O&M Project Engagement…Getting Involved!

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Gone but not forgotten…

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Mar. 8th, 2018
Table of Contents

• Terms/ Language
• O&M Engagement
  – Planning
  – Design Review
  – Construction
  • Commissioning
Objectives

• Goal:
  ➢ To expose water and wastewater plant operators to terms used by engineers when planning and designing projects
  ➢ To look at the different phases of a project and what your role will be in each phase
  ➢ Other goal - try to have some fun while sitting through this

• Reasons:
  ➢ To explain why Operations and Maintenance staff need to be involved in Project Engagement
  ➢ You may hear these terms and not understand them. These terms are not typically taught as part of a certification curriculum.
Terms

Deliverables
• Feasibility Study
• Pre-Design
• 30% Design
• 60% Design
• 90% Design
• Final Design
• Conformed Drawings
• Record Drawings

Components
• Legends
• Plan
• Section
• Detail
• Flow diagram
• P&ID
• 3-D
Feasibility Studies

• A process for determining the viability of a proposed project and providing a framework and direction for its development and delivery
Pre-design

• The phase where decisions are made for:
  – Process layouts
  – Equipment types
  – Control strategies

• Your opportunity to help guide the end product
Design - 30%, 60%, 90%

- As the design work progresses, it is presented in stages. The project costs are refined as the phases/milestones are met.
Final Design

• The 100% set of drawings and specifications

Bid Set

• The product from which the contractors develop their costs, bids and schedules

Conformed drawings

• Includes both plans and specifications and incorporated any addenda through the bid process. It is what the contractor uses to build the job.

Record drawings

• The set that reflects the finished project – may also be called “as-builts”

Comprehensive designs and drawings usually mean better results
Design Documents
Civil legends

Explains the abbreviations and symbols for civil disciplines – focused drawings only
Electrical legends

Explain the abbreviations and symbols for electrical – focused drawings only
Instrument and Control legends

Explains the abbreviations, loop, and tag nomenclature for instrumentation and control focused drawings only
Hydraulic grade line

Displays the water surface and structural elevations as it flows through the process in a section view.
So...what are we building?
Mechanical Demolition

Make sure something required for daily operation – perhaps in another part of the plant – is not being demolished
Electrical demolition

Make sure the power or control circuits being disconnected is not fed to another part of the plant.
Plan

Plan is an overhead view
Section is a side view
A section line indicated where a side view has been developed. The bubble on the section line shows the drawing number and location on the drawing.
Details

TYP means Typical
Feedback may include where to relocate fittings (valves, hose bibs, drains) and access points so you can work with the system
Putting it all together
A process flow diagram (PFD) displays the relationship between major equipment of a plant facility and does not show minor details such as piping details and designations.
A piping and instrumentation diagram (P&ID) shows the interconnection of process equipment and the instrumentation used to control the process.

A standard set of symbols is used and are generally based on *Instrumentation, Systems, and Automation Society (ISA)* Standard S5. 1
3-D – the future is here

Most engineering firms can provide this type of drawing, but the service may come at a premium.

Allows for better visualization
3-D examples

Access and layouts are much clearer
Operations and Maintenance Engagement
O&M Engagement

- Planning
- Design Review
- Construction
  - Commissioning
O&M Engagement: Planning

What is involved in planning and why is it important for O&M to be involved?

- **Master Plan**: A comprehensive or far-reaching plan of action… *Plan term may be for up to 10-30 years in duration*
- It’s important because it will affect things you do every day
- *Usually updated every five years*
- *To provide direction or guidance for the community…Studies may be recommended to reinforce the recommendations*
Planning: Feasibility Study

• Typically done prior to any design work
• Decisions are made for what technology and equipment will be used
• Your chance to learn what is good and bad with your options
• Ideally, you investigate – through site visits or your own initiative – what some of the options are so you can talk through them
O&M Engagement

- Planning
- Design Review
- Construction
  - Commissioning
O&M Engagement: Design Review

• At 30%, the general layout is presented...Still time for “bigger” changes... Don’t be afraid to speak up - what shows on paper may not be what you thought was discussed in the pre-design. Construction Specifications also are reviewed... Pay attention, this review is very important for you!!

• At 60%, the general layout is locked down and the support features – power, piping, HVAC – are penciled in... Still time for adjustments but the window is closing rapidly

• At 90%, the design is locked in, any changes come with an expensive re-work cost
Design: Why is it important for O&M to be involved?

