Steel City High-Rise

Thesis Final Report

Senior Thesis

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Project Location: Pittsburgh, PA

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STEEL CITY HIGH-RISE

Pittsburgh, Pennsylvania

Photo Courtesy of Turner Construction

Project Team:

- Owner: Millcraft Investors
- Architect: Arquitectonica
- Structural Engineer: Jezerinac Geers
- MEP: Emcor Services/Scalise Industries
- Interior Design: TDA – The Design Architect
- Construction Manager: Turner Construction Company

Structural System

- Mat foundations, grade beams, auger cast piles, and footings accompanied by a backfill of crushed/screened concrete
- Above grade will consist of wide flanged columns, beams, and girders
- Composite metal deck, concrete, and hollow tube steel components.

Exterior System

- Vision or spandrel glass framed with metallic metal panels and louvers
- Unexposed faces (abut to adjacent spaces) are 8" concrete masonry unit walls
- Roofing is 3" corrugated metal deck that has an over-laying system composed of TPO (Thermoplastic Poly-olefin) Roofing and Fluid-Applied Protected Membrane Roofing

General Project Information

- Occupancy: Hotel, Retail, Office, Garage
- Size (GSF): 440,000 SF
- Number of stories: 18 stories
- Building Height: 220 feet
- Construction: Jan 13, 2014 – Dec 10, 2015
- Construction Cost: $67,000,000
- Overall Project Cost: $100,000,000
- Project Delivery Method: GMP with CM at Risk

Mechanical System

- Six rooftop air handling units (ranging from 1,600 CFM to 50,000 CFM) to feed everywhere except the garage, the hotel rooms, and the retail spaces
- Self-contained packaged terminal air conditioning units (PTACs) that are thru-wall units and will have an outside air CFM of 70 for each hotel room

Electrical System

- 6, 3-½" conduit containing 4-#600MCM and 1#400EGC to power 277/480V main switchboard sized at 2000A
- 7, 4" conduits containing 4-#750MCM and 1#600EGC to power to a 277/480V main switch-board sized at 2500A
- 65 panels

Photos Courtesy of Arquitectonica

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Brian Peglowski, Project Engineer

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Millcraft Investments

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Family and Friends

God

OPP 2015 Captains

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Executive Summary

This thesis report will analyze the various issues that have arose throughout the construction of the Steel City High-Rise in Pittsburgh, Pennsylvania. This $100 million structure is comprised of retail space, office space, a parking garage, and hotel amenities, all within the heart of downtown Pittsburgh. Each portion of this building is very different in design, some more complicated than others. The project delivery is extremely unique and resulted in some interesting analyses opportunities. This report will go into further detail of the potential resolution of issues regarding the fabrication of structural steel, unique structural elements, collocation, and the vertical MEP systems of the building.

Analyses Summaries

Analysis 1: Fabrication of Structural Steel members

A huge issue throughout the construction of Steel City High-Rise was the fabrication of structural steel members lagging the erection crew. With the winter months being unpredictable in western Pennsylvania, Turner Construction Company was looking for opportunities to fast-track the beginning of the project to either complete the project ahead of schedule or to provide a cushion if inclement winter weather were to delay the steel erection. In theory and partially in practice the plan was wise and running smoothly up until it was time for steel to begin. The foundations, site work and utilities, and masonry ended up finishing over a month ahead of schedule; however, the steel fabrication process was too far behind for the structural erection to be able to capitalize on the schedule acceleration.

Analysis 2: Unique Structural Elements

Another area that served as a complication and potential issue pertained to the diverse members throughout the structure. With the exception of the office portion (the top six floors), typical, repetitious bays did not exist in the building. With 18 stories and 3,300 significant steel members, having a large number of unique members can slow down both the design process as well as the fabrication, detailing, and erection of the members as well.

Analysis 3: Collocation

The on-site offices for the Steel City High-Rise are located in a building that is adjacent to the site footprint. The offices house all of the project team that is currently working, with the exception of the structural engineer and the architect. The architect attends biweekly OAC meetings and the structural engineer phones into subcontractor and OAC meetings sporadically approximately 2 times a month. The construction industry is largely interest in the benefits, consequences, and reality of implementing collocation to a project to see if it actually does benefit the team and project as a whole.

Analysis 4: Vertical MEP

The majority of the MEP for this project is within the hotel portion of the building, it is nearly all running vertically. The reason for this is because all of the floor plans for each level of the hotel are identical, so the bathrooms and areas requiring MEP are stacked upon each other. This is an extremely efficient way to construct the MEP systems; however, the work is currently scheduled to occur after the structure is completed and is set to be installed one floor at a time.

Project Background

The Steel City High-Rise is a brand new, ground-up building that will be the newest addition to the prominent Pittsburgh Skyline. This new building offers easy access to hundreds of restaurants, various forms of entertainment (music, athletics, site-seeing, and social settings), the Cultural District, and assorted forms of public transportation including the recently expanded North Shore Connector. The high-rise itself is a mixed-use space that offers 128,000 square feet of office space, 14,000 square feet of retail space, nearly 200 hotel rooms, and over 300 parking spaces.

In addition to the Steel City High-Rise offering new opportunities and attractions to the city of Pittsburgh, it has also been designed with the intent to preserve the city and environment as much as possible. The project is on track to achieve a LEED Silver rating with the intent that 50% of the building's power will be generated from a renewable source and a goal to increase the energy performance improvement is set in place. Additionally, the building is implementing the new Healthy High Performance Cleaning program to reduce the carbon footprint by 75.69 tons.

The project delivery method for this project is unique in that the original construction manager left the project very early on, so a new contract was developed for Turner Construction Company to join the project. Turner Construction serves as one of the prime contractors for the project and holds a Guaranteed Maximum Price contract with the owner. Another prime contractor present on the project, Scalise Industries, is contracted for a Design-Build of all of the mechanical, electrical, and plumbing scope of the building.

The total cost of the Steel City High-Rise is expected to be $100 million, while the cost of construction will round in at $67,000,000. That $67,000,000 is further broken down between the two prime contractors' packages. Turner Construction Company has estimated their contracted work to be $57,000,000, while Scalise Industries has priced the MEP scope at $10,000,000. Aside from the ownership of the contracted work, the prime contractors were also given a 2% equity of the building giving them partial ownership at the time of the project's completion in late 2015.



Figure 1 (Left): Rendering of offices provided by Arquitectonica

Figure 2 (Middle): Rendering of Northeast facade provided by Arquitectonica

Figure 3 (Right): Rendering of lobby provided by Arquitectonica

Delivery Method

The project's delivery method (Figure 4) is somewhat unusual and unique in that Turner Construction was not initially a prime contractor for this project. A smaller general contractor was originally signed on to do the construction contract portions; however, they did not end up having the means to perform the work for a job of this magnitude. During the demolition phase, Turner was asked to come in and take over the project due to the good relations that Millcraft and Turner had on previous projects. Turner agreed to a lump sum for the preconstruction services and then the construction was contracted as a Guaranteed Maximum price with the Construction Manager at Risk. The other design entities had been contracted prior to Turner and with the original Construction Manager, so their contracts remained modified Design-Build. The design parties included TDA – The Design Architect (architect for hotel interiors and standards), JGA – Jezerinac Geers (structural engineer), CJL Engineering and Scalise Industries (MEP engineers), and Arquitectonica (lead architect).

Figure 4: Contract Type Breakdown

Subcontractor Selection and Staff

Aside from Turner, the contractors for the project were selected via a public bid. In most instances the lowest bidder was awarded the project; however, due to specific funding the project needed to meet certain MBE and WBE quotas, so in some cases the lowest bidder did not qualify. Payment and performance bonds, as well as bond verifications are required for all of the subcontractors involved in the project. In addition to the P&P bonds, all of the contractors are covered under CCIP policies as well.

The project staff is continuously growing as the project progresses in phases and introduces new trades and components to the site. The expected project staffing for Turner Construction Company will include a senior project manager, a project engineer, an assistant engineer, a superintendent, two assistant superintendents, a safety manager, a safety engineer, an estimating manager, a cost engineer, and a purchasing agent. There is a potential for a few additional assistant engineers and superintendents; however, that will be determined as needed. Additionally, Turner has continued to staff an estimating manager in order to manage future interior outfits that will be handled by the interiors division of Turner, otherwise known as the Special Projects Division (SPD).

Site Logistics

The project is in the heart of downtown Pittsburgh and it is within walking distance of the cultural district, the historic district, Pointe State Park, Market Square, many colleges and universities, notorious businesses, entertainment, farmer's markets, sporting event, and so much more. The area is a high traffic zone to both pedestrian and vehicular traffic. The streets to the north and south of the site are each one way streets, one having traffic travel to the west and the other to the east. To the west of the site is a popular outdoor gathering space and to the east is a traffic heavy road. Logistically, it was a challenge to please all parties with access to the site and access to the normal Pittsburgh amenities that are close by; however, a consensus was agreed upon. It was agreed upon that the outdoor space would only be used in the case of an emergency, as this was an area that is densely populated with the employed population of the city. It was determined that the street to the north of the site would be cut off from all pedestrian and vehicular traffic in order to accommodate deliveries, crews, and materials for the project. Careful coordination is being consider for the delivery of materials and the local municipality has been helping to control and direct the traffic during this time.

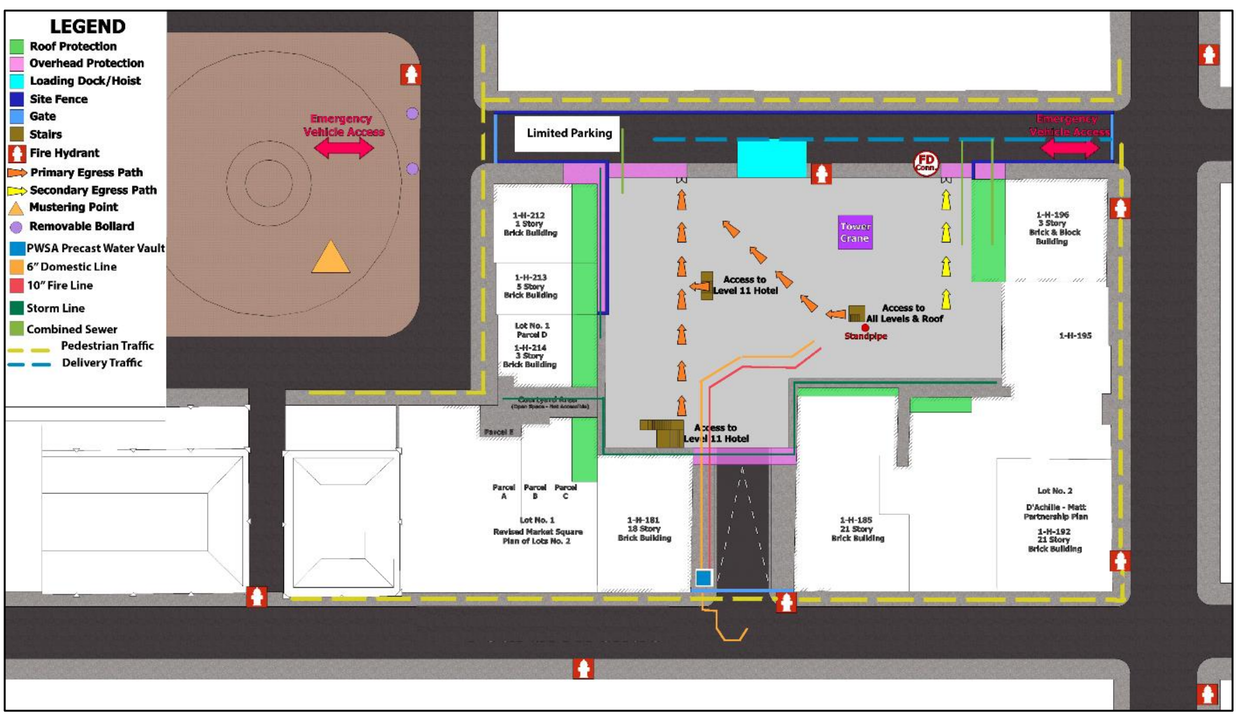


Figure 5: Site Logistics Plan and Footprint for Steel City High-Rise

The demolition of the area was minimal requiring the demolition of a small building and the rest of the footprint area being a parking lot. During the excavation process, old wells and utilities that were never document were found and temporarily delayed the work for a single work day. During that time a team of archeologists came to remove any valuables from the remains and then work proceeded as usual the following work day. The unmarked utilities posed a bit of a problem, but careful planning allowed the team to complete the excavation process without any incidents causing delay or harm to the project or the surrounding areas. Also, due to the site being surrounded along the East and West sides by existing buildings, there is no need for retention walls; however, it is crucial to monitor the condition of the basement walls as they are exposed during the excavation to ensure that excavation could be completely successfully and safely. The proposed and approved backfill for the excavation and foundation work is a crushed and screened concrete/masonry material that is to be compacted to a minimum of 100% of its maximum dry density.

Due to the fact that the footprint of the building is taking up most of the site footprint, there is no room for on-site job trailers. Fortunately, an adjacent building to the site had a vacant first floor that is currently being leased-out as the field office. This has allowed all of the on-site trades to work collaboratively under one collective roof. Additionally, because the site is extremely congested, there is minimal parking allocated to the superintendent and specific members of the team. Fencing is placed on all sides of the project where the site is not abut with an adjacent building and the fences will have a lock system on them for each trade in order to give access to only those directly involved with the construction.

Building Systems

Structural System

There are three different structural systems that are used throughout this building to serve three very different spaces. The entire building's structural system will be supported by a system of mat foundations, grade beams, auger cast piles, and footings accompanied by a backfill of crushed/screened concrete. The structure above grade will consist of wide flanged W14 columns that will span several stories and will range in size from a W 14x43 to a W 14x426. Between these columns span various series of wide flanged beams and girders to support each floor and slab. These beams and girders can be found in a range of depths from W8-W44 that vary in weight. The structure is also comprised of composite metal deck, concrete, and hollow tube steel components; however, these are separated into the aforementioned "three" separate spaces.

The first of these regions is what is called the podium. The podium is comprised of the first three levels of the structure which will house the garage ramp, retail space, a portion of the garage, and the restaurant space for the hotel. The first floor will span a height of 17.5 feet, while the next two floors will be 12 feet in height. The retail space floors are not to be finished within the contract, so they will have 4" of crushed aggregate on grade, while the other spaces on the first floor will be 4" of slab on grade concrete over 4" of the crushed aggregate. The remainder of the parking garage (in the podium and beyond) will be a 5" post-tensioned, normal weight slab, except over the retail space there will be a 4" wearing slab. The hotel slab within the podium region will be a 3 ¼" lightweight slab over a 2" 18 GA composite metal deck. The remaining hotel space above the podium will be 3 ¼" lightweight slab over a 3" 18 GA composite metal deck, while the office space will be a 3 ¼" lightweight slab over a 2" 18 GA composite metal deck. In addition to the columns and beams throughout the hotel region, there is a hollow structural steel system that spans from levels 4-1. These members are 4"x4" and have a thickness range of ¼" to ½".

Mechanical System

The mechanical systems and the electrical systems are much more straightforward and simple in retrospect. The mechanical system will be comprised of six rooftop air handling units. Two of the units will be 50,000 CFM for the office tower and will contain enthalpy wheels to supply the region with air. The other four will be for the hotel corridor (12,000 CFM), office lobby (1,600 CFM), kitchen (4,000 CFM), and the laundry room (3,600 CFM). These air handling units will feed the entire structure through ducts and exhaust fans with the exceptions of the garage (it is open to outside airflow), the hotel rooms, and the retail spaces. The hotel rooms will each have their own self-contained packaged terminal air conditioning units (PTACs) that are thru-wall units and will have an outside air CFM of 70. The retail packages are to remain core and shell and will be designed and outfitted by the respective tenants.

Electrical System

The buildings electrical service is owned by Duquesne Light and is fed by 6, 3-½" conduit containing 4-#600MCM and 1#400EGC and 7, 4" conduits containing 4-#750MCM and 1#600EGC . The 3-½" feeders are providing power to a 277/480V main switchboard sized at 2000A and the 4" feeders are providing power to a 277/480V main switchboard sized at 2500A. From these main switchboards there are 65 panels throughout the structure.

Building Façade System

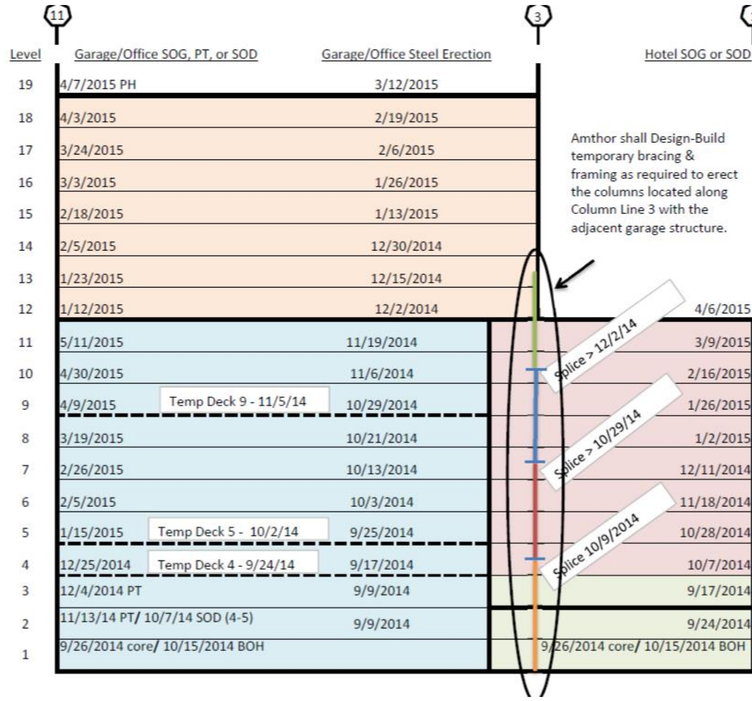
The façade of this building is fairly consistent and limited with the materials. Nearly every exposed face of the building is composed of vision glass, spandrel glass, metal panels, and metal louvers. The metal panels and louvers are metallic painted steel that will have both interior and exterior primer finishes. The lower retail spaces and the unexposed facades (facing other buildings) are an 8" concrete masonry unit wall due to the close proximity to adjacent spaces preventing further exterior finishes. The roofing is 3" corrugated metal deck that has an overlaying system composed of TPO (Thermoplastic Polyolefin) Roofing and Fluid-Applied Protected Membrane Roofing. The TPO will withstand uplift pressures, reduce thermal movement, and shall remain watertight throughout exposure to weather. The Fluid-Applied Protected Membrane Roofing will improve the lifecycle of the roof, while also reflecting solar radiation in order to reduce energy costs.

LEED

As previously mentioned, this project is aiming to earn a LEED Silver certification based upon the 2007 LEED Reference Guide for Green Building, Design & Construction Version 2.2. Some of the means by which this rating will be achieved include the coordination of the curtain wall R-values and the loads of the rooftop air handling units, a bike rack, local resources and materials, and separate sanitary and storm lines. In addition to aiming for LEED Silver, alternative designs for a Green Roof Garden have been designed, but they will only be implemented if time and resources are available further along in the project.

Schedule and Sequencing

Construction for the project began on January 13, 2014 with a 23 month duration that is currently aiming for an expedited 21 month schedule in hopes of a substantial completion date in early December of 2015. The schedule has a unique sequencing schedule as shown in the visual below. The steel will be erected based first and foremost according to the sequencing of the erection drawings, and secondly it will be erected based regions of the building. In a traditional building an entire floor may be sequenced together in a building, where as this project will erected several stories of steel for a given sequence, as well as pour decks on an office floor, prior to the hotel floors below. This system greatly reduces the OSHA issues by eliminating the risk of workers performing their responsibilities under slab edge conditions while iron workers are working at higher elevated sequences.



Source: Turner Construction Company

The schedule is going according to plan; however, the erection of the steel is expected to continue through the Pittsburgh winter months. Pittsburgh winters are less than desirable working conditions for the iron workers and it can often be difficult to predict whether or not it will be a severe winter with snow/ice accumulation and freezing/below freezing temperatures. The two month cushion that Turner has allotted due to the fast-track plan will help in the case that there is not currently enough leeway in the schedule for weather delays. Additionally, much of the project schedule is at the mercy of the steel fabricator, Amthor Steel Company. Early on in the project, the concrete/foundations subcontractor was able to fast-track their work and get ahead of the schedule; however, the intended steel was not able to swiftly follow due to the fabrication time associated with the members. Luckily, this did not set the project back, but it simply did not allow as much of a jump in the preliminary schedule time.

While the project is set to be completed in October of 2015, the Owner is still not anticipating occupancy until early January on the off chance that the early completion cannot be fulfilled. The hotel and two of the retail spaces are set to be open and operable for January of 2016. The two retail spaces will be two well-known restaurants on the ground floor: Burgatory and The Roost. Those retail spaces will be finished independent of the schedule for the rest of the structure as these tenants have their own teams that will be completing the interior work. Similarly, the office spaces are currently being negotiated with future tenants and are currently contracted to be core and shell at the completion date in October. There is an opportunity for the offices to begin their outfits sooner; however, they will be under a different contract and schedule than the rest of the structure.

Analysis 1: Fabrication of Structural Steel Members

Problem Identification

A long-term hurdle that occurred throughout much of the construction of Steel City High-Rise was the fabrication of structural steel members lagging the erection crew. Unfortunately, the winter conditions of western Pennsylvania are often unpredictable and rarely ideal for a steel erection crew. The Steel City High-Rise is scheduled to have much of the steel erection occurring through the entire winter season from Fall 2014-Spring 2015. Because it is impossible to forecast how much inclement weather could delay the project, the team aimed to fast-track the project from the very start.

The team explored several opportunities and found that accelerating the foundations work would accelerate the project up to two months ahead of schedule. This situation was ideal because the intention was to then start the steel erection two months ahead of schedule and to ultimately have a two month cushion that would allow for weather delays, while still completing the project on time, if not ahead of schedule. Unfortunately, a building with such a large magnitude of structural steel, the detailing, submitting, and fabrication of these members is a long process that greatly lags the amount of time that it takes an erection crew to place the members.

Analysis Goals

This depth will analyze the efficiency of fabricating various types of steel for a project. The Steel City High-Rise is an extremely steel-heavy building topping out with over 2,800 tons of structural steel elements. With over 3,000 pieces of steel, the critical path of the project was largely determined by the steel fabrication and erection process. The goal of this analysis is to provide the owner and designer team with information that would have provided the fabricator with the most ideal and efficient fabrication process in order to speed up the fabrication time.

Due to various unforeseen conditions on the project, there were several delays that ultimately slowed the anticipated start and pace for the fabrication of the steel. This analysis is designed to help with the planning and coordination prior to the start of the erection in order to prevent the gaps and delays that can often times occur. For this project in particular, the erection team was able to move very efficiently and were exceeding expectations with their work output; however, they were often delayed due to the lag of the steel deliveries as the steel members were still being fabricated at the shop.

Aside from the time savings that can come from perfecting the conditions and types of fabrication requests, this analysis has the potential to save on cost as well if the schedule can be maintained without falling behind. The important aspect to keep in mind will be maintaining or improving the quality of the design and function when making the schedule and expense improvements. In order to determine what the best case scenario would have been, the steel fabricator, Amthor Steel, weighed in on their experience with what conditions would be ideal for the most efficient fabrication process.

To complement the research behind best case fabrication processes, the evaluation of non-repetitious members will be performed in order to determine if a more typical design would have sped up the fabrication process as well.

Methodology

In order to complete this analysis the following deliverables must be completed:

- Research most efficient connection types during the fabrication process.
- Evaluate the fabrication shops and their capacity to store and output the fabricated members.
- Evaluate the fluidity and process behind the sequencing of the structure during the fabrication process.
- Develop site plan to determine how much steel can be delivered and stored at a time within the tight footprint.
- Calculate the cost of welded connections versus bolted connections.
- Research how much fabrication time can be saved by minimizing the different types of connections throughout the building.
- Research the cost, performance, and schedule for switching from cambered members to larger members.

Process

Background Research Performed

Preliminary research was done to evaluate the potential influences that can slow the fabrication process for the structural members of this project in particular and then for general construction projects that may affect the industry as a whole.

One of these factors was the fact that the submittal process for the erection drawings was extremely tedious and time consuming for the details to be reviewed and approved for fabrication. As various sequences were submitted and approved, the fabrication process began. With approximately 2,880 tons of structural steel going into this building, the fabrication process could only move so fast. The steel fabricator, Amthor Steel, was working diligently to fabricate the steel as swiftly as possible. In fact, they dedicated two of their shops solely to the steel at Steel City High-Rise in order to accelerate their pace.

Unfortunately, even with the two shops devoting their time to the steel fabrication, the erection team was working at a rate that was faster than the production and delivery of sequences. This was an issue that was not solely a result of the erection drawings taking longer than the team had anticipated, but rather a lack of communication as members of the design team were changing. Throughout the design of the structure there were major changes to the design team for the architectural design and the MEP engineers. The change of hand hindered some of the communication on the project, but this was an unforeseen circumstance.

While the change in designers and directives was something unpredictable, an analysis of the steel members could be evaluated. A discussion with the fabricators regarding what members took the longest to fabricate will reveal whether or not having more repetition in the member sizes could have helped speed up the fabrication process. Additionally, the details and connections of the members will be explored too in order to evaluate whether or not those specifics may have hindered the fabrication schedule and flow. The structure is also sequenced in a manner that has 7-10 sequences per floor; however, each sequence typically spans three floors. This means that the steel cannot be delivered to site until one sequence for all three floors is fabricated, rather than fabricating all sequences on a single, given floor.

This analysis will investigate the fabrication process itself to see what elements took the longest and how the process can be accelerated without sacrificing the quality of the project. The analysis will explore how the fabrication flow works as an isolated schedule, rather than including the time that it takes to get the final approved erection and detail drawings for fabrication.

Fabricator Discussion

1. Cambered Members

In order to better understand the fabrication process and how it looked for the Steel City High-Rise, the owner of Amthor Steel weighed in on the situation and process. A series of questions lead to a fruitful conversation about what factors influence the time and efficiency of fabrication the most. One of the largest contributing factors is whether or not there are cambered members within the design.

For this particular structure, there is a plethora of cambered members in order to save on the plenum space for each floor of the building. A cambered member significantly increases the fabrication time, especially when compared to a normal member. The fabrication process for a camber requires the steel to be normally fabricated as a typical flanged member; however, once that member is completed and set, it then has to either be superheated or significantly cooled in order to reshape the member. This process is extremely tedious and difficult to successfully complete on the first attempt because often times the member loses the intended design shape as it cools and attempts to revert back to its original form.

The tradeoff to eliminating the cambered members of the structure would be that the members would have to become much larger in order to oppose the deflection load that the cambers would otherwise have countered. Realistically, that change would not have been feasible beyond the design stages of the structure because it would consequentially have a domino effect of changes to the building in its entirety.

2. Unique Members and Connections

The next element to evaluate revolved around the lack of repeating members throughout the building. The fabricator explained that having similar members versus having all unique members ends up having virtually no impact on the fabrication time. Similar to the cambered members, there are certain types of members that may take longer than others to fabricate, but that is independent from the number of unique members. These time consuming elements include stout beams, which take longer to drill, and shear plates, which require both more time due to welding and more material.

With regards to the connections, an investigation into the impact of uniformity among connections was explored. Similar to the beam types, it is not so much a lack of uniformity that slows down the fabrication process, as much as it is dependent upon the type of connection. For instance, shear plates are much faster to fabricate and perimeter connections are generally more labor intensive and difficult to produce. The perimeters in particular are a tedious process because there is so much that needs to be coordinated with the floor and façade systems. A known fact for any project is that moment connections will always take longer to fabricate due to the additional reinforcement requirements, and in addition to lengthening the time due to fabrication, it adds more time for the erection process as well.

3. Sequencing and Erection Flow

Following the analyses of the member types and connections came the investigation behind the logic of the prescribed sequencing pattern for the fabrication and erection of the steel members. The first sequence of the structure included all of the vertical steel members that were to be set during the foundation pours for the building. That sequence is the only logically way to begin erection the structure; however, the remaining sequences could be reevaluated as they were erected vertically, three floors at a time. When talking to the erector, it was asked why it is more beneficial to have approximately 10 sequences per floor that were to move vertically for three floors at a time, rather than have each of the ten sequences move horizontally, one floor at a time. The 3 images below show the vertical progression of sequences 8 and 9 for 3 floors of the building.

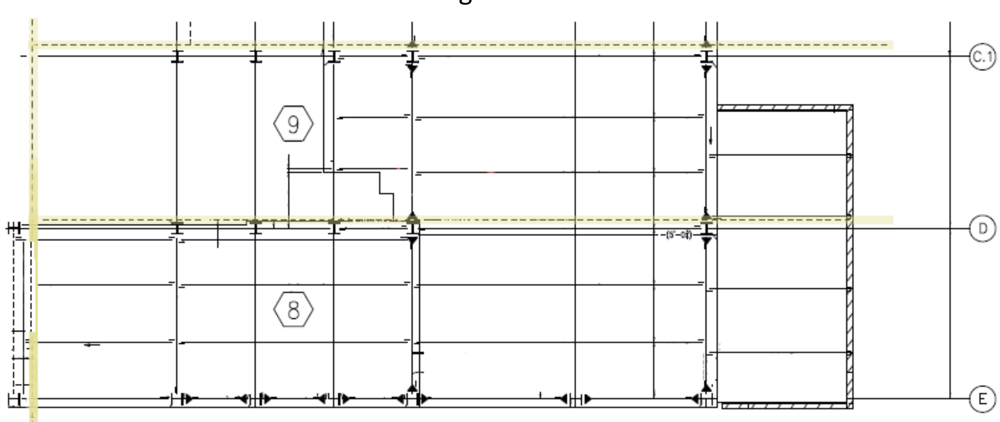


Figure 6: Level 2 (above): Sequences 8 and 9

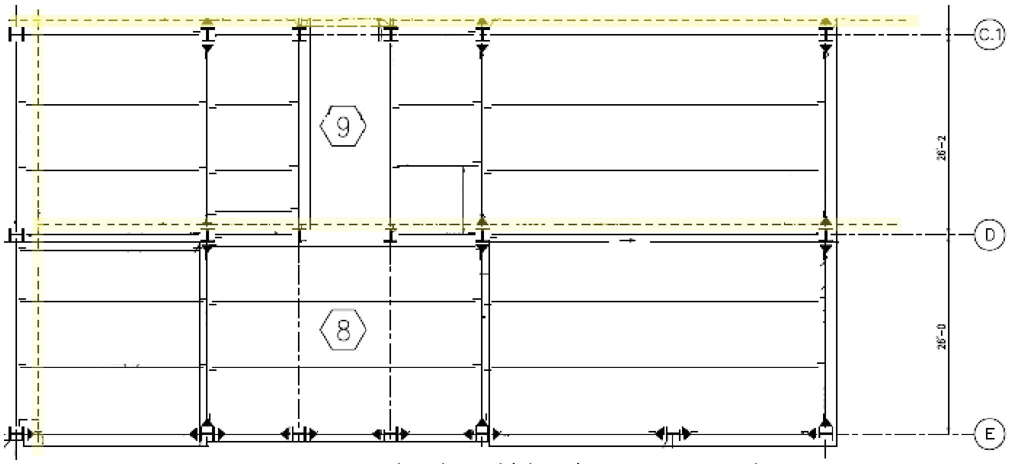


Figure 7: Level Mid-Level (above): Sequences 8 and 9

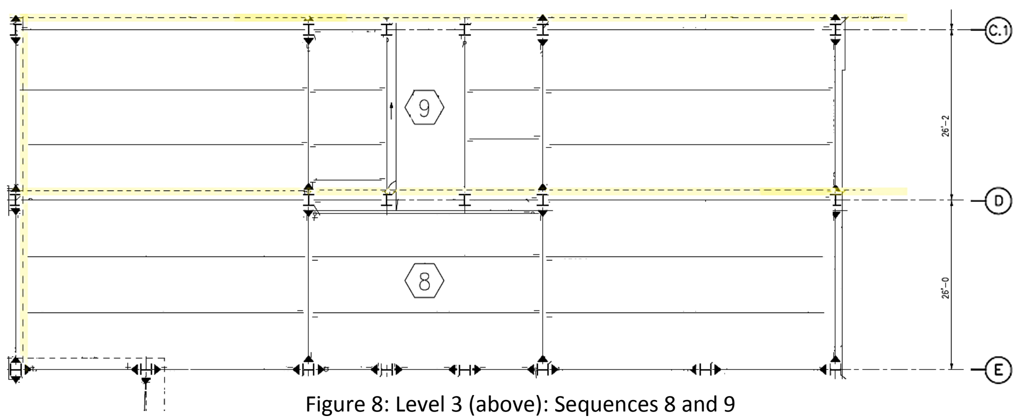


Figure 8: Level 3 (above): Sequences 8 and 9

The benefit to having the sequences span vertically several floors before progressing horizontally is that it allows the crew to prepare the floors and decks in order to allow the steel detailers to follow behind a sequence without the concern and risk of overhead working conditions. Additionally, it is more efficient for a tower crane to place steel in a confined region for more than one floor instead of consistently moving east to west for the entire length of the building.

4. Shop and Site Constraints

Outside of the fabrication process, space is a continuous concern for both the fabrication shop and site laydown staging areas. Regardless of how quickly the steel can be fabricated, if there is not an adequate amount of space for the produced members, then there is no point in speeding along the process. Normally, Amthor Steel, would allot a particular amount of space in the shop for the storage of steel for each project that the shop was currently in production for; however, this was not a normal circumstance. Amthor had decided to dedicate two shops solely to the production of the steel for Steel City High-Rise, deeming it unnecessary to stage off various sections of space for concurrent projects. This freedom to use all of the staging area available made space complications and restrictions non-existent. Fortunately, the erection team on-site was working at an efficient rate that allowed new steel to be delivered nearly every day to the site, so it was not possible for the shop to become too congested with members.

While there were never any congestion issues within the shops, the tight footprint of the site made it challenging to coordinate the steel deliveries to the site. The south, east, and west façades of the building are all abutted against surrounding tall structures, while the north façade faces a street that has been closed off from its normal pedestrian traffic (see Avenue #1 Figure 9 below). Avenue #1 is used for all truck deliveries to and from the site, as well as an area for staging steel and other various materials needed for the project. This avenue is extremely congested, particularly with regards to needing a clear pathway for the steel trucks, so alternate staging areas needed to be adapted as well. These areas are created by preparing the decks at levels 7, 10, 13, and 16 where the metal decks will act as working platforms for steel deliveries as the structure climbs higher.

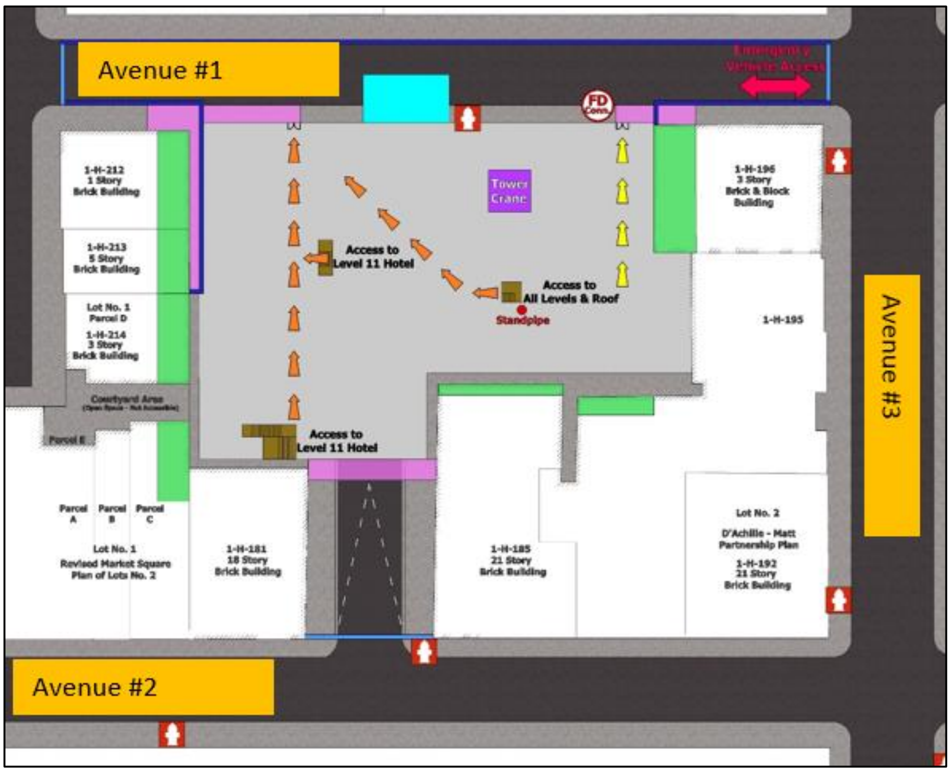


Figure 9: Site Logistics plan

Additional Camber Member Research

The purpose of incorporating cambered members into the structural design is to introduce an intention curvature that will compensate for deflection that is caused by dead loads associated with the structure. The idea is that the dead load will cause the cambered members to deflect back into a straight line, thus balancing out the load and slab thickness. Without cambering the beams, there will be a ponding effect in the concrete, due to a surface that is no longer flat. The only way to counter the ponding condition after it has surfaced would be to make the concrete thicker where the ponding is occurring, thus adding more load to the composite beams. In most cases this would result in a 10-15% increase in the volume of concrete when compared to the intended uniform slab thickness.

The alternative to not using cambered members would be to increase the size of the members in order to compensate for the resistance to the load deflection; however, depending on the number of members that would require cambering or an increase in size, this could result in the structural system as a whole needing to be larger in order for the footings, foundations, and columns in the load path to be able to support the new structural mass. In addition to requiring a structural redesign, increasing the size of the members could pose issues with the architecture and MEP trades within the building. Often times the composite members are sharing the plenum space with the mechanical, electrical, and plumbing systems, so increasing the size of the members could conflict with these systems and potentially not leave enough room for them.

The third alternative to cambering members would be implementing shoring into the design. The shoring is placed prior to the slab pour in order to brace against the deflection that the slab will cause; however, when the shores are removed the floor system will still experience deflection caused by its self-weight. This can lead eventually lead to ponding or cracking at the girders.

The upfront cost of cambering members can be more than that of non-cambered members due to the additional fabrication time and resources; however, this cost should be compared with the cost of the additional concrete needed to counter the ponding effect, the cost of the shoring members and installation, and the cost of bulking up to larger steel members that do not require cambering.

The cost analysis will proceed under the knowledge that the cambered members only have an added cost for the fabrication process, but the cambered members have no duration impact on the delivery, shakeout, or erection of the members. An analysis of the cost comparisons between the aforementioned alternatives and cambering members was performed by Civil Engineers Larson and Huzzard and reported in their study titled “Economical Use of Cambered Steel Beams”.

Larson and Huzzard explain the pros and cons associated with each design decision out of these four options and proceed to show the cost savings that result from the most economical and logical solution. The first of the four options that they analyze is the “ponding effect”, where the beams are allowed to deflect and the slab thickness varies to create a flat level. Research found that the additional concrete required to achieve a level surface was generally a substantial added cost to the system, and the cost increased with the spanned area from member to member.

The next alternative to be considered is the shoring method. Shoring costs can be difficult to quantify because the expense of the shoring needed is difficult to predict when considering its coordination and potential for interference with the schedule and other trades (i.e. MEPFP) that are intended to be working in those areas. Those costs when paired with the risk associated with eventual deflection and ponding make shoring a less desirable option.

The third option would be to overdesigning the beams to counter the deflection of the slab system. This option has great potential to reduce the number of shear studs on the member; however, the cost of the additional material to increase the size of the beam would far exceed the savings on the studs.

The process of cambering would take longer to fabricate and requires additional equipment and steps when heating or cooling the member in order to achieve the desired curvature. Overall, cambering ends up saving money by keeping a thinner, uniform concrete slab, as well as reducing the amount of steel needed in order to meet the structural performance to oppose the deflection of the self-weight.

The proof of the savings came from a specific study in which Larson and Huzzard analyze four scenarios: filler length beam 30' spaced at 10', filler length beam 38' spaced at 10', filler length beam 45' spaced at 10', and a 30' girder supporting a 30' filler beam. The results can be found in figure 10 below and the calculations for the cost comparisons can be found in Appendix D.

Case #	Case Description	Savings due to Camber $/ft ($/sf)	Savings due to H.S.Steel $/ft ($/sf)	Overall Savings $/ft ($/sf)
1	30'-0 beam @10'-0 o.c.	0.22 (0.022)	1.43 (0.143)	1.65 (0.165)
2	38'-0 beam @10'-0 o.c.	0.49 (0.049)	1.21 (0.121)	1.70 (0.170)
3	45'-0 beam @10'-0 o.c.	0.45 (0.045)	1.76 (0.176)	2.21 (0.221)
4	30'-0 girder @30'-0 o.c.	1.05 (0.035)	1.86 (0.062)	2.91 (0.097)

Figure 10: Steel Beam Cost Comparisons

Conclusions

Following discussion with the Amthor Steel and further investigating the benefits and constraints associated with cambering beams, the findings show that cambered members are economical when looked at as a bigger picture beyond the fabrication process. Jared Carrara provided insight to what the ideal conditions would be for the most economical and time conscious fabrication would look like and that would include: no skewed beams, no sloped or curved members, no moment connections, the elimination of haunch and tapered beams, and the simplification to all single angle connections. While those are all ideal situations from the fabrication standpoint, it quickly became clear that those conditions do not add value to the structure's life or function as a whole.

The fabrication for the Steel City High-Rise ended up being as efficient as anyone could have hoped for. Where time could have been saved during the fabrication, there would have been additional costs to the structural system in place of the savings that the fabrication could have accelerated the schedule. The best way to have aided this project as a whole would have been to have placed a higher precedence on the need for complete structural drawings and erection drawings in order to have started the fabrication earlier.

Analysis 2: Unique Structural Elements

Problem Identification

In addition to the fabrication process causing delays and concern on the project, the diversity of the members throughout the structural floor plan has also raised concerns. Excluding floors 13-18 for the office space, there are no typical bays or significant areas of repetitious members. The building tops out with over 3,300 substantial structural steel members, with very little uniformity between them. The lack of replication per sequence and per floor can significantly slow and delay the steel process in its entirety from the design to the fabrication and finally the erection. Developing a standard bay or form of repetition in the structural could reduce the cost and time of the structural system.

Analysis Goals

The goal of this analysis is to evaluate the design process of a structural steel building. The industry has a tendency to talk about how typical bays and modularization can drive a schedule of a project, but not all projects adopt such a belief. For this evaluation, an investigation into why such a structure does not seem to have much uniformity will be evaluated, as well as whether or not it is more difficult or time-consuming to have each structural element and member custom detailed and thought out for each part of the building.

This analysis will investigate what drives the design of the building and what decisions help the designer decide which design route to take for certain types of building types. Once the logic is dissected, it will be used to help evaluate the redesign of a room that was formerly purposed to be a pool for the hotel.

Please see appendix C to reference Erection Drawings to show unique structural design.

Methodology

In order to complete this analysis the following deliverables must be completed:

- Evaluate benefits and consequences of having the existing, inconsistent structural system with the designer and fabricator.
- Research the opportunities in schedule reduction, cost savings, and efficiency of standardization and SIPS scheduling.
- Research impact of submittal process for structures that have similar and repetitious floorplans or areas.
- Examine productivity of erection crews that are working on large varieties of members and connections within a day versus a select range.

Process

Background Research Performed

The design process becomes significantly longer with such a large number of distinctive members as each of these members has to be evaluated in great detail when determining the connections, loads, and details which in turn can also lengthen the submittal process. The submittal process requires the designer to submit the erection drawings and details, and every minute detail is examined and either is marked for approval, revisions, or denied. The more details that there are to examine the longer the review process is and the opportunity for design error increases. The submittal process for the structural steel details and erection drawings began in early April of 2014 and were not completed and approved in full for construction until late August of 2014.

Discussions with the designer and the fabricator could provide insight into whether there was a real benefit to this design. An alternative approach could be standardizing typical bays throughout the structure to expedite the schedule in various ways including the design and detailing process, the fabrication process, and the erection process. An analysis will provide further insight as to what drove the existing design: cost, sequence, performance, etc. Further research will show which approach is more beneficial based upon the cost, performance, and duration of the steel structure beginning with the design phase and ending with the completed installation. This evaluation shows great potential for pursuing a structural breadth that would require the redesign and creation of a typical bay for the building, as well as a building enclosure analysis of how the structural system and enclosure are connected.

Discussion with Structural Engineer

After discussing the design with the structural engineer, it became evident that there is a give and take with having a uniform bay versus a customized structural system. For this structure in particular, the building is clearly divided into sections that serve a different purpose and occupancy: retail/restaurant, hotel, parking garage, and office space. That being said, it’s difficult to design a uniform system that works well for such varying occupancies, while still remaining economic.

Customizing each floor and each region of the structure definitely makes for a longer design process for several reasons. Among these reasons would be the submittal process. With so many unique elements, not only do they take longer to detail and design, but they also take longer to be approved and analyzed prior to the start of the members being erected. This is a process that time should be carefully spent on rather than cut down because eliminating all errors and conflicts at this stage of the design will be what determines the success of the structure and the project staying on track.

Secondly, with four very different occupancy types, some occupying the same floors of a building, there is a lot of interdependency between the regions. For example, the hotel would never be able to primarily rely on hollow tube steel members, if it weren’t for the mass of the parking garage’s structure. Additionally, the load path can greatly affect the size of the members throughout the entire structure, so while the planning made be constructed and designed from the ground up, it must be analyzed from top to bottom as well to ensure the integrity and performance are suitable.

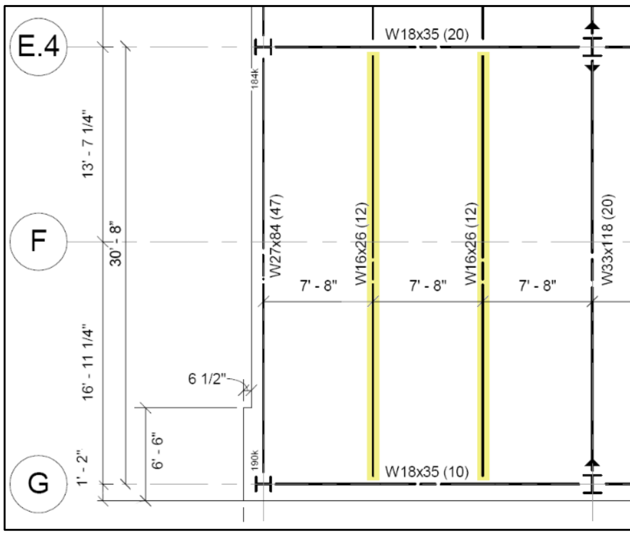
While this conversation made it clear that a more complex, unique structural design is better suited for this project, constructability still controls aspects of the design. For example, on a given floor plan in the hotel or retail space, the design would not be customized for the deck and slab for each room on the level, but rather designed to be sufficient enough for each of the spaces. Designing the slab and decking to be uniform across the floor allows for the installation and slab pour to be scheduled as two consecutive tasks that can be completed in a more timely manner than having it further broken down.

With constructability being considered, as well as having a logically drive design rather than uniformity, a structural and mechanical redesign emerged. In the original design for the structure, the second level of the hotel intended to have a pool room for the guests; however, after the start of the level 2 steel erection, the pool was removed from the plans. This allowed an opportunity to redesign the slab for that room and an opportunity to house some of the mechanical equipment for the building inside.

Structural Breadth

A structural breadth will be performed to redesign an interior space within the second floor footprint that was originally intended to serve the hotel pool. The pool has been removed from the plans for the hotel and I am proposing that the space be used to house air handling units for different locations within the structure. The bay will need to have steel and concrete design that will span the former void of the pool, while also withstanding the new load of the mechanical equipment. The load of the mechanical equipment will also be considered through the columns and the footings to make sure that the structure will remain structurally sound despite the design changes.

The Redesign



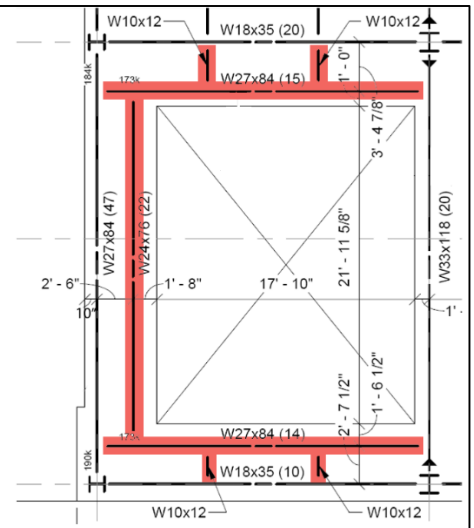


Figure 11 (Left): Proposed redesign of structural slab with new members highlighted in yellow.

Figure 12 (Right): Former structural design for the pool with eliminated members highlighted in red.

Deck Requirements:

3 – ¼" LW Concrete Slab

2" x 20 GA Composite Metal Deck

W/ 6X6- W2.9/W2.9 WWF

For constructability purposes, the deck and slab will be consistent with the rest of the level 2 floor plan. There may be an opportunity for a smaller gauge deck or a thinner light-weight concrete slab; however, it would be inefficient and potentially costly to have such a small room designed to have a different slab than the rest of level 2. The deck requirements are show below.

Composite Deck and Concrete

After analyzing the requirements for the composite metal decking, the Vulcraft Decking Catalog was referenced in order to obtain the specifications and properties of a 2VLI20 deck that is to have light-weight concrete. This information was used to determine the superimposed live loads associated with the given deck under the design circumstances, as well as to calculate the weights of the composite metal deck and the concrete slab.

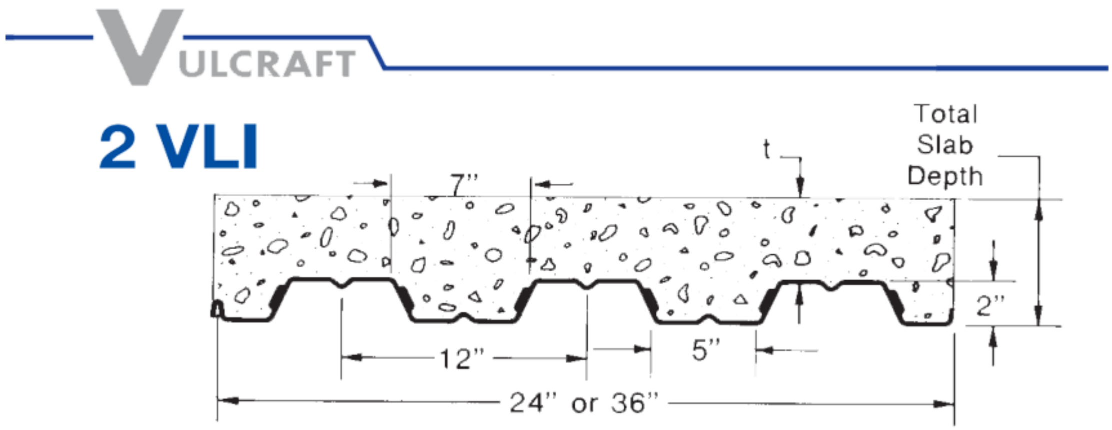


Figure 13: Vulcraft 2 VLI Composite Metal Deck

Total Slab Depth	Deck Type	SDI Max. Unshored Clear Span			Superimposed Live Load, PSF Clear Span (ft.-in.)						
		1 Span	2 Span	3 Span	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0
5 1/4"	2VLI22	7'-2	9'-3	9'-7	334	294	262	209	187	168	152
	2VLI20	8'-5	10--7	10'-11	377	331	293	263	237	190	171
(t=3 1/4")	2VLI19	9'-6	11'-8	12'-1	400	366	324	289	260	236	216
42 PSF	2VLI18	10'-6	12'-7	12'-7	400	400	355	319	288	263	241
	2VLI16	10'-9	12'-10	13'-3	400	400	400	367	330	300	274

Table 1: Vulcraft 2 VLI Composite Metal Deck Loads

Area of Deck: 30.75' x 23.25' = 714.9375 SF

Deck Type	Design Thickness	Weight PSF
2VLI22	0.0295	1.62
2VLI20	0.0358	1.97
2VLI19	0.0418	2.3
2VLI18	0.0474	2.61
2VLI16	0.0598	3.29

Table 2: Vulcraft 20 GA Deck Weight

Weight of 2VLI20 deck:

$$1.97\ PSF \times 714.9375\ SF = 1{,}408.4269\ lbs$$

Weight of LW Concrete:

$$115\ \text{PCF} \times \left(\frac{3.25\ in}{12\ in}\right)(1\ ft) = 31.1458\ PSF$$

$$31.1458\ PSF \times 714.9375\ SF = 22{,}267.3242\ lbs$$

Following the calculations for the weight of the composite metal decking and the concrete slab, it is essential to calculate the weight of the beams that are to be implemented in the design to span where the void of the pool had previously been detailed. There are two methods for determining the weight of the structural members. The first is a rough estimate that uses the numbers denoting the beam type and the second method is a more detailed analysis of each flange and plate making up the member. Both methods are shown below in order to compare and determine the most conservative approach.

Structural Members

Weight of the W16x26 Beams:

Designation	Dimensions						Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Top and Bottom Web Thickness t (in)	Center Web Thickness s (in)	Sectional Area (in²)	Weight (lb/ft)	I_x (in⁴)	I_y (in⁴)	W_x (in³)	W_y (in³)
W 16 x 26	15.69	5.5	0.345	0.25	7.68	26	301	9.6	38.4	3.5

Table 3: W12x26 according to ASTM A6

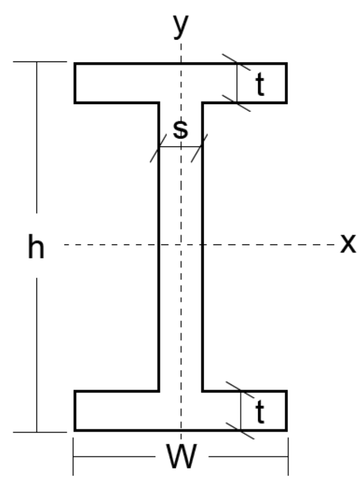


Figure 14: I Beam Cross Section

L= Total Length of W16x26 Beam= 30.75'=368"

Method A)

The 26 represents the weight of the beam being 26 lbs/LF; therefore,

$$Weight = 26 * 30.75" \; = \; 799.5 \; lbs \; \times \; 2 \; beams \; = \; 1{,}599 \; lbs$$

Method B)

Volume Calculations:

Top Flange:

$$V_T = t \times W \times L$$

$$= .345" \times 5.5" \times 368"$$

$$= \; 698.23 \; in^3$$

Bottom Flange:

$$V_B = t \times W \times L$$

$$= .345" \times 5.5" \times 368"$$

$$= \; 698.23 \; in^3$$

Middle Flange:

$$V_M = t \times h \times L$$

$$= .25" \times 15" \times 368"$$

$$= \; 1380 \; in^3$$

Total Volume:

$$V_{Tot} = \sum V$$
$$= V_T + V_B + V_M$$
$$= 698.23\ in^3 + 698.23\ in^3 + 1380\ in^3$$
$$= 2776.56\ in^3$$
$$\left(\frac{2776.56\ in^3}{1728\ \ in^3}\right) = 1.607 \text{ CF}$$

Weight of Beam:

$$1.607\ CF \times \left(\frac{490\ lb}{CF}\right) = 787.33\ lbs\ \times 2\ beams = 1{,}575\ lbs$$

After calculating the weight of the two beams using both methods, it was decided to proceed with the weight found in method A to be conservative with the load. The slab system weight comes from the combined total load of the beams, the concrete, and the deck as a whole system.

Total weight of the slab system:

$$W_{tot} = W_{deck} + W_{concrete} + W_{beams}$$
$$= 1{,}408.4269\ lbs + 22{,}267.3242\ lbs + 1599\ lbs$$
$$= 25{,}274.7511\ lbs$$
$$= 25.27\ kips$$

Following the analysis of the redesign, it is crucial to consider what load the previous design was anticipating for level two. Because this change is being made during the construction of the project, it is not feasible or possible to downsize the footings or structural columns below level two because they are already in place; however, it is still critical to make sure that the redesign does not exceed the load that the pool room design had been accounting for. As long as the redesign and the equipment placed within the room do not exceed the load of the pool room, then it can be assumed that the structural integrity of the foundation and building as a whole has been preserved.

Load from Former Design

Pool Considerations:

Pool Criteria	
Area	400 SF
Gallonage	8910
Cement	140 PCF
Length	22'
Width	18'
Depth	3'

Table 4: Pool Spec Criteria

Concrete Pool Shell				
Location	Thickness	Width	Length	CF
N Side	10.5"	4'2	18'	65.625
S Side	10.5"	4'2	18'	65.625
E Side	10.5"	4'2	24'	87.5
W Side	10.5"	4'2	24'	87.5
Base	8"	20'	24'	320
			Total CF	626.25

Table 5: Dimensions of Concrete Pool Shell

Weight of Concrete for Pool:

$$626.25\ CF\ \times \left(\frac{150\ lbs}{1\ CF}\right) = 93{,}937.5\ lbs$$

Weight of Water:

$$8910\ Gallons\ \times \left(\frac{8.3454\ lbs}{1\ Gallon}\right) = 74{,}357.514\ lbs$$

Weight of Deck: Area: 28 SF

$$1.97\ PSF\ \times 28\ SF = 55.16\ lbs$$

Weight of Concrete on Deck: Area: 28 SF

$$28\ SF\ \times 3.25' = 90.22\ CF$$

$$90.22\ CF \times \left(\frac{115\ lbs}{CF}\right) = 10{,}375.5\ lbs$$

Weight of Steel Members (see Figure 12 for reference to structural plan):

Pool Structural Members		
Members	Quantity	Length
W27x84	2	23.25'
W10x12	4	2.625'
W24x76	1	21.97'

Table 6: Pool Structural Members

$$\left(\frac{84\ lbs}{LF}\right) \times 23.25' = 1953\ lbs\ \times 2\ beams = 3{,}906\ lbs$$

$$\left(\frac{12\ lbs}{LF}\right) \times 2.625' = 31.5\ lbs\ \times 4\ beams = 126\ lbs$$

$$\left(\frac{76\ lbs}{LF}\right) \times 21.97' = 1{,}670\ lbs$$

Total Weight of Structural Pool Members: 5,702 lbs

$$\boldsymbol{Total\ Weight\ of\ Pool\ Design}: 184{,}428\ lbs = 184.4\ kips$$

Loading on W16x26

The specific beams and composite metal deck system that were chosen were selected due to their constructability; however, calculations still were necessary to show whether or not the beams could handle the load from the slab system and the placement of the air handler. The calculations were made using the weight of the slab system from the Vulcraft Catalog (Appendix E), the weight of the air handler in the JCI Performance Specifications (Appendix H), and the AISC W Shape Flexural Member Design (Appendix F).

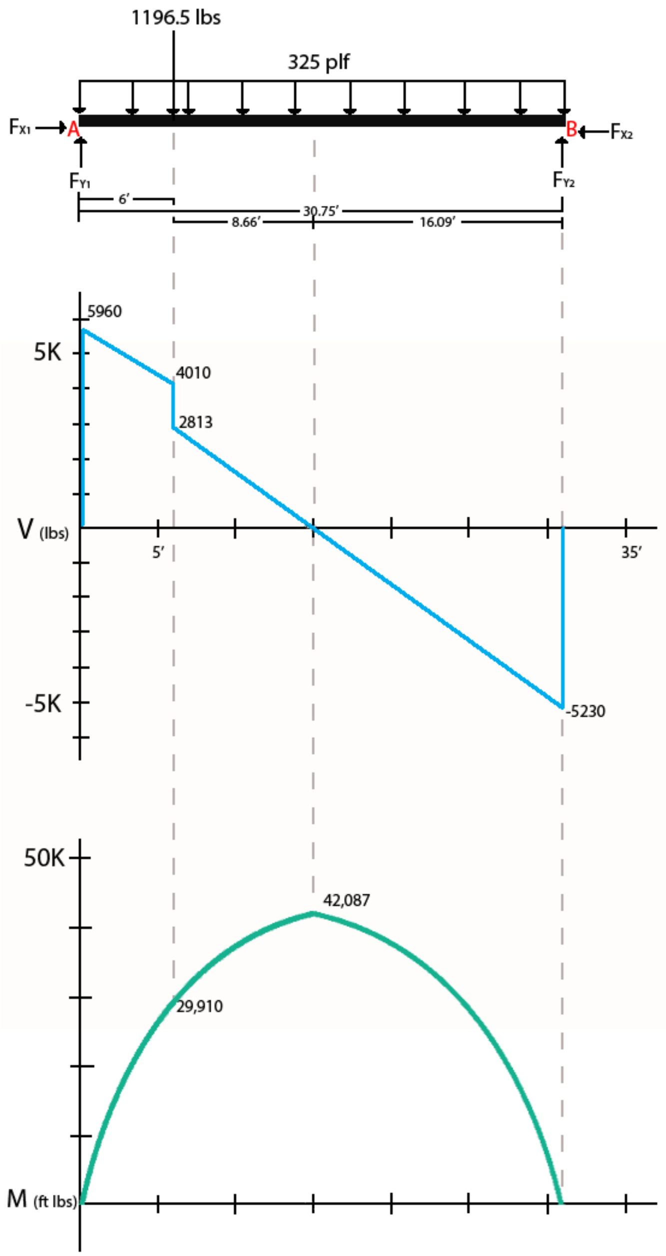


Figure 15: Loading on W16x26 by AHU and Floor

$Distributed\ Load:$

$$A_T \times 42\ PSF = 7.75' \times 42 = 325\ PLF$$

$$\sum F_X = -F_{X1} = F_{X2}$$

$$\sum F_Y = -1196.5 - (325\ PLF \times 30.75') + F_{Y1} + F_{Y2}$$

$$\sum M_A = (-1196.5 \times 6') - (9993.75 \times 15.375') + F_{Y2}(30.75') = 0$$

$$F_{Y2} = 5{,}230\ lbs$$

$$F_{Y1} = 5{,}960\ lbs$$

Max Moment: 42.1 ^{IK}

ΦM for W16x 26: 166 ^{IK}

42.1 ^{IK} ≤ 166 ^{IK} ∴ OK

Figure 16 below shows the required clearance around the sides of the air handler (shown in blue), as well as the placement of the air handle (shown in green). This location is the location that was used when performing the above calculations with respect to the load placement on each member. The dimensions of the air handling unit footprint are 13’-10” long by 5’-0” wide.

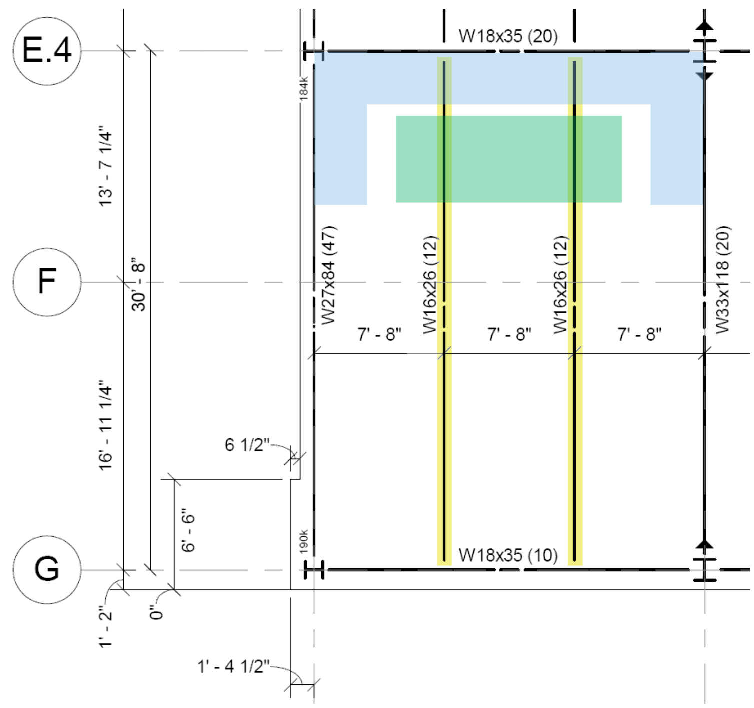


Figure 16: Placement and Clearance for new AHU in former pool room

Conclusion for Structural Breadth

Due to the fact that the footings and columns have already been placed and erected at the time of this redesign, there is no opportunity to potentially downsize the structural components. For the sake of this analysis, instead the previous loads from the pool system were evaluated and compared to the new load that will be imposed for the housing the mechanical unit. The calculations above show that the footings, foundation, and structure can support the new load for the redesign because the pool had a total load of 184.4 kips, whereas the redesign structural system and air handling unit will only produce a load of 27.7 kips.

In addition to the structure being adequate for this newly purposed space, the beams and metal deck that were chosen needed to be evaluated in order to check whether or not they could handle the load that air handling unit would be placing on them, as well as the deck and slab system. The calculations show that each beam can support a load of up to 166 kip-fts; however, the slab system and air handler will only be imposing a load of 42.1 kip-fts. This shows that not only are these members capable of handling the load, but also they have the ability to have future equipment placed in that area as well. Additionally, the removal of the pool would have created new meeting spaces on 2 floors that are not critical to the hotel operation and do not produce a revenue; therefore, there is no loss of profit by making this space suited for air handlers that were once housed on the roof.

Mechanical Breadth

A mechanical breadth will be performed in order to evaluate whether or not rooftop air handling units are the best systems for the building. Currently, the structure has an interior space that was to have a pool, but the owner has since decided to eliminate the pool due to the heating and maintenance costs associated with having a pool in Pittsburgh. This space has since been reevaluated to serve as an additional meeting space for the hotel food services staff. I plan to evaluate the impact of using this space for interior air handling units that can replace some of the rooftop units. In order to determine whether or not this would be a beneficial change to the design, I will be evaluating the upfront and lifecycle costs, as well as the added life of the equipment. I will also be considering the serviceability of interior units versus rooftop units, provided that the interior space is designed to bear the load of the units. I expect that interior air handling units will be a higher initial costs, but will be easier to maintain and will exceed the life of the rooftop units. Additionally, I will be researching whether or not it is more costly and economical to have the air handling units remain gas heat, rather than electric heat since the cost different between those resources is largely different.

Considerations

When initially analyzing the rooftop units of the Steel City High-Rise, it was important to consider whether or not there was reasonable cause to move the units from their existing locations to level 2 of the structure. It was also critical to consider what areas the units were servicing and whether the southwest corner of the second floor would be a logical area to run the duct and piping from.

The first equipment to consider would be the largest and most expensive equipment in order to see if that equipment can have added protection. The units, denoted as RTU-1 and RTU-2, are located on the 19th floor roof. These units are Mammoth manufactured and are customized packaged units that are intended to service the office tower of the structure. Upon evaluation of the units it became clear that moving these units down 17 levels and trying to route the ducts, refrigerant, and other components back up to the office towers would not add value to the project. Additionally, the units each have large condensers that cannot be housed within the building, so they would need to be separated and the units would need to be redesigned.

Aside RTU-1 and RTU-2, there are four other rooftop units that service different areas of the building. All of these units are from the Johnson Controls Incorporated Series 10 and they are comparable in their size and specifications, but are located in different areas. RTU-3 and RTU-4 are located on the level 12 roof in order to service the hotel corridors and the office lobby, while RTU-5 and RTU-6 are located on the level 3 roof with the intent to serve the hotel's commercial kitchen and laundry room. After analyzing the units, it was decided that RTU-5 and RTU-6 would be the most beneficial units to initially analyze since they are already located beside the former pool room.

The Redesign

Upon further analysis of RTU-5 and RTU-6, the redesign took a different direction. Typically in a hotel, the kitchen operates during certain peak hours and the laundry in many cases is done through the staff night shift. The redesign would not only analyze the benefits to bringing the units inside, but also the benefits of merging the two units into one.

Careful consideration was given to the specification sheets for each unit in order to determine what the performance elements would need to be in order to merge the two units. Both of these units also contained condensers, so in addition to combining the units, the condenser would have to be broken off as its own package that would remain on the level 3 roof with the refrigerant lines being rerouted once the new unit is placed inside. The important components that needed to be met when combining the two units include:

Cooling Performance
Refrigerant Type: R-410A

Gas Heating Performance
Entering DB Temp: 60 degrees F
Leaving DB Temp: 104.4
Heating Capacity: 300 MBH

Supply Air Blower Performance
SA: 5000 CFM
Static Pressure: 1.5 in WG
Drive Type: BELT

Unit Size > 10 Tons

Contact was made with Johnson Controls Incorporated in order to reconfigure the equipment in order to have an indoor air handling unit with a DX cooling coil that is capable of supplying the proper amount of tonnage and the required CFM.

New Air Handling Unit

Due to the fact that the air handler was being brought inside and would no longer be a rooftop unit, the condenser needed to be removed from the packaged unit in order to remain on the roof. Johnson Controls Incorporated provided a new unit, as well as the condenser needed to service the unit.

Unit Comparison			
Component	RTU-5	RTU-6	New AHU
Cooling Performance			
AirFlow (CFM)	4000	3600	5000
Refrigerant Type	R-41	R-41	R-41
Tonnage	10	7.5	13
Capacity (MBH)	123.4	93.1	154.3
Supply Air Blower Performance			
Motor Rating (HP)	3	3	5
Static Pressure	1.44	0.92	2.6
Drive Type	Belt	Belt	Belt
Total Unit			
Weight (lbs)	1205	1005	2393

Table 7: Air Handler Comparison: Old vs. New

Table 7 shows the unit comparison breakdown between the two former units and the new unit. The new unit will have a footprint of 13'-10" in length by 5'-0" in width. This will easily fit within the former pool room as the room is 30'-8" by 23'-3". This leaves potential for future units; however, it is important to note that separating the condenser from the rest of the air handler does require the addition of refrigerant piping to run from the unit on the second floor to the roof at level three above the kitchen where the condenser is to remain.

Figure 17 below shows the path for the refrigerant piping (show as the purple lines in the figure) and is dimensioned to show that 28 linear feet of piping is needed to feed the condenser to the air handler. The blue rectangle represents the condenser that will be placed in that area on the third floor roof above and the green rectangle shows the placement of the air handler. In addition to the horizontal piping will be the vertical piping that drops from the third floor roof to the second floor pool room. This drop will amount to an additional 15 linear feet of piping. The final consideration when determining how many linear feet are needed to connect the equipment is with respect to the elbows and fittings needed to make the drops. The additional equivalent length per elbow for ½" piping (typical for DX coils) is 3.6 feet (see Appendix J). This results in a total of 53'-10" to account for the three elbows and piping needed to connect the air handler and condenser.

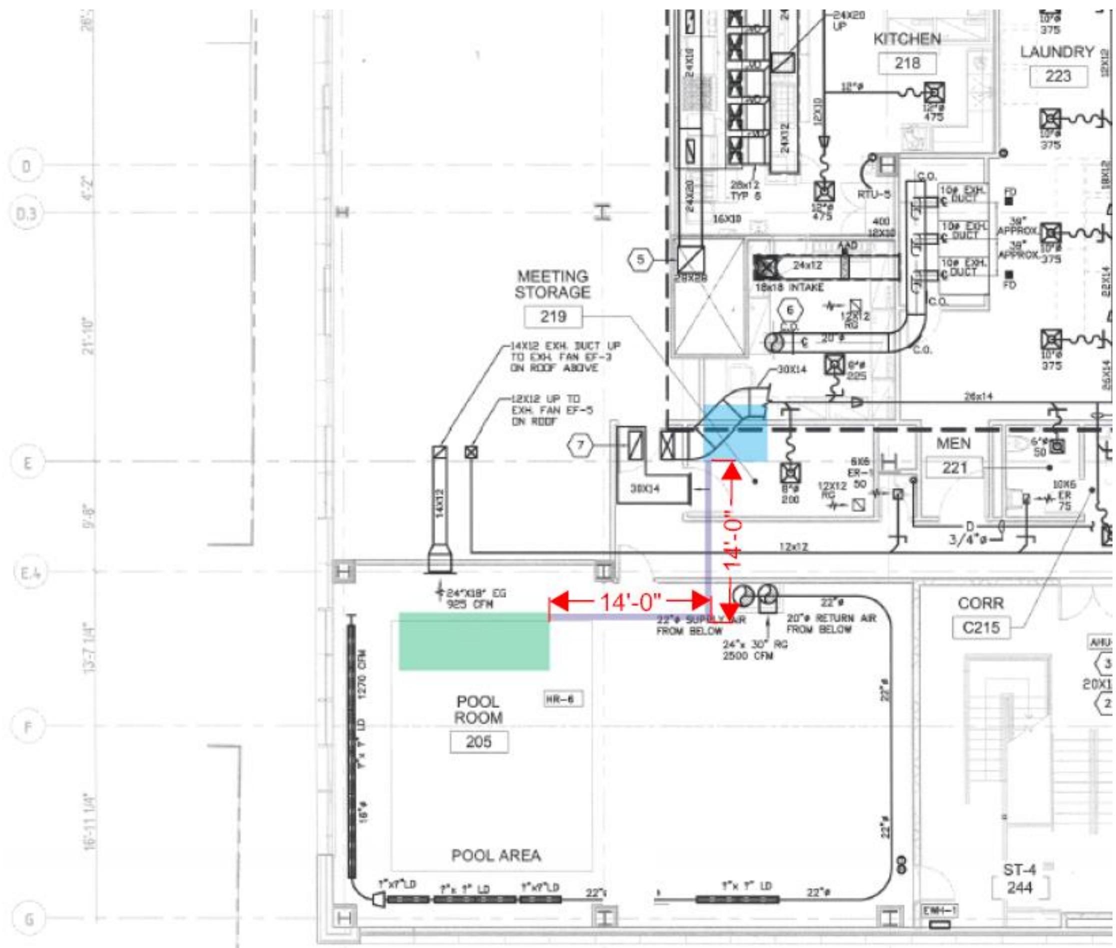


Figure 17: Refrigerant Piping from Condenser to AHU

The cost of ½" refrigerant piping is \$10.37/LF according to RSMeans Mechanical Cost Data and the 90° elbows are \$26.08 each. This would add a total of \$636.49 to the total price of implementing this unit, resulting in the grand total of \$14,136.49.

Benefits and Special Considerations

Laundry 100%	11:05 PM	5:00 AM
Kitchen 100%	5:05 AM	11:00 PM

In theory, combining the two units should make for a more efficient system. With the current design having two units, there would be two units that are operating at different times with some overlap, and they would each have several periods of starting and stopping. These constant starts and stops for each unit is inefficient and eats more energy than it would to maintain the operation of the unit. This period of starts and stops is known as short cycling your air handling unit. Short cycling your equipment leads to a shortened life of the unit, as well as an increase in the energy and thus an increase in the heating and cooling bills. The key element in the proposal to combine these two units will be the necessary cooperation from the hotel staffing.

If the hotel staff can follow a prescribed routine for what hours the laundry can operate, the laundry load can be coordinated around the kitchen's operating load. The bulk of laundry is typically done throughout the night, so this would require minor modification as the kitchen is not in use throughout the night. The kitchen load would operate to the fullest during the meals, and prior to meals and between the meals it would operate at about 70% of its typical load. The main hours of operation projected for each function are 11:05 PM-5:00 AM for the laundry and 5:05 AM-11:00 PM for the Kitchen. Refer to Figure 18 for the anticipated hour-by-hour operation projection schedule.

Restricting the laundry hours to 11:05 PM- 5:00 AM should not disrupt the overall productivity of the hotel staff because during the "off" hours the laundry can still be collected, transported to the laundry room, and sorted throughout the day. Additionally, the standard check-in to the hotel begins at 3:00 PM and check-out is at 12:00 PM, so from 5:00 AM to 3:00 PM, the laundry could continue to be folded and prepared in the rooms, while the collection process would begin all over again after check-out at 12:00 PM. The process can be seen below in Figure 19.

12:00 AM	Laundry
12:30 AM	
1:00 AM	
1:30 AM	
2:00 AM	
2:30 AM	
3:00 AM	
3:30 AM	
4:00 AM	
4:30 AM	
5:00 AM	70%
5:30 AM	
6:00 AM	Breakfast
6:30 AM	
7:00 AM	
7:30 AM	
8:00 AM	
8:30 AM	
9:00 AM	
9:30 AM	70%
10:00 AM	
10:30 AM	
11:00 AM	Lunch
11:30 AM	
12:00 PM	
12:30 PM	
1:00 PM	
1:30 PM	
2:00 PM	
2:30 PM	70%
3:00 PM	
3:30 PM	
4:00 PM	
4:30 PM	
5:00 PM	Dinner
5:30 PM	
6:00 PM	
6:30 PM	
7:00 PM	
7:30 PM	
8:00 PM	
8:30 PM	
9:00 PM	
9:30 PM	70%
10:00 PM	
10:30 PM	
11:00 PM	Laun
11:30 PM	
12:30 AM	

Figure 18: AHU Projected Operation Schedule

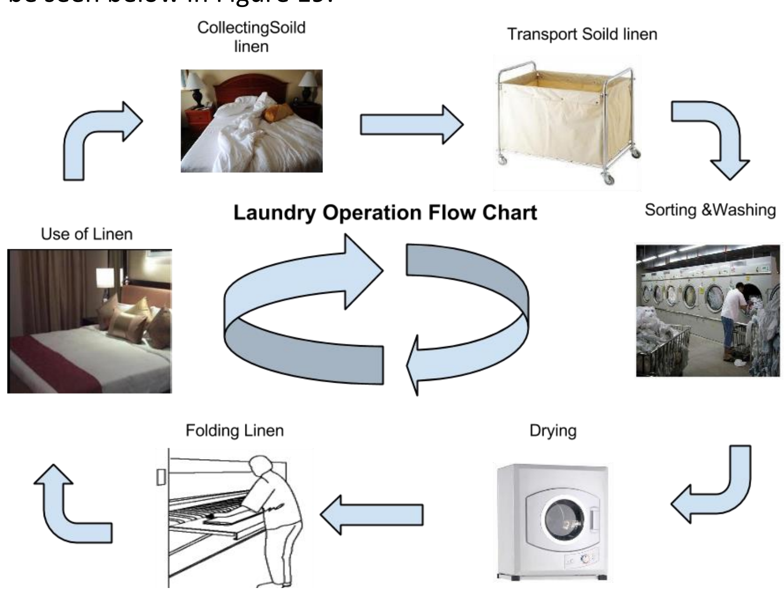


Figure 19: Hotel Laundry Operation Flow (Source: Set Up My Hotel)

Energy and Savings Analysis

When comparing the two units, the new unit had to be upsized; however, the anticipated cost savings did not occur. First, the upfront cost to install and purchase one unit rather than two is perhaps the most apparent and obvious savings at first glance. For these units in particular, to have combined the units and maintained a gas heat system, the unit would have cost $12,500, rather than the $9,000 for the proposed air handler. For many JCI air handlers there is an upfront cost difference between $3,000 and $4,000 between the gas heat and electric heat units. The unit was switched to electric heat rather than gas heat because the operational costs are comparable and the upfront cost could be reduced.

Beyond those surface costs there is a savings that results from the cooling as well. A cost comparison was performed to show how much eliminating a unit could save when compared to the amount of cooling the new, single unit would require annually. Due to the fact that these units have not been installed or operated within this building, the kW output was based on the horse power of the specified units comparatively.

