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Recognized benefits of 3-D Image Scanning and MEP Model Development for Improved As-built Verification of Vertical Structures and Complex MEP Systems Leading to Effective Contractor Management. A White Paper.

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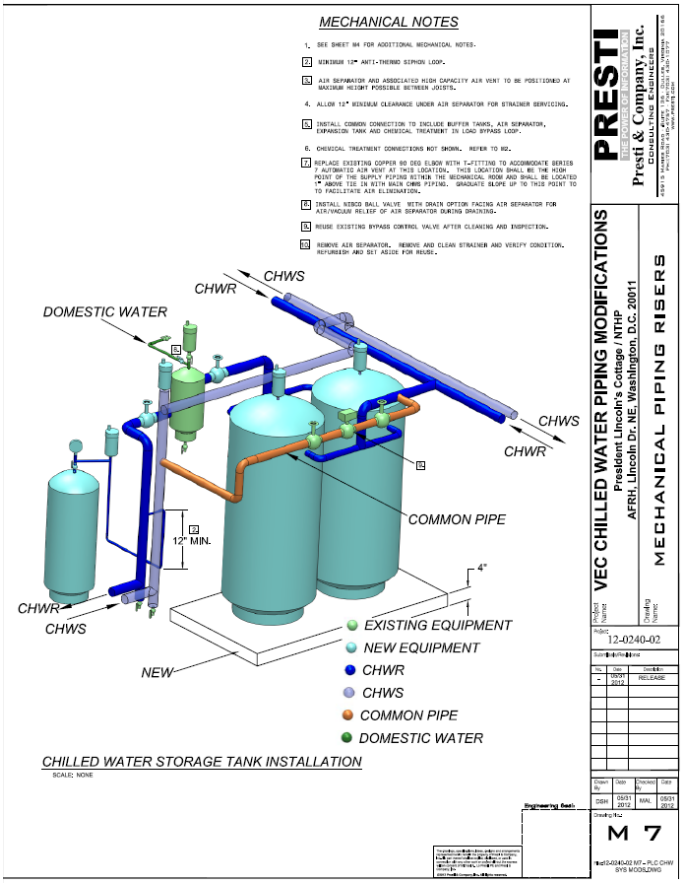
Background: The Department of General Services through the Division of Engineering and Buildings manages the Commonwealth of Virginia's owned buildings. This Group also manages the statewide building design and construction process, reviews design documents, maintains a centralized facility assessment system, and works with other government organizations to establish capital planning and project funding. In August of 2013, Presti & Company, Inc. was awarded a contract to further develop and complete vertical 3D scanning for interior of buildings. This technology is very new and most users are land surveyors who use the technology for exterior infrastructure mapping. PRESTI is the only MEP Consulting Engineering firm awarded a contract based on our experience working inside buildings with complex MEP systems.

