# COGENERATION:

# A SUSTAINABILITY PROJECT


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Submitted to the Graduate Faculty in partial fulfillment of the requirements of the degree Master of Science in Industrial Management in the Department of Engineering Technology of the University of Southern Indiana

November, 2004

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# Abstract

Qualitative and anecdotal evidence demonstrates that reducing waste and conserving resources promote corporate sustainability both economically and environmentally. Developing and applying new ideas to achieve higher performance and excellence have lead to the re-emergence of a past application at Mead Johnson Nutritionals (MJN). A turbine/generator project will focus on the importance of sustainability with respect to energy conservation and maximization of utility inputs. An existing turbine/generator removed from service in 1997 will be redesigned and reinstated to supplement present as well as, future energy utilization. Once an assessment of the feasibility is completed, an implementation plan for execution will be presented for capital funding. The project scope will achieve the customer's desired automated operational requirements. Facility Management (the customer) at MJN will be responsible for determining the turbine operating parameters. Ultimately, this project will make a considerable recurring contribution towards Bristol-Myers Squibb's (BMS) global sustainability goals.

## Acknowledgements:

The team would like to thank various individuals who have assisted in the completion of this project. We would like to thank the various professors of the University of Southern Indiana who have guided us during our studies, cumulating in the completion of this Industrial Management graduate degree. Specifically, Dr. David Schultz has been a mentor and guide throughout the program. Furthermore, Professor Eric Sprouls has also been a valuable academic resource in the completion of this undertaking.

We would also like to thank the management of Mead Johnson Nutritionals and Bristol-Myers Squibb for providing us the opportunity and resources to complete this program. Specifically, Byron Sanders, Bill Lasher, Guillermo Guillen, David Weber, Luanne Flikkema, Kim Carpenter, and John Wellemeyer have guided us throughout our studies with regard to this project.

We would also like to thank our fellow class members who challenged us and contributed to the successful progression throughout this journey. Finally, we would like to thank our families for continual support and encouragement to complete the program and prepare the submission of this report.

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# I. Introduction

## A. History

Mead Johnson Nutritionals (MJN) has established a worldwide leadership and recognition in the development of nutritional products that can be traced back nearly a century to founder Edward Mead Johnson. He was among the first to commit his efforts to the well being of babies and to the science of infant nutrition. Mead soon discovered that many babies were dying before their first birthday because of feeding problems. While developing a feeding formula for his son, he detected that starch was dextrinized into a cereal slurry to produce "dextrins and maltose".[1] Johnson began focusing his efforts on producing such a product. Ironically, his second son, Lambert, a chemist, discovered how the material could be powdered for mass production. (Today, powder manufacturing is the largest operation for MJN globally.) In 1915, Mead opened a new factory for his growing business in Evansville, Indiana.

MJN scientists developed Enfamil®[2] in 1959 that revolutionized infant feeding by providing a formula patterned after a nursing mother's milk, while packaging it in ready-to-use (RTU) bottles, along with sterilized, disposable nipples. Sterilization is a vital input process for the nutritional industry. Critical process parameters require accurate temperature controls and monitoring for consistent quality production.

Many research accomplishments helped maintain the company as the nutritional leader, earning recognition and respect in the health care industry. Under the pharmaceutical banner, Mead Johnson also developed many life-saving drugs. In

[1] "Global View: The Journey Continues." Mead Johnson Nutritionals Company. 2000
[2] Enfamil is a registered trademark of Mead Johnson Nutritionals, a Bristol-Myers Squibb Company

1967, Mead Johnson became a subsidiary of Bristol-Myers, which, in 1989 added E.I. Squibb to create the Bristol-Myers Squibb Company (BMS)[3]. Mead Johnson benefited from this merger by gaining access to the international market. This global expansion brought more stringent evaluation from the Food & Drug Administration (FDA) and increased awareness of corporate stewardship. In fulfilling this obligation, MJN has and continues to focus on sustainability.

**B. <u>Sustainability</u>**

Sustainability has been taken into more consideration by businesses in the past ten to fifteen years. It has been documented that the most eco-efficient companies are also the most successful. Jean-Marc Gilson, member of the board of the World Business Council for Sustainable Development (WBCSD), describes sustainability as being defined by three pillars: *environmental, social,* and *economic.*[4] Leading businesses maintain this sustainability by creating a positive, or at least a zero-negative ecological impact. It provides a social benefit that improves the quality of life for the future of humanity. In some circles, it is referred to as "greening" the organization. Sustainability goals are becoming more emphasized in many companies' code of conduct.

As an operating principle, sustainability does not work if it is imposed from outside an organization. It has to be accepted by all within an organization as a guiding principle. This requires a new economic paradigm that allows humans to live and work

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[3] "Global View: The Journey Continues."
[4] "How Innovation Supports Sustainability." Chemical Week Associates. 16 June 2004 <http://www.chemweek.com>

in ways that can preserve resources for decades and future generations. Environmental sustainability has reached a new strategic level in manufacturing because of its ties to cost reduction and/or innovative processes.

BMS adopted comprehensive sustainability objectives for 2010. These goals analyze performance against global environmental results and track and report progress to key stakeholders, both positive and negative. The desire is to exceed these parameters whenever possible. The past three years of data (see Figure 1) monitored by BMS demonstrate an increasing trend in $CO_2$ emissions.

**Figure 1**

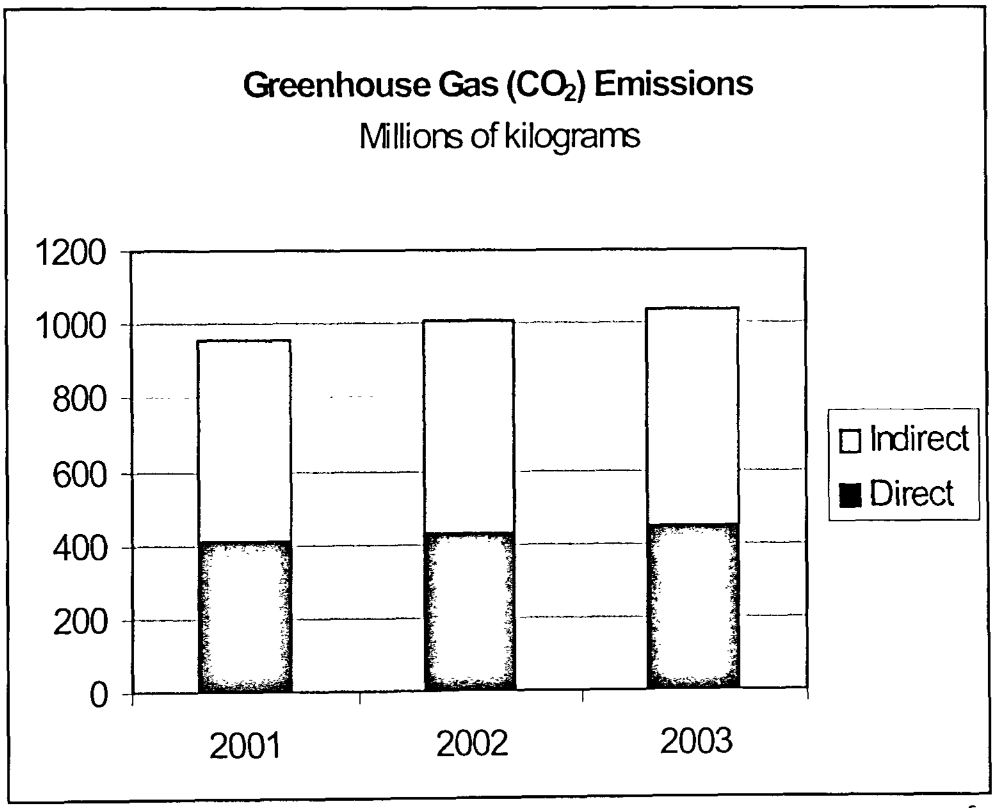


Figure 1: Bristol Myers Squibb Company 2004 Report of Sustainability 2010 Goals[5]

[5] "Building and Sustaining a Better World." Bristol-Myers Squibb Company. 2004 <htpp://www.bms.com/sustainability>

In 2003, BMS applied national-specific emission factors to calculate indirect greenhouse gas emissions from domestic purchased electricity. Indirect emissions from purchased electricity have increased one percent over the same time period. Sustainability projects are being researched and developed to alter this trend. The BMS Sustainability 2010 Goals for greenhouse gas emissions call for ten percent reduction, normalized by sales, of direct and indirect emissions (baseline year 2001). Since 2001, BMS direct and indirect greenhouse gas emissions have decreased four percent when normalized by sales. As of 2003, each facility calculates its own emissions, which provides a more accurate measure that reflects site-specific emissions controls.

### C. Turbine/Generator

Despite the initial capital costs, cogeneration looks increasingly attractive to nutritional and pharmaceutical companies. This is due, in part, to the use of large quantities of steam for sterilization. In addition, electricity is a staple of all manufacturing processes. Most firms plan to size their cogeneration equipment to satisfy thermal needs and to consume all of the electricity generated by the system internally. MJN's needs exceed this capability, and most of its electrical requirements are purchased from local utilities.

