INDIAN POINT FEASIBILITY STUDY

Prepared for

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EXECUTIVE SUMMARY

The scope of work was to determine the feasibility and cost of blasting rock for the excavation of the cooling towers for reactors number 2 and 3 and also blasting of the rock trenches for the placement of the new 12 foot diameter pipes for the closed loop cooling system.

The tentative blasting methods were determined and charge weights were calculated. The vibration levels were projected with information in similar rock types. The distances from the excavations to critical structures were determined and vibration levels were calculated at these structures.

Information in the FARC report indicated that the Indian Point 3 facility was built per requirements of the zone 2 of the Uniform Building Code i.e., corresponding to an intensity of VII on the Modified Mercalli Scale.

The maximum safe vibrations levels from blasting or other sources for the entire facility was considered to be no more than an earthquake of an intensity of VII on the Modified Mercalli Scale. The peak particle velocity range which corresponds to a Modified Mercalli Intensity of VII is between 3.5 inches per second to 6.3 inches per second.

A Mercalli Scale intensity of VII would produce a maximum peak particle velocity of about 6.3 inches per second. At a one hertz earthquake frequency this would produce a displacement of 1.114 inches, while a blast vibration producing the same peak particle velocity of 6.3 inches per second at a frequency of 50 hertz would produce a displacement of 0.020 inches. The earthquake ground displacement would be 315 times greater than that of blasting at the same particle velocity.

The review conducted of the past earthquake vibration standards at Indian Point, standards for weakly constructed residential structures, industrial structures, and 80 years of research data proves that blasting can be safely conducted at the reactor without any damage to the structure.

An extremely conservative vibration limit would be 2.0 inches per second which is the limit for residential structures. This vibration limit would protect the structures and allow construction at reasonable costs. According to the available data the reactor should be totally safe at **three times** this vibration limit if in fact it is built to withstand a Mercalli Intensity VII earthquake.

The following measurements were taken from the drawings for the construction of the large diameter pipe installations from the cooling towers. Blasting of trench rock costs $50/cubic yard. The $\$50/yd^3$ cost would cover the cost of all types of trench blasting on the project

The size of the trench needed for the four pipes would be 62 feet wide and 20 feet deep and 1722 feet long and equals 79,084 yd^3. The size of the trench needed for the two pipes would be 40 feet wide and 20 feet deep and 2500 feet long and equals 74,074 yd^3. The total volume of rock trench equals 153,158 yd^3. The total cost of trench blasting would be $7,657,900.

The volume of rock needed for excavation for the towers would be 1,946,842 yd^3 for the two towers. The cost of the excavation for the two cooling towers would be $7/cubic yard. The cost of the excavation for the towers is 1,946,842 yd^3 times $7.00 yd^3 equals $13,627,894.

The total cost of drilling and blasting would include the drilling and blasting cost, blasting consultant cost and seismic monitoring cost. These costs are listed below.

- Drilling and Blasting = $7,657,900 + $13,627,894 = $21,285,794
- Blasting Consultant = $500,000
- Seismic Monitoring Cost = $ 600,000

The total cost of excavation excluding the rock loading and haulage costs would be $22,385,794.

There are many different options for the disposal of the 2,100,000 yd^3 (bank) of rock which will be blasted. The rock can be placed on site, dumped into the ocean, sold to a quarry or crushed and sold from the site.

For the purpose of this study the ocean dumping cost is the highest and the only sure method of disposal since the rock quality is unknown at this time.

The state of New York and the State of New Jersey both are building artificial reefs off their shores. A permit would be needed from the Department of Environmental Conservation (DEC) to ocean dump rock from the Indian Point excavation. This should not be a problem because the DEC encourages the building of these reefs because they attract fish.

The cost of moving the rock from Indian Point to an artificial reef considers a round trip haul distance of 200 miles. Two 4000 yd^3 barges which hold 4500 tons would be provided as well as an ocean going tug boat. The blasted rock would be loaded into the barge by the construction company at Indian Point. The cost of digging the broken rock and the cost of moving the rock to the barge is not in the price. The cost to dump the 2,100,000 yd^3 of rock would be $18.90 per yd^3 or $39,690,000.

The total cost of drilling, blasting, and disposal (loading and haulage (on land) costs not included) would be $62,075,794 or $29.56 yd^3.

BLASTING FOR ROCK EXCAVATION AT INDIAN POINT

BACKGROUND

The scope of work was to determine the feasibility of blasting rock for the excavation of the cooling towers for reactors number 2 and 3 and also blasting of the rock trenches for the placement of the new 12 foot diameter pipes for the closed loop cooling system. The initial feasibility study considered the vibration levels generated by the blasting and determined whether the blasting could be done safely. The seismology information concerning the Indian Point site was obtained from the FSAR report.

The tentative blasting methods were determined and charge weights were calculated. The vibration levels were projected with information in similar rock types. The distances from the excavations to critical structures were determined and vibration levels were calculated at these structures.

The cost of excavating rock for placement of the cooling towers and associated trenches were determined as well as cost for disposal of the blasted rock.

VIBRATION STANDARDS FOR INDIAN POINT

Information in the FARC report indicated that the Indian Point 3 facility was built per requirements of the zone 2 of the Uniform Building Code i.e., corresponding to an intensity of VII on the Modified Mercalli Scale.

The maximum vibrations levels from blasting or other sources therefore for the entire facility will be considered for an earthquake of an intensity of VII on the Modified Mercalli Scale.

A previous study by Consolidated Edison of New York prepared in January 1976 Entitled "Economic and Environment Impact of Alternative Closed Cycle Cooling System" proposed a vibration limit of 1.0 inches per second peak particle velocity for blasting near operating reactors. The report also indicated that blasting was not uncommon at nuclear facilities with active reactors.

COMPARISON OF MERCALLI AND RICHTER SCALE

The strength of an earthquake is usually measured on one of two scales, the Modified Mercalli Scale and the Richter Scale. The Mercalli Scale is a rather arbitrary set of definitions based upon what people in the area feel, and their observations of damage to buildings around them. The scale goes from 1 to 12, using the descriptive titles of the intensity levels.

The Intensity Scale differs from the **Richter Magnitude Scale** in that the effects of any one earthquake vary greatly from place to place, so there may be many **Intensity** values (e.g.: **IV, VII**) measured for the same earthquake. Each earthquake, on the other hand, should have only one **Magnitude**, although the various methods of calculating it may give slightly different values (e.g.: **4.5, 4.6**). The Richter Scale is designed to allow easier comparison of earthquake magnitudes, regardless of the location.

C.F. Richter was a geologist living and working in California, U.S.A, an area subjected to hundreds of earthquakes every year. He took the existing Mercalli scale and tried to add a 'scientific' scale based on accurate measurements that could be recorded by seismographs (instruments used to measure vibration) regardless of their global location.
By measuring the speed, or acceleration, of the ground when it suddenly moves, he devised a scale that reflects the 'magnitude' of the shock.

The Richter scale for earthquake measurements is logarithmic. This means that each whole number step represents a ten-fold increase in measured amplitude. Thus, a magnitude 7 earthquake is 10 times larger than a 6, 100 times larger than a magnitude 5 and 1000 times as large as a 4 magnitude.

This is an open ended scale since it is based on measurements not descriptions. An earthquake detected only by very sensitive people registers as 3.5 on his scale, while the worst earthquake ever recorded reached 8.9 on the 'Richter Scale'.

Magnitude is a measure of the strength of an earthquake or strain energy released by it, as determined by seismographic observations.

Intensity is a measure of the effects of an earthquake at a particular place on humans, structures and (or) the land itself. The intensity at a point depends not only upon the strength of the earthquake (magnitude) but also upon the distance from the earthquake to the point and the local geology at that point.

There is no direct mathematical relationship between the Mercalli and Richter scale. Scientific observations have been able to make comparisons based on the results and effects. Table 1. shows a comparison of Mercalli Scale and Richter Scale values based on results and effects.

There is no direct general mathematical relationship between Richter scale and peak particle velocity. If some parameters are fixed then peak particle velocity can be calculated for Richter Scale values. The particle velocities are compared for different Richter Scale values in Table 1..

TABLE 1. COMPARISON OF MERCALLI SCALE AND RICHTER SCALE

MERCALLI SCALE	RESULTS AND EFFECTS	PPV at 1 Hz	RICHTER SCALE
I	Not noticeable by most humans	0.002 to 0.35	-1 to 3.5
II	Hangings objects sway, noticed by few people	0.35 to3.5	3.5 to 5.4
III	Many people feel movement	0.35 to3.5	3.5 to 5.4
IV	Doors windows shelves rattle	0.35 to3.5	3.5 to 5.4
V	Light fixtures move, pictures fall of walls, objects fall from shelves	0.35 to3.5	3.5 to 5.4
VI	Light furniture falls over, windows may crack, trees sway	0.35 to3.5	3.5 to 5.4
VII	Some people fall over, walls may crack	3.5 to 6.3	5.4 to 6.0
VIII	Heavy furniture falls over, some walls may crumble, chimneys fall	7.0 to 17.7	6.1 to 6.9
IX	Some buildings collapse, dams crack,	19.9 to 56	7.0 to 7.9
X	Most buildings damaged, roads crack, railroad tracks bend	Above 62.8	Over 8.0
XI	Bridges collapse, buried pipes break, most buildings collapse	Above 62.8	Over 8.0
XII	All manmade structures are destroyed, total destruction	Above 62.8	Over 8.0

From the three seismic wave parameters; displacement, acceleration, velocity, the velocity is the most closely related to energy and damage potential. This is the reason that the blasting industry uses particle velocity as the indicator for damage to structures.

FACTORS AFFECTING BLAST VIBRATION

PRINCIPAL FACTORS

There are two principal factors that affect the vibration level that results from detonation of an explosive charge. These are distance and charge size. Common sense indicates that it is safer to be far away from a blast than to be near it. Common sense further indicates that a large explosive charge will be more hazardous than a small charge.

CHARGE - DISTANCE RELATIONSHIP

Extensive research has been conducted to determine the mathematical relationship between vibration level, charge size, and distance. The U.S. Bureau of Mines Bulletin 656 (Nichols, Johnson and Duvall, 1971) states such a relationship. The relationship is:

$$V = H\left[\frac{D}{W^{\alpha}}\right]^{\beta}$$

where:

V = Predicted particle velocity (in/s)
W = Maximum explosive charge weight per delay (lbs)
D = Distance from shot to sensor measured in 100's of feet (e.g., for distance of 500 feet., D=5)
H = Particle velocity intercept
α = Charge weight exponent
β = Slope factor exponent

This is known as the Propagation Law because it shows how the particle velocity changes with distance and explosive charge weight. The numerical values for H α and β are slightly different for each component. For the longitudinal or radial component, the law is numerically expressed as:

$$V_r = 0.052\left(\frac{D}{W^{0.512}}\right)^{-1.63}$$

Introducing the following approximations:

$\alpha = 0.512 \cong 0.5$
$\beta = -1.63 \cong -1.6$

Expressing D in feet instead of hundreds of feet produces a simplified approximation for this relationship:

$$V = 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

where:

D = Distance from shot to sensor (ft)
W = Maximum explosive charge weight per delay (lbs)

The Dupont Blaster's Handbook (E.I. Dupont de Nemours & Co., 1977) gives the following relationship:

$$V = 160\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

ESTIMATING PARTICLE VELOCITY

The formulas enable one to estimate the particle velocity likely to result from the detonation of a given charge weight of explosive at a given distance. Obviously the Dupont formula will give a higher value for the expected particle velocity. From this, it can be seen that these formulas serve merely as guides, and only give ballpark figures.

The values of a, b an d H are determined by conditions in the area, rock type, local geology, thickness of overburden and other factors. The values of $\alpha = 0.5$ and $\beta = 1.6$ are fairly well fixed. The value of H is highly variable and is influenced by many factors.

CHARGE WEIGHT, DISTANCE EFFECTS

To illustrate the effect of charge weight and distance, two graphs are presented, one for charge weight vs. particle velocity, the second for distance vs. particle velocity, consider:

$$V = 100\left[\frac{d}{\sqrt{W}}\right]^{-1.6} = 100\frac{W^{0.8}}{d^{1.6}}$$

The above equation is useful in determining vibration levels that would occur at different distances and charge weights from the blast. This equation can be written in a different manner that will help predict the charge weight based on a certain vibration level that we would like to maintain as a maximum value. The equation would be written as follows:

$$W = d^2\left[\frac{V}{H}\right]^{1.25}$$

where:

W = Charge weight per delay (lbs/delay)
H = 100

d = Distance (ft)
V = Vibration level

Assuming a charge W produces a particle velocity V at a distance, d, in the equation. Then by letting W vary in multiples, 2W, 3W, etc., for the fixed value of d, the relative values of V are plotted against charge weight in Figure 1.

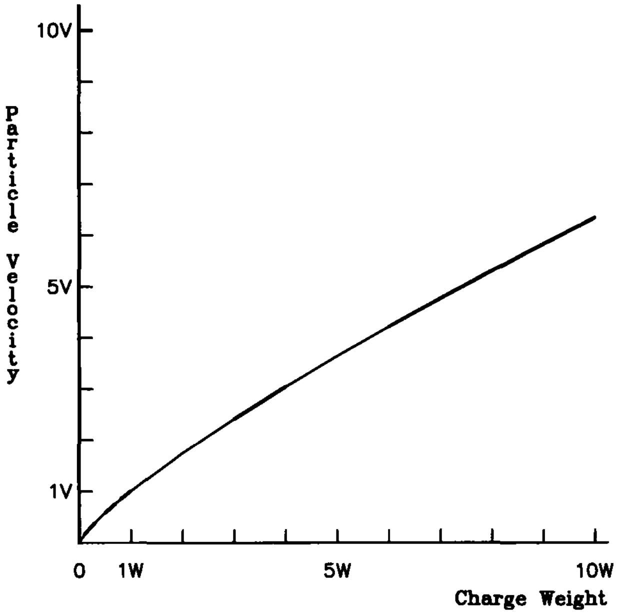

Figure 1. Relative Particle Velocity vs. Charge Weight

Similarly, assuming a charge W produces a particle velocity V at a distance d then by letting the distance increase in multiples 2d, 3d, etc., for a fixed value of W, the relative values of V can be computed. The relative values of V are plotted against distance in Figure 2.

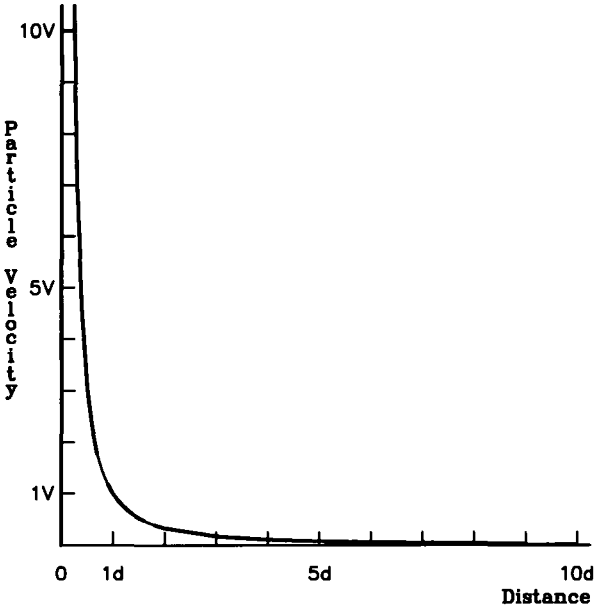

Figure 2. Particle Velocity vs. Distance Relationship

These graphs illustrate the effects produced, but a numerical example will be helpful. Consider the following questions:

Question: If the charge weight is doubled, how much will the particle velocity increase?

Using:

$$V_1 = 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

Calculate:

$$V_2 = 100\left(\frac{d}{\sqrt{2W}}\right)^{-1.6}$$

$$V_2 = 100\left(\frac{d}{1.41\sqrt{W}}\right)^{-1.6}$$

$$V_2 = 1.41^{1.6}100\left[\frac{d}{\sqrt{W}}\right]^{-1.6}$$

$$V_2 = 1.41^{1.6}V_1 = 1.74V_1$$

Answer: Doubling the charge weight increases the particle velocity 1.74 times. (Note: It is <u>not</u> double!)

Question: If the charge weight is cut in half, how much will the particle velocity decrease?

Using:

$$V_1 = 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

Calculate:

$$V_2 = 100\left(\frac{d}{\sqrt{\frac{W}{2}}}\right)^{-1.6}$$

$$V_2 = 100\left(\frac{d}{\frac{1}{1.41}\sqrt{W}}\right)^{-1.6}$$

$$V_2 = \frac{1}{1.41^{-1.6}}100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

$$V_2 = \frac{1}{1.74} = 0.57V_1 \cong 0.6V_1$$

Answer: Cutting the charge weight in half will decrease the particle velocity to six tenths its original value. (Note: It is <u>not</u> cut in half!)

Question: If the distance is doubled, how much will the particle velocity decrease?

Using:

$$V_1 = 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

Calculate:

$$V_2 = 100\left(\frac{2d}{\sqrt{W}}\right)^{-1.6}$$

$$V_2 = 2^{-1.6}100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

$$V_2 = \frac{1}{2^{1.6}}V_1 = 0.33V_1$$

Answer: If the distance is doubled, the particle velocity is reduced to one third of its original value. (Note: It is not cut in half!)

Question: If the distance is cut in half, how much will the particle velocity increase?

Using:

$$V_1 = 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

Calculate:

$$V_2 = 100\left(\frac{\frac{d}{2}}{\sqrt{W}}\right)^{-1.6}$$

$$V_2 = 2^{1.6} 100\left(\frac{d}{\sqrt{W}}\right)^{-1.6}$$

$$V_2 = 2^{1.6} V_1 = 3.03V_1 \cong 3V_1$$

Answer: If the distance is cut in half, the particle velocity will be tripled. (Note: It is not doubled!)

VIBRATION CONTROL

The operator would like to have a convenient, effective means of vibration control. The formulas just discussed are a means to such control, and have led to the development of other techniques.

DELAY BLASTING

Before discussing these techniques, delay blasting should be considered. With the development of the delay cap, particularly millisecond delays, a method came into play by which a large explosive charge could be detonated as a series of small charges, rather than one large charge. Obviously, the reduction in charge size can be made by the use of multiple delays. For example, the use of ten delays would reduce the effective vibration generating charge to one tenth the original charge.

Consider the following example:

A shot consists of 40 holes, 250 lbs. of explosive per hole with a total charge of 10,000 lbs. and is fired instantaneously. The probable vibration level can be calculated at a distance of 1,000 feet.

①①①①① ①①①①① ①①①①① ①①①①①

①①①①① ①①①①① ①①①①① ①①①①①

40 Holes Fired Instantaneously

$$V = 100\left(\frac{1000}{\sqrt{10000}}\right)^{-1.6} = 2.51 \text{ in/s}$$

This is a dangerously high particle velocity, two delays were introduced to reduce the vibration level. This divided the shot into two series or parts of 20 holes each, with 5,000 lbs. per delay.

MS2 ②②②②② ②②②②② ②②②②② ②②②②②

MS1 ①①①①① ①①①①① ①①①①① ①①①①①

20 Holes Fired Per Delay

$$V = 100\left(\frac{1000}{\sqrt{5000}}\right)^{-1.6} = 1.44 \text{in} / \text{s}$$

If two more delays MS3 and MS4 were introduced, reducing the number of holes per delay to 10 and the charge per delay to 2,500 lbs., the probable particle velocity can be calculated.

MS3 ③③③③③ ③③③③③ ④④④④④ ④④④④④ MS4

MS1 ①①①①① ①①①①① ②②②②② ②②②②② MS2

10 Holes Fired Per Delay

$$V = 100\left(\frac{1000}{\sqrt{2500}}\right)^{-1.6} = 0.83\text{in}/\text{s}$$

Thus a significant reduction in vibration level can be achieved by the use of delays. Why does delay blasting reduce vibration? The answer is fairly simple, but to understand it one must understand the difference between particle velocity and propagation velocity.

PROPAGATION VELOCITY VS. PARTICLE VELOCITY

Propagation velocity is more familiar. It is the speed at which a seismic wave travels through the earth from shot to sensor and beyond. The general range of values is from 1,000 to 20,000 ft/s. For a given area, the value is approximately constant.

Particle velocity is quite different. A rock particle vibrates in an elliptical orbit around a rest position. A simple example of particle motion and velocity is the motion of a fisherman in a boat. A passing speedboat generates a wave that passes under the fisherman, causing his boat to oscillate up and down. This is a particle motion. The speed at which it oscillates is particle velocity. Particle velocity is measured in inches per second (in/s) and is the parameter measured by the seismograph.

Delay blasting works or reduces the ground vibration because the seismic wave generated by one delay has traveled a considerable distance due to its propagation velocity before the next delay has fired. The second seismic wave travels at the same propagation velocity as the first and can never catch up to the first. So the seismic waves or vibrations are separated. The following Figure 3 illustrates the process.

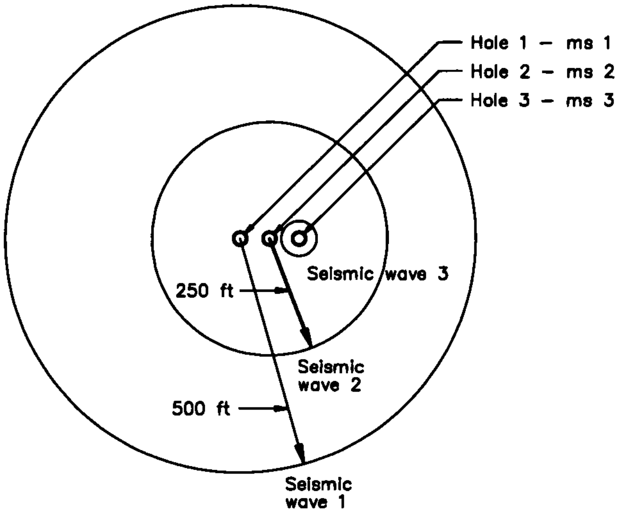

Figure 3. Seismic Waves from Delay Blasting

PARTICLE VELOCITY - SCALED DISTANCE GRAPH

This method involves seismic measurement in addition to calculating the scaled distance values from the blast data. Scaled distance is defined as actual distance in feet by the square root of the pounds of explosives fired per delay.

Data is then plotted on log-log graph paper with particle velocity on the vertical axis and scaled distance on the horizontal axis. To be effective, there must be a spread of data from low to high values. This can be accomplished fairly simple by placing the seismograph at increasingly greater distances on successive shots.

Plot the data on the graph, one point for each particle velocity-scaled distance pair. When all the points are plotted, a straight line or envelope should be drawn on the graph so that all the points are below the line. A reasonably accurate eyeball fit is sufficient (Figure 4).

After the data is plotted and the envelope line drawn in, a working value of scaled distance can be read off the graph using this procedure. Start on the particle velocity scale at the specified regulatory particle velocity, e.g., 1.0 in/s. Draw a line horizontally across the graph until it intersects the envelope line. At the point of intersection, drop a vertical line down to the scaled distance axis. The point at which it touches the scaled distance axis is the working value for scaled distance. This value will insure that particle velocities generated by blasting will be less than 1.0 in/s.

If the regulatory value for particle velocity is different from 1.0 in/s, like 2.0 in/s or 0.5 in/s, then start at the proper value and proceed in the same way in Figure 4.

TABLE 2 VIBRATION DATA

SHOT	DISTANCE (d)	CHARGE WEIGHT (W)	$\sqrt{W}$	SCALED DISTANCE (Ds)	PARTICLE VELOCITY
1	275	406	20.15	13.65	1.74
2	385	348	18.65	20.64	0.72
3	590	291	17.06	34.59	0.34
4	790	286	16.91	46.71	0.21
5	1060	362	19.03	55.71	0.17

The working value for scaled distance read from the graph is Ds = 19. This value can now be used to calculate charge weights and distances that will produce vibration levels less that 1.0 in/s.

For either the average method or the particle velocity-scaled distance method, an on-going addition of data as it occurs should be made. The square dot represents a shot that produced an undesirably high particle velocity due to propagation, cap scatter, bad drilling control, overloading the hole or whatever the cause. The high vibration shows up above the envelope line. Thus, the operator can take immediate steps to control the vibration. Also, a safety factor should be added to the adjusted Ds value. If the adjusted value is 19, then use a value of 23 or 25 as a safety factor.

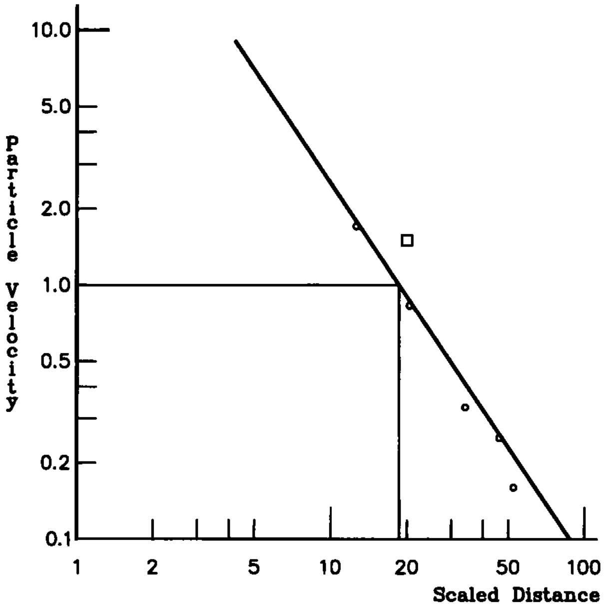

Figure 4. Particle Velocity vs. Scaled Distance

GROUND CALIBRATION

Ground calibration should be done when entering a new area or starting a new project. The two principal factors that affect vibration level are charge weight and distance. In addition, rock type, rock density, presence or absence of rock layering, slope of layers, nature of the terrain, blasthole conditions, presence or absence of water, all combine to influence the transmission of vibration. The simplest way to evaluate these factors is by observation of the vibration levels generated. This is called ground or area calibration.

Ground or area calibration can be accomplished by a scaled distance-particle velocity plot on log-log graph paper using data from a series of blasts as discussed previously. A minimum number of five shots will serve as a starter with more data added as additional shots are fired and recorded. The method synthesizes the many factors affecting vibration transmission and enables the operator to determine a safe working value for the scaled distance. Once the scaled distance is adequately determined, all shots should generate vibration levels less than the corresponding particle

GROUND CALIBRATION IN TRAPROCK (DIABASE)

Figure 5. is a site specific ground calibration in rock similar to that at Indian Point. The line on the graph is the ground vibration prediction line using the US Bureau formula. The 95% confidence line is the site specific prediction equation generated from actual data. (Appendix 1)

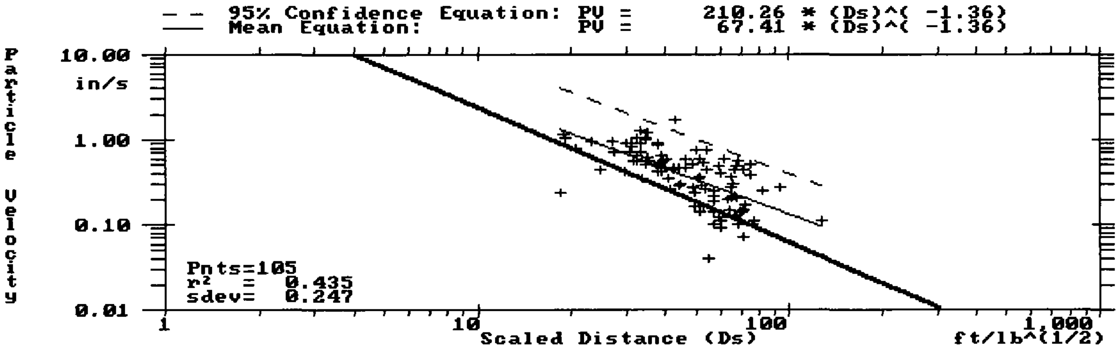

Figure 5. Site Specific Prediction Equation for Diabase

The prediction equation from Figure 5. can also be used to predict different charge weights for specific vibration levels at different distances. Table 3. shows the charge weight which can be used at different distances to produce specific amounts of vibration(PPV).

The pounds of explosive which can be fired per delay to generate specific maximum vibration levels (PPV) is shown for difference distances in table 2. These values were calculated using the propagation equation from figure 5.

TABLE 3. CHARGE WEIGHT /DELAY , PPV AT SPECIFIED DISTANCES

DISTANCE (FT)	PPV=0.25 IPS	PPV=0.50 IPS	PPV=1.0 IPS	PPV=2.0IPS
330	5.3 lb	14 lb	41 lb	114 lb
960	45 lb	124 lb	346 lb	962 lb
1660	134 lb	372 lb	1035 lb	2880 lb

TENTATIVE BLASTING PATTERN

A tentative blast design was prepared to determine the actual amount of explosive which would be used in the blasts. The design consisted of three-inch diameter blastholes drilled on a bench 25 feet high (Appendix 2). An explosive load of 48 pounds would be used per blasthole when blasting at distances greater than 350 ft from protected structures. At distances of less than 350 ft. blastholes can be deck loaded. All holes/charges would be independently delayed.

The anticipated maximum vibration utilizing this blast design for the trenches and the cooling towers would produce a maximum vibration (PPV) at the nuclear reactors as shown in Table 4. Blasting for the cooling towers would be 960 feet from the reactors at their closest point. The maximum anticipated vibration from blasting for the cooling towers is 0.26 inches per second. The 0.26 inches per second is 13% of the safe limit for residential structures. There is no possibility of any damage to any structure at Indian point at these vibration levels.

TABLE 4. PROJECTED VIBRATION (PPV) AT DIFFERENT DISTANCES

DISTANCE (FT)	CHARGE WEIGHT (LB)	PPV (IN/SEC)
330	24	0.70
960	48	0.26
1660	48	0.12

VIBRATION STANDARDS

The present vibration standards are the result of more than eighty years of research and investigation by concerned scientists. Houses, residential structures, are the weakest type of construction and those of most concern by the average person. Industrial structures are stronger and can tolerate higher vibration levels. Nuclear reactors are built stronger than most industrial structures

Vibration standards for residential structures will be discussed since they are the weakest structure for which mountains of vibration data exist. Vibration standards and limits are placed on residential structures by government agencies which have regulatory authority. The first significant investigation on residential structures was initiated by the U.S. Bureau of Mines in 1930, and culminated in 1942 with publication of Bulletin 442, Seismic Effects of Quarry Blasting. This and other programs will be briefly described.

Thoenen and Windes. Seismic Effects of Quarry Blasting U.S. Bureau of Mines, Bulletin 442, 1942.

Acceleration Index
Safe zone - less than 0.1 g
Caution zone - between 0.1 and 1.0 g
Damage zone - greater than 1.0 g

Crandell, F. J. Ground Vibration Due to Blasting and Its Effect Upon Structures. Journal of the Boston Society of Civil Engineers, 1949.

Energy Ratio Index $$\mathrm{ER} = \left(\frac{a}{f}\right)^2$$

where:

a = Acceleration (ft/s^2)
f = Frequency (Hz)

Safe zone = ER less than 3
Caution zone = ER between 3 and 6
Damage zone = ER greater than 6

Energy Ratio has the dimension of velocity and an ER = 1 is equivalent to a particle velocity = 1.9 in/s

Langefors, Westerberg and Kihlstrom. Ground Vibration in Blasting, Parts I-III, Water Power, 1958.

Velocity Index		
No damage	-	less than 2.8 in/s
Fine cracks	-	4.3 in/s
Cracking	-	6.3 in/s
Serious cracking	-	9.1 in/s

Edwards and Northwood. Experimental Blasting Studies on Structures. National Research Council. Ottawa: Canada, 1959.

Velocity Index		
Safe zone	-	Less than 2.0 in/s
Damage	-	4.0 to 5.0 in/s

Nichols, Johnson and Duvall, Blasting Vibration and Their Effects on Structures. U. S. Bureau of Mines, Bulletin, 656, 1971.

Velocity Index		
Safe zone	-	less than 2.0 in/s
Damage zone	-	greater than 2.0 in/s

In addition to the Bureau's own work, Bulletin 656 is also a synthesis of the work of the number of other investigators. Particle velocity is considered to be the best measure of damage potential. The safe vibration criterion was specified in Bulletin 656 as follows:

The safe vibration criterion is based on the measurement of individual components, and if the particle velocity of any component exceeds 2 in/s damage is likely to occur.

Damage means the development of fine cracks in plaster. Very quickly the particle velocity, 2 in/s, became known as the Safe Limit. Many regulations were and continue to be still based on this value. Additional levels of vibration based on the results of other investigations used in Bulletin 656 are the following:

Threshold of damage (4 in/s)
    opening of old cracks
    formation of new cracks
    dislodging of loose objects

Minor damage (5.4 in/s)
    fallen plaster
    broken windows
    fine cracks in masonry
    no weakening structure

Major damage (7.6 in/s)
    large cracks in masonry
    shifting of foundation-bearing walls
    serious weakening of structure

The major damage zone correlates reasonably well with the beginning damage level for natural earthquakes.

RECENT DAMAGE CRITERIA

In 1980, the U.S. Bureau of Mines reported on its most recent investigation of surface mine blasting in R.I. 8507 (Siskind, et al). Structural resonance responding to low frequency ground vibration, resulting in increased displacement and strain, was found to be a serious problem.

This reintroduced the dependence of damage on frequency. Prior to this, the safe limit particle velocity was independent of frequency. Also, measurements were made inside structures rather than just by ground measurements. Inside measurement seems quite reasonable and logical, but data from previous investigations of structural vibration yielded very poor results, hence, the emphasis on ground measurement.

The threshold of damage used in RI 8507 was specified as cosmetic damage of the most superficial type, of interior cracking that develops in all homes, independent of blasting.

The safe vibration level was defined as levels unlikely to produce interior cracking or other damages in residences.

Safe vibration levels as specified in RI 8507 are given in Table 5. These criteria are based on a 5% probability of damage.

TABLE 5. SAFE PEAK PARTICLE VELOCITY FOR RESIDENTIAL STRUCTURES
(RI 8507)

TYPE OF STRUCTURE	f < 40 Hz	f > 40 Hz
Modern homes - drywall interiors	0.75 in/s	2 in/s
Older homes - plaster on wood lath for interior walls	0.50 in/s	2 in/s

These safe vibration levels represent a conservative approach to damage and have been the subject of intense criticism by the blasting industry.

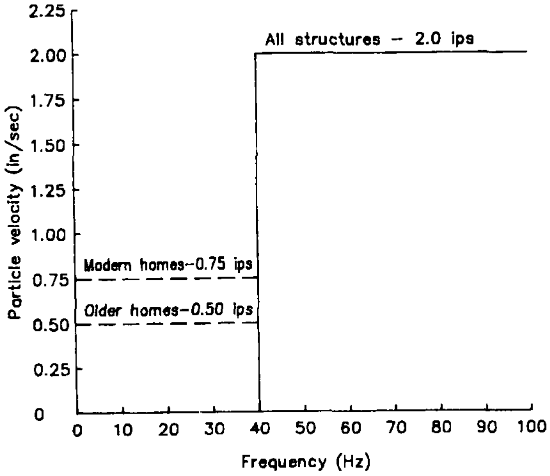

Figure 5. Safe Vibration Levels (RI 8507)

ALTERNATIVE BLASTING CRITERIA

RI 8507 also proposed alternative blasting criteria using a combination of displacement and velocity criteria applied over several frequency ranges. These alternative criteria are shown in Figure 6.

These criteria using both displacement and velocity over respective frequency ranges have not been accepted by all concerned. Instrumentation will need frequency reading capability in addition to the capability of reading both displacement and velocity in order to cover all ranges. This indicates the state of flux in which the question of safe vibration standards existed, which still exists today.

The problem is associated with the concept of what really constitutes vibration damage. The most superficial type of cracking advocated in RI 8507, while not to be condoned, is scarcely a realistic guide for control.

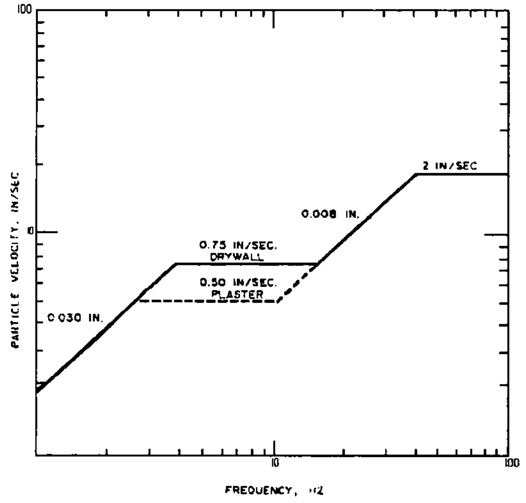

Figure 6. Alternative Blasting Level Criteria Source: RI 8507, U.S. Bureau of Mines

An important consideration to be noted is that there probably is no lower limit beyond which damage will not occur, since there will always be structures at the point of failure due to normal environmental stresses. It is not unusual to read of a structure collapsing for no apparent reason.

In RI 8896, (1984), "Effects of Repeated Blasting on a Wood-Frame House" U.S. Bureau of Mines, it indicates that cosmetic cracks occurred during construction of a test house and also during periods when no blasts were detonated. It was further noticed that human activity, temperature, and humidity changes caused strains equivalent to ground particle velocity of 1.2 in/s to 3.0 in/sec.

VIBRATION EFFECTS

Cracks produced in structures by natural earthquakes, which are low intensity effects, have a characteristic pattern called the X - crack or vibration crack. These cracks result from the fact that the top of a structure, due to its inertia, lags behind. The structure is deformed from a regular rectangular shape into a parallelogram, with one of its diagonals elongated and the other compressed. If the elongation exceeds the strength of the material, it will fail producing a tension crack. As the earth vibration reverses, the same thing will occur in reverse, with the opposite diagonals being elongated and compressed with the possible formation of another tension crack. When both cracks occur they form an X - crack pattern. Figure 7. illustrates the process. If it occurs, the X - crack pattern is most likely to be associated with large blasts.

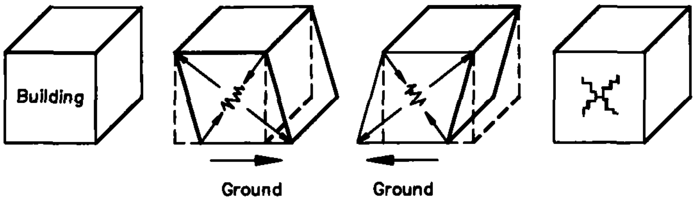

Figure 7. Vibration X - Crack Pattern

DIRECTIONAL VIBRATIONAL EFFECTS

The energy that moves out from the source of the blast, measured in terms of ground vibration and peak particle velocity, moves out in all directions from the source. If the ground would transmit vibration in the same manner in all directions and if all other factors remain constant, then theoretically at the same distance in any direction from a blast, the vibration levels would be equal. Unfortunately, on true job conditions, vibration transmission is not ideal and because of changes in the earth structure, vibration is transferred differently in different directions. The geologic structure, joints and faults, will change vibration levels and frequency in different directions of the source. Other factors dealing with blasting pattern design can also contribute to these directional vibration effects.

In the past, it was common practice to monitor behind the blast at the nearest structure since it was assumed that in this direction vibration levels would be greatest. Recommendations for monitoring practice have changed and research has shown that the highest vibration levels are commonly, not behind the shot, but to the sides of the blast. In particular, vibration levels are commonly highest in the direction towards which the delays are progressing. For example, if a blast is fired with the first hole on the left hand side of the pattern and the delays are progressing toward the right hand side of the pattern, then in the direction toward the right hand side of the pattern one would commonly find the highest vibration levels.

In order to calibrate the ground and determine site specific transmission characteristics, it is recommended that at least two seismographs be used when blasting in close proximity to structures. One seismograph placed on the end of the shot and one at 90 degrees. For example, behind the blast. After test shooting is completed and the transmission characteristics are known, the second seismograph may be unnecessary since the ground has already been calibrated and vibration levels in one direction can be related to vibration levels in the other direction.

FREQUENCY WAVE LENGTH EFFECTS

When a line of increased motion occurs, what are its dimensions and how large an area is affected? It will cover a space of the order of one to two wavelengths. Wavelength is defined as propagation velocity multiplied by the wave period

$$L = VT$$

where:

L = Wavelength (ft)
V = Propagation velocity (ft/s)
T = Wave period (s)

For a wave of period 1/10 sec and propagation velocity 2,000 ft/s, the wavelength is 200 feet.

Assuming the waves are approximately the same (Fig. 8.), at maximum coincidence the motion would be doubled but the wave length will be that of either wave since they are the same (Figure 9.).

Figure 8. Converging Equal Wavelets

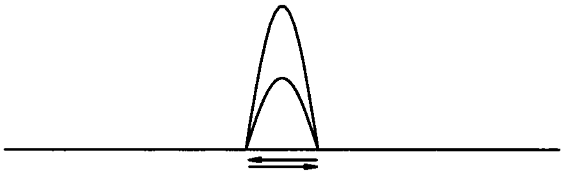

Figure 9. Composite Wave Motion at Maximum Coincidence

This form will be repeated after the maximum has occurred when the waves pass complete coincidence and begin to separate each into its own distinct form. Thus, there is a periodicity whose wavelength approaches the sum of the two wavelengths. Also, the wavelength of the composite motion varies from a single wavelength to approximately double the single wavelength. The converging and diverging wavelets are shown in Figure 10. and the resulting composite motion is shown in Figure 11.

The wave period and the frequency are both effected. At the point of maximum coincidence the period and frequency are those of the single wave. Since the period may approach double that of a single wave, the frequency will be cut approximately in half.

The significant points here are that they can exist.

1. A region of increased seismic motion and hence increased peak particle velocity with maximum at the center, minimum at the edges of the resultant combined waves.

2. The region in which this occurs, the order of two wave lengths wide approximately 400 to 800 feet depending on propagation velocity and wave period.

3. Wave periods will be increased to approximately double with a corresponding lowering of the frequency to half.

4. A region of high-seismic risk because of the increased motion and reduced frequency of vibration.

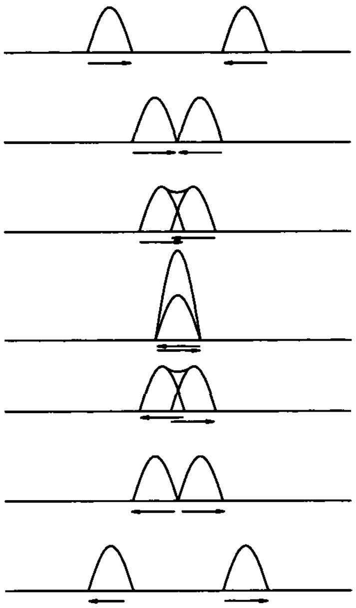

Figure 10. Converging and Diverging Wave Interaction

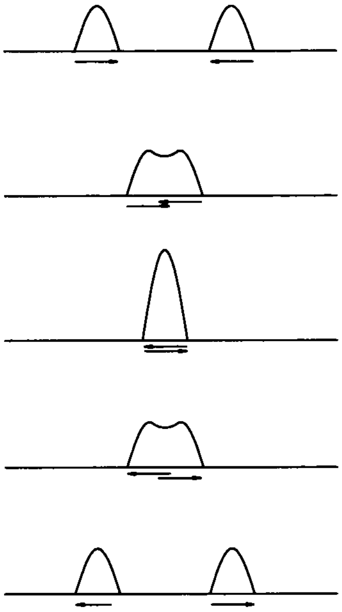

Figure 11. Composite Motion

NON-DAMAGE EFFECTS

Damage producing vibration seldom occurs, but many other effects occur that are disconcerting and alarming to persons who feel and hear the vibration. Some of these effects are:

- Walls and floors vibrate and make noise.
- Pipes and duct work may rattle.
- Loose objects, plates, etc., may rattle.
- Objects may slide over a table or shelf, and may fall off.
- Chandeliers and hanging objects may swing.
- Water may ripple and oscillate.
- Noise inside a structure is greatly amplified over noise outside.
- Vibration is very disturbing to occupants.

CAUSES FOR CRACKS OTHER THAN BLASTING

Cracking is a normal occurrence in the walls and ceilings of structures, and the causes are multiple, ranging from poor construction to normal environmental stress, such as thermal stresses, wind, etc. The Small Home, published by the Architects Small House Service Bureau of the United States, Inc. 1925, gave a list of reasons for the development of cracks, which included the following:

- Building a house on a hill.
- Failure to make the footings wide enough.
- Failure to carry the footings below the frost line.
- Width of footings not made proportional to the loads they carry.
- The posts in the basement not provided with separate footings.
- Failure to provide a base raised above the basement floor line for the setting of wooden posts.
- Not enough cement used in the concrete.
- Dirty sand or gravel used in the concrete.
- Failure to protect beams and sills form rotting through dampness.
- Setting floor joists one end on masonry and the other end on wood.
- Wooden beams used to support masonry over openings.
- Mortar, plaster, or concrete work allowed to freeze before setting.
- Braces omitted in wooden walls.
- Sheathing omitted in wooden walls (excepting in "back- plastered" construction).
- Drainage water from roof not carried away from foundations.
- Floor joists not bridged.
- Supporting posts too small.
- Cross beams too light.
- Sub-flooring omitted.
- Wooden walls not framed so as to equalize shrinkage.
- Poor materials used in plaster.
- Plaster applied too thin.

- Lath placed to close together.
- Lath run behind studs at corners.
- Metal reinforcement omitted in plaster at corners.
- Metal lath omitted where wooden walls join masonry.
- Metal lath omitted on wide expanses of ceiling.
- Plaster applied directly on masonry at chimney stack.
- Plaster applied on lath that is too dry.
- Too much cement in the stucco.
- Stucco not kept wet until set.
- Subsoil drainage not carried away from walls.
- First coat of plaster not properly keyed to backing.
- Floor joists placed too far apart.
- Wood beams spanned too long between posts.
- Failure to use double joists under unsupported partitions.
- Too few nails used.
- Rafters too light or too far apart.
- Failure to erect trusses over wide wooden openings.

* Published in Monthly Service Bulletin 44 of the Architects' Small House Service Bureau of the United States, Inc.

BLAST DESIGN TO REDUCE VIBRATION LEVELS

When vibration levels are too high and it becomes desirable and even necessary to reduce them, there are a number of options.

