

Off-Site Construction: Design of Efficient Mechanical Rooms for High Performance Buildings



**ENVIRONMENTAL
AIR
SYSTEMS, LLC**

AGENDA

- What is Off Site Construction (OSC)?
- Project Background
- Concept & Schematic Design
- Detailed Design
- Construction Management
- Lessons Learned



Off Site Construction

High Performance Buildings- When schedule, uptime, and reliability are essential.

- » Healthcare
- » Process Manufacturing
- » Data Centers
- » Pharmaceutical Manufacturing
- » Laboratory and Research Facilities
- » Institutional Applications





PROJECT BACKGROUND



BUSINESS NEEDS / PROJECT GOALS

- Increase Clients supply capacity for product line to 38M devices per annum by 2017
- Time critical project to ensure capacity available to meet demand
- Minimal impact to existing operations
- Additional Facilities Required:
 - Filling
 - Device Assembly
 - Packaging
 - Warehouse

PROJECT TIMELINE

Concept Design
March 2014

Schematic Design
July 2014

Detailed Design
Sept 2014

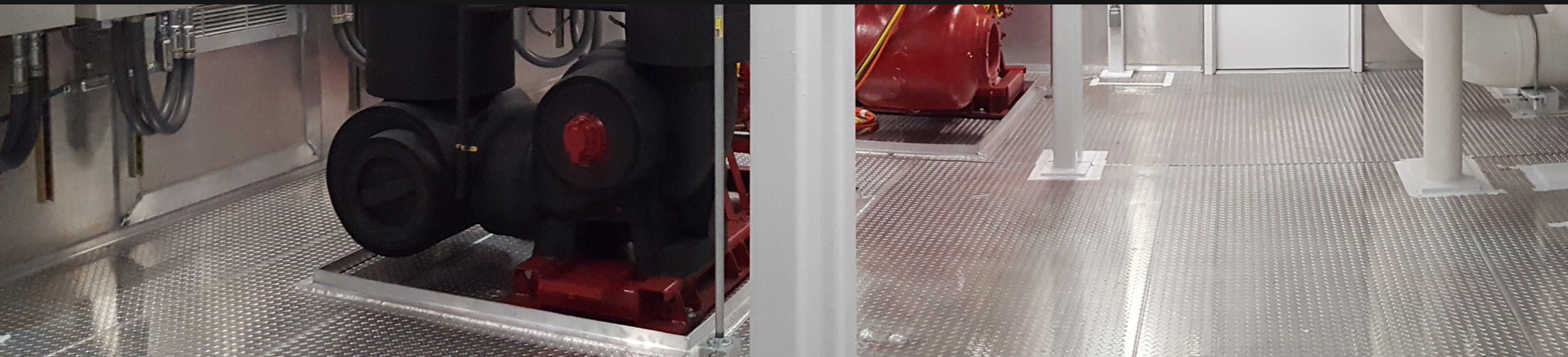
Construction
March 2015

Commissioning & Qualification
May 2015

1st Production Run
September 2016

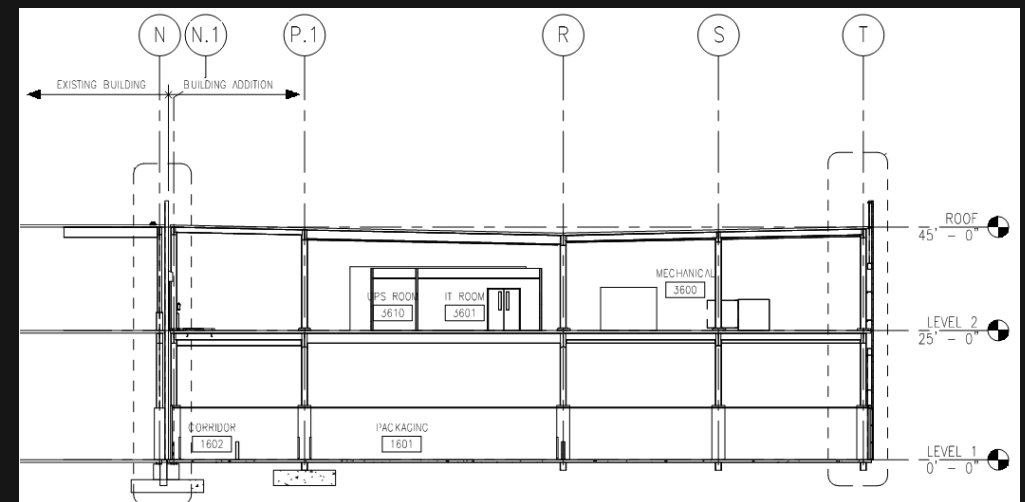


CONCEPT & SCHEMATIC DESIGN

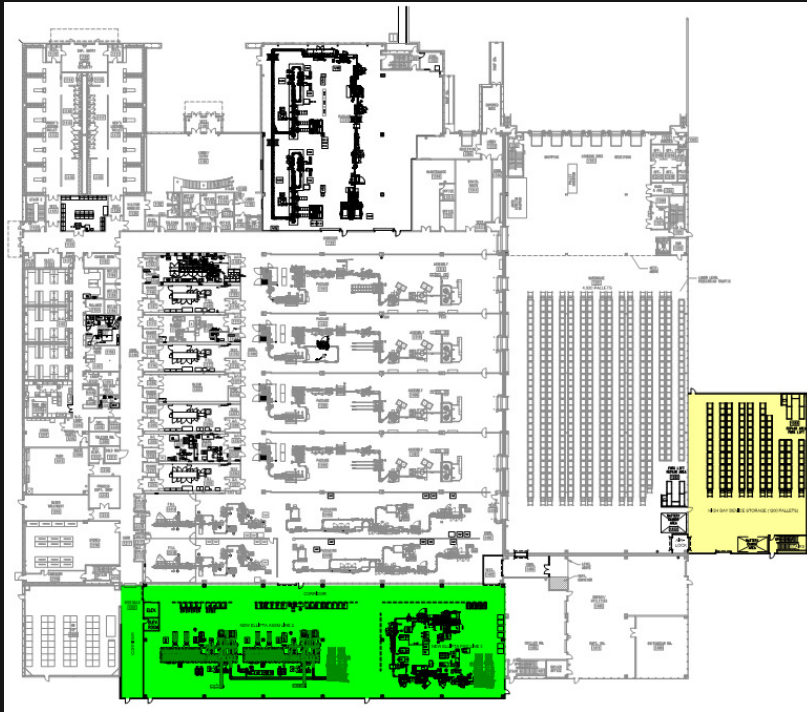


CONCEPT DESIGN

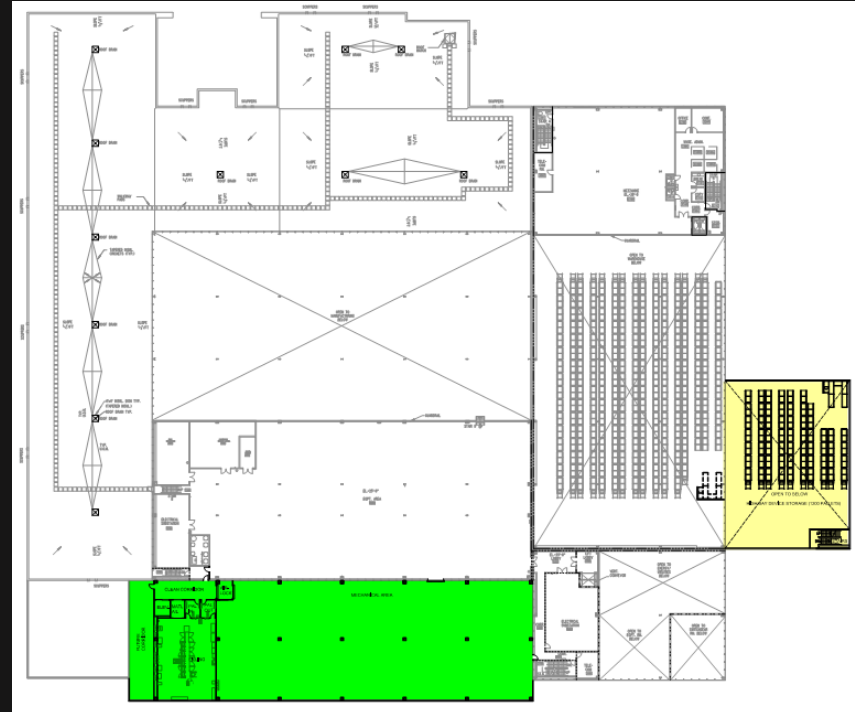
- Concept Design completed June 2014
- Included warehouse, manufacturing expansions
- Matched original building construction approach



