



IDEA2022

Building Connections

June 6-9 | Sheraton Centre Toronto Hotel | Toronto, ON



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Advantages of Point Cloud Mapping and 3D BIM Modeling

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Overview

- Definitions
 - Point cloud mapping (laser scanning)
 - 3D BIM modeling
- Applications for point cloud mapping
- Typical questions about point cloud mapping
- Advantages of implementing point cloud mapping during either the design or construction phase
- Issues associated with point cloud mapping (laser scanning)
- Integration of a point cloud map in the BIM model
- Coordination advantages for final project turnover
- Case studies

Point Cloud Mapping (Laser Scanning)

- A LIDAR (Light Detection & Ranging) scanner emits a laser over an area that is desired to be modeled.
- The laser locates a number of points of the modeled object on a coordinate plane. The scanner can be moved around to create more detailed models.
- A point cloud model can be created from one or several scans. This model can be imported into CAD/BIM software for coordination by the design/construction team.

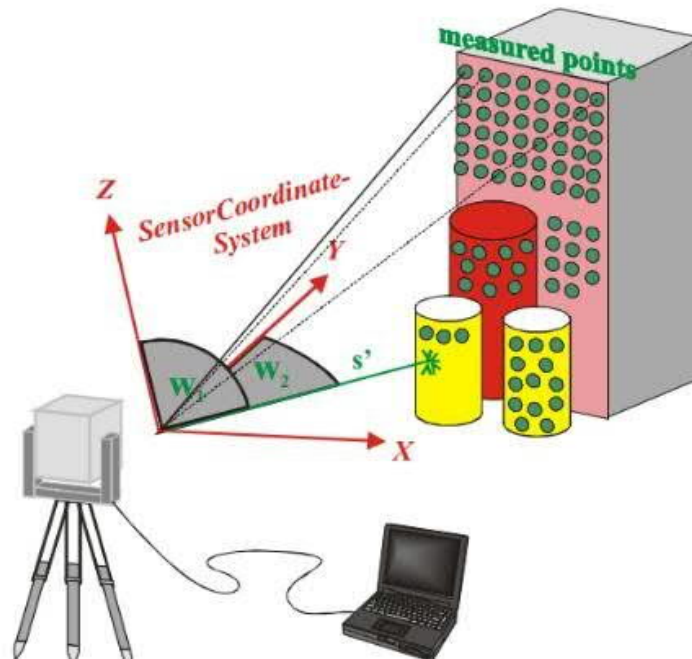
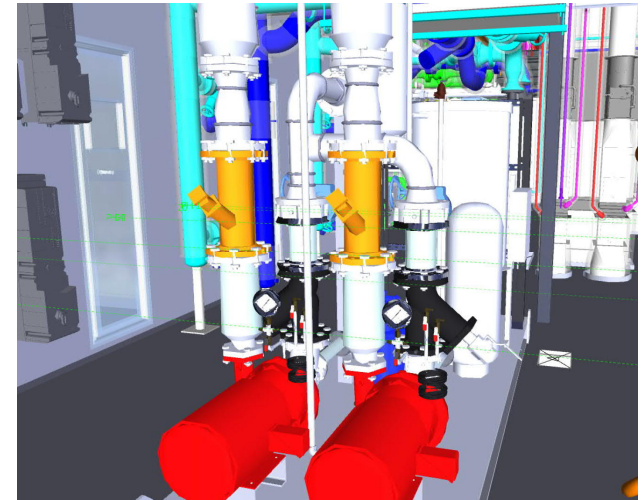


Image Source: Khomsin, Khomsin & Pratomo, Danar & Anjasmara, Ira & Ahmad, Faizzuddin. (2019). ANALYSIS OF THE VOLUME COMPARISON OF 3'S (TS, GNSS and TLS). E3S Web of Conferences. 94. 01014. 10.1051/e3sconf/20199401014.

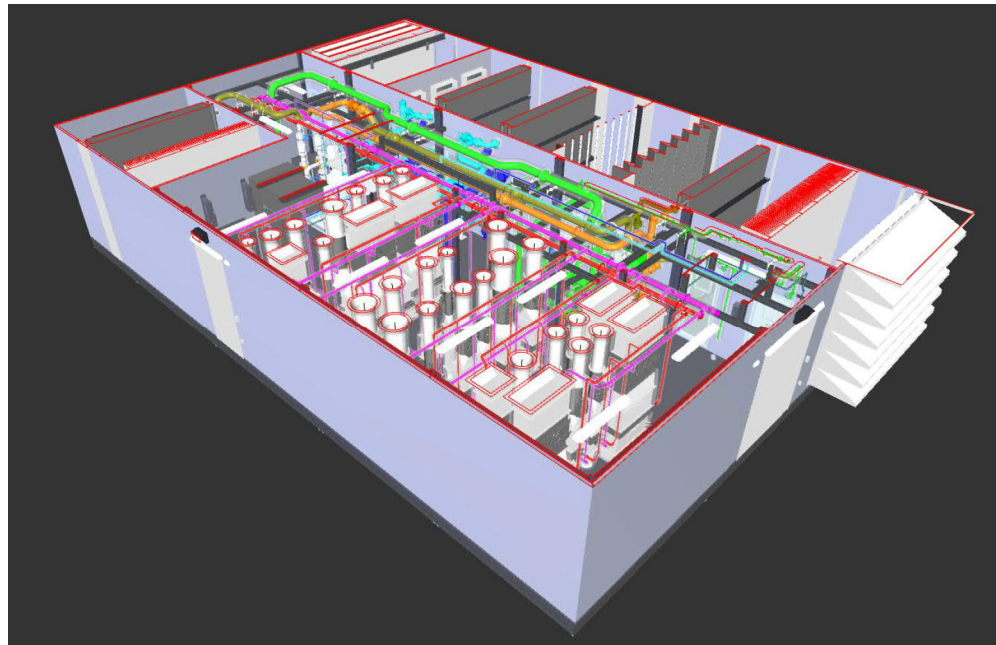
Building Information Modeling (BIM)

- ISO 19650-1:2018 defines BIM as:
Use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions.
- The US National Building Information Model Standard Project Committee has the following definition: Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.



