Linear Power Discretization and Nonlinear Formulations For Optimizing Hydropower in a Pumped-Storage System

Craig S. Moore

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Master of Science
in
Civil and Environmental Engineering

G.V. Loganathan, Chair
David Kibler
Tamim Younos

November 2, 2000
Blacksburg, Virginia

Keywords: electric system, hydropower, optimal scheduling, optimization, pumped storage, nonlinear programming, linear programming

Linear Power Discretization and Nonlinear Formulations
For
Optimizing Hydropower in a Pumped Storage System

Craig S. Moore

(Abstract)

Operation of a pumped storage system is dictated by the time dependent price of electricity and capacity limitations of the generating plants. This thesis considers the optimization of the Smith Mountain Lake-Leesville Pumped Storage-Hydroelectric facility. The constraints include the upper and lower reservoir capacities, downstream channel capacity and flood stage, in-stream flow needs, efficiency and capacity of the generating and pumping units, storage-release relationships, and permissible fluctuation of the upper reservoir water surface elevation to provide a recreational environment for the lake shore property owners.

Two formulations are presented: (1) a nonlinear mixed integer program and (2) a discretized linear mixed integer program. These formulations optimize the operating procedure to generate maximum revenue from the facility. Both formulations are general and are applicable to any pumped storage system. The nonlinear program retains the physical aspects of the system as they are but suffers from non-convexity related issues. The linear formulation uses a discretization scheme to approximate the nonlinear efficiency, pump, turbine, spillway discharge, tailrace elevation-discharge, and storage-elevation relationships. Also, there are binary unit dispatch and either/or constraints accommodating spill and gated release.

Both formulations are applied to a simplified scheme of the Smith Mountain Lake and Leesville pumped storage system. The simplified scheme uses a reduced number of generating and pumping units at the upper reservoir to accommodate the software limitations. Various sensitivity analyses were performed to test the formulations. The linear formulation consistently performs better than the nonlinear. The nonlinear solution requires a good starting point for optimization. It is most useful as a verification tool for the solution from the linear program on all occasions. The formulations yield the best schedules for generating and pumping. A coarse time interval limits the use of all pumps in the presence of the spill constraint. A sufficiently large difference in the diurnal unit price encourages short-term pump back as opposed to a weekly cycle. The Leesville (downstream) reservoir affects the power production schedule with its large (approx. 9 ft) forebay rise for every foot drop at the Smith Mountain Lake. The linear formulation provides a valuable tool for studying the system under a wide range of conditions without having to worry about the computational difficulties associated with the nonlinear formulation.

Acknowledgement

I would like to thank Dr. G.V. Loganathan, for his time, guidance, advice, and patience. He has provided many hours of support. Not only has he provided a foundation for my current research, but he his given me great insights for a long life of learning. I would like to thank and Dr. David Kibler and Dr. Tamim Younos for serving as members of my committee. Also, I would like to thank Dr. Kibler and Dr. Younos for the comments and direction that they provided.

I would like to thank the employees of AEP at the Smith Mountain Dam, the Leesville Dam, the Claytor Dam, and the Roanoke office for sharing their time and knowledge. I would like to specifically thank the late Mr. Randy Agnew (AEP - Power Dispatching Supervisor), Mr. Jim Thrasher (AEP - Hydro Generation), and Ms. Teresa Rogers (AEP - Hydro Generation) for sharing their knowledge and providing the needed data.

I would like to thank Jake and Catherine Moore, my parents, for their support and encouragement to excel in all that I do. They have provided a great environment to learn and grow. I can never express my complete appreciate of all their efforts in my life.

The faculty and students of the Hydrosystems and GIS/CAD divisions have encouraged and supported me throughout my time at Virginia Tech. I would like to thank them for their assistance.

I would like to thank Linette Dudley, James Moore, Dale Moore, Carl Moore and Donna Brown, my siblings, for encouraging me with all aspects of my life. I greatly appreciate their love and support.

I would like to thank Paula Moore, my wife, for her support through this time of work and research. She has been very patient with me. She has helped to keep me going in difficult times. Without her support, I would not have been able to finish this thesis.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

1.1 Problem Overview

Existing hydroelectric facilities have the ability to reduce air pollution, heat pollution, radioactive waste, and fly ash. Because of the ease with which water can be withdrawn or pumped up stream, hydropower facilities are used in conjunction with thermal plants, such as coal, oil, and nuclear. Pumped storage and hydroelectric plants are operated during peak power usage periods to make up for the shortfall that thermal power plants leave and during low power demand periods. The extra energy from thermal plants is used to pump water upstream to the upper reservoirs. This helps to run the thermal units in an efficient manner, as well as to prepare the hydropower plants for the next peak power demand.

The operating policy of a pumped storage hydropower system is composed of a profit maximizing function and a number of constraints. The profit function maximizes the revenue difference between production and consumption (pumping). Production yields a positive return, whereas, consumption results in a revenue loss. Pumping becomes a desirable alternative due to cost variations of electricity. The time dependent cost data clearly governs the operating policy of a pumped storage system. The practice of charging more money during peak demand periods has encouraged the production of power at the facility's maximum capacity during peak hours and pumping water from the lower reservoir to the upper reservoir during non-peak hours. There are two broad categories of hydro-scheduling, namely long-range and short-range. The long-range hydro-scheduling problem includes the prediction of water inflows, water use (other than for power), power demand, and water releases. This thesis focuses on short-term hydro-scheduling. This type of problem assumes that the load, inflows, unit availability and electric cost are all known. In this thesis, nonlinear and linear mixed integer program formulations are given for the optimization of the operation of a pumped storage system. The formulation is based on the Smith Mountain Lake-Leesville system. American Electric Power (AEP) is owner and operator of this system. See Figure 1-1 for a location of the hydroelectric facilities owned by AEP. The rest of this chapter is organized as follows. First, a brief history of the Smith Mountain Lake-Leesville system is presented. Next, this presentation helps to point out certain salient features of the pumped storage units as given in the section on problem description. Finally, the objectives and organization of the thesis are given.

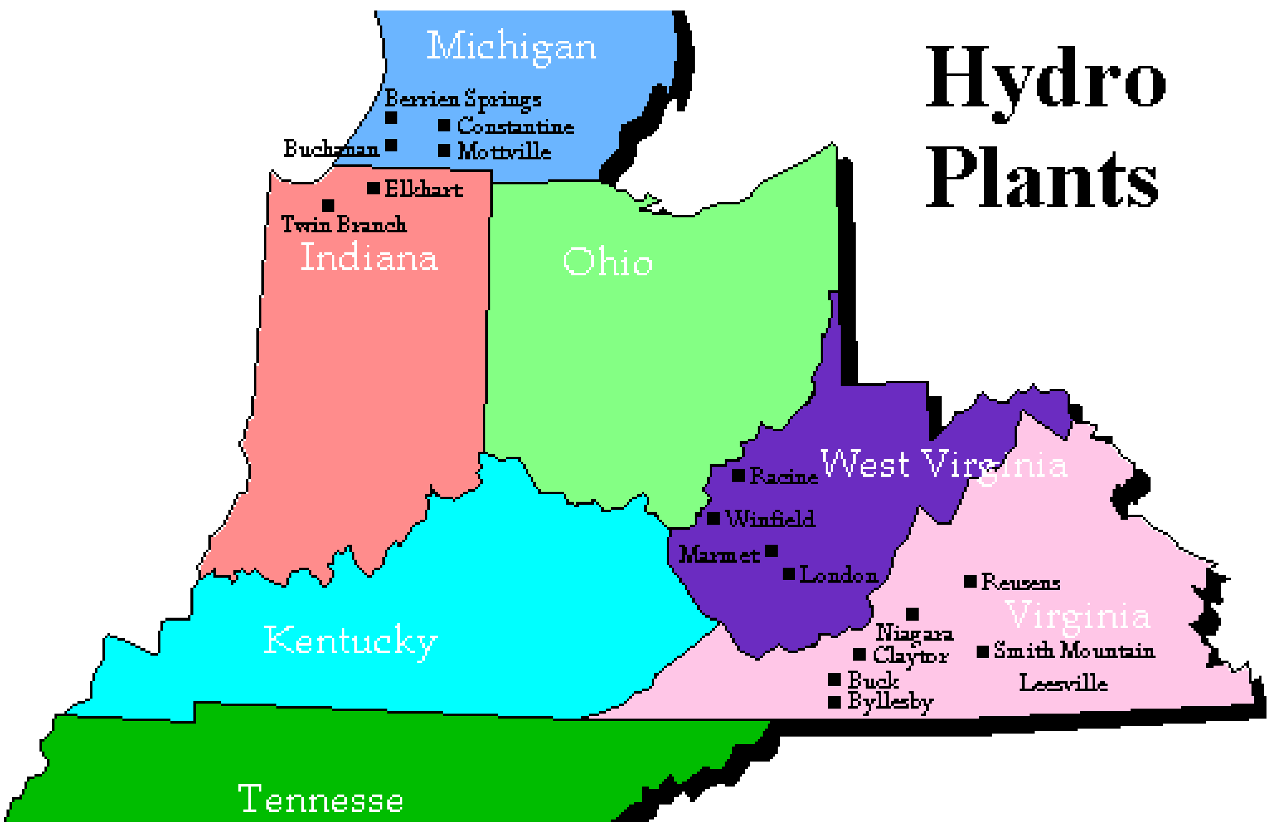

Figure 1-1. AEP Hydroelectric Plants

1.2 Project History

In the Operating Department Manual for the Smith Mountain Project, it states that the thought of constructing a dam along the Roanoke River originated in 1924. The property changed hands and AEP put forth an application in 1956 for a preliminary permit. The preliminary permit sought to place a conventional hydroelectric plant along the Roanoke River. The Roanoke River is a small river and could only provide a conventional hydropower potential of 40 to 60 MW (AEP, 1971). AEP revised the application to request the construction of a two-dam project. Figure 1-2 shows a detailed location of the Smith Mountain - Leesville pumped storage and hydroelectric facility. Approval of this application allowed AEP the opportunity to build a pumped storage facility. A hydropower study showed that the facility would have a generating capacity of 580 MW between two dams. Construction began in 1960, was completed in 1965, and the plant has been running ever since (AEP, 1971).

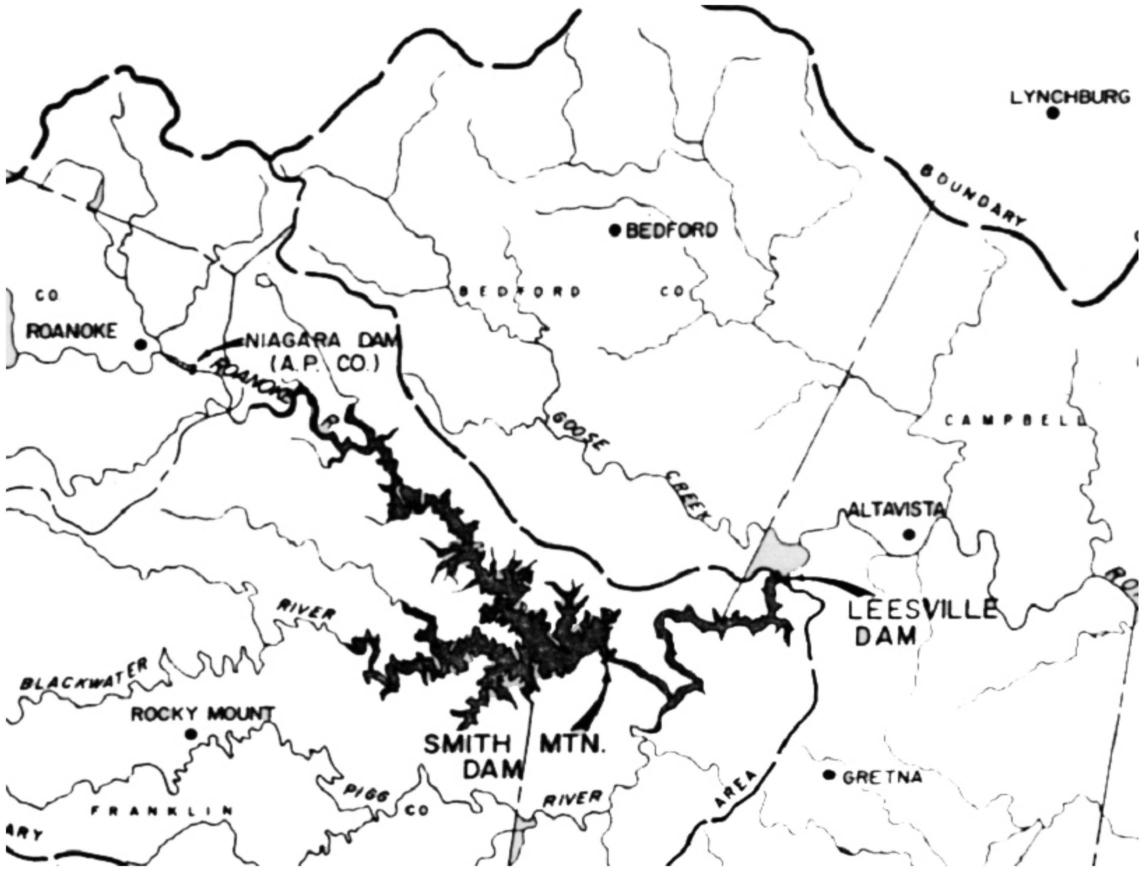

Figure 1-2. Location of Smith Mountain - Leesville Pumped Storage and Hydroelectric Facility (AEP, 1971)

1.3 Smith Mountain Lake

The Smith Mountain-Leesville pumped storage hydroelectric facility is used to generate electricity for AEP. The facility consists of two dams and corresponding reservoirs. The upper reservoir, Smith Mountain Lake, is 40 miles (64 km) long and has 400 miles (645 km) of shoreline. Water storage for Smith Mountain Lake is 1.14 million Ac-ft (1844 million m^3) with an upper operating level of 795.00 ft (242.32 m) above sea level. The power pool fluctuation is limited to approximately 2 ft (0.61 m) because of the maximum storage available in the lower reservoir. The Smith Mountain dam is an arch concrete dam 235 ft (71.6 m) high and 816 ft (249 m) long. The dam houses five power-generating units, each of which has a Francis-type turbine. Units 1 and 5 can produce 70 megawatts of electricity each with 6,000 cfs (156 m3/s) of water passing through each penstock; units 2 and 4 can produce 160 megawatts each, passing 11,000 cfs (425 m3/s) through each penstock; and unit 3 can produce 100 megawatts, passing 8000 cfs (227 m3/s) through the penstock. In addition to power generation, units 1, 3, and 5 are used to pump water from the lower reservoir back into the Smith Mountain Lake. Shown in Figure 1-3 are the penstocks for units 2, 3, and, 4. Units 2 and 4 are designed as turbines only. Units 1, 3, and, 5 are reversible units, acting as pumps or turbines, depending on the need (AEP, 1971).

Figure 1-3. Smith Mountain Dam

1.4 Leesville Lake

Leesville Lake is the lower reservoir and is 17 miles (27 km) long with 100 miles (161 km) of shoreline. The water storage capacity in the Leesville Lake is 95,000 Ac-ft (117 million m^3) and the reservoir level can fluctuate by as much as 13 ft (3.96 m).

Releasing one foot (0.3 m) of the water at Smith Mountain Lake can raise the Leesville Lake level by 6 ft (1.83 m). The Leesville Dam is 90 ft (27.4 m) high and 980 ft (299 m) long. The dam houses two fixed blade propeller power generating units, each with a capacity of 20 megawatts. The primary function of this reservoir is to provide a holding pool of water that can be pumped back into Smith Mountain Lake (AEP, 1971).

1.5 Problem Description

An important aspect of hydropower operation is the load curve. The load curve represents the power demand as a function of time. Quick fluctuations in the load curve and slow response of thermal units can create serious problems with the stability of the electrical system. Because electricity cannot be stored, the demand has to be met with simultaneous production that results in slight excess and deficit. By current regulations, the area control error must cross zero every ten minutes (see section 0). This error must be minimized within a selected time duration. For this reason, pumped storage provides an exceptional benefit to power companies. The pumped storage facility, or any hydroelectric facility, can begin to produce power in less than 15 minutes. Another advantage of a pumped storage facility is its ability to consume power. The pumped storage and hydroelectric facility can be producing power, along with the thermal units, for peak demands. When the demand decreases dramatically the thermal units will take time to reduce their output, but the pumped storage facility can reduce its output almost instantaneously, then reverse the units and begin consuming power. AEP does not divide the load between its plants such that a particular plant is required to produce a percentage of the total load. Instead, AEP optimizes the usage of thermal units and adjusts the hydroelectric plants to meet the overall system load. Therefore, Smith Mountain Lake is brought online only to meet peak demands or sudden increases in load. When there is a surplus of electrical energy in AEP's region, Smith Mountain Lake is used to meet the area control error requirement through the use of the pumps. Smith Mountain Lake can provide a net difference of 900 MW on the grid in about 15 minutes. This can be done by switching from pumping, which uses 300MW of energy, to producing 600 MW of energy in less than 15 minutes.

1.6 Objectives

The general objective of this thesis is to mathematically formulate the workings of a pumped storage system to obtain an optimal operating procedure. The specific objectives are as follows:

1. Formulate a mathematical non-linear model for the best operation of pumped storage systems.
2. Obtain an efficient linear formulation from the nonlinear formulation
3. Solve both formulations with reduced data from the Smith Mountain Lake-Leesville system.

The remainder of the thesis is organized as follows. Chapter 2 presents an overview of the electrical system. Chapter 3 contains the nonlinear formulation. Chapter 4 has the efficient linear formulation. Chapter 5 contains the results and summary. Chapter 6 presents the conclusions and recommendations.

Chapter 2 Electrical System

2.1 Introduction

The electrical system of the United States consists of many different parts and subsystems. Three important parts of the system are the source, demand, and the grid. The source is made up of different generating facilities. The demand consists of industrial, commercial, municipal, agricultural, and residential loads that extract energy through the grid from the source. The grid is a network of transmission lines, distribution lines, and interconnections with other utility companies. The grid contains substations and other devices, which are used to regulate the voltage and distribute the power to the demand. For more information on power systems, refer to Wood and Wollenberg (1984).

Electricity must be used the moment it is produced. It cannot be stored in large quantities for a long time. Also, there is nothing similar to a valve to alter the flow; the flow must be controlled by generation. This process is like synchronizing several pumps to satisfy the time varying demand of water without the benefit of valves and storage tanks. From the power plant, the electricity is transmitted at nearly the speed of light over transmission lines, which are normally supported by tall steel towers. Transmission lines are operated at a high voltage, which reduces energy losses due to resistance. On transmission lines, the neutral wire is located above the current carrying wires. The neutral wire serves as a lightning arrester and in some cases houses optical fibers for use by the utility owner or may be leased out to other companies. The destination of a transmission line is a substation. There, the voltage is reduced by a step down transformer and transferred to smaller lines called distribution lines. They are typically carried on wooden poles, which distribute electricity to neighborhoods, commercial areas and farms. On distribution lines, the neutral wire is located below the current carrying wires, for safety reasons. The neutral wire, ideally, should not carry any electrical flow because it is grounded every few poles. The neutral wire is grounded by connecting it to the ground with a copper wire. This serves to carry any extra electricity into the ground where it cannot cause harm (Randy Agnew, personal interview, 1997).

All parts of an electrical system work together. Consider this analogy of water to the electrical system. Given a bucket (grid), consider that person A (source or generation) begins to pour water into the bucket while person E (demand) starts to withdraw water from the bucket. This event ensures person E that the water being withdrawn from the bucket is from person A. Another situation is when person A (source 1), person B (source 2), and person C (source 3) all have their own water to fill the same bucket. Person E (demand 1) begins to withdraw water from the bucket. This water may have come from person A, B, C, or any combination. Now another person F (demand 2) joins person E at the bucket. Person F begins to withdraw water from the bucket. This final situation makes it difficult to determine from whom the water is coming, other than the fact that person A knows how much they have added to the bucket, person B knows how much they have added to the bucket, and the same for person C. On the other end, person E and person F know how much each has withdrawn. The exact beginning and the exact destination of a drop of water is undeterminable, but the quantities of the supply and demand are measurable. Thus each person A, B, and C will get paid according to the amount each supplied and each person E and F will pay the amount withdrawn. This analogy of a bucket of water to an electrical system is a simplification of the electrical system, but it helps one to understand better. The previous cases have ignored the possibility of water overflow from the bucket or the bucket going dry. The water level in the bucket can be used to describe the system frequency and voltage. Consider the first situation with only one source and one demand; A and E. If person A (source) is adding water at the rate of S_A and person E is withdrawing at the rate of D_E, where $S_A > D_E$ then the volume in the bucket will begin to rise. This is like too much electricity generation, which causes the frequency and voltage to increase. Frequency is measured in cycles per second. One complete revolution of an electric device is considered one cycle. Now add person F to this same situation, withdrawing water at the rate of D_F, where $D_E + D_F > S_A$. The volume in the bucket will begin to decrease also causing the outlet pressure to decrease. A similar effect happens when the power demand is greater than generation. The frequency and voltage will start to decrease causing motors and clocks to run slower. For more details on how frequency and voltage are affected as the result of load variation the reader should consult the books by Faulkenberry and Coffer (1996) and Elgerd (1982).

2.2 Power Generation

There are three main types of generating units: thermal (steam), gas combustion, and hydroelectric. These systems have different operating procedures. A thermal unit has a slow start-up and shutdown process and therefore, is unable to quickly adapt for large increases or decreases in demand. A hydroelectric unit can be engaged or disengaged in two minutes. This is why hydropower is primarily used during peak demand periods. For multiple thermal and hydropower units to be connected to the grid, they must be synchronized. It is critical that the generating units be in synchronization with the system. This synchronization ensures that the unit is operating at the correct frequency.

For synchronization to take place, Elgerd (1982) states that the following conditions must be satisfied: (1) the generator and network frequencies be equal, (2) the phase sequence of the generator match that of the network, (3) the generator emf and network voltage be equal in magnitude, and (4) the emf and network voltage have equal phase. The unit can then produce or consume power. Because alternate current and voltage are sinusoidal in nature, the power varies both positively and negatively with time as opposed to DC power, which is always positive. The power generated is obtained as the product of sinusoidal voltage and the current, called the apparent power (expressed in Volt-Amps, VA), which is the power sent to a device. The apparent power is also used to calculate heat generation by the equipment, and for sizing wires and circuit breakers. Apparent power is the amount of power drawn out of the generator.

However, the power utilized by the device is only the positive portion of the power (the cosine component) called the real power measured in watts (W). The difference between the apparent power and the real power is known as the reactive power, which is both positive and negative with an average of zero power. The ratio of real power to the apparent power is called the power factor. Therefore, the generator or any power supply must provide the actual load divided by the power factor as the apparent power to support the device. The power factor is determined based on the phase angle between the voltage and the current.

Some large utility companies depend on steam units for the majority of their generation. There are two major types of steam units; those fired by coal and those run by nuclear fuel. If the unit is off-line (cold), then there is a significant time lag to bring the unit in to synchronization. If the unit is in synchronization then it takes approximately 20-30 minutes to bring one unit up to a generating capacity of 100 MW. Therefore, if a utility company notices their demand increasing by a significant amount in a short period of time, multiple plants will increase their power production with units already on-line. For example, if demand requires an increase of 100 MW in power production, five plants will each be raised 20MW; thus the time required to produce 100MW will only be 10 minutes, as opposed to 20-30 minutes for one plant. The units have a narrow band of high efficiency, which is near full capacity. Typically, the units are kept running close to full capacity because of the efficiency curve. The units are only brought on-line when there is a definite need to produce more power for a long period of time. Also, the units are only taken off-line when there is no other way to reduce the power output or there is a long period of expected power surplus (Agnew, personal interview, 1997).

Run-of-the river hydropower generating facilities can be used both for peak and base loads. These facilities are typically constrained by reservoir levels and downstream minimum and maximum flow. They may be utilized for other water resources, such as irrigation, flood control, and recreation. For base loads, the turbine units are typically set to an automated mode.

This automated mode will vary the discharge through the unit depending upon the power output required and the minimum stream flow required.

Pumped storage plays an important role in the generation, demand, and control aspects of the system. The pumped storage idea works because the selling price of electricity is dependent on time. Typically, pumped storage is used in conjunction with thermal power. Pumped storage systems store electricity in the form of potential energy (water). The facility will operate the turbines during the peak hours of the day when the cost of electricity is the highest. Thus, the utility company will receive a larger profit for the same water than if it was released through the turbines during non-peak hours. The cost of electricity is cheapest when the demand is the lowest. This idle time during the non-peak hours allows the electric company to use excess power to reverse the turbines and pump water up stream. If the company does not have excess electricity, then it will purchase the power from an adjacent utility company at the lower non-peak cost. This allows a pumped storage system to be economically feasible. The downstream channel constraints can be dictated by an environmental, political, or recreational consideration or by a regulatory agency. The maximum allowable flow for the channel may be set to reduce erosion or prevent flooding downstream of the reservoir. For small channels, the minimum allowable flow for the channel may be set to ensure a healthy aquatic life system, or to allow fishing and recreational boating. However, meeting this minimum water level may require water to be released through control gates, by-passing the turbines. Koebbe (1993) has stated that pumped storage has been proven, to date, to be the most efficient and cost-effective energy storage. There are more than 180 plants worldwide with a combined capacity greater than 70,000 MW (Koebbe, 1993).

2.3 Transmission and Distribution

The transmission network is the backbone of the electrical system. What makes a system more reliable is the ability to interconnect many generating units and other electric companies. As mentioned previously, when one generating unit cannot supply adequate power, another generating unit connected to the same grid can increase production and supply the needed power. A map of AEP's transmission line layout is shown in Figure 2-1 and the transmission network linking the Smith Mountain – Leesville system is shown in Figure 2-2).

Transmission lines transport power at a high voltage and low current. This allows the power to be transmitted with less resistance and therefore, less waste in the form of heat. Typical transmission voltages are 34.5kV to 765kV (Faulkenberry and Coffer, 1996).

The ability to transmit large quantities of electricity from the generating plant to a local system (distribution network) is a vital part of delivering reliable electricity. To get from a transmission line to a distribution line, the power must go through a substation. A substation is the link between a power company and the residential and commercial electricity users. Distribution lines are operated at a lower voltage level for safety reasons. Generally, the distribution system has voltage levels with in a range of 11.6 to 34.5 kV (Faulkenberry and Coffer, 1996).

The voltage along the distribution line will decrease because of consumers withdrawing electrical power and line losses. For this reason there is a range of voltages, 110 to 125 volts, which a consumer may receive. The voltage that a consumer receives is dependent upon the overall load and their distance from the substation. Because of this phenomenon, the voltage leveling at the substation is set higher than the nominal voltage and the voltage will decrease the further the consumer is from the substation.

The United States is divided into two major electrical grids; the eastern grid and the western grid. These grids are not completely isolated, but are only connected in a few locations.

These connections between the east and west are considered a weak link because they will “trip” before allowing too much power to be drawn across the connection. The eastern grid is very strong with many interconnections between utility companies in the eastern U.S. These interconnections bring added stability to the system (Agnew, personal interview, 1998).

Interconnections between utility companies create a balance between generation and demand. The benefit comes when looking at the fluctuation in peak demand periods. While one electric company may be experiencing a peak demand, another company may have electricity to spare. The company with extra power supplies the grid and is, in effect, selling their extra power to the company that needs it. Another factor that is affected by the grid is the system inertia. The interconnections create a larger grid, which increases the inertia. Therefore, small fluctuations in generation and demand are less noticeable.

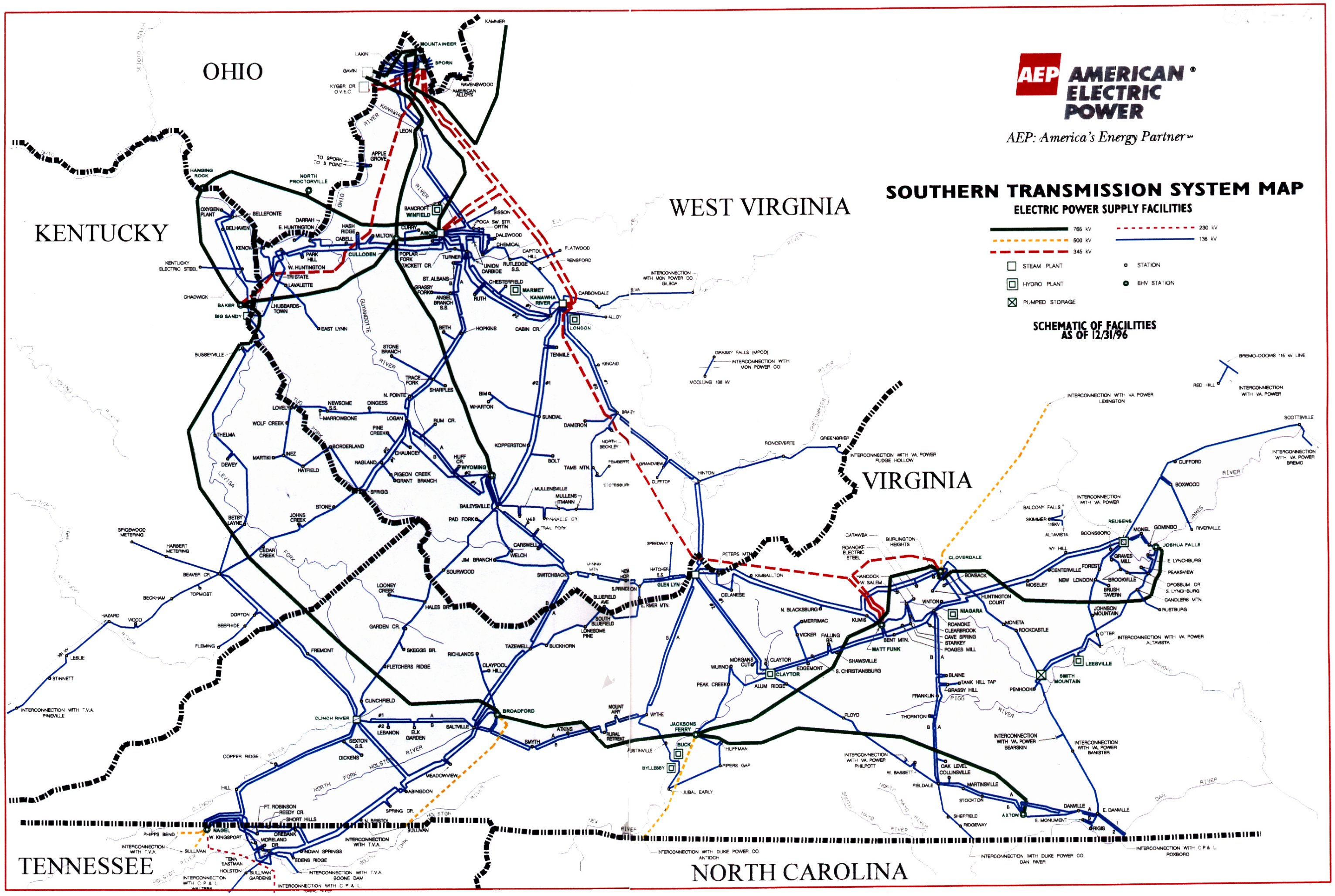

Figure 2-1. AEP Southern Transmission System Map (AEP, 1999)

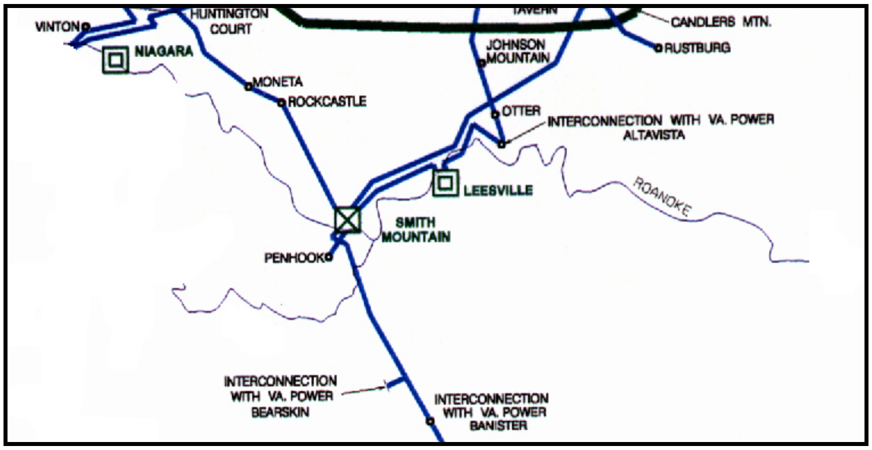

Figure 2-2. Transmission Network from Smith Mountain and Leesville (AEP, 1999)

2.4 System Control

The fluctuations that occur because of load changes present the system operator with the complex task of balancing generation with demand. As the load changes so does frequency (f), voltage (V), phase angles (ϕ), current (I), torque (T), power (P) and kinetic energy (W_{kin}). Elgerd (1982) puts it as follows. The electromechanical air-gap torque that is developed within the generator forms the basic link between the mechanical turbine power, and the electrical power transmitted from the generator terminals. The physical law that controls this phenomenon is the force on the current carrying conductor placed in a magnetic field, which is the vector product of the magnetic field strength and the current. If this law is applied to the rotor based magnetic field wave and stator based current wave, the stator is subject to a force (and torque) acting in the direction of rotation. The rotor is subject to an equal and opposite reaction force and torque. This torque tends to decelerate the rotor, but is prevented from doing so by the turbine torque. Therefore, there is an intimate connection between the magnetic field - current induced torque and the mechanical torque of the turbine. If the system experiences a drop in load (excess generation), then there will be an imbalance and the frequency increases. This frequency increase will cause motors, clocks, etc. to run faster. As the frequency increases the motors will realize a higher load torque. The increases in the load torque will withdraw more power from the grid. This withdrawal of power will deplete the excess supply, which will allow the system to reach equilibrium. The cost for this equilibrium is a higher frequency, along with changes in voltage, phase angles, current, torque, power, and kinetic energy. These changes can cause severe damage to the generating unit and to the electricity users if not controlled. For example, a thermal unit requires a specific angular velocity for the turborotor. If this angular velocity is not maintained, the resonance within the turborotor may reach a critical rate and cause cracks or complete failure (Elgerd, 1982).

The Automatic Load-Frequency Control (ALFC) provides compensation for small variations in the load and frequency. The ALFC provides generator control of power output and frequency. The ALFC has the ability to make small adjustments by changing the position of the valve on a thermal unit or the wicket gates on a hydro unit. These changes are used to increase or decrease the power output to coincide with the small and quick fluctuations in demand. The ALFC has a response time of one to several seconds. A second function of the ALFC is to provide extended frequency control. This portion of the ALFC is non-responsive to the quick changes; instead, it balances the frequency and power over several minutes. The Automatic Voltage Regulator (AVR) provides system stability through regulation of DC power supplied to the generator field. This DC power is supplied through an exciter. An exciter is either a DC generator, or a brushless or static type generator. The exciter energizes the generator field windings which controls the voltage (Elgerd, 1982). For more information on AC electrical machines refer to Hambley (1997).

Depending upon the system demand, power companies have a certain range of power production that must be maintained. Over a given period, a power company may produce more than or less than the required power demand; however, this excess and deficiency must equal zero when summed for this time period. This condition can be considered a curve function, and when integrated computes a positive and negative area. This area is called the area control error (see Figure 2-3) and is regulated by North American Electric Reliability Council (NERC) in accordance with East Central Area Reliability Coordinate Agreement (ECAR). See Figure 2-4 for the states affected by ECAR. NERC requires that all power companies maintain these criteria, or else the inadvertent energy will increase or decrease beyond the acceptable levels. This increase or decrease in energy will affect the overall performance of the system (Randy Agnew, personal interview, 1998; Don Benjamin, personal communication, 1999; and NERC, 1996).

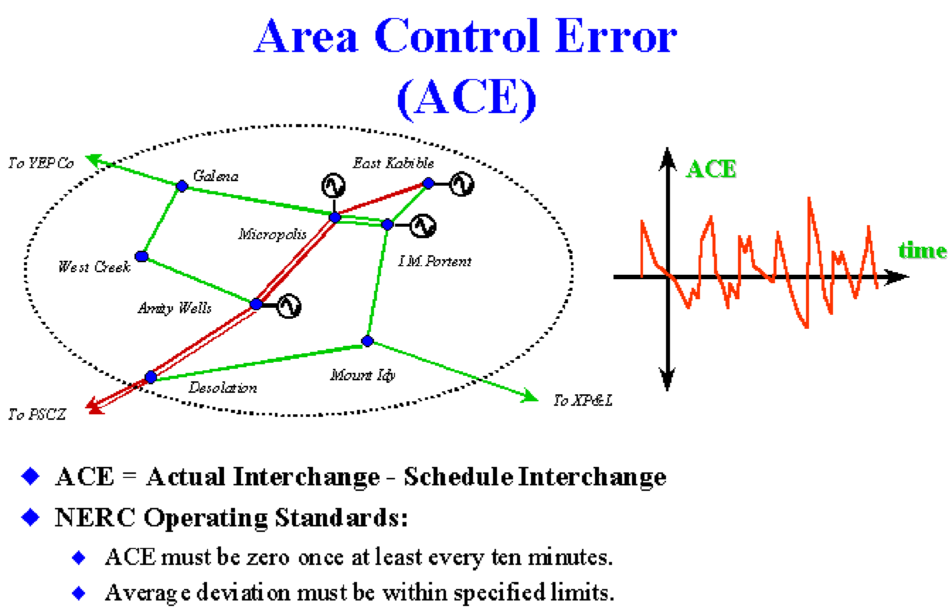

Figure 2-3. Area Control Error (Walton, 1999)

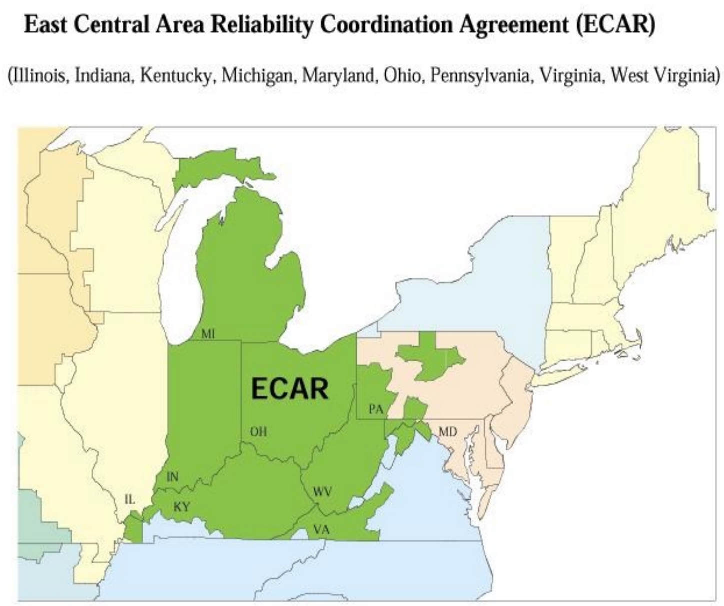

Figure 2-4. ECAR region, to which AEP belongs. (NERC)

When the demand starts to drop quicker than the utility company can reduce its production, the company can divert it to its pumped storage facility to pump (use electrical power) water into the upper reservoir. The increase in power demand created by the pumps will help to balance the supply and demand curves. This balance of supply and demand allows the area control error to cross zero (see Figure 2-3). This method of increasing the load through "energy storage" is preferred because fluctuating the production of the steam plants is expensive and inefficient. In the next chapter an optimization for the efficient operation of a pumped storage system is given. The formulation yields both the generating and pumping schedules while maximizing revenue.

Chapter 3 Formulation of Pumped Storage Optimization Problem

3.1 Introduction

Because electricity cannot be stored as is, it must be delivered as soon as it is produced. However, there have been attempts to store electricity by indirect means including pumped hydro storage, compressed air storage, and battery storage, as well as, super conducting magnetic field storage and demand side management (Paula, 1990; Henry and Graeser, 1985). In pumped storage, the water is pumped back to an upper reservoir during the weekend and withdrawn during the week to satisfy the peak load. Compressed air energy storage involves compressing air into a container. When needed, the compressed air is heated with a fuel and the expanding air does work on a turbine. Batteries are recharged with an AC current inducing a chemical reaction among the constituents of the battery. Typically, the reverse reaction results in discharging the battery. Super conducting magnetic energy storage provides a means of directly maintaining the energy in the magnetic field. Demand side management, as opposed to the (energy) supplier's storage schemes, aims to utilize electrical energy efficiently on the users' end. A general feature of demand side management is to use electricity the previous night to heat or cool a storage medium such as bricks or chilled water. The next day utilize the heat from the bricks or circulate the chilled water to cool the building. In this thesis, the focus is on the pumped storage units.

Pumping is a desirable alternative due to the variations in the cost of electricity. The practice of charging more money during peak demands has encouraged the production of power at the facility's maximum capacity during peak hours and pumping water from the lower reservoir to the upper reservoir during non-peak hours.

Velz (1971) discusses the environmental impacts of the pumped storage systems. These include flooding of large areas, alteration of the hydrology, changes to aquatic biology and fish, danger from possible failure of dams, and overhead high voltage transmission lines. However, the approval of such projects clearly indicates their benefits over the environmental impacts. Also, many of these effects can be minimized. Another important fact is the ever-growing demand for electrical energy. Hydro units have little to no polluting effects on the environment, whereas, all other major modes of power generation have serious effects.

An important issue in hydropower operation is the load curve. Quick fluctuations in the load curve and the slow response of thermal units can create serious problems with the voltage and area control error. Because demand must be met with simultaneous production and thermal units cannot quickly respond to increases and decreases in demand, pumped storage units provide an exceptional benefit to power companies. The pumped storage facility can produce power in less than 15 minutes, and can be used along with the thermal units for peak demand periods. When the demand decreases the hydro unit can consume the excess power from the thermal units by pumping water to the upper reservoir. Eriksen and Pedersen (1997) and Giles and Wunderlich (1991) have formulated criteria related to the value of hydropower. They consider the exponential growth in the thermal unit costs above certain threshold power to satisfy the peak demand, as well as, the costs involved in chasing the peaks and valleys of the load curve. Cohen and Wan (1985) group the optimization models related to pumped storage as marginal cost models, linear/nonlinear, and dynamic programming (DP) models. They also provide a DP formulation to a basic pumped storage problem. Gorenstin et al. (1992) point out the curse of dimensionality associated with the DP formulation. In addition, DP does not have such general purpose software, as does the linear programming (LP) and nonlinear programming (NLP). However, Lee and Chen (1992) provide good details related to the constraints involved in a pumped storage system within a DP framework (also, see Lee et al. 1987). Li et al. (1992) apply a network model for a hydrothermal coordination problem. From the literature survey, the following points emerge. No detailed explicit formulation is readily available. The non-convex nature of the NLP formulation is not discussed in detail, and solutions to overcome multiple local optima are not offered. Linearization schemes have not been suggested. In this thesis a well detailed formulation with sufficient explanation is presented. Because of the non-convex nature of the NLP problem, a suitable linearized version is also presented.

AEP does not divide the load between its plants such that a particular plant is required to produce a percentage of the total load. Instead, AEP optimizes the usage of thermal units and adjusts the hydroelectric plants to meet the remaining system load. Therefore, Smith Mountain Lake is brought online only to meet the peak demands or sudden increases in load. When there is a surplus of electrical energy in AEP's region, Smith Mountain Lake is used to meet the area control error requirement by running the pumps. Smith Mountain Lake can provide a net difference of 900 MW on the grid in about 15 minutes. The three turbines, that also pump, can use 300 MW of energy to pump, and then switch to producing 600 MW in less than 15 minutes.

In the following pages, a mathematical formulation based on this real system is presented. A schematic of the system is shown in Figure 3-1. The formulation results in a nonlinear integer program. The solution space is non-convex because of the need for binary variables as well as the product form of the power constraints. As pointed out in Chapter 1, this thesis focuses on short-term hydro-scheduling. Short-term hydro-scheduling assumes that the power demand, inflows, unit availability and electric cost are all known. The following notations are used.

3.2 List of Notations

A_j^P	=	Efficiency coefficient for the jth pump
A^{S1}	=	Coefficient for the stage-storage relationship in the upper reservoir
A^{S2}	=	Coefficient for the stage-storage relationship in the lower reservoir
A^{TR2}	=	Coefficient for the stage-discharge relationship in the lower tailrace
A_j^{T1}	=	Efficiency coefficient for the jth turbine in the upper reservoir
A_j^{T2}	=	Efficiency coefficient for the jth turbine in the lower reservoir
A_j^{HP}	=	Coefficient for the head-discharge relationship for the jth pump in the upper reservoir
A^{Spill1}	=	Coefficient for the spillway stage-discharge relationship in the upper reservoir
$A1_j$	=	Efficiency coefficient for the jth pump in the upper reservoir
B_j^P	=	Efficiency coefficient for the jth pump
B^{S1}	=	Constant for the stage-storage relationship in the upper reservoir
B^{S2}	=	Constant for the stage-storage relationship in the lower reservoir
B^{TR2}	=	Coefficient for the stage-discharge relationship in the lower tailrace
B_j^{T1}	=	Efficiency coefficient for the jth turbine in the upper reservoir
B_j^{T2}	=	Efficiency coefficient for the jth turbine in the lower reservoir
B_j^{HP}	=	Coefficient for the head-discharge relationship for the jth pump in the upper reservoir
B^{Spill1}	=	Coefficient for the spillway stage-discharge relationship in the upper reservoir
C_j^P	=	Efficiency coefficient for the jth pump
C^{Spill1}	=	Constant for the spillway stage-discharge relationship in the upper reservoir
C^{TR2}	=	Coefficient for the stage-discharge relationship in the lower tailrace
C_j^{T1}	=	Efficiency coefficient for the jth turbine in the upper reservoir
C_j^{T2}	=	Efficiency coefficient for the jth turbine in the lower reservoir
Cd	=	Orifice Discharge Coefficient
$Chan(t)$	=	Discharge through the downstream channel (cfs)
$\underline{Chan}, \overline{Chan}$	=	Minimum and maximum capacity of the downstream channel (cfs)
D_j^P	=	Efficiency constant for the jth pump
D^{TR2}	=	Constant for the stage-discharge relationship in the lower tailrace
D_j^{T1}	=	Efficiency constant for the jth turbine in the upper reservoir
D_j^{T2}	=	Efficiency constant for the jth turbine in the lower reservoir
$C(t)$	=	Cost Coefficient ($/MW)
$FB1(t)$	=	Forebay elevation for the upper reservoir (ft)
$FB2(t)$	=	Forebay elevation for the lower reservoir (ft)
g	=	Acceleration due to gravity (ft/s^2)
$Gated(t)$	=	Controlled discharge through the lower dam (cfs)

$\overline{Gated}$ = Maximum discharge through the lower dam (cfs)
$H1(t)$ = Head for the upper reservoir (ft)
$H2(t)$ = Head for the lower reservoir (ft)
$HP_j^{ON}(t)$ = Head value for the jth unit when pumping (ft)
$HP_j^{OFF}(t)$ = Head value for the jth unit when not pumping (ft)
$I1(t)$ = Inflow to upper reservoir (cfs)
$I2(t)$ = Inflow to lower reservoir (cfs)
$JT1$ = Total number of turbines for the upper reservoir
$JT2$ = Total number of turbines for the lower reservoir
JP = Total number of pumps
$PP(t)$ = Total power consumed by the pumps (MW)
$PP_j(t)$ = Power consumed by the jth pump (MW)
$PT(t)$ = Total power produced from all of the turbines (MW)
$PT1_j(t)$ = Power produced by the jth turbine for the upper reservoir (MW)
$PT2_j(t)$ = Power produced by the jth turbine for the lower reservoir (MW)
$QT1_j(t)$ = Discharge for the jth turbine for the upper reservoir (cfs)
$QT2_j(t)$ = Discharge for the jth turbine for the lower reservoir (cfs)
$\underline{QT1}_j, \overline{QT1}_j$ = Minimum and maximum discharge for the jth turbine for the upper reservoir (cfs)
$\underline{QT2}_j, \overline{QT2}_j$ = Minimum and maximum discharge for the jth turbine for the lower reservoir (cfs)
$QP_j(t)$ = Discharge for the jth pump (cfs)
$\underline{QP}_j, \overline{QP}_j$ = Minimum and maximum discharge for the jth pump (cfs)
$S1(t)$ = Upper reservoir storage (ft^3)
$\overline{S1}$ = Maximum upper reservoir storage (ft^3)
$S2(t)$ = Lower reservoir storage (ft^3)
$\overline{S2}$ = Maximum lower reservoir storage (ft^3)
$Spill1^{YES}(t)$ = Water elevation with spillage in the upper reservoir (ft)
$Spill1^{NO}(t)$ = Water elevation with no spillage in the upper reservoir (ft)
$\underline{Spill1^{YES}}, \overline{Spill1^{YES}}$ = Elevation of the dam crest and maximum water elevation in the upper reservoir (ft)
$\underline{Spill1^{NO}}, \overline{Spill1^{NO}}$ = Minimum and maximum water elevation in the upper reservoir with out spillage (ft)
$Spill2^{NO}(t)$ = Water elevation with no spillage in the upper reservoir (ft)
$Spill2^{YES}(t)$ = Water elevation with spillage in the upper reservoir (ft)
$\underline{Spill2^{NO}}, \overline{Spill2^{NO}}$ = Minimum and maximum water elevation in the lower reservoir with out spillage (ft)
$\underline{Spill2^{YES}}, \overline{Spill2^{YES}}$ = Elevation of the dam crest and maximum water elevation in the lower reservoir (ft)
$TR2(t)$ = Tailrace elevation for the lower reservoir (ft)
t = Time
$UnContRel(t)$ = Discharge through the spillway in the upper dam (cfs)

$\overline{UnContRel}$	=	Maximum discharge through the spillway in the upper dam (cfs)
z	=	Objective Function ($)
$\beta^{NO}(t)$	=	1, no spillage in the upper reservoir
$\beta^{YES}(t)$	=	1, spillage in the upper reservoir
$\delta 1(t)$	=	0, turbines offline
$\delta 2(t)$	=	0, pumps offline
$\eta T2_j(t)$	=	Efficiency for the jth turbine for the lower reservoir
$\eta T1_j(t)$	=	Efficiency for the jth turbine for the upper reservoir
$\eta P_j(t)$	=	Efficiency for the jth pump
$\nu_j(t)$	=	1, jth pump is producing
γ	=	Specific weight of water (pcf)
$\mu 1_j(t)$	=	1, jth turbine is producing for upper reservoir
$\mu 2_j(t)$	=	1, jth turbine is producing for lower reservoir
$\theta^{NO}(t)$	=	1, no spillage in the upper reservoir
$\theta^{YES}(t)$	=	1, spillage in the upper reservoir

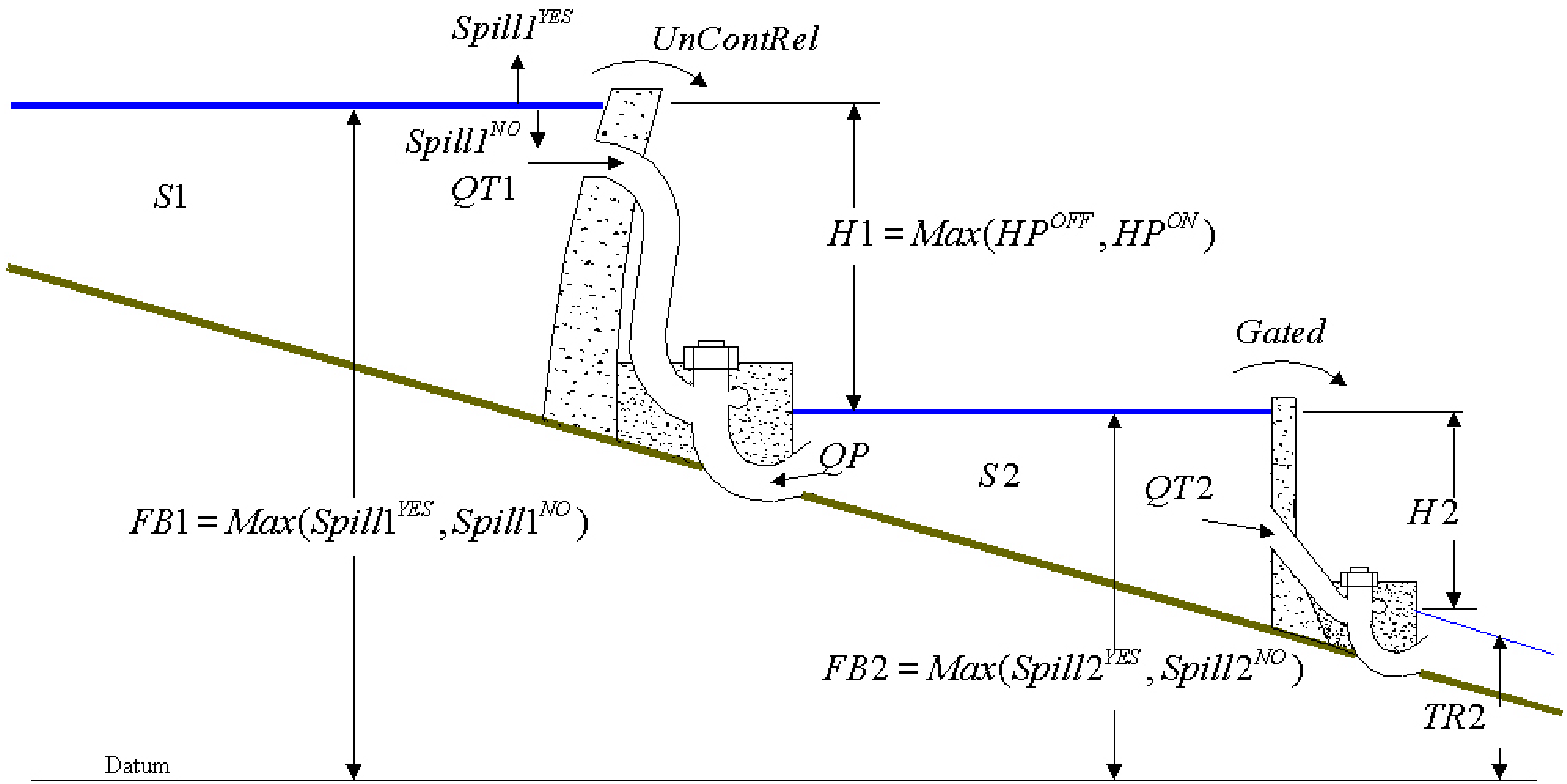

Figure 3-1. Schematic of Pumped Storage System

3.3 Nonlinear Mathematical Formulation

The following formulation is a nonlinear mixed-integer programming model and is a subproblem of the electrical system. Figure 3-1 gives a schematic of the pumped storage system. The objective function given in equation (3.2.1) consists of the time varying cost of power produced from the turbines, and the power consumed by the pumps. The formulation includes the following constraints. For clarity the constraints are organized as follows: Total power produced (3.2.2); upper reservoir power production which includes the definition of head over the unit (3.2.3), power produced (3.2.4), efficiency of the turbine (3.2.5), and flow limits (3.2.6); identical constraints (3.2.7) through (3.2.10) apply for the lower reservoir. The next set of constraints applies to power consumed by the pumps for lifting water back to the upper reservoir. These constraints are: pump power required in (3.2.11), total pump power (3.2.12), efficiency of pumps (3.2.13), and flow limits (3.2.14). Constraints (3.2.15) through (3.2.19) together accomplish the following. When the binary variable $\nu_j = 0$, no pumping is possible as the pump flow is set to zero and there may or may not be spillage from the upper reservoir by (3.2.15); also, $HP^{ON}(t)$ is set to zero. When $HP^{ON}(t)$ is zero, the actual head H1(t) is set to $HP^{OFF}(t)$ by (3.2.18). When the binary variable $\nu_j(t) = 1$, the upper reservoir water level is set below the spill level. The flow is defined by (3.2.14) and the corresponding head is selected from (3.2.19) based on the pump characteristic curve. The constraints (3.2.20) through (3.2.23) control the spill behavior by the binary variables, $\theta^{YES}(t)$ and $\theta^{NO}(t)$. The constraints (3.2.24) through (3.2.29) control whether the unit works as a pump or turbine aided by the binary variables $\delta1(t)$ and $\delta2(t)$. These two variables in turn, dictate to the unit a specific binary variables, $\nu_j(t)$ for pumps and $\mu_j(t)$ for turbines as given by the constraints (3.2.24) and (3.2.25). The uncontrolled release from the upper reservoir during a spill is given by the constraints (3.2.30) and (3.2.31). The wicket gate area is determined by (3.2.32). The lower reservoir spill pattern is modeled by the constraints (3.2.33) through (3.2.36). The gated release from the lower reservoir during spill is given by (3.2.37). The tailrace-channel flow relation is given in (3.2.38). The instream flow requirement is given by (3.2.39). The channel flow including the gated release and lower dam turbine flow is given in (3.2.40). The storage-elevation relationships are given in the constraints (3.2.42) through (3.2.45) for the upper and lower reservoirs respectively. The continuity constrains are given in (3.2.46) and (3.2.47) for the upper and lower reservoirs. The entire formulation is given below.

Maximize: $$Z = \sum_t C(t)(PT(t) - PP(t)) \tag{3.2.1}$$

Subject to:

Total power production

$$PT(t) = \sum_{j=1}^{JT1} PT1_j(t) + \sum_{j=1}^{JT2} PT2_j(t) \tag{3.2.2}$$

- **Upper Reservoir Power Production**

head definition

$$H1(t) = FB1(t) - FB2(t) \tag{3.2.3}$$

Assume that the tailrace elevation for Smith Mountain Lake (see Figure 3-2) is equal to the forebay elevation for Leesville Lake (see Equation (3.2.3))

Figure 3-2. Tailrace of Smith Mountain Dam

power

$$PT1_j(t) = \eta T1_j \gamma H1(t) QT1_j(t) \quad (3.2.4)$$

efficiency of turbine unit

$$\eta T1_j(t) = A_j^{T1} QT1_j^3(t) + \mathrm{B}_j^{T1} QT1_j^2(t) + C_j^{T1} QT1_j(t) + D_j^{T1} \quad (3.2.5)$$

flow limits

$$\underline{QT1}_j \mu 1_j(t) \le QT1_j(t) \le \overline{QT1}_j \mu 1_j(t) \quad (3.2.6)$$

Figure 3-3. 26 ft Penstock at Smith Mountain Dam

- **Lower reservoir power production**

$$H2(t) = FB2(t) - TR2(t) \tag{3.2.7}$$

power

$$PT2_j(t) = \eta T2_j(t)\gamma H2_j(t) QT2_j(t) \tag{3.2.8}$$

efficiency

$$\eta T21_j(t) = A_j^{T2} QT2_j^3(t) + \mathrm{B}_j^{T2} QT2_j^2(t) + C_j^{T2} QT2_j(t) + D_j^{T2} \tag{3.2.9}$$

flow limits

$$\underline{QT2}_j \mu 2_j(t) \le QT2_j(t) \le \overline{QT2}_j \mu 2_j(t) \tag{3.2.10}$$

- **Pump Consumption**

power consumed by jth pump

$$PP_j(t) = \frac{\gamma H1(t) \bullet QP_j(t)}{\eta P_j(t)} \tag{3.2.11}$$

total pump power

$$PP(t) = \sum_{j=1}^{JP} PP_j(t) \tag{3.2.12}$$

efficiency

$$\eta P_j(t) = A_j^P QP_j^3(t) \ + B_j^P QP_j^2(t) + C_j^P QP_j(t) + D_j^P \tag{3.2.13}$$

flow limits

$$\underline{QP}_j \nu_j(t) \le QP_j(t) \le \overline{QP}_j \nu_j(t) \tag{3.2.14}$$

- **Pump Operation constraints**

  spill head

$$HP_j^{OFF}(t) \le \overline{Spill1^{YES}}(1 - \nu_j(t)) \tag{3.2.15}$$

pump head

$$HP_j^{ON}(t) \le \overline{Spill1^{NO}}\nu_j(t) \tag{3.2.16}$$

flow limit for pump j

$$QP_j(t) \le \overline{QP_j}\nu_j(t) \tag{3.2.17}$$

head for pump or spill

$$H1(t) = HP_j^{ON}(t) + HP_j^{OFF}(t) \tag{3.2.18}$$

pump characteristic curve

$$HP_j^{ON}(t) = A_j^{HP} QP_j(t) + B_j^{HP}\nu_j(t) \tag{3.2.19}$$

Once it is decided that the pump is operating, then HP^{ON} assumes the value of H1 and $\nu(t)$ equals 1. If the pump is not operating then HP^{ON} and $\nu(t)$ must equal 0. When pumping, no spilling should occur at the upper dam. If the forebay (FB1) elevation is less than the dam crest, then there is no spillage (see Equations (3.2.20) and (3.2.21)). The forebay elevation for the upper reservoir has a range of 787.00 to 811.00 feet. If water is passing through the spillways, $Spill1^{NO}(t) = 0$ and $Spill1^{YES}(t)$ will have a value within a certain range (see Equation (3.2.22)). At any given time, only one of the variables $Spill1^{NO}(t)$ or $Spill1^{YES}(t)$ will have a value. This value falls within a certain range as dictated by the physical constraints of the system (see Equations (3.2.21), (3.2.22) and (3.2.23)).

- **Spill constraints**

forebay head for upper reservoir

$$FB1(t) = Spill1^{NO}(t) + Spill1^{YES}(t) \quad (3.2.20)$$

spill/ no spill constraints

$$\underline{Spill1}^{NO}\theta^{NO}(t) \leq Spill1^{NO}(t) < \overline{Spill1}^{NO}\theta^{NO}(t) \quad (3.2.21)$$

$$\underline{Spill1}^{YES}\theta^{YES}(t) \leq Spill1^{YES}(t) \leq \overline{Spill1}^{YES}\theta^{YES}(t) \quad (3.2.22)$$

$$\theta^{NO}(t) + \theta^{YES}(t) = 1 \quad (3.2.23)$$

Figure 3-4. Left spillway at Smith Mountain Dam

The turbines may operate at any head range above minimum power pool elevation (787.00ft). There are three issues that surround the operation of the units: (1) pumps should not operate if water is spilling from the upper reservoir, (2) it is not physically possible for a unit to operate as a turbine and a pump simultaneously, and (3) it is not practical for a unit to operate as a turbine with the adjacent unit operating as a pump. In part, equations (3.2.24) and (3.2.25) serve to overcome these issues. The main purpose of equations (3.2.24) through (3.2.28) is to insure that if one unit operates as a turbine then any other unit if on, must also operate as a turbine. The same applies if one unit operates as a pump.

- **Unit selection constraints**

Turbine selection

$$\sum_{j}^{JT1} \mu 1_j(t) \leq JT1 \cdot \delta 1(t) \text{ (Turbines)} \tag{3.2.24}$$

Pump selection

$$\sum_{j}^{JP} \nu_j(t) \leq JP \cdot \delta 2(t) \text{ (Pumps)} \tag{3.2.25}$$

$$\mu_j(t) \in 0,1 \; \forall j \tag{3.2.26}$$

$$\nu_j(t) \in 0,1 \; \forall j \tag{3.2.27}$$

Turbine or pump

$$\delta 1(t) + \delta 2(t) \leq 1 \tag{3.2.28}$$

pump only if no spill

$$\delta 2(t) \leq \theta^{NO}(t) \tag{3.2.29}$$

If there is no spillage, $\theta^{NO}(t) = 1$, then $\delta 2(t) = 0$ or 1. This relationship between discharge through the spillway (see Figure 3-4) and the forebay elevation (see Equation (3.2.21)) ensures that pumping will not occur if the forebay elevation is above 795.00ft. When the forebay elevation is above the crest of the dam, then $\theta^{NO}(t) = 0$ and $\theta^{YES}(t) = 1$ causing $\nu(t) = 0$ (see Equation (3.2.25) and Equation (3.2.29)). Hence, $HP^{OFF}(t)$ is equal to H1(t) because the forebay elevation is above the crest of the dam. If there is no spillage then H1 will equal either $HP^{ON}(t)$ or $HP^{OFF}(t)$. This depends on the need to pump. If there is no pumping then $\nu(t)=0$ forces $H1(t)=HP^{OFF}(t)$ (see Equation (3.2.15) and Equation (3.2.18)). When there is no pumping, there may or may not be spillage because $\nu(t)=0$, $\delta 2(t)=0$ or 1, and $\theta^{NO}(t)=0$ or 1. If $\theta^{NO}(t)=0$ then there is no spillage, but there is spillage when $\theta^{NO}(t)=1$.

Uncontrolled release at the upper dam

$$0 \le UnContRel(t) \le \overline{UnContRel} \tag{3.2.30}$$

Must spill for uncontrolled release

$$UnContRel(t) = A^{Spill1} Spill1^{YES}(t)^2 - B^{Spill1} Spill1^{YES}(t) + C^{Spill1}\theta^{YES}(t) \tag{3.2.31}$$

wicket gate area

$$QT1_j(t) = A1_j(t) Cd\sqrt{2gH1(t)} \tag{3.2.32}$$

- **Lower Reservoir Spill Constraints**

$$FB2(t) = Spill2^{NO}(t) + Spill2^{YES}(t) \tag{3.2.33}$$

$$\underline{Spill2^{NO}}\beta^{NO}(t) \le Spill2^{NO}(t) < \overline{Spill2^{NO}}\beta^{NO}(t) \tag{3.2.34}$$

$$\underline{Spill2^{YES}}\beta^{YES}(t) \le Spill2^{YES}(t) \le \overline{Spill2^{YES}}\beta^{YES}(t) \tag{3.2.35}$$

$$\beta^{NO}(t) + \beta^{YES}(t) = 1 \tag{3.2.36}$$

The forebay range for the lower reservoir is the minimum power pool elevation to the top of the dam. For most situations the spillway at Leesville can pass a large flood (see Figure 3-5). Under normal operating conditions there is no need to pass water through the spillway. The release of water through the control structure is a function of two variables, water elevation above the crest, and gate opening. The gate opening is controlled by a plant operator. The release of water can range from 0 to 150,000 cfs. Typical power pool elevation is from 600.00 to 613.00 ft. For this reason, the only constraint placed on the gated release of water is that the water elevation must be above 613.00 ft. However, water does not have to pass through the gate at this elevation. This only provides an opportunity for the release of water through the gate. If the water level is at or below 613.00 ft then $\beta^{YES}(t) = 0$ forcing the Gated(t) variable to equal 0.

Gated release

$$0 \le Gated(t) \le \overline{Gated}\beta^{YES}(t) \tag{3.2.37}$$

Tailrace-flow relationship

$$TR2(t) = A^{TR2}Chan^3(t) + B^{TR2}Chan^2(t) + C^{TR2}Chan(t) + D^{TR2} \tag{3.2.38}$$

Instream flow requirement

$$weekly\ average\left(\sum_{j=1}^{2} QT2_j(t) + Gated(t)\right) \ge \underline{Chan} \tag{3.2.39}$$

Channel flow

$$Chan(t) = \sum_{j=1}^{JT2} QT2_j(t) + Gated(t) \tag{3.2.40}$$

$$Chan(t) \le \overline{Chan} \tag{3.2.41}$$

Figure 3-5. Leesville Dam and Spillway

Storage-Elevation relationship for the upper reservoir

$$S1(t) = A^{S1}FB1(t) - B^{S1} \tag{3.2.42}$$

$$S1(t) \leq \overline{\mathrm{S1}} \tag{3.2.43}$$

Storage-Elevation relationship for the lower reservoir

$$S2(t) = A^{S2}FB2(t) - B^{S2} \tag{3.2.44}$$

$$S2(t) \leq \overline{\mathrm{S2}} \tag{3.2.45}$$

Permit requirements set upper and lower limits on the down stream channel flow. The permit states that a minimum average weekly flow of 650 cfs (109,200 cfsh/week) must be released from the Leesville Reservoir. The maximum flow must be less than

20,000 cfs during any time period. The minimum flow requirement is for stream habitat and the maximum flow requirement is to prevent downstream flooding.

Continuity for the upper reservoir

$$S1(t+\Delta t) = S1(t) - \sum_{j=1}^{JT1} QT1_j(t) \bullet \Delta t + \sum_{j=1}^{JP} QP_j(t) \bullet \Delta t + \sum_{j=1}^{I1} I1_j(t) \bullet \Delta t - UnContRel(t)\Delta t \qquad (3.2.46)$$

Continuity for the lower reservoir

$$S2(t+\Delta t) = S2(t) + \sum_{j=1}^{JT1} QT1_j(t)\Delta t - \sum_{j=1}^{JP} QP_j(t)\Delta t - \sum_{j=1}^{JT2} QT2_j(t)\Delta t + \sum_{j=1}^{I2} I2_j(t)\Delta t + UnContRel(t)\Delta t - Gated(t)\Delta t \qquad (3.2.47)$$

3.4 Solution Methodology

The above formulation is a nonlinear mixed-integer program and its solution is complex. The problem has a vast array of variables and constraints when analyzed for one hour time steps over a period of a few weeks. A simplified problem has been created in order to provide actual solutions for the variables. The problem has the same constraints, but the number of generating and pumping units, and the time step was increased from one hour to one day. This smaller version is used so that the results can be checked for reasonableness. The nonlinear formulation is solved using LINGO (see APPENDIX B). The results of this program are presented in Chapter 5. For more information on NLP please see Ravindran et al. (1987) and Reklaitis et al. (1983). For more information on LINGO please see Schrage (1998) and LINDO Systems (1998).

Chapter 4 Mixed-integer Linear Formulation

4.1 Introduction

In this chapter a linearized version of the nonlinear formulation of chapter 3 is presented. The nonlinear problem is difficult to solve and lacks a global optimal solution due to non-convexity. The linear problem has a global optimum but is valid only for the linearized constraints and the objective. Therefore, the form of the linearization is crucial. In the following, the range of head over the turbine and the range for the flows are divided into discrete class intervals. The mid points of these class intervals are utilized to obtain estimates of power, head over the turbine, pump, and the released flow. As intervals become small, the solution will improve at an increased computational burden. However, no new theoretical difficulties arise as far as the formulation is concerned. In the following, the formulation is presented following the flow. That is, the sequence of the constraints follow the physical entities, namely, upper reservoir, its turbine/pump discharge, lower reservoir, its turbine, gated release at the lower reservoir, and the downstream channel. The storage relations are included at the end for the upper and the lower reservoirs.

4.2 *List of Notation*

$A1_j$	=	Efficiency coefficient for the jth pump in the upper reservoir
A^{S1}	=	Coefficient for the stage-storage relationship in the upper reservoir
A^{S2}	=	Coefficient for the stage-storage relationship in the lower reservoir
A^{Spill}	=	Coefficient for the spillway stage-discharge
A^{TR2}	=	Coefficient for the downstream tailrace stage-discharge relationship
B^{S1}	=	Constant for the stage-storage relationship in the upper reservoir
B^{S2}	=	Constant for the stage-storage relationship in the lower reservoir
B^{Spill}	=	Coefficient for the spillway stage-discharge relationship
B^{TR2}	=	Coefficient for the downstream tailrace stage-discharge relationship
C^{Spill}	=	Constant for the spillway stage-discharge relationship
C^{TR2}	=	Coefficient for the downstream tailrace stage-discharge relationship
C(t)	=	Cost Coefficient ($/MW)
Cd	=	Orifice Discharge Coefficient
$Chan(t)$	=	Discharge through the downstream channel (cfs)
$Chan_m^l$ $Chan_m^u$	=	Lower and Upper bound on the channel flow for the mth interval (cfs)
D^{TR2}	=	Constant for the downstream tailrace stage-discharge relationship
$FB1(t)$	=	Forebay elevation for the upper reservoir (ft)
$FB1_k^l, FB1_k^u$	=	Lower and Upper Bound Forebay elevation for the upper reservoir for the kth head interval (ft)
$FB2(t)$	=	Forebay elevation for the lower reservoir (ft)
g	=	Acceleration due to gravity (ft/s^2)
$Gated(t)$	=	Controlled discharge through the lower dam (cfs)
$\overline{Gated}$	=	Maximum discharge through the lower dam (cfs)
$H1(t)$	=	Head for the upper reservoir (ft)
$H1_k^l, H1_k^u$	=	Lower and upper bound for the kth head interval (ft)
$H2(t)$	=	Head for the lower reservoir (ft)
$H2_k^l, H2_k^u$	=	Lower and upper bound on the head for the kth head interval (ft)
i	=	Index variable
$I2(t)$	=	Inflow to lower reservoir (cfs)
j	=	Index variable for units
$JI1$	=	Total number of inflows for the upper reservoir
$JI2$	=	Total number of inflows for the lower reservoir
JP	=	Total number of pumps
$JT1$	=	Total number of turbines for the upper reservoir
$JT2$	=	Total number of turbines for the lower reservoir
k	=	Index variable for head
K1	=	Total number of head intervals for the upper reservoir
K2	=	Total number of head intervals for the lower reservoir
$M1$	=	Total number of discharge intervals for the upper reservoir
$M2$	=	Total number of discharge intervals for the lower reservoir

$PP(t)$ = Total power consumed by the pumps (MW)

$PP_j(t)$ = Power consumed by the jth pump (MW)

$PP_{k,j}$ = Power consumed by the jth pumps in the kth head interval (MW)

$PT(t)$ = Total power produced from all of the turbines (MW)

$PT1(t)$ = Power produced by the turbine for the upper reservoir (MW)

$PT1_j(t)$ = Power produced by the jth turbine for the upper reservoir (MW)

$PT1_{k,j,m}$ = Power produced for the kth head and mth discharge interval by the jth turbine in the upper reservoir (MW)

$PT2(t)$ = Power produced by the turbine for the lower reservoir (MW)

$PT2_j(t)$ = Power produced by the jth turbine for the lower reservoir (MW)

$PT2_{k,j,m}$ = Power produced for the kth head and mth discharge interval by the jth turbine in the lower reservoir (MW)

$Produce(t)$ = 1, no pumps can operate

$Pump(t)$ = 1, no turbines can operate

$QP(t)$ = Total discharge for the pumps (cfs)

$QP_j(t)$ = Discharge for the jth pump (cfs)

$QP^l_{k,j}, QP^u_{k,j}$ = Lower and upper discharge bound for the jth unit at the kth head (cfs)

$QT1(t)$ = Total discharge for the turbine for the upper reservoir (cfs)

$QT1_j(t)$ = Discharge for the jth turbine for the upper reservoir (cfs)

$QT1^l_{k,j,m}\ QT1^u_{k,j,m}$ = Lower and upper bound on discharge for the kth head, jth unit, and mth discharge for the upper reservoir (cfs)

$QT2(t)$ = Total discharge for the turbine for the lower reservoir (cfs)

$QT2_j(t)$ = Discharge for the jth turbine for the lower reservoir (cfs)

$QT2^l_{k,j,m}, QT2^u_{k,j,m}$ = Lower and upperbound on discharge for the kth head, jth unit, and mth discharge for the lower reservoir (cfs)

$S1(t)$ = Upper reservoir storage (ft^3)

$\overline{S1}$ = Maximum upper reservoir storage (ft^3)

$S2(t)$ = Lower reservoir storage (ft^3)

$\overline{S2}$ = Maximum lower reservoir storage (ft^3)

$Spill1^{NO}(t)$ = Water elevation with no spillage in the upper reservoir (ft)

$Spill1^{YES}(t)$ = Water elevation with spillage in the upper reservoir (ft)

$\underline{Spill1^{NO}}, \overline{Spill1^{NO}}$ = Minimum and maximum water elevation in the upper reservoir with out spillage (ft)

$\underline{Spill1^{YES}}, \overline{Spill1^{YES}}$ = Elevation of the dam crest and maximum water elevation in the upper reservoir (ft)

$Spill1^l_i, Spill1^u_i$ = Lower and Upper elevation bound of spillage for the ith head interval for the upper reservoir (ft)

$Spill2^{NO}(t)$ = Water elevation with no spillage in the upper reservoir (ft)

$Spill2^{YES}(t)$ = Water elevation with spillage in the upper reservoir (ft)

$\underline{Spill2^{NO}}, \overline{Spill2^{NO}}$	=	Minimum and maximum water elevation in the lower reservoir with out spillage (ft)
$\underline{Spill2^{YES}}, \overline{Spill2^{YES}}$	=	Elevation of the dam crest and maximum water elevation in the lower reservoir (ft)
$TR2(t)$	=	Tailrace elevation for the lower reservoir (ft)
$TR2_m^l, TR2_m^u$	=	Lower and Upper bound of tailrace elevation for the mth discharge interval for the downstream channel (ft)
$Turbine(t)$	=	Controls all units produce or not produce
$UnContRel(t)$	=	Discharge through the spillway in the upper dam (cfs)
$UnContRel_i$	=	Discharge through the spillway for the ith head interval in the upper dam (cfs)
x	=	mid-point of upper reservoir head
$\alpha_j(t)$	=	1, pump operating
$\beta_j(t)$	=	1, turbine operating
$\delta 1_k(t)$	=	Determines the kth head interval for the upper reservoir
$\delta 2_k(t)$	=	Determines the kth head interval for the lower reservoir
γ	=	Specific weight of water (pcf)
$\theta_i(t)$	=	1, sets discharge for the ith interval through the spillway
$\theta^{YES}(t)$	=	1, spillage only in one head interval for the upper reservoir
$\theta_i^{YES}(t)$	=	1, spillage in the upper reservoir for the ith head interval
$\theta^{NO}(t)$	=	1, no spillage in the upper reservoir
$\eta_{k,j}$	=	Efficiency for the jth pump at the kth head interval
$\eta_{k,j,m}$	=	Efficiency for the jth turbine for the mth discharge at the kth head interval
$\phi 1_{k,j,m}(t)$	=	1, discharge from the jth unit for the mth discharge at the kth head interval for the upper reservoir
$\phi 2_{k,j,m}(t)$	=	1, discharge from the jth unit for the mth discharge at the kth head interval for the lower reservoir
$v_{k,j}(t)$	=	1, jth pump is producing
$\sigma^{Yes}(t)$	=	Controls gated discharge from the lower reservoir
$\sigma^{No}(t)$	=	No spillage at the lower reservoir
$\varsigma_m(t)$	=	Tailrace elevation at the mth discharge

4.3 *Linear Mathematical Formulation*

- **Discretization of upper reservoir head for the turbine**

Consider the upper reservoir. The head is divided into several intervals (see Figure 4-1 and Table 4-3) k=1,2…K. The interval one has an upper head value of $H1_1^u$ and a lower head value of $H1_1^l$; note that $H1_2^u = H1_1^l$. The actual head H1(t) for the upper reservoir can lie in only one of these intervals, as given by equation (4.2.1) and (4.2.2). The head value is bracketed by the appropriate bounds as given below:

$$H1_k^l \, \delta 1_k(t) \le H1(t) \le H1_k^u \, \delta 1_k(t) \tag{4.2.1}$$

and

$$\sum_{k=1}^{K1} \delta 1_k(t) = 1 \text{ and } \delta 1_k(t) = 0 \text{ or } 1 \tag{4.2.2}$$

There will be K1T_t many variables with K1 = total number of head intervals and T_t= total number of time steps. The head was divided into intervals because power, which is a nonlinear equation, is mainly a function of head and discharge (see equations **(3.2.2)**, **(3.2.4)**, and **(3.2.11)**).

