Long-term Sustainability in Thermal Drying Facility Operations Through Strategic Capital Improvements and Innovative Asset Management

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October 17, 2019
MWRA History & Background

- Massachusetts Water Resources Authority (MWRA) established in 1984
- MWRA assets are located in an area of more than 800 square miles, spanning from the Chicopee Valley to Boston Harbor
- Delivers an average of 200 MGD to its water customers
- Collects and treats an average of 350 MGD of wastewater, with a peak capacity of over 1,200 MGD

MWRA provides wholesale water and wastewater services to over 3.1 million people in 61 communities
History of MWRA/NEFCO Partnership

- 1982-1983, claims that the Massachusetts Clean Waters Act had been violated
- Biosolids drying project initiated as part of efforts to clean Boston Harbor
- 1986 – Daniel O'Connell's Sons (DOC) wins contract for Biosolids Pelletizing Facility (BPF)
  - NEFCO is created for the operation of the BPF
- 1991 – startup and operation of BPF begins
- Over 28+ years of BPF operations:
  - ~7 Billion Gallons of sludge received
  - ~800,000 dry tons of biosolids processed
Tighe & Bond History and Background

- Tighe & Bond support of NEFCO projects:
  - Quincy, MA MWRA (original) – 140 DTPD
  - Quincy, MA MWRA (upgrade) – 280 DTPD (rebuilt 4 original trains and added 2 more)
  - Cumberland, MD – 15 DTPD
  - Detroit, MI – 420 DTPD
  - West Palm Beach, FL – facility support and upgrades
  - Shakopee, MN – engineering assistance

- Additional Tighe & Bond thermal drying experience:
  - Nashville, TN – 137 DTPD
  - Ocean County, NJ – 50 DTPD
Quincy Biosolids Processing Facility (BPF)

**Liquid Sludge Overview**
- 4-5 days/week, 2 MGD of anaerobically digested sludge is pumped to NEFCO from MWRA's Deer Island Treatment Plant (DITP)
- 4 one-million-gallon concrete sludge storage tanks
- 12 dewatering centrifuges produce sludge cake of 25 to 30% solids

**Drying Process Overview**
- 6 dryer process trains, typically 3 operate at a time
- Each train permitted for 6,500 lb/hr of sludge (78 DTPD)
- 3 trains operating = 234 DTPD

**Dry Product Storage**
- 9 product storage silos onsite
- Each silo capable of storing 600 tons of product
- 99% of product shipped to customers, 1% is bagged by MWRA

**Breakdown of bulk product usage:**
- Land application for agricultural uses (55-70%)
- Fertilizer blending (30-35%)
- Alternative fuel (0-25%)
BPF Upgrade History

- Original Plant Design: four dryer trains, dewatering using belt filter presses
- Upgrades to the BPF over the previous contracts:
  - Belt filter presses replaced with centrifuges for dewatering
  - Two additional dryer trains added
  - Original dryers upgraded to include process air recirculation
  - Pipeline for pumping sludge constructed
  - Dryer drum for Train #2 replaced in 2012
Capital Improvement Projects at MWRA BPF

- Designed and managed by NEFCO and Tighe & Bond
- Based on budgeted Capital Improvements Plan developed by NEFCO and approved by MWRA
- Competitively bid in accordance with Mass. General Law Chapter 149
- Sometimes the old saying of “Don’t fix what’s not broken” is not the best approach!
- Being proactive and making selective and timely improvements is often most beneficial
Capital Improvement Projects at MWRA BPF

- Proactive – fix it before it breaks!
- Why be proactive? A few examples:
  - Safety
  - System reliability
  - Extend useful life of overall facility
  - Spare part/replacement availability
- Protect your investments!
  - Close to $0.5 Billion invested into BPF
  - CIP cost of $9.3 Million, <2% of overall investment
Capital Improvement Projects at MWRA BPF

- Strategic improvements selectively chosen between MWRA & NEFCO aimed at promoting long-term sustainable solutions
- Originally broken out into three separate contracts:
  - Painting, electrical, and mechanical improvements
- During design, dryer drum reliability and useful life of three of six trains became a concern
- Final design included two separate contracts:
  - Contract #1 – Painting ($650k)
  - Contract #2 – Electrical & mechanical improvements, replacement of three dryer drums, main fans and burner housings ($8.68 Million)
Capital Improvement Projects – Org Chart

MWRA

NEFCO

Tighe & Bond

Contract #1: Soep Painting Corp.