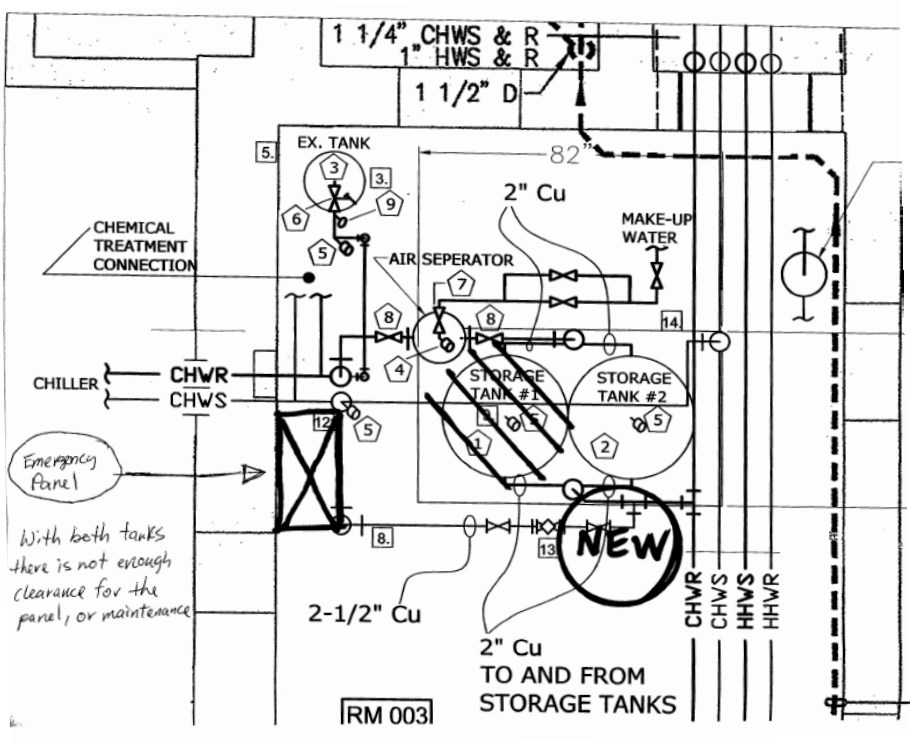
The Problem: For centuries, the qualified MEP Engineer, Architect, and construction Manager has relied on field notes, sketches and other forms of communication from the installing contractor. As the quality of information and accuracy has improved in the design phase, generally we expected the quality of contractor correspondence to improve as well. However, what we found in contrary was because of time constraints and rush of many projects, the information we were obtaining from installing contractors was unreliable and not accurate. Generally, if this information was not validated and the contractor authorized to make design changes, experience dictates an increase in change orders, a drastic rise in project costs, and often degradation in system operating performance.



To the right is the right hand portion of a high quality project drawings issued on a recent project. Full plan views were also included in the drawing package but not shown for brevity.

The Old Solution: Typically when a field problem arose and a configuration non-conformance issue was identified, most design professionals would request the contractor to provide documentation illustrating the circumstance and then request and RFI for clarification. The Engineers would generally assume contractor information as accurate as the contractor was understood to have an innate knowledge of the situation. Most Engineers, Architects and Construction Managers assume that the correspondence coming from the field to be accurate and fully validated when received.

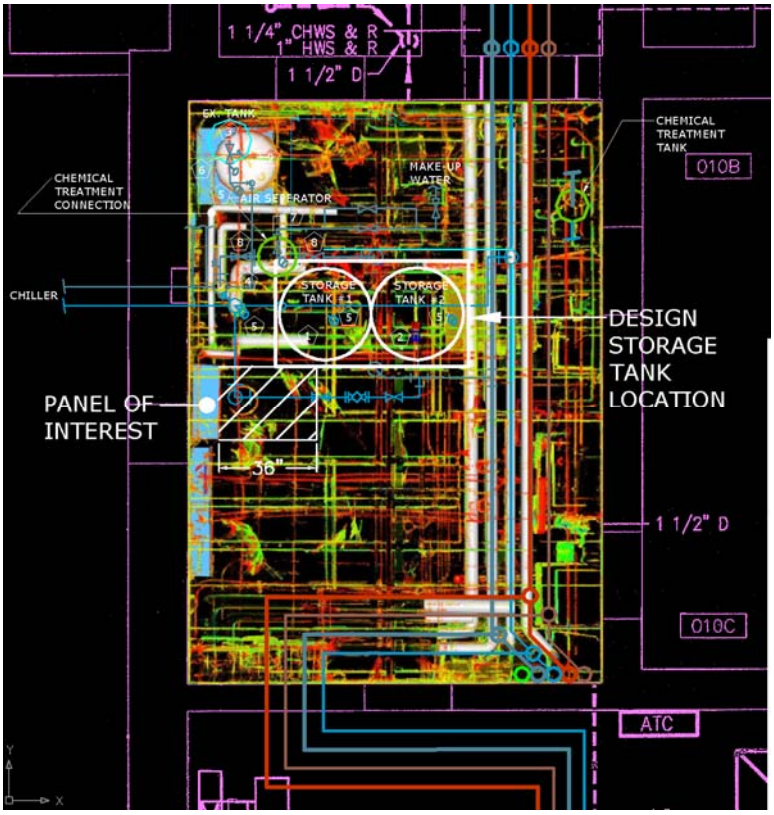
As Engineers, Architects, Construction Managers pushed hard for improved documentation to the field, generally the assumption is that the field contractors are reciprocating and providing accurate field information fully vetting issues for the benefit of the project.