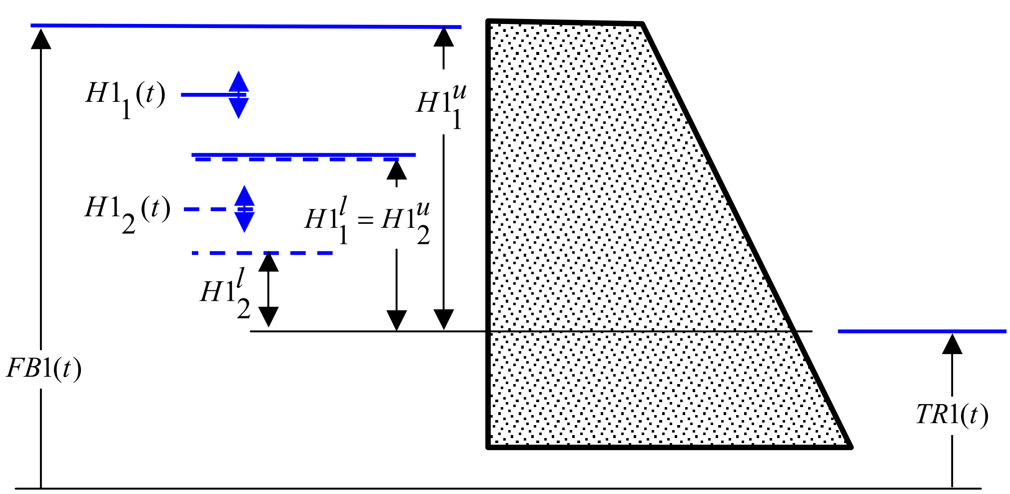

Figure 4-1. Head Intervals for Upper Reservoir

$$H1(t) = FB1(t) - FB2(t) \tag{4.2.3}$$

- **Turbine Power Production**

Consider the j[th] turbine operating under the upper reservoir head interval k. The value of the k[th] head interval is utilized as the head for turbine operation denoted by $H1(t)$. Under the head $H1(t)$, the turbine operates with an efficiency versus flow curve as shown in Figure 4-2. The midpoint of the upper and lower bound on head is used to calculate the power generated by the turbines in equation (4.2.4). In equation (4.2.11), the flow range is divided into m=1,2…M intervals, with the upper boundary flow as $QT^{u}_{j,k,m}$ and the lower boundary flow as $QT^{l}_{j,k,m}$. $QT_{j,k,m}$ represents flow through turbine j for the k[th] head interval and for the m[th] flow interval. Also, note that $QT^{l}_{j,k,m} = QT^{u}_{j,k,m+1}$. Efficiency is a function of the midpoint discharge (see Figure 4-2). The power for the m[th] flow interval for the j[th] turbine unit operating under the k[th] head interval can be written as

$$PT1_{k,j,m} = \gamma \frac{QT1^{l}_{k,j,m} + QT1^{u}_{k,j,m}}{2} \eta_{k,j,m} \frac{H1^{l}_{k} + H1^{u}_{k}}{2} \tag{4.2.4}$$

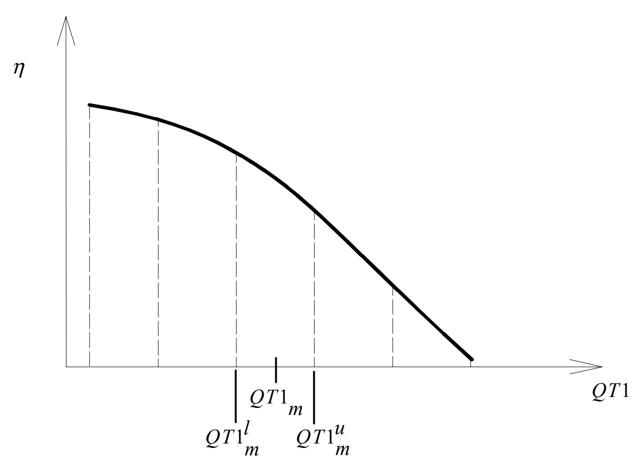

Figure 4-2. Efficiency vs. Turbine Discharge

In reality, the discharge $QT1_j$ is also a function of the wicket gate opening area. Operating the wicket gate allows the operator direct control of the discharge (reduction of discharge for any head) which in effect controls the power produced by that turbine.

$$QT1_j = A1_j Cd\sqrt{2gH1} \tag{4.2.5}$$

- **Head Interval Selection**

  The j[th] turbine flow curve corresponding to the head interval k is selected along with the most appropriate flow interval by

  $$\sum_{m=1}^{M1} \phi 1_{k,j,m}(t) \le \delta 1_k(t), \text{ for } \forall j \text{ and } \forall k \quad (4.2.6)$$

  and

  $$\phi 1_{k,j,m}(t) = 0 \text{ or } 1 \tag{4.2.7}$$

  Equation (4.2.6), ensures that only the flow interval corresponding to the selected k[th] head interval, k^*, can be utilized. All other choices are discarded due to $\delta 1_k = 0$ for $k = k^*$.

- **Total Power at the Upper Reservoir**

  The power produced by the j[th] unit for time t, is written as

  $$PT1_j(t) = \sum_{k=1}^{K1}\sum_{m=1}^{M1} PT1_{k,j,m}\phi 1_{k,j,m}(t) \tag{4.2.8}$$

  There are $K1JT1MT_t$ such $\phi 1_{k,j,m}(t)$ variables. Therefore, the total power produced by all upper reservoir units for time t, is

  $$PT1(t) = \sum_{j=1}^{JT1} PT1_j(t) \tag{4.2.9}$$

The total power produced by the entire facility, upper and lower reservoir turbines is

$$PT(t) = PT1(t) + PT2(t) \tag{4.2.10}$$

- **Continuous Flow**

A continuous flow variable, $QT1_j(t)$ in the reservoir continuity equation is used, as opposed to the midpoint value used in the turbine power equation (4.2.4) (see Table 4-4). The continuous flow is restricted by the bounds

$$QT1^l_{k,j,m}\phi 1_{k,j,m}(t) \le QT1_j(t) \le QT1^u_{k,j,m}\phi 1_{k,j,m}(t) \tag{4.2.11}$$

and the total flow through the turbines for time t, is given by

$$QT1(t) = \sum_{j=1}^{JT1} QT1_j(t) \quad \text{for each } j \tag{4.2.12}$$

- **Pump Power Consumption**

Pumps operate under the same head as the turbines because the same unit acts either as turbine or pump. When pumps are operational, no turbines can function. The flows are put into intervals the same as for the turbines. The power consumed by pump unit j, for the head interval k, is given by

$$PP_{k,j} = \gamma \frac{\left(\frac{QP^l_{k,j} + QP^u_{k,j}}{2}\right)\left(\frac{H1^l_k + H1^u_k}{2}\right)}{\eta_{k,j}} \tag{4.2.13}$$

The efficiency is a function of the pump discharge. The pump efficiency is calculated based on the midpoint of the discharge interval (see Figure 4-3), and then used in the pump power equation.

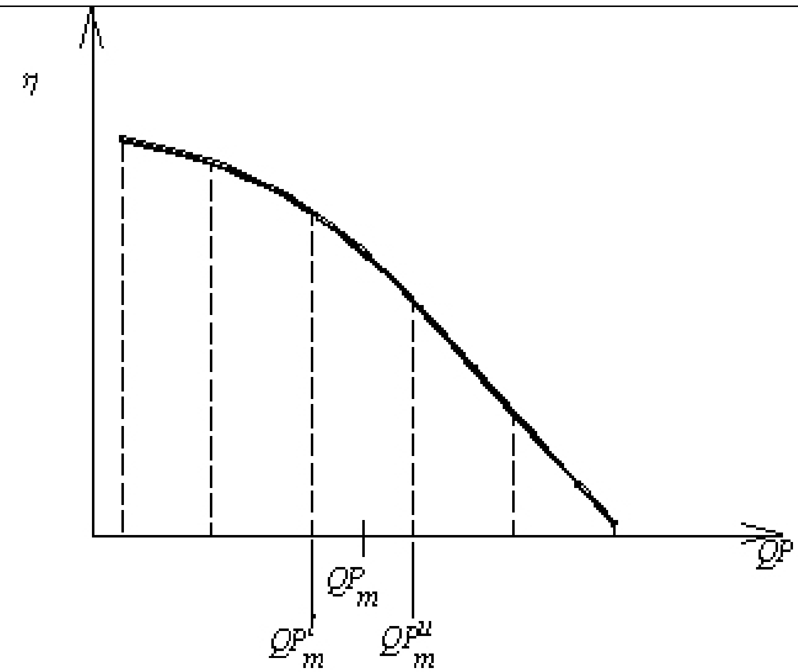

Figure 4-3. Efficiency vs. Pump Discharge

Note that the pump head will uniquely select the appropriate flow from the pump characteristic curve (see Figure 4-4). The power consumed by pump j for period t is given by

$$PP_j(t) = \sum_{k=1}^{K1} PP_{k,j} v_{k,j}(t) \tag{4.2.14}$$

$$PP(t) = \sum_{j=1}^{J1} PP_j(t) \tag{4.2.15}$$

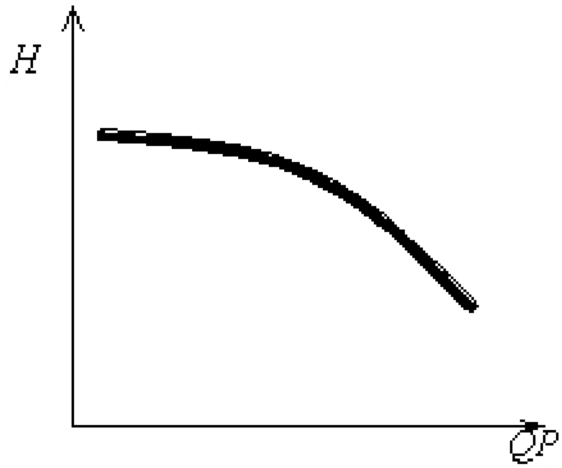

Figure 4-4. Head vs. Pump Discharge

- **Spill Related Head Constraints**

The pump head interval corresponds to $\delta 1$ head interval (see Equation (4.2.16)). However, if the forebay elevation exceeds the dam crest then $\theta^{NO}(t) = 0$, forcing $v_{k,j}(t) = 0$ for all k and all j. Thus, there is no pumping when the forebay elevation exceeds the dam crest, but the turbines may produce energy because no restrictions have been placed on $\phi 1(t)$ with regards to the dam crest elevation.

$$v_{k,j}(t) \le \delta 1_k(t) \text{ and } v_{k,j}(t) = 0 \text{ or } 1, \ \forall k \text{ and } \forall j \tag{4.2.16}$$

The piecewise linearization creates a small problem for the pumping head interval because the head is relative, whereas, the dam crest (795 ft) is in terms of an absolute elevation. There is a finite range of the head intervals where the possibility occurs that a pump could run with spillage. This happens because of the dependence of head on the forebay elevation of both the upper and lower reservoir. This possibility of a pump operating and spillage occurring simultaneously is considered in Equation (4.2.17). Equation (4.2.17) prevents any pump from running when the water level is above the crest of the dam (see Equation (4.2.28)) .

- **Pump Shut-off with Spill**

$v_{k,j}(t) \le \theta^{NO}(t), \ \forall k \text{ and } \forall j$ (4.2.17)

The flow through j^th pump is selected from

$$QP^{l}_{k,j} v_{k,j}(t) \le QP_j(t) \le QP^{u}_{k,j} v_{k,j}(t) \quad (4.2.18)$$

and the total pumped flow, $QP(t) = \sum_{j=1}^{JP} QP_j(t)$ (4.2.19)

- **Either Turbine or Pump, but NOT Both**

The turbine operation is controlled by the integer variable $\beta_j(t)$ (see Equation (4.2.20)). If $\beta_j(t)$ =1, then the turbine unit j operates at a specific head k (see Equation (4.2.1) and (4.2.2)) and discharge m (see Equation (4.2.11) and (4.2.12)).

$$\beta_j(t) = \sum_{k=1}^{K1} \sum_{m=1}^{M1} \phi 1_{k,j,m}(t), \quad \text{for each } j \quad (4.2.20)$$

The pump operation is controlled by the integer variable $\alpha_j(t)$ (see Equation (4.2.21)). If $\alpha_j(t)$ =1, then the pump unit j operates at a specific head k and discharge m.

$$\alpha_j(t) = \sum_{k=1}^{K1} v_{k,j}(t), \ \text{for each } j \quad (4.2.21)$$

A unit cannot simultaneously operate as a pump and turbine, nor should a unit operate as a turbine and the adjacent unit operate as a pump. Therefore, the pumps and turbines are restricted from operating at the same time (see Equation (4.2.22)). The unit j will operate either as turbine or pump is given by

$\beta_j(t) + \alpha_j(t) \le 1, \text{ for } \forall j$ (4.2.22)

To ensure no pump is operating when at least one turbine is operating the following constraints are imposed. The number of turbines and pumps that operate at time, t

$$Turbine(t) = \sum_{j=1}^{JT1} \beta_j(t) \tag{4.2.23}$$

and $$Pump(t) = \sum_{j=1}^{JP} \alpha_j(t) \tag{4.2.24}$$

The following equations (4.2.25) and (4.2.26) provide a switch between turbine, pump, and idle (no) operation. If at least one turbine is operating then the variable Produce(t)=1.

$$\text{Turbine}(t) \le JT1 \cdot \text{Produce}(t) \;\text{ and }\; \text{Produce(t)} = 0 \text{ or } 1 \tag{4.2.25}$$

If at least one turbine is operating, then the pumps cannot operate (see Equation (4.2.26)) because Produce(t)=1. If pumps are operational then Produce(t)=0, by equation (4.2.26), which shuts down all upper reservoir turbines.

$$Pump(t) \le JP \cdot (1 - \text{Produce}(t)) \tag{4.2.26}$$

- **Spillage for Upper Reservoir**

$$FB1(t) = Spill1^{NO}(t) + Spill1^{YES}(t) \tag{4.2.27}$$

$$\underline{Spill1^{NO}}\theta^{NO}(t) \le Spill1^{NO}(t) \le \overline{Spill1^{NO}}\theta^{NO}(t) \tag{4.2.28}$$

$$\underline{Spill1^{YES}}\theta^{YES}(t) \le Spill1^{YES}(t) \le \overline{Spill1^{YES}}\theta^{YES}(t) \tag{4.2.29}$$

FB1(t) is controlled by the head interval, storage equation, and the continuity equation. Once the forebay elevation is greater than 795 ft then spillage will occur. This spillage can be controlled by piecewise linearization of the forebay elevation (see Table 4-6).

$$Spill1_i^l \theta_i^{YES}(t) \le Spill1^{YES}(t) \le Spill1_i^u \theta_i^{YES}(t) \tag{4.2.30}$$

- **Uncontrolled Spillway Flow from Upper Reservoir**

$$\sum_{i=1}^{I} UnContRel_i \theta_i(t) = UnContRel(t) \tag{4.2.31}$$

$$\theta^{NO}(t) + \theta^{YES}(t) = 1 \tag{4.2.32}$$

$$\sum_{i=1}^{I} \theta_i(t) = \theta^{YES} \tag{4.2.33}$$

- **Discretization for Uncontrolled Flow**

$$UnContRel_i = A^{Spill} x^2 - B^{Spill} x + C^{Spill} \tag{4.2.34}$$

$$x = \frac{FB1_k^l + FB1_k^u}{2} \tag{4.2.35}$$

- **Leesville Lower Reservoir Height**

The lower reservoir head is divided in to intervals (see Equation (4.2.36) and (4.2.37)). Under the head $H2(t)$ (see Equation (4.2.38)), the turbine will operate in a specific discharge range and efficiency. The head is the difference of the lower reservoir's forebay elevation and the tailrace elevation (see Equation (4.2.52)). The midpoints of a given head interval and discharge interval are used to calculate the power generated by the turbines (see Equation (4.2.39)).

$$H2_k^l \delta 2_k(t) \le H2(t) \le H2_k^u \delta 2_k(t) \tag{4.2.36}$$

$$\text{and} \sum_{k=1}^{K2} \delta 2_k(t) = 1 \text{ and } \delta 2_k(t) = 0 \text{ or } 1 \tag{4.2.37}$$

$$H2(t) = FB2(t) - TR2(t) \tag{4.2.38}$$

- **Power Constraints**

The lower reservoir head is discretized and provides an interval that is used in the lower turbine power production equation:

$$PT2_{k,j,m} = \gamma \frac{QT2^{l}_{k,j,m} + QT2^{u}_{k,j,m}}{2} \eta_{k,j,m} \frac{H2^{l}_{k} + H2^{u}_{k}}{2} \tag{4.2.39}$$

$$\sum_{m=1}^{M2} \phi 2_{k,j,m}(t) \leq \delta 2_{k}(t), \quad \forall j,\ \forall k \tag{4.2.40}$$

and $\phi 2_{k,j,m}(t) = 0$ or 1 (4.2.41)

- **Total Power from Lower Reservoir**

The turbine power production equation for the lower reservoir is the same as equation (4.2.4) except for the variables. The turbine power production is given by:

$$PT2_{j}(t) = \sum_{k=1}^{K2} \sum_{m=1}^{M2} PT2_{k,j,m} \phi 2_{k,j,m}(t) \tag{4.2.42}$$

$$PT2(t) = \sum_{j=1}^{JT2} PT2_{j}(t) \tag{4.2.43}$$

The power generated from equation (4.2.42) is used in equation (4.2.10) to provide a total power produced between the upper and lower reservoir.

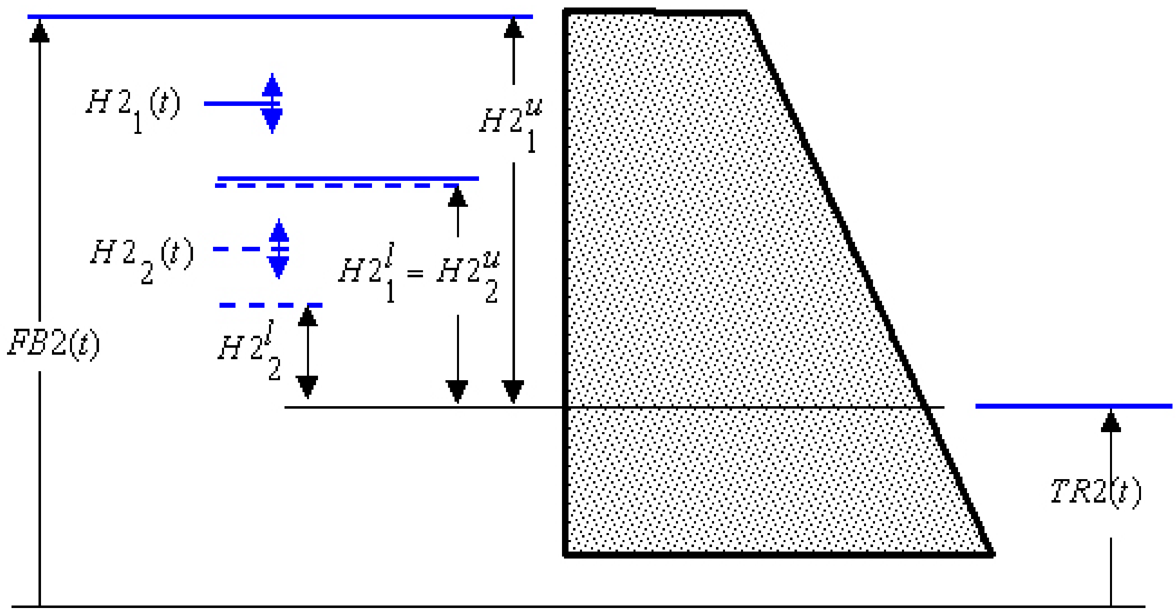

Figure 4-5. Height Intervals for the lower reservoir

- **Continuous Flow Selection for Lower Reservoir**

A continuous flow variable, $QT2_j(t)$, is used in the lower reservoir continuity equation. This continuous flow variable is restricted by the bounds (see Table 4-8)

$$QT2^l_{k,j,m}\phi 2_{k,j,m}(t) \leq QT2_j(t) \leq QT2^u_{k,j,m}\phi 2_{k,j,m}(t) \qquad (4.2.44)$$

The total flow through the turbines for time, t is given by

$$QT2(t) = \sum_{j=1}^{JT2} QT2_j(t) \ \text{ for each } j \qquad (4.2.45)$$

The lower reservoir has a gated spillway. Discharge through the spillway can occur with any head, which is also capable of producing power. The operation of the controlled discharge through this gated spillway adds some difficulty in achieving a solution. The elevation of the spillway is below the power pool level. The formulation allows the solution to release water through the spillway at any head level above the crest of the spillway. The program must decide if it is best to release water, which cannot generate a profit, through the spillway, hold the water for another time period, or pump the water in to the upper reservoir (see Equations (4.2.46) through (4.2.50)).

- **Spill Related Constraints for Lower Reservoir**

$$FB2(t) = Spill2^{NO}(t) + Spill2^{YES}(t) \quad (4.2.46)$$

$$\underline{Spill2^{NO}}\sigma^{NO}(t) \le Spill2^{NO}(t) < \overline{Spill2^{NO}}\sigma^{NO}(t) \quad (4.2.47)$$

$$\underline{Spill2^{YES}}\sigma^{YES}(t) \le Spill2^{YES}(t) \le \overline{Spill2^{YES}}\sigma^{YES}(t) \quad (4.2.48)$$

$$\sigma^{NO}(t) + \sigma^{YES}(t) = 1 \quad (4.2.49)$$

- **Gated Release**

$$0 \le Gated(t) \le \overline{Gated}\sigma^{YES}(t) \quad (4.2.50)$$

- **Channel Flow**

$$Chan(t) = \sum_{j=1}^{JT2} QT2_j(t) + Gated(t) \quad (4.2.51)$$

- **Tailrace Discretization**

$$TR2^{l}_{m}\varsigma_m(t) \le TR2(t) \le TR2^{u}_{m}\varsigma_m(t) \quad (4.2.52)$$

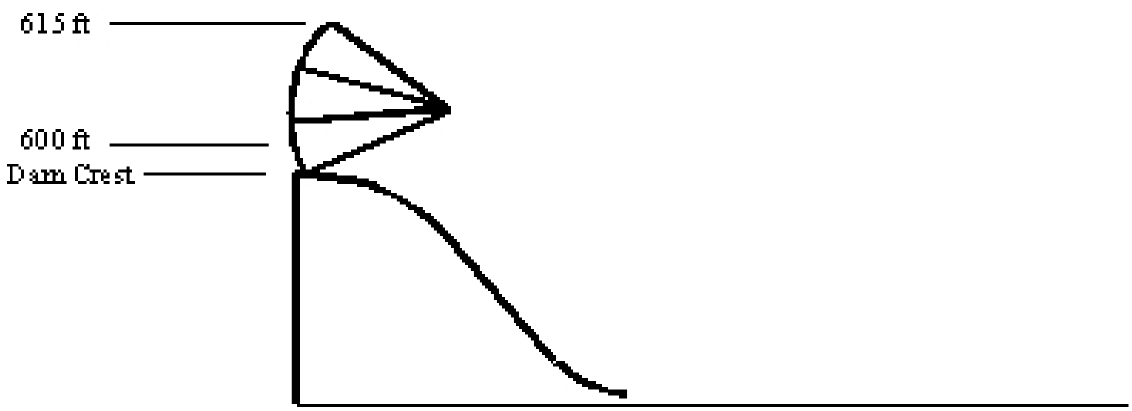

Figure 4-6. Lower Reservoir Gate

The tailrace elevation for the lower reservoir is divided in to intervals that correspond to a given channel discharge (see Equation (4.2.52)). For a given m value, there is a specific range that contains the channel discharge, $Chan(t)$. The tailrace elevation is then based on this specific range of channel discharge, such that there is a lower bound and an upper bound for the tailrace (see Equation (4.2.52) and Table 4-9).

$$TR2(t) = A^{TR2}Chan^3(t) + B^{TR2}Chan^2(t) + C^{TR2}Chan(t) + D^{TR2} \tag{4.2.53}$$

- **Channel flow Discretization**

$$Chan_m^l \varsigma_m(t) \leq Chan(t) \leq Chan_m^u \varsigma_m(t) \tag{4.2.54}$$

$$\sum_{m=1}^{MChan} \varsigma_m(t) \leq 1 \tag{4.2.55}$$

- **Storage-Elevation Relationship**

$$S1(t) \ = A^{S1}FB1(t) - B^{S1} \tag{4.2.56}$$

$$S2(t) = A^{S2}FB2(t) - B^{S2} \tag{4.2.57}$$

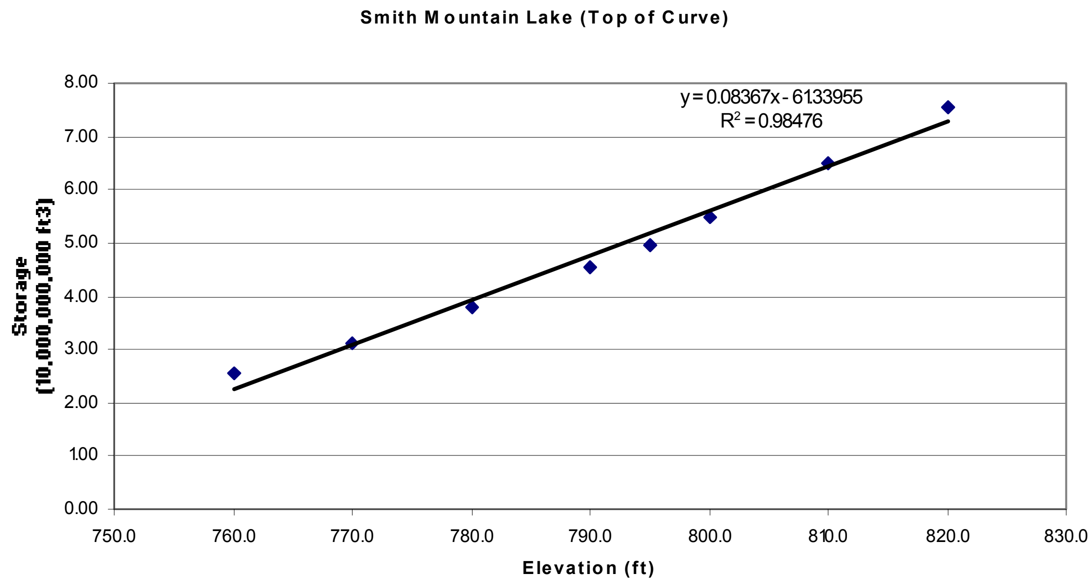

Table 4-1. Smith Mountain Lake Stage-Storage Relationship

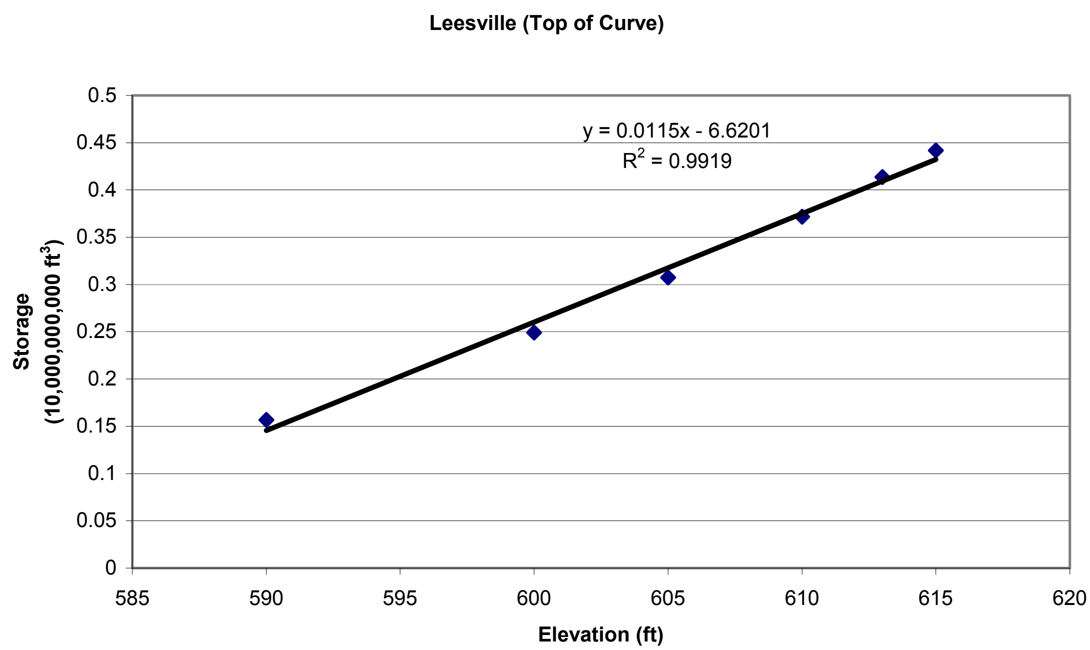

Table 4-2. Leesville Stage-Storage Relationship

- **Storage Constraints**

$$S1(t) \le \overline{S1} \tag{4.2.58}$$

$$S2(t) \le \overline{S2} \tag{4.2.59}$$

- **Upper Reservoir continuity**

$$S1(t+\Delta t) = S1(t) - QT1(t)\Delta t + QP(t)\Delta t + \sum_{j=1}^{JI1} I1_j(t)\Delta t - UnContRel(t)\Delta t \tag{4.2.60}$$

- **Lower reservoir continuity**

$$S2(t+\Delta t) = S2(t) + QT1(t)\Delta t - QP(t)\Delta t - QT2(t)\Delta t + \sum_{j=1}^{JI2} I2_j(t)\Delta t + UnContRel(t)\Delta t - Gated(t)\Delta t \tag{4.2.61}$$

4.4 Implementation of the Linear Formulation

The above formulation is applied to the Smith Mountain-Leesville data. The data tables are given below. Table 4-3, Table 4-4, and Table 4-5 list the head intervals for the Smith Mountain turbines, turbine flows, and pump flows. Table 4-7 and Table 4-8 list the intervals for the Leesville head, and turbine flows. Table 4-6 lists the spillage intervals for the upper reservoir. Table 4-9 provides the channel flow and tail race intervals. Short-term scheduling assumes that certain values are known. These known values (see Table 4-10) are the forebay elevations for the upper and lower reservoirs for the first time step and the inflows for both reservoirs for all the time steps. This data is used to solve the problem. The results are documented in the next chapter.

Table 4-3. Upper Reservoir Head Discretization

Interval k	Lower Bound (ft)	Upper Bound (ft)
1	170.00	179.999
2	180.00	180.999
3	181.00	181.999
4	182.00	182.999
5	183.00	183.999
6	184.00	184.999
7	185.00	185.999
8	186.00	186.999
9	187.00	187.999
10	188.00	195.000

Table 4-4. Upper Reservoir Discharge Discretization

Interval, m	Lower Bound (ft)	Upper Bound (ft)
1	2.450	4.65
2	4.6501	4.85
3	4.8501	5.05
4	5.0501	5.25
5	5.2501	5.45
6	5.4501	5.65

Table 4-5. Upper Reservoir Pump Discharge Discretization

Interval, k	Upper Bound (1000 cfs)	Lower Bound (1000 cfs)
1	4.7034	4.9338
2	4.6803	4.7033
3	4.6573	4.6803
4	4.6342	4.6572
5	4.6112	4.6342
6	4.5881	4.6111
7	4.5651	4.5881
8	4.542	4.565
9	4.519	4.542
10	4.3576	4.5189

Table 4-6. Upper Reservoir Spillway Elevation Discretization

Interval i	Lower Bound (ft)	Upper Bound (ft)
1	795.001	798
2	798.001	805
3	805.001	811

Table 4-7. Lower Reservoir Head Discretization

Interval, k	Lower Bound (ft)	Upper Bound (ft)
1	59.00	60.74
2	60.75	62.49
3	62.50	64.24
4	64.25	65.99
5	66.00	67.74
6	67.75	69.49
7	69.50	71.24
8	71.25	72.99
9	73.00	74.74
10	74.75	76.49

Table 4-8. Lower Reservoir Discharge Discretization

Interval, m	Lower Bound (1000 cfs)	Upper Bound (1000 cfs)
1	2.450	3.450
2	3.4501	3.6500
3	3.6501	3.8500
4	3.8501	4.0500
5	4.0501	4.2500
6	4.2501	5.0000

Table 4-9. Channel Discharge and Tailrace Discretization

	Channel Discharge (1000 cfs)		Channel Elevation (ft)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
1	0	1.3	532.573	533.997
2	2.5	3.8	535.367	536.685
3	5.0	6.3	537.950	539.166
4	7.5	8.8	540.332	541.449
5	10.0	11.3	542.520	543.544
6	12.5	13.8	544.524	545.459
7	15.0	16.3	546.352	547.204
8	17.5	18.8	548.015	548.786
9	20.0	21.3	549.519	550.215

Table 4-10. Given Data for Upper and Lower Reservoirs

Variable	Given Value
FB1(1)	792.00 ft
FB2(1)	605.00 ft
I1(1)	3 (1000 cfs)
I1(2)	1 (1000 cfs)
I1(3)	2 (1000 cfs)
I2(1)	3 (1000 cfs)
I2(2)	6 (1000 cfs)
I2(3)	3 (1000 cfs)

Chapter 5 Results and Discussion

5.1 Overview

Two formulations were developed and applied to a simplified scheme of the Smith Mountain - Leesville pumped storage and hydroelectric system. This scheme used a reduced number of generating and pumping units at the upper reservoir. This was done in order to reduce the number of variables and constraints. Both formulations were applied to the same scheme so that the results compared. The results are included in the proceeding sections.

5.2 Nonlinear Formulation Implementation

The nonlinear formulation does not guarantee a global optimal solution because the solution space is non-convex (Ravindran, et al., 1987 and Simmons, 1975). The solution space is non-convex because there are binary variables in the formulation and the power production/consumption functions are in product form. The computer software package LINGO was used to solve the nonlinear formulation. For ease of input to LINGO, the code was created within Excel using Visual Basic for Applications (VBA). The nonlinear programming code used in LINGO is included in **APPENDIX B**. There is computational difficulty with LINGO, which became apparent when making adjustments to the cost coefficients of the objective function. Consider the example objective function f(x)=CA, where A is a variable and C is a cost coefficient. Assume that a feasible solution exists for C=10, then the objective function will return 10A. Given that a feasible solution exists for C=10, then C=100 should return 100A. However, when changing the cost coefficient of the objective function, LINGO has difficulty maintaining feasibility. There is no apparent reason for this instability. Because of this instability finding a feasible solution was sporadic at best. To improve the chance of finding a feasible solution, if one does exist, initial conditions were given from the linear approximation of the nonlinear formulation. Using this starting point LINGO was able to find a near global optimal solution in less than 2 seconds with 53 iterations. The formulation consists of 145 variables of which 36 were binary variables, and 165 constraints of which 25 were nonlinear.

5.3 Linear Formulation Implementation

The mixed-integer linear formulation guarantees a global optimal solution, if a feasible solution exists, within the tolerance of its approximations (Ravindran, et al., 1987). It was solved using the computer program CPLEX, which uses a branch-and-bound algorithm and the simplex method. An interesting aspect of the formulation hidden in the linearization of the power constraint was realized. Because only midpoints are used in power computation, for any flow that lies between the lower and upper limits of the flow constraint, the same constant power value is reported for a selected head over the unit. The algorithm chooses the lower bound flow to conserve flow for later use. At the same time reports a slightly larger power value as done in the power constraint with the mid-interval flow value. For a specific discharge interval, the power output or consumption will be the same regardless of the actual discharge. The algorithm tends to conserve water for the next time step by releasing an amount that is representative of the lower bound for a given interval. This conservation of water will allow a slightly greater head and storage for the next time step. The solution from this formulation can be improved by increasing the discretized intervals of the nonlinear constraints. As the discretized intervals increase, the linear algorithm approaches the true global optimal solution, as well as increasing the computational effort exponentially. This computational effort is becoming less of a disadvantage as improvements to computers and technology are made.

5.4 Results

Discussion of analyses 1 and 2

Four different solutions corresponding to four different runs named analysis 1, 2, 3, and 4 are reported in this section. Analyses 1 and 2 differ in the price of power for day 3. In analysis 1, the price of power on day 3 is $100 per unit and in analysis 2, the price of power is $1,000 per unit. The price of power for days 1 and 2 are kept the same for both the analyses at $10 and $0.0001 per unit of power respectively. The prices are suitably chosen to check the logic of the formulation as well as the performance of the software (Also, the real prices are not available!). Using the prices of $10, $0.0001, and $100 for days 1, 2, and 3 in analysis 1, should encourage near maximum power production on day 3. The whole schedule should be coordinated on how much power to produce in day 1 for tangible profit and how much flow to conserve in the reservoirs for maximum possible production on day 3. The same logic has been accentuated in analysis 2 by not only encouraging near maximum power production on day 3, but also inducing pumping on day 2 with an attractive price of $1,000 per unit of power for day 3. The objective function values are given in Table 5-1. Table 5-2 shows given data for the mixed integer linear and nonlinear formulations. Both formulations used the same given data for all the following variables and time steps, inflow and cost coefficient for all time steps, forebay and tailrace elevations for the 1st time step for the upper and lower reservoirs. See **APPENDIX B** for the initial conditions used in the LINGO implementation. CPLEX did not require input of initial conditions. Table 5-3 has the results for forebay elevation, turbine head, and tailrace elevation values for the upper and lower reservoirs. The notation for forebay elevation FB12, indicates the elevation for reservoir 1 on day 2; H21 indicates head value at reservoir 2 on day 1; TR21 indicates tailrace elevation for reservoir 2 on day 1. Table 5-4 contains the turbine flows $QTi_{j,k}$ interpreted as the turbine flow on the kth day, through unit j, for reservoir i. Table 5-5 contains the pump flow values from unit j for kth day given as $QP_{j,k}$. The total power generated for days 1, 2, and 3 are given in Table 5-6. Table 5-7 and Table 5-8 as $PTi_{j,k}$, the power produced from the ith reservoir, using the jth turbine, on the kth day. Table 5-9 has pump power results. The lower reservoir turbine flows are listed in Table 5-10. Table 5-11 and Table 5-12 show the downstream channel release components made up of gated and uncontrolled releases and turbine releases. Table 5-13 and Table 5-14 contain the upper and lower reservoir storage values for days 1, 2, and 3.

For both analyses, the importance of head in the power equation has forced the solution to conserve water on day 2 (see Table 5-4). However, there is not enough of a cost benefit to increase the head in the first analysis through pumping (see Table 5-5). In analysis 2, there is enough of an increase in the cost coefficient to warrant the cost of pumping water back into the upper reservoir for use in the turbines during the 3rd time step. Not only does analysis 2 conserve water in the upper reservoir as in analysis 1, but it also conserves water in the lower reservoir (see Table 5-10).

Discussion of analyses 3 and 4:

To emphasize the main points of the nature of the formulation and maintain brevity, only the linear formulation results are reported for analyses 3 and 4. Table 5-15 has the objective function values. Table 5-16 contains the key input data. Table 5-17 contains the head values. Table 5-18 shows the turbine flow values by units and Table 5-19 shows the pump flow values. Tables 5-20 through Table 5-23 contain the total turbine power per day, power produced by each unit for the upper and lower reservoirs, and pump power consumed. Table 5-24 shows the turbine flow for the lower reservoir. Table 5-25 contains the downstream channel flows. Tables 5-26 and 5-27 present the storage values for the upper and lower reservoir respectively.

In analyses 3 and 4 all prices associated with power are zero except for day 3. Further, in analysis 4 all inflows are set to zero. It is anticipated that the pumps will work at no cost to lift water from the lower reservoir to the upper reservoir on days 1 and 2 in order to produce maximum power on day 3. This logic is borne out in Table 5-23 for analysis 3. Table 5-23 shows that the pumps run only on day 1. That is because in Table 5-17, FB22 is already at 601.5778 ft, which is a drop of almost 3.5 ft from the original FB21 of 605 ft. By constraint (4.2.18), once the head is fixed, all pumps run at the same rate, pumping the same amount of water. Therefore, if pumps 1 and 2 pump on day 2, FB22 will fall below 600 ft which is not permitted. In analysis 3, because of the inflow to the reservoir, the level FB22 recuperates to 603.8382 for the same rate of pumping. This level and further inflow support additional pumping on day 2, resulting in an improved profit value given in Table 5-15.

A most interesting point in analysis 4 is the wastage of water on day 2, by reservoir 1. Table 5-18 shows that through turbine 2, 2.45 units of flow are released to produce a power of 580.4 units on day 2, as given in Tables 5-20 and 5-21, without generating any revenue. This flow results in a drop of 0.253 ft in reservoir 1 which raises the reservoir 2 level to 603.4237 ft from 601.5778. Clearly, there is a larger head for the turbine at reservoir 1 if no flow is released on day 2. This is explained by referring to Table 4-3 in which the 10^{th} head interval (188.00 to 195.00 ft) contains both the head values H12 of 190.8913 and H13 of 188.7923 results in the same constant middle value of 191.5 used in the power calculation. Therefore, the release of 2.45 units through the turbine unit 2 on day 2 is an alternate optimum to the solution of not releasing any flow on day 2 and maintaining the lower reservoir elevation at 601.5778 ft. Therefore, the finer the discretization intervals, the more the software can sense small differences in the solutions. Also, note that because of the limited lower turbine capacity of 4.25 units, the maximum channel flow becomes 8.25 units in Table 5-25.

Table 5-1. Objective Function.

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
Z ($)	260165	259505	2399176	2394365

Table 5-2. Constant Values for input to the Models.

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
CP1 ($)	10.00	10.00	10.00	10.00
CP2 ($)	0.0001	0.0001	0.0001	0.0001
CP3 ($)	100.00	100.00	1000.00	1000.00
I11 (1000 cfs)	3.00	3.00	3.00	3.00
I12 (1000 cfs)	1.00	1.00	1.00	1.00
I13 (1000 cfs)	2.00	2.00	2.00	2.00
I21 (1000 cfs)	3.00	3.00	3.00	3.00
I22 (1000 cfs)	6.00	6.00	6.00	6.00
I23 (1000 cfs)	3.00	3.00	3.00	3.00
FB11 (ft)	792.00	792.00	792.00	792.00
FB21 (ft)	605.00	605.00	605.00	605.00

Table 5-3. Forebay Elevation and Head for Upper and Lower Reservoir.

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (ft)	Linear Value (ft)	Nonlinear Value (ft)	Linear Value(ft)
FB12	791.14	791.18	791.73	791.53
FB13	791.25	791.29	792.76	792.58
H11	187.00	187.00	187.00	187.00
H12	182.90	182.30	187.74	184.56
H13	186.02	188.25	192.76	188.00
FB22	607.94	608.88	603.98	606.98
FB23	604.92	603.04	600.00	604.58
TR21	542.52	540.75	542.52	540.75
TR22	542.52	544.63	535.08	533.99
TR23	542.52	540.54	542.52	540.33
H21	62.48	64.25	62.48	64.25
H22	65.72	64.25	68.90	72.99
H23	62.71	62.50	57.48	64.25

Table 5-4. Turbine Discharge for Upper Reservoir.

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)
QT111	5.65	5.45	5.65	5.073881
QT121	5.65	5.45	0	2.45
QT112	0.00	0.00	0	0
QT122	0.00	0.00	0	0
QT113	5.65	5.45	5.65	5.4501
QT123	5.65	5.45	5.65	5.4501

Table 5-5. Pump Discharge for Upper Reservoir

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)
QP11	0.00	0.00	0	0
QP21	0.00	0.00	0	0
QP12	0.00	0.00	4.53	4.59
QP22	0.00	0.00	4.53	4.59
QP13	0.00	0.00	0	0
QP23	0.00	0.00	0	0

Table 5-6. Total Power Produced for Upper and Lower Dams.

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
PT1	2372.03	2337.26	1459.21	1866.55
PT2	574.72	534.82	62.52	0
PT3	2364.44	2361.32	2384.58	2375.70

Table 5-7. Individual Unit Power Produced for Upper Reservoir

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
PT111	912.82	901.22	912.82	843.83
PT121	912.82	901.22	0	568.27
PT112	0.00	0.00	0	0
PT122	0.00	0.00	0	0
PT113	908.04	920.44	940.96	920.44
PT123	908.04	920.44	940.96	920.44

Table 5-8. Individual Unit Power Produced for Lower Reservoir

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
PT211	273.20	267.41	273.1951	187.04
PT221	273.20	267.41	273.1951	267.41
PT212	287.36	267.41	0	0
PT222	287.36	267.41	62.52259	0
PT213	274.18	260.22	251.3326	267.41
PT223	274.18	260.22	251.3326	267.41

Table 5-9. Pump Power Consumed

Variable	Analysis 1		Analysis 2	
	Nonlinear Value	Linear Value	Nonlinear Value	Linear Value
PP11	0.00	0.00	0	0
PP21	0.00	0.00	0	0
PP12	0.00	0.00	940.22	947.79
PP22	0.00	0.00	940.22	947.79
PP13	0.00	0.00	0	0
PP23	0.00	0.00	0	0

Table 5-10. Turbine Discharge for Lower Reservoir

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)
QT211	5.00	4.25	5	3.65
QT221	5.00	4.50	5	4.25
QT212	5.00	5.00	0	0
QT222	5.00	5.00	2.24	0
QT213	5.00	4.25	5	4.25
QT223	5.00	4.25	5	4.25

Table 5-11. Spillway Discharge for Upper and Lower Dams

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)
UNCONTREL1	0.00	0.00	0	0
UNCONTREL2	0.00	0.00	0	0
UNCONTREL3	0.00	0.00	0	0
GATED1	0.00	0.00	0	0
GATED2	0.00	3.75	0	0
GATED3	0.00	0.00	0	0

Table 5-12. Downstream Discharge

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)	Nonlinear Value (1000 cfs)	Linear Value (1000 cfs)
CHAN1	10.00	8.75	10	7.9002
CHAN2	10.00	13.75	2.235	0
CHAN3	10.00	8.50	10	8.5002

Table 5-13. Upper Reservoir Storage

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (10^6 ft^3)	Linear Value (10^6 ft^3)	Nonlinear Value (10^6 ft^3)	Linear Value (10^6 ft^3)
S11	4.92526	4.92526	4.92526	4.92526
S12	4.85355	4.85701	4.90237	4.88618
S13	4.86219	4.86565	4.98921	4.97410

Table 5-14. Lower Reservoir Storage

Variable	Analysis 1		Analysis 2	
	Nonlinear Value (10^6 ft^3)	Linear Value (10^6 ft^3)	Nonlinear Value (10^6 ft^3)	Linear Value (10^6 ft^3)
S21	0.31744	0.31744	0.31744	0.31744
S22	0.35459	0.36193	0.30577	0.34010
S23	0.32003	0.29497	0.26010	0.31266

Output from the linear formulation for different cost coefficients and inflow values.

Table 5-15. Objective Function.

Variable	Analysis 3	Analysis 4
Z ($)	2375700	2361320

Table 5-16. Constant Values for input to the Models.

Variable	Analysis 3	Analysis 4
CP1 ($)	0	0
CP2 ($)	0.0000	0.0000
CP3 ($)	1000	1000
I11 (1000 cfs)	3	0
I12 (1000 cfs)	1	0
I13 (1000 cfs)	2	0
I21 (1000 cfs)	3	0
I22 (1000 cfs)	6	0
I23 (1000 cfs)	3	0
FB11 (ft)	792	792
FB21 (ft)	605	605

Table 5-17. Forebay Elevation and Head for Upper and Lower Reservoir.

Variable	Analysis 3 (ft)	Analysis 4 (ft)
FB12	792.7788	792.469
FB13	793.3488	792.216
H11	187	187
H12	188.9407	190.8913
H13	188.3946	188.7923
FB22	603.8382	601.5778
FB23	604.9541	603.4237
TR21	532.573	532.573
TR22	532.5982	533.8378
TR23	540.7041	540.9237
H21	72.427	72.427
H22	71.24	67.74
H23	64.25	62.5

Table 5-18. Turbine Discharge for Upper Reservoir.

Variable	Analysis 3 (1000 cfs)	Analysis 4 (1000 cfs)
QT111	0	0
QT121	0	0
QT112	0	0
QT122	0	2.45
QT113	5.4501	5.4501
QT123	5.4501	5.4501

Table 5-19. Pump Discharge for Upper Reservoir.

Variable	Analysis 3 (1000 cfs)	Analysis 4 (1000 cfs)
QP11	4.542	4.542
QP21	0	0
QP12	4.5189	0
QP22	0	0
QP13	0	0
QP23	0	0

Table 5-20. Individual Unit Power Produced for Upper Reservoir.

Variable	Analysis 3	Analysis 4
PT111	0	0
PT121	0	0
PT112	0	0
PT122	0	580.4
PT113	920.44	920.44
PT123	267.41	260.22

Table 5-21. Individual Unit Power Produced for Lower Reservoir.

Variable	Analysis 3	Analysis 4
PT211	0	0
PT221	0	0
PT212	0	0
PT222	0	0
PT213	267.41	260.22
PT223	267.41	260.22

Table 5-22. Pump Power Consumed

Variable	Analysis 3	Analysis 4
PP11	945.699	945.699
PP21	0	0
PP12	942.211	0
PP22	0	0
PP13	0	0
PP23	0	0

Table 5-23. Turbine Discharge for Lower Reservoir

Variable	Analysis 3 (1000 cfs)	Analysis 4 (1000 cfs)
QT211	0	0
QT221	0	0
QT212	4.2501	4.2501
QT222	0	0
QT213	0	0
QT223	4.2501	4.2501

Table 5-24. Downstream Discharge.

Variable	Analysis 3 (1000 cfs)	Analysis 4 (1000 cfs)
CHAN1	0	0
CHAN2	0	0
CHAN3	8.5002	8.5002

Table 5-25. Upper Reservoir Storage.

Variable	Analysis 3 (10^6 ft^3)	Analysis 4 (10^6 ft^3)
S11	4.925264	4.925264
S12	4.990427	4.964507
S13	5.03811	4.943339

Table 5-26. Lower Reservoir Storage

Variable	Analysis 3 (10^6 ft^3)	Analysis 4 (10^6 ft^3)
S21	0.317435	0.317435
S22	0.304112	0.278192
S23	0.316909	0.29936

Chapter 6 Summary and Conclusions

Two methods of pumped storage optimization, mixed-integer nonlinear formulation, and mixed-integer linear formulation, have been presented. These two formulations are based on the Smith Mountain– Leesville system. The mixed-integer nonlinear formulation is a representation of the real system with no approximations. The solution space for the nonlinear formulation is non-convex; therefore, any optimal solution should be considered a local optimum and not a global optimum. To obtain a near global optimal solution, initial data has been supplied from the mixed-integer linear formulation.

The mixed-integer linear formulation provides the global optimal solution without any assistance. However, this solution is valid only for the linearized constraints. The formulation is quite general and overcomes computational difficulties associated with the nonlinear formulation. Because of these advantages it is recommended that a high quality solution be obtained first with the linear formulation and then tested for feasibility and near global optimum with the nonlinear formulation.

If computing power is a concern, the following method can be used to provide a more accurate solution. The formulation can be implemented in two phases. Phase one is the implementation of the formulation with a finite number of intervals over the entire range of each variable. This phase will develop a solution that is close to the global optimal solution. Phase two uses the solution computed in phase one to refine the range of each variable. The new range is composed of the same finite number of intervals, but is now denser around the phase 1 solution. This smaller interval will now provide a closer approximation of the global optimal solution.

If computing power is of no concern, then increase the number of intervals over the entire range of each variable. This will provide a denser interval, which will require more computational time than the previous method. The denser the intervals the better the approximation, such that an infinite number of intervals will provide an exact global optimal solution. These conclusions are borne out in the analysis 4 example of Chapter 5.

Either of the two formulations, linear and nonlinear, can be integrated as a subproblem into AEP's electrical system. For more information on hydropower integration with thermal power, please see Gulliver and Arndt (1991). AEP has only one pumped storage and hydroelectric facility, numerous thermal facilities and run-of-the river hydroelectric facilities. The thermal facilities produce most of the power while the hydroelectric facilities provide support. However, with the deregulation of the electrical industry, companies will need to operate at maximum efficiency in order to be competitive. Existing hydropower facilities will play an important role in this new electrical industry because it is an inexpensive source of energy. In order to achieve the full benefit of hydropower, use of these facilities must be optimized. From an academic perspective, the difficult constraints are the power relationship, unit commitment, and pump operation as dictated by the pump curve. All these constraints have been well formulated and tested out with verifiable example runs illustrated in Chapter 5. Therefore, embedding the thermal units within the framework of the present formulation does not pose any theoretical difficulties.

The examples presented in this thesis entail all the main characteristics of hydro-power optimization with a sufficiently detailed data set. Therefore, it may be considered as a test problem to check the efficiency of other algorithms in generating improved local optimal solutions. An important concern is the growth in the number of constraints for real-time solutions. If the price of power changes every hour, and there are significant number of units, the number of constraints can increase several thousands. A dedicated, well tested formulation is essential. It is believed that the present formulation is sufficiently simple to track the performance of each unit separately, and it accommodates all aspects of hydro-power optimization.

Bibliography

American Electric Power (AEP, 1971). *G.O. Operating Department Manual for Smith Mountain Project*. Vol. 1 – 3.

American Electric Power (1997). *Economic Impacts of the Wyoming-Cloverdale 765kV Transmission Project in West Virginia* . [Brochure]. Columbus, OH, September.

Cohen, A. I., and Wan, S. H. (1985). An Algorithm for Scheduling a Large Pumped Storage Plant, *IEEE Transactions on Power Apparatus and System*s, PAS-104(8), 2099-2104.

Using the CPLEX Callable Library including Using the CPLEX Base System (1997). ILOG, Inc., Incline Village, NV.

Divi, R., and Ruiu, D. (1989). Optimal Management of Multi-Purpose Reservoirs in a Hydro-Thermal Power System, *Water Management Decision Support*, 416-425.

Elgerd, O. I., (1982). *Electronic Energy System Theory: an Introduction*, McGraw-Hill, Inc., New York, NY.

Eriksen, P. B., and Pederson, J. (1997). "The Value of Hydropower import into a Thermal System." paper presented at Proceedings of the 3rd International Conference on Hydropower, Trondheim, Norway, June 30-July 2.

Faulkenberry, L. M., and Coffer, W. (1996). Electrical Power Distribution and Transmission, Prentice-Hall, Inc., Upper Saddle River, NJ.

Giles, J. E., and Wunderlich, W. O. (1991). Hourly Pumped-Storage Modeling with Microcomputer, *Journal of Energy Engineering*, 117(1), 40-56, April.

Gorenstin, B. G., Campodonico, N. M., Costa, J. P. and Pereira, M. V. F. (1991). Stochastic Optimization of a Hydro-Thermal System Including Network Constraints, IEEE Power Industry Computer Application Conference, Baltimore, MD, May 7-10.

Gulliver, J. S., and Arndt, R. E. A., *Hydropower Engineering Handbook*, McGraw-Hill, Inc., New York, NY, 1991.

Hambley, A. R. (1997). *Electrical Engineering Principles and Applications*, Prentice-Hall, Inc., Upper Saddle River, NJ.

Henry, P., and Graeser, J. E. (1985). Energy Storage: Developments in Pumped-Storage, *Water Power and Dam Construction*, 37(6), 13-16, June.

Hillier, F. S. and Lieberman, G.J. (2001). *Introduction to Operations Research*, 7nd Ed., McGraw-Hill, Inc., New York, NY.

Himmelblau, D.M. (1972). *Applied Nonlinear Programming,* McGraw-Hill, Inc., New York, NY.

Koebbe, R. S. (1993). Strategic Operating and Economic Benefits of Modular Pumped Storage, paper presented at Proceedings of the International Conference on Hydropower, Nashville, TN, August 10-13.

Lee, B. Y., Park, Y. M. and Lee, K. Y. (1987). Optimal generation planning for a thermal system with pumped-storage based analytical production costing model, *IEEE Transactions on Power Systems*, PWRS-2(2), 486-493, May.

Lee, T. Y., and Chen, N. (1992). The Effect of Pumped Storage on Hydrothermal Generation Coordination, *IEEE Transactions on Energy Conversion*, 7(4), 631-637, December.

Li, C., Jap, P. J. and Streiffert, D. L. (1993). Implementation of Network Flow Programming to the Hydrothermal Coordination in an Energy Management System, *IEEE Transactions on Power Systems*, 8(3), 1045-1053, August.

LINGO User's Guide (1998). Lindo Systems, Inc., Chicago, IL.

North American Electric Reliability Council. (NERC, 2000). Operating Manual. Retrieved October 22, 2000, from the World Wide Web: http://www.nerc.com/publications/.

Paula, G. (1990). Load Management, *Electrical World*, 204(8), 41-49, August.

Ravindran, A., Phillips, D. T. and Solberg, J. J. (1987). *Operations Research*, 2nd Ed., John Wiley & Sons, Inc., New York, NY.

Reklaitis, G. V., Ravindran, A. and Radgsdell, K. M. (1983). *Engineering Optimization*, John Wiley & Sons, Inc., New York, NY.

Schrage, L. (1998). *Optimization Modeling with LINGO*, Lindo Systems, Inc., Chicago, IL.

Simmons, D.M. (1975). *Nonlinear Programming for Operations Research*, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Velz, C.J., (1971). Environmental Aspects of Pumped Storage Development Reason or Emotion, International Conference on Pumped Storage Development and its Environment Effects, Proceedings No. 15, 478-479, Univ. of Wisconsin, Milwaukee, WI, September 19-24.

Wagner, H.M. (1969). *Principles of Operations Research: with Applications to Managerial Decisions*, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Walton, S. L., (1999). Rocky Mountain Restructuring: What Works for the Western States[Online]. Available: http://www.eren.doe.gov/electricity_restructuring/walton/ [2000, October 23].

Wood, A. J. and Wollenberg, B. F. (1984) "Hydrothermal Coordination." *Power Generation Operation & Control*, John Wiley & Sons, Inc., New York, NY.

Wurbs, R. A., *Modeling and Analysis of Reservoir System Operations*, Prentice-Hall, Inc., Upper Saddle River, NJ, 1996.

APPENDIX A Operations Research Solution Methodologies and Solvers

A.1 Introduction

This thesis uses three types of solution methodologies to solve the two formulations: simplex method, branch-and-bound method, and gradient search method. The two formulations contain integer variables, which makes them both mixed integer formulations. The formulations have an objective function, decision variables, constraints, and parameters. The focus here is to maximize the objective function. The objective function is based on the power produced by the turbines, the power consumed by the pumps, and the cost of power as a function of time. The decision variables are related to the discharge quantities. The parameters are the coefficients and constants used in the constraints. The following contains a brief overview of some programming types and the solution methodologies to the optimization process. Two solvers for linear and nonlinear programming are CPLEX and LINGO, respectively.

A.2 Linear Programming

There are three basic steps to formulating a linear problem: (1) identify the unknown variables (x_n), (2) identify the activities (constraints), making sure that each is in a linear form, and (3) develop the objective function (Z) in terms of the unknown variables (Ravindran, et al., 1987). The standard form of the linear programming problem is

$$
\begin{aligned}
\text{Maximize:} \quad & Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n \\
\text{Subject to:} \quad & a_{11}x_1 + a_{12}x_2 + \cdots a_{1n}x_n = b_1 \\
& a_{21}x_1 + a_{22}x_2 + \cdots a_{2n}x_n = b_2 \\
& \vdots \\
& a_{m1}x_1 + a_{m2}x_2 + \cdots a_{mn}x_n = b_m \\
& x_1, x_2, \cdots x_n \geq 0 \\
& b_1, b_2, \cdots b_m \geq 0
\end{aligned}
$$

If m=n then the linear equations can be solved simultaneously through simple matrix manipulations. If m>n, then the redundant equations can be removed and the remaining equations are solved using simple matrix manipulations. If n>m, then it becomes more difficult to determine the best solution without complete enumeration of the solution space. This third case is one of the reasons for using linear programming. Two theorems of linear programming state that the basic feasible solutions represent the corner points of the solution space and the optimum is obtained at one of the corner points. The typical method used to solve the linear program is the simplex method. By the theorems, only the corner points of the feasible region need to be checked. The simplex method looks at an adjacent corner point such that the new corner point has a better objective function value when compared to the previous solution. The simplex method is an efficient process that works around the boundary of the feasible region until it selects the optimal solution. It saves time by ignoring the solution space inside of the boundary and only enumerates the corner points. Also, it checks each of the corner points in systematic fashion that ensures it will reach the optimal solution (Hillier, 2001; Ravindran, et al., 1987; and Wagner, 1969).

The simplex method can be solved by an algebraic from, a tabular form, or a matrix form. The matrix form is called the revised simplex method and is well suited for computer manipulations. The revised simplex method uses the same foundation as the simplex method, but it takes advantage of the computer's ability to work with matrixes. Also, the revised simplex method is efficient in its optimality test because it does not do a complete enumeration of the variables. Instead, the method calculates only the coefficients of the variables important for the determination of optimality. (Ravindran, et al., 1987)

A.3 Nonlinear Programming

Nonlinear programming does not guarantee the return of an optimal solution, even if a solution does exist. Unlike linear programming, nonlinear programming may find an optimal solution at a corner point, a point inside the feasible region, or at a point of discontinuity. There have been numerous algorithms developed to solve nonlinear programs, but few have had success in solving applied problems (Ravindran, et al., 1987). A crucial consideration for nonlinear programming is whether or not the solution space is convex. If the solution space is convex then there is global maximum solution that exists for the problem. If the problem has equality and inequality constraints and a convex solution space, then the problem can be solved using the Kuhn-Tucker conditions. If a solution exists such that the Kuhn-Tucker conditions are satisfied, then this solution is the global optimal solution. If the solution space is non-convex then there is no guarantee that the solution will be the global optimal solution. An analytical approach can be applied to the nonlinear formulation through the use of derivatives.

The gradient method determines a good direction in which to search for new solutions and works well for unconstrained models. For constrained models, there are variations of the gradient method. The reduced gradient method works with the linear differentials of the objective function and constraints. It uses the differentiated equations to search along a linear path for the best local solution. The generalized reduced gradient (GRG) algorithm is based on the reduced gradient method. The GRG is modified so that it will work with nonlinear objective function and nonlinear constraints. This method works to approximate the constraints through linear representations. The gradient is then modified to utilize the approximate linear constraints and search for a local optimal point (Himmelblau, 1972; Reklaitis, 1983; and Simmons, 1975)

However, the analytical approach does not work well with large problems because of its reliance upon mathematical relationships and rules. Numerical methods can be used to solve the nonlinear problems. One such method used to solve constrained nonlinear problems is successive linear programming. Through the use of Taylor's expansion, the nonlinear equations are approximated with linear equations. An initial point is chosen as the starting point from which to solve the approximate linear program. This method will then use the previous solution to generate another solution. It works by an iterative process that tries to find the local optimal solution. This method does not guarantee a global optimal solution (Reklaitis, 1983).

A.4 Integer Programming

The branch-and-bound algorithm is typically used to solve the integer programming model. The branch-and-bound algorithm first works with the optimal solution from the linear program. This solution typically contains continuous values because it ignores the integer restrictions. The algorithm will then choose one of the fractional values and check the integer value above and below the fractional value, creating branches. The algorithm will then search for a valid lower bound by checking the numerous fractional values obtained. The algorithm compares the values from the same level and will terminate the branch with the lower objective value. It can terminate this branch with strong certainty because the addition of more integer restriction cannot improve the solution. The branch-and-bound algorithm will enumerate the remaining branches in search of terminating another branch. This process continues until all the branches have been terminated. This will provide the global optimum solution to the integer program. Also, it can be used in conjunction with linear and nonlinear solvers. The solution methodology is the same as above except the branch-and-bound algorithm will enumerate only the branches that require integer restriction.

A.5 Solvers: CPLEX and LINGO

CPLEX is a solver that works with linear and integer programs. The solver uses a revised simplex method to solve linear programming problems and a branch-and-bound algorithm to solve integer programming problems (CPLEX, 1997).

LINGO is a solver that works with linear, nonlinear, and integer programs. LINGO's linear solver is based on the revised simplex method. Its nonlinear solver uses both a successive linear program and a generalized reduced gradient algorithm. The integer solver is based on the branch-and-bound method (LINGO, 1998).