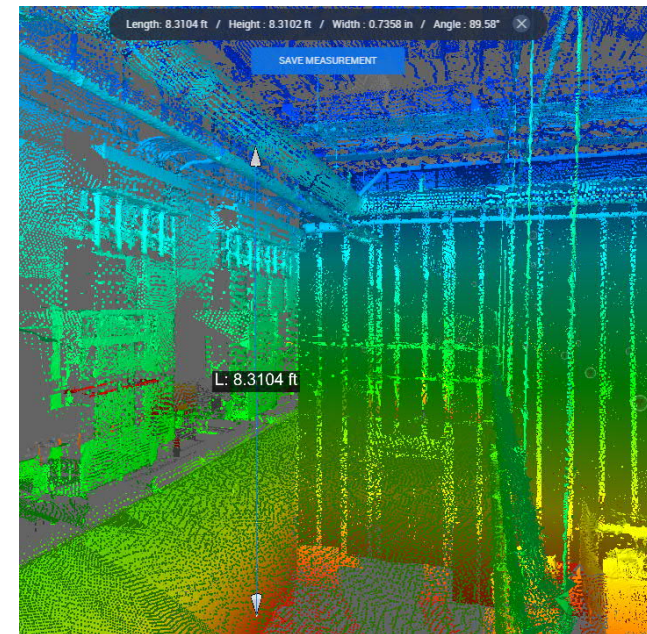
Applications for Point Cloud Mapping (Laser Scanning)

- Complex existing piping and ductwork layouts requiring high levels of coordination with new work.
- Accessibility is a key driver of design.
- Construction must occur during a short shutdown window and must be done correct the first time.
- Project is under a tight budget, and costly mistakes must be avoided.



Typical Questions - Point Cloud Mapping (Laser Scanning)

- Is it accurate?
 - New technology is accurate to within 1/32 of an inch
 - Improved accuracy when multiple scanning locations are combined
- Manual survey required?
 - May eliminate need for manual survey while saving time
 - Measurements can be taken directly from point cloud map without the need to revisit the survey site if information is missed
- Limitations of point cloud mapping?
 - Reflective surfaces can impact the accuracy
 - Smaller objects may not be clear in scan if digital noise exists (i.e., 1/2" piping or conduit)
 - All components need to be visible to scanner location
- Cost?
 - Typical cost for point cloud mapping is comparable to the cost associated with manual survey of the project area
 - Added cost to have point cloud converted into a BIM model (not required)

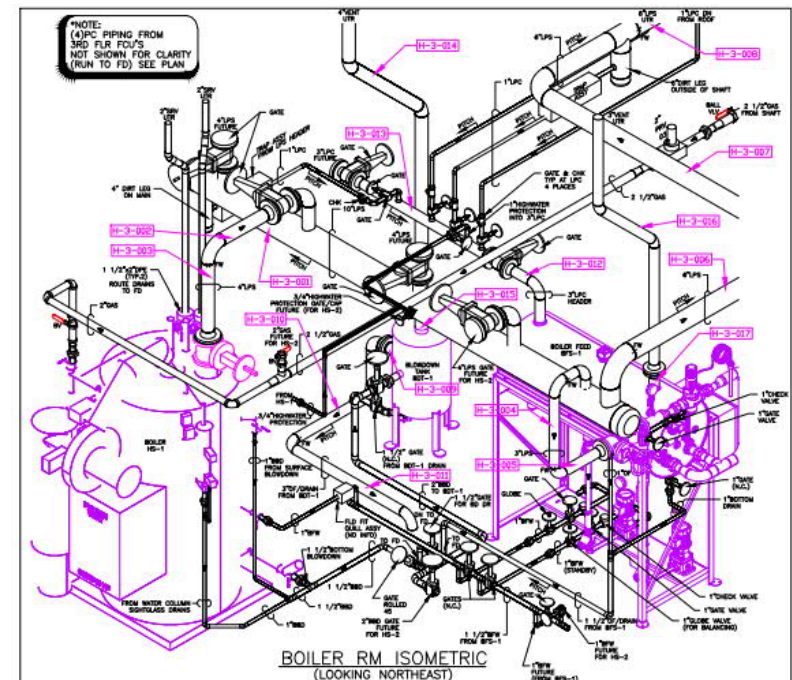


Point Cloud Mapping Implemented During Design

- Reduces site survey time and limits additional site surveys as the point cloud scan will contain all information on existing conditions
- Design will be based on highly accurate existing conditions
 - Eliminates risk of inaccurate record drawings (if record drawings exist)
 - Eliminates risk of inaccessible or elevated working conditions during survey to document accurate existing conditions
- Reduces the chances of change orders or redesign once construction begins
 - Costs associated with actual conditions will be included in contractor bid packages
- Allows for coordination with existing equipment or components that are to remain (clearance requirements, maintenance access, etc.)

