Final Thesis Report

Kaiser Permanente- Medical Office Building

8008 West Park Drive
McLean, VA 22102

Brooke Helgesen

Construction Management

Dr. Chimay Anumba

April 4, 2012


Courtesy of Anshen + Allen

KAISER PERMANENTE MOB AT TYSONS CORNER
MCLEAN, VA

Brooke Helgesen **Construction Management**

PROJECT OVERVIEW

Owner: Kaiser Permanente
Construction Manager: Jacobs
General Contractor: DPR Construction
Architect: Anshen+ Allen
Structural Engineer: Cagley and Associates, Inc
MEP Engineer: Leach Wallace Associates, Inc
BIM Engineer: DPR Construction
Civil Engineer: Vanasse Hangen Brustlin, Inc
Type: Medical office building and outpatient service facility
Size: 241,175 SF
Stories: 5 Levels above grade + Lower Level + Basement
Duration: 3/16/2011- 5/8/2012
Project Delivery Method: Design- Bid -Build with GMP

ELECTRICAL

- 5000A, 277/480V MDP switch board and paralleling low voltage switchgear.
- Electric Power is three phase, 4-wire, 120/208V enclosed bus-way system.
- Mass notification systems and nurse call stations.
- Installation of Verizon Line communication duct-bank connecting directly to the basement level TER room.

MECHANICAL:

- Multiple VAV air distribution control units located on the lower level, 2, 4, and the roof.
- Gas fired steam generators and electronic steam humidifiers.
- 2 Fire-tube gas boilers and 1 clean steam boiler for hot water distribution.
- Twin tank alternating concept with a meter initiation method for water treatment system.
- 500 ton chiller and cooling tower system.

STRUCTURAL

The 75' Mechanical Tower:

- HSS 8x8 X-braced and horizontal braced frame.
- Interior rigid moment connections connect the tower to the existing structure.
- Insulated metal wall panel exterior enclosure
- Concrete composite floor slab.

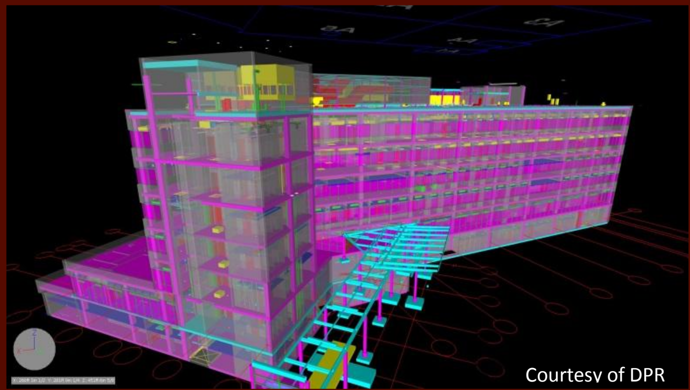
The Existing Building:

- Cast in place concrete column foundation and precast panel building enclosure.
- Concrete waffle floor slab.
- Additional horizontal steel members and vertical member single story support posts for support of loads from new medical equipment.

ARCHITECTURE & DESIGN

The architectural focus of the building is a state of the art and modern depiction of Kaiser Permanente's new spin on healthcare. Metal panel canopies will act as an attractive entry to the building. A noteworthy characteristic of the existing structure that will remain is the large outdoor terraces jutting out on the exterior of three stories of the building.

- Renovation of an existing precast panel office building to a modern medical office building.
- CDU, Imaging departments, pediatrics, Cardiology, radiology/ MRI, Hematology/Oncology clinics, Optical services and pharmacy retail.
- Construction of 75 ft mechanical tower on the south side of the building to house the MEP systems.
- Installation of new mechanical units, interior build out, new glass and glazing, erection of reinforcing steel, installation of a new 7-stop patient elevator, and renovation of vehicular roundabout.


Courtesy of DPR

FIRE PROTECTION & PLUMBING

- Automatic wet sprinkler and standpipe system.
- Wall and ceiling mounted medical gas panels.

SUSTAINABILITY

- Tracking the Green Guide for Healthcare version 2.0. Focuses on reducing consumption, enhancing the healing process and eliminating toxic materials used during construction.
- Use of day-lighting with a storefront glazing system and ribbon windows to promote healing.
- Temporary LED lighting system used for potential future cost savings and consumption reduction.
- DPR's paperless environment (all electronic files).
- Resource Efficient Energy Saver Award for DPR trailer, sustainable practices, and recycling efforts.

Executive Summary

The Senior Thesis Final Report is intended to describe the results and recommendations for the four analysis topics executed on the Kaiser Permanente Medical Office Building. The project includes the renovation of an existing 250,000 SF building and construction of a new mechanical tower. The analyses were developed to address challenging issues the project faced. Although, the main focus of these analyses is to add value to the building through value engineering, sustainability, and aesthetics.

Analysis 1: Integrated Project Delivery Method on Coffer Re-design Issue

In order to address the cost and time challenges associated with the coffer re-design of the existing waffle slab, the project delivery method for this project needed to be reconsidered. For the analysis, the project delivery method was changed from design-bid-build to Integrated Project Delivery in order to research the impact it would have on the coffer design issue. A successful IPD case study for a similar renovation project was explored in order to compare the process, risk, and cost of IPD versus design-bid-build. The results of the analysis indicated that IPD would be a viable option for Kaiser Tysons because if done correctly, it could lead to cost savings and better use of time. Although it was found IPD can present issues of risk and owner's trust, through early collaboration and positive benefits it is highly recommended.

Analysis 2: Façade Re-design

Due to the water infiltration issues associated with the existing, cracked precast panels and glazing, a new façade design was explored. The analysis replaced the existing exterior façade with a Kawneer 1600 Curtain Wall system to encompass both the cladding and glazing in one unit. The impact on the schedule, cost, and value added was found to see the feasibility of this change. Also, an architectural breadth aided in this analysis to further explore aesthetical value added. Results concluded that the Curtain Wall system would cost $2, 440,980 which is an increase of $402,120 from the cost of the required precast panel epoxy injections and new glazing. This change also showed no impact on the schedule duration because the activity was able to be incorporated before building construction began. The architectural breadth also showed added value from overall exterior aesthetic enhancement and increase in natural interior lighting.

Analysis 3: LED Temporary Lights

With the extensive amount of medical equipment and high demand for energy, the maintenance costs and energy consumption of this building can result in staggering numbers. The lifecycle costs and carbon footprint of the building could potentially be a problem in the future if not addressed during design. To address this issue, an analysis was conducted to compare the energy and cost of the LED FLEX SLS temporary lighting system versus the standard fluorescent temporary lighting system used. The amount of energy that was saved during the construction timeframe by converting from fluorescent to LED was researched and found to save 88, 036 Watts over the duration of the 13 month project. Cost analysis for this product and other temporary lighting systems was also explored by finding energy cost, initial upfront cost versus the money saved from energy savings, and second project use cost. It was found that the FLEX SLS system had the lowest costs and could be reused from project to project. Additionally, an electrical/lighting breadth was performed in order to see differences in the lighting layout and power plan between the systems. The results of the breadth concluded further cost and material savings for the FLEX SLS system due to the modules and kit configuration.

Analysis 4: Addition of Green Roof Exterior Terraces

Due to the fact that Kaiser Permanente MOB is the renovation of an existing structure, the lack of sustainable features is something to be addressed. Sustainable design is a critical industry issue that is becoming a standard for most commercial buildings to utilize. The analysis conducted involved incorporating green roofs on the existing exterior terraces to provide patient access. Since Kaiser

Permanente believes that light and nature aids in the healing process, a green roof terrace supports this vision. Factors explored were green roof types based on structural limitations, initial and maintenance costs, value added, and contribution to patient healing. After choosing a modularized extensive system, designing the layout, and finding associated cost, it was concluded that this would be an inexpensive, quick, and valuable addition to reach sustainable goals and improve patient comfort.

Acknowledgements

A special thanks to…

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Professor Holland
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Industry Members:

Family, Friends
and many more!

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Project Background

The Kaiser Permanente Medical Office Building at Tysons Corner is located at 8008 West Park Drive in McLean, Virginia 22102. The occupant of this medical facility will be Kaiser Permanente, a predominant healthcare company in the area. The project involves the conversion of a 241,175 sq. ft. existing facility from a commercial type office building to a modern 5-story medical office building plus a lower level and basement. The new MOB will include surgical suites, ASC, CDU, Imaging departments, pediatrics, OB/GYN, Cardiology, radiology including MRI's, Hematology/Oncology clinics, Optical services and pharmacy retail. The renovation includes complete interior build out, new glass and glazing, installation of reinforcing steel, refurbishing of existing elevators and installation of a new 7-stop patient elevator. There will also be the addition of a new 75 foot mechanical tower to be built on the south side of the building to house the MEP systems and new mechanical units.

The construction management team on the job is Jacobs, the General Contractor is DPR Construction and the architect is Anshen+ Allen. The Engineers on the job are Cagley and Associates, Inc. (Structural Engineer), Leach Wallace Associates, Inc. (MEP Engineer), DPR Construction (BIM Engineer) and Vanasse Hangen Brustlin, Inc. (Civil Engineer and Landscape Architect). The start date of construction was March 16, 2011 and the substantial completion is May 8, 2012. This project is a Design–Bid-Build with a contracted GMP amount of $44, 078,649.

The architectural focus of the building is meant to be state of the art and modern to depict Kaiser Permanente's new spin on healthcare. The exterior façade consists of existing precast panels and the installation of metal panels. A storefront glass Curtain wall system will be at the main entry points, as well as metal canopies, balconies and towers. The building will utilize natural light with large ribbon windows wrapping the building. A noteworthy characteristic of the existing structure that will remain are three large outdoor terraces jutting out on the exterior of three stories of the building. The architecture of the site will also undergo advancements such as the improved vehicular roundabout at the entrance to support circulation to the facility.

Existing Conditions & Phasing Plans

**Please refer to Appendix A for existing conditions plan and phasing plans.

The site of the Kaiser Permanente MOB includes the existing office building to be turned into the healthcare facility, the existing parking garage and the proposed mechanical tower and parking garage. The Federal Home Loan Mortgage building is the closest surrounding structure and shares Private Drive with the site. The existing utilities are domestic water, electric and a communications line junction box. KP will not tap into the gas line but instead will supply their own propane tank source, further information about this utility has not been determined. Included in construction will be the propped Verizon line that will lead directly to the TER room in the basement of the building which is shown in yellow on the existing conditions plan. Egress in and out of the site is limited to personnel only and delivery traffic and vehicular traffic has designated locations as noted on the plan. The delivery circle on the north side of the building will change egress depending on the phase of construction. Private drive will remain open to the public and must remain clear at all times during construction. The trailers are located on the roof of the existing parking garage, which is also where all construction personnel will park.

The phasing for the Verizon line duct bank involved moving the site fencing on the North side of the building to block off one side of the delivery circle so that no traffic could affect digging the duct bank. Likewise, the other side of the delivery circle will be closed off once digging effects that area and site fencing will be open again on the original side. Another major issue is the material hoist crane must be disassembled in order to feed the duct bank into the TER room located in the basement. This affects deliveries so that all deliveries must be lifted through the window openings to the upper floors instead of using the hoist. Also, the north side pedestrian entrance into the building will need to be moved to a side door located on the north-east side of the building and the ramp from the parking garage will have kited pedestrian access depending on the location of duct bank work. Another change made is that Private Drive needed to be brought down to one-lane traffic so that the sidewalk could be demolished and the duct bank could be run underneath. This required the contractor to provide workers for traffic control so that private drive was not affected. The contractor thought the site plan through very well and tried to utilize the space that was available. Although not having the material hoist was an inconvenience, it was temporary and a necessary action to construct the duct bank.

During the erection of the mechanical tower, the site plan will need to be modified in order to accommodate the 90 ton hydraulic truck crane necessary for this phase. The crane will be located behind the mechanical tower in order to lift steel members for the framing and bracing of the tower. The crane has a main boom length of 140 ft. in order to reach the top of the 75 ft. mechanical tower. Access into the building via the entrance on the South side to the lower level will no longer be available, so egress will need to be limited to the South east door into the basement. The site fencing on the south side will need to be moved to enclose the mechanical tower work from the lot where areas will be made on the south side. For safety and convenience purposes, all above ceiling rough-in work in the existing building will be complete on the face where the mechanical tower attaches.

An 8-story parking garage will be erected on the Kaiser Permanente site and will be constructed by Coakley Williams construction. Although the construction will not be done by DPR, they are still responsible for the entire site and need to plan accordingly to allow Coakley Williams to perform their work. During the excavation of the parking garage, the site plan for the Kaiser Permanente building needs to be altered by having site fencing at the North West corner of KP MOB to block any egress near that corner. This will allow for Coakley to have their equipment and deliveries come into their area of the site without any interruptions. As noted in the plan by the large blue arrow, the entrance into the site at this location is solely for Coakley Williams. A wash rack will also be installed at the entrance to the garage area to ensure that no dirt or debris is carried onto Private Drive, since it is a public road. This plan closely follows the plan that the contractor enacted although for this plan, site fencing was added at the South West corner of the building to keep parking garage construction and mechanical tower construction separate.

Local Conditions

Tysons Corner is known to be a highly populated business district right outside Washington D.C., which means that parking is scarce. With the Tysons I and II malls located minutes from the site, traffic congestion is an issue. Luckily with the KP project there is an existing parking garage on site east of the building. This area allowed for four levels of parking for all parties involved in the project plus any extra room for visitors. Regulations are strict about parking on public access roads to the neighboring businesses so having this parking garage is crucial to site egress. Also, there is an existing delivery roundabout in the north area of the building which was used for delivery trucks so idling on public roads is not an issue. There are no preferred methods of construction for Fairfax County. Since it is in a highly congested area, space can be limited and so construction sites need to plan accordingly.

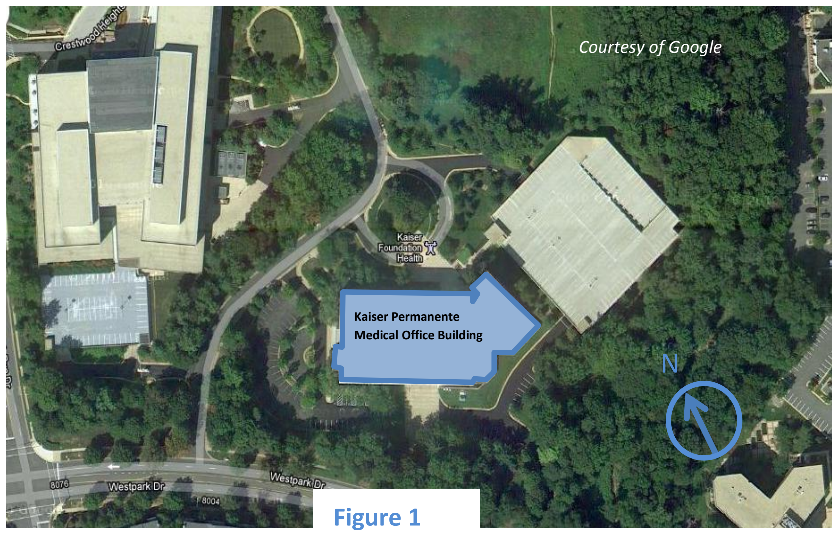


Figure 1

To meet recycling guidelines of the county, a construction waste management plan is being utilized on this project. All construction and demolition waste will be disposed of on site in a comingled container (excluding chemical waste, aggregate and large quantities of glass). This waste will be sorted by a Con-Serv Industries and will be based on weight. These weights are identified by CSI after sorting a container and disseminated to DPR on a monthly basis. The reports will include a container-by-container breakdown, a monthly summary, and a project summary. There are recycling and tipping fees enforced for Fairfax County based on the materials and weight that construction sites must obey. Also, necessary permits for commercial renovations of existing buildings in Fairfax County are the building permit, electrical permit, mechanical permit and plumbing permit.

Tysons Corner is located in the central region of Fairfax County known as the Piedmont Upland region. This area is predominantly covered with soil and weathered rock. Bedrock is common and usually has soils that are thick plastic clays. The type of soil on site is mainly compromised of silt loam, loam, and gravelly sand to loam, according to Fairfax County Surveys. The typical solid profile is 0 to 8 inches of silt loam, 8 to 60 inches of loam and 50 to 62 inches of gravelly sand to loam. The depth of the water table is between 10 to 24 feet and the available water capacity is about 8.6 inches.

Client Information

Kaiser Permanente is the owner on this project. They are a company that is on the cutting edge of healthcare by offering several "Hubs" that provide health care to Kaiser Members. They are taking over the healthcare industry, especially in Northern VA, with KP Tysons being one of the eleven medical offices that offer primary/ specialty care and outpatient services (Kass). The purpose of this project is to continue promoting growth within the healthcare industry and making Kaiser Permanente an accessible and convenient place for healthcare.

The expectations that Kaiser Permanente has as a client for this project is that schedule is a critical factor. With a first patient date in place for September 14, 2012, it is crucial that construction is on time. This being said, quality is no way compromised in order to meet the schedule requirements. Daily inspections were enacted on the jobsite to ensure every detail of construction was according to standard. If assembly, product type or other discrepancies were found, further installation would stop until it was according to KP code. Since DPR has been a GC for Kaiser Permanente before, they were familiar with the higher standards that KP requires on their healthcare facilities. For instance, since the existing structure is an older structure it used an outdated waffle slab. With this, some discrepancy about quality ensued with the design for fire rating the coffers. The task wound up to be a severe hindrance on the schedule since KP had certain standards to be met and changes in design were back and forth. The issue was eventually handled although time needed to be made up since this set back wall framing and other trades installing above ceiling rough-in.

In addition to a strict schedule and high level quality, Kaiser Permanente issued many bulletins/ changes during construction. With these bulletins frequently being issued, increase in productivity was expected and overtime became a norm for some trades. As mentioned early, DPR drywall was required to work overtime and weekends in order to make up time for the coffer setback.

As for sequencing, Kaiser Permanente was specifically interested in the mock rooms being complete so that Kaiser Representatives could visualize the rooms and make changes as needed. The owner's satisfaction was mainly contingent on having everything be of highest quality and according to KP standard, having the building complete by final completion and having any bulletin/ change be done regardless of cost or overtime needed to complete it.

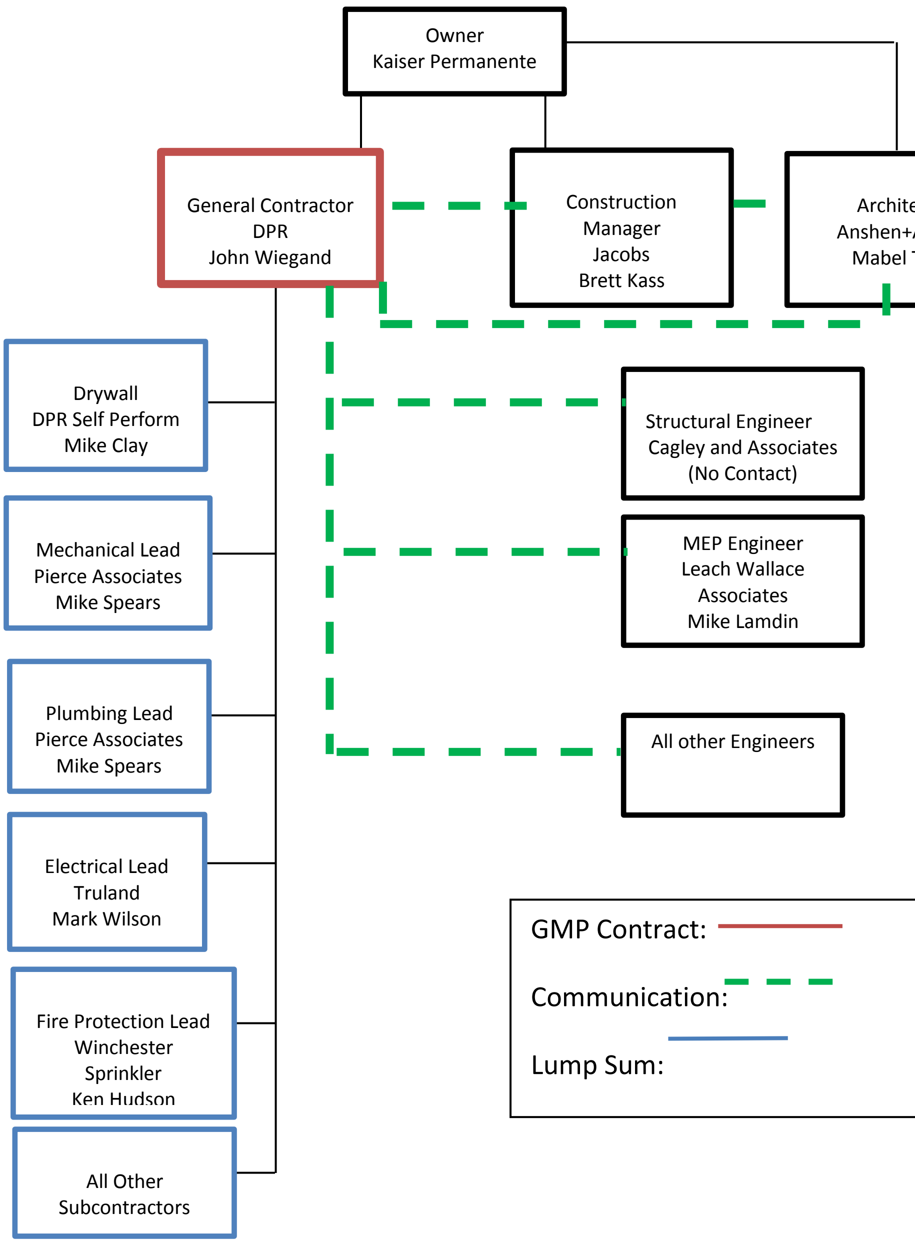
Project Delivery System

This project is being delivered as a Design-Bid-Build with contracted GMP. This approach was chosen because this is the typical system that Kaiser Permanente follows on their construction projects. A Design Build was not an option on this project because of the complexity of the MEP systems in a healthcare facility.

For this project the "just in time" delivery method was used. In order to increase productivity, the less materials stored on site is crucial. Deliveries were made on an as needed basis and it kept the jobsite more organized and safer. Also, construction was from the 5th floor down in order to keep a logical flow of work down and out of the building. Each floor consisted of five areas or quadrants and work flowed work counterclockwise from A2 to A1.

Staffing Plan

The general contractor on the Kaiser Permanente project is DPR Construction and the CM is Jacobs. Jacob's role was to act as the owner's representative and perform all duties and responsibilities that the owner would exercise, including changing contract documents, (please refer to project organizational chart on following page).The KP staff and Jacob's staff were housed in one trailer on site while DPR was in another. Jacobs and DPR worked closely so that any communication DPR would have with Kaiser Permanente would include Jacobs as well. Jacobs would also relay information from KP and in turn, DPR would then ensure it was followed through on site. DPR owned the entire site and therefore was liable for all subcontractors and onsite activity. They had full risk of any errors or omissions of the scope of all the subcontractors on site.



The contract held between DPR and Kaiser Permanente is a GMP. This contract entitles upon project completion that the contractor will receive 30% of unused portion of the GMP amount and the owner will retain 70%. DPR's general conditions cost, general requirements cost and direct cost of construction which they initially paid for will be reimbursed to them but not exceeding the GMP amount.

The general contractor under this agreement is responsible for providing insurance. They must furnish Kaiser Permanente with certificates of insurance completed. The types of insurance acquired on this project were: Commercial General Liability, Business auto insurance, workers compensation, umbrella liability insurance, contractor's equipment and contractor's pollution legal liability insurance.

Building Systems Summary

Although The Kaiser Permanente MOB is not a LEED rated project, DPR Construction and Kaiser Permanente are taking the initiative to build a sustainable building and construction site. The Green Guide for Healthcare version 2.0 is being tracked on this project. The GGHC is modeled off the Green Building Council's LEED rating system and focuses on innovative technologies to reduce consumption, utilize design elements to enhance to healing process and eliminate toxic materials used during construction. The main sustainable features of the building include use of day-lighting with the storefront glazing system and ribbon windows. This design allows for more natural light and less artificial lighting, which helps promote healing.

During building construction, sustainable practices are enacted such as temporary LED lighting research to measure the consumption of LED temporary lights versus fluorescent temporary lights. If this LED system results in a successful outcome of reducing cost and consumption, these energy saving practices will be utilized on future Kaiser Permanente projects as well as DPR Projects. Also DPR as a company is emphasizing a paperless environment where all paper documents are replaced with electronic files when permitting. All RFI's and submittals are done electronically as well as plans and specs. The DPR trailer complex won the Resource Efficient Energy Saver Award for their sustainable practices and recycling efforts.

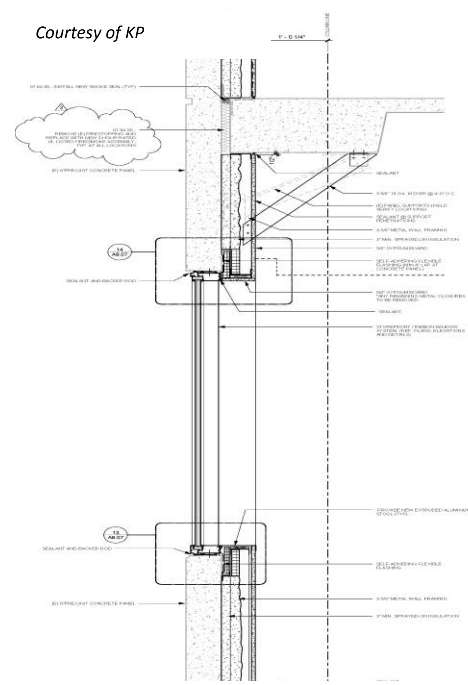
Yes	No	Work Scope	Questions/ Issues
X		Demolition Required	Types of materials, lead paint, or asbestos?
X		Structural Steel Frame	Type of bracing, composite slab, crane size, type, location
X		Cast in Place Concrete	Horiz. and vert. formwork types, concrete placement methods
	X	Precast Concrete	Casting location, connection methods, crane size/ type/ location
X		Mechanical System	Mech. room location, system type, types of distribution systems, types of fire suppression
X		Electrical system	Size/ capacity, redundancy
	X	Masonry	Load bearing or veneer, connection details, scaffolding
X		Curtain Wall	Materials included, construction methods, design responsibility
X		Support of Excavation	Type of excavation support system, dewatering system, permanent vs. temporary

Demolition

Demolition on this project will be minor and only involve concrete. Primarily demolition will be of existing exterior concrete sidewalks and areas of concrete waffle slab within the building. Also, the removal of existing precast panels will take place where the new mechanical tower will be erected and attached to the existing building. No harmful/ toxic materials will need to be dealt with.

Cast-in-Place Concrete

Cast in place concrete will be used for the Slab on Grade of the new mechanical tower addition as well as a retaining wall around the mechanical tower, in-fills of the sanitary trenches in the basement, thickened MRI slabs, etc. The horizontal and vertical formwork types used were both smooth formed and rough formed consisting of plywood and metal. Ready mixed concrete was used and poured continuously in one layer or in horizontal layers. For in-fills and slabs, the concrete was finished with a hand trowel. For larger areas, such as the retaining wall concrete, a machine trowel was utilized.



Typical Exterior Detail

Figure 1

Precast Concrete

Although precast concrete panels will not be installed on this project, the existing building is constructed of 6” precast concrete panels that will remain as the enclosure of the building. As seen in the typical exterior wall detail (figure 1) precast panels and a storefront/ ribbon window will be the building enclosure. During construction these panels were removed to allow for the erection of the new mechanical tower, which will be made of insulated metal panels.

Structural Steel

Structural steel will primarily be used for the construction of the 75 foot mechanical tower. It will consist of HSS 8x8 X-bracing up the sides of the tower as evidenced in Figure 2. Horizontal bracing will be used inside of the tower for the framing using HSS8x4. There will be six perimeter HSS columns and three interior columns Figure 3. A line of interior rigid moment connections will exist closest to the connection of the tower to the existing structure. Insulated metal wall panels will be fastened directly to the HSS members for the exterior enclosure of the tower.

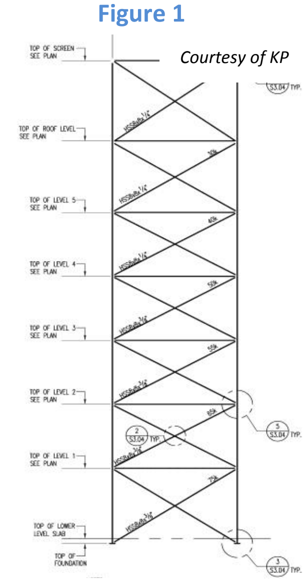


Figure 2

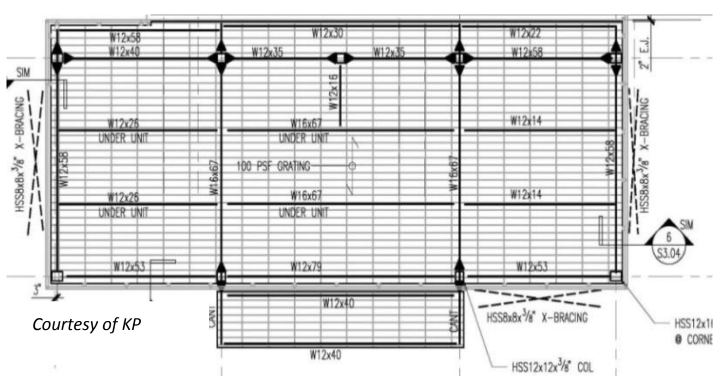


Figure 3

A concrete composite slab will be used for the mechanical tower floors as shown in Figure 4. As for the existing building, structural steel members are needed on varying floors for support of added loads from the medical equipment to be installed. Since the existing slab is a concrete waffle slab, steel members will be placed horizontally under the floor slab between the ribs or the ribs will be cut to fit the members. This will occur in locations that require extra reinforcing, perimeters of new stairway openings and framing of mechanical shafts. Structural steel members will also be used vertically between floors as single story support posts.

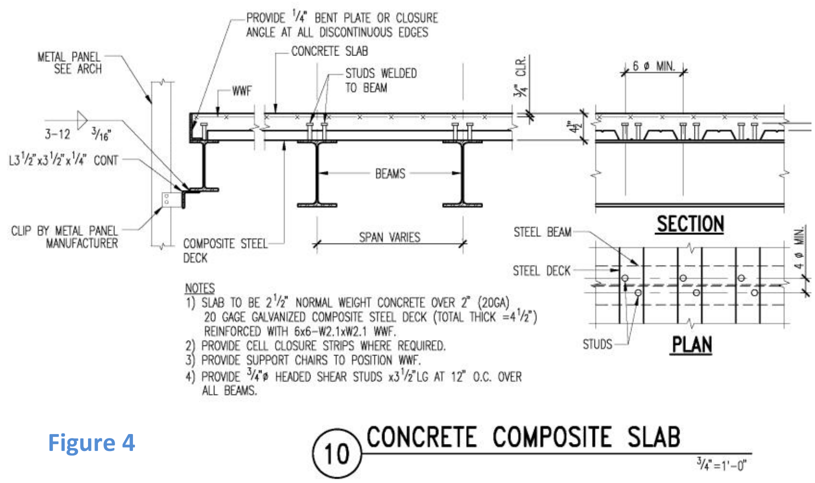


Figure 4

A 90 ton hydraulic truck crane will be used by the subcontractor BG Crane to erect the structural steel. The main boom has an arm length of 140 ft. in order to reach the top of the 75 ft. mechanical tower and the top of the existing building. The crane will be located on the South East corner of the building near the mechanical tower in order to distribute the structural steel members for inside the existing structure as well as for the mechanical tower construction.

Mechanical

The air distribution system used in the KP MOB will consist of multiple Variable Air Volume Control Units (figure 5) located on the lower level, level 2, level 4 and the roof. There will be gas fired steam generators and electronic steam humidifiers in the mechanical room located in the basement.

Courtesy of KP

DESIG.	LOCATION	SERVIC[E]	TOTAL CFM (NOTE 7) MAX	TOTAL CFM (NOTE 7) CURRENT CONNECTED LOAD	MIN. OA (CFM)	EXT. / TOTAL STATIC PRESSURE (IN. W.C.)
AHU-1	LOWER LEVEL	LOWER LEVEL AND LEVEL 1 INTERIOR ZONE	46,000	41,520	11,500	3.95 / 7.71
AHU-2	LEVEL 2	LEVEL 2 AND LEVEL 3 INTERIOR ZONE	50,000	44,665	12,500	3.95 / 7.26
AHU-3	LEVEL 4	LEVEL 4 INTERIOR ZONE	34,000	30,100	8,500	3.5 / 7.05
AHU-4	ROOF	LEVEL 2 THROUGH LEVEL 5 PERIMETER ZONE	54,000	50,745	13,500	5.0 / 7.86
AHU-5	ROOF	BASEMENT THROUGH LEVEL 5 PERIMETER ZONE	70,000	63,430	17,500	5.2 / 8.42
AHU-6	ROOF	LEVEL 5 O.R. SUITE	40,000	33,285	10,000 (NOTE 8)	4.0 / 8.24

Figure 5

AHU Schedule

The hot water system will be comprised of fire-tube gas boilers and clean steam boilers located in the basement boiler room. The water treatment system will be run by a twin tank alternating concept with a meter initiation method. Chilled water will be distributed from 500 ton minimum cooling capacity centrifugal water chiller located in the basement. Located on the roof will be the stainless steel cooling tower, which has an induced draft counter -flow and super-low sound fan.

The fire protection used in the building will be a combination of a wet type automatic sprinkler and standpipe system. The building and mechanical equipment rooms will utilize this standard sprinkler system design. However, the Telecommunication Equipment Room and electrical rooms will have double interlock pre-action systems. The main entrance and loading dock areas have dry-pipe systems. The fire protection will also include installation of new fire stopping and smoke seals around the perimeters of the floors.

Electrical

Since the KP building is a healthcare facility, it will require advanced electrical systems to be installed that the existing office building did not originally have. Because of this fact, the existing switchboard room in the basement will be remodeled to a MDP switchboard and paralleling low voltage switchgear (Figure 6). The new switchboard will be 5000A and a voltage of 480Y/277. The power source for interior lighting is a 120/277V circuit and the static uninterrupted power supply will have an output voltage of 208Y/120V and input voltage of 480V. The communications systems will be low voltage electrical power conductors and cables. The different communications pathways throughout the building will include mass notification systems and nurse call stations.

Courtesy of KP

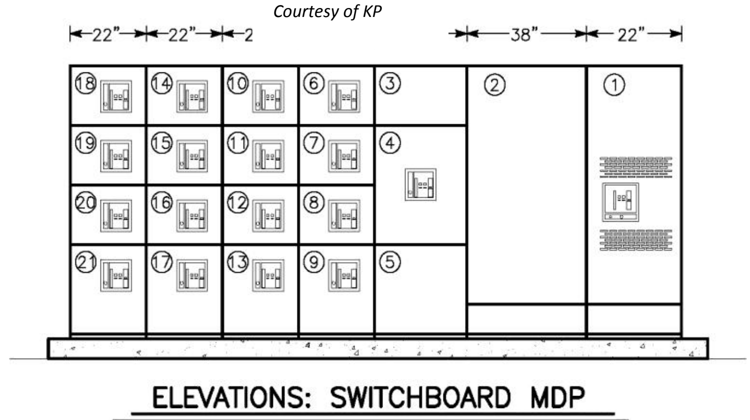


Figure 6

Throughout the building will be 100A three phase enclosed bus-way assemblies with 200% neutral and are 4 pole at 208V. All temporary construction power will be used from the existing switchboard and transformer located in the basement level main electrical room. The permanent transformers to be installed will be low voltage floor mounted and ceiling mounted transformers.

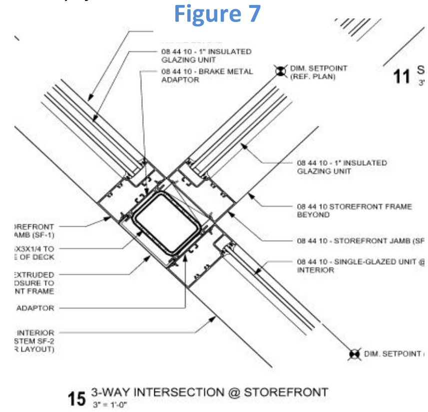
The electrical work on this project also includes a duct bank for the Verizon communications line to be routed across the site and to feed into the TER room located in the basement. The Verizon line will use 4” conduit connecting from the junction box on West Park Drive to the North side of the building at the location of the TER room.

Curtain wall

A curtain wall system will not be used on this building although a storefront system will be used at the entrance vestibule. A storefront system is only comprised of one story versus a curtain wall which is multiple stories. The storefront system will be constructed of different types of glass including: insulated vision glass, monolithic glass and laminated vision glass. The storefront will be held up by an aluminum frame that will fasten to the glass panels. This system can be seen in Figure 7.

Courtesy of KP

Figure 7



Plumbing

Plumbing will include Medical Gas boxes dispersed throughout the building primarily on the fifth floor. The medical gas will either be wall mounted panels above patient beds providing ½” compressed air, ½” carbon dioxide, ½” nitrogen and ¾” vacuum piping (Figure 8). Also, ceiling mounted medical gas will be located in surgical suites above the operating tables supplying ¾” oxygen, ½” Medical air, ¾” vacuum, ¾” anesthesia and ½” nitrous Oxide piping. Plumbing will also include installing sanitary trenches in the basement and all overhead plumbing for chilled and hot water systems.

Courtesy of KP

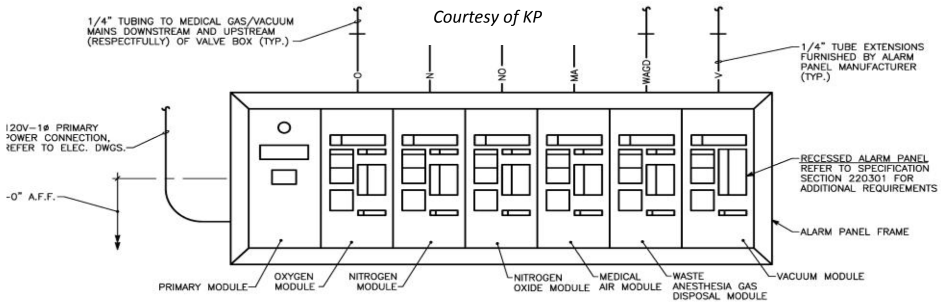


Figure 8 DETAIL – TYPICAL MEDICAL GAS/VACUUM

Support of Excavation:

The main excavation on site will be for the mechanical tower addition and the elevator pit located on the lower level of the existing building. The mechanical tower excavation will not use any support for excavation except a 1 to-1 slope step back. As for the elevator pit, an 8” x 8” timber shoring system engineered by the subcontractor will be used to support excavation.

No dewatering system is specified for this project and there has been no need thus far for any dewatering.

Project Cost Evaluation

**Please refer to Appendix B for further cost details and Building Assemblies Estimate.

The Direct Building Construction Cost:
This is excluding: land costs, site work, general conditions, taxes, insurance, and fee

$37,868,053

The building is 240,000 SF so this cost comes to:

$157.78 per SF

The Total project Cost is:

$44,078,649

With the square footage at 240,00SF this comes to:

$183.66 per SF

The Mechanical System Cost is:

$14,375,000 or
$59.90 per SF

Electrical System Cost is:

$7,842,891 or
$32.68 per SF

The Structural System Cost is:

$2,323,100 or
$9.68 per SF

The Total Assemblies Cost of the MEP systems (including plumbing, mechanical, electrical, communications cabling) is:

$23,517,953

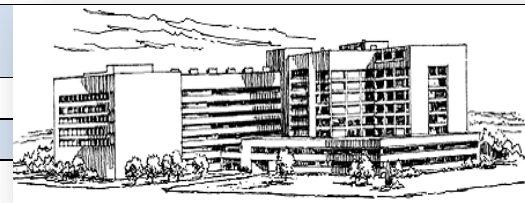
	Square Foot Cost Estimate Report	
Estimate Name:	***Kaiser Permanente-MOB***	
Building Type:	**Hospital, 4-8 Story with Precast Concrete Panels With Exposed Aggregate / R/Conc. Frame**	
Location:	**FAIRFAX, VA**	
Story Count:	**6**	
Story Height (L.F.):	**14**	
Floor Area (S.F.):	**241175**	
Labor Type:	**Union**	
Basement Included:	**Yes**	
Data Release:	**Year 2010**	Costs are derived from a building model with basic components.
Cost Per Square Foot:	**$190.52**	Scope differences and market conditions can cause costs to vary significantly.
Building Cost:	**$45,947,500**	

Table 1

The square foot cost estimate was developed using the RS Means Cost Works program. Some of the assumptions made for this estimate were that the Kaiser Permanente MOB is a renovation of the existing building. RS means does not provide square foot cost data for renovations so the estimate is based on new construction. The building type for the estimate was a 4-8 story hospital. The reason for this selection is to get the best possible estimate based on the structure of the building. RS means data does not provide information for Medical Office buildings with a concrete frame and precast concrete panels. The decision was made to follow cost data based on the structure, since the KP MOB will need to be able to support the weight of the medical equipment, much like a hospital. There are 5 above grade levels and 2 below grade levels on the KP project so a 6 story building with a basement was assumed for this estimate. Also, no architectural or designer fees were included in the estimate. The square foot estimate resulted in $45, 947, 500, which is a fair cost compared to the direct building cost of $37,868 053. Other factors that could have impacted this price are the building systems assumed in the estimate.

For the assemblies estimate evaluation, the results differ slightly then the actual assemblies cost because of some other influences. The assumptions made for this estimate were the quantities of each of the system's components . Generalizations were made based on the most typical designs seen througout the contract drawings. There are other systems within the building that were minor in comparison to the systems selected, which results in cost fluctuation. The total for plumbing, fire protection, HVAC and electrical assemblies in the estimate came to $13,054,090. This cost is about 10 million dollars less then the actural cost of $23,517,953. It can be assumed that this is because communcations was included in the actual cost, where as in the estimate communications systems were not accounted for. Also, the takeoff of L.F. of mechanical duct work and plumbing piping were not taken into consideration. This assemblies estimate was meant to summarize the major systems and equiptment utilized in the building and perform an approximate cost evaluation.

General Conditions Summary

***Please Reference Appendix C for detailed Estimate

For the general conditions estimate on this project, the estimate is based on the general contractor, DPR's general conditions. It was assumed the owner, owner's representative and subcontractors are responsible for their own general conditions. It was also assumed that the project duration is 13 months and so the total costs given are divided by the duration to produce monthly cost per item. There were 6 main categories within the estimate: labor, material, equipment, other, subcontractor and surveying, which resulted in a total general conditions cost of $3,972,344.
The labor category included cost for the project team payment as well as the labor costs associated with the jobsite office setup/removal and periodic cleanup of the site. There was a material hoist on site although the labor for operating the hoist was not considered a part of general conditions because a laborer from DPR self-perform was in charge of this task. Opening protection needed to be added to the general conditions since there was labor for the wood doors to cover the openings on each floor, where the material hoist would stop to deliver materials. The total cost for labor was $2,563,306.

The material category includes the materials associated with such tasks as jobsite office setup/removal and the tools needed for cleanup. There was $12,343 for the jobsite safety which included the "Right to Know" safety boards which were on each floor that housed personal protection such as earplugs, lens cleaning stations and first aid kits. This total material cost was $21,179.

Equipment for the site included the jobsite office setup/ removal equipment needed such as tools, trucks, etc. Jobsite safety equipment such as personal protective equipment, first aid kits, etc. Also included are the DPR pickup trucks for certain DPR employees that are used for traveling from the jobsite to the DPR main office or for commuting to the project from home. Fire extinguishers were included in the equipment category since they were used in the trailers as well as on-site. The total cost was $75,407.

The 'Other' category is predominantly where the GC components are. The main costs included the trash chutes, which were hung off the exterior of the existing structural and were very useful through construction. Power washing the façade was another major component of this category since the existing precast panels were remaining on the building they needed to be cleaned. Other items such as the trailer rental, jobsite office setup and computers were necessary for the daily needs of DPR. Computers were a significant cost especially since DPR was utilizing a "paperless" environment, where all plans, specs and documents were electronic. This meant that every member of staff needed a computer monitor for the office, as well as an ipad for field. Also a big, flat screen television adorned the trailer wall for group viewing of construction documents on a larger scale. The use of BIM on the project also required technology cost to increase for general conditions with the computers and projection screens necessary. Since Kaiser Permanente requires a high standard of building, quality control on the project was critical and factored into the general conditions cost for about $10,000 per month. Jobsite Safety is included in this category for any other parts that were not included in materials and equipment jobsite safety, such as the cost for training workers on safety, safety posters, etc. Site security is usually included in general conditions cost although for the DPR general conditions it is not. The reason is because site security was provided through Jacobs, the construction manager, by having an on-site security guard during working hours to monitor the site. Dumpsters were another significant cost for general conditions since there was demolition of existing concrete walks and slabs, a lot of packaging from frequent deliveries, and large amounts of workers at once producing waste. From the high volume of waste produced, the dumpsters were being emptied very frequently and needed to be dispersed around the site to maintain cleanliness.

The remaining general conditions category is subcontractor general condition cost. The components of this cost is similar to the above components but is applied since DPR is responsible for the subcontractors. There needs to be cost associated with being responsible for cleanup of the subcontractors, incorporating subcontractors in jobsite safety, dumpsters for subcontractors, etc. The final category of surveying was included in the general conditions cost to show it may be a component if necessary although up until this point no site surveying has been needed since it is an existing structure.

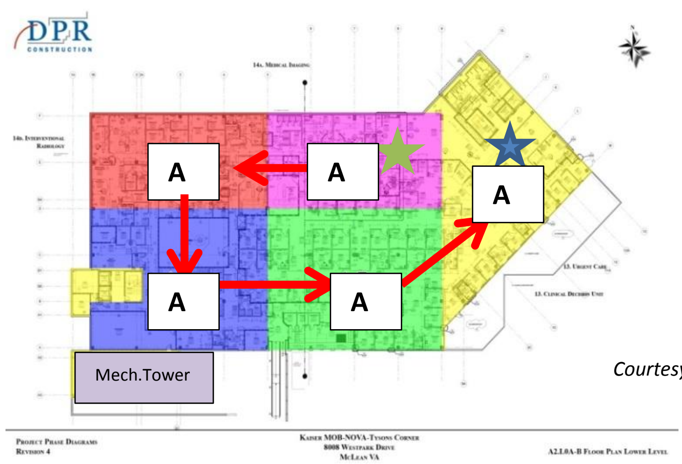
Detailed Project Schedule

***Please refer to Appendix D for Project Schedule

The Kaiser Permanente Tysons Corner project schedule was not a standard CPM schedule that defined distinct phases and used typical trade sequencing. Instead, a schedule was specifically developed to maximize productivity, minimize time and mold to the existing building's layout. This is due to the fact that this project required a strict deadline for substantial completion on March 15, 2012 to allow for Kaiser to move in and be ready for first patient on September 14, 2012. Even with the many change orders and bulletins that Kaiser Permanente initiated during construction, the deadline remained for substantial completion to be met on time, which required a schedule with flexibility.

This being stated, the detailed schedule that I developed is meant to reflect the typical schedule to be followed for each floor interior build-out as well as major phases including mechanical tower construction, miscellaneous exterior construction and important completion dates. For the interior build out phase, the schedule shows specifically the fifth floor typical activities associated with interior build out of the existing building. This is due to the layout and work flow remaining identical for the lower level up to the fifth floor so these activities will be repeated. The construction will be top down, which is reflected on the schedule with the fifth floor constructed first then succeeding floors. The workflow sequence on each level is seen in the figure 1 below. The figure shows the typical floor layouts and how they were divided into quadrants in order to breakdown areas and assign a starting and ending point. The work flow begins at A2 indicated with a green star then flows counterclockwise around to A3, A4, A5, and finishes at A1 (blue star).

Figure 1



Courtesy of DPR

Since timing was critical for the project, the work flow used was the best approach to minimize time spent between different trades work in a certain area. This layout made sequencing easy, organized, and time efficient because trades could follow one another and know where to work next. For example overhead rough-in was started in A2 and worked counterclockwise, directly followed by framing and blocking. It helped to keep each trade moving consistently and being pushed along by the following trade. It is important to note that once one task was begun the following task would begin as soon as the preceding task was far enough ahead, as seen in the schedule structure. Unfortunately with this following of trade setup, there were times when one trade could hold up another. An example was closing in coffers was delayed because of design setbacks. This delayed overhead rough-in to proceed and the framing track to be installed. In order to make up time, the schedule was adapted to move forward with rough-in on other quadrants/floors, frame priority walls in other quadrants/ floors, etc.

The other major phases that I incorporated on the schedule were happening throughout the interior build-out of the existing structure. The mechanical tower construction did not majorly effect the interior build-out construction since it was outside of the existing building footprint. The only significant activity was the removal of the precast panels on the existing structure where the mechanical tower attaches to the building. Also the mechanical tower relied on the MEP rough-in of the existing building to be fit out so that the mechanical in the tower could be connected to the existing structure equipment..

On each floor, the west side telecomm rooms were treated as part of the A1 quadrant as seen in yellow (Figure 1). This was decided because A1 was the last quadrant in the counter clockwise rotation to be constructed. The telecomm rooms needed to be done last because a large amounted of the wiring from the floor fed into this room, so all quadrants were done first as evidenced by the schedule.

The basement mechanical and electrical plant is another interesting phase because there is a lot of overlapping activities that would typically precede each other. As seen in the schedule, the basement mechanical/electrical room is toward the end of the schedule timeline and closer to completion dates. As a result, the overlapping of activities becomes more prevalent. For instance, F/R/P Concrete equipment pads is still taking place while mechanical rough in is beginning in the same area. Also, there are multiple pieces of equipment being installed while other equipment is being hoisted and set. This overlapping effect is what kept construction moving and deadlines kept.

For this project there are many critical paths rather than one specific path. For each phase, a critical path exists and drives the substantial completion and first patient date. The main critical path activities are those that narrow in and effect the ending dates if they are behind. These activities can be seen in the schedule and include the construction of the main entrance canopy and metal panels in the exterior construction phase. Also, completing AHU connections and enclosure for the mechanical tower is a latter activity that is affected by the completion of the interior build out of the existing structure. This is to allow for the mechanical tower and existing structure to be connected. These activities along with finishing the basement mechanical/electrical plant effect when MEP startup and commission can begin. Once MEP equipment startup and commissioning is complete, this will propel Kaiser Permanent/ DPR inspections and turnover. With substantial completion met, Kaiser Permanente will be able to move in and start commissioning in order to prepare for their first patient on September 14, 2012. The main take away of the schedule is that the driving force of the schedule is on-time completion. No matter what changes occurred during construction, the substantial completion date and the first patient date must be met.

Analysis 1: Integrated Project Delivery Method for Coffer Re-design Issue

Problem Identification

The Kaiser Permanente MOB project uses the traditional design bid build approach as its project delivery method. Though this is a typical method, some projects could experience great benefits of utilizing an Integrated Project Delivery Method. IPD is a new critical industry issue that is struggling to be implemented because of its unfamiliarity and vague benefits. Although it is important to realize that IPD is a great method to consider for increased accuracy of estimating and to gain a greater understanding of design by the project team.

The Kaiser MOB experienced issues regarding approval for the coffer design of the existing waffle slab configuration. The design discrepancy caused ongoing cost and schedule problems throughout construction. This hindrance was mainly due to the repetitive and lengthy process for review, redesign, and resubmission of the altered design. At the time the final design was approved and shop drawings were received, work had already begun for interior build-out. This change in design resulted in reconfiguring phasing of above ceiling rough-in, the inability to hang the track for the framing studs and a chain reaction of other trades that were to continue or begin work in these areas. This design issue contributed to a 2 month schedule delay of interior build-out and major cost concerns. The costs estimated during the bid process did not anticipate these design delays during construction, which proved to be another negative attribute of Design Bid Build.

Background Research

DPR IPD Lecture
PACE Roundtable 2011

Research Goal and Potential Solution

The goal of this analysis is to research and compare the costs and risks of IPD versus Design Bid Build specifically for the coffer design issue.

The potential solution for the cost losses and schedule delays associated with the coffer design issue is to implement Integrated Project Delivery Techniques early on in the project. This project delivery method would allow for collaboration during the design phase and a better understanding of the coffer design by all parties involved. This greater understanding of design results in better accuracy of cost estimates associated with this scope of work and less risk later on.

In order to thoroughly compare the results of IPD on the coffer design issue and produce tangible evidence, a similar design issue for an IPD project will be researched. During this exploration, the process of design, risk associated with the design later in construction, the costs for estimating the design and scope of work, etc. will be looked at. These practices will be compared to the Design Bid Build practices for the coffer design on the Kaiser Project. Conclusions will be drawn from this analysis to see the benefits gained from IPD.

Methodology

- Review the details of the design discrepancy that arose with the coffers
- Contact General Contractor and personnel to find the process involved in estimating the coffer design during bidding. Also find costs allocated for risk, unforeseen conditions, and scope of work.

- Interview coffer design Bid team on their knowledge of the design. Ask if conversing with project team earlier on could have produced better understanding of the design.
- Converse with engineers or subcontractors of the project to find their perspective on coffer design cost, risk and their role in design.
- Find/ Research Case study of project that used Integrated Project Delivery Method.
- Contact members of case study project teams to receive cost data and opinions on IPD Method.
- Compare cost data and risks of coffer design under Design Bid Build approach versus the IPD case study.
- Summarize results found and formulate the cost benefits and risk IPD can have on design versus the traditional Design Bid Build delivery method

Resources and tools to be used

- General Contractor
- Engineers
- Owner
- Subcontractors
- Project team members of Case study
- Information from Pace Roundtable
- Relevant publications
- Industry Members

Expected Outcome

The results of the analysis are expected to support the idea that Integrated Project Delivery is a viable option for projects to pursue. The findings of utilizing IPD should show cost benefits, less risk during construction and an overall efficient estimating and design process. The outcome can prove that if IPD were utilized, the coffer design issue could have been mitigated as compared to the Design Bid Build approach.

Case Study Research: The House of the Temple of the Scottish Rite

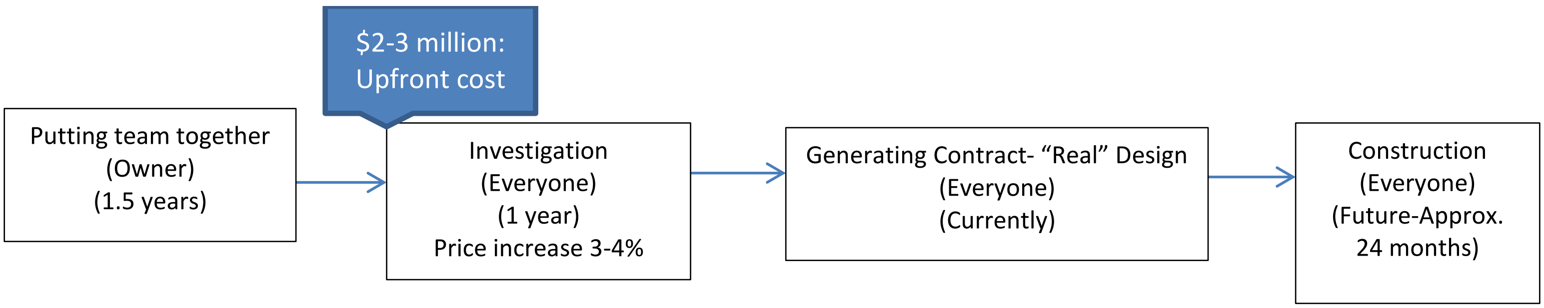
In order to adequately compare Design-Bid-Build to IPD, research was conducted on a successful IPD project. The House of Temple of the Scottish Rite is a $43 million renovation project in downtown Washington D.C. that is utilizing IPD from the start of the project. The process began with the owner, the Scottish Rite of Freemasonry and architect John Russell Pope. Together they decided that they wanted this project run a different way because of the familiarity with the traditions of the industry. It was then agreed that the mason would be chosen next to join the IPD group, which is contrary to traditional order. To follow was the structural engineer, mechanical subcontractor and electrical subcontractor. The last party chosen was the General Contractor, in contrast to Design-Bid-Build which usually picks the GC first. The owner did this to ensure that members of the team were handpicked by them and all in agreement of IPD before the GC came in. In order to select the GC, the Scottish Rite did not once discuss money and cost for the project. GC's were simply interviewed based on their IPD capabilities and willingness to work as a team. DPR was chosen as the GC for the project and planning started immediately after.

Everyone sat together and decided to first dive into the structure of the building and investigate. Since this is a historical building it was necessary to try to eliminate a majority of the unforeseen conditions that could appear later on. Although $20,000 was spent on just digging to the foundation and checking the foundation and soil were adequate, it was a necessary step for the wellbeing on the whole team. Every step in the process was discussed and decided on together, allowing each team member's needs to be considered. The investigation continued in each sector of mechanical, structural, electrical, fire protection, etc. to ensure everyone knew what conditions they were working with. The team would continue the routine of meetings where each member would discuss what tasks were important for them and they put a cost to their work. The other trades were present to discuss any issues with each other's work and then the owner could allot money to each trade. The list of tasks started with 60 important items and through discussion was reduced to 30 definite tasks. The tasks were prioritized, planned, attacked, and then moved on to the next. According to Tom Krajewski, every member of the team was "sharp, engaged and thinking". Team members were paid for their thoughts/ ideas during this process so it created dedication from each member. Since in any project nothing can be known for sure, communication is the key. There is no need for paper in the beginning because obstacles are not known yet. In this Preconstruction stage, specific mechanical, electrical, structural expertise is not needed yet, only ideas and planning are important. The owner's representative knew that ideas and communication was a better set of documents then actual bid plans that are created by people that hardly know the project.

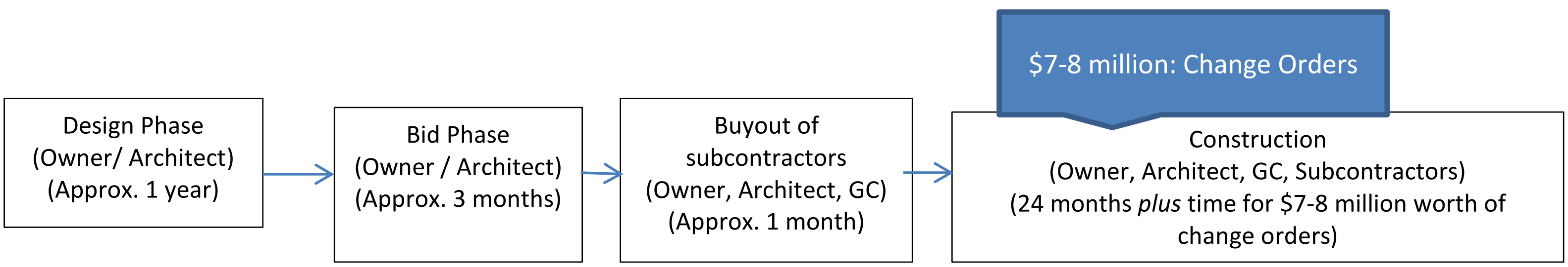
Money never once became an issue because budgets were created together and the owner was realistic about what it took to get work done. The money factor was a give and take effect, meaning that team members had to put aside their personal goals and think of team goals. For instance, DPR decided to have the investigation meetings/ work free of charge so the owner could see if this was in fact the right team and GC for them. Later on when budget was discussed, DPR estimated $38 million. After consideration, it was raised to $43 million by the owner because he knew they needed more and treated DPR as a teammate. This push and pull was how the team balanced every aspect of the project and worked together. It took a selfless mindset and understanding of how IPD works in order to be productive and make money in the end.

Though the project is still under construction, the basic steps of the project process are outlined below. This is compared to a basic process of Design-Bid-Build. After discussing cost comparison with Tom Krajewski, if the same project was compared with IPD vs. Design-Bid-Build, the cost would differ between the two. The major difference is with IPD money is being spent upfront for planning and Design-Bid-Build acquires cost later on from change orders due to lack of communication/ planning. The blue figure below represents the extra cost acquired with each process; otherwise the cost for each is the same. IPD spends $2-3 million upfront in order to use the investigation process to the fullest. Though this is taking a risk for the owner to trust the team will plan efficiently and utilize this money, it will save time and money later in construction. Comparing this to the DBB costs acquired, it can be seen that a typical DBB will accumulate $7-8 million in change orders during construction.

The House of Temple Project: IPD



The House of Temple Project: Design-Bid-Build (Hypothetical)



Design-Bid-Build versus IPD

From the research performed, below is a chart created to show the major differences between Design-Bid-Build and IPD as a project delivery method.

Design Bid Build	IPD
Delegated risk	Shared risk
Uncertainties not foreseeable	Uncertainties more predictable/ quantifiable
Only separate parties can benefit from risk management	Include EVERYONE in risk management
Hidden costs: increased claims/ disputes, getting quality contractors to replace original lower quality contractors, change orders, reputation, etc.	Majority of cost is known upfront at the beginning of the project. Adequate planning minimizes change orders, disputes, etc.
Limits cooperation and coordination, innovation	Promotes teamwork and more ideas
Contract documents are known from the beginning although not always accurate.	Lack of contract documents that spell out in detail what happens in failed events
Everyone has their own risk/ goals.	Built on trust/ must have good team

Overview of Coffer Design Issue

****Please refer to Appendix E for detailed information*

The overall process of the coffer design issue can be found in APPENDIX E. It is a timeline of the events that occurred and the lengthy process that delayed work and cost money. This timeline shows the inefficiencies of Design-Bid-Build on the Kaiser Tysons project for the specific coffer design case. In pre-construction, the waffle slab was identified as an issue for the MEP trades as they would be core drilling through the slab. Drilling through a rib in the waffle slab would have compromised the structure. Thus, the MEP trades had it written into their contract that they would not be held responsible for coordination and design due to the waffle slab. However, it was assumed that the waffle slab would not cause any coordination or design issues when it came to architectural aspects. Unfortunately, there were design issues that arose, hence creating the events in the timeline.