Contract #2: IPC Lydon (GC)

Wayne J. Griffin Electric, Inc.
Contract #1 – Painting
Scope: Silos – five (original) of nine silos onsite repainted
Contract #1 – Painting
Scope: Exterior of concrete sludge holding tanks and select interior office and entrance space
Contract #2 – Mechanical Improvements

- Currently in construction – 3 interim milestones with substantial completion in August 2020
- Dryer Drums: replaced remaining three original drums
- Burner and Main ID Fan Housings
  - Stainless Steel instead of Carbon Steel
- Screw Conveyors
  - Six vertical conveyors replaced
  - Three inclined conveyors replaced
Contract #2 – Mechanical Improvements (Continued)

- Additional Safety Upgrades
  - Replacement of aging nitrogen generator with new larger unit
  - Replacement of aging 50 HP air compressor with 100 HP unit
    - Helps meet facility air usage demand, allows dedicating existing 150 HP compressor to the new higher capacity nitrogen generator
  - Replacement of aging loading and un-loading dust collectors on product storage silos
- Replacement of aging 30-ton bridge crane hoist with travel limitations used for maintenance activities and dryer drum replacements
Contract #2 – Electrical Improvements

- Full replacement of MCCs for three trains, upgrades to two facility wide shared MCCs
- Communications Upgrade – Coax replaced with Fiber
- Programming Updates – SCADA
- PLC Upgrades – Silo thermocouple PLCs
- VFD upgrades on two of the four RTOs
Upgrade Outcomes

- Extended life of the plant
  - Silos: full exterior coating will help slow metal loss to corrosion extending useful life of silos
  - Concrete storage tanks: continued protection of concrete and improved aesthetics
  - Dryer Trains: replacement of critical, long lead time, and difficult to replace equipment
- Improved reliability for operations
- Safety improvements
Now that MWRA and NEFCO have further invested into the facility, how do we ensure continued successful operations?
NEFCO’s Asset Management Plans

- NEFCO is a steward of MWRA’s assets, proper asset management is critical
- High-level, coordinated plan developed for overseeing the asset management process
- Goal of delivering a desired standard of service in a way that combines multi-disciplinary management techniques
- NEFCO uses several guidelines for development of AMPs
  - WERF SIMPLE
  - Uptime® Elements™

• 1. Asset Registration
• 2. Asset Inventory Management
• 3. Asset Condition Assessment
• 4. Asset Failure Mode Analysis
• 5. Determination of Asset Residual Life
• 6. Determination of Asset Life Cycle & Replacement Costs
• 7. Determination of Levels of Service (LOS)
• 8. Determination of Business Risk (“Asset Criticality”)
• 9. Optimize O&M Investment in Assets
• 10. Optimize Capital Investment in Assets
• 11. Leverage eMaint® CMMS for Asset Management
Criticality Assessment

- Goal is to identify which equipment has greatest potential impact on operations
- Used to development maintenance & operations strategies, capital improvement plans, etc.
- Many factors considered in grading:
  - Safety
  - Environmental
  - Quality
  - Throughput
  - Operational Cost
- Drives further Asset Management activities:
  - Critical Spare Parts
  - Maintenance Optimization
  - Condition Monitoring
Condition Monitoring

- Goal is to make sure that the most critical equipment never has a major failure
- Traditional monitoring during routine operations and maintenance activities
- More advanced real-time monitoring can be a fantastic investment
Vibration Analysis

- Partnered with Augury Systems to look at real-time vibration monitoring and analysis on critical equipment
- Initially piloted at the MCES Final Stabilization Facility in Shakopee, MN
- Single drying train with no built-in redundancy, so availability and uptime are crucial for operations
Vibration Analysis – What do we see?

Figure 2: Pre-repair spectral data and the vibrations associated with the defect are clearly identified.
Vibration Analysis – What are we catching?

### BUSINESS CASE: WEST PALM BEACH, FLORIDA

<table>
<thead>
<tr>
<th>Repair Made</th>
<th>Machine Name</th>
<th>Cost of Repair</th>
<th>Cost Avoided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Align the shafts</td>
<td>Mixer Dryer Feed 101</td>
<td>$370</td>
<td>$35,000</td>
</tr>
<tr>
<td>Pressure wash fan blades</td>
<td>RTO Fan 2</td>
<td>$640</td>
<td>$40,000</td>
</tr>
<tr>
<td>Bearings replaced</td>
<td>Fan Main 01</td>
<td>$7500</td>
<td>$40,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$8,510</strong></td>
<td><strong>$115,000</strong></td>
</tr>
</tbody>
</table>

Augury Cost: $20,000
NEFCO WPB Savings: $115,000+
ROI: 303%

*IN LESS THAN 6 MONTHS*
Temperature Monitoring

- Key component of all plant operations
- Temperatures monitored at multiple points throughout the process using thermocouples
- For additional monitoring, plant managers are equipped with thermal imaging cameras
Temperature Monitoring – What do we see?
Temperature Monitoring – What are we catching?