Point Cloud Mapping Implemented During Construction

- Shop drawings and contractor coordination will be based on highly accurate existing conditions
 - Reduces time for shop drawing creation in congested areas
- Allows for coordination with existing equipment or components that are to remain (clearance requirements, maintenance access, etc.)
 - Changes may be required to be made by contractor to meet requirements versus project design drawings



Issues with Point Cloud Mapping (Laser Scanning)

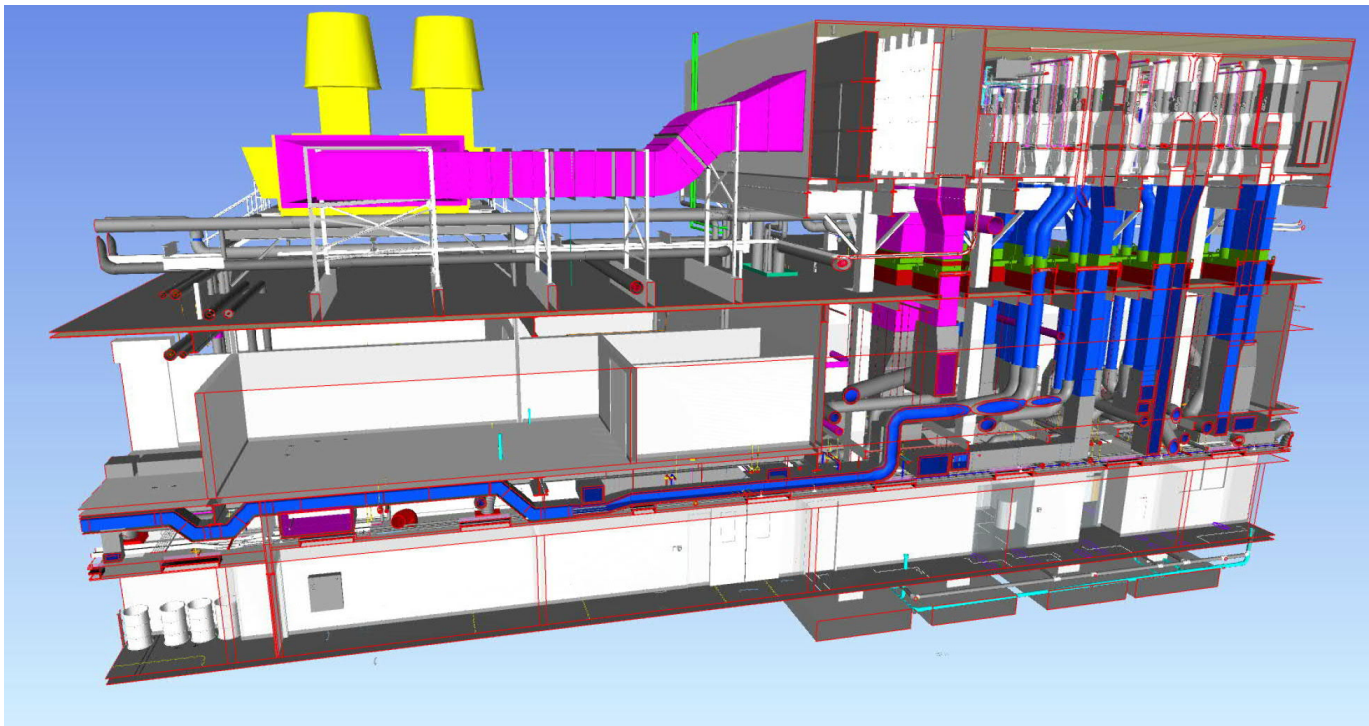
- Access to the entire project area is required to allow for a complete model
 - Line of sight required to accurately show all objects
 - Objects hidden from scanner will not be visible unless additional scans from multiple angles are completed
 - Complexity of project area determines the quantity of scans required to be completed
- Lighting levels can impact the detail of the point cloud creating a grainy image with increased signal noise
- Manual survey will be required to determine pipe, duct, equipment, etc. sizes if insulated when reliable record drawings do not exist

Integration of Point Cloud Mapping and 3D BIM Model

- Allows for accurate existing conditions to be shown in the design or contractor coordination model
- Clash detection can be utilized to determine if any conflicts exist with existing conditions
- Items/components in the point cloud can be set as demolished eliminating inaccurate conflicts in the clash report
- Integration can be completed during the design or as part of the shop drawing development

Coordination – Contractor Installation

- Streamlines coordination efforts between multiple trades and the existing conditions
 - Clash detection will include all existing conditions that are to remain
- Reduces upfront schedule to complete a full survey by the contractor to determine existing conditions allowing for a quicker turnaround on shop drawings



Coordination - Owner

- Ability to verify installation locations for all equipment or components that require routine maintenance are acceptable to owner
- Allows for virtual walkthrough to be completed prior to installation
 - Modifications can be made to layout based on owner review
 - Identify all valves that require chainwheels if unable to locate below 6'-0"
 - Verify access via ladder and or lift if required for equipment or components
- Scan can be completed as part of project turnover to document the as-built conditions