Many other change orders, RFI's, and bulletins followed this same pattern throughout construction for this project due to the structure of Design-Bid-Build. The lesson learned is that it is a requirement to have all team members on the same page from the beginning of the project. Since so many players are involved in a project, they all look out for their own interests before discussing them with the team. DPR attempted to design a solution to the coffer issue when it first identified (instead of letting the architect solve it) in an attempt to save time. Although in doing so, it led to a longer paper trail of RFI's, miscommunication, time and money.

Cost Impact

After speaking with parties involved in the coffer design issue and analyzing the situation, the cost was estimated to be about $250,000 that was not expected. When considering lost labor hours, extra materials, removal and re-installation, repeat inspections, time spent remediating the problem, etc; the cost impact adds up quickly. Initially the problem was small and could have been fixed if it was caught in time and agreed upon by the team as a whole. In the end, when time and lack of early collaboration results, it affects all trades and members on the project. One of the biggest threats of IPD is to have shared risk although even in Design Bid Build risk can hurt everyone.

Schedule Impact

The coffer design issue created a major delay in the project schedule because of the lack of communication and unforeseen conditions that the waffle slab presented. Not only was hanging track affected but many of the other trades on the project. It held up MEP overhead significantly as well as interior wall framing. It also limited the areas where penetrations through floors could exist and where the MEP trades could place their hangers. It required DPR to use its own resources i.e. structural engineer, third party fire stop engineer, vendors, etc. in order to remediate the problem. The overall process of the coffer issue took a total of 5 months to be resolved. Within these 5 months, trades were delayed and kept pushing back the schedule. From the start of original design to the end of design, the production of coffers dropped from an average of 25 coffers per day per man to 16 coffers per day per man. This is a staggering fact considering how much work could have been complete within the 5 months lost.

Conclusions/ Recommendations

After investigating the key factors of the IPD method used on The House of Temple, it is evident that this is a beneficial project delivery method. Though both IPD and DBB have positives and negative attributes, IPD can save more money and time in the long run if done correctly.

Aside from money and time, IPD offers a more enjoyable approach to building by utilizing team goals to increase quality and productivity. As seen in the House of the Temple case study and from Tom Krajewski, team dynamic and significant relationships can result from IPD for future projects.

Kaiser Tysons suffered a 5 month delay in schedule and $250,000 loss from an issue that could have been mitigated with IPD. Kaiser Tysons could have utilized their time in the beginning by planning together with all parties and identifying issues. Dan Crutchfield of DPR dealt heavily with this issue during construction. When asked about IPD helping this issue he said, "I think IPD would have been helpful in this situation. Having everybody in the room (not just the MEP trades) could have prevented the mass amount of issues that this caused." With IPD, the coffer design issue could have presented itself during initial meetings and been resolved as a team.

Although factors such as buying into IPD, trust, and shared risk are concepts that give IPD a negative reputation, it is still an option that could have been utilized for Kaiser Tysons. By initially taking the shared risk with an IPD team, it can ultimately cause much less risk then DBB and the coffer issue. Tom Krajewski mentioned a valid point during our interview that shows that IPD was the original delivery method. He identified that if we look back at great builders, such as Brunelleschi, the concept of IPD is utilized. Brunelleschi was an architect, a builder and an engineer all in one, which is the way a successful project team should function.

Analysis 2: Curtain Wall Façade Re-design

Problem Identification

The existing precast panels on the exterior of the building and the windows were both experiencing water leakage due to cracks in the panels and gaps in the windows. There was not any work originally associated with the panels or windows besides power-washing them since they are to remain as the permanent building enclosure. Although after testing the panels for water infiltration, they failed the testing and cracks were found in many of the panels. After potential solutions were given, the owner decided to not replace the panels but instead spot treat the cracks with an epoxy injection. For the windows an added scope of work was added to the original GMP which includes an entirely new glazing system including aluminum mullions and glazing units. From a value perspective of the building, there are better solutions that could have been utilized instead of a quick fix to the existing panels. Also, as seen in Image 1, the building is outdated and not utilizing its full aesthetic potential from the renovation.

Image 1: Exterior Facade

Background Research

- Spoke with General Contractor's Project Manager about potential options for improvement.
- Explored potential Curtain wall options and benefits.

Research Goal and Potential Solution

The goal is to replace the existing precast panels and glazing with a complete Curtain wall system that would add aesthetic value and improve day-lighting with minimal impact on cost and schedule.

The potential solution of replacing the existing precast panels and glazing with a complete Curtain wall system is mainly to add value to the building. Updating the existing building façade would significantly enhance the aesthetic characteristics of the building. The existing precast panels are an outdated look that does not align with Kaiser Permanente's forward thinking outlook on healthcare. An updated Curtain Wall could allow for Kaiser to collaborate and add further input on the building's design and appearance. An architectural breadth will be incorporated into this analysis to depict the aesthetic changes a curtain wall system would have on exterior appearance.

If a Curtain wall system were to be used, it would consist of all one unit that would be hung on the structure's frame. This one unit system would include enclosure and glazing, which would eliminate the need for replacing the existing glazing separately. The cost associated with a unitized curtain wall system will be compared to the existing precast panels and glazing units restoration cost.

Methodology

- Research types of Curtain Wall systems while considering type, size, feasibility, cost, etc.
- Interview the owner for further input on their aesthetic vision for the building.
- Design the Curtain wall system with elevations and sections.
- Explore the cost associated with precast panel system versus installation of curtain wall.
- Determine the constructability factors associated with the Curtain wall system.

- Compile results of aesthetics, cost and schedule associated with the Curtain wall system chosen.

Resources and Tools

- Owner
- Curtain Wall manufacturer
- General Contractor
- Knowledge from applicable AE courses
- Relevant publications
- Industry Members

Expected Outcome

After this analysis and breadth topic, it is expected that the Curtain wall system chosen will provide value in numerous ways to the building. These areas will include enhancement of exterior aesthetic appeal and increased day-lighting with minimal impact to the cost and schedule.

Curtain Wall System and Application

***Please refer to **Appendix F** for detailed 1600 Wall System information*

After speaking with the curtain wall system company, Kawneer, a 1600 Wall System 1 was chosen to use on the Kaiser Permanente building. Factors such as location, typical climate, building use, and design influenced the decision. This type of system is commonly used for low to mid rise buildings where high performance is desired. The design is versatile and a smooth monolithic glass façade will let in maximum light.

Once the system was chosen, the areas of application to the building needed to be considered. The surface area that the curtain wall system would cover was calculated. The square footages are neglecting the mechanical tower addition, the Northeast corner of the building, the storefront vestibule entranceways, and loading dock doors. The Northeast corner does not have windows because it houses mechanical shafts, elevators and stairways so a curtain wall system is not necessary on the enclosed concrete structure. The surface area that will be stripped of precast and glazing and replaced with the curtain wall is calculated below. As seen in Figures 2,3,4,5 the surface area in blue represents the Curtain Wall coverage area.

West & East Facades: 11,584 SF
North & South Facades: 22,708 SF
Total: 34,292 SF

Figure 2

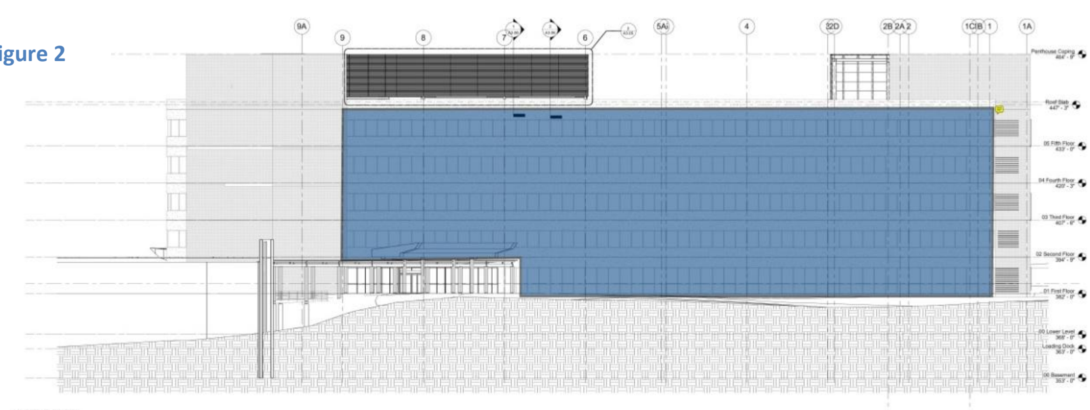


Figure 3

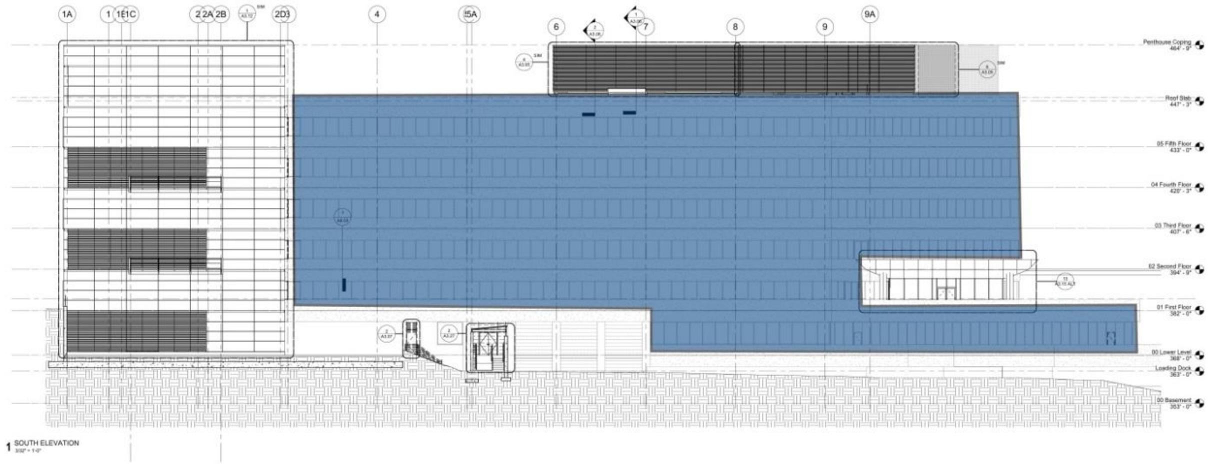
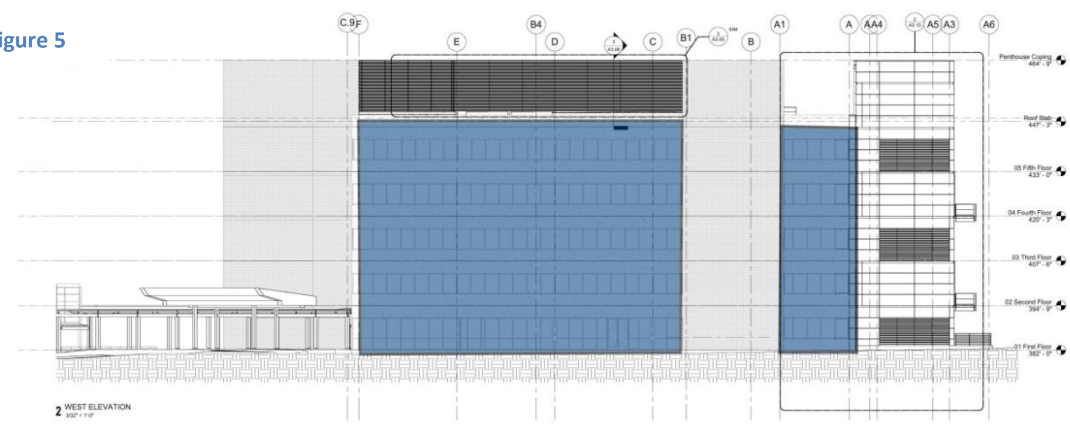


Figure 4

Figure 5



Cost Comparison

After speaking with Kawneer, Emittsburgs Glass and John Wiegand, the superintendent of the project an average cost of $65 per SF was determined for the 1600 Wall System.

Curtain Wall 1600 System

Cost per SF (Materials & Installation): $65/ SF
$65 X 34,292 SF (surface area)= $2,228,980
Demo/ Removal Precast & glazing = $212,000
Total=$2,440,980

Comparison to precast injections/glazing replacement:

Glazing: $1.1 million
Existing Sill Protection: $15,360
Precast Panel inspections/Testing: $12,500
Epoxy Injections: $750,000
Precast Cleaning: $55,000
Demo of Existing Glazing: $106,000
Total=$2,038,860

Cost vs. Benefits of the Curtain Wall System

After calculating total cost of the Curtain Wall system versus fixing the existing precast panels there is only a $402,120 difference between costs. Keeping the existing precast panels and applying the epoxy injections to remediate water leakage is a costly choice for simply temporarily mending the problem. The precast panels are about 25 years old and give the building an outdated look. From a cost standpoint, a completely new curtain wall system for virtually the same amount of money as the existing precast is the better value engineering choice. The curtain wall system will lend greater quality to the building in many ways such as air infiltration/ water infiltration protection, solar gain, and an updated product for the owner. The architectural benefits of this change would greatly improve the appearance of the building and result in a transformed exterior façade. There would be more windows utilized with the curtain wall system design since the use of slender metal mullions and spandrels can create an open façade. Also, the owner and architect can work closely to attend to the owner's wants and needs for faced design.

The idea of a hospital building with natural light is an ideal feature to aid in healing, thermal radiation, and aesthetics. When considering quality versus cost, an extra $409,200 is not a great expense compared to the improvements a curtain wall can offer. It will have a longer lifespan compared to the already 25 year old precast panels. Further in the future, the owner will have to maintain the precast panels again if a crack was missed. Further cracking could lead to additional water infiltration which would then affect the in-wall medical equipment of the building. This would demand for hospital rooms to be closed down in order for construction to be done. The curtain wall however has an inch air gap away from interior walls. This means in the slight chance water infiltration were to occur, it would not affect interior walls and hospital rooms. The curtain wall will aid to ease of maintenance in the future which can add to additional savings.

Schedule Impact

Shop drawings: 8 weeks
Fabrication: 8-10 weeks
Removal: 120 days
Replacement/Installation: 140 days

The above durations were calculated based on the amount of surface area the curtain wall façade will cover and the standard Kawneer manufacturing times. After discussing the system with a Kawneer representative, the shop drawings were estimated to take about 8 weeks. Kawneer also estimated that fabrication of the panels and delivery to site would be about 8-10 weeks' time. While the shop drawings and fabrication is occurring, this allows time for the removal of the existing precast panels and glazing. Once removal is underway, the installation of the curtain wall can begin.

Schedule Considerations

****Please refer to Appendix F for amended schedule*

Determining where the curtain wall system would fit into the project schedule posed some challenging issues. Since the deadline for completion is very strict, any addition to the schedule time would not be welcomed. After speaking with the architect for the owner, the conclusion was reached that any addition to the schedule because of the curtain wall system would not be agreed upon. The owner was more than happy with the decision to keep the precast panels and glazing. When asked about the unforeseen issues of the precast panel cracking and water infiltration, they still agreed it was worth the cost associated with it and the overtime that was necessary for the epoxy injections and glazing. This was an indication that the first challenge would be to implement the curtain wall system idea without delaying the schedule.

Another issue was how to remove and install the new curtain wall on the exterior while renovation and interior fit out work was ongoing. Coordination and sequencing would be needed to ensure that interior and exterior work did not collide and cause delay. Initially it was considered that since interior fit out work flow was occurring counterclockwise rotation, top floor down to bottom floor that exterior curtain wall work could counteract this. The removal of precast would start on the bottom floor and rotate around and up the building clockwise. Sequencing and productivity would have to remain according to plan in order to avoid collision of work. Once this idea was visually mapped out and durations were applied, it was found that this idea would ultimately lead to collisions and schedule delay. Also, there was the decision to be made to remove all precast panels at once and then begin the curtain wall installation or having these be simultaneous tasks. Other concerns such as weather, safety and fall protection, congestion on site, etc; also came up while brainstorming solutions. After speaking with a variety of industry members and hearing a variety of opinions for how to go about this, the best decision was reached for this project.

The removal and installation of the curtain wall system would be scheduled before any on site construction begins. It was found that the building was vacant for years before it was purchased by Kaiser Permanente. The interior demolition and gutting of the building was done by another party prior to Kaiser Permanente bidding the project out to the general contractors. This leaves time between the interior demolition and the start of the bid process and construction. This time can be utilized to remove the existing precast panels and glazing and install the new curtain wall system. In order to implement this, Kaiser Permanente would hire subcontractors to come and perform this work starting when they bought the building in the beginning of September. In order to avoid collision, the removal and installation of the curtain wall would need to be finished by April 4th 2011, when exterior construction begins and interior fit-out begins on the 5th floor. The contract was awarded to DPR construction on February 28th 2011 and up until April 4th 2011 preconstruction activities, shop drawings, fabrication, and delivery were occurring. Using the durations calculated above for removal of precast panels and installation of the curtain wall, these activities can be incorporated into the schedule

(See Appendix F)

The first activity to schedule was the shop drawings of the curtain wall system. These need to be scheduled immediately so that the design and fabrication of the curtain wall would finish and leave enough time for the 140 day installation duration. Shop drawings will take about 50 days and is going to start on September 6th 2010. The ending date will be November 12th 2010, which is based on an average 5 day work week.

Starting on September 6th 2010 as well is the removal of the precast panels. Since the removal does not rely on the shop drawings and fabrication, it can begin immediately. Also, removal needs to be at least 25 days ahead of curtain wall installation in order to avoid removal and installation happening on the same side of the building at once.

The removal pattern will be bottom to top starting at the South-West corner of the building near the mechanical tower addition. Since the mechanical tower addition takes place later in the project, the area the tower meets the existing structure will have precast panels removed but not curtain wall installed. For the duration of the project this bay of the building façade will remain open except for plastic covering. This provides a great opportunity for interior fit-out deliveries to occur through this opening. Also, starting at this corner with removal will give immediate access to this area for any excavation work that needs to occur in April 2011 for the mechanical tower foundation.

When the removal was initially estimated at 5 work days per week, it did not allow enough time for curtain wall installation to finish by April 2011. Therefore, the work week for the removal of the precast will include Saturdays for a 6 day work week. This results in removal ending December 20th 2010.

Fabrication of the curtain wall is estimated to take 65 days. Therefore, fabrication would start about 2 weeks after shop drawings begin on September 20th 2010. This will allow time for shop drawing approval and fabrication to be underway. Many of the curtain wall materials are generic so fabrication will be an efficient production. The sooner that fabrication begins the curtain wall installation can be underway. Fabrication will finish around December 17th 2010 assuming a typical 5 day work week.

The curtain wall installation is heavily dependent on the shop drawings and fabrication, which is crucial to meeting the deadline around April 2011 when other work begins. Also, the curtain wall will need to undergo inspections and commissioning so time needs to be allotted for this at the completion of the curtain wall. Considering that fabrication begins September 20th 2010, roughly 3 weeks of fabrication will be underway until curtain wall installation will begin on October 10th, 2010. In order to finish on time, the curtain wall installation will follow the same 6 day work week as removal of precast panels did. This will accelerate the schedule and ensure on time completion. Curtain wall installation will then finish on March 21, 2011 after 140 days of work. Inspections will be ongoing throughout the installation of the curtain wall system. In the remaining float time from March 21, 2011 until April 4, 2011 will allow time for cleanup and final turnover of the curtain wall system.

By implementing this scheduling approach for the curtain wall system, this ensures that installing the curtain wall will not delay the project schedule and will utilize time that the building was not being worked on. Also, other there are other benefits such as having the building skin on the building for the rest of the project and during in climate weather. The need for detailed coordination strategies to address safety between interior and exterior work will not be necessary since the curtain wall activities happen well before other work begins. Another factor of site congestion in relation to the removal/ installation will not be as much as a concern since the site will not be undergoing work during this time. Considering the installation of the curtain wall system, lay down area will be needed around the building in order to construct the frames. It his activity were to happen after April 2011 when other work was ongoing, it would create major logistic challenges.

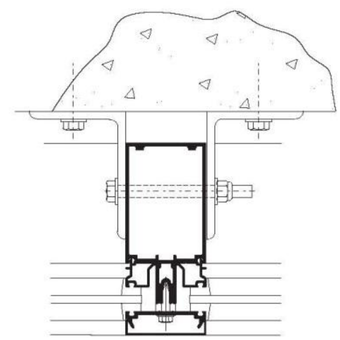
Installation

***** See Appendix F for details**

For the removal of the precast panels, a lift will be used. There will be 2 workers on the lift and 3 workers on the interior of the building to de-attach the panels from the structure. The panel will then be brought down on the lift and loaded on a truck to be taken away.

For the curtain wall installation, the curtain walls will be fabricated off site and shipped knock down to the site. A crane will be needed to load the interior of the building with glass crates for the curtain wall. The frames would be built on the side of the building, requiring lay down room. This should not be a concern because there is space around the perimeter of the building and it will not be in use due to when this activity fits into the schedule. There would be workers located on the floor slab of a level and workers in a swing stage on the outside of the building.

Attachment of the curtain wall will be to the existing floor slabs as seen in the Figure 6 detail. The curtain wall will suspend from and tie back into the roof parapet. The maximum vertical span for the glass is 30 feet before a splice extrusion is needed. The maximum horizontal glass span is 5 feet between mullions. Since the concrete columns are inset, there will be a snap trim used to account for the gap between the interior space and curtain wall. Further attachment details of the curtain wall to the existing structure can be found in APPENDIX F.



ANCHORING TO FLOOR SLAB

Figure 6

Architectural Breadth

****Please refer to Appendix F*

In order to convey the aesthetic benefits that a curtain wall system would offer, a visual representation of the curtain wall on the Kaiser Tysons Building is necessary. The architectural breadth is to design the layout of the curtain wall façade to best fit the exterior skeleton of the building.

When examining the existing building it is seen that each floor height is about 13 feet. The floor slab at each level is about 1'-1/2" thick which means the spandrel width must be at least this dimension to cover the slab thickness. Also, the overhead space in the ceiling plenum for each level needs to be considered in order to ensure that this cannot be seen from the exterior. Therefore, a 3 foot wide horizontal metal spandrel was chosen to wrap the building where the precast panels initially were. Aside from these horizontal spandrels and 2" vertical mullions with 5 foot spacing, the rest of the façade will be glass. (*Design Elevations can be found in Appendix F)*

Incorporating natural light was a major factor in the design since the interior space functions as a medical facility and a place of healing. With the curtain wall system, there is now 10 feet of glass per floor versus the 7 feet of glass on the existing façade. This 30% increase of exterior surface area covered by glass will benefit the occupants view to nature. The introduction of natural light into the building will be a positive change not only for the exterior appearance but also the interior atmosphere. The existing building envelope was mostly precast panels, which limited window space. The interior was darker and closed in so the inside to outside relationship was very weak.

The curtain wall system however offers a closer connection between the interior of the building and nature by letting more natural light in. The façade appears lighter with the glass and metal mullions rather than having the concrete precast panels, which visually weigh the building down. The curtain wall creates a smooth and streamlined look to make the building exterior more cohesive. The materials of shiny metal framing and reflective glass are similar in appearance and blend well together. This differs from the previous precast panels which cut the building into concrete segments and hid the structural skeleton.

The curtain wall system also offers the building a newer and more modern look in order to fit in better with its surroundings. Since Tysons Corner is conveniently located on the outskirts of Washington D.C. it is becoming an increasingly popular area. In order to address its popularity, it is becoming a built up area with high end commercial buildings, hotels, and luxury apartments. Previously the Kaiser Tysons building was hidden among these other buildings because of the weathered and outdated concrete panels. The existing building reflected a boring, dismal façade that clearly showed its 1980’s construction date. The previous architectural aesthetics did not align with the high quality, innovative, and fresh vision of Kaiser Permanente in the healthcare industry. As a company, Kaiser Permanente is trying to change the image of healthcare but incorporating an all-in-one medical facility for members all under one roof. In order to mimic this vision architecturally, the curtain wall depicts an integrated and flowing façade to show this all-in-one center idea.

Height is also an aspect that can be achieved more effectively with a curtain wall then with the precast panels. The repetitive metal vertical lines of the curtain wall give the appearance of height and longitudinal shape. Soaring, vertical buildings that stand proud are associated with successful companies, which is the ultimate goal of Kaiser Tysons and any company. By decreasing the emphasis on horizontal banding around the building and increasing the amount of vertical lines, the curtain wall offers an open and taller design then the previous precast panels did. The vertical and horizontal mullions of the curtain wall were kept thin for this design so that the glass could be the main component. The 3 foot horizontal metal spandrels accent the latitudinal aspect that the building also has just enough to not overpower the verticalness.

Recommendation and Conclusion

After analyzing the various aspects of implementing a curtain wall system to replace the existing precast panels and glazing, many positive results were found.

First it was found after a cost evaluation that the overall price difference between the original scope of work of keeping the precast panels versus the proposed removal of the precast panels and installation of curtain wall system was approximately a $402,120 increase. This would mean the owner would have to put forth more money in order to implement the curtain wall system although there are benefits to outweigh this cost.

After a schedule analysis, it was found that this activity could occur before the building starts construction due to its vacancy. This would mean that there would be no delay of other trades or increase in project duration.

Another benefit of the curtain wall is ease of installation, better water infiltration protection, improved airtightness, and a longer façade life. In addition to these, an architectural breadth was done to witness the aesthetic benefits a curtain wall would offer versus the precast panels. It was found that a modern and light inviting façade would dramatically enhance the building aesthetics and interior atmosphere.

Considering all of these benefits, it is highly recommended that the owner spend the extra cost associated with implementing a curtain wall system in order to experience the many benefits it offers.

Analysis 3: Replacement of temporary lights from Fluorescent to LED

Problem Identification

A potential problem of the Kaiser MOB project is the lack of sustainable features that were incorporated into the design. With the extensive amount of medical equipment and high demand for energy, the maintenance costs and energy consumption of this building can result in staggering numbers. The lifecycle costs and carbon footprint of the building can potentially be a problem in the future if not addressed during design. As discussed during PACE as a critical industry issue, sustainability is becoming a popular topic and opportunities are increasing. Though sustainable features tend to demand a high upfront cost, the future benefits over the course of the building are rewarding when considering lifecycle costs. Also, in order to ensure this building has a long lifecycle, it needs to stay current with the industry standards. This means that in order to ensure a timeless building design, the Kaiser Tysons Project needs to explore further sustainable practices.

Background Research

- Conversed with a representative for the LED temporary light product in California to further understand the system. The representative was more than willing to offer research, product data and case studies for this product. Consistent contact will occur throughout the development of this analysis for further insight.

Image2: LED Temporary Light

Research Goal and Potential Solution

The goal of this research is to address the lack of sustainable features and the high energy demand of the building systems. This will be addressed by switching all temporary lights from fluorescent to energy saving LED lights.

In order to reach this goal, the potential LED energy savings system that this project began to utilize on a small scale will be applied to the entire building. The majority of the temporary lighting used in the building was the typical fluorescent lighting. The only exception was on the first floor which had a single circuit of 15 temporary LED lights. These LED temporary lights are a new product that use a lot less energy and could potentially lead to cost savings versus typical fluorescent lights. The small study was started on this system by simply tracking the energy consumption of the fluorescent versus LED system. For this analysis and breadth topic option (detailed further in Appendix A), the study is going to encompass the whole building utilizing LED lights. The amount of energy that can be saved during the construction timeframe just by converting from fluorescent to LED will be researched. Also, cost analysis for this product will be explored by finding the payback period as well as considering the initial upfront cost versus the money saved from energy savings. These costs can be compared to the standard fluorescent temporary light system to understand the magnitude of savings and benefits incurred.

It is important to note that though this solution may present positive results for minimizing energy used for temporarily lighting, the expensive reality of the initial cost of the lights will still need to be considered. After the analysis is conducted, a comparison will be explored to understand the practicality of utilizing these lights.

Methodology

- Compile research already collected about LED product

- Speak with LED light representative about analysis and his suggestions.
- Research the quantity of fluorescent lights and LED lights that the entire building needs in order to meet temporary lighting requirements
- Find the initial cost, payback period, energy cost and energy consumption associated with fluorescent temporary lights for the entire building
- Find the initial cost, payback period, energy cost and energy consumption associated with LED temporary lights for the entire building based on the data of the small case study results.
- Compare all cost and energy data of fluorescent versus LED lights
- Summarize conclusions of results and decide if LED lights are viable solution

Resources and tools to be used

- Daniel Lax, Clear-Vu Lighting
- AE Faculty
- Kaiser Permanente Project team
- Relevant publications
- Industry members

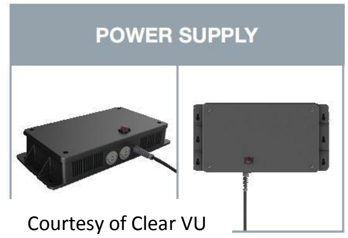
Expected Outcome

This analysis is expected to show the potential energy savings and long term cost benefits of LED temporary lights instead of fluorescent lights for the Kaiser project. This analysis could further prove that LED temporary lights are a great opportunity for Kaiser Permanente to start using this product on all their projects and decrease their energy costs. Ideally, it could become a part of a new industry trend to explore better ways to sustain the building during the construction process through temporary lighting.

Research

****Please refer to Appendix G for more information*

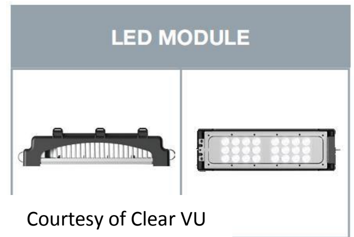
Components of the Flex SLS System



Courtesy of Clear VU

Power Supply

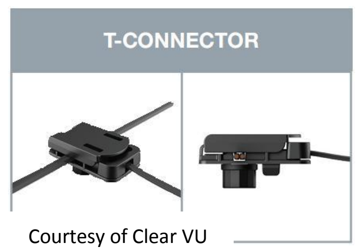
- 450W transformer accepts 110-265VAC input and outputs 24VDC to energizes up to 12 modules on a single bus line
- Can utilize 2 simultaneous bus lines



Courtesy of Clear VU

LED Module

•Each module produces 2000 “focused” lumens directed at the target area, delivering approximately 8 fc @ 15 ft. spacing on center. 10 ft. mounting height.
•Lumen Maintenance: 70% at 50,000 hours
•Different configurations (e.g. 2-module low bay) and mounting options available

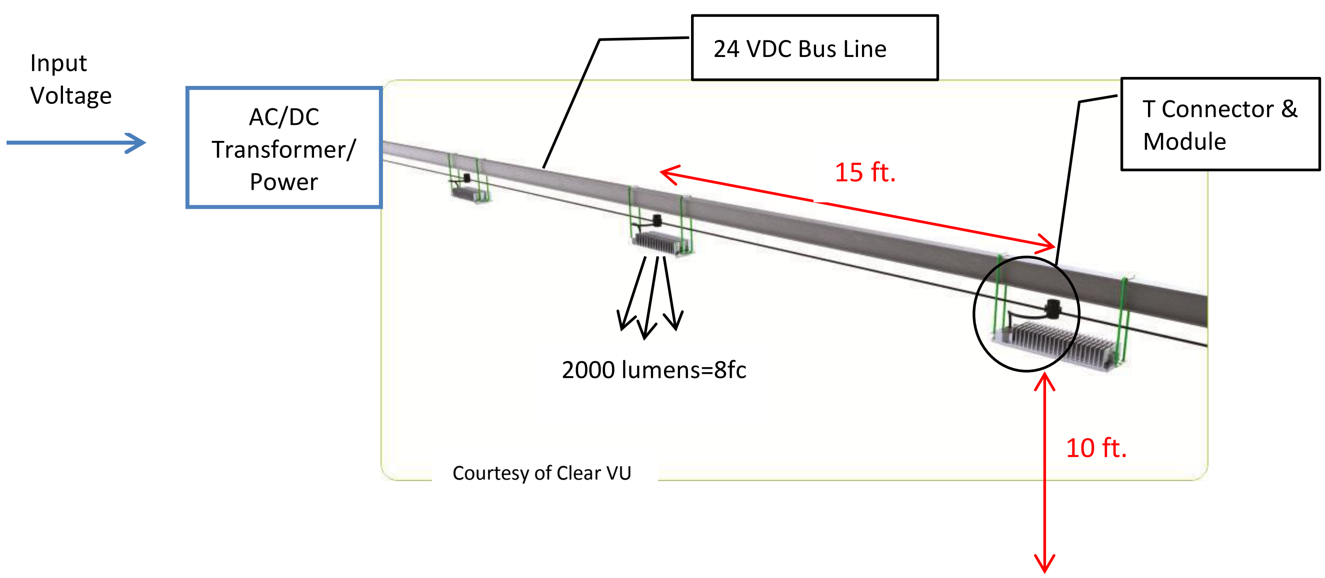


Courtesy of Clear VU

T-Connector & 24VDC Bus Line

•Easy-to-use and quick-to-install T-Splice enables user defined spacing and reconfiguration
•125’ length 12 gauge wire standard or 300’ 10 gauge.

Schematic Representation of LED System



Courtesy of Clear VU

	LED	Incandescent	Metal Halide	Fluorescent
Durability	Solid State circuitry, not affected by vibration and impact. No filament, no glass to break	Easily damaged by vibration or impact causing failure	Easily damaged by vibration or impact causing failure	Easily damaged by vibration or impact causing failure
Lifetime	Minimum 50,000 hours at 70% lumen maintenance	50% failure rate at 2,000 hours for typical 75 Watt bulb	Depending on type of bulb, 10,000-15,000 hours is common	Depending on bulb typically 24,000 hours
Efficacy	Recent technology gains yield efficiencies up to 100 lm/W	Incandescent sources emit 15 lm/W. Light is also being emitted in the non-visible spectrum.	Metal halide sources emit in the 65+ lm/W range.	Fluorescent sources are about 48+ lm/W range.
Viewing Angle	LEDs are directional light sources. The light output has a 100 degree native spread, which is enhanced by optics to the task area. (FIGURE A)	Light is emitted in 360 degrees. Usable light is light emitted in the desired direction. Light emitted elsewhere is considered wasted light.	Light is emitted in 360 degrees. Usable light is light emitted in the desired direction. Light emitted elsewhere is considered wasted light.	Light is emitted in 360 degrees. Usable light is light emitted in the desired direction. Light emitted elsewhere is considered wasted light. (FIGURE B)

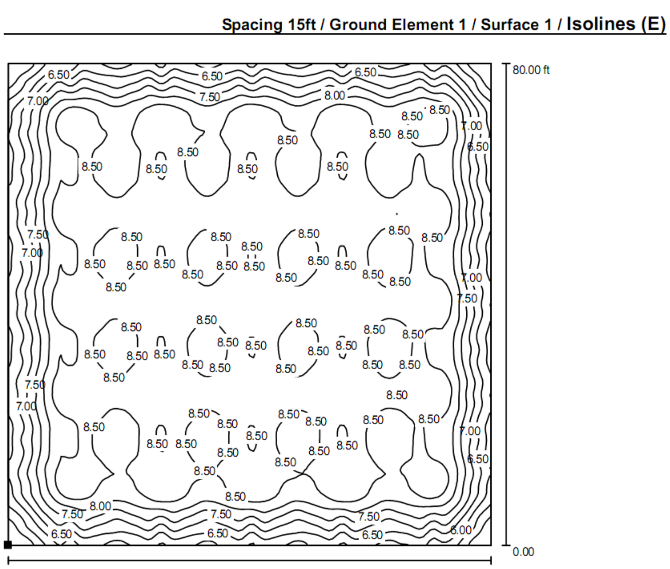


FIGURE A: Photometric Graph- Flex LED System proposed for the Kaiser Tysons Project

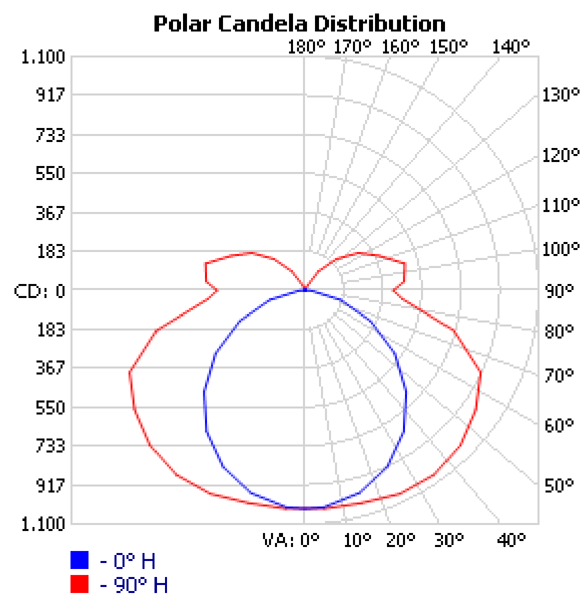


FIGURE B: Photometric Graph-F32T8 Linear Fluorescent, 2 lamps, 2900 lumens/lamp used on the Kaiser Tysons Project

Kaiser Tysons Power Comparison Analysis

****Please refer to Appendix G for further information*

Another way in which the Flex SLS LED system compares to other temporary lighting systems is with the amount of power it consumes. In order to figure out an estimate of the amount of power consumed by each system over the project duration, calculations were performed as seen below.

Project duration= 13months
30days /month*24 hours*13months= 9360hrs of illumination

The 9360 hrs. of illumination is true for Incandescent, Metal Halide and Fluorescent since they run 24 hrs. a day at 100% power. In other words, there is not an option to dim these lights at night when work complete for the day. The Flex LED system comes with a dimming option in order to save additional power by turning the lights to 50% of their power at night. In order to remain conservative in this analysis this dimming option will not be incorporated.

In order to obtain power consumption for the project the typical power consumption of temporary lighting of a 250,000 SF building was used. This is acceptable for this analysis since the Kaiser Tysons project is also 250,000 SF.

Table 1

	Incandescent	Metal Halide	Compact Fl.	Flex LED
Power Consumption	246,580 W	119,340 W	104, 800 W	16,764 W

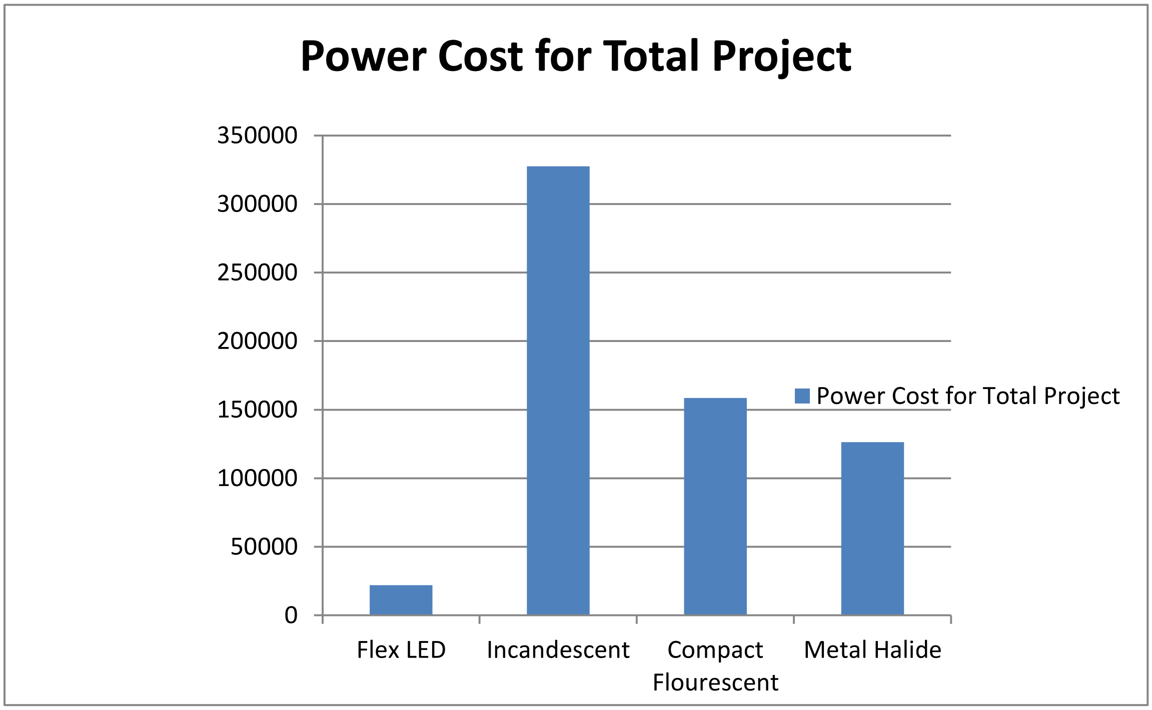
As seen in TABLE 1, the compact fluorescent lights use 6 times the amount of Wattage that the Flex LED system uses. If Kaiser Tysons were to switch from the compact fluorescent temporary lighting to the Flex LED then 88,036 Watts could be saved over the duration of the project.

In order to better understand the impact of the power difference between the systems, typical cost per kWh can be incorporated. Considering the location of McLean VA, a typical electricity cost was found to be $.14/kWh. By performing the calculation below, an electricity cost is estimated for each system.

Hours of illumination * kW * $.14/kWh = Total Electricity Cost for the Project Duration

Table 2

	Incandescent	Metal Halide	Compact Fl.	Flex LED
Project Duration Electricity Cost	$327, 000	$158, 500	$139, 200	$22,000



Graph E- Power Cost 13 month duration

As evidenced by the table 2 and graph E above, the other systems electricity costs greatly surpass the Flex LED electricity cost. This is mainly due to the power supply step down transformer box that the FLEX SLS utilizes, which decreases the voltage through the low voltage bus lines.

Kaiser Tysons Cost Comparison Analysis

A detailed component cost comparison was performed to further analyze the Flex LED system to the fluorescent system used at Kaiser Tysons and other typical temporary lighting systems. Not only does power output and electricity cost need to be considered when comparing systems, but also the initial cost, maintenance cost, and cost for future projects if the system is reused.

The initial step was to determine the general temporary lighting information for the project to determine the quantity of lighting each system would require. In order to meet the United States Occupational Health and Safety Administration (OSHA) requirements, at least 5 foot-candles on the floor throughout the building is necessary while work is going on. This information is summarized in tables 3 & 4 below. For calculations and assumptions for this information, refer to **APPENDIX G**.

Table 3

General Project Information		Units
Space to Illuminate	250,000	Sq. Ft
Number of Floors of this Type	1	
Ceiling Height	12	Ft
Desired Illumination on Floor	5	Fc

Table 4

FLEX SLS LED System		Units
LED Modules per Kit	15	lights
Wire Length	270	Ft
Light Module Spacing Ft	15	
Light Module Coverage Sq. Ft	289	
Kits Needed	58	
LED Modules Needed	870	
LED Modules Per 1000 Sq. Ft	3.46	
Unit Power	27.2	watts
PS efficiency	86%	percent
Incandescent		
Lights per 1000 Sq. Ft	10	lights
Unit Power	100	watts
PS efficiency	100%	percent
Metal Halide		
Lights per 1000 Sq. Ft	1.11	lights
Unit Power	400	watts
PS efficiency	91%	percent
Compact Fluorescent		
Lights per 1000 Sq. Ft	10	lights
Unit Power	34	watts
PS efficiency	75%	percent

Table 5

Breakdown of Total Cost per system (13 month duration)				
Total Cost Breakdown	Flex LED	Incandescent	Metal Halide	Compact Fluorescent
Component	155,034	43,750	37,500	43,750
Install/uninstall	21,829	37,500	62,500	37,500
Maintenance	30,469	153,563	82,875	120,335
Power	21,968	327,600	158,545	126,329
Total	**198,832**	**562,413**	**341,420**	**325,314**

The information for each system above was taken and used to create a breakdown of each system into its cost components for a realistic comparison. The table 5 shows the 4 cost breakdown categories as: component cost, install/uninstall cost, maintenance cost and power cost, which was calculated previously. The detailed information used to calculate these Total project costs can be found in APPENDIX G. It is important to note that the costs below are specifically for the total cost for the Kaiser Tysons project with duration of 13 months.

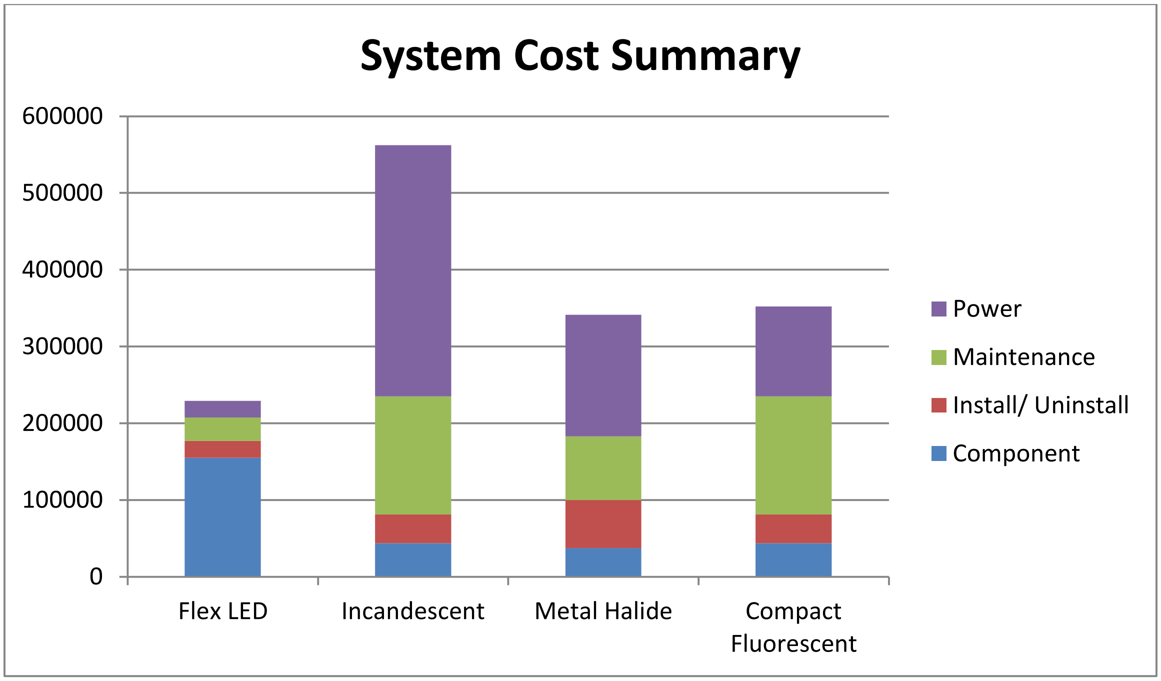


Figure 7

As seen in the Table 5 and visual representation of these costs in FIGURE 7, the initial component cost for the FLEX LED system surpasses the other three systems. In particular, comparing the initial cost for the FLEX versus Fluorescent lighting used at Kaiser, there is about a $100,000 difference. Although, this component cost for the FLEX includes modules, T-connector, bus-line and power supply. Although this cost is a high expense to initially pay, through further upcoming analysis in second project use and the electrical breadth, this cost can be justified.

The install/ uninstall cost for the systems is not a dramatic difference although there is still significant cost savings if the FLEX is chosen over the original compact fluorescent used. Due to the kit that the FLEX system comes in, installation is much quicker compared to the other systems. The main reason is due to the T-connector equipment that is used to hook to the bus-line and modules with a simple clip in. This can save a sufficient amount of time during installation, especially since all the kits are each designated 15 modules per stringer. Incandescent, metal halide and fluorescent all require separate stringer to be hung to connect all the lights which increases labor cost for the electrician. Not only is decreased labor time a benefit of the FLEX but also safety for the electrician. Since the LED power source is separate from the low voltage wiring and modules, this makes for a safer jobsite. The fixtures simply clip on and off for easy relocation with less safety hazards.

Considering the maintenance cost for each system, the FLEX is half to a third less than the cost of the other systems. Maintenance time and cost is especially important to consider for temporary lighting because a labor force has to be taken away from building construction to upkeep the lighting systems. The incandescent system and compact fluorescent in particular have a very high maintenance cost due to the quality of the system. Incandescent bulbs and fluorescent bulbs break very easily, so the frequency of changing them is high. For example, the incandescent/ compact fluorescent bulb changing hours per day for a 250,000 SF building is around 4 hours while the FLEX system is approx. 7 minutes. On the Kaiser Tysons project, there was a dedicated electrician solely responsible for changing fluorescent bulbs and replacing the fixtures that broke. Assuming a labor cost of $75 per hour labor changing fee, this can be a large sum of money over 13 month duration. Although, the cost of the incandescent bulbs is much cheaper than an LED module, the difference is that the LED modules virtually cannot break. They are able to be dropped from ten feet and remain intact and working. This is very beneficial for re-use on future projects.

Lastly, as previously calculated, the power output and electricity cost for the FLEX is one of the main benefits the system offers. Whether the owner, GC, or another party is paying the electric bill, it saves them money by using the FLEX. The light emitted by the FLEX is spread more efficiently compared to the fluorescent lights used on the project. For instance, the actual light that contributes to the task lighting is only about 34 watts for the fluorescent lights. This is due to the light emitting to the sides instead of contributing to the direct lighting. For the Kaiser Tysons project, the GC was responsible for the temporary lighting electric bill which means they could have saved around $100,000 on electric by switching from the fluorescent lighting to the FLEX system. Aside from cost, the low energy consumption is a great sustainable initiative in order to increase LEED points for the site and project.

Another component of temporary lighting to consider for a cost comparison is re-using the systems for future projects. Since the FLEX system initial upfront cost is about $100,000 more than the other systems, it can be a hard cost to endure. Although, the benefit of the FLEX LED is that after spending this money initially, the system can be re-used on future projects because of the high durability. The other systems are rarely re-used on future projects because they are damaged by the end of the first project. This means that the system component will have to be re-bought for every successive project unlike the FLEX LED. A cost comparison is summarized in the Table 6 and Figure 8 below to show the first project versus second project use of each system. It is important to note the project size of 250,000 SF building and duration of 13 months is assumed for the second project as well. Detailed information such as the percent lost for each system from project to project can be found in APPENDIX G.

% Lost on Second Project				Orig. Total Project Cost vs. 2nd Total Project Cost	
Flex: Module loss %	20	Percent	*	$198,832	$74,559
Flex: Power supply loss %	10	Percent	*		
Flex: Wire loss %	100	Percent	*		
Incandescent loss %	50	Percent	*	$562,413	$540,538
Metal halide loss%	50	Percent	*	$341,420	$322,670
Compact Fluorescent loss%	50	Percent	*	$352,074	$330,199

Table 6

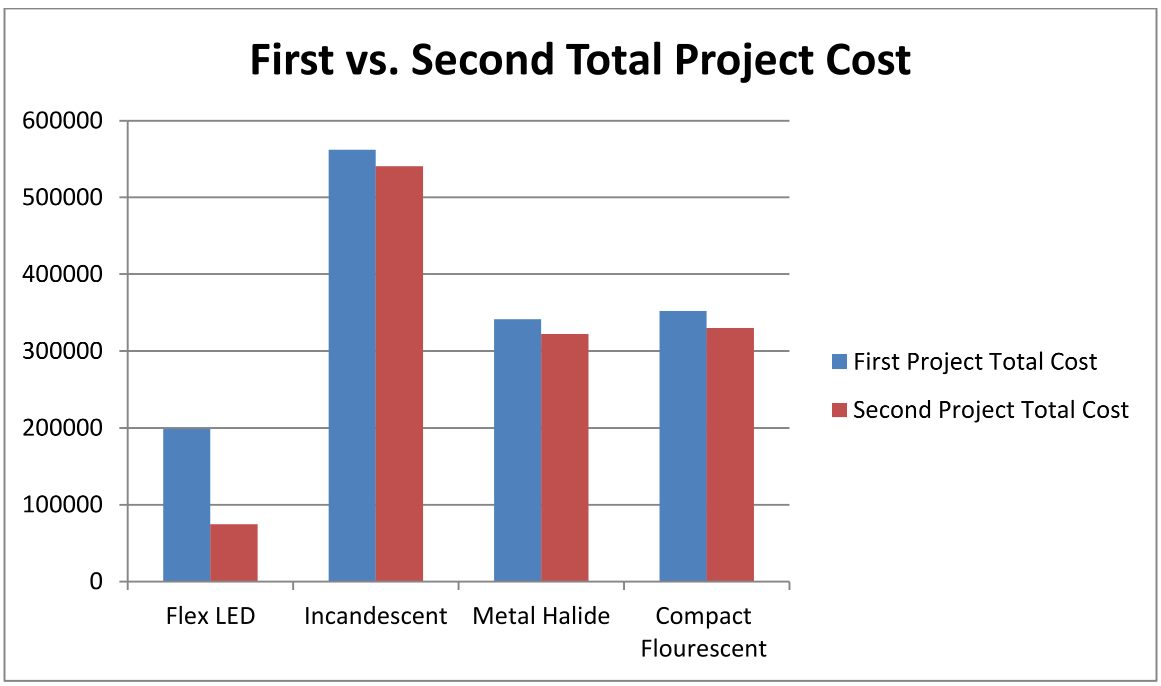


Figure 8

It can be concluded from the first to second project cost comparison that the FLEX system has a significant decrease in cost from the first to second project. This is because the component cost was already paid for in the first project and the system is completely reusable in the second project. The other systems decrease slightly from first to second cost because the system is assumed to be 50% loss. When considering five successive projects in a row, this cost savings adds up greatly for the FLEX. Considerations such as wire loss due to construction damage were taken into account for the FLEX LED as well as the other three systems to remain conservative in the analysis. It can be seen below in FIGURE 9, the cumulative cost after 5 years for each system. With a life span of about 50,000 hours, the FLEX system can withstand reuse for 5.3 consecutive projects that require 9360 hours (13 month duration).

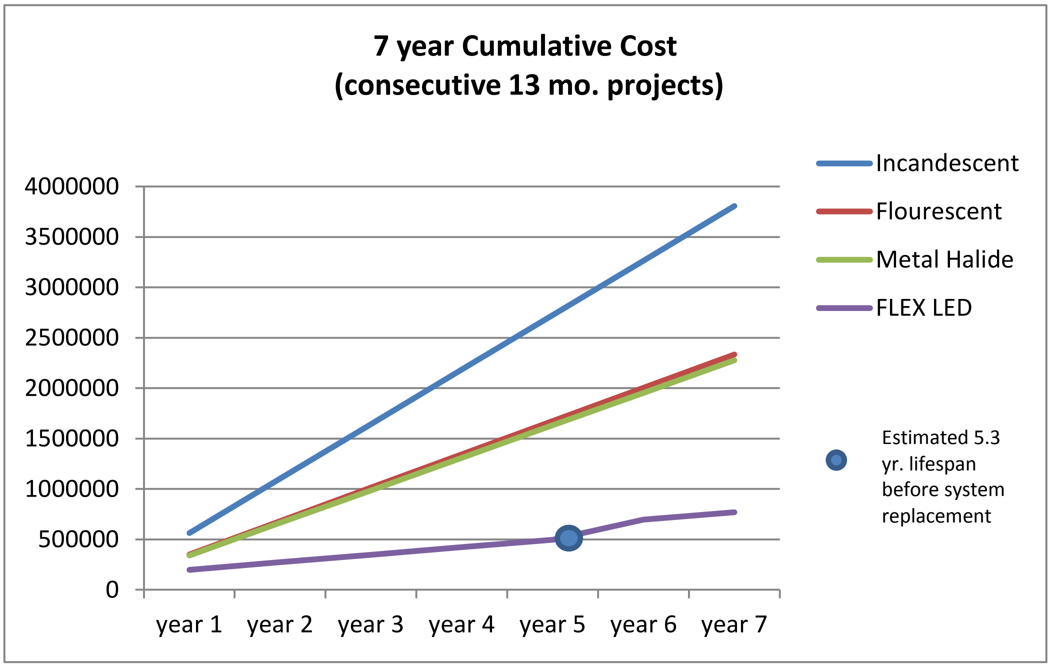


Figure 9

If the General contractor or owner were to purchase the FLEX LED system, it can be seen that it would be a wise investment for use on future projects. Also, in the event that the general contractor was responsible for the electricity cost, they would have a competitive advantage over other general contractors trying to win the job. They could potentially have their bid $200,000-$300,000 lower than other companies just because of the savings of owning the FLEX system.

Electrical Breadth: Kaiser Tysons Power Plan

Another component to consider for the temporary lighting system is the difference in the power plan and layout required for each system. The connection and layout of each system to the power supply can pose positive or negative cost effects. The electrical breadth further explores the fluorescent temporary lighting system used on Kaiser Tysons and compares it to the power plan if the FLEX LED were to be used. By designing each system to this specific project, a better comparison can be made for the feasibility of connection and additional cost that each system would pose for connection.

The temporary power for the project was provided by the existing equipment and power supply from Dominion power. The 480 V power source came into the building from the north side and fed into the existing switchgear located in the basement. The switchgear connected 208/120 V to the main 600 Amp temporary panel via the old fire pump connection. The temporary panel then had two feeders: one that fed to the secondary panel on the first floor dedicated to the basement, lower level and first floor.

The other fed the secondary panel on the second floor dedicated to the second, third, fourth, fifth and the roof. Each floor was attached to their dedicated secondary panel via 120 V, 12 gauge wires. At this point, the Flex LED and fluorescent systems share the same setup which can be seen in the Schematic Power representation and typical power plan in APPENDIX G.

For the Flex LED system, there were approximately 4 circuits of 120V, 12 gauge wire needed to connect to 4 power supply boxes to feed the 8 kits needed per floor. Specific calculations for this can be found in APPENDIX G.

For the fluorescent system, according to the electrical contractor Truland, 20 foot spacing on center is needed for this system. Also, about 30 F32T8 fixtures can be dedicated to 1 circuit. It was found that on a typical floor of approximately 27,500 SF that about 70 fixtures are needed. This requires 3 circuits of 120 V, 12 gauge wires to string the 70 fixtures.

This differs from the FLEX because there is no need for the 12 gauge wire to string the modules together. The FLEX simply connects from the secondary panel box via the 120 Volt 12 gauge circuit to the power supply box included in the FLEX kit. The power supply is a step down transformer used to convert the 120 Volts to the 24 Volt bus-lines which then connects the modules. Essentially the FLEX system is already laid out and just needs to be hung because all the required wires, connectors, modules, and power supply are included.

It can be seen that the main difference between the connection and layout of the FLEX versus fluorescent system is the 12 gauge wire that is needed to connect the fluorescent lights and feed them back to the circuit. Though this may not seem like a large difference, when a cost and labor rate is paired with this information, it could lead to additional cost savings for the FLEX system.

Calculation of 12 gauge wire additional cost for Fluorescent:

7 strands at 180' long= 1260 Ft per floor
1 spool (250 ft) of 12 gauge portable cable, max 300 Volt= $300.
Need 6 spools per floor
6 spools X $300 X 7 floors= $12, 600

The conclusion from the Power Plan electrical breadth analysis is an additional **cost savings of $12,600** by using LED FLEX SLS versus Fluorescent Lighting.

Obstacles

With any new system introduced into the industry there are positives and negatives. It is clear that the LED FLEX SLS system provides the owner, general contractor and subcontractors many benefits. Although some of the main factors to consider when evaluating the FLEX system is what defers clients away from using them. These obstacles include upfront cost of the FLEX compared to other systems. The FLEX is almost three times the amount of other systems upfront component cost. Whether owners, general contractors or subcontractors are looking to buy the product, it is a hard first cost to endure. This is usually what clients see first and decide to go the safe route of Incandescent or fluorescent. If clients could see past the initial cost and look at the future cost information and benefits the upfront cost usually does not seem that difficult to pay.

Another obstacle is having the electrician buy into the system. Usually the owner or general contractor will purchase the FLEX system to save temporary electric costs and for re-use on future projects. This leaves the electrician having to adapt to a new temporary lighting system that is unfamiliar to laborers. Most electricians are veterans in their field and do not want to be bothered with learning new, innovative systems that require different techniques. Also, from a cost perspective they do not see power savings the FLEX offers because they are not paying the temporary electric. The installation and maintenance time is also less for the FLEX so they may see this as loss of profit versus the high maintenance charges acquired for incandescent or fluorescent lighting.

Kaiser Tysons Project LED vs. Fluorescent Analysis Summary:

Cost

- Reduces labor and maintenance cost of electrician because don't need to replace bulbs. Also, installation of the modular is simpler than normal temporary lights.
- Power savings cost for the GC or owner, whomever is paying electric
  - If GC: If they buy the system to reuse on projects, they can have their bid 200,000 to 300,000 dollars lower than other companies and win jobs.
  - If owner: They are happy because this will keep their electric bill down and save on labor costs for installation of this system.
- Cost Savings of $12,600 from power plan of fluorescent vs. LED system.

First project use cost LED= $198,832
First Project cost Fluorescent = $352,074 + $12,600(power plan)=$364,674
Total Savings for First Project cost using LED FLEX System=$165,842

Safety

- Less fire hazard from LED lights- this means the insurance cost goes down during construction.
- Compact fluorescent use mercury in them so they are not good for construction. People are uncomfortable/ scared with using these because of breakage. Cost for cleanup, safety, time etc.
- Metal Halide and incandescent both break very easily.

Sustainability

- LED System saves **88,036 Watts** of power versus Fluorescents for a 13 month duration project
- ½ million pounds of carbon dioxide saved
- If you wanted to be LEED credited- this is one of the simplest ways to do it.

Conclusions & Recommendation:

After analyzing the LED FLEX SLS system based on practicality, cost, and setup versus other popular temporary lighting systems, I highly recommend the owner tried this system for Kaiser Tysons Project. They require less maintenance, increased jobsite safety, ease of installation and major cost savings which makes them a legitimate option for temporary lighting.

Analysis 4: Utilize Green Roof on Exterior Terraces

Problem Identification

A potential problem for the Kaiser Permanente building is the lack of sustainable features that the building incorporates. Since it is an older building, the original design did not include sustainable features because they were not existent at that time. However, now that building sustainable features is becoming popular and is considered a critical industry issue, the lack of sustainability this project has is not sufficient. A client such as Kaiser that is becoming increasingly successful in the healthcare world needs a building that shows this. Due to the fact that this is a healthcare building, green features and increased lighting are aspects that could add value for the patients and owner.

Background research

- Exploration of the effect of nature and light on the healing process

Research Goal and Potential Solution

The goal of this analysis is to add value and sustainable features to the design of the building.

