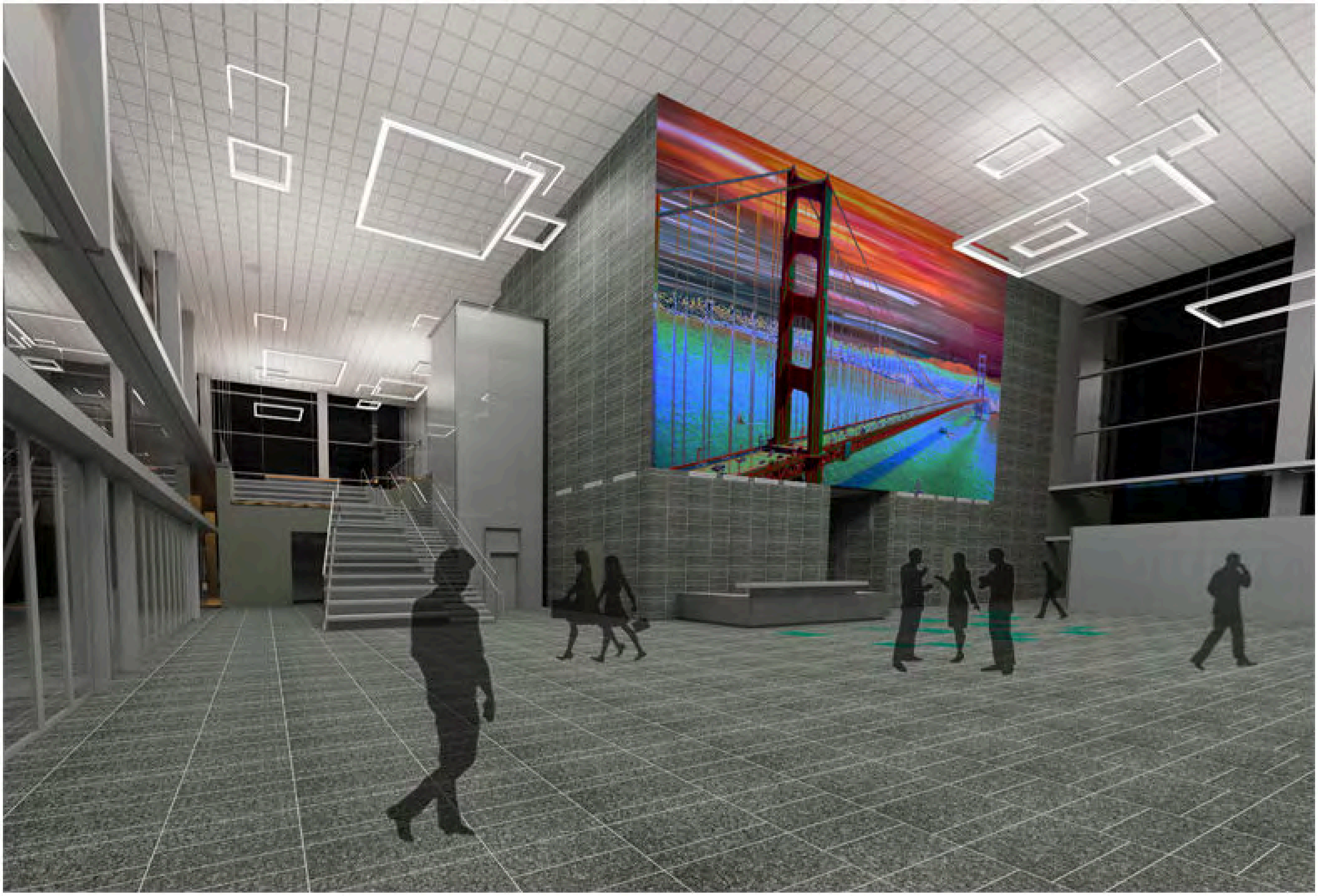
AEVITAS

UNENDING COMMITMENT TO INTEGRATED DESIGN



Taking an *integrated approach*, **AEVITAS** strives to *minimize environmental influences* by *engaging our community* with *sustainable* practices in energy conservation & emission reduction.

[ZERO**impact**]

ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition

Team Registration Number **03-2014**

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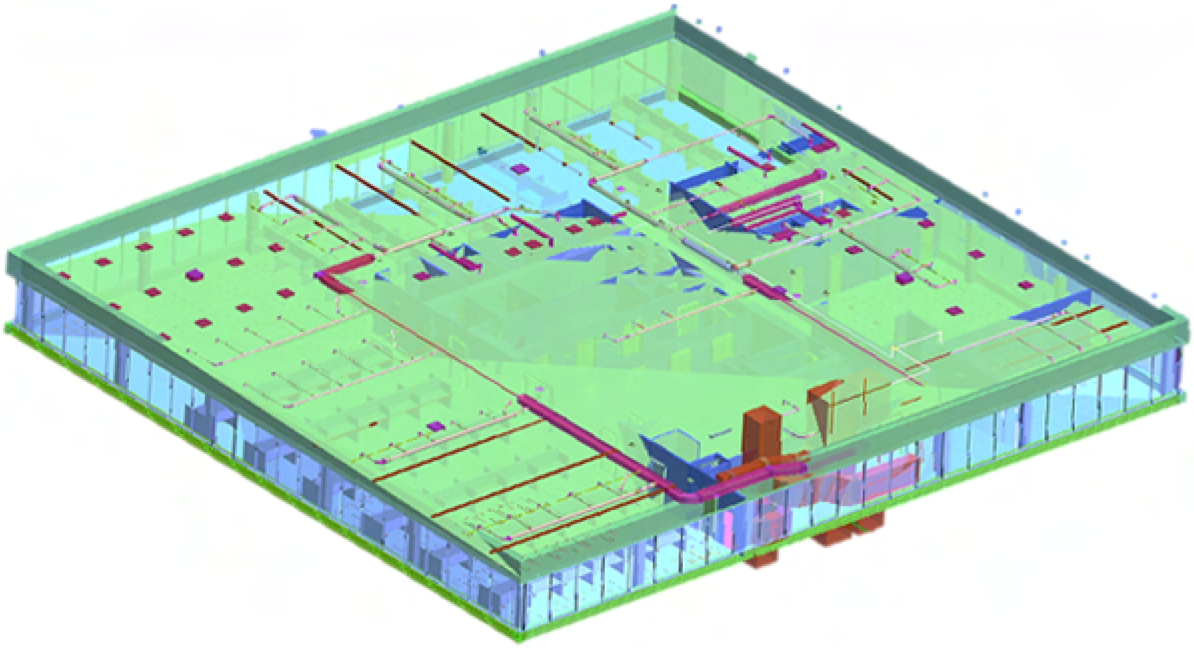

ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition

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INTEGRATION

Table of Contents

Integration Narrative

Supporting Documents

Drawings

EXECUTIVE SUMMARY

The following report details the building systems integration of 350 Mission, San Francisco.

With the end goal of designing a net-zero high-rise building in the heart of San Francisco, **AEVITAS** developed the overarching attitude of [ZERO**impact**], encompassing four design goals of [ZERO**interruption**], [ZERO**energy**], [ZERO**waste**], and [ZERO**emissions**]. Through integrated design analysis, **AEVITAS** achieves these goals through effective and efficient collaboration. **AEVITAS** is an integrated design team, composed of representatives from the construction, structural, electrical, and mechanical disciplines. Through a unified effort, 350 Mission's environmental impact has subsided. Information about the design of 350 Mission can be found in **AEVITAS**' reports as detailed in Table 1.

TABLE 1: SYSTEM OVERVIEW BREAKDOWN

ARCHITECTURAL	Floor Plan Changes, Vestibule Addition, Integrated Public Art Piece
FAÇADE	Natural Ventilation Louvers, Seismic Connections, Electrochromic Glazing
MECHANICAL	Radiant Floor System, Natural Ventilation Louvers, Dedicated Outdoor Air System
LIGHTING	LED Lighting, DALI Controls Responsive to Daylighting and Occupancy, Task Lighting
ENERGY GENERATION	Onsite Solar Array, Offsite Solar Array, Human Waste to Power Converter
ELECTRICAL	AC and DC Distribution, Natural Gas-Powered Fuel Cells, Dual Electrical Risers
STRUCTURAL	Steel Superstructure, Braced Frame Core, Composite Beams and Deck, Outrigger System, Concrete Substructure
CONSTRUCTION	Production Planning, Matrix Scheduling, Waste Management, BIM Execution Planning, Site Planning

350 Mission is located in the South of Market (SoMa) district of downtown San Francisco, an energetic, diverse neighborhood housing several prominent high rise buildings. The area is subject to microclimates and sub-microclimates due to the city's dynamic topography and marine layer.

In developing the most effective and optimal design of 350 Mission, a decision making system measures each system selection's alignment with the four design goals as well as impact and integration with the other disciplines. In addition to several diverse forms of media utilized for both communication and information exchanges, **AEVITAS** held documented weekly coordination meetings. A Building Information Model (BIM) Execution Plan established a schedule and coordination of software programs.

350 Mission features several integrated building components. The substructure requires a composite slurry wall system combined with internal diagonal bracing to support the excavation for the mat foundation. The building envelope balances architectural design with daylighting and natural ventilation louvers while incorporating constructability and structural weight. Supply diffusers in the lobby integrate and avoid clashing with both the core structure and interactive public artwork to supply outdoor air to the occupants directly. Similar to the lobby, radiant tubing and electrical conduit are coordinated and located on top of the concrete slab to increase flexibility and feasibility.

Given San Francisco's location, all building components, including power, ventilation, and support, are detailed to maintain function during and after a seismic event. Facilities Integration Maintenance assists in building operation and maintenance for all disciplines and components. Under the LEED 2009 for New Construction and Major Renovations Checklist, 350 Mission can achieve LEED Platinum Accreditation, accumulating 93 points out of a possible 110 points. The collaboration and integration of all building disciplines results in a holistic net-zero design of 350 Mission.

TEAM DIRECTION: GOALS AND ATTITUDE

350 Mission is above all else, a collaboration. Through a joint effort, the concept of 'net-zero building' has grown to fully encompass the idea of green living and **AEVITAS** is on the forefront of this movement. In order to reach the infinite goals that are stemming from such sustainable building ideas, **AEVITAS** set out to define the way the team would approach 350 Mission. Provided with an established architectural design but a different set of owner goals, the team has been dedicated to making design decisions that reflect the new goals of the owner, as well as the community and future tenants. **AEVITAS** is a talented team comprised of eight individuals with varying educations and diverse experience including backgrounds in structural design, MEP systems design, and construction engineering and management.

For the *2014 ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition*, teams are challenged to embrace the "development and integration of innovative and original solutions to the design challenge." With an emphasis placed on "integration of the engineered systems and construction management plan for a high performance building."

When coming together as a unified design force, the team as a whole was adamant early on about developing something more than a set of goals, something that would enable our interconnected thought process throughout design – our over-arching attitude. This attitude would encompass all team-driven specifications, with the owner profile and competition goals providing direction. From these motives, [ZERO**impact**] was born. [ZERO**impact**] is the way the project team defines the sustainable practices that are driving design decisions and owner goal integration. Within this all-encompassing team attitude and a strong mission statement, there are four focus areas that the goals are derived from, as shown below in Figure 1.

Taking an *integrated approach*, **AEVITAS** strives to *minimize environmental influences* by *engaging our community* with *sustainable* practices in energy conservation and emission reduction.

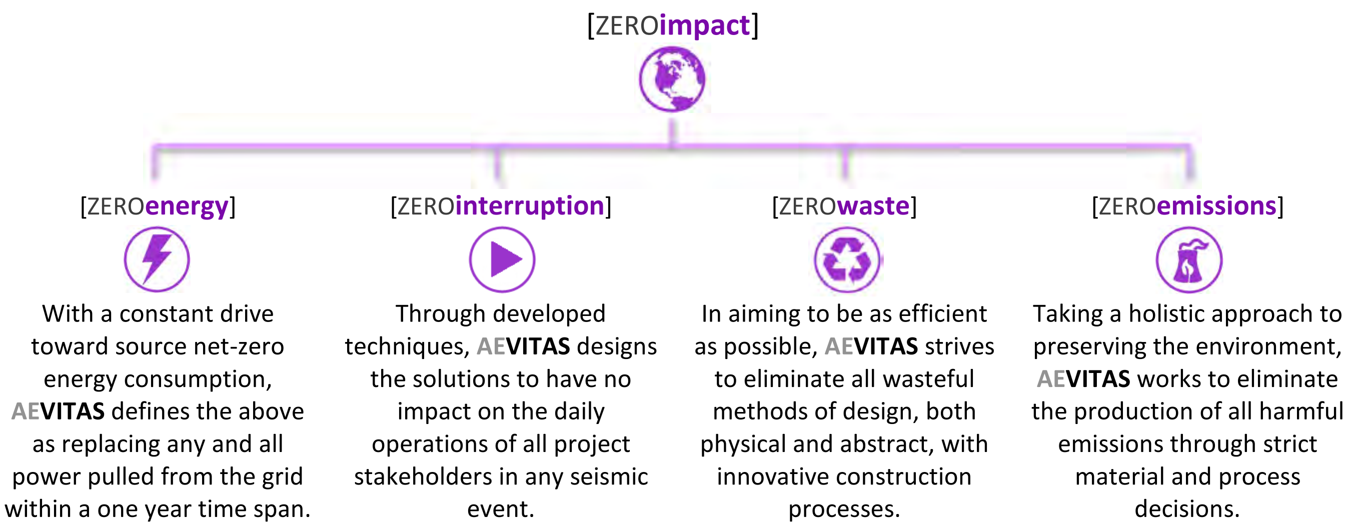


FIGURE 1: AEVITAS ATTITUDE WITH GOAL BREAKOUT

In the following report, **AEVITAS** has responded to the owner's goals to establish a building that is as close to having zero impact on all project stakeholders when possible. The symbols of the goals appear throughout the report to show the actions **AEVITAS** took to achieve these goals. As one cohesive team – with the project requirements established, the opinion of net-zero defined, mission statement created, and the attitude of [ZERO**impact**] applied – **AEVITAS** created the systems and solutions found in this report to achieve all goals of 350 Mission. Throughout all design and project decision making, application of the [ZERO**impact**] attitude was the ultimate driving force.

PROJECT INTRODUCTION

350 Mission Street is located in the heart of San Francisco's developing business district which is shown highlighted on Figure 2 below. Located adjacent to the Trans bay Transit Center, 350 Mission will be a high traffic landmark for business men and women as well as tourists or others moving by mode of public transportation. A 30 story high-rise office space, the tower addresses needs of both the private tenants of the building as well as the public surrounding the location. Within the building there is an interactive public art feature to provide community engagement, a restaurant and café space, a 5 story open concept lobby space, 25 floors of rentable office space, a green roof space, and natural ventilation curtain wall features. This high performance space will work to create [ZERO**impact**] on all project stakeholders.

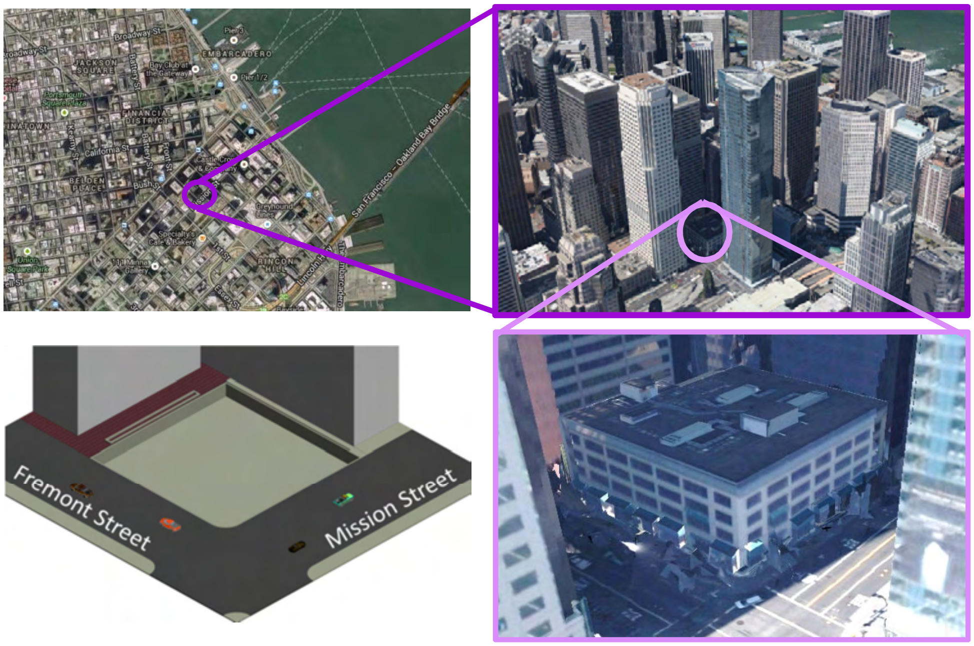


FIGURE 2: EXISTING CONDITIONS AND LOCATION OF 350 MISSION BUILDING SITE

Project Stakeholders

As one of the first steps for eventual success of the project, **AEVITAS** decided to clearly define all members that are invested in the project's success. With the location of the site in a very urban environment, it was clear early on that defining the project stakeholders would help to maintain [ZERO**impact**] on all those who come in contact with **AEVITAS**'s definition of 350 Mission. As a team, we consider the future tenants, the owner, the realty company, the public transportation system, nearby business owners, the café and restaurant leasers, engineers, architects, and contractors all to be major stakeholders in the success and safety of the project. Throughout the entire design and construction processes, these stakeholders have been consulted or considered in all major decisions. The primary concern during these processes was the safety and security of these individuals. It was important to the goal set established by the team to have [ZERO**interruption**] on the daily schedules and lives of those mentioned.

COLLABORATION

Decision Making System

After establishing the team dynamic and which direction to take, **AEVITAS** began to delve deeper into the 4 main focus areas that were defined while reflecting the [ZERO**impact**] approach. The first step in the design process was to come together as a team and start analyzing different engineered systems to include within the final design. Keeping with the overall attitude and to maintain accountability between different design disciplines, a point tracking system was created to measure areas of each system that would align with [ZERO**energy**], [ZERO**waste**], [ZERO**emissions**], and [ZERO**interruption**] but also consider the owner driven specific evaluation criteria. These evaluation criteria helped to guarantee that all facets of the wants and needs of the owner and future tenants were being taken into consideration for all design decisions. Each system will be initially researched then presented to **AEVITAS** as a whole and analyzed on a points system from double positive

	SYSTEM DESCRIPTION	ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														RECOMMENDED?
		ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE/CLIMATE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	
Heating/Cooling	Radiant Slabs - Heating/Cooling Plant Located on Roof	++	+	0	+	0	+	+	+	+	--	0	-	+	-	0	++	+	++	YES
	Under Floor Air Distribution	+	0	0	+	0	-	+	+	+	-	-	0	0	0	0	+	+	+	NO

FIGURE 3: AEVITAS DECISION POINT SYSTEM

++	BEST
+	POSITIVE
0	NO IMPACT
-	NEGATIVE
--	WORST

(++) to double negative (--). Above, in Figure 3, a sample of system in action along with a key is shown. This example shows an analysis of some preliminary mechanical system ideas, Underfloor Air Distribution (UFAD) and Radiant Slabs. In the four main goal sets that we developed early on, Radiant Slabs score above Under Floor Air Distribution, or UFAD. Receiving the best possible rating in the energy category as well as practicality and effectiveness and only one worst in the area of complexity, the decision was made to move forward with this mechanical system. When making these large design decisions, even an extremely integrated project team like **AEVITAS** includes members of different disciplines who value different criteria in different ways. However, with the establishment of the Decision Point System before the preliminary design stages even took place, we were able to maintain consistency in mindset at which systems compliment a combination of owner and project goals in the most effective way. The full point systems for all design decisions in all disciplines can be referenced in Supporting Documentation, page #. Beyond the rating, there were many factors that had input to the 'plus' or 'minus' that each system or item was rated. In the Supporting Documentation there is more information about the decision point system as well as a full description about why each system was given the rating and what information went into make that decision.

Coordination Meetings

Throughout all phases of the project, **AEVITAS** developed and implemented a system of communication structure that mirrors how actual large scale projects such as 350 Mission Street would be managed. Each week starts with a coordination meeting with all options present and focused on the tasks at hand. In order to be as organized and efficient as possible, each option comes into the meeting with their Weekly Report filled out and ready to discuss. The Weekly Report is a document that **AEVITAS** developed to provide continuous accountability throughout the year and project duration. Included within the report are categories such as: accomplishments of the previous week, coordination meeting points of the last week, issues to discuss in the coming week, goals for the upcoming week, meetings to schedule for the upcoming week, and long term look-ahead items. Organized on the team's Google Drive folder, each report is available in real time to each member of the group. With these issues being taken care of before each meeting as well as the presence of the Meeting Agenda and Meeting Minutes, **AEVITAS** has the ability to make the best use of the coordination meeting time. Reference Supporting Documentation page # for sample Weekly Report documents.

Communication Methods

In order to maintain contact and consistency throughout the team and duration of the project, **AEVITAS** decided upon the means of communication as a first step in the project. Below, in Figure 4 is a graphical representation of the communication methods have and continue to use as a team. The main means of file backup that we have utilized is a private team drive on a shared location. With this shared drive, information is constantly up to date and able to be accessed. For times when we are not on location to access our project team's share drive,

AEVITAS updates all information to the team Google Drive as well. The two drives share the same organization structure and are combined and backed up on a weekly basis after weekly coordination meetings discussed in the earlier section. For long term back up, **AEVITAS** is utilizing an external hard drive. For quick questions and communications for inter-team discussion, GroupMe, a group texting communication application for smart phones, has been a great tool. Trello is web-based application that is available on all smart phones to help manage lists and activities for large groups of people; **AEVITAS** has found this system to be best in managing, tracking, and coordinating information exchanges.

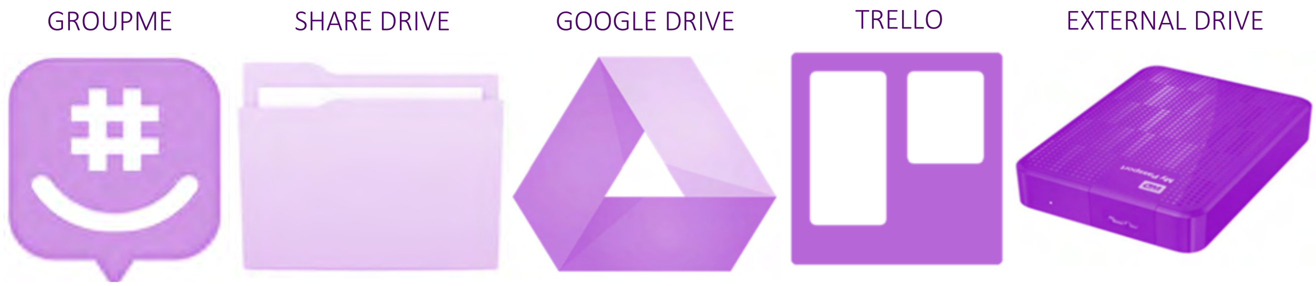


FIGURE 4: AEVITAS COMMUNICATION METHODS

Information Exchanges

Each member possesses a common understanding that not all information can be exchanged during our weekly coordination meeting time. Often, there are individual meetings between various options to coordinate specific tasks, trade information, pass off models, and make inter-option decisions. Because it is important to be transparent with any and all information, **AEVITAS** as a team established an Information Exchanges document within the team's Google Drive. The document is comprised of a system conducive to tracking the information from option to option. Each discipline is designated a color and each option also has a heading in the document. If a mechanical engineer transfers the energy model to the lighting and electrical engineers for analysis, the mechanical engineer would document this by dating and detailing the exchange in their color under the L/E heading. With this system in place, all information exchanges are tracked in an easily viewable document to ensure all group members are aware and following the data trail.

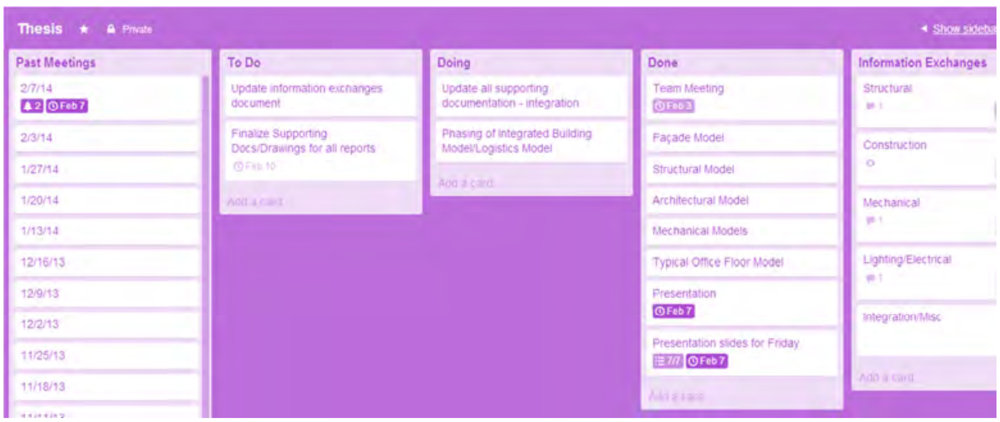


FIGURE 5: TRELLO INFORMATION EXCHANGES

Building Information Modeling and Management Execution Plan

In order to maintain efficiency and goal oriented decision making, **AEVITAS** implemented a BIM Execution Plan. With the aim of being as industry realistic as possible, it was important to have coordination meetings early on with all options and disciplines present to develop the plan moving throughout all phases of the project. The purpose of a typical Building Information Modeling Execution Plan in industry is to lead a team through the planning process for BIM by adapting the planning principle that every project implementing BIM (Building Information Modeling) in some way should "begin with the end in mind." This process helps to incorporate all stakeholders in the project (Architectural, Engineering, Construction, and Operations) to communicate their goals for executing BIM in the future of the project and its' lifecycle. This document was a guiding factor to help keep the team on schedule and centered on the tasks that needed to be accomplished. Parts of this document are shown in all discipline reports, specifically Construction with emphasis in BIM uses; to reference this matrix see page # of Supporting Documentation. All software exchanges, information exchanges, and quality control graphics are parts of the original BIM Ex plan.

One of the primary challenges in the early design phase of this project was the interactions between varieties of computer software. Early on, it was important to **AEVITAS** to sit down and discuss all programs the team would be using and how they would relate to each other. This way, we were able to ensure that all programs would work together efficiently and effectively to produce the highest caliber model for our final design. With the quick guide shown in Table 2, we were able to eliminate problems early on that may have caused hard decisions later. This software data exchange table shows the different programs that our project team members used throughout the project, the specific way they were used, the file type that they produced, and what input and output they can give and receive. For example, as per this chart, one would be able to determine that after developing an AutoCAD floor plan, the plan can be input into AGI32 to perform lighting calculations but cannot be put back into AutoCAD.

TABLE 2: SOFTWARE DATA EXCHANGES

PROGRAM	USES	FILE TYPE	INPUT FROM	OUTPUT TO
AGI	Lighting Calculations	.agi	AutoCAD	N/A
AUTOCAD	Floor Plans, Site Logistics Plan, Detailing	.dwg & .dxf	Revit	IES, EQuest, AGI32, Rhino
C.A.P.S.	Fan Selection	-	-	-
DAYSIM	Daylight Calculations	.hea	AutoCAD	Excel
DIVA FOR RHINO	Daylighting Calculations, Solar Radiation Maps	.3dm	AutoCAD	Excel
DYNASONICS	Acoustic Calculations	.AIM	-	-
EQUEST	Compliance Analysis	.pd2	AutoCAD	-
ETABS	Lateral System Modeling and Design of the Structural System	.EDB	-	-
IES	Load and Energy Simulation	.mit	AutoCAD	Excel
NAVISWORKS	Clash Detection, 4D Modeling	.nwc & .nwf	Revit, Project	-
PROJECT	Project scheduling	.mpp	Excel	
RAM	Modeling and Design of the Structural and Gravity Systems	.rss	-	-
REVIT	Floor Plans, Model Development	.rvt	-	AutoCAD
RS MEANS	Cost Analysis	-	-	Quantity Takeoff, Excel
TACO	Pump Selection and Riser Diagram	-	-	-
TRANE TRACE	Load Simulation	.trc	-	-

After determining the variety of software that **AEVITAS** intended to use, a graphical representation was developed to further understanding at which programs would be utilized most and how they interact together in the timeline of the project. This image is shown in Figure 6.

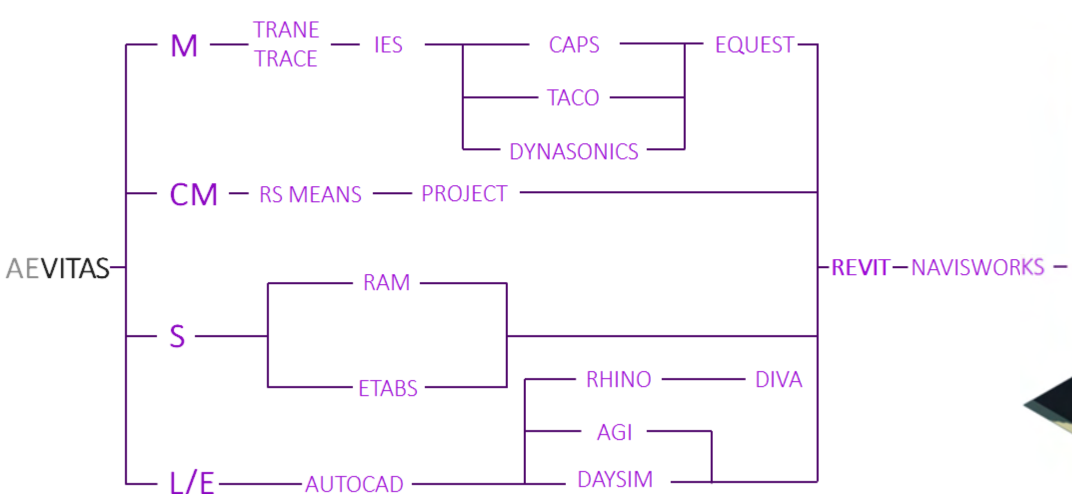


FIGURE 6: SOFTWARE USAGE TIMELINE

350 MISSION BUILDING FEATURES

With the new defined set of owner and team goals determined, the design of the **AEVITAS** 350 Mission Street began to take shape. Coming together, the project team was able to design a building that refocused the project on the [ZERO**impact**] attitude; driving us toward a net-zero building. To ensure an integrated approach, the building was approached in sections. In the next few pages, the design of the site, substructure, superstructure and core, building envelope, lobby, and typical office floors are shown. By dividing the building into these zones, **AEVITAS** was able to provide a more integrated look into 350 Mission Street.