CONCEPT DESIGN



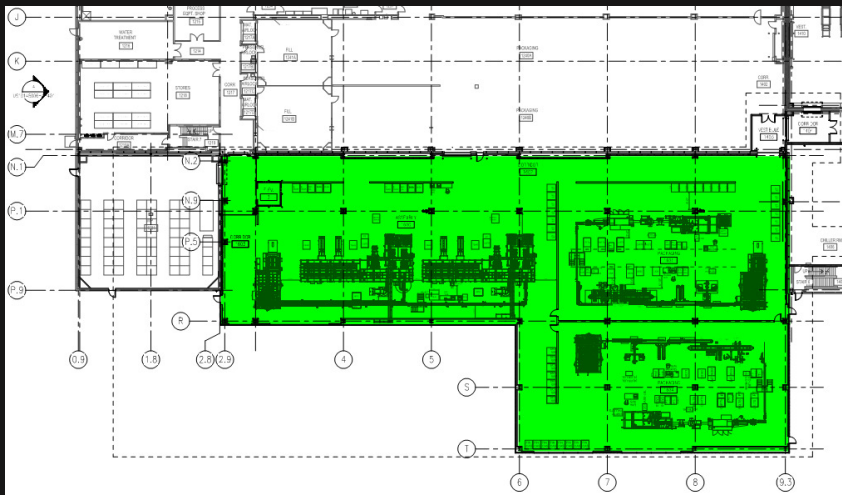
1st Floor



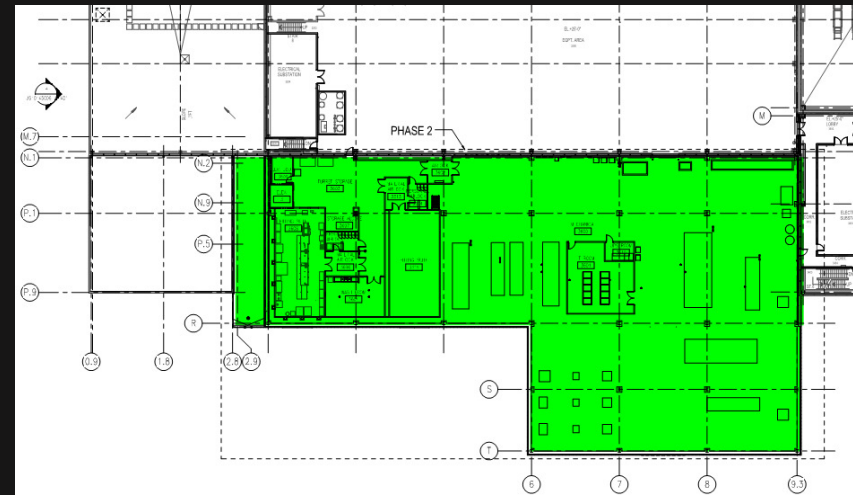
2nd Floor

SCHEMATIC DESIGN

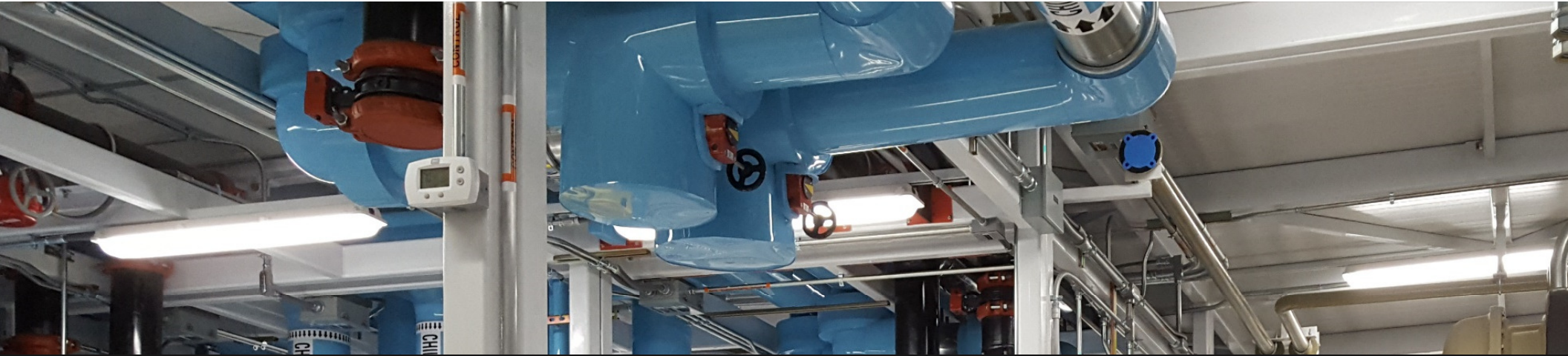
- Added 2nd Packaging Line
- Added 2nd Fill Line
- Added IT Room
- Same basic approach



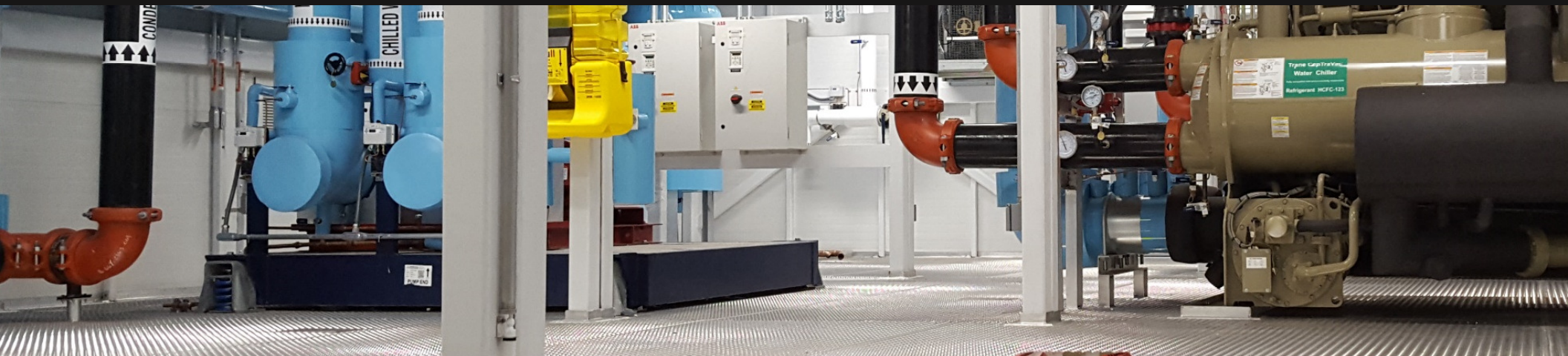
1st Floor



2nd Floor



DETAILED DESIGN

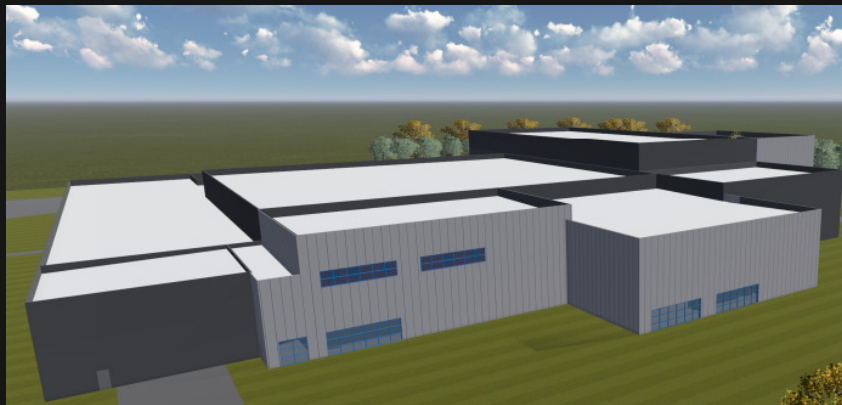


DETAILED DESIGN

- Client sent RFP to construction management firms
- Requested suggestions for cost and schedule improvements
- Construction Manager suggested with their proposal that the project utilize a modular construction method for the 2nd floor mechanical space

