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Evaluating Opportunities For Increased HVAC Energy Efficiency For A Ryerson University Building With eQuest Energy Modeling

Bomani A. Khemet
Ryerson University

EVALUATING OPPORTUNITIES FOR INCREASED HVAC ENERGY EFFICIENCY FOR A RYERSON UNIVERSITY BUILDING WITH eQUEST ENERGY MODELING

By

Bomani Ajamu Khemet
Bachelors of Applied Science University of Ottawa, Ottawa 2000
Master of Engineering Howard University, Washington D.C. 2003

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Abstract

Energy used by primary and secondary Heating Ventilation and Air Conditioning systems in post-secondary schools can account for a significant share of the total energy expenditure throughout the lifetime of these buildings. The following is a study of a Ryerson University buildings' Heating Ventilation and Air Conditioning system through the use of eQUEST energy modelling techniques. A baseline energy model was created and was compared to the buildings' existing energy consumption, and energy intensity benchmarks. Suggested improvements to the existing Variable Air Volume system were determined by comparing the baseline VAV eQUEST simulation against two subsequent hydronic based eQUEST models; the Fan Coil System, and the Water Source Heat Pump System.

Acknowledgements

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1. Introduction

The goal of this research is to determine what building equipment upgrades can achieve energy efficiency in a midsized post-secondary institutional building located on Ryerson University campus through the use of energy modeling estimates.

Energy efficient green buildings can be implemented by integrating a variety of design strategies. However, all green buildings should consider the absolute reduction in energy use as a central strategy. According to the Building Science Corporation: *"The solution to this problem begins with awareness of the importance of operational energy consumption to environmental damage, resource depletion, habitat destruction, and hence, to green buildings. Solutions will take many forms, but all will involve prediction of energy consumption, and confirmation that the designed low-energy building is actually built and operated as one."* (Straube, John, 2009).

According to the US Department of Energy, there are a variety of mature building automation technologies that are either unused or underutilised within multi-zoned buildings (DOE, 2012) which can reduce overall energy use. Moreover, the CMHC estimates that a well-constructed, multi-zone midrise buildings' operational energy can account for as much as 74% of the energy consumed over a building's lifetime (CMHC, 2000). The energy intensity of office building with underground parking averaged over wood, steel and concrete structures in Vancouver and Toronto for 50 years is shown in Figure 1. The graph illustrates that the total Operational Energy represents 85.5% of the total energy consumed by these building types as compared to 8.3% and 6.2% for

Recurring Embodied Energy, and Initial Embodied energy respectively. Although the building in this research is not an office building, the graph does provide an indication of the relative importance of operational energy in perimeter-core buildings in urban Canada.

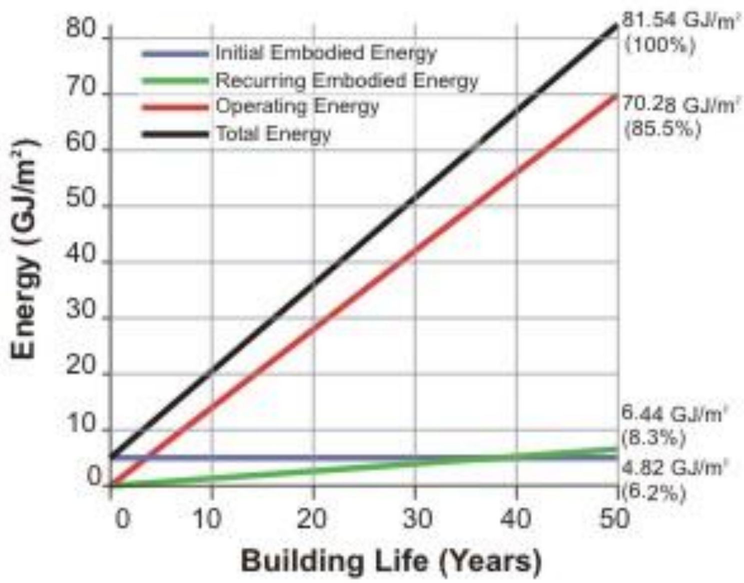

Figure 1: Office Building in Vancouver and Toronto (CanadianArchitect, 2012)

This makes for a compelling argument that current and future energy use is perhaps the most important issue to be address when designing the built environment. A properly designed building envelope establishes the theoretical limits on whole building performance, and can significantly minimize the energy required to operate the building. However even the best designed building envelopes can become increasingly energy inefficient without a minimum level of controlled conditioned air. The proportion of financial first costs of Building Services is also a motivating factor in building design. In fact, mechanical systems can represent up to 15% of capital costs for Schools/Universities, and nearly 20-25% of a building's construction cost for specialty buildings such as Medical Facilities and Laboratories. (Daryl L. Orth, 2009).

This research effort is both timely and complimentary to Ryerson's Energy Reduction program which is part of the University's overall sustainability strategy. Through the application of this strategy Ryerson's heat energy consumed was reduced by 25% by decommissioning on the campus' central boiler plant and converting the primary heating system over to a district heating system supplied by Enwave (Ryerson-University, 2012). Perhaps this investigation of secondary HVAC Systems can help Ryerson University achieve further gains in its quest for efficient energy management.

2. Methodology & Approach

At the outset a literature review was undertaken to evaluate the current state of knowledge in HVAC application for multi-level, perimeter-core buildings. When possible, the journal entries and articles pertaining to cold heating dominated climates were favoured. The information that was unearthed included information ranging from “best practices” for HVAC energy efficiency, to Case Studies examined in technical journals.

A shortlist of four buildings were initial selected this study in order to reflect a diversity of building programming, floor plate size, building height and equipment vintage. Those buildings included the Ryerson’s Undergraduate Library, The Engineering Building, The Architecture Building, and Eric Palin Hall. All four buildings were both large enough to have multiple thermal zones, and warranted the use of a Building Automation System. Eric Palin Hall was finally selected from this shortlist based on its unique construction history, massing qualities and available data.

Long term energy data as well as architectural and mechanical drawings were requested and provided by Ryerson’s Campus Facilities. Energy usage over several years allow for the detection of seasonal or yearly anomalies to be identified. A rudimentary energy model was constructed in eQUEST based on the architectural, mechanical, and operational and energy use data collected. The baseline eQUEST energy model was compared to both actual energy consumption data, and to select benchmarks from national or provincial databases. Two additional eQUEST energy simulation models with identical building envelopes and loading conditions were produced with upgraded secondary Heating Ventilation and Air Conditioning equipment.

The difference in energy consumption were computed and compared to determine if any significant energy savings could be gained from a proposed system upgrade.

3. Energy Benchmarks and Simulations

Energy benchmarking is an important part of building design and evaluation since it allows for the objective comparison of a current building with: modeled simulations, existing governmental targets, existing building stock, or for a comparison between energy models themselves. A convenient manner to measure building energy use is to use measured or modeled energy per unit area (Group, 2012). Convenient and comprehensive values for energy intensity by building type, climate location, and building size can be found in benchmark data sources such as National Resources Canada (NRCAN, 2007), BOMA BESt (BOMA, 2011) or even the Environmental Protection Agency (EPA, 2003). Detailed building simulations verified against actual energy usage can help confirm which HVAC systems or components are responsible for the most significant share of energy usage (Hyunjoo Kim, 2011). However, for a building simulation model to approach the actual energy performance of the building, it is necessary to have detailed information about building occupancy, thermostat settings, and detailed metering information from the utility authorities responsible (Bejrowski, 2008).

4. Central Heating and Cooling

For cold climates, a select variety of central heating and cooling plants are typically in use for large core and perimeter buildings. There are general two types of system in common usage; the All Air Systems such as Constant Air Volume and Variable Air Volume, or Hydronic Systems; which include Fan Coil and Water Source Heat Pumps. The energy required to service these various systems can originate from a district energy system, or locally in a heating plant and cooling plant. These central plants are typically sized according to the building at peak load rather than the sum of individual maximum loads. For instance, the maximum solar load will not occur at the same time on the south and west façade. Hence the central plant is typically sized appropriately using a diversity factor which can be as little as 45% of the sum of all peak loads in a particular building being served (ASHRAE, 2008). However, caution should be exercised when estimating energy usage solely based on building demand via primary heating and cooling equipment such as boilers and chillers. The operation and behaviour of the secondary HVAC equipment such as the Air Handling Units, Fan Coils, and Water Source Heat Pumps and VAV's must be taken consideration. A single building can have drastically different energy usage patterns in the cooling and heating seasons based on the secondary equipment selected. (Ivan Korolija, 2010).

5. Variable Air Volume System

HVAC systems utilizing the Variable Air Volume system achieve thermal comfort by varying the quantity of conditioned supply air delivered to the space rather than varying the temperature of the air being supplied to the space. Perhaps the greatest energy saving feature of the VAV system is near the perimeter. At the perimeter of the building solar cooling loads varying with outside temperature. This allows for supply air quality to the perimeter to be reduced. Humidity control can be a problem with VAV systems for areas that are sensitive to fluctuating humidity such as laboratories and spaces that house industrial process. In these cases Constant Volume air handling must be applied (ASHRAE, 2008, p. 4.11). Additionally, there may be a risk of poor occupant comfort due to reduced air circulation under some thermal loading conditions with VAV systems. This occurs because the human body is more sensitive to elevated temperature in the areas of poor air circulation. Since the skins ability for evaporative cooling is reduced, the reduced a VAV system must make adjustments to conform to this need. More specifically, part load conditions may require (a) the need to raise supply air temperature of the entire system, thus increasing humidity; (b) supply reheat or auxiliary heat in the particular zone, in addition to already condition air, or (c) provide a method of air recirculation such as an induction unit, blended air recirculation with plenum or room air with supply air (ASHRAE, 2008, p. 4.11).

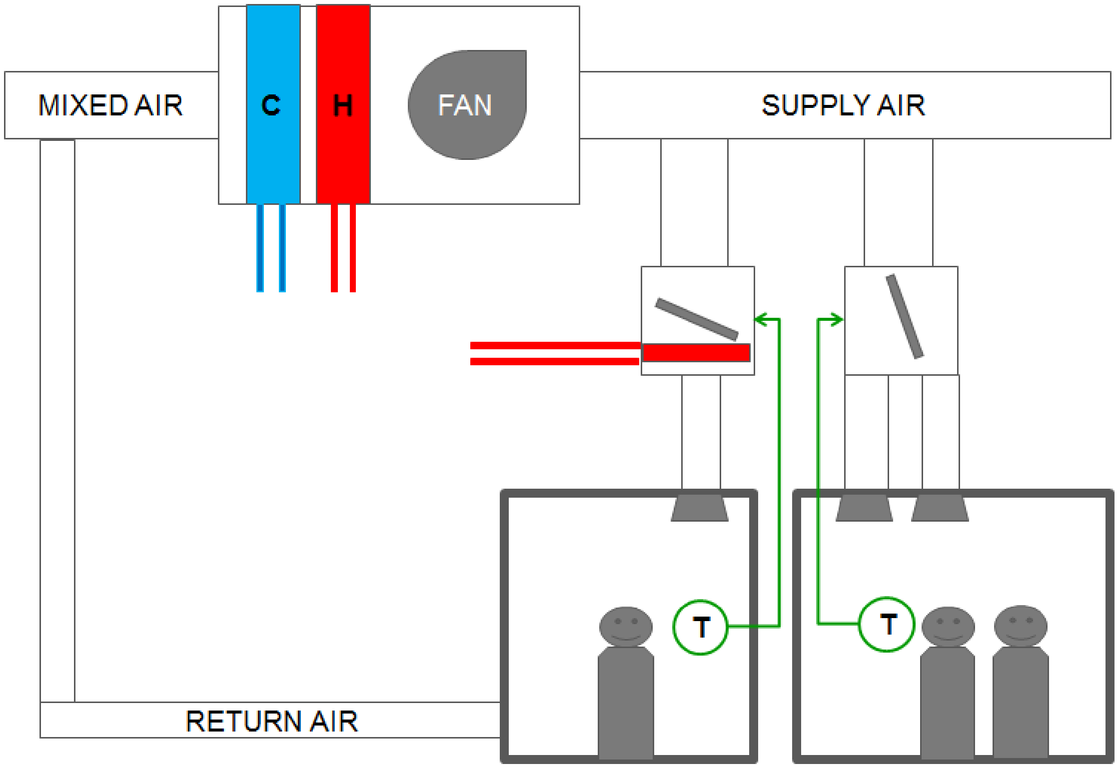

Figure 2: Variable Air Volume System Schematic

A schematic of the Variable Air Volume System is illustrated in Figure 2. Fresh outdoor air and return air are mixed together before entering the Air Handling Unit which can provide all or most of the air conditioning requirements to the occupied space. When the outdoor conditions are below the minimum supply air requirements, the AHU's heating coil warms the incoming air to satisfy the design temperatures. Similarity, the cooling coil is activated if the outdoor conditions are above the designed supply air temperature. The air is circulated via a fan in the central AHU and sent to the occupied spaces. The thermostat, identified in a green circling the symbol "T", modulates the supply volume of conditioned air via a small damper in the VAV box. The VAV box is typically located in the ceiling plenum. The schematic in Figure 2 shows two possible Variable Air Volume configurations. One configuration supplies an occupant space via VAV with a hot water reheat coil while the other VAV duct is without a hot water reheat capability.