The original turbine/generator used by MJN was a 750-kilowatt (kW) cogeneration operation implemented in 1930 that supplied between five and ten percent of the plant's electrical needs. In 1984, a plan was developed to purchase an additional 90 – 180 kW unit to supplement the existing electrical demand. If implemented, this system would have drastically impacted facility capacity. The planned additional turbine/generator would have been forced-fit into the already crowded Power House structure. Facility Management determined that a better system would be a cogeneration system capable of a maximum of one megawatt (1000-kW).

The one megawatt Murray Turbine was purchased in 1995. The unit was configured with a single-valve modulating system better suited for a consistently high steam flow rate. Operating the system in this manner would optimize its efficiency. However, the actual MJN steam profile forced the valve to oscillate at the low end of its control limit. This initiated a damaging actuation of the value. In addition, the production operation at MJN typically required random spikes of steam demand. The incompatible system design with these operational parameters resulted in multiple failures of the valve. Maintenance repair costs accumulated beyond budgeted expenses. The Facility Management team at MJN determined to decommission the Murray Turbine rather than investing technical improvement to maintain its function. Decommissioning occurred in 1997.

In 2001, BMS developed their Sustainability 2010 Goals. This allowed consideration of innovative projects regarding sustainability initiatives. The Murray Turbine was a potential project that fit this category. Furthermore, recent turbine technology advancements created opportunities for remedial modifications to the Murray Turbine. It was assessed for reconfiguration to meet the specific MJN application. The combination of technological enhancements and communication of customized turbine opportunities led to the consideration of refurbishing and retrofitting the equipment. The MJN Cogeneration Sustainability Project will implement these improvements to optimize the current steam load profile.

## II. Project Parameters

### A. Description of Project

The existing turbine equipment will be refurbished and redesigned to operate in an optimized steam flow and pressure range. The original Murray Turbine Recommissioning project was approved on April 20, 2004. The objective of this energy savings project is to utilize the existing Murray turbine/generator asset to offset a portion of the electricity supplied by the local utility company.[6] This will be done by routing steam used for production through the turbine/generator. The turbine will adapt to the required steam load based on the governor control module. As demand fluctuates, the governor will allow a faster reaction time in the steam system due to its integrated automation control. This system will monitor demand requirements to optimize the performance of the turbine/generator.

The cost of automation is merited because it is a key component of equipment control. As previously stated, the initial set up of the Murray Turbine resulted in prohibitive down time and maintenance concerns. Preventative measures, such as, critical temperature and pressure monitoring devices, vibration sensitivity monitors, and automated shut-off valves have been installed on the turbine. These additional automation expenditures were justified to ensure equipment longevity, maximum operating effectiveness and minimal manual intervention. Furthermore, the addition of automation controls for inlet and exhaust shutoff valves operations will allow steam

[6] Current energy provider is Vectren Energy Deliver Company.

isolation. Adding this degree of automation should drastically reduce equipment downtime and enhance system efficiency.

The reconditioned turbine/generator arrived for reinstallation at the end of the third quarter, 2004. Required piping and construction are to be completed during the fourth quarter, 2004, for planned commissioning and start-up. The redesigned work was completed at Tuthill Energy Systems in Burlington, Iowa, with equipment inspection conducted by MJN Maintenance personnel. Figure 2 is a pictorial model of the cogeneration concept. Figures 3 and 4 show the modified turbine testing phase at Tuthill Energy Systems.

**Figure 2**

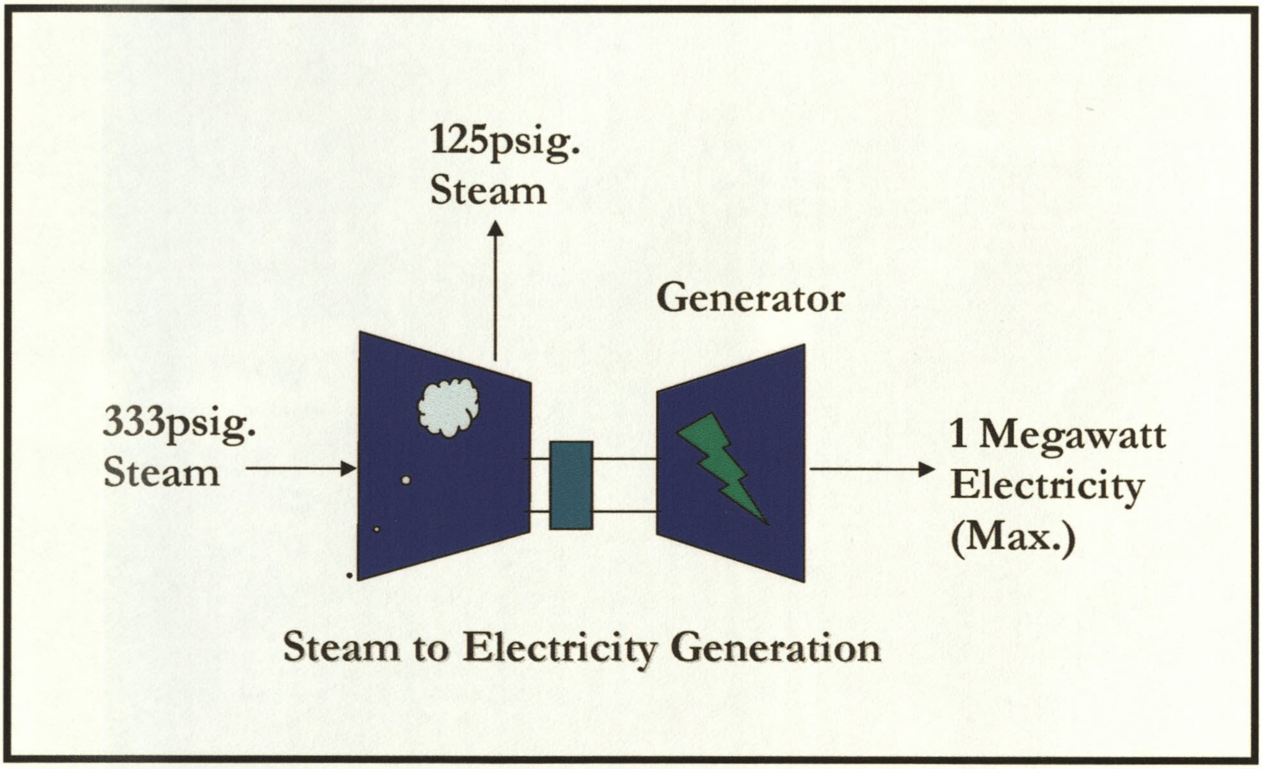


Figure 2 Cogeneration Concept

## Figure 3

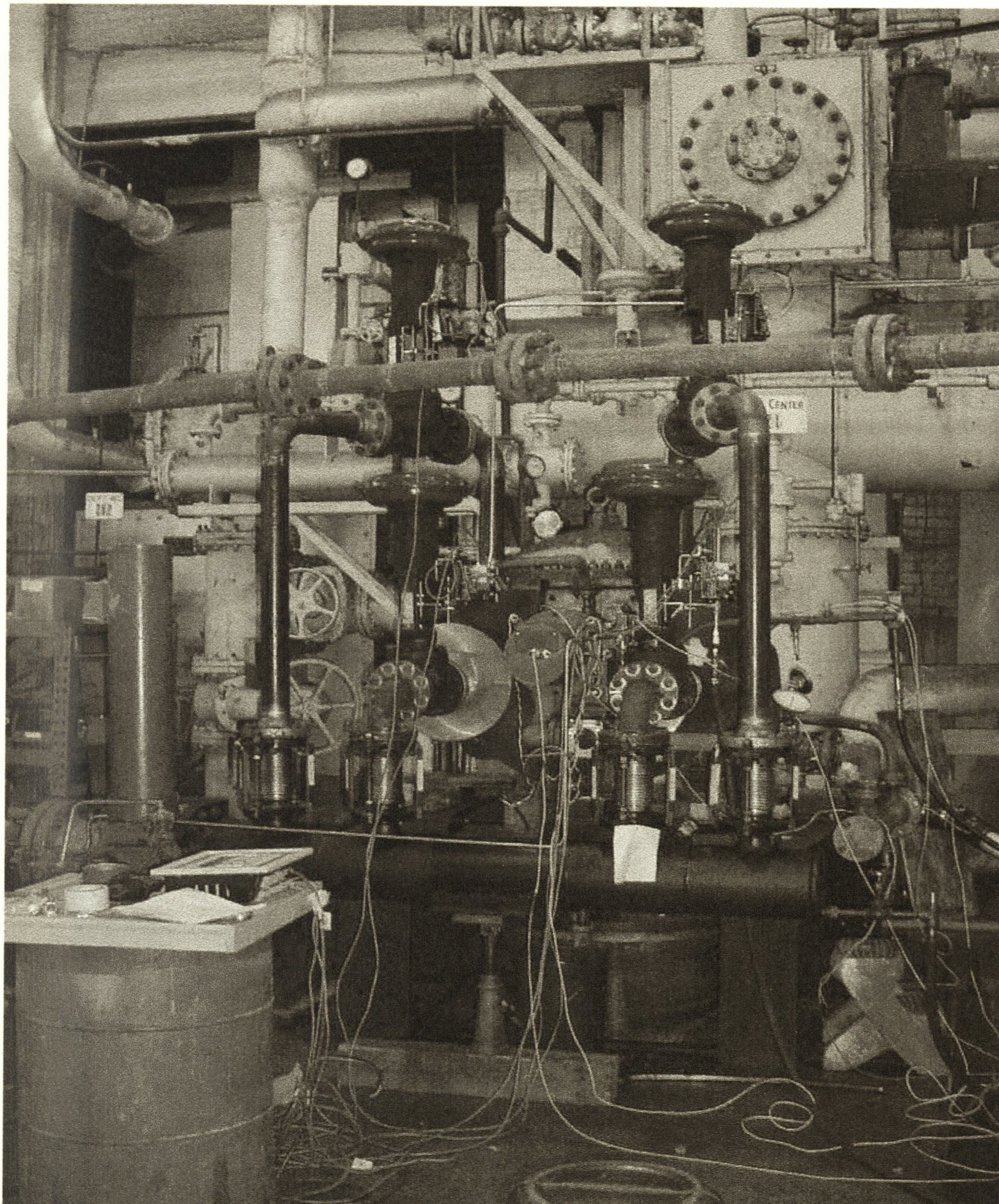

Figure 3 – Murray Turbine testing of automation controls and four value configuration at Tuthill Energy Systems, Burlington, Iowa.