Site and Substructure

Excavation/Bracing

The water table on the site is located three to 12 feet below grade indicating that a significant dewatering operation would be required during excavation. For this reason, a slurry wall was chosen as the main shoring system to be used on the 350 Mission project because of its low permeability. This system will be constructed before the excavation of the cofferdam for the building. The slurry wall will require extra bracing to resist the hydrostatic loads created by the soil outside of the building footprint. After weighing several options, the construction and structural disciplines came to the conclusion that internal diagonal bracing would be the best solution because it would create a diaphragm to resist the lateral loads and still allow the construction of the central concrete core; an example of the system that was developed is shown in Figure 7. Another consideration with the bracing was the depth spacing at which these diaphragms would be placed and how many levels of bracing would be needed. It was determined that a standard concrete slurry wall would require a large amount of bracing and would be relatively thick, taking space away from the building footprint. A composite slurry wall consisting of concrete and steel I-beams was determined to provide a more rigid diaphragm for the excavation using less bracing and providing a more slender profile. These decisions required large coordination efforts between the construction and structural engineers to reach a solution that would be cost and schedule effective while providing a sufficient foundation to support 350 Mission.

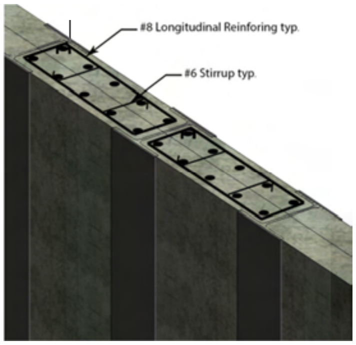


FIGURE 7: SLURRY WALL DETAIL

Foundation

The soils report indicated that the most feasible foundation system would be a mat foundation due to the bedrock depth on the site at 250 feet below grade. The type of structure used has a large influence on the thickness of the foundation and thus the cost of material and installation. A steel building frame was determined to be lighter than a concrete structure and would thus save on foundations costs and provide benefits in other aspects of the building such as its seismic performance and coordination with building systems.

Substructure

A major consideration in the substructure of the 350 Mission building was determining the location of the fuel cells that are responsible for a large portion of the buildings power. The cells' large footprint and load on the building structural system created a coordination issue between the electrical, structural, and architectural designs. From and architectural standpoint it was determined that the electric car spaces in the parking garage would have to be moved elsewhere to provide the room for the fuel cells. The structural design would then have to change to accommodate this significant loading in this area. As a team

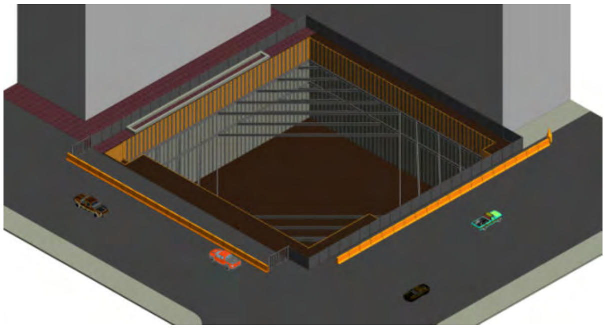


FIGURE 8: SUBSTRUCTURE DIAGONAL BRACING

AEVITAS decided that the fuel cells were crucial to the success of the goal for the building to be net-zero and that. Moving the parking spaces was not a major issue as they were simply moved to the other end of the main electrical room on level B1 in the building. This decision did lead to higher costs in the structure because the slabs in this area had to be thickened to accommodate the load but it is expected that the cost will eventually be paid off by the returns of the fuel cells.

Superstructure and Core

In order to design and build the most efficient building to fit within **AEVITAS**' goals, the superstructure was a collaboration of all the disciplines involved in the design and construction of 350 Mission.

Core

The steel braced frame core is crucial for the structure, as it is part of the main lateral force resisting system. All areas within the core have a reduced amount of lateral drift, and the rigidity in this region is stiffer. For this reason, all of the emergency evacuation routes were placed inside of the core boundary. Additionally, the primary riser for the electrical system connects to the electrical room on every floor on the west side of the core. A secondary riser is located on the east side of the building, and can provide back-up emergency power to the building. The dual riser system allows the building to stay powered in the event of an earthquake, and the primary riser within the core minimizes the loads from the earthquake onto the risers. Both risers have flexible connections to the utility lines, to further minimize damage to the risers.

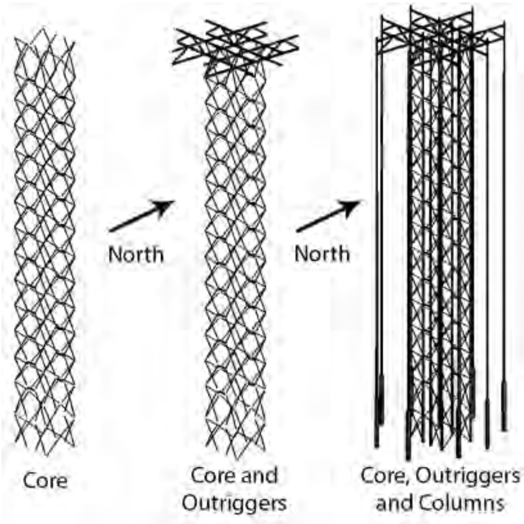


FIGURE 9: SUPERSTRUCTURE DIAGRAMS

The bracing in the core was designed to minimize construction time, instead of using a more traditional solid concrete shear wall. With steel, the erection process is faster, and does not need expensive formwork or a prolonged curing time. Additionally, the steel braced frame core alone can support most earthquake loads during construction, which keeps the project on schedule. The added ductility inherent within steel absorbs the forces from wind and earthquakes and distributes the forces down to the foundation, instead of cracking and needing costly repairs before the building is fully constructed.

Floors

The floor system of the superstructure is a concrete composite deck on steel beams and girders. The mechanical team worked with the structural team to add in radiant heating above the concrete floor. The mechanical team also coordinated with the structure, so that the ducts and pipes that rise vertically along the building would not conflict with any of the beams. All teams came together to ensure the plenum space below the floors was an accurate height to fit all the necessary equipment without unnecessarily increasing the height of the building.

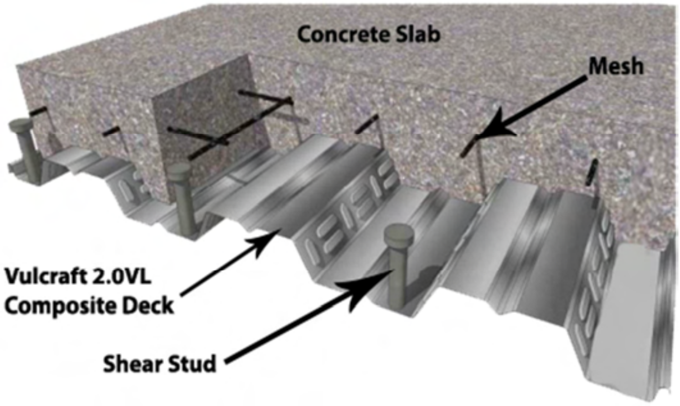


FIGURE 10: COMPOSITE DECKING DETAIL

Construction

For the construction of the superstructure, the floors follow the core. The core is always at least two floors above the level of the floor being constructed. This allows the elevators to be installed faster, and prevents the building from being damaged if there is an earthquake during construction. With the braced frame core being installed before the floors, the floors will be fully tied into the core to provide a rigid diaphragm necessary to achieve the reduced lateral drift of the building. During construction of the floors, there is no need for temporary shoring, which allows other trades to work on the floors after they are far enough into the cure cycle (7 days), instead of waiting for the upper floors to be cured as well. While the steel increases the height of the building from the original concrete structure, the savings in cost for a more traditional composite floor instead of post-tensioned cabled concrete, as well as a savings in time due to the shortened erection and curing schedule outweigh the negatives for the **AEVITAS** goal set.

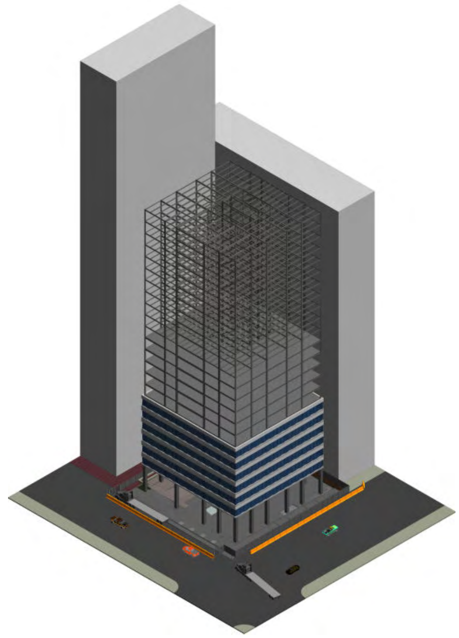


FIGURE 11: CONSTRUCTION FLOW

Building Envelope

From the new owner's goal set along with the [ZERO**impact**] attitude that **AEVITAS** has developed, the new façade design utilizes a prefabricated panelized curtain wall system that consists of a double paned glass with an alternating saw-tooth, woven design and an innovative louver system at the finished floor level to allow for natural ventilation into the building. The system is a variation on the original architectural design provided by the owner's architectural design team but restructured to fit the new goals of the owner and **AEVITAS**. Because 350 Mission was designed to be a net-zero building, there needed to be a delicate balance between energy usage, construction time, and weight. Utilizing a façade that is 100% glass would negatively affect the heating, cooling, and weight issues of the building, while removing glass would negatively affect daylighting and building aesthetics. Therefore, coordination between all disciplines was required to design a functional, energy efficient, and a constructible façade for 350 Mission. Reference the Lighting/Electrical and construction reports for more detailed information involving the façade detail as well as the constructability concerns involving construction.

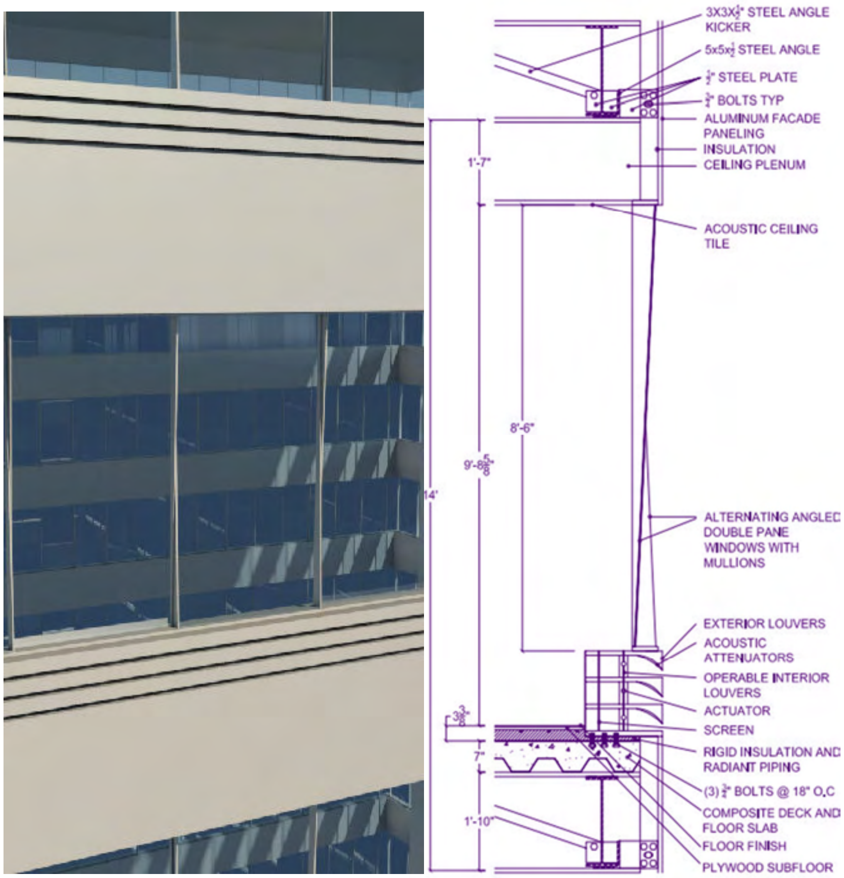


FIGURE 12: FAÇADE RENDER AND DETAIL

Daylighting

To maximize the daylighting in 350 Mission, three simulations were developed and analyzed using each 10', 8.5' and 7' as glass heights on the typical office floors; these dimensions correspond as 70%, 60%, and 50% amounts of glazing respectively. After analyzing the energy savings from each simulation, the 8.5' glass was chosen. This allowed for space allocation below the window for a natural ventilation louver system. Another benefit provided a reduced weight for the overall façade panels. This option was on a one percent decrease in daylight harvesting potential in comparison to the 10' windows. Electrochromic glazing was chosen for the office floors. This special glass tints or untints based on the environmental conditions and control system settings. As its visible light transmittance changes, so does the solar heat gain coefficient. Data gathered from the Building Automation System (BAS) will be used to optimize the tint levels for both the daylighting and mechanical systems.

Natural Ventilation

In order to continue integration throughout all parts of the façade, **AEVITAS** looked toward our [ZERO**energy**] goal to see how the extra space that wasn't being utilized for daylighting purposes could be used for benefit to other systems. In the 1.5' of space below the electrochromic glass panels, there are natural ventilation louvers present to tie in to the mechanical part of 350 Mission. The louvered section of the wall is comprised of three pieces. The outside pieces are the acoustic louvers, in the middle of the section there are actuators and adjustable louvers, and on the inside of the section there is a screen that offers a visually appealing finish to the system. The natural ventilation will operate when weather permits, to supply outdoor air to rooms directly along the façade. Interior spaces will remain be supplied though the DOAS mechanical system. Louvers will open and close based on control sequences to allow outdoor air to enter directly into the space. This will reduce fan runtime, and energy consumption with respect to a typical mechanically ventilated system. A diagram of the control zones can be seen in the appendix section.

Connections

Because the façade is such a large part of **AEVITAS**'s mission for the construction of 350 Mission, a connection design was needed to reduce the work done in field, creating an efficient system of installing such a complicated piece. Designing a connection that would allow for the prefabrication of the panels was crucial for schedule. With these things in mind, a bolted connection was designed to ensure this part of the panel would also be acceptable to prefabricate.

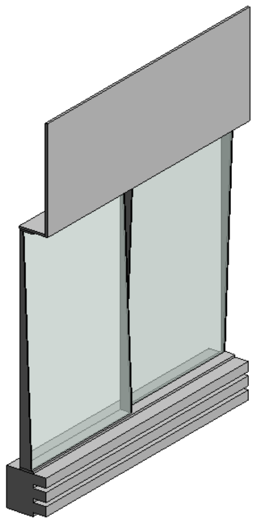


FIGURE 13: VIRTUAL MOCKUP OF FAÇADE PANEL

With prefabrication, there is traditionally a higher risk of tolerance issues as well as a higher possibility of leaks in the building skin. To prevent any tolerance issues, after the enclosure is designed, a physical mockup will be constructed to discuss and analyze tolerance constraints the panels must be built to. The panels will be constructed at a testing facility where the physical mockup will be tested for leaks to confirm that the system will be successful in stopping air, water, and moisture leaks. The workers that assemble and test this mockup in the facility will be the ones constructing the system on site making it an experiment as well as a learning tool to hopefully expedite the installation on site. Not only will **AEVITAS** build a physical sample of the prefabricated panel to test, but also a virtual mockup. By building and coordinating a virtual mockup of the panel before it is prefabricated, the organization of the process with run much more smoothly; a sample of a virtural mockup **AEVITAS** created is shown in Figure 13.

Lobby

LED Media Wall

The original lobby design prominently features a three story LED media canvas. While this is a novel way to interact with the public and attract people to the lobby, its operation would require a substantial amount of energy, which is not ideal for a building aiming to be highly energy efficient. The new design transforms the space housing the LED wall into a similar public attraction, but one using less energy.

PaveGen is a company that produces energy-generating floor tiles that use piezoelectric polymer material to convert kinetic energy produced by human foot traffic to electricity. The technology is a new kind of renewable energy, one that directly interacts with humans. However, it is relatively new and is not yet a realistic source of building-scale energy generation as the electrical output is too low, and the cost too high. This required a creative method of integrating this technology into 350 Mission's design.

Public Art

The San Francisco Planning Department requires that new construction projects allocate 1% of the total construction cost of the building to publicly displayable art. This presented a unique opportunity to purchase the PaveGen tiles under the public art allowance, as long as they are somehow integrated into a work of art. The proposal is to hold a competition for local artists to create a mural that creatively incorporates the dynamic lighting effects to be installed on the feature wall. The PaveGen tiles will also be installed throughout the lobby floor in a pattern determined by the artist, with each tile activating some portion of the lighting in the mural. In this way, people walking across the lobby will be interacting with the public art using the kinetic energy of footsteps. The images below portray a potential entry in the public art competition.

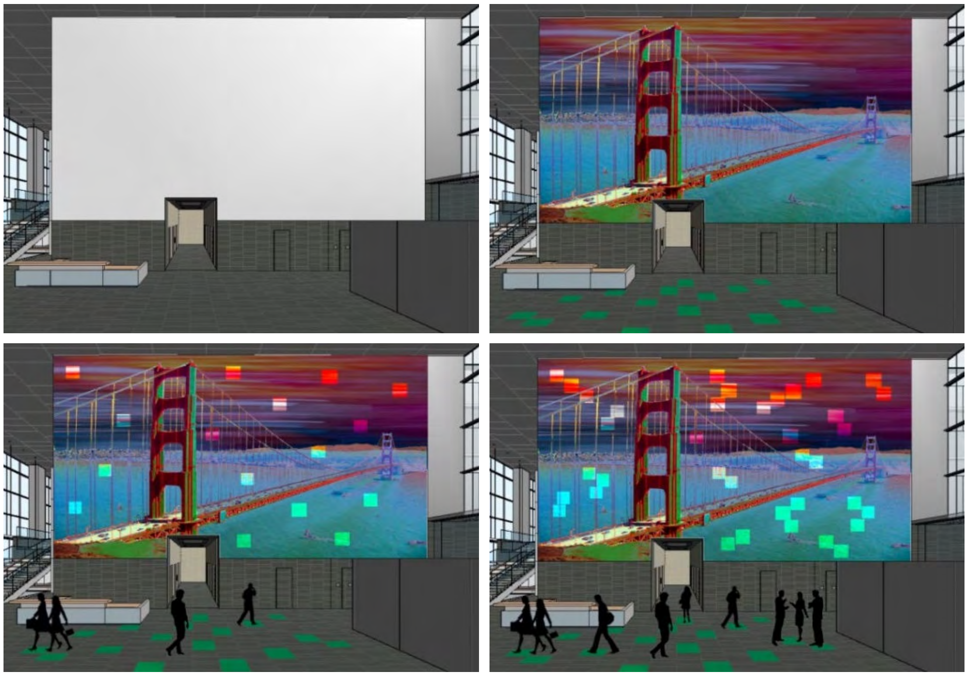


FIGURE 14: PAVGEN LOBBY INTERACTION

Teaching Tool

As important as energy efficient building systems are to creating a near net-zero high rise, occupant participation is also critical to minimizing energy use. The interactive art display is intended to make the building occupants more conscious of their role in conserving, and even in this case, creating energy. To supplement this, television screens will be placed next to each entrance to the elevator bank on each floor displaying that floor's energy use profile each month. In this way, floor occupants are challenged to be more energy conscious than other floors or reduce energy consumption from the same month during the previous year.

Art Wall Coordination

Using the feature lobby wall for a public art display created an opportunity for coordination between the lighting/electrical and mechanical disciplines. In order to integrate luminaires into the mural, a second wall is placed two feet from the core. It is within this gypsum wall that the luminaires for the public art are installed. The wall also houses a mechanical supply duct spanning the lobby, with diffusers integrated into the mural serving the space load.

Floor and Ceiling Coordination

Similar to the office spaces, the floor in the lobby required a coordinated effort. The radiant heating system, the electrical wires from the PaveGen tiles, and the conduit runs feeding the retail area are all placed within the floor slab. Overhead, a drop ceiling conceals the HVAC equipment serving the lobby and houses the electrical runs supplying the pendant-mounted overhead lighting.

Architectural Integration

The structural design requires more columns than the original structure, but they are smaller in size, allowing the vast space to feel as large and impressive as intended. In order to adjust to the current column spacing, the main entrance to 350 Mission from Mission Street was shifted to the south. A second entrance was also added along Beale Street for accessibility from both primary thoroughfares. The two main entrances were also placed within vestibules, as is required by the California Building Code. In order to lessen the mechanical heating load, the walls no longer open to the sidewalks, but the curtain wall maintains the intended transparency from the street into the lobby.

Typical Office Floor

To maximize the energy efficiency and comfort of the office space, while minimizing material use, building time, and cost, special considerations must be taken into account. The following sections will detail AVEITAS' approach to these considerations.

Plenum Coordination

A typical area of major concern for space planning is the plenum located above a drop ceiling. The design of 350 Missions calls for numerous systems in this narrow band. However, expanding the plenum will encroach on leasable volume and increasing the floor to floor height will increase the building cost and material usage. So, coordination in 3-dimensions is required to ensure a function design with the narrowest plenum possible.

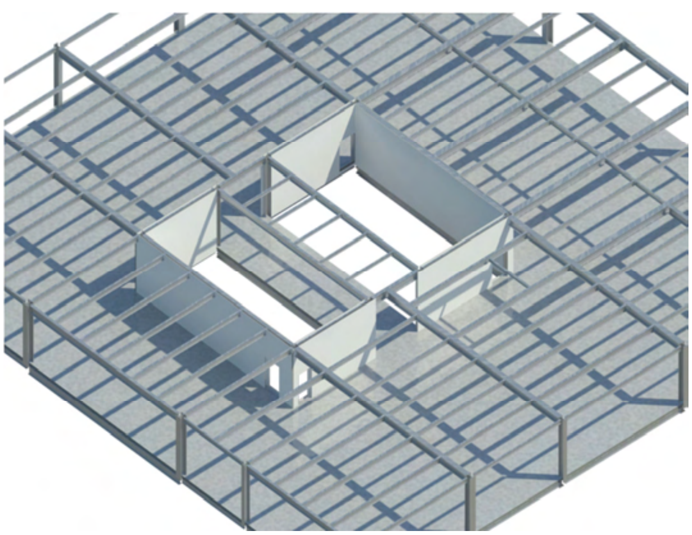


FIGURE 15: STRUCTURAL LAYOUT FOR TYPICAL OFFICE FLOOR

Electrical Supply

To maximize plenum space for the ductwork and structural systems, shallow recessed lighting is used within the office space. The electrical conduit serving these lights, the mechanical equipment, as well as the electric actuators for the exterior louvers runs through the ceiling plenum. The conduit's route through the plenum is flexible and falls under the category of "means and methods," so it was not modeled in a 3D environment, however, the recessed lighting is incorporated into the model.

Ductwork

Since the design of 350 Mission calls for a dedicated outdoor air system (DOAS), and underfloor radiant heating and cooling, the ducts are much smaller when compared to a typical design. This made it possible to shrink the plenum space, thus shrinking the floor-to-floor height, resulting in material and cost savings. Another mechanical consideration within the ceiling space is the coordination of lights and diffusers. Considerable care was taken to select linear diffusers that matched the linear lighting pattern. Additionally, the diffusers were placed in such a fashion, as to not interfere with the lighting scheme. To ensure proper ductwork and diffuser placement it is modeled in its entirety in a 3D environment, and clash detection was performed.

Structure

Due to the change in structural material from concrete to steel, there was some concern about the lateral system in the core interfering with doors. To ensure that this was not an issue, the lateral system was modeled and the door locations were coordinated.

Clash Detection

The design of 350 Mission incorporates complex layouts within tight spaces. To minimize constructability issues, Navisworks was used to perform clash detection. The lighting, mechanical, and structural layouts were imported and an analysis was performed. Active clashes are highlighted, as illustrated in Figure 16. After the clashes were identified, the design was altered to alleviate the clashing. Typically, the most flexible equipment within the plenum space is the ductwork. So, the mechanical design was the first layout that was altered in order to achieve a clash-free design.

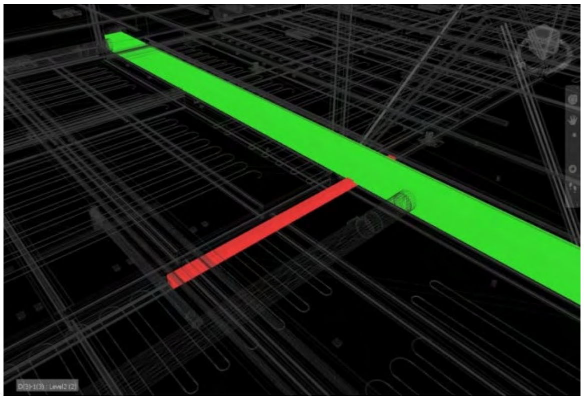


FIGURE 16: ACTIVE CLASH OF MECHANICAL DUCT AND RECESSED

Receptacle Conduit and Radiant System Coordination

Since both the radiant cooling and heating system piping and receptacle conduit pull boxes will occupy the same area within the subfloor, special consideration was taken to ensure access to conduit pathways. To complete the task, coordination drawings were created within Revit where both the radiant piping and electrical conduit are present. After some manipulation of the radiant piping, an efficient wiring route was determined. The typical office floor receptacle wiring and radiant piping coordination can be seen in the appendix.

SEISMIC INTEGRATION CONSIDERATIONS

In the case of a seismic event or natural disaster, 350 Mission will return to near immediate occupancy through robust mechanical design and [ZEROinterruption] features. The mechanical heating and cooling plants are located in the mechanical penthouse, maximizing leasable space value as well as preventing possible flood and water damage. A 4800 gallon potable water storage tank is also located in the mechanical penthouse to allow for gravity based distribution throughout the building in case of power failure to the domestic water pumps.In regards to robust design, on slab radiant heating and cooling was chosen for occupant safety and durability. Overhead radiant ceiling panels and active chilled beams pose a potential collapse liability in the case of a seismic event and require additional structural support. Radiant floor heating and cooling grids are located on top of the structural slab, posing little risk to the occupants.

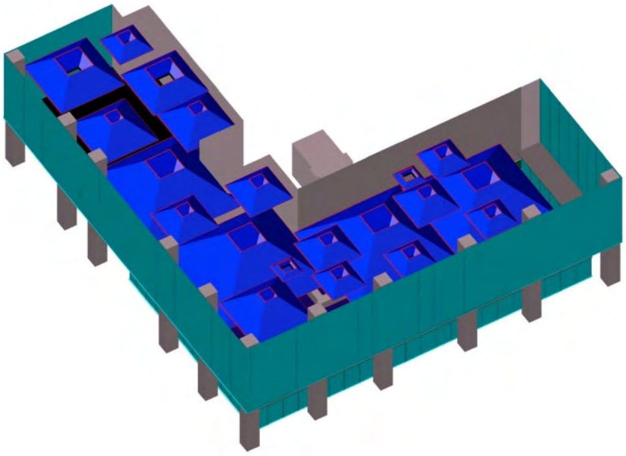


FIGURE 17: LOBBY LIGHTING SHOWING REQUIRED LUMINAIRE SWING

One of the challenges with the design in the space was the conflict between the criteria of visually reducing the scale of the lobby and creating an earthquake-conscious design. The scale reduction was achieved through the use of suspended luminaires; however, these can be dangerous in earthquake scenarios. Neither criterion could be discarded as each was developed for a reason, one for occupant comfort and the other for occupant safety. In order to address both of these concerns, the initial conceptual design using suspended luminaires was maintained, and the design for the lobby follows the guidelines set forth by the Federal Emergency Management Agency (FEMA) and the California Department of General Services (DGS) for the support of pendant mounted light fixtures in earthquake-prone areas. The design addresses concerns about swing radius of the fixtures and the strength of cable connections and supports.

Dual Electrical Risers

As San Francisco is located in a seismic region, the electrical system was designed with an extra emphasis on safety and redundancy. In the event of an earthquake or other emergency, it is important for the emergency lighting and other important electrical loads to be maintained. While most buildings have a single set of electrical risers carrying power to the entire building, the electrical design for 350 Mission contains two sets of electrical risers, one located in the main electrical room and the other located in the electrical closet that occur on each floor, as shown in Figure 18. Multiple electrical risers have been utilized in other buildings in earthquake-prone areas, such as Taipei 101 in Taiwan.

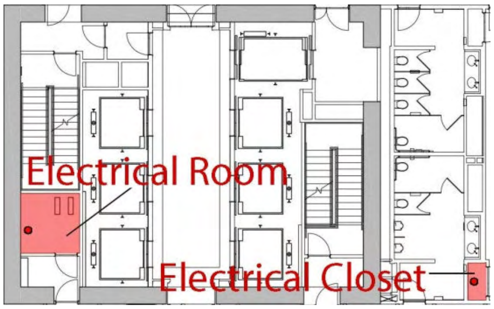


FIGURE 18: ELECTRICAL RISER LOCATIONS

These rooms are located on opposite sides of the core, decreasing the likelihood that risers located in both locations would be damaged in the event of an earthquake.

The electrical room will contain the normal power electrical risers, both AC and DC, and a DC emergency riser. During normal building operation, the entire electrical load will be served by the electrical room. If the utility fails during an emergency, the building will switch to battery power and feed the emergency loads, which are all on DC power, through the electrical room emergency riser.

If the electrical risers in the main electrical room are damaged, the building clearly will have undergone serious structural damage, and occupant safety during egress will be of paramount importance. In this situation, getting power to the emergency loads would be impossible with a traditional single riser. 350 Mission has a secondary emergency riser that serves the life safety loads. If the primary riser is damaged, an automatic transfer switch (ATS) will switch the emergency battery feed to this secondary emergency riser, supplying power to the most vital building loads. All of the emergency loads are on DC power, and as a result, the electrical closet will only contain a DC riser.

FACILITIES INTEGRATION MAINTENANCE

In a net-zero building it is common to have state of the art equipment and systems, however whether the building is operating at a net-zero capacity or not is contingent on how efficiently the equipment is operating. The equipment and systems cannot be expected to run perfectly throughout the building lifetime by themselves so it is important to have a management plan for the facility to minimize the cost of inefficiency.

Contractual Recommendations

It would most likely be in the best interest of the owner to enter into operations and maintenance contracts with the MEP contractors responsible for building the system. The benefit to this is that the contractors who built the system will know how to operate those systems at maximum efficiency. It also saves the owner any time and money associated with hiring a 3rd party facilities maintenance staff that will have to be trained as to how the systems are supposed to operate. This would be accomplished through a 2 year renewable contract with the mechanical, electrical, plumbing, and controls specialty contractors responsible for the design and construction of the systems. These maintenance contracts should be predetermined so it is known that the specialty contractor can provide this service before they are chosen to build the project but the operations and maintenance contracts will be separate from the bridging design build contract previously discussed.

Facilities Integrated Model

During the design and construction of the 350 Mission building a facilities integration model will be created as a means to assist in the operations and maintenance contracts to be utilized following the completion of the construction. This will also likely benefit the team during systems testing at system start up. The model will contain cut sheets for the equipment in the building and cost information for commonly replaced materials in the building making itself a valuable asset in any future updates to the building.

