Water and Liquid Nitrogen Conservation and Waste Reduction

TEL FSI, INC.

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University of Minnesota
Driven to Discover™

TEL FSI Supervisor: Mark Jones
Company Background

• TEL FSI is a Subsidiary of Tokyo Electron US Holdings (TEH)
• Located in Chaska, MN
• Manufactures Semiconductor and Surface Preparation Equipment
• Two Clean Rooms: Production and Process Lab
• Products: ORION, ZETA, ANTARES
Motivation for Change

• Tokyo Electron Ltd. (TEL) Corporate Environmental Goals
• TEL FSI Supports with Site-Wide Water and Waste Goals
• Financial Savings
Project Overview

1. Reduce Deionized (DI) Water Usage in Process Lab:
   - Find where water is sent to drain vs. reclaim
   - Recommend monitoring systems

2. Determine Liquid Nitrogen Usage Benchmarks and Reductions:
   - Determine benchmarks
   - Check for nitrogen gas leaks
   - Make recommendations for reductions
3. Optimize Recycling:
   • Determine waste stream composition
   • Reduce usage and recycle industry-specific items
   • Increase recycling percentage
Methods

• Water
  • Nomenclature system for valves
  • Quantify water usage per tool

• Liquid Nitrogen
  • Ultrasonic leak detection
  • Flow meter and pressure tests
  • Data logs from tools

• Waste
  • Conduct trash sort
  • Recommend and implement specialty recycling streams
Water Reduction
Benchmarks – Water

- Goal of Using Less Water than in Calendar Year 2015
- Process Lab Uses 75% of Total Water
- Water Sent to Bypass for Reclaim or drain for Sewage
- Tank Level Measurements
Water Findings – Tank Level

Idle Drain Volume of Process Lab DI Water

- **ORION 1**: 54%
- **ORION 2**: 24%
- **ZETA, MPD, MPC**: 18%
- **HVAC**: 4%
- **Magellan**: 0%
## Water Recommendation – ORION 1

1. Decommission ORION 1
   - Tool is not in use
   - Will save 40% of facility water
   - Additional savings in electricity and chemical usage

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Water Reduction (per year)</th>
<th>Implementation cost</th>
<th>Estimated net savings (per year)</th>
<th>Payback period</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Decommission ORION 1</td>
<td>40%</td>
<td>None</td>
<td>$75,000</td>
<td>Immediate</td>
<td>Implemented July 27th, 2016</td>
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</table>
Water Findings – Bucket Catches

Drain Rate Process Lab Tools

- **Tank Level**
- **Bucket Catches**

<table>
<thead>
<tr>
<th></th>
<th>HVAC</th>
<th>ORION 2</th>
<th>ZETA, MPD, MPC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100%</strong> Tank</td>
<td>0</td>
<td>36%</td>
<td>14%</td>
<td>33%</td>
</tr>
<tr>
<td><strong>Bucket Catches</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
Water Recommendation- Monitoring

2. Install Water Meters
   - Assist in future water reductions
   - Process Lab is dynamic

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<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Install Water Meters</td>
<td>Potential 23%</td>
<td>$15,000</td>
<td>$42,000</td>
<td>4 months</td>
<td>In Review</td>
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</table>
Liquid Nitrogen and Nitrogen Gas Reductions
Benchmarks - Liquid Nitrogen

• Delivered as Liquid Nitrogen (LN₂)
• Portion is Intentionally Converted to Nitrogen Gas (N₂)
• Goal of Using Less Nitrogen than in 2015
• Uses:
  • Product testing
  • Idle state for tools
  • Nitrogen blanket for reverse osmosis
## Nitrogen Recommendation – ORION 1

ORION 1 Uses $N_2$ in Wafer Testing and Idle State

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Nitrogen Reduction (per year)</th>
<th>Implementation cost</th>
<th>Net savings (per year)</th>
<th>Payback period</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>1. Decommission ORION 1</td>
<td>3%</td>
<td>None</td>
<td>$15,000</td>
<td>Immediate</td>
<td>Implemented July 27th, 2016</td>
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Nitrogen Findings – Ultrasonic Leak Detection

