1; x5HC04.UP=0.3;
x5HC05.UP=0.3; x5HC06.UP=0.3; x5HC07.UP=0.3;
x5HC08.UP=0.3; x5HC11.UP=0.3; x5HC14.UP=0.3;
x5HC15.UP=0.3; x5HC16.UP=0.3; x5HC22.UP=0.5;
x5HC23.UP=0.5; x5HC24.UP=0.5; x5HC25.UP=0.5;
x5HC26.UP=0.5; x5HC27.UP=0.5; x5HC28.UP=0.5;
x5HC29.UP=0.3; x5HC30.UP=0.3; x5HC31.UP=0.3;
x5HC33.UP=2.5; x5HC34.UP=2.5; x5HC38.UP=2.5;
x5HC40.UP=2.5; x5HC41.UP=2.5; x5HC45.UP=2.5;
x5R1.UP=0.3; x5R29.UP=0.4; x5SC401.UP=0.1;
x5SC404.UP=0.1; x5SC405.UP=0.1; x5SC406.UP=0.1;
x5SC407.UP=0.1; x5SC409.UP=0.1; x5SC411.UP=0.1;
x5SC412.UP=0.1; x5SC413.UP=0.1; x5SC414.UP=0.1;
x6SC401.UP=0.1; x6SC404.UP=0.12; x6SC405.UP=0.1;
x6SC406.UP=0.1; x6SC407.UP=0.1; x6SC409.UP=0.1;
x6SC411.UP=0.1; x6SC412.UP=0.1; x6SC413.UP=0.1;
x6SC414.UP=0.1; x7AC09.UP=0.1; x7AC20.UP=0.1;
x7AC31.UP=0.1; x7AC42.UP=0.1; x7C301.UP=0.1;
x7C302.UP=0.3; x7C303.UP=0.1; x7C306.UP=0.8;
x7C307.UP=0.8; x7C308.UP=0.3; x7C309.UP=0.3;
x7C310.UP=0.2; x7C311.UP=1; x7C312.UP=0.5;
x7C315.UP=0.01; x7C316.UP=0.01; x7C317.UP=0.1;
x7C318.UP=0.15; x7C319.UP=0.15; x7C320.UP=0.1;
x7C321.UP=0.1; x7C322.UP=0.1; x7C323.UP=0.02;
x7C324.UP=0.1; x7C325.UP=0.2; x7C326.UP=0.2;
x7C328.UP=0.2; x7C329.UP=0.1; x7C401.UP=1;
x7C402.UP=0.6; x7C403.UP=1; x7C404.UP=1;
x7C405.UP=1; x7C406.UP=1; x7C407.UP=1;
x7C408.UP=1; x7C409.UP=1; x7C410.UP=1;
x7C411.UP=1; x7C412.UP=0.2; x7C413.UP=0.3;
x7C414.UP=0.1; x7C415.UP=0.1; x7C417.UP=0.08;
x7C418.UP=0.1; x7C419.UP=0.1; x7C425.UP=1;
x7C426.UP=1; x7C427.UP=1; x7C428.UP=0.5;
x7C430.UP=0.35; x7C431.UP=0.3; x7C432.UP=0.3;
x7HC01.UP=0.6; x7HC02.UP=0.6; x7HC03.UP=0.1;
x7HC04.UP=0.25; x7HC05.UP=0.25; x7HC06.UP=0.3;
x7HC07.UP=0.3; x7HC08.UP=0.3; x7HC11.UP=0.3;
```

```
x7HC14.UP=0.3; x7HC15.UP=0.3; x7HC16.UP=0.3;
x7HC22.UP=0.5; x7HC23.UP=0.5; x7HC24.UP=0.5;
x7HC25.UP=0.5; x7HC26.UP=0.5; x7HC27.UP=0.5;
x7HC28.UP=0.5; x7HC29.UP=0.5; x7HC30.UP=0.5;
x7HC31.UP=0.6; x7HC33.UP=2; x7HC34.UP=2;
x7HC38.UP=2; x7HC40.UP=2; x7HC41.UP=2;
x7HC45.UP=2; x7R1.UP=0.5; x7R29.UP=0.6;
x7SC401.UP=0.1; x7SC404.UP=0.12; x7SC405.UP=0.12;
x7SC406.UP=0.01; x7SC407.UP=0.1; x7SC409.UP=0.1;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 104
GAMS 2.50A Windows NT/95/98

```
x7SC411.UP=0.1; x7SC412.UP=0.1; x7SC413.UP=0.1;
x7SC414.UP=0.1; x8AC09.UP=0.1; x8AC20.UP=0.1;
x8AC31.UP=0.1; x8AC42.UP=0.1; x9AC09.UP=0.3;
x9AC20.UP=0.3; x9AC31.UP=0.3; x9AC42.UP=0.3;
xAC02.UP=1; xAC05.UP=1; xAC07.UP=1;
xAC09.UP=1; xAC12.UP=1; xAC15.UP=1;
xAC18.UP=1; xAC20.UP=1; xAC23.UP=1;
xAC26.UP=1; xAC29.UP=1; xAC31.UP=1;
xAC34.UP=1; xAC37.UP=1; xAC40.UP=1;
xAC42.UP=1; xiC10AC09.UP=1; xiC10AC20.UP=1;
xiC10AC31.UP=1; xiC10AC42.UP=1; xiC11AC09.UP=1;
xiC11AC20.UP=1; xiC11AC31.UP=1; xiC11AC42.UP=1;
xM1C606D.UP=0.5; xM3C606D.UP=0.5; xM4C606D.UP=0.65;
xM5C606D.UP=0.5; xM7C606D.UP=1; xx1C302.UP=0.25;
xx1C308.UP=0.5; xx1C310.UP=0.5; xx1C311.UP=0.3;
xx1C312.UP=1; xx1C323.UP=0.2; xx1C325.UP=1;
xx1C405.UP=0.01; xx1C408.UP=1; xx1C425.UP=1;
xx1C428.UP=1; xx1C430.UP=0.5; xx1C431.UP=0.1;
xx1HC28.UP=0.2; xx1HC29.UP=0.2; xx1HC30.UP=0.2;
xx1HC32.UP=0.1; xx1R1.UP=0.2; xx1R29.UP=0.1;
xx1SC406.UP=0.2; xx1SC408.UP=0.1; xx2HC28.UP=0.1;
xx2HC29.UP=0.1; xx2HC30.UP=0.1; xx2R1.UP=0.1;
xx2R29.UP=0.1; xx2SC406.UP=0.1; xx2SC408.UP=1;
xx3C302.UP=1; xx3C308.UP=1; xx3C310.UP=1;
xx3C311.UP=1; xx3C312.UP=1; xx3C323.UP=0.92;
xx3C325.UP=0.5; xx3C405.UP=0.1; xx3C408.UP=1;
xx3C425.UP=1; xx3C428.UP=1; xx3C430.UP=0.1;
xx3C431.UP=0.5; xx3C432.UP=0.15; xx3HC28.UP=0.8;
xx3HC29.UP=0.8; xx3HC30.UP=0.6; xx3HC32.UP=1;
xx3R1.UP=0.8; xx3R29.UP=0.6; xx3SC406.UP=0.1;
xx3SC408.UP=1; xx4C302.UP=0.5; xx4C308.UP=0.5;
xx4C310.UP=0.3; xx4C311.UP=0.5; xx4C312.UP=0.15;
xx4C323.UP=0.28; xx4C325.UP=0.05; xx4C405.UP=0.2;
xx4C408.UP=0.3; xx4C409.UP=0.3; xx4C425.UP=1;
xx4C427.UP=1; xx4C428.UP=1; xx4C430.UP=1;
xx4C431.UP=1; xx4C432.UP=1; xx4HC28.UP=0.3;
xx4HC29.UP=0.3; xx4HC30.UP=0.3; xx4HC32.UP=0.5;
xx4R1.UP=0.3; xx4R29.UP=0.3; xx4SC406.UP=1;
xx4SC408.UP=0.05; xx5C302.UP=0.1; xx5C308.UP=0.8;
xx5C310.UP=0.1; xx5C311.UP=0.1; xx5C312.UP=0.3;
xx5C323.UP=0.15; xx5C325.UP=0.001; xx5C405.UP=0.2;
xx5C408.UP=0.3; xx5C425.UP=1; xx5C428.UP=1;
xx5C430.UP=1; xx5C431.UP=1; xx5HC28.UP=0.3;
xx5HC29.UP=0.3; xx5HC30.UP=0.3; xx5HC32.UP=0.2;
xx5R1.UP=0.3; xx5R29.UP=0.3; xx5SC406.UP=0.15;
xx5SC408.UP=0.1; xx6SC406.UP=0.1; xx6SC408.UP=1;
```

_Economic Optimization Program 05/15/01 16:49:39 PAGE 105
GAMS 2.50A Windows NT/95/98

```
xx7C302.UP=0.2; xx7C308.UP=0.1; xx7C310.UP=0.1;
xx7C311.UP=0.3; xx7C312.UP=0.1; xx7C323.UP=0.1;
xx7C325.UP=0.1; xx7C405.UP=1; xx7C408.UP=1;
xx7C425.UP=1; xx7C428.UP=1; xx7C430.UP=1;
xx7C431.UP=1; xx7HC28.UP=0.4; xx7HC29.UP=0.5;
xx7HC30.UP=0.5; xx7HC32.UP=0.2; xx7R1.UP=0.5;
xx7R29.UP=0.5; xx7SC406.UP=0.1; xx7SC408.UP=0.1;
y1HC28.UP=0.5; y1HC29.UP=0.5; y1HC30.UP=0.5;
y1HC31.UP=0.4; y1R1.UP=0.5; y1R29.UP=0.5;
y2HC28.UP=0.1; y2HC29.UP=0.1; y2HC30.UP=0.1;
y2HC31.UP=0.1; y2R1.UP=0.1; y2R29.UP=0.1;
y3HC28.UP=0.9; y3HC29.UP=0.9; y3HC30.UP=0.85;
y3HC31.UP=0.85; y3R1.UP=0.9; y3R29.UP=0.85;
y4HC28.UP=0.5; y4HC29.UP=0.3; y4HC30.UP=0.4;
y4HC31.UP=0.3; y4R1.UP=0.3; y4R29.UP=0.5;
y5HC28.UP=0.2; y5HC29.UP=0.2; y5HC30.UP=0.2;
y5HC31.UP=0.2; y5R1.UP=0.2; y5R29.UP=0.2;
y7HC28.UP=0.5; y7HC29.UP=0.1; y7HC30.UP=0.1;
y7HC31.UP=0.2; y7R1.UP=0.1; y7R29.UP=0.2;
yy1HC28.UP=0.5; yy1HC29.UP=0.6; yy1HC30.UP=0.6;
yy1R1.UP=0.6; yy1R29.UP=0.6; yy2HC28.UP=0.1;
yy2HC29.UP=0.1; yy2HC30.UP=0.1; yy2R1.UP=0.1;
yy2R29.UP=0.1; yy3HC28.UP=0.9; yy3HC29.UP=0.8;
yy3HC30.UP=0.8; yy3R1.UP=0.8; yy3R29.UP=0.8;
yy4HC28.UP=0.3; yy4HC29.UP=0.3; yy4HC30.UP=0.3;
yy4R1.UP=0.3; yy4R29.UP=0.3; yy5HC28.UP=0.2;
yy5HC29.UP=0.2; yy5HC30.UP=0.1; yy5R1.UP=0.2;
yy5R29.UP=0.2; yy7HC28.UP=0.2; yy7HC29.UP=0.2;
yy7HC30.UP=0.1; yy7R1.UP=0.1; yy7R29.UP=0.2;
```

```
4647
4648  MODEL Alkyl /ALL/;
4649  OPTION LIMCOL=0;
4650  OPTION LIMROW=0;
4651  OPTION ITERLIM= 10000;
4652  OPTION DOMLIM= 0;
4653  OPTION RESLIM= 10000;
4654
4655  OPTION NLP=CONOPT2;
4656  SOLVE Alkyl Using NLP Maximizing ObjVar;
4657


COMPILATION TIME     =        0.660 SECONDS      1.6 Mb      WIN-18-097
_Economic Optimization Program                                          05/15/01 16:49:39  PAGE    106
Model Statistics    SOLVE ALKYL USING NLP FROM LINE 4656                        GAMS 2.50A    Windows NT/95/98



MODEL STATISTICS

BLOCKS OF EQUATIONS    1630     SINGLE EQUATIONS     1630
BLOCKS OF VARIABLES    1635     SINGLE VARIABLES     1635
NON ZERO ELEMENTS      6592     NON LINEAR N-Z       4104
DERIVATIVE POOL          17     CONSTANT POOL          199
CODE LENGTH           74192


GENERATION TIME      =        0.550 SECONDS      3.0 Mb      WIN-18-097


EXECUTION TIME       =        0.710 SECONDS      2.9 Mb      WIN-18-097
_Economic Optimization Program                                          05/15/01 16:49:39  PAGE    107
                                                               GAMS 2.50A  Windows NT/95/98


          S O L V E      S U M M A R Y

     MODEL   ALKYL               OBJECTIVE  OBJVAR
     TYPE    NLP                 DIRECTION  MAXIMIZE
     SOLVER  CONOPT2             FROM LINE  4656

**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      2 LOCALLY OPTIMAL
**** OBJECTIVE VALUE               29.1128

 RESOURCE USAGE, LIMIT          9.949     10000.000
 ITERATION COUNT, LIMIT        63         10000
 EVALUATION ERRORS              0             0


     C O N O P T   Wintel  version 2.070F-003-035
     Copyright (C) ARKI Consulting and Development A/S
                   Bagsvaerdvej 246 A
                   DK-2880 Bagsvaerd, Denmark

 Using control program file C:\PROGRAM FILES\GAMSIDE\CONOPT2.OPT

 Rtmaxj=1E9;
 rtnwmi=1E-8;
 *rtredg=1E-9;
 *lslack =t;
 lsscal= t;
 *lstcrs =t;
 lfstal =2000;


 ** Warning **  Rtmaxj is very large. Try to scale the model.
                CONOPT may become unreliable and there are no
                guaranties.

 ** Optimal solution. Reduced gradient less than tolerance.


 CONOPT time Total                       9.512 seconds
   of which: Function evaluations        1.926 = 20.2%
             Derivative evaluations      0.762 =  8.0%

 Work length =     3.45 Mbytes
    Estimate =     3.45 Mbytes
    Max used =     1.93 Mbytes
_Economic Optimization Program                                          05/15/01 16:49:39  PAGE    108
                                                               GAMS 2.50A  Windows NT/95/98


                       LOWER          LEVEL          UPPER         MARGINAL

---- EQU EQU1              .              .              .              .
---- EQU EQU2              .              .              .          739.4425
---- EQU EQU3              .              .              .            0.0235
---- EQU EQU4              .              .              .          -10.5486
```

---- EQU EQU5	.	.	.	-31.4441
---- EQU EQU6	.	.	.	0.8396
---- EQU EQU7	.	.	.	0.1236
---- EQU EQU8	.	.	.	-0.7526
---- EQU EQU9	.	.	.	0.2006
---- EQU EQU10	.	.	.	0.0024
---- EQU EQU11	1.0000	1.0000	1.0000	4.1594
---- EQU EQU12	.	.	.	EPS
---- EQU EQU13	.	.	.	EPS
---- EQU EQU14	460.0000	460.0000	460.0000	-0.0015
---- EQU EQU15	.	.	.	0.0003
---- EQU EQU16	.	.	.	EPS
---- EQU EQU17	.	.	.	1145.6702
---- EQU EQU18	-70.0000	-70.0000	-70.0000	-0.0004
---- EQU EQU19	.	.	.	EPS
---- EQU EQU20	1.0000	1.0000	1.0000	71.4458
---- EQU EQU21	.	.	.	-0.7449
---- EQU EQU22	.	.	.	EPS
---- EQU EQU23	.	.	.	-0.0002
---- EQU EQU24	.	.	.	118.6951
---- EQU EQU25	.	.	.	118.1386
---- EQU EQU26	.	.	.	-0.0002
---- EQU EQU27	.	.	.	-0.0490
---- EQU EQU28	.	.	.	-0.0001
---- EQU EQU29	.	.	.	0.0029
---- EQU EQU30	.	.	.	-0.0497
---- EQU EQU31	.	.	.	EPS
---- EQU EQU32	.	.	.	0.0004
---- EQU EQU33	.	.	.	-275.6855
---- EQU EQU34	.	.	.	8.0277
---- EQU EQU35	.	.	.	8.4063
---- EQU EQU36	.	.	.	0.0232
---- EQU EQU37	.	.	.	-115.8303
---- EQU EQU38	.	.	.	-82.6546
---- EQU EQU39	.	.	.	-64.7196
---- EQU EQU40	.	.	.	11.9525
---- EQU EQU41	.	.	.	EPS
---- EQU EQU42	1.0000	1.0000	1.0000	-4.8177
---- EQU EQU43	1.0000	1.0000	1.0000	480.6352
---- EQU EQU44	1.0000	1.0000	1.0000	-6.6694

_Economic Optimization Program 05/15/01 16:49:39 PAGE 109
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU45	1.0000	1.0000	1.0000	0.6527
---- EQU EQU46	1.0000	1.0000	1.0000	EPS
---- EQU EQU47	1.0000	1.0000	1.0000	-187.9903
---- EQU EQU48	1.0000	1.0000	1.0000	195.0964
---- EQU EQU49	1.0000	1.0000	1.0000	1.5425
---- EQU EQU50	1.0000	1.0000	1.0000	-0.2369
---- EQU EQU51	1.0000	1.0000	1.0000	57.5949
---- EQU EQU52	1.0000	1.0000	1.0000	-53.6290
---- EQU EQU53	1.0000	1.0000	1.0000	-599.6805
---- EQU EQU54	1.0000	1.0000	1.0000	-2.4033
---- EQU EQU55	1.0000	1.0000	1.0000	38.1402
---- EQU EQU56	1.0000	1.0000	1.0000	-0.6670
---- EQU EQU57	1.0000	1.0000	1.0000	-0.5897
---- EQU EQU58	1.0000	1.0000	1.0000	-1.4836
---- EQU EQU59	1.0000	1.0000	1.0000	EPS
---- EQU EQU60	1.0000	1.0000	1.0000	.
---- EQU EQU61	1.0000	1.0000	1.0000	-4.1130
---- EQU EQU62	1.0000	1.0000	1.0000	-0.4251
---- EQU EQU63	1.0000	1.0000	1.0000	1.0731
---- EQU EQU64	1.0000	1.0000	1.0000	88.6032
---- EQU EQU65	1.0000	1.0000	1.0000	47.1447
---- EQU EQU66	1.0000	1.0000	1.0000	1.9278
---- EQU EQU67	1.0000	1.0000	1.0000	283.4007
---- EQU EQU68	1.0000	1.0000	1.0000	.
---- EQU EQU69	1.0000	1.0000	1.0000	-1.5441
---- EQU EQU70	1.0000	1.0000	1.0000	EPS
---- EQU EQU71	1.0000	1.0000	1.0000	EPS
---- EQU EQU72	1.0000	1.0000	1.0000	-0.1797
---- EQU EQU73	1.0000	1.0000	1.0000	268.1690
---- EQU EQU74	1.0000	1.0000	1.0000	-290.7238
---- EQU EQU75	1.0000	1.0000	1.0000	25.2985
---- EQU EQU76	.	.	.	EPS
---- EQU EQU77	.	.	.	EPS
---- EQU EQU78	.	.	.	0.0093
---- EQU EQU79	.	.	.	-0.0083
---- EQU EQU80	.	.	.	0.0009
---- EQU EQU81	.	.	.	0.0124
---- EQU EQU82	.	.	.	0.0005
---- EQU EQU83	.	.	.	-0.0056
---- EQU EQU84	.	.	.	EPS
---- EQU EQU85	.	.	.	0.8074
---- EQU EQU86	.	.	.	EPS
---- EQU EQU87	.	.	.	0.0129
---- EQU EQU88	.	.	.	EPS

_Economic Optimization Program 05/15/01 16:49:39 PAGE 110
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU89	.	.	.	0.0037
---- EQU EQU90	.	.	.	-6.1941
---- EQU EQU91	.	.	.	214.4071
---- EQU EQU92	.	.	.	0.5261
---- EQU EQU93	.	.	.	113.2581
---- EQU EQU94	.	.	.	710.4108
---- EQU EQU95	.	.	.	113.4234
---- EQU EQU96	.	.	.	113.5545
---- EQU EQU97	.	.	.	1.3817
---- EQU EQU98	.	.	.	118.3296
---- EQU EQU99	.	.	.	744.3364
---- EQU EQU100	.	.	.	118.6955
---- EQU EQU101	.	.	.	118.9888
---- EQU EQU102	.	.	.	EPS
---- EQU EQU103	.	.	.	-0.8074
---- EQU EQU104	.	.	.	0.0173
---- EQU EQU105	.	.	.	0.0005
---- EQU EQU106	.	.	.	0.0003
---- EQU EQU107	.	.	.	3.2816042E-7
---- EQU EQU108	.	.	.	EPS
---- EQU EQU109	.	.	.	EPS
---- EQU EQU110	.	.	.	EPS
---- EQU EQU111	.	.	.	EPS
---- EQU EQU112	.	.	.	EPS
---- EQU EQU113	.	.	.	EPS
---- EQU EQU114	.	.	.	EPS
---- EQU EQU115	.	.	.	1.4959
---- EQU EQU116	.	.	.	0.3785
---- EQU EQU117	.	.	.	0.0007
---- EQU EQU118	.	.	.	7.1057781E-6
---- EQU EQU119	.	.	.	EPS
---- EQU EQU120	.	.	.	EPS
---- EQU EQU121	.	.	.	EPS
---- EQU EQU122	.	.	.	EPS
---- EQU EQU123	.	.	.	-0.0007
---- EQU EQU124	.	.	.	EPS
---- EQU EQU125	.	.	.	-0.0074
---- EQU EQU126	.	.	.	0.0005
---- EQU EQU127	.	.	.	-0.0330
---- EQU EQU128	.	.	.	-142.8070
---- EQU EQU129	.	.	.	-194.9739
---- EQU EQU130	.	.	.	0.0536
---- EQU EQU131	.	.	.	EPS
---- EQU EQU132	.	.	.	EPS

_Economic Optimization Program 05/15/01 16:49:39 PAGE 111
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU133	.	.	.	EPS
---- EQU EQU134	.	.	.	EPS
---- EQU EQU135	.	.	.	EPS
---- EQU EQU136	.	.	.	EPS
---- EQU EQU137	0.1500	0.1500	0.1500	0.1337
---- EQU EQU138	15.0000	15.0000	15.0000	-29.4541
---- EQU EQU139	15.0000	15.0000	15.0000	1.1390
---- EQU EQU140	15.0000	15.0000	15.0000	0.1338
---- EQU EQU141	15.0000	15.0000	15.0000	0.0660
---- EQU EQU142	.	.	.	10.0266
---- EQU EQU143	.	.	.	152.9267
---- EQU EQU144	.	.	.	-67.1301
---- EQU EQU145	.	.	.	-170.0790
---- EQU EQU146	.	.	.	-163.4739
---- EQU EQU147	.	.	.	-0.8182
---- EQU EQU148	.	.	.	5.1171800E-5
---- EQU EQU149	.	.	.	EPS
---- EQU EQU150	.	.	.	EPS
---- EQU EQU151	.	.	.	EPS
---- EQU EQU152	.	.	.	-0.0003
---- EQU EQU153	.	.	.	-0.0019
---- EQU EQU154	.	.	.	-0.0002
---- EQU EQU155	.	.	.	-1.099730E-5
---- EQU EQU156	.	.	.	-5.322803E-6
---- EQU EQU157	1.0000	1.0000	1.0000	4.0764
---- EQU EQU158	.	.	.	253.2285
---- EQU EQU159	.	.	.	-12.5082
---- EQU EQU160	.	.	.	-3.8347
---- EQU EQU161	.	.	.	-2.7680
---- EQU EQU162	.	.	.	-0.7577
---- EQU EQU163	1.0000	1.0000	1.0000	-0.4944
---- EQU EQU164	-290.0000	-290.0000	-290.0000	-0.0409
---- EQU EQU165	.	.	.	-115.8303
---- EQU EQU166	.	.	.	-82.6546
---- EQU EQU167	.	.	.	-64.7196
---- EQU EQU168	.	.	.	201.1220
---- EQU EQU169	.	.	.	-0.0027
---- EQU EQU170	.	.	.	0.0011

---- EQU EQU171	.	.	.	EPS
---- EQU EQU172	.	.	.	EPS
---- EQU EQU173	.	.	.	0.9789
---- EQU EQU174	.	.	.	EPS
---- EQU EQU175	.	.	.	25.7544
---- EQU EQU176	.	.	.	349.7236

_Economic Optimization Program 05/15/01 16:49:39 PAGE 112
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU177	.	.	.	18.0425
---- EQU EQU178	.	.	.	14.8017
---- EQU EQU179	.	.	.	-0.1213
---- EQU EQU180	.	.	.	11.9525
---- EQU EQU181	1.0000	1.0000	1.0000	-2.5433
---- EQU EQU182	1.0000	1.0000	1.0000	.
---- EQU EQU183	.	.	.	0.0585
---- EQU EQU184	.	.	.	EPS
---- EQU EQU185	.	.	.	EPS
---- EQU EQU186	.	.	.	EPS
---- EQU EQU187	.	.	.	EPS
---- EQU EQU188	.	.	.	EPS
---- EQU EQU189	.	.	.	0.0012
---- EQU EQU190	.	.	.	EPS
---- EQU EQU191	.	.	.	EPS
---- EQU EQU192	.	.	.	EPS
---- EQU EQU193	.	.	.	EPS
---- EQU EQU194	1.0000	1.0000	1.0000	1.9812
---- EQU EQU195	.	.	.	-853.0956
---- EQU EQU196	.	.	.	19.3446
---- EQU EQU197	.	.	.	11.9384
---- EQU EQU198	.	.	.	10.1690
---- EQU EQU199	.	.	.	0.9104
---- EQU EQU200	1.0000	1.0000	1.0000	-17.8060
---- EQU EQU201	.	.	.	-0.0002
---- EQU EQU202	.	.	.	-4391.9189
---- EQU EQU203	.	.	.	4.1086
---- EQU EQU204	.	.	.	4.1086
---- EQU EQU205	.	.	.	3909.3001
---- EQU EQU206	.	.	.	4.1094
---- EQU EQU207	.	.	.	4.1089
---- EQU EQU208	.	.	.	4.1089
---- EQU EQU209	.	.	.	-4.1089
---- EQU EQU210	.	.	.	-147.6805
---- EQU EQU211	.	.	.	EPS
---- EQU EQU212	.	.	.	EPS
---- EQU EQU213	.	.	.	-4.0709
---- EQU EQU214	.	.	.	-4.0710
---- EQU EQU215	.	.	.	-3.8716
---- EQU EQU216	.	.	.	-4070.9701
---- EQU EQU217	.	.	.	11551.6039
---- EQU EQU218	.	.	.	14178.9548
---- EQU EQU219	.	.	.	16975.8098
---- EQU EQU220	.	.	.	22279.5462

_Economic Optimization Program 05/15/01 16:49:39 PAGE 113
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU221	.	.	.	24934.4914
---- EQU EQU222	.	.	.	27543.6260
---- EQU EQU223	.	.	.	19627.6738
---- EQU EQU224	.	.	.	30195.3153
---- EQU EQU225	.	.	.	-647.9201
---- EQU EQU226	.	.	.	-4.3720
---- EQU EQU227	.	.	.	11306.9948
---- EQU EQU228	.	.	.	-11262.3527
---- EQU EQU229	.	.	.	-14160.3290
---- EQU EQU230	.	.	.	-22752.7269
---- EQU EQU231	.	.	.	-11551.6039
---- EQU EQU232	.	.	.	-11017.6385
---- EQU EQU233	.	.	.	-14178.9548
---- EQU EQU234	.	.	.	-16973.8419
---- EQU EQU235	.	.	.	77.6883
---- EQU EQU236	.	.	.	-0.0011
---- EQU EQU237	.	.	.	0.0274
---- EQU EQU238	.	.	.	-161.2654
---- EQU EQU239	.	.	.	-197.0497
---- EQU EQU240	.	.	.	38.0952
---- EQU EQU241	.	.	.	-161.2639
---- EQU EQU242	.	.	.	-161.2624
---- EQU EQU243	.	.	.	-704.6349
---- EQU EQU244	.	.	.	139.9478
---- EQU EQU245	.	.	.	-4353.5409
---- EQU EQU246	.	.	.	-345.8274
---- EQU EQU247	.	.	.	-199.1877
---- EQU EQU248	1.0000	1.0000	1.0000	EPS
---- EQU EQU249	.	.	.	-0.2353
---- EQU EQU250	.	.	.	EPS