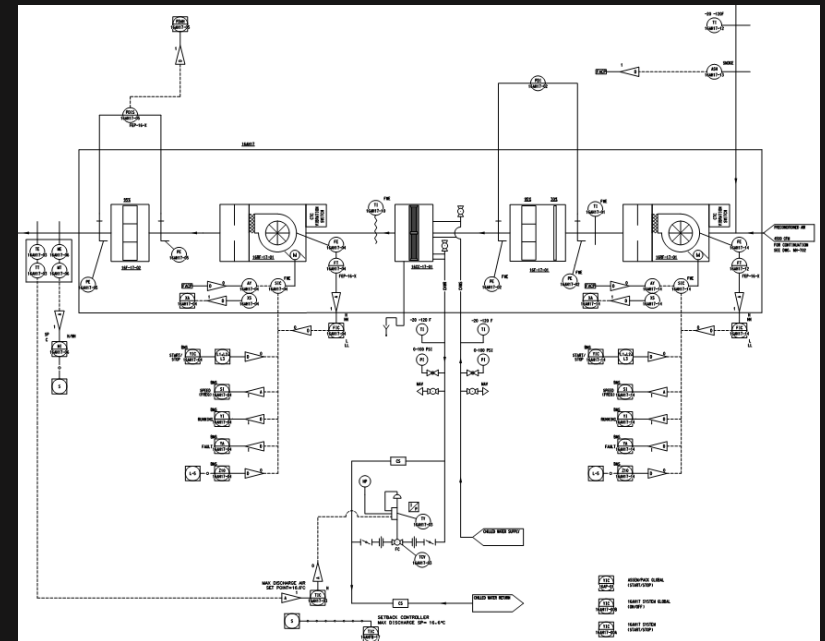
DETAILED DESIGN

- Upon award of CM contract, series of meetings held with Client, Engineer, CM and OSC Provider to discuss viability of modular approach
- Toured a nearby existing OSC modular mechanical penthouse with client's facilities engineering and maintenance personnel
- Detailed assessment of impact to design schedule and cost



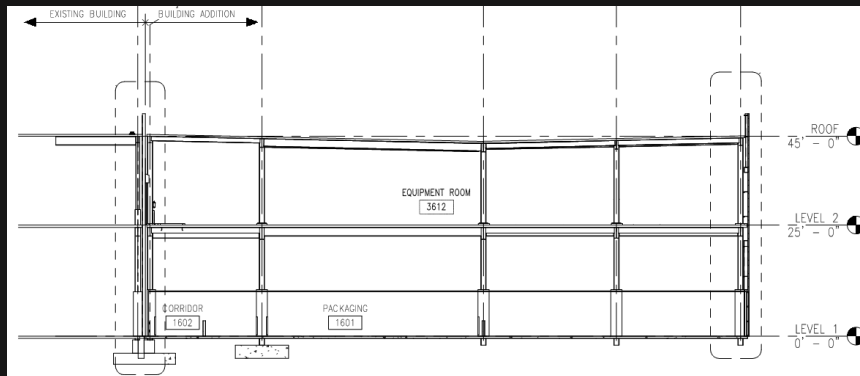
DETAILED DESIGN

- Under proposed path forward, OSC fabricator would take Schematic/early Detailed Design documents as basis of their design
 - P&IDs
 - Single Line Diagrams
 - General Arrangements
 - Specifications
- OSC Fabricator to produce detailed design and fabrication documents
- Engineer of Record to review fab drawings as submittals

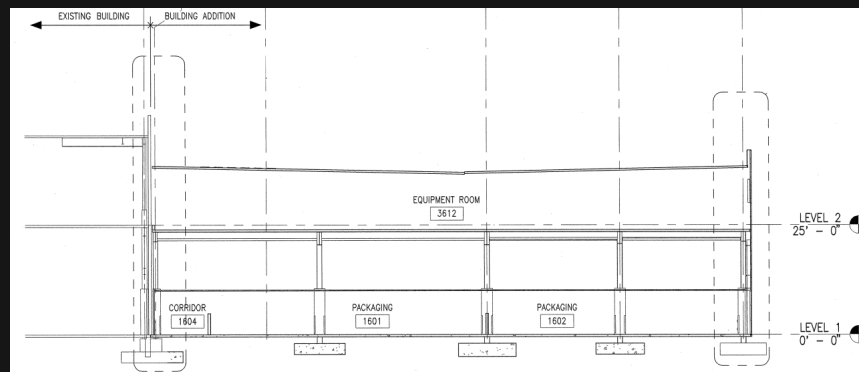


DETAILED DESIGN

E.O.R. "back-up" to Concept/Schematic Design to incorporate modular approach



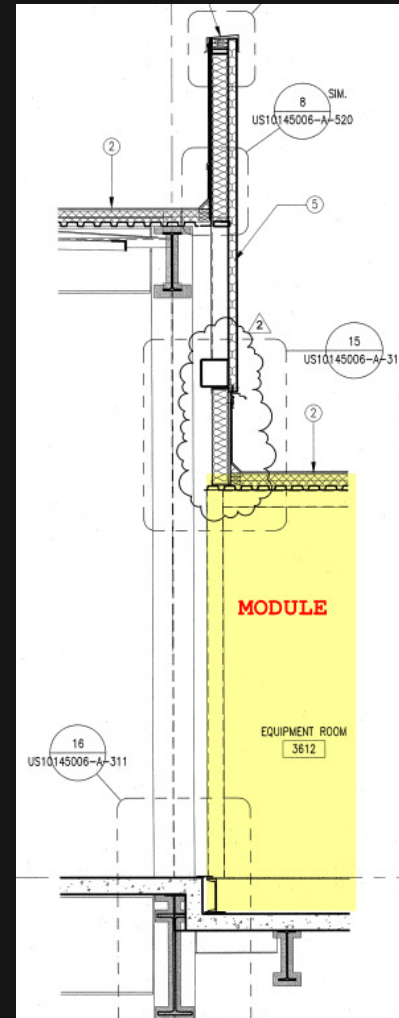
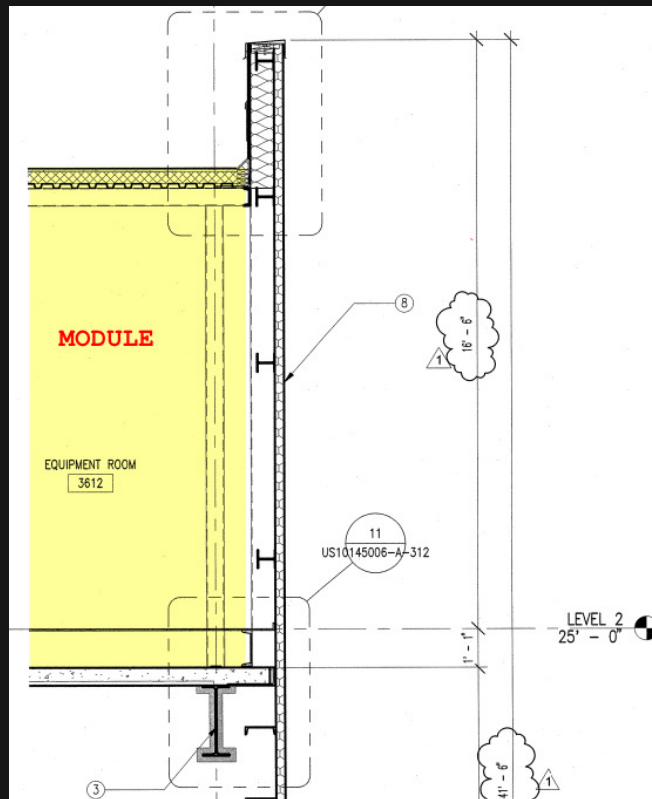
Building Section
Stick-Built



