NAVIGATING SCADA FROM DESIGN TO STARTUP

CASE STUDY OF THE METROPOLITAN DISTRICT WET WEATHER EXPANSION PROJECT SCADA IMPLEMENTATION

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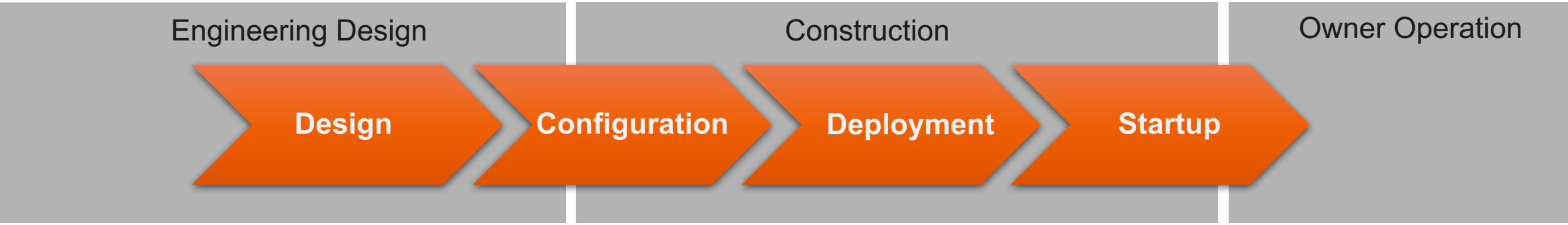
SCADA Continuum

Life-cycle of project process control system/SCADA implementation

Plant management	Design Engineer	Electricians	Construction management
Operation supervisors	Multiple Consultants	Vendor system integrators	Startup managers
Shift operators	Site liaisons	Mechanical installers	Field inspectors



Planning for successful startup begins during design.

Agenda

1. Overview of Project
2. SCADA Design Standardization
3. SCADA Configuration & Deployment
4. SCADA Startup and Commissioning
5. Conclusions

Project Overview

Hartford Water Pollution Control Facility

Wet Weather Expansion Project - Overview

Contract 20

Preliminary Treatment

- Coarse and fine screens
- 210 mgd Influent pump station
- Screenings handling facilities
- Grit dewatering facilities
- Septage receiving station
- Biofilters for odor control
- Standby generators

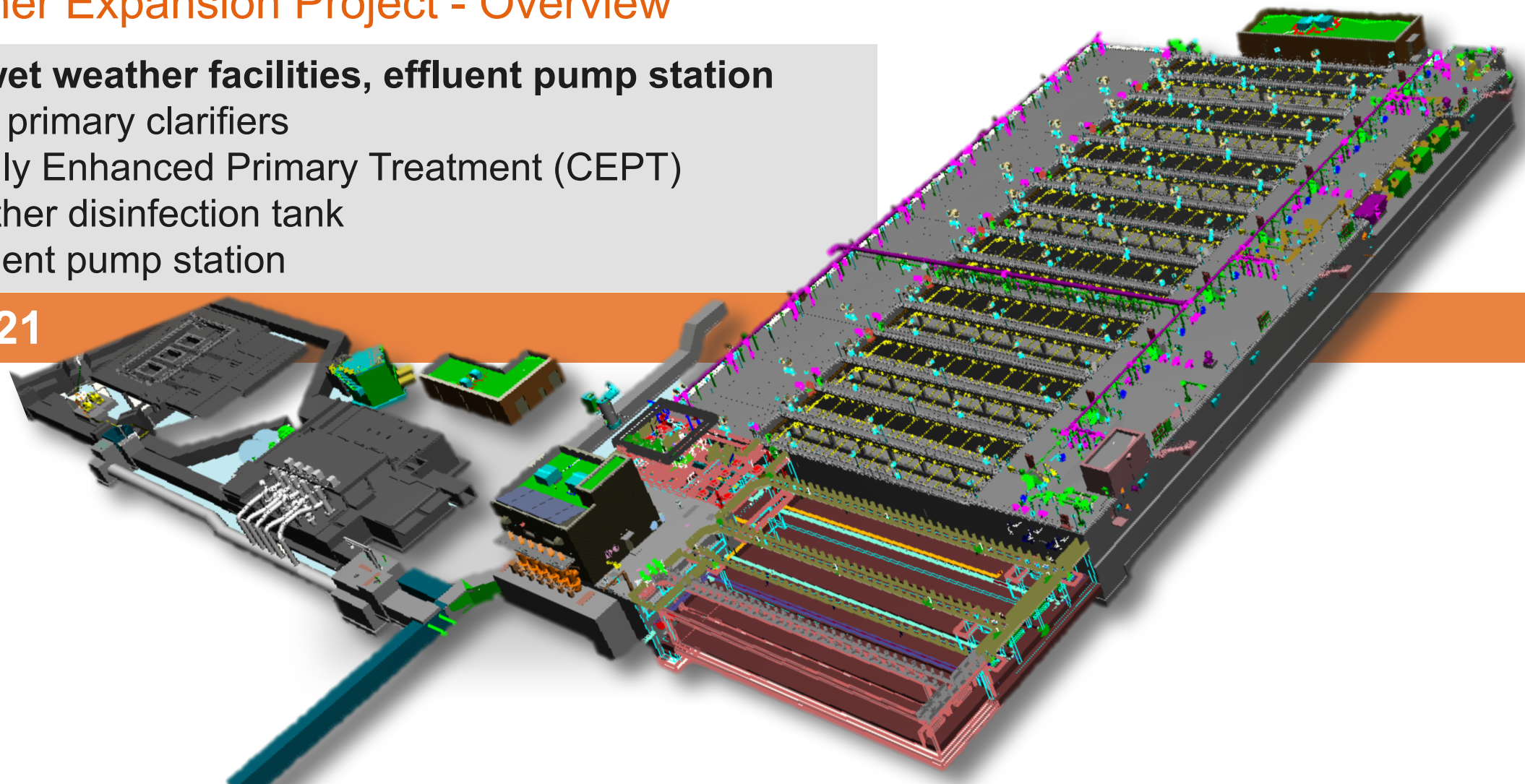
Hartford Water Pollution Control Facility