**Figure 4**

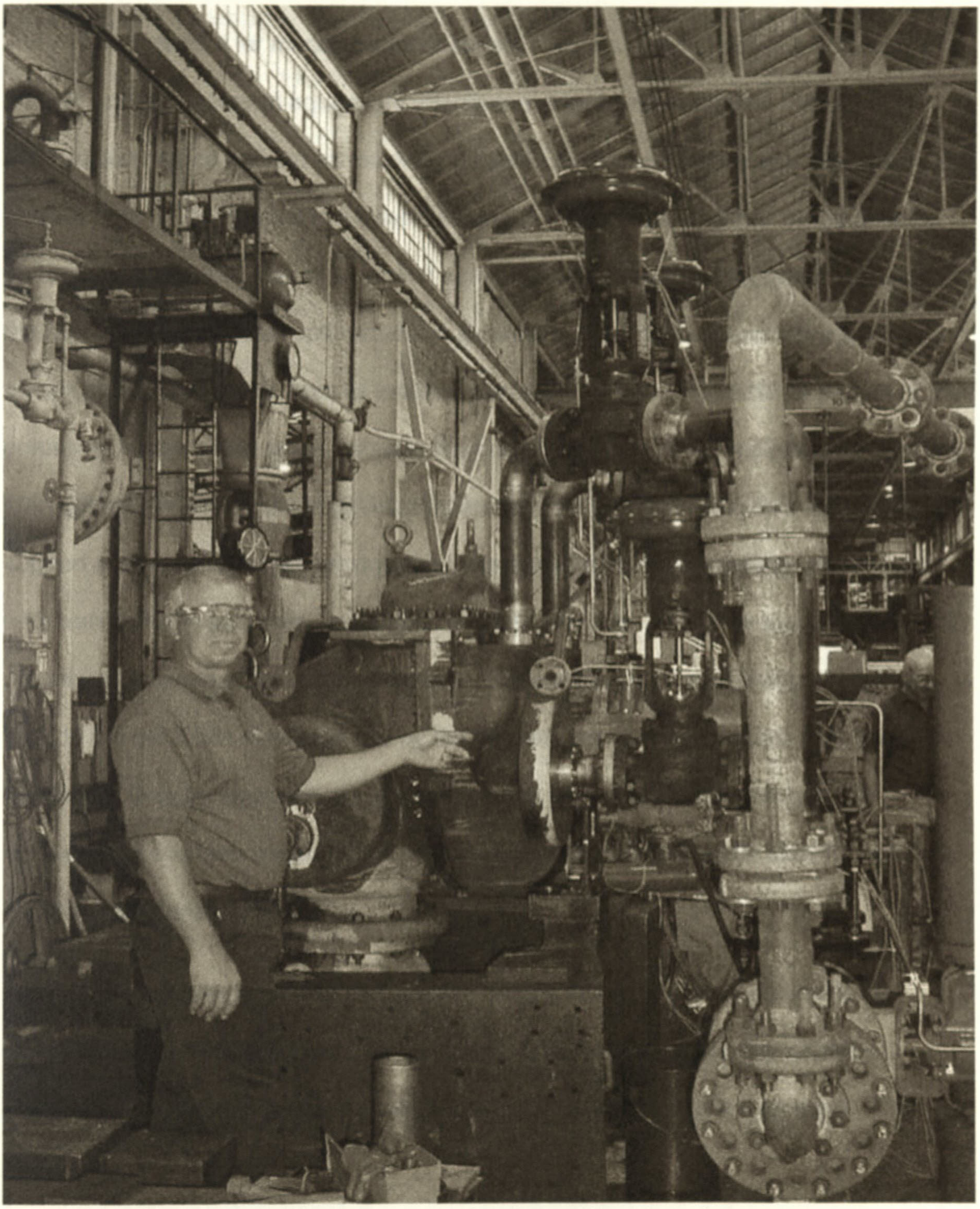

Figure 4 – MJN Employee at Tuthill Energy Systems indicating Murray Turbine modified inlet.

## B. Advantages of Implementation

The objective for management of assets – assets optimization – is combining greater uptime, improved equipment effectiveness and cost reduction. Asset optimization can be defined as maximized uptime and overall equipment effectiveness at least cost.[7] This project is a classic example of asset optimization. When greater uptime combines with overall improved equipment effectiveness, the prime objective for the management of asset optimization is achieved. BMS collects and reports data on electricity and fuel usage from its facilities worldwide. For MJN to fulfill its portion of the corporate sustainability goals, projects like cogeneration must be implemented. Facility Management is committed to developing and investing in promising new technology to support sustainability wherever possible. Standardized facility reporting will produce information that is accurate, accessible, and interpretable. This also supports the BMS' corporate Continuous Innovation initiative. The company's Sustainability 2010 Goals include the reduction of energy use by ten percent, normalized by sales, from the 2001 baseline.[8] Only by aggressively reducing energy consumption can this goal be achieved. The turbine cogeneration project is a major undertaking by MJN for reducing electric utility consumption.

The objective is to utilize an existing turbine asset to offset a portion of the electricity supplied by the local utility provider. Once implemented, the turbine's designated operating parameters will be based on production steam demand. This

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[7] Baur, Tim. "Cogeneration solutions, Deciding if it's right for your plant." Plant Services Oct. 2003. 15 Oct. 2004 <http://www.plantservices.com>

[8] "Building and Sustaining a Better World."

demand fluctuates continuously during a twenty-four hour period. Figure 5 is a scatter diagram of the maximum steam flow per week plotted as weekly data points and recorded as pounds per hour (lbs/hr). On a daily basis, average steam flow rates are captured. The linear line, referenced below, depicts the average maximum data points per week. The average weekly maximum values are approximately ninety thousand (90,000) lbs/hr of steam. The daily average maximum steam flow values were also recorded during this same period. The mean of these average these values, yields approximately fifty-five thousand (55,000) lbs/hr of steam.