APPENDIX B Lingo Implementation

Input code to LINGO for Analysis 1

```
!Given Data
Data:
CP1=10;
CP2=0.0001;
CP3=100;

I10=0;
I11=3;
I12=1;
I13=2;

I20=0;
I21=3;
I22=6;
I23=3;
FB11=792;
FB21=605;

ENDDATA

!INITIAL STARTING POINTS;
INIT:

H12=182.88;
H13=188.33;
FB12=791.277;
FB13=792.34;
QT111=5;
QT112=0;
QT113=4.85;
QT121=5;
QT122=0;
QT123=4.85;
QP11=0;
QP12=4.66;
QP13=0;
QP21=0;
```

```
QP22=4.66;
QP23=0;
TR21=540.75;
TR22=536.685;
TR23=541.449;
QT211=4.25;
QT212=0;
QT213=4.25;
QT221=4.25;
QT222=2.5;
QT223=4.25;
ENDINIT

[OBJECTIVE]MAX =CP1*PT1-CP1*PP1+CP2*PT2-CP2*PP2+CP3*PT3-CP3*PP3;


 [Eqn1_2]PT1=PT111+PT121+PT211+PT221;
[Eqn1_3]PT2=PT112+PT122+PT212+PT222;
[Eqn1_4]PT3=PT113+PT123+PT213+PT223;

[Eqn1_5]PP1=PP11+PP21;
[Eqn1_6]PP2=PP12+PP22;
[Eqn1_7]PP3=PP13+PP23;

[Eqn1_8]H11=FB11-FB21;
[Eqn1_9]H12=FB12-FB22;
[Eqn1_10]H13=FB13-FB23;

[Eqn1_11]PT111=(0.00663*QT111^4-0.11057*QT111^3+0.59393*QT111^2-
0.15787*QT111)*H11;
[Eqn1_12]PT112=(0.00663*QT112^4-0.11057*QT112^3+0.59393*QT112^2-
0.15787*QT112)*H12;
[Eqn1_13]PT113=(0.00663*QT113^4-0.11057*QT113^3+0.59393*QT113^2-
0.15787*QT113)*H13;

[Eqn1_14]PT121=(0.00663*QT121^3-0.11057*QT121^2+0.59393*QT121-
0.15787)*H11*QT121;
[Eqn1_15]PT122=(0.00663*QT122^3-0.11057*QT122^2+0.59393*QT122-
0.15787)*H12*QT122;
[Eqn1_16]PT123=(0.00663*QT123^3-0.11057*QT123^2+0.59393*QT123-
0.15787)*H13*QT123;

[Eqn1_17]2.45*MU111<=QT111;
[Eqn1_18]2.45*MU112<=QT112;
[Eqn1_19]2.45*MU113<=QT113;

[Eqn1_20]QT111<=5.65*MU111;
[Eqn1_21]QT112<=5.65*MU112;
[Eqn1_22]QT113<=5.65*MU113;
```

```
[Eqn1_23]2.45*MU121<=QT121;
[Eqn1_24]2.45*MU122<=QT122;
[Eqn1_25]2.45*MU123<=QT123;

[Eqn1_26]QT121<=5.65*MU121;
[Eqn1_27]QT122<=5.65*MU122;
[Eqn1_28]QT123<=5.65*MU123;

[Eqn1_29]PT211=(-0.0280*QT211^3+0.2555*QT211^2-
0.5263*QT211+0.6185)*H21*QT211;
[Eqn1_30]PT212=(-0.0280*QT212^3+0.2555*QT212^2-
0.5263*QT212+0.6185)*H22*QT212;
[Eqn1_31]PT213=(-0.0280*QT213^3+0.2555*QT213^2-
0.5263*QT213+0.6185)*H23*QT213;

[Eqn1_32]PT221=(-0.0280*QT221^3+0.2555*QT221^2-
0.5263*QT221+0.6185)*H21*QT221;
[Eqn1_33]PT222=(-0.0280*QT222^3+0.2555*QT222^2-
0.5263*QT222+0.6185)*H22*QT222;
[Eqn1_34]PT223=(-0.0280*QT223^3+0.2555*QT223^2-
0.5263*QT223+0.6185)*H23*QT223;

[Eqn1_35]2.2*MU211<=QT211;
[Eqn1_36]2.2*MU212<=QT212;
[Eqn1_37]2.2*MU213<=QT213;

[Eqn1_38]QT211<=5*MU211;
[Eqn1_39]QT212<=5*MU212;
[Eqn1_40]QT213<=5*MU213;

[Eqn1_41]2.2*MU221<=QT221;
[Eqn1_42]2.2*MU222<=QT222;
[Eqn1_43]2.2*MU223<=QT223;

[Eqn1_44]QT221<=5*MU221;
[Eqn1_45]QT222<=5*MU222;
[Eqn1_46]QT223<=5*MU223;

[Eqn1_47]PP11=H11*QP11/(0.1683*QP11^3-2.3937*QP11^2+11.291*QP11-
16.769);
[Eqn1_48]PP12=H12*QP12/(0.1683*QP12^3-2.3937*QP12^2+11.291*QP12-
16.769);
[Eqn1_49]PP13=H13*QP13/(0.1683*QP13^3-2.3937*QP13^2+11.291*QP13-
16.769);

[Eqn1_50]PP21=H11*QP21/(0.1683*QP21^3-2.3937*QP21^2+11.291*QP21-
16.769);
[Eqn1_51]PP22=H12*QP22/(0.1683*QP22^3-2.3937*QP22^2+11.291*QP22-
16.769);
```

```
[Eqn1_52]PP23=H13*QP23/(0.1683*QP23^3-2.3937*QP23^2+11.291*QP23-
16.769);

[Eqn1_53]FB11=SPILL1_NO1+SPILL1_YES1;
[Eqn1_54]FB12=SPILL1_NO2+SPILL1_YES2;
[Eqn1_55]FB13=SPILL1_NO3+SPILL1_YES3;

[Eqn1_56]787*THETA_NO1<=SPILL1_NO1;
[Eqn1_57]787*THETA_NO2<=SPILL1_NO2;
[Eqn1_58]787*THETA_NO3<=SPILL1_NO3;

[Eqn1_59]SPILL1_NO1<=795*THETA_NO1;
[Eqn1_60]SPILL1_NO2<=795*THETA_NO2;
[Eqn1_61]SPILL1_NO3<=795*THETA_NO3;

[Eqn1_62]795.01*THETA_YES1<=SPILL1_YES1;
[Eqn1_63]795.01*THETA_YES2<=SPILL1_YES2;
[Eqn1_64]795.01*THETA_YES3<=SPILL1_YES3;

[Eqn1_65]SPILL1_YES1<=811*THETA_YES1;
[Eqn1_66]SPILL1_YES2<=811*THETA_YES2;
[Eqn1_67]SPILL1_YES3<=811*THETA_YES3;

[Eqn1_68]THETA_NO1+THETA_YES1=1;
[Eqn1_69]THETA_NO2+THETA_YES2=1;
[Eqn1_70]THETA_NO3+THETA_YES3=1;


[Eqn1_71]UNCONTREL1=0.127193*SPILL1_YES1^2-
201.334682*SPILL1_YES1+79671.751374*THETA_YES1;
[Eqn1_72]UNCONTREL2=0.127193*SPILL1_YES2^2-
201.334682*SPILL1_YES2+79671.751374*THETA_YES2;
[Eqn1_73]UNCONTREL3=0.127193*SPILL1_YES3^2-
201.334682*SPILL1_YES3+79671.751374*THETA_YES3;

[Eqn1_74]MU111+MU121<=2*DELTA11;
[Eqn1_75]MU112+MU122<=2*DELTA12;
[Eqn1_76]MU113+MU123<=2*DELTA13;

[Eqn1_77]NU111+NU121<=2*DELTA21;
[Eqn1_78]NU112+NU122<=2*DELTA22;
[Eqn1_79]NU113+NU123<=2*DELTA23;

[Eqn1_80]DELTA21+DELTA11<=1;
[Eqn1_81]DELTA22+DELTA12<=1;
[Eqn1_82]DELTA23+DELTA13<=1;

[Eqn1_83]DELTA21<=THETA_NO1;
[Eqn1_84]DELTA22<=THETA_NO2;
[Eqn1_85]DELTA23<=THETA_NO3;
```

```
[Eqn1_86]HPOFF11<=211*(1-NU111);
[Eqn1_87]HPOFF12<=211*(1-NU112);
[Eqn1_88]HPOFF13<=211*(1-NU113);

[Eqn1_89]HPOFF21<=211*(1-NU121);
[Eqn1_90]HPOFF22<=211*(1-NU122);
[Eqn1_91]HPOFF23<=211*(1-NU123);

[Eqn1_92]HPON11<=195*NU111;
[Eqn1_93]HPON12<=195*NU112;
[Eqn1_94]HPON13<=195*NU113;

[Eqn1_95]HPON21<=195*NU121;
[Eqn1_96]HPON22<=195*NU122;
[Eqn1_97]HPON23<=195*NU123;

[Eqn1_98]H11=HPON11+HPOFF11;
[Eqn1_99]H12=HPON12+HPOFF12;
[Eqn1_100]H13=HPON13+HPOFF13;

[Eqn1_101]H11=HPON21+HPOFF21;
[Eqn1_102]H12=HPON22+HPOFF22;
[Eqn1_103]H13=HPON23+HPOFF23;

[Eqn1_104]HPON11=-43.282*QP11+383.61*NU111;
[Eqn1_105]HPON12=-43.282*QP12+383.61*NU112;
[Eqn1_106]HPON13=-43.282*QP13+383.61*NU113;

[Eqn1_107]HPON21=-43.282*QP21+383.61*NU121;
[Eqn1_108]HPON22=-43.282*QP22+383.61*NU122;
[Eqn1_109]HPON23=-43.282*QP23+383.61*NU123;

[Eqn1_110]QP11<=4.9*NU111;
[Eqn1_111]QP12<=4.9*NU112;
[Eqn1_112]QP13<=4.9*NU113;

[Eqn1_113]QP21<=4.9*NU121;
[Eqn1_114]QP22<=4.9*NU122;
[Eqn1_115]QP23<=4.9*NU123;

[Eqn1_116]H21=FB21-TR21;
[Eqn1_117]H22=FB22-TR22;
[Eqn1_118]H23=FB23-TR23;

[Eqn1_119]FB21=SPILL2_NO1+SPILL2_YES1;
[Eqn1_120]FB22=SPILL2_NO2+SPILL2_YES2;
[Eqn1_121]FB23=SPILL2_NO3+SPILL2_YES3;

[Eqn1_122]GATED1<=150*BETA_YES1;
```

```
[Eqn1_123]GATED2<=150*BETA_YES2;
[Eqn1_124]GATED3<=150*BETA_YES3;

[Eqn1_125]600*BETA_NO1<=SPILL2_NO1;
[Eqn1_126]600*BETA_NO2<=SPILL2_NO2;
[Eqn1_127]600*BETA_NO3<=SPILL2_NO3;

[Eqn1_128]SPILL2_NO1<=615*BETA_NO1;
[Eqn1_129]SPILL2_NO2<=615*BETA_NO2;
[Eqn1_130]SPILL2_NO3<=615*BETA_NO3;

[Eqn1_131]613.005*BETA_YES1<=SPILL2_NO1;
[Eqn1_132]613.005*BETA_YES2<=SPILL2_NO2;
[Eqn1_133]613.005*BETA_YES3<=SPILL2_NO3;

[Eqn1_134]SPILL2_YES1<=615*BETA_YES1;
[Eqn1_135]SPILL2_YES2<=615*BETA_YES2;
[Eqn1_136]SPILL2_YES3<=615*BETA_YES3;

[Eqn1_137]BETA_NO1+BETA_YES1=1;
[Eqn1_138]BETA_NO2+BETA_YES2=1;
[Eqn1_139]BETA_NO3+BETA_YES3=1;

[Eqn1_140]TR20=0.000095*CHAN0^3-
0.017586*CHAN0^2+1.161031*CHAN0+532.573;
[Eqn1_141]TR21=0.000095*CHAN1^3-
0.017586*CHAN1^2+1.161031*CHAN1+532.573;
[Eqn1_142]TR22=0.000095*CHAN2^3-
0.017586*CHAN2^2+1.161031*CHAN2+532.573;
[Eqn1_143]TR23=0.000095*CHAN3^3-
0.017586*CHAN3^2+1.161031*CHAN3+532.573;

[Eqn1_144]CHAN0=QT210+QT220+GATED0;
[Eqn1_145]CHAN1=QT211+QT221+GATED1;
[Eqn1_146]CHAN2=QT212+QT222+GATED2;
[Eqn1_147]CHAN3=QT213+QT223+GATED3;

[Eqn1_148]CHAN1<=20;
[Eqn1_149]CHAN2<=20;
[Eqn1_150]CHAN3<=20;

[Eqn1_151]S10=0.083667*FB10-61.339;
[Eqn1_152]S11=0.083667*FB11-61.339;
[Eqn1_153]S12=0.083667*FB12-61.339;
[Eqn1_154]S13=0.083667*FB13-61.339;
[Eqn1_155]S14=0.083667*FB14-61.339;

[Eqn1_156]S20=0.011467*FB20-6.6201;
[Eqn1_157]S21=0.011467*FB21-6.6201;
[Eqn1_158]S22=0.011467*FB22-6.6201;
```

```
[Eqn1_159]S23=0.011467*FB23-6.6201;
[Eqn1_160]S24=0.011467*FB24-6.6201;


[Eqn1_161]S11=S10+(-(QT110+QT120)+QP10+QP20+I10-
UNCONTREL0)*3600*24/10000000;
[Eqn1_162]S12=S11+(-(QT111+QT121)+QP11+QP21+I11-
UNCONTREL1)*3600*24/10000000;
[Eqn1_163]S13=S12+(-(QT112+QT122)+QP12+QP22+I12-
UNCONTREL2)*3600*24/10000000;
[Eqn1_164]S14=S13+(-(QT113+QT123)+QP13+QP23+I13-
UNCONTREL3)*3600*24/10000000;

[Eqn1_165]S21=S20+(QT110+QT120-QP10-QP20+UNCONTREL0+I20-QT210-
QT220-GATED0)*3600*24/10000000;
[Eqn1_166]S22=S21+(QT111+QT121-QP11-QP21+UNCONTREL1+I21-QT211-
QT221-GATED1)*3600*24/10000000;
[Eqn1_167]S23=S22+(QT112+QT122-QP12-QP22+UNCONTREL2+I22-QT212-
QT222-GATED2)*3600*24/10000000;
[Eqn1_168]S24=S23+(QT113+QT123-QP13-QP23+UNCONTREL3+I23-QT213-
QT223-GATED3)*3600*24/10000000;

[Eqn1_169]@BIN(MU111);
[Eqn1_170]@BIN(MU112);
[Eqn1_171]@BIN(MU113);


[Eqn1_172]@BIN(MU121);
[Eqn1_173]@BIN(MU122);
[Eqn1_174]@BIN(MU123);

[Eqn1_175]@BIN(MU211);
[Eqn1_176]@BIN(MU212);
[Eqn1_177]@BIN(MU213);

[Eqn1_178]@BIN(MU221);
[Eqn1_179]@BIN(MU222);
[Eqn1_180]@BIN(MU223);

[Eqn1_181]@BIN(THETA_NO1);
[Eqn1_182]@BIN(THETA_NO2);
[Eqn1_183]@BIN(THETA_NO3);

[Eqn1_184]@BIN(THETA_YES1);
[Eqn1_185]@BIN(THETA_YES2);
[Eqn1_186]@BIN(THETA_YES3);

[Eqn1_187]@BIN(DELTA11);
[Eqn1_188]@BIN(DELTA12);
[Eqn1_189]@BIN(DELTA13);
```

```
[Eqn1_190]@BIN(NU111);
[Eqn1_191]@BIN(NU112);
[Eqn1_192]@BIN(NU113);

[Eqn1_193]@BIN(NU121);
[Eqn1_194]@BIN(NU122);
[Eqn1_195]@BIN(NU123);

[Eqn1_196]@BIN(DELTA21);
[Eqn1_197]@BIN(DELTA22);
[Eqn1_198]@BIN(DELTA23);

[Eqn1_199]@BIN(BETA_NO1);
[Eqn1_200]@BIN(BETA_NO2);
[Eqn1_201]@BIN(BETA_NO3);

[Eqn1_202]@BIN(BETA_YES1);
[Eqn1_203]@BIN(BETA_YES2);
[Eqn1_204]@BIN(BETA_YES3);
```

Output from LINGO for Analysis 1

```
Rows=    165 Vars=    145 No. integer vars=     36
 Nonlinear rows=     25 Nonlinear vars=     30 Nonlinear constraints=     25
 Nonzeros=    492 Constraint nonz=   434 Density=0.020
 No. < :  84 No. =:  80 No. > :   0, Obj=MAX Single cols=    5


 ** WARNING ** Problem is poorly scaled.  The units
 of the rows and variables should be changed so the
 coefficients cover a much smaller range.

 Local optimal solution found at step:           242
 Objective value:                           260164.8
 Branch count:                                     4
```

Variable	Value	Reduced Cost
CP1	10.00000	0.0000000
CP2	0.1000000E-03	0.0000000
CP3	100.0000	0.0000000
I10	0.0000000	0.0000000
I11	3.000000	0.0000000
I12	1.000000	0.0000000
I13	2.000000	0.0000000
I20	0.0000000	0.0000000
I21	3.000000	0.0000000
I22	6.000000	0.0000000
I23	3.000000	0.0000000
FB11	792.0000	0.0000000
FB21	605.0000	0.0000000
H12	182.9030	0.0000000
H13	186.0201	0.0000000
FB12	791.1429	0.0000000
FB13	791.2462	0.0000000
QT111	5.650000	0.0000000
QT112	0.0000000	0.0000000
QT113	5.650000	0.0000000
QT121	5.650000	0.0000000
QT122	0.0000000	0.0000000
QT123	5.650000	0.0000000
QP11	0.0000000	0.0000000
QP12	0.0000000	0.0000000
QP13	0.0000000	0.0000000
QP21	0.0000000	0.0000000
QP22	0.0000000	0.0000000
QP23	0.0000000	0.0000000
TR21	542.5197	0.0000000
TR22	542.5197	0.0000000
TR23	542.5197	0.0000000
QT211	5.000000	0.0000000
QT212	5.000000	0.0000000
QT213	5.000000	0.0000000
QT221	5.000000	0.0000000
QT222	5.000000	0.0000000
QT223	5.000000	0.0000000
PT1	2372.034	0.0000000
PP1	0.0000000	0.0000000

PT2	574.7231	0.0000000
PP2	0.0000000	0.0000000
PT3	2364.444	0.0000000
PP3	0.0000000	0.0000000
PT111	912.8218	0.0000000
PT121	912.8218	0.0000000
PT211	273.1951	0.0000000
PT221	273.1951	0.0000000
PT112	0.0000000	0.0000000
PT122	0.0000000	0.0000000
PT212	287.3616	0.0000000
PT222	287.3616	0.0000000
PT113	908.0386	0.0000000
PT123	908.0386	0.0000000
PT213	274.1834	0.0000000
PT223	274.1834	0.0000000
PP11	0.0000000	0.0000000
PP21	0.0000000	0.0000000
PP12	0.0000000	0.0000000
PP22	0.0000000	0.0000000
PP13	0.0000000	0.0000000
PP23	0.0000000	0.0000000
H11	187.0000	0.0000000
FB22	608.2399	0.0000000
FB23	605.2260	0.0000000
MU111	1.000000	0.0000000
MU112	0.0000000	0.0000000
MU113	1.000000	0.0000000
MU121	1.000000	0.0000000
MU122	0.0000000	0.0000000
MU123	1.000000	0.0000000
H21	62.48029	0.0000000
H22	65.72020	0.0000000
H23	62.70633	0.0000000
MU211	1.000000	0.0000000
MU212	1.000000	0.0000000
MU213	1.000000	0.0000000
MU221	1.000000	0.0000000
MU222	1.000000	0.0000000
MU223	1.000000	0.0000000
SPILL1_NO1	792.0000	0.0000000
SPILL1_YES1	0.0000000	0.0000000
SPILL1_NO2	791.1429	0.0000000
SPILL1_YES2	0.0000000	0.0000000
SPILL1_NO3	791.2462	0.0000000
SPILL1_YES3	0.0000000	0.0000000
THETA_NO1	1.000000	0.0000000
THETA_NO2	1.000000	0.0000000
THETA_NO3	1.000000	0.0000000
THETA_YES1	0.0000000	0.0000000
THETA_YES2	0.0000000	0.0000000
THETA_YES3	0.0000000	0.0000000
UNCONTREL1	0.0000000	0.0000000
UNCONTREL2	0.0000000	0.0000000
UNCONTREL3	0.0000000	0.0000000
DELTA11	1.000000	0.0000000
DELTA12	0.0000000	0.0000000
DELTA13	1.000000	0.0000000
NU111	0.0000000	0.0000000
NU121	0.0000000	0.0000000
DELTA21	0.0000000	0.0000000

NU112	0.0000000	0.0000000
NU122	0.0000000	0.0000000
DELTA22	0.0000000	0.0000000
NU113	0.0000000	0.0000000
NU123	0.0000000	0.0000000
DELTA23	0.0000000	0.0000000
HPOFF11	187.0000	0.0000000
HPOFF12	182.9030	0.0000000
HPOFF13	186.0201	0.0000000
HPOFF21	187.0000	0.0000000
HPOFF22	182.9030	0.0000000
HPOFF23	186.0201	0.0000000
HPON11	0.0000000	0.0000000
HPON12	0.0000000	0.0000000
HPON13	0.0000000	0.0000000
HPON21	0.0000000	0.0000000
HPON22	0.0000000	0.0000000
HPON23	0.0000000	0.0000000
SPILL2_NO1	605.0000	0.0000000
SPILL2_YES1	0.0000000	0.0000000
SPILL2_NO2	608.2399	0.0000000
SPILL2_YES2	0.0000000	0.0000000
SPILL2_NO3	605.2260	0.0000000
SPILL2_YES3	0.0000000	0.0000000
GATED1	0.0000000	0.0000000
BETA_YES1	0.0000000	0.0000000
GATED2	0.0000000	0.0000000
BETA_YES2	0.0000000	0.0000000
GATED3	0.0000000	0.0000000
BETA_YES3	0.0000000	0.0000000
BETA_NO1	1.000000	0.0000000
BETA_NO2	1.000000	0.0000000
BETA_NO3	1.000000	0.0000000
TR20	532.5730	0.0000000
CHAN0	0.0000000	0.0000000
CHAN1	10.00000	0.0000000
CHAN2	10.00000	0.0000000
CHAN3	10.00000	0.0000000
QT210	0.0000000	0.0000000
QT220	0.0000000	0.0000000
GATED0	0.0000000	0.0000000
S10	4.925264	0.0000000
FB10	792.0000	0.0000000
S11	4.925264	0.0000000
S12	4.853552	0.0000000
S13	4.862192	0.0000000
S14	4.781840	0.0000000
FB14	790.2858	0.0000000
S20	0.3174350	0.0000000
FB20	605.0000	0.0000000
S21	0.3174350	0.0000000
S22	0.3545870	0.0000000
S23	0.3200270	0.0000000
S24	0.3571790	0.0000000
FB24	608.4659	0.0000000
QT110	0.0000000	0.0000000
QT120	0.0000000	0.0000000
QP10	0.0000000	0.0000000
QP20	0.0000000	0.0000000
UNCONTREL0	0.0000000	0.0000000

Row	Slack or Surplus	Dual Price
OBJECTIVE	260164.8	1.000000
EQN1_2	0.0000000	0.0000000
EQN1_3	0.0000000	0.0000000
EQN1_4	0.0000000	0.0000000
EQN1_5	0.0000000	0.0000000
EQN1_6	0.0000000	0.0000000
EQN1_7	0.0000000	0.0000000
EQN1_8	0.0000000	0.0000000
EQN1_9	-0.8526513E-13	0.0000000
EQN1_10	-0.5684342E-13	0.0000000
EQN1_11	0.0000000	0.0000000
EQN1_12	0.0000000	0.0000000
EQN1_13	-0.1136868E-12	0.0000000
EQN1_14	0.0000000	0.0000000
EQN1_15	0.0000000	0.0000000
EQN1_16	-0.1136868E-12	0.0000000
EQN1_17	3.200000	0.0000000
EQN1_18	0.0000000	0.0000000
EQN1_19	3.200000	0.0000000
EQN1_20	0.0000000	0.0000000
EQN1_21	0.0000000	0.0000000
EQN1_22	0.0000000	0.0000000
EQN1_23	3.200000	0.0000000
EQN1_24	0.0000000	0.0000000
EQN1_25	3.200000	0.0000000
EQN1_26	0.0000000	0.0000000
EQN1_27	0.0000000	0.0000000
EQN1_28	0.0000000	0.0000000
EQN1_29	0.0000000	0.0000000
EQN1_30	0.0000000	0.0000000
EQN1_31	-0.5684342E-13	0.0000000
EQN1_32	0.0000000	0.0000000
EQN1_33	0.0000000	0.0000000
EQN1_34	-0.5684342E-13	0.0000000
EQN1_35	2.800000	0.0000000
EQN1_36	2.800000	0.0000000
EQN1_37	2.800000	0.0000000
EQN1_38	0.0000000	0.0000000
EQN1_39	0.0000000	0.0000000
EQN1_40	0.0000000	0.0000000
EQN1_41	2.800000	0.0000000
EQN1_42	2.800000	0.0000000
EQN1_43	2.800000	0.0000000
EQN1_44	0.0000000	0.0000000
EQN1_45	0.0000000	0.0000000
EQN1_46	0.0000000	0.0000000
EQN1_47	0.0000000	0.0000000
EQN1_48	0.0000000	0.0000000
EQN1_49	0.0000000	0.0000000
EQN1_50	0.0000000	0.0000000
EQN1_51	0.0000000	0.0000000
EQN1_52	0.0000000	0.0000000
EQN1_53	0.0000000	0.0000000
EQN1_54	0.0000000	0.0000000
EQN1_55	0.0000000	0.0000000
EQN1_56	5.000000	0.0000000
EQN1_57	4.142894	0.0000000
EQN1_58	4.246160	0.0000000
EQN1_59	3.000000	0.0000000
EQN1_60	3.857106	0.0000000

EQN1_61	3.753840	0.0000000
EQN1_62	0.0000000	0.0000000
EQN1_63	0.0000000	0.0000000
EQN1_64	0.0000000	0.0000000
EQN1_65	0.0000000	0.0000000
EQN1_66	0.0000000	0.0000000
EQN1_67	0.0000000	0.0000000
EQN1_68	0.0000000	0.0000000
EQN1_69	0.0000000	0.0000000
EQN1_70	0.0000000	0.0000000
EQN1_71	0.0000000	0.0000000
EQN1_72	0.0000000	0.0000000
EQN1_73	0.0000000	0.0000000
EQN1_74	0.0000000	0.0000000
EQN1_75	0.0000000	0.0000000
EQN1_76	0.0000000	0.0000000
EQN1_77	0.0000000	0.0000000
EQN1_78	0.0000000	0.0000000
EQN1_79	0.0000000	0.0000000
EQN1_80	0.0000000	0.0000000
EQN1_81	1.000000	0.0000000
EQN1_82	0.0000000	0.0000000
EQN1_83	1.000000	0.0000000
EQN1_84	1.000000	0.0000000
EQN1_85	1.000000	0.0000000
EQN1_86	24.00000	0.0000000
EQN1_87	28.09701	0.0000000
EQN1_88	24.97988	0.0000000
EQN1_89	24.00000	0.0000000
EQN1_90	28.09701	0.0000000
EQN1_91	24.97988	0.0000000
EQN1_92	0.0000000	0.0000000
EQN1_93	0.0000000	0.0000000
EQN1_94	0.0000000	0.0000000
EQN1_95	0.0000000	0.0000000
EQN1_96	0.0000000	0.0000000
EQN1_97	0.0000000	0.0000000
EQN1_98	0.0000000	0.0000000
EQN1_99	0.0000000	0.0000000
EQN1_100	0.0000000	0.0000000
EQN1_101	0.0000000	0.0000000
EQN1_102	0.0000000	0.0000000
EQN1_103	0.0000000	0.0000000
EQN1_104	0.0000000	0.0000000
EQN1_105	0.0000000	0.0000000
EQN1_106	0.0000000	0.0000000
EQN1_107	0.0000000	0.0000000
EQN1_108	0.0000000	0.0000000
EQN1_109	0.0000000	0.0000000
EQN1_110	0.0000000	0.0000000
EQN1_111	0.0000000	0.0000000
EQN1_112	0.0000000	0.0000000
EQN1_113	0.0000000	0.0000000
EQN1_114	0.0000000	0.0000000
EQN1_115	0.0000000	0.0000000
EQN1_116	0.0000000	0.0000000
EQN1_117	0.0000000	0.0000000
EQN1_118	-0.1421085E-13	0.0000000
EQN1_119	0.0000000	0.0000000
EQN1_120	0.0000000	0.0000000
EQN1_121	0.0000000	0.0000000

EQN1_122	0.0000000	0.0000000
EQN1_123	0.0000000	0.0000000
EQN1_124	0.0000000	0.0000000
EQN1_125	5.000000	0.0000000
EQN1_126	8.239908	0.0000000
EQN1_127	5.226042	0.0000000
EQN1_128	10.00000	0.0000000
EQN1_129	6.760092	0.0000000
EQN1_130	9.773958	0.0000000
EQN1_131	605.0000	0.0000000
EQN1_132	608.2399	0.0000000
EQN1_133	605.2260	0.0000000
EQN1_134	0.0000000	0.0000000
EQN1_135	0.0000000	0.0000000
EQN1_136	0.0000000	0.0000000
EQN1_137	0.0000000	0.0000000
EQN1_138	0.0000000	0.0000000
EQN1_139	0.0000000	0.0000000
EQN1_140	0.0000000	0.0000000
EQN1_141	0.0000000	0.0000000
EQN1_142	0.0000000	0.0000000
EQN1_143	0.0000000	0.0000000
EQN1_144	0.0000000	0.0000000
EQN1_145	0.0000000	0.0000000
EQN1_146	0.0000000	0.0000000
EQN1_147	0.0000000	0.0000000
EQN1_148	10.00000	0.0000000
EQN1_149	10.00000	0.0000000
EQN1_150	10.00000	0.0000000
EQN1_151	-0.7019043E-06	0.0000000
EQN1_152	0.0000000	0.0000000
EQN1_153	-0.7019043E-06	0.0000000
EQN1_154	-0.7019043E-06	0.0000000
EQN1_155	-0.7019043E-06	0.0000000
EQN1_156	-0.2136230E-07	0.0000000
EQN1_157	0.0000000	0.0000000
EQN1_158	-0.2136230E-07	0.0000000
EQN1_159	-0.2136231E-07	0.0000000
EQN1_160	-0.2136230E-07	0.0000000
EQN1_161	-0.1183166E-06	0.0000000
EQN1_162	-0.2040710E-06	0.0000000
EQN1_163	-0.3346798E-09	0.0000000
EQN1_164	-0.6693597E-09	0.0000000
EQN1_165	-0.3633499E-08	0.0000000
EQN1_166	-0.1907380E-10	0.0000000
EQN1_167	-0.1454354E-09	0.0000000
EQN1_168	-0.7271767E-10	0.0000000

Input to LINGO for Analysis 2

```
Data:
CP1=10;
CP2=0.0001;
CP3=1000;
```

All others remained the same.

Output from LINGO for Analysis 2

```
Local optimal solution found at step:          441
 Objective value:                          2399176.
 Branch count:                                   6
```

Variable	Value	Reduced Cost
CP1	10.00000	0.0000000
CP2	0.1000000E-03	0.0000000
CP3	1000.000	0.0000000
I10	0.0000000	0.0000000
I11	3.000000	0.0000000
I12	1.000000	0.0000000
I13	2.000000	0.0000000
I20	0.0000000	0.0000000
I21	3.000000	0.0000000
I22	6.000000	0.0000000
I23	3.000000	0.0000000
FB11	792.0000	0.0000000
FB21	605.0000	0.0000000
H12	187.7435	0.0000000
H13	192.7642	0.0000000
FB12	791.7263	0.0000000
FB13	792.7642	0.0000000
QT111	5.650000	0.0000000
QT112	0.0000000	1008.168
QT113	5.650000	0.0000000
QT121	0.0000000	1263.470
QT122	0.0000000	1008.168
QT123	5.650000	0.0000000
QP11	0.0000000	0.0000000
QP12	4.525356	0.0000000
QP13	0.0000000	0.0000000
QP21	0.0000000	0.0000000
QP22	4.525356	0.0000000
QP23	0.0000000	0.0000000
TR21	542.5197	0.0000000
TR22	535.0814	0.0000000
TR23	542.5197	0.0000000
QT211	5.000000	0.0000000
QT212	0.0000000	0.5819210E-02
QT213	5.000000	0.0000000
QT221	5.000000	0.0000000

QT222	2.235283	0.0000000
QT223	5.000000	0.0000000
PT1	1459.212	0.0000000
PP1	0.0000000	10.00000
PT2	62.52259	0.0000000
PP2	1880.440	0.0000000
PT3	2384.584	0.0000000
PP3	0.1208989E-04	1000.000
PT111	912.8218	0.0000000
PT121	0.0000000	0.0000000
PT211	273.1951	0.0000000
PT221	273.1951	0.0000000
PT112	0.0000000	0.0000000
PT122	0.0000000	0.0000000
PT212	0.0000000	-0.1000000E-03
PT222	62.52259	0.0000000
PT113	940.9593	0.0000000
PT123	940.9593	0.0000000
PT213	251.3326	0.0000000
PT223	251.3326	0.0000000
PP11	0.0000000	0.0000000
PP21	0.0000000	0.0000000
PP12	940.2199	0.0000000
PP22	940.2199	0.0000000
PP13	0.0000000	0.0000000
PP23	0.0000000	0.0000000
H11	187.0000	0.0000000
FB22	603.9828	0.0000000
FB23	600.0000	0.0000000
MU111	1.000000	-2429.513
MU112	0.0000000	0.0000000
MU113	1.000000	-814366.3
MU121	0.0000000	0.0000000
MU122	0.0000000	0.0000000
MU123	1.000000	-814366.3
H21	62.48029	0.0000000
H22	68.90140	0.0000000
H23	57.48029	0.0000000
MU211	1.000000	-1076.372
MU212	0.0000000	0.0000000
MU213	1.000000	-112240.5
MU221	1.000000	-1076.372
MU222	1.000000	0.0000000
MU223	1.000000	-112240.5
SPILL1_NO1	792.0000	0.0000000
SPILL1_YES1	0.0000000	0.0000000
SPILL1_NO2	791.7263	0.0000000
SPILL1_YES2	0.0000000	0.0000000
SPILL1_NO3	792.7642	0.0000000
SPILL1_YES3	0.0000000	0.0000000
THETA_NO1	1.000000	0.0000000
THETA_NO2	1.000000	0.0000000
THETA_NO3	1.000000	0.0000000
THETA_YES1	0.0000000	0.0000000
THETA_YES2	0.0000000	0.0000000
THETA_YES3	0.0000000	0.0000000
UNCONTREL1	0.0000000	968.2530
UNCONTREL2	0.0000000	1008.165
UNCONTREL3	0.0000000	0.0000000
DELTA11	1.000000	0.0000000
DELTA12	0.0000000	0.0000000

DELTA13	1.000000	0.0000000
NU111	0.0000000	0.0000000
NU121	0.0000000	0.2868652E-03
DELTA21	0.0000000	-9488.880
NU112	1.000000	-8935.186
NU122	1.000000	-4020.496
DELTA22	1.000000	0.0000000
NU113	0.0000000	0.0000000
NU123	0.0000000	0.0000000
DELTA23	0.0000000	0.0000000
HPOFF11	187.0000	0.0000000
HPOFF12	0.0000000	-23.29237
HPOFF13	192.7642	0.0000000
HPOFF21	187.0000	0.0000000
HPOFF22	0.0000000	0.0000000
HPOFF23	192.7642	0.0000000
HPON11	0.0000000	0.0000000
HPON12	187.7435	0.0000000
HPON13	0.0000000	0.0000000
HPON21	0.0000000	0.0000000
HPON22	187.7435	0.0000000
HPON23	0.0000000	0.0000000
SPILL2_NO1	605.0000	0.0000000
SPILL2_YES1	0.0000000	0.0000000
SPILL2_NO2	603.9828	0.0000000
SPILL2_YES2	0.0000000	0.0000000
SPILL2_NO3	600.0000	0.0000000
SPILL2_YES3	0.0000000	1017.807
GATED1	0.0000000	108.3731
BETA_YES1	0.0000000	0.0000000
GATED2	0.0000000	0.5819210E-02
BETA_YES2	0.0000000	0.0000000
GATED3	0.0000000	7326.657
BETA_YES3	0.0000000	-610684.3
BETA_NO1	1.000000	0.0000000
BETA_NO2	1.000000	0.0000000
BETA_NO3	1.000000	0.0000000
TR20	534.5083	0.0000000
CHAN0	1.710779	0.0000000
CHAN1	10.00000	0.0000000
CHAN2	2.235283	0.0000000
CHAN3	10.00000	0.0000000
QT210	0.5735152	0.0000000
QT220	0.5686318	0.0000000
GATED0	0.5686318	0.0000000
S10	4.923321	0.0000000
FB10	791.9768	0.0000000
S11	4.925264	0.0000000
S12	4.902368	0.0000000
S13	4.989206	0.0000000
S14	4.908854	0.0000000
FB14	791.8039	0.0000000
S20	0.3341593	0.0000000
FB20	606.4584	0.0000000
S21	0.3174350	0.0000000
S22	0.3057710	0.0000000
S23	0.2601000	0.0000000
S24	0.2972520	0.0000000
FB24	603.2399	0.0000000
QT110	1.178490	0.0000000
QT120	1.178490	0.0000000

QP10	1.290646	0.0000000
QP20	1.291244	0.0000000
UNCONTREL0	0.0000000	0.0000000

Row	Slack or Surplus	Dual Price
OBJECTIVE	2399176.	1.000000
EQN1_2	-0.6792933E-04	10.00000
EQN1_3	-0.4419385E-06	0.1000000E-03
EQN1_4	-0.2060936E-05	1000.000
EQN1_5	0.0000000	0.0000000
EQN1_6	0.0000000	-0.1000000E-03
EQN1_7	-0.1208989E-04	0.0000000
EQN1_8	0.0000000	48.81400
EQN1_9	0.0000000	-46.58574
EQN1_10	0.0000000	9762.800
EQN1_11	0.0000000	10.00000
EQN1_12	0.0000000	0.1000000E-03
EQN1_13	0.0000000	1000.000
EQN1_14	0.0000000	10.00000
EQN1_15	0.0000000	0.1000000E-03
EQN1_16	0.0000000	1000.000
EQN1_17	3.200000	0.0000000
EQN1_18	0.0000000	0.0000000
EQN1_19	3.200000	0.0000000
EQN1_20	0.0000000	430.0022
EQN1_21	0.0000000	0.0000000
EQN1_22	0.0000000	144135.6
EQN1_23	0.0000000	0.0000000
EQN1_24	0.0000000	0.0000000
EQN1_25	3.200000	0.0000000
EQN1_26	0.0000000	0.0000000
EQN1_27	0.0000000	0.0000000
EQN1_28	0.0000000	144135.6
EQN1_29	0.0000000	10.00000
EQN1_30	0.0000000	0.0000000
EQN1_31	0.0000000	1000.000
EQN1_32	0.0000000	10.00000
EQN1_33	0.0000000	0.1000000E-03
EQN1_34	0.0000000	1000.000
EQN1_35	2.800000	0.0000000
EQN1_36	0.0000000	0.0000000
EQN1_37	2.800000	0.0000000
EQN1_38	0.0000000	215.2745
EQN1_39	0.0000000	0.0000000
EQN1_40	0.0000000	22448.11
EQN1_41	2.800000	0.0000000
EQN1_42	0.3528253E-01	0.0000000
EQN1_43	2.800000	0.0000000
EQN1_44	0.0000000	215.2745
EQN1_45	2.764717	0.0000000
EQN1_46	0.0000000	22448.11
EQN1_47	0.0000000	0.0000000
EQN1_48	0.0000000	-0.1000000E-03
EQN1_49	0.0000000	0.0000000
EQN1_50	0.0000000	0.0000000
EQN1_51	0.0000000	-0.1000000E-03
EQN1_52	0.0000000	0.0000000
EQN1_53	0.0000000	0.0000000
EQN1_54	0.0000000	0.0000000
EQN1_55	0.0000000	0.0000000
EQN1_56	5.000000	0.0000000

EQN1_57	4.726344	0.0000000
EQN1_58	5.764246	0.0000000
EQN1_59	3.000000	0.0000000
EQN1_60	3.273656	0.0000000
EQN1_61	2.235754	0.0000000
EQN1_62	0.0000000	0.0000000
EQN1_63	0.0000000	0.0000000
EQN1_64	0.0000000	0.0000000
EQN1_65	0.0000000	0.0000000
EQN1_66	0.0000000	0.0000000
EQN1_67	0.0000000	0.0000000
EQN1_68	0.0000000	0.0000000
EQN1_69	0.0000000	0.0000000
EQN1_70	0.0000000	0.0000000
EQN1_71	0.0000000	0.0000000
EQN1_72	0.0000000	0.0000000
EQN1_73	0.0000000	0.0000000
EQN1_74	1.000000	0.0000000
EQN1_75	0.0000000	0.0000000
EQN1_76	0.0000000	0.0000000
EQN1_77	0.0000000	4744.440
EQN1_78	0.0000000	0.0000000
EQN1_79	0.0000000	0.0000000
EQN1_80	0.0000000	0.0000000
EQN1_81	0.0000000	0.0000000
EQN1_82	0.0000000	0.0000000
EQN1_83	1.000000	0.0000000
EQN1_84	0.0000000	0.0000000
EQN1_85	1.000000	0.0000000
EQN1_86	24.00000	0.0000000
EQN1_87	0.0000000	0.0000000
EQN1_88	18.23575	0.0000000
EQN1_89	24.00000	0.0000000
EQN1_90	0.0000000	23.29237
EQN1_91	18.23575	0.0000000
EQN1_92	0.0000000	0.0000000
EQN1_93	7.256477	0.0000000
EQN1_94	0.0000000	0.0000000
EQN1_95	0.0000000	0.0000000
EQN1_96	7.256477	0.0000000
EQN1_97	0.0000000	0.0000000
EQN1_98	0.0000000	0.0000000
EQN1_99	0.0000000	23.29237
EQN1_100	0.0000000	0.0000000
EQN1_101	0.0000000	0.0000000
EQN1_102	0.0000000	23.29237
EQN1_103	0.0000000	0.0000000
EQN1_104	0.0000000	0.0000000
EQN1_105	0.0000000	23.29237
EQN1_106	0.0000000	0.0000000
EQN1_107	0.0000000	0.0000000
EQN1_108	0.0000000	23.29237
EQN1_109	0.0000000	0.0000000
EQN1_110	0.0000000	968.2530
EQN1_111	0.3746436	0.0000000
EQN1_112	0.0000000	0.0000000
EQN1_113	0.0000000	968.2530
EQN1_114	0.3746436	0.0000000
EQN1_115	0.0000000	0.0000000
EQN1_116	0.0000000	87.45000
EQN1_117	0.0000000	0.9074213E-04

EQN1_118	0.0000000	8745.000
EQN1_119	0.0000000	0.0000000
EQN1_120	0.0000000	0.0000000
EQN1_121	0.0000000	-1017.807
EQN1_122	0.0000000	0.0000000
EQN1_123	0.0000000	0.0000000
EQN1_124	0.0000000	0.0000000
EQN1_125	5.000000	0.0000000
EQN1_126	3.982820	0.0000000
EQN1_127	0.0000000	1017.807
EQN1_128	10.00000	0.0000000
EQN1_129	11.01718	0.0000000
EQN1_130	15.00000	0.0000000
EQN1_131	605.0000	0.0000000
EQN1_132	603.9828	0.0000000
EQN1_133	600.0000	0.0000000
EQN1_134	0.0000000	0.0000000
EQN1_135	0.0000000	0.0000000
EQN1_136	0.0000000	0.0000000
EQN1_137	0.0000000	0.0000000
EQN1_138	0.0000000	0.0000000
EQN1_139	0.0000000	-610684.3
EQN1_140	0.0000000	0.0000000
EQN1_141	0.0000000	-87.45000
EQN1_142	0.0000000	-0.9074213E-04
EQN1_143	0.0000000	-8745.000
EQN1_144	0.0000000	0.0000000
EQN1_145	0.0000000	-73.26656
EQN1_146	0.0000000	-0.9834956E-04
EQN1_147	0.0000000	-7326.657
EQN1_148	10.00000	0.0000000
EQN1_149	17.76472	0.0000000
EQN1_150	10.00000	0.0000000
EQN1_151	-0.8640000E-06	0.0000000
EQN1_152	0.0000000	116129.6
EQN1_153	0.0000000	556.7994
EQN1_154	0.0000000	-116686.4
EQN1_155	-0.3538826E-08	0.0000000
EQN1_156	-0.8640000E-06	0.0000000
EQN1_157	0.0000000	4063.262
EQN1_158	0.0000000	-4062.600
EQN1_159	0.0000000	-0.6621367
EQN1_160	-0.2679271E-06	0.0000000
EQN1_161	0.0000000	0.0000000
EQN1_162	0.0000000	116129.6
EQN1_163	0.0000000	116686.4
EQN1_164	0.0000000	0.0000000
EQN1_165	0.0000000	0.0000000
EQN1_166	0.0000000	4063.262
EQN1_167	0.0000000	0.6621367
EQN1_168	0.0000000	0.0000000

APPENDIX C CPLEX Implementation

Input to CPLEX for Analysis 1

```
MAXIMIZE
10PT1_1+.0001PT1_2+100PT1_3-10PP_1-.0001PP_2-
100PP_3+10PT2_1+.0001PT2_2+100PT2_3

st

\ Equation 8.1

188delta1_101+187delta1_91+186delta1_81+185delta1_71+184delta1_61+183delta1_51+182de
lta1_41+181delta1_31+180delta1_21+
170delta1_11-H1_1<=0
188delta1_102+187delta1_92+186delta1_82+185delta1_72+184delta1_62+183delta1_52+182de
lta1_42+181delta1_32+180delta1_22+
170delta1_12-H1_2<=0
188delta1_103+187delta1_93+186delta1_83+185delta1_73+184delta1_63+183delta1_53+182de
lta1_43+181delta1_33+180delta1_23+
170delta1_13-H1_3<=0
195delta1_101+187.999delta1_91+186.999delta1_81+185.999delta1_71+184.999delta1_61+18
3.999delta1_51+182.999delta1_41+
181.999delta1_31+180.999delta1_21+179.999delta1_11-H1_1=>0
195delta1_102+187.999delta1_92+186.999delta1_82+185.999delta1_72+184.999delta1_62+18
3.999delta1_52+182.999delta1_42+
181.999delta1_32+180.999delta1_22+179.999delta1_12-H1_2=>0
195delta1_103+187.999delta1_93+186.999delta1_83+185.999delta1_73+184.999delta1_63+18
3.999delta1_53+182.999delta1_43+
181.999delta1_33+180.999delta1_23+179.999delta1_13-H1_3=>0


\ Equation 8.2

delta1_101+delta1_91+delta1_81+delta1_71+delta1_61+delta1_51+delta1_41+delta1_31+delta
1_21+delta1_11=1
delta1_102+delta1_92+delta1_82+delta1_72+delta1_62+delta1_52+delta1_42+delta1_32+delta
1_22+delta1_12=1
delta1_103+delta1_93+delta1_83+delta1_73+delta1_63+delta1_53+delta1_43+delta1_33+delta
1_23+delta1_13=1

\ Equation 8.3
```

FB1_1-FB2_1-H1_1=0
FB1_2-FB2_2-H1_2=0
FB1_3-FB2_3-H1_3=0

\ Equation 8.6

phi1_1161+phi1_1151+phi1_1141+phi1_1131+phi1_1121+phi1_1111-delta1_11<=0
phi1_2161+phi1_2151+phi1_2141+phi1_2131+phi1_2121+phi1_2111-delta1_21<=0
phi1_3161+phi1_3151+phi1_3141+phi1_3131+phi1_3121+phi1_3111-delta1_31<=0
phi1_4161+phi1_4151+phi1_4141+phi1_4131+phi1_4121+phi1_4111-delta1_41<=0
phi1_5161+phi1_5151+phi1_5141+phi1_5131+phi1_5121+phi1_5111-delta1_51<=0
phi1_6161+phi1_6151+phi1_6141+phi1_6131+phi1_6121+phi1_6111-delta1_61<=0
phi1_7161+phi1_7151+phi1_7141+phi1_7131+phi1_7121+phi1_7111-delta1_71<=0
phi1_8161+phi1_8151+phi1_8141+phi1_8131+phi1_8121+phi1_8111-delta1_81<=0
phi1_9161+phi1_9151+phi1_9141+phi1_9131+phi1_9121+phi1_9111-delta1_91<=0
phi1_10161+phi1_10151+phi1_10141+phi1_10131+phi1_10121+phi1_10111-delta1_101<=0
phi1_1261+phi1_1251+phi1_1241+phi1_1231+phi1_1221+phi1_1211-delta1_11<=0
phi1_2261+phi1_2251+phi1_2241+phi1_2231+phi1_2221+phi1_2211-delta1_21<=0
phi1_3261+phi1_3251+phi1_3241+phi1_3231+phi1_3221+phi1_3211-delta1_31<=0
phi1_4261+phi1_4251+phi1_4241+phi1_4231+phi1_4221+phi1_4211-delta1_41<=0
phi1_5261+phi1_5251+phi1_5241+phi1_5231+phi1_5221+phi1_5211-delta1_51<=0
phi1_6261+phi1_6251+phi1_6241+phi1_6231+phi1_6221+phi1_6211-delta1_61<=0
phi1_7261+phi1_7251+phi1_7241+phi1_7231+phi1_7221+phi1_7211-delta1_71<=0
phi1_8261+phi1_8251+phi1_8241+phi1_8231+phi1_8221+phi1_8211-delta1_81<=0
phi1_9261+phi1_9251+phi1_9241+phi1_9231+phi1_9221+phi1_9211-delta1_91<=0
phi1_10261+phi1_10251+phi1_10241+phi1_10231+phi1_10221+phi1_10211-delta1_101<=0
phi1_1162+phi1_1152+phi1_1142+phi1_1132+phi1_1122+phi1_1112-delta1_12<=0
phi1_2162+phi1_2152+phi1_2142+phi1_2132+phi1_2122+phi1_2112-delta1_22<=0
phi1_3162+phi1_3152+phi1_3142+phi1_3132+phi1_3122+phi1_3112-delta1_32<=0
phi1_4162+phi1_4152+phi1_4142+phi1_4132+phi1_4122+phi1_4112-delta1_42<=0
phi1_5162+phi1_5152+phi1_5142+phi1_5132+phi1_5122+phi1_5112-delta1_52<=0
phi1_6162+phi1_6152+phi1_6142+phi1_6132+phi1_6122+phi1_6112-delta1_62<=0
phi1_7162+phi1_7152+phi1_7142+phi1_7132+phi1_7122+phi1_7112-delta1_72<=0
phi1_8162+phi1_8152+phi1_8142+phi1_8132+phi1_8122+phi1_8112-delta1_82<=0
phi1_9162+phi1_9152+phi1_9142+phi1_9132+phi1_9122+phi1_9112-delta1_92<=0
phi1_10162+phi1_10152+phi1_10142+phi1_10132+phi1_10122+phi1_10112-delta1_102<=0
phi1_1262+phi1_1252+phi1_1242+phi1_1232+phi1_1222+phi1_1212-delta1_12<=0
phi1_2262+phi1_2252+phi1_2242+phi1_2232+phi1_2222+phi1_2212-delta1_22<=0
phi1_3262+phi1_3252+phi1_3242+phi1_3232+phi1_3222+phi1_3212-delta1_32<=0
phi1_4262+phi1_4252+phi1_4242+phi1_4232+phi1_4222+phi1_4212-delta1_42<=0
phi1_5262+phi1_5252+phi1_5242+phi1_5232+phi1_5222+phi1_5212-delta1_52<=0
phi1_6262+phi1_6252+phi1_6242+phi1_6232+phi1_6222+phi1_6212-delta1_62<=0
phi1_7262+phi1_7252+phi1_7242+phi1_7232+phi1_7222+phi1_7212-delta1_72<=0
phi1_8262+phi1_8252+phi1_8242+phi1_8232+phi1_8222+phi1_8212-delta1_82<=0
phi1_9262+phi1_9252+phi1_9242+phi1_9232+phi1_9222+phi1_9212-delta1_92<=0

phi1_10262+phi1_10252+phi1_10242+phi1_10232+phi1_10222+phi1_10212-delta1_102<=0
phi1_1163+phi1_1153+phi1_1143+phi1_1133+phi1_1123+phi1_1113-delta1_13<=0
phi1_2163+phi1_2153+phi1_2143+phi1_2133+phi1_2123+phi1_2113-delta1_23<=0
phi1_3163+phi1_3153+phi1_3143+phi1_3133+phi1_3123+phi1_3113-delta1_33<=0
phi1_4163+phi1_4153+phi1_4143+phi1_4133+phi1_4123+phi1_4113-delta1_43<=0
phi1_5163+phi1_5153+phi1_5143+phi1_5133+phi1_5123+phi1_5113-delta1_53<=0
phi1_6163+phi1_6153+phi1_6143+phi1_6133+phi1_6123+phi1_6113-delta1_63<=0
phi1_7163+phi1_7153+phi1_7143+phi1_7133+phi1_7123+phi1_7113-delta1_73<=0
phi1_8163+phi1_8153+phi1_8143+phi1_8133+phi1_8123+phi1_8113-delta1_83<=0
phi1_9163+phi1_9153+phi1_9143+phi1_9133+phi1_9123+phi1_9113-delta1_93<=0
phi1_10163+phi1_10153+phi1_10143+phi1_10133+phi1_10123+phi1_10113-delta1_103<=0
phi1_1263+phi1_1253+phi1_1243+phi1_1233+phi1_1223+phi1_1213-delta1_13<=0
phi1_2263+phi1_2253+phi1_2243+phi1_2233+phi1_2223+phi1_2213-delta1_23<=0
phi1_3263+phi1_3253+phi1_3243+phi1_3233+phi1_3223+phi1_3213-delta1_33<=0
phi1_4263+phi1_4253+phi1_4243+phi1_4233+phi1_4223+phi1_4213-delta1_43<=0
phi1_5263+phi1_5253+phi1_5243+phi1_5233+phi1_5223+phi1_5213-delta1_53<=0
phi1_6263+phi1_6253+phi1_6243+phi1_6233+phi1_6223+phi1_6213-delta1_63<=0
phi1_7263+phi1_7253+phi1_7243+phi1_7233+phi1_7223+phi1_7213-delta1_73<=0
phi1_8263+phi1_8253+phi1_8243+phi1_8233+phi1_8223+phi1_8213-delta1_83<=0
phi1_9263+phi1_9253+phi1_9243+phi1_9233+phi1_9223+phi1_9213-delta1_93<=0
phi1_10263+phi1_10253+phi1_10243+phi1_10233+phi1_10223+phi1_10213-delta1_103<=0

\ Equation 8.8

920.44phi1_10161+891.46phi1_10151+861.84phi1_10141+831.31phi1_10131+799.66phi1_101
21+580.4phi1_10111
+901.22phi1_9161+872.84phi1_9151+843.83phi1_9141+813.94phi1_9131+782.96phi1_9121+
568.27phi1_9111+
896.41phi1_8161+868.18phi1_8151+839.33phi1_8141+809.6phi1_8131+778.78phi1_8121+565
.24phi1_8111+
891.6phi1_7161+863.53phi1_7151+834.83phi1_7141+805.26phi1_7131+774.61phi1_7121+562
.21phi1_7111+
886.8phi1_6161+858.87phi1_6151+830.33phi1_6141+800.92phi1_6131+770.43phi1_6121+559
.18phi1_6111+
881.99phi1_5161+854.22phi1_5151+825.83phi1_5141+796.58phi1_5131+766.26phi1_5121+55
6.15phi1_5111
+877.18phi1_4161+849.56phi1_4151+821.33phi1_4141+792.24phi1_4131+762.08phi1_4121+
553.12phi1_4111
+872.38phi1_3161+844.91phi1_3151+816.83phi1_3141+787.9phi1_3131+757.9phi1_3121+55
0.09phi1_3111+
867.57phi1_2161+840.25phi1_2151+812.33phi1_2141+783.56phi1_2131+753.73phi1_2121+54
7.06phi1_2111+
841.13phi1_1161+814.65phi1_1151+787.58phi1_1141+759.68phi1_1131+730.76phi1_1121+53
0.39phi1_1111-PT1_11=0

920.44phi1_10162+891.46phi1_10152+861.84phi1_10142+831.31phi1_10132+799.66phi1_101
22+580.4phi1_10112+

901.22phi1_9162+872.84phi1_9152+843.83phi1_9142+813.94phi1_9132+782.96phi1_9122+56
8.27phi1_9112
+896.41phi1_8162+868.18phi1_8152+839.33phi1_8142+809.6phi1_8132+778.78phi1_8122+5
65.24phi1_8112
+891.6phi1_7162+863.53phi1_7152+834.83phi1_7142+805.26phi1_7132+774.61phi1_7122+5
62.21phi1_7112
+886.8phi1_6162+858.87phi1_6152+830.33phi1_6142+800.92phi1_6132+770.43phi1_6122+5
59.18phi1_6112
+881.99phi1_5162+854.22phi1_5152+825.83phi1_5142+796.58phi1_5132+766.26phi1_5122+
556.15phi1_5112
+877.18phi1_4162+849.56phi1_4152+821.33phi1_4142+792.24phi1_4132+762.08phi1_4122+
553.12phi1_4112
+872.38phi1_3162+844.91phi1_3152+816.83phi1_3142+787.9phi1_3132+757.9phi1_3122+55
0.09phi1_3112
+867.57phi1_2162+840.25phi1_2152+812.33phi1_2142+783.56phi1_2132+753.73phi1_2122+
547.06phi1_2112
+841.13phi1_1162+814.65phi1_1152+787.58phi1_1142+759.68phi1_1132+730.76phi1_1122+
530.39phi1_1112-PT1_12=0

920.44phi1_10163+891.46phi1_10153+861.84phi1_10143+831.31phi1_10133+799.66phi1_101
23+580.4phi1_10113
+901.22phi1_9163+872.84phi1_9153+843.83phi1_9143+813.94phi1_9133+782.96phi1_9123+
568.27phi1_9113
+896.41phi1_8163+868.18phi1_8153+839.33phi1_8143+809.6phi1_8133+778.78phi1_8123+5
65.24phi1_8113
+891.6phi1_7163+863.53phi1_7153+834.83phi1_7143+805.26phi1_7133+774.61phi1_7123+5
62.21phi1_7113
+886.8phi1_6163+858.87phi1_6153+830.33phi1_6143+800.92phi1_6133+770.43phi1_6123+5
59.18phi1_6113
+881.99phi1_5163+854.22phi1_5153+825.83phi1_5143+796.58phi1_5133+766.26phi1_5123+
556.15phi1_5113
+877.18phi1_4163+849.56phi1_4153+821.33phi1_4143+792.24phi1_4133+762.08phi1_4123+
553.12phi1_4113
+872.38phi1_3163+844.91phi1_3153+816.83phi1_3143+787.9phi1_3133+757.9phi1_3123+55
0.09phi1_3113
+867.57phi1_2163+840.25phi1_2153+812.33phi1_2143+783.56phi1_2133+753.73phi1_2123+
547.06phi1_2113
+841.13phi1_1163+814.65phi1_1153+787.58phi1_1143+759.68phi1_1133+730.76phi1_1123+
530.39phi1_1113-PT1_13=0

920.44phi1_10261+891.46phi1_10251+861.84phi1_10241+831.31phi1_10231+799.66phi1_102
21+
580.4phi1_10211+901.22phi1_9261+872.84phi1_9251+843.83phi1_9241+813.94phi1_9231+78
2.96phi1_9221+
568.27phi1_9211+896.41phi1_8261+868.18phi1_8251+839.33phi1_8241+809.6phi1_8231+778
.78phi1_8221+
565.24phi1_8211+891.6phi1_7261+863.53phi1_7251+834.83phi1_7241+805.26phi1_7231+774
.61phi1_7221+
562.21phi1_7211+886.8phi1_6261+858.87phi1_6251+830.33phi1_6241+800.92phi1_6231+770
.43phi1_6221+

559.18phi1_6211+881.99phi1_5261+854.22phi1_5251+825.83phi1_5241+796.58phi1_5231+76
6.26phi1_5221
+556.15phi1_5211+877.18phi1_4261+849.56phi1_4251+821.33phi1_4241+792.24phi1_4231+
762.08phi1_4221
+553.12phi1_4211+872.38phi1_3261+844.91phi1_3251+816.83phi1_3241+787.9phi1_3231+7
57.9phi1_3221+
550.09phi1_3211+867.57phi1_2261+840.25phi1_2251+812.33phi1_2241+783.56phi1_2231+75
3.73phi1_2221
+547.06phi1_2211+841.13phi1_1261+814.65phi1_1251+787.58phi1_1241+759.68phi1_1231+
730.76phi1_1221
+530.39phi1_1211-PT1_21=0

920.44phi1_10262+891.46phi1_10252+861.84phi1_10242+831.31phi1_10232+799.66phi1_102
22+580.4phi1_10212
+901.22phi1_9262+872.84phi1_9252+843.83phi1_9242+813.94phi1_9232+782.96phi1_9222+
568.27phi1_9212
+896.41phi1_8262+868.18phi1_8252+839.33phi1_8242+809.6phi1_8232+778.78phi1_8222+5
65.24phi1_8212
+891.6phi1_7262+863.53phi1_7252+834.83phi1_7242+805.26phi1_7232+774.61phi1_7222+5
62.21phi1_7212
+886.8phi1_6262+858.87phi1_6252+830.33phi1_6242+800.92phi1_6232+770.43phi1_6222+5
59.18phi1_6212
+881.99phi1_5262+854.22phi1_5252+825.83phi1_5242+796.58phi1_5232+766.26phi1_5222+
556.15phi1_5212
+877.18phi1_4262+849.56phi1_4252+821.33phi1_4242+792.24phi1_4232+762.08phi1_4222+
553.12phi1_4212
+872.38phi1_3262+844.91phi1_3252+816.83phi1_3242+787.9phi1_3232+757.9phi1_3222+55
0.09phi1_3212+
867.57phi1_2262+840.25phi1_2252+812.33phi1_2242+783.56phi1_2232+753.73phi1_2222+54
7.06phi1_2212
+841.13phi1_1262+814.65phi1_1252+787.58phi1_1242+759.68phi1_1232+730.76phi1_1222+
530.39phi1_1212-PT1_22=0

920.44phi1_10263+891.46phi1_10253+861.84phi1_10243+831.31phi1_10233+799.66phi1_102
23+580.4phi1_10213
+901.22phi1_9263+872.84phi1_9253+843.83phi1_9243+813.94phi1_9233+782.96phi1_9223+
568.27phi1_9213
+896.41phi1_8263+868.18phi1_8253+839.33phi1_8243+809.6phi1_8233+778.78phi1_8223+5
65.24phi1_8213
+891.6phi1_7263+863.53phi1_7253+834.83phi1_7243+805.26phi1_7233+774.61phi1_7223+5
62.21phi1_7213
+886.8phi1_6263+858.87phi1_6253+830.33phi1_6243+800.92phi1_6233+770.43phi1_6223+5
59.18phi1_6213
+881.99phi1_5263+854.22phi1_5253+825.83phi1_5243+796.58phi1_5233+766.26phi1_5223+
556.15phi1_5213
+877.18phi1_4263+849.56phi1_4253+821.33phi1_4243+792.24phi1_4233+762.08phi1_4223+
553.12phi1_4213
+872.38phi1_3263+844.91phi1_3253+816.83phi1_3243+787.9phi1_3233+757.9phi1_3223+55
0.09phi1_3213+

867.57phi1_2263+840.25phi1_2253+812.33phi1_2243+783.56phi1_2233+753.73phi1_2223+547.06phi1_2213
+841.13phi1_1263+814.65phi1_1253+787.58phi1_1243+759.68phi1_1233+730.76phi1_1223+530.39phi1_1213-PT1_23=0

\ Equation 8.9

PT1_21+PT1_11-PT1_1=0
PT1_22+PT1_12-PT1_2=0
PT1_23+PT1_13-PT1_3=0

\ Equation 8.10

PT_1-PT1_1-PT2_1=0
PT_2-PT1_2-PT2_2=0
PT_3-PT1_3-PT2_3=0

\ Equation 8.11

5.4501phi1_10161+5.2501phi1_10151+5.0501phi1_10141+4.8501phi1_10131+4.6501phi1_10121+2.45phi1_10111+5.4501phi1_9161+5.2501phi1_9151+
5.0501phi1_9141+4.8501phi1_9131+4.6501phi1_9121+2.45phi1_9111+5.4501phi1_8161+5.2501phi1_8151+5.0501phi1_8141+4.8501phi1_8131+
4.6501phi1_8121+2.45phi1_8111+5.4501phi1_7161+5.2501phi1_7151+5.0501phi1_7141+4.8501phi1_7131+4.6501phi1_7121+2.45phi1_7111+
5.4501phi1_6161+5.2501phi1_6151+5.0501phi1_6141+4.8501phi1_6131+4.6501phi1_6121+2.45phi1_6111+5.4501phi1_5161+5.2501phi1_5151+
5.0501phi1_5141+4.8501phi1_5131+4.6501phi1_5121+2.45phi1_5111+5.4501phi1_4161+5.2501phi1_4151+5.0501phi1_4141+4.8501phi1_4131+
4.6501phi1_4121+2.45phi1_4111+5.4501phi1_3161+5.2501phi1_3151+5.0501phi1_3141+4.8501phi1_3131+4.6501phi1_3121+2.45phi1_3111+
5.4501phi1_2161+5.2501phi1_2151+5.0501phi1_2141+4.8501phi1_2131+4.6501phi1_2121+2.45phi1_2111+5.4501phi1_1161+5.2501phi1_1151+
5.0501phi1_1141+4.8501phi1_1131+4.6501phi1_1121+2.45phi1_1111-QT1_11<=0

5.65phi1_10161+5.45phi1_10151+5.25phi1_10141+5.05phi1_10131+4.85phi1_10121+4.65phi1_10111+5.65phi1_9161+5.45phi1_9151+5.25phi1_9141
+5.05phi1_9131+4.85phi1_9121+4.65phi1_9111+5.65phi1_8161+5.45phi1_8151+5.25phi1_8141+5.05phi1_8131+4.85phi1_8121+4.65phi1_8111+
5.65phi1_7161+5.45phi1_7151+5.25phi1_7141+5.05phi1_7131+4.85phi1_7121+4.65phi1_7111+5.65phi1_6161+5.45phi1_6151+5.25phi1_6141+
5.05phi1_6131+4.85phi1_6121+4.65phi1_6111+5.65phi1_5161+5.45phi1_5151+5.25phi1_5141+5.05phi1_5131+4.85phi1_5121+4.65phi1_5111+
5.65phi1_4161+5.45phi1_4151+5.25phi1_4141+5.05phi1_4131+4.85phi1_4121+4.65phi1_4111+5.65phi1_3161+5.45phi1_3151+5.25phi1_3141+

5.05phi1_3131+4.85phi1_3121+4.65phi1_3111+5.65phi1_2161+5.45phi1_2151+5.25phi1_2141
+5.05phi1_2131+4.85phi1_2121+4.65phi1_2111+
5.65phi1_1161+5.45phi1_1151+5.25phi1_1141+5.05phi1_1131+4.85phi1_1121+4.65phi1_1111
-QT1_11=>0

5.4501phi1_10162+5.2501phi1_10152+5.0501phi1_10142+4.8501phi1_10132+4.6501phi1_101
22+2.45phi1_10112+5.4501phi1_9162+5.2501phi1_9152
+5.0501phi1_9142+4.8501phi1_9132+4.6501phi1_9122+2.45phi1_9112+5.4501phi1_8162+5.2
501phi1_8152+5.0501phi1_8142+4.8501phi1_8132+
4.6501phi1_8122+2.45phi1_8112+5.4501phi1_7162+5.2501phi1_7152+5.0501phi1_7142+4.85
01phi1_7132+4.6501phi1_7122+2.45phi1_7112+
5.4501phi1_6162+5.2501phi1_6152+5.0501phi1_6142+4.8501phi1_6132+4.6501phi1_6122+2.
45phi1_6112+5.4501phi1_5162+5.2501phi1_5152+
5.0501phi1_5142+4.8501phi1_5132+4.6501phi1_5122+2.45phi1_5112+5.4501phi1_4162+5.25
01phi1_4152+5.0501phi1_4142+4.8501phi1_4132+
4.6501phi1_4122+2.45phi1_4112+5.4501phi1_3162+5.2501phi1_3152+5.0501phi1_3142+4.85
01phi1_3132+4.6501phi1_3122+2.45phi1_3112+
5.4501phi1_2162+5.2501phi1_2152+5.0501phi1_2142+4.8501phi1_2132+4.6501phi1_2122+2.
45phi1_2112+5.4501phi1_1162+5.2501phi1_1152+
5.0501phi1_1142+4.8501phi1_1132+4.6501phi1_1122+2.45phi1_1112-QT1_12<=0

5.65phi1_10162+5.45phi1_10152+5.25phi1_10142+5.05phi1_10132+4.85phi1_10122+4.65phi1
_10112+5.65phi1_9162+5.45phi1_9152+5.25phi1_9142
+5.05phi1_9132+4.85phi1_9122+4.65phi1_9112+5.65phi1_8162+5.45phi1_8152+5.25phi1_81
42+5.05phi1_8132+4.85phi1_8122+4.65phi1_8112
+5.65phi1_7162+5.45phi1_7152+5.25phi1_7142+5.05phi1_7132+4.85phi1_7122+4.65phi1_71
12+5.65phi1_6162+5.45phi1_6152+5.25phi1_6142
+5.05phi1_6132+4.85phi1_6122+4.65phi1_6112+5.65phi1_5162+5.45phi1_5152+5.25phi1_51
42+5.05phi1_5132+4.85phi1_5122+4.65phi1_5112
+5.65phi1_4162+5.45phi1_4152+5.25phi1_4142+5.05phi1_4132+4.85phi1_4122+4.65phi1_41
12+5.65phi1_3162+5.45phi1_3152+5.25phi1_3142
+5.05phi1_3132+4.85phi1_3122+4.65phi1_3112+5.65phi1_2162+5.45phi1_2152+5.25phi1_21
42+5.05phi1_2132+4.85phi1_2122+4.65phi1_2112
+5.65phi1_1162+5.45phi1_1152+5.25phi1_1142+5.05phi1_1132+4.85phi1_1122+4.65phi1_11
12-QT1_12=>0

5.4501phi1_10163+5.2501phi1_10153+5.0501phi1_10143+4.8501phi1_10133+4.6501phi1_101
23+2.45phi1_10113+5.4501phi1_9163+5.2501phi1_9153
+5.0501phi1_9143+4.8501phi1_9133+4.6501phi1_9123+2.45phi1_9113+5.4501phi1_8163+5.2
501phi1_8153+5.0501phi1_8143+4.8501phi1_8133
+4.6501phi1_8123+2.45phi1_8113+5.4501phi1_7163+5.2501phi1_7153+5.0501phi1_7143+4.8
501phi1_7133+4.6501phi1_7123+2.45phi1_7113
+5.4501phi1_6163+5.2501phi1_6153+5.0501phi1_6143+4.8501phi1_6133+4.6501phi1_6123+
2.45phi1_6113+5.4501phi1_5163+5.2501phi1_5153
+5.0501phi1_5143+4.8501phi1_5133+4.6501phi1_5123+2.45phi1_5113+5.4501phi1_4163+5.2
501phi1_4153+5.0501phi1_4143+4.8501phi1_4133
+4.6501phi1_4123+2.45phi1_4113+5.4501phi1_3163+5.2501phi1_3153+5.0501phi1_3143+4.8
501phi1_3133+4.6501phi1_3123+2.45phi1_3113+
5.4501phi1_2163+5.2501phi1_2153+5.0501phi1_2143+4.8501phi1_2133+4.6501phi1_2123+2.
45phi1_2113+5.4501phi1_1163+5.2501phi1_1153+

5.0501phi1_1143+4.8501phi1_1133+4.6501phi1_1123+2.45phi1_1113-QT1_13<=0

5.65phi1_10163+5.45phi1_10153+5.25phi1_10143+5.05phi1_10133+4.85phi1_10123+4.65phi1
_10113+5.65phi1_9163+5.45phi1_9153+5.25phi1_9143
+5.05phi1_9133+4.85phi1_9123+4.65phi1_9113+5.65phi1_8163+5.45phi1_8153+5.25phi1_81
43+5.05phi1_8133+4.85phi1_8123+4.65phi1_8113+
5.65phi1_7163+5.45phi1_7153+5.25phi1_7143+5.05phi1_7133+4.85phi1_7123+4.65phi1_7113
+5.65phi1_6163+5.45phi1_6153+5.25phi1_6143+
5.05phi1_6133+4.85phi1_6123+4.65phi1_6113+5.65phi1_5163+5.45phi1_5153+5.25phi1_5143
+5.05phi1_5133+4.85phi1_5123+4.65phi1_5113+
5.65phi1_4163+5.45phi1_4153+5.25phi1_4143+5.05phi1_4133+4.85phi1_4123+4.65phi1_4113
+5.65phi1_3163+5.45phi1_3153+5.25phi1_3143+
5.05phi1_3133+4.85phi1_3123+4.65phi1_3113+5.65phi1_2163+5.45phi1_2153+5.25phi1_2143
+5.05phi1_2133+4.85phi1_2123+4.65phi1_2113+
5.65phi1_1163+5.45phi1_1153+5.25phi1_1143+5.05phi1_1133+4.85phi1_1123+4.65phi1_1113
-QT1_13=>0

5.4501phi1_10261+5.2501phi1_10251+5.0501phi1_10241+4.8501phi1_10231+4.6501phi1_102
21+2.45phi1_10211+5.4501phi1_9261+5.2501phi1_9251
+5.0501phi1_9241+4.8501phi1_9231+4.6501phi1_9221+2.45phi1_9211+5.4501phi1_8261+5.2
501phi1_8251+5.0501phi1_8241+4.8501phi1_8231+
4.6501phi1_8221+2.45phi1_8211+5.4501phi1_7261+5.2501phi1_7251+5.0501phi1_7241+4.85
01phi1_7231+4.6501phi1_7221+2.45phi1_7211+
5.4501phi1_6261+5.2501phi1_6251+5.0501phi1_6241+4.8501phi1_6231+4.6501phi1_6221+2.
45phi1_6211+5.4501phi1_5261+5.2501phi1_5251+
5.0501phi1_5241+4.8501phi1_5231+4.6501phi1_5221+2.45phi1_5211+5.4501phi1_4261+5.25
01phi1_4251+5.0501phi1_4241+4.8501phi1_4231+
4.6501phi1_4221+2.45phi1_4211+5.4501phi1_3261+5.2501phi1_3251+5.0501phi1_3241+4.85
01phi1_3231+4.6501phi1_3221+2.45phi1_3211+
5.4501phi1_2261+5.2501phi1_2251+5.0501phi1_2241+4.8501phi1_2231+4.6501phi1_2221+2.
45phi1_2211+5.4501phi1_1261+5.2501phi1_1251+
5.0501phi1_1241+4.8501phi1_1231+4.6501phi1_1221+2.45phi1_1211-QT1_21<=0

5.65phi1_10261+5.45phi1_10251+5.25phi1_10241+5.05phi1_10231+4.85phi1_10221+4.65phi1
_10211+5.65phi1_9261+5.45phi1_9251+5.25phi1_9241+
5.05phi1_9231+4.85phi1_9221+4.65phi1_9211+5.65phi1_8261+5.45phi1_8251+5.25phi1_8241
+5.05phi1_8231+4.85phi1_8221+4.65phi1_8211+
5.65phi1_7261+5.45phi1_7251+5.25phi1_7241+5.05phi1_7231+4.85phi1_7221+4.65phi1_7211
+5.65phi1_6261+5.45phi1_6251+5.25phi1_6241+
5.05phi1_6231+4.85phi1_6221+4.65phi1_6211+5.65phi1_5261+5.45phi1_5251+5.25phi1_5241
+5.05phi1_5231+4.85phi1_5221+4.65phi1_5211+
5.65phi1_4261+5.45phi1_4251+5.25phi1_4241+5.05phi1_4231+4.85phi1_4221+4.65phi1_4211
+5.65phi1_3261+5.45phi1_3251+5.25phi1_3241+
5.05phi1_3231+4.85phi1_3221+4.65phi1_3211+5.65phi1_2261+5.45phi1_2251+5.25phi1_2241
+5.05phi1_2231+4.85phi1_2221+4.65phi1_2211+
5.65phi1_1261+5.45phi1_1251+5.25phi1_1241+5.05phi1_1231+4.85phi1_1221+4.65phi1_1211
-QT1_21=>0

5.4501phi1_10262+5.2501phi1_10252+5.0501phi1_10242+4.8501phi1_10232+4.6501phi1_102
22+2.45phi1_10212+5.4501phi1_9262+5.2501phi1_9252+

5.0501phi1_9242+4.8501phi1_9232+4.6501phi1_9222+2.45phi1_9212+5.4501phi1_8262+5.25
01phi1_8252+5.0501phi1_8242+4.8501phi1_8232+
4.6501phi1_8222+2.45phi1_8212+5.4501phi1_7262+5.2501phi1_7252+5.0501phi1_7242+4.85
01phi1_7232+4.6501phi1_7222+2.45phi1_7212+
5.4501phi1_6262+5.2501phi1_6252+5.0501phi1_6242+4.8501phi1_6232+4.6501phi1_6222+2.
45phi1_6212+5.4501phi1_5262+5.2501phi1_5252+
5.0501phi1_5242+4.8501phi1_5232+4.6501phi1_5222+2.45phi1_5212+5.4501phi1_4262+5.25
01phi1_4252+5.0501phi1_4242+4.8501phi1_4232+
4.6501phi1_4222+2.45phi1_4212+5.4501phi1_3262+5.2501phi1_3252+5.0501phi1_3242+4.85
01phi1_3232+4.6501phi1_3222+2.45phi1_3212+
5.4501phi1_2262+5.2501phi1_2252+5.0501phi1_2242+4.8501phi1_2232+4.6501phi1_2222+2.
45phi1_2212+5.4501phi1_1262+5.2501phi1_1252+
5.0501phi1_1242+4.8501phi1_1232+4.6501phi1_1222+2.45phi1_1212-QT1_22<=0

5.65phi1_10262+5.45phi1_10252+5.25phi1_10242+5.05phi1_10232+4.85phi1_10222+4.65phi1
_10212+5.65phi1_9262+5.45phi1_9252+5.25phi1_9242+
5.05phi1_9232+4.85phi1_9222+4.65phi1_9212+5.65phi1_8262+5.45phi1_8252+5.25phi1_8242
+5.05phi1_8232+4.85phi1_8222+4.65phi1_8212+
5.65phi1_7262+5.45phi1_7252+5.25phi1_7242+5.05phi1_7232+4.85phi1_7222+4.65phi1_7212
+5.65phi1_6262+5.45phi1_6252+5.25phi1_6242+
5.05phi1_6232+4.85phi1_6222+4.65phi1_6212+5.65phi1_5262+5.45phi1_5252+5.25phi1_5242
+5.05phi1_5232+4.85phi1_5222+4.65phi1_5212+
5.65phi1_4262+5.45phi1_4252+5.25phi1_4242+5.05phi1_4232+4.85phi1_4222+4.65phi1_4212
+5.65phi1_3262+5.45phi1_3252+5.25phi1_3242+
5.05phi1_3232+4.85phi1_3222+4.65phi1_3212+5.65phi1_2262+5.45phi1_2252+5.25phi1_2242
+5.05phi1_2232+4.85phi1_2222+4.65phi1_2212+
5.65phi1_1262+5.45phi1_1252+5.25phi1_1242+5.05phi1_1232+4.85phi1_1222+4.65phi1_1212
-QT1_22=>0

5.4501phi1_10263+5.2501phi1_10253+5.0501phi1_10243+4.8501phi1_10233+4.6501phi1_102
23+2.45phi1_10213+5.4501phi1_9263+5.2501phi1_9253+
5.0501phi1_9243+4.8501phi1_9233+4.6501phi1_9223+2.45phi1_9213+5.4501phi1_8263+5.25
01phi1_8253+5.0501phi1_8243+4.8501phi1_8233+
4.6501phi1_8223+2.45phi1_8213+5.4501phi1_7263+5.2501phi1_7253+5.0501phi1_7243+4.85
01phi1_7233+4.6501phi1_7223+2.45phi1_7213+
5.4501phi1_6263+5.2501phi1_6253+5.0501phi1_6243+4.8501phi1_6233+4.6501phi1_6223+2.
45phi1_6213+5.4501phi1_5263+5.2501phi1_5253+
5.0501phi1_5243+4.8501phi1_5233+4.6501phi1_5223+2.45phi1_5213+5.4501phi1_4263+5.25
01phi1_4253+5.0501phi1_4243+4.8501phi1_4233+
4.6501phi1_4223+2.45phi1_4213+5.4501phi1_3263+5.2501phi1_3253+5.0501phi1_3243+4.85
01phi1_3233+4.6501phi1_3223+2.45phi1_3213+
5.4501phi1_2263+5.2501phi1_2253+5.0501phi1_2243+4.8501phi1_2233+4.6501phi1_2223+2.
45phi1_2213+5.4501phi1_1263+5.2501phi1_1253+
5.0501phi1_1243+4.8501phi1_1233+4.6501phi1_1223+2.45phi1_1213-QT1_23<=0

5.65phi1_10263+5.45phi1_10253+5.25phi1_10243+5.05phi1_10233+4.85phi1_10223+4.65phi1
_10213+5.65phi1_9263+5.45phi1_9253+5.25phi1_9243+
5.05phi1_9233+4.85phi1_9223+4.65phi1_9213+5.65phi1_8263+5.45phi1_8253+5.25phi1_8243
+5.05phi1_8233+4.85phi1_8223+4.65phi1_8213

+5.65phi1_7263+5.45phi1_7253+5.25phi1_7243+5.05phi1_7233+4.85phi1_7223+4.65phi1_72
13+5.65phi1_6263+5.45phi1_6253+5.25phi1_6243
+5.05phi1_6233+4.85phi1_6223+4.65phi1_6213+5.65phi1_5263+5.45phi1_5253+5.25phi1_52
43+5.05phi1_5233+4.85phi1_5223+4.65phi1_5213
+5.65phi1_4263+5.45phi1_4253+5.25phi1_4243+5.05phi1_4233+4.85phi1_4223+4.65phi1_42
13+5.65phi1_3263+5.45phi1_3253+5.25phi1_3243
+5.05phi1_3233+4.85phi1_3223+4.65phi1_3213+5.65phi1_2263+5.45phi1_2253+5.25phi1_22
43+5.05phi1_2233+4.85phi1_2223+4.65phi1_2213
+5.65phi1_1263+5.45phi1_1253+5.25phi1_1243+5.05phi1_1233+4.85phi1_1223+4.65phi1_12
13-QT1_23=>0

\ Equation 8.12

QT1_21+QT1_11-QT1_1=0
QT1_22+QT1_12-QT1_2=0
QT1_23+QT1_13-QT1_3=0

\ Equation 8.14
942.211nu_1011+945.699nu_911+946.447nu_811+947.145nu_711+947.793nu_611+948.391nu
_511+948.939nu_411+949.436nu_311+949.883
nu_211+951.427nu_111-PP_11=0
942.211nu_1012+945.699nu_912+946.447nu_812+947.145nu_712+947.793nu_612+948.391nu
_512+948.939nu_412+949.436nu_312+949.883
nu_212+951.427nu_112-PP_12=0
942.211nu_1013+945.699nu_913+946.447nu_813+947.145nu_713+947.793nu_613+948.391nu
_513+948.939nu_413+949.436nu_313+949.883
nu_213+951.427nu_113-PP_13=0
942.211nu_1021+945.699nu_921+946.447nu_821+947.145nu_721+947.793nu_621+948.391nu
_521+948.939nu_421+949.436nu_321+949.883
nu_221+951.427nu_121-PP_21=0
942.211nu_1022+945.699nu_922+946.447nu_822+947.145nu_722+947.793nu_622+948.391nu
_522+948.939nu_422+949.436nu_322+949.883
nu_222+951.427nu_122-PP_22=0
942.211nu_1023+945.699nu_923+946.447nu_823+947.145nu_723+947.793nu_623+948.391nu
_523+948.939nu_423+949.436nu_323+949.883
nu_223+951.427nu_123-PP_23=0