Wet Weather Expansion Project - Overview

Clarifiers, wet weather facilities, effluent pump station

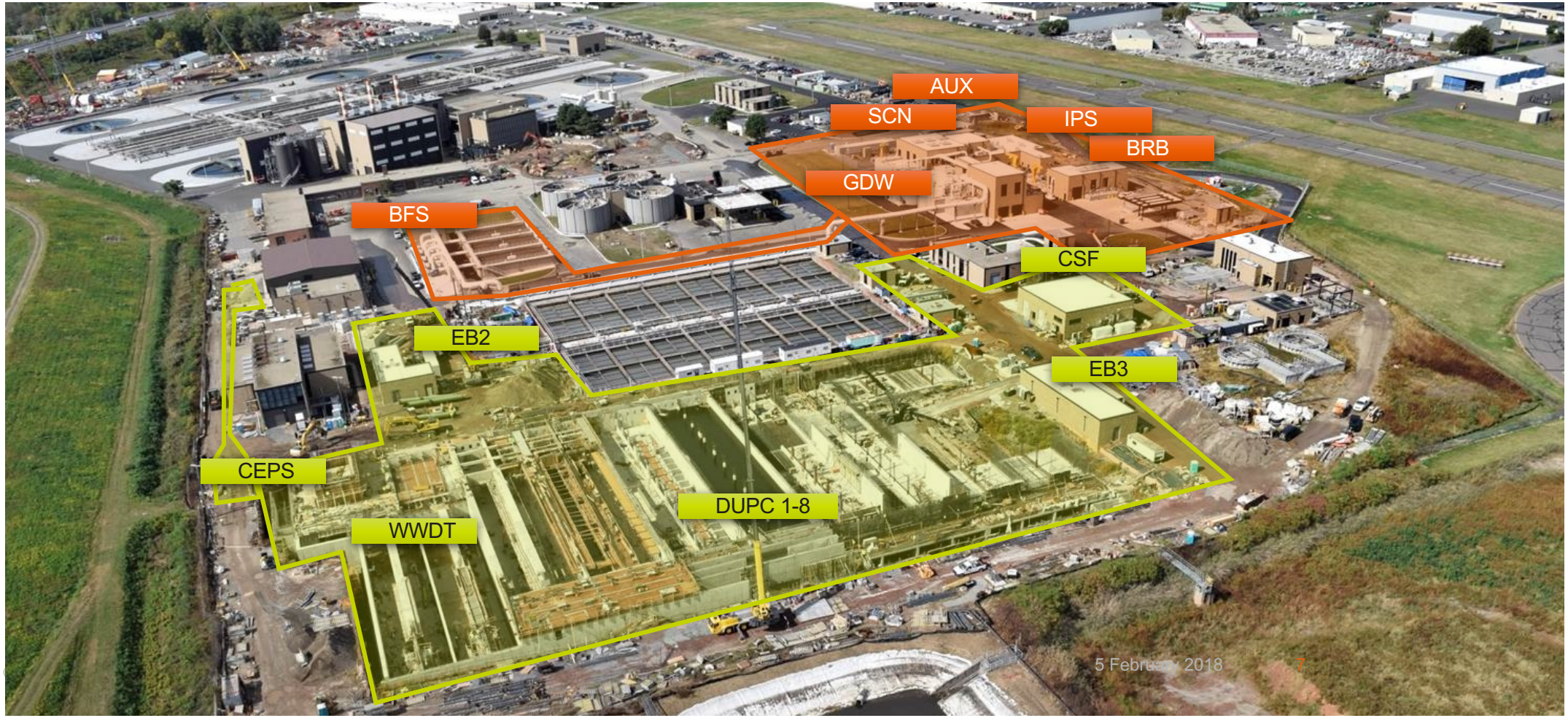
- Dual-use primary clarifiers
- Chemically Enhanced Primary Treatment (CEPT)
- Wet weather disinfection tank
- New effluent pump station

Contract 21



SCADA Overview

Wet Weather Expansion Project - SCADA Implementation Overview



SCADA Assets – By the Numbers

Wet Weather Expansion Project - SCADA Implementation Overview

Hardware

- 200+ new instruments
- 250+ networked valve actuators
- 40+ networked VFDs
- 30+ new PLCs
- 20+ networked vendor package PLC/OITs
- 20+ managed switches
- 7 new HMI Operator Kiosks
- 4 new redundant HMI servers
- Plant-wide redundant fiber optic network loop

Digital / Software

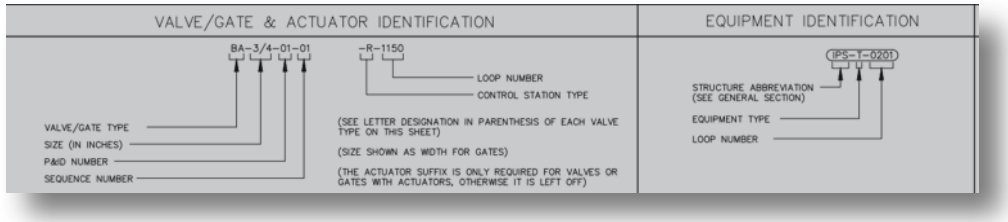
- 100+ packaged vendor OIT screens
- 300+ of new HMI Screens configured
- 1000s++ of lines of new PLC code configured

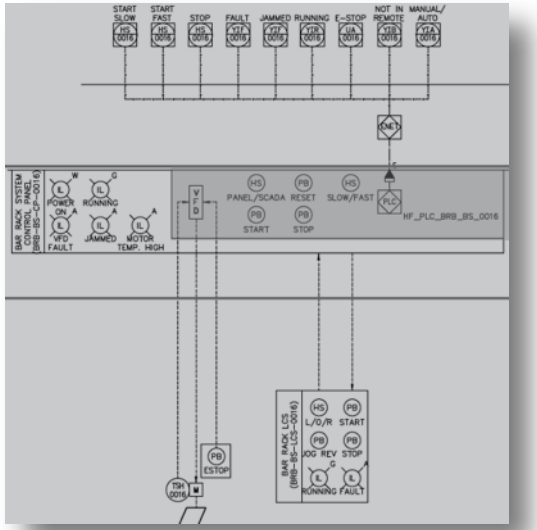
Design Standardization

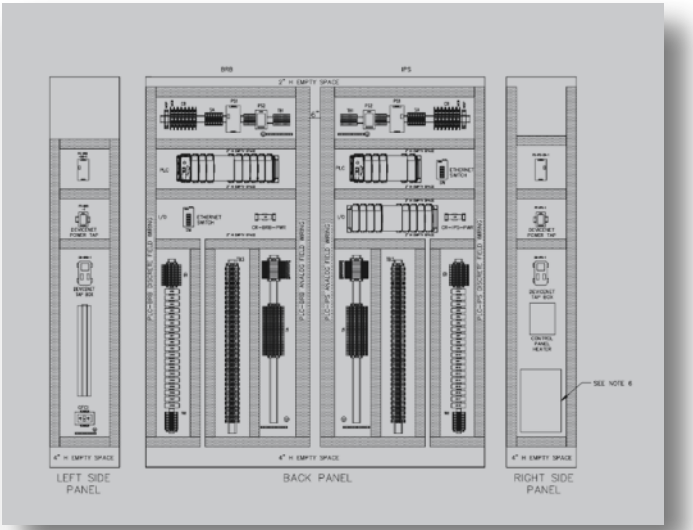
Standardization – I&C Design

Across all design contracts:

- **Asset Tagging/ Nomenclature**
- **Control Hierarchy / Local and Remote controls**
- P&ID Symbols/ Lead Sheets
- Control Panel Layouts
- Standard Specifications





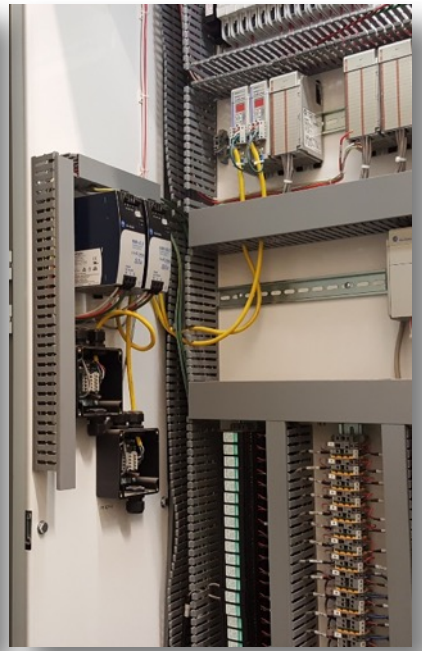


Common philosophy standardized final SCADA / operational schemes.

Standardization – Hardware Components

- Instrumentation / Actuators
- **PLCs, including:**
  - **Process Control**
  - **Vendor Packages**
  - **HVAC Systems**
- **Vendor Packages**
- Panel components
- Operator interfaces
- Process cameras