6. Fan Coil System

As opposed to the VAV all air system, the Fan Coil System conditions air from within a zone and is thus classified as an In-Room Terminal System. These units will recirculate tempered air by forced convection in a room through its heating or cooling coils. The coils are typically supplied with cold water or a hot water solution. The basic elements of fan coil unit are the finned tube heating/cooling coil, the filter, and the fan. The temperature of the air from the Fan Coil is modified by the modulation of fan speed, fluid speed or a combination of both. The most common method of supplying the water to the cooling coils is by using a Two Pipe or Four Pipe system. The Two Pipe system supplies either chilled water or hot water in the first pipe and returning cool water or warm water in the other pipe. These Two Pipe fan coils require a seasonal changeover which switches the whole building between cooling and heating seasons. The advantage of the four pipe system is that it does not require a change over date since both chilled water and hot water can be supplied to a battery of units simultaneously. The Two Pipe systems have a lower initial cost on account of half the piping requirement, but four pipe systems are typically more efficient since they can accommodate simultaneous heating and cooling needs that arise in the perimeter-core buildings and during transition seasons. On the whole, fan coil units require periodic maintenance of the filter and condensate drain and piping. The condensate drain pan must be cleaned to avoid water accumulation in the zones and lower the risk of bacterial growth (ASHRAE, 2008).

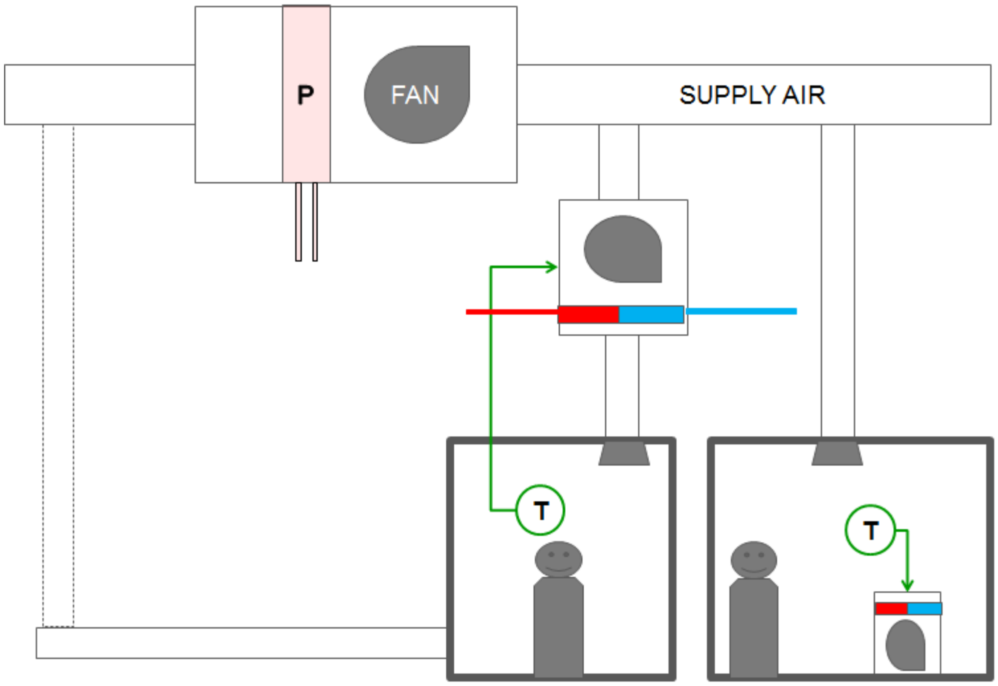

Figure 3: Fan Coil System Schematic

Figure 3 illustrates the basic functions of a Fan Coil System. Fresh air is taken from the outdoors with a Make-Up Air Unit which may temper incoming air with a preheat coil marked in this illustration by a “P”. Since space conditioning takes place near the occupied space rather than at a central rooftop condition, the supply air condition can be broader in the FCU system as compared to VAV. Once the supply air reaches the Fan Coil Unit it is fully conditioned based on the thermostat settings in the occupied space denoted with a letter “T”. The illustration shows the configuration of both an in-terminal Fan Coil and plenum mounted Fan Coil system in the two rooms.

7. Water Source Heat Pump System

The water source heat pump is single packaged piece of equipment that provides both heating and cooling by utilising water as a heat source during the heating season and water as a heat sink during the cooling season. Heat is transferred between the air and water via a refrigerant which has a low boiling point. The main components of a Water Source Heat Pump are; the compressor, the refrigerant to water heat exchanger, the refrigerant to air heat exchanger, an expansion device and a reversing valve which changes the mode of operation. Water Source Heat Pumps can be located directly in the zone as vertical and horizontal units, in the room plenum, or serve several zones by being located in a hallway plenum (ASHRAE, 2008). In practice, the WSHP is a replacement alternative to the VAV system with re-heat. Although each individual Water Source Heat Pump defines its individual zone, it is tied together to other WSHP's through a single water loop and can thus be considered a system. Instead of a central duct system the WSHP uses the water loop to move energy around the building as needed. Although individual heat pumps may reverse from cooling mode to heating mode the central water loop linking all these heat pumps can remain between 21^{o}C and 32^{o}C year round. The risk of condensation on the pipe surfaces are minimized since the pipe temperatures are always above the air's dew point (Ask, 2008).

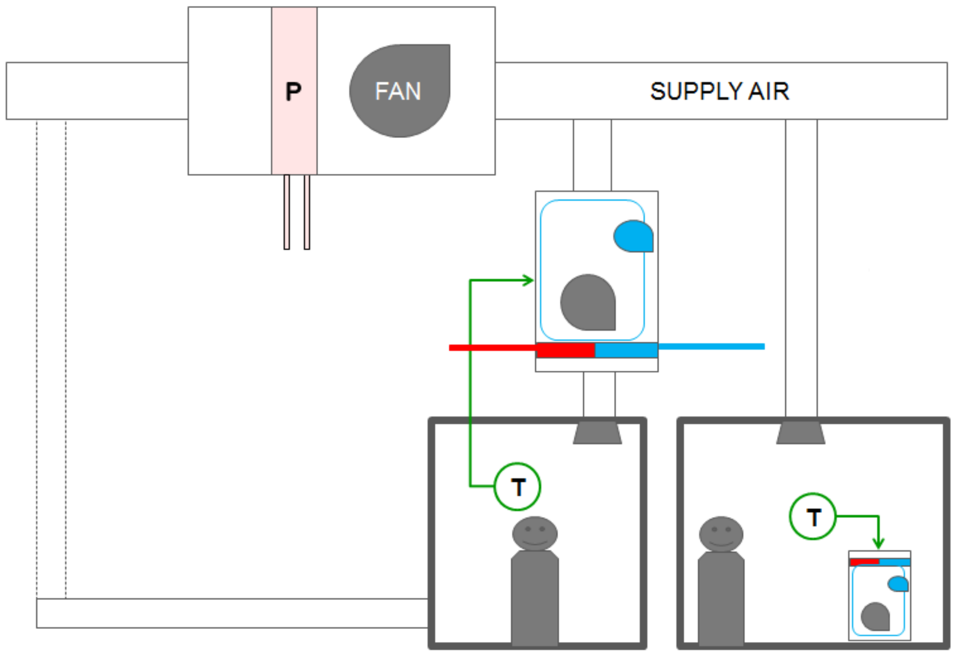

Figure 4: Water Source Heat Pump System Schematic

Figure 4 illustrates the basic functions of a Water Source Heat Pump System. Fresh air is taken from the outdoors with a Make-Up Air Unit which may tempered the air with a preheat coil marked in this illustration by a “P”. Since space conditioning takes place near the occupied space rather than at a central rooftop condition, the supply air condition will be broader than a VAV system. Similarly to the FCU describe above, the supply air reaches the WSHP and is fully conditioned in local coils. Unlike the FCU, lower grade heat is captured through the refrigerant cycle and delivered to the zone to be conditioned. The illustration shows both a terminal WSHP and Plenum mounted WSHP.

8. System Comparisons

HVAC system can be readily compared for performance by use of software simulations. The Air Conditioning manufacturer McQuay has done such an analysis for a particular new School in the Chicago area. In their simulation comparison, McQuay examined various common HVAC solutions and examined; their maximum loading capabilities, total first costs, utility costs, maintenance cost, energy intensity, and energy intensity per dollar as shown in Table 1 below. The highlighted items represent the system types of interest. According to this analysis, the building energy usage for VAV system were higher than the standard WSHP and FCU systems. However the energy intensity cost were higher with the WSHP and FCU as compared to the VAV simulation. The annual energy intensity and energy intensity per dollar was further reduced below that of the VAV when a heat recovery systems such as enthalpy wheels were implemented.

System	Max Cooling Load Tons	Max. Heating Load Mbh	First Cost $/ft²	Total First Cost $	Utility Cost $/yr	Maint. Cost $/yr	Building Energy Usage Btu/(ft²-yr)	Building Energy Cost Btu/(ft²-yr)
Chiller/AHU/FPVAV Series	470	4965	$8.30	$1,642,447	$169,119	$19,735	46189	0.8541
Chiller/AHU/FPVAV Parallel	470	4965	$8.31	$1,644,622	$159,844	$19,735	44295	0.8073
Chiller/AHU/Dual Duct Dual Fan	470	4965	$8.91	$1,764,270	$161,156	$18,499	44303	0.8139
Chiller/AHU/VAV Reheat	470	4965	$8.19	$1,620,692	$159,040	$18,777	43728	0.8032
Applied Rooftop/VAV Reheat	470	4965	$6.08	$1,203,011	$162,861	$20,459	43889	0.8225
Vertical Self-Contained/VAV Reheat	470	4965	$6.34	$1,255,221	$160,773	$20,177	43868	0.8120
WSHP/MUA	430	4615	$5.38	$1,065,240	$180,841	$24,493	41449	0.9133
GSHP/MUA	430	4615	$7.10	$1,405,800	$175,759	$24,493	39671	0.8877
Chiller/Fan Coil/MUA	430	4615	$8.60	$1,702,800	$172,903	$17,204	41154	0.8732
Unit Ventilator	441	4615	$5.77	$1,142,460	$161,159	$20,434	40707	0.8139
WSHP/MUA w/ Enthalpy Wheel	348	4615	$5.53	$1,094,940	$163,844	$24,493	31934	0.8275
GSHP/MUA w/ Ehthalpy Wheel	348	4615	$7.25	$1,435,500	$156,762	$24,493	30156	0.8018
Chiller/Fan Coil/MUA w/ Enthalpy Wheel	348	4615	$8.74	$1,730,520	$155,906	$17,204	31639	0.7874

Table 1: HVAC System Comparison of Chicago School (McQuay, 2012)

9. Building Selection: Eric Palin Hall

A site tour was conducted on a short list of buildings including; the undergraduate library the engineering building and the architecture building and Eric Palin Hall . Eric Palin Hall was ultimately selected to perform the research. EPH is located on 87 Gerrard Street, Toronto, Ontario and sits on approximately 3507m^2 of land in the North East section of Ryerson University Campus. The building itself has been through a number of major renovations.