Building Section
Modular

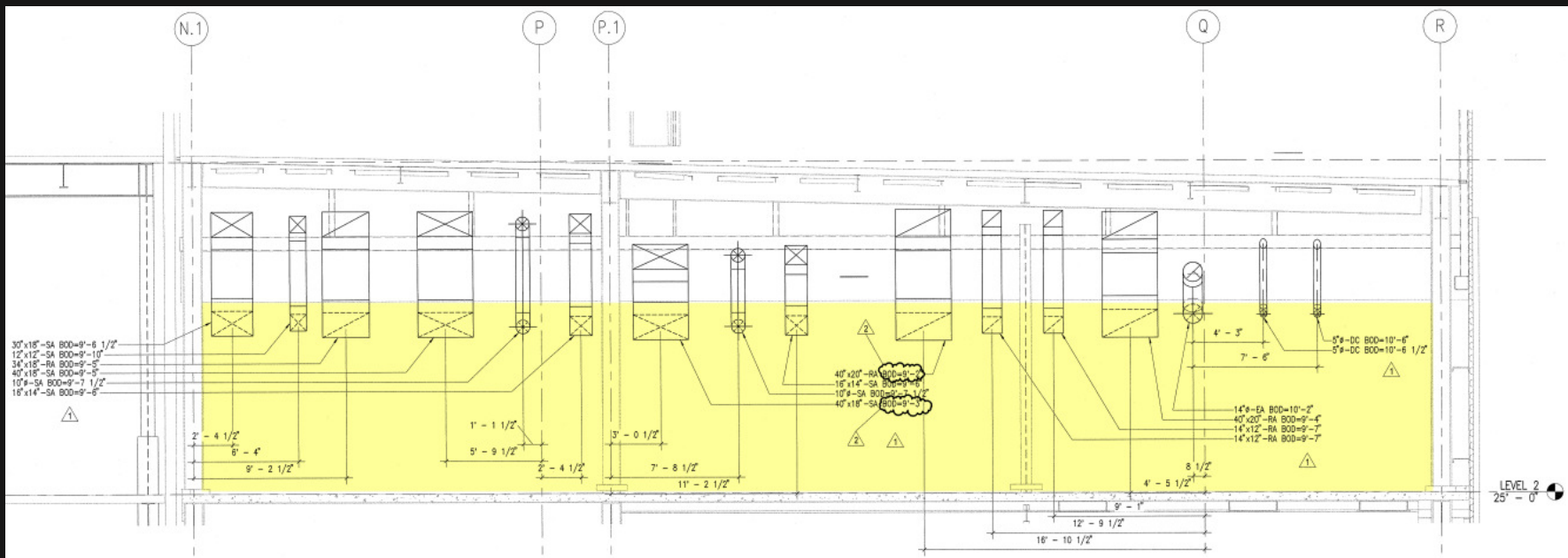
DETAILED DESIGN

Architectural Details



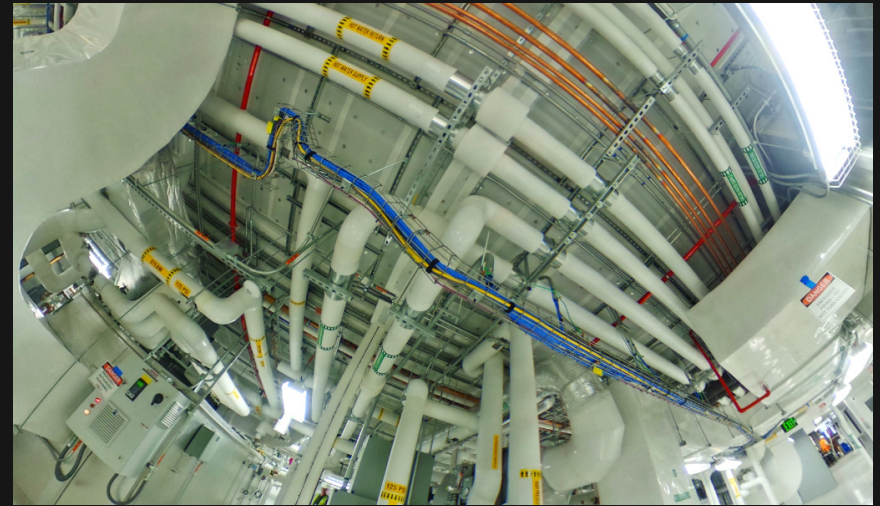
DETAILED DESIGN

Mechanical Details



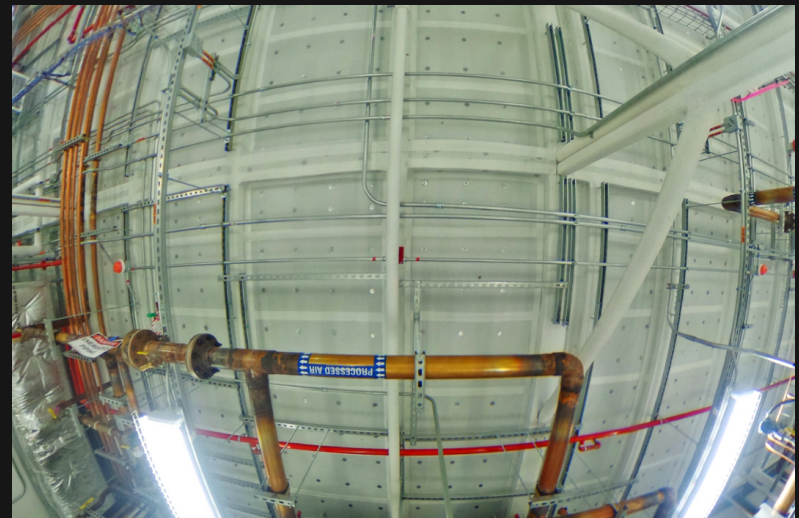
UNIQUE TRAITS

- Several unique traits set this project apart from previous projects
- "Open Construction"
- The off site constructed portion was integrated into the existing building



UNIQUE TRAITS

- The entire structure was fire proofed with an intumescent paint and fire rated board
- This met the same fire ratings as the existing building and the expansion
- Conventional construction methods incorporated to match the existing building's architectural requirements



DETAILED DESIGN

- OSC provider, Engineer of record, and CM have implemented this type of project execution at multiple facilities prior to this project
