Reducing Your Steam On Peak Demand and Consumption

Sim Zirkiyev
Steam Conservation and Peak Demand Reduction Programs

- **General Voluntary Demand Reduction Program (GVDRP)**
  - Demand reductions using a building’s techniques of choice

- **Storage of Thermal Energy in Existing Mechanical systems (STEEMs)**
  - Use stored thermal energy in buildings to shift or reduce customers’ steam peak

- **Best Practices (Steam Usage Audits)**
  - Provide recommendations to help customers reduce overall consumption and on-peak demand
• Three customers participated
• The following were some demand reduction techniques that customers found helpful:
  ▪ Preheating the building at 4 a.m. or 5 a.m. by running fans without opening outside air dampers prior to 6 a.m.
  ▪ Raising circulating water temperature prior to 6 a.m. and manually lowering the temperature
  ▪ Slowing down the VFD fans from 6 a.m. to 11 a.m.
• Starting up fans earlier may be economical for customers with poor steam load factors
• Tips will be posted on www.coned.com/steam by June 2007
GVDRP Participant Result

On Peak Period

14°F at 6 AM

12°F at 6 AM

Heated Water Loops 100°F to 160°F

Manually Reset Water Temps 160°F to 90°F for 5 hours

Reset Water Temps from 90°F to 120°F during On Peak Period

Steam Demand (lbs/hr)

0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00

Time

1/21/05 - Normal Operating Day

3/7/07 - Occurrence Day
Another GVDRP Participant: 1221 Sixth Avenue

- 2.7 million square feet
- 52 stories in height, completed in 1970
- Single Duct VAV interior fans w/HW heating coils
- Single Duct VAV perimeter fans serving induction units w/HW heating coils
1221 Sixth Ave – Normal Operating Day

Building Steam Demand (Mlbs/hr)

Time

0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00

ON PEAK PERIOD

11°F Morning

Normal Operating Day 02/06/07
1221 Sixth Ave – GVDRP Operation Day

Building Steam Demand (Mlbs/hr)

- Normal Operating Day 02/06/07
- Occurrence Day 01/26/07

Reduced Demand by 7,000 lbs/hr

11°F morning

On Peak Period
1221 Sixth Ave: Reduction Steps Before 6:00 a.m.

- Start select fans (31) 1 hr earlier than normal
- Set SA set points to 85°F vs. Off condition
- Raise secondary water temp to 130°F vs. Reset schedule
- Raise pre/reheat water temp to 140°F vs. Reset schedule
- Raise radiation water temp to 160°F vs. Reset schedule
- Set fan speed to 60htz (100%) vs. Off condition
Reduction Steps After 6:00 AM

- Reduce SA set points to 65°F vs. return air reset
- Reduce secondary and pre/reheat water temps to 120°F vs. Reset schedule
- Reduce radiation water temp to 140°F vs. Reset Schedule
- Set fan speed to 50htz (83%) vs. Static pressure control
- Lower steam supply from 40# to 25#
## 1221 Sixth Ave – Projected Savings for One Monthly Period

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Peak Demand (2/6/07)</td>
<td>39.75 Mlb/hr</td>
</tr>
<tr>
<td>On Peak Demand (1/26/07 GVDRP)</td>
<td>32.78 Mlb/hr</td>
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<tr>
<td>On Peak Demand Savings (6.97 Mlb/hr X $755.41)</td>
<td>$5,265</td>
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<tr>
<td>All Time Peak Demand (2/6/07)</td>
<td>39.00 Mlb/hr</td>
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<tr>
<td>All Time Peak Demand (2/9 GVDRP)</td>
<td>51.00 Mlb/hr</td>
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<td>All Time Peak Demand Savings (12 Mlb/hr X $79.03)</td>
<td>-$948</td>
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<tr>
<td>Net Steam Demand Charge Savings</td>
<td>$4,317</td>
</tr>
<tr>
<td>Electric Savings ($389.00 x 22 weekdays)</td>
<td>-$8,558</td>
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<tr>
<td><strong>NET RESULT</strong></td>
<td><strong>-$4,241</strong></td>
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</table>
## GVDRP: Results Summary