## Figure 5

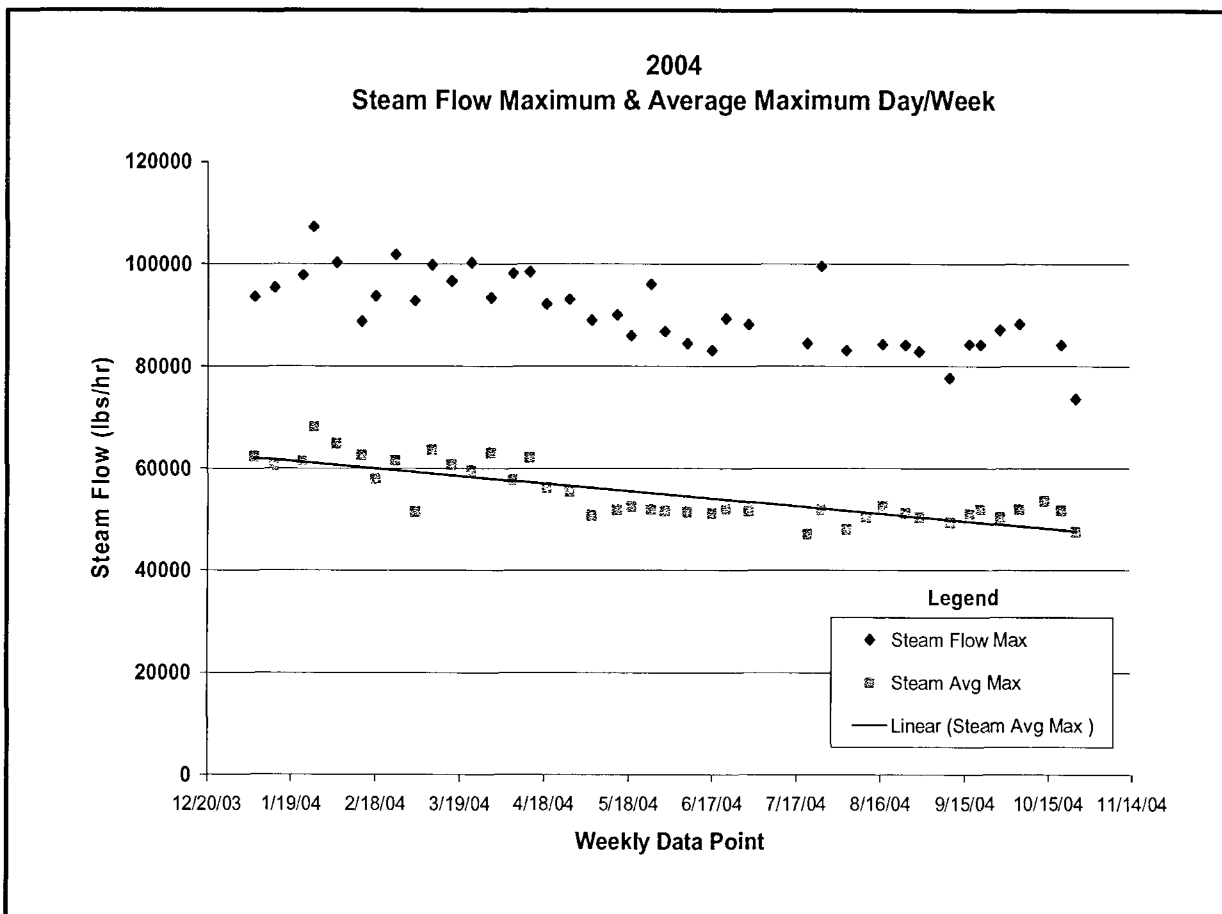


Figure 5: Steam Flow Scatter Plot

The turbine operational range is between approximately twenty-four thousand (24,000) lbs/hr and eighty-eight thousand (88,000) lbs/hr. The following graph indicates the performance curve projected for this application.

**Figure 6**

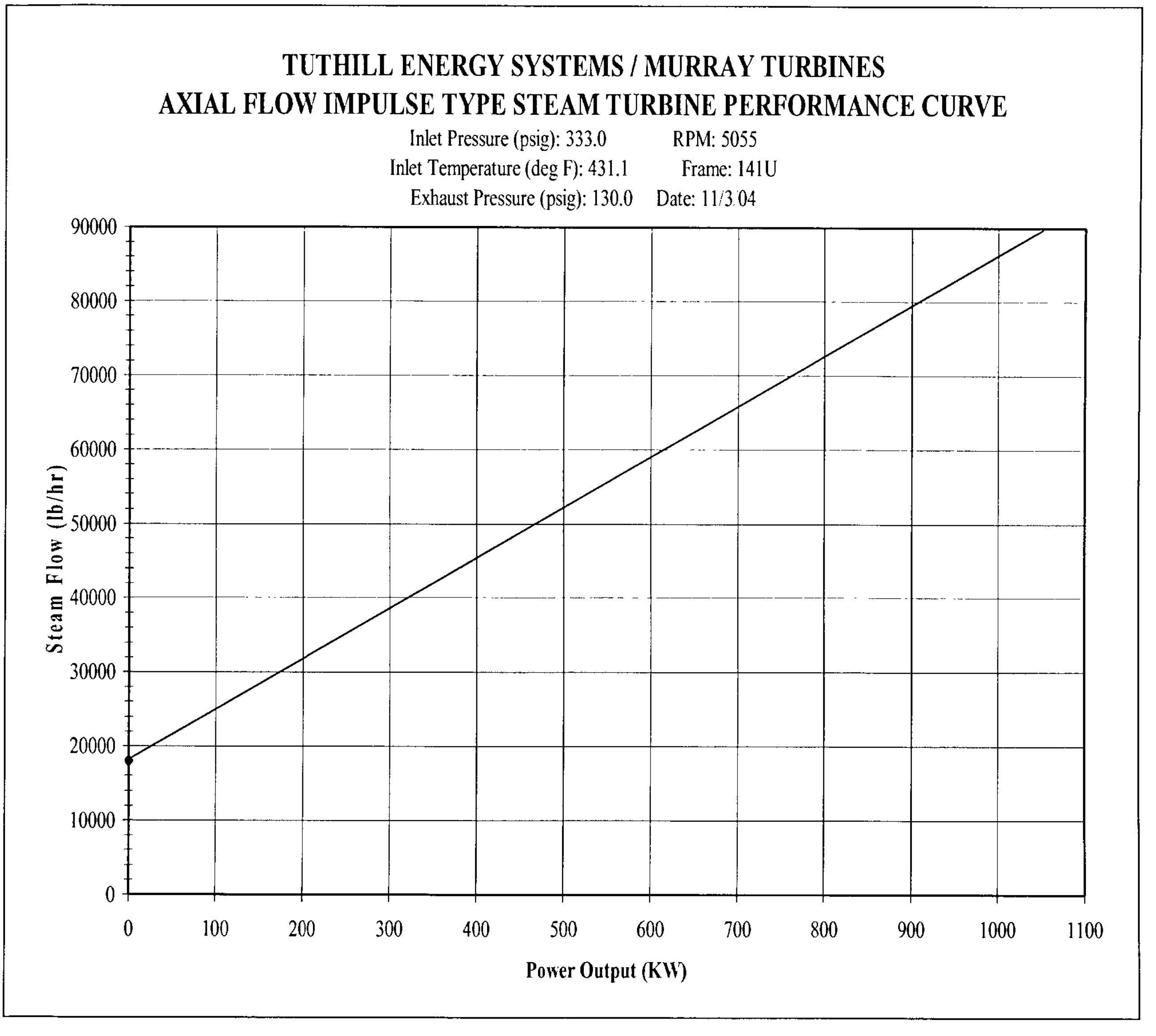


Figure 6: Tuthill Energy Systems steam turbine performance curve.[9]

[9] Source: Tuthill Energy Systems. Graph. Burlington, IA, 2004.

## C. Challenges/Contingency Planning

Piping challenges were identified as the project progressed past initial scope development. The primary piping change included additional connections to allow redundant steam supply and enhance control of steam flow. This would accomplish the ability to supply additional steam if the maximum turbine flow is exceeded.

Additional monitoring and preventative measures were taken to increase the accuracy of data for critical temperature and pressure readings. New technologies in temperature and pressure-compensating flow transmitters were specified for this application. Inlet and exhaust shutoff valves, a sodium analyzer and a steam separator were applied to the piping configuration, reducing potential turbine blade damage. These contingency plans were deemed unnecessary in the original scope, and later identified as wise reliability additions. Each equipment addition involved an associated increase in engineering support and drawing modification costs.

An analysis was conducted on the Murray Turbine Sustainability Project to determine the feasibility of implementation. Three contingency options were reviewed for cost implications and sustainability value to MJN. The three evaluated options included:

1) Do nothing option

2) Refurbish turbine and place into existing system

3) Recommission turbine, automate, modify piping and controls to add redundancy and flexibility to system

### *Do nothing option*

The turbine/generator unit remained idle in its original configuration for approximately seven years. During this period, straight line depreciation had reduced the book value of the equipment. The Do Nothing Option would have allowed the unit to continue depreciating for twenty years. At that time, the equipment would be scrapped for zero book value. This option was deemed unacceptable after the equipment was positively assessed for possible alternation to the valve system.

### *Refurbish turbine/generator option*

The Murray Turbine was assessed for possible refurbishing and placement into the current steam flow system. No additional piping for reconfiguration would be included in the refurbishing project. The steam flow system would operate in its present configuration. Redundancy within the steam flow controls would not be added to ensure peak operation consistency. The turbine/generated would be refurbished to reduce maintenance repair time and cost. However, the system would remain manually controlled and adjusted based on steam demand requirements. This option was rejected based on inefficiencies in the system and minimal benefit to MJN Sustainability goals. Refurbishing the turbine/generator without reconfiguring the steam flow system would only effect existing production demand. There was no contingency included for future increases in steam demand. The system would remain manually controlled.

***Recommission turbine/generator option***

An assessment was completed on modifying the Murray Turbine to provide an operational back-up system, ensuring against steam outages to production operations. An automated control system would be added to the turbine/generator to monitor equipment performance and adjust steam flow through alternate pressure control valves (PCV), maintaining adequate steam flow. Redundancy will be incorporated into the steam flow operation in association with the turbine. Both offline and online turbine operations will be addressed. Refer to Appendix 1 for pictorial layout of the recommissioned turbine/generator configuration.

When the turbine is offline for preventative maintenance or shutdown activity, the alternate pressure control valves will allow down-stream operations for both Nutritional and Pharmaceutical Processing to continue. When the turbine is online, the exhaust pressure will typically provide adequate steam flow for both processing suits (Nutritional and Pharmaceutical). The automated control system will ensure steam flow demand is supplied appropriately and will monitor the system overall for excess loading requirements. The turbine will maximize its cogeneration function at eighty-eight thousand (88,000) lbs/hr of steam flow. Demand exceeding this level will be directly fed from the steam source to the required production area.