The potential solution involves incorporating green roofs on the existing exterior terraces and providing patient access to promote healing. The large terraces, as seen in Image 3, offer a great opportunity to utilize the open space for a unique sustainable feature. Since Kaiser Permanente believes that light and nature aids in the healing process, a green roof terrace would support their vision.

Image 3: Exterior Terraces

The different types of green roofs will be researched and compared to see which would apply best for a medical facility. Also, the cost for installation and upkeep could be compared to the cost of the renovation of the existing terraces. The cost of a green roof can potentially outweigh the amount of value added for the owner and its patients. Another benefit of the green roof terraces is the load associated with the green roof will not affect the entire structure throughout the building. The impacts of the green roof terraces to the structural support of the building will be acknowledged to ensure this is a viable option. Maintenance costs will be determined based on the type of green roof chosen and its requirements for upkeep.

Methodology

- Research benefits of light and nature on healing process
- Explore advantages of green roofs to building value

- Research types of green roofs and loads associated with each type
- Find Costs associated with installation and maintenance by speaking with manufacturers/ subcontractors
- Compare value added versus cost of installation and maintenance

Resources and tools

- Green roof manufacturers/ subcontractors
- Industry members
- Relevant publications

Expected Outcome

Once the green roof feature is installed to the exterior terraces and analyzed, it is anticipated that this will produce positive results. The benefits of this addition are likely to improve the sustainability of the building, offer value at a reasonable cost, and improve the well-being of the occupants.

Research: Green Roof Impact on Patient Healing Process

In order to adequately compare the benefits that a green roof terrace would offer versus the cost of the system, research was conducted to compile some necessary information for the decision.

There are a variety of benefits of a green roof system such as controlling storm water runoff, improving water quality, mitigating urban heat-island effects, and prolonging the service life of roofing materials. However, for this analysis the advantages researched will specifically pertain to wellbeing and the healing process of patients. Since Kaiser Permanente is a medical facility, patient healing processes are extremely important to the reputation of the facility. This means that positive results of green roof exposure may act as a good incentive to the owner in exchange for the added cost. Not only can green roofs result in positive health results for the patient but also all occupants of the building.

During research it was found that there are many healthcare projects across the U.S. that utilized green roofs for healing process reasons. In particular, the St. Elizabeth Hospital Cancer Center in Wisconsin executed a green roof for health benefits. The roof of the St. Elizabeth Cancer Center was converted into a green roof area that was viewable to patients staying or receiving their cancer treatments at the Center. It was designed to promote healing as well as be environmentally conscious. The vice president of performance excellence, Gary Kusnierz of Affinity Health comments on the green roof project, “In addition to being environmentally friendly, our green roof actually aids in the healing process…Giving (our patients) the most soothing and healing environment possible is just one way we deliver our promise” (“St. Elizabeth”). In addition to creating a comforting and peaceful environment, the green roof is meant to help with energy savings and in-turn will reduce cooling costs.

Conducting further research on green roofs resulted in additional sources stating positive healing effects and additional positive health related effects. With regard to the healing process, it was found that studies show post-operative patients with a view of nature had a quicker recovery process, needed less medication and received less unfavorable assessments then those that did not. This evidence shows that even the slightest exposure to greenery such as viewing it can have positive results. When taken to the next level of giving patients the opportunity to be surrounded by that environment with a green roof, the effects should show further benefits.

Other health advantages found were that green roofs can reduce the transmission of noise. It was stated that for extensive green roofs the sound is reduced by about 40 decibels and intensive can reduce sound by 46-60 decibels. The ability for green roofs to have good noise attenuation helps significantly in a medical facility where noise level needs to be kept to a minimum.

Another advantage found was that green roofs can reduce stress. Since leisurely activities involving nature is found to be serene, it can help people deal with their stress. Especially in a high stress environment such as a hospital, having access to nature via a green roof can help patients, staff, and families reduce anxiety.

A green roof not only offers health benefits to the patients but also the workforce. It was found that increased productivity resulted from views of nature and exposure to it. A green roof could help lead to the staff experiencing less headaches or other ailments. Simply a natural view in a place of employment contributes to job satisfaction which helps productivity. This also leads to a similar advantage of decreased employee sick days. In correspondence with increased job satisfaction, less stress, and decreased ailments, the number of sick days can actually decrease with views of green areas. In a hospital environment, employee sickness is something that needs to be avoided in order to remain productive for sick patients as well as reducing the threat of further sickness to patients.

Application of Green Roof System to Kaiser Tysons Project

After researching that green roofs do in fact have positive health benefits, the next step was to choose the best type of green roof for this project. The options of green roofs are extensive versus intensive. It was found in Table 7 below the main differences between intensive versus extensive green roofs.

Table 7

Intensive	Extensive
Irrigation System Required/ Regular Maintenance	No Irrigation system required/ Less Maintenance
Typically $15-$25 per sf.	Typically $8-$20 per sf.
80-150 lbs/ sf.	18-34 lbs/ sf.
Require 6”-36” growing depth	Require 3”-4” growing depth
Wide variety of plants & shrubs	Limited to sedums & grass
Usually chosen for aesthetics, recreational, sporting use	Usually chosen for urban heat island effect

The weight of each type of green roof first needs to be considered in order to ensure that the exterior terraces are able to hold the load. The exterior terraces of the building are deemed assembly areas (A-3), so the loads associated with those spaces need to be met. The requirements for the concrete on the exterior terraces is a 3500 psi and 150 pcf weight which is allowable with typical green roof concrete requirements of at least 2500 psi and 115 pcf weight. The construction drawings state that the corresponding loads for the building assembly areas are:

Dead Load (Concrete Slab) = 150 psf
Live Load for Assembly Areas (Non Reducible) = 100 psf
Snow Load= 18 psf
Total Load= 268 psf

Since the exterior terraces do not carry additional floors above them because they are cantilevered, only the dead load of the concrete slab of the terraces was considered. The total load is 268 psf. According to typical structural requirements, a 5% change to the initial total load is allowable although any percentage higher would need to consider further structural analysis. The typical weight of a saturated extensive roof is 18 psf and a saturated intensive roof is about 30 psf. When considering these loads in comparison to the structural load, Table 8 below shows the results.

Table 8

Structural Load + Green Roof Load	Percent Change
Extensive: 268 psf + 18 psf= 286 psf	6.6%
Intensive: 268 psf + 30 psf= 298 psf	11.1%

When the percent change of each type of green roof is taken into account, it can be seen that the percent change of both types exceed 5%. This means that further structural calculation would need to be performed in order to ensure the exterior terraces are stable enough to hold the green roof. Since the purpose of this analysis is not to prove in depth structural calculations for a green roof system, they will not be detailed in this report. However it is acknowledged that both systems would need to undergo considerations from a structural engineer to ensure stability.

In order to proceed with this analysis of the benefits of a green roof for this project, further research was conducted for a lighter weight extensive green roof. It was found that instead of using a typical extensive roof, that the company LiveRoof developed modularized green roofs. A modularized green roof is much quicker installation, requires less maintenance, is lighter weight, and creates a monolithic look. The LiveRoof offers a variety of different types of systems in order to fit the project.

It was found that the LiveRoof LITE System is a lightweight extensive green roof that is great for renovation projects because it can meet structural limitations of the building. The saturated weight of this system is about 15 lbs/sf. When re-evaluating the previous structural calculation to account for the decrease from 18lbs/sf to 15 lbs/sf the following can be seen in Table 9:

Table 9

Structural Load + LiveRoof Load	Percent Change
Extensive: 268 psf + 15 psf= 283 psf	5%

The decrease from the previous 6.5% to 5% shows that the LiveRoof is a more conservative structural option since it meets the 5% allowable additional load. From a safety and design standpoint, this option would offer greater reassurance that the structural characteristics of the exterior terraces would adequately support the LiveRoof. The LiveRoof LITE system will be the chosen system for the Kaiser Tysons project.

The next necessary step once the extensive green roof is chosen is to discover the components of the system. Seen in TABLE 10 and Figure 10 below are the components and typical layers of the extensive roof.

Table 10

LiveRoof Lite
Soil: Appx. 2 1/2" deep.
Module Size: 1' x 2' x 1 7/8"
Saturated Weight: Appx. 15 lbs/sf saturated and vegetated. **Dry Weight**: Appx. 12 lbs/sf (confirm with your local licensed grower)
Merits: Ideal for retrofit projects where load limitations exist.
Plants: Succulent ground covers, water conserving accent plants, and hardy spring blooming bulbs.

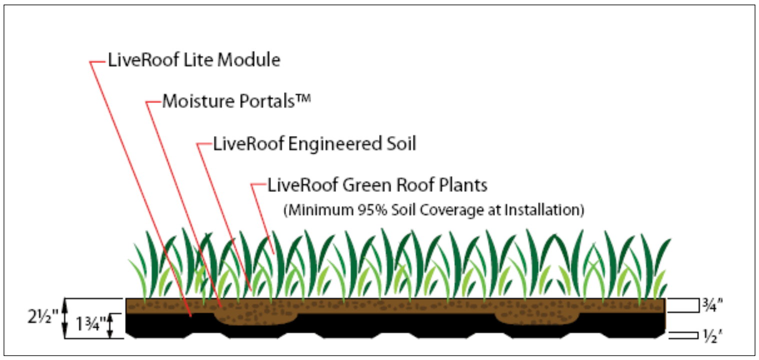


Figure 10

The next step is calculating the 3 exterior terrace areas to cover with green roof.

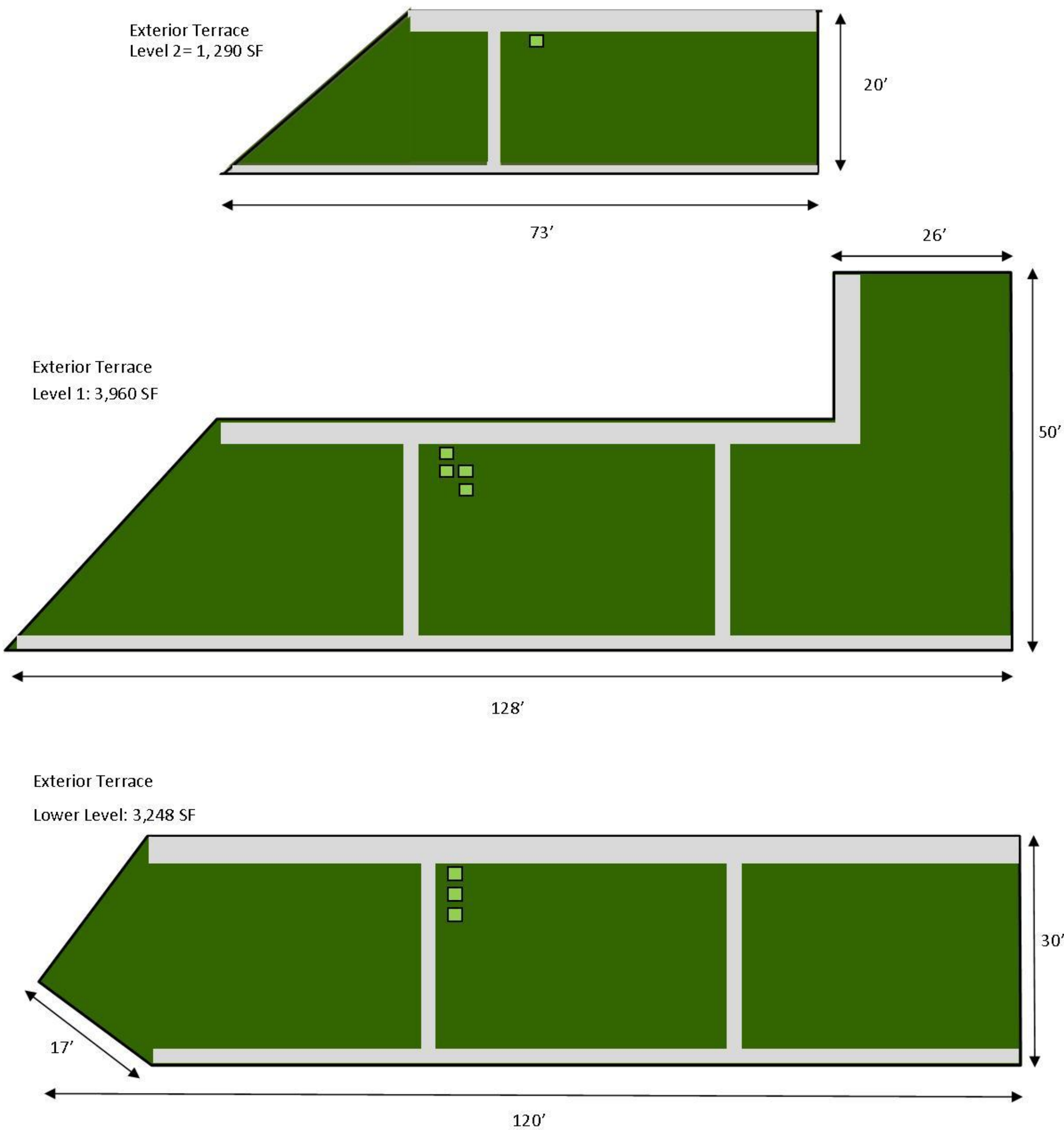
Lower Level Terrace: 3,248 SF
First Level Terrace: 3,960 SF
Second Level Terrace: 1,290 SF

Total: 8,500 SF
Approx. Modules needed: 2,125 modules

Design layout

The following design layout for exterior terraces on Lower Level, first, and second levels can be seen below in FIGURE 11. The dark green area represents where the LiveRoof modules will be placed simultaneously next to each other. The small, light green squares represent one 2’ x 2’ module to show the size ratio of the module to the terrace square footage. A great benefit of the LiveRoof system is that there will be no seams between the modules so the grid pattern that they will be installed in will result in a natural, monolithic green roof. Installing the concrete walking pavers, as seen in grey in FIGURE 11 will allow accessibility to the terraces for occupants of the building for both recreational purposes and maintenance tasks. The view to all the terraces from the interior of the building is planned to be an open, glass system, which will further enhance the natural indoor to outdoor experience.

Figure 11



Exterior Terrace
Level 2= 1, 290 SF
20'
73'
26'
Exterior Terrace
Level 1: 3,960 SF
50'
128'
Exterior Terrace
Lower Level: 3,248 SF
30'
17'
120'

Installation Procedure/ Schedule

***Please See **Appendix H** for detailed installation guide and system specifications.

As compared the built- in- place extensive green roof that was going to be used, the modular green roof offers greater benefits for installation time and process. Since the plants are already grown and mature in the module upon delivery, this takes out a lot of the labor required for the built- in- place roofs.

Also, since seasons in Mclean VA can reach a variety of extremities, the plants can be chosen to be wind and drought resistant. The modules will also allow flexibility for rearranging, rotating, and individual replacement.

The installation of the modular roof will be able to occur at any time of the year regardless of the climate because the plants are already developed and strong in their modules. This is a great benefit because the Kaiser Tysons Project can fit this activity into the schedule based on other work and not the weather.

The simple installation steps of the LiveRoof system can be seen below in Figure 12.

Figure 12 (courtesy of LiveRoof)

Step 1:
Insert the LiveRoof® Soil Elevator™ into LiveRoof® module.

Step 2
LiveRoof® module is filled to the top of Soil Elevator™ with LiveRoof® engineered growing medium.

STEP 3
LiveRoof® Plants are grown to maturity approximately 1 inch above the LiveRoof® module.

STEP 4
Installer sets LiveRoof® modules tightly in place on the roof within LiveRoof® recommended edge treatments.

STEP 5
LiveRoof® Soil Elevator™ is removed for a beautiful, seamless instantly mature green roof.

STEP 6
Water thoroughly to settle any loose growing medium and to get your LiveRoof® off to a great start.

The modular green roof installation will follow the above steps for the Kaiser Tysons Project along with a few additional steps. First, a waterproofing membrane will be installed on top of the existing concrete terraces because the modules require a roofing membrane (such as TPO) to act as the base.

While the waterproofing membrane is occurring, the modules will begin to be delivered to site ready for immediate installation. A lift will be used to transport the modules from the delivery palettes up to the terraces. A crane is usually needed for typical built-in-place green roofs although this is not necessary based on the weight of the LiveRoof Lite modules and the height of the terraces above ground. This will significantly increase efficiency because a lift is portable and able to be on site at any time. Furthermore a crane would require logistical concerns and also be much more expensive.

Installation will then proceed until the green roof modules are completely installed. After this will be installation of the pavers between the modules, and then final cleanup.

It is estimated that it would take approximately 2 days for waterproofing membrane installation on all three terraces. Another 4 days (about 1 min per module installation time) for module installation on all three terraces. Then walking paver installation would take 1 day and 1 day of cleanup would be allocated. This means roughly 8 days will be dedicated to this activity.

Since this modularized green roof requires minimal installation time, this activity will not affect the schedule or other activities. It can be incorporated into the schedule at a variety of times during the project. According to the Kaiser Tysons project scope there is no work taking place on the exterior terraces during the project duration. Therefore, this provides a great area to perform work without logistical concerns or schedule limitations. This is an excellent installation time considering the result the green roof has to the appearance of the terraces.

Cost Considerations

Due to the design flexibility of the LiveRoof system, the decreased installation time, and the all-in-one compact modules, it can actually lower the cost as compared to built-in-place. Typical extensive green roofs that are built layer upon layer can lead to greater costs because they require high labor costs, greater materials cost, and long term maintenance and irrigation system cost. The LiveRoof will not need an irrigation system nor will require significant maintenance. The LiveRoof has a longer life span before replacement then the built in place, which requires tearing up a large area of the system in order for replacement.

Based on information obtained from the LiveRoof Company, it would cost around $16/SF for an extensive modularized system on the Kaiser Tysons project. This cost includes installation, materials, etc. Considering the square footage of the exterior terraces the following price can be estimated:

8, 500 SF X $16/SF

= **$136,000**

When considering this cost to the owner versus the benefits the system will offer, this seems to be a viable solution. The implementation of the green roof will provide patients with a comforting environment and natural view to enhance the healing process. For Kaiser Permanente, a green roof terrace can help them to reach higher sustainability goals, improve building aesthetics and value, as well as give them an advantage in the industry. They will provide a nurturing atmosphere for their patients as well as a less stressful work environment for their employees. Looking at the grand scheme of the project, $136,000 is not a large amount of money compared to the project's numerous bulletins and change orders. If the cost was an issue, the activity is flexible and could be added later on if the owner decides to pursue this option. Also, not all three exterior terraces would have to undergo this modification if the cost is too steep for the owner.

According to the information provided on the LiveRoof website, Kaiser Permanente could see a payback period of about 14 years for this initial cost from the energy savings this green roof would provide. Since a green roof is a quick and cost effective way to be sustainable, it is an efficient way to increase LEED points for the project.

Conclusions/ Recommendations

Considering all of the benefits a green roof can offer, especially if the modularized LiveRoof system was used instead of built-in-place, it is a recommended option for the owner. Solely looking at the health benefits mentioned for patients and occupants of the building, green roof terraces would pay for themselves. Offering a positive experience for patients and aiding in their healing time can help Kaiser differentiate from other competitors in the market. Furthermore, the quick installation time, flexibility of design, sustainability benefits, and reasonable cost are all additional advantages of this modification. It is suggested for the owner to pursue this option further on the Kaiser Permanente Project.

Resources

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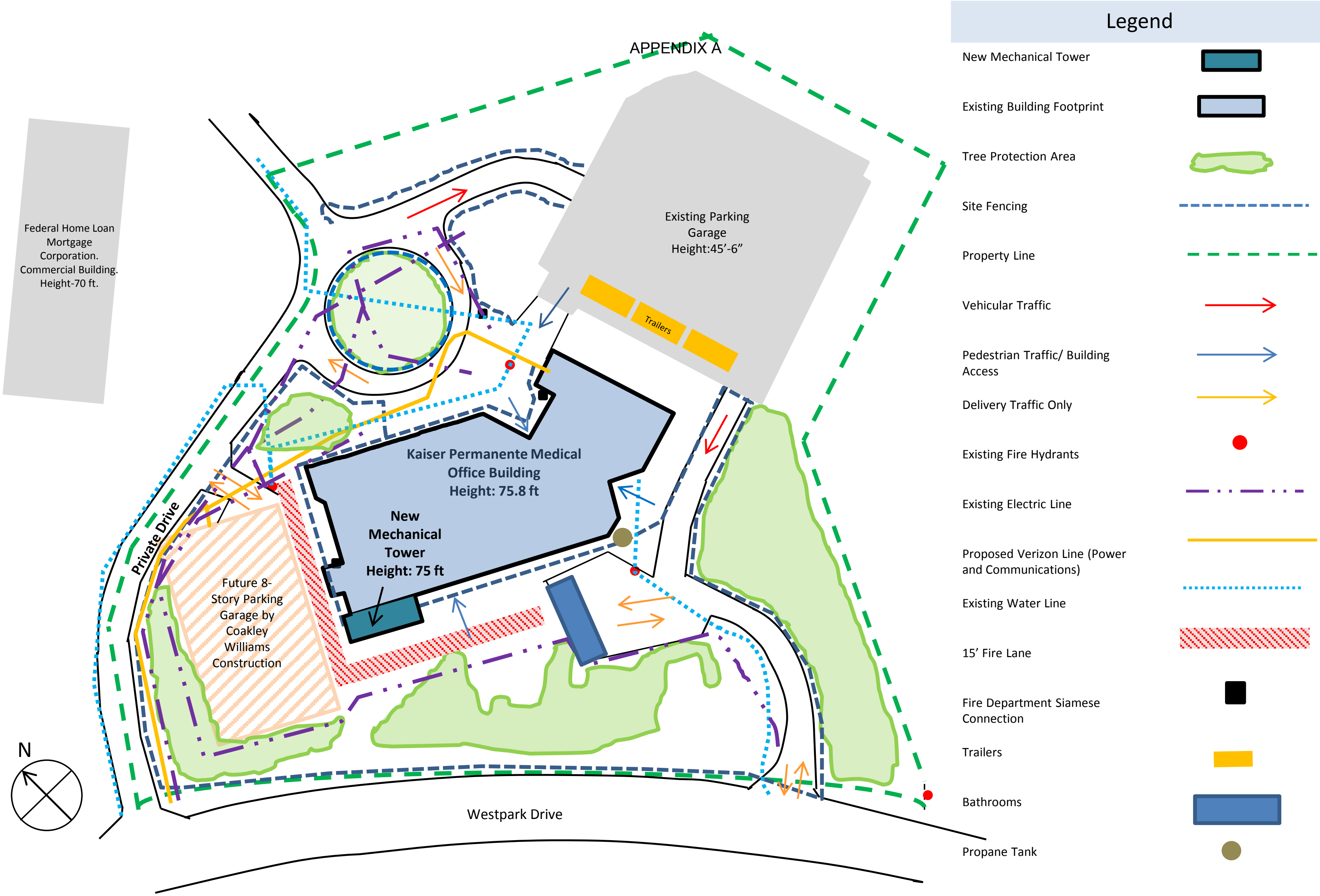
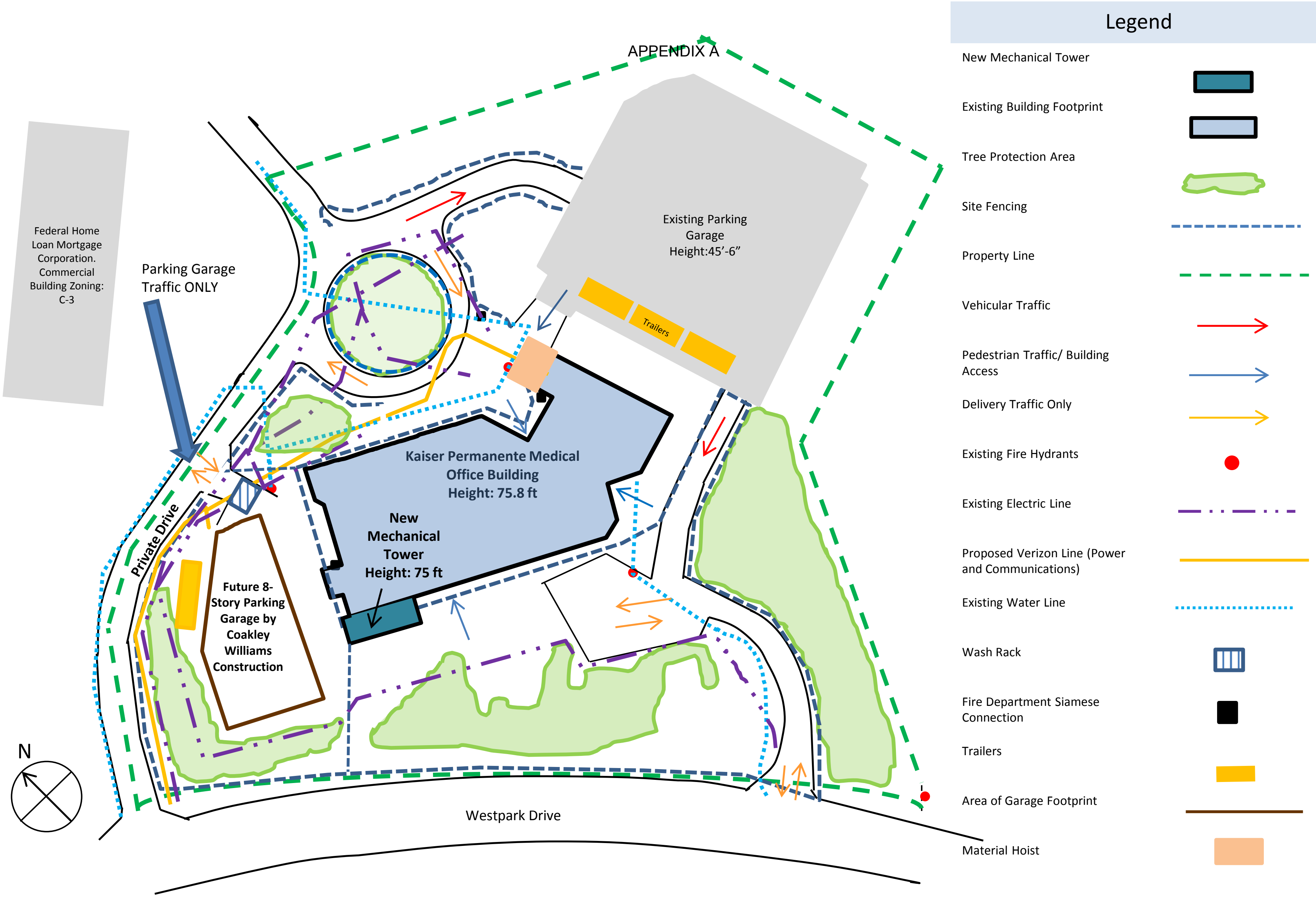
Kaiser Permanente Medical Office Building Project (2010-2012) Drawings , Specifications Sheets, and various other documents

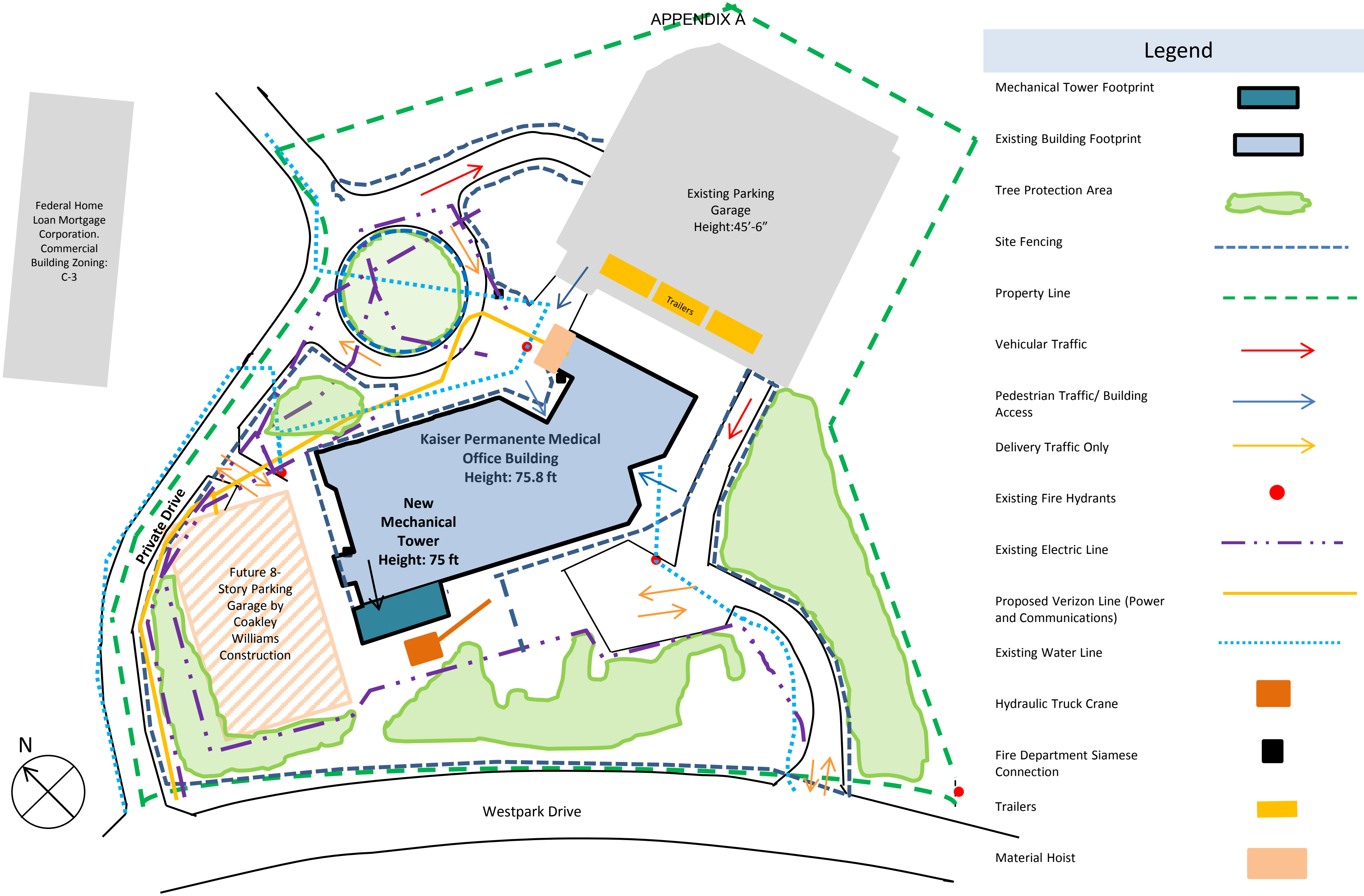
APPENDIX A



Kaiser Permanente – Medical Office Building	Existing Conditions Plan	Brooke Helgesen
		8.23.11

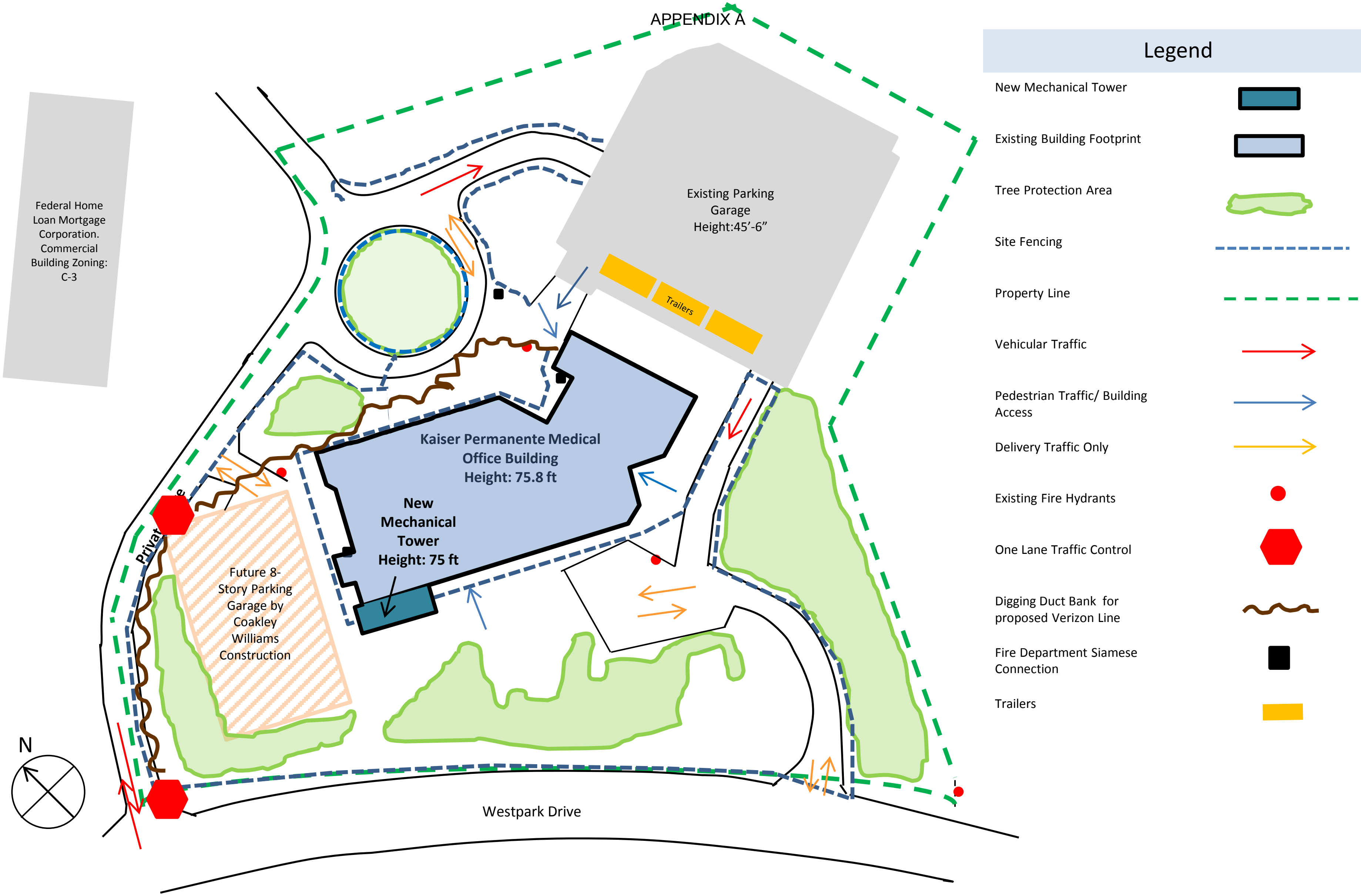


Kaiser Permanente – Medical Office Building	Site Plan- Excavation of Parking Garage	Brooke Helgesen 8.23.11



Kaiser Permanente – Medical Office Building	Site Plan- Mechanical Tower Erection	Brooke Helgesen 8.23.11

APPENDIX A



KAISER PERMANENTE – MEDICAL OFFICE BUILDING	SITE PLAN- VERIZON LINE DUCT BANK	BROOKE HELGESEN 8.23.11

APPENDIX B

Square Foot Cost Estimate Report

Estimate	**Kaiser Permanente-MOB**
Building Type:	**Hospital, 4-8 Story with Precast Concrete Panels With Exposed Aggregate / R/Conc. Frame**
Location:	**FAIRFAX, VA**
Count:	**6**
Height	**14**
Area	**241175**
Type:	**Union**
Included:	**Yes**
Release:	**Year 2010**
Square	**$190.52**
Cost:	**$45,947,500**

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per S.F.	Cost
A Substructure		2.30%	$4.40	$1,061,500
A1010	**Standard Foundations**		$2.28	$549,000
	KSF, 12" deep x 32" wide			
	8' - 6" square x 27" deep			
A1030	**Slab on Grade**		$0.72	$173,500
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	**Basement Excavation**		$0.47	$114,000
	site storage			
A2020	**Basement Walls**		$0.93	$225,000
	thick			
B Shell		20.60%	$39.28	$9,473,000
B1010	**Floor Construction**		$19.71	$4,753,500
	height, 251 lbs/LF, 4000PSI			
	height, 394 lbs/LF, 4000PSI			
	15'x15' bay, 75 PSF superimposed load, 153 PSF total load			
	75 PSF superimposed load, 204 PSF total load			
B1020	**Roof Construction**		$3.01	$725,000
	16" deep beam, 14" slab, 174 PSF total load			
B2010	**Exterior Walls**		$10.63	$2,563,500
	insulation, low rise			
B2020	**Exterior Windows**		$4.13	$996,000
	Windows, aluminum, sliding, insulated glass, 5' x 3'			
B2030	**Exterior Doors**		$0.75	$180,000
	6'-0" x 10'-0" opening			
	hardware, 6'-0" x 10'-0" opening			
	0" opening			
B3010	**Roof Coverings**		$1.03	$249,000
	adhesive			

	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Flashing, copper, no backing, 16 oz, < 500 lbs			
B3020	**Roof Openings**		**$0.02**	**$6,000**
	steel, 165 lbs			
C Interiors		**21.10%**	**$40.10**	**$9,671,000**
C1010	**Partitions**		**$6.33**	**$1,526,000**
	board base, 3-5/8" @ 24",s ame opposite face, no insulation			
	Gypsum board, 1 face only, 5/8" with 1/16" lead			
C1020	**Interior Doors**		**$10.52**	**$2,536,000**
	3'-0" x 7'-0" x 1-3/8"			
	0" x 1-3/8"			
C1030	**Fittings**		**$0.92**	**$221,500**
	Partitions, hospital curtain, ceiling hung, poly oxford cloth			
C2010	**Stair Construction**		**$1.20**	**$290,500**
	Stairs, steel, cement filled metal pan & picket rail, 12 risers, with landing			
C3010	**Wall Finishes**		**$6.30**	**$1,518,500**
	Glazed coating			
	primer & 2 coats			
	Vinyl wall covering, fabric back, medium weight			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		**$8.53**	**$2,058,000**
	Composition flooring, epoxy terrazzo, maximum			
	Terrazzo, maximum			
	Vinyl, composition tile, maximum			
	Tile, ceramic natural clay			
C3030	**Ceiling Finishes**		**$6.30**	**$1,520,500**
	crc, 36" OC support			
	channel grid, suspended support			
D Services		**47.50%**	**$90.39**	**$21,800,500**
D1010	**Elevators and Lifts**		**$6.04**	**$1,456,500**
	200 FPM			
D2010	**Plumbing Fixtures**		**$10.83**	**$2,612,000**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, raised deck, PE on CI, 42" x 21" dual level, triple bowl compartment			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 22" x 18"			
	Bathtub, recessed, PE on CI, mat bottom, 5'-6" long			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	**Domestic Water Distribution**		**$6.43**	**$1,551,000**
	Electric water heater, commercial, 100< F rise, 1000 gal, 480 KW 1970 GPH			

D2040	**Rain Water Drainage**	**$0.48**	**$116,000**
	Roof drain, CI, soil,single hub, 5" diam, 10' high		
	Roof drain, CI, soil,single hub, 5" diam, for each additional foot add		
D3010	**Energy Supply**	**$3.19**	**$769,500**
	Hot water reheat system for 200,000 SF hospital		
D3020	**Heat Generating Systems**	**$0.35**	**$85,500**
	Boiler, electric, steel, steam, 510 KW, 1,740 MBH		
D3030	**Cooling Generating Systems**	**$2.51**	**$606,500**
	Chiller, reciprocating, water cooled, standard controls, 100 ton		
	Chiller, reciprocating, water cooled, standard controls, 150 ton		
	Chiller, reciprocating, water cooled, standard controls, 200 ton		
D3090	**Other HVAC Systems/Equip**	**$29.87**	**$7,203,000**
	Ductwork for 200,000 SF hospital model		
	Boiler, cast iron, gas, hot water, 2856 MBH		
	Boiler, cast iron, gas, hot water, 320 MBH		
	AHU, rooftop, cool/heat coils, VAV, filters, 5,000 CFM		
	AHU, rooftop, cool/heat coils, VAV, filters, 10,000 CFM		
	AHU, rooftop, cool/heat coils, VAV, filters, 20,000 CFM		
	VAV terminal, cooling, hot water reheat, with actuator / controls, 200 CFM		
	AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM		
	draft damper, 1500 CFM		
	draft damper, 2750 CFM		
	Commercial kitchen exhaust/make-up air system, rooftop, gas, 5000 CFM		
	Plate heat exchanger, 400 GPM		
D4010	**Sprinklers**	**$2.38**	**$574,000**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF		
	10,000 SF		
	Standard High Rise Accessory Package 8 story		
D4020	**Standpipes**	**$0.38**	**$92,000**
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor		
	floors		
	steel door & frame		
	Alarm, electric pressure switch (circuit closer)		
	Escutcheon plate, for angle valves, polished brass, 2-1/2"		
	Fire pump, electric, with controller, 5" pump, 100 HP, 1000 GPM		
	Fire pump, electric, for jockey pump system, add		
	Siamese, with plugs & chains, polished brass, sidewalk, 4" x 2-1/2" x 2-1/2"		
	Valves, angle, wheel handle, 300 lb, 2-1/2"		
	Cabinet assembly, includes. adapter, rack, hose, and nozzle		
D5010	**Electrical Service/Distribution**	**$3.28**	**$791,500**
	phase, 4 wire, 120/208 V, 2000 A		
	Feeder installation 600 V, including RGS conduit and XHHW wire, 2000 A		
	Switchgear installation, incl switchboard, panels & circuit breaker, 2000 A		
D5020	**Lighting and Branch Wiring**	**$18.08**	**$4,361,500**

	with transformer			
	Wall switches, 5.0 per 1000 SF			
	Miscellaneous power, 1.2 watts			
	Central air conditioning power, 4 watts			
	Motor installation, three phase, 460 V, 15 HP motor size			
	V 15 HP, 575 V 20 HP			
	fixtures @32 watt per 1000 SF			
D5030	**Communications and Security**		**$2.33**	**$561,000**
	detectors, includes outlets, boxes, conduit and wire			
	Fire alarm command center, addressable with voice, excl. wire & conduit			
	Internet wiring, 8 data/voice outlets per 1000 S.F.			
D5090	**Other Electrical Systems**		**$4.23**	**$1,020,500**
	engine with fuel tank, 100 kW			
	engine with fuel tank, 400 kW			
	kW			
E Equipment & Furnishings		**8.60%**	**$16.34**	**$3,941,500**
E1020	**Institutional Equipment**		**$12.38**	**$2,986,500**
	distilled water, economy			
	Architectural equipment, sink, epoxy resin, 25" x 16" x 10"			
	Architectural equipment, laboratory equipment eye wash, hand held			
	Fume hood, complex, including fixtures and ductwork			
	double door, 28"x67"x52"			
	hospital			
	semiautomatic, 50 racks/hr			
	KW			
	gallons			
	burners, 2 ovens & 24" griddle			
	system, economy			
	Special construction, refrigerators, prefabricated, walk-in, 7'-6" high, 6' x 6'			
	sinks, washers & dry tables			
E1090	**Other Equipment**		**$0.00**	**$0**
E2020	**Moveable Furnishings**		**$3.96**	**$955,000**
	per room			
F Special Construction		**0.00%**	**$0.00**	**$0**
G Building Sitework		**0.00%**	**$0.00**	**$0**
SubTotal		**100%**	**$190.52**	**$45,947,500**
Contractor Fees (General Conditions,Overhead,Profit)		**0.00%**	**$0.00**	**$0**
Architectural Fees		**0.00%**	**$0.00**	**$0**
User Fees		**0.00%**	**$0.00**	**$0**
Total Building Cost			**$190.52**	**$45,947,500**

Assemblies Estimate using RS Means Cost Data Reference 2010						
Equipment/ System	**System Components**	**RS Means Parameters**	**Price/ quantity**	**Quantity**	**Total**	**RS Means 2010 page#**
Plumbing						
Domestic Hot Water Heater	1125 MBH, 1500 GPH, 500 Gallons	600 MBH, 576 GPH	$22,275/each	2	$44,550	286
Wall hung water closets	Wall hung, grouped side by side	Wall hung, close couple	$2310/each	Approx. 40	$92,400	267
Wall hung lavatory sinks	Wall hung	Wall hung 20"x18"	$1545/ each	Approx. 45	$69, 525	270
Total					**$206, 475**	
HVAC						
Gas Boiler	4423 MBH	4720 MBH	$88,400/unit	2	$176, 800	317
Steam Boiler	4423 MBH	4720 MBH	$84,400/unit	1	$84,400	317
Chilled Water/Cooling Tower system	500 tons	Medical Center 60,000 S.F., 140,000 ton	$45.40/SF (adjusted for 241,175 SF)	241,175 SF	$10,949,345	324
Total					**$11,210,545**	
Fire Protection						
Wet sprinkler system	Approx. 34,000 SF coverage on each floor	Ordinary hazard, one floor, 50,000 S.F.	$3.66/ SF (add'tl floors) $3.06/SF	34,000 + 34,000 (6)	$748, 680	345
Total					**$748, 680**	
Electrical						
Electric Service, 3 Phase, 4 wire	3 phase, 4 wire, 120/208 V, 100 A	3 phase, 4 wire,120/208 V, 100A	$2, 275/each	1	$2, 275	354
Duplex receptacle	125 V, 2 Pole, 3 wire, 20 A	16 per 1000 S.F.	$3.40/ sf	241, 175	$819,995	357
Switchgear/Switchboard/Panels/ Circuit Breaker	5000A, 277/480V	2000A, 277/ 480 V	$55,100/each (add 20% for 277/480V)	1	55,100+$11020= $66,120	356
Total					**$888, 390**	
Total of Assemblies					**$13,054,090**	

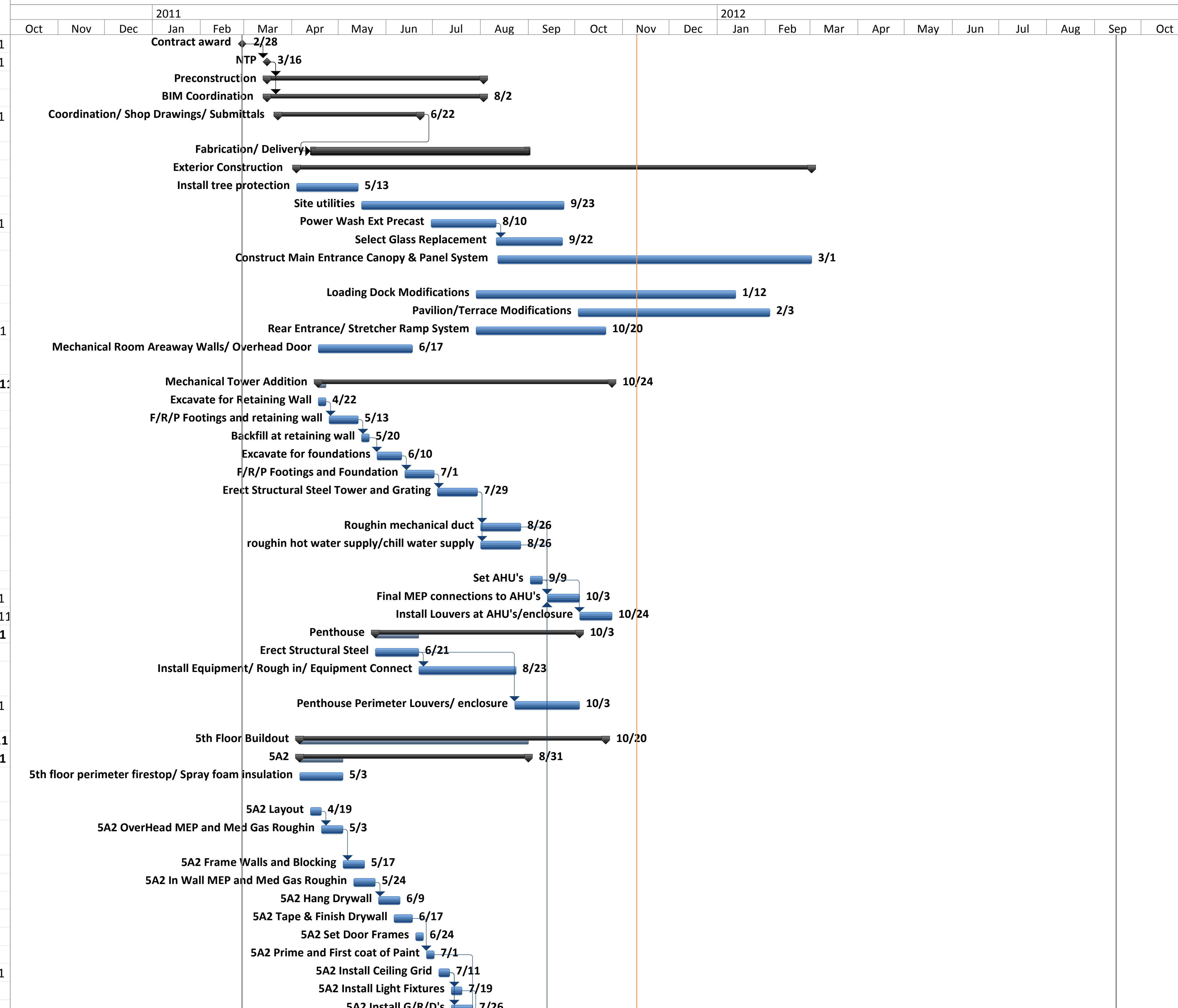
General Conditions Estimate- Kaiser Tysons Corner

	Monthly Cost	Projected Total Cost
Labor		
Misc MEP Layout	47	610
Project Execuetive	10,706	139,181
Project Manager	17,503	227,543
Project Superintendent	23,870	310,315
Project Engineer	49,042	637,555
Project Accountant	2,000	26,009
Field Office Coordinator	8,055	104,725
Scheduling Engineer	2,817	36,631
MEP Coordinator	17,079	222,028
Jobsite Office- Setup/ Removal	2,615	34,000
Bim Engineer	7,352	95,583
Superindent- OR's	10,165	132,155
Superindent- QC	5,806	75,484
Precast Superintendent	8,500	110,500
Safety Engineer	2,461	32,000
Jobsite Safety	7,922	102,987
Material Handling/ Hoisting	0	0
Personnel Hoisting	5,835	75,861
Floor Protection	422	5,491
Interim Clean-Up	14,387	187,038
Safety: Opening Protection	277	3,610
Total Labor:	**197,177**	**2,563,306**
Material		
Jobsite Office- Setup/ Removal	636	8,269
Jobsite Safety	949	12,343
Interim Clean-Up	44	567
Total Material:	**1,629**	**21,179**
Equipment		
Jobsite Office- Setup/ Removal	2,110	27,433
Pick Up Trucks	2,798	36,377
Jobsite Safety	549	7,137
Fire Extinguishers	346	4,500
Total Equipment:	**5800**	**75,407**
Other		
Concrete Walks	151	1,975
Trash Chutes	246	32,000
Existing Sill Protection	1,181	15,360
Power Wash Façade	3,076	40,000
Field Office Coordinator	231	3,000

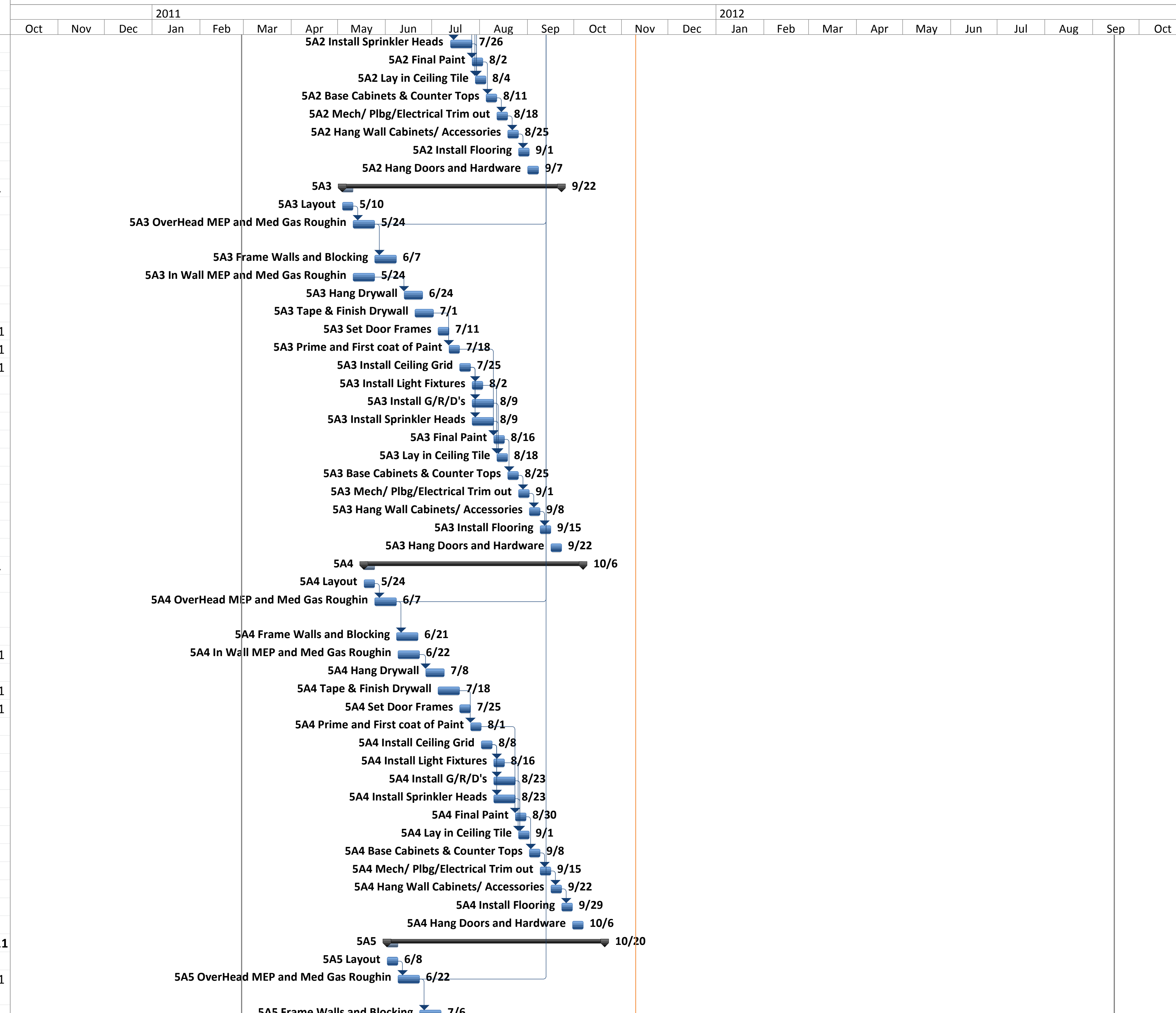
Trailer Rental	5,244	68,173
Jobsite Office- Setup/ Removal	9,486	123,324
Furniture Rental	68	880
Computers/Printers	6,089	79,160
Supplies/ Petty Cash	2,319	30,157
Postage/ Federal Express	229	2,978
Telephone install/ service	153	2,000
Telephone Monthly	1,390	18,072
Travel Related Expenses	438	5,705
Promotions and Entertainment	0	0
Audio Visual Innovations	0	0
Pick Up Trucks	37	476
Fuel- Trucks/Cars	2,573	33,459
Blueprinting/reproduction	340	4,422
Progress Photographs	384	5,000
Superintendent QC	10,059	130,779
Network Setup	2,032	26,423
Jobsite Safety	6,338	82,396
Expendable Tools	22	284
Material Handling/ Hoisting	3,506	45,582
Temp Elec Set-up/Removal	1,384	18,000
Temp Toliets	1,672	21,743
Wood Barricades/Signs	307	4,000
Interim Clean-Up	396	5,143
Final Clean	6,153	80,000
Site Security	0	0
Misc. Site Requirements	0	0
Debris Box	4,344	56,483
GC Change Orders	3,546	46,105
Other Total:	**75,649**	**983,440**
Subcontractor		
Trash Chutes	801	10,411
Jobsite Office Setup/Removal	5,654	73,507
Jobsite safety	5,480	71,247
Material Handling/Hoisting	8,023	104,308
Interim Clean-up	667	8,670
Site Security	1,412	18,353
Debris Boxes	3,270	42,517
Subcontractor Total:	**25,308**	**329,012**
Surveying	**0**	**0**
Report total	**305,564**	**3,972,344**

APPENDIX D

ID	Task Mode	Trade	Task Name	Duration	Start	Finish
1			Contract award	0 days	Mon 2/28/11	Mon 2/28/11
2			NTP	0 days	Wed 3/16/11	Wed 3/16/11
3			Preconstruction	100 days	Wed 3/16/11	Tue 8/2/11
4			BIM Coordination	100 days	Wed 3/16/11	Tue 8/2/11
5			Coordination/ Shop Drawings/ Submittals	66 days	Wed 3/23/11	Wed 6/22/11
6			Fabrication/ Delivery	102 days	Wed 4/13/11	Thu 9/1/11
7		Exterior Constr	Exterior Construction	239 days	Mon 4/4/11	Thu 3/1/12
8			Install tree protection	30 days	Mon 4/4/11	Fri 5/13/11
9			Site utilities	95 days	Mon 5/16/11	Fri 9/23/11
10			Power Wash Ext Precast	30 days	Thu 6/30/11	Wed 8/10/11
11			Select Glass Replacement	31 days	Thu 8/11/11	Thu 9/22/11
12			Construct Main Entrance Canopy & Panel System	145 days	Fri 8/12/11	Thu 3/1/12
13			Loading Dock Modifications	120 days	Fri 7/29/11	Thu 1/12/12
14			Pavilion/Terrace Modifications	90 days	Mon 10/3/11	Fri 2/3/12
15			Rear Entrance/ Stretcher Ramp System	60 days	Fri 7/29/11	Thu 10/20/11
16			Mechanical Room Areaway Walls/ Overhead Door	45 days	Mon 4/18/11	Fri 6/17/11
17		**Mechanical Tov**	**Mechanical Tower Addition**	**136 days**	**Mon 4/18/11**	**Mon 10/24/1**
18			Excavate for Retaining Wall	5 days	Mon 4/18/11	Fri 4/22/11
19			F/R/P Footings and retaining wall	15 days	Mon 4/25/11	Fri 5/13/11
20			Backfill at retaining wall	5 days	Mon 5/16/11	Fri 5/20/11
21			Excavate for foundations	12 days	Thu 5/26/11	Fri 6/10/11
22			F/R/P Footings and Foundation	15 days	Mon 6/13/11	Fri 7/1/11
23			Erect Structural Steel Tower and Grating	20 days	Mon 7/4/11	Fri 7/29/11
24			Roughin mechanical duct	20 days	Mon 8/1/11	Fri 8/26/11
25			roughin hot water supply/chill water supply	20 days	Mon 8/1/11	Fri 8/26/11
26			Set AHU's	6 days	Fri 9/2/11	Fri 9/9/11
27			Final MEP connections to AHU's	15 days	Tue 9/13/11	Mon 10/3/11
28			Install Louvers at AHU's/enclosure	15 days	Tue 10/4/11	Mon 10/24/11
29			**Penthouse**	**94 days**	**Wed 5/25/11**	**Mon 10/3/11**
30			Erect Structural Steel	20 days	Wed 5/25/11	Tue 6/21/11
31			Install Equipment/ Rough in/ Equipment Connect	45 days	Wed 6/22/11	Tue 8/23/11
32			Penthouse Perimeter Louvers/ enclosure	30 days	Tue 8/23/11	Mon 10/3/11
33			**5th Floor Buildout**	**142 days**	**Wed 4/6/11**	**Thu 10/20/11**
34			**5A2**	**106 days**	**Wed 4/6/11**	**Wed 8/31/11**
35			5th floor perimeter firestop/ Spray foam insulation	20 days	Wed 4/6/11	Tue 5/3/11
36			5A2 Layout	5 days	Wed 4/13/11	Tue 4/19/11
37			5A2 OverHead MEP and Med Gas Roughin	10 days	Wed 4/20/11	Tue 5/3/11
38			5A2 Frame Walls and Blocking	10 days	Wed 5/4/11	Tue 5/17/11
39			5A2 In Wall MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
40			5A2 Hang Drywall	10 days	Fri 5/27/11	Thu 6/9/11
41			5A2 Tape & Finish Drywall	10 days	Mon 6/6/11	Fri 6/17/11
42			5A2 Set Door Frames	5 days	Mon 6/20/11	Fri 6/24/11
43			5A2 Prime and First coat of Paint	5 days	Mon 6/27/11	Fri 7/1/11
44			5A2 Install Ceiling Grid	5 days	Tue 7/5/11	Mon 7/11/11
45			5A2 Install Light Fixtures	5 days	Wed 7/13/11	Tue 7/19/11
46			5A2 Install G/R/D's	10 days	Wed 7/13/11	Tue 7/26/11