WHAT WERE THEY THINKING?

Finished water piping to the Finished Water Pumps... how do I isolate the pump???
Design oversight examples

How accurate do you think this flow meter is?

Other examples:

- Missed valves and flush connections
- Equipment access
- Sampling considerations
- Equipment and materials handling
Design oversight examples

Is the valve open or closed? How can it be accessed if it needs repair?

No flush ports, floor drains, containment, or high volume water designed in.
Design oversight examples

Pressures gages are installed backwards from inspection landing (and the pipe nipples are too short to see the gage)
O&M Engagement

- Planning
- Design Review
- Construction
  - Commissioning
### Specification categories

<table>
<thead>
<tr>
<th>+PROCUREMENT &amp; CONTRACTING REQUIREMENTS GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Division 00 – Procurement and Contracting Requirements *</td>
</tr>
<tr>
<td><em>Introductory Information</em></td>
</tr>
<tr>
<td><em>Procurement Requirements</em></td>
</tr>
<tr>
<td><em>Contracting Requirements</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-SPECIFICATIONS GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Division 01 – General Requirements</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-FACILITY CONSTRUCTION SUBGROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Division 02 – Existing Conditions</em></td>
</tr>
<tr>
<td><em>Division 03 – Concrete</em></td>
</tr>
<tr>
<td><em>Division 04 – Masonry</em></td>
</tr>
<tr>
<td><em>Division 05 – Metals</em></td>
</tr>
<tr>
<td><em>Division 06 – Wood, Plastics, and Composites</em></td>
</tr>
<tr>
<td><em>Division 07 – Thermal and Moisture Protection</em></td>
</tr>
<tr>
<td><em>Division 08 – Openings</em></td>
</tr>
<tr>
<td><em>Division 09 – Finishes</em></td>
</tr>
<tr>
<td><em>Division 10 – Specialties</em></td>
</tr>
<tr>
<td><em>Division 11 – Equipment</em></td>
</tr>
<tr>
<td><em>Division 12 – Furnishings</em></td>
</tr>
<tr>
<td><em>Division 13 – Special Construction</em></td>
</tr>
<tr>
<td><em>Division 14 – Conveying Equipment</em></td>
</tr>
<tr>
<td>- Division 15 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 16 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 17 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 18 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 19 – Reserved for Future Expansion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-FACILITY SERVICES SUBGROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Division 20 – Reserved for Future Expansion</em></td>
</tr>
<tr>
<td><em>Division 21 – Fire Suppression</em></td>
</tr>
<tr>
<td><em>Division 22 – Plumbing</em></td>
</tr>
<tr>
<td><em>Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)</em></td>
</tr>
<tr>
<td>- Division 24 – Reserved for Future Expansion</td>
</tr>
<tr>
<td><em>Division 25 – Integrated Automation</em></td>
</tr>
<tr>
<td><em>Division 26 – Electrical</em></td>
</tr>
<tr>
<td><em>Division 27 – Communications</em></td>
</tr>
<tr>
<td><em>Division 28 – Electronic Safety and Security</em></td>
</tr>
<tr>
<td>- Division 29 – Reserved for Future Expansion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-SITE AND INFRASTRUCTURE SUBGROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Division 30 – Reserved for Future Expansion</em></td>
</tr>
<tr>
<td><em>Division 31 – Earthwork</em></td>
</tr>
<tr>
<td><em>Division 32 – Exterior Improvements</em></td>
</tr>
<tr>
<td><em>Division 33 – Utilities</em></td>
</tr>
<tr>
<td><em>Division 34 – Transportation</em></td>
</tr>
<tr>
<td><em>Division 35 – Waterway and Marine Construction</em></td>
</tr>
<tr>
<td>- Division 36 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 37 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 38 – Reserved for Future Expansion</td>
</tr>
<tr>
<td>- Division 39 – Reserved for Future Expansion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-PROCESS EQUIPMENT SUBGROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Division 40 – Process Integration</em></td>
</tr>
<tr>
<td><em>Division 41 – Material Processing and Handling Equipment</em></td>
</tr>
<tr>
<td><em>Division 42 – Process Heating, Cooling, and Drying Equipment</em></td>
</tr>
<tr>
<td><em>Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment</em></td>
</tr>
<tr>
<td><em>Division 44 – Pollution and Waste Control Equipment</em></td>
</tr>
<tr>
<td><em>Division 45 – Industry-Specific Manufacturing Equipment</em></td>
</tr>
<tr>
<td>Division 46 – Water and Wastewater Equipment</td>
</tr>
<tr>
<td>- Division 47 – Reserved for Future Expansion</td>
</tr>
<tr>
<td><em>Division 48 – Electrical Power Generation</em></td>
</tr>
<tr>
<td>- Division 49 – Reserved for Future Expansion</td>
</tr>
</tbody>
</table>

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Each Division holds many sub-categories.