Case Study – SE PA Pharmaceutical Company – Utility Rack & Chiller Installation

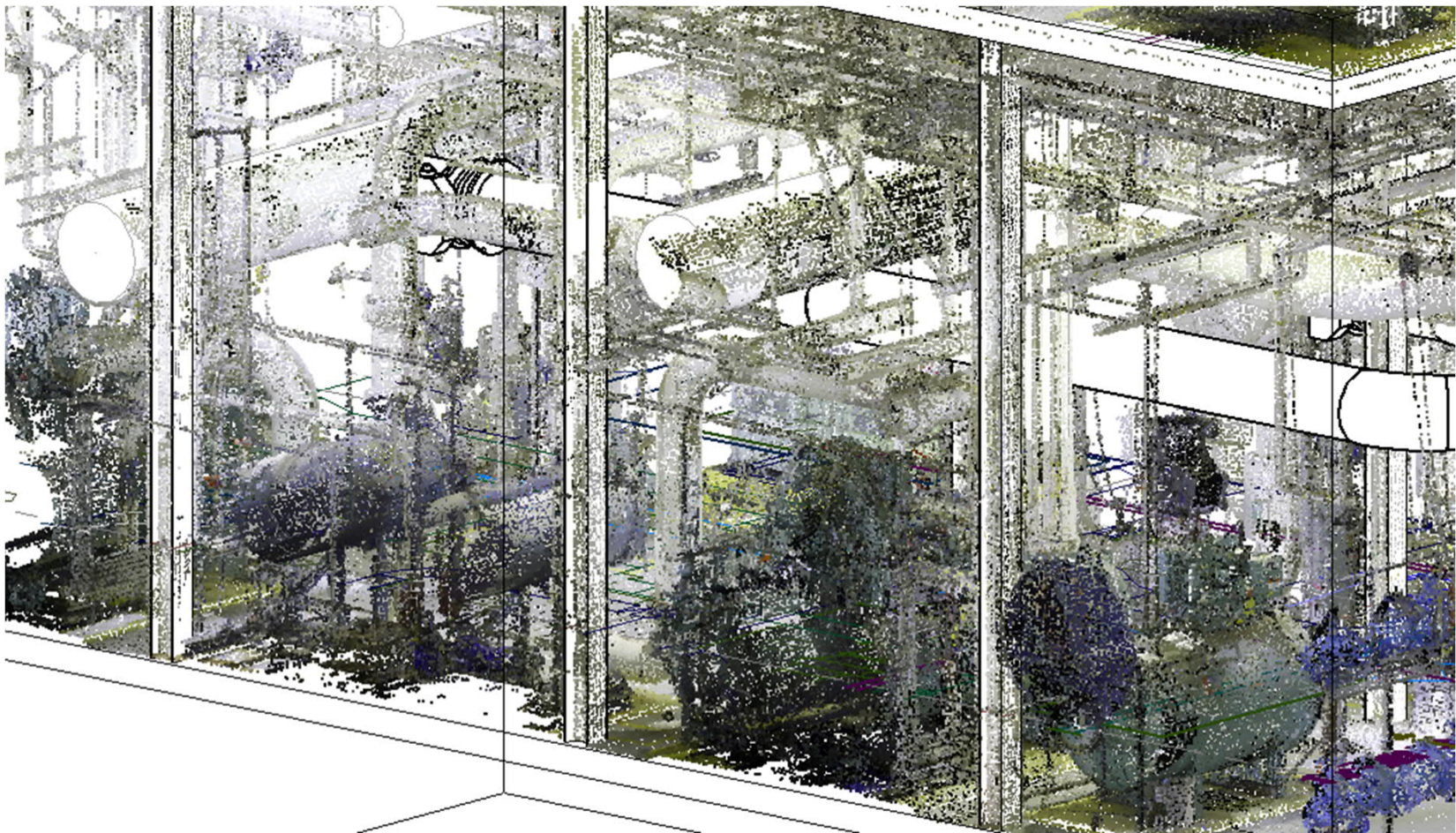


Figure – Point Cloud Map Chiller Plant 1st Floor – 30" CHWS Pipe Connection to Existing Coordination

