A Recipe For Success

Progressive Design-Build Restores Reliability to a Critical Pump Station

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Project Background

Procurement Approach

Pre-Construction Phase

Construction/Commissioning
Project Background
NEORSD Plants in Cleveland Area

- Easterly: 85/1,600 mgd
- Westerly: 70/1,800 mgd
- Southerly: 125/1,100 mgd
Southerly Wastewater Treatment Center
RAS Screw Pumps

Replace Pumps Nos. 2-7

Pump No. 1 Replaced in 2012 (but not drive unit)
Proposed new work included screw pumps, deflector plates, gear reducers, motors, soft starters, concrete walls, trough grout, bearing lubrication systems and support bases.

Demolition included existing screw pumps and deflector plates, gear reducers, motors, soft starters, bearing lubrication systems, trough grout and support bases.
Proposed new work included soft starters

Proposed new work included motors, gear reducers, couplings, support bases and lubrication systems
Proposed new work included motors, gear reducers, couplings, support bases and lubrication systems.

Proposed new work included raise divider walls.
Procurement Approach
Procurement Approach

- District historically used Design-Bid-Build approach
- Ohio law changed construction process in June 2011
- Equipment replacement lends itself to Design-Build
- Reliability concerns made schedule a critical element
  - Design-Build schedule was 22 months
  - Design-Bid-Build schedule was 30 months
Progressive Design-Build Approach

- Quals-based selection, single contract Design-Builder
- Design-Builder starts design
- Construction cost estimate ‘progressively’ developed in an ‘open book’ format
- Owner and Design-Builder mutually agree upon a Guaranteed Maximum Price (GMP) at about 60%
- Once GMP agreed upon, the Design-Builder proceeds to construction

Note: If no acceptable GMP is reached, Owner has option to bid out construction in the typical design-bid-build format
Features & Benefits

- Advantages
  - Single point of responsibility
  - Value based selections (vs. lowest price from bids)
  - Early budget confirmation and ongoing budget/scope management
  - Streamlined procurement and delivery

Result: On time, on budget with Value Added
Progressive Design-Build Project Cost Categories

Contract Amount/ Guaranteed Maximum Price (GMP $4.6M)

- General Allowance (GA) and Specific Allowance (SA)
- NEORSD/DB Agreed Cost of Construction Estimate
- Screw Pumps Lump Sum

As Proposed/Bid
- DB Fee% of Construction
- General Conditions Lump Sum
- Design & Preconstruction Lump Sum

Negotiated Contract Amount/GMP
- DB Fee% of Construction
- General Conditions Lump Sum
- Design & Preconstruction Lump Sum
## Proposed Project Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>August 8, 2012</td>
<td>Issued RFP</td>
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<tr>
<td>September 6, 2012</td>
<td>Proposals due</td>
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<tr>
<td>September 21, 2012</td>
<td>Notification to selected Design-Builder</td>
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<tr>
<td>October 19, 2012</td>
<td>Notice to Proceed for pre-construction period</td>
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<tr>
<td>June 1, 2014</td>
<td>Construction complete</td>
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</tbody>
</table>

Total Project Budget Is $4.785M
Proposal Selection Criteria

- Delivery (25%)
- Qualifications (20%)
- Technical Approach (45%)

Presentation and Interview (10% if required)
Proposal Selection and Award

- Two Design-Build proposals submitted
- Kokosing/HDR team selected as best value
- Kokosing/HDR Pricing Information:
  - $456,000-Design and Pre-construction Services
  - $260,000-General Conditions
  - 6.5% fee on cost of work
  - 12% Business Opportunity Participation
03 Pre-construction Phase
Pre-Construction Team

HDR Design Management, Mechanical, Process, Structural

Kokosing Construction Company, Inc. Constructability, Cost Development

SIGMA Electrical and I/C

Rii Hazardous Materials and Existing Conditions Survey

Mechanical Solutions, Inc. Vibration Analysis
Developing the Best Solution Requires Collaboration

Multiple Perspectives Are Critical
Screw Pumping System
MSI Mobilized to Perform the Vibration/Mechanical Analysis Quickly

**Goal:** Understanding root cause of gear box failures

**Steps:**

1. **Background review**
2. **Equipment setup & calibration**
3. **Torque & axial thrust measurement**
4. **Testing**
5. **Analysis & reporting**

- Gearbox & foundation flexibility
- Radial Proximity Probes
- Impact
- Operating Deflection Shape
Comprehensive Workshops Were Held with 5 Manufacturers

▪ Vendors briefed on current issues

▪ Vendors presented
  o Company history
  o Product overview
  o Differentiators - Unique equipment features
  o Recommendations for this facility, based on their industry experience

Primary benefit of workshops – O&M stakeholders engagement and input at ALL WORKSHOPS
Key Technical Issues Discussed at Workshops