\ Equation 8.15

PP_21+PP_11-PP_1=0
PP_22+PP_12-PP_2=0
PP_23+PP_13-PP_3=0

```
\ Equation 8.16

nu_111-delta1_11<=0
nu_121-delta1_11<=0
nu_211-delta1_21<=0
nu_221-delta1_21<=0
nu_311-delta1_31<=0
nu_321-delta1_31<=0
nu_411-delta1_41<=0
nu_421-delta1_41<=0
nu_511-delta1_51<=0
nu_521-delta1_51<=0
nu_611-delta1_61<=0
nu_621-delta1_61<=0
nu_711-delta1_71<=0
nu_721-delta1_71<=0
nu_811-delta1_81<=0
nu_821-delta1_81<=0
nu_911-delta1_91<=0
nu_921-delta1_91<=0
nu_1011-delta1_101<=0
nu_1021-delta1_101<=0
nu_112-delta1_12<=0
nu_122-delta1_12<=0
nu_212-delta1_22<=0
nu_222-delta1_22<=0
nu_312-delta1_32<=0
nu_322-delta1_32<=0
nu_412-delta1_42<=0
nu_422-delta1_42<=0
nu_512-delta1_52<=0
nu_522-delta1_52<=0
nu_612-delta1_62<=0
nu_622-delta1_62<=0
nu_712-delta1_72<=0
nu_722-delta1_72<=0
nu_812-delta1_82<=0
nu_822-delta1_82<=0
nu_912-delta1_92<=0
nu_922-delta1_92<=0
nu_1012-delta1_102<=0
nu_1022-delta1_102<=0
nu_113-delta1_13<=0
nu_123-delta1_13<=0
nu_213-delta1_23<=0
nu_223-delta1_23<=0
nu_313-delta1_33<=0
nu_323-delta1_33<=0
nu_413-delta1_43<=0
nu_423-delta1_43<=0
```

nu_513-delta1_53<=0
nu_523-delta1_53<=0
nu_613-delta1_63<=0
nu_623-delta1_63<=0
nu_713-delta1_73<=0
nu_723-delta1_73<=0
nu_813-delta1_83<=0
nu_823-delta1_83<=0
nu_913-delta1_93<=0
nu_923-delta1_93<=0
nu_1013-delta1_103<=0
nu_1023-delta1_103<=0

\ EQUATION 8.17

nu_111-theta_NO_1<=0
nu_121-theta_NO_1<=0
nu_211-theta_NO_1<=0
nu_221-theta_NO_1<=0
nu_311-theta_NO_1<=0
nu_321-theta_NO_1<=0
nu_411-theta_NO_1<=0
nu_421-theta_NO_1<=0
nu_511-theta_NO_1<=0
nu_521-theta_NO_1<=0
nu_611-theta_NO_1<=0
nu_621-theta_NO_1<=0
nu_711-theta_NO_1<=0
nu_721-theta_NO_1<=0
nu_811-theta_NO_1<=0
nu_821-theta_NO_1<=0
nu_911-theta_NO_1<=0
nu_921-theta_NO_1<=0
nu_1011-theta_NO_1<=0
nu_1021-theta_NO_1<=0
nu_112-theta_NO_2<=0
nu_122-theta_NO_2<=0
nu_212-theta_NO_2<=0
nu_222-theta_NO_2<=0
nu_312-theta_NO_2<=0
nu_322-theta_NO_2<=0
nu_412-theta_NO_2<=0
nu_422-theta_NO_2<=0
nu_512-theta_NO_2<=0
nu_522-theta_NO_2<=0
nu_612-theta_NO_2<=0
nu_622-theta_NO_2<=0

```
nu_712-theta_NO_2<=0
nu_722-theta_NO_2<=0
nu_812-theta_NO_2<=0
nu_822-theta_NO_2<=0
nu_912-theta_NO_2<=0
nu_922-theta_NO_2<=0
nu_1012-theta_NO_2<=0
nu_1022-theta_NO_2<=0
nu_113-theta_NO_3<=0
nu_123-theta_NO_3<=0
nu_213-theta_NO_3<=0
nu_223-theta_NO_3<=0
nu_313-theta_NO_3<=0
nu_323-theta_NO_3<=0
nu_413-theta_NO_3<=0
nu_423-theta_NO_3<=0
nu_513-theta_NO_3<=0
nu_523-theta_NO_3<=0
nu_613-theta_NO_3<=0
nu_623-theta_NO_3<=0
nu_713-theta_NO_3<=0
nu_723-theta_NO_3<=0
nu_813-theta_NO_3<=0
nu_823-theta_NO_3<=0
nu_913-theta_NO_3<=0
nu_923-theta_NO_3<=0
nu_1013-theta_NO_3<=0
nu_1023-theta_NO_3<=0


\ EQUATION 8.18
4.5189nu_1011+4.542nu_911+4.565nu_811+4.5881nu_711+4.6111nu_611+4.6342nu_511+4.6
572nu_411+4.6803nu_311+4.7033nu_211+
4.9338nu_111-QP_11=>0
4.3576nu_1011+4.519nu_911+4.542nu_811+4.5651nu_711+4.5881nu_611+4.6112nu_511+4.6
342nu_411+4.6573nu_311+4.6803nu_211+
4.7034nu_111-QP_11<=0
4.5189nu_1012+4.542nu_912+4.565nu_812+4.5881nu_712+4.6111nu_612+4.6342nu_512+4.6
572nu_412+4.6803nu_312+4.7033nu_212+
4.9338nu_112-QP_12=>0
4.3576nu_1012+4.519nu_912+4.542nu_812+4.5651nu_712+4.5881nu_612+4.6112nu_512+4.6
342nu_412+4.6573nu_312+4.6803nu_212+
4.7034nu_112-QP_12<=0
4.5189nu_1013+4.542nu_913+4.565nu_813+4.5881nu_713+4.6111nu_613+4.6342nu_513+4.6
572nu_413+4.6803nu_313+4.7033nu_213+
4.9338nu_113-QP_13=>0
4.3576nu_1013+4.519nu_913+4.542nu_813+4.5651nu_713+4.5881nu_613+4.6112nu_513+4.6
342nu_413+4.6573nu_313+4.6803nu_213+
4.7034nu_113-QP_13<=0
```

4.5189nu_1021+4.542nu_921+4.565nu_821+4.5881nu_721+4.6111nu_621+4.6342nu_521+4.6572nu_421+4.6803nu_321+4.7033nu_221+
4.9338nu_121-QP_21=>0
4.3576nu_1021+4.519nu_921+4.542nu_821+4.5651nu_721+4.5881nu_621+4.6112nu_521+4.6342nu_421+4.6573nu_321+4.6803nu_221+
4.7034nu_121-QP_21<=0
4.5189nu_1022+4.542nu_922+4.565nu_822+4.5881nu_722+4.6111nu_622+4.6342nu_522+4.6572nu_422+4.6803nu_322+4.7033nu_222+
4.9338nu_122-QP_22=>0
4.3576nu_1022+4.519nu_922+4.542nu_822+4.5651nu_722+4.5881nu_622+4.6112nu_522+4.6342nu_422+4.6573nu_322+4.6803nu_222+
4.7034nu_122-QP_22<=0
4.5189nu_1023+4.542nu_923+4.565nu_823+4.5881nu_723+4.6111nu_623+4.6342nu_523+4.6572nu_423+4.6803nu_323+4.7033nu_223+
4.9338nu_123-QP_23=>0
4.3576nu_1023+4.519nu_923+4.542nu_823+4.5651nu_723+4.5881nu_623+4.6112nu_523+4.6342nu_423+4.6573nu_323+4.6803nu_223+
4.7034nu_123-QP_23<=0

\ EQUATION 8.19

QP_21+QP_11-QP_1=0
QP_22+QP_12-QP_2=0
QP_23+QP_13-QP_3=0

\ Equation 8.20
phi1_10161+phi1_10151+phi1_10141+phi1_10131+phi1_10121+phi1_10111+phi1_9161+phi1_9151+phi1_9141+phi1_9131+phi1_9121+
phi1_9111+phi1_8161+phi1_8151+phi1_8141+phi1_8131+phi1_8121+phi1_8111+phi1_7161+
phi1_7151+phi1_7141+phi1_7131+phi1_7121
+phi1_7111+phi1_6161+phi1_6151+phi1_6141+phi1_6131+phi1_6121+phi1_6111+phi1_5161
+phi1_5151+phi1_5141+phi1_5131+phi1_5121
+phi1_5111+phi1_4161+phi1_4151+phi1_4141+phi1_4131+phi1_4121+phi1_4111+phi1_3161
+phi1_3151+phi1_3141+phi1_3131+phi1_3121
+phi1_3111+phi1_2161+phi1_2151+phi1_2141+phi1_2131+phi1_2121+phi1_2111+phi1_1161
+phi1_1151+phi1_1141+phi1_1131+phi1_1121
+phi1_1111 - Beta_11 = 0
phi1_10162+phi1_10152+phi1_10142+phi1_10132+phi1_10122+phi1_10112+phi1_9162+phi1_9152+phi1_9142+phi1_9132+phi1_9122+
phi1_9112+phi1_8162+phi1_8152+phi1_8142+phi1_8132+phi1_8122+phi1_8112+phi1_7162+
phi1_7152+phi1_7142+phi1_7132+phi1_7122
+phi1_7112+phi1_6162+phi1_6152+phi1_6142+phi1_6132+phi1_6122+phi1_6112+phi1_5162
+phi1_5152+phi1_5142+phi1_5132+phi1_5122
+phi1_5112+phi1_4162+phi1_4152+phi1_4142+phi1_4132+phi1_4122+phi1_4112+phi1_3162
+phi1_3152+phi1_3142+phi1_3132+phi1_3122

+phi1_3112+phi1_2162+phi1_2152+phi1_2142+phi1_2132+phi1_2122+phi1_2112+phi1_1162
+phi1_1152+phi1_1142+phi1_1132+phi1_1122
+phi1_1112 - Beta_12 = 0
phi1_10163+phi1_10153+phi1_10143+phi1_10133+phi1_10123+phi1_10113+phi1_9163+phi1
_9153+phi1_9143+phi1_9133+phi1_9123+
phi1_9113+phi1_8163+phi1_8153+phi1_8143+phi1_8133+phi1_8123+phi1_8113+phi1_7163+
phi1_7153+phi1_7143+phi1_7133+phi1_7123
+phi1_7113+phi1_6163+phi1_6153+phi1_6143+phi1_6133+phi1_6123+phi1_6113+phi1_5163
+phi1_5153+phi1_5143+phi1_5133+phi1_5123
+phi1_5113+phi1_4163+phi1_4153+phi1_4143+phi1_4133+phi1_4123+phi1_4113+phi1_3163
+phi1_3153+phi1_3143+phi1_3133+phi1_3123
+phi1_3113+phi1_2163+phi1_2153+phi1_2143+phi1_2133+phi1_2123+phi1_2113+phi1_1163
+phi1_1153+phi1_1143+phi1_1133+phi1_1123
+phi1_1113 - Beta_13 = 0
phi1_10261+phi1_10251+phi1_10241+phi1_10231+phi1_10221+phi1_10211+phi1_9261+phi1
_9251+phi1_9241+phi1_9231+phi1_9221+
phi1_9211+phi1_8261+phi1_8251+phi1_8241+phi1_8231+phi1_8221+phi1_8211+phi1_7261+
phi1_7251+phi1_7241+phi1_7231+phi1_7221
+phi1_7211+phi1_6261+phi1_6251+phi1_6241+phi1_6231+phi1_6221+phi1_6211+phi1_5261
+phi1_5251+phi1_5241+phi1_5231+phi1_5221
+phi1_5211+phi1_4261+phi1_4251+phi1_4241+phi1_4231+phi1_4221+phi1_4211+phi1_3261
+phi1_3251+phi1_3241+phi1_3231+phi1_3221
+phi1_3211+phi1_2261+phi1_2251+phi1_2241+phi1_2231+phi1_2221+phi1_2211+phi1_1261
+phi1_1251+phi1_1241+phi1_1231+phi1_1221
+phi1_1211 - Beta_21 = 0
phi1_10262+phi1_10252+phi1_10242+phi1_10232+phi1_10222+phi1_10212+phi1_9262+phi1
_9252+phi1_9242+phi1_9232+phi1_9222+
phi1_9212+phi1_8262+phi1_8252+phi1_8242+phi1_8232+phi1_8222+phi1_8212+phi1_7262+
phi1_7252+phi1_7242+phi1_7232+phi1_7222
+phi1_7212+phi1_6262+phi1_6252+phi1_6242+phi1_6232+phi1_6222+phi1_6212+phi1_5262
+phi1_5252+phi1_5242+phi1_5232+phi1_5222
+phi1_5212+phi1_4262+phi1_4252+phi1_4242+phi1_4232+phi1_4222+phi1_4212+phi1_3262
+phi1_3252+phi1_3242+phi1_3232+phi1_3222
+phi1_3212+phi1_2262+phi1_2252+phi1_2242+phi1_2232+phi1_2222+phi1_2212+phi1_1262
+phi1_1252+phi1_1242+phi1_1232+phi1_1222
+phi1_1212 - Beta_22 = 0
phi1_10263+phi1_10253+phi1_10243+phi1_10233+phi1_10223+phi1_10213+phi1_9263+phi1
_9253+phi1_9243+phi1_9233+phi1_9223+
phi1_9213+phi1_8263+phi1_8253+phi1_8243+phi1_8233+phi1_8223+phi1_8213+phi1_7263+
phi1_7253+phi1_7243+phi1_7233+phi1_7223
+phi1_7213+phi1_6263+phi1_6253+phi1_6243+phi1_6233+phi1_6223+phi1_6213+phi1_5263
+phi1_5253+phi1_5243+phi1_5233+phi1_5223
+phi1_5213+phi1_4263+phi1_4253+phi1_4243+phi1_4233+phi1_4223+phi1_4213+phi1_3263
+phi1_3253+phi1_3243+phi1_3233+phi1_3223
+phi1_3213+phi1_2263+phi1_2253+phi1_2243+phi1_2233+phi1_2223+phi1_2213+phi1_1263
+phi1_1253+phi1_1243+phi1_1233+phi1_1223
+phi1_1213 - Beta_23 = 0

\ Equation 8.21

```
nu_1011+nu_911+nu_811+nu_711+nu_611+nu_511+nu_411+nu_311+nu_211+nu_111-
Alpha_11=0
nu_1012+nu_912+nu_812+nu_712+nu_612+nu_512+nu_412+nu_312+nu_212+nu_112-
Alpha_12=0
nu_1013+nu_913+nu_813+nu_713+nu_613+nu_513+nu_413+nu_313+nu_213+nu_113-
Alpha_13=0
nu_1021+nu_921+nu_821+nu_721+nu_621+nu_521+nu_421+nu_321+nu_221+nu_121-
Alpha_21=0
nu_1022+nu_922+nu_822+nu_722+nu_622+nu_522+nu_422+nu_322+nu_222+nu_122-
Alpha_22=0
nu_1023+nu_923+nu_823+nu_723+nu_623+nu_523+nu_423+nu_323+nu_223+nu_123-
Alpha_23=0


\ Equation 8.22

Alpha_11+Beta_11 <= 1
Alpha_12+Beta_12 <= 1
Alpha_13+Beta_13 <= 1
Alpha_21+Beta_21 <= 1
Alpha_22+Beta_22 <= 1
Alpha_23+Beta_23 <= 1


\ Equation 8.23

Beta_21+Beta_11-Turbine_1=0
Beta_22+Beta_12-Turbine_2=0
Beta_23+Beta_13-Turbine_3=0



\ Equation 8.24

Alpha_21+Alpha_11-Pump_1=0
Alpha_22+Alpha_12-Pump_2=0
Alpha_23+Alpha_13-Pump_3=0

\ Equation 8.25

Turbine_1-2Produce_1<=0
Turbine_2-2Produce_2<=0
Turbine_3-2Produce_3<=0


\ Equation 8.26

Pump_1+2Produce_1<=2
Pump_2+2Produce_2<=2
Pump_3+2Produce_3<=2
```

```
\ Equation 8.27

FB1_1-Spill1_NO_1-Spill1_YES_1=0
FB1_2-Spill1_NO_2-Spill1_YES_2=0
FB1_3-Spill1_NO_3-Spill1_YES_3=0



\ Equation 8.28

787theta_NO_1-Spill1_NO_1<=0
787theta_NO_2-Spill1_NO_2<=0
787theta_NO_3-Spill1_NO_3<=0
Spill1_NO_1-795theta_NO_1<=0
Spill1_NO_2-795theta_NO_2<=0
Spill1_NO_3-795theta_NO_3<=0

\ Equation 8.29

795.0001theta_YES_1-Spill1_YES_1<=0
795.0001theta_YES_2-Spill1_YES_2<=0
795.0001theta_YES_3-Spill1_YES_3<=0
Spill1_YES_1-811theta_YES_1<=0
Spill1_YES_2-811theta_YES_2<=0
Spill1_YES_3-811theta_YES_3<=0



\ Equation 8.31

811theta_31+805theta_21+798theta_11-SPILL1_YES_1<=0
811theta_32+805theta_22+798theta_12-SPILL1_YES_2<=0
811theta_33+805theta_23+798theta_13-SPILL1_YES_3<=0

808theta_31+801.5theta_21+796.5theta_11-SPILL1_YES_1=>0
808theta_32+801.5theta_22+796.5theta_12-SPILL1_YES_2=>0
808theta_33+801.5theta_23+796.5theta_13-SPILL1_YES_3=>0


\ Equation 8.32
33.059theta_31+11.073theta_21+1.474theta_11-UnContRel_1=0
33.059theta_32+11.073theta_22+1.474theta_12-UnContRel_2=0
33.059theta_33+11.073theta_23+1.474theta_13-UnContRel_3=0


\ Equation 8.33

theta_NO_1+theta_YES_1=1
```

```
theta_NO_2+theta_YES_2=1
theta_NO_3+theta_YES_3=1


\ Equation 8.34

theta_31+theta_21+theta_11-theta_YES_1=0
theta_32+theta_22+theta_12-theta_YES_2=0
theta_33+theta_23+theta_13-theta_YES_3=0


\ Equation 8.36

74.75delta2_101+73delta2_91+71.25delta2_81+69.5delta2_71+67.75delta2_61+66delta2_51+6
4.25delta2_41+62.5delta2_31+60.75delta2_21+59delta2_11
-H2_1<=0
74.75delta2_102+73delta2_92+71.25delta2_82+69.5delta2_72+67.75delta2_62+66delta2_52+6
4.25delta2_42+62.5delta2_32+60.75delta2_22+59delta2_12
-H2_2<=0
74.75delta2_103+73delta2_93+71.25delta2_83+69.5delta2_73+67.75delta2_63+66delta2_53+6
4.25delta2_43+62.5delta2_33+60.75delta2_23+59delta2_13
-H2_3<=0
76.49delta2_101+74.74delta2_91+72.99delta2_81+71.24delta2_71+69.49delta2_61+67.74delta2
_51+65.99delta2_41+64.24delta2_31+62.49delta2_21+
60.74delta2_11-H2_1=>0
76.49delta2_102+74.74delta2_92+72.99delta2_82+71.24delta2_72+69.49delta2_62+67.74delta2
_52+65.99delta2_42+64.24delta2_32+62.49delta2_22+
60.74delta2_12-H2_2=>0
76.49delta2_103+74.74delta2_93+72.99delta2_83+71.24delta2_73+69.49delta2_63+67.74delta2
_53+65.99delta2_43+64.24delta2_33+62.49delta2_23+
60.74delta2_13-H2_3=>0

\ Equation 8.37

delta2_101+delta2_91+delta2_81+delta2_71+delta2_61+delta2_51+delta2_41+delta2_31+delta
2_21+delta2_11=1
delta2_102+delta2_92+delta2_82+delta2_72+delta2_62+delta2_52+delta2_42+delta2_32+delta
2_22+delta2_12=1
delta2_103+delta2_93+delta2_83+delta2_73+delta2_63+delta2_53+delta2_43+delta2_33+delta
2_23+delta2_13=1

\ Equation 8.38

FB2_1-TR2_1-H2_1=0
FB2_2-TR2_2-H2_2=0
FB2_3-TR2_3-H2_3=0

\Equation 8.40

phi2_1161+phi2_1151+phi2_1141+phi2_1131+phi2_1121+phi2_1111-delta2_11<=0
```

phi2_2161+phi2_2151+phi2_2141+phi2_2131+phi2_2121+phi2_2111-delta2_21<=0
phi2_3161+phi2_3151+phi2_3141+phi2_3131+phi2_3121+phi2_3111-delta2_31<=0
phi2_4161+phi2_4151+phi2_4141+phi2_4131+phi2_4121+phi2_4111-delta2_41<=0
phi2_5161+phi2_5151+phi2_5141+phi2_5131+phi2_5121+phi2_5111-delta2_51<=0
phi2_6161+phi2_6151+phi2_6141+phi2_6131+phi2_6121+phi2_6111-delta2_61<=0
phi2_7161+phi2_7151+phi2_7141+phi2_7131+phi2_7121+phi2_7111-delta2_71<=0
phi2_8161+phi2_8151+phi2_8141+phi2_8131+phi2_8121+phi2_8111-delta2_81<=0
phi2_9161+phi2_9151+phi2_9141+phi2_9131+phi2_9121+phi2_9111-delta2_91<=0
phi2_10161+phi2_10151+phi2_10141+phi2_10131+phi2_10121+phi2_10111-delta2_101<=0
phi2_1261+phi2_1251+phi2_1241+phi2_1231+phi2_1221+phi2_1211-delta2_11<=0
phi2_2261+phi2_2251+phi2_2241+phi2_2231+phi2_2221+phi2_2211-delta2_21<=0
phi2_3261+phi2_3251+phi2_3241+phi2_3231+phi2_3221+phi2_3211-delta2_31<=0
phi2_4261+phi2_4251+phi2_4241+phi2_4231+phi2_4221+phi2_4211-delta2_41<=0
phi2_5261+phi2_5251+phi2_5241+phi2_5231+phi2_5221+phi2_5211-delta2_51<=0
phi2_6261+phi2_6251+phi2_6241+phi2_6231+phi2_6221+phi2_6211-delta2_61<=0
phi2_7261+phi2_7251+phi2_7241+phi2_7231+phi2_7221+phi2_7211-delta2_71<=0
phi2_8261+phi2_8251+phi2_8241+phi2_8231+phi2_8221+phi2_8211-delta2_81<=0
phi2_9261+phi2_9251+phi2_9241+phi2_9231+phi2_9221+phi2_9211-delta2_91<=0
phi2_10261+phi2_10251+phi2_10241+phi2_10231+phi2_10221+phi2_10211-delta2_101<=0
phi2_1162+phi2_1152+phi2_1142+phi2_1132+phi2_1122+phi2_1112-delta2_12<=0
phi2_2162+phi2_2152+phi2_2142+phi2_2132+phi2_2122+phi2_2112-delta2_22<=0
phi2_3162+phi2_3152+phi2_3142+phi2_3132+phi2_3122+phi2_3112-delta2_32<=0
phi2_4162+phi2_4152+phi2_4142+phi2_4132+phi2_4122+phi2_4112-delta2_42<=0
phi2_5162+phi2_5152+phi2_5142+phi2_5132+phi2_5122+phi2_5112-delta2_52<=0
phi2_6162+phi2_6152+phi2_6142+phi2_6132+phi2_6122+phi2_6112-delta2_62<=0
phi2_7162+phi2_7152+phi2_7142+phi2_7132+phi2_7122+phi2_7112-delta2_72<=0
phi2_8162+phi2_8152+phi2_8142+phi2_8132+phi2_8122+phi2_8112-delta2_82<=0
phi2_9162+phi2_9152+phi2_9142+phi2_9132+phi2_9122+phi2_9112-delta2_92<=0
phi2_10162+phi2_10152+phi2_10142+phi2_10132+phi2_10122+phi2_10112-delta2_102<=0
phi2_1262+phi2_1252+phi2_1242+phi2_1232+phi2_1222+phi2_1212-delta2_12<=0
phi2_2262+phi2_2252+phi2_2242+phi2_2232+phi2_2222+phi2_2212-delta2_22<=0
phi2_3262+phi2_3252+phi2_3242+phi2_3232+phi2_3222+phi2_3212-delta2_32<=0
phi2_4262+phi2_4252+phi2_4242+phi2_4232+phi2_4222+phi2_4212-delta2_42<=0
phi2_5262+phi2_5252+phi2_5242+phi2_5232+phi2_5222+phi2_5212-delta2_52<=0
phi2_6262+phi2_6252+phi2_6242+phi2_6232+phi2_6222+phi2_6212-delta2_62<=0
phi2_7262+phi2_7252+phi2_7242+phi2_7232+phi2_7222+phi2_7212-delta2_72<=0
phi2_8262+phi2_8252+phi2_8242+phi2_8232+phi2_8222+phi2_8212-delta2_82<=0
phi2_9262+phi2_9252+phi2_9242+phi2_9232+phi2_9222+phi2_9212-delta2_92<=0
phi2_10262+phi2_10252+phi2_10242+phi2_10232+phi2_10222+phi2_10212-delta2_102<=0
phi2_1163+phi2_1153+phi2_1143+phi2_1133+phi2_1123+phi2_1113-delta2_13<=0
phi2_2163+phi2_2153+phi2_2143+phi2_2133+phi2_2123+phi2_2113-delta2_23<=0
phi2_3163+phi2_3153+phi2_3143+phi2_3133+phi2_3123+phi2_3113-delta2_33<=0
phi2_4163+phi2_4153+phi2_4143+phi2_4133+phi2_4123+phi2_4113-delta2_43<=0
phi2_5163+phi2_5153+phi2_5143+phi2_5133+phi2_5123+phi2_5113-delta2_53<=0
phi2_6163+phi2_6153+phi2_6143+phi2_6133+phi2_6123+phi2_6113-delta2_63<=0
phi2_7163+phi2_7153+phi2_7143+phi2_7133+phi2_7123+phi2_7113-delta2_73<=0
phi2_8163+phi2_8153+phi2_8143+phi2_8133+phi2_8123+phi2_8113-delta2_83<=0
phi2_9163+phi2_9153+phi2_9143+phi2_9133+phi2_9123+phi2_9113-delta2_93<=0
phi2_10163+phi2_10153+phi2_10143+phi2_10133+phi2_10123+phi2_10113-delta2_103<=0
phi2_1263+phi2_1253+phi2_1243+phi2_1233+phi2_1223+phi2_1213-delta2_13<=0

phi2_2263+phi2_2253+phi2_2243+phi2_2233+phi2_2223+phi2_2213-delta2_23<=0
phi2_3263+phi2_3253+phi2_3243+phi2_3233+phi2_3223+phi2_3213-delta2_33<=0
phi2_4263+phi2_4253+phi2_4243+phi2_4233+phi2_4223+phi2_4213-delta2_43<=0
phi2_5263+phi2_5253+phi2_5243+phi2_5233+phi2_5223+phi2_5213-delta2_53<=0
phi2_6263+phi2_6253+phi2_6243+phi2_6233+phi2_6223+phi2_6213-delta2_63<=0
phi2_7263+phi2_7253+phi2_7243+phi2_7233+phi2_7223+phi2_7213-delta2_73<=0
phi2_8263+phi2_8253+phi2_8243+phi2_8233+phi2_8223+phi2_8213-delta2_83<=0
phi2_9263+phi2_9253+phi2_9243+phi2_9233+phi2_9223+phi2_9213-delta2_93<=0
phi2_10263+phi2_10253+phi2_10243+phi2_10233+phi2_10223+phi2_10213-delta2_103<=0

\ Equation 8.42

310.53phi2_10161+262.59phi2_10151+240.15phi2_10141+217.19phi2_10131+194.21phi2_101
21+129.16phi2_10111+303.34phi2_9161+256.52phi2_9151+
234.59phi2_9141+212.17phi2_9131+189.72phi2_9121+126.17phi2_9111+296.15phi2_8161+25
0.44phi2_8151+229.04phi2_8141+207.14phi2_8131+
185.22phi2_8121+123.18phi2_8111+288.97phi2_7161+244.36phi2_7151+223.48phi2_7141+20
2.12phi2_7131+180.73phi2_7121+120.19phi2_7111+
281.78phi2_6161+238.29phi2_6151+217.92phi2_6141+197.09phi2_6131+176.23phi2_6121+11
7.2phi2_6111+274.59phi2_5161+232.21phi2_5151+
212.36phi2_5141+192.06phi2_5131+171.74phi2_5121+114.21phi2_5111+267.41phi2_4161+22
6.13phi2_4151+206.81phi2_4141+187.04phi2_4131+
167.24phi2_4121+111.23phi2_4111+260.22phi2_3161+220.06phi2_3151+201.25phi2_3141+18
2.01phi2_3131+162.75phi2_3121+108.24phi2_3111+
253.04phi2_2161+213.98phi2_2151+195.69phi2_2141+176.98phi2_2131+158.26phi2_2121+10
5.25phi2_2111+245.85phi2_1161+207.9phi2_1151+
190.13phi2_1141+171.96phi2_1131+153.76phi2_1121+102.26phi2_1111-PT2_11=0
310.53phi2_10162+262.59phi2_10152+240.15phi2_10142+217.19phi2_10132+194.21phi2_101
22+129.16phi2_10112+303.34phi2_9162+256.52phi2_9152+
234.59phi2_9142+212.17phi2_9132+189.72phi2_9122+126.17phi2_9112+296.15phi2_8162+25
0.44phi2_8152+229.04phi2_8142+207.14phi2_8132+
185.22phi2_8122+123.18phi2_8112+288.97phi2_7162+244.36phi2_7152+223.48phi2_7142+20
2.12phi2_7132+180.73phi2_7122+120.19phi2_7112+
281.78phi2_6162+238.29phi2_6152+217.92phi2_6142+197.09phi2_6132+176.23phi2_6122+11
7.2phi2_6112+274.59phi2_5162+232.21phi2_5152+
212.36phi2_5142+192.06phi2_5132+171.74phi2_5122+114.21phi2_5112+267.41phi2_4162+22
6.13phi2_4152+206.81phi2_4142+187.04phi2_4132+
167.24phi2_4122+111.23phi2_4112+260.22phi2_3162+220.06phi2_3152+201.25phi2_3142+18
2.01phi2_3132+162.75phi2_3122+108.24phi2_3112+
253.04phi2_2162+213.98phi2_2152+195.69phi2_2142+176.98phi2_2132+158.26phi2_2122+10
5.25phi2_2112+245.85phi2_1162+207.9phi2_1152+
190.13phi2_1142+171.96phi2_1132+153.76phi2_1122+102.26phi2_1112-PT2_12=0
310.53phi2_10163+262.59phi2_10153+240.15phi2_10143+217.19phi2_10133+194.21phi2_101
23+129.16phi2_10113+303.34phi2_9163+256.52phi2_9153+
234.59phi2_9143+212.17phi2_9133+189.72phi2_9123+126.17phi2_9113+296.15phi2_8163+25
0.44phi2_8153+229.04phi2_8143+207.14phi2_8133+
185.22phi2_8123+123.18phi2_8113+288.97phi2_7163+244.36phi2_7153+223.48phi2_7143+20
2.12phi2_7133+180.73phi2_7123+120.19phi2_7113+
281.78phi2_6163+238.29phi2_6153+217.92phi2_6143+197.09phi2_6133+176.23phi2_6123+11
7.2phi2_6113+274.59phi2_5163+232.21phi2_5153+

212.36phi2_5143+192.06phi2_5133+171.74phi2_5123+114.21phi2_5113+267.41phi2_4163+22
6.13phi2_4153+206.81phi2_4143+187.04phi2_4133+
167.24phi2_4123+111.23phi2_4113+260.22phi2_3163+220.06phi2_3153+201.25phi2_3143+18
2.01phi2_3133+162.75phi2_3123+108.24phi2_3113+
253.04phi2_2163+213.98phi2_2153+195.69phi2_2143+176.98phi2_2133+158.26phi2_2123+10
5.25phi2_2113+245.85phi2_1163+207.9phi2_1153+
190.13phi2_1143+171.96phi2_1133+153.76phi2_1123+102.26phi2_1113-PT2_13=0
310.53phi2_10261+262.59phi2_10251+240.15phi2_10241+217.19phi2_10231+194.21phi2_102
21+129.16phi2_10211+303.34phi2_9261+256.52phi2_9251+
234.59phi2_9241+212.17phi2_9231+189.72phi2_9221+126.17phi2_9211+296.15phi2_8261+25
0.44phi2_8251+229.04phi2_8241+207.14phi2_8231
+185.22phi2_8221+123.18phi2_8211+288.97phi2_7261+244.36phi2_7251+223.48phi2_7241+
202.12phi2_7231+180.73phi2_7221+120.19phi2_7211
+281.78phi2_6261+238.29phi2_6251+217.92phi2_6241+197.09phi2_6231+176.23phi2_6221+
117.2phi2_6211+274.59phi2_5261+232.21phi2_5251+
212.36phi2_5241+192.06phi2_5231+171.74phi2_5221+114.21phi2_5211+267.41phi2_4261+22
6.13phi2_4251+206.81phi2_4241+187.04phi2_4231
+167.24phi2_4221+111.23phi2_4211+260.22phi2_3261+220.06phi2_3251+201.25phi2_3241+
182.01phi2_3231+162.75phi2_3221+108.24phi2_3211
+253.04phi2_2261+213.98phi2_2251+195.69phi2_2241+176.98phi2_2231+158.26phi2_2221+
105.25phi2_2211+245.85phi2_1261+207.9phi2_1251+
190.13phi2_1241+171.96phi2_1231+153.76phi2_1221+102.26phi2_1211-PT2_21=0
310.53phi2_10262+262.59phi2_10252+240.15phi2_10242+217.19phi2_10232+194.21phi2_102
22+129.16phi2_10212+303.34phi2_9262+256.52phi2_9252+
234.59phi2_9242+212.17phi2_9232+189.72phi2_9222+126.17phi2_9212+296.15phi2_8262+25
0.44phi2_8252+229.04phi2_8242+207.14phi2_8232+
185.22phi2_8222+123.18phi2_8212+288.97phi2_7262+244.36phi2_7252+223.48phi2_7242+20
2.12phi2_7232+180.73phi2_7222+120.19phi2_7212+
281.78phi2_6262+238.29phi2_6252+217.92phi2_6242+197.09phi2_6232+176.23phi2_6222+11
7.2phi2_6212+274.59phi2_5262+232.21phi2_5252+
212.36phi2_5242+192.06phi2_5232+171.74phi2_5222+114.21phi2_5212+267.41phi2_4262+22
6.13phi2_4252+206.81phi2_4242+187.04phi2_4232+
167.24phi2_4222+111.23phi2_4212+260.22phi2_3262+220.06phi2_3252+201.25phi2_3242+18
2.01phi2_3232+162.75phi2_3222+108.24phi2_3212+
253.04phi2_2262+213.98phi2_2252+195.69phi2_2242+176.98phi2_2232+158.26phi2_2222+10
5.25phi2_2212+245.85phi2_1262+207.9phi2_1252+
190.13phi2_1242+171.96phi2_1232+153.76phi2_1222+102.26phi2_1212-PT2_22=0
310.53phi2_10263+262.59phi2_10253+240.15phi2_10243+217.19phi2_10233+194.21phi2_102
23+129.16phi2_10213+303.34phi2_9263+256.52phi2_9253
+234.59phi2_9243+212.17phi2_9233+189.72phi2_9223+126.17phi2_9213+296.15phi2_8263+
250.44phi2_8253+229.04phi2_8243+207.14phi2_8233+
185.22phi2_8223+123.18phi2_8213+288.97phi2_7263+244.36phi2_7253+223.48phi2_7243+20
2.12phi2_7233+180.73phi2_7223+120.19phi2_7213+
281.78phi2_6263+238.29phi2_6253+217.92phi2_6243+197.09phi2_6233+176.23phi2_6223+11
7.2phi2_6213+274.59phi2_5263+232.21phi2_5253+
212.36phi2_5243+192.06phi2_5233+171.74phi2_5223+114.21phi2_5213+267.41phi2_4263+22
6.13phi2_4253+206.81phi2_4243+187.04phi2_4233+
167.24phi2_4223+111.23phi2_4213+260.22phi2_3263+220.06phi2_3253+201.25phi2_3243+18
2.01phi2_3233+162.75phi2_3223+108.24phi2_3213+

253.04phi2_2263+213.98phi2_2253+195.69phi2_2243+176.98phi2_2233+158.26phi2_2223+10
5.25phi2_2213+245.85phi2_1263+207.9phi2_1253+
190.13phi2_1243+171.96phi2_1233+153.76phi2_1223+102.26phi2_1213-PT2_23=0

\ Equation 8.43

PT2_21+PT2_11-PT2_1=0
PT2_22+PT2_12-PT2_2=0
PT2_23+PT2_13-PT2_3=0

\ Equation 8.44

4.2501phi2_10161+4.0501phi2_10151+3.8501phi2_10141+3.6501phi2_10131+3.4501phi2_101
21+2.45phi2_10111+4.2501phi2_9161+4.0501phi2_9151+
3.8501phi2_9141+3.6501phi2_9131+3.4501phi2_9121+2.45phi2_9111+4.2501phi2_8161+4.05
01phi2_8151+3.8501phi2_8141+3.6501phi2_8131+
3.4501phi2_8121+2.45phi2_8111+4.2501phi2_7161+4.0501phi2_7151+3.8501phi2_7141+3.65
01phi2_7131+3.4501phi2_7121+2.45phi2_7111+
4.2501phi2_6161+4.0501phi2_6151+3.8501phi2_6141+3.6501phi2_6131+3.4501phi2_6121+2.
45phi2_6111+4.2501phi2_5161+4.0501phi2_5151+
3.8501phi2_5141+3.6501phi2_5131+3.4501phi2_5121+2.45phi2_5111+4.2501phi2_4161+4.05
01phi2_4151+3.8501phi2_4141+3.6501phi2_4131+
3.4501phi2_4121+2.45phi2_4111+4.2501phi2_3161+4.0501phi2_3151+3.8501phi2_3141+3.65
01phi2_3131+3.4501phi2_3121+2.45phi2_3111+
4.2501phi2_2161+4.0501phi2_2151+3.8501phi2_2141+3.6501phi2_2131+3.4501phi2_2121+2.
45phi2_2111+4.2501phi2_1161+4.0501phi2_1151+
3.8501phi2_1141+3.6501phi2_1131+3.4501phi2_1121+2.45phi2_1111-QT2_11<=0

5phi2_10161+4.25phi2_10151+4.05phi2_10141+3.85phi2_10131+3.65phi2_10121+3.45phi2_1
0111+5phi2_9161+4.25phi2_9151+4.05phi2_9141+
3.85phi2_9131+3.65phi2_9121+3.45phi2_9111+5phi2_8161+4.25phi2_8151+4.05phi2_8141+3
.85phi2_8131+3.65phi2_8121+3.45phi2_8111+
5phi2_7161+4.25phi2_7151+4.05phi2_7141+3.85phi2_7131+3.65phi2_7121+3.45phi2_7111+5
phi2_6161+4.25phi2_6151+4.05phi2_6141+3.85phi2_6131+
3.65phi2_6121+3.45phi2_6111+5phi2_5161+4.25phi2_5151+4.05phi2_5141+3.85phi2_5131+3
.65phi2_5121+3.45phi2_5111+5phi2_4161+4.25phi2_4151+
4.05phi2_4141+3.85phi2_4131+3.65phi2_4121+3.45phi2_4111+5phi2_3161+4.25phi2_3151+4
.05phi2_3141+3.85phi2_3131+3.65phi2_3121+3.45phi2_3111+
5phi2_2161+4.25phi2_2151+4.05phi2_2141+3.85phi2_2131+3.65phi2_2121+3.45phi2_2111+5
phi2_1161+4.25phi2_1151+4.05phi2_1141+3.85phi2_1131+
3.65phi2_1121+3.45phi2_1111-QT2_11=>0

4.2501phi2_10162+4.0501phi2_10152+3.8501phi2_10142+3.6501phi2_10132+3.4501phi2_101
22+2.45phi2_10112+4.2501phi2_9162+4.0501phi2_9152
+3.8501phi2_9142+3.6501phi2_9132+3.4501phi2_9122+2.45phi2_9112+4.2501phi2_8162+4.0
501phi2_8152+3.8501phi2_8142+3.6501phi2_8132+
3.4501phi2_8122+2.45phi2_8112+4.2501phi2_7162+4.0501phi2_7152+3.8501phi2_7142+3.65
01phi2_7132+3.4501phi2_7122+2.45phi2_7112+
4.2501phi2_6162+4.0501phi2_6152+3.8501phi2_6142+3.6501phi2_6132+3.4501phi2_6122+2.
45phi2_6112+4.2501phi2_5162+4.0501phi2_5152+

3.8501phi2_5142+3.6501phi2_5132+3.4501phi2_5122+2.45phi2_5112+4.2501phi2_4162+4.0501phi2_4152+3.8501phi2_4142+3.6501phi2_4132+3.4501phi2_4122+2.45phi2_4112+4.2501phi2_3162+4.0501phi2_3152+3.8501phi2_3142+3.6501phi2_3132+3.4501phi2_3122+2.45phi2_3112+4.2501phi2_2162+4.0501phi2_2152+3.8501phi2_2142+3.6501phi2_2132+3.4501phi2_2122+2.45phi2_2112+4.2501phi2_1162+4.0501phi2_1152+3.8501phi2_1142+3.6501phi2_1132+3.4501phi2_1122+2.45phi2_1112-QT2_12<=0

5phi2_10162+4.25phi2_10152+4.05phi2_10142+3.85phi2_10132+3.65phi2_10122+3.45phi2_10112+5phi2_9162+4.25phi2_9152+4.05phi2_9142+3.85phi2_9132+3.65phi2_9122+3.45phi2_9112+5phi2_8162+4.25phi2_8152+4.05phi2_8142+3.85phi2_8132+3.65phi2_8122+3.45phi2_8112+5phi2_7162+4.25phi2_7152+4.05phi2_7142+3.85phi2_7132+3.65phi2_7122+3.45phi2_7112+5phi2_6162+4.25phi2_6152+4.05phi2_6142+3.85phi2_6132+3.65phi2_6122+3.45phi2_6112+5phi2_5162+4.25phi2_5152+4.05phi2_5142+3.85phi2_5132+3.65phi2_5122+3.45phi2_5112+5phi2_4162+4.25phi2_4152+4.05phi2_4142+3.85phi2_4132+3.65phi2_4122+3.45phi2_4112+5phi2_3162+4.25phi2_3152+4.05phi2_3142+3.85phi2_3132+3.65phi2_3122+3.45phi2_3112+5phi2_2162+4.25phi2_2152+4.05phi2_2142+3.85phi2_2132+3.65phi2_2122+3.45phi2_2112+5phi2_1162+4.25phi2_1152+4.05phi2_1142+3.85phi2_1132+3.65phi2_1122+3.45phi2_1112-QT2_12=>0

4.2501phi2_10163+4.0501phi2_10153+3.8501phi2_10143+3.6501phi2_10133+3.4501phi2_10123+2.45phi2_10113+4.2501phi2_9163+4.0501phi2_9153+3.8501phi2_9143+3.6501phi2_9133+3.4501phi2_9123+2.45phi2_9113+4.2501phi2_8163+4.0501phi2_8153+3.8501phi2_8143+3.6501phi2_8133+3.4501phi2_8123+2.45phi2_8113+4.2501phi2_7163+4.0501phi2_7153+3.8501phi2_7143+3.6501phi2_7133+3.4501phi2_7123+2.45phi2_7113+4.2501phi2_6163+4.0501phi2_6153+3.8501phi2_6143+3.6501phi2_6133+3.4501phi2_6123+2.45phi2_6113+4.2501phi2_5163+4.0501phi2_5153+3.8501phi2_5143+3.6501phi2_5133+3.4501phi2_5123+2.45phi2_5113+4.2501phi2_4163+4.0501phi2_4153+3.8501phi2_4143+3.6501phi2_4133+3.4501phi2_4123+2.45phi2_4113+4.2501phi2_3163+4.0501phi2_3153+3.8501phi2_3143+3.6501phi2_3133+3.4501phi2_3123+2.45phi2_3113+4.2501phi2_2163+4.0501phi2_2153+3.8501phi2_2143+3.6501phi2_2133+3.4501phi2_2123+2.45phi2_2113+4.2501phi2_1163+4.0501phi2_1153+3.8501phi2_1143+3.6501phi2_1133+3.4501phi2_1123+2.45phi2_1113-QT2_13<=0

5phi2_10163+4.25phi2_10153+4.05phi2_10143+3.85phi2_10133+3.65phi2_10123+3.45phi2_10113+5phi2_9163+4.25phi2_9153+4.05phi2_9143+3.85phi2_9133+3.65phi2_9123+3.45phi2_9113+5phi2_8163+4.25phi2_8153+4.05phi2_8143+3.85phi2_8133+3.65phi2_8123+3.45phi2_8113+5phi2_7163+4.25phi2_7153+4.05phi2_7143+3.85phi2_7133+3.65phi2_7123+3.45phi2_7113+5phi2_6163+4.25phi2_6153+4.05phi2_6143+3.85phi2_6133+3.65phi2_6123+3.45phi2_6113+5phi2_5163+4.25phi2_5153+4.05phi2_5143+3.85phi2_5133+3.65phi2_5123+3.45phi2_5113+5phi2_4163+4.25phi2_4153+4.05phi2_4143+3.85phi2_4133+3.65phi2_4123+3.45phi2_4113+5phi2_3163+4.25phi2_3153+4.05phi2_3143+3.85phi2_3133+3.65phi2_3123+3.45phi2_3113

+5phi2_2163+4.25phi2_2153+4.05phi2_2143+3.85phi2_2133+3.65phi2_2123+3.45phi2_2113+
5phi2_1163+4.25phi2_1153+4.05phi2_1143+3.85phi2_1133+
3.65phi2_1123+3.45phi2_1113-QT2_13=>0

4.2501phi2_10261+4.0501phi2_10251+3.8501phi2_10241+3.6501phi2_10231+3.4501phi2_102
21+2.45phi2_10211+4.2501phi2_9261+4.0501phi2_9251+
3.8501phi2_9241+3.6501phi2_9231+3.4501phi2_9221+2.45phi2_9211+4.2501phi2_8261+4.05
01phi2_8251+3.8501phi2_8241+3.6501phi2_8231+
3.4501phi2_8221+2.45phi2_8211+4.2501phi2_7261+4.0501phi2_7251+3.8501phi2_7241+3.65
01phi2_7231+3.4501phi2_7221+2.45phi2_7211+
4.2501phi2_6261+4.0501phi2_6251+3.8501phi2_6241+3.6501phi2_6231+3.4501phi2_6221+2.
45phi2_6211+4.2501phi2_5261+4.0501phi2_5251+
3.8501phi2_5241+3.6501phi2_5231+3.4501phi2_5221+2.45phi2_5211+4.2501phi2_4261+4.05
01phi2_4251+3.8501phi2_4241+3.6501phi2_4231+
3.4501phi2_4221+2.45phi2_4211+4.2501phi2_3261+4.0501phi2_3251+3.8501phi2_3241+3.65
01phi2_3231+3.4501phi2_3221+2.45phi2_3211+
4.2501phi2_2261+4.0501phi2_2251+3.8501phi2_2241+3.6501phi2_2231+3.4501phi2_2221+2.
45phi2_2211+4.2501phi2_1261+4.0501phi2_1251+
3.8501phi2_1241+3.6501phi2_1231+3.4501phi2_1221+2.45phi2_1211-QT2_21<=0

5phi2_10261+4.25phi2_10251+4.05phi2_10241+3.85phi2_10231+3.65phi2_10221+3.45phi2_1
0211+5phi2_9261+4.25phi2_9251+4.05phi2_9241+
3.85phi2_9231+3.65phi2_9221+3.45phi2_9211+5phi2_8261+4.25phi2_8251+4.05phi2_8241+3
.85phi2_8231+3.65phi2_8221+3.45phi2_8211+
5phi2_7261+4.25phi2_7251+4.05phi2_7241+3.85phi2_7231+3.65phi2_7221+3.45phi2_7211+5
phi2_6261+4.25phi2_6251+4.05phi2_6241+
3.85phi2_6231+3.65phi2_6221+3.45phi2_6211+5phi2_5261+4.25phi2_5251+4.05phi2_5241+3
.85phi2_5231+3.65phi2_5221+3.45phi2_5211+
5phi2_4261+4.25phi2_4251+4.05phi2_4241+3.85phi2_4231+3.65phi2_4221+3.45phi2_4211+5
phi2_3261+4.25phi2_3251+4.05phi2_3241+
3.85phi2_3231+3.65phi2_3221+3.45phi2_3211+5phi2_2261+4.25phi2_2251+4.05phi2_2241+3
.85phi2_2231+3.65phi2_2221+3.45phi2_2211+
5phi2_1261+4.25phi2_1251+4.05phi2_1241+3.85phi2_1231+3.65phi2_1221+3.45phi2_1211-
QT2_21=>0

4.2501phi2_10262+4.0501phi2_10252+3.8501phi2_10242+3.6501phi2_10232+3.4501phi2_102
22+2.45phi2_10212+4.2501phi2_9262+4.0501phi2_9252+
3.8501phi2_9242+3.6501phi2_9232+3.4501phi2_9222+2.45phi2_9212+4.2501phi2_8262+4.05
01phi2_8252+3.8501phi2_8242+3.6501phi2_8232+
3.4501phi2_8222+2.45phi2_8212+4.2501phi2_7262+4.0501phi2_7252+3.8501phi2_7242+3.65
01phi2_7232+3.4501phi2_7222+2.45phi2_7212+
4.2501phi2_6262+4.0501phi2_6252+3.8501phi2_6242+3.6501phi2_6232+3.4501phi2_6222+2.
45phi2_6212+4.2501phi2_5262+4.0501phi2_5252+
3.8501phi2_5242+3.6501phi2_5232+3.4501phi2_5222+2.45phi2_5212+4.2501phi2_4262+4.05
01phi2_4252+3.8501phi2_4242+3.6501phi2_4232
+3.4501phi2_4222+2.45phi2_4212+4.2501phi2_3262+4.0501phi2_3252+3.8501phi2_3242+3.6
501phi2_3232+3.4501phi2_3222+2.45phi2_3212+
4.2501phi2_2262+4.0501phi2_2252+3.8501phi2_2242+3.6501phi2_2232+3.4501phi2_2222+2.
45phi2_2212+4.2501phi2_1262+4.0501phi2_1252+
3.8501phi2_1242+3.6501phi2_1232+3.4501phi2_1222+2.45phi2_1212-QT2_22<=0

5phi2_10262+4.25phi2_10252+4.05phi2_10242+3.85phi2_10232+3.65phi2_10222+3.45phi2_10212+5phi2_9262+4.25phi2_9252+4.05phi2_9242+3.85phi2_9232+3.65phi2_9222+3.45phi2_9212+5phi2_8262+4.25phi2_8252+4.05phi2_8242+3.85phi2_8232+3.65phi2_8222+3.45phi2_8212+5phi2_7262+4.25phi2_7252+4.05phi2_7242+3.85phi2_7232+3.65phi2_7222+3.45phi2_7212+5phi2_6262+4.25phi2_6252+4.05phi2_6242+3.85phi2_6232+3.65phi2_6222+3.45phi2_6212+5phi2_5262+4.25phi2_5252+4.05phi2_5242+3.85phi2_5232+3.65phi2_5222+3.45phi2_5212+5phi2_4262+4.25phi2_4252+4.05phi2_4242+3.85phi2_4232+3.65phi2_4222+3.45phi2_4212+5phi2_3262+4.25phi2_3252+4.05phi2_3242+3.85phi2_3232+3.65phi2_3222+3.45phi2_3212+5phi2_2262+4.25phi2_2252+4.05phi2_2242+3.85phi2_2232+3.65phi2_2222+3.45phi2_2212+5phi2_1262+4.25phi2_1252+4.05phi2_1242+3.85phi2_1232+3.65phi2_1222+3.45phi2_1212-QT2_22=>0

4.2501phi2_10263+4.0501phi2_10253+3.8501phi2_10243+3.6501phi2_10233+3.4501phi2_10223+2.45phi2_10213+4.2501phi2_9263+4.0501phi2_9253+3.8501phi2_9243+3.6501phi2_9233+3.4501phi2_9223+2.45phi2_9213+4.2501phi2_8263+4.0501phi2_8253+3.8501phi2_8243+3.6501phi2_8233+3.4501phi2_8223+2.45phi2_8213+4.2501phi2_7263+4.0501phi2_7253+3.8501phi2_7243+3.6501phi2_7233+3.4501phi2_7223+2.45phi2_7213+4.2501phi2_6263+4.0501phi2_6253+3.8501phi2_6243+3.6501phi2_6233+3.4501phi2_6223+2.45phi2_6213+4.2501phi2_5263+4.0501phi2_5253+3.8501phi2_5243+3.6501phi2_5233+3.4501phi2_5223+2.45phi2_5213+4.2501phi2_4263+4.0501phi2_4253+3.8501phi2_4243+3.6501phi2_4233+3.4501phi2_4223+2.45phi2_4213+4.2501phi2_3263+4.0501phi2_3253+3.8501phi2_3243+3.6501phi2_3233+3.4501phi2_3223+2.45phi2_3213+4.2501phi2_2263+4.0501phi2_2253+3.8501phi2_2243+3.6501phi2_2233+3.4501phi2_2223+2.45phi2_2213+4.2501phi2_1263+4.0501phi2_1253+3.8501phi2_1243+3.6501phi2_1233+3.4501phi2_1223+2.45phi2_1213-QT2_23<=0

5phi2_10263+4.25phi2_10253+4.05phi2_10243+3.85phi2_10233+3.65phi2_10223+3.45phi2_10213+5phi2_9263+4.25phi2_9253+4.05phi2_9243+3.85phi2_9233+3.65phi2_9223+3.45phi2_9213+5phi2_8263+4.25phi2_8253+4.05phi2_8243+3.85phi2_8233+3.65phi2_8223+3.45phi2_8213+5phi2_7263+4.25phi2_7253+4.05phi2_7243+3.85phi2_7233+3.65phi2_7223+3.45phi2_7213+5phi2_6263+4.25phi2_6253+4.05phi2_6243+3.85phi2_6233+3.65phi2_6223+3.45phi2_6213+5phi2_5263+4.25phi2_5253+4.05phi2_5243+3.85phi2_5233+3.65phi2_5223+3.45phi2_5213+5phi2_4263+4.25phi2_4253+4.05phi2_4243+3.85phi2_4233+3.65phi2_4223+3.45phi2_4213+5phi2_3263+4.25phi2_3253+4.05phi2_3243+3.85phi2_3233+3.65phi2_3223+3.45phi2_3213+5phi2_2263+4.25phi2_2253+4.05phi2_2243+3.85phi2_2233+3.65phi2_2223+3.45phi2_2213+5phi2_1263+4.25phi2_1253+4.05phi2_1243+3.85phi2_1233+3.65phi2_1223+3.45phi2_1213-QT2_23=>0

\ Equation 8.45

QT2_21+QT2_11-QT2_1=0
QT2_22+QT2_12-QT2_2=0

```
QT2_23+QT2_13-QT2_3=0


\ Equation 8.46

FB2_1-Spill2_NO_1-Spill2_YES_1=0
FB2_2-Spill2_NO_2-Spill2_YES_2=0
FB2_3-Spill2_NO_3-Spill2_YES_3=0


\ Equation 8.47

600sigma_NO_1-Spill2_NO_1<=0
600sigma_NO_2-Spill2_NO_2<=0
600sigma_NO_3-Spill2_NO_3<=0
Spill2_NO_1-613sigma_NO_1<=0
Spill2_NO_2-613sigma_NO_2<=0
Spill2_NO_3-613sigma_NO_3<=0

\ Equation 8.48

600.00001sigma_YES_1-Spill2_YES_1<=0
600.00001sigma_YES_2-Spill2_YES_2<=0
600.00001sigma_YES_3-Spill2_YES_3<=0
Spill2_YES_1-615sigma_YES_1<=0
Spill2_YES_2-615sigma_YES_2<=0
Spill2_YES_3-615sigma_YES_3<=0

\ Equation 8.49

sigma_NO_1+sigma_YES_1=1
sigma_NO_2+sigma_YES_2=1
sigma_NO_3+sigma_YES_3=1

\ Equation 8.50
Gated_1>=0
Gated_2>=0
Gated_3>=0
Gated_1-150sigma_YES_1<=0
Gated_2-150sigma_YES_2<=0
Gated_3-150sigma_YES_3<=0

\ Equation 8.51
QT2_21+QT2_11+Gated_1-Chan_1=0
QT2_22+QT2_12+Gated_2-Chan_2=0
QT2_23+QT2_13+Gated_3-Chan_3=0

\ Equation 8.52
```

```
549.519zeta_91+548.014zeta_81+546.352zeta_71+544.524zeta_61+542.52zeta_51+540.332zeta
_41+537.95zeta_31+535.367zeta_21+532.573zeta_11
-TR2_1<=0

549.519zeta_92+548.014zeta_82+546.352zeta_72+544.524zeta_62+542.52zeta_52+540.332zeta
_42+537.95zeta_32+535.367zeta_22+532.573zeta_12
-TR2_2<=0

549.519zeta_93+548.014zeta_83+546.352zeta_73+544.524zeta_63+542.52zeta_53+540.332zeta
_43+537.95zeta_33+535.367zeta_23+532.573zeta_13
-TR2_3<=0

550.215zeta_91+548.786zeta_81+547.204zeta_71+545.459zeta_61+543.544zeta_51+541.449ze
ta_41+539.166zeta_31+536.685zeta_21+533.997zeta_11
-TR2_1=>0

550.215zeta_92+548.786zeta_82+547.204zeta_72+545.459zeta_62+543.544zeta_52+541.449ze
ta_42+539.166zeta_32+536.685zeta_22+533.997zeta_12
-TR2_2=>0

550.215zeta_93+548.786zeta_83+547.204zeta_73+545.459zeta_63+543.544zeta_53+541.449ze
ta_43+539.166zeta_33+536.685zeta_23+533.997zeta_13
-TR2_3=>0

\ Equation 8.53

20zeta_91+17.5zeta_81+15zeta_71+12.5zeta_61+10zeta_51+7.5zeta_41+5zeta_31+2.5zeta_21+
0zeta_11-Chan_1<=0
20zeta_92+17.5zeta_82+15zeta_72+12.5zeta_62+10zeta_52+7.5zeta_42+5zeta_32+2.5zeta_22+
0zeta_12-Chan_2<=0
20zeta_93+17.5zeta_83+15zeta_73+12.5zeta_63+10zeta_53+7.5zeta_43+5zeta_33+2.5zeta_23+
0zeta_13-Chan_3<=0
21.25zeta_91+18.75zeta_81+16.25zeta_71+13.75zeta_61+11.25zeta_51+8.75zeta_41+6.25zeta_
31+3.75zeta_21+1.25zeta_11-Chan_1=>0
21.25zeta_92+18.75zeta_82+16.25zeta_72+13.75zeta_62+11.25zeta_52+8.75zeta_42+6.25zeta_
32+3.75zeta_22+1.25zeta_12-Chan_2=>0
21.25zeta_93+18.75zeta_83+16.25zeta_73+13.75zeta_63+11.25zeta_53+8.75zeta_43+6.25zeta_
33+3.75zeta_23+1.25zeta_13-Chan_3=>0

\ Equation 8.54

zeta_91+zeta_81+zeta_71+zeta_61+zeta_51+zeta_41+zeta_31+zeta_21+zeta_11=1
zeta_92+zeta_82+zeta_72+zeta_62+zeta_52+zeta_42+zeta_32+zeta_22+zeta_12=1
zeta_93+zeta_83+zeta_73+zeta_63+zeta_53+zeta_43+zeta_33+zeta_23+zeta_13=1

\ Equation 8.55

S1_1-0.083667FB1_1=-61.339
S1_2-0.083667FB1_2=-61.339
S1_3-0.083667FB1_3=-61.339
```

```
\ Equation 8.56

S2_1-0.011467FB2_1=-6.6201
S2_2-0.011467FB2_2=-6.6201
S2_3-0.011467FB2_3=-6.6201


\ Equation 8.59

S1_2-S1_1+0.00864QT1_1-0.00864QP_1-0.00864I1_1+0.00864UnContRel_1=0
S1_3-S1_2+0.00864QT1_2-0.00864QP_2-0.00864I1_2+0.00864UnContRel_2=0
S1_4-S1_3+0.00864QT1_3-0.00864QP_3-0.00864I1_3+0.00864UnContRel_3=0


\ Equation 8.60


S2_2-S2_1-0.00864QT1_1+0.00864QT2_1+0.00864QP_1-0.00864I2_1+0.00864Gated_1-
0.00864UnContRel_1=0
S2_3-S2_2-0.00864QT1_2+0.00864QT2_2+0.00864QP_2-0.00864I2_2+0.00864Gated_2-
0.00864UnContRel_2=0
S2_4-S2_3-0.00864QT1_3+0.00864QT2_3+0.00864QP_3-0.00864I2_3+0.00864Gated_3-
0.00864UnContRel_3=0


\ Fixed Values



I1_1 = 3
I1_2 = 1
I1_3 = 2

I2_1 = 3
I2_2 = 6
I2_3 = 3



FB1_1=792
FB2_1=605

Bounds

3<S1_4<7
0<S2_4<10

\ Equation 8.1
0<H1_1<212
```

```
0<H1_2<212
0<H1_3<212

600<FB2_1<615
600<FB2_2<615
600<FB2_3<615



\ Equation 8.3
770<FB1_1<812
770<FB1_2<812
587<FB2_1<620
587<FB2_2<620
770<FB1_3<812
587<FB2_3<620

\ Bounds on the upper turbine flow
0<QT1_21<5.5
0<QT1_11<5.5

0<QT1_22<5.5
0<QT1_12<5.5

0<QT1_23<5.5
0<QT1_13<5.5

0<QT2_21<5.5
0<QT2_11<5.5

0<QT2_22<5.5
0<QT2_12<5.5

0<QT2_23<5.5
0<QT2_13<5.5

532<=TR2_1<=551
532<=TR2_2<=551
532<=TR2_3<=551



binaries

delta1_11 delta1_21 delta1_31 delta1_41 delta1_51 delta1_61 delta1_71 delta1_81 delta1_91
delta1_101
delta1_12 delta1_22 delta1_32 delta1_42 delta1_52 delta1_62 delta1_72 delta1_82 delta1_92
delta1_102
delta1_13 delta1_23 delta1_33 delta1_43 delta1_53 delta1_63 delta1_73 delta1_83 delta1_93
delta1_103
```

phi1_10263 phi1_10253 phi1_10243 phi1_10233 phi1_10223 phi1_10213 phi1_10163
phi1_10153 phi1_10143
phi1_10133 phi1_10123 phi1_10113 phi1_9263 phi1_9253 phi1_9243 phi1_9233 phi1_9223
phi1_9213 phi1_9163
phi1_9153 phi1_9143 phi1_9133 phi1_9123 phi1_9113 phi1_8263 phi1_8253 phi1_8243
phi1_8233 phi1_8223
phi1_8213 phi1_8163 phi1_8153 phi1_8143 phi1_8133 phi1_8123 phi1_8113 phi1_7263
phi1_7253 phi1_7243
phi1_7233 phi1_7223 phi1_7213 phi1_7163 phi1_7153 phi1_7143 phi1_7133 phi1_7123
phi1_7113 phi1_6263
phi1_6253 phi1_6243 phi1_6233 phi1_6223 phi1_6213 phi1_6163 phi1_6153 phi1_6143
phi1_6133 phi1_6123
phi1_6113 phi1_5263 phi1_5253 phi1_5243 phi1_5233 phi1_5223 phi1_5213 phi1_5163
phi1_5153 phi1_5143
phi1_5133 phi1_5123 phi1_5113 phi1_4263 phi1_4253 phi1_4243 phi1_4233 phi1_4223
phi1_4213 phi1_4163
phi1_4153 phi1_4143 phi1_4133 phi1_4123 phi1_4113 phi1_3263 phi1_3253 phi1_3243
phi1_3233 phi1_3223
phi1_3213 phi1_3163 phi1_3153 phi1_3143 phi1_3133 phi1_3123 phi1_3113 phi1_2263
phi1_2253 phi1_2243
phi1_2233 phi1_2223 phi1_2213 phi1_2163 phi1_2153 phi1_2143 phi1_2133 phi1_2123
phi1_2113 phi1_1263
phi1_1253 phi1_1243 phi1_1233 phi1_1223 phi1_1213 phi1_1163 phi1_1153 phi1_1143
phi1_1133 phi1_1123
phi1_1113 phi1_10262 phi1_10252 phi1_10242 phi1_10232 phi1_10222 phi1_10212
phi1_10162 phi1_10152
phi1_10142 phi1_10132 phi1_10122 phi1_10112 phi1_9262 phi1_9252 phi1_9242 phi1_9232
phi1_9222
phi1_9212 phi1_9162 phi1_9152 phi1_9142 phi1_9132 phi1_9122 phi1_9112 phi1_8262
phi1_8252 phi1_8242
phi1_8232 phi1_8222 phi1_8212 phi1_8162 phi1_8152 phi1_8142 phi1_8132 phi1_8122
phi1_8112 phi1_7262
phi1_7252 phi1_7242 phi1_7232 phi1_7222 phi1_7212 phi1_7162 phi1_7152 phi1_7142
phi1_7132 phi1_7122
phi1_7112 phi1_6262 phi1_6252 phi1_6242 phi1_6232 phi1_6222 phi1_6212 phi1_6162
phi1_6152 phi1_6142
phi1_6132 phi1_6122 phi1_6112 phi1_5262 phi1_5252 phi1_5242 phi1_5232 phi1_5222
phi1_5212 phi1_5162
phi1_5152 phi1_5142 phi1_5132 phi1_5122 phi1_5112 phi1_4262 phi1_4252 phi1_4242
phi1_4232 phi1_4222
phi1_4212 phi1_4162 phi1_4152 phi1_4142 phi1_4132 phi1_4122 phi1_4112 phi1_3262
phi1_3252 phi1_3242
phi1_3232 phi1_3222 phi1_3212 phi1_3162 phi1_3152 phi1_3142 phi1_3132 phi1_3122
phi1_3112 phi1_2262
phi1_2252 phi1_2242 phi1_2232 phi1_2222 phi1_2212 phi1_2162 phi1_2152 phi1_2142
phi1_2132 phi1_2122

phi1_2112 phi1_1262 phi1_1252 phi1_1242 phi1_1232 phi1_1222 phi1_1212 phi1_1162
phi1_1152 phi1_1142
phi1_1132 phi1_1122 phi1_1112 phi1_10261 phi1_10251 phi1_10241 phi1_10231 phi1_10221
phi1_10211
phi1_10161 phi1_10151 phi1_10141 phi1_10131 phi1_10121 phi1_10111 phi1_9261 phi1_9251
phi1_9241
phi1_9231 phi1_9221 phi1_9211 phi1_9161 phi1_9151 phi1_9141 phi1_9131 phi1_9121
phi1_9111 phi1_8261
phi1_8251 phi1_8241 phi1_8231 phi1_8221 phi1_8211 phi1_8161 phi1_8151 phi1_8141
phi1_8131 phi1_8121
phi1_8111 phi1_7261 phi1_7251 phi1_7241 phi1_7231 phi1_7221 phi1_7211 phi1_7161
phi1_7151 phi1_7141
phi1_7131 phi1_7121 phi1_7111 phi1_6261 phi1_6251 phi1_6241 phi1_6231 phi1_6221
phi1_6211 phi1_6161
phi1_6151 phi1_6141 phi1_6131 phi1_6121 phi1_6111 phi1_5261 phi1_5251 phi1_5241
phi1_5231 phi1_5221
phi1_5211 phi1_5161 phi1_5151
phi1_5141 phi1_5131 phi1_5121 phi1_5111 phi1_4261 phi1_4251 phi1_4241 phi1_4231
phi1_4221 phi1_4211
phi1_4161 phi1_4151 phi1_4141 phi1_4131 phi1_4121 phi1_4111 phi1_3261 phi1_3251
phi1_3241 phi1_3231
phi1_3221 phi1_3211 phi1_3161 phi1_3151 phi1_3141 phi1_3131 phi1_3121 phi1_3111
phi1_2261 phi1_2251
phi1_2241 phi1_2231 phi1_2221 phi1_2211 phi1_2161 phi1_2151 phi1_2141 phi1_2131
phi1_2121 phi1_2111
phi1_1261 phi1_1251 phi1_1241 phi1_1231 phi1_1221 phi1_1211 phi1_1161 phi1_1151
phi1_1141 phi1_1131
phi1_1121 phi1_1111

nu_111 nu_211 nu_311 nu_411 nu_511 nu_611 nu_711 nu_811 nu_911 nu_1011 nu_112
nu_212 nu_312 nu_412
nu_512 nu_612 nu_712 nu_812 nu_912 nu_1012 nu_113 nu_213 nu_313 nu_413 nu_513
nu_613 nu_713 nu_813
nu_913 nu_1013 nu_121 nu_221 nu_321 nu_421 nu_521 nu_621 nu_721 nu_821 nu_921
nu_1021 nu_122 nu_222
nu_322 nu_422 nu_522 nu_622 nu_722 nu_822 nu_922 nu_1022 nu_123 nu_223 nu_323
nu_423 nu_523 nu_623
nu_723 nu_823 nu_923 nu_1023

theta_NO_1 theta_NO_2 theta_NO_3
theta_YES_1 theta_YES_2 theta_YES_3

Beta_11 Beta_21 Beta_12 Beta_22 Beta_13 Beta_23
Alpha_11 Alpha_21 Alpha_12 Alpha_22 Alpha_13 Alpha_23

theta_11 theta_21 theta_31 theta_12 theta_22 theta_32 theta_13 theta_23 theta_33

delta2_11 delta2_21 delta2_31 delta2_41 delta2_51 delta2_61 delta2_71 delta2_81 delta2_91
delta2_101

delta2_12 delta2_22 delta2_32 delta2_42 delta2_52 delta2_62 delta2_72 delta2_82 delta2_92 delta2_102
delta2_13 delta2_23 delta2_33 delta2_43 delta2_53 delta2_63 delta2_73 delta2_83 delta2_93 delta2_103

phi2_10263 phi2_10253 phi2_10243 phi2_10233 phi2_10223 phi2_10213 phi2_10163 phi2_10153 phi2_10143 phi2_10133 phi2_10123
phi2_10113 phi2_9263 phi2_9253 phi2_9243 phi2_9233 phi2_9223 phi2_9213 phi2_9163 phi2_9153 phi2_9143 phi2_9133 phi2_9123
phi2_9113 phi2_8263 phi2_8253 phi2_8243 phi2_8233 phi2_8223 phi2_8213 phi2_8163 phi2_8153 phi2_8143 phi2_8133 phi2_8123
phi2_8113 phi2_7263 phi2_7253 phi2_7243 phi2_7233 phi2_7223 phi2_7213 phi2_7163 phi2_7153 phi2_7143 phi2_7133 phi2_7123
phi2_7113 phi2_6263 phi2_6253 phi2_6243 phi2_6233 phi2_6223 phi2_6213 phi2_6163 phi2_6153 phi2_6143 phi2_6133 phi2_6123
phi2_6113 phi2_5263 phi2_5253 phi2_5243 phi2_5233 phi2_5223 phi2_5213 phi2_5163 phi2_5153 phi2_5143 phi2_5133 phi2_5123
phi2_5113 phi2_4263 phi2_4253 phi2_4243 phi2_4233 phi2_4223 phi2_4213 phi2_4163 phi2_4153 phi2_4143 phi2_4133 phi2_4123
phi2_4113 phi2_3263 phi2_3253 phi2_3243 phi2_3233 phi2_3223 phi2_3213 phi2_3163 phi2_3153 phi2_3143 phi2_3133 phi2_3123
phi2_3113 phi2_2263 phi2_2253 phi2_2243 phi2_2233 phi2_2223 phi2_2213 phi2_2163 phi2_2153 phi2_2143 phi2_2133 phi2_2123
phi2_2113 phi2_1263 phi2_1253 phi2_1243 phi2_1233 phi2_1223 phi2_1213 phi2_1163 phi2_1153 phi2_1143 phi2_1133 phi2_1123
phi2_1113 phi2_10262 phi2_10252 phi2_10242 phi2_10232 phi2_10222 phi2_10212 phi2_10162 phi2_10152 phi2_10142 phi2_10132
phi2_10122 phi2_10112 phi2_9262 phi2_9252 phi2_9242 phi2_9232 phi2_9222 phi2_9212 phi2_9162 phi2_9152 phi2_9142 phi2_9132
phi2_9122 phi2_9112 phi2_8262 phi2_8252 phi2_8242 phi2_8232 phi2_8222 phi2_8212 phi2_8162 phi2_8152 phi2_8142 phi2_8132
phi2_8122 phi2_8112 phi2_7262 phi2_7252 phi2_7242 phi2_7232 phi2_7222 phi2_7212 phi2_7162 phi2_7152 phi2_7142 phi2_7132
phi2_7122 phi2_7112 phi2_6262 phi2_6252 phi2_6242 phi2_6232 phi2_6222 phi2_6212 phi2_6162 phi2_6152 phi2_6142 phi2_6132
phi2_6122 phi2_6112 phi2_5262 phi2_5252 phi2_5242 phi2_5232 phi2_5222 phi2_5212 phi2_5162 phi2_5152 phi2_5142 phi2_5132
phi2_5122 phi2_5112 phi2_4262 phi2_4252 phi2_4242 phi2_4232 phi2_4222 phi2_4212 phi2_4162 phi2_4152 phi2_4142 phi2_4132
phi2_4122 phi2_4112 phi2_3262 phi2_3252 phi2_3242 phi2_3232 phi2_3222 phi2_3212 phi2_3162 phi2_3152 phi2_3142 phi2_3132
phi2_3122 phi2_3112 phi2_2262 phi2_2252 phi2_2242 phi2_2232 phi2_2222 phi2_2212 phi2_2162 phi2_2152 phi2_2142 phi2_2132
phi2_2122 phi2_2112 phi2_1262 phi2_1252 phi2_1242 phi2_1232 phi2_1222 phi2_1212 phi2_1162 phi2_1152 phi2_1142 phi2_1132
phi2_1122 phi2_1112 phi2_10261 phi2_10251 phi2_10241 phi2_10231 phi2_10221 phi2_10211 phi2_10161 phi2_10151 phi2_10141
phi2_10131 phi2_10121 phi2_10111 phi2_9261 phi2_9251 phi2_9241 phi2_9231 phi2_9221 phi2_9211 phi2_9161 phi2_9151 phi2_9141

phi2_9131 phi2_9121 phi2_9111 phi2_8261 phi2_8251 phi2_8241 phi2_8231 phi2_8221
phi2_8211 phi2_8161 phi2_8151 phi2_8141
phi2_8131 phi2_8121 phi2_8111 phi2_7261 phi2_7251 phi2_7241 phi2_7231 phi2_7221
phi2_7211 phi2_7161 phi2_7151 phi2_7141
phi2_7131 phi2_7121 phi2_7111 phi2_6261 phi2_6251 phi2_6241 phi2_6231 phi2_6221
phi2_6211 phi2_6161 phi2_6151 phi2_6141
phi2_6131 phi2_6121 phi2_6111 phi2_5261 phi2_5251 phi2_5241 phi2_5231 phi2_5221
phi2_5211 phi2_5161 phi2_5151 phi2_5141
phi2_5131 phi2_5121 phi2_5111 phi2_4261 phi2_4251 phi2_4241 phi2_4231 phi2_4221
phi2_4211 phi2_4161 phi2_4151 phi2_4141
phi2_4131 phi2_4121 phi2_4111 phi2_3261 phi2_3251 phi2_3241 phi2_3231 phi2_3221
phi2_3211 phi2_3161 phi2_3151 phi2_3141
phi2_3131 phi2_3121 phi2_3111 phi2_2261 phi2_2251 phi2_2241 phi2_2231 phi2_2221
phi2_2211 phi2_2161 phi2_2151 phi2_2141
phi2_2131 phi2_2121 phi2_2111 phi2_1261 phi2_1251 phi2_1241 phi2_1231 phi2_1221
phi2_1211 phi2_1161 phi2_1151 phi2_1141
phi2_1131 phi2_1121 phi2_1111

sigma_YES_1 sigma_YES_2 sigma_YES_3
sigma_NO_1 sigma_NO_2 sigma_NO_3

zeta_11 zeta_21 zeta_31 zeta_41 zeta_51 zeta_61 zeta_71 zeta_81 zeta_91 zeta_12 zeta_22
zeta_32 zeta_42 zeta_52 zeta_62
zeta_72 zeta_82 zeta_92 zeta_13 zeta_23 zeta_33 zeta_43 zeta_53 zeta_63 zeta_73 zeta_83
zeta_93

Produce_1
Produce_2
Produce_3

Output from CPLEX for Analysis 1

```
PROBLEM NAME      cplex099.txt
 DATA    NAME
 OBJECTIVE VALUE  259504.7
 STATUS           OPTIMAL SOLN
 ITERATION        4

 OBJECTIVE                                   (MAX)
 RHS
 RANGES
 BOUNDS


 SECTION 1 - ROWS
```