CHARGE REDUCTION

The maximum charge per delay may be reduced by decreasing the number of holes per delay. If the number of holes per delay cannot be reduced then it may be possible to deck load and fire each hole with two or more delays.

BLAST DESIGN

The vibration level can be reduced by redesigning the blast so that less energy per hole is necessary to fragment the rock. This may require changing the hole spacing, the burden and even the hole size. A change in explosive may be helpful also. This requires going back to square one and starting over. This is an extreme circumstance and not likely to be necessary.

BLASTING STANDARD FOR NON-RESIDENTIAL STRUCTURES

Vibration standards can be divided into two other groups in addition to the normal building standards, high level vibration structures and low level vibration sensitive components.

BLASTING NEAR CONCRETE STRUCTURES

On many demolition projects, old concrete is near the blasting operation. In fact, it is not uncommon to blast away part of a structure, leaving the other structure intact. This is a common procedure when locks along rivers need to be refurbished. When locks become eroded due to the water and the environmental conditions, approximately two feet of old concrete is blasted away and new concrete is poured in its place. It is obvious that the concrete that remains from the original structure has been subjected to very high peak particle velocity. Oriard measured values of strain and peak particle velocity that produced various types of failure in concrete. His results are given in Table 6.

TABLE 6. FAILURE IN CONCRETE DUE TO VIBRATION

TYPE	STRAIN (μin/in)	PPV (in/s)
Static	140	20
Grout Spall	700	100
Skin Spall	1300	200
Cracking	2400	375

GREEN CONCRETE

Concrete and bridges fall into the high level vibration structures. Green concrete, however, is not in this group. Different types of concrete exist. Therefore, general conservative guidelines for concrete may be given. Since concrete acquires about one third its strength in 72 hours, after this time a peak particle velocity of 1.0 in/s is a reasonable maximum until the concrete reaches full strength at 28 days. Before 72 hours it is not advisable to blast.

BLASTING NEAR GREEN CONCRETE

It is not uncommon to have blasting operations in one section of a project and the pouring of concrete in another. Contractors do have concern as to what effect the blasting vibration has on the integrity of the new structure being poured. Some guidelines for peak particle velocities related to time after pouring are given in Table 7.

TABLE 7. VIBRATION LEVELS FOR GREEN CONCRETE

TIME AFTER POUR (HOURS)	PPV (in/s)
0 - 4 Hours	2.00

4 - 24	Hours	0.25
1 - 3	Days	1.00
3 - 7	Days	2.00
7 - 10	Days	5.00
> 10	Days	10.00

SENSITIVITY TO VIBRATION

Human beings are remarkably sensitive to vibration. If this were not so, the vibration problem would scarcely exist. The explosive technology of today insures that most operations are conducted in a safe manner. In relatively few cases is there a significant probability of damage.

Since vibration is felt in practically all cases, the reaction to this sensation is one of curiosity, concern, and even fear. Hence, it is important to understand something about human response to vibration that depends on vibration levels, frequency and duration. In addition to these physical factors, it is important to keep in mind that human response is a highly subjective phenomenon.

Human response has been investigated by many researchers. One of the early investigations was by Reiher and Meister, Berlin, 1931. Other investigations were made by Goldman, 1948, and Wiss and Parmelee, 1974. A composite of these investigators' results was presented graphically in the U. S. Bureau of Mines RI 8507, Siskind, et al, 1980. This composite is represented here in Figure 12.

The human response curves are all similar and highly subjective in that the response is a mixture of physiological and psychological factors individual to each person. Based on these curves, a very simple and practical set of human responses can be designated as shown in Figure 8.

TABLE 8. HUMAN RESPONSE

RESPONSE	PARTICLE VELOCITY	DISPLACEMENT AT 10 Hz	DISPLACEMENT AT 40 Hz
Noticeable	0.02 in/s	0.00032 in	0.00008 in
Troublesome	0.2 in/s	0.0032 in	0.0008 in
Severe	0.7 in/s	0.011 in	0.0028 in

Vibration is a fact of daily life, which one regularly experiences but is seldom aware of. This type of vibration has been designated cultural vibration. Generally, it elicits no reaction from the person affected.

Other vibration that contrasts sharply, because it is not part of the daily experience but is unusual, has been designated A-cultural. It surprises a person, is disturbing, and causes an acute awareness.

Some examples of cultural and A-cultural vibration are listed in the following:

CULTURAL VIBRATION

- Automobile
- Commuter Train
- Household
- Industrial Plant or Office
- Airplane

Common Denominator:
No reaction

A-CULTURAL VIBRATION

- Blasting
- Pile Driving
- Impact Machinery
- Jack Hammer
- Forging Hammers

Common Denominator:
Persons react because these vibrations are unfamiliar, disturbing

Blasting is definitely A-cultural for the average person. The annoyance and fear associated with it begin at levels much lower that the damage level for structures.

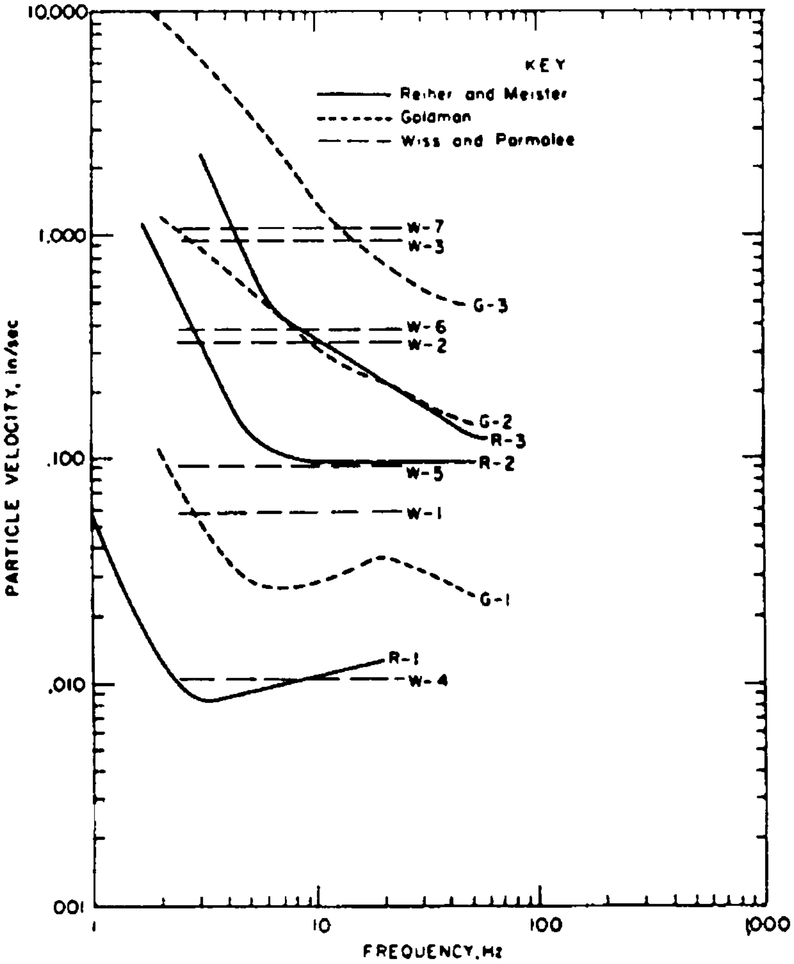

Figure 12. Human Response To Vibration (RI 8507)

ENVIRONMENTAL VIBRATION

Blast vibrations are sensed by individuals at very low levels. Blasting vibration is A-cultural vibration and because the public equates blasting and explosives with death and destruction rather than progress and improvements in quality of life they are apprehensive about any blasting vibration that they sense.

All activities produce some amount of vibration and are constantly present in homes and structures. Environmental factors such as wind, heating and cooling, changes in humidity, traffic, trains, thunder, fireworks and minor earthquakes all produce stress in a structure. The research conducted by the United States Bureau of Mines showed that strains equivalent to those produced by blast vibrations of three inches per second could result from normal environmental stresses. In most cases the public are either unaware or not concerned by the effects of environmental vibration.

ACTIVITY	SCALE																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
WALKING	X	X	X	X	X															
TRAIN NEARBY	X	X	X	X	X	X														
WALKING ON WOOD FLOOR	X	X	X	X	X	X	X													
PILE DRIVING, PUNCH BARGE	X	X	X	X	X	X	X	X												
GARBAGE DISPOSAL	X	X	X	X	X	X	X	X	X											
JUMPING	X	X	X	X	X	X	X	X	X											
DOOR SLAMS	X	X	X	X	X	X	X	X	X											
POUNDING NAILS	X	X	X	X	X	X	X	X	X	X										
DAILY ENVIRONMENTAL CHANGE	X	X	X	X	X	X	X	X	X	X	X	X								
RIDING IN AUTOMOBILE	X	X	X	X	X	X	X	X	X	X	X	X	X							
PEAK PARTICLE VELOCITY	0.001	0.002	0.004	0.008	0.016	0.032	0.064	0.128	0.256	0.512	1.024	2.048	4.096	8.192	16.38	32.77	65.54	131.07	262.14	524.29

Figure 13. Konya's Environmental Vibration Scale^{TM}

KONYA'S VIBRATION SCALE

It is often difficult for the public to understand the magnitudes of vibration from blasting and relate this to normal environmental vibration which they sense every day. Since blast vibration is A-cultural and triggers response people become concerned about vibration levels from blasting while they are not concerned about the same vibration levels from cultural vibration which occurs every day in their lives. To put vibration in the proper perspective we can compare both the A-cultural and cultural vibration magnitudes. To do this in a simple understandable manner use the Konya Scale where we can divide the vibration levels into 20 different classes. We can start with a peak particle velocity of 0.001 to less than 0.002 inches per second and put all vibration less than 0.002 in class one. Class one is the level at which some (very few) people can perceive vibration. We then double the previous number from 0.001 to 0.002. Class two vibration would be 0.002 to less than 0.004. Class three would double again to 0.004 but less than 0.008 and so on.

This class method can be used for both blast effects and separately for environmental vibration. The two charts can then be easily compared without confusion. Konya's Blast Effects

Scale shows the PPV levels and the class numbers for Human perception and potential damage which can result at high vibration levels. Konya's Environmental Vibration Scale shows vibration levels from normal activities (Figure 13.).

For example, class five vibration is the level where most people perceive vibration (Konya's Blast Effects Scale (Figure 14.)) and some become concerned that the vibration will damage their home. Class five on Konya's Environmental Vibration Scale shows that all normal activities on the chart produce vibration at class five or greater. In general most regulatory bodies allow vibration to at least class 10 because they understand that no structural damage can occur in homes at these vibration levels.

EFFECTS	VIBRATION CLASS NUMBER																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PERCEPTION BY OLDER POPULATION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PERCEPTION BY ALL					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WATER RIPPLES						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PIPES RATTLE						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOOSE OBJECTS RATTLE						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CRACK EXTENSIONS IN PLASTER (INVISIBLE)											X	X	X	X	X	X	X	X	X	X
CRACK EXTENSIONS (VISIBLE)												X	X	X	X	X	X	X	X	X
NEW CRACK FORMATION (PLASTER)													X	X	X	X	X	X	X	X
FINE CRACKS IN MASONRY													X	X	X	X	X	X	X	X
BROKEN WINDOWS													X	X	X	X	X	X	X	X
CHIMNEY DAMAGE														X	X	X	X	X	X	X
LARGE CRACKS IN MASONRY WALLS														X	X	X	X	X	X	X
CRACKS IN CONCRETE WALLS																		X	X	X
CRACKS IN CONCRETE SLABS																			X	X
CRACKS IN MASSIVE CONCRETE																				X
PEAK PARTICLE VELOCITY IN INCHES/SECOND (THRESHOLD VALUES)	0.001	0.002	0.004	0.008	0.016	0.032	0.064	0.128	0.256	0.512	1.024	2.048	4.096	8.192	16.38	32.77	65.54	131.07	262.14	524.29

Figure 14. Konya's Blast Effects Scale ™

COMPARISON OF BLAST AND EARTHQUAKE VIBRATION

An earthquake is a regional event, while blasting is a local event. Blasting produces a vibration which rapidly decays in intensity in distances measured in feet while the decay of vibration from earthquakes is measured in miles from the source.

To understand the differences between earthquake and blasting magnitude one can compare the same magnitude particle velocity for earthquake frequencies and that from blast vibrations in geologic materials at Indian Point. Earthquake frequencies are generally less than one hertz while blasting frequencies for close proximity construction blasting is above 50 hertz. At the same measured particle velocity the movement (displacement) of the earth is greater in earthquakes than in blasting. Table 9. shows a comparison in displacement for the same particle velocities at different frequencies.

A Mercalli Scale intensity of VII would produce a maximum peak particle velocity of about 6.3 inches per second. At a one hertz earthquake frequency this would produce a displacement of 1.114 inches, while a blast vibration producing the same peak particle velocity of 6.3 inches per second at a frequency of 50 hertz would produce a displacement of 0.020 inches. The earthquake ground displacement would be 315 times greater than that of blasting at the same particle velocity.

TABLE 9. COMPARISON OF DISPLACEMENT IN INCHES

MERCALLI MAGNITUDE	RICHTER SCALE	PPV at 1 Hz, (in)	DISP at 1 Hz, (in)	DISP at 50 Hz, (in)
I	-1 to 3.5	0.002 to 0.35	0.0003 to 0.0557	6.37E-06 to 0.0011
II	3.5 to 5.4	0.35 to3.5	0.0557 to 0.5570	0.0011 to 0.0111
III	3.5 to 5.4	0.35 to3.5	0.0557 to 0.5570	0.0011 to 0.0111
IV	3.5 to 5.4	0.35 to3.5	0.0557 to 0.5570	0.0011 to 0.0111
V	3.5 to 5.4	0.35 to3.5	0.0557 to 0.5570	0.0011 to 0.0111
VI	3.5 to 5.4	0.35 to3.5	0.0557 to 0.5570	0.0011 to 0.0111
VII	5.4 to 6.0	3.5 to 6.3	0.5570 to1.003	0.0111 to 0.0200
VIII	6.1 to 6.9	7.0 to 17.7	1.114 to 2.810	0.0222 to 0.0563
IX	7.0 to 7.9	19.9 to 56	3.168 to 8.917	0.0634 to 0.1780
X	Over 8.0	Above 62.8	Above 10.000	Above 0.2000
XI	Over 8.0	Above 62.8	Above 10.000	Above 0.2000
XII	Over 8.0	Above 62.8	Above 10.000	Above 0.2000

PROPOSED SAFE BLASTING VIBRATION LIMITS

The review conducted of the past earthquake vibration standards at Indian Point, standards for weakly constructed residential structures, industrial structures, and 80 years of research data proves that blasting can be safely conducted at the reactor without any damage to the structure.

An extremely conservative vibration limit would be 2.0 inches per second which is the limit for residential structures. This vibration limit would protect the structures and allow construction at reasonable costs. According to the available data the reactor should be totally safe at **three times** this vibration limit if in fact it is built to withstand a Mercalli Intensity VII earthquake.

It is obvious that blasting mats must be used for cover of the blasting area to protect the electrical wires and any other delicate structure which could be damaged by small pieces of flyrock.

The excavation for the tower will vary in distance from 960 feet to 1660 feet from the reactors.

The major trenching would be 330 feet at it's closest point to the reactors. The turbine generator buildings would be about 55 feet from the trench blasting

ASSESSMENT OF ROCK QUANTITIES AND COSTS

ROCK TRENCHES

The following measurements were taken from the drawings for the large diameter pipe installations from the cooling towers. Blasting of trench rock costs \$50/cubic yard. The \$50/yd^3 cost would cover the cost of all types of trench blasting on the project

- Four pipe trench, 62 feet wide and 20 feet deep and 1722 feet long equals 79,084 yd^3
- Two pipe trench, 40 feet wide and 20 feet deep and 2500 feet long equals 74,074 yd^3
- Total trench rock equals 153,158 yd^3

At a cost of \$50.00 per yd^3 the total cost of trench blasting would be \$7,657,900

COOLING TOWERS

The cost of the excavation for the two cooling towers would be \$7/cubic yard.

The volume of rock needed for excavation for the towers would be the total rock excavation minus the rock excavated for the trenches. The total volume was 2,100,000 yd^3 minus the 153,158 cubic yards for trenches leaves 1,946,842 yd^3 for the two towers.

The cost of the excavation for the towers is 1,946,842 yd^3 times \$7.00 yd^3 equals \$13,627,894 (Appendix 3).

TOTAL DRILLING AND BLASTING COST

The total cost of drilling and blasting would include the drilling and blasting cost, blasting consultant and seismic monitoring cost. These costs are listed below.

- Drilling and blasting = \$7,657,900 + \$13,627,894 = \$21,285,794
- Blasting Consultant = \$500,000
- Seismic Monitoring Cost = \$ 600,000

The Total Cost of Drilling and Blasting = $22,385,794

DISPOSAL OF BROKEN ROCK

There are many different options for the disposal of the 2,100,000 yd^3 (bank) of rock which will be blasted. The rock can be placed on site, dumped into the ocean, sold to quarry or crushed and sold from the site.

For the purpose of this study the ocean dumping cost is the highest and the only sure method of disposal since the rock quality is unknown at this time.

WASTED ON SITE

The most economic method of disposal would be on site. The cost for site disposal would be the cost of loading the material into trucks and the short haul distance with the trucks.

OCEAN DUMPING

The state of New York and the State of New Jersey both are building artificial reefs of their shores. The offshore reefs are used for dumping rock from barges in the current harbor deepening projects. A permit would be needed from the Department of Environmental Conservation to ocean dump rock from the Indian Point excavation. This should not be a problem because the DEC encourages the building of these reefs because they attract fish.

Great Lakes Dredge and Dock Company was contacted and provided the cost of moving the rock from Indian Point to an artificial reef. The haul distance was 200 miles round trip. Two 4000 yd^3 barges which hold 4500 tons would be provided as well as an ocean going tug boat. The blasted rock would be loaded into the barge by the construction company at Indian Point. The cost of digging the broken rock and the cost of moving the rock to the barge is not in the price given below. The cost to dump the 2,100,000 yd^3 of rock would be $18.90 per yd^3.

If all the material is dumped into the ocean the **cost would be $39,690,000.**

SALE TO QUARRY

I have talked to Tilcon Quarry Management concerning stone produced from blasting at Indian Point. If the stone is of good quality they may be interested in some business arrangement which could reduce the disposal cost from that of ocean dumping. In my opinion if the stone quality is good the cost of disposal may be cut to about $4,000,000 to $6,000,000.

CRUSHING ON SITE

If the rock is of sufficient quality a crushing contractor could set up a crushing plant on the property and crush the rock for $5 to $7 /ton. This crushed rock could possibly be sold to a quarry or contractors and also could be used for the needs of the site construction. If the rock could be sold from the site a profit of at least $2.00 per ton should be realized. This could produce a revenue of $5,000,000 to $10,000,000 for the 4,950,000 tons excavated depending on the quality of the stone.

The minimum quantity of crushed stone necessary for base material under the cooling towers as well as fill around the pipes was estimated as follows. The base under the 700 foot diameter excavations for the two cooling towers would require 28,500 yd^3 or 55, 800 tons of rock base material for a one foot deep base.

Bedding material will be needed surrounding the 12 foot diameter and other pipes. The bedding at minimum would be 103,000 yd^3 or 195,000 tons of fill around pipes.

The 131,500 tons of rock brought into the site would cost about $15 per ton or about $29 per cubic yard of crushed stone delivered to the property. This would be at minimum an additional cost of $4,000,000.

TOTAL COST OF DRILLING, BLASTING, AND DISPOSAL (LOADING AND HAULAGE COSTS NOT INCLUDED)

The total cost of drilling, blasting, and disposal would be as follows:

☐	Drilling and blasting	$22,385,794
☐	Ocean dumping	$39,690,000.
☐	**Total cost**	**$62,075,794**

EXECUTION OF PROJECT

The project would require a competent drilling and blasting contractor. The contractor should not be selected on low bid alone but also on reputation and past history of successfully completing delicate projects. The contractor must be required to hire a reputable blasting consultant who must be present on the project. The costs shown in this report are conservative and provides for the selection of a competent contractor and blasting consultant.

Core drilling must be done prior to any construction on the project. RQD and percent recovery are important information which must be given the contractors/owners Blasting consultant.

Test blast would be conducted at the farthest distance (1660 feet) from the reactor using small charges to test the scaling factors and determine the site specific vibration decay factors. At least six seismographs would be strategically placed during the test blast phase of the project.

At least four seismographs would be strategically placed and monitored during all production blasting.

CONCLUSIONS

It is feasible and safe to blast the rock for the cooling towers and trenches at Indian Point. The Mercalli Intensity of VII for which the facility was designed was the limiting vibration level. It was determined that the blasting could be accomplished at a much lower level or a fraction of the vibration limit. It is suggested that vibration can easily be controlled well below the safe maximum level and that the residential structure vibration limit of 2 inches per second be adopted for all blasting at the facility. The industrial buildings can tolerate much greater vibration limits than residential structures. The actual vibration produced from blasting the cooling towers will be 6% to 13% of safe limits for residential structures and be totally safe for the reactors and other buildings on site. The vibration from the trench blasting will also be well below the residential safe limits.

Cost calculations were conducted for drilling and blasting as well as the rock disposal. The only method of rock disposal that is certain and known at this time is ocean dumping of the waste rock. This is also the most expensive option. Other less expensive methods of rock disposal may be possible once the quality of the rock is known.

APPENDIX 1 – VIBRATION CONSULTANT PROGRAM

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Precision Blasting                        VIBRATION CONSULTANT                           V5.00 Page:        1
Services, Inc.                                                                                 Date: 05-20-2003
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Number of records: 105    File: PPTILIKN.VIB  2003-Jan-15  Wed  11:02    9,640
INDIAN POINT

G R O U N D   V I B R A T I O N   D A T A  (Data points: 105):
95% confidence level equation:  PV =      210.26 * (Ds) ^ (-1.36)
Coefficient of determination (r² - "goodness of fit") =  0.435     Standard deviation =  0.247

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No.  SHOT        LOCATION            DATE    DAY  TIME     P.P.V. FREQUENCY  AIR      DISTANCE    CHARGE    SCALED DISTANCES
                                                                             PRESSURE             WEIGHT   VIBRAT.  AIRPRES.
                                                             in/s      Hz       dB          ft        lb
----------------------------------------------------------------------------------------------------------------------------

  1  10-02 IKON  Bot lev wst face 01-23-2002 Wed  10:32      0.94      50     126.00    180.00     60.00     23.24     45.98
  2  11-02 IKON  2 lev west face  01-25-2002 Fri  10:46      0.26     100     112.00    325.00     62.00     41.28     82.11
  3  12-02 IKON  2 lev west face  01-28-2002 Mon  10:02      0.52      62     118.00    276.00     63.00     34.77     69.36
  4  13-02 IKON  2 lev North face 01-30-2002 Wed  09:58      0.35      36     120.00    310.00     83.50     33.92     70.93
  5  14-02 IKON  BOT LEV EST FACE 02-05-2002 Tue  09:50      0.43      36     114.00    170.00     19.00     39.00     63.71
  6  15-02 IKON  2ND LVL WEST FC  02-26-2002 Tue  10:31      0.56      50     124.00    310.00     76.00     35.56     73.19
  7  16-02 IKON  2ND LVL WEST FC  02-27-2002 Wed  10:46      0.30      71     118.00    370.00     68.00     44.87     90.65
  8  17-02 IKON  3RD LVL SOUTH FC 03-01-2002 Fri  11:48      0.40      33     116.00    360.00     36.00     60.00    109.03
  9  18-02 IKON  B LVL S FC NE PT 03-05-2002 Tue  10:52      0.56      45     117.00    215.00     39.00     34.43     63.40
 10  19-02 IKON  2ND LEVEL W      03-07-2002 Thu  09:33      0.92      45     123.00    270.00     81.00     30.00     62.40
 11  20-02 IKON  BTM LVL SOUTH FC 03-12-2002 Tue  10:31      0.74      22     121.00    475.00     89.00     50.35    106.39
 12  21-02 IKON  2ND LVL WEST FC  03-13-2002 Wed  09:22      0.34      62     120.00    370.00     81.00     41.11     85.51
 13  22-02 IKON  BTM LVL STH FACE 03-14-2002 Thu  11:13      0.45      33     112.00    370.00     31.00     66.45    117.78
 14  23-02 IKON  BTM LVL WEST FC  03-15-2002 Fri  03:19      0.52      33     114.00    475.00     40.00     75.10    138.89
 15  24-02 IKON  BTM LVL WEST FC  03-19-2002 Tue  01:16      0.15      37     110.00    470.00     43.00     71.67    134.16
 16  26-02 IKON  BTM LVL WEST FC  03-22-2002 Fri  03:30      0.44      39     116.00    470.00     43.00     71.67    134.16
 17  28-02 IKON  BTM LVL WEST FC  03-27-2002 Wed  11:55      0.15      45     112.00    422.00     43.00     64.35    120.45
 18  30-02 IKON  BTM LVL WEST FC  04-03-2002 Wed  12:38      0.55      36     116.00    420.00     38.00     68.13    124.93
 19  30-02 IKON  BTM LVL WEST FC  04-03-2002 Wed  12:38      0.10      27     110.00    420.00     38.00     68.13    124.93
 20  31-02 IKON  BTM LVL SOUTH FC 04-04-2002 Thu  01:26      0.13      50     106.00    430.00     40.00     67.99    125.73
 21  32-02 IKON  2ND LVL WEST FC  04-05-2002 Fri  11:19      0.91      50     118.00    197.00     40.00     31.15     57.60
 22  32-02 IKON  2ND LVL WEST FC  04-05-2002 Fri  11:19      0.91      50     118.00    197.00     40.00     31.15     57.60
 23  33-02 IKON  BTM LVL WEST FC  04-08-2002 Mon  10:40      0.58      45     117.00    382.00     38.00     61.97    113.62
 24  34-02 IKON  BTM LVL WEST FC  04-09-2002 Tue  03:38      0.12      63     109.00    420.00     40.00     66.41    122.81
 25  35-02 IKON  BTM LVL WEST FC  04-11-2002 Thu  11:16      0.74      31     117.00    345.00     40.00     54.55    100.88
 26  36-02 IKON  BTM LEVEL SOUTH  04-12-2002 Fri  11:29      0.25      28     111.00    520.00     40.00     82.22    152.05
 27  37-02 IKON  BTM LVL WEST FC  04-15-2002 Mon  12:56      0.25      28     110.00    375.00     43.00     57.19    107.04
 28  37-02 IKON  BTM LVL WEST FC  04-15-2002 Mon  12:56      0.14      83     112.00    375.00     43.00     57.19    107.04
 29  38-02 IKON  BTM LVL WEST FC  04-17-2002 Wed  11:23      0.37      33     116.00    428.00     43.00     65.27    122.17
 30  39-02 IKON  BTM LVL WEST FC  04-18-2002 Thu  10:27      0.44      42     116.00    342.00     40.00     54.07    100.00
 31  41-02 IKON  BTM LVL WEST FC  04-23-2002 Tue  12:13      0.49      31     119.00    427.00     40.00     67.51    124.86
 32  42-02 IKON  BTM LVL WEST FC  04-24-2002 Wed  10:54      0.22      56     109.00    422.00     40.00     66.72    123.39
 33  45-02 IKON  BTM LVL WEST FC  04-29-2002 Mon  12:39      0.09      36     109.00    377.00     39.00     60.37    111.17
 34  46-02 IKON  3RD LVL WEST FC  05-01-2002 Wed  12:27      0.10      22     109.00    435.00     40.00     68.78    127.19
 35  49-02 IKON  2ND LVL WEST FC  05-06-2002 Mon  10:28      0.56      56     117.00    190.00     36.00     31.67     57.54
 36  52-02 IKON  2ND LVL WEST FC  05-08-2002 Wed  12:29      1.04     710     121.00    204.00     40.00     32.26     59.65
 37  53-02 IKON  2ND LVL SOUTH FC 05-10-2002 Fri  11:27      0.16     830     112.00    280.00     28.00     52.92     92.21
 38  58-02 IKON  2ND LVL WEST FC  05-21-2002 Tue  12:38      0.16      83     109.00    296.00     36.00     49.33     89.64
 39  60-02 IKON  2 LVL W FC RAMP  05-23-2002 Thu  02:35      0.96      63     124.00    162.00     36.00     27.00     49.06
 40  61-02 IKON  2ND LVL WEST FC  05-28-2002 Tue  12:40      0.29      63     120.00    325.00     54.00     44.23     85.98
 41  62-02 IKON  2ND LVL SOUTH FC 05-29-2002 Wed  11:12      0.43      71     116.00    225.00     58.00     29.54     58.13
 42  63-02 IKON  2 LVL W FC RAMP  05-31-2002 Fri  01:49      0.44      38     116.00    148.00     36.00     24.67     44.82
 43  65-02 IKON  2ND LVL WEST FC  06-03-2002 Mon  03:25      0.57     630     117.00    317.00     65.00     39.32     78.84
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Precision Blasting
Services, Inc.

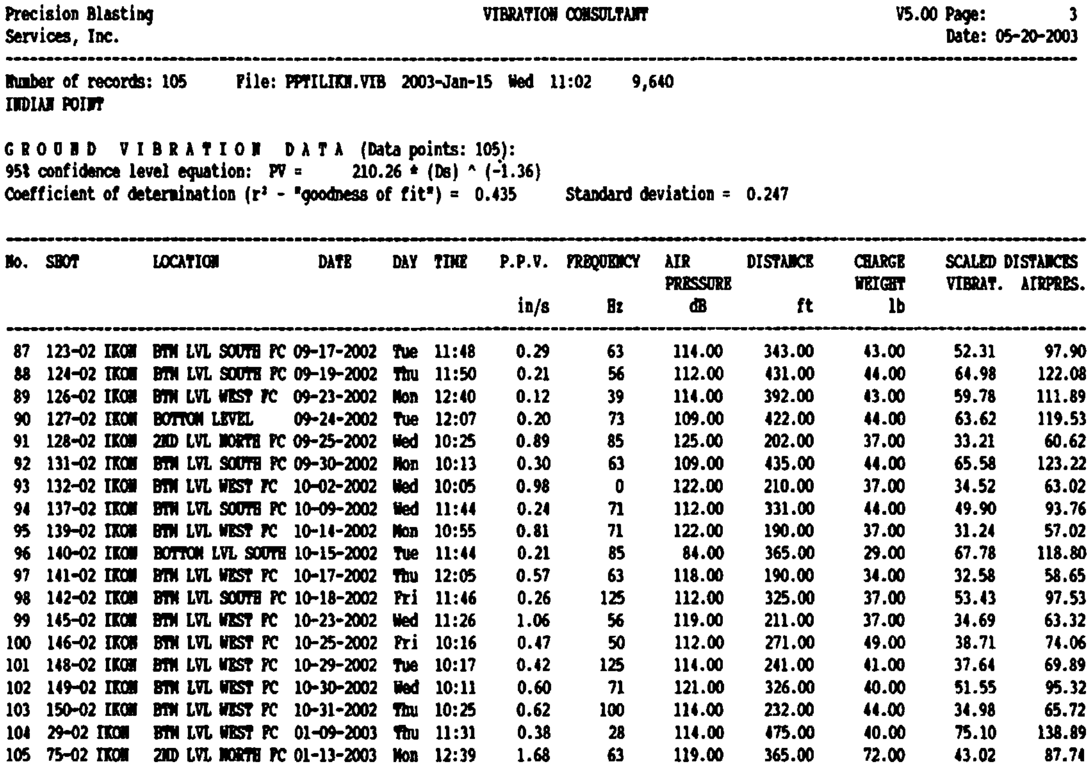
VIBRATION CONSULTANT

V5.00 Page: 2
Date: 05-20-2003

Number of records: 105 File: PPTILIKN.VIB 2003-Jan-15 Wed 11:02 9,640
INDIAN POINT

GROUND VIBRATION DATA (Data points: 105):
95% confidence level equation: PV = 210.26 * (Ds) ^ (-1.36)
Coefficient of determination (r² - "goodness of fit") = 0.435 Standard deviation = 0.247

No.	SHOT	LOCATION	DATE	DAY	TIME	P.P.V. in/s	FREQUENCY Hz	AIR PRESSURE dB	DISTANCE ft	CHARGE WEIGHT lb	SCALED DISTANCES VIBRAT.	SCALED DISTANCES AIRPRES.
44	64-02 IKON	2ND LVL WEST PC	06-03-2002	Mon	11:07	0.10	630	126.00	475.00	69.00	57.18	115.81
45	66-02 IKON	2ND LVL WEST PC	06-05-2002	Wed	11:14	0.54	56	123.00	475.00	80.00	53.11	110.24
46	67-02 IKON	2ND LVL SOUTH PC	06-06-2002	Thu	10:48	0.73	100	119.00	260.00	72.00	30.64	62.50
47	68-02 IKON	2ND LVL WEST PC	06-10-2002	Mon	11:18	0.51	50	123.00	424.00	75.00	48.96	100.54
48	69-02 IKON	2ND LVL EAST PC	06-12-2002	Wed	01:45	0.64	100	118.00	269.00	68.00	32.62	65.90
49	70-02 IKON	2 LV RAMP W FACE	06-14-2002	Fri	12:27	0.71	28	123.00	217.00	43.00	33.09	61.94
50	71-02 IKON	2ND LVL EAST PC	06-18-2002	Tue	01:54	0.53	71	118.00	307.00	64.00	38.38	76.75
51	72-02 IKON	2ND LVL NORTH PC	06-19-2002	Wed	10:10	0.46	50	117.00	350.00	68.00	42.44	85.75
52	73-02 IKON	2ND LVL NORTH PC	06-20-2002	Thu	09:44	0.71	50	131.00	264.00	92.00	27.52	58.48
53	74-02 IKON	2ND LVL EAST PC	06-24-2002	Mon	11:24	0.46	71	118.00	330.00	68.00	40.02	80.85
54	77-02 IKON	2ND LVL NORTH PC	07-01-2002	Mon	11:58	1.27	50	121.00	279.00	71.00	33.11	67.38
55	78-02 IKON	1ST LVL WEST PC	07-02-2002	Tue	10:02	0.37	33	116.00	283.00	30.00	51.67	91.08
56	79-02 IKON	2ND LVL EAST PC	07-03-2002	Wed	11:18	0.28	45	114.00	420.00	73.00	49.16	100.49
57	80-02 IKON	1ST LVL WEST PC	07-08-2002	Mon	02:50	0.44	63	119.00	243.00	33.00	42.30	75.76
58	81-02 IKON	1ST LVL WEST PC	07-09-2002	Tue	10:30	0.59	71	116.00	268.00	33.00	46.65	83.55
59	82-02 IKON	2ND LVL NORTH PC	07-09-2002	Tue	12:58	0.47	63	118.00	278.00	36.00	46.33	84.19
60	83-02 IKON	1ST LVL WEST PC	07-11-2002	Thu	10:34	0.58	56	118.00	231.00	33.00	40.21	72.02
61	84-02 IKON	1ST LVL WEST PC	07-15-2002	Mon	03:26	0.48	31	116.00	217.00	33.00	37.77	67.65
62	85 IKON	2ND LVL FLOOR	07-17-2002	Wed	08:59	0.28	45	116.00	420.00	20.00	93.91	154.73
63	86 IKON	2ND LVL NORTH PC	07-17-2002	Wed	10:59	0.46	71	114.00	255.00	33.00	44.39	79.50
64	87-02 IKON	1ST LVL WEST PC	07-18-2002	Thu	11:38	0.65	56	116.00	223.00	33.00	38.82	69.52
65	89-02 IKON	TOP LVL N QY PC	07-22-2002	Mon	12:03	0.11	56	112.00	777.00	37.00	127.74	233.18
66	90-02 IKON	2ND LVL WEST PC	07-23-2002	Tue	10:47	0.85	56	119.00	228.00	36.00	38.00	69.05
67	91-02 IKON	BTM LVL WEST PC	07-24-2002	Wed	10:17	0.07	56	106.00	420.00	35.00	70.99	128.40
68	92-02 IKON	2ND LVL WEST PC	07-26-2002	Fri	11:27	0.90	71	120.00	215.00	32.00	38.01	67.72
69	94-02 IKON	BTM LVL WEST PC	07-30-2002	Tue	12:45	0.17	38	114.00	431.00	36.00	71.83	130.53
70	95-02 IKON	2ND LVL WEST PC	08-02-2002	Fri	10:49	0.80	71	121.00	158.00	58.00	20.75	40.82
71	97-02 IKON	BTM LVL WEST PC	08-07-2002	Wed	10:56	0.28	50	114.00	392.00	36.00	65.33	118.72
72	98-02 IKON	BOTTOM LEVEL	08-08-2002	Thu	11:02	0.14	56	114.00	414.00	36.00	69.00	125.38
73	99-02 IKON	BTM LVL WEST PC	08-09-2002	Fri	09:32	0.11	100	114.00	460.00	36.00	76.67	139.31
74	100-02 IKON	2ND LEVEL	08-12-2002	Mon	10:42	1.04	56	122.00	160.00	70.00	19.12	38.82
75	101-02 IKON	BTM LVL WEST PC	08-14-2002	Wed	09:31	0.10	26	114.00	450.00	35.00	76.06	137.57
76	103-02 IKON	3RD LEVEL	08-16-2002	Fri	10:01	0.11	50	109.00	370.00	38.00	60.02	110.05
77	103-02 IKON	3RD LEVEL	08-16-2002	Fri	10:01	0.14	26	112.00	320.00	38.00	51.91	95.18
78	105-02 IKON	2ND LVL WEST PC	08-19-2002	Mon	11:30	1.16	45	123.00	160.00	72.00	18.86	38.46
79	106-02 IKON	BTM LVL WEST PC	08-20-2002	Tue	10:50	0.14	38	114.00	450.00	41.00	70.28	130.50
80	107-02 IKON	BTM LVL SOUTH PC	08-21-2002	Wed	11:27	0.19	50	106.00	376.00	43.00	57.34	107.32
81	109-02 IKON	BTM LVL WEST PC	08-23-2002	Fri	11:44	0.35	100	109.00	475.00	86.00	51.22	107.61
82	111-02 IKON	BTM LVL SOUTH PC	08-27-2002	Tue	10:30	0.22	167	109.00	375.00	43.00	57.19	107.04
83	112-02 IKON	BTM LVL WEST PC	08-28-2002	Wed	10:02	0.24	45	116.00	120.00	43.00	18.30	34.25
84	113-02 IKON	2ND LVL WEST PC	08-30-2002	Fri	10:29	1.19	71	124.00	185.00	28.00	34.96	60.92
85	114-02 IKON	BTM LVL SOUTH PC	09-03-2002	Tue	10:45	0.04	1	100.00	360.00	43.00	54.90	102.76
86	121-02 IKON	BTM LVL WEST PC	09-13-2002	Fri	12:13	0.49	45	114.00	390.00	43.00	59.47	111.32



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Precision Blasting                          VIBRATION CONSULTANT                         V5.00 Page:        3
Services, Inc.                                                                                 Date: 05-20-2003
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Number of records: 105      File: PPTILIKN.VIB  2003-Jan-15  Wed  11:02     9,640
INDIAN POINT

G R O U N D   V I B R A T I O N   D A T A  (Data points: 105):
95% confidence level equation:  PV =      210.26 * (Ds) ^ (-1.36)
Coefficient of determination (r² - "goodness of fit") =  0.435      Standard deviation =  0.247

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No.  SHOT          LOCATION              DATE      DAY  TIME     P.P.V.  FREQUENCY   AIR      DISTANCE     CHARGE     SCALED DISTANCES
                                                                                    PRESSURE               WEIGHT     VIBRAT.  AIRPRES.
                                                                  in/s        Hz      dB           ft         lb
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 87  123-02 IKON  BTM LVL SOUTH PC 09-17-2002  Tue  11:48     0.29       63     114.00     343.00      43.00      52.31     97.90
 88  124-02 IKON  BTM LVL SOUTH PC 09-19-2002  Thu  11:50     0.21       56     112.00     431.00      44.00      64.98    122.08
 89  126-02 IKON  BTM LVL WEST PC  09-23-2002  Mon  12:40     0.12       39     114.00     392.00      43.00      59.78    111.89
 90  127-02 IKON  BOTTOM LEVEL     09-24-2002  Tue  12:07     0.20       73     109.00     422.00      44.00      63.62    119.53
 91  128-02 IKON  2ND LVL NORTH PC 09-25-2002  Wed  10:25     0.89       85     125.00     202.00      37.00      33.21     60.62
 92  131-02 IKON  BTM LVL SOUTH PC 09-30-2002  Mon  10:13     0.30       63     109.00     435.00      44.00      65.58    123.22
 93  132-02 IKON  BTM LVL WEST PC  10-02-2002  Wed  10:05     0.98        0     122.00     210.00      37.00      34.52     63.02
 94  137-02 IKON  BTM LVL SOUTH PC 10-09-2002  Wed  11:44     0.24       71     112.00     331.00      44.00      49.90     93.76
 95  139-02 IKON  BTM LVL WEST PC  10-14-2002  Mon  10:55     0.81       71     122.00     190.00      37.00      31.24     57.02
 96  140-02 IKON  BOTTOM LVL SOUTH 10-15-2002  Tue  11:44     0.21       85      84.00     365.00      29.00      67.78    118.80
 97  141-02 IKON  BTM LVL WEST PC  10-17-2002  Thu  12:05     0.57       63     118.00     190.00      34.00      32.58     58.65
 98  142-02 IKON  BTM LVL SOUTH PC 10-18-2002  Fri  11:46     0.26      125     112.00     325.00      37.00      53.43     97.53
 99  145-02 IKON  BTM LVL WEST PC  10-23-2002  Wed  11:26     1.06       56     119.00     211.00      37.00      34.69     63.32
100  146-02 IKON  BTM LVL WEST PC  10-25-2002  Fri  10:16     0.47       50     112.00     271.00      49.00      38.71     74.06
101  148-02 IKON  BTM LVL WEST PC  10-29-2002  Tue  10:17     0.42      125     114.00     241.00      41.00      37.64     69.89
102  149-02 IKON  BTM LVL WEST PC  10-30-2002  Wed  10:11     0.60       71     121.00     326.00      40.00      51.55     95.32
103  150-02 IKON  BTM LVL WEST PC  10-31-2002  Thu  10:25     0.62      100     114.00     232.00      44.00      34.98     65.72
104  29-02 IKON   BTM LVL WEST PC  01-09-2003  Thu  11:31     0.38       28     114.00     475.00      40.00      75.10    138.89
105  75-02 IKON   2ND LVL NORTH PC 01-13-2003  Mon  12:39     1.68       63     119.00     365.00      72.00      43.02     87.74
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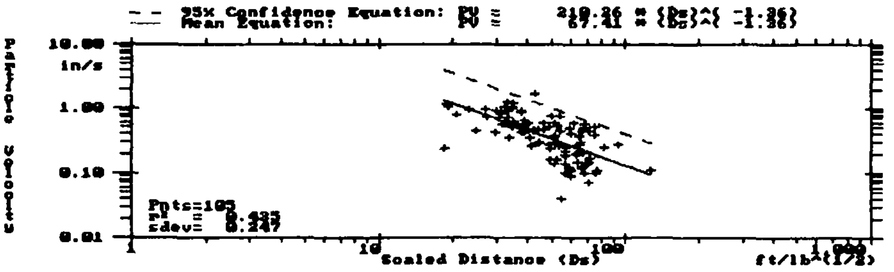
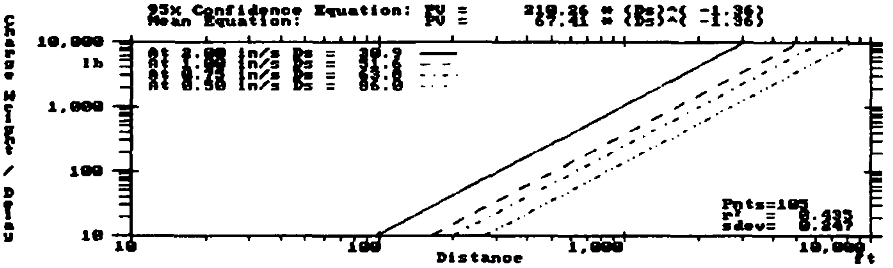
Precision Blasting
Services, Inc.