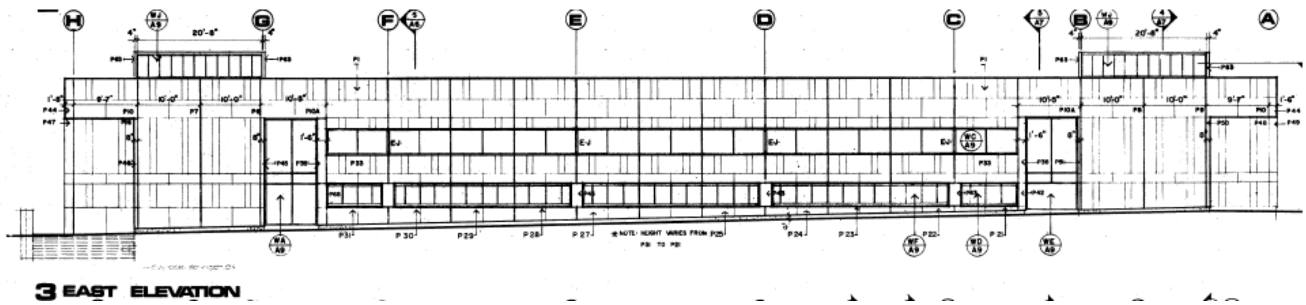

Figure 5: East elevation 1st and 2nd Floor

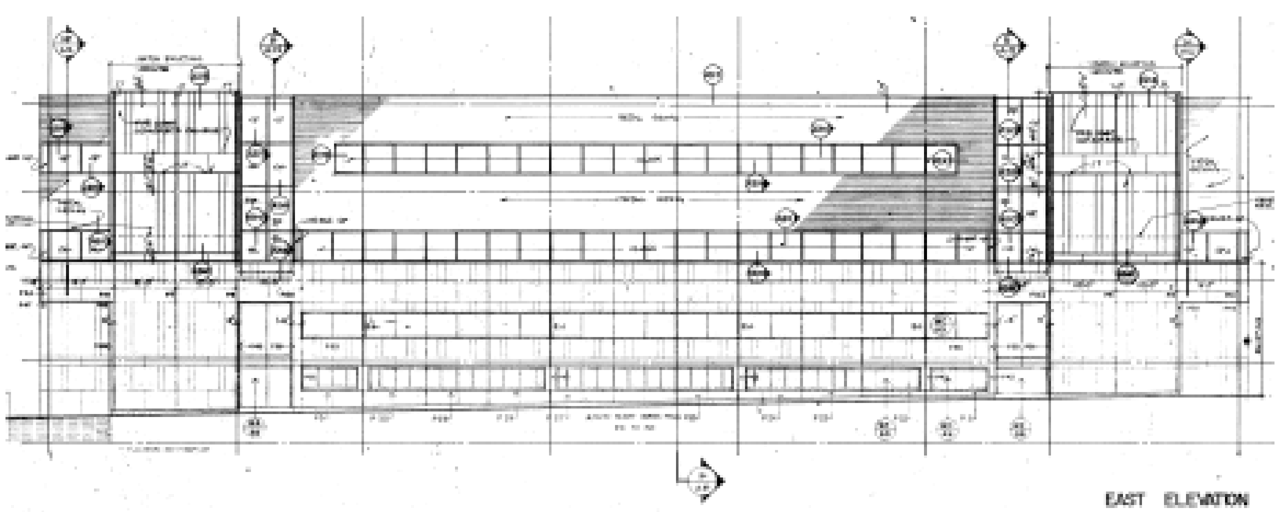

Figure 6: East elevation, Addition of 3rd and 4th Floor

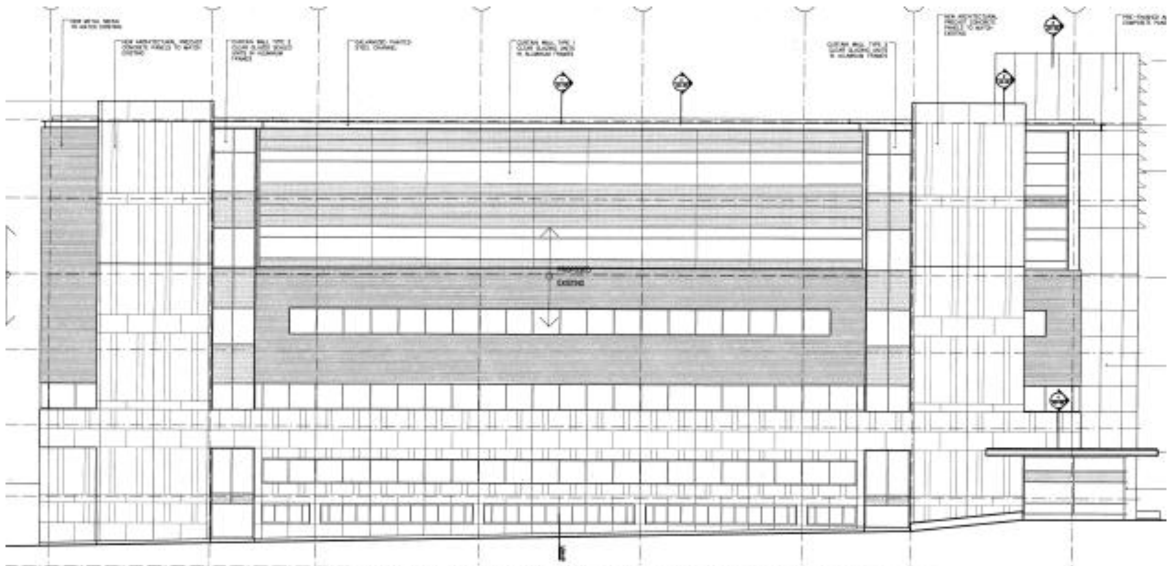

Figure 7: East Elevation, Addition of 5th and 6th Floor

It was originally constructed as a two story building as the Technology Annex 1971 (Lee, 2012). The building envelope was clad in precast concrete panels and the ground floor remains partially buried. In 1985, a third and fourth floor were added. This time the walls made of a combination of poured concrete and concrete masonry units, clad in metal wall siding with 3” of insulation. Finally in 2002, an additional 5th and 6th floor were added to the building with these additional floors consisting of a mixture of curtain wall, metal wall siding and prefabricated concrete panels.

Figure 8: Mix of Cladding from various renovations to Eric Palin Hall/SHE

10. Eric Palin Hall HVAC System Description

The building currently has seven Air Handling Units installed on the roof served by a glycol solution for heating coils and chilled water for the cooling coils. The Air Handling units are also equipped for low pressure steam humidification. There is also an air cooled condensing unit and five heat exchangers. One heat exchanger is dedicated for the domestic hot water supply, two others are dedicated to service the Air Handlers and the remaining exchangers are to supply the VAV boxes with hot water reheat. Steam is provided to the basement of the facility from Enwave's central district heating system (Ryerson-University, 2012) that serves downtown Toronto buildings within the financial core. The high pressure steam is stepped down to medium pressure steam in the risers and further reduced to low pressure steam for each AHU. Condensate from all processes is collected in a condensate receiver and returned to the central chilled water plant. Chilled water is supplied to the Eric Palin Hall through a Ryerson Campus Central Cooling Plant located at the roof and basement of the edifice. Three chillers are located in the basement, one of which was newly installed in spring of 2012. For heat rejection, recently upgraded cooling towers are located on the library rooftop.

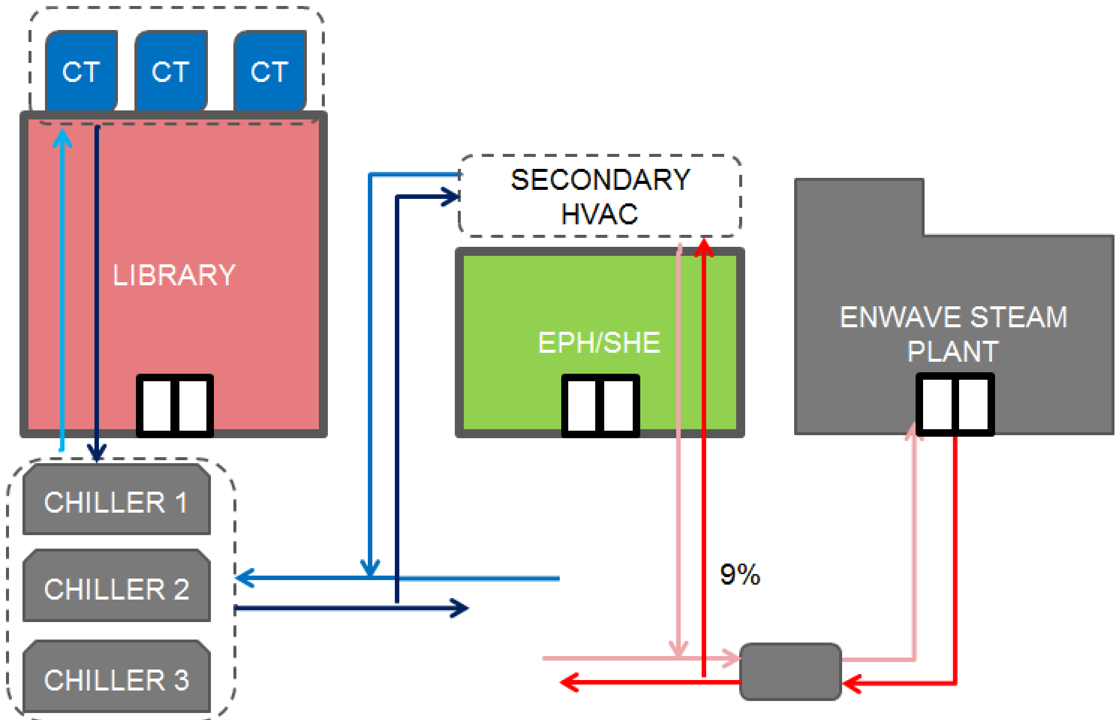

Figure 9: Primary HVAC System Schematic

A schematic description of EPH/SHE's primary HVAC system is illustrated in Figure 9 with the cooling plant on the left hand side and the heating plant located on the right. The chilled water demand is similarly metered centrally at the cooling plant located atop and below the Ryerson University Library Building. The 416 kPa steam is stepped down to a low pressure steam of 103 kPa which is fed to all of the seven Air Handling Units for steam humidification. Another portion of the low pressure steam is directed to the unit heaters in the penthouse and the remaining steam is used in the five heat exchangers. One steam heat exchanger is used to heat the domestic hot water. Two other heat exchangers are used to heat the Glycol solution for the AHU heating coils. The remaining heat exchanger is used to transfer the steam's energy to heat the hot water supply for the VAV reheat coils the 5 and 6th floors. The Chilled water supply is pumped at 79L/s directly into the air handling cooling coils when needed.

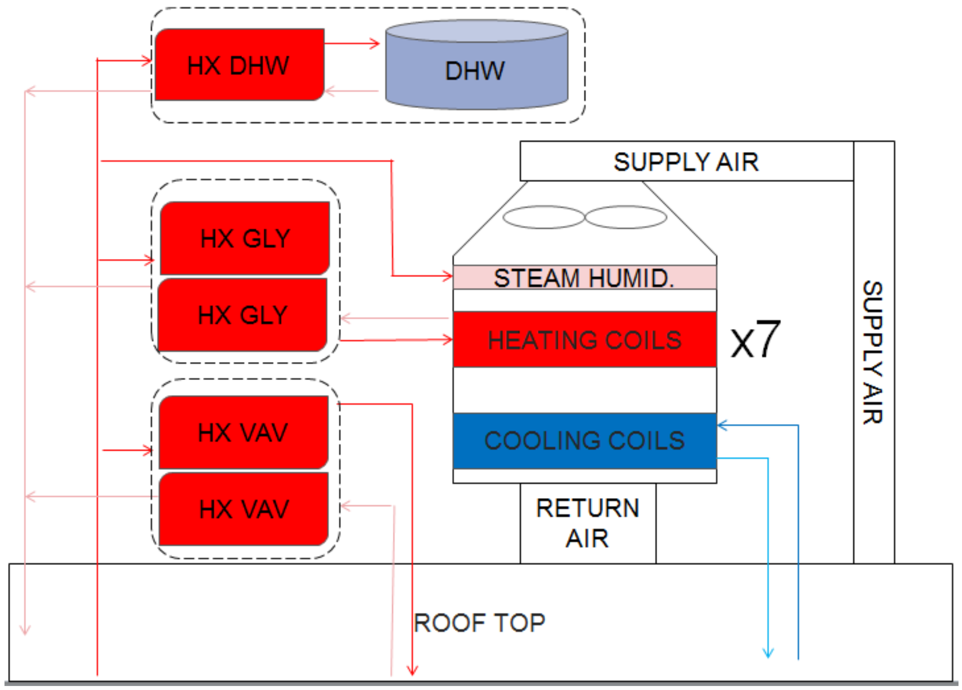

Figure 10: Secondary HVAC System Schematic

The secondary HVAC system is illustrated in Figure 10, where the linkage between the cooling and heating are made clear. The occupied space is supplied by a combination of Variable Air Volume and VAV with hot water re-heat. The first four floors are cooled with several VAV boxes while the newest fifth and six floors are supplied with VAV with hot water reheat. Conditioned air is supplied by seven rooftop air handlers with heating coils, cooling coils, and steam humidification capabilities. The conditioned air is distributed by AHU's fan via ductwork. The conditioned air is further and controlled by Variable Air Volume boxes spread throughout the core and shell of the building. Analysis of the mechanical building plans reveal that there are 40 VAV boxes on the 6th floor and 39 VAV boxes on the 5th floor with approximately 189 VAV boxes throughout the whole building. The VAV boxes that supply these zones vary in capacity from 47 L/s to 590 L/s of supply air.