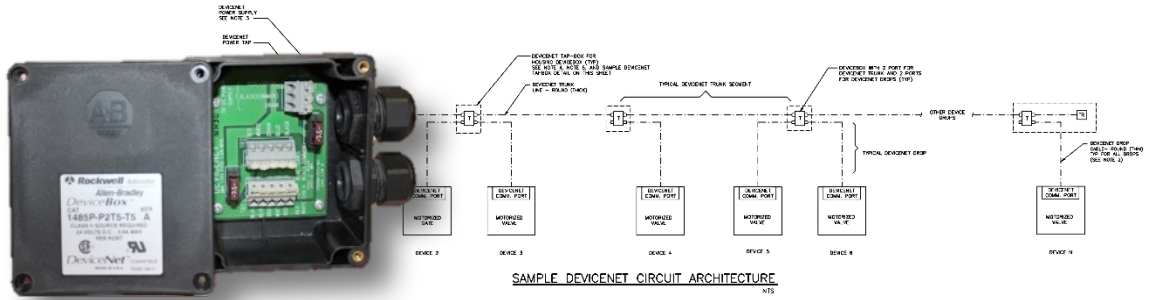


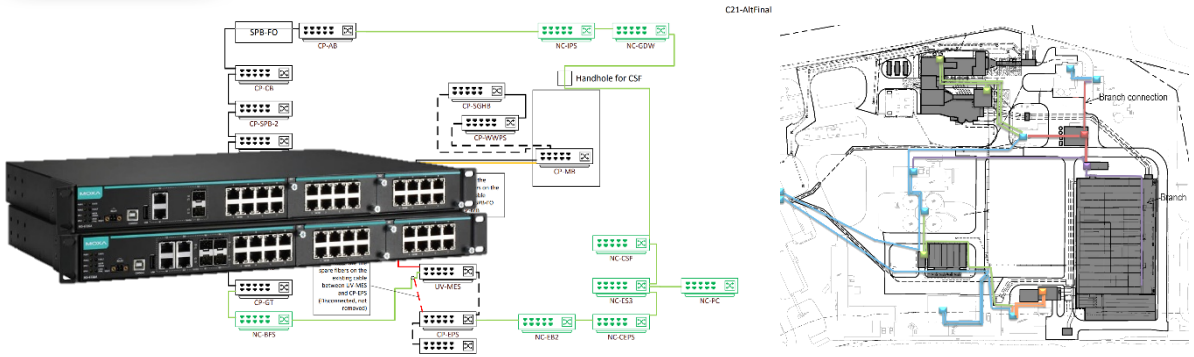



Parts standardization supports post-construction SCADA asset maintenance.

Standardization – Networking

- **Network protocols / enclosures**
- **Architecture – Fiber/ Ethernet network/ bus network**
  - Managed switch implementation
  - Fieldbus (Devicenet) topology/ failure analysis/ segmentation
  - VFD networking architecture
- Staging and continuity between construction

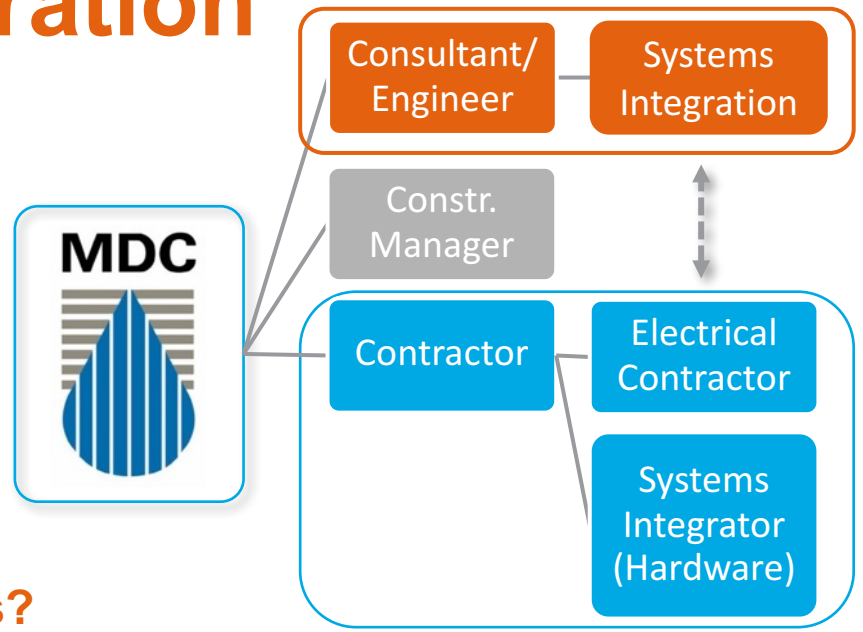




Ensuring network compatibility removes hours of troubleshooting at startup.

Standardization – Systems Integration

- Common systems integration approach specified / both process & HVAC systems
- **AESS - Application engineering software supplier (HMI/PLC configuration)**
  - **Engineer (Arcadis)**
  - **Systems Integrator (NIC Systems Corporation)**



Benefits?

Engineer has in-depth knowledge of process / design

Integrator brings years of configuration expertise/ Owner preference knowledge

Owner has direct control over software engineering

Owner has direct control over system commissioning and optimization

Systems integration approach allows for greater Owner control of end product.

SCADA Configuration – Stakeholder Workshops

Stakeholder Engagement

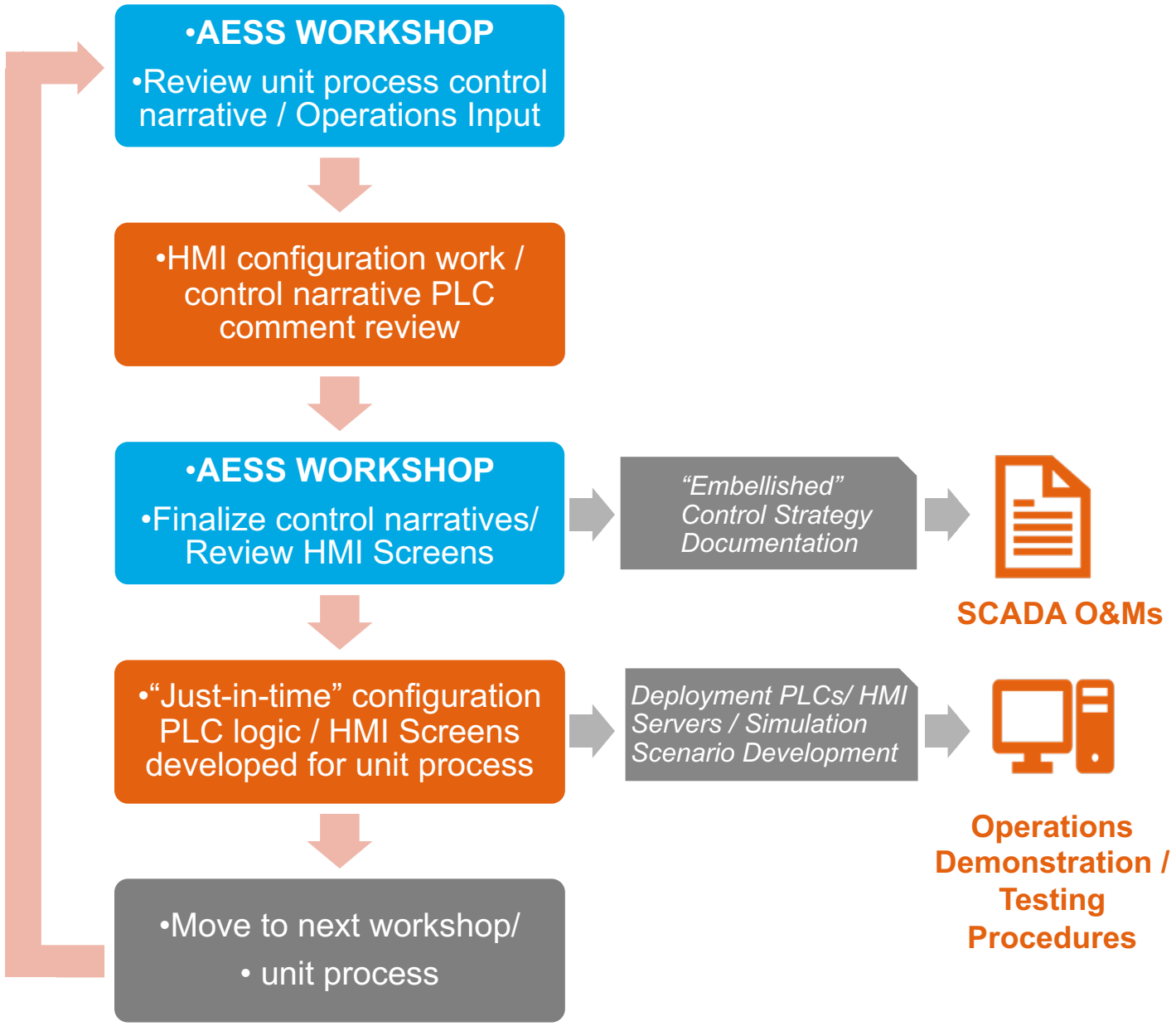
- Bi-weekly operations (AESS) workshops
- **Started prior to construction.** Started in design. Then, after NTP from May 2014, continues uninterrupted to date (except during Contract Startup)
- Over **40+** workshops held
- Milestones in Configuration: **Demonstration sessions** with **full scenario simulation**