Converting HP to kW:

$$HP \times \frac{.7457\ kW}{HP}$$

$$kW \times \left(\frac{8766\ hours}{year}\right)$$

$$kW(hrs) \times \left(\frac{\$00.0989}{kW}\right)$$

Cooling Power Yearly Cost of RTU-5 and RTU-6:

$$3\ HP\ \times \frac{.7457\ kW}{HP} = 2.2371\ kW$$

$$2.2371\ kW\ \times \left(\frac{8766\ hours}{year}\right)$$

$$= 19{,}610.4186\ kWhrs/year$$

$$19{,}610.4186\ kW(hr) \times \left(\frac{\$00.0989}{kW(hr)}\right)$$

$$= \$1{,}939.47/year$$

Cooling Power Yearly Cost of New Indoor AHU:

$$5\ HP\ \times \frac{.7457\ kW}{HP} = 3.7285\ kW$$

$$3.7285\ kW\ \times \left(\frac{8766\ hours}{year}\right)$$

$$= 32{,}684.031\ kWhrs/year$$

$$32{,}684.031\ kW(hr) \times \left(\frac{\$00.0989}{kW(hr)}\right)$$

$$= \$3{,}232.45/year$$

Annual Savings Comparison:

OLD Cost: $3,878.94

New Cost: $3,232.45

Total Savings: $636.49

Operation Schedule Comparison

Figure 20 below shows a schematic representation of the two different operating schedules of RTU-5 and RTU-6. The green curve represents the laundry operating at its peak loading from 11:00 PM to 5:00 AM. The blue curve represents the kitchen operating at its peak loading from 5:00 AM- 11:00 PM. The yellow line represents the base load that the units will operate at with the red line showing the maximum loading that the units do operate at rather than the max loading the units can handle. It is important to note that this is a schematic depiction of the two units to illustrate how and when they operate; however, this graph is not intended to suggest that the both rooftop units experience the same peak load. The unit servicing the laundry room (RTU-5) will generally experience a lower peak operating load than the unit servicing the kitchen (RTU-6).

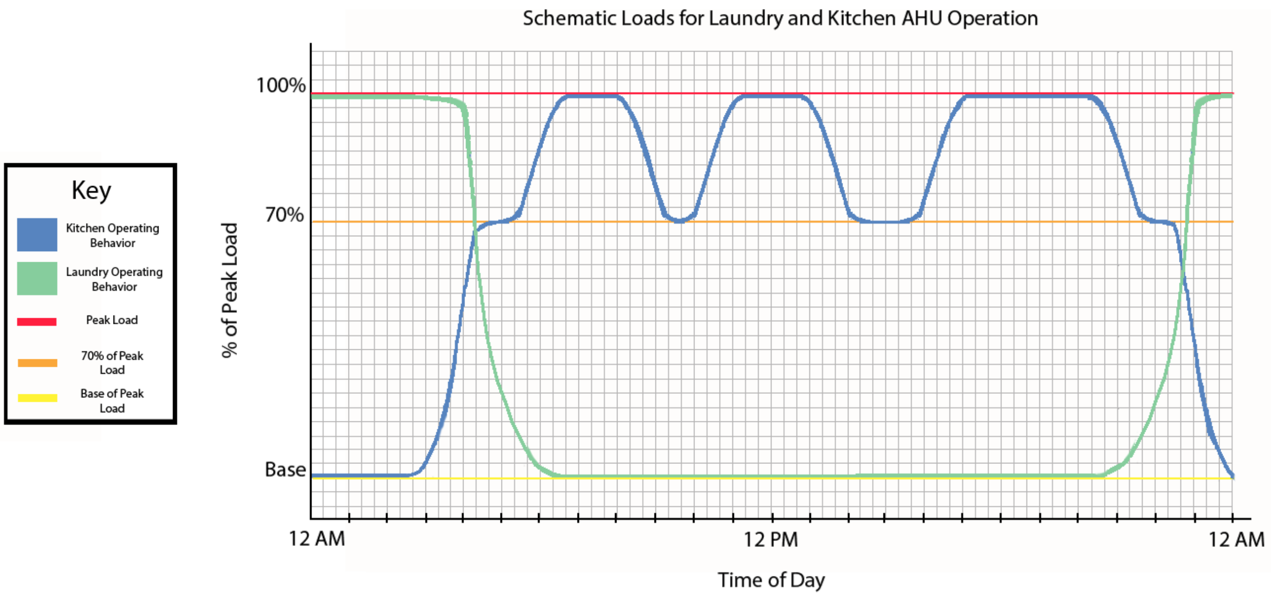


Figure 20: Schematic Cooling Load Schedule for RTU-5 and RTU-6

Conclusion for Mechanical Breadth

If the owner can see past the upfront cost they can greatly benefit from making such a change. While there are minimal energy savings or changes when switching from gas heat to electric heat, combining the units makes a more efficient system by eliminating the constant starts and stops that would have occurred with having two separate units. By eliminating the opportunity for this short cycling to occur, the longevity of the unit is preserved as well. In addition to the prolonged existence due to riddance of short cycling, the unit also experiences a prolonged lifespan due to the fact that it cannot be weathered and worn down by elements and exterior conditions on the roof.

Conclusion

The decision to design a building that has a uniform bay versus a structure that is unique in many ways or in every way, is not a black and white decision. The occupancy and performance of each area needs to be carefully considered, as well as the option that will be most cost-effective for the owner without sacrificing quality. For a building that has one type of occupancy and similar activities throughout the space, a typical bay might make sense, where as a structure with a more complex nature may require more careful planning with a unique structure.

The opportunity to make aspects of a unique structure more standard come along with constructability considerations. For that reason, slabs and decking will typically be applied over an entire floor or the majority of a floor, rather than adapting those elements to each room individually. With respect to the idea of standardizing some aspects for the sake of constructability, that can be applied to the redesign of the pool area. Designing that area to have similar members and the same deck and slab system as the surrounding spaces would make that construction process go smoothly, as well as giving an opportunity to further protect the equipment that is essential to the success of the kitchen and laundry spaces.

Analysis 3: Critical Industry Research: Collocation

Problem Identification

Collocation is a hot topic in the construction industry and it has been heavily debated as to whether or not there is real benefit to establishing collocation on a project and to what extent. To begin, it is important to clearly define what collocation is in the construction industry. Collocation can be defined as a lean construction technique that is aimed to improve and expand the communication by physically integrating the project team and owner to work together in a single location (on-site or nearby).

At the Steel City High-Rise, collocation was partially established with all of the project team present in the field office, with the exception of the structural engineer and the architect. Arquitectonica sends their architect to the field office for biweekly Owner-Architect-Contractor meetings, whereas the structural engineer conference calls in on occasion. It appears that there is an added value to the collocation of the various parties and that the problematic areas tend to correlate with the respective parties that are not actively engaged in the collocation plan.

Analysis Goals

Adopting collocation seems to be something that the industry seems to be divided on. Many who have taken the leap of faith to implement collocation to a project have positive reviews for how the project went, while many are weary about the coordination to make collocation a reality. The goal of this analysis will be to investigate the added value of collocation, the types of projects that benefit from collocation, the added costs associated with implementing collocation, and parties and people that should be actively engaged in collocation should it be established.

By reaching out to a diverse audience within the construction industry, the hope is to generate proof that either supports or debunks that there is added value to collocating the project team. If the research and testimonies point towards collocation being a strength to the construction industry, then the construction industry can more wholly embrace the culture and performance opportunities that collocation has to offer.

Methodology

In order to complete this analysis the following deliverables must be completed:

- Industry Survey to ask questions such as:
  - What size project (small, medium, large) would largely benefit from collocation?
  - Is there a correlation between the project size and the success of collocation?

- In your experience does collocation work better on new construction, renovations, or is it an equal opportunity for both?
- What parties should be actively engaged in collocation? Subcontractors? Owner? Designers?
- Do you see collocation as an added cost to the project or a preventative measure for avoiding incurred future costs?
- Does it have a positive or negative impact on a company's operations as a whole outside the scope of this project?
- Have you noticed the various members of the project team becoming more reliable, less reliable, or neutral?
- Does collocation improve or hinder the maintenance and management of the project?
- What are the additional and sizeable costs that can be a result of collocation?
- How is the response time impacted by collocation for inquiries, RFIs, submittals, and conflict resolution?
- Have you noticed an impact on productivity as a result of collocation?
- Scaled questions:
  - How would you rank the impact of collocation on a project overall?
    - 1 (negative impact), 3 (neutral impact), 5 (significant improvement)
  - Would you recommend that collocation be implemented more often?
    - 1 (never), 3 (needs further testing), 5 (absolutely)

Process

Background Research Performed

Survey

Many of the issues, miscommunications, and questions that have occurred throughout construction were resolved very quickly due to the collocation of the team. Nearly all of issues that have been difficult to handle in a timely manner have been matters that needed to be taken up with the architect and/or the structural engineer.

In order to see if this is merely coincidental or if it in fact is a result of those parties being the only two that are not participating in collocation, a survey will be sent out to industry leaders and PACE members. This survey will explain the situation and ask a series of questions related to the circumstances. After the data is collected, it will be compared to the experience at Steel City High-Rise to see if complete collocation would have been a better opportunity.

Please refer to Appendix L for copy of industry survey

Case Study

DPR Construction performed a study alongside of Standford University's Center for Integrated Facilities (CIFE) to analyze relationships between the various groups on a project team and who is interacting the most frequent. Their study aims to analyze the benefits and parties that should be collocated in order to experience the maximum benefits that collaborative environments can offer. The term for collocation that they mention is called "The Integrated Big Room" in which they use a collocated space on-site to bring together the project team and building owner and/or occupant.

DPR Construction's study goes through both the primary and secondary benefits that collocation can and does offer. First, bringing the various groups under one roof gives the team the ability to design an integrated building more effectively, as well as allowing the groups to form complementing goals and visions from the very beginning. An immediate and apparent benefit to collocation is the ability for the team to quickly consult one another and get more immediate feedback on inquiries.

Construction is expanding and becoming more complicated and innovative every day, so coordinating trades becomes more elaborate for many projects and their teams. With the evolution and complexity of construction comes the need for timely responses to RFIs, Submittals, and other documents that can significantly impact the schedule for the project. Collocation helps address these needs directly and efficiently, thus reducing the risk associated with those delays. All the while, the early on collaboration and shared workspace allows the group to prevent conflicts that may have arisen further down the road between trades. Additionally, a collocated environment helps the various entities see their goals as aims to advance not only their individual company, but the project as a whole.

DPR Construction addresses the fact that the largest challenge or question revolving the decision to collocate or to stay separated is: who or what trades should be engaged in collocation? Smaller trades in many cases do not require elaborate, if any, coordination with other trades on the project, so it can be easy to exclude them from collocation, but other trades can be more difficult to place. DPR Construction decided to use a large project that they currently had a contract for in order to evaluate which groups were interacting the most, and whether they were sending information, receiving information, or both. An algorithm was developed and used to create TIIS (Team Information Interaction Sequence) that showed the interdependencies among different disciplines. A TIIS will vary with different projects, but can be adapted for any group and the involved parties. Figure 21 shows the example for this particular case study project (a hospital).

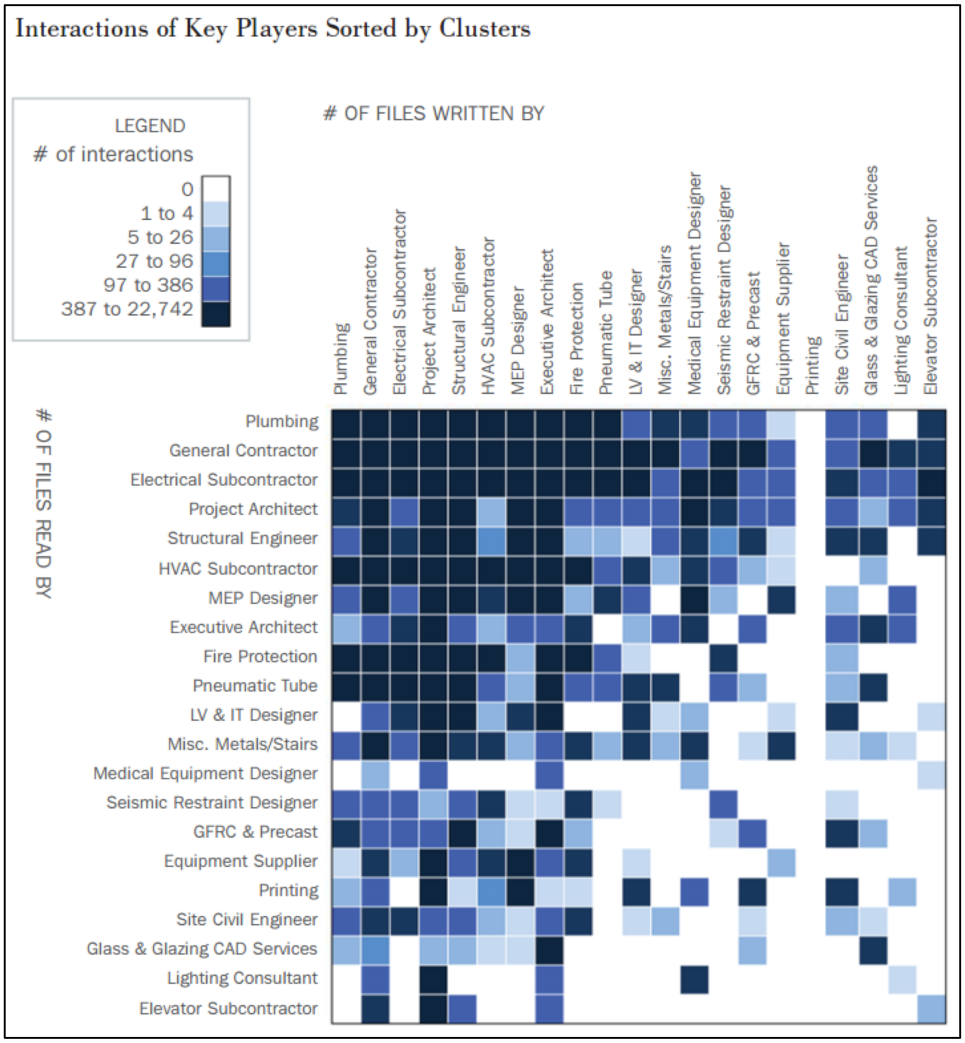


Figure 21: DPR Case Study of Interactions on large hospital project

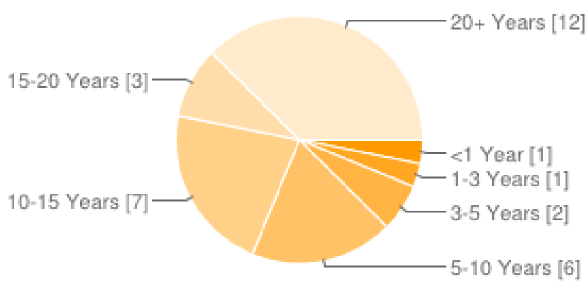
The TIIS shows that architect what experiencing a highly concentrated "betweenness centrality". What that means is that the architect had a high correlation of communication between more parties than any other group. This shows that the architect has more frequent collaboration among all parties is potentially passing the most information regarding the project out of anyone. Often times this is also the case for the GC/CM and is often why they are responsible for leading the collaborative meetings among the different disciplines. After identifying the groups that experience the most exchanges of information, the team can better plan who should be included in the collocation and at what points in the project. A TIIS can be modeled and remodeled for various parts of a project, rather than adapting one for the duration of the project. Once the collaboration is better understood it can allow for the most efficient and valuable communication and planning for the project and team. Perhaps the most beneficial part of collocation is the transparency that it creates among parties that potentially would not have had much consideration or understanding of one another had they not been placed in a collaborative workspace.

Survey Results

The Participants

The survey gained participation from 34 industry contacts that had a range of backgrounds and volunteered to give insight into their experience with collocation. Of the 32 participants, there was a variety of titles and roles held within the construction world including project/construction manager, project engineer, superintendent, preconstruction, in addition to a few “other” roles within upper management and BIM coordination. These professionals not only offered a variety of insight from their roles in the industry, but also with their years of experience. See figure 22 below for the experience breakdown.

How many years have you been in the industry?



<1 Year	1	3.1%
1-3 Years	1	3.1%
3-5 Years	2	6.3%
5-10 Years	6	18.8%
10-15 Years	7	21.9%
15-20 Years	3	9.4%
20+ Years	12	37.5%

Figure 22: Experience breakdown of participants

Interestingly enough, despite the diversity in the experience and roles of the participants, there was a unanimous agreement that working on a collocated project is a positive experience and that regular face to face interaction is the most beneficial form of communication. When asked what key decision points determine whether or not to use collocation, there was again a sense of consensus among the group with no outlying suggestions. The key considerations that were most common include the budget, location of team with respect to the site, size of project (physically and monetarily), complexity of project, duration of project, delivery system, schedule, benefit of collaboration, and need for an expedited RFI and submittal turnaround.

Project Applicability

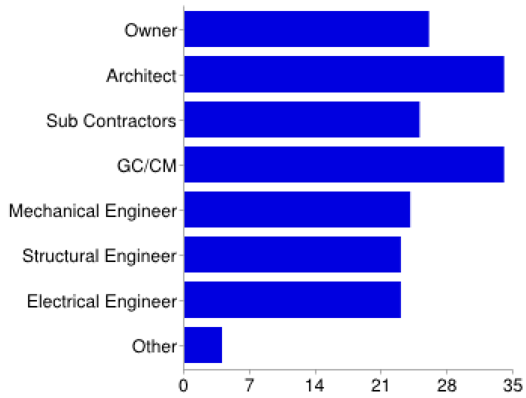
The next segment of the questionnaire focused on whether or not collocation is best suited for large projects. The three questions asked if the participants agreed or disagreed with the following statements a) Collocation is more beneficial on large projects b) Collocation is easier to implement on large projects and c) Collocation is more successful for large projects. For all three questions the results were that 28% somewhat-strongly disagreed and 72% somewhat-strong agreed. The unique part of these ratios is that the responses to each question varied for each participant, but the ratio balanced out each time. Many of the survey partakers gave additional comments and feedback to explain that often times the size of the project doesn't have as much of a factor as the complexity of the project. The larger the project it, the more likely it is that it can financially support collocation; however, any size project can experience benefits from the collaborative environment that results from collocation. In addition to the complexity impacting the need for collocation, it is important to consider the duration of the project as well. It can be a difficult sell to persuade all parties to participate and relocate if the project duration is too short. Professionals feel that collocation is better suited for projects that are at least a year long venture.

The results became less conclusive as the participants were asked which phases were the easiest or hardest to implement collocation during (schematic design, design development, early construction, and late construction). Most of the results were in a 40:60 range, with early construction having the strongest correlation of 69:31. Early construction had the strongest association to having the easiest implementation with collocation for a project. The additional comments made by the professionals explained that collocation does not necessarily become easier to implement at certain stages, there it will always be challenging to work out the logistics, but there are certain times where collocation would be more crucial regardless of the level of difficulty - especially during construction. That being said, the earlier the communication and chemistry builds between the designers, the smoother the process generally goes. Additionally, the personalities can really make or break the collocation process regardless of what point it is implemented. Some may argue that the sooner collocation occurs, the sooner the team can make changes of personnel to create a better dynamic among the team; however, not all companies are able to move the project teams around depending on how much other work the company is involved in. As a collective unit, the question shows that collocation implementation will vary by several outside factors, but there is potential for it to be established and have value at nearly any phase.

Presence throughout Collocation

Following the analysis of the value of collocation is the ever-important question of who should be participating in collocation in order for it to be successful. Below Figure 23 shows the results of the survey for various roles that are involved in the project. There was a 100% participant view that it is essential for the GC/CM and the Architect to be participants in collocation. Many felt that the owner should be involved as well, and additional comments were received explaining that the owner may not need to be collocated for the full 40 hour work week; however, they must be readily available for input and in order to make prompt decisions. Subcontractors were also a strong recommendation; however, this would likely be limited to the larger packages on a project because it is rare for an owner to want to pay for the design assistance that comes along with collocating subcontractors. The professionals further explained that the designers are key contacts, but similar to the owner they aren't always necessary for daily participation. That being said, they stressed the importance of having a regularly scheduled presence to the collocated site. The "other" responses were all from participants noting that any key designers should be involved, as these will vary with each project, furthering supporting the aforementioned statement regarding the core designers. There were not parties that were seen as being unnecessary, but rather more subjective to the circumstances.

Identify which parties on the project you feel are important/necessary to be present in the collocated space



Owner	26	76.5%
Architect	34	100%
Sub Contractors	25	73.5%
GC/CM	34	100%
Mechanical Engineer	24	70.6%
Structural Engineer	23	67.6%
Electrical Engineer	23	67.6%
Other	4	11.8%

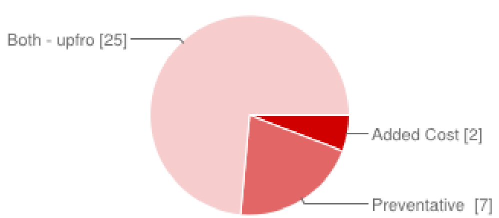
Figure 23: Results of Collocation Party Participation

Further comments from the professionals provided further insight to participation in collocated projects. The need for a party's participation in no way suggests that they are required to be present from start to finish of the project. Many of the groups will participate at different stages of the project with respect to the work on site, with the exception of the GC/CM, the Architect, and a special circumstance who will participate for the full project duration. Additional considerations that impact collocation contribution substantially are the risks associated with the project, as well as the type of project. It is important for the driving project risks and priorities to be identified early on in the project in order to get professional involvement in collocation from the partakers that are more closely related to those risks and urgencies. Outside of the risk, the project type can greatly change the needs for a collocated staff. For example, if the project is a data center, then it is probably essential to have full MEP representation for the collocated office.

Consequences of Collocation

One of the biggest criticisms of collocation that is frequently brought up is the additional cost implications that come with locating representatives from several groups to one geographic location; however, how substantial are these costs? The survey contributors were asked if overall the incurred costs were seen as added costs, a preventative measure, or perhaps a little bit of both that could add value to the life of the project. Figure 24 shows the results.

Do you view collocation as an added cost to the project or as a preventative measure for avoiding future incurred costs and conflicts?



Added Cost	2	5.9%
Preventative Measure	7	20.6%
Both - upfront cost that benefits the life of the project	25	73.5%

Figure 24: Results of Collocation Cost Association

A key element to whether collocation's performance will be beneficial or detrimental weighs heavily on the willingness of the participants. Once the collocated groups are outlined and planned for, those contributors have to give their full participation. Without the complete dedication of any significant party the value can become more limited. Of the 34 PACE professionals, 27 have participated in a collocation project. Of those 27 reps, 71% of them find that the value of collocation suffers when full participation and cooperation is not given by all of the involved groups.

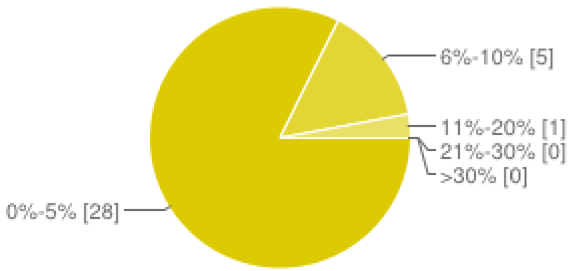
It was interesting to see that while 29% of the participants did not necessarily agree that full involvement could be detrimental to the value of collocation, all but two of the professionals felt that the project team is more reliable when collocated and that improved productivity is a result of collocation. A perfect example of the increase productivity due to reliability can be seen in the response time for RFIs, submittals, inquiries, and conflict resolution. 95% of the professionals said that the response time for those major items improves proportionally with collocated project teams. Slower response times for any one of these issues or items can be extremely damaging and disadvantageous to the project schedule and budget. From that angle, most would consider reliability and increased productivity added value to the project, even if it does not make a significant impact monetarily. For these reasons, it is crucial to plan collocation early on in the project planning, even if it isn't implemented until a later phase of construction, in order to establish a grounds with the groups that are to be dedicated to the collocation.

Another common concern with collocation is the argument that a company's operations as a whole can be slowed or harmed by dedicating one person to one project in a particular geographic region, as opposed to housing them at the company office whether they may or may not be tasked with more than one project. Only 20% of the industry professionals somewhat agreed with that possibility. There are circumstances where that might be true, but those are often circumstances in which collocation would not be considered for that party. Those cases would typically pertain to small projects or groups that have limited scope in the grand scheme of the overall project. Additionally, the resources at the collocated site can greatly impact how well the company can operate in a collocated space. If the technology and access to programs, equipment, and records are not adequate enough the production can be greatly inhibited.

While considering the well-being of each group that is to be connected and collocated, it is also important to consider the preservation and maintenance of that company's work on site. All but one of the industry professionals said that in their experience, the maintenance and management of a party's work on the project is improved by collocation. The one professional that somewhat disagreed, has not worked on a collocated space before but speculated the proportional relationship between collocation and serviceability/maintenance.

The final major consequence or outcome that can result from collocation that raises the most concern is the upfront costs associated with collocation. The additional costs to consider would include the increase in the general conditions for the cost of having a larger office space, travel expenses, housing, and technology. Some of these costs will be offset from the travel expenses that would have incurred from parties having to travel to and from the jobsite, but overall when applied to an appropriate project (typically one that is large and complex enough with a duration greater than one year) these costs would not make up a large portion of the project cost. Below Figure 25 shows what scaled percentage of the total project cost the professionals have seen collocation amounting to.

What scale of added costs they have witnessed, as a percentage of project costs?



0%-5%	**28**	82.4%
6%-10%	**5**	14.7%
11%-20%	**1**	2.9%
21%-30%	**0**	0%
>30%	**0**	0%

Figure 25: Professional Experience for Cost of Collocation as Portion of Total Project Cost

At the conclusion of the interview the professionals were asked whether or not they would recommend that collocation be implemented more often. They were given the option to a) strongly disagree, b) somewhat disagree, c) remain neutral to current practices, d) somewhat agree, or e) strongly agree. Of the 34 participants, none disagreed to any extent, while 18% remained neutral (with half of those individuals having never worked on a collocated project), 44% somewhat agreed, and 38% strongly agreed. Overall, that gave resulted in 82% of the participants agreeing that collocation could and should be implemented more often than it currently is.

Conclusion

Research and the survey showed that collocation can offer better integration among disciplines, increased and better communication, dispute reduction and swift decision making, better commitment thus more reliability and accountability, early problem identification, and a more collaborative environment, but there are secondary effects that result from collocation as well. These include both quantifiable results such as preserving and planning the best schedule and budget (potential reducing the time and cost of the project), as well as non-quantifiable results such as long-term relationships between trades and companies, job satisfaction (for both the team and the owner), and higher level of trust and sense of a team atmosphere. The industry professionals explained that it can largely benefit BIM accuracy, as well as a new respect and understanding for all trades in the project. Today, the innovation and growth of construction and design has taken the “master builder” title from the architect, and made it something that can only be achieved in a team venture. All of these direct and indirect benefits ultimately can round out a project and results in a better design, increased quality, and a better end result for both the hired team and the owner.

The key drivers for determining the feasibility of implementing a collocated team are generally the size of the project (physically and monetarily), the duration of the project, and the complexity of the project. Once it is determined whether or not the project is suited for a collocated team, it is essential to establish commitment from the parties that are joining the venture. The research shows definitive results from the industry and research that there are large benefits to having the architect collocated and with that comes a high risk that the project can experience difficulties without the availability and presence of the architect or architect's rep. Additionally, the upfront added costs should not discount the added value and benefits, as well as preventative measures that collocation can offer each facet of the group from laborers to management and ownership of the project. It is inevitable that circumstances will arise that prevent all parties from being able to physically participate in collocation and in those cases, consideration should be given to bluebeam studio meetings and or GoTo meetings. Bluebeam studio meetings offer collaborative tools in a "cloud" that allows several users to collaborate real time together on PDFs, all the while tracking who is making the changes and when. GoTo meetings provide the opportunity to have high-definition video conferences, audio communication, shared computer screens, and personalizing a conference call url for all collaborators to join.

Had full commitment been established and enforced at the Steel City High-Rise, there could have been less conflict when turning over new points of contact for major members of the design team, as well as better planning for the future. The steel for this structure has always been the critical driver or inhibitor of the schedule, so the opportunity to have collocated the structural engineer and the architect with Turner Construction would have allowed for an opportunity to efficiently and promptly address concerns and changes that could have saved the schedule. This may have allowed for an opportunity to have accelerated the planning that controlled when the fabrication began. An earlier start in the fabrication process could have further reduced the schedule and ultimately the cost of construction for the Steel City High-Rise.

Analysis 4: Vertical MEP

Problem Identification

The mechanical, electrical, and plumbing systems for the structure are fairly simple for the anticipated completion, as they are either standardized for the hotel requirements or the reoccurring office spaces and many areas are to remain core and shell for future tenant fit-out. The majority of the MEP is housed within the hotel portion of the structure, where the floorplan layout is very similar and repetitive. Because of this, the MEP systems are stacked vertically in order to rise through all of the bathrooms and necessary spaces without taking up a lot of space. While this process is extremely efficient in terms of constructability, the work is not currently scheduled in a way that maximizes the schedule of the project as a whole.

Analysis Goals

The main goal for this analysis will be to accelerate the schedule and thus save on both time and cost for the project. The earlier that the project reaches substantial completion, the sooner that the building can start to generate a revenue with bringing in occupants, tenants, and users to the offices, hotel, and retail spaces. Since the building progresses vertically, time can be saved if different crews can follow one another up through the structure without having large breaks between the various trades. The steel on the project is the critical driver of the entire project and has been scheduled efficiently; however, the MEP finishes are another critical element to the project that can make or break the schedule. The key considerations when altering the schedule will be maintaining necessary relationships between predecessors and successors, as well as considering the necessary precautions to maintain safe working conditions for all trades and workers.

Methodology

In order to complete this analysis the following deliverables must be completed:

- Evaluation of the overhead working conditions and safety analysis
- Research of QA/QC requirements for MEP work prior to the building enclosure
- Rescheduling of MEP throughout the vertical progression of the schedule

Process

Background Research Performed

Currently, the MEP systems are scheduled to commence after major structural elements have been erected, but this process does not move in a consistent vertical direction. The schedule reflects that the MEP systems will be installed one floor at a time following the topping out of certain roof levels of the structure; however, it may be possible to achieve a more efficient schedule.

An alternate approach to be explored would be having the MEP installation climb with the structure and have the roofs be accelerated in order to allow the MEP trades to continue progression. This would mean that as a level of the structure is completed and moving to the next level, the MEP would start one or two floors below the newly started structural elements. This could allow the work to occur simultaneously and potentially save on schedule time and money.

Logic of Sequence Analysis

Prior to making any major changes to the schedule it was important to analyze the current logic behind the sequence of events as well as analyzing what specific requirements needed to be met by the specifications in order to fully install the MEP systems. Aside from the obvious need to have certain floors of the structure erected, there were several criteria that applied to different parts of the building, but not to every floor.

For example, level 1, unlike all other levels of the building, has MEP worked under the slab. This is the first task that needs to occur for the MEP in the building after the utility lines have been established because the slab will be poured after the MEP is set. For the rest of the building the slabs will be poured or placed prior to the MEP work because none of it will be contained within the slab.

The next key item to consider is the slabs on deck and the slab on grade. In the case of level, these will be the next step in the sequence, where as it will be the leading item for many floors on higher levels of the structure. Following the slab pours will be the post-tensioned slab placement for the mid-level, level 2, and level 3 so that the spray-on fire-proofing can commence on the first 2 floors. The need for the floor above to be placed is so that the fire-proofing can be applied to the underside of the slab as well.

The next item to launch in the MEP trade sequence will be the MEP rough-in. The rough-in is to follow the fire-proofing efforts. As the rough-in is occurring on each floor, the framing is happening simultaneously in preparation for the drywall and other interior trades. The drywall is constrained by the level 3 roof (for the levels 1-3) and by the level 12 roof (for levels 4-12), as well as the metal panels and curtain wall/storefront. Essentially the specifications and logic call for the building and floors to be watertight prior to the drywall installation within the building.

Once the drywall is installed the wall finishes, flooring, and MEP finish begins followed by the hotel furniture, fixtures, and equipment which mark the completion of the hotel, the core and shell substantial completion and ultimately the completion of the project.

Schedule Reduction

Overall, the general sequence of the trades outlined above remained true; however, there were a few key elements that could be tweaked and recoordinated to allow for a schedule reduction in the overall project. The first of these changes revolves around the coordination of the spray-on fire-proofing and the MEP rough-in. The rough-in takes twice the amount of time that the fire-proofing does and does not have to be a finish-finish sequence. This allowed for a schedule change to adjust the rough-in start date to be a week after the spray-on fire-proofing begins. These trades can have an overlap of their work time because both are set to begin in the same place and the lag of one week will prevent the MEP from physically catching up or interfering with the spray-on fire-proofing.

The next opportunity for a savings was rearranging the schedule to allow the level 3 roof to begin after the slab on deck and post-tensioned deck on level 5 were completed. Waiting for the slabs to be completed two floors above the roof gives some cushion to the trades working in those areas so that there aren't conflicting tasks among different groups and to allow the structure to progress vertically for the number of floors that coordinate within those sequences. Reworking the schedule to have this roof completed early requires the steel erection team to take a two week hiatus on the vertical progression at level 10 in the hotel and at level 16 in the office area.

This change allows levels 1-3 to make significant strides in the schedule with the interior finishes by allowing the drywall and MEP finishes to begin ahead of schedule. The roof at level 12 does not need to be moved up because it was set to be done before level 3 originally and ends up meshing well with the pace of the schedule after level 3 roof has been adjusted. Ultimately, this lead to all of the MEP finishes being complete a month earlier than originally anticipated which then resulted in the hotel furniture, fixtures, and equipment and the overall project substantial completion to finish a month ahead of schedule.

Safety Analysis

Overall, the MEP schedule was able to be reworked in a way that does not pose any new safety considerations or threats. With the halting of the steel erection that would be occurring in the office levels during the roof construction for levels 3 and 12, it eliminates any concern for the overhead working conditions as they will be nonexistent. Due to the fact that the work is being reorganized, rather than changed, the safety netting is already accommodating for all edge conditions and overhead conditions that should occur during construction; however, Turner Construction had originally allotted $150,000 for safety netting and overhead protection, but ended up having a remaining a cushion of $100,000 that was not used. If for any reason a safety concern surfaces due to the accelerated roof systems at levels 3 and 12, there will be room in the budget to accommodate those safety needs, as safety will never be something that is sacrificed for the Steel City High-Rise.

Please refer to Appendix N for the new schedule

Conclusions

In order to make a complete conclusion, the cost needs to be analyzed in addition to the time savings. Since the schedule is namely causing an acceleration of the start time for interior trades, rather than shortening the durations of work, it will not cause reductions in the time needed for the major pieces of equipment or the crews (tower crane, hoist, etc.); however, it will save on a month's worth of general condition fees. Figure 26 shows the monthly costs of the general condition items to result in a savings of $173,154.76 per month of reduction.

Steel City High-Rise // Pittsburgh, PA
GMP - General Conditions

Code	Section	Total	$/Month
0110	TEMPORARY FACILITIES		
	Job Office	$ 83,600.00	$ 3,344.00
	Tools and Supplies for Turner Staff	$ 10,100.00	$ 404.00
	TOTAL: TEMPORARY FACILITIES	$ 93,700.00	$ 3,748.00
0160	GENERAL EXPENSE		
	Office Equipment & Supplies	$ 44,600.00	$ 1,784.00
	Telephone & Internet	$ 56,300.00	$ 2,252.00
	Blueprints & Copier	$ 59,400.00	$ 2,376.00
	Computer /Software License/Quality Control Infrastructure	$ 70,200.00	$ 2,808.00
	Account Payable	$ 40,300.00	$ 1,612.00
	Living / Travel Allowance & Relocation Expenses	$ 20,800.00	$ 832.00
	Progress Photos	$ 8,600.00	$ 344.00
	Miscellaneous General Expenses	$ 22,800.00	$ 912.00
	TOTAL: GENERAL EXPENSE	$ 323,000.00	$ 12,920.00
0170	PROJECT STAFF		
	Preconstruction	$ 281,787.00	$ 11,271.48
	Superintendence	$ 1,309,789.00	$ 52,391.56
	Engineering	$ 438,267.00	$ 17,530.68
	Accounting & Direct Purchase Procurement	$ 183,750.00	$ 7,350.00
	Safety	$ 39,317.00	$ 1,572.68
	Purchasing	$ 25,006.00	$ 1,000.24
	Management	$ 283,701.00	$ 11,348.04
	IT & Onsite Field Secretary	$ 64,037.00	$ 2,561.48
	TOTAL: PROJECT STAFF	$ 2,625,654.00	$ 105,026.16
0180	FRINGES/TAXES/INS./BONDS		
	General Liability Insurance	749,110	$29,964
	Payment and Performance Bond	537,405	$21,496
	TOTAL: PROJECT STAFF	$ 1,286,515.00	$51,461
	TOTAL: GENERAL CONDITIONS	$ 4,328,869.00	$ 173,154.76

Project Schedule

Preconstruction	10	Mos
Construction	23	Mos
Close-Out	2	Mos
On-site Duration	24	Mos

Figure 26: Cost of General Conditions per Month

In addition to the general conditions savings generated from a one month reduction of the project schedule, there will be an extra month of revenue that the building can produce. Prior to the rework of the vertical MEP schedule the schedule was already reduced from a 23 month construction schedule to a 21 month construction schedule. With the new reworking of the MEP sequencing and roof systems at level 3 and 12, the schedule is set to be completed in 20 months. That gives the owner the opportunity to get the hotel operational earlier, as well as to get the tenants into the offices and retail spaces earlier than expected. The building is projected to generate an owner revenue of $2,000,000 annually, resulting in a monthly revenue of $167,000. Therefore, for every additional month that the owner can get the leases started, he can expect to make $167,000 in addition to saving over $173,000 in general conditions. This would result in at least $340,000 going back to the owner prior to the originally anticipated completion in December 2015. In theory, a 3 month reduction in the schedule would nearly double that amount, but for conservative purposes in case of unforeseen conditions the maximum savings of $1,020,464.28 cannot be promised, but rather listed as a potential.

At the very least, an opportunity to save on $167,000 of general conditions and to begin generating an income on the leased spaces early on is advantageous to the owner. This would allow the owner to start making a return on the large investment that he made upfront to begin seeing the physical gains of such a venture.

Final Recommendations and Conclusions

Over the course of the last 8 months, the Steel City High-Rise was analyzed in order to find areas in which the construction process, various systems, and key components (such as budget and schedule) could be optimized in a way that would better the team, the owner, and the construction industry. Research, discussions with various members of the team and the owner, and careful consideration for the budget and schedule resulted in four analyses and two redesign proposals. The purpose of this report was to demonstrate the educational resources and lessons that were learned over the past five years in the Architectural Engineering program and are in no way intended to demote the work of the project team or the owner of the Steel City High-Rise. The following recommendations and conclusions were drawn from the four analyses:

Analysis 1: Fabrication of Structural Steel members

Conversations with the fabricator, Amthor Steel, paired with additional research into the pros and cons associated with cambering beams, conclusions were drawn as to whether or not the fabrication process and prescribed cambered members were best suited for the Steel City High-Rise. The fabrication process was analyzed on a large scale to evaluate the most efficient fabrication, as well as the most economical options for the project as a whole.

The owner of Amthor Steel provided insight to what the most idyllic members, connections, and conditions would be to provide both a timely fabrication and an economical one. This would include: no skewed beams, no sloped or curved members, no moment connections, the elimination of haunch and tapered beams, and the simplification to all single angle connections. While those may provide a look into what the perfect conditions would be from the fabrication standpoint, it quickly became clear that those conditions do not add value to the structure's life or function as a whole.

The best way to have aided the Steel City High-Rise would have been to have expedited the need to being and complete the structural and erection drawings to have accelerated the fabrication start. An option to have made this a reality is collocating the structural engineer and architect, which can be seen in Analysis 3.

Analysis 2: Unique Structural Elements

There are several factors that determine whether or not the structural designer will go with a uniform or unique design. Among those major factors are the need to remain ecomonical for the owner's sake without sacrificing the quality and performance of the building, as well as the occupancy and purpose of the spaces within the region. For a simpler building that has limited purposed and occupancies types, a uniform structural design may be better suited, where as a structure varying occupancies and purposes may require more careful planning with a unique structure in order to reach both the performance and economical goals.

The elimination of the pool posed for a perfect opportunity to consider how constructability can influence areas that can be made more standard despite having a unique structure. While this proposed slab design can suit multiple types of occupancies and purposes, the potential for housing former rooftop units within the structure is an enticing opportunity. Housing the units inside further protects and prolongs the lifespan of the units, not to mention the fact that they become easier to service from inside than they would on a roof. By moving two units inside and combining them the owner has the opportunity to have a more efficient unit with a higher durability than what two rooftop units could have provided.

Analysis 3: Collocation

Researching a case study and surveying a diverse group of construction industry professionals gave a lot of insight into the reality of collocating project teams. While collocation may not be ideal for a small budget or a project that is not complicated, the general consensus and research showed that there are gains and opportunities that collocation can offer. To name just a few of the added benefits they would include: swift conflict resolution, increased collaboration and communication, better understanding and respect of other trades, increased integration within the project design and construction process, preservation and awareness of efficient schedules and budgets, not to mention the long-term relationships and trust that such a project creates between industry workers as well as between owners and trade companies.

Once it is determined whether or not the project is suited for a collocated team, it is essential to establish commitment from the parties that are joining the venture. If any of the major parties do not commit to the process the benefits of collocation can be restricted, if not overcome by the negative consequences that result in the conflicts from the missing party. Additionally, the minimal upfront costs should not discount the added value and benefits, as well as preventative measures that collocation can offer to all individuals and groups associated with the project.

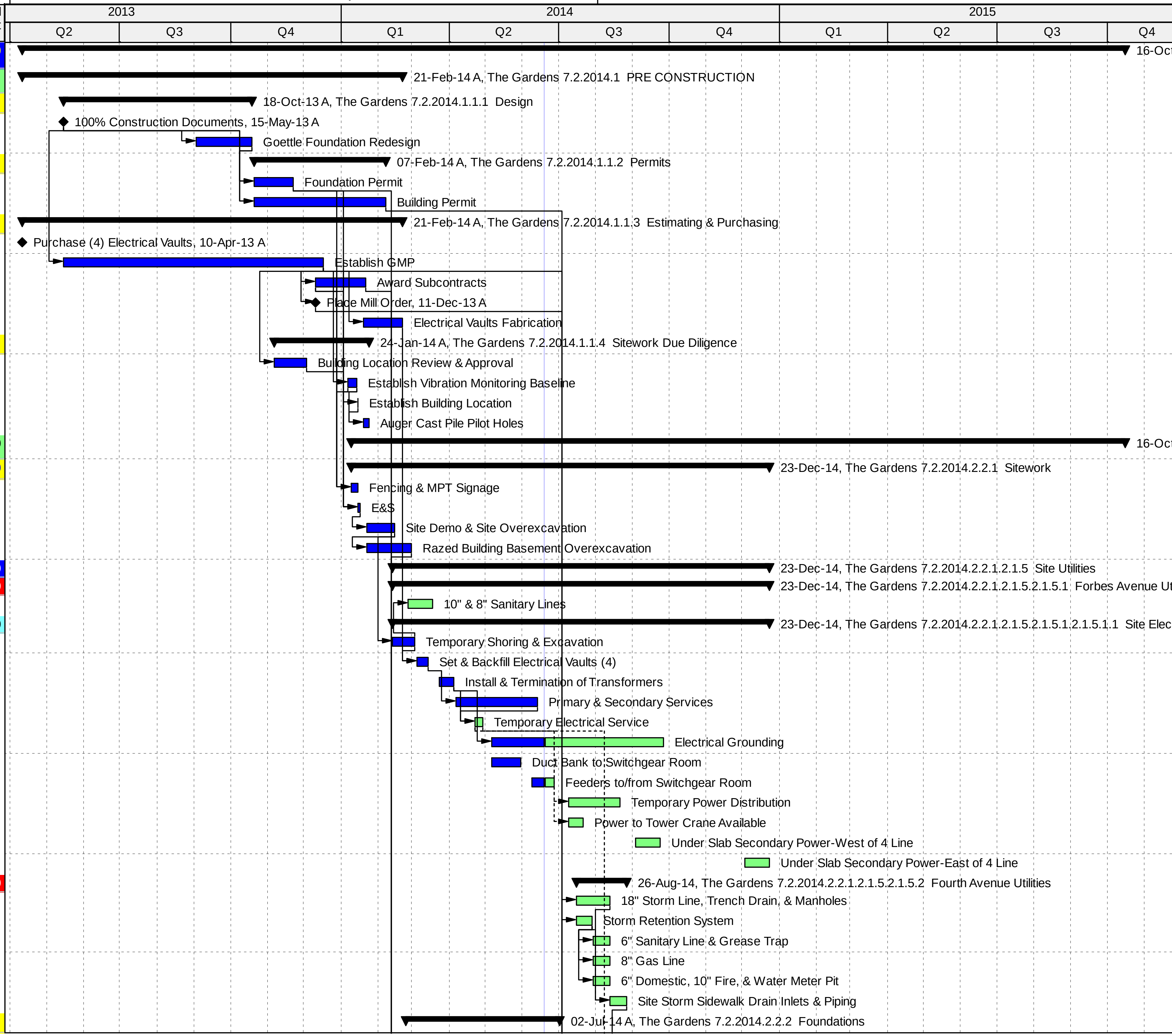
Analysis 4: Vertical MEP

Both the schedule and cost savings were analyzed for the reworking of the schedule sequence. The rearranging of activities allows for a month's reduction in the schedule, which can save at least one month of general conditions costs. Additionally, with the addition of this one month acceleration, the building is set for a substantial completion 3 months ahead of schedule. This would allow the owners to begin making an income anywhere from 1-3 months early. The general conditions would save $173,154.76 per month of reduction and the building is set to annually earn $2,000,000 or $167,000 monthly. This would result in at least $340,000 going back to the owner prior to the originally anticipated completion in December 2015. In theory, a 3 month reduction in the schedule would nearly triple that amount, but for conservative purposes in case of unforeseen conditions the maximum savings of $1,020,464.28 can only be mentioned as a maximum potential. Regardless of how many months early the building begins to generate a return, this would allow the owner to start making a return on the large investment that he made upfront to begin seeing the physical gains of such a venture.

Appendix A: Original Schedule

Edited from Source: Turner Construction via Arquitectonica

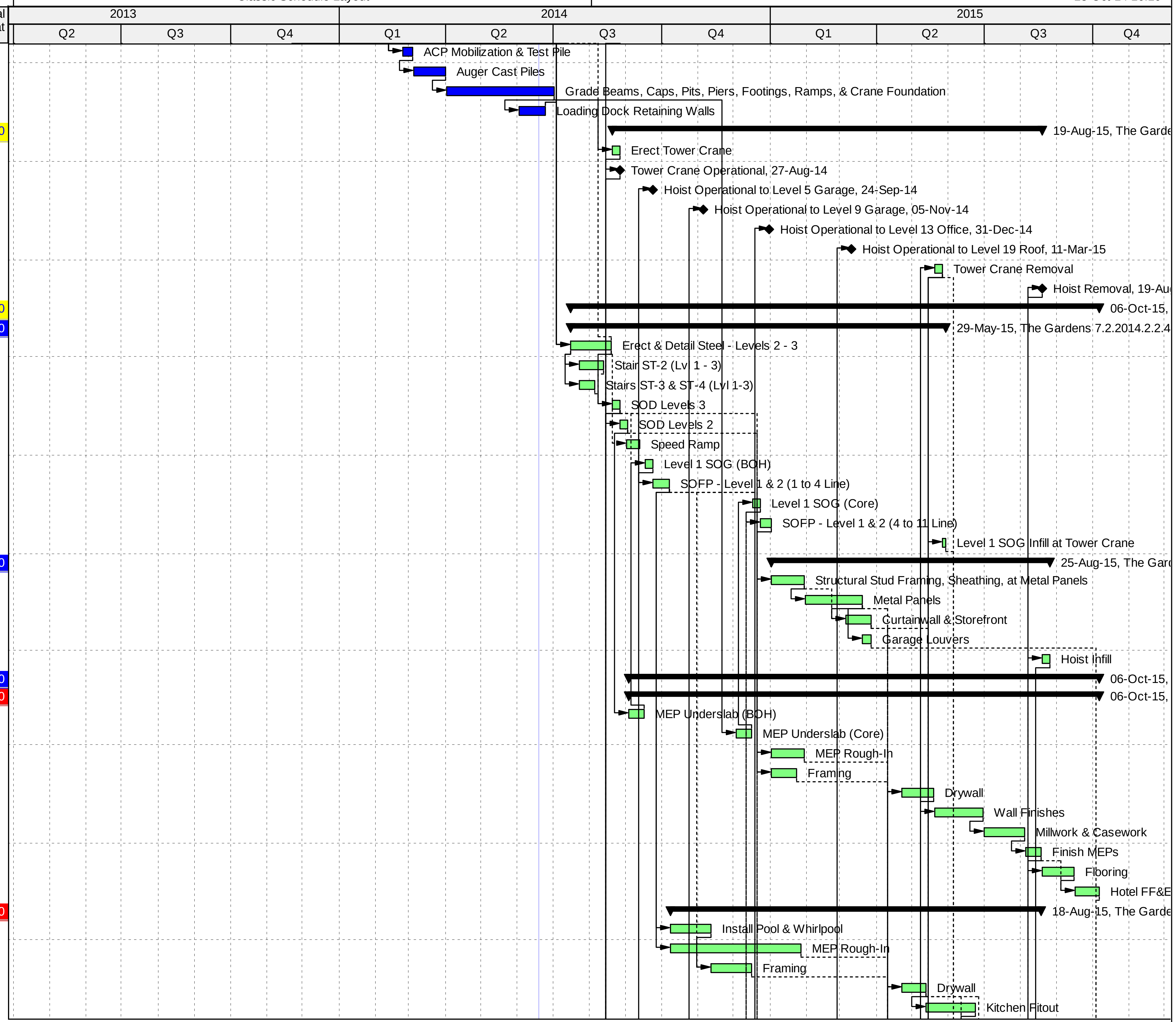
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
The Gardens 7.2.2014 The		658	10-Apr-13 A	16-Oct-15	0
The Gardens 7.2.2014.1 PI		218	10-Apr-13 A	21-Feb-14 A	
The Gardens 7.2.2014.1.1.1 De		113	15-May-13	18-Oct-13 A	
3	100% Construction Documents	0	15-May-13		
4	Goettle Foundation Redesign	35	02-Sep-13 A	18-Oct-13 A	
The Gardens 7.2.2014.1.1.2 Pe		80	21-Oct-13 A	07-Feb-14 A	
6	Foundation Permit	25	21-Oct-13 A	22-Nov-13 A	
7	Building Permit	80	21-Oct-13 A	07-Feb-14 A	
The Gardens 7.2.2014.1.1.3 Es		205	10-Apr-13 A	21-Feb-14 A	
9	Purchase (4) Electrical Vaults	0	10-Apr-13 A		
	Establish GMP	155	15-May-13	17-Dec-13 A	
	Award Subcontracts	30	11-Dec-13 A	21-Jan-14 A	
	Place Mill Order	0	11-Dec-13 A		
	Electrical Vaults Fabrication	30	20-Jan-14 A	21-Feb-14 A	
The Gardens 7.2.2014.1.1.4 Si		53	06-Nov-13 A	24-Jan-14 A	
	Building Location Review & Apr	20	06-Nov-13 A	03-Dec-13 A	
	Establish Vibration Monitoring E	5	07-Jan-14 A	14-Jan-14 A	
	Establish Building Location	2	15-Jan-14 A	15-Jan-14 A	
	Auger Cast Pile Pilot Holes	5	20-Jan-14 A	24-Jan-14 A	
The Gardens 7.2.2014.2 C(		465	09-Jan-14 A	16-Oct-15	0
The Gardens 7.2.2014.2.2.1 Si		252	09-Jan-14 A	23-Dec-14	0
	Fencing & MPT Signage	10	09-Jan-14 A	15-Jan-14 A	
	E&S	5	15-Jan-14 A	16-Jan-14 A	
	Site Demo & Site Overexcavat	15	22-Jan-14 A	14-Feb-14 A	
	Razed Building Basement Ove	15	22-Jan-14 A	28-Feb-14 A	
The Gardens 7.2.2014.2.2.1.2.1.		227	13-Feb-14 A	23-Dec-14	0
The Gardens 7.2.2014.2.2.1.2		227	13-Feb-14 A	23-Dec-14	0
	10" & 8" Sanitary Lines	15	26-Feb-14	18-Mar-14	
The Gardens 7.2.2014.2.2		227	13-Feb-14 A	23-Dec-14	0
	Temporary Shoring & Excavati	17	13-Feb-14 A	03-Mar-14 A	
	Set & Backfill Electrical Vaults (	10	05-Mar-14 A	14-Mar-14 A	
	Install & Termination of Transfo	10	24-Mar-14 A	04-Apr-14 A	
	Primary & Secondary Services	15	07-Apr-14 A	13-Jun-14 A	
	Temporary Electrical Service	5	22-Apr-14	29-Apr-14*	
	Electrical Grounding	104	06-May-14	26-Sep-14	
	Duct Bank to Switchgear Room	19	06-May-14	30-May-14	
	Feeders to/from Switchgear Rc	15	09-Jun-14 A	27-Jun-14	
	Temporary Power Distribution	32	09-Jul-14	21-Aug-14	
	Power to Tower Crane Availabl	9	09-Jul-14	21-Jul-14	
	Under Slab Secondary Power-\	15	03-Sep-14*	23-Sep-14	
	Under Slab Secondary Power-I	15	03-Dec-14*	23-Dec-14	
The Gardens 7.2.2014.2.2.1.2		30	16-Jul-14	26-Aug-14	0
	18" Storm Line, Trench Drain, &	20	16-Jul-14	12-Aug-14	
	Storm Retention System	10	16-Jul-14	29-Jul-14	
	6" Sanitary Line & Grease Trap	10	30-Jul-14	12-Aug-14	
	8" Gas Line	10	30-Jul-14	12-Aug-14	
	6" Domestic, 10" Fire, & Water	10	30-Jul-14	12-Aug-14	
	Site Storm Sidewalk Drain Inlet	10	13-Aug-14	26-Aug-14	
The Gardens 7.2.2014.2.2.2 Fo		102	24-Feb-14 A	02-Jul-14 A	



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

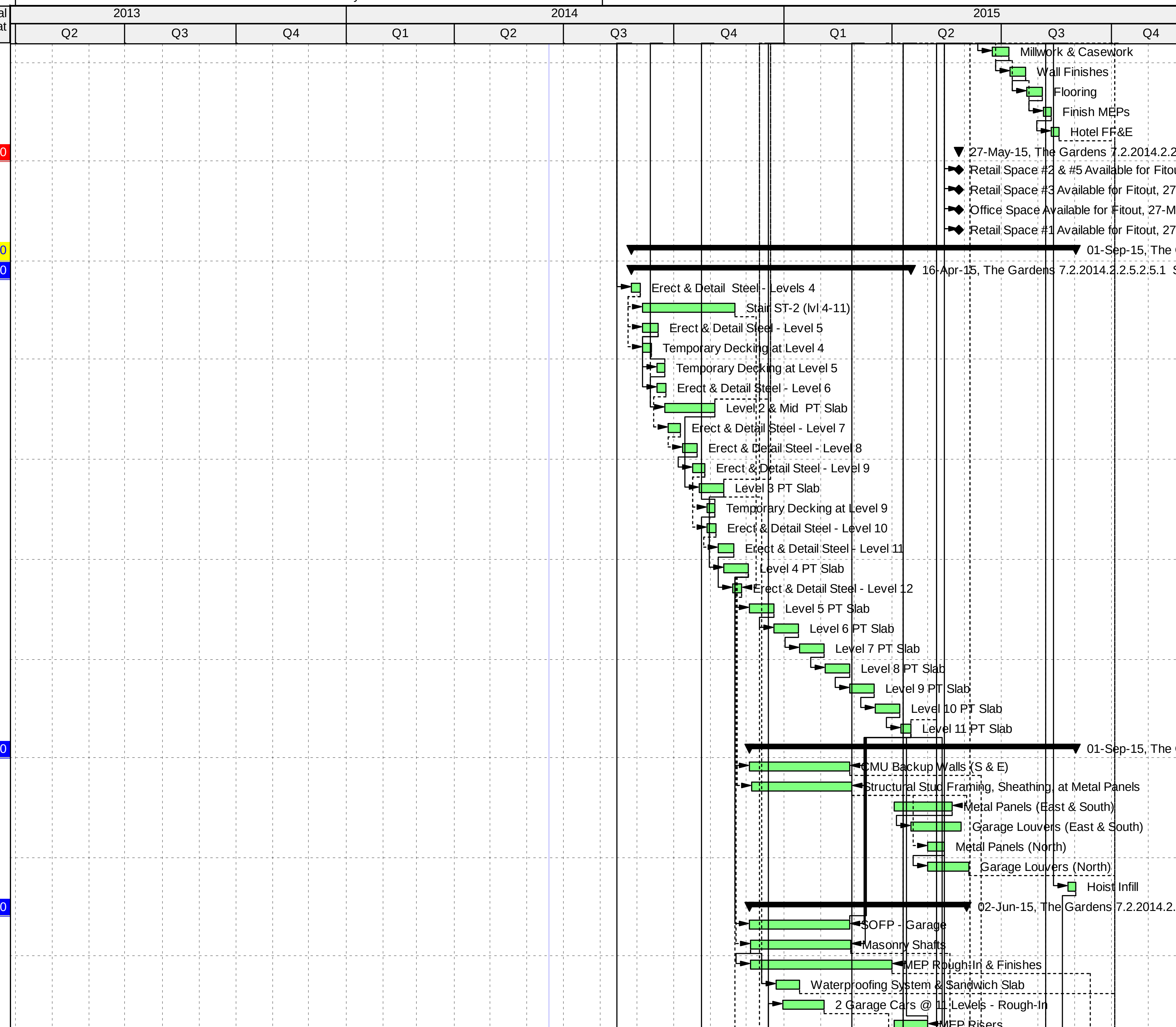
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	ACP Mobilization & Test Pile	7	24-Feb-14 A	04-Mar-14 A	
	Auger Cast Piles	40	05-Mar-14 A	01-Apr-14 A	
	Grade Beams, Caps, Pits, Pier	75	02-Apr-14 A	02-Jul-14 A	
	Loading Dock Retaining Walls	20	02-Jun-14 A	24-Jun-14 A	
The Gardens 7.2.2014.2.2.3 Hc		260	20-Aug-14	19-Aug-15	0
	Erect Tower Crane	5	20-Aug-14	26-Aug-14	
	Tower Crane Operational	0	27-Aug-14		
	Hoist Operational to Level 5 Ga	0	24-Sep-14		
	Hoist Operational to Level 9 Ga	0	05-Nov-14		
	Hoist Operational to Level 13 C	0	31-Dec-14		
	Hoist Operational to Level 19 F	0	11-Mar-15		
	Tower Crane Removal	5	20-May-15	26-May-15	
	Hoist Removal	0	19-Aug-15		
The Gardens 7.2.2014.2.2.4 Pc		320	16-Jul-14	06-Oct-15	0
The Gardens 7.2.2014.2.2.4.2.4.		228	16-Jul-14	29-May-15	0
	Erect & Detail Steel - Levels 2 -	25	16-Jul-14	19-Aug-14	
	Stair ST-2 (Lvl 1 - 3)	15	23-Jul-14	12-Aug-14	
	Stairs ST-3 & ST-4 (Lvl 1-3)	10	23-Jul-14	05-Aug-14	
	SOD Levels 3	5	20-Aug-14	26-Aug-14	
	SOD Levels 2	5	27-Aug-14	02-Sep-14	
	Speed Ramp	10	01-Sep-14	12-Sep-14	
	Level 1 SOG (BOH)	5	17-Sep-14	23-Sep-14	
	SOFP - Level 1 & 2 (1 to 4 Line)	10	24-Sep-14	07-Oct-14	
	Level 1 SOG (Core)	5	17-Dec-14	23-Dec-14	
	SOFP - Level 1 & 2 (4 to 11 Lir	8	24-Dec-14	02-Jan-15	
	Level 1 SOG Infill at Tower Cra	3	27-May-15	29-May-15	
The Gardens 7.2.2014.2.2.4.2.4.		168	02-Jan-15	25-Aug-15	0
	Structural Stud Framing, Sheat	20	02-Jan-15	30-Jan-15	
	Metal Panels	35	30-Jan-15	20-Mar-15	
	Curtainwall & Storefront	15	06-Mar-15	27-Mar-15	
	Garage Louvers	5	20-Mar-15	27-Mar-15	
	Hoist Infill	5	19-Aug-15	25-Aug-15	
The Gardens 7.2.2014.2.2.4.2.4.		285	03-Sep-14	06-Oct-15	0
The Gardens 7.2.2014.2.2.4.2		285	03-Sep-14	06-Oct-15	0
	MEP Underslab (BOH)	10	03-Sep-14	16-Sep-14	
	MEP Underslab (Core)	10	03-Dec-14	16-Dec-14	
	MEP Rough-In	20	02-Jan-15	30-Jan-15	
	Framing	15	02-Jan-15	23-Jan-15	
	Drywall	20	22-Apr-15	19-May-15	
	Wall Finishes	30	20-May-15	30-Jun-15	
	Millwork & Casework	25	01-Jul-15	04-Aug-15	
	Finish MEPs	10	05-Aug-15	18-Aug-15	
	Flooring	20	19-Aug-15	15-Sep-15	
	Hotel FF&E	15	16-Sep-15	06-Oct-15	
The Gardens 7.2.2014.2.2.4.2		225	08-Oct-14	18-Aug-15	0
	Install Pool & Whirlpool	25	08-Oct-14	11-Nov-14	
	MEP Rough-In	80	08-Oct-14	27-Jan-15	
	Framing	25	12-Nov-14	16-Dec-14	
	Drywall	15	22-Apr-15	12-May-15	
	Kitchen Fitout	30	13-May-15	23-Jun-15	



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

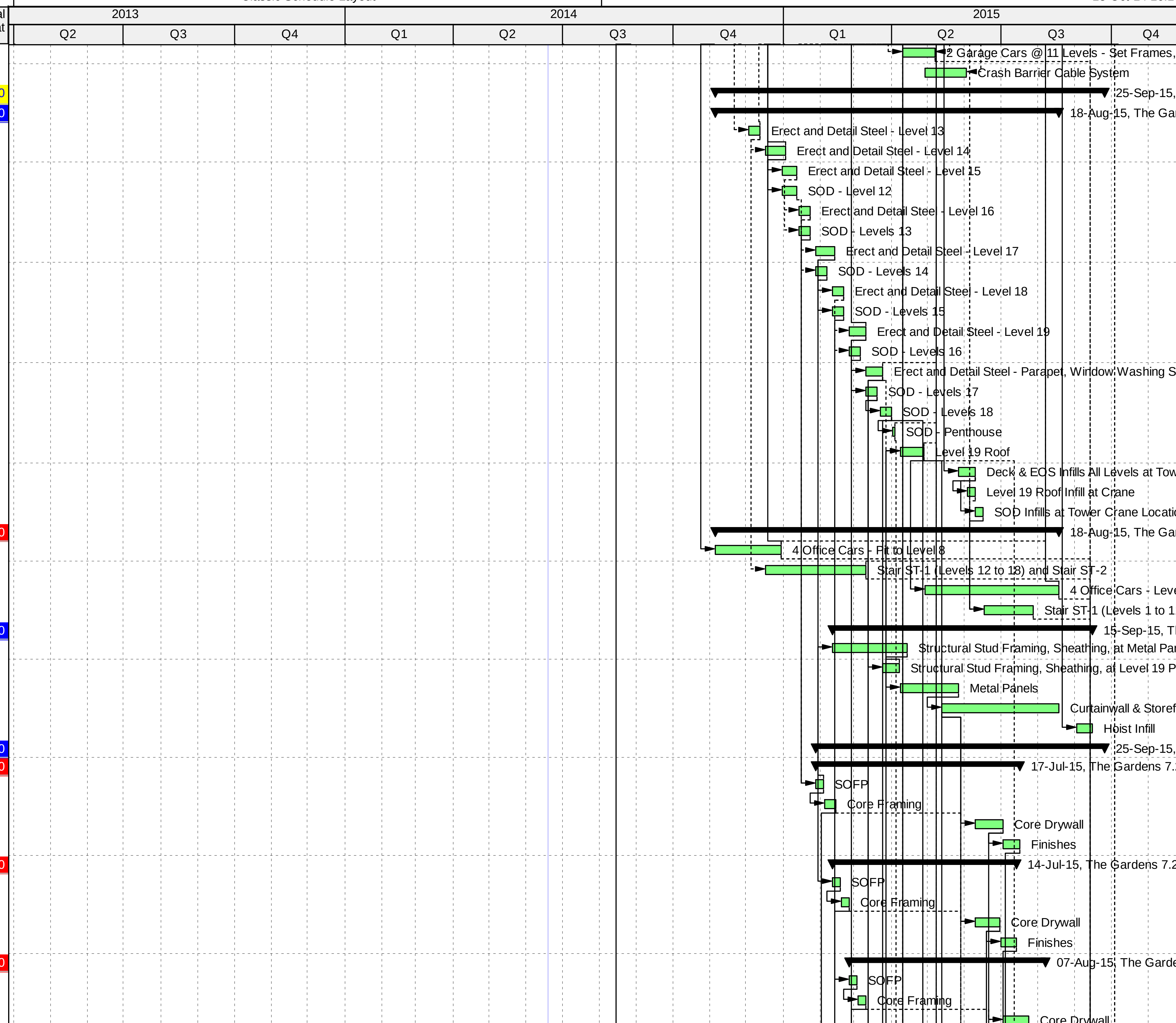
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	Millwork & Casework	10	24-Jun-15	07-Jul-15	
	Wall Finishes	10	08-Jul-15	21-Jul-15	
	Flooring	10	22-Jul-15	04-Aug-15	
	Finish MEPs	5	05-Aug-15	11-Aug-15	
	Hotel FF&E	5	12-Aug-15	18-Aug-15	
	The Gardens 7.2.2014.2.2.4.	0	27-May-15	27-May-15	0
	Retail Space #2 & #5 Available	0	27-May-15		
	Retail Space #3 Available for Fi	0	27-May-15		
	Office Space Available for Fitout	0	27-May-15		
	Retail Space #1 Available for Fi	0	27-May-15		
	The Gardens 7.2.2014.2.2.5 Ga	265	27-Aug-14	01-Sep-15	0
	The Gardens 7.2.2014.2.2.5.2.5.	167	27-Aug-14	16-Apr-15	0
	Erect & Detail Steel - Levels 4	8	27-Aug-14	03-Sep-14	
	Stair ST-2 (lvl 4-11)	55	05-Sep-14	21-Nov-14	
	Erect & Detail Steel - Level 5	8	05-Sep-14	18-Sep-14	
	Temporary Decking at Level 4	5	05-Sep-14	12-Sep-14	
	Temporary Decking at Level 5	5	17-Sep-14	23-Sep-14	
	Erect & Detail Steel - Level 6	8	17-Sep-14	24-Sep-14	
	Level 2 & Mid PT Slab	20	24-Sep-14	04-Nov-14	
	Erect & Detail Steel - Level 7	8	26-Sep-14	06-Oct-14	
	Erect & Detail Steel - Level 8	8	08-Oct-14	20-Oct-14	
	Erect & Detail Steel - Level 9	8	17-Oct-14	27-Oct-14	
	Level 3 PT Slab	15	22-Oct-14	11-Nov-14	
	Temporary Decking at Level 9	5	29-Oct-14	04-Nov-14	
	Erect & Detail Steel - Level 10	8	29-Oct-14	05-Nov-14	
	Erect & Detail Steel - Level 11	8	07-Nov-14	20-Nov-14	
	Level 4 PT Slab	15	12-Nov-14	02-Dec-14	
	Erect & Detail Steel - Level 12	10	19-Nov-14	26-Nov-14	
	Level 5 PT Slab	15	03-Dec-14	23-Dec-14	
	Level 6 PT Slab	15	24-Dec-14	13-Jan-15	
	Level 7 PT Slab	15	14-Jan-15	03-Feb-15	
	Level 8 PT Slab	15	04-Feb-15	24-Feb-15	
	Level 9 PT Slab	15	25-Feb-15	17-Mar-15	
	Level 10 PT Slab	15	18-Mar-15	07-Apr-15	
	Level 11 PT Slab	7	08-Apr-15	16-Apr-15	
	The Gardens 7.2.2014.2.2.5.2.5.	195	03-Dec-14	01-Sep-15	0
	CMU Backup Walls (S & E)	60	03-Dec-14	24-Feb-15	
	Structural Stud Framing, Sheat	60	05-Dec-14	26-Feb-15	
	Metal Panels (East & South)	35	03-Apr-15	21-May-15	
	Garage Louvers (East & South)	30	17-Apr-15	28-May-15	
	Metal Panels (North)	10	01-May-15	14-May-15	
	Garage Louvers (North)	25	01-May-15	04-Jun-15	
	Hoist Infill	5	26-Aug-15	01-Sep-15	
	The Gardens 7.2.2014.2.2.5.2.5.	130	03-Dec-14	02-Jun-15	0
	SOFP - Garage	60	03-Dec-14	24-Feb-15	
	Masonry Shafts	60	04-Dec-14	25-Feb-15	
	MEP Rough-In & Finishes	85	04-Dec-14	01-Apr-15	
	Waterproofing System & Sandv	15	25-Dec-14	14-Jan-15	
	2 Garage Cars @ 11 Levels - I	25	31-Dec-14	03-Feb-15	
	MEP Risers	20	03-Apr-15	30-Apr-15	



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

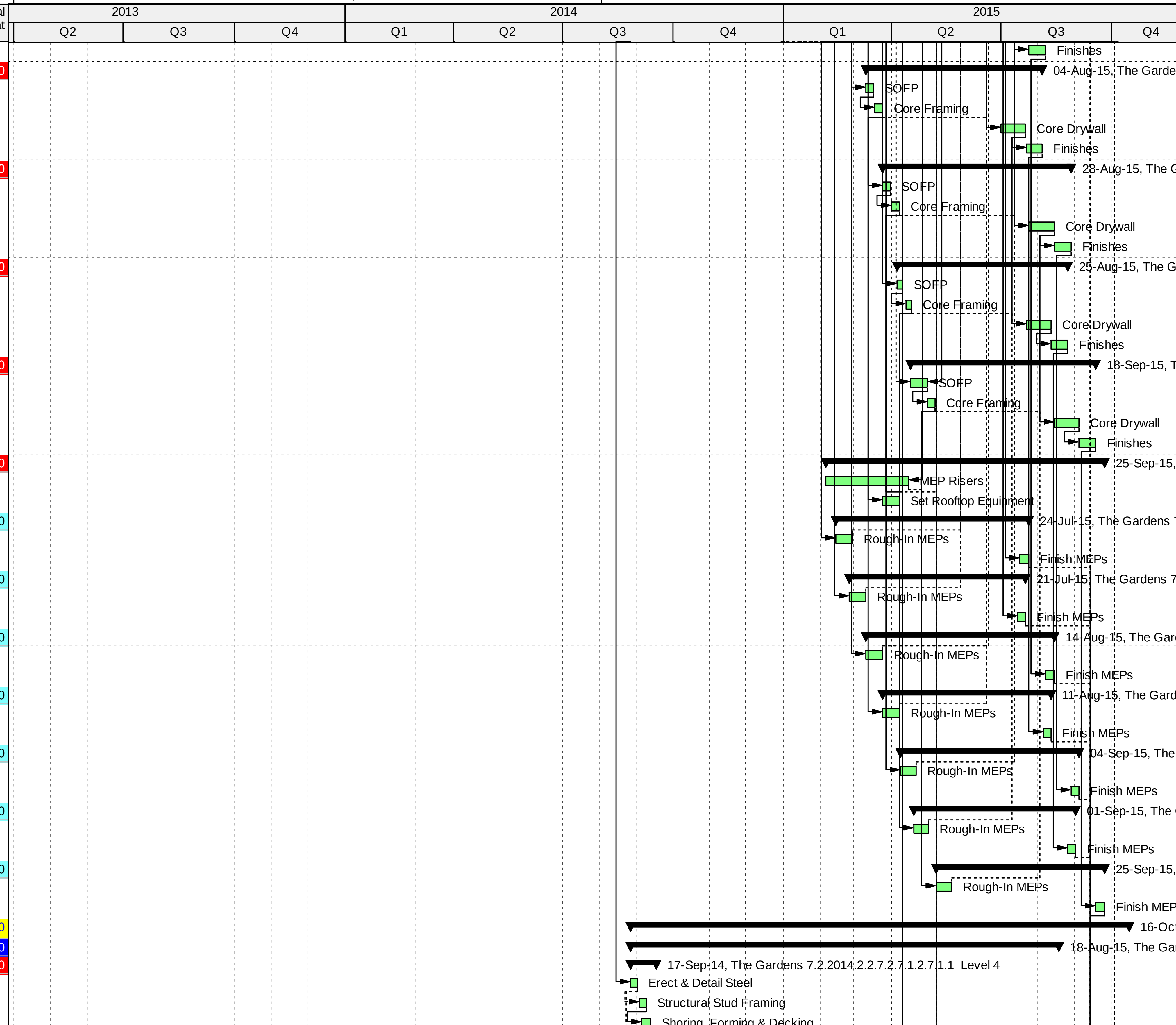
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	2 Garage Cars @ 11 Levels - (	20	10-Apr-15	07-May-15	
	Crash Barrier Cable System	25	29-Apr-15	02-Jun-15	
	The Gardens 7.2.2014.2.2.6 Of	233	05-Nov-14	25-Sep-15	0
	The Gardens 7.2.2014.2.2.6.2.6.	205	05-Nov-14	18-Aug-15	0
	Erect and Detail Steel - Level 1	10	03-Dec-14	12-Dec-14	
	Erect and Detail Steel - Level 1	10	17-Dec-14	02-Jan-15	
	Erect and Detail Steel - Level 1	10	31-Dec-14	12-Jan-15	
	SOD - Level 12	8	31-Dec-14	12-Jan-15	
	Erect and Detail Steel - Level 1	10	14-Jan-15	23-Jan-15	
	SOD - Levels 13	8	14-Jan-15	23-Jan-15	
	Erect and Detail Steel - Level 1	10	28-Jan-15	12-Feb-15	
	SOD - Levels 14	8	28-Jan-15	06-Feb-15	
	Erect and Detail Steel - Level 1	10	11-Feb-15	20-Feb-15	
	SOD - Levels 15	8	11-Feb-15	20-Feb-15	
	Erect and Detail Steel - Level 1	10	25-Feb-15	10-Mar-15	
	SOD - Levels 16	8	25-Feb-15	06-Mar-15	
	Erect and Detail Steel - Parape	10	11-Mar-15	24-Mar-15	
	SOD - Levels 17	8	11-Mar-15	20-Mar-15	
	SOD - Levels 18	8	23-Mar-15	01-Apr-15	
	SOD - Penthouse	2	02-Apr-15	03-Apr-15	
	Level 19 Roof	15	08-Apr-15	28-Apr-15	
	Deck & EOS Infills All Levels at	10	27-May-15	09-Jun-15	
	Level 19 Roof Infill at Crane	5	03-Jun-15	09-Jun-15	
	SOD Infills at Tower Crane Loc	5	10-Jun-15	16-Jun-15	
	The Gardens 7.2.2014.2.2.6.2	205	05-Nov-14	18-Aug-15	0
	4 Office Cars - Pit to Level 8	40	05-Nov-14	30-Dec-14	
	Stair ST-1 (Levels 12 to 18) an	60	17-Dec-14	10-Mar-15	
	4 Office Cars - Level 9 to Pentl	80	29-Apr-15	18-Aug-15	
	Stair ST-1 (Levels 1 to 11)	30	17-Jun-15	28-Jul-15	
	The Gardens 7.2.2014.2.2.6.2.6.	155	11-Feb-15	15-Sep-15	0
	Structural Stud Framing, Sheat	45	11-Feb-15	14-Apr-15	
	Structural Stud Framing, Sheat	10	25-Mar-15	07-Apr-15	
	Metal Panels	35	08-Apr-15	26-May-15	
	Curtainwall & Storefront	70	13-May-15	18-Aug-15	
	Hoist Infill	10	02-Sep-15	15-Sep-15	
	The Gardens 7.2.2014.2.2.6.2.6.	173	28-Jan-15	25-Sep-15	0
	The Gardens 7.2.2014.2.2.6.2	123	28-Jan-15	17-Jul-15	0
	SOFP	5	28-Jan-15	03-Feb-15	
	Core Framing	8	04-Feb-15	13-Feb-15	
	Core Drywall	18	10-Jun-15	03-Jul-15	
	Finishes	10	03-Jul-15	17-Jul-15	
	The Gardens 7.2.2014.2.2.6.2	110	11-Feb-15	14-Jul-15	0
	SOFP	5	11-Feb-15	17-Feb-15	
	Core Framing	5	18-Feb-15	24-Feb-15	
	Core Drywall	15	10-Jun-15	30-Jun-15	
	Finishes	10	01-Jul-15	14-Jul-15	
	The Gardens 7.2.2014.2.2.6.2	118	25-Feb-15	07-Aug-15	0
	SOFP	5	25-Feb-15	03-Mar-15	
	Core Framing	5	04-Mar-15	10-Mar-15	
	Core Drywall	15	03-Jul-15	24-Jul-15	



Actual Level of Effort | Remaining Work | ◆ ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