Let’s discuss three sections within Division 1 that can really affect O&M staff and facility operation.
O&M Engagement: Construction

- Specifications are used to help with construction activities, and they are legal documents!
  - 01_14_00 WORK SEQUENCE AND RESTRICTIONS
  - 01_78_23 OPERATION AND MAINTENANCE DATA
  - 01_91_14 TESTING, TRAINING, AND FACILITY START-UP
- Why is this important…Because you know more about your facility than anyone else
Construction Specifications

• 01_14_00 WORK SEQUENCE AND RESTRICTIONS

Requirements for sequencing and scheduling construction activities affecting the existing site and facility, work restrictions and coordination between construction staff and operations and maintenance (O&M) staff.
Div 1 - Section 01_14_00 – Work Sequence and Restrictions

1.02 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

A. Wastewater Facility Conditions:
1. The Robert W. Hite Treatment Facility is the Metro Wastewater Reclamation District's member agencies only means of treating domestic and industrial wastewater prior to discharging to the South Platte River. Impairing the operational capabilities of this treatment plant will result in serious environmental damage and monetary fines as indicated in Paragraph 1.04.C.
2. CONTRACTOR shall conduct work in a manner that will not impair the operational capabilities of essential unit treatment processes or reduce the capacity of the entire treatment plant below levels sufficient to treat the raw wastewater to the effluent quality limitations specified in the discharge permit.
3. The Work requires that essential unit process elements of the facility be removed from service for modifications, tie-ins, start-up, and testing. Removal of essential elements results in alteration of plant services and process performance and flexibility features. These impacts are anticipated to be tolerable when the stipulated sequences and constraints are used as a guideline for completion of Work. All sequences and constraints indicated herein, as well as other sequences and constraints necessary to maintain the treatment plant operational, as defined, should be properly incorporated into the CONTRACTOR's work plans and schedules.
4. The status of the treatment plant shall be defined as "operational" when the essential elements are returned to normal operating conditions.
5. Stipulated sequences and constraints will extend the CONTRACTOR's construction schedule and add complexity to the Work.

1.04 COMPLIANCE WITH NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

A. The existing facility is operating under the terms of a National Pollutant Discharge Elimination System permit issued by the Colorado Department of Public Health and Environment. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent. A copy of the existing permit is on file for review at the Metro Wastewater Reclamation District.

1.06 OPERATIONS AND MAINTENANCE ACCESS

A. Provide safe, continuous access to process, mechanical, electrical, and control equipment for plant OWNER.

B. CONTRACTOR shall be aware that work within an operating treatment plant involves potential exposure to and spills of raw wastewater, bio-active sludge, digested sludge, sludge cake, dust, chemicals, and other associated wastewater process units. Adequate precautions to maintain clean and safe working areas for CONTRACTOR and OWNER are required.
If you delay the Contractor because a constraint was not defined, it will cost you even more money.
Div 1 Section 01_73_23 Operation and Maintenance Data
1. SUMMARY

A. Section includes: Preparation and submittal of paper and electronic operation and maintenance manuals. Operation and maintenance information shall be provided for each piece of equipment, equipment assembly, or subassembly and material provided or modified under this contract.

B. Section includes: Providing information for all new assets provided under this contract to populate the RWF computerized maintenance management system (CMMS) in accordance with Standard Operating Procedure (SOP) AM.100, Asset Tagging Convention. The asset information shall be furnished electronically in editable document format (e.g., Microsoft Word document or Excel workbook) on a CD or DVD. Asset information files shall contain the attribute columns that are attached at the end of this Specification.

C. Related sections:
   1. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01 78 23.01 – Closeout Submittals
      b. Section 01 78 23.02 – Equipment Summary Form (Sample)
      c. Section 01 78 23.03 – Equipment Warranty Summary (Sample)

Be careful of what you ask for…
Maintenance Data

1. SUBMITTALS

A. Submit four (4) printed bound copies, and one (1) electronic copy of the draft operation and maintenance manuals and asset information files to ENGINEER for review and acceptance. Draft operation and maintenance manuals shall be submitted to the ENGINEER prior to shipment of equipment to the site. The manuals must be accepted by the ENGINEER before field quality control testing and before training of each piece of equipment or system may start.