LEED ANALYSIS

Under the LEED 2009 for New Construction and Major Renovations Checklist, 350 Mission can achieve LEED Platinum Accreditation, accumulating 93 points out of a possible 110 points. LEED accreditation is a proven method of determining high performance buildings. Only an integrated, combined effort from all disciplines results in a highly LEED accredited building. For breakdown of 350 Mission's LEED points please see the Integration Supporting Documents.

CONCLUSION

Through the overarching attitude of [ZERO**impact**], encompassing four design goals of [ZERO**interruption**], [ZERO**energy**], [ZERO**waste**], and [ZERO**emissions**], 350 Mission's environmental impact has been reduced. Aspects of the electrical, mechanical, and structural design, as well as construction and facilities management have culminated in a net-zero design

Measures of Success

The entire visualization of **AEVITAS**'s 350 Mission Street was an integration of efforts from a variety of disciplines, talents, and backgrounds. During the entire process, AEVITAS was primarily focused on how we could come together as a team and develop the best final product by incorporating the owner's vision and team's vision to produce a sustainable project that replaces all energy sources needed to power the building back into the atmosphere to be used in other ways; we defined this concept as [ZERO**impact**]. After so much hard work and determination to meet the goals we set for ourselves, those intimate with the **AEVITAS** 350 Mission project wanted a way to measure the success of the project against the original goals.

AEVITAS developed a way to measure the lessening impact on the environment, a graphic of this can be seen in Figure 19. In order to show a normalized graphical representation some of the values we have been tracking throughout the design and construction process, all numbers started out with a baseline value of the starting number, the worst that the value would be. Then **AEVITAS** worked to decrease these values throughout design decision, goal focusing, and waste management.

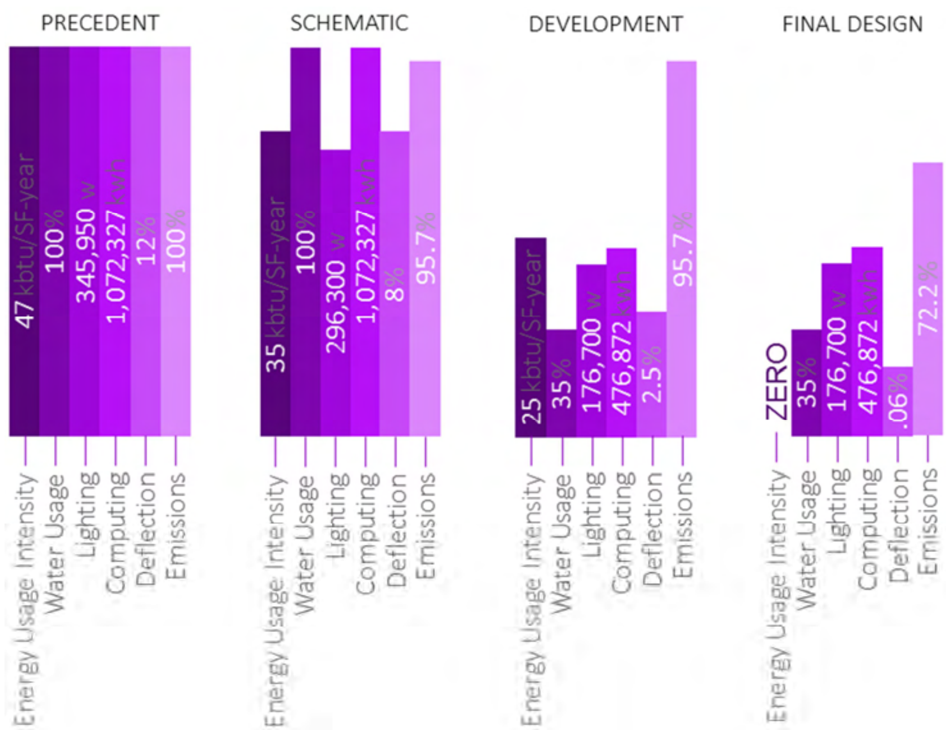


FIGURE 19: MEASURES OF SUCCESS

3-D modeling and construction phasing has been detailed in order to avoid construction issues and coordinate the mechanical, electrical and structural systems. Additionally, the façade, office, and lobby are designed in accordance with local code, and offer a substantial savings over the baseline building. These savings are shown in Figure 19.

- Source Energy Use Intensity of zero (0 kbtu/SF-Year)
- 65% reduction in water use, compared to the baseline
- 40% reduction in lighting power density
- 56% reduction in receptacle loading
- Structural deflection of 0.06% of the building height
- 27.8% reduction in site CO_2 emissions
- An aggressive 25 month construction schedule

The analyses show a design that adequately addresses the attitude of [ZERO**impact**], without losing sight of the bottom line. In attrition to being net-zero, the design also offers a competitive life-cycle-cost of 10.6 years when compared to the baseline building. **AEVITAS** strongly believes 350 Mission is a constructible, innovative, high-performance and realistic design for a net-zero building.

REFERENCES

All documents, references, consultations and companies who helped with this report are sited on the Construction, Lighting/Electrical, Mechanical, and Structural Reports; reference these separate documents for more information on sources.

BUILDING INFORMATION MODELING USES

BIM USE	PROJECT VALUE	RESPONSIBLE PARTY	VALUE TO RESPONSIBLE PARTY	CAPABILITY RATING			ADDITIONAL RESOURCES	NOTES	PROCEED?
	HIGH/MED/LOW		HIGH/MED/LOW	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
Detailed Estimation	MED	Construction Managers	HIGH	3	3	3	Past project data, detailed and accurate structural model	Good comunication of changes throughout the process is crucial	**YES**
		Structural Engineers	LOW	1	1	3			
4D Modeling	HIGH	Construction Managers	HIGH	3	3	3	Accurate and detailed schedule	Full participation from all parties	**YES**
		Structural Engineers	LOW	1	1	2	Accurate and complete BIMs		
		Mechanical Engineers	LOW	1	1	2			
		Lighting/Electrical Engineers	LOW	1	1	2			
Clash Detection	HIGH	Construction Managers	HIGH	3	3	3	Latest Navisworks software, using Manage 2014 on 350 Mission. Accurate and complete BIMs	High value to all parties due to preventative measures in saving both time and money for all parties	**YES**
		Structural Engineers	HIGH	3	3	3			
		Mechanical Engineers	MED	2	3	3			
		Lighting/Electrical Engineers	MED	1	3	3			
3D Coordination	HIGH	Construction Managers	HIGH	3	3	3	Full party participation for accurate Building Information Modeling	Modeling learning curve possible	**YES**
		Structural Engineers	HIGH	3	3	3			
		Mechanical Engineers	MED	3	3	3			
		Lighting/Electrical Engineers	MED	2	2	2			
		Owner	HIGH	1	1	1			
		Architects	MED	2	2	2			
Engineering Analyses	MED	Structural Engineers	HIGH	3	3	3	Must have access to all updated technologies and programs		**YES**
		Mechanical Engineers	HIGH	3	3	3			
		Lighting/Electrical Engineers	HIGH	3	3	3			
Facilities Integration Modeling	MED	Construction Managers	MED	2	2	1	Cost Data integrated with building elements, must have accurate and updated information in BIM for all systems	High value to owner, can save a lot of time and money for all. This process will be necessary to continuation of the netzero process and AEVITAS' ZEROimpact goalset	**MAYBE**
		Structural Engineers	LOW	1	1	1			
		Mechanical Engineers	HIGH	3	3	3			
		Lighting/Electrical Engineers	MED	2	2	2			
		Owner	HIGH	3	1	1	Must be onboard with decisions		
		Building Manager	HIGH	3	3	3	Must receive training		
Site Logistics	LOW	Construction Managers	HIGH	3	3	2	Updated location information	CM to coordinate input from all	**YES**
Design Authoring	HIGH	Structural Engineers	MED	3	3	3	Collaborative Design Cooperation		**YES**
		Mechanical Engineers	MED	3	3	3			
		Lighting/Electrical Engineers	MED	3	3	3			
		Owner	MED	1	1	1			
		Architects	HIGH	3	3	3			

DECISION POINT SYSTEMS

Construction Management

		ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														
	SYSTEM DESCRIPTION	ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	RECOMMENDED?
Production Tracking	SIPS Scheduling	0	0	+	0	0	+	0	++	+	-	+	+	++	++	+	++	0	++	Y
	Last Planner	0	0	+	0	0	++	0	++	+	-	0	-	++	+	+	+	0	+	M
	CPM Schedule	0	0	+	0	0	-	0	+	-	++	0	-	0	0	0	+	0	-	N
Reduce Reuse Recycle	WM Bagster	0	0	+	0	0	-	+	+	+	+	+	+	0	-	0	--	--	--	N
	WM DART	0	0	++	++	0	-	+	0	+	-	0	-	0	-	+	+	+	+	Y
	Recycled Matl.	0	0	++	++	0	-	++	0	+	+	0	0	0	0	0	+	0	+	Y
Prefabrication	Toilet Racks	0	0	+	0	0	+	0	+	++	+	+	0	+	+	0	++	0	++	Y
	Façade Panels	0	+	+	0	0	+	0	+	-	-	-	0	+	-	0	+	0	++	M
	Overhead Racks	0	0	+	0	0	-	0	+	+	--	--	0	+	--	0	-	0	-	N
Virtual Construction	Augmented Reality	0	0	-	0	0	--	0	0	+	--	0	--	+	+	+	-	+	-	N
	FIM	++	0	++	+	0	-	++	0	++	--	0	--	++	+	++	++	+	+	Y
	Virtual Mockups	0	0	+	0	0	+	0	0	+	+	0	0	+	0	+	+	0	+	M
	4D Model	0	0	+	0	0	-	0	++	+	+	0	+	+	++	++	++	0	++	Y
Project Delivery	Bridging D-B-O-M	++	0	+	+	0	--	0	0	++	-	0	0	++	0	0	++	++	++	Y
	IPD	0	0	+	0	0	-	0	0	++	--	0	0	++	0	0	-	0	+	N
	CM Agency	0	0	+	0	0	+	0	0	+	+	0	0	+	0	0	+	0	+	N

Explanation of Decisions

Production Tracking

System	Reasoning for *Accepting* or Rejecting	Details
SIPS Scheduling/Matrix Schedule	*Detail, Minimal Waste, Repetitive*	*Minimizes wasted time in the schedule, determines a detailed breakdown of the sequence of work, excels in repetitive spaces*
Last Planner System	Doesn't effectively allow a set duration for repetitive work	The Last Planner system was identified as a feasible option for minimizing wasted time, however due to the repetitive nature of the design of office buildings it was not the optimal choice to maximize the efficiency of the typical office floor construction.
CPM Scheduling	Not Applicable, Waste	CPM scheduling is not a valid application for high rises due to the nature of how they are sequenced. Since the building grows vertically different tasks are accomplished on different floors.

Reduce Reuse Recycle

System	Reasoning for *Accepting* or Rejecting	Details
WM DART	*Workforce Involvement, Client Marketing*	*The use of Waste Management's newest tool the Diversion and Recycling Tracking Tool will allow the tracking of the waste being hauled offsite and location to where it is going. The "green facts" that the tool generates create a relatable statistic that when presented will draw in more participation.*
WM Bagster	Not Feasible for the Project, OSHA Concerns	The "Bagster" is another solution that Waste Management offers, it is a flexible dumpster that would be useful for separating waste on the separate floors of the building, and this would allow reuse of any scraps collected on that floor.
Recycled Materials	*Achieve LEED points, contribute to Future Recycling*	The use of recycled material for the finishes in the building is an absolute must in regards to getting LEED points. Aside from that it is important include materials that can be recycled in future renovations.

Virtual Construction

System	Reasoning for *Accepting* or Rejecting	Details
Facilities Integrated Model (FIM)	*Maintenance, Sustainability, Lifecycle*	*With the high performance equipment included in the design of the 350 Mission project and the desire of the building owners to have a net zero building, a FIM seems absolutely necessary in the lifecycle maintenance of the building*
Virtual Mockups	*Visual Representation, Constructability*	*Virtual mockups will provide a visual representation of the prefabricated façade panels, assisting in their prefabrication*
4D Model	*Visual Representation of Sequencing conflicts*	*A 4D model linking the schedule to the site logistics and building model allow the identification of space conflicts and sequencing issues in the construction process. This is crucial to the success of the 350 Mission site due to the tight constraints for the buildings construction.*
Augmented Reality	Cost, Ineffective	Augmented Reality was determined to be too expensive and timely to justify using the tool. It was determined that this tool would not show anything more than the renderings would

Prefabrication

System	Reasoning for *Accepting* or Rejecting	Details
Toilet Racks	*Cost Effectivenes, Time Savings*	*The typical office floors in the building have the exact same bathroom layout on each floor, this provides the opportunity to prefabricate the plumbing racks that feed the toilets and thus save time during the installation on site.*
Façade Panels	*Cost Savings, Schedule Savings*	The façade system designed for the 350 Mission building is rather complicated and it integrates the operable louvers used for natural ventilation into the building enclosure. Panelizing and prefabricating the systems will provide installation time savings and allow the panels to be constructed and tested offsite.
Overhead Racks	Not feasible	With the duct layout in the buildings office floors and the minimal duct on the floors, prefabricating overhead racks for the office floors in not a feasible option in the buildings construction.

Project Delivery

System	Reasoning for *Accepting* or Rejecting	Details
Bridging Design-Build w/ Operate and Maintain	*Facilities Maintenance, Group effort*	*Since SOM has provided the architectural design for the building this is the most feasible option for the delivery of the 350 Mission building. This delivery allows the owner more control on the architectural look of the building but still allows collaboration between the design teams.*
IPD	Complicated to pull off, Costly	IPD would be a very good solution as the delivery method for the 350 Mission project. The downsides however, are that it requires all parties being involved for the start, since SOM was not part of the AEVITAS team it is not applicable.
CM Agency	Less Collaboration	With CM agency there is still a separation of interest between the parties, each entity is still in it to make their own money rather than come together as a group to determine design and construction fees

Mechanical

		ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														
	SYSTEM DESCRIPTION	ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE/CLIMATE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	RECOMMENDED?
Heating/Cooling	Radiant Slabs - Heating/Cooling Plant Located on Roof	++	+	0	+	0	+	+	+	+	--	0	-	+	-	0	++	+	++	YES
	Under Floor Air Distribution	+	0	0	+	0	-	+	+	+	-	-	0	0	0	0	+	+	+	NO
Ventilation	Natural Ventilation	++	+	++	++	0	-	++	+	0	-	0	-	+	-	+	++	+	++	YES
	Dedicated Outdoor Air System	+	0	0	+	0	+	+	+	0	+	+	0	0	0	0	++	+	+	YES
Energy	Trigeneration	-	0	++	0	++	--	+	--	+	--	-	--	+	--	+	--	--	--	No
	Cogeneration	+	0	+	0	++	--	+	--	+	--	-	--	+	--	+	+	++	+	YES
Misc.	Improved Façade	+	0	0	+	0	--	+	0	+	0	0	0	++	-	0	+	0	+	YES
	Modular Equipment	0	0	0	0	0	++	0	++	-	+	+	++	+	0	0	+	+	0	YES
	Rain-Water Collection, Gavity Fed Graywater	0	+	++	+	0	0	++	+	-	+	--	0	+	+	+	+	+	+	YES

Explanation of Decisions

Alternative Mechanical Component	Reason(s) for Rejection	Details
Trigeneration (Combined heat, cooling, and power)	Cost, energy consumption, issue of scale	Similar to cogeneration, the required turbine energy exceeds the baseline model's energy usage and will not pay off. 350 Mission does not generate excess heat to provide an absorption chiller.
Under floor air distribution (UFAD)	Feasibility	With an end goal of net-zero, through energy simulations, under floor air distribution did not lower energy usage in the building compared to radiant heating/cooling.
Chilled beams	Seismic concern	Active chilled beams in the ceiling with both heating and cooling coils require additional structural connections in case of a seismic event, increasing cost and construction coordination.
Variable refrigerant flow	Feasibility	Vertical pipework limitations create challenges in VRF application in high rise buildings.

Alternative Mechanical Component	Reason(s) for Rejection	Details
Geothermal wells	Cost, feasibility, seismic consideration	Geothermal wells require high installation costs and for 350 Mission's heating/cooling load, geothermal wells covering the building's footprint are not sufficient in energy generation. Drilling in a highly seismic region also risks induced seismic events.
Green roof	Cost, building site, issue of scale	While green roofs can reduce heat island effect and absorb rainwater, the size of 350 Mission's roof proves ineffective for green roofs in comparison to the use of photovoltaic energy generation. The higher initial investment and regular maintenance prove disadvantageous also.
Double skin façade	Cost, structural weight, daylighting limitations	A double skin façade provides additional thermal insulation and comfort but come at the significantly additional cost in construction, operation, and maintenance. The added weight to the building's structure increases stress on the columns and connections. The double skin decreases transmittance, complicating daylighting analysis and use of electrochromic glass on the façade. Energy model result accuracy with double skin facades varies as well.
Solar thermal	Building site	Solar thermal arrays have been successfully implemented to preheat domestic water and other applications in buildings however, photovoltaic energy generation is more liable, effective, and efficient for 350 Mission.
Radiant Ceiling Panels	Condensation concern, seismic consideration	Integrating with natural ventilation, radiant ceiling panels pose condensation concerns, given San Francisco's high humidity. Occupants may experience water dripping due to condensate collection on overhead panels. Due to seismic considerations, overhead mechanical components weighing 20 lbs or greater require additional structural support, adding to costs and construction time.

Lighting/Electrical

		ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														
	SYSTEM DESCRIPTION	ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE/CLIMATE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	RECOMMENDED?
ONSITE ENERGY	Solar Power	++	0	0	+	+	-	++	0	0	0	++	+	0	-	+	++	-	-	YES
	Wind Power	++	0	0	+	0	-	++	0	0	0	+	0	0	--	++	++	-	--	NO
	Geothermal Power	++	0	0	+	+	--	++	0	+	--	--	--	--	--	+	--	--	--	NO
	Fuel Cells	++	0	-	+	+	-	+	0	+	-	-	-	0	-	++	-	-	+	YES
	Human Waste to Power	++	0	++	++	+	-	++	0	++	-	+	-	+	0	++	+	+	+	YES
	Municipal Waste to Power	++	0	++	++	+	-	++	0	++	-	+	-	0	0	++	0	0	0	NO
	Algae Biomass	++	0	0	+	+	--	++	0	+	--	-	-	0	-	++	-	-	-	NO
	PaveGen Tiles	++	0	+	+	+	--	++	0	++	0	++	-	+	+	++	+	-	0	YES
OFFSITE ENERGY	Tidal Power	++	0	0	+	0	--	++	0	++	--	-	--	0	-	+	-	-	+	NO
	Solar Power	++	0	0	+	++	-	++	0	0	-	-	0	0	0	+	++	+	++	YES
	Geothermal Power	++	0	0	+	++	--	++	0	+	--	--	--	0	-	+	--	--	+	NO
	Wind Power	++	0	0	+	++	--	++	0	0	--	--	-	0	-	+	-	-	+	NO
ELECTRICAL SYSTEM	AC/DC Distribution	+	+	++	0	+	-	+	0	++	-	-	-	0	0	+	+	+	++	YES
	Dual Risers	0	++	-	0	0	--	0	0	+	-	-	-	-	-	0	+	0	+	YES
	Paralleling Switchgear	-	++	-	0	0	--	0	0	0	-	0	-	0	0	0	0	-	0	YES
	Double Ended Substation	-	++	-	0	0	--	0	0	0	-	0	-	0	0	0	-	--	++	NO
DAYLIGHTING	Shades	++	0	+	0	0	-	+	0	0	-	-	-	0	0	0	+	+	+	NO
	Electrochromic Glass	++	0	+	0	0	-	+	0	++	0	+	+	++	0	++	0	+	+	YES
ELECTRIC LIGHTING	LED Lighting	++	0	++	0	+	-	++	0	0	0	0	0	0	0	0	++	++	++	YES
	DALI Control System	++	+	++	0	+	-	++	0	0	+	0	+	+	0	++	++	++	++	YES
	Task Lighting	++	+	++	0	+	-	++	0	+	-	-	0	0	0	0	++	++	++	YES

Explanation of Decisions

Onsite Energy

System	Reasoning for Rejecting	Details
Solar	Building site	Photovoltaic energy generation is common in a commercial context in San Francisco, with many current installations. In this case however, onsite solar was rejected due to the building site. 350 Mission is surrounded by many, taller buildings that cast a shadow on the building site for much of the year. Given that PV arrays are typically only 10 - 15% efficient in converting photons into DC electricity, placing an array on a site that is shaded for large durations throughout the year will not produce the desired energy generation.
Wind	Building site	The average wind speed required for building-scale wind turbines is about 12 mph, and San Francisco's average wind speed is 7 mph. However, the effect of wind funneling through

		the downtown buildings also had to be considered. In general, tall buildings to the northwest of Market Street tend to obstruct and redirect the flow of wind, decreasing the downwind resource southeast of Market. Given that 350 Mission's height is lower than many of the surrounding buildings, is has an especially low potential for wind power.
Geothermal electrical generation	Feasibility, threat of induced seismicity	While geothermal heating is possible, ground water temperatures hot enough to power steam turbines for electricity generation require drilling more than 1 mile into the earth. This scale of drilling would not reasonably occur under a highrise in downtown San Francisco. Drilling at that scale for geothermal wells in a highly seismic region also runs the risk of induced seismic events, events that could be catastrophic in a highly developed area.
Municipal Waste to Power Converter	Inadequate volume of input materials	The city of San Francisco is on a mission to become the greenest city in America, with the ultimate goal of diverting 100% of its waste from landfills by the year 2020. The city is currently diverting about 80% of its waste due to composting and recycling programs. The conversion process takes non-recyclable and non-compostable waste and turns it into usable power through a gasification process. While this technology was found to be very useful, with the small amount of applicable waste produced by the 350 Mission, it is not worth the investment and will not produce a useful amount of power.
Biomass	Issue of scale, location	While algae and plant biomass has been successfully implemented in buildings, the scale of onsite biomass that could be achieved in an urban setting for a highrise would not provide enough electrical power to justify the additional costs and maintenance associated with it. Successful building installations of algae have taken place on sites with a great deal of sun exposure, which is necessary to cultivate the biomass. Instead of creating biomass fuels onsite, the goal is to utilize byproducts of occupancy, namely human waste and municipal waste, to create energy.
PaveGen	Cost, lack of useful production	PaveGen floor tiles use piezoelectric polymers to convert kinetic energy in the form of footsteps to mechanical energy. This technology was explored due to the anticipated high foot traffic in the building lobby and circulation spaces and because it is highly renewable by harnessing the movement of occupants. While PaveGen is a unique feature, the energy generated is difficult to quantify based on its existing installations (several have been installed in past testing phases) and the initial cost is unreasonable for a large installation. Instead, PaveGen will be used as a teaching tool in the public art installation and not relied upon as a substantial source of energy.

Offsite Energy

System	Reasoning for Rejecting	Details
Tidal energy	Infancy of technology, lack of suitable locations, permits	San Francisco Bay was identified as a potential site for tidal energy because it has strong currents, minimal turbulent flow, and areas with appropriate depths. An extensive study was conducted jointly by PG&E, the City of San Francisco, and Golden Gate Energy Company on the potential use of tidal power as a renewable energy source in San Francisco Bay. The study found that the only locations in the generally shallow bay that were deep enough for tidal turbines and had high enough water velocity to move them were located in shipping lanes. As of May 2011, after pumping millions of dollars into the study, PG&E abandoned its efforts, saying that tidal power is still too new for practical use in the Bay.
Geothermal electrical generation	Cost, issue of scale, procurement of land	San Francisco lies within California's "Pacific Ring of Fire," which makes it a prime location for geothermal energy generation. PG&E receives some of its utility capacity from The Geysers, a large complex of geothermal plants located 72 miles north of San Francisco. Creating a geothermal electrical generation site to offset the energy usage of one building becomes impractical due to the cost and issues of scale associated with it.
Wind	Issue of scale, procurement of land	Most wind energy in California is concentrated at three utility-scale wind farms. The closest one is located at Altamont Pass, lying 40 miles east of San Francisco. The use of wind energy has seen large increases in California over the past decade, and offshore wind has even been explored by the city of San Francisco. However, much like geothermal electrical generation, creating a large-scale wind farm to offset the electrical use of one building is an ambitious pursuit. Not to mention, PG&E already uses the wind energy at Altamont Pass as one of its renewable sources.

Structural

		ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														
	SYSTEM DESCRIPTION	ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE/CLIMATE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	RECOMMENDED?
GRAVITY SYSTEM	Composite Beams and Deck	0	0	+	-	0	0	+	+	0	0	-	0	+	-	0	+	+	++	Yes
	Wood Floor	+	0	++	++	0	+	++	+	++	-	-	-	0	--	++	--	--	-	No
	Non-Composite Beams and Deck	0	0	-	-	0	-	0	+	0	0	--	0	-	-	0	-	0	-	No
LATERAL SYSTEM	Steel Braced Frame Core	0	+	+	0	0	-	+	++	0	-	+	0	++	+	+	++	+	++	Yes
	Concrete Core	0	+	-	--	0	+	0	-	0	-	0	-	-	-	0	0	-	+	No
	Steel Shear Walls	0	0	+	0	0	-	+	+	+	0	+	0	-	+	+	+	0	+	No
SPECIAL SEISMIC DESIGN	Outriggers	0	+	+	0	0	-	+	-	+	--	-	0	-	+	+	-	+	++	Yes
	Outrigger and Dampers	+	++	+	0	0	--	+	-	++	--	-	--	-	0	+	-	-	++	Maybe
	Base Isolation System	+	++	0	0	0	--	--	--	++	--	--	--	--	0	++	-	0	++	No

Explanation of Decisions

Gravity System

System	Reasoning for *Accepting* or Rejecting	Details
Composite Beams and Deck	*Effectiveness, Phaseabilty, Practicality*	*Composite beams and decking minimize beam sizes by using the concrete and the steel together. It cuts down on construction time and costs instead of using concrete only. It does use some concrete, so the emissions aren't as nice, but the lifecycle of the system is better, with less maintenance.*
Wood Flooring	Practicality, Climate Issues, Complexity	While wood flooring is innovative, renewable, sustainable, and innovative, the system was not chosen due to the practicality of using wood. Getting the appropriate fire rating would have been difficult while still maintain the appeal of wood flooring. The connections between the steel frame and the wood flooring were too expensive and difficult to use wood as a solution for the gravity system.
Non-Composite Beams and Deck	Effectiveness, Waste, Cost	Non-composite beams and decking provide the same function as composite beams and decking, but since the steel is not integrated with the concrete by the use of shear studs, the supporting beams need to be thicker and heavier. The system can support the load, but as effectively as a composite beam and deck system.

Lateral System

System	Reasoning for *Accepting* or Rejecting	Details
Steel Braced Frame Core	*Phaseabilty, Integration, Effectiveness*	*A steel braced core allows for things to pass through, such as doors or pipes without disrupting the effectiveness of the system. The construction time is greatly reduced, and it becomes a viable system for lateral stability immediately after it is erected, and therefore can help in the event of an earthquake during construction.*
Concrete Core	Emissions, Space Needed, Integration	Using a concrete core increases emissions of the building compared to steel. The concrete core would need to be thicker, and any electrical and mechanical ducts, piping, or conduit would need to be cut through, which decreases the effectiveness of the system. It has a longer construction time, and requires additional formwork.
Steel Shear Wall	Cost, Integration	A steel shear wall poses similar problems as a concrete shear wall as anything that needs to pass through needs to be cut out of the system. A solid plate shear wall is more expensive than bracing, and the welded connections take longer and cost more than bolted connections for the brace frame system.

Special Seismic Design

System	Reasoning for *Accepting* or Rejecting	Details
Outriggers	*Effectiveness, Sustainability, Lifecycle*	*Outriggers, in conjunction with the core, are effective in decreasing the height to width ratio, require very little maintenance and use existing columns for the lateral system. The location of the outriggers does not interfere with any other floor, and can be installed quickly without adding too much time to the construction schedule.*
Outriggers and Dampers	Cost, Complexity, Maintenance	Including dampers with the outriggers greatly increase the cost of the system, and require more maintenance throughout the lifetime of the building. It adds extra time to the construction of the building, and requires specialty contractors to install correctly. The amount of reduction in lateral drift is only a small percentage.
Base Isolation System	Complexity, Cost, Space Needed	A base isolation system requires a lot of space, poses complications between the edge of the building and the site, and is very costly to produce an isolation system that can properly isolate the entire building. It is complex, and needs to be maintained frequently to ensure it performs the way it is intended to.

MEETING AGENDA SAMPLE

AEVITAS | Meeting Agenda | 1/13/14

OPENING ITEMS

- Meeting Minutes taken by: ____________________
    - Reference in the AEVITAS Google Drive Under: Integration – Meeting Minutes – 1/13/14
- Timeline: 2 Weeks – Next Deadline, 4 Weeks – Final Submission

MEETING SPECIFIC TOPICS

- Discuss Individual Advisor Meeting notes
- Ideas for the Integration Presentation, who will be assuming lead role?
- BIM's for presentations/reports and who will be responsible for them
- Revit Model Discussion (How will the Lobby be modeling individually?)
    - Facade modeling – when will this be complete?
- Supporting Documentation sharing between disciplines – who needs what?
- Discussion of verb tense consistency in reports
- Integration Report responsibilities
- Page limit discussion
- 5th Façade face analysis results – green roof or PV array?
- References discussion
- Update Information Exchange document continuously
- When can we start clash detection?
- PDF document linking?

GENERAL

- Design Decisions to make?
- What inter-discipline meetings need to be scheduled?
- Feedback on this meeting?
- Opinions on how to be more efficient?
- Opinions on how we are operating?

Coordination Meeting | 1

MEETING MINUTES SAMPLE

Meeting Minutes taken by: ____________________
Timeline: 2 Weeks – Next Deadline, 4 Weeks – Final Submission

MEETING SPECIFIC TOPICS

- Individual Advisor Meeting Notes
  - Mechanical: Net-zero energy consumption finally achieved through PV array offsite
  - Structural: Continue modeling outriggers
  - Construction: Phasing plan complete
  - Lighting/Electrical: PV array on roof is a go
- BIM's progress
  - Integration of models is proceeding on Navisworks, Construction to take lead
- Revit Model Discussion
  - Facade modeling – completed
  - Lobby – completed and ready to run individual analyses
- Supporting Documentation sharing between disciplines
  - Structural to develop software exchanges timeline
- Integration Report responsibilities
  - Substructure, FIM/Building Management: Construction
  - Building Envelope: Lighting/Electrical
  - Typical Office Floor: Mechanical
  - Superstructure: Structural
- Page limit discussion
  - Title Page, Executive Summary, and Table of Contents not included in 15 page limit
- 5th Façade face analysis results
  - Proceeding with PV array
- When can we start clash detection
  - Starting 1/16/14

Conclusion: Continue to update Information Exchanges Document!