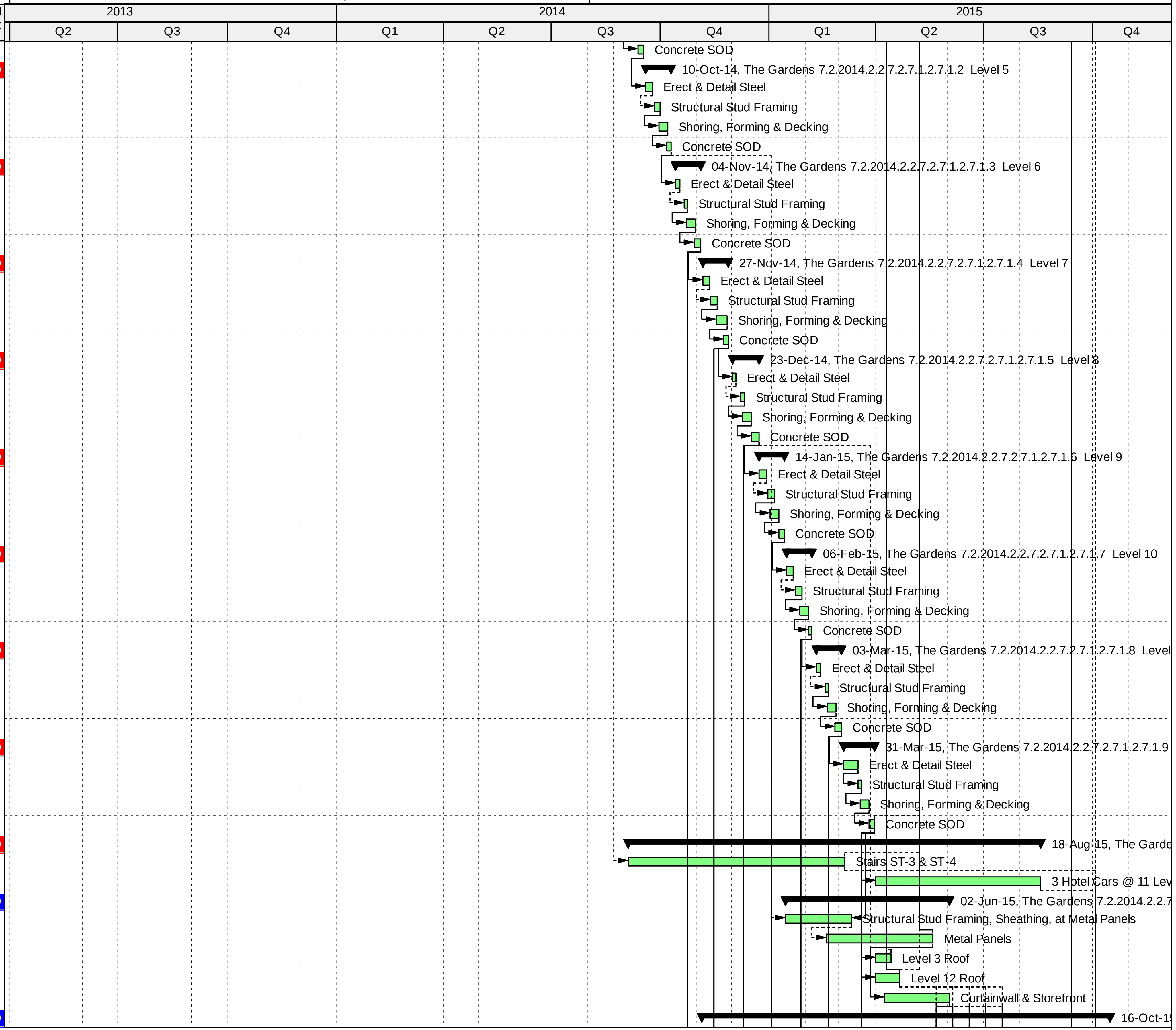
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	Finishes	10	24-Jul-15	07-Aug-15	
	The Gardens 7.2.2014.2.2.6.:	105	11-Mar-15	04-Aug-15	0
	SOFP	5	11-Mar-15	17-Mar-15	
	Core Framing	5	18-Mar-15	24-Mar-15	
	Core Drywall	15	01-Jul-15	21-Jul-15	
	Finishes	10	22-Jul-15	04-Aug-15	
	The Gardens 7.2.2014.2.2.6.:	113	25-Mar-15	28-Aug-15	0
	SOFP	5	25-Mar-15	31-Mar-15	
	Core Framing	5	01-Apr-15	07-Apr-15	
	Core Drywall	15	24-Jul-15	14-Aug-15	
	Finishes	10	14-Aug-15	28-Aug-15	
	The Gardens 7.2.2014.2.2.6.:	102	06-Apr-15	25-Aug-15	0
	SOFP	5	06-Apr-15	10-Apr-15	
	Core Framing	5	13-Apr-15	17-Apr-15	
	Core Drywall	15	22-Jul-15	11-Aug-15	
	Finishes	10	12-Aug-15	25-Aug-15	
	The Gardens 7.2.2014.2.2.6.:	111	17-Apr-15	18-Sep-15	0
	SOFP	10	17-Apr-15	30-Apr-15	
	Core Framing	5	01-May-15	07-May-15	
	Core Drywall	15	14-Aug-15	04-Sep-15	
	Finishes	10	04-Sep-15	18-Sep-15	
	The Gardens 7.2.2014.2.2.6.:	167	05-Feb-15	25-Sep-15	0
	MEP Risers	50	05-Feb-15	15-Apr-15	
	Set Rooftop Equipment	10	25-Mar-15	07-Apr-15	
	The Gardens 7.2.2014.2.2	115	13-Feb-15	24-Jul-15	0
	Rough-In MEPs	10	13-Feb-15	27-Feb-15	
	Finish MEPs	5	17-Jul-15	24-Jul-15	
	The Gardens 7.2.2014.2.2	105	25-Feb-15	21-Jul-15	0
	Rough-In MEPs	10	25-Feb-15	10-Mar-15	
	Finish MEPs	5	15-Jul-15	21-Jul-15	
	The Gardens 7.2.2014.2.2	113	11-Mar-15	14-Aug-15	0
	Rough-In MEPs	10	11-Mar-15	24-Mar-15	
	Finish MEPs	5	07-Aug-15	14-Aug-15	
	The Gardens 7.2.2014.2.2	100	25-Mar-15	11-Aug-15	0
	Rough-In MEPs	10	25-Mar-15	07-Apr-15	
	Finish MEPs	5	05-Aug-15	11-Aug-15	
	The Gardens 7.2.2014.2.2	108	08-Apr-15	04-Sep-15	0
	Rough-In MEPs	10	08-Apr-15	21-Apr-15	
	Finish MEPs	5	28-Aug-15	04-Sep-15	
	The Gardens 7.2.2014.2.2	97	20-Apr-15	01-Sep-15	0
	Rough-In MEPs	10	20-Apr-15	01-May-15	
	Finish MEPs	5	26-Aug-15	01-Sep-15	
	The Gardens 7.2.2014.2.2	101	08-May-15	25-Sep-15	0
	Rough-In MEPs	10	08-May-15	21-May-15	
	Finish MEPs	5	18-Sep-15	25-Sep-15	
	The Gardens 7.2.2014.2.2.7 Hc	298	27-Aug-14	16-Oct-15	0
	The Gardens 7.2.2014.2.2.7.2.7.	255	27-Aug-14	18-Aug-15	0
	The Gardens 7.2.2014.2.2.7.:	16	27-Aug-14	17-Sep-14	0
	Erect & Detail Steel	6	27-Aug-14	01-Sep-14	
	Structural Stud Framing	4	03-Sep-14	08-Sep-14	
	Shoring, Forming & Decking	6	05-Sep-14	12-Sep-14	



Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

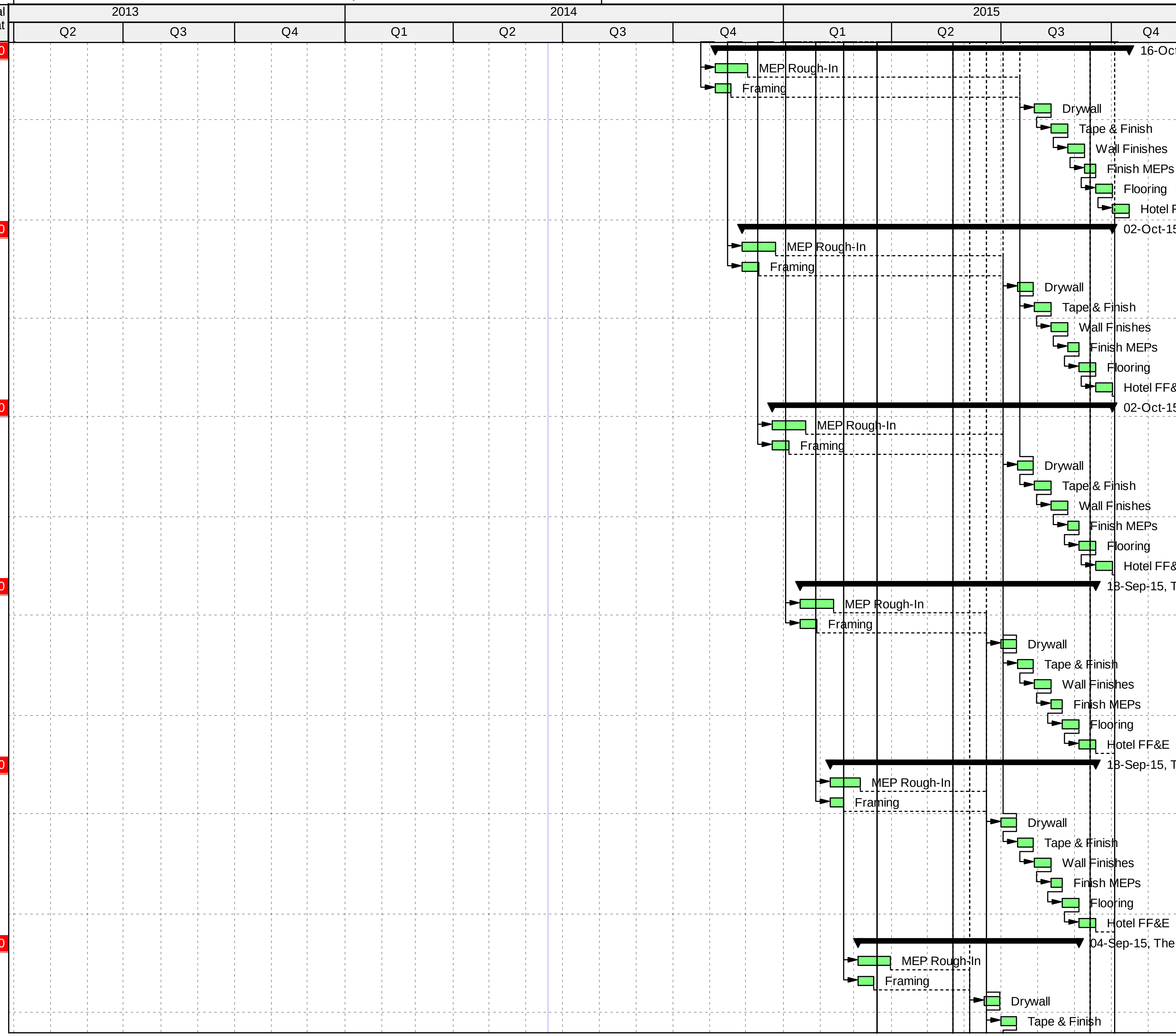
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	Concrete SOD	4	12-Sep-14	17-Sep-14	
	The Gardens 7.2.2014.2.2.7.:	16	19-Sep-14	10-Oct-14	0
	Erect & Detail Steel	6	19-Sep-14	24-Sep-14	
	Structural Stud Framing	4	26-Sep-14	01-Oct-14	
	Shoring, Forming & Decking	6	30-Sep-14	07-Oct-14	
	Concrete SOD	4	07-Oct-14	10-Oct-14	
	The Gardens 7.2.2014.2.2.7.:	16	14-Oct-14	04-Nov-14	0
	Erect & Detail Steel	6	14-Oct-14	17-Oct-14	
	Structural Stud Framing	4	21-Oct-14	24-Oct-14	
	Shoring, Forming & Decking	6	23-Oct-14	30-Oct-14	
	Concrete SOD	4	30-Oct-14	04-Nov-14	
	The Gardens 7.2.2014.2.2.7.:	16	06-Nov-14	27-Nov-14	0
	Erect & Detail Steel	6	06-Nov-14	11-Nov-14	
	Structural Stud Framing	4	13-Nov-14	18-Nov-14	
	Shoring, Forming & Decking	6	17-Nov-14	26-Nov-14	
	Concrete SOD	4	24-Nov-14	27-Nov-14	
	The Gardens 7.2.2014.2.2.7.:	16	01-Dec-14	23-Dec-14	0
	Erect & Detail Steel	6	01-Dec-14	04-Dec-14	
	Structural Stud Framing	4	08-Dec-14	11-Dec-14	
	Shoring, Forming & Decking	6	10-Dec-14	17-Dec-14	
	Concrete SOD	4	17-Dec-14	23-Dec-14	
	The Gardens 7.2.2014.2.2.7.:	16	24-Dec-14	14-Jan-15	0
	Erect & Detail Steel	6	24-Dec-14	30-Dec-14	
	Structural Stud Framing	4	31-Dec-14	05-Jan-15	
	Shoring, Forming & Decking	6	02-Jan-15	09-Jan-15	
	Concrete SOD	4	09-Jan-15	14-Jan-15	
	The Gardens 7.2.2014.2.2.7.:	16	16-Jan-15	06-Feb-15	0
	Erect & Detail Steel	6	16-Jan-15	21-Jan-15	
	Structural Stud Framing	4	23-Jan-15	28-Jan-15	
	Shoring, Forming & Decking	6	27-Jan-15	03-Feb-15	
	Concrete SOD	4	03-Feb-15	06-Feb-15	
	The Gardens 7.2.2014.2.2.7.:	16	10-Feb-15	03-Mar-15	0
	Erect & Detail Steel	6	10-Feb-15	13-Feb-15	
	Structural Stud Framing	4	17-Feb-15	20-Feb-15	
	Shoring, Forming & Decking	6	19-Feb-15	26-Feb-15	
	Concrete SOD	4	26-Feb-15	03-Mar-15	
	The Gardens 7.2.2014.2.2.7.:	19	05-Mar-15	31-Mar-15	0
	Erect & Detail Steel	9	05-Mar-15	17-Mar-15	
	Structural Stud Framing	4	17-Mar-15	20-Mar-15	
	Shoring, Forming & Decking	6	19-Mar-15	26-Mar-15	
	Concrete SOD	4	26-Mar-15	31-Mar-15	
	The Gardens 7.2.2014.2.2.7.:	249	04-Sep-14	18-Aug-15	0
	Stairs ST-3 & ST-4	132	04-Sep-14	06-Mar-15	
	3 Hotel Cars @ 11 Levels	100	01-Apr-15	18-Aug-15	
	The Gardens 7.2.2014.2.2.7.2.7.	99	15-Jan-15	02-Jun-15	0
	Structural Stud Framing, Sheat	40	15-Jan-15	11-Mar-15	
	Metal Panels	65	18-Feb-15	19-May-15	
	Level 3 Roof	10	01-Apr-15	14-Apr-15	
	Level 12 Roof	15	01-Apr-15	21-Apr-15	
	Curtainwall & Storefront	40	08-Apr-15	02-Jun-15	
	The Gardens 7.2.2014.2.2.7.2.7.	248	05-Nov-14	16-Oct-15	0



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

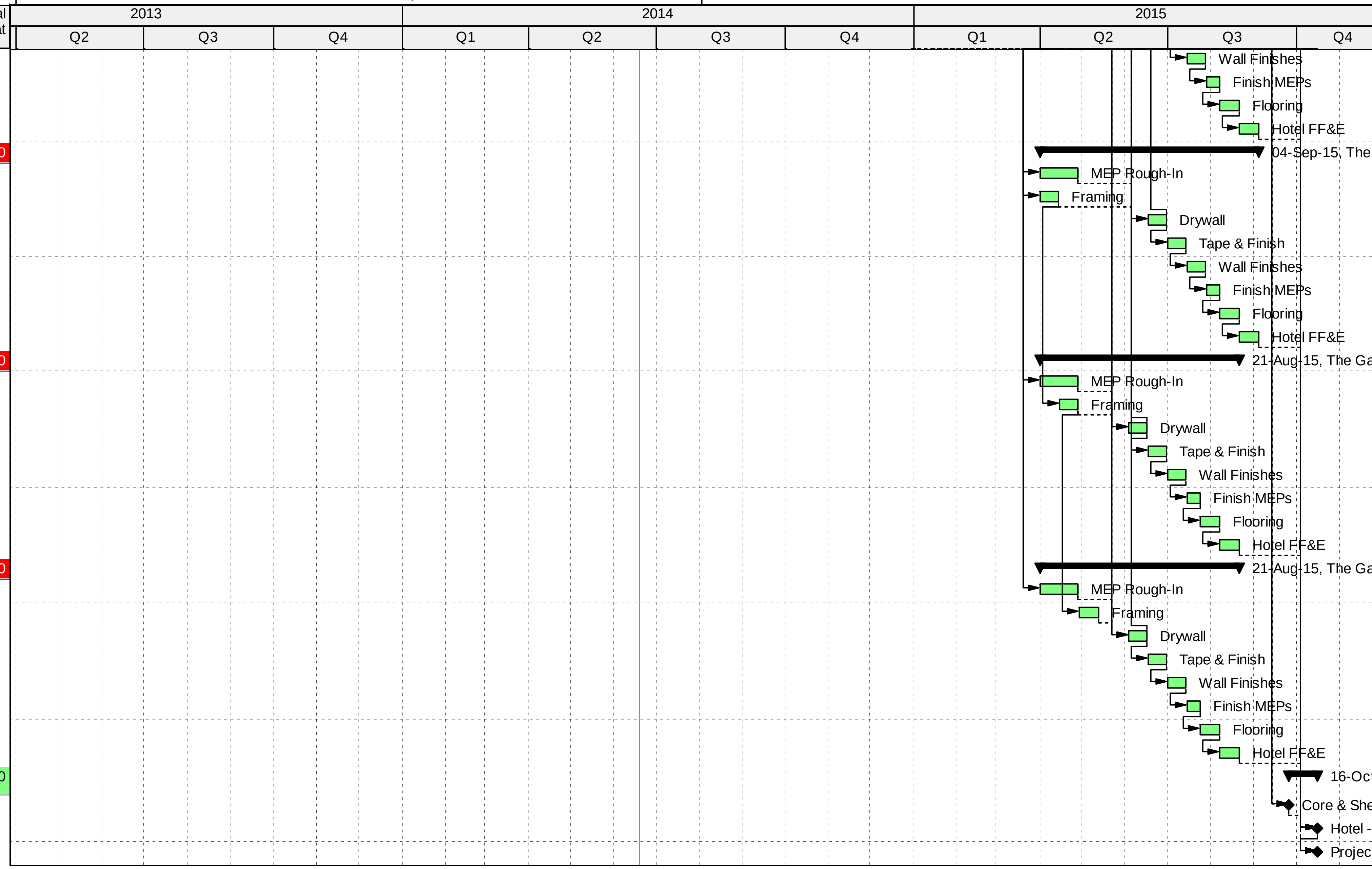
Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	The Gardens 7.2.2014.2.2.7.	248	05-Nov-14	16-Oct-15	0
	MEP Rough-In	20	05-Nov-14	02-Dec-14	
	Framing	10	05-Nov-14	18-Nov-14	
	Drywall	10	29-Jul-15	11-Aug-15	
	Tape & Finish	10	12-Aug-15	25-Aug-15	
	Wall Finishes	10	26-Aug-15	08-Sep-15	
	Finish MEPs	8	09-Sep-15	18-Sep-15	
	Flooring	10	18-Sep-15	02-Oct-15	
	Hotel FF&E	10	02-Oct-15	16-Oct-15	
	The Gardens 7.2.2014.2.2.7.	221	28-Nov-14	02-Oct-15	0
	MEP Rough-In	20	28-Nov-14	25-Dec-14	
	Framing	10	28-Nov-14	11-Dec-14	
	Drywall	10	15-Jul-15	28-Jul-15	
	Tape & Finish	10	29-Jul-15	11-Aug-15	
	Wall Finishes	10	12-Aug-15	25-Aug-15	
	Finish MEPs	8	26-Aug-15	04-Sep-15	
	Flooring	10	04-Sep-15	18-Sep-15	
	Hotel FF&E	10	18-Sep-15	02-Oct-15	
	The Gardens 7.2.2014.2.2.7.	204	23-Dec-14	02-Oct-15	0
	MEP Rough-In	20	23-Dec-14	19-Jan-15	
	Framing	10	23-Dec-14	05-Jan-15	
	Drywall	10	15-Jul-15	28-Jul-15	
	Tape & Finish	10	29-Jul-15	11-Aug-15	
	Wall Finishes	10	12-Aug-15	25-Aug-15	
	Finish MEPs	8	26-Aug-15	04-Sep-15	
	Flooring	10	04-Sep-15	18-Sep-15	
	Hotel FF&E	10	18-Sep-15	02-Oct-15	
	The Gardens 7.2.2014.2.2.7.	177	15-Jan-15	18-Sep-15	0
	MEP Rough-In	20	15-Jan-15	11-Feb-15	
	Framing	10	15-Jan-15	28-Jan-15	
	Drywall	10	01-Jul-15	14-Jul-15	
	Tape & Finish	10	15-Jul-15	28-Jul-15	
	Wall Finishes	10	29-Jul-15	11-Aug-15	
	Finish MEPs	8	12-Aug-15	21-Aug-15	
	Flooring	10	21-Aug-15	04-Sep-15	
	Hotel FF&E	10	04-Sep-15	18-Sep-15	
	The Gardens 7.2.2014.2.2.7.	160	09-Feb-15	18-Sep-15	0
	MEP Rough-In	20	09-Feb-15	06-Mar-15	
	Framing	10	09-Feb-15	20-Feb-15	
	Drywall	10	01-Jul-15	14-Jul-15	
	Tape & Finish	10	15-Jul-15	28-Jul-15	
	Wall Finishes	10	29-Jul-15	11-Aug-15	
	Finish MEPs	8	12-Aug-15	21-Aug-15	
	Flooring	10	21-Aug-15	04-Sep-15	
	Hotel FF&E	10	04-Sep-15	18-Sep-15	
	The Gardens 7.2.2014.2.2.7.	133	04-Mar-15	04-Sep-15	0
	MEP Rough-In	20	04-Mar-15	31-Mar-15	
	Framing	10	04-Mar-15	17-Mar-15	
	Drywall	10	17-Jun-15	30-Jun-15	
	Tape & Finish	10	01-Jul-15	14-Jul-15	



Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
	Wall Finishes	10	15-Jul-15	28-Jul-15	
	Finish MEPs	8	29-Jul-15	07-Aug-15	
	Flooring	10	07-Aug-15	21-Aug-15	
	Hotel FF&E	10	21-Aug-15	04-Sep-15	
	The Gardens 7.2.2014.2.2.7.	113	01-Apr-15	04-Sep-15	0
	MEP Rough-In	20	01-Apr-15	28-Apr-15	
	Framing	10	01-Apr-15	14-Apr-15	
	Drywall	10	17-Jun-15	30-Jun-15	
	Tape & Finish	10	01-Jul-15	14-Jul-15	
	Wall Finishes	10	15-Jul-15	28-Jul-15	
	Finish MEPs	8	29-Jul-15	07-Aug-15	
	Flooring	10	07-Aug-15	21-Aug-15	
	Hotel FF&E	10	21-Aug-15	04-Sep-15	
	The Gardens 7.2.2014.2.2.7.	103	01-Apr-15	21-Aug-15	0
	MEP Rough-In	20	01-Apr-15	28-Apr-15	
	Framing	10	15-Apr-15	28-Apr-15	
	Drywall	10	03-Jun-15	16-Jun-15	
	Tape & Finish	10	17-Jun-15	30-Jun-15	
	Wall Finishes	10	01-Jul-15	14-Jul-15	
	Finish MEPs	8	15-Jul-15	24-Jul-15	
	Flooring	10	24-Jul-15	07-Aug-15	
	Hotel FF&E	10	07-Aug-15	21-Aug-15	
	The Gardens 7.2.2014.2.2.7.	103	01-Apr-15	21-Aug-15	0
	MEP Rough-In	20	01-Apr-15	28-Apr-15	
	Framing	10	29-Apr-15	12-May-15	
	Drywall	10	03-Jun-15	16-Jun-15	
	Tape & Finish	10	17-Jun-15	30-Jun-15	
	Wall Finishes	10	01-Jul-15	14-Jul-15	
	Finish MEPs	8	15-Jul-15	24-Jul-15	
	Flooring	10	24-Jul-15	07-Aug-15	
	Hotel FF&E	10	07-Aug-15	21-Aug-15	
	The Gardens 7.2.2014.3 O	15	25-Sep-15	16-Oct-15	0
383	Core & Shell - Substantial Com	0	25-Sep-15		
384	Hotel - Substantial Completion	0	16-Oct-15		
385	Project Substantial Completion	0	16-Oct-15		



Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities

Appendix B: Site Logistics

Edited from Source: Turner Construction via Arquitectonica

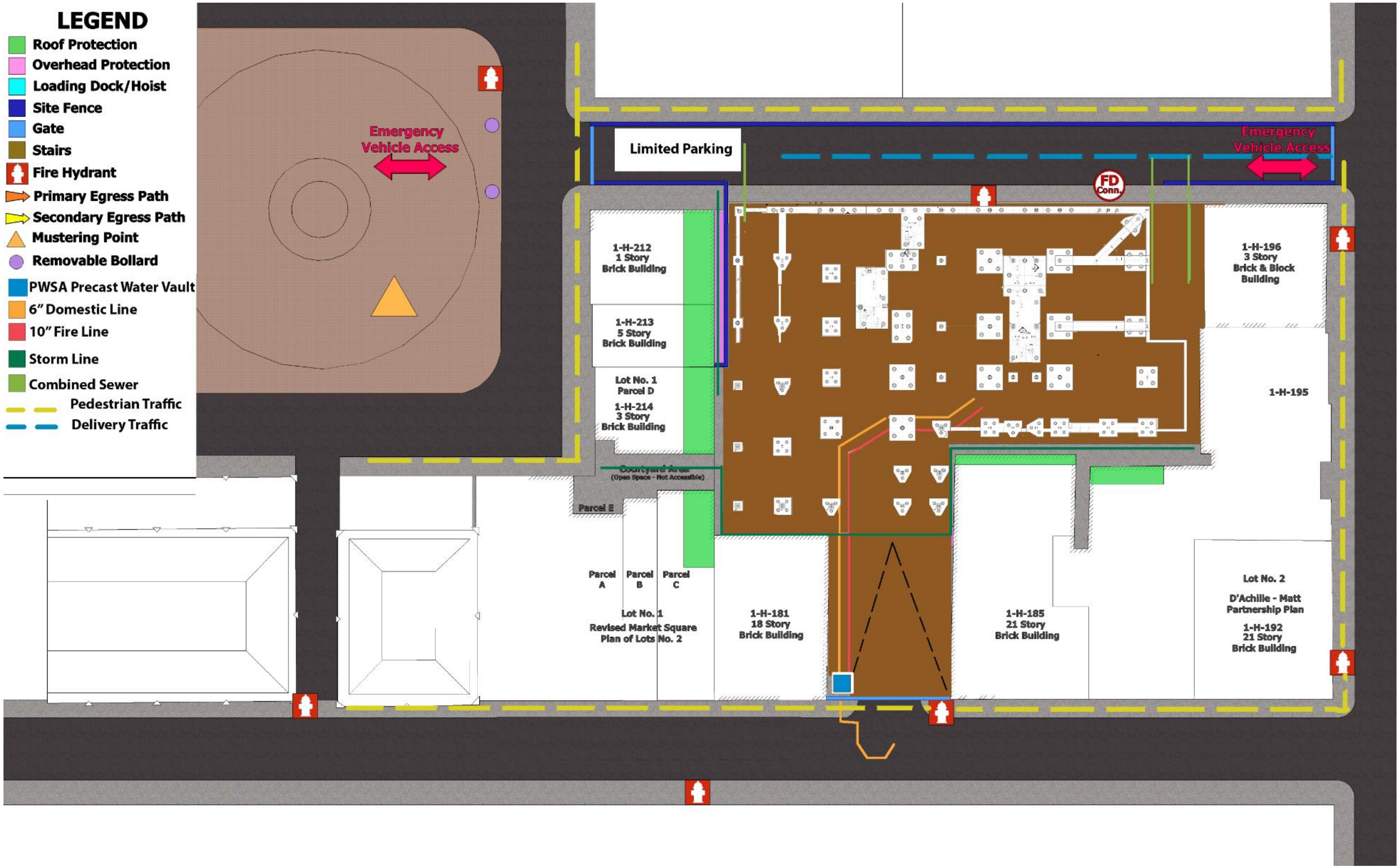


Figure E.1: Pile Cap and Grade Beam Site Logistics Plan

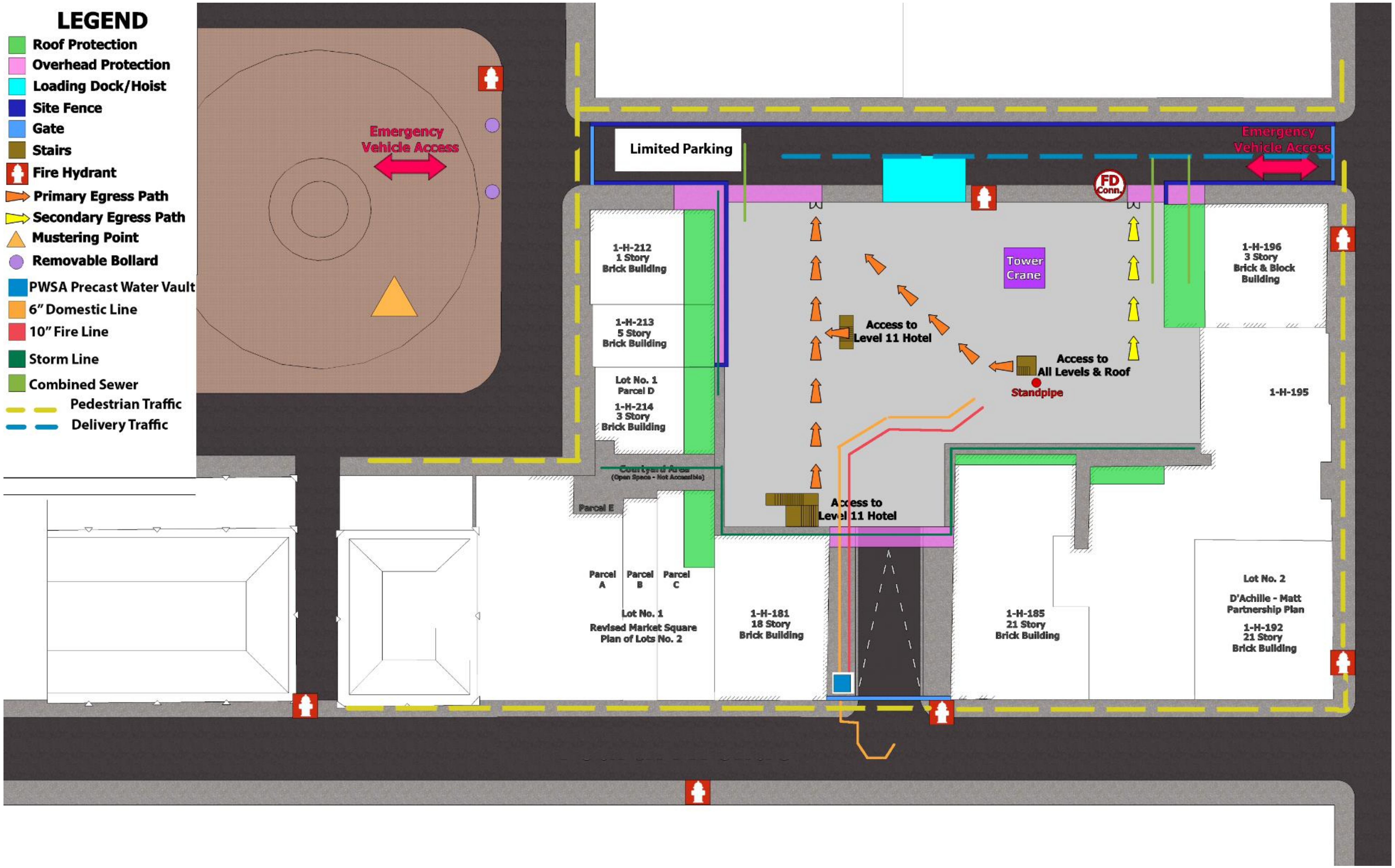


Figure E.2: Steel Erection Site Logistics Plan

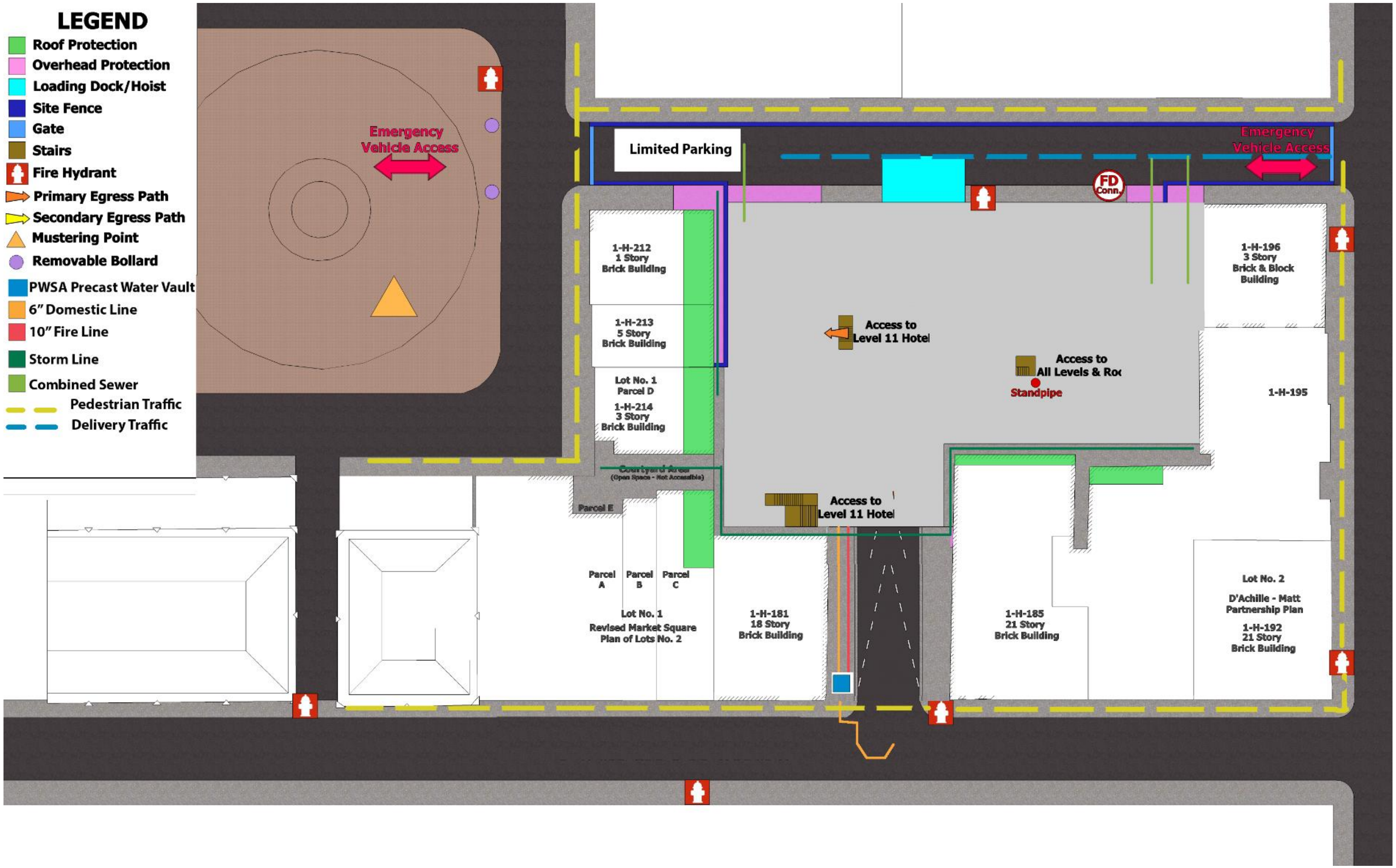
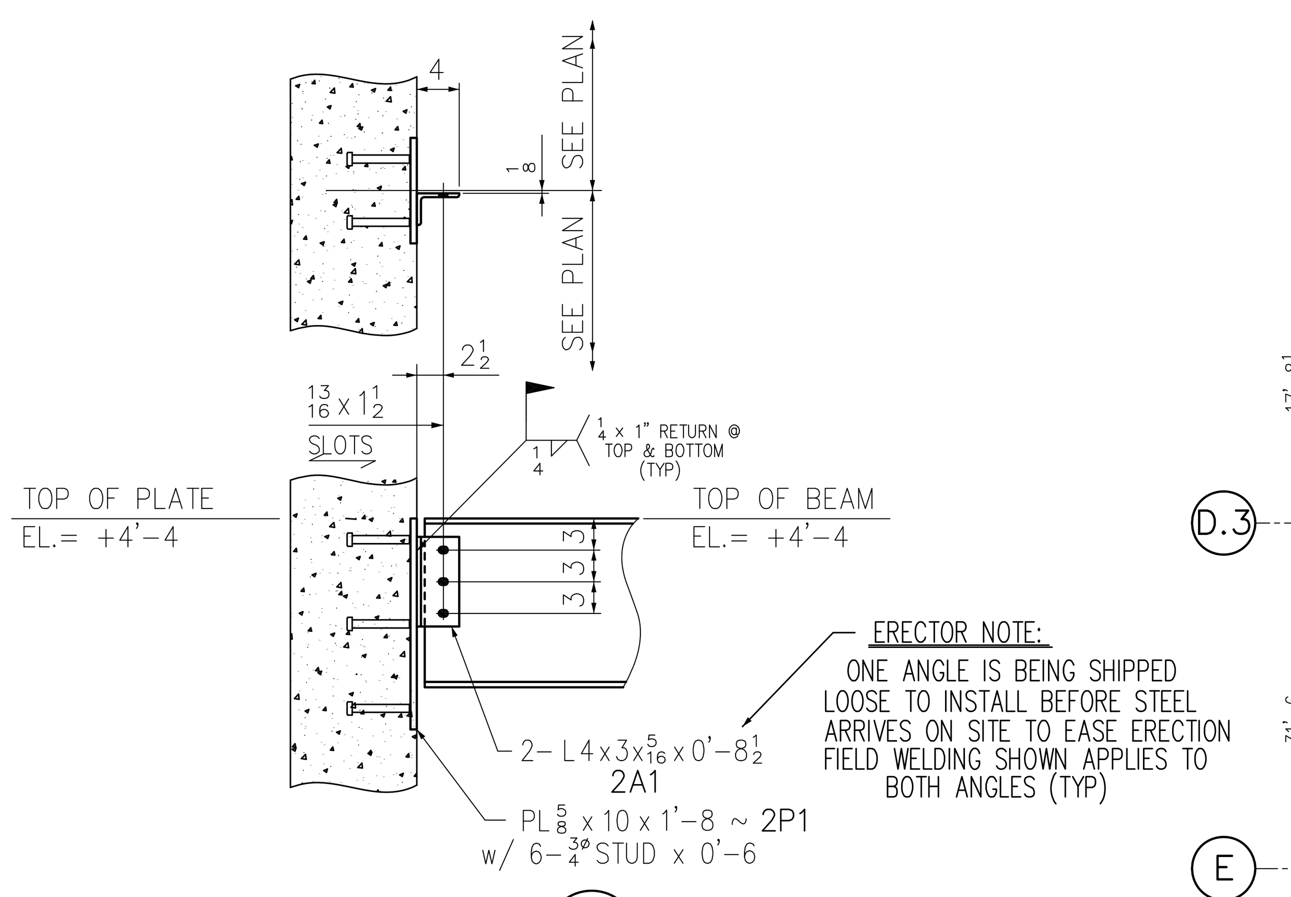


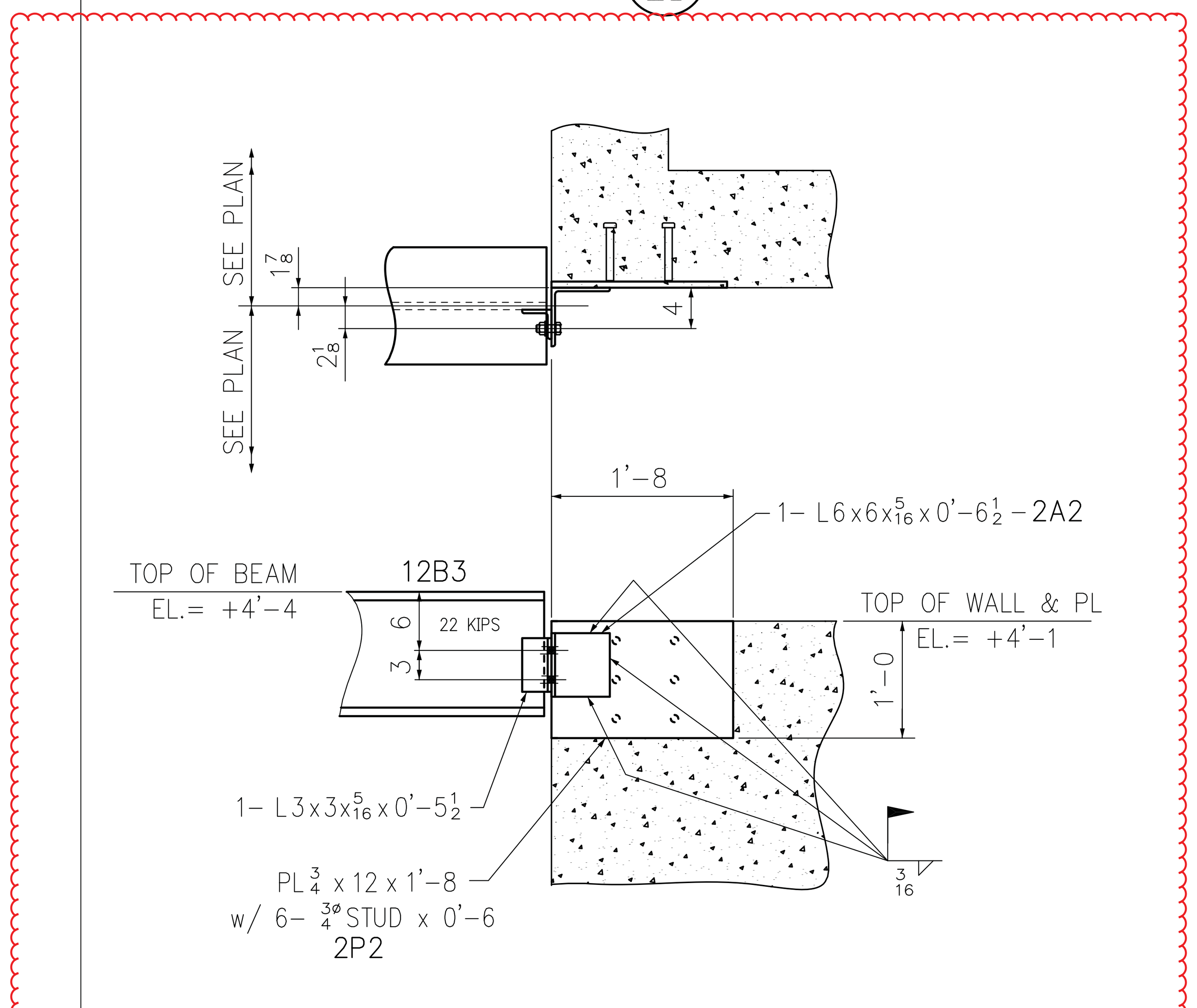
Figure E.3: Finishes Site Logistics Plan

Appendix C: Erection Drawings

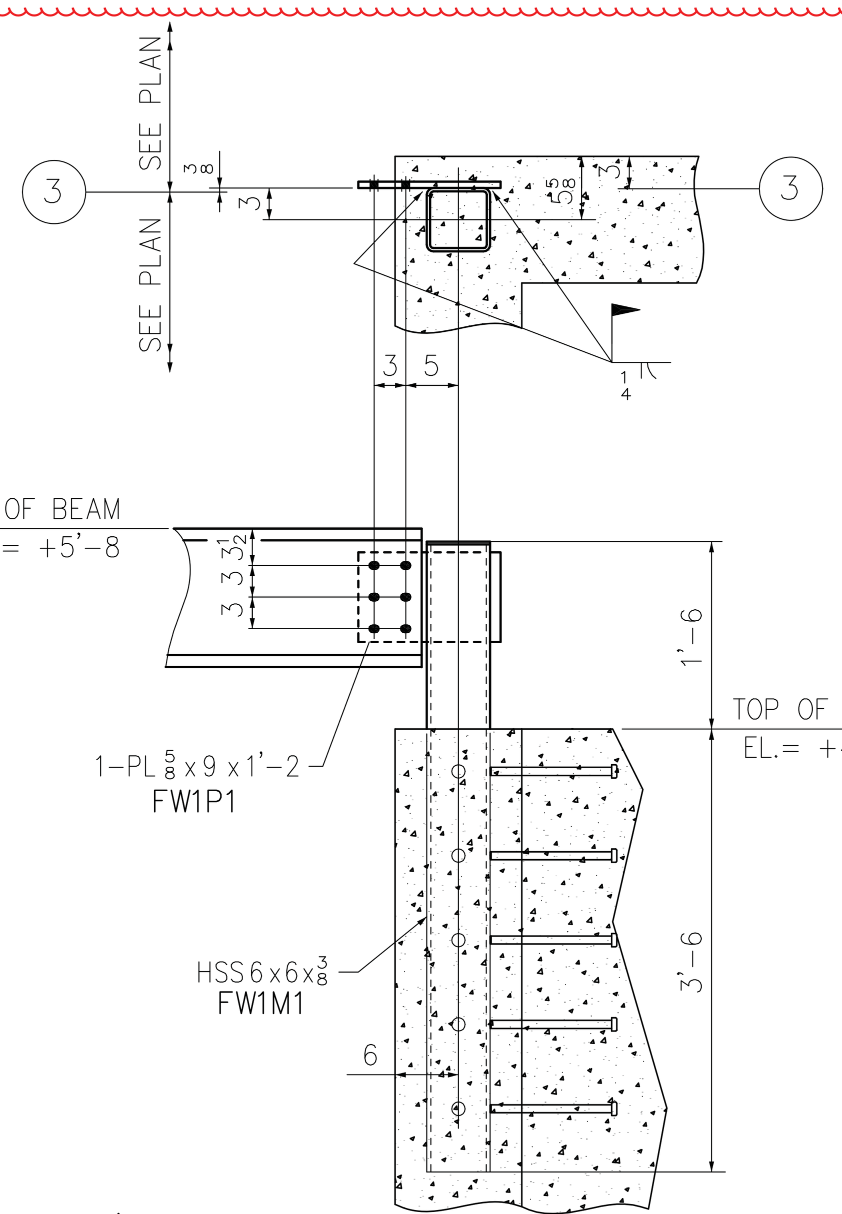
Edited from Source: Turner Construction via Arquitectonica



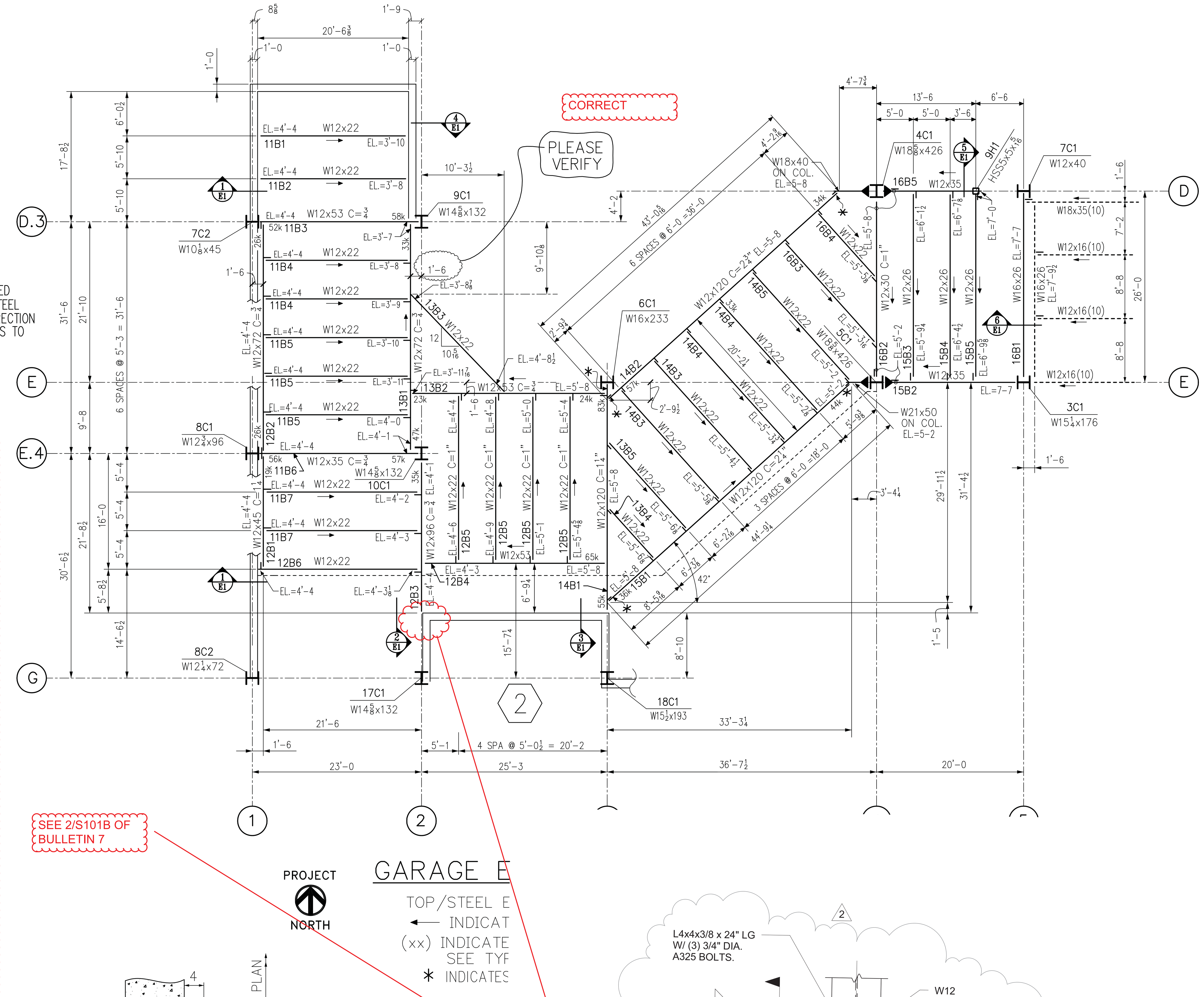
SECTION 1
SCALE: 1" = 1'-0" REF: 15/ S306

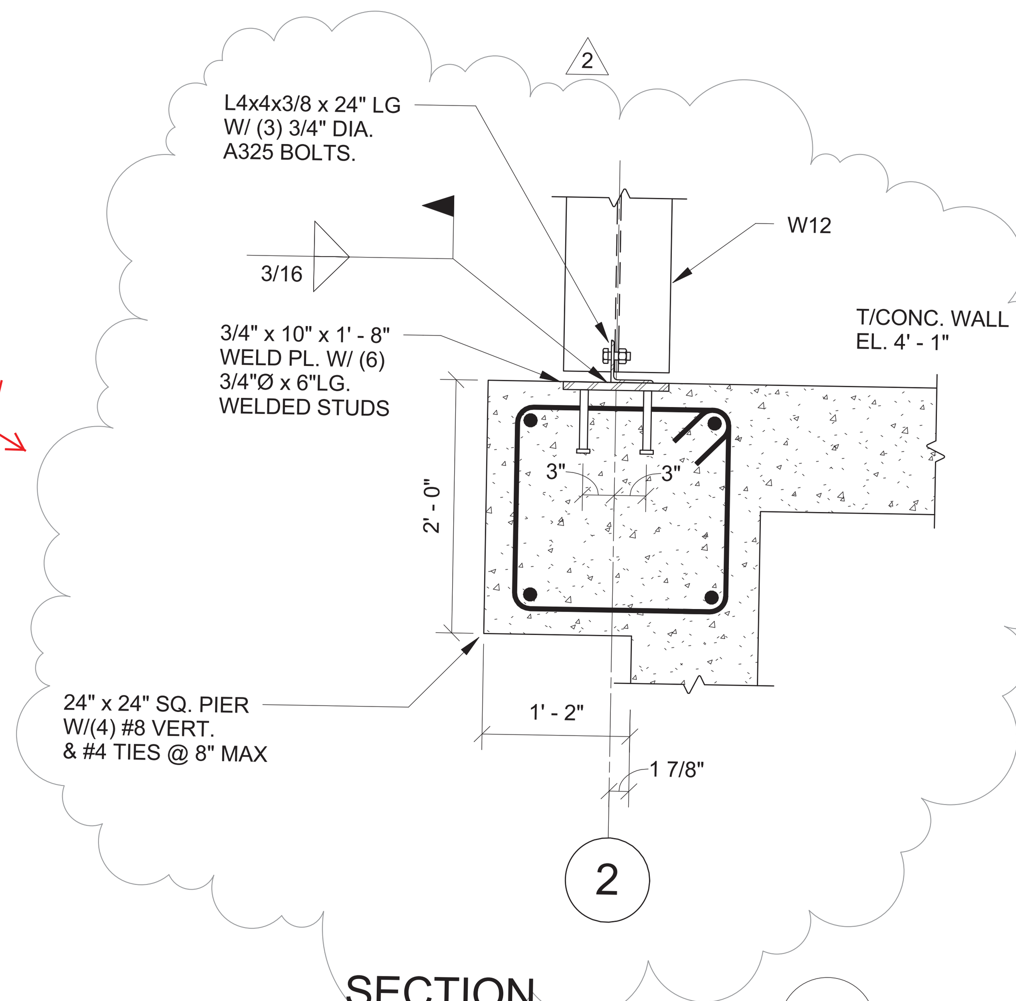


SECTION 2
SCALE: 1" = 1'-0" REF: 15/ S307

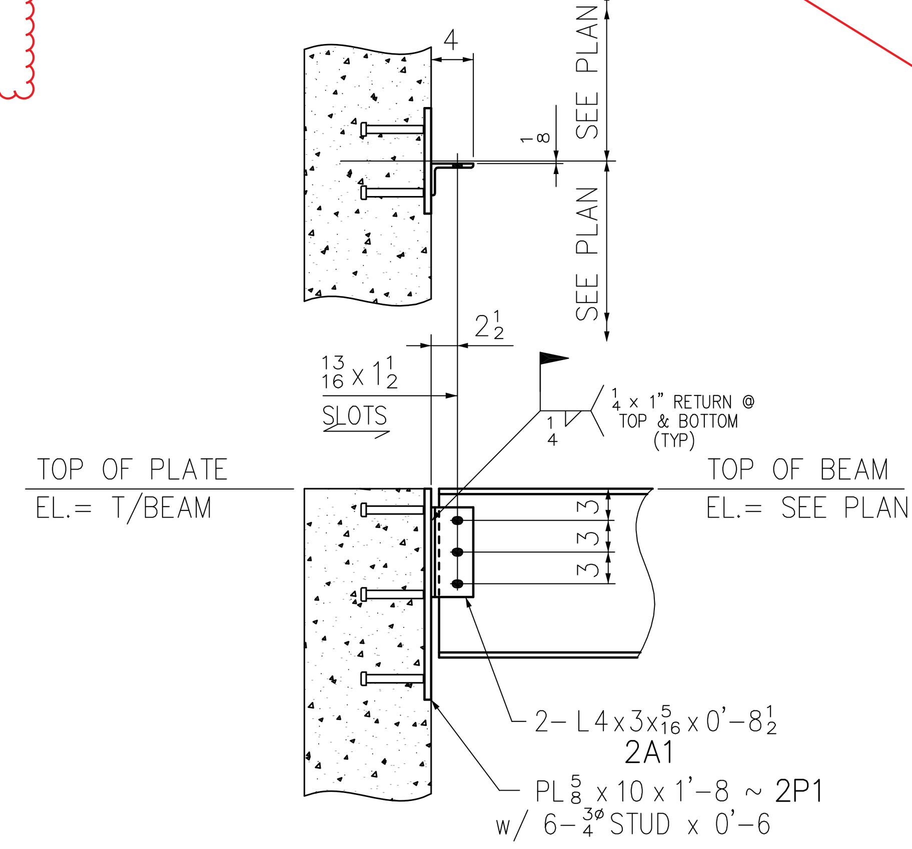


SECTION 3
SCALE: 1" = 1'-0" REF: RFI #92

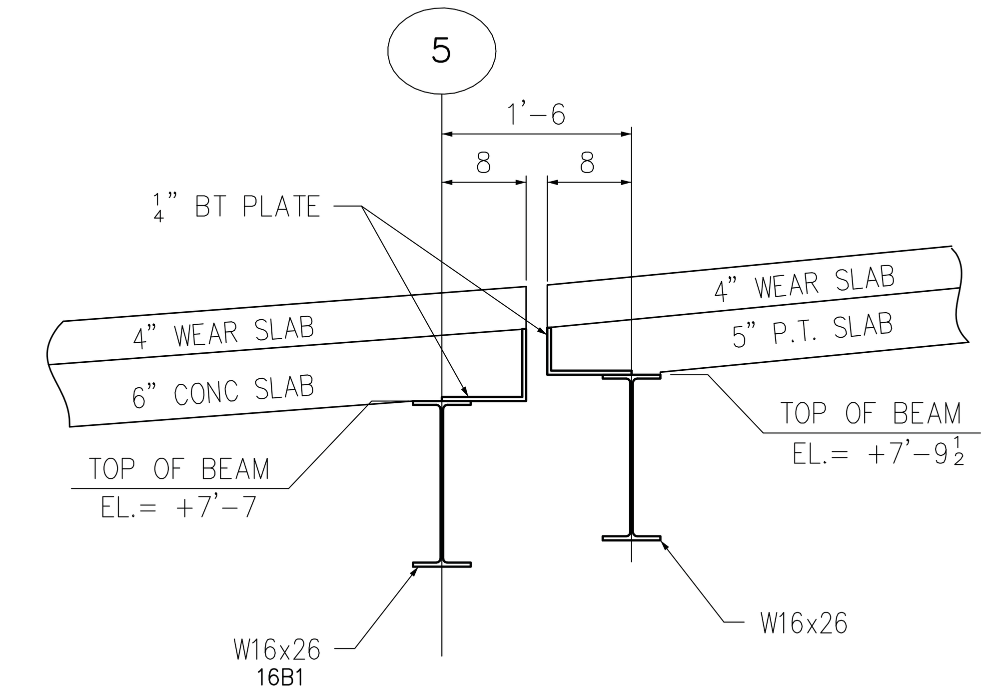




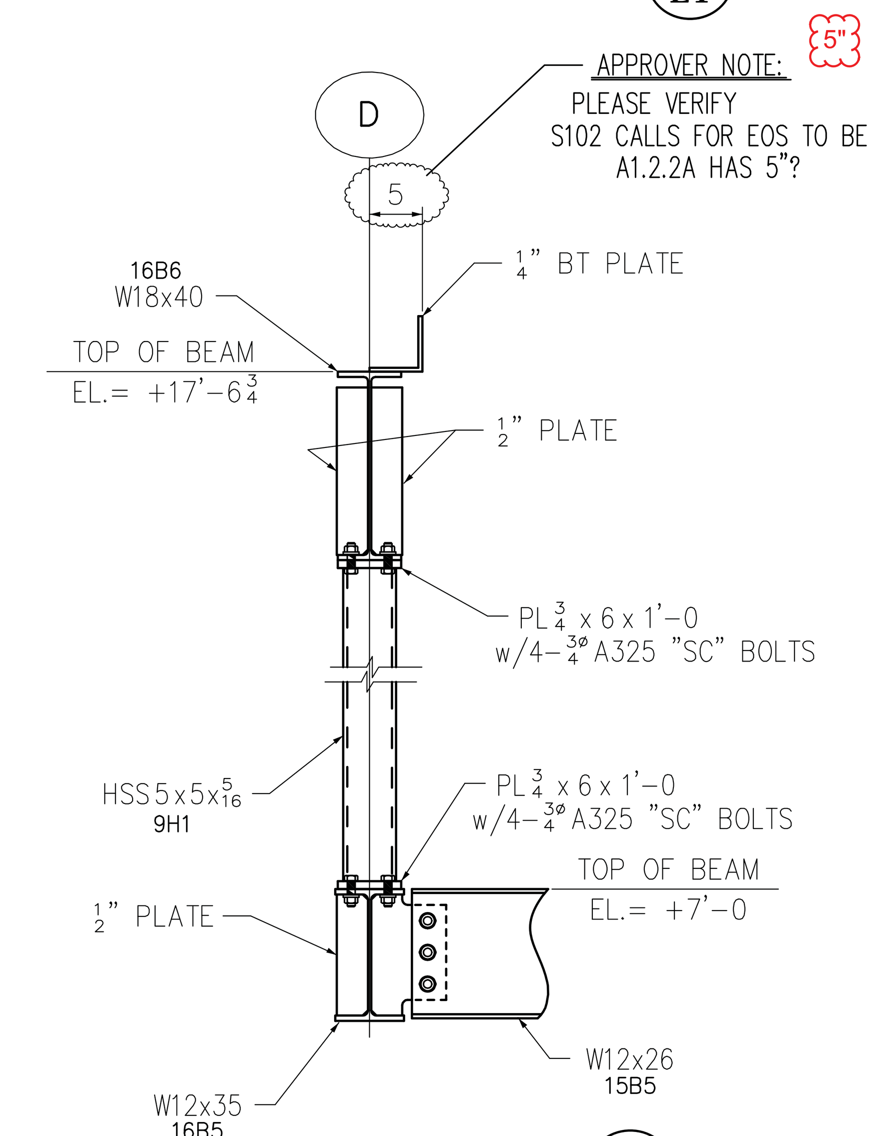
SECTION 2
3/4" = 1'-0"



SECTION 4
SCALE: 1" = 1'-0" REF: 21/ S306



SECTION 6
SCALE: 1" = 1'-0" REF: 13/ S307



SECTION 5
SCALE: 1" = 1'-0" REF: 19/ S307

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR NEW YORK, NY 10011-6903
TEL 212 254 2700 FAX 212 533 9293
Project No 22920
Control No 051200-0012-00581 DL 06/17/2014
Reviewed
Make Corrections as Noted
Revise and Resubmit
Rejected

Jezerinac Geers Structural Engineering
JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/17/14
NO EXCEPTIONS TAKEN
✓ MAKE CORRECTIONS NOTED
REVISE AND RESUBMIT
NOT REVIEWED
REJECTED
JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

Turner Construction Company
Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 06/03/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

1	5/02/14 REVISED SECTION 3 PER RFI #92

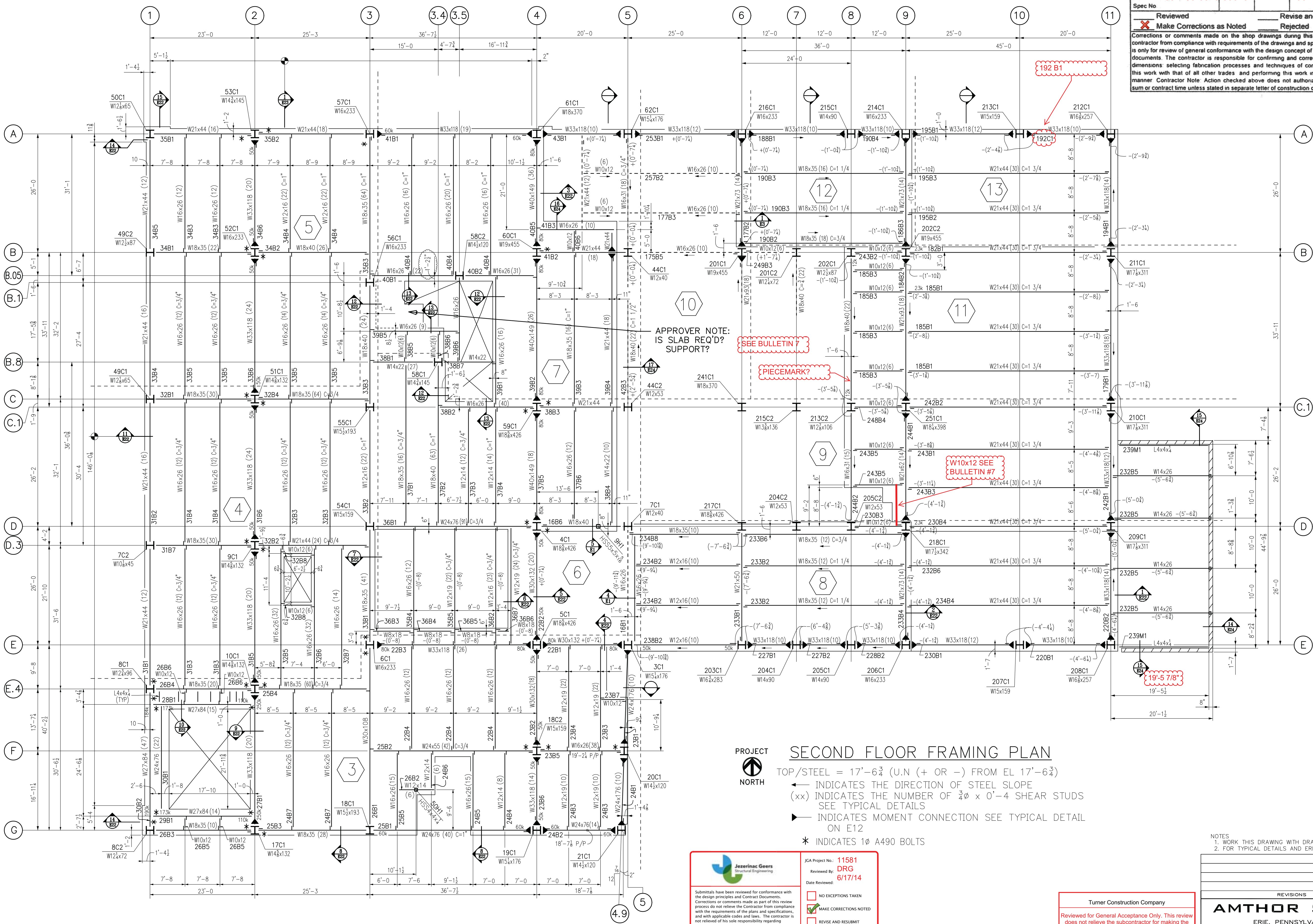
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL
THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
GARAGE ENTRY RAMP FRAMING PLAN
DRAWN BB
CHECKED GR
CONTRACT NO. 6425
DWG. NO. E1

REF: S101B

E1

SECOND FLOOR FRAMING PLAN



TOP/STEEL = 17'-6¾ (U.N (+ OR –) FROM EL 17'-6¾)

← INDICATES THE DIRECTION OF STEEL SLOPE

(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

* INDICATES 1ø A490 BOLTS

NOTES
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No	22920	Subm No	Checked By	Return Date
Control No	051200-0013-00613		DL	06/18/2014
Spec No				

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general conformance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing his work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/17/14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 06/10/2014

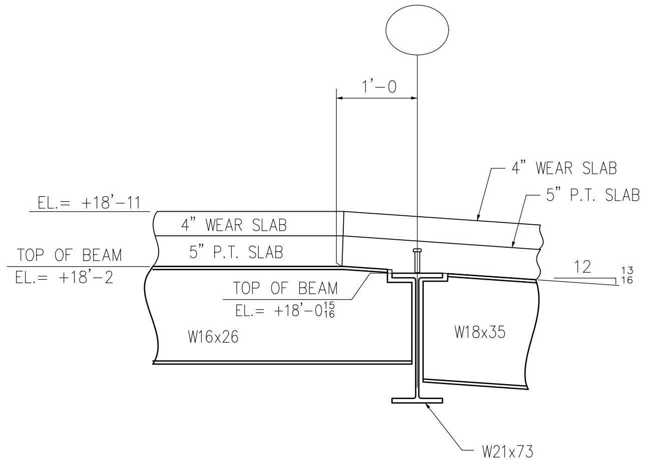
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

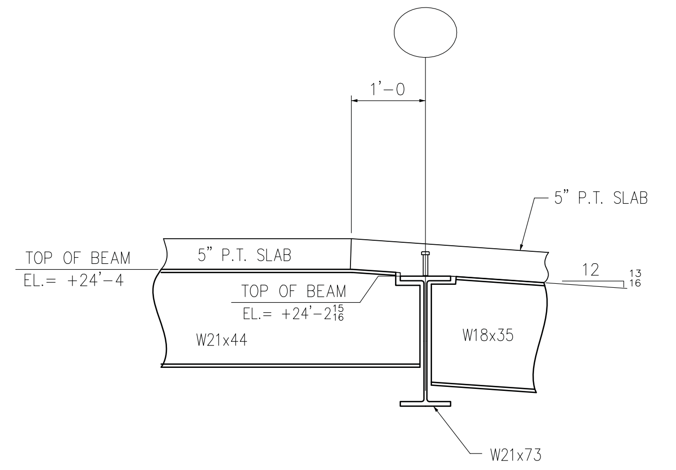
THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
SECOND FLOOR FRAMING PLAN

Drawn	AY	Contract No.	Dwg. No.
Checked	GR	6425	E2
Approved			

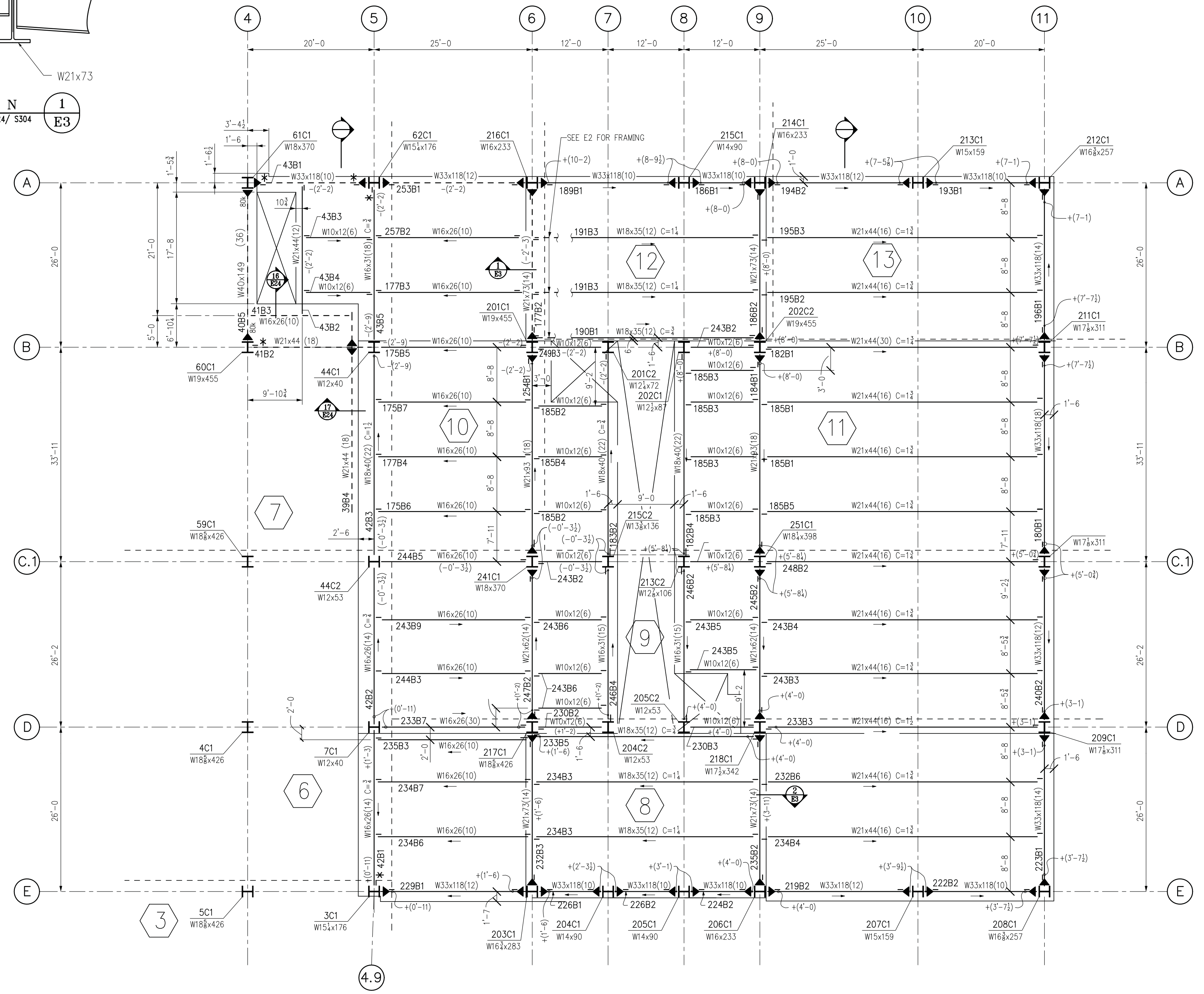
REF. S102



SECTION 1 — SCALE: 1" = 1'-0" REF: 24/ S304 — E3



SECTION 2 — SCALE: 1" = 1'-0" REF: 9/ S304 — E3



ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No	22920	Subm No	Checked By	Return Date
Control No	051200-0013-00614		DL	06/18/2014
Spec No				

___ Reviewed — ___ Revise and Resubmit
X Make Corrections as Noted — ___ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

Jezerinac Geers Structural Engineering
JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/17/14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the subcontractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

PROJECT NORTH

MID LEVEL FRAMING PLAN

TOP/STEEL = 20'-4 (UN (+ OR –) FROM EL. 20'-4)
◄— INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶ INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12
* INDICATES 1ø A490 BOLTS

APP VERIFY ALL BM ELEVS

APP FURNISH ALL BLANK DIMS

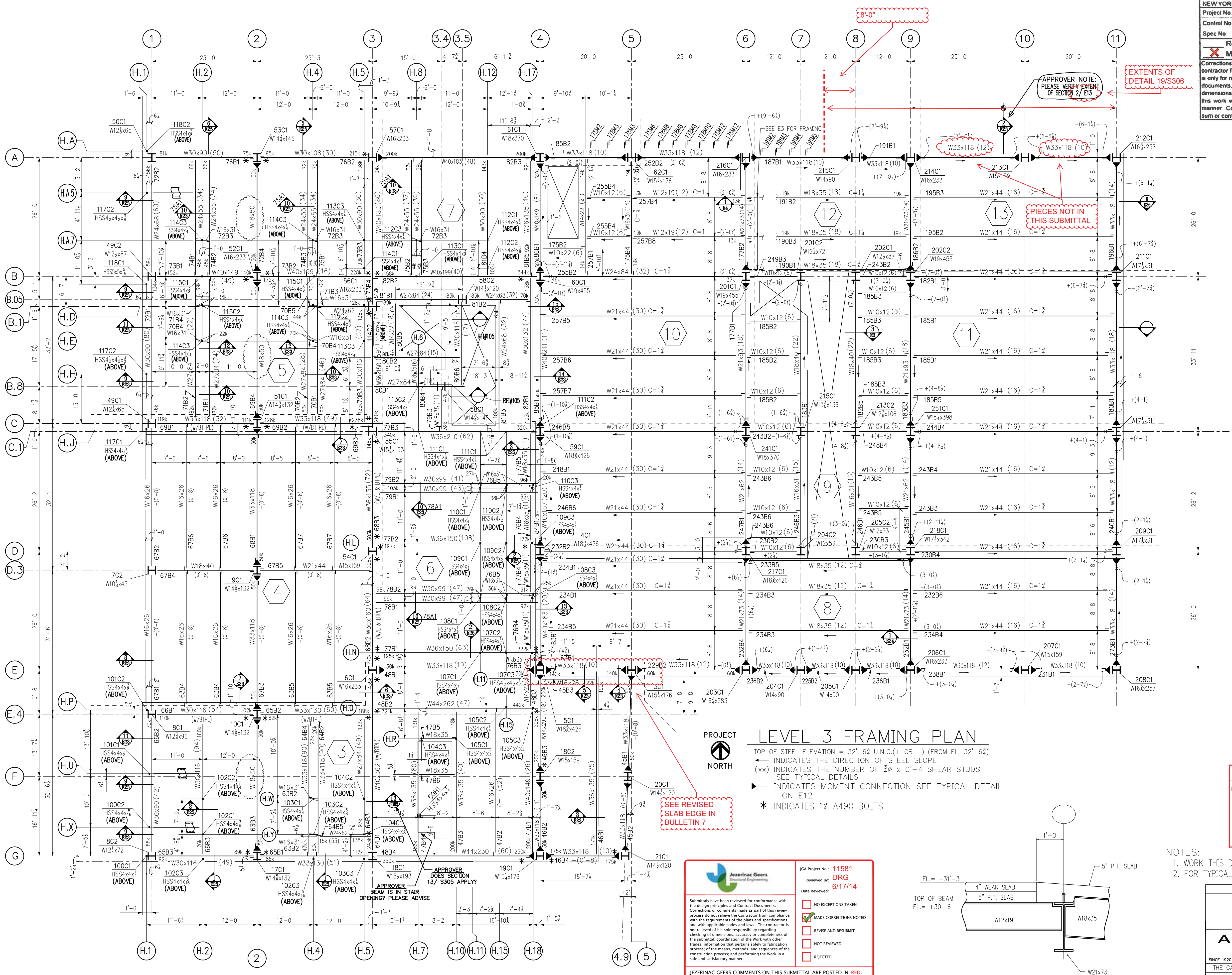
Turner Construction Company
Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 06/10/2014

REF: S102A

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 — CARRARA STEEL
THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
MID LEVEL FRAMING PLAN
DRAWN: ECB — CHECKED: CR — APPROVED:
CONTRACT NO. 6425 — DWG. NO. E3

E3



PROJECT NORTH

LEVEL 3 FRAMING PLAN

TOP OF STEEL ELEVATION = 32'-6¾ U.N.O.(+ OR –) (FROM EL. 32'-6¾")
⟵ INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶ INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12
* INDICATES 1ø A490 BOLTS

SECTION 1/E4
SCALE: 1" = 1'-0" REF: 24/ S304

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No 22920	Subm No	Checked By	Return Date
Control No 051200-0013	00615	DL	06/18/2014
Spec No			

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 06/10/2014

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/17/14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

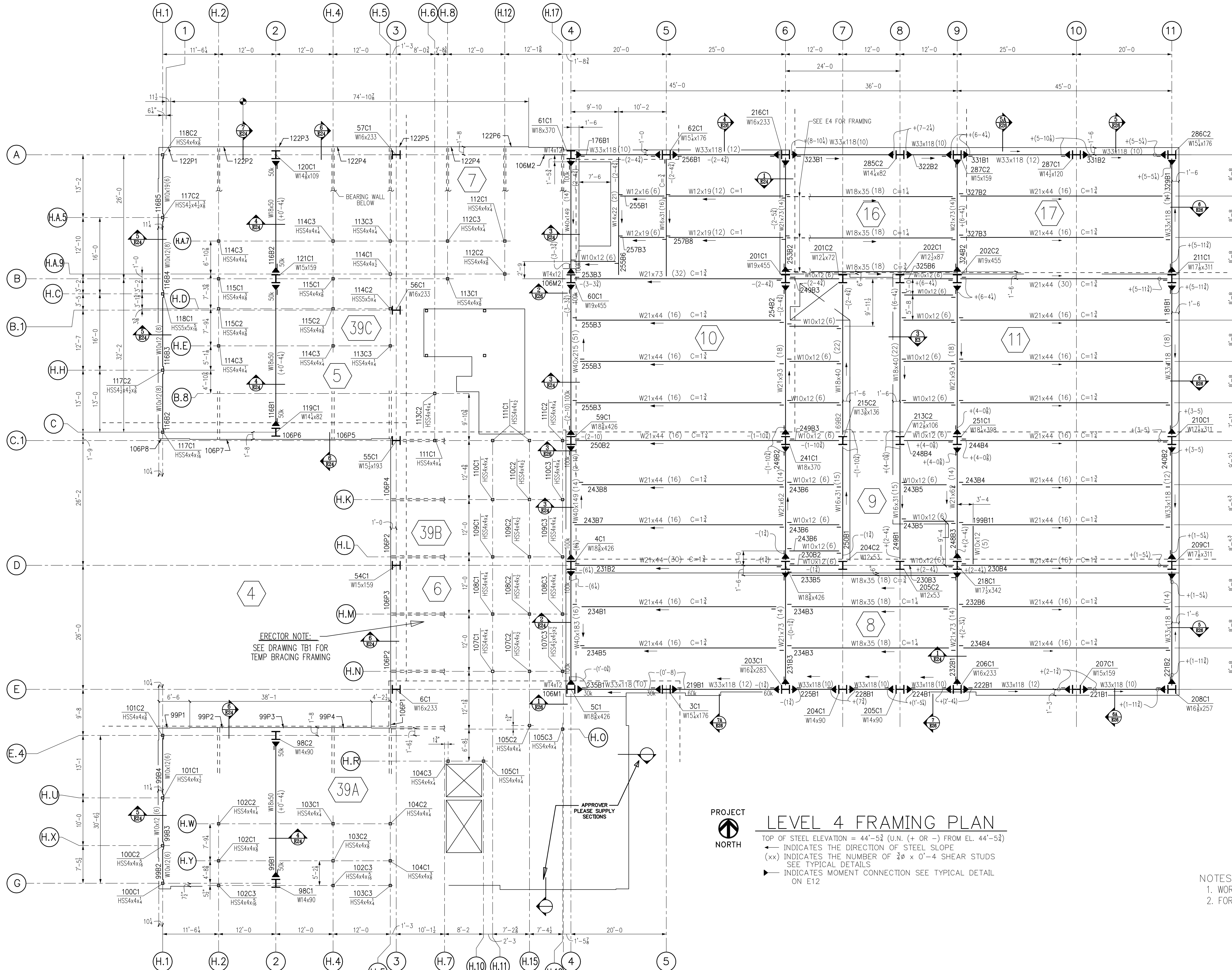
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
3rd LEVEL FRAMING PLAN