VIBRATION CONSULTANT

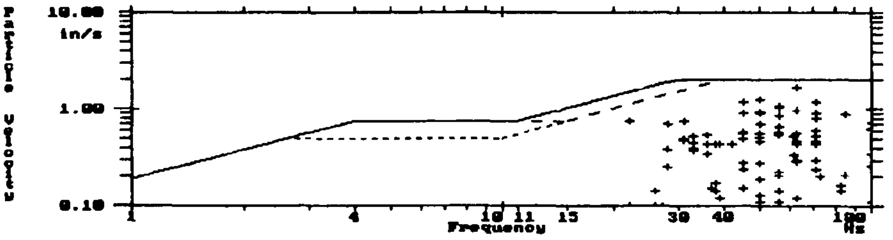
V5.00 Page: 4
Date: 05-20-2003

Number of records: 105 File: PPTILIKN.VIB 2003-Jan-15 Wed 11:02 9,640
INDIAN POINT





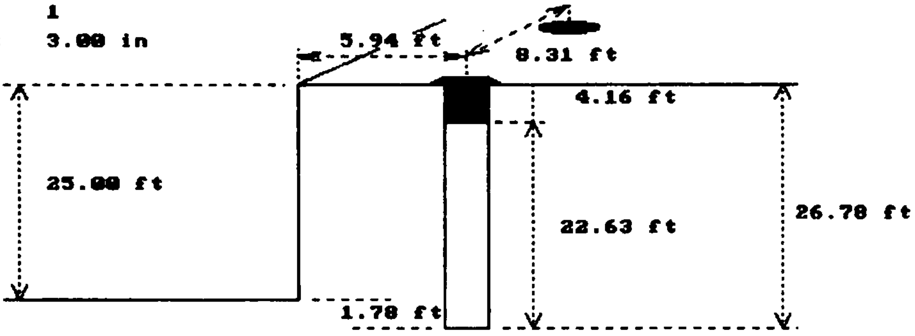
USBM RI8507 and OSMRE Analysis



APPENDIX 2 – BLAST DESIGNER PROGRAM

```
Precision Blasting               B L A S T             V5.01 Page:          1
Services, Inc.                 D E S I G N E R               Date: 05-20-2003
------------------------------------------------------------------------------
                                 INDIAN POINT

      INPUT DATA OF ENTRY 1 Column loaded borehole with one explosive

      Fixed production ............      100    holes

      Initiation .................. Delayed

      Total number of holes    .....      100
      Diameter of blast hole   .....        3.00 in
      Hole depth               .....       26.78 ft
      Bench height             .....       25.00 ft
      Subdrill                 .....        1.78 ft
      Burden                   .....        5.94 ft
      Spacing                  .....        8.31 ft
      Stemming (chips)         .....        4.16 ft

      Number of primers        .....        1    / hole
      Number of initiators     .....        1    / hole
      Number of surface delays .....        1    / hole

      Delay time along the row .....       25    ms
      Delay time between rows  .....      100    ms

      Column explosive type    ..... EMULSION
      Expl. charge diameter    .....        2.50 in
      Expl. spec. gravity      .....        1.20
      Expl. bulk strength      .....        0.00
      Loading density          .....        2.55 lb/ft
      Weight of explosive      .....       57.78 lb
      Length of explosive      .....       22.63 ft

      Rock type                ..... DIABASE
      Rock spec. gravity       .....        2.80 g/cm3
```

```
Precision Blasting              B L A S T            V5.01 Page:          2
Services, Inc.                D E S I G N E R              Date: 05-20-2003
----------------------------------------------------------------------------
                                  INDIAN POINT

      RESULTS OF ENTRY 1    Column loaded borehole with one explosive

 E N T R Y    1
 Diameter =   3.00 in
```



```
      Total drill length       .....    2,678.12 ft

      Powder factor            .....        1.26 lb/yd3

      Powder ratio             .....        0.79 yd3/lb

      Total explosive          .....    5,777.74 lb

      Tot. volume produced     .....    4,569.70 yd3

      Tot. weight produced     .....   10,783.48 ton
```

```
Precision Blasting                 B L A S T              V5.01 Page:          3
Services, Inc.                  D E S I G N E R                 Date: 05-20-2003
--------------------------------------------------------------------------------

E N T R Y                 1            2            3            4        units
==================   ============ ============ ============ ============ =======
File name:
------------------   ------------ ------------ ------------ ------------ -------

Initiation                Delayed

Top explosive            EMULSION
Expl. charge diamete         2.50                                        in
Expl. spec. gravity          1.20                                        g/cm3
Expl. bulk strength
Powder column length        22.63                                        ft
Loading density              2.55                                        lb/ft
Explosive weight            57.78                                        lb
Top rock type             DIABASE
Rock spec. gravity           2.80                                        g/cm3
------------------   ------------ ------------ ------------ ------------ -------
Bottom explosive
Expl. charge diamete                                                     in
Expl. spec. gravity                                                      g/cm3
Expl. bulk strength
Explosive weight                                                         lb
Loading density                                                          lb/ft
Explosive weight                                                         lb
Bottom rock type
Rock spec. gravity                                                       g/cm3
------------------   ------------ ------------ ------------ ------------ -------
Number of holes            100.00
Hole diameter                3.00                                        in
Bench height                25.00                                        ft
Hole depth                  26.78                                        ft
Subdrill                     1.78                                        ft
Drilling angle                                                           °

Burden                       5.94                                        ft
Spacing                      8.31                                        ft

Stemming (chips)             4.16                                        ft
Stemming (dust)                                                          ft

Total drill length       2,678.12                                        ft

Powder factor                1.26                                        lb/yd3
Powder ratio                 0.79                                        yd3/lb

Total col. explosive     5,777.74                                        lb
Total base explosive                                                     lb
Total explosive          5,777.74                                        lb

Tot. volume produced     4,569.70                                        yd3
Tot. weight produced    10,783.48                                        ton

-----------------------------END OF SUMMARY REPORT------------------------------
```

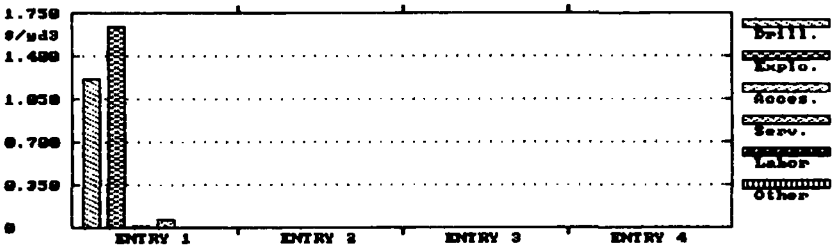
APPENDIX 3 – BLAST COST ANALYST PROGRAM

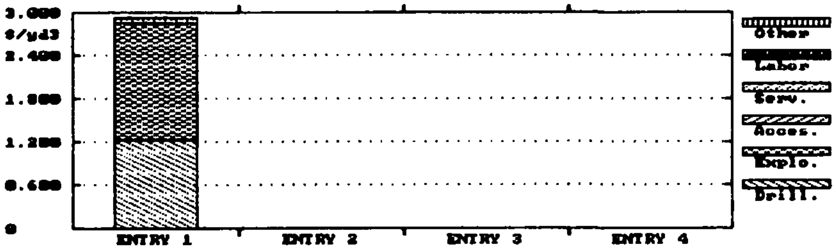
```
Precision Blasting            BLASTING COST ANALYST        V5.01 Page:           1
Services, Inc.                                                   Date: 05-20-2003
---------------------------------------------------------------------------------
                                    INDIAN POINT

      ENTRY  1      Column loaded borehole

      P A T T E R N

      Total number of holes .............        100
      Diameter of the blasthole .........          3.00  in
      Burden ............................          6.00  ft
      Spacing ...........................          8.00  ft
      Stemming ..........................          8.00  ft
      Subdrill ..........................          2.00  ft
      Bench height ......................         25.00  ft
      Hole depth ........................         27.00  ft

      Rock type ......................... DIABASE
      Specific gravity of the rock ......          2.80  g/cm3

      D R I L L I N G

      Total drill length ................      2,700.00  ft
      Drilling cost per length ..........          2.00  $/ft
      Total drill cost ..................      5,400.00  $
      Drill factor ......................          0.61  ft/yd3
      Drilling cost per volume ..........          1.22  $/yd3
      Drilling cost per weight ..........          0.51  $/ton

      E X P L O S I V E S

      Type (brand) of explosive  . . . . . EMULSION
      Specific gravity of explosive.......         1.20  g/cm3
      Diameter of explosive...............         2.50  in
      Energy..............................         0.00
      Cost of explosive...................         1.5000  $/lb

      Total weight of explosive .........      4,851.98  lb
      Total cost of explosive / volume . .         1.64  $/yd3
      Total cost of explosive / weight . .         0.69  $/ton
      Powder factor  . . . . . . . . . . .         1.09  lb/yd3
                                                   0.92  yd3/lb
      Total cost of explosive  . . . . . .     7,277.97  $

      Energy . . . . . . . . . . . . . . .         0.00  /yd3
      Energy . . . . . . . . . . . . . . .         0.00  /ton

      -------------------------------------------------------------------
          Initiators          Delay    Quantity   Cost/Unit          Cost
                                ms
      -------------------------------------------------------------------
       1  DUAL DELAY         25,350          6        6.00          36.00
      -------------------------------------------------------------------
                                       Total initiator cost:        36.00

      Rock volume  . . . . . . . . . . . .     4,444.44  yd3
      Rock weight  . . . . . . . . . . . .    10,487.90  ton
```

```
Precision Blasting           BLASTING COST ANALYST        V5.01 Page:          2
Services, Inc.                                                  Date: 05-20-2003
--------------------------------------------------------------------------------
                                 INDIAN POINT

      ENTRY  1     Column loaded borehole


      --------------------------------------------------------------------------
      Category                 Total cost  Percent     Cost/weight    Cost/volume
                                        $        %          $/ton          $/yd3
      --------------------------------------------------------------------------
      Drill cost                 5,400.00    41.49          0.515          1.215
      Explosive cost             7,277.97    55.92          0.694          1.638
      Initiator cost                36.00     0.28          0.003          0.008
      Primer cost
      Surface delay cost
      Sleeves cost
      Delivery cost
      Protection cost
      Pumping cost
      Service cost                 300.00     2.31          0.029          0.068
      Seismic monitor cost
      Labor cost
      Other costs
      --------------------------------------------------------------------------
      Total cost                13,013.97                   1.241          2.928
      --------------------------------------------------------------------------
```

```
Precision Blasting          BLASTING COST ANALYST      V5.01 Page:          3
Services, Inc.                                               Date: 05-20-2003
-------------------------------------------------------------------------------
E N T R Y            1             2             3             4          unit
=============== ============= ============= ============= ============= ========
File
--------------- ------------- ------------- ------------- ------------- --------
Number of holes      100
Hole diameter           3.00                                             in
Burden                  6.00                                             ft
Spacing                 8.00                                             ft
Stemming                8.00                                             ft
Subdrill                2.00                                             ft
Bench height           25.00                                             ft
Hole depth             27.00                                             ft
--------------- ------------- ------------- ------------- ------------- --------
Rock type            DIABASE
Spec. gr. rock          2.80                                             g/cm3
--------------- ------------- ------------- ------------- ------------- --------
Drill length        2,700.00                                             ft
Drill cost/vol.         1.22                                             $/yd3
Drill cost/wgh.         0.51                                             $/ton
Drill factor            0.61                                             ft/yd3
Drill cost          5,400.00                                             $
--------------- ------------- ------------- ------------- ------------- --------
Explosive A:        EMULSION
          B:
          C:
--------------- ------------- ------------- ------------- ------------- --------
Expl. weight        4,851.98                                             lb
Expl. cost/vol.         1.64                                             $/yd3
Expl. cost/wgh.         0.69                                             $/ton
Powder factor           1.09                                             lb/yd3
                        0.92                                             yd3/lb
Expl. cost          7,277.97                                             $
--------------- ------------- ------------- ------------- ------------- --------
Energy                                                                   /yd3
                                                                         /ton
--------------- ------------- ------------- ------------- ------------- --------
Initiator cost         36.00                                             $
Primer cost                                                              $
Surface delay                                                            $
Sleeve cost                                                              $
Delivery cost                                                            $
Protection cost                                                          $
Pumping cost                                                             $
Shot service          300.00                                             $
Seismic monitor                                                          $
Labor cost                                                               $
Other cost                                                               $
--------------- ------------- ------------- ------------- ------------- --------
Rock volume         4,444.44                                             yd3
                   10,487.90                                             ton
--------------- ------------- ------------- ------------- ------------- --------
Cost                    2.93                                             $/yd3
                        1.24                                             $/ton
=============== ============= ============= ============= ============= ========
Total cost         13,013.97                                             $
```

```
Precision Blasting          BLASTING COST ANALYST      V5.01 Page:          4
Services, Inc.                                               Date: 05-20-2003
------------------------------------------------------------------------------

E N T R Y              1             2             3             4        unit
=============== ============= ============= ============= ============= ========
File name:
--------------- ------------- ------------- ------------- ------------- --------
Drill cost              1.22                                            $/yd3
Expl. cost              1.64                                            $/yd3
Accessories             0.01                                            $/yd3
Services                0.07                                            $/yd3
Labor cost                                                              $/yd3
Other cost                                                              $/yd3
=============== ============= ============= ============= ============= ========
Total cost              2.93                                            $/yd3
--------------- ------------- ------------- ------------- ------------- --------
```





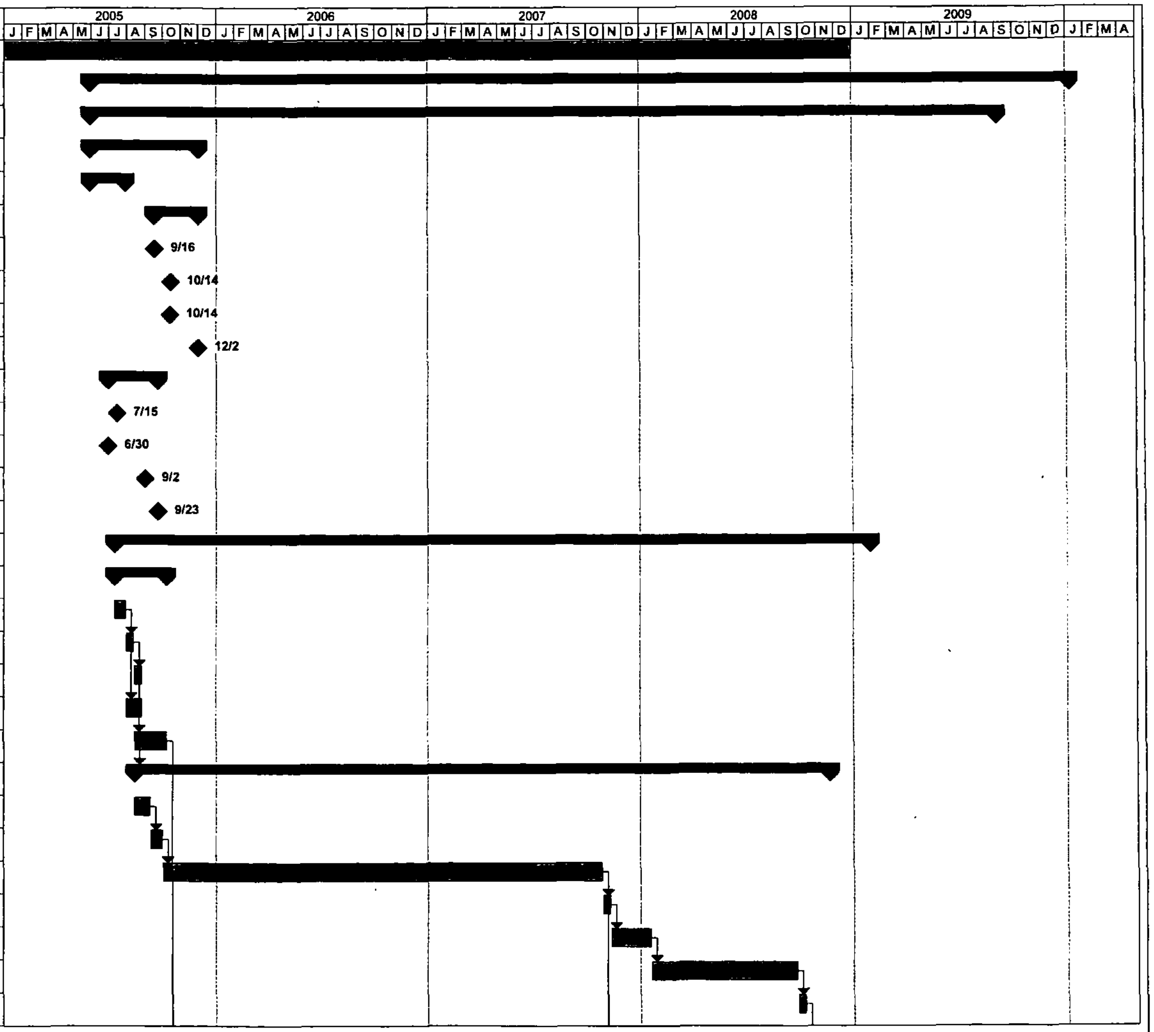
APPENDIX 6B – COOLING SYSTEM CONVERSION SCHEDULE

Economic and Environmental Impacts Associated with
Conversion of Indian Point Units 2 and 3 To A Closed-Loop
Condenser Cooling Water Configuration

Attachment 6

Appendix 6B

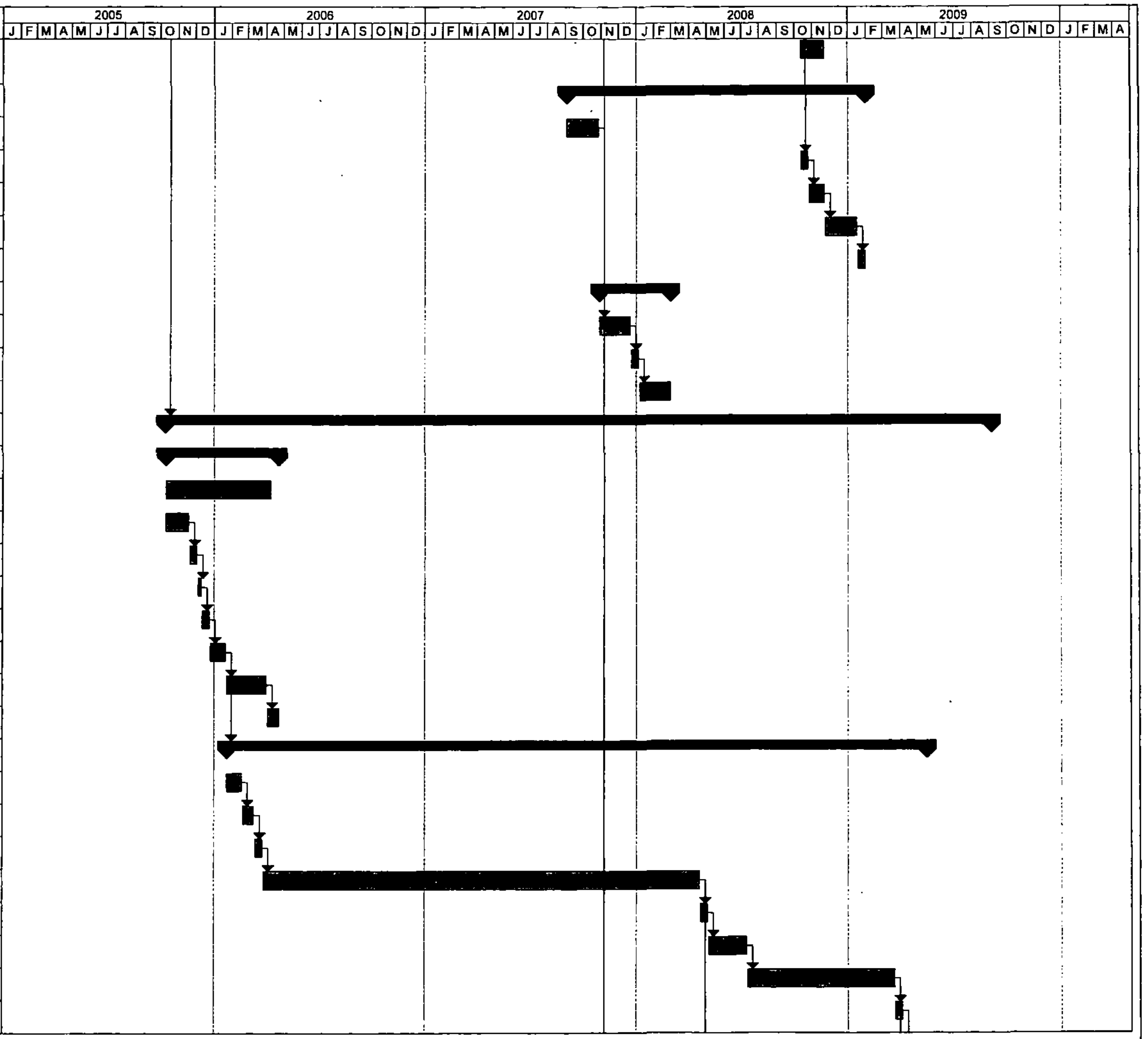
ID	Task Name	Duration	Start	Finish
1	**Design Engineering and Mod Packages**	208.6 wks	Mon 1/3/05	Wed 12/31/08
2	**Cooling Tower Conversion Construction Schedule**	**241 wks**	**Mon 5/30/05**	**Fri 1/8/10**
3	**Phase I - Online (Pre-Outage)**	**223 wks**	**Mon 5/30/05**	**Fri 9/4/09**
4	**Mobilization**	**26.8 wks**	**Mon 5/30/05**	**Fri 12/2/05**
5	**Site Support Setup**	**9 wks**	**Mon 5/30/05**	**Fri 7/29/05**
9	**Long Lead Material Order Placement**	**10.8 wks**	**Fri 9/16/05**	**Fri 12/2/05**
10	Cooling Towers	0 days	Fri 9/16/05	Fri 9/16/05
11	Large Bore Piping	0 days	Fri 10/14/05	Fri 10/14/05
12	Large MOV Valves and Pumps	0 days	Fri 10/14/05	Fri 10/14/05
13	Transformers and Switchgear	0 days	Fri 12/2/05	Fri 12/2/05
14	**Major Subcontract Execution**	**12.2 wks**	**Thu 6/30/05**	**Fri 9/23/05**
15	Cooling Tower Erection	0 days	Fri 7/15/05	Fri 7/15/05
16	Blasting and Excavation	0 days	Thu 6/30/05	Thu 6/30/05
17	Mechanical	0 days	Fri 9/2/05	Fri 9/2/05
18	Electrical	0 days	Fri 9/23/05	Fri 9/23/05
19	**IP Unit #2**	**186 wks**	**Mon 7/11/05**	**Fri 1/30/09**
20	**General Site Requirements**	**13 wks**	**Mon 7/11/05**	**Fri 10/7/05**
21	Access Road Construction	3 wks	Mon 7/11/05	Fri 7/29/05
22	Fence Relocation and Additions	2 wks	Mon 8/1/05	Fri 8/12/05
23	Security Modifications	2 wks	Mon 8/15/05	Fri 8/26/05
24	Install Environmental Protection	4 wks	Mon 8/1/05	Fri 8/26/05
25	Barge Access Construction	8 wks	Mon 8/15/05	Fri 10/7/05
26	**Cooling Tower Construction**	**171 wks**	**Mon 8/15/05**	**Fri 11/21/08**
27	Clearing and Grubbing	4 wks	Mon 8/15/05	Fri 9/9/05
28	First Cut Excavation	3 wks	Mon 9/12/05	Fri 9/30/05
29	Blasting and Rock Removal	108 wks	Mon 10/3/05	Fri 10/26/07
30	Backfill and Compaction	2 wks	Mon 10/29/07	Fri 11/9/07
31	Foundations	10 wks	Mon 11/12/07	Fri 1/18/08
32	Tower Erection	36 wks	Mon 1/21/08	Fri 9/26/08
33	Curtain Slab Grade and Bed	2 wks	Mon 9/29/08	Fri 10/10/08



Project: IP Cooling Water Conversion
Date: Tue 6/3/03

Task	■	Progress	■	Summary	■	External Tasks	▨	Deadline ⇩
Split	....	Milestone	◆	Project Summary	■	External Milestone	◆	

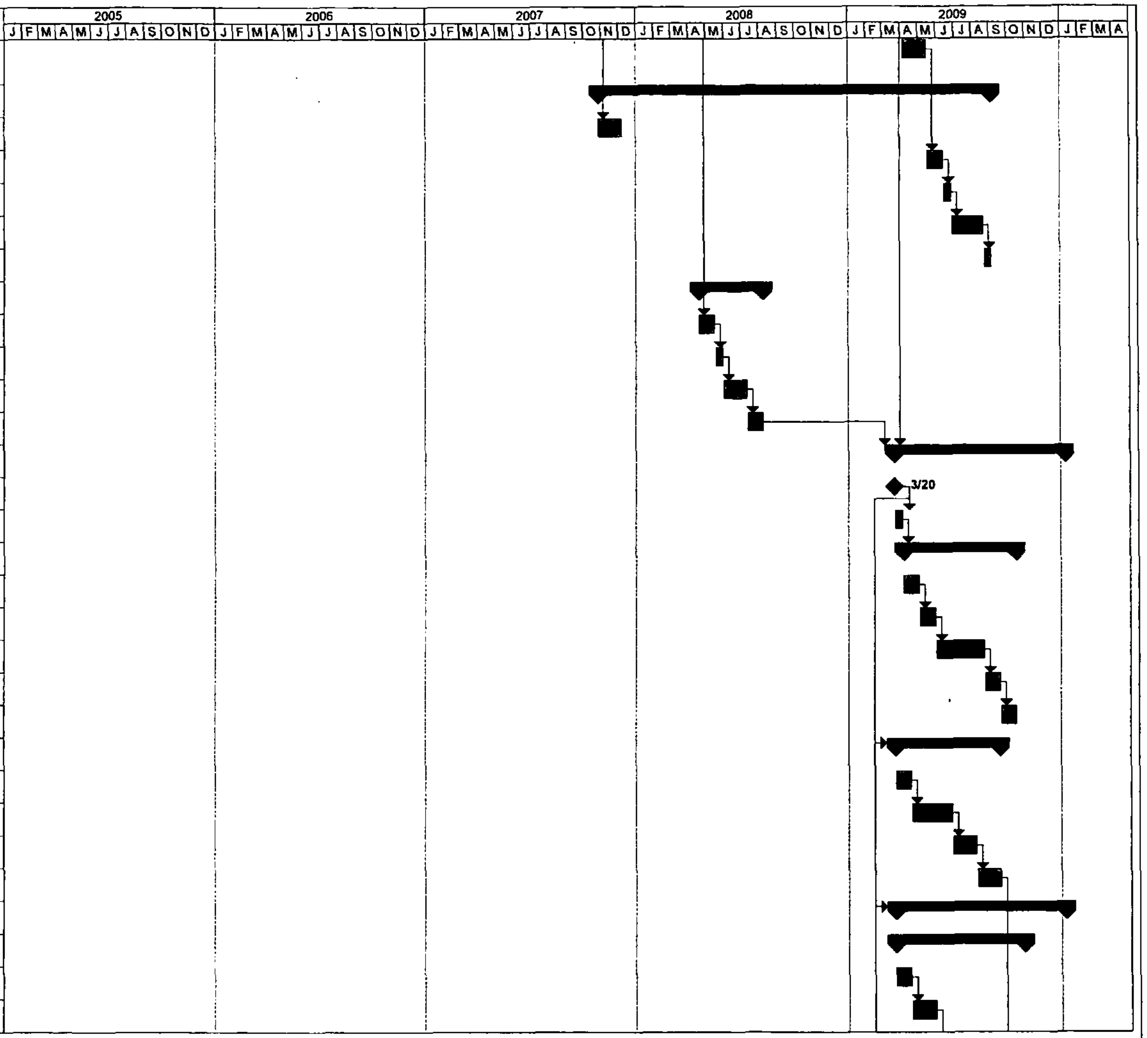
ID	Task Name	Duration	Start	Finish
34	Switchgear Building and Transformer Pads	6 wks	Mon 10/13/08	Fri 11/21/08
35	**Major Electrical**	**74 wks**	**Mon 9/3/07**	**Fri 1/30/09**
36	HV Tower and Supply Lines	8 wks	Mon 9/3/07	Fri 10/26/07
37	Trench and Install Ductbanks	2 wks	Mon 10/13/08	Fri 10/24/08
38	Install Major Equipment	4 wks	Mon 10/27/08	Fri 11/21/08
39	Tower Equipment Interconnections	8 wks	Mon 11/24/08	Fri 1/16/09
40	Instrumentation and Controls	2 wks	Mon 1/19/09	Fri 1/30/09
41	**Major Mechanical**	**18 wks**	**Mon 10/29/07**	**Fri 2/29/08**
42	Trenching and Excavation	8 wks	Mon 10/29/07	Fri 12/21/07
43	Install Thrust Blocks and Tie-backs	2 wks	Mon 12/24/07	Fri 1/4/08
44	Install Large Bore Piping	8 wks	Mon 1/7/08	Fri 2/29/08
45	**IP Unit #3**	**204 wks**	**Mon 10/10/05**	**Fri 9/4/09**
46	**General Site Requirements**	**28 wks**	**Mon 10/10/05**	**Fri 4/21/06**
47	Relocated Natural Gas Pipeline	26 wks	Mon 10/10/05	Fri 4/7/06
48	Relocate Parking Lot	6 wks	Mon 10/10/05	Fri 11/18/05
49	Access Road Construction	2 wks	Mon 11/21/05	Fri 12/2/05
50	Fence Relocation and Additions	1 wk	Mon 12/5/05	Fri 12/9/05
51	Security Modifications	2 wks	Mon 12/12/05	Fri 12/23/05
52	Install Environmental Protection	4 wks	Mon 12/26/05	Fri 1/20/06
53	Relocate Sewage Lift Stations	10 wks	Mon 1/23/06	Fri 3/31/06
54	Demo Existing Sewage Treatment	3 wks	Mon 4/3/06	Fri 4/21/06
55	**Cooling Tower Construction**	**173 wks**	**Mon 1/23/06**	**Fri 5/15/09**
56	Clearing and Grubbing	4 wks	Mon 1/23/06	Fri 2/17/06
57	First Cut Excavation	3 wks	Mon 2/20/06	Fri 3/10/06
58	Demo Existing Parking Lot	2 wks	Mon 3/13/06	Fri 3/24/06
59	Blasting and Rock Removal	108 wks	Mon 3/27/06	Fri 4/18/08
60	Backfill and Compaction	2 wks	Mon 4/21/08	Fri 5/2/08
61	Foundations	10 wks	Mon 5/5/08	Fri 7/11/08
62	Tower Erection	36 wks	Mon 7/14/08	Fri 3/20/09
63	Curtain Slab Grade and Bed	2 wks	Mon 3/23/09	Fri 4/3/09



Project: IP Cooling Water Conversion
Date. Fri 5/30/03

Task	▬	Progress	▬	Summary	▬	External Tasks	▨	Deadline	⇩
Split	....	Milestone	◆	Project Summary	▬	External Milestone	◆		

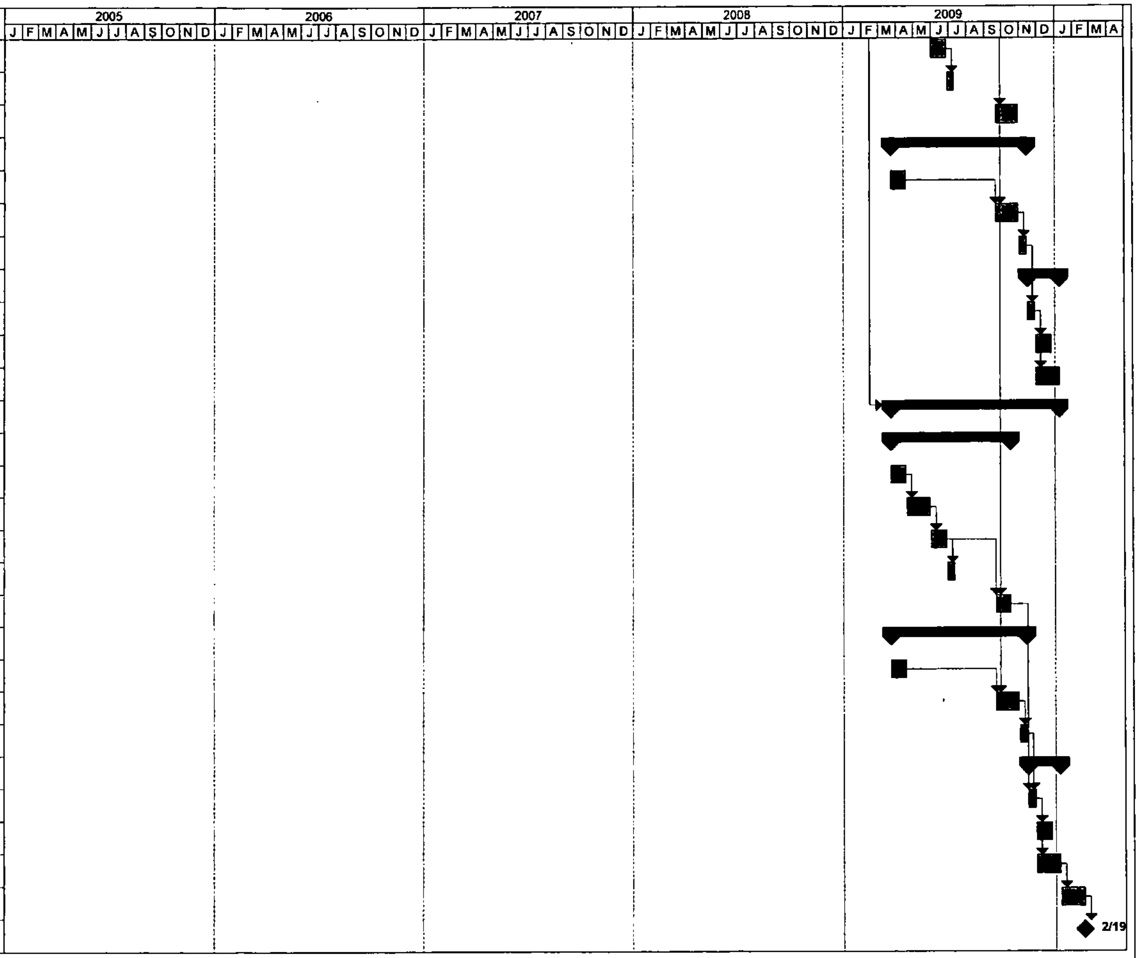
ID	Task Name	Duration	Start	Finish
64	Switchgear Building and Transformer Pads	6 wks	Mon 4/6/09	Fri 5/15/09
65	**Major Electrical**	**97 wks**	**Mon 10/29/07**	**Fri 9/4/09**
66	HV Supply Lines	6 wks	Mon 10/29/07	Fri 12/7/07
67	Install Major Equipment	4 wks	Mon 5/18/09	Fri 6/12/09
68	Trench and Install Ductbanks	2 wks	Mon 6/15/09	Fri 6/26/09
69	Tower Equipment Interconnections	8 wks	Mon 6/29/09	Fri 8/21/09
70	Instrumentation and Controls	2 wks	Mon 8/24/09	Fri 9/4/09
71	**Major Mechanical**	**16 wks**	**Mon 4/21/08**	**Fri 8/8/08**
72	Trenching and Excavation	4 wks	Mon 4/21/08	Fri 5/16/08
73	Install Thrust Blocks and Tie-backs	2 wks	Mon 5/19/08	Fri 5/30/08
74	Install Large Bore Piping	6 wks	Mon 6/2/08	Fri 7/11/08
75	Testing and Backfill	4 wks	Mon 7/14/08	Fri 8/8/08
76	**Phase II (Outage Required)**	**42 wks**	**Fri 3/20/09**	**Fri 1/8/10**
77	Outage Begins	0 wks	Fri 3/20/09	Fri 3/20/09
78	Mobilize Equipment and Setup	2 wks	Mon 3/23/09	Fri 4/3/09
79	**Discharge Canal Modifications**	**28 wks**	**Mon 4/6/09**	**Fri 10/16/09**
80	Temporary Quay Wall	4 wks	Mon 4/6/09	Fri 5/1/09
81	Selective Demo	4 wks	Mon 5/4/09	Fri 5/29/09
82	Dewater and Dredge	12 wks	Mon 6/1/09	Fri 8/21/09
83	Intake Construction	4 wks	Mon 8/24/09	Fri 9/18/09
84	Permanent Quay Wall	4 wks	Mon 9/21/09	Fri 10/16/09
85	**Major Excavation of Service Lane**	**26 wks**	**Mon 3/23/09**	**Fri 9/18/09**
86	Locate Underground Obstructions	4 wks	Mon 3/23/09	Fri 4/17/09
87	Drive Sheet Piling	10 wks	Mon 4/20/09	Fri 6/26/09
88	Trenching and Excavation	6 wks	Mon 6/29/09	Fri 8/7/09
89	Precast Pile and Saddles	6 wks	Mon 8/10/09	Fri 9/18/09
90	**IP Unit #2**	**42 wks**	**Mon 3/23/09**	**Fri 1/8/10**
91	**Pump House**	**32 wks**	**Mon 3/23/09**	**Fri 10/30/09**
92	Excavation and Selective Demo	4 wks	Mon 3/23/09	Fri 4/17/09
93	Construction	6 wks	Mon 4/20/09	Fri 5/29/09



Project: IP Cooling Water Conversion
Date: Fri 5/30/03

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┈┈┈	Milestone	◆	Project Summary	▬	External Milestone	◆		

ID	Task Name	Duration	Start	Finish
94	Mechanical	4 wks	Mon 6/1/09	Fri 6/26/09
95	Electrical	2 wks	Mon 6/29/09	Fri 7/10/09
96	Install Large Bore Return Piping	6 wks	Mon 9/21/09	Fri 10/30/09
97	**Condenser Tie-in**	**34 wks**	**Mon 3/23/09**	**Fri 11/13/09**
98	Reroute Existing Supply Lines	4 wks	Mon 3/23/09	Fri 4/17/09
99	Install New Supply Piping	6 wks	Mon 9/21/09	Fri 10/30/09
100	Tie-in	2 wks	Mon 11/2/09	Fri 11/13/09
101	**Shake out and Testing**	**8 wks**	**Mon 11/16/09**	**Fri 1/8/10**
102	Pressure Testing	2 wks	Mon 11/16/09	Fri 11/27/09
103	Backfill and Repave	4 wks	Mon 11/30/09	Fri 12/25/09
104	Final Systems Testing	6 wks	Mon 11/30/09	Fri 1/8/10
105	**IP Unit #3**	**42 wks**	**Mon 3/23/09**	**Fri 1/8/10**
106	**Pump House**	**30 wks**	**Mon 3/23/09**	**Fri 10/16/09**
107	Excavation and Selective Demo	4 wks	Mon 3/23/09	Fri 4/17/09
108	Construction	6 wks	Mon 4/20/09	Fri 5/29/09
109	Mechanical	4 wks	Mon 6/1/09	Fri 6/26/09
110	Electrical	2 wks	Mon 6/29/09	Fri 7/10/09
111	Install Large Bore Return Piping	4 wks	Mon 9/21/09	Fri 10/16/09
112	**Condenser Tie-in**	**34 wks**	**Mon 3/23/09**	**Fri 11/13/09**
113	Reroute Existing Supply Lines	4 wks	Mon 3/23/09	Fri 4/17/09
114	Install New Supply Piping	6 wks	Mon 9/21/09	Fri 10/30/09
115	Tie-in	2 wks	Mon 11/2/09	Fri 11/13/09
116	**Shake out and Testing**	**8 wks**	**Mon 11/16/09**	**Fri 1/8/10**
117	Pressure Testing	2 wks	Mon 11/16/09	Fri 11/27/09
118	Backfill and Repave	4 wks	Mon 11/30/09	Fri 12/25/09
119	Final Systems Testing	6 wks	Mon 11/30/09	Fri 1/8/10
120	Demobilization	6 wks	Mon 1/11/10	Fri 2/19/10
121	Project Completion	0 wks	Fri 2/19/10	Fri 2/19/10



Project: IP Cooling Water Conversion
Date: Fri 5/30/03

Task	■	Progress	▬	Summary	▬	External Tasks	▨	Deadline	⇩
Split	....	Milestone	◆	Project Summary	▬	External Milestone	◆		

Attachment 7
Electrical Distribution Model Output Reports

ETAP® PowerStation ® Model Results

This attachment is provided to model the anticipated electrical distribution system required to support conversion of Indian Point Units 2 and 3 to a closed loop condenser cooling water configuration, and account for expected electrical parasitic losses due to the new components. The following documents are included in this attachment (for Indian Point 2 and Indian Point 3):

One Line Sketches of the proposed Distribution System as modeled including,

- 138kV One Line Distribution for Indian Point 2 and Indian Point 3
- One Line Distribution for Indian Point 2
- One Line Distribution for Indian Point 3

Analytical evaluation via ETAP PowerStation model of projected plant power demand using load flow and voltage drop calculations. The evaluation is presented as excerpts from the output reports of two loading configurations:

- Load Flow and voltage drop of tower fan and circulating water pump loads at full load.
- Load Flow and voltage drop of tower fan and circulating water pump loads at the reduced load representative of wet cycle fans and circulating water pumps only.

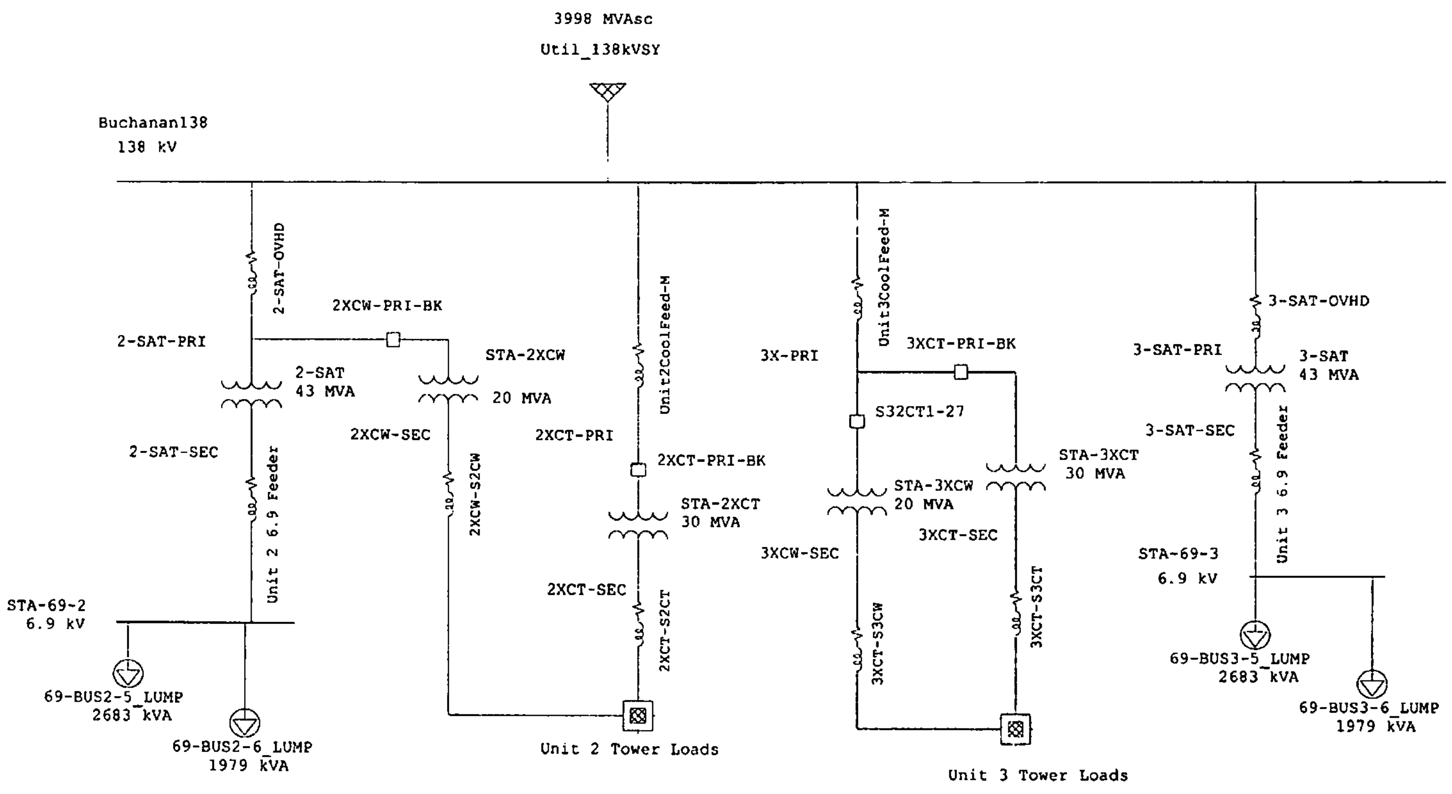
Analytical evaluation via ETAP PowerStation model of projected plant short circuit burden using IEEE methodology and calculations. The evaluation is presented as excerpts from the output report which assumed maximum fault and rated loading conditions.

The software model was developed and run using the following assumed parameters:

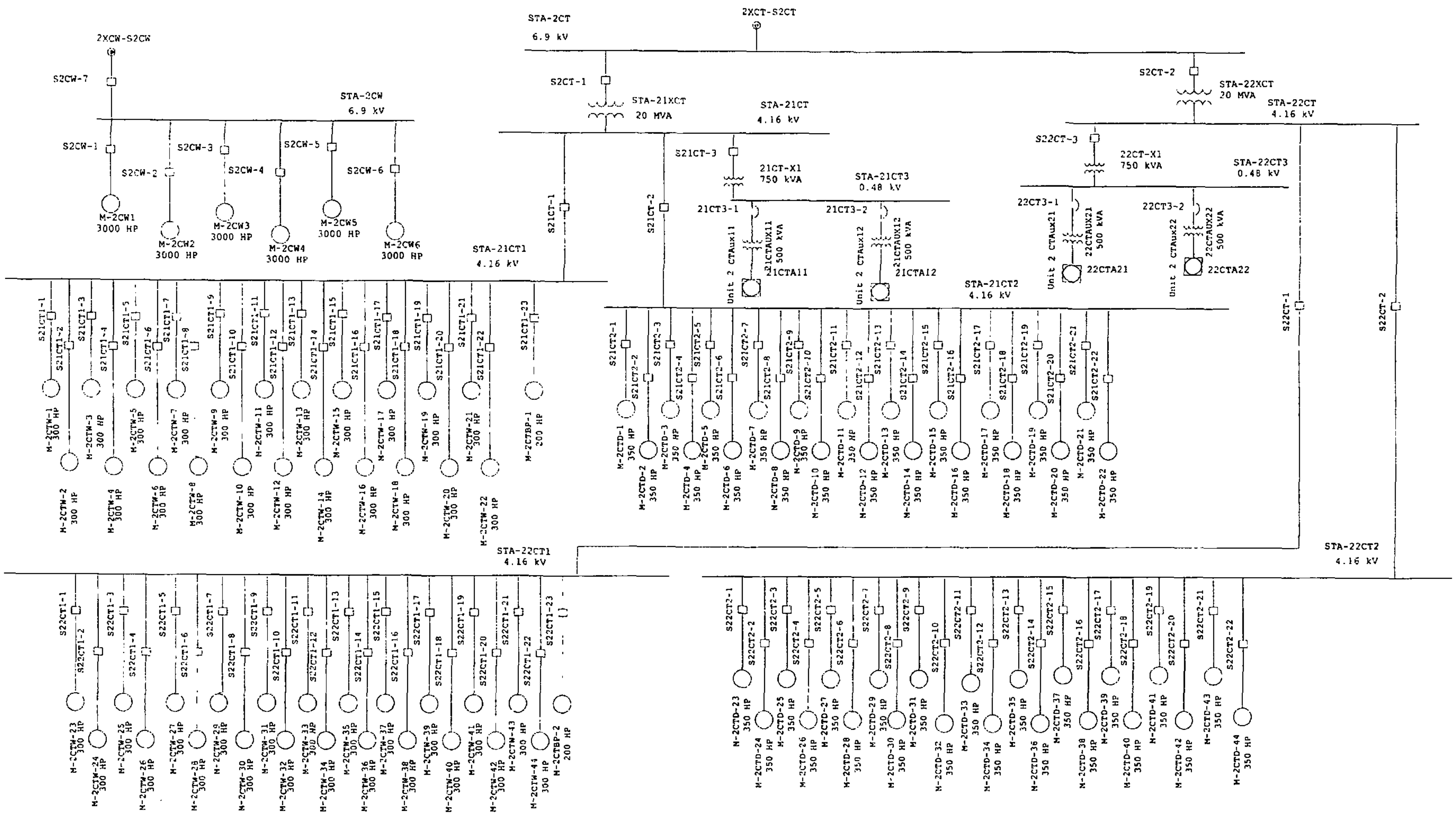
- Motors, cables, and transformer characteristics were sized based upon preliminary vendor information of tower configuration and required horsepower. Subsequent analytical parameters were assumed based upon the standard or typical values available in the software database for the input size of each component.
- The 138kV Buchanan Substation parameters were taken from a representative Indian Point 2 calculation (FEX-00143-00). Likewise, Indian Point 2 loads on the Buchanan Substation during normal operation were derived from the same calculation by assuming lumped load groups equivalent to the Indian Point 2 calculated load. Based upon plant similarities, the same assumed load was used for Indian Point 3.
- The fans for dry cycle cooling were either assumed to be on at full load (350HP) during nominal conditions, or off during wet cycle only conditions. Reduction in parasitic load due to variable speed dry cycle fan motors is not considered directly in this analysis, rather, it is accounted for in the percent of the time the tower is assumed to be in either full load or wet cycle only conditions.