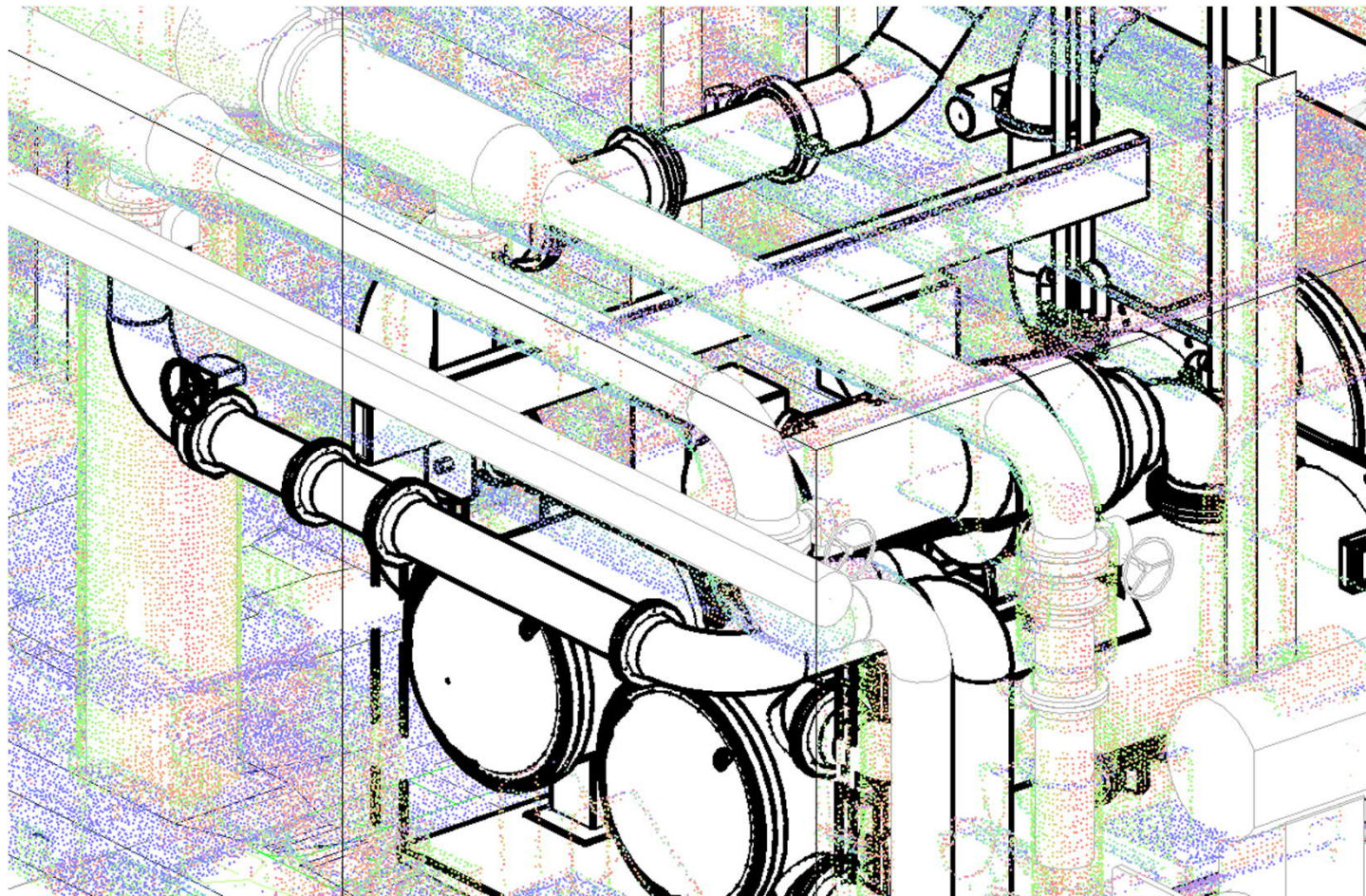


Figure – Point Cloud Map Chiller Plant 2nd Floor – 2,000-ton Chiller & Hoist Beam Installation Coordination

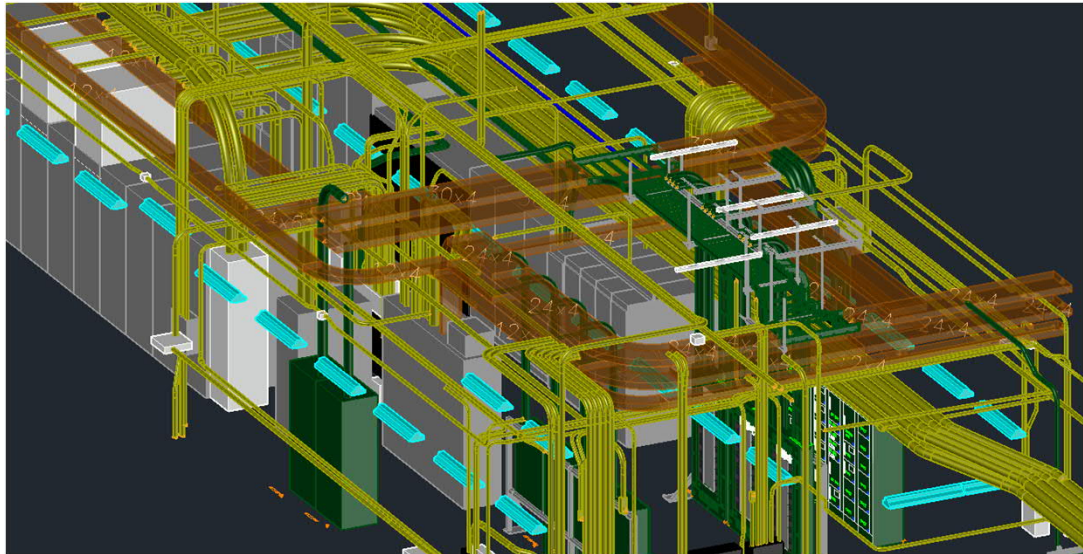
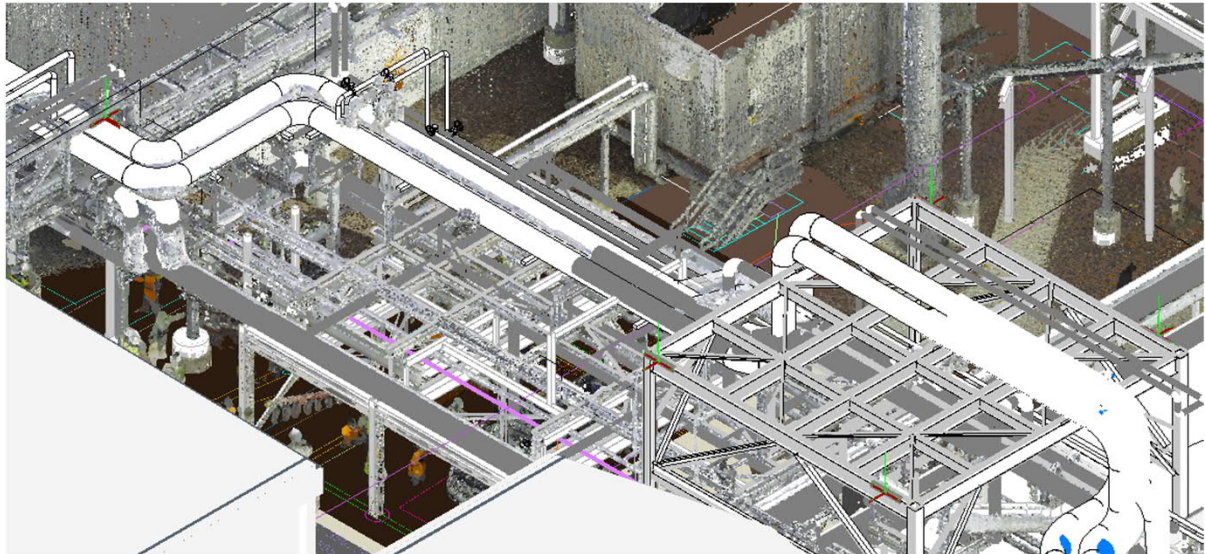
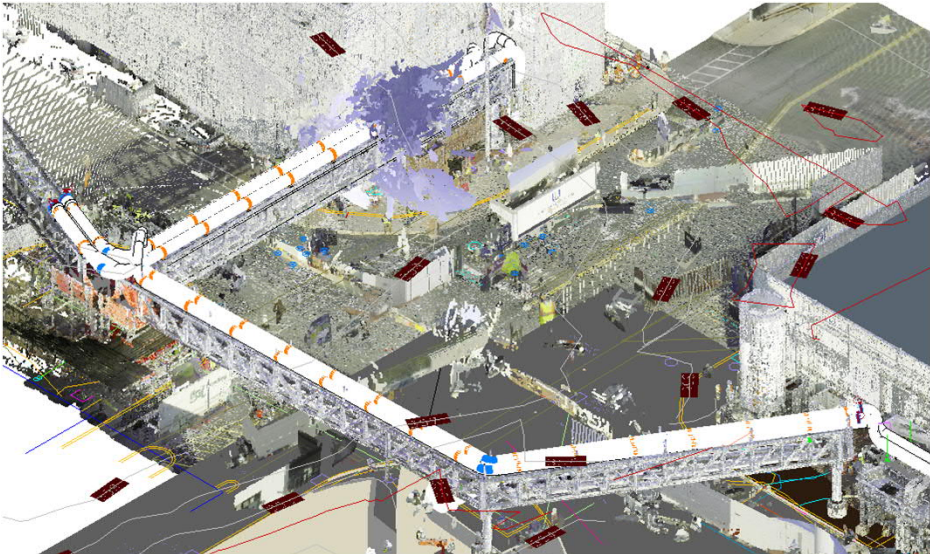