Drawn BB	Contract No.	Dwg. No.
Checked GR	6425	E4
Approved		

S.103, S. 103A

E4



LEVEL 4 FRAMING PLAN

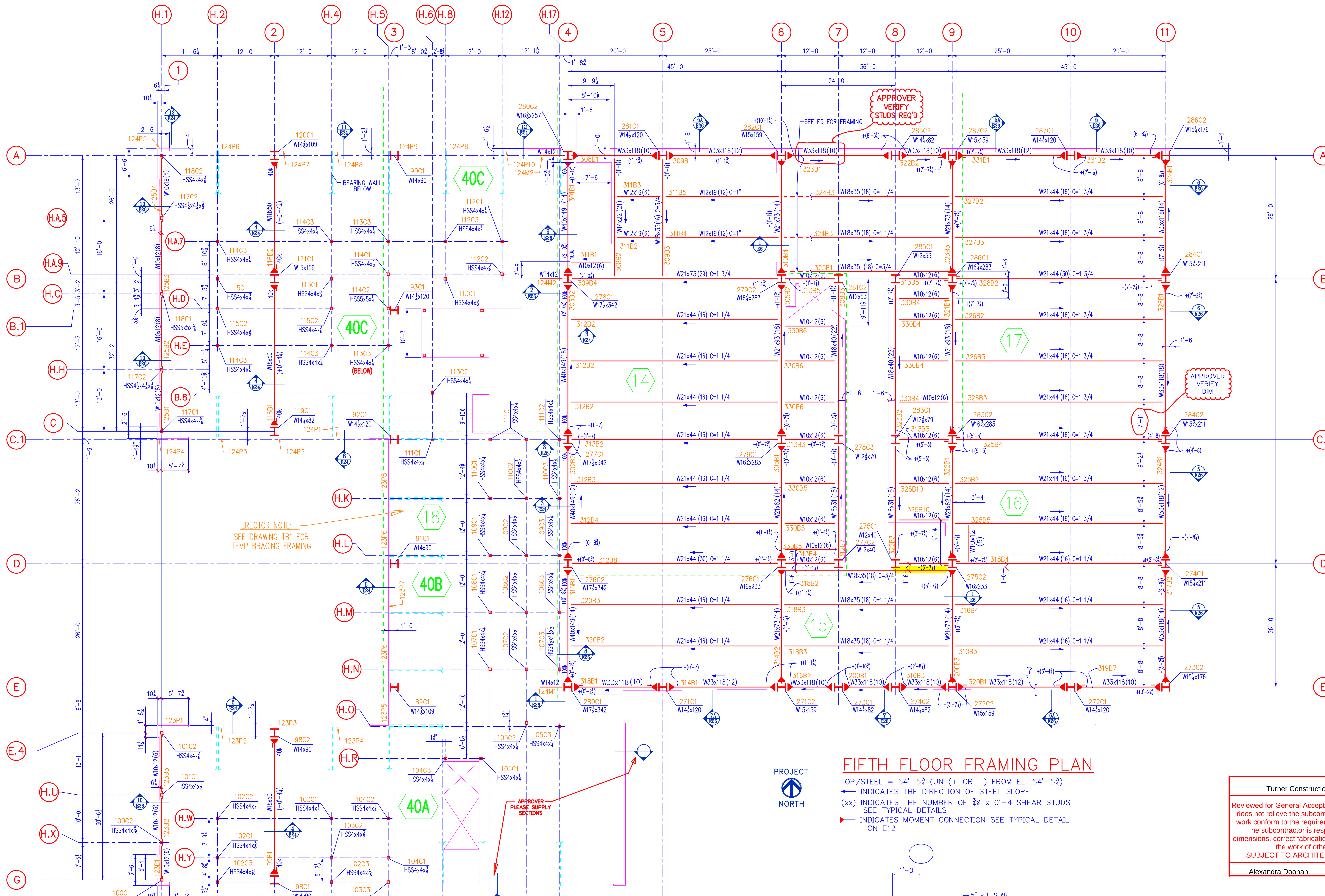
PROJECT NORTH

TOP OF STEEL ELEVATION = 44'-5⅜ (U.N. (+ OR −) FROM EL. 44'-5⅜)
← INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REF: S104, S104A

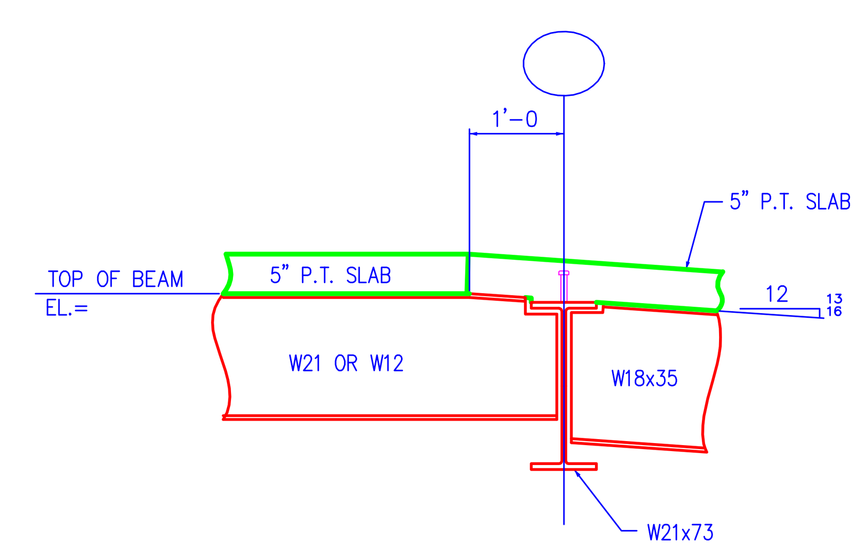
REVISIONS	
AMTHOR STEEL	
ERIE, PENNSYLVANIA	
SINCE 1920	CARRARA STEEL
THE GARDENS AT MARKET SQUARE	
PITTSBURGH, PA	
CUST: TURNER CONSTRUCTION	
4TH LEVEL FRAMING PLAN	
DRAWN BB/AY; CHECKED GR; APPROVED	CONTRACT NO. 6425 — DWG. NO. E5



FIFTH FLOOR FRAMING PLAN

TOP/STEEL = 54'–5¾ (UN (+ OR –) FROM EL. 54'–5¾)
← INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'–4 SHEAR STUDS SEE TYPICAL DETAILS
INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

PROJECT NORTH



SECTION 1/E6
SCALE: 1" = 1'–0" REF: 9/ S304

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 06/24/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

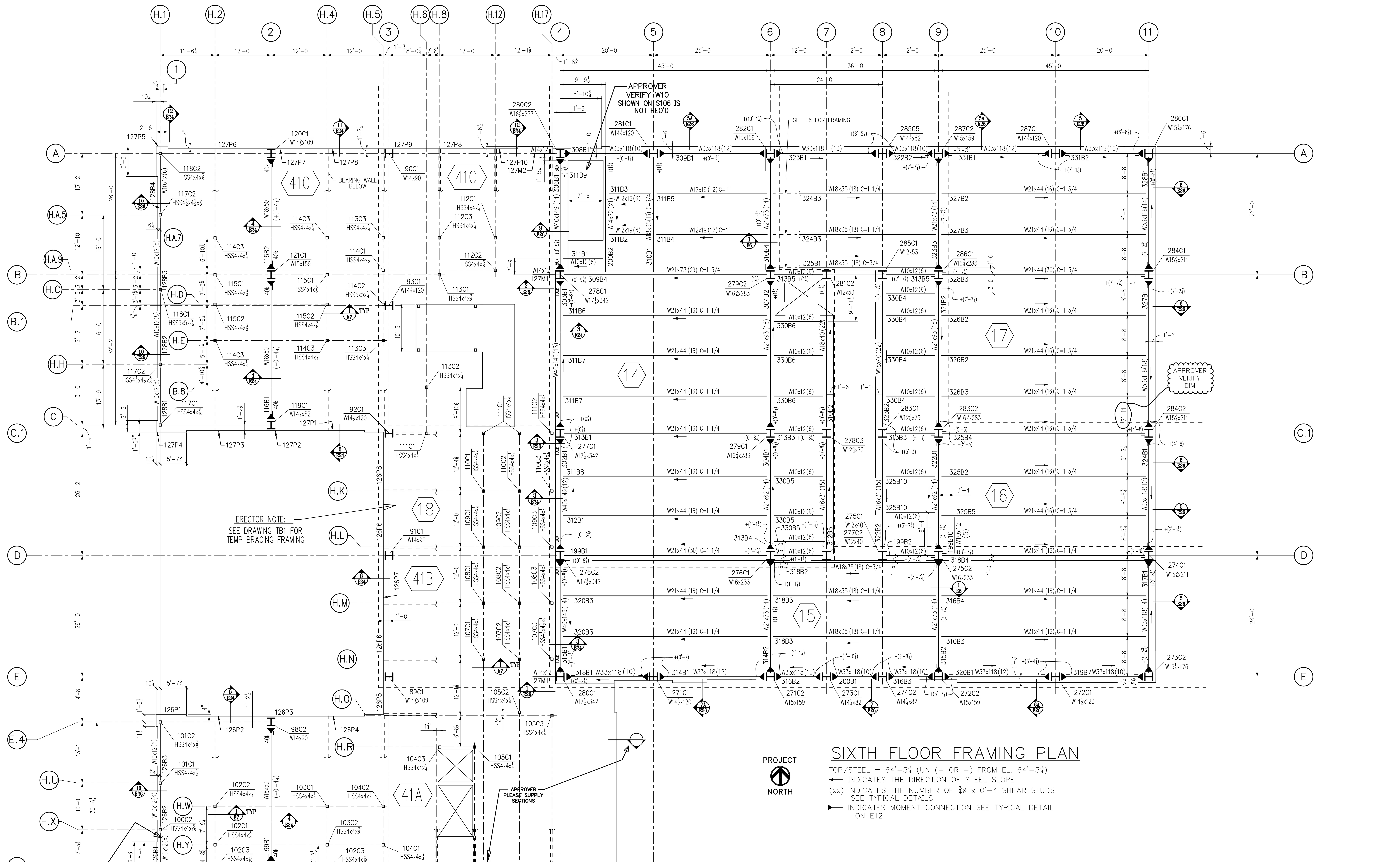
THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
5TH FLOOR FRAMING PLAN

DRAWN AY
CHECKED GR
APPROVED

CONTRACT NO. 6425
DWG. NO. E6

REF: S105 & S105A

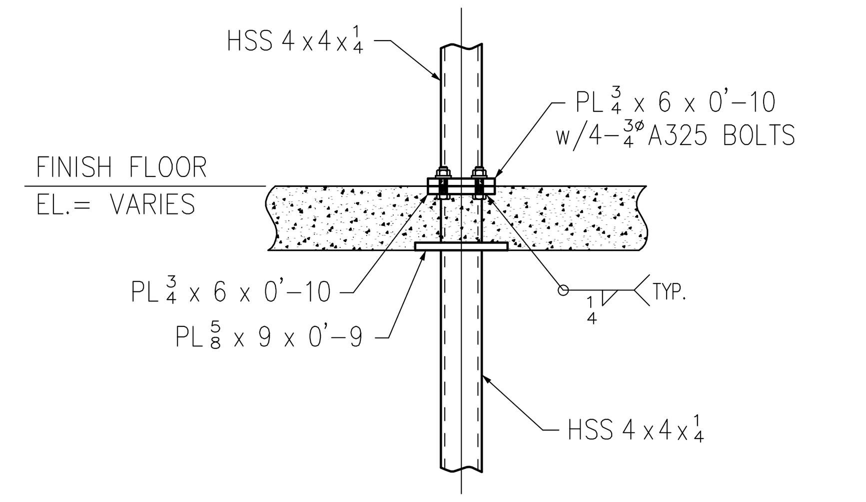
E6



SIXTH FLOOR FRAMING PLAN

TOP/STEEL = 64'-5¾ (UN (+ OR –) FROM EL. 64'-5¾)
← INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶ INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

PROJECT NORTH



SECTION 1/E7
SCALE: 1" = 1'-0" REF: 12/ S303

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REF: S106 & S106A

REVISIONS

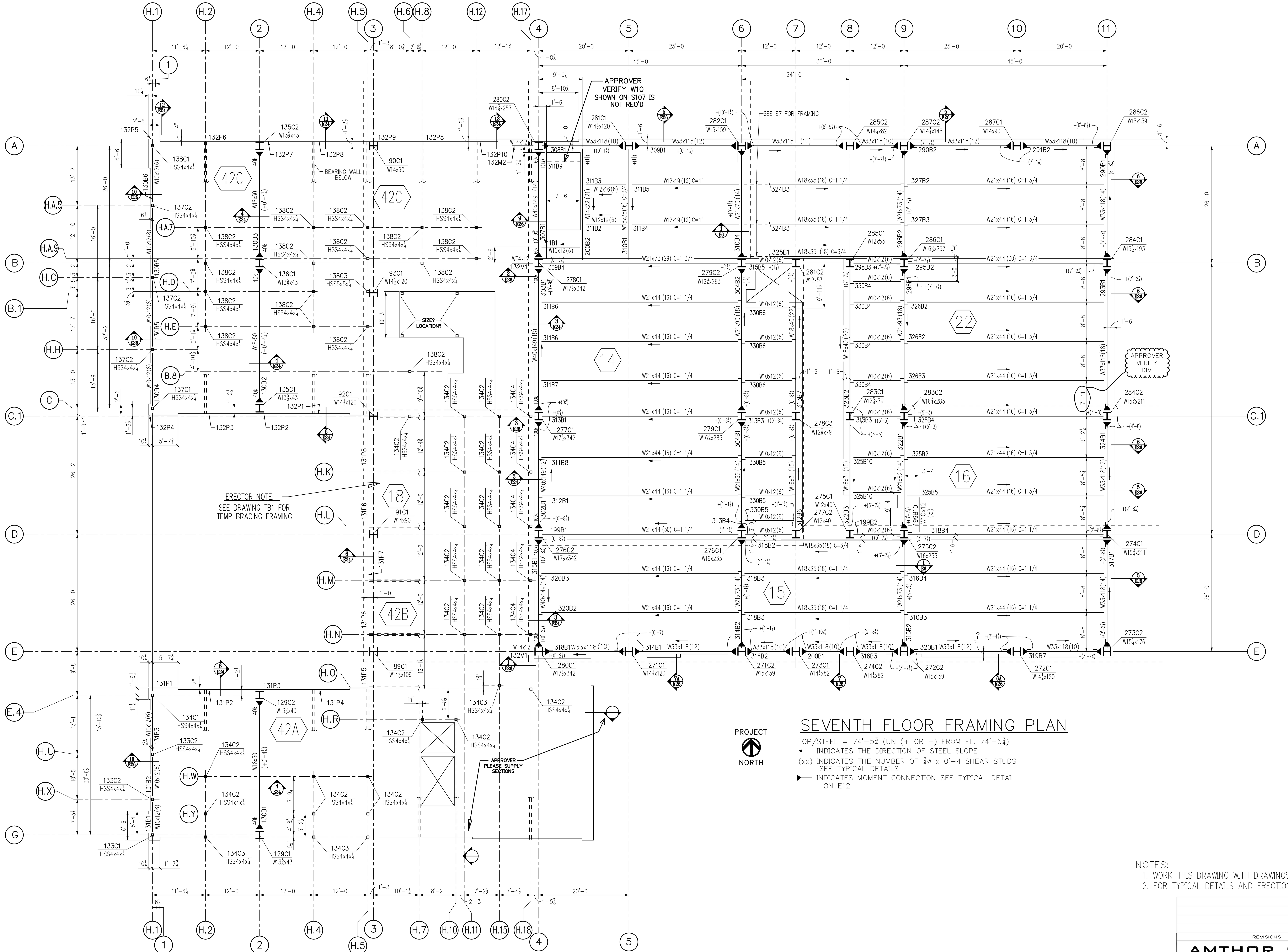
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
6TH FLOOR FRAMING PLAN

DRAWN AY
CHECKED GR
APPROVED

CONTRACT NO. 6425
DWG. NO. E7

E7



SEVENTH FLOOR FRAMING PLAN

TOP/STEEL = 74'-5¾ (UN (+ OR –) FROM EL. 74'-5¾)
← INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

PROJECT NORTH

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REF: S107 & S107A

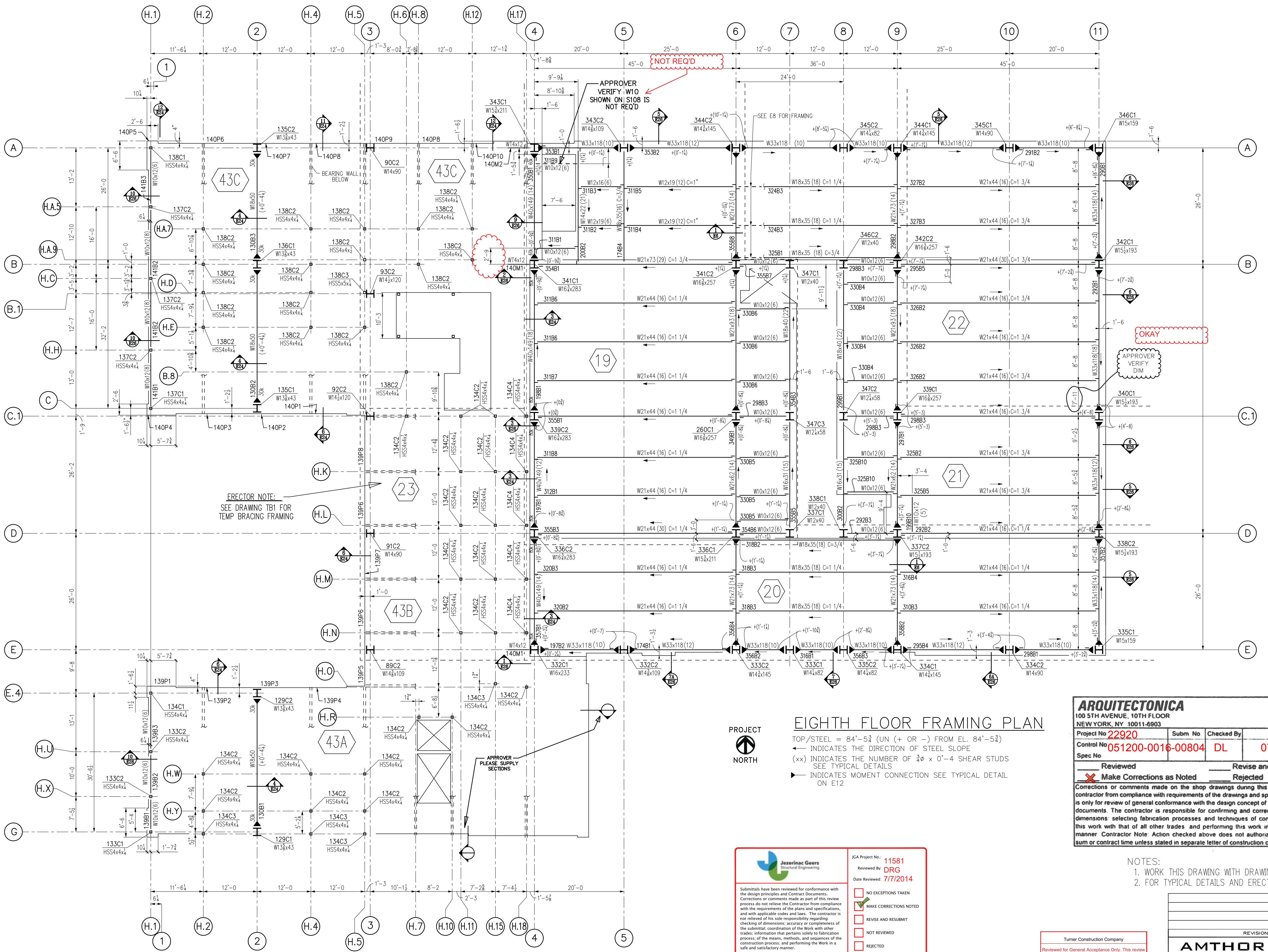
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
7TH FLOOR FRAMING PLAN

DRAWN AY	CONTRACT No.	DWG. No.
CHECKED GR	6425	E8
APPROVED		

E8



PROJECT NORTH

EIGHTH FLOOR FRAMING PLAN

TOP/STEEL = 84'–5¾ (UN (+ OR –) FROM EL. 84'–5¾)

← INDICATES THE DIRECTION OF STEEL SLOPE

(xx) INDICATES THE NUMBER OF ¾ø x 0'–4 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm No	Checked By	Return Date
Control No 051200-0016-00804 Spec No		DL	07/08/2014

____ Reviewed ____ Revise and Resubmit
_X_ Make Corrections as Noted ____ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 7/7/2014

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 06/30/2014

REF: S108 & S108A

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
8TH FLOOR FRAMING PLAN

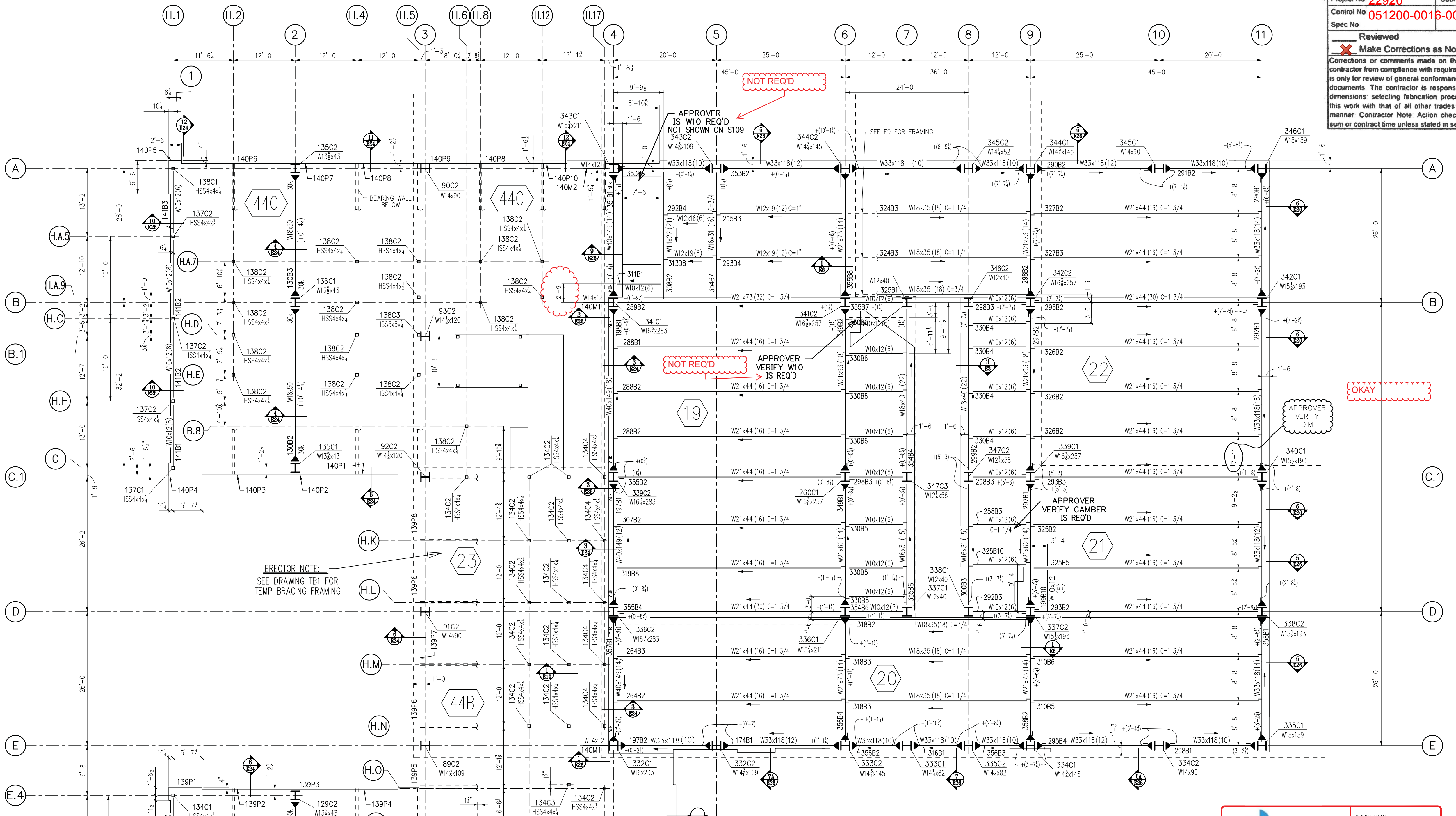
Drawn AY	Contract No.	Dwg. No.
Checked GR	6425	E9
Approved		

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No 22920	Subm No	Checked By	Return Date
Control No 051200-0016-00805		DL	07/08/2014
Spec No			

____ Reviewed ____ Revise and Resubmit
X Make Corrections as Noted ____ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization



PROJECT NORTH

NINTH FLOOR FRAMING PLAN

TOP/STEEL = 94'-5½ (UN (+ OR –) FROM EL. 94'-5½)
← INDICATES THE DIRECTION OF STEEL SLOPE
(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS
▶ INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

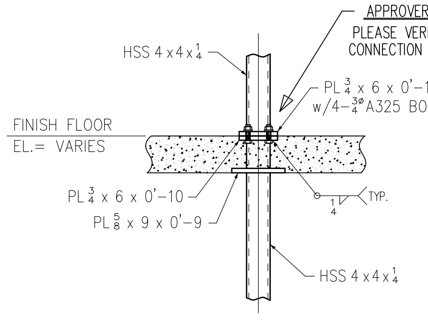
Jezerinac Geers Structural Engineering

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of its sole responsibility regarding checking of dimensions, accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

JGA Project No: 11581
Reviewed By: DRG
Date Reviewed: 7/7/2014

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.



SECTION 1 E10
SCALE: 1" = 1'-0" REF: 12/ S303

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

Turner Construction Company
Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL
Alexandra Doonan 06/30/2014

REF: S109 & S109A

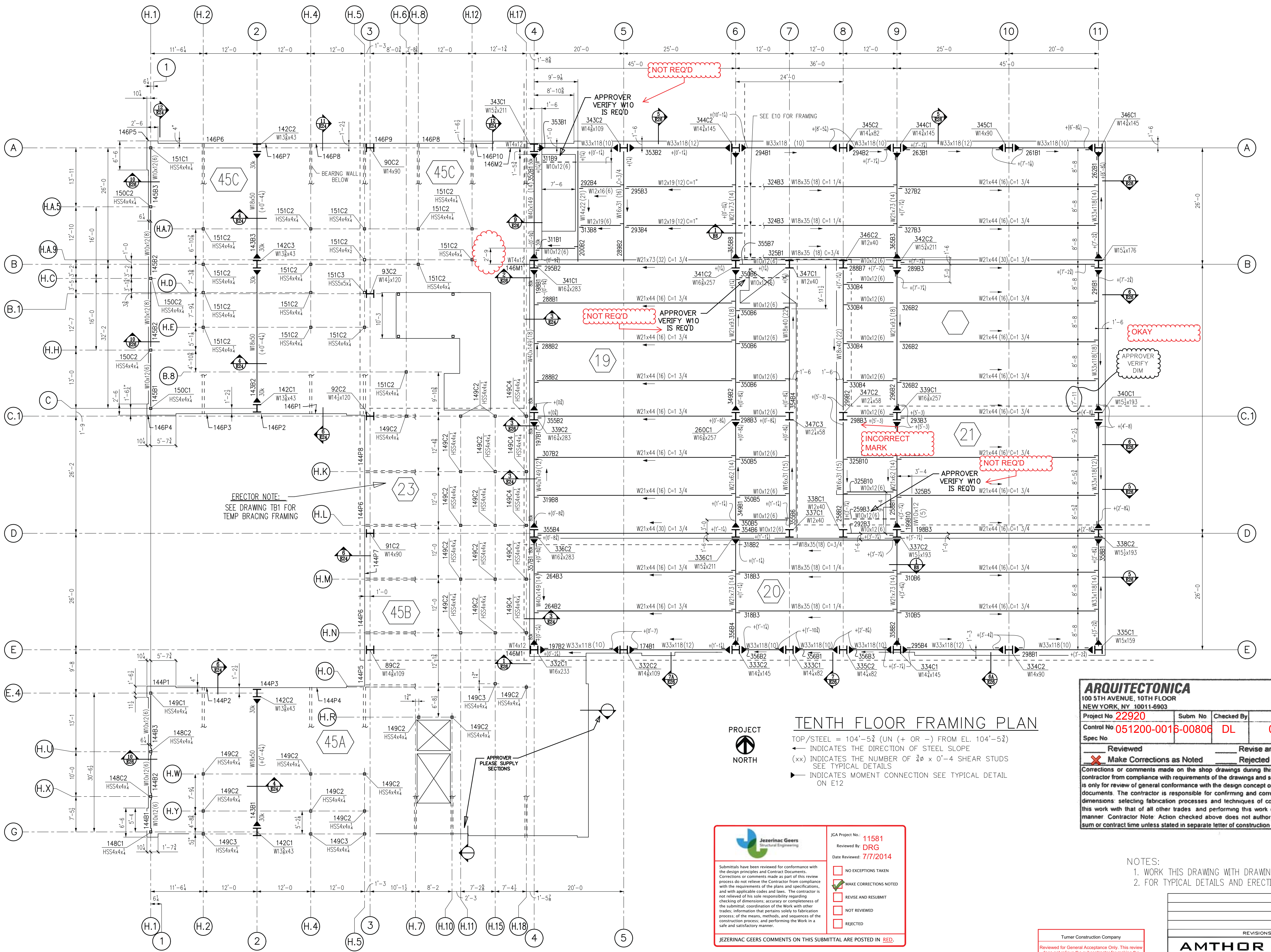
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
9TH FLOOR FRAMING PLAN

DRAWN AY	CONTRACT NO.	DWG. NO.
CHECKED GR	6425	E10
APPROVED		

E10



TENTH FLOOR FRAMING PLAN

TOP/STEEL = 104'-5¾ (UN (+ OR –) FROM EL. 104'-5¾)

← INDICATES THE DIRECTION OF STEEL SLOPE

(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No 22920	Subm No	Checked By	Return Date
Control No 051200-0016-00806 Spec No		DL	07/08/2014

___ Reviewed   ___ Revise and Resubmit
X Make Corrections as Noted   ___ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 7/7/2014

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 06/30/2014

REF: S110 & S110A

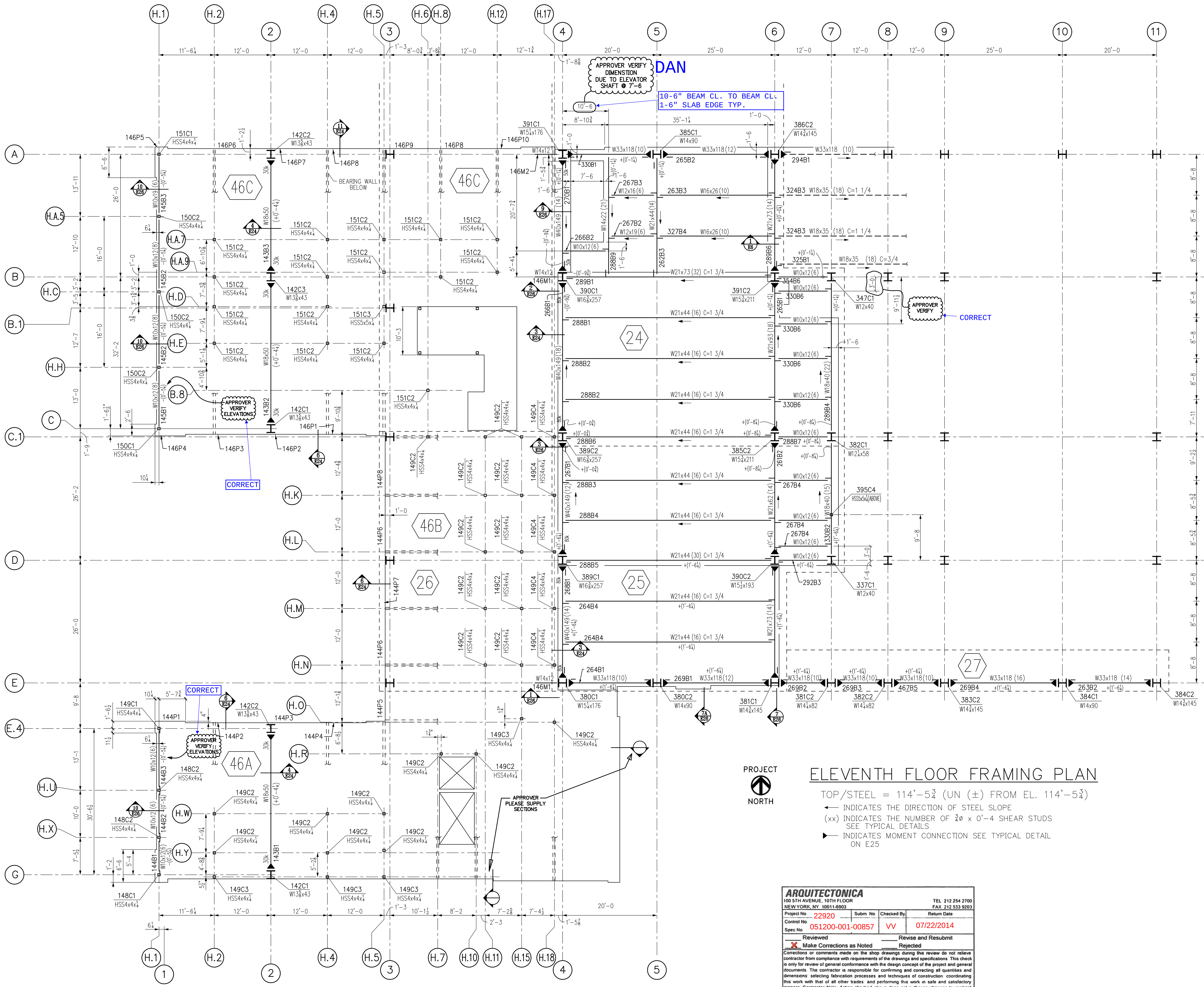
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920   CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
10TH FLOOR FRAMING PLAN

DRAWN AY	CONTRACT No.	DWG. No.
CHECKED GR / APPROVED	6425	E11

E11



PROJECT NORTH

ELEVENTH FLOOR FRAMING PLAN

TOP/STEEL = 114'-5¾ (UN (±) FROM EL. 114'-5¾)

← INDICATES THE DIRECTION OF STEEL SLOPE

(xx) INDICATES THE NUMBER OF ¾Ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E25

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No	22920	Subm No	Checked By	Return Date
Control No / Spec No	051200-001-00857		VV	07/22/2014

Reviewed — Revise and Resubmit
X Make Corrections as Noted — Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-18-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication processes; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- NO EXCEPTIONS TAKEN
- X MAKE CORRECTIONS NOTED
- REVISE AND RESUBMIT
- NOT REVIEWED
- REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company
Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 07/07/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E25

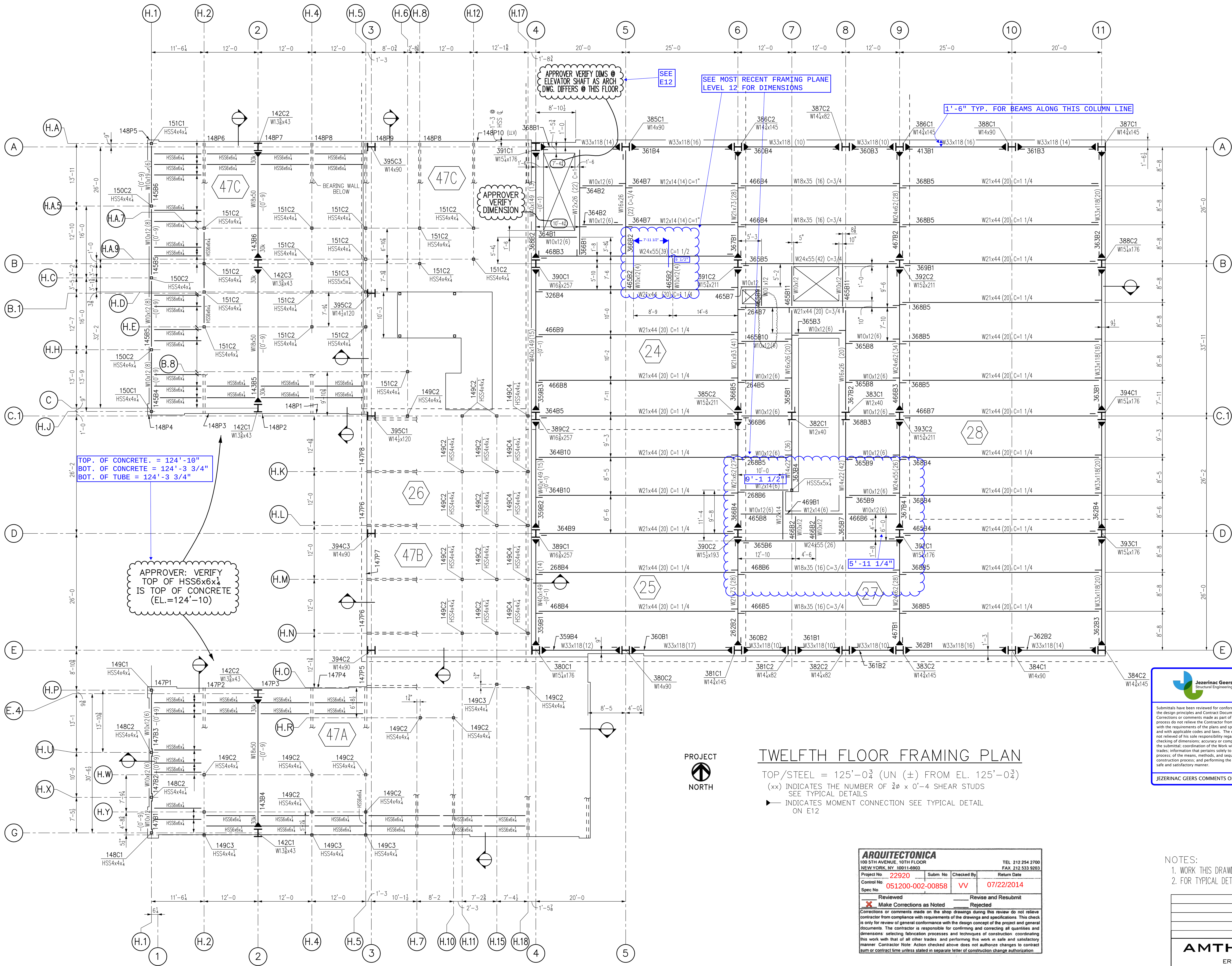
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 — CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
11TH FLOOR FRAMING PLAN

Drawn	AY	Contract No.	Dwg. No.
Checked	GR	6425	E12
Approved			

REF: S111, S111A



TWELFTH FLOOR FRAMING PLAN

TOP/STEEL = 125'-0¾ (UN (±) FROM EL. 125'-0¾)

(xx) INDICATES THE NUMBER OF ¾ø x 0'-4 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-18-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/07/2014

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm. No	Checked By	Return Date
Control No / Spec No 051200-002-00858		VV	07/22/2014

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

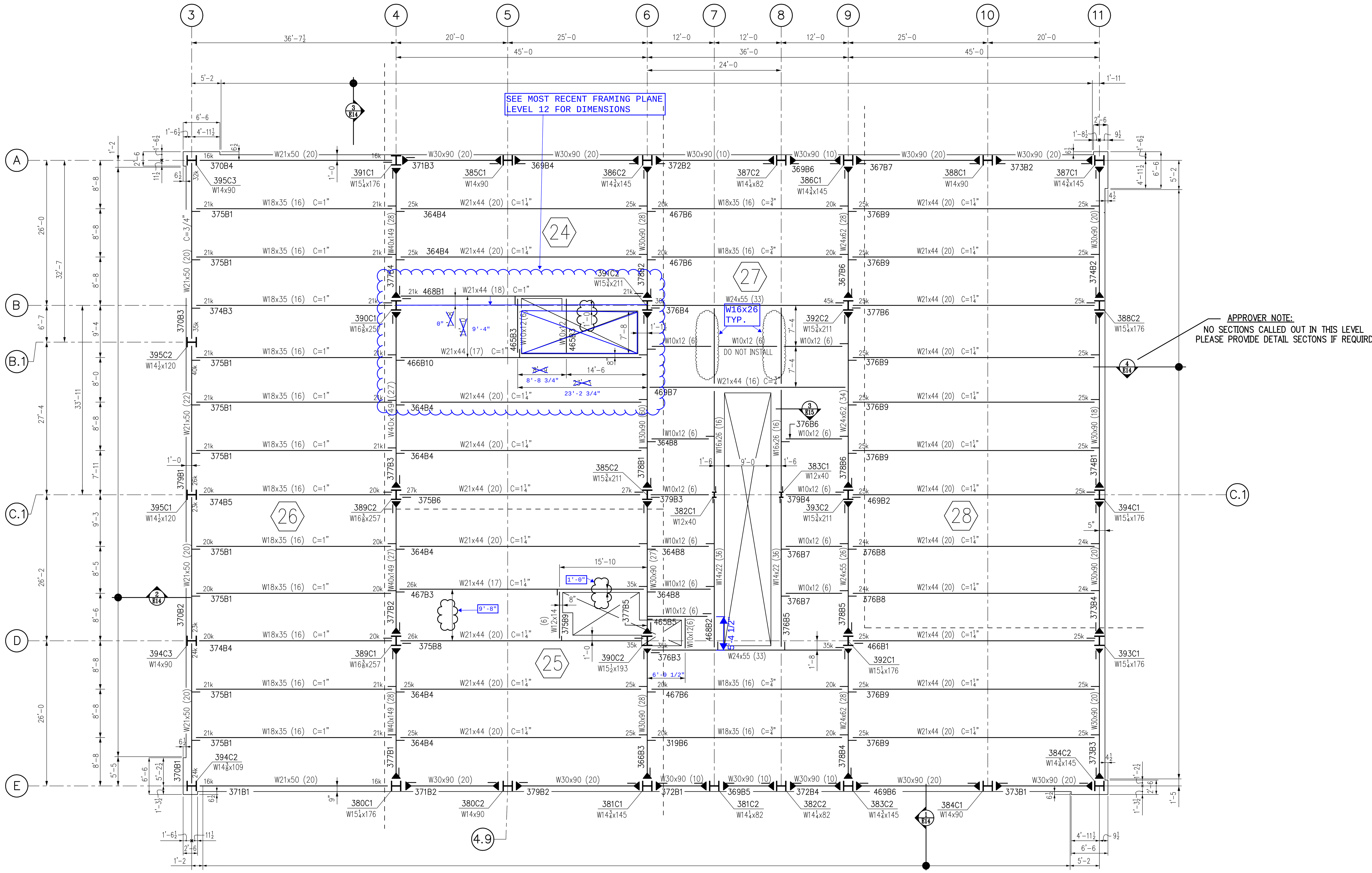
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
12TH FLOOR FRAMING PLAN

DRAWN AY	CONTRACT NO.	DWG. NO.
CHECKED GR	6425	E13
APPROVED		

REF: S112, S112A

E13



PROJECT NORTH

LEVEL 13 FRAMING PLAN

TOP OF STEEL ELEVATION = 139'-0¾

(xx) INDICATES THE NUMBER OF ¾ø x 0'-3½ SHEAR STUDS SEE TYPICAL DETAILS

INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

APPROVER NOTE: PLEASE VERIFY STUD LENGTH 3 ON S304 CALLS FOR ALL STUDS TO BE 4" LONG

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm. No	Checked By	Return Date
Control No 051200-003-00859 / Spec No		VV	07/22/2014

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

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Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-18-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

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Turner Construction Company

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SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/07/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

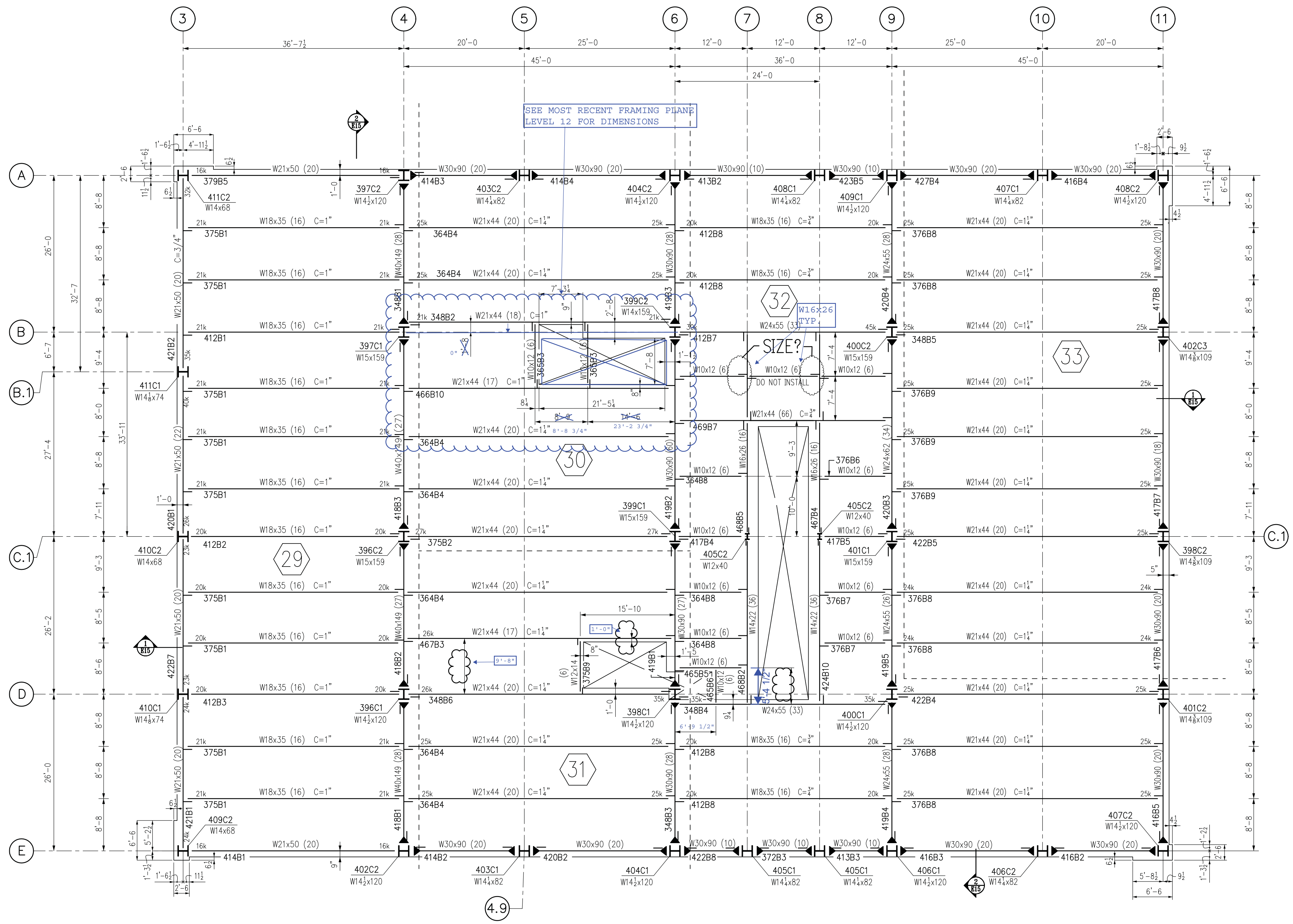
REVISIONS

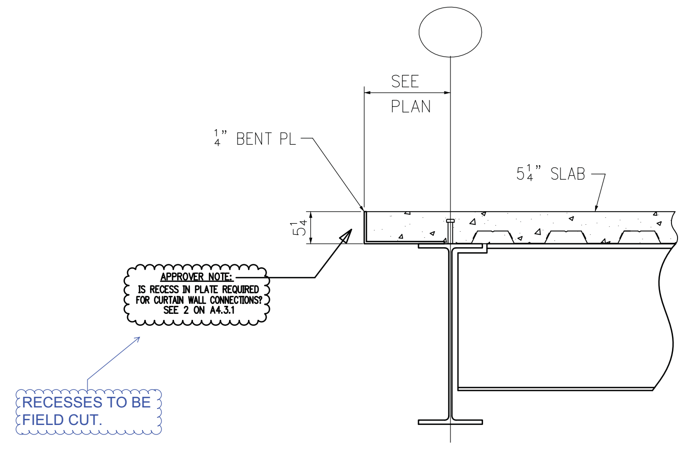
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
13TH LEVEL FRAMING PLAN

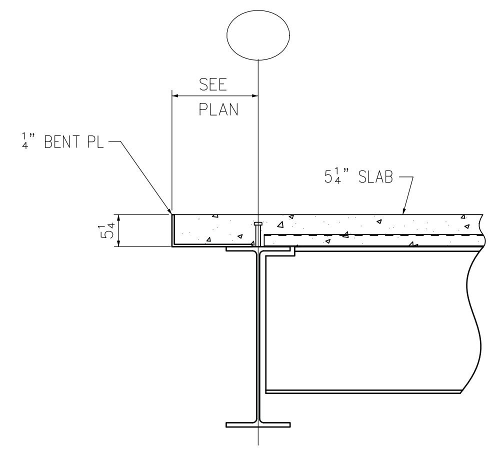
DRAWN DH	CONTRACT No.	DWG. No.
CHECKED GR	6425	E14
APPROVED		

REF. S113





SECTION 1/E15
SCALE: 1" = 1'-0" REF: 10/ S306



SECTION 2/E15
SCALE: 1" = 1'-0" REF: 9/ S306

PROJECT NORTH

LEVEL 14 FRAMING PLAN

TOP OF STEEL ELEVATION = 153'-0 3/4"

(xx) INDICATES THE NUMBER OF 3/4ø x 0'-3 1/2 SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No 22920	Subm. No	Checked By	Return Date
Control No / Spec No 051200-01227-001		VV	07/22/2014

__ Reviewed
X Make Corrections as Noted
__ Revise and Resubmit
__ Rejected

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Jezerinac Geers
Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-22-14

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☐ NO EXCEPTIONS TAKEN
☒ MAKE CORRECTIONS NOTED
☐ REVISE AND RESUBMIT
☐ NOT REVIEWED
☐ REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company

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SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/15/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

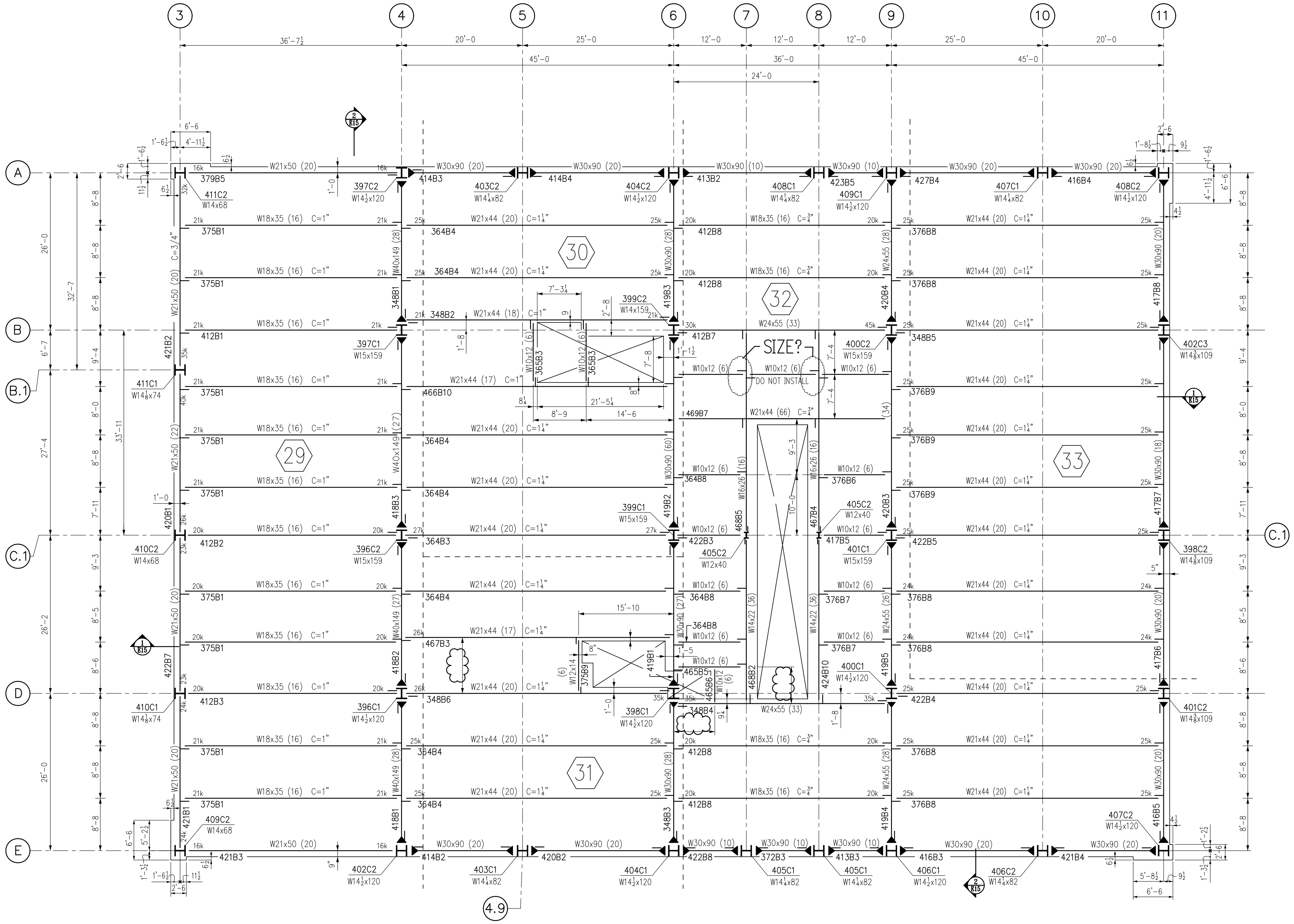
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
14TH LEVEL FRAMING PLAN

DRAWN DH / CHECKED GR / APPROVED	CONTRACT NO. 6425	DWG. NO. E15

REF. S113

E15



PROJECT NORTH

LEVEL 15 FRAMING PLAN

TOP OF STEEL ELEVATION = 167'-0¾
(xx) INDICATES THE NUMBER OF ¾Ø x 0'-3½ SHEAR STUDS SEE TYPICAL DETAILS
▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ALL OPENING QUESTIONS TYP FOR E14 THRU E19

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-22-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm No	Checked By	Return Date
Control No 051200-01227-002 Spec No		VV	07/22/2014

____ Reviewed ____ Revise and Resubmit
X Make Corrections as Noted ____ Rejected

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Turner Construction Company
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SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 07/15/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

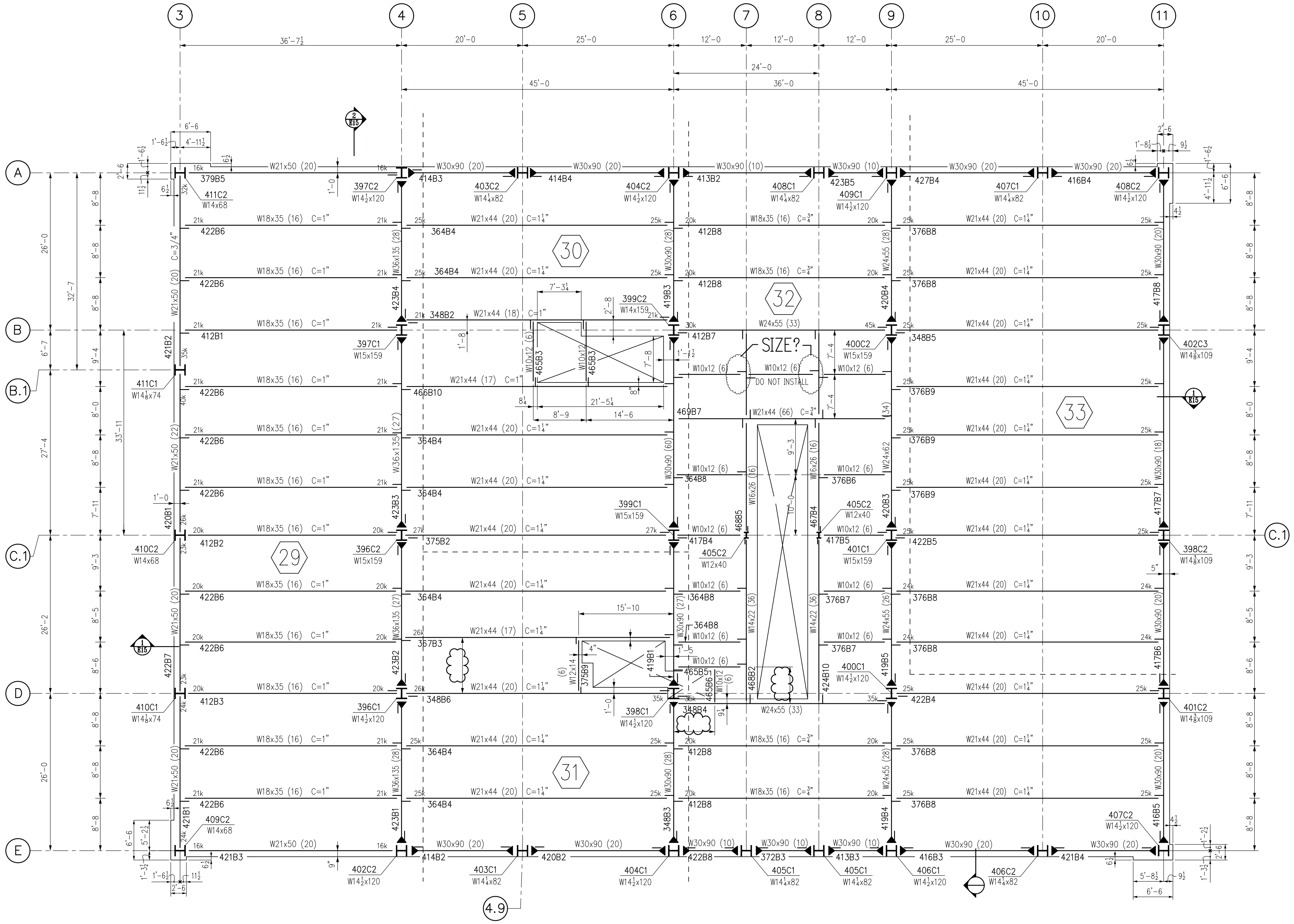
REF. S113

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL
THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
15TH LEVEL FRAMING PLAN

DRAWN DH	CONTRACT NO.	DWG. NO.
CHECKED GR	6425	E16
APPROVED		

E16



PROJECT NORTH

LEVEL 16 FRAMING PLAN

TOP OF STEEL ELEVATION = 181'–0¾

(xx) INDICATES THE NUMBER OF ¾ø x 0'–3½ SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
FAX 212 533 9203

Project No 22920	Subm No	Checked By	Return Date
Control No / Spec No 051200-01229-003		VV	07/22/2014

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

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Jezerinac Geers
Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-22-14

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- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company

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SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/15/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REF. S113

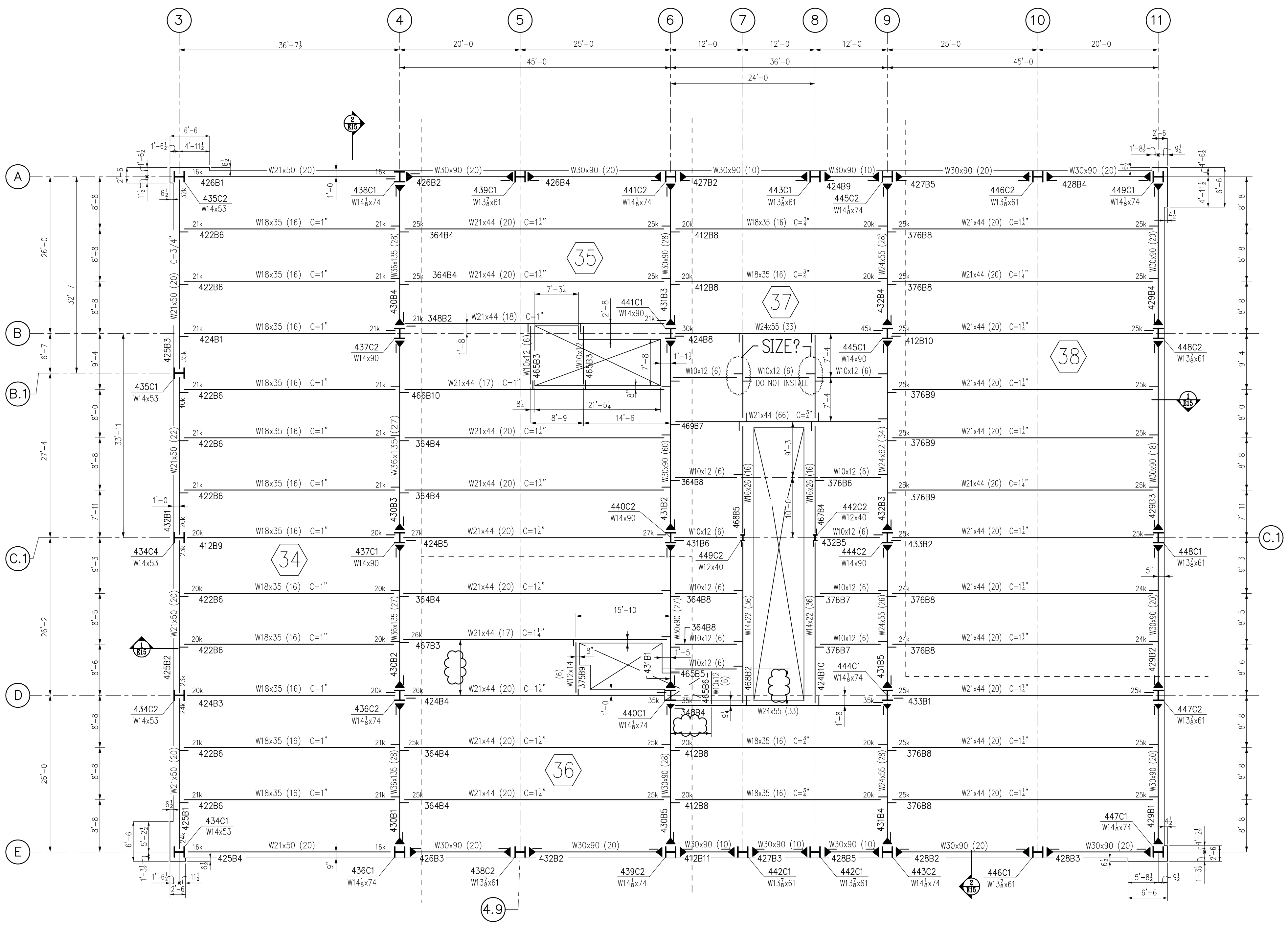
REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
16TH LEVEL FRAMING PLAN

Drawn DH	Contract No.	Dwg. No.
Checked GR	6425	E17
Approved		

E17



PROJECT NORTH

LEVEL 17 FRAMING PLAN

TOP OF STEEL ELEVATION = 195'-0¾

(xx) INDICATES THE NUMBER OF ¾⌀ x 0'-3½ SHEAR STUDS SEE TYPICAL DETAILS

INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm. No	Checked By	Return Date
Control No			
Spec No 051200-01230-0004		VV 07/22/2014	

____ Reviewed ____ Revise and Resubmit
X Make Corrections as Noted ____ Rejected

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Jezerinac Geers
Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-22-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/15/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

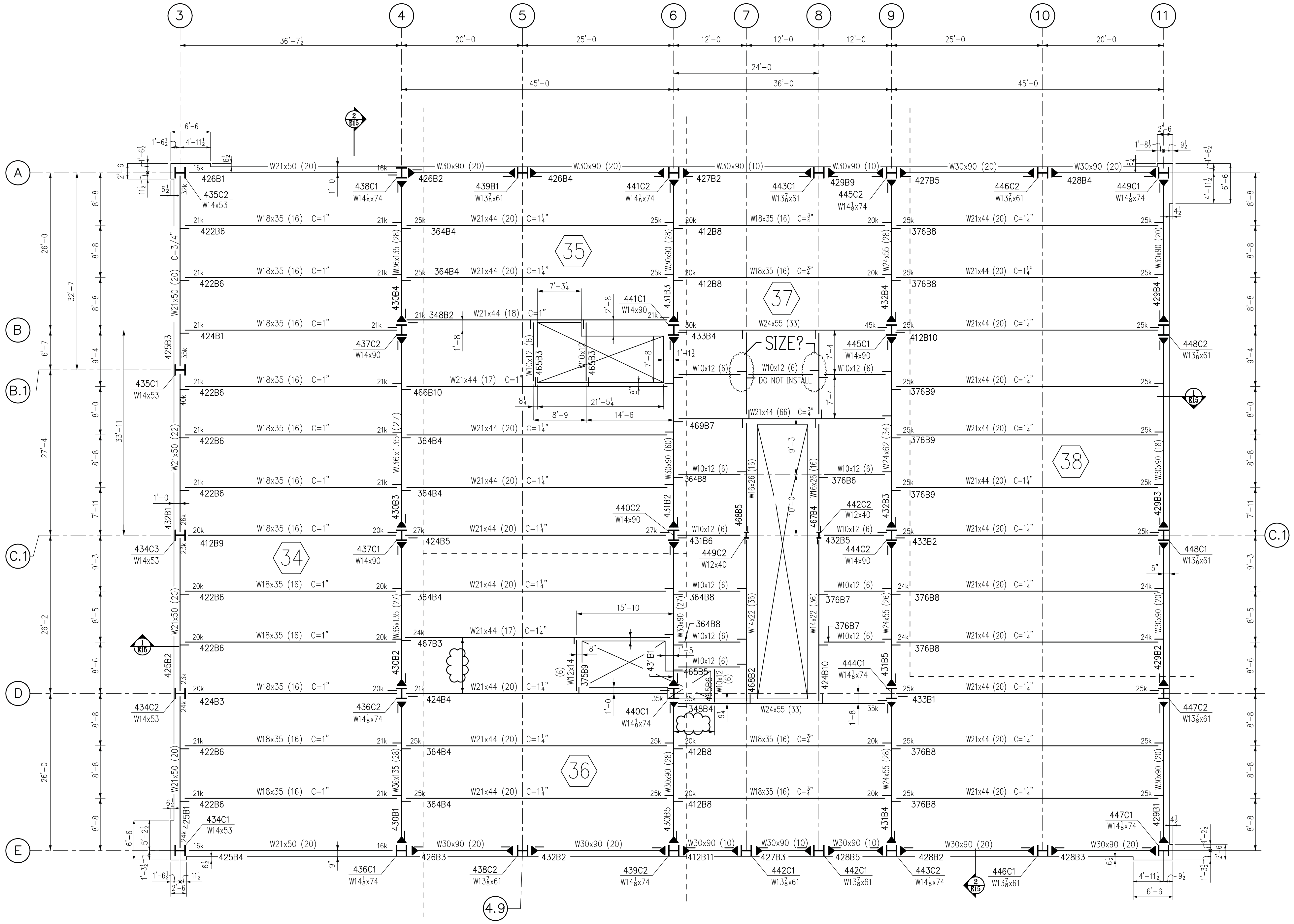
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
17TH LEVEL FRAMING PLAN

DRAWN DH	CONTRACT No.	DWG. No.
CHECKED GR	6425	E18
APPROVED		

REF. S113

E18



ALL OPENING QUESTIONS TYP FOR E14 THRU E19

PROJECT NORTH

LEVEL 18 FRAMING PLAN

TOP OF STEEL ELEVATION = 209'-0¾"

(xx) INDICATES THE NUMBER OF ¾⌀ x 0"-3½ SHEAR STUDS SEE TYPICAL DETAILS

▶— INDICATES MOMENT CONNECTION SEE TYPICAL DETAIL ON E12

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212 254 2700
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Project No 22920	Subm. No	Checked By	Return Date
Control No / Spec No 051200-01231-005		VV	07/22/2014

_____ Reviewed _____ Revise and Resubmit
_____ Make Corrections as Noted _____ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: PJM
Date Reviewed: 7-22-14

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN BLUE.

Turner Construction Company

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SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 07/15/2014

NOTES:
1. WORK THIS DRAWING WITH DRAWINGS E
2. FOR TYPICAL DETAILS AND ERECTION NOTES SEE E21

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS AT MARKET SQUARE
PITTSBURGH, PA
CUST: TURNER CONSTRUCTION
18TH LEVEL FRAMING PLAN

DRAWN DH	CONTRACT No.	DWG. No.
CHECKED GR	6425	E19
APPROVED		

REF. S113

E19


SECTION 1 SCALE: 1" = 1'-0" REF: 22/ S304 E22
5" P.T. SLAB
TOP OF BEAM EL.= VARIES
TOP OF BEAM EL.= +12'-0
VARIES
W14x26
SECTION 2 SCALE: 1" = 1'-0" REF: 9/ S304 E22
4" WEAR SLAB
5" P.T. SLAB
1'-0
EL.= +14'-2
TOP OF BEAM EL.= +13'-5
W18x35
W12x19
W21x73
SECTION 3 SCALE: 1" = 1'-0" REF: 15/ S304 E22
SEE PLAN
5¼" SLAB
5/16" BENT PLATE
TOP OF BEAM EL.= +17'-6¾
TOP OF BEAM EL.= +17'-3¾
HSS6x4x¼
43B4
APPROVER NOTE: PLEASE VERIFY
SECTION 4 SCALE: 1" = 1'-0" E22
5¼" SLAB
TOP OF BEAM EL.= +18'-2
TOP OF BEAM EL.= +17'-6¾
Jezerinac Geers Structural Engineering
JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14
NO EXCEPTIONS TAKEN
MAKE CORRECTIONS NOTED
REVISE AND RESUBMIT
NOT REVIEWED
REJECTED
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JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.
SECTION 5 SCALE: 1" = 1'-0" REF: 16/ S305 E22
5¼" SLAB
TOP OF BEAM EL.= +18'-2
TOP OF BEAM EL.= +17'-6¾
L3x3x¼ DECK SUPPORT
SECTION 6 SCALE: 1" = 1'-0" REF: 8/ S306 E22
SCREED ANGLE
5¼" SLAB
L3x3x¼ DECK SUPPORT
SECTION 7 SCALE: 1" = 1'-0" REF: 8/ S306 E22
PL11x5¼x¼ BENT
5¼" SLAB
1'-0
L3x3x¼ DECK SUPPORT
SECTION 8 SCALE: 1" = 1'-0" REF: 16/ S306 E22
PL12x5¼x¼ BENT
1'-1
SECTION 9 SCALE: 1" = 1'-0" REF: 2/ S306 E22
5¼" SLAB
1'-0
PL11x5¼x¼ BENT
EL.= +18'-0
27A2 ~ L3x3x¼x1'-0 w/ 2-½" EXP BOLTS (3" EMBED)
PL½x4½x0'-8
ARCH VERIFY
L4x4x¼ @ EACH WT4
27A1
WT4x12 @ 2'-8 O/C & 12" FROM EACH END
TOP OF SLAB EL.= +
15-0
L8x6x½ (LLV) (4 SIDES) w/ ½" STUD x 0'-6 @ 16" O/C
6"
SECTION 12 SCALE: 1" = 1'-0" REF: 16/ S304 E22
SEE PLAN
5/16" BENT PLATE
SECTION 13 SCALE: 1" = 1'-0" REF: 17/ S304 E22
SEE PLAN
5/16" BENT PLATE
ARQUITECTONICA
Project No. 22920
Control No. 051200-001 - 00505
Checked By DL
Return Date 06/12/2014
Make Corrections as Noted
SECTION 10 SCALE: 1" = 1'-0" REF: 1/ S306 E22
E.4
5¼" SLAB
3'-4⅞
1'-0
PL11x5¼x¼ BENT
EL.= +18'-0
PL½x4½x0'-8
L4x4x¼ @ EACH WT4
27A3
APPROVER NOTE: ARE KICKER ANGLES REQUIRED ALONG COLUMN LINES "1" & "G"?
WT4x12 @ 2'-8 O/C & 12" FROM EACH END
TOP OF SLAB EL.= +
15-0
ARCH VERIFY
L8x6x½ (LLV) (4 SIDES) w/ ½" STUD x 0'-6 @ 16" O/C
6"
SECTION 11 SCALE: 1" = 1'-0" REF: 18/ S306 E22
C6x8.2
L3x3x¼
PL11x5¼x¼ BENT
L3x3x¼ @ 4'-0 o/c
L2½x2½x3/16 @ 4'-0 o/c
L3x3x¼x1'-0 w/ 2-½" EXP BOLTS (3" EMBED)
L3x3x¼
CONT. L3x3x¼
4"
3" ARCH VERIFY
SECTION 14 SCALE: 1" = 1'-0" REF: 17/ S306 E22
1'-4½
BENT PL15½x5¼x5/16 w/ ½" STUD x 0'-6 @ 16" O/C
L2½x2½x3/16
3"
SECTION 15 SCALE: 1" = 1'-0" REF: 17/ S306 E22
1'-6½
BENT PL17½x5¼x5/16 w/ ½" STUD x 0'-6 @ 16" O/C
L2½x2½x3/16 @ 4'-0 o/c
L3x3x¼x1'-4 w/ 2-½" EXP BOLTS (3" EMBED)
3"
Turner Construction Company
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Alexandra Doonan 05/28/2014
REF DWG: S304,S305,S306
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920
CARRARA STEEL
THE GARDENS
PITTSBURGH, PENNSYLVANIA
CUST: TURNER CONSTRUCTION
SECTIONS & DETAILS
DRAWN MTD
CONTRACT NO. 6425
DWG. NO. E22

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
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Project No 22920	Subm. No	Checked By	Return Date
Control No 051200-0011-00506		DL	06/12/2014
Spec No			

___ Reviewed ___ Revise and Resubmit
X Make Corrections as Noted ___ Rejected

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Jezerinac Geers Structural Engineering

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14

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- [x] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [ ] NOT REVIEWED
- [ ] REJECTED

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Turner Construction Company

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SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 05/28/2014

REF DWG: S304,S305,S306

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

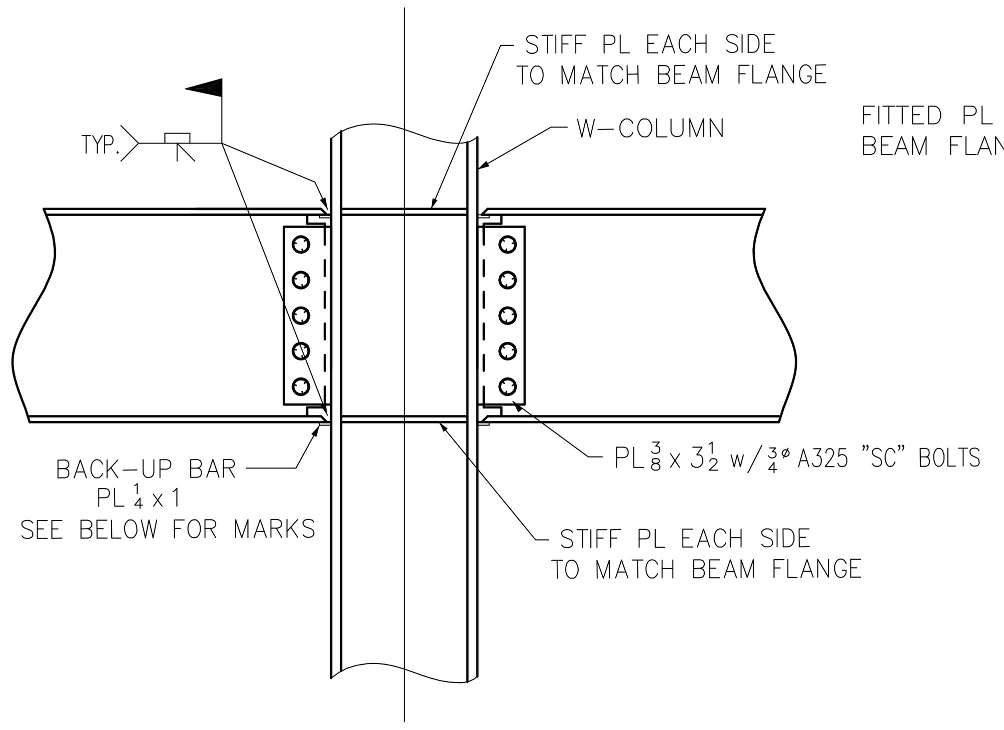
THE GARDENS
PITTSBURGH, PENNSYLVANIA.
CUST: TURNER CONSTRUCTION
SECTIONS & DETAILS

DRAWN MTD	CONTRACT No.	DWG. No.
CHECKED	6425	E23
APPROVED		


5" P.T. SLAB
5" P.T. SLAB
TOP OF BEAM
W18x35
W21x44
W21x73
1'-0
SECTION 1 E24
SCALE: 1" = 1'-0" REF: 9/ S304
EL.= +45'-0
6¼" SLAB
5" P.T. SLAB
5/16" BENT PLATE w/ ½" STUD x 0'-8 @ 12" O/C
PL 7 x 4 x ¼ x 1'-0 @ 4'-0 O/C w/ 2- ⅜" HILTI KWIK BOLTS @ 8" O/C (FINGER TIGHT)
1'-7
1'-0⅜
SECTION 2 E24
SCALE: 1" = 1'-0" REF: 2/ S308
EL.= +45'-0
6¼" SLAB
5" P.T. SLAB
PL 7 x 4 x ¼ x 1'-0 @ 4'-0 O/C w/ 2- ⅜" HILTI KWIK BOLTS @ 8" O/C (FINGER TIGHT)
1'-7
1'-0⅜
SECTION 3 E24
SCALE: 1" = 1'-0" REF: 5/ S303
ERECTOR NOTE: NO SHEARS STUDS
EL.= VARIES
6¼" SLAB
CONT. L3x3x¼ DECK SUPPORT
2@8
2@8
SECTION 4 E24
SCALE: 1" = 1'-0" REF: 6/ S303
11 3/4" ARCH VERIFY
NO
APPROVER NOTE: ARE STUDS REQ'D?
BENT PL19 x 6¼ x 5/16 w/ ½" STUD x 0'-6 @ 16" O/C
1'-8
L3x3x¼ CONT.
L3x3x¼ @ 4'-0 o/c
L2½x2½x3/16 @ 4'-0 o/c
HSS4x4x¼ BETWEEN COL'S
L2½x2½x3/16 @ 4'-0 o/c
L3x3x¼ CONT.
3'-9
1'-9
1'-0 3/4"
SECTION 5 E24
SCALE: 1" = 1'-0" REF: 7/ S306
APPROVER NOTE: PLEASE SUPPLY WIDTH OF PLATE
1'-8"
CONT. PL x 6¼ x 5/16 BENT
SEE PLAN
APPROVER NOTE: HOW IS BENT PLATE ATTACHED TO BEARING WALLS?
1/8" FILLET WELD BETWEEN BOTTOM OF PLATE AND TOP TRACK, 2" LONG, 8" SPACING EACH SIDE
BEARING WALL
SECTION 6 E24
SCALE: 1" = 1'-0" REF: 19/ S304
APPROVER NOTE: PLEASE VERIFY BEARING WALLS STOP AT EDGE OF SLAB
CM/ GC NOTE: BENT PLATES MUST BE SHORED BETWEEN BEARING WALLS NOT BY AMTHOR
YES
APPROVER NOTE: DOES PLATE EXTENT BACK TO COLUMN LINE?
CONT. PL20 x 6¼ x 5/16 BENT
1'-8
CONT. L3x3x¼
HSS4x4x¼
USE L3X3X1/4 4" LONG, WELD TO STUD W/ 1/8" FILLET
APPROVER NOTE: PLEASE SUPPLY HOW TUBE IS TO CLIP TO STUD WALL
4'-0
3'-9
SECTION 7 E24
SCALE: 1" = 1'-0" REF: 22/ S305
SECTION 8 E24
SCALE: 1" = 1'-0" REF: 5/ S303
PL6¼ x 4¾ x ¼ BENT
5¾
SECTION 9 E24
SCALE: 1" = 1'-0" REF: 3/ S303
CONT. PL36 x 6¼ x 5/16 BENT
2'-2
SECTION 10 E24
SCALE: 1" = 1'-0" REF: 4/ S306
APPROVER NOTE: DOES PLATE EXTENT BACK TO COLUMN LINE?
CONT. PL14½ x 6¼ x 5/16 BENT
1'-2½
SECTION 11 E24
SCALE: 1" = 1'-0" REF: 23/ S305
YES
APPROVER NOTE: DOES PLATE EXTENT BACK TO COLUMN LINE?
CONT. PL18½ x 6¼ x 5/16 BENT
1'-6½
SECTION 12 E24
SCALE: 1" = 1'-0" REF: 4/ S306
EL.= +65'-0
PL17 x 5 x ¼ BENT
1'-6
APPROVER NOTE: PLEASE VERIFY BENT PLATE IS ONLY REQUIRED @ ELEVATOR OPENING
SECTION 13 E24
SCALE: 1" = 1'-0" REF: 5/ S305
SEE PLAN
SEE PLAN
EL.=12'-0
W14x26
1-PL¼ x 5½ x 0'-6 2BP1
2-⅜"RODx1'-4 2AR1
T/PL EL.= 10'-10⅛
PROJECTION
SECTION 14 E24
SCALE: 1" = 1'-0" REF: 16/ S307
EL.=12'-0
CONT. L4 x 4 x ¼ w/
APPROVER NOTE: PLEASE SUPPLY ANCHOR TYPE,SIZE AND SPACING
SECTION 15 E24
SCALE: 1" = 1'-0" REF: 20/ S307
11" @ OVERLAP
APPROVER NOTE: VERIFY BENT PLATE IS REQ'D
5/16" BENT PLATE
5¼" SLAB
3'-6
2'-6
1'-4¾
4" WEARING SLAB
TOP OF BEAM EL.= +17'-6¾
TOP OF BEAM EL.= VARIES
5" P.T. SLAB
APPROVER NOTE: SLABS OVERLAP? PLEASE ADVISE
SECTION 17 E24
SCALE: 1" = 1'-0" REF: 22/ S306
PL½ x 6½ x 3'-0
1'-10¼
5/16" BENT PLATE
5¼" SLAB
TOP OF BEAM EL.= +18'-2
TOP OF BEAM EL.= +17'-6¾
W21x44
W10x12
40B6
W16x26
41B3
SECTION 16 E24
SCALE: 1" = 1'-0" REF: 22/ S306
Jezerinac Geers Structural Engineering
JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14
NO EXCEPTIONS TAKEN
MAKE CORRECTIONS NOTED
REVISE AND RESUBMIT
NOT REVIEWED
REJECTED
JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.
ARQUITECTONICA
Project No. 22920
Control No. 051200-0011-00507 DL 06/12/2014
Reviewed
Make Corrections as Noted
Revise and Resubmit
Rejected
Turner Construction Company
Reviewed for General Acceptance Only. SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 05/28/2014
REVISIONS
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920
CARRARA STEEL
THE GARDENS
PITTSBURGH, PENNSYLVANIA.
CUST: TURNER CONSTRUCTION
SECTIONS & DETAILS
DRAWN MTD
CONTRACT No. 6425
DWG. No. E24
REF DWG: S304,S305,S306

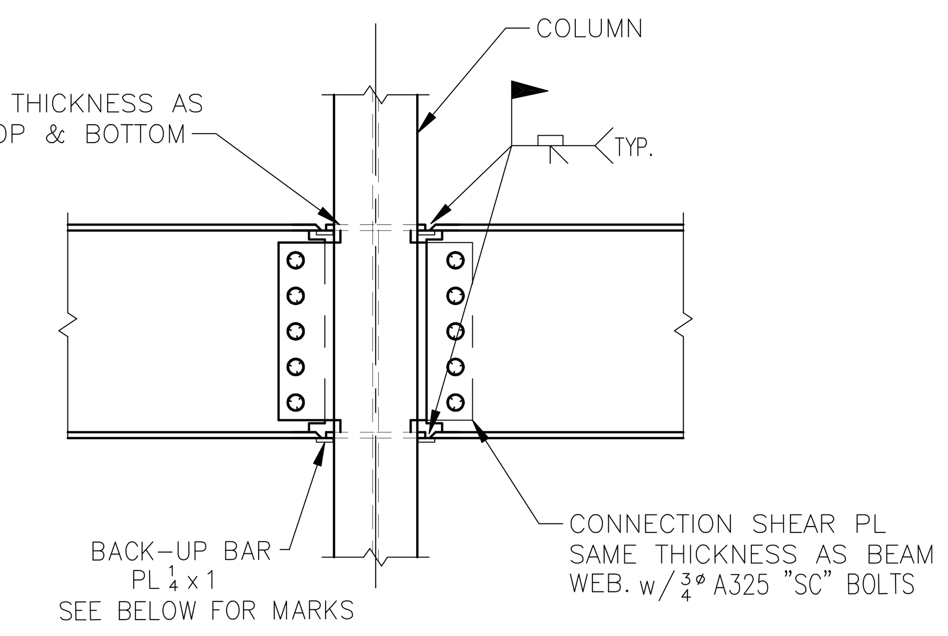
ERECTOR NOTES:

1) WOOD ATTACHED TO STEEL BY RAMSET OR EQUAL **NOT** BY AMTHOR.
2) ALL A325 BOLTS IN STANDARD HOLES, TO HAVE ONE HARDENED WASHER UNDER THE TURNED ELEMENT. A HARDENED WASHER MUST COVER ALL OVERSIZED OR SHORT SLOTTED HOLES IN THE OUTER PLIES OF A CONNECTION. ALL LONG SLOS IN AN OUTER PLY OF A CONNECTION MUST BE COVER BY A 5/16" PLATE WASHER
3) ALL FIELD BOLTS ARE ¾"ASTM–A325 U.N.O.
4) ALL SHOP & FIELD BOLTS TO BE TIGHTENED AS FOLLOWS,
   A) BOLTS ARE TO BE TIGHTENED TO THE "SNUG TIGHT" CONDITION, WHERE ALL PLIES OF A CONNECTION ARE IN FIRM CONTACT.
   B) BOLTS NOTED "S.C." INDICATE SLIP CRITICAL BOLTS AND ARE TO BE TIGHTENED TO FULL PRETENSIONING LOAD.
5) FIELD WELD PER LATEST AWS SPECS–70 KSI (SEE SECTIONS & DETAILS)
6) ERECTOR PLACE MARKED END OF PIECE TO CORRESPOND WITH LOCATION OF PIECE MARKS ON ERECTION DWG's.