The example to the right illustrates recent and typical communication from a contractor stating that the tanks could not be located because they would interfere with the installed electrical panel.

Initially, we were somewhat perplexed in that, as experienced MEP Engineers, we have always recognized the significance and constraints of the electrical systems/panels minimum clearance and the code requirement of 36"

A New Methodology: Enter 3D imaging technology and model development. 3D Imaging technology is the most advanced technology for replicating any three dimensional object with an infinite series of points organized in a polar coordinated geospatial relationship. 3D scanning in the construction industry refers to the practice of using 3D imaging systems to capture existing conditions in the built environment. 3D imaging systems are instruments that are used to rapidly measure the range and bearing to the 3D coordinates of points on an object or within a region of interest. Examples of 3D imaging systems are laser scanners, also referred to as laser radars or LADARS (laser detection and ranging), and LIDARS (light detection and ranging). Measurements from 3D systems are made without physical contact between the instrument and the object

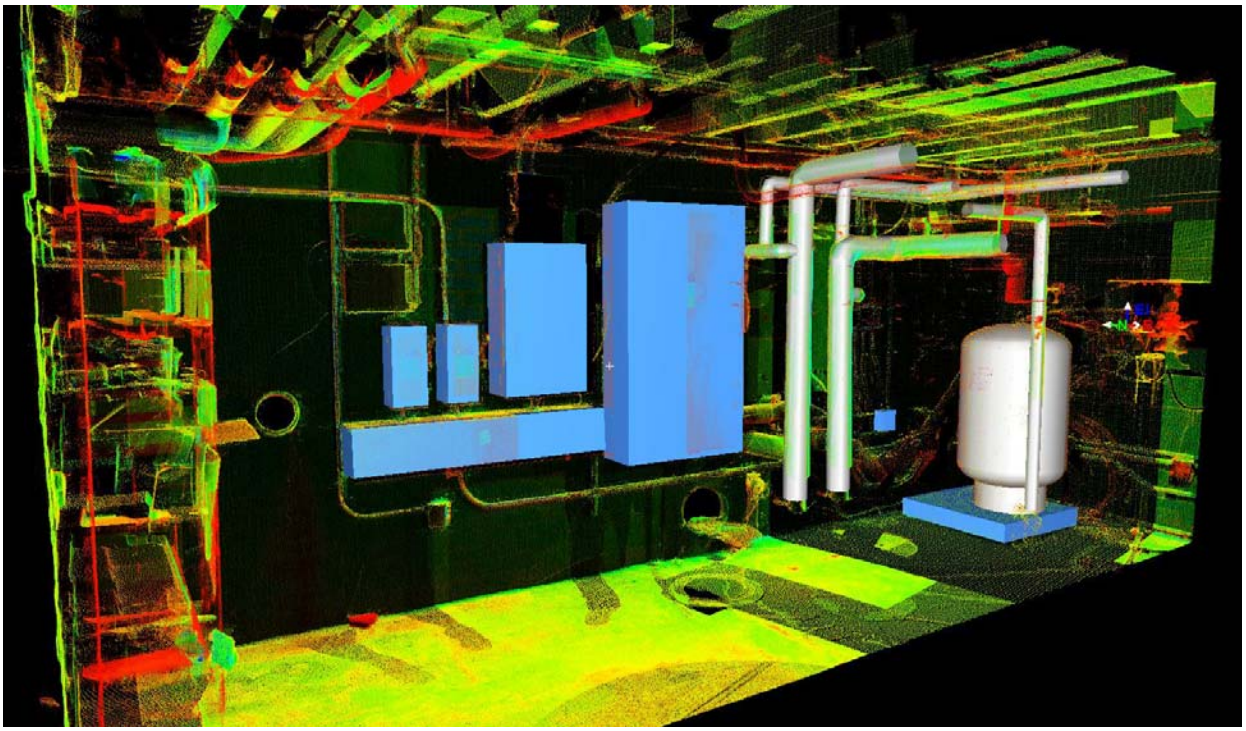


and propriety methodology is available to take this measurement data and convert it into usable and valuable information. The maximum ranges of 3D imaging systems vary from under 1 meter to over 1 kilometer, and measurement errors vary from sub-millimeter level to centimeter level. At present time, Presti & Company, Inc. has experience with accuracies of 2 mm in 30 m ranges. However, due to the complexity of the post data processing phase and the cost of the most accurate equipment, the significance of selecting the proper accuracy for the scanning application is of paramount importance. We have found that the solution providers that recognize this fact and provide a matrix of scanning resolution solutions for a typical building application is the most cost effective approach. This is of particular importance when historic structures are scanned as confirmed during our recent work at President Lincoln's Cottage for the National Trust for Historic Preservation.

Revisiting our Example: Upon receipt of the contractor RFI, we completed a comparison of the contractors concern with information we had gathered from a 3D scanned image at the site. While we developed this project in 2D space, the image on the following page fully verified the design and illustrated that indeed the contractors sketch was inaccurate. We promptly issued a clarification requesting the contractor to refrain from proceeding with equipment pad concrete pours in the incorrect location and suggested a mockup of the tank locations. See the image below.

Note the clarity and precision we were able to illustrate. Note also the clearance between the panel maintenance space and the tank location. With confidence we then waited for the results of the field mock-up trial. To the surprise of the Owner, the tanks in the specified location fit perfectly with adequate clearance to proceed with the project as designed.

Below shows another image of a 3D view of the modeled spatial point data.