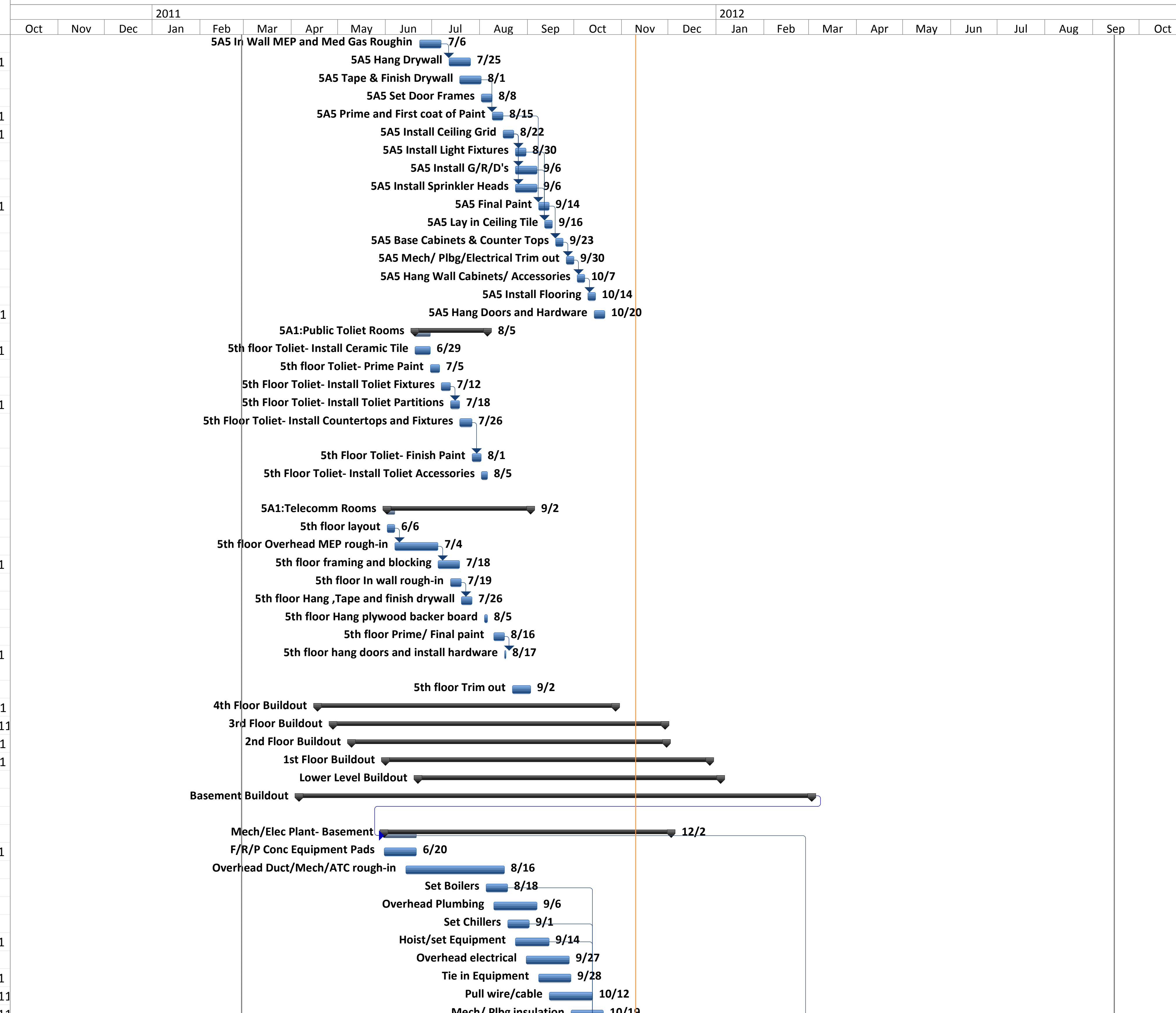


ID		Task Mode	Trade	Task Name	Duration	Start	Finish
47				5A2 Install Sprinkler Heads	10 days	Wed 7/13/11	Tue 7/26/11
48				5A2 Final Paint	5 days	Wed 7/27/11	Tue 8/2/11
49				5A2 Lay in Ceiling Tile	5 days	Fri 7/29/11	Thu 8/4/11
50				5A2 Base Cabinets & Counter Tops	5 days	Fri 8/5/11	Thu 8/11/11
51				5A2 Mech/ Plbg/Electrical Trim out	5 days	Fri 8/12/11	Thu 8/18/11
52				5A2 Hang Wall Cabinets/ Accessories	5 days	Fri 8/19/11	Thu 8/25/11
53				5A2 Install Flooring	5 days	Fri 8/26/11	Thu 9/1/11
54				5A2 Hang Doors and Hardware	5 days	Thu 9/1/11	Wed 9/7/11
55				**5A3**	**102 days**	**Wed 5/4/11**	**Thu 9/22/11**
56				5A3 Layout	5 days	Wed 5/4/11	Tue 5/10/11
57				5A3 OverHead MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
58				5A3 Frame Walls and Blocking	10 days	Wed 5/25/11	Tue 6/7/11
59				5A3 In Wall MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
60				5A3 Hang Drywall	10 days	Mon 6/13/11	Fri 6/24/11
61				5A3 Tape & Finish Drywall	10 days	Mon 6/20/11	Fri 7/1/11
62				5A3 Set Door Frames	5 days	Tue 7/5/11	Mon 7/11/11
63				5A3 Prime and First coat of Paint	5 days	Tue 7/12/11	Mon 7/18/11
64				5A3 Install Ceiling Grid	5 days	Tue 7/19/11	Mon 7/25/11
65				5A3 Install Light Fixtures	5 days	Wed 7/27/11	Tue 8/2/11
66				5A3 Install G/R/D's	10 days	Wed 7/27/11	Tue 8/9/11
67				5A3 Install Sprinkler Heads	10 days	Wed 7/27/11	Tue 8/9/11
68				5A3 Final Paint	5 days	Wed 8/10/11	Tue 8/16/11
69				5A3 Lay in Ceiling Tile	5 days	Fri 8/12/11	Thu 8/18/11
70				5A3 Base Cabinets & Counter Tops	5 days	Fri 8/19/11	Thu 8/25/11
71				5A3 Mech/ Plbg/Electrical Trim out	5 days	Fri 8/26/11	Thu 9/1/11
72				5A3 Hang Wall Cabinets/ Accessories	5 days	Fri 9/2/11	Thu 9/8/11
73				5A3 Install Flooring	5 days	Fri 9/9/11	Thu 9/15/11
74				5A3 Hang Doors and Hardware	5 days	Fri 9/16/11	Thu 9/22/11
75				**5A4**	**102 days**	**Wed 5/18/11**	**Thu 10/6/11**
76				5A4 Layout	5 days	Wed 5/18/11	Tue 5/24/11
77				5A4 OverHead MEP and Med Gas Roughin	10 days	Wed 5/25/11	Tue 6/7/11
78				5A4 Frame Walls and Blocking	10 days	Wed 6/8/11	Tue 6/21/11
79				5A4 In Wall MEP and Med Gas Roughin	10 days	Thu 6/9/11	Wed 6/22/11
80				5A4 Hang Drywall	10 days	Mon 6/27/11	Fri 7/8/11
81				5A4 Tape & Finish Drywall	10 days	Tue 7/5/11	Mon 7/18/11
82				5A4 Set Door Frames	5 days	Tue 7/19/11	Mon 7/25/11
83				5A4 Prime and First coat of Paint	5 days	Tue 7/26/11	Mon 8/1/11
84				5A4 Install Ceiling Grid	5 days	Tue 8/2/11	Mon 8/8/11
85				5A4 Install Light Fixtures	5 days	Wed 8/10/11	Tue 8/16/11
86				5A4 Install G/R/D's	10 days	Wed 8/10/11	Tue 8/23/11
87				5A4 Install Sprinkler Heads	10 days	Wed 8/10/11	Tue 8/23/11
88				5A4 Final Paint	5 days	Wed 8/24/11	Tue 8/30/11
89				5A4 Lay in Ceiling Tile	5 days	Fri 8/26/11	Thu 9/1/11
90				5A4 Base Cabinets & Counter Tops	5 days	Fri 9/2/11	Thu 9/8/11
91				5A4 Mech/ Plbg/Electrical Trim out	5 days	Fri 9/9/11	Thu 9/15/11
92				5A4 Hang Wall Cabinets/ Accessories	5 days	Fri 9/16/11	Thu 9/22/11
93				5A4 Install Flooring	5 days	Fri 9/23/11	Thu 9/29/11
94				5A4 Hang Doors and Hardware	5 days	Fri 9/30/11	Thu 10/6/11
95				**5A5**	**101 days**	**Thu 6/2/11**	**Thu 10/20/11**
96				5A5 Layout	5 days	Thu 6/2/11	Wed 6/8/11
97				5A5 OverHead MEP and Med Gas Roughin	10 days	Thu 6/9/11	Wed 6/22/11
98				5A5 Frame Walls and Blocking	10 days	Thu 6/23/11	Wed 7/6/11



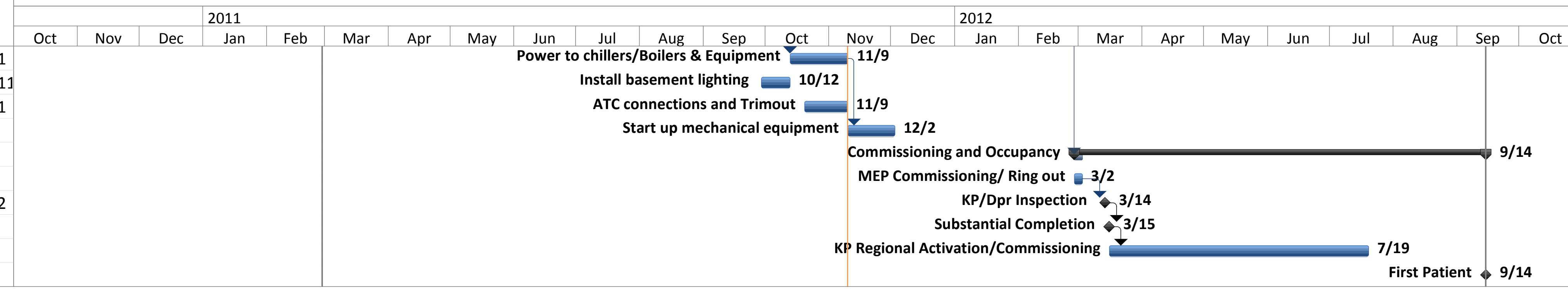
APPENDIX D

ID	Ta Mo	Trade	Task Name	Duration	Start	Finish
99			5A5 In Wall MEP and Med Gas Roughin	10 days	Thu 6/23/11	Wed 7/6/11
100			5A5 Hang Drywall	10 days	Tue 7/12/11	Mon 7/25/11
101			5A5 Tape & Finish Drywall	10 days	Tue 7/19/11	Mon 8/1/11
102			5A5 Set Door Frames	5 days	Tue 8/2/11	Mon 8/8/11
103			5A5 Prime and First coat of Paint	5 days	Tue 8/9/11	Mon 8/15/11
104			5A5 Install Ceiling Grid	5 days	Tue 8/16/11	Mon 8/22/11
105			5A5 Install Light Fixtures	5 days	Wed 8/24/11	Tue 8/30/11
106			5A5 Install G/R/D's	10 days	Wed 8/24/11	Tue 9/6/11
107			5A5 Install Sprinkler Heads	10 days	Wed 8/24/11	Tue 9/6/11
108			5A5 Final Paint	5 days	Thu 9/8/11	Wed 9/14/11
109			5A5 Lay in Ceiling Tile	5 days	Mon 9/12/11	Fri 9/16/11
110			5A5 Base Cabinets & Counter Tops	5 days	Mon 9/19/11	Fri 9/23/11
111			5A5 Mech/ Plbg/Electrical Trim out	5 days	Mon 9/26/11	Fri 9/30/11
112			5A5 Hang Wall Cabinets/ Accessories	5 days	Mon 10/3/11	Fri 10/7/11
113			5A5 Install Flooring	5 days	Mon 10/10/11	Fri 10/14/11
114			5A5 Hang Doors and Hardware	5 days	Fri 10/14/11	Thu 10/20/11
115			**5A1:Public Toliet Rooms**	**35 days**	**Mon 6/20/11**	**Fri 8/5/11**
116			5th floor Toliet- Install Ceramic Tile	8 days	Mon 6/20/11	Wed 6/29/11
117			5th floor Toliet- Prime Paint	4 days	Thu 6/30/11	Tue 7/5/11
118			5th Floor Toliet- Install Toliet Fixtures	4 days	Thu 7/7/11	Tue 7/12/11
119			5th Floor Toliet- Install Toliet Partitions	4 days	Wed 7/13/11	Mon 7/18/11
120			5th Floor Toliet- Install Countertops and Fixtures	6 days	Tue 7/19/11	Tue 7/26/11
121			5th Floor Toliet- Finish Paint	4 days	Wed 7/27/11	Mon 8/1/11
122			5th Floor Toliet- Install Toliet Accessorie	4 days	Tue 8/2/11	Fri 8/5/11
123			**5A1:Telecomm Rooms**	**67 days**	**Thu 6/2/11**	**Fri 9/2/11**
124			5th floor layout	3 days	Thu 6/2/11	Mon 6/6/11
125			5th floor Overhead MEP rough-in	20 days	Tue 6/7/11	Mon 7/4/11
126			5th floor framing and blocking	10 days	Tue 7/5/11	Mon 7/18/11
127			5th floor In wall rough-in	5 days	Wed 7/13/11	Tue 7/19/11
128			5th floor Hang ,Tape and finish drywall	5 days	Wed 7/20/11	Tue 7/26/11
129			5th floor Hang plywood backer board	2 days	Thu 8/4/11	Fri 8/5/11
130			5th floor Prime/ Final paint	5 days	Wed 8/10/11	Tue 8/16/11
131			5th floor hang doors and install hardware	1 day	Wed 8/17/11	Wed 8/17/11
132			5th floor Trim out	10 days	Mon 8/22/11	Fri 9/2/11
133			4th Floor Buildout	139 days	Mon 4/18/11	Thu 10/27/11
134			3rd Floor Buildout	153 days	Thu 4/28/11	Mon 11/28/11
135			2nd Floor Buildout	146 days	Tue 5/10/11	Tue 11/29/11
136			1st Floor Buildout	150 days	Wed 6/1/11	Tue 12/27/11
137			Lower Level Buildout	140 days	Wed 6/22/11	Tue 1/3/12
138			Basement Buildout	238 days	Wed 4/6/11	Fri 3/2/12
139						
140			**Mech/Elec Plant- Basement**	**134 days**	**Tue 5/31/11**	**Fri 12/2/11**
141			F/R/P Conc Equipment Pads	15 days	Tue 5/31/11	Mon 6/20/11
142			Overhead Duct/Mech/ATC rough-in	46 days	Tue 6/14/11	Tue 8/16/11
143			Set Boilers	10 days	Fri 8/5/11	Thu 8/18/11
144			Overhead Plumbing	20 days	Wed 8/10/11	Tue 9/6/11
145			Set Chillers	10 days	Fri 8/19/11	Thu 9/1/11
146			Hoist/set Equipment	16 days	Wed 8/24/11	Wed 9/14/11
147			Overhead electrical	20 days	Wed 8/31/11	Tue 9/27/11
148			Tie in Equipment	15 days	Thu 9/8/11	Wed 9/28/11
149			Pull wire/cable	20 days	Thu 9/15/11	Wed 10/12/11
150			Mech/ Plbg insulation	15 days	Thu 9/29/11	Wed 10/19/11

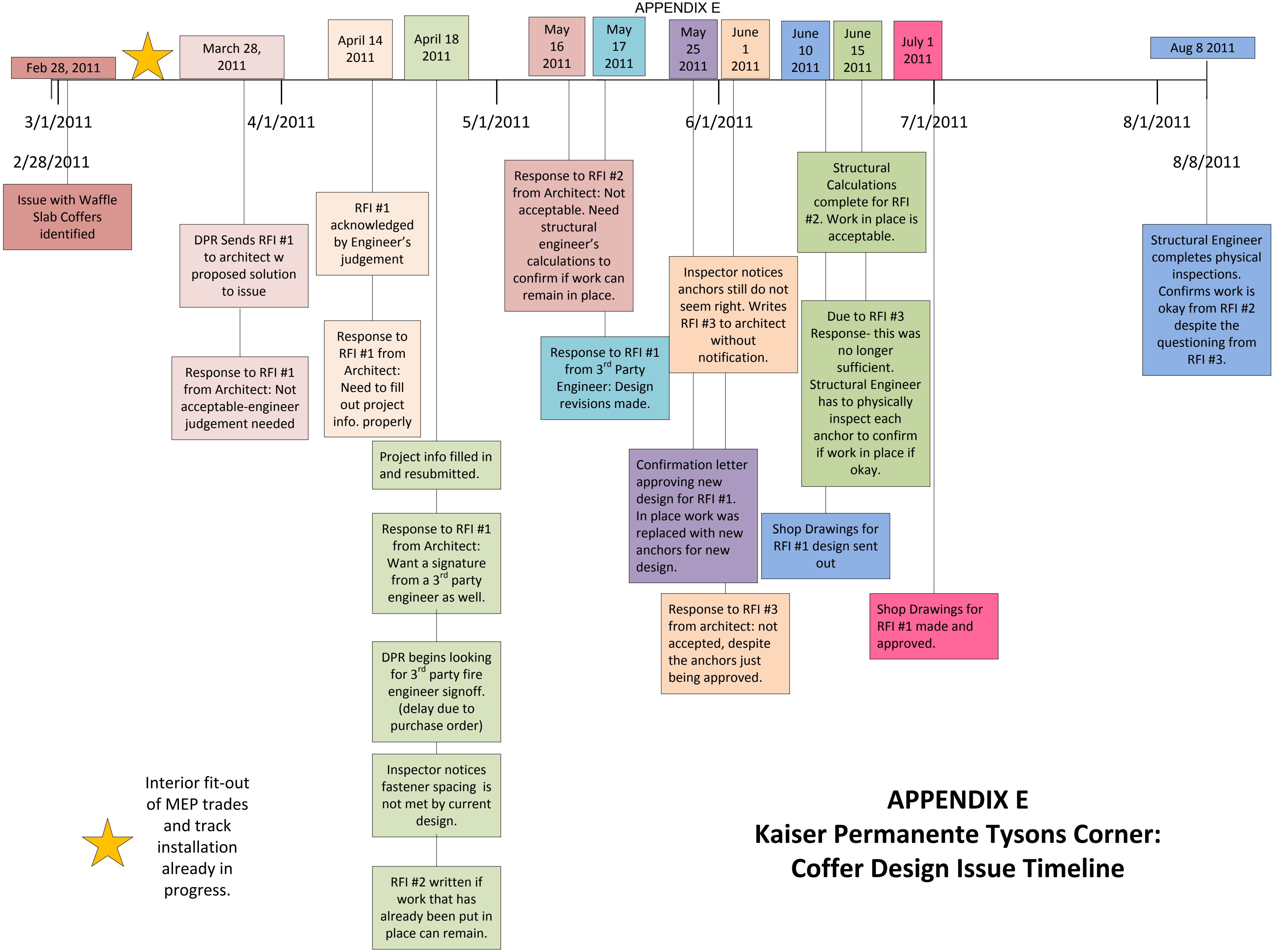


APPENDIX D

ID		Task Mode	Trade	Task Name	Duration	Start	Finish
151				Power to chillers/Boilers & Equipment	20 days	Thu 10/13/11	Wed 11/9/11
152				Install basement lighting	10 days	Thu 9/29/11	Wed 10/12/11
153				ATC connections and Trimout	15 days	Thu 10/20/11	Wed 11/9/11
154				Start up mechanical equipment	17 days	Thu 11/10/11	Fri 12/2/11
155				**Commissioning and Occupancy**	**144 days**	**Tue 2/28/12**	**Fri 9/14/12**
156				MEP Commissioning/ Ring out	4 days	Tue 2/28/12	Fri 3/2/12
157				KP/Dpr Inspection	0 days	Wed 3/14/12	Wed 3/14/12
158				Substantial Completion	0 days	Thu 3/15/12	Thu 3/15/12
159				KP Regional Activation/Commissioning	90 days	Fri 3/16/12	Thu 7/19/12
160				First Patient	0 days	Fri 9/14/12	Fri 9/14/12



APPENDIX E



APPENDIX E
Kaiser Permanente Tysons Corner: Coffer Design Issue Timeline

Features

- 1600 Wall System®1 is an outside glazed captured curtain wall
- 1600 Wall System®1 has a 2-1/2" (63.5) sight line
- Standard 6" (152.4) or 7-1/2" (190.5) depth systems
- Infill options up to 1-1/8" (28.6)
- Concealed fastener joinery creates smooth, monolithic appearance
- Open-back horizontals and perimeters are available for cost savings
- Shear block fabrication method
- Corners and splayed mullions available
- Offers integrated entrance framing systems
- Silicone compatible glazing materials for long-lasting seals
- 1600 Wall System®1 has been small and large missile impact and cycle tested
- Two color option
- Permanodic® anodized finishes in 7 choices
- Painted finishes in standard and custom choices

Optional Features

- Steel reinforcing available
- Rain screen and backpans
- Optional deep profile and bull nose covers available
- Deep and heavy-weight mullions available
- Veneer system available
- Integrates with standard Kawneer windows and concealed GLASSvent™
- Integrates with 1600 SUNSHADE™ and 1600 POWERSHADE®

Product Applications

- Ideal for low to mid-rise applications where high performance is desired
- It also is the right choice for high span applications

For specific product applications,
Consult your Kawneer representative.

Architects - Most extrusion and window types illustrated in this catalog are standard products for Kawneer. These concepts have been expanded and modified to afford you design freedom. Some miscellaneous details are non-standard and are intended to demonstrate how the system can be modified to expand design flexibility. Please contact your Kawneer representative for further assistance.

LAWS AND BUILDING AND SAFETY CODES GOVERNING THE DESIGN AND USE OF GLAZED ENTRANCE, WINDOW, AND CURTAIN WALL PRODUCTS VARY WIDELY. KAWNEER DOES NOT CONTROL THE SELECTION OF PRODUCT CONFIGURATIONS, OPERATING HARDWARE, OR GLAZING MATERIALS, AND ASSUMES NO RESPONSIBILITY THEREFOR.

Metric (SI) conversion figures are included throughout these details for reference. Numbers in parentheses ( ) are millimeters unless otherwise noted.

The following metric (SI) units are found in these details:

m – meter
cm – centimeter
mm – millimeter
s – second
Pa – pascal
MPa – megapascal

Kawneer reserves the right to change configurations without prior notice when deemed necessary for product improvement.

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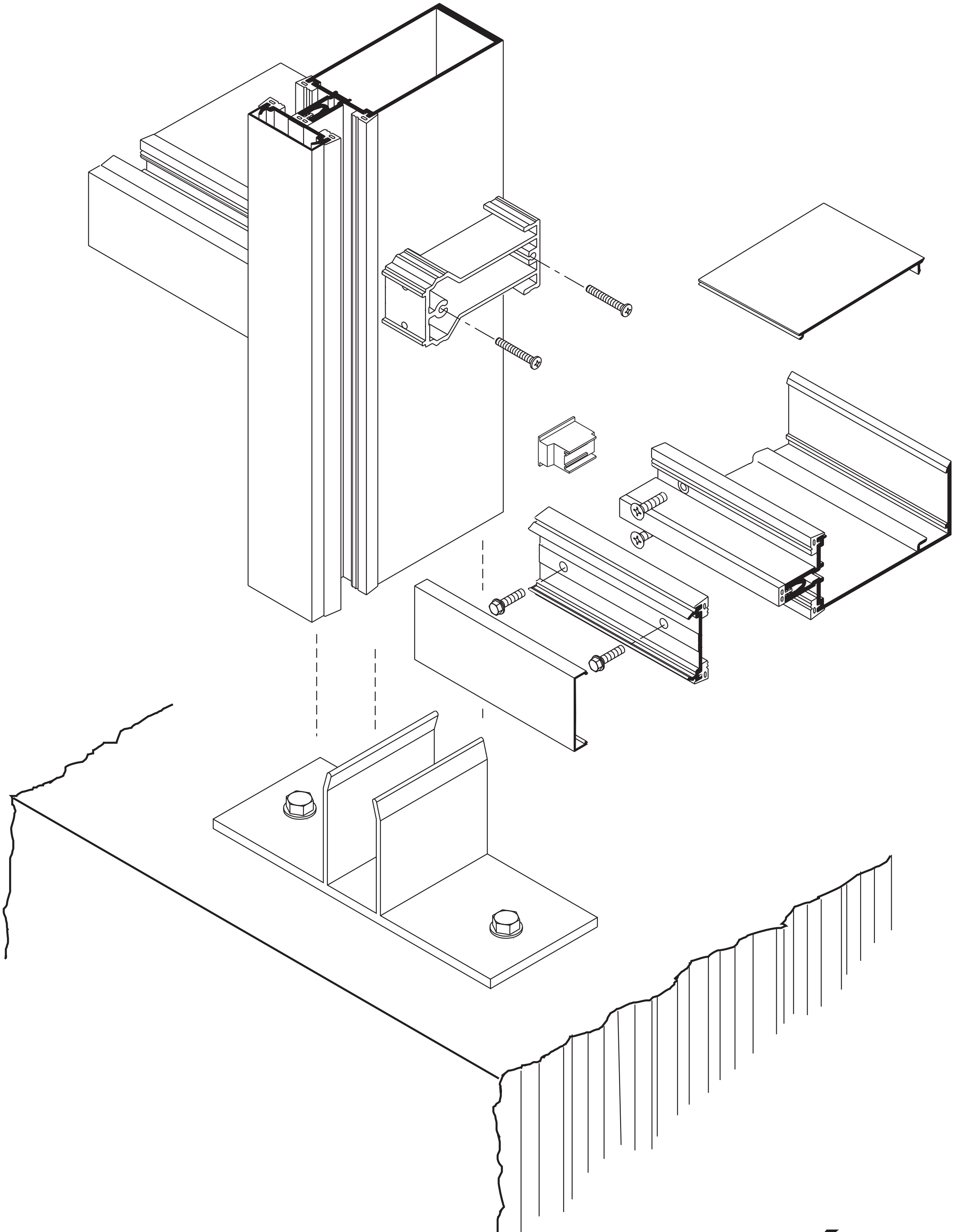

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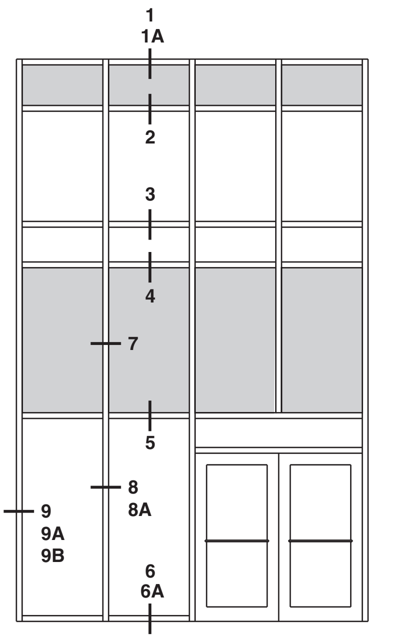
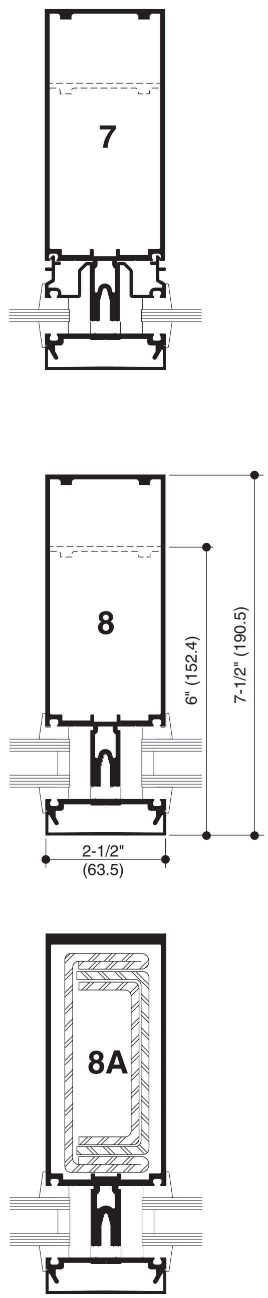
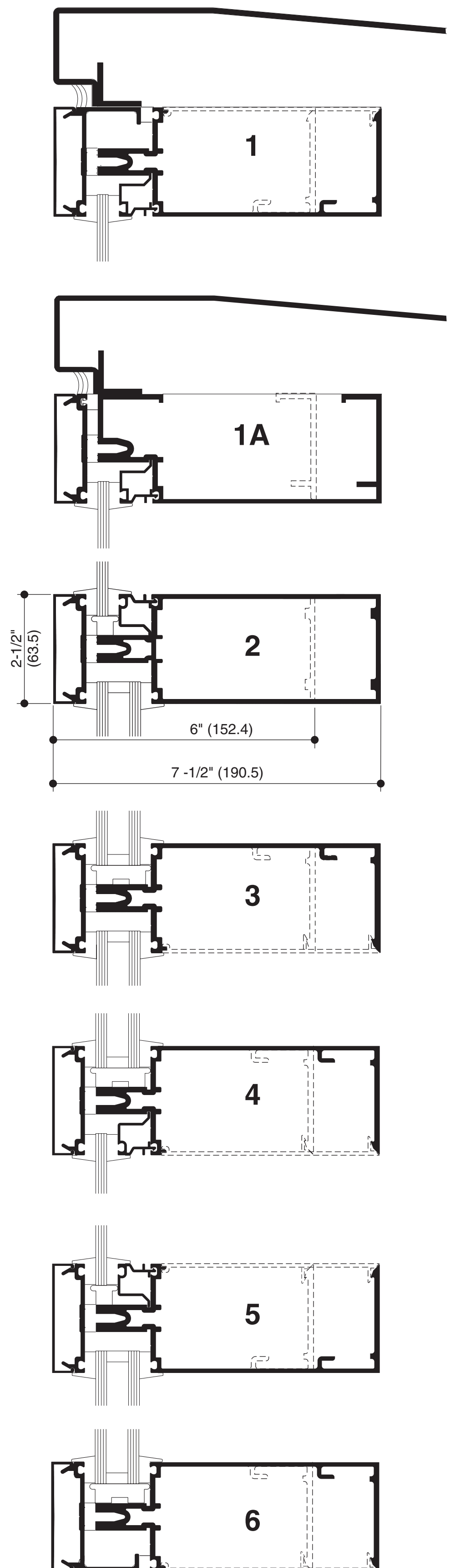
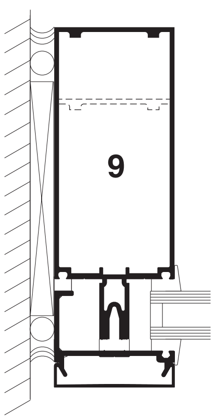


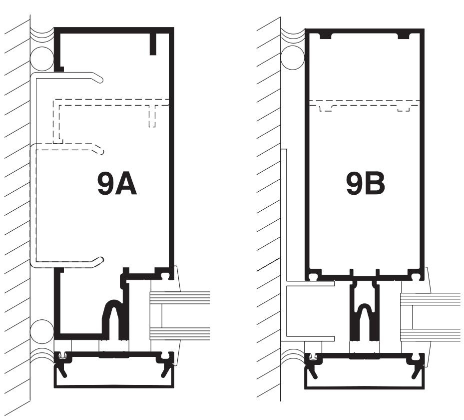
ELEVATION IS NUMBER KEYED TO DETAILS

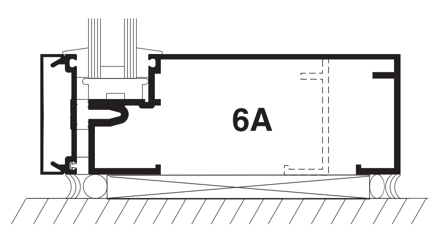


OPTIONAL STEEL
REINFORCING
AS REQUIRED









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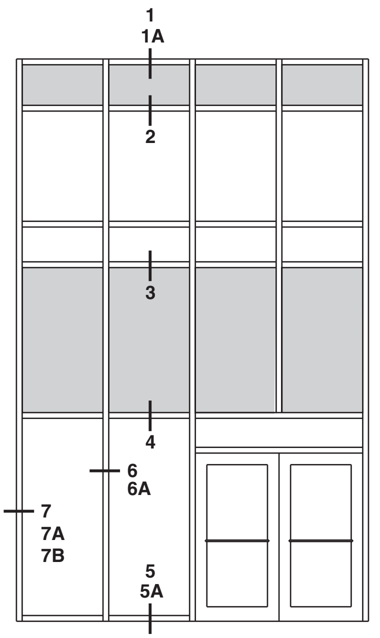

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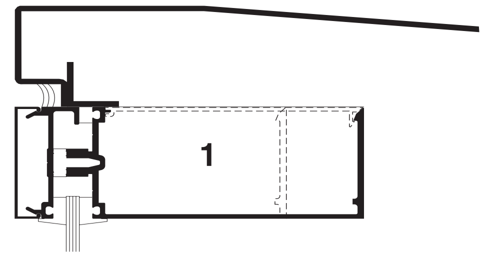

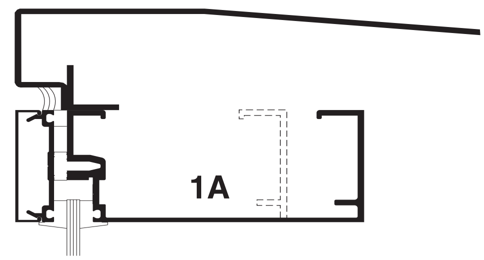

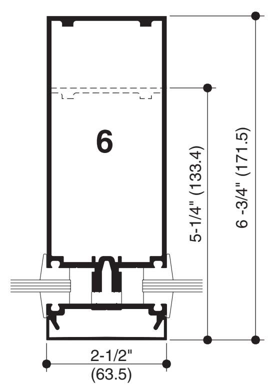

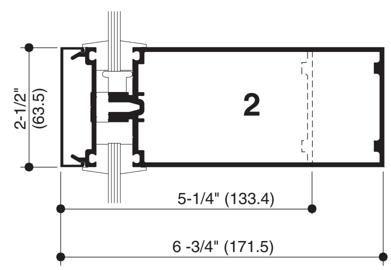

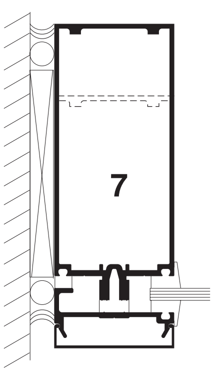

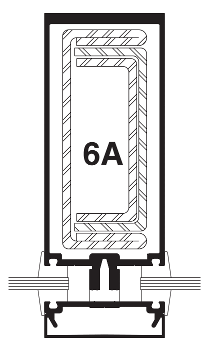

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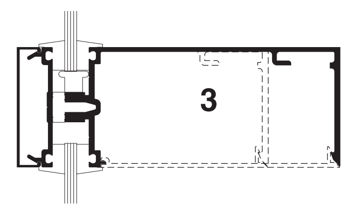
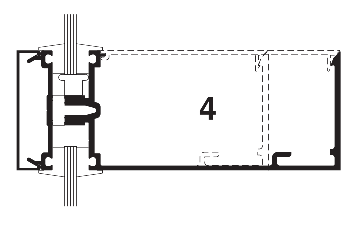
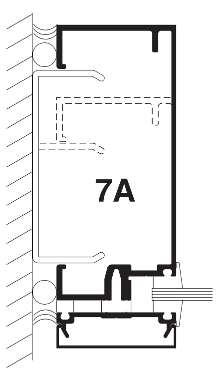
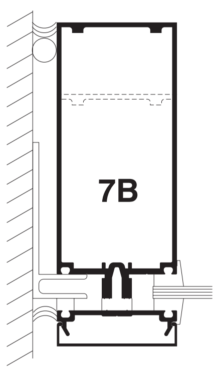
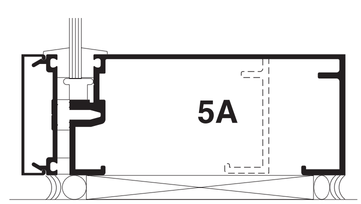
REINFORCING
AS REQUIRED

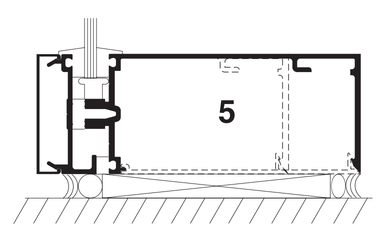








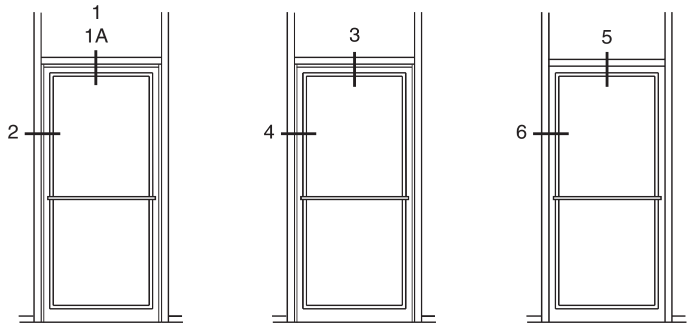




Laws and building and safety codes governing the design and use of glazed entrance, window, and curtain wall products vary widely. Kawneer does not control the selection of product configurations, operating hardware, or glazing materials, and assumes no responsibility therefor.

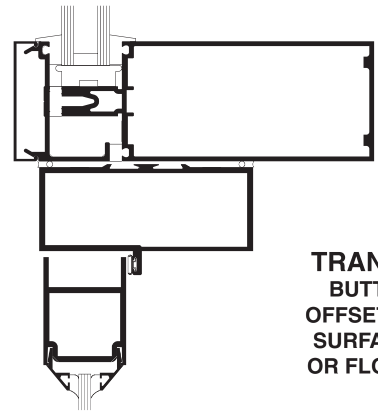
Kawneer reserves the right to change configuration without prior notice when deemed necessary for product improvement.

SCALE 3" = 1'-0"

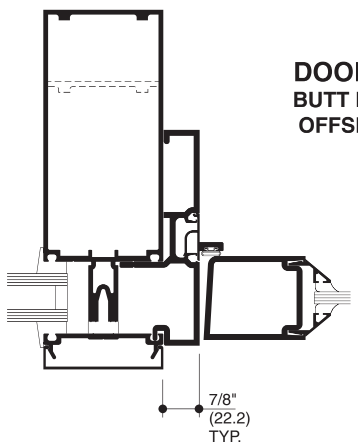


B/H OR O/P **C/H** **B/H OR O/P**

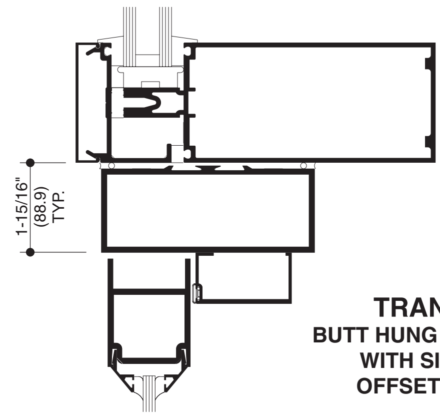
ELEVATION IS NUMBER KEYED TO DETAILS



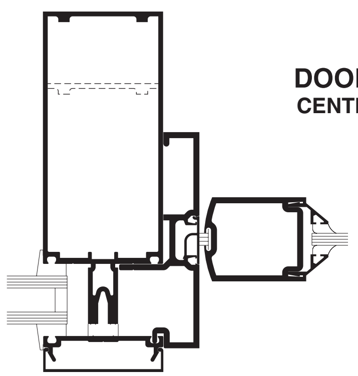
1
TRANSOM BAR
BUTT HUNG OR OFFSET PIVOT WITH SURFACE CLOSER OR FLOOR CLOSER



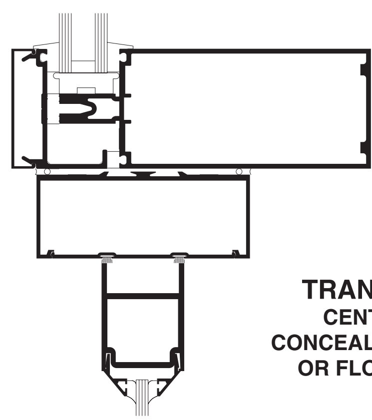
2
DOOR JAMB
BUTT HUNG OR OFFSET PIVOT



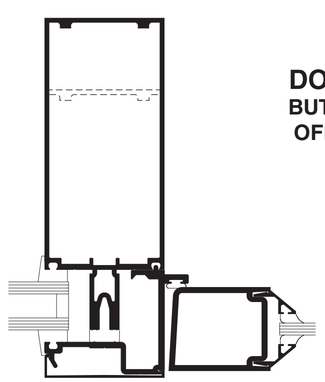
1A
TRANSOM BAR
BUTT HUNG OR OFFSET PIVOT WITH SINGLE ACTING OFFSET ARM CLOSER



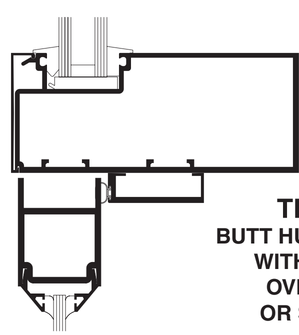
4
DOOR JAMB
CENTER HUNG



3
TRANSOM BAR
CENTER HUNG CONCEALED OVERHEAD OR FLOOR CLOSER

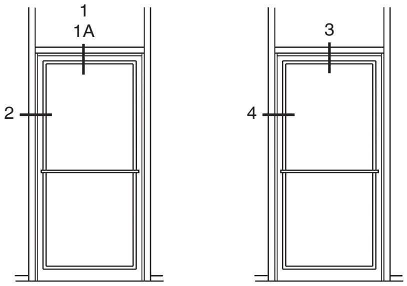


6
DOOR JAMB
BUTT HUNG OR OFFSET PIVOT



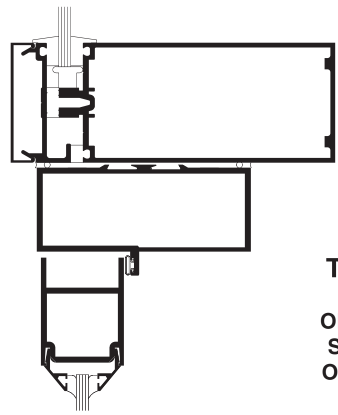
5
TRANSOM BAR
BUTT HUNG OR OFFSET PIVOT WITH LCN CONCEALED OVER HEAD CLOSER OR SURFACE CLOSER

SCALE 3" = 1'-0"



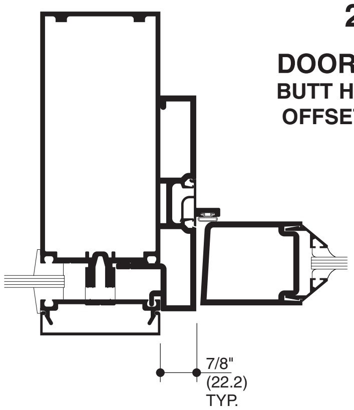
B/H OR O/P **C/H**

ELEVATION IS NUMBER KEYED TO DETAILS



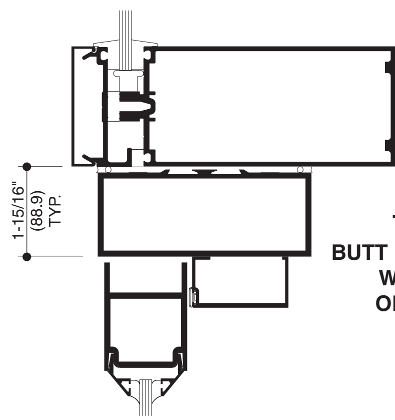
1

TRANSOM BAR
BUTT HUNG OR OFFSET PIVOT WITH SURFACE CLOSER OR FLOOR CLOSER



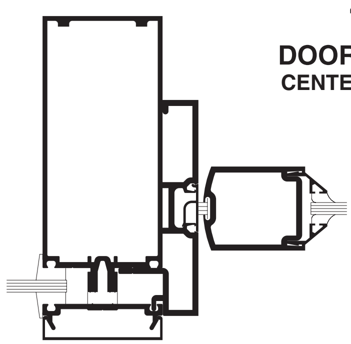
2

DOOR JAMB
BUTT HUNG OR OFFSET PIVOT



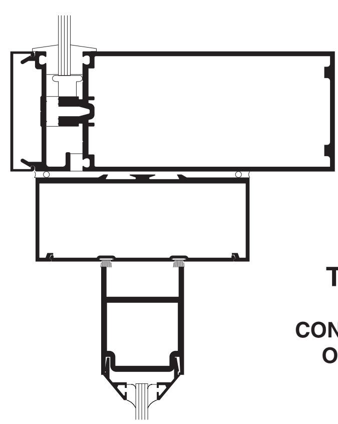
1A

TRANSOM BAR
BUTT HUNG OR OFFSET PIVOT WITH SINGLE ACTING OFFSET ARM CLOSER



4

DOOR JAMB
CENTER HUNG

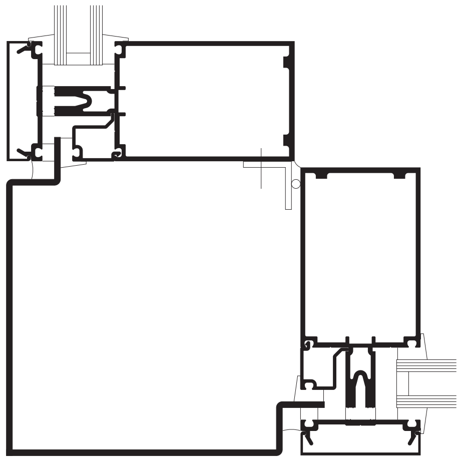


3

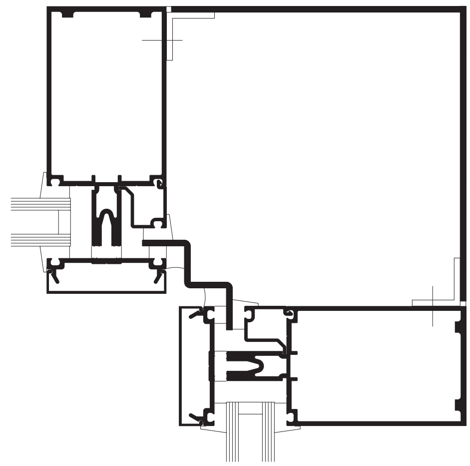
TRANSOM BAR
CENTER HUNG CONCEALED OVERHEAD OR FLOOR CLOSER

SCALE 3" = 1'-0"

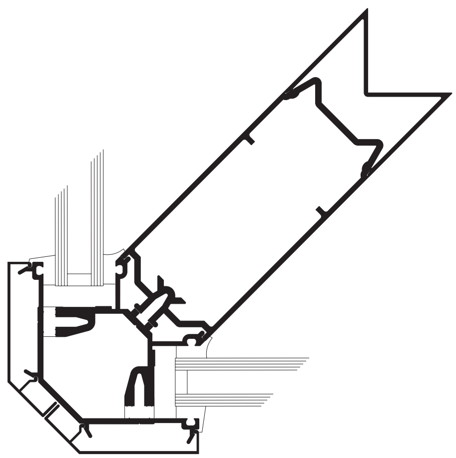
NOTE: 1" SYSTEM SHOWN, 1/4" SYSTEM SIMILAR.



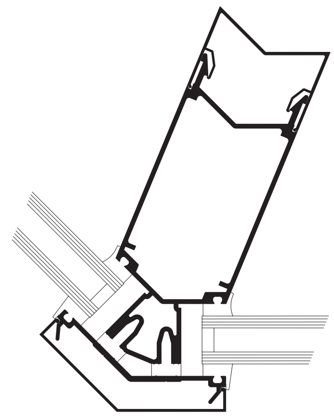
90° OUTSIDE CORNER



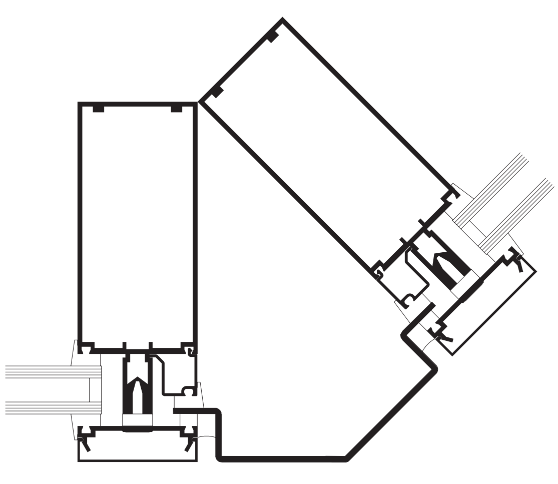
90° INSIDE CORNER



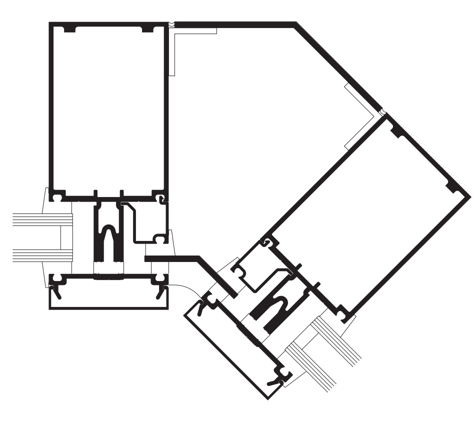
90° OUTSIDE CORNER



135° OUTSIDE CORNER

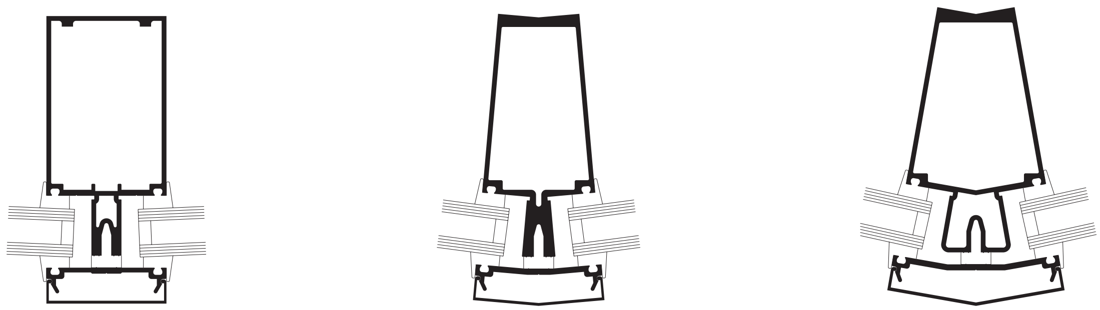


135° OUTSIDE CORNER



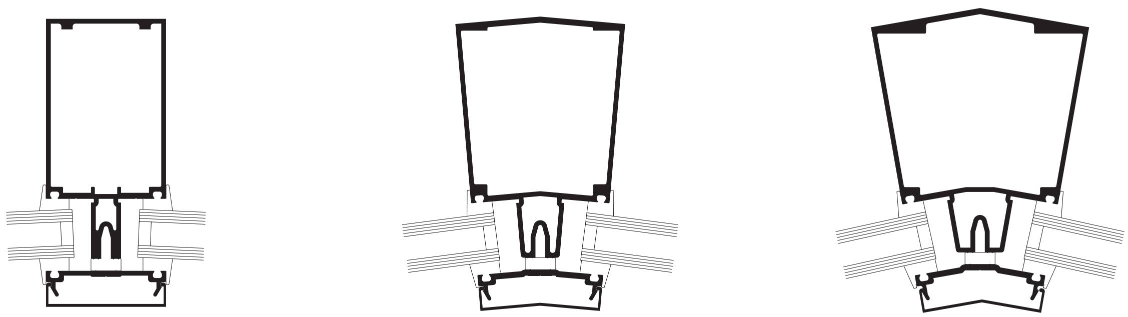
135° INSIDE CORNER

SCALE 3" = 1'-0"



0° TO 5° 5° TO 15° 15° TO 25°

OUTSIDE SPLAYED MULLIONS

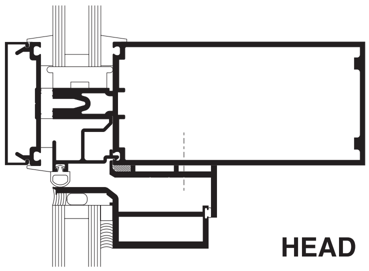


0° TO 5° 5° TO 15° 15° TO 25°

INSIDE SPLAYED MULLIONS

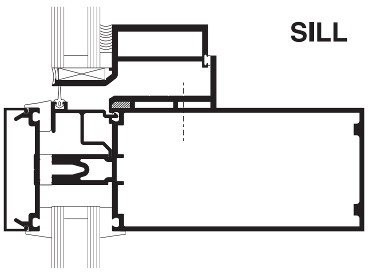
SCALE 3" = 1'-0"

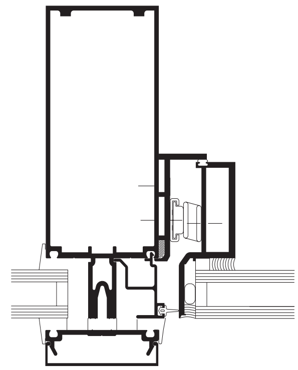
1600 GLASSVENT



HEAD

SILL

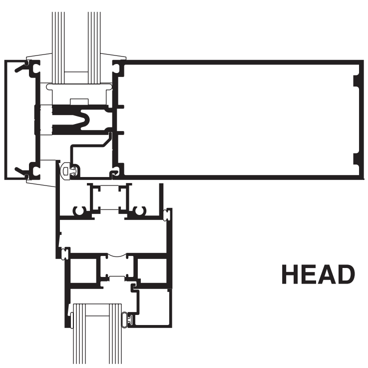




JAMB

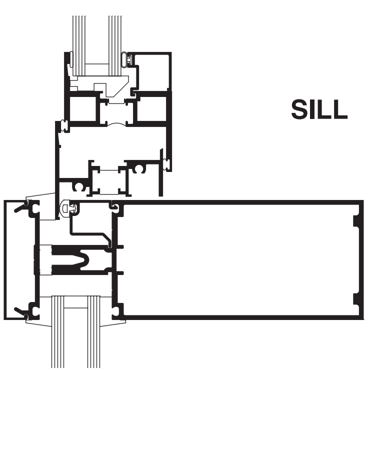
8225 TL WINDOWS

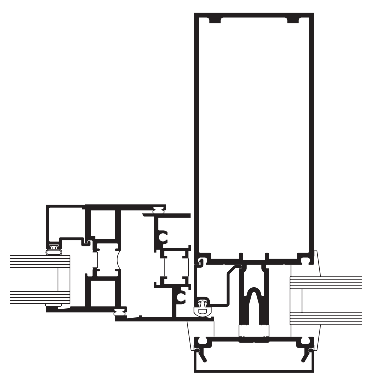
NOTE: Other vent types can be accommodated. Contact your Kawneer representative for other options.



HEAD

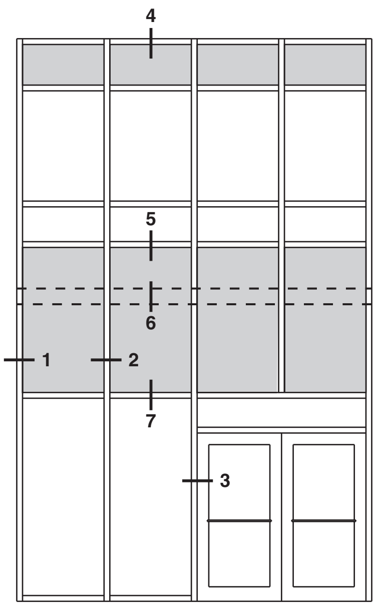
SILL





JAMB

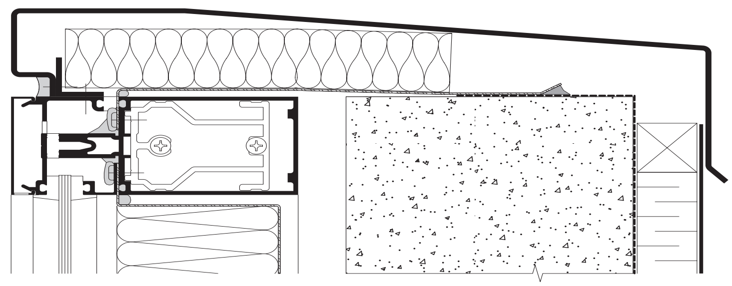
SCALE 3" = 1'-0"



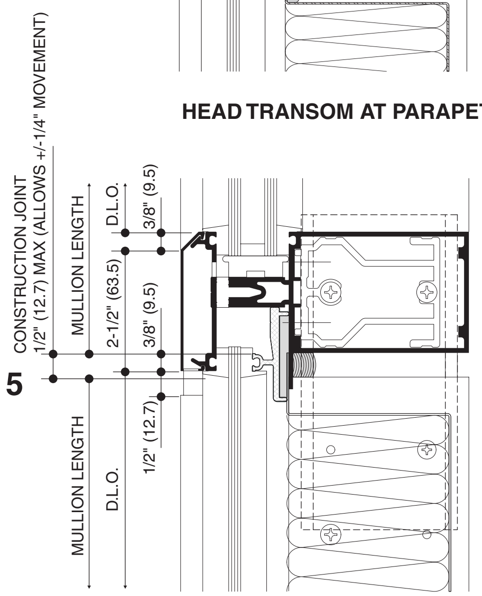
ELEVATION IS NUMBER KEYED TO DETAILS

NOTE: 6" SYSTEM SHOWN, 7-1/2" SYSTEM SIMILAR

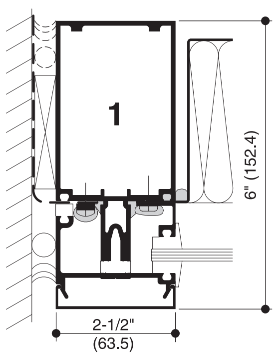
4



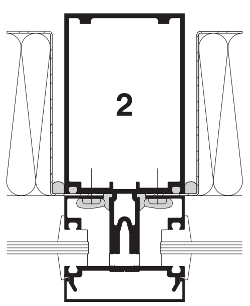
HEAD TRANSOM AT PARAPET FLASHING



EXPANSION JOINT

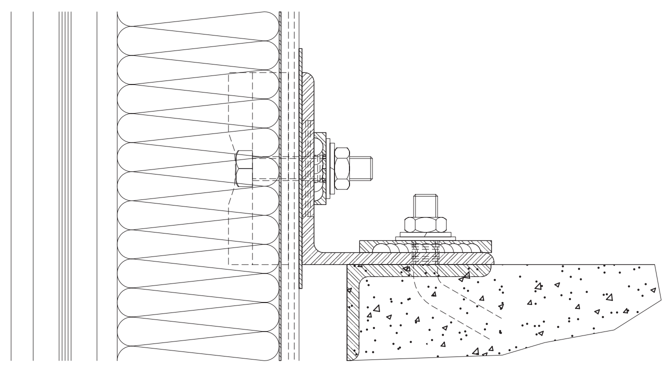


JAMB MULLION AT SPANDREL

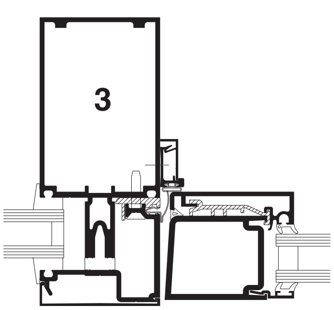


MULLION AT SPANDREL

6

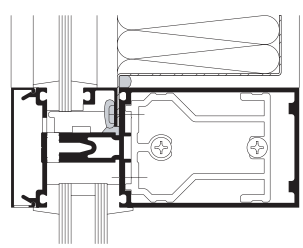


TYPICAL DEADLOAD ANCHOR



THERMALLY BROKEN DOOR ADAPTOR FOR INSULCLAD DOORS

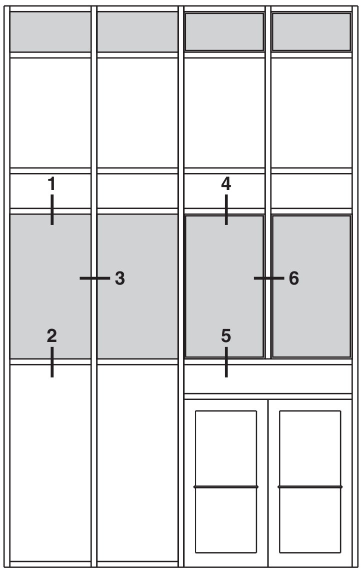
7



TRANSOM – SPANDREL OVER VISION

KAWNEER AN ALCOA COMPANY

SCALE 3" = 1'-0"



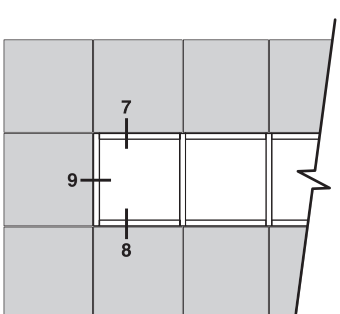
ELEVATION IS NUMBER KEYED TO DETAILS

NOTE: 6" SYSTEM SHOWN, 7-1/2" SYSTEM SIMILAR

***Reynobond ACM (Aluminum Composite Material) is manufactured by Alcoa Cladding Systems.**

Reynobond ACM panels are available in a wide variety of sizes and shapes and are colored with Colorweld® 300 coatings. Colorweld® 300 coatings are Kynar 500®/Hylar 5000® finishes which feature durable polyvinylidene fluoride (PVDF) resins. Colorweld® 300 Series 4 finishes are designed to match Kawneer's anodized colors.

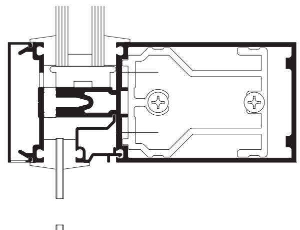
For additional information on Reynobond contact 770-840-6456.



GLAZED-IN PANEL

- PRIME SEALED SHOWN WITH 4.0mm REYNOBOND PANEL, 6.0mm SIMILAR.
- RAIN SCREEN, PRESSURE EQUALIZED (BACKPAN) OPTIONAL

1



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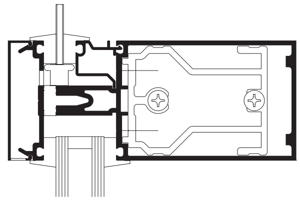
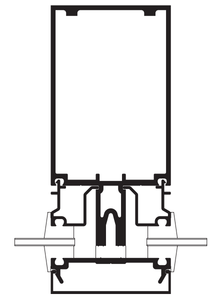


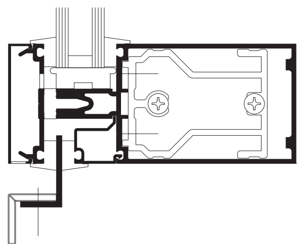


3

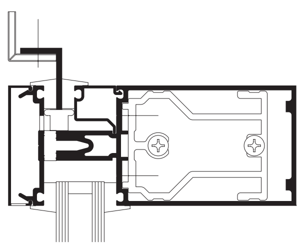
FLUSH PANEL

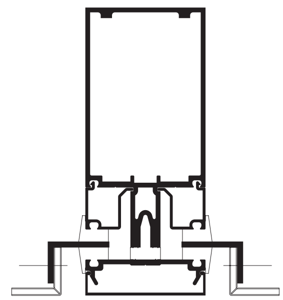
- PRIME SEALED SHOWN WITH 4.0mm REYNOBOND PANEL, 6.0mm SIMILAR.
- RAIN SCREEN, PRESSURE EQUALIZED (BACKPAN) OPTIONAL

4



5



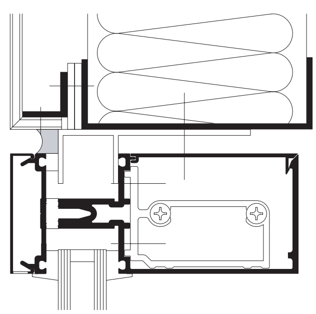


6

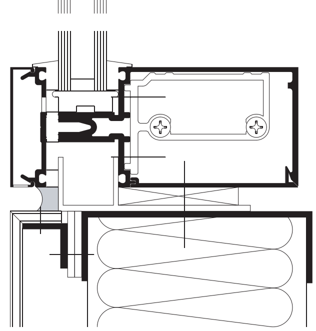
PUNCHED OPENING / RIBBON WINDOW INTEGRATION

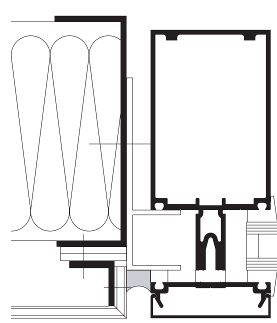
- SHOWN WITH 6.0mm REYNOBOND PANEL, 4.0mm SIMILAR.