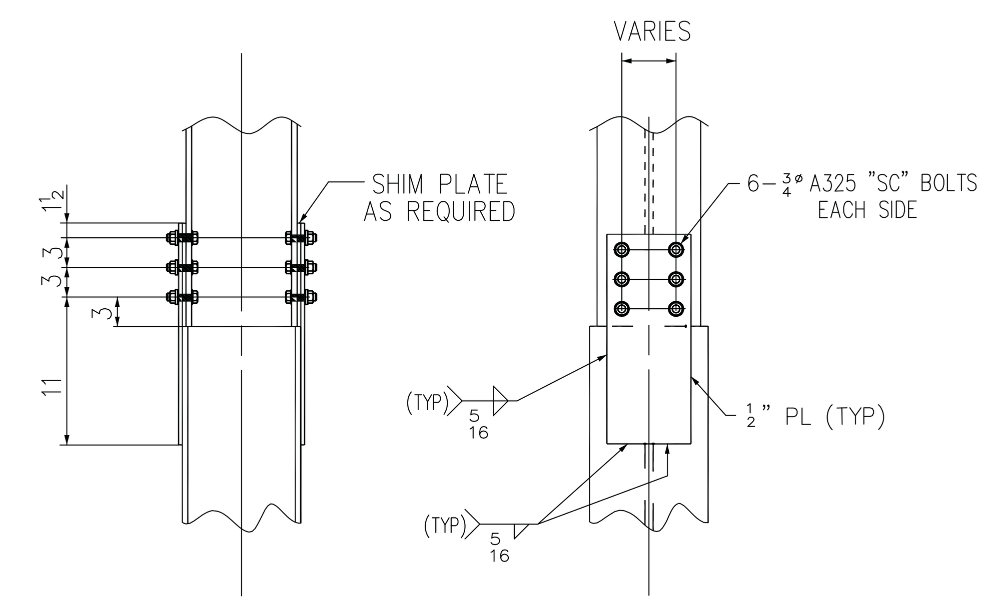
TYPICAL MOMENT CONNECTION TO COLUMN FLANGE DETAIL

6" BEAM FLANGE ~
7" BEAM FLANGE ~
9" BEAM FLANGE ~
10½" BEAM FLANGE ~
12½" BEAM FLANGE ~

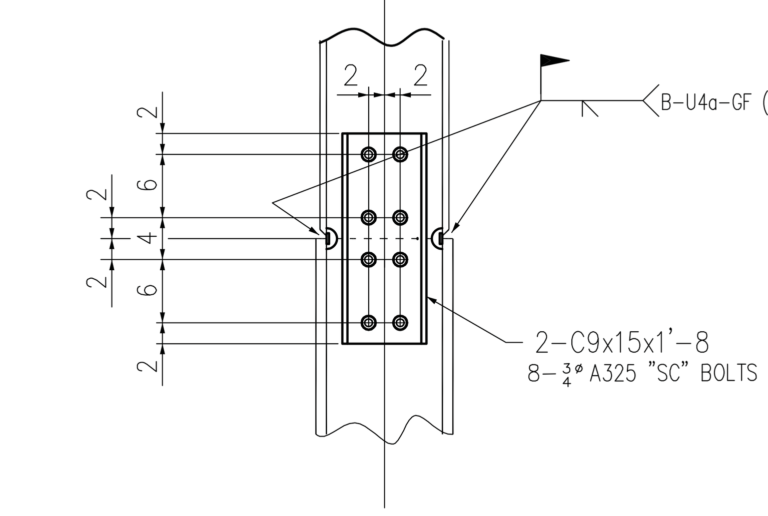


TYPICAL MOMENT CONNECTION TO COLUMN WEB DETAIL

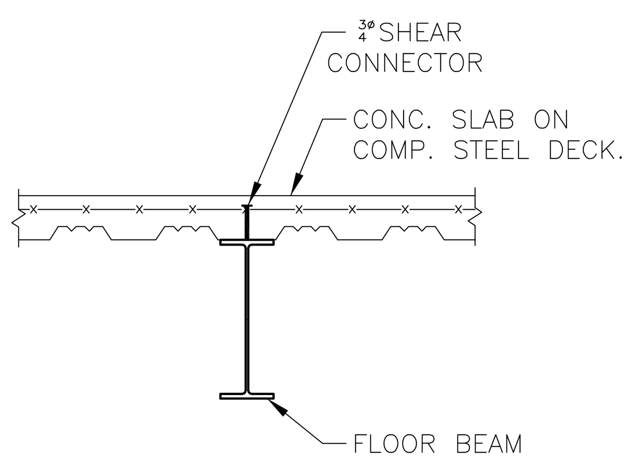
6" BEAM FLANGE ~
7" BEAM FLANGE ~
9" BEAM FLANGE ~
10½" BEAM FLANGE ~
12½" BEAM FLANGE ~



TYPICAL COLUMN SPLICE DETAIL
(SIMILAR DEPTH SHAFTS) REF: 1/ S200



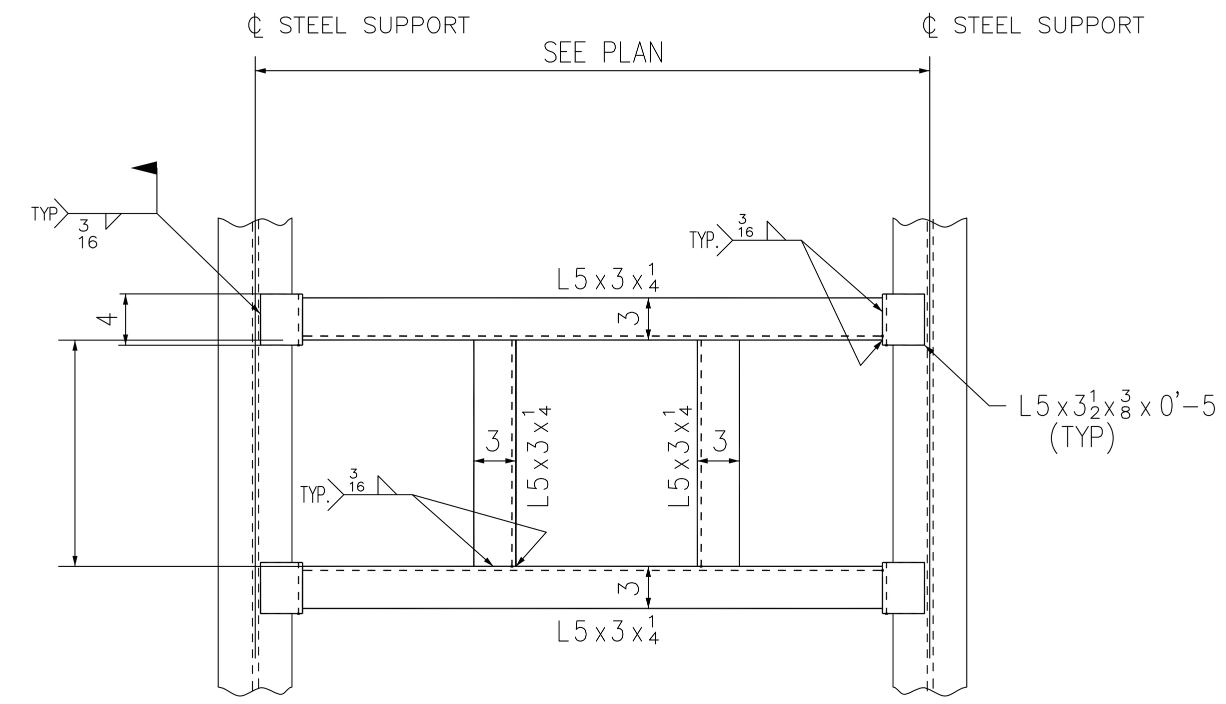
MOMENT FRAME COLUMN SPLICE DETAIL
(SIMILAR DEPTH SHAFTS) REF: 1/ S201



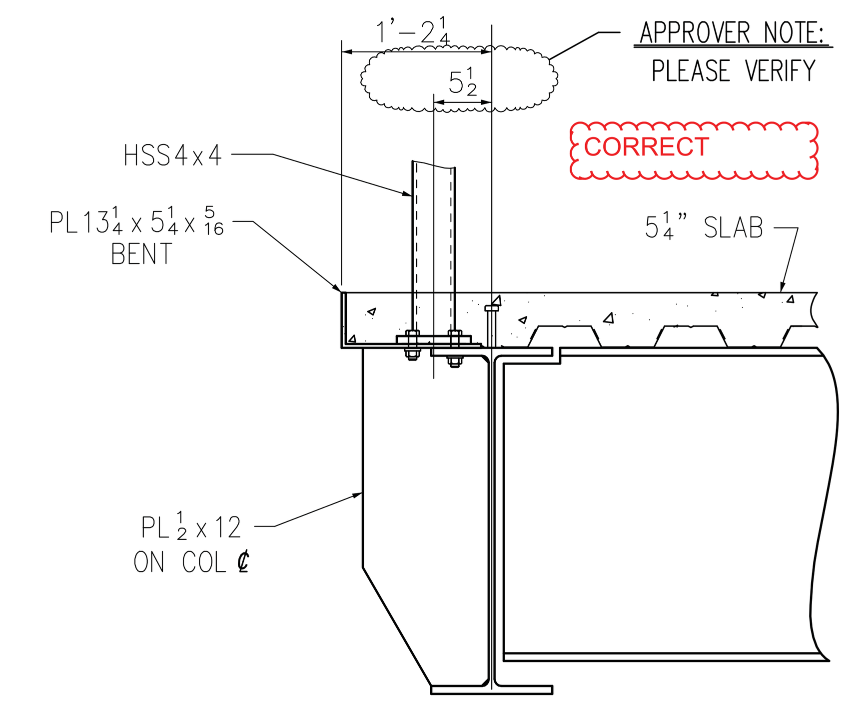
TYPICAL SHEAR STUD PLACEMENT DETAIL

NOTES:

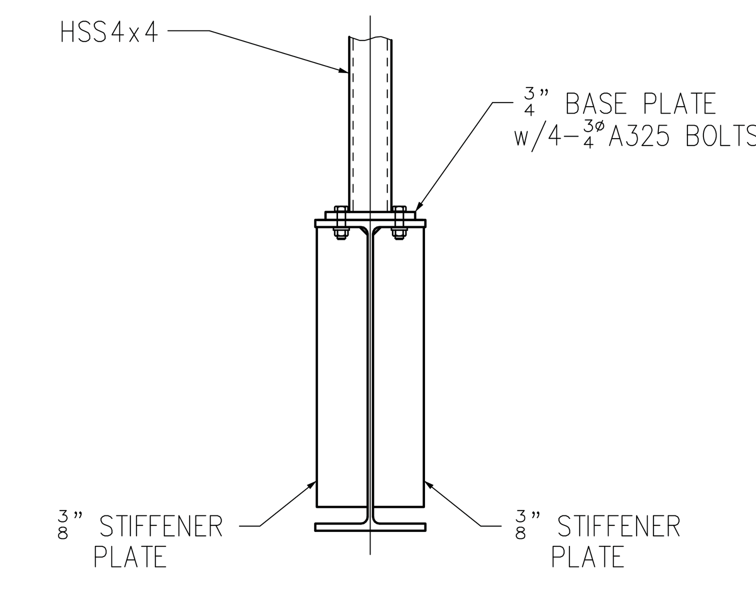
1) ALL STUDS TO BE ¾" x 0'–4" AFTER WELDING ~ SHEAR STUD CONNECTORS ARE INDICATED THUS (xx) ON PLAN.
2) PLACE SHEAR STUDS IN ONE ROW ON MEMBER CENTERLINE WHENEVER POSSIBLE. DO NOT EXCEED TWO ROWS OF STUDS SIDE BY SIDE
3) THE TOTAL NUMBER OF STUDS SHOWN ON PLAN ARE TO BE SPACED EQUALLY ALONG THE LENGTH OF THE MEMBER OR BETWEEN CONNECTED ELEMENTS WHERE MULTIPLE STUD DESIGNATIONS ARE GIVEN. STUDS ARE TO BE A MINIMUM OF 4" ON CENTER AND A MAXIMUM OF 36" ON CENTER.
4) SHEAR STUDS PLACED SIDE BY SIDE ARE TO BE A MINIMUM OF 3" ON CENTER.
5) LOCATE FIRST STUD 6" MINIMUM OR 12" MAXIMUM FROM END OF MEMBER



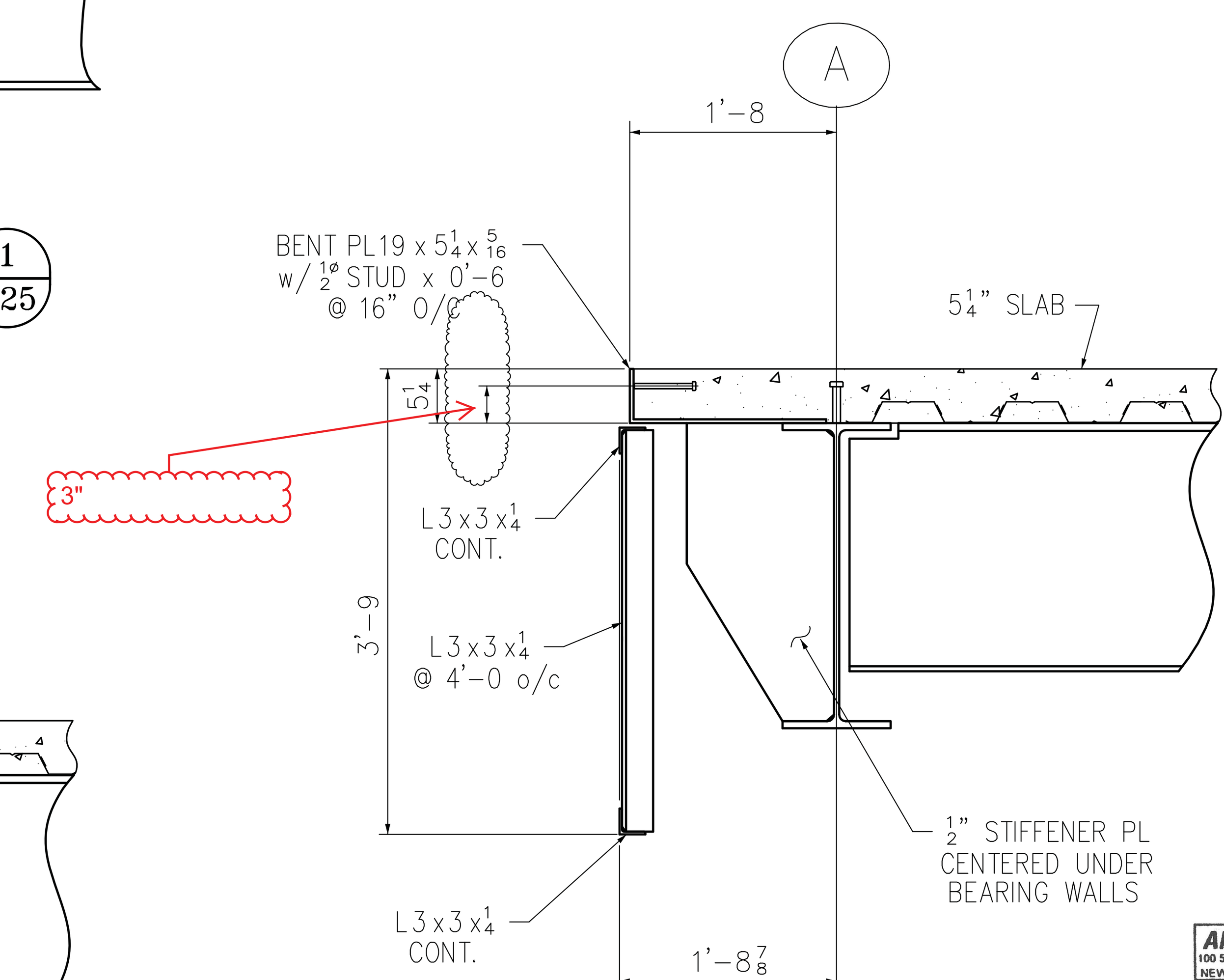
TYPICAL FLOOR FRAME DETAIL



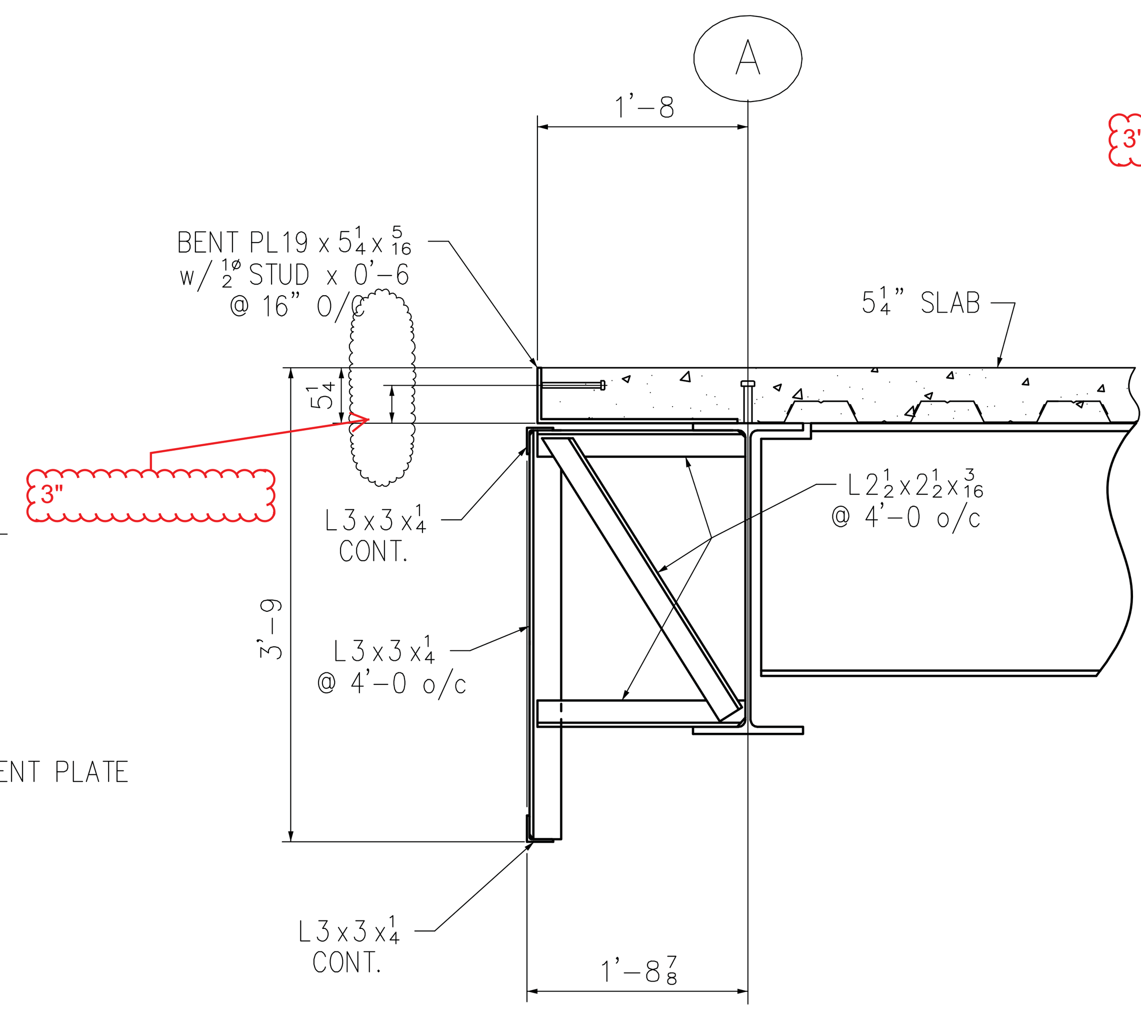
SECTION 1 E25
SCALE: 1" = 1'–0" REF: 21/ S304



SECTION 2 E25
SCALE: 1" = 1'–0" REF: 14/ S306

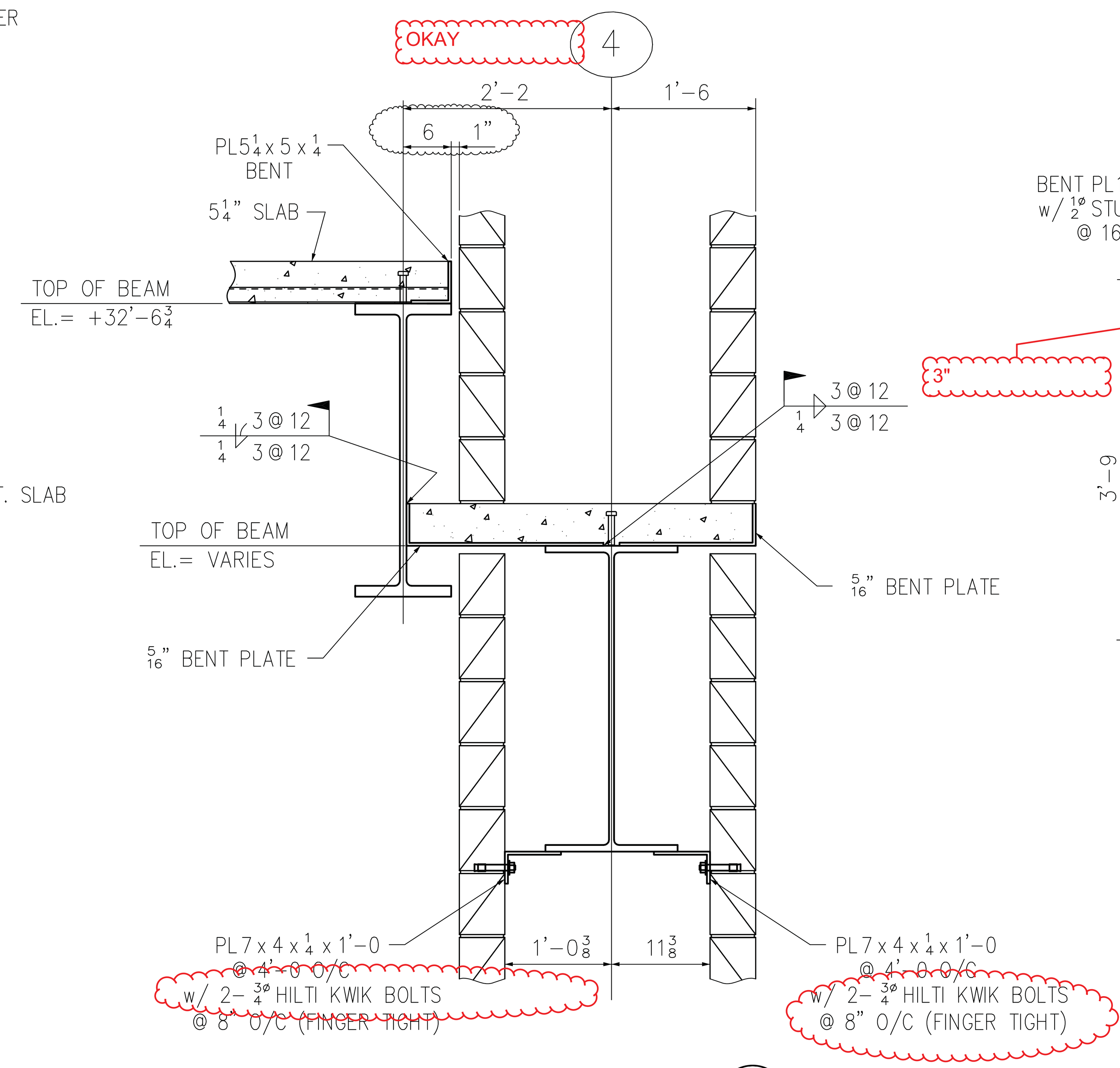


SECTION 6 E25
SCALE: 1" = 1'–0" REF: 11/ S306

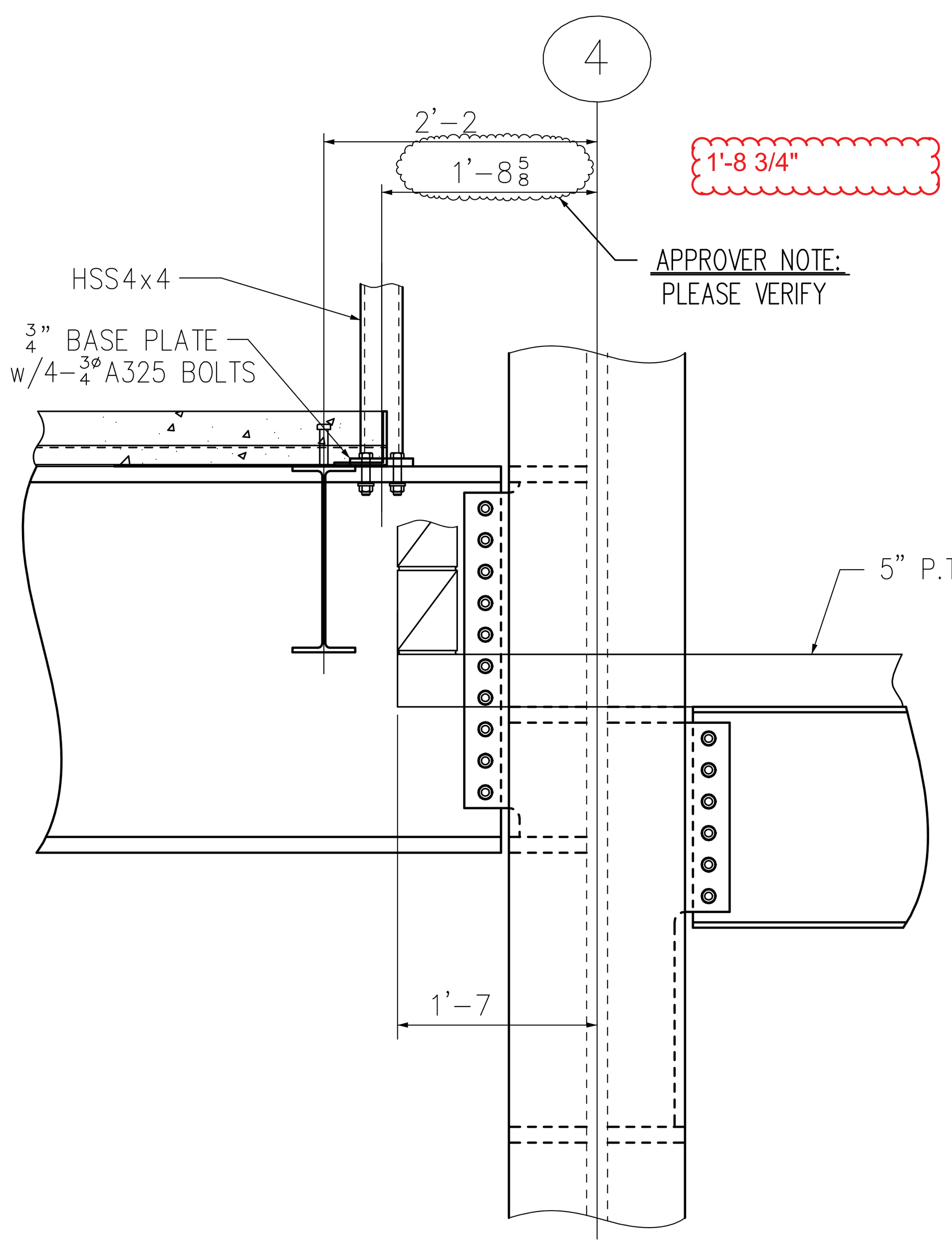


SECTION 5 E25
SCALE: 1" = 1'–0" REF: 21/ S305

USE 5/8" ADHESIVE ANCHORS PER 1/ S002



SECTION 4 E25
SCALE: 1" = 1'–0" REF: 1/ S308



SECTION 3 E25
SCALE: 1" = 1'–0" REF: 21/ S307

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR NEW YORK, NY 10011-6903 TEL 212 254 2700 FAX 212 533 9203

Project No.	Submittal No.	Checked By	Return Date
22920			
Control No. 051200-0011-0050		DL	06/12/2014
Spec No.			

Reviewed — Revise and Resubmit
X Make Corrections as Noted — Rejected

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Jezerinac Geers Structural Engineering

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JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14

- [ ] NO EXCEPTIONS TAKEN
- [x] MAKE CORRECTIONS NOTED
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Alexandra Doonan 05/28/2014

REVISIONS

AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920 — CARRARA STEEL

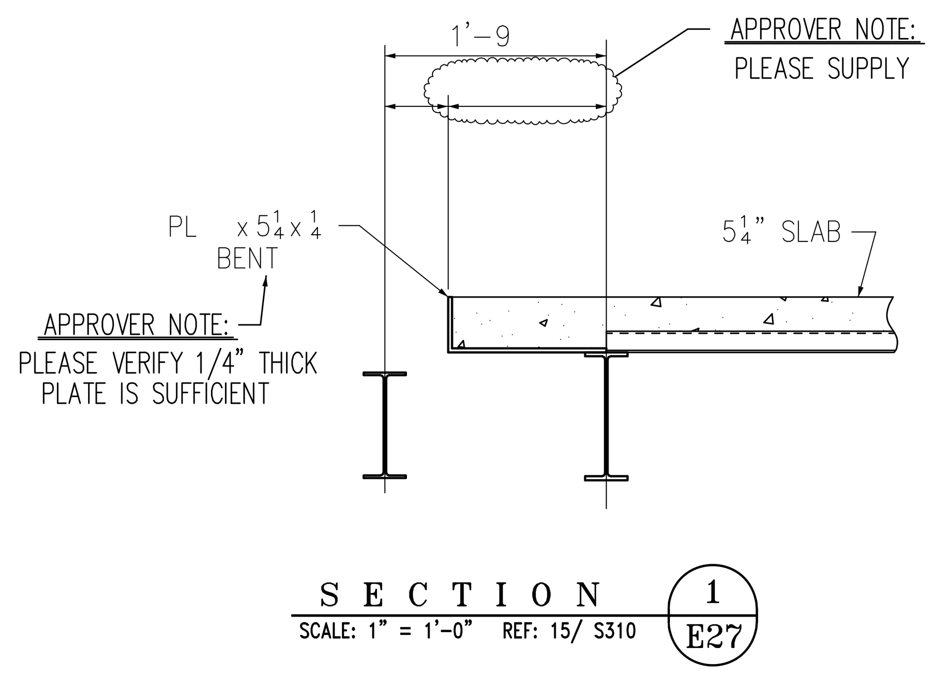
THE GARDENS
PITTSBURGH, PENNSYLVANIA.
CUST: TURNER CONSTRUCTION
TYPICAL SECTIONS & DETAILS

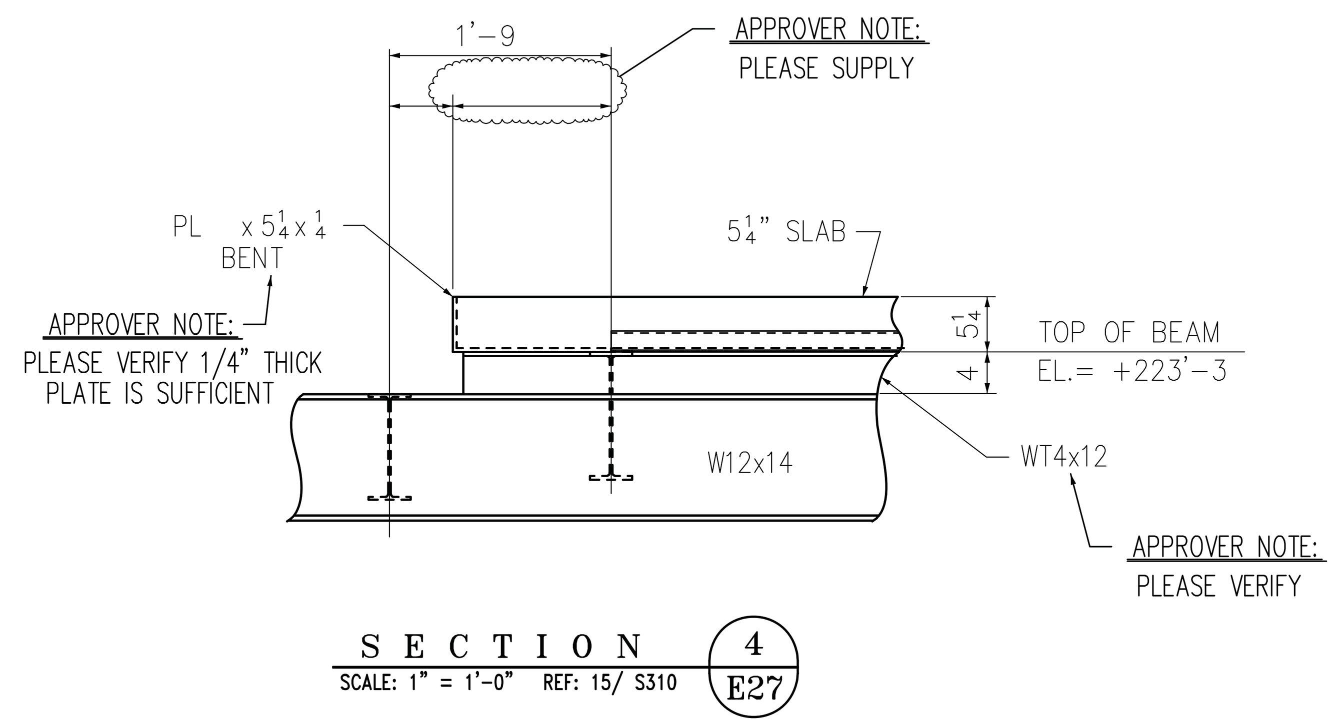
DRAWN: MTD
CHECKED
APPROVED

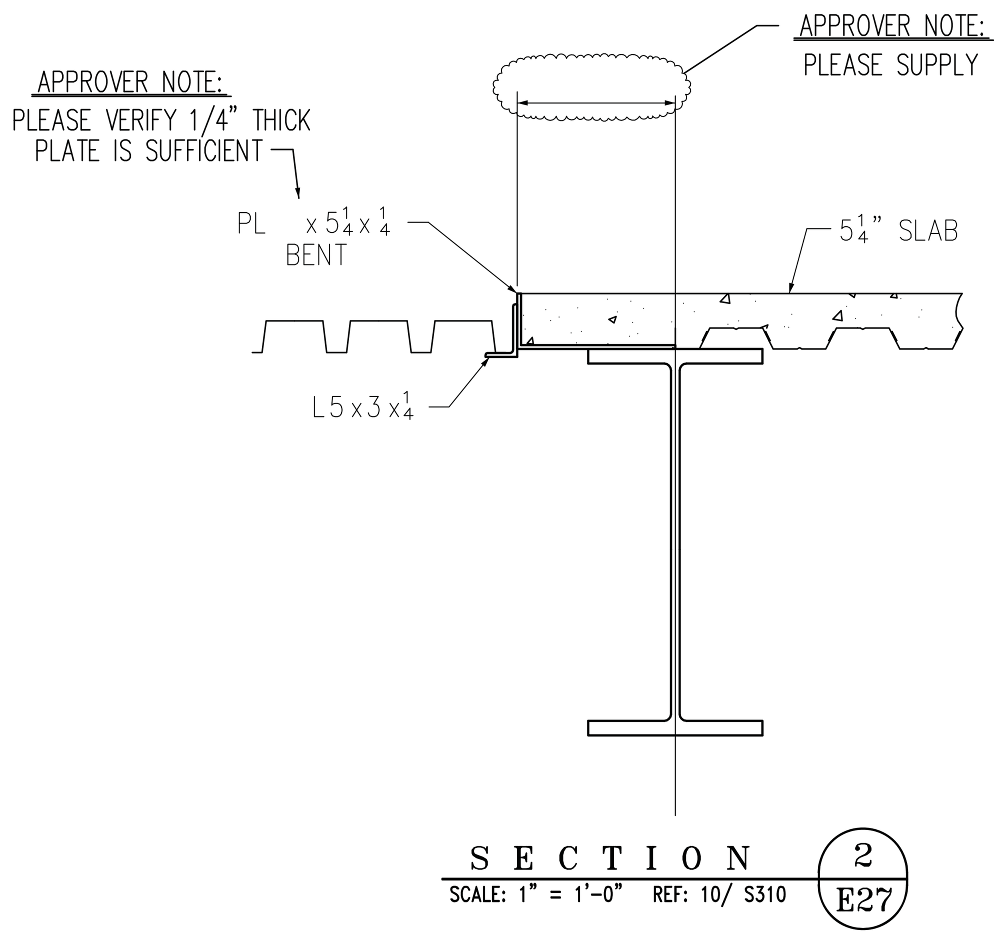
CONTRACT No. 6425
DWG. No. E25

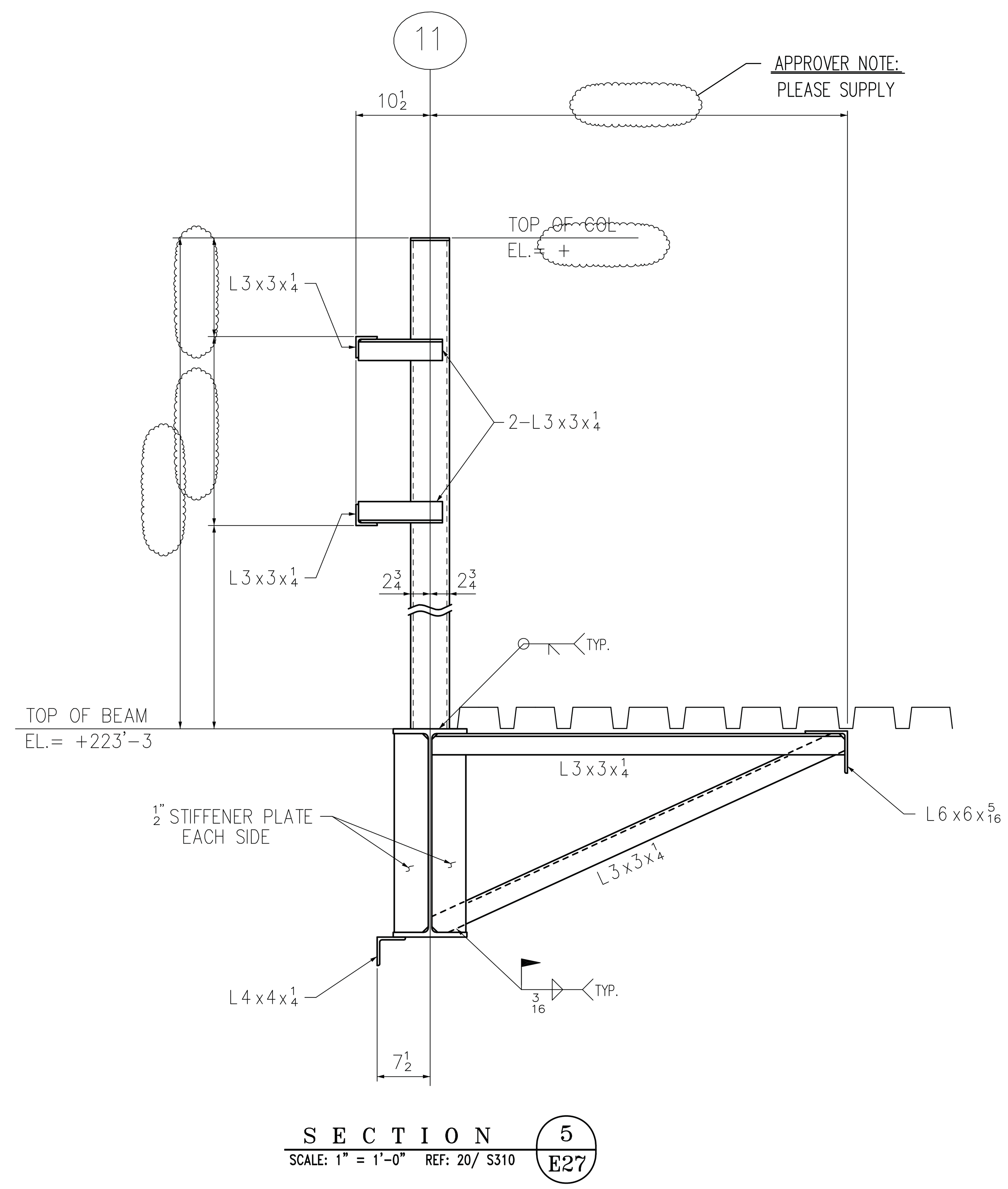
REF DWG: S304,S305,S306

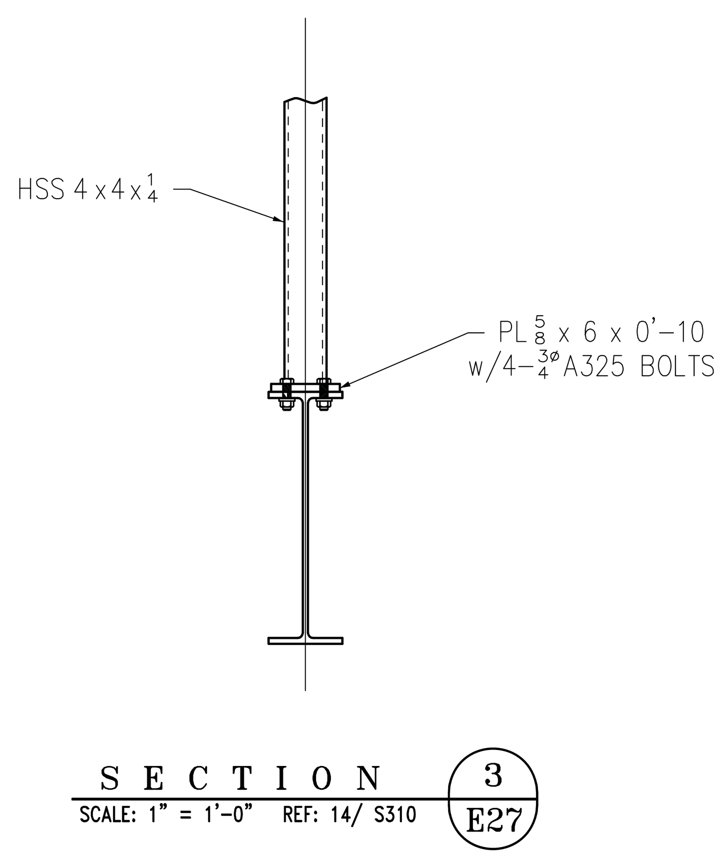
5 SPACES @ 8" = 3'-4
1'-10
PL 3/4 x 6 x 0'-10 w/4-3/4"A325 BOLTS
WT4x12x5'-0 ~ 106M1 w/ 1/2" STUD x 0'-4 @ 8" O.C
5" P.T. SLAB
1'-7
SECTION 1 E26
SCALE: 1" = 1'-0" REF: 4/ S308
PL 3/4 x 6 x 0'-10
PL 3/4 x 8 x 1'-7 w/4-3/4"A325 BOLTS
WT4x12x5'-0 ~ 106M2 w/ 1/2" STUD x 0'-4 @ 8" O.C
SECTION 2 E26
SCALE: 1" = 1'-0" REF: 4/ S308
APPROVER NOTE: PLEASE VERIFY, TUBE INTERFERES WITH SLAB & 6" CMU WALL
1'-8 3/4"
1'-8 5/8
HSS 6 x 4 x 1/4
PL 5/8 x 6 1/2 x 0'-9
PL 3/4 x 6 x 0'-10 w/4-3/4"A325 BOLTS
HSS 4 x 4 x 1/4 111C2
SECTION 3 E26
SCALE: 1" = 1'-0" REF: 3/ S308
1'-8 "
A
6
5" P.T. SLAB
EL.= +41'-0
1'-1
HSS6 x 4 x 1/4
L3 x 3 x 1/4
4'-0" ARCH VERIFY
3'-9
4-0
D
1/2"
L3 x 3 x 1/4
HSS6 x 4 x 1/4
APPROVER NOTE: PLEASE SIZE
SECTION 4 E26
SCALE: 1" = 1'-0" REF: 3/ S307
CORRECT
APPROVER NOTE: PLEASE VERIFY, S104 SHOWS EOS @ 1'-6 SECTION 4 ON S307 HAS EOS @ 1'-5
1'-6
APPROVER NOTE: IS BENT PLATE REQ'D? PLEASE SIZE
SECTION 5 E26
SCALE: 1" = 1'-0" REF: 4/ S307
CORRECT
APPROVER NOTE: PLEASE VERIFY, S104 SHOWS EOS @ 1'-6 SECTION 7 ON S307 HAS EOS @ 1'-5
1'-6 SECT 6
1'-3 SECT 6A
APPROVER NOTE: IS BENT PLATE REQ'D? PLEASE SIZE
SEE BULLETIN #7
APPROVER NOTE: IS BENT PLATE REQ'D? PLEASE SIZE
SEE 1/S002
SECTION 6 6A E26 E26
SCALE: 1" = 1'-0" REF: 7/ S307
APPROVER NOTE: PLEASE VERIFY, S104 SHOWS EOS @ 6 1/2" SECTION 8 ON S307 HAS EOS @ 11"
E
6 1/2 SECT 7
1'-3 1/2 SECT 7A
APPROVER NOTE: PLEASE VERIFY, S104 SHOWS EOS @ 1'-3 1/2" SECTION 9 ON S307 HAS EOS @ 1'-8
APPROVER NOTE: IS BENT PLATE REQ'D? PLEASE SIZE
SEE BULLETIN #7
SECTION 7 7A E26 E26
SCALE: 1" = 1'-0" REF: 8&9/ S307
1'-7
6 1/4" SLAB
PL 7 x 4 x 1/4 x 1'-0 @ 4'-0 O/C w/ 2-3/8" HILTI KWIK BOLTS @ 8" O/C (FINGER TIGHT)
1'-0 3/8
USE 5/8" ADHESIVE ANCHORS PER 1/ S002
SECTION 8 E26
SCALE: 1" = 1'-0" REF: 5/ S308
1'-7 1'-6
6 1/4" SLAB
3@12
3@12
5/16" BENT PLATE
TOP OF BEAM EL.= VARIES
TOP OF BEAM EL.=
5/16" BENT PLATE
HSS 6 x 4 x 1/4
APPROVER NOTE: PLEASE SUPPLY
PL 7 x 4 x 1/4 x 1'-0 @ 4'-0 O/C w/ 2-3/8" HILTI KWIK BOLTS @ 8" O/C (FINGER TIGHT)
1'-0 3/8
11 3/8
PL 7 x 4 x 1/4 x 1'-0 @ 4'-0 O/C w/ 2-3/8" HILTI KWIK BOLTS @ 8" O/C (FINGER TIGHT)
SECTION 9 E26
SCALE: 1" = 1'-0" REF: 6/ S308
USE 5/8" ADHESIVE ANCHORS PER 1/ S002
H.1
6 1/4
BENT PL 6 1/4 x 5 1/4 x 5/16 w/ 1/2" STUD x 0'-6 @ 16" O/C
APPROVER NOTE: ARE STUDS REQ'D?
NOT REQ'D
L3 x 3 x 1/4 CONT.
L3 x 3 x 1/4 @ 4'-0 o/c
3'-9
2"
HSS4 x 4 x 1/4 BETWEEEN COLS
L2 1/2 x 2 1/2 x 3/16 @ 4'-0 o/c
L3 x 3 x 1/4 CONT.
7 1/4 6 1/4
1
SECTION 10 E26
SCALE: 1" = 1'-0" REF: 7/ S306
STEEL FRAMING NOT REQUIRED FROM LEVELS 5-11
APPROVER NOTE: PLEASE SUPPLY CONNECTION
HSS 6 x 4 x 1/4
SECTION 11 E26
SCALE: 1" = 1'-0"
Jezerinac Geers Structural Engineering
JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14
NO EXCEPTIONS TAKEN
MAKE CORRECTIONS NOTED
REVISE AND RESUBMIT
NOT REVIEWED
REJECTED
JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.
ARQUITECTONICA
Project No 22920
Control No 051200-001-00509 DL 06/12/2014
Reviewed
Make Corrections as Noted
Revise and Resubmit
Rejected
Turner Construction Company
Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades. SUBJECT TO ARCHITECT'S APPROVAL.
Alexandra Doonan 05/28/2014
REVISIONS
AMTHOR STEEL
ERIE, PENNSYLVANIA
SINCE 1920
CARRARA STEEL
THE GARDENS
PITTSBURGH, PENNSYLVANIA.
CUST: TURNER CONSTRUCTION
TYPICAL SECTIONS & DETAILS
DRAWN MTD
CONTRACT No. 6425
DWG. No. E26











Jezerinac Geers Structural Engineering

Submittals have been reviewed for conformance with the design principles and Contract Documents. Corrections or comments made as part of this review process do not relieve the Contractor from compliance with the requirements of the plans and specifications, and with applicable codes and laws. The contractor is not relieved of his sole responsibility regarding checking of dimensions; accuracy or completeness of the submittal; coordination of the Work with other trades; information that pertains solely to fabrication process; of the means, methods, and sequences of the construction process; and performing the Work in a safe and satisfactory manner.

JGA Project No.: 11581
Reviewed By: DRG
Date Reviewed: 6/09/14

- [ ] NO EXCEPTIONS TAKEN
- [ ] MAKE CORRECTIONS NOTED
- [ ] REVISE AND RESUBMIT
- [x] NOT REVIEWED
- [ ] REJECTED

JEZERINAC GEERS COMMENTS ON THIS SUBMITTAL ARE POSTED IN RED.

Turner Construction Company

Reviewed for General Acceptance Only. This review does not relieve the subcontractor for making the work conform to the requirements of the contract. The subcontractor is responsible for all the dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECT'S APPROVAL.

Alexandra Doonan 05/28/2014

ARQUITECTONICA
100 5TH AVENUE, 10TH FLOOR
NEW YORK, NY 10011-6903
TEL 212.254.2700
FAX 212.533.9203

Project No 22920	Subm. No	Checked By	Return Date
Control No 051200-0011-00510		DL	06/12/2014
Spec No			

NOT Reviewed ____ Revise and Resubmit
____ Make Corrections as Noted ____ Rejected

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general documents. The contractor is responsible for confirming and correcting all quantities and dimensions: selecting fabrication processes and techniques of construction: coordinating this work with that of all other trades and performing this work in safe and satisfactory manner. Contractor Note: Action checked above does not authorize changes to contract sum or contract time unless stated in separate letter of construction change authorization.

REVISIONS

AMTHOR STEEL

ERIE, PENNSYLVANIA
SINCE 1920 CARRARA STEEL

THE GARDENS
PITTSBURGH, PENNSYLVANIA.
CUST: TURNER CONSTRUCTION
TYPICAL SECTIONS & DETAILS

DRAWN MTD	CONTRACT No.	DWG. No.
CHECKED	6425	E27
APPROVED		

Appendix D: Cost Comparison of Structural Member Calculations


Edited from Source: Turner Construction via Arquitectonica

Table 1

COST COMPARISON: CASE 1
30'-0 span filler beam, 10'-0 o.c.

	Description	$/ft	$/sf
50/C)	W16x26 grade 50	7.41	
	20 studs	1.00	
	theoretical deflection = 1.07"		
	camber = 75% of defl. = 13/16"	0.78	
	TOTAL	9.19	0.919
50/U)	W16x26 grade 50	7.41	
	20 studs	1.00	
	theoretical deflection = 1.07"		
	ponding conc.= 75% of defl.= 13/16"	1.00	
	TOTAL	9.41	0.941
36/U)	W16x31 grade 36	8.37	
	34 studs	1.70	
	theoretical deflection = 0.86"		
	ponding conc.= 75% of defl. = 5/8"	0.77	
	TOTAL	10.84	1.084
36/C)	W16x31 grade 36	8.37	
	34 studs	1.70	
	theoretical deflection = 0.86"		
	camber = 75% of defl. = 5/8"	0.93	
	TOTAL	11.00	1.100

Savings:

	$/ft	$/sf
camber:	0.22	0.022
high-strength steel:	1.43	0.143
TOTAL	1.65	0.165

Table 2

COST COMPARISON; CASE 2

38'-0 span filler beam, 10'-0 o.c.

	Description	$/ft	$/sf
50/C)	W18x35 grade 50	9.98	
	36 studs	1.42	
	theoretical deflection = 1.63"		
	camber = 75% of defl. = 1 1/4"	1.05	
	TOTAL	12.45	1.245
50/U)	W18x35 grade 50	9.98	
	36 studs	1.42	
	theoretical deflection = 1.63"		
	ponding conc.= 75% of defl. = 1 1/4"	1.54	
	TOTAL	12.94	1.294
36/U)	W21x44 grade 36	11.88	
	34 studs	1.34	
	theoretical deflection = 0.99"		
	ponding conc.= 75% of defl. = 3/4"	0.93	
	TOTAL	14.15	1.415
36/C)	W21x44 grade 36	11.88	
	34 studs	1.34	
	theoretical deflection = 0.99"		
	camber = 75% of defl. = 3/4"	1.32	
	TOTAL	14.54	1.454

Savings:

camber:	0.49	0.049
high-strength steel:	1.21	0.121
TOTAL	1.70	0.170

Table 3

COST COMPARISON; CASE 3
45'-0 span filler beam,10'-0 o.c.

	Description	$/ft	$/sf
50/C)	W21x44 grade 50	12.54	
	44 studs	1.47	
	theoretical deflection = 1.94"		
	camber = 75% of defl. = 1 7/16"	1.32	
	TOTAL	15.33	1.533
50/U)	W21x44 grade 50	12.54	
	44 studs	1.47	
	theoretical deflection = 1.94"		
	ponding conc.= 75% of defl. = 1 7/16"	1.77	
	TOTAL	15.78	1.578
36/C)	W24x55 grade 36	14.85	
	46 studs	1.53	
	theoretical deflection = 1.21"		
	camber = 75% of defl. = 15/16"	1.10	
	TOTAL	17.48	1.748
36/U)	W24x55 grade 36	14.85	
	46 studs	1.53	
	theoretical deflection = 1.21"		
	ponding conc.= 75% of defl. = 15/16"	1.16	
	TOTAL	17.54	1.754

Savings:

	$/ft	$/sf
camber:	0.45	0.045
high-strength steel:	1.76	0.176
TOTAL	2.21	0.221

Table 4

COST COMPARISON; CASE 4

30'-0 span girder supp't 30'-0 beams @ 10'-0 o.c.

	Description	$/ft	$/sf
50/C)	W21x50 grade 50	14.25	
	52 studs	2.60	
	theoretical deflection = 0.89"		
	camber = 75% of defl. = 11/16"	1.50	
	TOTAL	18.35	0.612
50/U)	W21X50 grade 50	14.25	
	52 studs	2.60	
	theoretical deflection = 0.89"		
	ponding conc.= 75% of defl. = 11/16"	2.55	
	TOTAL	19.40	0.647
36/C)	W24x62 grade 36	16.74	
	58 studs	2.90	
	theoretical deflection = 0.56"		
	camber = 75% of defl. = 7/16"	1.24	
	TOTAL	20.88	0.696
36/U)	W24x62 grade 36	16.74	
	58 studs	2.90	
	theoretical deflection = 0.56"		
	ponding conc.= 75% of defl. = 7/16"	1.62	
	TOTAL	21.26	0.709

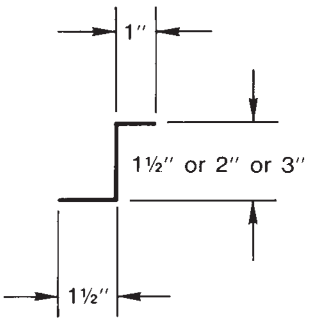
Savings:

	$/ft	$/sf
camber:	1.05	0.035
high-strength steel:	1.86	0.062
TOTAL	2.91	0.097

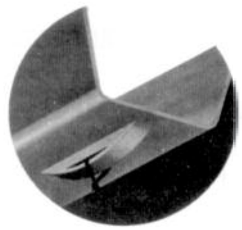
Appendix E: Vulcraft Catalog Decks

Edited from Source: Turner Construction via Arquitectonica

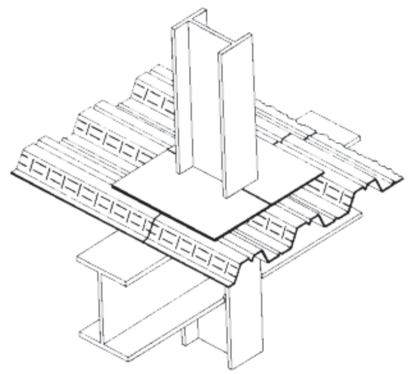
NON-COMPOSITE & COMPOSITE DECK DETAILS



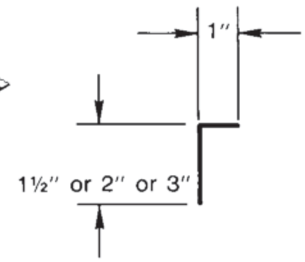
"Z" Closure



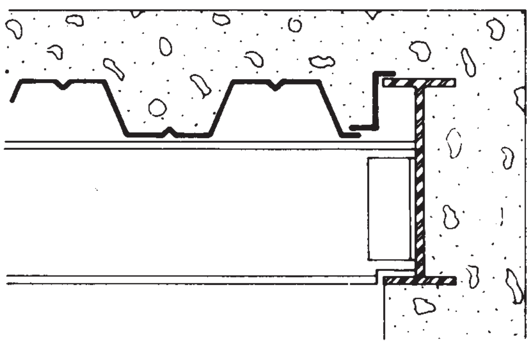
Hanger Tab
Max. Load
60 lbs. per Tab
#12 Wire Minimum



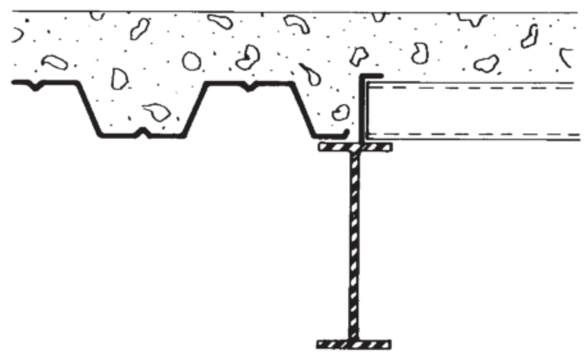
COLUMN CLOSURE



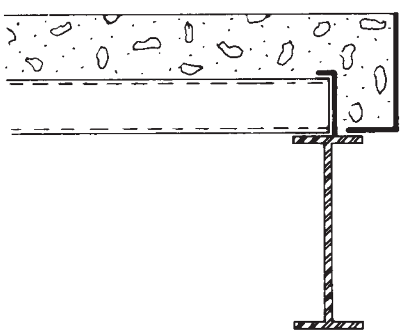
Cell Closure



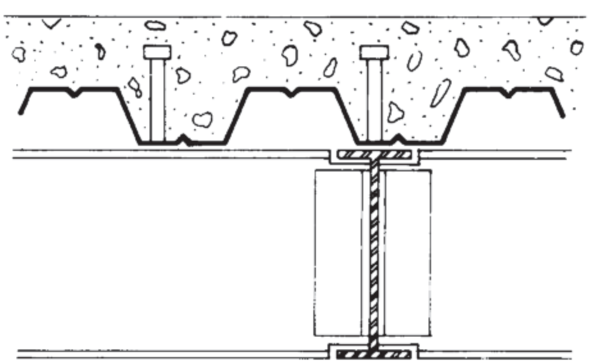
"z" CLOSURE



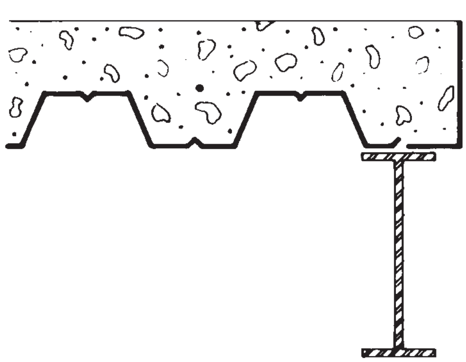
CELL CLOSURE



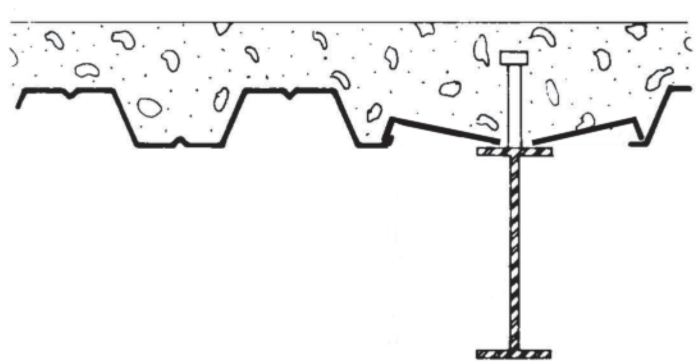
POUR STOP AT END



STUD LOCATIONS



POUR STOP AT SIDE



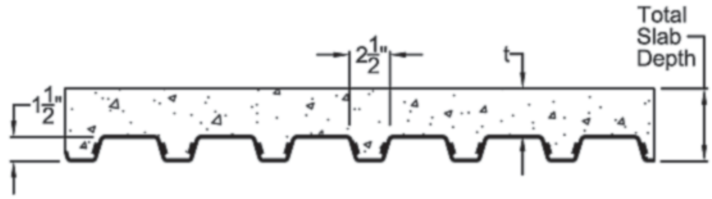
GIRDER FILLER

COMPOSITE

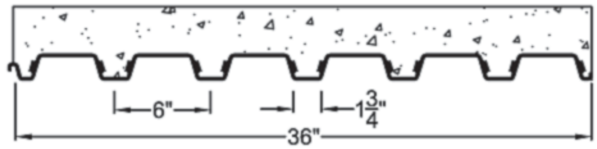
1.5 VL, VLI

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0
ICBO Approved (N0. 3415)

VL



VLI



Interlocking side lap is not drawn to show actual detail.

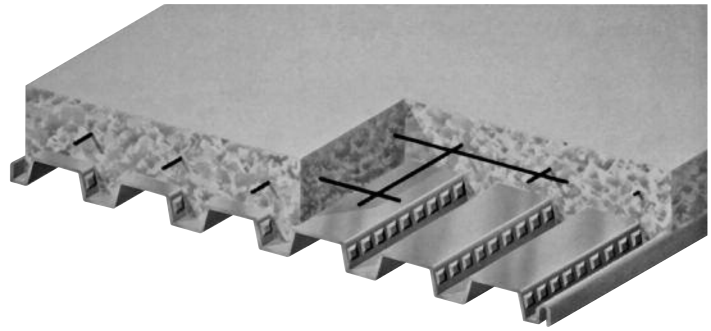
STEEL SECTION PROPERTIES

Deck Type	Design Thickness in	Deck Weight psf	Section Properties I_p in^4/ft	S_p in^3/ft	I_n in^4/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
1.5VL22	0.0295	1.78	0.143	0.169	0.177	0.179	2754	50
1.5VL20	0.0358	2.14	0.186	0.224	0.222	0.231	3322	50
1.5VL19	0.0418	2.49	0.230	0.271	0.260	0.282	3857	50
1.5VL18	0.0474	2.82	0.272	0.311	0.295	0.324	4350	50
1.5VL16	0.0598	3.54	0.373	0.404	0.373	0.411	4336	40

(N=9.35) NORMAL WEIGHT CONCRETE (145 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span 1 SPAN	2 SPAN	3 SPAN	Superimposed Live Load, PSF Clear Span (ft.-in.) 5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0
3.50 (t=2.00) 33 PSF	1.5VL22	5'-10	7'-10	7'-10	314	279	230	206	186	169	154	141	130	120	111	100	87	76	67
	1.5VL20	7'-0	9'-4	9'-6	345	306	275	249	227	187	171	157	144	133	124	108	94	82	73
	1.5VL19	7'-11	10'-3	10'-8	372	330	296	268	244	224	186	171	157	145	134	116	101	88	78
	1.5VL18	8'-8	11'-0	11'-2	395	351	315	285	260	238	220	204	168	156	142	123	107	94	82
	1.5VL16	8'-10	11'-0	11'-4	397	353	316	286	261	239	221	205	169	156	145	135	119	105	92
4.00 (t=2.50) 39 PSF	1.5VL22	5'-6	7'-5	7'-5	366	325	267	239	216	196	179	164	151	139	129	119	111	103	96
	1.5VL20	6'-7	8'-10	8'-11	400	356	319	289	239	217	198	182	167	155	143	133	124	115	108
	1.5VL19	7'-5	9'-9	10'-1	400	383	344	311	283	235	215	197	182	168	156	145	135	126	115
	1.5VL18	8'-1	10'-5	10'-7	400	400	365	330	301	276	254	211	194	180	167	156	145	136	122
	1.5VL16	8'-3	10'-5	10'-9	400	400	365	330	301	276	255	211	194	180	167	155	145	136	127
4.50 (t=3.00) 45 PSF	1.5VL22	5'-3	7'-1	7'-1	400	345	307	275	248	225	205	188	173	159	147	136	127	118	109
	1.5VL20	6'-3	8'-5	8'-6	400	400	366	303	274	249	227	208	192	177	164	152	142	132	123
	1.5VL19	7'-1	9'-3	9'-7	400	400	393	356	325	269	246	226	208	192	179	166	155	144	135
	1.5VL18	7'-8	9'-11	10'-1	400	400	400	378	344	316	262	241	222	206	191	178	166	155	145
	1.5VL16	7'-10	9'-11	10'-3	400	400	400	377	344	315	262	240	222	205	190	177	165	155	145
5.00 (t=3.50) 51 PSF	1.5VL22	5'-0	6'-9	6'-9	400	391	347	311	280	254	232	213	195	180	167	154	143	133	124
	1.5VL20	6'-0	8'-1	8'-2	400	400	400	343	310	281	257	236	217	200	186	172	160	149	139
	1.5VL19	6'-9	8'-11	9'-2	400	400	400	400	335	304	278	255	235	218	202	188	175	163	153
	1.5VL18	7'-3	9'-6	9'-8	400	400	400	400	389	324	297	272	251	233	216	201	187	175	164
	1.5VL16	7'-5	9'-6	9'-10	400	400	400	400	388	323	295	271	250	232	215	200	187	175	164
5.50 (t=4.00) 57 PSF	1.5VL22	4'-10	6'-6	6'-6	400	400	388	348	314	285	260	238	219	202	186	173	160	149	138
	1.5VL20	5'-9	7'-9	7'-10	400	400	400	383	346	314	287	263	243	224	208	193	179	167	156
	1.5VL19	6'-5	8'-6	8'-9	400	400	400	400	374	340	311	286	263	243	226	210	196	183	171
	1.5VL18	7'-0	9'-1	9'-4	400	400	400	400	400	363	331	305	281	260	241	225	210	196	183
	1.5VL16	7'-1	9'-2	9'-5	400	400	400	400	400	361	330	303	279	259	240	224	209	195	183
6.00 (t=4.50) 63 PSF	1.5VL22	4'-8	6'-4	6'-4	400	400	400	385	347	315	288	263	242	223	206	191	178	165	153
	1.5VL20	5'-6	7'-5	7'-6	400	400	400	400	383	348	318	292	269	248	230	213	199	185	173
	1.5VL19	6'-2	8'-2	8'-5	400	400	400	400	400	377	344	316	291	270	250	232	217	202	189
	1.5VL18	6'-8	8'-9	9'-0	400	400	400	400	400	400	367	337	311	288	267	249	232	217	203
	1.5VL16	6'-10	8'-10	9'-1	400	400	400	400	400	399	365	335	309	286	266	248	231	216	202

Notes:
1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.



SLAB INFORMATION

Total Slab Depth, in.	Theo. Concrete Volume Yd^3 / 100 ft^2	Theo. Concrete Volume ft^3 / ft^2	Recommended Welded Wire Fabric
3 1/2	0.78	0.211	6x6 - W1.4xW1.4
4	0.94	0.253	6x6 - W1.4xW1.4
4 1/2	1.09	0.294	6x6 - W1.4xW1.4
4 3/4	1.17	0.315	6x6 - W1.4xW1.4
5	1.24	0.336	6x6 - W2.1xW2.1
5 1/2	1.40	0.378	6x6 - W2.1xW2.1
5 3/4	1.48	0.398	6x6 - W2.1xW2.1
6	1.55	0.419	6x6 - W2.1xW2.1

COMPOSITE

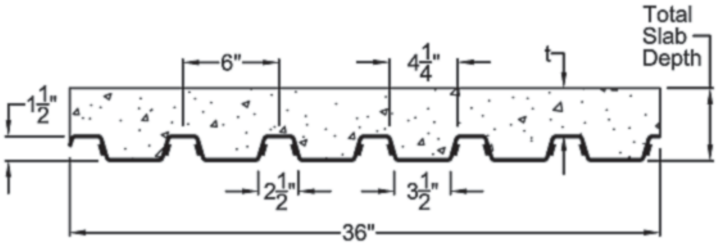
(N=14.15) LIGHTWEIGHT CONCRETE (110 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span			Superimposed Live Load, PSF Clear Span (ft.-in.)														
		1 SPAN	2 SPAN	3 SPAN	5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0
	1.5VL22	6'-4	8'-5	8'-6	278	247	222	185	167	152	139	124	105	89	76	66	57	50	44
3.50	1.5VL20	7'-8	9'-7	9'-11	305	271	243	220	201	184	154	135	114	97	83	72	62	54	48
(t=2.00)	1.5VL19	8'-8	10'-7	11'-0	329	292	262	237	216	198	173	145	122	104	89	77	67	58	51
26 PSF	1.5VL18	9'-6	11'-4	11'-9	350	311	279	252	230	211	184	153	129	110	94	81	71	62	54
	1.5VL16	9'-8	11'-5	11'-10	352	312	280	253	231	212	195	171	144	122	105	91	79	69	61
	1.5VL22	6'-0	8'-1	8'-1	324	288	258	215	194	177	161	148	136	126	113	98	85	75	66
4.00	1.5VL20	7'-3	9'-7	9'-9	355	315	283	256	233	195	178	164	151	140	123	106	92	81	71
(t=2.50)	1.5VL19	8'-2	10'-7	10'-11	382	339	304	275	251	230	212	178	164	152	131	113	99	86	76
30 PSF	1.5VL18	8'-11	11'-4	11'-5	400	360	323	292	266	244	225	209	175	162	139	120	104	91	80
	1.5VL16	9'-1	11'-4	11'-8	400	360	323	292	266	244	225	209	195	162	151	134	116	102	90
	1.5VL22	5'-9	7'-8	7'-8	372	330	275	246	223	202	185	170	156	145	134	125	116	106	93
4.50	1.5VL20	6'-11	9'-2	9'-4	400	361	324	293	246	223	204	188	173	160	149	139	129	114	101
(t=3.00)	1.5VL19	7'-9	10'-1	10'-5	400	388	348	315	287	264	221	203	188	174	162	151	140	122	107
35 PSF	1.5VL18	8'-6	10'-10	11'-0	400	400	369	334	305	279	258	239	200	186	173	161	147	129	114
	1.5VL16	8'-7	10'-10	11'-2	400	400	369	334	304	279	257	239	199	185	172	160	150	140	126
	1.5VL22	5'-7	7'-7	7'-7	396	352	293	263	237	216	197	181	167	154	143	133	124	115	108
4.75	1.5VL20	6'-9	9'-0	9'-1	400	385	345	312	262	238	218	200	184	171	159	148	138	129	118
(t=3.25)	1.5VL19	7'-7	9'-11	10'-3	400	400	371	336	306	281	235	216	200	185	172	160	150	140	126
37 PSF	1.5VL18	8'-3	10'-7	10'-9	400	400	393	356	324	298	274	231	213	198	184	171	160	150	133
	1.5VL16	8'-5	10'-7	11'-0	400	400	392	355	324	297	274	230	212	197	183	171	159	149	140
	1.5VL22	5'-6	7'-5	7'-5	400	374	311	279	252	229	209	192	177	164	152	141	131	123	115
5.00	1.5VL20	6'-7	8'-10	8'-11	400	400	367	332	278	253	231	212	196	181	168	157	146	137	128
(t=3.50)	1.5VL19	7'-5	9'-9	10'-1	400	400	394	356	325	273	250	230	212	197	183	170	159	149	140
39 PSF	1.5VL18	8'-1	10'-5	10'-7	400	400	400	378	344	316	291	245	226	210	195	182	170	159	149
	1.5VL16	8'-3	10'-5	10'-9	400	400	400	377	343	315	291	244	225	209	194	181	169	159	149
	1.5VL22	5'-2	7'-0	7'-0	400	400	367	329	297	270	247	227	209	193	179	166	155	145	135
5.75	1.5VL20	6'-2	8'-4	8'-5	400	400	400	362	327	298	272	250	231	214	199	185	172	161	151
(t=4.25)	1.5VL19	7'-0	9'-2	9'-6	400	400	400	400	383	322	295	271	250	232	215	201	187	175	165
46 PSF	1.5VL18	7'-7	9'-10	10'-0	400	400	400	400	400	372	314	289	267	247	230	214	200	188	176
	1.5VL16	7'-9	9'-10	10'-2	400	400	400	400	400	371	312	287	265	246	229	213	199	187	175

Notes:
1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.