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU251	.	.	.	-199.1939
---- EQU EQU252	.	.	.	43.1651
---- EQU EQU253	.	.	.	237.0142
---- EQU EQU254	.	.	.	38.0387
---- EQU EQU255	.	.	.	37.8675
---- EQU EQU256	.	.	.	1.4679
---- EQU EQU257	.	.	.	1.8240
---- EQU EQU258	.	.	.	0.3662
---- EQU EQU259	1.0000	1.0000	1.0000	-34655.3030
---- EQU EQU260	.	.	.	-3909.3001
---- EQU EQU261	.	.	.	4391.9189
---- EQU EQU262	1.0000	1.0000	1.0000	30152.2623
---- EQU EQU263	1.0000	1.0000	1.0000	EPS
---- EQU EQU264	.	.	.	-19610.0364

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU265	.	.	.	-22279.9911
---- EQU EQU266	.	.	.	-24934.4914
---- EQU EQU267	.	.	.	-27543.6260
---- EQU EQU268	.	.	.	-30208.5612
---- EQU EQU269	.	.	.	EPS
---- EQU EQU270	.	.	.	-0.0191
---- EQU EQU271	414.6000	414.6000	414.6000	-0.1133
---- EQU EQU272	.	.	.	-0.0002
---- EQU EQU273	.	.	.	0.0007
---- EQU EQU274	.	.	.	-0.2783
---- EQU EQU275	.	.	.	0.0206
---- EQU EQU276	.	.	.	-1.4778
---- EQU EQU277	.	.	.	-0.0002
---- EQU EQU278	.	.	.	0.0007
---- EQU EQU279	1.0000	1.0000	1.0000	EPS
---- EQU EQU280	.	.	.	-3920.2789
---- EQU EQU281	.	.	.	4404.2166
---- EQU EQU282	1.0000	1.0000	1.0000	35904.5185
---- EQU EQU283	1.0000	1.0000	1.0000	EPS
---- EQU EQU284	.	.	.	-4.1200
---- EQU EQU285	.	.	.	25002.6937
---- EQU EQU286	.	.	.	22339.1337
---- EQU EQU287	.	.	.	17021.0679
---- EQU EQU288	.	.	.	14217.0026
---- EQU EQU289	.	.	.	-0.1413
---- EQU EQU290	.	.	.	129.9365
---- EQU EQU291	.	.	.	-0.5838
---- EQU EQU292	.	.	.	-2.5624
---- EQU EQU293	.	.	.	-1.8140
---- EQU EQU294	.	.	.	-1.9706
---- EQU EQU295	1.0000	1.0000	1.0000	1.8240
---- EQU EQU296	.	.	.	-2.3847
---- EQU EQU297	.	.	.	-2.2866
---- EQU EQU298	.	.	.	0.1549
---- EQU EQU299	.	.	.	-0.0544
---- EQU EQU300	.	.	.	0.0532
---- EQU EQU301	1.0000	1.0000	1.0000	-0.1219
---- EQU EQU302	.	.	.	-44.0126
---- EQU EQU303	.	.	.	-235.1783
---- EQU EQU304	.	.	.	-36.9474
---- EQU EQU305	.	.	.	-36.1915
---- EQU EQU306	.	.	.	11582.5038
---- EQU EQU307	.	.	.	-4082.0793
---- EQU EQU308	.	.	.	-3.8827

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU309	.	.	.	-4404.2166
---- EQU EQU310	.	.	.	-4.0820
---- EQU EQU311	.	.	.	30275.3750
---- EQU EQU312	.	.	.	4.1200
---- EQU EQU313	.	.	.	4.1200
---- EQU EQU314	.	.	.	4.1207
---- EQU EQU315	.	.	.	3920.2789
---- EQU EQU316	.	.	.	4.1196
---- EQU EQU317	.	.	.	4.1196
---- EQU EQU318	.	.	.	-4.0821
---- EQU EQU319	.	.	.	-11048.5343
---- EQU EQU320	.	.	.	-27616.6053
---- EQU EQU321	.	.	.	-25002.6937
---- EQU EQU322	.	.	.	-22339.8242
---- EQU EQU323	.	.	.	-19655.1392
---- EQU EQU324	.	.	.	0.0248
---- EQU EQU325	.	.	.	-0.0023
---- EQU EQU326	.	.	.	87.8220
---- EQU EQU327	.	.	.	27616.6053
---- EQU EQU328	.	.	.	-14217.0026
---- EQU EQU329	.	.	.	19680.0947
---- EQU EQU330	.	.	.	-11582.5038

---- EQU EQU331	.	.	.	-22806.4593
---- EQU EQU332	.	.	.	-14199.8544
---- EQU EQU333	.	.	.	-11291.2898
---- EQU EQU334	.	.	.	11339.8148
---- EQU EQU335	.	.	.	-4.3847
---- EQU EQU336	.	.	.	-649.0836
---- EQU EQU337	.	.	.	-30296.1156
---- EQU EQU338	.	.	.	-17018.2290
---- EQU EQU339	1.0000	1.0000	1.0000	EPS
---- EQU EQU340	.	.	.	-197.7392
---- EQU EQU341	.	.	.	44.0126
---- EQU EQU342	.	.	.	235.1783
---- EQU EQU343	.	.	.	36.9474
---- EQU EQU344	.	.	.	36.1915
---- EQU EQU345	1.0000	1.0000	1.0000	-39032.9400
---- EQU EQU346	.	.	.	-199.1877
---- EQU EQU347	.	.	.	-231.0785
---- EQU EQU348	.	.	.	-4229.7093
---- EQU EQU349	.	.	.	257.6077
---- EQU EQU350	.	.	.	-706.9530
---- EQU EQU351	.	.	.	-161.2624
---- EQU EQU352	.	.	.	-161.2639

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU353	.	.	.	38.0952
---- EQU EQU354	.	.	.	-197.0497
---- EQU EQU355	.	.	.	-161.2654
---- EQU EQU356	.	.	.	-4.883566E-6
---- EQU EQU357	.	.	.	EPS
---- EQU EQU358	.	.	.	2.3789940E-5
---- EQU EQU359	1.0000	1.0000	1.0000	EPS
---- EQU EQU360	1.0000	1.0000	1.0000	EPS
---- EQU EQU361	1.0000	1.0000	1.0000	74557.3811
---- EQU EQU362	1.0000	1.0000	1.0000	-78323.0110
---- EQU EQU363	.	.	.	EPS
---- EQU EQU364	.	.	.	EPS
---- EQU EQU365	1.0000	1.0000	1.0000	4132.5959
---- EQU EQU366	.	.	.	EPS
---- EQU EQU367	1.0000	1.0000	1.0000	2067.0435
---- EQU EQU368	.	.	.	-3933.3380
---- EQU EQU369	.	.	.	4418.8414
---- EQU EQU370	.	.	.	-161.2654
---- EQU EQU371	.	.	.	-197.0497
---- EQU EQU372	.	.	.	38.0952
---- EQU EQU373	.	.	.	-161.2639
---- EQU EQU374	.	.	.	2.4490
---- EQU EQU375	.	.	.	71.4458
---- EQU EQU376	.	.	.	2.2677
---- EQU EQU377	.	.	.	-1.2644
---- EQU EQU378	.	.	.	0.0011
---- EQU EQU379	.	.	.	EPS
---- EQU EQU380	.	.	.	2285.2246
---- EQU EQU381	.	.	.	-50.1414
---- EQU EQU382	.	.	.	-39.8209
---- EQU EQU383	.	.	.	-38.1591
---- EQU EQU384	.	.	.	-32.3196
---- EQU EQU385	.	.	.	-133.6911
---- EQU EQU386	.	.	.	0.6200
---- EQU EQU387	.	.	.	2.5785
---- EQU EQU388	.	.	.	1.8350
---- EQU EQU389	.	.	.	1.9784
---- EQU EQU390	1.0000	1.0000	1.0000	-7.3263
---- EQU EQU391	.	.	.	197.7392
---- EQU EQU392	.	.	.	1.4860127E-6
---- EQU EQU393	.	.	.	1.4860127E-6
---- EQU EQU394	.	.	.	EPS
---- EQU EQU395	.	.	.	179.9891
---- EQU EQU396	.	.	.	176.3066

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU397	.	.	.	-4.0202
---- EQU EQU398	.	.	.	33.6907
---- EQU EQU399	.	.	.	-2.8400
---- EQU EQU400	.	.	.	33.9158
---- EQU EQU401	.	.	.	364.8746
---- EQU EQU402	-20.0000	-20.0000	-20.0000	EPS
---- EQU EQU403	.	.	.	-3.350189E-7
---- EQU EQU404	.	.	.	-0.0683
---- EQU EQU405	.	.	.	-194.2702
---- EQU EQU406	.	.	.	EPS
---- EQU EQU407	.	.	.	-172.9634
---- EQU EQU408	.	.	.	364.7427
---- EQU EQU409	.	.	.	20.3835
---- EQU EQU410	.	.	.	15.8714

---- EQU EQU411	.	.	.	-161.2624
---- EQU EQU412	.	.	.	-710.9957
---- EQU EQU413	.	.	.	372.7427
---- EQU EQU414	.	.	.	-4084.8949
---- EQU EQU415	.	.	.	-115.9677
---- EQU EQU416	.	.	.	-199.1877
---- EQU EQU417	.	.	.	-4418.8414
---- EQU EQU418	.	.	.	-4.1332
---- EQU EQU419	.	.	.	4.1326
---- EQU EQU420	.	.	.	4.1326
---- EQU EQU421	.	.	.	3933.3380
---- EQU EQU422	.	.	.	4.1342
---- EQU EQU423	.	.	.	4.1332
---- EQU EQU424	.	.	.	4.1332
---- EQU EQU425	.	.	.	-11083.5953
---- EQU EQU426	.	.	.	-4.0952
---- EQU EQU427	.	.	.	-27701.7091
---- EQU EQU428	.	.	.	-3.8959
---- EQU EQU429	.	.	.	-4095.2949
---- EQU EQU430	.	.	.	11617.5659
---- EQU EQU431	.	.	.	14260.5673
---- EQU EQU432	.	.	.	17073.2101
---- EQU EQU433	.	.	.	22408.3222
---- EQU EQU434	.	.	.	25082.1568
---- EQU EQU435	.	.	.	30368.9002
---- EQU EQU436	.	.	.	-14260.5673
---- EQU EQU437	.	.	.	-30403.8032
---- EQU EQU438	.	.	.	-648.7712
---- EQU EQU439	.	.	.	-4.3984
---- EQU EQU440	.	.	.	11375.1857

_Economic Optimization Program 05/15/01 16:49:39 PAGE 118
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU441	.	.	.	-11325.8672
---- EQU EQU442	.	.	.	-14243.7742
---- EQU EQU443	.	.	.	-22860.7113
---- EQU EQU444	.	.	.	-4.0953
---- EQU EQU445	.	.	.	19740.7576
---- EQU EQU446	.	.	.	-17068.4476
---- EQU EQU447	.	.	.	27701.7091
---- EQU EQU448	.	.	.	176.0509
---- EQU EQU449	.	.	.	-0.0062
---- EQU EQU450	.	.	.	0.0243
---- EQU EQU451	.	.	.	-19700.5325
---- EQU EQU452	.	.	.	-22409.4625
---- EQU EQU453	.	.	.	20.4920
---- EQU EQU454	.	.	.	15.8856
---- EQU EQU455	.	.	.	25.9485
---- EQU EQU456	.	.	.	349.8365
---- EQU EQU457	.	.	.	18.1369
---- EQU EQU458	.	.	.	14.8149
---- EQU EQU459	.	.	.	-1.2718
---- EQU EQU460	.	.	.	14.4140
---- EQU EQU461	.	.	.	.
---- EQU EQU462	.	.	.	.
---- EQU EQU463	.	.	.	.
---- EQU EQU464	.	.	.	EPS
---- EQU EQU465	.	.	.	-0.6613
---- EQU EQU466	.	.	.	EPS
---- EQU EQU467	.	.	.	EPS
---- EQU EQU468	.	.	.	-25082.1568
---- EQU EQU469	.	.	.	-11617.5659
---- EQU EQU470	1.0000	1.0000	1.0000	-295.6086
---- EQU EQU471	1.0000	1.0000	1.0000	EPS
---- EQU EQU472	1.0000	1.0000	1.0000	-293.5564
---- EQU EQU473	1.0000	1.0000	1.0000	58924.7749
---- EQU EQU474	1.0000	1.0000	1.0000	EPS
---- EQU EQU475	1.0000	1.0000	1.0000	-64821.9262
---- EQU EQU476	1.0000	1.0000	1.0000	EPS
---- EQU EQU477	.	.	.	EPS
---- EQU EQU478	.	.	.	EPS
---- EQU EQU479	1.0000	1.0000	1.0000	4154.7871
---- EQU EQU480	.	.	.	-3955.4961
---- EQU EQU481	.	.	.	4443.8006
---- EQU EQU482	.	.	.	-199.1877
---- EQU EQU483	.	.	.	EPS
---- EQU EQU484	.	.	.	-3998.2660

_Economic Optimization Program 05/15/01 16:49:39 PAGE 119
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU485	.	.	.	493.5684
---- EQU EQU486	.	.	.	EPS
---- EQU EQU487	.	.	.	-161.2624
---- EQU EQU488	.	.	.	-161.2639
---- EQU EQU489	.	.	.	38.0952
---- EQU EQU490	.	.	.	-197.0497

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU491	.	.	.	-161.2654
---- EQU EQU492	.	.	.	-11139.4872
---- EQU EQU493	.	.	.	-4443.8006
---- EQU EQU494	.	.	.	22520.8873
---- EQU EQU495	.	.	.	17157.5170
---- EQU EQU496	.	.	.	EPS
---- EQU EQU497	.	.	.	1.9514
---- EQU EQU498	.	.	.	19.6953
---- EQU EQU499	.	.	.	3.1478
---- EQU EQU500	.	.	.	3.1478
---- EQU EQU501	.	.	.	-6.9218
---- EQU EQU502	.	.	.	134.7156
---- EQU EQU503	.	.	.	-0.0002
---- EQU EQU504	.	.	.	.
---- EQU EQU505	.	.	.	-151.7068
---- EQU EQU506	.	.	.	14330.6321
---- EQU EQU507	.	.	.	11673.4641
---- EQU EQU508	.	.	.	-4117.1693
---- EQU EQU509	.	.	.	-3.9178
---- EQU EQU510	.	.	.	30525.6814
---- EQU EQU511	.	.	.	-4.1171
---- EQU EQU512	.	.	.	-14330.6321
---- EQU EQU513	.	.	.	4.1551
---- EQU EQU514	.	.	.	4.1551
---- EQU EQU515	.	.	.	4.1556
---- EQU EQU516	.	.	.	3955.4961
---- EQU EQU517	.	.	.	4.1548
---- EQU EQU518	.	.	.	4.1548
---- EQU EQU519	.	.	.	-4.1551
---- EQU EQU520	.	.	.	-27844.1751
---- EQU EQU521	.	.	.	-4.1172
---- EQU EQU522	.	.	.	-25205.6495
---- EQU EQU523	.	.	.	-22521.8442
---- EQU EQU524	.	.	.	-19804.5538
---- EQU EQU525	.	.	.	0.0250
---- EQU EQU526	.	.	.	-0.0044
---- EQU EQU527	.	.	.	144.4748
---- EQU EQU528	.	.	.	27844.1751

_Economic Optimization Program 05/15/01 16:49:39 PAGE 120
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU529	.	.	.	25205.6495
---- EQU EQU530	.	.	.	19839.1980
---- EQU EQU531	.	.	.	-11673.4641
---- EQU EQU532	.	.	.	-22978.3434
---- EQU EQU533	.	.	.	-14313.2768
---- EQU EQU534	.	.	.	-11382.3569
---- EQU EQU535	.	.	.	11430.5786
---- EQU EQU536	.	.	.	-4.4198
---- EQU EQU537	.	.	.	-646.0399
---- EQU EQU538	.	.	.	-30554.7466
---- EQU EQU539	.	.	.	-17153.4775
---- EQU EQU540	.	.	.	-108.2554
---- EQU EQU541	.	.	.	-84.7653
---- EQU EQU542	.	.	.	15.6546
---- EQU EQU543	.	.	.	-264.3686
---- EQU EQU544	.	.	.	-272.0867
---- EQU EQU545	.	.	.	-274.0357
---- EQU EQU546	.	.	.	-275.1186
---- EQU EQU547	.	.	.	201.5224
---- EQU EQU548	.	.	.	-37.6805
---- EQU EQU549	.	.	.	-237.1473
---- EQU EQU550	.	.	.	-37.8083
---- EQU EQU551	.	.	.	-37.9108
---- EQU EQU552	.	.	.	-0.0041
---- EQU EQU553	.	.	.	197.9946
---- EQU EQU554	.	.	.	-35.7843
---- EQU EQU555	.	.	.	-235.1449
---- EQU EQU556	.	.	.	-35.7858
---- EQU EQU557	.	.	.	-35.7873
---- EQU EQU558	.	.	.	2.1380
---- EQU EQU559	1.0000	1.0000	1.0000	EPS
---- EQU EQU560	1.0000	1.0000	1.0000	-257.6948
---- EQU EQU561	.	.	.	197.9946
---- EQU EQU562	.	.	.	-35.7843
---- EQU EQU563	.	.	.	-235.1449
---- EQU EQU564	.	.	.	-35.7858
---- EQU EQU565	.	.	.	-35.7873
---- EQU EQU566	.	.	.	2.1380
---- EQU EQU567	1.0000	1.0000	1.0000	EPS
---- EQU EQU568	1.0000	1.0000	1.0000	-350.4860
---- EQU EQU569	.	.	.	197.9946
---- EQU EQU570	.	.	.	-35.7843
---- EQU EQU571	.	.	.	-235.1449
---- EQU EQU572	.	.	.	-35.7858

_Economic Optimization Program 05/15/01 16:49:39 PAGE 121
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU573	.	.	.	-35.7873
---- EQU EQU574	.	.	.	2.1380
---- EQU EQU575	1.0000	1.0000	1.0000	-5.8831
---- EQU EQU576	.	.	.	EPS
---- EQU EQU577	.	.	.	247.0809
---- EQU EQU578	.	.	.	-58.8576
---- EQU EQU579	.	.	.	-6.5801
---- EQU EQU580	.	.	.	-247.0795
---- EQU EQU581	.	.	.	-247.0823
---- EQU EQU582	.	.	.	-25.7024
---- EQU EQU583	.	.	.	EPS
---- EQU EQU584	.	.	.	37.9268
---- EQU EQU585	.	.	.	563.7981
---- EQU EQU586	.	.	.	558.6125
---- EQU EQU587	.	.	.	1.6111
---- EQU EQU588	.	.	.	-1.5056
---- EQU EQU589	.	.	.	-0.0062
---- EQU EQU590	.	.	.	-0.1020
---- EQU EQU591	.	.	.	-37.7269
---- EQU EQU592	.	.	.	-237.1746
---- EQU EQU593	.	.	.	-37.8306
---- EQU EQU594	.	.	.	-37.9137
---- EQU EQU595	.	.	.	-0.0033
---- EQU EQU596	.	.	.	-0.0592
---- EQU EQU597	.	.	.	-0.0110
---- EQU EQU598	.	.	.	-78.5463
---- EQU EQU599	.	.	.	96.5662
---- EQU EQU600	.	.	.	561.2303
---- EQU EQU601	.	.	.	85.6422
---- EQU EQU602	.	.	.	90.2179
---- EQU EQU603	.	.	.	EPS
---- EQU EQU604	.	.	.	EPS
---- EQU EQU605	.	.	.	EPS
---- EQU EQU606	.	.	.	-162.6883
---- EQU EQU607	.	.	.	EPS
---- EQU EQU608	.	.	.	-41.5681
---- EQU EQU609	.	.	.	-4.9088
---- EQU EQU610	.	.	.	-3.2363
---- EQU EQU611	.	.	.	-1.1134
---- EQU EQU612	.	.	.	EPS
---- EQU EQU613	.	.	.	0.0008
---- EQU EQU614	.	.	.	EPS
---- EQU EQU615	.	.	.	78.2407
---- EQU EQU616	.	.	.	696.7670

_Economic Optimization Program 05/15/01 16:49:39 PAGE 122
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU617	.	.	.	106.9964
---- EQU EQU618	.	.	.	111.9546
---- EQU EQU619	.	.	.	-196.8561
---- EQU EQU620	.	.	.	8.5154
---- EQU EQU621	.	.	.	238.1716
---- EQU EQU622	.	.	.	36.9750
---- EQU EQU623	.	.	.	38.2620
---- EQU EQU624	.	.	.	237.2945
---- EQU EQU625	.	.	.	37.9263
---- EQU EQU626	.	.	.	37.9257
---- EQU EQU627	.	.	.	237.2919
---- EQU EQU628	.	.	.	37.9250
---- EQU EQU629	.	.	.	37.9255
---- EQU EQU630	.	.	.	37.9245
---- EQU EQU631	1.0000	1.0000	1.0000	EPS
---- EQU EQU632	.	.	.	-25.7024
---- EQU EQU633	.	.	.	EPS
---- EQU EQU634	.	.	.	37.9255
---- EQU EQU635	.	.	.	556.3881
---- EQU EQU636	.	.	.	237.2914
---- EQU EQU637	.	.	.	37.9256
---- EQU EQU638	.	.	.	37.9256
---- EQU EQU639	.	.	.	75.8513
---- EQU EQU640	.	.	.	1122.4106
---- EQU EQU641	.	.	.	474.5864
---- EQU EQU642	.	.	.	75.8513
---- EQU EQU643	.	.	.	75.8513
---- EQU EQU644	.	.	.	EPS
---- EQU EQU645	.	.	.	EPS
---- EQU EQU646	1.0000	1.0000	1.0000	4119.5536
---- EQU EQU647	.	.	.	-25.7024
---- EQU EQU648	.	.	.	EPS
---- EQU EQU649	.	.	.	42.4560
---- EQU EQU650	.	.	.	-174.6816
---- EQU EQU651	.	.	.	EPS
---- EQU EQU652	.	.	.	0.6950
---- EQU EQU653	.	.	.	212.5271
---- EQU EQU654	.	.	.	31.9201
---- EQU EQU655	.	.	.	32.9969
---- EQU EQU656	.	.	.	-1.2253

---- EQU EQU657	.	.	.	757.1763
---- EQU EQU658	.	.	.	123.8732
---- EQU EQU659	.	.	.	118.4941
---- EQU EQU660	.	.	.	-0.0235

_Economic Optimization Program 05/15/01 16:49:39 PAGE 123
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU661	.	.	.	212.2233
---- EQU EQU662	.	.	.	31.8152
---- EQU EQU663	.	.	.	32.9186
---- EQU EQU664	.	.	.	EPS
---- EQU EQU665	.	.	.	EPS
---- EQU EQU666	.	.	.	-246.6870
---- EQU EQU667	.	.	.	-36.9750
---- EQU EQU668	.	.	.	-38.2620
---- EQU EQU669	.	.	.	-195.4356
---- EQU EQU670	.	.	.	622.1107
---- EQU EQU671	.	.	.	265.6404
---- EQU EQU672	.	.	.	42.4565
---- EQU EQU673	.	.	.	42.4571
---- EQU EQU674	.	.	.	113.7768
---- EQU EQU675	.	.	.	1678.7987
---- EQU EQU676	.	.	.	711.8778
---- EQU EQU677	.	.	.	113.7768
---- EQU EQU678	.	.	.	113.7769
---- EQU EQU679	1.0000	1.0000	1.0000	4599.5101
---- EQU EQU680	.	.	.	EPS
---- EQU EQU681	.	.	.	EPS
---- EQU EQU682	1.0000	1.0000	1.0000	1.5602
---- EQU EQU683	.	.	.	199.7327
---- EQU EQU684	.	.	.	-37.8848
---- EQU EQU685	.	.	.	-558.6050
---- EQU EQU686	.	.	.	-237.2673
---- EQU EQU687	.	.	.	-37.9063
---- EQU EQU688	.	.	.	-37.9233
---- EQU EQU689	.	.	.	-11.6175
---- EQU EQU690	.	.	.	EPS
---- EQU EQU691	.	.	.	18.9638
---- EQU EQU692	.	.	.	118.6847
---- EQU EQU693	.	.	.	18.9661
---- EQU EQU694	.	.	.	18.9689
---- EQU EQU695	.	.	.	18.5709
---- EQU EQU696	.	.	.	116.2140
---- EQU EQU697	.	.	.	18.5723
---- EQU EQU698	.	.	.	36.6645
---- EQU EQU699	.	.	.	-0.4015
---- EQU EQU700	.	.	.	248.1267
---- EQU EQU701	.	.	.	40.5932
---- EQU EQU702	.	.	.	38.8305
---- EQU EQU703	.	.	.	-58.4071
---- EQU EQU704	.	.	.	195.0964

_Economic Optimization Program 05/15/01 16:49:39 PAGE 124
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU705	.	.	.	195.0964
---- EQU EQU706	.	.	.	195.0964
---- EQU EQU707	.	.	.	26.4569
---- EQU EQU708	.	.	.	18.5741
---- EQU EQU709	.	.	.	-11.6175
---- EQU EQU710	1.0000	1.0000	1.0000	2034.8564
---- EQU EQU711	.	.	.	EPS
---- EQU EQU712	1.0000	1.0000	1.0000	EPS
---- EQU EQU713	.	.	.	EPS
---- EQU EQU714	.	.	.	229.4418
---- EQU EQU715	.	.	.	36.6677
---- EQU EQU716	.	.	.	36.6714
---- EQU EQU717	.	.	.	37.5346
---- EQU EQU718	.	.	.	234.8987
---- EQU EQU719	.	.	.	37.5384
---- EQU EQU720	.	.	.	37.5429
---- EQU EQU721	1.0000	1.0000	1.0000	EPS
---- EQU EQU722	.	.	.	-11.6175
---- EQU EQU723	.	.	.	EPS
---- EQU EQU724	.	.	.	24.9951
---- EQU EQU725	.	.	.	156.4133
---- EQU EQU726	.	.	.	24.9971
---- EQU EQU727	.	.	.	24.9994
---- EQU EQU728	.	.	.	11.6694
---- EQU EQU729	.	.	.	73.0285
---- EQU EQU730	.	.	.	11.6706
---- EQU EQU731	.	.	.	11.6719
---- EQU EQU732	1.0000	1.0000	1.0000	2708.3250
---- EQU EQU733	.	.	.	EPS
---- EQU EQU734	.	.	.	EPS
---- EQU EQU735	1.0000	1.0000	1.0000	1267.8697
---- EQU EQU736	.	.	.	1335.9985

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU737	.	.	.	6.0683
---- EQU EQU738	.	.	.	3.5666
---- EQU EQU739	.	.	.	2.9062
---- EQU EQU740	.	.	.	0.3678
---- EQU EQU741	.	.	.	.
---- EQU EQU742	.	.	.	330.0284
---- EQU EQU743	.	.	.	14.8947
---- EQU EQU744	.	.	.	11.6539
---- EQU EQU745	.	.	.	0.0111
---- EQU EQU746	-290.0000	-290.0000	-290.0000	0.1887
---- EQU EQU747	.	.	.	EPS
---- EQU EQU748	.	.	.	0.0019

_Economic Optimization Program 05/15/01 16:49:39 PAGE 125
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU749	.	.	.	7.5981224E-6
---- EQU EQU750	.	.	.	3.1867
---- EQU EQU751	-290.0000	-290.0000	-290.0000	-0.1887
---- EQU EQU752	.	.	.	EPS
---- EQU EQU753	.	.	.	-2.3793
---- EQU EQU754	.	.	.	-0.0002
---- EQU EQU755	.	.	.	-0.0003
---- EQU EQU756	.	.	.	0.0054
---- EQU EQU757	414.6000	414.6000	414.6000	-0.0270
---- EQU EQU758	.	.	.	0.0005
---- EQU EQU759	.	.	.	-0.0003
---- EQU EQU760	829.2000	829.2000	829.2000	-0.0002
---- EQU EQU761	.	.	.	1.0758167E-5
---- EQU EQU762	.	.	.	EPS
---- EQU EQU763	.	.	.	-1.503969E-7
---- EQU EQU764	.	.	.	-0.0669
---- EQU EQU765	481.0000	481.0000	481.0000	0.1268
---- EQU EQU766	.	.	.	-0.1765
---- EQU EQU767	.	.	.	0.1229
---- EQU EQU768	962.0000	962.0000	962.0000	0.2458
---- EQU EQU769	.	.	.	0.0005
---- EQU EQU770	1.0000	1.0000	1.0000	2.4347
---- EQU EQU771	.	.	.	0.0005
---- EQU EQU772	1.0000	1.0000	1.0000	3.8482
---- EQU EQU773	.	.	.	0.0005
---- EQU EQU774	.	.	.	0.0008
---- EQU EQU775	.	.	.	0.0008
---- EQU EQU776	.	.	.	.
---- EQU EQU777	.	.	.	0.0008
---- EQU EQU778	.	.	.	1.4840
---- EQU EQU779	.	.	.	1.7898
---- EQU EQU780	.	.	.	-247.0809
---- EQU EQU781	.	.	.	-0.0004
---- EQU EQU782	.	.	.	EPS
---- EQU EQU783	.	.	.	0.0004
---- EQU EQU784	.	.	.	-0.0002
---- EQU EQU785	.	.	.	3.2736710E-5
---- EQU EQU786	.	.	.	EPS
---- EQU EQU787	.	.	.	0.0020
---- EQU EQU788	.	.	.	-0.0027
---- EQU EQU789	.	.	.	0.0016
---- EQU EQU790	.	.	.	-0.0016
---- EQU EQU791	.	.	.	EPS
---- EQU EQU792	.	.	.	-0.0039