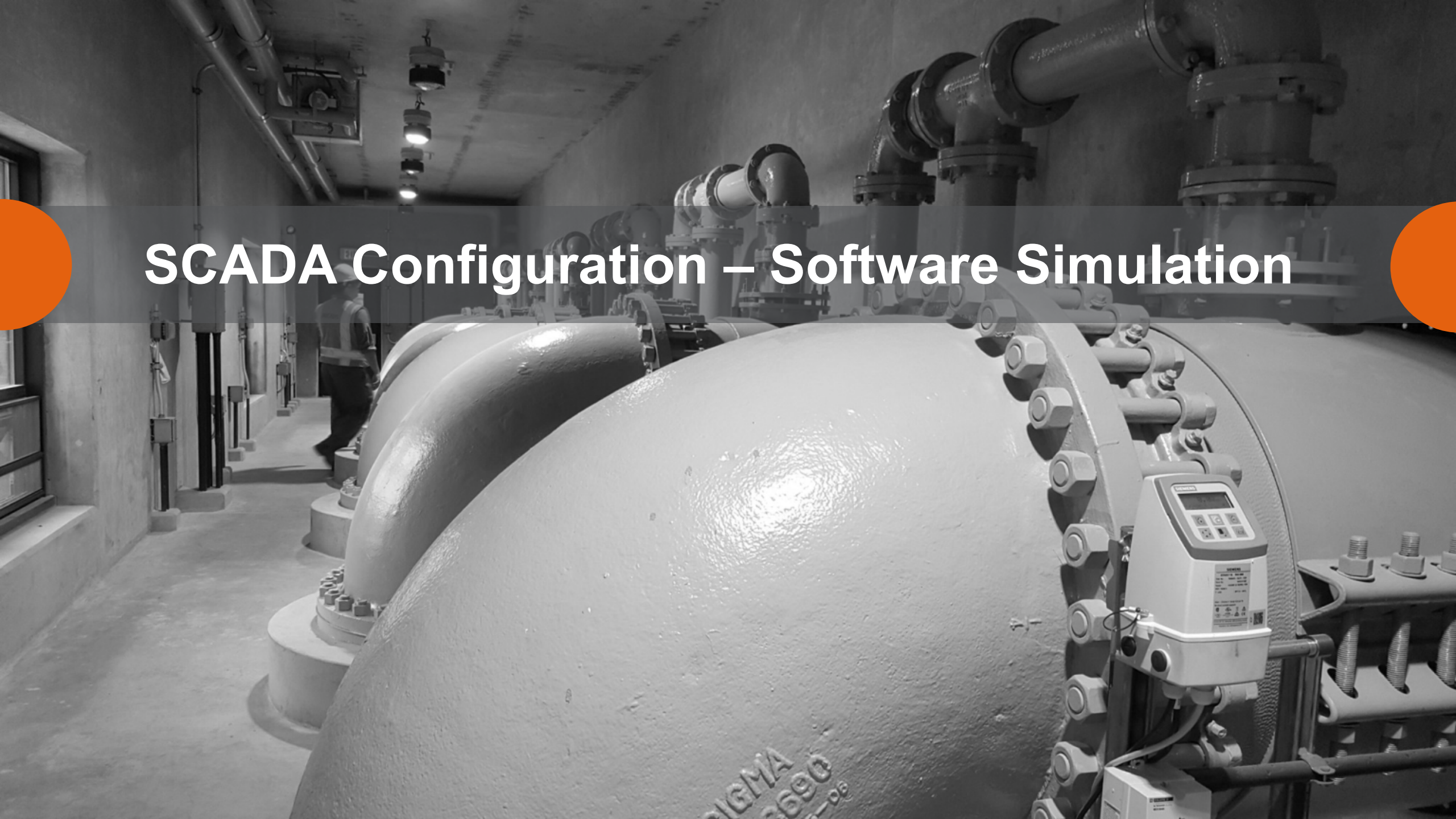
Plant Supervisors
Operation Supervisors
Project Managers
I&C/ SCADA Managers / Techs
Systems Integrator
Consultant
Electrical Techs
Shift Operators

Engagement early and often by MDC Operations drove understanding and planning for startup needs.

SCADA Workshops

- Process Control/ Operation Strategies
- Alarm Management/ Rationalization
- Navigation
- Trending/ Historian
- Information Management Systems



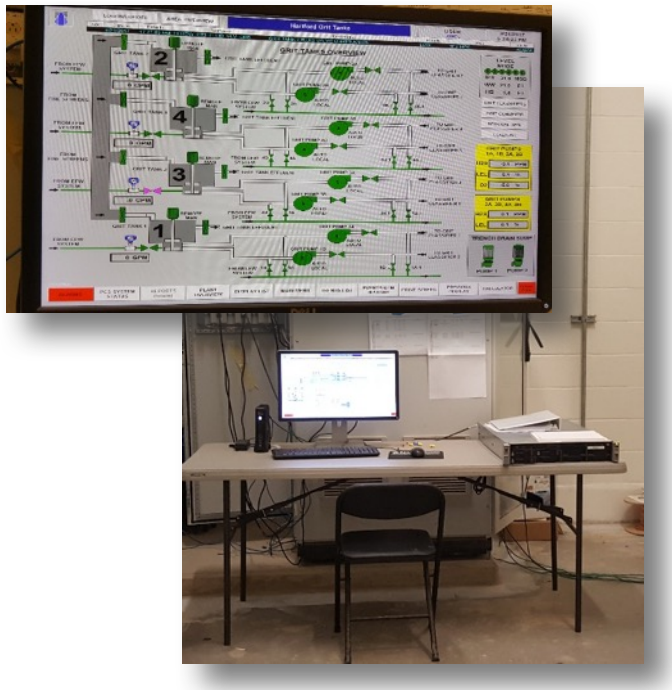


SCADA Configuration – Software Simulation

SCADA Simulations – Wet Weather Scenarios

(3) Witnessed software demonstrations held prior to startup

- All project **SCADA servers and PLC CPUs** brought into workshop
- **Live simulator HMI** developed by NIC and used to simulate all field I/O and strategy conditions
- **Initial equipment set ups** prior to testing (valves, lead/lag, OOS) essentially walkthrough of pre-commissioning setup



Scenario simulation was the foundation for Functional Demonstration Testing procedures during startup and commissioning.

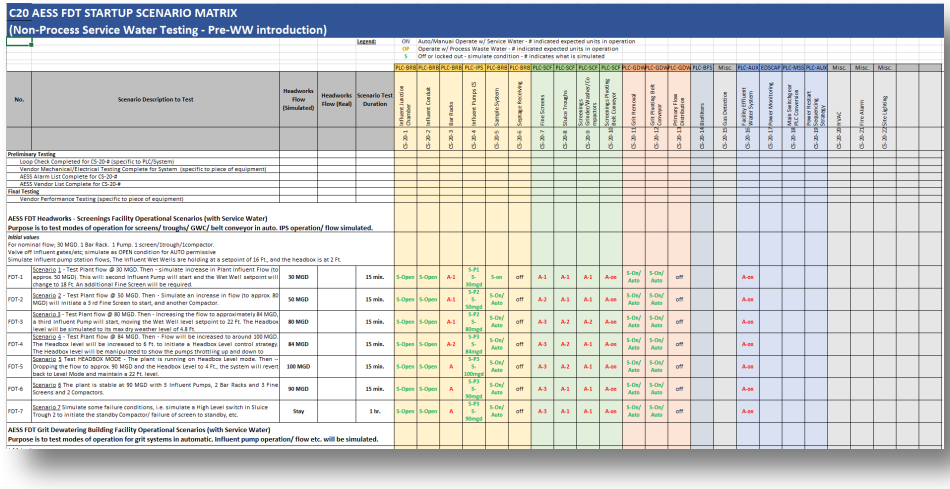
SCADA Simulations – Initial Values

Stepped through flow events

- **Scenario Matrix -** 8 scenarios from nominal flow to 210 mgd (wet weather event)
- All modes of control simulated