1.5 VLR

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0



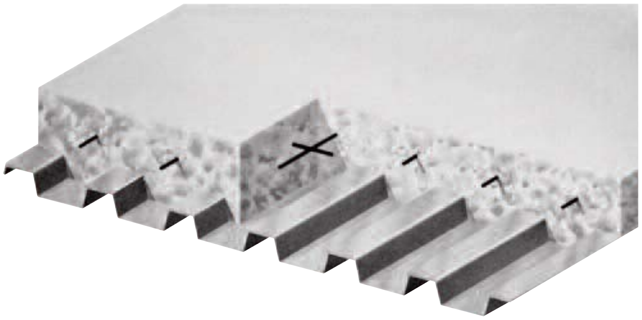
STEEL SECTION PROPERTIES

Deck Type	Design Thickness in	Deck Weight psf	Section Properties I_p in^4/ft	S_p in^3/ft	I_n in^4/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
1.5VLR22	0.0295	1.78	0.177	0.179	0.143	0.169	2754	50
1.5VLR20	0.0358	2.14	0.222	0.231	0.186	0.224	3322	50
1.5VLR19	0.0418	2.49	0.260	0.282	0.230	0.271	3857	50
1.5VLR18	0.0474	2.82	0.295	0.324	0.272	0.311	4350	50
1.5VLR16	0.0598	3.54	0.373	0.411	0.373	0.404	4336	40

(N=9.35) NORMAL WEIGHT CONCRETE (145 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span 1 SPAN	2 SPAN	3 SPAN	Superimposed Live Load, PSF Clear Span (ft.-in.) 5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0
3.50 (t=2.00) 38 PSF	1.5VLR22	5'-9	7'-8	7'-9	314	279	227	203	183	166	151	138	127	117	108	100	92	86	77
	1.5VLR20	6'-10	8'-9	9'-1	345	306	275	249	203	184	168	154	141	130	120	112	104	94	83
	1.5VLR19	7'-8	9'-8	9'-11	372	330	296	268	244	224	182	167	154	142	132	122	114	100	88
	1.5VLR18	8'-5	10'-3	10'-8	395	351	315	285	260	238	220	179	165	152	141	131	119	105	92
	1.5VLR16	8'-5	10'-5	10'-9	397	353	316	286	261	239	221	180	165	153	142	132	123	115	101
4.00 (t=2.50) 44 PSF	1.5VLR22	5'-6	7'-3	7'-5	366	325	264	236	213	193	176	161	147	136	125	116	107	100	93
	1.5VLR20	6'-5	8'-4	8'-8	400	356	319	261	236	214	195	179	164	151	140	130	121	112	105
	1.5VLR19	7'-3	9'-2	9'-6	400	383	344	311	283	232	212	194	179	165	153	142	132	123	115
	1.5VLR18	7'-11	9'-9	10'-1	400	400	365	330	301	276	226	207	191	177	164	152	142	132	124
	1.5VLR16	7'-11	9'-11	10'-3	400	400	365	330	301	276	226	207	191	176	164	152	142	132	124
4.50 (t=3.00) 50 PSF	1.5VLR22	5'-3	6'-11	7'-1	400	342	303	271	245	222	202	185	170	156	144	133	124	115	107
	1.5VLR20	6'-2	8'-0	8'-3	400	400	366	300	270	245	224	205	188	174	161	149	139	129	120
	1.5VLR19	6'-11	8'-9	9'-1	400	400	393	356	293	266	243	223	205	189	175	163	151	141	132
	1.5VLR18	7'-6	9'-4	9'-8	400	400	400	378	344	316	259	238	219	202	188	174	163	152	142
	1.5VLR16	7'-7	9'-6	9'-10	400	400	400	377	344	315	258	237	218	202	187	174	162	151	141
5.00 (t=3.50) 56 PSF	1.5VLR22	5'-0	6'-8	6'-10	400	387	344	308	277	251	229	209	192	177	164	151	140	130	121
	1.5VLR20	5'-10	7'-8	7'-11	400	400	379	339	306	278	254	232	214	197	182	169	157	146	136
	1.5VLR19	6'-7	8'-5	8'-8	400	400	400	400	331	301	275	252	232	214	199	184	172	160	149
	1.5VLR18	7'-2	9'-0	9'-3	400	400	400	400	389	321	293	269	248	229	213	198	184	172	161
	1.5VLR16	7'-3	9'-1	9'-5	400	400	400	400	388	320	292	268	247	228	212	197	183	171	160
5.50 (t=4.00) 62 PSF	1.5VLR22	4'-10	6'-5	6'-7	400	400	385	344	310	281	256	235	216	199	183	170	157	146	136
	1.5VLR20	5'-8	7'-4	7'-7	400	400	400	380	343	311	284	260	239	221	204	190	176	164	153
	1.5VLR19	6'-4	8'-1	8'-4	400	400	400	400	371	337	308	282	260	240	222	207	192	179	168
	1.5VLR18	6'-11	8'-8	8'-11	400	400	400	400	395	359	328	301	278	257	238	221	206	193	180
	1.5VLR16	6'-11	8'-9	9'-1	400	400	400	400	393	357	327	300	276	255	237	220	205	192	179
6.00 (t=4.50) 68 PSF	1.5VLR22	4'-8	6'-2	6'-4	400	400	400	382	344	312	284	260	239	220	204	188	175	162	151
	1.5VLR20	5'-6	7'-1	7'-4	400	400	400	400	380	345	315	289	265	245	227	210	196	182	170
	1.5VLR19	6'-2	7'-10	8'-1	400	400	400	400	400	374	341	313	288	266	247	229	213	199	186
	1.5VLR18	6'-9	8'-4	8'-7	400	400	400	400	400	398	364	334	308	285	264	245	229	214	200
	1.5VLR16	6'-9	8'-6	8'-9	400	400	400	400	400	396	362	332	306	283	262	244	228	213	199

Notes:
1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.



SLAB INFORMATION

Total Slab Depth, in.	Theo. Concrete Volume Yd³ / 100 ft²	Theo. Concrete Volume ft³ / ft²	Recommended Welded Wire Fabric
3 1/2	0.92	0.247	6x6 - W1.4xW1.4
4	1.07	0.289	6x6 - W1.4xW1.4
4 1/2	1.22	0.331	6x6 - W1.4xW1.4
4 3/4	1.30	0.352	6x6 - W1.4xW1.4
5	1.38	0.372	6x6 - W2.1xW2.1
5 1/2	1.53	0.414	6x6 - W2.1xW2.1
5 3/4	1.61	0.435	6x6 - W2.1xW2.1
6	1.69	0.456	6x6 - W2.1xW2.1

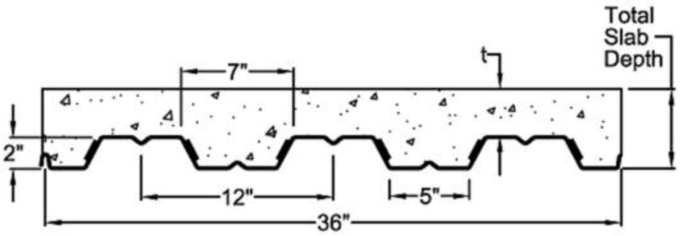
(N=14.15) LIGHTWEIGHT CONCRETE (110 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span			Superimposed Live Load, PSF Clear Span (ft.-in.)														
		1 SPAN	2 SPAN	3 SPAN	5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0
	1.5VLR22	6'-4	8'-2	8'-5	278	247	222	182	164	149	136	125	115	103	88	76	66	58	51
3.50	1.5VLR20	7'-5	9'-5	9'-9	305	271	243	220	201	165	151	139	128	110	94	82	71	62	55
(t=2.00)	1.5VLR19	8'-6	10'-5	10'-9	329	292	262	237	216	198	183	163	137	117	100	86	75	66	58
30 PSF	1.5VLR18	9'-3	11'-1	11'-6	350	311	279	252	230	211	195	171	144	123	105	91	79	69	61
	1.5VLR16	9'-3	11'-3	11'-8	352	312	280	253	231	212	195	181	158	135	115	100	87	76	67
	1.5VLR22	6'-0	7'-11	8'-1	324	288	258	212	192	174	159	146	134	124	115	106	98	86	76
4.00	1.5VLR20	7'-1	9'-1	9'-5	355	315	283	256	233	192	176	161	149	137	127	119	105	92	81
(t=2.50)	1.5VLR19	8'-0	10'-0	10'-4	382	339	304	275	251	230	212	175	161	149	139	128	111	97	85
34 PSF	1.5VLR18	8'-9	10'-8	11'-0	400	360	323	292	266	244	225	209	172	160	148	134	116	102	90
	1.5VLR16	8'-9	10'-10	11'-2	400	360	323	292	266	244	225	209	172	159	148	138	128	112	98
	1.5VLR22	5'-9	7'-7	7'-9	372	330	272	244	220	200	183	167	154	142	132	122	114	106	99
4.50	1.5VLR20	6'-9	8'-9	9'-0	400	361	324	293	243	221	202	185	171	158	146	136	127	118	111
(t=3.00)	1.5VLR19	7'-8	9'-7	9'-11	400	388	348	315	287	264	219	201	185	171	159	148	138	129	120
39 PSF	1.5VLR18	8'-4	10'-3	10'-7	400	400	369	334	305	279	258	214	198	183	170	158	148	138	126
	1.5VLR16	8'-4	10'-4	10'-9	400	400	369	334	304	279	257	213	197	182	169	158	147	138	129
	1.5VLR22	5'-8	7'-6	7'-7	396	352	290	260	235	213	195	178	164	152	141	130	121	113	106
4.75	1.5VLR20	6'-7	8'-7	8'-10	400	385	345	312	259	235	215	198	182	168	156	145	135	126	118
(t=3.25)	1.5VLR19	7'-6	9'-5	9'-9	400	400	371	336	306	281	233	214	197	183	170	158	147	138	129
41 PSF	1.5VLR18	8'-2	10'-1	10'-5	400	400	393	356	324	298	274	228	211	195	181	169	158	147	138
	1.5VLR16	8'-2	10'-2	10'-6	400	400	392	355	324	297	274	227	210	194	180	168	157	147	138
	1.5VLR22	5'-6	7'-4	7'-6	400	374	308	276	250	227	207	190	175	161	149	139	129	120	112
5.00	1.5VLR20	6'-6	8'-5	8'-8	400	400	367	332	275	250	229	210	193	179	166	154	144	134	126
(t=3.50)	1.5VLR19	7'-4	9'-3	9'-6	400	400	394	356	325	271	248	227	210	194	180	168	157	146	137
43 PSF	1.5VLR18	8'-0	9'-10	10'-2	400	400	400	378	344	316	291	242	224	207	192	179	167	157	147
	1.5VLR16	8'-0	10'-0	10'-4	400	400	400	377	343	315	291	241	223	206	192	178	167	156	146
	1.5VLR22	5'-3	6'-11	7'-1	400	400	364	326	295	268	244	224	206	191	177	164	153	142	133
5.75	1.5VLR20	6'-2	8'-0	8'-3	400	400	400	360	325	295	270	248	229	211	196	182	170	159	149
(t=4.25)	1.5VLR19	6'-11	8'-9	9'-1	400	400	400	400	351	319	292	268	248	229	213	198	185	173	162
50 PSF	1.5VLR18	7'-6	9'-4	9'-8	400	400	400	400	400	372	311	286	264	245	227	212	198	185	174
	1.5VLR16	7'-7	9'-6	9'-10	400	400	400	400	400	371	309	284	263	243	226	211	197	184	173

Notes:
1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.

2 VLI

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0
ICBO Approved (No. 3415)



Interlocking side lap is not drawn to show actual detail.

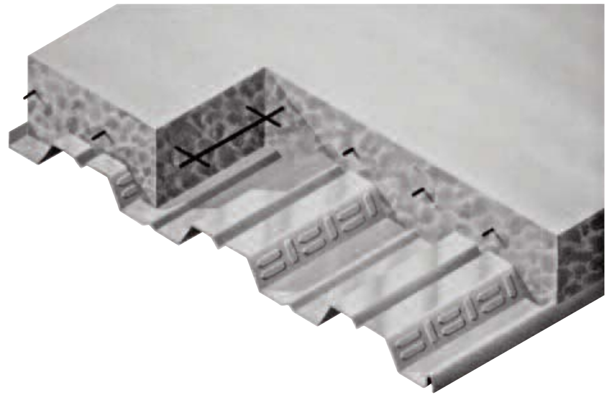
STEEL SECTION PROPERTIES

Deck Type	Design Thickness in	Deck Weight psf	Section Properties I_p in^4/ft	S_p in^3/ft	I_n in^4/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
2VLI22	0.0295	1.62	0.324	0.263	0.321	0.266	1832	50
2VLI20	0.0358	1.97	0.409	0.341	0.406	0.346	2698	50
2VLI19	0.0418	2.30	0.492	0.420	0.489	0.426	3190	50
2VLI18	0.0474	2.61	0.559	0.495	0.558	0.504	3608	50
2VLI16	0.0598	3.29	0.704	0.653	0.704	0.653	3618	40

(N=9.35) NORMAL WEIGHT CONCRETE (145 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span 1 SPAN	2 SPAN	3 SPAN	Superimposed Live Load, PSF Clear Span (ft.-in.) 5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6
	2VLI22	7'-4	9'-6	9'-9	274	239	211	188	145	129	115	104	94	85	78	71	65	59	54
4.00	2VLI20	8'-7	10'-10	11'-2	310	269	236	210	188	170	155	117	106	96	87	80	73	67	61
(t=2.00)	2VLI19	9'-9	11'-11	12'-4	344	298	261	231	207	186	169	155	142	106	97	88	81	74	68
39 PSF	2VLI18	10'-9	12'-9	12'-9	373	324	285	253	228	206	188	172	159	147	137	103	95	87	81
	2VLI16	11'-1	13'-2	13'-5	400	376	330	292	261	235	214	195	180	166	154	143	109	100	93
	2VLI22	6'-11	9'-0	9'-4	319	278	245	190	168	150	134	121	109	99	90	83	76	69	63
4.50	2VLI20	8'-2	10'-3	10'-7	361	313	275	244	219	198	152	136	123	112	102	93	85	78	72
(t=2.50)	2VLI19	9'-2	11'-5	11'-9	400	346	303	268	240	216	196	180	136	124	113	103	94	86	79
45 PSF	2VLI18	10'-2	12'-4	12'-4	400	376	331	295	264	239	218	200	184	171	130	119	110	102	94
	2VLI16	10'-5	12'-6	12'-11	400	400	383	339	303	274	248	227	209	193	150	137	126	117	108
	2VLI22	6'-7	8'-7	8'-11	364	317	279	217	192	171	153	138	125	113	103	94	86	79	72
5.00	2VLI20	7'-9	9'-10	10'-2	400	356	313	278	249	193	173	156	141	128	116	106	97	89	82
(t=3.00)	2VLI19	8'-9	10'-11	11'-3	400	394	345	306	273	247	224	172	156	141	128	117	107	99	91
51 PSF	2VLI18	9'-7	11'-10	11'-11	400	400	377	336	301	273	249	228	210	162	148	136	126	116	107
	2VLI16	9'-11	12'-0	12'-4	400	400	400	386	346	312	283	259	238	187	171	157	144	133	123
	2VLI22	6'-4	8'-0	8'-6	400	355	278	244	216	192	172	155	140	127	116	106	97	89	81
5.50	2VLI20	7'-5	9'-5	9'-9	400	400	351	312	244	217	194	175	158	143	131	119	109	100	92
(t=3.50)	2VLI19	8'-4	10'-5	10'-9	400	400	388	343	307	277	215	193	175	159	144	132	121	111	102
57 PSF	2VLI18	9'-2	11'-4	11'-7	400	400	400	377	338	306	279	256	199	182	167	153	141	130	121
	2VLI16	9'-5	11'-6	11'-10	400	400	400	400	388	350	318	290	230	210	192	176	162	150	138
	2VLI22	6'-1	7'-5	8'-2	400	394	308	270	239	213	191	172	156	141	129	118	108	99	90
6.00	2VLI20	7'-1	9'-1	9'-4	400	400	390	346	271	241	215	194	175	159	145	132	121	111	102
(t=4.00)	2VLI19	8'-0	10'-1	10'-5	400	400	400	381	340	307	239	215	194	176	160	146	134	123	113
63 PSF	2VLI18	8'-10	10'-11	11'-3	400	400	400	400	375	339	309	243	221	202	185	170	157	145	134
	2VLI16	9'-1	11'-1	11'-5	400	400	400	400	400	388	352	322	255	233	213	195	180	166	154
	2VLI22	5'-11	6'-11	7'-11	400	390	339	297	263	234	210	189	171	155	141	129	118	108	99
6.50	2VLI20	6'-11	8'-9	9'-0	400	400	400	337	297	264	237	213	193	175	159	145	133	122	112
(t=4.50)	2VLI19	7'-10	9'-8	10'-0	400	400	400	400	374	293	262	236	213	193	176	161	147	135	124
69 PSF	2VLI18	8'-7	10'-6	10'-11	400	400	400	400	400	373	340	268	243	222	203	187	172	159	147
	2VLI16	8'-10	10'-8	11'-0	400	400	400	400	400	400	387	309	280	256	234	215	198	183	169

Notes:
1. Minimum exterior bearing length required is 2.00 inches. Minimum interior bearing length required is 4.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.



SLAB INFORMATION

Total Slab Depth, in.	Theo. Concrete Volume		Recommended Welded Wire Fabric
	Yd^3 / 100 ft^2	ft^3 / ft^2	
4	0.93	0.250	6x6 - W1.4xW1.4
4 1/2	1.08	0.292	6x6 - W1.4xW1.4
5	1.23	0.333	6x6 - W1.4xW1.4
5 1/4	1.31	0.354	6x6 - W1.4xW1.4
5 1/2	1.39	0.375	6x6 - W2.1xW2.1
6	1.54	0.417	6x6 - W2.1xW2.1
6 1/4	1.62	0.438	6x6 - W2.1xW2.1
6 1/2	1.70	0.458	6x6 - W2.1xW2.1

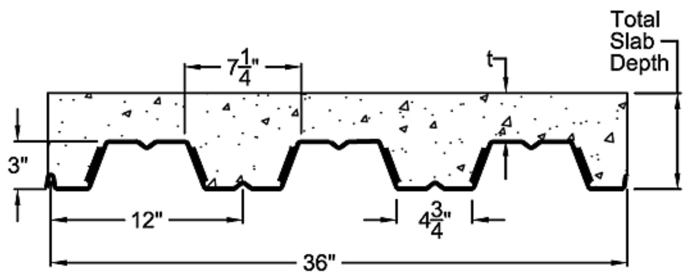
(N=14.15) LIGHTWEIGHT CONCRETE (110 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span			Superimposed Live Load, PSF Clear Span (ft.-in.)														
		1 SPAN	2 SPAN	3 SPAN	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6	13'-0
	2VLI22	8'-1	10'-3	10'-7	238	209	186	167	152	120	108	98	90	82	75	69	64	59	55
4.00	2VLI20	9'-6	11'-8	12'-1	268	235	209	187	169	153	140	129	101	92	84	78	72	66	61
(t=2.00)	2VLI19	10'-10	13'-0	13'-2	297	260	230	206	185	168	153	141	130	121	93	86	79	73	68
30 PSF	2VLI18	11'-7	13'-7	13'-7	324	285	253	227	205	187	171	158	146	136	127	119	92	86	80
	2VLI16	12'-3	14'-3	14'-4	377	330	292	261	235	214	195	179	165	153	143	133	118	98	91
	2VLI22	7'-8	9'-10	10'-2	276	243	216	194	155	139	126	114	104	96	88	81	75	69	64
4.50	2VLI20	9'-0	11'-3	11'-7	312	273	243	217	196	178	163	128	117	107	98	90	83	77	72
(t=2.50)	2VLI19	10'-3	12'-5	12'-9	346	302	268	239	215	195	178	164	151	118	108	100	92	85	79
35 PSF	2VLI18	11'-2	13'-1	13'-1	376	331	294	264	238	217	199	183	170	158	147	116	107	100	93
	2VLI16	11'-7	13'-8	13'-10	400	384	340	303	273	248	227	208	192	178	166	155	123	114	106
	2VLI22	7'-4	9'-5	9'-9	315	277	247	197	176	159	143	130	119	109	100	92	85	79	73
5.00	2VLI20	8'-7	10'-9	11'-2	355	312	276	248	224	203	161	146	133	122	112	103	95	88	82
(t=3.00)	2VLI19	9'-9	11'-11	12'-4	394	345	305	272	245	223	203	187	147	135	124	114	105	97	90
39 PSF	2VLI18	10'-9	12'-9	12'-9	400	377	335	300	272	247	227	209	193	180	143	132	122	114	106
	2VLI16	11'-0	13'-1	13'-5	400	400	387	346	311	283	258	237	219	203	189	151	140	130	121
	2VLI22	7'-2	9'-3	9'-7	334	294	262	209	187	168	152	138	126	116	106	98	90	84	78
5.25	2VLI20	8'-5	10'-7	10'-11	377	331	293	263	237	190	171	155	142	130	119	110	101	94	87
(t=3.25)	2VLI19	9'-6	11'-8	12'-1	400	366	324	289	260	236	216	198	156	143	131	121	111	103	95
42 PSF	2VLI18	10'-6	12'-7	12'-7	400	400	355	319	288	263	241	222	205	191	151	140	130	121	113
	2VLI16	10'-9	12'-10	13'-3	400	400	400	367	330	300	274	252	232	215	173	160	148	138	128
	2VLI22	7'-0	9'-1	9'-5	353	311	277	222	198	178	161	147	134	122	113	104	96	89	82
5.50	2VLI20	8'-3	10'-4	10'-9	399	350	310	278	251	201	181	165	150	137	126	116	107	99	92
(t=3.50)	2VLI19	9'-4	11'-6	11'-10	400	387	342	306	275	250	228	182	165	151	139	128	118	109	101
44 PSF	2VLI18	10'-3	12'-5	12'-5	400	400	376	337	305	278	254	234	217	174	160	148	138	128	119
	2VLI16	10'-6	12'-7	13'-0	400	400	400	388	350	317	290	266	246	228	184	170	157	146	136
	2VLI22	6'-8	8'-7	8'-11	400	362	291	258	231	208	188	171	156	143	131	121	112	103	96
6.25	2VLI20	7'-9	9'-10	10'-2	400	400	361	323	260	234	211	192	175	160	147	135	125	115	107
(t=4.25)	2VLI19	8'-9	10'-11	11'-3	400	400	398	356	320	291	233	212	193	176	162	149	137	127	118
51 PSF	2VLI18	9'-8	11'-10	11'-11	400	400	400	392	355	323	296	273	220	202	187	173	160	149	139
	2VLI16	9'-11	12'-0	12'-5	400	400	400	400	400	369	337	310	253	232	214	198	183	170	158

Notes:
1. Minimum exterior bearing length required is 2.00 inches. Minimum interior bearing length required is 4.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.

3 VLI

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0
ICBO Approved (No. 3415)



Interlocking side lap is not drawn to show actual detail.

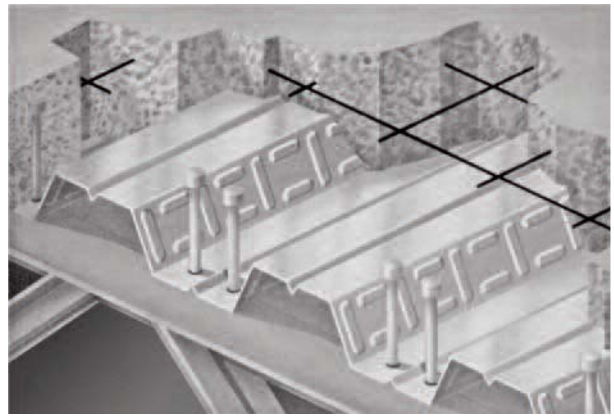
STEEL SECTION PROPERTIES

Deck Type	Design Thickness in	Deck Weight psf	Section Properties I_p in^4/ft	S_p in^3/ft	I_n in^4/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
3VLI22	0.0295	1.77	0.730	0.414	0.729	0.426	1528	50
3VLI20	0.0358	2.14	0.920	0.534	0.919	0.551	2698	50
3VLI19	0.0418	2.50	1.104	0.654	1.102	0.676	3678	50
3VLI18	0.0474	2.84	1.254	0.770	1.252	0.797	4729	50
3VLI16	0.0598	3.58	1.580	1.013	1.580	1.013	5309	40

(N=9.35) NORMAL WEIGHT CONCRETE (145 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span 1 SPAN	2 SPAN	3 SPAN	Superimposed Live Load, PSF Clear Span (ft.-in.) 7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6	13'-0	13'-6	14'-0
5.00 (t=2.00) 45 PSF	3VLI22	9'-2	10'-7	11'-8	216	195	176	161	148	109	99	90	83	76	70	64	59	54	50
	3VLI20	10'-8	12'-11	13'-4	241	216	196	178	163	150	139	129	93	85	78	72	66	61	57
	3VLI19	12'-0	14'-4	14'-7	265	237	214	194	178	163	151	140	131	122	115	79	73	67	62
	3VLI18	12'-10	15'-1	15'-1	289	261	238	218	201	186	173	161	151	142	134	127	92	86	80
	3VLI16	13'-5	15'-7	15'-11	327	294	267	243	223	206	191	178	167	156	147	139	132	96	89
5.50 (t=2.50) 51 PSF	3VLI22	8'-9	9'-8	10'-11	247	222	201	184	137	124	113	103	94	87	80	73	67	62	57
	3VLI20	10'-1	12'-4	12'-9	275	247	223	203	186	171	159	116	106	97	89	82	76	70	65
	3VLI19	11'-4	13'-8	14'-2	302	270	244	222	203	186	172	160	149	107	98	90	83	77	71
	3VLI18	12'-5	14'-7	14'-7	330	298	271	248	229	212	197	184	173	162	153	112	105	98	92
	3VLI16	12'-9	14'-11	15'-5	373	335	304	277	255	235	218	203	190	178	168	159	117	109	102
6.00 (t=3.00) 57 PSF	3VLI22	8'-4	8'-10	10'-1	277	249	226	171	154	140	127	116	106	97	89	82	76	70	65
	3VLI20	9'-8	11'-10	12'-3	309	277	250	228	209	193	143	130	119	109	100	92	85	79	73
	3VLI19	10'-10	13'-2	13'-7	339	304	274	249	227	209	193	179	131	120	110	102	94	87	80
	3VLI18	11'-10	14'-2	14'-2	370	334	304	279	257	238	221	207	194	182	136	126	118	110	103
	3VLI16	12'-2	14'-4	14'-10	400	376	341	311	286	264	245	228	213	200	189	141	132	123	115
6.50 (t=3.50) 63 PSF	3VLI22	8'-0	8'-3	9'-4	307	277	251	190	171	155	141	129	118	108	99	91	84	78	72
	3VLI20	9'-3	11'-5	11'-9	343	307	278	253	232	174	158	144	132	121	111	103	95	87	81
	3VLI19	10'-4	12'-8	13'-1	377	337	304	276	252	232	214	159	146	134	123	113	104	96	89
	3VLI18	11'-4	13'-9	13'-10	400	371	338	309	285	264	246	229	215	162	151	140	131	122	115
	3VLI16	11'-7	13'-10	14'-3	400	400	378	345	317	293	272	253	237	222	169	157	146	136	128
7.00 (t=4.00) 69 PSF	3VLI22	7'-9	7'-8	8'-8	338	304	233	209	188	171	155	142	130	119	109	101	93	86	79
	3VLI20	9'-0	10'-11	11'-4	377	338	305	278	255	192	174	159	145	133	122	113	104	96	89
	3VLI19	10'-1	12'-3	12'-7	400	370	334	303	277	255	236	175	160	147	135	124	115	106	98
	3VLI18	11'-0	13'-3	13'-6	400	400	371	340	313	290	270	252	236	178	166	154	144	135	126
	3VLI16	11'-4	13'-4	13'-9	400	400	400	379	348	322	298	278	260	200	185	172	161	150	140
7.50 (t=4.50) 75 PSF	3VLI22	7'-7	7'-2	8'-2	368	331	254	228	205	186	169	154	141	130	119	110	101	93	86
	3VLI20	8'-9	10'-2	11'-0	400	368	333	303	231	209	190	173	158	145	134	123	113	105	97
	3VLI19	9'-10	11'-10	12'-2	400	400	364	331	302	278	209	191	175	160	147	136	125	116	107
	3VLI18	10'-9	12'-10	13'-3	400	400	400	370	341	316	294	275	210	195	181	168	157	147	138
	3VLI16	11'-0	12'-11	13'-4	400	400	400	400	380	351	325	303	283	218	202	188	175	164	153

Notes:
1. Minimum exterior bearing length required is 2.50 inches. Minimum interior bearing length required is 5.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.



SLAB INFORMATION

Total Slab Depth, in.	Theo. Concrete Volume Yd^3 / 100 ft^2	ft^3 / ft^2	Recommended Welded Wire Fabric
5	1.08	0.292	6x6 - W1.4xW1.4
5 1/2	1.23	0.333	6x6 - W1.4xW1.4
6	1.39	0.375	6x6 - W1.4xW1.4
6 1/4	1.47	0.396	6x6 - W1.4xW1.4
6 1/2	1.54	0.417	6x6 - W2.1xW2.1
7	1.70	0.458	6x6 - W2.1xW2.1
7 1/4	1.77	0.479	6x6 - W2.1xW2.1
7 1/2	1.85	0.500	6x6 - W2.1xW2.1

(N=14.15) LIGHTWEIGHT CONCRETE (110 PCF)

TOTAL SLAB DEPTH	DECK TYPE	SDI Max. Unshored Clear Span 1 SPAN	2 SPAN	3 SPAN	Superimposed Live Load, PSF Clear Span (ft.-in.) 8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6	13'-0	13'-6	14'-0	14'-6	15'-0
5.00 (t=2.00) 35 PSF	3VLI22	10'-2	12'-4	12'-9	141	127	115	105	96	67	60	54	49	45	40				
	3VLI20	11'-11	14'-2	14'-7	163	147	133	121	110	102	94	87	59	54	49	44	40		
	3VLI19	13'-4	15'-7	15'-7	185	166	150	136	124	114	105	97	90	84	79	52	47	43	
	3VLI18	13'-9	16'-1	16'-1	244	222	204	188	174	162	151	142	133	126	119	112	85	79	75
	3VLI16	14'-5	16'-11	16'-11	277	254	234	217	202	189	177	166	157	149	141	134	127	99	94
5.50 (t=2.50) 39 PSF	3VLI22	9'-8	11'-7	12'-2	161	145	131	120	85	77	69	62	56	51	46	42			
	3VLI20	11'-3	13'-7	14'-0	186	167	151	138	126	116	107	74	67	61	56	51	46	42	
	3VLI19	12'-8	15'-0	15'-1	211	189	171	155	142	130	120	111	103	96	65	59	54	49	45
	3VLI18	13'-4	15'-7	15'-7	278	253	232	214	198	184	172	161	152	143	135	103	97	91	85
	3VLI16	14'-0	16'-4	16'-5	316	289	267	247	230	215	202	190	179	170	161	153	146	114	107
6.00 (t=3.00) 44 PSF	3VLI22	9'-3	10'-9	11'-9	181	163	147	107	96	86	78	70	63	57	52	47	43		
	3VLI20	10'-9	13'-1	13'-6	209	188	170	155	141	130	93	84	76	69	63	57	52	47	43
	3VLI19	12'-1	14'-5	14'-8	237	212	192	174	159	146	135	125	116	80	73	67	61	56	51
	3VLI18	12'-11	15'-2	15'-2	312	284	261	240	223	207	193	181	170	161	124	116	109	102	96
	3VLI16	13'-7	15'-9	16'-0	354	325	299	277	258	241	226	213	201	190	181	172	135	128	121
6.25 (t=3.25) 46 PSF	3VLI22	9'-1	10'-4	11'-6	191	172	155	113	101	91	82	74	67	60	55	50	45	41	
	3VLI20	10'-6	12'-10	13'-3	221	198	179	163	149	137	98	88	80	73	66	60	55	50	46
	3VLI19	11'-10	14'-2	14'-6	250	224	202	184	168	154	142	131	93	84	77	70	64	59	54
	3VLI18	12'-9	15'-0	15'-0	329	300	275	253	235	218	204	191	180	169	131	122	115	108	101
	3VLI16	13'-4	15'-6	15'-10	374	343	316	293	272	254	239	225	212	201	190	151	143	135	128
6.50 (t=3.50) 48 PSF	3VLI22	8'-11	10'-0	11'-4	200	180	134	119	107	96	86	78	70	64	58	52	47	43	
	3VLI20	10'-4	12'-7	13'-0	232	209	189	172	157	114	103	93	84	77	70	63	58	53	48
	3VLI19	11'-7	14'-0	14'-4	263	236	213	193	176	162	149	138	98	89	81	74	68	62	57
	3VLI18	12'-7	14'-9	14'-9	346	316	289	267	247	230	215	201	189	178	138	129	121	113	107
	3VLI16	13'-0	15'-2	15'-7	393	360	332	308	286	268	251	236	223	211	200	159	150	142	134
7.25 (t=4.25) 55 PSF	3VLI22	8'-5	9'-1	10'-4	230	173	153	137	122	110	99	89	81	73	66	60	55	49	45
	3VLI20	9'-9	12'-0	12'-5	267	240	217	197	146	131	118	107	97	88	80	73	66	61	55
	3VLI19	10'-11	13'-4	13'-9	302	271	244	222	203	186	137	124	112	102	93	85	78	71	65
	3VLI18	12'-0	14'-4	14'-4	398	362	332	306	284	264	246	231	217	169	158	148	139	130	123
	3VLI16	12'-4	14'-6	15'-0	400	400	381	353	329	307	288	271	256	207	194	183	173	163	154

Notes:
1. Minimum exterior bearing length required is 2.50 inches. Minimum interior bearing length required is 5.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.

Appendix F: AISC W Shapes

Edited from Source: Turner Construction via Arquitectonica

Table 3-2 (continued)
W Shapes
Selection by Z_x

Z_x $F_y = 50$ ksi

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF	BF	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
	in.^{3}	kip-ft	kip-ft	kip-ft	kip-ft	kips	kips	ft	ft	in.^{4}	kips	kips
		[redacted]	LRFD	[redacted]	LRFD	[redacted]	LRFD				[redacted]	LRFD
W18×35	**66.5**	[redacted]	**249**	[redacted]	**151**	[redacted]	**12.1**	**4.31**	**12.4**	**510**	[redacted]	**159**
W12×45	64.2	[redacted]	241	[redacted]	151	[redacted]	5.75	6.89	22.4	348	[redacted]	121
W16×36	64.0	[redacted]	240	[redacted]	148	[redacted]	9.31	5.37	15.2	448	[redacted]	140
W14×38	61.5	[redacted]	231	[redacted]	143	[redacted]	8.10	5.47	16.2	385	[redacted]	131
W10×49	60.4	[redacted]	227	[redacted]	143	[redacted]	3.67	8.97	31.6	272	[redacted]	102
W8×58	59.8	[redacted]	224	[redacted]	137	[redacted]	2.56	7.42	41.7	228	[redacted]	134
W12×40	57.0	[redacted]	214	[redacted]	135	[redacted]	5.50	6.85	21.1	307	[redacted]	106
W10×45	54.9	[redacted]	206	[redacted]	129	[redacted]	3.89	7.10	26.9	248	[redacted]	106
W14×34	**54.6**	[redacted]	**205**	[redacted]	**128**	[redacted]	**7.59**	**5.40**	**15.6**	**340**	[redacted]	**120**
W16×31	**54.0**	[redacted]	**203**	[redacted]	**124**	[redacted]	**10.2**	**4.13**	**11.9**	**375**	[redacted]	**131**
W12×35	51.2	[redacted]	192	[redacted]	120	[redacted]	6.43	5.44	16.7	285	[redacted]	113
W8×48	49.0	[redacted]	184	[redacted]	113	[redacted]	2.53	7.35	35.2	184	[redacted]	102
W14×30	**47.3**	[redacted]	**177**	[redacted]	**110**	[redacted]	**6.99**	**5.26**	**14.9**	**291**	[redacted]	**112**
W10×39	46.8	[redacted]	176	[redacted]	111	[redacted]	3.77	6.99	24.2	209	[redacted]	93.7
W16×26[v]	**44.2**	[redacted]	**166**	[redacted]	**101**	[redacted]	**8.96**	**3.96**	**11.2**	**301**	[redacted]	**106**
W12×30	43.1	[redacted]	162	[redacted]	101	[redacted]	5.89	5.37	15.6	238	[redacted]	96.3
W14×26	**40.2**	[redacted]	**151**	[redacted]	**92.7**	[redacted]	**7.99**	**3.81**	**11.1**	**245**	[redacted]	**106**
W8×40	39.8	[redacted]	149	[redacted]	93.2	[redacted]	2.47	7.21	29.9	146	[redacted]	89.1
W10×33	38.8	[redacted]	146	[redacted]	91.9	[redacted]	3.59	6.85	21.8	171	[redacted]	84.7
W12×26	**37.2**	[redacted]	**140**	[redacted]	**87.7**	[redacted]	**5.42**	**5.33**	**14.9**	**204**	[redacted]	**84.3**
W10×30	36.6	[redacted]	137	[redacted]	85.0	[redacted]	4.62	4.84	16.1	170	[redacted]	94.2
W8×35	34.7	[redacted]	130	[redacted]	81.9	[redacted]	2.43	7.17	27.0	127	[redacted]	75.5
W14×22	**33.2**	[redacted]	**125**	[redacted]	**76.1**	[redacted]	**7.14**	**3.67**	**10.4**	**199**	[redacted]	**94.8**
W10×26	31.3	[redacted]	117	[redacted]	73.2	[redacted]	4.36	4.80	14.9	144	[redacted]	80.6
W8×31[f]	30.4	[redacted]	114	[redacted]	72.2	[redacted]	2.37	7.18	24.8	110	[redacted]	68.4
W12×22	**29.3**	[redacted]	**110**	[redacted]	**66.7**	[redacted]	**6.99**	**3.00**	**9.17**	**156**	[redacted]	**96.0**
W8×28	27.2	[redacted]	102	[redacted]	63.8	[redacted]	2.50	5.72	21.0	98.0	[redacted]	68.9
W10×22	**26.0**	[redacted]	**97.5**	[redacted]	**60.9**	[redacted]	**4.02**	**4.70**	**13.8**	**118**	[redacted]	**73.2**
W12×19	**24.7**	[redacted]	**92.6**	[redacted]	**55.9**	[redacted]	**6.43**	**2.90**	**8.62**	**130**	[redacted]	**85.7**
W8x24	23.1	[redacted]	86.6	[redacted]	54.9	[redacted]	2.39	5.69	19.0	82.7	[redacted]	58.3
W10×19	**21.6**	[redacted]	**81.0**	[redacted]	**49.3**	[redacted]	**4.77**	**3.09**	**9.72**	**96.3**	[redacted]	**76.8**
W8×21	20.4	[redacted]	76.5	[redacted]	47.8	[redacted]	2.79	4.45	14.8	75.3	[redacted]	62.1

[redacted] LRFD

$\Omega_b = 1.67$ $\phi_b = 0.90$
$\Omega_v = 1.50$ $\phi_v = 1.00$

[f] Shape exceeds compact limit for flexure with $F_y = 50$ ksi.
[v] Shape does not meet the h/t_w limit for shear in Specification Section G2.1a with $F_y = 50$ ksi, $\Omega_v = 1.67$, $\phi_v = 0.90$.

Table 3-2 (continued)
W Shapes
Selection by Z_x

$F_y = 50$ ksi Z_x

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF	BF	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
	in.^{3}	kip-ft	kip-ft	kip-ft	kip-ft	kips	kips	ft	ft	in.^{4}	kips	kips
		[redacted]	LRFD	[redacted]	LRFD	[redacted]	LRFD				[redacted]	LRFD
W12×16	**20.1**	[redacted]	**75.4**	[redacted]	**44.9**	[redacted]	**5.75**	**2.73**	**8.03**	**103**	[redacted]	**79.1**
W10×17	18.7	[redacted]	70.1	[redacted]	42.5	[redacted]	4.49	2.98	9.13	81.9	[redacted]	72.8
W12×14[v]	**17.4**	[redacted]	**65.2**	[redacted]	**39.1**	[redacted]	**5.15**	**2.66**	**7.74**	**88.6**	[redacted]	**64.3**
W8×18	17.0	[redacted]	63.8	[redacted]	39.9	[redacted]	2.61	4.34	13.50	61.9	[redacted]	56.2
W10×15	16.0	[redacted]	60.0	[redacted]	36.2	[redacted]	4.14	2.86	8.61	68.9	[redacted]	69.0
W8×15	13.6	[redacted]	51.0	[redacted]	31.0	[redacted]	2.88	3.09	10.00	48.0	[redacted]	59.6
W10×12[f]	**12.6**	[redacted]	**46.9**	[redacted]	**28.6**	[redacted]	**3.53**	**2.87**	**8.05**	**53.8**	[redacted]	**56.3**
W8×13	11.4	[redacted]	42.8	[redacted]	26.0	[redacted]	2.65	2.98	9.30	39.6	[redacted]	55.1
W8×10[f]	**8.9**	[redacted]	**32.9**	[redacted]	**20.5**	[redacted]	**2.28**	**3.14**	**8.56**	**30.8**	[redacted]	**40.2**

[redacted] LRFD

$\Omega_b = 1.67$ $\phi_b = 0.90$
$\Omega_v = 1.50$ $\phi_v = 1.00$

[f] Shape exceeds compact limit for flexure with $F_y = 50$ ksi.
[v] Shape does not meet the h/t_w limit for shear in Specification Section G2.1a with $F_y = 50$ ksi, $\Omega_v = 1.67$, $\phi_v = 0.90$.

Appendix G: Rooftop Unit Specs (Old Units)

Edited from Source: Turner Construction via Arquitectonica

Johnson Controls

Series 10

Single Package R-410A Air Conditioner

Project Name: **THE GARDENS**	Unit Model #: **J10ZHN20V4TZZ6**
Quantity: **1** Tag #: **RTU-5**	System: **J10ZHN20V4TZZ6**

Cooling Performance

Total capacity	123.4	MBH
Sensible capacity	94.3	MBH
Refrigerant type	R-410A	
Efficiency (at ARI)	11.70	EER
Integrated eff. (at ARI)	12.00	IEER
Ambient DB temp.	95.0	°F
Entering DB temp.	77.0	°F
Entering WB temp.	63.8	°F
Leaving DB temp.	55.2	°F
Leaving WB temp.	53.3	°F
Power input (w/o blower)	8.57	kW
Sound power	90	dB(A)

Gas Heating Performance

Entering DB temp.	60	°F
Heating output capacity (Max)	192	MBH
Supply air	4000	CFM
Heating input capacity (Max)	240	MBH
Leaving DB temp.	104.4	°F
Air temp. rise	44.4	°F
SSE	80.0	%
Stages	2	

Supply Air Blower Performance

Supply air	4000	CFM
Ext. static pressure	1.44	IWG
Unit static resistance	0.56	IWG
Blower speed	1362	RPM
Max BHP of Motor (including service factor)	3.45	HP
Duct location	Bottom	
Motor rating	3.00	HP
Actual required BHP	3.43	HP
Power input	3.20	kW
Elevation	0	ft.
Drive type	BELT	
Requires field-supplied drive	true	

Electrical Data

Power supply	460-3-60	
Unit min circuit ampacity	30.6	Amps
Unit max over-current protection	35	Amps

Dimensions & Weight

Hgt	51 in.	Len	89 in.	Wth	59 in.
Weight with factory installed options					1205 lbs.

Clearances

Right	12 in.	Front	36 in.	Back	36 in.
Top	72 in.	Bottom	0 in.	Left	36 in.

Note: Please refer to the tech guide for listed maximum static pressures

10 Ton

- JCI Series 10 units are manufactured at an ISO 9001 registered facility and each rooftop is completely computer-run tested prior to shipment.

Unit Features

- Unit Cabinet Constructed of Powder Painted Steel, Certified At 1000 Hours Salt Spray Test (ASTM B-117 Standards)
- Through-the-Curb and Through-the-Base Utility Connections
- Full perimeter base rails with built in rigging capabilities
- Hinged Access Panels
- Slide-Out Condensate Drain Pan
- Scroll Compressors
- Two Stage Cooling
- Solid Core Liquid Line Filter Driers
- Microchannel Condenser Coil
- 192 MBH Output Aluminized Steel, Two Stage Gas Heat
- Unit Ships with 2" Pleated Filters (MERV 7) with a Standard Filter Rack that will Accept up to 4" Filters
- Single Point Power Connection
- HACR Circuit Breaker/Disconnect
- Powered Convenience Outlet (110 VAC / 15 Amp)
- Phase Monitor
- Single Enthalpy Low Leak Slab Economizer w/Barometric Relief and Hoods (Bottom Return Only)
- Short Circuit Current: 5kA RMS Symmetrical

Standard Unit Controller: Simplicity Control Board

- Safety Monitoring - Monitors the high and low-pressure switches, the freezestats, the gas valve, if applicable, and the temperature limit switch on gas and electric heat units. The unit control board will alarm on ignition failures, safety lockouts and repeated limit switch trips.

Warranty

- One (1) Year Limited Warranty on the Complete Unit
- Five (5) Year Warranty - Compressors
- Ten (10) Year Warranty - Aluminized Steel Tubular Heat Exchangers

Project Name: **THE GARDENS**	Unit Model #: **J10ZHN20V4TZZ6**
Quantity: **1** Tag #: **RTU-5**	System: **J10ZHN20V4TZZ6**

Factory Installed Options

J10ZHN20V4TZZ6

Nominal Cooling Capacity:	**J10**	10 Ton Two Stage Cooling
Product Category:	**Z**	Johnson Controls Series 10 Single Packaged R-410A Air Conditioner
Product Identifier:	**H**	11.7 EER / 12 IEER
Heat Type and Nominal Heat Capacity:	**N20**	192 MBH Output Aluminized Steel, Two Stage Gas Heat
Airflow:	**V**	3 HP High Static Belt Drive Blower Single Enthalpy Low Leak Slab Economizer w/Barometric Relief and Hoods (Bottom Return Only)
Voltage:	**4**	460-3-60
Installation Options:	**T**	HACR Circuit Breaker/Disconnect Powered Convenience Outlet (110 VAC / 15 Amp)
Additional Options:	**ZZ**	2" Pleated Filters (MERV 7) Microchannel Condenser Coil Phase Monitor Composite Drain Pan
Product Generation:	**6**	

Field Installed Accessories

- ○ ~~1BD0408 - Burglar Bars (32.0 lbs)~~
- ○ ~~1CG0420 - Coil Guard (27.0 lbs)~~
- ○ ~~1FE0412 - Flue Exhaust Extension Kit (14.0 lbs)~~
- ○ ~~1GP0405 - Gas Piping Kit for Bottom Gas Supply Connection with External Shut-Off (includes: Internal gas pipe, fittings, gas cock & panel gaskets) (10.0 lbs)~~
- ○ ~~1HG0411 - Hail Guard Kit (37.0 lbs)~~
- ○ ~~1NP0442 - Natural Gas to Propane Conversion Kit (2-Stage) (2.0 lbs)~~
- ○ ~~1RC0470 - Roof Curb - 8" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)~~
- ● 1RC0471 - Roof Curb - 14" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)
- ○ ~~1RC0472 - Roof Curb, Transition-Sunline 7.5T thru 12.5T to Predator 3.0T thru 12.5T (Shipped Assembled) (200.0 lbs)~~
- ○ ~~1RC0476 - Roof Curb - 24" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)~~
- ○ ~~1WC0412 - Wooden Crate (445.0 lbs)~~
- ○ ~~2AP0401 - Air Proving Switch (1.0 lbs)~~
- ○ ~~2AQ04700324B - Space CO2 Sensor (To maintain CO2 levels in a conditioned space.) (2.0 lbs)~~
- ○ ~~2AQ04700424C - CO2 Control Kit - Unit Mounted with Mounting Hardware (5.0 lbs)~~
- ○ ~~2DF0402 - Dirty Filter Switch (1.0 lbs)~~
- ○ ~~2EP07700424 - JCI Branded, 2 Heat / 2 Cool, Electronic 7 Day Programmable, T600MSP-3 (2.0 lbs)~~
- ○ ~~2LA04704632 - Low Ambient Kit (6.0 lbs)~~
- ○ ~~2PE04704746 - Power Exhaust 460V without Baro Relief Downflow or Horizontal - For Use with Honeywell Jade Models~~
- ○ ~~2SD04700824 - Smoke Detector Kit w/ Mounting Hardware for Supply Air (Horizontal/Downflow) Only (9.4 lbs)~~
- ○ ~~2SD04700924 - Smoke Detector Kit w/ Mounting Hardware for Return Air (Downflow Only) Only (10.0 lbs)~~
- ○ ~~2SD04701024 - Smoke Detector Kit w/ Mounting Hardware for Supply (Horizontal/Downflow) and Return Air (Downflow Only) (8.0 lbs)~~
- ○ ~~ASC SERVICES - Charges for this Service are Applicable. Application, Startup & Commissioning (ASC) Services Available with Daily Fee Plus Expenses. This Service Provides a 90 Day DOA Benefit When Completed by a Factory Certified Technician. Contact Your Distributor, Dealer, or Sales Representative. Distributors Can Call 1-877-874-7378 for an ASC Quote.~~

Project Name: **THE GARDENS** Unit Model #: **J10ZHN20V4TZZ6**

Quantity: **1** Tag #: **RTU-5** System: **J10ZHN20V4TZZ6**

- ○ S1-02546381000 - Dual Enthalpy Control - For Economizers equipped with Honeywell Jade Control Only. (0.2 lbs)
- ● S1-02815208000 - Blower Sheave for 8.5 and 10 Ton High Static Field Installed Drive (3.0 lbs)
- ● S1-A52 - Belt for 8.5 and 10 Ton High Static Field Installed Drive (0.4 lbs)

Project Name: **THE GARDENS** Unit Model #: **J10ZHN20V4TZZ6**

Quantity: **1** Tag #: **RTU-5** System: **J10ZHN20V4TZZ6**

Consolidated Drawing

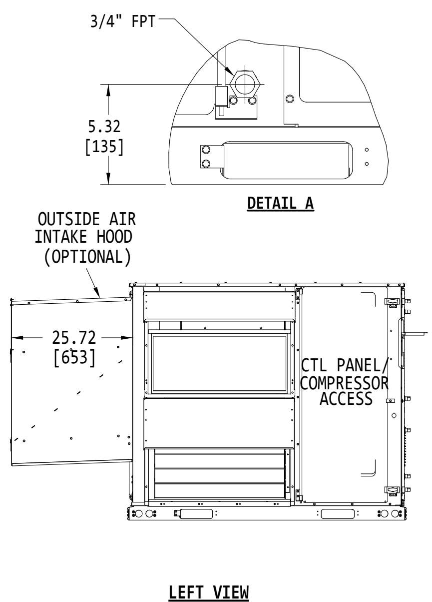
NOTES:
1. FOR OUTDOOR USE ONLY.
2. WEIGHTS SHOWN ARE FOR COOLING ONLY UNITS.
3. MIN. CLEARANCES TO BE:
   RIGHT SIDE: 12 [305]
   LEFT SIDE: 36 [915]
   FRONT: 36 [915]
   REAR: 36 [915]
   TOP: 72 [1830]
   BOTTOM: 0 [0]
4. TO REMOVE THE SLIDE-OUT DRAIN PAN, A REAR CLEARANCE OF 60 in (1525 mm) IS REQUIRED. IF SPACE IS UNAVAILABLE, THE DRAIN PAN CAN BE REMOVED THROUGH THE FRONT BY SEPARATING THE CORNER WALL.
5. FOR SMALLER SERVICE AND OPERATIONAL CLEARANCES CONTACT YOUR APPLICATION ENGINEERING DEPARTMENT.
6. DOWNFLOW DUCTS DESIGNED TO BE ATTACHED TO ACCESSORY ROOF CURB ONLY. IF UNIT IS MOUNTED SIDE SUPPLY, IT IS RECOMMENDED THAT THE DUCTS ARE SUPPORTED BY CROSS BRACES, AS DONE ON ACCESSORY ROOF CURBS.
7. SIDE DUCT FLANGES ARE 0.75" HIGH. BOTTOM DUCTS DO NOT HAVE FLANGES.
8. MINIMUM CONDENSATION TRAP HEIGHT SHALL BE 1.5 TIMES THE LOWEST NEGATIVE STATIC.
9. DIMENSIONS IN [ ] ARE IN MILLIMETERS OR KILOGRAMS.
10. OPTIONAL COIL GUARDS, POWER EXHAUST, GAS HEAT, ECONOMIZER, DISCONNECT SWITCH, CONVENIENCE OUTLET, AND BAROMETRIC RELIEF AND FRESH AIR HOODS SHOWN.

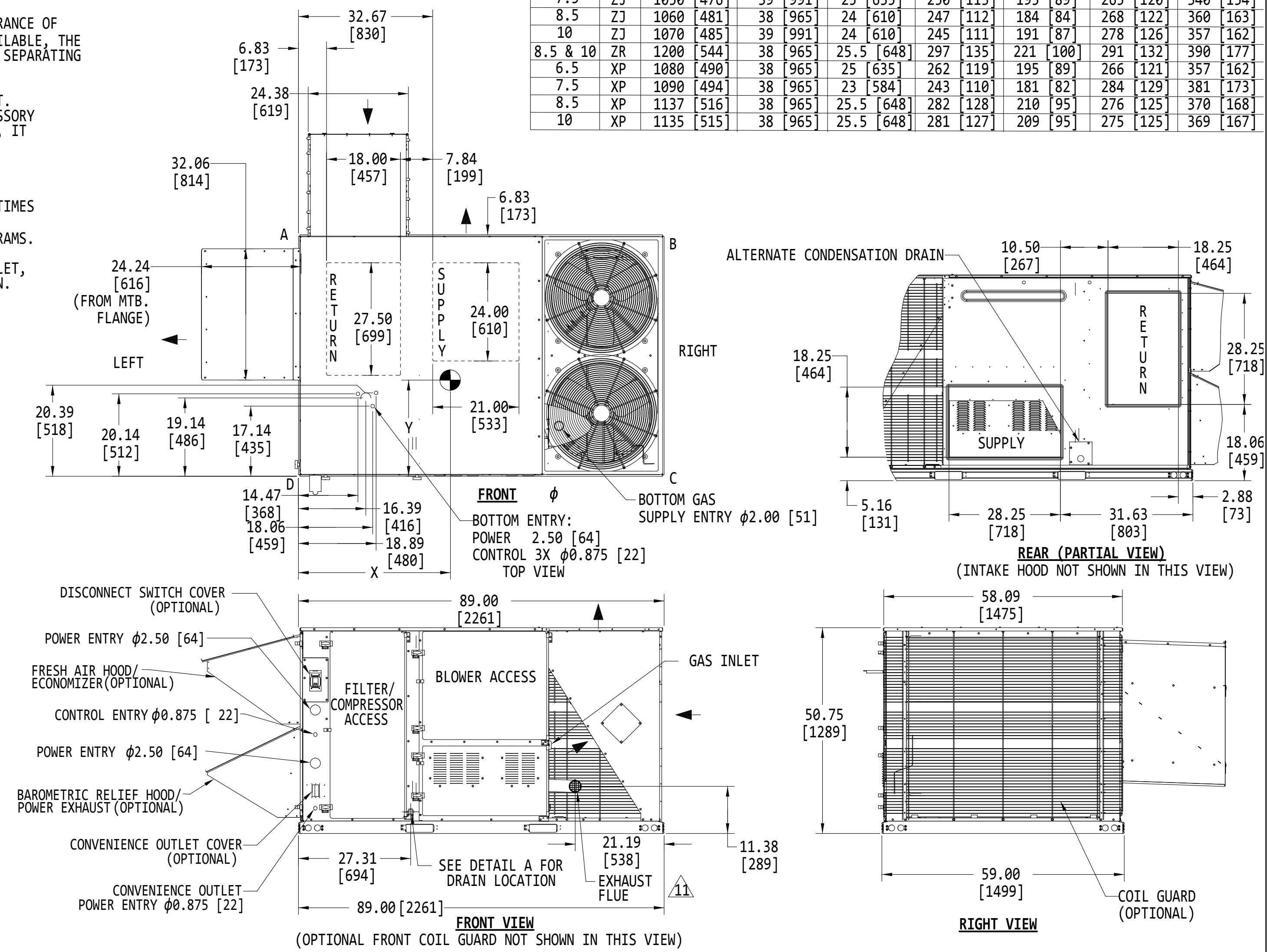
△11 EXCEPT XP (HEAT PUMP) UNITS.

➤ DIRECTION OF AIRFLOW

◉ CENTER OF GRAVITY

TONNAGE	UNIT	OPERATING WEIGHT (LBS) (BASE UNIT)	CENTER OF GRAVITY LOCATION (BASE UNIT)		4 POINT CORNER LOADS (LBS) (BASE UNIT)			
			X	Y	A	B	C	D
8.5	ZF	1007 [458]	38 [965]	24 [610]	235 [107]	175 [79]	255 [116]	342 [155]
10	ZF	1103 [501]	38 [965]	24 [610]	257 [117]	192 [87]	279 [127]	375 [170]
8.5	ZH	1030 [467]	38 [965]	24 [610]	240 [109]	179 [81]	261 [118]	350 [159]
10	ZH	1090 [494]	38 [965]	24 [610]	254 [115]	189 [86]	276 [125]	371 [168]
6.5	ZJ	1030 [467]	39 [991]	25 [635]	245 [111]	191 [87]	260 [118]	333 [151]
7.5	ZJ	1050 [476]	39 [991]	25 [635]	250 [113]	195 [89]	265 [120]	340 [154]
8.5	ZJ	1060 [481]	38 [965]	24 [610]	247 [112]	184 [84]	268 [122]	360 [163]
10	ZJ	1070 [485]	39 [991]	24 [610]	245 [111]	191 [87]	278 [126]	357 [162]
8.5 & 10	ZR	1200 [544]	38 [965]	25.5 [648]	297 [135]	221 [100]	291 [132]	390 [177]
6.5	XP	1080 [490]	38 [965]	25 [635]	262 [119]	195 [89]	266 [121]	357 [162]
7.5	XP	1090 [494]	38 [965]	23 [584]	243 [110]	181 [82]	284 [129]	381 [173]
8.5	XP	1137 [516]	38 [965]	25.5 [648]	282 [128]	210 [95]	276 [125]	370 [168]
10	XP	1135 [515]	38 [965]	25.5 [648]	281 [127]	209 [95]	275 [125]	369 [167]

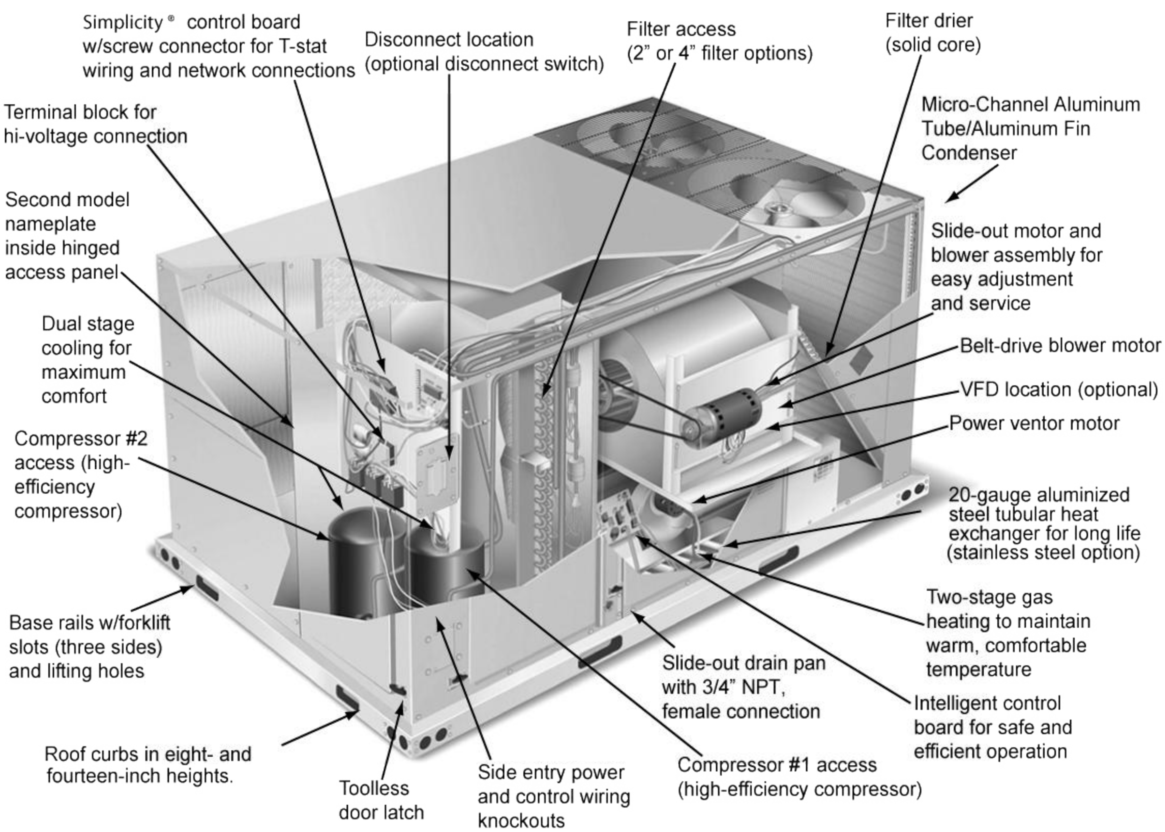




Project Name: **THE GARDENS**	Unit Model #: **J10ZHN20V4TZZ6**
Quantity: **1** Tag #: **RTU-5**	System: **J10ZHN20V4TZZ6**

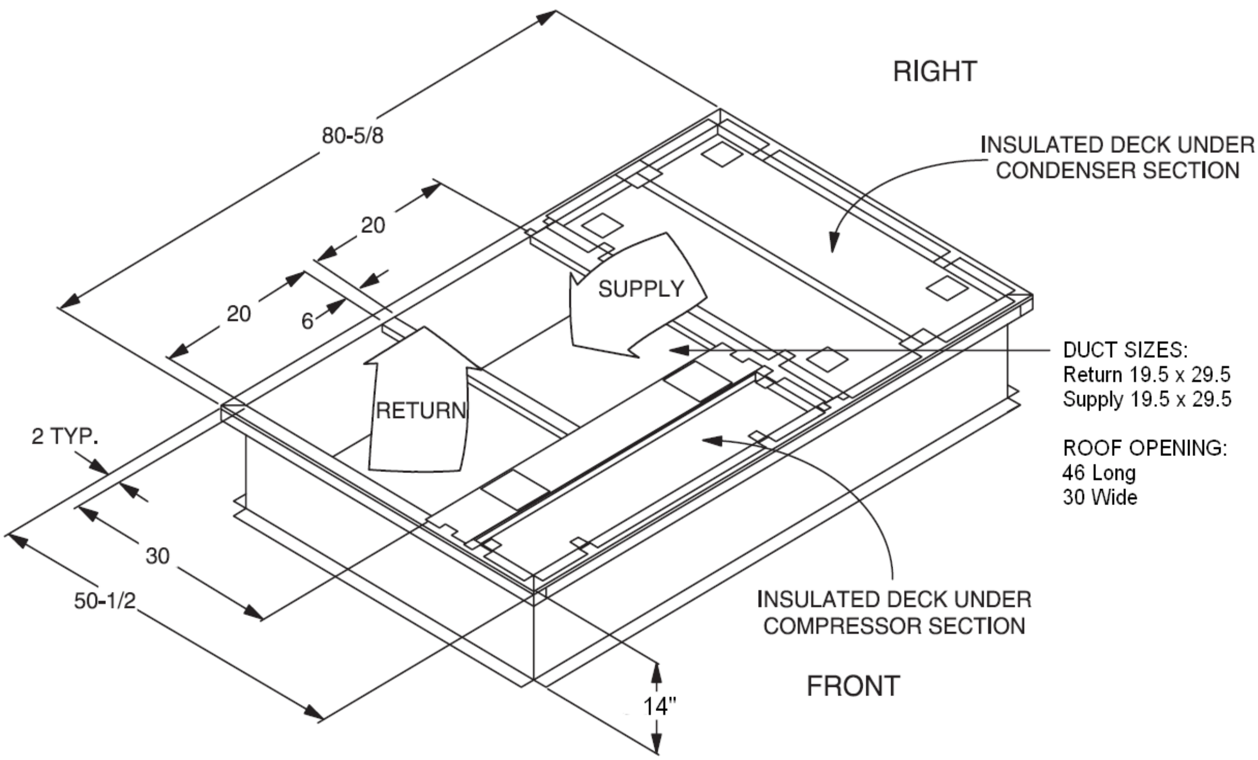
Component Location

6 1/2 Through 10 Tons



Project Name: **THE GARDENS**	Unit Model #: **J10ZHN20V4TZZ6**
Quantity: **1** Tag #: **RTU-5**	System: **J10ZHN20V4TZZ6**

1RC0471 Roof Curb



* Supply and Return Air (Including duct support rails) as shown, are typical for bottom duct applications.
For location of horizontal duct applications (On rear of unit), refer to Unit Dimensions details.

1RC0471 Roof Curb Dimensions

Project Name: **THE GARDENS** Unit Model #: **J07ZHN10V4TZZ50002**

Quantity: **1** Tag #: **RTU-6** System: **J07ZHN10V4TZZ50002**

Cooling Performance		
Total capacity	93.1	MBH
Sensible capacity	77.1	MBH
Refrigerant type	R-410A	
Efficiency (at ARI)	11.50	EER
Integrated eff. (at ARI)	12.60	IEER
Ambient DB temp.	95.0	°F
Entering DB temp.	77.0	°F
Entering WB temp.	63.8	°F
Leaving DB temp.	57.2	°F
Leaving WB temp.	55.2	°F
Part load efficiency	13	IPLV
Power input (w/o blower)	7.04	kW
Sound power	83	dB(A)

Gas Heating Performance		
Entering DB temp.	60	°F
Heating output capacity (Max)	96	MBH
Supply air	3600	CFM
Heating input capacity (Max)	120	MBH
Leaving DB temp.	84.7	°F
Air temp. rise	24.7	°F
SSE	80.0	%
Stages	2	

Supply Air Blower Performance		
Supply air	3600	CFM
Ext. static pressure	0.92	IWG
Unit static resistance	0.48	IWG
Blower speed	1641	RPM
Max BHP of Motor (including service factor)	3.45	HP
Duct location	Bottom	
Motor rating	3.00	HP
Actual required BHP	3.34	HP
Power input	3.12	kW
Elevation	0	ft.
Drive type	BELT	
Requires field-supplied drive	true	

Electrical Data		
Power supply	460-3-60	
Unit min circuit ampacity	24.7	Amps
Unit max over-current protection	25	Amps

Dimensions & Weight					
Hgt	42 in.	Len	89 in.	Wth	59 in.
Weight with factory installed options					1005 lbs.

Clearances					
Right	12 in.	Front	36 in.	Back	36 in.
Top	72 in.	Bottom	0 in.	Left	36 in.

Note: Please refer to the tech guide for listed maximum static pressures

7.5 Ton

- JCI Series 10 units are manufactured at an ISO 9001 registered facility and each rooftop is completely computer-run tested prior to shipment.

Unit Features

- Unit Cabinet Constructed of Powder Painted Steel, Certified At 1000 Hours Salt Spray Test (ASTM B-117 Standards)
- Through-the-Curb and Through-the-Base Utility Connections
- Full perimeter base rails with built in rigging capabilities
- Hinged Access Panels
- Slide-Out Condensate Drain Pan
- Reciprocating Compressor
- Two Stage Cooling
- Solid Core Liquid Line Filter Driers
- Microchannel Condenser Coil
- 96 MBH Output Aluminized Steel, Two Stage Gas Heat
- 3 HP High Static Belt Drive Blower
- Unit Ships with 4" Pleated Filters (MERV 13)
- Single Point Power Connection
- HACR Circuit Breaker/Disconnect
- Powered Convenience Outlet (110 VAC / 15 Amp)
- Phase Monitor
- Single Enthalpy Low Leak Slab Economizer w/Barometric Relief and Hoods (Bottom Return Only)
- Short Circuit Current: 5kA RMS Symmetrical

Standard Unit Controller: Simplicity Control Board

- Safety Monitoring - Monitors the high and low-pressure switches, the freezestats, the gas valve, if applicable, and the temperature limit switch on gas and electric heat units. The unit control board will alarm on ignition failures, safety lockouts and repeated limit switch trips.

Warranty

- One (1) Year Limited Warranty on the Complete Unit
- Five (5) Year Warranty - Compressors
- Ten (10) Year Warranty - Aluminized Steel Tubular Heat Exchangers

Project Name: **THE GARDENS**	Unit Model #: **J07ZHN10V4TZZ50002**
Quantity: **1** Tag #: **RTU-6**	System: **J07ZHN10V4TZZ50002**

Factory Installed Options

J07ZHN10V4TZZ50002

Nominal Cooling Capacity:	**J07**	7.5 Ton Two Stage Cooling
Product Category:	**Z**	Johnson Controls Series 10 Single Packaged R-410A Air Conditioner
Product Identifier:	**H**	11.5 EER / 12.6 IEER
Heat Type and Nominal Heat Capacity:	**N10**	96 MBH Output Aluminized Steel, Two Stage Gas Heat
Airflow:	**V**	3 HP High Static Belt Drive Blower Single Enthalpy Low Leak Slab Economizer w/Barometric Relief and Hoods (Bottom Return Only)
Voltage:	**4**	460-3-60
Installation Options:	**T**	HACR Circuit Breaker/Disconnect Powered Convenience Outlet (110 VAC / 15 Amp)
Additional Options:	**ZZ**	4" Pleated Filters (MERV 13) Microchannel Condenser Coil Phase Monitor Composite Drain Pan
Product Generation:	**5**	

Field Installed Accessories

- ○ ~~1BD0408 - Burglar Bars (32.0 lbs)~~
- ○ ~~1CG0428 - Coil Guard (20.0 lbs)~~
- ○ ~~1FE0412 - Flue Exhaust Extension Kit (14.0 lbs)~~
- ○ ~~1FF0415 - 2" Only metal Filter Frame Kit (16.0 lbs)~~
- ○ ~~1GP0405 - Gas Piping Kit for Bottom Gas Supply Connection with External Shut-Off (includes: Internal gas pipe, fittings, gas cock & panel gaskets) (10.0 lbs)~~
- ○ ~~1HG0415 - Hail Guard Kit (50.0 lbs)~~
- ○ ~~1NP0442 - Natural Gas to Propane Conversion Kit (2-Stage) (2.0 lbs)~~
- ○ ~~1RC0470 - Roof Curb - 8" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)~~
- ● 1RC0471 - Roof Curb - 14" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)
- ○ ~~1RC0472 - Roof Curb, Transition-Sunline 7.5T thru 12.5T to Predator 3.0T thru 12.5T (Shipped Assembled) (200.0 lbs)~~
- ○ ~~1RC0476 - Roof Curb - 24" High, Flat, Uninsulated, Full Perimeter (Shipped Knocked Down) (135.0 lbs)~~
- ○ ~~1WC0412 - Wooden Crate (445.0 lbs)~~
- ○ ~~2AP0401 - Air Proving Switch (1.0 lbs)~~
- ○ ~~2AQ04700324B - Space CO2 Sensor (To maintain CO2 levels in a conditioned space.) (2.0 lbs)~~
- ○ ~~2AQ04700424C - CO2 Control Kit - Unit Mounted with Mounting Hardware (5.0 lbs)~~
- ○ ~~2DF0402 - Dirty Filter Switch (1.0 lbs)~~
- ○ ~~2EP07700424 - JCI Branded, 2 Heat / 2 Cool, Electronic 7 Day Programmable, T600MSP-3 (2.0 lbs)~~
- ○ ~~2LA04704632 - Low Ambient Kit (6.0 lbs)~~
- ○ ~~2PE04704746 - Power Exhaust 460V without Baro Relief Downflow or Horizontal - For Use with Honeywell Jade Models~~
- ○ ~~2SD04700824 - Smoke Detector Kit w/ Mounting Hardware for Supply Air (Horizontal/Downflow) Only (9.4 lbs)~~
- ○ ~~2SD04700924 - Smoke Detector Kit w/ Mounting Hardware for Return Air (Downflow Only) Only (10.0 lbs)~~
- ○ ~~2SD04701024 - Smoke Detector Kit w/ Mounting Hardware for Supply (Horizontal/Downflow) and Return Air (Downflow Only) (8.0 lbs)~~
- ○ ~~ASC SERVICES - Charges for this Service are Applicable. Application, Startup & Commissioning (ASC) Services Available with Daily Fee Plus Expenses. This Service Provides a 90 Day DOA Benefit When Completed by a Factory Certified Technician. Contact Your Distributor, Dealer, or Sales Representative. Distributors Can Call 1-877-874-7378 for an ASC Quote~~.

Project Name: **THE GARDENS** | Unit Model #: **J07ZHN10V4TZZ50002**

Quantity: **1** Tag #: **RTU-6** | System: **J07ZHN10V4TZZ50002**

- ○ S1-02546381000 - Dual Enthalpy Control - For Economizers equipped with Honeywell Jade Control Only. (0.2 lbs)
- ● S1-02812363700 - Blower Sheave for 7.5 Ton High Static Field Installed Drive (2.0 lbs)
- ● S1-A47 - Belt A47 for Field Installed Drive (0.3 lbs)

Johnson Controls

Series 10

Single Package R-410A Air Conditioner

Project Name: **THE GARDENS** — Unit Model #: **J07ZHN10V4TZZ50002**

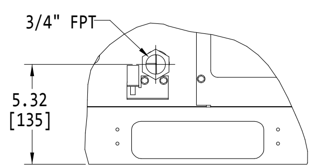
Quantity: **1** Tag #: **RTU-6** — System: **J07ZHN10V4TZZ50002**

Consolidated Drawing

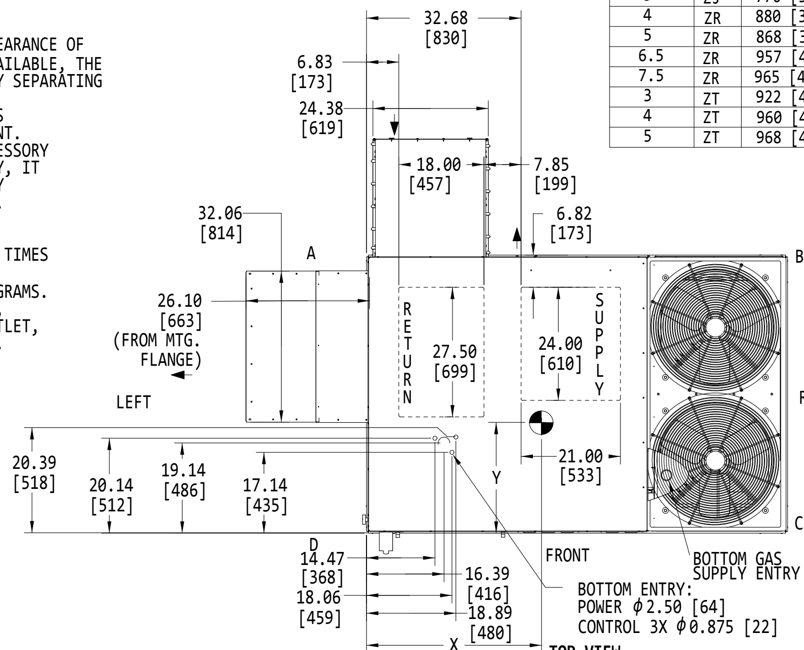
NOTES:
1. FOR OUTDOOR USE ONLY.
2. WEIGHTS SHOWN ARE FOR COOLING ONLY UNITS.
3. MIN. CLEARANCES TO BE:
   RIGHT SIDE: 12 [305]
   LEFT SIDE: 36 [915]
   FRONT: 36 [915]
   REAR: 36 [915]
   TOP: 72 [1830]
   BOTTOM: 0 [0]
4. TO REMOVE THE SLIDE-OUT DRAIN PAIN, A REAR CLEARANCE OF 60 in (1525 mm) IS REQUIRED. IF SPACE IS UNAVAILABLE, THE DRAIN PAN CAN BE REMOVED THROUGH THE FRONT BY SEPARATING THE CORNER WALL.
5. FOR SMALLER SERVICE AND OPERATIONAL CLEARANCES CONTACT YOUR APPLICATION ENGINEERING DEPARTMENT.
6. DOWNFLOW DUCTS DESIGNED TO BE ATTACHED TO ACCESSORY ROOF CURB ONLY. IF UNIT IS MOUNTED SIDE SUPPLY, IT IS RECOMMENDED THAT THE DUCTS ARE SUPPORTED BY CROSS BRACES, AS DONE ON ACCESSORY ROOF CURBS.
7. SIDE DUCT FLANGES ARE 0.75" HIGH. BOTTOM DUCTS DO NOT HAVE FLANGES.
8. MINIMUM CONDENSATION TRAP HEIGHT SHALL BE 1.5 TIMES THE LOWEST NEGATIVE STATIC.
9. DIMENSIONS IN [ ] ARE IN MILLIMETERS OR KILOGRAMS.
10. OPTIONAL COIL GUARDS, POWER EXHAUST, GAS HEAT, ECONOMIZER, DISCONNECT SWITCH, CONVENIENCE OUTLET, AND BAROMETRIC RELIEF & FRESH AIR HOODS SHOWN.
11. DELETED
12. 8 TUBE HEAT EXCHANGER IS NOT AVAILABLE FOR 3 & 4 TON UNITS.