• Ultrasonic Leak Detection
• Traced Nitrogen, Argon, and Compressed Dry Air (CDA) Lines
• Leak Monitoring System Implemented in 2014
Nitrogen Recommendation – Gas Leaks

Ultrasonic Leak Detection
- Identified N$_2$, Argon, and CDA
- Most were small leaks
- Approximately 0.4 SCFM

<table>
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<th>Recommendation</th>
<th>Nitrogen Reduction (per year)</th>
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<th>Payback period</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Fix Leaks</td>
<td>1.5%</td>
<td>None</td>
<td>$6,600</td>
<td>Immediate</td>
<td>Partially Implemented</td>
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Recycling Optimization
Benchmarks – Waste

• TEL FSI Projected Recycle Rate of 75% for Calendar Year 2016
• TEL Corporate Goal of 97%
• Reuses and Recycles Shipping and Packaging items
• Recycles Industry-specific Items
Waste Findings

Trash Composition

- Trash: 44%
- Clean Room Garments: 12%
- Plastic Films: 13%
- Single Sort: 10%
- Organics: 19%
- Misc. Recycling: 2%
Waste Recommendation – Expand Recycling Streams

• Add Compost Stream
• Expand Plastic Films Recycling
  • Add to Process Lab
  • Education materials
• Utilize VWR Clean Room Garment Recycling Program
  • Accepts bouffants, shoe covers, beard covers
  • Turns into plastic resin
Waste Recommendation – Send Trash to Waste To Energy Facility

- Hennepin County Energy Recovery Center (HERC)
  - Incinerates trash to produce electricity and steam
  - Reduces landfill waste by 75%
  - Reduces global warming potential by 96%

- Would Require Switching Waste Hauler

Annual Global Warming Potential

<table>
<thead>
<tr>
<th></th>
<th>HERC</th>
<th>HERO</th>
<th>Landfill</th>
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<tbody>
<tr>
<td>Carbon Dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td></td>
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# Waste Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Waste Diverted or Repurposed (Tons/Year)</th>
<th>Proposed Recycling Rate</th>
<th>Net savings (per year)</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Implement Compost and Switch Recycling Hauler</td>
<td>4</td>
<td>79.4%</td>
<td>$240</td>
<td>Planned</td>
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<tr>
<td>Expand Plastic Films Recycling</td>
<td>3.2</td>
<td>78.2%</td>
<td>None</td>
<td>Partially Implemented</td>
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<tr>
<td>Recycle Clean Room Supplies through VWR</td>
<td>2.3</td>
<td>77.2%</td>
<td>-$1200</td>
<td>Planned</td>
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<tr>
<td>Switch Hauler to utilize Waste to Energy Facility (HERC)</td>
<td>12</td>
<td>92.8%</td>
<td>$5,100</td>
<td>Planned</td>
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<tr>
<td>Switch Paper Shredding Hauler</td>
<td>None</td>
<td>No Change</td>
<td>$620</td>
<td>Implemented</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>19.2</strong></td>
<td><strong>95.7%</strong></td>
<td><strong>$4,800</strong></td>
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## Summary of Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Reduction (per year)</th>
<th>Implementation Cost</th>
<th>Net savings (per year)</th>
<th>Status</th>
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<tbody>
<tr>
<td>Water Recommendations</td>
<td>63%</td>
<td>$15,000</td>
<td>$117,000</td>
<td>Implemented or In Review</td>
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<tr>
<td>Nitrogen Recommendations</td>
<td>4.3%</td>
<td>None</td>
<td>$21,600</td>
<td>Partially or Fully Implemented</td>
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<tr>
<td>Waste Recommendations</td>
<td>19.2 tons</td>
<td>None</td>
<td>$4,800</td>
<td>In Review or Being Implemented</td>
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<tr>
<td><strong>Total</strong></td>
<td>--</td>
<td>$15,000</td>
<td><strong>$168,000</strong></td>
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Personal Benefits

- Experience Working Within and Leading Teams
- Confidence in Working in a New Field
- Expanded Future Career Horizons
Questions?

Project was supported in part by the Minnesota Pollution Control Agency (MPCA) and the Metropolitan Council Environmental Services (MCES)