Power to circulating water loads passes through transformers STA-2XCW and STA-3XCW. Power to tower loads (wet and dry fans and booster pumps) passes through transformers STA-2XCT and STA-3XCT. The expected power flow is highlighted in the report excerpts.

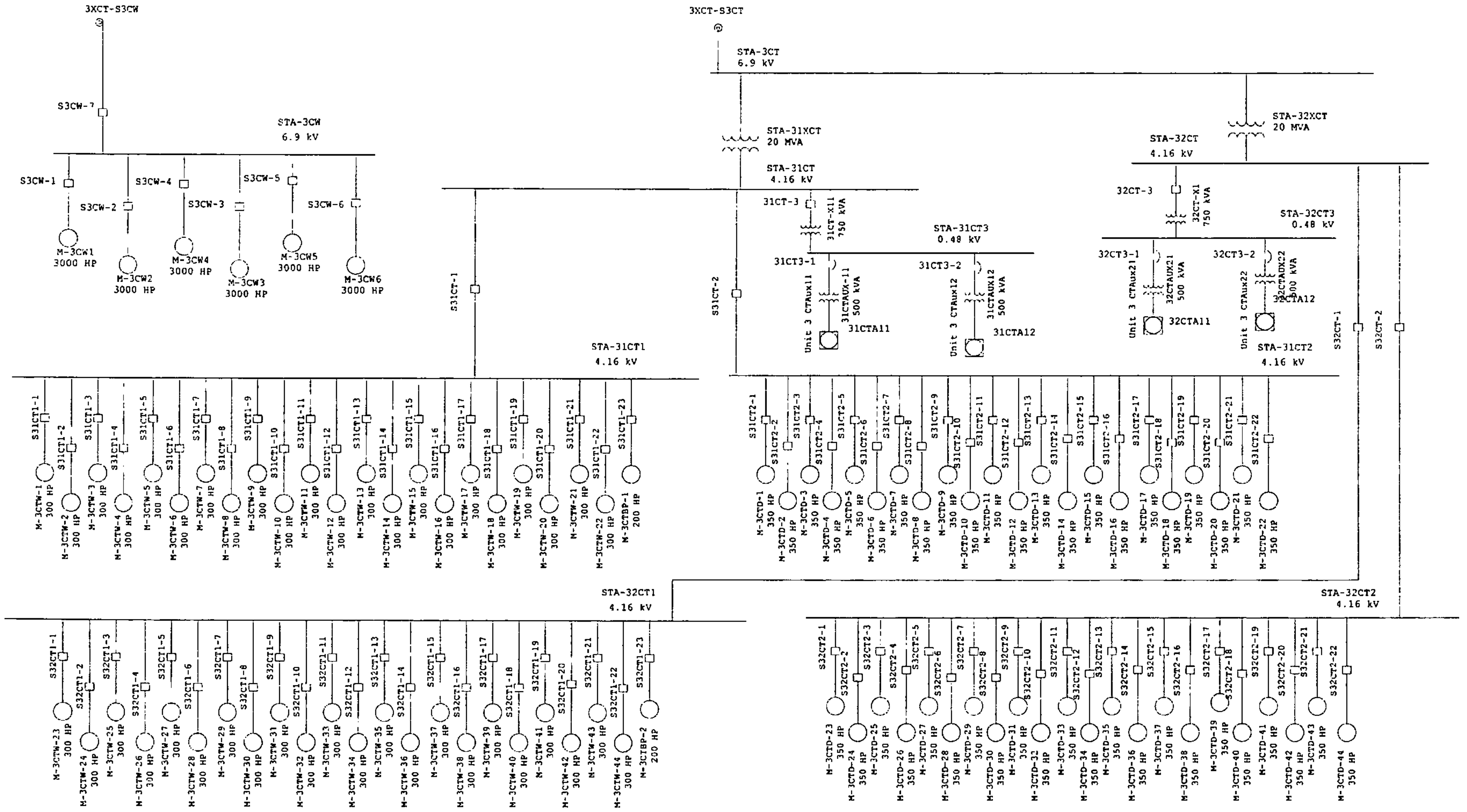
One-Line Diagram - IP-138kV



One-Line Diagram - IP-138kV=>Unit 2 Tower Loads



One-Line Diagram - IP-138kV=>Unit 3 Tower Loads



```
YSTEM ANALYSIS
    Project:  IP Load Flow                                    ====================           Page:       1
    Location: IP 2 & 3                                         PowerStation 4.0.4C            Date:   06-02-2003
    Contract: CO199                                                                           SN:     ENERCONSVC
    Engineer: Eric J Praser                                   Study Case:  LF -FullLoad      File:   IndianPoint
------------------------------------------------------------------------------------------------------------------
    Indian Point 2 & 3 Cooling Tower
    Wet and Dry loads at nominal.
==================================================================================================================


                                              Electrical Transient Analyzer Program
                                              -------------------------------------


                                                      LOAD FLOW ANALYSIS
                                                Loading Category 2 ( Normal       )

                                                        Normal Loading
                                                        --------------


                            Swing      Gen.      Load      Total
                            -----      -----     -----     -----
    Number of Buses:          1          0        40        41


                            XFRM2      React.  Line/Cable   Imp.     Tie PD     XFRM3     Total
                            -----      -----   ----------   -----    -------    -----     -----
    Number of Branches:      22          0        10         0         8          0        40





    Maximum Number of Iterations:      99

    Precision  of  the  Solution:      .00010  MW and Mvar

    Method of Solution:    Newton-Raphson

    System Frequency:      60.0    Hz

    Unit System:          English

    Data Filename:        IndianPoint

    Output Filename:      L:\PROJECTS\CO\CO199\BYRON-ELECTRICAL\IPMODEL\FullLoad.lfr
```

```
LOAD FLOW REPORT
         Project:  IP Load Flow                          ====================                          Page:      11
         Location: IP 2 & 3                               PowerStation 4.0.4C                          Date:   06-02-2003
         Contract: C0199                                                                               SN:     ENERCONSVC
         Engineer: Eric J Praser                         Study Case:  LF -FullLoad                     File:   IndianPoint
-------------------------------------------------------------------------------------------------------------------------
         Indian Point 2 & 3 Cooling Tower
         Wet and Dry loads at nominal.
=========================================================================================================================

         Bus Information & Nom kV    Voltage     Generation    Motor Load    Static  Load              Load Flow                  XFRM
         ======================== =========== ============ ============ ============ ==================================== =====
              ID        Type   kV   % Mag. Ang.   MW    Mvar    MW    Mvar    MW    Mvar  To Bus ID      MW    Mvar   Amp  %PF   % Tap
         ------------ ---- ----- ------ ---- ----- ----- ----- ----- ----- ----- ------------ ----- ----- ---- ----- -----

         2-SAT-PRI    Load 138.00  99.97  0.0  0.00  0.00  0.00  0.00  0.00  0.00 Buchanan138  -17.56 -10.92   86  84.9
                                                                                  2-SAT-SEC      4.09   2.56   20  84.8 -2.500
                                                                                  2XCW-SEC      13.47   8.35   66  85.0 -2.500

         2-SAT-SEC    Load   6.90 101.58 -0.8  0.00  0.00  0.00  0.00  0.00  0.00 STA-69-2       4.09   2.48  393  85.5
                                                                                  2-SAT-PRI     -4.09  -2.48  393  85.5

         2XCT-PRI     Load 138.00  99.96  0.0  0.00  0.00  0.00  0.00  0.00  0.00 Buchanan138  -23.99 -13.57  115  87.0
                                                                                  2XCT-SEC      23.99  13.57  115  87.0 -2.500

         2XCT-SEC     Load   6.90 100.96 -4.0  0.00  0.00  0.00  0.00  0.00  0.00 STA-2CT       23.90  11.40 2194  90.3
                                                                                  2XCT-PRI     -23.90 -11.40 2194  90.3  2.500

         2XCW-SEC     Load   6.90 101.19 -3.3  0.00  0.00  0.00  0.00  0.00  0.00 STA-2CW       13.41   7.28 1261  87.9
                                                                                  2-SAT-PRI    -13.41  -7.28 1261  87.9  2.500

         3-SAT-PRI    Load 138.00  99.99  0.0  0.00  0.00  0.00  0.00  0.00  0.00 Buchanan138   -4.09  -2.56   20  84.8
                                                                                  3-SAT-SEC      4.09   2.56   20  84.8 -2.500

         3-SAT-SEC    Load   6.90 101.61 -0.8  0.00  0.00  0.00  0.00  0.00  0.00 STA-69-3       4.09   2.48  393  85.5
                                                                                  3-SAT-PRI     -4.09  -2.48  393  85.5

         3XCT-SEC     Load   6.90 100.97 -4.0  0.00  0.00  0.00  0.00  0.00  0.00 STA-3CT       23.92  11.48 2199  90.2
                                                                                  3X-PRI       -23.92 -11.48 2199  90.2  2.500

         3XCW-SEC     Load   6.90 101.13 -3.3  0.00  0.00  0.00  0.00  0.00  0.00 STA-3CW       13.42   7.31 1263  87.8
                                                                                  3X-PRI       -13.42  -7.31 1263  87.8  2.500

         3X-PRI       Load 138.00  99.93  0.0  0.00  0.00  0.00  0.00  0.00  0.00 Buchanan138  -37.47 -22.04  181  86.2
                                                                                  3XCT-SEC      24.00  13.65  115  86.9 -2.500
                                                                                  3XCW-SEC      13.47   8.38   66  84.9 -2.500

         21CTA11      Load   0.12  96.53-10.1  0.00  0.00  0.00  0.00  0.25  0.12 STA-21CT3     -0.25  -0.12 1396  90.0

         21CTA12      Load   0.12  96.06-10.1  0.00  0.00  0.18  0.11  0.07  0.04 STA-21CT3     -0.25  -0.15 1472  85.0

         22CTA21      Load   0.12 101.62 -6.0  0.00  0.00  0.00  0.00  0.00  0.00 STA-22CT3      0.00   0.00    2   0.0

         22CTA22      Load   0.12 101.62 -6.0  0.00  0.00  0.00  0.00  0.00  0.00 STA-22CT3      0.00   0.00    4   0.0

         31CTA11      Load   0.12  96.82-10.2  0.00  0.00  0.00  0.00  0.25  0.12 STA-31CT3     -0.25  -0.12 1400  90.0


   *   A regulated (constant voltage) bus.
```

```
LOAD FLOW SUMMARY
     Project:  IP Load Flow                      ====================                        Page:     23
     Location: IP 2 & 3                           PowerStation 4.0.4C                         Date:  06-02-2003
     Contract: C0199                                                                          SN:    ENERCONSVC
     Engineer: Eric J Praser                     Study Case:  LF -FullLoad                    File:  IndianPoint
-----------------------------------------------------------------------------------------------------------------
     Indian Point 2 & 3 Cooling Tower
     Wet and Dry loads at nominal.
=================================================================================================================


                                          SUMMARY OF TOTAL GENERATION, LOADING & DEMAND
                                          ---------------------------------------------


                                    MW             Mvar           MVA             % PF
                                =========      =========      =========      ==============

          Swing Bus(es):          83.150         49.118         96.574        86.1  Lagging

          Generators:              0.000          0.000          0.000       100.0  Lagging

          Total Demand:           83.150         49.118         96.574        86.1  Lagging
                                ---------      ---------      ---------      --------------
          Total Motor Load:       80.213         38.626         89.029        90.1  Lagging

          Total Static Load:       2.444          1.422

          Apparent Losses:         0.493          9.070


          System Mismatch:         0.000          0.000


          Number of Iterations =    3
```

```
SYSTEM ANALYSIS
      Project:  IP Load Flow                                 ===================                                Page:      1
      Location: IP 2 & 3                                      PowerStation 4.0.4C                               Date:  06-02-2003
      Contract: CO199                                                                                           SN:    ENERCONSVC
      Engineer: Eric J Praser                                Study Case:  LF-WetLoad                            File:  IndianPoint
---------------------------------------------------------------------------------------------------------------------------------
      Indian Point 2 & 3 Cooling Tower
      Dry Loads off, Wet cycle loads at nominal.
=================================================================================================================================


                                                      Electrical Transient Analyzer Program
                                                      -------------------------------------


                                                               LOAD FLOW ANALYSIS
                                                         Loading Category 8 ( Wet Only      )

                                                                 Normal Loading
                                                                 --------------


                                Swing      Gen.      Load      Total
                                -----      -----     -----     -----
      Number of Buses:            1          0        40        41



                                XFRM2      React.   Line/Cable   Imp.     Tie PD      XFRM3      Total
                                -----      -----    ----------   -----    -------     -----      -----
      Number of Branches:        22          0         10         0          8          0         40






      Maximum Number of Iterations:      99

      Precision  of  the  Solution:      .00010  MW and Mvar

      Method of Solution:   Newton-Raphson

      System Frequency:     60.0    Hz

      Unit System:         English

      Data Filename:       IndianPoint

      Output Filename:     L:\PROJECTS\CO\CO199\BYRON-ELECTRICAL\IPMODEL\WetLoad.lfr
```

```
LOAD FLOW REPORT
     Project:  IP Load Flow                               ====================                          Page:      11
     Location: IP 2 & 3                                     PowerStation 4.0.4C                         Date:   06-02-2003
     Contract: CO199                                                                                    SN:     ENERCONSVC
     Engineer: Eric J Praser                             Study Case:  LF-WetLoad                        File:   IndianPoint
-------------------------------------------------------------------------------------------------------------------------
     Indian Point 2 & 3 Cooling Tower
     Dry Loads off, Wet cycle loads at nominal.
=========================================================================================================================


     Bus Information & Nom kV     Voltage      Generation     Motor Load    Static  Load               Load Flow                XFRM
     ========================   ===========  ============   ============  ============  ======================================  =====
        ID        Type   kV     % Mag. Ang.    MW     Mvar    MW     Mvar    MW     Mvar    To Bus ID       MW    Mvar   Amp  %PF   % Tap
     ------------ ---- -----   ------ ----   -----  -----   -----  -----   -----  -----   -------------  -----  -----  ---- -----  -----

     2-SAT-PRI    Load 138.00   99.97  0.0    0.00   0.00    0.00   0.00    0.00   0.00   Buchanan138   -17.56 -10.92    86  84.9
                                                                                          2-SAT-SEC       4.09   2.56    20  84.8 -2.500
                                                                                          2XCW-SEC       13.47   8.35    66  85.0 -2.500

     2-SAT-SEC    Load   6.90  101.58 -0.8    0.00   0.00    0.00   0.00    0.00   0.00   STA-69-2        4.09   2.48   393  85.5
                                                                                          2-SAT-PRI      -4.09  -2.48   393  85.5

     2XCT-PRI     Load 138.00   99.98  0.0    0.00   0.00    0.00   0.00    0.00   0.00   Buchanan138   -10.67  -5.16    49  90.0
                                                                                          2XCT-SEC       10.67   5.16    49  90.0 -2.500

     2XCT-SEC     Load   6.90  103.47 -1.7    0.00   0.00    0.00   0.00    0.00   0.00   STA-2CT        10.65   4.76   943  91.3
                                                                                          2XCT-PRI      -10.65  -4.76   943  91.3  2.500

     2XCW-SEC     Load   6.90  101.19 -3.3    0.00   0.00    0.00   0.00    0.00   0.00   STA-2CW        13.41   7.28  1261  87.9
                                                                                          2-SAT-PRI     -13.41  -7.28  1261  87.9  2.500

     3-SAT-PRI    Load 138.00   99.99  0.0    0.00   0.00    0.00   0.00    0.00   0.00   Buchanan138    -4.09  -2.56    20  84.8
                                                                                          3-SAT-SEC       4.09   2.56    20  84.8 -2.500

     3-SAT-SEC    Load   6.90  101.61 -0.8    0.00   0.00    0.00   0.00    0.00   0.00   STA-69-3        4.09   2.48   393  85.5
                                                                                          3-SAT-PRI      -4.09  -2.48   393  85.5

     3XCT-SEC     Load   6.90  103.51 -1.7    0.00   0.00    0.00   0.00    0.00   0.00   STA-3CT        10.42   4.66   922  91.3
                                                                                          3X-PRI        -10.42  -4.66   922  91.3  2.500

     3XCW-SEC     Load   6.90  101.16 -3.3    0.00   0.00    0.00   0.00    0.00   0.00   STA-3CW        13.42   7.31  1263  87.8
                                                                                          3X-PRI        -13.42  -7.31  1263  87.8  2.500

     3X-PRI       Load 138.00   99.96  0.0    0.00   0.00    0.00   0.00    0.00   0.00   Buchanan138   -23.90 -13.43   114  87.2
                                                                                          3XCT-SEC       10.43   5.05    48  90.0 -2.500
                                                                                          3XCW-SEC       13.47   8.38    66  84.9 -2.500

     21CTA11      Load   0.12  105.30 -2.6    0.00   0.00    0.00   0.00    0.00   0.00   STA-21CT3       0.00   0.00     0   0.0

     21CTA12      Load   0.12  105.30 -2.6    0.00   0.00    0.00   0.00    0.00   0.00   STA-21CT3       0.00   0.00     0   0.0

     22CTA21      Load   0.12  105.30 -2.6    0.00   0.00    0.00   0.00    0.00   0.00   STA-22CT3       0.00   0.00     0   0.0

     22CTA22      Load   0.12  105.30 -2.6    0.00   0.00    0.00   0.00    0.00   0.00   STA-22CT3       0.00   0.00     0   0.0

     31CTA11      Load   0.12  105.81 -2.6    0.00   0.00    0.00   0.00    0.00   0.00   STA-31CT3       0.00   0.00     0   0.0



  *   A regulated (constant voltage) bus.
```

```
Project:  IP Load Flow                          ====================                        Page:      23
      Location: IP 2 & 3                              PowerStation 4.0.4C                          Date:  06-02-2003
      Contract: C0199                                                                              SN:    ENERCONSVC
      Engineer: Eric J Praser                        Study Case:  LF-WetLoad                       File:  IndianPoint
--------------------------------------------------------------------------------------------------------------------------------
      Indian Point 2 & 3 Cooling Tower
      Dry Loads off, Wet cycle loads at nominal.
================================================================================================================================



                                              SUMMARY OF TOTAL GENERATION, LOADING & DEMAND
                                              ---------------------------------------------


                                    MW           Mvar          MVA            % PF
                                =========     =========     =========     =============

            Swing Bus(es):        56.236        32.086        64.746        86.9  Lagging

            Generators:            0.000         0.000         0.000       100.0  Lagging

            Total Demand:         56.236        32.086        64.746        86.9  Lagging
                                ---------     ----------    ----------    --------------
            Total Motor Load:     54.234        27.444        60.782        89.2  Lagging

            Total Static Load:     1.797         1.090

            Apparent Losses:       0.204         3.552


            System Mismatch:       0.000         0.000


            Number of Iterations =    3
```

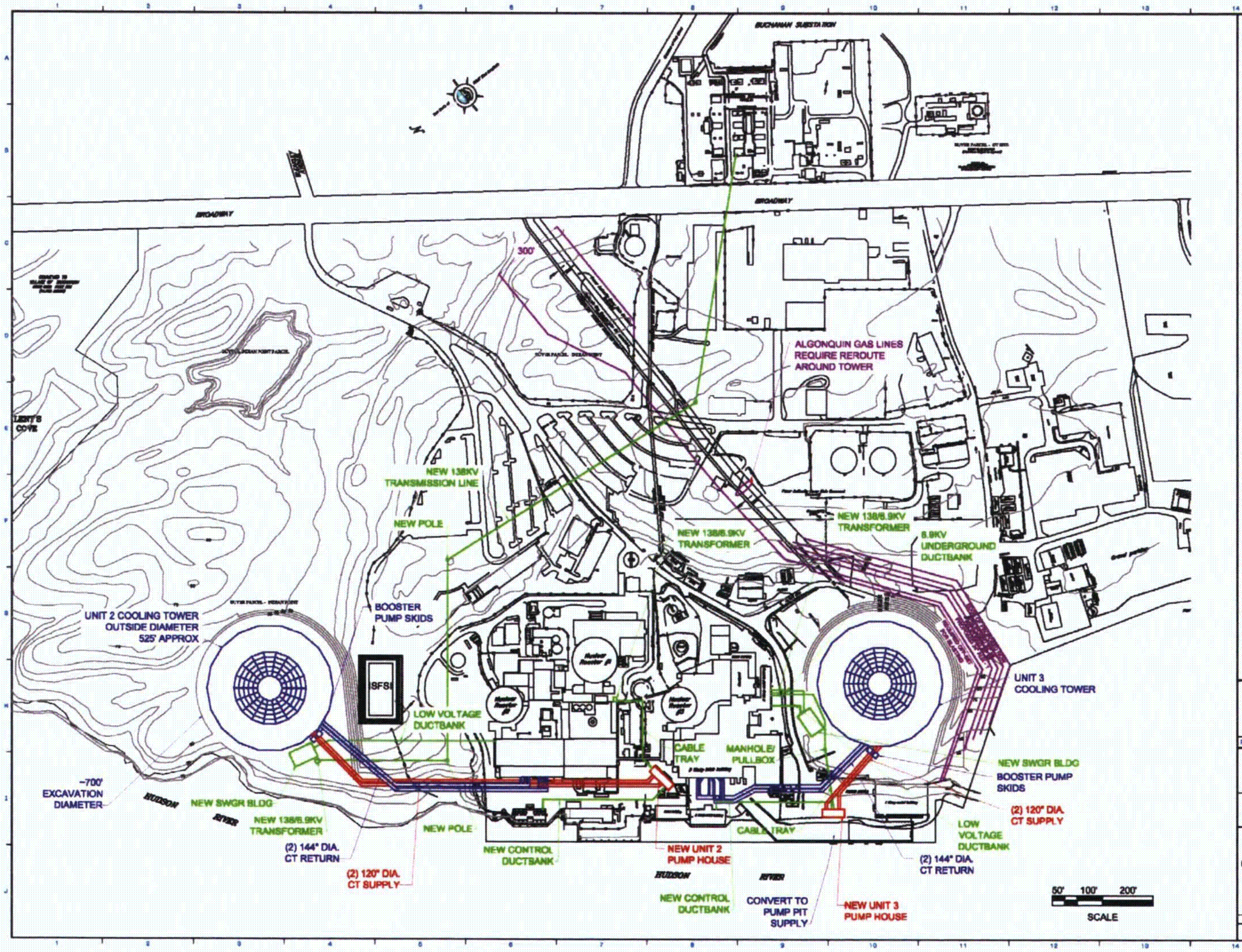
```
SYSTEM ANALYSIS
      Project:  IP Load Flow                             ====================                              Page:      1
      Location: IP 2 & 3                                  PowerStation 4.0.4C                              Date:  06-02-2003
      Contract: CO199                                                                                      SN:    ENERCONSVC
      Engineer: Eric J Praser                            Study Case:  SC                                   File:  IndianPoint
 -----------------------------------------------------------------------------------------------------------------------------------
      Indian Point 2 & 3 Cooling Tower

 ===================================================================================================================================



                                                 Electrical Transient Analyzer Program
                                                 -------------------------------------


                                                        SHORT CIRCUIT ANALYSIS
                                                        ----------------------
                                                        3-Phase, LG, LL, & LLG
                                                 1/2 Cycle (Momentary) Fault Currents



                             Swing      Gen.     Load      Total
                             -----     -----     -----     -----
      Number of Buses:           1         0       40        41


                             XFRM2     REACT. LINE/CABLE   IMP.    TIE PD     XFRM3     TOTAL
                             -----     -----  ----------  -----    -------    -----     -----
      Number of Branches:      22        0       10         0         8         0        40


                             Synch.    Synch.     Ind.     Lump      Uti-
                              Gen.     Motor     Motor     Motor     lity      Total
                             -----     -----     -----     -----     -----     -----
      Number of Machines:        0         0      288         6         1     295



       System Frequency:  60.0 Hz

       Unit System:       English

       Data File Name:    IndianPoint

       Output File Name:  L:\PROJECTS\CO\CO199\BYRON-ELECTRICAL\IPMODEL\IP2&3.shr
```

```
                                              S. C. SUMMARY REPORT
Project:  IP Load Flow                        ===================                             Page:     67
Location: IP 2 & 3                             PowerStation 4.0.4C                            Date:   06-02-2003
Contract: C0199                                                                               SN:     ENERCONSVC
Engineer: Eric J Praser                       Study Case:  SC                                 File:   IndianPoint
------------------------------------------------------------------------------------------------------------------
Indian Point 2 & 3 Cooling Tower

==================================================================================================================

 1/2 Cycle - Three-Phase, LG, LL, & LLG Faults:     ( Prefault Voltage =  100 % of the Bus Nominal Voltage)

  Bus  Information         3-Phase Fault              Line-to-Ground Fault      . Line-to-Line Fault        Line-to-Line-to-Ground*
=====================  =======================    ======================  =====================   ======================
     ID         kV      Real    Imag.     Mag.    Real    Imag.     Mag.    Real    Imag.    Mag.    Real   Imag.    Mag.
------------ --------  ------  -------  -------  ------  -------  -------  ------  -------  -------  ------  -------  -------
2-SAT-PRI     138.00   1.344  -17.499   17.550   0.412   -4.736    4.754  15.155    1.164   15.199 -15.276    0.205   15.277
2-SAT-SEC       6.90   1.182  -23.835   23.864   1.111  -23.607   23.633  20.642    1.024   20.667  20.120   12.715   23.801
2XCT-PRI      138.00   1.348  -17.495   17.547   0.412   -4.736    4.754  15.151    1.167   15.196 -15.273    0.202   15.274
2XCT-SEC        6.90   1.833  -34.909   34.957   1.529  -31.582   31.619  30.232    1.588   30.274  29.583   16.004   33.635
2XCW-SEC        6.90   1.218  -26.425   26.453   1.120  -22.681   22.709  22.885    1.055   22.909 -23.400    8.878   25.027
3-SAT-PRI     138.00   1.371  -17.462   17.516   0.413   -4.735    4.753  15.122    1.187   15.169 -15.244    0.182   15.245
3-SAT-SEC       6.90   1.185  -23.837   23.867   1.113  -23.608   23.634  20.644    1.026   20.669  20.121   12.718   23.804
3XCT-SEC        6.90   1.668  -34.860   34.900   1.335  -31.560   31.588  30.189    1.444   30.224  29.645   15.859   33.621
3XCW-SEC        6.90   1.242  -26.308   26.337   1.131  -22.624   22.652  22.784    1.076   22.809 -23.301    8.846   24.923
3X-PRI        138.00   1.322  -17.532   17.582   0.410   -4.738    4.756  15.183    1.145   15.226 -15.304    0.225   15.306
21CTA11         0.12   2.303  -22.797   22.913   2.319  -25.911   26.014  19.743    1.994   19.843  18.627   16.993   25.214
21CTA12         0.12   3.993  -26.544   26.843   3.597  -29.054   29.276  22.988    3.458   23.247  21.513   19.473   29.017
22CTA21         0.12   2.189  -22.251   22.358   2.231  -25.436   25.534  19.270    1.896   19.363  18.179   16.734   24.708
22CTA22         0.12   2.189  -22.251   22.358   2.231  -25.436   25.534  19.270    1.896   19.363  18.179   16.734   24.708
31CTA11         0.12   2.302  -22.791   22.907   2.318  -25.906   26.009  19.738    1.994   19.838  18.622   16.991   25.209
31CTA12         0.12   3.992  -26.538   26.837   3.596  -29.049   29.271  22.983    3.457   23.241  21.508   19.470   29.012
32CTA11         0.12   2.188  -22.244   22.352   2.230  -25.431   25.528  19.264    1.895   19.357  18.174   16.731   24.702
32CTA12         0.12   2.188  -22.244   22.352   2.230  -25.431   25.528  19.264    1.895   19.357  18.174   16.731   24.702
Buchanan138   138.00   0.636  -18.444   18.455   0.364   -4.807    4.821  15.973    0.551   15.982 -16.086    0.831   16.107
STA-2CT         6.90   1.863  -34.755   34.805   1.920  -31.141   31.201  30.099    1.614   30.142 -31.060   12.489   33.477
STA-2CW         6.90   1.226  -26.365   26.394   1.318  -22.467   22.506  22.833    1.062   22.858 -23.496    8.723   25.063
STA-3CT         6.90   1.821  -34.118   34.166   3.108  -29.413   29.576  29.547    1.577   29.589 -31.425   11.300   33.395
STA-3CW         6.90   1.280  -26.017   26.049   2.044  -21.565   21.661  22.532    1.109   22.559 -23.702    8.075   25.040
STA-21CT        4.16   1.934  -32.581   32.638   2.044  -35.362   35.421  28.216    1.675   28.266  27.134   21.006   34.315
STA-21CT1       4.16   1.934  -32.581   32.638   2.044  -35.362   35.421  28.216    1.675   28.266  27.134   21.006   34.315
STA-21CT2       4.16   1.934  -32.581   32.638   2.044  -35.362   35.421  28.216    1.675   28.266  27.134   21.006   34.315
STA-21CT3       0.48   2.831  -15.649   15.903   2.776  -15.586   15.831  13.552    2.452   13.772  12.191   10.213   15.904
STA-22CT        4.16   1.902  -32.491   32.547   2.019  -35.292   35.349  28.138    1.647   28.186  27.064   20.957   34.229
STA-22CT1       4.16   1.902  -32.491   32.547   2.019  -35.292   35.349  28.138    1.647   28.186  27.064   20.957   34.229
STA-22CT2       4.16   1.902  -32.491   32.547   2.019  -35.292   35.349  28.138    1.647   28.186  27.064   20.957   34.229
STA-22CT3       0.48   2.471  -14.680   14.886   2.534  -14.931   15.145  12.713    2.140   12.892 -14.014    5.456   15.038
STA-31CT        4.16   1.905  -32.123   32.180   2.017  -34.909   34.968  27.820    1.650   27.868  26.750   20.762   33.862
STA-31CT1       4.16   1.905  -32.123   32.180   2.017  -34.909   34.968  27.820    1.650   27.868  26.750   20.762   33.862
STA-31CT2       4.16   1.905  -32.123   32.180   2.017  -34.909   34.968  27.820    1.650   27.868  26.750   20.762   33.862
STA-31CT3       0.48   2.828  -15.638   15.892   2.775  -15.579   15.824  13.543    2.449   13.763  12.182   10.209   15.894
STA-32CT        4.16   1.873  -32.034   32.089   1.992  -34.839   34.896  27.742    1.622   27.790  26.680   20.714   33.777
STA-32CT1       4.16   1.873  -32.034   32.089   1.992  -34.839   34.896  27.742    1.622   27.790  26.680   20.714   33.777
STA-32CT2       4.16   1.873  -32.034   32.089   1.992  -34.839   34.896  27.742    1.622   27.790  26.680   20.714   33.777

  All fault currents are symmetrical momentary ( 1/2 cycle ) values in rms kA.
* LLG fault current is the larger of the two faulted line currents.
```

```
                                                    S. C. SUMMARY REPORT
Project:  IP Load Flow                              ====================                                Page:     68
Location: IP 2 & 3                                   PowerStation 4.0.4C                                Date:  06-02-2003
Contract: C0199                                                                                         SN:    ENERCONSVC
Engineer: Eric J Praser                             Study Case:  SC                                     File:  IndianPoint
-------------------------------------------------------------------------------------------------------------------------------------
Indian Point 2 & 3 Cooling Tower

=====================================================================================================================================

 1/2 Cycle - Three-Phase, LG, LL, & LLG Faults:     ( Prefault Voltage =  100 % of the Bus Nominal Voltage)


  Bus  Information         3-Phase Fault          Line-to-Ground Fault       Line-to-Line Fault      Line-to-Line-to-Ground*
====================  ========================  ========================  ========================  ========================
     ID          kV     Real    Imag.     Mag.    Real    Imag.     Mag.    Real    Imag.     Mag.    Real    Imag.     Mag.
------------ -------  ------  -------  -------  ------  -------  -------  ------  -------  -------  ------  -------  -------
STA-32CT3       0.48   2.468  -14.669   14.875   2.532  -14.924   15.137  12.704    2.137   12.882 -14.004    5.456   15.029
STA-69-2        6.90   1.311  -23.115   23.152   2.144  -22.162   22.265  20.018    1.136   20.050 -21.440    9.476   23.441
STA-69-3        6.90   1.312  -23.578   23.614   1.266  -23.182   23.216  20.419    1.136   20.451  19.808   12.535   23.441

  All fault currents are symmetrical momentary ( 1/2 cycle ) values in rms kA.
* LLG fault current is the larger of the two faulted line currents.
```

Attachment 2

Post Modification Site Rendering and Conceptual Drawings



Cooling Towers (typical for two):

Tower Type:
Counterflow, forced draft, plume abated (hybrid) with low noise fans & sound attenuation baffles.

Tower Geometry:
OD= 524.8 ft
Overall Ht. = 166 ft.
ID exit cone: 241.4 ft.
No. fans (wet section) = 44 (Motor Output Power = 300 HP)
No. fans (dry section)= 44 (Motor Output Power = 360 HP)

Wet Section Data:
Flow = 700,000 gpm
Plan area of fill: 121660 ft2
Fill Type: 6 ft. PVC low fouling film (MCT FC-18)
DE type / drift rate: Cellular PVC (MCT TU-12)/ drift rate .001%
Distribution system: FRP headers/PVC pipes
Nozzles: High efficiency polypropylene

Dry Section Data:
Flow= 245,000 gpm
Element type: 4 row/ 2 pass
Tube type: 1" OD Titanium
Fin Type: 2.25" OD Aluminum fins @ 11 fins/in ("L" fin)
Tube length = 49 ft.
No. tubes/ bundle = 216
No. bundles = 264

Thermal Data:
Wet design condition: (76 WBT, 88 CWT, 108 HWT)
HP (motor output wet section) = 270 HP, evaporation rate = 1.67%, Vexit= 1233 fpm

Hybrid Operation@ plume abatement design point (27 WBT @ 80 % RH)
HP (MOP wet section) = 300 HP, evaporation rate = .81%, CWT = 59 °F, Vexit=2260 fpm
HP (MOP dry section)= 360 HP

Pumping Head Required for Tower:

Main Pumps:
700,000 gpm @ 45 ft. TDH

Booster Pumps Required for Dry Section:
245000 gpm @ 28 ft

Electrical Distribution:

The design assumes there is adequate room in the Unit 1 138KV switchyard to install a circuit breaker and transformer to feed the new Unit 2 circ water pumps. If not, the breaker and transformer will be installed near the new Unit 2 Switchgear Building and a ductline installed along the same excavation as the 120" diameter pipes from the Unit 2 cooling tower to the new pump house.

The design assumes a new overhead line will have to be run to the Buchanan substation. If possible, a tap can be made in the overhead 138KV feeder at the existing pole between the Buchanan substation and the plant for a new 138KV overhead feeder to the Unit 2 cooling tower.

A control ductbank is shown from the old circ water pump house to the new for control of the new pumps. This is based on the assumption that no new control circuits will be routed back into the plant and the existing controls can simply be extended from the existing pump house.

Depicted design does not address safety related control and instrumentation interlocks, which will require plant and control room interfaces not shown.

Circulating Water Pumps:

(6) Pumps required per Unit
Type - Vertical Turbine / 1 Stage
117,000 gpm @ 72.0 TDH
Bowl and Impeller - 316 SS
3000 HP / 445 RPM / 4160 V
40 ft. NPSHR

REV	REASON FOR CHANGE	DRN/CHK	DGR/RCV	APP	DATE

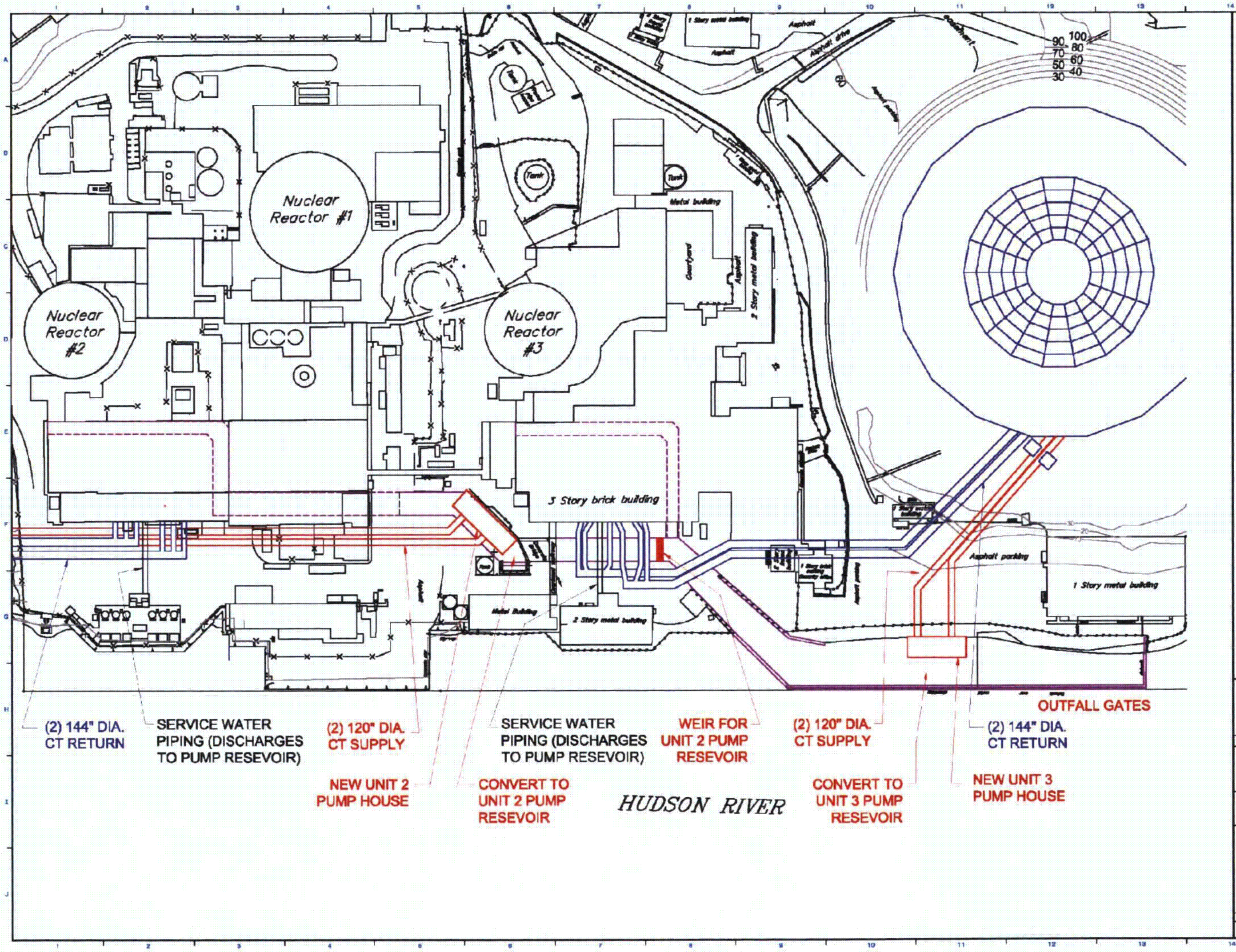
ENERCON SERVICES, INC.
Kennesaw, GA 30144

CLIENT
ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED LOOP
CONDENSER COOLING CONVERSION

SITE LAYOUT

SCALE	DRAWING NUMBER	REV
	ENTGIJ011-SK-001	0



Cooling Towers (typical for two):

Tower Type:
Counterflow, forced draft, plume abated (hybrid) with low noise fans & sound attenuation baffles.

Tower Geometry:
OD= 524.8 ft
Overall H.L = 166 ft.
ID exit cone: 241.4 ft.
No. fans (wet section) = 44 (Motor Output Power = 300 HP)
No. fans (dry section)= 44 (Motor Output Power = 360 HP)

Wet Section Data:
Flow = 760,000 gpm
Plan area of fill: 121680 ft2
Fill Type: 6 ft. PVC low fouling film (MCT FC 18)
DE type / drift rate: Cellular PVC (MCT TU-12)/ drift rate .001%
Distribution system: FRP headers/PVC pipes
Nozzles: High efficiency polypropylene

Dry Section Data:
Flow= 246,000 gpm
Element type: 4 row/ 2 pass
Tube type: 1" OD Titanium
Fin Type: 2.25" OD Aluminum fins @ 11 fins/in ("L" fin)
Tube length = 49 ft
No. tubes/ bundle = 215
No. bundles = 284

Thermal Data:
Wet design condition: (76 WBT, 86 CWT, 108 HWT)
HP (motor output wet section) = 270 HP, evaporation rate = 1.67%, Vexit= 1293 fpm

Hybrid Operation@ plume abatement design point (27 WBT @ 90 % RH)
HP (MOP wet section) = 300 HP, evaporation rate = .81%, CWT = 59 °F, Vexit=2250 fpm
HP (MOP dry section)= 360 HP

Pumping Head Required for Tower:

Main Pumps:
760,000 gpm @ 45 ft. TDH

Booster Pumps Required for Dry Section:
246000 gpm @ 28 ft

Electrical Distribution:

The design assumes there is adequate room in the Unit 1 138KV switchyard to install a circuit breaker and transformer to feed the new Unit 2 circ water pumps. If not, the breaker and transformer will be installed near the new Unit 2 Switchgear Building and a ductline installed along the same excavation as the 120" diameter pipes from the Unit 2 cooling tower to the new pump house.

The design assumes a new overhead line will have to be run to the Buchanan substation. If possible, a tap can be made in the overhead 138KV feeder at the existing pole between the Buchanan substation and the plant for a new 138KV overhead feeder to the Unit 2 cooling tower.

A control ductbank is shown from the old circ water pump house to the new for control of the new pumps. This is based on the assumption that no new control circuits will be routed back into the plant and the existing controls can simply be extended from the existing pump house.

Depicted design does not address safety related control and instrumentation interfaces, which will require plant and control room interfaces not shown.

Circulating Water Pumps:

(6) Pumps required per Unit
Type - Vertical Turbine / 1 Stage
117,000 gpm @ 72.0 TDH
Bowl and Impeller - 316 SS
3900 HP / 446 RPM / 4160 V
40 ft. NPSHR

REV	REASON FOR CHANGE	DRN/CHK	DGN/REV	APP.	DATE

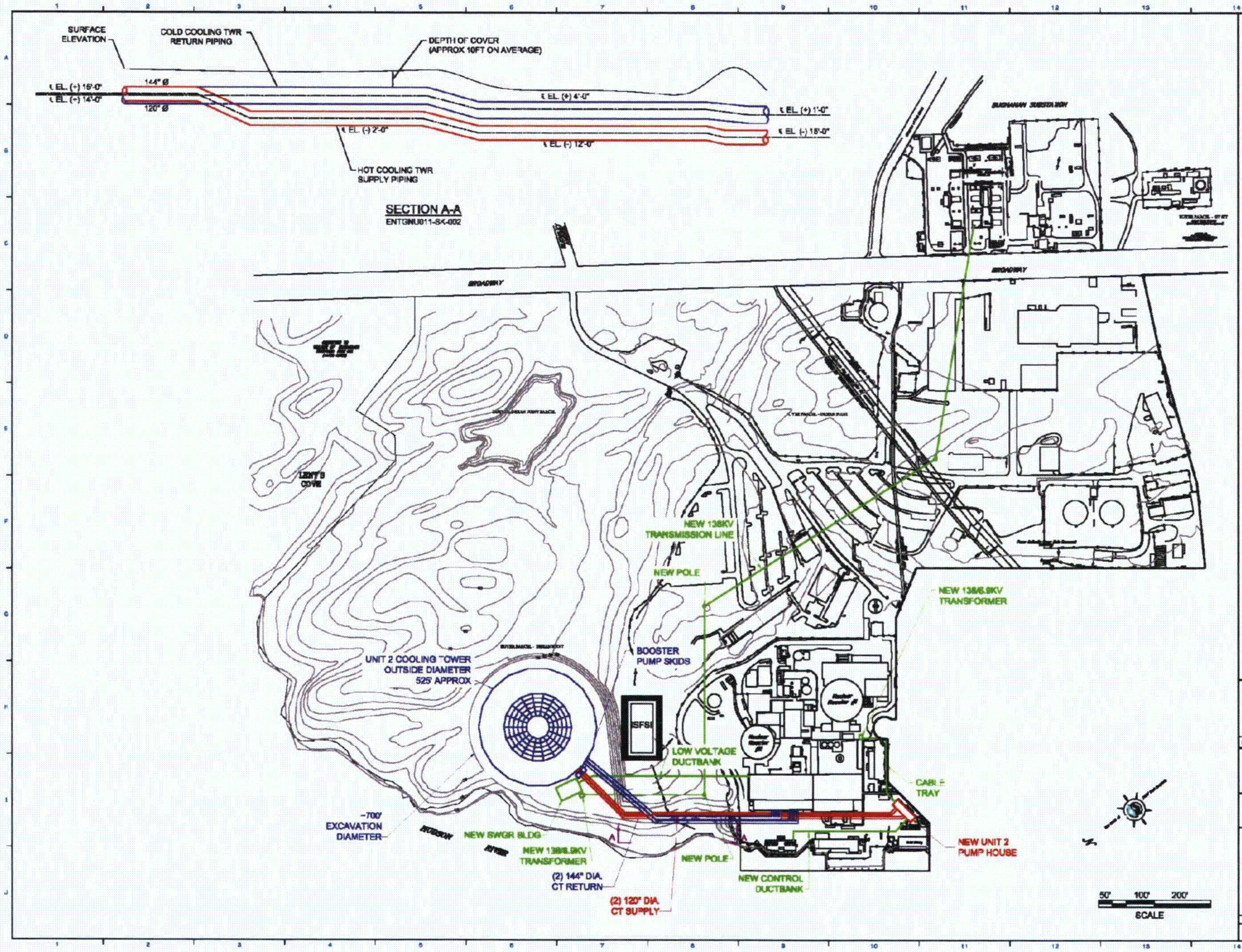
ENERCON SERVICES, INC.
Kennesaw, GA 30144

CLIENT
ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED LOOP
CONDENSER COOLING CONVERSION

SITE LAYOUT

SCALE	DRAWING NUMBER	REV
	ENTGNU011-SK-001A	0



Cooling Towers:

Tower Type:
Counterflow, forced draft, plume abated (hybrid) with low noise fans & sound attenuation baffles.