B. Revise and resubmit draft manuals and asset information files, as required, for each piece of equipment or system. The final manual and asset information files shall be accepted by the ENGINEER at least 60 calendar days before starting to train the FACILITY’s personnel on each piece of equipment or system. Submit five (5) printed bound copies and five (5) electronic copies on CD or DVD of the final accepted manuals and asset information files within 30 calendar days of acceptance of equipment or systems. Final manuals shall include all previous submittal information pertinent to the operation and maintenance manuals and asset information files, all source quality control testing data, field quality control test results, startup reports, training materials, and detailed course outlines that could not be included prior to start-up, testing, and training. Shipment of equipment will not be considered complete until all required manuals and equipment data has been received.
O&M Engagement

- Planning
- Design Review
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  - Commissioning
### PART 1  GENERAL

#### 1.01  SUMMARY

**A.** Section includes: Requirements for equipment and system testing and facility start-up, including the following:

2. Start-up Plan.
5. Functional Testing.
6. Pre-operational Testing
8. Operational Testing
10. Certificate of Proper Installation
11. Training of OWNER’s Personnel.
12. Valve and Gate Identification.
13. Record Keeping.

**B.** Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 01140 - Work Restrictions.
   b. Section 01324 - Progress Schedules and Reports.
   c. Section 03936 - Water Leakage Test for Concrete Structures.
   d. Section 13950 - Testing, Calibration, and Commissioning.
   e. Section 15050 - Basic Mechanical Materials and Methods.
   f. Section 15954 - HVAC Systems Testing, Adjusting and Balancing.
   g. Section 15958 - Mechanical Equipment Testing.
   h. Section 16950 - Field Electrical Acceptance Tests.

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Being comprehensive saves work in the end.
O&M Engagement: Commissioning

- Construction commissioning is the process in which responsibility and ownership of a constructed asset is transferred from the contractor to the owner.
- Commissioning follows a specific process:
  - Factory Acceptance Testing (FAT)
  - Pre-testing
  - Function Testing
    - Training
  - Performance Testing
Commissioning: Factory Acceptance Testing (FAT)

• Factory Performance Testing (Source Quality Control and/or Factory Acceptance Testing): Tests as described in individual Specification sections, which refers to testing performed on specified equipment at manufacturer’s facility prior to shipment
Commissioning: Pre-Testing

- Tasks that the contractor shall complete as pre-requisites to Functional Testing
- Equipment
  - Calibrate testing equipment
  - Inspect and clean equipment, devices, connected piping, and structures
  - Check equipment for soundness
  - Remove rust preventative
  - Inspect bearings
  - Adjust clearances and torque
  - Flush lubrication systems
  - Flush fuel system
  - Remove temporary supports, bracing, or other foreign objects
  - Check rotating machinery for correct direction of rotation
  - Perform cold alignment and hot alignment to manufacturer’s tolerances
  - Adjust V-belt tension and variable pitch sheaves
  - Inspect hand and motorized valves for proper adjustment
  - Test piping for leaks
  - Install gratings, safety chains, handrails, and shaft guards
Commissioning: Pre-Testing

• Electrical Systems
  – Perform insulation resistance tests on wiring
  – Perform continuity tests on grounding systems
  – Test and set switchgear and circuit breaker relays
  – Perform direct current (DC) high potential tests on all cables that will operate at more than 2,000 volts
  – Test electrical equipment to assure that meter readings
  – Check motors for actual full load amperage draw
  – Verify drive rotation, equipment speed, control sequence, and other conditions are correct

• Instrumentation Systems
  – Bench or field calibrate instruments and make required adjustments
  – Leak test pneumatic controls and instrument air piping
  – Energize transmitting and control signal systems, verify proper operation, ranges and settings
  – Confirm monitoring, interlocks and manual control are operational
  – Test to assure that controls are operational in automatic and manual modes
  – Confirm that all programming and setup and installation of Process Control Systems are complete
  – Confirm that the wiring and support systems for equipment have been inspected and are completely operational

• HVAC systems
  – Perform testing of heating, ventilating, and air conditioning (HVAC) equipment
  – Test hydronic systems
Commissioning: Functional Testing