## III. Results

### A. Cost Implications

**Simple Payback Calculation:**

An original simple payback of 2.8 years was based on previous production estimations. The results are calculated based on a linear average of steam flow during typical production days based on [redacted] cost of energy (reference Figure 7). This was a simple model before production forecast required an increase to a seven day operation. The following Simple Payback calculation includes total peak charge cost reduction of $18,000 annually. **Payback = $500,000/$184,000 = 2.72 years.**

**Figure 7**

**Original Savings Estimation**

| Winter Steam Demand Months: December, January, February, March | | | |
|---|---|---|---|
| Days per Month | Hrs / Day | kW / Day | Energy Cost / kW |
| 30 | 24 | 500 | [redacted] |
| TOTAL ENERGY COST FOR PERIOD: | | | [redacted] |

| Spring/Fall Steam Demand Months: April, May, October, November | | | |
|---|---|---|---|
| Days per Month | Hrs / Day | kW / Day | Energy Cost / kW |
| 30 | 24 | 450 | [redacted] |
| TOTAL ENERGY COST FOR PERIOD: | | | [redacted] |

| Summer Steam Demand Months: June, July, August, September | | | |
|---|---|---|---|
| Days per Month | Hrs / Day | kW / Day | Energy Cost / kW |
| 30 | 24 | 320 | [redacted] |
| TOTAL ENERGY COST FOR PERIOD: | | | [redacted] |

Figure 7: Simple Payback calculation based on average kW generation period.

The modified payback of 3.8 years resulted from a savings of $211,450 annually based on current production forecast and data from actual steam charts (reference Figure 8). The savings stream will begin as soon as the turbine is fully operational.

## Figure 8

### Revised Savings Estimation

| Winter Steam Demand Months: December, January, February, March | | | |
|---|---|---|---|
| **Days per Month** | **Hrs / Day** | **kW / Day** | **Energy Cost / kW** |
| 30 | 20 | 680 | [redacted] |
| 30 | 4 | 300 | |
| **TOTAL ENERGY COST FOR PERIOD:** | | | [redacted] |

| Spring/Fall Steam Demand Months: April, May, October, November | | | |
|---|---|---|---|
| **Days per Month** | **Hrs / Day** | **kW / Day** | **Energy Cost / kW** |
| 30 | 24 | 620 | [redacted] |
| 30 | 4 | 400 | |
| **TOTAL ENERGY COST FOR PERIOD:** | | | [redacted] |

| Summer Steam Demand Months: June, July, August, September | | | |
|---|---|---|---|
| **Days per Month** | **Hrs / Day** | **kW / Day** | **Energy Cost / kW** |
| 30 | 24 | 590 | [redacted] |
| 30 | 4 | 250 | |
| **TOTAL ENERGY COST FOR PERIOD:** | | | [redacted] |

| Estimated Peak Charge Cost Reduction (yearly) | |
|---|---|
| **kW** | **Energy Cost / kW / month** |
| 150 | $10.00 |
| **TOTAL PEAK REDUCTION YEARLY: $18,000** | |

Figure 8: Simple Payback calculation based on daily steam data.

NOTE: Amount of savings will vary depending on production uptime, turbine uptime and seasonal conditions. **Payback = $800,000/$211,450 = 3.78 years.**

## B. Sensitivity Analysis

There are several areas of sensitivity that were considered during the analysis process. The electrical cost projections for upcoming years will drastically impact the savings generated by the turbine/generator project. The continuous increase in energy cost will generate a greater savings due to avoidance of purchasing from the local utility provider. Rate increases from ten to twenty percent have been proposed by the utility provider.

Seasonal variations in temperature will affect steam demand, specifically during cooler periods. Figure 5, The Steam Flow Scatter Plot, reflects the situation of a higher steam load during colder months, January through March. The highest generation of savings will correspond to the addition of building heat requirements and line heat loses.

Production demand will be a factor of sensitivity. There are projected production increases for the next several years that will result in more consistent steam loads. The weekend production activity will be the major contributor to the consistency of the steam load, and this will positively affect turbine uptime during these periods. Overall, the impacts will be positive on the saving stream.

# IV. Conclusions

Cogeneration is a technology-driven practice that needs to be incorporated into many companies' core behaviors. Applications for cogeneration to achieve sustainability goals have major potential at this time due to automation advancements and equipment enhancements. The future applications for cogeneration will become global as other countries with an inconsistent electrical supply continue to expand their role in an interactive economy. Steam maximization is only one facet of cogeneration applications for operating turbines. Gas-driven turbines, utilizing byproducts of landfill operations, are another possible opportunity for cogeneration. As production activities grow, the viability of turbine applications should also be considered. This is even more relevant to infrastructure coordination by maintaining an uninterrupted utility supply. Utility outages result in costly downtime and reduction in production efficiencies.

As industry expansion reaches unparalleled frontiers of intense development and natural resource depletion, social responsibility costs have to be viewed as an element of any critical capital improvement plan. Cogeneration is a means of ensuring that today's development will not alter tomorrow's world. Agencies, such as Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), state, and local regulatory organizations, monitor companies' continual commitment to sustaining efforts by protecting the environment and enhancing the quality of human life for generations to come. Cogeneration, as a sustainability strategy, is a concept that some companies fail to recognize as a valuable capital investment.

The Murray Turbine project exemplifies the essence of the BMS/MJN 2010 corporate goals, while upholding the three pillars of sustainability. *Environmentally*, the re-commissioned turbine/generator provides electrical power without adding to greenhouse gas emissions. The zero net-negative impact to emissions benefits not only MJN, but the community in which it operates. *Socially*, the project complies with MJN's emphasis on corporate responsibility as it strives to be the world's leading provider of science based pediatric nutrition and pharmaceutical products and services. Finally, the third pillar of sustainability is the *economic* impact. The project will generate an increasingly greater savings as electric rates and production steam usage increase. The benefit of fully utilizing the potential of an idle turbine/generator asset is unquestionably a positive economic factor in the sustainability triad.

## V. Footnotes

[1] "Global View: The Journey Continues." Mead Johnson Nutritionals Company. 2000

[2] Enfamil is a registered trademark of Mead Johnson Nutritionals, a Bristol-Myers Squibb Company

[3] "Global View: The Journey Continues." Mead Johnson Nutritionals Company. 2000

[4] "How Innovation Supports Sustainability." Chemical Week Associates. 16 June 2004 <http://www.chemweek.com>

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[6] Current energy provider is Vectren Energy Deliver Company.

[7] Baur, Tim. "Cogeneration solutions, Deciding if it's right for your plant." Plant Services Oct. 2003. 15 Oct. 2004 <http://www.plantservices.com>

[8] "Building and Sustaining a Better World." Bristol-Myers Squibb Company. 2004 <http://www.bms.com/sustainability>

[9] Source: Tuthill Energy Systems. Graph. Burlington, IA, 2004.

## VI. References

Baur, Tim. "Cogeneration solutions, Deciding if it's right for your plant." Plant Services Oct. 2003. 15 Oct. 2004 <http://www.plantservices.com>

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"Global View: The Journey Continues." Mead Johnson Nutritionals Company. 2000

"How Innovation Supports Sustainability." Chemical Week Associates. 16 June 2004 <http://www.chemweek.com>

Mead Johnson Nutritionals, a Bristol-Myers Squibb Company

Tuthill Energy Systems. Graph. Burlington, IA, 2004.

## VII. Glossary of Terms

Asset optimization: Maximized uptime and overall equipment effectiveness at least cost

Cogeneration: The simultaneous production of electricity and useful heat from the same fuel or energy.

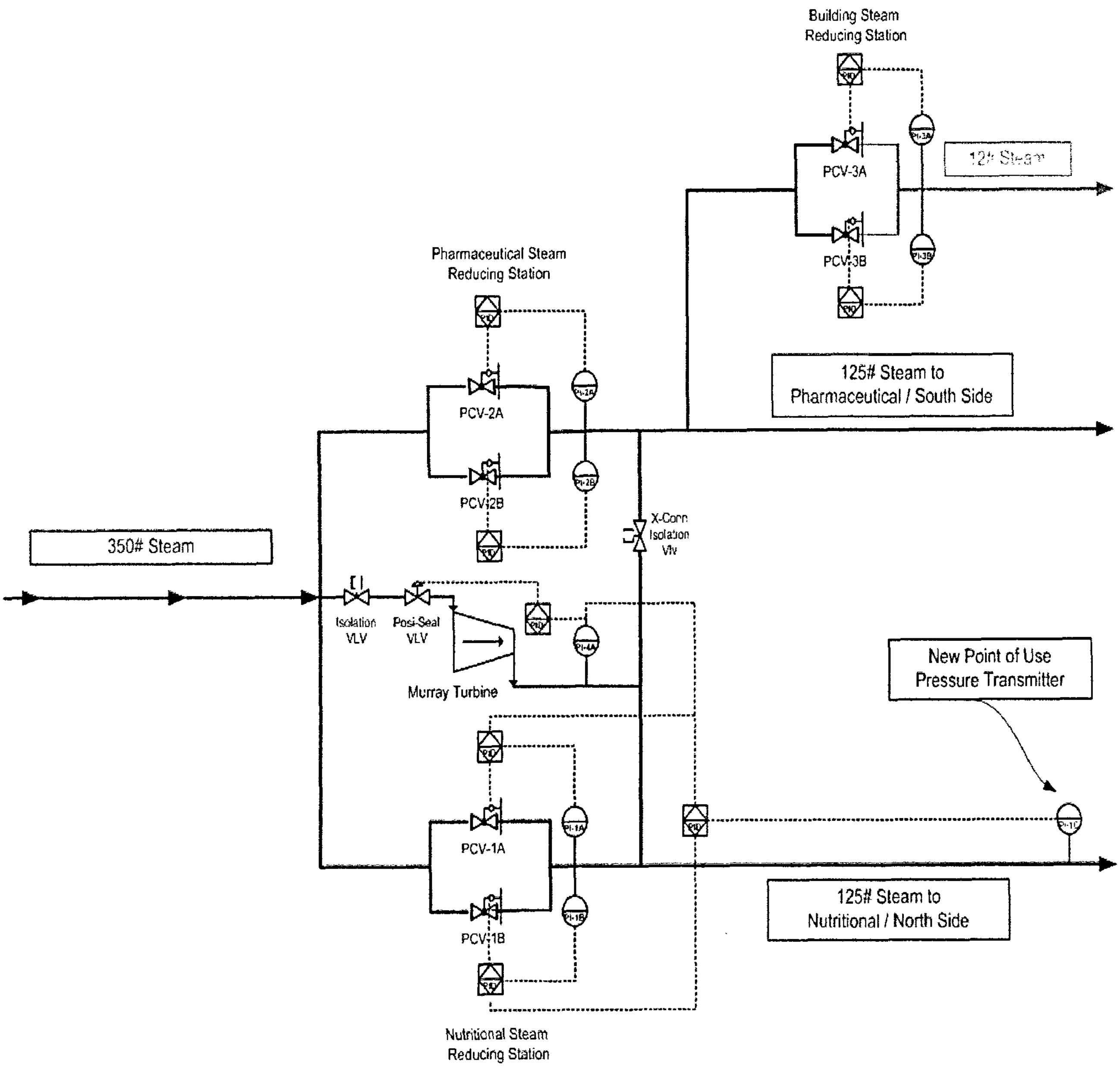
Payback: The amount of time taken to breakeven on an investment usually stated in years. Used to justify investments that need to be recovered quickly because of uncertainties, but it is unsuitable for longer-term investments because it ignores profits expected beyond the breakeven point and does not consider the time value of money.