Tower Geometry:
OD= 524.8 ft
Overall Ht. = 168 ft.
ID exit cone: 241.4 ft.
No. fans (wet section) = 44 (Motor Output Power = 300 HP)
No. fans (dry section)= 44 (Motor Output Power = 350 HP)

Wet Section Data:
Flow = 700,000 gpm
Plan area of fill: 121560 ft2
Fill Type: 6 ft. PVC low fouling film (MCT FC 18)
DE type / drift rate: Cellular PVC (MCT TU-12)/ drift rate .001%
Distribution system: FRP headers/PVC pipes
Nozzles: High efficiency polypropylene

Dry Section Data:
Flow= 246,000 gpm
Element type: 4 row/ 2 pass
Tube type: 1" OD Titanium
Fin Type: 2.25" OD Aluminum fins @ 11 fins/in ("L" fin)
Tube length = 49 ft
No. tubes/ bundle = 216
No. bundles = 264

Thermal Data:
Wet design condition: (76 WBT, 88 CWT, 108 HWT)
HP (motor output wet section) = 270 HP, evaporation rate = 1.67%, Vexit= 1233 fpm

Hybrid Operation@ plume abatement design point (27 WBT @ 90 % RH)
HP (MOP wet section) = 300 HP, evaporation rate = .81%, CWT = 69 °F
Vexit=2260 fpm
HP (MOP dry section)= 350 HP

Pumping Head Required for Tower:

Main Pumps:
700,000 gpm @ 45 ft. TDH

Booster Pumps Required for Dry Section:
246000 gpm @ 26 ft

Electrical Distribution:

The design assumes there is adequate room in the Unit 1 138KV switchyard to install a circuit breaker and transformer to feed the new Unit 2 circ water pumps. If not, the breaker and transformer will be installed near the new Unit 2 Switchgear Building and a cortline installed along the same excavation as the 120" diameter pipes from the Unit 2 cooling tower to the new pump house.

The design assumes a new overhead line will have to be run to the Buchanan substation. If possible, a tap can be made in the overhead 138KV feeder at the existing pole between the Buchanan substation and the plant for a new 138KV overhead feeder to the Unit 2 cooling tower.

A control ductbank is shown from the old circ water pump house to the new for control of the new pumps. This is based on the assumption that no new control circuits will be routed back into the plant and the existing controls can simply be extended from the existing pump house.

Detailed design does not address safety related control and instrumentation interlocks, which will require plant and control room interfaces not shown.

Circulating Water Pumps:

(6) Pumps required per Unit
Type - Vertical Turbine / 1 Stage
117,000 gpm @ 72.0 TDH
Bowl and Impeller - 316 SS
3000 HP / 445 RPM / 4160 V
40 ft. NPSHR

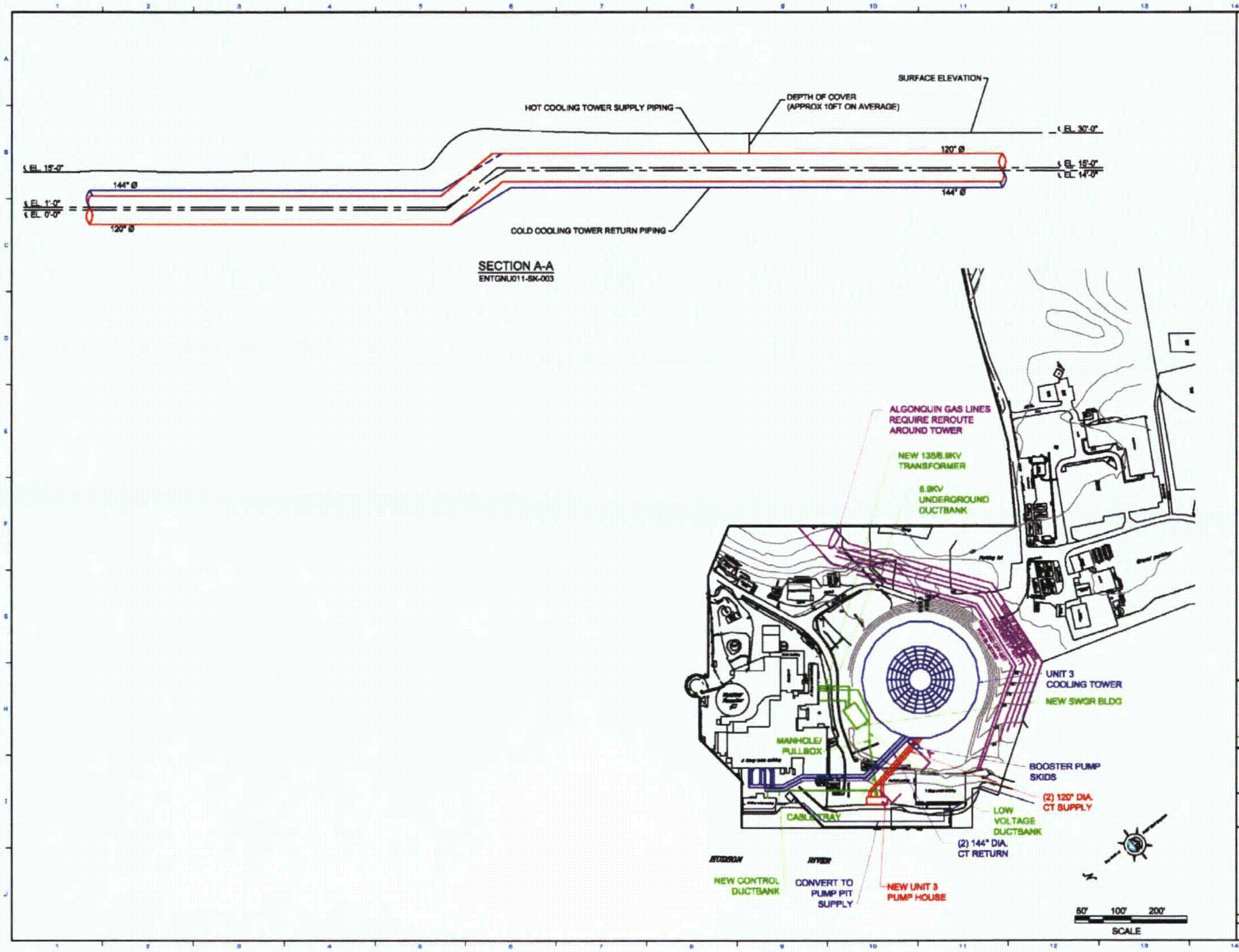
REV	REASON FOR CHANGE	DRN/CHK	DSN/REV	APP.	DATE

ENERCON SERVICES, INC.
Kennesaw, GA 30144

CLIENT
ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED LOOP
CONDENSER COOLING CONVERSION
UNIT 2
SITE LAYOUT

SCALE	DRAWING NUMBER	REV
	ENTGINU011-SK-002	0



Cooling Towers:

Tower Type:
Counterflow, forced draft, plume abated (hybrid) with low noise fans & sound attenuation baffles.

Tower Geometry:
OD= 524.8 ft
Overall Ht. = 188 ft.
ID exit cone: 241.4 ft.
No. fans (wet section) = 44 (Motor Output Power = 300 HP)
No. fans (dry section)= 44 (Motor Output Power = 360 HP)

Wet Section Data:
Flow = 700,000 gpm
Plan area of fill: 121560 ft2
Fill Type: 6 ft. PVC low fouling film (MCT PC-18)
DE type / drift rate: Cellular PVC (MCT TU-12)/ drift rate .001%
Distribution system: FRP headers/PVC pipes
Nozzles: High efficiency polypropylene

Dry Section Data:
Flow= 345,000 gpm
Element type: 4 row/ 2 pass
Tube type: 1" OD Titanium
Fin Type: 2.25" OD Aluminum fins @ 11 fins/in ("L" fin)
Tube length = 49 ft.
No. tubes/ bundle = 216
No. bundles = 264

Thermal Data:
Wet design condition: (76 WBT, 88 CWT, 108 HWT)
HP (motor output wet section) = 270 HP, evaporation rate = 1.67%, Vexit= 1233 fpm

Hybrid Operation@ plume abatement design point (27 WBT @ 90 % RH)
HP (MOP wet section) = 300 HP, evaporation rate = .61%, CWT = 89 °F, Vexit=2260 fpm
HP (MOP dry section)= 360 HP

Pumping Head Required for Tower:

Main Pumps:
700,000 gpm @ 45 ft. TDH

Booster Pumps Required for Dry Section:
245000 gpm @ 28 ft

Electrical Distribution:

The design assumes there is adequate room in the Unit 1 138KV switchyard to install a circuit breaker and transformer to feed the new Unit 2 circ water pumps. If not, the breaker and transformer will be installed near the new Unit 2 Switchgear Building and a ductline installed along the same excavation as the 120" diameter pipes from the Unit 2 cooling tower to the new pump house.

The design assumes a new overhead line will have to be run to the Buchanan substation. If possible, a tap can be made in the overhead 138KV feeder at the existing pole between the Buchanan substation and the plant for a new 138KV overhead feeder to the Unit 2 cooling tower.

A control ductbank is shown from the old circ water pump house to the new for control of the new pumps. This is based on the assumption that no new control circuits will be routed back into the plant and the existing controls can simply be extended from the existing pump house.

Depicted design does not address safety related control and instrumentation interlocks, which will require plant and control room interfaces not shown.

Circulating Water Pumps:

(6) Pumps required per Unit
Type - Vertical Turbine / 1 Stage
117,000 gpm @ 72.0 TDH
Bowl and Impeller - 316 SS
3000 HP / 440 RPM / 4160 V
40 ft. NPSHR

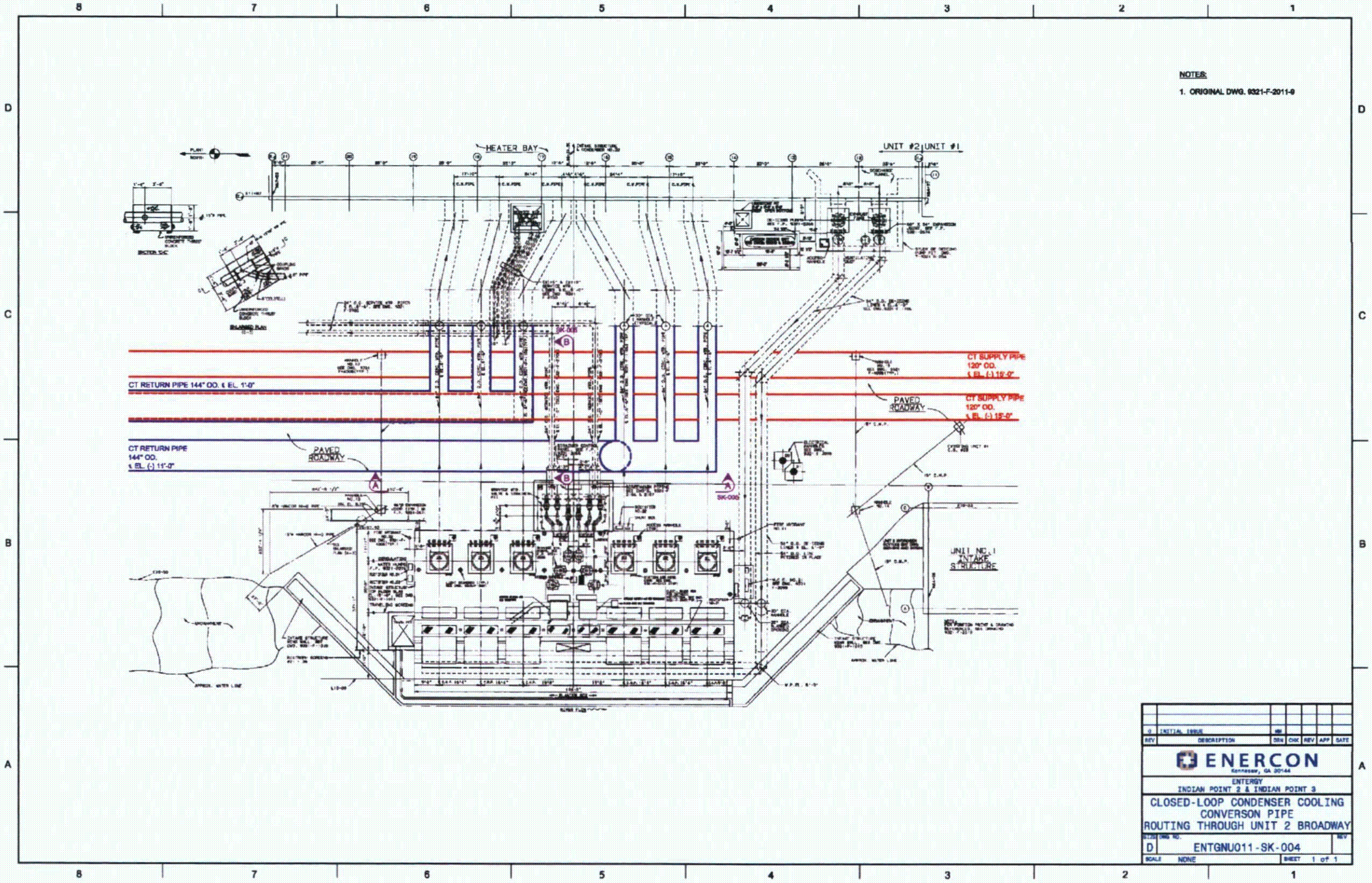
REV	REASON FOR CHANGE	DRN/CHK	DGN/REV	APP.	DATE

ENERCON SERVICES, INC.
Kennesaw, GA 30144

CLIENT
ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED LOOP
CONDENSER COOLING CONVERSION
UNIT 3
SITE LAYOUT

SCALE	DRAWING NUMBER	REV
	ENTGNU011-SK-003	0



NOTES:

1. ORIGINAL DWG. 9321-F-2011-9

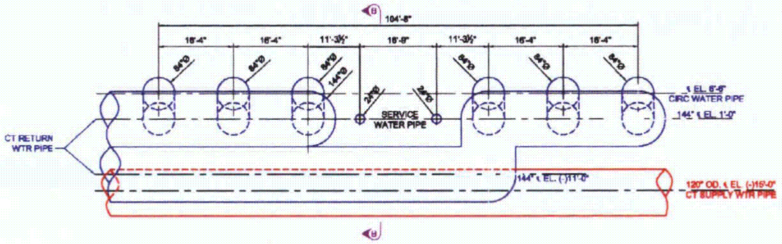
REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
0	INITIAL ISSUE	MM				

ENERCON
Kennesaw, GA 30144

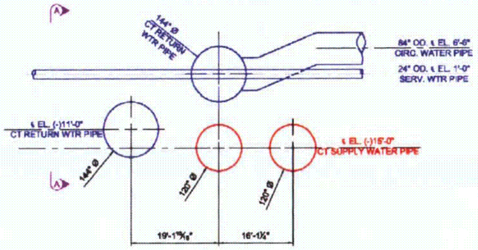
ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED-LOOP CONDENSER COOLING
CONVERSON PIPE
ROUTING THROUGH UNIT 2 BROADWAY

SIZE D
DWG NO. ENTGNU011-SK-004
REV
SCALE NONE
SHEET 1 of 1



SECTION A-A
(ENTGNU011-SK-004)



SECTION B-B
(ENTGNU011-SK-004)

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
	INITIAL ISSUE	MM				

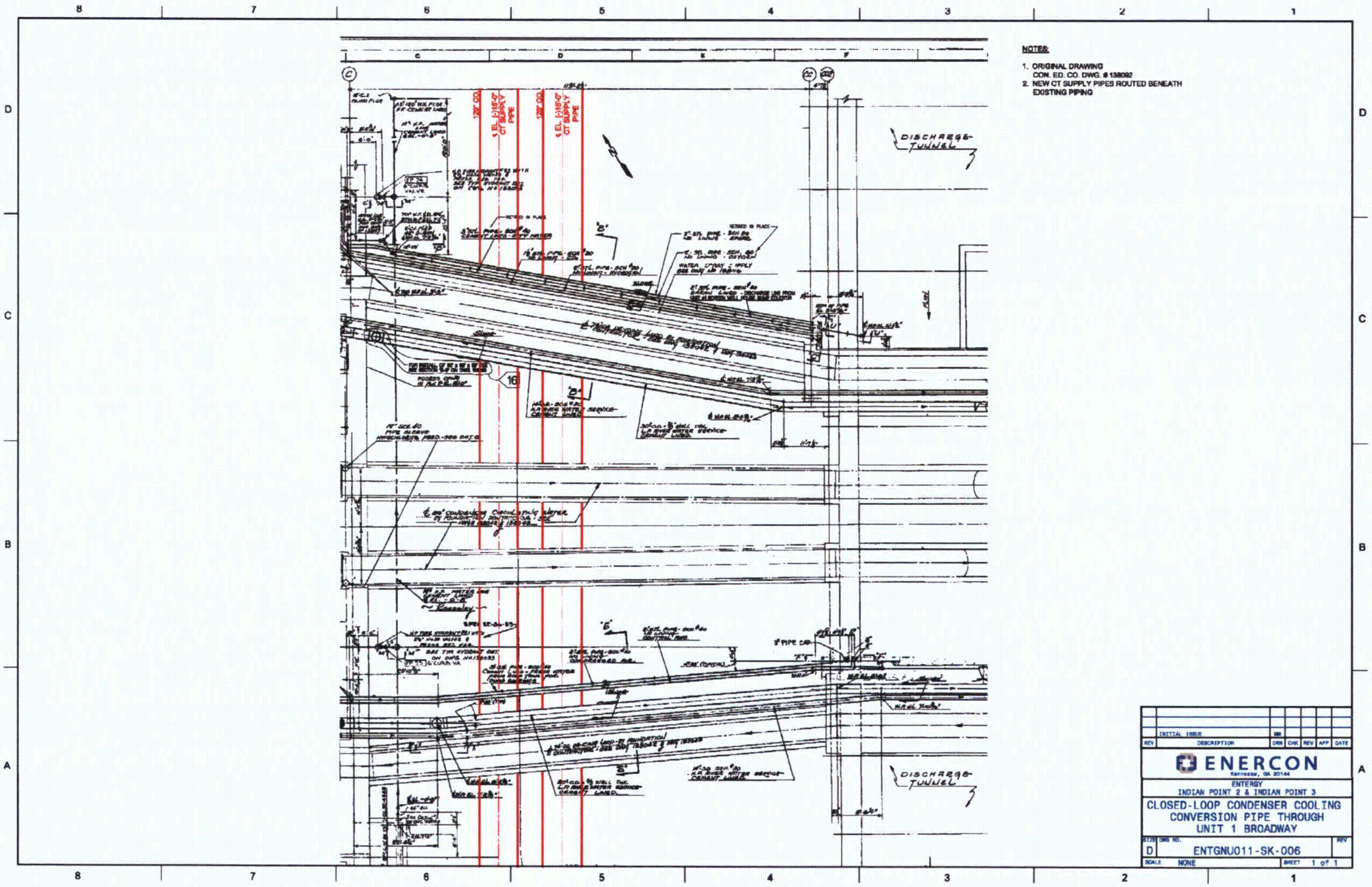
ENERCON
Kennesaw, GA 30144

ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED-LOOP CONDENSER COOLING
CONVERSION PIPE ROUTING THROUGH
UNIT 2 BROADWAY SECTION VIEWS

SIZE	DWG NO.	REV
D	ENTGNU011-SK-005	

SCALE NONE
SHEET 1 of 1



NOTES:

1. ORIGINAL DRAWING
   CON. ED. CO. DWG. # 138092
2. NEW CT SUPPLY PIPES ROUTED BENEATH
   EXISTING PIPING

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
	INITIAL ISSUE	MM				

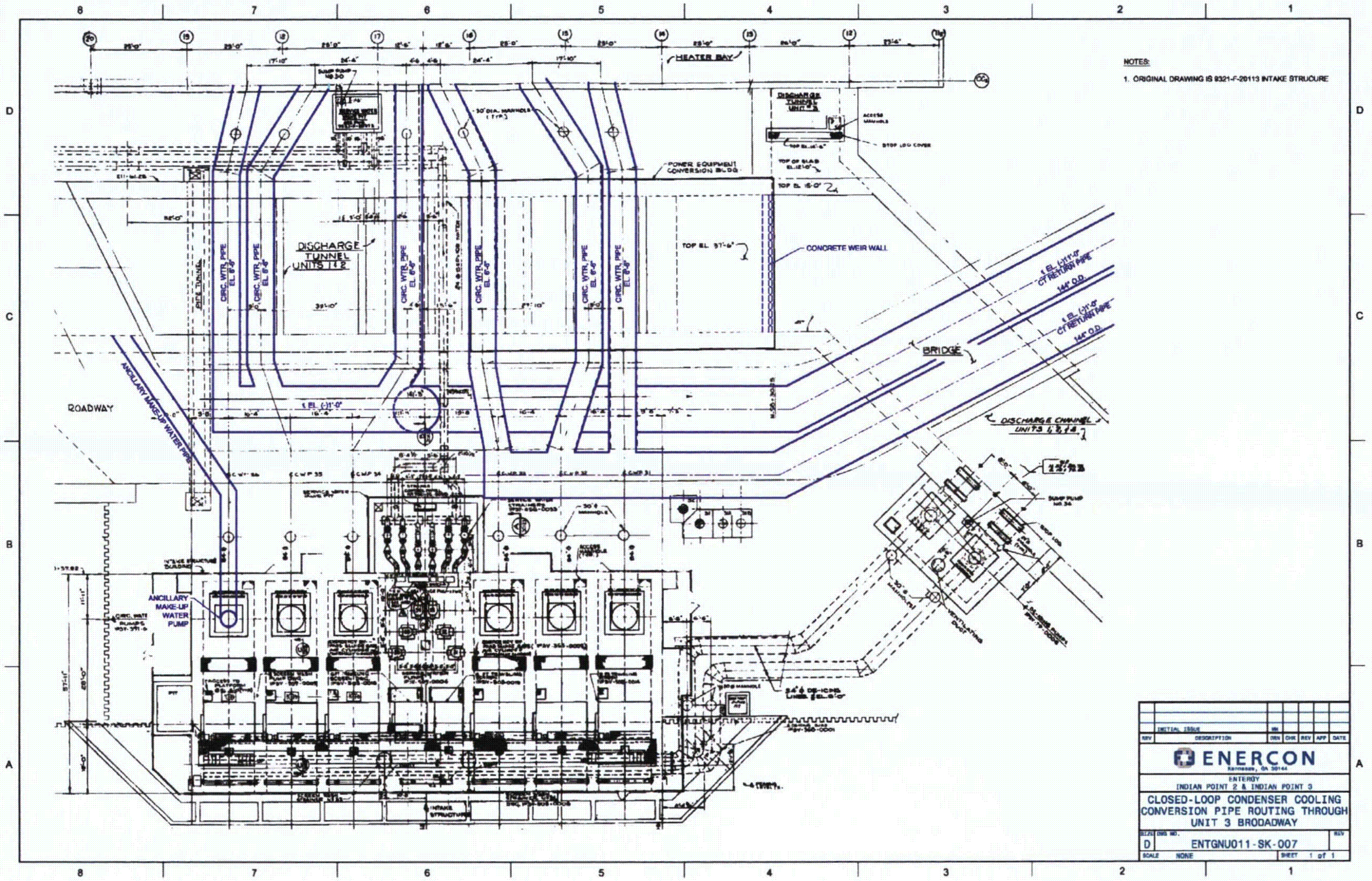
ENERCON
Kennesaw, GA 30144

ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED-LOOP CONDENSER COOLING
CONVERSION PIPE THROUGH
UNIT 1 BROADWAY

SIZE D DWG NO. ENTGNU011-SK-006 REV

SCALE NONE SHEET 1 of 1



NOTES:

1. ORIGINAL DRAWING IS 9321-F-20113 INTAKE STRUCURE

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
	INITIAL ISSUE	MN				

ENERCON
Kennesaw, GA 30144

ENTERGY
INDIAN POINT 2 & INDIAN POINT 3

CLOSED-LOOP CONDENSER COOLING
CONVERSION PIPE ROUTING THROUGH
UNIT 3 BRODADWAY

SIZE D
DWG NO. ENTGNU011-SK-007
REV
SCALE NONE
SHEET 1 of 1

Attachment 3

Subsurface Radiological Considerations Related to Construction of Closed-Loop Cooling at Indian Point Energy Center Units 2 and 3

GZA GeoEnvironmental, Inc.

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Engineers and
Scientists

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Phone: 781-278-3700
Fax: 781-278-5701

SUBSURFACE RADIOLOGICAL CONSIDERATIONS RELATED TO CONSTRUCTION OF CLOSED-LOOP COOLING AT INDIAN POINT ENERGY CENTER UNITS 2 AND 3

Introduction

As noted in the Enercon Services, Inc. ("Enercon") closed-loop cooling report[1] (the "Enercon Report") and proposed by the New York State Department of Environmental Conservation ("NYSDEC"), construction of two large counter-flow, forced draft, plume abated hybrid cooling towers and associated piping (the "NYSDEC Proposed Project") at Indian Point Energy Center ("IPEC") Units 2 and 3, requires excavation and disposal of soil and bedrock at the basins for the proposed Unit 2 and Unit 3 cooling towers, as well as for the piping trenches that connect the proposed cooling towers to their respective circulating water systems. Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC ("Entergy") retained GZA GeoEnvironmental, Inc. ("GZA") to address radiological contamination issues as part of its feasibility assessment undertaken pursuant to the NYSDEC Assistant Commissioner's August 13, 2008 Interim Decision. GZA has extensive experience monitoring the groundwater on the IPEC site using various instrumentation installations which were constructed as part of the 2008 Hydrogeologic Site Investigation.[2]

As can be seen on Figures 1 and 2, groundwater containing Tritium and Strontium migrates through a portion of the excavation area for the NYSDEC Proposed Project. The delineated (shaded) Tritium and Strontium "plume areas" are defined as areas on these figures where the rolling yearly average groundwater radionuclide activities[3] are greater than 5,000 pCi/L and 2

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[1] Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration, by Enercon Services, Inc.

[2] Hydrogeologic Site Investigation Report, January 7, 2008, prepared by GZA GeoEnvironmental, Inc, on behalf of Enercon Services, Inc., for Entergy Nuclear Northeast, Indian Point Energy Center, 450 Broadway, Buchanan, NY 10511.

[3] For radionuclides in groundwater, the level of contamination is reported as the activity of each radionuclide, which is the measured radiation intensity emitted by each radionuclide per unit time in a specified volume of water (e.g., picocurie per liter – pCi/L).

pCi/L, respectively.[4] GZA previously developed the plume delineations and rolling average data shown on Figures 1 and 2 based on quarterly groundwater sampling and elevation measurements taken at various monitoring points during 2008, as well as the analyses summarized in previous Quarterly Groundwater Monitoring Reports[5] and the Conceptual Site Model ("CSM") presented in the 2008 Hydrogeologic Site Investigation Report.[6] The Figures 1 and 2 also present radionuclide activities for each individual sampling depth at each location, both within and outside of the delineated (shaded) plume areas. In addition to Tritium and Strontium, other radionuclides such as Cesium, Cobalt and Nickel (additional primary indicator radionuclides) have also been detected on the site. These detections are generally disperse, however, and do not appear to represent defined groundwater plumes. The more recent data for Cesium, Cobalt and Nickel are presented in the Quarterly Groundwater Monitoring Reports, and the more historic data are presented in the Hydrologic Site Investigation Report.[7]

As discussed in further detail below, groundwater exists in the interstitial pore spaces and fractures in bulk soil and bedrock deposits. If groundwater within the soil and bedrock is contaminated, excavated material will also be contaminated, and sampling and analysis protocols would be developed and employed. Moreover, construction of the NYSDEC Proposed Project would require "dewatering," a process used to maintain dry conditions during construction. Due to site conditions, dewatering would involve using continuous pumping of contaminated groundwater. As also discussed in further detail below, this dewatering would require special precautions to prevent migration of radionuclide contaminated groundwater to clean areas.

Locations For Which Sampling and Analysis Protocols Would be Developed and Employed for Construction of the NYSDEC Proposed Project

GZA understands from Entergy's counsel that NRC regulations (10 C.F.R. Part 20 Subpart K) require that all radionuclide contaminated soil and bedrock excavated for construction of the NYSDEC Proposed Project be identified, handled, treated and disposed of appropriately. Limited radionuclide data exists for soil and bedrock in the areas requiring excavation under the NYSDEC Proposed Project, particularly at depth. Therefore, GZA used the areal and vertical extent of radionuclide contamination in groundwater as an indicator of soil and bedrock contamination for excavation management planning purposes. Specifically, if groundwater within the bulk soil/bedrock deposit is contaminated, the excavated bulk material will also be contaminated (in part, because contaminated groundwater will be retained in the bulk material during and after

---

[4] The plume delineation boundary values were established at one-quarter of the drinking water standards for these radionuclides. Although GZA emphasizes that drinking water standards (USEPA MCLs) do not apply to the IPEC property given that there are no drinking water sources on or proximate to the site, the MCLs do provide a useful benchmark for comparisons of relative human risk. Where yearly rolling average radionuclide activity data were available for multiple depths at a given location, GZA used the highest value to develop plume delineations. This is a typical approach to represent three-dimensional contaminant data sets on two-dimensional maps.

[5] Quarterly Groundwater Monitoring Reports are required under IP Site Management Manual, Quality Related Administrative Procedure, IP-SSM, CY-110.

[6] Hydrogeologic Site Investigation Report, January 7, 2008, prepared by GZA GeoEnvironmental, Inc, on behalf of Enercon Services, Inc., for Entergy Nuclear Northeast, Indian Point Energy Center, 450 Broadway, Buchanan, NY 10511.

[7] GZA notes that Cesium, Cobalt and Nickel have not been detected in the groundwater within the proposed excavation areas during the more recent sampling for the Quarterly Groundwater Monitoring Reports (Quarter 2 2007 through Quarter 4 2008). However, GZA has previously detected Cesium and Nickel in groundwater within these areas, as well as Nickel in areas upgradient of the proposed excavations for the NYSDEC Proposed Project.

excavation). Groundwater contaminant levels (in pCi/L), however, are not directly translatable into soil/bedrock activity levels (in pico curie per kilogram - pCi/Kg), particularly for radionuclides such as Strontium, which preferentially partition out of the groundwater and adsorb onto the solid mineral surfaces of the soil grains/intact bedrock.[8] Thus, it is GZA's recommendation that sampling and analysis protocols would be developed and employed to assess actual radionuclide levels in the excavated material. These sampling and analysis protocols would be developed to properly and prudently identify potentially contaminated soil/bedrock within the proposed excavation areas.

Within the shaded groundwater plumes of Figures 1 and 2, and at other identified locations known to contain radionuclides elevated above Minimum Detectable Concentrations ("MDCs"),[9] it is GZA's recommendation that sampling and analysis protocols would be developed and employed to prudently determine appropriate handling and disposal requirements and manage the work in accordance with NRC regulations. In addition, sampling and analysis protocols would also be employed in areas outside, but proximate to the delineated plumes and known areas of contamination. This prudent course of action is considered appropriate to manage the risks always inherent in subsurface work, and in particular because of the site's subsurface hydrogeologic variability. Moreover, it is GZA's opinion that sampling and analysis protocols would also be needed because Entergy's site acquisition is recent relative to the extended extent of site history.

Based on the existing groundwater data, additional areas which would undergo testing for construction of the NYSDEC Proposed Project for Unit 2 extend northward from the shaded plume at least to the northern edge of the Riverfront area, and southward from the shaded plume to the proposed Unit 2 pump house structure (see Figures 1 and 2). In addition, although there is no plume delineated on these figures in the Unit 3 Riverfront area, radionuclide activity is expected in the groundwater in this area, but below the plume delineation limits (enumerated above). As such, additional sampling and analysis protocols also would be applied to material excavated from the Unit 3 Riverfront area (at least from the proposed Unit 2 pump house structure to the North, to the proposed Unit 3 pump house structure to the South) to increase the level of certainty that all radionuclide contaminated material requiring special handling and disposal would be identified prior to disposal.

Construction Dewatering

During the excavation process, not only would soil and bedrock contaminated with radionuclides require disposal, but contaminated groundwater located under the site would also need to be continually pumped from the excavation areas to maintain dry conditions required for construction and backfilling. This is because the NYSDEC Proposed Project would require excavations at depths well below the groundwater table. As advised by Entergy's consultant Enercon, excavations would begin at the cooling tower basin locations, followed by excavation of proximate pipe trenching, with pipe trenching in the Riverfront area (the primary location of

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[8] In these cases, the radionuclides may become concentrated on the solid surfaces over time. The degree to which this time-dependent concentration process occurs is highly site specific (both from site to site and within a single site), and therefore is difficult to predict and/or establish experimentally.

[9] The groundwater is also contaminated with radionuclides in some areas outside of the shaded plumes, but at activities below the plume delineation levels of 5,000 pCi/L and 2 pCi/L (for Tritium and Strontium respectively). Where currently detected above MDC, these data have been provided on Figures 1 and 2. For a more complete summary of these detections over time, refer to the Quarterly Groundwater Monitoring Reports and the Hydrogeologic Site Investigation Report.

the identified contaminated groundwater) completed last. This excavation sequencing would be required to minimize plant outage time during construction. If construction dewatering was implemented in the same sequence as excavation (as would be typical construction procedure[10]) however, it would cause the groundwater to migrate from contaminated areas to clean areas,[11] thus resulting in spreading of radionuclides in the subsurface. To control this "plume spreading," an atypical dewatering sequence would have to be adopted. This would entail starting the groundwater dewatering in the contaminated areas (within Riverfront in the vicinity of Unit 2 and Unit 1, and potentially Unit 3[12]) prior to excavation in these areas, but coincident with excavation and dewatering in the adjacent clean areas which would be excavated first.[13] This dewatering would also have to be continued until completion of the excavation. As such, dewatering would be executed for a longer period of time than would be typical of normal construction practice, thus increasing costs.

It is anticipated that the dewatering would be accomplished with a line of closely spaced groundwater extraction wells (on the order of 25 to 75 feet apart) on each side of the trench excavation in the Riverfront area. These wells would likely extend to an elevation of approximately (-) 45 feet so as to allow the groundwater elevation to be reduced to approximately elevation (-) 20 feet (to below the bottom of the excavation) along the centerline of the pipe trench. Based on the 3-dimensional numeric computer model previously developed by GZA as part of the 2008 Hydrogeologic Investigation for the IPEC site, dewatering flow rates from the contaminated plume area in the vicinity of the Unit 2 proposed piping trenches are estimated to be approximately 60 gallons per minute (gpm) prior to excavation and dewatering in adjacent areas. As advised by Enercon, it is expected that this phase of the dewatering would last approximately one month, resulting in the collection of approximately 2.7 million gallons of radionuclide contaminated groundwater. Once dewatering begins in the adjacent clean areas, the flow rate from the contaminated area is anticipated to decrease to approximately 55 gpm.[14] As further advised by Enercon, it is expected that this phase of the

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[10] Typically, construction sequencing is developed to minimize the area and length of time over which dewatering is employed to reduce its added cost. As such, dewatering is typically not started until the excavation is about to reach the groundwater depth, and is only employed in the area actually being excavated. Therefore, dewatering would start in the cooling tower basin locations and would continue there until construction was completed up to the water table surface, and then it would be discontinued in this area. As the excavation proceeded from the basin locations along the piping trenches, the dewatering would just precede the excavations as they advanced towards, and then into the contaminated Riverfront area.

[11] With typical dewatering sequencing, as the excavation, and thus the dewatering, approaches the plume within Riverfront area, the groundwater elevation in the dewatered area would be below that in the plume area. The contaminated groundwater at the higher elevation would thus flow downward towards the lower elevations in the dewatered area, thus causing the radionuclide plume to migrate into clean areas where it had not previously existed.

[12] The dewatering flow rates subsequently provided below apply only to those areas involving contaminated groundwater from the Tritium and Strontium plumes in the Unit 2 proposed piping trench area; plumes shown as shaded in Figures 1 and 2. It is predicted that there is also Tritium and Strontium in the groundwater in the Riverfront area down gradient of Unit 3, but at concentrations below approximately 3000 pCi/L and 1.5 pCi/L, respectively. Although lower than the levels within the shaded plumes, these activities are still above those predicted in the area of the Unit 3 cooling tower and the associated piping. As such, dewatering for the Unit 3 piping trenches may require similar constraints, and thus added cost, for dewatering sequencing, treatment and disposal similar to that for the Unit 2 area.

[13] With dewatering in the contaminated area preceding that in the adjacent clean areas, the groundwater elevations in the contaminated area could be maintained below those in the clean areas. Therefore the clean water would then be at the higher elevations and would thus flow downward into the contaminated area. Clean groundwater flowing in would then prevent the contaminated groundwater from flowing out, thus preventing the plume from spreading into cleaner areas.

[14] Prior to the start of dewatering in the adjacent clean areas, clean water to the North and South of the contaminated area would be pulled into the contaminated area by the dewatering wells, mixed with the contaminated water and pumped out for disposal. Once dewatering starts in the adjacent clean areas, this

work will require 12 months, resulting in the collection of approximately 29 million additional gallons of radionuclide contaminated groundwater (approximately 32 million Gallons total).[15]
As indicated above, the dewatering flow rates and volume estimates provided above are for the Unit 2 proposed piping trenches only; additional dewatering constraints, and the associated cost increases, may need to be implemented for the Unit 3 proposed piping trenches to control the potential spreading of lower level radionuclides. If dewatering were to be required to control plume spreading in this area also, it would more than double the flow rate requiring treatment and disposal.[16]

Disposal of Radionuclide Contaminated Water Which Would be Generated During Construction Dewatering

Once groundwater is extracted by the dewatering systems, it must be disposed of in accordance with applicable rules and regulations. Groundwater extracted from the contaminated area will contain Tritium, Strontium and potentially other radionuclides at lower activity levels, including Cesium, Cobalt and Nickel. Treating the extracted groundwater prior to disposal increases the range of possible disposal options. Treatment methods exist for removing radionuclides from water, except for Tritium. A primary treatment method is to flow the contaminated water though various beds of specialized resins, which remove the radionuclides. Based on Enercon and Entergy evaluation of ongoing treatment of groundwater at Unit 1, it is anticipated that this treatment would cost at least $ 7,000,000 for Operation and Maintenance, and disposal of contaminated treatment resin. Even this treatment, however, still leaves Tritium in the extracted water, for which there is no practical removal method.[17] Therefore, the groundwater extracted during piping construction in and proximate to the contaminated areas will contain Tritium after treatment, potentially impacting, and limiting, disposal options.

The most practical and cost effective method to dispose of the Tritium-contaminated groundwater generated during the dewatering of excavations for the NYSDEC Proposed Project would be to dispose of it to the Hudson River (with prior dilution through the Discharge Canal) in compliance with NRC regulations. However, Entergy's counsel has advised GZA that NYSDEC appears to believe they have jurisdiction over disposal of groundwater contaminated with radionuclides.[18] It is GZA's understanding that NYSDEC further believes disposal of radionuclide contaminated groundwater to the Hudson River is not permissible under State regulations. If disposal of the Tritiated groundwater to the Discharge Canal is thus found to be infeasible, three other potential disposal options exist, but each has serious drawbacks which would likely render it technically infeasible, as discussed below.

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flow from the North and South will be picked up by these additional clean area dewatering wells, and will remain uncontaminated. Therefore, the flow of water into the contaminated area will decrease somewhat.

[15] During this portion of the work, substantial additional groundwater will also be generated by dewatering in areas outside the contaminated areas (primarily associated with dewatering for the cooling tower basin excavations). The volume of this dewatering flow has not been quantified herein given that it should not be contaminated and thus would not require special treatment and disposal. Therefore, it is assumed that this water can be handled as part of the typical construction process and discharged to the Hudson River without treatment for radionuclides.

[16] Based on the 3-dimensional numeric computer model previously developed by GZA as part of the 2008 Hydrogeologic Investigation for the IPEC site , indicates a projected dewatering flow rate for the Unit 3 area would be approximately 100 gpm, as compared to that for the Unit 2 area of 60 gpm.

[17] Methods do exist to remove tritium from water. However, these methods are not cost effective for the high groundwater flows required to dewater the excavations for the NYSDEC Proposed Project.

[18] NYSDEC letter of May 13, 2009 regarding: Notice of Incomplete Application / Request for Additional Information, Joint Application for CWA § 401 Water Quality Certification, NRC License Renewal – Indian Point Units 2 and 3, DEC Nos:3-5522-00011/00030 [IP2] and 3-5522-00105/00031 [IP3].

The first potential option would be to pump the water to the sanitary sewer system. It appears that this option would be in compliance with NRC regulations (10 C.F.R. Part 20 Subpart K § 20.2003, Disposal by Release into Sanitary Sewerage). Sanitary sewer disposal is also routinely utilized for non-radiological contamination, such as industrial chemical discharges, because the municipal treatment systems can eliminate many of these chemical contaminants prior to ultimate discharge to a surface water body. However, there are a number of issues which must be addressed to demonstrate the feasibility of this option. First, the IPEC sanitary lift station pumping capacity, as well as the piping to the sanitary sewer connection may need to be upgraded to handle the increased flow (the increase in flow from dewatering would more than triple the allowed normal average daily flow). Second, even if the IPEC system could handle this discharge, intentional discharge of groundwater to the sanitary system, whether contaminated or not, is specifically disallowed by the Agreement with the Village of Buchanan.[19] Third, even if the Village agreed to modify the terms of the current Agreement, it is unlikely that the Publically Owned Treatment Works ("POTW") is physically capable of handling the added dewatering flow rate. As provided by Enercon, the Buchanan POTW has a listed total capacity of 0.5 million gallons per day ("mgd"), which is equal to approximately 350 gpm. The dewatering flow rate for the plume area of the Unit 2 proposed piping trenching is 55 to 60 gpm. This is over 15% of the total POTW capacity absent any contingency for the potential inclusion of Unit 3 proposed piping trench dewatering flow (a projected additional 100 gpm, bringing the potential total additional flow to nearly 50% of the total plant capacity). Therefore, it does not appear that disposal of the groundwater dewatering flow to the POTW is technically feasible, even if the Village of Buchanan were willing to amend the Agreement.[20]

The second potential option would be to truck the water off-site for disposal. As advised by Enercon, there are only two operating facilities in the country, Energy Solutions and Perma-Fix, which can accept and disposes of free liquids contaminated with radionuclides, provided that they at least meet Class A waste acceptance criteria.[21] Off-site disposal would likely entail trucking through local roads. Each truck can carry 6000 gallons of water,[22] amounting to over 10,500 total truck trips. (one trip in to pick up and one trip out for disposal for each 6,000 gallons of water). During peak pumping periods, it is expected that the frequency would be approximately 30 truck trips per day, on both week days and weekends. The cost for this off-site disposal option would be approximately $10 / gallon for transportation and disposal, for a total cost of $320 million.[23] However, this option was found to be infeasible, beyond just the costs involved,

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[19] "Agreement between Village of Buchanan and IPEC", dated July 1, 1987

[20] It is noted that the Town of Peekskill POTW has a larger capacity of 10mgd, as based on data provided by Enercon. However, this POTW is 4 miles away, rendering its use impractical.

[21] 10 C.F.R. 61.55 Code of Federal Regulations, Title 10, Energy, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

[22] Large tanker trucks range in capacity from 5,500 gallons to 9,000 gallons. A common truck size of 6,000 gallons was selected for this computation to balance a reduced number of truck trips (as compared with 5,500 gallon or smaller capacity trucks), with the difficulties associated with larger trucks (e.g., 9,000 gallon capacity) on smaller local roads.