- A North Carolina Certified Modular Building was ultimately provided to satisfy the local municipality



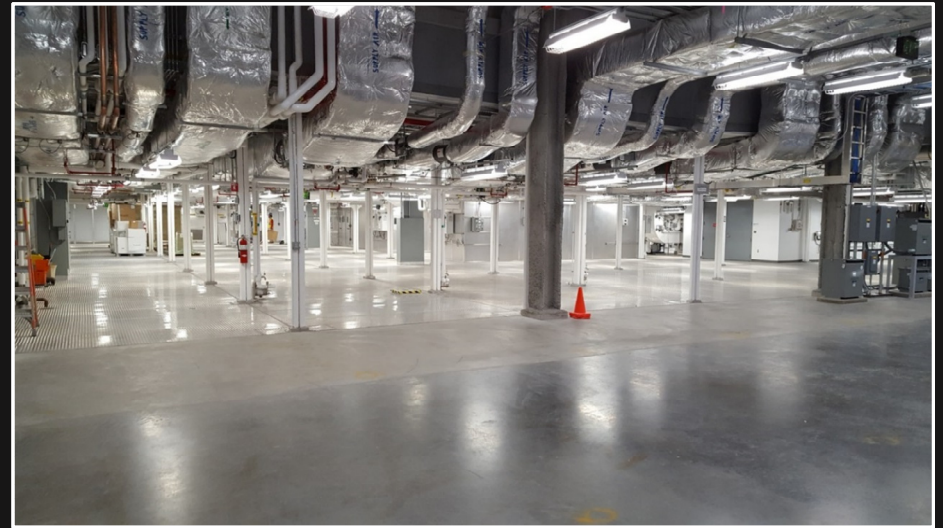
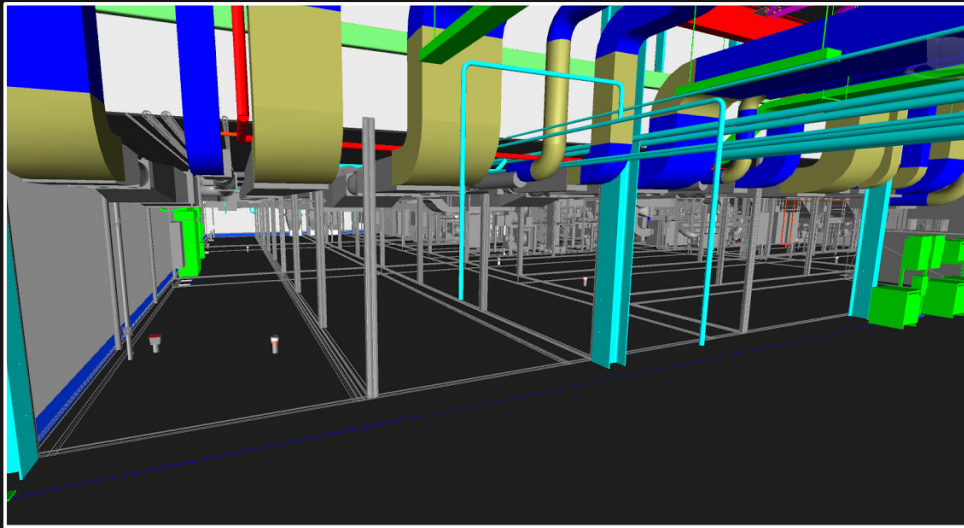
DESIGN

- The integrated project team met virtually on a weekly basis
- Coordination of the model involved fewer trades, therefore reducing clashes and the opportunity for errors



DETAILED DESIGN

Coordination Details



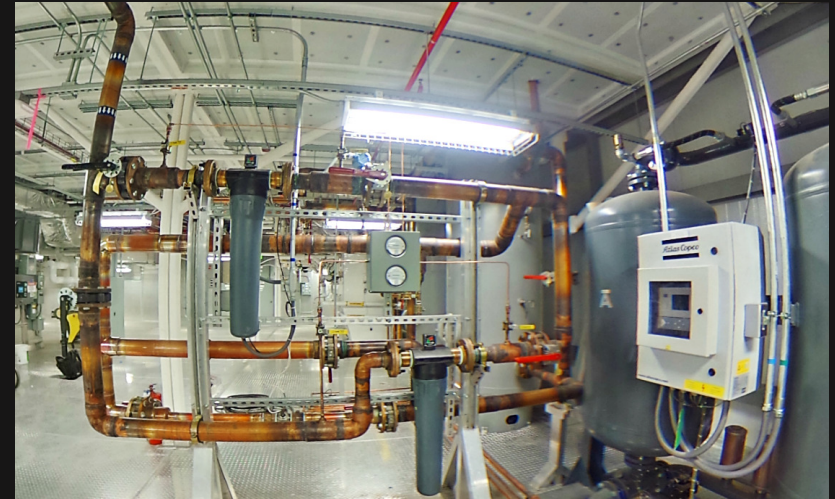
DESIGN TECHNICAL DETAILS

- The design included:
 - (3) custom air handling units
 - (3) desiccant dehumidification units
 - (3) dust collectors with exhaust fans
 - HEPA Bag In Bag Out Filtration.
- Process and instrument compressed air plant.
- The IT room consists of:
 - (10) racks
 - UPS
 - Cable tray and busways
 - Dual cooling CRAC unit