7



8

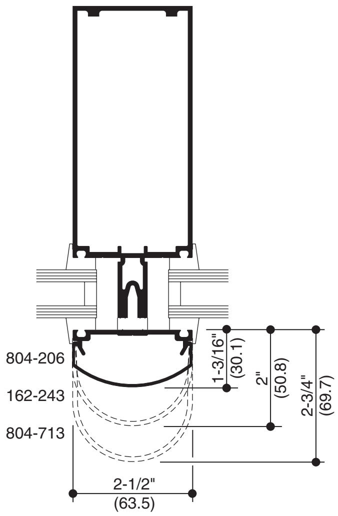




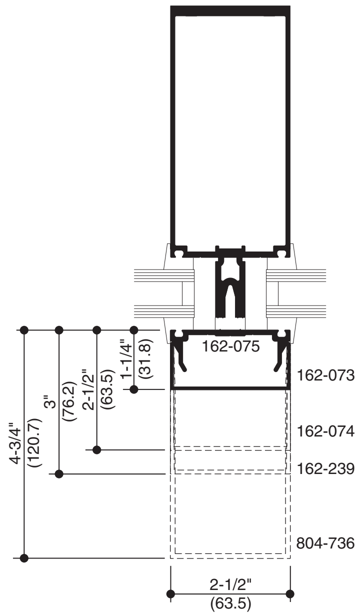
9

SCALE 3" = 1'-0"

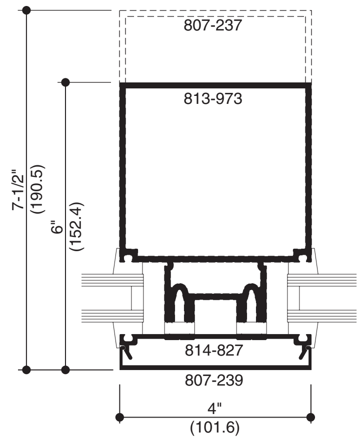
Architects – Most extrusion and window types illustrated in this catalog are standard products for Kawneer. These concepts have been expanded and modified to afford you design freedom. Some miscellaneous details are non-standard and are intended to demonstrate how the system can be modified to expand design flexibility. Please contact your Kawneer representative for further assistance.



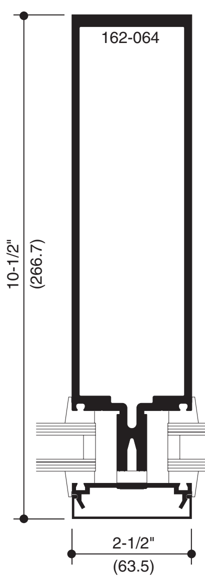
OPTIONAL COVERS



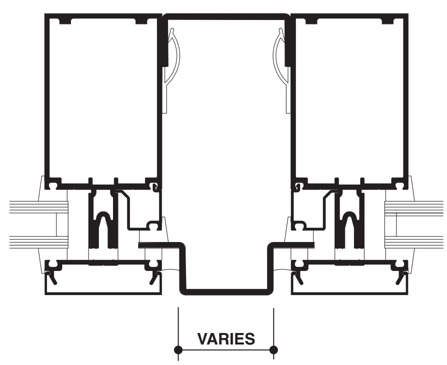
OPTIONAL COVERS



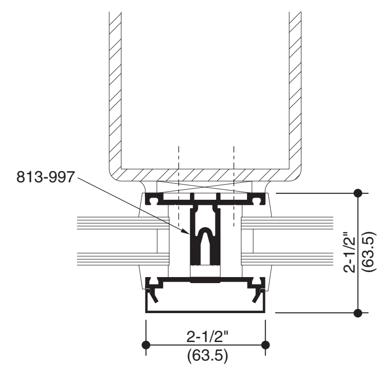
4" SIGHT LINE



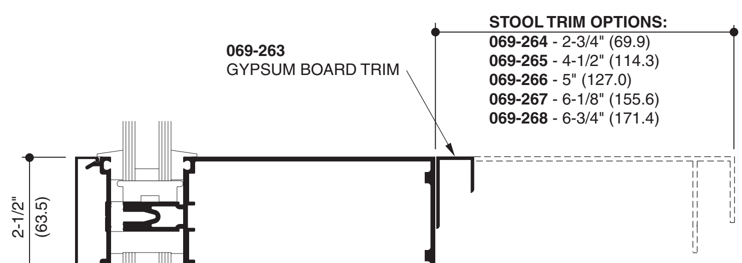
DEEP MULLION



DOUBLE MULLION



VENEER SYSTEM

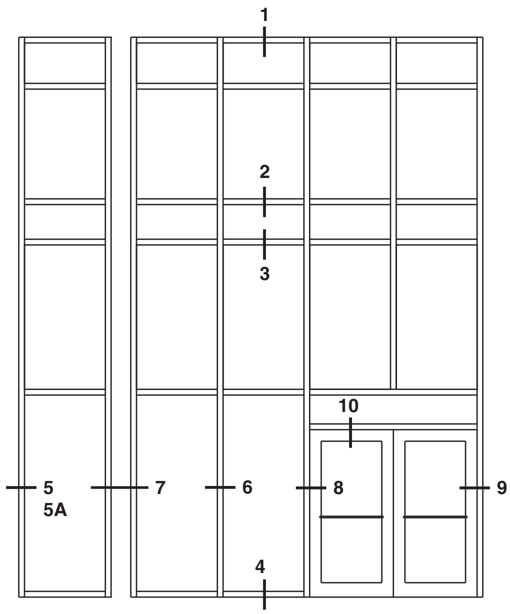


NOTE:
STOOL TRIMS REQUIRE **069-271** TRIM CLIP PACKAGE

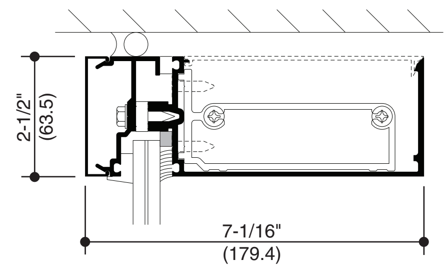
INTERIOR STOOL TRIM

NOTE: DETAILS SHOWN WITH 9/16" INFILL AND ARE GLAZED FOR FOR LARGE MISSLE IMPACT (LMI). SEE NEXT PAGE FOR OTHER GLAZING OPTIONS.

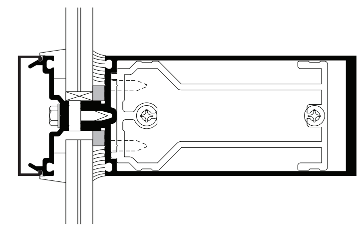
SCALE 3" = 1'-0"



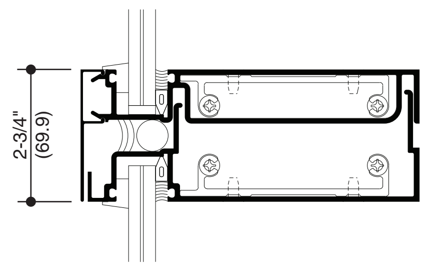
ELEVATION IS NUMBER KEYED TO DETAILS



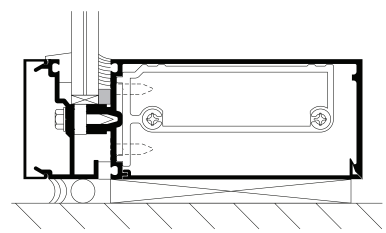
1
HEAD



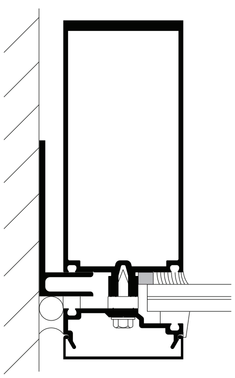
2
HORIZONTAL



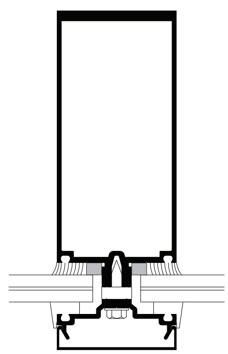
3
EXPANSION HORIZONTAL



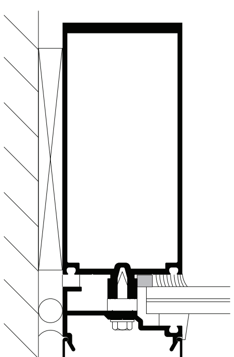
4
SILL



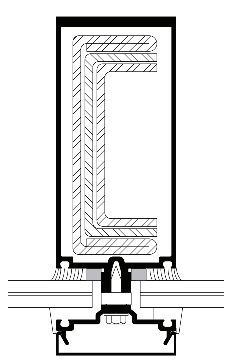
5
JAMB



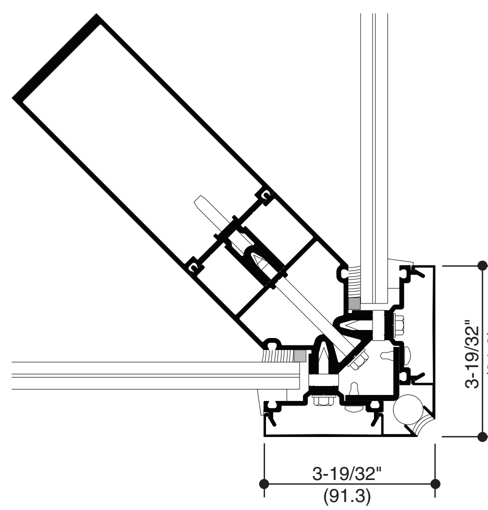
6
VERTICAL



5A
JAMB



OPTIONAL STEEL REINFORCING AS REQUIRED



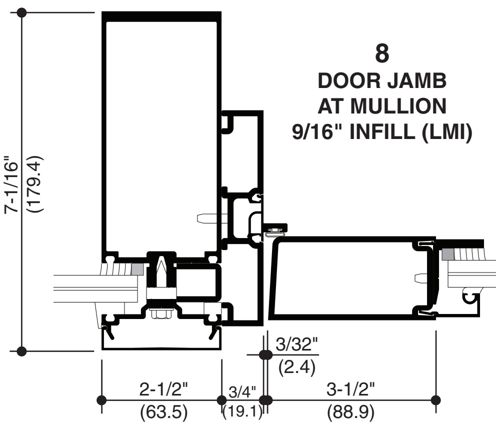
7
90° CORNER

Laws and building and safety codes governing the design and use of glazed entrance, window, and curtain wall products vary widely. Kawneer does not control the selection of product configurations, operating hardware, or glazing materials, and assumes no responsibility therefor.

Kawneer reserves the right to change configuration without prior notice when deemed necessary for product improvement.

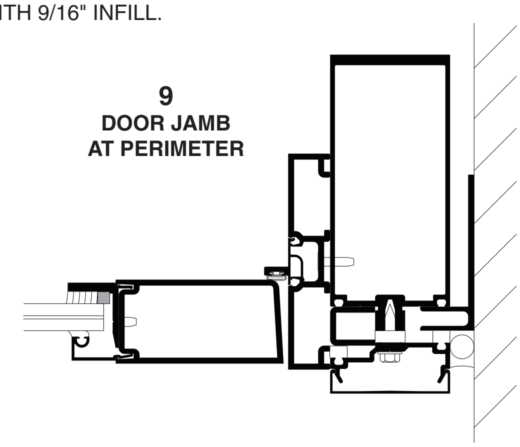
SCALE 3" = 1'-0"

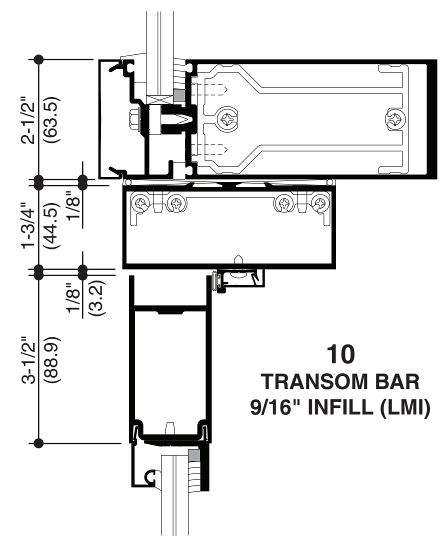
NOTE: 350 IR DOORS ARE USED WITH IMPACT FRAMING.
DOORS ARE GLAZED WITH 9/16" INFILL.



8
DOOR JAMB AT MULLION 9/16" INFILL (LMI)

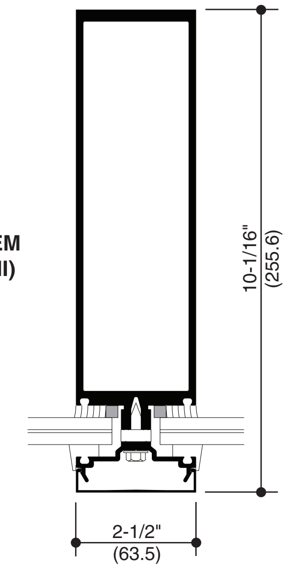
9
DOOR JAMB AT PERIMETER





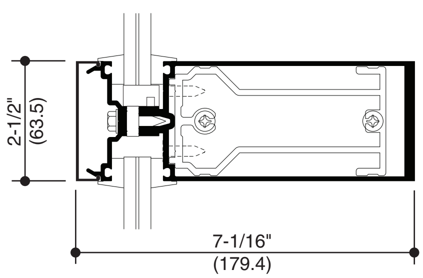
10
TRANSOM BAR 9/16" INFILL (LMI)

OPTIONAL 10" DEEP SYSTEM 9/16" INFILL (LMI)

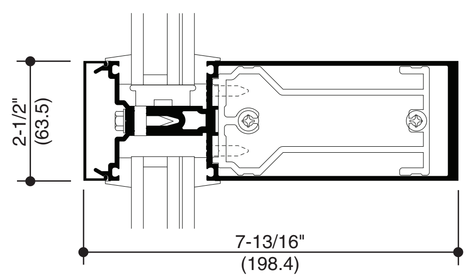


GLAZING OPTIONS

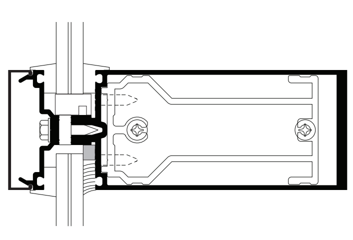
9/16" INFILL (SMI) SMALL MISSILE IMPACT



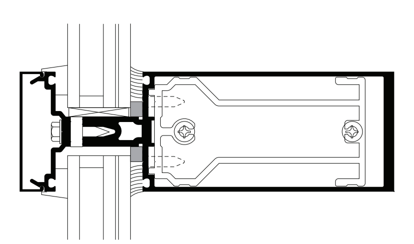
1-5/16" INFILL (SMI) SMALL MISSILE IMPACT



9/16" INFILL (SMI) OVER 9/16" INFILL (LMI)

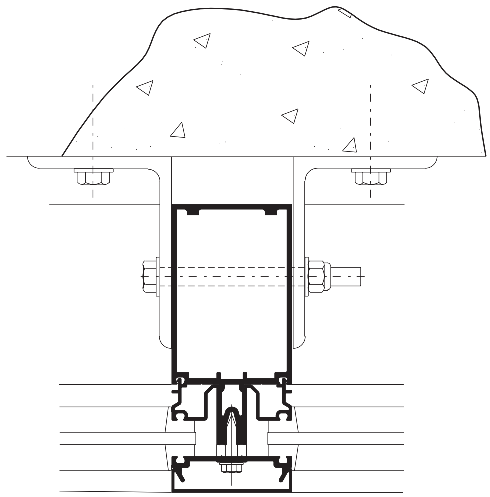


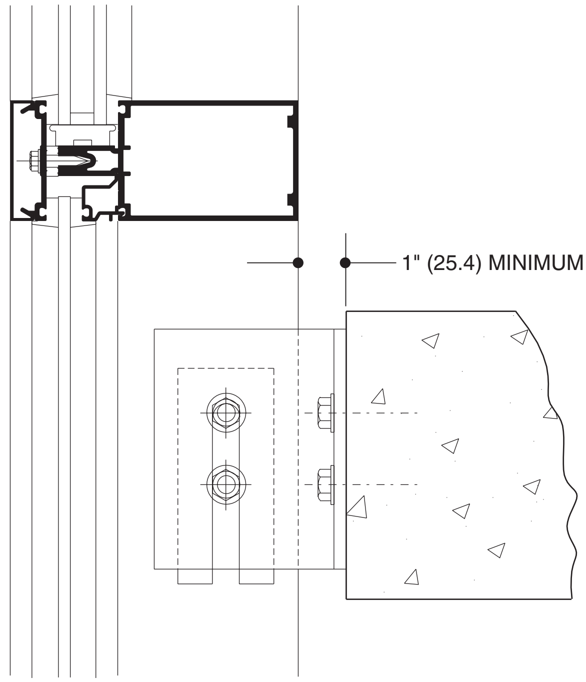
1-5/16" INFILL (LMI) LARGE MISSILE IMPACT



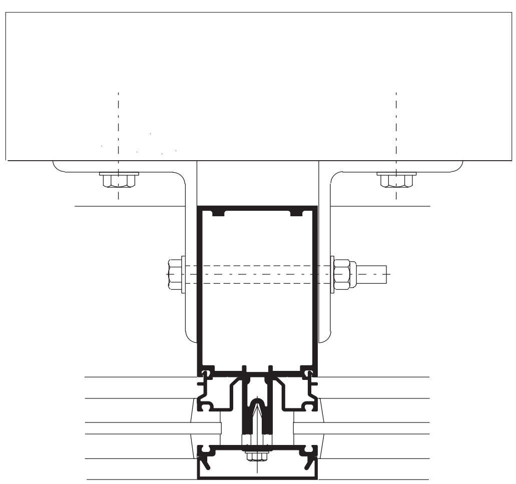
KAWNEER
AN ALCOA COMPANY

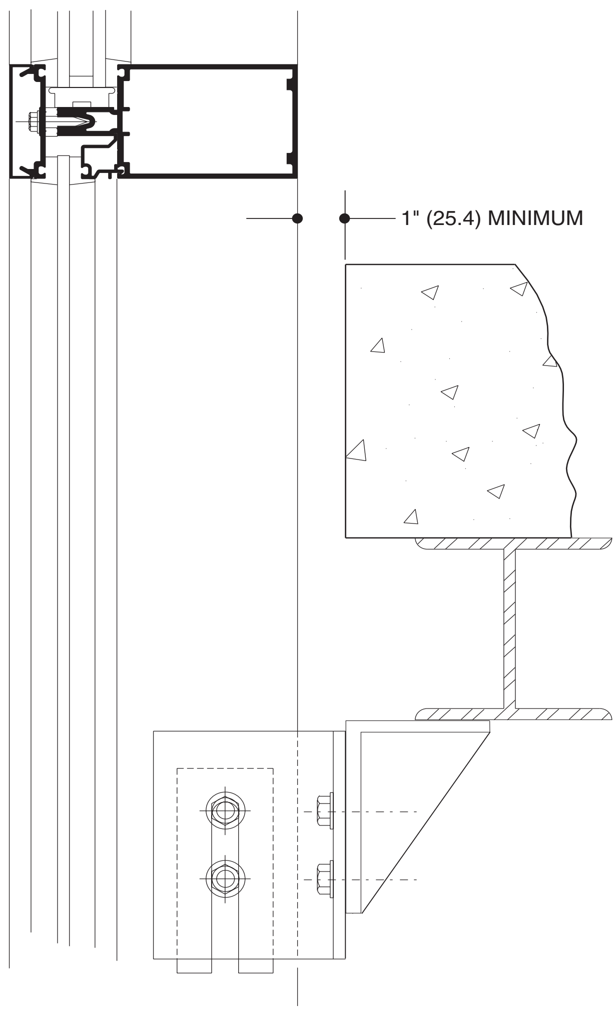
Actual project conditions will determine specific anchor design. Details on this page are for reference only.





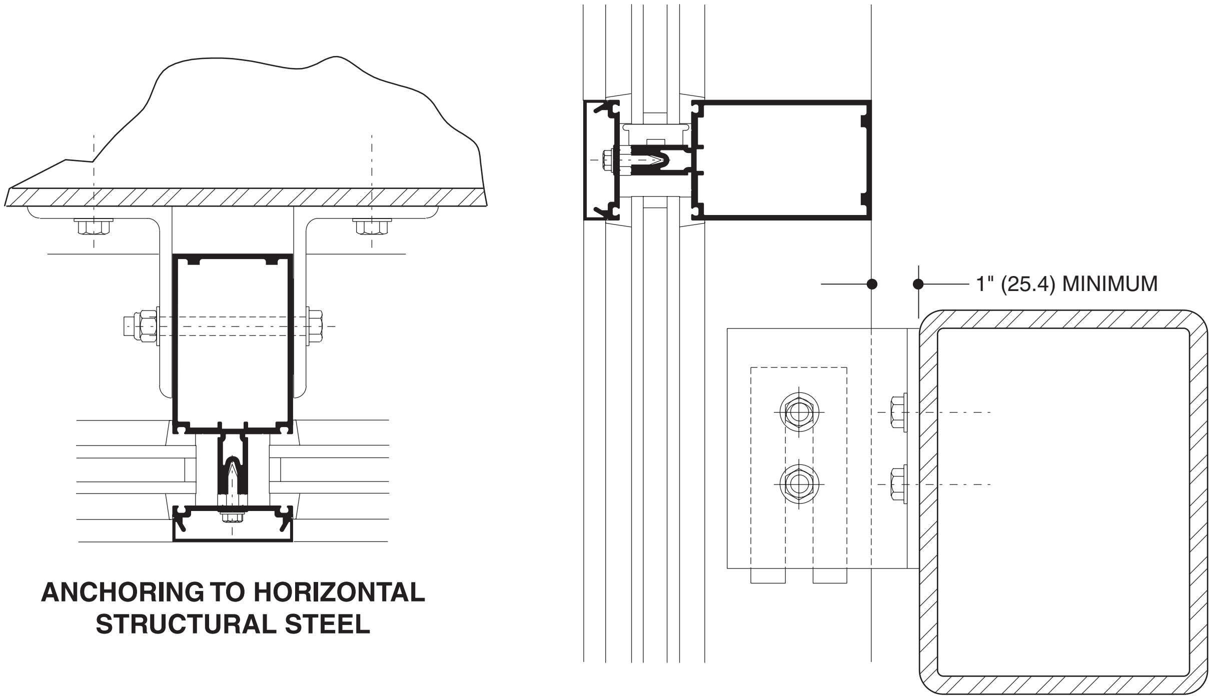
ANCHORING TO FLOOR SLAB



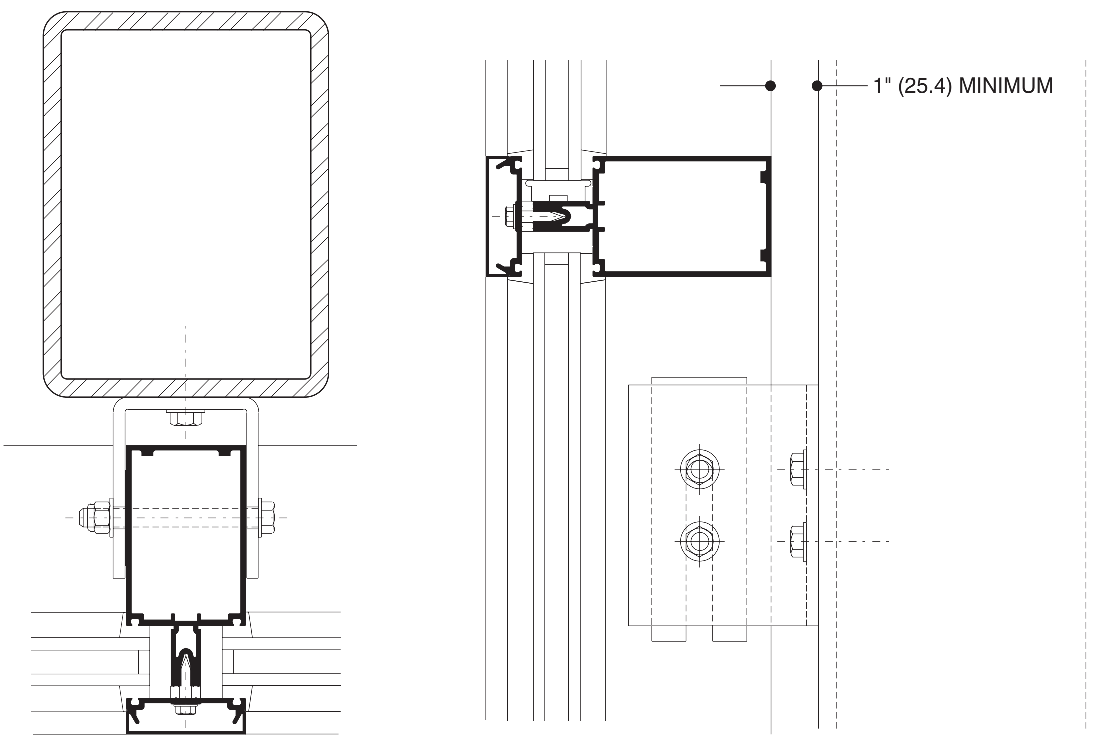


ANCHORING TO SUPPORT STEEL

Actual project conditions will determine specific anchor design. Details on this page are for reference only.



ANCHORING TO HORIZONTAL STRUCTURAL STEEL



ANCHORING TO VERTICAL STRUCTURAL STEEL

WIND LOAD CHARTS

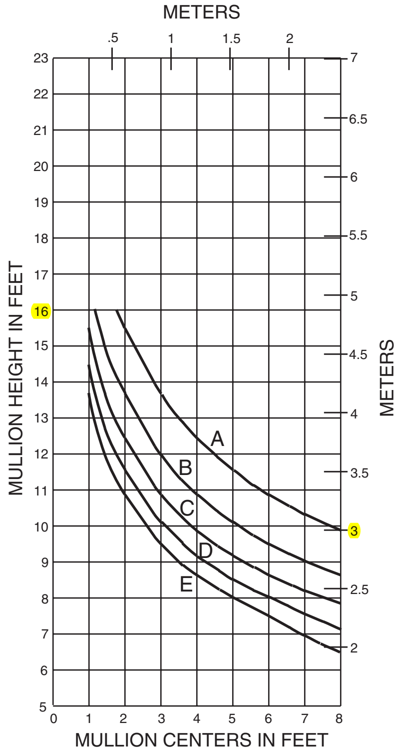
Mullions are designed for deflection limitations in accordance with AAMA TIR-A11 of L/175 up to 13'-6" and L/240 +1/4" above 13'-6". These curves are for mullions WITH HORIZONTALS and are based on engineering calculations for stress and deflection. Allowable wind load stress for ALUMINUM 15,152 p.s.i. (104MPa), STEEL 30,000 p.s.i. (207MPa.). Charted curves, in all cases are for the limiting value. A 4/3 increase in allowable stress has not been used to develop these curves. For special situations not covered by these curves, contact your Kawneer representative for additional information.

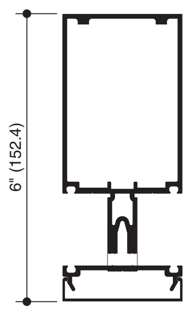
DEADLOAD CHARTS

Horizontal or deadload limitations are based upon 1/8" (3.2), maximum allowable deflection at the center of an intermediate horizontal member. The accompanying charts are calculated for 1" (25.4) thick insulating glass or 1/4" (6.35) thick glass supported on two setting blocks placed at the loading points shown.

A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)

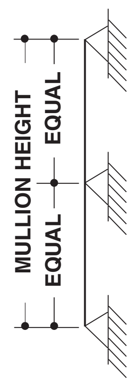
SINGLE SPAN



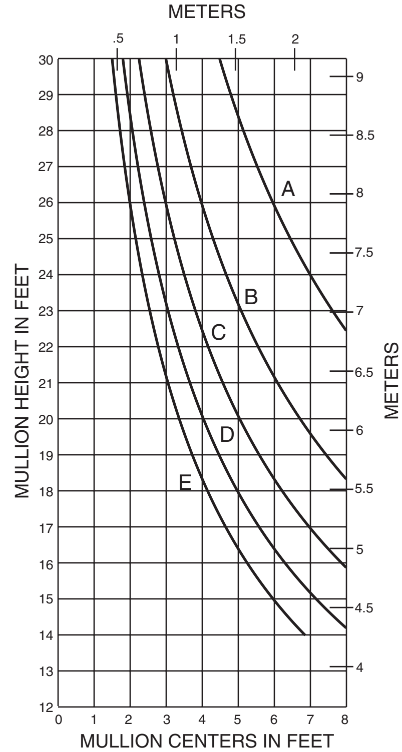


162-001

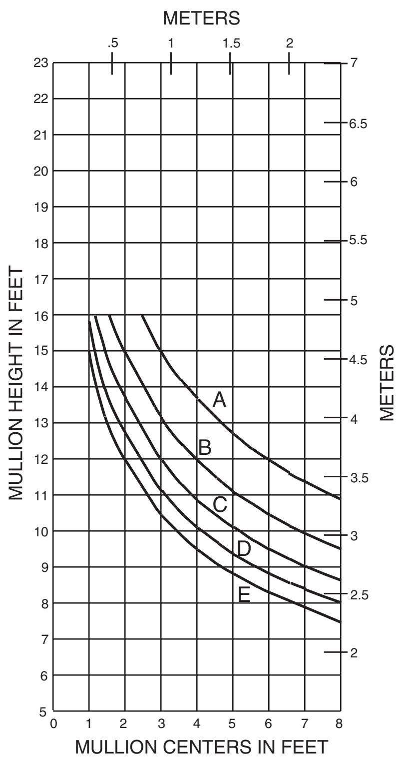
I = 5.035(209.57 x 10[4])
S = 1.993(32.66 x 10[3])

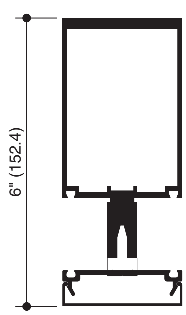


TWIN SPAN



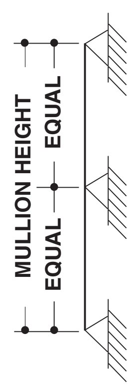
SINGLE SPAN



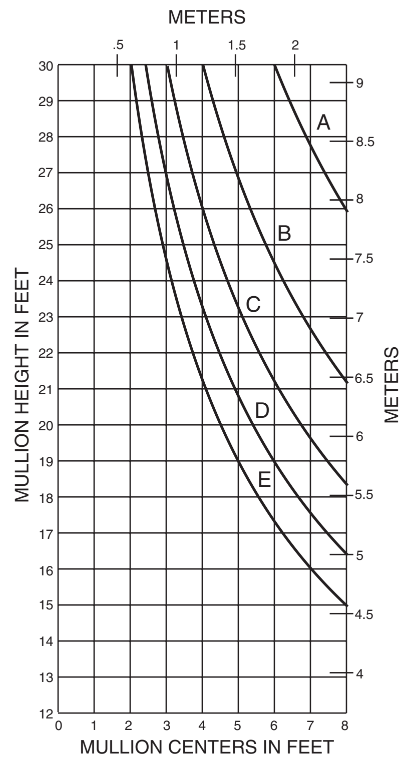


162-002

I = 6.779(282.16 x 10[4])
S = 2.652(43.46 x 10[3])



TWIN SPAN



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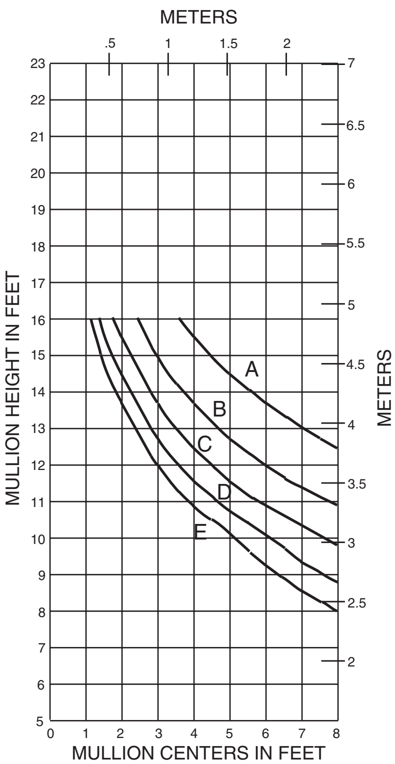
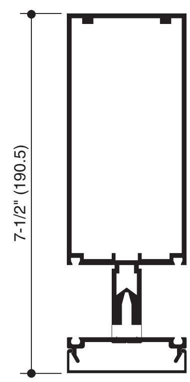
A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)

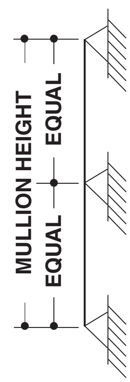
SINGLE SPAN



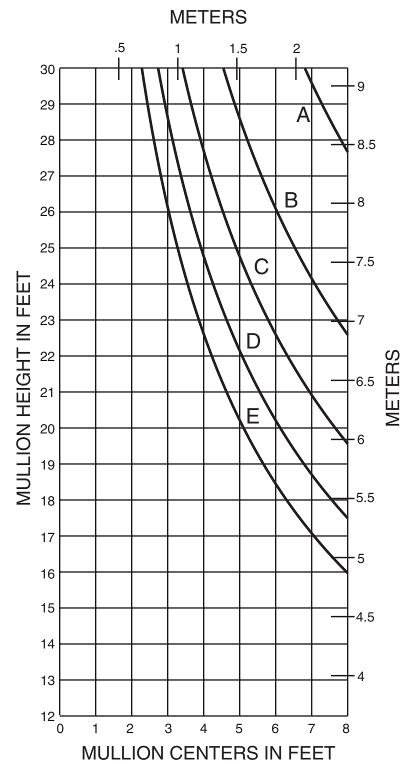


162-003

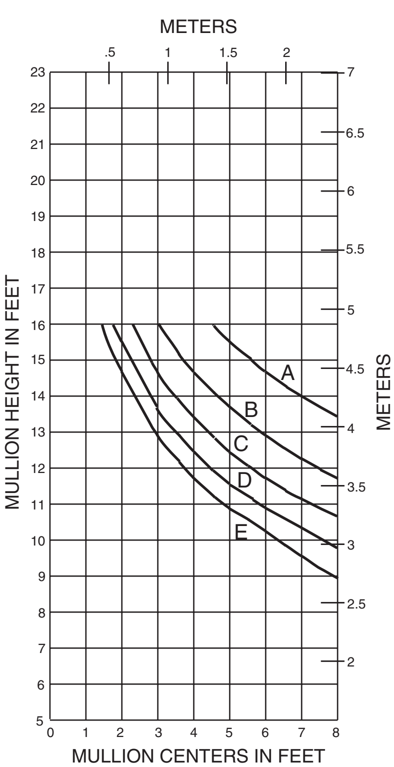
I = 10.135(421.85 x 10^4)
S = 3.027(49.60 x 10^3)

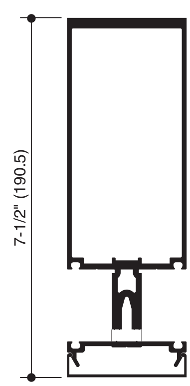


TWIN SPAN



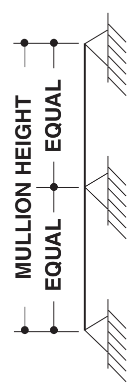
SINGLE SPAN



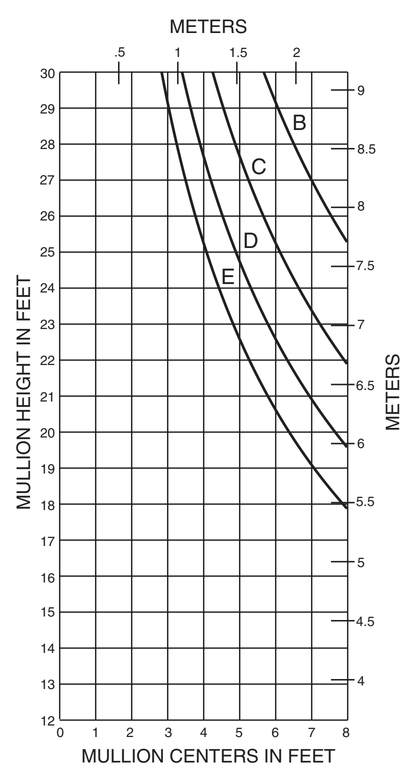


162-004

I = 12.736(530.11 x 10^4)
S = 3.791(62.12 x 10^3)



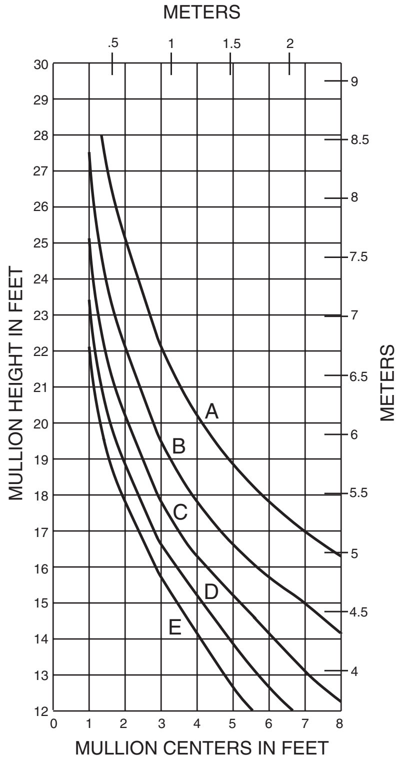
TWIN SPAN

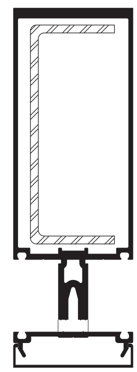


A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)

SINGLE SPAN

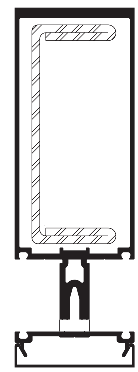
162-004 W/162-300





162-004
W/162-300

Ia = 12.736(530.11 x 10^4)
Sa = 3.791(62.12 x 10^3)
Is = 3.805(158.37 x 10^4)
Ss = 1.669(27.35 x 10^3)

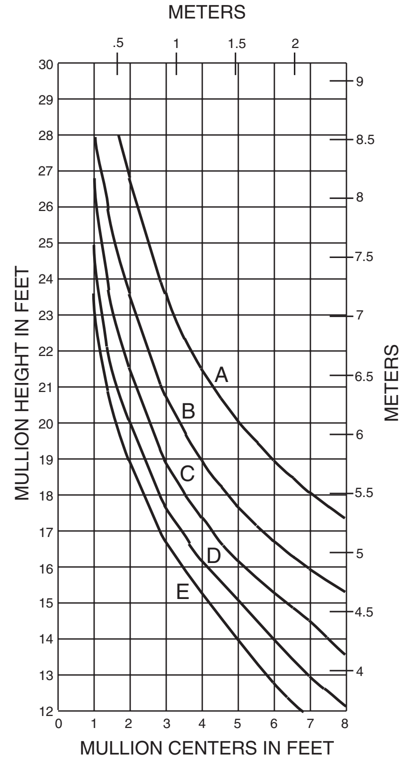


162-004
W/162-301

Ia = 12.736(530.11 x 10^4)
Sa = 3.791(62.12 x 10^3)
Is = 5.684(236.59 x 10^4)
Ss = 2.493(40.85 x 10^3)

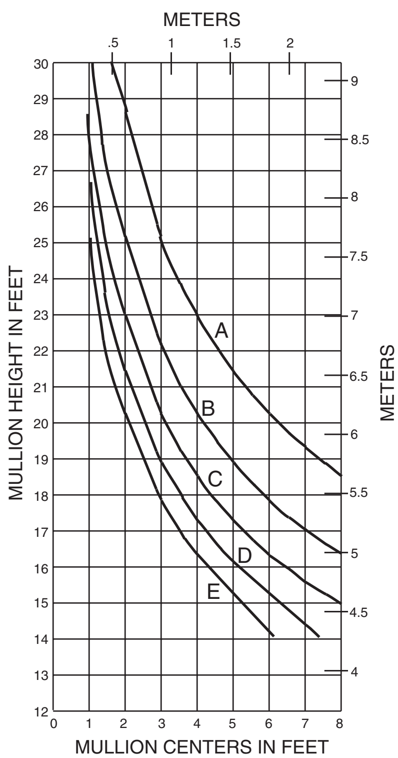
SINGLE SPAN

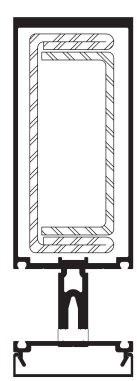
162-004 W/162-301



SINGLE SPAN

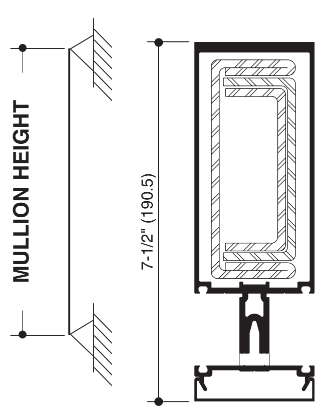
162-004 W/162-301/302





162-004
W/162-301/302

Ia = 12.736(530.11 x 10^4)
Sa = 3.791(62.12 x 10^3)
Is = 7.893(328.53 x 10^4)
Ss = 3.462(56.73 x 10^3)

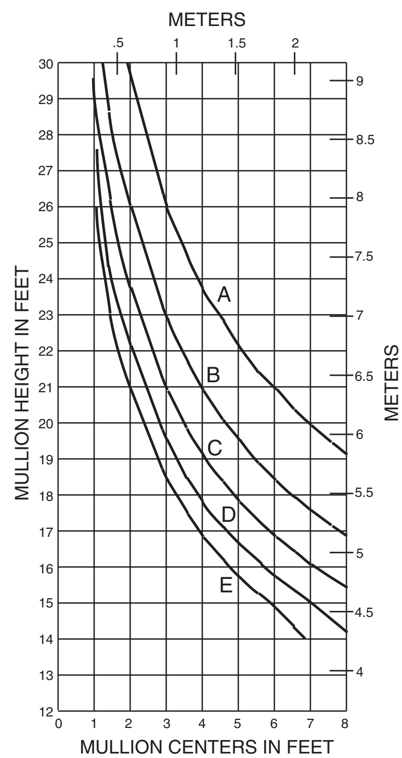


162-004
W/162-301/302/303

Ia = 12.736(530.11 x 10^4)
Sa = 3.791(62.12 x 10^3)
Is = 9.347(389.05 x 10^4)
Ss = 4.100(67.19 x 10^3)

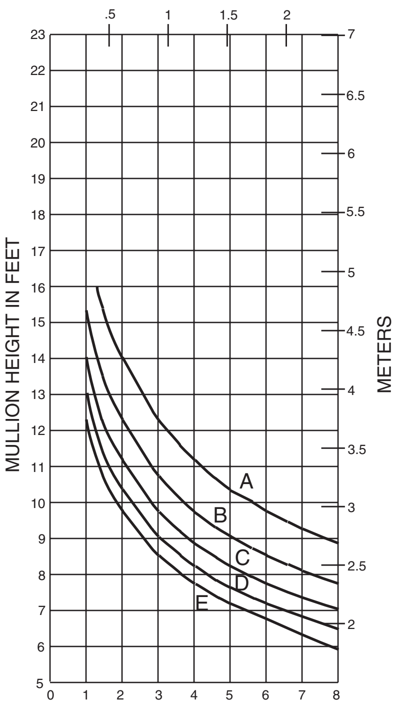
SINGLE SPAN

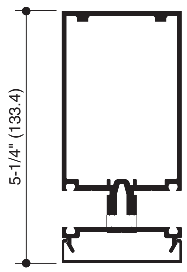
162-004 W/162-301/302/303



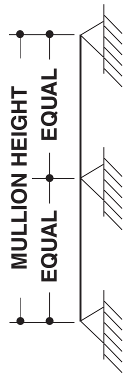
A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)

SINGLE SPAN

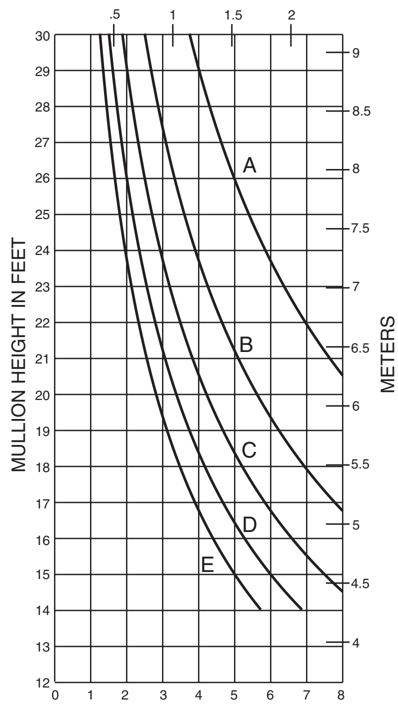




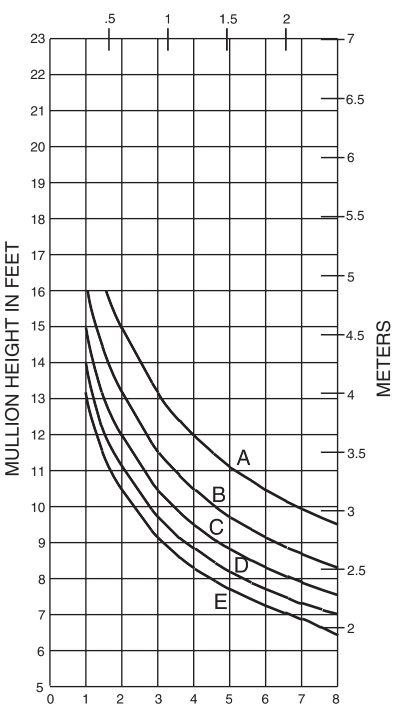
162-013
I = 3.662(152.42 x 10⁴)
S = 1.662(27.24 x 10³)

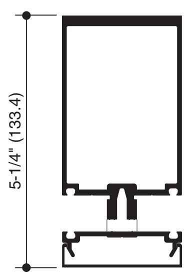


TWIN SPAN

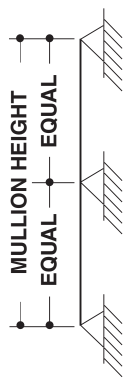


SINGLE SPAN

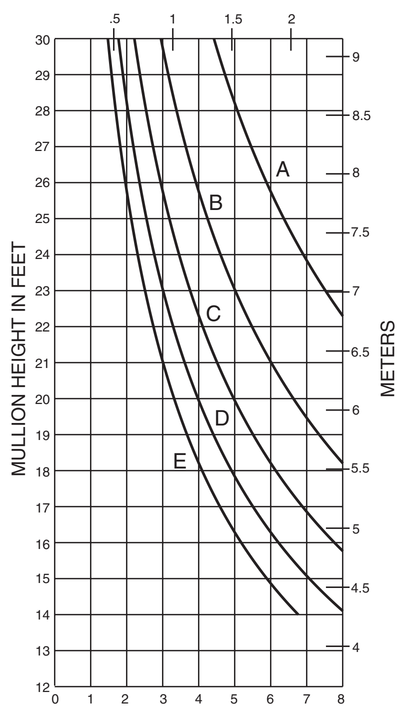




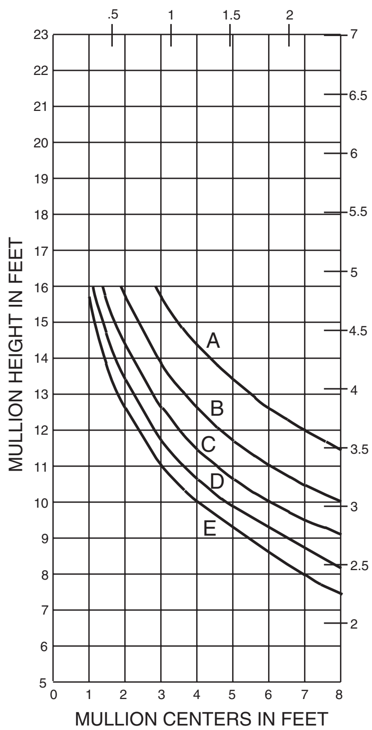
162-014
I = 4.5071(87.60 x 10⁴)
S = 1.968(32.25 x 10³)



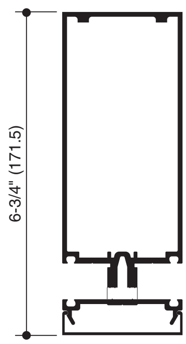
TWIN SPAN



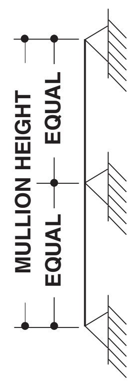
SINGLE SPAN



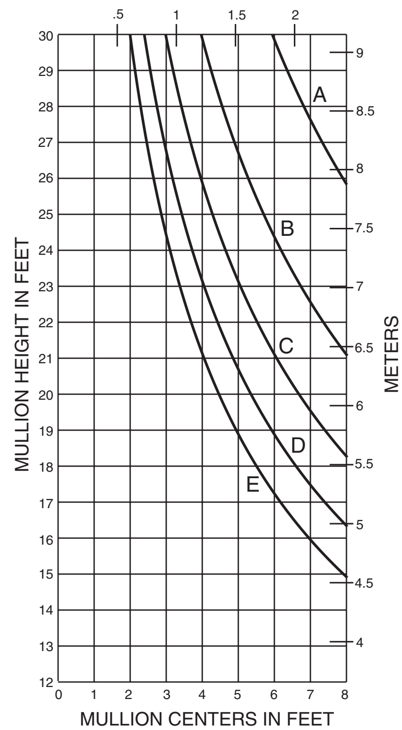
A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)



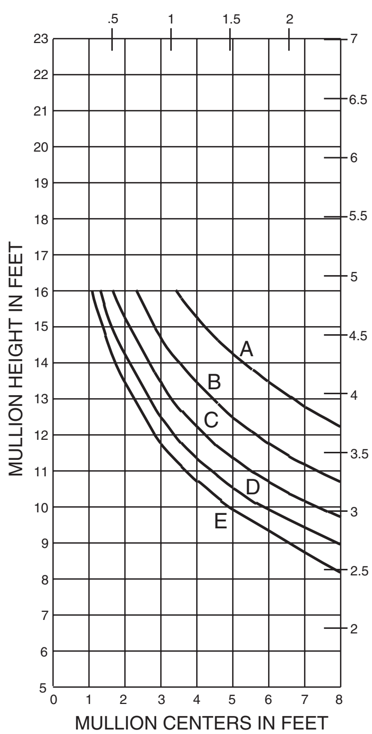
162-015
I = 7.915(329.45 x 10^4)
S = 2.635(43.18 x 10^3)

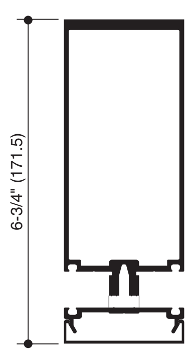


TWIN SPAN

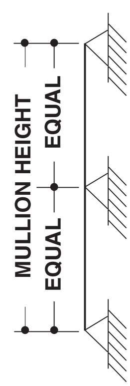


SINGLE SPAN

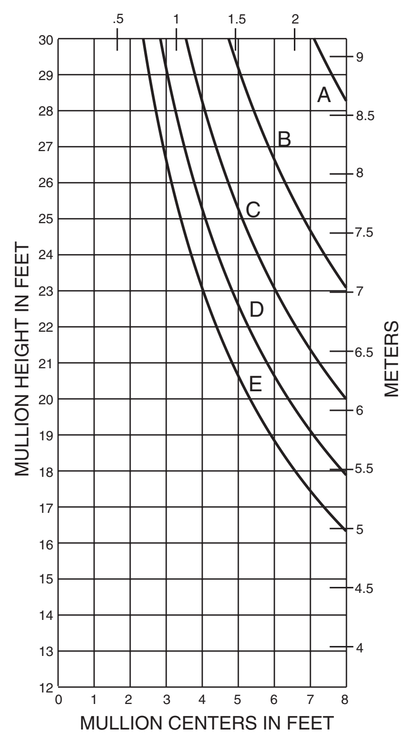




162-016
I = 9.594(399.33 x 10^4)
S = 3.163(51.83 x 10^3)



TWIN SPAN



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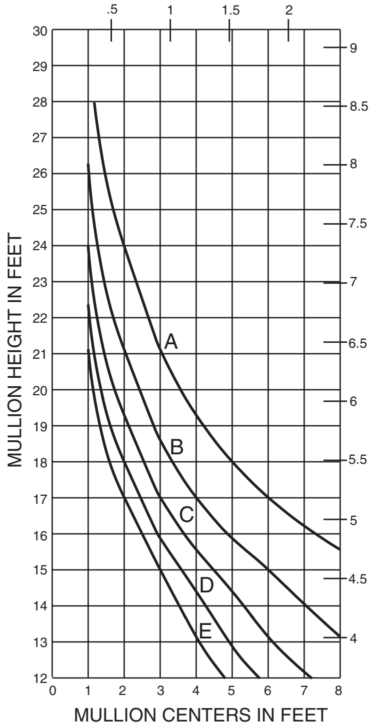
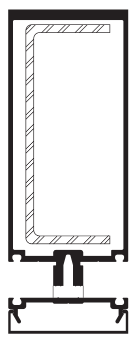
A = 20 PSF (960)
B = 30 PSF (1440)
C = 40 PSF (1920)
D = 50 PSF (2400)
E = 60 PSF (2880)

SINGLE SPAN

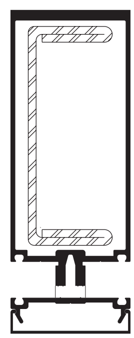
162-016 W/162-300





162-016
W/162-300

Ia = 9.594(399.33 x 10^4)
Sa = 3.163(51.83 x 10^3)
Is = 3.805(158.37 x 10^4)
Ss = 1.669(27.35 x 10^3)

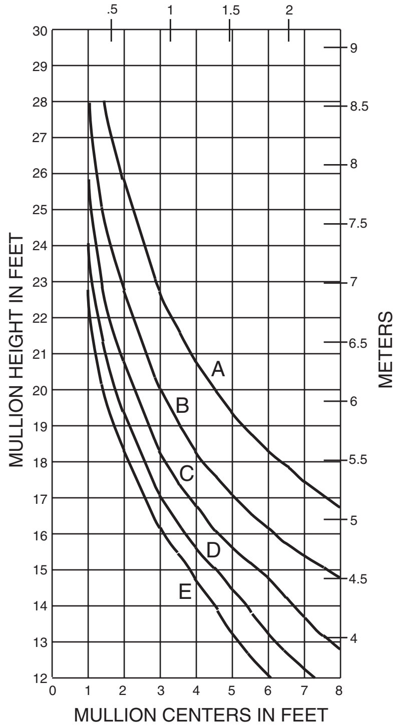


162-016
W/162-301

Ia = 9.594(399.33 x 10^4)
Sa = 3.163(51.83 x 10^3)
Is = 5.684(236.59 x 10^4)
Ss = 2.493(40.85 x 10^3)

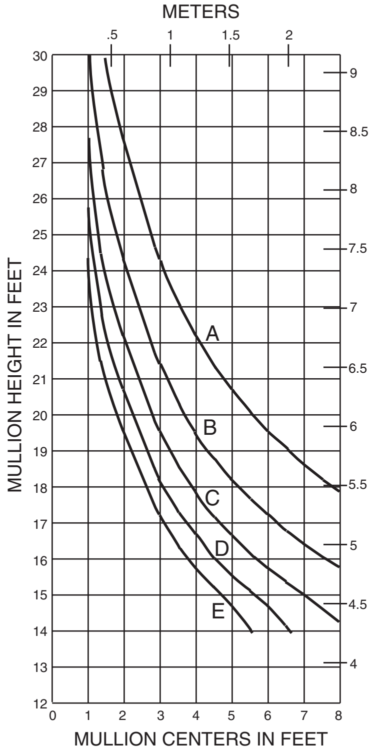
SINGLE SPAN

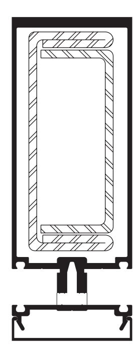
162-016 W/162-301



SINGLE SPAN

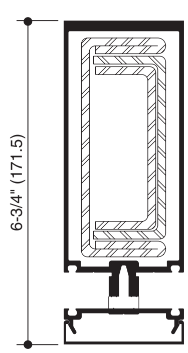
162-016 W/162-301/302





162-016
W/162-301/302

Ia = 9.594(399.33 x 10^4)
Sa = 3.163(51.83 x 10^3)
Is = 7.893(328.53 x 10^4)
Ss = 3.462(56.73 x 10^3)

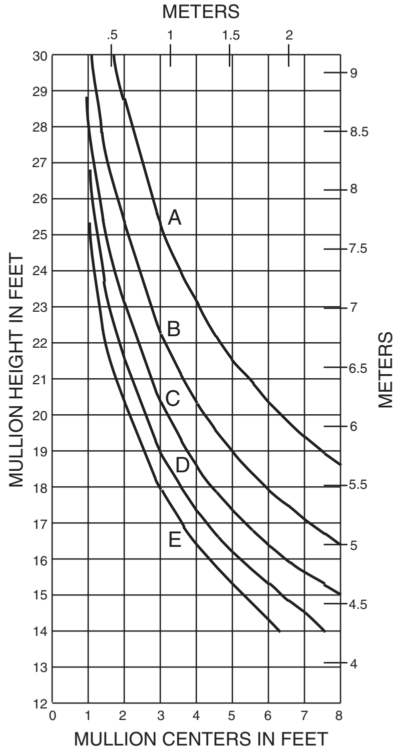


162-016
W/162-301/302/303

Ia = 9.594(399.33 x 10^4)
Sa = 3.163(51.83 x 10^3)
Is = 9.347(389.05 x 10^4)
Ss = 4.100(67.19 x 10^3)

SINGLE SPAN

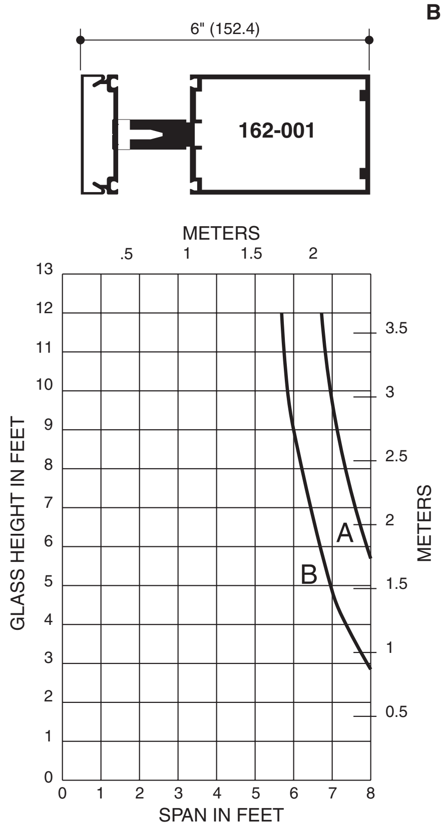
162-016 W/162-301/302/303

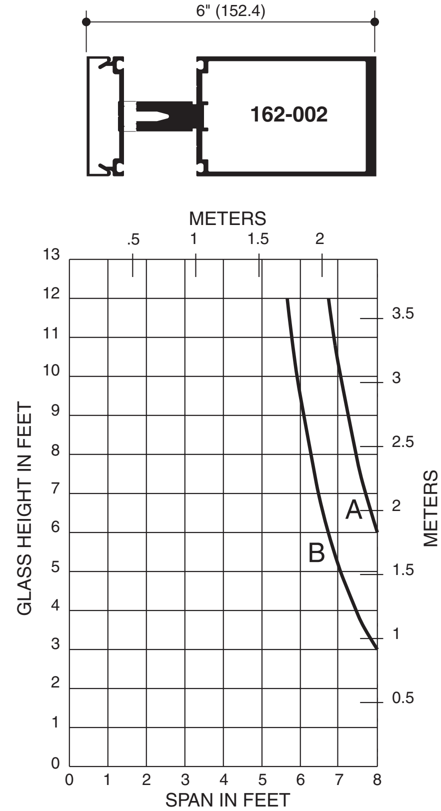


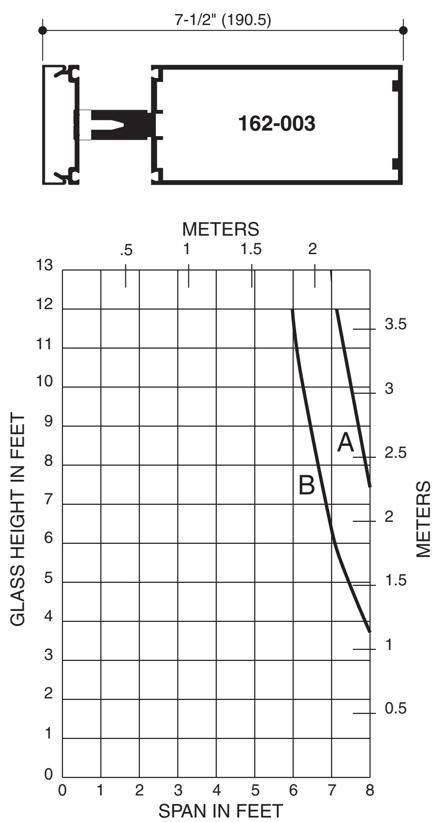
Laws and building and safety codes governing the design and use of glazed entrance, window, and curtain wall products vary widely. Kawneer does not control the selection of product configurations, operating hardware, or glazing materials, and assumes no responsibility therefor.