Figure – Point Cloud Map Electrical Room – New Medium Voltage Chiller Feed



Figures – Point Cloud Map Utility Rack– Coordination of New CHWS/R, HPS, and PC Piping on Existing/New Utility Rack

Case Study – Philadelphia Pharmaceutical Company – Fit-out

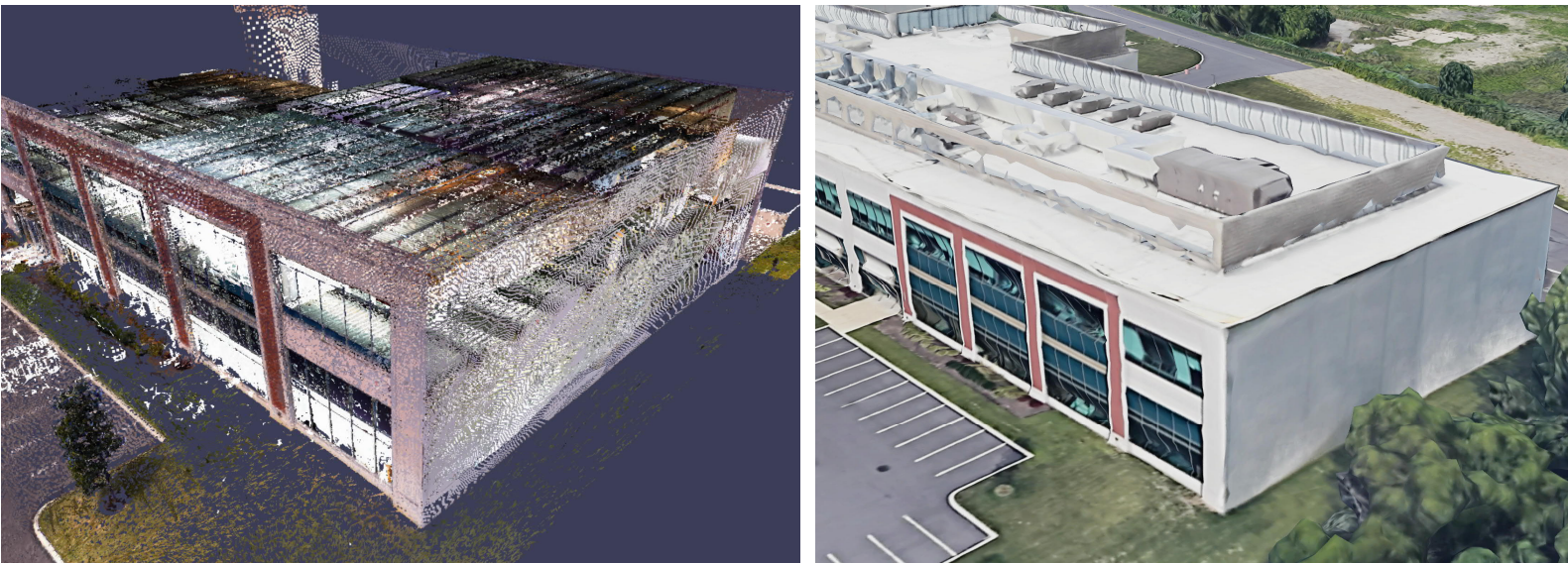


Figure – Building Exterior - Laser Scan (Left) and Google Earth Image (Right)



Figure – Electrical Panels on Walkable Ceiling - Laser Scan (Left) and Photograph (Right)



Figure – Chilled Water Piping - Laser Scan (Left) and Photograph (Right)