DESIGN TECHNICAL DETAILS

- Mechanical and HVAC piping including:
 - Chilled water Supply and Return
 - Hot Water Supply and Return
 - Medium pressure steam and condensate
 - Pure steam
 - Compressed air.
- All piping requiring insulation was insulated in the factory.
- Plumbing including:
 - Domestic cold and hot water
 - Non-potable water
 - Floor drains provided. Final connections made by on-site plumbing contractor.
- Fully piped roof drain system.



DESIGN TECHNICAL DETAILS

- Mechanical and HVAC duct work including:
 - In-duct humidifiers
 - Reheat coils
 - Cooling coils
 - Fire dampers
 - Sound attenuators
 - Phoenix Air control valves
 - Duct accessories and insulation.



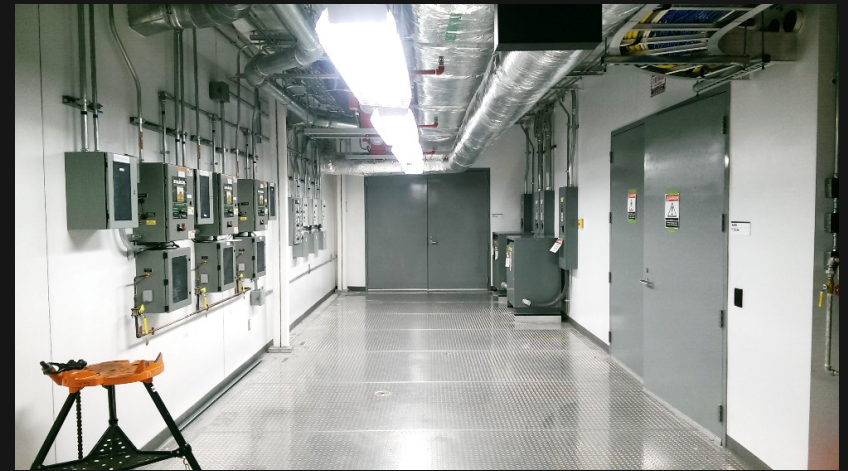
DESIGN TECHNICAL DETAILS

- The electrical system including:
 - Main distribution panels,
 - Conduit
 - Lighting
 - emergency lighting and egress lighting
 - Variable frequency drives
 - Distribution system for all equipment in the mechanical room.



DESIGN TECHNICAL DETAILS

- Controls system, all tying into a Rockwell Automation BAS, including:
 - All end devices such as pressure and differential sensors
 - Temperature and humidity sensors
 - Control valves
 - Actuators



DESIGN TECHNICAL DETAILS

- Misc. mechanical equipment including:
 - Fan coil units
 - Emergency shower/eye wash stations
 - Steam condensate pumps
 - OA intake louvers
 - General exhaust fans.
- Complete with:
 - Fire protection
 - Fire alarm
 - Factory installed roof system



Detailed Design Sept 2014

DESIGN TECHNICAL DETAILS





CONSTRUCTION MANAGEMENT



LEADING UP TO DELIVERY

- Completing as much of the build at OSC Fabricators facility
- Drying-in of building was dependent on module roof
 - Drove all construction activities to be prepared for dry-in
 - Penthouse was the critical path of the project and facilitated getting the building dried in sooner
 - Detailed Logistic Plans For Delivery



INSTALLATION PROCESS

- Delivery dry-runs ensured seamless delivery and setting of modules
- Greater tolerance needed to allow for creep/growth of modules
- Unforeseen field adjustment were required
 - Matching up fixed installations to modules
- Late changes and firm delivery date meant an increase in onsite work was required



IMPROVED SCHEDULE

- Parallel Construction Process
 - Typical sequential activities became parallel
 - Weather = No Problem
- Pre-commissioning
 - Checkout prior to leaving factory
 - Protocol & Asset Management Information gathering
- Dry-in and Condition Space Faster
- Improved QA/QC
- Within 10 days 17,000 sq. ft. was 85-90% complete with piping, electrical, and equipment installation

INCREASED SAFETY

- Ground level work
- Manufacturing environment
- Reduced site laydown/storage requirements
- Client "Zero Access" requirements addressed



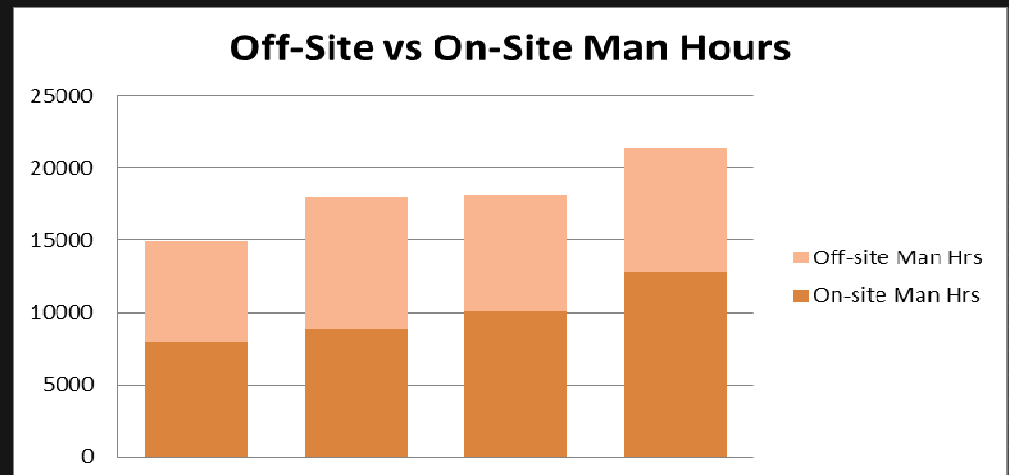
DESIGN ADVANTAGES

- Reduced overall height
- Efficient equipment layout with integrated economics
- Provided space for future line infrastructure