Row	AT	Activity	Slack Activity	Lower Limit	Upper Limit	Dual Activity
	BS	259504.7	-259505	NONE	NONE	1
c1	BS	0	0	NONE	0	0
c2	BS	-0.30367	0.303671	NONE	0	0
c3	BS	-0.2463	0.246303	NONE	0	0
c4	BS	0.999	-0.999	0	NONE	0
c5	BS	0.695329	-0.69533	0	NONE	0
c6	BS	6.753698	-6.7537	0	NONE	0
c7	EQ	1	0	1	1	-9012.2
c8	EQ	1	0	1	1	-0.17448
c9	EQ	1	0	1	1	-12018
c10	EQ	0	0	0	0	0
c11	EQ	0	0	0	0	0
c12	EQ	0	0	0	0	0
c13	UL	0	0	NONE	0	-8411.3
c14	UL	0	0	NONE	0	-8675.7
c15	UL	0	0	NONE	0	-8723.8
c16	UL	0	0	NONE	0	-8771.8
c17	UL	0	0	NONE	0	-8819.9
c18	UL	0	0	NONE	0	-8868
c19	UL	0	0	NONE	0	-8916
c20	UL	0	0	NONE	0	-8964.1
c21	UL	0	0	NONE	0	-9012.2
c22	BS	0	0	NONE	0	0
c23	BS	0	0	NONE	0	0
c24	BS	0	0	NONE	0	0

c25	BS	0	0	NONE	0	0
c26	BS	0	0	NONE	0	0
c27	BS	0	0	NONE	0	0
c28	BS	0	0	NONE	0	0
c29	UL	0	0	NONE	0	0
c30	UL	0	0	NONE	0	-48.1
c31	BS	0	0	NONE	0	0
c32	BS	0	0	NONE	0	0
c33	UL	0	0	NONE	0	-0.08411
c34	UL	0	0	NONE	0	-0.08676
c35	UL	0	0	NONE	0	-0.08724
c36	BS	-1	1	NONE	0	0
c37	UL	0	0	NONE	0	-0.0882
c38	UL	0	0	NONE	0	-0.08868
c39	UL	0	0	NONE	0	-0.08916
c40	UL	0	0	NONE	0	-0.08964
c41	UL	0	0	NONE	0	-0.09012
c42	UL	0	0	NONE	0	-0.09204
c43	UL	0	0	NONE	0	-0.08411
c44	UL	0	0	NONE	0	-0.08676
c45	UL	0	0	NONE	0	-0.08724
c46	BS	-1	1	NONE	0	0
c47	UL	0	0	NONE	0	-0.0882
c48	UL	0	0	NONE	0	-0.08868
c49	UL	0	0	NONE	0	-0.08916
c50	UL	0	0	NONE	0	-0.08964
c51	UL	0	0	NONE	0	-0.09012
c52	UL	0	0	NONE	0	-0.09204
c53	BS	0	0	NONE	0	0
c54	UL	0	0	NONE	0	-2644
c55	UL	0	0	NONE	0	-3125
c56	UL	0	0	NONE	0	-3605
c57	UL	0	0	NONE	0	-4086
c58	UL	0	0	NONE	0	-4567
c59	UL	0	0	NONE	0	-5047
c60	UL	0	0	NONE	0	-5528
c61	UL	0	0	NONE	0	-6009
c62	UL	0	0	NONE	0	-7931
c63	BS	0	0	NONE	0	0
c64	UL	0	0	NONE	0	-2644
c65	UL	0	0	NONE	0	-3125
c66	UL	0	0	NONE	0	-3605
c67	UL	0	0	NONE	0	-4086
c68	UL	0	0	NONE	0	-4567
c69	UL	0	0	NONE	0	-5047
c70	UL	0	0	NONE	0	-5528
c71	UL	0	0	NONE	0	-6009
c72	UL	0	0	NONE	0	-7931
c73	EQ	0	0	0	0	10
c74	EQ	0	0	0	0	0.0001
c75	EQ	0	0	0	0	100

c76	EQ	0	0	0	0	10
c77	EQ	0	0	0	0	0.0001
c78	EQ	0	0	0	0	100
c79	EQ	0	0	0	0	10
c80	EQ	0	0	0	0	0.0001
c81	EQ	0	0	0	0	100
c82	EQ	0	0	0	0	0
c83	EQ	0	0	0	0	0
c84	EQ	0	0	0	0	0
c85	UL	0	0	NONE	0	0
c86	BS	0.1999	-0.1999	0	NONE	0
c87	UL	0	0	NONE	0	0
c88	BS	0	0	0	NONE	0
c89	UL	0	0	NONE	0	0
c90	BS	0.1999	-0.1999	0	NONE	0
c91	UL	0	0	NONE	0	0
c92	BS	0.1999	-0.1999	0	NONE	0
c93	UL	0	0	NONE	0	0
c94	BS	0	0	0	NONE	0
c95	UL	0	0	NONE	0	0
c96	BS	0.1999	-0.1999	0	NONE	0
c97	EQ	0	0	0	0	0
c98	EQ	0	0	0	0	0
c99	EQ	0	0	0	0	0
c100	EQ	0	0	0	0	-10
c101	EQ	0	0	0	0	-0.0001
c102	EQ	0	0	0	0	-100
c103	EQ	0	0	0	0	-10
c104	EQ	0	0	0	0	-0.0001
c105	EQ	0	0	0	0	-100
c106	EQ	0	0	0	0	-10
c107	EQ	0	0	0	0	-0.0001
c108	EQ	0	0	0	0	-100
c109	BS	0	0	NONE	0	0
c110	BS	0	0	NONE	0	0
c111	BS	0	0	NONE	0	0
c112	BS	0	0	NONE	0	0
c113	BS	0	0	NONE	0	0
c114	BS	0	0	NONE	0	0
c115	BS	0	0	NONE	0	0
c116	BS	0	0	NONE	0	0
c117	BS	0	0	NONE	0	0
c118	BS	0	0	NONE	0	0
c119	BS	0	0	NONE	0	0
c120	BS	0	0	NONE	0	0
c121	BS	0	0	NONE	0	0
c122	BS	0	0	NONE	0	0
c123	BS	0	0	NONE	0	0
c124	BS	0	0	NONE	0	0
c125	BS	-1	1	NONE	0	0
c126	BS	-1	1	NONE	0	0

c127	BS	0	0	NONE	0	0
c128	BS	0	0	NONE	0	0
c129	BS	0	0	NONE	0	0
c130	BS	0	0	NONE	0	0
c131	BS	0	0	NONE	0	0
c132	BS	0	0	NONE	0	0
c133	BS	0	0	NONE	0	0
c134	BS	0	0	NONE	0	0
c135	BS	-1	1	NONE	0	0
c136	BS	-1	1	NONE	0	0
c137	BS	0	0	NONE	0	0
c138	BS	0	0	NONE	0	0
c139	BS	0	0	NONE	0	0
c140	BS	0	0	NONE	0	0
c141	BS	0	0	NONE	0	0
c142	BS	0	0	NONE	0	0
c143	BS	0	0	NONE	0	0
c144	BS	0	0	NONE	0	0
c145	BS	0	0	NONE	0	0
c146	BS	0	0	NONE	0	0
c147	BS	0	0	NONE	0	0
c148	BS	0	0	NONE	0	0
c149	BS	0	0	NONE	0	0
c150	BS	0	0	NONE	0	0
c151	BS	0	0	NONE	0	0
c152	BS	0	0	NONE	0	0
c153	BS	0	0	NONE	0	0
c154	BS	0	0	NONE	0	0
c155	BS	0	0	NONE	0	0
c156	BS	0	0	NONE	0	0
c157	BS	0	0	NONE	0	0
c158	BS	0	0	NONE	0	0
c159	BS	0	0	NONE	0	0
c160	BS	0	0	NONE	0	0
c161	BS	0	0	NONE	0	0
c162	BS	0	0	NONE	0	0
c163	BS	0	0	NONE	0	0
c164	BS	0	0	NONE	0	0
c165	BS	0	0	NONE	0	0
c166	BS	0	0	NONE	0	0
c167	BS	-1	1	NONE	0	0
c168	BS	-1	1	NONE	0	0
c169	BS	-1	1	NONE	0	0
c170	BS	-1	1	NONE	0	0
c171	BS	-1	1	NONE	0	0
c172	BS	-1	1	NONE	0	0
c173	BS	-1	1	NONE	0	0
c174	BS	-1	1	NONE	0	0
c175	BS	-1	1	NONE	0	0
c176	BS	-1	1	NONE	0	0
c177	BS	-1	1	NONE	0	0

c178	BS	-1	1	NONE	0	0
c179	BS	-1	1	NONE	0	0
c180	BS	-1	1	NONE	0	0
c181	BS	-1	1	NONE	0	0
c182	BS	-1	1	NONE	0	0
c183	BS	-1	1	NONE	0	0
c184	BS	-1	1	NONE	0	0
c185	BS	-1	1	NONE	0	0
c186	BS	-1	1	NONE	0	0
c187	BS	-1	1	NONE	0	0
c188	BS	-1	1	NONE	0	0
c189	BS	-1	1	NONE	0	0
c190	BS	-1	1	NONE	0	0
c191	BS	-1	1	NONE	0	0
c192	BS	-1	1	NONE	0	0
c193	BS	-1	1	NONE	0	0
c194	BS	-1	1	NONE	0	0
c195	BS	-1	1	NONE	0	0
c196	BS	-1	1	NONE	0	0
c197	BS	-1	1	NONE	0	0
c198	BS	-1	1	NONE	0	0
c199	BS	-1	1	NONE	0	0
c200	BS	-1	1	NONE	0	0
c201	BS	-1	1	NONE	0	0
c202	BS	-1	1	NONE	0	0
c203	BS	-1	1	NONE	0	0
c204	BS	-1	1	NONE	0	0
c205	BS	-1	1	NONE	0	0
c206	BS	-1	1	NONE	0	0
c207	BS	-1	1	NONE	0	0
c208	BS	-1	1	NONE	0	0
c209	BS	-1	1	NONE	0	0
c210	BS	-1	1	NONE	0	0
c211	BS	-1	1	NONE	0	0
c212	BS	-1	1	NONE	0	0
c213	BS	-1	1	NONE	0	0
c214	BS	-1	1	NONE	0	0
c215	BS	-1	1	NONE	0	0
c216	BS	-1	1	NONE	0	0
c217	BS	-1	1	NONE	0	0
c218	BS	-1	1	NONE	0	0
c219	BS	-1	1	NONE	0	0
c220	BS	-1	1	NONE	0	0
c221	BS	-1	1	NONE	0	0
c222	BS	-1	1	NONE	0	0
c223	BS	-1	1	NONE	0	0
c224	BS	-1	1	NONE	0	0
c225	BS	-1	1	NONE	0	0
c226	BS	-1	1	NONE	0	0
c227	BS	-1	1	NONE	0	0
c228	BS	-1	1	NONE	0	0

c229	LL	0	0	0	NONE	0
c230	BS	0	0	NONE	0	0
c231	LL	0	0	0	NONE	0.019284
c232	BS	0	0	NONE	0	0
c233	BS	0	0	0	NONE	0
c234	BS	0	0	NONE	0	0
c235	LL	0	0	0	NONE	0
c236	BS	0	0	NONE	0	0
c237	LL	0	0	0	NONE	0.019284
c238	BS	0	0	NONE	0	0
c239	BS	0	0	0	NONE	0
c240	BS	0	0	NONE	0	0
c241	EQ	0	0	0	0	0
c242	EQ	0	0	0	0	0
c243	EQ	0	0	0	0	0
c244	EQ	0	0	0	0	0
c245	EQ	0	0	0	0	0
c246	EQ	0	0	0	0	-84113
c247	EQ	0	0	0	0	-8916
c248	EQ	0	0	0	0	0
c249	EQ	0	0	0	0	-84113
c250	EQ	0	0	0	0	0
c251	EQ	0	0	0	0	0
c252	EQ	0	0	0	0	0
c253	EQ	0	0	0	0	0
c254	EQ	0	0	0	0	0
c255	EQ	0	0	0	0	0
c256	BS	1	0	NONE	1	0
c257	BS	0	1	NONE	1	0
c258	BS	1	0	NONE	1	0
c259	BS	1	0	NONE	1	0
c260	BS	0	1	NONE	1	0
c261	BS	1	0	NONE	1	0
c262	EQ	0	0	0	0	0
c263	EQ	0	0	0	0	0
c264	EQ	0	0	0	0	0
c265	EQ	0	0	0	0	0
c266	EQ	0	0	0	0	0
c267	EQ	0	0	0	0	0
c268	UL	0	0	NONE	0	0
c269	BS	-2	2	NONE	0	0
c270	UL	0	0	NONE	0	0
c271	BS	2	0	NONE	2	0
c272	BS	2	0	NONE	2	0
c273	BS	2	0	NONE	2	0
c274	EQ	0	0	0	0	0
c275	EQ	0	0	0	0	0
c276	EQ	0	0	0	0	0
c277	BS	-5	5	NONE	0	0
c278	BS	-4.18417	4.184174	NONE	0	0
c279	BS	-4.28744	4.28744	NONE	0	0

c280	BS	-3	3	NONE	0	0
c281	BS	-3.81583	3.815826	NONE	0	0
c282	BS	-3.71256	3.71256	NONE	0	0
c283	BS	0	0	NONE	0	0
c284	BS	0	0	NONE	0	0
c285	UL	0	0	NONE	0	0
c286	BS	0	0	NONE	0	0
c287	BS	0	0	NONE	0	0
c288	BS	0	0	NONE	0	0
c289	BS	0	0	NONE	0	0
c290	BS	0	0	NONE	0	0
c291	BS	0	0	NONE	0	0
c292	BS	0	0	0	NONE	0
c293	BS	0	0	0	NONE	0
c294	BS	0	0	0	NONE	0
c295	BS	0	0	0	0	0
c296	EQ	0	0	0	0	0
c297	EQ	0	0	0	0	0
c298	BS	1	0	1	1	0
c299	EQ	1	0	1	1	0
c300	EQ	1	0	1	1	0
c301	BS	0	0	0	0	0
c302	EQ	0	0	0	0	0
c303	EQ	0	0	0	0	0
c304	UL	0	0	NONE	0	0
c305	UL	0	0	NONE	0	0
c306	UL	0	0	NONE	0	0
c307	BS	1.74	-1.74	0	NONE	0
c308	BS	1.74	-1.74	0	NONE	0
c309	BS	1.74	-1.74	0	NONE	0
c310	EQ	1	0	1	1	-5348.2
c311	EQ	1	0	1	1	-0.05348
c312	EQ	1	0	1	1	-52044
c313	EQ	0	0	0	0	0
c314	EQ	0	0	0	0	0
c315	EQ	0	0	0	0	0
c316	UL	0	0	NONE	0	-2458.5
c317	UL	0	0	NONE	0	-2530.4
c318	UL	0	0	NONE	0	-2602.2
c319	UL	0	0	NONE	0	-2674.1
c320	UL	0	0	NONE	0	-2745.9
c321	UL	0	0	NONE	0	-2817.8
c322	UL	0	0	NONE	0	-2889.7
c323	UL	0	0	NONE	0	-2961.5
c324	UL	0	0	NONE	0	-3033.4
c325	BS	0	0	NONE	0	0
c326	UL	0	0	NONE	0	-2458.5
c327	UL	0	0	NONE	0	-2530.4
c328	UL	0	0	NONE	0	-2602.2
c329	UL	0	0	NONE	0	-2674.1
c330	UL	0	0	NONE	0	-2745.9

c331	UL	0	0	NONE	0	-2817.8
c332	UL	0	0	NONE	0	-2889.7
c333	UL	0	0	NONE	0	-2961.5
c334	UL	0	0	NONE	0	-3033.4
c335	BS	0	0	NONE	0	0
c336	UL	0	0	NONE	0	-0.02459
c337	UL	0	0	NONE	0	-0.0253
c338	UL	0	0	NONE	0	-0.02602
c339	UL	0	0	NONE	0	-0.02674
c340	UL	0	0	NONE	0	-0.02746
c341	UL	0	0	NONE	0	-0.02818
c342	UL	0	0	NONE	0	-0.0289
c343	UL	0	0	NONE	0	-0.02844
c344	UL	0	0	NONE	0	-0.03033
c345	UL	0	0	NONE	0	-0.03105
c346	UL	0	0	NONE	0	-0.02459
c347	UL	0	0	NONE	0	-0.0253
c348	UL	0	0	NONE	0	-0.02602
c349	UL	0	0	NONE	0	-0.02674
c350	UL	0	0	NONE	0	-0.02602
c351	UL	0	0	NONE	0	-0.02818
c352	UL	0	0	NONE	0	-0.0289
c353	UL	0	0	NONE	0	-0.02504
c354	UL	0	0	NONE	0	-0.03033
c355	UL	0	0	NONE	0	-0.03105
c356	UL	0	0	NONE	0	-24585
c357	UL	0	0	NONE	0	-25304
c358	UL	0	0	NONE	0	-26022
c359	UL	0	0	NONE	0	-26741
c360	UL	0	0	NONE	0	-27459
c361	UL	0	0	NONE	0	-28178
c362	UL	0	0	NONE	0	-28897
c363	UL	0	0	NONE	0	-29615
c364	UL	0	0	NONE	0	-30334
c365	UL	0	0	NONE	0	-31053
c366	UL	0	0	NONE	0	-24585
c367	UL	0	0	NONE	0	-25304
c368	UL	0	0	NONE	0	-26022
c369	UL	0	0	NONE	0	-26741
c370	UL	0	0	NONE	0	-27459
c371	UL	0	0	NONE	0	-28178
c372	UL	0	0	NONE	0	-28897
c373	UL	0	0	NONE	0	-29615
c374	UL	0	0	NONE	0	-30334
c375	UL	0	0	NONE	0	-31053
c376	EQ	0	0	0	0	10
c377	EQ	0	0	0	0	0.0001
c378	EQ	0	0	0	0	100
c379	EQ	0	0	0	0	10
c380	EQ	0	0	0	0	0.0001
c381	EQ	0	0	0	0	100

c382	EQ	0	0	0	0	10
c383	EQ	0	0	0	0	0.0001
c384	EQ	0	0	0	0	100
c385	UL	0	0	NONE	0	0
c386	BS	0.7499	-0.7499	0	NONE	0
c387	BS	-0.7499	0.7499	NONE	0	0
c388	LL	0	0	0	NONE	0
c389	UL	0	0	NONE	0	0
c390	BS	0.7499	-0.7499	0	NONE	0
c391	BS	-0.2498	0.2498	NONE	0	0
c392	BS	0.5001	-0.5001	0	NONE	0
c393	BS	-0.7499	0.7499	NONE	0	0
c394	LL	0	0	0	NONE	0
c395	UL	0	0	NONE	0	0
c396	BS	0.7499	-0.7499	0	NONE	0
c397	EQ	0	0	0	0	0
c398	EQ	0	0	0	0	0
c399	EQ	0	0	0	0	0
c400	EQ	0	0	0	0	0
c401	EQ	0	0	0	0	0
c402	EQ	0	0	0	0	0
c403	BS	0	0	NONE	0	0
c404	BS	0	0	NONE	0	0
c405	BS	-3.04114	3.041138	NONE	0	0
c406	BS	0	0	NONE	0	0
c407	UL	0	0	NONE	0	0
c408	BS	-9.95886	9.958862	NONE	0	0
c409	BS	-4.99999	4.99999	NONE	0	0
c410	BS	-8.88049	8.880493	NONE	0	0
c411	UL	0	0	NONE	0	0
c412	BS	-10	10	NONE	0	0
c413	BS	-6.1195	6.119497	NONE	0	0
c414	BS	0	0	NONE	0	0
c415	EQ	1	0	1	1	0
c416	EQ	1	0	1	1	0
c417	EQ	1	0	1	1	0
c418	BS	0	0	0	NONE	0
c419	BS	3.75	-3.75	0	NONE	0
c420	BS	0	0	0	NONE	0
c421	BS	-150	150	NONE	0	0
c422	BS	-146.25	146.25	NONE	0	0
c423	BS	0	0	NONE	0	0
c424	EQ	0	0	0	0	0
c425	EQ	0	0	0	0	0
c426	EQ	0	0	0	0	0
c427	BS	-0.418	0.418	NONE	0	0
c428	BS	-0.1065	0.106503	NONE	0	0
c429	BS	-0.20914	0.209138	NONE	0	0
c430	BS	0.699	-0.699	0	NONE	0
c431	BS	0.828497	-0.8285	0	NONE	0
c432	BS	0.907862	-0.90786	0	NONE	0

c433	BS	-1.25	1.25	NONE	0	0
c434	BS	-1.25	1.25	NONE	0	0
c435	BS	-1.0002	1.0002	NONE	0	0
c436	LL	0	0	0	NONE	0
c437	LL	0	0	0	NONE	0
c438	BS	0.2498	-0.2498	0	NONE	0
c439	EQ	1	0	1	1	0
c440	EQ	1	0	1	1	0
c441	EQ	1	0	1	1	0
c442	EQ	-61.339	0	-61.339	-61.339	0
c443	EQ	-61.339	0	-61.339	-61.339	0
c444	EQ	-61.339	0	-61.339	-61.339	0
c445	EQ	-6.6201	0	-6.6201	-6.6201	0
c446	EQ	-6.6201	0	-6.6201	-6.6201	0
c447	EQ	-6.6201	0	-6.6201	-6.6201	0
c448	EQ	0	0	0	0	0
c449	EQ	0	0	0	0	0
c450	EQ	0	0	0	0	0
c451	EQ	0	0	0	0	0
c452	EQ	0	0	0	0	0
c453	EQ	0	0	0	0	0
c454	EQ	3	0	3	3	0
c455	EQ	1	0	1	1	0
c456	EQ	2	0	2	2	0
c457	EQ	3	0	3	3	0
c458	EQ	6	0	6	6	0
c459	EQ	3	0	3	3	0
c460	EQ	792	0	792	792	0
c461	EQ	605	0	605	605	0

2 - COLU MNS

.....CO	LUMN..... AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
PT1_1	BS	1802.44	10	0	NONE	0
PT1_2	BS	0	0.0001	0	NONE	0
PT1_3	BS	1840.88	100	0	NONE	0
PP_1	BS	0	-10	0	NONE	0
PP_2	BS	0	-0.0001	0	NONE	0
PP_3	BS	0	-100	0	NONE	0
PT2_1	BS	534.82	10	0	NONE	0
PT2_2	BS	534.82	0.0001	0	NONE	0
PT2_3	BS	520.44	100	0	NONE	0
delta1_	101 EQ	0	0	0	0	-9012.2
delta1_	91 BS	1	0	1	1	0
delta1_	81 BS	0	0	0	0	0
delta1_	71 EQ	0	0	0	0	-96.2
delta1_	61 EQ	0	0	0	0	-144.2
delta1_	51 EQ	0	0	0	0	-192.3
delta1_	41 EQ	0	0	0	0	-240.4
delta1_	31 EQ	0	0	0	0	-288.4

delta1_	21	EQ	0	0	0	0	-336.5
delta1_	11	EQ	0	0	0	0	-600.9
H1_1	BS		187	0	0	212	0
delta1_	102	EQ	0	0	0	0	0.009612
delta1_	92	EQ	0	0	0	0	0.005768
delta1_	82	EQ	0	0	0	0	0.004806
delta1_	72	EQ	0	0	0	0	0.003844
delta1_	62	EQ	0	0	0	0	0.002884
delta1_	52	EQ	0	0	0	0	0.001922
delta1_	42	EQ	1	0	1	1	-0.17448
delta1_	32	BS	0	0	0	0	0
delta1_	22	EQ	0	0	0	0	-0.00096
delta1_	12	EQ	0	0	0	0	-0.00625
H1_2	BS		182.3037	0	0	212	0
delta1_	103	EQ	1	0	1	1	3844
delta1_	93	BS	0	0	0	0	0
delta1_	83	EQ	0	0	0	0	-962
delta1_	73	EQ	0	0	0	0	-1924
delta1_	63	EQ	0	0	0	0	-2884
delta1_	53	EQ	0	0	0	0	-3846
delta1_	43	EQ	0	0	0	0	-4808
delta1_	33	EQ	0	0	0	0	-5768
delta1_	23	EQ	0	0	0	0	-6730
delta1_	13	EQ	0	0	0	0	-12018
H1_3	BS		188.2463	0	0	212	0
FB1_1	BS		792	0	770	812	0
FB2_1	BS		605	0	587	620	0
FB1_2	BS		791.1842	0	770	812	0
FB2_2	BS		608.8805	0	587	620	0
FB1_3	BS		791.2874	0	770	812	0
FB2_3	BS		603.0411	0	587	620	0
phi1_11	61	BS	0	0	0	0	0
phi1_11	51	EQ	0	0	0	0	-264.8
phi1_11	41	EQ	0	0	0	0	-535.5
phi1_11	31	EQ	0	0	0	0	-814.5
phi1_11	21	EQ	0	0	0	0	-1103.7
phi1_11	11	EQ	0	0	0	0	-3107.4
phi1_21	61	BS	0	0	0	0	0
phi1_21	51	EQ	0	0	0	0	-273.2
phi1_21	41	EQ	0	0	0	0	-552.4
phi1_21	31	EQ	0	0	0	0	-840.1
phi1_21	21	EQ	0	0	0	0	-1138.4
phi1_21	11	EQ	0	0	0	0	-3205.1
phi1_31	61	BS	0	0	0	0	0
phi1_31	51	EQ	0	0	0	0	-274.7
phi1_31	41	EQ	0	0	0	0	-555.5
phi1_31	31	EQ	0	0	0	0	-844.8
phi1_31	21	EQ	0	0	0	0	-1144.8
phi1_31	11	EQ	0	0	0	0	-3222.9
phi1_41	61	BS	0	0	0	0	0
phi1_41	51	EQ	0	0	0	0	-276.2

phi1_41	41	EQ	0	0	0	0	-558.5
phi1_41	31	EQ	0	0	0	0	-849.4
phi1_41	21	EQ	0	0	0	0	-1151
phi1_41	11	EQ	0	0	0	0	-3240.6
phi1_51	61	BS	0	0	0	0	0
phi1_51	51	EQ	0	0	0	0	-277.7
phi1_51	41	EQ	0	0	0	0	-561.6
phi1_51	31	EQ	0	0	0	0	-854.1
phi1_51	21	EQ	0	0	0	0	-1157.3
phi1_51	11	EQ	0	0	0	0	-3258.4
phi1_61	61	BS	0	0	0	0	0
phi1_61	51	EQ	0	0	0	0	-279.3
phi1_61	41	EQ	0	0	0	0	-564.7
phi1_61	31	EQ	0	0	0	0	-858.8
phi1_61	21	EQ	0	0	0	0	-1163.7
phi1_61	11	EQ	0	0	0	0	-3276.2
phi1_71	61	BS	0	0	0	0	0
phi1_71	51	EQ	0	0	0	0	-280.7
phi1_71	41	EQ	0	0	0	0	-567.7
phi1_71	31	EQ	0	0	0	0	-863.4
phi1_71	21	EQ	0	0	0	0	-1169.9
phi1_71	11	EQ	0	0	0	0	-3293.9
phi1_81	61	BS	0	0	0	0	0
phi1_81	51	EQ	0	0	0	0	-282.3
phi1_81	41	EQ	0	0	0	0	-570.8
phi1_81	31	EQ	0	0	0	0	-868.1
phi1_81	21	EQ	0	0	0	0	-1176.3
phi1_81	11	EQ	0	0	0	0	-3311.7
phi1_91	61	BS	1	0	1	1	0
phi1_91	51	EQ	0	0	0	0	-283.8
phi1_91	41	EQ	0	0	0	0	-573.9
phi1_91	31	EQ	0	0	0	0	-872.8
phi1_91	21	EQ	0	0	0	0	-1182.6
phi1_91	11	EQ	0	0	0	0	-3329.5
phi1_10	161	EQ	0	0	0	0	9204.4
phi1_10	151	EQ	0	0	0	0	8914.6
phi1_10	141	EQ	0	0	0	0	8618.4
phi1_10	131	EQ	0	0	0	0	8313.1
phi1_10	121	EQ	0	0	0	0	7996.6
phi1_10	111	EQ	0	0	0	0	5804
phi1_12	61	EQ	0	0	0	0	-504.7
phi1_12	51	EQ	0	0	0	0	-769.5
phi1_12	41	EQ	0	0	0	0	-1040.2
phi1_12	31	EQ	0	0	0	0	-1319.2
phi1_12	21	EQ	0	0	0	0	-1608.4
phi1_12	11	EQ	0	0	0	0	-3612.1
phi1_22	61	EQ	0	0	0	0	-240.3
phi1_22	51	EQ	0	0	0	0	-513.5
phi1_22	41	EQ	0	0	0	0	-792.7
phi1_22	31	EQ	0	0	0	0	-1080.4
phi1_22	21	EQ	0	0	0	0	-1378.7

phi1_22	11	EQ	0	0	0	0	-3445.4
phi1_32	61	EQ	0	0	0	0	-192.2
phi1_32	51	EQ	0	0	0	0	-466.9
phi1_32	41	EQ	0	0	0	0	-747.7
phi1_32	31	EQ	0	0	0	0	-1037
phi1_32	21	EQ	0	0	0	0	-1337
phi1_32	11	EQ	0	0	0	0	-3415.1
phi1_42	61	EQ	0	0	0	0	-144.2
phi1_42	51	EQ	0	0	0	0	-420.4
phi1_42	41	EQ	0	0	0	0	-702.7
phi1_42	31	EQ	0	0	0	0	-993.6
phi1_42	21	EQ	0	0	0	0	-1295.2
phi1_42	11	EQ	0	0	0	0	-3384.8
phi1_52	61	EQ	0	0	0	0	-96.1
phi1_52	51	EQ	0	0	0	0	-373.8
phi1_52	41	EQ	0	0	0	0	-657.7
phi1_52	31	EQ	0	0	0	0	-950.2
phi1_52	21	EQ	0	0	0	0	-1253.4
phi1_52	11	EQ	0	0	0	0	-3354.5
phi1_62	61	EQ	0	0	0	0	-48
phi1_62	51	EQ	0	0	0	0	-327.3
phi1_62	41	EQ	0	0	0	0	-612.7
phi1_62	31	EQ	0	0	0	0	-906.8
phi1_62	21	EQ	0	0	0	0	-1211.7
phi1_62	11	EQ	0	0	0	0	-3324.2
phi1_72	61	BS	0	0	0	0	0
phi1_72	51	EQ	0	0	0	0	-280.7
phi1_72	41	EQ	0	0	0	0	-567.7
phi1_72	31	EQ	0	0	0	0	-863.4
phi1_72	21	EQ	0	0	0	0	-1169.9
phi1_72	11	EQ	0	0	0	0	-3293.9
phi1_82	61	BS	0	0	0	0	0
phi1_82	51	EQ	0	0	0	0	-282.3
phi1_82	41	EQ	0	0	0	0	-570.8
phi1_82	31	EQ	0	0	0	0	-868.1
phi1_82	21	EQ	0	0	0	0	-1176.3
phi1_82	11	EQ	0	0	0	0	-3311.7
phi1_92	61	EQ	1	0	1	1	96.2
phi1_92	51	EQ	0	0	0	0	-187.6
phi1_92	41	EQ	0	0	0	0	-477.7
phi1_92	31	EQ	0	0	0	0	-776.6
phi1_92	21	EQ	0	0	0	0	-1086.4
phi1_92	11	EQ	0	0	0	0	-3233.3
phi1_10	261	EQ	0	0	0	0	288.4
phi1_10	251	EQ	0	0	0	0	-1.4
phi1_10	241	EQ	0	0	0	0	-297.6
phi1_10	231	EQ	0	0	0	0	-602.9
phi1_10	221	EQ	0	0	0	0	-919.4
phi1_10	211	EQ	0	0	0	0	-3112
phi1_11	62	BS	0	0	0	0	0
phi1_11	52	EQ	0	0	0	0	-0.00265

phi1_11	42	EQ	0	0	0	0	-0.00536
phi1_11	32	EQ	0	0	0	0	-0.00815
phi1_11	22	EQ	0	0	0	0	-0.01104
phi1_11	12	EQ	0	0	0	0	-0.03107
phi1_21	62	BS	0	0	0	0	0
phi1_21	52	EQ	0	0	0	0	-0.00273
phi1_21	42	EQ	0	0	0	0	-0.00552
phi1_21	32	EQ	0	0	0	0	-0.0084
phi1_21	22	EQ	0	0	0	0	-0.01138
phi1_21	12	EQ	0	0	0	0	-0.03205
phi1_31	62	BS	0	0	0	0	0
phi1_31	52	EQ	0	0	0	0	-0.00275
phi1_31	42	EQ	0	0	0	0	-0.00556
phi1_31	32	EQ	0	0	0	0	-0.00845
phi1_31	22	EQ	0	0	0	0	-0.01145
phi1_31	12	EQ	0	0	0	0	-0.03223
phi1_41	62	EQ	0	0	0	0	0.087718
phi1_41	52	EQ	0	0	0	0	0.084956
phi1_41	42	EQ	0	0	0	0	0.082133
phi1_41	32	EQ	0	0	0	0	0.079224
phi1_41	22	EQ	0	0	0	0	0.076208
phi1_41	12	EQ	0	0	0	0	0.055312
phi1_51	62	BS	0	0	0	0	0
phi1_51	52	EQ	0	0	0	0	-0.00278
phi1_51	42	EQ	0	0	0	0	-0.00562
phi1_51	32	EQ	0	0	0	0	-0.00854
phi1_51	22	EQ	0	0	0	0	-0.01157
phi1_51	12	EQ	0	0	0	0	-0.03258
phi1_61	62	BS	0	0	0	0	0
phi1_61	52	EQ	0	0	0	0	-0.00279
phi1_61	42	EQ	0	0	0	0	-0.00565
phi1_61	32	EQ	0	0	0	0	-0.00859
phi1_61	22	EQ	0	0	0	0	-0.01164
phi1_61	12	EQ	0	0	0	0	-0.03276
phi1_71	62	BS	0	0	0	0	0
phi1_71	52	EQ	0	0	0	0	-0.00281
phi1_71	42	EQ	0	0	0	0	-0.00568
phi1_71	32	EQ	0	0	0	0	-0.00863
phi1_71	22	EQ	0	0	0	0	-0.0117
phi1_71	12	EQ	0	0	0	0	-0.03294
phi1_81	62	BS	0	0	0	0	0
phi1_81	52	EQ	0	0	0	0	-0.00282
phi1_81	42	EQ	0	0	0	0	-0.00571
phi1_81	32	EQ	0	0	0	0	-0.00868
phi1_81	22	EQ	0	0	0	0	-0.01176
phi1_81	12	EQ	0	0	0	0	-0.03312
phi1_91	62	BS	0	0	0	0	0
phi1_91	52	EQ	0	0	0	0	-0.00284
phi1_91	42	EQ	0	0	0	0	-0.00574
phi1_91	32	EQ	0	0	0	0	-0.00873
phi1_91	22	EQ	0	0	0	0	-0.01183

phi1_91	12	EQ	0	0	0	0	-0.0333
phi1_10	162	BS	0	0	0	0	0
phi1_10	152	EQ	0	0	0	0	-0.0029
phi1_10	142	EQ	0	0	0	0	-0.00586
phi1_10	132	EQ	0	0	0	0	-0.00891
phi1_10	122	EQ	0	0	0	0	-0.01208
phi1_10	112	EQ	0	0	0	0	-0.034
phi1_12	62	BS	0	0	0	0	0
phi1_12	52	EQ	0	0	0	0	-0.00265
phi1_12	42	EQ	0	0	0	0	-0.00536
phi1_12	32	EQ	0	0	0	0	-0.00815
phi1_12	22	EQ	0	0	0	0	-0.01104
phi1_12	12	EQ	0	0	0	0	-0.03107
phi1_22	62	BS	0	0	0	0	0
phi1_22	52	EQ	0	0	0	0	-0.00273
phi1_22	42	EQ	0	0	0	0	-0.00552
phi1_22	32	EQ	0	0	0	0	-0.0084
phi1_22	22	EQ	0	0	0	0	-0.01138
phi1_22	12	EQ	0	0	0	0	-0.03205
phi1_32	62	BS	0	0	0	0	0
phi1_32	52	EQ	0	0	0	0	-0.00275
phi1_32	42	EQ	0	0	0	0	-0.00556
phi1_32	32	EQ	0	0	0	0	-0.00845
phi1_32	22	EQ	0	0	0	0	-0.01145
phi1_32	12	EQ	0	0	0	0	-0.03223
phi1_42	62	EQ	0	0	0	0	0.087718
phi1_42	52	EQ	0	0	0	0	0.084956
phi1_42	42	EQ	0	0	0	0	0.082133
phi1_42	32	EQ	0	0	0	0	0.079224
phi1_42	22	EQ	0	0	0	0	0.076208
phi1_42	12	EQ	0	0	0	0	0.055312
phi1_52	62	BS	0	0	0	0	0
phi1_52	52	EQ	0	0	0	0	-0.00278
phi1_52	42	EQ	0	0	0	0	-0.00562
phi1_52	32	EQ	0	0	0	0	-0.00854
phi1_52	22	EQ	0	0	0	0	-0.01157
phi1_52	12	EQ	0	0	0	0	-0.03258
phi1_62	62	BS	0	0	0	0	0
phi1_62	52	EQ	0	0	0	0	-0.00279
phi1_62	42	EQ	0	0	0	0	-0.00565
phi1_62	32	EQ	0	0	0	0	-0.00859
phi1_62	22	EQ	0	0	0	0	-0.01164
phi1_62	12	EQ	0	0	0	0	-0.03276
phi1_72	62	BS	0	0	0	0	0
phi1_72	52	EQ	0	0	0	0	-0.00281
phi1_72	42	EQ	0	0	0	0	-0.00568
phi1_72	32	EQ	0	0	0	0	-0.00863
phi1_72	22	EQ	0	0	0	0	-0.0117
phi1_72	12	EQ	0	0	0	0	-0.03294
phi1_82	62	BS	0	0	0	0	0
phi1_82	52	EQ	0	0	0	0	-0.00282

phi1_82	42	EQ	0	0	0	0	-0.00571
phi1_82	32	EQ	0	0	0	0	-0.00868
phi1_82	22	EQ	0	0	0	0	-0.01176
phi1_82	12	EQ	0	0	0	0	-0.03312
phi1_92	62	BS	0	0	0	0	0
phi1_92	52	EQ	0	0	0	0	-0.00284
phi1_92	42	EQ	0	0	0	0	-0.00574
phi1_92	32	EQ	0	0	0	0	-0.00873
phi1_92	22	EQ	0	0	0	0	-0.01183
phi1_92	12	EQ	0	0	0	0	-0.0333
phi1_10	262	BS	0	0	0	0	0
phi1_10	252	EQ	0	0	0	0	-0.0029
phi1_10	242	EQ	0	0	0	0	-0.00586
phi1_10	232	EQ	0	0	0	0	-0.00891
phi1_10	222	EQ	0	0	0	0	-0.01208
phi1_10	212	EQ	0	0	0	0	-0.034
phi1_11	63	BS	0	0	0	0	0
phi1_11	53	EQ	0	0	0	0	-2648
phi1_11	43	EQ	0	0	0	0	-5355
phi1_11	33	EQ	0	0	0	0	-8145
phi1_11	23	EQ	0	0	0	0	-11037
phi1_11	13	EQ	0	0	0	0	-31074
phi1_21	63	BS	0	0	0	0	0
phi1_21	53	EQ	0	0	0	0	-2732
phi1_21	43	EQ	0	0	0	0	-5524
phi1_21	33	EQ	0	0	0	0	-8401
phi1_21	23	EQ	0	0	0	0	-11384
phi1_21	13	EQ	0	0	0	0	-32051
phi1_31	63	BS	0	0	0	0	0
phi1_31	53	EQ	0	0	0	0	-2747
phi1_31	43	EQ	0	0	0	0	-5555
phi1_31	33	EQ	0	0	0	0	-8448
phi1_31	23	EQ	0	0	0	0	-11448
phi1_31	13	EQ	0	0	0	0	-32229
phi1_41	63	BS	0	0	0	0	0
phi1_41	53	EQ	0	0	0	0	-2762
phi1_41	43	EQ	0	0	0	0	-5585
phi1_41	33	EQ	0	0	0	0	-8494
phi1_41	23	EQ	0	0	0	0	-11510
phi1_41	13	EQ	0	0	0	0	-32406
phi1_51	63	BS	0	0	0	0	0
phi1_51	53	EQ	0	0	0	0	-2777
phi1_51	43	EQ	0	0	0	0	-5616
phi1_51	33	EQ	0	0	0	0	-8541
phi1_51	23	EQ	0	0	0	0	-11573
phi1_51	13	EQ	0	0	0	0	-32584
phi1_61	63	BS	0	0	0	0	0
phi1_61	53	EQ	0	0	0	0	-2793
phi1_61	43	EQ	0	0	0	0	-5647
phi1_61	33	EQ	0	0	0	0	-8588
phi1_61	23	EQ	0	0	0	0	-11637

phi1_61	13	EQ	0	0	0	0	-32762
phi1_71	63	BS	0	0	0	0	0
phi1_71	53	EQ	0	0	0	0	-2807
phi1_71	43	EQ	0	0	0	0	-5677
phi1_71	33	EQ	0	0	0	0	-8634
phi1_71	23	EQ	0	0	0	0	-11699
phi1_71	13	EQ	0	0	0	0	-32939
phi1_81	63	BS	0	0	0	0	0
phi1_81	53	EQ	0	0	0	0	-2823
phi1_81	43	EQ	0	0	0	0	-5708
phi1_81	33	EQ	0	0	0	0	-8681
phi1_81	23	EQ	0	0	0	0	-11763
phi1_81	13	EQ	0	0	0	0	-33117
phi1_91	63	BS	0	0	0	0	0
phi1_91	53	EQ	0	0	0	0	-2838
phi1_91	43	EQ	0	0	0	0	-5739
phi1_91	33	EQ	0	0	0	0	-8728
phi1_91	23	EQ	0	0	0	0	-11826
phi1_91	13	EQ	0	0	0	0	-33295
phi1_10	163	BS	1	0	1	1	0
phi1_10	153	EQ	0	0	0	0	-2898
phi1_10	143	EQ	0	0	0	0	-5860
phi1_10	133	EQ	0	0	0	0	-8913
phi1_10	123	EQ	0	0	0	0	-12078
phi1_10	113	EQ	0	0	0	0	-34004
phi1_12	63	BS	0	0	0	0	0
phi1_12	53	EQ	0	0	0	0	-2648
phi1_12	43	EQ	0	0	0	0	-5355
phi1_12	33	EQ	0	0	0	0	-8145
phi1_12	23	EQ	0	0	0	0	-11037
phi1_12	13	EQ	0	0	0	0	-31074
phi1_22	63	BS	0	0	0	0	0
phi1_22	53	EQ	0	0	0	0	-2732
phi1_22	43	EQ	0	0	0	0	-5524
phi1_22	33	EQ	0	0	0	0	-8401
phi1_22	23	EQ	0	0	0	0	-11384
phi1_22	13	EQ	0	0	0	0	-32051
phi1_32	63	BS	0	0	0	0	0
phi1_32	53	EQ	0	0	0	0	-2747
phi1_32	43	EQ	0	0	0	0	-5555
phi1_32	33	EQ	0	0	0	0	-8448
phi1_32	23	EQ	0	0	0	0	-11448
phi1_32	13	EQ	0	0	0	0	-32229
phi1_42	63	BS	0	0	0	0	0
phi1_42	53	EQ	0	0	0	0	-2762
phi1_42	43	EQ	0	0	0	0	-5585
phi1_42	33	EQ	0	0	0	0	-8494
phi1_42	23	EQ	0	0	0	0	-11510
phi1_42	13	EQ	0	0	0	0	-32406
phi1_52	63	BS	0	0	0	0	0
phi1_52	53	EQ	0	0	0	0	-2777

phi1_52	43	EQ	0	0	0	0	-5616
phi1_52	33	EQ	0	0	0	0	-8541
phi1_52	23	EQ	0	0	0	0	-11573
phi1_52	13	EQ	0	0	0	0	-32584
phi1_62	63	BS	0	0	0	0	0
phi1_62	53	EQ	0	0	0	0	-2793
phi1_62	43	EQ	0	0	0	0	-5647
phi1_62	33	EQ	0	0	0	0	-8588
phi1_62	23	EQ	0	0	0	0	-11637
phi1_62	13	EQ	0	0	0	0	-32762
phi1_72	63	BS	0	0	0	0	0
phi1_72	53	EQ	0	0	0	0	-2807
phi1_72	43	EQ	0	0	0	0	-5677
phi1_72	33	EQ	0	0	0	0	-8634
phi1_72	23	EQ	0	0	0	0	-11699
phi1_72	13	EQ	0	0	0	0	-32939
phi1_82	63	BS	0	0	0	0	0
phi1_82	53	EQ	0	0	0	0	-2823
phi1_82	43	EQ	0	0	0	0	-5708
phi1_82	33	EQ	0	0	0	0	-8681
phi1_82	23	EQ	0	0	0	0	-11763
phi1_82	13	EQ	0	0	0	0	-33117
phi1_92	63	BS	0	0	0	0	0
phi1_92	53	EQ	0	0	0	0	-2838
phi1_92	43	EQ	0	0	0	0	-5739
phi1_92	33	EQ	0	0	0	0	-8728
phi1_92	23	EQ	0	0	0	0	-11826
phi1_92	13	EQ	0	0	0	0	-33295
phi1_10	263	BS	1	0	1	1	0
phi1_10	253	EQ	0	0	0	0	-2898
phi1_10	243	EQ	0	0	0	0	-5860
phi1_10	233	EQ	0	0	0	0	-8913
phi1_10	223	EQ	0	0	0	0	-12078
phi1_10	213	EQ	0	0	0	0	-34004
PT1_11	BS		901.22	0	0	NONE	0
PT1_12	BS		0	0	0	NONE	0
PT1_13	BS		920.44	0	0	NONE	0
PT1_21	BS		901.22	0	0	NONE	0
PT1_22	BS		0	0	0	NONE	0
PT1_23	BS		920.44	0	0	NONE	0
PT_1	BS		2337.26	0	0	NONE	0
PT_2	BS		534.82	0	0	NONE	0
PT_3	BS		2361.32	0	0	NONE	0
QT1_11	BS		5.4501	0	0	5.5	0
QT1_12	BS		0	0	0	5.5	0
QT1_13	BS		5.4501	0	0	5.5	0
QT1_21	BS		5.4501	0	0	5.5	0
QT1_22	BS		0	0	0	5.5	0
QT1_23	BS		5.4501	0	0	5.5	0
QT1_1	BS		10.9002	0	0	NONE	0
QT1_2	BS		0	0	0	NONE	0

QT1_3	BS	10.9002	0	0	NONE	0
nu_1011	EQ	0	0	0	0	-9422.11
nu_911	EQ	0	0	0	0	-9456.99
nu_811	EQ	0	0	0	0	-9464.47
nu_711	EQ	0	0	0	0	-9471.45
nu_611	EQ	0	0	0	0	-9477.93
nu_511	EQ	0	0	0	0	-9483.91
nu_411	EQ	0	0	0	0	-9489.39
nu_311	EQ	0	0	0	0	-9494.36
nu_211	EQ	0	0	0	0	-9498.83
nu_111	EQ	0	0	0	0	-9514.27
PP_11	BS	0	0	0	NONE	0
nu_1012	EQ	0	0	0	0	-0.00708
nu_912	EQ	0	0	0	0	-0.00698
nu_812	EQ	0	0	0	0	-0.00661
nu_712	EQ	0	0	0	0	-0.00624
nu_612	EQ	0	0	0	0	-0.00586
nu_512	EQ	0	0	0	0	-0.00547
nu_412	EQ	0	0	0	0	-0.00509
nu_312	EQ	0	0	0	0	-0.00469
nu_212	EQ	0	0	0	0	-0.00429
nu_112	BS	0	0	0	0	0
PP_12	BS	0	0	0	NONE	0
nu_1013	EQ	0	0	0	0	-94221.1
nu_913	EQ	0	0	0	0	-94569.9
nu_813	EQ	0	0	0	0	-94644.7
nu_713	EQ	0	0	0	0	-94714.5
nu_613	EQ	0	0	0	0	-94779.3
nu_513	EQ	0	0	0	0	-94839.1
nu_413	EQ	0	0	0	0	-94893.9
nu_313	EQ	0	0	0	0	-94943.6
nu_213	EQ	0	0	0	0	-94988.3
nu_113	EQ	0	0	0	0	-95142.7
PP_13	BS	0	0	0	NONE	0
nu_1021	EQ	0	0	0	0	-9422.11
nu_921	EQ	0	0	0	0	-9456.99
nu_821	EQ	0	0	0	0	-9464.47
nu_721	EQ	0	0	0	0	-9471.45
nu_621	EQ	0	0	0	0	-9477.93
nu_521	EQ	0	0	0	0	-9483.91
nu_421	EQ	0	0	0	0	-9489.39
nu_321	EQ	0	0	0	0	-9494.36
nu_221	EQ	0	0	0	0	-9498.83
nu_121	EQ	0	0	0	0	-9514.27
PP_21	BS	0	0	0	NONE	0
nu_1022	EQ	0	0	0	0	-0.00708
nu_922	EQ	0	0	0	0	-0.00698
nu_822	EQ	0	0	0	0	-0.00661
nu_722	EQ	0	0	0	0	-0.00624
nu_622	EQ	0	0	0	0	-0.00586
nu_522	EQ	0	0	0	0	-0.00547

nu_422	EQ		0	0	0	0	-0.00509
nu_322	EQ		0	0	0	0	-0.00469
nu_222	EQ		0	0	0	0	-0.00429
nu_122	BS		0	0	0	0	0
PP_22	BS		0	0	0	NONE	0
nu_1023	EQ		0	0	0	0	-94221.1
nu_923	EQ		0	0	0	0	-94569.9
nu_823	EQ		0	0	0	0	-94644.7
nu_723	EQ		0	0	0	0	-94714.5
nu_623	EQ		0	0	0	0	-94779.3
nu_523	EQ		0	0	0	0	-94839.1
nu_423	EQ		0	0	0	0	-94893.9
nu_323	EQ		0	0	0	0	-94943.6
nu_223	EQ		0	0	0	0	-94988.3
nu_123	EQ		0	0	0	0	-95142.7
PP_23	BS		0	0	0	NONE	0
theta_N	O_1	EQ	1	0	1	1	0
theta_N	O_2	BS	1	0	1	1	0
theta_N	O_3	BS	1	0	1	1	0
QP_11	BS		0	0	0	NONE	0
QP_12	LL		0	0	0	NONE	-0.01928
QP_13	LL		0	0	0	NONE	0
QP_21	BS		0	0	0	NONE	0
QP_22	LL		0	0	0	NONE	-0.01928
QP_23	LL		0	0	0	NONE	0
QP_1	BS		0	0	0	NONE	0
QP_2	BS		0	0	0	NONE	0
QP_3	BS		0	0	0	NONE	0
Beta_11	BS		1	0	1	1	0
Beta_12	BS		0	0	0	0	0
Beta_13	EQ		1	0	1	1	84113
Beta_21	EQ		1	0	1	1	8916
Beta_22	BS		0	0	0	0	0
Beta_23	EQ		1	0	1	1	84113
Alpha_1	1	BS	0	0	0	0	0
Alpha_1	2	BS	0	0	0	0	0
Alpha_1	3	BS	0	0	0	0	0
Alpha_2	1	BS	0	0	0	0	0
Alpha_2	2	BS	0	0	0	0	0
Alpha_2	3	BS	0	0	0	0	0
Turbine	_1	BS	2	0	0	NONE	0
Turbine	_2	BS	0	0	0	NONE	0
Turbine	_3	BS	2	0	0	NONE	0
Pump_1	BS		0	0	0	NONE	0
Pump_2	BS		0	0	0	NONE	0
Pump_3	BS		0	0	0	NONE	0
Produce	_1	BS	1	0	1	1	0
Produce	_2	EQ	1	0	1	1	0
Produce	_3	BS	1	0	1	1	0
Spill1_	NO_1	BS	792	0	0	NONE	0
Spill1_	YES_1	LL	0	0	0	NONE	0

Spill1_	NO_2	BS	791.1842	0	0	NONE	0
Spill1_	YES_2	LL	0	0	0	NONE	0
Spill1_	NO_3	BS	791.2874	0	0	NONE	0
Spill1_	YES_3	LL	0	0	0	NONE	0
theta_Y	ES_1	EQ	0	0	0	0	0
theta_Y	ES_2	BS	0	0	0	0	0
theta_Y	ES_3	BS	0	0	0	0	0
theta_3	1	EQ	0	0	0	0	0
theta_2	1	EQ	0	0	0	0	0
theta_1	1	EQ	0	0	0	0	0
SPILL1_	YES_1	LL	0	0	0	NONE	0
theta_3	2	EQ	0	0	0	0	0
theta_2	2	EQ	0	0	0	0	0
theta_1	2	EQ	0	0	0	0	0
SPILL1_	YES_2	LL	0	0	0	NONE	0
theta_3	3	EQ	0	0	0	0	0
theta_2	3	EQ	0	0	0	0	0
theta_1	3	BS	0	0	0	0	0
SPILL1_	YES_3	LL	0	0	0	NONE	0
UnContR	el_1	LL	0	0	0	NONE	0
UnContR	el_2	BS	0	0	0	NONE	0
UnContR	el_3	BS	0	0	0	NONE	0
delta2_	101	EQ	0	0	0	0	-5348.2
delta2_	91	EQ	0	0	0	0	718.6
delta2_	81	EQ	0	0	0	0	574.8
delta2_	71	EQ	0	0	0	0	431.2
delta2_	61	EQ	0	0	0	0	287.4
delta2_	51	EQ	0	0	0	0	143.6
delta2_	41	BS	1	0	1	1	0
delta2_	31	EQ	0	0	0	0	-143.8
delta2_	21	EQ	0	0	0	0	-287.4
delta2_	11	EQ	0	0	0	0	-431.2
H2_1	BS		64.25	0	0	NONE	0
delta2_	102	EQ	0	0	0	0	0.008624
delta2_	92	EQ	0	0	0	0	0.007186
delta2_	82	BS	0	0	0	0	0
delta2_	72	EQ	0	0	0	0	0.004312
delta2_	62	EQ	0	0	0	0	0.002874
delta2_	52	BS	0	0	0	0	0
delta2_	42	BS	1	0	1	1	0
delta2_	32	EQ	0	0	0	0	-0.00144
delta2_	22	EQ	0	0	0	0	-0.00287
delta2_	12	EQ	0	0	0	0	-0.00431
H2_2	BS		64.25	0	0	NONE	0
delta2_	103	EQ	0	0	0	0	10062
delta2_	93	EQ	0	0	0	0	8624
delta2_	83	EQ	0	0	0	0	7186
delta2_	73	EQ	0	0	0	0	5750
delta2_	63	EQ	0	0	0	0	4312
delta2_	53	EQ	0	0	0	0	2874
delta2_	43	EQ	0	0	0	0	1438

delta2_	33	BS	1	0	1	1	0
delta2_	23	EQ	0	0	0	0	-1436
delta2_	13	EQ	0	0	0	0	-2874
H2_3	BS		62.5	0	0	NONE	0
TR2_1	BS		540.75	0	532	551	0
TR2_2	BS		544.6305	0	532	551	0
TR2_3	BS		540.5411	0	532	551	0
phi2_11	61	BS	0	0	0	0	0
phi2_11	51	EQ	0	0	0	0	-379.5
phi2_11	41	EQ	0	0	0	0	-557.2
phi2_11	31	EQ	0	0	0	0	-738.9
phi2_11	21	EQ	0	0	0	0	-920.9
phi2_11	11	EQ	0	0	0	0	-1435.9
phi2_21	61	BS	0	0	0	0	0
phi2_21	51	EQ	0	0	0	0	-390.6
phi2_21	41	EQ	0	0	0	0	-573.5
phi2_21	31	EQ	0	0	0	0	-760.6
phi2_21	21	EQ	0	0	0	0	-947.8
phi2_21	11	EQ	0	0	0	0	-1477.9
phi2_31	61	BS	0	0	0	0	0
phi2_31	51	EQ	0	0	0	0	-401.6
phi2_31	41	EQ	0	0	0	0	-589.7
phi2_31	31	EQ	0	0	0	0	-782.1
phi2_31	21	EQ	0	0	0	0	-974.7
phi2_31	11	EQ	0	0	0	0	-1519.8
phi2_41	61	BS	1	0	1	1	0
phi2_41	51	EQ	0	0	0	0	-412.8
phi2_41	41	EQ	0	0	0	0	-606
phi2_41	31	EQ	0	0	0	0	-803.7
phi2_41	21	EQ	0	0	0	0	-1001.7
phi2_41	11	EQ	0	0	0	0	-1561.8
phi2_51	61	BS	0	0	0	0	0
phi2_51	51	EQ	0	0	0	0	-423.8
phi2_51	41	EQ	0	0	0	0	-622.3
phi2_51	31	EQ	0	0	0	0	-825.3
phi2_51	21	EQ	0	0	0	0	-1028.5
phi2_51	11	EQ	0	0	0	0	-1603.8
phi2_61	61	BS	0	0	0	0	0
phi2_61	51	EQ	0	0	0	0	-434.9
phi2_61	41	EQ	0	0	0	0	-638.6
phi2_61	31	EQ	0	0	0	0	-846.9
phi2_61	21	EQ	0	0	0	0	-1055.5
phi2_61	11	EQ	0	0	0	0	-1645.8
phi2_71	61	BS	0	0	0	0	0
phi2_71	51	EQ	0	0	0	0	-446.1
phi2_71	41	EQ	0	0	0	0	-654.9
phi2_71	31	EQ	0	0	0	0	-868.5
phi2_71	21	EQ	0	0	0	0	-1082.4
phi2_71	11	EQ	0	0	0	0	-1687.8
phi2_81	61	BS	0	0	0	0	0
phi2_81	51	EQ	0	0	0	0	-457.1

phi2_81	41	EQ	0	0	0	0	-671.1
phi2_81	31	EQ	0	0	0	0	-890.1
phi2_81	21	EQ	0	0	0	0	-1109.3
phi2_81	11	EQ	0	0	0	0	-1729.7
phi2_91	61	BS	0	0	0	0	0
phi2_91	51	EQ	0	0	0	0	-468.2
phi2_91	41	EQ	0	0	0	0	-687.5
phi2_91	31	EQ	0	0	0	0	-911.7
phi2_91	21	EQ	0	0	0	0	-1136.2
phi2_91	11	EQ	0	0	0	0	-1771.7
phi2_10	161	EQ	0	0	0	0	3105.3
phi2_10	151	EQ	0	0	0	0	2625.9
phi2_10	141	EQ	0	0	0	0	2401.5
phi2_10	131	EQ	0	0	0	0	2171.9
phi2_10	121	EQ	0	0	0	0	1942.1
phi2_10	111	EQ	0	0	0	0	1291.6
phi2_12	61	BS	0	0	0	0	0
phi2_12	51	EQ	0	0	0	0	-379.5
phi2_12	41	EQ	0	0	0	0	-557.2
phi2_12	31	EQ	0	0	0	0	-738.9
phi2_12	21	EQ	0	0	0	0	-920.9
phi2_12	11	EQ	0	0	0	0	-1435.9
phi2_22	61	BS	0	0	0	0	0
phi2_22	51	EQ	0	0	0	0	-390.6
phi2_22	41	EQ	0	0	0	0	-573.5
phi2_22	31	EQ	0	0	0	0	-760.6
phi2_22	21	EQ	0	0	0	0	-947.8
phi2_22	11	EQ	0	0	0	0	-1477.9
phi2_32	61	BS	0	0	0	0	0
phi2_32	51	EQ	0	0	0	0	-401.6
phi2_32	41	EQ	0	0	0	0	-589.7
phi2_32	31	EQ	0	0	0	0	-782.1
phi2_32	21	EQ	0	0	0	0	-974.7
phi2_32	11	EQ	0	0	0	0	-1519.8
phi2_42	61	BS	1	0	1	1	0
phi2_42	51	EQ	0	0	0	0	-412.8
phi2_42	41	EQ	0	0	0	0	-606
phi2_42	31	EQ	0	0	0	0	-803.7
phi2_42	21	EQ	0	0	0	0	-1001.7
phi2_42	11	EQ	0	0	0	0	-1561.8
phi2_52	61	BS	0	0	0	0	0
phi2_52	51	EQ	0	0	0	0	-423.8
phi2_52	41	EQ	0	0	0	0	-622.3
phi2_52	31	EQ	0	0	0	0	-825.3
phi2_52	21	EQ	0	0	0	0	-1028.5
phi2_52	11	EQ	0	0	0	0	-1603.8
phi2_62	61	BS	0	0	0	0	0
phi2_62	51	EQ	0	0	0	0	-434.9
phi2_62	41	EQ	0	0	0	0	-638.6
phi2_62	31	EQ	0	0	0	0	-846.9
phi2_62	21	EQ	0	0	0	0	-1055.5

phi2_62	11	EQ	0	0	0	0	-1645.8
phi2_72	61	BS	0	0	0	0	0
phi2_72	51	EQ	0	0	0	0	-446.1
phi2_72	41	EQ	0	0	0	0	-654.9
phi2_72	31	EQ	0	0	0	0	-868.5
phi2_72	21	EQ	0	0	0	0	-1082.4
phi2_72	11	EQ	0	0	0	0	-1687.8
phi2_82	61	BS	0	0	0	0	0
phi2_82	51	EQ	0	0	0	0	-457.1
phi2_82	41	EQ	0	0	0	0	-671.1
phi2_82	31	EQ	0	0	0	0	-890.1
phi2_82	21	EQ	0	0	0	0	-1109.3
phi2_82	11	EQ	0	0	0	0	-1729.7
phi2_92	61	BS	0	0	0	0	0
phi2_92	51	EQ	0	0	0	0	-468.2
phi2_92	41	EQ	0	0	0	0	-687.5
phi2_92	31	EQ	0	0	0	0	-911.7
phi2_92	21	EQ	0	0	0	0	-1136.2
phi2_92	11	EQ	0	0	0	0	-1771.7
phi2_10	261	EQ	0	0	0	0	3105.3
phi2_10	251	EQ	0	0	0	0	2625.9
phi2_10	241	EQ	0	0	0	0	2401.5
phi2_10	231	EQ	0	0	0	0	2171.9
phi2_10	221	EQ	0	0	0	0	1942.1
phi2_10	211	EQ	0	0	0	0	1291.6
phi2_11	62	BS	0	0	0	0	0
phi2_11	52	EQ	0	0	0	0	-0.0038
phi2_11	42	EQ	0	0	0	0	-0.00557
phi2_11	32	EQ	0	0	0	0	-0.00739
phi2_11	22	EQ	0	0	0	0	-0.00921
phi2_11	12	EQ	0	0	0	0	-0.01436
phi2_21	62	BS	0	0	0	0	0
phi2_21	52	EQ	0	0	0	0	-0.00391
phi2_21	42	EQ	0	0	0	0	-0.00574
phi2_21	32	EQ	0	0	0	0	-0.00761
phi2_21	22	EQ	0	0	0	0	-0.00948
phi2_21	12	EQ	0	0	0	0	-0.01478
phi2_31	62	BS	0	0	0	0	0
phi2_31	52	EQ	0	0	0	0	-0.00402
phi2_31	42	EQ	0	0	0	0	-0.0059
phi2_31	32	EQ	0	0	0	0	-0.00782
phi2_31	22	EQ	0	0	0	0	-0.00975
phi2_31	12	EQ	0	0	0	0	-0.0152
phi2_41	62	BS	1	0	1	1	0
phi2_41	52	EQ	0	0	0	0	-0.00413
phi2_41	42	EQ	0	0	0	0	-0.00606
phi2_41	32	EQ	0	0	0	0	-0.00804
phi2_41	22	EQ	0	0	0	0	-0.01002
phi2_41	12	EQ	0	0	0	0	-0.01562
phi2_51	62	BS	0	0	0	0	0
phi2_51	52	EQ	0	0	0	0	-0.00424

phi2_51	42	EQ	0	0	0	0	-0.00622
phi2_51	32	EQ	0	0	0	0	-0.00825
phi2_51	22	EQ	0	0	0	0	-0.01029
phi2_51	12	EQ	0	0	0	0	-0.01604
phi2_61	62	BS	0	0	0	0	0
phi2_61	52	EQ	0	0	0	0	-0.00435
phi2_61	42	EQ	0	0	0	0	-0.00639
phi2_61	32	EQ	0	0	0	0	-0.00847
phi2_61	22	EQ	0	0	0	0	-0.01056
phi2_61	12	EQ	0	0	0	0	-0.01646
phi2_71	62	BS	0	0	0	0	0
phi2_71	52	EQ	0	0	0	0	-0.00446
phi2_71	42	EQ	0	0	0	0	-0.00655
phi2_71	32	EQ	0	0	0	0	-0.00869
phi2_71	22	EQ	0	0	0	0	-0.01082
phi2_71	12	EQ	0	0	0	0	-0.01688
phi2_81	62	EQ	0	0	0	0	0.001177
phi2_81	52	EQ	0	0	0	0	-0.00339
phi2_81	42	EQ	0	0	0	0	-0.00553
phi2_81	32	EQ	0	0	0	0	-0.00772
phi2_81	22	EQ	0	0	0	0	-0.00992
phi2_81	12	EQ	0	0	0	0	-0.01612
phi2_91	62	BS	0	0	0	0	0
phi2_91	52	EQ	0	0	0	0	-0.00468
phi2_91	42	EQ	0	0	0	0	-0.00688
phi2_91	32	EQ	0	0	0	0	-0.00912
phi2_91	22	EQ	0	0	0	0	-0.01136
phi2_91	12	EQ	0	0	0	0	-0.01772
phi2_10	162	BS	0	0	0	0	0
phi2_10	152	EQ	0	0	0	0	-0.00479
phi2_10	142	EQ	0	0	0	0	-0.00704
phi2_10	132	EQ	0	0	0	0	-0.00933
phi2_10	122	EQ	0	0	0	0	-0.01163
phi2_10	112	EQ	0	0	0	0	-0.01814
phi2_12	62	BS	0	0	0	0	0
phi2_12	52	EQ	0	0	0	0	-0.0038
phi2_12	42	EQ	0	0	0	0	-0.00557
phi2_12	32	EQ	0	0	0	0	-0.00739
phi2_12	22	EQ	0	0	0	0	-0.00921
phi2_12	12	EQ	0	0	0	0	-0.01436
phi2_22	62	BS	0	0	0	0	0
phi2_22	52	EQ	0	0	0	0	-0.00391
phi2_22	42	EQ	0	0	0	0	-0.00574
phi2_22	32	EQ	0	0	0	0	-0.00761
phi2_22	22	EQ	0	0	0	0	-0.00948
phi2_22	12	EQ	0	0	0	0	-0.01478
phi2_32	62	BS	0	0	0	0	0
phi2_32	52	EQ	0	0	0	0	-0.00402
phi2_32	42	EQ	0	0	0	0	-0.0059
phi2_32	32	EQ	0	0	0	0	-0.00782
phi2_32	22	EQ	0	0	0	0	-0.00975

phi2_32	12	EQ	0	0	0	0		-0.0152
phi2_42	62	BS	1	0	1	1		0
phi2_42	52	EQ	0	0	0	0		-0.00413
phi2_42	42	EQ	0	0	0	0		-0.00606
phi2_42	32	EQ	0	0	0	0		-0.00804
phi2_42	22	EQ	0	0	0	0		-0.01002
phi2_42	12	EQ	0	0	0	0		-0.01562
phi2_52	62	EQ	0	0	0	0		0.001436
phi2_52	52	EQ	0	0	0	0		-0.0028
phi2_52	42	EQ	0	0	0	0		-0.00479
phi2_52	32	EQ	0	0	0	0		-0.00682
phi2_52	22	EQ	0	0	0	0		-0.00885
phi2_52	12	EQ	0	0	0	0		-0.0146
phi2_62	62	BS	0	0	0	0		0
phi2_62	52	EQ	0	0	0	0		-0.00435
phi2_62	42	EQ	0	0	0	0		-0.00639
phi2_62	32	EQ	0	0	0	0		-0.00847
phi2_62	22	EQ	0	0	0	0		-0.01056
phi2_62	12	EQ	0	0	0	0		-0.01646
phi2_72	62	BS	0	0	0	0		0
phi2_72	52	EQ	0	0	0	0		-0.00446
phi2_72	42	EQ	0	0	0	0		-0.00655
phi2_72	32	EQ	0	0	0	0		-0.00869
phi2_72	22	EQ	0	0	0	0		-0.01082
phi2_72	12	EQ	0	0	0	0		-0.01688
phi2_82	62	EQ	0	0	0	0		0.004571
phi2_82	52	BS	0	0	0	0		0
phi2_82	42	EQ	0	0	0	0		-0.00214
phi2_82	32	EQ	0	0	0	0		-0.00433
phi2_82	22	EQ	0	0	0	0		-0.00652
phi2_82	12	EQ	0	0	0	0		-0.01273
phi2_92	62	BS	0	0	0	0		0
phi2_92	52	EQ	0	0	0	0		-0.00468
phi2_92	42	EQ	0	0	0	0		-0.00688
phi2_92	32	EQ	0	0	0	0		-0.00912
phi2_92	22	EQ	0	0	0	0		-0.01136
phi2_92	12	EQ	0	0	0	0		-0.01772
phi2_10	262	BS	0	0	0	0		0
phi2_10	252	EQ	0	0	0	0		-0.00479
phi2_10	242	EQ	0	0	0	0		-0.00704
phi2_10	232	EQ	0	0	0	0		-0.00933
phi2_10	222	EQ	0	0	0	0		-0.01163
phi2_10	212	EQ	0	0	0	0		-0.01814
phi2_11	63	BS	0	0	0	0		0
phi2_11	53	EQ	0	0	0	0		-3795
phi2_11	43	EQ	0	0	0	0		-5572
phi2_11	33	EQ	0	0	0	0		-7389
phi2_11	23	EQ	0	0	0	0		-9209
phi2_11	13	EQ	0	0	0	0		-14359
phi2_21	63	BS	0	0	0	0		0
phi2_21	53	EQ	0	0	0	0		-3906

phi2_21	43	EQ	0	0	0	0	-5735
phi2_21	33	EQ	0	0	0	0	-7606
phi2_21	23	EQ	0	0	0	0	-9478
phi2_21	13	EQ	0	0	0	0	-14779
phi2_31	63	BS	1	0	1	1	0
phi2_31	53	EQ	0	0	0	0	-4016
phi2_31	43	EQ	0	0	0	0	-5897
phi2_31	33	EQ	0	0	0	0	-7821
phi2_31	23	EQ	0	0	0	0	-9747
phi2_31	13	EQ	0	0	0	0	-15198
phi2_41	63	BS	0	0	0	0	0
phi2_41	53	EQ	0	0	0	0	-4128
phi2_41	43	EQ	0	0	0	0	-6060
phi2_41	33	EQ	0	0	0	0	-8037
phi2_41	23	EQ	0	0	0	0	-10017
phi2_41	13	EQ	0	0	0	0	-15618
phi2_51	63	BS	0	0	0	0	0
phi2_51	53	EQ	0	0	0	0	-4238
phi2_51	43	EQ	0	0	0	0	-6223
phi2_51	33	EQ	0	0	0	0	-8253
phi2_51	23	EQ	0	0	0	0	-10285
phi2_51	13	EQ	0	0	0	0	-16038
phi2_61	63	BS	0	0	0	0	0
phi2_61	53	EQ	0	0	0	0	-4349
phi2_61	43	EQ	0	0	0	0	-6386
phi2_61	33	EQ	0	0	0	0	-8469
phi2_61	23	EQ	0	0	0	0	-10555
phi2_61	13	EQ	0	0	0	0	-16458
phi2_71	63	BS	0	0	0	0	0
phi2_71	53	EQ	0	0	0	0	-4461
phi2_71	43	EQ	0	0	0	0	-6549
phi2_71	33	EQ	0	0	0	0	-8685
phi2_71	23	EQ	0	0	0	0	-10824
phi2_71	13	EQ	0	0	0	0	-16878
phi2_81	63	BS	0	0	0	0	0
phi2_81	53	EQ	0	0	0	0	-4571
phi2_81	43	EQ	0	0	0	0	-6711
phi2_81	33	EQ	0	0	0	0	-8901
phi2_81	23	EQ	0	0	0	0	-11093
phi2_81	13	EQ	0	0	0	0	-17297
phi2_91	63	BS	0	0	0	0	0
phi2_91	53	EQ	0	0	0	0	-4682
phi2_91	43	EQ	0	0	0	0	-6875
phi2_91	33	EQ	0	0	0	0	-9117
phi2_91	23	EQ	0	0	0	0	-11362
phi2_91	13	EQ	0	0	0	0	-17717
phi2_10	163	BS	0	0	0	0	0
phi2_10	153	EQ	0	0	0	0	-4794
phi2_10	143	EQ	0	0	0	0	-7038
phi2_10	133	EQ	0	0	0	0	-9334
phi2_10	123	EQ	0	0	0	0	-11632

phi2_10	113	EQ	0	0	0	0	-18137
phi2_12	63	BS	0	0	0	0	0
phi2_12	53	EQ	0	0	0	0	-3795
phi2_12	43	EQ	0	0	0	0	-5572
phi2_12	33	EQ	0	0	0	0	-7389
phi2_12	23	EQ	0	0	0	0	-9209
phi2_12	13	EQ	0	0	0	0	-14359
phi2_22	63	BS	0	0	0	0	0
phi2_22	53	EQ	0	0	0	0	-3906
phi2_22	43	EQ	0	0	0	0	-5735
phi2_22	33	EQ	0	0	0	0	-7606
phi2_22	23	EQ	0	0	0	0	-9478
phi2_22	13	EQ	0	0	0	0	-14779
phi2_32	63	BS	1	0	1	1	0
phi2_32	53	EQ	0	0	0	0	-4016
phi2_32	43	EQ	0	0	0	0	-5897
phi2_32	33	EQ	0	0	0	0	-7821
phi2_32	23	EQ	0	0	0	0	-9747
phi2_32	13	EQ	0	0	0	0	-15198
phi2_42	63	BS	0	0	0	0	0
phi2_42	53	EQ	0	0	0	0	-4128
phi2_42	43	EQ	0	0	0	0	-6060
phi2_42	33	EQ	0	0	0	0	-8037
phi2_42	23	EQ	0	0	0	0	-10017
phi2_42	13	EQ	0	0	0	0	-15618
phi2_52	63	BS	0	0	0	0	0
phi2_52	53	EQ	0	0	0	0	-4238
phi2_52	43	EQ	0	0	0	0	-6223
phi2_52	33	EQ	0	0	0	0	-8253
phi2_52	23	EQ	0	0	0	0	-10285
phi2_52	13	EQ	0	0	0	0	-16038
phi2_62	63	BS	0	0	0	0	0
phi2_62	53	EQ	0	0	0	0	-4349
phi2_62	43	EQ	0	0	0	0	-6386
phi2_62	33	EQ	0	0	0	0	-8469
phi2_62	23	EQ	0	0	0	0	-10555
phi2_62	13	EQ	0	0	0	0	-16458
phi2_72	63	BS	0	0	0	0	0
phi2_72	53	EQ	0	0	0	0	-4461
phi2_72	43	EQ	0	0	0	0	-6549
phi2_72	33	EQ	0	0	0	0	-8685
phi2_72	23	EQ	0	0	0	0	-10824
phi2_72	13	EQ	0	0	0	0	-16878
phi2_82	63	BS	0	0	0	0	0
phi2_82	53	EQ	0	0	0	0	-4571
phi2_82	43	EQ	0	0	0	0	-6711
phi2_82	33	EQ	0	0	0	0	-8901
phi2_82	23	EQ	0	0	0	0	-11093
phi2_82	13	EQ	0	0	0	0	-17297
phi2_92	63	BS	0	0	0	0	0
phi2_92	53	EQ	0	0	0	0	-4682

phi2_92	43	EQ	0	0	0	0	-6875
phi2_92	33	EQ	0	0	0	0	-9117
phi2_92	23	EQ	0	0	0	0	-11362
phi2_92	13	EQ	0	0	0	0	-17717
phi2_10	263	BS	0	0	0	0	0
phi2_10	253	EQ	0	0	0	0	-4794
phi2_10	243	EQ	0	0	0	0	-7038
phi2_10	233	EQ	0	0	0	0	-9334
phi2_10	223	EQ	0	0	0	0	-11632
phi2_10	213	EQ	0	0	0	0	-18137
PT2_11	BS		267.41	0	0	NONE	0
PT2_12	BS		267.41	0	0	NONE	0
PT2_13	BS		260.22	0	0	NONE	0
PT2_21	BS		267.41	0	0	NONE	0
PT2_22	BS		267.41	0	0	NONE	0
PT2_23	BS		260.22	0	0	NONE	0
QT2_11	BS		4.2501	0	0	5.5	0
QT2_12	BS		5	0	0	5.5	0
QT2_13	BS		4.2501	0	0	5.5	0
QT2_21	BS		4.4999	0	0	5.5	0
QT2_22	BS		5	0	0	5.5	0
QT2_23	BS		4.2501	0	0	5.5	0
QT2_1	BS		8.75	0	0	NONE	0
QT2_2	BS		10	0	0	NONE	0
QT2_3	BS		8.5002	0	0	NONE	0
Spill2_	NO_1	LL	0	0	0	NONE	0
Spill2_	YES_1	BS	605	0	0	NONE	0
Spill2_	NO_2	BS	0	0	0	NONE	0
Spill2_	YES_2	BS	608.8805	0	0	NONE	0
Spill2_	NO_3	BS	603.0411	0	0	NONE	0
Spill2_	YES_3	LL	0	0	0	NONE	0
sigma_N	O_1	BS	0	0	0	0	0
sigma_N	O_2	BS	0	0	0	0	0
sigma_N	O_3	BS	1	0	1	1	0
sigma_Y	ES_1	EQ	1	0	1	1	0
sigma_Y	ES_2	EQ	1	0	1	1	0
sigma_Y	ES_3	BS	0	0	0	0	0
Gated_1	LL		0	0	0	NONE	0
Gated_2	BS		3.75	0	0	NONE	0
Gated_3	LL		0	0	0	NONE	0
Chan_1	BS		8.75	0	0	NONE	0
Chan_2	BS		13.75	0	0	NONE	0
Chan_3	BS		8.5002	0	0	NONE	0
zeta_91	EQ		0	0	0	0	0
zeta_81	EQ		0	0	0	0	0
zeta_71	EQ		0	0	0	0	0
zeta_61	EQ		0	0	0	0	0
zeta_51	EQ		0	0	0	0	0
zeta_41	BS		1	0	1	1	0
zeta_31	EQ		0	0	0	0	0
zeta_21	EQ		0	0	0	0	0

zeta_11	EQ	0	0	0	0	0
zeta_92	EQ	0	0	0	0	0
zeta_82	EQ	0	0	0	0	0
zeta_72	EQ	0	0	0	0	0
zeta_62	EQ	1	0	1	1	0
zeta_52	BS	0	0	0	0	0
zeta_42	EQ	0	0	0	0	0
zeta_32	EQ	0	0	0	0	0
zeta_22	EQ	0	0	0	0	0
zeta_12	EQ	0	0	0	0	0
zeta_93	EQ	0	0	0	0	0
zeta_83	EQ	0	0	0	0	0
zeta_73	EQ	0	0	0	0	0
zeta_63	EQ	0	0	0	0	0
zeta_53	EQ	0	0	0	0	0
zeta_43	EQ	1	0	1	1	0
zeta_33	EQ	0	0	0	0	0
zeta_23	EQ	0	0	0	0	0
zeta_13	BS	0	0	0	0	0
S1_1	BS	4.925264	0	0	NONE	0
S1_2	BS	4.857006	0	0	NONE	0
S1_3	BS	4.865646	0	0	NONE	0
S2_1	BS	0.317435	0	0	NONE	0
S2_2	BS	0.361933	0	0	NONE	0
S2_3	BS	0.294973	0	0	NONE	0
I1_1	BS	3	0	0	NONE	0
I1_2	BS	1	0	0	NONE	0
S1_4	BS	4.788749	0	3	7	0
I1_3	BS	2	0	0	NONE	0
I2_1	BS	3	0	0	NONE	0
I2_2	BS	6	0	0	NONE	0
S2_4	BS	0.341629	0	0	10	0
I2_3	BS	3	0	0	NONE	0