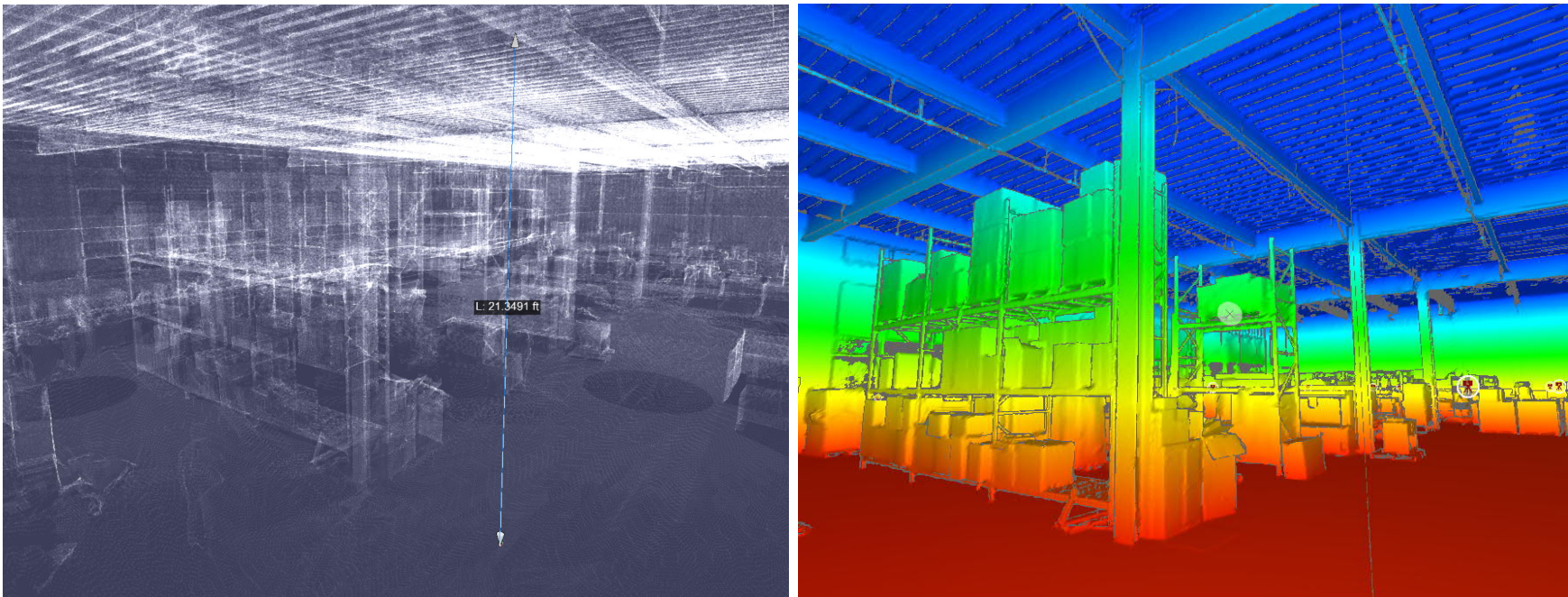
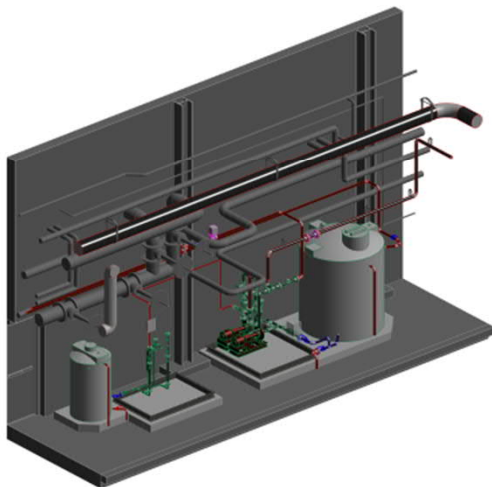
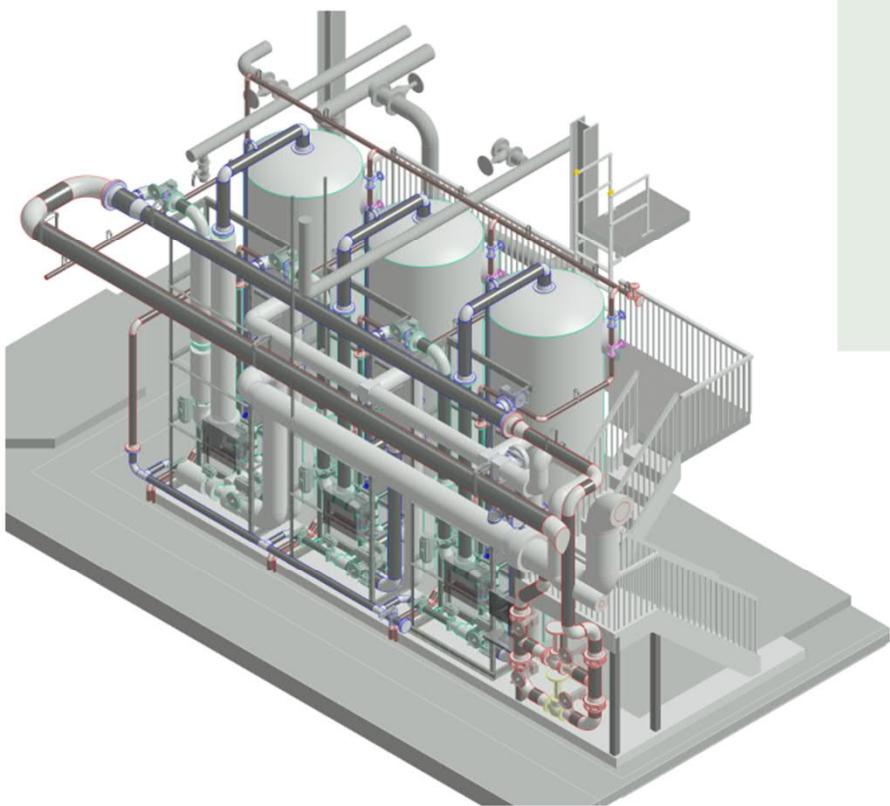