LEED CHECKLIST

Under the LEED 2009 for New Construction and Major Renovations Checklist, 350 Mission can achieve LEED Platinum Accreditation, accumulating 93 points out of a possible 110 points.

Sustainable Sites (21/26 Points)

Prereq 1	Construction Activity Pollution Prevention	
Credit 1	Site Selection	1 Point
Credit 2	Development Density and Community Connectivity	5 Points
Credit 4.1	Alternative Transportation – Public Transportation Access	6 Points
Credit 4.2	Alternative Transportation – Bicycle Storage and Changing Rooms	1 Point
Credit 4.3	Alternative Transportation – Low-Emitting and Fuel-Efficient Vehicles	3 Points
Credit 4.4	Alternative Transportation – Parking Capacity	2 Points
Credit 6.1	Stormwater Design – Quantity Control	1 Point
Credit 7.1	Heat Island Effect – Non-roof	1 Point
Credit 8	Light Pollution Reduction	1 Point

Water Efficiency (10/10 Points)

Prereq 1	Water Use Reduction – 20% Reduction	
Credit 1	Water Efficient Landscaping | No Potable Water Use or Irrigation	4 Points
Credit 2	Innovative Wastewater Technologies	2 Points
Credit 3	Water Use Reduction | Reduce by 40%	4 Points

Energy and Atmosphere (31/35 Points)

Prereq 1	Fundamental Commissioning of Building Energy Systems	
Prereq 2	Minimum Energy Performance	
Prereq 3	Fundamental Refrigerant Management	
Credit 1	Optimize Energy Performance| Improve by 48%+ for New Buildings	19 Points
Credit 2	On-Site Renewable Energy | 72% Renewable Energy	7 Points
Credit 3	Enhanced Commissioning	2 Points
Credit 5	Measurement and Verification	3 Points

Materials and Resources (9/14 Points)

Prereq 1	Storage and Collection of Recyclables	
Credit 2	Construction Waste Management | 75% Recycled or Salvaged	2 Points
Credit 3	Materials Reuse | Reuse 10%	2 Points
Credit 4	Recycled Content | 20% of Materials	2 Points
Credit 5	Regional Materials	2 Points
Credit 7	Certified Wood	1 Point

Indoor Environmental Quality (14/15 Points)

Prereq 1	Minimum Indoor Air Quality Performance	1 Point
Prereq 2	Environmental Tobacco Smoke (ETS) Control	1 Point
Credit 1	Outdoor Air Delivery Monitoring	1 Point
Credit 2	Increased Ventilation	1 Point
Credit 3.1	Construction IAQ Management Plan – During Construction	1 Point
Credit 3.2	Construction IAQ Management Plan – Before Occupancy	1 Point
Credit 4.1	Low-Emitting Materials – Adhesives and Sealants	1 Point
Credit 4.2	Low-Emitting Materials – Paints and Coatings	1 Point
Credit 4.3	Low-Emitting Materials – Flooring Systems	1 Point
Credit 4.4	Low-Emitting Materials – Composite Wood and Agrifiber Products	1 Point
Credit 5	Indoor Chemical and Pollutant Source Control	1 Point
Credit 6.1	Controllability of Systems – Lighting	1 Point
Credit 6.2	Controllability of Systems – Thermal Comfort	1 Point
Credit 7.1	Thermal Comfort – Design	1 Point
Credit 7.2	Thermal Comfort – Verification	1 Point
Credit 8.2	Daylight and Views - Views	1 Point

Innovation and Design Process (4/6 Points)

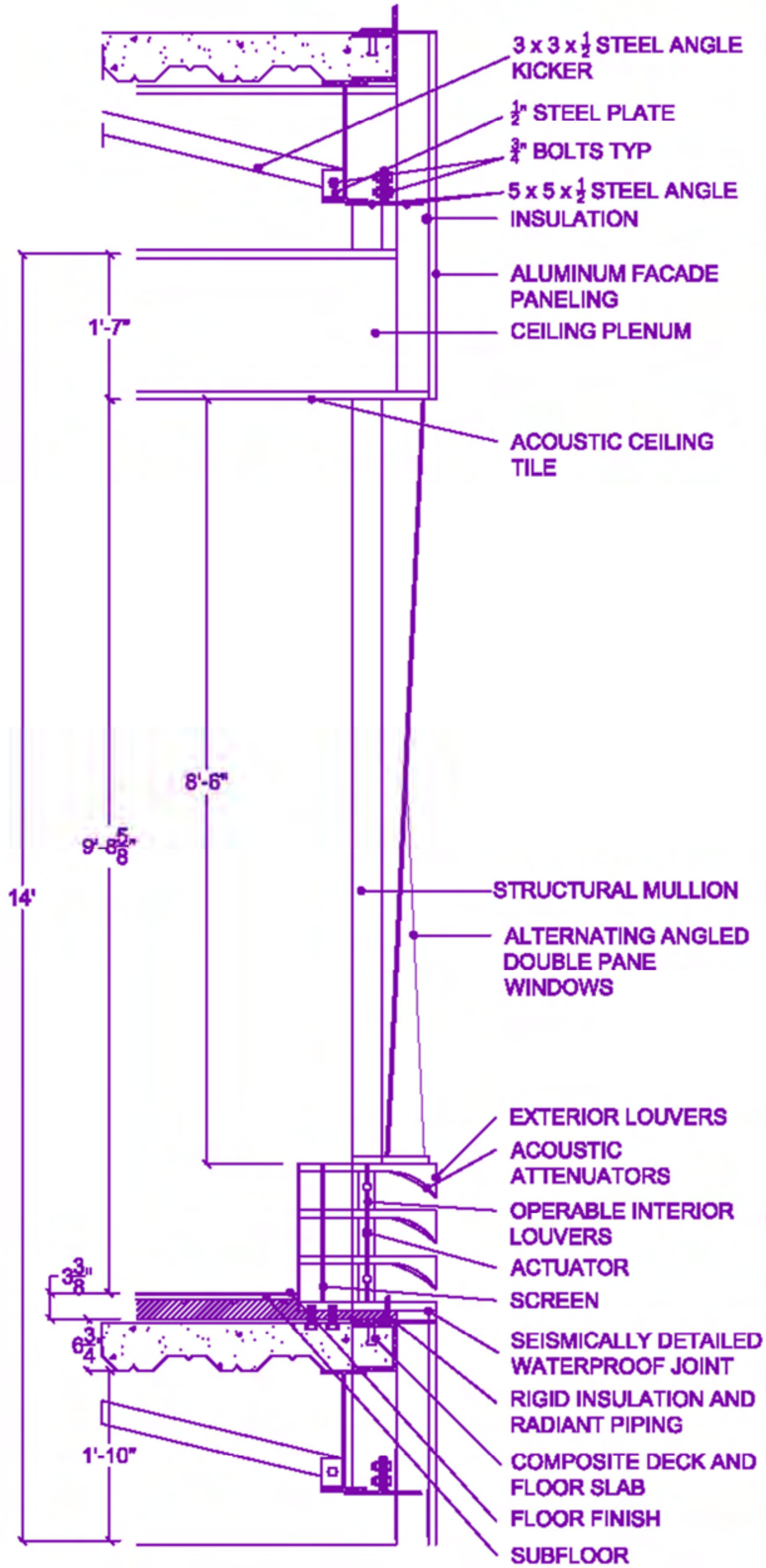
Credit 1.1	Innovation in Design: Acoustics Pilot Credit	1 Point
Credit 1.2	Innovation in Design: Interior Lighting – Quality Pilot Credit	1 Point
Credit 1.3	Innovation in Design: Sustainable Wastewater Management Pilot Credit	1 Point
Credit 2	LEED Accredited Professional	1 Point

Regional Priority Credits (4/4 Points)

Credit 1.1	Regional Priority: On-site Renewable Energy	1 Point
Credit 1.2	Regional Priority: Daylight & Views - Daylight	1 Point
Credit 1.3	Regional Priority: Innovative wastewater technologies	1 Point
Credit 1.4	Regional Priority: Water use reduction	1 Point

Total LEED Points 93/110

FAÇADE SECTION DETAIL

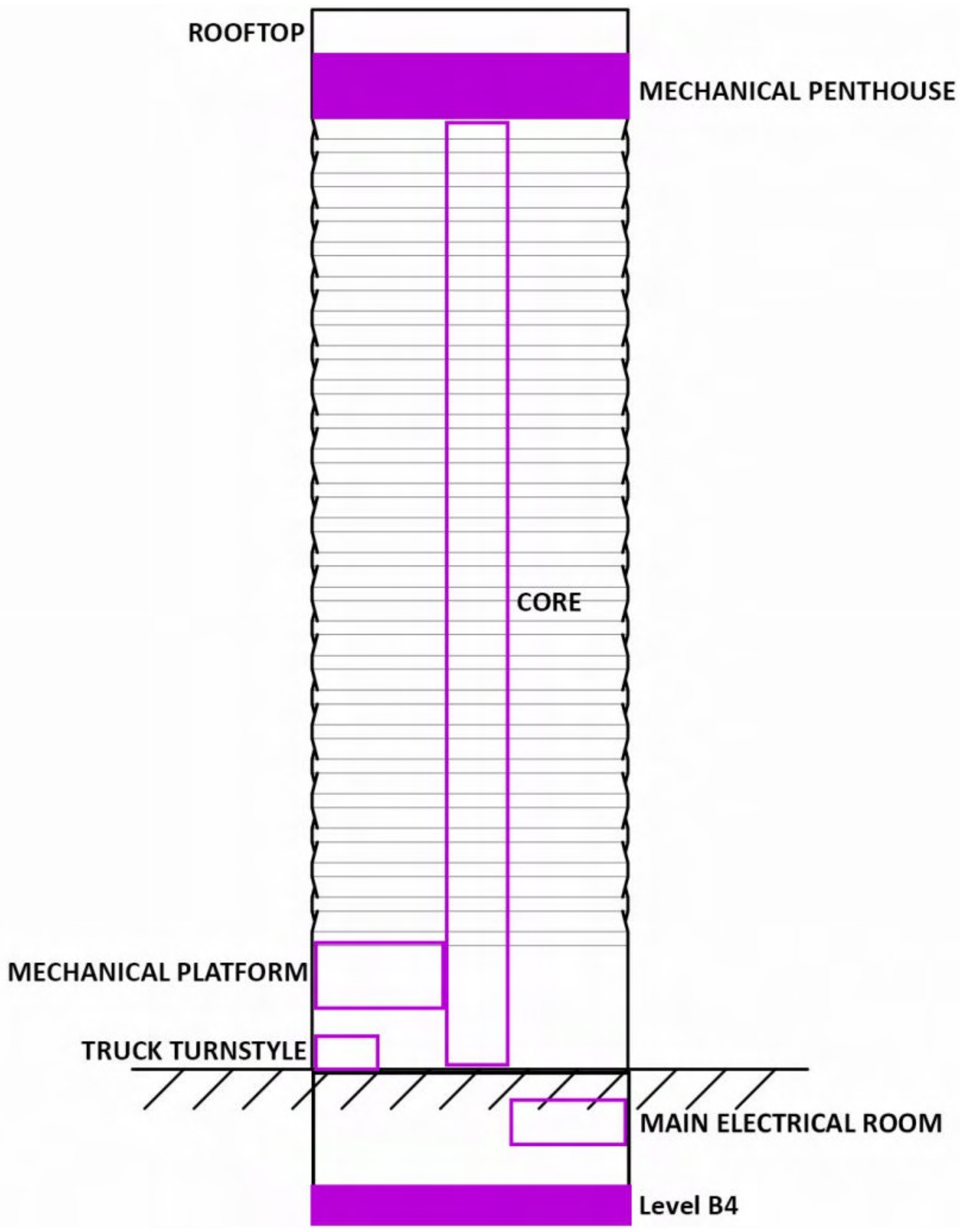


FULL ESTIMATE BY CSI DIVISION

CSI DIVISION		TOTALS	$/SF	% OF TOTAL
Division 2 - Existing Conditions		**$626,080.00**	**$1.47**	**0.43%**
02 40 00	Demolition/Remediation	$626,080.00	$1.47	0.43%
Division 3 - Concrete		**$11,837,280.00**	**$27.85**	**8.13%**
03 10 00	Concrete Forming	$1,761,760.00	$4.15	1.21%
03 20 00	Concrete Reinforcing	$2,577,120.00	$6.06	1.77%
03 30 00	Cast In Place Concrete	$7,498,400.00	$17.64	5.15%
Division 4 - Masonry		**$87,360.00**	**$0.21**	**0.06%**
04 00 00	Masonry	$87,360.00	$0.21	0.06%
Division 5 - Metals		**$17,239,040.00**	**$40.56**	**11.84%**
05 10 00	Structural Steel	$13,395,200.00	$31.52	9.20%
05 30 00	Metal Decking	$1,718,080.00	$4.04	1.18%
05 50 00	Miscellaneous Metals	$2,125,760.00	$5.00	1.46%
Division 6 - Wood, Plastics, Comp		**$262,080.00**	**$0.62**	**0.18%**
06 20 00	Millwork	$262,080.00	$0.62	0.18%
Division 7 - Thermal and Moisture Prot		**$1,849,120.00**	**$4.35**	**1.27%**
07 10 00	Water Proofing	$917,280.00	$2.16	0.63%
07 50 00	Membrane Roofing	$451,360.00	$1.06	0.31%
07 80 00	Spray On Fireproofing	$480,480.00	$1.13	0.33%
Division 8 - Openings		**$21,883,680.00**	**$51.49**	**15.03%**
08 10 00	Doors and Frames	$567,840.00	$1.34	0.39%
08 30 00	Overhead Doors	$101,920.00	$0.24	0.07%
08 80 00	Glazing/Curtain Walls	$20,384,000.00	$47.96	14.00%
08 90 00	Louvers and Vents	$829,920.00	$1.95	0.57%
Division 9 - Finishes		**$5,649,280.00**	**$13.29**	**3.88%**
09 20 00	Drywall/Partitions	$1,907,360.00	$4.49	1.31%
09 30 00	Tiling	$232,960.00	$0.55	0.16%
09 50 00	Ceilings	$2,620,800.00	$6.17	1.80%
09 60 00	Carpet Tile	$436,800.00	$1.03	0.30%
09 90 00	Painting	$451,360.00	$1.06	0.31%
Division 10 - Specialties		**$1,601,600.00**	**$3.77**	**1.10%**
10 00 00	Specialties/Signage	$1,601,600.00	$3.77	1.10%
Division 11 - Equipment		**$1,150,240.00**	**$2.71**	**0.79%**
11 00 00	Equipment	$1,150,240.00	$2.71	0.79%
Division 12 - Furnishings		**$262,080.00**	**$0.62**	**0.18%**
12 40 00	Furnishings and Accessories	$262,080.00	$0.62	0.18%
Division 14 - Conveying Equipment		**$6,828,640.00**	**$16.07**	**4.69%**
14 20 00	Elevators	$6,828,640.00	$16.07	4.69%
Division 21 - Fire Suppression		**$2,082,080.00**	**$4.90**	**1.43%**
21 00 00	Fire Suppression	$2,082,080.00	$4.90	1.43%
Division 22 - Plumbing		**$4,411,680.00**	**$10.38**	**3.03%**
22 00 00	Plumbing	$4,411,680.00	$10.38	3.03%
Division 23 - HVAC		**$18,957,120.00**	**$44.60**	**13.02%**
23 00 00	HVAC	$18,957,120.00	$44.60	13.02%
Division 26 - Electrical		**$20,456,800.00**	**$48.13**	**14.05%**
26 00 00	Electrical	$20,456,800.00	$48.13	14.05%
Division 27 - Communications		**$2,358,720.00**	**$5.55**	**1.62%**
27 00 00	Communications	$2,358,720.00	$5.55	1.62%
Division 31 - Earthwork		**$13,832,000.00**	**$32.55**	**9.50%**
31 00 00	Earthwork	$11,706,240.00	$27.54	8.04%
31 40 00	Shoring and Underpinning	$582,400.00	$1.37	0.40%
31 50 00	Excavation Support and Prot	$1,543,360.00	$3.63	1.06%
Division 32 - Exterior Improvements		**$436,800.00**	**$1.03**	**0.30%**
32 00 00	Hardscaping/Site Work	$436,800.00	$1.03	0.30%
Division 33 - Utilities		**$436,800.00**	**$1.03**	**0.30%**
33 00 00	Utilities	$436,800.00	$1.03	0.30%
Direct Costs		$145,600,000.00	$342.59	90.83%
General Conditions		$8,983,700.00	$21.14	6.17%
Fee		$4,368,000.00	$10.28	3.00%
Total Building Cost		**$158,951,700.00**	**$374.00**	**100.00%**

EQUIPMENT SCHEDULE AND LOCATION KEY

OPTION	EQUIPMENT	QUANTITY	DIMENSIONS (LWH)	LOCATION	CUT SHEET AND SPECIFICATION INFO
MECHANICAL	Boiler	3	5'2" - 3'1" - 6'3"	Penthouse	Boiler
	Chiller	3	14'2" - 6'6" - 7'5"	Penthouse	Chiller
	DOAS Fans	2	5' - 5' - 7'	Rooftop	DOAS Fans
	DOAS 1 AHU	1	11'7" - 4'5" - 9'5"	Penthouse	DOAS 1 AHU
	DOAS 2 AHU	1	11'7" - 4'5" - 9'5"	Mech. Platform M206	DOAS 2 AHU
	Smoke Exhaust Fan	1	6' - 6' - 7'	Rooftop	Smoke Exhaust Fan
	Kitchen Exhaust Fan	1	4' - 4' -6'	Mech. Platform M206	Kitchen Exhaust Fan
	Bathroom Fan + VFD 1	1	4' - 4' -6'	Rooftop	Bathroom Fan + VFD 1
	Bathroom Fan + VFD 2	1	4' - 4' -6'	Mech. Platform M206	Bathroom Fan + VFD 2
	Garage Exhaust Fan	1	5' - 5' - 7'	Near truck turnstyle	Garage Exhaust Fan
	HVAC Primary Pumps + VFD	6	1' - 1' - 1'6"	Penthouse	HVAC Primary Pumps + VFD
	HVAC Secondary Pumps + VFD	2	1' - 1' - 1'6"	Penthouse	HVAC Secondary Pumps + VFD
	Tertiary Pumps + VFD	26 (1 per fl.)	1' - 1' - 1'6"	Mech. Space per floor	Tertiary Pumps + VFD
	Dom. Water Booster Pumps + VFD	2	1' - 1' - 1'6"	Pump RM (Level B4)	Dom. Water Booster Pumps + VFD
	Fire Pump + VFD	1	1' - 1' - 1'6"	Fire Pump RM (Level B4)	Fire Pump + VFD
	Cooling Tower	1	13'11" - 22'5" - 22'7"	Penthouse	Cooling Tower
	Greywater Storage Tank	1	See room size	RM B422B (Level B4)	Greywater Storage Tank
	Robust Potable Storage Tank	1	12'D - 10'H	Penthouse	Robust Potable Storage Tank
	Fire Suppression Tank	1	See room size	RM B422A (Level B4)	Fire Suppression Tank
LIGHTING/ELECTRICAL	Fuel Cell	3	27'4" - 8'4" - 10'	Penthouse Electrical Room (2) and Main Electrical Room (1)	Fuel Cell
	Human Waste to Energy	1		Storage B420 (Level B4)	Human Waste to Energy
	Onsite Solar	200 kW	15,000 $ft.^2$	Rooftop	Onsite Solar
	Paralleling Switchgear	2	24' - 3'6" - 8'	Penthouse Electrical Room (1) and Main Electrical Room (1)	Paralleling Switchgear
	Battery Pack	2		Penthouse Electrical Room, Server Room	Battery Pack
	Rectifier	1		Penthouse Electrical Room	Rectifier
	Inverter	1		Penthouse Electrical Room	Inverter
	Primary Transformers	2	Provided by Utility	Service Entrance (PG&E vault)	Primary Transformers
	Secondary Transformers	27		Electrical Room every floor	Secondary Transformers
	Rack Servers	50		Server Room	Rack Servers
	Equipment Distribution Panelboards	4		Penthouse Electrical Room (2) and Main Electrical Room (2)	Equipment Distribution Panelboards
	Branch Panelboards	75		Electrical Room per floor	Branch Panelboards
	Primary ATS	1		Penthouse Electrical Room	Primary ATS
	Secondary ATS	26 (1 per fl.)		Electrical Room per floor	Secondary ATS



LIFECYCLE COST ANALYSIS

Life Cycle Cost Analysis	**Project Information**	
Options Comparison	**Building**	350 Mission St.
Input Table	**Project Name**	AEVITAS Thesis
Date January 15, 2014	**Project Type (lighting, heating, etc)**	HVAC system

Costs

	BASELINE		**Proposed**	
Initial Costs				
	Total Cost	$ 10,989,149	Total Cost	$ 26,779,952
	Incentives	$ -	Incentives	$ 7,642,500
	Net Costs	**$ 10,989,149**	**Net Costs**	**$ 19,137,452**
Replacement Costs				
	Expected Life (Years)	20	Expected Life (Years)	20
	Replacement Cost	$ 10,989,149	Replacement Cost	$ 26,779,952

One Time Operating Costs

		Materials	**Labor**	**Total**		**Materials**	**Labor**	**Total**
FY14	Year 1	$ 178,400	$ 250,000	$ 428,400	Year 1	$ -	$ 400,000	$ 400,000
FY15	Year 2	$ 178,400	$ 250,000	$ 428,400	Year 2	$ -	$ 400,000	$ 400,000
FY16	Year 3	$ 178,400	$ 250,000	$ 428,400	Year 3	$ -	$ 400,000	$ 400,000
FY17	Year 4	$ 178,400	$ 250,000	$ 428,400	Year 4	$ -	$ 400,000	$ 400,000
FY18	Year 5	$ 178,400	$ 250,000	$ 428,400	Year 5	$ -	$ 400,000	$ 400,000
FY19	Year 6	$ 178,400	$ 250,000	$ 428,400	Year 6	$ 294,400	$ 400,000	$ 694,400
FY20	Year 7	$ 178,400	$ 250,000	$ 428,400	Year 7	$ 294,400	$ 400,000	$ 694,400
FY21	Year 8	$ 178,400	$ 250,000	$ 428,400	Year 8	$ 294,400	$ 400,000	$ 694,400
FY22	Year 9	$ 178,400	$ 250,000	$ 428,400	Year 9	$ 294,400	$ 400,000	$ 694,400
FY23	Year 10	$ 178,400	$ 250,000	$ 428,400	Year 10	$ 480,820	$ 400,000	$ 880,820
FY24	Year 11	$ 178,400	$ 250,000	$ 428,400	Year 11	$ 294,400	$ 400,000	$ 694,400
FY25	Year 12	$ 178,400	$ 250,000	$ 428,400	Year 12	$ 294,400	$ 400,000	$ 694,400
FY26	Year 13	$ 178,400	$ 250,000	$ 428,400	Year 13	$ 294,400	$ 400,000	$ 694,400
FY27	Year 14	$ 178,400	$ 250,000	$ 428,400	Year 14	$ 294,400	$ 400,000	$ 694,400
FY28	Year 15	$ 178,400	$ 250,000	$ 428,400	Year 15	$ 294,400	$ 400,000	$ 694,400
FY29	Year 16	$ 178,400	$ 250,000	$ 428,400	Year 16	$ 294,400	$ 400,000	$ 694,400
FY30	Year 17	$ 178,400	$ 250,000	$ 428,400	Year 17	$ 294,400	$ 400,000	$ 694,400
FY31	Year 18	$ 178,400	$ 250,000	$ 428,400	Year 18	$ 294,400	$ 400,000	$ 694,400
FY32	Year 19	$ 178,400	$ 250,000	$ 428,400	Year 19	$ 294,400	$ 400,000	$ 694,400
FY33	Year 20	$ 178,400	$ 250,000	$ 428,400	Year 20	$ 480,820	$ 400,000	$ 880,820
	Totals	**$ 3,568,000**	**$ 5,000,000**	**$ 8,568,000**	**Totals**	**$ 4,788,840**	**$ 8,000,000**	**$ 12,788,840**
	Yr 20 Remaining Equip. Value			**$ -**	**Yr 20 Remaining Equip. Value**			**$ -**

Annual Consumption

	BASELINE		**Proposed**	
	Annual Consumption	Cost ($)	Annual Consumption	Cost ($)
Electricity	3,504,241	$ 588,390	-5,543,956	$ (582,614.34)
Natural Gas	83,432	$ 79,260.57	168,952	$ 146,297.23
	TOTALS	**$ 667,651**	**TOTALS**	**$ (436,317)**

Assumptions

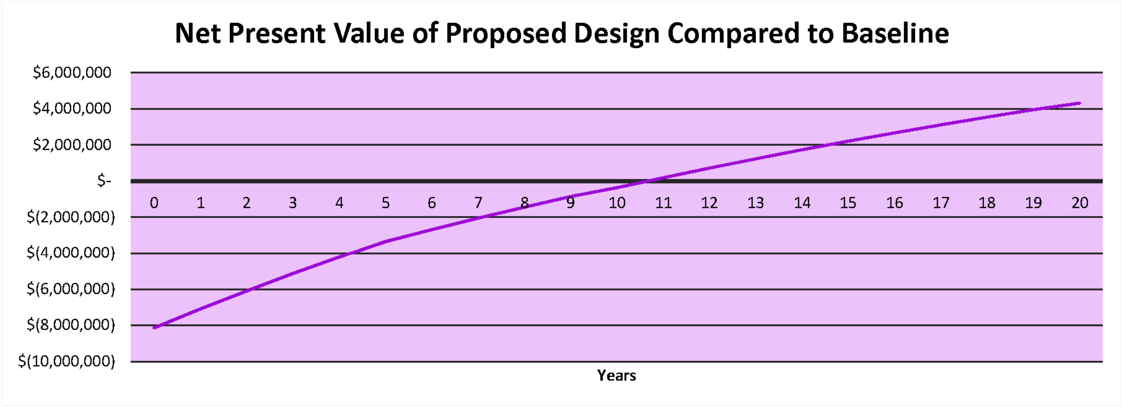
Discount Rate	**Escalation Rates**				**Study Period**
	Electricity	**Natural Gas**	**Materials**	**Maint. and Labor**	
8.00%	3.75%	5.00%	**1.73%**	**1.73%**	**20**

Life Cycle Cost Analysis	**Project Information**	
Options Comparison	**Building**	350 Mission St.
Results Table	**Project Name**	AEVITAS Thesis
Date January 15, 2014	**Project Type (lighting, heating, etc)**	HVAC system

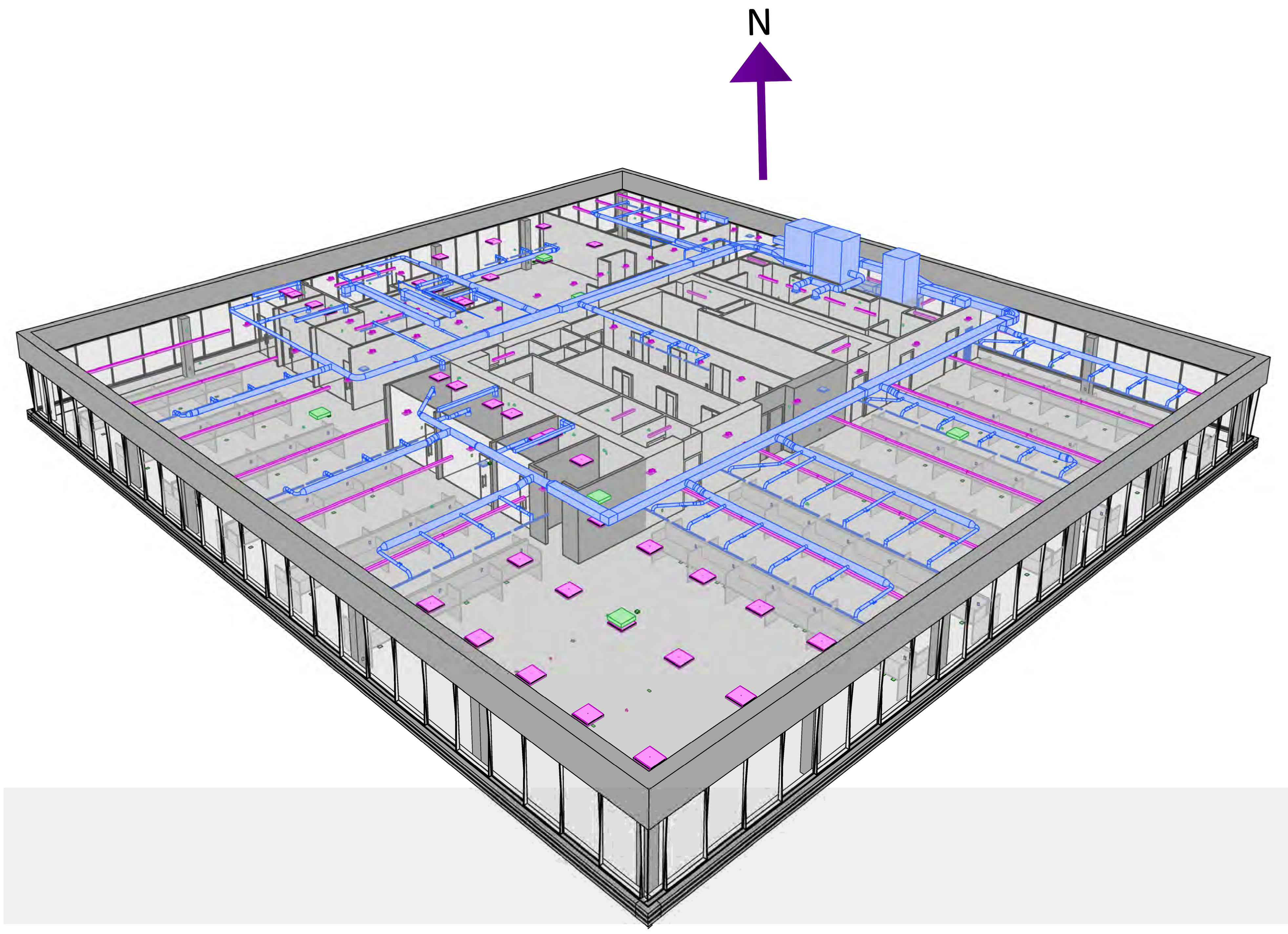
Baseline 20 Year Total Cost of Ownership (TCO)	**Cost to Own**
	$ 24,350,582