[23] These values account for the Unit 2 piping trenches only; additional dewatering constraints, and the associated truck trip and cost increases, may need to be implemented for the Unit 3 proposed piping trenches.

given the dewatering pumping rate of 55 to 60 gallons per minute (80,000 to 90,000 gallons per day) far exceeds the capacity of this disposal facility.[24]

The third potential option would be to attempt to re-inject the extracted groundwater back into the subsurface on-site. This could potentially be accomplished with a series of re-injection wells drilled into the bedrock along the upgradient portion of the plume area. In concept, the contaminated water would be kept in continual recirculation within the existing on-site plume. In reality, however, this could cause plume spreading at the IPEC site. To begin with, it is generally much easier to extract groundwater from the subsurface than it is to re-inject this groundwater back into the same subsurface deposits[25]. This general "rule of thumb" is particularly true for fractured bedrock, such as exists at the IPEC site. The added difficulty expected for re-injection would likely therefore spread Tritiated water outside the boundaries of the existing plume. This would not only then cause plume spreading, but the spreading could easily be along bedrock fractures of indeterminate location and extent (on and potentially off-site). In addition, the area of excavation that would require dewatering for piping construction is located relatively close to the Hudson River. As such, sufficient extraction to prevent plume spreading in this area would inevitably induce some infiltration of river water back into the site, and into the extraction wells. This clean water would mix with the contaminated water, resulting in a greater volume of contaminated water than that currently flowing within the plume.[26] Therefore, re-injection of this larger volume of contaminated water at the upgradient edge of the plume would necessarily result in plume spreading; i.e., the plume would have to expand to carry the additional flow. Given the above analysis, on-site reinjection of the contaminated water extracted during construction dewatering for the NYSDEC Proposed Project is considered infeasible because of the on-site, and potentially off-site, plume spreading it would inevitably cause.

Conclusions

It is GZA's recommendation that excavation for the NYSDEC Proposed Project would employ implementation of sampling and analysis protocols for the soil and bedrock removed from the piping trenches along the entire Riverfront area, from its most northern extent to the proposed Unit 3 Pump House to the South.

In addition, the dewatering used to maintain dry construction conditions within the proposed piping trenches would require atypical construction sequencing to prevent the spreading of radionuclide contaminated groundwater into cleaner areas. This required control of plume spreading would result in more prolonged and extensive dewatering than would otherwise be required if the groundwater was not contaminated, thus increasing operation and treatment costs.

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[24] As advised by Enercon, Energy Solutions and Perma-Fix, both located in Oak Ridge, TN,, can currently accept only a total of 3600 gallons of free liquid containing radionuclides per day. It is assumed that a portion of this total capacity would be utilized by others at the time of construction dewatering, thereby reducing the capacity available for accepting the IPEC dewatering flow. Even at full capacity, this facility could only treat about 4 percent of the projected dewatering flow rate from the Unit 2area only (absent any contingency for the potential inclusion of an additional flow of nearly 150,000 gpd for Unit 3 piping trench dewatering).

[25] F. G. Driscoll, "Groundwater and Wells"; Johnson Division; 1986, St. Paul, MN; pg. 771

[26] In addition, other sources of clean water would be captured during dewatering of the plume area, and would further increase the volume of the water requiring re-injection. These include the clean groundwater at the periphery of the plume to the North and South at the beginning of dewatering (as described above) and infiltration of precipitation.

After treatment, the radionuclide contaminated groundwater, which would still contain Tritium, must be disposed of. Given the continuous flow rate of 55 to 60 gpm, practical disposal options appear limited to discharge to the Hudson River. While disposal to the Hudson River appears consistent with NRC regulations, GZA has been advised by Entergy's counsel that NYSDEC appears to believe they have jurisdiction over disposal of groundwater contaminated with radionuclides, and believes that disposal to the Hudson River is not permissible under State regulations. GZA concludes, therefore, that disposal options for radionuclide contaiminated groundwater generated by the NYSDEC Proposed Project are limited.

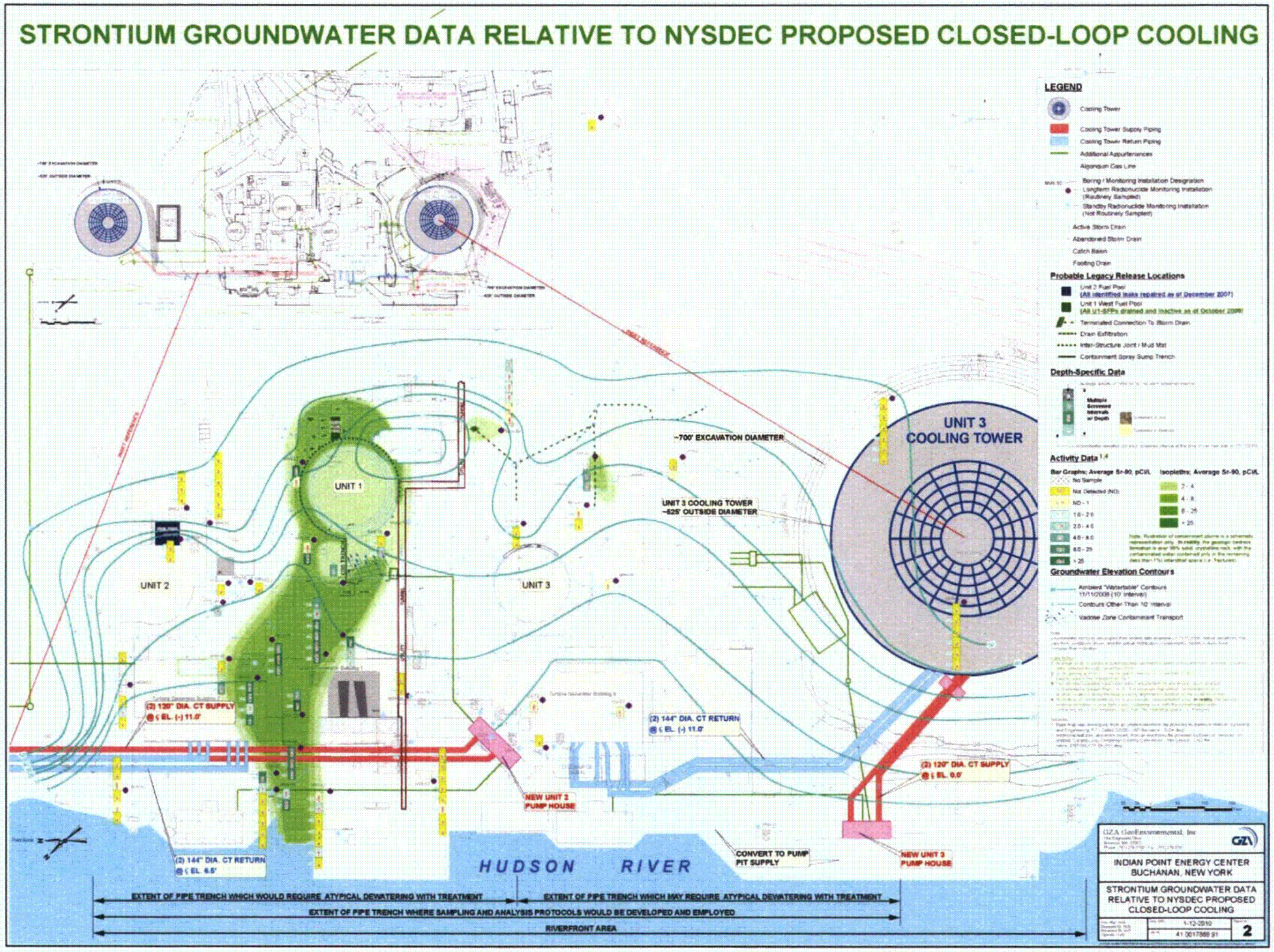


Figure 1 Conceptual Closed-Loop Cooling Layout with Strontium Groundwater Data

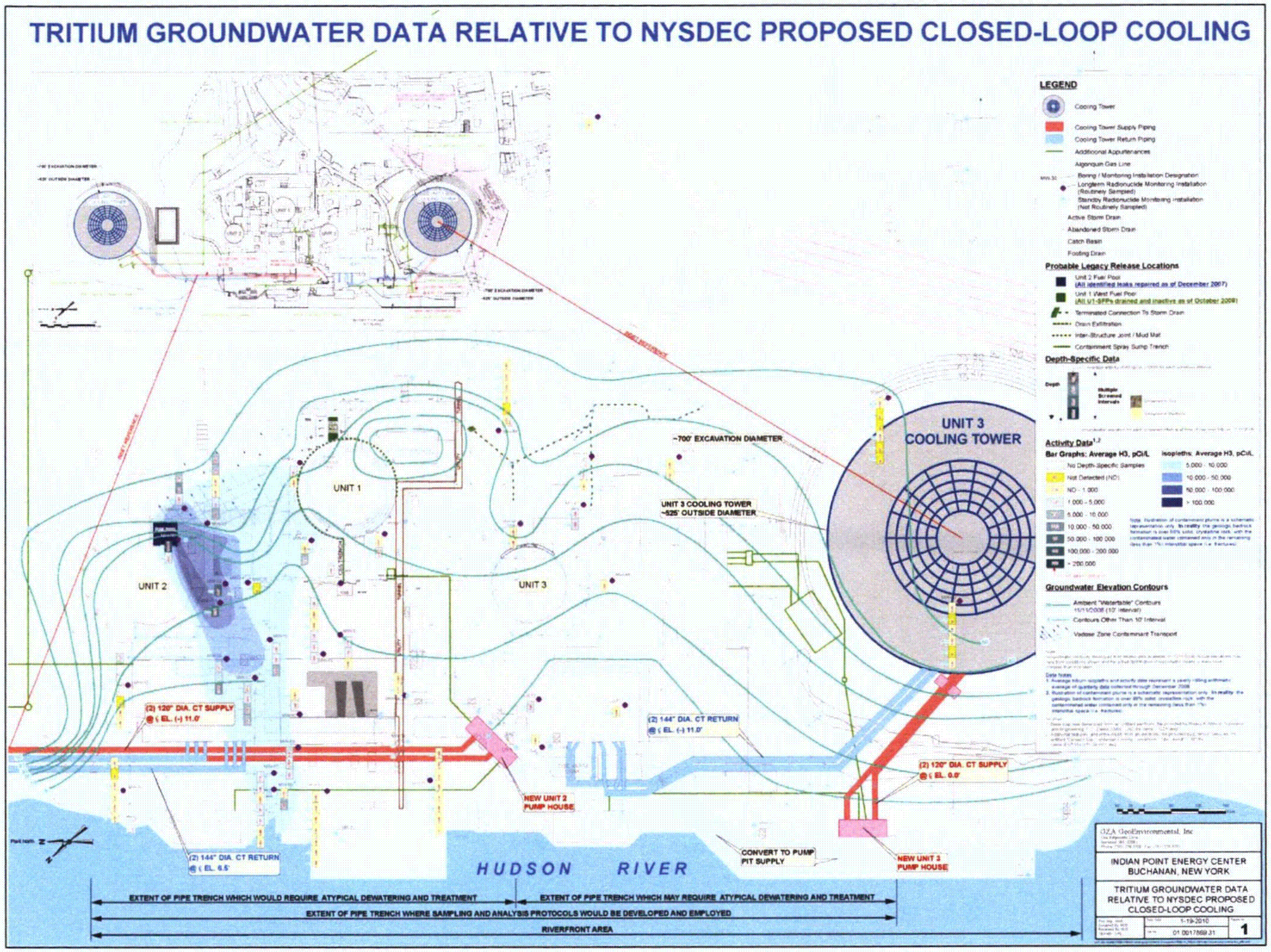


Figure 2 Conceptual Closed-Loop Cooling Layout with Tritium Groundwater Data

Attachment 4

Closed-Loop Performance

Table 4-1 IPEC Meteorological Data Recovery Rate (2001-2008)

Month	**Recover Rate** *(%)*
January	99.8%
February	99.8%
March	99.0%
April	99.6%
May	99.2%
June	99.5%
July	99.7%
August	90.8%
September	86.8%
October	92.4%
November	99.9%
December	99.6%
Annual	97.2%

[1] Meteorological data recovery rate is significantly better than is typical seen in the commercial nuclear power industry, and far exceeds the 90% recovery rate criteria set forth by RG 1.23 (Ref. 12.27)

Table 4-2 Hudson River Temperature Data Recovery Rate (2001-2008)

Month	**Recover Rate** *(%)*
January	100.0%
February	100.0%
March	99.6%
April	100.0%
May	99.6%
June	100.0%
July	100.0%
August	99.6%
September	99.2%
October	100.0%
November	100.0%
December	100.0%
Annual	99.8%

Performance evaluation of power system efficiency (PEPSE) is a steady-state energy balance software program that calculates the performance of electric generating plants. It is used throughout the world by fossil-fired plants, nuclear plants, gas turbine plants, combined cycles plants, and plants with atypical fluid systems. A plant analysis model is constructed by the user's development of a plant schematic that mimics the actual plant component connections. The plant analysis model is benchmarked against actual plant data to ensure accuracy of the analysis.

The evaluation of closed-loop cooling for IPEC is performed using a PEPSE model that provides the expected plant operational parameters and power reductions associated with conversion of IPEC to closed-loop cooling. The PEPSE model is tuned to each Unit's actual performance and, therefore, provides an accurate summary of the expected results of conversion to closed-loop cooling.

The IPEC PEPSE models were reviewed, updated, and run. The figures below show the IPEC PEPSE models, input similar to a general arrangement drawing, after they have been updated and run at a user defined circulating water temperature of 65°F.

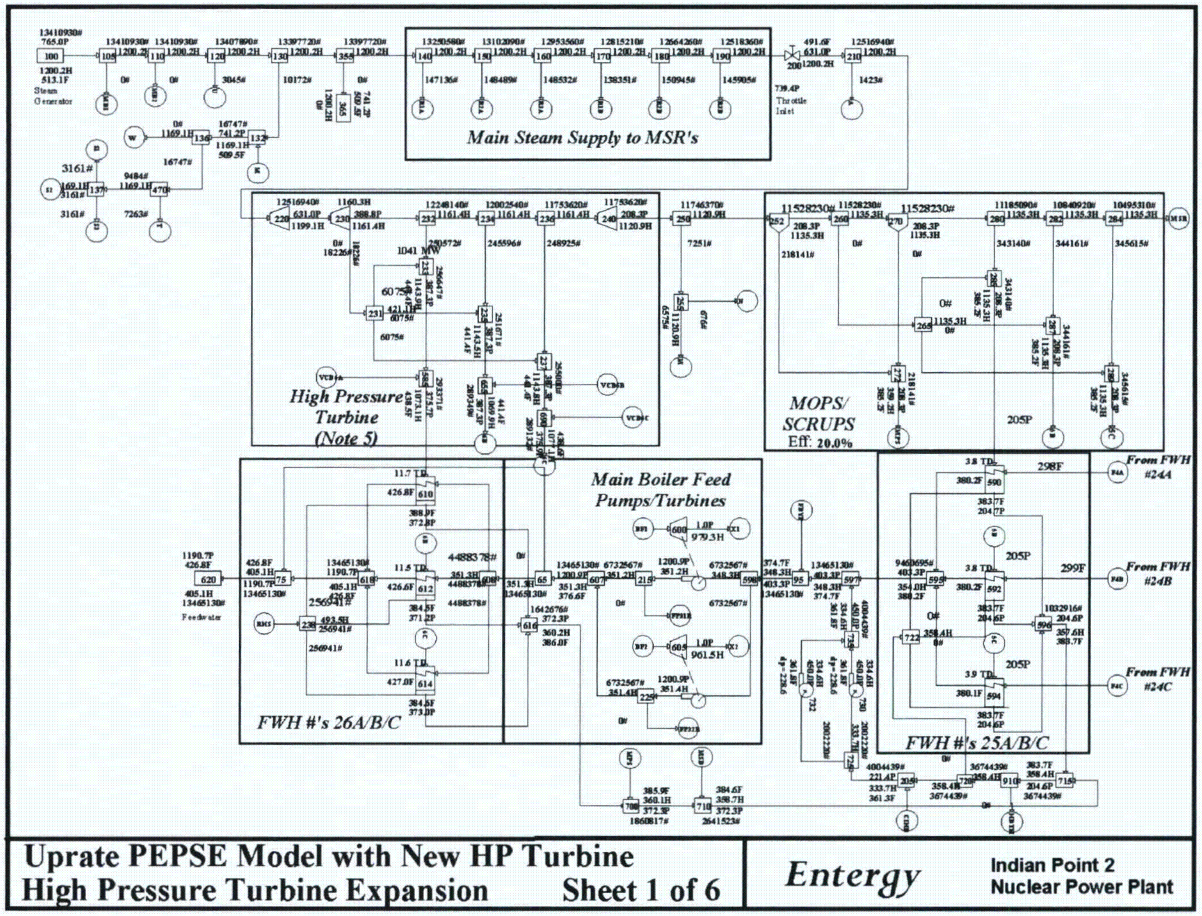
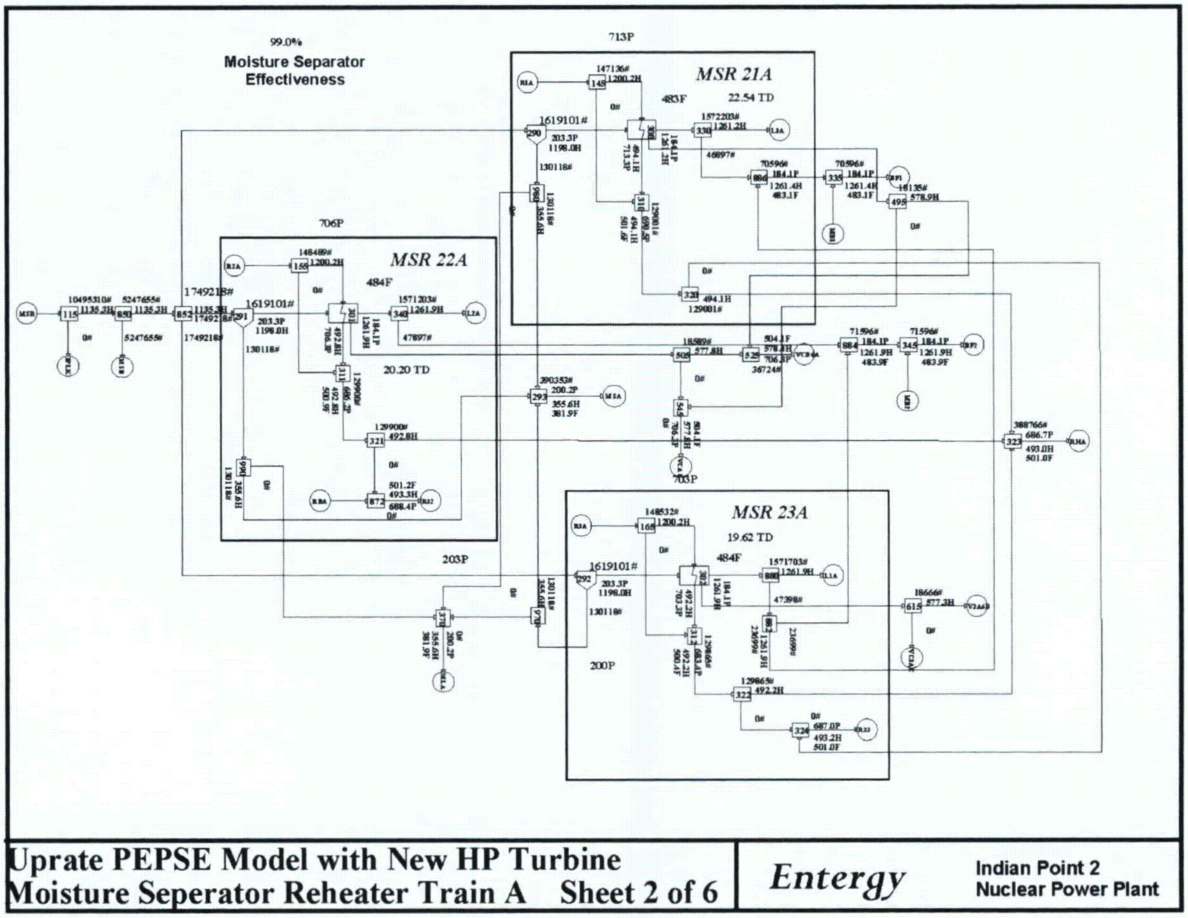


Figure 4-1 IPEC Unit 2 PEPSE Model, Sheet 1

The main components included in Sheet 1 are the input component for the Reactor Flow, the High Pressure Turbine components, the Main Steam Supply components to the Moisture Separator Reheater components, the Feedwater Heater 25 A/B/C and 26 A/B/C components, the Main Boiler Feed Pump/Turbine components, and Moisture Pre-Separator / Special Cross Under Pipe Separator components.



Uprate PEPSE Model with New HP Turbine
Moisture Seperator Reheater Train A Sheet 2 of 6

Entergy

Indian Point 2
Nuclear Power Plant

Figure 4-2 IPEC Unit 2 PEPSE Model, Sheet 2

The main components included in Sheet 2 are the Moisture Separator Reheater 21A, 22A, and 23A components.

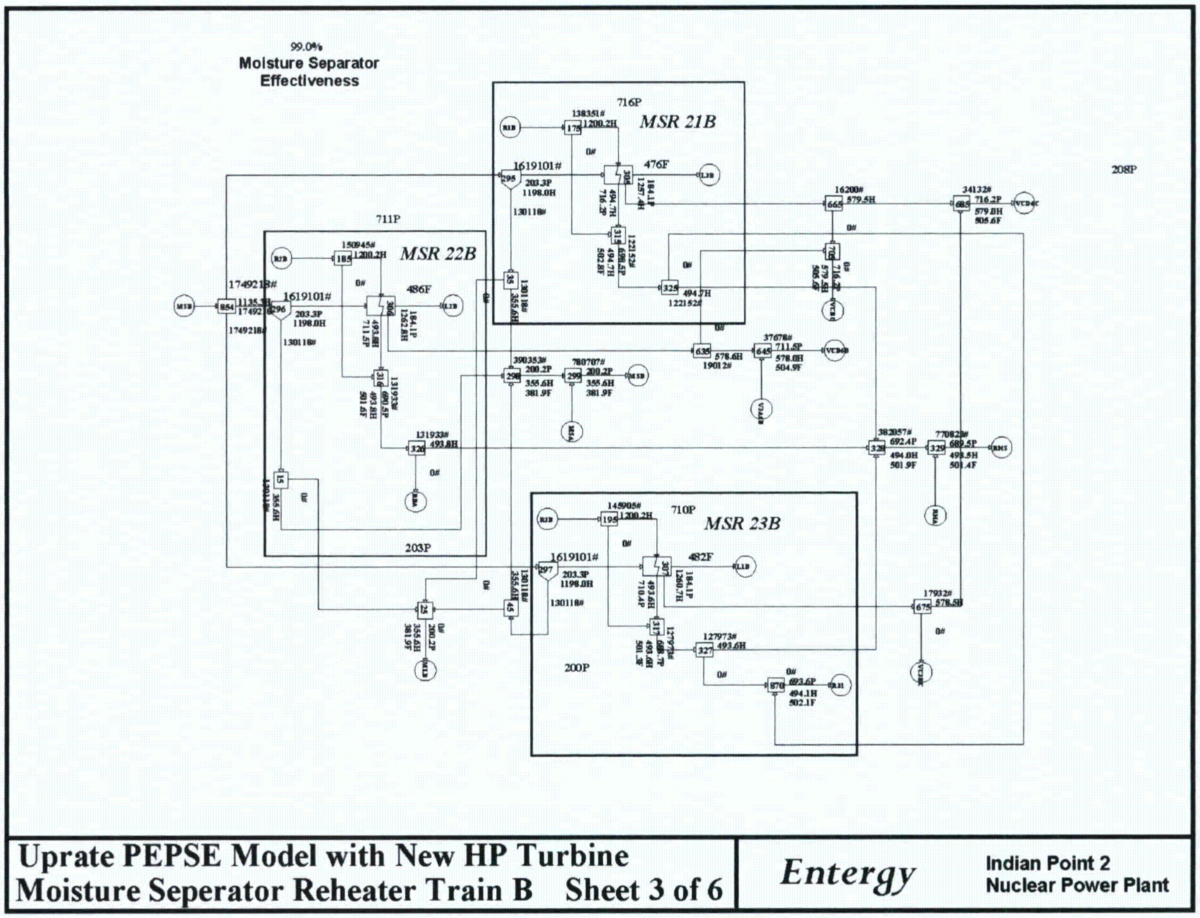


Figure 4-3 IPEC Unit 2 PEPSE Model, Sheet 3

The main components included in Sheet 3 are the Moisture Separator Reheater 21B, 22B, and 23B components.

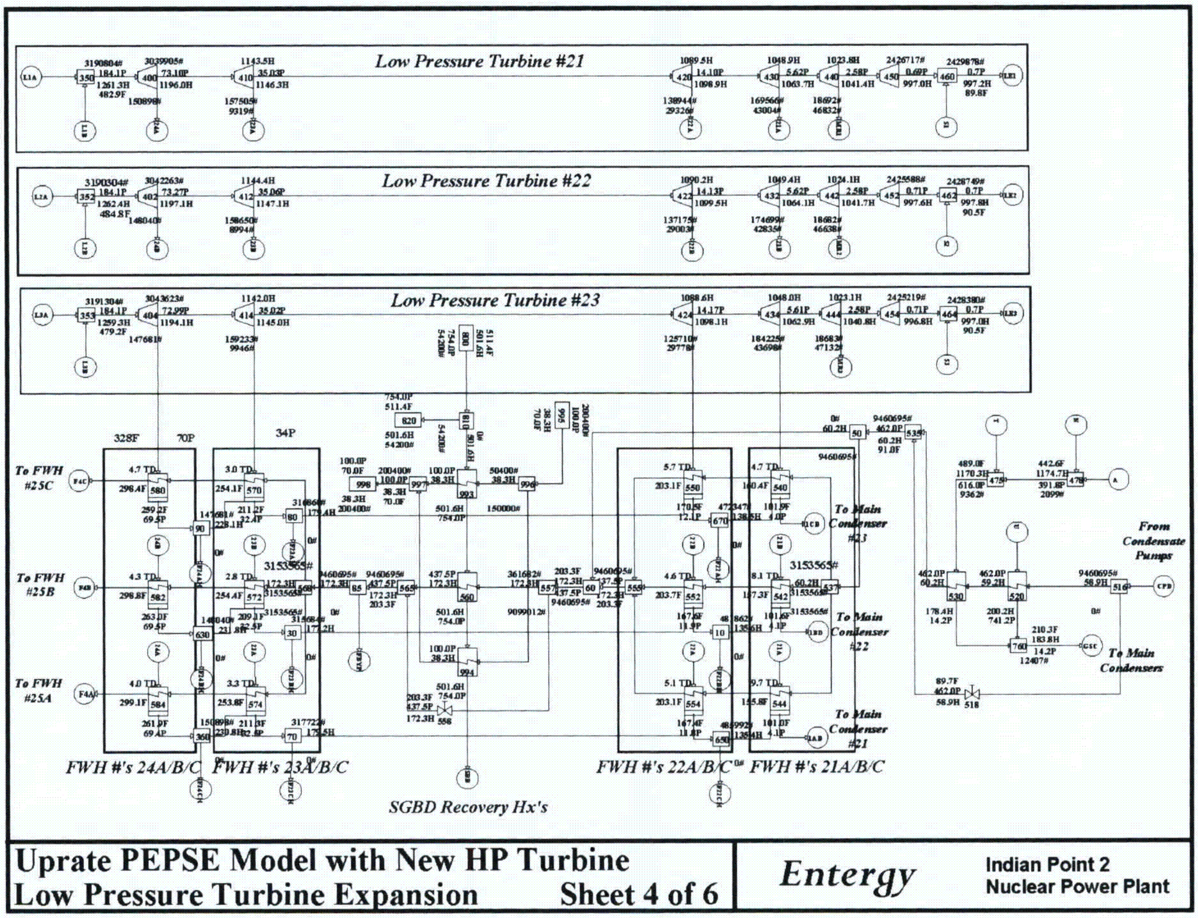
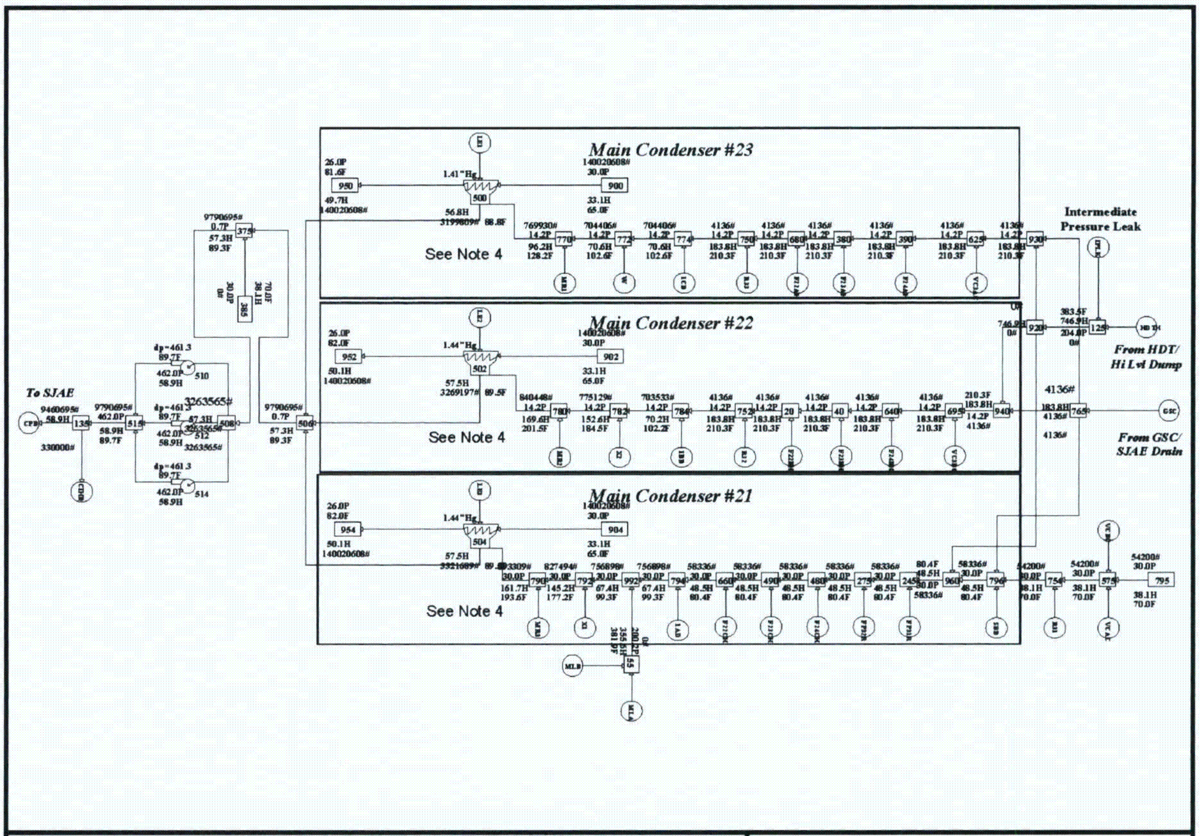


Figure 4-4 IPEC Unit 2 PEPSE Model, Sheet 4

The main components included in Sheet 4 are the Low Pressure Turbine 21, 22, and 23 components, and the Feedwater Heater 21 A/B/C, 22 A/B/C, 23 A/B/C, and 24 A/B/C components.

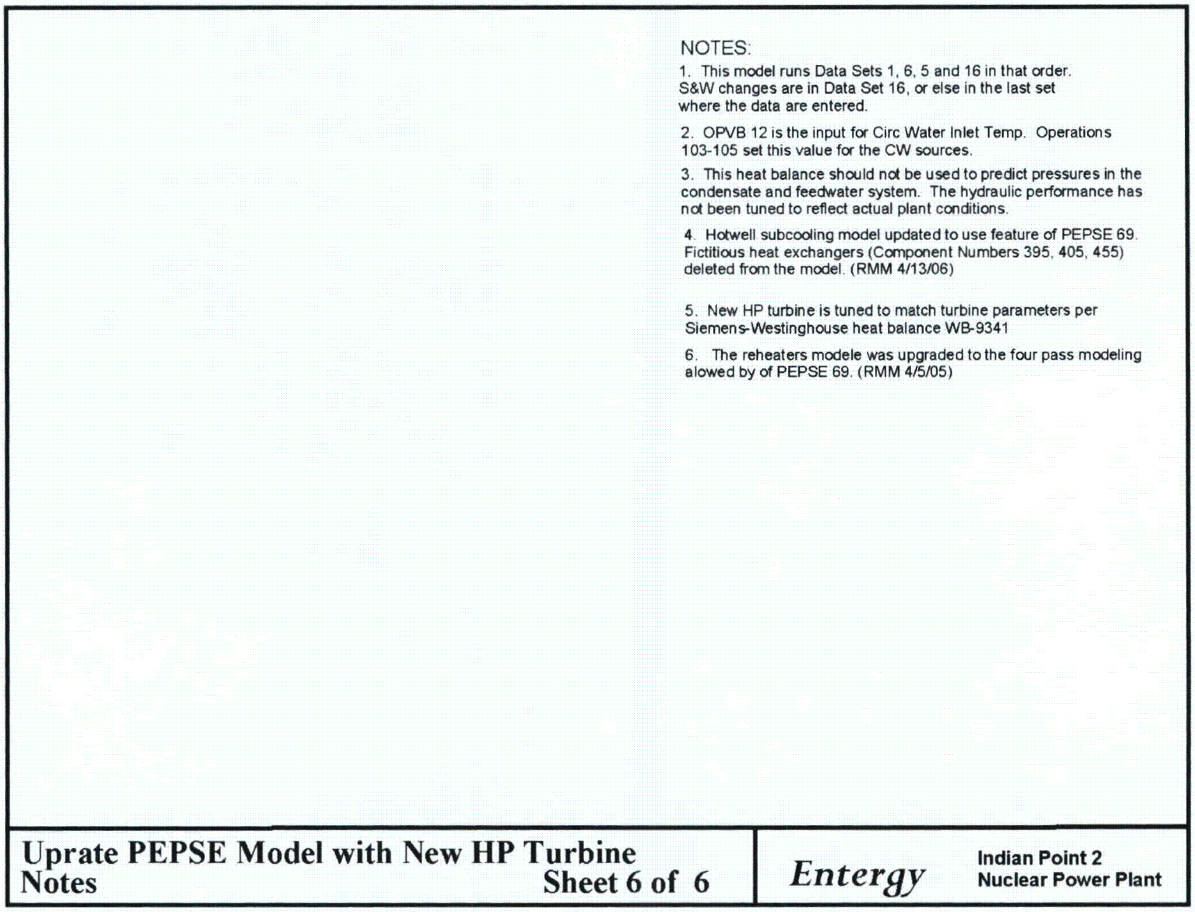


Uprate PEPSE Model with New HP Turbine
Main Condensers **Sheet 5 of 6**

Entergy **Indian Point 2**
Nuclear Power Plant

Figure 4-5 IPEC Unit 2 PEPSE Model, Sheet 5

The main components included in Sheet 5 are the Main Condenser 21, 22, and 23 components.



NOTES:

1. This model runs Data Sets 1, 6, 5 and 16 in that order. S&W changes are in Data Set 16, or else in the last set where the data are entered.

2. OPVB 12 is the input for Circ Water Inlet Temp. Operations 103-105 set this value for the CW sources.

3. This heat balance should not be used to predict pressures in the condensate and feedwater system. The hydraulic performance has not been tuned to reflect actual plant conditions.

4. Hotwell subcooling model updated to use feature of PEPSE 69. Fictitious heat exchangers (Component Numbers 395, 405, 455) deleted from the model. (RMM 4/13/06)

5. New HP turbine is tuned to match turbine parameters per Siemens-Westinghouse heat balance WB-9341

6. The reheaters modele was upgraded to the four pass modeling alowed by of PEPSE 69. (RMM 4/5/05)

Uprate PEPSE Model with New HP Turbine
Notes **Sheet 6 of 6**

Entergy **Indian Point 2**
Nuclear Power Plant

Figure 4-6 IPEC Unit 2 PEPSE Model, Sheet 6

Sheet 6 includes the notes associated with the Unit 3 PEPSE Model. Notes detail the model updates, the data used to benchmark model performance, and the limitations on the model. The notes provided indicate that information gathered from the main steam system is valid for use in this analysis.

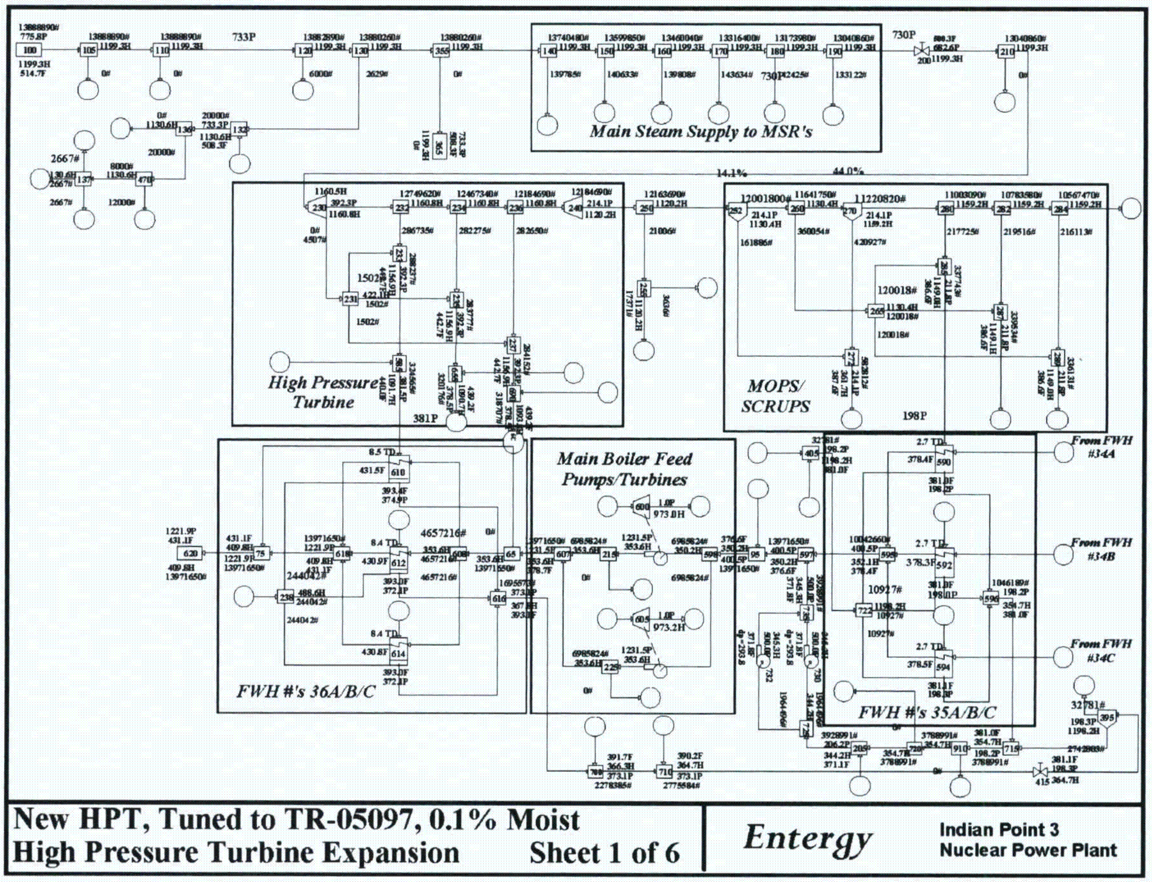


Figure 4-7 IPEC Unit 3 PEPSE Model, Sheet 1

The main components included in Sheet 1 are the input component for the Reactor Flow, the High Pressure Turbine components, the Main Steam Supply components to the Moisture Separator Reheater components, the Feedwater Heater 35 A/B/C and 36 A/B/C components, the Main Boiler Feed Pump/Turbine components, and Moisture Pre-Separator / Special Cross Under Pipe Separator components.

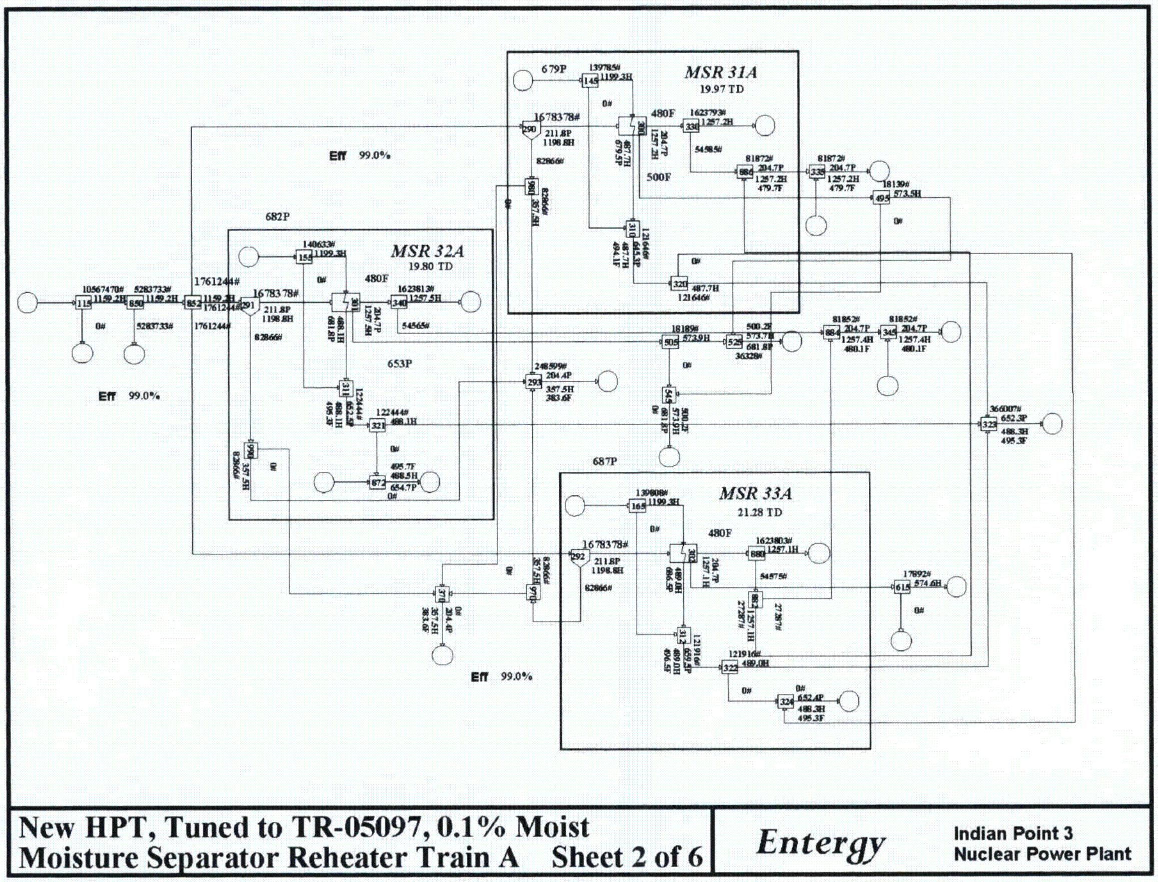


Figure 4-8 IPEC Unit 3 PEPSE Model, Sheet 2

The main components included in Sheet 2 are the Moisture Separator Reheater 31A, 32A, and 33A components.

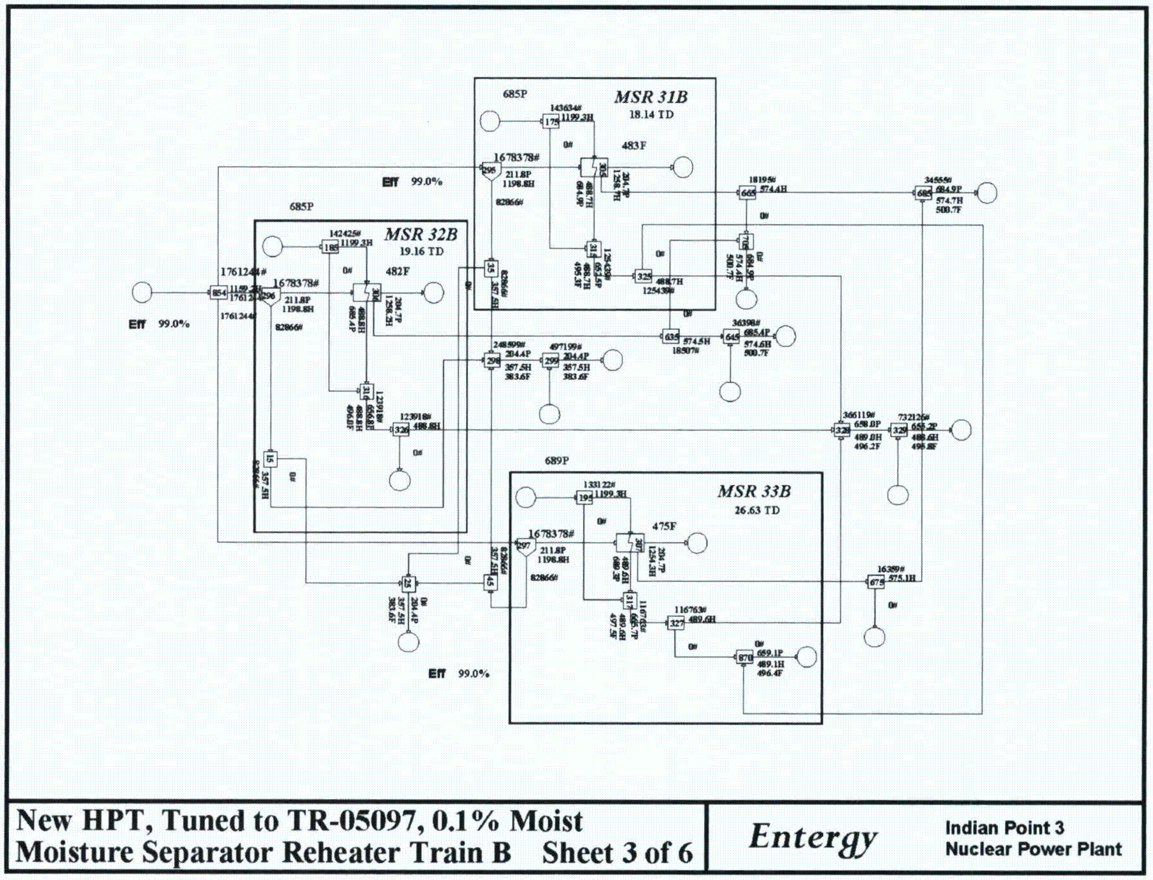


Figure 4-9 IPEC Unit 3 PEPSE Model, Sheet 3

The main components included in Sheet 3 are the Moisture Separator Reheater 31B, 32B, and 33B components.