_Economic Optimization Program 05/15/01 16:49:39 PAGE 126
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU793	.	.	.	2.1685
---- EQU EQU794	.	.	.	2.3503
---- EQU EQU795	.	.	.	-130.4259
---- EQU EQU796	.	.	.	-0.0002
---- EQU EQU797	1.0000	1.0000	1.0000	-74.4210
---- EQU EQU798	1.0000	1.0000	1.0000	-4.2485
---- EQU EQU799	.	.	.	0.0002
---- EQU EQU800	.	.	.	-0.8963
---- EQU EQU801	.	.	.	-3.0854
---- EQU EQU802	.	.	.	-3.0636
---- EQU EQU803	.	.	.	-4.0226
---- EQU EQU804	.	.	.	205.0403
---- EQU EQU805	1.0000	1.0000	1.0000	-13.7947
---- EQU EQU806	1.0000	1.0000	1.0000	1.2921
---- EQU EQU807	1.0000	1.0000	1.0000	EPS
---- EQU EQU808	.	.	.	0.0004
---- EQU EQU809	.	.	.	0.0004
---- EQU EQU810	.	.	.	-36.1925
---- EQU EQU811	.	.	.	-36.9649
---- EQU EQU812	.	.	.	-235.1859
---- EQU EQU813	.	.	.	-44.0350
---- EQU EQU814	.	.	.	197.5278
---- EQU EQU815	1.0000	1.0000	1.0000	-34.6338
---- EQU EQU816	.	.	.	-0.0012

---- EQU EQU817	1.0000	1.0000	1.0000	-0.6165
---- EQU EQU818	.	.	.	-0.0004
---- EQU EQU819	1.0000	1.0000	1.0000	2.2228
---- EQU EQU820	.	.	.	0.0013
---- EQU EQU821	.	.	.	-0.0026
---- EQU EQU822	1.0000	1.0000	1.0000	-3.1189
---- EQU EQU823	.	.	.	-129.8636
---- EQU EQU824	.	.	.	-75.0613
---- EQU EQU825	.	.	.	-0.0028
---- EQU EQU826	.	.	.	-0.0033
---- EQU EQU827	.	.	.	0.0262
---- EQU EQU828	.	.	.	-0.0395
---- EQU EQU829	.	.	.	179.0351
---- EQU EQU830	.	.	.	0.0125
---- EQU EQU831	.	.	.	0.0015
---- EQU EQU832	.	.	.	-0.0041
---- EQU EQU833	.	.	.	EPS
---- EQU EQU834	.	.	.	-0.0325
---- EQU EQU835	.	.	.	-0.0074
---- EQU EQU836	.	.	.	EPS

_Economic Optimization Program 05/15/01 16:49:39 PAGE 127
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU837	.	.	.	97.4240
---- EQU EQU838	.	.	.	561.7365
---- EQU EQU839	.	.	.	86.0476
---- EQU EQU840	.	.	.	90.2670
---- EQU EQU841	.	.	.	-0.0037
---- EQU EQU842	.	.	.	0.0017
---- EQU EQU843	.	.	.	2.4700
---- EQU EQU844	.	.	.	-76.4291
---- EQU EQU845	.	.	.	90.2491
---- EQU EQU846	.	.	.	85.8953
---- EQU EQU847	.	.	.	561.5435
---- EQU EQU848	.	.	.	97.0979
---- EQU EQU849	.	.	.	122.1607
---- EQU EQU850	.	.	.	122.0308
---- EQU EQU851	.	.	.	764.2605
---- EQU EQU852	.	.	.	1799.8378
---- EQU EQU853	.	.	.	121.8674
---- EQU EQU854	.	.	.	3.2051
---- EQU EQU855	.	.	.	0.0075
---- EQU EQU856	.	.	.	36.7935
---- EQU EQU857	.	.	.	36.5197
---- EQU EQU858	.	.	.	235.6900
---- EQU EQU859	.	.	.	43.8635
---- EQU EQU860	.	.	.	0.0012
---- EQU EQU861	.	.	.	-0.0008
---- EQU EQU862	.	.	.	-197.5278
---- EQU EQU863	.	.	.	122.1752
---- EQU EQU864	.	.	.	122.1478
---- EQU EQU865	.	.	.	764.4052
---- EQU EQU866	.	.	.	1799.4677
---- EQU EQU867	.	.	.	122.1131
---- EQU EQU868	.	.	.	-5.583682E-6
---- EQU EQU869	.	.	.	-1.522649E-5
---- EQU EQU870	.	.	.	-0.0002
---- EQU EQU871	.	.	.	-0.0008
---- EQU EQU872	.	.	.	-0.0005
---- EQU EQU873	.	.	.	-0.0008
---- EQU EQU874	.	.	.	-0.0006
---- EQU EQU875	.	.	.	0.0012
---- EQU EQU876	.	.	.	-0.0011
---- EQU EQU877	.	.	.	0.0006
---- EQU EQU878	.	.	.	-0.0005
---- EQU EQU879	.	.	.	0.0007
---- EQU EQU880	.	.	.	-0.0007

_Economic Optimization Program 05/15/01 16:49:39 PAGE 128
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU881	.	.	.	0.0014
---- EQU EQU882	.	.	.	-0.0005
---- EQU EQU883	.	.	.	0.0019
---- EQU EQU884	.	.	.	-0.0008
---- EQU EQU885	.	.	.	0.0026
---- EQU EQU886	.	.	.	-0.0011
---- EQU EQU887	.	.	.	0.0013
---- EQU EQU888	.	.	.	-0.0005
---- EQU EQU889	.	.	.	EPS
---- EQU EQU890	1.0000	1.0000	1.0000	580.9977
---- EQU EQU891	.	.	.	EPS
---- EQU EQU892	.	.	.	EPS
---- EQU EQU893	.	.	.	EPS
---- EQU EQU894	1.0000	1.0000	1.0000	-775.7304
---- EQU EQU895	.	.	.	-30.5486
---- EQU EQU896	.	.	.	0.9622

---- EQU EQU897	.	.	.	EPS
---- EQU EQU898	.	.	.	0.6939
---- EQU EQU899	1.0000	1.0000	1.0000	-2.4466
---- EQU EQU900	.	.	.	-20.4102
---- EQU EQU901	1.0000	1.0000	1.0000	2.3301
---- EQU EQU902	.	.	.	17.6850
---- EQU EQU903	1.0000	1.0000	1.0000	-4.8969
---- EQU EQU904	.	.	.	6.3563
---- EQU EQU905	.	.	.	0.0479
---- EQU EQU906	.	.	.	0.2052
---- EQU EQU907	.	.	.	0.4431
---- EQU EQU908	.	.	.	0.5155
---- EQU EQU909	.	.	.	0.2513
---- EQU EQU910	.	.	.	0.1975
---- EQU EQU911	.	.	.	-0.0239
---- EQU EQU912	.	.	.	-0.1636
---- EQU EQU913	.	.	.	-2.4210
---- EQU EQU914	.	.	.	.
---- EQU EQU915	.	.	.	EPS
---- EQU EQU916	.	.	.	-3.1041
---- EQU EQU917	.	.	.	EPS
---- EQU EQU918	.	.	.	2.3301
---- EQU EQU919	.	.	.	1.8464
---- EQU EQU920	.	.	.	2.2595
---- EQU EQU921	.	.	.	3.0548
---- EQU EQU922	.	.	.	3.4327
---- EQU EQU923	.	.	.	EPS
---- EQU EQU924	1.0000	1.0000	1.0000	EPS

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU925	.	.	.	EPS
---- EQU EQU926	.	.	.	EPS
---- EQU EQU927	.	.	.	-8.129644E-5
---- EQU EQU928	.	.	.	-0.0052
---- EQU EQU929	.	.	.	-8.338969E-5
---- EQU EQU930	.	.	.	EPS
---- EQU EQU931	.	.	.	0.0002
---- EQU EQU932	.	.	.	3.2458764E-7
---- EQU EQU933	.	.	.	-0.0022
---- EQU EQU934	.	.	.	EPS
---- EQU EQU935	.	.	.	EPS
---- EQU EQU936	.	.	.	-0.0095
---- EQU EQU937	.	.	.	-0.0244
---- EQU EQU938	.	.	.	-1.5881
---- EQU EQU939	.	.	.	-0.0251
---- EQU EQU940	.	.	.	EPS
---- EQU EQU941	.	.	.	0.0553
---- EQU EQU942	.	.	.	9.9525061E-5
---- EQU EQU943	.	.	.	-0.6654
---- EQU EQU944	.	.	.	-5.446712E-7
---- EQU EQU945	1.000000E-20	1.000000E-20	1.000000E-20	-0.0030
---- EQU EQU946	1.000000E-10	1.000000E-10	1.000000E-10	.
---- EQU EQU947	1.0000	1.0000	1.0000	0.0723
---- EQU EQU948	1.0000	1.0000	1.0000	-3.0164
---- EQU EQU949	1.0000	1.0000	1.0000	201.7389
---- EQU EQU950	.	.	.	-35.6602
---- EQU EQU951	.	.	.	EPS
---- EQU EQU952	.	.	.	EPS
---- EQU EQU953	.	.	.	9.1457
---- EQU EQU954	.	.	.	-197.9394
---- EQU EQU955	.	.	.	EPS
---- EQU EQU956	.	.	.	0.0244
---- EQU EQU957	.	.	.	-0.0031
---- EQU EQU958	.	.	.	-3.105374E-5
---- EQU EQU959	.	.	.	849.9004
---- EQU EQU960	.	.	.	-12.2702
---- EQU EQU961	.	.	.	EPS
---- EQU EQU962	.	.	.	EPS
---- EQU EQU963	.	.	.	.
---- EQU EQU964	.	.	.	-0.1840
---- EQU EQU965	1.0000	1.0000	1.0000	5.8053
---- EQU EQU966	.	.	.	236.4038
---- EQU EQU967	.	.	.	-4.9447
---- EQU EQU968	1.0000	1.0000	1.0000	-6.1668

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU969	.	.	.	-135.8837
---- EQU EQU970	.	.	.	3.6117
---- EQU EQU971	.	.	.	-173.7968
---- EQU EQU972	.	.	.	-58.6936
---- EQU EQU973	.	.	.	-43.9023
---- EQU EQU974	.	.	.	-33.3131
---- EQU EQU975	.	.	.	3.3458312E-5
---- EQU EQU976	.	.	.	0.0002

---- EQU EQU977	.	.	.	-9.868383E-7
---- EQU EQU978	.	.	.	-156.5698
---- EQU EQU979	.	.	.	39.4413
---- EQU EQU980	.	.	.	-161.4870
---- EQU EQU981	.	.	.	-168.9435
---- EQU EQU982	.	.	.	EPS
---- EQU EQU983	.	.	.	EPS
---- EQU EQU984	.	.	.	3.7540
---- EQU EQU985	.	.	.	EPS
---- EQU EQU986	.	.	.	-0.0033
---- EQU EQU987	.	.	.	-0.0002
---- EQU EQU988	.	.	.	-12.2927
---- EQU EQU989	.	.	.	-0.0002
---- EQU EQU990	.	.	.	EPS
---- EQU EQU991	.	.	.	EPS
---- EQU EQU992	.	.	.	0.0005
---- EQU EQU993	.	.	.	18.2882
---- EQU EQU994	.	.	.	0.0002
---- EQU EQU995	.	.	.	-0.4178
---- EQU EQU996	.	.	.	-0.0004
---- EQU EQU997	.	.	.	-0.0004
---- EQU EQU998	.	.	.	-19.5119
---- EQU EQU999	.	.	.	EPS
---- EQU EQU1000	.	.	.	EPS
---- EQU EQU1001	.	.	.	0.0004
---- EQU EQU1002	.	.	.	0.0008
---- EQU EQU1003	.	.	.	23.1579
---- EQU EQU1004	.	.	.	-0.0005
---- EQU EQU1005	.	.	.	-0.5101
---- EQU EQU1006	.	.	.	-0.0005
---- EQU EQU1007	.	.	.	-52.9250
---- EQU EQU1008	.	.	.	EPS
---- EQU EQU1009	.	.	.	EPS
---- EQU EQU1010	.	.	.	0.0005
---- EQU EQU1011	.	.	.	0.0011
---- EQU EQU1012	.	.	.	57.4111

_Economic Optimization Program 05/15/01 16:49:39 PAGE 131
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1013	.	.	.	-0.0002
---- EQU EQU1014	.	.	.	-0.2272
---- EQU EQU1015	.	.	.	-26.9557
---- EQU EQU1016	.	.	.	14.7139
---- EQU EQU1017	.	.	.	EPS
---- EQU EQU1018	.	.	.	-1.3083
---- EQU EQU1019	.	.	.	EPS
---- EQU EQU1020	.	.	.	EPS
---- EQU EQU1021	.	.	.	106.6872
---- EQU EQU1022	.	.	.	-53.9898
---- EQU EQU1023	.	.	.	-17.7963
---- EQU EQU1024	.	.	.	-13.2202
---- EQU EQU1025	.	.	.	-3.7871
---- EQU EQU1026	1.0000	1.0000	1.0000	-8.7174
---- EQU EQU1027	.	.	.	EPS
---- EQU EQU1028	.	.	.	EPS
---- EQU EQU1029	.	.	.	EPS
---- EQU EQU1030	.	.	.	EPS
---- EQU EQU1031	.	.	.	EPS
---- EQU EQU1032	.	.	.	EPS
---- EQU EQU1033	.	.	.	196.8561
---- EQU EQU1034	.	.	.	-0.0002
---- EQU EQU1035	.	.	.	-19.9284
---- EQU EQU1036	.	.	.	EPS
---- EQU EQU1037	.	.	.	0.0002
---- EQU EQU1038	.	.	.	EPS
---- EQU EQU1039	.	.	.	27.2255
---- EQU EQU1040	.	.	.	0.0005
---- EQU EQU1041	.	.	.	28.7143
---- EQU EQU1042	.	.	.	0.8837
---- EQU EQU1043	.	.	.	151.6290
---- EQU EQU1044	.	.	.	24.0227
---- EQU EQU1045	.	.	.	24.2086
---- EQU EQU1046	.	.	.	109.0437
---- EQU EQU1047	.	.	.	3.8482
---- EQU EQU1048	.	.	.	597.3280
---- EQU EQU1049	.	.	.	94.6296
---- EQU EQU1050	.	.	.	95.4174
---- EQU EQU1051	.	.	.	26.4268
---- EQU EQU1052	.	.	.	0.9805
---- EQU EQU1053	.	.	.	139.5615
---- EQU EQU1054	.	.	.	22.1017
---- EQU EQU1055	.	.	.	22.2811
---- EQU EQU1056	.	.	.	76.7991

_Economic Optimization Program 05/15/01 16:49:39 PAGE 132
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL

---- EQU EQU1057	.	.	.	4.8345
---- EQU EQU1058	.	.	.	550.5377
---- EQU EQU1059	.	.	.	87.8279
---- EQU EQU1060	.	.	.	-0.0216
---- EQU EQU1061	.	.	.	EPS
---- EQU EQU1062	.	.	.	EPS
---- EQU EQU1063	.	.	.	0.1840
---- EQU EQU1064	.	.	.	88.1256
---- EQU EQU1065	.	.	.	0.0118
---- EQU EQU1066	.	.	.	0.0087
---- EQU EQU1067	1.0000	1.0000	1.0000	0.8837
---- EQU EQU1068	1.0000	1.0000	1.0000	0.9805
---- EQU EQU1069	.	.	.	-0.0023
---- EQU EQU1070	.	.	.	-0.0023
---- EQU EQU1071	.	.	.	197.3845
---- EQU EQU1072	.	.	.	-0.0023
---- EQU EQU1073	1.0000	1.0000	1.0000	0.0671
---- EQU EQU1074	1.0000	1.0000	1.0000	EPS
---- EQU EQU1075	.	.	.	-0.0021
---- EQU EQU1076	1.0000	1.0000	1.0000	EPS
---- EQU EQU1077	.	.	.	-0.0021
---- EQU EQU1078	1.0000	1.0000	1.0000	EPS
---- EQU EQU1079	.	.	.	-0.0021
---- EQU EQU1080	.	.	.	197.3845
---- EQU EQU1081	.	.	.	0.0015
---- EQU EQU1082	.	.	.	0.0015
---- EQU EQU1083	.	.	.	-197.3845
---- EQU EQU1084	.	.	.	0.0015
---- EQU EQU1085	1.0000	1.0000	1.0000	.
---- EQU EQU1086	1.0000	1.0000	1.0000	EPS
---- EQU EQU1087	.	.	.	EPS
---- EQU EQU1088	.	.	.	-0.0015
---- EQU EQU1089	.	.	.	1.7598832E-6
---- EQU EQU1090	.	.	.	1.7609987E-6
---- EQU EQU1091	.	.	.	4.5385072E-6
---- EQU EQU1092	.	.	.	0.0019
---- EQU EQU1093	.	.	.	0.0002
---- EQU EQU1094	.	.	.	0.0005
---- EQU EQU1095	1.0000	1.0000	1.0000	-2.3757
---- EQU EQU1096	1.0000	1.0000	1.0000	0.5264
---- EQU EQU1097	.	.	.	3.1443
---- EQU EQU1098	.	.	.	0.1897
---- EQU EQU1099	1.0000	1.0000	1.0000	54.7188
---- EQU EQU1100	.	.	.	-0.0002

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1101	.	.	.	-0.0148
---- EQU EQU1102	.	.	.	-0.0036
---- EQU EQU1103	.	.	.	-0.0002
---- EQU EQU1104	.	.	.	-0.0113
---- EQU EQU1105	1.0000	1.0000	1.0000	-18.4516
---- EQU EQU1106	.	.	.	-20.5752
---- EQU EQU1107	.	.	.	-10.2335
---- EQU EQU1108	.	.	.	-204.8089
---- EQU EQU1109	.	.	.	1.4377
---- EQU EQU1110	1.0000	1.0000	1.0000	5.5419
---- EQU EQU1111	.	.	.	160.4563
---- EQU EQU1112	.	.	.	-3.0240
---- EQU EQU1113	.	.	.	4.3872
---- EQU EQU1114	.	.	.	-19.0896
---- EQU EQU1115	.	.	.	-8.6305
---- EQU EQU1116	.	.	.	-4.9457
---- EQU EQU1117	.	.	.	2.0252
---- EQU EQU1118	.	.	.	-6.6887
---- EQU EQU1119	.	.	.	-1.3964
---- EQU EQU1120	1.0000	1.0000	1.0000	EPS
---- EQU EQU1121	.	.	.	-7.1461
---- EQU EQU1122	.	.	.	10.4684
---- EQU EQU1123	.	.	.	0.7707
---- EQU EQU1124	1.0000	1.0000	1.0000	EPS
---- EQU EQU1125	.	.	.	-2.391058E-6
---- EQU EQU1126	.	.	.	2.4527452E-5
---- EQU EQU1127	.	.	.	0.0060
---- EQU EQU1128	.	.	.	0.0005
---- EQU EQU1129	.	.	.	3.1975
---- EQU EQU1130	.	.	.	2.4430
---- EQU EQU1131	.	.	.	1.8439
---- EQU EQU1132	1.0000	1.0000	1.0000	13.9991
---- EQU EQU1133	.	.	.	-2.7660
---- EQU EQU1134	.	.	.	-2.2166
---- EQU EQU1135	.	.	.	-1.1048
---- EQU EQU1136	1.0000	1.0000	1.0000	EPS
---- EQU EQU1137	.	.	.	5.6286907E-7
---- EQU EQU1138	.	.	.	-9.772393E-6
---- EQU EQU1139	.	.	.	0.0015
---- EQU EQU1140	.	.	.	-0.0007
---- EQU EQU1141	.	.	.	-0.0013
---- EQU EQU1142	.	.	.	-3.3042

---- EQU EQU1143	.	.	.	-5.4321
---- EQU EQU1144	.	.	.	-9.7107

_Economic Optimization Program 05/15/01 16:49:39 PAGE 134
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1145	.	.	.	-2.6925
---- EQU EQU1146	.	.	.	EPS
---- EQU EQU1147	.	.	.	-1.173723E-6
---- EQU EQU1148	.	.	.	EPS
---- EQU EQU1149	.	.	.	-0.0007
---- EQU EQU1150	.	.	.	-0.0033
---- EQU EQU1151	.	.	.	-0.0224
---- EQU EQU1152	.	.	.	1.0822804E-7
---- EQU EQU1153	.	.	.	-0.0062
---- EQU EQU1154	.	.	.	-1.9093
---- EQU EQU1155	.	.	.	-0.4248
---- EQU EQU1156	.	.	.	-0.5443
---- EQU EQU1157	.	.	.	EPS
---- EQU EQU1158	.	.	.	-3.419010E-7
---- EQU EQU1159	.	.	.	-0.0012
---- EQU EQU1160	152.2500	152.2500	152.2500	EPS
---- EQU EQU1161	181.2500	181.2500	181.2500	0.0024
---- EQU EQU1162	118.9000	118.9000	118.9000	-0.0023
---- EQU EQU1163	40.6000	40.6000	40.6000	0.0003
---- EQU EQU1164	9.8600	9.8600	9.8600	-0.0107
---- EQU EQU1165	.	.	.	0.0005
---- EQU EQU1166	.	.	.	0.0008
---- EQU EQU1167	.	.	.	0.0011
---- EQU EQU1168	.	.	.	0.0005
---- EQU EQU1169	.	.	.	-197.3845
---- EQU EQU1170	.	.	.	-0.1433
---- EQU EQU1171	.	.	.	42.2773
---- EQU EQU1172	.	.	.	233.4949
---- EQU EQU1173	.	.	.	35.2285
---- EQU EQU1174	.	.	.	34.5310
---- EQU EQU1175	.	.	.	-1.6571
---- EQU EQU1176	.	.	.	38.7692
---- EQU EQU1177	.	.	.	234.8470
---- EQU EQU1178	.	.	.	33.9297
---- EQU EQU1179	.	.	.	35.6850
---- EQU EQU1180	.	.	.	-2.4431
---- EQU EQU1181	.	.	.	8.4227
---- EQU EQU1182	.	.	.	-161.8800
---- EQU EQU1183	.	.	.	1.3499
---- EQU EQU1184	.	.	.	-870.8523
---- EQU EQU1185	.	.	.	-135.6765
---- EQU EQU1186	.	.	.	-132.8731
---- EQU EQU1187	.	.	.	73.6341
---- EQU EQU1188	.	.	.	-93.7551

_Economic Optimization Program 05/15/01 16:49:39 PAGE 135
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1189	.	.	.	-557.9297
---- EQU EQU1190	.	.	.	-82.1982
---- EQU EQU1191	.	.	.	-86.2782
---- EQU EQU1192	.	.	.	4.0072
---- EQU EQU1193	.	.	.	-0.0040
---- EQU EQU1194	.	.	.	-0.0140
---- EQU EQU1195	.	.	.	EPS
---- EQU EQU1196	.	.	.	0.0047
---- EQU EQU1197	.	.	.	EPS
---- EQU EQU1198	.	.	.	-0.0002
---- EQU EQU1199	.	.	.	-0.2754
---- EQU EQU1200	.	.	.	1.2921
---- EQU EQU1201	.	.	.	0.0983
---- EQU EQU1202	.	.	.	-0.1999
---- EQU EQU1203	1.0000	1.0000	1.0000	EPS
---- EQU EQU1204	.	.	.	-0.0022
---- EQU EQU1205	.	.	.	-0.0110
---- EQU EQU1206	1.0000	1.0000	1.0000	12.9395
---- EQU EQU1207	.	.	.	0.0029
---- EQU EQU1208	1.0000	1.0000	1.0000	EPS
---- EQU EQU1209	1.0000	1.0000	1.0000	EPS
---- EQU EQU1210	.	.	.	EPS
---- EQU EQU1211	.	.	.	EPS
---- EQU EQU1212	.	.	.	EPS
---- EQU EQU1213	.	.	.	EPS
---- EQU EQU1214	.	.	.	EPS
---- EQU EQU1215	.	.	.	EPS
---- EQU EQU1216	.	.	.	EPS
---- EQU EQU1217	.	.	.	EPS
---- EQU EQU1218	.	.	.	EPS
---- EQU EQU1219	.	.	.	EPS
---- EQU EQU1220	.	.	.	EPS
---- EQU EQU1221	.	.	.	EPS
---- EQU EQU1222	.	.	.	EPS

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1223	.	.	.	EPS
---- EQU EQU1224	.	.	.	EPS
---- EQU EQU1225	.	.	.	EPS
---- EQU EQU1226	.	.	.	13.1442
---- EQU EQU1227	.	.	.	EPS
---- EQU EQU1228	.	.	.	EPS
---- EQU EQU1229	.	.	.	EPS
---- EQU EQU1230	.	.	.	EPS
---- EQU EQU1231	.	.	.	EPS
---- EQU EQU1232	.	.	.	-57.9659

_Economic Optimization Program 05/15/01 16:49:39 PAGE 136
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1233	.	.	.	EPS
---- EQU EQU1234	1.0000	1.0000	1.0000	EPS
---- EQU EQU1235	1.0000	1.0000	1.0000	EPS
---- EQU EQU1236	537.9500	537.9500	537.9500	-4.645815E-5
---- EQU EQU1237	152.2500	152.2500	152.2500	EPS
---- EQU EQU1238	181.2500	181.2500	181.2500	0.0006
---- EQU EQU1239	118.9000	118.9000	118.9000	-0.0006
---- EQU EQU1240	40.6000	40.6000	40.6000	0.0001
---- EQU EQU1241	9.8600	9.8600	9.8600	-0.0027
---- EQU EQU1242	.	.	.	0.4930
---- EQU EQU1243	.	.	.	-0.1965
---- EQU EQU1244	.	.	.	0.7608
---- EQU EQU1245	.	.	.	-0.2993
---- EQU EQU1246	.	.	.	1.2931
---- EQU EQU1247	.	.	.	-3.8885
---- EQU EQU1248	.	.	.	0.3595
---- EQU EQU1249	.	.	.	-1.4025
---- EQU EQU1250	.	.	.	0.0583
---- EQU EQU1251	.	.	.	-0.2714
---- EQU EQU1252	.	.	.	8.0376
---- EQU EQU1253	.	.	.	EPS
---- EQU EQU1254	1.0000	1.0000	1.0000	0.0576
---- EQU EQU1255	1.0000	1.0000	1.0000	EPS
---- EQU EQU1256	.	.	.	0.0093
---- EQU EQU1257	.	.	.	-0.0009
---- EQU EQU1258	.	.	.	0.0009
---- EQU EQU1259	.	.	.	EPS
---- EQU EQU1260	.	.	.	0.0133
---- EQU EQU1261	.	.	.	-0.0051
---- EQU EQU1262	.	.	.	-2.3793
---- EQU EQU1263	.	.	.	-0.0129
---- EQU EQU1264	.	.	.	-0.0015
---- EQU EQU1265	.	.	.	EPS
---- EQU EQU1266	.	.	.	-0.0004
---- EQU EQU1267	.	.	.	-0.0003
---- EQU EQU1268	.	.	.	EPS
---- EQU EQU1269	.	.	.	EPS
---- EQU EQU1270	.	.	.	1.3511
---- EQU EQU1271	.	.	.	-0.2693
---- EQU EQU1272	.	.	.	0.8084
---- EQU EQU1273	.	.	.	-0.1876
---- EQU EQU1274	.	.	.	0.2959
---- EQU EQU1275	.	.	.	-0.1757
---- EQU EQU1276	.	.	.	0.1442

_Economic Optimization Program 05/15/01 16:49:39 PAGE 137
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1277	.	.	.	-1.2676
---- EQU EQU1278	.	.	.	0.4484
---- EQU EQU1279	.	.	.	-2.0993
---- EQU EQU1280	1.0000	1.0000	1.0000	EPS
---- EQU EQU1281	1.0000	1.0000	1.0000	EPS
---- EQU EQU1282	.	.	.	.
---- EQU EQU1283	.	.	.	EPS
---- EQU EQU1284	.	.	.	-0.2875
---- EQU EQU1285	.	.	.	0.1510
---- EQU EQU1286	.	.	.	-0.5846
---- EQU EQU1287	.	.	.	0.2854
---- EQU EQU1288	.	.	.	-1.4742
---- EQU EQU1289	.	.	.	-0.6680
---- EQU EQU1290	.	.	.	0.5579
---- EQU EQU1291	.	.	.	-2.4043
---- EQU EQU1292	.	.	.	0.9941
---- EQU EQU1293	.	.	.	-5.9615
---- EQU EQU1294	.	.	.	0.0165
---- EQU EQU1295	.	.	.	-0.9929
---- EQU EQU1296	.	.	.	-0.0005
---- EQU EQU1297	.	.	.	-1.2583
---- EQU EQU1298	.	.	.	36.5555
---- EQU EQU1299	.	.	.	41.9813
---- EQU EQU1300	.	.	.	235.4692
---- EQU EQU1301	.	.	.	36.2546
---- EQU EQU1302	.	.	.	-197.3845