11. Simulation Inputs

The simulation inputs were determined from the mechanical drawings, the architectural drawings, and the operational HVAC set points supplied by the Campus Facilities and Sustainability Office. For modeling purposes, the building envelope was estimated to be made of a uniform material of 203 mm concrete walls with RSI of 2.61 and with galvanized steel finish. In reality the building envelope is partly made up of concrete masonry units, poured concrete with and smaller proportion of curtain wall and metal frame supported siding and precast concrete. The ground floor was modeled as above grade despite the fact that the ground floor is partially below ground. The roof was modeled as Built-Up-Roof supported 102 mm concrete slab with RSI 4.4 insulation. The window to wall ratio were determined using BLUEBEAM PDF Revu (BlueBeam Software, 2012) software which allowed for the direct measurement and calculation of the window and spandrel panel areas for each exterior wall.

BUILDING ENVELOPE INPUTS	NOTES
ROOF SURFACES	
4" Concrete	manual
Roof Built up, Medium	manual
5" polystyrene R25 (Interior Insulation)	manual
ABOVE GRADE WALLS	
8" CMU	manual
Steel Galvanized Gray Dark	manual
R15 Insulation	manual
GROUND FLOOR	
Earth Contact	manual
8" concrete	manual
SHELL TIGHTNESS	
0.038 CFM/FT2 (PERIM), 0.001 CFM (CORE)	auto/default
CEILINGS	
Lay in Acoustic Tile	manual
VERTICAL WALLS	
mass	manual
FLOORS	
vinyl Tile	manual
6" concrete	manual
EXTERIOR WINDOW	
Double clear/Tint 1/4", 1/2"air	manual
Aluminium Frame	manual
37% WWR North Face (spandrel panel incl.)	manual
13% WWR South Face (spandrel panel incl.)	manual
37% WWR East Face (spandrel panel incl.)	manual
33% WWR West Face (spandrel panel incl.)	manual

Table 2: Building Envelope Simulation Inputs

Table 2 shows the details of the simulation inputs used in the eQUEST simulated baseline model. This includes the roof, above grade walls, ground floor, shell tightness, ceilings floors and exterior windows. The note column indicates a “manual” or “auto/default” to identify which inputs were determined or calculated (ie. Manual) from information collected during the building audit or set as automatically by eQUEST based on general building type supplied by the user.

ACTIVITY AREA ALLOCATION				
AREA TYPE	AREA (%)	DESIGN MAX OCCUP. SF/PERSON	DESIGN VENTILATION CFM/PERSON	NOTES
Classroom Lecture	50	30	15	manual/auto/auto
Office General	20	150	20	manual/auto/auto
Corridor	12	150	7.5	manual/auto/auto
Laboratory	10	150	20	manual/auto/auto
Computer Room/PC Lab	3	75	15	manual/auto/auto
Restroom	3	52.5	50	manual/auto/auto
Vocational Areas	2	75	20	auto/auto/auto

Table 3: Activity Area Allocation Inputs

To determine the building occupancy of EPH/SHE an Area allocation was estimated based on the building architectural drawings. Default values for area type occupancy and design ventilation per area type were determined based on the area values as listed in Table 3.

Occupied Load by Activity Area	NOTES
Percent Area	Manual Settings
Lighting	Default Settings
Task Lights	Default Settings
Plug Loads	Default Settings
Unoccupied Activity Area	
Percent Area	Manual Settings
Occupancy (%)	Default Settings
Lighting (%)	Default Settings
Task Light (%)	Default Settings
Plug Load (%)	Default Settings
Main Schedule Information	
Monday - Sunday	
No Holidays	Manual Setting
Hours 8am - 9pm	Default Settings
Occupied %; 95	Default Settings
Lighting Load %; 95	Default Settings
Equipment Load %: 95	Default Settings

Table 4: Occupancy and Schedule Inputs

EPH's building occupancy and scheduling inputs were entered in accordance to the default settings of eQUEST as shown in Table 4. In addition, Lighting, Task Lighting, and Plug Loads were held constant for all simulation cases. It should be noted that actual occupant loading may vary during a twelve month period since enrollment during the summer months may be reduced. However, the eQUEST simulation did not take fluctuations in load schedule and occupancy into consideration.

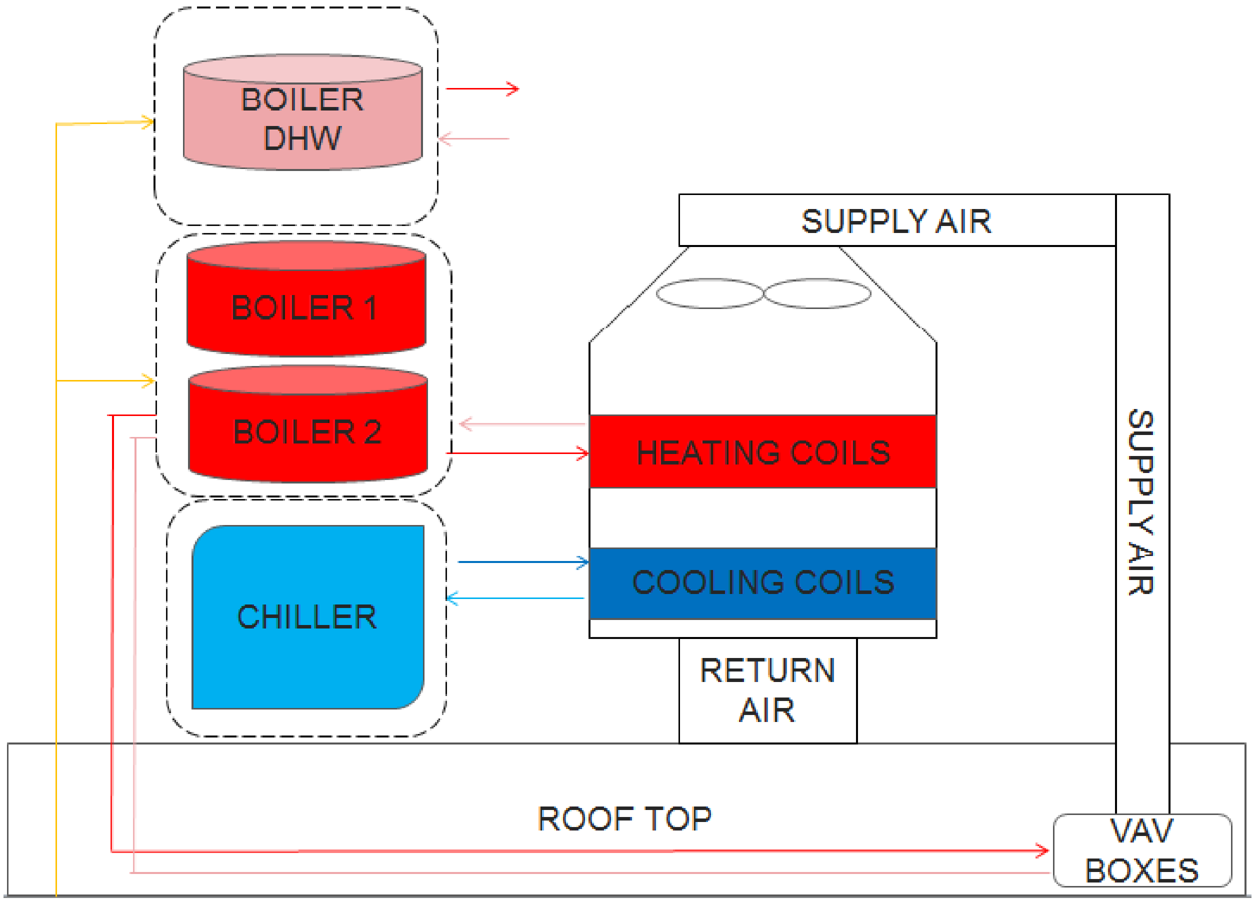

Figure 11: Simulated HVAC System Schematic

The HVAC system was modelled by using a chiller and boiler plant instead of a district heating arrangement as seen in Figure 11. The single Air Handling Unit is representative of the total cooling heating and air supply required for the simulated version of EPH. The local chiller and boilers were auto-sized based on the building size and details of the air handling equipment provided based on inspection and calculations. The conversion of the steam to Glycol solution and hot water was simplified to two boilers with additional domestic hot water supply. The centrally supplied chilled water was simplified to a local chiller and cooling tower configuration.

HVAC SYSTEM TYPE			NOTES
Cooling Source	Chilled Water Coils		manual
Heating Source	Hot Water Coils		manual
Hot Water Source	Hot Water Loop		manual
System Type	VAV with HW RH		manual
Return Air Path	Ducted		manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Setpoints	75.2	82.4	manual
Heating Setpoints	71.6	64.4	manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Design Temperature	71.6	55.4	manual
Heating Design Temperature	75.2	64.4	manual
Minimum Design Air Flow (cfm/ft2)		0.63	manual
VAV Minimum Air Flow (%)	40% Core	30% Perimeter	auto
Supply Fans			
Power and Motor Efficiency	108 BHP	High Efficiency	manual/manual
Fan Flow	178910 cfm		manual
Fan type	Variable Speed Drive		auto
Return Fans			
Power and Motor Efficiency	82 BHP	High Efficiency	manual/manual
Fan Flow	Auto-size		auto
Fan type	Variable Speed Drive		auto
Primary Cooling Equipment			
Chilled Water System			autosized
Chillers			autosized
Open Tower with Heat Exchanger			manual
Primary Heating Equipment			autosized
Boiler			autosized
Domestic Hot Water			autosized

Table 5: Variable Air Volume Simulation Input

Typical design temperature set points for the cooling and heating season were taken from Campus Facilities and added manually to the model. The details of the manually and auto-sized HVAC system data used in the eQUEST simulation is summarised in Table 5. The minimum design airflow value in Table 5 is actually the result of a detailed set of calculations based on the drawings EPH's HVAC system. eQUEST requires that a total value of the AHU's be entered into the software program to estimate energy usage, rather than adding every individually know equipment separately. Hence the known data was assemble and combined into a single amalgamated Air Handling Unit, with a calculated return and supply fan power, heating load, and supply air volume per unit area. The actual ventilation for first, second, third, and fourth floors were calculated based on HVAC equipment available from the previous renovations as seen in Table 6.