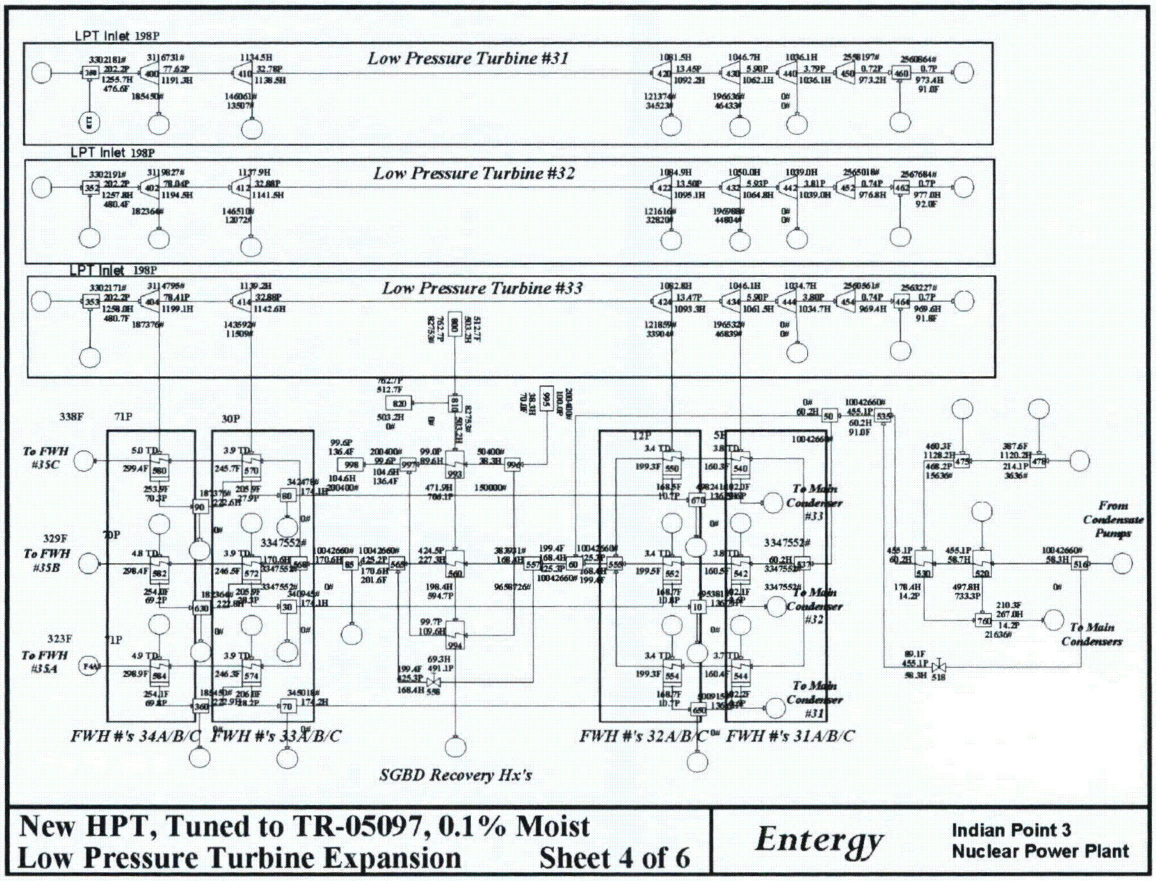


Figure 4-10 IPEC Unit 3 PEPSE Model, Sheet 4

The main components included in Sheet 4 are the Low Pressure Turbine 31, 32, and 33 components, and the Feedwater Heater 31 A/B/C, 32 A/B/C, 33 A/B/C, and 34 A/B/C components.

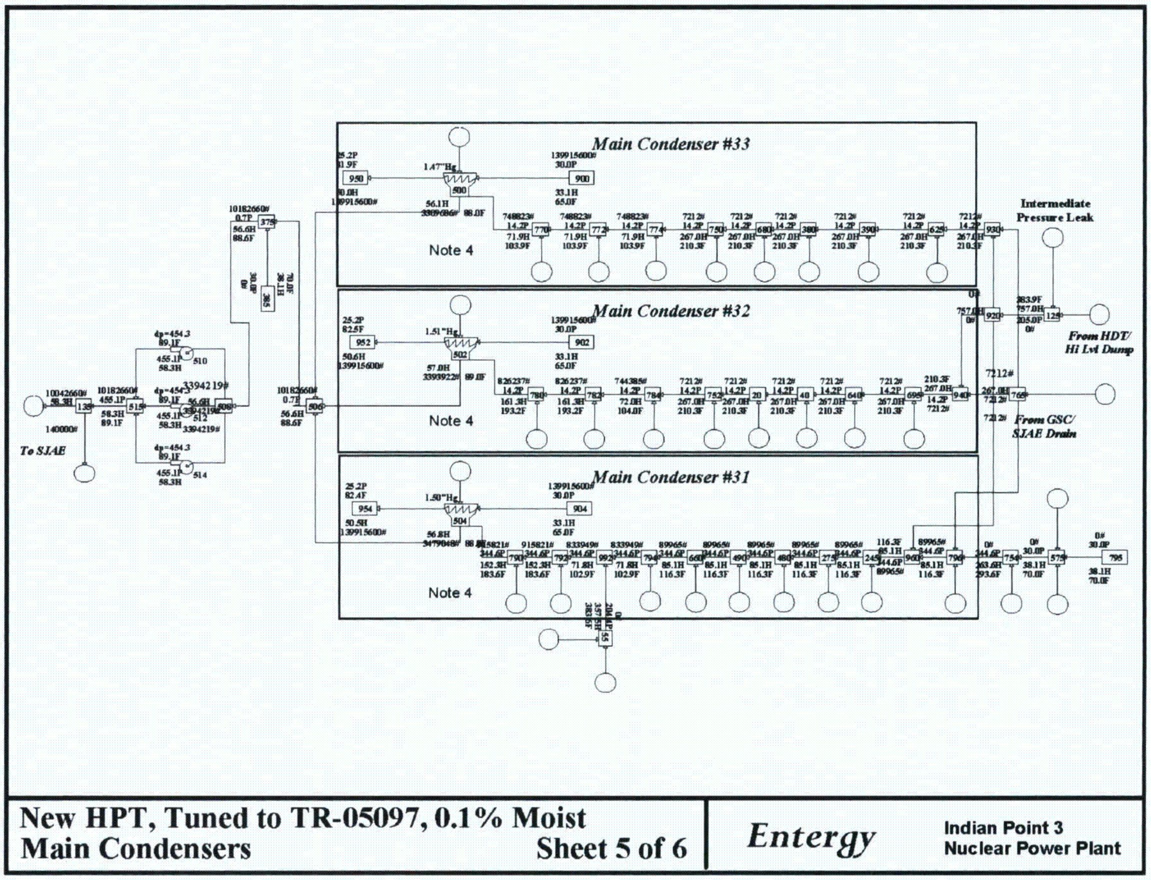
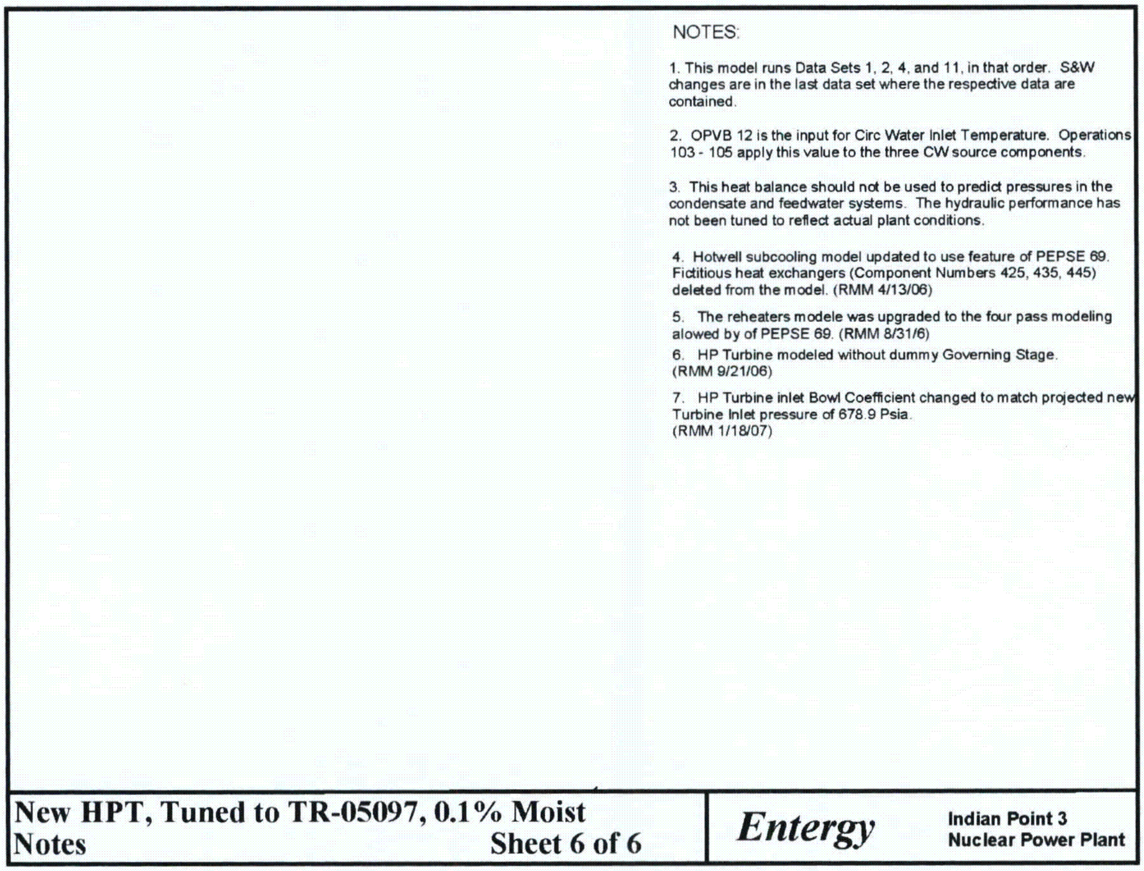


Figure 4-11 IPEC Unit 3 PEPSE Model, Sheet 5

The main components included in Sheet 5 are the Main Condenser 31, 32, and 33 components.



NOTES:

1. This model runs Data Sets 1, 2, 4, and 11, in that order. S&W changes are in the last data set where the respective data are contained.

2. OPVB 12 is the input for Circ Water Inlet Temperature. Operations 103 - 105 apply this value to the three CW source components.

3. This heat balance should not be used to predict pressures in the condensate and feedwater systems. The hydraulic performance has not been tuned to reflect actual plant conditions.

4. Hotwell subcooling model updated to use feature of PEPSE 69. Fictitious heat exchangers (Component Numbers 425, 435, 445) deleted from the model. (RMM 4/13/06)

5. The reheaters modele was upgraded to the four pass modeling alowed by of PEPSE 69. (RMM 8/31/6)

6. HP Turbine modeled without dummy Governing Stage. (RMM 9/21/06)

7. HP Turbine inlet Bowl Coefficient changed to match projected new Turbine Inlet pressure of 678.9 Psia. (RMM 1/18/07)

New HPT, Tuned to TR-05097, 0.1% Moist **Notes** **Sheet 6 of 6**	***Entergy***	**Indian Point 3** **Nuclear Power Plant**

Figure 4-12 IPEC Unit 3 PEPSE Model, Sheet 6

Sheet 6 includes the notes associated with the Unit 3 PEPSE Model. Notes detail the model updates, the data used to benchmark model performance, and the limitations on the model. The notes provided indicate that information gathered from the main steam system is valid for use in this analysis.

Indian Point Unit 2 Average Closed-Loop Cooling Operational Losses (MWe)

Month	2001	2002	2003	2004	2005	2006	2007	2008
January	4.7	7.6	3.1	2.9	4.2	8.1	8.2	6.6
February	5.5	7.3	3.7	5.1	4.0	6.3	3.3	6.6
March	7.3	9.8	5.6	10.1	5.2	9.6	9.1	9.2
April	15.9	18.4	9.4	16.9	15.3	17.4	15.1	18.3
May	23.7	22.3	11.4	23.5	18.4	23.4	23.4	20.2
June	25.7	24.9	8.2	13.1	19.5	24.4	18.1	20.4
July	11.6	13.3	0.4	8.5	6.3	20.6	9.3	8.1
August	11.3	6.8	0.0	11.6	3.5	7.7	0.0	3.9
September	8.6	10.5	0.0	12.0	2.7	11.6	0.6	7.5
October	13.4	10.7	9.5	14.1	14.2	14.5	13.8	8.6
November	14.9	13.2	15.3	13.3	15.0	18.5	11.2	11.5
December	10.2	6.4	7.2	7.7	6.1	11.7	7.4	6.3
Annual	12.8	12.6	6.2	11.6	9.6	14.5	11.4	10.6

Indian Point Unit 3 Average Closed-Loop Cooling Operational Losses (MWe)

Month	2001	2002	2003	2004	2005	2006	2007	2008
January	0.0	0.1	0.0	0.0	0.0	0.2	0.6	0.1
February	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.2
March	0.0	0.4	0.0	0.3	0.0	0.5	0.5	0.2
April	2.2	5.2	0.6	3.7	3.2	4.1	2.0	4.4
May	10.7	9.6	3.1	13.2	7.4	10.9	11.5	8.7
June	17.8	16.2	3.9	10.3	14.8	17.0	13.8	15.1
July	9.8	11.7	0.3	7.5	5.7	17.4	8.2	7.3
August	10.3	6.3	0.0	10.2	3.4	7.0	0.0	3.4
September	6.9	8.5	0.0	9.3	2.5	8.6	0.5	6.2
October	7.2	5.6	3.9	6.5	7.1	7.1	8.8	4.2
November	4.7	2.4	3.6	3.2	3.4	4.8	2.7	2.7
December	1.9	0.0	0.2	0.2	0.0	0.8	0.1	0.2
Annual	6.0	5.5	1.3	5.4	4.0	6.6	4.5	4.4

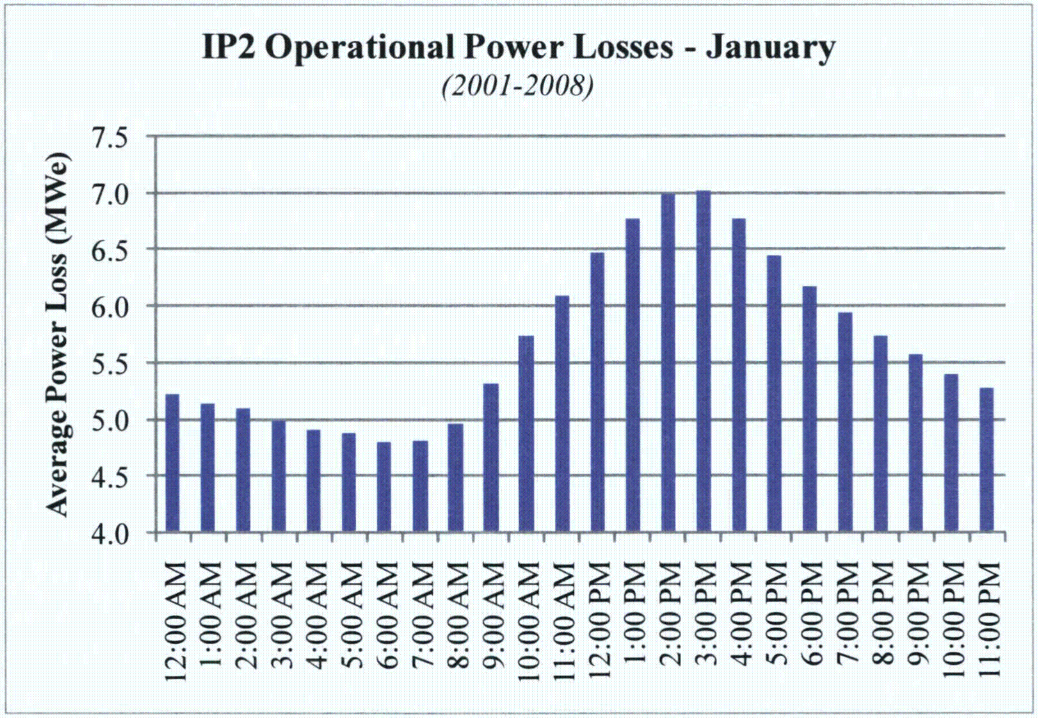
Indian Point Unit 2 Maximum Closed-Loop Cooling Operational Losses (MWe)

Month	2001	2002	2003	2004	2005	2006	2007	2008
January	13.9	24.7	12.2	18.4	17.2	29.4	36.7	25.8
February	20.3	20.8	12.3	13.8	11.5	26.2	11.3	28.9
March	13.1	25.3	17.4	29.4	14.6	29.7	31.8	27.5
April	39.6	42.4	29.5	36.1	33.8	35.0	33.2	43.3
May	38.8	43.6	24.8	43.2	33.9	42.9	41.9	42.2
June	39.5	45.8	22.3	33.6	36.6	42.9	38.1	47.4
July	28.1	34.8	9.8	24.9	21.6	34.5	27.2	19.0
August	24.1	21.5	0.0	26.8	17.9	27.5	0.0	17.2
September	25.2	25.1	3.7	27.4	14.3	28.3	3.9	27.1
October	33.5	29.9	31.6	29.5	28.1	34.1	30.8	25.7
November	30.9	37.6	38.3	31.0	34.0	39.5	30.0	28.5
December	27.3	21.7	24.5	26.4	17.1	39.1	27.4	24.4
Annual	39.6	45.8	38.3	43.2	36.6	42.9	41.9	47.4

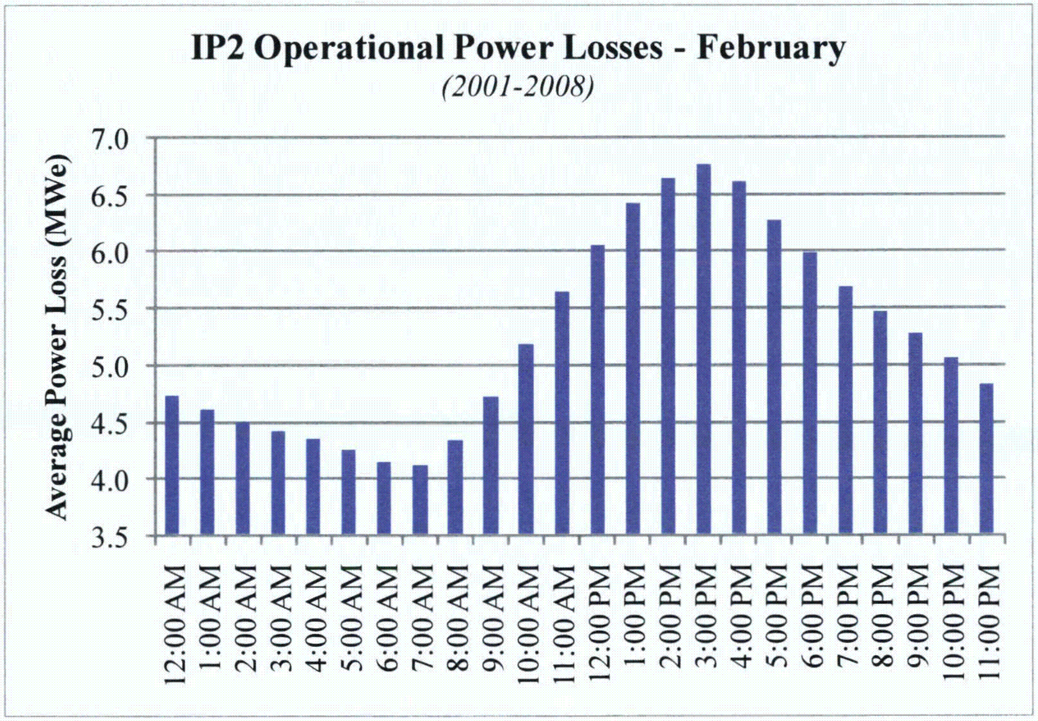
Indian Point Unit 3 Maximum Closed-Loop Cooling Operational Losses (MWe)

Month	2001	2002	2003	2004	2005	2006	2007	2008
January	0.0	6.2	0.0	1.7	1.0	9.7	16.1	6.8
February	2.9	3.4	0.0	0.0	0.0	7.2	0.0	9.2
March	0.0	6.6	1.2	9.8	0.0	10.1	11.7	8.2
April	19.3	24.1	9.9	17.6	16.9	16.2	13.0	22.1
May	22.8	29.2	10.6	29.3	19.2	30.4	28.1	28.3
June	31.5	33.0	14.8	29.6	29.4	32.1	31.1	38.0
July	26.6	32.2	7.8	23.6	21.7	32.2	26.0	17.4
August	23.9	21.0	0.0	25.5	17.8	27.6	0.0	15.3
September	22.2	21.5	2.6	22.8	13.6	22.3	2.9	25.2
October	21.8	24.9	17.4	18.6	21.3	20.8	23.7	15.2
November	16.4	20.2	21.2	14.0	16.2	20.4	14.0	13.0
December	12.0	4.0	6.1	7.4	1.0	20.1	8.2	6.1
Annual	31.5	33.0	21.2	29.6	29.4	32.2	31.1	38.0

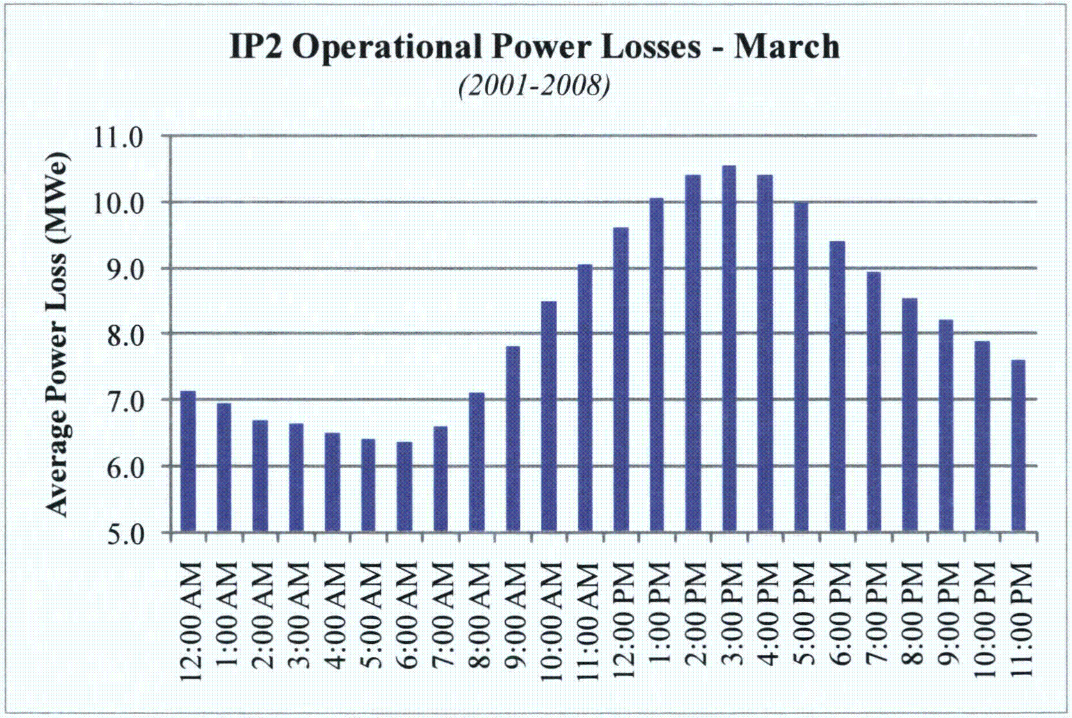
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	5.2	29.3
1:00 AM	5.1	29.8
2:00 AM	5.1	30.3
3:00 AM	5.0	30.7
4:00 AM	4.9	31.0
5:00 AM	4.9	30.7
6:00 AM	4.8	34.0
7:00 AM	4.8	33.8
8:00 AM	5.0	35.0
9:00 AM	5.3	36.3
10:00 AM	5.7	36.7
11:00 AM	6.1	34.8
12:00 PM	6.5	33.5
1:00 PM	6.8	32.8
2:00 PM	7.0	31.2
3:00 PM	7.0	29.0
4:00 PM	6.8	27.1
5:00 PM	6.4	27.3
6:00 PM	6.2	26.6
7:00 PM	5.9	28.7
8:00 PM	5.7	29.0
9:00 PM	5.6	29.1
10:00 PM	5.4	28.0
11:00 PM	5.3	29.2



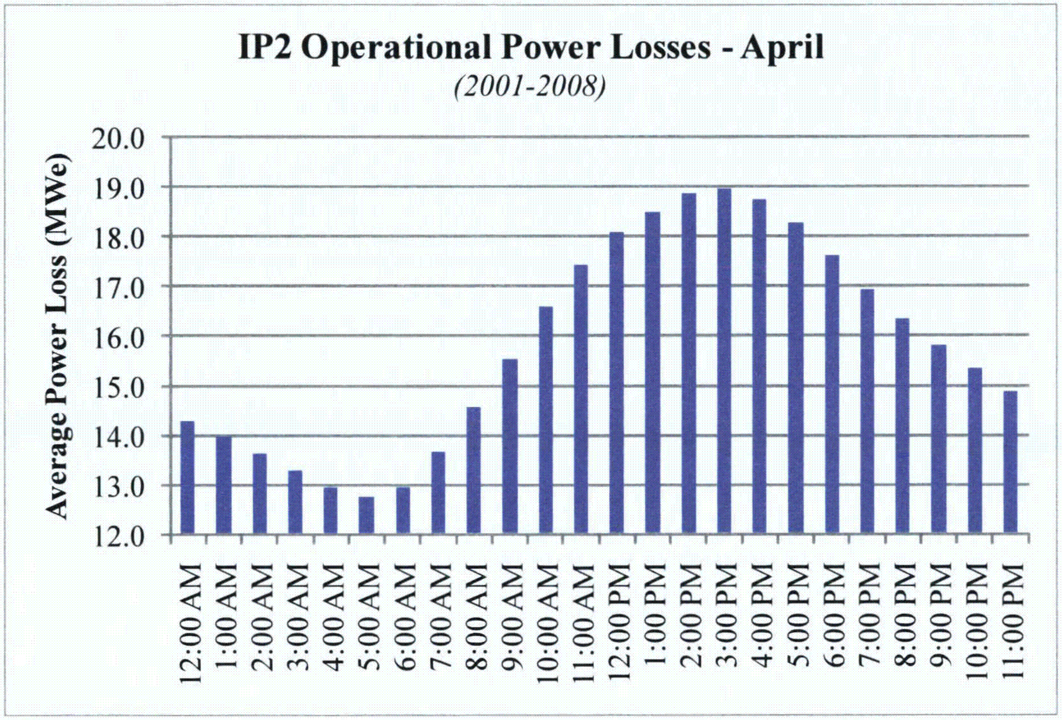
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	4.7	19.5
1:00 AM	4.6	20.1
2:00 AM	4.5	21.5
3:00 AM	4.4	23.9
4:00 AM	4.4	23.9
5:00 AM	4.3	24.0
6:00 AM	4.1	24.2
7:00 AM	4.1	24.8
8:00 AM	4.3	27.3
9:00 AM	4.7	27.5
10:00 AM	5.2	28.3
11:00 AM	5.6	28.7
12:00 PM	6.1	28.2
1:00 PM	6.4	28.9
2:00 PM	6.6	24.0
3:00 PM	6.8	22.7
4:00 PM	6.6	21.4
5:00 PM	6.3	19.2
6:00 PM	6.0	18.0
7:00 PM	5.7	17.3
8:00 PM	5.5	16.8
9:00 PM	5.3	19.7
10:00 PM	5.1	18.1
11:00 PM	4.8	20.1



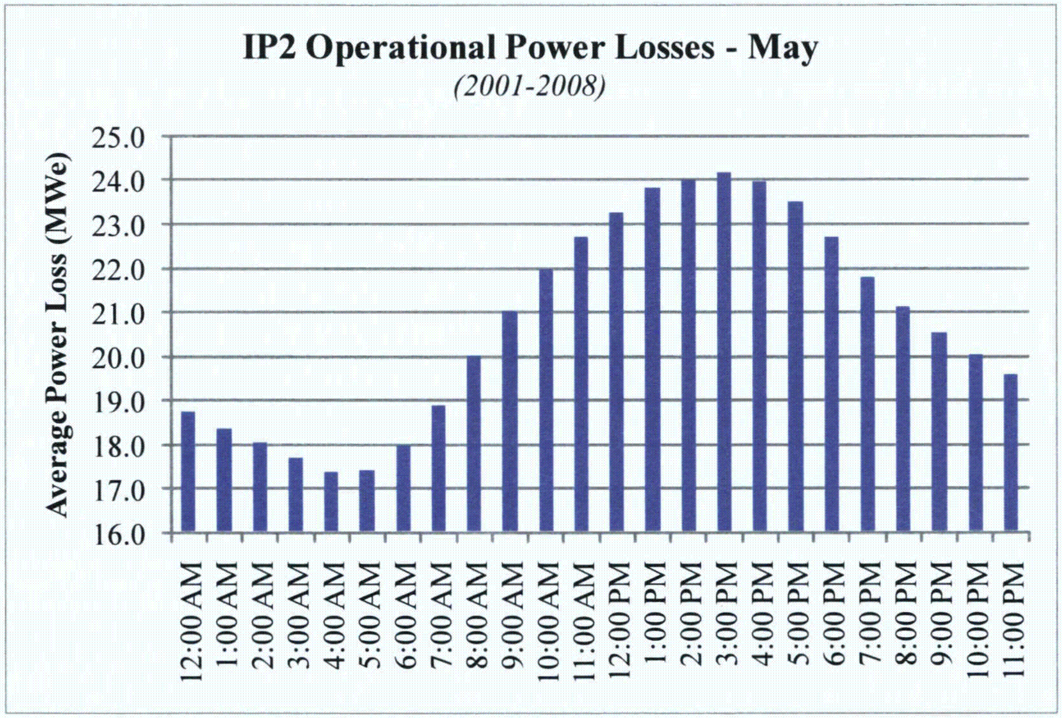
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	7.1	25.4
1:00 AM	7.0	25.3
2:00 AM	6.7	22.7
3:00 AM	6.6	23.1
4:00 AM	6.5	27.5
5:00 AM	6.4	26.5
6:00 AM	6.4	24.1
7:00 AM	6.6	22.6
8:00 AM	7.1	21.3
9:00 AM	7.8	26.6
10:00 AM	8.5	31.2
11:00 AM	9.0	31.0
12:00 PM	9.6	31.4
1:00 PM	10.0	31.3
2:00 PM	10.4	31.5
3:00 PM	10.5	31.8
4:00 PM	10.4	31.5
5:00 PM	10.0	29.5
6:00 PM	9.4	27.7
7:00 PM	8.9	25.3
8:00 PM	8.5	24.8
9:00 PM	8.2	25.6
10:00 PM	7.9	26.1
11:00 PM	7.6	25.6



Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	14.3	37.4
1:00 AM	14.0	36.9
2:00 AM	13.6	35.7
3:00 AM	13.3	35.1
4:00 AM	12.9	35.1
5:00 AM	12.8	34.6
6:00 AM	12.9	35.6
7:00 AM	13.7	38.2
8:00 AM	14.6	40.1
9:00 AM	15.5	41.4
10:00 AM	16.6	42.4
11:00 AM	17.4	41.7
12:00 PM	18.1	42.4
1:00 PM	18.5	42.0
2:00 PM	18.9	43.3
3:00 PM	19.0	41.8
4:00 PM	18.7	41.7
5:00 PM	18.3	41.1
6:00 PM	17.6	41.5
7:00 PM	16.9	40.1
8:00 PM	16.3	39.3
9:00 PM	15.8	38.4
10:00 PM	15.3	37.7
11:00 PM	14.9	37.6



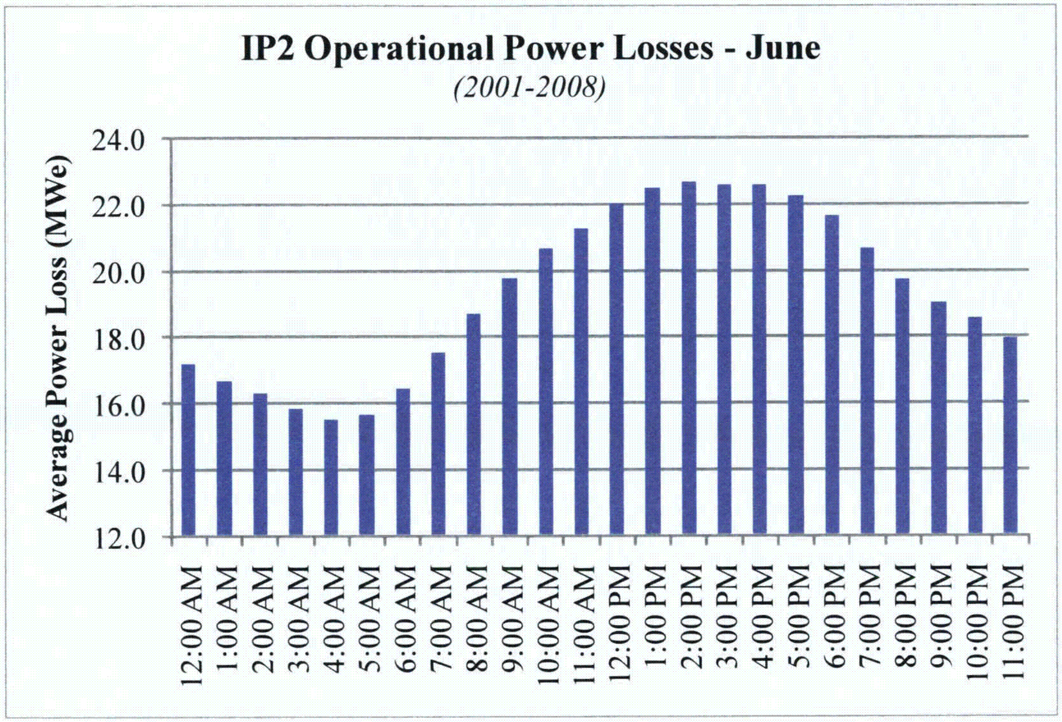
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	18.7	35.4
1:00 AM	18.4	35.0
2:00 AM	18.0	34.6
3:00 AM	17.7	33.9
4:00 AM	17.4	32.6
5:00 AM	17.4	33.0
6:00 AM	18.0	34.1
7:00 AM	18.9	37.3
8:00 AM	20.0	40.0
9:00 AM	21.0	41.1
10:00 AM	22.0	41.8
11:00 AM	22.7	42.7
12:00 PM	23.3	43.1
1:00 PM	23.8	43.6
2:00 PM	24.0	43.6
3:00 PM	24.2	43.3
4:00 PM	24.0	42.9
5:00 PM	23.5	41.8
6:00 PM	22.7	39.7
7:00 PM	21.8	38.2
8:00 PM	21.1	37.6
9:00 PM	20.5	36.9
10:00 PM	20.0	36.0
11:00 PM	19.6	35.5



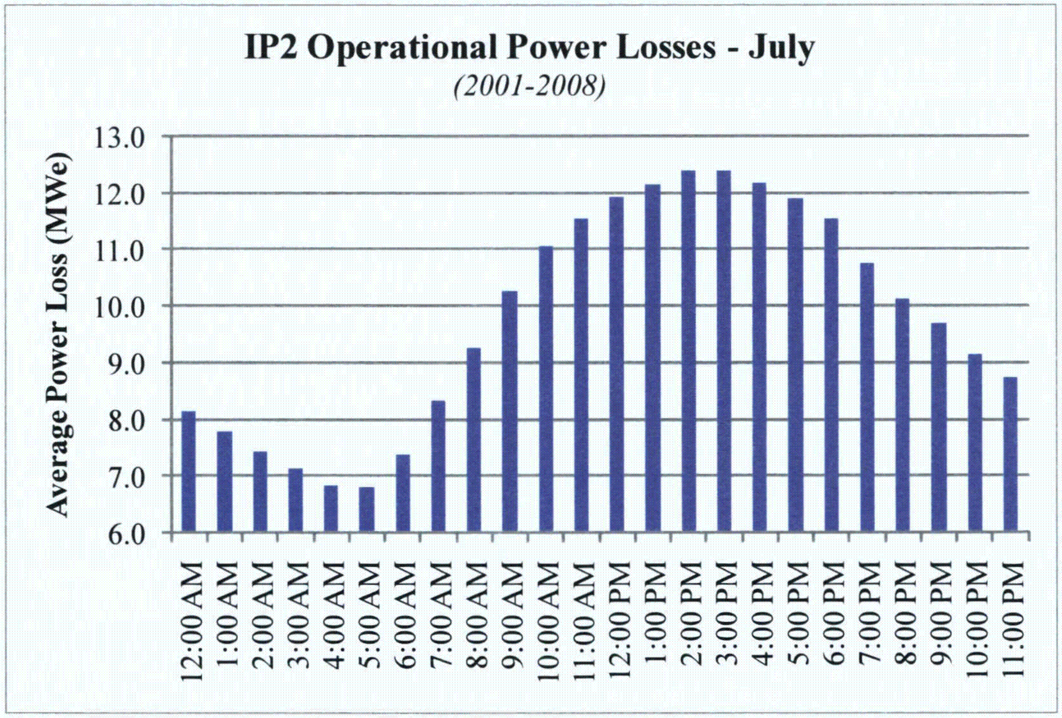
IP2 Operational Power Losses - May

(2001-2008)

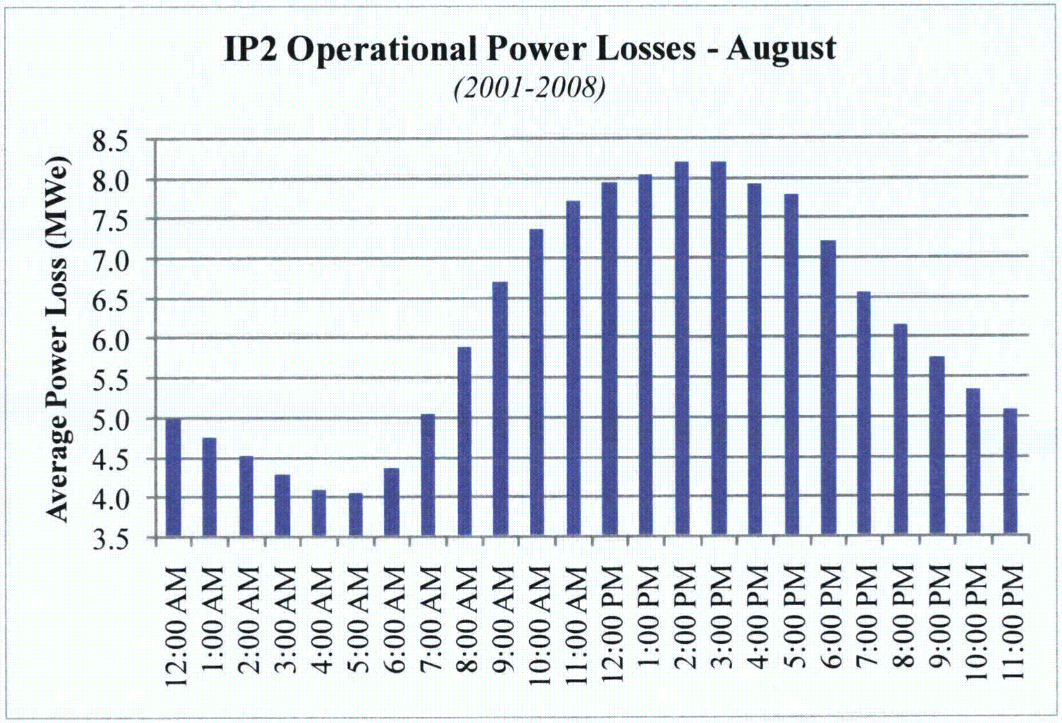
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	17.2	39.3
1:00 AM	16.7	38.6
2:00 AM	16.3	38.1
3:00 AM	15.8	36.7
4:00 AM	15.5	35.5
5:00 AM	15.7	37.7
6:00 AM	16.4	38.3
7:00 AM	17.5	38.8
8:00 AM	18.7	40.2
9:00 AM	19.8	41.1
10:00 AM	20.7	41.7
11:00 AM	21.3	43.6
12:00 PM	22.0	44.6
1:00 PM	22.5	45.3
2:00 PM	22.7	47.4
3:00 PM	22.6	46.8
4:00 PM	22.6	45.6
5:00 PM	22.2	45.1
6:00 PM	21.6	43.2
7:00 PM	20.6	41.4
8:00 PM	19.7	40.5
9:00 PM	19.0	40.2
10:00 PM	18.5	39.6
11:00 PM	17.9	39.0



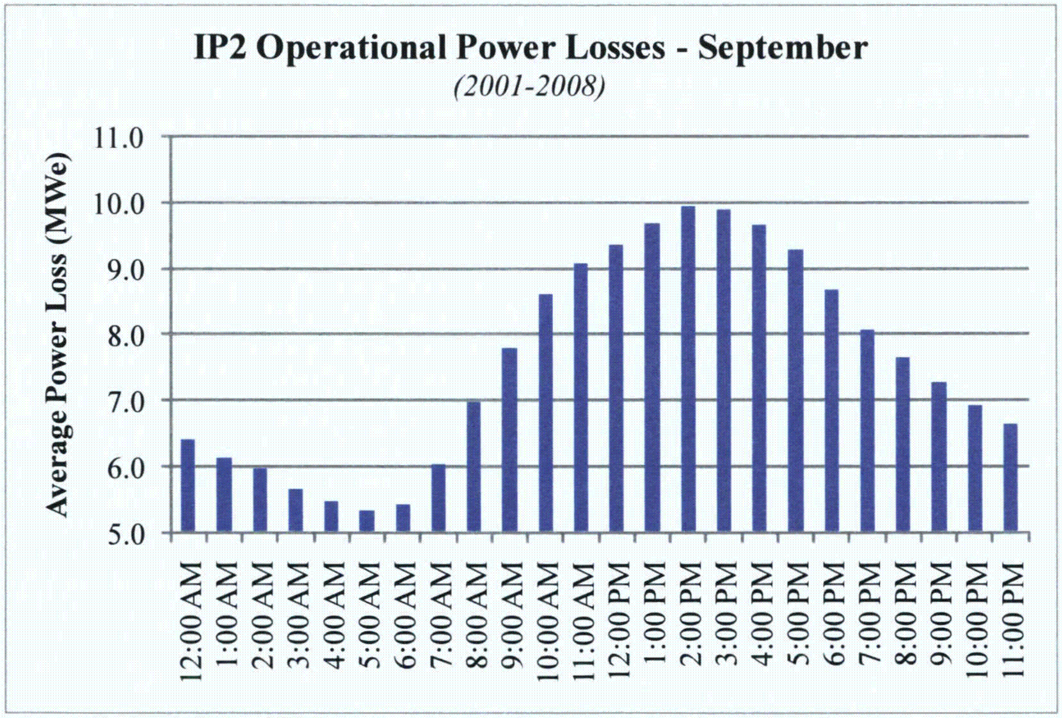
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	8.1	29.2
1:00 AM	7.8	27.7
2:00 AM	7.4	27.1
3:00 AM	7.1	26.6
4:00 AM	6.8	26.2
5:00 AM	6.8	26.2
6:00 AM	7.4	26.9
7:00 AM	8.3	27.9
8:00 AM	9.3	28.8
9:00 AM	10.3	30.0
10:00 AM	11.0	31.5
11:00 AM	11.5	33.4
12:00 PM	11.9	34.0
1:00 PM	12.2	33.8
2:00 PM	12.4	33.7
3:00 PM	12.4	34.8
4:00 PM	12.2	34.7
5:00 PM	11.9	34.7
6:00 PM	11.5	34.5
7:00 PM	10.7	32.9
8:00 PM	10.1	31.4
9:00 PM	9.7	31.5
10:00 PM	9.1	32.0
11:00 PM	8.7	31.9



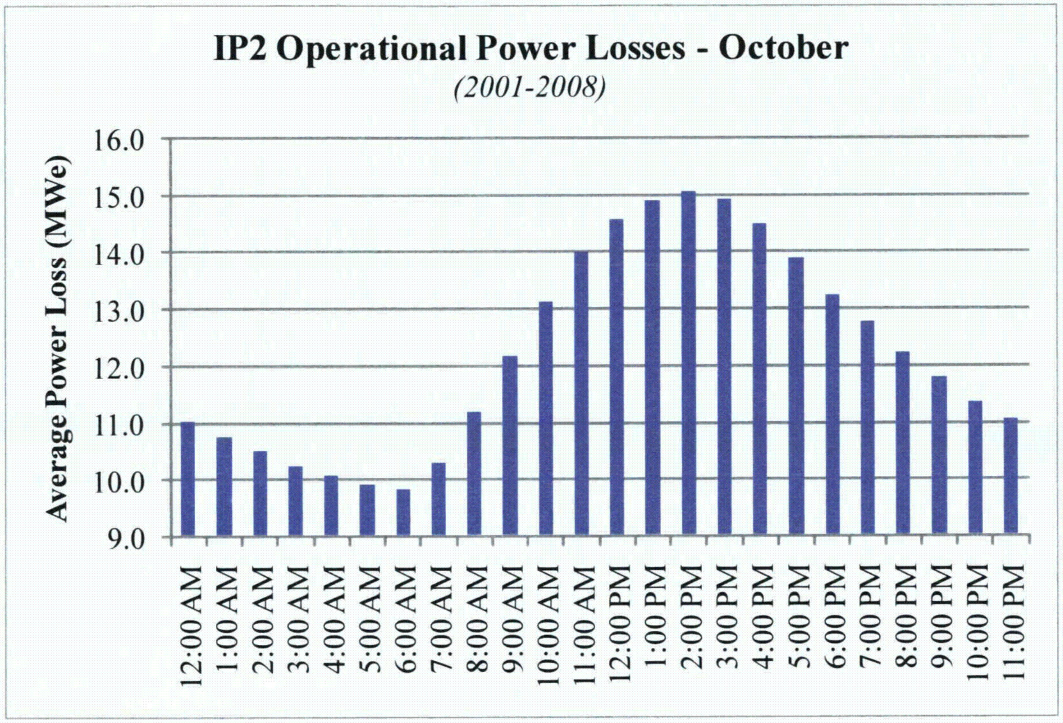
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	5.0	21.2
1:00 AM	4.8	21.4
2:00 AM	4.5	20.6
3:00 AM	4.3	20.0
4:00 AM	4.1	19.6
5:00 AM	4.0	20.2
6:00 AM	4.4	21.1
7:00 AM	5.0	22.4
8:00 AM	5.9	24.1
9:00 AM	6.7	24.0
10:00 AM	7.4	25.7
11:00 AM	7.7	27.0
12:00 PM	7.9	27.5
1:00 PM	8.0	27.4
2:00 PM	8.2	27.5
3:00 PM	8.2	27.4
4:00 PM	7.9	27.1
5:00 PM	7.8	26.2
6:00 PM	7.2	23.8
7:00 PM	6.6	22.4
8:00 PM	6.2	22.2
9:00 PM	5.7	22.0
10:00 PM	5.3	22.3
11:00 PM	5.1	22.8