Return on Investment (ROI): How much profit or cost savings is realized. An ROI calculation is sometimes used along with other approaches to develop a business case for a given proposal.

Sustainability: Defines how companies can meet their needs without compromising the ability of future generations to meet their needs. Sustainability at Bristol-Myers Squibb means delivering on the company's mission to extend and enhance human life in a way that supports the capability of future generations to meet their needs.

# VIII. Appendices

## Appendix 1: Murray Turbine Delta V Interface Functional Requirements



# Appendix 2: Payback/Depreciation Spreadsheet – 2% Inflation (est.)

| Murray Turbine Project | | Valuation | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
| ($000's) | Total | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| COGS | (2,058) | | (211) | (215) | (220) | (224) | (228) | (233) | (238) | (242) | (247) | (252) | (257) | (262) | (268) | (273) | (278) | (284) | (290) | (295) | (301) | (307) |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Gross Margin | 2,058 | - | 211 | 215 | 220 | 224 | 228 | 233 | 238 | 242 | 247 | 252 | 257 | 262 | 268 | 273 | 278 | 284 | 290 | 295 | 301 | 307 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Savings Contribution | 2,058 | - | 211 | 215 | 220 | 224 | 228 | 233 | 238 | 242 | 247 | 252 | 257 | 262 | 268 | 273 | 278 | 284 | 290 | 295 | 301 | 307 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Book Depreciation (GAAP)Not Real | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Pre-tax Earnings | 1,698 | - | 171 | 175 | 180 | 184 | 188 | 193 | 198 | 202 | 207 | 212 | 217 | 222 | 228 | 233 | 238 | 244 | 250 | 255 | 261 | 267 |
| Taxes @ 37% | 628 | - | 63 | 65 | 66 | 68 | 70 | 71 | 73 | 75 | 77 | 79 | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 95 | 97 | 99 |
| Net Earnings | 1,070 | - | 108 | 110 | 113 | 116 | 119 | 122 | 125 | 127 | 131 | 134 | 137 | 140 | 143 | 147 | 150 | 154 | 157 | 161 | 165 | 168 |
| **Adjustments:** | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| (Capital Expenditures) | (800) | (800) | | | | | | | | | | | | | | | | | | | | |
| Deferred Taxes (Cash Flow Advanta | 439 | | 74 | 156 | 100 | 60 | 31 | 31 | 31 | (4) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) |
| After-tax Cash Flow | 1,069 | (800) | 222 | 306 | 253 | 216 | 190 | 193 | 196 | 163 | 131 | 134 | 137 | 140 | 143 | 147 | 150 | 154 | 157 | 161 | 165 | 168 |
| Pre-Tax Cash Flow | 1,258 | (800) | 211 | 215 | 220 | 224 | 228 | 233 | 238 | 242 | 247 | 252 | 257 | 262 | 268 | 273 | 278 | 284 | 290 | 295 | 301 | 307 |

| | | | |
|---|---|---|---|
| **Discount Rate** | [redacted] | IRR | 27% |
| **Pre-Tax NPV** | | | |
| **After-Tax NPV** | | | |

**For guidance, please refer to ROI Standards document.**

# Murray Turbine

## *Return on Investment Analysis - Assumptions/Business Rationale*

***Key Assumptions:***

- 2% inflation factor used
- Assumed savings will be captured for entire useful life
- Assumed no salvage value
- 20 year useful life
- Assumes interim cash flows will be reinvested at same ROI
- Conservatively assumes prices from Vectren (electricity provider) will not increase greater than the 2% inflation factor

***Business Rationale:***

- The project will save on energy costs. The turbine will produce electricity that would otherwise have to be purchased by Vectren.

# Appendix 3: Payback/Depreciation Spreadsheet – 4% Inflation (est.)

**Murray Turbine Project**

## Valuation

| | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **($000's)** | **Total** | **Year 0** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** | **Year 7** | **Year 8** | **Year 9** | **Year 10** | **Year 11** | **Year 12** | **Year 13** | **Year 14** | **Year 15** | **Year 16** | **Year 17** | **Year 18** | **Year 19** | **Year 20** |
| | - | | | | | | | | | | | | | | | | | | | | | |
| COGS | (2,233) | | (211) | (219) | (228) | (237) | (247) | (257) | (267) | (278) | (289) | (300) | (312) | (325) | (338) | (351) | (365) | (380) | (395) | (411) | (427) | (445) |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Gross Margin | 2,233 | - | 211 | 219 | 228 | 237 | 247 | 257 | 267 | 278 | 289 | 300 | 312 | 325 | 338 | 351 | 365 | 380 | 395 | 411 | 427 | 445 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Savings Contribution | 2,233 | - | 211 | 219 | 228 | 237 | 247 | 257 | 267 | 278 | 289 | 300 | 312 | 325 | 338 | 351 | 365 | 380 | 395 | 411 | 427 | 445 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Book Depreciation (GAAP)Not Real | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Pre-tax Earnings | 1,873 | - | 171 | 179 | 188 | 197 | 207 | 217 | 227 | 238 | 249 | 260 | 272 | 285 | 298 | 311 | 325 | 340 | 355 | 371 | 387 | 405 |
| Taxes @ 37% | 693 | - | 63 | 66 | 70 | 73 | 77 | 80 | 84 | 88 | 92 | 96 | 101 | 105 | 110 | 115 | 120 | 126 | 131 | 137 | 143 | 150 |
| Net Earnings | 1,180 | - | 108 | 113 | 119 | 124 | 130 | 137 | 143 | 150 | 157 | 164 | 172 | 179 | 188 | 196 | 205 | 214 | 224 | 234 | 244 | 255 |
| **Adjustments:** | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| (Capital Expenditures) | (800) | (800) | | | | | | | | | | | | | | | | | | | | |
| Deferred Taxes (Cash Flow Advanta | 439 | | 74 | 156 | 100 | 60 | 31 | 31 | 31 | (4) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) |
| After-tax Cash Flow | 1,179 | (800) | 222 | 309 | 259 | 224 | 201 | 208 | 214 | 186 | 157 | 164 | 172 | 179 | 188 | 196 | 205 | 214 | 224 | 234 | 244 | 255 |
| Pre-Tax Cash Flow | 1,433 | (800) | 211 | 219 | 228 | 237 | 247 | 257 | 267 | 278 | 289 | 300 | 312 | 325 | 338 | 351 | 365 | 380 | 395 | 411 | 427 | 445 |

| | | | | |
|---|---|---|---|---|
| **Discount Rate** | [redacted] | | IRR | 29% |
| **Pre-Tax NPV** | | | | |
| **After-Tax NPV** | | | | |

For guidance, please refer to ROI Standards document.

# Murray Turbine

## *Return on Investment Analysis - Assumptions/Business Rationale*

***Key Assumptions:***

- 4% inflation factor used
- Assumed savings will be captured for entire useful life
- Assumed no salvage value
- 20 year useful life
- Assumes interim cash flows will be reinvested at same ROI
- Assumes prices from Vectren (electricity provider) will not increase greater than the 4% inflation factor

***Business Rationale:***

- The project will save on energy costs. The turbine will produce electricity that would otherwise have to be purchased by Vectren.