DIRECTION OF AIRFLOW
CENTER OF GRAVITY

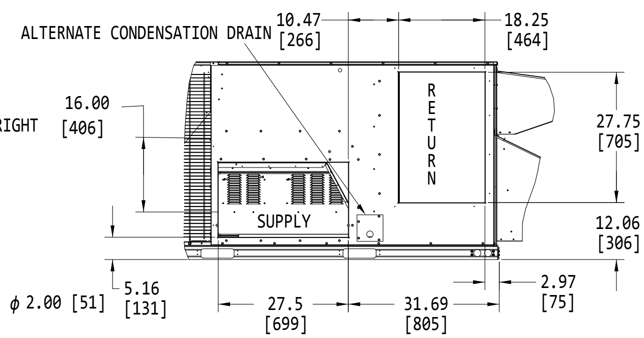
TONNAGE	UNIT	OPERATING WEIGHT(LBS) (BASE UNIT)	CENTER OF GRAVITY LOCATION (BASE UNIT) X	CENTER OF GRAVITY LOCATION (BASE UNIT) Y	4 POINT CORNER LOADS (LBS) (BASE UNIT) A	B	C	D
6.5	ZF	860 [390]	38 [965]	24 [610]	200 [91]	149 [68]	218 [99]	292 [133]
7.5	ZF	880 [399]	38 [965]	24 [610]	205 [93]	153 [69]	223 [101]	299 [136]
5	ZH	864 [393]	40 [1016]	26 [660]	210 [95]	171 [78]	217 [99]	266 [121]
6.5 & 7.5	ZH	910 [413]	38 [965]	24 [610]	212 [96]	158 [72]	230 [104]	309 [140]
5	ZJ	770 [349]	40 [1016]	24 [610]	172 [78]	141 [64]	205 [93]	251 [114]
4	ZR	880 [399]	40 [1016]	26 [660]	214 [97]	174 [79]	221 [100]	271 [123]
5	ZR	868 [394]	40 [1016]	26 [660]	211 [96]	172 [78]	218 [99]	267 [121]
6.5	ZR	957 [435]	38 [965]	23 [584]	214 [97]	161 [73]	249 [113]	333 [151]
7.5	ZR	965 [438]	38 [965]	23 [584]	216 [98]	161 [73]	251 [114]	337 [153]
3	ZT	922 [418]	42.4 [1077]	24.7 [627]	202 [92]	184 [84]	255 [116]	281 [128]
4	ZT	960 [436]	42.5 [1080]	25.5 [648]	217 [98]	198 [90]	260 [118]	285 [129]
5	ZT	968 [439]	41.6 [1057]	25.5 [648]	223[101]	196 [89]	257 [117]	293 [133]



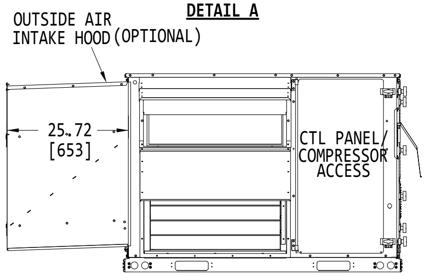
DETAIL A



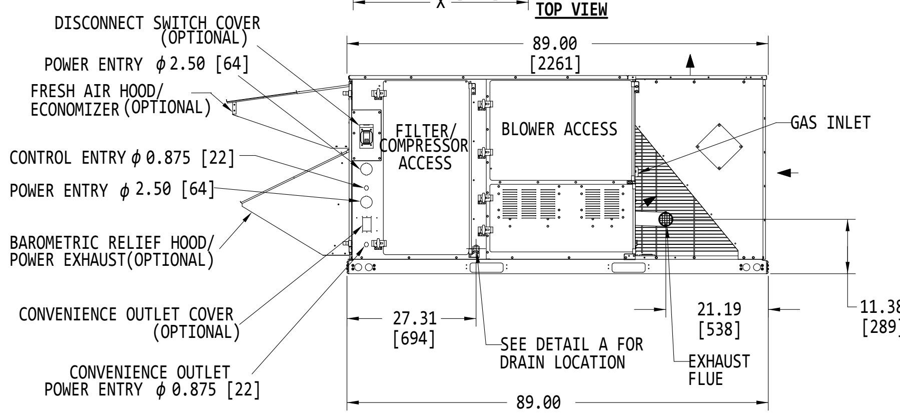
TOP VIEW



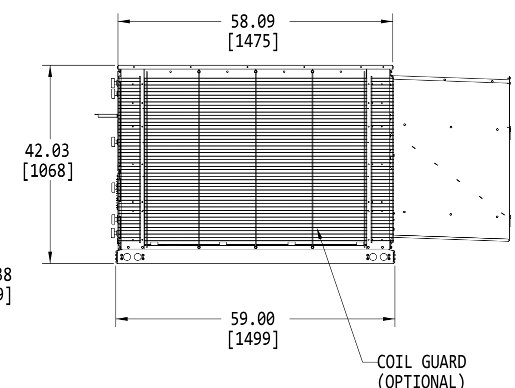
REAR (PARTIAL VIEW)
(INTAKE HOOD NOT SHOWN IN THIS VIEW)



LEFT VIEW



FRONT VIEW
(OPTIONAL FRONT COIL GUARD NOT SHOWN IN THIS VIEW)



RIGHT VIEW

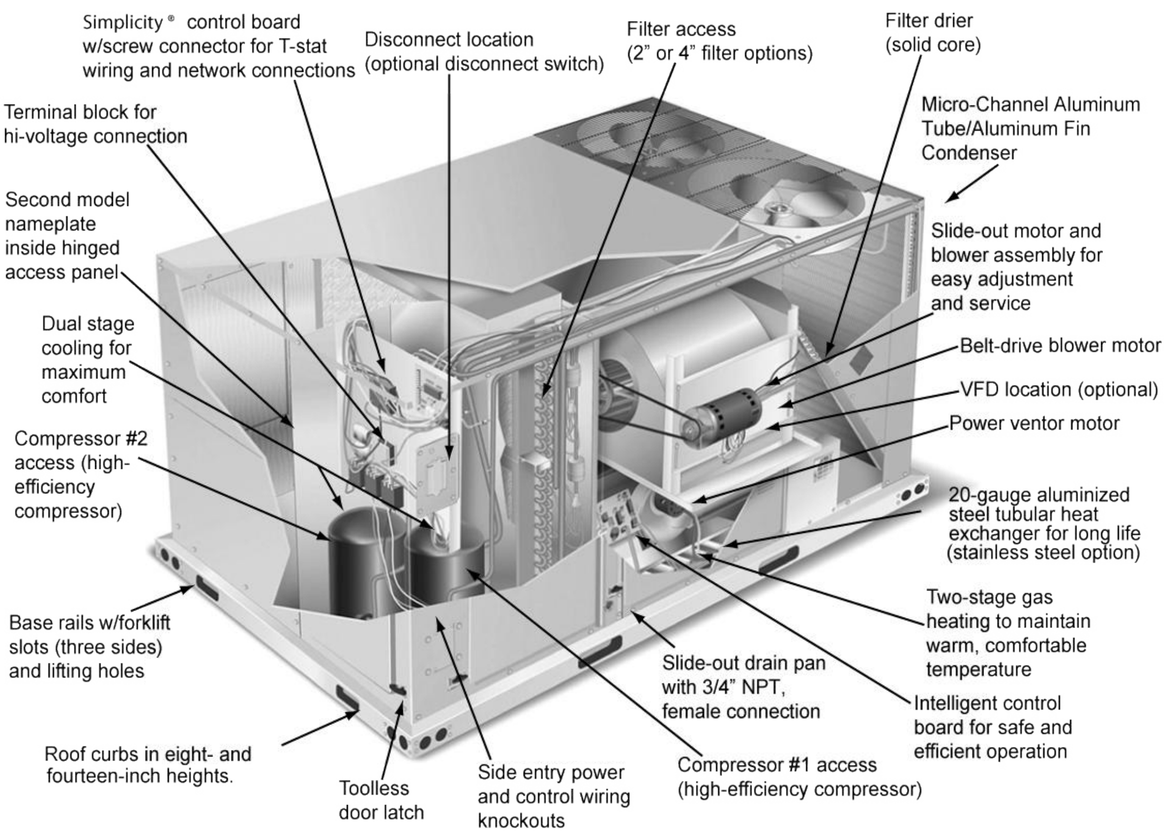
Series 10

Single Package R-410A Air Conditioner

Project Name: **THE GARDENS**	Unit Model #: **J07ZHN10V4TZZ50002**
Quantity: **1** Tag #: **RTU-6**	System: **J07ZHN10V4TZZ50002**

Component Location

6 1/2 Through 10 Tons

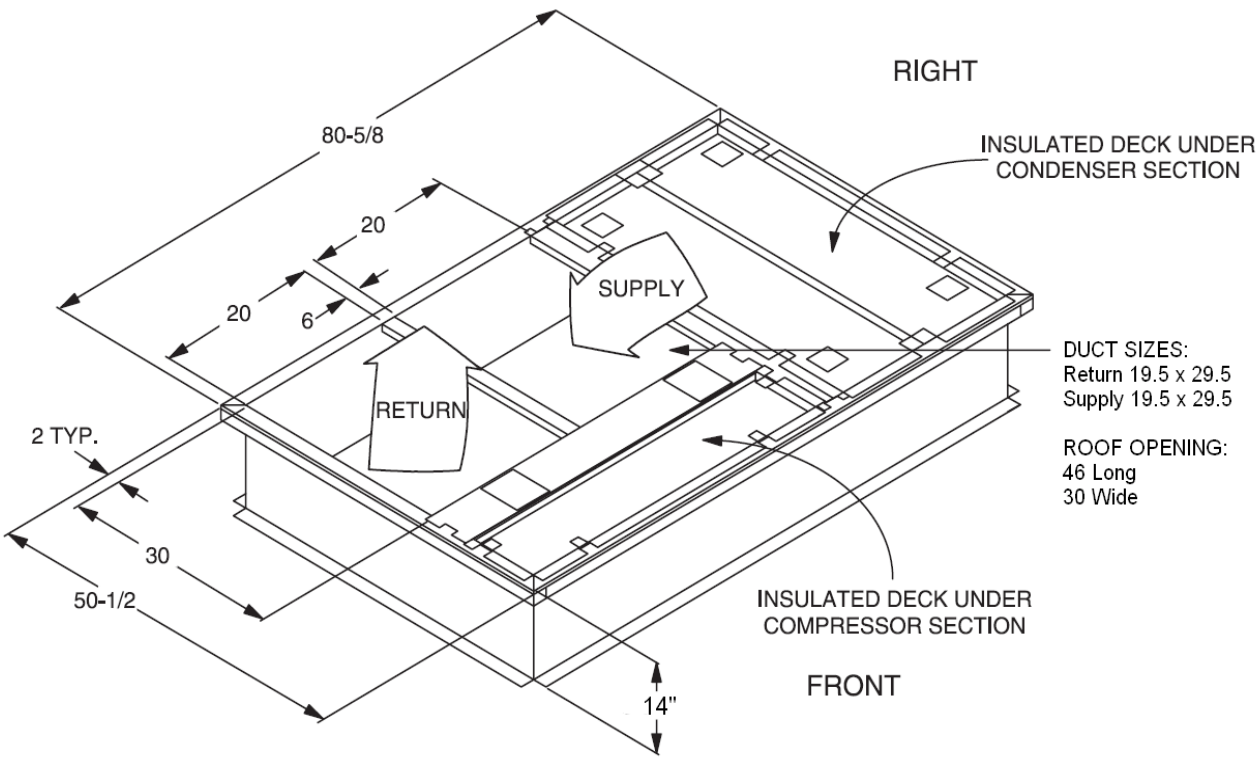


Series 10

Single Package R-410A Air Conditioner

Project Name: **THE GARDENS**	Unit Model #: **J07ZHN10V4TZZ50002**
Quantity: **1** Tag #: **RTU-6**	System: **J07ZHN10V4TZZ50002**

1RC0471 Roof Curb



* Supply and Return Air (Including duct support rails) as shown, are typical for bottom duct applications.
For location of horizontal duct applications (On rear of unit), refer to Unit Dimensions details.

1RC0471 Roof Curb Dimensions

Appendix H: Air Handling Unit Specs (New Unit)

Edited from Source: Turner Construction via Arquitectonica

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Unit Sequence

Tier 1 **FS <<< EH <<< XA <<< CC <<< FM**

Basic Unit Options

Insulation Type: (Refer to Each Segment)
Base Rail Height: 3"
Performance: High Performance

Statement of compliance of standard units.

JCI/York Solution AHU's meet IBC seismic requirements for non-critical equipment (Ip = 1.0) for locations with design spectral response Sds <= 0.43. Units must be rigid mounted.

The anchorage of the unit to the ground or building structure needs to be evaluated by and is the responsibility of the engineer of record.

Specification of seismic requirements is the responsibility of the project design engineer. If formal certification is required, please contact your sales representative and/or application engineer for review. Certain application and site requirements may require additional cost and/or lead time.

Unit Special Quotes
None

***Note:Component locations are listed as Segment Hand (Unit Hand) : ex. Left (Right)**
See Submittal Drawing for additional details

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Segments Listed Starting At Air Inlet

FM – Filter/Mixing Box Segment

Segment Detail

Segment Air Pressure Drop (in. w.g.): 0.51

	Outside Air (OA)	Return/Mixed Air (RA/MA)
AirFlow (CFM)	5000	5000
Opening (QTY) Size	15.25Hx46.00W	15.25Hx46.00W
Area per Opening (ft²)	4.87	4.87
Location	Front-High(Front)	Bottom
Damper (QTY) Size	(1)15.25x46	(1)15.25x46
Damper Type	Control	Control
Configuration	100%	100%
Damper Model	CD60	CD60
Damper Material	Galvanized	Galvanized
Blade Orientation	Parallel	Parallel
Min. Allowed CFM	N/A	N/A
Damper Linkage	Unlinked	Unlinked

Filter Media Detail

Filter Type	4" Mini-Pleat80-85% Eff, (MERV 13)
Filter Area (ft²)	16.00
Filter QTY/Size	(8)24x12
Load Option	Side
Filter APD (in. w.g.)	0.29
Dirty Filter Allowance	0.00
Spare Filter Type	None
Spare Filter QTY	0

Filter/Mixing Box Segment Options

Interior Galvanized Liner
Insulation: R-13 Foam Insulation
Galvanized Floor Liner STD Gauge
Exterior Galvanized Liner
Access Door on Left Side(Left) 36H x 30W
Standard Door Latch, No Lock, Outward Opening

Dampers Selected are ASHRAE 90.1 Compliant

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

CC – Cooling Coil Segment

Coil Segment Details	
Coil Space:	7"

Coil Segment Options

Interior Galvanized Liner
Insulation: R-13 Foam Insulation
Galvanized Floor Liner STD Gauge
Exterior Galvanized Liner
17" IAQ Coil Drain Pan Left (Left)
Stainless Steel
Access Door on Left Side(Left) 36H x 18W
Standard Door Latch, No Lock, Outward Opening
Bulkhead Material Galvanized
Coil Supports Galvanized

UV Surface Decontamination Detail

None

XA Access Segment

Access Segment Details	
Segment Length:	36 "

Access Segment Options

Interior Galvanized Liner
Insulation: R-13 Foam Insulation
Galvanized Floor Liner STD Gauge
Exterior Galvanized Liner
Access Door on Left Side(Left) 36H x 18W
Standard Door Latch, No Lock, Outward Opening
Fluorescent Light
33" Additional Core Growth

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

EH – Electric Heat Segment

Segment Details

Element Type:	Open
Segment Length:	24"
APD (in. w.g.):	0.04
Voltage:	460 / 480
Kw:	40.00
Kw Rating Method:	Standard KW Rating
Temperature Rise °F:	25.5
Entering Air Temperature °F:	80.0
Leaving Air Temp °F:	105.5
Amperage Draw:	50.20
Stages:	2 Stages
Control Voltage:	24 VAC
Minimum CFM Required:	2578

Segment Options

Access Door on Left Side(Left) 36H x 21W
Standard Door Latch, No Lock, Outward Opening
Outside Door Handle on Control Side Door (Left)
Pilot Lights: None
Control Panel Mounting: Standard
Control Interlocks: Airflow Switch and Dry Contact Interlock
Protective Screen: Both
Heater Control Type: Staged
Contactor Options: Magnetic Disconnecting
Control Panel Hand: Left (Left)
Disconnect Switch: Non Fused
Supply fusing: Included
Nema Rating: NEMA 1
Controller Options: None
Field Terminated Wiring

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

FS - Supply Fan Segment

Segment Details

Segment Air Pressure Drop (in. w.g.):	0.00
Air Flow (CFM):	5000
Altitude (ft.):	0
TSP/ESP (in. w.g.):	2.60/ 1.50
Air Inlet:	Front(Front)
Fan Discharge:	Rear(Rear)

Fan Segment Options

1" Spring Isolator
Interior Galvanized Liner
Insulation: R-13 Foam Insulation
Galvanized Floor Liner STD Gauge
Exterior Galvanized Liner
External Light Switch
Convenience Outlet 15A
Fan AFMS Airflow Constant (K Factor): 11065.00
Transducer Range: 0-0.25"
Inverter Drive Balancing
Access Door on Left Side(Left) 36H x 18W
Standard Door Latch, No Lock, Outward Opening

Fan Detail

Type:	FC
Size:	15-11
Construction:	II
Bearing Options:	None
Fan RPM:	1052
BHP:	3.57
Fan BHP w/ Belt Loss:	3.82
Outlet Velocity (ft/min):	2720

Motor Detail (per motor)

Motor Type:	Baldor ODP Premium Efficiency
HP	5.0
Voltage/Phase/Frequency:	460/3/60 Hz
Insulation Class:	F
Motor RPM:	1800
Frame Size:	184
Location:	Left(Left)
Drive Type:	Belt Drive
Belt Drive Type:	Fixed
Full Load Amps (FLA):	6.60
Efficiency:	89.5%

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	**1**	**Solution Indoor Air Handler 42 x 60**	**5000**

Motor Control – Supply Fan

Motor Control Details	
Motor Control Type:	Variable Frequency Drive
Motor HP:	5.0

Motor Control Electrical Details	
Full Load Amps (FLA):	8.8

Motor Control Options

None Disconnect

RFI/EMI EMC Filter
Swinging DC Line Choke (equivalent to 5% Input Line Reactor)
Modbus RTU, Johnson N2, Siemens FLN, BACnet

Environmental	
Ambient Temperature (°F):	5 to 104
Storage Temperature (°F):	-40 to 158
Humidity:	MAX 95% RH non-condensing
Altitude:	3,300 ft. without derate (1% derate for each additional 330 ft.)
Enclosure:	NEMA 1

Input	
Rated Input Voltage:	380/400/415/440/460/480 +10% -15% VAC 3 phase
Rated Input Current Amps:	8.80
Heat Loss in Watts 100% Load:	127.00
Efficiency (%):	98.00

Output	
Output Current Amps:	8.8
Overload Current Rating:	110% for 1 minute every 10 minutes

Drives are rated for use below 3,300 ft and 104°F.
Use Derating Charts in Air-Mod Engineering Guide Form 100.42-EG1 (212) for use above these limits.

Copper Conductors Only

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Coils & Spacers Listed Starting In Direction Of Air Flow

CC Coil - 01

Coil General/Physical Details				Air Side Performance		Fluid Side Performance	
Location:	0	Rows:	4	Air Flow (scfm):	5000	Fluid Type:	R-41
Tag:	AirCoil	Fins Per Inch:	13	Altitude (ft.):	0	Suct Tmp(°F):	0a
Application:	Cooling	Circuit:	10	EAT-DB (°F):	77.0	RPD (PSI):	45.00
Coil Type:	DX	Finned Height (in.):	32.50	EAT-WB (°F):	63.8	Fluid Weight(lb):	3.7
Face Type:	Full	Finned Length (in.):	48	LAT-DB (°F):	55.4	Fluid Volume(ft³):	7.8
Tube Diameter:	1/2" BDX	Coil Face Area (ft²):	10.8	LAT-WB (°F):	53.4		0.6
Tube Material:	Copper	Coil Conn. Loc.:	Left(Left)	FV (ft/min):	463		
Tube Wall Thickness:	.016"	Suct Conn Size:	1-5/8	SMBH:	119.5		
Fouling Factor (hft²°F/btu):	N/A	Liq Conn Size:	7/8	TMBH:	154.3		
Fin Type:	Corrugated	Distributor Data:		APD (in. w.g.):	0.55		
Fin Thickness:	.006"	Distributors:	2				
Fin Material:	Aluminum	Pct. Cap					
Casing Material:	Galvanized	Split(Inter):	50-50				
Connection Material:	Copper						
Connection Type:	Sweat						
Coating:	None						

All ratings are based on entering sub-cooled liquid refrigerant temperature of 110°F.

Ratings are for coils manufactured by Johnson Controls, Inc., 507 E. Michigan St., Milwaukee WI 53202.

BDX Tube Spacing: 1.25" x 1.08"

AHRI Messages:
This coil is rated in accordance with the AHRI Forced-Circulation Air-Cooling and Air-Heating Coils Certification program which is based on AHRI Standard 410. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

NOTE: Auxiliary Side Connectors for hot gas bypass are provided for ONE circuit only.
Coil Dll Version: 7.2a

Electrical Circuit Summary

Short-Circuit Summary	
5 kA rms Symmetrical	480 V Maximum

Circuit 1	Circuit 1 Electrical Details	
Supply Fan Motor Control	Full Load Amps (FLA):	8.8
	Minimum Circuit Ampacity (MCA):	11.0
	Maximum Overcurrent Protection:	17.50

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	**1**	**Solution Indoor Air Handler 42 x 60**	**5000**

Circuit 2	Circuit 2 Electrical Details	
Electric Heat1	Electric Heat Amps:	50.2
	Minimum Circuit Ampacity (MCA):	62.8
	Maximum Overcurrent Protection:	70.00

Circuit 3	Circuit 3 Electrical Details	
Lights and Outlets		
	Maximum Overcurrent Protection:	15.00

Static Pressure Summary

Segment	Component	Supply (in. w.g.)	Return Fan (in. w.g.)
FM Filter / Mixing Box	Opening Pressure Drop	0.18	
	Control Galvanized (CD60)	0.04	
	4" Mini-Pleat 80-85% Eff, (MERV 13)	0.29	
CC Variable Length Cooling Coil	Cooling 4 rows 13 fins	0.55	
EH Electric Heat	Electric Heater	0.04	
FS-DWDI Supply Fan	External Static Pressure - User Entered Pressure Drop	1.50	
Total		**2.60**	**0.00**

Air handling unit parameters vary depending on conditions. Parameters such as airflows, air pressure drops, and coil capacities are shown for design conditions.

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Dimension & Weights Summary

Section	Length* (in.)	Width** (in.)	Height (in.)	Weight (lbs.)
FM Filter / Mixing Box Segment	33	60	42	366
CC Variable Length Cooling Coil Segment	33	60	42	682
XA Variable Length Access Segment	36	60	42	282
EH Electric Heat Segment	24	60	42	308
FS-DWDI Supply Fan Segment	40	60	42	755
Overall:	**166**	**60**	**42**	**2393**

*The length includes bottom tier segments only.
**The width does not include coil connection extensions or door latches that extent beyond the unit casing.
The width does not include the depth of any pipe chases.

Shipping Skid Summary

Shipping Skid	Length* (in.)	Width** (in.)	Height*** (in.)	Weight (lbs.)
(FS-DWDI EH XA CC FM)	167	72	49	2393

Ship Loose:
None

*The length includes any mounted rain-hoods, discharge flanges, tie-down brackets, shipping wood-blocks, front dampers, split connectors, electrical/control components, outrigging extensions, isolation dampers, inlet baskets
**The width includes any door handles, coil connections, drain connections, lifting lugs, mounted pipe-chases, electrical/control components, tie-down brackets, side dampers
***The height includes any base-rails, shipping wood-blocks, roof peak, discharge flanges, mounted gas-furnace flue pipes

Shipping Skid Sequence

Tier (FS < EH < XA < CC < FM)

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Sound Summary

Octave Band Sound Power Levels (dB Re. 1 picowatt)

	63	125	250	500	1000	2000	4000	8000	dBA
Ducted Discharge Rear-1, FS	94	93	88	88	86	82	79	77	
Return Air Bottom-1, FM	85	83	72	72	72	71	69	62	
Outside Air Front-1, FM	79	77	66	68	68	67	64	58	74

Sound data tested in accordance with AHRI-260 (2001), Standard for Sound Rating of Ducted Air Moving and Conditioning Equipment.

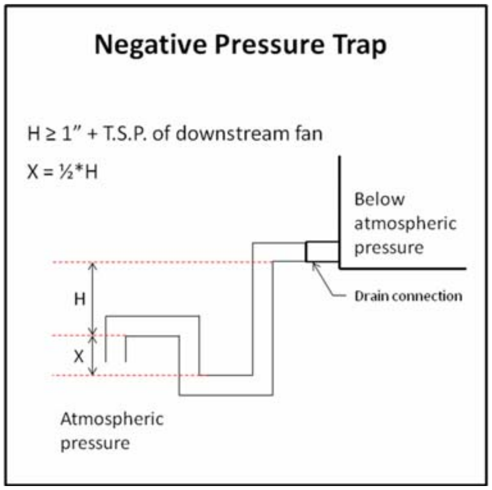
Notes:

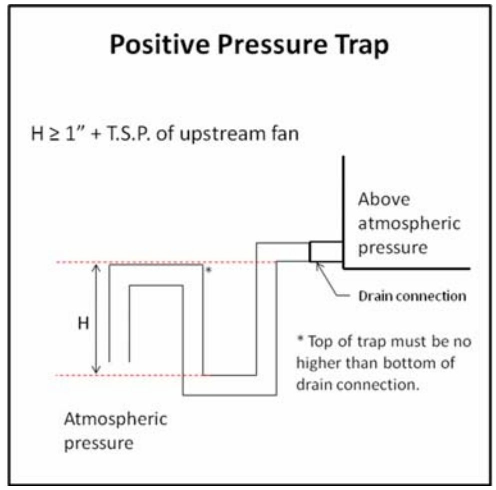
1. The overall A-weighted sound power level is only applicable to sound radiation outdoors and casing radiated sound. This metric does not apply to ducted components
2. Return air sound powers are estimated using 85% of unit flow. Outside air sound powers are estimated using 15% of unit flow.

SOLUTION AIR HANDLING UNIT PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model	Air Flow (CFM)
AHU-1	1	Solution Indoor Air Handler 42 x 60	5000

Recommended Trap Height Summary



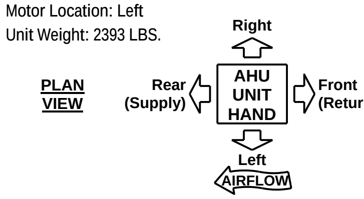


Segment	Applicable Fan	Fan TSP [in H_2O]	Positive or Negative	Calculated Dimensions			Recommended		Base Rail Height
				H	X	H + X	H	H + X	
CC	Supply Fan	2.60"	Negative	3.60"	1.80"	5.40"	3.75"	5.75"	3"

Notes:
Formulas and calculations are recommendations only. Contractor shall determine actual dimensions required for each trap based on jobsite conditions, and application requirements.
Refer to section 2 (Installation) of the IOM for more information.

UNIT CONSTRUCTION

Model: Solution-XTI-42x60 Construction: Indoor
Motor Location: Left
Unit Weight: 2393 LBS.



NOTES

Units with a baserail and a bottom opening: Duct connection flush with the bottom of unit, not flush with bottom of baserail.

Refer to performance report for shipping split details.

Allow sufficient space around the unit for removing the access panels and various parts of the unit. A minimum clearance equal to the width of the unit must be provided on one side of the unit for removing the coil or fan assembly.

Contractor responsible for penetrations and connections of all electrical boxes and internal coil connections.

Overall dimensions account for: coil connections, electrical enclosures, AMS-60 damper/EAML louver (if applicable,) base rail - in order to convey the true space requirements for the unit.

Certain items may extend beyond cabinet dimensions including: door handles, light switches, lifting lugs , electrical boxes, gas fuel system, etc.

Dimension tolerances: Unit (+/- 1/2"); Piping (+/- 2")
(SL) - Designates Shipped Loose Item(s)

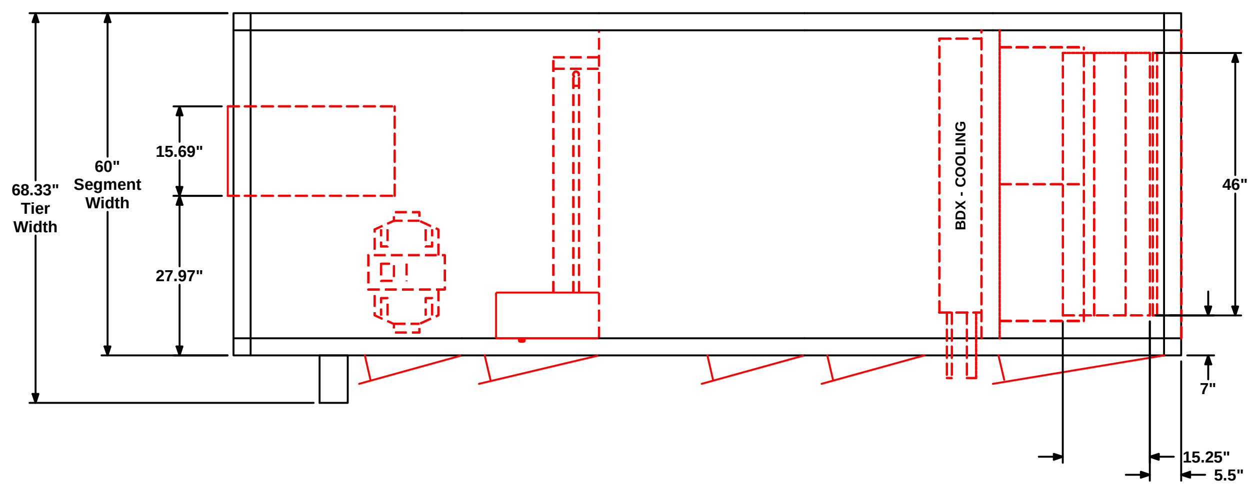
PIPING CONNECTIONS
(In order of Airflow)

Segment	Type	Hand	Quantity	Supply	Return
CC	Sweat	Left	2 Dist 2 Ret	7/8"	1 5/8"

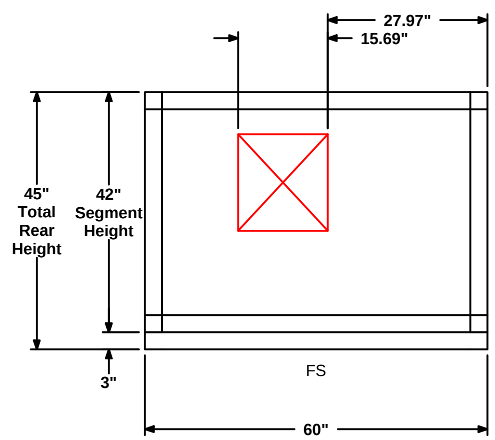
Drain pan connection size 1 1/4" MPT SCH 40
(Connections on LEFT side of unit)

SECTION LIST
(LENGTHS INCLUDE END CHANNELS)

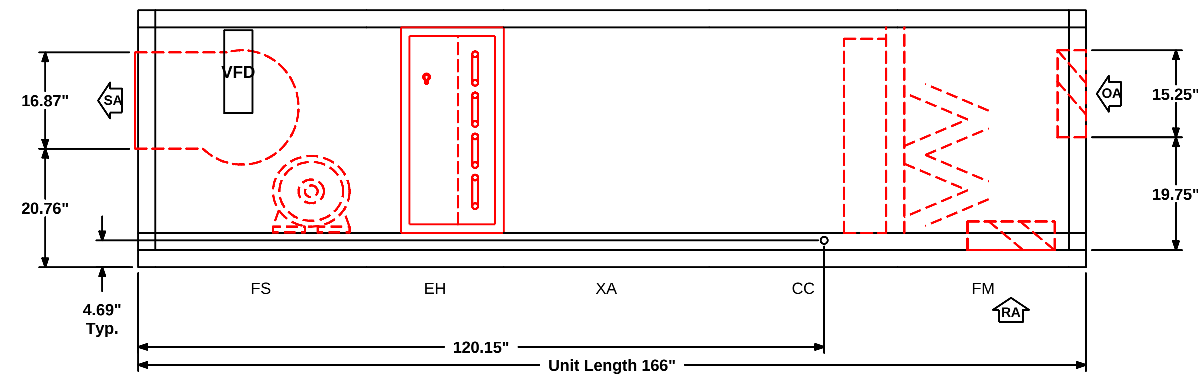
SECT	DESCRIPTION
FS (40)	Supply Fan - 15-11 DWDI - 5.00 HP
EH (24)	Electric Heat
XA (36)	Variable Length Access
CC (33)	Cooling Coil
FM (33)	Filter/Mixing Box



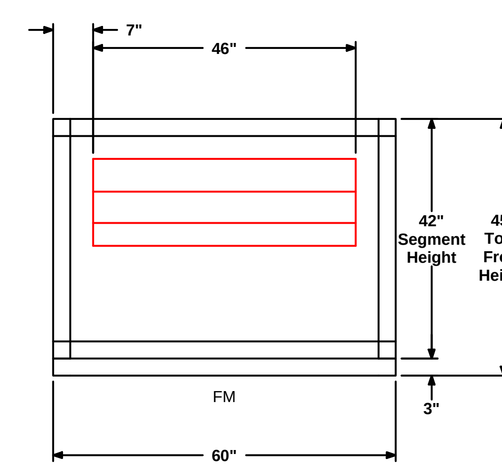
PLAN VIEW
TIER 1



REAR (OUTLET) END VIEW



ELEVATION VIEW



FRONT (INLET) END VIEW

PRODUCT DRAWING

SOLUTION AIR HANDLING UNIT DETAIL
MODEL: Solution-XTI-42x60
NOT FOR CONSTRUCTION

Project Name: Bistline AE Senior Thesis
Location:
Engineer:
Contractor:
For:

Sold To:
Cust Purch Order#:
Contract#:
UNIT TAG: AHU-1

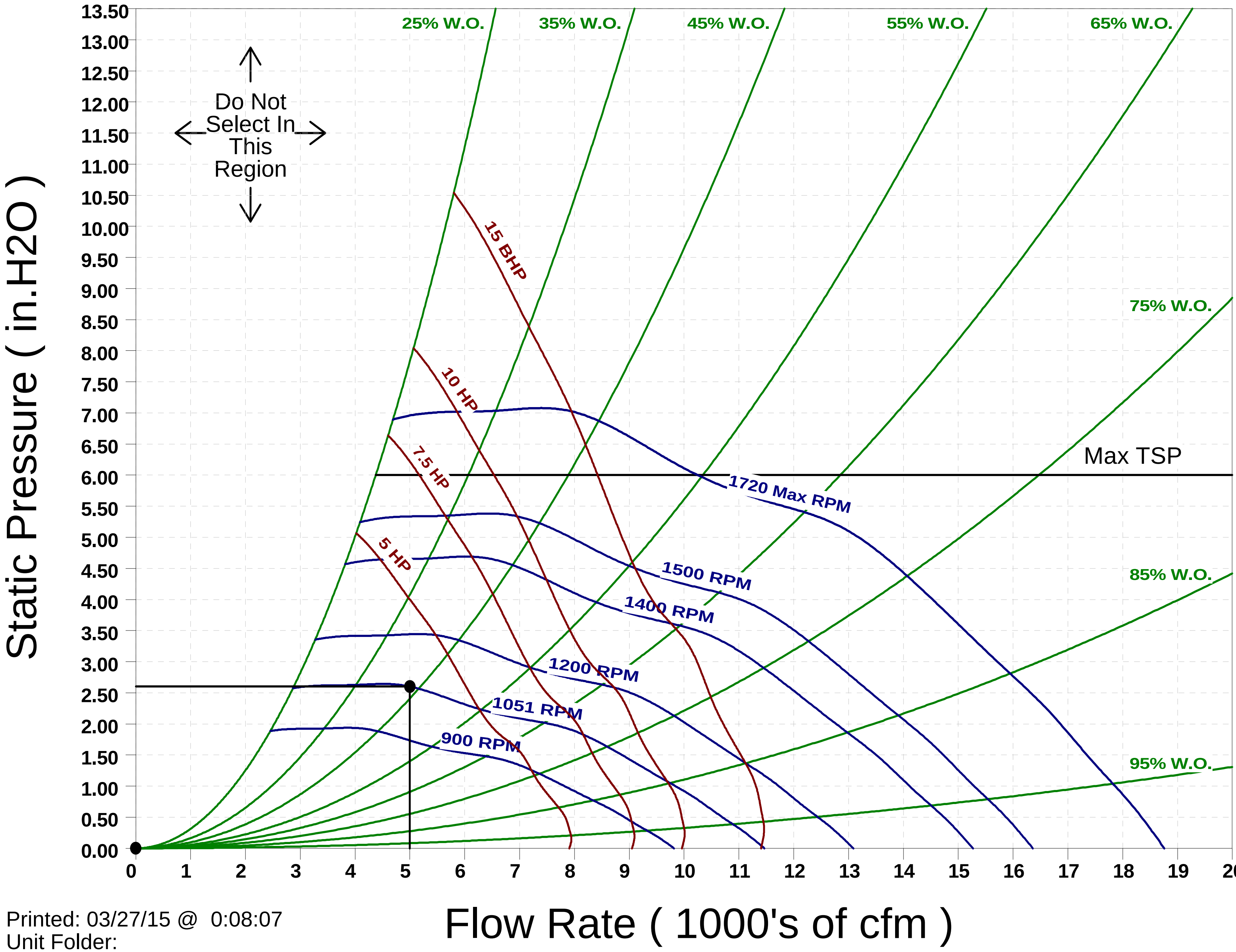
Date: 3/27/2015 0:0:1
Version: 1.1.0.6210
Form No.: 100.09-EG1
Dwg. Lev.: 5/03
Dwg. Scale : NTS

Serial Number:
SQ Database Number:
Software Release:
Dwg. Name:
Dwg. Location:

YORK
A JOHNSON CONTROLS COMPANY

Solution Fan Rating Curve

Project Name	Unit Tag	Qty	Model	Seg	Fan Type	Class	Size
Bistline AE Senior Thesis	AHU-1	1	XTI-42x60	FS	FC	II	15-11



Operating Point

Draw Typ	Draw-Thru
Flow (cfm):	5000
TSP (in.H2O):	2.60
Altitude (ft):	0
RPM:	1051
BHP:	3.57
O.V.:	2720

Fan Limits

Max RPM:	1720
Max TSP:	6

Cabinet Limits

Max HP:	15

Printed: 03/27/15 @ 0:08:07
Unit Folder:

Appendix I: Condenser Specs (New)

Edited from Source: Turner Construction via Arquitectonica

SUBMITTAL DATA

For: Approval

Order #:		**Date:**	03/31/2015
Project:	PSU AE Thesis		
Project #:			
Location:			

Date

03/31/2015

Project Name

PSU AE Thesis

Project Number

Client / Purchaser

Submittal Summary Page

Qty	Tag #	Model #	Description
1		J15YCC00A4AAA4	15 Ton 11.2 EER/ 12.2 IEER/ 12.5 IPLV, Johnson Controls Series 20 Split System R-410A Air Conditioner, 2-Pipe R-410A, 460-3-60, Microchannel Condenser Coil, Simplicity® SE Control
1		1HG0417	Hail Guard
1		2PM04700124	Phase Monitor Kit - Includes Control and associated wiring. This accessory provides protection against phase reversal, loss or unbalance. (Used on YC/YD/PC/PD Models).

Equipment start-up and commissioning by a factory trained technician is recommended.
Contact your supplying distributor or sales representative for additional information & guidance.

Series 20 OD Split System

Split Outdoor R-410A

Project Name: **PSU AE Thesis**	Unit Model #: **J15YCC00A4AAA4**
Quantity: **1**	System: **J15YCC00A4AAA4**

Cooling Performance

Total capacity	160.2	MBH
Refrigerant type	R-410A	
Ambient DB temp.	95.0	°F
Power input (w/o blower)	13.36	kW
Suction pressure	131	psig
Saturated suction temp.	45	°F

Electrical Data

Power supply	460-3-60	
Unit min circuit ampacity	32.2	Amps
Unit max over-current protection	40	Amps

Dimensions & Weight

Hgt	45 in.	Len	59 in.	Wth	64 in.
Weight with factory installed options					914 lbs.

Clearances

Right	30 in.	Front	36 in.	Back	24 in.
Top	120 in.	Bottom	0 in.	Left	30 in.

Note: Please refer to the tech guide for listed maximum static pressures

15 Ton

- Series 20 Split System Units are Manufactured at an ISO 9001 Registered Facility.

Unit Features

- Unit Cabinet Constructed of Powder Painted Steel, Certified At 1000 Hours Salt Spray Test (ASTM B-117 Standards)
- Full Perimeter Base Rails with Built in Rigging Capabilities
- Scroll Compressors with Crankcase Heater
- Single Refrigeration Circuit (2 Pipe)
- Liquid Line Driers (Supplied for Field Installation)
- Aluminum Tube/ Aluminum Fin Microchannel Coils
- Back Seating Suction and Liquid Line Service Valves
- Inherently Protected Fan Motors
- Low Ambient to 40ºF
- Side or Bottom Single Point Power Connections
- Short Circuit Current: 5kA RMS Symmetrical

Standard Unit Controller: Simplicity Control Board

- Anti-Short Cycle Protection, Lead-Lag, Low Voltage Protection, On-Board Diagnostic and Fault Code Display
- Safety Monitoring - Monitors the High and Low-Pressure Switches. The Unit Control Board will Alarm on Compressor Lockouts and Repeated Limit Switch Trips.

BAS Controller

- Simplicity SE Control

Warranty

- One (1) Year Limited Warranty on All Other Parts
- Five (5) Year Limited Warranty on Compressors

Series 20 OD Split System

Split Outdoor R-410A

Project Name: **PSU AE Thesis**	Unit Model #: **J15YCC00A4AAA4**
Quantity: **1**	System: **J15YCC00A4AAA4**

Factory Installed Options

J15YCC00A4AAA4

Nominal Cooling Capacity:	**J15**	15 Ton 11.2 EER/ 12.2 IEER/ 12.5 IPLV
Product Category:	**Y**	Johnson Controls Series 20 Split System R-410A Air Conditioner
Product Identifier:	**C**	2-Pipe R-410A
Heat Type and Nominal Heat Capacity:	**C00**	
Airflow:	**A**	
Voltage:	**4**	460-3-60
Additional Options:	**AA**	Microchannel Condenser Coil Simplicity® SE Control

Field Installed Accessories

- 1HG0417 - Hail Guard (67.0 lbs)
- 2PM04700124 - Phase Monitor Kit - Includes Control and associated wiring. This accessory provides protection against phase reversal, loss or unbalance. (Used on YC/YD/PC/PD Models). (13.0 lbs)

Project Name: **PSU AE Thesis** | Unit Model #: **J15YCC00A4AAA4**

Quantity: **1** | System: **J15YCC00A4AAA4**

Consolidated Drawing

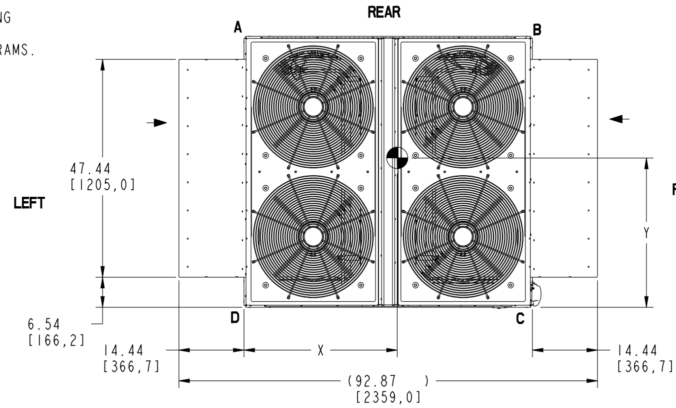
NOTES:
1. FOR OUTDOOR USE ONLY.
2. WEIGHTS SHOWN ARE FOR OPERATING, WITHOUT HAIL GUARDS.
3. MIN. CLEARANCES TO BE:
   - RIGHT SIDE: 30 [762]
   - LEFT SIDE: 30 [762]
   - FRONT: 36 [914]
   - REAR: 24 [610]
   - TOP: 120 [3048]
   - BOTTOM: 0 [0]
4. FOR SMALLER SERVICE AND OPERATIONAL CLEARANCES CONTACT JOHNSON CONTROLS APPLICATION ENGINEERING DEPARTMENT.
5. DIMENSIONS IN [ ] ARE IN MILLIMETERS OR KILOGRAMS.

⚠6 PD/PJ & YD/YJ UNITS ONLY.

TONNAGE	UNIT	OPERATING WEIGHT (LBS) (BASE UNIT)	CENTER OF GRAVITY LOCATION (BASE UNIT)		4 POINT CORNER LOADS (LBS) (BASE UNIT)			
			X	Y	A	B	C	D
15	PC	968 [439]	32.5 [825,5]	33 [838,2]	266 [121]	274 [124]	217 [98]	211 [96]
15	PD	942 [427]	34 [863,6]	32.5 [825,5]	243 [110]	275 [125]	225 [102]	199 [90]
15	YC	909 [412]	32.5 [825,5]	31.5 [800,1]	239 [108]	246 [112]	215 [98]	209 [95]
15	YD	894 [406]	32.5 [825,5]	31.5 [800,1]	235 [107]	242 [110]	212 [96]	206 [93]

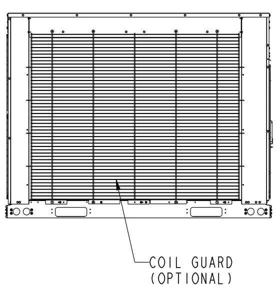
DIRECTION OF AIRFLOW

CENTER OF GRAVITY

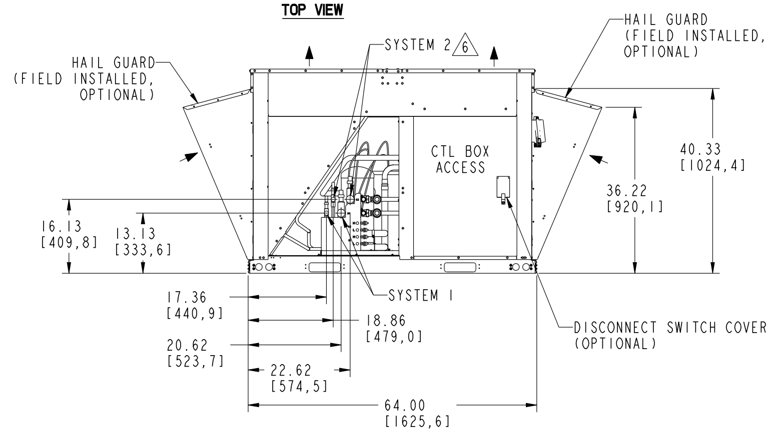


TOP VIEW

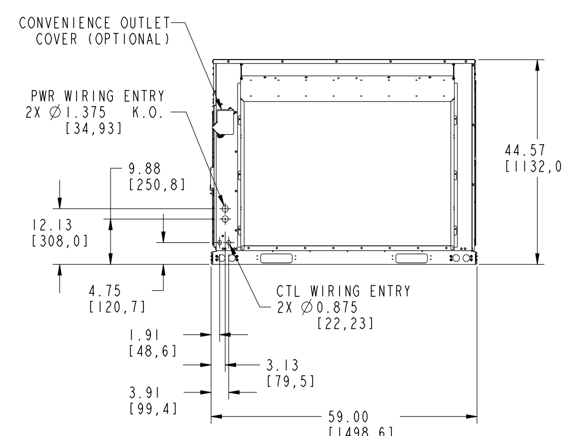
SYSTEM DATA				
	SYSTEM 1		SYSTEM 2	
	SUCTION LINE O.D.	LIQUID LINE O.D.	SUCTION LINE O.D.	LIQUID LINE O.D.
PC	1.625 [41,28]	0.875 [22,23]	N/A	N/A
YC	1.625 [41,28]	0.875 [22,23]	N/A	N/A
PD	1.375 [34,93]	0.625 [15,88]	1.375 [34,93]	0.625 [15,88]
YD	1.375 [34,93]	0.625 [15,88]	1.375 [34,93]	0.625 [15,88]



LEFT VIEW
HAIL GUARD NOT SHOWN IN THIS VIEW



FRONT VIEW
COIL GUARD NOT SHOWN IN THIS VIEW



RIGHT VIEW

SUBMITTAL DWG, OUTDOOR SPLIT, 15 TON, 2 & 4 PIPE, 44.5" CABINET	DWG NO. UST-PREDOD-40DF45H	REV B
	PART NO.	SHT NO 1 OF 1

Project Name: **PSU AE Thesis** Unit Model #: **J15YCC00A4AAA4**

Quantity: **1** System: **J15YCC00A4AAA4**

Piping & Connection

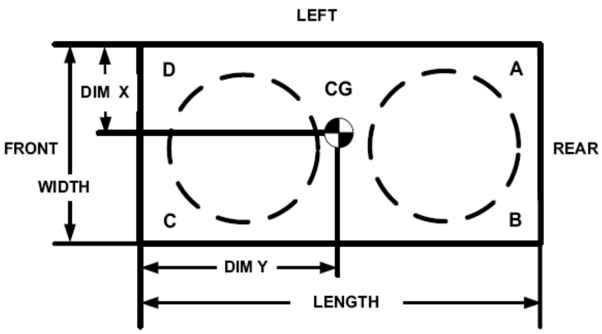
Piping and Electrical Connection Sizes (Inches)

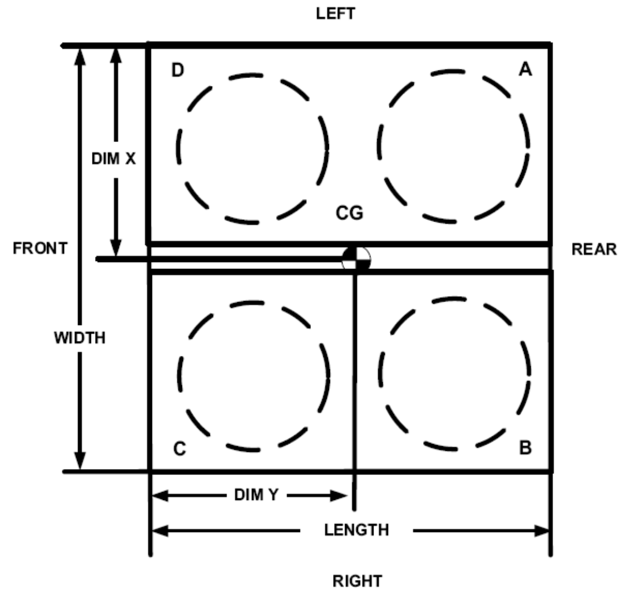
MODEL	J07PC	J10PC	J07YC	J10YC	J10YD	J12YC	J12YD
No. Refrigeration Circuits	1	1	1	1	2	1	2
Suction Line OD (in.)	1 1/8	1 3/8	1 1/8	1 3/8	1 1/8	1 3/8	1 1/8
Liquid Line OD (in.)	5/8	7/8	5/8	7/8	5/8	7/8	5/8
Power Wiring Knockout	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8
Control Wiring Knockout	7/8	7/8	7/8	7/8	7/8	7/8	7/8

MODEL	J15PC	J15PD	J20PC	J20PD	J15YC	J15YD	J20YC	J20YD	J25YC
No. Refrigeration Circuits	1	2	1	2	1	2	1	2	1
Suction Line OD (in.)	1 5/8	1 3/8	1 5/8	1 3/8	1 5/8	1 3/8	1 5/8	1 3/8	1 5/8
Liquid Line OD (in.)	7/8	5/8	7/8	5/8	7/8	5/8	7/8	5/8	7/8
Power Wiring Knockout	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8
Control Wiring Knockout	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8

Project Name: **PSU AE Thesis**	Unit Model #: **J15YCC00A4AAA4**
Quantity: **1**	System: **J15YCC00A4AAA4**

Corner Weights & Center of Gravity





NOTE: Front of unit is considered the side having the unit control box.

Corner Weights & Center of Gravity AC/HP Units

Model	Weight (lbs.)		Center of Gravity (in.)		4 Point Load Location (lbs.)			
	Shipping	Operating	X	Y	A	B	C	D
J07PC	421	430	17.3	33	110	130	103	87
J10PC	543	574	16.4	32.3	153	161	134	127
J15PC	947	968	32.5	33	266	274	217	211
J15PD	921	942	34	32.5	243	275	225	199
J20PC	1116	1152	32.1	30.8	300	301	276	275
J20PD	1090	1126	31.2	31.8	311	295	253	267
J07YC	390	387	17	32.3	99	113	94	82
J10YC	499	497	17.3	32.3	124	147	122	103
J10YD	493	490	17.4	32.5	123	147	120	100
J12YC	499	497	17	32.3	127	145	120	105
J12YD	493	490	17.4	32.5	123	147	120	100
J15YC	914	909	32.5	31.5	239	246	215	209
J15YD	899	894	32.5	31.5	235	242	212	206
J20YC	945	942	30.3	31.0	261	234	212	236
J20YD	930	927	32.7	31.8	244	255	218	210
J25YC	945	942	30.3	31.0	261	234	212	236

Appendix J: Piping Screwed Fittings

Edited from Source: Turner Construction via Arquitectonica

Calculating pipe length for fittings in the refrigerant piping:

Screwed Fittings - equivalent length in feet

Equivalent length (in feet) of straight pipe for fittings like bends, returns, tees and valves. (Pipe size in inches)

Equivalent Length of Straight Pipe for Valves and Fittings (feet)												
Screwed Fittings		Pipe Size										
		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Elbows	Regular 90 deg	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
	Long radius 90 deg	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.6	4.0	4.6
	Regular 45 deg	0.3	0.5	0.7	0.9	1.3	1.7	2.1	2.7	3.2	4.0	5.5
Tees	Line flow	0.8	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12.0	17.0
	Branch flow	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12.0	13.0	17.0	21.0
Return Bends	Regular 180 deg	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
Valves	Globe	21.0	22.0	22.0	24.0	29.0	37.0	42.0	54.0	62.0	79.0	110.0
	Gate	0.3	0.5	0.6	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.5
	Angle	12.8	15.0	15.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0
	Swing Check	7.2	7.3	8.0	8.8	11.0	13.0	15.0	19.0	22.0	27.0	38.0
Strainer			4.6	5.0	6.6	7.7	18.0	20.0	27.0	29.0	34.0	42.0

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Appendix K: RSMeans Copper Pipe and Fitting Cost Data

Edited from Source: Turner Construction via Arquitectonica

22 11 13 – Facility Water Distribution Piping

22 11 13.16 Pipe Fittings, Brass		Crew	Daily Output	Labor-Hours	Unit	2014 Bare Costs Material	Labor	Equipment	[redacted]
1760	5″	Q-2	8	3	Ea.	2,125	161		2,286
1780	6″		7	3.429		2,950	184		3,134
2000	Tee, 1/8″	1 Plum	9	.889		21	51		72
2040	1/4″		9	.889		21	51		72
2060	3/8″		9	.889		21	51		72
2080	1/2″		8	1		21	57.50		78.50
2100	3/4″		7	1.143		30	66		96
2120	1″		6	1.333		54.50	76.50		131
2140	1-1/4″	Q-1	10	1.600		93.50	83		176.50
2160	1-1/2″		9	1.778		105	92		197
2180	2″		8	2		175	104		279
2200	2-1/2″		7	2.286		415	118		533
2220	3″		5	3.200		635	166		801
2240	4″	Q-2	7	3.429		1,575	184		1,759
2260	5″		5	4.800		3,275	258		3,533
2280	6″		4	6		5,150	320		5,470
2500	Coupling, 1/8″	1 Plum	26	.308		15.05	17.70		32.75
2540	1/4″		22	.364		15.05	21		36.05
2560	3/8″		18	.444		15.05	25.50		40.55
2580	1/2″		15	.533		15.05	30.50		45.55
2600	3/4″		14	.571		21	33		54
2620	1″		13	.615		36	35.50		71.50
2640	1-1/4″	Q-1	22	.727		60	37.50		97.50
2660	1-1/2″		20	.800		78.50	41.50		120
2680	2″		18	.889		130	46		176
2700	2-1/2″		14	1.143		221	59		280
2720	3″		10	1.600		305	83		388
2740	4″	Q-2	12	2		630	107		737
2760	5″		10	2.400		1,175	129		1,304
2780	6″		9	2.667		1,675	143		1,818
3000	Union, 125 lb.								
3020	1/8″	1 Plum	12	.667	Ea.	51.50	38.50		90
3040	1/4″		12	.667		51.50	38.50		90
3060	3/8″		12	.667		51.50	38.50		90
3080	1/2″		11	.727		51.50	42		93.50
3100	3/4″		10	.800		70.50	46		116.50
3120	1″		9	.889		106	51		157
3140	1-1/4″	Q-1	16	1		154	52		206
3160	1-1/2″		15	1.067		183	55.50		238.50
3180	2″		13	1.231		247	64		311
3200	2-1/2″		10	1.600		675	83		758
3220	3″		7	2.286		1,050	118		1,168
3240	4″	Q-2	10	2.400		3,250	129		3,379
3320	For 250 lb. (navy pattern), add					100%			

22 11 13.23 Pipe/Tube, Copper		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total
0010	**PIPE/TUBE, COPPER**, Solder joints R221113-50								
0100	Solder								
0120	Solder, lead free, roll				Lb.	10.10			10.10
1000	Type K tubing, couplings & clevis hanger assemblies 10′ O.C.								
1100	1/4″ diameter	1 Plum	84	.095	L.F.	4.62	5.50		10.12
1120	3/8″ diameter		82	.098		3.99	5.60		9.59
1140	1/2″ diameter		78	.103		4.47	5.90		10.37

22 11 13 – Facility Water Distribution Piping

22 11 1[redacted], Copper		Crew	Daily Output	Labor-Hours	Unit	2014 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
1160	[redacted] diameter	1 Plum	77	.104	L.F.	5.95	6		11.95	15.55
1180	3/4″ diameter		74	.108		7.80	6.20		14	18
1200	1″ diameter		66	.121		10.60	7		17.60	22
1220	1-1/4″ diameter		56	.143		13.25	8.20		21.45	27
1240	1-1/2″ diameter		50	.160		17.15	9.20		26.35	33
1260	2″ diameter		40	.200		26.50	11.50		38	46.50
1280	2-1/2″ diameter	Q-1	60	.267		41	13.80		54.80	66.50
1300	3″ diameter		54	.296		58	15.35		73.35	86.50
1320	3-1/2″ diameter		42	.381		82	19.75		101.75	120
1330	4″ diameter		38	.421		101	22		123	144
1340	5″ diameter		32	.500		203	26		229	262
1360	6″ diameter	Q-2	38	.632		305	34		339	385
1380	8″ diameter	″	34	.706		480	38		518	590
1390	For other than full hard temper, add					13%				
1440	For silver solder, add						15%			
1800	For medical clean, (oxygen class), add					12%				
1950	To delete cplgs. & hngrs., 1/4″-1″ pipe, subtract					27%	60%			
1960	1-1/4″ -3″ pipe, subtract					14%	52%			
1970	3-1/2″-5″ pipe, subtract					10%	60%			
1980	6″-8″ pipe, subtract					19%	53%			
2000	Type L tubing, couplings & clevis hanger assemblies 10′ O.C.									
2100	1/4″ diameter	1 Plum	88	.091	L.F.	2.30	5.25		7.55	10.45
2120	3/8″ diameter		84	.095		3.13	5.50		8.63	11.75
2140	1/2″ diameter		81	.099		3.37	5.70		9.07	12.30
2160	5/8″ diameter		79	.101		5.35	5.85		11.20	14.65
2180	3/4″ diameter		76	.105		5.15	6.05		11.20	14.80
2200	1″ diameter		68	.118		7.85	6.75		14.60	18.85
2220	1-1/4″ diameter		58	.138		11.25	7.95		19.20	24.50
2240	1-1/2″ diameter		52	.154		14.35	8.85		23.20	29
2260	2″ diameter		42	.190		22	10.95		32.95	40.50
2280	2-1/2″ diameter	Q-1	62	.258		35.50	13.35		48.85	59
2300	3″ diameter		56	.286		48.50	14.80		63.30	76
2320	3-1/2″ diameter		43	.372		70.50	19.25		89.75	107
2340	4″ diameter		39	.410		85.50	21.50		107	126
2360	5″ diameter		34	.471		168	24.50		192.50	222
2380	6″ diameter	Q-2	40	.600		244	32		276	315
2400	8″ diameter	″	36	.667		370	36		406	465
2410	For other than full hard temper, add					21%				
2590	For silver solder, add						15%			
2900	For medical clean, (oxygen class), add					12%				
2940	To delete cplgs. & hngrs., 1/4″-1″ pipe, subtract					37%	63%			
2960	1-1/4″-3″ pipe, subtract					12%	53%			
2970	3-1/2″-5″ pipe, subtract					12%	63%			
2980	6″-8″ pipe, subtract					24%	55%			
3000	Type M tubing, couplings & clevis hanger assemblies 10′ O.C.									
3100	1/4″ diameter	1 Plum	90	.089	L.F.	2.58	5.10		7.68	10.55
3120	3/8″ diameter		87	.092		2.65	5.30		7.95	10.90
3140	1/2″ diameter		84	.095		2.65	5.50		8.15	11.20
3160	5/8″ diameter		81	.099		4.30	5.70		10	13.35
3180	3/4″ diameter		78	.103		3.99	5.90		9.89	13.30
3200	1″ diameter		70	.114		6.50	6.60		13.10	17.10
3220	1-1/4″ diameter		60	.133		9.55	7.65		17.20	22
3240	1-1/2″ diameter		54	.148		12.85	8.55		21.40	27

22 11 13.23 Pipe/Tube, Copper		Crew	Daily Output	Labor-Hours	Unit	Material (2014 Bare Costs)	Labor (2014 Bare Costs)	Equipment (2014 Bare Costs)	Total (2014 Bare Costs)	Total Incl O&P
3260	2" diameter	1 Plum	44	.182	L.F.	20	10.45		[redacted]	38
3280	2-1/2" diameter	Q-1	64	.250		31.50	12.95		44.45	54
3300	3" diameter		58	.276		43	14.30		57.30	69
3320	3-1/2" diameter		45	.356		64.50	18.40		82.90	[illegible]
3340	4" diameter		40	.400		79	20.50		99.50	[illegible]
3360	5" diameter		36	.444		168	23		191	[illegible]
3370	6" diameter	Q-2	42	.571		244	30.50		274.50	[illegible]
3380	8" diameter	"	38	.632		370	34		404	[illegible]
3440	For silver solder, add						15%			
3960	To delete cplgs. & hngrs., 1/4"-1" pipe, subtract					35%	65%			
3970	1-1/4"-3" pipe, subtract					19%	56%			
3980	3-1/2"-5" pipe, subtract					13%	65%			
3990	6"-8" pipe, subtract					28%	58%			
4000	Type DWV tubing, couplings & clevis hanger assemblies 10' O.C.									
4100	1-1/4" diameter	1 Plum	60	.133	L.F.	9.95	7.65		17.60	[illegible]
4120	1-1/2" diameter		54	.148		12.45	8.55		21	[illegible]
4140	2" diameter		44	.182		17.05	10.45		27.50	[illegible]
4160	3" diameter	Q-1	58	.276		35	14.30		49.30	[illegible]
4180	4" diameter		40	.400		62	20.50		82.50	[illegible]
4200	5" diameter		36	.444		154	23		177	[illegible]
4220	6" diameter	Q-2	42	.571		230	30.50		260.50	[illegible]
4240	8" diameter	"	38	.632		540	34		574	[illegible]
4730	To delete cplgs. & hngrs., 1-1/4"-2" pipe, subtract					16%	53%			
4740	3"-4" pipe, subtract					13%	60%			
4750	5"-8" pipe, subtract					23%	58%			
5200	ACR tubing, type L, hard temper, cleaned and									
5220	capped, no couplings or hangers									
5240	3/8" OD				L.F.	2.47			2.47	[illegible]
5250	1/2" OD					3.02			3.02	[illegible]
5260	5/8" OD					4.26			4.26	[illegible]
5270	3/4" OD					4.73			4.73	[illegible]
5280	7/8" OD					4.73			4.73	[illegible]
5290	1-1/8" OD					6.85			6.85	[illegible]
5300	1-3/8" OD					9.25			9.25	[illegible]
5310	1-5/8" OD					11.80			11.80	[illegible]
5320	2-1/8" OD					27.50			27.50	[illegible]
5330	2-5/8" OD					27.50			27.50	[illegible]
5340	3-1/8" OD					37			37	[illegible]
5350	3-5/8" OD					48.50			48.50	[illegible]
5360	4-1/8" OD					61.50			61.50	[illegible]
5380	ACR tubing, type L, hard, cleaned and capped									
5381	No couplings or hangers									
5384	3/8"	1 Stpi	160	.050	L.F.	2.47	2.93		5.40	[illegible]
5385	1/2"		160	.050		3.02	2.93		5.95	[illegible]
5386	5/8"		160	.050		4.26	2.93		7.19	[illegible]
5387	3/4"		130	.062		4.73	3.60		8.33	[illegible]
5388	7/8"		130	.062		4.73	3.60		8.33	[illegible]
5389	1-1/8"		115	.070		6.85	4.07		10.92	[illegible]
5390	1-3/8"		100	.080		9.25	4.68		13.93	[illegible]
5391	1-5/8"		90	.089		11.80	5.20		17	[illegible]
5392	2-1/8"		80	.100		27.50	5.85		33.35	[illegible]
5393	2-5/8"	Q-5	125	.128		27.50	6.75		34.25	[illegible]
5394	3-1/8"		105	.152		37	8		45	[illegible]

22 11 13.23 Pipe/Tube, Copper		Crew	Daily Output	Labor-Hours	Unit	Material (2014 Bare Costs)	Labor (2014 Bare Costs)	Equipment (2014 Bare Costs)	Total (2014 Bare Costs)	Total Incl O&P
5395	4-1/8"	Q-5	95	.168	L.F.	61.50	8.85		70.35	81
5800	Refrigeration tubing, dryseal, 50' coils									
5840	1/8" OD				Coil	34.50			34.50	38
5850	3/16" OD					40.50			40.50	44.50
5860	1/4" OD					46.50			46.50	51
5870	5/16" OD					62.50			62.50	68.50
5880	3/8" OD					67.50			67.50	74.50
5890	1/2" OD					93.50			93.50	103
5900	5/8" OD					125			125	138
5910	3/4" OD					150			150	165
5920	7/8" OD					305			305	335
5930	1-1/8" OD					410			410	450
5940	1-3/8" OD					555			555	610
5950	1-5/8" OD					710			710	780
9400	Sub assemblies used in assembly systems									
9410	Chilled water unit, coil connections per unit under 10 ton	Q-5	.80	20	System	1,175	1,050		2,225	2,900
9420	Chilled water unit, coil connections per unit 10 ton and up		1	16		1,875	840		2,715	3,325
9430	Chilled water dist. piping per ton, less than 61 ton systems		26	.615		21	32.50		53.50	72
9440	Chilled water dist. piping per ton, 61 through 120 ton systems	Q-6	31	.774		47.50	42.50		90	117
9450	Chilled water dist. piping/ton, 135 ton systems and up	Q-8	25.40	1.260		63.50	70	2.18	135.68	178
9510	Refrigerant piping/ton of cooling for remote condensers	Q-5	2	8		440	420		860	1,125
9520	Refrigerant piping per ton up to 10 ton w/remote condensing unit		2.40	6.667		182	350		532	730
9530	Refrigerant piping per ton, 20 ton w/remote condensing unit		2	8		276	420		696	940
9540	Refrigerant piping per ton, 40 ton w/remote condensing unit		1.90	8.421		365	445		810	1,075
9550	Refrigerant piping per ton, 75-80 ton w/remote condensing unit	Q-6	2.40	10		570	545		1,115	1,450
[redacted]	piping per ton, 100 ton w/remote condensing unit	"	2.20	10.909		765	595		1,360	1,750

[redacted] Pipe/Tube Fittings, Copper

		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	**PIPE/TUBE FITTINGS, COPPER**, Wrought unless otherwise noted									
0040	Solder joints, copper x copper									
0070	90° elbow, 1/4"	1 Plum	22	.364	Ea.	9.70	21		30.70	42
0090	3/8"		22	.364		9.25	21		30.25	41.50
0100	1/2"		20	.400		3.08	23		26.08	38.50
0110	5/8"		19	.421		10.65	24		34.65	48
0120	3/4"		19	.421		6.95	24		30.95	44
0130	1"		16	.500		17	29		46	62
0140	1-1/4"		15	.533		25.50	30.50		56	74.50
0150	1-1/2"		13	.615		40.50	35.50		76	98
0160	2"		11	.727		72.50	42		114.50	143
0170	2-1/2"	Q-1	13	1.231		146	64		210	258
0180	3"		11	1.455		195	75.50		270.50	330
0190	3-1/2"		10	1.600		685	83		768	875
0200	4"		9	1.778		500	92		592	690
0210	5"		6	2.667		2,100	138		2,238	2,500
0220	6"	Q-2	9	2.667		2,800	143		2,943	3,300
0230	8"	"	8	3		10,300	161		10,461	11,600
0250	45° elbow, 1/4"	1 Plum	22	.364		17.30	21		38.30	50.50
0270	3/8"		22	.364		14.80	21		35.80	48
0280	1/2"		20	.400		5.65	23		28.65	41.50
0290	5/8"		19	.421		27	24		51	66
0300	3/4"		19	.421		9.90	24		33.90	47.50
0310	1"		16	.500		25	29		54	71
0320	1-1/4"		15	.533		33.50	30.50		64	83.50

Appendix L: Collocation Survey

Edited from Source: Turner Construction via Arquitectonica

Collocation in Construction

This questionnaire is designed to evaluate whether or not collocation is a benefit to the construction industry, particularly on a large project. The type of collocation that this survey is looking to evaluate the potential value of having the construction and design teams housed within a shared work space.The information gathered will be analyzed alongside additional research for my thesis project. Thank you for your time and help!

* Required

What role(s) have you had in the construction industry? *

Check all that apply

- ☐ PM/CM
- ☐ Project Engineer
- ☐ Superintendent
- ☐ Preconstruction
- ☐ Other: ____________

How many years have you been in the industry? *

- ○ <1 Year
- ○ 1-3 Years
- ○ 3-5 Years
- ○ 5-10 Years
- ○ 10-15 Years
- ○ 15-20 Years
- ○ 20+ Years
- ○ Other: ____________

Personal Experience

Have you worked in a collocated space/project before? *

- ○ Yes
- ○ No

Did you find that the collocated work space/project was a generally positive experience? *

- ○ Yes
- ○ No

Do you find regular face to face interaction to be more beneficial? *

compared to other means of contact such as phone calls and emails

- ○ Yes
- ○ No

What do you consider to be key decision points when determining whether or not to use collocation? *

____

Collocation of a Shared Work Space

Do you agree or disagree with the following: *

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
Collocation is more beneficial on large projects	○	○	○	○
Collocation is easier to implement on large projects	○	○	○	○
Collocation is more successful for large projects	○	○	○	○

Would you like to further comment on the above question?

What level of difficulty does each stage of construction face in order to implement collocation? *

	Easy to Implement	Mostly Easy	Somewhat Challenging	Very Challenging/Many Obstacles
Early Schematic Design	●	●	●	●
Design Development -> CD	●	●	●	●
Early Construction	●	●	●	●
Late Construction	●	●	●	●

Would you like to further comment on the above question?

Who should participate in collocation?

Identify which parties on the project you feel are important/necessary to be present in the collocated space *

select all that apply

- Owner
- Architect
- Sub Contractors
- GC/CM
- Mechanical Engineer
- Structural Engineer
- Electrical Engineer
- Other:

Would you like to further comment on the above question?

With what frequency should the following parties be present in a collocated space for a project?

	1 (low frequency)	2	3 (high frequency)
Owner	●	●	●
Architect	●	●	●
Structural Engineer	●	●	●
Mechanical Engineer	●	●	●
Electrical Engineer	●	●	●
CM/GC	●	●	●
Misc Subs (mason, painter, etc)	●	●	●

Would you like to further comment on the above question?

Consequences of Collocation

Do you view collocation as an added cost to the project or as a preventative measure for avoiding future incurred costs and conflicts? *

- Added Cost
- Preventative Measure
- Both - upfront cost that benefits the life of the project

Would you like to further comment on the above question?

Do you agree or disagree with the following:

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
Value is limited when not all parties and personnel are collocated	●	●	●	●
Collocation has a negative impact on a company's operations as a whole outside of the particular project	●	●	●	●
Members of the project team become more reliable when collocated	●	●	●	●
Maintenance and management of the project improves during collocation	●	●	●	●
Response time for inquiries, RFIs, submittals, and conflict resolution improves with collocation	●	●	●	●
Overall productivity improves with collocation	●	●	●	●

Would you like to further comment on the above question?

What additional costs should a project budget if they are pursuing collocation? *

e.g. Increased Contract admin time, travel etc. Put NA if you do not have an answer

What scale of added costs they have witnessed, as a percentage of project costs? *

- 0%-5%
- 6%-10%
- 11%-20%
- 21%-30%
- >30%

What other potential benefits are available as a result of collocation? *

Put NA if you do not have an answer

Conclusions

Would you recommend that collocation be implemented more often? *

	1	2	3	4	5	
Not beneficial	●	●	●	●	●	Highly recommend

Final comments, questions, concerns, or testimonies?

Please add any information that you feel may help support or debunk the need for collocation in the field.

Appendix M: Collocation Survey Graphic Analysis

Edited from Source: Turner Construction via Arquitectonica

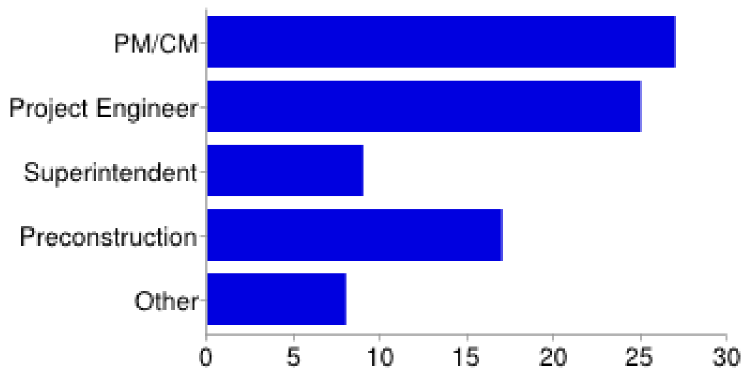
ashleybistline@gmail.com
Edit this form

34 responses

View all responses   Publish analytics

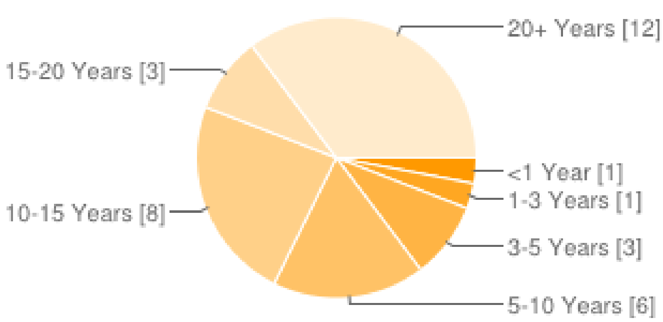
Summary

What role(s) have you had in the construction industry?



PM/CM	**27**	79.4%
Project Engineer	**25**	73.5%
Superintendent	**9**	26.5%
Preconstruction	**17**	50%
Other	**8**	23.5%

How many years have you been in the industry?

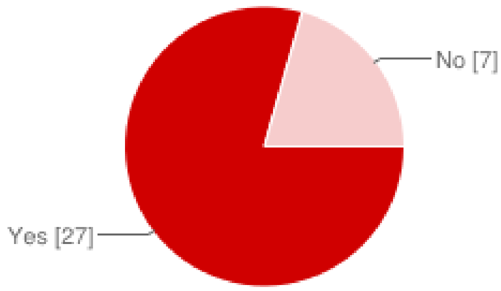


<1 Year	**1**	2.9%
1-3 Years	**1**	2.9%
3-5 Years	**3**	8.8%
5-10 Years	**6**	17.6%

10-15 Years	**8**	23.5%
15-20 Years	**3**	8.8%
20+ Years	**12**	35.3%

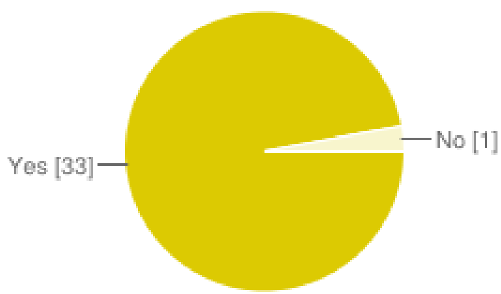
Personal Experience

Have you worked in a collocated space/project before?



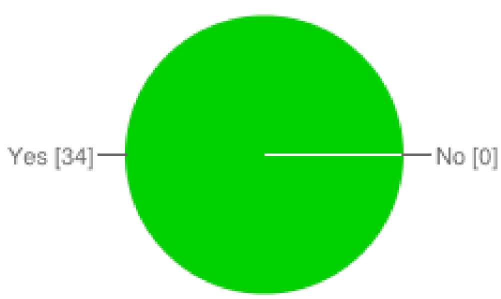
Yes	**27**	79.4%
No	**7**	20.6%

Did you find that the collocated work space/project was a generally positive experience?



Yes	**33**	97.1%
No	**1**	2.9%

Do you find regular face to face interaction to be more beneficial?



Yes	**34**	100%
No	**0**	0%

What do you consider to be key decision points when determining whether or not to use collocation?

Budget - can the design team afford a full time on site presence.

Procurement methodology and Owner acceptance of integrated approach when the project is not a design-build or integrated project delivery.

Design team cost

Time of the Project and Value of Co-location

Cost, level of collaboration required or desired

Project Complexity, Status of Documentation at start of project and Schedule

Need for team work

There always needs to be a reason, i.e. high intensive electrical, unique steel project, etc. Do not collocate just because its better to have face to face conversations, there needs to be a greater need for it.

Contractual Format

collaboration, schedule, needed turnaround time for RFIs, submittals

Contractual Arrangements between parties, team chemistry and experience working together, Owner part of colo or not?

Not sure.

If collocation is to succeed, decision makers from the Design Team, Contractor and Owner/CM must me onsite together. I've had this happen in the past and it expedites field decisions and confirmations. Also, the designers don't generally carry a budget for a full time Construction Administrator once the project begins. I believe it worked best for all parties to have the Construction Administrator onsite once we started closing up walls to confirm paint colors, analyze mock-ups and benchmarks, substitution requests, etc.

Scale of the project.

not sure

cost benefit

Volume & Complexity

Project type, delivery method and contract type, Owner, past experience

The size and duration of the project.

benefit of collaboration

Will collocation improve communications and result in more timely decision making and more productive use of time.

Unfortunately it is financial.

Complexity and schedule of the project.

Project size/complexity, owner thought process, team buy in, team geographical location.

Contract Structure and Terms, Geographic Relationships of Teams, Past Relationships of Teams,

I think it's essential in a design/build atmosphere. Especially during the early phases of construction.

Location of firms on project vs. project location - can key individuals from all firms easily commute to the collocation?

delivery system and complexity

Duration of the project, size of the team, proximity to the site from base office, dollar value of the project

Complexity of the issue or situation

Schedule - It will make coordination faster. Cost - Does it save your company from renting an office space? Is the owner providing this space? CM? etc.