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1303	.	.	.	EPS
---- EQU EQU1304	537.9500	537.9500	537.9500	-0.0001
---- EQU EQU1305	.	.	.	-558.5066
---- EQU EQU1306	.	.	.	EPS
---- EQU EQU1307	.	.	.	-161.2895
---- EQU EQU1308	.	.	.	-0.0004
---- EQU EQU1309	.	.	.	0.0021
---- EQU EQU1310	.	.	.	2.9384
---- EQU EQU1311	.	.	.	199.2414
---- EQU EQU1312	.	.	.	0.0563
---- EQU EQU1313	.	.	.	-37.9154
---- EQU EQU1314	.	.	.	0.0005
---- EQU EQU1315	1.0000	1.0000	1.0000	0.2372
---- EQU EQU1316	.	.	.	-0.0028
---- EQU EQU1317	1.0000	1.0000	1.0000	-7.2623
---- EQU EQU1318	.	.	.	0.0012
---- EQU EQU1319	.	.	.	4.2362975E-5
---- EQU EQU1320	.	.	.	0.0060

_Economic Optimization Program 05/15/01 16:49:39 PAGE 138
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1321	.	.	.	0.0005
---- EQU EQU1322	.	.	.	0.0034
---- EQU EQU1323	.	.	.	0.0022
---- EQU EQU1324	.	.	.	5.7905730E-5
---- EQU EQU1325	.	.	.	0.0044
---- EQU EQU1326	.	.	.	0.0008
---- EQU EQU1327	.	.	.	-0.0034
---- EQU EQU1328	.	.	.	0.0011
---- EQU EQU1329	.	.	.	0.0066
---- EQU EQU1330	.	.	.	2.7962082E-5
---- EQU EQU1331	.	.	.	0.0051
---- EQU EQU1332	.	.	.	-0.0034
---- EQU EQU1333	.	.	.	0.0005
---- EQU EQU1334	.	.	.	0.0025
---- EQU EQU1335	.	.	.	EPS
---- EQU EQU1336	.	.	.	0.0050
---- EQU EQU1337	.	.	.	0.0015
---- EQU EQU1338	.	.	.	EPS
---- EQU EQU1339	.	.	.	0.0007
---- EQU EQU1340	.	.	.	0.0172
---- EQU EQU1341	.	.	.	-0.0020
---- EQU EQU1342	.	.	.	EPS
---- EQU EQU1343	.	.	.	EPS
---- EQU EQU1344	.	.	.	EPS
---- EQU EQU1345	.	.	.	EPS
---- EQU EQU1346	.	.	.	EPS
---- EQU EQU1347	.	.	.	EPS
---- EQU EQU1348	.	.	.	EPS
---- EQU EQU1349	.	.	.	EPS
---- EQU EQU1350	.	.	.	EPS
---- EQU EQU1351	.	.	.	EPS
---- EQU EQU1352	.	.	.	EPS
---- EQU EQU1353	.	.	.	EPS
---- EQU EQU1354	.	.	.	EPS
---- EQU EQU1355	.	.	.	EPS
---- EQU EQU1356	.	.	.	EPS
---- EQU EQU1357	.	.	.	EPS
---- EQU EQU1358	.	.	.	EPS
---- EQU EQU1359	.	.	.	EPS
---- EQU EQU1360	.	.	.	1753.5625
---- EQU EQU1361	.	.	.	-558.9070
---- EQU EQU1362	.	.	.	458.8627
---- EQU EQU1363	.	.	.	-499.6314
---- EQU EQU1364	.	.	.	-0.0033

_Economic Optimization Program 05/15/01 16:49:39 PAGE 139
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1365	.	.	.	EPS
---- EQU EQU1366	.	.	.	-502.1738
---- EQU EQU1367	.	.	.	-302.8299
---- EQU EQU1368	.	.	.	-302.9130
---- EQU EQU1369	.	.	.	-0.2124
---- EQU EQU1370	.	.	.	72.2686
---- EQU EQU1371	.	.	.	0.0053
---- EQU EQU1372	.	.	.	EPS
---- EQU EQU1373	.	.	.	48.7113
---- EQU EQU1374	.	.	.	721.8557
---- EQU EQU1375	.	.	.	718.6371
---- EQU EQU1376	.	.	.	450.8974
---- EQU EQU1377	.	.	.	-0.0428
---- EQU EQU1378	.	.	.	EPS
---- EQU EQU1379	.	.	.	71.9146
---- EQU EQU1380	.	.	.	43.5843
---- EQU EQU1381	.	.	.	43.5842
---- EQU EQU1382	.	.	.	-20.1904

---- EQU EQU1383	.	.	.	EPS
---- EQU EQU1384	.	.	.	EPS
---- EQU EQU1385	.	.	.	EPS
---- EQU EQU1386	.	.	.	438.1338
---- EQU EQU1387	.	.	.	-6.9549
---- EQU EQU1388	.	.	.	72.2686
---- EQU EQU1389	.	.	.	EPS
---- EQU EQU1390	.	.	.	43.5843
---- EQU EQU1391	.	.	.	71.9146
---- EQU EQU1392	.	.	.	-0.0428
---- EQU EQU1393	.	.	.	0.0053
---- EQU EQU1394	.	.	.	43.9408
---- EQU EQU1395	.	.	.	EPS
---- EQU EQU1396	.	.	.	EPS
---- EQU EQU1397	.	.	.	43.5842
---- EQU EQU1398	.	.	.	EPS
---- EQU EQU1399	.	.	.	790.9057
---- EQU EQU1400	.	.	.	EPS
---- EQU EQU1401	.	.	.	-20.1904
---- EQU EQU1402	.	.	.	EPS
---- EQU EQU1403	.	.	.	EPS
---- EQU EQU1404	-290.0000	-290.0000	-290.0000	EPS
---- EQU EQU1405	.	.	.	793.7703
---- EQU EQU1406	.	.	.	481.7180
---- EQU EQU1407	.	.	.	494.4817
---- EQU EQU1408	.	.	.	48.6685

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1409	.	.	.	0.0053
---- EQU EQU1410	.	.	.	2.2004
---- EQU EQU1411	.	.	.	4.2006
---- EQU EQU1412	.	.	.	EPS
---- EQU EQU1413	.	.	.	1.9250
---- EQU EQU1414	.	.	.	2.3662
---- EQU EQU1415	.	.	.	4.0239
---- EQU EQU1416	.	.	.	-0.0017
---- EQU EQU1417	.	.	.	118.6970
---- EQU EQU1418	.	.	.	-5.9964
---- EQU EQU1419	.	.	.	0.0525
---- EQU EQU1420	.	.	.	-10.3647
---- EQU EQU1421	.	.	.	1.2891
---- EQU EQU1422	414.6000	414.6000	414.6000	-0.1533
---- EQU EQU1423	.	.	.	1.1052
---- EQU EQU1424	.	.	.	-9.0156
---- EQU EQU1425	.	.	.	-0.0263
---- EQU EQU1426	.	.	.	0.0005
---- EQU EQU1427	.	.	.	-16.4464
---- EQU EQU1428	.	.	.	24.7479
---- EQU EQU1429	.	.	.	-0.1655
---- EQU EQU1430	.	.	.	-0.5560
---- EQU EQU1431	.	.	.	-0.4640
---- EQU EQU1432	.	.	.	2.1256
---- EQU EQU1433	.	.	.	1.7610
---- EQU EQU1434	.	.	.	36.3474
---- EQU EQU1435	.	.	.	0.4433
---- EQU EQU1436	.	.	.	204.9417
---- EQU EQU1437	.	.	.	54.7890
---- EQU EQU1438	.	.	.	-0.0032
---- EQU EQU1439	.	.	.	EPS
---- EQU EQU1440	.	.	.	EPS
---- EQU EQU1441	.	.	.	EPS
---- EQU EQU1442	.	.	.	21.4095
---- EQU EQU1443	.	.	.	-0.0103
---- EQU EQU1444	.	.	.	38.3817
---- EQU EQU1445	.	.	.	EPS
---- EQU EQU1446	.	.	.	330.2436
---- EQU EQU1447	.	.	.	EPS
---- EQU EQU1448	.	.	.	339.8641
---- EQU EQU1449	.	.	.	541.6731
---- EQU EQU1450	.	.	.	544.0991
---- EQU EQU1451	.	.	.	-561.6332
---- EQU EQU1452	.	.	.	24.2424

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU EQU1453	.	.	.	0.0224
---- EQU EQU1454	.	.	.	0.0013
---- EQU EQU1455	.	.	.	EPS
---- EQU EQU1456	.	.	.	EPS
---- EQU EQU1457	.	.	.	EPS
---- EQU EQU1458	.	.	.	EPS
---- EQU EQU1459	.	.	.	20.0818
---- EQU EQU1460	.	.	.	23.2009
---- EQU EQU1461	.	.	.	7.1635
---- EQU EQU1462	.	.	.	EPS

```
---- EQU EQU1463          .          .          .          0.0078
---- EQU EQU1464          .          .          .            EPS
---- EQU EQU1465          .          .          .         -0.1746
---- EQU EQU1466          .          .          .          0.0443
---- EQU EQU1467          .          .          .          2.9517
---- EQU EQU1468       1.0000     1.0000     1.0000     -0.2553
---- EQU EQU1469          .          .          .         -0.0033
---- EQU EQU1470          .          .          .         -0.0033
---- EQU EQU1471       1.0000     1.0000     1.0000     -0.0241
---- EQU EQU1472          .          .          .            EPS
---- EQU EQU1473       1.0000     1.0000     1.0000         .
---- EQU EQU1474          .          .          .            EPS
---- EQU EQU1475          .          .          .            EPS
---- EQU EQU1476       1.0000     1.0000     1.0000         .
---- EQU EQU1477          .          .          .         -8.0171
---- EQU EQU1478          .          .          .            EPS
---- EQU EQU1479          .          .          .         -0.7515
---- EQU EQU1480          .          .          .         -5.6930
---- EQU EQU1481       1.0000     1.0000     1.0000      9.3606
---- EQU EQU1482          .          .          .         -3.4279
---- EQU EQU1483          .          .          .            EPS
---- EQU EQU1484          .          .          .         -5.7204
---- EQU EQU1485          .          .          .         -0.0014
---- EQU EQU1486          .          .          .        332.8291
---- EQU EQU1487       1.0000     1.0000     1.0000     -0.8828
---- EQU EQU1488          .          .          .            EPS
---- EQU EQU1489          .          .          .            EPS
---- EQU EQU1490          .          .          .     -1.708206E-5
---- EQU EQU1491          .          .          .     -5.979112E-6
---- EQU EQU1492       1.0000     1.0000     1.0000      5.6781
---- EQU EQU1493          .          .          .         -5.4814
---- EQU EQU1494       1.0000     1.0000     1.0000     35.5543
---- EQU EQU1495       1.0000     1.0000     1.0000     -0.9137
---- EQU EQU1496          .          .          .     -6.015542E-5
_Economic Optimization Program                                            05/15/01 16:49:39  PAGE    142
                                                                  GAMS 2.50A  Windows NT/95/98


                      LOWER      LEVEL      UPPER     MARGINAL

---- EQU EQU1497       1.0000     1.0000     1.0000      5.3433
---- EQU EQU1498          .          .          .        182.6973
---- EQU EQU1499          .          .          .         -3.7959
---- EQU EQU1500          .          .          .         -0.6435
---- EQU EQU1501          .          .          .            EPS
---- EQU EQU1502          .          .          .         -0.0007
---- EQU EQU1503          .          .          .        -17.2225
---- EQU EQU1504          .          .          .         -5.0672
---- EQU EQU1505          .          .          .         -3.5676
---- EQU EQU1506          .          .          .         -0.0007
---- EQU EQU1507          .          .          .         -0.9425
---- EQU EQU1508       1.0000     1.0000     1.0000         .
---- EQU EQU1509          .          .          .         -0.0068
---- EQU EQU1510          .          .          .         -0.0002
---- EQU EQU1511          .          .          .            EPS
---- EQU EQU1512          .          .          .         -0.0258
---- EQU EQU1513       1.0000     1.0000     1.0000    -35.7349
---- EQU EQU1514          .          .          .         -0.2124
---- EQU EQU1515       1.0000     1.0000     1.0000      7.8830
---- EQU EQU1516          .          .          .          0.0415
---- EQU EQU1517       1.0000     1.0000     1.0000    181.1745
---- EQU EQU1518          .          .          .            EPS
---- EQU EQU1519          .          .          .          0.1709
---- EQU EQU1520       1.0000     1.0000     1.0000   -241.7364
---- EQU EQU1521          .          .          .          0.0291
---- EQU EQU1522       1.0000     1.0000     1.0000     -7.6874
---- EQU EQU1523          .          .          .         -0.0291
---- EQU EQU1524          .          .          .         -7.9697
---- EQU EQU1525          .          .          .         -7.7259
---- EQU EQU1526          .          .          .         -1.0000
---- EQU EQU1527          .          .          .          1.0000
---- EQU EQU1528       6.8883     6.8883     6.8883     -1.0000
---- EQU EQU1529          .          .          .          1.0000
---- EQU EQU1530          .          .          .            EPS
---- EQU EQU1531          .          .          .          0.0074
---- EQU EQU1532          .          .          .          0.0258
---- EQU EQU1533          .          .          .          0.0325
---- EQU EQU1534          .          .          .          2.9778
---- EQU EQU1535          .          .          .         92.2780
---- EQU EQU1536          .          .          .         -0.9549
---- EQU EQU1537          .          .          .        -42.7343
---- EQU EQU1538          .          .          .          0.0291
---- EQU EQU1539          .          .          .         -0.2000
---- EQU EQU1540          .          .          .         -0.0001
_Economic Optimization Program                                            05/15/01 16:49:39  PAGE    143
                                                                  GAMS 2.50A  Windows NT/95/98


                      LOWER      LEVEL      UPPER     MARGINAL

---- EQU EQU1541          .          .          .          1.3434
---- EQU EQU1542          .          .          .          3.9985
```

---- EQU EQU1543	.	.	.	-4.5809
---- EQU EQU1544	.	.	.	-0.1831
---- EQU EQU1545	.	.	.	1.4141
---- EQU EQU1546	.	.	.	-0.0641
---- EQU EQU1547	.	.	.	36.7162
---- EQU EQU1548	.	.	.	EPS
---- EQU EQU1549	.	.	.	EPS
---- EQU EQU1550	.	.	.	544.0439
---- EQU EQU1551	.	.	.	3.4597
---- EQU EQU1552	.	.	.	EPS
---- EQU EQU1553	.	.	.	EPS
---- EQU EQU1554	.	.	.	-1.5748
---- EQU EQU1555	.	.	.	EPS
---- EQU EQU1556	.	.	.	EPS
---- EQU EQU1557	.	.	.	510.2405
---- EQU EQU1558	10.2210	10.2210	10.2210	-2.2002
---- EQU EQU1559	10.2210	10.2210	10.2210	EPS
---- EQU EQU1560	.	.	.	EPS
---- EQU EQU1561	.	.	.	EPS
---- EQU EQU1562	.	.	.	-4.2202
---- EQU EQU1563	.	.	.	544.0292
---- EQU EQU1564	.	.	.	EPS
---- EQU EQU1565	10.2210	10.2210	10.2210	-0.0129
---- EQU EQU1566	10.2210	10.2210	10.2210	-19.2382
---- EQU EQU1567	10.2210	10.2210	10.2210	-0.9495
---- EQU EQU1568	10.2210	10.2210	10.2210	-0.1865
---- EQU EQU1569	.	.	.	95.3695
---- EQU EQU1570	.	.	.	47.8879
---- EQU EQU1571	.	.	.	.
---- EQU EQU1572	.	.	.	213.7931
---- EQU EQU1573	.	.	.	EPS
---- EQU EQU1574	.	.	.	EPS
---- EQU EQU1575	.	.	.	1.2321
---- EQU EQU1576	.	.	.	0.8346
---- EQU EQU1577	.	.	.	EPS
---- EQU EQU1578	.	.	.	EPS
---- EQU EQU1579	.	.	.	EPS
---- EQU INEQU1	-INF	0.0759	1.0000	.
---- EQU INEQU2	8.0000	8.4588	+INF	.
---- EQU INEQU3	10.0000	12.0087	+INF	.
---- EQU INEQU4	10.0000	13.8440	+INF	.
---- EQU INEQU5	10.0000	14.1458	+INF	.

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU INEQU6	300.0000	300.0000	+INF	-0.0008
---- EQU INEQU7	10.0000	24.2003	+INF	.
---- EQU INEQU8	-404.6000	-359.0690	+INF	.
---- EQU INEQU9	-404.6000	-359.0690	+INF	.
---- EQU INEQU10	300.0000	322.5997	+INF	.
---- EQU INEQU11	10.0000	10.0000	+INF	-0.0409
---- EQU INEQU12	10.0000	104.7508	+INF	.
---- EQU INEQU13	10.0000	93.2720	+INF	.
---- EQU INEQU14	300.0000	303.5753	+INF	.
---- EQU INEQU15	10.0000	69.9127	+INF	.
---- EQU INEQU16	300.0000	337.0859	+INF	.
---- EQU INEQU17	10.0000	10.4340	+INF	.
---- EQU INEQU18	300.0000	307.2720	+INF	.
---- EQU INEQU19	10.0000	39.0859	+INF	.
---- EQU INEQU20	300.0000	304.5245	+INF	.
---- EQU INEQU21	10.0000	12.1433	+INF	.
---- EQU INEQU22	10.0000	12.3580	+INF	.
---- EQU INEQU23	10.0000	10.0000	+INF	-0.0035
---- EQU INEQU24	298.0000	363.3260	+INF	.
---- EQU INEQU25	8.0000	68.3260	+INF	.
---- EQU INEQU26	8.0000	8.0000	+INF	-0.7971
---- EQU INEQU27	8.0000	12.1637	+INF	.
---- EQU INEQU28	8.0000	8.4331	+INF	.
---- EQU INEQU29	8.0000	8.2197	+INF	.
---- EQU INEQU30	8.0000	16.0857	+INF	.
---- EQU INEQU31	298.0000	328.4033	+INF	.
---- EQU INEQU32	10.0000	12.0087	+INF	.
---- EQU INEQU33	300.0000	328.4033	+INF	.
---- EQU INEQU34	10.0000	10.0000	+INF	EPS
---- EQU INEQU35	10.0000	10.0000	+INF	-0.0020
---- EQU INEQU36	-471.0000	-405.0000	+INF	.
---- EQU INEQU37	-471.0000	-460.9878	+INF	.
---- EQU INEQU38	-404.6000	-363.3260	+INF	.
---- EQU INEQU39	-404.6000	-403.7525	+INF	.
---- EQU INEQU40	10.0000	12.1921	+INF	.
---- EQU INEQU41	10.0000	13.7160	+INF	.
---- EQU INEQU42	-404.6000	-336.6046	+INF	.
---- EQU INEQU43	-404.6000	-336.6046	+INF	.
---- EQU INEQU44	10.0000	10.0000	+INF	-0.2615
---- EQU INEQU45	300.0000	300.0000	+INF	.
---- EQU INEQU46	10.0000	13.0955	+INF	.
---- EQU INEQU47	300.0000	318.7440	+INF	.
---- EQU INEQU48	10.0000	10.5454	+INF	.
---- EQU INEQU49	300.0000	300.0000	+INF	-0.0012

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU INEQU50	-INF	.	0.0001	.
---- EQU OBJNAME	.	.	.	1.0000

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR FAC02	0.0900	0.1600	0.1600	374.0119
---- VAR FAC12	0.0100	0.1600	0.9000	.
---- VAR FAC23	0.0100	0.1600	0.9000	.
---- VAR FAC34	0.0100	0.1600	0.9000	.
---- VAR FAC45	0.0100	0.1600	0.9000	.
---- VAR FC308	1.0000	3.1197	6.0000	.
---- VAR FC316	0.1000	1.7518	1.8000	.
---- VAR FC320	0.0100	0.0459	1.5000	.
---- VAR FC322	0.1000	1.5684	1.6000	.
---- VAR FC328	0.0100	0.0545	1.0000	.
---- VAR FC329	0.1000	0.7635	3.0000	.
---- VAR FC403	0.1000	2.3677	5.0000	.
---- VAR FC407	0.7500	0.9348	5.0000	.
---- VAR FC412	0.0100	0.0420	1.0000	.
---- VAR FC417	0.1000	0.1439	2.0000	.
---- VAR FHC01	0.7950	0.8979	1.5000	.
---- VAR FHC32	0.5000	1.9569	5.0000	.
---- VAR FSC402	0.1000	0.4587	4.0000	.
---- VAR FSC405	.	0.3148	3.0000	.
---- VAR FSC411	0.1000	1.3267	3.2000	.
---- VAR FSC413	0.1000	0.1439	0.5000	.
---- VAR FSTME612	0.0500	0.0888	1.0000	.
---- VAR PC302	101.0000	101.0000	187.0000	-0.0008
---- VAR PC310	230.0000	260.0000	360.0000	.
---- VAR PC601	600.0000	625.0000	625.0000	0.0195
---- VAR PC603	1600.0000	1691.3731	1800.0000	.
---- VAR QHC07	0.1000	1.9469	5.0000	.
---- VAR QHC11	0.1000	1.7391	5.0000	.
---- VAR QHC14	0.1000	1.7391	5.0000	.
---- VAR QHC16	0.1000	1.7391	5.0000	.
---- VAR QHC34	0.1000	1.1464	5.0000	.
---- VAR QHC38	0.1000	0.5352	5.0000	.
---- VAR QHC41	0.1000	0.8699	5.0000	.
---- VAR QHC45	0.1000	0.8518	5.0000	.
---- VAR TAC09	280.0000	280.0000	300.0000	-0.0036
---- VAR TAC12	280.0000	280.0000	300.0000	.
---- VAR TAC23	280.0000	280.0000	300.0000	.
---- VAR TAC31	280.0000	280.0000	300.0000	-0.0010
---- VAR TAC34	280.0000	280.0000	300.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 146
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR TAC42	280.0000	280.0000	300.0000	-0.0030
---- VAR TAC45	280.0000	280.0000	300.0000	.
---- VAR TC303	260.0000	280.6862	300.0000	.
---- VAR TC306	320.0000	349.4271	368.0000	.
---- VAR TC307	300.0000	328.4033	330.0000	.
---- VAR TC308	270.0000	328.4033	350.0000	.
---- VAR TC315	300.0000	307.3612	320.0000	.
---- VAR TC316	335.0000	345.2250	370.0000	.
---- VAR TC317	300.0000	359.0690	420.0000	.
---- VAR TC321	250.0000	300.0000	350.0000	.
---- VAR TC324	359.0000	359.0690	385.0000	.
---- VAR TC325	300.0000	322.5997	360.0000	.
---- VAR TC404	305.0000	305.2492	325.0000	.
---- VAR TC405	410.0000	410.0000	440.0000	-0.0269
---- VAR TC407	298.0000	303.5753	350.0000	.
---- VAR TC408	405.0000	405.0000	440.0000	-0.8220
---- VAR TC410	345.0000	363.3260	369.0000	.
---- VAR TC414	300.0000	337.0859	368.0000	.
---- VAR TC418	301.0000	307.1433	350.0000	.
---- VAR TC419	298.0000	304.5245	310.0000	.
---- VAR THC32	250.0000	261.9077	310.0000	.
---- VAR TSC402	310.0000	322.8886	340.0000	.
---- VAR TSC403	320.0000	336.6046	350.0000	.
---- VAR TSC405	300.0000	300.0000	360.0000	-0.4217
---- VAR TSC408	300.0000	318.7440	330.0000	.
---- VAR TSC413	295.0000	300.0000	350.0000	.
---- VAR X11AC12	0.8800	0.9687	0.9990	.
---- VAR X11AC23	0.8800	0.9424	0.9990	.
---- VAR X11AC34	0.8800	0.9162	0.9990	.
---- VAR X11AC45	0.8800	0.8900	0.9990	.
---- VAR X1C316	0.0100	0.1166	0.5000	.
---- VAR X1C325	0.5000	1.0000	1.0000	.
---- VAR X1C417	0.0200	0.0200	0.2000	-52.0438
---- VAR X1HC32	.	0.0228	0.1000	.
---- VAR X1SC402	.	0.0063	0.1000	.
---- VAR X1SC403	.	.	0.1000	.

---- VAR X1SC408	.	0.0200	0.1000	.
---- VAR X2SC402	.	.	0.1000	.
---- VAR X2SC403	.	.	0.1000	-13.6611
---- VAR X2SC408	.	.	0.1000	.
---- VAR X3C316	0.5000	0.7851	1.0000	.
---- VAR X3C325	.	1.5978930E-6	0.1000	.
---- VAR X3C417	0.3500	0.9738	1.0000	.
---- VAR X3HC32	0.1000	0.7604	1.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 147
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X3SC402	0.2000	0.3216	0.4200	.
---- VAR X3SC403	.	0.0234	0.1000	.
---- VAR X3SC408	0.5000	0.9739	1.0000	.
---- VAR X4C316	0.0010	0.0894	0.2000	.
---- VAR X4C417	0.0010	0.0061	0.4000	.
---- VAR X4HC32	.	0.1401	0.5000	.
---- VAR X4SC402	0.4800	0.5280	0.7000	.
---- VAR X4SC403	0.5000	0.7666	1.0000	.
---- VAR X4SC408	.	0.0061	0.1000	.
---- VAR X5C316	.	0.0056	0.0100	.
---- VAR X5C417	.	3.3333334E-5	0.1500	.
---- VAR X5HC32	.	0.0288	2.5000	.
---- VAR X5SC402	.	0.0686	0.1000	.
---- VAR X5SC403	.	0.1000	0.1000	.
---- VAR X5SC408	.	.	0.1000	.
---- VAR X6SC402	.	0.0686	0.1000	.
---- VAR X6SC403	.	0.1000	0.1200	.
---- VAR X6SC408	.	.	0.1000	.
---- VAR X7HC32	.	0.0479	2.0000	.
---- VAR X7SC402	.	0.0069	0.1000	.
---- VAR X7SC403	.	0.0100	0.1000	.
---- VAR X7SC408	.	.	0.1000	.
---- VAR XX1C322	.	0.1133	0.1200	.
---- VAR XX1C414	.	0.0762	0.0800	.
---- VAR XX1HC01	.	0.0976	0.5000	.
---- VAR XX2HC01	0.1000	0.1296	0.6000	.
---- VAR XX3C317	0.5000	0.7900	1.0000	.
---- VAR XX3C322	0.5000	0.7900	1.0000	.
---- VAR XX3C407	.	2.3780783E-5	0.1000	.
---- VAR XX3C412	.	0.0021	0.1500	.
---- VAR XX3C414	0.5000	0.8081	1.0000	.
---- VAR XX3HC01	.	0.0125	0.5500	.
---- VAR XX4C317	.	0.0899	0.2000	.
---- VAR XX4C322	.	0.0899	0.2000	.
---- VAR XX4C407	0.0100	0.0851	0.3000	.
---- VAR XX4C412	0.5000	0.8771	1.0000	.
---- VAR XX4C414	.	0.1067	0.2000	.
---- VAR XX4HC01	.	0.1108	0.3000	.
---- VAR XX5C407	0.0100	0.1512	0.5000	.
---- VAR XX5C412	.	0.0568	0.1000	.
---- VAR XX5C414	.	0.0010	0.1000	.
---- VAR XX7C414	.	0.0080	0.0080	1021.4560
---- VAR OBJVAR	-INF	29.1128	+INF	.
---- VAR C10PC623	.	3.8395828E-5	0.5000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 148
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR C10PC625	.	7.7797929E-5	0.5000	.
---- VAR C10PC627	.	0.0002	0.5000	.
---- VAR C10PC629	.	0.0002	0.5000	.
---- VAR C2C623	.	0.0165	0.1000	.
---- VAR C2C625	.	0.0151	0.1000	.
---- VAR C2C627	.	0.0148	0.1000	.
---- VAR C2C629	.	0.0152	0.1000	.
---- VAR C3C623	.	3.9512	6.0000	.
---- VAR C3C625	.	2.5135	6.0000	.
---- VAR C3C627	.	1.4717	6.0000	.
---- VAR C3C629	.	1.7742	6.0000	.
---- VAR C3PC623	.	1.2420	10.0000	.
---- VAR C3PC625	.	1.1980	10.0000	.
---- VAR C3PC627	.	1.2165	10.0000	.
---- VAR C3PC629	.	1.1915	10.0000	.
---- VAR C4PC623	.	0.0276	1.0000	.
---- VAR C4PC625	.	0.0418	1.0000	.
---- VAR C4PC627	.	0.0726	1.0000	.
---- VAR C4PC629	.	0.0589	1.0000	.
---- VAR C5PC623	.	0.0004	0.1000	.
---- VAR C5PC625	.	0.0010	0.1000	.
---- VAR C5PC627	.	0.0028	0.1000	.
---- VAR C5PC629	.	0.0019	0.1000	.
---- VAR C7PC623	.	4.1042795E-5	0.1000	.
---- VAR C7PC625	.	0.0002	0.1000	.
---- VAR C7PC627	.	0.0016	0.1000	.
---- VAR C7PC629	.	0.0008	0.1000	.
---- VAR C8PC623	.	0.0016	0.1000	.