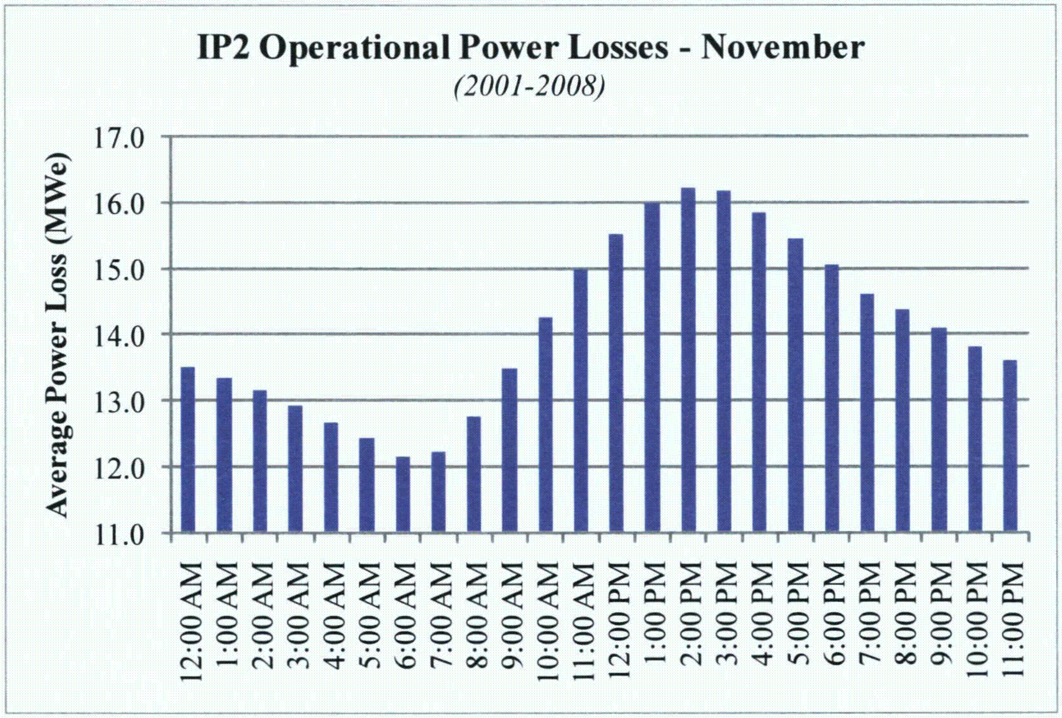
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	6.4	25.1
1:00 AM	6.1	23.3
2:00 AM	6.0	25.2
3:00 AM	5.7	25.2
4:00 AM	5.5	24.1
5:00 AM	5.3	24.6
6:00 AM	5.4	25.6
7:00 AM	6.0	27.2
8:00 AM	7.0	27.5
9:00 AM	7.8	28.3
10:00 AM	8.6	28.2
11:00 AM	9.1	27.5
12:00 PM	9.4	26.6
1:00 PM	9.7	26.7
2:00 PM	9.9	27.1
3:00 PM	9.9	27.4
4:00 PM	9.7	25.9
5:00 PM	9.3	24.4
6:00 PM	8.7	24.4
7:00 PM	8.1	24.7
8:00 PM	7.7	24.7
9:00 PM	7.3	25.0
10:00 PM	6.9	24.6
11:00 PM	6.6	24.0



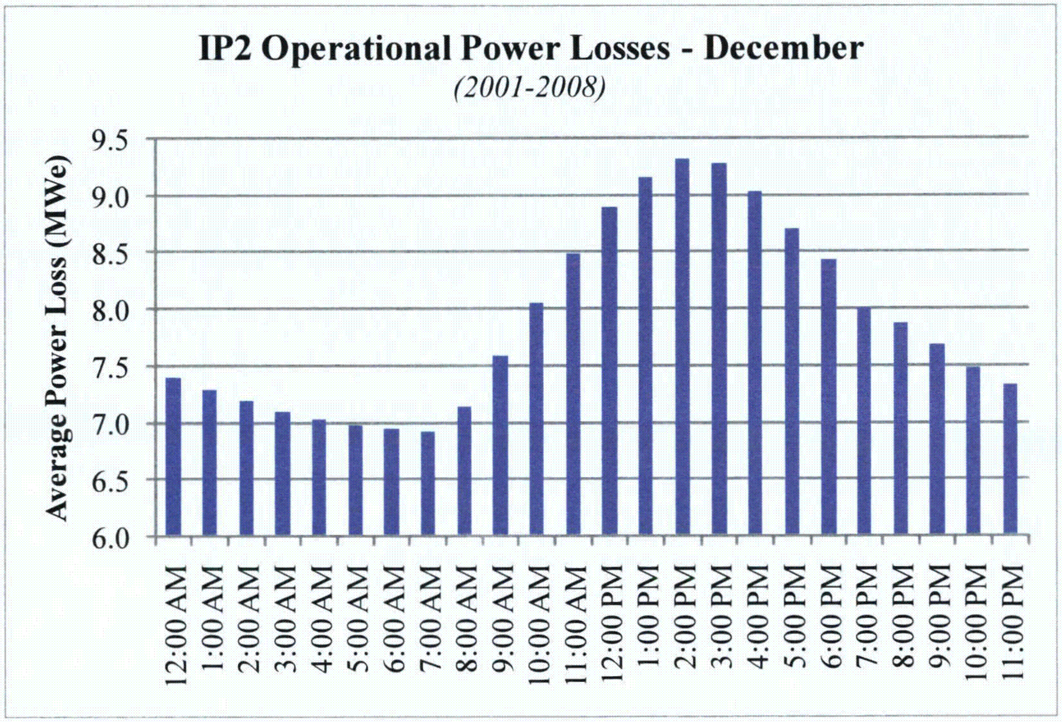
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	11.0	31.6
1:00 AM	10.7	31.3
2:00 AM	10.5	30.9
3:00 AM	10.2	30.5
4:00 AM	10.1	30.0
5:00 AM	9.9	29.6
6:00 AM	9.8	29.3
7:00 AM	10.3	29.1
8:00 AM	11.2	29.9
9:00 AM	12.2	31.5
10:00 AM	13.1	32.5
11:00 AM	14.0	34.1
12:00 PM	14.6	33.7
1:00 PM	14.9	32.4
2:00 PM	15.1	33.1
3:00 PM	14.9	33.5
4:00 PM	14.5	31.8
5:00 PM	13.9	30.6
6:00 PM	13.2	30.5
7:00 PM	12.8	30.6
8:00 PM	12.2	30.9
9:00 PM	11.8	30.8
10:00 PM	11.4	30.5
11:00 PM	11.1	31.2



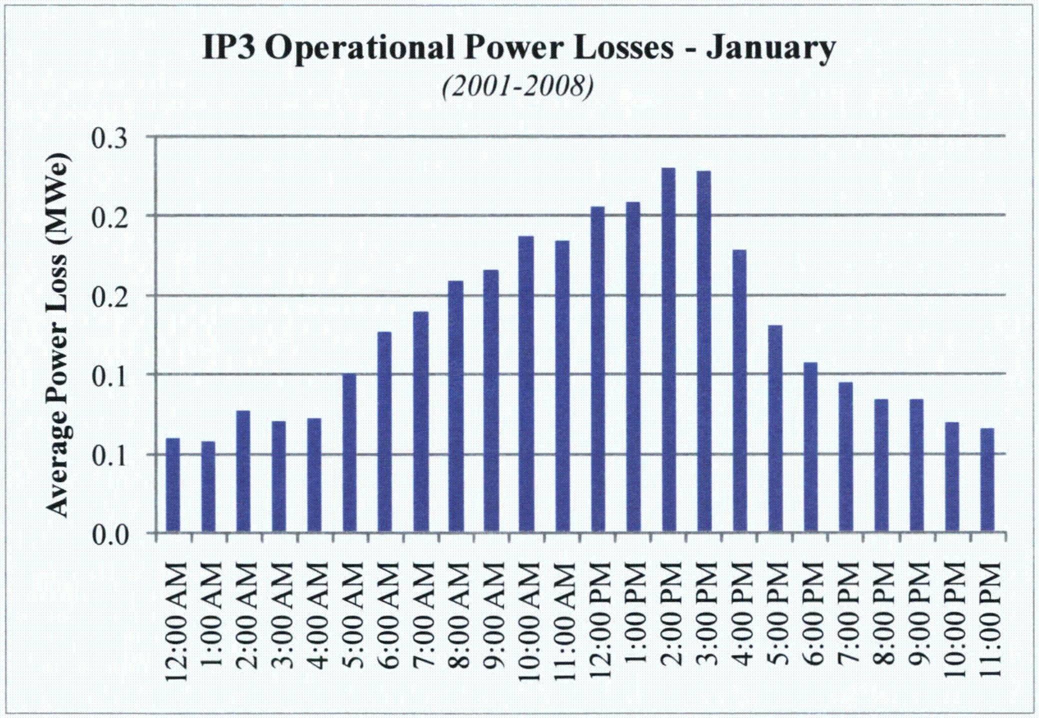
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	13.5	37.2
1:00 AM	13.3	36.0
2:00 AM	13.2	34.6
3:00 AM	12.9	32.1
4:00 AM	12.7	32.1
5:00 AM	12.4	32.5
6:00 AM	12.2	33.0
7:00 AM	12.2	32.9
8:00 AM	12.8	32.7
9:00 AM	13.5	34.0
10:00 AM	14.3	36.1
11:00 AM	15.0	37.3
12:00 PM	15.5	37.7
1:00 PM	16.0	38.0
2:00 PM	16.2	38.8
3:00 PM	16.2	38.6
4:00 PM	15.8	38.1
5:00 PM	15.5	38.6
6:00 PM	15.1	38.8
7:00 PM	14.6	39.0
8:00 PM	14.4	39.3
9:00 PM	14.1	38.8
10:00 PM	13.8	39.5
11:00 PM	13.6	38.7



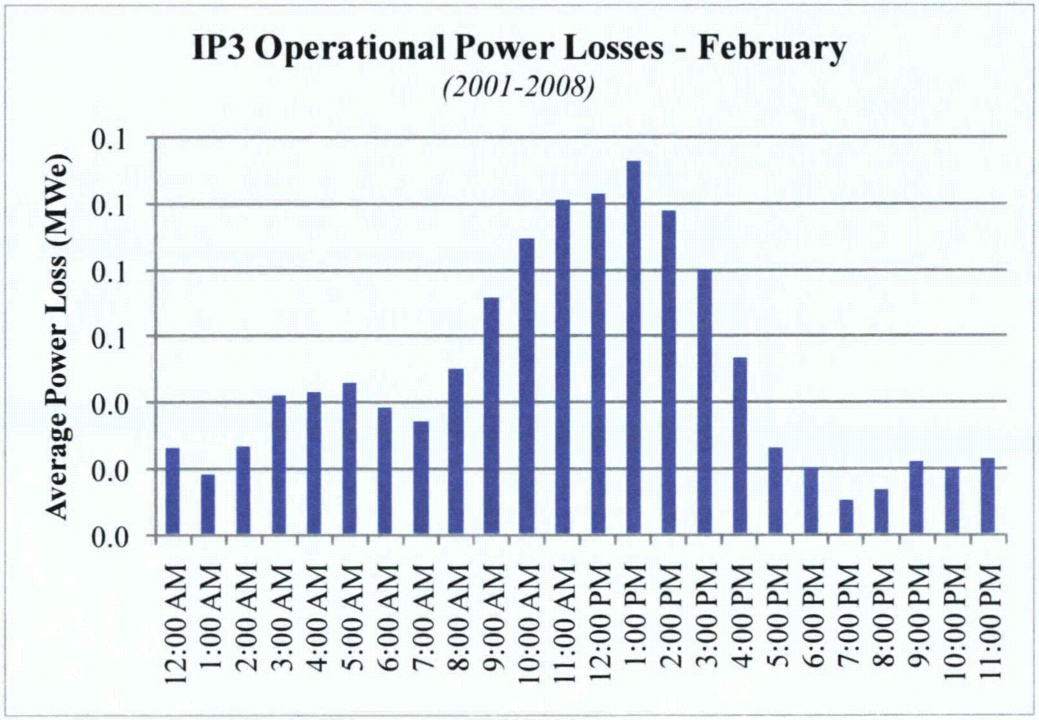
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	7.4	32.5
1:00 AM	7.3	32.6
2:00 AM	7.2	32.6
3:00 AM	7.1	32.9
4:00 AM	7.0	32.6
5:00 AM	7.0	32.6
6:00 AM	6.9	34.2
7:00 AM	6.9	34.3
8:00 AM	7.1	34.5
9:00 AM	7.6	36.1
10:00 AM	8.0	34.8
11:00 AM	8.5	34.6
12:00 PM	8.9	34.8
1:00 PM	9.1	34.7
2:00 PM	9.3	34.5
3:00 PM	9.3	34.7
4:00 PM	9.0	35.5
5:00 PM	8.7	36.0
6:00 PM	8.4	39.1
7:00 PM	8.0	26.0
8:00 PM	7.9	29.9
9:00 PM	7.7	27.4
10:00 PM	7.5	22.4
11:00 PM	7.3	20.7



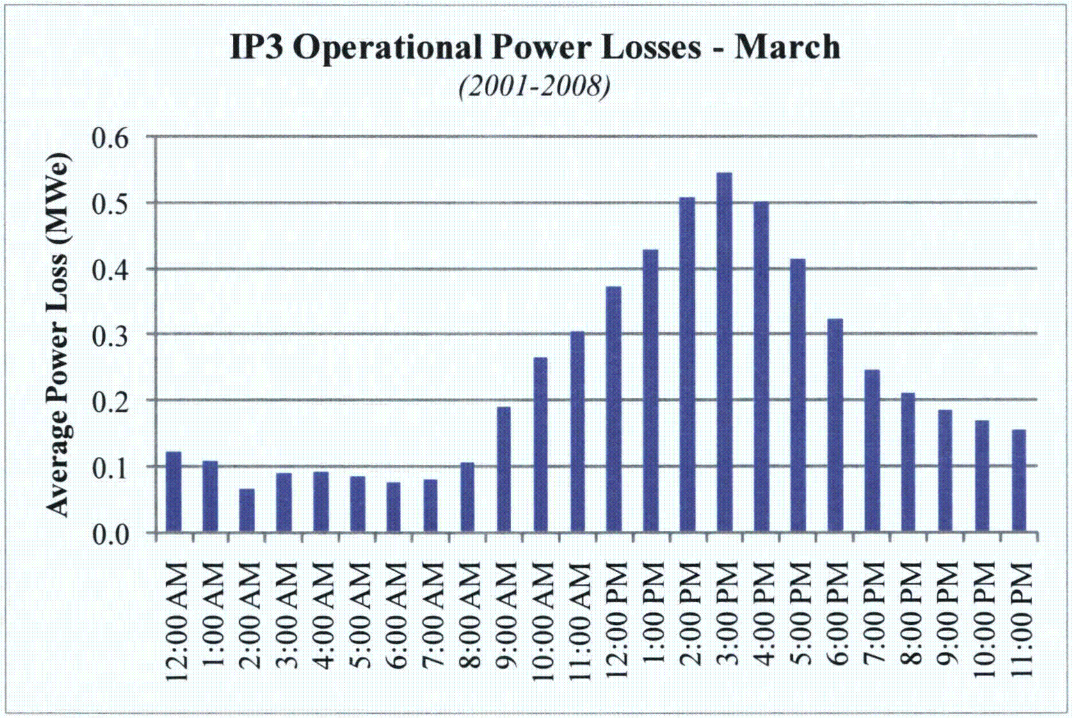
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	0.1	9.8
1:00 AM	0.1	10.2
2:00 AM	0.1	10.5
3:00 AM	0.1	10.9
4:00 AM	0.1	11.1
5:00 AM	0.1	10.9
6:00 AM	0.1	13.7
7:00 AM	0.1	13.5
8:00 AM	0.2	14.6
9:00 AM	0.2	15.7
10:00 AM	0.2	16.1
11:00 AM	0.2	14.4
12:00 PM	0.2	13.3
1:00 PM	0.2	12.6
2:00 PM	0.2	11.2
3:00 PM	0.2	9.5
4:00 PM	0.2	8.0
5:00 PM	0.1	8.1
6:00 PM	0.1	7.6
7:00 PM	0.1	9.2
8:00 PM	0.1	9.5
9:00 PM	0.1	9.6
10:00 PM	0.1	8.7
11:00 PM	0.1	9.7



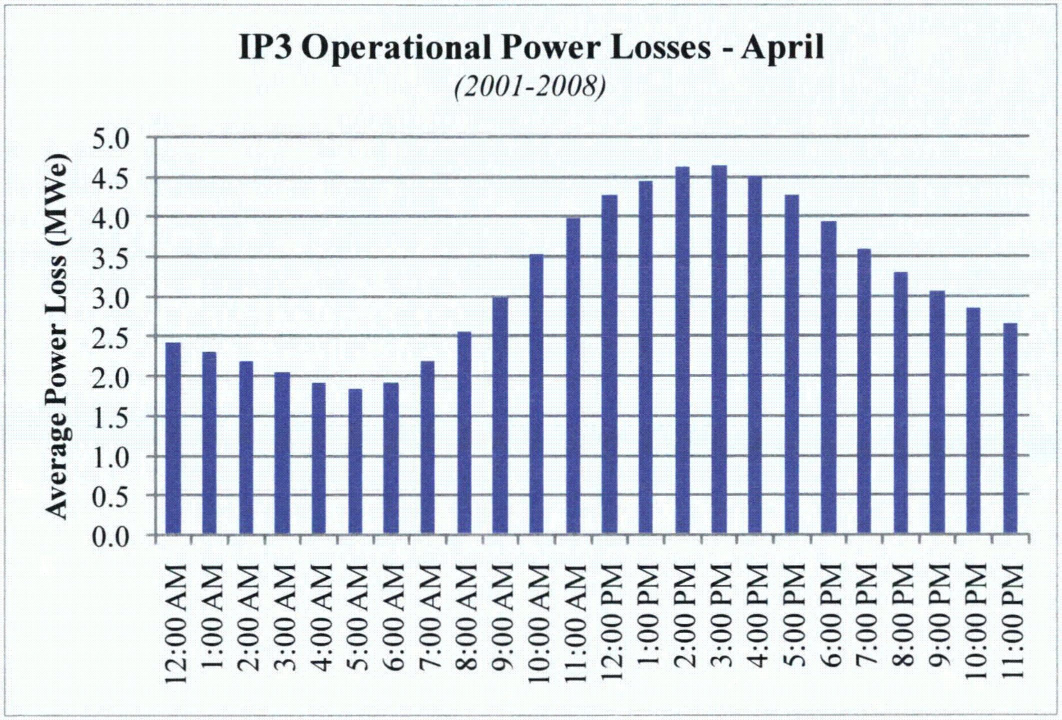
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	0.0	2.5
1:00 AM	0.0	2.9
2:00 AM	0.0	3.8
3:00 AM	0.0	5.4
4:00 AM	0.0	5.5
5:00 AM	0.0	5.6
6:00 AM	0.0	5.6
7:00 AM	0.0	6.1
8:00 AM	0.1	8.0
9:00 AM	0.1	8.1
10:00 AM	0.1	8.8
11:00 AM	0.1	9.1
12:00 PM	0.1	8.7
1:00 PM	0.1	9.2
2:00 PM	0.1	5.5
3:00 PM	0.1	4.7
4:00 PM	0.1	3.7
5:00 PM	0.0	2.3
6:00 PM	0.0	1.5
7:00 PM	0.0	1.1
8:00 PM	0.0	0.8
9:00 PM	0.0	2.6
10:00 PM	0.0	1.6
11:00 PM	0.0	2.9



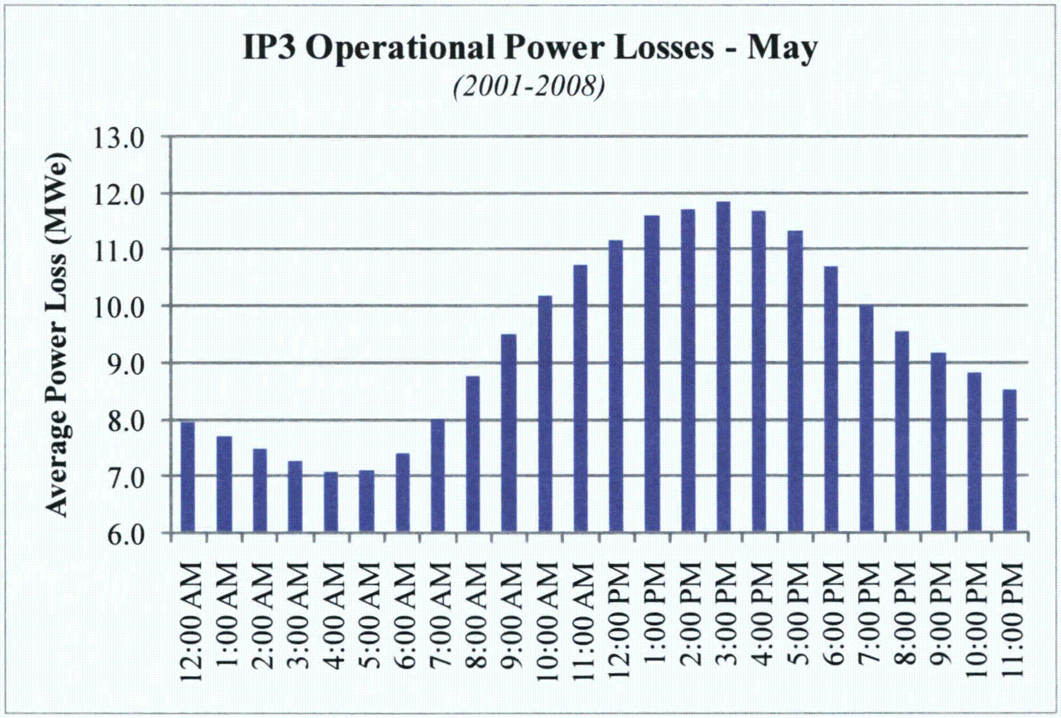
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	0.1	6.5
1:00 AM	0.1	6.6
2:00 AM	0.1	4.5
3:00 AM	0.1	4.8
4:00 AM	0.1	8.2
5:00 AM	0.1	7.4
6:00 AM	0.1	5.6
7:00 AM	0.1	4.6
8:00 AM	0.1	3.6
9:00 AM	0.2	7.4
10:00 AM	0.3	11.2
11:00 AM	0.3	11.0
12:00 PM	0.4	11.3
1:00 PM	0.4	11.3
2:00 PM	0.5	11.4
3:00 PM	0.5	11.7
4:00 PM	0.5	11.4
5:00 PM	0.4	9.7
6:00 PM	0.3	8.3
7:00 PM	0.2	6.5
8:00 PM	0.2	6.1
9:00 PM	0.2	6.7
10:00 PM	0.2	7.0
11:00 PM	0.2	6.6



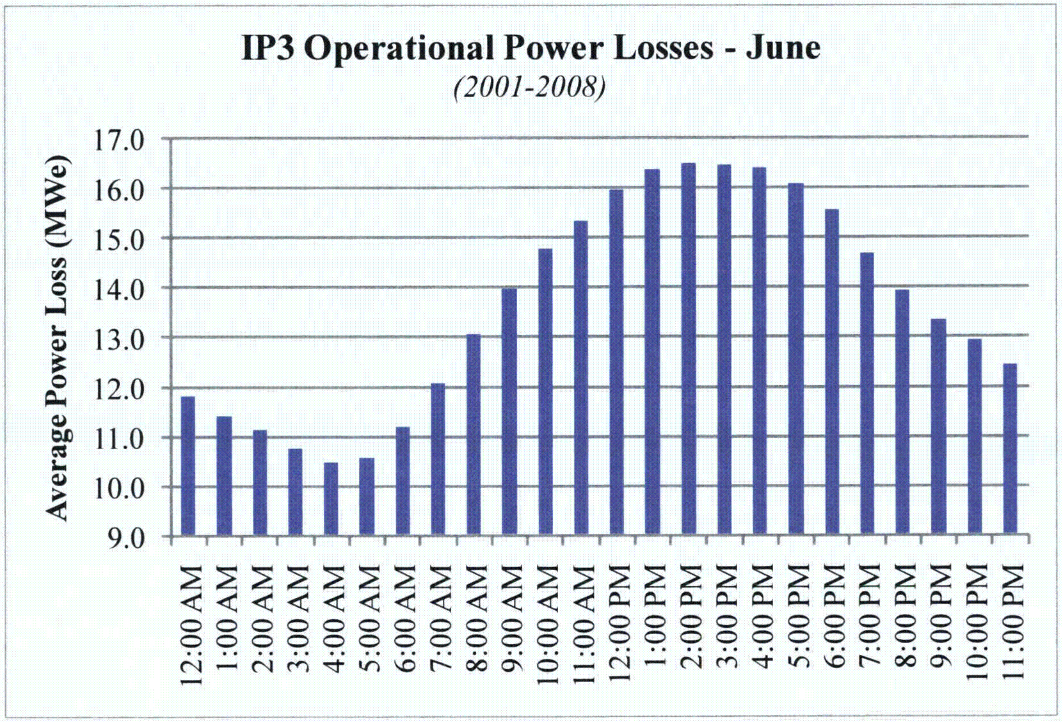
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	2.4	19.0
1:00 AM	2.3	18.5
2:00 AM	2.2	18.1
3:00 AM	2.0	17.0
4:00 AM	1.9	16.9
5:00 AM	1.8	16.5
6:00 AM	1.9	17.4
7:00 AM	2.2	19.7
8:00 AM	2.6	21.4
9:00 AM	3.0	22.6
10:00 AM	3.5	23.0
11:00 AM	4.0	22.9
12:00 PM	4.3	23.5
1:00 PM	4.4	22.7
2:00 PM	4.6	24.1
3:00 PM	4.6	23.1
4:00 PM	4.5	22.1
5:00 PM	4.3	21.9
6:00 PM	3.9	22.1
7:00 PM	3.6	20.9
8:00 PM	3.3	20.2
9:00 PM	3.1	19.3
10:00 PM	2.8	18.7
11:00 PM	2.7	18.7



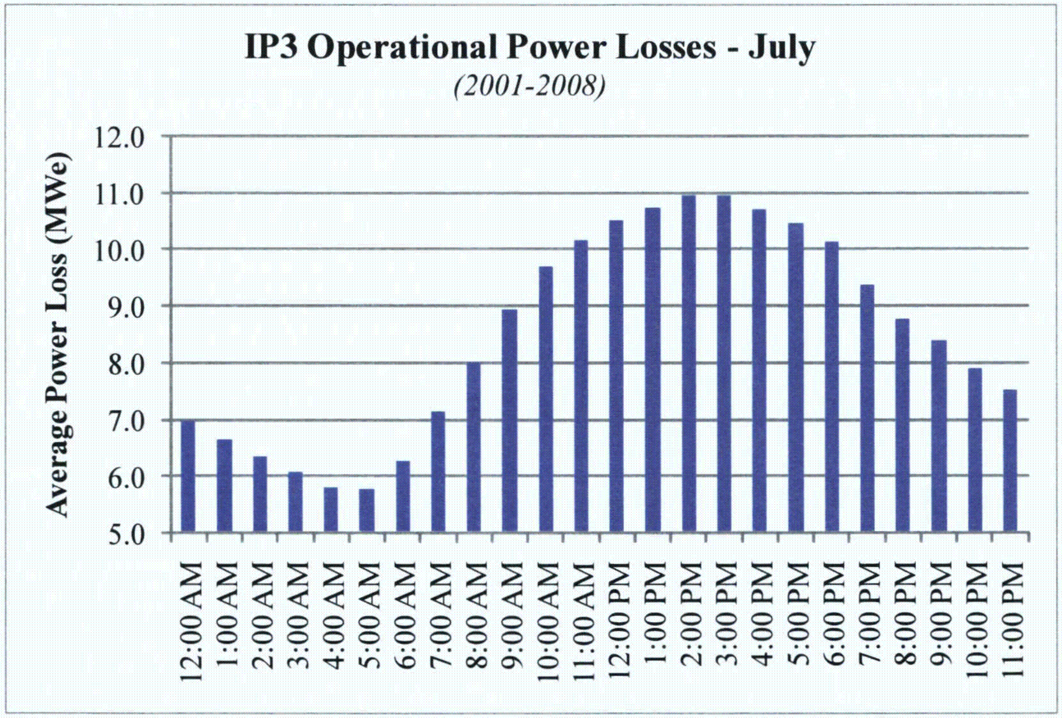
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	7.9	22.8
1:00 AM	7.7	21.6
2:00 AM	7.5	20.9
3:00 AM	7.3	20.9
4:00 AM	7.1	21.0
5:00 AM	7.1	21.2
6:00 AM	7.4	22.2
7:00 AM	8.0	25.1
8:00 AM	8.8	27.6
9:00 AM	9.5	28.7
10:00 AM	10.2	29.4
11:00 AM	10.7	30.4
12:00 PM	11.2	29.8
1:00 PM	11.6	29.7
2:00 PM	11.7	29.6
3:00 PM	11.8	29.5
4:00 PM	11.7	29.1
5:00 PM	11.3	27.6
6:00 PM	10.7	25.7
7:00 PM	10.0	24.4
8:00 PM	9.5	23.9
9:00 PM	9.2	23.8
10:00 PM	8.8	23.7
11:00 PM	8.5	23.0



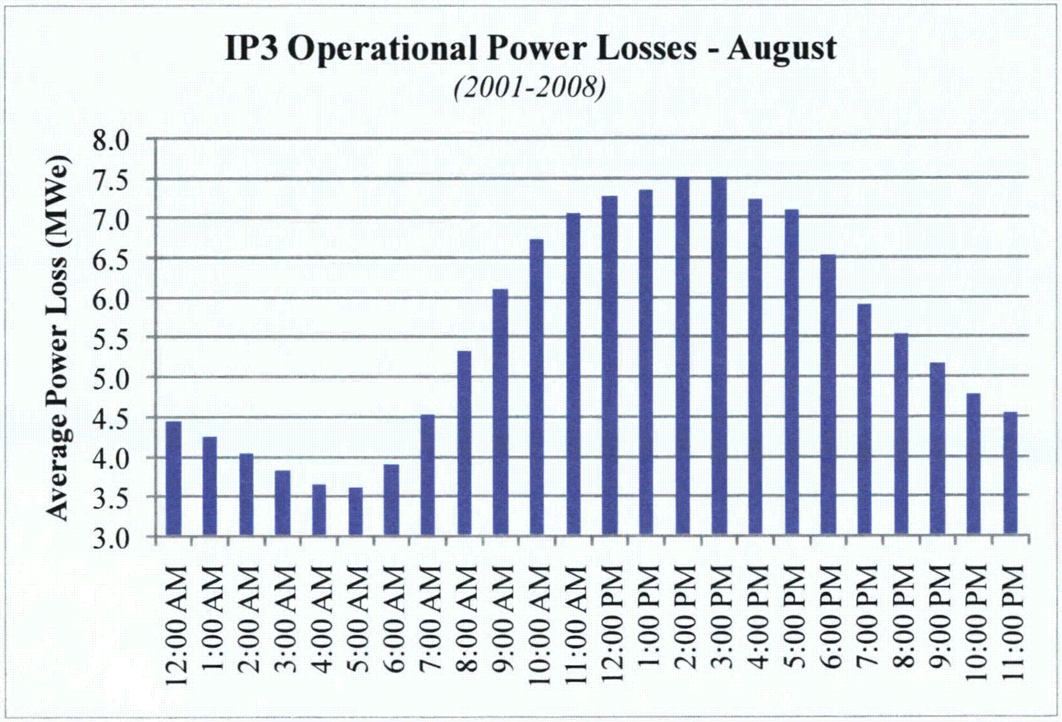
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	11.8	27.9
1:00 AM	11.4	27.9
2:00 AM	11.1	27.5
3:00 AM	10.8	24.5
4:00 AM	10.5	24.3
5:00 AM	10.6	24.4
6:00 AM	11.2	26.5
7:00 AM	12.1	29.0
8:00 AM	13.1	30.7
9:00 AM	14.0	31.4
10:00 AM	14.8	33.2
11:00 AM	15.3	34.4
12:00 PM	15.9	35.5
1:00 PM	16.4	36.2
2:00 PM	16.5	38.0
3:00 PM	16.4	37.4
4:00 PM	16.4	36.0
5:00 PM	16.1	33.1
6:00 PM	15.6	33.3
7:00 PM	14.7	31.9
8:00 PM	13.9	30.6
9:00 PM	13.3	29.9
10:00 PM	12.9	28.8
11:00 PM	12.4	27.6



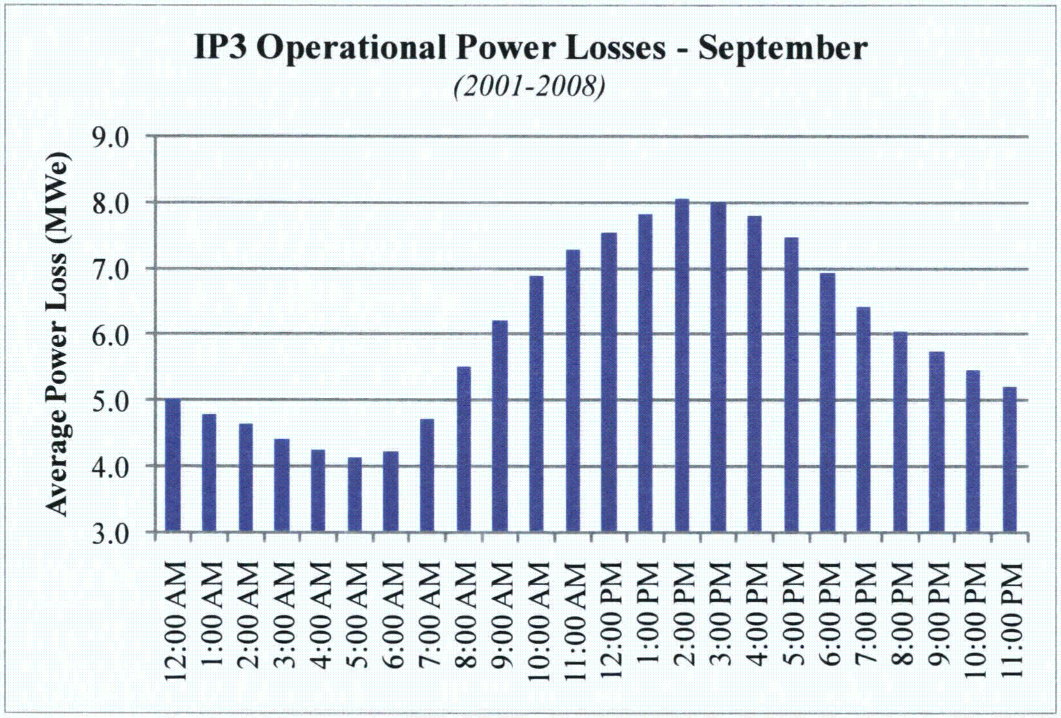
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	7.0	26.9
1:00 AM	6.7	25.3
2:00 AM	6.3	24.6
3:00 AM	6.1	24.0
4:00 AM	5.8	23.1
5:00 AM	5.8	22.7
6:00 AM	6.3	23.8
7:00 AM	7.1	25.2
8:00 AM	8.0	26.5
9:00 AM	8.9	27.8
10:00 AM	9.7	28.6
11:00 AM	10.2	30.6
12:00 PM	10.5	31.3
1:00 PM	10.7	31.1
2:00 PM	11.0	31.0
3:00 PM	10.9	32.2
4:00 PM	10.7	32.0
5:00 PM	10.5	32.1
6:00 PM	10.1	32.2
7:00 PM	9.4	30.1
8:00 PM	8.8	28.4
9:00 PM	8.4	28.6
10:00 PM	7.9	29.1
11:00 PM	7.5	29.1



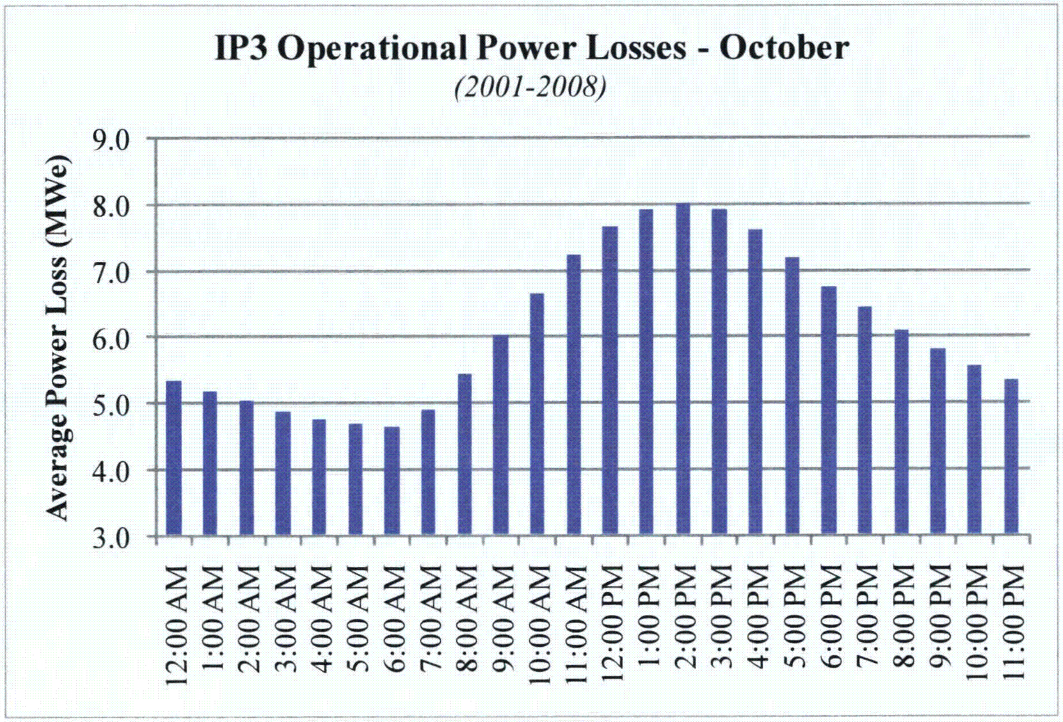
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	4.5	21.0
1:00 AM	4.2	21.1
2:00 AM	4.0	20.3
3:00 AM	3.8	19.6
4:00 AM	3.7	19.0
5:00 AM	3.6	19.7
6:00 AM	3.9	20.6
7:00 AM	4.5	22.1
8:00 AM	5.3	23.9
9:00 AM	6.1	24.0
10:00 AM	6.7	25.6
11:00 AM	7.1	27.0
12:00 PM	7.3	27.5
1:00 PM	7.4	27.4
2:00 PM	7.5	27.6
3:00 PM	7.5	27.4
4:00 PM	7.2	27.1
5:00 PM	7.1	26.1
6:00 PM	6.5	23.5
7:00 PM	5.9	21.9
8:00 PM	5.5	21.8
9:00 PM	5.2	21.5
10:00 PM	4.8	21.8
11:00 PM	4.5	22.3



Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	5.0	21.1
1:00 AM	4.8	19.4
2:00 AM	4.6	21.3
3:00 AM	4.4	21.3
4:00 AM	4.2	20.2
5:00 AM	4.1	19.1
6:00 AM	4.2	19.8
7:00 AM	4.7	21.3
8:00 AM	5.5	21.5
9:00 AM	6.2	22.3
10:00 AM	6.9	22.2
11:00 AM	7.3	21.7
12:00 PM	7.5	23.3
1:00 PM	7.8	24.7
2:00 PM	8.1	25.1
3:00 PM	8.0	25.2
4:00 PM	7.8	23.9
5:00 PM	7.5	22.3
6:00 PM	6.9	20.9
7:00 PM	6.4	20.1
8:00 PM	6.1	20.3
9:00 PM	5.8	21.1
10:00 PM	5.5	21.3
11:00 PM	5.2	20.7



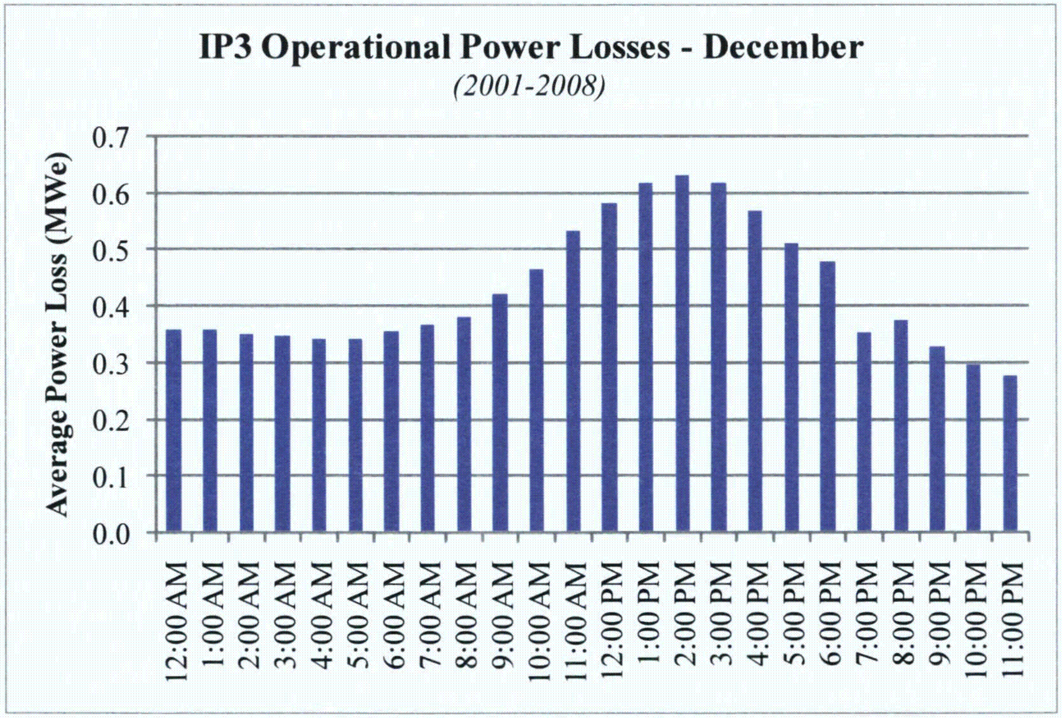
Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	5.3	20.6
1:00 AM	5.2	20.9
2:00 AM	5.0	20.6
3:00 AM	4.9	20.2
4:00 AM	4.8	20.3
5:00 AM	4.7	20.4
6:00 AM	4.6	20.7
7:00 AM	4.9	21.2
8:00 AM	5.4	21.8
9:00 AM	6.0	22.2
10:00 AM	6.7	23.0
11:00 AM	7.2	23.7
12:00 PM	7.7	23.3
1:00 PM	7.9	24.2
2:00 PM	8.0	24.9
3:00 PM	7.9	24.7
4:00 PM	7.6	24.1
5:00 PM	7.2	22.9
6:00 PM	6.8	23.0
7:00 PM	6.4	23.4
8:00 PM	6.1	23.2
9:00 PM	5.8	23.4
10:00 PM	5.6	19.9
11:00 PM	5.3	20.5



IP3 Operational Power Losses - October

(2001-2008)

Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	0.4	14.2
1:00 AM	0.4	14.4
2:00 AM	0.3	14.4
3:00 AM	0.3	14.6
4:00 AM	0.3	14.4
5:00 AM	0.3	14.4
6:00 AM	0.4	15.8
7:00 AM	0.4	15.9
8:00 AM	0.4	16.0
9:00 AM	0.4	17.3
10:00 AM	0.5	16.2
11:00 AM	0.5	16.1
12:00 PM	0.6	16.2
1:00 PM	0.6	16.2
2:00 PM	0.6	16.0
3:00 PM	0.6	16.2
4:00 PM	0.6	16.9
5:00 PM	0.5	17.3
6:00 PM	0.5	20.1
7:00 PM	0.4	8.1
8:00 PM	0.4	12.2
9:00 PM	0.3	8.2
10:00 PM	0.3	7.0
11:00 PM	0.3	6.7



Time	Power Loss (MWe)	
	Average	Maximum
12:00 AM	0.4	14.2
1:00 AM	0.4	14.4
2:00 AM	0.3	14.4
3:00 AM	0.3	14.6
4:00 AM	0.3	14.4
5:00 AM	0.3	14.4
6:00 AM	0.4	15.8
7:00 AM	0.4	15.9
8:00 AM	0.4	16.0
9:00 AM	0.4	17.3
10:00 AM	0.5	16.2
11:00 AM	0.5	16.1
12:00 PM	0.6	16.2
1:00 PM	0.6	16.2
2:00 PM	0.6	16.0
3:00 PM	0.6	16.2
4:00 PM	0.6	16.9
5:00 PM	0.5	17.3
6:00 PM	0.5	20.1
7:00 PM	0.4	8.1
8:00 PM	0.4	12.2
9:00 PM	0.3	8.2
10:00 PM	0.3	7.0
11:00 PM	0.3	6.7