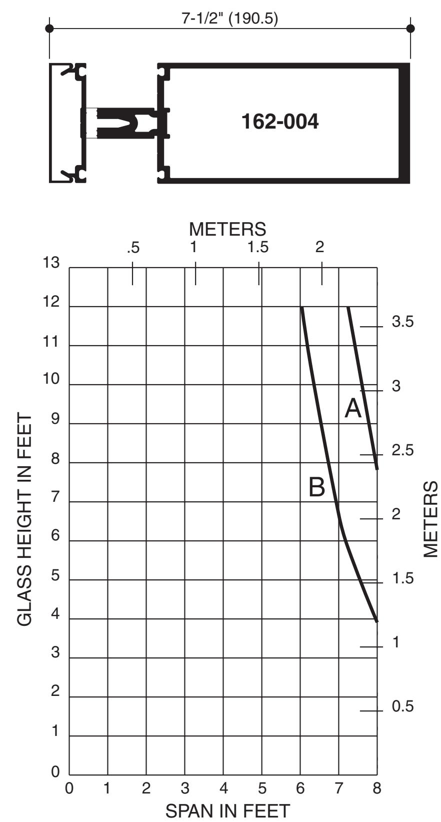
Kawneer reserves the right to change configuration without prior notice when deemed necessary for product improvement.

A - 1/4" GLASS (1/4 POINT LOADING)
B - 1" GLASS (1/4 POINT LOADING)

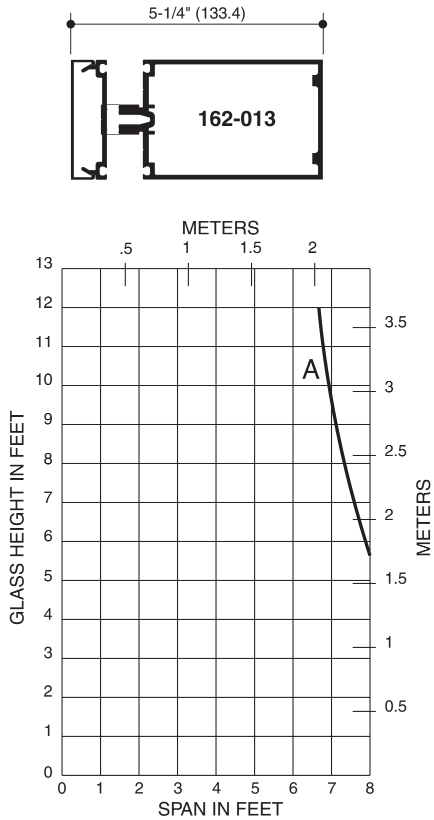


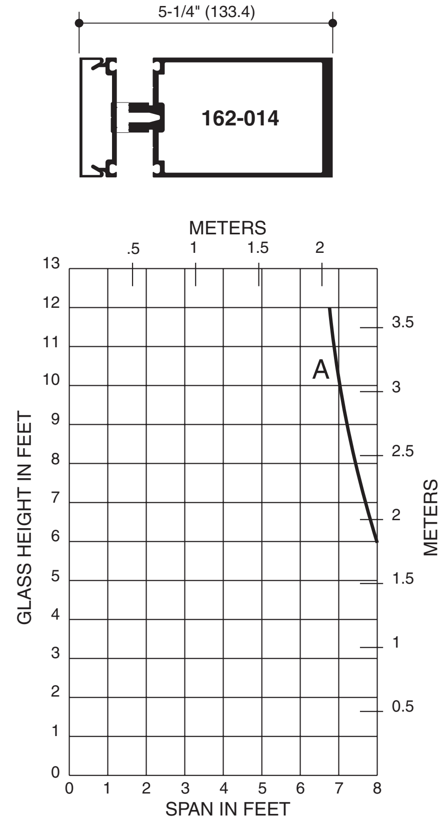


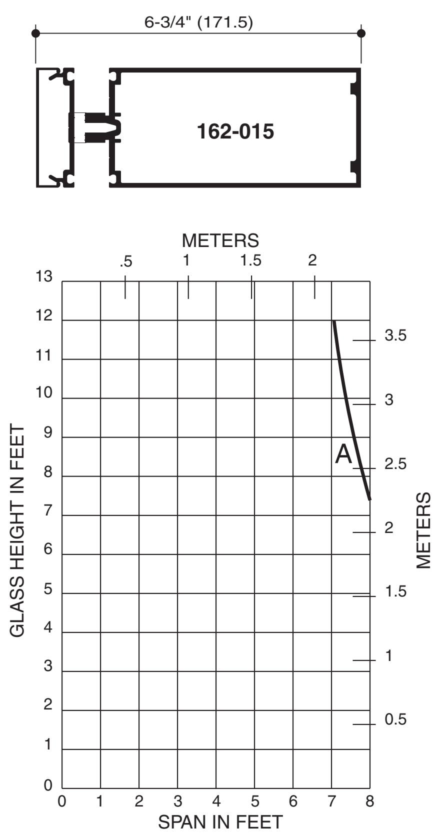


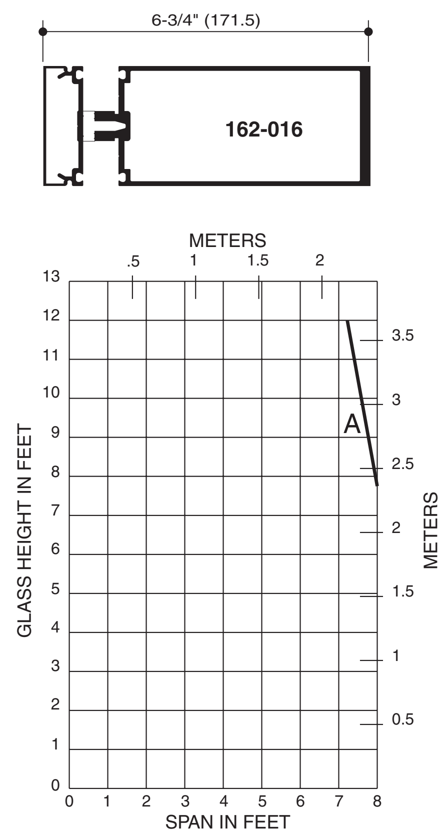


A - 1/4" GLASS (1/4 POINT LOADING)



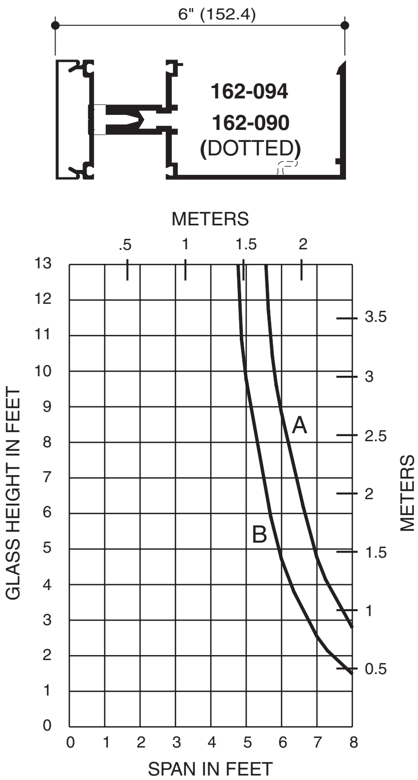




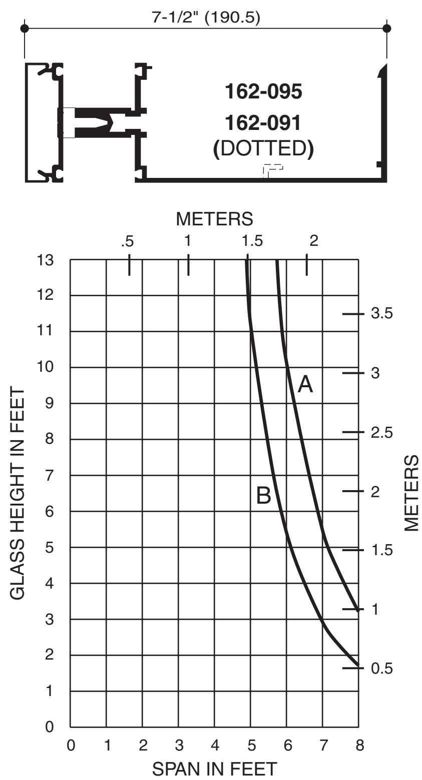


DEADLOAD CHARTS (OPEN BACK)

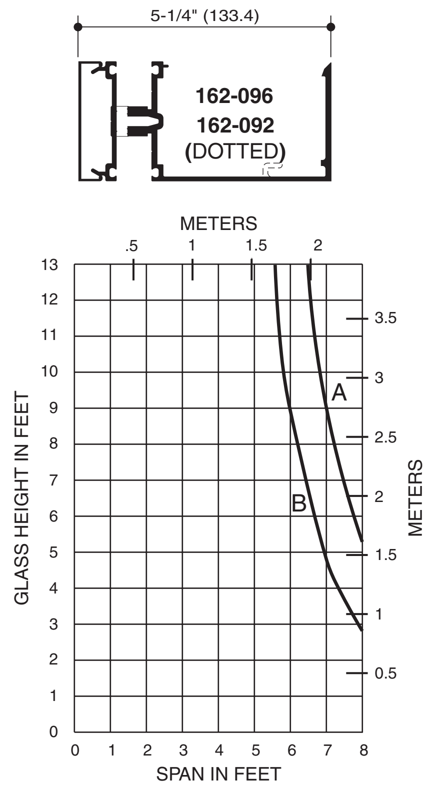
A - 1" GLASS (1/8 POINT LOADING)
B - 1" GLASS (1/4 POINT LOADING)



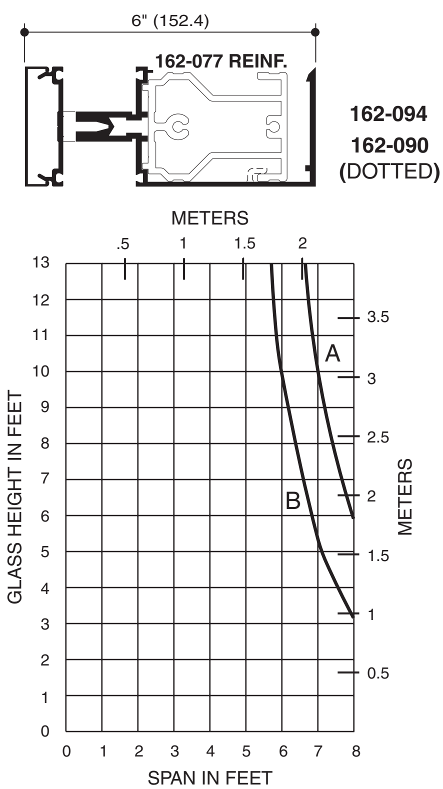
A - 1" GLASS (1/8 POINT LOADING)
B - 1" GLASS (1/4 POINT LOADING)



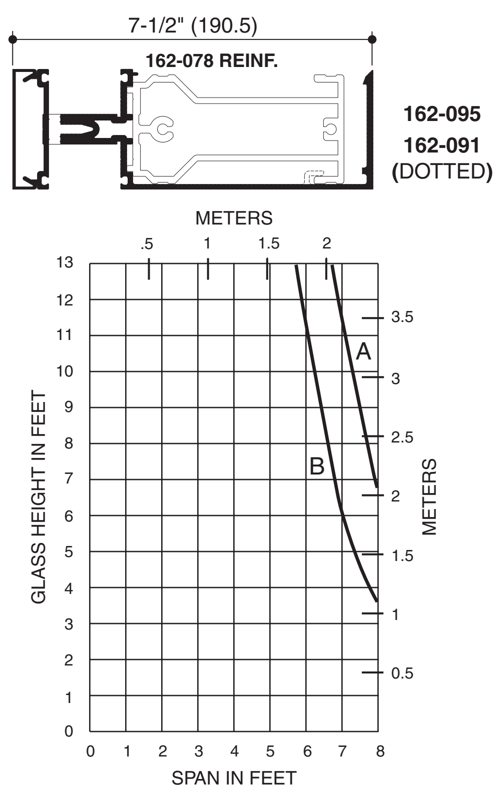
A - 1/4" GLASS (1/8 POINT LOADING)
B - 1/4" GLASS (1/4 POINT LOADING)



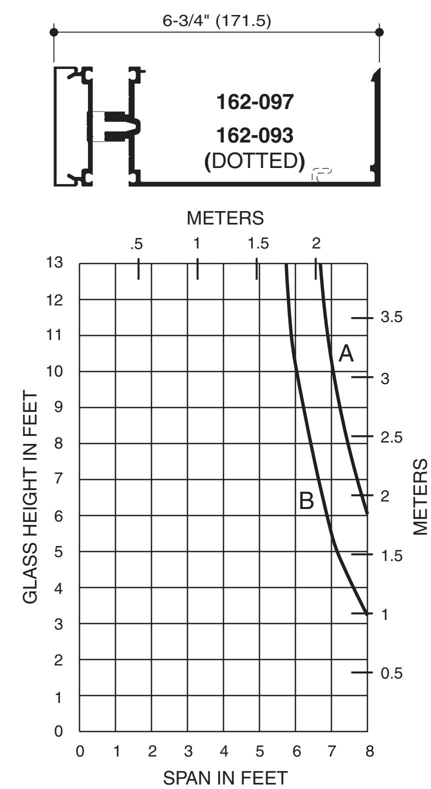
A - 1" GLASS (1/8 POINT LOADING)
B - 1" GLASS (1/4 POINT LOADING)



A - 1" GLASS (1/8 POINT LOADING)
B - 1" GLASS (1/4 POINT LOADING)



A - 1/4" GLASS (1/8 POINT LOADING)
B - 1/4" GLASS (1/4 POINT LOADING)



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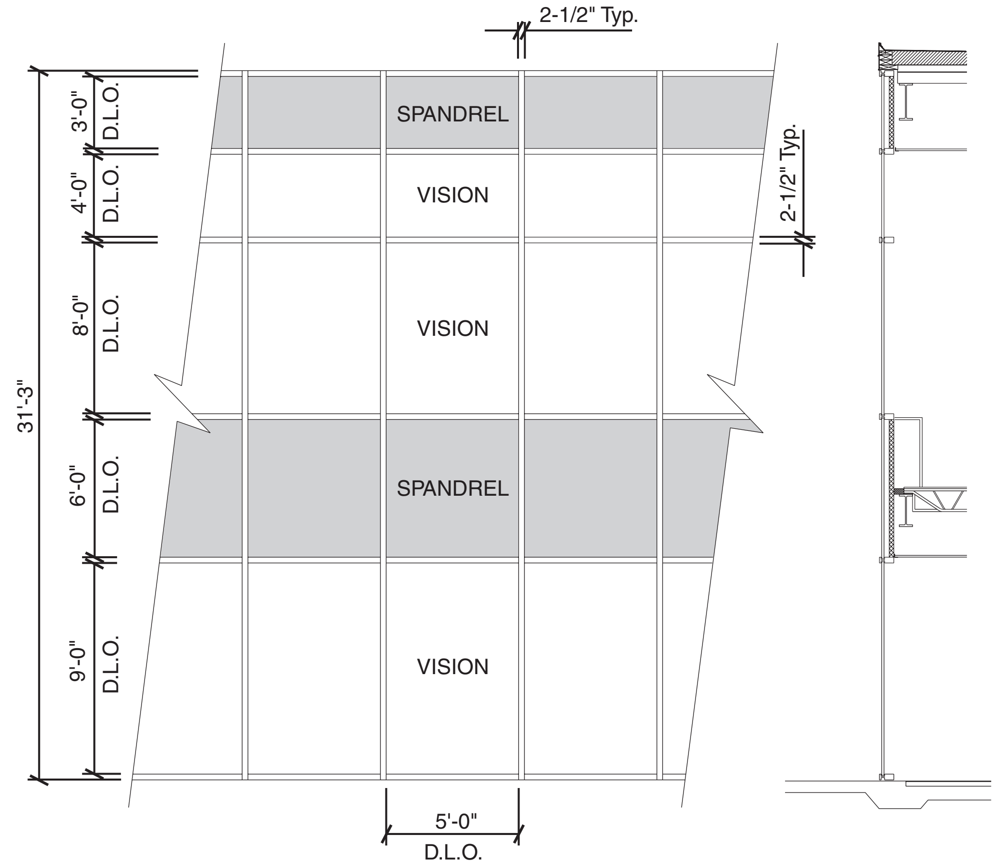
Project Specific U-factor
Example Calculation
(Based on single bay of Curtain Wall/Window Wall)



Vision Area

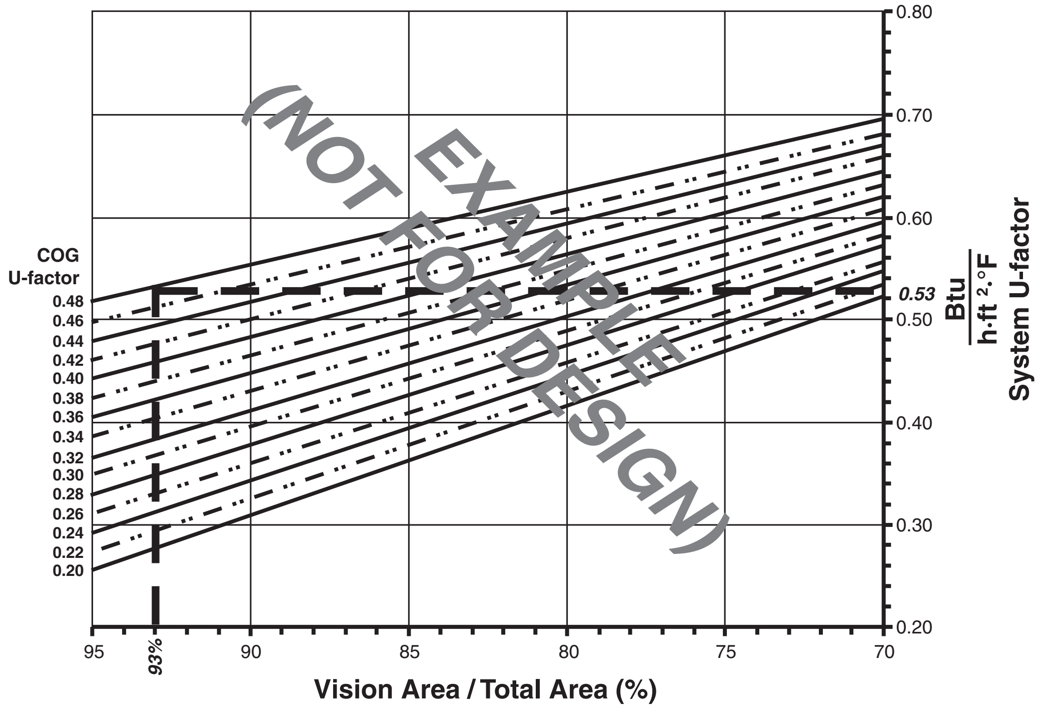
Example Glass U-factor	= 0.48 Btu/(ft² · h · °F)
Vision Area	= 5(9 + 8 + 4) = 105.0 ft²
Total Area (Vision)	= 5' 2-1/2" (9' 3-3/4" + 8' 2-1/2" + 4' 2-1/2") = 113.2 ft²
Percentage of Vision Glass	= (Vision Area ÷ Total Area)100 = (105.0 ÷ 113.2)100 = 93%

Spandrel Area

Example Spandrel R-value	= 15 (ft² · h · °F)/Btu
Spandrel Area	= 5(6 + 3) = 45.0 ft²
Total Area (Spandrel)	= 5' 2-1/2" (6' 2-1/2" + 3' 3-3/4") = 49.6 ft²
Percent of Spandrel	= (Spandrel Area ÷ Total Area)100 = (45.0 ÷ 49.6)100 = 91%

Vision Area Chart

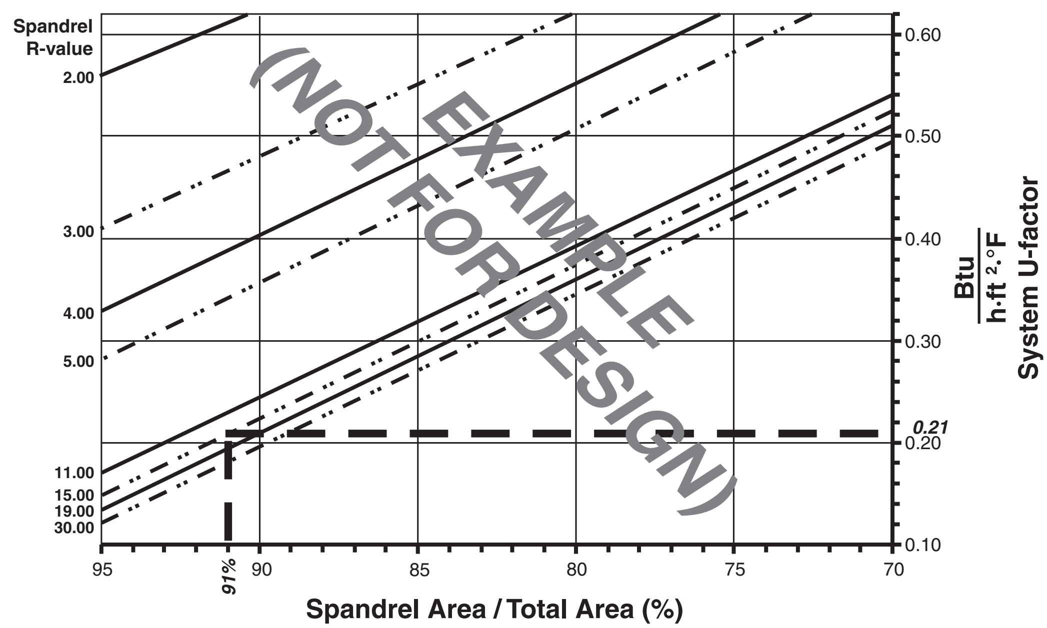
System U-factor vs Percent of Vision Area



Based on a single curtain wall bay of 93% vision glass and center of glass U-factor of 0.48, System U-factor is equal to 0.53 Btu/(h·ft ²·°F)

Spandrel Area Chart

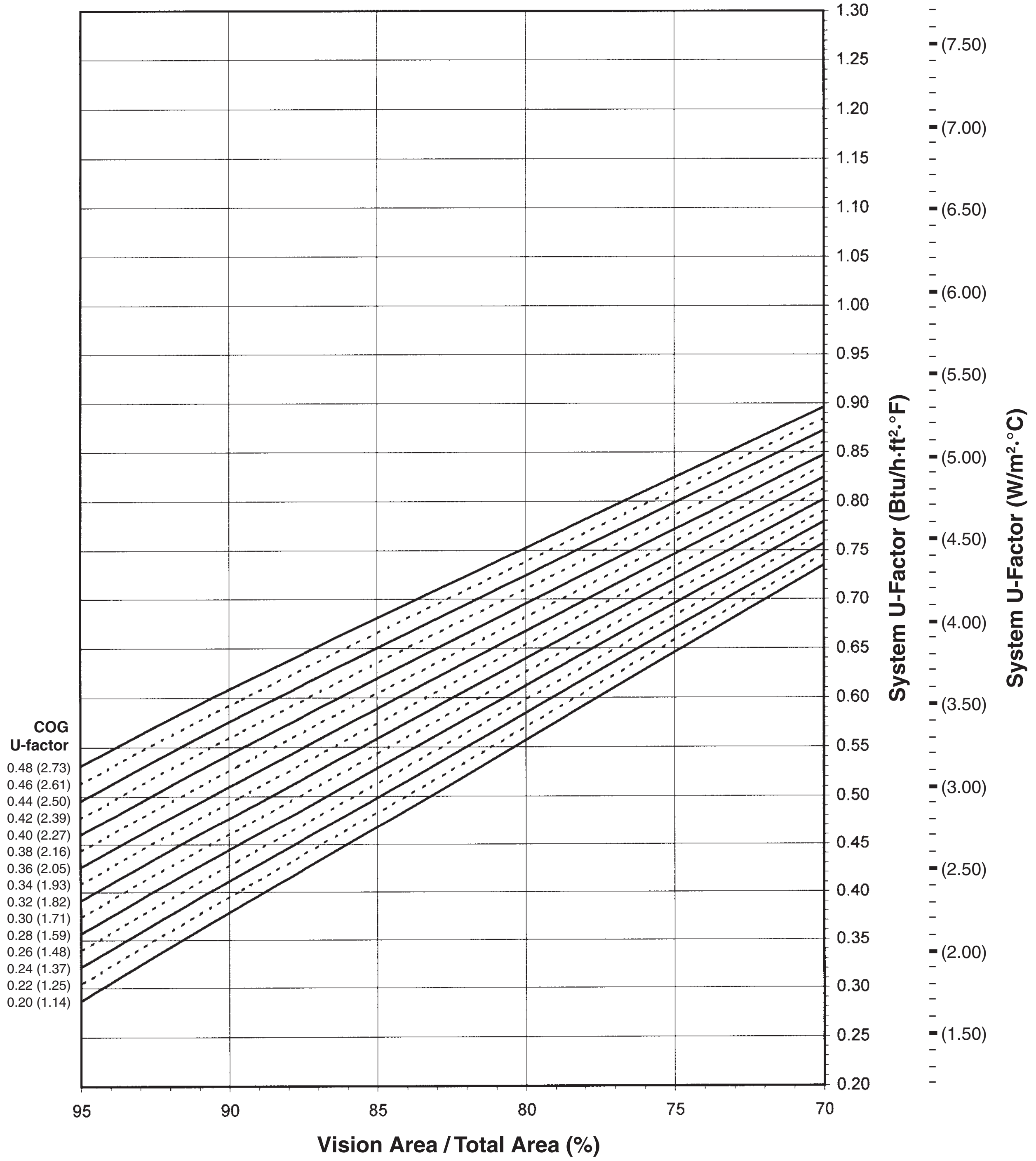
System U-factor vs Percent of Spandrel Area



Based on a single curtain wall bay of 91% spandrel and center of spandrel R-value of 15, system U-factor is equal to 0.21 Btu/(h·ft ²·°F)

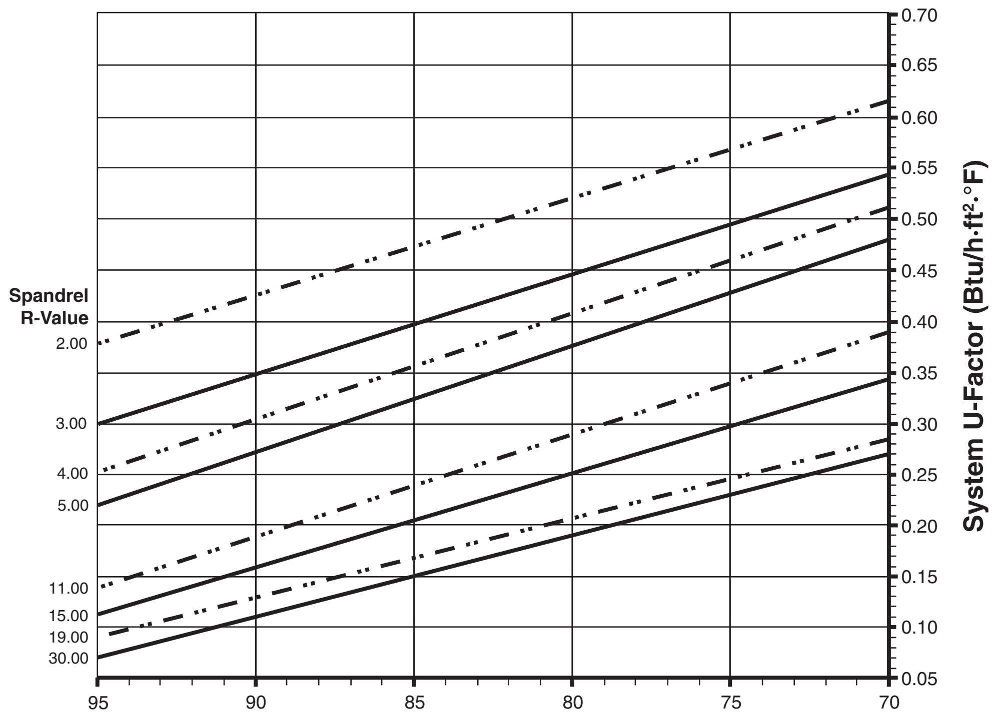
Note:
Values in parentheses are metric.
COG=Center of Glass.
Charts are generated per AAMA 507.

System U-Factor for Vision Glass

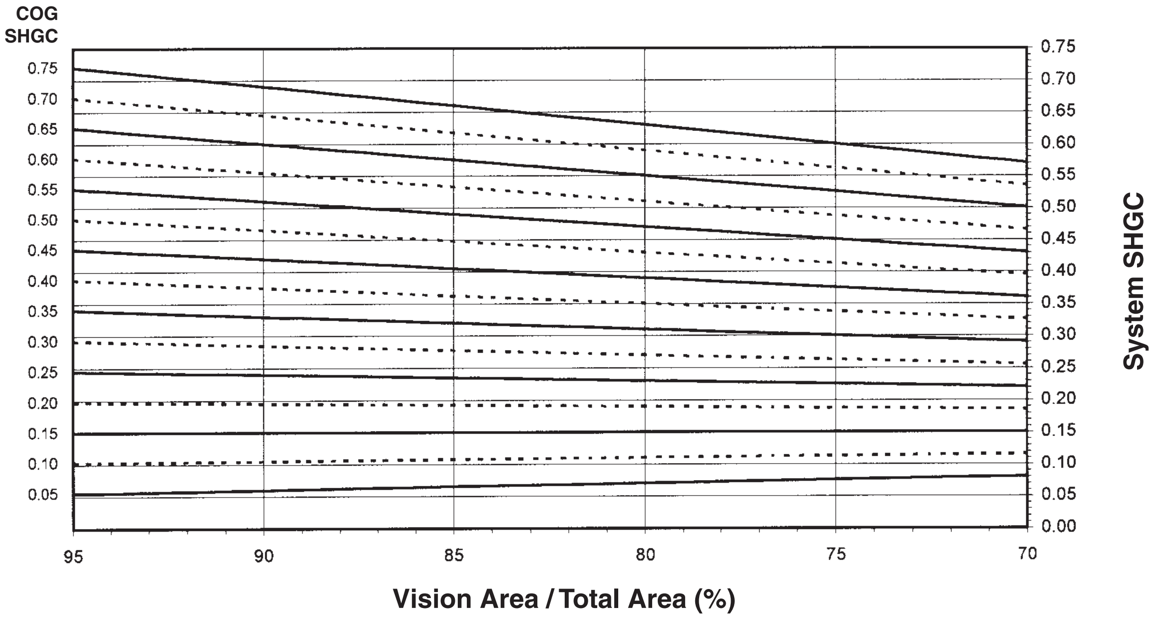


Note:
Values in parentheses are metric.
COG=Center of Glass.
Charts are generated per AAMA 507.

System U-Factors for Spandrel Glass

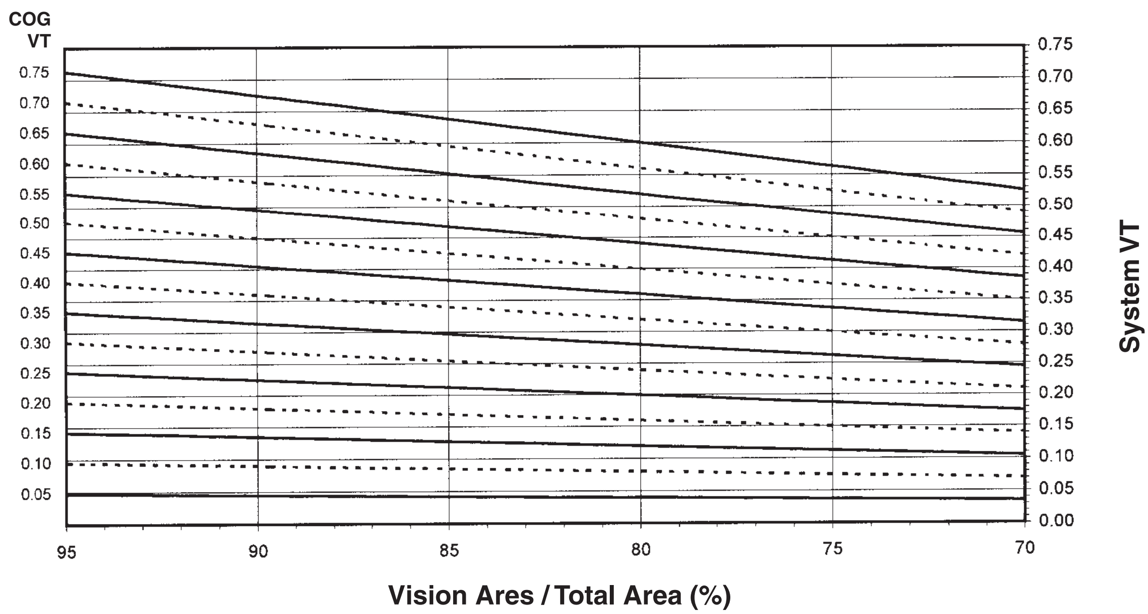


System Solar Heat Gain Coefficient (SHGC) vs Percent of Vision Area



Charts are generated per AAMA 507.

System Visible Transmittance (VT) vs Percent of Vision Area



Charts are generated per AAMA 507.

Thermal Transmittance [1] (BTU/hr • ft^2 • °F)

Glass U-Factor [3]	Overall U-Factor [4]
0.48	0.61
0.46	0.60
0.44	0.58
0.42	0.56
0.40	0.55
0.38	0.53
0.36	0.51
0.34	0.50
0.32	0.48
0.30	0.47
0.28	0.45
0.26	0.43
0.24	0.42
0.22	0.40
0.20	0.38

SHGC Matrix [2]

Glass SHGC [3]	Overall SHGC [4]
0.75	0.69
0.70	0.64
0.65	0.60
0.60	0.55
0.55	0.51
0.50	0.46
0.45	0.42
0.40	0.37
0.35	0.33
0.30	0.28
0.25	0.24
0.20	0.20
0.15	0.15
0.10	0.11
0.05	0.06

Visible Transmittance [2]

Glass VT [3]	Overall VT [4]
0.75	0.67
0.70	0.63
0.65	0.58
0.60	0.54
0.55	0.49
0.50	0.45
0.45	0.40
0.40	0.36
0.35	0.31
0.30	0.27
0.25	0.22
0.20	0.18
0.15	0.13
0.10	0.09
0.05	0.04

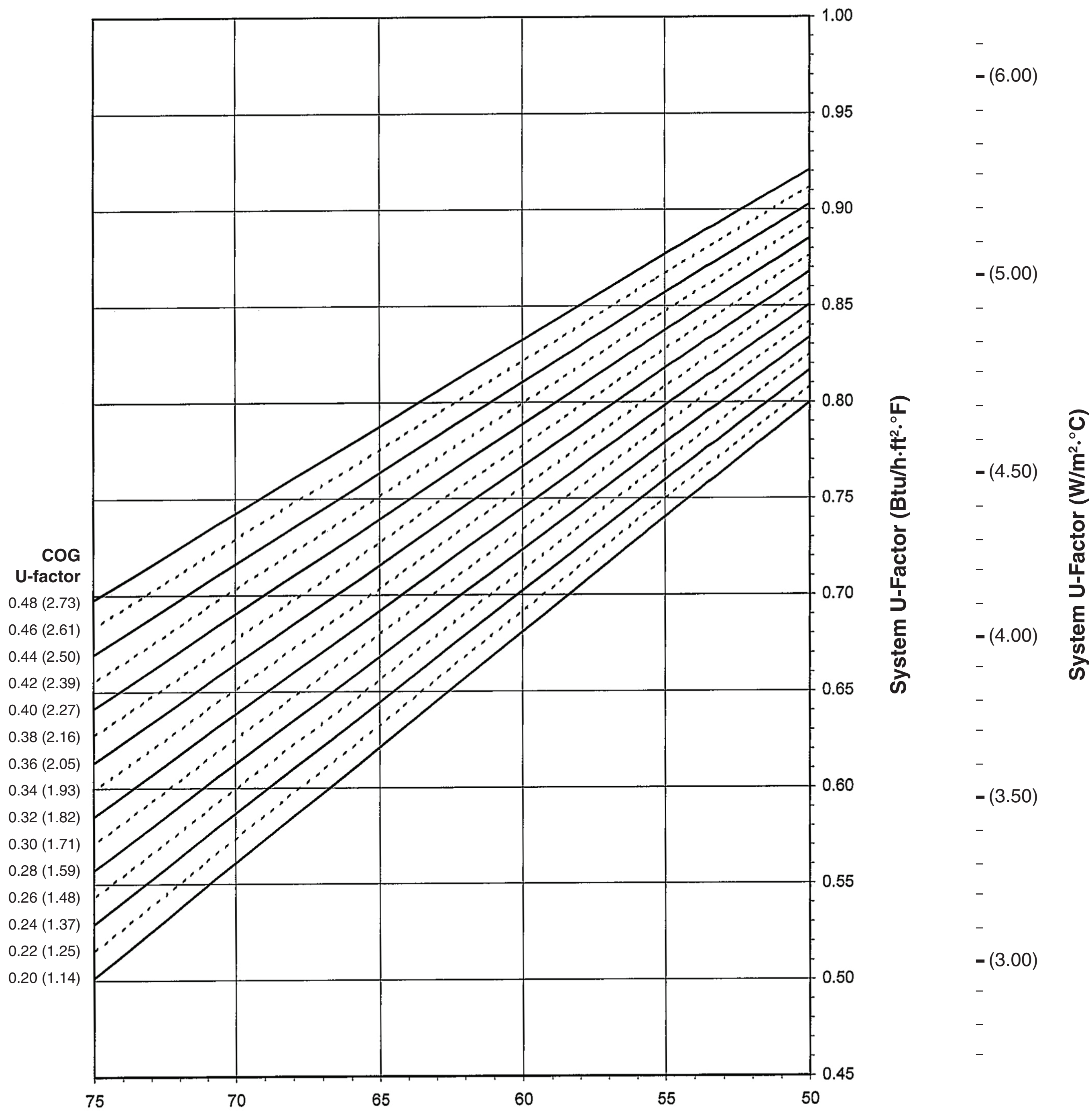
NOTE: For glass values that are not listed, linear interpolation is permitted.

1. U-Factors are determined in accordance with NFRC 100.
2. SHGC and VT values are determined in accordance with NFRC 200.
3. Glass properties are based on center of glass values and are obtained from your glass supplier.
4. Overall U-Factor, SHGC, and VT Matricies are based on the standard NFRC specimen size of 2000mm wide by 2000mm high (78-3/4" by 78-3/4").

1600 System®1 with GLASSvent™ - Projecting (Awning - Single)

Note:
Values in parentheses are metric.
COG = Center of Glass.
Charts are generated per AMMA 507

System U-Factor for Vision Glass

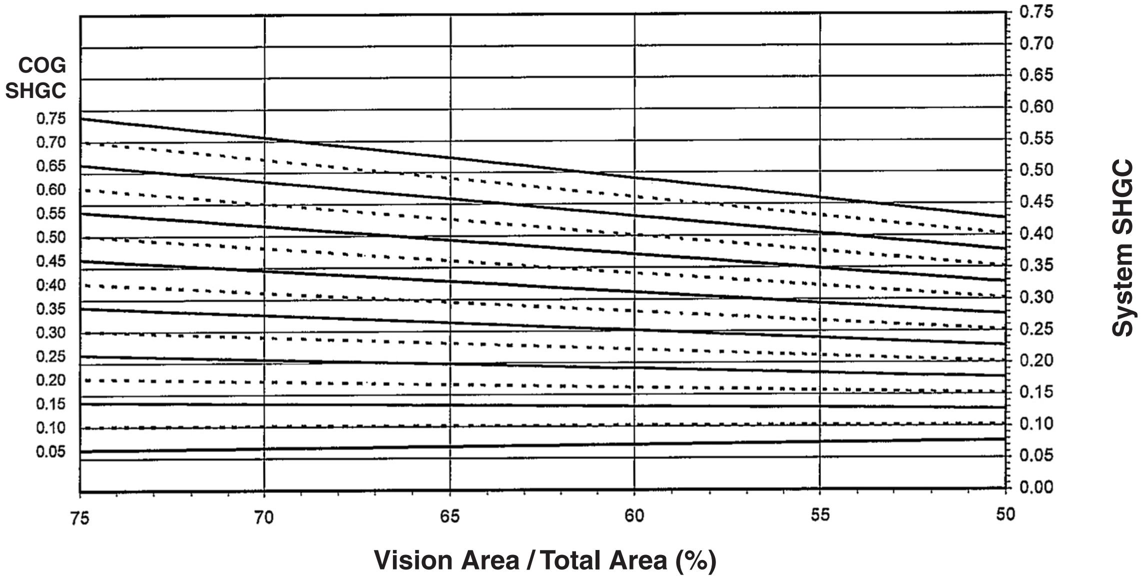


Percent of Glass Area = Vision Area/Total Area
Daylight Opening / Projected Area

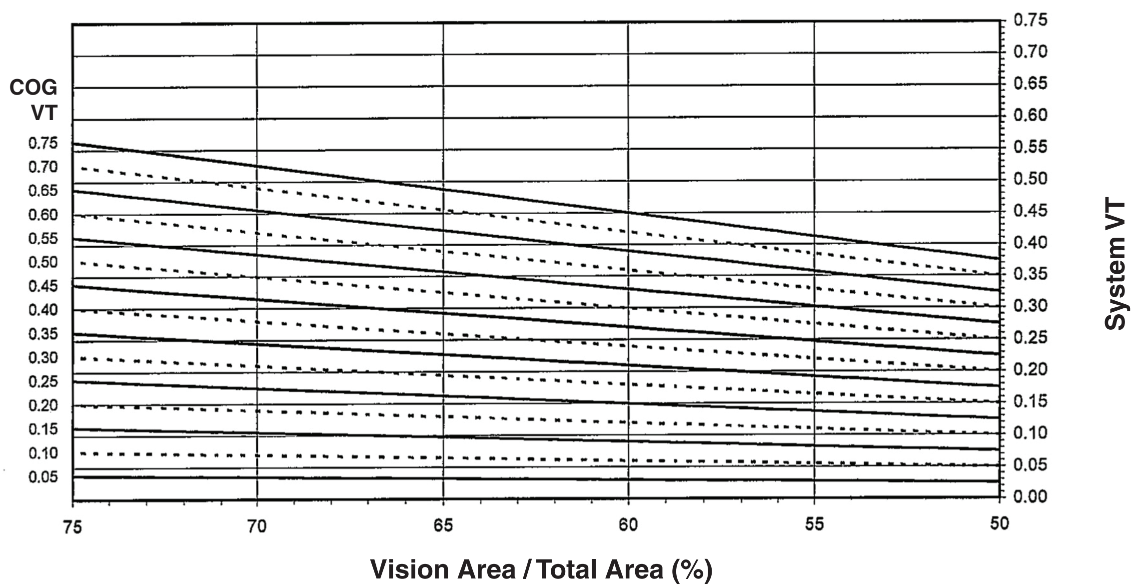
Notes for System U-factor, SHGC and VT charts:
For glass values that are not listed, linear interpolation is permitted.
Glass properties are based on center of glass values and are obtained from your glass supplier.

1600 System®1 with GLASSvent™ - Projecting (Awning - Single)

System Solar Heat Gain Coefficient (SHGC) vs Percent of Vision Area



System Visible Transmittance (VT) vs Percent of Vision Area



1600 System®1 with GLASSvent™ - Projecting (Awning - Single)

Thermal Transmittance[1] (BTU/hr • ft ^{2} • °F)

Glass U-Factor [3]	Overall U-Factor [4]
0.48	0.87
0.46	0.86
0.44	0.85
0.42	0.84
0.40	0.83
0.38	0.82
0.36	0.81
0.34	0.80
0.32	0.79
0.30	0.78
0.28	0.77
0.26	0.76
0.24	0.76
0.22	0.75
0.20	0.74

SHGC Matrix [2]

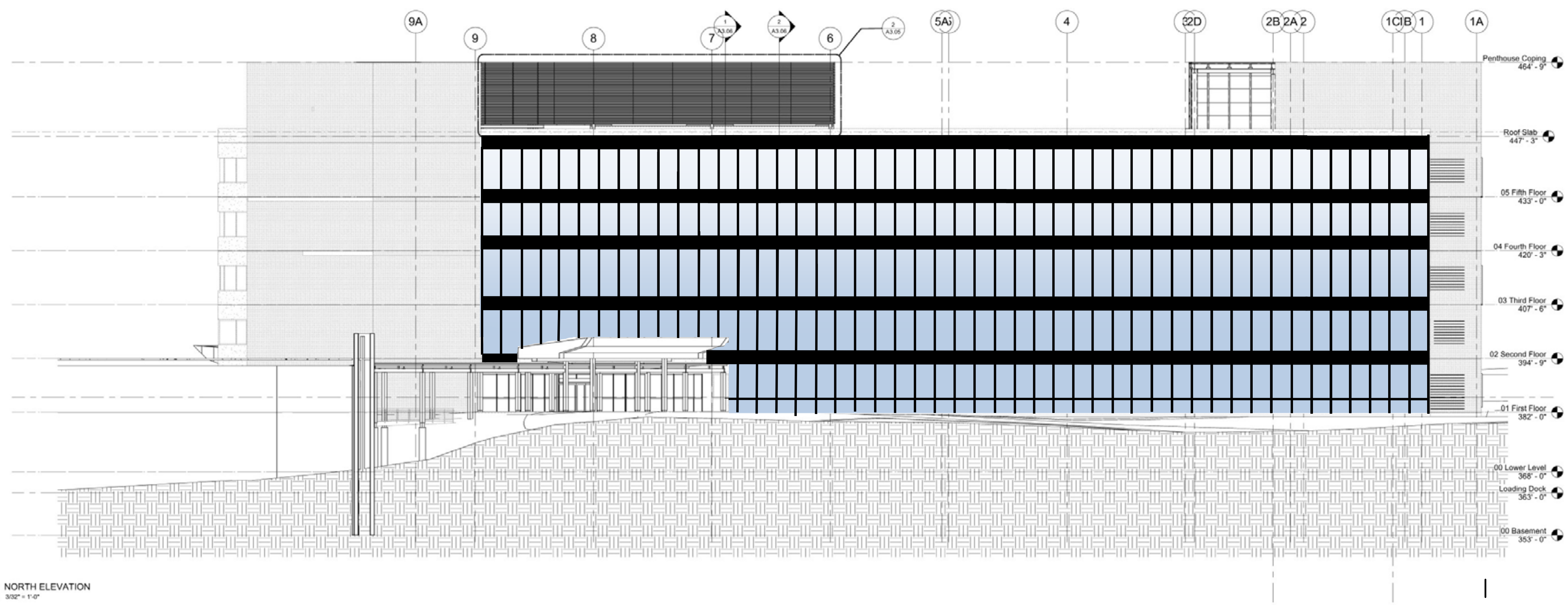
Glass SHGC [3]	Overall Glass U-Factor [4]
0.75	0.46
0.70	0.43
0.65	0.41
0.60	0.38
0.55	0.35
0.50	0.32
0.45	0.30
0.40	0.27
0.35	0.24
0.30	0.21
0.25	0.18
0.20	0.16
0.15	0.13
0.10	0.10
0.05	0.07

Visible Transmittance [2]

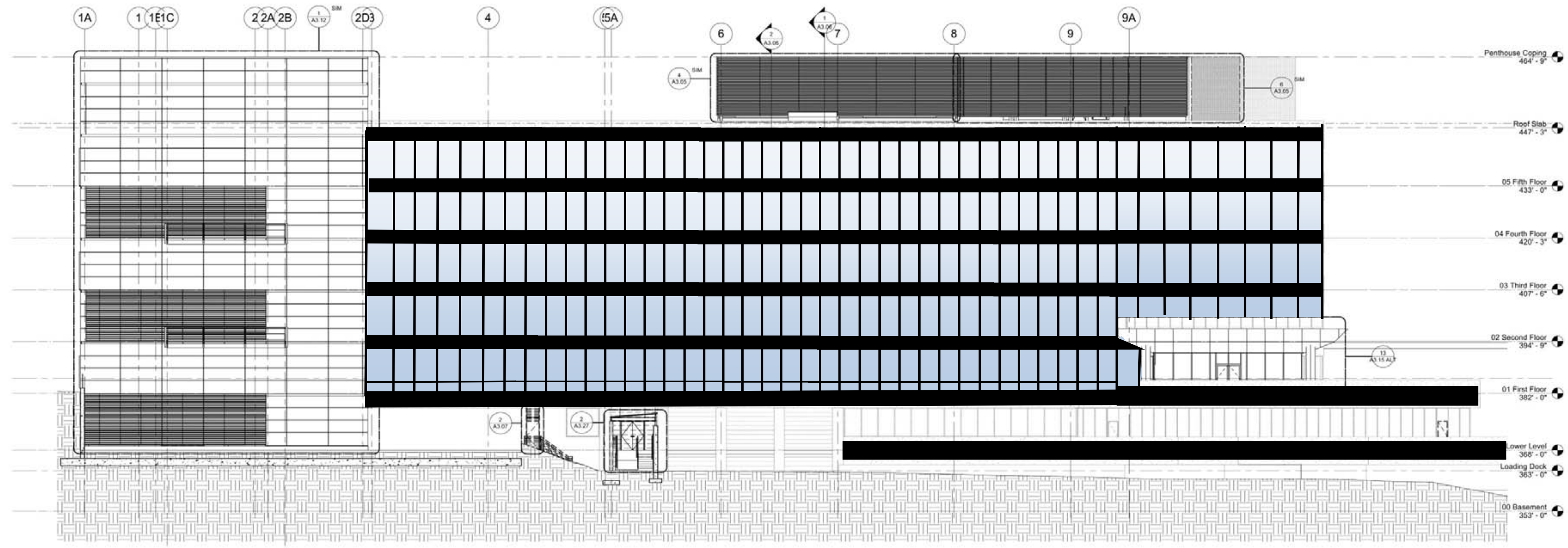
Glass VT [3]	Overall VT [4]
0.75	0.42
0.70	0.39
0.65	0.36
0.60	0.33
0.55	0.30
0.50	0.28
0.45	0.25
0.40	0.22
0.35	0.19
0.30	0.17
0.25	0.14
0.20	0.11
0.15	0.08
0.10	0.06
0.05	0.03

NOTE: For glass values that are not listed, linear interpolation is permitted.
1. U-Factors are determined in accordance with NFRC 100.
2. SHGC and VT values are determined in accordance with NFRC 200.
3. Glass properties are based on center of glass values and are obtained from your glass supplier.
4. Overall U-Factor, SHGC, and VT Matricies are based on the standard NFRC specimen size of 1200mm wide by 1500mm high (47-1/4" by 59-1/16").

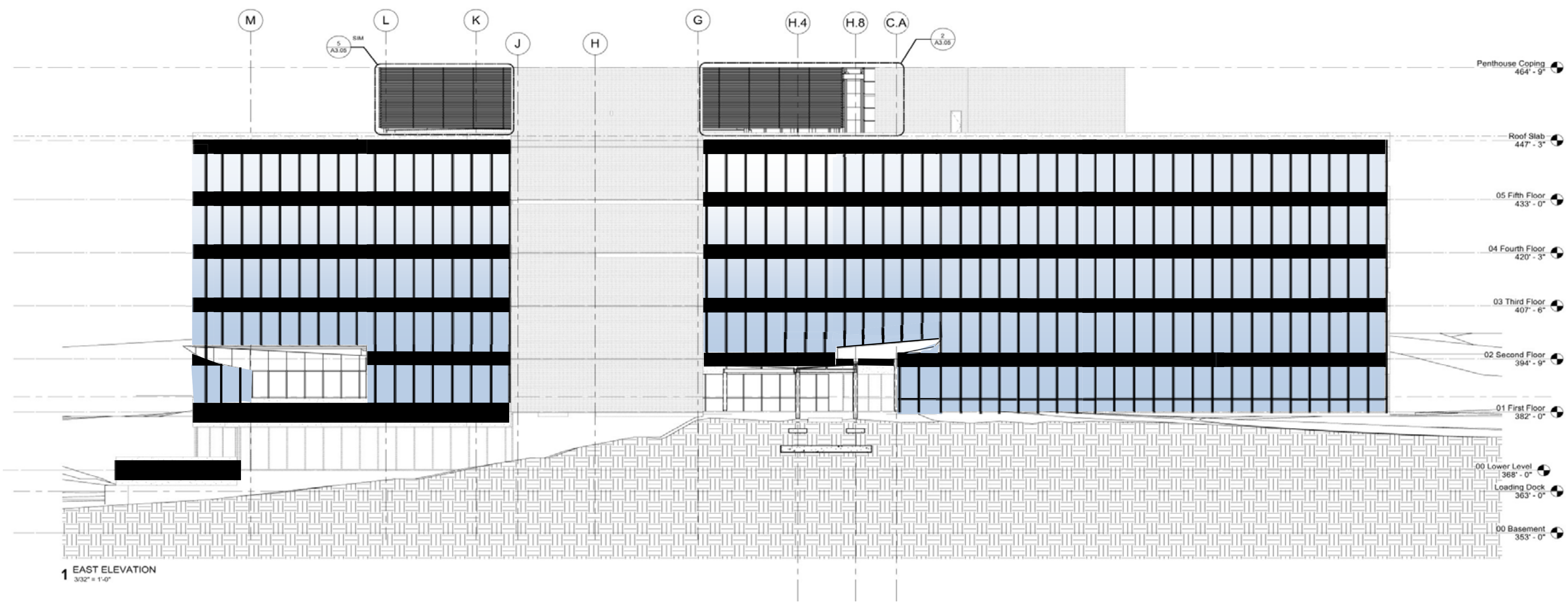
APPENDIX F- Architectural Breadth



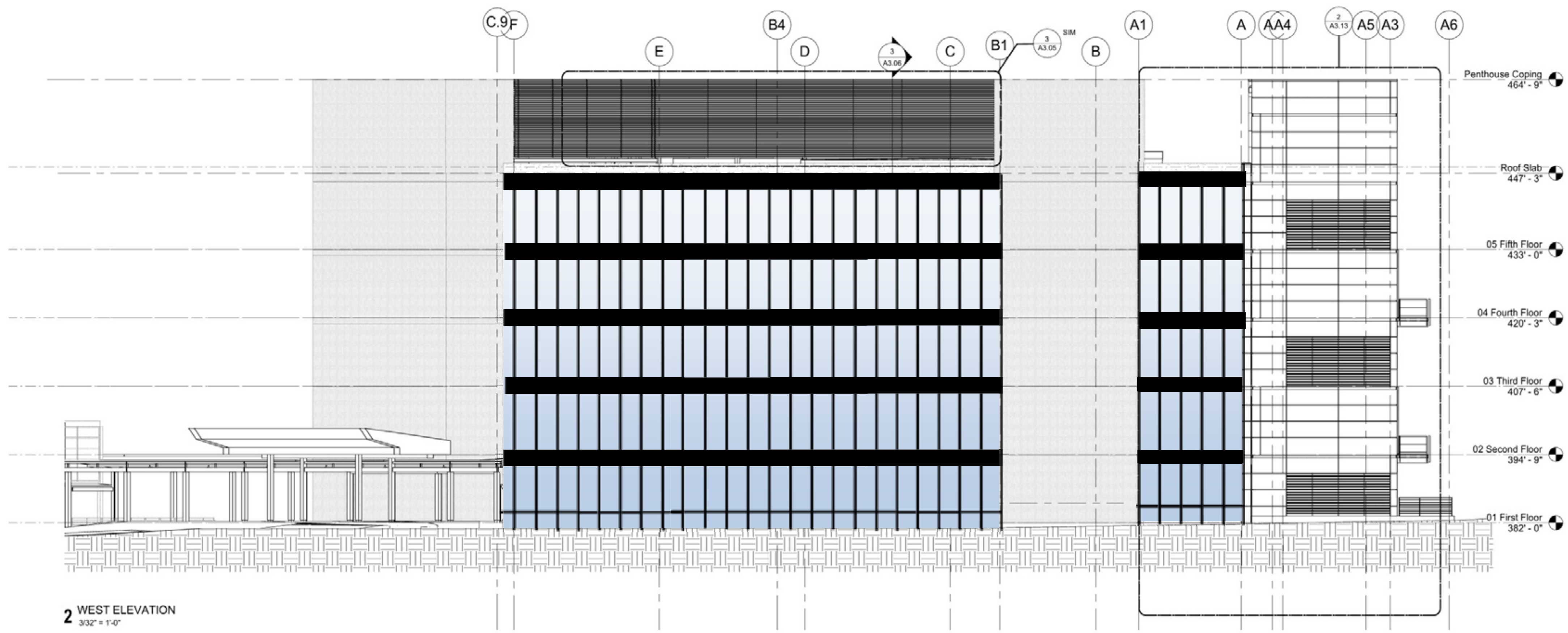
1 NORTH ELEVATION
3/32" = 1'-0"