---- VAR C8PC625	.	0.0035	0.1000	.
---- VAR C8PC627	.	0.0099	0.1000	.
---- VAR C8PC629	.	0.0069	0.1000	.
---- VAR C9PC623	.	0.4585	10.0000	.
---- VAR C9PC625	.	0.6434	10.0000	.
---- VAR C9PC627	.	1.0975	10.0000	.
---- VAR C9PC629	.	0.9108	10.0000	.
---- VAR CHXC623	2.5000	13.4316	15.0000	.
---- VAR CHXC625	2.5000	14.2010	15.0000	.
---- VAR CHXC627	2.5000	14.6961	15.0000	.
---- VAR CHXC629	2.5000	14.0353	15.0000	.
---- VAR CIC10PC623	.	.	1.0000	.
---- VAR CIC10PC625	.	.	1.0000	.
---- VAR CIC10PC627	.	.	1.0000	.
---- VAR CIC10PC629	.	.	1.0000	.
---- VAR CIC11PC623	.	1.4680088E-5	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 149
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR CIC11PC625	.	4.5601952E-5	0.1000	.
---- VAR CIC11PC627	.	0.0002	0.1000	.
---- VAR CIC11PC629	.	0.0001	0.1000	.
---- VAR CIC4EC623	.	0.0031	0.1000	.
---- VAR CIC4EC625	.	0.0031	0.1000	.
---- VAR CIC4EC627	.	0.0031	0.1000	.
---- VAR CIC4EC629	.	0.0031	0.1000	.
---- VAR CIC5EC623	.	0.0007	0.1000	.
---- VAR CIC5EC625	.	0.0009	0.1000	.
---- VAR CIC5EC627	.	0.0014	0.1000	.
---- VAR CIC5EC629	.	0.0013	0.1000	.
---- VAR CIC8EC623	.	0.0183	0.3000	.
---- VAR CIC8EC625	.	0.0267	0.3000	.
---- VAR CIC8EC627	.	0.0448	0.3000	.
---- VAR CIC8EC629	.	0.0380	0.3000	.
---- VAR COST	-10000.0000	144.2870	10000.0000	.
---- VAR DTE601	5.0000	12.9391	50.0000	.
---- VAR DTE602	5.0000	77.9954	90.0000	.
---- VAR DTE603	5.0000	10.0000	50.0000	.
---- VAR DTE605	5.0000	20.9198	50.0000	.
---- VAR DTE609A	5.0000	10.2703	20.0000	.
---- VAR DTE610	5.0000	13.9944	50.0000	.
---- VAR DTE611	5.0000	16.0549	50.0000	.
---- VAR DTE612	10.0000	55.5310	90.0000	.
---- VAR DTE613	4.0000	21.2999	30.0000	.
---- VAR DTE616	10.0000	98.9004	120.0000	.
---- VAR DTE617	5.0000	34.0905	50.0000	.
---- VAR DTE621A	5.0000	28.7599	50.0000	.
---- VAR DTE621B	5.0000	26.6950	40.0000	.
---- VAR DTE626	5.0000	13.2984	50.0000	.
---- VAR DTE627A	5.0000	55.0000	55.0000	0.5475
---- VAR DTE627B	5.0000	31.5672	50.0000	.
---- VAR DTE628	5.0000	11.1374	60.0000	.
---- VAR DTE629	5.0000	17.3923	80.0000	.
---- VAR DTE633	5.0000	12.1527	50.0000	.
---- VAR DTE634	5.0000	19.6708	20.0000	.
---- VAR DTE640	5.0000	20.7286	50.0000	.
---- VAR DTE641	5.0000	16.3756	50.0000	.
---- VAR DTE695A	5.0000	76.0000	90.0000	.
---- VAR DTE695B	5.0000	48.0061	60.0000	.
---- VAR DTE696A	10.0000	51.2740	90.0000	.
---- VAR DTE696B	10.0000	31.0608	90.0000	.
---- VAR DTE6XX	1.0000	1.1787	50.0000	.
---- VAR EARNINGS	-10000.0000	181.6027	10000.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 150
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR F1C601	.	.	0.1000	-0.2745
---- VAR F1C603	.	0.7330	1.0000	.
---- VAR F1C606A	.	0.0100	1.0000	.
---- VAR F2C601	0.5000	0.9941	1.0000	.
---- VAR F3C601	0.0500	0.0500	1.0000	-13.7780
---- VAR F3C603	.	1.0000	1.0000	.
---- VAR F3C606A	.	0.0025	1.0000	.
---- VAR F4C601	0.9500	0.9964	1.0000	.
---- VAR F4C603	.	1.0000	1.0000	.
---- VAR F4C606A	.	0.8876	1.0000	.
---- VAR F5C601	0.5000	1.0000	1.0000	.
---- VAR F5C603	0.5000	1.0000	1.0000	.
---- VAR F5C606A	0.5000	0.9886	1.0000	.
---- VAR F6C601	0.5000	1.0000	1.0000	.
---- VAR F7C601	0.5000	1.0000	1.0000	.
---- VAR F7C603	0.5000	1.0000	1.0000	.
---- VAR F7C606A	0.5000	0.9993	1.0000	.
---- VAR FAC05	0.1000	6.9259	20.0000	.
---- VAR FAC07	0.1000	7.0859	20.0000	.
---- VAR FAC09	0.0100	8.8646	20.0000	.

---- VAR FAC15	0.1000	8.4886	20.0000	.
---- VAR FAC18	0.1000	8.6486	20.0000	.
---- VAR FAC20	0.0100	9.9564	20.0000	.
---- VAR FAC26	0.1000	18.2520	20.0000	.
---- VAR FAC29	0.1000	18.4120	20.0000	.
---- VAR FAC31	0.0100	19.9121	20.0000	.
---- VAR FAC37	0.1000	14.7376	20.0000	.
---- VAR FAC40	0.1000	14.8976	20.0000	.
---- VAR FAC42	0.0100	16.3873	20.0000	.
---- VAR FC301	1.0000	3.7087	6.0000	.
---- VAR FC302	0.1000	0.3807	5.0000	.
---- VAR FC303	2.0000	4.0893	6.0000	.
---- VAR FC306	0.1000	4.8715	15.0000	.
---- VAR FC307	0.0001	4.8715	15.0000	.
---- VAR FC309	0.0001	3.1197	10.0000	.
---- VAR FC310	0.0001	0.7821	3.0000	.
---- VAR FC311	.	2.3375	8.0000	.
---- VAR FC312	0.0001	1.7518	5.0000	.
---- VAR FC315	0.0001	1.7518	5.0000	.
---- VAR FC317	0.1000	1.6973	3.0000	.
---- VAR FC318	0.0001	1.6973	3.0000	.
---- VAR FC319	0.0001	1.6973	3.0000	.
---- VAR FC321	.	0.0830	5.0000	.
---- VAR FC323	0.5000	0.8012	3.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR FC324	0.5000	0.8012	3.0000	.
---- VAR FC325	0.5000	0.8181	3.0000	.
---- VAR FC326	0.0100	0.8181	3.0000	.
---- VAR FC401	0.1000	2.3677	5.0000	.
---- VAR FC402	0.1000	2.3677	5.0000	.
---- VAR FC404	.	2.3677	5.0000	.
---- VAR FC405	0.1000	0.9348	2.0000	.
---- VAR FC406	.	0.9348	5.0000	.
---- VAR FC408	.	3.2323	10.0000	.
---- VAR FC409	.	3.2323	10.0000	.
---- VAR FC410	0.1000	0.8605	10.0000	.
---- VAR FC411	.	0.8605	10.0000	.
---- VAR FC413	.	0.0420	1.0000	.
---- VAR FC414	0.1000	2.9946	5.0000	.
---- VAR FC415	.	2.9946	10.0000	.
---- VAR FC418	0.1000	3.1385	5.0000	.
---- VAR FC419	0.0001	3.1385	10.0000	.
---- VAR FC425	1.0000	3.9120	10.0000	.
---- VAR FC426	.	3.0516	5.0000	.
---- VAR FC427	.	2.9772	10.0000	.
---- VAR FC428	.	2.1168	5.0000	.
---- VAR FC430	1.0000	3.9120	10.0000	.
---- VAR FC431	.	2.9772	10.0000	.
---- VAR FC432	1.0000	2.9352	5.0000	.
---- VAR FCWE603	0.1000	0.1864	20.0000	.
---- VAR FCWE605	0.1000	6.7919	15.0000	.
---- VAR FCWE609A	0.0100	0.0887	1.0000	.
---- VAR FCWE611	0.1000	3.0202	20.0000	.
---- VAR FCWE613	0.1000	2.4810	15.0000	.
---- VAR FCWE617	1.0000	1.5510	25.0000	EPS
---- VAR FCWE621A	0.1000	5.4552	10.0000	.
---- VAR FCWE621B	0.1000	6.9388	20.0000	.
---- VAR FCWE626	0.1000	0.9759	20.0000	.
---- VAR FCWE627A	0.1000	0.5522	10.0000	.
---- VAR FCWE627B	0.1000	0.5404	30.0000	.
---- VAR FCWE634	4.0000	7.2327	60.0000	.
---- VAR FCWE640	0.4000	0.4000	50.0000	-0.0208
---- VAR FCWE641A	0.1000	4.2849	30.0000	.
---- VAR FCWE641B	0.1000	0.9924	10.0000	.
---- VAR FHC02	0.0100	0.8979	5.0000	.
---- VAR FHC03	1.0000	3.2215	10.0000	.
---- VAR FHC04	1.0000	3.2215	10.0000	.
---- VAR FHC05	1.0000	3.2215	10.0000	.
---- VAR FHC06	1.0000	4.1195	12.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR FHC07	1.0000	1.1195	5.0000	.
---- VAR FHC08	1.0000	3.0000	5.0000	.
---- VAR FHC11	1.0000	1.0000	5.0000	-0.0308
---- VAR FHC14	1.0000	1.0000	5.0000	-0.0999
---- VAR FHC15	1.0000	2.0000	5.0000	.
---- VAR FHC16	1.0000	1.0000	5.0000	-0.1815
---- VAR FHC22	1.0000	1.4898	6.0000	.
---- VAR FHC23	1.0000	1.5002	6.0000	.
---- VAR FHC24	1.0000	2.9899	6.0000	.
---- VAR FHC25	1.0000	1.3078	6.0000	.
---- VAR FHC26	1.0000	4.2977	6.0000	.
---- VAR FHC27	1.0000	1.7787	10.0000	.

---- VAR FHC28	1.0000	6.0764	12.0000	.
---- VAR FHC29	.	1.2304	12.0000	.
---- VAR FHC30	.	1.2304	12.0000	.
---- VAR FHC31	.	6.0764	12.0000	.
---- VAR FHC33	.	0.9669	1.0000	.
---- VAR FHC34	.	0.6592	1.0000	.
---- VAR FHC38	.	0.3078	1.0000	.
---- VAR FHC40	.	0.9899	1.0000	.
---- VAR FHC41	.	0.5002	1.0000	.
---- VAR FHC45	.	0.4898	1.0000	.
---- VAR FLHC28	1.0000	3.1642	10.0000	.
---- VAR FLHC29	.	0.6407	12.0000	.
---- VAR FLHC30	.	0.4686	12.0000	.
---- VAR FLHC31	.	2.3677	12.0000	.
---- VAR FLR1	.	2.5234	10.0000	.
---- VAR FLR29	.	1.8991	12.0000	.
---- VAR FMC302	.	0.0067	0.1000	.
---- VAR FMC308	0.0001	0.0538	0.5000	.
---- VAR FMC310	.	0.0138	0.8000	.
---- VAR FMC311	.	0.0399	0.5000	.
---- VAR FMC312	.	0.0312	0.1000	.
---- VAR FMC317	0.0010	0.0300	0.1000	.
---- VAR FMC322	.	0.0277	1.0000	.
---- VAR FMC323	.	0.0141	0.4000	.
---- VAR FMC325	0.0100	0.0185	1.0000	.
---- VAR FMC405	.	0.0114	0.1000	.
---- VAR FMC407	.	0.0114	0.1000	.
---- VAR FMC408	.	0.0396	2.0000	.
---- VAR FMC409	.	0.0396	0.2000	.
---- VAR FMC412	.	0.0007	0.1000	.
---- VAR FMC414	0.0001	0.0523	0.1000	.
---- VAR FMC425	.	0.0580	2.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR FMC427	.	0.0466	0.2000	.
---- VAR FMC428	.	0.0338	0.1000	.
---- VAR FMC430	.	0.0605	0.2000	.
---- VAR FMC431	.	0.0491	1.0000	.
---- VAR FMC432	.	0.0484	0.1000	.
---- VAR FMHC01	.	0.0124	0.1000	.
---- VAR FMHC32	.	0.0332	0.1000	.
---- VAR FMLHC28	0.0100	0.0498	0.2000	.
---- VAR FMLHC29	.	0.0101	0.1000	.
---- VAR FMLHC30	.	0.0072	0.1000	.
---- VAR FMLR1	.	0.0397	0.2000	.
---- VAR FMLR29	.	0.0291	0.1000	.
---- VAR FMSC403	0.0010	0.0052	0.1000	.
---- VAR FMSC406	.	0.0242	0.1000	.
---- VAR FMSC408	.	0.0255	1.0000	.
---- VAR FMVHC28	.	0.0509	0.2000	.
---- VAR FMVHC29	.	0.0103	0.1000	.
---- VAR FMVHC30	.	0.0132	0.1000	.
---- VAR FMVR1	.	0.0406	0.2000	.
---- VAR FMVR29	.	0.0512	0.1000	.
---- VAR FR1	.	4.8460	12.0000	.
---- VAR FR29	.	4.8460	12.0000	.
---- VAR FSC401	0.1000	0.4587	5.0000	.
---- VAR FSC403	0.1000	0.3148	3.0000	.
---- VAR FSC404	0.1000	0.3148	3.0000	.
---- VAR FSC406	.	1.4706	3.0000	.
---- VAR FSC407	.	1.4706	3.0000	.
---- VAR FSC408	0.0500	1.4706	3.2000	.
---- VAR FSC409	0.0500	1.4706	3.2000	.
---- VAR FSC412	0.1020	0.1439	1.0000	.
---- VAR FSC414	.	4.7975272E-5	0.5000	.
---- VAR FSTME602	0.1000	0.2118	1.0000	.
---- VAR FSTME695A	.	0.4038	10.0000	.
---- VAR FSTME695B	0.1000	0.1000	10.0000	-340.5316
---- VAR FSTME696A	0.0100	0.1142	10.0000	.
---- VAR FSTME696B	0.0100	0.0190	10.0000	.
---- VAR FVHC28	.	2.9122	8.0000	.
---- VAR FVHC29	.	0.5897	12.0000	.
---- VAR FVHC30	.	0.7618	12.0000	.
---- VAR FVHC31	.	3.7087	12.0000	.
---- VAR FVR1	.	2.3225	12.0000	.
---- VAR FVR29	.	2.9468	12.0000	.
---- VAR H1C601	0.8000	1.0638	2.0000	.
---- VAR H1C603	-3.0000	-0.3655	1.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR H1C606A	.	0.9921	10.0000	.
---- VAR H2C601	0.3950	0.6979	5.0000	.
---- VAR H3C601	0.5000	2.2985	6.0000	.
---- VAR H3C603	.	0.2650	1.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR H3C606A	-65.0000	-65.0000	-35.0000	-0.0002
---- VAR H4C601	0.4500	0.7114	2.0000	.
---- VAR H4C603	.	0.3365	1.0000	.
---- VAR H4C606A	-10.0000	-5.99963E-20	1.0000	.
---- VAR H5C601	0.5000	0.9443	1.5000	.
---- VAR H5C603	.	0.4400	1.5000	.
---- VAR H5C606A	-5.0000	0.4867	2.0000	.
---- VAR H6C601	0.5000	0.9672	3.0000	.
---- VAR H7C601	0.5000	1.0062	1.5000	.
---- VAR H7C603	.	0.5113	1.5000	.
---- VAR H7C606A	.	0.5519	1.0000	.
---- VAR HAC02	.	9.6649	10000.0000	.
---- VAR HAC05	10.0000	354.6816	10000.0000	.
---- VAR HAC07	10.0000	364.3465	10000.0000	.
---- VAR HAC09	10.0000	1366.4582	10000.0000	.
---- VAR HAC12	.	8.1937	10000.0000	.
---- VAR HAC15	10.0000	374.6660	10000.0000	.
---- VAR HAC18	10.0000	382.8597	10000.0000	.
---- VAR HAC20	10.0000	1076.1438	10000.0000	.
---- VAR HAC23	.	7.0620	10000.0000	.
---- VAR HAC26	10.0000	717.1264	10000.0000	.
---- VAR HAC29	10.0000	724.1884	10000.0000	.
---- VAR HAC31	10.0000	1509.4617	10000.0000	.
---- VAR HAC34	.	6.2820	10000.0000	.
---- VAR HAC37	10.0000	538.9715	10000.0000	.
---- VAR HAC40	10.0000	545.2535	10000.0000	.
---- VAR HAC42	10.0000	1456.4752	10000.0000	.
---- VAR HACAC09	10.0000	445.9795	10000.0000	.
---- VAR HACAC20	10.0000	399.8959	10000.0000	.
---- VAR HACAC31	10.0000	733.2773	10000.0000	.
---- VAR HACAC42	10.0000	685.6993	10000.0000	.
---- VAR HC301	10.0000	3259.6087	10000.0000	.
---- VAR HC302	.	324.8391	5000.0000	.
---- VAR HC303	0.0001	3584.4478	10000.0000	.
---- VAR HC306	0.0001	4675.3384	10000.0000	.
---- VAR HC307	0.0001	3128.1527	10000.0000	.
---- VAR HC308	0.0001	1998.4013	10000.0000	.
---- VAR HC309	0.0001	1954.0900	10000.0000	.
---- VAR HC310	0.0001	693.6764	5000.0000	.
---- VAR HC311	0.0010	1260.4136	10000.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 155
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR HC312	0.0001	1640.5462	10000.0000	.
---- VAR HC312LIQ	.	1129.7514	10000.0000	.
---- VAR HC315	0.0001	1034.0568	10000.0000	.
---- VAR HC316	0.0001	1210.7225	10000.0000	.
---- VAR HC317	0.0001	1238.7144	10000.0000	.
---- VAR HC318	0.0001	1062.0487	10000.0000	.
---- VAR HC319	0.0001	969.4326	10000.0000	.
---- VAR HC321	.	47.4076	5000.0000	.
---- VAR HC322	0.0001	895.8203	5000.0000	.
---- VAR HC323	.	584.7248	10000.0000	.
---- VAR HC324	0.0001	775.1915	10000.0000	.
---- VAR HC325	0.0001	773.4379	10000.0000	.
---- VAR HC326	0.0001	538.1101	5000.0000	.
---- VAR HC329	0.0001	502.2361	5000.0000	.
---- VAR HC401	.	1222.9616	5000.0000	.
---- VAR HC402	10.0000	1230.0497	10000.0000	.
---- VAR HC403	0.0001	1294.6622	10000.0000	.
---- VAR HC404	0.0001	1347.0794	10000.0000	.
---- VAR HC405	0.0001	751.3369	5000.0000	.
---- VAR HC406	0.0001	698.9197	5000.0000	.
---- VAR HC407	0.0001	509.0253	5000.0000	.
---- VAR HC408	0.0001	2553.6794	10000.0000	.
---- VAR HC408VAP	10.0000	3329.0390	10000.0000	.
---- VAR HC409	0.0001	3521.0390	10000.0000	.
---- VAR HC410	0.0001	608.7064	10000.0000	.
---- VAR HC410VAP	10.0000	853.7388	10000.0000	.
---- VAR HC411	10.0000	894.4285	10000.0000	.
---- VAR HC412	0.0001	41.9762	5000.0000	.
---- VAR HC412LIQ	1.0000	30.3886	1000.0000	.
---- VAR HC413	0.0001	23.5844	5000.0000	.
---- VAR HC414	0.0001	2833.5880	10000.0000	.
---- VAR HC414LIQ	10.0000	1994.4218	10000.0000	.
---- VAR HC415	0.0001	1761.4453	5000.0000	.
---- VAR HC417	0.0001	82.0847	5000.0000	.
---- VAR HC418	0.0001	1843.5300	10000.0000	.
---- VAR HC419	0.0001	1823.0505	10000.0000	.
---- VAR HC425	10.0000	2767.4661	10000.0000	.
---- VAR HC426	10.0000	2158.7597	5000.0000	.
---- VAR HC427	.	3010.0998	10000.0000	.
---- VAR HC428	10.0000	2115.6713	10000.0000	.
---- VAR HC430	10.0000	2735.3920	10000.0000	.
---- VAR HC431	10.0000	2975.4635	10000.0000	.
---- VAR HC432	10.0000	2933.4873	10000.0000	.
---- VAR HC623	10.0000	86.7552	5000.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 156
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR HC625	10.0000	10.0000	5000.0000	-0.0003
---- VAR HC627	10.0000	10.0000	5000.0000	-0.0006
---- VAR HC629	10.0000	140.9275	5000.0000	.
---- VAR HHC01	.	470.9653	5000.0000	.
---- VAR HHC02	.	463.8772	5000.0000	.
---- VAR HHC03	1.0000	1870.4581	10000.0000	.
---- VAR HHC04	10.0000	1805.8456	10000.0000	.
---- VAR HHC05	10.0000	1744.7563	10000.0000	.
---- VAR HHC06	10.0000	2208.6335	10000.0000	.
---- VAR HHC07	10.0000	600.2049	5000.0000	.
---- VAR HHC11	10.0000	536.1429	5000.0000	.
---- VAR HHC14	10.0000	536.1429	5000.0000	.
---- VAR HHC16	10.0000	536.1429	5000.0000	.
---- VAR HHC29	20.0000	845.1483	10000.0000	.
---- VAR HHC30	20.0000	906.2376	10000.0000	.
---- VAR HHC31	100.0000	4482.5703	10000.0000	.
---- VAR HHC32	.	935.5745	5000.0000	.
---- VAR HHC34	.	315.1517	5000.0000	.
---- VAR HHC38	.	147.1412	5000.0000	.
---- VAR HHC41	.	239.1304	5000.0000	.
---- VAR HHC45	.	234.1512	5000.0000	.
---- VAR HLHC29	.	328.5750	10000.0000	.
---- VAR HLHC30	.	239.1871	10000.0000	.
---- VAR HLHC31	20.0000	1222.9616	10000.0000	.
---- VAR HLR1	.	1294.1055	10000.0000	.
---- VAR HLR29	10.0000	969.8760	10000.0000	.
---- VAR HR1	.	3328.6500	10000.0000	.
---- VAR HR29	20.0000	3576.3327	10000.0000	.
---- VAR HSC401	10.0000	279.8453	10000.0000	.
---- VAR HSC402	10.0000	284.0376	10000.0000	.
---- VAR HSC403	10.0000	204.7536	10000.0000	.
---- VAR HSC404	10.0000	200.5613	10000.0000	.
---- VAR HSC405	10.0000	175.9339	10000.0000	.
---- VAR HSC406	0.1000	956.5194	10000.0000	.
---- VAR HSC407	10.0000	1410.8739	10000.0000	.
---- VAR HSC408	10.0000	1354.1002	10000.0000	.
---- VAR HSC409	10.0000	908.0290	5000.0000	.
---- VAR HSC411	10.0000	819.1895	5000.0000	.
---- VAR HSC412	10.0000	88.8395	10000.0000	.
---- VAR HSC413	10.0000	82.0611	10000.0000	.
---- VAR HSC414	.	0.0236	500.0000	.
---- VAR HVHC29	10.0000	516.5734	10000.0000	.
---- VAR HVHC30	10.0000	667.0506	10000.0000	.
---- VAR HVHC31	20.0000	3259.6087	10000.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR HVR1	.	2034.5445	10000.0000	.
---- VAR HVR29	10.0000	2606.4566	10000.0000	.
---- VAR K1C323	1.0000	2.0354	3.0000	.
---- VAR K1C325	0.5000	1.0000	2.0000	.
---- VAR K1C408	1.0000	7.9557	15.0000	.
---- VAR K1C414	1.0000	2.5362	4.0000	.
---- VAR K1C428	.	4.2370	10.0000	.
---- VAR K1C430	1.0000	3.7549	6.0000	.
---- VAR K1C601	1.5000	2.6034	3.0000	.
---- VAR K1C603	1.0000	1.2665	3.0000	.
---- VAR K1C606A	1.0000	1.8218	3.0000	.
---- VAR K1C606C	1.0000	4.1667	7.0000	.
---- VAR K1C614B	2.0000	3.2880	3.5000	.
---- VAR K1C615_A	0.5000	2.3914	4.0000	.
---- VAR K1C616_A	0.5000	2.8252	5.0000	.
---- VAR K1E633	1.0000	4.0740	5.5000	.
---- VAR K1E6XX	1.0000	4.0370	5.5000	.
---- VAR K1SC406	2.0000	3.6174	5.0000	.
---- VAR K1SC408	1.5000	2.4874	3.5000	.
---- VAR K2C601	0.5000	0.7617	1.0000	.
---- VAR K2E633	0.2000	1.1530	1.5000	.
---- VAR K2E6XX	0.2000	1.1425	1.5000	.
---- VAR K2SC406	0.5000	1.1373	1.2000	.
---- VAR K2SC408	0.5000	0.7204	1.0000	.
---- VAR K3C323	0.5000	0.8944	1.5000	.
---- VAR K3C325	0.0100	0.4011	1.5000	.
---- VAR K3C408	1.0000	3.8360	6.0000	.
---- VAR K3C414	0.5000	1.0578	3.0000	.
---- VAR K3C428	.	1.8859	5.0000	.
---- VAR K3C430	1.0000	1.6462	5.0000	.
---- VAR K3C601	0.5000	1.0389	2.0000	.
---- VAR K3C603	0.5000	0.5239	1.0000	.
---- VAR K3C606A	0.5000	0.7277	3.0000	.
---- VAR K3C606C	1.0000	1.8481	5.0000	.
---- VAR K3C614B	0.6000	1.0405	1.5000	.
---- VAR K3C615_A	0.1000	0.9748	2.0000	.
---- VAR K3C616_A	0.1000	1.0094	2.0000	.
---- VAR K3E633	0.3000	1.3727	2.0000	.

---- VAR K3E6XX	0.3000	1.3602	3.0000	.
---- VAR K3SC406	1.0000	1.5069	2.0000	.
---- VAR K3SC408	0.7000	0.9866	1.5000	.
---- VAR K4C323	0.5000	0.6793	1.0000	.
---- VAR K4C325	0.0300	0.2894	1.0000	.
---- VAR K4C408	1.0000	3.0229	5.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 158
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR K4C414	0.5000	0.7808	2.0000	.
---- VAR K4C428	.	1.4416	5.0000	.
---- VAR K4C430	0.5000	1.2488	3.0000	.
---- VAR K4C601	0.2000	0.7472	1.0000	.
---- VAR K4C603	0.1000	0.3849	1.0000	.
---- VAR K4C606A	0.1000	0.5237	3.0000	.
---- VAR K4C606C	1.0000	1.4103	4.0000	.
---- VAR K4C614B	0.5000	0.6541	1.0000	.
---- VAR K4C615_A	0.0500	0.7037	1.5000	.
---- VAR K4C616_A	0.0500	0.6776	1.5000	.
---- VAR K4E633	0.2000	0.9005	1.5000	.
---- VAR K4E6XX	0.2000	0.8923	1.5000	.
---- VAR K4SC406	0.8000	1.1115	1.5000	.
---- VAR K4SC408	0.5000	0.7071	1.0000	.
---- VAR K5C323	0.1000	0.3108	0.6000	.
---- VAR K5C325	0.1000	0.1194	0.6000	.
---- VAR K5C408	0.5000	1.5088	3.0000	.
---- VAR K5C414	0.1000	0.3372	2.0000	.
---- VAR K5C428	.	0.6686	2.0000	.
---- VAR K5C430	0.2000	0.5700	1.5000	.
---- VAR K5C601	0.1000	0.3065	0.5000	.
---- VAR K5C603	0.0100	0.1647	0.5000	.
---- VAR K5C606A	0.1000	0.2151	1.0000	.
---- VAR K5C606C	0.1000	0.6517	1.2000	.
---- VAR K5C614B	0.0500	0.1859	0.8000	.
---- VAR K5C615_A	0.0020	0.2696	1.0000	.
---- VAR K5C616_A	0.0020	0.2215	1.0000	.
---- VAR K5E633	0.0500	0.3075	1.0000	.
---- VAR K5E6XX	0.0500	0.3047	1.0000	.
---- VAR K5SC406	0.1000	0.4794	0.6000	.
---- VAR K5SC408	0.2000	0.2880	0.6000	.
---- VAR K6C601	0.1000	0.2384	1.0000	.
---- VAR K6SC406	.	0.3815	0.5000	.
---- VAR K6SC408	0.1000	0.2233	0.5000	.
---- VAR K7C323	0.1000	0.1213	0.3000	.
---- VAR K7C325	0.0010	0.0399	0.2000	.
---- VAR K7C408	0.1000	0.6737	1.0000	.
---- VAR K7C414	0.0500	0.1205	1.0000	.
---- VAR K7C428	.	0.2663	2.0000	.
---- VAR K7C430	.	0.2216	1.0000	.
---- VAR K7C601	0.0100	0.1015	0.5000	.
---- VAR K7C603	0.0100	0.0580	0.5000	.
---- VAR K7C606A	0.0500	0.0713	0.5000	.
---- VAR K7C614B	0.0010	0.0456	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 159
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR K7C615_A	0.0010	0.1025	1.0000	.
---- VAR K7C616_A	0.0110	0.0668	1.0000	.
---- VAR K7E633	0.0100	0.0747	0.1000	.
---- VAR K7E6XX	0.0100	0.0740	0.1000	.
---- VAR K7SC406	0.1000	0.1710	0.3000	.
---- VAR K7SC408	0.0500	0.0943	0.2000	.
---- VAR KP1C601	1.0000	3.1476	5.0000	.
---- VAR KP1C603	1.0000	1.7975	3.0000	.
---- VAR KP1C606A	1.0000	2.2725	5.0000	.
---- VAR KP1C606D	1.0000	6.1168	12.0000	.
---- VAR KP2C601	0.5000	0.9604	1.5000	.
---- VAR KP3C601	1.0000	1.2878	2.0000	.
---- VAR KP3C603	0.5000	0.7776	1.5000	.
---- VAR KP3C606A	0.5000	0.9345	3.0000	.
---- VAR KP3C606D	1.0000	2.8514	5.0000	.
---- VAR KP4C601	0.5000	0.9400	1.5000	.
---- VAR KP4C603	0.2000	0.5858	1.0000	.
---- VAR KP4C606A	0.1000	0.6841	3.0000	.
---- VAR KP4C606D	1.0000	2.2235	5.0000	.
---- VAR KP5C601	0.1000	0.3971	1.0000	.
---- VAR KP5C603	0.1000	0.2635	0.5000	.
---- VAR KP5C606A	0.1000	0.2907	1.0000	.
---- VAR KP5C606D	1.0000	1.0786	5.0000	.
---- VAR KP6C601	0.1000	0.3131	1.0000	.
---- VAR KP7C601	0.0100	0.1373	1.0000	.
---- VAR KP7C603	0.0100	0.1002	0.3000	.
---- VAR KP7C606A	0.0500	0.1014	0.5000	.
---- VAR KP7C606D	0.1000	0.4605	5.0000	.
---- VAR KWAD1	50.0000	171.1066	300.0000	.
---- VAR KWAD2	105.0000	288.8934	355.0000	.