Name	**Location**	**Capacity CFM**	**Sup BHP**	**RETURN FAN BHP**	**Sup Fan KW**	**Ret Fan KW**	**COOLING MBH**	**HEATING MBH**	**COOLING Tons**	**HEATING Tons**	**COOLING Kwh**	**HEATING Kwh**	**Floor Space 37749**	**CFM/sqft**	
AHU1a	FLOOR 1	15000.00	10.00	5.00	5.59	3.73	420	262	35	22	123	77	9437	0.63	
AHU1b	FLOOR 1	13000.00	7.50	5.00	5.59	3.73	400	228	33	19	117	67	18875	1.45	
AHU1c	FLOOR 1	11500.00	5.00	3.00	3.73	2.24	403	211	34	18	118	62	9437	0.82	
AHU2a	FLOOR 2	10700.00	5.00	3.00	3.73	2.24	316	228	26	19	93	67	9437	0.88	
AHU2b	FLOOR 2	12500.00	7.50	5.00	5.59	3.73	387	230	32	19	113	67	18875	1.51	
AHU2c	FLOOR 2	12000.00	7.50	5.00	5.59	3.73	369	230	31	19	108	67	9437	0.79	
AHU3a	FLOOR 3	8000.00	5.00	7.50	3.73	5.59	600	360	50	30	176	106	18875	2.36	
AHU3b	FLOOR 3	8000.00	5.00	7.50	3.73	5.59	600	360	50	30	176	106	18875	2.36	
AHU4a	FLOOR 4	8000.00	5.00	7.50	3.73	5.59	600	520	50	43	176	152	18875	2.36	
AHU4b	FLOOR 4	18000.00	5.00	7.50	3.73	5.59	600	520	50	43	176	152	18875	1.05	
AHU5	FLOOR 5	30350.00	22.50	13	15	10	1223	701	102	58	358	205	37749	1.24	
AHU6	FLOOR 6	31860.00	22.50	13	15	10	1223	701	102	58	358	205	37749	1.18	
Name	Location	Capacity CFM	Sup BHP	RETURN FAN BHP	Sup Fan KW	Ret Fan KW	COOLING MBH	HEATING MBH	COOLING Tons	HEATING Tons	COOLING Kwh	HEATING Kwh	Floor Space 37749	**CFM/sqft MAX**	**CFM/sqft MINIMUM**
Amalgam. AHU	N/A	178910.0	107.5	82.0	74.6	61.1	7141.0	4551.0	595.1	379.3	2092.8	1333.8	226494.0	**1.27**	**0.63**

Table 6: Total Air Flow per Unit Area

On the fifth and sixth floor, Air flow per unit area was determined by tabulating the minimum and maximum air flows for each Variable Air Volume box listed in the SHE's mechanical drawings. These values were then input to the calculation shown in Table 6. Hence the average airflow per unit area served was based on the total area served and the estimated total supply air delivered.

VAV UnitNumber	low CFM	high CFM
501	350	700
516	250	500
520	725	1250
502	600	1200
537	285	570
518	420	840
521	725	1250
522	725	1250
503	630	1260
504	550	1100
519	420	840
523	725	1250
535	205	510
531	310	620
505	50	100
506	500	1000
507	400	800
526	260	530
508	500	1000
538	560	1120
524	275	550
527	380	760
528	250	500
529	460	920
530	270	540
532	420	840
536	580	1160
534	420	840
533	200	400
5150	575	1150
5153	225	550
5154	225	550
514	140	280
513	275	550
512	350	700
511	250	500
510	125	250
509	310	620
508	500	1000
SUM	**15420**	**30350**

VAV UnitNumber	low CFM	high CFM
601	650	1305
639	285	570
616	600	1200
617	570	1140
618	425	850
621	675	1350
622	625	1250
615	625	1275
614	460	925
641	320	640
635	400	800
638	225	450
636	100	150
637	125	250
613	235	470
612	350	700
636	100	150
632	310	615
631	300	600
628	260	515
630	390	785
629	100	200
611	650	1305
610	370	740
609	150	300
605	500	1000
643	225	450
607	500	1000
630	390	785
629	100	200
627	480	970
608	325	650
626	260	520
625	235	470
640	240	480
603	650	1300
602	650	1300
619	426	850
623	625	1250
620	425	850
624	625	1250
SUM	**15956**	**31860**

Table 7: Total Airflow on 5th and 6th Floors

HVAC SYSTEM TYPE			NOTES
Cooling Source	Chilled Water Coils		manual
Heating Source	Hot Water Coils		manual
Hot Water Source	Hot Water Loop		manual
System Type	4 Pipe FCU with HW RH		manual
Return Air Path	Ducted		manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Setpoints	75.2	82.4	manual
Heating Setpoints	71.6	64.4	manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Design Temperature	71.6	55.4	manual
Heating Design Temperature	75.2	64.4	manual
Minimum Design Air Flow (cfm/ft2)		0.63	manual
Supply Fans			
Power and Motor Efficiency	55.09 BHP	High Efficiency	auto/auto
Fan Flow	Auto-size		auto
Primary Cooling Equipment			
Chilled Water System			autosized
Chillers			autosized
Open Tower with Heat Exchanger			manual
Primary Heating Equipment			autosized
Boiler			autosized
Domestic Hot Water			autosized

Table 8: Four Pipe Fan Coil Simulation Inputs

To simulate a Fan Coil System, the only choice was to use the four pipe system. eQUEST 3-64 does not allow for the simulation of a two pipe system at this time. The cooling and heating set points, together with the cooling design temperature and heating design temperatures were kept constant to match the conditions in the eQUEST VAV simulation as shown in Table 8. The minimum design air flow was also held constant based on the actual building air flow rate as specified and calculated in Table6. The overall power and motor efficiency of the supply fans was auto-sized by eQUEST. The chilled water system, the chillers and primary heating equipment was also auto-sized. They were set to the same capacity range as in the Variable Air Volume eQUEST simulation. However the heat rejection via the Open Tower was changed manually to match the VAV simulation equipment.

HVAC SYSTEM TYPE			**NOTES**
Cooling Source	DX coils		manual
Heating Source	DX coils (Heat Pump)		manual
Heat Pump Source	Hot Water Loop		manual
System Type	WSHP		manual
Return Air Path	Ducted		manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Setpoints	75.2	82.4	manual
Heating Setpoints	71.6	64.4	manual
	Occupied (F)	**Unoccupied (F)**	
Cooling Design Temperature	71.6	55.4	manual
Heating Design Temperature	75.2	64.4	manual
Minimum Design Air Flow (cfm/ft2)		0.63	manual
Packaged HVAC Equipment			
Cooling Overall size			autosized
Heating Overall size			autosized
Water Source HP Equipment			
Water Source HP Equipment			autosized
Open Tower with Heat Exchanger			manual
Boiler			autosized
Domestic Hot Water			autosized

Table 9: Water Source Heat Pump Simulation Inputs

To simulate the Water Source Heat Pump System, the Direct Expansion cooling and heating sources were selected. The cooling and heating set points, together with the cooling design and heating design temperatures, were kept constant and matched the VAV eQUEST System and the Four Pipe Fan Coil eQUEST System simulations for consistency. Table 9 shows that the minimum design air flow was also held constant based on the actual building rate as specified and calculated in Table 6. The overall size of the packaged HVAC equipment was auto-sized by eQUEST. The chilled water system, the chillers and primary heating equipment were also auto-sized. These were kept at the same capacity range as in the Variable Air Volume eQUEST simulation and Four Pipe Fan Coil eQUEST simulation. As before, the heat rejection via the Open Tower was changed manually to match both the VAV and the FCU simulation input parameters.

12. Results

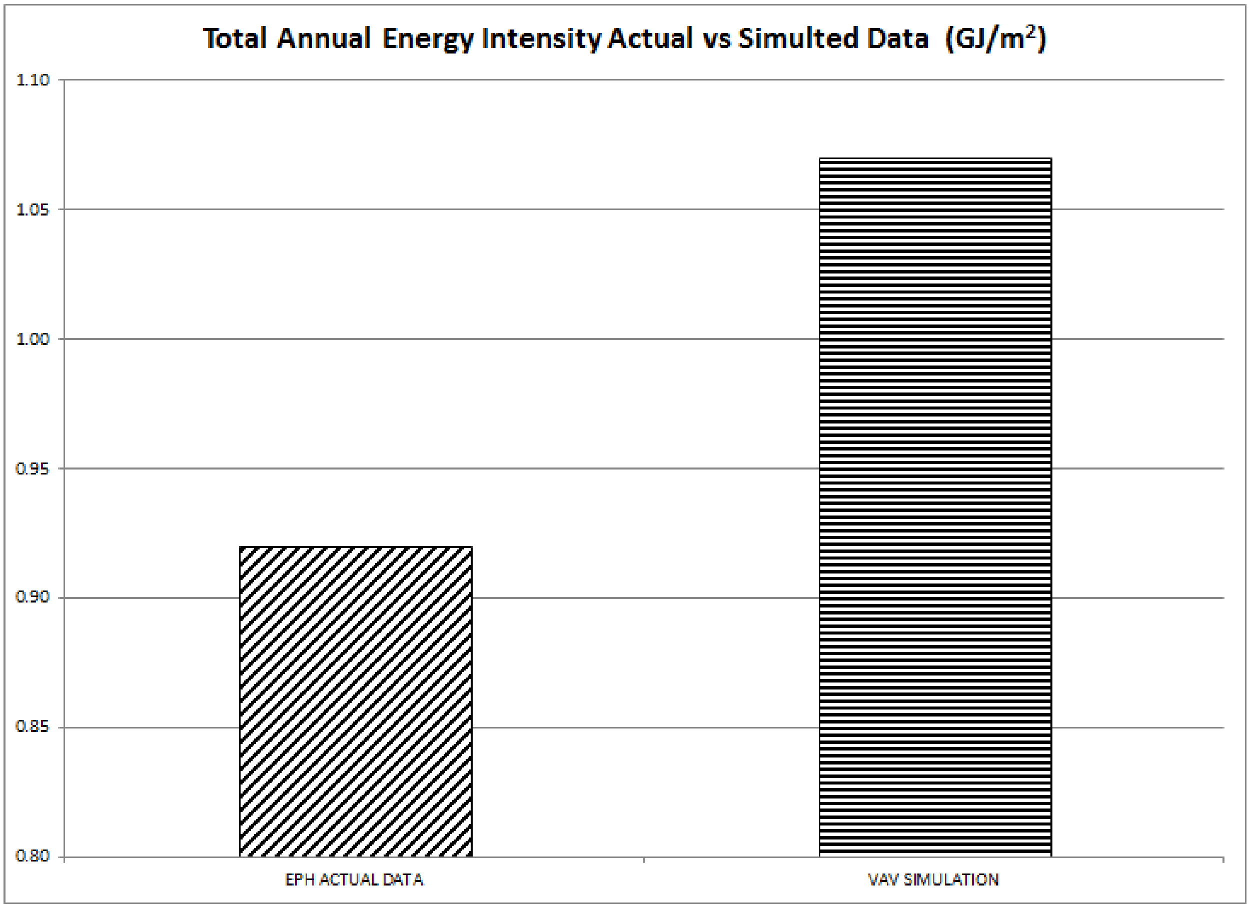

Figure 12: Actual and Simulated Annual Energy Intensity

Actual energy intensity was compared to the simulated energy usage as shown in Figure 12. The actual energy usage was determined to be approximately 15% below the predicted energy usage estimated by the energy model at 0.93 GJ/ m^2 compared to 1.07 GJ/ m^2. There are several reasons why this discrepancy between the energy model and the actual data may exist. First the quantity of energy consumed by EPH/SHE is an averaged value for a steam meter that represents 9.5% of the total steam consumption by building area. The total area served by meter 1 is 223127m^2 of

(Hossain, 2010). EPH only estimated to accounts for 21050 m^2 or 9.5% of that space heating demand. This means that high performance buildings and low performance buildings energy consumption may be masked by other buildings tied to the same meter. Currently there is no other comparable method to track the actual steam consumption of EPH/SHE without the installation of steam mass flow meter at the inlet of the building. Additionally, steam humidification which is present in actual EPH building adds sensible heat to the supply air. As a result there may be some marginal efficiency gained from the steam humidification during the heating season. Furthermore, simplifications were made with the simulated building envelope based on the most prominently used wall and insulation features in the architectural drawings. Infiltration and exfiltration rates where auto-calculated by eQUEST based on the building type and envelope specification input by the user. Lastly, the Variable Air Volume eQUEST energy model is based on a central boiler and chiller plant which is less efficient than a district heating system which is in current use. As discussed above, Ryerson University had decommissioned its' central boiler plant and replaced it with Enwave's steam service. This enabled Ryerson to save up to 25% in steam related energy (Ryerson-University, 2012). Moreover, Ryerson University also uses a recently upgraded central chilling plant located in the undergraduate library that services most of the cooling needs of the campus. This difference may also account for the variation in energy intensity between the actual and simulated EPH/SHE buildings.