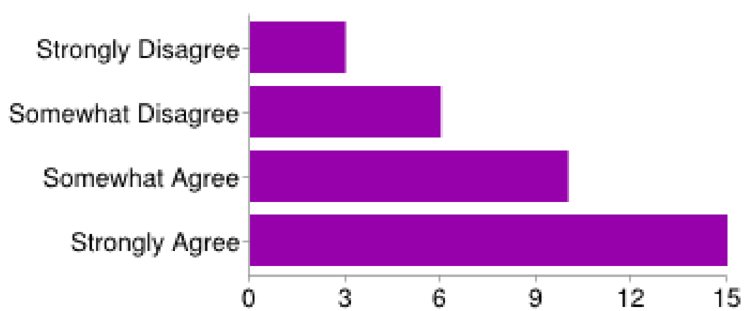
available budgets

Size of project and location of teams. Is it necessary, and if not is it financially viable. If yes to either, you shoudl do it.

Location of A/E team to project site, location of project site in relation to all other parties

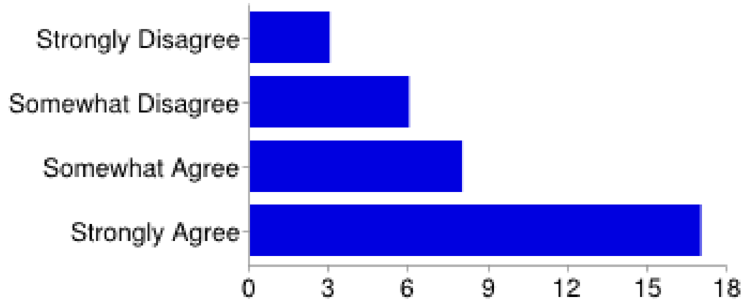
Collocation of a Shared Work Space

Collocation is more beneficial on large projects [Do you agree or disagree with the following:]



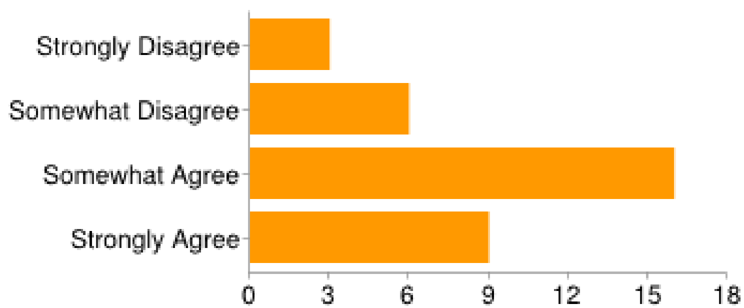
Strongly Disagree	**3**	8.8%
Somewhat Disagree	**6**	17.6%
Somewhat Agree	**10**	29.4%
Strongly Agree	**15**	44.1%

Collocation is easier to implement on large projects [Do you agree or disagree with the following:]



Strongly Disagree	**3**	8.8%
Somewhat Disagree	**6**	17.6%
Somewhat Agree	**8**	23.5%
Strongly Agree	**17**	50%

Collocation is more successful for large projects [Do you agree or disagree with the following:]



Strongly Disagree	**3**	8.8%
Somewhat Disagree	**6**	17.6%
Somewhat Agree	**16**	47.1%
Strongly Agree	**9**	26.5%

Would you like to further comment on the above question?

As long as the funds are in place to support the relocation of associates, and for the temporary office spaces, the size of the job should not be a driver, but the duration may be. Generally it makes more sense to have people relocate for something that is at least a year in duration

Collocation would be beneficial on all projects (small to large)

It always depends on what the project is and its relative risks. Partial co-location is often helpful.

The issue is cost. It is not cost effective to set up a collocation space and move the design and construction teams on small projects with smaller budgets.

Some people cannot work well in a collocation arrangement and will need to be replaced. Also, collocation assumes team members will have the necessary equipment. If they have low powered computers because the arrangement is temporary, collocating could be a detriment. We have seen that.

Again, I think the complexity of the problem and not the size has more to do with the interaction than anything. The size is a consideration depending quantity of issues required to be resolved.

There is the potential to have similar benefits to collocation with smaller projects, too.

I don't know that it is actually more successful on larger projects, it just may be more necessary or more value. Could still have the same success.

I don't think that the size of the project is the most important aspect to look at when determining of collocation will be of benefit.

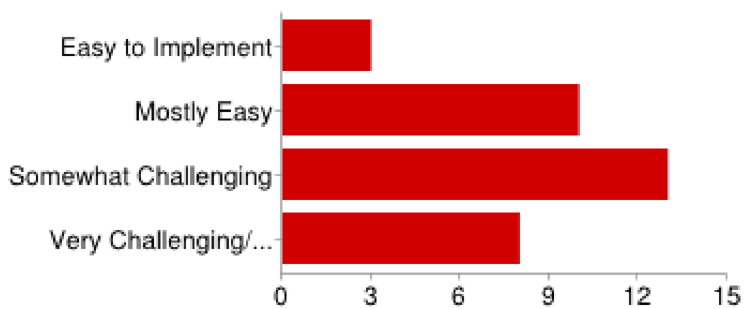
You should define large projects $ / SQFT. urban, etc. I believe it works for all size projects where a team needs to interact

Larger projects likely can financially support collocation - but I don't think success is tied to project size.

Size definitly has an impact, but complexityhas a role as well.

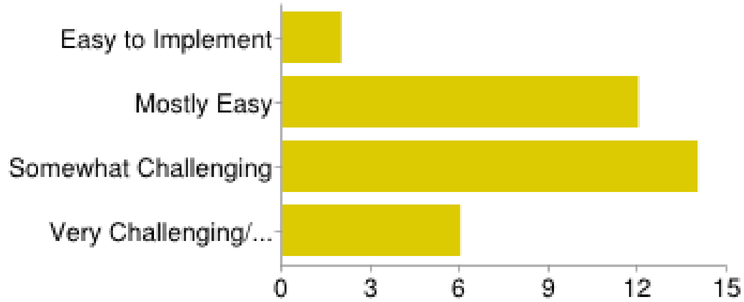
Project size does not dictate co-location value.

Early Schematic Design [What level of difficulty does each stage of construction face in order to implement collocation?]



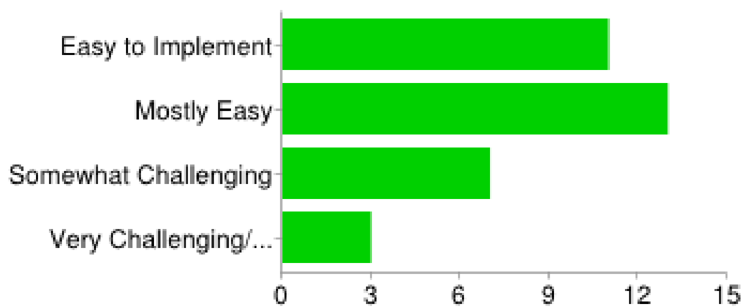
Easy to Implement	**3**	8.8%
Mostly Easy	**10**	29.4%
Somewhat Challenging	**13**	38.2%
Very Challenging/Many Obstacles	**8**	23.5%

Design Development -> CD [What level of difficulty does each stage of construction face in order to implement collocation?]



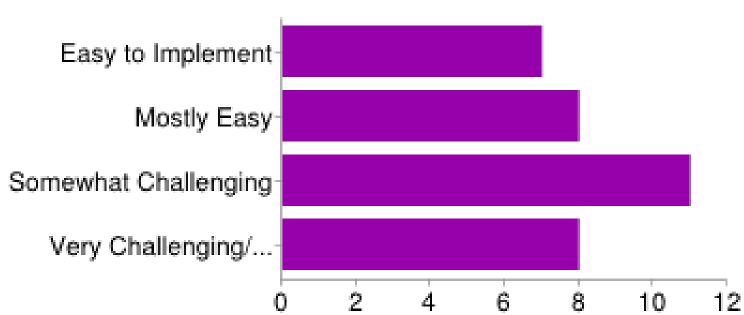
Easy to Implement	**2**	5.9%
Mostly Easy	**12**	35.3%
Somewhat Challenging	**14**	41.2%
Very Challenging/Many Obstacles	**6**	17.6%

Early Construction [What level of difficulty does each stage of construction face in order to implement collocation?]



Easy to Implement	**11**	32.4%
Mostly Easy	**13**	38.2%
Somewhat Challenging	**7**	20.6%
Very Challenging/Many Obstacles	**3**	8.8%

Late Construction [What level of difficulty does each stage of construction face in order to implement collocation?]



Easy to Implement	**7**	20.6%
Mostly Easy	**8**	23.5%
Somewhat Challenging	**11**	32.4%
Very Challenging/Many Obstacles	**8**	23.5%

Would you like to further comment on the above question?

As the design is completed and the design team moves into the construction administration segment of the job during construction, the tendency is for the designer to want to move the design team members on to new projects.

Like mentioned above, I believe it works well towards the end of the project.

Ease of implementation is dependent on specific job circumstance and locatioon of the various team memebers

Co-location value is mostly achieved with high value during the detailing/coordination phase of the project (ie-providing a constructible design/approach)

The earlier the team gets together, the easier it will be. Also, there is more benefit to collocation in the early design stages than there is in the CA phase.

I don't think that collocations is neccessarily easy to implement as there are a lot of logistical and work flow chanllenges to work through. Also cost is a significant factor at all stages of the preconstruction and construction phases.

It all depends on the work load of each party at the time, and the cash flow at each stage, and other workload for project leaders.

Collocation does not make sense for SD. The work is not at the point where multiple disciplines are heavily involved with the details. DD and Early construction are the most beneficial stages.

There usually isn't a project office during the SD and CD design, so it is hard to co-locate

Most of the risks and rewards play out during the construction phase, so it becomes more and more challenging

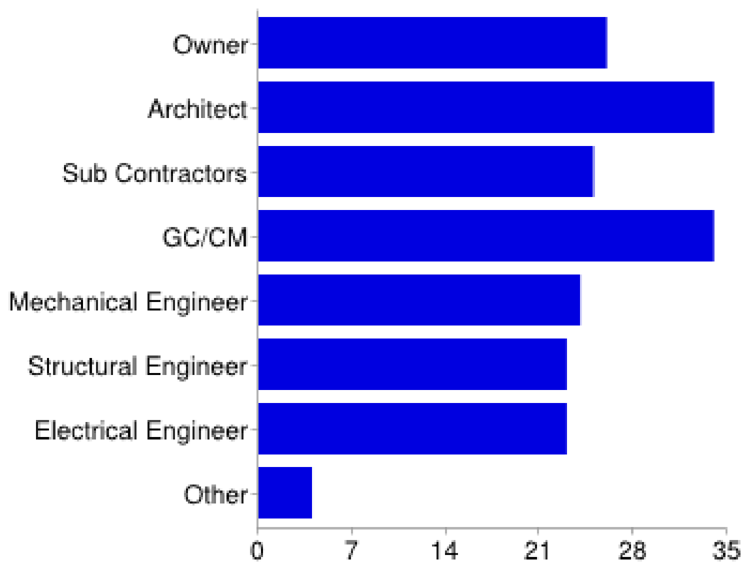
The experience depends on the people on the team--I have been involved in precon with a team that was not compatible and it was difficult. Then I was on a team that did it late in the construction project and it went great and the project and team was well rewarded. Its all challenging depending on the personality of the team.

Depends on when contracts are written and type of contract

During DD phase, collocation will most likely not occur/not effective. Once construction begins, however, it is essential on big jobs.

Who should participate in collocation?

Identify which parties on the project you feel are important/necessary to be present in the collocated space



Owner	**26**	76.5%
Architect	**34**	100%
Sub Contractors	**25**	73.5%
GC/CM	**34**	100%
Mechanical Engineer	**24**	70.6%
Structural Engineer	**23**	67.6%
Electrical Engineer	**23**	67.6%
Other	**4**	11.8%

Would you like to further comment on the above question?

The owner does not necessarily need to be collocates with the team but must be readily available to make prompt decisions.

Co-location participants should be identified based on the risk profile of the Project and the risk priorities.

Sub-contractors are really the most beneficial people because they are the most familiar with the installation and real application of the drawings. However, very rarely does anyone want to pay for the design assistance that a sub contractor can offer so rarely are they a part of the mix.

as many stakeholders as are able to collocate should if able

In regards to public funded projects, you will have a GC and the Owner will have a CM, so each would need to be involved.

Design team is dependent on stage of project

Depending on the complexity of the Project of system, participation requirements vary

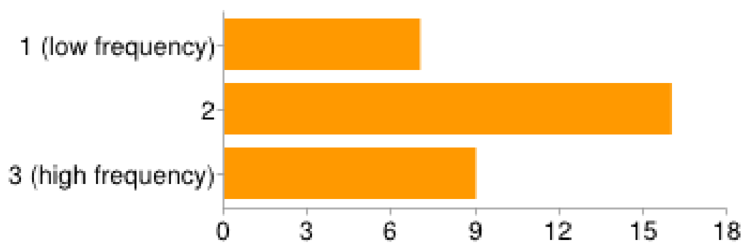
The structural engineer might not have to be there every day, but they do need to participate

The answer to this question really depends on the project itself and where the potential risks are during construction. At a minimum it is usually important to have the above indicated parties present.

I believevve they are all important but at different times of the project's design and construction.

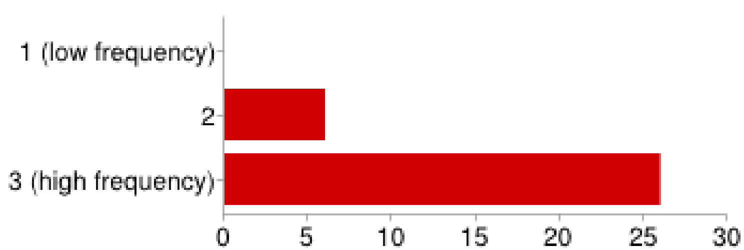
Owner's input and participation is key.

Owner [With what frequency should the following parties be present in a collocated space for a project?]



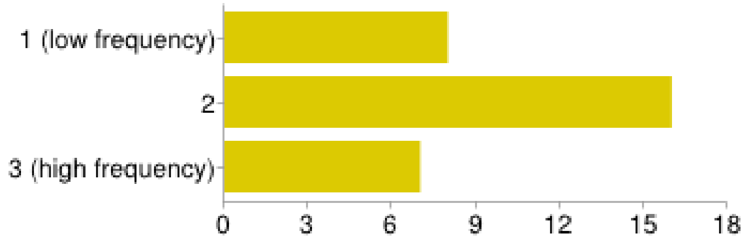
1 (low frequency)	**7**	20.6%
2	**16**	47.1%
3 (high frequency)	**9**	26.5%

Architect [With what frequency should the following parties be present in a collocated space for a project?]



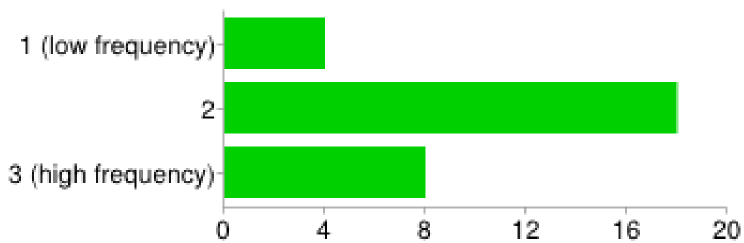
1 (low frequency)	**0**	0%
2	**6**	17.6%
3 (high frequency)	**26**	76.5%

Structural Engineer [With what frequency should the following parties be present in a collocated space for a project?]



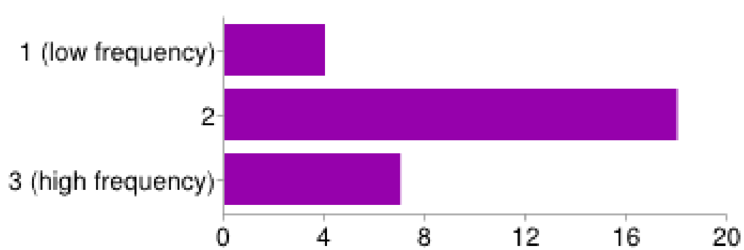
1 (low frequency)	**8**	23.5%
2	**16**	47.1%
3 (high frequency)	**7**	20.6%

Mechanical Engineer [With what frequency should the following parties be present in a collocated space for a project?]



1 (low frequency)	**4**	11.8%
2	**18**	52.9%
3 (high frequency)	**8**	23.5%

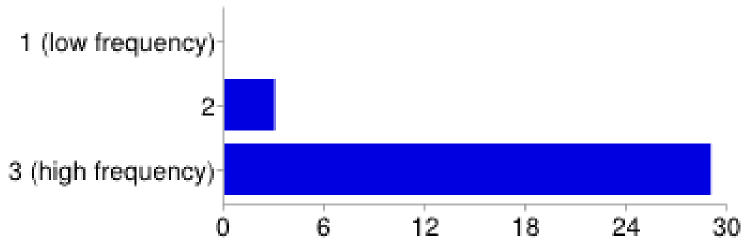
Electrical Engineer [With what frequency should the following parties be present in a collocated space for a project?]



1 (low frequency)	**4**	11.8%
2	**18**	52.9%
3 (high frequency)	**7**	20.6%

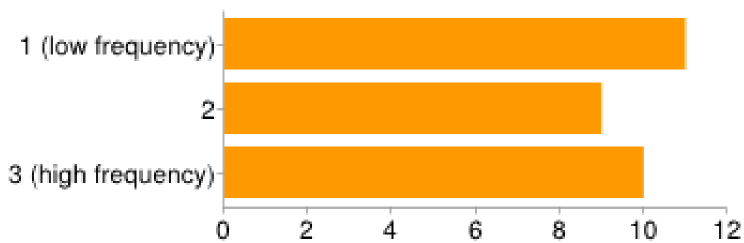
CM/GC [With what frequency should the following parties be present in a

collocated space for a project?]



1 (low frequency)	**0**	0%
2	**3**	8.8%
3 (high frequency)	**29**	85.3%

Misc Subs (mason, painter, etc) [With what frequency should the following parties be present in a collocated space for a project?]



1 (low frequency)	**11**	32.4%
2	**9**	26.5%
3 (high frequency)	**10**	29.4%

Would you like to further comment on the above question?

Depends on the stage of the project.

The frequency is based more on design and complexity. Rather than based on the base building or area type. Determining the frequency and interaction has more to do with type of project.

Again, MEP subs and electrical engineers may need to be more present than the architect in technical projects like Data Centers or Hospitals, they are KEY!

Separate CM and GC, but both would be full time. Architect would not be needed much from ground breaking until the walls are being closed in.

Again depends on the project.

Depends on timeline of project

It really depends on what phase of the job, to be honest.

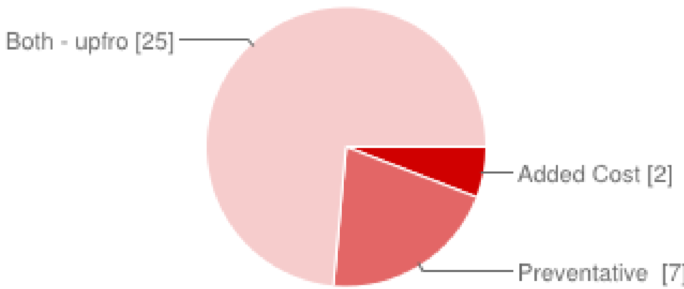
Owner and Architect involvement are crucial in managing expectations and minimizing field re-work.

answers assume that the Architect is the desing lead for the other design disciplines

Again subs are a great resource but no one wants to spend the money that far downt he chain for ther time.

Consequences of Collocation

Do you view collocation as an added cost to the project or as a preventative measure for avoiding future incurred costs and conflicts?



Added Cost	**2**	5.9%
Preventative Measure	**7**	20.6%
Both - upfront cost that benefits the life of the project	**25**	73.5%

Would you like to further comment on the above question?

At the end of the day, collocation saves money. It reduced total time for the project, and it greatly reduces change orders.

If collocation is determined to be a good fit for the particular project then this statement should be true.

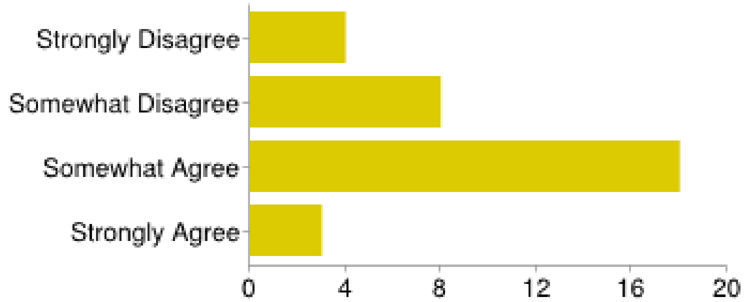
Again, I think design/build = collocation

It's an added cost to the Architect, no cost to GC or CM. Most times their trailers are next to each other on big projects. I think the schedule and quality benefits outweigh the direct cost to the Owner, I would recommend paying for it.

It should not be an added cost but an expectation on the forefront

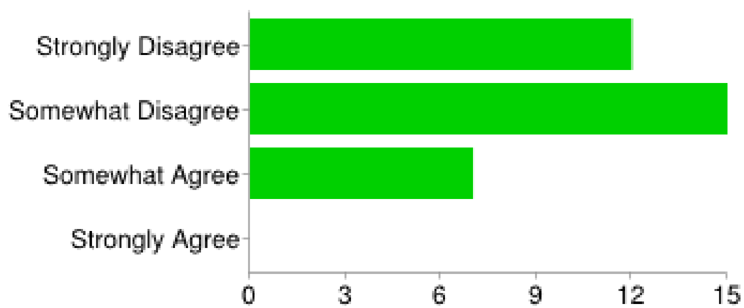
Co-location is an investment to the long term success of a project.

Value is limited when not all parties and personnel are collocated [Do you agree or disagree with the following:]



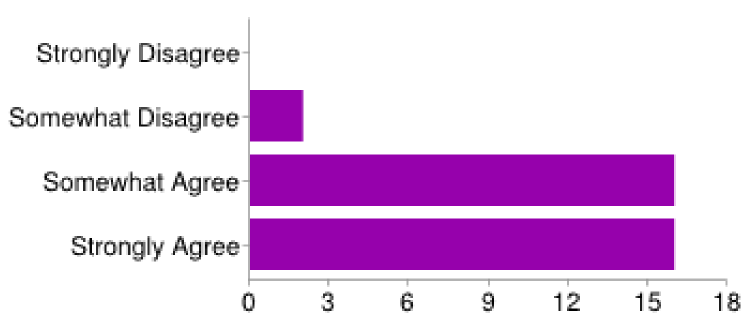
Strongly Disagree	**4**	11.8%
Somewhat Disagree	**8**	23.5%
Somewhat Agree	**18**	52.9%
Strongly Agree	**3**	8.8%

Collocation has a negative impact on a company's operations as a whole outside of the particular project [Do you agree or disagree with the following:]



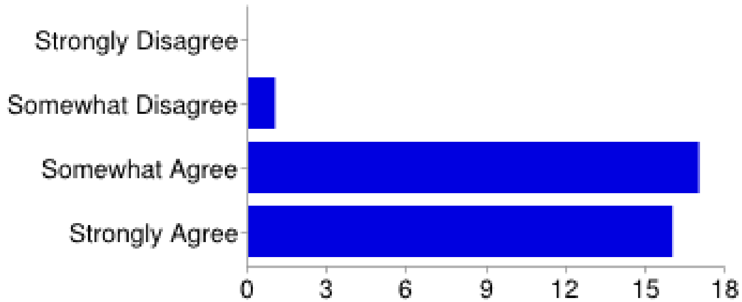
Strongly Disagree	**12**	35.3%
Somewhat Disagree	**15**	44.1%
Somewhat Agree	**7**	20.6%
Strongly Agree	**0**	0%

Members of the project team become more reliable when collocated [Do you agree or disagree with the following:]



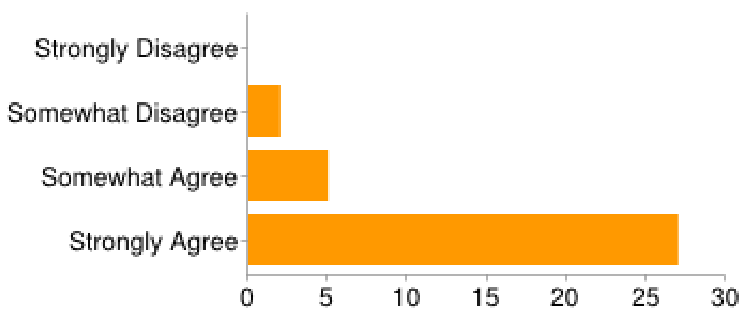
Strongly Disagree	**0**	0%
Somewhat Disagree	**2**	5.9%
Somewhat Agree	**16**	47.1%
Strongly Agree	**16**	47.1%

Maintenance and management of the project improves during collocation [Do you agree or disagree with the following:]



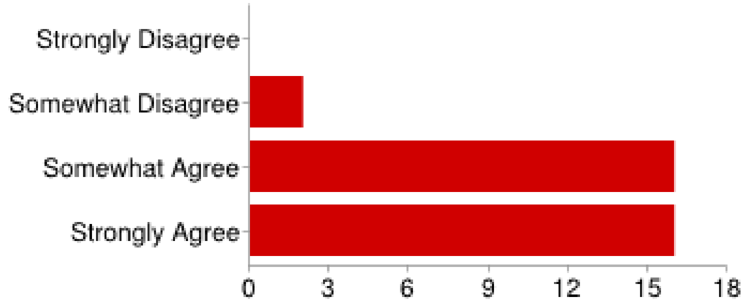
Strongly Disagree	**0**	0%
Somewhat Disagree	**1**	2.9%
Somewhat Agree	**17**	50%
Strongly Agree	**16**	47.1%

Response time for inquiries, RFIs, submittals, and conflict resolution improves with collocation [Do you agree or disagree with the following:]



Strongly Disagree	**0**	0%
Somewhat Disagree	**2**	5.9%
Somewhat Agree	**5**	14.7%
Strongly Agree	**27**	79.4%

Overall productivity improves with collocation [Do you agree or disagree with the following:]



Strongly Disagree	**0**	0%
Somewhat Disagree	**2**	5.9%
Somewhat Agree	**16**	47.1%
Strongly Agree	**16**	47.1%

Would you like to further comment on the above question?

The project needs to be large enough where the parties are dedicated to the project. If someone is on multiple projects it may not make sense.

N/A

These are assumptions based on my Design Build Experience with teams working closely together - but not collocated.

Productivity will be negatively impacted if the parties don't have adequate computer equipment. Also, not having access to some resources that are back at the office could have a negative impact.

Productivity depends on the committment of the team members to the project

Depends on the people and willingness to colloborate

Not sure about overall productivity improving or not.

What additional costs should a project budget if they are pursuing collocation?

Larger on site trailer facility, increased costs for A/E

increased technology costs

Office space size, Increase CA costs,

NA

All labor, burden, travel, overhead, etc that goes along with running any company. It needs to be trated as it's own project.

Travel

Minimal additional cost outside of the space. Each party must commit the people to make it work. Key members must truly relocate to the project. Flying in and out will not generally give the results the team is looking for from collocation.

None. Should have the same cost if they are collocated or remote.

Good computers and food. Seriously, collocation is a bit if a hardship for the team mebers, depending on how far it is from home. Feed the team. It helps. Also, travel may add cost.

Relocation costs for people, temp office set-up, rental, and removal, perhaps some addiitonal travel for the relocated associates to their home on a regular basis

Personnel costs for all parties being collocated, travel costs, housing costs, temporary office expenses, etc.

There are obvious General Conditions costs (added trailers/office furniture/temp utilities) but on big jobs you will have these anyway...so I really don't see it as being an added cost.

Travel/Housing

Added reimbursables for living expenses and time.

Increased General Requirements to support co-location, and reimbursable costs associated with design team CA

n/a

na

not sure

Design Team Cost Plus Temp Office Space

Not sure of your definition of collocation, but the Owner/CM is generally in one trailer and the Contractor has its own trailer. You need to find space for the Architect which could mean a larger trailer or a separate one.

Minimual

Cost of collocation space and travel

Depends on staff and duration

Travel, general conditions for the collaboartion environment

Housing, Office Rental, Temp Office, Furniture, Cleaning

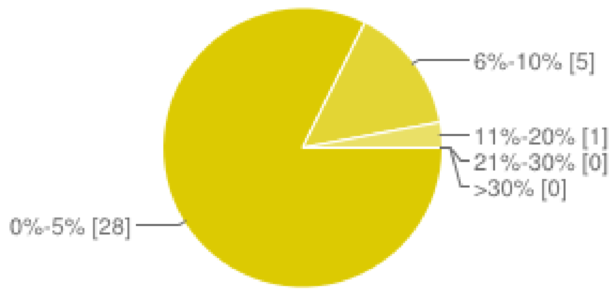
All project overhead -- cost depends on project size and complexity

The largest cost is a space to work. This may require a larger or additional job site trailers, rental spaces, or on site office build outs.

Larger trailer space and associated costs and travel

Increased GCs and Increased Travel costs from A/E team

What scale of added costs they have witnessed, as a percentage of project costs?



0%-5%	**28**	82.4%
6%-10%	**5**	14.7%
11%-20%	**1**	2.9%
21%-30%	**0**	0%
>30%	**0**	0%

What other potential benefits are available as a result of collocation?

N/A

integration, coordination of space, accurate BIMs

NA

Early problem identification

Trust, Team Building, Job Satisfaction, strengthened relationships for future projects

na

Team building is not something that is quantifiable, however there is an intrinsic value to that. Also, understanding of other disciplines will help all constituents in the future. The word "Architect" means "Master-Builder". That is rarely the case anymore because each part of a building has become so specializeed that it requires many different specialty consultants and contractors to get the job done. Collocation and the sharing of knowledge between disciplines helps get back to the "master-builder" idea by educating everyone to be more diverse.

not sure

Future Work and Business Relationships with all parties

face-to-face communication is always more reliable and clear than electronic communication (phone, email, text, etc)

Stronger education of each team members roles & responsibilities

Teamwork, engagement, commitment to the team, accountability to each other, better schedule results, fewer disputes.

Much better designed and constructed building.

Higher project satisfaction.

Increased trust between team members

Expedites decisions on the final product. Allows for more timely punch list walks.

Build it right the first time.

Increased quality

Reduced schedule of construction.

Would you rather discuss things over the phone or in person?

Better coordination, easier to communicate and resolve issues, indirect collaboration due to closeness

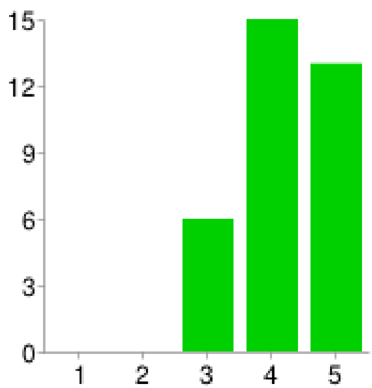
Better end product, more enjoyable expereince, speed to market

Better long term relationships that carry over to other opportunities

It's small compared to project cost. 0-3% at most.

Conclusions

Would you recommend that collocation be implemented more often?



1	**0**	0%
2	**0**	0%
3	**6**	17.6%
4	**15**	44.1%
5	**13**	38.2%

Final comments, questions, concerns, or testimonies?

Co-location should be evaluated by each project team and understand the pros/cons to mitigate project risks.

Hope I helped, if you need to ask more questions, I can be emailed at: Chris White cwhite@gilbaneco.com

My experience was as a design engineer on a very large design build project that was phased over 10 years. It made sense to have the design team working together on the next phase while the construction team was working on the previous phase. We were able to support the construction team and they were able to support the future design. Everyone worked very closely together and for the most part it worked well. It does create a disconnect between the home office and staff in the field which can be detrimental to your career, but it benefits the project.

Once the team gets to working well, virtual collocation can be beneficial, but it seems the team needs to get to know each other first, and that takes time. Hence the actual collocation real time.

Design Teams and Owners are not as accustomed to relocating for a project full-time. Especially the Design Team members engaged during Design. Those who are used to doing CA (Construction Administration) on the Architect's side may be more open to it. Much like other Project Delivery approaches that cost more up-front for bigger dividends on the back-end, there is often resistance to committing the funds early on without it being a more tried and true approach in the industry.

I have not participated in a collocation - so the form requiring answers to all questions may skew your results.

I have never worked on a collocated project. Therefore, my responses are based on lessons and experiences I have obtained from my peers.

Collocation will give positive results on any project. If a project can support the initial cost of collocation, it should be considered.

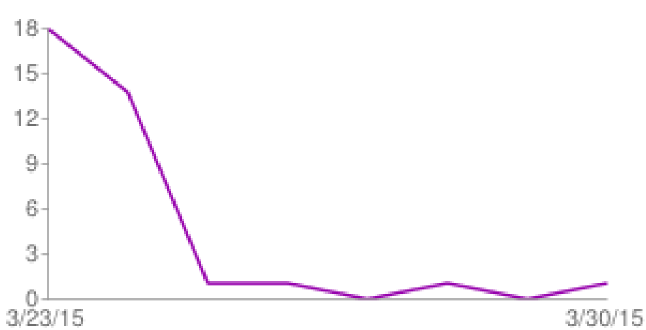
Not all projects are appropriate for co-location. The larger the project the more beneficial co-location is.

Teams that cannot co-locate should look into options like goto meetings and bluebeam studio to increase communication and efficiency in other ways.

I know I have said it already, but I think if these questions were geared towards contract type, you may see a big change in the answers. May want to add that as a question. Also, building type also dictates the need for collocation. My time working with a large general contractor, I have been involved on nearly $500 million worth of projects in 4 years, all have been extremely MEP intensive/complicated and fast projects. It forced collocation as a design/build team. Constructing a large core and shell office building may not need as much collocation/onsite collaboration.

Given the right circumstance and team members, collocation can significantly improve a project's overall quality and speed to project completion.

Number of daily responses



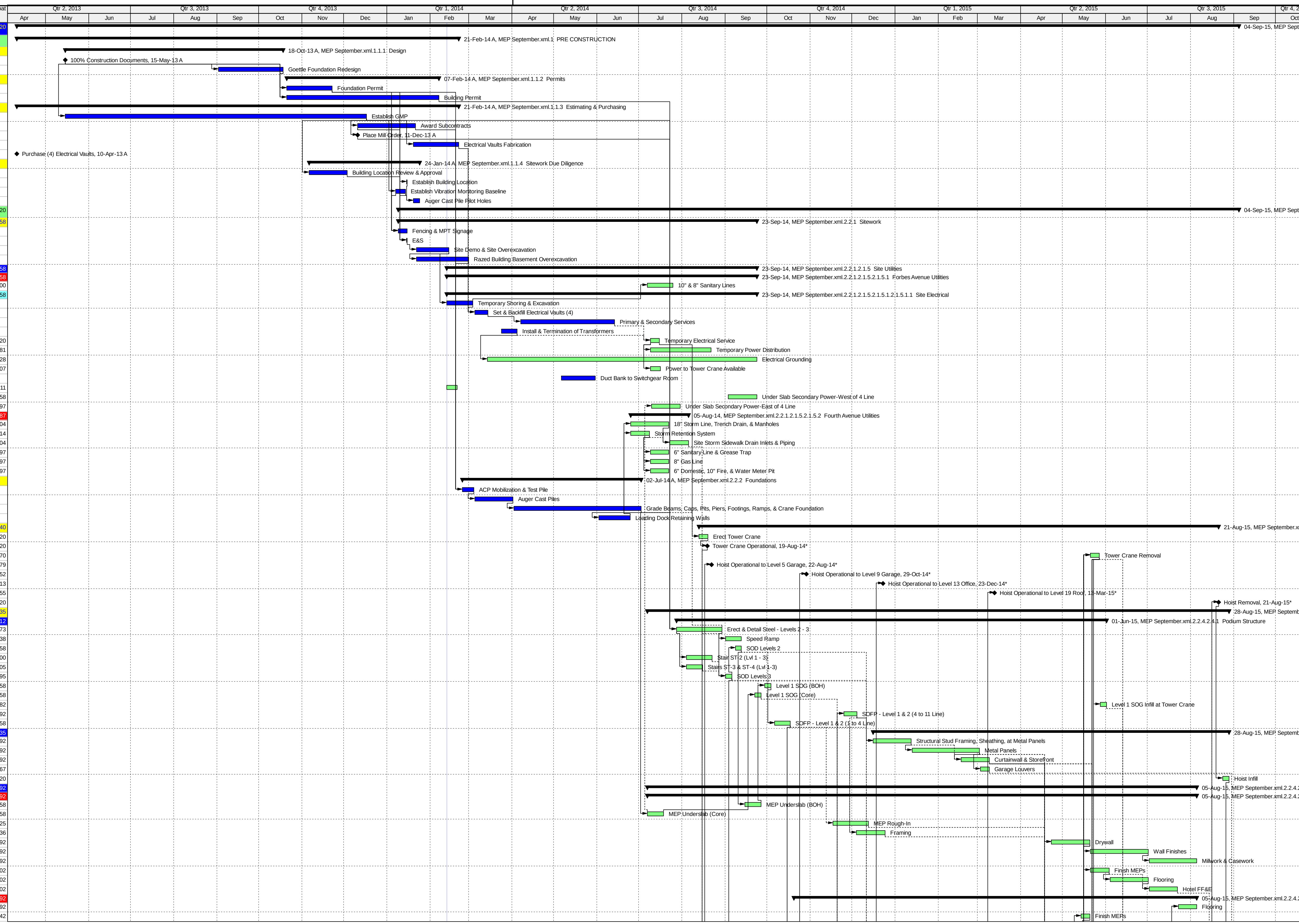
Appendix N: New MEP Reworked Schedule

Edited from Source: Turner Construction via Arquitectonica

Date	Revision	Checked	Approved

Actual Level of Effort · Actual Work · Remaining Work · Critical Remaining Work · Milestone

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
MEP September.xml The Gardens		628	10-Apr-13 A	04-Sep-15	20
MEP September.xml.1 PRE CONST		218	10-Apr-13	21-Feb-1	
MEP September.xml.1.1.1 Design		113	15-May-1	18-Oct-13	
3	100% Construction Documents	0	15-May-1		
4	Goettle Foundation Redesign	35	02-Sep-13	18-Oct-13	
MEP September.xml.1.1.2 Permits		80	21-Oct-13	07-Feb-1	
6	Foundation Permit	25	21-Oct-13	22-Nov-1	
7	Building Permit	80	21-Oct-13	07-Feb-1	
MEP September.xml.1.1.3 Estimating & P		205	10-Apr-13	21-Feb-1	
10	Establish GMP	155	15-May-1	17-Dec-1	
11	Award Subcontracts	30	11-Dec-13	21-Jan-14	
12	Place Mill Order	0	11-Dec-13		
13	Electrical Vaults Fabrication	30	20-Jan-14	21-Feb-1	
9	Purchase (4) Electrical Vaults	0	10-Apr-13		
MEP September.xml.1.1.4 Sitework Due D		53	06-Nov-13	24-Jan-14	
15	Building Location Review & Appr	20	06-Nov-13	03-Dec-1	
16	Establish Building Location	2	15-Jan-14	15-Jan-14	
17	Establish Vibration Monitoring Ba	5	07-Jan-14	14-Jan-14	
18	Auger Cast Pile Pilot Holes	5	20-Jan-14	24-Jan-14	
MEP September.xml.2 CONSTRUC		435	09-Jan-14	04-Sep-15	20
MEP September.xml.2.2.1 Sitework		187	09-Jan-14	23-Sep-14	258
21	Fencing & MPT Signage	5	09-Jan-14	15-Jan-14	
22	E&S	1	15-Jan-14	15-Jan-14	
23	Site Demo & Site Overexcavation	15	22-Jan-14	14-Feb-1	
24	Razed Building Basement Overe	15	22-Jan-14	28-Feb-1	
MEP September.xml.2.2.1.2.1.5 Site Utilities		162	13-Feb-14	23-Sep-14	258
MEP September.xml.2.2.1.2.1.5.2.1.5.1 F		162	13-Feb-14	23-Sep-14	258
40	10" & 8" Sanitary Lines	15	07-Jul-14*	25-Jul-14	300
MEP September.xml.2.2.1.2.1.5.2.1.5.1		162	13-Feb-14	23-Sep-14	258
28	Temporary Shoring & Excavation	13	13-Feb-14	03-Mar-1	
29	Set & Backfill Electrical Vaults (4)	10	05-Mar-14	14-Mar-1	
30	Primary & Secondary Services	50	07-Apr-14	13-Jun-14	
31	Install & Termination of Transforn	10	24-Mar-14	04-Apr-14	
32	Temporary Electrical Service	5	09-Jul-14*	15-Jul-14	20
33	Temporary Power Distribution	32	09-Jul-14	21-Aug-14	281
34	Electrical Grounding	100	06-May-14	23-Sep-14	328
35	Power to Tower Crane Available	6	09-Jul-14	16-Jul-14	307
36	Duct Bank to Switchgear Room	19	06-May-14	30-May-1	
37	Feeders to/from Switchgear Roo	15	09-Jun-14	20-Feb-14	411
38	Under Slab Secondary Power-W	15	03-Sep-14*	23-Sep-14	258
39	Under Slab Secondary Power-Ea	15	10-Jul-14*	30-Jul-14	297
MEP September.xml.2.2.1.2.1.5.2.1.5.2 F		30	25-Jun-14	05-Aug-14	387
42	18" Storm Line, Trench Drain, & I	20	25-Jun-14*	22-Jul-14	104
43	Storm Retention System	10	25-Jun-14*	08-Jul-14	114
44	Site Storm Sidewalk Drain Inlets	10	23-Jul-14*	05-Aug-14	104
45	6" Sanitary Line & Grease Trap	10	09-Jul-14*	22-Jul-14	397
46	8" Gas Line	10	09-Jul-14*	22-Jul-14	397
47	6" Domestic, 10" Fire, & Water M	10	09-Jul-14*	22-Jul-14	397
MEP September.xml.2.2.2 Foundations		102	24-Feb-14	02-Jul-14	
49	ACP Mobilization & Test Pile	7	24-Feb-14	04-Mar-1	
50	Auger Cast Piles	40	05-Mar-14	01-Apr-14	
51	Grade Beams, Caps, Pits, Piers,	75	02-Apr-14	02-Jul-14	
52	Loading Dock Retaining Walls	20	02-Jun-14	24-Jun-14	
MEP September.xml.2.2.3 Hoisting & Vert		267	13-Aug-14	21-Aug-15	40
54	Erect Tower Crane	5	13-Aug-14*	19-Aug-14	20
55	Tower Crane Operational	0	19-Aug-14*		20
56	Tower Crane Removal	5	21-May-15*	27-May-15	70
57	Hoist Operational to Level 5 Gara	0	22-Aug-14*		279
58	Hoist Operational to Level 9 Gara	0	29-Oct-14*		252
59	Hoist Operational to Level 13 Offi	0	23-Dec-14*		213
60	Hoist Operational to Level 19 Ro	0	13-Mar-15*		155
61	Hoist Removal	0	21-Aug-15*		20
MEP September.xml.2.2.4 Podium		300	07-Jul-14	28-Aug-15	35
MEP September.xml.2.2.4.2.4.1 Podium Str		221	28-Jul-14	01-Jun-15	112
64	Erect & Detail Steel - Levels 2 - 3	25	28-Jul-14*	29-Aug-14	73
65	Speed Ramp	10	01-Sep-14*	12-Sep-14	338
66	SOD Levels 2	5	08-Sep-14*	12-Sep-14	158
67	Stair ST-2 (Lvl 1 - 3)	15	04-Aug-14*	22-Aug-14	100
68	Stairs ST-3 & ST-4 (Lvl 1-3)	10	04-Aug-14*	15-Aug-14	105
69	SOD Levels 3	5	01-Sep-14*	05-Sep-14	95
70	Level 1 SOG (BOH)	5	29-Sep-14*	03-Oct-14	158
71	Level 1 SOG (Core)	5	22-Sep-14*	26-Sep-14	258
72	Level 1 SOG Infill at Tower Crane	3	28-May-15*	01-Jun-15	82
73	SOFP - Level 1 & 2 (4 to 11 Line)	8	25-Nov-14*	04-Dec-14	92
74	SOFP - Level 1 & 2 (1 to 4 Line)	10	06-Oct-14*	17-Oct-14	158
MEP September.xml.2.2.4.2.4.2 Podium Ext		184	16-Dec-14	28-Aug-15	35
76	Structural Stud Framing, Sheathi	20	16-Dec-14*	12-Jan-15	92
77	Metal Panels	35	13-Jan-15*	02-Mar-15	92
78	Curtainwall & Storefront	15	17-Feb-15*	09-Mar-15	92
79	Garage Louvers	5	03-Mar-15*	09-Mar-15	167
80	Hoist Infill	5	24-Aug-15*	28-Aug-15	20
MEP September.xml.2.2.4.2.4.3 Podium Fit		283	07-Jul-14	05-Aug-15	92
MEP September.xml.2.2.4.2.4.3.2.4.3.1 L		283	07-Jul-14	05-Aug-15	92
83	MEP Underslab (BOH)	10	15-Sep-14*	26-Sep-14	158
84	MEP Underslab (Core)	10	07-Jul-14*	18-Jul-14	258
85	MEP Rough-In	20	17-Nov-14*	12-Dec-14	125
86	Framing	15	04-Dec-14*	24-Dec-14	136
87	Drywall	20	23-Apr-15*	20-May-15	92
88	Wall Finishes	30	21-May-15*	01-Jul-15	92
89	Millwork & Casework	25	02-Jul-15*	05-Aug-15	92
90	Finish MEPs	10	21-May-15*	03-Jun-15	102
91	Flooring	20	04-Jun-15*	01-Jul-15	102
92	Hotel FF&E	15	02-Jul-15*	22-Jul-15	102
MEP September.xml.2.2.4.2.4.3.2.4.3.2 L		208	20-Oct-14	05-Aug-15	92
100	Flooring	10	23-Jul-15*	05-Aug-15	92
101	Finish MEPs	5	14-May-15*	20-May-15	142



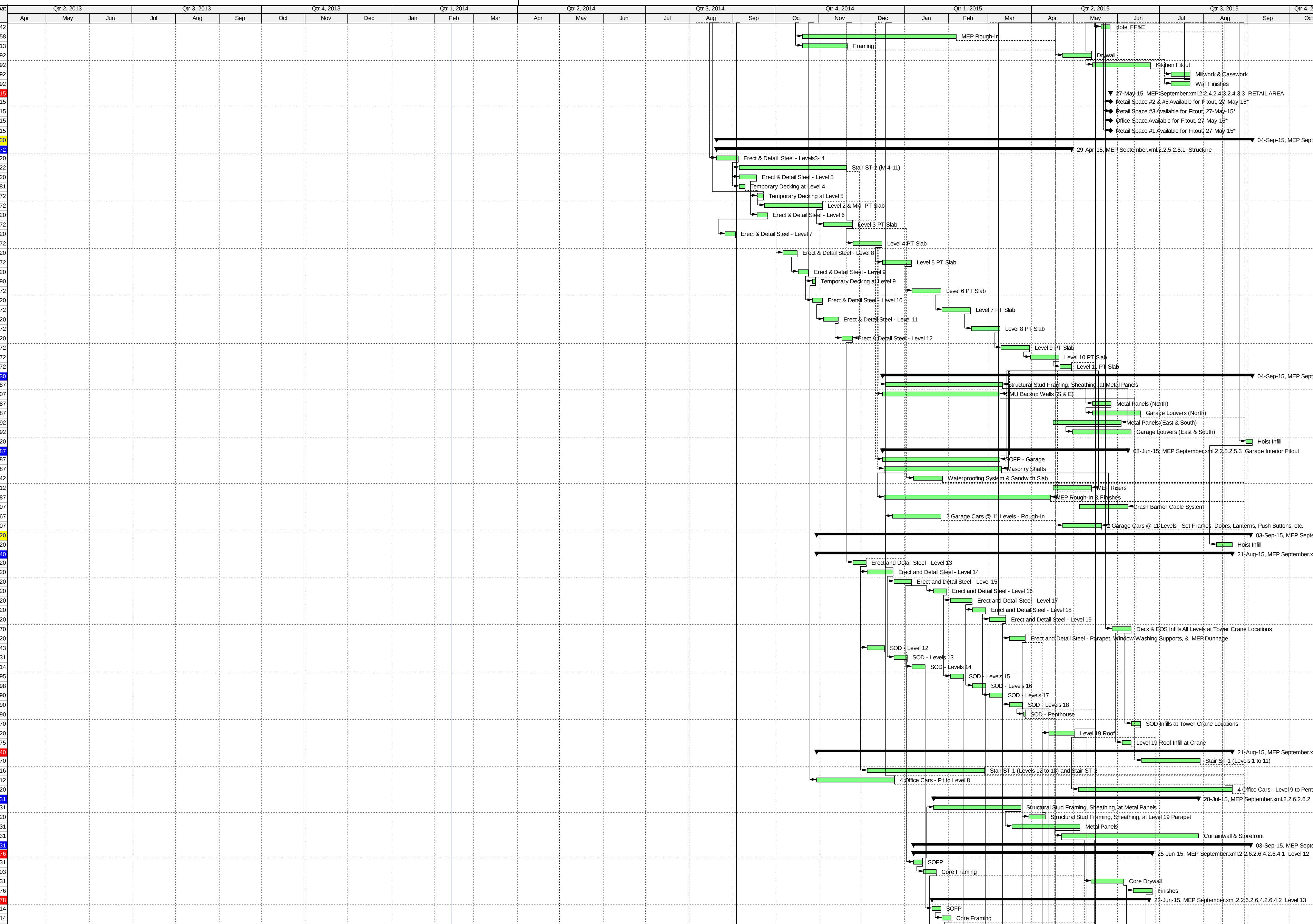
Actual Level of Effort
Remaining Work
Milestone
Actual Work
Critical Remaining Work
summary

TASK filter: All Activities

Date	Revision	Checked	Approved

Actual Level of Effort — Actual Work — Remaining Work — Critical Remaining Work — ◆ Milestone — summary

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
102	Hotel FF&E	5	20-May-15*	26-May-15	142
94	MEP Rough-In	80	20-Oct-14*	06-Feb-15	158
95	Framing	25	20-Oct-14*	21-Nov-14	213
96	Drywall	15	23-Apr-15*	13-May-15	92
97	Kitchen Fitout	30	14-May-15*	24-Jun-15	92
98	Millwork & Casework	10	09-Jul-15*	22-Jul-15	92
99	Wall Finishes	10	09-Jul-15*	22-Jul-15	92
MEP September.xml.2.2.4.2.4.3.2.4.3.3 R		0	27-May-15	27-May-15	115
104	Retail Space #2 & #5 Available fo	0	27-May-15*		115
105	Retail Space #3 Available for Fito	0	27-May-15*		115
106	Office Space Available for Fitout	0	27-May-15*		115
107	Retail Space #1 Available for Fito	0	27-May-15*		115
MEP September.xml.2.2.5 Garage		273	20-Aug-14	04-Sep-15	30
MEP September.xml.2.2.5.2.5.1 Structure		181	20-Aug-14	29-Apr-15	72
110	Erect & Detail Steel - Levels3- 4	8	20-Aug-14*	04-Sep-14	20
111	Stair ST-2 (lvl 4-11)	55	05-Sep-14*	20-Nov-14	22
112	Erect & Detail Steel - Level 5	8	05-Sep-14*	17-Sep-14	20
113	Temporary Decking at Level 4	5	05-Sep-14*	09-Sep-14	81
114	Temporary Decking at Level 5	5	18-Sep-14*	22-Sep-14	72
115	Level 2 & Mid PT Slab	20	23-Sep-14*	03-Nov-14	72
116	Erect & Detail Steel - Level 6	8	18-Sep-14*	25-Sep-14	20
117	Level 3 PT Slab	15	04-Nov-14*	24-Nov-14	72
118	Erect & Detail Steel - Level 7	8	26-Aug-14*	02-Sep-14	20
119	Level 4 PT Slab	15	25-Nov-14*	15-Dec-14	72
120	Erect & Detail Steel - Level 8	8	06-Oct-14*	16-Oct-14	20
121	Level 5 PT Slab	15	16-Dec-14*	05-Jan-15	72
122	Erect & Detail Steel - Level 9	8	17-Oct-14*	24-Oct-14	20
123	Temporary Decking at Level 9	5	27-Oct-14*	29-Oct-14	90
124	Level 6 PT Slab	15	06-Jan-15*	26-Jan-15	72
125	Erect & Detail Steel - Level 10	8	27-Oct-14*	03-Nov-14	20
126	Level 7 PT Slab	15	27-Jan-15*	16-Feb-15	72
127	Erect & Detail Steel - Level 11	8	04-Nov-14*	14-Nov-14	20
128	Level 8 PT Slab	15	17-Feb-15*	09-Mar-15	72
129	Erect & Detail Steel - Level 12	10	17-Nov-14*	24-Nov-14	20
130	Level 9 PT Slab	15	10-Mar-15*	30-Mar-15	72
131	Level 10 PT Slab	15	31-Mar-15*	20-Apr-15	72
132	Level 11 PT Slab	7	21-Apr-15*	29-Apr-15	72
MEP September.xml.2.2.5.2.5.2 Garage Ext		189	16-Dec-14	04-Sep-15	30
134	Structural Stud Framing, Sheathi	60	18-Dec-14*	11-Mar-15	87
135	CMU Backup Walls (S & E)	60	16-Dec-14*	09-Mar-15	107
136	Metal Panels (North)	10	14-May-15*	27-May-15	87
137	Garage Louvers (North)	25	14-May-15*	17-Jun-15	87
138	Metal Panels (East & South)	35	16-Apr-15*	03-Jun-15	92
139	Garage Louvers (East & South)	30	30-Apr-15*	10-Jun-15	92
140	Hoist Infill	5	31-Aug-15*	04-Sep-15	20
MEP September.xml.2.2.5.2.5.3 Garage Inte		125	16-Dec-14	08-Jun-15	87
142	SOFP - Garage	60	16-Dec-14*	09-Mar-15	87
143	Masonry Shafts	60	17-Dec-14*	10-Mar-15	87
144	Waterproofing System & Sandwi	15	07-Jan-15*	27-Jan-15	142
145	MEP Risers	20	16-Apr-15*	13-May-15	112
146	MEP Rough-In & Finishes	80	17-Dec-14*	14-Apr-15	87
147	Crash Barrier Cable System	25	05-May-15*	08-Jun-15	107
148	2 Garage Cars @ 11 Levels - Ro	25	23-Dec-14*	26-Jan-15	167
149	2 Garage Cars @ 11 Levels - Se	20	23-Apr-15*	20-May-15	107
MEP September.xml.2.2.6 Office Tower		221	30-Oct-14	03-Sep-15	20
182	Hoist Infill	10	10-Aug-15	21-Aug-15	20
MEP September.xml.2.2.6.2.6.1 Office Stru		212	30-Oct-14	21-Aug-15	40
152	Erect and Detail Steel - Level 13	10	25-Nov-14*	04-Dec-14	20
153	Erect and Detail Steel - Level 14	10	05-Dec-14*	23-Dec-14	20
154	Erect and Detail Steel - Level 15	10	24-Dec-14*	05-Jan-15	20
155	Erect and Detail Steel - Level 16	10	21-Jan-15*	30-Jan-15	20
156	Erect and Detail Steel - Level 17	10	02-Feb-15*	17-Feb-15	20
157	Erect and Detail Steel - Level 18	10	18-Feb-15*	27-Feb-15	20
158	Erect and Detail Steel - Level 19	10	02-Mar-15*	13-Mar-15	20
159	Deck & EOS Infills All Levels at Tc	10	28-May-15*	10-Jun-15	70
160	Erect and Detail Steel - Parapet,	10	16-Mar-15*	27-Mar-15	20
161	SOD - Level 12	8	05-Dec-14*	17-Dec-14	43
162	SOD - Levels 13	8	24-Dec-14*	02-Jan-15	31
163	SOD - Levels 14	8	06-Jan-15*	15-Jan-15	114
164	SOD - Levels 15	8	02-Feb-15*	11-Feb-15	95
165	SOD - Levels 16	8	18-Feb-15*	27-Feb-15	98
166	SOD - Levels 17	8	02-Mar-15*	11-Mar-15	90
167	SOD - Levels 18	8	16-Mar-15*	25-Mar-15	90
168	SOD - Penthouse	2	26-Mar-15*	27-Mar-15	90
169	SOD Infills at Tower Crane Locat	5	11-Jun-15*	17-Jun-15	70
170	Level 19 Roof	15	13-Apr-15*	01-May-15	20
171	Level 19 Roof Infill at Crane	5	04-Jun-15*	10-Jun-15	75
MEP September.xml.2.2.6.2.6.1.2.6.1.21 S		212	30-Oct-14	21-Aug-15	40
173	Stair ST-1 (Levels 1 to 11)	30	18-Jun-15*	29-Jul-15	70
174	Stair ST-1 (Levels 12 to 18) and S	60	05-Dec-14*	26-Feb-15	116
175	4 Office Cars - Pit to Level 8	40	30-Oct-14*	24-Dec-14	112
176	4 Office Cars - Level 9 to Penthou	80	04-May-15*	21-Aug-15	20
MEP September.xml.2.2.6.2.6.2 Office Exte		135	21-Jan-15	28-Jul-15	31
178	Structural Stud Framing, Sheathi	45	21-Jan-15*	24-Mar-15	31
179	Structural Stud Framing, Sheathi	10	30-Mar-15*	10-Apr-15	20
180	Metal Panels	35	18-Mar-15*	05-May-15	31
181	Curtainwall & Storefront	70	22-Apr-15*	28-Jul-15	31
MEP September.xml.2.2.6.2.6.4 Office Inter		172	07-Jan-15	03-Sep-15	31
MEP September.xml.2.2.6.2.6.4.2.6.4.1 L		122	07-Jan-15	25-Jun-15	76
185	SOFP	5	07-Jan-15*	13-Jan-15	31
186	Core Framing	8	14-Jan-15*	23-Jan-15	103
187	Core Drywall	18	13-May-15*	05-Jun-15	31
188	Finishes	10	12-Jun-15*	25-Jun-15	76
MEP September.xml.2.2.6.2.6.4.2.6.4.2 L		111	20-Jan-15	23-Jun-15	78
190	SOFP	5	20-Jan-15*	26-Jan-15	114
191	Core Framing	5	27-Jan-15*	02-Feb-15	114
192	Core Drywall	15	20-May-15*	09-Jun-15	48



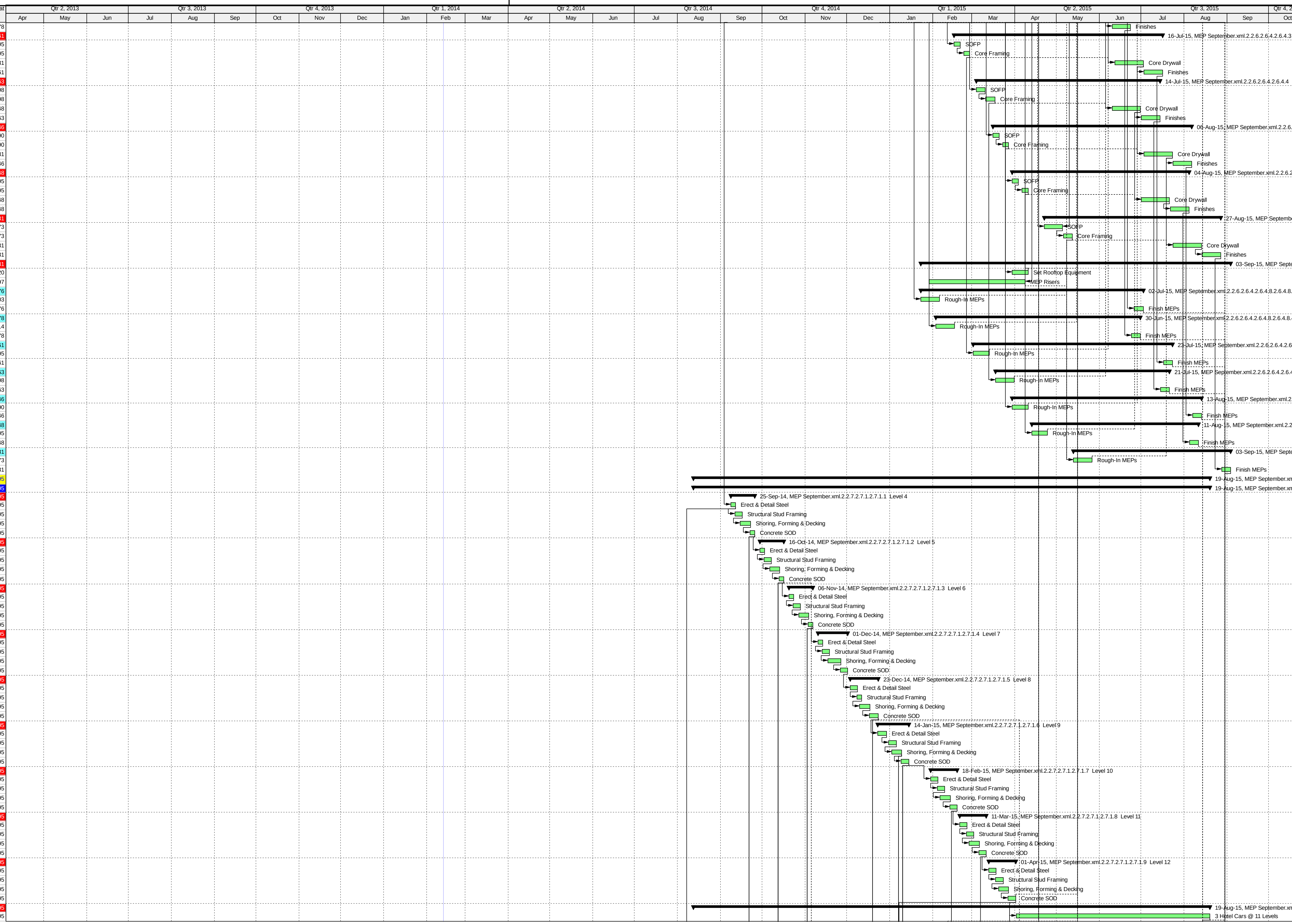
Actual Level of Effort — Remaining Work — ◆ Milestone
Actual Work — Critical Remaining Work — summary

TASK filter: All Activities

Date	Revision	Checked	Approved

Actual Level of Effort · Actual Work · Remaining Work · Critical Remaining Work · ◆ Milestone · summary

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
193	Finishes	10	10-Jun-15*	23-Jun-15	78
MEP September.xml.2.2.6.2.6.4.2.6.4.3 L		109	16-Feb-15	16-Jul-15	61
195	SOFP	5	16-Feb-15*	20-Feb-15	95
196	Core Framing	5	23-Feb-15*	27-Feb-15	95
197	Core Drywall	15	12-Jun-15*	02-Jul-15	31
198	Finishes	10	03-Jul-15*	16-Jul-15	61
MEP September.xml.2.2.6.2.6.4.2.6.4.4 L		95	04-Mar-15	14-Jul-15	63
200	SOFP	5	04-Mar-15*	10-Mar-15	98
201	Core Framing	5	11-Mar-15*	17-Mar-15	98
202	Core Drywall	15	10-Jun-15*	30-Jun-15	48
203	Finishes	10	01-Jul-15*	14-Jul-15	63
MEP September.xml.2.2.6.2.6.4.2.6.4.5 L		104	16-Mar-15	06-Aug-15	46
205	SOFP	5	16-Mar-15*	20-Mar-15	90
206	Core Framing	5	23-Mar-15*	27-Mar-15	90
207	Core Drywall	15	03-Jul-15*	23-Jul-15	31
208	Finishes	10	24-Jul-15*	06-Aug-15	46
MEP September.xml.2.2.6.2.6.4.2.6.4.6 L		92	30-Mar-15	04-Aug-15	48
210	SOFP	5	30-Mar-15*	03-Apr-15	95
211	Core Framing	5	06-Apr-15*	10-Apr-15	95
212	Core Drywall	15	01-Jul-15*	21-Jul-15	48
213	Finishes	10	22-Jul-15*	04-Aug-15	48
MEP September.xml.2.2.6.2.6.4.2.6.4.7 L		92	22-Apr-15	27-Aug-15	31
215	SOFP	10	22-Apr-15*	05-May-15	73
216	Core Framing	5	06-May-15*	12-May-15	73
217	Core Drywall	15	24-Jul-15*	13-Aug-15	31
218	Finishes	10	14-Aug-15*	27-Aug-15	31
MEP September.xml.2.2.6.2.6.4.2.6.4.8 M		160	23-Jan-15	03-Sep-15	31
220	Set Rooftop Equipment	10	30-Mar-15*	10-Apr-15	20
221	MEP Risers	50	29-Jan-15*	08-Apr-15	97
MEP September.xml.2.2.6.2.6.4.2.6.4.8		115	23-Jan-15	02-Jul-15	76
223	Rough-In MEPs	10	23-Jan-15*	05-Feb-15	103
224	Finish MEPs	5	26-Jun-15*	02-Jul-15	76
MEP September.xml.2.2.6.2.6.4.2.6.4.8		106	03-Feb-15	30-Jun-15	78
226	Rough-In MEPs	10	03-Feb-15*	16-Feb-15	114
227	Finish MEPs	5	24-Jun-15*	30-Jun-15	78
MEP September.xml.2.2.6.2.6.4.2.6.4.8		104	02-Mar-15	23-Jul-15	61
229	Rough-In MEPs	10	02-Mar-15*	13-Mar-15	95
230	Finish MEPs	5	17-Jul-15*	23-Jul-15	61
MEP September.xml.2.2.6.2.6.4.2.6.4.8		90	18-Mar-15	21-Jul-15	63
232	Rough-In MEPs	10	18-Mar-15*	31-Mar-15	98
233	Finish MEPs	5	15-Jul-15*	21-Jul-15	63
MEP September.xml.2.2.6.2.6.4.2.6.4.8		99	30-Mar-15	13-Aug-15	46
235	Rough-In MEPs	10	30-Mar-15*	10-Apr-15	90
236	Finish MEPs	5	07-Aug-15*	13-Aug-15	46
MEP September.xml.2.2.6.2.6.4.2.6.4.8		87	13-Apr-15	11-Aug-15	48
238	Rough-In MEPs	10	13-Apr-15*	24-Apr-15	95
239	Finish MEPs	5	05-Aug-15*	11-Aug-15	48
MEP September.xml.2.2.6.2.6.4.2.6.4.8		82	13-May-15	03-Sep-15	31
241	Rough-In MEPs	10	13-May-15*	26-May-15	73
242	Finish MEPs	5	28-Aug-15*	03-Sep-15	31
MEP September.xml.2.2.7 Hotel		267	12-Aug-14	19-Aug-15	95
MEP September.xml.2.2.7.2.7.1 Hotel Struc		267	12-Aug-14	19-Aug-15	95
MEP September.xml.2.2.7.2.7.1.2.7.1.1 L		14	08-Sep-14	25-Sep-14	95
246	Erect & Detail Steel	6	08-Sep-14*	11-Sep-14	95
247	Structural Stud Framing	4	11-Sep-14*	16-Sep-14	95
248	Shoring, Forming & Decking	6	15-Sep-14*	22-Sep-14	95
249	Concrete SOD	4	22-Sep-14*	25-Sep-14	95
MEP September.xml.2.2.7.2.7.1.2.7.1.2 L		14	29-Sep-14	16-Oct-14	95
251	Erect & Detail Steel	6	29-Sep-14*	02-Oct-14	95
252	Structural Stud Framing	4	02-Oct-14*	07-Oct-14	95
253	Shoring, Forming & Decking	6	06-Oct-14*	13-Oct-14	95
254	Concrete SOD	4	13-Oct-14*	16-Oct-14	95
MEP September.xml.2.2.7.2.7.1.2.7.1.3 L		14	20-Oct-14	06-Nov-14	95
256	Erect & Detail Steel	6	20-Oct-14*	23-Oct-14	95
257	Structural Stud Framing	4	23-Oct-14*	28-Oct-14	95
258	Shoring, Forming & Decking	6	27-Oct-14*	03-Nov-14	95
259	Concrete SOD	4	03-Nov-14*	06-Nov-14	95
MEP September.xml.2.2.7.2.7.1.2.7.1.4 L		16	10-Nov-14	01-Dec-14	95
261	Erect & Detail Steel	6	10-Nov-14*	13-Nov-14	95
262	Structural Stud Framing	4	13-Nov-14*	18-Nov-14	95
263	Shoring, Forming & Decking	6	17-Nov-14*	26-Nov-14	95
264	Concrete SOD	4	26-Nov-14*	01-Dec-14	95
MEP September.xml.2.2.7.2.7.1.2.7.1.5 L		14	03-Dec-14	23-Dec-14	95
266	Erect & Detail Steel	6	03-Dec-14*	08-Dec-14	95
267	Structural Stud Framing	4	08-Dec-14*	11-Dec-14	95
268	Shoring, Forming & Decking	6	10-Dec-14*	17-Dec-14	95
269	Concrete SOD	4	17-Dec-14*	23-Dec-14	95
MEP September.xml.2.2.7.2.7.1.2.7.1.6 L		17	23-Dec-14	14-Jan-15	95
271	Erect & Detail Steel	6	23-Dec-14*	29-Dec-14	95
272	Structural Stud Framing	4	31-Dec-14*	05-Jan-15	95
273	Shoring, Forming & Decking	6	02-Jan-15*	09-Jan-15	95
274	Concrete SOD	4	09-Jan-15*	14-Jan-15	95
MEP September.xml.2.2.7.2.7.1.2.7.1.7 L		14	30-Jan-15	18-Feb-15	95
276	Erect & Detail Steel	6	30-Jan-15*	04-Feb-15	95
277	Structural Stud Framing	4	04-Feb-15*	09-Feb-15	95
278	Shoring, Forming & Decking	6	06-Feb-15*	13-Feb-15	95
279	Concrete SOD	4	13-Feb-15*	18-Feb-15	95
MEP September.xml.2.2.7.2.7.1.2.7.1.8 L		14	20-Feb-15	11-Mar-15	95
281	Erect & Detail Steel	6	20-Feb-15*	25-Feb-15	95
282	Structural Stud Framing	4	25-Feb-15*	02-Mar-15	95
283	Shoring, Forming & Decking	6	27-Feb-15*	06-Mar-15	95
284	Concrete SOD	4	06-Mar-15*	11-Mar-15	95
MEP September.xml.2.2.7.2.7.1.2.7.1.9 L		14	13-Mar-15	01-Apr-15	95
286	Erect & Detail Steel	9	13-Mar-15*	18-Mar-15	95
287	Structural Stud Framing	4	18-Mar-15*	23-Mar-15	95
288	Shoring, Forming & Decking	6	20-Mar-15*	27-Mar-15	95
289	Concrete SOD	4	27-Mar-15*	01-Apr-15	95
MEP September.xml.2.2.7.2.7.1.2.7.1.10 S		267	12-Aug-14	19-Aug-15	95
291	3 Hotel Cars @ 11 Levels	100	02-Apr-15*	19-Aug-15	95



Actual Level of Effort · Remaining Work · ◆ Milestone

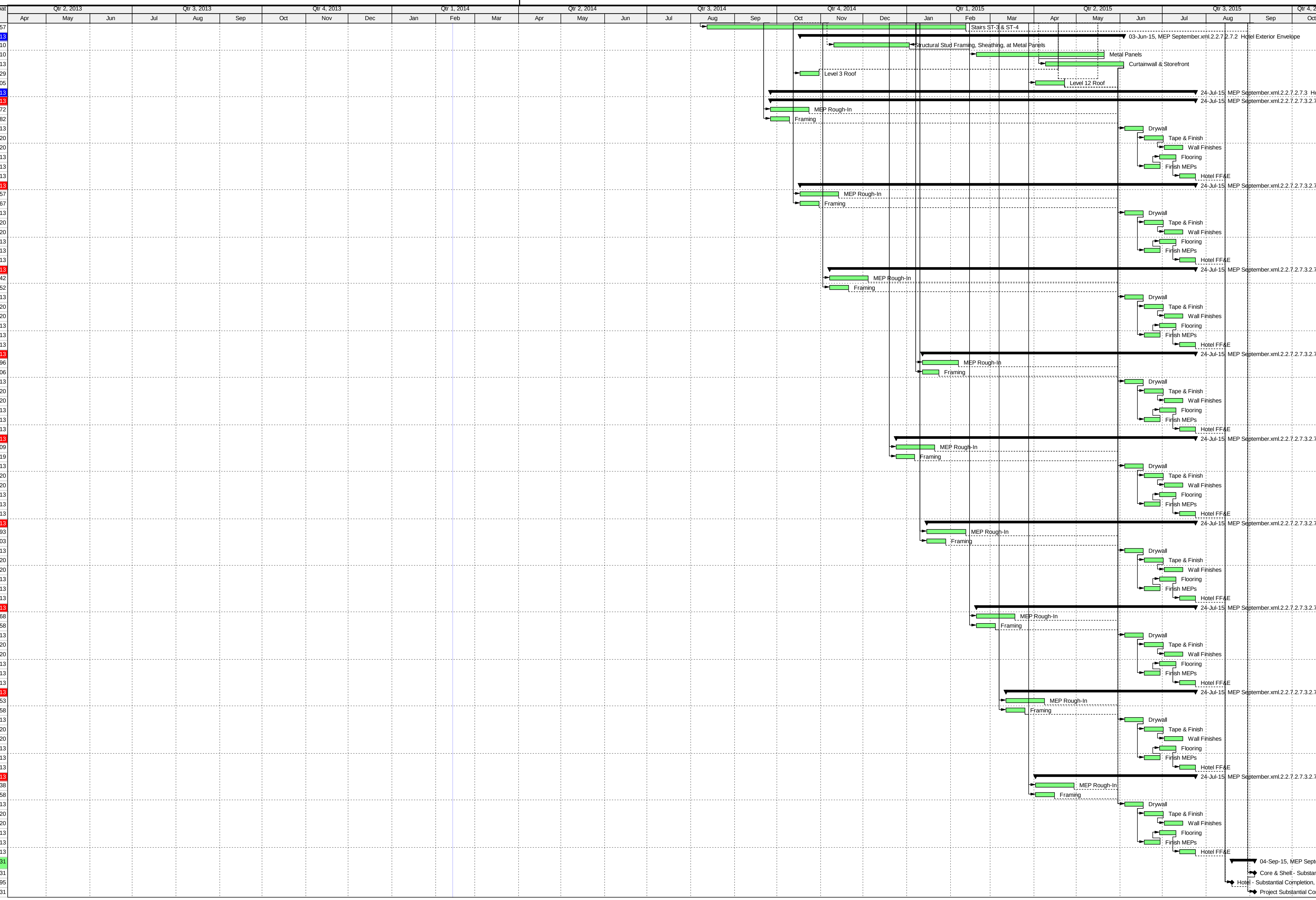
Actual Work · Critical Remaining Work · summary

TASK filter: All Activities

Date	Revision	Checked	Approved

Actual Level of Effort · Actual Work · Remaining Work · Critical Remaining Work · ◆ Milestone

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
292	Stairs ST-3 & ST-4	132	12-Aug-14*	11-Feb-15	157
MEP September.xml.2.2.7.2.7.2 Hotel Exter		164	17-Oct-14	03-Jun-15	113
294	Structural Stud Framing, Sheathi	40	10-Nov-14	02-Jan-15	110
295	Metal Panels	65	19-Feb-15*	20-May-15	110
296	Curtainwall & Storefront	40	09-Apr-15*	03-Jun-15	113
297	Level 3 Roof	10	17-Oct-14*	30-Oct-14	229
298	Level 12 Roof	15	02-Apr-15*	22-Apr-15	105
MEP September.xml.2.2.7.2.7.3 Hotel Fit Ou		216	26-Sep-14	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.1 L		216	26-Sep-14	24-Jul-15	113
301	MEP Rough-In	20	26-Sep-14*	23-Oct-14	272
302	Framing	10	26-Sep-14*	09-Oct-14	282
303	Drywall	10	04-Jun-15*	17-Jun-15	113
304	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
305	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
306	Flooring	10	29-Jun-15*	10-Jul-15	113
307	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
308	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.2 L		201	17-Oct-14	24-Jul-15	113
310	MEP Rough-In	20	17-Oct-14*	13-Nov-14	257
311	Framing	10	17-Oct-14*	30-Oct-14	267
312	Drywall	10	04-Jun-15*	17-Jun-15	113
313	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
314	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
315	Flooring	10	29-Jun-15*	10-Jul-15	113
316	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
317	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.3 L		186	07-Nov-14	24-Jul-15	113
319	MEP Rough-In	20	07-Nov-14*	04-Dec-14	242
320	Framing	10	07-Nov-14*	20-Nov-14	252
321	Drywall	10	04-Jun-15*	17-Jun-15	113
322	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
323	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
324	Flooring	10	29-Jun-15*	10-Jul-15	113
325	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
326	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.4 L		140	12-Jan-15	24-Jul-15	113
328	MEP Rough-In	20	12-Jan-15*	06-Feb-15	196
329	Framing	10	12-Jan-15*	23-Jan-15	206
330	Drywall	10	04-Jun-15*	17-Jun-15	113
331	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
332	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
333	Flooring	10	29-Jun-15*	10-Jul-15	113
334	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
335	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.5 L		153	24-Dec-14	24-Jul-15	113
337	MEP Rough-In	20	24-Dec-14*	20-Jan-15	209
338	Framing	10	24-Dec-14*	06-Jan-15	219
339	Drywall	10	04-Jun-15*	17-Jun-15	113
340	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
341	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
342	Flooring	10	29-Jun-15*	10-Jul-15	113
343	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
344	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.6 L		137	15-Jan-15	24-Jul-15	113
346	MEP Rough-In	20	15-Jan-15*	11-Feb-15	193
347	Framing	10	15-Jan-15*	28-Jan-15	203
348	Drywall	10	04-Jun-15*	17-Jun-15	113
349	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
350	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
351	Flooring	10	29-Jun-15*	10-Jul-15	113
352	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
353	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.7 L		112	19-Feb-15	24-Jul-15	113
355	MEP Rough-In	20	19-Feb-15*	18-Mar-15	168
356	Framing	10	19-Feb-15*	04-Mar-15	158
357	Drywall	10	04-Jun-15*	17-Jun-15	113
358	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
359	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
360	Flooring	10	29-Jun-15*	10-Jul-15	113
361	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
362	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.8 L		97	12-Mar-15	24-Jul-15	113
364	MEP Rough-In	20	12-Mar-15*	08-Apr-15	153
365	Framing	10	12-Mar-15*	25-Mar-15	158
366	Drywall	10	04-Jun-15*	17-Jun-15	113
367	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
368	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
369	Flooring	10	29-Jun-15*	10-Jul-15	113
370	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
371	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.2.2.7.2.7.3.2.7.3.9 L		82	02-Apr-15	24-Jul-15	113
373	MEP Rough-In	20	02-Apr-15*	29-Apr-15	138
374	Framing	10	02-Apr-15*	15-Apr-15	158
375	Drywall	10	04-Jun-15*	17-Jun-15	113
376	Tape & Finish	10	18-Jun-15*	01-Jul-15	120
377	Wall Finishes	10	02-Jul-15*	15-Jul-15	120
378	Flooring	10	29-Jun-15*	10-Jul-15	113
379	Finish MEPs	8	18-Jun-15*	29-Jun-15	113
380	Hotel FF&E	10	13-Jul-15*	24-Jul-15	113
MEP September.xml.3 OCCUPANC		12	19-Aug-15	04-Sep-15	31
382	Core & Shell - Substantial Compl	0	04-Sep-15*		31
383	Hotel - Substantial Completion	0	19-Aug-15*		95
384	Project Substantial Completion	0	04-Sep-15*		31



Actual Level of Effort · Remaining Work · ◆ ◆ Milestone
Actual Work · Critical Remaining Work · summary

TASK filter: All Activities