---- VAR LPC601	1.0000	1.7854	5.0000	.
---- VAR LPC603	1.0000	2.4984	10.0000	.
---- VAR LPC606A	0.5000	2.7522	5.0000	.
---- VAR PC303	101.0000	101.0000	140.0000	-0.0032
---- VAR PC306	650.0000	870.0000	900.0000	.
---- VAR PC307	600.0000	800.0000	850.0000	.
---- VAR PC308	600.0000	800.0000	800.0000	0.0006
---- VAR PC309	580.0000	780.0000	780.0000	.
---- VAR PC311	260.0000	260.0000	400.0000	-0.0001
---- VAR PC312	600.0000	800.0000	850.0000	.
---- VAR PHC30	101.0000	132.0436	140.0000	EPS
---- VAR PHC32	101.0000	101.0000	200.0000	.
---- VAR PR29	101.0000	133.2555	140.0000	.
---- VAR PROFIT	10.0000	29.1128	10000.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR Q2HC07	.	0.0387	1.0000	.
---- VAR Q2HC11	.	0.0346	1.0000	.
---- VAR Q2HC14	.	0.0346	1.0000	.
---- VAR Q2HC16	.	0.0346	1.0000	.
---- VAR QFP1C606A	.	0.0243	1.0000	.
---- VAR QFP3C606A	.	0.0024	0.1000	.
---- VAR QFP4C606A	.	0.8557	1.0000	.
---- VAR QFP5C606A	.	0.6016	1.0000	.
---- VAR QFP7C606A	.	0.2539	1.0000	.
---- VAR QS1C606A	.	0.7801	1.0000	.
---- VAR QS3C606A	.	0.5164	1.0000	.
---- VAR QS4C606A	.	0.0502	0.5000	.
---- VAR QS5C606A	.	0.0276	0.5500	.
---- VAR QS7C606A	.	0.0052	0.1600	.
---- VAR R10C623	.	.	0.1000	.
---- VAR R10C625	.	.	0.1000	.
---- VAR R10C627	.	1.4078353E-6	0.1000	.
---- VAR R10C629	.	1.1954751E-6	0.1000	.
---- VAR R2C623	.	0.0097	0.8320	.
---- VAR R2C625	.	0.0087	0.8320	.
---- VAR R2C627	.	0.0087	0.8320	.
---- VAR R2C629	.	0.0087	0.8320	.
---- VAR R3C623	.	0.0112	0.1500	.
---- VAR R3C625	.	0.0102	0.1500	.
---- VAR R3C627	.	0.0102	0.1500	.
---- VAR R3C629	.	0.0102	0.1500	.
---- VAR R4C623	.	0.0015	0.0300	.
---- VAR R4C625	.	0.0015	0.0300	.
---- VAR R4C627	.	0.0015	0.0300	.
---- VAR R4C629	.	0.0014	0.0300	.
---- VAR R5C623	.	8.5081000E-6	0.3000	.
---- VAR R5C625	.	1.2019948E-5	0.3000	.
---- VAR R5C627	.	2.0557128E-5	0.3000	.
---- VAR R5C629	.	1.7021917E-5	0.3000	.
---- VAR R7C623	.	.	0.0500	.
---- VAR R7C625	.	.	0.0500	.
---- VAR R7C627	.	.	0.0500	.
---- VAR R7C629	.	.	0.0500	.
---- VAR R8C623	.	8.9334292E-6	0.1000	.
---- VAR R8C625	.	1.2406103E-5	0.1000	.
---- VAR R8C627	.	2.0681053E-5	0.1000	.
---- VAR R8C629	.	1.7308833E-5	0.1000	.
---- VAR R9C623	.	0.0097	0.1000	.
---- VAR R9C625	.	0.0087	0.1000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR R9C627	.	0.0087	0.1000	.
---- VAR R9C629	.	0.0087	0.1000	.
---- VAR RHO2HC07	610.0000	650.0000	650.0000	0.0317
---- VAR RHO2HC11	610.0000	650.0000	650.0000	0.0284
---- VAR RHO2HC14	610.0000	650.0000	650.0000	0.0285
---- VAR RHO2HC16	610.0000	650.0000	650.0000	0.0287
---- VAR RHOAC09	1500.0000	1700.0000	1700.0000	0.0002
---- VAR RHOAC20	1500.0000	1700.0000	1700.0000	0.0002
---- VAR RHOAC31	1500.0000	1700.0000	1700.0000	0.0002
---- VAR RHOAC42	1500.0000	1700.0000	1700.0000	0.0002
---- VAR RIC10C623	.	.	0.3000	.
---- VAR RIC10C625	.	.	0.3000	.
---- VAR RIC10C627	.	.	0.3000	.
---- VAR RIC10C629	.	.	0.3000	.
---- VAR RIC11C623	.	.	0.1000	.
---- VAR RIC11C625	.	.	0.1000	.
---- VAR RIC11C627	.	1.1922910E-6	0.1000	.
---- VAR RIC11C629	.	.	0.1000	.
---- VAR SF1S34	0.0001	0.0270	1.0000	.
---- VAR SF2S34	.	0.0489	1.0000	.
---- VAR SFS11	0.1000	0.5000	0.8000	.
---- VAR SFS19	0.1000	0.4941	0.8000	.

---- VAR SFS2	0.1000	0.7975	1.0000	.
---- VAR SFS23	0.1000	0.6817	0.8000	.
---- VAR SFS27	0.1000	0.5053	0.8000	.
---- VAR SFS41	0.0001	0.9859	1.0000	.
---- VAR SFS42	0.0001	0.7800	1.0000	.
---- VAR SFS5	0.1000	0.2718	0.5000	.
---- VAR SFS7	0.1000	0.3333	0.8000	.
---- VAR SM1C601	1.0000	2.5926	5.0000	.
---- VAR SM1C603	0.0500	0.5764	1.0000	.
---- VAR SM1C606A	0.1000	2.4236	5.0000	.
---- VAR SM1C606D	1.0000	2.9391	5.0000	.
---- VAR SM2C601	0.5000	0.7910	1.0000	.
---- VAR SM3C601	0.5000	1.0607	2.0000	.
---- VAR SM3C603	0.0010	0.2493	0.5000	.
---- VAR SM3C606A	0.1000	0.9966	5.0000	.
---- VAR SM3C606D	1.0000	1.3082	10.0000	.
---- VAR SM4C601	0.4000	0.7743	1.5000	.
---- VAR SM4C603	0.0100	0.1878	0.5000	.
---- VAR SM4C606A	0.1000	0.7296	5.0000	.
---- VAR SM4C606D	0.5000	1.0000	5.0000	.
---- VAR SM5C601	0.1000	0.3270	0.6000	.
---- VAR SM5C603	0.0100	0.0845	0.5000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR SM5C606A	0.0500	0.3100	5.0000	.
---- VAR SM5C606D	0.1000	0.4638	5.0000	.
---- VAR SM6C601	0.1000	0.2579	1.0000	.
---- VAR SM7C601	0.0100	0.1131	0.2000	.
---- VAR SM7C603	0.0010	0.0321	0.2000	.
---- VAR SM7C606A	0.0010	0.1081	5.0000	.
---- VAR SM7C606D	0.1000	0.1847	5.0000	.
---- VAR SN1C601	1.0000	2.8857	5.0000	.
---- VAR SN1C603	1.0000	1.3570	3.0000	.
---- VAR SN1C606A	1.0000	3.4785	20.0000	.
---- VAR SN2C601	0.5000	0.8443	1.5000	.
---- VAR SN3C601	0.5000	1.1515	1.5000	.
---- VAR SN3C603	0.5000	0.5613	1.5000	.
---- VAR SN3C606A	1.0000	1.3895	15.0000	.
---- VAR SN4C601	0.5000	0.8282	1.0000	.
---- VAR SN4C603	0.2000	0.4124	1.0000	.
---- VAR SN4C606A	0.8000	1.0000	10.0000	.
---- VAR SN5C601	0.1000	0.3398	0.8000	.
---- VAR SN5C603	0.1000	0.1764	0.4000	.
---- VAR SN5C606A	0.3000	0.4107	10.0000	.
---- VAR SN6C601	0.1000	0.2643	1.0000	.
---- VAR SN7C601	0.0100	0.1125	0.5000	.
---- VAR SN7C603	0.0100	0.0622	0.5000	.
---- VAR SN7C606A	0.1000	0.1362	5.0000	.
---- VAR TAC02	276.0000	276.0000	290.0000	-2.925791E-5
---- VAR TAC05	273.0000	280.0000	300.0000	.
---- VAR TAC07	273.0000	280.0006	300.0000	.
---- VAR TAC15	273.0000	280.0000	300.0000	.
---- VAR TAC18	273.0000	280.0611	300.0000	.
---- VAR TAC20	280.0000	280.0000	300.0000	-0.0019
---- VAR TAC26	273.0000	280.0000	300.0000	.
---- VAR TAC29	273.0000	280.1146	300.0000	.
---- VAR TAC37	273.0000	280.0000	300.0000	.
---- VAR TAC40	273.0000	280.0363	300.0000	.
---- VAR TC301	200.0000	282.6006	300.0000	.
---- VAR TC302	250.0000	261.9077	290.0000	.
---- VAR TC309	270.0000	322.9752	350.0000	.
---- VAR TC310	200.0000	288.1849	310.0000	.
---- VAR TC311	270.0000	288.1849	310.0000	.
---- VAR TC312	300.0000	328.4033	369.0000	.
---- VAR TC318	250.0000	321.5069	365.0000	.
---- VAR TC319	250.0000	300.0000	400.0000	.
---- VAR TC320	250.0000	300.0000	400.0000	.
---- VAR TC322	250.0000	300.0000	400.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR TC323	300.0000	359.0690	420.0000	.
---- VAR TC326	300.0000	322.5997	360.0000	.
---- VAR TC328	300.0000	322.5997	360.0000	.
---- VAR TC329	300.0000	322.5997	375.0000	.
---- VAR TC401	260.0000	282.6006	300.0000	.
---- VAR TC402	270.0000	283.9220	305.0000	.
---- VAR TC403	280.0000	295.8124	320.0000	.
---- VAR TC406	298.0000	389.0844	400.0000	.
---- VAR TC409	400.0000	460.9878	461.0000	.
---- VAR TC411	300.0000	403.7525	418.0000	.
---- VAR TC412	330.0000	363.3260	405.0000	.
---- VAR TC413	250.0000	301.0000	350.0000	.
---- VAR TC415	250.0000	307.2720	400.0000	.
---- VAR TC417	275.0000	299.9913	350.0000	.

---- VAR TC425	300.0000	363.3260	410.0000	.
---- VAR TC426	300.0000	363.3260	410.0000	.
---- VAR TC427	360.0000	375.0766	405.0000	.
---- VAR TC428	300.0000	364.9471	405.0000	.
---- VAR TC430	300.0000	358.0220	400.0000	.
---- VAR TC431	300.0000	363.3260	405.0000	.
---- VAR TC432	350.0000	363.3260	400.0000	.
---- VAR TCWOTE609A	298.0000	308.1986	320.0000	.
---- VAR TCWOTE621A	298.0000	326.6519	355.0000	.
---- VAR TCWOTE621B	298.0000	298.0000	325.0000	-0.0063
---- VAR TCWOTE627A	295.0000	295.0000	360.0000	EPS
---- VAR TCWOTE627B	293.0000	293.0000	310.0000	-0.6540
---- VAR TCWOTE641A	295.0000	318.4033	360.0000	.
---- VAR TCWOTE641B	295.0000	312.9752	325.0000	.
---- VAR TCWOUTE603	296.8360	321.4823	350.0000	.
---- VAR TCWOUTE605	298.0000	305.6485	320.0000	.
---- VAR TCWOUTE611	295.0000	297.3066	350.0000	.
---- VAR TCWOUTE613	298.0000	312.5997	320.0000	.
---- VAR TCWOUTE617	295.0000	319.1717	350.0000	.
---- VAR TCWOUTE626	295.0000	295.0000	310.0000	-0.0030
---- VAR TCWOUTE634	295.0000	340.9683	360.0000	.
---- VAR TCWOUTE640	295.0000	316.3947	330.0000	.
---- VAR THC01	295.0000	296.2800	370.0000	.
---- VAR THC02	275.0000	292.6006	302.0000	.
---- VAR THC03	290.0000	304.2455	360.0000	.
---- VAR THC04	280.0000	296.0857	310.0000	.
---- VAR THC05	270.0000	288.2197	300.0000	.
---- VAR THC06	273.0000	289.0923	300.0000	.
---- VAR THC07	273.0000	289.0923	300.0000	.
---- VAR THC11	273.0000	289.0923	300.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR THC14	273.0000	289.0923	300.0000	.
---- VAR THC16	273.0000	289.0923	300.0000	.
---- VAR THC22	273.0000	280.0000	290.0000	.
---- VAR THC23	273.0000	280.0000	290.0000	.
---- VAR THC24	273.0000	280.0000	290.0000	.
---- VAR THC25	273.0000	280.0000	290.0000	.
---- VAR THC26	273.0000	280.0000	290.0000	.
---- VAR THC27	273.0000	280.0000	290.0000	.
---- VAR THC28	270.0000	280.0000	290.0000	.
---- VAR THC29	270.0000	280.0000	290.0000	.
---- VAR THC30	250.0000	280.0000	300.0000	.
---- VAR THC31	260.0000	282.6006	310.0000	.
---- VAR THC34	250.0000	261.9077	310.0000	.
---- VAR THC38	250.0000	261.9077	310.0000	.
---- VAR THC41	250.0000	261.9077	310.0000	.
---- VAR THC45	250.0000	261.9077	310.0000	.
---- VAR TMC601	315.0000	329.7466	360.0000	.
---- VAR TMC603	350.0000	352.1470	375.0000	.
---- VAR TMC606A	327.0000	331.6356	370.0000	.
---- VAR TMC606D	370.0000	387.4735	400.0000	.
---- VAR TMK601	273.0000	307.0119	333.0000	.
---- VAR TNC601	310.0000	320.8163	340.0000	.
---- VAR TNC603	320.0000	333.9124	375.0000	.
---- VAR TNC606A	310.0000	321.1676	370.0000	.
---- VAR TR1	270.0000	280.0000	290.0000	.
---- VAR TR29	260.0000	280.0000	300.0000	.
---- VAR TSC401	280.0000	319.2902	350.0000	.
---- VAR TSC404	310.0000	331.4823	365.0000	.
---- VAR TSC406	320.0000	336.6046	360.0000	.
---- VAR TSC407	320.0000	336.6046	400.0000	.
---- VAR TSC409	308.0000	318.7440	360.0000	.
---- VAR TSC411	308.0000	318.7440	375.0000	.
---- VAR TSC412	308.0000	318.7440	360.0000	.
---- VAR TSC414	275.0000	275.0000	320.0000	-3.485868E-7
---- VAR UTILITIES	-10000.0000	8.2029	10000.0000	.
---- VAR VFC614B	0.1000	0.1628	0.8000	.
---- VAR VFC615	0.0010	0.3596	0.6000	.
---- VAR VFC616	0.0500	0.2507	1.0000	.
---- VAR VFM3	.	0.4793	0.5500	.
---- VAR VPC601	1.0000	1.4706	5.0000	.
---- VAR VPC603	0.0100	0.8012	3.0000	.
---- VAR VPC606A	0.1000	2.9352	10.0000	.
---- VAR X10AC09	.	.	0.1000	.
---- VAR X10AC20	.	.	0.1000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X10AC31	.	.	0.1000	.
---- VAR X10AC42	.	.	0.1000	.
---- VAR X11AC02	0.9700	0.9980	0.9980	702.6718
---- VAR X11AC05	0.8900	0.9687	0.9990	.
---- VAR X11AC07	0.8900	0.9693	0.9990	.
---- VAR X11AC09	.	0.7743	1.0000	.

---- VAR X11AC15	0.8900	0.9424	0.9990	.
---- VAR X11AC18	0.8900	0.9429	0.9990	.
---- VAR X11AC20	.	0.8186	1.0000	.
---- VAR X11AC26	0.8900	0.9162	0.9990	.
---- VAR X11AC29	0.8900	0.9164	0.9990	.
---- VAR X11AC31	.	0.8472	1.0000	.
---- VAR X11AC37	0.8900	0.8900	0.9990	-708.3909
---- VAR X11AC40	0.8900	0.8903	0.9990	.
---- VAR X11AC42	.	0.8091	1.0000	.
---- VAR X12AC02	0.0020	0.0020	0.0300	.
---- VAR X12AC05	0.0010	0.0313	0.1100	.
---- VAR X12AC07	0.0010	0.0307	0.1100	.
---- VAR X12AC09	.	0.0251	0.1000	.
---- VAR X12AC12	0.0010	0.0313	0.1200	.
---- VAR X12AC15	0.0010	0.0576	0.1100	.
---- VAR X12AC18	0.0010	0.0571	0.1100	.
---- VAR X12AC20	.	0.0500	0.1000	.
---- VAR X12AC23	0.0010	0.0576	0.1200	.
---- VAR X12AC26	0.0010	0.0838	0.1100	.
---- VAR X12AC29	0.0010	0.0836	0.1100	.
---- VAR X12AC31	.	0.0775	0.1000	.
---- VAR X12AC34	0.0010	0.0838	0.1200	.
---- VAR X12AC37	0.0010	0.1100	0.1100	.
---- VAR X12AC40	0.0010	0.1097	0.1100	.
---- VAR X12AC42	.	0.1000	0.1000	4.6738
---- VAR X12AC45	0.0010	0.1100	0.1200	.
---- VAR X1AC09	.	0.0090	0.1000	.
---- VAR X1AC20	.	0.0065	0.1000	.
---- VAR X1AC31	.	0.0035	0.1000	.
---- VAR X1AC42	.	0.0042	0.1000	.
---- VAR X1C301	.	0.0671	0.2000	.
---- VAR X1C302	.	0.0780	0.2000	.
---- VAR X1C303	0.0500	0.0681	0.2200	.
---- VAR X1C306	.	0.0721	0.5000	.
---- VAR X1C307	.	0.0721	0.5000	.
---- VAR X1C308	.	0.0472	0.4000	.
---- VAR X1C309	.	0.0472	0.5000	.
---- VAR X1C310	.	0.0931	0.5000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 166
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X1C311	.	0.0318	0.2000	.
---- VAR X1C312	.	0.1166	1.0000	.
---- VAR X1C315	0.0001	0.1166	1.0000	.
---- VAR X1C317	.	0.0882	0.3000	.
---- VAR X1C318	0.0001	0.0882	0.3000	.
---- VAR X1C319	0.0001	0.0882	0.1000	.
---- VAR X1C320	.	0.0882	0.1000	.
---- VAR X1C321	0.0001	0.0882	0.1000	.
---- VAR X1C322	.	0.0882	0.1500	.
---- VAR X1C323	.	0.0882	0.2000	.
---- VAR X1C324	.	0.0882	0.3000	.
---- VAR X1C326	0.4000	1.0000	1.0000	.
---- VAR X1C328	0.4000	1.0000	1.0000	.
---- VAR X1C329	0.4000	1.0000	1.0000	.
---- VAR X1C401	.	0.0147	0.2000	.
---- VAR X1C402	.	0.0147	0.2000	.
---- VAR X1C403	.	0.0147	0.2000	.
---- VAR X1C404	.	0.0147	0.2000	.
---- VAR X1C405	.	.	0.0100	.
---- VAR X1C406	.	.	0.0100	.
---- VAR X1C407	.	.	0.0100	.
---- VAR X1C408	.	.	1.0000	.
---- VAR X1C409	.	.	0.0100	.
---- VAR X1C410	0.0001	0.0003	1.0000	.
---- VAR X1C411	.	0.0003	0.1000	.
---- VAR X1C412	.	0.0015	0.0500	.
---- VAR X1C413	.	0.0015	0.1000	.
---- VAR X1C414	.	0.0586	0.2500	.
---- VAR X1C415	.	0.0586	0.2000	.
---- VAR X1C418	.	0.0569	0.3000	.
---- VAR X1C419	0.0001	0.0569	0.2000	.
---- VAR X1C425	.	0.0003	0.1000	.
---- VAR X1C426	.	0.0003	0.1000	.
---- VAR X1C427	.	0.0004	1.0000	.
---- VAR X1C428	.	0.0005	0.1000	.
---- VAR X1C430	.	0.0005	0.1000	.
---- VAR X1C431	.	0.0015	0.1000	.
---- VAR X1C432	.	0.0015	0.1000	.
---- VAR X1HC01	0.0010	0.0592	0.3000	.
---- VAR X1HC02	.	0.0592	0.3000	.
---- VAR X1HC03	0.0001	0.0577	0.2000	.
---- VAR X1HC04	.	0.0577	0.2000	.
---- VAR X1HC05	.	0.0577	0.2000	.
---- VAR X1HC06	.	0.0580	0.2000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 167
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X1HC07	.	0.0580	0.2000	.
---- VAR X1HC08	.	0.0580	0.2000	.
---- VAR X1HC11	.	0.0580	0.2000	.
---- VAR X1HC14	.	0.0580	0.2000	.
---- VAR X1HC15	.	0.0580	0.2000	.
---- VAR X1HC16	.	0.0580	0.2000	.
---- VAR X1HC22	.	0.0464	0.5000	.
---- VAR X1HC23	.	0.0463	0.5000	.
---- VAR X1HC24	.	0.0464	0.5000	.
---- VAR X1HC25	.	0.0497	0.5000	.
---- VAR X1HC26	.	0.0474	0.5000	.
---- VAR X1HC27	.	0.0450	0.5000	.
---- VAR X1HC28	.	0.0187	0.2000	.
---- VAR X1HC29	.	0.0187	0.2000	.
---- VAR X1HC30	.	0.0144	0.2000	.
---- VAR X1HC31	.	0.0147	0.1000	.
---- VAR X1HC33	.	0.0228	0.1000	.
---- VAR X1HC34	.	0.0228	0.1000	.
---- VAR X1HC38	.	0.0228	0.1000	.
---- VAR X1HC40	.	0.0228	0.1000	.
---- VAR X1HC41	.	0.0228	0.1000	.
---- VAR X1HC45	.	0.0228	0.1000	.
---- VAR X1R1	.	0.0187	0.1000	.
---- VAR X1R29	.	0.0147	0.2000	.
---- VAR X1SC401	.	0.0063	0.1000	.
---- VAR X1SC404	.	.	0.1000	.
---- VAR X1SC405	.	.	0.1000	.
---- VAR X1SC406	.	.	0.1000	.
---- VAR X1SC407	.	.	0.1000	.
---- VAR X1SC409	.	0.0200	0.1000	.
---- VAR X1SC411	.	0.0200	0.1000	.
---- VAR X1SC412	.	0.0200	0.1000	.
---- VAR X1SC413	.	0.0200	0.1000	.
---- VAR X1SC414	.	.	0.1000	.
---- VAR X2AC09	.	.	1.0000	.
---- VAR X2AC20	.	.	1.0000	.
---- VAR X2AC31	.	.	1.0000	.
---- VAR X2AC42	.	.	1.0000	.
---- VAR X2C301	.	.	0.0100	.
---- VAR X2C417	.	3.3333333E-5	0.1000	.
---- VAR X2C418	.	0.0009	0.1000	.
---- VAR X2C419	.	0.0009	0.1000	.
---- VAR X2HC01	0.1000	0.1000	0.7000	.
---- VAR X2HC02	0.1000	0.1000	1.0000	-467.4856

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X2HC03	.	0.0009	0.1000	.
---- VAR X2HC04	.	0.0009	0.1000	.
---- VAR X2HC05	.	0.0009	0.1000	.
---- VAR X2HC06	.	0.0225	0.1500	.
---- VAR X2HC07	.	0.0225	0.1500	.
---- VAR X2HC08	.	0.0225	0.1500	.
---- VAR X2HC11	.	0.0225	0.1500	.
---- VAR X2HC14	.	0.0225	0.1500	.
---- VAR X2HC15	.	0.0225	0.1500	.
---- VAR X2HC16	.	0.0225	0.1500	.
---- VAR X2HC22	.	.	0.1000	.
---- VAR X2HC23	.	.	0.1000	.
---- VAR X2HC24	.	.	0.1000	.
---- VAR X2HC25	.	.	0.1000	.
---- VAR X2HC26	.	.	0.1000	.
---- VAR X2HC27	.	.	0.1000	.
---- VAR X2HC28	.	.	0.1000	.
---- VAR X2HC29	.	.	0.1000	.
---- VAR X2HC30	.	.	0.1000	.
---- VAR X2HC31	.	.	0.1000	EPS
---- VAR X2R1	.	.	0.1000	.
---- VAR X2R29	.	.	0.1000	.
---- VAR X2SC401	.	.	0.1000	.
---- VAR X2SC404	.	.	0.1000	.
---- VAR X2SC405	.	.	0.1000	.
---- VAR X2SC406	.	.	0.1000	.
---- VAR X2SC407	.	.	0.1000	.
---- VAR X2SC409	.	.	0.1000	.
---- VAR X2SC411	.	.	0.1000	.
---- VAR X2SC412	.	.	0.1000	.
---- VAR X2SC413	.	.	0.1000	.
---- VAR X2SC414	.	0.1000	0.1000	0.0240
---- VAR X3AC09	.	0.1350	0.7000	.
---- VAR X3AC20	.	0.0859	0.7000	.
---- VAR X3AC31	.	0.0503	0.7000	.
---- VAR X3AC42	.	0.0606	0.7000	.
---- VAR X3C301	0.5000	0.7721	1.0000	.
---- VAR X3C302	0.4500	0.8214	1.0000	.
---- VAR X3C303	0.5000	0.7767	0.8000	.
---- VAR X3C306	.	0.7813	1.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X3C307	.	0.7813	1.0000	.
---- VAR X3C308	.	0.7791	1.0000	.
---- VAR X3C309	0.2000	0.7791	0.8000	.
---- VAR X3C310	.	0.8052	1.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X3C311	.	0.7703	1.0000	.
---- VAR X3C312	.	0.7851	1.0000	.
---- VAR X3C315	0.0001	0.7851	1.0000	.
---- VAR X3C317	0.5000	0.8104	1.0000	.
---- VAR X3C318	0.0001	0.8104	1.0000	.
---- VAR X3C319	0.0001	0.8104	1.0000	.
---- VAR X3C320	0.0001	0.8104	1.0000	.
---- VAR X3C321	0.0001	0.8104	1.0000	.
---- VAR X3C322	.	0.8104	1.0000	.
---- VAR X3C323	0.5000	0.8104	0.9500	.
---- VAR X3C324	0.5000	0.8104	0.9500	.
---- VAR X3C326	.	1.5978930E-6	0.5000	.
---- VAR X3C328	.	1.5969259E-6	0.5000	.
---- VAR X3C329	.	1.5978930E-6	0.5000	.
---- VAR X3C401	.	0.5001	1.0000	.
---- VAR X3C402	.	0.5001	0.8000	.
---- VAR X3C403	0.0001	0.5001	1.0000	.
---- VAR X3C404	0.0001	0.5001	1.0000	.
---- VAR X3C405	.	1.6916491E-5	0.1000	.
---- VAR X3C406	.	1.6916491E-5	0.0100	.
---- VAR X3C407	.	1.6916491E-5	0.0100	.
---- VAR X3C408	.	1.6916491E-5	1.0000	.
---- VAR X3C409	.	1.6916491E-5	0.0100	.
---- VAR X3C410	0.0001	0.0010	0.1000	.
---- VAR X3C411	0.0001	0.0010	0.2000	.
---- VAR X3C412	.	0.0020	0.1000	.
---- VAR X3C413	.	0.0020	0.1000	.
---- VAR X3C414	0.5000	0.8198	1.0000	.
---- VAR X3C415	.	0.8198	1.0000	.
---- VAR X3C418	0.0001	0.8269	1.0000	.
---- VAR X3C419	0.0001	0.8269	1.0000	.
---- VAR X3C425	.	0.0010	0.1000	.
---- VAR X3C426	0.0001	0.0010	0.1000	.
---- VAR X3C427	.	0.0013	1.0000	.
---- VAR X3C428	.	0.0014	0.3000	.
---- VAR X3C430	.	0.0015	0.1000	.
---- VAR X3C431	.	0.0020	0.1000	.
---- VAR X3C432	.	0.0020	0.1000	.
---- VAR X3HC01	0.0100	0.0100	0.6000	-179.0197
---- VAR X3HC02	.	0.0100	0.5000	.
---- VAR X3HC03	0.1000	0.8264	1.0000	.
---- VAR X3HC04	0.1000	0.8264	1.0000	.
---- VAR X3HC05	0.1000	0.8264	1.0000	.
---- VAR X3HC06	0.3000	0.6485	1.0000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X3HC07	0.3000	0.6485	1.0000	.
---- VAR X3HC08	0.3000	0.6485	1.0000	.
---- VAR X3HC11	0.3000	0.6485	1.0000	.
---- VAR X3HC14	0.3000	0.6485	1.0000	.
---- VAR X3HC15	0.3000	0.6485	1.0000	.
---- VAR X3HC16	0.3000	0.6485	1.0000	.
---- VAR X3HC22	0.1000	0.6670	0.9000	.
---- VAR X3HC23	0.1000	0.6676	0.9000	.
---- VAR X3HC24	0.1000	0.6673	0.9000	.
---- VAR X3HC25	0.1000	0.6540	0.9000	.
---- VAR X3HC26	0.1000	0.6633	0.9000	.
---- VAR X3HC27	0.1000	0.6730	0.9000	.
---- VAR X3HC28	0.1000	0.5617	0.6000	.
---- VAR X3HC29	0.1000	0.5617	0.6000	.
---- VAR X3HC30	0.1000	0.4951	0.6000	.
---- VAR X3HC31	0.1000	0.5001	0.6000	.
---- VAR X3HC33	0.1000	0.7604	1.0000	.
---- VAR X3HC34	0.1000	0.7604	1.0000	.
---- VAR X3HC38	0.1000	0.7604	1.0000	.
---- VAR X3HC40	0.1000	0.7604	1.0000	.
---- VAR X3HC41	0.1000	0.7604	1.0000	.
---- VAR X3HC45	0.1000	0.7604	1.0000	.
---- VAR X3R1	.	0.5617	0.6000	.
---- VAR X3R29	0.1000	0.5014	0.6000	.
---- VAR X3SC401	0.2000	0.3216	0.4000	.
---- VAR X3SC404	.	0.0234	0.1000	.
---- VAR X3SC405	.	0.0234	0.1000	.
---- VAR X3SC406	.	0.0234	0.1000	.
---- VAR X3SC407	.	0.0234	0.1000	.
---- VAR X3SC409	0.5000	0.9739	1.0000	.
---- VAR X3SC411	0.5000	0.9739	1.0000	.
---- VAR X3SC412	0.5000	0.9739	1.0000	.