Input to CPLEX for Analysis 2

```
MAXIMIZE
10PT1_1+.0001PT1_2+1000PT1_3-10PP_1-.0001PP_2-
1000PP_3+10PT2_1+.0001PT2_2+1000PT2_3


st

all remained the same
```

Output from CPLEX for Analysis 2

Integer optimal solution (0.0001/0): Objective = 2.3943653104e+06
Current MIP best bound = 2.3946032854e+06 (gap = 237.975)
Solution time = 325.63 sec. Iterations = 669466 Nodes = 45538 (584)

Iteration log . . .
Iteration: 1 Scaled infeas = 10.070089

Primal - Optimal: Objective = 2.3943653104e+06
Solution time = 0.02 sec. Iterations = 5 (5)

PROBLEM NAME cplex100.txt
DATA NAME
OBJECTIVE VALUE 2394365
STATUS OPTIMAL SOLN
ITERATION 5

OBJECTIVE (MAX)
RHS
RANGES
BOUNDS

Row	AT	Activity	Slack Activity	Lower Limit	Upper Limit	Dual Activity
	BS	2394365	-2394365	NONE	NONE	1

c1	BS	0	0	NONE	0	0
c2	BS	-0.55598	0.555979	NONE	0	0
c3	UL	0	0	NONE	0	0
c4	BS	0.999	-0.999	0	NONE	0
c5	BS	0.443021	-0.44302	0	NONE	0
c6	BS	7	-7	0	NONE	0
c7	EQ	1	0	1	1	-3521.7
c8	BS	1	0	1	1	0
c9	EQ	1	0	1	1	-132180
c10	EQ	0	0	0	0	0
c11	EQ	0	0	0	0	0
c12	EQ	0	0	0	0	0
c13	BS	0	0	NONE	0	0
c14	BS	0	0	NONE	0	0
c15	BS	0	0	NONE	0	0
c16	UL	0	0	NONE	0	-48
c17	UL	0	0	NONE	0	-96.1
c18	UL	0	0	NONE	0	-144.2
c19	UL	0	0	NONE	0	-192.2
c20	UL	0	0	NONE	0	-240.3
c21	BS	0	0	NONE	0	0
c22	BS	0	0	NONE	0	0
c23	UL	0	0	NONE	0	-2728.6
c24	UL	0	0	NONE	0	-2993
c25	UL	0	0	NONE	0	-3521.7
c26	UL	0	0	NONE	0	-3089.1
c27	UL	0	0	NONE	0	-3137.2
c28	UL	0	0	NONE	0	-3185.3
c29	UL	0	0	NONE	0	-3233.3
c30	UL	0	0	NONE	0	-3281.4
c31	BS	0	0	NONE	0	0
c32	BS	0	0	NONE	0	0
c33	BS	0	0	NONE	0	0
c34	UL	0	0	NONE	0	0
c35	BS	0	0	NONE	0	0
c36	BS	0	0	NONE	0	0
c37	BS	0	0	NONE	0	0
c38	BS	-1	1	NONE	0	0
c39	UL	0	0	NONE	0	0
c40	BS	0	0	NONE	0	0
c41	BS	0	0	NONE	0	0
c42	BS	0	0	NONE	0	0
c43	BS	0	0	NONE	0	0
c44	BS	0	0	NONE	0	0
c45	BS	0	0	NONE	0	0
c46	BS	0	0	NONE	0	0
c47	BS	0	0	NONE	0	0
c48	BS	-1	1	NONE	0	0
c49	BS	0	0	NONE	0	0
c50	BS	0	0	NONE	0	0
c51	BS	0	0	NONE	0	0

c52	BS	0	0	NONE	0	0
c53	BS	0	0	NONE	0	0
c54	UL	0	0	NONE	0	-26440
c55	UL	0	0	NONE	0	-31250
c56	UL	0	0	NONE	0	-36050
c57	UL	0	0	NONE	0	-40860
c58	UL	0	0	NONE	0	-45670
c59	UL	0	0	NONE	0	-50470
c60	UL	0	0	NONE	0	-55280
c61	UL	0	0	NONE	0	-60090
c62	UL	0	0	NONE	0	-79310
c63	BS	0	0	NONE	0	0
c64	BS	0	0	NONE	0	0
c65	UL	0	0	NONE	0	-4810
c66	UL	0	0	NONE	0	-9610
c67	UL	0	0	NONE	0	-14420
c68	UL	0	0	NONE	0	-19230
c69	UL	0	0	NONE	0	-24030
c70	UL	0	0	NONE	0	-28840
c71	UL	0	0	NONE	0	-72090
c72	UL	0	0	NONE	0	-52870
c73	EQ	0	0	0	0	10
c74	EQ	0	0	0	0	0.0001
c75	EQ	0	0	0	0	1000
c76	EQ	0	0	0	0	10
c77	EQ	0	0	0	0	0.0001
c78	EQ	0	0	0	0	1000
c79	EQ	0	0	0	0	10
c80	EQ	0	0	0	0	0.0001
c81	EQ	0	0	0	0	1000
c82	EQ	0	0	0	0	0
c83	EQ	0	0	0	0	0
c84	EQ	0	0	0	0	0
c85	BS	-0.02378	0.023781	NONE	0	0
c86	BS	0.176119	-0.17612	0	NONE	0
c87	BS	0	0	NONE	0	0
c88	LL	0	0	0	NONE	0
c89	UL	0	0	NONE	0	0
c90	BS	0.1999	-0.1999	0	NONE	0
c91	UL	0	0	NONE	0	0
c92	BS	2.2	-2.2	0	NONE	0
c93	BS	0	0	NONE	0	0
c94	LL	0	0	0	NONE	0
c95	UL	0	0	NONE	0	0
c96	BS	0.1999	-0.1999	0	NONE	0
c97	EQ	0	0	0	0	0
c98	EQ	0	0	0	0	0
c99	EQ	0	0	0	0	0
c100	EQ	0	0	0	0	-10
c101	EQ	0	0	0	0	-0.0001
c102	EQ	0	0	0	0	-1000

c103	EQ	0	0	0	0	-10
c104	EQ	0	0	0	0	-0.0001
c105	EQ	0	0	0	0	-1000
c106	EQ	0	0	0	0	-10
c107	EQ	0	0	0	0	-0.0001
c108	EQ	0	0	0	0	-1000
c109	BS	0	0	NONE	0	0
c110	BS	0	0	NONE	0	0
c111	BS	0	0	NONE	0	0
c112	BS	0	0	NONE	0	0
c113	BS	0	0	NONE	0	0
c114	BS	0	0	NONE	0	0
c115	BS	0	0	NONE	0	0
c116	BS	0	0	NONE	0	0
c117	BS	0	0	NONE	0	0
c118	BS	0	0	NONE	0	0
c119	BS	0	0	NONE	0	0
c120	BS	0	0	NONE	0	0
c121	UL	0	0	NONE	0	-96.2
c122	BS	0	0	NONE	0	0
c123	BS	0	0	NONE	0	0
c124	BS	0	0	NONE	0	0
c125	BS	-1	1	NONE	0	0
c126	BS	-1	1	NONE	0	0
c127	BS	0	0	NONE	0	0
c128	BS	0	0	NONE	0	0
c129	BS	0	0	NONE	0	0
c130	BS	0	0	NONE	0	0
c131	BS	0	0	NONE	0	0
c132	BS	0	0	NONE	0	0
c133	UL	0	0	NONE	0	0
c134	BS	0	0	NONE	0	0
c135	BS	0	0	NONE	0	0
c136	BS	0	0	NONE	0	0
c137	BS	0	0	NONE	0	0
c138	UL	0	0	NONE	0	0
c139	BS	0	0	NONE	0	0
c140	UL	0	0	NONE	0	0
c141	BS	0	0	NONE	0	0
c142	BS	0	0	NONE	0	0
c143	BS	0	0	NONE	0	0
c144	BS	0	0	NONE	0	0
c145	BS	0	0	NONE	0	0
c146	BS	0	0	NONE	0	0
c147	BS	0	0	NONE	0	0
c148	BS	0	0	NONE	0	0
c149	BS	0	0	NONE	0	0
c150	BS	0	0	NONE	0	0
c151	BS	0	0	NONE	0	0
c152	BS	0	0	NONE	0	0
c153	BS	0	0	NONE	0	0

c154	BS	0	0 NONE	0	0
c155	BS	0	0 NONE	0	0
c156	BS	0	0 NONE	0	0
c157	BS	0	0 NONE	0	0
c158	BS	0	0 NONE	0	0
c159	BS	0	0 NONE	0	0
c160	BS	0	0 NONE	0	0
c161	BS	0	0 NONE	0	0
c162	BS	0	0 NONE	0	0
c163	BS	0	0 NONE	0	0
c164	BS	0	0 NONE	0	0
c165	BS	0	0 NONE	0	0
c166	BS	0	0 NONE	0	0
c167	BS	-1	1 NONE	0	0
c168	BS	-1	1 NONE	0	0
c169	BS	-1	1 NONE	0	0
c170	BS	-1	1 NONE	0	0
c171	BS	-1	1 NONE	0	0
c172	BS	-1	1 NONE	0	0
c173	BS	-1	1 NONE	0	0
c174	BS	-1	1 NONE	0	0
c175	BS	-1	1 NONE	0	0
c176	BS	-1	1 NONE	0	0
c177	BS	-1	1 NONE	0	0
c178	BS	-1	1 NONE	0	0
c179	BS	-1	1 NONE	0	0
c180	BS	-1	1 NONE	0	0
c181	BS	-1	1 NONE	0	0
c182	BS	-1	1 NONE	0	0
c183	BS	-1	1 NONE	0	0
c184	BS	-1	1 NONE	0	0
c185	BS	-1	1 NONE	0	0
c186	BS	-1	1 NONE	0	0
c187	BS	-1	1 NONE	0	0
c188	BS	-1	1 NONE	0	0
c189	BS	-1	1 NONE	0	0
c190	BS	-1	1 NONE	0	0
c191	BS	-1	1 NONE	0	0
c192	BS	-1	1 NONE	0	0
c193	BS	-1	1 NONE	0	0
c194	BS	-1	1 NONE	0	0
c195	BS	-1	1 NONE	0	0
c196	BS	-1	1 NONE	0	0
c197	BS	-1	1 NONE	0	0
c198	BS	-1	1 NONE	0	0
c199	BS	0	0 NONE	0	0
c200	BS	0	0 NONE	0	0
c201	BS	-1	1 NONE	0	0
c202	BS	-1	1 NONE	0	0
c203	BS	-1	1 NONE	0	0
c204	BS	-1	1 NONE	0	0

c205	BS	-1	1	NONE	0	0
c206	BS	-1	1	NONE	0	0
c207	BS	-1	1	NONE	0	0
c208	BS	-1	1	NONE	0	0
c209	BS	-1	1	NONE	0	0
c210	BS	-1	1	NONE	0	0
c211	BS	-1	1	NONE	0	0
c212	BS	-1	1	NONE	0	0
c213	BS	-1	1	NONE	0	0
c214	BS	-1	1	NONE	0	0
c215	BS	-1	1	NONE	0	0
c216	BS	-1	1	NONE	0	0
c217	BS	-1	1	NONE	0	0
c218	BS	-1	1	NONE	0	0
c219	BS	-1	1	NONE	0	0
c220	BS	-1	1	NONE	0	0
c221	BS	-1	1	NONE	0	0
c222	BS	-1	1	NONE	0	0
c223	BS	-1	1	NONE	0	0
c224	BS	-1	1	NONE	0	0
c225	BS	-1	1	NONE	0	0
c226	BS	-1	1	NONE	0	0
c227	BS	-1	1	NONE	0	0
c228	BS	-1	1	NONE	0	0
c229	LL	0	0	0	NONE	1928.386
c230	BS	0	0	NONE	0	0
c231	BS	0.023	-0.023	0	NONE	0
c232	UL	0	0	NONE	0	0
c233	BS	0	0	0	NONE	0
c234	BS	0	0	NONE	0	0
c235	LL	0	0	0	NONE	1928.386
c236	BS	0	0	NONE	0	0
c237	BS	0.023	-0.023	0	NONE	0
c238	UL	0	0	NONE	0	0
c239	BS	0	0	0	NONE	0
c240	BS	0	0	NONE	0	0
c241	EQ	0	0	0	0	0
c242	EQ	0	0	0	0	0
c243	EQ	0	0	0	0	0
c244	EQ	0	0	0	0	-8723.8
c245	EQ	0	0	0	0	0
c246	EQ	0	0	0	0	-841130
c247	EQ	0	0	0	0	-5682.7
c248	EQ	0	0	0	0	0
c249	EQ	0	0	0	0	-867570
c250	EQ	0	0	0	0	0
c251	EQ	0	0	0	0	0
c252	EQ	0	0	0	0	0
c253	EQ	0	0	0	0	0
c254	EQ	0	0	0	0	0
c255	EQ	0	0	0	0	0

c256	BS	1	0	NONE	1	0
c257	BS	1	0	NONE	1	0
c258	BS	1	0	NONE	1	0
c259	BS	1	0	NONE	1	0
c260	BS	1	0	NONE	1	0
c261	BS	1	0	NONE	1	0
c262	EQ	0	0	0	0	0
c263	EQ	0	0	0	0	0
c264	EQ	0	0	0	0	0
c265	EQ	0	0	0	0	0
c266	EQ	0	0	0	0	0
c267	EQ	0	0	0	0	0
c268	UL	0	0	NONE	0	0
c269	UL	0	0	NONE	0	0
c270	UL	0	0	NONE	0	0
c271	BS	2	0	NONE	2	0
c272	BS	2	0	NONE	2	0
c273	BS	2	0	NONE	2	0
c274	EQ	0	0	0	0	0
c275	EQ	0	0	0	0	0
c276	EQ	0	0	0	0	0
c277	BS	-5	5	NONE	0	0
c278	BS	-4.53284	4.532835	NONE	0	0
c279	BS	-5.5837	5.583695	NONE	0	0
c280	BS	-3	3	NONE	0	0
c281	BS	-3.46717	3.467165	NONE	0	0
c282	BS	-2.41631	2.416305	NONE	0	0
c283	BS	0	0	NONE	0	0
c284	BS	0	0	NONE	0	0
c285	UL	0	0	NONE	0	0
c286	BS	0	0	NONE	0	0
c287	BS	0	0	NONE	0	0
c288	BS	0	0	NONE	0	0
c289	BS	0	0	NONE	0	0
c290	BS	0	0	NONE	0	0
c291	BS	0	0	NONE	0	0
c292	BS	0	0	0	NONE	0
c293	BS	0	0	0	NONE	0
c294	BS	0	0	0	NONE	0
c295	BS	0	0	0	0	0
c296	EQ	0	0	0	0	0
c297	EQ	0	0	0	0	0
c298	BS	1	0	1	1	0
c299	EQ	1	0	1	1	0
c300	EQ	1	0	1	1	0
c301	BS	0	0	0	0	0
c302	EQ	0	0	0	0	0
c303	EQ	0	0	0	0	0
c304	UL	0	0	NONE	0	0
c305	BS	-1.74	1.74	NONE	0	0
c306	UL	0	0	NONE	0	0

c307	BS	1.74	-1.74	0	NONE	0
c308	LL	0	0	0	NONE	0
c309	BS	1.74	-1.74	0	NONE	0
c310	EQ	1	0	1	1	-5204.4
c311	EQ	1	0	1	1	-0.057794
c312	EQ	1	0	1	1	-534820
c313	EQ	0	0	0	0	0
c314	EQ	0	0	0	0	0
c315	EQ	0	0	0	0	0
c316	UL	0	0	NONE	0	-2458.5
c317	UL	0	0	NONE	0	-2530.4
c318	UL	0	0	NONE	0	-2602.2
c319	UL	0	0	NONE	0	-1672.4
c320	UL	0	0	NONE	0	-2745.9
c321	UL	0	0	NONE	0	-2817.8
c322	UL	0	0	NONE	0	-2889.7
c323	UL	0	0	NONE	0	-2961.5
c324	UL	0	0	NONE	0	-3033.4
c325	BS	0	0	NONE	0	0
c326	UL	0	0	NONE	0	-2458.5
c327	UL	0	0	NONE	0	-2674
c328	UL	0	0	NONE	0	-2602.2
c329	UL	0	0	NONE	0	-3532
c330	UL	0	0	NONE	0	-2745.9
c331	UL	0	0	NONE	0	-2817.8
c332	UL	0	0	NONE	0	-2889.7
c333	UL	0	0	NONE	0	-2961.5
c334	UL	0	0	NONE	0	-3033.4
c335	BS	0	0	NONE	0	0
c336	UL	0	0	NONE	0	-0.024585
c337	UL	0	0	NONE	0	-0.025304
c338	UL	0	0	NONE	0	-0.026022
c339	UL	0	0	NONE	0	-0.026741
c340	UL	0	0	NONE	0	-0.027459
c341	UL	0	0	NONE	0	-0.028178
c342	UL	0	0	NONE	0	-0.028897
c343	BS	-1	1	NONE	0	0
c344	UL	0	0	NONE	0	-0.030334
c345	UL	0	0	NONE	0	-0.026259
c346	UL	0	0	NONE	0	-0.024585
c347	UL	0	0	NONE	0	-0.025304
c348	UL	0	0	NONE	0	-0.026022
c349	UL	0	0	NONE	0	-0.026741
c350	UL	0	0	NONE	0	-0.027459
c351	UL	0	0	NONE	0	-0.028178
c352	UL	0	0	NONE	0	-0.028897
c353	BS	-1	1	NONE	0	0
c354	UL	0	0	NONE	0	-0.030334
c355	UL	0	0	NONE	0	-0.026259
c356	UL	0	0	NONE	0	-245850
c357	UL	0	0	NONE	0	-253040

c358	UL	0	0	NONE	0	-260220
c359	UL	0	0	NONE	0	-267410
c360	UL	0	0	NONE	0	-274590
c361	UL	0	0	NONE	0	-281780
c362	UL	0	0	NONE	0	-288970
c363	UL	0	0	NONE	0	-296150
c364	UL	0	0	NONE	0	-303340
c365	UL	0	0	NONE	0	-310530
c366	UL	0	0	NONE	0	-245850
c367	UL	0	0	NONE	0	-253040
c368	UL	0	0	NONE	0	-260220
c369	UL	0	0	NONE	0	-267410
c370	UL	0	0	NONE	0	-274590
c371	UL	0	0	NONE	0	-281780
c372	UL	0	0	NONE	0	-288970
c373	UL	0	0	NONE	0	-296150
c374	UL	0	0	NONE	0	-303340
c375	UL	0	0	NONE	0	-310530
c376	EQ	0	0	0	0	10
c377	EQ	0	0	0	0	0.0001
c378	EQ	0	0	0	0	1000
c379	EQ	0	0	0	0	10
c380	EQ	0	0	0	0	0.0001
c381	EQ	0	0	0	0	1000
c382	EQ	0	0	0	0	10
c383	EQ	0	0	0	0	0.0001
c384	EQ	0	0	0	0	1000
c385	UL	0	0	NONE	0	0
c386	BS	0.1999	-0.1999	0	NONE	0
c387	UL	0	0	NONE	0	0
c388	BS	0	0	0	NONE	0
c389	UL	0	0	NONE	0	0
c390	BS	0.7499	-0.7499	0	NONE	0
c391	UL	0	0	NONE	0	0
c392	BS	0.7499	-0.7499	0	NONE	0
c393	UL	0	0	NONE	0	0
c394	BS	0	0	0	NONE	0
c395	UL	0	0	NONE	0	0
c396	BS	0.7499	-0.7499	0	NONE	0
c397	EQ	0	0	0	0	0
c398	EQ	0	0	0	0	0
c399	EQ	0	0	0	0	0
c400	EQ	0	0	0	0	0
c401	EQ	0	0	0	0	0
c402	EQ	0	0	0	0	0
c403	BS	0	0	NONE	0	0
c404	BS	-6.97686	6.976856	NONE	0	0
c405	BS	-4.5837	4.583695	NONE	0	0
c406	BS	0	0	NONE	0	0
c407	BS	-6.02314	6.023144	NONE	0	0
c408	BS	-8.41631	8.416305	NONE	0	0

c409	BS	-4.99999	4.99999	NONE	0	0
c410	UL	0	0	NONE	0	0
c411	UL	0	0	NONE	0	0
c412	BS	-10	10	NONE	0	0
c413	BS	0	0	NONE	0	0
c414	BS	0	0	NONE	0	0
c415	EQ	1	0	1	1	0
c416	EQ	1	0	1	1	0
c417	EQ	1	0	1	1	0
c418	BS	0	0	0	NONE	0
c419	BS	0	0	0	NONE	0
c420	BS	0	0	0	NONE	0
c421	BS	-150	150	NONE	0	0
c422	BS	0	0	NONE	0	0
c423	BS	0	0	NONE	0	0
c424	EQ	0	0	0	0	0
c425	EQ	0	0	0	0	0
c426	EQ	0	0	0	0	0
c427	BS	-0.418	0.418	NONE	0	0
c428	BS	-1.41386	1.413856	NONE	0	0
c429	BS	-0.0017	0.001695	NONE	0	0
c430	BS	0.699	-0.699	0	NONE	0
c431	BS	0.010144	-0.01014	0	NONE	0
c432	BS	1.115305	-1.11531	0	NONE	0
c433	BS	-0.4002	0.4002	NONE	0	0
c434	BS	0	0	NONE	0	0
c435	BS	-1.0002	1.0002	NONE	0	0
c436	BS	0.8498	-0.8498	0	NONE	0
c437	BS	1.25	-1.25	0	NONE	0
c438	BS	0.2498	-0.2498	0	NONE	0
c439	EQ	1	0	1	1	0
c440	EQ	1	0	1	1	0
c441	EQ	1	0	1	1	0
c442	EQ	-61.339	0	-61.339	-61.339	0
c443	EQ	-61.339	0	-61.339	-61.339	0
c444	EQ	-61.339	0	-61.339	-61.339	0
c445	EQ	-6.6201	0	-6.6201	-6.6201	0
c446	EQ	-6.6201	0	-6.6201	-6.6201	0
c447	EQ	-6.6201	0	-6.6201	-6.6201	0
c448	EQ	0	0	0	0	0
c449	EQ	0	0	0	0	0
c450	EQ	0	0	0	0	0
c451	EQ	0	0	0	0	0
c452	EQ	0	0	0	0	0
c453	EQ	0	0	0	0	0
c454	EQ	3	0	3	3	0
c455	EQ	1	0	1	1	0
c456	EQ	2	0	2	2	0
c457	EQ	3	0	3	3	0
c458	EQ	6	0	6	6	0
c459	EQ	3	0	3	3	0

c460	EQ	792	0	792	792	0
c461	EQ	605	0	605	605	0

2 - COLU

.....CO	AT	...ACTIVITY...	NPUT COST..	..LOW ER LIMIT.	..U PPER LIMIT.	.REDUCED COST.
PT1_1	BS	1412.1	10	0	NONE	0
PT1_2	BS	0	0.0001	0	NONE	0
PT1_3	BS	1840.88	1000	0	NONE	0
PP_1	BS	0	-10	0	NONE	0
PP_2	BS	1895.586	-0.0001	0	NONE	0
PP_3	BS	0	-1000	0	NONE	0
PT2_1	BS	454.45	10	0	NONE	0
PT2_2	BS	0	0.0001	0	NONE	0
PT2_3	BS	534.82	1000	0	NONE	0
delta1_	EQ	0	0	0	0	-3521.7
delta1_	EQ	1	0	1	1	-3521.7
delta1_	BS	0	0	0	0	0
delta1_	BS	0	0	0	0	0
delta1_	EQ	0	0	0	0	-192.2
delta1_	EQ	0	0	0	0	-288.4
delta1_	EQ	0	0	0	0	-384.6
delta1_	BS	0	0	0	0	0
delta1_	EQ	0	0	0	0	-528.7
delta1_	EQ	0	0	0	0	-793.1
H1_1	BS	187	0	0	212	0
delta1_	EQ	0	0	0	0	0
delta1_	EQ	0	0	0	0	0
delta1_	EQ	0	0	0	0	0
delta1_	BS	0	0	0	0	0
delta1_	BS	1	0	1	1	0
delta1_	BS	0	0	0	0	0
delta1_	EQ	0	0	0	0	0
delta1_	BS	0	0	0	0	0
delta1_	BS	0	0	0	0	0
delta1_	EQ	0	0	0	0	0
H1_2	BS	184.556	0	0	212	0
delta1_	BS	1	0	1	1	0
delta1_	BS	0	0	0	0	0
delta1_	EQ	0	0	0	0	-48060
delta1_	EQ	0	0	0	0	-57680
delta1_	EQ	0	0	0	0	-67280
delta1_	EQ	0	0	0	0	-76900
delta1_	EQ	0	0	0	0	-86520
delta1_	EQ	0	0	0	0	-96120
delta1_	EQ	0	0	0	0	-105740
delta1_	EQ	0	0	0	0	-132180
H1_3	BS	188	0	0	212	0
FB1_1	BS	792	0	770	812	0

FB2_1	BS	605	0	587	620	0
FB1_2	BS	791.5328	0	770	812	0
FB2_2	BS	606.9769	0	587	620	0
FB1_3	BS	792.5837	0	770	812	0
FB2_3	BS	604.5837	0	587	620	0
phi1_11	EQ	0	0	0	0	-312.5
phi1_11	EQ	0	0	0	0	-577.3
phi1_11	EQ	0	0	0	0	-848
phi1_11	EQ	0	0	0	0	-1127
phi1_11	EQ	0	0	0	0	-1416.2
phi1_11	EQ	0	0	0	0	-3419.9
phi1_21	EQ	0	0	0	0	-48.1
phi1_21	EQ	0	0	0	0	-321.3
phi1_21	EQ	0	0	0	0	-600.5
phi1_21	EQ	0	0	0	0	-888.2
phi1_21	EQ	0	0	0	0	-1186.5
phi1_21	EQ	0	0	0	0	-3253.2
phi1_31	BS	0	0	0	0	0
phi1_31	EQ	0	0	0	0	-274.7
phi1_31	EQ	0	0	0	0	-555.5
phi1_31	EQ	0	0	0	0	-844.8
phi1_31	EQ	0	0	0	0	-1144.8
phi1_31	EQ	0	0	0	0	-3222.9
phi1_41	BS	0	0	0	0	0
phi1_41	EQ	0	0	0	0	-276.2
phi1_41	EQ	0	0	0	0	-558.5
phi1_41	EQ	0	0	0	0	-849.4
phi1_41	EQ	0	0	0	0	-1151
phi1_41	EQ	0	0	0	0	-3240.6
phi1_51	BS	0	0	0	0	0
phi1_51	EQ	0	0	0	0	-277.7
phi1_51	EQ	0	0	0	0	-561.6
phi1_51	EQ	0	0	0	0	-854.1
phi1_51	EQ	0	0	0	0	-1157.3
phi1_51	EQ	0	0	0	0	-3258.4
phi1_61	BS	0	0	0	0	0
phi1_61	EQ	0	0	0	0	-279.3
phi1_61	EQ	0	0	0	0	-564.7
phi1_61	EQ	0	0	0	0	-858.8
phi1_61	EQ	0	0	0	0	-1163.7
phi1_61	EQ	0	0	0	0	-3276.2
phi1_71	BS	0	0	0	0	0
phi1_71	EQ	0	0	0	0	-280.7
phi1_71	EQ	0	0	0	0	-567.7
phi1_71	EQ	0	0	0	0	-863.4
phi1_71	EQ	0	0	0	0	-1169.9
phi1_71	EQ	0	0	0	0	-3293.9
phi1_81	BS	0	0	0	0	0
phi1_81	EQ	0	0	0	0	-282.3
phi1_81	EQ	0	0	0	0	-570.8
phi1_81	EQ	0	0	0	0	-868.1

phi1_81	EQ	0	0	0	0	-1176.3
phi1_81	EQ	0	0	0	0	-3311.7
phi1_91	EQ	0	0	0	0	288.4
phi1_91	EQ	0	0	0	0	4.6
phi1_91	EQ	1	0	1	1	-285.5
phi1_91	EQ	0	0	0	0	-584.4
phi1_91	EQ	0	0	0	0	-894.2
phi1_91	EQ	0	0	0	0	-3041.1
phi1_10	EQ	0	0	0	0	480.6
phi1_10	EQ	0	0	0	0	190.8
phi1_10	EQ	0	0	0	0	-105.4
phi1_10	EQ	0	0	0	0	-410.7
phi1_10	EQ	0	0	0	0	-727.2
phi1_10	EQ	0	0	0	0	-2919.8
phi1_12	BS	0	0	0	0	0
phi1_12	EQ	0	0	0	0	-264.8
phi1_12	EQ	0	0	0	0	-535.5
phi1_12	EQ	0	0	0	0	-814.5
phi1_12	EQ	0	0	0	0	-1103.7
phi1_12	EQ	0	0	0	0	-3107.4
phi1_22	BS	0	0	0	0	0
phi1_22	EQ	0	0	0	0	-273.2
phi1_22	EQ	0	0	0	0	-552.4
phi1_22	EQ	0	0	0	0	-840.1
phi1_22	EQ	0	0	0	0	-1138.4
phi1_22	EQ	0	0	0	0	-3205.1
phi1_32	EQ	0	0	0	0	-480.6
phi1_32	EQ	0	0	0	0	-755.3
phi1_32	EQ	0	0	0	0	-1036.1
phi1_32	EQ	0	0	0	0	-1325.4
phi1_32	EQ	0	0	0	0	-1625.4
phi1_32	EQ	0	0	0	0	-3703.5
phi1_42	BS	0	0	0	0	0
phi1_42	EQ	0	0	0	0	-276.2
phi1_42	EQ	0	0	0	0	-558.5
phi1_42	EQ	0	0	0	0	-849.4
phi1_42	EQ	0	0	0	0	-1151
phi1_42	EQ	0	0	0	0	-3240.6
phi1_52	BS	0	0	0	0	0
phi1_52	EQ	0	0	0	0	-277.7
phi1_52	EQ	0	0	0	0	-561.6
phi1_52	EQ	0	0	0	0	-854.1
phi1_52	EQ	0	0	0	0	-1157.3
phi1_52	EQ	0	0	0	0	-3258.4
phi1_62	BS	0	0	0	0	0
phi1_62	EQ	0	0	0	0	-279.3
phi1_62	EQ	0	0	0	0	-564.7
phi1_62	EQ	0	0	0	0	-858.8
phi1_62	EQ	0	0	0	0	-1163.7
phi1_62	EQ	0	0	0	0	-3276.2
phi1_72	BS	0	0	0	0	0

phi1_72	EQ	0	0	0	0	-280.7
phi1_72	EQ	0	0	0	0	-567.7
phi1_72	EQ	0	0	0	0	-863.4
phi1_72	EQ	0	0	0	0	-1169.9
phi1_72	EQ	0	0	0	0	-3293.9
phi1_82	BS	0	0	0	0	0
phi1_82	EQ	0	0	0	0	-282.3
phi1_82	EQ	0	0	0	0	-570.8
phi1_82	EQ	0	0	0	0	-868.1
phi1_82	EQ	0	0	0	0	-1176.3
phi1_82	EQ	0	0	0	0	-3311.7
phi1_92	EQ	0	0	0	0	3329.5
phi1_92	EQ	0	0	0	0	3045.7
phi1_92	EQ	0	0	0	0	2755.6
phi1_92	EQ	0	0	0	0	2456.7
phi1_92	EQ	0	0	0	0	2146.9
phi1_92	BS	1	0	1	1	0
phi1_10	EQ	0	0	0	0	3521.7
phi1_10	EQ	0	0	0	0	3231.9
phi1_10	EQ	0	0	0	0	2935.7
phi1_10	EQ	0	0	0	0	2630.4
phi1_10	EQ	0	0	0	0	2313.9
phi1_10	EQ	0	0	0	0	121.3
phi1_11	EQ	0	0	0	0	0.084113
phi1_11	EQ	0	0	0	0	0.081465
phi1_11	EQ	0	0	0	0	0.078758
phi1_11	EQ	0	0	0	0	0.075968
phi1_11	EQ	0	0	0	0	0.073076
phi1_11	EQ	0	0	0	0	0.053039
phi1_21	EQ	0	0	0	0	0.086757
phi1_21	EQ	0	0	0	0	0.084025
phi1_21	EQ	0	0	0	0	0.081233
phi1_21	EQ	0	0	0	0	0.078356
phi1_21	EQ	0	0	0	0	0.075373
phi1_21	EQ	0	0	0	0	0.054706
phi1_31	EQ	0	0	0	0	0.087238
phi1_31	EQ	0	0	0	0	0.084491
phi1_31	EQ	0	0	0	0	0.081683
phi1_31	EQ	0	0	0	0	0.07879
phi1_31	EQ	0	0	0	0	0.07579
phi1_31	EQ	0	0	0	0	0.055009
phi1_41	EQ	0	0	0	0	0.087718
phi1_41	EQ	0	0	0	0	0.084956
phi1_41	EQ	0	0	0	0	0.082133
phi1_41	EQ	0	0	0	0	0.079224
phi1_41	EQ	0	0	0	0	0.076208
phi1_41	EQ	0	0	0	0	0.055312
phi1_51	EQ	0	0	0	0	0.088199
phi1_51	EQ	0	0	0	0	0.085422
phi1_51	EQ	0	0	0	0	0.082583
phi1_51	EQ	0	0	0	0	0.079658

phi1_51	EQ	0	0	0	0	0.076626
phi1_51	EQ	0	0	0	0	0.055615
phi1_61	EQ	0	0	0	0	0.08868
phi1_61	EQ	0	0	0	0	0.085887
phi1_61	EQ	0	0	0	0	0.083033
phi1_61	EQ	0	0	0	0	0.080092
phi1_61	EQ	0	0	0	0	0.077043
phi1_61	EQ	0	0	0	0	0.055918
phi1_71	EQ	0	0	0	0	0.08916
phi1_71	EQ	0	0	0	0	0.086353
phi1_71	EQ	0	0	0	0	0.083483
phi1_71	EQ	0	0	0	0	0.080526
phi1_71	EQ	0	0	0	0	0.077461
phi1_71	EQ	0	0	0	0	0.056221
phi1_81	EQ	0	0	0	0	0.089641
phi1_81	EQ	0	0	0	0	0.086818
phi1_81	EQ	0	0	0	0	0.083933
phi1_81	EQ	0	0	0	0	0.08096
phi1_81	EQ	0	0	0	0	0.077878
phi1_81	EQ	0	0	0	0	0.056524
phi1_91	EQ	0	0	0	0	0.090122
phi1_91	EQ	0	0	0	0	0.087284
phi1_91	EQ	0	0	0	0	0.084383
phi1_91	EQ	0	0	0	0	0.081394
phi1_91	EQ	0	0	0	0	0.078296
phi1_91	EQ	0	0	0	0	0.056827
phi1_10	EQ	0	0	0	0	0.092044
phi1_10	EQ	0	0	0	0	0.089146
phi1_10	EQ	0	0	0	0	0.086184
phi1_10	EQ	0	0	0	0	0.083131
phi1_10	EQ	0	0	0	0	0.079966
phi1_10	EQ	0	0	0	0	0.05804
phi1_12	EQ	0	0	0	0	0.084113
phi1_12	EQ	0	0	0	0	0.081465
phi1_12	EQ	0	0	0	0	0.078758
phi1_12	EQ	0	0	0	0	0.075968
phi1_12	EQ	0	0	0	0	0.073076
phi1_12	EQ	0	0	0	0	0.053039
phi1_22	EQ	0	0	0	0	0.086757
phi1_22	EQ	0	0	0	0	0.084025
phi1_22	EQ	0	0	0	0	0.081233
phi1_22	EQ	0	0	0	0	0.078356
phi1_22	EQ	0	0	0	0	0.075373
phi1_22	EQ	0	0	0	0	0.054706
phi1_32	EQ	0	0	0	0	0.087238
phi1_32	EQ	0	0	0	0	0.084491
phi1_32	EQ	0	0	0	0	0.081683
phi1_32	EQ	0	0	0	0	0.07879
phi1_32	EQ	0	0	0	0	0.07579
phi1_32	EQ	0	0	0	0	0.055009
phi1_42	EQ	0	0	0	0	0.087718

phi1_42	EQ	0	0	0	0	0.084956
phi1_42	EQ	0	0	0	0	0.082133
phi1_42	EQ	0	0	0	0	0.079224
phi1_42	EQ	0	0	0	0	0.076208
phi1_42	EQ	0	0	0	0	0.055312
phi1_52	EQ	0	0	0	0	0.088199
phi1_52	EQ	0	0	0	0	0.085422
phi1_52	EQ	0	0	0	0	0.082583
phi1_52	EQ	0	0	0	0	0.079658
phi1_52	EQ	0	0	0	0	0.076626
phi1_52	EQ	0	0	0	0	0.055615
phi1_62	EQ	0	0	0	0	0.08868
phi1_62	EQ	0	0	0	0	0.085887
phi1_62	EQ	0	0	0	0	0.083033
phi1_62	EQ	0	0	0	0	0.080092
phi1_62	EQ	0	0	0	0	0.077043
phi1_62	EQ	0	0	0	0	0.055918
phi1_72	EQ	0	0	0	0	0.08916
phi1_72	EQ	0	0	0	0	0.086353
phi1_72	EQ	0	0	0	0	0.083483
phi1_72	EQ	0	0	0	0	0.080526
phi1_72	EQ	0	0	0	0	0.077461
phi1_72	EQ	0	0	0	0	0.056221
phi1_82	EQ	0	0	0	0	0.089641
phi1_82	EQ	0	0	0	0	0.086818
phi1_82	EQ	0	0	0	0	0.083933
phi1_82	EQ	0	0	0	0	0.08096
phi1_82	EQ	0	0	0	0	0.077878
phi1_82	EQ	0	0	0	0	0.056524
phi1_92	EQ	0	0	0	0	0.090122
phi1_92	EQ	0	0	0	0	0.087284
phi1_92	EQ	0	0	0	0	0.084383
phi1_92	EQ	0	0	0	0	0.081394
phi1_92	EQ	0	0	0	0	0.078296
phi1_92	EQ	0	0	0	0	0.056827
phi1_10	EQ	0	0	0	0	0.092044
phi1_10	EQ	0	0	0	0	0.089146
phi1_10	EQ	0	0	0	0	0.086184
phi1_10	EQ	0	0	0	0	0.083131
phi1_10	EQ	0	0	0	0	0.079966
phi1_10	EQ	0	0	0	0	0.05804
phi1_11	BS	0	0	0	0	0
phi1_11	EQ	0	0	0	0	-26480
phi1_11	EQ	0	0	0	0	-53550
phi1_11	EQ	0	0	0	0	-81450
phi1_11	EQ	0	0	0	0	-110370
phi1_11	EQ	0	0	0	0	-310740
phi1_21	BS	0	0	0	0	0
phi1_21	EQ	0	0	0	0	-27320
phi1_21	EQ	0	0	0	0	-55240
phi1_21	EQ	0	0	0	0	-84010

phi1_21	EQ	0	0	0	0	-113840
phi1_21	EQ	0	0	0	0	-320510
phi1_31	BS	0	0	0	0	0
phi1_31	EQ	0	0	0	0	-27470
phi1_31	EQ	0	0	0	0	-55550
phi1_31	EQ	0	0	0	0	-84480
phi1_31	EQ	0	0	0	0	-114480
phi1_31	EQ	0	0	0	0	-322290
phi1_41	BS	0	0	0	0	0
phi1_41	EQ	0	0	0	0	-27620
phi1_41	EQ	0	0	0	0	-55850
phi1_41	EQ	0	0	0	0	-84940
phi1_41	EQ	0	0	0	0	-115100
phi1_41	EQ	0	0	0	0	-324060
phi1_51	BS	0	0	0	0	0
phi1_51	EQ	0	0	0	0	-27770
phi1_51	EQ	0	0	0	0	-56160
phi1_51	EQ	0	0	0	0	-85410
phi1_51	EQ	0	0	0	0	-115730
phi1_51	EQ	0	0	0	0	-325840
phi1_61	BS	0	0	0	0	0
phi1_61	EQ	0	0	0	0	-27930
phi1_61	EQ	0	0	0	0	-56470
phi1_61	EQ	0	0	0	0	-85880
phi1_61	EQ	0	0	0	0	-116370
phi1_61	EQ	0	0	0	0	-327620
phi1_71	BS	0	0	0	0	0
phi1_71	EQ	0	0	0	0	-28070
phi1_71	EQ	0	0	0	0	-56770
phi1_71	EQ	0	0	0	0	-86340
phi1_71	EQ	0	0	0	0	-116990
phi1_71	EQ	0	0	0	0	-329390
phi1_81	BS	0	0	0	0	0
phi1_81	EQ	0	0	0	0	-28230
phi1_81	EQ	0	0	0	0	-57080
phi1_81	EQ	0	0	0	0	-86810
phi1_81	EQ	0	0	0	0	-117630
phi1_81	EQ	0	0	0	0	-331170
phi1_91	BS	0	0	0	0	0
phi1_91	EQ	0	0	0	0	-28380
phi1_91	EQ	0	0	0	0	-57390
phi1_91	EQ	0	0	0	0	-87280
phi1_91	EQ	0	0	0	0	-118260
phi1_91	EQ	0	0	0	0	-332950
phi1_10	BS	1	0	1	1	0
phi1_10	EQ	0	0	0	0	-28980
phi1_10	EQ	0	0	0	0	-58600
phi1_10	EQ	0	0	0	0	-89130
phi1_10	EQ	0	0	0	0	-120780
phi1_10	EQ	0	0	0	0	-340040
phi1_12	EQ	0	0	0	0	-26440

phi1_12	EQ	0	0	0	0	-52920
phi1_12	EQ	0	0	0	0	-79990
phi1_12	EQ	0	0	0	0	-107890
phi1_12	EQ	0	0	0	0	-136810
phi1_12	EQ	0	0	0	0	-337180
phi1_22	BS	0	0	0	0	0
phi1_22	EQ	0	0	0	0	-27320
phi1_22	EQ	0	0	0	0	-55240
phi1_22	EQ	0	0	0	0	-84010
phi1_22	EQ	0	0	0	0	-113840
phi1_22	EQ	0	0	0	0	-320510
phi1_32	BS	0	0	0	0	0
phi1_32	EQ	0	0	0	0	-27470
phi1_32	EQ	0	0	0	0	-55550
phi1_32	EQ	0	0	0	0	-84480
phi1_32	EQ	0	0	0	0	-114480
phi1_32	EQ	0	0	0	0	-322290
phi1_42	BS	0	0	0	0	0
phi1_42	EQ	0	0	0	0	-27620
phi1_42	EQ	0	0	0	0	-55850
phi1_42	EQ	0	0	0	0	-84940
phi1_42	EQ	0	0	0	0	-115100
phi1_42	EQ	0	0	0	0	-324060
phi1_52	BS	0	0	0	0	0
phi1_52	EQ	0	0	0	0	-27770
phi1_52	EQ	0	0	0	0	-56160
phi1_52	EQ	0	0	0	0	-85410
phi1_52	EQ	0	0	0	0	-115730
phi1_52	EQ	0	0	0	0	-325840
phi1_62	BS	0	0	0	0	0
phi1_62	EQ	0	0	0	0	-27930
phi1_62	EQ	0	0	0	0	-56470
phi1_62	EQ	0	0	0	0	-85880
phi1_62	EQ	0	0	0	0	-116370
phi1_62	EQ	0	0	0	0	-327620
phi1_72	BS	0	0	0	0	0
phi1_72	EQ	0	0	0	0	-28070
phi1_72	EQ	0	0	0	0	-56770
phi1_72	EQ	0	0	0	0	-86340
phi1_72	EQ	0	0	0	0	-116990
phi1_72	EQ	0	0	0	0	-329390
phi1_82	BS	0	0	0	0	0
phi1_82	EQ	0	0	0	0	-28230
phi1_82	EQ	0	0	0	0	-57080
phi1_82	EQ	0	0	0	0	-86810
phi1_82	EQ	0	0	0	0	-117630
phi1_82	EQ	0	0	0	0	-331170
phi1_92	EQ	0	0	0	0	-38440
phi1_92	EQ	0	0	0	0	-66820
phi1_92	EQ	0	0	0	0	-95830
phi1_92	EQ	0	0	0	0	-125720

phi1_92	EQ	0	0	0	0	-156700
phi1_92	EQ	0	0	0	0	-371390
phi1_10	BS	1	0	1	1	0
phi1_10	EQ	0	0	0	0	-28980
phi1_10	EQ	0	0	0	0	-58600
phi1_10	EQ	0	0	0	0	-89130
phi1_10	EQ	0	0	0	0	-120780
phi1_10	EQ	0	0	0	0	-340040
PT1_11	BS	843.83	0	0	NONE	0
PT1_12	BS	0	0	0	NONE	0
PT1_13	BS	920.44	0	0	NONE	0
PT1_21	BS	568.27	0	0	NONE	0
PT1_22	BS	0	0	0	NONE	0
PT1_23	BS	920.44	0	0	NONE	0
PT_1	BS	1866.55	0	0	NONE	0
PT_2	BS	0	0	0	NONE	0
PT_3	BS	2375.7	0	0	NONE	0
QT1_11	BS	5.073881	0	0	5.5	0
QT1_12	BS	0	0	0	5.5	0
QT1_13	BS	5.4501	0	0	5.5	0
QT1_21	BS	2.45	0	0	5.5	0
QT1_22	BS	0	0	0	5.5	0
QT1_23	BS	5.4501	0	0	5.5	0
QT1_1	BS	7.523881	0	0	NONE	0
QT1_2	BS	0	0	0	NONE	0
QT1_3	BS	10.9002	0	0	NONE	0
nu_1011	EQ	0	0	0	0	-707.9273
nu_911	EQ	0	0	0	0	-698.2616
nu_811	EQ	0	0	0	0	-661.3887
nu_711	EQ	0	0	0	0	-720.023
nu_611	EQ	0	0	0	0	-585.9501
nu_511	EQ	0	0	0	0	-547.3844
nu_411	EQ	0	0	0	0	-508.5115
nu_311	EQ	0	0	0	0	-468.9358
nu_211	EQ	0	0	0	0	-429.0529
nu_111	BS	0	0	0	0	0
PP_11	BS	0	0	0	NONE	0
nu_1012	EQ	0	0	0	0	-0.0942211
nu_912	EQ	0	0	0	0	-0.0945699
nu_812	EQ	0	0	0	0	-0.0946447
nu_712	EQ	0	0	0	0	-0.0947145
nu_612	EQ	1	0	1	1	-0.0947793
nu_512	EQ	0	0	0	0	-0.0948391
nu_412	EQ	0	0	0	0	-0.0948939
nu_312	EQ	0	0	0	0	-0.0949436
nu_212	EQ	0	0	0	0	-0.0949883
nu_112	EQ	0	0	0	0	-0.0951427
PP_12	BS	947.793	0	0	NONE	0
nu_1013	EQ	0	0	0	0	-942211
nu_913	EQ	0	0	0	0	-945699
nu_813	EQ	0	0	0	0	-946447

nu_713	EQ	0	0	0	0	-947145
nu_613	EQ	0	0	0	0	-947793
nu_513	EQ	0	0	0	0	-948391
nu_413	EQ	0	0	0	0	-948939
nu_313	EQ	0	0	0	0	-949436
nu_213	EQ	0	0	0	0	-949883
nu_113	EQ	0	0	0	0	-951427
PP_13	BS	0	0	0	NONE	0
nu_1021	EQ	0	0	0	0	-707.9273
nu_921	EQ	0	0	0	0	-698.2616
nu_821	EQ	0	0	0	0	-661.3887
nu_721	EQ	0	0	0	0	-623.823
nu_621	EQ	0	0	0	0	-585.9501
nu_521	EQ	0	0	0	0	-547.3844
nu_421	EQ	0	0	0	0	-508.5115
nu_321	EQ	0	0	0	0	-468.9358
nu_221	EQ	0	0	0	0	-429.0529
nu_121	BS	0	0	0	0	0
PP_21	BS	0	0	0	NONE	0
nu_1022	EQ	0	0	0	0	-0.0942211
nu_922	EQ	0	0	0	0	-0.0945699
nu_822	EQ	0	0	0	0	-0.0946447
nu_722	EQ	0	0	0	0	-0.0947145
nu_622	EQ	1	0	1	1	-0.0947793
nu_522	EQ	0	0	0	0	-0.0948391
nu_422	EQ	0	0	0	0	-0.0948939
nu_322	EQ	0	0	0	0	-0.0949436
nu_222	EQ	0	0	0	0	-0.0949883
nu_122	EQ	0	0	0	0	-0.0951427
PP_22	BS	947.793	0	0	NONE	0
nu_1023	EQ	0	0	0	0	-942211
nu_923	EQ	0	0	0	0	-945699
nu_823	EQ	0	0	0	0	-946447
nu_723	EQ	0	0	0	0	-947145
nu_623	EQ	0	0	0	0	-947793
nu_523	EQ	0	0	0	0	-948391
nu_423	EQ	0	0	0	0	-948939
nu_323	EQ	0	0	0	0	-949436
nu_223	EQ	0	0	0	0	-949883
nu_123	EQ	0	0	0	0	-951427
PP_23	BS	0	0	0	NONE	0
theta_N	EQ	1	0	1	1	0
theta_N	BS	1	0	1	1	0
theta_N	BS	1	0	1	1	0
QP_11	LL	0	0	0	NONE	-1928.386
QP_12	BS	4.5881	0	0	NONE	0
QP_13	LL	0	0	0	NONE	0
QP_21	LL	0	0	0	NONE	-1928.386
QP_22	BS	4.5881	0	0	NONE	0
QP_23	LL	0	0	0	NONE	0
QP_1	BS	0	0	0	NONE	0

QP_2	BS	9.1762	0	0	NONE	0
QP_3	BS	0	0	0	NONE	0
Beta_11	EQ	1	0	1	1	8723.8
Beta_12	BS	0	0	0	0	0
Beta_13	EQ	1	0	1	1	841130
Beta_21	EQ	1	0	1	1	5682.7
Beta_22	BS	0	0	0	0	0
Beta_23	EQ	1	0	1	1	867570
Alpha_1	BS	0	0	0	0	0
Alpha_1	BS	1	0	1	1	0
Alpha_1	BS	0	0	0	0	0
Alpha_2	BS	0	0	0	0	0
Alpha_2	BS	1	0	1	1	0
Alpha_2	BS	0	0	0	0	0
Turbine	BS	2	0	0	NONE	0
Turbine	BS	0	0	0	NONE	0
Turbine	BS	2	0	0	NONE	0
Pump_1	BS	0	0	0	NONE	0
Pump_2	BS	2	0	0	NONE	0
Pump_3	BS	0	0	0	NONE	0
Produce	BS	1	0	1	1	0
Produce	BS	0	0	0	0	0
Produce	BS	1	0	1	1	0
Spill1_	BS	792	0	0	NONE	0
Spill1_	LL	0	0	0	NONE	0
Spill1_	BS	791.5328	0	0	NONE	0
Spill1_	LL	0	0	0	NONE	0
Spill1_	BS	792.5837	0	0	NONE	0
Spill1_	LL	0	0	0	NONE	0
theta_Y	EQ	0	0	0	0	0
theta_Y	BS	0	0	0	0	0
theta_Y	BS	0	0	0	0	0
theta_3	EQ	0	0	0	0	0
theta_2	EQ	0	0	0	0	0
theta_1	EQ	0	0	0	0	0
SPILL1_	LL	0	0	0	NONE	0
theta_3	EQ	0	0	0	0	0
theta_2	EQ	0	0	0	0	0
theta_1	EQ	0	0	0	0	0
SPILL1_	LL	0	0	0	NONE	0
theta_3	EQ	0	0	0	0	0
theta_2	EQ	0	0	0	0	0
theta_1	BS	0	0	0	0	0
SPILL1_	LL	0	0	0	NONE	0
UnContR	LL	0	0	0	NONE	0
UnContR	BS	0	0	0	NONE	0
UnContR	BS	0	0	0	NONE	0
delta2_	EQ	0	0	0	0	-5204.4
delta2_	EQ	0	0	0	0	862.4
delta2_	EQ	0	0	0	0	718.6
delta2_	EQ	0	0	0	0	575

delta2_	EQ	0	0	0	0	431.2
delta2_	EQ	0	0	0	0	287.4
delta2_	BS	1	0	1	1	0
delta2_	BS	0	0	0	0	0
delta2_	BS	0	0	0	0	0
delta2_	EQ	0	0	0	0	-287.4
H2_1	BS	64.25	0	0	NONE	0
delta2_	EQ	0	0	0	0	-0.005276
delta2_	EQ	0	0	0	0	0.002874
delta2_	EQ	1	0	1	1	-0.057794
delta2_	BS	0	0	0	0	0
delta2_	EQ	0	0	0	0	-0.001438
delta2_	EQ	0	0	0	0	-0.002876
delta2_	EQ	0	0	0	0	-0.004312
delta2_	EQ	0	0	0	0	-0.00575
delta2_	EQ	0	0	0	0	-0.007186
delta2_	EQ	0	0	0	0	-0.008624
H2_2	BS	72.99	0	0	NONE	0
delta2_	EQ	0	0	0	0	86240
delta2_	EQ	0	0	0	0	71860
delta2_	EQ	0	0	0	0	57480
delta2_	EQ	0	0	0	0	43120
delta2_	EQ	0	0	0	0	28740
delta2_	EQ	0	0	0	0	14360
delta2_	BS	1	0	1	1	0
delta2_	EQ	0	0	0	0	-14380
delta2_	EQ	0	0	0	0	-28740
delta2_	EQ	0	0	0	0	-43120
H2_3	BS	64.25	0	0	NONE	0
TR2_1	BS	540.75	0	532	551	0
TR2_2	BS	533.9869	0	532	551	0
TR2_3	BS	540.3337	0	532	551	0
phi2_11	BS	0	0	0	0	0
phi2_11	EQ	0	0	0	0	-379.5
phi2_11	EQ	0	0	0	0	-557.2
phi2_11	EQ	0	0	0	0	-738.9
phi2_11	EQ	0	0	0	0	-920.9
phi2_11	EQ	0	0	0	0	-1435.9
phi2_21	BS	0	0	0	0	0
phi2_21	EQ	0	0	0	0	-390.6
phi2_21	EQ	0	0	0	0	-573.5
phi2_21	EQ	0	0	0	0	-760.6
phi2_21	EQ	0	0	0	0	-947.8
phi2_21	EQ	0	0	0	0	-1477.9
phi2_31	BS	0	0	0	0	0
phi2_31	EQ	0	0	0	0	-401.6
phi2_31	EQ	0	0	0	0	-589.7
phi2_31	EQ	0	0	0	0	-782.1
phi2_31	EQ	0	0	0	0	-974.7
phi2_31	EQ	0	0	0	0	-1519.8
phi2_41	EQ	0	0	0	0	1001.7

phi2_41	EQ	0	0	0	0	588.9
phi2_41	EQ	0	0	0	0	395.7
phi2_41	EQ	1	0	1	1	198
phi2_41	BS	0	0	0	0	0
phi2_41	EQ	0	0	0	0	-560.1
phi2_51	BS	0	0	0	0	0
phi2_51	EQ	0	0	0	0	-423.8
phi2_51	EQ	0	0	0	0	-622.3
phi2_51	EQ	0	0	0	0	-825.3
phi2_51	EQ	0	0	0	0	-1028.5
phi2_51	EQ	0	0	0	0	-1603.8
phi2_61	BS	0	0	0	0	0
phi2_61	EQ	0	0	0	0	-434.9
phi2_61	EQ	0	0	0	0	-638.6
phi2_61	EQ	0	0	0	0	-846.9
phi2_61	EQ	0	0	0	0	-1055.5
phi2_61	EQ	0	0	0	0	-1645.8
phi2_71	BS	0	0	0	0	0
phi2_71	EQ	0	0	0	0	-446.1
phi2_71	EQ	0	0	0	0	-654.9
phi2_71	EQ	0	0	0	0	-868.5
phi2_71	EQ	0	0	0	0	-1082.4
phi2_71	EQ	0	0	0	0	-1687.8
phi2_81	BS	0	0	0	0	0
phi2_81	EQ	0	0	0	0	-457.1
phi2_81	EQ	0	0	0	0	-671.1
phi2_81	EQ	0	0	0	0	-890.1
phi2_81	EQ	0	0	0	0	-1109.3
phi2_81	EQ	0	0	0	0	-1729.7
phi2_91	BS	0	0	0	0	0
phi2_91	EQ	0	0	0	0	-468.2
phi2_91	EQ	0	0	0	0	-687.5
phi2_91	EQ	0	0	0	0	-911.7
phi2_91	EQ	0	0	0	0	-1136.2
phi2_91	EQ	0	0	0	0	-1771.7
phi2_10	EQ	0	0	0	0	3105.3
phi2_10	EQ	0	0	0	0	2625.9
phi2_10	EQ	0	0	0	0	2401.5
phi2_10	EQ	0	0	0	0	2171.9
phi2_10	EQ	0	0	0	0	1942.1
phi2_10	EQ	0	0	0	0	1291.6
phi2_12	BS	0	0	0	0	0
phi2_12	EQ	0	0	0	0	-379.5
phi2_12	EQ	0	0	0	0	-557.2
phi2_12	EQ	0	0	0	0	-738.9
phi2_12	EQ	0	0	0	0	-920.9
phi2_12	EQ	0	0	0	0	-1435.9
phi2_22	EQ	0	0	0	0	-143.6
phi2_22	EQ	0	0	0	0	-534.2
phi2_22	EQ	0	0	0	0	-717.1
phi2_22	EQ	0	0	0	0	-904.2

phi2_22	EQ	0	0	0	0	-1091.4
phi2_22	EQ	0	0	0	0	-1621.5
phi2_32	BS	0	0	0	0	0
phi2_32	EQ	0	0	0	0	-401.6
phi2_32	EQ	0	0	0	0	-589.7
phi2_32	EQ	0	0	0	0	-782.1
phi2_32	EQ	0	0	0	0	-974.7
phi2_32	EQ	0	0	0	0	-1519.8
phi2_42	EQ	1	0	1	1	-857.9
phi2_42	EQ	0	0	0	0	-1270.7
phi2_42	EQ	0	0	0	0	-1463.9
phi2_42	EQ	0	0	0	0	-1661.6
phi2_42	EQ	0	0	0	0	-1859.6
phi2_42	EQ	0	0	0	0	-2419.7
phi2_52	BS	0	0	0	0	0
phi2_52	EQ	0	0	0	0	-423.8
phi2_52	EQ	0	0	0	0	-622.3
phi2_52	EQ	0	0	0	0	-825.3
phi2_52	EQ	0	0	0	0	-1028.5
phi2_52	EQ	0	0	0	0	-1603.8
phi2_62	BS	0	0	0	0	0
phi2_62	EQ	0	0	0	0	-434.9
phi2_62	EQ	0	0	0	0	-638.6
phi2_62	EQ	0	0	0	0	-846.9
phi2_62	EQ	0	0	0	0	-1055.5
phi2_62	EQ	0	0	0	0	-1645.8
phi2_72	BS	0	0	0	0	0
phi2_72	EQ	0	0	0	0	-446.1
phi2_72	EQ	0	0	0	0	-654.9
phi2_72	EQ	0	0	0	0	-868.5
phi2_72	EQ	0	0	0	0	-1082.4
phi2_72	EQ	0	0	0	0	-1687.8
phi2_82	BS	0	0	0	0	0
phi2_82	EQ	0	0	0	0	-457.1
phi2_82	EQ	0	0	0	0	-671.1
phi2_82	EQ	0	0	0	0	-890.1
phi2_82	EQ	0	0	0	0	-1109.3
phi2_82	EQ	0	0	0	0	-1729.7
phi2_92	BS	0	0	0	0	0
phi2_92	EQ	0	0	0	0	-468.2
phi2_92	EQ	0	0	0	0	-687.5
phi2_92	EQ	0	0	0	0	-911.7
phi2_92	EQ	0	0	0	0	-1136.2
phi2_92	EQ	0	0	0	0	-1771.7
phi2_10	EQ	0	0	0	0	3105.3
phi2_10	EQ	0	0	0	0	2625.9
phi2_10	EQ	0	0	0	0	2401.5
phi2_10	EQ	0	0	0	0	2171.9
phi2_10	EQ	0	0	0	0	1942.1
phi2_10	EQ	0	0	0	0	1291.6
phi2_11	BS	0	0	0	0	0

phi2_11	EQ	0	0	0	0	-0.003795
phi2_11	EQ	0	0	0	0	-0.005572
phi2_11	EQ	0	0	0	0	-0.007389
phi2_11	EQ	0	0	0	0	-0.009209
phi2_11	EQ	0	0	0	0	-0.014359
phi2_21	BS	0	0	0	0	0
phi2_21	EQ	0	0	0	0	-0.003906
phi2_21	EQ	0	0	0	0	-0.005735
phi2_21	EQ	0	0	0	0	-0.007606
phi2_21	EQ	0	0	0	0	-0.009478
phi2_21	EQ	0	0	0	0	-0.014779
phi2_31	BS	0	0	0	0	0
phi2_31	EQ	0	0	0	0	-0.004016
phi2_31	EQ	0	0	0	0	-0.005897
phi2_31	EQ	0	0	0	0	-0.007821
phi2_31	EQ	0	0	0	0	-0.009747
phi2_31	EQ	0	0	0	0	-0.015198
phi2_41	BS	0	0	0	0	0
phi2_41	EQ	0	0	0	0	-0.004128
phi2_41	EQ	0	0	0	0	-0.00606
phi2_41	EQ	0	0	0	0	-0.008037
phi2_41	EQ	0	0	0	0	-0.010017
phi2_41	EQ	0	0	0	0	-0.015618
phi2_51	BS	0	0	0	0	0
phi2_51	EQ	0	0	0	0	-0.004238
phi2_51	EQ	0	0	0	0	-0.006223
phi2_51	EQ	0	0	0	0	-0.008253
phi2_51	EQ	0	0	0	0	-0.010285
phi2_51	EQ	0	0	0	0	-0.016038
phi2_61	BS	0	0	0	0	0
phi2_61	EQ	0	0	0	0	-0.004349
phi2_61	EQ	0	0	0	0	-0.006386
phi2_61	EQ	0	0	0	0	-0.008469
phi2_61	EQ	0	0	0	0	-0.010555
phi2_61	EQ	0	0	0	0	-0.016458
phi2_71	BS	0	0	0	0	0
phi2_71	EQ	0	0	0	0	-0.004461
phi2_71	EQ	0	0	0	0	-0.006549
phi2_71	EQ	0	0	0	0	-0.008685
phi2_71	EQ	0	0	0	0	-0.010824
phi2_71	EQ	0	0	0	0	-0.016878
phi2_81	EQ	0	0	0	0	0.029615
phi2_81	EQ	0	0	0	0	0.025044
phi2_81	EQ	0	0	0	0	0.022904
phi2_81	EQ	0	0	0	0	0.020714
phi2_81	EQ	0	0	0	0	0.018522
phi2_81	EQ	0	0	0	0	0.012318
phi2_91	BS	0	0	0	0	0
phi2_91	EQ	0	0	0	0	-0.004682
phi2_91	EQ	0	0	0	0	-0.006875
phi2_91	EQ	0	0	0	0	-0.009117

phi2_91	EQ	0	0	0	0	-0.011362
phi2_91	EQ	0	0	0	0	-0.017717
phi2_10	EQ	0	0	0	0	0.004794
phi2_10	BS	0	0	0	0	0
phi2_10	EQ	0	0	0	0	-0.002244
phi2_10	EQ	0	0	0	0	-0.00454
phi2_10	EQ	0	0	0	0	-0.006838
phi2_10	EQ	0	0	0	0	-0.013343
phi2_12	BS	0	0	0	0	0
phi2_12	EQ	0	0	0	0	-0.003795
phi2_12	EQ	0	0	0	0	-0.005572
phi2_12	EQ	0	0	0	0	-0.007389
phi2_12	EQ	0	0	0	0	-0.009209
phi2_12	EQ	0	0	0	0	-0.014359
phi2_22	BS	0	0	0	0	0
phi2_22	EQ	0	0	0	0	-0.003906
phi2_22	EQ	0	0	0	0	-0.005735
phi2_22	EQ	0	0	0	0	-0.007606
phi2_22	EQ	0	0	0	0	-0.009478
phi2_22	EQ	0	0	0	0	-0.014779
phi2_32	BS	0	0	0	0	0
phi2_32	EQ	0	0	0	0	-0.004016
phi2_32	EQ	0	0	0	0	-0.005897
phi2_32	EQ	0	0	0	0	-0.007821
phi2_32	EQ	0	0	0	0	-0.009747
phi2_32	EQ	0	0	0	0	-0.015198
phi2_42	BS	0	0	0	0	0
phi2_42	EQ	0	0	0	0	-0.004128
phi2_42	EQ	0	0	0	0	-0.00606
phi2_42	EQ	0	0	0	0	-0.008037
phi2_42	EQ	0	0	0	0	-0.010017
phi2_42	EQ	0	0	0	0	-0.015618
phi2_52	BS	0	0	0	0	0
phi2_52	EQ	0	0	0	0	-0.004238
phi2_52	EQ	0	0	0	0	-0.006223
phi2_52	EQ	0	0	0	0	-0.008253
phi2_52	EQ	0	0	0	0	-0.010285
phi2_52	EQ	0	0	0	0	-0.016038
phi2_62	BS	0	0	0	0	0
phi2_62	EQ	0	0	0	0	-0.004349
phi2_62	EQ	0	0	0	0	-0.006386
phi2_62	EQ	0	0	0	0	-0.008469
phi2_62	EQ	0	0	0	0	-0.010555
phi2_62	EQ	0	0	0	0	-0.016458
phi2_72	BS	0	0	0	0	0
phi2_72	EQ	0	0	0	0	-0.004461
phi2_72	EQ	0	0	0	0	-0.006549
phi2_72	EQ	0	0	0	0	-0.008685
phi2_72	EQ	0	0	0	0	-0.010824
phi2_72	EQ	0	0	0	0	-0.016878
phi2_82	EQ	0	0	0	0	0.029615

phi2_82	EQ	0	0	0	0	0.025044
phi2_82	EQ	0	0	0	0	0.022904
phi2_82	EQ	0	0	0	0	0.020714
phi2_82	EQ	0	0	0	0	0.018522
phi2_82	EQ	0	0	0	0	0.012318
phi2_92	BS	0	0	0	0	0
phi2_92	EQ	0	0	0	0	-0.004682
phi2_92	EQ	0	0	0	0	-0.006875
phi2_92	EQ	0	0	0	0	-0.009117
phi2_92	EQ	0	0	0	0	-0.011362
phi2_92	EQ	0	0	0	0	-0.017717
phi2_10	EQ	0	0	0	0	0.004794
phi2_10	BS	0	0	0	0	0
phi2_10	EQ	0	0	0	0	-0.002244
phi2_10	EQ	0	0	0	0	-0.00454
phi2_10	EQ	0	0	0	0	-0.006838
phi2_10	EQ	0	0	0	0	-0.013343
phi2_11	BS	0	0	0	0	0
phi2_11	EQ	0	0	0	0	-37950
phi2_11	EQ	0	0	0	0	-55720
phi2_11	EQ	0	0	0	0	-73890
phi2_11	EQ	0	0	0	0	-92090
phi2_11	EQ	0	0	0	0	-143590
phi2_21	BS	0	0	0	0	0
phi2_21	EQ	0	0	0	0	-39060
phi2_21	EQ	0	0	0	0	-57350
phi2_21	EQ	0	0	0	0	-76060
phi2_21	EQ	0	0	0	0	-94780
phi2_21	EQ	0	0	0	0	-147790
phi2_31	BS	0	0	0	0	0
phi2_31	EQ	0	0	0	0	-40160
phi2_31	EQ	0	0	0	0	-58970
phi2_31	EQ	0	0	0	0	-78210
phi2_31	EQ	0	0	0	0	-97470
phi2_31	EQ	0	0	0	0	-151980
phi2_41	BS	1	0	1	1	0
phi2_41	EQ	0	0	0	0	-41280
phi2_41	EQ	0	0	0	0	-60600
phi2_41	EQ	0	0	0	0	-80370
phi2_41	EQ	0	0	0	0	-100170
phi2_41	EQ	0	0	0	0	-156180
phi2_51	BS	0	0	0	0	0
phi2_51	EQ	0	0	0	0	-42380
phi2_51	EQ	0	0	0	0	-62230
phi2_51	EQ	0	0	0	0	-82530
phi2_51	EQ	0	0	0	0	-102850
phi2_51	EQ	0	0	0	0	-160380
phi2_61	BS	0	0	0	0	0
phi2_61	EQ	0	0	0	0	-43490
phi2_61	EQ	0	0	0	0	-63860
phi2_61	EQ	0	0	0	0	-84690

phi2_61	EQ	0	0	0	0	-105550
phi2_61	EQ	0	0	0	0	-164580
phi2_71	BS	0	0	0	0	0
phi2_71	EQ	0	0	0	0	-44610
phi2_71	EQ	0	0	0	0	-65490
phi2_71	EQ	0	0	0	0	-86850
phi2_71	EQ	0	0	0	0	-108240
phi2_71	EQ	0	0	0	0	-168780
phi2_81	BS	0	0	0	0	0
phi2_81	EQ	0	0	0	0	-45710
phi2_81	EQ	0	0	0	0	-67110
phi2_81	EQ	0	0	0	0	-89010
phi2_81	EQ	0	0	0	0	-110930
phi2_81	EQ	0	0	0	0	-172970
phi2_91	BS	0	0	0	0	0
phi2_91	EQ	0	0	0	0	-46820
phi2_91	EQ	0	0	0	0	-68750
phi2_91	EQ	0	0	0	0	-91170
phi2_91	EQ	0	0	0	0	-113620
phi2_91	EQ	0	0	0	0	-177170
phi2_10	BS	0	0	0	0	0
phi2_10	EQ	0	0	0	0	-47940
phi2_10	EQ	0	0	0	0	-70380
phi2_10	EQ	0	0	0	0	-93340
phi2_10	EQ	0	0	0	0	-116320
phi2_10	EQ	0	0	0	0	-181370
phi2_12	BS	0	0	0	0	0
phi2_12	EQ	0	0	0	0	-37950
phi2_12	EQ	0	0	0	0	-55720
phi2_12	EQ	0	0	0	0	-73890
phi2_12	EQ	0	0	0	0	-92090
phi2_12	EQ	0	0	0	0	-143590
phi2_22	BS	0	0	0	0	0
phi2_22	EQ	0	0	0	0	-39060
phi2_22	EQ	0	0	0	0	-57350
phi2_22	EQ	0	0	0	0	-76060
phi2_22	EQ	0	0	0	0	-94780
phi2_22	EQ	0	0	0	0	-147790
phi2_32	BS	0	0	0	0	0
phi2_32	EQ	0	0	0	0	-40160
phi2_32	EQ	0	0	0	0	-58970
phi2_32	EQ	0	0	0	0	-78210
phi2_32	EQ	0	0	0	0	-97470
phi2_32	EQ	0	0	0	0	-151980
phi2_42	BS	1	0	1	1	0
phi2_42	EQ	0	0	0	0	-41280
phi2_42	EQ	0	0	0	0	-60600
phi2_42	EQ	0	0	0	0	-80370
phi2_42	EQ	0	0	0	0	-100170
phi2_42	EQ	0	0	0	0	-156180
phi2_52	BS	0	0	0	0	0

phi2_52	EQ	0	0	0	0	-42380
phi2_52	EQ	0	0	0	0	-62230
phi2_52	EQ	0	0	0	0	-82530
phi2_52	EQ	0	0	0	0	-102850
phi2_52	EQ	0	0	0	0	-160380
phi2_62	BS	0	0	0	0	0
phi2_62	EQ	0	0	0	0	-43490
phi2_62	EQ	0	0	0	0	-63860
phi2_62	EQ	0	0	0	0	-84690
phi2_62	EQ	0	0	0	0	-105550
phi2_62	EQ	0	0	0	0	-164580
phi2_72	BS	0	0	0	0	0
phi2_72	EQ	0	0	0	0	-44610
phi2_72	EQ	0	0	0	0	-65490
phi2_72	EQ	0	0	0	0	-86850
phi2_72	EQ	0	0	0	0	-108240
phi2_72	EQ	0	0	0	0	-168780
phi2_82	BS	0	0	0	0	0
phi2_82	EQ	0	0	0	0	-45710
phi2_82	EQ	0	0	0	0	-67110
phi2_82	EQ	0	0	0	0	-89010
phi2_82	EQ	0	0	0	0	-110930
phi2_82	EQ	0	0	0	0	-172970
phi2_92	BS	0	0	0	0	0
phi2_92	EQ	0	0	0	0	-46820
phi2_92	EQ	0	0	0	0	-68750
phi2_92	EQ	0	0	0	0	-91170
phi2_92	EQ	0	0	0	0	-113620
phi2_92	EQ	0	0	0	0	-177170
phi2_10	BS	0	0	0	0	0
phi2_10	EQ	0	0	0	0	-47940
phi2_10	EQ	0	0	0	0	-70380
phi2_10	EQ	0	0	0	0	-93340
phi2_10	EQ	0	0	0	0	-116320
phi2_10	EQ	0	0	0	0	-181370
PT2_11	BS	187.04	0	0	NONE	0
PT2_12	BS	0	0	0	NONE	0
PT2_13	BS	267.41	0	0	NONE	0
PT2_21	BS	267.41	0	0	NONE	0
PT2_22	BS	0	0	0	NONE	0
PT2_23	BS	267.41	0	0	NONE	0
QT2_11	BS	3.6501	0	0	5.5	0
QT2_12	BS	0	0	0	5.5	0
QT2_13	BS	4.2501	0	0	5.5	0
QT2_21	BS	4.2501	0	0	5.5	0
QT2_22	BS	0	0	0	5.5	0
QT2_23	BS	4.2501	0	0	5.5	0
QT2_1	BS	7.9002	0	0	NONE	0
QT2_2	BS	0	0	0	NONE	0
QT2_3	BS	8.5002	0	0	NONE	0
Spill2_	LL	0	0	0	NONE	0