Operator input/ active review

- **Initial operator settings** inputted into SCADA O&M (setpoints, alarm limits, etc.)
- **Early "offline" deployment** of new project SCADA Servers for use by all shift operators



C20 AESS FDT STARTUP SCENARIO MATRIX
(Non-Process Service Water Testing - Pre-WW introduction)

Legend:
ON Auto/Manual Operate w/ Service Water - # indicated expected units in operation
OP Operate w/ Process Waste Water - # indicated expected units in operation
S Off or locked out - simulate condition - # indicates what is simulated

No.	Scenario Description to Test	Headworks Flow (Simulated)	Headworks Flow (Real)	Scenario Test Duration	Influent Isolation Chamber	Influent Conduit	Bar Racks	Influent Pumps (3)	Sample System	Garage Receiving	Fine Screens	Sluice Troughs	Screenings Compactor/Conveyor/Chute Isolation	Screenings Floating Belt Conveyor	Grit Removal	Grit Hauling Belt Conveyor	Primary Flow Splitting Box	Equipment	Gas Detection	Odor Control Foam System	Process Monitoring	Main Switchgear	Motor Control Center	Power Outage Emergency Generator	HVAC	Fire Alarm	Direct Lighting
					PLC-BRB	PLC-BRB	PLC-BRB	PLC-IPS	PLC-BRB	PLC-BRB	PLC-SCP	PLC-SCP	PLC-SCP	PLC-SCP	PLC-SCP	PLC-GDW	PLC-GDW	PLC-GDW	PLC-BFS	Misc.	PLC-AUX	DOSCAP	PLC-MSS	PLC-AUX	Misc.	Misc.	Misc.
					C5-20-1	C5-20-2	C5-20-3	C5-20-4	C5-20-5	C5-20-6	C5-20-7	C5-20-8	C5-20-9	C5-20-10	C5-20-11	C5-20-12	C5-20-13	C5-20-14	C5-20-15	C5-20-16	C5-20-17	C5-20-18	C5-20-19	C5-20-20	C5-20-21	C5-20-22	C5-20-23	C5-20-24	C5-20-25
Preliminary Testing																											
	Loop Check Completed for C5-20-# (specific to PLC/System)																										
	Vendor Mechanical/Electrical Testing Complete for System (specific to piece of equipment)																										
	AESS Alarm List Complete for C5-20-#																										
	AESS Vendor List Complete for C5-20-#																										
Final Testing																											
	Vendor Performance Testing (specific to piece of equipment)																										
AESS FDT Headworks - Screenings Facility Operational Scenarios (with Service Water)																											
Purpose is to test modes of operation for screens/ troughs/ GWC/ belt conveyor in auto. IPS operation/ flow simulated.																											
Initial values	For nominal flow; 90 MGD. 1 Bar Rack. 1 Pump. 1 screen/1trough/1compactor. Valve off influent gates/etc; simulate as OPEN condition for AUTO permissive. Simulate influent pump station flows, The Influent Wet Wells are holding at a setpoint of 16 Ft., and the headbox is at 2 Ft.																										
FDT-1	Scenario 1 - Test Plant flow @ 30 MGD. Then - simulate increase in Plant Influent Flow (to approx. 50 MGD). This will: second Influent Pump will start and the Wet Well setpoint will change to 18 Ft. An additional Fine Screen will be required.	30 MGD		15 min.	S-Open	S-Open	A-1	S-P1 S- 70mgd	S-on	off	A-1	A-1	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-2	Scenario 2 - Test Plant flow @ 50 MGD. Then - Simulate an increase in flow (to approx. 80 MGD) will initiate a 5 rd Fine Screen to start, and another Compactor.	50 MGD		15 min.	S-Open	S-Open	A-1	S-P1 S- 50mgd	S-On/ Auto	off	A-2	A-1	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-3	Scenario 3 - Test Plant flow @ 80 MGD. Then - Increasing the flow to approximately 84 MGD, a third Influent Pump will start, moving the Wet Well level setpoint to 22 Ft. The headbox level will be simulated to its max dry weather level of 4.8 Ft.	80 MGD		15 min.	S-Open	S-Open	A-1	S-P3 S- 80mgd	S-On/ Auto	off	A-3	A-2	A-2	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-4	Scenario 4 - Test Plant flow @ 84 MGD. Then - Flow will be increased to around 100 MGD. The Headbox level will be increased to 6 Ft. to initiate a Headbox Level control strategy. The Headbox level will be manipulated to show the pumps throttling up and down to	84 MGD		15 min.	S-Open	S-Open	A-2	S-P3 S- 84mgd	S-On/ Auto	off	A-3	A-2	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-5	Scenario 5 Test HEADBOX MODE - The plant is running on Headbox Level mode. Then - Dropping the flow to approx. 90 MGD and the Headbox Level to 4 Ft., the system will revert back to Level Mode and maintain a 22 Ft. level.	100 MGD		15 min.	S-Open	S-Open	A	S-P1 S- 100mgd	S-On/ Auto	off	A-3	A-2	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-6	Scenario 6 The plant is stable at 90 MGD with 5 Influent Pumps, 2 Bar Racks and 5 Fine Screens and 2 Compactors.	90 MGD		15 min.	S-Open	S-Open	A	S-P3 S- 90mgd	S-On/ Auto	off	A-3	A-1	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
FDT-7	Scenario 7 Simulate some failure conditions, i.e. simulate a High Level switch in Sluice Trough 2 to initiate the standby Compactor/ failure of screen to standby, etc.	Stay		1 hr.	S-Open	S-Open	A	S-P3 S- 90mgd	S-On/ Auto	off	A-3	A-1	A-1	A-on	S-On/ Auto	S-On/ Auto	off				A-on						
AESS FDT Grit Dewatering Building Facility Operational Scenarios (with Service Water)																											
Purpose is to test modes of operation for grit systems in automatic. Influent pump operation/ flow etc. will be simulated.																											

Initializing and stepping through simulated scenarios forced the team to review key operational settings, paving the way for these to be included in draft O&M.