1 SOUTH ELEVATION
3/32" = 1'-0"

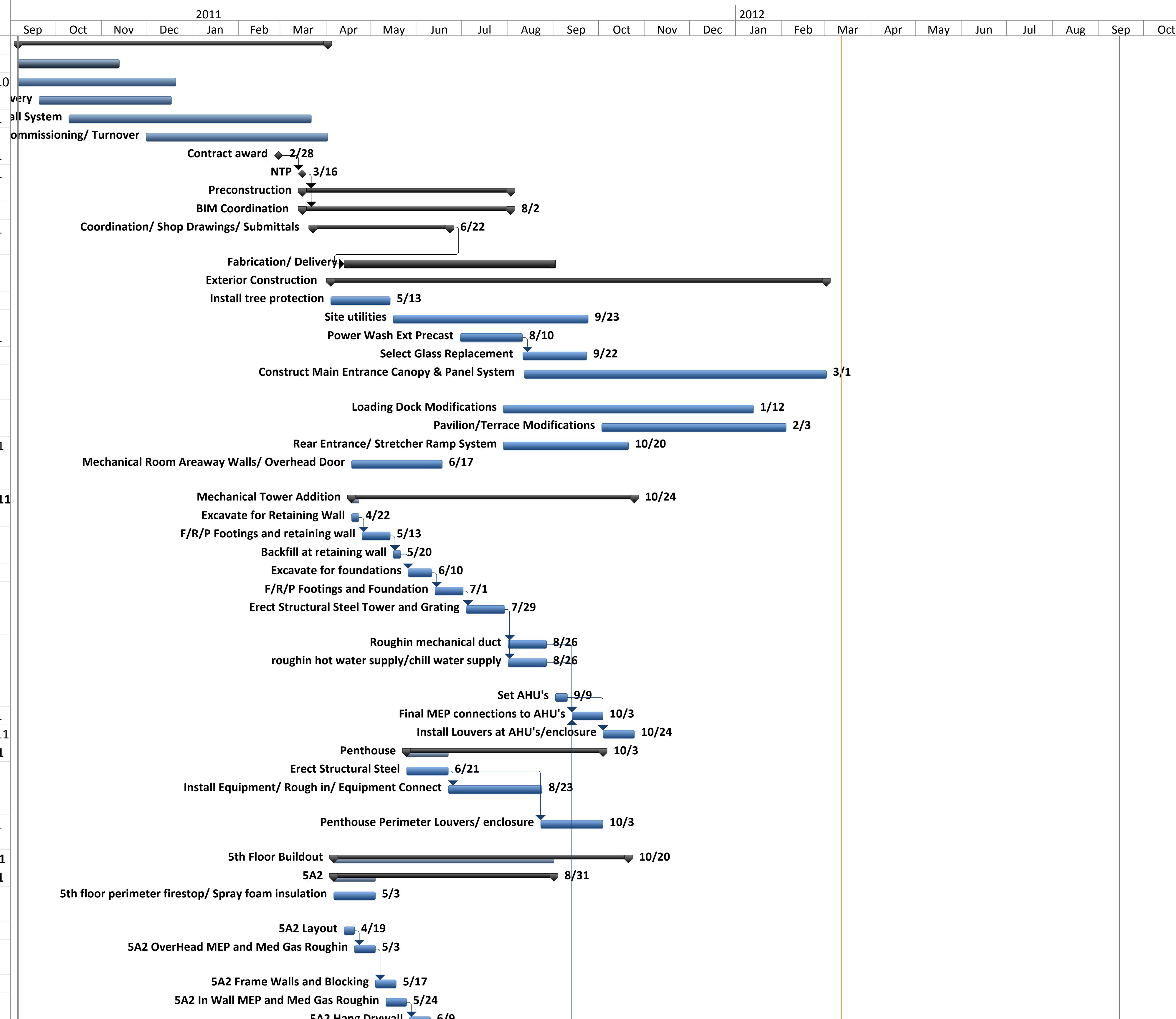


1 EAST ELEVATION
3/32" = 1'-0"

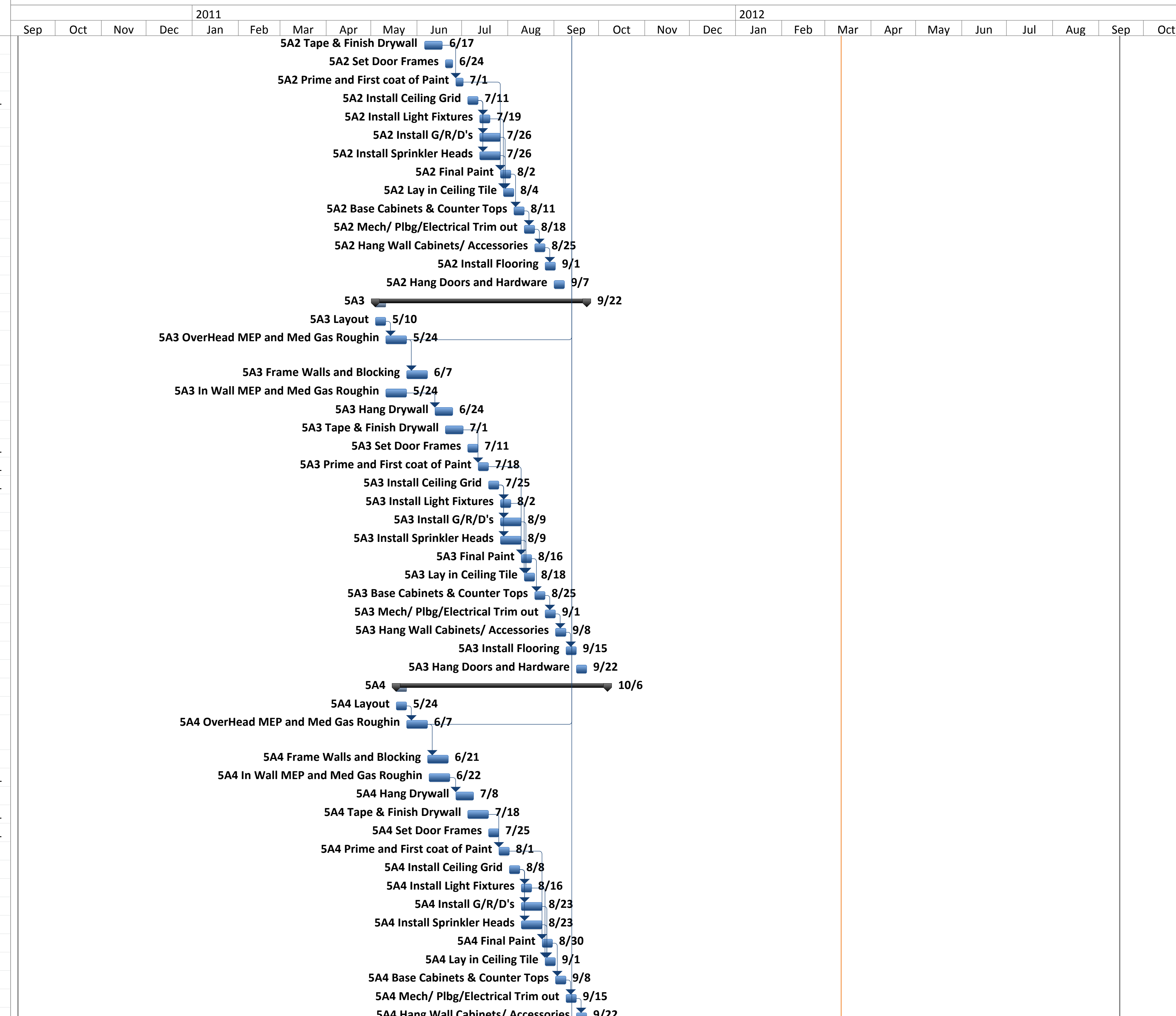


2 WEST ELEVATION
3/32" = 1'-0"

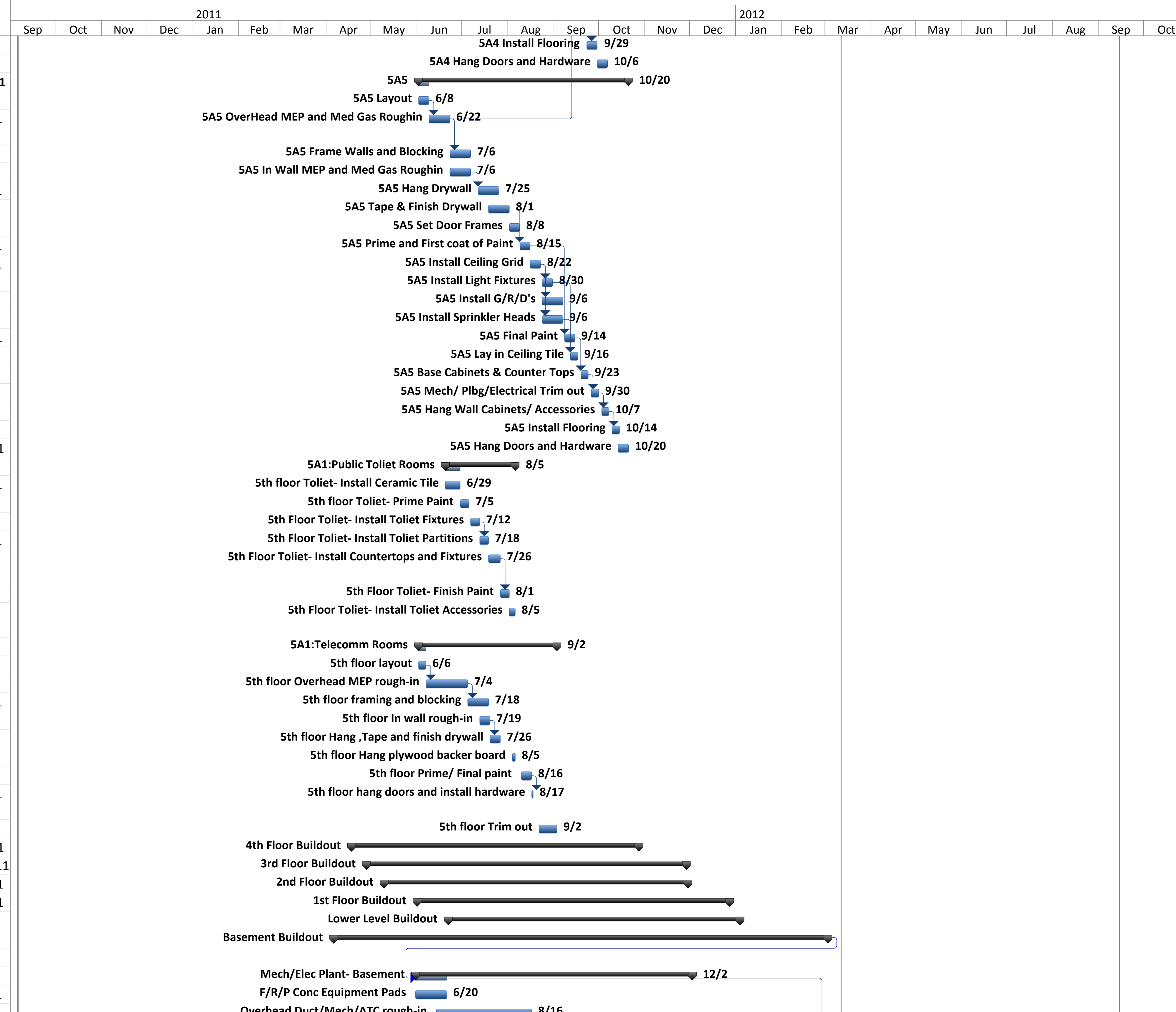
ID	Trade	Task Name	Duration	Start	Finish
1	Curtain Wall	Curtain Wall	150 days	Mon 9/6/10	Fri 4/1/11
2		Shop Drawings	50 days	Mon 9/6/10	Fri 11/12/10
3		Remove Precast Panels	76 days	Mon 9/6/10	Mon 12/20/10
4		Fabrication/ Delivery	65 days	Mon 9/20/10	Fri 12/17/10
5		Installation of Curtain Wall System	117 days	Sun 10/10/10	Mon 3/21/11
6		Inspection/ Commissioning/ Turnover	88 days	Wed 12/1/10	Fri 4/1/11
7		Contract award	0 days	Mon 2/28/11	Mon 2/28/11
8		NTP	0 days	Wed 3/16/11	Wed 3/16/11
9		Preconstruction	100 days	Wed 3/16/11	Tue 8/2/11
10		BIM Coordination	100 days	Wed 3/16/11	Tue 8/2/11
11		Coordination/ Shop Drawings/ Submittals	66 days	Wed 3/23/11	Wed 6/22/11
12		Fabrication/ Delivery	102 days	Wed 4/13/11	Thu 9/1/11
13	Exterior Constru	Exterior Construction	239 days	Mon 4/4/11	Thu 3/1/12
14		Install tree protection	30 days	Mon 4/4/11	Fri 5/13/11
15		Site utilities	95 days	Mon 5/16/11	Fri 9/23/11
16		Power Wash Ext Precast	30 days	Thu 6/30/11	Wed 8/10/11
17		Select Glass Replacement	31 days	Thu 8/11/11	Thu 9/22/11
18		Construct Main Entrance Canopy & Panel System	145 days	Fri 8/12/11	Thu 3/1/12
19		Loading Dock Modifications	120 days	Fri 7/29/11	Thu 1/12/12
20		Pavilion/Terrace Modifications	90 days	Mon 10/3/11	Fri 2/3/12
21		Rear Entrance/ Stretcher Ramp System	60 days	Fri 7/29/11	Thu 10/20/11
22		Mechanical Room Areaway Walls/ Overhead Door	45 days	Mon 4/18/11	Fri 6/17/11
23	Mechanical Tov	**Mechanical Tower Addition**	**136 days**	**Mon 4/18/11**	**Mon 10/24/11**
24		Excavate for Retaining Wall	5 days	Mon 4/18/11	Fri 4/22/11
25		F/R/P Footings and retaining wall	15 days	Mon 4/25/11	Fri 5/13/11
26		Backfill at retaining wall	5 days	Mon 5/16/11	Fri 5/20/11
27		Excavate for foundations	12 days	Thu 5/26/11	Fri 6/10/11
28		F/R/P Footings and Foundation	15 days	Mon 6/13/11	Fri 7/1/11
29		Erect Structural Steel Tower and Grating	20 days	Mon 7/4/11	Fri 7/29/11
30		Roughin mechanical duct	20 days	Mon 8/1/11	Fri 8/26/11
31		roughin hot water supply/chill water supply	20 days	Mon 8/1/11	Fri 8/26/11
32		Set AHU's	6 days	Fri 9/2/11	Fri 9/9/11
33		Final MEP connections to AHU's	15 days	Tue 9/13/11	Mon 10/3/11
34		Install Louvers at AHU's/enclosure	15 days	Tue 10/4/11	Mon 10/24/11
35		**Penthouse**	**94 days**	**Wed 5/25/11**	**Mon 10/3/11**
36		Erect Structural Steel	20 days	Wed 5/25/11	Tue 6/21/11
37		Install Equipment/ Rough in/ Equipment Connect	45 days	Wed 6/22/11	Tue 8/23/11
38		Penthouse Perimeter Louvers/ enclosure	30 days	Tue 8/23/11	Mon 10/3/11
39		**5th Floor Buildout**	**142 days**	**Wed 4/6/11**	**Thu 10/20/11**
40		**5A2**	**106 days**	**Wed 4/6/11**	**Wed 8/31/11**
41		5th floor perimeter firestop/ Spray foam insulation	20 days	Wed 4/6/11	Tue 5/3/11
42		5A2 Layout	5 days	Wed 4/13/11	Tue 4/19/11
43		5A2 OverHead MEP and Med Gas Roughin	10 days	Wed 4/20/11	Tue 5/3/11
44		5A2 Frame Walls and Blocking	10 days	Wed 5/4/11	Tue 5/17/11
45		5A2 In Wall MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
46		5A2 Hang Drywall	10 days	Fri 5/27/11	Thu 6/9/11



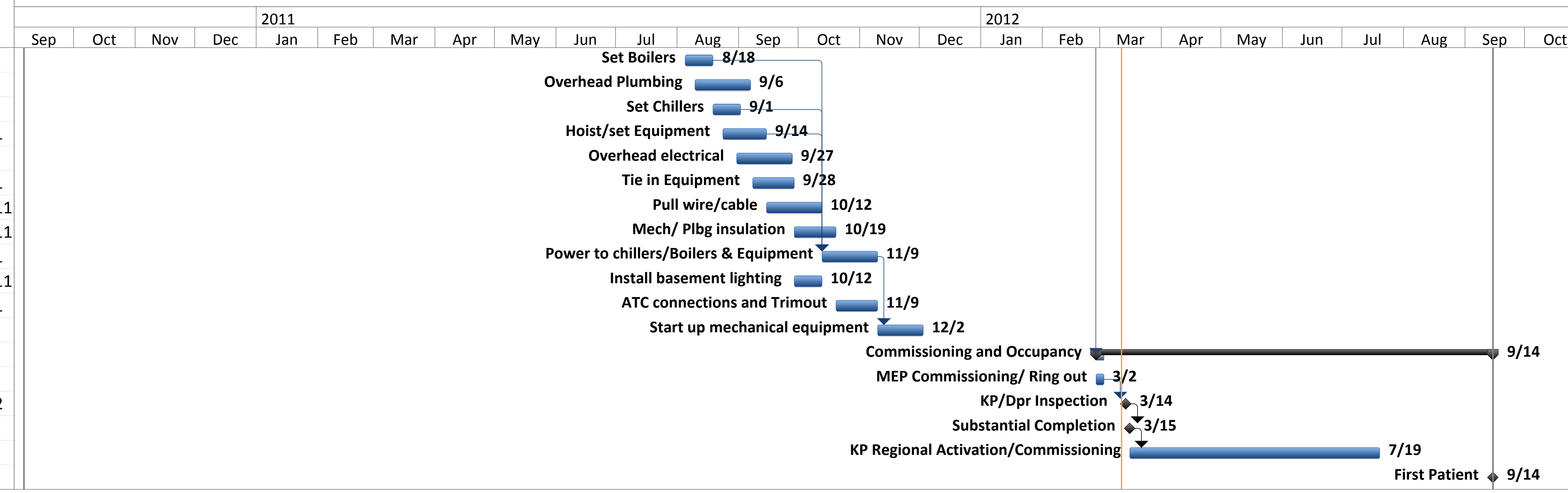
ID	Task Mode	Trade	Task Name	Duration	Start	Finish
47			5A2 Tape & Finish Drywall	10 days	Mon 6/6/11	Fri 6/17/11
48			5A2 Set Door Frames	5 days	Mon 6/20/11	Fri 6/24/11
49			5A2 Prime and First coat of Paint	5 days	Mon 6/27/11	Fri 7/1/11
50			5A2 Install Ceiling Grid	5 days	Tue 7/5/11	Mon 7/11/11
51			5A2 Install Light Fixtures	5 days	Wed 7/13/11	Tue 7/19/11
52			5A2 Install G/R/D's	10 days	Wed 7/13/11	Tue 7/26/11
53			5A2 Install Sprinkler Heads	10 days	Wed 7/13/11	Tue 7/26/11
54			5A2 Final Paint	5 days	Wed 7/27/11	Tue 8/2/11
55			5A2 Lay in Ceiling Tile	5 days	Fri 7/29/11	Thu 8/4/11
56			5A2 Base Cabinets & Counter Tops	5 days	Fri 8/5/11	Thu 8/11/11
57			5A2 Mech/ Plbg/Electrical Trim out	5 days	Fri 8/12/11	Thu 8/18/11
58			5A2 Hang Wall Cabinets/ Accessories	5 days	Fri 8/19/11	Thu 8/25/11
59			5A2 Install Flooring	5 days	Fri 8/26/11	Thu 9/1/11
60			5A2 Hang Doors and Hardware	5 days	Thu 9/1/11	Wed 9/7/11
61			**5A3**	**102 days**	**Wed 5/4/11**	**Thu 9/22/11**
62			5A3 Layout	5 days	Wed 5/4/11	Tue 5/10/11
63			5A3 OverHead MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
64			5A3 Frame Walls and Blocking	10 days	Wed 5/25/11	Tue 6/7/11
65			5A3 In Wall MEP and Med Gas Roughin	10 days	Wed 5/11/11	Tue 5/24/11
66			5A3 Hang Drywall	10 days	Mon 6/13/11	Fri 6/24/11
67			5A3 Tape & Finish Drywall	10 days	Mon 6/20/11	Fri 7/1/11
68			5A3 Set Door Frames	5 days	Tue 7/5/11	Mon 7/11/11
69			5A3 Prime and First coat of Paint	5 days	Tue 7/12/11	Mon 7/18/11
70			5A3 Install Ceiling Grid	5 days	Tue 7/19/11	Mon 7/25/11
71			5A3 Install Light Fixtures	5 days	Wed 7/27/11	Tue 8/2/11
72			5A3 Install G/R/D's	10 days	Wed 7/27/11	Tue 8/9/11
73			5A3 Install Sprinkler Heads	10 days	Wed 7/27/11	Tue 8/9/11
74			5A3 Final Paint	5 days	Wed 8/10/11	Tue 8/16/11
75			5A3 Lay in Ceiling Tile	5 days	Fri 8/12/11	Thu 8/18/11
76			5A3 Base Cabinets & Counter Tops	5 days	Fri 8/19/11	Thu 8/25/11
77			5A3 Mech/ Plbg/Electrical Trim out	5 days	Fri 8/26/11	Thu 9/1/11
78			5A3 Hang Wall Cabinets/ Accessories	5 days	Fri 9/2/11	Thu 9/8/11
79			5A3 Install Flooring	5 days	Fri 9/9/11	Thu 9/15/11
80			5A3 Hang Doors and Hardware	5 days	Fri 9/16/11	Thu 9/22/11
81			**5A4**	**102 days**	**Wed 5/18/11**	**Thu 10/6/11**
82			5A4 Layout	5 days	Wed 5/18/11	Tue 5/24/11
83			5A4 OverHead MEP and Med Gas Roughin	10 days	Wed 5/25/11	Tue 6/7/11
84			5A4 Frame Walls and Blocking	10 days	Wed 6/8/11	Tue 6/21/11
85			5A4 In Wall MEP and Med Gas Roughin	10 days	Thu 6/9/11	Wed 6/22/11
86			5A4 Hang Drywall	10 days	Mon 6/27/11	Fri 7/8/11
87			5A4 Tape & Finish Drywall	10 days	Tue 7/5/11	Mon 7/18/11
88			5A4 Set Door Frames	5 days	Tue 7/19/11	Mon 7/25/11
89			5A4 Prime and First coat of Paint	5 days	Tue 7/26/11	Mon 8/1/11
90			5A4 Install Ceiling Grid	5 days	Tue 8/2/11	Mon 8/8/11
91			5A4 Install Light Fixtures	5 days	Wed 8/10/11	Tue 8/16/11
92			5A4 Install G/R/D's	10 days	Wed 8/10/11	Tue 8/23/11
93			5A4 Install Sprinkler Heads	10 days	Wed 8/10/11	Tue 8/23/11
94			5A4 Final Paint	5 days	Wed 8/24/11	Tue 8/30/11
95			5A4 Lay in Ceiling Tile	5 days	Fri 8/26/11	Thu 9/1/11
96			5A4 Base Cabinets & Counter Tops	5 days	Fri 9/2/11	Thu 9/8/11
97			5A4 Mech/ Plbg/Electrical Trim out	5 days	Fri 9/9/11	Thu 9/15/11
98			5A4 Hang Wall Cabinets/ Accessories	5 days	Fri 9/16/11	Thu 9/22/11



ID		Task Mode	Trade	Task Name	Duration	Start	Finish
99				5A4 Install Flooring	5 days	Fri 9/23/11	Thu 9/29/11
100				5A4 Hang Doors and Hardware	5 days	Fri 9/30/11	Thu 10/6/11
101				**5A5**	**101 days**	**Thu 6/2/11**	**Thu 10/20/11**
102				5A5 Layout	5 days	Thu 6/2/11	Wed 6/8/11
103				5A5 OverHead MEP and Med Gas Roughin	10 days	Thu 6/9/11	Wed 6/22/11
104				5A5 Frame Walls and Blocking	10 days	Thu 6/23/11	Wed 7/6/11
105				5A5 In Wall MEP and Med Gas Roughin	10 days	Thu 6/23/11	Wed 7/6/11
106				5A5 Hang Drywall	10 days	Tue 7/12/11	Mon 7/25/11
107				5A5 Tape & Finish Drywall	10 days	Tue 7/19/11	Mon 8/1/11
108				5A5 Set Door Frames	5 days	Tue 8/2/11	Mon 8/8/11
109				5A5 Prime and First coat of Paint	5 days	Tue 8/9/11	Mon 8/15/11
110				5A5 Install Ceiling Grid	5 days	Tue 8/16/11	Mon 8/22/11
111				5A5 Install Light Fixtures	5 days	Wed 8/24/11	Tue 8/30/11
112				5A5 Install G/R/D's	10 days	Wed 8/24/11	Tue 9/6/11
113				5A5 Install Sprinkler Heads	10 days	Wed 8/24/11	Tue 9/6/11
114				5A5 Final Paint	5 days	Thu 9/8/11	Wed 9/14/11
115				5A5 Lay in Ceiling Tile	5 days	Mon 9/12/11	Fri 9/16/11
116				5A5 Base Cabinets & Counter Tops	5 days	Mon 9/19/11	Fri 9/23/11
117				5A5 Mech/ Plbg/Electrical Trim out	5 days	Mon 9/26/11	Fri 9/30/11
118				5A5 Hang Wall Cabinets/ Accessories	5 days	Mon 10/3/11	Fri 10/7/11
119				5A5 Install Flooring	5 days	Mon 10/10/11	Fri 10/14/11
120				5A5 Hang Doors and Hardware	5 days	Fri 10/14/11	Thu 10/20/11
121				**5A1:Public Toliet Rooms**	**35 days**	**Mon 6/20/11**	**Fri 8/5/11**
122				5th floor Toliet- Install Ceramic Tile	8 days	Mon 6/20/11	Wed 6/29/11
123				5th floor Toliet- Prime Paint	4 days	Thu 6/30/11	Tue 7/5/11
124				5th Floor Toliet- Install Toliet Fixtures	4 days	Thu 7/7/11	Tue 7/12/11
125				5th Floor Toliet- Install Toliet Partitions	4 days	Wed 7/13/11	Mon 7/18/11
126				5th Floor Toliet- Install Countertops and Fixtures	6 days	Tue 7/19/11	Tue 7/26/11
127				5th Floor Toliet- Finish Paint	4 days	Wed 7/27/11	Mon 8/1/11
128				5th Floor Toliet- Install Toliet Accessories	4 days	Tue 8/2/11	Fri 8/5/11
129				**5A1:Telecomm Rooms**	**67 days**	**Thu 6/2/11**	**Fri 9/2/11**
130				5th floor layout	3 days	Thu 6/2/11	Mon 6/6/11
131				5th floor Overhead MEP rough-in	20 days	Tue 6/7/11	Mon 7/4/11
132				5th floor framing and blocking	10 days	Tue 7/5/11	Mon 7/18/11
133				5th floor In wall rough-in	5 days	Wed 7/13/11	Tue 7/19/11
134				5th floor Hang ,Tape and finish drywall	5 days	Wed 7/20/11	Tue 7/26/11
135				5th floor Hang plywood backer board	2 days	Thu 8/4/11	Fri 8/5/11
136				5th floor Prime/ Final paint	5 days	Wed 8/10/11	Tue 8/16/11
137				5th floor hang doors and install hardware	1 day	Wed 8/17/11	Wed 8/17/11
138				5th floor Trim out	10 days	Mon 8/22/11	Fri 9/2/11
139				4th Floor Buildout	139 days	Mon 4/18/11	Thu 10/27/11
140				3rd Floor Buildout	153 days	Thu 4/28/11	Mon 11/28/11
141				2nd Floor Buildout	146 days	Tue 5/10/11	Tue 11/29/11
142				1st Floor Buildout	150 days	Wed 6/1/11	Tue 12/27/11
143				Lower Level Buildout	140 days	Wed 6/22/11	Tue 1/3/12
144				Basement Buildout	238 days	Wed 4/6/11	Fri 3/2/12
145							
146				**Mech/Elec Plant- Basement**	**134 days**	**Tue 5/31/11**	**Fri 12/2/11**
147				F/R/P Conc Equipment Pads	15 days	Tue 5/31/11	Mon 6/20/11
148				Overhead Duct/Mech/ATC rough-in	46 days	Tue 6/14/11	Tue 8/16/11



ID		Ta Mc	Trade	Task Name	Duration	Start	Finish
149				Set Boilers	10 days	Fri 8/5/11	Thu 8/18/11
150				Overhead Plumbing	20 days	Wed 8/10/11	Tue 9/6/11
151				Set Chillers	10 days	Fri 8/19/11	Thu 9/1/11
152				Hoist/set Equipment	16 days	Wed 8/24/11	Wed 9/14/11
153				Overhead electrical	20 days	Wed 8/31/11	Tue 9/27/11
154				Tie in Equipment	15 days	Thu 9/8/11	Wed 9/28/11
155				Pull wire/cable	20 days	Thu 9/15/11	Wed 10/12/11
156				Mech/ Plbg insulation	15 days	Thu 9/29/11	Wed 10/19/11
157				Power to chillers/Boilers & Equipment	20 days	Thu 10/13/11	Wed 11/9/11
158				Install basement lighting	10 days	Thu 9/29/11	Wed 10/12/11
159				ATC connections and Trimout	15 days	Thu 10/20/11	Wed 11/9/11
160				Start up mechanical equipment	17 days	Thu 11/10/11	Fri 12/2/11
161				**Commissioning and Occupancy**	**144 days**	**Tue 2/28/12**	**Fri 9/14/12**
162				MEP Commissioning/ Ring out	4 days	Tue 2/28/12	Fri 3/2/12
163				KP/Dpr Inspection	0 days	Wed 3/14/12	Wed 3/14/12
164				Substantial Completion	0 days	Thu 3/15/12	Thu 3/15/12
165				KP Regional Activation/Commissioning	90 days	Fri 3/16/12	Thu 7/19/12
166				First Patient	0 days	Fri 9/14/12	Fri 9/14/12

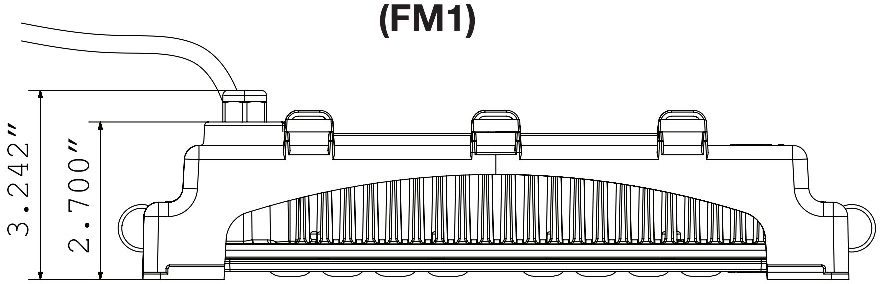


FLEX SLS
SITE LIGHTING SYSTEM

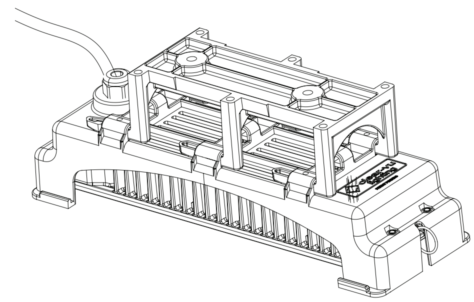
Specification Sheet

The FLEX SLS is a low voltage modular lighting system comprised of LED modules and a remote power supply. Ideal for temporary construction lighting, permanent lighting in mechanical rooms, interstitial spaces, and harsh environment applications.

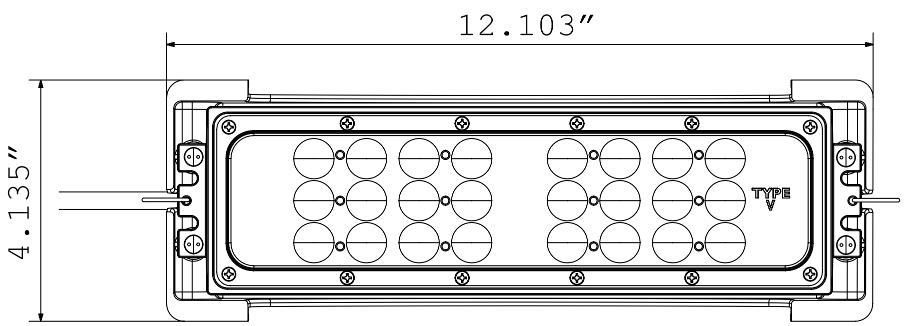
LED MODULE (FM1)



SIDE VIEW

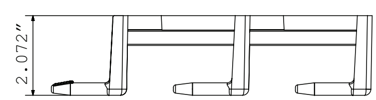


ISOMETRIC VIEW

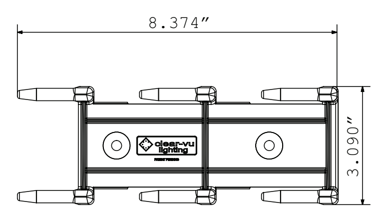


BOTTOM VIEW

SURFACE MOUNT BRACKET (MB1)



SIDE VIEW



BOTTOM VIEW

LED MODULE (FM1)

OPTIC

- Type V - 2100 lumens: 17' spacing for OSHA 5 fc compliance
- Color Temperature: ~5000K
- Lamp life – L70 @ 50,000 hours
- LM79, LM80

ELECTRICAL

- Input Voltage: 22 – 28VDC
- Power: 30W

MECHANICAL

- Operating Temperature: -30 – 50°C
- Weight: 3.3 lbs.
- IP67 – Waterproof up to 1 m.

ACCESSORIES

- **MB1** – Surface Mount Bracket
- **FM1BR** – Bridge/Shed Tamperproof Mount Bracket (not pictured)

c UL US

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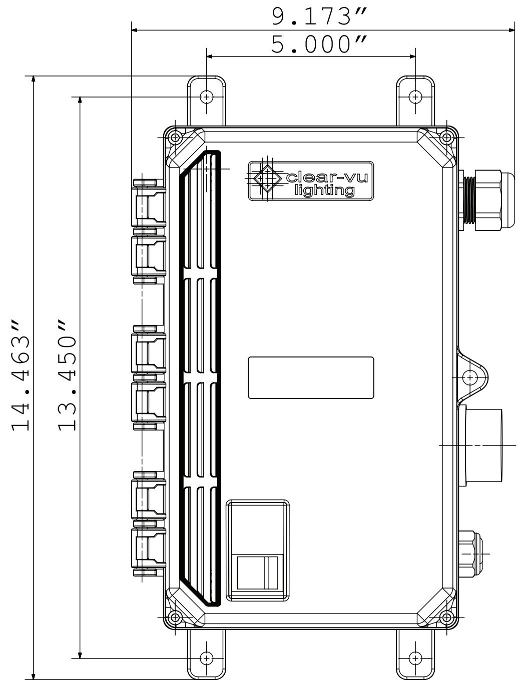
clear-vu lighting

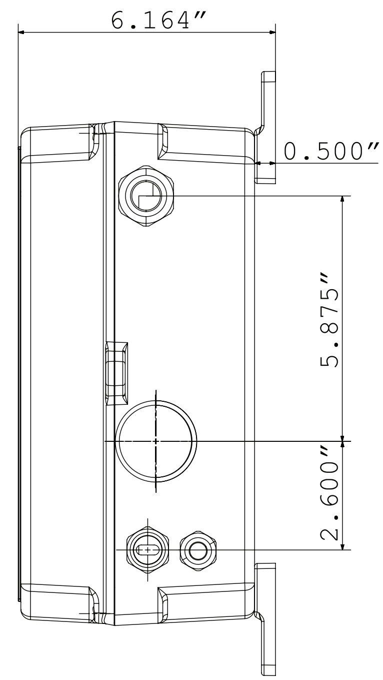
FLEX SLS
SITE LIGHTING SYSTEM

Specification Sheet

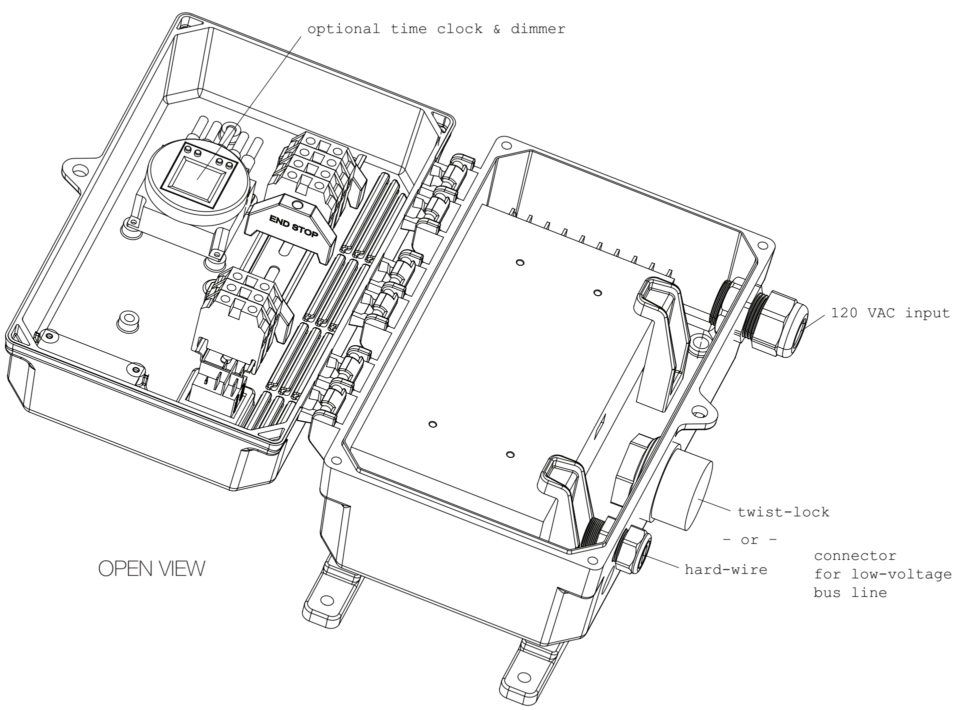
POWER SUPPLY (FPS450)



BOTTOM VIEW



SIDE VIEW



OPEN VIEW

POWER SUPPLY (FPS450)

ELECTRICAL

- Input Voltage:
  90-132VAC or 180 – 264VAC
- Output Voltage: 27.5VDC/18.75VDC
- Power: 450W

MECHANICAL

- Operating Temperature: -10 – 50°C
- Weight: 7.6 lbs.

ACCESSORIES

- **FPS450DT – Time Clock**
  Enables automatic programming for dimmer circuit

c UL US

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clear-vu lighting

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE

Ideal where high brightness and good illumination levels are required such as retail, light industrial and warehouses.

ATTRIBUTES

Available in one lamp or two lamp configuration.

CONSTRUCTION

Heavy-duty channel, die-formed from code-gauge steel.

Sturdy channel cover secured by captive quarter-turn latch for easy access to wireway.

Combination endplate/channel connector furnished with each fixture.

FINISH

Five-stage iron phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

ELECTRICAL

Thermally protected, resetting, Class P, UL Listed and CSA Certified ballast is standard. Sound rating depends on lamp/ballast combination.

AWM, TFN, THHN wire throughout, rated for required temperatures.

INSTALLATION

For unit or row installations, surface or suspended mounting.

LISTING

UL listed to US and Canadian safety standards. Optional: Mexico NOM.

Damp location listed.

Listed for 25 degree C ambient temperature.

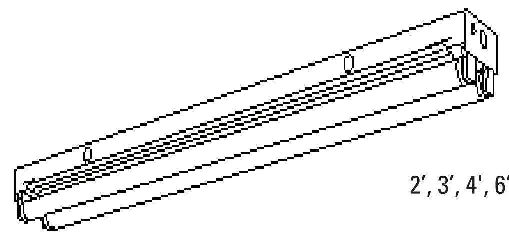
WARRANTY

Guaranteed for one year against mechanical defects in manufacture.

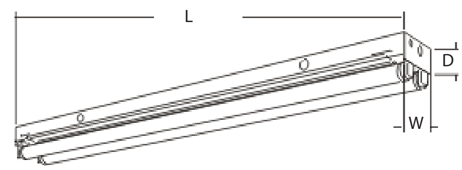
Specifications subject to change without notice.

General-Purpose Strip

C



2', 3', 4', 6' and 8' length
1 or 2 lamps



Specifications

Length: 24" (61.0)
36" (91.4)
48" (121.9)
72" (182.9)
96" (243.8)

Width: 4-3/8" (11.1)

Fixture Depth: 2-/16" (5.2)

All dimensions are inches (centimeters).

ORDERING INFORMATION Lead times will vary dependning upon options selected. Consult your sales representative.

Example: C 2 32 MVOLT GEB10IS

C					
Series	**Number of lamps**	**Lamp type**		**Voltage**	**Options**
C **General-purpose strip** For tandem double length unit, add prefix T. Example: TC	1 **2** lamp not included	T8		MVOLT[1,2]	**GEB** Electronic ballasts, ≤20%THD[3]
		17	17W T8 (24")	120	**GEB10IS** Electronic ballasts, ≤10%THD instant start[1,2]
		25	25W T8 (36")	277	GEB10RS T8 electronic ballast, ≤10%THD, rapid start
		32	32W T8 (48")	347	BILP High-efficiency ballast, .78bf (low), instant start
		96T8	59W T8 slimline (96")	others available	BINP T8 high-performance ballast, .88bf (normal), instant start
		T12 Slimline			BIHP T8 high-performance ballast, 1.20bf (high), instant start[4]
		36	30W slimline (36")		1/4 One four-lamp ballast[5]
		48	38W slimline (48")		**EL** Emergency battery pack (nominal 300 lumens)
		72	55W slimline (72")		GLR Internal fast-blow fuse (add X for external)[6]
		96	75W slimline (96")		GMF Internal slow-blow fuse (add X for external)[6]
		T12			PLR_ Plug-in wiring; specify 1, 2, or 3 branch circuits and hot wires (A = Black, B = Red, C = Blue, AB or AC)
		20	20W T12 (24")		TILW Tandem in-line wiring
		30	30W T12 (36")		CW Cold-weather ballast: 0 degree F starting temp
		40	40W T12 (48")		CSA CSA Certified (only required for 347V)
					NOM NOM Certified

Accessories: *Order as separate catalog number.*

SQ_	Swivel stem hanger (specify length in 2" increments)	HRC1®	Hooker T-bar hanger (1-1/2" from ceiling).
1B	Ceiling spacer (adjusts from 1-1/2" to 2-1/2" from ceiling)	WGCSMR	Wireguard, 4' white for symmetric reflector.[7]
CONLGC	12" screw-on channel connector	WGCASR	Wireguard, 4' white for asymmetric reflector.[7]
WGCU NST	Wireguard, 4' white. [7]	CSMR 48	Symmectric reflector, 4' white, 7" aperture.[7]
HC36	Chain hangers (1 pair, 36" long)	CASR 48	Asymmectric reflector, 4' white, 5-3/4" wide.[7]
HRC®	Hooker T-bar hanger (flush to ceiling)		

NOTES:

1 MVOLT standard for 120-277V applications, 50-60 mhz operation. Some options require voltage specified.
2 T8 lamps only.
3 Slimline lamps only.
4 Not available in 347V.
5 Not available in slimline.
6 Specify voltage.
7 Order two for 8' fixtures.

C General-Purpose Strip

MOUNTING DATA

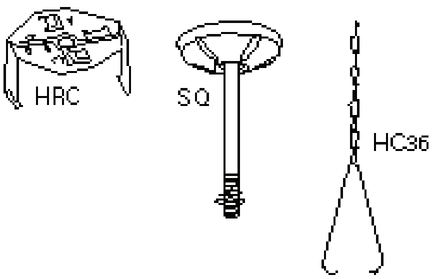
For unit or row installation, surface or suspended mounting.

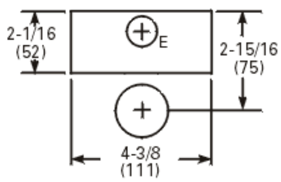
Unit installation — Minimum of two hangers required.

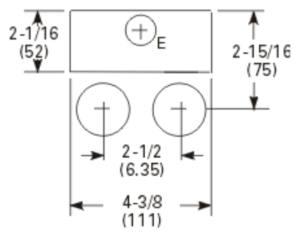
Row installation — Two hangers per channel required. One per fixture plus one per row if CONLGC installed.

Hooker® (HRC) and HC Hangers — Minimum two per channel (unit and row)

See ACCESSORIES below for hanging devices.





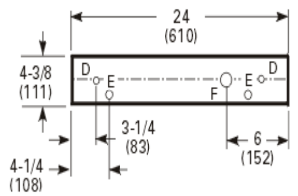


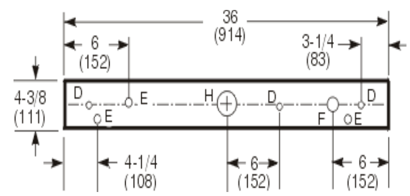
D = 11/16 (17) Dia.K.O.
E = 7/8 (22) Dia.K.O.
F = 1-1/4 (32) Dia.K.O.
H = 2 (51) Dia.K.O.

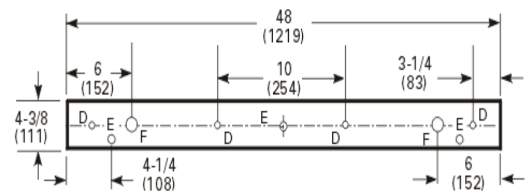
DIMENSIONS

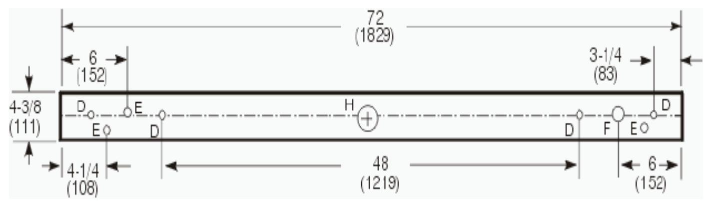
Inches (millimeters). Subject to change without notice.

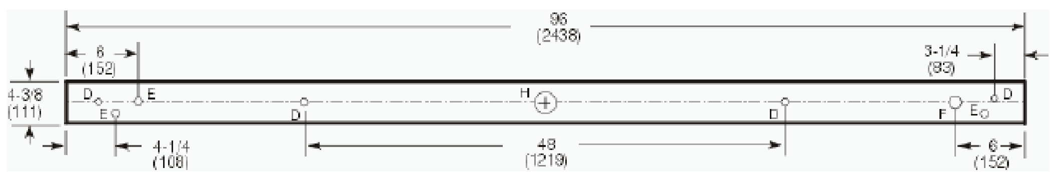
48", 72" and 96" have only two 7/8" K.O.'s 6" from each end
24" and 36" have only two 7/8" K.O.'s 3-1/4" from each end











PHOTOMETRICS

Calculated using the zonal cavity method in accordance with IESNA LM41 procedure. Floor reflectances are 20%. Lamp configurations shown are typical. All data based on 25°C. Full photometric data on these and other configurations available upon request.

C 2 32
TEST NO: LTL 5181
LUMENS PER LAMP: 2900

Coefficients of Utilization (pf 20%)

pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
RCR 0	106	106	106	102	102	102	93	93	93
1	89	84	79	85	80	76	78	74	71
2	76	68	62	72	66	60	66	61	56
3	65	57	50	62	55	49	57	51	45
4	57	48	42	55	47	40	50	43	38
5	51	42	35	48	40	34	44	37	32
6	45	36	30	43	35	29	40	33	28
7	41	32	26	39	31	25	36	29	24
8	37	29	23	35	28	22	33	26	21
9	34	26	20	32	25	20	30	23	19
10	31	23	18	30	23	18	28	21	17

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	842.1	14.5	15.6
0° - 40°	1435.8	24.8	26.7
0° - 60°	2810.1	48.4	52.2
0° - 90°	4362.5	75.2	81.0
90° - 180°	1021.0	17.6	19.0
0° - 180°	5383.6	92.8	100.0

C 2 96
TEST NO: LTL 18310
LUMENS PER LAMP: 6300

Coefficients of Utilization (pf 20%)

pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
RCR 0	103	103	103	98	98	98	90	90	90
1	86	82	78	82	78	74	75	72	69
2	74	67	61	70	64	59	64	59	55
3	64	56	49	61	54	48	56	49	44
4	56	47	41	53	46	40	49	42	37
5	49	41	35	47	39	34	43	37	31
6	44	36	30	42	34	29	39	32	27
7	40	32	26	38	30	25	35	28	24
8	36	28	23	35	27	22	32	25	21
9	33	25	20	32	25	20	29	23	19
10	30	23	18	29	22	18	27	21	17

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1785.8	14.2	15.7
0° - 40°	3042.4	24.1	26.8
0° - 60°	5944.0	47.2	52.3
0° - 90°	9027.5	71.6	79.4
90° - 180°	2341.8	18.6	20.6
0° - 180°	11369.4	90.2	100.0

Energy (Calculated in accordance with NEMA standard LE-5)

LER.FL	ANNUAL ENERGY COST*	LAMP DESCRIPTION	LAMP LUMENS	BALLAST FACTOR	WATTS
86.2	$2.79	(2)T8 F32	2900	.88	55

* Comparative yearly lighting energy cost per 1000 lumens

Energy (Calculated in accordance with NEMA standard LE-5)

ORDERING INFORMATION	LER.FL	ANNUAL ENERGY COST*	LAMP DESCRIPTION	LAMP LUMENS	BALLAST FACTOR	WATTS
C 2 32 MVOLT GEB10IS	77.6	$3.09	F32T8/735	2800	.88	59
C 2 32 MVOLT BILP	93.6	$2.56	F32T8/835/HT8	3100	.78	48

* Comparative yearly lighting energy cost per 1000 lumens

LITHONIA LIGHTING®
An Acuity Brands Company

FLEX SLS Savings Analysis Version 10.9

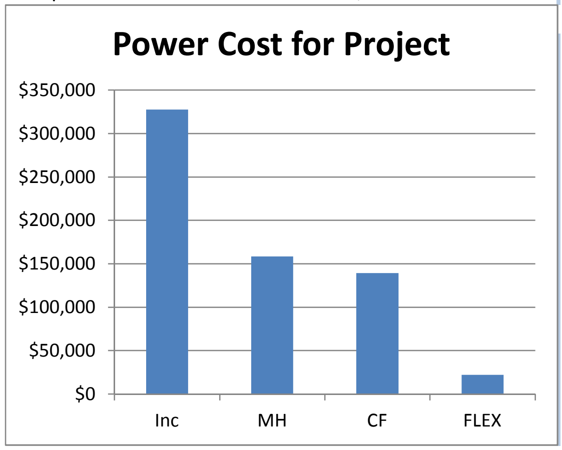
Floor Type (Style) Information

General Project Information	FT1	FT2	FT3	FT4	FT5	Units
Space to Illuminate	250,000	0	0	0	0	Sq Ft
Number of Floors of this Type	1	1	1	1	1	
Ceiling Height	12	12	12	12	12	Ft
Desired Illumination on Floor	5	5	5	5	5	Fc
LED Modules per Kit	15	0	0	0	0	lights
Wire Length	270	0	0	0	0	Ft
Light Module Spacing Ft	17	0	0	0	0	
Light Module Coverage Sq Ft	289	0	0	0	0	
Kits Needed	58	0	0	0	0	
LED Modules Needed	870	0	0	0	0	
LED Modules Per 1000 Sq Ft	3.46	0.00	0.00	0.00	0.00	

Power Information	Value	Units
Power Cost Per Kilowatt Hour	$0.140	Dollars
Hours/Month Illuminated	720	hours
% of Hours where partial ill. is allowed	50%	percent
Duration of Project	13	months
Incandescent		
Lights per 1000 Sq Ft	10	lights
Unit Power	100	watts
PS efficiency	100%	percent
Metal Halide		
Lights per 1000 Sq Ft	1.11	lights
Unit Power	400	watts
PS efficiency	91%	percent
Compact Fluorescent		
Lights per 1000 Sq Ft	10	lights
Unit Power	34	watts
PS efficiency	75%	percent
FLEX SLS (LED)		
Lights per 1000 Sq Ft (Average)	3.46	lights
Unit Power	27.2	watts
PS efficiency	86%	percent

Power Cost for Project	Value	Units
Inc	$327,600	Dollars
MH	$158,545	Dollars
CF	$139,230	Dollars
FLEX	$21,968	Dollars

Power Savings FLEX vs.	Value	Units
Incandescent	$305,632	Dollars
Metal Halide	$136,577	Dollars
Compact Fluorescent	$117,262	Dollars



FLEX Kit Costs	FT1	FT2	FT3	FT4	FT5	Grand Totals
LED Module Cost Each	$145	$0	$0	$0	$0	
LED Modules Needed	15	0	0	0	0	
LED Module Total Cost	$2,175	$0	$0	$0	$0	
Power Supply	$260	$0	$0	$0	$0	
Wire	$238	$0	$0	$0	$0	
Individual Kit Cost	**$2,673**	**$0**	**$0**	**$0**	**$0**	
Makeup Kit (Second Project)	$699	$0	$0	$0	$0	
Kits Needed	58	0	0	0	0	**58**
Total Kit Cost per Type	$155,034	$0	$0	$0	$0	**$155,034**
Average Cost per Square Foot	$0.62	$0.00	$0.00	$0.00	$0.00	**$0.62**

Purchase Cost Per 1000 Sq Ft	Value	Units
Incandescent	$175	Dollars
Metal Halide	$150	Dollars
Compact Fluorescent	$175	Dollars

Install Labor Information	Value	Units

Install/Uninstall Cost	Value	Units

Incandescent Per 1000 Sq Ft	60	minutes
Metal Halide Per 1000 Sq Ft	120	minutes
Compact Fluorescent Per 1000 Sq Ft	60	minutes
FLEX Power Supply	20	minutes
FLEX Wire	50	minutes
FLEX Module (LED) (each)	10	minutes

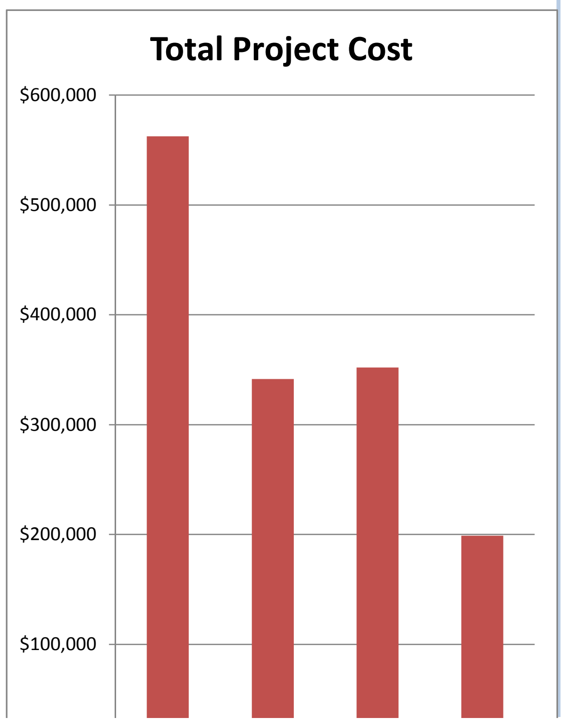
Incandescent	$37,500	Dollars
Metal Halide	$62,500	Dollars
Compact Fluorescent	$37,500	Dollars
FLEX SLS (LED)	$21,829	Dollars

Uninstall Labor Information	Value	Units
Incandescent Per 1000 Sq Ft	60	minutes
Metal Halide Per 1000 Sq Ft	80	minutes
Compact Fluorescent Per 1000 Sq Ft	60	minutes
FLEX Power Supply	10	minutes
FLEX Wire	2	minutes
FLEX Module (LED) (each)	10	minutes
Labor Cost Per Hour Installing	$75	Dollars

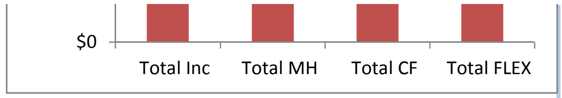
Maintenance Labor Information	Value	Units
Bulb Changing hours/day/ 1000 Sq Ft		
Incandescent	0.01	
Metal Halide	0.004	
Compact Fluorescent	0.01	
FLEX SLS (LED)	0.0005	
Labor Cost Per Hour Changing	$75	Dollars
Bulb Moving hours per 1000 Sq Ft		
Incandescent	0.015	
Metal Halide	0.01	
Compact Fluorescent	0.015	
FLEX SLS (LED)	0.005	
Labor Cost Per Hour Moving	$55	Dollars

Maintenance Cost	Value	Units
Bulb Changing Costs		
Incandescent	$73,125	Dollars
Metal Halide	$29,250	Dollars
Compact Fluorescent	$73,125	Dollars
FLEX SLS (LED)	$3,656	Dollars
Bulb Moving Costs		
Incandescent	$80,438	Dollars
Metal Halide	$53,625	Dollars
Compact Fluorescent	$80,438	Dollars
FLEX SLS (LED)	$26,813	Dollars

Cost Summary	Value	Units
Incandescent		
Component	$43,750	Dollars
Install / Uninstall	$37,500	Dollars
Maintenance	$153,563	Dollars
Power	$327,600	Dollars
Total Inc	$562,413	Dollars
Metal Halide		
Component	$37,500	Dollars
Install / Uninstall	$62,500	Dollars
Maintenance	$82,875	Dollars
Power	$158,545	Dollars
Total MH	$341,420	Dollars
Compact Fluorescent		
Component	$43,750	Dollars
Install / Uninstall	$37,500	Dollars
Maintenance	$153,563	Dollars
Power	$117,262	Dollars
Total CF	$352,074	Dollars
FLEX SLS (LED)		
Component	**$155,034**	Dollars
Install / Uninstall	$21,829	Dollars

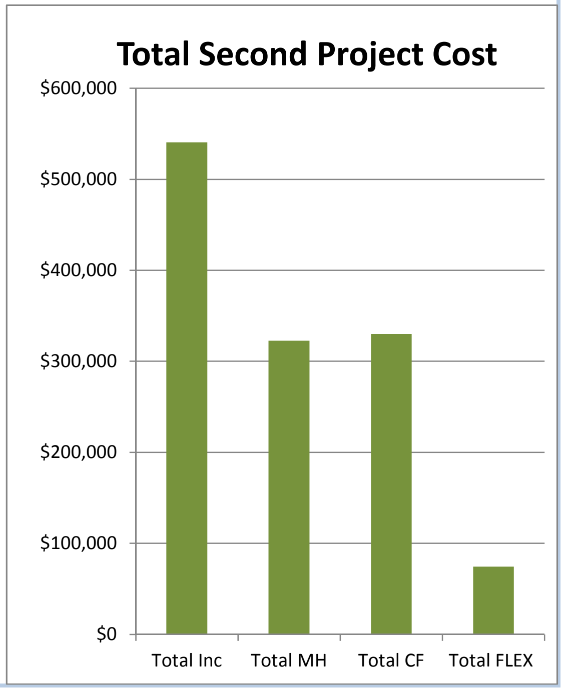


Maintenance	$30,469	Dollars
Power	$21,968	Dollars
Total FLEX	$198,832	Dollars



Second Project Information	Value	Units
Module Loss %	20%	percent
Power Supply Loss %	10%	percent
Wire Loss %	100%	percent
Incandescent Loss %	50%	percent
Metal Halide Loss %	50%	percent
Compact Fluorescent Loss %	50%	percent

Total 2nd Project Cost	Value	Units
Total Inc	$540,538	Dollars
Total MH	$322,670	Dollars
Total CF	$330,199	Dollars
Total FLEX	$74,559	Dollars

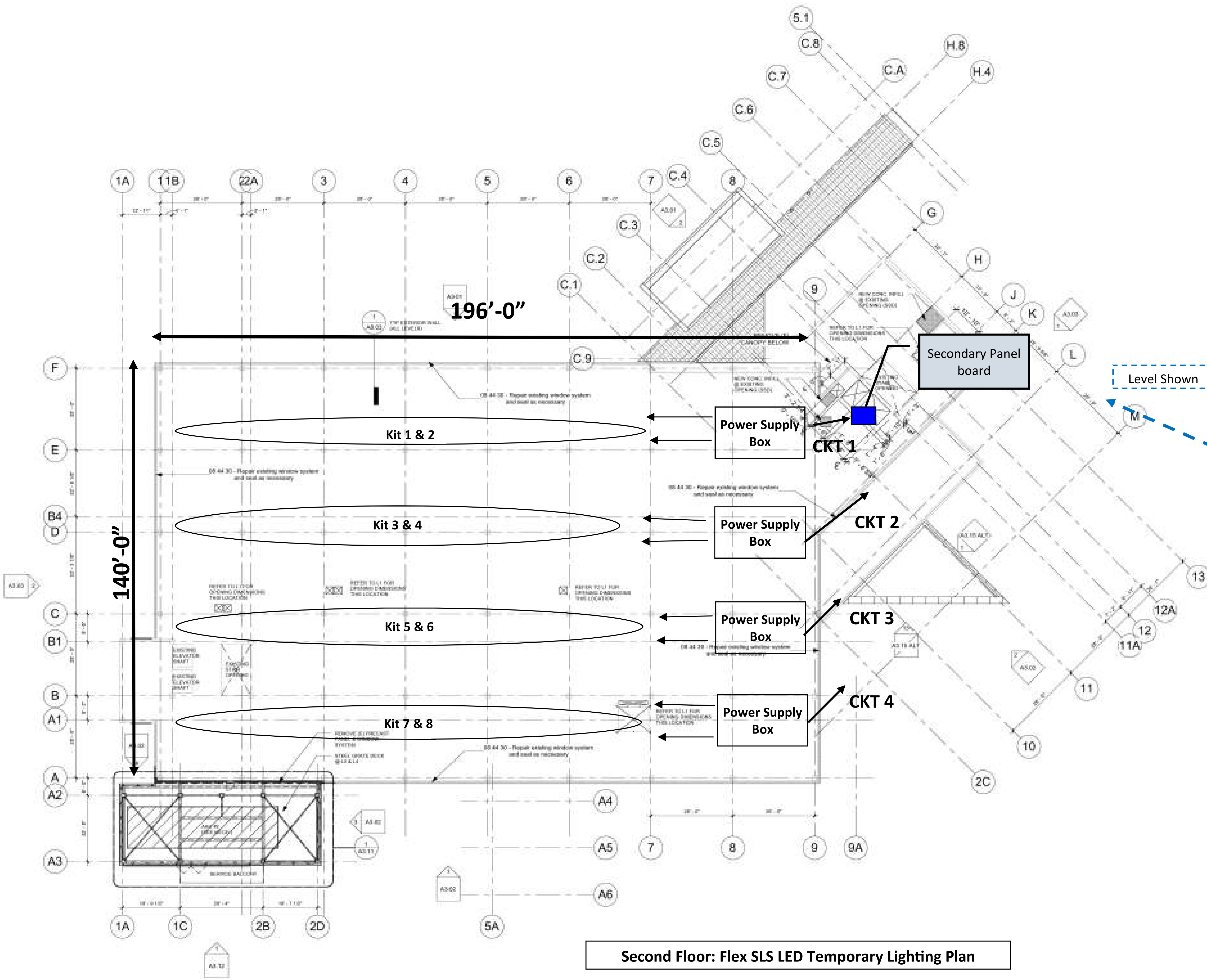


APPENDIX G

*****Assumptions for APPENDIX G:**

- There is no cost listed for the bulbs because LED bulbs never need to be changed- the module itself lasts for 6 years. So, to stay conservative no costs were assumed for the other lights to make it fair even though they break more often.
- For second project use: MH CFL and INC are all new systems. You do not re-use these systems because they are in poor condition. The LED are being reused because that is their point
- The percentage associated with loss on the second project refers to how many units were broken /lost/ damages from the first project to the second. It can be seen for the flex that human error will account for some loss of modules. Assuming that the wire will be chopped and not re-useable. For the CFL, MH, and INC there is a 50% loss because these systems are not being re-used because of their condition.
- Using 34 watts for compact fluorescent because some of light is deflecting to the sides.
- The footcandle requirement for the Kaiser Tysons project is 5 fc for task lighting. This also is the required value by OSHA.
- $8 re-lamping fee (material and labor) for T8 Fluorescent after each project.
- On the Kaiser project Two 32-watt T8 linear fluorescent strip lights were used (Product data attached). For the power and cost comparison, compact fluorescent is used since it is a more commonly used temporary light. Since compact fluorescent lights are usually more efficient then the T8 fluorescents, this can actually result in great power and cost savings for the Kaiser Tysons project.
- For the T8 Fluorescent fixture at Kaiser Tysons, an instant start electronic ballast is used.
- For Fluorescent layout, spacing from center to center of each fixture is 20 ft.