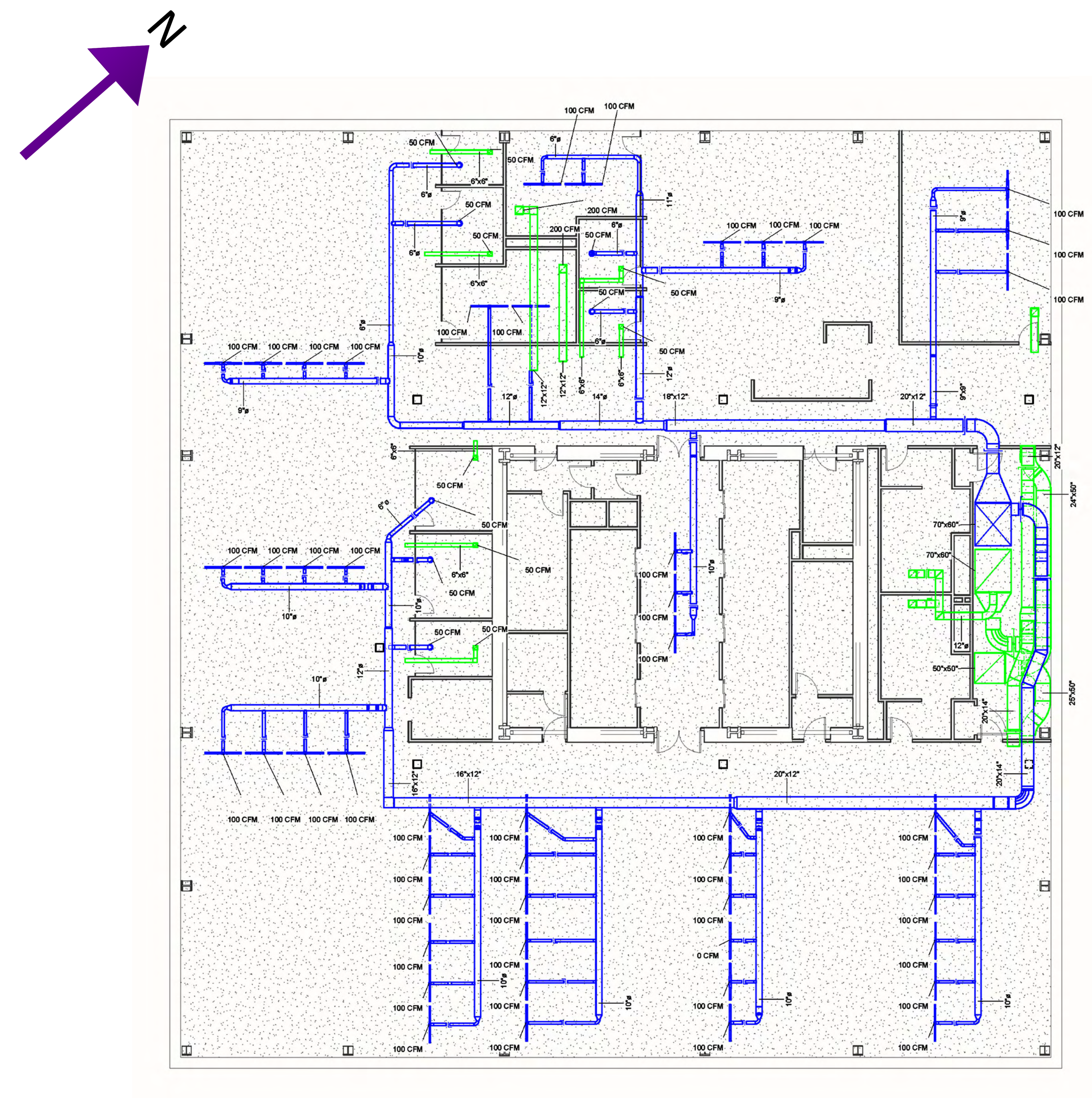
Proposed Design

	Cost/Savings Variable Cost Only
20 Yr Total Cost of Ownership	**$ 20,040,069**
20 Yr Net Present Value (NPV)	**$ 4,310,513**
Simple Payback Analysis	
	Cost/Savings Variable Cost Only
First Year Utility Savings (FY14 rates)	$1,103,968
Simple Payback Period (Years)	7.38
First Year Return on Investment	13.5%
Life Cycle Cost Metrics	
	Cost/Savings Variable Cost Only
20 Year Savings to Investment Ratio	1.52
Discounted Payback Period (Years)	See Graph
Adjusted Internal Rate of Return	14.0%