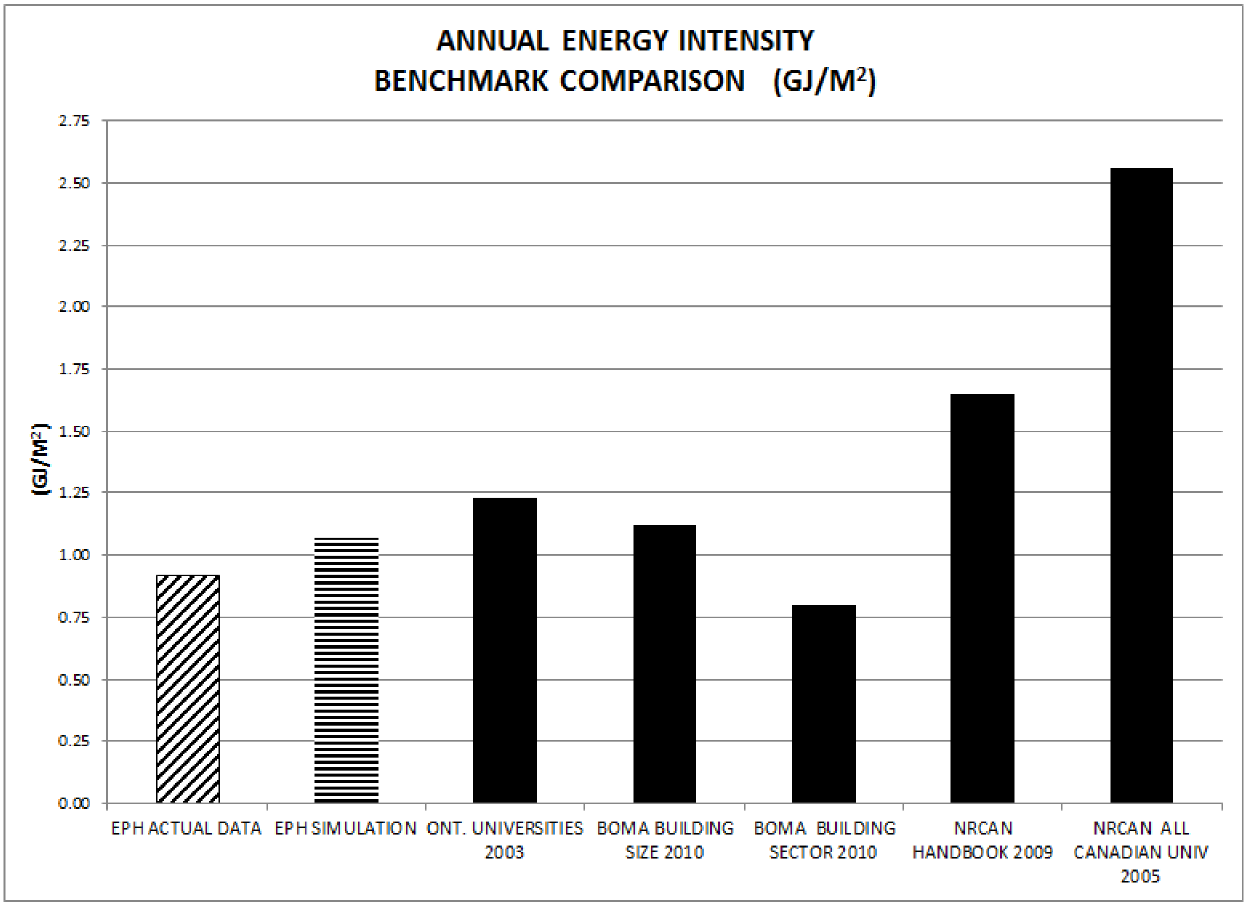

Figure 13: Annual Energy Intensity Benchmark Comparison

It is important to compare the actual total annual energy consumption to other benchmarks. Figure 13 depicts the actual and simulated annual energy intensity in GJ/m^2 of Eric Palin Hall to applicable standards. The first and most important observation is that the actual energy usage of EPH is significantly below the Survey of Ontario Universities 2003 at 1.23 GJ/m^2. , National Resources Canada Handbook 2009 by building sector at 1.65 GJ/m^2 and by National Resources Canada 2005, Survey of all Universities in Canada at 2.65GJ/m^2 (NRCAN, 2007). The large difference between these energy benchmarks can be attributed to the building sample attributed to each benchmark. The data sets represent a broad building spectrum and can make comparisons between the actual energy intensity and the benchmark values tentative. First, the building of the same general type can have tremendous variation in total floor area, massing, and dominant occupant use. Secondly, building location will affect energy consumption due to the differences in climate zone. With the exception of Vancouver, the Greater Toronto Area represents one of the mildest climates in the Canada and Ontario. Building age is also a significant factor in biasing building energy benchmarks use since many of the older schools have been built with brick and block construction. This usually implies that the older buildings would have been constructed with little or no insulation and poor airtightness, all of which would increase the energy intensity as expressed by a benchmark.

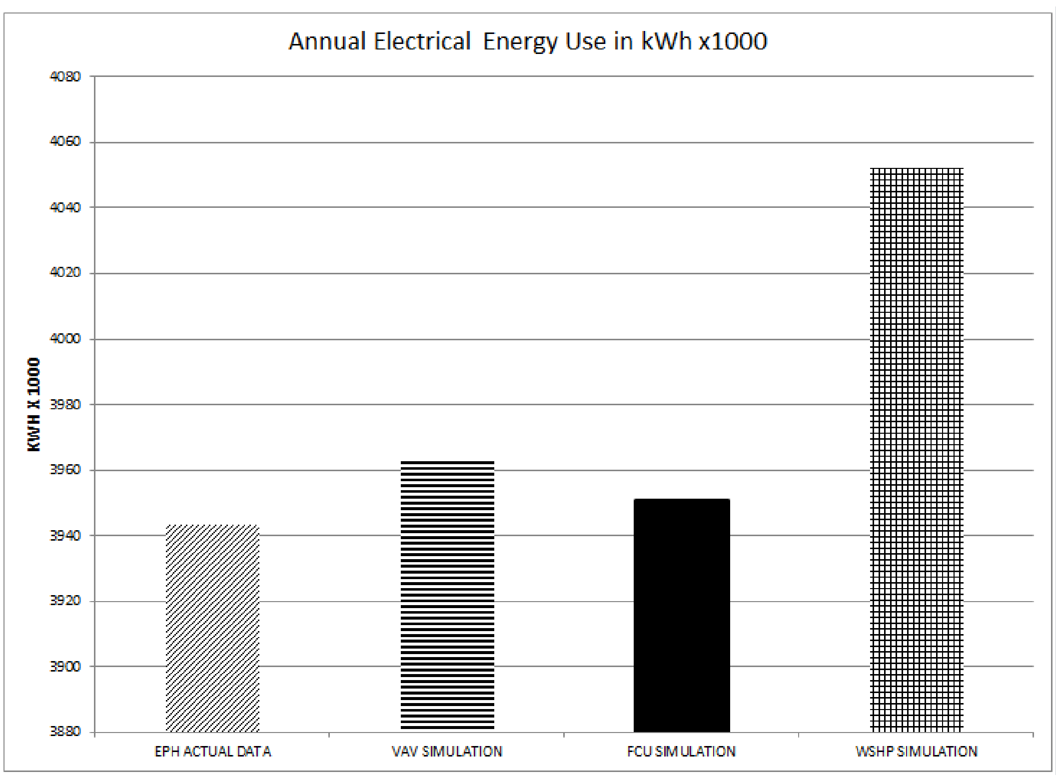

Figure 14: Annual Electrical Usage

Figure 14 shows that the total annual electricity usage between the simulated and actual EPH data is within 0.5% at 3 963 000 kWh to 3 944 000 kWh respectively. Although electricity is metered directly at EPH/SHE, how the electricity is being used has yet to be detailed. As discussed above, the lighting schedule was automatically estimated by eQUEST based on building operation guidelines, input building usage, massing and location. However many of these loading conditions are a result of non-HVAC related equipment and hence were out of the scope of this research.

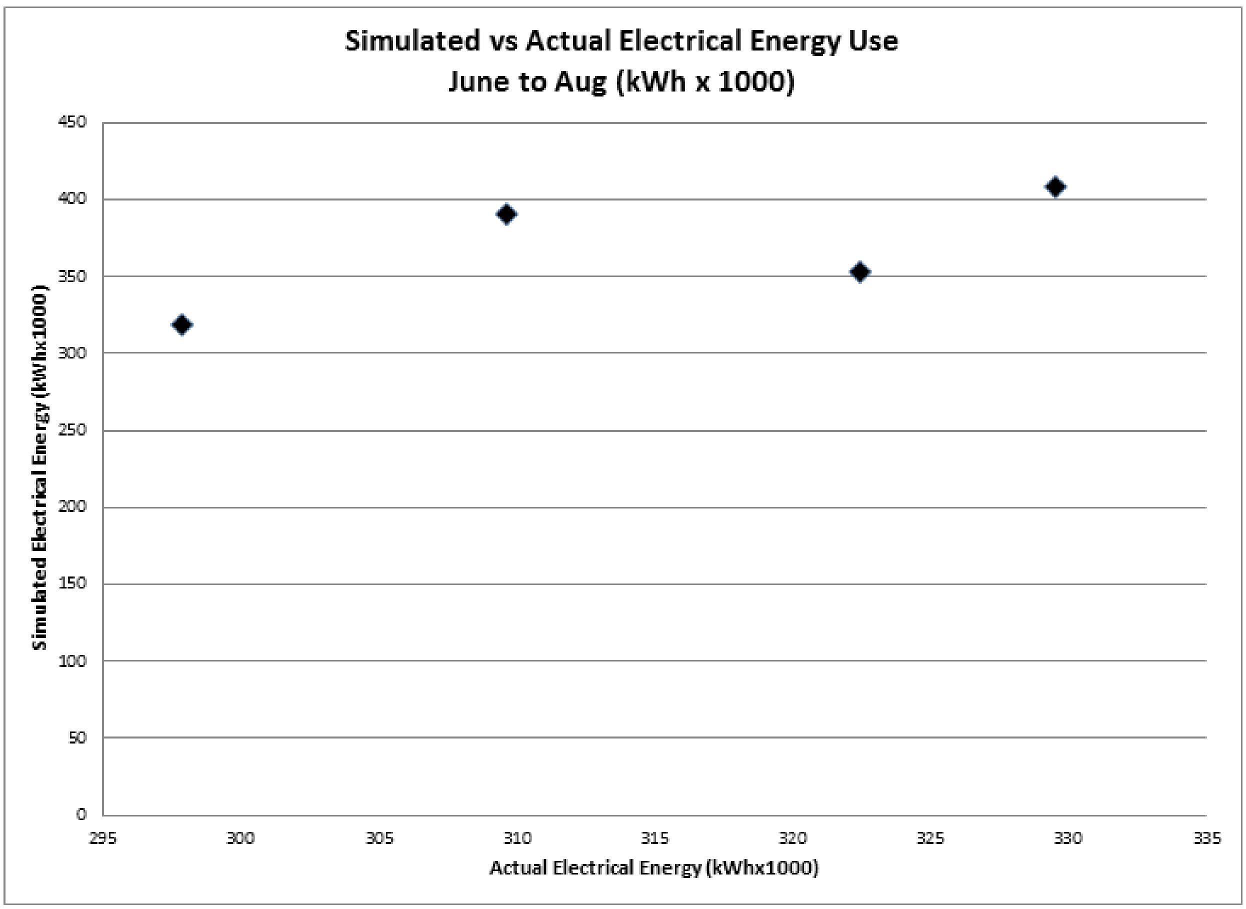

Figure 15: Simulated versus Actual Electrical Energy Use Cooling Season

Actual Electrical energy use was plotted against simulated electrical energy use in Figure 15. This graph shows a slightly positive correlation between actual and simulated electrical data during summer months between June and August.