<table>
<thead>
<tr>
<th>Occurrence Day</th>
<th>Outdoor Air Temp at 6 AM (°F)</th>
<th>1 - Iconic Midtown Office Highrise</th>
<th>1221 Sixth Avenue</th>
<th>2 - Midtown Office Highrise</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gross Area: 1.04 Million SF</td>
<td>Gross Area: 2.7 Million SF</td>
<td>Gross Area: 1.5 Million SF</td>
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<tr>
<td></td>
<td></td>
<td>On-Peak Demand Reduction (Mlbs/hr)</td>
<td>On-Peak Demand Reduction (Mlbs/hr)</td>
<td>On-Peak Demand Reduction (Mlbs/hr)</td>
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<tr>
<td></td>
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<td>Possible Demand Charge Savings ($/Month)</td>
<td>Possible Demand Charge Savings ($/Month)</td>
<td>Possible Demand Charge Savings ($/Month)</td>
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<tr>
<td></td>
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<td>Percent On-Peak Demand Reduction</td>
<td>Percent On-Peak Demand Reduction</td>
<td>Percent On-Peak Demand Reduction</td>
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<td>01/17/2007</td>
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<td>2.3</td>
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<td>1,900</td>
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<td></td>
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<td>N/A</td>
<td>6.7%</td>
<td>5.5%</td>
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<tr>
<td>01/26/2007</td>
<td>9</td>
<td>4.3</td>
<td>12.5</td>
<td>4.0</td>
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<td>3,600</td>
<td>10,500</td>
<td>3,300</td>
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<td>18.7%</td>
<td>27.7%</td>
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<td>5,800</td>
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<td>25.6%</td>
<td>25.6%</td>
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<tr>
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<td>3.2</td>
<td>8.1</td>
<td>8.6</td>
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<td>2,700</td>
<td>6,700</td>
<td>7,100</td>
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<td></td>
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<td>15.9%</td>
<td>20.4%</td>
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<tr>
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<td>2,700</td>
<td>6,700</td>
<td>7,100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.9%</td>
<td>20.4%</td>
<td>31.5%</td>
</tr>
<tr>
<td>02/09/2007</td>
<td>18</td>
<td>N/A</td>
<td>3.1</td>
<td>6.9</td>
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<tr>
<td></td>
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<td>N/A</td>
<td>2,600</td>
<td>5,700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
<td>9.1%</td>
<td>25.6%</td>
</tr>
<tr>
<td>03/07/2007</td>
<td>12</td>
<td>1.9</td>
<td>1.5</td>
<td>8.6</td>
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<td>1,600</td>
<td>1,300</td>
<td>7,100</td>
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<td></td>
<td></td>
<td>10.1%</td>
<td>4.1%</td>
<td>31.5%</td>
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<tr>
<td>Avg Demand Reduction:</td>
<td>3.1</td>
<td>14.9%</td>
<td>5.5</td>
<td>5.5</td>
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<tr>
<td></td>
<td></td>
<td>14.9%</td>
<td>13.6%</td>
<td>20.8%</td>
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Storage of Thermal Energy in Existing Mechanical Systems (STEEMs)

- Steam demand reduction technique developed in conjunction with Goldman Copeland Associates
  - STEEMs Using Constant Reset (~$5,000 to program)
  - STEEMs Using Dynamic Response (~$10,000 to program)
- Tested at 1 Penn Plaza (induction units) and 383 Madison Ave (fan-powered boxes).
- No effect on comfort conditions & no increase in overall steam consumption
- Good candidate buildings have
  - Induction, fan coil or other units with local thermostats
  - Circulating hot water
  - A programmable building management system
- Implementation tips will be posted on www.coned.com/steam by June, 2007
STEEMs
Using Constant Reset
Environmental Benefits of Steam (CO2) Existing Firetube Boilers
(70% Natural Gas / 30% No.6 Oil System-Wide Fuel Mix)

![Graph showing CO2 emissions comparison between Con Edison and a typical firetube boiler.]