Spill2_	BS	605	0	0	NONE	0
Spill2_	BS	606.9769	0	0	NONE	0
Spill2_	LL	0	0	0	NONE	0
Spill2_	BS	604.5837	0	0	NONE	0
Spill2_	LL	0	0	0	NONE	0
sigma_N	BS	0	0	0	0	0
sigma_N	BS	1	0	1	1	0
sigma_N	BS	1	0	1	1	0
sigma_Y	EQ	1	0	1	1	0
sigma_Y	BS	0	0	0	0	0
sigma_Y	BS	0	0	0	0	0
Gated_1	LL	0	0	0	NONE	0
Gated_2	LL	0	0	0	NONE	0
Gated_3	LL	0	0	0	NONE	0
Chan_1	BS	7.9002	0	0	NONE	0
Chan_2	BS	0	0	0	NONE	0
Chan_3	BS	8.5002	0	0	NONE	0
zeta_91	EQ	0	0	0	0	0
zeta_81	EQ	0	0	0	0	0
zeta_71	EQ	0	0	0	0	0
zeta_61	EQ	0	0	0	0	0
zeta_51	EQ	0	0	0	0	0
zeta_41	EQ	1	0	1	1	0
zeta_31	BS	0	0	0	0	0
zeta_21	EQ	0	0	0	0	0
zeta_11	EQ	0	0	0	0	0
zeta_92	EQ	0	0	0	0	0
zeta_82	EQ	0	0	0	0	0
zeta_72	EQ	0	0	0	0	0
zeta_62	EQ	0	0	0	0	0
zeta_52	EQ	0	0	0	0	0
zeta_42	EQ	0	0	0	0	0
zeta_32	EQ	0	0	0	0	0
zeta_22	EQ	0	0	0	0	0
zeta_12	BS	1	0	1	1	0
zeta_93	EQ	0	0	0	0	0
zeta_83	EQ	0	0	0	0	0
zeta_73	EQ	0	0	0	0	0
zeta_63	EQ	0	0	0	0	0
zeta_53	EQ	0	0	0	0	0
zeta_43	EQ	1	0	1	1	0
zeta_33	EQ	0	0	0	0	0
zeta_23	EQ	0	0	0	0	0
zeta_13	BS	0	0	0	0	0
S1_1	BS	4.925264	0	0	NONE	0
S1_2	BS	4.886178	0	0	NONE	0
S1_3	BS	4.9741	0	0	NONE	0
S2_1	BS	0.317435	0	0	NONE	0
S2_2	BS	0.340104	0	0	NONE	0
S2_3	BS	0.312661	0	0	NONE	0
I1_1	BS	3	0	0	NONE	0

I1_2	BS	1	0	0	NONE	0
S1_4	BS	4.897202	0	3	7	0
I1_3	BS	2	0	0	NONE	0
I2_1	BS	3	0	0	NONE	0
I2_2	BS	6	0	0	NONE	0
S2_4	BS	0.359317	0	0	10	0
I2_3	BS	3	0	0	NONE	0

Input to CPLEX for Analysis 3

```
MAXIMIZE
1000PT1_3-1000PP_3+1000PT2_3

st

all other remained the same
```

Output from CPLEX for Analysis 3

......ROW.......	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT.	..UPPER LIMIT.	.DUAL ACTIVITY
Row	AT	Activity	Slack Activity	Lower Limit	Upper Limit	Dual Activity
	BS	2394365	-2394365	NONE	NONE	1
c1	BS	0	0	NONE	0	0
c2	BS	-0.94068	0.9406814	NONE	0	0
c3	BS	-0.39464	0.3946398	NONE	0	0
c4	BS	0.999	-0.999	0	NONE	0
c5	BS	6.059319	-6.059319	0	NONE	0
c6	BS	6.60536	-6.60536	0	NONE	0
c7	EQ	1	0	1	1	0
c8	EQ	1	0	1	1	0
c9	EQ	1	0	1	1	-127370
c10	EQ	0	0	0	0	0
c11	EQ	0	0	0	0	0
c12	EQ	0	0	0	0	0
c13	BS	0	0	NONE	0	0
c14	BS	0	0	NONE	0	0
c15	BS	0	0	NONE	0	0
c16	BS	0	0	NONE	0	0

c17	BS	0	0	NONE	0	0
c18	BS	0	0	NONE	0	0
c19	UL	0	0	NONE	0	0
c20	BS	0	0	NONE	0	0
c21	BS	-1	1	NONE	0	0
c22	BS	0	0	NONE	0	0
c23	BS	0	0	NONE	0	0
c24	BS	0	0	NONE	0	0
c25	BS	0	0	NONE	0	0
c26	BS	0	0	NONE	0	0
c27	BS	0	0	NONE	0	0
c28	BS	0	0	NONE	0	0
c29	UL	0	0	NONE	0	0
c30	BS	0	0	NONE	0	0
c31	BS	-1	1	NONE	0	0
c32	BS	0	0	NONE	0	0
c33	BS	0	0	NONE	0	0
c34	BS	0	0	NONE	0	0
c35	BS	0	0	NONE	0	0
c36	BS	0	0	NONE	0	0
c37	BS	0	0	NONE	0	0
c38	BS	0	0	NONE	0	0
c39	BS	0	0	NONE	0	0
c40	BS	0	0	NONE	0	0
c41	BS	0	0	NONE	0	0
c42	BS	-1	1	NONE	0	0
c43	UL	0	0	NONE	0	0
c44	UL	0	0	NONE	0	0
c45	UL	0	0	NONE	0	0
c46	UL	0	0	NONE	0	0
c47	UL	0	0	NONE	0	0
c48	UL	0	0	NONE	0	0
c49	UL	0	0	NONE	0	0
c50	UL	0	0	NONE	0	0
c51	UL	0	0	NONE	0	0
c52	BS	-1	1	NONE	0	0
c53	BS	0	0	NONE	0	0
c54	UL	0	0	NONE	0	-26440
c55	UL	0	0	NONE	0	-31250
c56	UL	0	0	NONE	0	-36050
c57	UL	0	0	NONE	0	-40860
c58	UL	0	0	NONE	0	-45670
c59	UL	0	0	NONE	0	-50470
c60	UL	0	0	NONE	0	-55280
c61	UL	0	0	NONE	0	-60090
c62	UL	0	0	NONE	0	-79310
c63	BS	0	0	NONE	0	0
c64	BS	0	0	NONE	0	0
c65	BS	0	0	NONE	0	0
c66	UL	0	0	NONE	0	-4800

c67	UL	0	0	NONE	0	-9610
c68	UL	0	0	NONE	0	-14420
c69	UL	0	0	NONE	0	-19220
c70	UL	0	0	NONE	0	-24030
c71	UL	0	0	NONE	0	-28840
c72	UL	0	0	NONE	0	-48060
c73	EQ	0	0	0	0	0
c74	EQ	0	0	0	0	0
c75	EQ	0	0	0	0	1000
c76	EQ	0	0	0	0	0
c77	EQ	0	0	0	0	0
c78	EQ	0	0	0	0	1000
c79	EQ	0	0	0	0	0
c80	EQ	0	0	0	0	0
c81	EQ	0	0	0	0	1000
c82	EQ	0	0	0	0	0
c83	EQ	0	0	0	0	0
c84	EQ	0	0	0	0	0
c85	UL	0	0	NONE	0	0
c86	BS	0	0	0	NONE	0
c87	UL	0	0	NONE	0	0
c88	BS	0	0	0	NONE	0
c89	UL	0	0	NONE	0	0
c90	BS	0.1999	-0.1999	0	NONE	0
c91	UL	0	0	NONE	0	0
c92	BS	0	0	0	NONE	0
c93	UL	0	0	NONE	0	0
c94	BS	0	0	0	NONE	0
c95	UL	0	0	NONE	0	0
c96	BS	0.1999	-0.1999	0	NONE	0
c97	EQ	0	0	0	0	0
c98	EQ	0	0	0	0	0
c99	EQ	0	0	0	0	0
c100	EQ	0	0	0	0	0
c101	EQ	0	0	0	0	0
c102	EQ	0	0	0	0	-1000
c103	EQ	0	0	0	0	0
c104	EQ	0	0	0	0	0
c105	EQ	0	0	0	0	-1000
c106	EQ	0	0	0	0	0
c107	EQ	0	0	0	0	0
c108	EQ	0	0	0	0	-1000
c109	UL	0	0	NONE	0	0
c110	UL	0	0	NONE	0	0
c111	UL	0	0	NONE	0	0
c112	UL	0	0	NONE	0	0
c113	UL	0	0	NONE	0	0
c114	UL	0	0	NONE	0	0
c115	UL	0	0	NONE	0	0
c116	UL	0	0	NONE	0	0

c117	UL	0	0 NONE	0	0
c118	UL	0	0 NONE	0	0
c119	UL	0	0 NONE	0	0
c120	UL	0	0 NONE	0	0
c121	UL	0	0 NONE	0	0
c122	UL	0	0 NONE	0	0
c123	UL	0	0 NONE	0	0
c124	BS	0	0 NONE	0	0
c125	UL	0	0 NONE	0	0
c126	BS	-1	1 NONE	0	0
c127	BS	0	0 NONE	0	0
c128	BS	0	0 NONE	0	0
c129	BS	0	0 NONE	0	0
c130	UL	0	0 NONE	0	0
c131	UL	0	0 NONE	0	0
c132	UL	0	0 NONE	0	0
c133	UL	0	0 NONE	0	0
c134	UL	0	0 NONE	0	0
c135	UL	0	0 NONE	0	0
c136	UL	0	0 NONE	0	0
c137	BS	0	0 NONE	0	0
c138	UL	0	0 NONE	0	0
c139	BS	0	0 NONE	0	0
c140	UL	0	0 NONE	0	0
c141	BS	0	0 NONE	0	0
c142	UL	0	0 NONE	0	0
c143	BS	0	0 NONE	0	0
c144	UL	0	0 NONE	0	0
c145	UL	0	0 NONE	0	0
c146	UL	0	0 NONE	0	0
c147	UL	0	0 NONE	0	0
c148	BS	-1	1 NONE	0	0
c149	BS	0	0 NONE	0	0
c150	BS	0	0 NONE	0	0
c151	BS	0	0 NONE	0	0
c152	BS	0	0 NONE	0	0
c153	BS	0	0 NONE	0	0
c154	BS	0	0 NONE	0	0
c155	BS	0	0 NONE	0	0
c156	BS	0	0 NONE	0	0
c157	BS	0	0 NONE	0	0
c158	BS	0	0 NONE	0	0
c159	BS	0	0 NONE	0	0
c160	BS	0	0 NONE	0	0
c161	BS	0	0 NONE	0	0
c162	BS	0	0 NONE	0	0
c163	BS	0	0 NONE	0	0
c164	BS	0	0 NONE	0	0
c165	BS	0	0 NONE	0	0
c166	BS	0	0 NONE	0	0

c167	BS	-1	1 NONE	0	0
c168	BS	-1	1 NONE	0	0
c169	BS	-1	1 NONE	0	0
c170	BS	-1	1 NONE	0	0
c171	BS	-1	1 NONE	0	0
c172	BS	-1	1 NONE	0	0
c173	BS	-1	1 NONE	0	0
c174	BS	-1	1 NONE	0	0
c175	BS	-1	1 NONE	0	0
c176	BS	-1	1 NONE	0	0
c177	BS	-1	1 NONE	0	0
c178	BS	-1	1 NONE	0	0
c179	BS	-1	1 NONE	0	0
c180	BS	-1	1 NONE	0	0
c181	BS	-1	1 NONE	0	0
c182	BS	-1	1 NONE	0	0
c183	BS	-1	1 NONE	0	0
c184	BS	-1	1 NONE	0	0
c185	BS	0	0 NONE	0	0
c186	BS	-1	1 NONE	0	0
c187	BS	-1	1 NONE	0	0
c188	BS	-1	1 NONE	0	0
c189	BS	-1	1 NONE	0	0
c190	BS	-1	1 NONE	0	0
c191	BS	-1	1 NONE	0	0
c192	BS	-1	1 NONE	0	0
c193	BS	-1	1 NONE	0	0
c194	BS	-1	1 NONE	0	0
c195	BS	-1	1 NONE	0	0
c196	BS	-1	1 NONE	0	0
c197	BS	-1	1 NONE	0	0
c198	BS	-1	1 NONE	0	0
c199	BS	-1	1 NONE	0	0
c200	BS	-1	1 NONE	0	0
c201	BS	-1	1 NONE	0	0
c202	BS	-1	1 NONE	0	0
c203	BS	-1	1 NONE	0	0
c204	BS	-1	1 NONE	0	0
c205	BS	-1	1 NONE	0	0
c206	BS	-1	1 NONE	0	0
c207	BS	0	0 NONE	0	0
c208	BS	-1	1 NONE	0	0
c209	BS	-1	1 NONE	0	0
c210	BS	-1	1 NONE	0	0
c211	BS	-1	1 NONE	0	0
c212	BS	-1	1 NONE	0	0
c213	BS	-1	1 NONE	0	0
c214	BS	-1	1 NONE	0	0
c215	BS	-1	1 NONE	0	0
c216	BS	-1	1 NONE	0	0

c217	BS	-1	1	NONE	0	0
c218	BS	-1	1	NONE	0	0
c219	BS	-1	1	NONE	0	0
c220	BS	-1	1	NONE	0	0
c221	BS	-1	1	NONE	0	0
c222	BS	-1	1	NONE	0	0
c223	BS	-1	1	NONE	0	0
c224	BS	-1	1	NONE	0	0
c225	BS	-1	1	NONE	0	0
c226	BS	-1	1	NONE	0	0
c227	BS	-1	1	NONE	0	0
c228	BS	-1	1	NONE	0	0
c229	LL	0	0	0	NONE	0
c230	BS	-0.023	0.023	NONE	0	0
c231	LL	0	0	0	NONE	0
c232	BS	-0.1613	0.1613	NONE	0	0
c233	BS	0	0	0	NONE	0
c234	BS	0	0	NONE	0	0
c235	LL	0	0	0	NONE	0
c236	BS	0	0	NONE	0	0
c237	LL	0	0	0	NONE	0
c238	BS	0	0	NONE	0	0
c239	BS	0	0	0	NONE	0
c240	BS	0	0	NONE	0	0
c241	EQ	0	0	0	0	0
c242	EQ	0	0	0	0	0
c243	EQ	0	0	0	0	0
c244	EQ	0	0	0	0	0
c245	EQ	0	0	0	0	0
c246	EQ	0	0	0	0	-841130
c247	EQ	0	0	0	0	0
c248	EQ	0	0	0	0	0
c249	EQ	0	0	0	0	-872380
c250	EQ	0	0	0	0	0
c251	EQ	0	0	0	0	0
c252	EQ	0	0	0	0	0
c253	EQ	0	0	0	0	0
c254	EQ	0	0	0	0	0
c255	EQ	0	0	0	0	0
c256	BS	1	0	NONE	1	0
c257	BS	1	0	NONE	1	0
c258	BS	1	0	NONE	1	0
c259	BS	0	1	NONE	1	0
c260	BS	0	1	NONE	1	0
c261	BS	1	0	NONE	1	0
c262	EQ	0	0	0	0	0
c263	EQ	0	0	0	0	0
c264	EQ	0	0	0	0	0
c265	EQ	0	0	0	0	0
c266	EQ	0	0	0	0	0

c267	EQ	0	0	0	0	0
c268	BS	0	0	NONE	0	0
c269	UL	0	0	NONE	0	0
c270	UL	0	0	NONE	0	0
c271	BS	1	1	NONE	2	0
c272	BS	1	1	NONE	2	0
c273	BS	2	0	NONE	2	0
c274	EQ	0	0	0	0	0
c275	EQ	0	0	0	0	0
c276	EQ	0	0	0	0	0
c277	BS	-5	5	NONE	0	0
c278	BS	-5.77884	5.778836	NONE	0	0
c279	BS	-6.34875	6.348754	NONE	0	0
c280	BS	-3	3	NONE	0	0
c281	BS	-2.22116	2.221164	NONE	0	0
c282	BS	-1.65125	1.651246	NONE	0	0
c283	BS	0	0	NONE	0	0
c284	BS	0	0	NONE	0	0
c285	UL	0	0	NONE	0	0
c286	BS	0	0	NONE	0	0
c287	UL	0	0	NONE	0	0
c288	BS	0	0	NONE	0	0
c289	BS	0	0	NONE	0	0
c290	BS	0	0	NONE	0	0
c291	BS	0	0	NONE	0	0
c292	BS	0	0	0	NONE	0
c293	BS	0	0	0	NONE	0
c294	BS	0	0	0	NONE	0
c295	BS	0	0	0	0	0
c296	EQ	0	0	0	0	0
c297	EQ	0	0	0	0	0
c298	BS	1	0	1	1	0
c299	EQ	1	0	1	1	0
c300	EQ	1	0	1	1	0
c301	BS	0	0	0	0	0
c302	EQ	0	0	0	0	0
c303	EQ	0	0	0	0	0
c304	BS	-1.177	1.177	NONE	0	0
c305	BS	-1.74	1.74	NONE	0	0
c306	UL	0	0	NONE	0	0
c307	BS	0.563	-0.563	0	NONE	0
c308	LL	0	0	0	NONE	0
c309	BS	1.74	-1.74	0	NONE	0
c310	EQ	1	0	1	1	0
c311	EQ	1	0	1	1	0
c312	EQ	1	0	1	1	-534820
c313	EQ	0	0	0	0	0
c314	EQ	0	0	0	0	0
c315	EQ	0	0	0	0	0
c316	BS	0	0	NONE	0	0

c317	BS	0	0 NONE	0	0
c318	BS	0	0 NONE	0	0
c319	BS	0	0 NONE	0	0
c320	BS	0	0 NONE	0	0
c321	BS	0	0 NONE	0	0
c322	BS	0	0 NONE	0	0
c323	BS	-1	1 NONE	0	0
c324	BS	0	0 NONE	0	0
c325	BS	0	0 NONE	0	0
c326	BS	0	0 NONE	0	0
c327	BS	0	0 NONE	0	0
c328	BS	0	0 NONE	0	0
c329	BS	0	0 NONE	0	0
c330	BS	0	0 NONE	0	0
c331	BS	0	0 NONE	0	0
c332	BS	0	0 NONE	0	0
c333	BS	-1	1 NONE	0	0
c334	BS	0	0 NONE	0	0
c335	BS	0	0 NONE	0	0
c336	BS	0	0 NONE	0	0
c337	BS	0	0 NONE	0	0
c338	BS	0	0 NONE	0	0
c339	BS	0	0 NONE	0	0
c340	BS	0	0 NONE	0	0
c341	BS	0	0 NONE	0	0
c342	BS	-1	1 NONE	0	0
c343	BS	0	0 NONE	0	0
c344	BS	0	0 NONE	0	0
c345	BS	0	0 NONE	0	0
c346	BS	0	0 NONE	0	0
c347	BS	0	0 NONE	0	0
c348	BS	0	0 NONE	0	0
c349	BS	0	0 NONE	0	0
c350	UL	0	0 NONE	0	0
c351	BS	0	0 NONE	0	0
c352	BS	-1	1 NONE	0	0
c353	BS	0	0 NONE	0	0
c354	BS	0	0 NONE	0	0
c355	BS	0	0 NONE	0	0
c356	UL	0	0 NONE	0	-245850
c357	UL	0	0 NONE	0	-253040
c358	UL	0	0 NONE	0	-260220
c359	UL	0	0 NONE	0	-267410
c360	UL	0	0 NONE	0	-274590
c361	UL	0	0 NONE	0	-281780
c362	UL	0	0 NONE	0	-288970
c363	UL	0	0 NONE	0	-296150
c364	UL	0	0 NONE	0	-303340
c365	UL	0	0 NONE	0	-310530
c366	UL	0	0 NONE	0	-245850

c367	UL	0	0	NONE	0	-253040
c368	UL	0	0	NONE	0	-260220
c369	UL	0	0	NONE	0	-267410
c370	UL	0	0	NONE	0	-274590
c371	UL	0	0	NONE	0	-281780
c372	UL	0	0	NONE	0	-288970
c373	UL	0	0	NONE	0	-296150
c374	UL	0	0	NONE	0	-303340
c375	UL	0	0	NONE	0	-310530
c376	EQ	0	0	0	0	0
c377	EQ	0	0	0	0	0
c378	EQ	0	0	0	0	1000
c379	EQ	0	0	0	0	0
c380	EQ	0	0	0	0	0
c381	EQ	0	0	0	0	1000
c382	EQ	0	0	0	0	0
c383	EQ	0	0	0	0	0
c384	EQ	0	0	0	0	1000
c385	BS	0	0	NONE	0	0
c386	BS	0	0	0	NONE	0
c387	UL	0	0	NONE	0	0
c388	BS	0	0	0	NONE	0
c389	UL	0	0	NONE	0	0
c390	BS	0.7499	-0.7499	0	NONE	0
c391	BS	0	0	NONE	0	0
c392	BS	0	0	0	NONE	0
c393	UL	0	0	NONE	0	0
c394	BS	0	0	0	NONE	0
c395	UL	0	0	NONE	0	0
c396	BS	0.7499	-0.7499	0	NONE	0
c397	EQ	0	0	0	0	0
c398	EQ	0	0	0	0	0
c399	EQ	0	0	0	0	0
c400	EQ	0	0	0	0	0
c401	EQ	0	0	0	0	0
c402	EQ	0	0	0	0	0
c403	BS	0	0	NONE	0	0
c404	BS	-3.83816	3.838155	NONE	0	0
c405	BS	-4.95411	4.954114	NONE	0	0
c406	BS	0	0	NONE	0	0
c407	BS	-9.16185	9.161845	NONE	0	0
c408	BS	-8.04589	8.045886	NONE	0	0
c409	BS	-4.99999	4.99999	NONE	0	0
c410	UL	0	0	NONE	0	0
c411	UL	0	0	NONE	0	0
c412	BS	-10	10	NONE	0	0
c413	BS	0	0	NONE	0	0
c414	BS	0	0	NONE	0	0
c415	EQ	1	0	1	1	0
c416	EQ	1	0	1	1	0

c417	EQ	1	0	1	1	0
c418	BS	0	0	0	NONE	0
c419	BS	0	0	0	NONE	0
c420	BS	0	0	0	NONE	0
c421	BS	-150	150	NONE	0	0
c422	UL	0	0	NONE	0	0
c423	BS	0	0	NONE	0	0
c424	EQ	0	0	0	0	0
c425	EQ	0	0	0	0	0
c426	EQ	0	0	0	0	0
c427	UL	0	0	NONE	0	0
c428	BS	-0.02515	0.0251547	NONE	0	0
c429	BS	-0.37211	0.3721139	NONE	0	0
c430	BS	1.424	-1.424	0	NONE	0
c431	BS	1.398845	-1.398845	0	NONE	0
c432	BS	0.744886	-0.7448861	0	NONE	0
c433	UL	0	0	NONE	0	0
c434	UL	0	0	NONE	0	0
c435	BS	-1.0002	1.0002	NONE	0	0
c436	BS	1.25	-1.25	0	NONE	0
c437	BS	1.25	-1.25	0	NONE	0
c438	BS	0.2498	-0.2498	0	NONE	0
c439	EQ	1	0	1	1	0
c440	EQ	1	0	1	1	0
c441	EQ	1	0	1	1	0
c442	EQ	-61.339	0	-61.339	-61.339	0
c443	EQ	-61.339	0	-61.339	-61.339	0
c444	EQ	-61.339	0	-61.339	-61.339	0
c445	EQ	-6.6201	0	-6.6201	-6.6201	0
c446	EQ	-6.6201	0	-6.6201	-6.6201	0
c447	EQ	-6.6201	0	-6.6201	-6.6201	0
c448	EQ	0	0	0	0	0
c449	EQ	0	0	0	0	0
c450	EQ	0	0	0	0	0
c451	EQ	0	0	0	0	0
c452	EQ	0	0	0	0	0
c453	EQ	0	0	0	0	0
c454	EQ	3	0	3	3	0
c455	EQ	1	0	1	1	0
c456	EQ	2	0	2	2	0
c457	EQ	3	0	3	3	0
c458	EQ	6	0	6	6	0
c459	EQ	3	0	3	3	0
c460	EQ	792	0	792	792	0
c461	EQ	605	0	605	605	0

2 - COLUMNS

.....COLUMN.....	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.

PT1_3	BS	1840.88	1000	0	NONE	0
PP_3	BS	0	-1000	0	NONE	0
PT2_3	BS	534.82	1000	0	NONE	0
delta1_101	EQ	0	0	0	0	0
delta1_91	EQ	1	0	1	1	0
delta1_81	BS	0	0	0	0	0
delta1_71	BS	0	0	0	0	0
delta1_61	EQ	0	0	0	0	0
delta1_51	BS	0	0	0	0	0
delta1_41	EQ	0	0	0	0	0
delta1_31	EQ	0	0	0	0	0
delta1_21	EQ	0	0	0	0	0
delta1_11	BS	0	0	0	0	0
H1_1	BS	187	0	0	212	0
delta1_102	BS	1	0	1	1	0
delta1_92	BS	0	0	0	0	0
delta1_82	EQ	0	0	0	0	0
delta1_72	EQ	0	0	0	0	0
delta1_62	EQ	0	0	0	0	0
delta1_52	EQ	0	0	0	0	0
delta1_42	EQ	0	0	0	0	0
delta1_32	EQ	0	0	0	0	0
delta1_22	EQ	0	0	0	0	0
delta1_12	BS	0	0	0	0	0
H1_2	BS	188.9407	0	0	212	0
delta1_103	BS	1	0	1	1	0
delta1_93	EQ	0	0	0	0	-38440
delta1_83	EQ	0	0	0	0	-48060
delta1_73	EQ	0	0	0	0	-57680
delta1_63	EQ	0	0	0	0	-67280
delta1_53	EQ	0	0	0	0	-76900
delta1_43	EQ	0	0	0	0	-86520
delta1_33	EQ	0	0	0	0	-96120
delta1_23	EQ	0	0	0	0	-100930
delta1_13	EQ	0	0	0	0	-127370
H1_3	BS	188.3946	0	0	212	0
FB1_1	BS	792	0	770	812	0
FB2_1	BS	605	0	587	620	0
FB1_2	BS	792.7788	0	770	812	0
FB2_2	BS	603.8382	0	587	620	0
FB1_3	BS	793.3488	0	770	812	0
FB2_3	BS	604.9541	0	587	620	0
phi1_1161	EQ	0	0	0	0	0
phi1_1151	EQ	0	0	0	0	0
phi1_1141	EQ	0	0	0	0	0
phi1_1131	EQ	0	0	0	0	0
phi1_1121	EQ	0	0	0	0	0
phi1_1111	EQ	0	0	0	0	0
phi1_2161	EQ	0	0	0	0	0
phi1_2151	EQ	0	0	0	0	0

phi1_2141	EQ	0	0	0	0	0
phi1_2131	EQ	0	0	0	0	0
phi1_2121	EQ	0	0	0	0	0
phi1_2111	EQ	0	0	0	0	0
phi1_3161	EQ	0	0	0	0	0
phi1_3151	EQ	0	0	0	0	0
phi1_3141	EQ	0	0	0	0	0
phi1_3131	EQ	0	0	0	0	0
phi1_3121	EQ	0	0	0	0	0
phi1_3111	EQ	0	0	0	0	0
phi1_4161	EQ	0	0	0	0	0
phi1_4151	EQ	0	0	0	0	0
phi1_4141	EQ	0	0	0	0	0
phi1_4131	EQ	0	0	0	0	0
phi1_4121	EQ	0	0	0	0	0
phi1_4111	EQ	0	0	0	0	0
phi1_5161	EQ	0	0	0	0	0
phi1_5151	EQ	0	0	0	0	0
phi1_5141	EQ	0	0	0	0	0
phi1_5131	EQ	0	0	0	0	0
phi1_5121	EQ	0	0	0	0	0
phi1_5111	EQ	0	0	0	0	0
phi1_6161	EQ	0	0	0	0	0
phi1_6151	EQ	0	0	0	0	0
phi1_6141	EQ	0	0	0	0	0
phi1_6131	EQ	0	0	0	0	0
phi1_6121	EQ	0	0	0	0	0
phi1_6111	EQ	0	0	0	0	0
phi1_7161	EQ	0	0	0	0	0
phi1_7151	EQ	0	0	0	0	0
phi1_7141	EQ	0	0	0	0	0
phi1_7131	EQ	0	0	0	0	0
phi1_7121	EQ	0	0	0	0	0
phi1_7111	EQ	0	0	0	0	0
phi1_8161	EQ	0	0	0	0	0
phi1_8151	EQ	0	0	0	0	0
phi1_8141	EQ	0	0	0	0	0
phi1_8131	EQ	0	0	0	0	0
phi1_8121	EQ	0	0	0	0	0
phi1_8111	BS	0	0	0	0	0
phi1_9161	EQ	0	0	0	0	0
phi1_9151	EQ	0	0	0	0	0
phi1_9141	EQ	0	0	0	0	0
phi1_9131	EQ	0	0	0	0	0
phi1_9121	EQ	0	0	0	0	0
phi1_9111	EQ	0	0	0	0	0
phi1_10161	EQ	0	0	0	0	0
phi1_10151	EQ	0	0	0	0	0
phi1_10141	EQ	0	0	0	0	0
phi1_10131	EQ	0	0	0	0	0

phi1_10121	EQ	0	0	0	0	0
phi1_10111	EQ	0	0	0	0	0
phi1_1261	EQ	0	0	0	0	0
phi1_1251	EQ	0	0	0	0	0
phi1_1241	EQ	0	0	0	0	0
phi1_1231	EQ	0	0	0	0	0
phi1_1221	EQ	0	0	0	0	0
phi1_1211	EQ	0	0	0	0	0
phi1_2261	EQ	0	0	0	0	0
phi1_2251	EQ	0	0	0	0	0
phi1_2241	EQ	0	0	0	0	0
phi1_2231	EQ	0	0	0	0	0
phi1_2221	EQ	0	0	0	0	0
phi1_2211	EQ	0	0	0	0	0
phi1_3261	EQ	0	0	0	0	0
phi1_3251	EQ	0	0	0	0	0
phi1_3241	EQ	0	0	0	0	0
phi1_3231	EQ	0	0	0	0	0
phi1_3221	EQ	0	0	0	0	0
phi1_3211	EQ	0	0	0	0	0
phi1_4261	EQ	0	0	0	0	0
phi1_4251	EQ	0	0	0	0	0
phi1_4241	EQ	0	0	0	0	0
phi1_4231	EQ	0	0	0	0	0
phi1_4221	EQ	0	0	0	0	0
phi1_4211	EQ	0	0	0	0	0
phi1_5261	BS	0	0	0	0	0
phi1_5251	EQ	0	0	0	0	0
phi1_5241	EQ	0	0	0	0	0
phi1_5231	EQ	0	0	0	0	0
phi1_5221	EQ	0	0	0	0	0
phi1_5211	EQ	0	0	0	0	0
phi1_6261	EQ	0	0	0	0	0
phi1_6251	EQ	0	0	0	0	0
phi1_6241	EQ	0	0	0	0	0
phi1_6231	EQ	0	0	0	0	0
phi1_6221	EQ	0	0	0	0	0
phi1_6211	EQ	0	0	0	0	0
phi1_7261	EQ	0	0	0	0	0
phi1_7251	EQ	0	0	0	0	0
phi1_7241	EQ	0	0	0	0	0
phi1_7231	EQ	0	0	0	0	0
phi1_7221	EQ	0	0	0	0	0
phi1_7211	BS	0	0	0	0	0
phi1_8261	EQ	0	0	0	0	0
phi1_8251	EQ	0	0	0	0	0
phi1_8241	EQ	0	0	0	0	0
phi1_8231	EQ	0	0	0	0	0
phi1_8221	EQ	0	0	0	0	0
phi1_8211	EQ	0	0	0	0	0

phi1_9261	EQ	0	0	0	0	0
phi1_9251	EQ	0	0	0	0	0
phi1_9241	EQ	0	0	0	0	0
phi1_9231	EQ	0	0	0	0	0
phi1_9221	EQ	0	0	0	0	0
phi1_9211	EQ	0	0	0	0	0
phi1_10261	EQ	0	0	0	0	0
phi1_10251	EQ	0	0	0	0	0
phi1_10241	EQ	0	0	0	0	0
phi1_10231	EQ	0	0	0	0	0
phi1_10221	EQ	0	0	0	0	0
phi1_10211	EQ	0	0	0	0	0
phi1_1162	EQ	0	0	0	0	0
phi1_1152	EQ	0	0	0	0	0
phi1_1142	EQ	0	0	0	0	0
phi1_1132	EQ	0	0	0	0	0
phi1_1122	EQ	0	0	0	0	0
phi1_1112	EQ	0	0	0	0	0
phi1_2162	EQ	0	0	0	0	0
phi1_2152	EQ	0	0	0	0	0
phi1_2142	EQ	0	0	0	0	0
phi1_2132	EQ	0	0	0	0	0
phi1_2122	EQ	0	0	0	0	0
phi1_2112	EQ	0	0	0	0	0
phi1_3162	EQ	0	0	0	0	0
phi1_3152	EQ	0	0	0	0	0
phi1_3142	EQ	0	0	0	0	0
phi1_3132	EQ	0	0	0	0	0
phi1_3122	EQ	0	0	0	0	0
phi1_3112	EQ	0	0	0	0	0
phi1_4162	EQ	0	0	0	0	0
phi1_4152	EQ	0	0	0	0	0
phi1_4142	EQ	0	0	0	0	0
phi1_4132	EQ	0	0	0	0	0
phi1_4122	EQ	0	0	0	0	0
phi1_4112	EQ	0	0	0	0	0
phi1_5162	EQ	0	0	0	0	0
phi1_5152	EQ	0	0	0	0	0
phi1_5142	EQ	0	0	0	0	0
phi1_5132	EQ	0	0	0	0	0
phi1_5122	EQ	0	0	0	0	0
phi1_5112	EQ	0	0	0	0	0
phi1_6162	EQ	0	0	0	0	0
phi1_6152	EQ	0	0	0	0	0
phi1_6142	EQ	0	0	0	0	0
phi1_6132	EQ	0	0	0	0	0
phi1_6122	EQ	0	0	0	0	0
phi1_6112	EQ	0	0	0	0	0
phi1_7162	EQ	0	0	0	0	0
phi1_7152	EQ	0	0	0	0	0

phi1_7142	EQ	0	0	0	0	0
phi1_7132	EQ	0	0	0	0	0
phi1_7122	EQ	0	0	0	0	0
phi1_7112	EQ	0	0	0	0	0
phi1_8162	EQ	0	0	0	0	0
phi1_8152	EQ	0	0	0	0	0
phi1_8142	EQ	0	0	0	0	0
phi1_8132	EQ	0	0	0	0	0
phi1_8122	EQ	0	0	0	0	0
phi1_8112	EQ	0	0	0	0	0
phi1_9162	EQ	0	0	0	0	0
phi1_9152	EQ	0	0	0	0	0
phi1_9142	EQ	0	0	0	0	0
phi1_9132	EQ	0	0	0	0	0
phi1_9122	EQ	0	0	0	0	0
phi1_9112	EQ	0	0	0	0	0
phi1_10162	EQ	0	0	0	0	0
phi1_10152	EQ	0	0	0	0	0
phi1_10142	EQ	0	0	0	0	0
phi1_10132	EQ	0	0	0	0	0
phi1_10122	EQ	0	0	0	0	0
phi1_10112	EQ	0	0	0	0	0
phi1_1262	BS	0	0	0	0	0
phi1_1252	EQ	0	0	0	0	0
phi1_1242	EQ	0	0	0	0	0
phi1_1232	EQ	0	0	0	0	0
phi1_1222	EQ	0	0	0	0	0
phi1_1212	EQ	0	0	0	0	0
phi1_2262	BS	0	0	0	0	0
phi1_2252	EQ	0	0	0	0	0
phi1_2242	EQ	0	0	0	0	0
phi1_2232	EQ	0	0	0	0	0
phi1_2222	EQ	0	0	0	0	0
phi1_2212	EQ	0	0	0	0	0
phi1_3262	BS	0	0	0	0	0
phi1_3252	EQ	0	0	0	0	0
phi1_3242	EQ	0	0	0	0	0
phi1_3232	EQ	0	0	0	0	0
phi1_3222	EQ	0	0	0	0	0
phi1_3212	EQ	0	0	0	0	0
phi1_4262	BS	0	0	0	0	0
phi1_4252	EQ	0	0	0	0	0
phi1_4242	EQ	0	0	0	0	0
phi1_4232	EQ	0	0	0	0	0
phi1_4222	EQ	0	0	0	0	0
phi1_4212	EQ	0	0	0	0	0
phi1_5262	BS	0	0	0	0	0
phi1_5252	EQ	0	0	0	0	0
phi1_5242	EQ	0	0	0	0	0
phi1_5232	EQ	0	0	0	0	0

phi1_5222	EQ	0	0	0	0	0
phi1_5212	EQ	0	0	0	0	0
phi1_6262	BS	0	0	0	0	0
phi1_6252	EQ	0	0	0	0	0
phi1_6242	EQ	0	0	0	0	0
phi1_6232	EQ	0	0	0	0	0
phi1_6222	EQ	0	0	0	0	0
phi1_6212	EQ	0	0	0	0	0
phi1_7262	BS	0	0	0	0	0
phi1_7252	EQ	0	0	0	0	0
phi1_7242	EQ	0	0	0	0	0
phi1_7232	EQ	0	0	0	0	0
phi1_7222	EQ	0	0	0	0	0
phi1_7212	EQ	0	0	0	0	0
phi1_8262	BS	0	0	0	0	0
phi1_8252	EQ	0	0	0	0	0
phi1_8242	EQ	0	0	0	0	0
phi1_8232	EQ	0	0	0	0	0
phi1_8222	EQ	0	0	0	0	0
phi1_8212	EQ	0	0	0	0	0
phi1_9262	BS	0	0	0	0	0
phi1_9252	EQ	0	0	0	0	0
phi1_9242	EQ	0	0	0	0	0
phi1_9232	EQ	0	0	0	0	0
phi1_9222	EQ	0	0	0	0	0
phi1_9212	EQ	0	0	0	0	0
phi1_10262	EQ	0	0	0	0	0
phi1_10252	BS	0	0	0	0	0
phi1_10242	EQ	0	0	0	0	0
phi1_10232	EQ	0	0	0	0	0
phi1_10222	EQ	0	0	0	0	0
phi1_10212	EQ	0	0	0	0	0
phi1_1163	BS	0	0	0	0	0
phi1_1153	EQ	0	0	0	0	-26480
phi1_1143	EQ	0	0	0	0	-53550
phi1_1133	EQ	0	0	0	0	-81450
phi1_1123	EQ	0	0	0	0	-110370
phi1_1113	EQ	0	0	0	0	-310740
phi1_2163	BS	0	0	0	0	0
phi1_2153	EQ	0	0	0	0	-27320
phi1_2143	EQ	0	0	0	0	-55240
phi1_2133	EQ	0	0	0	0	-84010
phi1_2123	EQ	0	0	0	0	-113840
phi1_2113	EQ	0	0	0	0	-320510
phi1_3163	BS	0	0	0	0	0
phi1_3153	EQ	0	0	0	0	-27470
phi1_3143	EQ	0	0	0	0	-55550
phi1_3133	EQ	0	0	0	0	-84480
phi1_3123	EQ	0	0	0	0	-114480
phi1_3113	EQ	0	0	0	0	-322290

phi1_4163	BS	0	0	0	0	0
phi1_4153	EQ	0	0	0	0	-27620
phi1_4143	EQ	0	0	0	0	-55850
phi1_4133	EQ	0	0	0	0	-84940
phi1_4123	EQ	0	0	0	0	-115100
phi1_4113	EQ	0	0	0	0	-324060
phi1_5163	BS	0	0	0	0	0
phi1_5153	EQ	0	0	0	0	-27770
phi1_5143	EQ	0	0	0	0	-56160
phi1_5133	EQ	0	0	0	0	-85410
phi1_5123	EQ	0	0	0	0	-115730
phi1_5113	EQ	0	0	0	0	-325840
phi1_6163	BS	0	0	0	0	0
phi1_6153	EQ	0	0	0	0	-27930
phi1_6143	EQ	0	0	0	0	-56470
phi1_6133	EQ	0	0	0	0	-85880
phi1_6123	EQ	0	0	0	0	-116370
phi1_6113	EQ	0	0	0	0	-327620
phi1_7163	BS	0	0	0	0	0
phi1_7153	EQ	0	0	0	0	-28070
phi1_7143	EQ	0	0	0	0	-56770
phi1_7133	EQ	0	0	0	0	-86340
phi1_7123	EQ	0	0	0	0	-116990
phi1_7113	EQ	0	0	0	0	-329390
phi1_8163	BS	0	0	0	0	0
phi1_8153	EQ	0	0	0	0	-28230
phi1_8143	EQ	0	0	0	0	-57080
phi1_8133	EQ	0	0	0	0	-86810
phi1_8123	EQ	0	0	0	0	-117630
phi1_8113	EQ	0	0	0	0	-331170
phi1_9163	BS	0	0	0	0	0
phi1_9153	EQ	0	0	0	0	-28380
phi1_9143	EQ	0	0	0	0	-57390
phi1_9133	EQ	0	0	0	0	-87280
phi1_9123	EQ	0	0	0	0	-118260
phi1_9113	EQ	0	0	0	0	-332950
phi1_10163	BS	1	0	1	1	0
phi1_10153	EQ	0	0	0	0	-28980
phi1_10143	EQ	0	0	0	0	-58600
phi1_10133	EQ	0	0	0	0	-89130
phi1_10123	EQ	0	0	0	0	-120780
phi1_10113	EQ	0	0	0	0	-340040
phi1_1263	EQ	0	0	0	0	-31250
phi1_1253	EQ	0	0	0	0	-57730
phi1_1243	EQ	0	0	0	0	-84800
phi1_1233	EQ	0	0	0	0	-112700
phi1_1223	EQ	0	0	0	0	-141620
phi1_1213	EQ	0	0	0	0	-341990
phi1_2263	EQ	0	0	0	0	-4810
phi1_2253	EQ	0	0	0	0	-32130

phi1_2243	EQ	0	0	0	0	-60050
phi1_2233	EQ	0	0	0	0	-88820
phi1_2223	EQ	0	0	0	0	-118650
phi1_2213	EQ	0	0	0	0	-325320
phi1_3263	BS	0	0	0	0	0
phi1_3253	EQ	0	0	0	0	-27470
phi1_3243	EQ	0	0	0	0	-55550
phi1_3233	EQ	0	0	0	0	-84480
phi1_3223	EQ	0	0	0	0	-114480
phi1_3213	EQ	0	0	0	0	-322290
phi1_4263	BS	0	0	0	0	0
phi1_4253	EQ	0	0	0	0	-27620
phi1_4243	EQ	0	0	0	0	-55850
phi1_4233	EQ	0	0	0	0	-84940
phi1_4223	EQ	0	0	0	0	-115100
phi1_4213	EQ	0	0	0	0	-324060
phi1_5263	BS	0	0	0	0	0
phi1_5253	EQ	0	0	0	0	-27770
phi1_5243	EQ	0	0	0	0	-56160
phi1_5233	EQ	0	0	0	0	-85410
phi1_5223	EQ	0	0	0	0	-115730
phi1_5213	EQ	0	0	0	0	-325840
phi1_6263	BS	0	0	0	0	0
phi1_6253	EQ	0	0	0	0	-27930
phi1_6243	EQ	0	0	0	0	-56470
phi1_6233	EQ	0	0	0	0	-85880
phi1_6223	EQ	0	0	0	0	-116370
phi1_6213	EQ	0	0	0	0	-327620
phi1_7263	BS	0	0	0	0	0
phi1_7253	EQ	0	0	0	0	-28070
phi1_7243	EQ	0	0	0	0	-56770
phi1_7233	EQ	0	0	0	0	-86340
phi1_7223	EQ	0	0	0	0	-116990
phi1_7213	EQ	0	0	0	0	-329390
phi1_8263	BS	0	0	0	0	0
phi1_8253	EQ	0	0	0	0	-28230
phi1_8243	EQ	0	0	0	0	-57080
phi1_8233	EQ	0	0	0	0	-86810
phi1_8223	EQ	0	0	0	0	-117630
phi1_8213	EQ	0	0	0	0	-331170
phi1_9263	BS	0	0	0	0	0
phi1_9253	EQ	0	0	0	0	-28380
phi1_9243	EQ	0	0	0	0	-57390
phi1_9233	EQ	0	0	0	0	-87280
phi1_9223	EQ	0	0	0	0	-118260
phi1_9213	EQ	0	0	0	0	-332950
phi1_10263	BS	1	0	1	1	0
phi1_10253	EQ	0	0	0	0	-28980
phi1_10243	EQ	0	0	0	0	-58600
phi1_10233	EQ	0	0	0	0	-89130

phi1_10223	EQ	0	0	0	0	-120780
phi1_10213	EQ	0	0	0	0	-340040
PT1_11	BS	0	0	0	NONE	0
PT1_12	BS	0	0	0	NONE	0
PT1_13	BS	920.44	0	0	NONE	0
PT1_21	BS	0	0	0	NONE	0
PT1_22	BS	0	0	0	NONE	0
PT1_23	BS	920.44	0	0	NONE	0
PT1_1	BS	0	0	0	NONE	0
PT1_2	BS	0	0	0	NONE	0
PT_1	BS	0	0	0	NONE	0
PT2_1	BS	0	0	0	NONE	0
PT_2	BS	0	0	0	NONE	0
PT2_2	BS	0	0	0	NONE	0
PT_3	BS	2375.7	0	0	NONE	0
QT1_11	LL	0	0	0	5.5	0
QT1_12	BS	0	0	0	5.5	0
QT1_13	BS	5.4501	0	0	5.5	0
QT1_21	LL	0	0	0	5.5	0
QT1_22	BS	0	0	0	5.5	0
QT1_23	BS	5.4501	0	0	5.5	0
QT1_1	BS	0	0	0	NONE	0
QT1_2	BS	0	0	0	NONE	0
QT1_3	BS	10.9002	0	0	NONE	0
nu_1011	EQ	0	0	0	0	0
nu_911	BS	1	0	1	1	0
nu_811	BS	0	0	0	0	0
nu_711	BS	0	0	0	0	0
nu_611	BS	0	0	0	0	0
nu_511	EQ	0	0	0	0	0
nu_411	BS	0	0	0	0	0
nu_311	BS	0	0	0	0	0
nu_211	BS	0	0	0	0	0
nu_111	BS	0	0	0	0	0
PP_11	BS	945.699	0	0	NONE	0
nu_1012	EQ	1	0	1	1	0
nu_912	EQ	0	0	0	0	0
nu_812	EQ	0	0	0	0	0
nu_712	EQ	0	0	0	0	0
nu_612	EQ	0	0	0	0	0
nu_512	EQ	0	0	0	0	0
nu_412	BS	0	0	0	0	0
nu_312	BS	0	0	0	0	0
nu_212	BS	0	0	0	0	0
nu_112	BS	0	0	0	0	0
PP_12	BS	942.211	0	0	NONE	0
nu_1013	EQ	0	0	0	0	-942211
nu_913	EQ	0	0	0	0	-945699
nu_813	EQ	0	0	0	0	-946447
nu_713	EQ	0	0	0	0	-947145

nu_613	EQ	0	0	0	0	-947793
nu_513	EQ	0	0	0	0	-948391
nu_413	EQ	0	0	0	0	-948939
nu_313	EQ	0	0	0	0	-949436
nu_213	EQ	0	0	0	0	-949883
nu_113	EQ	0	0	0	0	-951427
PP_13	BS	0	0	0 NONE		0
nu_1021	EQ	0	0	0	0	0
nu_921	EQ	0	0	0	0	0
nu_821	BS	0	0	0	0	0
nu_721	BS	0	0	0	0	0
nu_621	BS	0	0	0	0	0
nu_521	BS	0	0	0	0	0
nu_421	BS	0	0	0	0	0
nu_321	BS	0	0	0	0	0
nu_221	BS	0	0	0	0	0
nu_121	EQ	0	0	0	0	0
PP_21	BS	0	0	0 NONE		0
nu_1022	EQ	0	0	0	0	0
nu_922	BS	0	0	0	0	0
nu_822	BS	0	0	0	0	0
nu_722	BS	0	0	0	0	0
nu_622	BS	0	0	0	0	0
nu_522	BS	0	0	0	0	0
nu_422	BS	0	0	0	0	0
nu_322	BS	0	0	0	0	0
nu_222	BS	0	0	0	0	0
nu_122	BS	0	0	0	0	0
PP_22	BS	0	0	0 NONE		0
nu_1023	EQ	0	0	0	0	-942211
nu_923	EQ	0	0	0	0	-945699
nu_823	EQ	0	0	0	0	-946447
nu_723	EQ	0	0	0	0	-947145
nu_623	EQ	0	0	0	0	-947793
nu_523	EQ	0	0	0	0	-948391
nu_423	EQ	0	0	0	0	-948939
nu_323	EQ	0	0	0	0	-949436
nu_223	EQ	0	0	0	0	-949883
nu_123	EQ	0	0	0	0	-951427
PP_23	BS	0	0	0 NONE		0
PP_1	BS	945.699	0	0 NONE		0
PP_2	BS	942.211	0	0 NONE		0
theta_NO_1	EQ	1	0	1	1	0
theta_NO_2	BS	1	0	1	1	0
theta_NO_3	BS	1	0	1	1	0
QP_11	BS	4.542	0	0 NONE		0
QP_12	BS	4.5189	0	0 NONE		0
QP_13	LL	0	0	0 NONE		0
QP_21	LL	0	0	0 NONE		0
QP_22	BS	0	0	0 NONE		0

QP_23	LL	0	0	0	NONE	0
QP_1	BS	4.542	0	0	NONE	0
QP_2	BS	4.5189	0	0	NONE	0
QP_3	BS	0	0	0	NONE	0
Beta_11	BS	0	0	0	0	0
Beta_12	BS	0	0	0	0	0
Beta_13	EQ	1	0	1	1	841130
Beta_21	BS	0	0	0	0	0
Beta_22	BS	0	0	0	0	0
Beta_23	EQ	1	0	1	1	872380
Alpha_11	BS	1	0	1	1	0
Alpha_12	EQ	1	0	1	1	0
Alpha_13	BS	0	0	0	0	0
Alpha_21	BS	0	0	0	0	0
Alpha_22	BS	0	0	0	0	0
Alpha_23	BS	0	0	0	0	0
Turbine_1	BS	0	0	0	NONE	0
Turbine_2	BS	0	0	0	NONE	0
Turbine_3	BS	2	0	0	NONE	0
Pump_1	BS	1	0	0	NONE	0
Pump_2	BS	1	0	0	NONE	0
Pump_3	BS	0	0	0	NONE	0
Produce_1	EQ	0	0	0	0	0
Produce_2	EQ	0	0	0	0	0
Produce_3	BS	1	0	1	1	0
Spill1_NO_1	BS	792	0	0	NONE	0
Spill1_YES_1	LL	0	0	0	NONE	0
Spill1_NO_2	BS	792.7788	0	0	NONE	0
Spill1_YES_2	BS	0	0	0	NONE	0
Spill1_NO_3	BS	793.3488	0	0	NONE	0
Spill1_YES_3	LL	0	0	0	NONE	0
theta_YES_1	EQ	0	0	0	0	0
theta_YES_2	EQ	0	0	0	0	0
theta_YES_3	BS	0	0	0	0	0
theta_31	EQ	0	0	0	0	0
theta_21	EQ	0	0	0	0	0
theta_11	EQ	0	0	0	0	0
SPILL1_YES_1	LL	0	0	0	NONE	0
theta_32	EQ	0	0	0	0	0
theta_22	EQ	0	0	0	0	0
theta_12	BS	0	0	0	0	0
SPILL1_YES_2	LL	0	0	0	NONE	0
theta_33	EQ	0	0	0	0	0
theta_23	EQ	0	0	0	0	0
theta_13	BS	0	0	0	0	0
SPILL1_YES_3	LL	0	0	0	NONE	0
UnContRel_1	LL	0	0	0	NONE	0
UnContRel_2	BS	0	0	0	NONE	0
UnContRel_3	BS	0	0	0	NONE	0
delta2_101	EQ	0	0	0	0	0

delta2_91	EQ	0	0	0	0	0
delta2_81	EQ	1	0	1	1	0
delta2_71	EQ	0	0	0	0	0
delta2_61	EQ	0	0	0	0	0
delta2_51	EQ	0	0	0	0	0
delta2_41	EQ	0	0	0	0	0
delta2_31	EQ	0	0	0	0	0
delta2_21	EQ	0	0	0	0	0
delta2_11	BS	0	0	0	0	0
H2_1	BS	72.427	0	0	NONE	0
delta2_102	EQ	0	0	0	0	0
delta2_92	EQ	0	0	0	0	0
delta2_82	EQ	0	0	0	0	0
delta2_72	EQ	1	0	1	1	0
delta2_62	EQ	0	0	0	0	0
delta2_52	BS	0	0	0	0	0
delta2_42	EQ	0	0	0	0	0
delta2_32	EQ	0	0	0	0	0
delta2_22	EQ	0	0	0	0	0
delta2_12	BS	0	0	0	0	0
H2_2	BS	71.24	0	0	NONE	0
delta2_103	EQ	0	0	0	0	86240
delta2_93	EQ	0	0	0	0	71860
delta2_83	EQ	0	0	0	0	57480
delta2_73	EQ	0	0	0	0	43120
delta2_63	EQ	0	0	0	0	28740
delta2_53	EQ	0	0	0	0	14360
delta2_43	BS	1	0	1	1	0
delta2_33	EQ	0	0	0	0	-14380
delta2_23	EQ	0	0	0	0	-28740
delta2_13	EQ	0	0	0	0	-43120
H2_3	BS	64.25	0	0	NONE	0
TR2_1	BS	532.573	0	532	551	0
TR2_2	BS	532.5982	0	532	551	0
TR2_3	BS	540.7041	0	532	551	0
phi2_1161	EQ	0	0	0	0	0
phi2_1151	EQ	0	0	0	0	0
phi2_1141	EQ	0	0	0	0	0
phi2_1131	EQ	0	0	0	0	0
phi2_1121	EQ	0	0	0	0	0
phi2_1111	EQ	0	0	0	0	0
phi2_2161	EQ	0	0	0	0	0
phi2_2151	EQ	0	0	0	0	0
phi2_2141	EQ	0	0	0	0	0
phi2_2131	EQ	0	0	0	0	0
phi2_2121	EQ	0	0	0	0	0
phi2_2111	EQ	0	0	0	0	0
phi2_3161	EQ	0	0	0	0	0
phi2_3151	EQ	0	0	0	0	0
phi2_3141	EQ	0	0	0	0	0

phi2_3131	EQ	0	0	0	0	0
phi2_3121	EQ	0	0	0	0	0
phi2_3111	EQ	0	0	0	0	0
phi2_4161	EQ	0	0	0	0	0
phi2_4151	EQ	0	0	0	0	0
phi2_4141	EQ	0	0	0	0	0
phi2_4131	EQ	0	0	0	0	0
phi2_4121	EQ	0	0	0	0	0
phi2_4111	EQ	0	0	0	0	0
phi2_5161	EQ	0	0	0	0	0
phi2_5151	EQ	0	0	0	0	0
phi2_5141	EQ	0	0	0	0	0
phi2_5131	EQ	0	0	0	0	0
phi2_5121	EQ	0	0	0	0	0
phi2_5111	EQ	0	0	0	0	0
phi2_6161	EQ	0	0	0	0	0
phi2_6151	EQ	0	0	0	0	0
phi2_6141	EQ	0	0	0	0	0
phi2_6131	EQ	0	0	0	0	0
phi2_6121	EQ	0	0	0	0	0
phi2_6111	EQ	0	0	0	0	0
phi2_7161	EQ	0	0	0	0	0
phi2_7151	EQ	0	0	0	0	0
phi2_7141	EQ	0	0	0	0	0
phi2_7131	EQ	0	0	0	0	0
phi2_7121	EQ	0	0	0	0	0
phi2_7111	EQ	0	0	0	0	0
phi2_8161	EQ	0	0	0	0	0
phi2_8151	EQ	0	0	0	0	0
phi2_8141	EQ	0	0	0	0	0
phi2_8131	EQ	0	0	0	0	0
phi2_8121	EQ	0	0	0	0	0
phi2_8111	EQ	0	0	0	0	0
phi2_9161	EQ	0	0	0	0	0
phi2_9151	EQ	0	0	0	0	0
phi2_9141	EQ	0	0	0	0	0
phi2_9131	EQ	0	0	0	0	0
phi2_9121	EQ	0	0	0	0	0
phi2_9111	EQ	0	0	0	0	0
phi2_10161	EQ	0	0	0	0	0
phi2_10151	EQ	0	0	0	0	0
phi2_10141	EQ	0	0	0	0	0
phi2_10131	EQ	0	0	0	0	0
phi2_10121	EQ	0	0	0	0	0
phi2_10111	EQ	0	0	0	0	0
phi2_1261	EQ	0	0	0	0	0
phi2_1251	EQ	0	0	0	0	0
phi2_1241	EQ	0	0	0	0	0
phi2_1231	EQ	0	0	0	0	0
phi2_1221	EQ	0	0	0	0	0

phi2_1211	EQ	0	0	0	0	0
phi2_2261	EQ	0	0	0	0	0
phi2_2251	EQ	0	0	0	0	0
phi2_2241	EQ	0	0	0	0	0
phi2_2231	EQ	0	0	0	0	0
phi2_2221	EQ	0	0	0	0	0
phi2_2211	EQ	0	0	0	0	0
phi2_3261	EQ	0	0	0	0	0
phi2_3251	EQ	0	0	0	0	0
phi2_3241	EQ	0	0	0	0	0
phi2_3231	EQ	0	0	0	0	0
phi2_3221	EQ	0	0	0	0	0
phi2_3211	EQ	0	0	0	0	0
phi2_4261	EQ	0	0	0	0	0
phi2_4251	EQ	0	0	0	0	0
phi2_4241	EQ	0	0	0	0	0
phi2_4231	EQ	0	0	0	0	0
phi2_4221	EQ	0	0	0	0	0
phi2_4211	EQ	0	0	0	0	0
phi2_5261	EQ	0	0	0	0	0
phi2_5251	EQ	0	0	0	0	0
phi2_5241	EQ	0	0	0	0	0
phi2_5231	EQ	0	0	0	0	0
phi2_5221	EQ	0	0	0	0	0
phi2_5211	EQ	0	0	0	0	0
phi2_6261	EQ	0	0	0	0	0
phi2_6251	EQ	0	0	0	0	0
phi2_6241	EQ	0	0	0	0	0
phi2_6231	EQ	0	0	0	0	0
phi2_6221	EQ	0	0	0	0	0
phi2_6211	EQ	0	0	0	0	0
phi2_7261	EQ	0	0	0	0	0
phi2_7251	EQ	0	0	0	0	0
phi2_7241	EQ	0	0	0	0	0
phi2_7231	EQ	0	0	0	0	0
phi2_7221	EQ	0	0	0	0	0
phi2_7211	EQ	0	0	0	0	0
phi2_8261	EQ	0	0	0	0	0
phi2_8251	EQ	0	0	0	0	0
phi2_8241	EQ	0	0	0	0	0
phi2_8231	EQ	0	0	0	0	0
phi2_8221	EQ	0	0	0	0	0
phi2_8211	EQ	0	0	0	0	0
phi2_9261	EQ	0	0	0	0	0
phi2_9251	EQ	0	0	0	0	0
phi2_9241	EQ	0	0	0	0	0
phi2_9231	EQ	0	0	0	0	0
phi2_9221	EQ	0	0	0	0	0
phi2_9211	EQ	0	0	0	0	0
phi2_10261	EQ	0	0	0	0	0

phi2_10251	EQ	0	0	0	0	0
phi2_10241	EQ	0	0	0	0	0
phi2_10231	EQ	0	0	0	0	0
phi2_10221	EQ	0	0	0	0	0
phi2_10211	EQ	0	0	0	0	0
phi2_1162	EQ	0	0	0	0	0
phi2_1152	EQ	0	0	0	0	0
phi2_1142	EQ	0	0	0	0	0
phi2_1132	EQ	0	0	0	0	0
phi2_1122	EQ	0	0	0	0	0
phi2_1112	EQ	0	0	0	0	0
phi2_2162	EQ	0	0	0	0	0
phi2_2152	EQ	0	0	0	0	0
phi2_2142	EQ	0	0	0	0	0
phi2_2132	EQ	0	0	0	0	0
phi2_2122	EQ	0	0	0	0	0
phi2_2112	EQ	0	0	0	0	0
phi2_3162	EQ	0	0	0	0	0
phi2_3152	EQ	0	0	0	0	0
phi2_3142	EQ	0	0	0	0	0
phi2_3132	EQ	0	0	0	0	0
phi2_3122	EQ	0	0	0	0	0
phi2_3112	EQ	0	0	0	0	0
phi2_4162	EQ	0	0	0	0	0
phi2_4152	EQ	0	0	0	0	0
phi2_4142	EQ	0	0	0	0	0
phi2_4132	EQ	0	0	0	0	0
phi2_4122	EQ	0	0	0	0	0
phi2_4112	EQ	0	0	0	0	0
phi2_5162	EQ	0	0	0	0	0
phi2_5152	EQ	0	0	0	0	0
phi2_5142	EQ	0	0	0	0	0
phi2_5132	EQ	0	0	0	0	0
phi2_5122	EQ	0	0	0	0	0
phi2_5112	EQ	0	0	0	0	0
phi2_6162	EQ	0	0	0	0	0
phi2_6152	EQ	0	0	0	0	0
phi2_6142	EQ	0	0	0	0	0
phi2_6132	EQ	0	0	0	0	0
phi2_6122	EQ	0	0	0	0	0
phi2_6112	EQ	0	0	0	0	0
phi2_7162	EQ	0	0	0	0	0
phi2_7152	EQ	0	0	0	0	0
phi2_7142	EQ	0	0	0	0	0
phi2_7132	EQ	0	0	0	0	0
phi2_7122	EQ	0	0	0	0	0
phi2_7112	EQ	0	0	0	0	0
phi2_8162	EQ	0	0	0	0	0
phi2_8152	EQ	0	0	0	0	0
phi2_8142	EQ	0	0	0	0	0

phi2_8132	EQ	0	0	0	0	0
phi2_8122	EQ	0	0	0	0	0
phi2_8112	EQ	0	0	0	0	0
phi2_9162	EQ	0	0	0	0	0
phi2_9152	EQ	0	0	0	0	0
phi2_9142	EQ	0	0	0	0	0
phi2_9132	EQ	0	0	0	0	0
phi2_9122	EQ	0	0	0	0	0
phi2_9112	EQ	0	0	0	0	0
phi2_10162	EQ	0	0	0	0	0
phi2_10152	EQ	0	0	0	0	0
phi2_10142	EQ	0	0	0	0	0
phi2_10132	EQ	0	0	0	0	0
phi2_10122	EQ	0	0	0	0	0
phi2_10112	EQ	0	0	0	0	0
phi2_1262	EQ	0	0	0	0	0
phi2_1252	EQ	0	0	0	0	0
phi2_1242	EQ	0	0	0	0	0
phi2_1232	EQ	0	0	0	0	0
phi2_1222	EQ	0	0	0	0	0
phi2_1212	EQ	0	0	0	0	0
phi2_2262	EQ	0	0	0	0	0
phi2_2252	EQ	0	0	0	0	0
phi2_2242	EQ	0	0	0	0	0
phi2_2232	EQ	0	0	0	0	0
phi2_2222	EQ	0	0	0	0	0
phi2_2212	EQ	0	0	0	0	0
phi2_3262	EQ	0	0	0	0	0
phi2_3252	EQ	0	0	0	0	0
phi2_3242	EQ	0	0	0	0	0
phi2_3232	EQ	0	0	0	0	0
phi2_3222	EQ	0	0	0	0	0
phi2_3212	EQ	0	0	0	0	0
phi2_4262	EQ	0	0	0	0	0
phi2_4252	EQ	0	0	0	0	0
phi2_4242	EQ	0	0	0	0	0
phi2_4232	EQ	0	0	0	0	0
phi2_4222	EQ	0	0	0	0	0
phi2_4212	EQ	0	0	0	0	0
phi2_5262	EQ	0	0	0	0	0
phi2_5252	EQ	0	0	0	0	0
phi2_5242	EQ	0	0	0	0	0
phi2_5232	EQ	0	0	0	0	0
phi2_5222	EQ	0	0	0	0	0
phi2_5212	EQ	0	0	0	0	0
phi2_6262	EQ	0	0	0	0	0
phi2_6252	EQ	0	0	0	0	0
phi2_6242	EQ	0	0	0	0	0
phi2_6232	EQ	0	0	0	0	0
phi2_6222	EQ	0	0	0	0	0

phi2_6212	EQ	0	0	0	0	0
phi2_7262	EQ	0	0	0	0	0
phi2_7252	EQ	0	0	0	0	0
phi2_7242	EQ	0	0	0	0	0
phi2_7232	EQ	0	0	0	0	0
phi2_7222	EQ	0	0	0	0	0
phi2_7212	EQ	0	0	0	0	0
phi2_8262	BS	0	0	0	0	0
phi2_8252	EQ	0	0	0	0	0
phi2_8242	EQ	0	0	0	0	0
phi2_8232	EQ	0	0	0	0	0
phi2_8222	EQ	0	0	0	0	0
phi2_8212	EQ	0	0	0	0	0
phi2_9262	EQ	0	0	0	0	0
phi2_9252	EQ	0	0	0	0	0
phi2_9242	EQ	0	0	0	0	0
phi2_9232	EQ	0	0	0	0	0
phi2_9222	EQ	0	0	0	0	0
phi2_9212	EQ	0	0	0	0	0
phi2_10262	EQ	0	0	0	0	0
phi2_10252	EQ	0	0	0	0	0
phi2_10242	EQ	0	0	0	0	0
phi2_10232	EQ	0	0	0	0	0
phi2_10222	EQ	0	0	0	0	0
phi2_10212	EQ	0	0	0	0	0
phi2_1163	BS	0	0	0	0	0
phi2_1153	EQ	0	0	0	0	-37950
phi2_1143	EQ	0	0	0	0	-55720
phi2_1133	EQ	0	0	0	0	-73890
phi2_1123	EQ	0	0	0	0	-92090
phi2_1113	EQ	0	0	0	0	-143590
phi2_2163	BS	0	0	0	0	0
phi2_2153	EQ	0	0	0	0	-39060
phi2_2143	EQ	0	0	0	0	-57350
phi2_2133	EQ	0	0	0	0	-76060
phi2_2123	EQ	0	0	0	0	-94780
phi2_2113	EQ	0	0	0	0	-147790
phi2_3163	BS	0	0	0	0	0
phi2_3153	EQ	0	0	0	0	-40160
phi2_3143	EQ	0	0	0	0	-58970
phi2_3133	EQ	0	0	0	0	-78210
phi2_3123	EQ	0	0	0	0	-97470
phi2_3113	EQ	0	0	0	0	-151980
phi2_4163	BS	1	0	1	1	0
phi2_4153	EQ	0	0	0	0	-41280
phi2_4143	EQ	0	0	0	0	-60600
phi2_4133	EQ	0	0	0	0	-80370
phi2_4123	EQ	0	0	0	0	-100170
phi2_4113	EQ	0	0	0	0	-156180
phi2_5163	BS	0	0	0	0	0

phi2_5153	EQ	0	0	0	0	-42380
phi2_5143	EQ	0	0	0	0	-62230
phi2_5133	EQ	0	0	0	0	-82530
phi2_5123	EQ	0	0	0	0	-102850
phi2_5113	EQ	0	0	0	0	-160380
phi2_6163	BS	0	0	0	0	0
phi2_6153	EQ	0	0	0	0	-43490
phi2_6143	EQ	0	0	0	0	-63860
phi2_6133	EQ	0	0	0	0	-84690
phi2_6123	EQ	0	0	0	0	-105550
phi2_6113	EQ	0	0	0	0	-164580
phi2_7163	BS	0	0	0	0	0
phi2_7153	EQ	0	0	0	0	-44610
phi2_7143	EQ	0	0	0	0	-65490
phi2_7133	EQ	0	0	0	0	-86850
phi2_7123	EQ	0	0	0	0	-108240
phi2_7113	EQ	0	0	0	0	-168780
phi2_8163	BS	0	0	0	0	0
phi2_8153	EQ	0	0	0	0	-45710
phi2_8143	EQ	0	0	0	0	-67110
phi2_8133	EQ	0	0	0	0	-89010
phi2_8123	EQ	0	0	0	0	-110930
phi2_8113	EQ	0	0	0	0	-172970
phi2_9163	BS	0	0	0	0	0
phi2_9153	EQ	0	0	0	0	-46820
phi2_9143	EQ	0	0	0	0	-68750
phi2_9133	EQ	0	0	0	0	-91170
phi2_9123	EQ	0	0	0	0	-113620
phi2_9113	EQ	0	0	0	0	-177170
phi2_10163	BS	0	0	0	0	0
phi2_10153	EQ	0	0	0	0	-47940
phi2_10143	EQ	0	0	0	0	-70380
phi2_10133	EQ	0	0	0	0	-93340
phi2_10123	EQ	0	0	0	0	-116320
phi2_10113	EQ	0	0	0	0	-181370
phi2_1263	BS	0	0	0	0	0
phi2_1253	EQ	0	0	0	0	-37950
phi2_1243	EQ	0	0	0	0	-55720
phi2_1233	EQ	0	0	0	0	-73890
phi2_1223	EQ	0	0	0	0	-92090
phi2_1213	EQ	0	0	0	0	-143590
phi2_2263	BS	0	0	0	0	0
phi2_2253	EQ	0	0	0	0	-39060
phi2_2243	EQ	0	0	0	0	-57350
phi2_2233	EQ	0	0	0	0	-76060
phi2_2223	EQ	0	0	0	0	-94780
phi2_2213	EQ	0	0	0	0	-147790
phi2_3263	BS	0	0	0	0	0
phi2_3253	EQ	0	0	0	0	-40160
phi2_3243	EQ	0	0	0	0	-58970

phi2_3233	EQ	0	0	0	0	-78210
phi2_3223	EQ	0	0	0	0	-97470
phi2_3213	EQ	0	0	0	0	-151980
phi2_4263	BS	1	0	1	1	0
phi2_4253	EQ	0	0	0	0	-41280
phi2_4243	EQ	0	0	0	0	-60600
phi2_4233	EQ	0	0	0	0	-80370
phi2_4223	EQ	0	0	0	0	-100170
phi2_4213	EQ	0	0	0	0	-156180
phi2_5263	BS	0	0	0	0	0
phi2_5253	EQ	0	0	0	0	-42380
phi2_5243	EQ	0	0	0	0	-62230
phi2_5233	EQ	0	0	0	0	-82530
phi2_5223	EQ	0	0	0	0	-102850
phi2_5213	EQ	0	0	0	0	-160380
phi2_6263	BS	0	0	0	0	0
phi2_6253	EQ	0	0	0	0	-43490
phi2_6243	EQ	0	0	0	0	-63860
phi2_6233	EQ	0	0	0	0	-84690
phi2_6223	EQ	0	0	0	0	-105550
phi2_6213	EQ	0	0	0	0	-164580
phi2_7263	BS	0	0	0	0	0
phi2_7253	EQ	0	0	0	0	-44610
phi2_7243	EQ	0	0	0	0	-65490
phi2_7233	EQ	0	0	0	0	-86850
phi2_7223	EQ	0	0	0	0	-108240
phi2_7213	EQ	0	0	0	0	-168780
phi2_8263	BS	0	0	0	0	0
phi2_8253	EQ	0	0	0	0	-45710
phi2_8243	EQ	0	0	0	0	-67110
phi2_8233	EQ	0	0	0	0	-89010
phi2_8223	EQ	0	0	0	0	-110930
phi2_8213	EQ	0	0	0	0	-172970
phi2_9263	BS	0	0	0	0	0
phi2_9253	EQ	0	0	0	0	-46820
phi2_9243	EQ	0	0	0	0	-68750
phi2_9233	EQ	0	0	0	0	-91170
phi2_9223	EQ	0	0	0	0	-113620
phi2_9213	EQ	0	0	0	0	-177170
phi2_10263	BS	0	0	0	0	0
phi2_10253	EQ	0	0	0	0	-47940
phi2_10243	EQ	0	0	0	0	-70380
phi2_10233	EQ	0	0	0	0	-93340
phi2_10223	EQ	0	0	0	0	-116320
phi2_10213	EQ	0	0	0	0	-181370
PT2_11	BS	0	0	0	NONE	0
PT2_12	BS	0	0	0	NONE	0
PT2_13	BS	267.41	0	0	NONE	0
PT2_21	BS	0	0	0	NONE	0
PT2_22	BS	0	0	0	NONE	0

PT2_23	BS	267.41	0	0	NONE	0
QT2_11	LL	0	0	0	5.5	0
QT2_12	BS	0	0	0	5.5	0
QT2_13	BS	4.2501	0	0	5.5	0
QT2_21	LL	0	0	0	5.5	0
QT2_22	LL	0	0	0	5.5	0
QT2_23	BS	4.2501	0	0	5.5	0
QT2_1	BS	0	0	0	NONE	0
QT2_2	BS	0	0	0	NONE	0
QT2_3	BS	8.5002	0	0	NONE	0
Spill2_NO_1	LL	0	0	0	NONE	0
Spill2_YES_1	BS	605	0	0	NONE	0
Spill2_NO_2	BS	603.8382	0	0	NONE	0
Spill2_YES_2	BS	0	0	0	NONE	0
Spill2_NO_3	BS	604.9541	0	0	NONE	0
Spill2_YES_3	LL	0	0	0	NONE	0
sigma_NO_1	BS	0	0	0	0	0
sigma_NO_2	BS	1	0	1	1	0
sigma_NO_3	BS	1	0	1	1	0
sigma_YES_1	EQ	1	0	1	1	0
sigma_YES_2	EQ	0	0	0	0	0
sigma_YES_3	BS	0	0	0	0	0
Gated_1	LL	0	0	0	NONE	0
Gated_2	BS	0	0	0	NONE	0
Gated_3	LL	0	0	0	NONE	0
Chan_1	BS	0	0	0	NONE	0
Chan_2	BS	0	0	0	NONE	0
Chan_3	BS	8.5002	0	0	NONE	0
zeta_91	BS	0	0	0	0	0
zeta_81	EQ	0	0	0	0	0
zeta_71	EQ	0	0	0	0	0
zeta_61	EQ	0	0	0	0	0
zeta_51	EQ	0	0	0	0	0
zeta_41	EQ	0	0	0	0	0
zeta_31	EQ	0	0	0	0	0
zeta_21	EQ	0	0	0	0	0
zeta_11	BS	1	0	1	1	0
zeta_92	BS	0	0	0	0	0
zeta_82	EQ	0	0	0	0	0
zeta_72	EQ	0	0	0	0	0
zeta_62	EQ	0	0	0	0	0
zeta_52	EQ	0	0	0	0	0
zeta_42	EQ	0	0	0	0	0
zeta_32	EQ	0	0	0	0	0
zeta_22	EQ	0	0	0	0	0
zeta_12	BS	1	0	1	1	0
zeta_93	EQ	0	0	0	0	0
zeta_83	EQ	0	0	0	0	0
zeta_73	EQ	0	0	0	0	0
zeta_63	EQ	0	0	0	0	0

zeta_53	EQ	0	0	0	0	0
zeta_43	EQ	1	0	1	1	0
zeta_33	EQ	0	0	0	0	0
zeta_23	EQ	0	0	0	0	0
zeta_13	BS	0	0	0	0	0
S1_1	BS	4.925264	0	0	NONE	0
S1_2	BS	4.990427	0	0	NONE	0
S1_3	BS	5.03811	0	0	NONE	0
S2_1	BS	0.317435	0	0	NONE	0
S2_2	BS	0.304112	0	0	NONE	0
S2_3	BS	0.316909	0	0	NONE	0
I1_1	BS	3	0	0	NONE	0
I1_2	BS	1	0	0	NONE	0
S1_4	BS	4.961212	0	3	7	0
I1_3	BS	2	0	0	NONE	0
I2_1	BS	3	0	0	NONE	0
I2_2	BS	6	0	0	NONE	0
S2_4	BS	0.363565	0	0	10	0
I2_3	BS	3	0	0	NONE	0