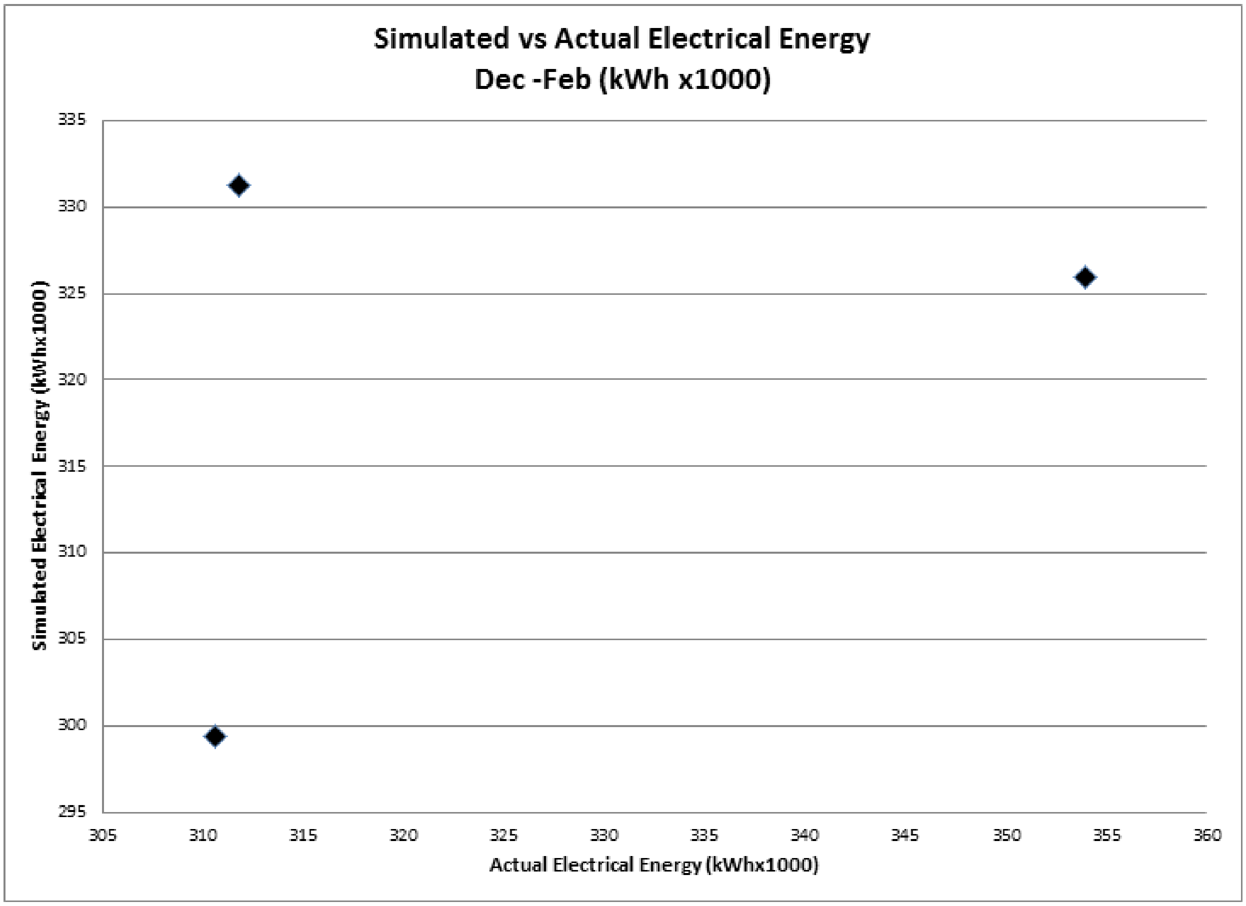

Figure 16: Simulated versus Actual Electrical Energy Use Heating Season

Actual Electrical energy use was plotted against simulated electrical energy use in Figure 16. This graph shows a slightly positive correlation between actual and simulated electrical data during winter months between December and February.

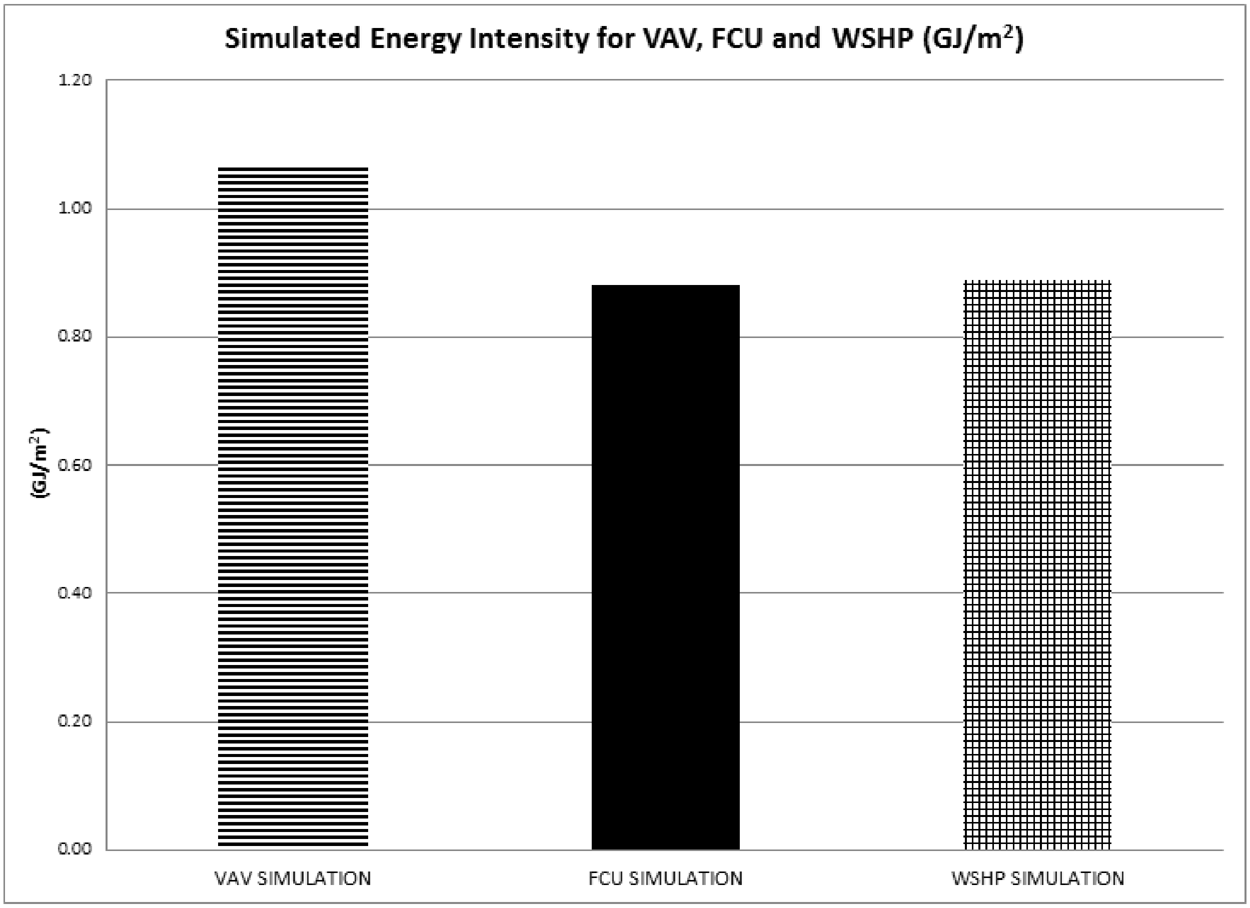

Figure 17: Simulated Intensity for VAV FCU and WSHP

Three simulations with different secondary Heating Ventilation and Air Conditioning systems were simulated with identical building envelopes and internal loading conditions to determine whether a system change could improve the overall energy efficiency of EPH/SHE. Figure17 shows that the simulated annual energy intensity for the Variable Air Volume, Fan Coil Unit and Water Source Heat Pump HVAC systems are 1.07 GJ/m^2, 0.88 GJ/m^2 and 0.89 GJ/m^2 respectively. This results in a net energy efficiency gain of 21% and 20% for the Four Pipe Fan Coil and the Water Source Heat Pump Systems respectively. In order to insure that the comparisons were conservative, the VAV model was given the most efficient configurations for the eQUEST simulation.

This included an economising cycle and the use of Variable Speed Drive VAV boxes rather than single speed settings.

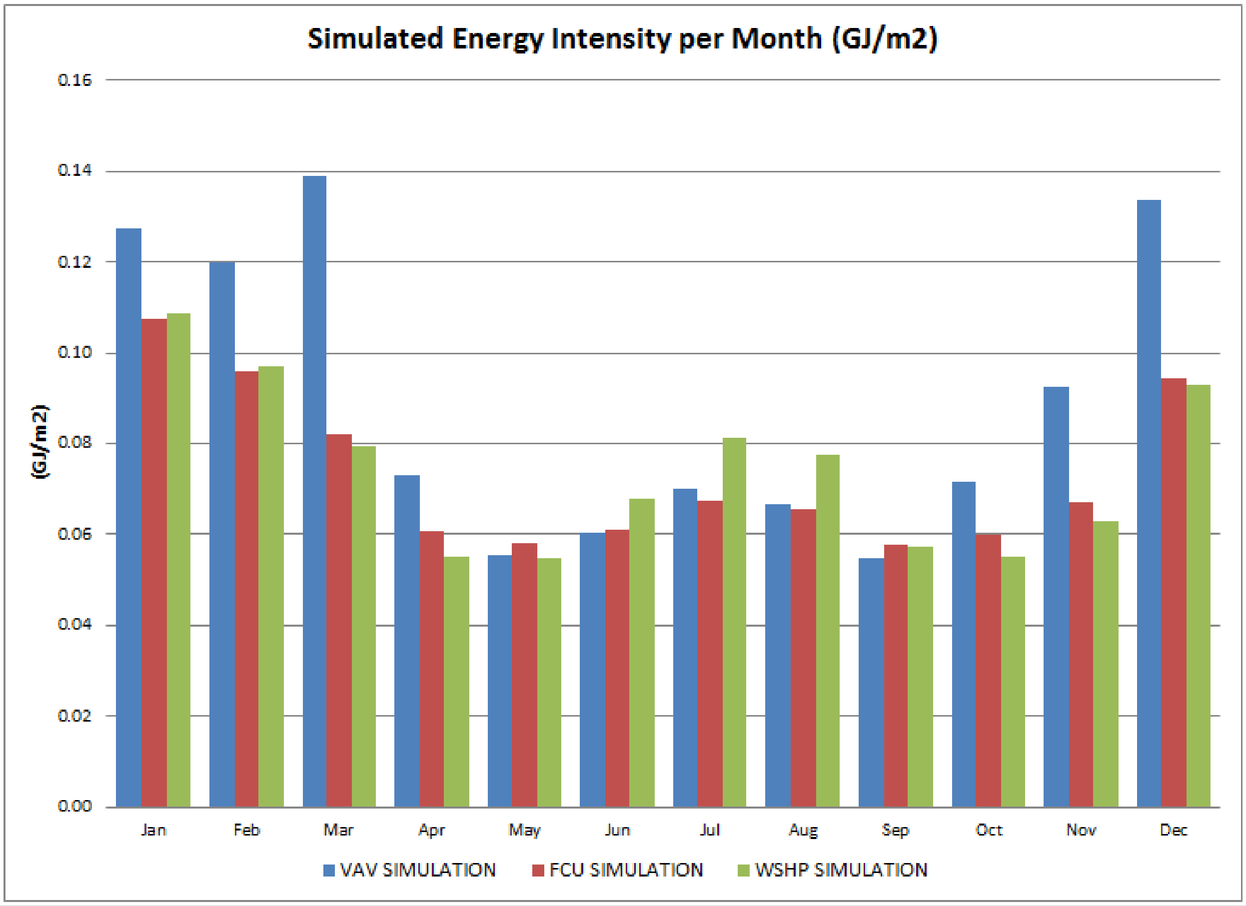

Figure 18: Simulated Monthly Energy Intensity

Since Figure 17 has been visually demonstrated that the VAV configuration is the most energy intense of the three simulated configurations, it can be further shown what conditions cause the extra energy consumption. Simulated monthly energy intensity by system and by month is shown in Figure 18. It is clear that the VAV consumes more energy during the heating and shoulder seasons between the months, October through April. The VAV's highest relative energy consumption occurs during the months of March and December. The VAV system only marginally performs better in the Month of

June and September. The FCU consumes less energy as compared to the WSHP during the hot summer months yet consumes slightly more energy than the WSHP over the transition months.