Typical Firetube Boiler

Con Edison

Source: AP - 42 (USEPA) Controlled Boilers - Low NOX Burners (Boilers < 100 MMBtu/hr)

Note: A seasonal boiler efficiency of approximately 60% was utilized to calculate the output based emission rate – Source: ASHRAE Journal – September 1994
STEEMs Using Constant Reset: Advantages and Challenges

**Advantages:**

- Easy and inexpensive to program (~$5,000 per location)

**Challenges:**

Operating engineers need to experiment

- Identify the duration of temperature ramp down in each circulating hot water loop

- The shorter the duration, the higher the demand reduction. However, if it is too short, then steam demand may increase after the ramp down is completed
STEEMs at One Penn Plaza

- Between 33rd & 34th Street and 7th & 8th Avenue
- 2.6 million square feet
- 57 stories
- Completed in 1970
- Interior fans w/steam heating coils
- Perimeter fans w/steam heating coils serving induction units
- All fans have returns
- STEEMs testing performed during last 2 winters
One Penn Plaza – Normal Operation

Normal Operating Day - 01/27/06
STEEMs Using Constant Reset Result at One Penn Plaza

24°F Morning

- Normal Operating Day - 01/27/06
- STEEMs Day - 03/21/06
STEEMs Using Constant Reset Result at One Penn Plaza

Demand Charge Savings: $3,200/month

Reduced Demand by 3,800 lbs/hr

ON PEAK PERIOD

STEEMs Activated

Normal Operating Day - 01/27/06
STEEMs Day - 03/21/06
STEEMs
Using Dynamic Response
STEEMs Using Dynamic Response Result at One Penn Plaza

Demand Reduction = 6,500 lbs/hr

26°F Morning

Demand Charge Savings: $5,400/month

01/18/2007 On-Peak Demand= 22,234 lbs/hr
02/18/2005 On-Peak Demand= 28,718 lbs/hr
STEEMs Using Dynamic Response: Operating Steps by the BMS

1. Thermal Charging
   • Prior to 6:00 a.m. increase temperatures in all the circulating hot water loops to a design maximum temperature (no greater than 190°F)

2. Automatically calculate steam flow rate set point using outdoor air temperature at 5:30 a.m.

3. Starting at 6:00 a.m. modulate all the hot water temperature control valves in unison to maintain the steam flow set point
   • Once water temperature reaches the minimum temperature limit in any loop, disengage that loop from STEEMs operation
   • If water temperature reaches the maximum temperature limit in any loop, shut the valves in that loop until a minimum temperature is reached, then disengage that loop from STEEMs operation
STEEMs Using Dynamic Response
How Can You Predict the Steam Demand Set Point?

Outdoor Air Temperature at 5:30 AM

Average Steam Flow, lbs/hr (6AM-10AM)

- Non-Monday Weekdays
STEEMs Using Dynamic Response
How Can You Predict the Steam Demand Set Point?

\[ y = -523.82x + 37572 \]

Outdoor Air Temperature at 5:30 AM

Average Steam Flow, lbs/hr (6AM-10AM)

Non-Monday Weekdays
Linear (Non-Monday Weekdays)
STEEMs Using Dynamic Response
How Can You Predict the Steam Demand Set Point?

Outdoor Air Temperature at 5:30 AM

Average Steam Flow, lbs/hr (6AM-10AM)

y = -523.20x + 37572
y = -849.47x + 49708

Mondays
Non-Monday Weekdays
Linear (Non-Monday Weekdays)
Linear (Mondays)
STEEMs Using Dynamic Response
How Can You Predict the Steam Demand Set Point?

Average Steam Flow, lbs/hr (6AM-10AM)

Outdoor Air Temperature at 5:30 AM

- Linear (Non-Monday Weekdays)
- Linear (Mondays)

y = -523.92x + 37572
y = -849.47x + 49708

Mondays
Non-Monday Weekdays
STEEMs Using Dynamic Response
How Can You Predict the Steam Demand Set Point?