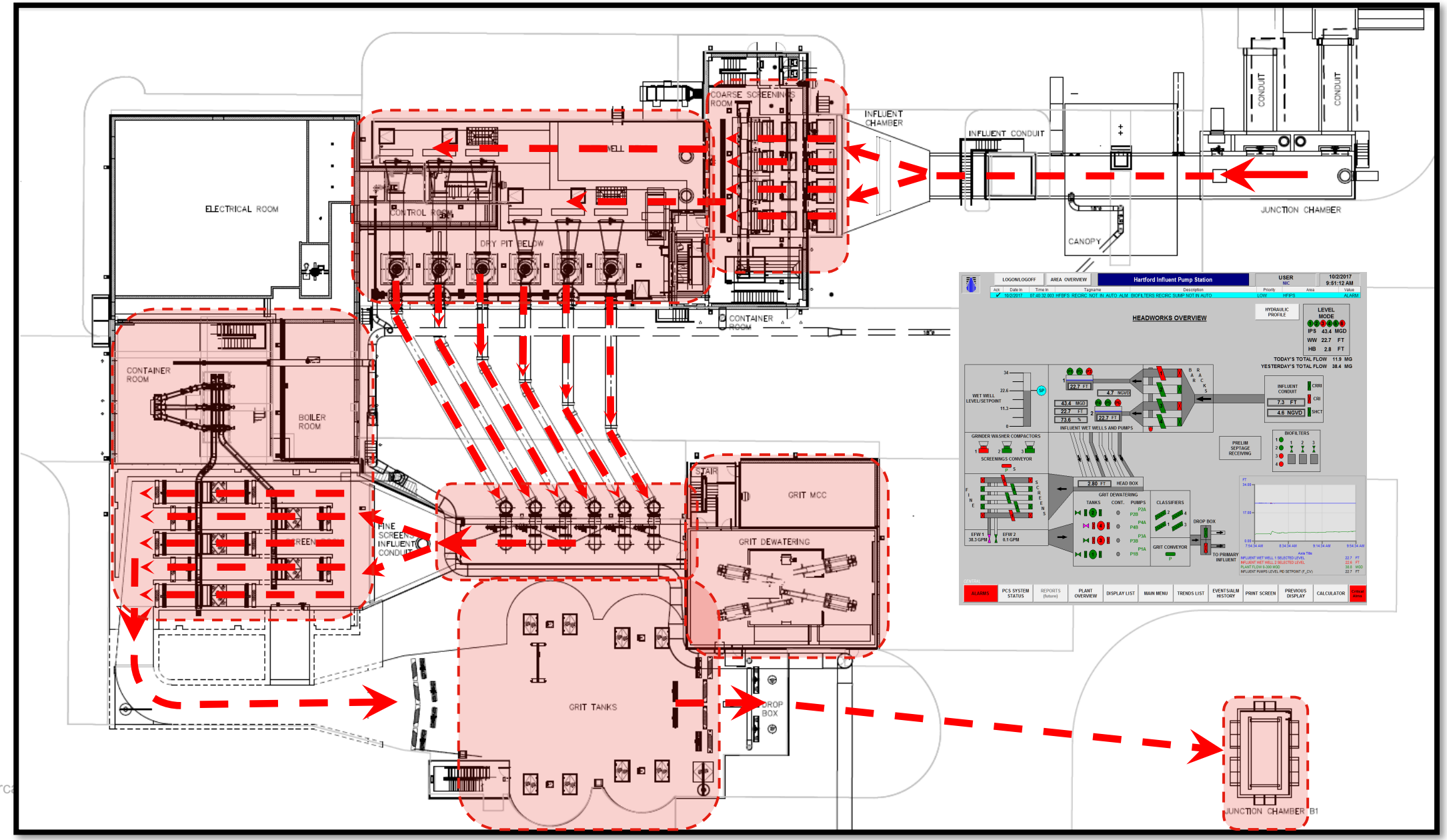
Startup!


WELCOME
USER
9/18/2017
6:34:11 AM
PLANT FLOW
WWPS FLOW
FE TURBIDITY
UV Flow
Ash Lagoon
Wet Weather Storage Basin
Dry Ash
Gravity Thickeners
Effluent Pump Station
Sludge Chamber
Critical Alarms Summary
Miscellaneous Alarms
Lighting
Temp Hypo
PRINT SCREEN
CALCULATOR

Facility Testing – Pre-WW Introduction

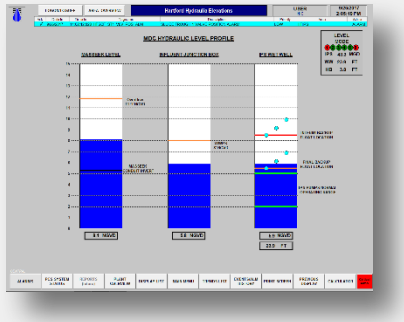
- (10) days of “offline” testing, followed Scenario Matrix developed
- Functional demonstration of all equipment using effluent water or in the dry as applicable

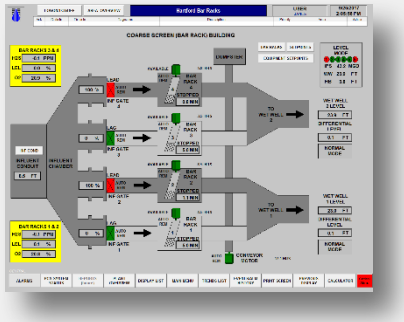
Process Flow Stream

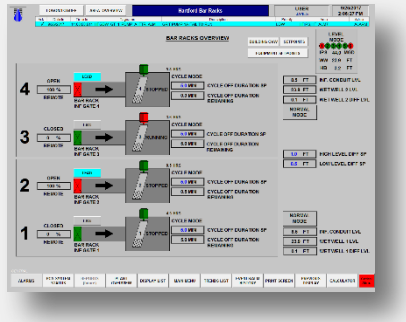


Bar Rack Facility

- (4) Coarse screens, vendor package systems with VFDs / PLC
- Integration of hydraulic profile ahead of bar racks for Operations review
- Optimize flow distribution to the IPS wet wells
- Automatic cycling and interlocking with wet well cleaning cycle

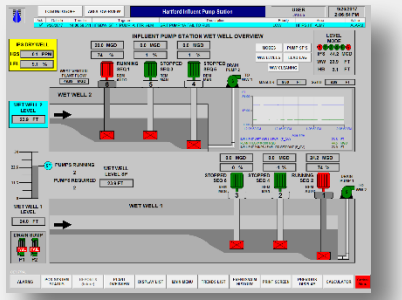


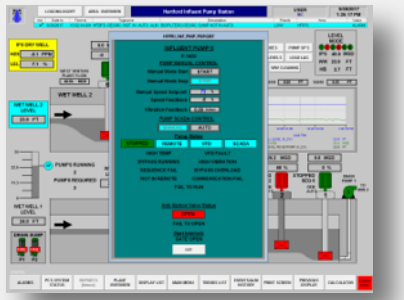


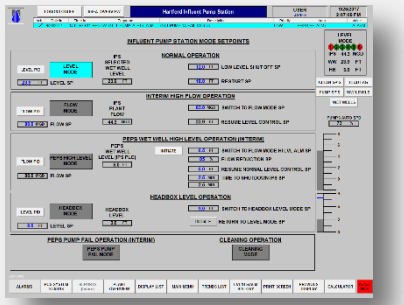


Influent Pump Station

- (6) submersible type pumps, 42 MGD capacity each
- Level control / multiple modes of operation to handle peak wet weather flows
- Integration of pump protection/ monitoring systems (vibration/ temperature/ diagnostics VFDs)
- Wet weather restart on power failure

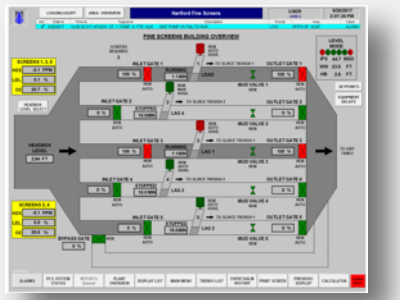


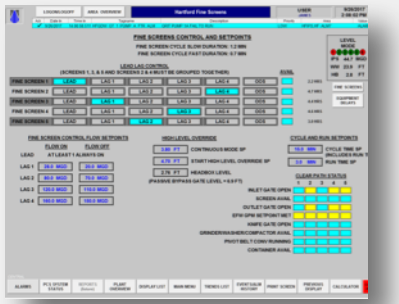


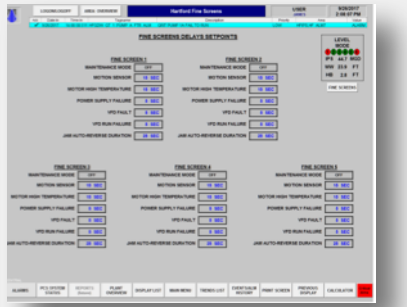


Fine Screens

- (5) packaged fine screen systems, integrated into SCADA
- Integration of vendor VFDs/ status events/ trips/ vendor counters
- Level control for high flow events
- Global operational settings for wet weather events