Significant Advantages: A major benefit to 3D imaging systems is the ability to capture existing conditions in a special representation more completely, and with a level of detail not possible with manual methods. Additional advantages include: reduced variance in construction bids, reduced errors and rework, improved responsiveness to project changes, schedule reduction, and 3D visualization. 3D visualization can be essential in explaining and understanding complex or complicated conditions. With the scanning equipment technology existing today, we can achieve up to 2 mm accuracy at 30 m depending on light conditions and reflectivity of the object surfaces. With this accuracy we can model mechanical (ductwork, piping, sprinkler) and electrical (conduit size) geometric shapes with ¼ inch of trade size accuracy. In addition, from this improved modeling capability we can conduct complex volumetric analysis for detailed hydronic piping systems and evaluating and resolving complex technical issues within hours instead of weeks. Specifically, we have used this technique to determine undersized buffer tank configurations on chilled water systems resulting in having solved 5 such instances of malfunctioning and premature chiller failure to date.

Presti & Company, Inc., through the use of internally developed proprietary methodology have developed methods for determining actual pipe material based on scanned point clouds and also have developed methodology for determining pipe size under insulation and insulation thickness using 3-D scanning. In addition, we have conducted preliminary studies on qualitative and quantitative point cloud delivery data evaluation. These methodologies have further strengthened our interest in this technology.

Applications: The primary applications of 3D imaging relative to as-built documentation include: repair of historic building facade, generation of 2D CAD plans/elevations, map several buildings in a BIM site model, document MEP conditions, develop reflected ceiling plans, document roof patterns, and document deformation of existing structures and structural elements and a host of support services in plant start-up and commissioning support activities. As a further note, we have found often as-built drawings generally has the outline of the architectural shell features somewhat accurate but rarely are any of the existing MEP systems properly located on the as-builts. Also, we have additionally found that most of the modeling completed by architects today is not accurate in that wall constructions are modeled normal to floors and our experience has shown that this is rarely the case in actual construction. Precise 3D scanning and proper model development has the ability accurately illustrate out-of-plumb services and skewed features which is an actual representation of the space. The resulting recommendation is that 3D image scanning and proper model development should be utilized to gather accurate existing building conditions.

Recommendation: Presti & Company is actively improving and further developing the technology to change the dynamics of high quality MEP design, plant start-up, commissioning, reliability and operations for general building constructions and complex plant projects. We welcome the opportunity to discuss where this technology from a proven high quality MEP Consulting Engineering firm like Presti & Company, Inc. can deliver significant benefits to your current project.

For more information please contact:

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