![Graph showing the relationship between outdoor air temperature and average steam flow.

- The graph includes two linear equations:
  - Monday's linear equation: $y = -523.92x + 37572$
  - Non-Monday Weekday's linear equation: $y = -849.47x + 49708$

- The graph highlights the average steam flow at 6AM-10AM with data points for Mondays and Non-Monday Weekdays.

- The graph indicates the operator specified offset with the value of 25,000 lbs/hr.

- The x-axis represents the outdoor air temperature at 5:30 AM, ranging from 0 to 35.

- The y-axis represents the average steam flow in lbs/hr, ranging from 0 to 50,000.
STEEMs Using Dynamic Response: Advantages and Challenges

**Advantages:**

- Higher demand reductions possible
- Less work by operating engineers required

**Challenges:**

- More complicated to program (estimated cost ~$10,000)
- Tuning the valves correctly is critical
STEEMs Using Dynamic Response
383 Madison Ave

Demand Charge Savings: $1,400/month

Demand Reduction = 1,800 lbs/hr

27°F Morning

Event Day: 01/11/2007  On-Peak Demand= 12,040 lbs/hr

Normal Operating Day: 02/01/2005  On-Peak Demand= 13,861 lbs/hr

STEEMs Activated

Demand Charge Savings: $1,400/month
Best Practices (Steam Usage Audits)

- Objective is to distribute “best practices” report to steam customers
- In process of auditing 30 select customers
- Initial set of recommendations will be posted on www.coned.com/steam by June, 2007
- Best Practices report for heating and cooling customers will be completed by December, 2007
STEAM Efficiency & Safety Tips

S - Shield pipes and valves from heat loss
T - Thermal energy recovery from condensate
E - Ensure vacuum at all times, if intended
A - Apply outdoor temperature reset
M - Maintain steam traps
Shield Pipes and Valves from Heat Loss (Insulate)

• Insufficient insulation causes excessive heat loss and condensate build-up that can result in pipe failure

• Valves and fittings have large surface areas from which heat escapes. Insulating them will provide energy savings and protection from burns

• Consider installing removable insulation jackets around valves and other components
Thermal Energy Recovery from Condensate

• The heat in condensate may be used to preheat domestic hot water before condensate is discharged into the sewer

• This reduces the amount of steam required to heat water and also the amount of city water required to dilute condensate before discharging it

• Depending on site conditions, paybacks for high-rise residential properties may be three years or less
Ensure Vacuum at All Times, If Intended

• If your steam system is designed to operate under vacuum, maintaining vacuum will ensure optimal operation

• Loss of vacuum may occur if:
  ▪ Steam traps are not maintained
  ▪Leaks in piping are present
  ▪Vacuum pumps are not working properly

• Each of these aspects should be remedied
Apply Outdoor Temperature Reset

- Some buildings that use circulating hot water for heating maintain constantly high water temperatures on cold and mild days
- Reduce circulating hot water temperatures on milder days and increase them on colder days
- If you are already resetting your water temperatures based on outdoor air temperature, consider shifting the reset schedule down for added energy savings
Maintain Steam Traps

- Periodically inspect your traps, especially any high-pressure traps, for proper operation.
- Traps that fail in a closed position may be a safety hazard as they may cause water hammer.
- Traps that fail in an open position let steam escape, thereby wasting energy.
- A Con Edison Steam customer with one failed-open high pressure trap with an equivalent 1/8" size orifice could experience a loss of approximately $1,500 per winter month.
## Summary

<table>
<thead>
<tr>
<th>Demand Reduction Technique</th>
<th>Is it Economically Feasible?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Your Load Factor is High</td>
</tr>
<tr>
<td></td>
<td>Your Load Factor is Low</td>
</tr>
<tr>
<td>Starting Up Fans Earlier</td>
<td>No</td>
</tr>
<tr>
<td>STEEMs</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Follow the STEAM Efficiency & Safety Tips**

**NOTE:** Load Factor for discussion purposes is defined as a ratio of cumulative consumption in a given month to the product of the on-peak demand and the number of hours that month.