- Functional testing performed by the CONTRACTOR shall simulate the actual operating conditions, using clean water
- The Contractor shall be required to operate system for three – seven days
- The Contractor shall functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper connection and operation
- The Contractor shall demonstrate to the Engineer proper rotation, alignment, speed, flow, pressure, vibration, sound (noise) level, adjustments, thrust restraint, and calibration
- The Contractor shall demonstrate to the Engineer proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions
- At the conclusion of the planned testing, the Contractor shall prepare a written report on the system and equipment tested, certifying products have been properly installed and lubricated, are in accurate alignment, are free from undue stress
For effective training, define the objectives and constraints
Div 1 - 01_91_14 – Training Portion

strategies such as planned whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies shall be detailed in the lesson plan document.

c. Handouts for training shall be attached to the lesson plans, cross-referenced by section or topic in the lesson plan.

d. The CONTRACTOR shall indicate the duration of each segment of the training lesson plans, as spelled out in outline.

7. The outline of the Maintenance Instruction lesson plans shall include the following, as applicable by craft:

a. Equipment operation: All crafts:
   1) Describe equipment's operating (process) function and system theory.
   2) Describe equipment's fundamental operating principles and dynamics.
   3) Identify equipment's mechanical, electrical, and electronic components and features.
   4) Identify all support equipment associated with the operation of subject equipment.
   5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process related to this project.
   6) Cite all hazards associated with the operations, exposure to chemicals associated with the component, or the way it is handled by the component.
   7) Specify the appropriate and safety precautions, equipment procedures to eliminate, reduce, or overcome these hazards.

b. Detailed component description: Specific for Mechanical, Electrical, Instrumentation, and Electrical:
   1) Describe Preventative Maintenance (PM) inspection required to perform an inspection of the equipment in potential trouble symptoms (anticipate breakdowns), maintenance requirements (predictive maintenance).
   2) Identify and describe in detail each component function.
   3) Where applicable, group relative components into sub-assemblies.
   4) Identify and describe in detail equipment safety features and controls interlocks.
   5) Review preventative maintenance frequency and tasks.
   6) Detail procedure to perform each PM activity performed less frequently.

c. Equipment troubleshooting: Specific for Mechanical, HVAC, Instrumentation, and Electrical:
   1) Define recommended systematic troubleshooting procedures that relate to specific craft problems.
   2) Provide component specific troubleshooting checklists, and their relationship to specific craft problems.

d. Equipment Corrective Maintenance (CM): Specific for Mechanical, HVAC, Instrumentation, and Electrical:
   1) Describe recommended equipment preparation requirements as they relate to specific craft problems.
   2) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.

3) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.

4) Perform at least two "hands-on" demonstrations of common creative maintenance repairs. Additional demonstrations may be required by the OWNER.

5) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

6) Describe recommended procedures to check/test equipment following a corrective maintenance repair.

8. "Hands-on" instruction shall be conducted according to the following descriptions.

   a. Course instructor shall present "hands-on" demonstrations of common corrective maintenance repairs for each group. The manufacturer shall provide the tools and equipment to conduct the demonstrations. Requests for supplemental assistance and facilities should be submitted with the CONTRACTOR's proposed lesson plans. Each trainee will demonstrate acquisition to the satisfaction of the instructor.

   b. "Hands-on" training situations where the OWNER's operations maintenance personnel will participate in disassembly or assembly of equipment, CONTRACTOR shall be responsible for such disassembly or assembly and, on completion of all "hands-on" training, shall provide certification of proper equipment operation to ENGINEER. Each trainee will demonstrate skills to the satisfaction of the instructor.

   c. "Hands-on" training of operations personnel will cover proper start-up, shut-down, and normal and alternative operating strategies. Each trainee will demonstrate skill acquisition to the satisfaction of the instructor.

   d. Each training session, distribute class evaluation documents by OWNER (Attachment 2) to determine overall effectiveness of the Return evaluation sheets to OWNER's Training Specialist when completed.

   e. Determinations judged "Unsatisfactory" by a majority of attendees shall be re-taught and conducted again until a satisfactory rating is achieved.

   f. At conclusion of training, submit electronically and three (3) hard copies of the final lesson plan, overhead transparencies, and handouts, plus two (2) copies of all other audio-visual aids utilized during each training course.

   g. Material shall be submitted as one final record submittal within 14 calendar days of training and submitted as a single transmittal for the record.
If you make the choice to not be involved, and something does not go the way you expected...