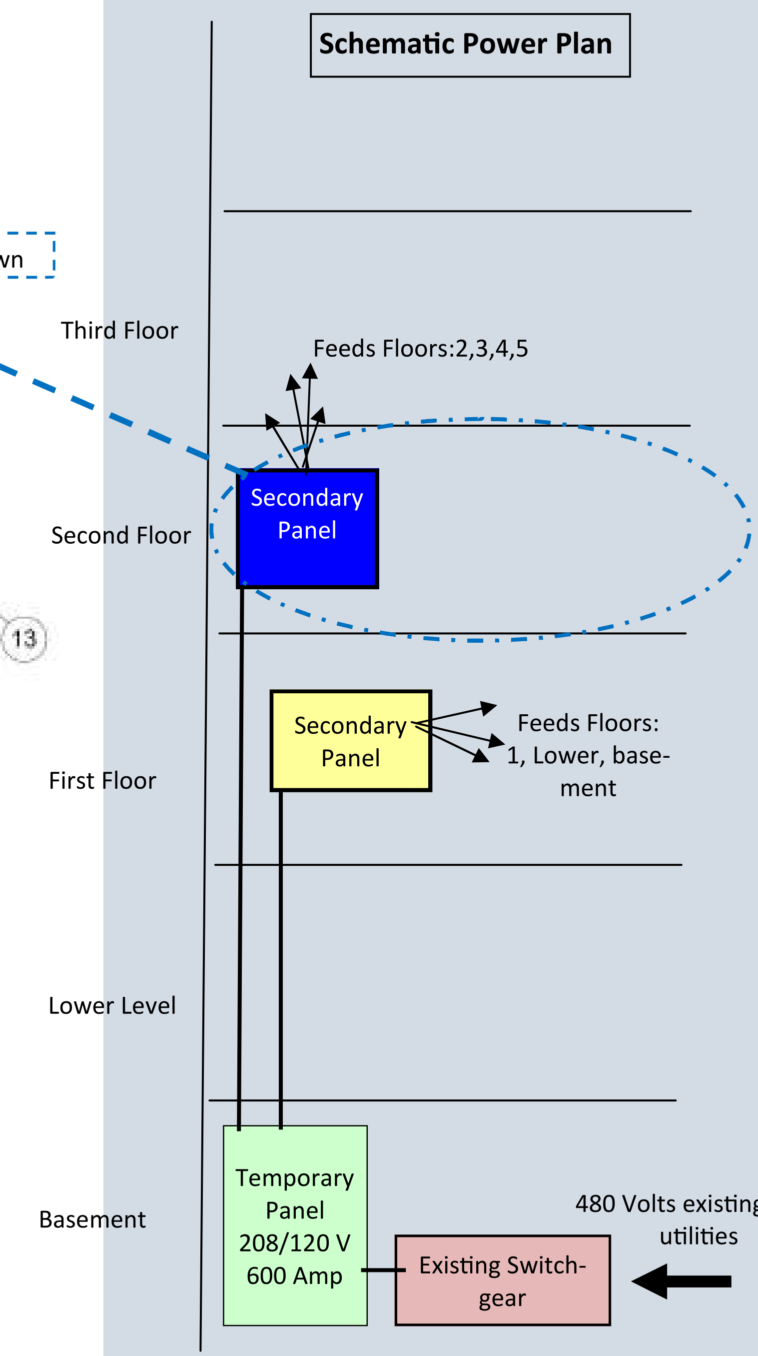
APPENDIX G



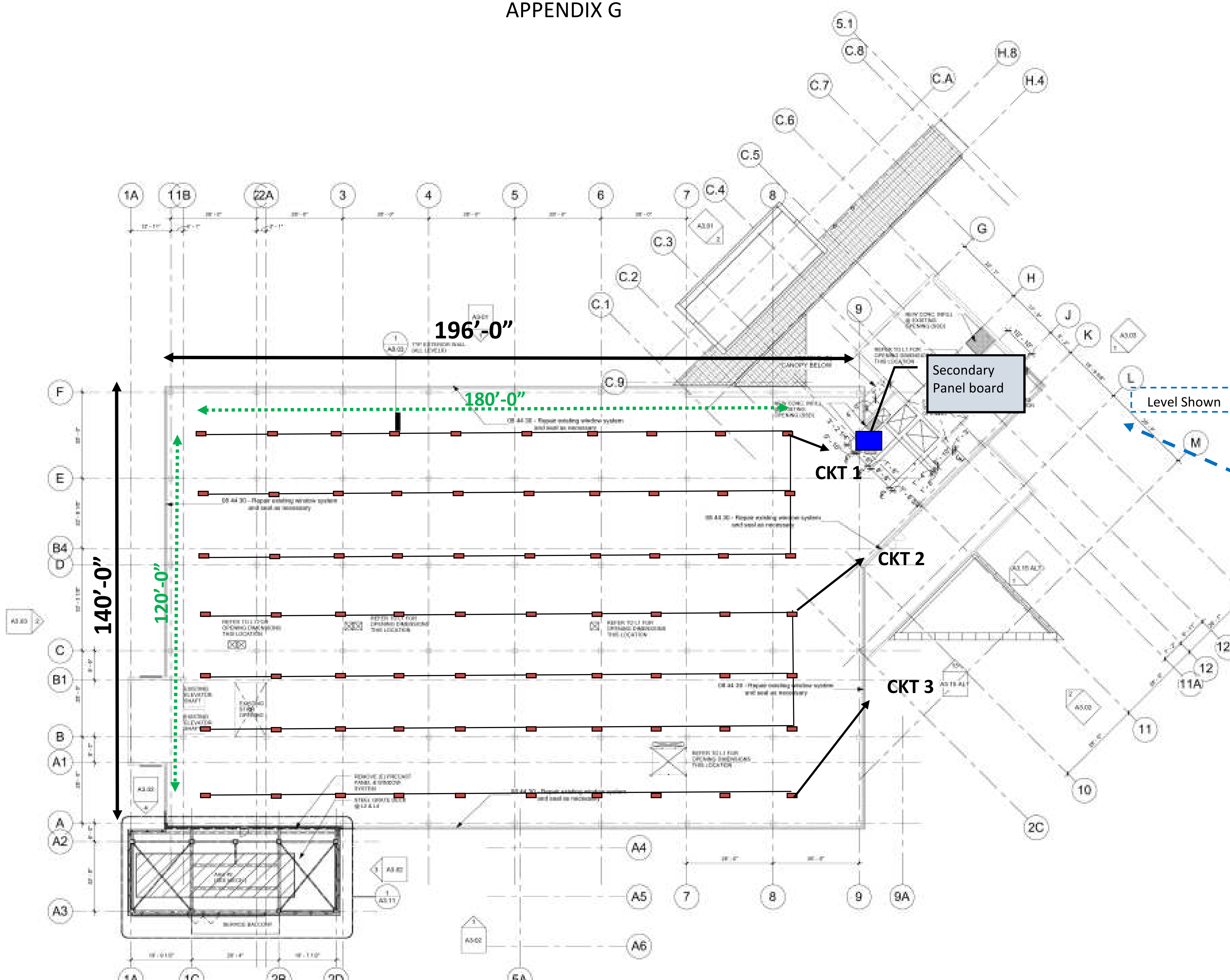
Second Floor: Flex SLS LED Temporary Lighting Plan

Assumptions:

LED Module Spacing= 15 ft
58 kits total/ 7 floors= 8 kits per floor
120 Modules per floor
Work Area: 27,440 SF



APPENDIX G



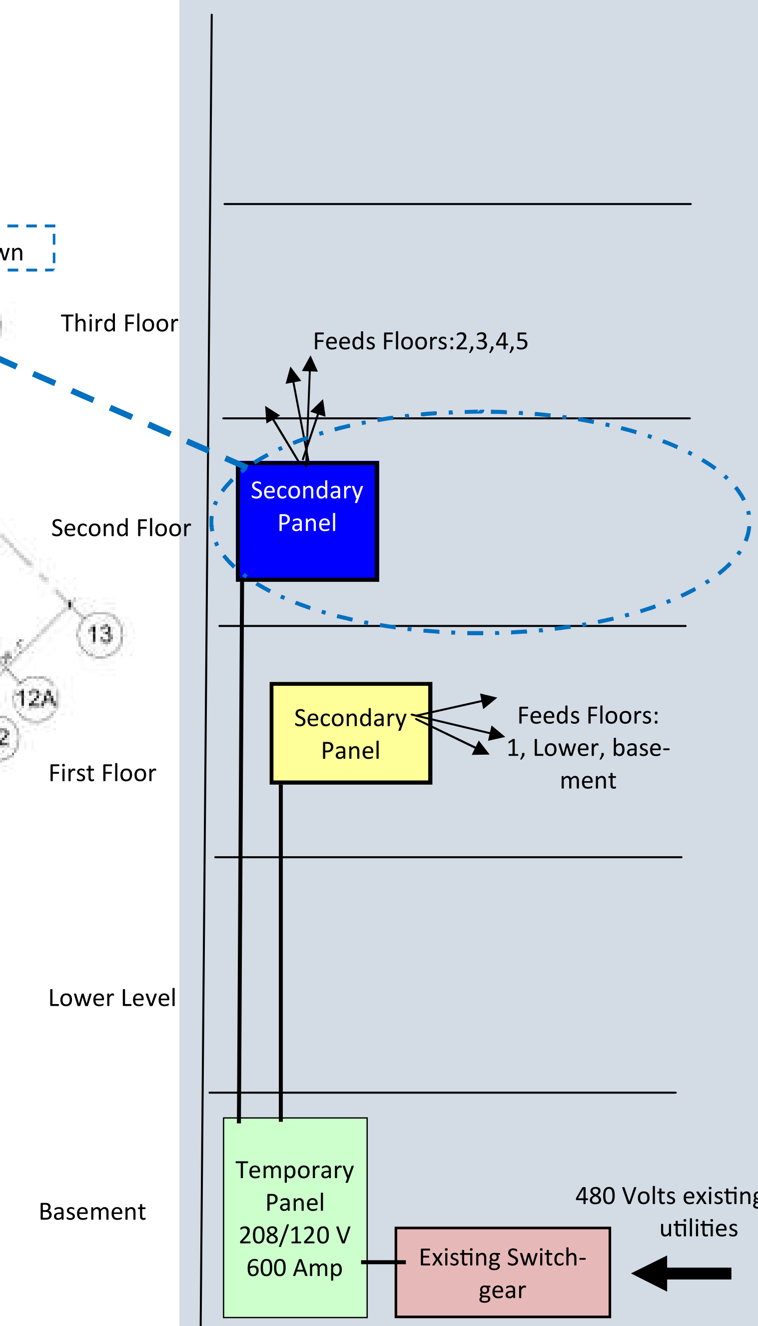
Second Floor: Fluorescent Temporary Lighting Plan

Assumptions and Calculations:

Fluorescent Fixture is 24" X 4"

20' by 20' spacing= 400 SF
Area of Work Area: 140' X 196' = 27440 SF
27440SF/ 400 SF= 70 Fixtures needed

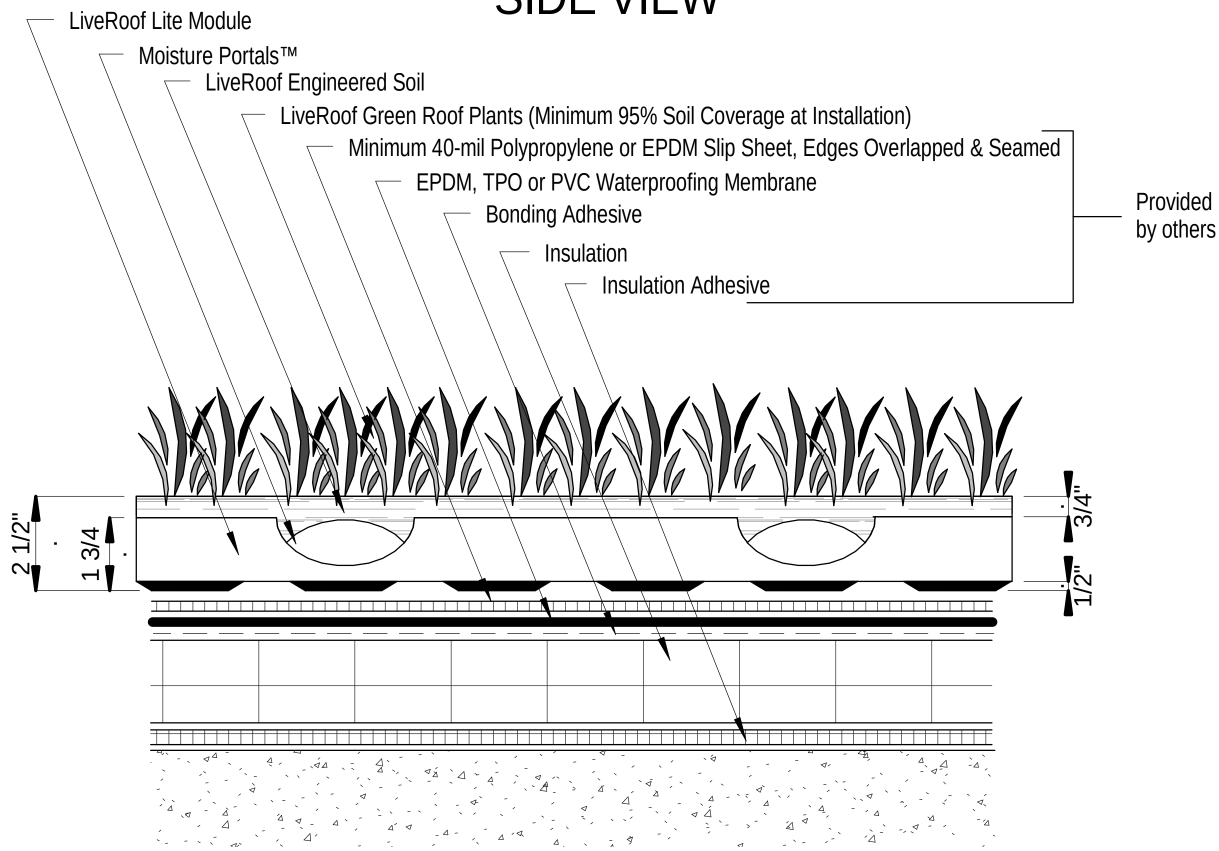
Fluorescent= 20ft spacing O.C.
30 Fixtures per circuit
27,500 SF (average floor size).
70 Fixtures needed
3 circuits needed (120V, 12 gauge)



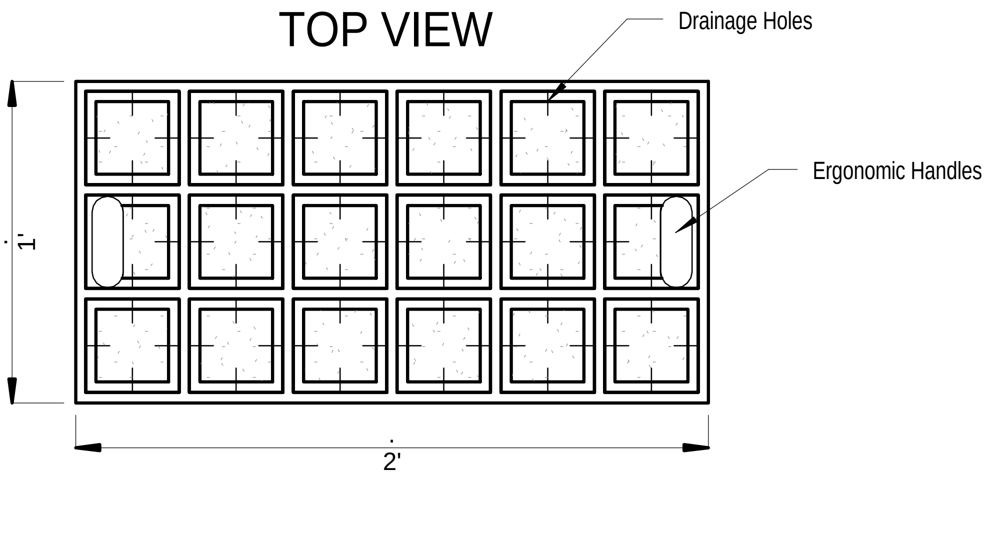
LiveRoof LITE SYSTEM

Over Conventional Roofing Assembly

SIDE VIEW



TOP VIEW



LiveRoof System Saturated Weight: 15-17 lbs / sf

NOT TO SCALE

ILLUSTRATIONS ARE TO CONCEPTUALLY ASSIST PROFESSIONALS IN DESIGNING LIVEROOF INSTALLATIONS. LIVEROOF DOES NOT ACCEPT RESPONSIBILTY FOR ENGINEERING BASED ON ILLUSTRATIONS. A QUALIFIED ROOFING SPECIALIST SHOULD BE CONSULTED TO DETERMINE APPROPRIATE WATERPROOFING AND ROOF DECK MATERIALS AND SUITABLE DESIGN.

LITE A
v2012-01-18

LiveRoof, LLC
P.O. Box 533
Spring Lake, MI 49456

(800) 875-1392
www.liveroof.com

LiveRoof

APPENDIX H- Green Roof Brochure

2011 LiveRoof® BRAND

Hybrid Green Roof System

Natural Function
Natural Beauty

FULLY-GROWN INVISIBLE MODULAR GREEN ROOF SYSTEM

"The Hybrid System"

SIMPLE EFFECTIVE ATTRACTIVE

Natural Function

LiveRoof is the only modular green roof system that uses patent pending Soil Elevator™ and Moisture Portal™ technology to unite the entire soil continuum. This allows for the natural sharing of water, nutrients and beneficial organisms across the entire rooftop strata.

It also minimizes hot, wet, and dry zones, and avoids compartmentalizing the growing medium into an unnatural "grid" as is the case with other modular systems.

By not compartmentalizing the soil into "grids" **LiveRoof functions like nature intended**, and the difference in performance is real.

Natural Function LiveRoof "soil elevation" design and moisture portals unite soil across the entire green roof strata for sharing, not compartmentalization, of water, nutrients, and beneficial organisms. This allows the plants to be more healthy, and hot/dry and wet spots are avoided.

Hybrid Technology

LiveRoof was designed to “package” the benefits of all green roof systems (and leave out the drawbacks). The table on the following page summarizes how the LiveRoof brand green roof combines the convenience of a modular system (quick install and easy roof access) with the natural function via soil integration of a plant-in-place system. Finally, LiveRoof brings the instant effect of a vegetative mat but with a much broader array of plant options and no soil interface problems.

No Photo Degradation
To completely prevent photo-degradation, LiveRoof is subterranean. The module edges are obscured, even during the dormant season.

No Air Gaps Between Modules
Uninterrupted continuum of soil eliminates air gaps for optimal R value, cooling value, and storm water absorption.

Proper Roof-Top Drainage
LiveRoof keeps the roof dry with drain channels that disperse water at 7.0 gallons per minute per lineal foot.

Satisfied Owners
Call your Local Licensed Grower today for a free demonstration, local LiveRoof On-Site Tour, and listing of Satisfied LiveRoof Owners.

See inside back cover for LiveRoof grower nearest you.

Subterranean Module
Gives a meadow-like look with no "grid" lines.

See inside back cover for LiveRoof grower nearest you.

Natural Beauty

The aesthetic advantages of LiveRoof are significant, and during spring, summer, fall or winter, **LiveRoof looks like a beautiful meadow.** Other modular systems may look like a man-made "grid" especially during the dormant season.

Weather exposed conventional modular systems may look like this during the dormant season.

Even during winter dormancy, LiveRoof is naturally beautiful.

NOTE: The success and appearance of any green roof system is dependent upon numerous factors such as the designer's specification, user's adherence to specified maintenance, specific variations in plant type, planting density, and adherence to proper installation.

See inside back cover for LiveRoof grower nearest you.

LiveRoof® Brand is an Instant Green Roof

Each LiveRoof module arrives to the job site with full grown plants inside the container and is simply set in place on the rooftop. The unique patent-pending soil elevators are then removed for a seamless fit and soil to soil contact. No need to start with a brown roof and farm it for years, hoping and waiting for it to become a green roof.

Natural Beauty

LiveRoof's monolithic soil continuum and unique plant mixtures bring 4-season aesthetics. Soil and plants obscure modules all 12 months of the year.

Proven Soil

The industry's best engineered soil, expected to last indefinitely.

See inside back cover for LiveRoof grower nearest you.

LiveRoof® BRAND Brings a Multitude of Advantages

	LiveRoof System	Other Systems
Backed by an Extensive Team of Leading Horticulturists Delivered 95% prevegetated	Yes	No
Evaporative Cooling Reduces indoor temperature 6 to 8 degrees during warm/hot weather and can reduce air-conditioning costs 25 to 50%	Optimal Day of Installation	Variable
Installed By Certified Installers	Yes	Variable
Instantly Mature/Instantly Beautiful Delivered 95% prevegetated	Always	Variable
LEED Points Enhances LEED ratings in many categories	Maximum	Variable
Maintenance Saves years of intensive and costly rooftop maintenance	Extremely Low Maintenance & Predictable Costs	Relatively High Maintenance & Unpredictable Costs
Meets Customer Expectation Well-established plants and roots mean an instantly functional green roof	Yes	No
Overall Value Saves time and money traditionally required to develop and maintain a green roof grown from plugs, seeds or cuttings	High Value & Predictable Cost	Variable Costs
Resistance to Wind Erosion	Optimal Day of Installation	Minimal Until Established
Successful Track Record	Yes	Variable
Weed Prevention Established planting is the best means for preventing weed encroachment	Hight Level of Weed Prevention	Variable Level of Weed Prevention
Total System Cost Over first five years	Predictable No Surprises	Variable

NOTE: The success and appearance of any green roof system is dependent upon numerous factors such as the designer's specification, user's adherence to specified maintenance, specific variation in plant type, planting density, and adherence to proper installation.

See inside back cover for LiveRoof grower nearest you.

LiveRoof® BRAND System Benefits

Why Use LiveRoof for Your Green Roof?

LiveRoof is an Instant Green Roof

Each LiveRoof module arrives at the job site with full-grown plants and is simply set in place on the rooftop. The unique patent-pending soil elevators are then removed for a seamless fit. No need to start with a brown roof and farm it for years, hoping and waiting for it to become a green roof.

LiveRoof Saves Money

Prevegetated modules discourage weeds and save the time and money traditionally required to develop and maintain a green roof grown from plugs, seeds or cuttings. Other systems may require three or more years for establishment and intensive care during this time period. Well-established plants and roots mean an instantly green, successful, fully functioning green roof. Maintenance cost estimates for traditionally planted green roofs vary from $1.00 to $2.00 per square foot annually. LiveRoof can be maintained for as little as $0.05 to $0.20 per square foot per year (depending on local labor rates). Being fully grown, LiveRoof plants act as a living mulch to help prevent weed establishment.

Designed and Developed by Experts

LiveRoof® was developed by horticulturists in a collaborative effort with experts in the fields of green roofing, roofing, logistics, architecture, manufacturing, construction, and ergonomics. The LiveRoof system, from its effective drain slots to its unique patent-pending Soil Elevators™ and Moisture Portals™, is specifically designed to grow plants on a rooftop environment.

No Ugly Seams

LiveRoof modules fit snugly together and are sealed tightly by soil and plants through the use of patent-pending Soil Elevators™ and overlapping edge design. This makes the modules of the system invisible for a seamless instantly green rooftop offered by no other modular system.

Patent pending LiveRoof Moisture Portals™ allow for moisture, soil and root cohesiveness. Other modular systems show unattractive plastic or metal seams. Such systems may eventually mature (the plants) to the point where seams are obscured during the summer months, but only to reappear during dormancy periods (fall, winter, and early spring) every year.

LiveRoof Eliminates the Risks Associated with Brown Roofs

Traditional green roof methods of planting 2 ¼ inch wide plugs on 9 inch centers equates to 95% brown roof (exposed soil) and only 5% green roof (plant material). These traditional brown roof plantings are prone to wind scour, water erosion, and weed encroachment. A brown roof also absorbs more heat and diminishes the benefits of a green roof.

See inside back cover for LiveRoof grower nearest you.

LiveRoof® BRAND Hybrid Green Roof Systems

LiveRoof Standard System

Soil: Appx. 4 ¼" deep.

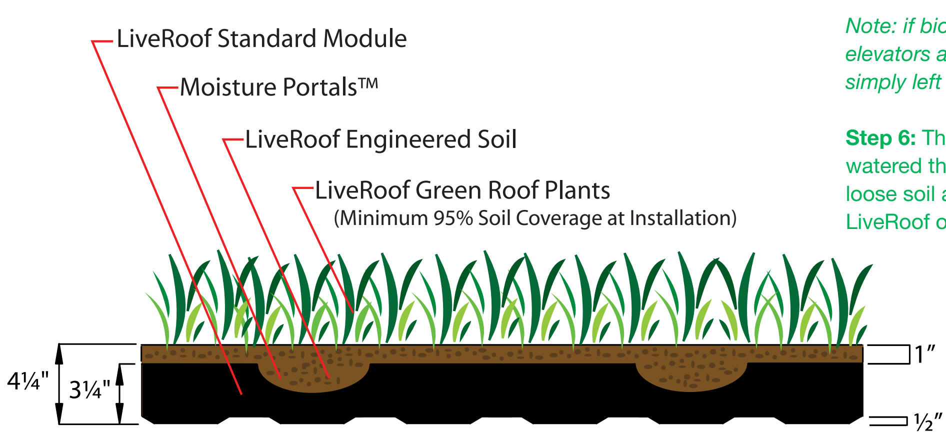
Module Size: 1' x 2' x 3 ¼"

Weight: Appx. 27-29 lbs/sf saturated and vegetated.

Merits: Maximizes storm water management, integrates perfectly with new construction and often times existing buildings.

Plants: Succulent ground covers, water conserving accent plants, and hardy spring blooming bulbs.

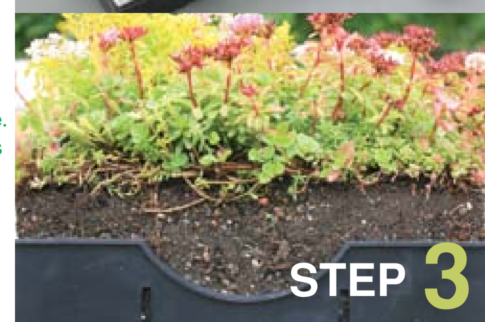
Also available **LiveRoof Lite**, ideal for retrofit projects at appx. 2 ¼" deep with saturated weight of 15-17lbs/sf. And, **LiveRoof Deep**, when a more garden-like effect is desired. 6" deep with saturated weight of 40-50 lbs/sf.



Step 1: The Licensed Grower inserts the LiveRoof Soil Elevator™ into LiveRoof module.

Step 2: LiveRoof module is filled to the top of Soil Elevator with LiveRoof engineered soil. Soil is settled by vibration and mechanically screeted off.

Step 3: LiveRoof Plants are grown to maturity approximately 1 inch above the LiveRoof module. In the LiveRoof Lite System plants are approximately ¾" above the module and in the LiveRoof Deep System they are approximately 2 ¾" above the module.



Step 4: Installer sets LiveRoof modules tightly in place on the roof from parapet to parapet or within LiveRoof RoofEdge, depending upon design.

Step 5: LiveRoof Soil Elevators™ are removed for a beautiful, seamless instantly mature green roof.

Note: if biodegradable soil elevators are used, they are simply left in place.

Step 6: The entire system is watered thoroughly to settle any loose soil and to get your LiveRoof off to a great start.

See inside back cover for LiveRoof grower nearest you.

Experienced

The LiveRoof Licensed Grower Network is composed of the horticultural industry's leading growers, collectively bringing you more than 500 years of horticultural experience and expertise.

Call your local grower to discuss your specific green roof project and to receive our 64 page informative catalog. Some topics include:

Specifications
Architecture & Engineering
LiveRoof Benefits
LEED Interface
Answers to Common Questions
Warranty Information

See inside back cover for LiveRoof grower nearest you.

LiveRoof® BRAND Supplier Network

Please call your local grower for a hands-on demonstration, catalog, pricing and specific plant recommendations. Buy Direct from LiveRoof, LLC in Michigan, Indiana, Illinois and southern Wisconsin.

Visit *www.LiveRoof.com* for a current listing of Growers, Designers and Installers.

1. **N.A.T.S. Nursery Ltd.**
   British Columbia
   Suzanne Charest
   (604) 530-9300
   liveroof@natsnursery.com

2. **GreenFeathers Living Roof Plants and Systems**
   Oregon
   Bob Adams, (503) 357-2904
   liveroof@greenfeathersroof.com

3. **Native Sons & Florasource**
   California
   Jennifer Scarano,
   (805) 481-5996
   liveroof@nativeson.com
   Tom Hawkins, (949) 498-1131
   Mike Connelly, (831) 422-3175
   liveroof@florasourceltd.com

4. **Hawaiian Sunshine Nursery**
   Brian Leong (866) 714-7837
   pgs@hawaiinursery.com

5. **Summit Valley Turf Farms**
   Montana
   Charissa Wagner,
   (406) 287-2268
   liveroofmontana@yahoo.com

6. **J&J Nursery**
   Utah
   Jim Webster, (801) 949-7291
   jwalandscape@gmail.com

7. **Eagle Lake Turf Farms Ltd.**
   Alberta
   Jan Bjerreskov, (403) 295-0477
   Eric Heuver, (403) 934-6813
   jan.liveroof@eaglelaketurf.com

8. **Colorado Green Roofs & Walls**
   Gene Pielin or Carrie Waldron
   (970) 212-0620
   genep@gulleygreenhouse.com

9. **Bachmans Inc.**
   MN and parts of ND, SD & WI
   Doug Danielsen
   (800) 525-6641
   liveroof@bachmans.com

10. **Roof Top Sedums, LLC**
    IA & parts of IL, KS, NE, & MO
    Teresa Nelson, (563) 676-9775
    Roxanne Nagel, (563) 505-7032
    info@rooftopsedums.com

11. **Texas Green Roofs**
    (903) 882-7541
    x 215 Ed Borgers
    x 213 Randy Jackson
    emborger@earthlink.net

12. **Green Gate Farms**
    Parts of MO & IL
    Larry Becker, (636) 798-2202
    larrybecker@greengatefarms.com

13. **LiveRoof® LLC**
    MI & parts of IL, IN & WI
    Julie Ardner, John Scholten, or
    Jennifer Smith (800) 875-1392
    sales@liveroof.com

14. **Southeast Green Roofs, LLC**
    TN, KY & Southern IN
    Owen Slaughter, (615) 290-3400
    Andy Sudbrock, (615) 799-8719
    owen@southeastgreenroofs.com

15. **LiveRoof Ontario, Inc.**
    Kees Govers
    (519) 245-4039
    kees@liveroofontario.ca

16. **Corso's Perennials**
    OH and parts of PA & WV
    Dan Cartell, (216) 408-9611
    Gus Corso,
    (888) 816-8608 x219
    liveroof@corsosperennials.com

17. **Riverbend Nursery**
    DC, NC, VA & parts of MD, WV
    Jim Snyder or
    Kelly Connoley-Phillips,
    (800) 638-3362
    Scott Titanish or
    Janie Schepker
    liveroof@riverbendnursery.com

18. **NY Green Roof, LLC**
    Central and Western NY
    Liz Sanders, (585) 703-7211
    hydroguys@gmail.com

19. **BiotectureFl, div. of Reflections of Nature Landscape Nursery**
    Northern FL
    Angie Loper, (904) 415-3893
    James Loper, (904) 225-9915
    rnlnursery@comcast.net

20. **Coastal Landscape & Maintenance**
    Southern FL
    Susan Cone (954)924-4014 x12
    (561) 640-5930
    clmsue@bellsouth.net

21. **Climax Urban Greening, Inc.**
    Quebec
    Denis Faucher, (418) 930-9148
    liveroof@videotron.ca

22. **Prides Corner Farms Wholesale Nursery**
    CT, ME, NH, VT, MA, RI & Southeast NY
    Jim Costello or Rich Palmer
    (800) 437-5168
    Ray DeFeo
    (860) 234-6723
    liveroof@pridescorner.com

23. **Creek Hill Nursery**
    DE, MD, PA & parts of NJ
    Paul Cook, (717) 723-0855
    Ron Strasko, (717) 556-0000
    paul@creekhillnursery.com

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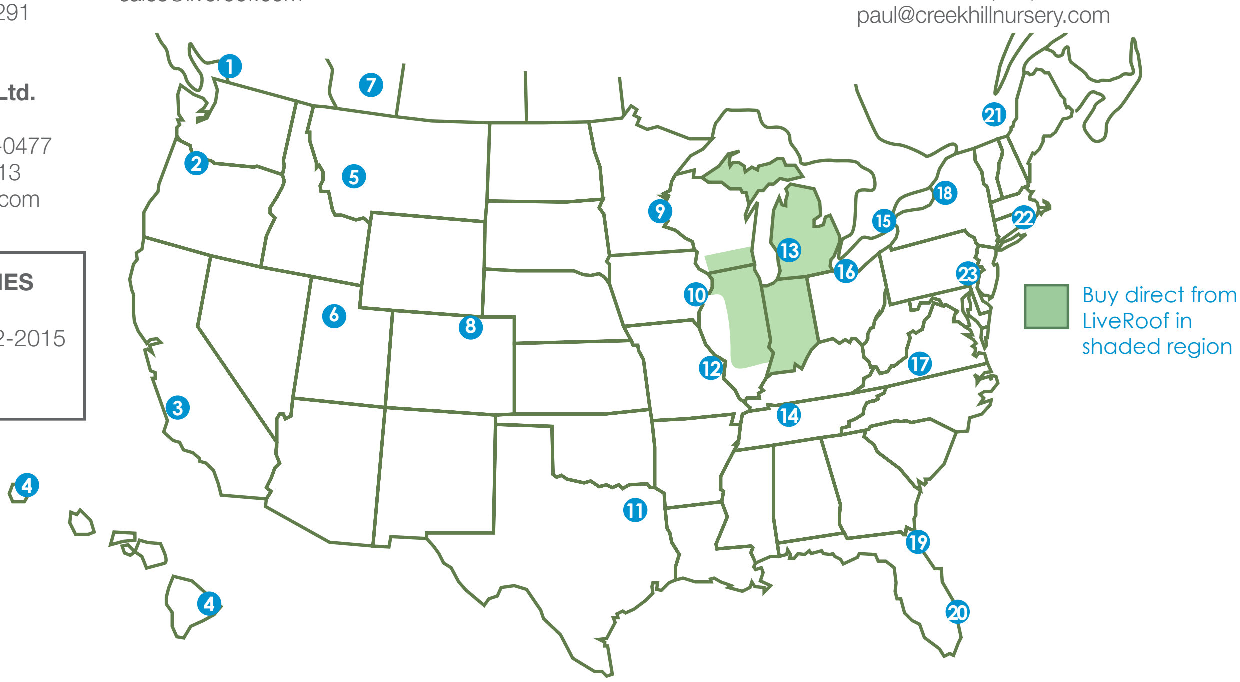
PlantedRoof.com
Dana McIntyre, +1 (978) 922-2015
Cell +1 (978) 430-2101
international@liveroof.com



LiveRoof® BRAND

"The Hybrid System"

Natural Function
Natural Beauty

LiveRoof, LLC
A Subsidiary of Hortech, Inc.

See Inside Back Cover For a Supplier Nearest You, and to arrange for a Personal Consultation.

See LiveRoof.com For Additional Information

Printed On Rapidly Renewable Eucalyptus Paper with Soy Based Inks

SIMPLE EFFECTIVE ATTRACTIVE

PREVEGETATED
INVISIBLE-MODULAR
GREEN ROOF SYSTEM

LiveRoof® Installation
Guide of Standardized Procedures

Introduction

The LiveRoof® prevegetated green roof system is simple and easy to install, but like everything else, it can be done well or poorly. At LiveRoof we want to make sure that each LiveRoof system is installed properly every time, so we developed these standardized procedures. These will help you plan for and correctly install the LiveRoof® green roof system.

Each time you install a LiveRoof®, you should bring this LiveRoof® Installation Guide of standardized procedures and follow it step by step. It is the consistent execution of these Standardized Procedures that will create:

- Optimum performance and best appearance
- Maximum value and customer satisfaction
- A great reputation for the LiveRoof® brand, your company and staff

Why Green Roofs?

Green roofs have become popular for both their financial and environmental benefits.

- Green roofs protect the roof from the sun, wind, heat, and cold and can extend the life of the roof by up to 40 years

  When you consider that the average life expectancy of a roof may be only 15 years, and it may cost as much as 20 dollars per square foot to replace a worn out roof, it is easy to see that green roofs make financial sense.
- Reduce air conditioning costs by 25% or more (for the floor under the green roof)
- Reduce or eliminate storm water discharge fees
- Allow building owners to sell or rent their properties more easily

From an Environmental Perspective

- Green roofs help to reduce the effects of Global Warming
- Release oxygen and absorb green house gases
- Keep pollutants out of lakes and streams
- Absorb sound and reduce noise
- Help to replace the plants that existed before the building was built
- Provide natural views, helping to make people calmer, happier and more productive

LiveRoof®
Green Roof Systems

Why Choose LiveRoof® for Your Green Roof?

LiveRoof® is a unique patent pending green roof system with prevegetated "invisible" modules. It arrives fully grown for an instantly mature green roof! Other systems require you to start with a brown roof (in other words bare soil and small plants) and grow the roof to maturity - a process that often takes more than 3 years. But LiveRoof is pregrown; there is no longer a need to spend years farming the rooftop trying to make it green. And unlike other modular green roof systems, LiveRoof® is invisible and subterranean so it is attractive and natural looking. It is also sheltered from the sun so it will last indefinitely.

Because LiveRoof® is fully grown, the very day of installation it pays dividends through reduced maintenance, immediate evaporative cooling, erosion control and most importantly owner satisfaction.

LiveRoof® is also unique in that is was developed by a team of horticulturists, roofers, architects, and material handling experts. It uses the finest green roof soil and plants, and is expected to last indefinitely (not a few years like some systems).

You should be proud to be part of each and every LiveRoof® installation and always strive to conduct the installation as precisely as possible. The LiveRoof® standardized procedures are intended to help you to do just that.

Disclaimer:

Of course, each roof design is unique and you will have to use your expertise and judgment to cope with the nuances of each job. You should always adhere to proper roofing and horticultural principles and realize that, as the installer, you are responsible for the quality of each LiveRoof® installation.

Similarly, you must always protect the integrity of the water-proofing system and building, protect the plants on the job site before and during installation, and properly install accessory components (like edging, irrigation and pavers), as well as the actual LiveRoof® modules.

We hope that the following standardized procedures will serve you well as you represent your company, the building owner, and the LiveRoof® brand. At LiveRoof® we take great pride in the quality of our system. We hope that you will take great pride in the quality of your installations, and in the knowledge that by installing LiveRoof® you are helping to make the world a better place.

LiveRoof® Installation Standardized Procedures

The following Standardized Procedures represent the steps that you should follow when installing the LiveRoof® system.

Step A

Advance Preparation

Always prepare for your LiveRoof® installation long before the LiveRoof® modules ever get to the job site. This will save you time and money, and ensure maximum quality.

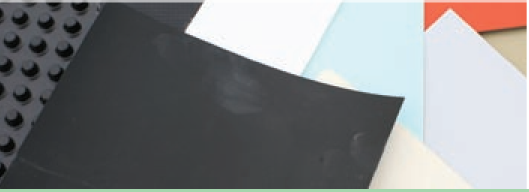
Be committed to timely communication. Stay in touch with your LiveRoof® grower and the contractor or owner who hired you to do the installation.

Determine how many modules you will install each day and schedule delivery with your LiveRoof® grower 2 to 3 weeks in advance so the grower can make arrangements for trucks and drivers.

Know in advance who will install the protective slip sheet/root barrier and plan to follow the architect's specifications. Next ensure that the protective slip sheet/root barrier is pre-approved by the manufacturer of the waterproofing system. Normally the slip sheet will be 40 mil. thick or thicker;

- TPO, PVC, Polyethylene or Polypropylene, with seams overlapped and fastened by heat weld
- EPDM, with seams overlapped a minimum of 3 inches and glued with adhesive of the type that is impervious to and unaffected by moisture, or it may also be...
- Low profile polypropylene drain board overlapped 3-6 inches and glued with manufacturer-recommended adhesive.

NEVER USE A FUZZY MOISTURE HOLDING FABRIC, SUCH AS NEEDLE PUNCHED POLYETHYLENE OR FELT as a slip sheet/root barrier. This type of fabric stays wet and encourages root growth that could impede drainage. It is also impossible to sweep and keep clean during the installation process. If you become aware that a moisture holding fabric, such as needle punched polyethylene or felt, has been installed by another contractor, stop the process immediately, and have them replace it with the proper material.


proper slip sheet/root barrier materials are durable smooth-surfaced & can easily be swept clean.


improper materials are fuzzy, trap water, and cannot be swept clean during installation.

LiveRoof®
Green Roof Systems

Step B

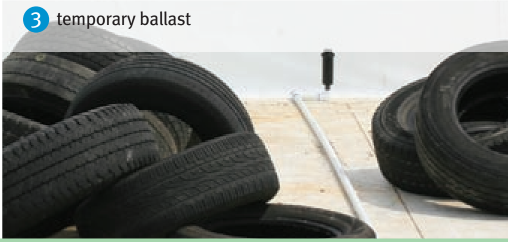
Job Site Readiness Before Installation

1. Visit the jobsite and the rooftop with a representative from the roofing contractor to get approval for beginning the LiveRoof® installation.
2. At this point, the roof should have been tested, either by flooding or other means, to ensure that it is waterproof. This should come to you with an official written sign-off from the installer of the waterproofing system or general contractor.
3. The protective slip sheet/root barrier and irrigation system (if any) may also be in place and held down with temporary ballast (weight) at this time. Alternatively, you may be responsible to place the protective slip sheet/root barrier. If that is the case, its placement will be done in the near future.

1 plan ahead

2 waterproofing evaluation

3 temporary ballast

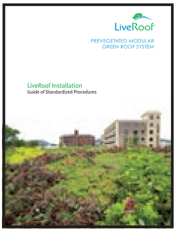


Step C
Preparation for Personal Safety and Property Security

Conduct a preinstallation training session with your staff and attend to the following:

1. Give everyone on the installation team a copy of this booklet, LiveRoof® Standardized Procedures and review the installation process.
2. Review all OSHA and related safety procedures. Be diligent with safety harnesses and other special safety equipment for working on rooftops. In many cases you will have to rope off the edges of the roof.
3. Review proper body mechanics and posture for lifting modules. Bend your legs, not your back.
4. Review the importance of protecting the roofing membranes from scratches and punctures. Always report scratches or punctures to the roofing contractor. Never cover up any damage or defect.

1 everyone gets an installation guide



2 review safety and security measures

3 use proper body mechanics

4 protect the roofing membranes, report scractches and punctures

LiveRoof®
Green Roof Systems

5. Plan to protect the parapet from bumping and abrasion.

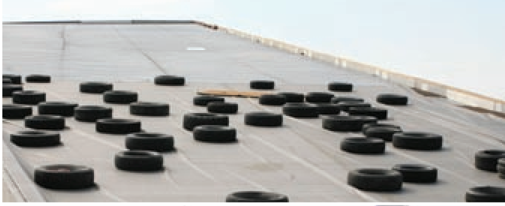
6. If it is your responsibility, properly install the protective slipsheet/root barrier. Ensure that this is preapproved by the manufacturer of the waterproofing system and held down with temporary ballast (weight).

7. Plan for protective sheets of plywood or closed cell foam to further protect the roof surface during installation.

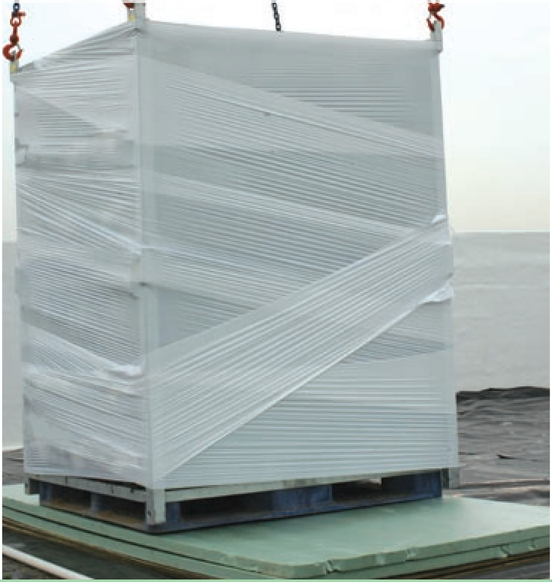
8. Understand that when using lifting equipment, lifting capacity decreases as the boom is extended. Use equipment that is big enough to easily do the job safely.

5 protect the parapet

6 place slip sheet/root barrier & hold with temporary ballast



7 protect roof surfaces from mechanical damage



8 lifting capacity decreases with boom extension

9. Edging is lightweight, plan to hold it in place with temporary ballast as a safety procedure to keep it from blowing off the roof. If the design calls for the edging to be affixed to the slip sheet, it may be done so with a manufacturer-approved adhesive. Edging should never be mechanically attached to the roof surface. One should never penetrate roofing membranes.

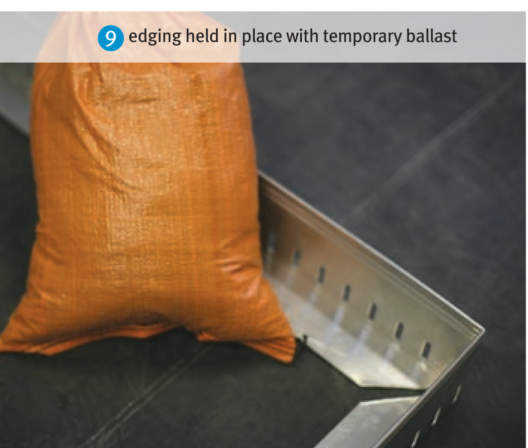
10. Never set the Hoppit® directly on the rooftop; instead cushion it with tires or closed cell foam and exert only enough pressure to keep it from twisting.

    *A Hoppit® loaded with 18 standard modules may weigh 1100 pounds. If loaded with 36 modules, it will weigh 2200 pounds, etc. Regardless of what device is used for conveyance, account for its weight as well as the modules.

11. Throughout the installation, constantly sweep up debris and loose growing medium, as it occurs. Do not install modules on top of gravel, debris, etc., as this could damage protective membranes.

12. When plants arrive shrink-wrapped, they will bake in the sun very quickly. Always, get them to the roof right away, unwrap, unload and install them.

13. Avoid walking on plants during installation.



9 edging held in place with temporary ballast

10 plan to cushion Hoppits®

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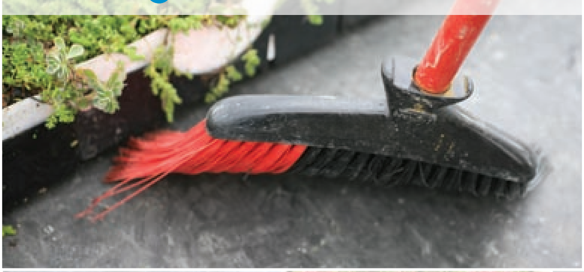
14. Conveyors can be set on transportable jack-stands. But, these stands must have rubber bases or be set upon plywood to protect the roof membranes, please no sharp edges on roof!

15. Remember that even a flat roof will have enough slope to shed water. If carts are used on the roof, be sure that even when fully loaded they can be easily wheeled about, stopped and braked. Apply brakes or chock the wheels as needed to hold carts in place.

Note: Never work in freezing temperatures and never install frozen LiveRoof modules as frozen soil will prevent the modules from fitting tightly together.

Important: If ever the slightest damage occurs to the underlying roof membrane, stop the process and report it to the roofing contractor for immediate repair. NEVER COVER OVER ANY DAMAGE OR DEFECT. Roof leaks can never be tolerated.



11 sweep up loose soil before placing modules

12 unload Hoppits® quickly to prevent overheating

13 respect the plants and avoid walking on them

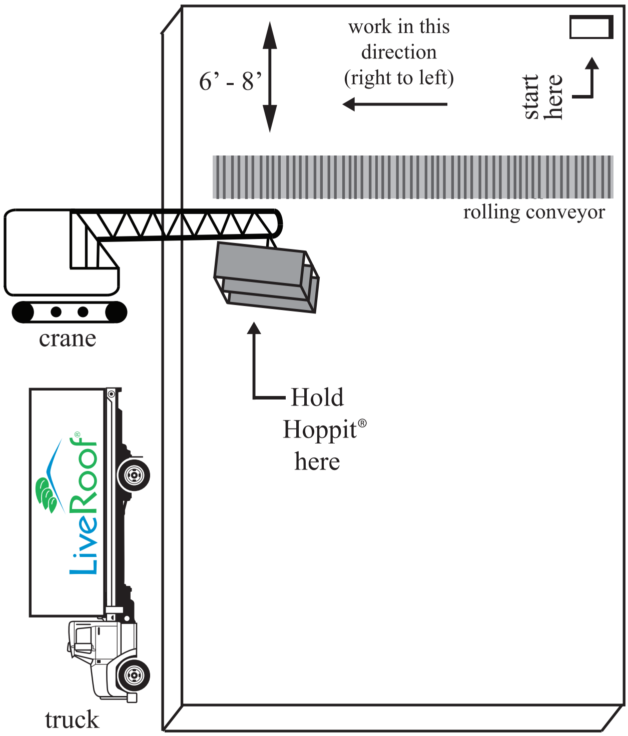
14 only smooth rubber-cushioned equipment on roof

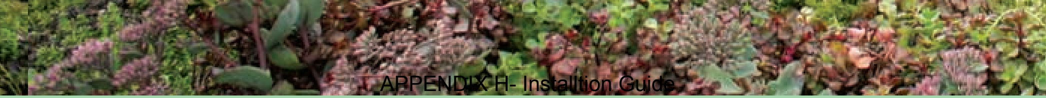
Step D
Set Up for Efficient Installation

Plan to Work Smart Not Hard!

1. Decide upon safe and efficient placement of truck and crane.
2. Decide upon efficient rooftop unloading point and placement of conveyors.
3. Establish a point of delivery to roller conveyors and run the roller conveyors parallel to the line of installation. Roller conveyors can be set on transportable jack-stands (with rubber feet) or tires. Conveyors should be set parallel to the line of installation and within 8 to 10 feet of the line of installation. Then, 7 or 8 rows of modules can be set before the conveyor needs to be moved back another 8 to 10 feet.

   *A well-designed installation will require almost no walking! If you are walking, you are wasting time and driving up your costs.

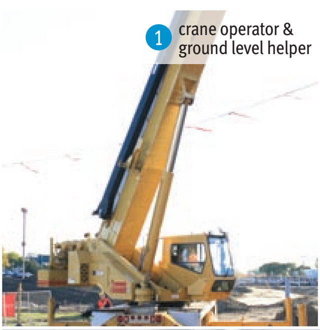


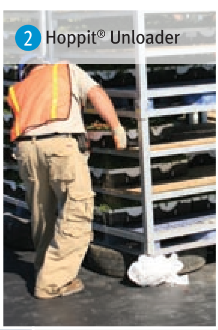


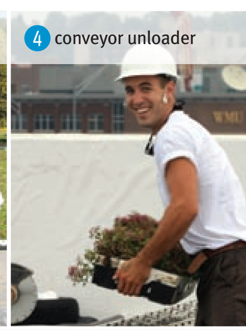
4. **Designate the various roles each team member will perform and plan to switch functions every hour or so. Do not multi-task, focus on doing one job right! These roles include:**

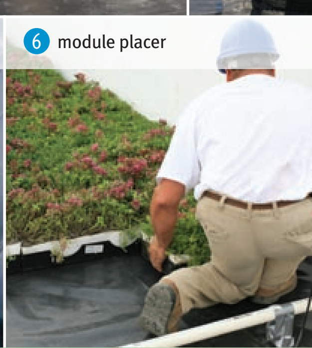
    1. A crane or lift truck operator and Hoppit® loader at ground level
    2. A Hoppit® unloader on the roof top who removes modules from the Hoppit® and places them on the conveyor
    3. A module transporter who gently moves modules along conveyor
    4. A conveyor unloader on the roof top sets modules on roof surface for module placer.
    5. A designated sweeper to keep the roof clean
    6. A module placer on the roof top
    7. A puller to remove soil elevators

    Let everyone know that every time a truck is unloaded, it should be filled back up with empty delivery Hoppits®. Otherwise, additional trips with the truck will have to be made and additional charges will be applied.









Step E

Efficiently Conducting a LiveRoof Installation

1. 1-2 days before installation (if not already done by other contractor), install slip-sheet/root barrier as specified, weld, tape or glue all seams, then install irrigation as specified. Use temporary ballast (tires) to hold things in place.

2. Cut and prepare all edging and install pavers that are part of the plan.

   *If edging is left on roof, be sure to secure it with temporary ballast.

3. Set up conveyors parallel to the line of installation as previously determined.

4. YOU WILL USUALLY INSTALL MODULES FROM RIGHT TO LEFT, because of the orientation of the overlapping lip. If you fail to do this, you will not be able to install the modules correctly.

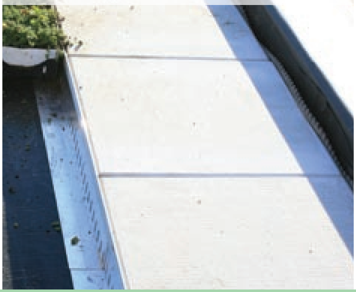
   A. IT IS ALMOST ALWAYS BEST TO START IN A RIGHT HAND CORNER OF THE ROOF, so that the overlapping edges align correctly.

   B. If you have to place modules across long expanses without a hard edge to push against, you may use chalk lines to ensure straight rows.

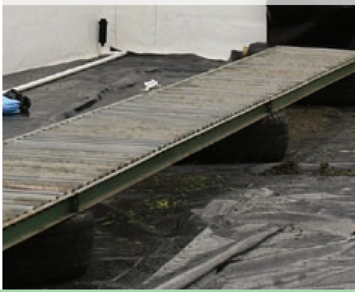
5. Lift Hoppit® over the parapet and rest lightly upon tires to keep from twisting. Do not rest full weight of Hoppit® on roof.

Another method of transport is to use a crane or forklift to place or suspend the Hoppits™ in the vicinity of where the modules will be installed.

1 Install slipsheet/root barrier



2 Install edging and pavers



3 conveyors set up

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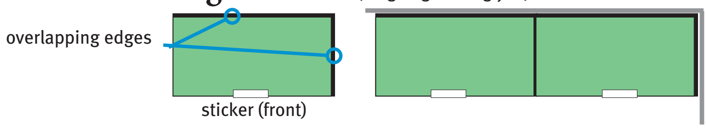
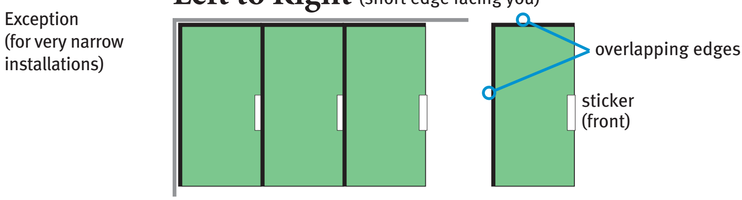
4A Almost always you will work from right to left.

Right to Left (long edge facing you)



Left to Right (short edge facing you)




4A work from right to left & overlap edges


4B chalk lines


5 Hoppit® delivered to roof by crane

5 Hoppit® gently rests upon tires

6. Hoppit® unloader removes modules and places them on conveyor. Stickers all facing module placer.

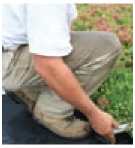
   Notice: When removing LiveRoof® modules, from the Hoppit® or other conveyance device, do not pull on, push against, remove, or otherwise disturb, jar or dislodge the flexible soil elevators. When handling the LiveRoof modules, do so by using the hand grips.

7. Module transporter pushes modules down conveyor line, in a smooth manner so they don't bang together and displace soil.

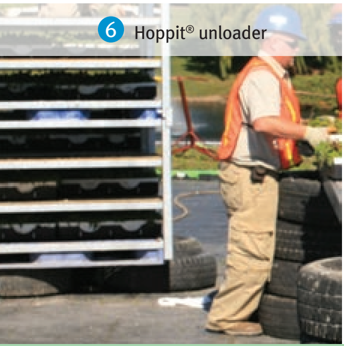
8. The sweeper must clean the surface before the module placer sets down each module. Avoid setting modules on soil or debris.

IMPORTANT: Avoid walking on any spilled aggregate or setting modules on top of aggregate. This can damage roofing membranes. During the entire installation the designated sweeper must sweep the roof surface clean and away from the previously placed modules, before placing each new module. Sweep with a corn or kitchen-type broom. Do not use a blower as it will blow gravel under the modules and membranes.

SAFETY: Use proper body mechanics and posture when lifting or setting down LiveRoof® modules. Bend with your knees, not your back and keep the module close to your body.



LiveRoof modules have a front and back side. The front side (the side away from you as you are placing the modules) and the right side have overlapping edges that center the containers and make them align correctly. The orange sticker should face the installer during placement.



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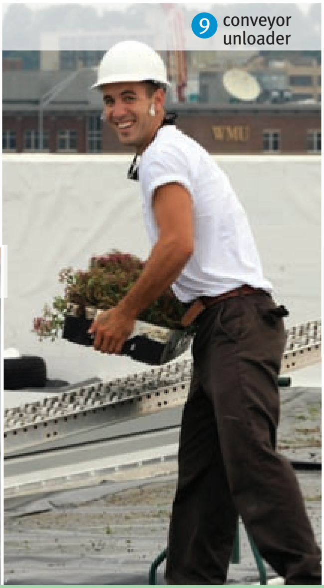
9. Conveyor Unloader removes module from conveyor and sets on roof near module placer with sticker facing out.
10. Once the surface is swept clean the module placer sets down the first module and tightly pushes it in against the edging or parapet with the overlapping lip facing away from him.

IMPORTANT: <u>The sticker must face the Module Placer!</u>

The overlapping lip faces away from the Module Placer!

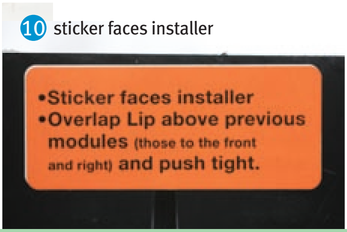
IMPORTANT: LiveRoof modules have a front and back.

- The overlapping lip is oriented away from the placer.
- The short right side also has an overlapping lip.

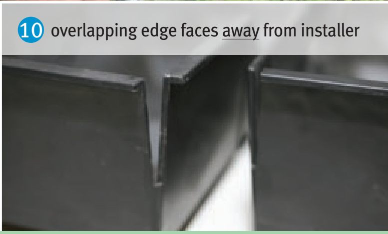


9 conveyor unloader

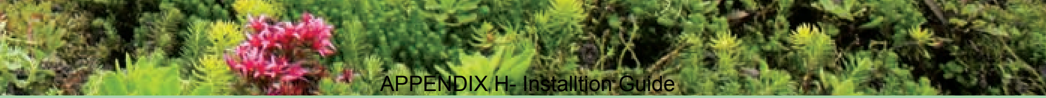
10 placer sets module with sticker facing himself.



10 sticker faces installer



10 overlapping edge faces <u>away</u> from installer



11. Set the second module next to it.
    - Make sure its overlapping lip overlaps the half-moon shaped "moisture portal" of the first module.
    - Line them up precisely!
    - Flip any overhanging plant material up and out of the way.
    - Lift and place module snugly in place.
    - Continue to repeat this process until the first row is installed.

      Or, once the first row has 5 to 10 modules placed, another placer may begin the process with the second row.

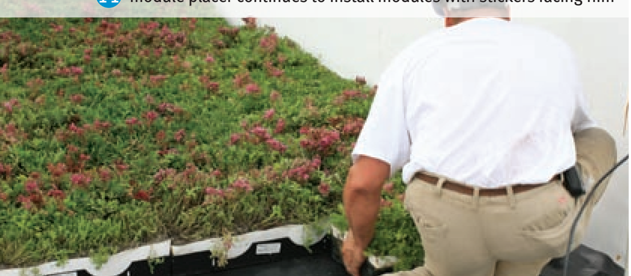
12. REMOVAL OF SOIL ELEVATORS: As the second row is set, the flexible "soil elevators" from the modules in the first row will be 100% surrounded by either modules or edging. AT THIS POINT THEY SHOULD BE PULLED OUT BY THE PULLER.

A good puller can pull 2 adjacent soil elevators out at the same time.

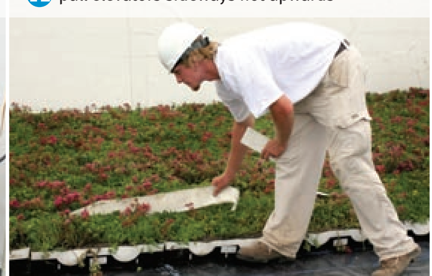
- Soil elevators must be pulled in a sideways fashion not upward (which displaces soil).
- You may want to use a pair of spring loaded pliers.
- Always pull as you go. Don't wait or you will end up trampling the plants and you will overlook many of the soil elevators.
- The puller should bag the soil elevators as he removes them. They should be recycled.

12. The above processes are repeated over and over until all modules are placed.

11 module placer continues to install modules with stickers facing him



12 pull elevators sideways not upwards



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Custom cutting modules to fit odd-sized areas

LiveRoof® modules may be cut, with mature plants and soil in the container, with a radial arm saw with masonry blade much as one would use to cut paver stones. A portable masonry saw also works and a reciprocating saw may be used for curved cuts. Always install modules in a manner that minimizes custom cutting to make installation easier and more cost effective. Always wear protective goggles and gloves.

* Handle gently; the roots will bind the soil, but can be disturbed by rough handling.
* Use a cardboard die or tape measure to transfer your measurements to the person doing the cutting.

IMPORTANT: If the roof is sloping and custom cutting is required, start at the bottom and work up. This way if there is any compression, the compression will be against modules that have not been cut.

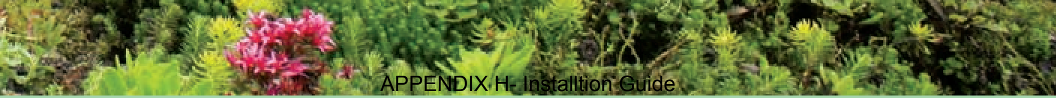
When the custom cutting is to be done on a non-draining edge, (top or side of the roof) custom cut modules may be held in place by fitting tightly against either another module or the edging.

In the event of soil infilling between module and parapet or edging, where the gap is 4 inches or less, use filter fabric and LiveRoof® brand engineered green roof soil.


radial arm saw


portable masonry saw


reciprocating saw



Step F
Wrap up and Initial Watering

The job is not finished until all delivery modules are loaded back on the grower's truck. If the driver must wait or return to the job site additional charges will apply.

INITIAL WATERING

Once installed, immediately and completely water plants. Soak the soil from top to bottom; this settles the soil and requires about 1 1/4 gallons of water per module.

SITE CLEANUP

Clean the job site daily and at the end of the job, clean up the job site 100%, leaving no waste or debris.

FINAL SIGN OFF AND MAINTENANCE PROTOCOL

Arrange for final sign-off on the installation. (refer to certified installer training manual.)

Give the owner a copy of the LiveRoof® Maintenance Protocol.

Installation before initial watering

Initial watering

Final sign-off

Dubuque, IA

Grand Rapids, MI

London, Ontario

Muskegon, MI

APPENDIX H- Installtion Guide

LiveRoof® Green Roof Systems

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