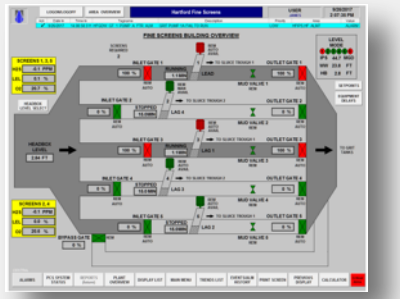


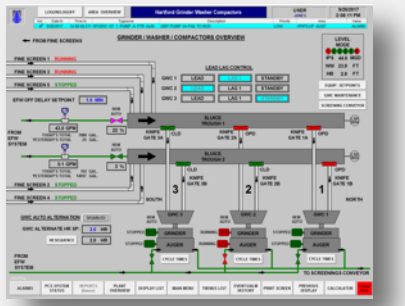


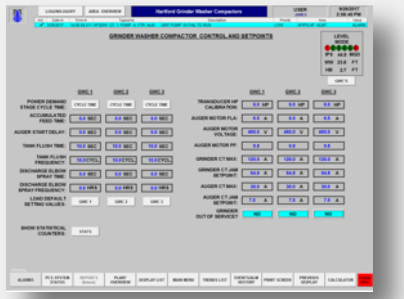


Screenings Handling

- (3) Grinder / Washer / Compactor Packaged System
- Automatically integrated with fine screen and effluent water operation
- Networked integration/ equipment status/ counters
- All vendor commissioning and timer settings available within SCADA
- Pivoting Belt Conveyor for managing screenings disposal

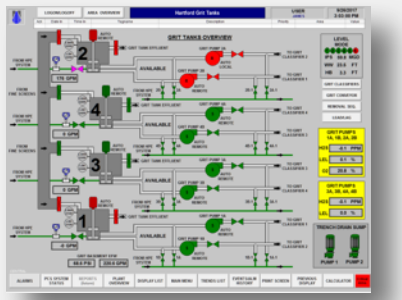


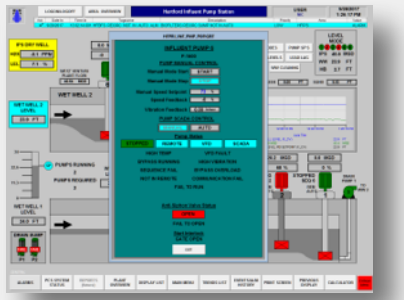


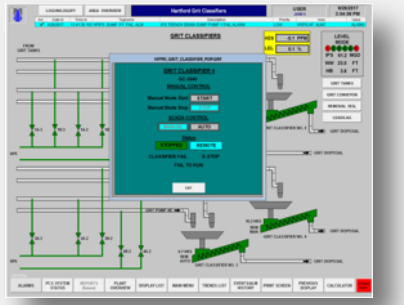


Grit Removal

- (4) 24-foot-diameter centrifugal vortex type grit chambers, 70 MGD rating / (2) 500 GPM pumps/ chamber
- Grit pumps automatically run on a timer sequence to extract grit deposited in the vortex hoppers
- Monitoring of runtimes/ equipment failures

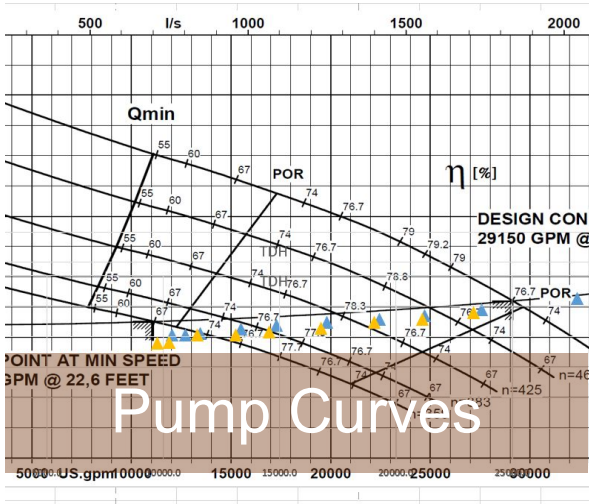


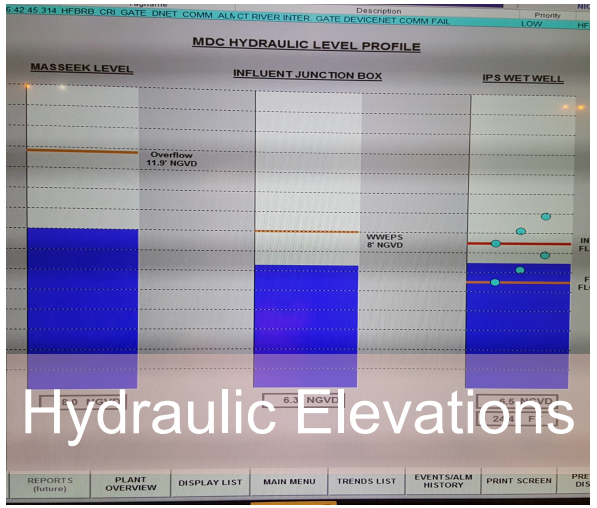




Facility Testing – WW Introduction

- Loop tuning for the major pump control loops/ modes of control
- Development of pump curves and review of hydraulic conditions
- Demonstration of vendor equipment operation
- Troubleshooting individual settings/ optimization