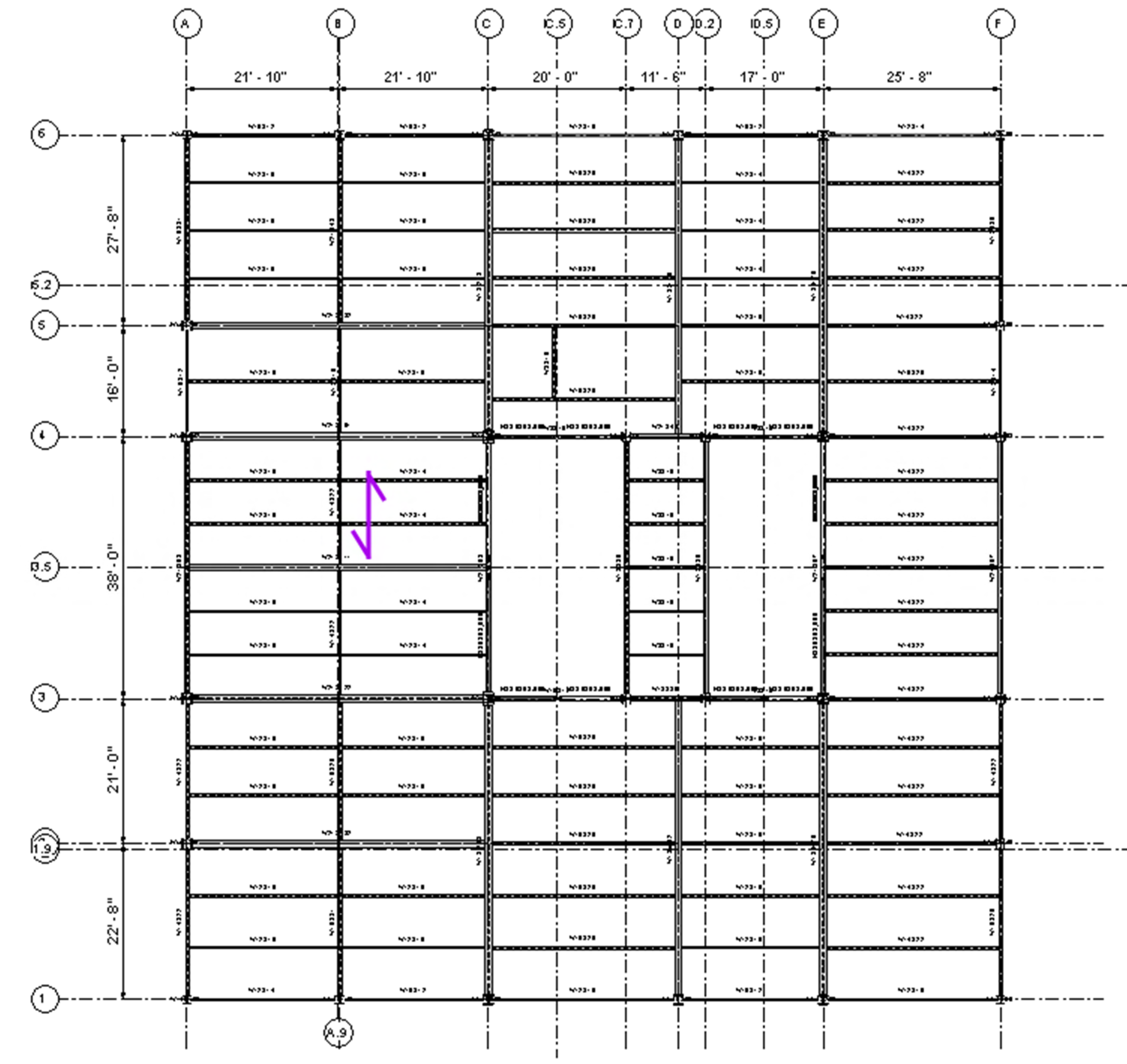


AEVITAS | Typical Office Floor

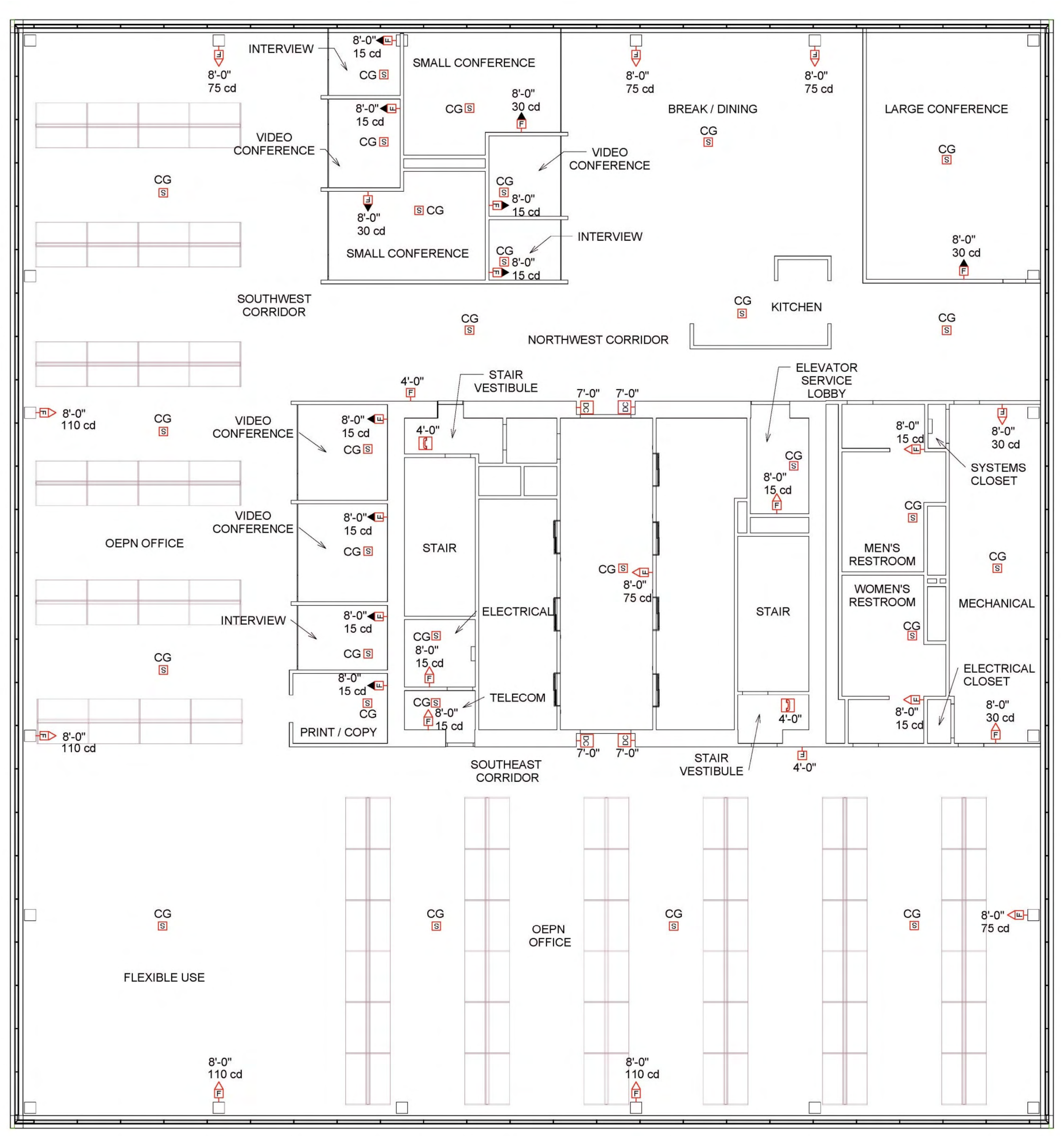




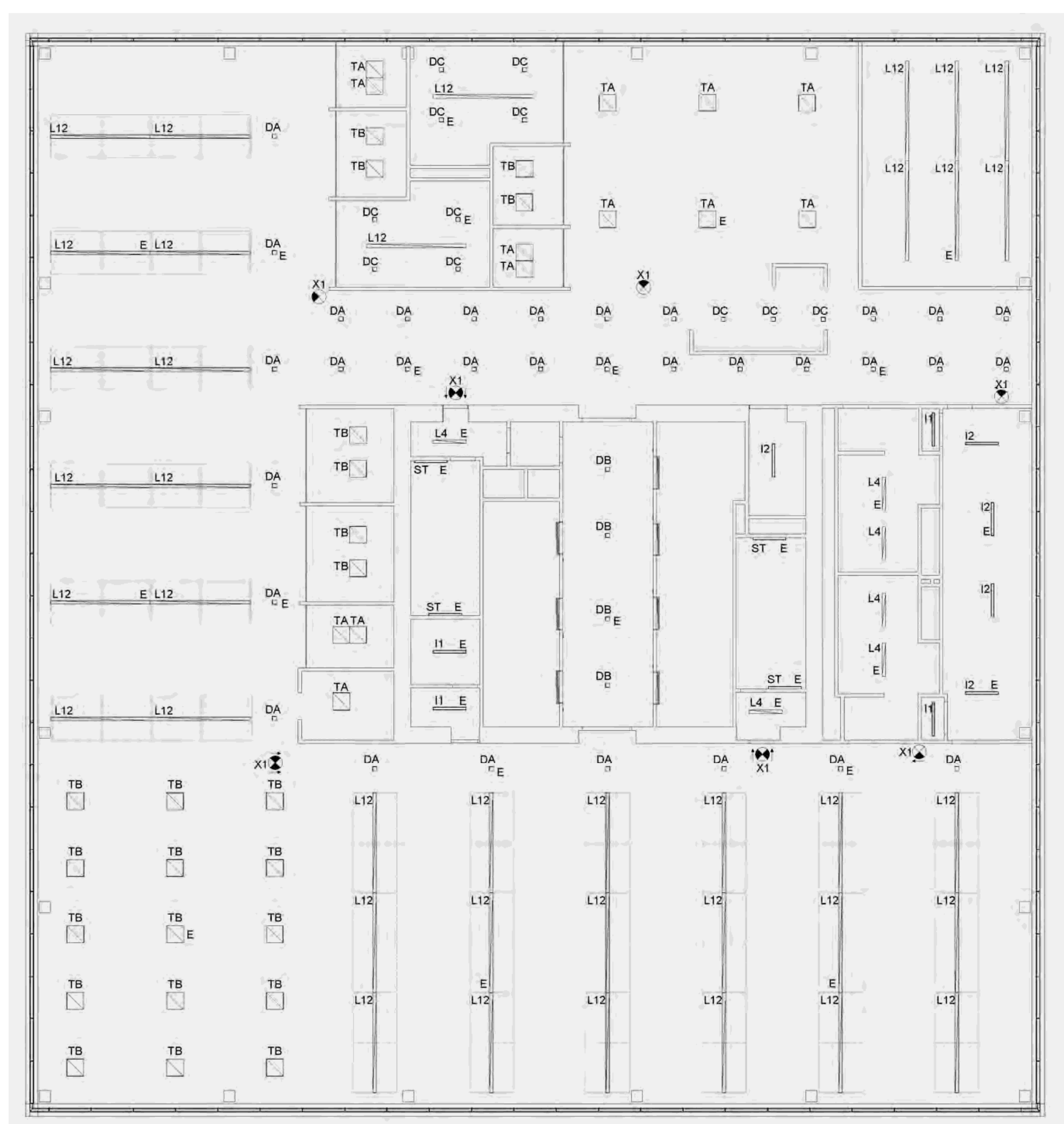
OFFICE MECHANICAL



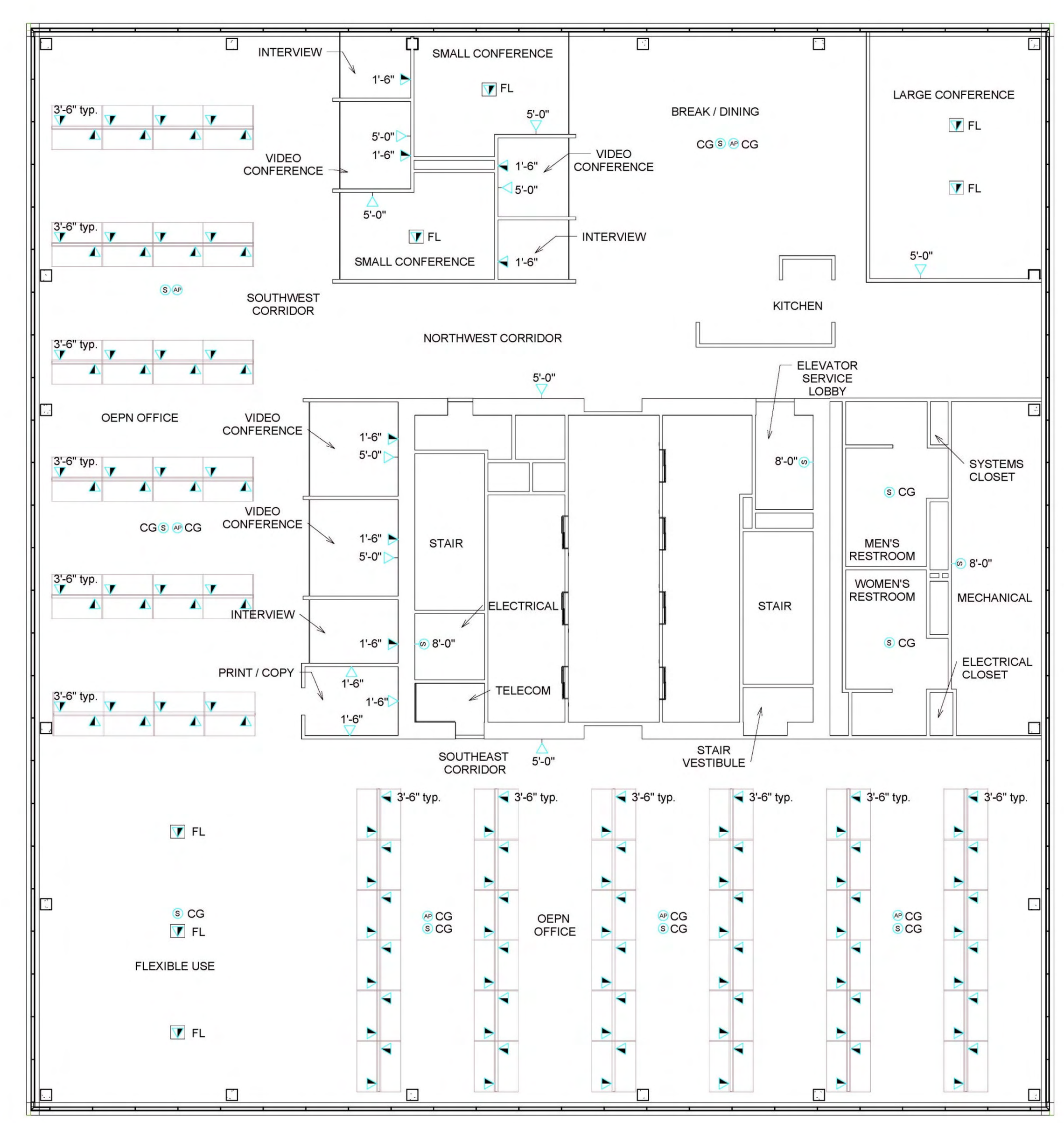
OFFICE STRUCTURAL



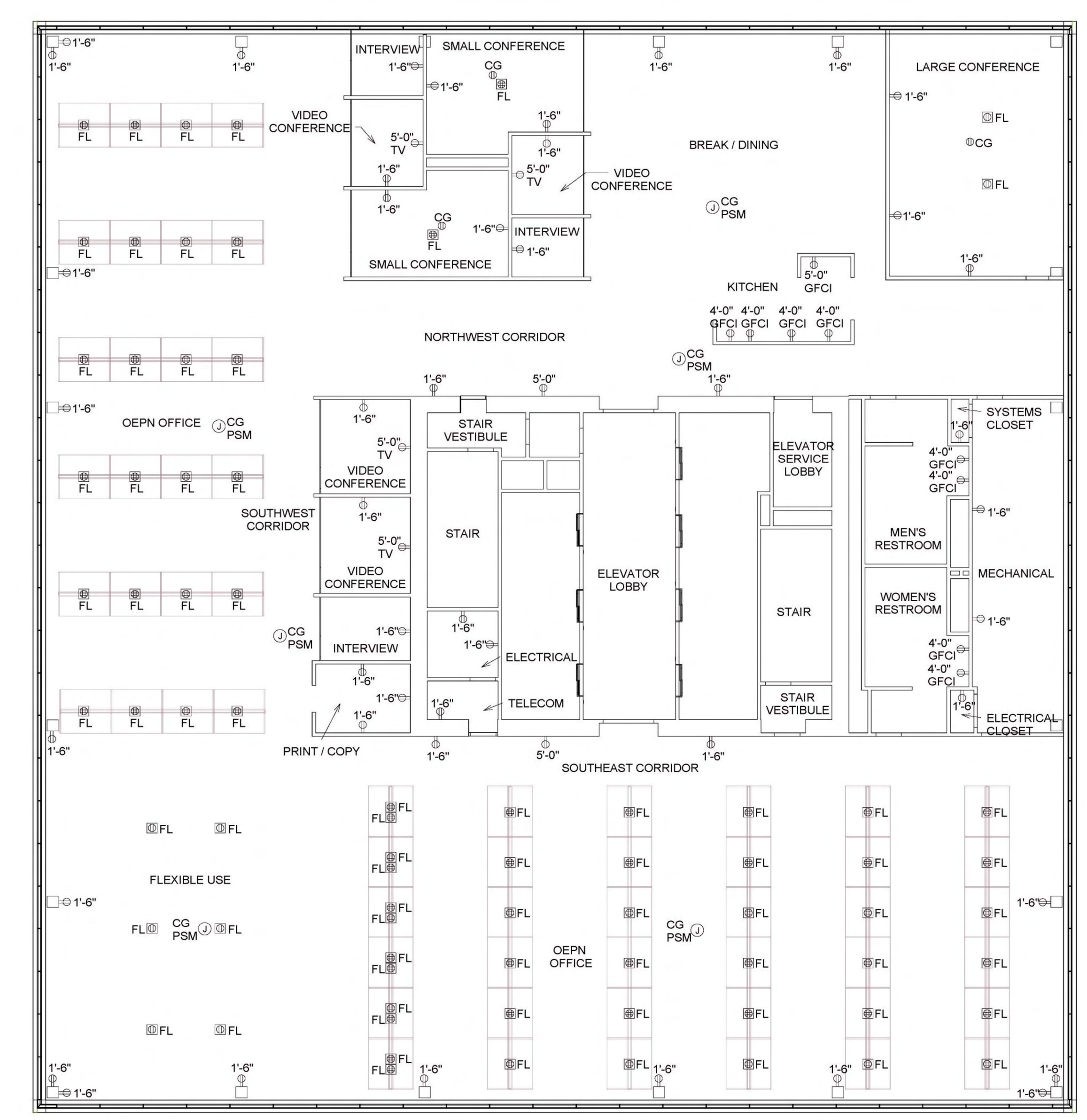
OFFICE FIRE ALARM



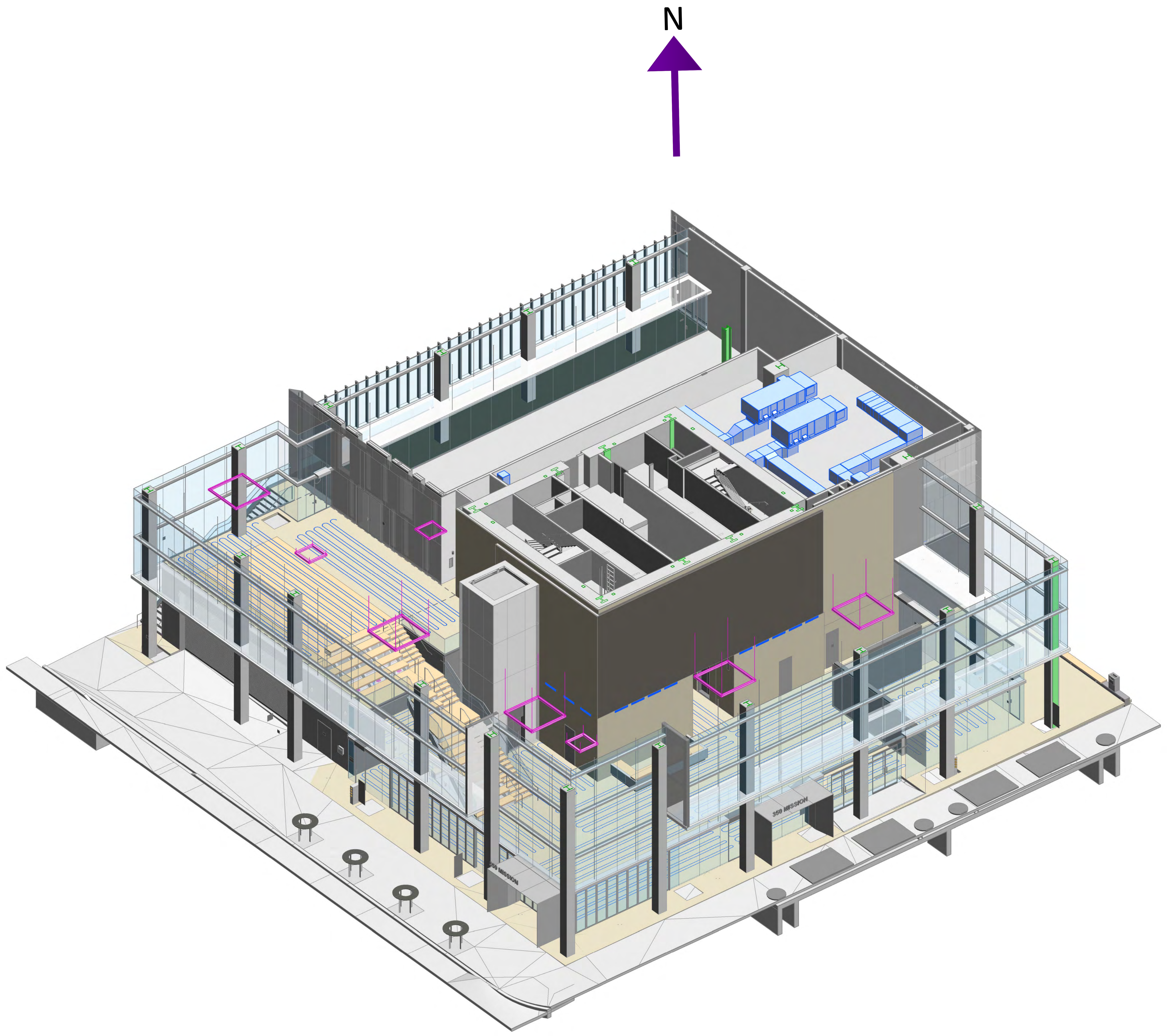
OFFICE LIGHTING

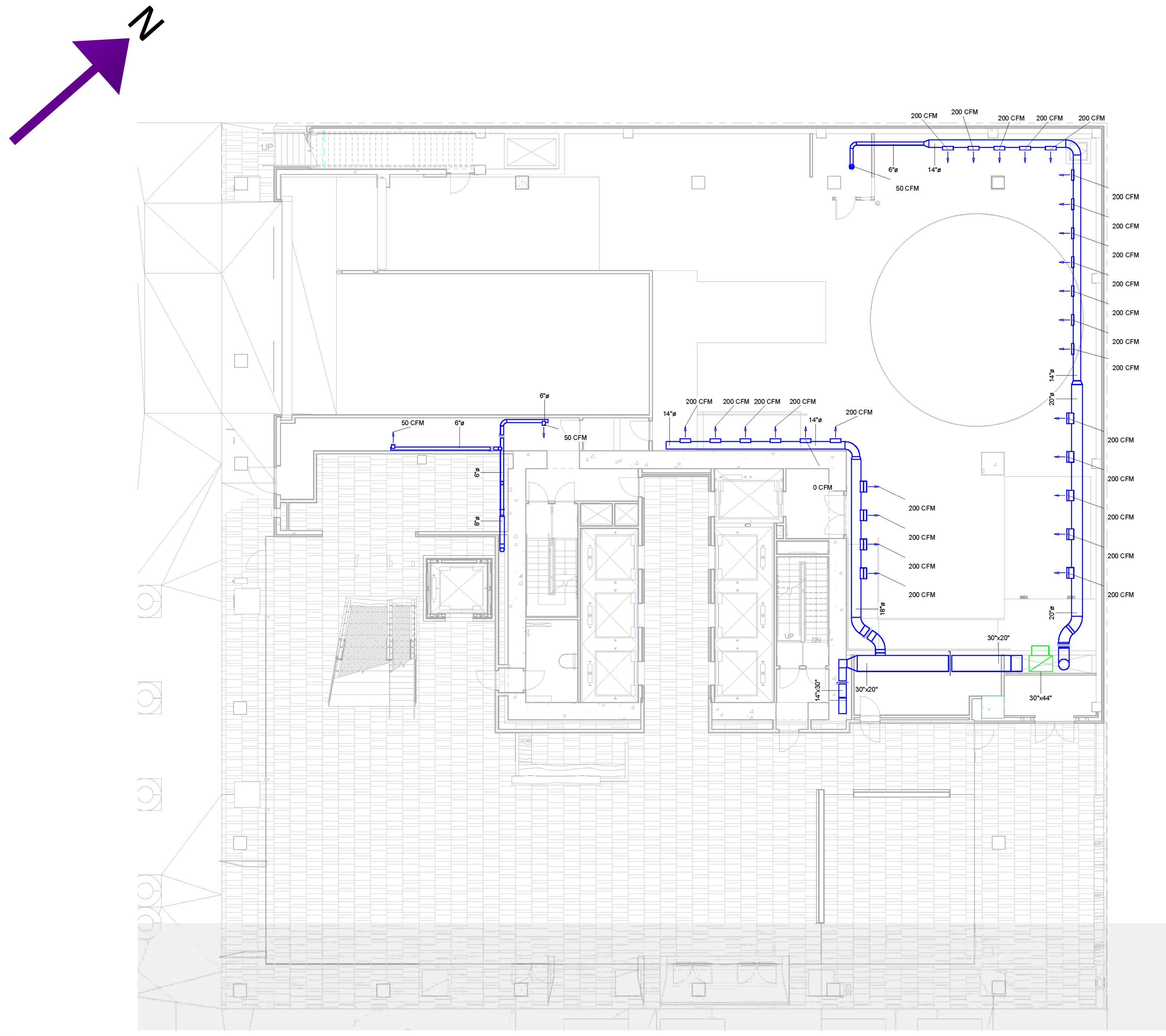


OFFICE DATA | TELECOM

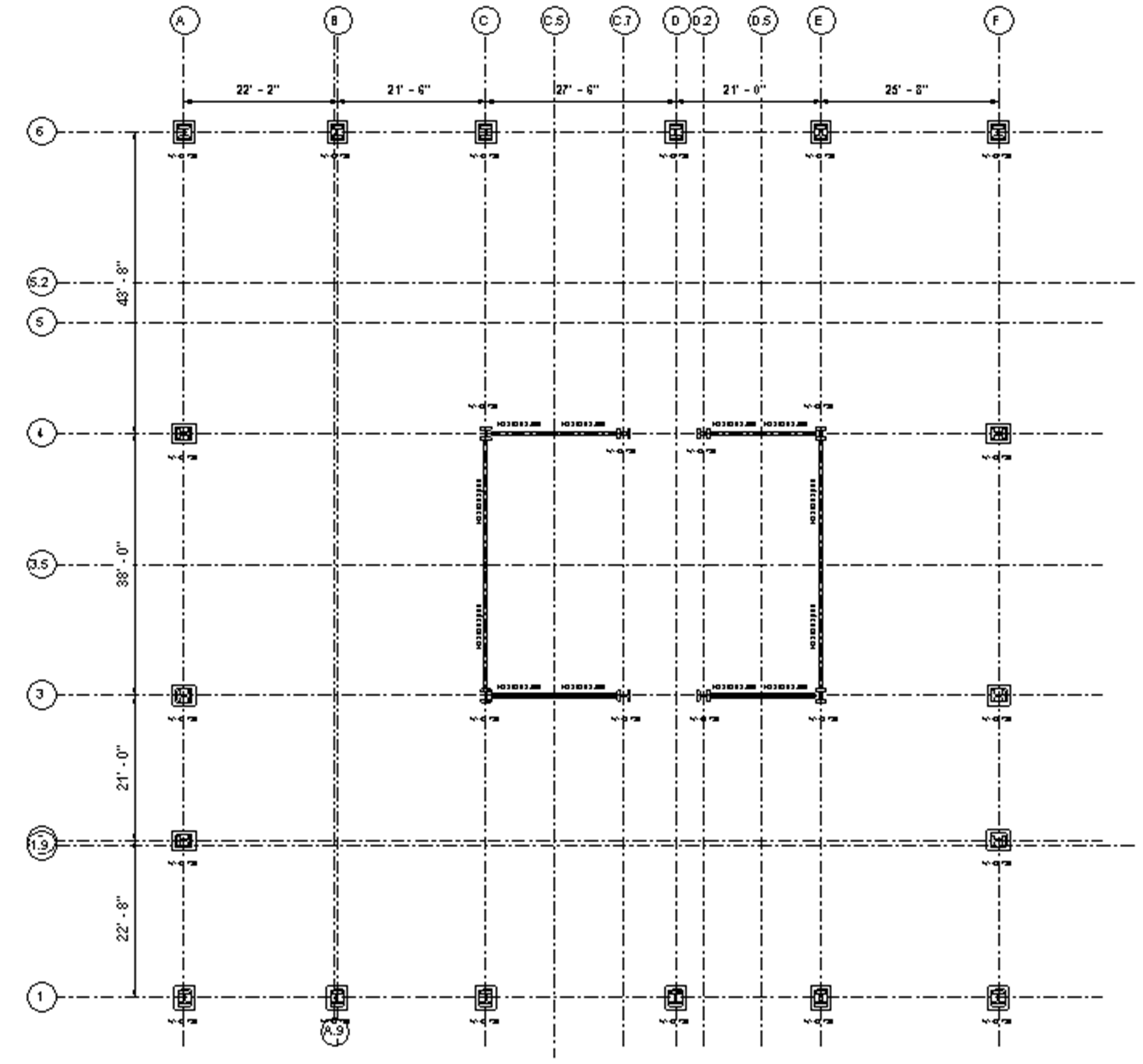


OFFICE POWER

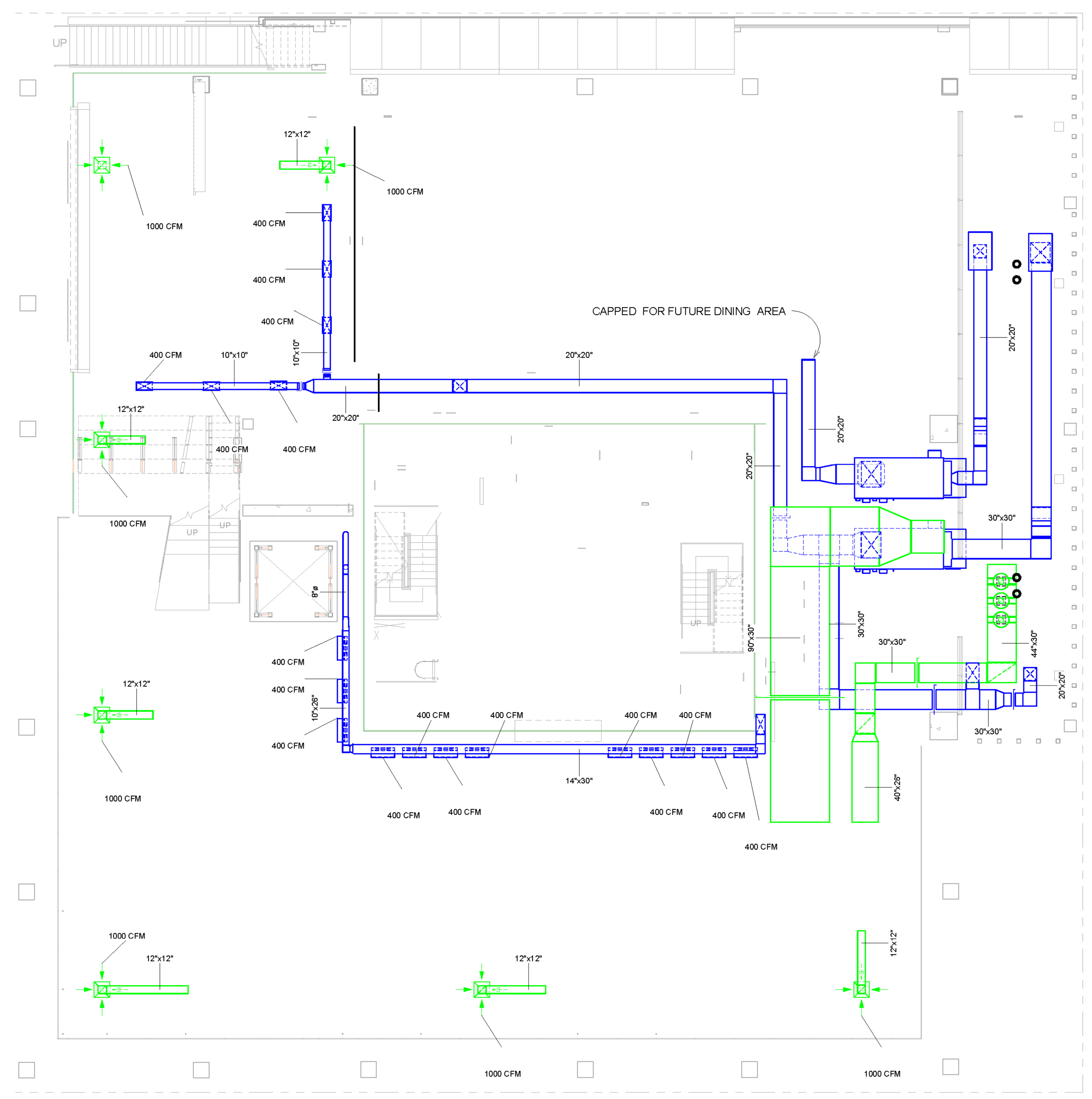




LOWER LOBBY MECHANICAL



LOBBY STRUCTURAL

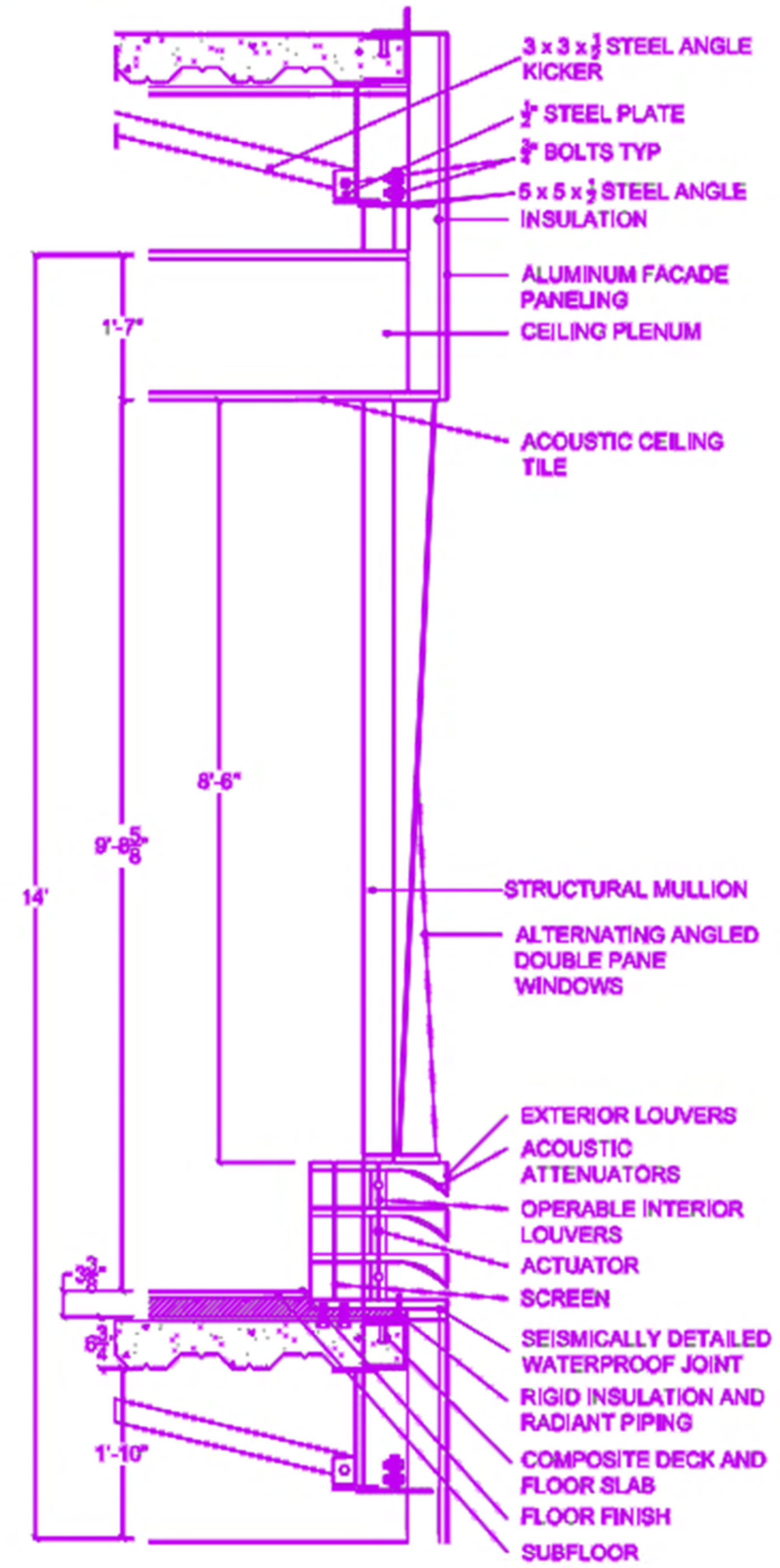


UPPER LOBBY MECHANICAL

LOBBY LIGHTING

TYPICAL OFFICE FLOOR SECTION

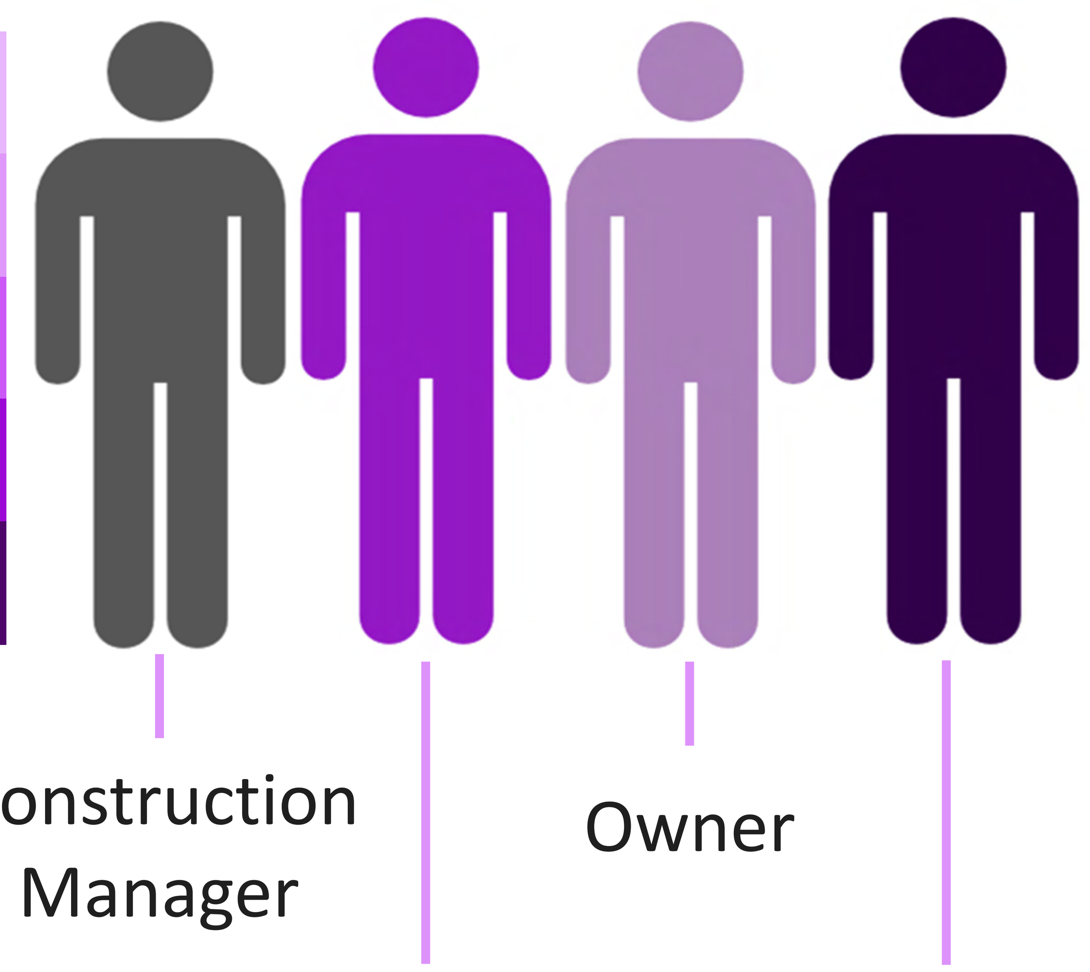
E-W LOBBY SECTION



FAÇADE SECTION

FACILITY DATA

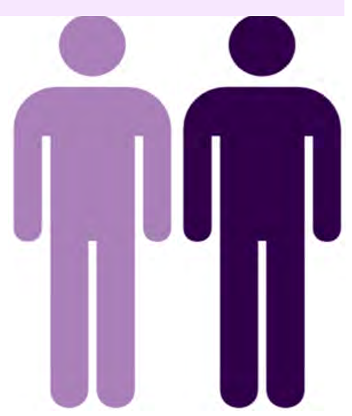
- SPACE DATA
- UTILIES DATA
- AS-BUILTS
- WORK ORDERS
- EQUIPMENT LIST



*Facilities Maintenance is a large part of AEVITAS's plan in helping 350 Mission to succeed in being [zero**impact**] by reaching net-zero energy consumption. In order for the building to perform so effectively, it will be critical that all pieces of equipment are functioning at maximum efficiency. The facility data includes space data, utilities information, as-built drawings, work orders, and equipment lists. Through these sources of information, a BIM was developed to keep all information in one place. The human figure graphics represent those who have an impact on the facilities integration modeling throughout the entire process.*

SPACE DATA

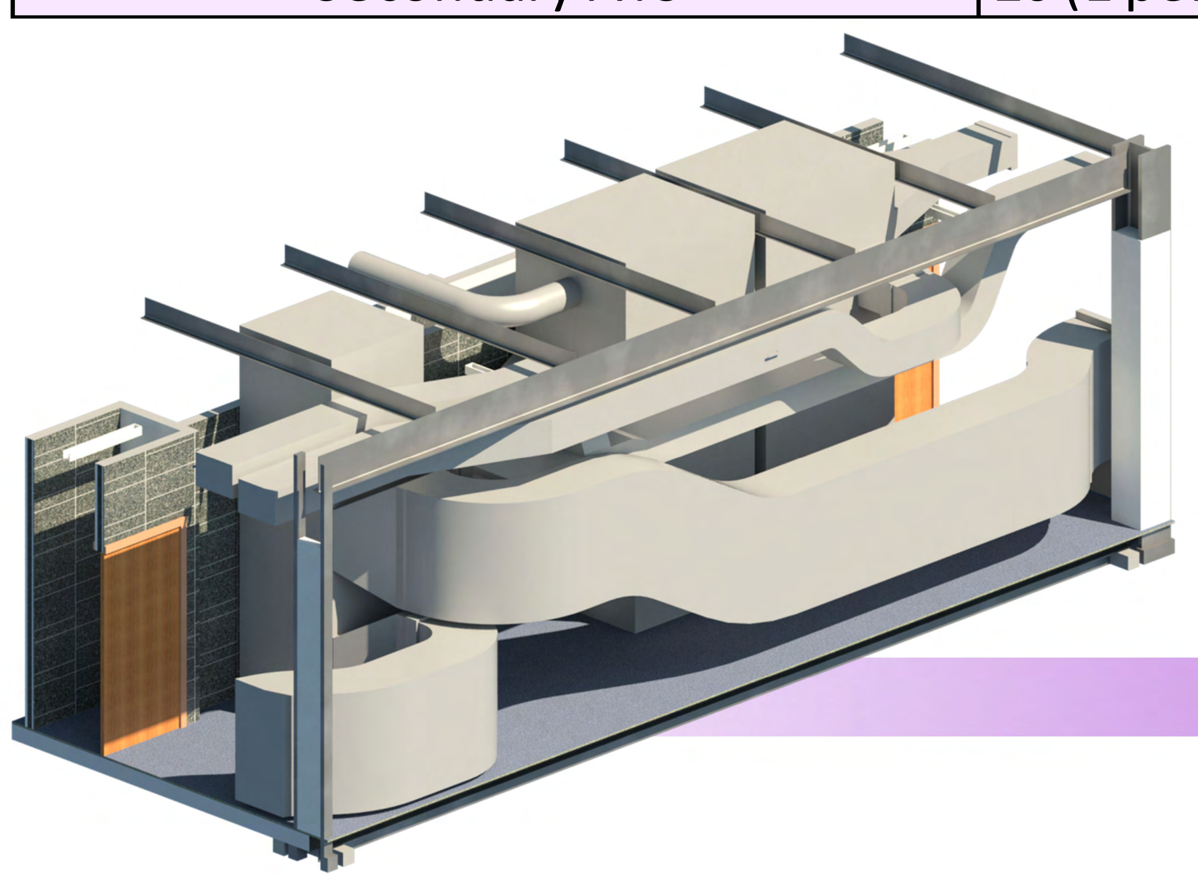
The Owner and the Facility Management Company have an impact on the space data and how it will change from tenant to tenant. These individuals are responsible for maintaining accurate space data after construction ends. During the operate phase and the lifecycle of the building, maintaining this section of the model will ensure proper zoning controls for all MEP systems which will improve the operations of all machinery. This type of information within the Building Information Model made for Facilities Integration and Maintenance can also be used to determine quantities of material for replacement in the future.



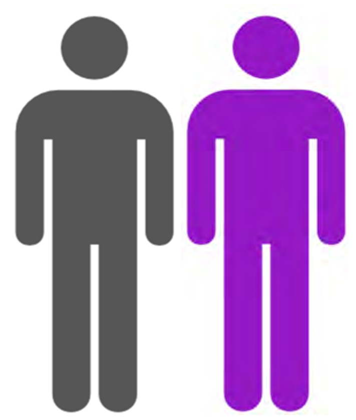
Flooring	New Group Description		
Flooring.New Item	Carpet	12,376.675	ft²
Flooring.New Item_2	Tile	715.049	ft²

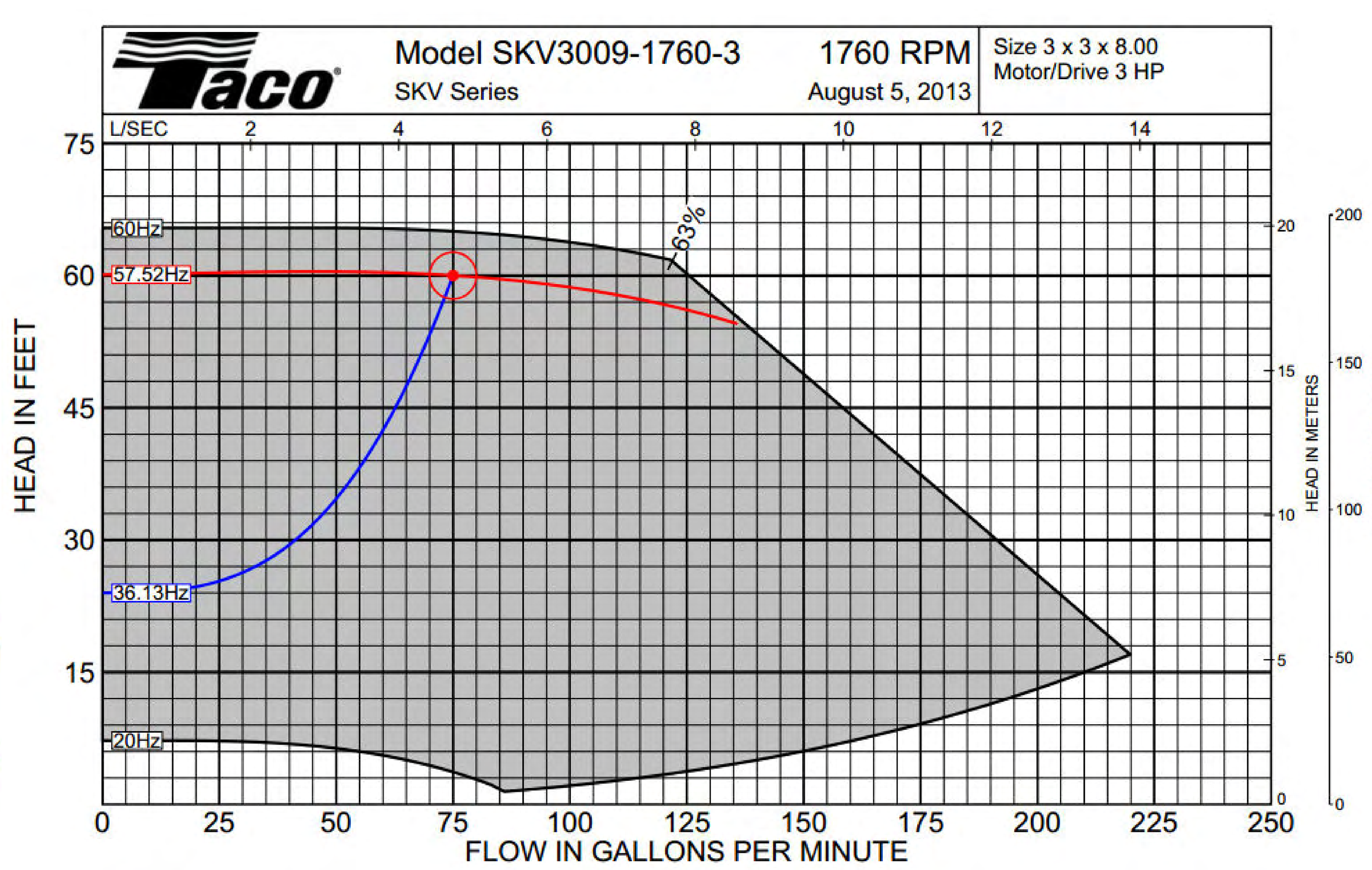
EQUIPMENT LIST WITH CUT SHEET AND COST DATA

EQUIPMENT	QUANTITY	DIMENSIONS (LWH)	LOCATION	CUT SHEET AND SPECIFICATION INFO
Tertiary Pumps + VFD	26 (1 per fl.)	1' - 1' - 1'6"	Mech. Space per floor	Tertiary Pumps + VFD
Secondary Transformers	27		Electrical Room every floor	Secondary Transformers
Branch Panelboards	75		Electrical Room per floor	Branch Panelboards
Secondary ATS	26 (1 per fl.)		Electrical Room per floor	Secondary ATS



Throughout the BIM, each individual piece of equipment is connected to the equipment list, the cut sheet for the machine, as well as cost replacement and maintenance information. The specialty contractors will turn this over to the facility managers during the five year contract time span. All BIMs are linked together to provide ultimate visibility of all working parts and pieces of the MEP equipment. The architectural model is also linked to provide information on items such as filter changes for the natural ventilation louvers.





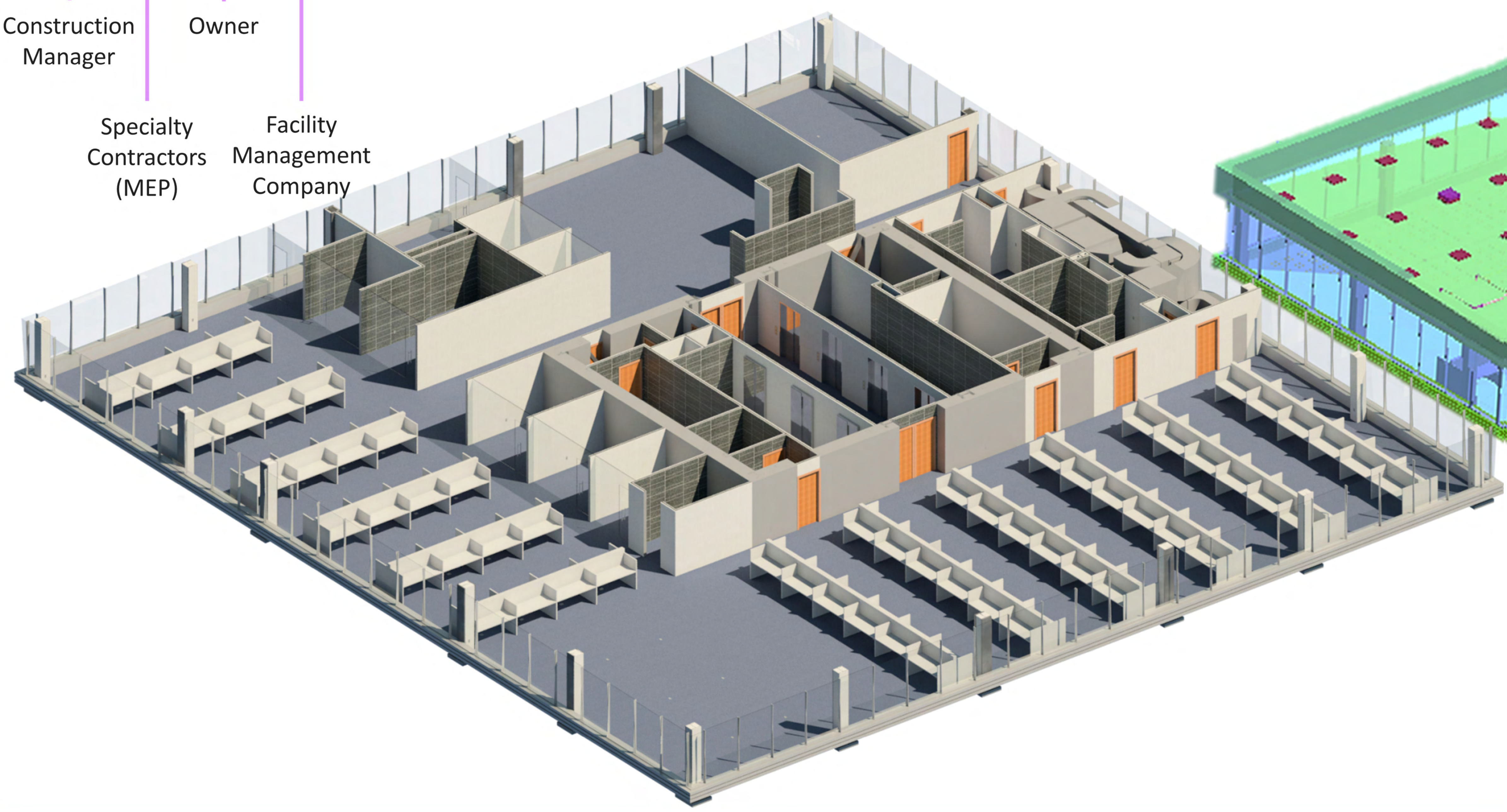
AEVITAS | Facilities Integration Modeling – Typical Office Floor Example Continued

Construction Manager

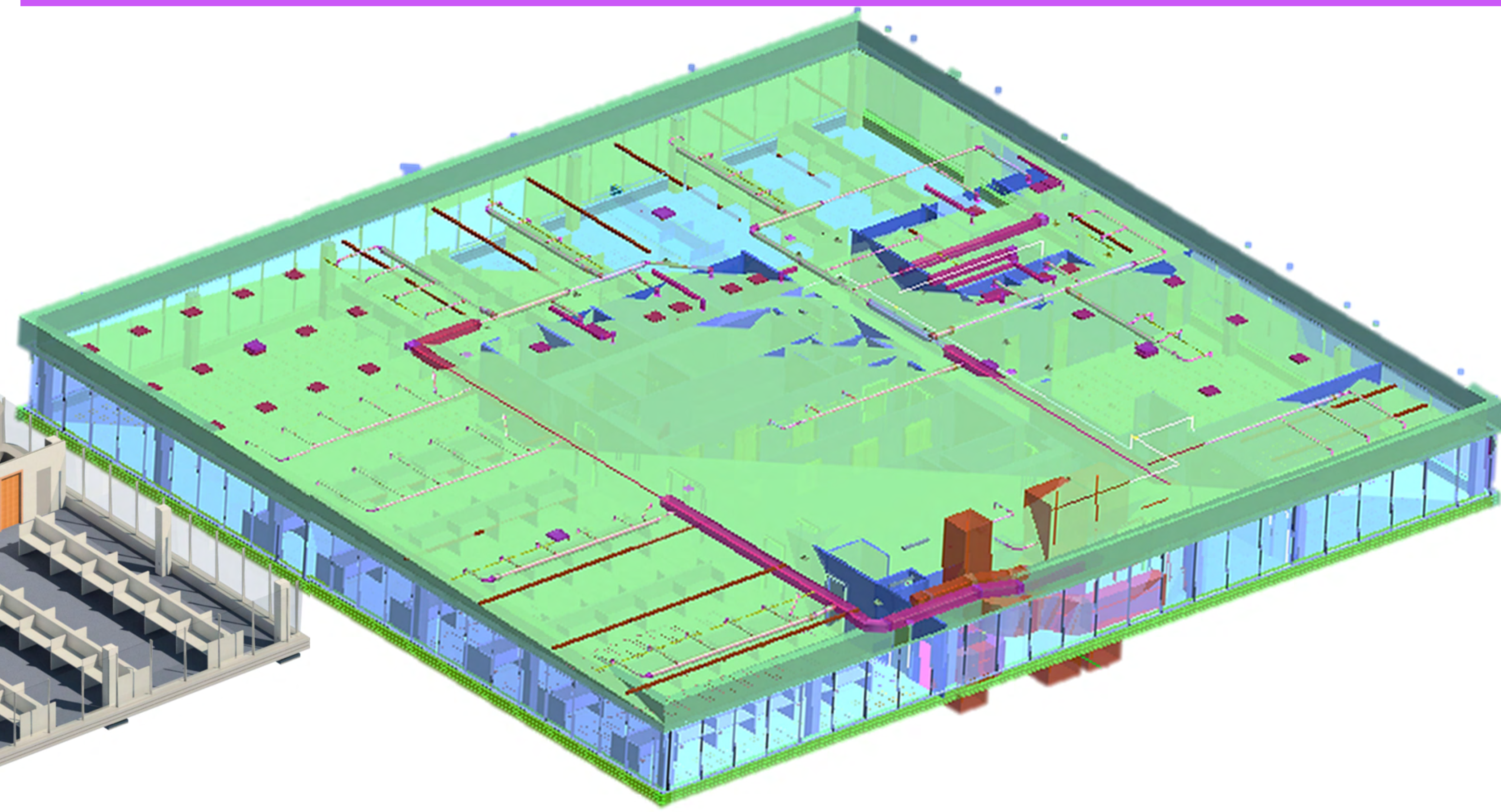
Owner

Specialty Contractors (MEP)