- Gear box design
- Drive configuration (belt vs. direct)
- Soft start vs. VFDs
- Screw flight/torque tube design
- Liner, stainless steel vs. grouted
- Bearing type
- System startup/operation
- Coatings
Workshops Provided the Foundation for Solid Decision Making

- Gear box service factor – Use 2.4
- Improved operating efficiencies
- Variable frequency drives (value added)
  - Energy savings
  - Improved process control
  - Lower starring impact loads
  - But, must consider:
    - Upsizing for constant torque
    - Gear box lube across speed range
Workshops Also Allowed Us to be Confident in the Selection of Trough Liners

- Stainless steel trough liners offer many benefits
- Closer tolerances than grout
  - Higher operating efficiency
- Allows faster installation
  - Lower construction cost
  - Shorter construction schedule
- Longer service life than grout

Screw pump liner use is much more prevalent in Europe than U.S.
### Completed Design for GMP Development

<table>
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<tr>
<th>ACTIVITY</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
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<tbody>
<tr>
<td>Notice to Proceed</td>
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<tr>
<td>Mechanical Solutions Testing</td>
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<td>Workshops with Pump Manufacturers</td>
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<tr>
<td>Develop Pumping System Procurement Package</td>
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<td>Equipment 'Bid' Period</td>
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<td>Select/Release Pumping Equipment</td>
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<td>Submit 60% Design</td>
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<td>Finalize GMP</td>
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Selected vendor equipment data was incorporated into 3D model.

- **9 Weeks**
- **12.5 Weeks**
- **15 Weeks**
3D Enabled Design to be Completed in 3 Months
Benefits of Progressive Design-Build During Design Phase

- Owner input to 60%, when GMP is developed
  - Workshops critical for O&M engagement
- Compressed design/construction schedule
- Ongoing constructability reviews
- Regular cost updates – budget confidence
- Allows added value opportunity identification

In addition, annual energy savings of $55,000/year are expected
Construction/Commissioning
Construction Work

- Project constraints to work activities
  - Limited access to forebays (prior to value added improvements)
  - Single screw replacement at one time
  - Maintain flow rates to meet plant demands even during high flow events
  - By-pass pumping contingency plan
Construction Work/Process

Prior to screw pump replacement, forebay access work

Safe removal of Existing Equipment
Construction Work/Process

Removal of Existing Screw Auger (approximately 26,000 lbs.)
Construction Work/Process

Screw Replace: Installation of new 96” Screw auger and stainless steel trough (250 ton Grove screw auger assembly approximately 34,000 lbs)
Construction Work/Process

Screw replace:
Installation of new screw auger and stainless steel trough
Construction Work/Process

Installation of new upper bearing assembly

Installation of new motor and gear box
Construction Work/Process

- Installation of new motor and gear box pedestal
- Installation of new motor base with lower bearing grease pump
Construction Work/Process

Installation of new VFD Drives

Installation of new gate actuators, setting gate limits
Lessons Learned

- Communication is key
- Collaborative effort
- Value added design cost
- Effects on operation
Lesson Learned: Communication is Key

- Always communicate every change in the design
- Be sure each group acknowledges the change
- Verify that any field changes can be made amendable to the given field conditions
Lesson Learned: Collaborative Effort

- Have the right “Decisions Makers” at the table
- Keep the dialog open and on topic to resolve the issue
- Be sure each side understands what level of detail is expected at the 60% review and the acceptance of GMP for construction
Lesson Learned: Value Added Design Cost

- Through the valued added items, it was noted that several of the items would require additional cost to the design portion of the project budget.

- Given the dynamic environment of the Design-Build process, it was noted that the Owner would be wise to include a value added design budget as well as a construction contingency for all future projects.
Lesson Learned: Effects on Operations

- Overall improved reliability
- More efficient system
- Less need for personnel during operations
Design-Build Benefits

**Sound and timely decision making...**

**leads to a Value Added Project**

Example: Added safety measures in forebays for staff, VFD drives improved efficiency and finally updating existing PLC control with flow pace
Design-Build Benefits

- Working as a cohesive group. . .Designer, Builder & Owner. . .shorten project delivery time through ongoing engineering reviews.
  - Example: Initial Construction Phase schedule will be shortened by as much as four (4) weeks from start of the project.
Design-Build Conclusion

Would we do it again...Yes

- “Design-build is working and giving the Operations and Maintenance Staff a more reliable second stage pumping system every day.”

Brian Flanagan
Southerly Plant Operations
Unit Process Manager
Questions

Other contributing team members:

- Gary Hoffman
- Tom Vasel
- George Schur
- Kevin Zebrowski
- Patricia Martinak
- Paul Crum
- Larry Shimerka
- Brian Flanagan
- Brian Anielski

- Kim Kennedy
- Mike Paine
- Dino Angelopoulos
- John Awezec
- Mike Roble

- Dennis Tinkler
- Adam Pooch
- Dave Hays