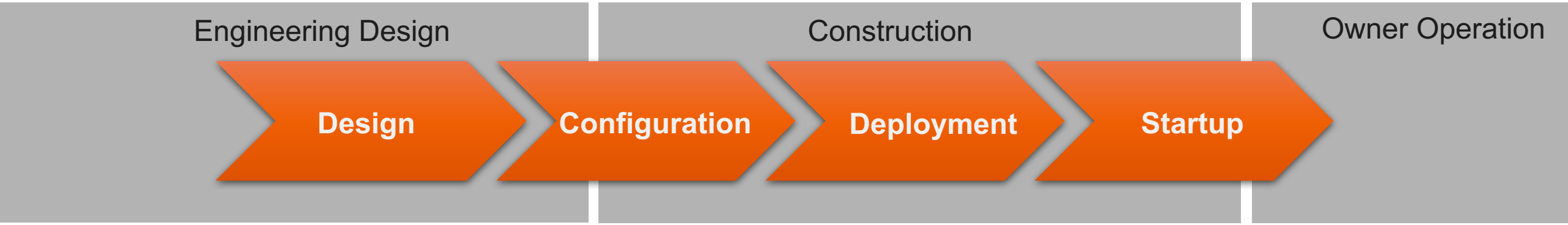




Conclusions

Conclusion – Success Factors

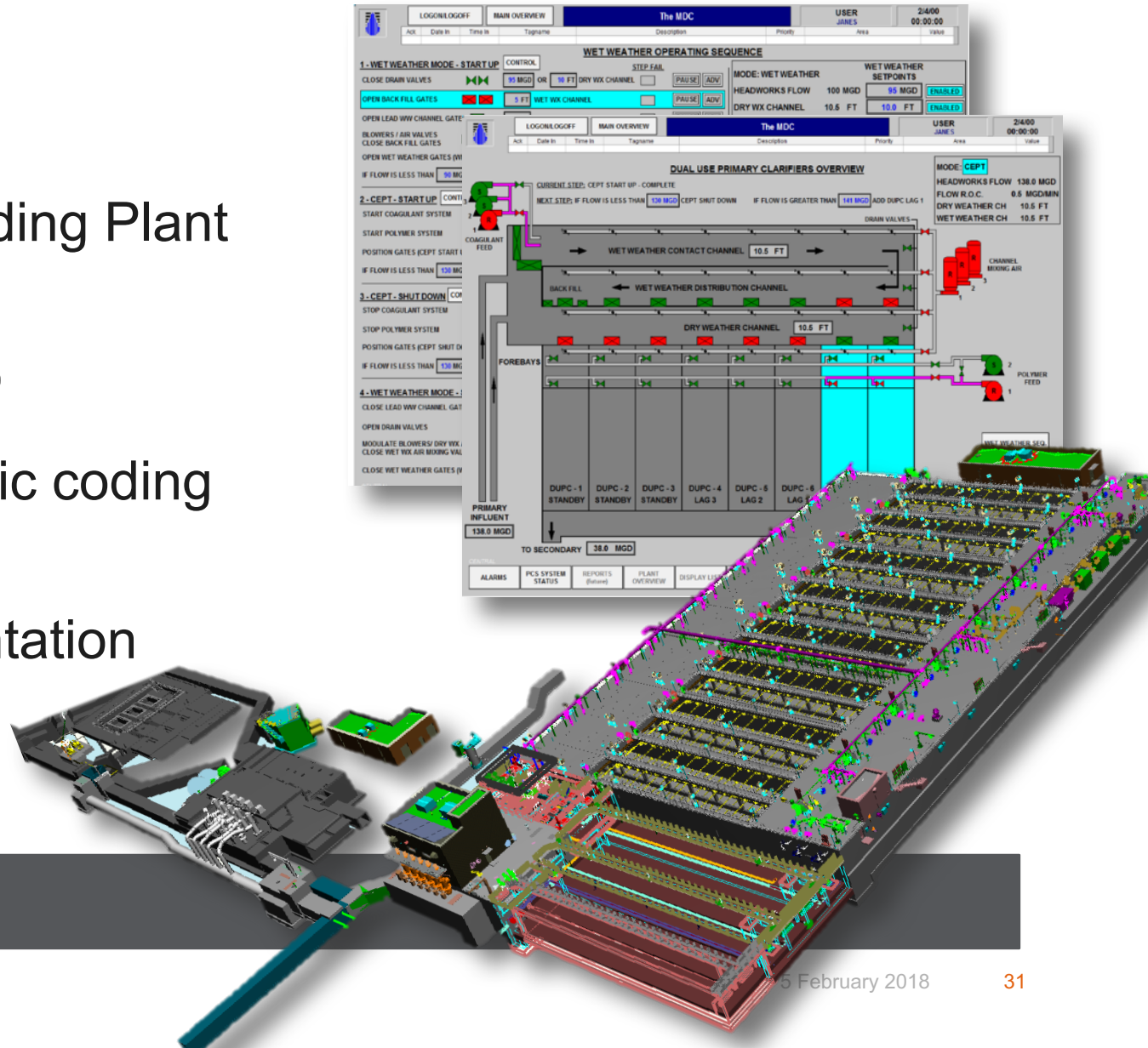
- **Standardization** of design elements (specifications, asset components, network topologies)
- Continued engagement through regular SCADA **stakeholder workshops**, with operations, management and technical staff input
- Scenario development and **simulation demonstration** prior to deployment, as a “dry-run” of pre-commissioning activities



Planning for successful startup begins during design.

Looking Ahead…

- Currently involved in Contract 21 configuration and workshops, including Plant Master Wet Weather Strategy
- Approximately 2x the amount of I/O
- Just-in-time development of the logic coding for processors occurring now.
- Following similar SCADA implementation approach



Startup this summer….

Acknowledgements

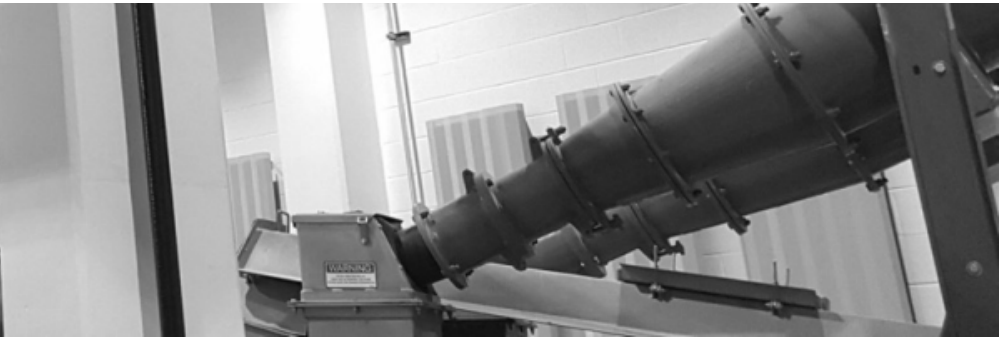
MDC

In association with
ARCADIS
ch2m:
Brown AND Caldwell

JACOBS
In Association With PARSONS

NIC
SYSTEMS CORPORATION

Nickerson
GENERAL CONTRACTORS



Questions?

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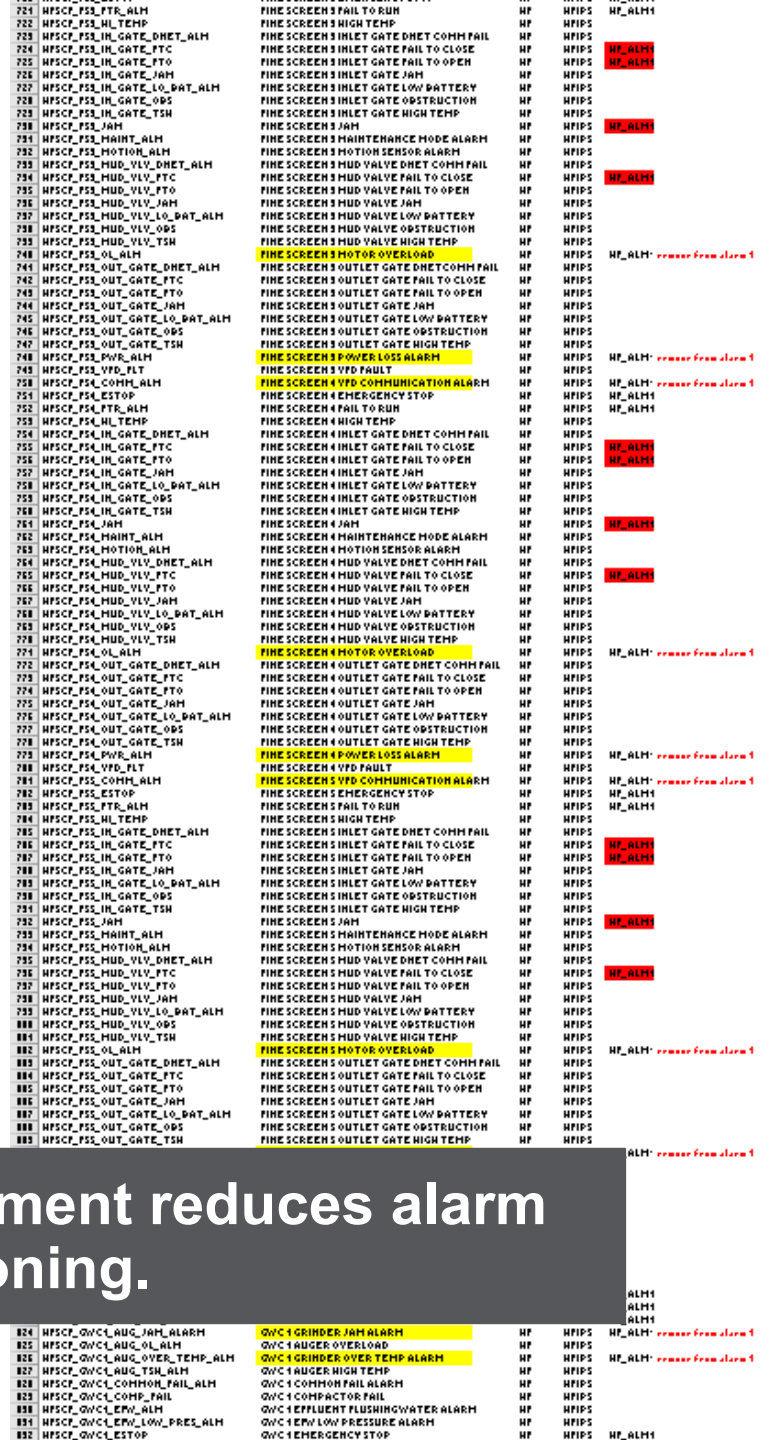
Alarm Management

- Workshops held to rationalize Alarm Master Database
  - Initial pre-deployment, based on initial philosophy, designated priorities (2 workshops, larger groups)
  - During commissioning, prior to introduction of process flow, to reconfirm and go back through rationalization (2 workshops, smaller groups)
- Equipment failure/ performance/ trips
- Focused on:
  - **Areas / Priority (Critical/ Audible)**
  - **Distribution (Process/ Maintenance)**



Working through initial alarm rationalization pre-deployment reduces alarm troubleshooting efforts during commissioning.