---- VAR X3SC413	0.5000	0.9739	1.0000	.
---- VAR X3SC414	0.5000	0.5000	1.0000	-0.0001
---- VAR X4AC09	.	0.0235	0.2000	.
---- VAR X4AC20	.	0.0148	0.2000	.
---- VAR X4AC31	.	0.0087	0.2000	.
---- VAR X4AC42	.	0.0105	0.2000	.
---- VAR X4C301	.	0.1161	0.5000	.
---- VAR X4C302	.	0.0951	0.5000	.
---- VAR X4C303	0.0500	0.1142	0.2000	.
---- VAR X4C306	.	0.1108	0.8000	.
---- VAR X4C307	.	0.1108	0.8000	.
---- VAR X4C308	.	0.1228	0.5000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 171
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X4C309	.	0.1228	0.4000	.
---- VAR X4C310	.	0.0932	0.3000	.
---- VAR X4C311	.	0.1328	0.5000	.
---- VAR X4C312	.	0.0894	1.0000	.
---- VAR X4C315	0.0001	0.0894	0.3000	.
---- VAR X4C317	.	0.0922	0.2000	.
---- VAR X4C318	0.0001	0.0922	0.3000	.
---- VAR X4C319	0.0001	0.0922	0.3000	.
---- VAR X4C320	0.0001	0.0922	0.3000	.
---- VAR X4C321	0.0001	0.0922	0.3000	.
---- VAR X4C322	.	0.0922	0.4000	.
---- VAR X4C323	0.0100	0.0922	0.2500	.
---- VAR X4C324	0.0100	0.0922	0.2500	.
---- VAR X4C325	.	.	0.1000	.
---- VAR X4C326	.	.	0.1000	.
---- VAR X4C328	.	.	0.1000	.
---- VAR X4C329	.	.	0.1000	.
---- VAR X4C401	0.0010	0.1147	0.5000	.
---- VAR X4C402	0.0010	0.1147	0.5000	.
---- VAR X4C403	0.0001	0.1147	0.3000	.
---- VAR X4C404	0.0001	0.1147	0.3000	.
---- VAR X4C405	0.0001	0.0605	0.2000	.
---- VAR X4C406	.	0.0605	0.2000	.
---- VAR X4C407	0.0100	0.0605	0.3000	.
---- VAR X4C408	.	0.0605	0.2000	.
---- VAR X4C409	.	0.0605	0.3000	.
---- VAR X4C410	0.0001	0.5357	1.0000	.
---- VAR X4C411	.	0.5357	1.0000	.
---- VAR X4C412	0.5000	0.8408	1.0000	.
---- VAR X4C413	0.0001	0.8408	1.0000	.
---- VAR X4C414	0.0100	0.1083	0.2500	.
---- VAR X4C415	0.0001	0.1083	0.3000	.
---- VAR X4C418	0.0001	0.1036	0.3000	.
---- VAR X4C419	0.0001	0.1036	0.3000	.
---- VAR X4C425	.	0.5357	1.0000	.
---- VAR X4C426	0.0001	0.5357	1.0000	.
---- VAR X4C427	.	0.6849	1.0000	.
---- VAR X4C428	.	0.7456	1.0000	.
---- VAR X4C430	0.5000	0.6543	1.0000	.
---- VAR X4C431	0.0001	0.8408	1.0000	.
---- VAR X4C432	0.5000	0.8408	1.0000	.
---- VAR X4HC01	.	0.0886	0.2500	.
---- VAR X4HC02	.	0.0886	0.2500	.
---- VAR X4HC03	.	0.1033	0.3000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 172
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X4HC04	.	0.1033	0.5000	.
---- VAR X4HC05	.	0.1033	0.5000	.
---- VAR X4HC06	.	0.1001	0.4000	.
---- VAR X4HC07	.	0.1001	0.4000	.
---- VAR X4HC08	.	0.1001	0.4000	.
---- VAR X4HC11	.	0.1001	0.4000	.
---- VAR X4HC14	.	0.1001	0.4000	.
---- VAR X4HC15	.	0.1001	0.4000	.
---- VAR X4HC16	.	0.1001	0.4000	.
---- VAR X4HC22	.	0.1158	0.5000	.
---- VAR X4HC23	.	0.1161	0.5000	.
---- VAR X4HC24	.	0.1159	0.5000	.
---- VAR X4HC25	.	0.1125	0.5000	.
---- VAR X4HC26	.	0.1149	0.5000	.
---- VAR X4HC27	.	0.1172	0.5000	.
---- VAR X4HC28	.	0.1207	0.5000	.
---- VAR X4HC29	.	0.1207	0.3000	.
---- VAR X4HC30	.	0.1140	0.3000	.
---- VAR X4HC31	.	0.1147	0.3000	.
---- VAR X4HC33	.	0.1401	0.5000	.
---- VAR X4HC34	.	0.1401	0.5000	.
---- VAR X4HC38	.	0.1401	0.5000	.
---- VAR X4HC40	.	0.1401	0.5000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X4HC41	.	0.1401	0.5000	.
---- VAR X4HC45	.	0.1401	0.5000	.
---- VAR X4R1	.	0.1207	0.3000	.
---- VAR X4R29	0.0100	0.1148	0.3000	.
---- VAR X4SC401	0.5000	0.5280	0.7000	.
---- VAR X4SC404	0.4800	0.7666	1.0000	.
---- VAR X4SC405	0.4800	0.7666	1.0000	.
---- VAR X4SC406	0.7000	0.7666	1.0000	.
---- VAR X4SC407	0.7000	0.7666	1.0000	.
---- VAR X4SC409	.	0.0061	0.1000	.
---- VAR X4SC411	.	0.0061	0.1000	.
---- VAR X4SC412	.	0.0061	0.1000	.
---- VAR X4SC413	.	0.0061	0.1000	.
---- VAR X4SC414	.	0.1000	0.1000	0.0094
---- VAR X5AC09	.	0.0062	0.1000	.
---- VAR X5AC20	.	0.0041	0.1000	.
---- VAR X5AC31	.	0.0023	0.1000	.
---- VAR X5AC42	.	0.0028	0.1000	.
---- VAR X5C301	.	0.0179	0.2000	.
---- VAR X5C302	.	0.0056	0.1000	.
---- VAR X5C303	.	0.0167	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 173
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X5C306	.	0.0150	0.6000	.
---- VAR X5C307	.	0.0150	0.6000	.
---- VAR X5C308	.	0.0202	0.2000	.
---- VAR X5C309	.	0.0202	0.2000	.
---- VAR X5C310	.	0.0057	0.1000	.
---- VAR X5C311	.	0.0250	0.2000	.
---- VAR X5C312	.	0.0056	0.4000	.
---- VAR X5C315	0.0001	0.0056	0.1000	.
---- VAR X5C317	.	0.0058	0.1000	.
---- VAR X5C318	0.0001	0.0058	0.1000	.
---- VAR X5C319	0.0001	0.0058	0.1000	.
---- VAR X5C320	.	0.0058	0.1000	.
---- VAR X5C321	0.0001	0.0058	0.1000	.
---- VAR X5C322	.	0.0058	0.1000	.
---- VAR X5C323	0.0020	0.0058	0.1000	.
---- VAR X5C324	0.0020	0.0058	0.1000	.
---- VAR X5C325	.	.	0.0100	.
---- VAR X5C326	.	.	0.0100	.
---- VAR X5C328	.	.	0.0100	.
---- VAR X5C329	.	.	0.0100	.
---- VAR X5C401	.	0.0516	0.5000	.
---- VAR X5C402	.	0.0516	0.5000	.
---- VAR X5C403	0.0001	0.0516	0.2000	.
---- VAR X5C404	.	0.0516	0.2000	.
---- VAR X5C405	.	0.1335	0.2000	.
---- VAR X5C406	.	0.1335	0.2000	.
---- VAR X5C407	.	0.1335	0.2000	.
---- VAR X5C408	.	0.1335	0.2000	.
---- VAR X5C409	.	0.1335	0.3000	.
---- VAR X5C410	0.0001	0.0932	1.0000	.
---- VAR X5C411	.	0.0932	1.0000	.
---- VAR X5C412	.	0.0676	0.1000	.
---- VAR X5C413	.	0.0676	0.3000	.
---- VAR X5C414	.	0.0013	0.1000	.
---- VAR X5C415	.	0.0013	0.1000	.
---- VAR X5C418	.	0.0012	0.1000	.
---- VAR X5C419	0.0001	0.0012	0.1000	.
---- VAR X5C425	.	0.0932	1.0000	.
---- VAR X5C426	0.0001	0.0932	1.0000	.
---- VAR X5C427	.	0.0805	1.0000	.
---- VAR X5C428	.	0.0754	0.4000	.
---- VAR X5C430	.	0.0833	0.1000	.
---- VAR X5C431	.	0.0676	0.2000	.
---- VAR X5C432	.	0.0676	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 174
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X5HC01	.	0.1422	0.1500	.
---- VAR X5HC02	.	0.1422	0.1500	.
---- VAR X5HC03	.	0.0013	0.1000	.
---- VAR X5HC04	.	0.0013	0.3000	.
---- VAR X5HC05	.	0.0013	0.3000	.
---- VAR X5HC06	.	0.0320	0.3000	.
---- VAR X5HC07	.	0.0320	0.3000	.
---- VAR X5HC08	.	0.0320	0.3000	.
---- VAR X5HC11	.	0.0320	0.3000	.
---- VAR X5HC14	.	0.0320	0.3000	.
---- VAR X5HC15	.	0.0320	0.3000	.
---- VAR X5HC16	.	0.0320	0.3000	.
---- VAR X5HC22	.	0.0310	0.5000	.
---- VAR X5HC23	.	0.0310	0.5000	.
---- VAR X5HC24	.	0.0310	0.5000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X5HC25	.	0.0313	0.5000	.
---- VAR X5HC26	.	0.0311	0.5000	.
---- VAR X5HC27	.	0.0309	0.5000	.
---- VAR X5HC28	.	0.0463	0.5000	.
---- VAR X5HC29	0.0100	0.0463	0.3000	.
---- VAR X5HC30	.	0.0520	0.3000	.
---- VAR X5HC31	.	0.0516	0.3000	.
---- VAR X5HC33	.	0.0288	2.5000	.
---- VAR X5HC34	.	0.0288	2.5000	.
---- VAR X5HC38	.	0.0288	2.5000	.
---- VAR X5HC40	.	0.0288	2.5000	.
---- VAR X5HC41	.	0.0288	2.5000	.
---- VAR X5HC45	.	0.0288	2.5000	.
---- VAR X5R1	.	0.0463	0.3000	.
---- VAR X5R29	0.0100	0.0516	0.4000	.
---- VAR X5SC401	0.0080	0.0686	0.1000	.
---- VAR X5SC404	.	0.1000	0.1000	.
---- VAR X5SC405	.	0.1000	0.1000	1.9580
---- VAR X5SC406	0.0100	0.1000	0.1000	.
---- VAR X5SC407	0.0100	0.1000	0.1000	.
---- VAR X5SC409	.	.	0.1000	.
---- VAR X5SC411	.	.	0.1000	.
---- VAR X5SC412	.	.	0.1000	.
---- VAR X5SC413	.	.	0.1000	.
---- VAR X5SC414	.	0.1000	0.1000	0.0094
---- VAR X6SC401	.	0.0686	0.1000	.
---- VAR X6SC404	.	0.1000	0.1200	.
---- VAR X6SC405	.	0.1000	0.1000	3.4527
---- VAR X6SC406	.	0.1000	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 175
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X6SC407	.	0.1000	0.1000	.
---- VAR X6SC409	.	.	0.1000	.
---- VAR X6SC411	.	.	0.1000	.
---- VAR X6SC412	.	.	0.1000	.
---- VAR X6SC413	.	.	0.1000	.
---- VAR X6SC414	.	0.1000	0.1000	0.0240
---- VAR X7AC09	.	0.0211	0.1000	.
---- VAR X7AC20	.	0.0154	0.1000	.
---- VAR X7AC31	.	0.0082	0.1000	.
---- VAR X7AC42	.	0.0099	0.1000	.
---- VAR X7C301	.	0.0268	0.1000	.
---- VAR X7C302	.	.	0.3000	.
---- VAR X7C303	.	0.0243	0.1000	.
---- VAR X7C306	.	0.0208	0.8000	.
---- VAR X7C307	.	0.0208	0.8000	.
---- VAR X7C308	.	0.0307	0.3000	.
---- VAR X7C309	.	0.0307	0.3000	.
---- VAR X7C310	.	0.0028	0.2000	.
---- VAR X7C311	.	0.0401	1.0000	.
---- VAR X7C312	.	0.0033	0.5000	.
---- VAR X7C315	.	0.0033	0.0100	.
---- VAR X7C316	.	0.0033	0.0100	.
---- VAR X7C317	.	0.0034	0.1000	.
---- VAR X7C318	.	0.0034	0.1500	.
---- VAR X7C319	.	0.0034	0.1500	.
---- VAR X7C320	.	0.0034	0.1000	.
---- VAR X7C321	.	0.0034	0.1000	.
---- VAR X7C322	.	0.0034	0.1000	.
---- VAR X7C323	.	0.0034	0.0200	.
---- VAR X7C324	.	0.0034	0.1000	.
---- VAR X7C325	.	.	0.2000	.
---- VAR X7C326	.	.	0.2000	.
---- VAR X7C328	.	.	0.2000	.
---- VAR X7C329	.	.	0.1000	.
---- VAR X7C401	.	0.3189	1.0000	.
---- VAR X7C402	.	0.3189	0.6000	.
---- VAR X7C403	0.0001	0.3189	1.0000	.
---- VAR X7C404	0.0001	0.3189	1.0000	.
---- VAR X7C405	0.0001	0.8059	1.0000	.
---- VAR X7C406	0.0010	0.8059	1.0000	.
---- VAR X7C407	0.0100	0.8059	1.0000	.
---- VAR X7C408	.	0.8059	1.0000	.
---- VAR X7C409	.	0.8059	1.0000	.
---- VAR X7C410	0.0001	0.3698	1.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 176
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X7C411	.	0.3698	1.0000	.
---- VAR X7C412	.	0.0882	0.2000	.
---- VAR X7C413	.	0.0882	0.3000	.
---- VAR X7C414	.	0.0120	0.1000	.
---- VAR X7C415	.	0.0120	0.1000	.
---- VAR X7C417	0.0001	0.0001	0.0800	-38.1402
---- VAR X7C418	0.0001	0.0106	0.1000	.

---- VAR X7C419	.	0.0106	0.1000	.
---- VAR X7C425	0.2000	0.3698	1.0000	.
---- VAR X7C426	0.0001	0.3698	1.0000	.
---- VAR X7C427	.	0.2328	1.0000	.
---- VAR X7C428	.	0.1771	0.5000	.
---- VAR X7C430	.	0.2603	0.3500	.
---- VAR X7C431	.	0.0882	0.3000	.
---- VAR X7C432	.	0.0882	0.3000	.
---- VAR X7HC01	.	0.6000	0.6000	.
---- VAR X7HC02	.	0.6000	0.6000	34.0552
---- VAR X7HC03	.	0.0104	0.1000	.
---- VAR X7HC04	.	0.0104	0.2500	.
---- VAR X7HC05	.	0.0104	0.2500	.
---- VAR X7HC06	.	0.1389	0.3000	.
---- VAR X7HC07	.	0.1389	0.3000	.
---- VAR X7HC08	.	0.1389	0.3000	.
---- VAR X7HC11	.	0.1389	0.3000	.
---- VAR X7HC14	.	0.1389	0.3000	.
---- VAR X7HC15	.	0.1389	0.3000	.
---- VAR X7HC16	.	0.1389	0.3000	.
---- VAR X7HC22	.	0.1397	0.5000	.
---- VAR X7HC23	.	0.1391	0.5000	.
---- VAR X7HC24	.	0.1394	0.5000	.
---- VAR X7HC25	.	0.1525	0.5000	.
---- VAR X7HC26	.	0.1434	0.5000	.
---- VAR X7HC27	.	0.1340	0.5000	.
---- VAR X7HC28	.	0.2525	0.5000	.
---- VAR X7HC29	0.1000	0.2525	0.5000	.
---- VAR X7HC30	0.1000	0.3246	0.5000	.
---- VAR X7HC31	0.1000	0.3189	0.6000	.
---- VAR X7HC33	.	0.0479	2.0000	.
---- VAR X7HC34	.	0.0479	2.0000	.
---- VAR X7HC38	.	0.0479	2.0000	.
---- VAR X7HC40	.	0.0479	2.0000	.
---- VAR X7HC41	.	0.0479	2.0000	.
---- VAR X7HC45	.	0.0479	2.0000	.
---- VAR X7R1	.	0.2525	0.5000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR X7R29	0.1000	0.3175	0.6000	.
---- VAR X7SC401	.	0.0069	0.1000	.
---- VAR X7SC404	.	0.0100	0.1200	.
---- VAR X7SC405	.	0.0100	0.1200	.
---- VAR X7SC406	.	0.0100	0.0100	2.9674
---- VAR X7SC407	.	0.0100	0.1000	.
---- VAR X7SC409	.	.	0.1000	.
---- VAR X7SC411	.	.	0.1000	.
---- VAR X7SC412	.	.	0.1000	.
---- VAR X7SC413	.	.	0.1000	.
---- VAR X7SC414	.	0.1000	0.1000	0.0240
---- VAR X8AC09	.	4.6550938E-6	0.1000	.
---- VAR X8AC20	.	5.7557385E-6	0.1000	.
---- VAR X8AC31	.	4.7975916E-6	0.1000	.
---- VAR X8AC42	.	4.8789678E-6	0.1000	.
---- VAR X9AC09	.	0.0058	0.3000	.
---- VAR X9AC20	.	0.0046	0.3000	.
---- VAR X9AC31	.	0.0023	0.3000	.
---- VAR X9AC42	.	0.0028	0.3000	.
---- VAR XAC02	0.4000	0.4999	1.0000	.
---- VAR XAC05	0.4000	0.4978	1.0000	.
---- VAR XAC07	0.4000	0.4979	1.0000	.
---- VAR XAC09	0.4000	0.4809	1.0000	.
---- VAR XAC12	0.4000	0.4978	1.0000	.
---- VAR XAC15	0.4000	0.4959	1.0000	.
---- VAR XAC18	0.4000	0.4959	1.0000	.
---- VAR XAC20	0.4000	0.4854	1.0000	.
---- VAR XAC23	0.4000	0.4959	1.0000	.
---- VAR XAC26	0.4000	0.4938	1.0000	.
---- VAR XAC29	0.4000	0.4939	1.0000	.
---- VAR XAC31	0.4000	0.4880	1.0000	.
---- VAR XAC34	0.4000	0.4938	1.0000	.
---- VAR XAC37	0.4000	0.4917	1.0000	.
---- VAR XAC40	0.4000	0.4917	1.0000	.
---- VAR XAC42	0.4000	0.4844	1.0000	.
---- VAR XIC10AC09	.	.	1.0000	.
---- VAR XIC10AC20	.	.	1.0000	.
---- VAR XIC10AC31	.	.	1.0000	.
---- VAR XIC10AC42	.	.	1.0000	.
---- VAR XIC11AC09	.	.	1.0000	.
---- VAR XIC11AC20	.	.	1.0000	.
---- VAR XIC11AC31	.	.	1.0000	.
---- VAR XIC11AC42	.	.	1.0000	.
---- VAR XM1C606D	.	0.0002	0.5000	.

LOWER	LEVEL	UPPER	MARGINAL

---- VAR XM3C606D	.	0.0008	0.5000	.
---- VAR XM4C606D	.	0.5575	0.6500	.
---- VAR XM5C606D	.	0.0980	0.5000	.
---- VAR XM7C606D	.	0.3436	1.0000	.
---- VAR XX1C302	.	0.1003	0.2500	.
---- VAR XX1C308	.	0.0621	0.5000	.
---- VAR XX1C310	.	0.1193	0.5000	.
---- VAR XX1C311	.	0.0422	0.3000	.
---- VAR XX1C312	.	0.1485	1.0000	.
---- VAR XX1C323	.	0.1133	0.2000	.
---- VAR XX1C325	0.4000	1.0000	1.0000	.
---- VAR XX1C405	.	.	0.0100	.
---- VAR XX1C408	.	.	1.0000	.
---- VAR XX1C425	.	0.0005	1.0000	.
---- VAR XX1C428	.	0.0006	1.0000	.
---- VAR XX1C430	.	0.0007	0.5000	.
---- VAR XX1C431	.	0.0020	0.1000	.
---- VAR XX1HC28	0.0100	0.0270	0.2000	.
---- VAR XX1HC29	.	0.0270	0.2000	.
---- VAR XX1HC30	0.0100	0.0213	0.2000	.
---- VAR XX1HC32	.	0.0305	0.1000	.
---- VAR XX1R1	.	0.0270	0.2000	.
---- VAR XX1R29	.	0.0218	0.1000	.
---- VAR XX1SC406	.	.	0.2000	.
---- VAR XX1SC408	.	0.0262	0.1000	.
---- VAR XX2HC28	.	.	0.1000	.
---- VAR XX2HC29	.	.	0.1000	.
---- VAR XX2HC30	.	.	0.1000	-0.0576
---- VAR XX2R1	.	.	0.1000	.
---- VAR XX2R29	.	.	0.1000	EPS
---- VAR XX2SC406	.	.	0.1000	.
---- VAR XX2SC408	.	.	1.0000	.
---- VAR XX3C302	0.5000	0.8024	1.0000	.
---- VAR XX3C308	.	0.7783	1.0000	.
---- VAR XX3C310	.	0.7837	1.0000	.
---- VAR XX3C311	.	0.7764	1.0000	.
---- VAR XX3C312	.	0.7587	1.0000	.
---- VAR XX3C323	0.5000	0.7900	0.9200	.
---- VAR XX3C325	.	1.2128590E-6	0.5000	.
---- VAR XX3C405	.	2.3780783E-5	0.1000	.
---- VAR XX3C408	.	2.3780783E-5	1.0000	.
---- VAR XX3C425	.	0.0011	1.0000	.
---- VAR XX3C428	.	0.0015	1.0000	.
---- VAR XX3C430	.	0.0017	0.1000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR XX3C431	.	0.0021	0.5000	.
---- VAR XX3C432	.	0.0021	0.1500	.
---- VAR XX3HC28	0.2000	0.6141	0.8000	.
---- VAR XX3HC29	0.1000	0.6141	0.8000	.
---- VAR XX3HC30	0.1000	0.5571	0.6000	.
---- VAR XX3HC32	0.3000	0.7712	1.0000	.
---- VAR XX3R1	0.1000	0.6141	0.8000	.
---- VAR XX3R29	0.1000	0.5626	0.6000	.
---- VAR XX3SC406	.	0.0245	0.1000	.
---- VAR XX3SC408	0.5000	0.9678	1.0000	.
---- VAR XX4C302	.	0.0929	0.5000	.
---- VAR XX4C308	.	0.1227	0.5000	.
---- VAR XX4C310	.	0.0907	0.3000	.
---- VAR XX4C311	.	0.1338	0.5000	.
---- VAR XX4C312	.	0.0863	0.1500	.
---- VAR XX4C323	0.0800	0.0899	0.2800	.
---- VAR XX4C325	.	.	0.0500	.
---- VAR XX4C405	0.0001	0.0851	0.2000	.
---- VAR XX4C408	.	0.0851	0.3000	.
---- VAR XX4C409	0.0001	0.0851	0.3000	.
---- VAR XX4C425	.	0.6219	1.0000	.
---- VAR XX4C427	.	0.7538	1.0000	.
---- VAR XX4C428	.	0.8037	1.0000	.
---- VAR XX4C430	0.5000	0.7278	1.0000	.
---- VAR XX4C431	0.0001	0.8771	1.0000	.
---- VAR XX4C432	0.5000	0.8771	1.0000	.
---- VAR XX4HC28	0.0100	0.1320	0.3000	.
---- VAR XX4HC29	0.0100	0.1320	0.3000	.
---- VAR XX4HC30	0.0100	0.1283	0.3000	.
---- VAR XX4HC32	.	0.1421	0.5000	.
---- VAR XX4R1	.	0.1320	0.3000	.
---- VAR XX4R29	0.0100	0.1288	0.3000	.
---- VAR XX4SC406	0.6000	0.8003	1.0000	.
---- VAR XX4SC408	.	0.0060	0.0500	.
---- VAR XX5C302	.	0.0044	0.1000	.
---- VAR XX5C308	.	0.0163	0.8000	.
---- VAR XX5C310	.	0.0045	0.1000	.
---- VAR XX5C311	.	0.0203	0.1000	.
---- VAR XX5C312	.	0.0044	0.3000	.
---- VAR XX5C323	0.0010	0.0046	0.1500	.
---- VAR XX5C325	.	.	0.0010	.