Facility Management Company

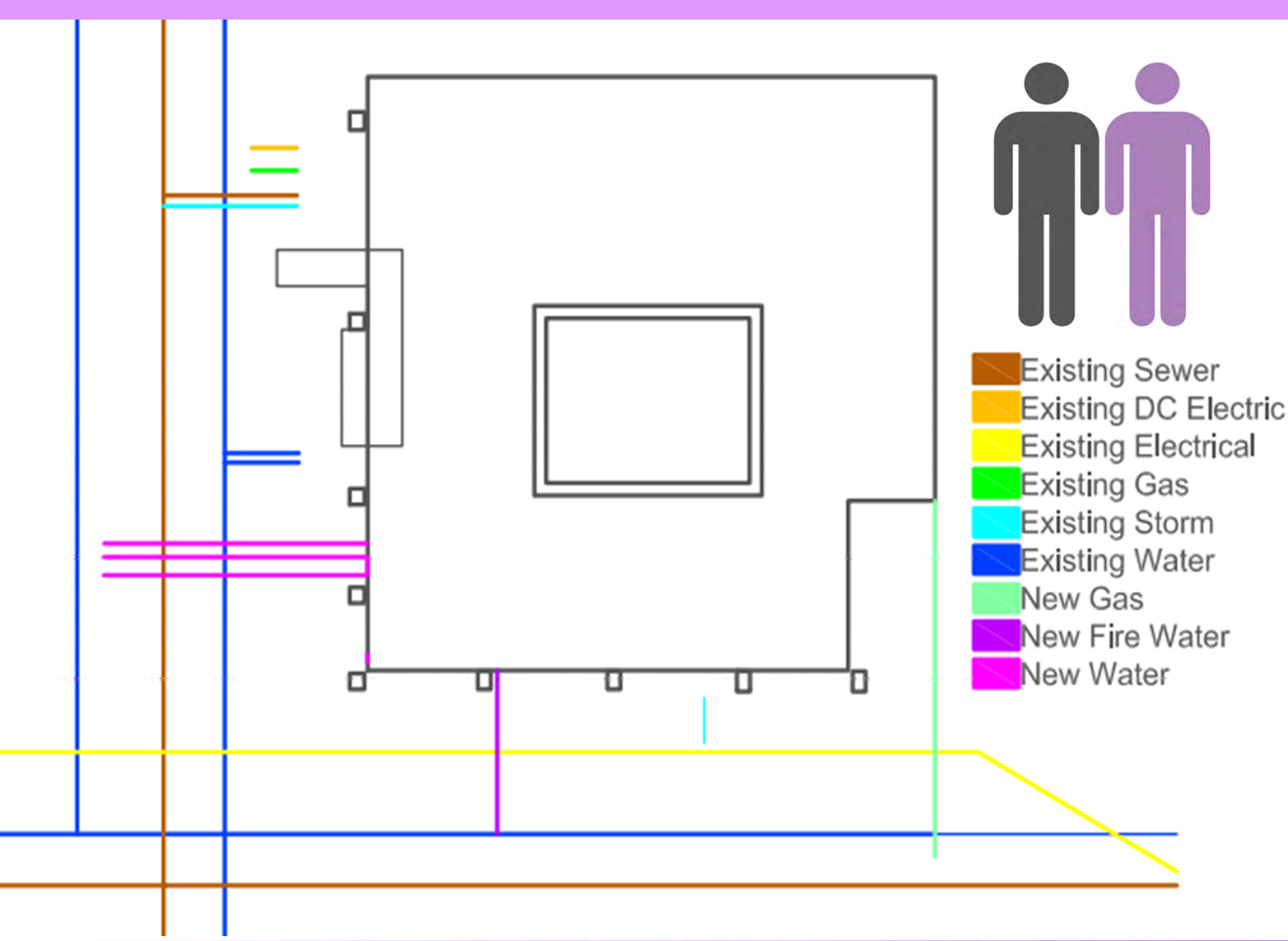


AS-BUILTS



The models shown above represent the as-builts in model form. Through this virtual look into each space of the building, the facility manager or owner will be able to view the space in a more concise and readable way. By clicking on items throughout these models, data can be retrieved involving cost, maintenance, or specifications. These models are linked to all utilities data, work orders, space planning, and equipment lists.

UTILIES DATA



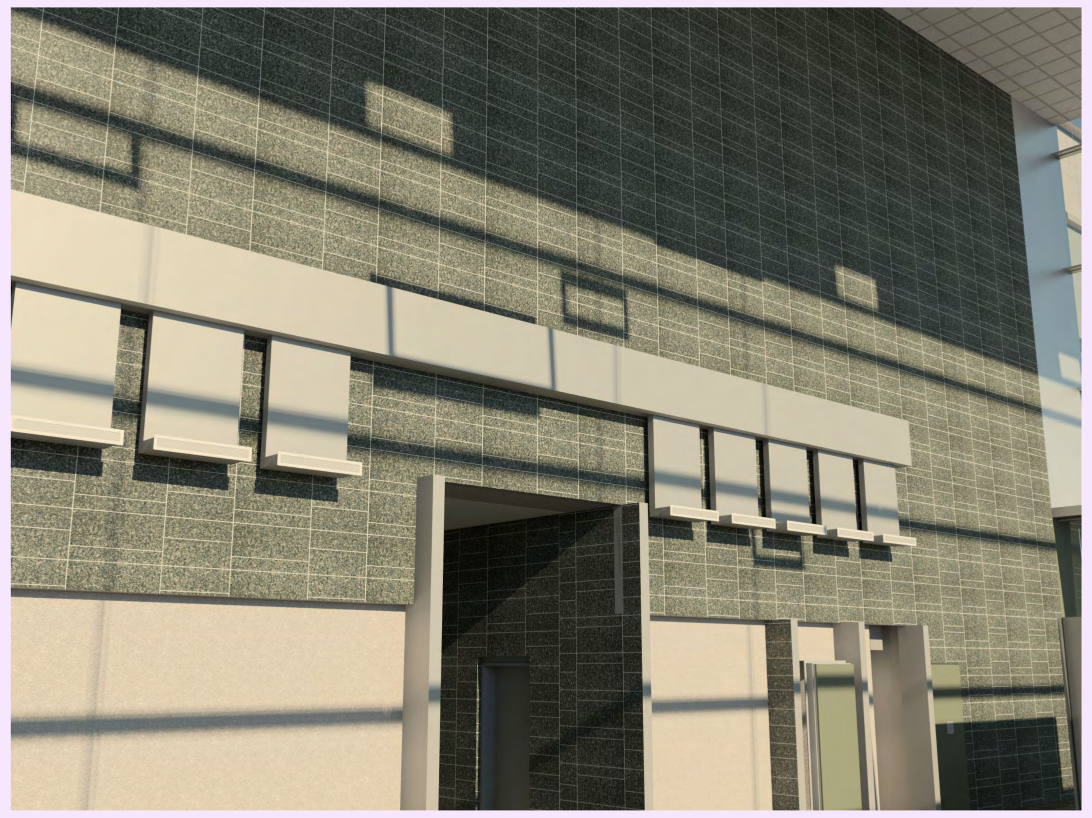
The area to the left represents Utilities Data that is stored within the Building Information Models. This data will be used to identify changing utility rates of cost data as well as locations throughout the building that access the public utility. This information is used in emergency planning as well as day to day operations.

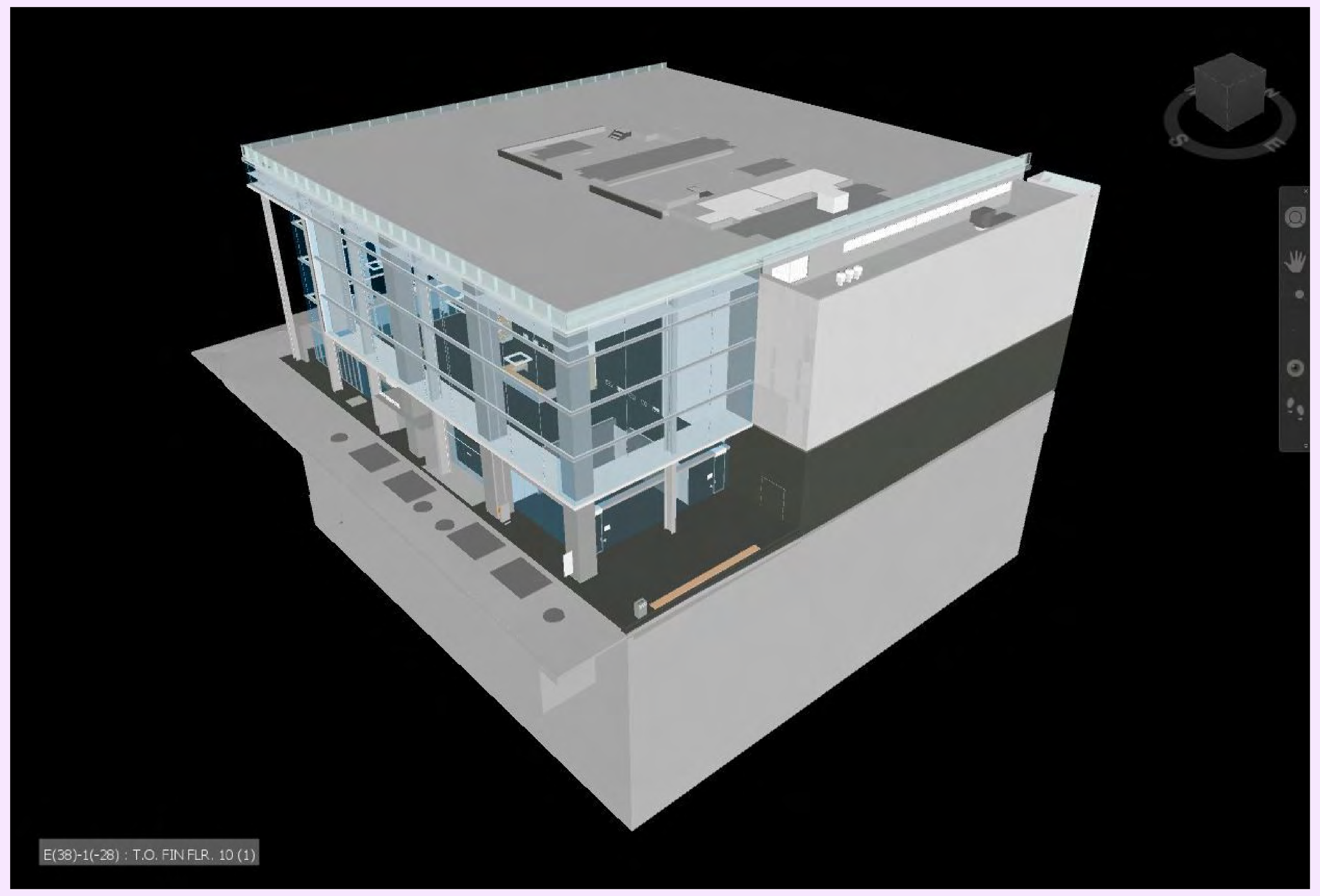
WORK ORDERS

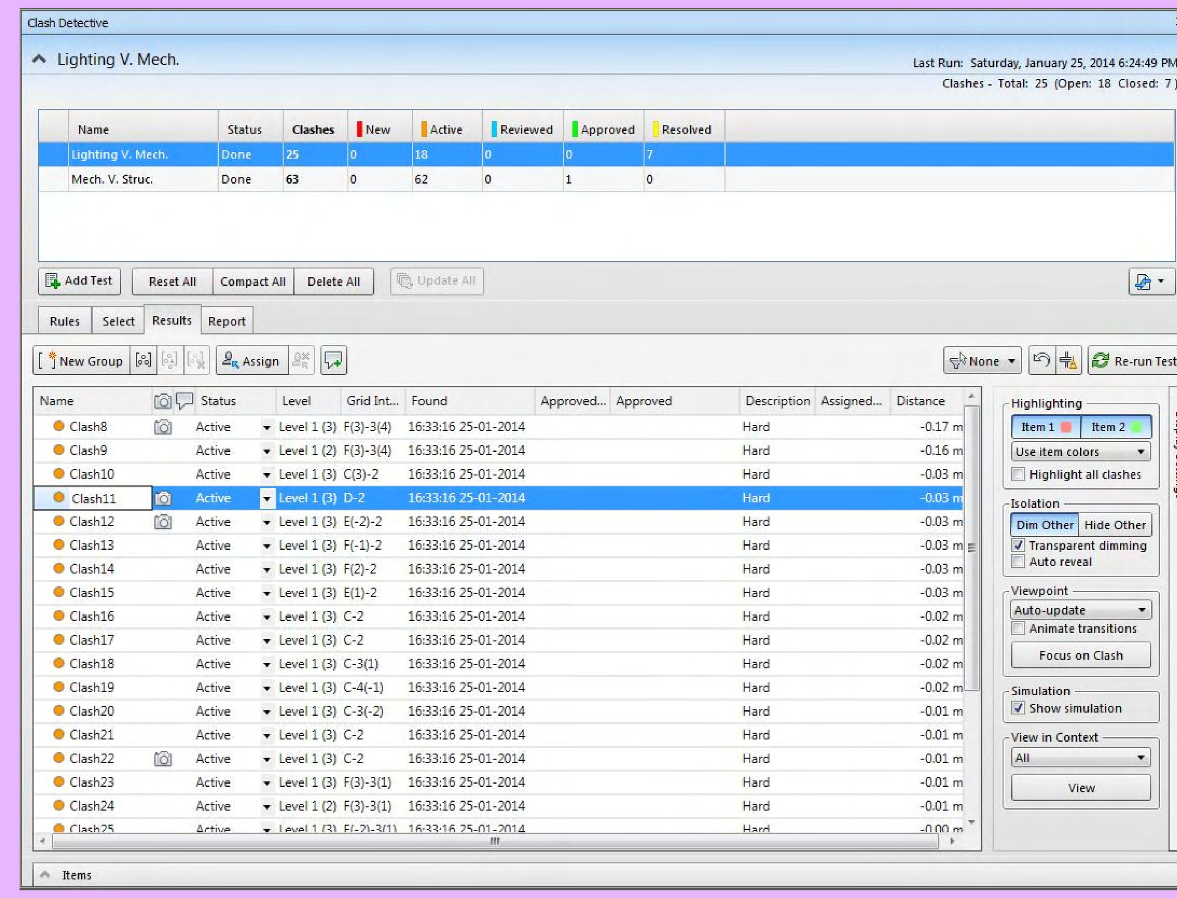
Lighting/Electrical	OfficeFloorLE			
Lighting/Electrical.Communication	Communication Devices			
Lighting/Electrical.Communicati...	Communication Device - Wall - Copy			
Lighting/Electrical.Communicati...	Voice-Data Outlet	7.000	ea	
Lighting/Electrical.Communicati...	Communication Device - Wall			
Lighting/Electrical.Communicati...	Voice-Data Outlet	127.000	ea	
Lighting/Electrical.Communicati...	Data Outlet	3.000	ea	
Lighting/Electrical.Communicati...	Speaker	3.000	ea	
Lighting/Electrical.Communicati...	TV Outlet	9.000	ea	
Lighting/Electrical.Conduit	Conduits			
Lighting/Electrical.Conduit Fittings	Conduit Fittings			
Lighting/Electrical.Data	Data Devices			
Lighting/Electrical.Electrical Eq...	Electrical Equipment			
Lighting/Electrical.Electrical Fixt...	Electrical Fixtures			
Lighting/Electrical.Fire Alarm	Fire Alarm Devices			
Lighting/Electrical.Lighting Fixtu...	Lighting Fixtures			
Lighting/Electrical.Lighting Fixtu...	INDUSTRIAL SURFACE			
Lighting/Electrical.Lighting Fixtu...	AXIS 2X2			
Lighting/Electrical.Lighting Fixtu...	Day 2x2 4400lm	23.000	ea	Lamps rated for 50,000h use, maintenance check on drivers every 5 years.
Lighting/Electrical.Lighting Fixtu...	Day 2x2 2500lm	13.000	ea	Lamps rated for 50,000h use, maintenance check on drivers every 5 years.

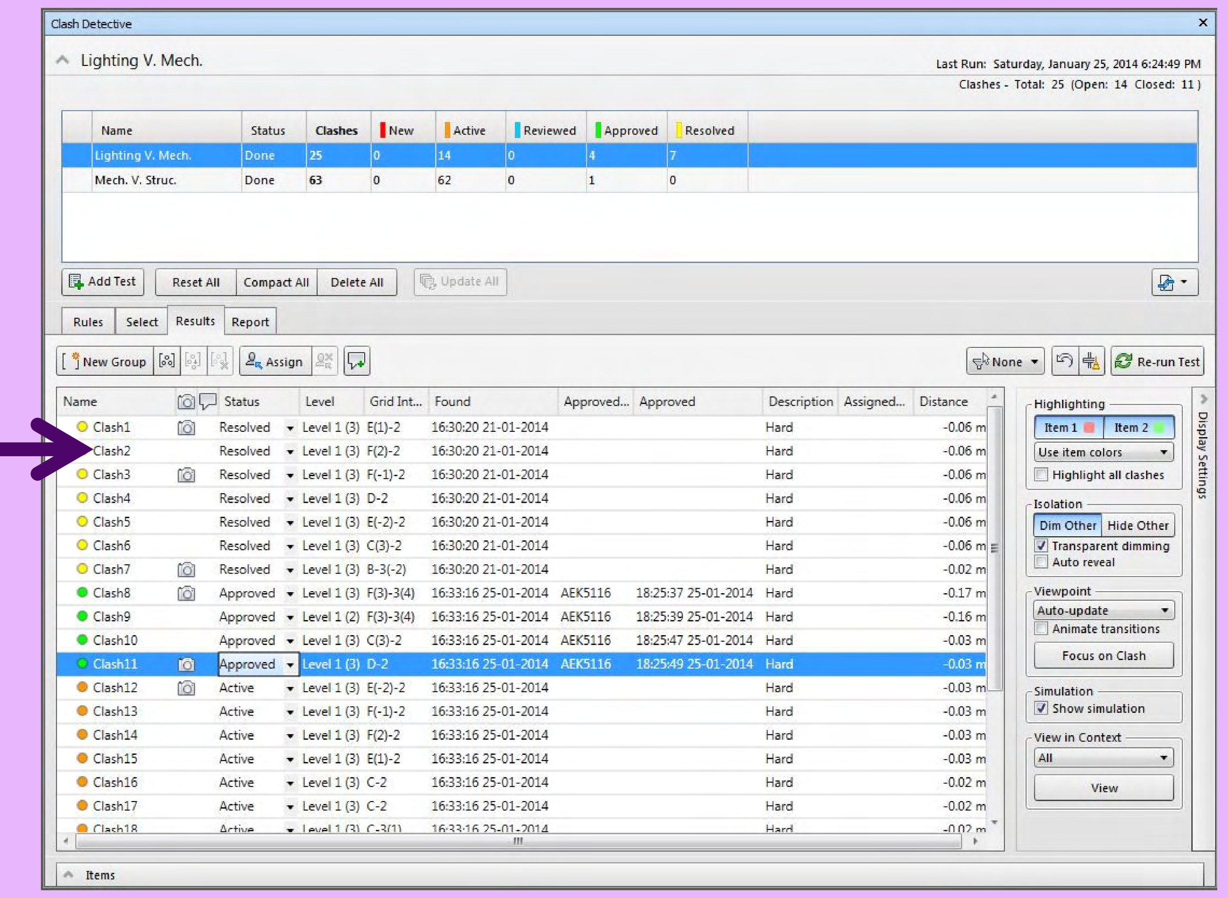
The information to the left is developed from Quantity Takeoff. Here, the lighting and electrical takeoff for the typical office floor is shown . For example, if the owner wanted to update all speakers on a floor, they would have 3 to locate and change. Work orders can also be entered through this system to allow for routine maintenance throughout the building or to alert facility managers of issues at any given time.