# Appendix 4: Payback/Depreciation Spreadsheet – 6% Inflation (est.)

| Murray Turbine Project | | | | | | | | | | Valuation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
| ($000's) | Total | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| COGS | (2,425) | | (211) | (224) | (237) | (251) | (266) | (282) | (299) | (317) | (336) | (356) | (378) | (401) | (425) | (450) | (477) | (506) | (536) | (568) | (602) | (638) |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Gross Margin | 2,425 | - | 211 | 224 | 237 | 251 | 266 | 282 | 299 | 317 | 336 | 356 | 378 | 401 | 425 | 450 | 477 | 506 | 536 | 568 | 602 | 638 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Savings Contribution | 2,425 | - | 211 | 224 | 237 | 251 | 266 | 282 | 299 | 317 | 336 | 356 | 378 | 401 | 425 | 450 | 477 | 506 | 536 | 568 | 602 | 638 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Book Depreciation (GAAP)Not Real | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | - | | | | | | | | | | | | | | | | | | | | | |
| Pre-tax Earnings | 2,065 | - | 171 | 184 | 197 | 211 | 226 | 242 | 259 | 277 | 296 | 316 | 338 | 361 | 385 | 410 | 437 | 466 | 496 | 528 | 562 | 598 |
| Taxes @ 37% | 764 | - | 63 | 68 | 73 | 78 | 84 | 90 | 96 | 103 | 110 | 117 | 125 | 133 | 142 | 152 | 162 | 172 | 184 | 195 | 208 | 221 |
| Net Earnings | 1,301 | - | 108 | 116 | 124 | 133 | 143 | 153 | 163 | 175 | 187 | 199 | 213 | 227 | 242 | 258 | 275 | 293 | 312 | 333 | 354 | 377 |
| **Adjustments:** | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 360 | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| (Capital Expenditures) | (800) | (800) | | | | | | | | | | | | | | | | | | | | |
| Deferred Taxes (Cash Flow Advanta | 439 | | 74 | 156 | 100 | 60 | 31 | 31 | 31 | (4) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) | (40) |
| After-tax Cash Flow | 1,300 | (800) | 222 | 312 | 264 | 233 | 214 | 224 | 234 | 211 | 187 | 199 | 213 | 227 | 242 | 258 | 275 | 293 | 312 | 333 | 354 | 377 |
| Pre-Tax Cash Flow | 1,625 | (800) | 211 | 224 | 237 | 251 | 266 | 282 | 299 | 317 | 336 | 356 | 378 | 401 | 425 | 450 | 477 | 506 | 536 | 568 | 602 | 638 |
| **Discount Rate** | [redacted] | | IRR | 31% | | | | | | | | | | | | | | | | | | |
| **Pre-Tax NPV** | | | | | | | | | | | | | | | | | | | | | | |
| **After-Tax NPV** | | | | | | | | | | | | | | | | | | | | | | |

**For guidance, please refer to ROI Standards document.**

# Murray Turbine

## *Return on Investment Analysis - Assumptions/Business Rationale*

***Key Assumptions:***

- 6% inflation factor used
- Assumed savings will be captured for entire useful life
- Assumed no salvage value
- 20 year useful life
- Assumes interim cash flows will be reinvested at same ROI
- Pessimistically assumes prices from Vectren (electricity provider) will not increase greater than the 2% inflation factor

***Business Rationale:***

- The project will save on energy costs. The turbine will produce electricity that would otherwise have to be purchased by Vectren.

# Appendix 5: Payback Calculation

Calculation formula for Figures 7 and 8.

Proprietary information is removed from figures.

Payback Calculation:

Numbers of days in given month x

Hours in a day x

Avg. kW usage per day x

Cost of energy =

Payback Savings

Total savings for year with peak demand charge included =

3.78yr Payback with $800,000 capital investment

Payback = $800,000/$211,347 = 3.78 years

Initial investment: $800,000

Annual savings: $211, 347

# Appendix 6: Steam Flow Scatter Plot Data

EVL Steam Flow

| Date | Maximum | Minimum | Average | Calculated Average |
|---|---|---|---|---|
| 6/2/2003 | 41598 | 31003 | 36235 | 36301 |
| 6/3/2003 | 87338 | 29505 | 54550 | 58422 |
| 6/4/2003 | 88812 | 30829 | 53677 | 59821 |
| 6/5/2003 | 78438 | 28988 | 48907 | 53713 |
| 6/6/2003 | 83372 | 28548 | 51779 | 55960 |
| 6/7/2003 | 48945 | 22613 | 30628 | 35779 |
| 6/8/2003 | 48894 | 22921 | 32333 | 35908 |
| 6/9/2003 | 77942 | 23748 | 43681 | 50845 |
| 6/10/2003 | 89384 | 23771 | 52362 | 56577 |
| 6/11/2003 | 91806 | 30037 | 52013 | 60922 |
| 6/12/2003 | 88668 | 27849 | 50010 | 58258 |
| 6/13/2003 | 84515 | 26099 | 48577 | 55307 |
| 6/14/2003 | 46016 | 21921 | 29640 | 33969 |
| 6/15/2003 | 38612 | 21133 | 28934 | 29873 |
| 6/16/2003 | 68201 | 21804 | 39944 | 45002 |
| 6/17/2003 | 89742 | 24932 | 51064 | 57337 |
| 6/18/2003 | 78554 | 32296 | 53356 | 55425 |
| 6/19/2003 | 77011 | 32565 | 52259 | 54788 |
| 6/20/2003 | 82166 | 29483 | 51977 | 55825 |
| 6/21/2003 | 53713 | 18355 | 33679 | 36034 |
| 6/22/2003 | 28853 | 18944 | 22153 | 23898 |
| 6/23/2003 | 64051 | 17916 | 33743 | 40984 |
| 6/24/2003 | 73205 | 17721 | 39398 | 45463 |
| 6/25/2003 | 67260 | 20844 | 39869 | 44052 |
| 6/26/2003 | 66550 | 20982 | 37649 | 43766 |
| 6/27/2003 | 74342 | 24197 | 43119 | 49269 |
| 6/28/2003 | 38864 | 17361 | 22677 | 28113 |
| 6/29/2003 | 25778 | 18542 | 21794 | 22160 |
| 6/30/2003 | 71327 | 20419 | 39010 | 45873 |
| 7/1/2003 | 71556 | 22588 | 41291 | 47072 |
| 7/2/2003 | 60166 | 19676 | 35603 | 39921 |
| 7/3/2003 | 51213 | 16864 | 27901 | 34039 |
| 7/4/2003 | 25193 | 17801 | 21377 | 21497 |
| 7/5/2003 | 40076 | 4 | 4659 | 20040 |
| 7/6/2003 | 43346 | 7 | 13904 | 21677 |
| 7/7/2003 | 25321 | 15773 | 20536 | 20547 |
| 7/8/2003 | 34270 | 16821 | 22082 | 25545 |
| 7/9/2003 | 39905 | 14837 | 22452 | 27371 |
| 7/10/2003 | 38624 | 15407 | 22728 | 27015 |
| 7/11/2003 | 35230 | 18279 | 22719 | 26754 |
| 7/12/2003 | 31228 | 17950 | 21913 | 24589 |
| 7/13/2003 | 59397 | 19217 | 29490 | 39307 |
| 7/14/2003 | 62782 | 23993 | 35508 | 43387 |
| 7/15/2003 | 75712 | 21025 | 41038 | 48369 |
| 7/16/2003 | 77299 | 17815 | 40906 | 47557 |
| 7/17/2003 | 73877 | 21467 | 43736 | 47672 |
| 7/18/2003 | 75271 | 21437 | 42935 | 48354 |
| 7/19/2003 | 40677 | 20176 | 28311 | 30427 |
| 7/20/2003 | 53487 | 16920 | 25922 | 35204 |