Figure –Shell Space – Point Cloud (Left) and 3D Heightmap View (Right)

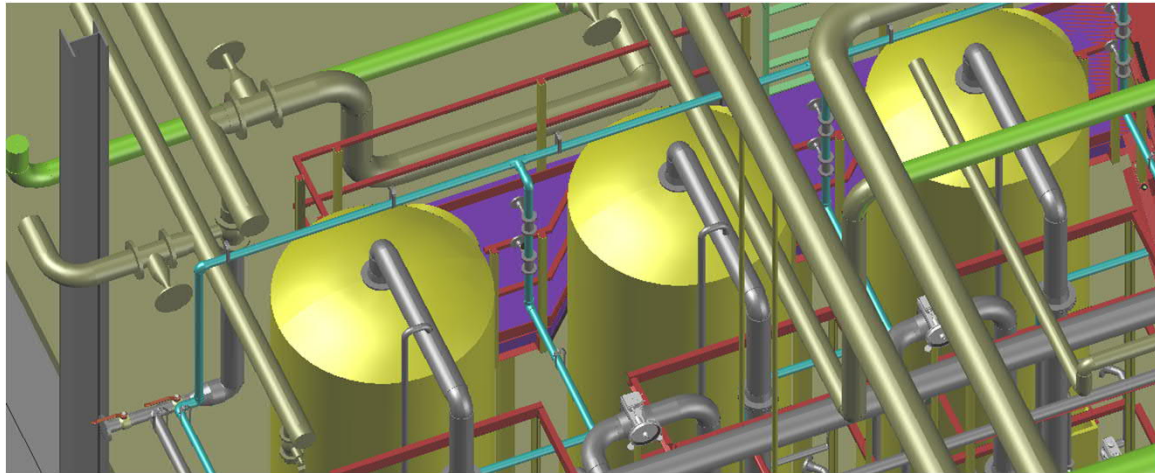
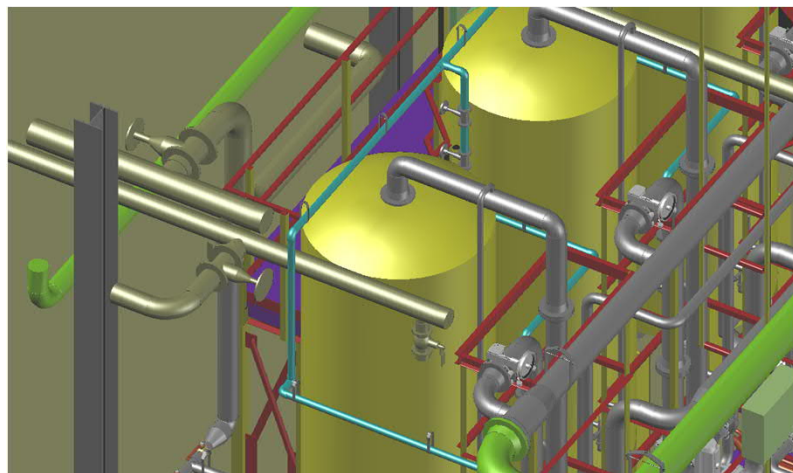
Case Study – SE PA Pharmaceutical Company – Condensate Polisher



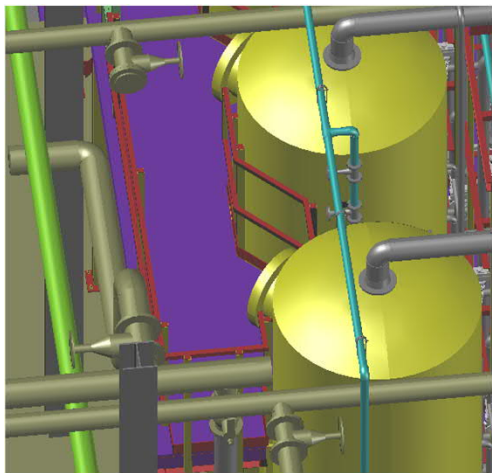
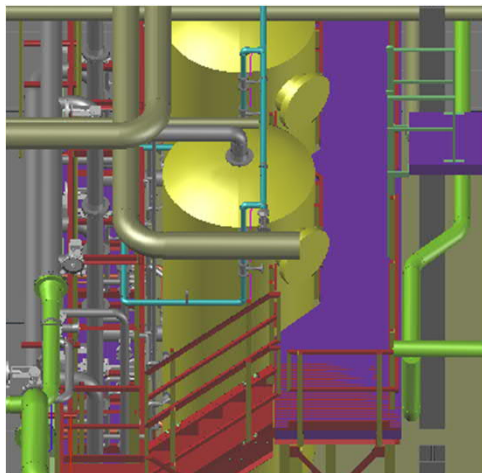
Figures – BIM Model and Final Installation



Figures – BIM Model - Final Design



Figures – Coordination with Existing Conditions (from Point Cloud Map)



Figures – Coordination with Existing Conditions (from Point Cloud Map)

Thank You!



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