---- VAR XX5C405	0.0001	0.1512	0.2000	.
---- VAR XX5C408	.	0.1512	0.3000	.
---- VAR XX5C425	.	0.0872	1.0000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 180
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR XX5C428	.	0.0655	1.0000	.
---- VAR XX5C430	.	0.0747	1.0000	.
---- VAR XX5C431	.	0.0568	1.0000	.
---- VAR XX5HC28	0.0100	0.0408	0.3000	.
---- VAR XX5HC29	.	0.0408	0.3000	.
---- VAR XX5HC30	.	0.0471	0.3000	.
---- VAR XX5HC32	.	0.0235	0.2000	.
---- VAR XX5R1	.	0.0408	0.3000	.
---- VAR XX5R29	.	0.0466	0.3000	.
---- VAR XX5SC406	.	0.0841	0.1500	.
---- VAR XX5SC408	.	.	0.1000	.
---- VAR XX6SC406	.	0.0841	0.1000	.
---- VAR XX6SC408	.	.	1.0000	-4.0268
---- VAR XX7C302	.	.	0.2000	-0.7740
---- VAR XX7C308	.	0.0207	0.1000	.
---- VAR XX7C310	.	0.0018	0.1000	.
---- VAR XX7C311	.	0.0272	0.3000	.
---- VAR XX7C312	.	0.0021	0.1000	.
---- VAR XX7C323	0.0020	0.0022	0.1000	.
---- VAR XX7C325	.	.	0.1000	-31.8651
---- VAR XX7C405	0.0001	0.7636	1.0000	.
---- VAR XX7C408	.	0.7636	1.0000	.
---- VAR XX7C425	.	0.2893	1.0000	.
---- VAR XX7C428	.	0.1287	1.0000	.
---- VAR XX7C430	.	0.1952	1.0000	.
---- VAR XX7C431	.	0.0620	1.0000	.
---- VAR XX7HC28	0.1000	0.1861	0.4000	.
---- VAR XX7HC29	.	0.1861	0.5000	.
---- VAR XX7HC30	0.1000	0.2462	0.5000	.
---- VAR XX7HC32	.	0.0327	0.2000	.
---- VAR XX7R1	0.1000	0.1861	0.5000	.
---- VAR XX7R29	0.1000	0.2402	0.5000	.
---- VAR XX7SC406	.	0.0070	0.1000	.
---- VAR XX7SC408	.	.	0.1000	.
---- VAR Y1HC28	0.0500	0.0771	0.5000	.
---- VAR Y1HC29	0.0500	0.0771	0.5000	.
---- VAR Y1HC30	0.0500	0.0665	0.5000	.
---- VAR Y1HC31	0.0500	0.0671	0.4000	.
---- VAR Y1R1	.	0.0771	0.5000	.
---- VAR Y1R29	0.0500	0.0673	0.5000	.
---- VAR Y2HC28	.	.	0.1000	.
---- VAR Y2HC29	.	.	0.1000	.
---- VAR Y2HC30	.	.	0.1000	.
---- VAR Y2HC31	.	.	0.1000	.

_Economic Optimization Program 05/15/01 16:49:39 PAGE 181
GAMS 2.50A Windows NT/95/98

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR Y2R1	.	.	0.1000	.
---- VAR Y2R29	.	.	0.1000	.
---- VAR Y3HC28	0.2000	0.7795	0.9000	.
---- VAR Y3HC29	0.1000	0.7795	0.9000	.
---- VAR Y3HC30	0.1000	0.7713	0.8500	.
---- VAR Y3HC31	0.1000	0.7721	0.8500	.
---- VAR Y3R1	0.1000	0.7795	0.9000	.
---- VAR Y3R29	0.1000	0.7723	0.8500	.
---- VAR Y4HC28	.	0.1099	0.5000	.
---- VAR Y4HC29	.	0.1099	0.3000	.
---- VAR Y4HC30	0.0100	0.1165	0.4000	.
---- VAR Y4HC31	.	0.1161	0.3000	.
---- VAR Y4R1	.	0.1099	0.3000	.
---- VAR Y4R29	.	0.1160	0.5000	.
---- VAR Y5HC28	.	0.0144	0.2000	.
---- VAR Y5HC29	.	0.0144	0.2000	.
---- VAR Y5HC30	.	0.0181	0.2000	.
---- VAR Y5HC31	.	0.0179	0.2000	.
---- VAR Y5R1	.	0.0144	0.2000	.
---- VAR Y5R29	.	0.0178	0.2000	.
---- VAR Y7HC28	0.0100	0.0191	0.5000	.
---- VAR Y7HC29	.	0.0191	0.1000	.
---- VAR Y7HC30	.	0.0275	0.1000	.
---- VAR Y7HC31	.	0.0268	0.2000	.
---- VAR Y7R1	.	0.0191	0.1000	.
---- VAR Y7R29	.	0.0266	0.2000	.
---- VAR YY1HC28	0.1000	0.1000	0.5000	.
---- VAR YY1HC29	0.1000	0.1000	0.6000	.
---- VAR YY1HC30	0.0500	0.0869	0.6000	.
---- VAR YY1R1	0.1000	0.1000	0.6000	-23.5298
---- VAR YY1R29	0.0500	0.0878	0.6000	.
---- VAR YY2HC28	.	.	0.1000	.
---- VAR YY2HC29	.	.	0.1000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR YY2HC30	.	.	0.1000	.
---- VAR YY2R1	.	.	0.1000	.
---- VAR YY2R29	.	.	0.1000	.
---- VAR YY3HC28	0.1000	0.7677	0.9000	.
---- VAR YY3HC29	0.1000	0.7677	0.8000	.
---- VAR YY3HC30	0.1000	0.7647	0.8000	.
---- VAR YY3R1	0.1000	0.7677	0.8000	.
---- VAR YY3R29	0.1000	0.7652	0.8000	.
---- VAR YY4HC28	0.0100	0.1082	0.3000	.
---- VAR YY4HC29	0.0100	0.1082	0.3000	.
---- VAR YY4HC30	0.0100	0.1155	0.3000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR YY4R1	.	0.1082	0.3000	.
---- VAR YY4R29	0.0100	0.1150	0.3000	.
---- VAR YY5HC28	0.0010	0.0114	0.2000	.
---- VAR YY5HC29	.	0.0114	0.2000	.
---- VAR YY5HC30	.	0.0145	0.1000	.
---- VAR YY5R1	.	0.0114	0.2000	.
---- VAR YY5R29	.	0.0142	0.2000	.
---- VAR YY7HC28	.	0.0127	0.2000	.
---- VAR YY7HC29	.	0.0127	0.2000	.
---- VAR YY7HC30	.	0.0184	0.1000	.
---- VAR YY7R1	.	0.0127	0.1000	.
---- VAR YY7R29	.	0.0178	0.2000	.

FAC02
FAC12
FAC23
FAC34
FAC45
FC308
FC316
FC320
FC322
FC328
FC329
FC403
FC407
FC412
FC417
FHC01
FHC32
FSC402
FSC405
FSC411
FSC413
FSTME612
PC302
PC310
PC601
PC603
QHC07
QHC11
QHC14
QHC16
QHC34

QHC38
QHC41
QHC45
TAC09
TAC12
TAC23
TAC31
TAC34
TAC42
TAC45
TC303
TC306
TC307
TC308
TC315
TC316
TC317
TC321
TC324
TC325
TC404
TC405
TC407
TC408
TC410
TC414
TC418

TC419
THC32
TSC402
TSC403
TSC405
TSC408
TSC413
X11AC12
X11AC23
X11AC34
X11AC45
X1C316
X1C325
X1C417
X1HC32
X1SC402
X1SC403
X1SC408
X2SC402

X2SC403
X2SC408
X3C316
X3C325
X3C417
X3HC32
X3SC402
X3SC403
X3SC408
X4C316
X4C417
X4HC32
X4SC402
X4SC403
X4SC408
X5C316
X5C417
X5HC32
X5SC402
X5SC403
X5SC408
X6SC402
X6SC403
X6SC408
X7HC32
X7SC402
X7SC403
X7SC408
XX1C322
XX1C414
XX1HC01
XX2HC01
XX3C317
XX3C322
XX3C407
XX3C412
XX3C414
XX3HC01
XX4C317
XX4C322
XX4C407
XX4C412
XX4C414
XX4HC01
XX5C407
XX5C412

XX5C414
XX7C414
OBJVAR objective or profit function
C10PC623
C10PC625
C10PC627
C10PC629
C2C623
C2C625
C2C627
C2C629
C3C623
C3C625
C3C627
C3C629
C3PC623
C3PC625
C3PC627
C3PC629

C4PC623
C4PC625
C4PC627
C4PC629
C5PC623
C5PC625
C5PC627
C5PC629
C7PC623
C7PC625
C7PC627
C7PC629
C8PC623
C8PC625
C8PC627
C8PC629
C9PC623
C9PC625
C9PC627
C9PC629
CHXC623
CHXC625
CHXC627
CHXC629
CIC10PC623
CIC10PC625
CIC10PC627

CIC10PC629
CIC11PC623
CIC11PC625
CIC11PC627
CIC11PC629
CIC4EC623
CIC4EC625
CIC4EC627
CIC4EC629
CIC5EC623
CIC5EC625
CIC5EC627
CIC5EC629
CIC8EC623
CIC8EC625
CIC8EC627
CIC8EC629
COST
DTE601
DTE602
DTE603
DTE605
DTE609A
DTE610
DTE611
DTE612
DTE613
DTE616
DTE617
DTE621A
DTE621B
DTE626
DTE627A
DTE627B
DTE628
DTE629
DTE633
DTE634
DTE640
DTE641
DTE695A
DTE695B
DTE696A
DTE696B
DTE6XX
EARNINGS

F1C601
F1C603
F1C606A
F2C601
F3C601
F3C603
F3C606A
F4C601
F4C603
F4C606A
F5C601

F5C603
F5C606A
F6C601
F7C601
F7C603
F7C606A
FAC05
FAC07
FAC09
FAC15
FAC18
FAC20
FAC26
FAC29
FAC31
FAC37
FAC40
FAC42
FC301
FC302
FC303
FC306
FC307
FC309
FC310
FC311
FC312
FC315
FC317
FC318
FC319
FC321
FC323
FC324
FC325

FC326
FC401
FC402
FC404
FC405
FC406
FC408
FC409
FC410
FC411
FC413
FC414
FC415
FC418
FC419
FC425
FC426
FC427
FC428
FC430
FC431
FC432
FCWE603
FCWE605
FCWE609A
FCWE611
FCWE613
FCWE617
FCWE621A
FCWE621B
FCWE626
FCWE627A
FCWE627B
FCWE634
FCWE640
FCWE641A
FCWE641B
FHC02
FHC03
FHC04
FHC05
FHC06
FHC07
FHC08
FHC11
FHC14

FHC15
FHC16
FHC22

FHC23
FHC24
FHC25
FHC26
FHC27
FHC28
FHC29
FHC30
FHC31
FHC33
FHC34
FHC38
FHC40
FHC41
FHC45
FLHC28
FLHC29
FLHC30
FLHC31
FLR1
FLR29
FMC302
FMC308
FMC310
FMC311
FMC312
FMC317
FMC322
FMC323
FMC325
FMC405
FMC407
FMC408
FMC409
FMC412
FMC414
FMC425
FMC427
FMC428
FMC430
FMC431
FMC432
FMHC01

FMHC32
FMLHC28
FMLHC29
FMLHC30
FMLR1
FMLR29
FMSC403
FMSC406
FMSC408
FMVHC28
FMVHC29
FMVHC30
FMVR1
FMVR29
FR1
FR29
FSC401
FSC403
FSC404
FSC406
FSC407
FSC408
FSC409
FSC412
FSC414
FSTME602
FSTME695A
FSTME695B
FSTME696A
FSTME696B
FVHC28
FVHC29
FVHC30
FVHC31
FVR1
FVR29
H1C601
H1C603
H1C606A
H2C601
H3C601
H3C603
H3C606A
H4C601
H4C603

H4C606A

H5C601
H5C603
H5C606A
H6C601
H7C601
H7C603
H7C606A
HAC02
HAC05
HAC07
HAC09
HAC12
HAC15
HAC18
HAC20
HAC23
HAC26
HAC29
HAC31
HAC34
HAC37
HAC40
HAC42
HACAC09
HACAC20
HACAC31
HACAC42
HC301
HC302
HC303
HC306
HC307
HC308
HC309
HC310
HC311
HC312
HC312LIQ
HC315
HC316
HC317
HC318
HC319
HC321
HC322
HC323

HC324
HC325
HC326
HC329
HC401
HC402
HC403
HC404
HC405
HC406
HC407
HC408
HC408VAP
HC409
HC410
HC410VAP
HC411
HC412
HC412LIQ
HC413
HC414
HC414LIQ
HC415
HC417
HC418
HC419
HC425
HC426
HC427
HC428
HC430
HC431
HC432
HC623
HC625
HC627
HC629

HHC01
HHC02
HHC03
HHC04
HHC05
HHC06
HHC07
HHC11
HHC14

HHC16
HHC29
HHC30
HHC31
HHC32
HHC34
HHC38
HHC41
HHC45
HLHC29
HLHC30
HLHC31
HLR1
HLR29
HR1
HR29
HSC401
HSC402
HSC403
HSC404
HSC405
HSC406
HSC407
HSC408
HSC409
HSC411
HSC412
HSC413
HSC414
HVHC29
HVHC30
HVHC31
HVR1
HVR29
K1C323
K1C325
K1C408
K1C414
K1C428
K1C430
K1C601
K1C603
K1C606A
K1C606C
K1C614B
K1C615_A

K1C616_A
K1E633
K1E6XX
K1SC406
K1SC408
K2C601
K2E633
K2E6XX
K2SC406
K2SC408
K3C323
K3C325
K3C408
K3C414
K3C428
K3C430
K3C601
K3C603
K3C606A
K3C606C
K3C614B
K3C615_A
K3C616_A
K3E633
K3E6XX
K3SC406
K3SC408
K4C323
K4C325

K4C408
K4C414
K4C428
K4C430
K4C601
K4C603
K4C606A
K4C606C
K4C614B
K4C615_A
K4C616_A
K4E633
K4E6XX
K4SC406
K4SC408
K5C323
K5C325

K5C408
K5C414
K5C428
K5C430
K5C601
K5C603
K5C606A
K5C606C
K5C614B
K5C615_A
K5C616_A
K5E633
K5E6XX
K5SC406
K5SC408
K6C601
K6SC406
K6SC408
K7C323
K7C325
K7C408
K7C414
K7C428
K7C430
K7C601
K7C603
K7C606A
K7C614B
K7C615_A
K7C616_A
K7E633
K7E6XX
K7SC406
K7SC408
KP1C601
KP1C603
KP1C606A
KP1C606D
KP2C601
KP3C601
KP3C603
KP3C606A
KP3C606D
KP4C601
KP4C603
KP4C606A

KP4C606D
KP5C601
KP5C603
KP5C606A
KP5C606D
KP6C601
KP7C601
KP7C603
KP7C606A
KP7C606D
KWAD1
KWAD2
LPC601
LPC603
LPC606A
PC303
PC306
PC307
PC308
PC309
PC311

PC312
PHC30
PHC32
PR29
PROFIT
Q2HC07
Q2HC11
Q2HC14
Q2HC16
QFP1C606A
QFP3C606A
QFP4C606A
QFP5C606A
QFP7C606A
QS1C606A
QS3C606A
QS4C606A
QS5C606A
QS7C606A
R10C623
R10C625
R10C627
R10C629
R2C623
R2C625

R2C627
R2C629
R3C623
R3C625
R3C627
R3C629
R4C623
R4C625
R4C627
R4C629
R5C623
R5C625
R5C627
R5C629
R7C623
R7C625
R7C627
R7C629
R8C623
R8C625
R8C627
R8C629
R9C623
R9C625
R9C627
R9C629
RHO2HC07
RHO2HC11
RHO2HC14
RHO2HC16
RHOAC09
RHOAC20
RHOAC31
RHOAC42
RIC10C623
RIC10C625
RIC10C627
RIC10C629
RIC11C623
RIC11C625
RIC11C627
RIC11C629
SF1S34
SF2S34
SFS11
SFS19

SFS2
SFS23
SFS27
SFS41
SFS42
SFS5
SFS7
SM1C601
SM1C603
SM1C606A
SM1C606D
SM2C601
SM3C601

SM3C603
SM3C606A
SM3C606D
SM4C601
SM4C603
SM4C606A
SM4C606D
SM5C601
SM5C603
SM5C606A
SM5C606D
SM6C601
SM7C601
SM7C603
SM7C606A
SM7C606D
SN1C601
SN1C603
SN1C606A
SN2C601
SN3C601
SN3C603
SN3C606A
SN4C601
SN4C603
SN4C606A
SN5C601
SN5C603
SN5C606A
SN6C601
SN7C601
SN7C603
SN7C606A

TAC02
TAC05
TAC07
TAC15
TAC18
TAC20
TAC26
TAC29
TAC37
TAC40
TC301
TC302
TC309
TC310
TC311
TC312
TC318
TC319
TC320
TC322
TC323
TC326
TC328
TC329
TC401
TC402
TC403
TC406
TC409
TC411
TC412
TC413
TC415
TC417
TC425
TC426
TC427
TC428
TC430
TC431
TC432
TCWOTE609A
TCWOTE621A
TCWOTE621B
TCWOTE627A
TCWOTE627B

TCWOTE641A
TCWOTE641B
TCWOUTE603
TCWOUTE605
TCWOUTE611

TCWOUTE613
TCWOUTE617
TCWOUTE626
TCWOUTE634
TCWOUTE640
THC01
THC02
THC03
THC04
THC05
THC06
THC07
THC11
THC14
THC16
THC22
THC23
THC24
THC25
THC26
THC27
THC28
THC29
THC30
THC31
THC34
THC38
THC41
THC45
TMC601
TMC603
TMC606A
TMC606D
TMK601
TNC601
TNC603
TNC606A
TR1
TR29
TSC401
TSC404

TSC406
TSC407
TSC409
TSC411
TSC412
TSC414
UTILITIES
VFC614B
VFC615
VFC616
VFM3
VPC601
VPC603
VPC606A
X10AC09
X10AC20
X10AC31
X10AC42
X11AC02
X11AC05
X11AC07
X11AC09
X11AC15
X11AC18
X11AC20
X11AC26
X11AC29
X11AC31
X11AC37
X11AC40
X11AC42
X12AC02
X12AC05
X12AC07
X12AC09
X12AC12
X12AC15
X12AC18
X12AC20
X12AC23
X12AC26
X12AC29
X12AC31
X12AC34
X12AC37
X12AC40

X12AC42
X12AC45
X1AC09
X1AC20
X1AC31
X1AC42
X1C301
X1C302
X1C303
X1C306
X1C307
X1C308
X1C309
X1C310
X1C311
X1C312
X1C315
X1C317
X1C318
X1C319
X1C320
X1C321
X1C322
X1C323
X1C324
X1C326
X1C328
X1C329
X1C401
X1C402
X1C403
X1C404
X1C405
X1C406
X1C407
X1C408
X1C409
X1C410
X1C411
X1C412
X1C413
X1C414
X1C415
X1C418
X1C419
X1C425

X1C426
X1C427
X1C428
X1C430
X1C431
X1C432
X1HC01
X1HC02
X1HC03
X1HC04
X1HC05
X1HC06
X1HC07
X1HC08
X1HC11
X1HC14
X1HC15
X1HC16
X1HC22
X1HC23
X1HC24
X1HC25
X1HC26
X1HC27
X1HC28
X1HC29
X1HC30
X1HC31
X1HC33
X1HC34
X1HC38
X1HC40
X1HC41
X1HC45
X1R1
X1R29
X1SC401
X1SC404
X1SC405

X1SC406
X1SC407
X1SC409
X1SC411
X1SC412
X1SC413
X1SC414

X2AC09
X2AC20
X2AC31
X2AC42
X2C301
X2C417
X2C418
X2C419
X2HC01
X2HC02
X2HC03
X2HC04
X2HC05
X2HC06
X2HC07
X2HC08
X2HC11
X2HC14
X2HC15
X2HC16
X2HC22
X2HC23
X2HC24
X2HC25
X2HC26
X2HC27
X2HC28
X2HC29
X2HC30
X2HC31
X2R1
X2R29
X2SC401
X2SC404
X2SC405
X2SC406
X2SC407
X2SC409
X2SC411
X2SC412
X2SC413
X2SC414
X3AC09
X3AC20
X3AC31
X3AC42

X3C301
X3C302
X3C303
X3C306
X3C307
X3C308
X3C309
X3C310
X3C311
X3C312
X3C315
X3C317
X3C318
X3C319
X3C320
X3C321
X3C322
X3C323
X3C324
X3C326
X3C328
X3C329
X3C401
X3C402
X3C403
X3C404
X3C405
X3C406
X3C407
X3C408
X3C409

X3C410
X3C411
X3C412
X3C413
X3C414
X3C415
X3C418
X3C419
X3C425
X3C426
X3C427
X3C428
X3C430
X3C431
X3C432

X3HC01
X3HC02
X3HC03
X3HC04
X3HC05
X3HC06
X3HC07
X3HC08
X3HC11
X3HC14
X3HC15
X3HC16
X3HC22
X3HC23
X3HC24
X3HC25
X3HC26
X3HC27
X3HC28
X3HC29
X3HC30
X3HC31
X3HC33
X3HC34
X3HC38
X3HC40
X3HC41
X3HC45
X3R1
X3R29
X3SC401
X3SC404
X3SC405
X3SC406
X3SC407
X3SC409
X3SC411
X3SC412
X3SC413
X3SC414
X4AC09
X4AC20
X4AC31
X4AC42
X4C301
X4C302

X4C303
X4C306
X4C307
X4C308
X4C309
X4C310
X4C311
X4C312
X4C315
X4C317
X4C318
X4C319
X4C320
X4C321
X4C322
X4C323
X4C324
X4C325
X4C326
X4C328
X4C329
X4C401
X4C402

X4C403
X4C404
X4C405
X4C406
X4C407
X4C408
X4C409
X4C410
X4C411
X4C412
X4C413
X4C414
X4C415
X4C418
X4C419
X4C425
X4C426
X4C427
X4C428
X4C430
X4C431
X4C432
X4HC01

X4HC02
X4HC03
X4HC04
X4HC05
X4HC06
X4HC07
X4HC08
X4HC11
X4HC14
X4HC15
X4HC16
X4HC22
X4HC23
X4HC24
X4HC25
X4HC26
X4HC27
X4HC28
X4HC29
X4HC30
X4HC31
X4HC33
X4HC34
X4HC38
X4HC40
X4HC41
X4HC45
X4R1
X4R29
X4SC401
X4SC404
X4SC405
X4SC406
X4SC407
X4SC409
X4SC411
X4SC412
X4SC413
X4SC414
X5AC09
X5AC20
X5AC31
X5AC42
X5C301
X5C302
X5C303

X5C306
X5C307
X5C308
X5C309
X5C310
X5C311
X5C312
X5C315
X5C317
X5C318
X5C319
X5C320
X5C321
X5C322
X5C323

X5C324
X5C325
X5C326
X5C328
X5C329
X5C401
X5C402
X5C403
X5C404
X5C405
X5C406
X5C407
X5C408
X5C409
X5C410
X5C411
X5C412
X5C413
X5C414
X5C415
X5C418
X5C419
X5C425
X5C426
X5C427
X5C428
X5C430
X5C431
X5C432
X5HC01
X5HC02

X5HC03
X5HC04
X5HC05
X5HC06
X5HC07
X5HC08
X5HC11
X5HC14
X5HC15
X5HC16
X5HC22
X5HC23
X5HC24
X5HC25
X5HC26
X5HC27
X5HC28
X5HC29
X5HC30
X5HC31
X5HC33
X5HC34
X5HC38
X5HC40
X5HC41
X5HC45
X5R1
X5R29
X5SC401
X5SC404
X5SC405
X5SC406
X5SC407
X5SC409
X5SC411
X5SC412
X5SC413
X5SC414
X6SC401
X6SC404
X6SC405
X6SC406
X6SC407
X6SC409
X6SC411
X6SC412

X6SC413
X6SC414
X7AC09
X7AC20
X7AC31
X7AC42
X7C301

X7C302
X7C303
X7C306
X7C307
X7C308
X7C309
X7C310
X7C311
X7C312
X7C315
X7C316
X7C317
X7C318
X7C319
X7C320
X7C321
X7C322
X7C323
X7C324
X7C325
X7C326
X7C328
X7C329
X7C401
X7C402
X7C403
X7C404
X7C405
X7C406
X7C407
X7C408
X7C409
X7C410
X7C411
X7C412
X7C413
X7C414
X7C415
X7C417

X7C418
X7C419
X7C425
X7C426
X7C427
X7C428
X7C430
X7C431
X7C432
X7HC01
X7HC02
X7HC03
X7HC04
X7HC05
X7HC06
X7HC07
X7HC08
X7HC11
X7HC14
X7HC15
X7HC16
X7HC22
X7HC23
X7HC24
X7HC25
X7HC26
X7HC27
X7HC28
X7HC29
X7HC30
X7HC31
X7HC33
X7HC34
X7HC38
X7HC40
X7HC41
X7HC45
X7R1
X7R29
X7SC401
X7SC404
X7SC405
X7SC406
X7SC407
X7SC409
X7SC411

X7SC412
X7SC413
X7SC414
X8AC09
X8AC20
X8AC31
X8AC42
X9AC09
X9AC20
X9AC31
X9AC42
XAC02
XAC05
XAC07
XAC09
XAC12
XAC15
XAC18
XAC20
XAC23
XAC26
XAC29
XAC31
XAC34
XAC37
XAC40
XAC42
XIC10AC09
XIC10AC20
XIC10AC31
XIC10AC42
XIC11AC09
XIC11AC20
XIC11AC31
XIC11AC42
XM1C606D
XM3C606D
XM4C606D
XM5C606D
XM7C606D
XX1C302
XX1C308
XX1C310
XX1C311
XX1C312
XX1C323

XX1C325
XX1C405
XX1C408
XX1C425
XX1C428
XX1C430
XX1C431
XX1HC28
XX1HC29
XX1HC30
XX1HC32
XX1R1
XX1R29
XX1SC406
XX1SC408
XX2HC28
XX2HC29
XX2HC30
XX2R1
XX2R29
XX2SC406
XX2SC408
XX3C302
XX3C308
XX3C310
XX3C311
XX3C312
XX3C323
XX3C325
XX3C405
XX3C408
XX3C425
XX3C428
XX3C430
XX3C431
XX3C432
XX3HC28
XX3HC29
XX3HC30
XX3HC32
XX3R1

XX3R29
XX3SC406
XX3SC408
XX4C302
XX4C308

XX4C310
XX4C311
XX4C312
XX4C323
XX4C325
XX4C405
XX4C408
XX4C409
XX4C425
XX4C427
XX4C428
XX4C430
XX4C431
XX4C432
XX4HC28
XX4HC29
XX4HC30
XX4HC32
XX4R1
XX4R29
XX4SC406
XX4SC408
XX5C302
XX5C308
XX5C310
XX5C311
XX5C312
XX5C323
XX5C325
XX5C405
XX5C408
XX5C425
XX5C428
XX5C430
XX5C431
XX5HC28
XX5HC29
XX5HC30
XX5HC32
XX5R1
XX5R29
XX5SC406
XX5SC408
XX6SC406
XX6SC408
XX7C302

XX7C308
XX7C310
XX7C311
XX7C312
XX7C323
XX7C325
XX7C405
XX7C408
XX7C425
XX7C428
XX7C430
XX7C431
XX7HC28
XX7HC29
XX7HC30
XX7HC32
XX7R1
XX7R29
XX7SC406
XX7SC408
Y1HC28
Y1HC29
Y1HC30
Y1HC31
Y1R1
Y1R29
Y2HC28
Y2HC29
Y2HC30
Y2HC31
Y2R1
Y2R29
Y3HC28

```
  Y3HC29
  Y3HC30
  Y3HC31
  Y3R1
  Y3R29
  Y4HC28
  Y4HC29
  Y4HC30
  Y4HC31
  Y4R1
  Y4R29
  Y5HC28
  Y5HC29
```


```
  Y5HC30
  Y5HC31
  Y5R1
  Y5R29
  Y7HC28
  Y7HC29
  Y7HC30
  Y7HC31
  Y7R1
  Y7R29
  YY1HC28
  YY1HC29
  YY1HC30
  YY1R1
  YY1R29
  YY2HC28
  YY2HC29
  YY2HC30
  YY2R1
  YY2R29
  YY3HC28
  YY3HC29
  YY3HC30
  YY3R1
  YY3R29
  YY4HC28
  YY4HC29
  YY4HC30
  YY4R1
  YY4R29
  YY5HC28
  YY5HC29
  YY5HC30
  YY5R1
  YY5R29
  YY7HC28
  YY7HC29
  YY7HC30
  YY7R1
  YY7R29


**** REPORT SUMMARY :        0     NONOPT
                             0 INFEASIBLE
                             0 UNBOUNDED
                             0     ERRORS
```


```
EXECUTION TIME       =        0.170 SECONDS     1.3 Mb      WIN-18-097


USER: Ralph W. Pike                              G990726:1450AP-WIN
      Louisiana State University, Department of Chemical EngineeriDC267

**** FILE SUMMARY

INPUT      C:\PROGRAM FILES\GAMSIDE\DO_ECON
OUTPUT     C:\PROGRAM FILES\GAMSIDE\DO_ECON.LST
SAVE       C:\PROGRAM FILES\GAMSIDE\PUT_DATA.G0?
```