Important maintenance items from both an operational and safety perspective:

- Wearing of ductwork and insulation
- Material buildup and bridging issues
- “Hot spots” in the process
Utilizing Computerized Maintenance Management Systems (CMMS)

- **Central Storage of Data**
  Gain visibility into maintenance activities to comply with regulatory standards & increase accountability

- **Work Order & Scheduling**
  Standardize processes, eliminate manual entry, manage materials usage, improve work completion rates

- **Extend Life of Assets**
  Track Maintenance Activities over the lifecycle of an asset, make informed repair vs replace decisions

- **Reduce Maintenance Costs**
  Reduce overtime hours, waste spoilage, equipment downtime, reduction in inventory
CMMS Diagram

**Assets**: What you want to track in the system

**Charges**: Track costs, both Labour and Parts, associated with a Work Order

**Work Orders**: Vehicle for recording activities performed

**Parts**: Your Inventory

**PMs**: Scheduled Preventative Maintenance

**Standard Tasks and Procedures**: Create a Library of Tasks to be assigned to your PMs or Work Orders

**Condition Monitoring**: Condition Monitoring to generate work orders

**Requests**: Users enter Requests for work

**Contacts**: Users, employees, supervisors, suppliers, vendors, etc.

**Report Writer**: Understand the data you’re collecting

**Purchase Orders**: Purchasing the Parts/Services needed
Maintenance Scheduling

- Look at maintenance from three perspectives:
  - Predictive
  - Preventative
  - Unplanned
- Increased availability of the facility when unplanned maintenance is reduced
- Reliability improves as Asset Management Plan shifts to predictive and preventative activities
Benefits of Flexibility in Scheduling

**Graph 1:**
- Title: System Load Graph
- Description: Graph showing load variation over time.

**Graph 2:**
- Title: Heat Temperature
- Description: Graph showing temperature variations over a period.

**Table:**
- Title: Weather
- Data:
  - **Day 2:** Sat 10/12
  - **Day 3:** Sun 10/13
  - **Day 4:** Mon 10/14
  - **Day 5:** Tue 10/15
  - **Day 6:** Wed 10/16
  - **Day 7:** Thu 10/17
  - **High Temperature - Boston:** 58, 65, 54, 62, 58
  - **Dew Point - Boston:** 40, 45, 53, 41, 53, 38
  - **High Temperature - Hartford:** 65, 65, 67, 52, 60, 54
  - **Dew Point - Hartford:** 40, 40, 48, 38, 53, 35

**Table:**
- Title: Generating Capacity Position
- Data:
  - **Total Capacity Supply (Obligation FC):** 31,704, 31,704, 31,704
  - **Anticipated Cold Weather Outages:** 0, 0, 0, 0, 0, 0
  - **Other Generation Outages:** 8,575, 8,521, 8,719, 8,996, 8,264, 8,700
  - **Anticipated No-Lost Load Offered:** 1,066, 1,066, 1,066, 1,066, 1,066
  - **Total Generation Available:** 23,085, 24,149, 24,149
  - **Imports at Time of Peak:** 1,865, 1,895, 3,625
  - **Total Available Generation and Imports:** 23,940, 25,044, 27,840
  - **Projected Peak Load:** 13,000, 13,250, 14,250
  - **Replacement Reserve Requirement:** 160, 160, 160
  - **Required Reserve:** 2,869, 2,869, 2,869
  - **Required Reserve Including Replacement:** 2,869, 2,869, 2,869
  - **Total Load Plus Required Reserve:** 15,963, 15,713, 16,713
  - **Projected Surplus or Deficiency:** 16,307, 13,331, 12,637
  - **Available Demand Response Resources:** 459, 409, 409

**Logos:**
- *NEFCO*
- *Tighe&Bond*
Impacts on Facility Sustainability

- Environmental & Financial
  - Reduce the need for investment in new infrastructure and equipment
  - Improve efficiency of operations

- Social
  - Improved safety for employees and community
  - Continue reliable operations with no nuisances to public
Innovative and proactive asset management, along with targeted capital improvements, will help ensure that the Biosolids Processing Facility in Quincy will continue to serve the MWRA for another 30 years!
Questions?