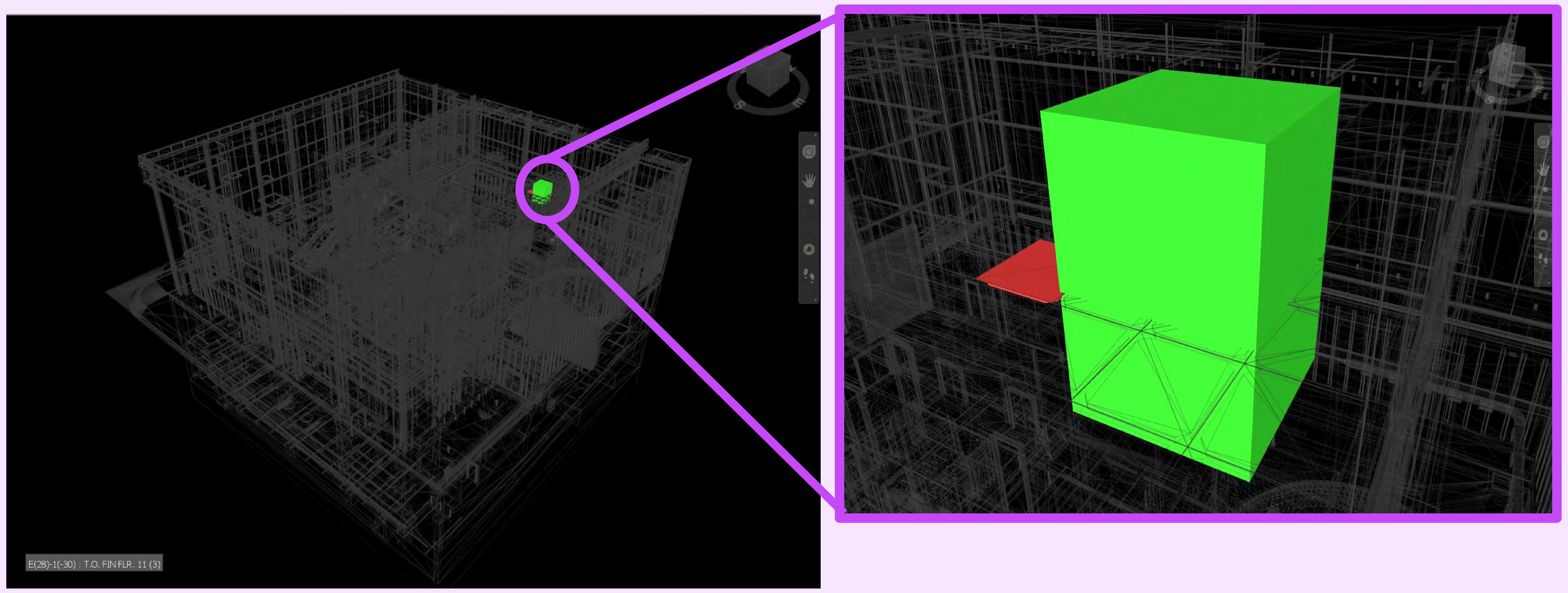
LOBBY

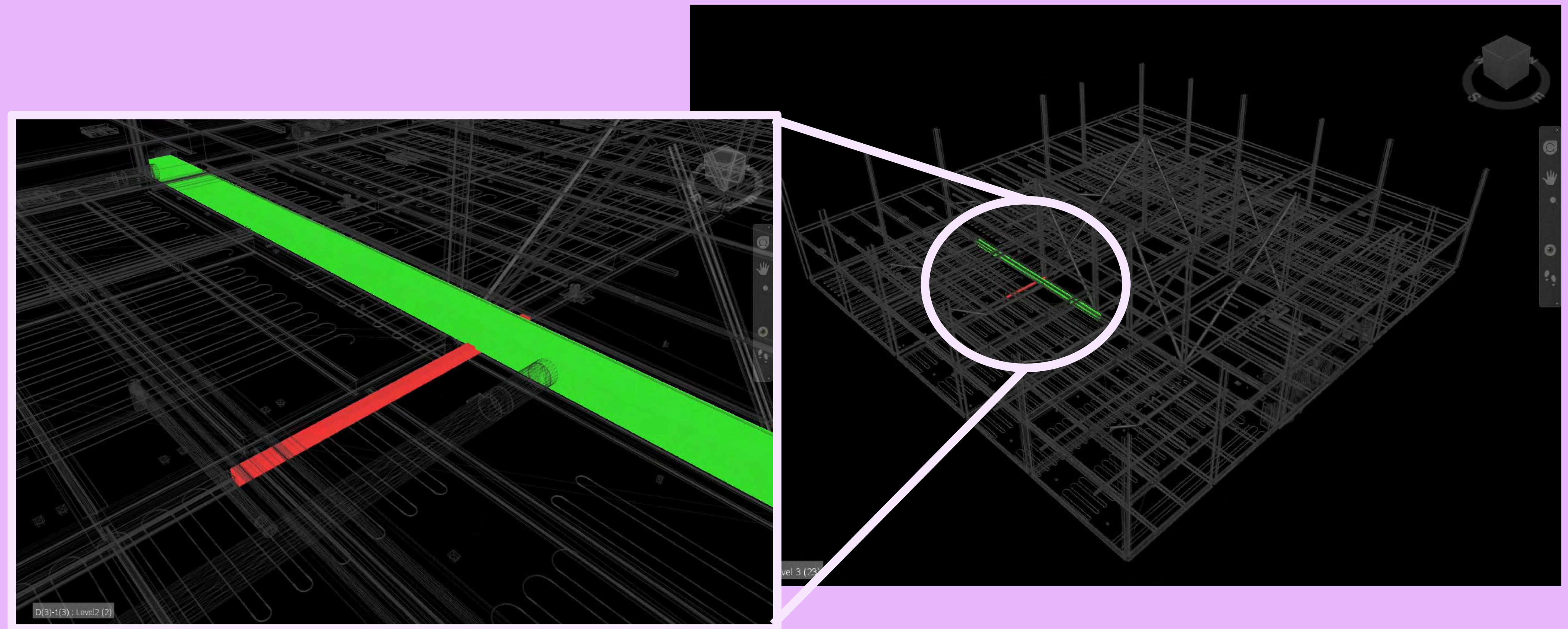


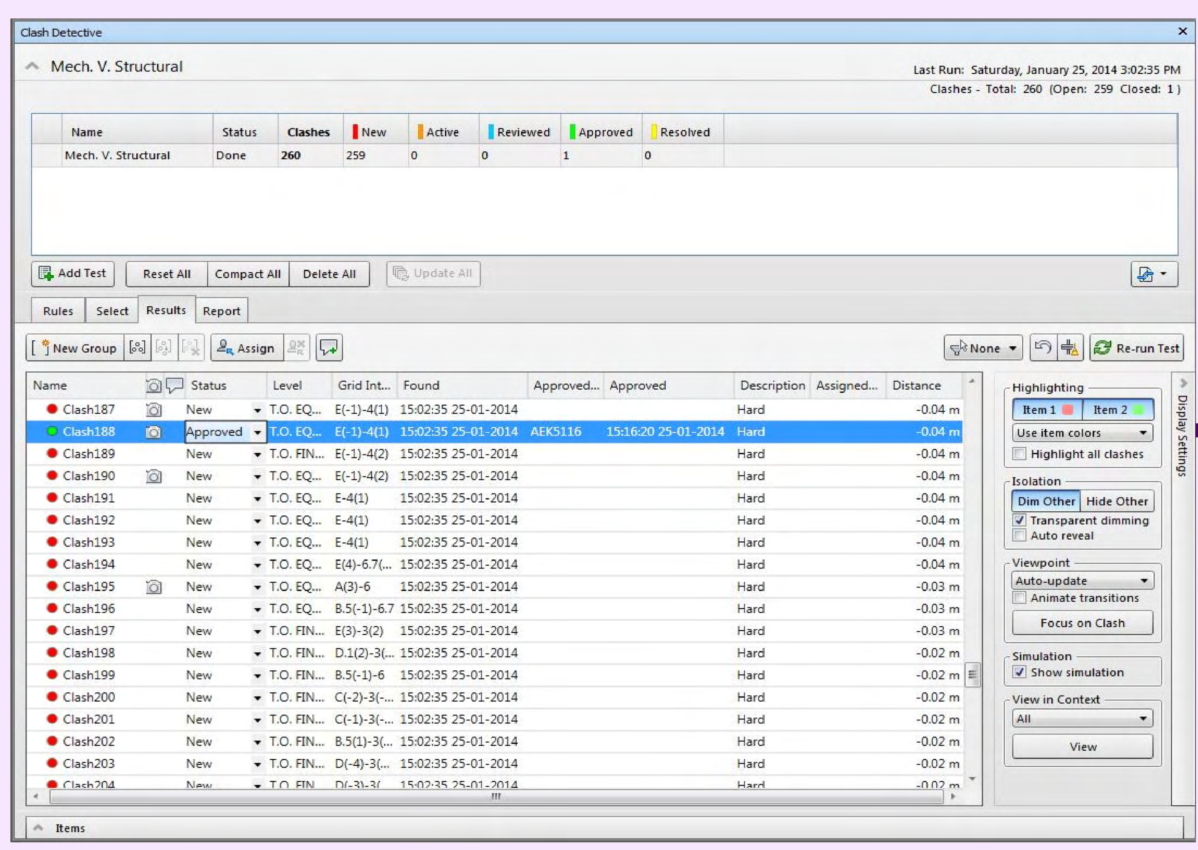


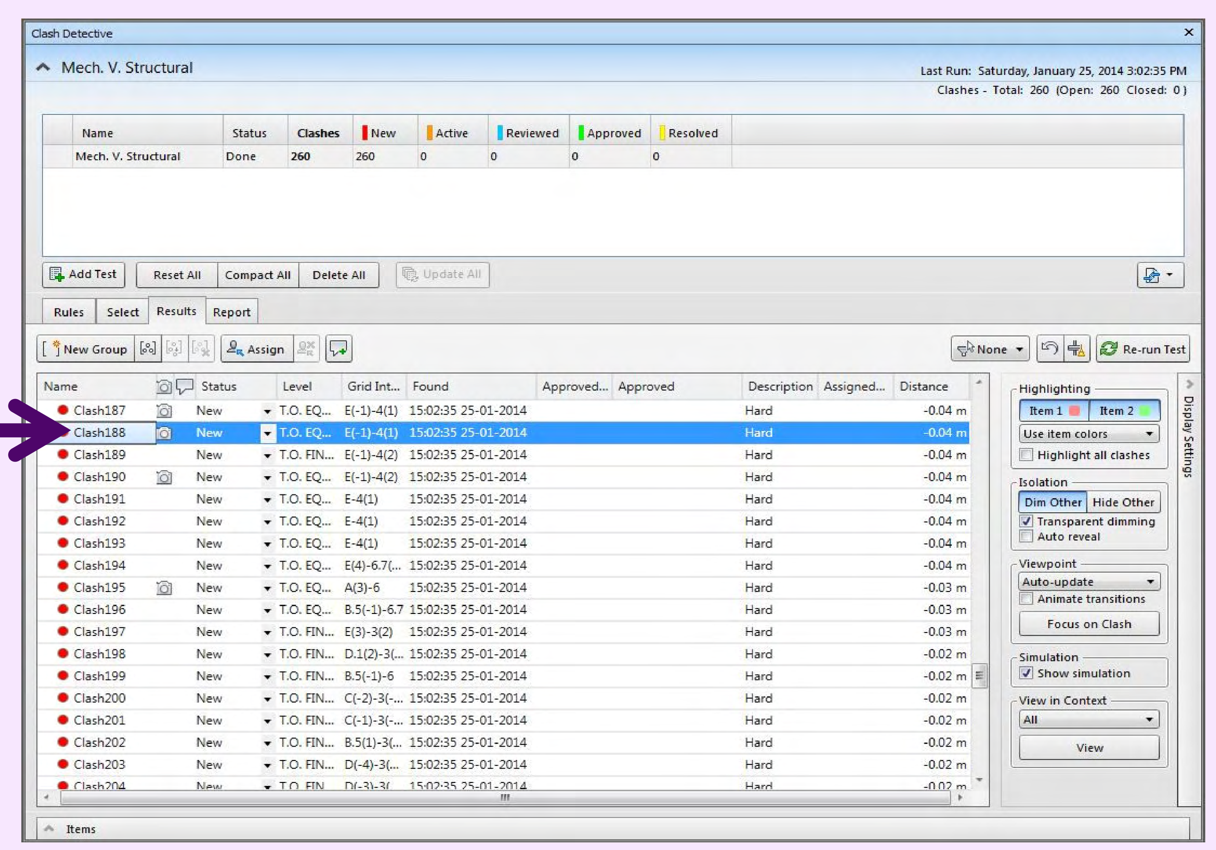


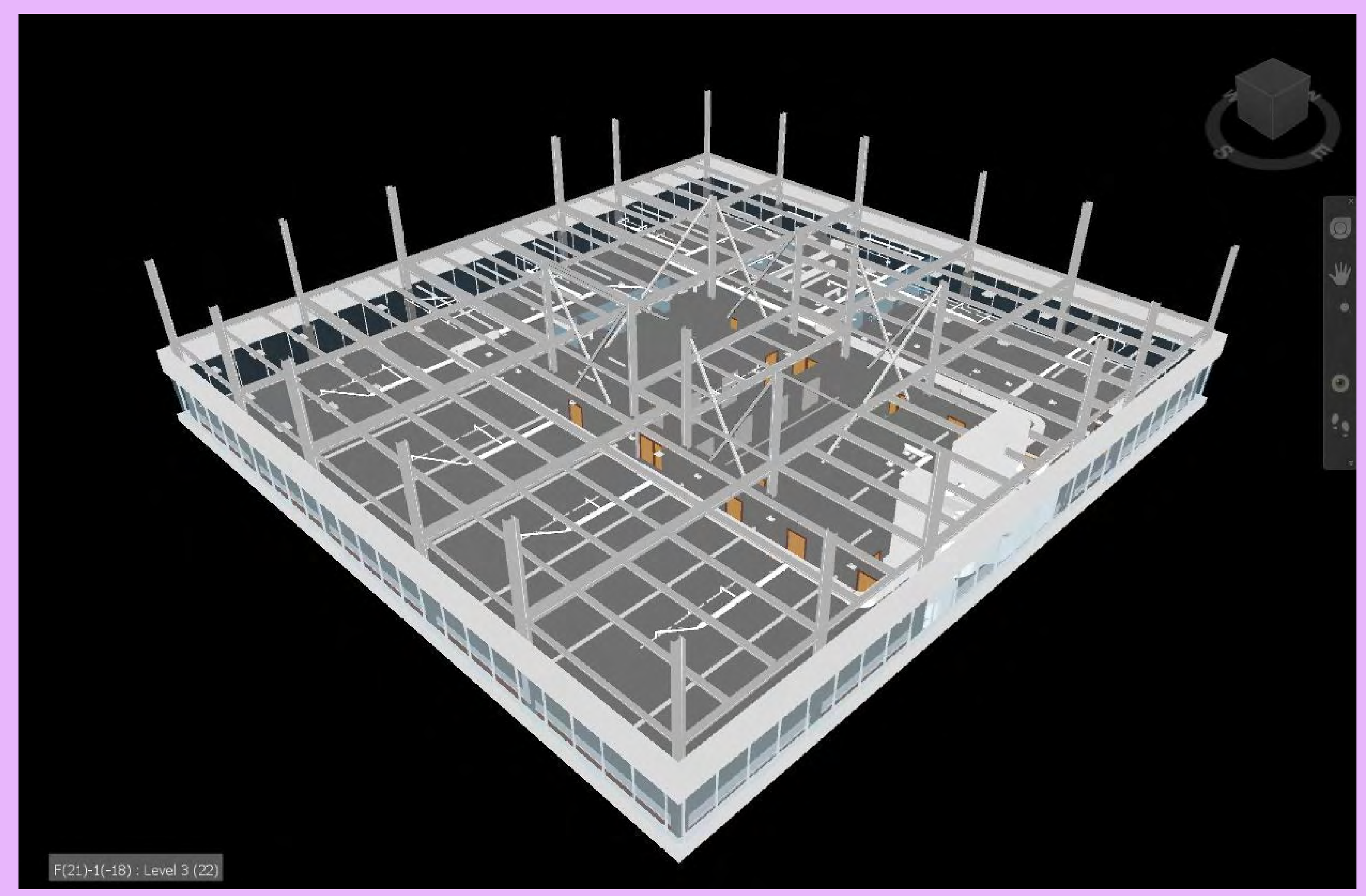






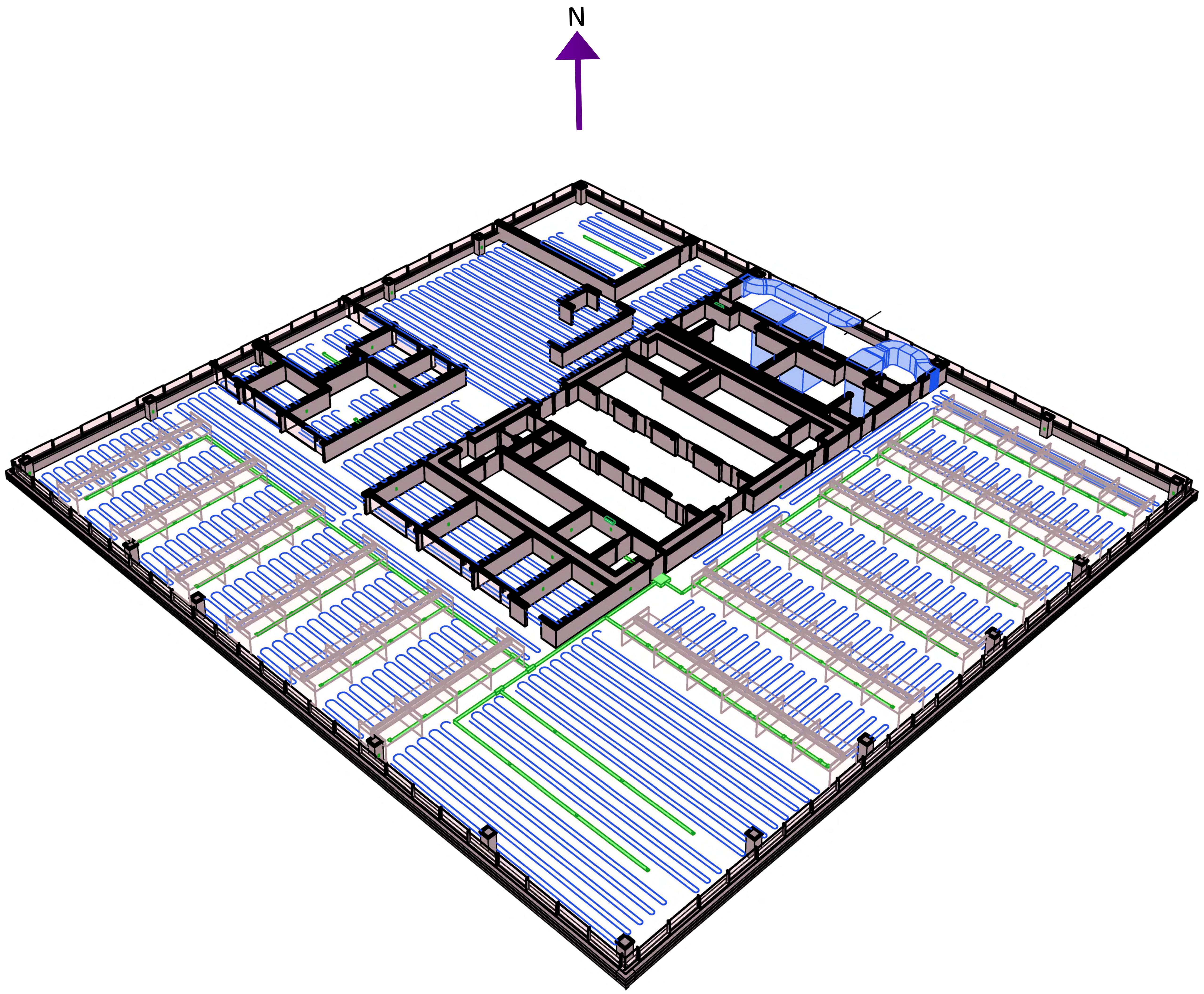






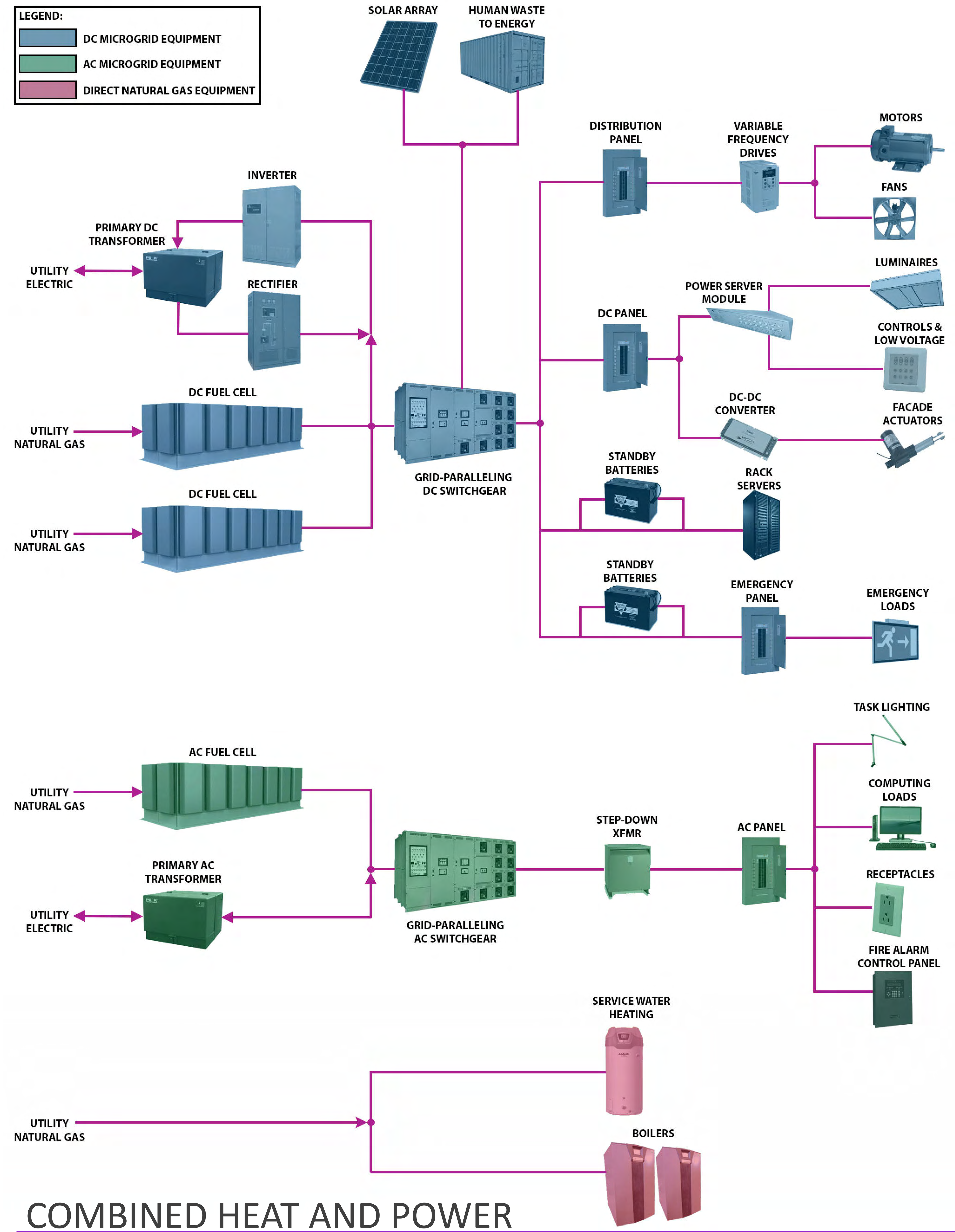
Clash Detection was performed on the main coordination areas of AEVITAS's 350 Mission. In order to facilitate as integration an approach as possible, all disciplines were present during clash detection meetings. This drawing is an example of some major clashes within the typical office floor as well as the lobby. In the final designs, all clashes were resolved.

OFFICE FLOOR



RADIANT PIPING & ELECTRICAL CONDUIT COORDINATION

The AC electrical distribution feeding the open office work stations runs through conduit in the 4.5" concrete topping. Radiant piping is also distributed throughout the space in a raised subfloor that extends 4" above the top of the floor slab. While the conduit and radiant piping runs in completely separate parts of the floor, their placement is still coordinated in the event that one or both system components need to be accessed for maintenance. Also, while both systems run at different heights, they cannot overlap because the electrical pull boxes extend to the top of finished floor at the receptacle terminals.



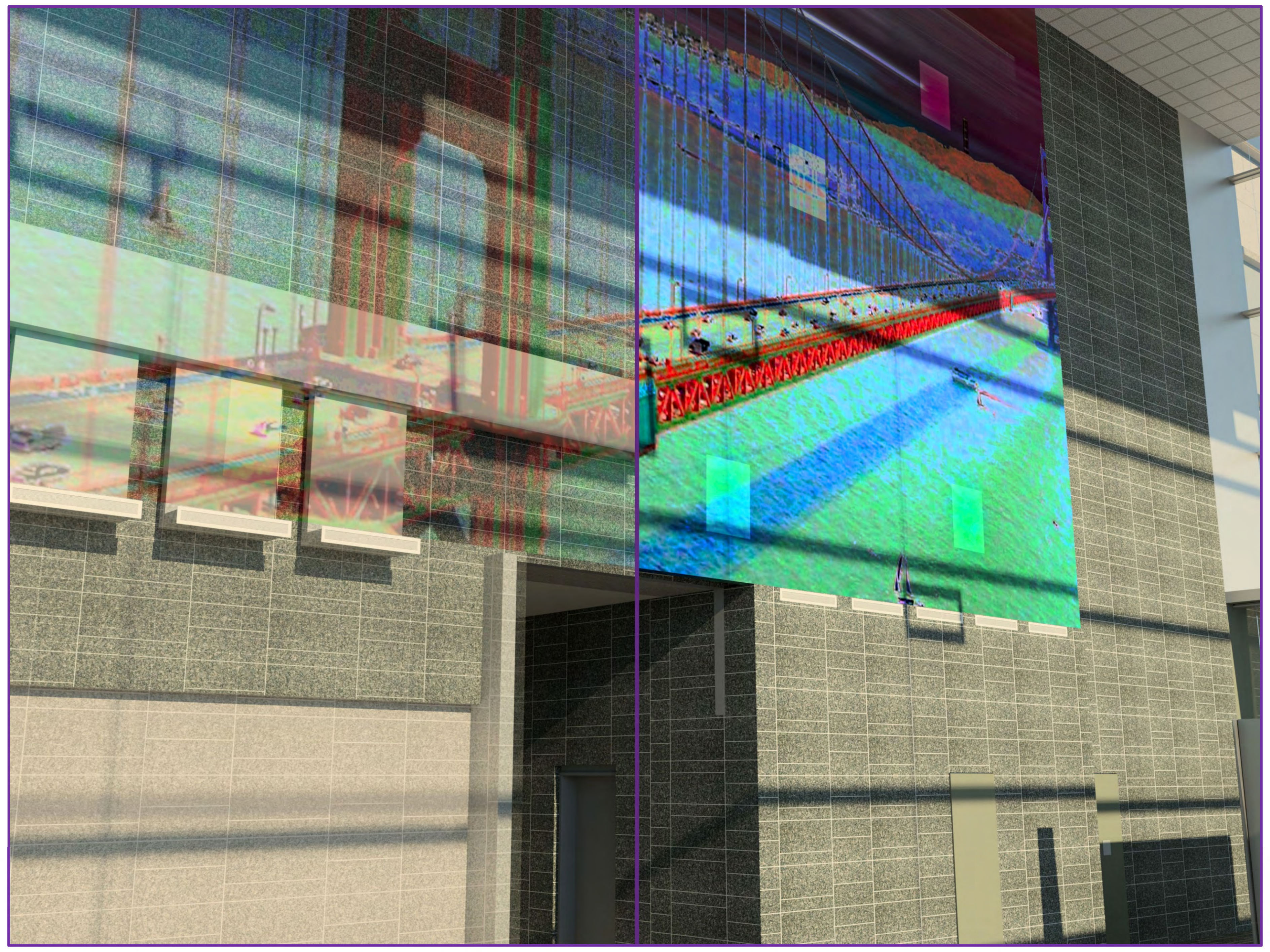
COMBINED HEAT AND POWER

In collaboration with the electrical engineers, an effective combined heat and power system was devised. This diagram shows how the gas, AC electric and DC electric serve 350 Mission.

AEVITAS | Gantt Chart Schedule – Full Building

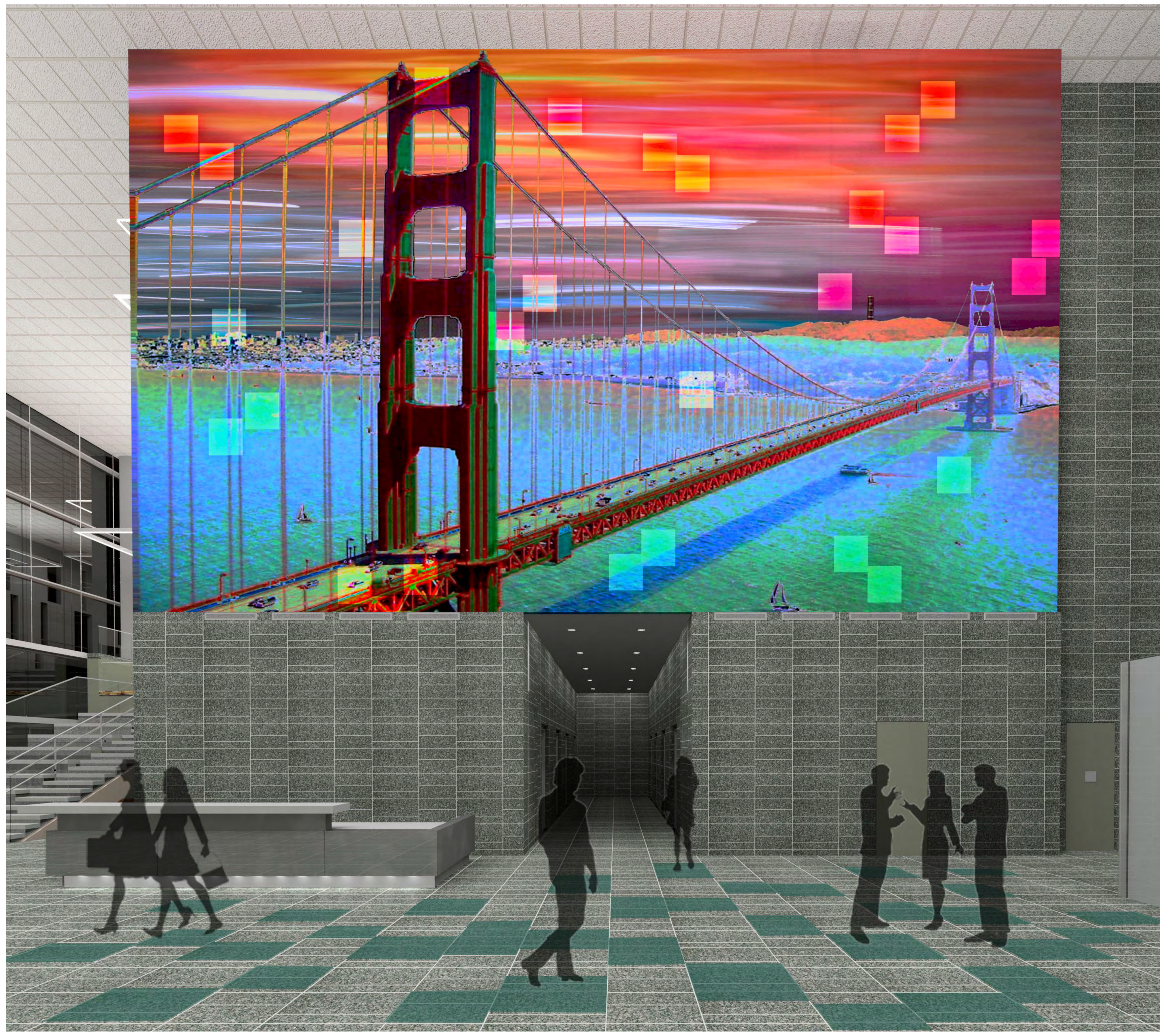
	Task Name	Duration	Start	Finish	Free Slack	Total Slack
1	Notice to Proceed	0 days	Mon 4/7/14	Mon 4/7/14	0 days	145 days
2	Existing Building Demo	65 days	Mon 4/7/14	Fri 7/4/14	0 days	145 days
3	Mobilization	10 days	Mon 7/7/14	Fri 7/18/14	0 days	145 days
4	Slurry Wall Excavation and Installation	30 days	Mon 7/21/14	Fri 8/29/14	0 days	145 days
5	Bulk Excavation	55 days	Mon 9/1/14	Fri 11/14/14	0 days	145 days
6	Diagonal Cross Lot Shoring	30 days	Mon 9/29/14	Fri 11/7/14	0 days	145 days
7	Mat Foundation Excavation	10 days	Mon 11/10/14	Fri 11/21/14	0 days	145 days
8	Foundation Waterproofing	60 days	Mon 11/24/14	Fri 2/13/15	0 days	145 days
9	FRP Mat Foundation Footing	15 days	Mon 12/1/14	Fri 12/19/14	0 days	330 days
10	FRP Foundation Core	40 days	Mon 12/22/14	Fri 2/13/15	0 days	330 days
11	FRP Substructure Floors, Columns, Walls	55 days	Mon 1/12/15	Fri 3/27/15	0 days	115 days
12	Set Structural steel to 5th floor	20 days	Mon 3/30/15	Fri 4/24/15	0 days	115 days
13	Set Structural steel to Mech 1	80 days	Mon 4/27/15	Fri 8/14/15	0 days	135 days
14	Lift Major Equipment within building	10 days	Mon 8/17/15	Fri 8/28/15	20 days	135 days
15	Pour Concrete floors to Equip Plat	10 days	Mon 5/11/15	Fri 5/22/15	0 days	115 days
16	Place Concrete Slabs to Mech 1	80 days	Mon 5/25/15	Fri 9/11/15	0 days	115 days
17	Lift and Set rooftop equipment	10 days	Mon 9/14/15	Fri 9/25/15	0 days	115 days
18	Set Structural Steel to Parapet	20 days	Mon 9/28/15	Fri 10/23/15	0 days	115 days
19	Steel Top Out	0 days	Mon 10/26/15	Mon 10/26/15	10 days	125 days
20	Permanent Roof	25 days	Mon 11/9/15	Fri 12/11/15	0 days	115 days
21	Building Watertight	0 days	Mon 12/14/15	Mon 12/14/15	115 days	115 days
22	Start Curtain Wall at 5th floor	10 days	Mon 6/15/15	Fri 6/26/15	0 days	115 days
23	Curtain wall to Parapet floor	100 days	Mon 6/29/15	Fri 11/13/15	0 days	115 days
24	Curtain wall G to 5th Floor	35 days	Mon 10/26/15	Fri 12/11/15	0 days	115 days
25	Set basement Equipment	10 days	Mon 5/11/15	Fri 5/22/15	0 days	160 days
26	Permanent Power Startup	10 days	Mon 7/20/15	Fri 7/31/15	0 days	205 days
27	Permanent Power Available	0 days	Mon 8/3/15	Mon 8/3/15	50 days	205 days
28	Substructure Rough In	40 days	Mon 5/25/15	Fri 7/17/15	0 days	220 days
29	Substructure Interiors	40 days	Mon 6/8/15	Fri 7/31/15	45 days	70 days
30	Elevator shaft work	80 days	Mon 6/22/15	Fri 10/9/15	0 days	155 days
31	Energize elev machines	5 days	Mon 10/12/15	Fri 10/16/15	115 days	155 days
32	Building Core Riser Rough In (Matrix Sched)	80 days	Mon 8/10/15	Fri 11/27/15	0 days	125 days
33	Lobby work	100 days	Mon 8/24/15	Fri 1/8/16	0 days	25 days
34	Sitework/Hardscaping	30 days	Mon 12/28/15	Fri 2/5/16	35 days	75 days
35	Release of Matrix Schedule	0 days	Mon 8/17/15	Mon 8/17/15	15 days	15 days
36	Typ Floor Construction (Matrix Schedule)	185 days	Mon 9/7/15	Fri 5/20/16	0 days	0 days
37	Commissioning & Start ups	60 days	Mon 2/29/16	Fri 5/20/16	0 days	0 days
38	Substantial Completion	0 days	Mon 3/28/16	Mon 3/28/16	0 days	40 days
39	Allow Tenant work to begin	0 days	Tue 3/29/16	Tue 3/29/16	39 days	39 days

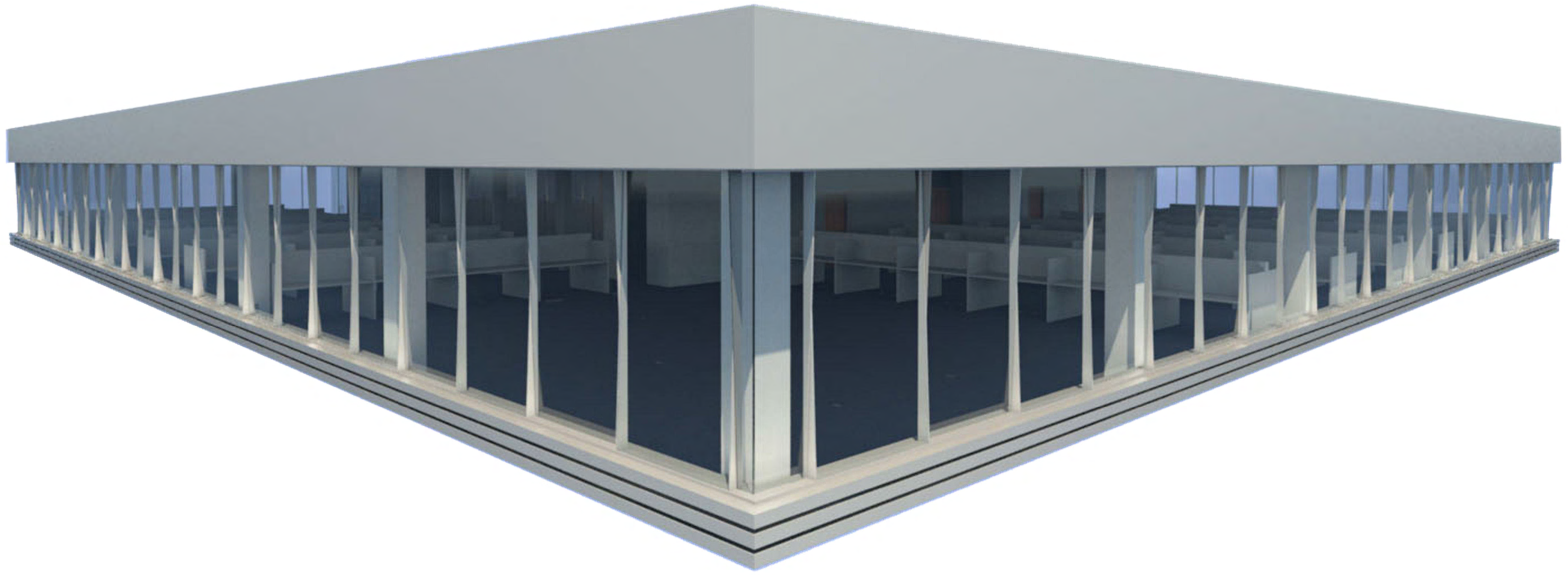
AEVITAS | Design Process Flow



PUBLIC ART AND VENTILATION

The mechanical system integrates with the architecture design, structure, and lighting components to effectively serve the space. The diagram illustrates the integration of the duct work with the public art feature. The left half image reveals the duct work path along the core, while the right half image is the actual depiction of the space.





OPEN OFFICE

The open office has been redesigned to maximize daylighting and flexibility. The aesthetic of the ceiling from the perspective of the occupants is also an important consideration. Linear mechanical diffusers are installed to match the linear luminaires