Overhead Door Efficiency Project
At Armstrong International

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Objectives

• Analyze the cost associated with running the overhead door heaters on an annual basis.
• Analyze the air movement through the overhead doors in Plant 1 and Plant 2/3.
• Provide alternative solutions to help increase the efficiency of the overhead doors.
Basic Door Information

- **Plant 1**
  - 12’ Wide X 13’8” Tall
  - 40 second cycle time (Time needed to open and immediately close.)
  - 460,000 Btu Heater
    - 80% Efficient
- **Plant 2/3**
  - 12’ Wide X 12’ Tall
  - 30 second cycle time (Time needed to open and immediately close.)
  - 402,000 Btu Heater
    - 80% Efficient
Overhead Door Heater Cost

- Estimated cost per heating season with an average cycle time of 3.5 minutes, with 88 cycles per day for 120 days:
  - $4,048
- Estimated cost per heating season with an average cycle time of 1 minute, with 88 cycles per day for 120 days:
  - $1,110
- Possible door heater savings by door cycle time reduction:
  - $2,938
- Average open time of 1 minute represents a baseline best case scenario. The actual active heater and boiler time could be several minutes in length.
Boiler Estimated Cost

• Boiler cost for the 2009 heating season:
  – $66,893
    • Very close to an average door cycle time of 3.5 minutes for
      the 120 day heating season.

• Boiler cost based on a 1 minute average cycle time:
  – $18,520
    • Current value based on costs needed to run the boiler for
      a 120 day heating season.

• Savings possible through door cycle time reduction from 3.5 minutes to 1 minute:
  – $48,373
Heat Energy Lost

- Indoor temperature during heating season was assumed to be 75 degrees.
- The cutoff outdoor temperature for the heaters to run was assumed to be 55 degrees.
- Energy loss was calculated for an inside-outside temperature difference range of 20 degrees minimum to 75 degrees maximum with 45 degrees being the average.
## Heat Loss Through Door

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Unit 1</th>
<th>Value 2</th>
<th>Unit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Door 1 (A):</td>
<td>144</td>
<td>ft^2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of Door 2 (A):</td>
<td>162</td>
<td>ft^2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Heat of Air (Cp):</td>
<td>0.0288</td>
<td>BTU/lb-°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. Velocity (v):</td>
<td>5.87</td>
<td>ft/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ Temp (min):</td>
<td>20</td>
<td>°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ Temp(avg):</td>
<td>45</td>
<td>°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ Temp (max):</td>
<td>75</td>
<td>°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density of Air (ρ):</td>
<td>0.075</td>
<td>lb/ft³</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Q = v * A * Δ Temp * Cp*ρ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 1(min):</td>
<td>167974</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 1(max):</td>
<td>460102</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 1 (avg):</td>
<td>295780</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 2(min):</td>
<td>147890</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 2(max):</td>
<td>517615</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q loss door 2 (avg):</td>
<td>332752</td>
<td>BTU/hr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cost Based on Energy Required to Heat Incoming Air

• Costs were calculated based on a 3.5 minute cycle time.
• Door 1 loses an average of 295,780 BTU/hr for a cost per heating season of $1,111.43
• Door 2 loses an average of 332,753 BTU/hr for a cost per heating season of $1250.34.
Overhead Door Efficiency Solutions

• Driver Education
  – Signs to serve as reminders for the drivers.

• Overhead Door Modification
  – Changing how the doors work and the size of their opening.

• Magnetic Proximity Sensor System
  – Detects forklifts as they enter and exit a given zone, opening and closing the doors as necessary.

• Temperature Control Valve
  – Will limit the amount of energy used by the heaters based on the temperature outside.
Driver Education and Door Modification

• During our study, the drivers demonstrated the ability to keep door cycle times to 1 minute or less.
  – Education
  – Signs
  – Incentives

• Changing the height and speed at which the doors open can also bring simple and meaningful results.
  – Limiting the open height to 10’ would save 15 seconds between the two doors.
  – The total cost per heating season for a 3.5 minute cycles is $4,048.
  – Estimated savings of $289 annually for a 15 second reduction.
  – Changing out the gears would also help the doors open faster, lessening the time the heaters ran.
Proximity Sensor

- Door Loop Setup System: $714.00
- Construction Equipment: $100.00
- Labor & Other Materials: $300.00

- Total Estimated Cost: $1,114.00
  - Costs include hardware needed for the system as well as construction equipment and labor.

- Return on Investment: Approximately 4 Months.
Temperature Control Valve

• Hardware:
  – Valve: $1,500
  – Controller (Sensor): $1,000
  – Installation: $500
  – Total Cost: ~$3,000

• Estimated 37% reduction in energy use per heating season yielding $24,750 in savings per year.

• Return on Investment estimated to be approximately 2 months.
# Summary Of All Options

<table>
<thead>
<tr>
<th>Overhead Door Solution</th>
<th>Cost To Implement Given Solution (All costs are estimates.)</th>
<th>Savings</th>
<th>Return on Investment (ROI figures are all estimates.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Education/Door Modification</td>
<td>$1,000</td>
<td>$578 (Based on an average open door time reduction of 30 seconds.)</td>
<td>2 years (maximum)</td>
</tr>
<tr>
<td>Proximity Sensor</td>
<td>$1,114</td>
<td>$2,938</td>
<td>4 months</td>
</tr>
<tr>
<td>Temperature Control Valve</td>
<td>$3,000</td>
<td>$24,750</td>
<td>2 months</td>
</tr>
<tr>
<td>Proximity Sensor and Temperature Control Valve</td>
<td>$4,114</td>
<td>$28,493</td>
<td>2 months</td>
</tr>
<tr>
<td>Driver Education/Door Modification and Temperature Control Valve</td>
<td>$4,000</td>
<td>$25,328 (minimum)</td>
<td>2 months</td>
</tr>
</tbody>
</table>
Conclusions

• The overhead door heaters are consuming considerably less heat than the boilers are generating. This excess heat loss makes up for the bulk of the cost.

• During our time spent recording door cycles, we concluded that drivers can keep the doors open for less than 1 minute.

• Several low cost solutions are available that can decrease how long the doors are open. These solutions are generally able to repay themselves in less than 2 years and would begin to generate money for the company afterwards.
Thank You!

• Armstrong International
  – Greg Martin
  – Ed Kirchner
  – Jim Arjmand

• Western Michigan University
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  – Dr. David Meade
  – All other colleagues