| | | | | |
|---|---|---|---|---|
| 7/21/2003 | 83413 | 22412 | 50297 | 52913 |
| 7/22/2003 | 88317 | 30592 | 53222 | 59455 |
| 7/23/2003 | 81706 | 29323 | 51907 | 55514 |
| 7/24/2003 | 78602 | 25586 | 47271 | 52094 |
| 7/25/2003 | 72916 | 24350 | 44520 | 48633 |
| 7/26/2003 | 44434 | 23546 | 31554 | 33990 |
| 7/27/2003 | 50090 | 24733 | 34248 | 37411 |
| 7/28/2003 | 75862 | 23905 | 45282 | 49884 |
| 7/29/2003 | 88019 | 27722 | 50943 | 57870 |
| 7/30/2003 | 82814 | 30164 | 50014 | 56489 |
| 7/31/2003 | 78095 | 30802 | 50510 | 54448 |
| 8/1/2003 | 83399 | 24575 | 47287 | 53987 |
| 8/2/2003 | 39528 | 19694 | 25000 | 29611 |
| 8/3/2003 | 51304 | 18538 | 25557 | 34921 |
| 8/4/2003 | 75309 | 17715 | 43905 | 46512 |
| 8/5/2003 | 87395 | 25784 | 49843 | 56589 |
| 8/6/2003 | 78757 | 30113 | 51226 | 54435 |
| 8/7/2003 | 80006 | 31184 | 52264 | 55595 |
| 8/8/2003 | 77759 | 29868 | 50149 | 53814 |
| 8/9/2003 | 55582 | 22831 | 36761 | 39206 |
| 8/10/2003 | 44702 | 26155 | 32325 | 35428 |
| 8/11/2003 | 74674 | 26176 | 44136 | 50425 |
| 8/12/2003 | 86438 | 25357 | 50321 | 55898 |
| 8/13/2003 | 83221 | 29795 | 52167 | 56508 |
| 8/14/2003 | 80002 | 31855 | 51924 | 55928 |
| 8/15/2003 | 69112 | 20737 | 42526 | 44925 |
| 8/16/2003 | 41359 | 14025 | 22307 | 27692 |
| 8/17/2003 | 50532 | 16019 | 24843 | 33275 |
| 8/18/2003 | 77463 | 19313 | 43156 | 48388 |
| 8/19/2003 | 85509 | 24811 | 47112 | 55160 |
| 8/20/2003 | 85912 | 33261 | 52190 | 59586 |
| 8/21/2003 | 76868 | 30508 | 47726 | 53688 |
| 8/22/2003 | 82587 | 28046 | 47551 | 55316 |
| 8/23/2003 | 40838 | 21810 | 29345 | 31324 |
| 8/24/2003 | 42386 | 24986 | 30824 | 33686 |
| 8/25/2003 | 62114 | 24290 | 39085 | 43202 |
| 8/26/2003 | 80124 | 24506 | 47403 | 52315 |
| 8/27/2003 | 78592 | 29149 | 48921 | 53871 |
| 8/28/2003 | 83723 | 29649 | 50282 | 56686 |
| 8/29/2003 | 84432 | 21530 | 43476 | 52981 |
| 8/30/2003 | 52511 | 16626 | 23627 | 34569 |
| 8/31/2003 | 25340 | 15993 | 19632 | 20666 |
| 9/1/2003 | 23507 | 16402 | 19468 | 19954 |
| 9/2/2003 | 81243 | 17294 | 40476 | 49269 |
| 9/3/2003 | 74847 | 22471 | 45733 | 48659 |
| 9/4/2003 | 80949 | 23566 | 51506 | 52257 |
| 9/5/2003 | 77646 | 29353 | 48448 | 53500 |
| 9/6/2003 | 50911 | 16595 | 26500 | 33753 |
| 9/7/2003 | 54001 | 16872 | 22673 | 35437 |
| 9/8/2003 | 56209 | 23407 | 36818 | 39808 |
| 9/9/2003 | 83054 | 23584 | 50416 | 53319 |
| 9/10/2003 | 84477 | 28353 | 51610 | 56415 |
| 9/11/2003 | 85838 | 28920 | 52425 | 57379 |
| 9/12/2003 | 75879 | 27498 | 47561 | 51689 |
| 9/13/2003 | 52366 | 18939 | 30310 | 35653 |

| | | | | |
|---|---|---|---|---|
| 9/14/2003 | 38345 | 20729 | 27986 | 29537 |
| 9/15/2003 | 66226 | 22266 | 40637 | 44246 |
| 9/16/2003 | 85132 | 23441 | 48471 | 54286 |
| 9/17/2003 | 91879 | 28145 | 52484 | 60012 |
| 9/18/2003 | 84744 | 27825 | 51260 | 56285 |
| 9/19/2003 | 85481 | 27613 | 46707 | 56547 |
| 9/20/2003 | 57834 | 15975 | 23745 | 36905 |
| 9/21/2003 | 52444 | 16290 | 22942 | 34367 |
| 9/22/2003 | 62770 | 23914 | 38128 | 43342 |
| 9/23/2003 | 85641 | 23031 | 46193 | 54336 |
| 9/24/2003 | 78744 | 23677 | 41509 | 51211 |
| 9/25/2003 | 70881 | 23289 | 38385 | 47085 |
| 9/26/2003 | 72496 | 22188 | 44243 | 47342 |
| 9/27/2003 | 39230 | 21162 | 29516 | 30196 |
| 9/28/2003 | 40182 | 22150 | 30628 | 31166 |
| 9/29/2003 | 68132 | 25139 | 41292 | 46636 |
| 9/30/2003 | 91820 | 26573 | 50822 | 59197 |
| 10/1/2003 | 107084 | 25462 | 53277 | 66273 |
| 10/2/2003 | 100288 | 26721 | 51762 | 63505 |
| 10/3/2003 | 109764 | 17707 | 51126 | 63736 |
| 10/4/2003 | 27643 | 16721 | 20717 | 22182 |
| 10/5/2003 | 29457 | 16292 | 20753 | 22875 |
| 10/6/2003 | 129828 | 17965 | 43361 | 73897 |
| 10/7/2003 | 114226 | 22383 | 50586 | 68304 |
| 10/8/2003 | 124595 | 23476 | 55099 | 74035 |
| 10/9/2003 | 135003 | 23 | 49575 | 67513 |
| 10/10/2003 | 124216 | 20604 | 50774 | 72410 |
| 10/11/2003 | 47901 | 14481 | 27430 | 31191 |
| 10/12/2003 | 40842 | 17929 | 27953 | 29385 |
| 10/13/2003 | 128220 | 23392 | 51485 | 75806 |
| 10/14/2003 | 140209 | 24865 | 53761 | 82537 |
| 10/15/2003 | 97829 | 24969 | 54552 | 61399 |
| 10/16/2003 | 98054 | 24698 | 47898 | 61376 |
| 10/17/2003 | 88996 | 23784 | 49034 | 56390 |
| 10/18/2003 | 48925 | 21875 | 32241 | 35400 |
| 10/19/2003 | 42824 | 22219 | 29740 | 32522 |
| 10/20/2003 | 56638 | 23861 | 38511 | 40250 |
| 10/21/2003 | 89861 | 22346 | 48612 | 56103 |
| 10/22/2003 | 85236 | 24528 | 49924 | 54882 |
| 10/23/2003 | 85702 | 25178 | 45594 | 55440 |
| 10/24/2003 | 85851 | 18598 | 44103 | 52224 |
| 10/25/2003 | 34748 | 17263 | 21212 | 26006 |
| 10/26/2003 | 57731 | 14998 | 26447 | 36365 |
| 10/26/2003 | 70990 | 27832 | 42505 | 49411 |
| 11/27/2003 | 28773 | 20687 | 24116 | 24730 |
| 11/28/2003 | 34529 | 23734 | 28974 | 29131 |
| 11/29/2003 | 34516 | 23185 | 28162 | 28850 |
| 11/30/2003 | 60021 | 15572 | 27890 | 37797 |
| 12/1/2003 | 62396 | 21772 | 43950 | 42084 |
| 12/2/2003 | 94519 | 34288 | 56329 | 64404 |
| 12/3/2003 | 93890 | 29847 | 56655 | 61868 |
| 12/4/2003 | 87376 | 30306 | 54476 | 58841 |
| 12/5/2003 | 89681 | 32413 | 57128 | 61047 |
| 12/6/2003 | 60669 | 27618 | 42478 | 44144 |
| 12/7/2003 | 46427 | 24028 | 34387 | 35227 |

| | | | | |
|---|---|---|---|---|
| 12/8/2003 | 68493 | 28608 | 45415 | 48551 |
| 12/9/2003 | 95501 | 28250 | 56178 | 61875 |
| 12/10/2003 | 93082 | 28804 | 56162 | 60943 |
| 12/11/2003 | 97177 | 27503 | 49771 | 62340 |
| 12/12/2003 | 88398 | 27281 | 50074 | 57839 |
| 12/13/2003 | 57589 | 32575 | 42218 | 45082 |
| 12/14/2003 | 47732 | 30868 | 38805 | 39300 |
| 12/15/2003 | 215169 | 28485 | 56300 | 121827 |
| 12/16/2003 | 111397 | 24922 | 54270 | 68159 |
| 12/17/2003 | 87853 | 38108 | 58301 | 62980 |
| 12/18/2003 | 82489 | 31459 | 54005 | 56974 |
| 12/19/2003 | 67504 | 28086 | 46899 | 47795 |
| 12/20/2003 | 44059 | 26383 | 32503 | 35221 |
| 12/21/2003 | 34743 | 21676 | 27239 | 28210 |
| 12/22/2003 | 34309 | 20668 | 25848 | 27488 |
| 12/23/2003 | 32142 | 20902 | 26711 | 26522 |
| 12/24/2003 | 33609 | 25271 | 28699 | 29440 |
| 12/25/2003 | 34192 | 24014 | 28346 | 29103 |
| 12/26/2003 | 33972 | 21558 | 27068 | 27765 |
| 12/27/2003 | 61441 | 21537 | 32966 | 41489 |
| 12/28/2003 | 49990 | 26012 | 35268 | 38001 |
| 12/29/2003 | 65990 | 21404 | 35812 | 43697 |
| 12/30/2003 | 59075 | 28905 | 38353 | 43990 |
| 12/31/2003 | 47059 | 20922 | 33116 | 33991 |
| 1/1/2004 | 30866 | 18871 | 24080 | 24869 |
| 1/2/2004 | 26570 | 18889 | 22083 | 22730 |
| 1/3/2004 | 32725 | 18215 | 21022 | 25470 |
| 1/4/2004 | 145973 | 19938 | 35675 | 82955 |
| 1/5/2004 | 81283 | 32070 | 51793 | 56677 |
| 1/6/2004 | 93638 | 34864 | 61375 | 64251 |
| 1/7/2004 | 90688 | 38637 | 59353 | 64663 |
| 1/8/2004 | 81651 | 37318 | 52629 | 59484 |
| 1/9/2004 | 84141 | 34766 | 56590 | 59454 |
| 1/10/2004 | 60522 | 32140 | 41659 | 46331 |
| 1/11/2004 | 49358 | 29848 | 37487 | 39603 |
| 1/12/2004 | 82486 | 31157 | 48647 | 56822 |
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