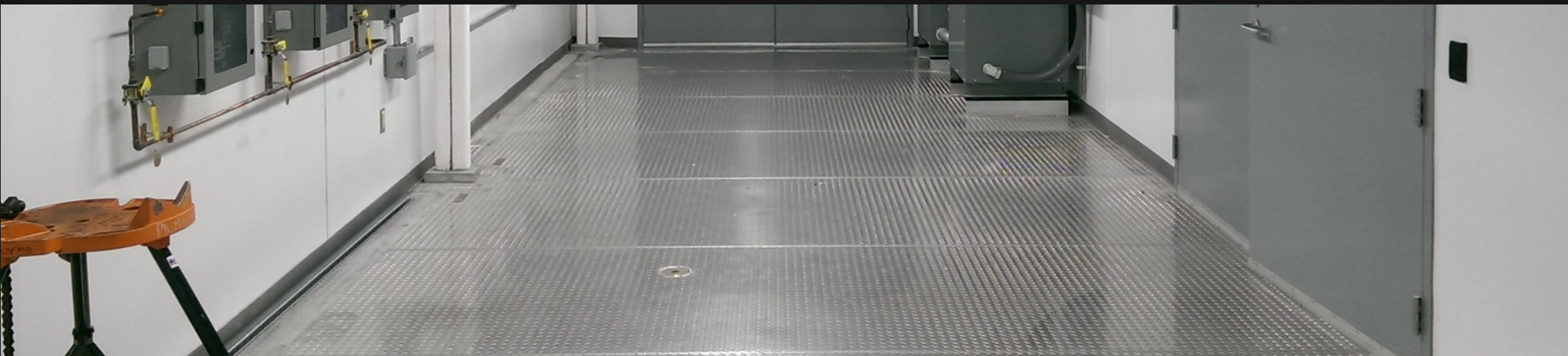
CONSTRUCTION ADVANTAGES

- Offsite construction reduces the safety risk for project
- Site logistics and cleanliness were far more manageable
 - On-site onboarding
 - Parking
 - Laydown





LESSONS LEARNED



THINGS THAT WENT WELL

- No safety incidents
- Regular meetings with Fabricator, CM, Owner, Design Firm
- Designer level coordination
- 3-D model integration
- Module delivery 'Dry-Run'
- Module setting planning and execution



OPPORTUNITIES FOR IMPROVEMENT

- CM should have a dedicated resource at off-site construction location
- A more formal off-site checkout prior to releasing modules for delivery
 - Factory Acceptance Testing approach
- Having an alternate delivery date to allow for more offsite work completion
- Define and resolve building code requirements early (building vs. listed equipment)



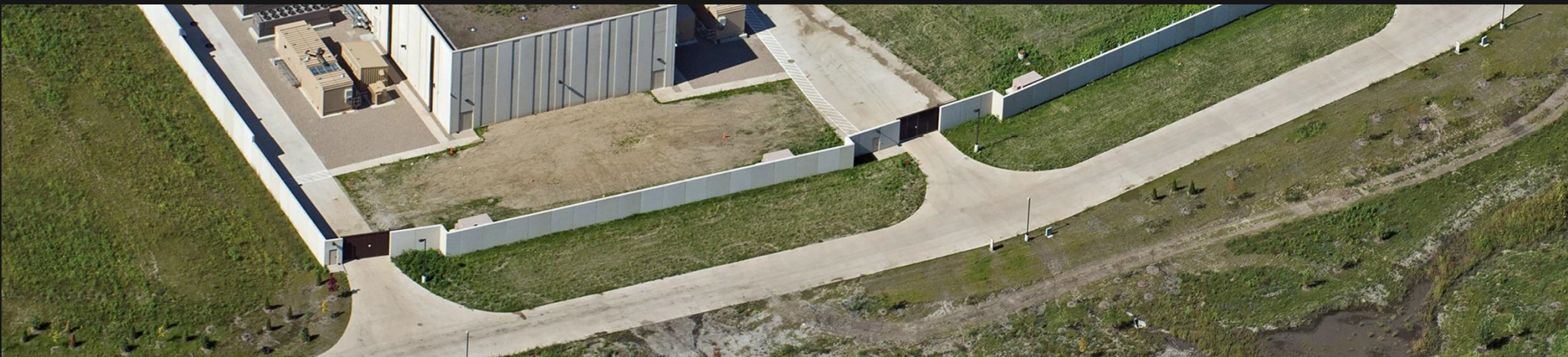
OPPORTUNITIES FOR IMPROVEMENT

- Allow for more dimensional variance
- Tighter control of field contractors with regards to meeting dimensional requirements
- Better document variances between construction specifications and fabricators typical materials and methods
- Should've discussed modular approach earlier in the design process





WOULD CLIENT DO IT AGAIN?



YES.

Factors that made off-site construction the right choice for this project

- Elevated mechanical space
- Schedule Driven project
- Expansion to operating facility
- Stringent security clearance and training requirements for on-site workers
- Enabled fabrication of complex systems to begin much earlier while building shell was progressing
- Workers were exempt from stringent training and security clearance requirements for working on site
- On site contractor facilities were reduced to half of what would have been needed for on site construction saving space, cost and improved logistics
- Less onsite work and workers reduced risk of disrupting plant operations
- The above resulted in overall construction cost and schedule savings



OnsiteView.com

**Ellypta - Camera 2
Time-lapse Video
April 10, 2015 - February 27, 2016**

Thank you!