Input to CPLEX for Analysis 4

MAXIMIZE
1000PT1_3-1000PP_3+1000PT2_3

```
st

all remained the same
```

Output from CPLEX for Analysis 4

Row	AT	Activity	Slack Activity	Lower Limit	Upper Limit	Dual Activity
c1	BS	0	0	NONE	0	0
c2	BS	-2.89128	2.891281	NONE	0	0
c3	BS	-0.79229	0.792285	NONE	0	0
c4	BS	0.999	-0.999	0	NONE	0
c5	BS	4.108719	-4.10872	0	NONE	0
c6	BS	6.207715	-6.20772	0	NONE	0
c7	EQ	1	0	1	1	0
c8	EQ	1	0	1	1	0
c9	EQ	1	0	1	1	-127370
c10	EQ	0	0	0	0	0
c11	EQ	0	0	0	0	0
c12	EQ	0	0	0	0	0
c13	BS	0	0	NONE	0	0
c14	BS	0	0	NONE	0	0
c15	BS	0	0	NONE	0	0
c16	BS	0	0	NONE	0	0
c17	UL	0	0	NONE	0	0
c18	BS	0	0	NONE	0	0
c19	UL	0	0	NONE	0	0
c20	BS	0	0	NONE	0	0
c21	BS	-1	1	NONE	0	0
c22	BS	0	0	NONE	0	0
c23	BS	0	0	NONE	0	0
c24	BS	0	0	NONE	0	0
c25	BS	0	0	NONE	0	0
c26	UL	0	0	NONE	0	0
c27	BS	0	0	NONE	0	0
c28	BS	0	0	NONE	0	0

c29	BS	0	0	NONE	0	0
c30	BS	0	0	NONE	0	0
c31	BS	-1	1	NONE	0	0
c32	BS	0	0	NONE	0	0
c33	BS	0	0	NONE	0	0
c34	BS	0	0	NONE	0	0
c35	BS	0	0	NONE	0	0
c36	BS	0	0	NONE	0	0
c37	BS	0	0	NONE	0	0
c38	BS	0	0	NONE	0	0
c39	UL	0	0	NONE	0	0
c40	BS	0	0	NONE	0	0
c41	BS	0	0	NONE	0	0
c42	BS	-1	1	NONE	0	0
c43	BS	0	0	NONE	0	0
c44	BS	0	0	NONE	0	0
c45	BS	0	0	NONE	0	0
c46	BS	0	0	NONE	0	0
c47	BS	0	0	NONE	0	0
c48	UL	0	0	NONE	0	0
c49	BS	0	0	NONE	0	0
c50	UL	0	0	NONE	0	0
c51	UL	0	0	NONE	0	0
c52	BS	0	0	NONE	0	0
c53	BS	0	0	NONE	0	0
c54	UL	0	0	NONE	0	-26440
c55	UL	0	0	NONE	0	-31250
c56	UL	0	0	NONE	0	-36050
c57	UL	0	0	NONE	0	-40860
c58	UL	0	0	NONE	0	-45670
c59	UL	0	0	NONE	0	-50470
c60	UL	0	0	NONE	0	-55280
c61	UL	0	0	NONE	0	-60090
c62	UL	0	0	NONE	0	-79310
c63	BS	0	0	NONE	0	0
c64	BS	0	0	NONE	0	0
c65	BS	0	0	NONE	0	0
c66	UL	0	0	NONE	0	-4800
c67	UL	0	0	NONE	0	-9610
c68	UL	0	0	NONE	0	-14420
c69	UL	0	0	NONE	0	-19220
c70	UL	0	0	NONE	0	-24030
c71	UL	0	0	NONE	0	-28840
c72	UL	0	0	NONE	0	-48060
c73	EQ	0	0	0	0	0
c74	EQ	0	0	0	0	0
c75	EQ	0	0	0	0	1000
c76	EQ	0	0	0	0	0
c77	EQ	0	0	0	0	0
c78	EQ	0	0	0	0	1000

c79	EQ	0	0	0	0	0
c80	EQ	0	0	0	0	0
c81	EQ	0	0	0	0	1000
c82	EQ	0	0	0	0	0
c83	EQ	0	0	0	0	0
c84	EQ	0	0	0	0	0
c85	BS	0	0 NONE		0	0
c86	BS	0	0	0 NONE		0
c87	BS	0	0 NONE		0	0
c88	BS	0	0	0 NONE		0
c89	UL	0	0 NONE		0	0
c90	BS	0.1999	-0.1999	0 NONE		0
c91	BS	0	0 NONE		0	0
c92	BS	0	0	0 NONE		0
c93	UL	0	0 NONE		0	0
c94	BS	2.2	-2.2	0 NONE		0
c95	UL	0	0 NONE		0	0
c96	BS	0.1999	-0.1999	0 NONE		0
c97	EQ	0	0	0	0	0
c98	EQ	0	0	0	0	0
c99	EQ	0	0	0	0	0
c100	EQ	0	0	0	0	0
c101	EQ	0	0	0	0	0
c102	EQ	0	0	0	0	-1000
c103	EQ	0	0	0	0	0
c104	EQ	0	0	0	0	0
c105	EQ	0	0	0	0	-1000
c106	EQ	0	0	0	0	0
c107	EQ	0	0	0	0	0
c108	EQ	0	0	0	0	-1000
c109	BS	0	0 NONE		0	0
c110	BS	0	0 NONE		0	0
c111	BS	0	0 NONE		0	0
c112	UL	0	0 NONE		0	0
c113	BS	0	0 NONE		0	0
c114	UL	0	0 NONE		0	0
c115	BS	0	0 NONE		0	0
c116	UL	0	0 NONE		0	0
c117	BS	0	0 NONE		0	0
c118	UL	0	0 NONE		0	0
c119	BS	0	0 NONE		0	0
c120	UL	0	0 NONE		0	0
c121	BS	0	0 NONE		0	0
c122	UL	0	0 NONE		0	0
c123	BS	0	0 NONE		0	0
c124	UL	0	0 NONE		0	0
c125	UL	0	0 NONE		0	0
c126	BS	-1	1 NONE		0	0
c127	BS	0	0 NONE		0	0
c128	BS	0	0 NONE		0	0

c129	UL	0	0 NONE	0	0
c130	BS	0	0 NONE	0	0
c131	UL	0	0 NONE	0	0
c132	BS	0	0 NONE	0	0
c133	UL	0	0 NONE	0	0
c134	BS	0	0 NONE	0	0
c135	UL	0	0 NONE	0	0
c136	BS	0	0 NONE	0	0
c137	UL	0	0 NONE	0	0
c138	BS	0	0 NONE	0	0
c139	UL	0	0 NONE	0	0
c140	BS	0	0 NONE	0	0
c141	UL	0	0 NONE	0	0
c142	BS	0	0 NONE	0	0
c143	UL	0	0 NONE	0	0
c144	BS	0	0 NONE	0	0
c145	UL	0	0 NONE	0	0
c146	BS	0	0 NONE	0	0
c147	BS	-1	1 NONE	0	0
c148	BS	-1	1 NONE	0	0
c149	BS	0	0 NONE	0	0
c150	BS	0	0 NONE	0	0
c151	BS	0	0 NONE	0	0
c152	BS	0	0 NONE	0	0
c153	BS	0	0 NONE	0	0
c154	BS	0	0 NONE	0	0
c155	BS	0	0 NONE	0	0
c156	BS	0	0 NONE	0	0
c157	BS	0	0 NONE	0	0
c158	BS	0	0 NONE	0	0
c159	BS	0	0 NONE	0	0
c160	BS	0	0 NONE	0	0
c161	BS	0	0 NONE	0	0
c162	BS	0	0 NONE	0	0
c163	BS	0	0 NONE	0	0
c164	BS	0	0 NONE	0	0
c165	BS	0	0 NONE	0	0
c166	BS	0	0 NONE	0	0
c167	BS	-1	1 NONE	0	0
c168	BS	-1	1 NONE	0	0
c169	BS	-1	1 NONE	0	0
c170	BS	-1	1 NONE	0	0
c171	BS	-1	1 NONE	0	0
c172	BS	-1	1 NONE	0	0
c173	BS	-1	1 NONE	0	0
c174	BS	-1	1 NONE	0	0
c175	BS	-1	1 NONE	0	0
c176	BS	-1	1 NONE	0	0
c177	BS	-1	1 NONE	0	0
c178	BS	-1	1 NONE	0	0

c179	BS	-1	1 NONE	0	0
c180	BS	-1	1 NONE	0	0
c181	BS	-1	1 NONE	0	0
c182	BS	-1	1 NONE	0	0
c183	BS	-1	1 NONE	0	0
c184	BS	-1	1 NONE	0	0
c185	BS	0	0 NONE	0	0
c186	BS	-1	1 NONE	0	0
c187	BS	-1	1 NONE	0	0
c188	BS	-1	1 NONE	0	0
c189	BS	-1	1 NONE	0	0
c190	BS	-1	1 NONE	0	0
c191	BS	-1	1 NONE	0	0
c192	BS	-1	1 NONE	0	0
c193	BS	-1	1 NONE	0	0
c194	BS	-1	1 NONE	0	0
c195	BS	-1	1 NONE	0	0
c196	BS	-1	1 NONE	0	0
c197	BS	-1	1 NONE	0	0
c198	BS	-1	1 NONE	0	0
c199	BS	-1	1 NONE	0	0
c200	BS	-1	1 NONE	0	0
c201	BS	-1	1 NONE	0	0
c202	BS	-1	1 NONE	0	0
c203	BS	-1	1 NONE	0	0
c204	BS	-1	1 NONE	0	0
c205	BS	-1	1 NONE	0	0
c206	BS	-1	1 NONE	0	0
c207	BS	-1	1 NONE	0	0
c208	BS	-1	1 NONE	0	0
c209	BS	-1	1 NONE	0	0
c210	BS	-1	1 NONE	0	0
c211	BS	-1	1 NONE	0	0
c212	BS	-1	1 NONE	0	0
c213	BS	-1	1 NONE	0	0
c214	BS	-1	1 NONE	0	0
c215	BS	-1	1 NONE	0	0
c216	BS	-1	1 NONE	0	0
c217	BS	-1	1 NONE	0	0
c218	BS	-1	1 NONE	0	0
c219	BS	-1	1 NONE	0	0
c220	BS	-1	1 NONE	0	0
c221	BS	-1	1 NONE	0	0
c222	BS	-1	1 NONE	0	0
c223	BS	-1	1 NONE	0	0
c224	BS	-1	1 NONE	0	0
c225	BS	-1	1 NONE	0	0
c226	BS	-1	1 NONE	0	0
c227	BS	-1	1 NONE	0	0
c228	BS	-1	1 NONE	0	0

c229	LL	0	0		0	NONE		0
c230	BS	-0.023	0.023	NONE			0	0
c231	LL	0	0		0	NONE		0
c232	BS	0	0	NONE			0	0
c233	BS	0	0		0	NONE		0
c234	BS	0	0	NONE			0	0
c235	LL	0	0		0	NONE		0
c236	BS	0	0	NONE			0	0
c237	LL	0	0		0	NONE		0
c238	BS	0	0	NONE			0	0
c239	BS	0	0		0	NONE		0
c240	BS	0	0	NONE			0	0
c241	EQ	0	0		0		0	0
c242	EQ	0	0		0		0	0
c243	EQ	0	0		0		0	0
c244	EQ	0	0		0		0	0
c245	EQ	0	0		0		0	0
c246	EQ	0	0		0		0	-841130
c247	EQ	0	0		0		0	0
c248	EQ	0	0		0		0	0
c249	EQ	0	0		0		0	-872380
c250	EQ	0	0		0		0	0
c251	EQ	0	0		0		0	0
c252	EQ	0	0		0		0	0
c253	EQ	0	0		0		0	0
c254	EQ	0	0		0		0	0
c255	EQ	0	0		0		0	0
c256	UL	1	0	NONE			1	0
c257	BS	0	1	NONE			1	0
c258	BS	1	0	NONE			1	0
c259	BS	0	1	NONE			1	0
c260	BS	1	0	NONE			1	0
c261	BS	1	0	NONE			1	0
c262	EQ	0	0		0		0	0
c263	EQ	0	0		0		0	0
c264	EQ	0	0		0		0	0
c265	EQ	0	0		0		0	0
c266	EQ	0	0		0		0	0
c267	EQ	0	0		0		0	0
c268	BS	0	0	NONE			0	0
c269	BS	-1	1	NONE			0	0
c270	UL	0	0	NONE			0	0
c271	BS	1	1	NONE			2	0
c272	UL	2	0	NONE			2	0
c273	BS	2	0	NONE			2	0
c274	EQ	0	0		0		0	0
c275	EQ	0	0		0		0	0
c276	EQ	0	0		0		0	0
c277	BS	-5	5	NONE			0	0
c278	BS	-5.46904	5.469037	NONE			0	0

c279	BS	-5.21603	5.216034	NONE	0	0
c280	BS	-3	3	NONE	0	0
c281	BS	-2.53096	2.530963	NONE	0	0
c282	BS	-2.78397	2.783966	NONE	0	0
c283	BS	0	0	NONE	0	0
c284	BS	0	0	NONE	0	0
c285	UL	0	0	NONE	0	0
c286	BS	0	0	NONE	0	0
c287	BS	0	0	NONE	0	0
c288	BS	0	0	NONE	0	0
c289	BS	0	0	NONE	0	0
c290	BS	0	0	NONE	0	0
c291	BS	0	0	NONE	0	0
c292	BS	0	0	0	NONE	0
c293	BS	0	0	0	NONE	0
c294	BS	0	0	0	NONE	0
c295	BS	0	0	0	0	0
c296	EQ	0	0	0	0	0
c297	EQ	0	0	0	0	0
c298	BS	1	0	1	1	0
c299	EQ	1	0	1	1	0
c300	EQ	1	0	1	1	0
c301	BS	0	0	0	0	0
c302	EQ	0	0	0	0	0
c303	EQ	0	0	0	0	0
c304	BS	-1.177	1.177	NONE	0	0
c305	BS	-1.74	1.74	NONE	0	0
c306	UL	0	0	NONE	0	0
c307	BS	0.563	-0.563	0	NONE	0
c308	LL	0	0	0	NONE	0
c309	BS	1.74	-1.74	0	NONE	0
c310	EQ	1	0	1	1	0
c311	EQ	1	0	1	1	0
c312	EQ	1	0	1	1	-520440
c313	EQ	0	0	0	0	0
c314	EQ	0	0	0	0	0
c315	EQ	0	0	0	0	0
c316	BS	0	0	NONE	0	0
c317	BS	0	0	NONE	0	0
c318	BS	0	0	NONE	0	0
c319	BS	0	0	NONE	0	0
c320	BS	0	0	NONE	0	0
c321	BS	0	0	NONE	0	0
c322	BS	0	0	NONE	0	0
c323	BS	-1	1	NONE	0	0
c324	BS	0	0	NONE	0	0
c325	BS	0	0	NONE	0	0
c326	BS	0	0	NONE	0	0
c327	BS	0	0	NONE	0	0
c328	BS	0	0	NONE	0	0

c329	BS	0	0	NONE	0	0
c330	BS	0	0	NONE	0	0
c331	BS	0	0	NONE	0	0
c332	BS	0	0	NONE	0	0
c333	BS	-1	1	NONE	0	0
c334	BS	0	0	NONE	0	0
c335	BS	0	0	NONE	0	0
c336	BS	0	0	NONE	0	0
c337	BS	0	0	NONE	0	0
c338	BS	0	0	NONE	0	0
c339	BS	0	0	NONE	0	0
c340	BS	-1	1	NONE	0	0
c341	BS	0	0	NONE	0	0
c342	BS	0	0	NONE	0	0
c343	BS	0	0	NONE	0	0
c344	BS	0	0	NONE	0	0
c345	BS	0	0	NONE	0	0
c346	BS	0	0	NONE	0	0
c347	UL	0	0	NONE	0	0
c348	BS	0	0	NONE	0	0
c349	BS	0	0	NONE	0	0
c350	BS	-1	1	NONE	0	0
c351	BS	0	0	NONE	0	0
c352	BS	0	0	NONE	0	0
c353	BS	0	0	NONE	0	0
c354	BS	0	0	NONE	0	0
c355	BS	0	0	NONE	0	0
c356	UL	0	0	NONE	0	-245850
c357	UL	0	0	NONE	0	-253040
c358	UL	0	0	NONE	0	-260220
c359	UL	0	0	NONE	0	-267410
c360	UL	0	0	NONE	0	-274590
c361	UL	0	0	NONE	0	-281780
c362	UL	0	0	NONE	0	-288970
c363	UL	0	0	NONE	0	-296150
c364	UL	0	0	NONE	0	-303340
c365	UL	0	0	NONE	0	-310530
c366	UL	0	0	NONE	0	-245850
c367	UL	0	0	NONE	0	-253040
c368	UL	0	0	NONE	0	-260220
c369	UL	0	0	NONE	0	-267410
c370	UL	0	0	NONE	0	-274590
c371	UL	0	0	NONE	0	-281780
c372	UL	0	0	NONE	0	-288970
c373	UL	0	0	NONE	0	-296150
c374	UL	0	0	NONE	0	-303340
c375	UL	0	0	NONE	0	-310530
c376	EQ	0	0	0	0	0
c377	EQ	0	0	0	0	0
c378	EQ	0	0	0	0	1000

c379	EQ	0	0		0		0	0
c380	EQ	0	0		0		0	0
c381	EQ	0	0		0		0	1000
c382	EQ	0	0		0		0	0
c383	EQ	0	0		0		0	0
c384	EQ	0	0		0		0	1000
c385	BS	0	0	NONE			0	0
c386	BS	0	0		0	NONE		0
c387	UL	0	0	NONE			0	0
c388	BS	0	0		0	NONE		0
c389	UL	0	0	NONE			0	0
c390	BS	0.7499	-0.7499		0	NONE		0
c391	BS	0	0	NONE			0	0
c392	BS	0	0		0	NONE		0
c393	UL	0	0	NONE			0	0
c394	BS	0	0		0	NONE		0
c395	UL	0	0	NONE			0	0
c396	BS	0.7499	-0.7499		0	NONE		0
c397	EQ	0	0		0		0	0
c398	EQ	0	0		0		0	0
c399	EQ	0	0		0		0	0
c400	EQ	0	0		0		0	0
c401	EQ	0	0		0		0	0
c402	EQ	0	0		0		0	0
c403	BS	0	0	NONE			0	0
c404	BS	-1.57776	1.577755	NONE			0	0
c405	BS	-3.42375	3.423748	NONE			0	0
c406	BS	0	0	NONE			0	0
c407	BS	-11.4222	11.42224	NONE			0	0
c408	BS	-9.57625	9.576252	NONE			0	0
c409	BS	-4.99999	4.99999	NONE			0	0
c410	BS	0	0	NONE			0	0
c411	UL	0	0	NONE			0	0
c412	BS	-10	10	NONE			0	0
c413	BS	0	0	NONE			0	0
c414	BS	0	0	NONE			0	0
c415	EQ	1	0		1		1	0
c416	EQ	1	0		1		1	0
c417	EQ	1	0		1		1	0
c418	BS	0	0		0	NONE		0
c419	BS	0	0		0	NONE		0
c420	BS	0	0		0	NONE		0
c421	BS	-150	150	NONE			0	0
c422	BS	0	0	NONE			0	0
c423	BS	0	0	NONE			0	0
c424	EQ	0	0		0		0	0
c425	EQ	0	0		0		0	0
c426	EQ	0	0		0		0	0
c427	UL	0	0	NONE			0	0
c428	BS	-1.26476	1.264755	NONE			0	0

c429	BS	-0.59175	0.591748	NONE	0	0
c430	BS	1.424	-1.424	0	NONE	0
c431	BS	0.159245	-0.15924	0	NONE	0
c432	BS	0.525252	-0.52525	0	NONE	0
c433	UL	0	0	NONE	0	0
c434	UL	0	0	NONE	0	0
c435	BS	-1.0002	1.0002	NONE	0	0
c436	BS	1.25	-1.25	0	NONE	0
c437	BS	1.25	-1.25	0	NONE	0
c438	BS	0.2498	-0.2498	0	NONE	0
c439	EQ	1	0	1	1	0
c440	EQ	1	0	1	1	0
c441	EQ	1	0	1	1	0
c442	EQ	-61.339	0	-61.339	-61.339	0
c443	EQ	-61.339	0	-61.339	-61.339	0
c444	EQ	-61.339	0	-61.339	-61.339	0
c445	EQ	-6.6201	0	-6.6201	-6.6201	0
c446	EQ	-6.6201	0	-6.6201	-6.6201	0
c447	EQ	-6.6201	0	-6.6201	-6.6201	0
c448	EQ	0	0	0	0	0
c449	EQ	0	0	0	0	0
c450	EQ	0	0	0	0	0
c451	EQ	0	0	0	0	0
c452	EQ	0	0	0	0	0
c453	EQ	0	0	0	0	0
c454	BS	0	0	0	0	0
c455	BS	0	0	0	0	0
c456	BS	0	0	0	0	0
c457	BS	0	0	0	0	0
c458	BS	0	0	0	0	0
c459	BS	0	0	0	0	0
c460	EQ	792	0	792	792	0
c461	EQ	605	0	605	605	0

2 - COLUMNS

.....COLUMN..	... AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
PT1_3	BS	1840.88	1000	0	NONE	0
PP_3	BS	0	-1000	0	NONE	0
PT2_3	BS	520.44	1000	0	NONE	0
delta1_101	EQ	0	0	0	0	0
delta1_91	BS	1	0	1	1	0
delta1_81	BS	0	0	0	0	0
delta1_71	BS	0	0	0	0	0
delta1_61	EQ	0	0	0	0	0
delta1_51	BS	0	0	0	0	0
delta1_41	BS	0	0	0	0	0
delta1_31	EQ	0	0	0	0	0
delta1_21	EQ	0	0	0	0	0

delta1_11	EQ	0	0	0	0	0
H1_1	BS	187	0	0	212	0
delta1_102	EQ	1	0	1	1	0
delta1_92	EQ	0	0	0	0	0
delta1_82	EQ	0	0	0	0	0
delta1_72	EQ	0	0	0	0	0
delta1_62	EQ	0	0	0	0	0
delta1_52	EQ	0	0	0	0	0
delta1_42	EQ	0	0	0	0	0
delta1_32	EQ	0	0	0	0	0
delta1_22	EQ	0	0	0	0	0
delta1_12	BS	0	0	0	0	0
H1_2	BS	190.8913	0	0	212	0
delta1_103	BS	1	0	1	1	0
delta1_93	EQ	0	0	0	0	-38440
delta1_83	EQ	0	0	0	0	-48060
delta1_73	EQ	0	0	0	0	-57680
delta1_63	EQ	0	0	0	0	-67280
delta1_53	EQ	0	0	0	0	-76900
delta1_43	EQ	0	0	0	0	-86520
delta1_33	EQ	0	0	0	0	-96120
delta1_23	EQ	0	0	0	0	-100930
delta1_13	EQ	0	0	0	0	-127370
H1_3	BS	188.7923	0	0	212	0
FB1_1	BS	792	0	770	812	0
FB2_1	BS	605	0	587	620	0
FB1_2	BS	792.469	0	770	812	0
FB2_2	BS	601.5778	0	587	620	0
FB1_3	BS	792.216	0	770	812	0
FB2_3	BS	603.4237	0	587	620	0
phi1_1161	EQ	0	0	0	0	0
phi1_1151	EQ	0	0	0	0	0
phi1_1141	EQ	0	0	0	0	0
phi1_1131	EQ	0	0	0	0	0
phi1_1121	EQ	0	0	0	0	0
phi1_1111	EQ	0	0	0	0	0
phi1_2161	EQ	0	0	0	0	0
phi1_2151	EQ	0	0	0	0	0
phi1_2141	EQ	0	0	0	0	0
phi1_2131	EQ	0	0	0	0	0
phi1_2121	EQ	0	0	0	0	0
phi1_2111	EQ	0	0	0	0	0
phi1_3161	EQ	0	0	0	0	0
phi1_3151	EQ	0	0	0	0	0
phi1_3141	EQ	0	0	0	0	0
phi1_3131	EQ	0	0	0	0	0
phi1_3121	EQ	0	0	0	0	0
phi1_3111	EQ	0	0	0	0	0
phi1_4161	EQ	0	0	0	0	0
phi1_4151	EQ	0	0	0	0	0

phi1_4141	EQ	0	0	0	0	0
phi1_4131	EQ	0	0	0	0	0
phi1_4121	EQ	0	0	0	0	0
phi1_4111	EQ	0	0	0	0	0
phi1_5161	EQ	0	0	0	0	0
phi1_5151	EQ	0	0	0	0	0
phi1_5141	EQ	0	0	0	0	0
phi1_5131	EQ	0	0	0	0	0
phi1_5121	EQ	0	0	0	0	0
phi1_5111	EQ	0	0	0	0	0
phi1_6161	EQ	0	0	0	0	0
phi1_6151	EQ	0	0	0	0	0
phi1_6141	EQ	0	0	0	0	0
phi1_6131	EQ	0	0	0	0	0
phi1_6121	EQ	0	0	0	0	0
phi1_6111	EQ	0	0	0	0	0
phi1_7161	EQ	0	0	0	0	0
phi1_7151	EQ	0	0	0	0	0
phi1_7141	EQ	0	0	0	0	0
phi1_7131	EQ	0	0	0	0	0
phi1_7121	EQ	0	0	0	0	0
phi1_7111	EQ	0	0	0	0	0
phi1_8161	EQ	0	0	0	0	0
phi1_8151	EQ	0	0	0	0	0
phi1_8141	EQ	0	0	0	0	0
phi1_8131	EQ	0	0	0	0	0
phi1_8121	EQ	0	0	0	0	0
phi1_8111	EQ	0	0	0	0	0
phi1_9161	EQ	0	0	0	0	0
phi1_9151	EQ	0	0	0	0	0
phi1_9141	EQ	0	0	0	0	0
phi1_9131	EQ	0	0	0	0	0
phi1_9121	EQ	0	0	0	0	0
phi1_9111	EQ	0	0	0	0	0
phi1_10161	EQ	0	0	0	0	0
phi1_10151	EQ	0	0	0	0	0
phi1_10141	EQ	0	0	0	0	0
phi1_10131	EQ	0	0	0	0	0
phi1_10121	EQ	0	0	0	0	0
phi1_10111	EQ	0	0	0	0	0
phi1_1261	EQ	0	0	0	0	0
phi1_1251	EQ	0	0	0	0	0
phi1_1241	EQ	0	0	0	0	0
phi1_1231	EQ	0	0	0	0	0
phi1_1221	EQ	0	0	0	0	0
phi1_1211	EQ	0	0	0	0	0
phi1_2261	EQ	0	0	0	0	0
phi1_2251	EQ	0	0	0	0	0
phi1_2241	EQ	0	0	0	0	0
phi1_2231	EQ	0	0	0	0	0

phi1_2221	EQ	0	0	0	0	0
phi1_2211	EQ	0	0	0	0	0
phi1_3261	EQ	0	0	0	0	0
phi1_3251	EQ	0	0	0	0	0
phi1_3241	EQ	0	0	0	0	0
phi1_3231	EQ	0	0	0	0	0
phi1_3221	EQ	0	0	0	0	0
phi1_3211	EQ	0	0	0	0	0
phi1_4261	EQ	0	0	0	0	0
phi1_4251	EQ	0	0	0	0	0
phi1_4241	EQ	0	0	0	0	0
phi1_4231	EQ	0	0	0	0	0
phi1_4221	EQ	0	0	0	0	0
phi1_4211	EQ	0	0	0	0	0
phi1_5261	EQ	0	0	0	0	0
phi1_5251	EQ	0	0	0	0	0
phi1_5241	EQ	0	0	0	0	0
phi1_5231	EQ	0	0	0	0	0
phi1_5221	EQ	0	0	0	0	0
phi1_5211	EQ	0	0	0	0	0
phi1_6261	EQ	0	0	0	0	0
phi1_6251	EQ	0	0	0	0	0
phi1_6241	EQ	0	0	0	0	0
phi1_6231	EQ	0	0	0	0	0
phi1_6221	EQ	0	0	0	0	0
phi1_6211	EQ	0	0	0	0	0
phi1_7261	EQ	0	0	0	0	0
phi1_7251	EQ	0	0	0	0	0
phi1_7241	EQ	0	0	0	0	0
phi1_7231	EQ	0	0	0	0	0
phi1_7221	EQ	0	0	0	0	0
phi1_7211	EQ	0	0	0	0	0
phi1_8261	EQ	0	0	0	0	0
phi1_8251	EQ	0	0	0	0	0
phi1_8241	EQ	0	0	0	0	0
phi1_8231	EQ	0	0	0	0	0
phi1_8221	EQ	0	0	0	0	0
phi1_8211	EQ	0	0	0	0	0
phi1_9261	EQ	0	0	0	0	0
phi1_9251	EQ	0	0	0	0	0
phi1_9241	EQ	0	0	0	0	0
phi1_9231	EQ	0	0	0	0	0
phi1_9221	EQ	0	0	0	0	0
phi1_9211	EQ	0	0	0	0	0
phi1_10261	EQ	0	0	0	0	0
phi1_10251	EQ	0	0	0	0	0
phi1_10241	EQ	0	0	0	0	0
phi1_10231	EQ	0	0	0	0	0
phi1_10221	EQ	0	0	0	0	0
phi1_10211	EQ	0	0	0	0	0

phi1_1162	EQ	0	0	0	0	0
phi1_1152	EQ	0	0	0	0	0
phi1_1142	EQ	0	0	0	0	0
phi1_1132	EQ	0	0	0	0	0
phi1_1122	EQ	0	0	0	0	0
phi1_1112	EQ	0	0	0	0	0
phi1_2162	EQ	0	0	0	0	0
phi1_2152	EQ	0	0	0	0	0
phi1_2142	EQ	0	0	0	0	0
phi1_2132	EQ	0	0	0	0	0
phi1_2122	EQ	0	0	0	0	0
phi1_2112	EQ	0	0	0	0	0
phi1_3162	EQ	0	0	0	0	0
phi1_3152	EQ	0	0	0	0	0
phi1_3142	EQ	0	0	0	0	0
phi1_3132	EQ	0	0	0	0	0
phi1_3122	EQ	0	0	0	0	0
phi1_3112	EQ	0	0	0	0	0
phi1_4162	EQ	0	0	0	0	0
phi1_4152	EQ	0	0	0	0	0
phi1_4142	EQ	0	0	0	0	0
phi1_4132	EQ	0	0	0	0	0
phi1_4122	EQ	0	0	0	0	0
phi1_4112	EQ	0	0	0	0	0
phi1_5162	EQ	0	0	0	0	0
phi1_5152	EQ	0	0	0	0	0
phi1_5142	EQ	0	0	0	0	0
phi1_5132	EQ	0	0	0	0	0
phi1_5122	EQ	0	0	0	0	0
phi1_5112	EQ	0	0	0	0	0
phi1_6162	EQ	0	0	0	0	0
phi1_6152	EQ	0	0	0	0	0
phi1_6142	EQ	0	0	0	0	0
phi1_6132	EQ	0	0	0	0	0
phi1_6122	EQ	0	0	0	0	0
phi1_6112	EQ	0	0	0	0	0
phi1_7162	EQ	0	0	0	0	0
phi1_7152	EQ	0	0	0	0	0
phi1_7142	EQ	0	0	0	0	0
phi1_7132	EQ	0	0	0	0	0
phi1_7122	EQ	0	0	0	0	0
phi1_7112	BS	0	0	0	0	0
phi1_8162	EQ	0	0	0	0	0
phi1_8152	EQ	0	0	0	0	0
phi1_8142	EQ	0	0	0	0	0
phi1_8132	EQ	0	0	0	0	0
phi1_8122	EQ	0	0	0	0	0
phi1_8112	EQ	0	0	0	0	0
phi1_9162	EQ	0	0	0	0	0
phi1_9152	EQ	0	0	0	0	0

phi1_9142	EQ	0	0	0	0	0
phi1_9132	EQ	0	0	0	0	0
phi1_9122	EQ	0	0	0	0	0
phi1_9112	EQ	0	0	0	0	0
phi1_10162	EQ	0	0	0	0	0
phi1_10152	EQ	0	0	0	0	0
phi1_10142	EQ	0	0	0	0	0
phi1_10132	EQ	0	0	0	0	0
phi1_10122	EQ	0	0	0	0	0
phi1_10112	EQ	0	0	0	0	0
phi1_1262	EQ	0	0	0	0	0
phi1_1252	EQ	0	0	0	0	0
phi1_1242	EQ	0	0	0	0	0
phi1_1232	EQ	0	0	0	0	0
phi1_1222	EQ	0	0	0	0	0
phi1_1212	EQ	0	0	0	0	0
phi1_2262	EQ	0	0	0	0	0
phi1_2252	EQ	0	0	0	0	0
phi1_2242	EQ	0	0	0	0	0
phi1_2232	EQ	0	0	0	0	0
phi1_2222	EQ	0	0	0	0	0
phi1_2212	EQ	0	0	0	0	0
phi1_3262	EQ	0	0	0	0	0
phi1_3252	EQ	0	0	0	0	0
phi1_3242	EQ	0	0	0	0	0
phi1_3232	EQ	0	0	0	0	0
phi1_3222	EQ	0	0	0	0	0
phi1_3212	EQ	0	0	0	0	0
phi1_4262	EQ	0	0	0	0	0
phi1_4252	EQ	0	0	0	0	0
phi1_4242	EQ	0	0	0	0	0
phi1_4232	EQ	0	0	0	0	0
phi1_4222	EQ	0	0	0	0	0
phi1_4212	EQ	0	0	0	0	0
phi1_5262	EQ	0	0	0	0	0
phi1_5252	EQ	0	0	0	0	0
phi1_5242	EQ	0	0	0	0	0
phi1_5232	EQ	0	0	0	0	0
phi1_5222	EQ	0	0	0	0	0
phi1_5212	EQ	0	0	0	0	0
phi1_6262	EQ	0	0	0	0	0
phi1_6252	EQ	0	0	0	0	0
phi1_6242	EQ	0	0	0	0	0
phi1_6232	EQ	0	0	0	0	0
phi1_6222	EQ	0	0	0	0	0
phi1_6212	BS	0	0	0	0	0
phi1_7262	EQ	0	0	0	0	0
phi1_7252	EQ	0	0	0	0	0
phi1_7242	EQ	0	0	0	0	0
phi1_7232	EQ	0	0	0	0	0

phi1_7222	EQ	0	0	0	0	0
phi1_7212	EQ	0	0	0	0	0
phi1_8262	EQ	0	0	0	0	0
phi1_8252	EQ	0	0	0	0	0
phi1_8242	EQ	0	0	0	0	0
phi1_8232	EQ	0	0	0	0	0
phi1_8222	EQ	0	0	0	0	0
phi1_8212	BS	0	0	0	0	0
phi1_9262	EQ	0	0	0	0	0
phi1_9252	EQ	0	0	0	0	0
phi1_9242	EQ	0	0	0	0	0
phi1_9232	EQ	0	0	0	0	0
phi1_9222	EQ	0	0	0	0	0
phi1_9212	BS	0	0	0	0	0
phi1_10262	EQ	0	0	0	0	0
phi1_10252	EQ	0	0	0	0	0
phi1_10242	EQ	0	0	0	0	0
phi1_10232	EQ	0	0	0	0	0
phi1_10222	EQ	0	0	0	0	0
phi1_10212	EQ	1	0	1	1	0
phi1_1163	BS	0	0	0	0	0
phi1_1153	EQ	0	0	0	0	-26480
phi1_1143	EQ	0	0	0	0	-53550
phi1_1133	EQ	0	0	0	0	-81450
phi1_1123	EQ	0	0	0	0	-110370
phi1_1113	EQ	0	0	0	0	-310740
phi1_2163	BS	0	0	0	0	0
phi1_2153	EQ	0	0	0	0	-27320
phi1_2143	EQ	0	0	0	0	-55240
phi1_2133	EQ	0	0	0	0	-84010
phi1_2123	EQ	0	0	0	0	-113840
phi1_2113	EQ	0	0	0	0	-320510
phi1_3163	BS	0	0	0	0	0
phi1_3153	EQ	0	0	0	0	-27470
phi1_3143	EQ	0	0	0	0	-55550
phi1_3133	EQ	0	0	0	0	-84480
phi1_3123	EQ	0	0	0	0	-114480
phi1_3113	EQ	0	0	0	0	-322290
phi1_4163	BS	0	0	0	0	0
phi1_4153	EQ	0	0	0	0	-27620
phi1_4143	EQ	0	0	0	0	-55850
phi1_4133	EQ	0	0	0	0	-84940
phi1_4123	EQ	0	0	0	0	-115100
phi1_4113	EQ	0	0	0	0	-324060
phi1_5163	BS	0	0	0	0	0
phi1_5153	EQ	0	0	0	0	-27770
phi1_5143	EQ	0	0	0	0	-56160
phi1_5133	EQ	0	0	0	0	-85410
phi1_5123	EQ	0	0	0	0	-115730
phi1_5113	EQ	0	0	0	0	-325840

phi1_6163	BS	0	0	0	0	0
phi1_6153	EQ	0	0	0	0	-27930
phi1_6143	EQ	0	0	0	0	-56470
phi1_6133	EQ	0	0	0	0	-85880
phi1_6123	EQ	0	0	0	0	-116370
phi1_6113	EQ	0	0	0	0	-327620
phi1_7163	BS	0	0	0	0	0
phi1_7153	EQ	0	0	0	0	-28070
phi1_7143	EQ	0	0	0	0	-56770
phi1_7133	EQ	0	0	0	0	-86340
phi1_7123	EQ	0	0	0	0	-116990
phi1_7113	EQ	0	0	0	0	-329390
phi1_8163	BS	0	0	0	0	0
phi1_8153	EQ	0	0	0	0	-28230
phi1_8143	EQ	0	0	0	0	-57080
phi1_8133	EQ	0	0	0	0	-86810
phi1_8123	EQ	0	0	0	0	-117630
phi1_8113	EQ	0	0	0	0	-331170
phi1_9163	BS	0	0	0	0	0
phi1_9153	EQ	0	0	0	0	-28380
phi1_9143	EQ	0	0	0	0	-57390
phi1_9133	EQ	0	0	0	0	-87280
phi1_9123	EQ	0	0	0	0	-118260
phi1_9113	EQ	0	0	0	0	-332950
phi1_10163	BS	1	0	1	1	0
phi1_10153	EQ	0	0	0	0	-28980
phi1_10143	EQ	0	0	0	0	-58600
phi1_10133	EQ	0	0	0	0	-89130
phi1_10123	EQ	0	0	0	0	-120780
phi1_10113	EQ	0	0	0	0	-340040
phi1_1263	EQ	0	0	0	0	-31250
phi1_1253	EQ	0	0	0	0	-57730
phi1_1243	EQ	0	0	0	0	-84800
phi1_1233	EQ	0	0	0	0	-112700
phi1_1223	EQ	0	0	0	0	-141620
phi1_1213	EQ	0	0	0	0	-341990
phi1_2263	EQ	0	0	0	0	-4810
phi1_2253	EQ	0	0	0	0	-32130
phi1_2243	EQ	0	0	0	0	-60050
phi1_2233	EQ	0	0	0	0	-88820
phi1_2223	EQ	0	0	0	0	-118650
phi1_2213	EQ	0	0	0	0	-325320
phi1_3263	BS	0	0	0	0	0
phi1_3253	EQ	0	0	0	0	-27470
phi1_3243	EQ	0	0	0	0	-55550
phi1_3233	EQ	0	0	0	0	-84480
phi1_3223	EQ	0	0	0	0	-114480
phi1_3213	EQ	0	0	0	0	-322290
phi1_4263	BS	0	0	0	0	0
phi1_4253	EQ	0	0	0	0	-27620

phi1_4243	EQ	0	0	0	0	-55850
phi1_4233	EQ	0	0	0	0	-84940
phi1_4223	EQ	0	0	0	0	-115100
phi1_4213	EQ	0	0	0	0	-324060
phi1_5263	BS	0	0	0	0	0
phi1_5253	EQ	0	0	0	0	-27770
phi1_5243	EQ	0	0	0	0	-56160
phi1_5233	EQ	0	0	0	0	-85410
phi1_5223	EQ	0	0	0	0	-115730
phi1_5213	EQ	0	0	0	0	-325840
phi1_6263	BS	0	0	0	0	0
phi1_6253	EQ	0	0	0	0	-27930
phi1_6243	EQ	0	0	0	0	-56470
phi1_6233	EQ	0	0	0	0	-85880
phi1_6223	EQ	0	0	0	0	-116370
phi1_6213	EQ	0	0	0	0	-327620
phi1_7263	BS	0	0	0	0	0
phi1_7253	EQ	0	0	0	0	-28070
phi1_7243	EQ	0	0	0	0	-56770
phi1_7233	EQ	0	0	0	0	-86340
phi1_7223	EQ	0	0	0	0	-116990
phi1_7213	EQ	0	0	0	0	-329390
phi1_8263	BS	0	0	0	0	0
phi1_8253	EQ	0	0	0	0	-28230
phi1_8243	EQ	0	0	0	0	-57080
phi1_8233	EQ	0	0	0	0	-86810
phi1_8223	EQ	0	0	0	0	-117630
phi1_8213	EQ	0	0	0	0	-331170
phi1_9263	BS	0	0	0	0	0
phi1_9253	EQ	0	0	0	0	-28380
phi1_9243	EQ	0	0	0	0	-57390
phi1_9233	EQ	0	0	0	0	-87280
phi1_9223	EQ	0	0	0	0	-118260
phi1_9213	EQ	0	0	0	0	-332950
phi1_10263	BS	1	0	1	1	0
phi1_10253	EQ	0	0	0	0	-28980
phi1_10243	EQ	0	0	0	0	-58600
phi1_10233	EQ	0	0	0	0	-89130
phi1_10223	EQ	0	0	0	0	-120780
phi1_10213	EQ	0	0	0	0	-340040
PT1_11	BS	0	0	0	NONE	0
PT1_12	BS	0	0	0	NONE	0
PT1_13	BS	920.44	0	0	NONE	0
PT1_21	BS	0	0	0	NONE	0
PT1_22	BS	580.4	0	0	NONE	0
PT1_23	BS	920.44	0	0	NONE	0
PT1_1	BS	0	0	0	NONE	0
PT1_2	BS	580.4	0	0	NONE	0
PT_1	BS	0	0	0	NONE	0
PT2_1	BS	0	0	0	NONE	0

PT_2	BS	580.4	0	0	NONE	0
PT2_2	BS	0	0	0	NONE	0
PT_3	BS	2361.32	0	0	NONE	0
QT1_11	LL	0	0	0	5.5	0
QT1_12	LL	0	0	0	5.5	0
QT1_13	BS	5.4501	0	0	5.5	0
QT1_21	LL	0	0	0	5.5	0
QT1_22	BS	2.45	0	0	5.5	0
QT1_23	BS	5.4501	0	0	5.5	0
QT1_1	BS	0	0	0	NONE	0
QT1_2	BS	2.45	0	0	NONE	0
QT1_3	BS	10.9002	0	0	NONE	0
nu_1011	EQ	0	0	0	0	0
nu_911	EQ	1	0	1	1	0
nu_811	EQ	0	0	0	0	0
nu_711	EQ	0	0	0	0	0
nu_611	EQ	0	0	0	0	0
nu_511	EQ	0	0	0	0	0
nu_411	EQ	0	0	0	0	0
nu_311	EQ	0	0	0	0	0
nu_211	EQ	0	0	0	0	0
nu_111	BS	0	0	0	0	0
PP_11	BS	945.699	0	0	NONE	0
nu_1012	BS	0	0	0	0	0
nu_912	BS	0	0	0	0	0
nu_812	BS	0	0	0	0	0
nu_712	BS	0	0	0	0	0
nu_612	BS	0	0	0	0	0
nu_512	BS	0	0	0	0	0
nu_412	BS	0	0	0	0	0
nu_312	BS	0	0	0	0	0
nu_212	BS	0	0	0	0	0
nu_112	BS	0	0	0	0	0
PP_12	BS	0	0	0	NONE	0
nu_1013	EQ	0	0	0	0	-942211
nu_913	EQ	0	0	0	0	-945699
nu_813	EQ	0	0	0	0	-946447
nu_713	EQ	0	0	0	0	-947145
nu_613	EQ	0	0	0	0	-947793
nu_513	EQ	0	0	0	0	-948391
nu_413	EQ	0	0	0	0	-948939
nu_313	EQ	0	0	0	0	-949436
nu_213	EQ	0	0	0	0	-949883
nu_113	EQ	0	0	0	0	-951427
PP_13	BS	0	0	0	NONE	0
nu_1021	EQ	0	0	0	0	0
nu_921	EQ	0	0	0	0	0
nu_821	BS	0	0	0	0	0
nu_721	BS	0	0	0	0	0
nu_621	BS	0	0	0	0	0

nu_521	BS	0	0	0	0	0
nu_421	BS	0	0	0	0	0
nu_321	BS	0	0	0	0	0
nu_221	BS	0	0	0	0	0
nu_121	BS	0	0	0	0	0
PP_21	BS	0	0	0	NONE	0
nu_1022	BS	0	0	0	0	0
nu_922	EQ	0	0	0	0	0
nu_822	EQ	0	0	0	0	0
nu_722	EQ	0	0	0	0	0
nu_622	EQ	0	0	0	0	0
nu_522	EQ	0	0	0	0	0
nu_422	EQ	0	0	0	0	0
nu_322	EQ	0	0	0	0	0
nu_222	EQ	0	0	0	0	0
nu_122	EQ	0	0	0	0	0
PP_22	BS	0	0	0	NONE	0
nu_1023	EQ	0	0	0	0	-942211
nu_923	EQ	0	0	0	0	-945699
nu_823	EQ	0	0	0	0	-946447
nu_723	EQ	0	0	0	0	-947145
nu_623	EQ	0	0	0	0	-947793
nu_523	EQ	0	0	0	0	-948391
nu_423	EQ	0	0	0	0	-948939
nu_323	EQ	0	0	0	0	-949436
nu_223	EQ	0	0	0	0	-949883
nu_123	EQ	0	0	0	0	-951427
PP_23	BS	0	0	0	NONE	0
PP_1	BS	945.699	0	0	NONE	0
PP_2	BS	0	0	0	NONE	0
theta_NO_1	EQ	1	0	1	1	0
theta_NO_2	BS	1	0	1	1	0
theta_NO_3	BS	1	0	1	1	0
QP_11	BS	4.542	0	0	NONE	0
QP_12	BS	0	0	0	NONE	0
QP_13	LL	0	0	0	NONE	0
QP_21	LL	0	0	0	NONE	0
QP_22	BS	0	0	0	NONE	0
QP_23	LL	0	0	0	NONE	0
QP_1	BS	4.542	0	0	NONE	0
QP_2	BS	0	0	0	NONE	0
QP_3	BS	0	0	0	NONE	0
Beta_11	BS	0	0	0	0	0
Beta_12	BS	0	0	0	0	0
Beta_13	EQ	1	0	1	1	841130
Beta_21	BS	0	0	0	0	0
Beta_22	BS	1	0	1	1	0
Beta_23	EQ	1	0	1	1	872380
Alpha_11	BS	1	0	1	1	0
Alpha_12	EQ	0	0	0	0	0

Alpha_13	BS	0	0	0	0	0
Alpha_21	BS	0	0	0	0	0
Alpha_22	EQ	0	0	0	0	0
Alpha_23	BS	0	0	0	0	0
Turbine_1	BS	0	0	0	NONE	0
Turbine_2	BS	1	0	0	NONE	0
Turbine_3	BS	2	0	0	NONE	0
Pump_1	BS	1	0	0	NONE	0
Pump_2	BS	0	0	0	NONE	0
Pump_3	BS	0	0	0	NONE	0
Produce_1	EQ	0	0	0	0	0
Produce_2	BS	1	0	1	1	0
Produce_3	BS	1	0	1	1	0
Spill1_NO_1	BS	792	0	0	NONE	0
Spill1_YES_1	LL	0	0	0	NONE	0
Spill1_NO_2	BS	792.469	0	0	NONE	0
Spill1_YES_2	LL	0	0	0	NONE	0
Spill1_NO_3	BS	792.216	0	0	NONE	0
Spill1_YES_3	LL	0	0	0	NONE	0
theta_YES_1	EQ	0	0	0	0	0
theta_YES_2	BS	0	0	0	0	0
theta_YES_3	BS	0	0	0	0	0
theta_31	EQ	0	0	0	0	0
theta_21	EQ	0	0	0	0	0
theta_11	EQ	0	0	0	0	0
SPILL1_YES_1	LL	0	0	0	NONE	0
theta_32	EQ	0	0	0	0	0
theta_22	EQ	0	0	0	0	0
theta_12	EQ	0	0	0	0	0
SPILL1_YES_2	LL	0	0	0	NONE	0
theta_33	EQ	0	0	0	0	0
theta_23	EQ	0	0	0	0	0
theta_13	BS	0	0	0	0	0
SPILL1_YES_3	LL	0	0	0	NONE	0
UnContRel_1	LL	0	0	0	NONE	0
UnContRel_2	BS	0	0	0	NONE	0
UnContRel_3	BS	0	0	0	NONE	0
delta2_101	EQ	0	0	0	0	0
delta2_91	EQ	0	0	0	0	0
delta2_81	EQ	1	0	1	1	0
delta2_71	EQ	0	0	0	0	0
delta2_61	EQ	0	0	0	0	0
delta2_51	EQ	0	0	0	0	0
delta2_41	EQ	0	0	0	0	0
delta2_31	EQ	0	0	0	0	0
delta2_21	EQ	0	0	0	0	0
delta2_11	BS	0	0	0	0	0
H2_1	BS	72.427	0	0	NONE	0
delta2_102	EQ	0	0	0	0	0
delta2_92	EQ	0	0	0	0	0

delta2_82	EQ	0	0	0	0	0
delta2_72	EQ	0	0	0	0	0
delta2_62	EQ	0	0	0	0	0
delta2_52	EQ	1	0	1	1	0
delta2_42	EQ	0	0	0	0	0
delta2_32	EQ	0	0	0	0	0
delta2_22	EQ	0	0	0	0	0
delta2_12	BS	0	0	0	0	0
H2_2	BS	67.74	0	0	NONE	0
delta2_103	EQ	0	0	0	0	100620
delta2_93	EQ	0	0	0	0	86240
delta2_83	EQ	0	0	0	0	71860
delta2_73	EQ	0	0	0	0	57500
delta2_63	EQ	0	0	0	0	43120
delta2_53	EQ	0	0	0	0	28740
delta2_43	EQ	0	0	0	0	14380
delta2_33	BS	1	0	1	1	0
delta2_23	EQ	0	0	0	0	-14360
delta2_13	EQ	0	0	0	0	-28740
H2_3	BS	62.5	0	0	NONE	0
TR2_1	BS	532.573	0	532	551	0
TR2_2	BS	533.8378	0	532	551	0
TR2_3	BS	540.9237	0	532	551	0
phi2_1161	EQ	0	0	0	0	0
phi2_1151	EQ	0	0	0	0	0
phi2_1141	EQ	0	0	0	0	0
phi2_1131	EQ	0	0	0	0	0
phi2_1121	EQ	0	0	0	0	0
phi2_1111	EQ	0	0	0	0	0
phi2_2161	EQ	0	0	0	0	0
phi2_2151	EQ	0	0	0	0	0
phi2_2141	EQ	0	0	0	0	0
phi2_2131	EQ	0	0	0	0	0
phi2_2121	EQ	0	0	0	0	0
phi2_2111	EQ	0	0	0	0	0
phi2_3161	EQ	0	0	0	0	0
phi2_3151	EQ	0	0	0	0	0
phi2_3141	EQ	0	0	0	0	0
phi2_3131	EQ	0	0	0	0	0
phi2_3121	EQ	0	0	0	0	0
phi2_3111	EQ	0	0	0	0	0
phi2_4161	EQ	0	0	0	0	0
phi2_4151	EQ	0	0	0	0	0
phi2_4141	EQ	0	0	0	0	0
phi2_4131	EQ	0	0	0	0	0
phi2_4121	EQ	0	0	0	0	0
phi2_4111	EQ	0	0	0	0	0
phi2_5161	EQ	0	0	0	0	0
phi2_5151	EQ	0	0	0	0	0
phi2_5141	EQ	0	0	0	0	0

phi2_5131	EQ	0	0	0	0	0
phi2_5121	EQ	0	0	0	0	0
phi2_5111	EQ	0	0	0	0	0
phi2_6161	EQ	0	0	0	0	0
phi2_6151	EQ	0	0	0	0	0
phi2_6141	EQ	0	0	0	0	0
phi2_6131	EQ	0	0	0	0	0
phi2_6121	EQ	0	0	0	0	0
phi2_6111	EQ	0	0	0	0	0
phi2_7161	EQ	0	0	0	0	0
phi2_7151	EQ	0	0	0	0	0
phi2_7141	EQ	0	0	0	0	0
phi2_7131	EQ	0	0	0	0	0
phi2_7121	EQ	0	0	0	0	0
phi2_7111	EQ	0	0	0	0	0
phi2_8161	EQ	0	0	0	0	0
phi2_8151	EQ	0	0	0	0	0
phi2_8141	EQ	0	0	0	0	0
phi2_8131	EQ	0	0	0	0	0
phi2_8121	EQ	0	0	0	0	0
phi2_8111	EQ	0	0	0	0	0
phi2_9161	EQ	0	0	0	0	0
phi2_9151	EQ	0	0	0	0	0
phi2_9141	EQ	0	0	0	0	0
phi2_9131	EQ	0	0	0	0	0
phi2_9121	EQ	0	0	0	0	0
phi2_9111	EQ	0	0	0	0	0
phi2_10161	EQ	0	0	0	0	0
phi2_10151	EQ	0	0	0	0	0
phi2_10141	EQ	0	0	0	0	0
phi2_10131	EQ	0	0	0	0	0
phi2_10121	EQ	0	0	0	0	0
phi2_10111	EQ	0	0	0	0	0
phi2_1261	EQ	0	0	0	0	0
phi2_1251	EQ	0	0	0	0	0
phi2_1241	EQ	0	0	0	0	0
phi2_1231	EQ	0	0	0	0	0
phi2_1221	EQ	0	0	0	0	0
phi2_1211	EQ	0	0	0	0	0
phi2_2261	EQ	0	0	0	0	0
phi2_2251	EQ	0	0	0	0	0
phi2_2241	EQ	0	0	0	0	0
phi2_2231	EQ	0	0	0	0	0
phi2_2221	EQ	0	0	0	0	0
phi2_2211	EQ	0	0	0	0	0
phi2_3261	EQ	0	0	0	0	0
phi2_3251	EQ	0	0	0	0	0
phi2_3241	EQ	0	0	0	0	0
phi2_3231	EQ	0	0	0	0	0
phi2_3221	EQ	0	0	0	0	0

phi2_3211	EQ	0	0	0	0	0
phi2_4261	EQ	0	0	0	0	0
phi2_4251	EQ	0	0	0	0	0
phi2_4241	EQ	0	0	0	0	0
phi2_4231	EQ	0	0	0	0	0
phi2_4221	EQ	0	0	0	0	0
phi2_4211	EQ	0	0	0	0	0
phi2_5261	EQ	0	0	0	0	0
phi2_5251	EQ	0	0	0	0	0
phi2_5241	EQ	0	0	0	0	0
phi2_5231	EQ	0	0	0	0	0
phi2_5221	EQ	0	0	0	0	0
phi2_5211	EQ	0	0	0	0	0
phi2_6261	EQ	0	0	0	0	0
phi2_6251	EQ	0	0	0	0	0
phi2_6241	EQ	0	0	0	0	0
phi2_6231	EQ	0	0	0	0	0
phi2_6221	EQ	0	0	0	0	0
phi2_6211	EQ	0	0	0	0	0
phi2_7261	EQ	0	0	0	0	0
phi2_7251	EQ	0	0	0	0	0
phi2_7241	EQ	0	0	0	0	0
phi2_7231	EQ	0	0	0	0	0
phi2_7221	EQ	0	0	0	0	0
phi2_7211	EQ	0	0	0	0	0
phi2_8261	EQ	0	0	0	0	0
phi2_8251	EQ	0	0	0	0	0
phi2_8241	EQ	0	0	0	0	0
phi2_8231	EQ	0	0	0	0	0
phi2_8221	EQ	0	0	0	0	0
phi2_8211	EQ	0	0	0	0	0
phi2_9261	EQ	0	0	0	0	0
phi2_9251	EQ	0	0	0	0	0
phi2_9241	EQ	0	0	0	0	0
phi2_9231	EQ	0	0	0	0	0
phi2_9221	EQ	0	0	0	0	0
phi2_9211	EQ	0	0	0	0	0
phi2_10261	EQ	0	0	0	0	0
phi2_10251	EQ	0	0	0	0	0
phi2_10241	EQ	0	0	0	0	0
phi2_10231	EQ	0	0	0	0	0
phi2_10221	EQ	0	0	0	0	0
phi2_10211	EQ	0	0	0	0	0
phi2_1162	EQ	0	0	0	0	0
phi2_1152	EQ	0	0	0	0	0
phi2_1142	EQ	0	0	0	0	0
phi2_1132	EQ	0	0	0	0	0
phi2_1122	EQ	0	0	0	0	0
phi2_1112	EQ	0	0	0	0	0
phi2_2162	EQ	0	0	0	0	0

phi2_2152	EQ	0	0	0	0	0
phi2_2142	EQ	0	0	0	0	0
phi2_2132	EQ	0	0	0	0	0
phi2_2122	EQ	0	0	0	0	0
phi2_2112	EQ	0	0	0	0	0
phi2_3162	EQ	0	0	0	0	0
phi2_3152	EQ	0	0	0	0	0
phi2_3142	EQ	0	0	0	0	0
phi2_3132	EQ	0	0	0	0	0
phi2_3122	EQ	0	0	0	0	0
phi2_3112	EQ	0	0	0	0	0
phi2_4162	EQ	0	0	0	0	0
phi2_4152	EQ	0	0	0	0	0
phi2_4142	EQ	0	0	0	0	0
phi2_4132	EQ	0	0	0	0	0
phi2_4122	EQ	0	0	0	0	0
phi2_4112	EQ	0	0	0	0	0
phi2_5162	EQ	0	0	0	0	0
phi2_5152	EQ	0	0	0	0	0
phi2_5142	EQ	0	0	0	0	0
phi2_5132	EQ	0	0	0	0	0
phi2_5122	EQ	0	0	0	0	0
phi2_5112	EQ	0	0	0	0	0
phi2_6162	EQ	0	0	0	0	0
phi2_6152	EQ	0	0	0	0	0
phi2_6142	EQ	0	0	0	0	0
phi2_6132	EQ	0	0	0	0	0
phi2_6122	EQ	0	0	0	0	0
phi2_6112	EQ	0	0	0	0	0
phi2_7162	EQ	0	0	0	0	0
phi2_7152	EQ	0	0	0	0	0
phi2_7142	EQ	0	0	0	0	0
phi2_7132	EQ	0	0	0	0	0
phi2_7122	EQ	0	0	0	0	0
phi2_7112	EQ	0	0	0	0	0
phi2_8162	EQ	0	0	0	0	0
phi2_8152	EQ	0	0	0	0	0
phi2_8142	EQ	0	0	0	0	0
phi2_8132	EQ	0	0	0	0	0
phi2_8122	EQ	0	0	0	0	0
phi2_8112	EQ	0	0	0	0	0
phi2_9162	EQ	0	0	0	0	0
phi2_9152	EQ	0	0	0	0	0
phi2_9142	EQ	0	0	0	0	0
phi2_9132	EQ	0	0	0	0	0
phi2_9122	EQ	0	0	0	0	0
phi2_9112	EQ	0	0	0	0	0
phi2_10162	EQ	0	0	0	0	0
phi2_10152	EQ	0	0	0	0	0
phi2_10142	EQ	0	0	0	0	0

phi2_10132	EQ	0	0	0	0	0
phi2_10122	EQ	0	0	0	0	0
phi2_10112	EQ	0	0	0	0	0
phi2_1262	EQ	0	0	0	0	0
phi2_1252	EQ	0	0	0	0	0
phi2_1242	EQ	0	0	0	0	0
phi2_1232	EQ	0	0	0	0	0
phi2_1222	EQ	0	0	0	0	0
phi2_1212	EQ	0	0	0	0	0
phi2_2262	EQ	0	0	0	0	0
phi2_2252	EQ	0	0	0	0	0
phi2_2242	EQ	0	0	0	0	0
phi2_2232	EQ	0	0	0	0	0
phi2_2222	EQ	0	0	0	0	0
phi2_2212	BS	0	0	0	0	0
phi2_3262	EQ	0	0	0	0	0
phi2_3252	EQ	0	0	0	0	0
phi2_3242	EQ	0	0	0	0	0
phi2_3232	EQ	0	0	0	0	0
phi2_3222	EQ	0	0	0	0	0
phi2_3212	EQ	0	0	0	0	0
phi2_4262	EQ	0	0	0	0	0
phi2_4252	EQ	0	0	0	0	0
phi2_4242	EQ	0	0	0	0	0
phi2_4232	EQ	0	0	0	0	0
phi2_4222	EQ	0	0	0	0	0
phi2_4212	EQ	0	0	0	0	0
phi2_5262	EQ	0	0	0	0	0
phi2_5252	EQ	0	0	0	0	0
phi2_5242	EQ	0	0	0	0	0
phi2_5232	EQ	0	0	0	0	0
phi2_5222	EQ	0	0	0	0	0
phi2_5212	EQ	0	0	0	0	0
phi2_6262	EQ	0	0	0	0	0
phi2_6252	EQ	0	0	0	0	0
phi2_6242	EQ	0	0	0	0	0
phi2_6232	EQ	0	0	0	0	0
phi2_6222	EQ	0	0	0	0	0
phi2_6212	EQ	0	0	0	0	0
phi2_7262	EQ	0	0	0	0	0
phi2_7252	EQ	0	0	0	0	0
phi2_7242	EQ	0	0	0	0	0
phi2_7232	EQ	0	0	0	0	0
phi2_7222	EQ	0	0	0	0	0
phi2_7212	EQ	0	0	0	0	0
phi2_8262	EQ	0	0	0	0	0
phi2_8252	EQ	0	0	0	0	0
phi2_8242	EQ	0	0	0	0	0
phi2_8232	EQ	0	0	0	0	0
phi2_8222	EQ	0	0	0	0	0

phi2_8212	EQ	0	0	0	0	0
phi2_9262	EQ	0	0	0	0	0
phi2_9252	EQ	0	0	0	0	0
phi2_9242	EQ	0	0	0	0	0
phi2_9232	EQ	0	0	0	0	0
phi2_9222	EQ	0	0	0	0	0
phi2_9212	EQ	0	0	0	0	0
phi2_10262	BS	0	0	0	0	0
phi2_10252	EQ	0	0	0	0	0
phi2_10242	EQ	0	0	0	0	0
phi2_10232	EQ	0	0	0	0	0
phi2_10222	EQ	0	0	0	0	0
phi2_10212	EQ	0	0	0	0	0
phi2_1163	BS	0	0	0	0	0
phi2_1153	EQ	0	0	0	0	-37950
phi2_1143	EQ	0	0	0	0	-55720
phi2_1133	EQ	0	0	0	0	-73890
phi2_1123	EQ	0	0	0	0	-92090
phi2_1113	EQ	0	0	0	0	-143590
phi2_2163	BS	0	0	0	0	0
phi2_2153	EQ	0	0	0	0	-39060
phi2_2143	EQ	0	0	0	0	-57350
phi2_2133	EQ	0	0	0	0	-76060
phi2_2123	EQ	0	0	0	0	-94780
phi2_2113	EQ	0	0	0	0	-147790
phi2_3163	BS	1	0	1	1	0
phi2_3153	EQ	0	0	0	0	-40160
phi2_3143	EQ	0	0	0	0	-58970
phi2_3133	EQ	0	0	0	0	-78210
phi2_3123	EQ	0	0	0	0	-97470
phi2_3113	EQ	0	0	0	0	-151980
phi2_4163	BS	0	0	0	0	0
phi2_4153	EQ	0	0	0	0	-41280
phi2_4143	EQ	0	0	0	0	-60600
phi2_4133	EQ	0	0	0	0	-80370
phi2_4123	EQ	0	0	0	0	-100170
phi2_4113	EQ	0	0	0	0	-156180
phi2_5163	BS	0	0	0	0	0
phi2_5153	EQ	0	0	0	0	-42380
phi2_5143	EQ	0	0	0	0	-62230
phi2_5133	EQ	0	0	0	0	-82530
phi2_5123	EQ	0	0	0	0	-102850
phi2_5113	EQ	0	0	0	0	-160380
phi2_6163	BS	0	0	0	0	0
phi2_6153	EQ	0	0	0	0	-43490
phi2_6143	EQ	0	0	0	0	-63860
phi2_6133	EQ	0	0	0	0	-84690
phi2_6123	EQ	0	0	0	0	-105550
phi2_6113	EQ	0	0	0	0	-164580
phi2_7163	BS	0	0	0	0	0

phi2_7153	EQ	0	0	0	0	-44610
phi2_7143	EQ	0	0	0	0	-65490
phi2_7133	EQ	0	0	0	0	-86850
phi2_7123	EQ	0	0	0	0	-108240
phi2_7113	EQ	0	0	0	0	-168780
phi2_8163	BS	0	0	0	0	0
phi2_8153	EQ	0	0	0	0	-45710
phi2_8143	EQ	0	0	0	0	-67110
phi2_8133	EQ	0	0	0	0	-89010
phi2_8123	EQ	0	0	0	0	-110930
phi2_8113	EQ	0	0	0	0	-172970
phi2_9163	BS	0	0	0	0	0
phi2_9153	EQ	0	0	0	0	-46820
phi2_9143	EQ	0	0	0	0	-68750
phi2_9133	EQ	0	0	0	0	-91170
phi2_9123	EQ	0	0	0	0	-113620
phi2_9113	EQ	0	0	0	0	-177170
phi2_10163	BS	0	0	0	0	0
phi2_10153	EQ	0	0	0	0	-47940
phi2_10143	EQ	0	0	0	0	-70380
phi2_10133	EQ	0	0	0	0	-93340
phi2_10123	EQ	0	0	0	0	-116320
phi2_10113	EQ	0	0	0	0	-181370
phi2_1263	BS	0	0	0	0	0
phi2_1253	EQ	0	0	0	0	-37950
phi2_1243	EQ	0	0	0	0	-55720
phi2_1233	EQ	0	0	0	0	-73890
phi2_1223	EQ	0	0	0	0	-92090
phi2_1213	EQ	0	0	0	0	-143590
phi2_2263	BS	0	0	0	0	0
phi2_2253	EQ	0	0	0	0	-39060
phi2_2243	EQ	0	0	0	0	-57350
phi2_2233	EQ	0	0	0	0	-76060
phi2_2223	EQ	0	0	0	0	-94780
phi2_2213	EQ	0	0	0	0	-147790
phi2_3263	BS	1	0	1	1	0
phi2_3253	EQ	0	0	0	0	-40160
phi2_3243	EQ	0	0	0	0	-58970
phi2_3233	EQ	0	0	0	0	-78210
phi2_3223	EQ	0	0	0	0	-97470
phi2_3213	EQ	0	0	0	0	-151980
phi2_4263	BS	0	0	0	0	0
phi2_4253	EQ	0	0	0	0	-41280
phi2_4243	EQ	0	0	0	0	-60600
phi2_4233	EQ	0	0	0	0	-80370
phi2_4223	EQ	0	0	0	0	-100170
phi2_4213	EQ	0	0	0	0	-156180
phi2_5263	BS	0	0	0	0	0
phi2_5253	EQ	0	0	0	0	-42380
phi2_5243	EQ	0	0	0	0	-62230

phi2_5233	EQ	0	0	0	0	-82530
phi2_5223	EQ	0	0	0	0	-102850
phi2_5213	EQ	0	0	0	0	-160380
phi2_6263	BS	0	0	0	0	0
phi2_6253	EQ	0	0	0	0	-43490
phi2_6243	EQ	0	0	0	0	-63860
phi2_6233	EQ	0	0	0	0	-84690
phi2_6223	EQ	0	0	0	0	-105550
phi2_6213	EQ	0	0	0	0	-164580
phi2_7263	BS	0	0	0	0	0
phi2_7253	EQ	0	0	0	0	-44610
phi2_7243	EQ	0	0	0	0	-65490
phi2_7233	EQ	0	0	0	0	-86850
phi2_7223	EQ	0	0	0	0	-108240
phi2_7213	EQ	0	0	0	0	-168780
phi2_8263	BS	0	0	0	0	0
phi2_8253	EQ	0	0	0	0	-45710
phi2_8243	EQ	0	0	0	0	-67110
phi2_8233	EQ	0	0	0	0	-89010
phi2_8223	EQ	0	0	0	0	-110930
phi2_8213	EQ	0	0	0	0	-172970
phi2_9263	BS	0	0	0	0	0
phi2_9253	EQ	0	0	0	0	-46820
phi2_9243	EQ	0	0	0	0	-68750
phi2_9233	EQ	0	0	0	0	-91170
phi2_9223	EQ	0	0	0	0	-113620
phi2_9213	EQ	0	0	0	0	-177170
phi2_10263	BS	0	0	0	0	0
phi2_10253	EQ	0	0	0	0	-47940
phi2_10243	EQ	0	0	0	0	-70380
phi2_10233	EQ	0	0	0	0	-93340
phi2_10223	EQ	0	0	0	0	-116320
phi2_10213	EQ	0	0	0	0	-181370
PT2_11	BS	0	0	0	NONE	0
PT2_12	BS	0	0	0	NONE	0
PT2_13	BS	260.22	0	0	NONE	0
PT2_21	BS	0	0	0	NONE	0
PT2_22	BS	0	0	0	NONE	0
PT2_23	BS	260.22	0	0	NONE	0
QT2_11	LL	0	0	0	5.5	0
QT2_12	BS	0	0	0	5.5	0
QT2_13	BS	4.2501	0	0	5.5	0
QT2_21	LL	0	0	0	5.5	0
QT2_22	LL	0	0	0	5.5	0
QT2_23	BS	4.2501	0	0	5.5	0
QT2_1	BS	0	0	0	NONE	0
QT2_2	BS	0	0	0	NONE	0
QT2_3	BS	8.5002	0	0	NONE	0
Spill2_NO_1	LL	0	0	0	NONE	0
Spill2_YES_1	BS	605	0	0	NONE	0

Spill2_NO_2	BS	601.5778	0	0	NONE	0
Spill2_YES_2	LL	0	0	0	NONE	0
Spill2_NO_3	BS	603.4237	0	0	NONE	0
Spill2_YES_3	LL	0	0	0	NONE	0
sigma_NO_1	BS	0	0	0	0	0
sigma_NO_2	BS	1	0	1	1	0
sigma_NO_3	BS	1	0	1	1	0
sigma_YES_1	EQ	1	0	1	1	0
sigma_YES_2	EQ	0	0	0	0	0
sigma_YES_3	BS	0	0	0	0	0
Gated_1	LL	0	0	0	NONE	0
Gated_2	LL	0	0	0	NONE	0
Gated_3	LL	0	0	0	NONE	0
Chan_1	BS	0	0	0	NONE	0
Chan_2	BS	0	0	0	NONE	0
Chan_3	BS	8.5002	0	0	NONE	0
zeta_91	BS	0	0	0	0	0
zeta_81	EQ	0	0	0	0	0
zeta_71	EQ	0	0	0	0	0
zeta_61	EQ	0	0	0	0	0
zeta_51	EQ	0	0	0	0	0
zeta_41	EQ	0	0	0	0	0
zeta_31	EQ	0	0	0	0	0
zeta_21	EQ	0	0	0	0	0
zeta_11	BS	1	0	1	1	0
zeta_92	BS	0	0	0	0	0
zeta_82	EQ	0	0	0	0	0
zeta_72	EQ	0	0	0	0	0
zeta_62	EQ	0	0	0	0	0
zeta_52	EQ	0	0	0	0	0
zeta_42	EQ	0	0	0	0	0
zeta_32	EQ	0	0	0	0	0
zeta_22	EQ	0	0	0	0	0
zeta_12	BS	1	0	1	1	0
zeta_93	EQ	0	0	0	0	0
zeta_83	EQ	0	0	0	0	0
zeta_73	EQ	0	0	0	0	0
zeta_63	EQ	0	0	0	0	0
zeta_53	EQ	0	0	0	0	0
zeta_43	EQ	1	0	1	1	0
zeta_33	EQ	0	0	0	0	0
zeta_23	EQ	0	0	0	0	0
zeta_13	BS	0	0	0	0	0
S1_1	BS	4.925264	0	0	NONE	0
S1_2	BS	4.964507	0	0	NONE	0
S1_3	BS	4.943339	0	0	NONE	0
S2_1	BS	0.317435	0	0	NONE	0
S2_2	BS	0.278192	0	0	NONE	0
S2_3	BS	0.29936	0	0	NONE	0
I1_1	LL	0	0	0	NONE	0

I1_2	LL	0	0	0	NONE	0
S1_4	BS	4.849161	0	3	7	0
I1_3	LL	0	0	0	NONE	0
I2_1	LL	0	0	0	NONE	0
I2_2	LL	0	0	0	NONE	0
S2_4	BS	0.320096	0	0	10	0
I2_3	LL	0	0	0	NONE	0

Vita

Craig S. Moore

Craig S. Moore was born on January 24, 1972 in Lexington, Virginia. He graduated third in his class from Natural Bridge High School in 1990. Upon graduation from high school, Craig entered Va. Tech and completed one semester of study. Due to health problems, Craig was compelled to withdraw from Va. Tech and work with his father's construction business. During this time, Craig also attended Virginia Western Community College and earned two degrees, an Associate in Applied Science degree in Civil Engineering Technology and an Associate in Science degree in Engineering. In 1994, Craig was able to return to Va. Tech and complete his undergraduate education. He received a Bachelor of Science degree in Civil Engineering in May of 1996. After graduation, Craig worked for The Lane Construction Corporation in Buena Vista, Virginia for seven months. In January of 1997, Craig returned to Va. Tech under the Geodetics/Hydrosystems division to study for a Masters of Science degree. During his time in graduate school, Craig worked as a project engineer for a local engineering firm for one year. He developed hands-on labs that integrated engineering and math for freshman calculus students in the SUCCEED program. Within the department, Craig served as a hydraulics teaching assistant and surveying lab instructor. He helped develop the new course CEE Measurements and served as lab instructor for two semesters and an instructor for three semesters. He has worked as a surveying consultant to the Transportation Research Group locating sensors on the Smart Road. Craig has also donated many hours to other graduate students assisting with such topics as GPS, GIS, surveying, and creating terrain models in AutoCAD for use in hydraulic analysis.

Craig is a member of the American Society of Civil Engineers, American Congress on Surveying and Mapping, American Society of Photogrammety and Remote Sensing, and Chi Epsilon.

Craig will receive his Master of Science degree in Civil Engineering in December of 2000.

Craig is married to the former Paula Jeanette Kiefer of Norfolk, Virginia, who is also a graduate of the Civil Engineering Department at Va. Tech.