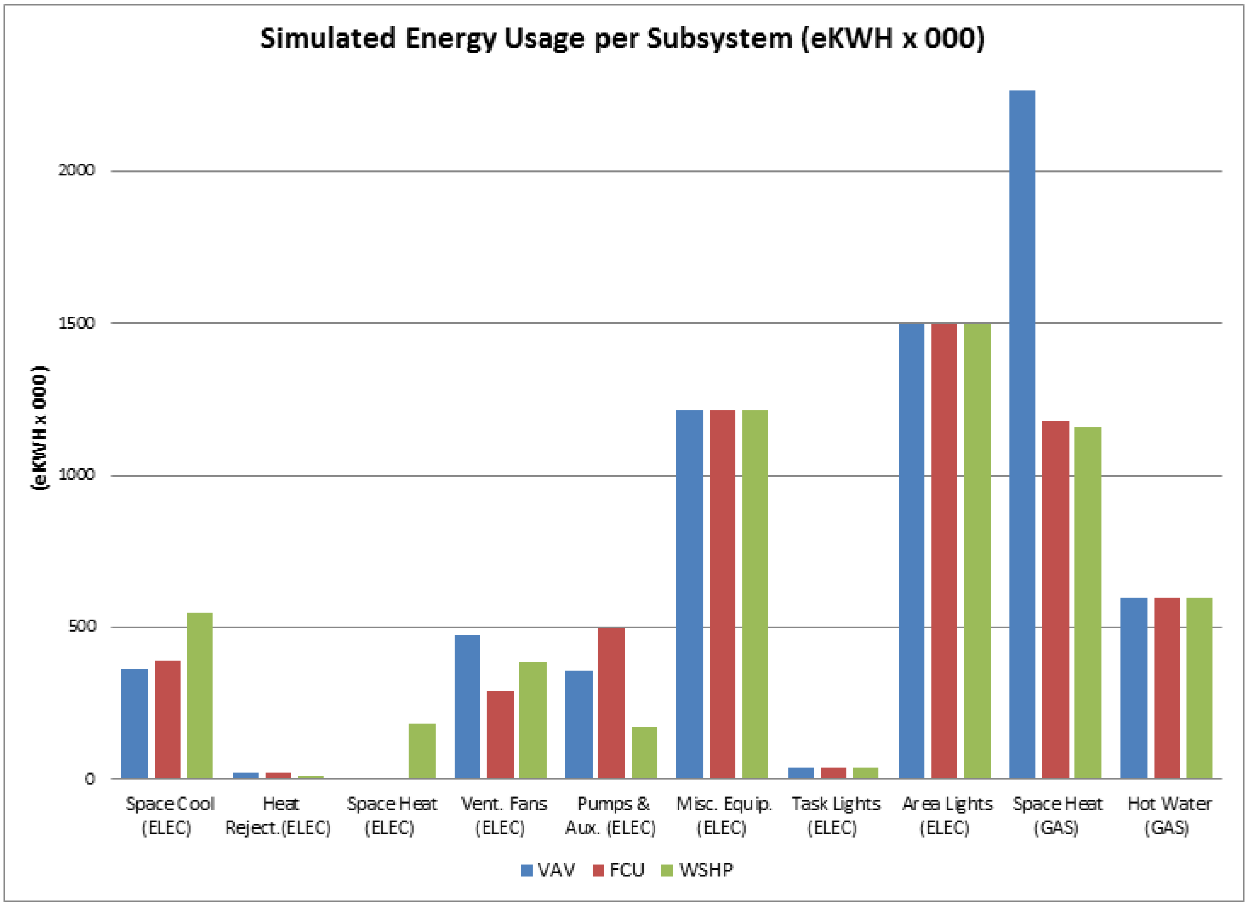

Figure 19: Simulated Energy Usage per Subsystem

The total annual energy consumption is compared in equivalent kWh and is further disaggregated by building subsystem. The additional energy consumption of the simulated VAV systems is clearly shown by the Space Heating column where a comparison of the various simulated systems has shown that the VAV is was nearly twice the amount of energy as compared to the FCU and WSHP systems. The Fan Coil unit uses relatively more pumping energy as a result of its four pipe systems required.

Also in relative term, the WSHP System uses electricity for spacing heating and more electricity for space cooling on account of its' compressors controlling the flow of refrigerant. However, the dominant feature of this graph is the quantity of energy used for space heating.

BASELINE VAV HW REAHEAT

ELECTRICITY KWH X1000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	8	7	9	10	23	61	95	81	36	15	8	9	360
Heat Reject.	0	0	0	0	1	4	7	6	3	1	0	0	23
Space Heat	0	0	0	0	0	0	0	0	0	0	0	0	0
Vent. Fans	55	55	63	26	22	31	39	36	25	25	35	60	472
Pumps & Aux.	29	26	29	28	29	31	34	33	30	29	28	29	355
Misc. Equip.	103	93	103	100	103	100	103	103	100	103	100	103	1214
Task Lights	3	3	3	3	3	3	3	3	3	3	3	3	40
Area Lights	127	115	127	123	127	123	127	127	123	127	123	127	1499
Total	326	299	334	290	309	354	409	391	319	303	297	331	3963

GAS CONSUMPTION BTU X000,000,000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	1.4	1.4	1.6	0.5	0.1	0.0	0.0	0.0	0.0	0.4	0.8	1.5	7.7
Hot Water	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	2.0
Total	1.6	1.6	1.8	0.7	0.2	0.2	0.2	0.2	0.2	0.5	1.0	1.7	9.8

GAS CONSUMPTION KWH X1000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	419	402	478	138	15	0	0	0	0	114	243	451	2265
Hot Water	56	53	59	56	53	47	47	44	41	44	47	53	598
Total	475	454	536	193	67	47	47	44	44	158	290	504	2863

TOTAL CONSUMPTION eKWHX1000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	745	701	812	428	324	354	409	391	319	417	540	783	6228

TOTAL CONSUMPTION GJ

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	2682	2523	2922	1540	1167	1273	1472	1407	1150	1503	1945	2817	22421

ENERGY INTENSITY GJ/M2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	0.13	0.12	0.14	0.07	0.06	0.06	0.07	0.07	0.05	0.07	0.09	0.13	1.07

ELECTRICAL ENERGY INTENSITY GJ/M2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	0.015	0.014	0.016	0.014	0.015	0.017	0.019	0.019	0.015	0.014	0.014	0.016	0.188

ENERGY INTENSITY eKWH/FT2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	3.3	3.1	3.6	1.9	1.4	1.6	1.8	1.7	1.4	1.8	2.4	3.5	27.5

Table 10: VAV Simulation Output and Calculations

A granular look at the simulation output and the calculations of energy intensity are for the Variable Air Volume, Four Pipe Fan Coil, and Water Source Heat Pump systems are detailed in Table 10, Table 11, and Table 12 respectively on both a monthly and annual basis.

FOUR PIPE FAN COIL

ELECTRICITY KWH X1000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	8	8	9	16	33	64	89	79	43	22	10	9	389
Heat Reject.	0	0	0	0	2	4	6	5	3	1	0	0	22
Space Heat	0	0	0	0	0	0	0	0	0	0	0	0	0
Vent. Fans	25	22	25	24	25	24	25	25	24	25	24	25	290
Pumps & Aux.	43	39	43	41	43	41	42	41	41	42	41	43	498
Misc. Equip.	103	93	103	100	103	100	103	103	100	103	100	103	1214
Task Lights	3	3	3	3	3	3	3	3	3	3	3	3	40
Area Lights	127	115	127	123	127	123	127	127	123	127	123	127	1499
Total	310	280	310	307	336	358	395	384	337	324	301	310	3951

GAS CONSUMPTION BTU X000,000,000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	1.1	1.0	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8	4.0
Hot Water	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	2.0
Total	1.3	1.1	0.8	0.3	0.2	0.2	0.2	0.2	0.1	0.2	0.5	1.0	6.1

GAS CONSUMPTION KWH X1000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	319	281	170	47	3	0	0	0	0	26	91	243	1178
Hot Water	56	53	59	56	53	47	47	44	41	44	47	53	598
Total	375	331	229	100	56	47	47	44	41	70	138	296	1773

TOTAL CONSUMPTION eKWHX1000

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
629	561	480	354	339	358	395	384	337	350	392	553	5129

TOTAL CONSUMPTION GJ

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2265	2019	1726	1274	1220	1290	1423	1381	1214	1261	1412	1990	18465

ENERGY INTENSITY GJ/M2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
0.11	0.10	0.08	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.07	0.09	0.88

ELECTRICAL ENERGY INTENSITY GJ/M2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
0.015	0.013	0.015	0.015	0.016	0.017	0.019	0.018	0.016	0.015	0.014	0.015	0.188

ENERGY INTENSITY eKWH/FT2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2.8	2.5	2.1	1.6	1.5	1.6	1.7	1.7	1.5	1.5	1.7	2.4	22.6

Table 11: FCU Simulation Output and Calculations

WATER SOURCE HEAT PUMP													
ELECTRICITY KWH X1000													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	4	33	112	176	156	57	10	0	0	547
Heat Reject.	0	0	0	0	0	2	5	4	1	0	0	0	13
Space Heat	49	43	27	8	1	0	0	0	0	5	15	37	184
Vent. Fans	33	29	33	31	33	31	33	33	31	33	31	33	382
Pumps & Aux	10	9	7	7	17	24	28	27	21	11	6	8	174
Misc. Equip.	103	93	103	100	103	100	103	103	100	103	100	103	1214
Task Lights	3	3	3	3	3	3	3	3	3	3	3	3	40
Area Lights	127	115	127	123	127	123	127	127	123	127	123	127	1499
Total	325	292	300	276	317	396	474	453	336	292	278	312	4052
GAS CONSUMPTION BTU X000,000,000													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	1.1	0.9	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8	3.9
Hot Water	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	2.0
Total	1.3	1.1	0.8	0.4	0.2	0.2	0.2	0.2	0.1	0.3	0.5	1.0	6.0
GAS CONSUMPTION KWH X1000													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	311	275	164	47	3	0	0	0	0	29	91	232	1155
Hot Water	56	53	59	56	53	47	47	44	41	44	47	53	595
Total	366	325	223	103	56	47	47	44	41	73	138	284	1750
TOTAL CONSUMPTION eKWHX1000													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	636	568	464	323	320	396	474	453	336	322	369	543	5207
TOTAL CONSUMPTION GJ													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	2288	2044	1670	1163	1152	1426	1707	1632	1211	1157	1329	1955	18745
ENERGY INTENSITY GJ/M2													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	0.11	0.10	0.08	0.06	0.05	0.07	0.08	0.08	0.06	0.05	0.06	0.09	0.89
ELECTRICAL ENERGY INTENSITY GJ/M2													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	0.015	0.014	0.014	0.013	0.015	0.019	0.023	0.022	0.016	0.014	0.013	0.015	0.19
ENERGY INTENSITY eKWH/FT2													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	2.8	2.5	2.0	1.4	1.4	1.7	2.1	2.0	1.5	1.4	1.6	2.4	23.0

Table 12: WSHP Simulation Output and Calculations

13. Conclusion

An energy model of Eric Palin Hall has been created through the use of architectural, mechanical, and operational information. Based on the information available it was determined energy efficiency improvements would be more accurate based on the replacement of secondary HVAC equipment rather than optimizing the building automations operational set points. EPH/SHE actual energy data was compared to the eQUEST simulation model that attempted to replicate the Variable Air Volume system currently in use. Actual annual energy intensity was found to be 0.93 GJ/m^2 and 1.07 GJ/m^2 for the Actual and Simulated VAV cases respectively. The two additional models where created with differing secondary HVAC equipment: a Fan Coil Unit System and a Water Source Heat Pump system. The primary system including the heating and cooling plants we held constant to the base case. These simulations yielded values of 1.07 $GJ/m^2$2, 0.88 GJ/m^2, and 0.89 GJ/m^2 for the VAV, FCU, and WSHP for the secondary systems respectively. These results suggest that a Water Source Heat Pump could be considered as a the most viable and practical equipment replacement option in EPH/SHE for short and long term energy efficiency.

14. Discussion

Eric Palin Hall is currently using an All Air System to supply comfort to its occupants. All Air System centrally condition their supply air at locations which can be at considerable distances from the targeted terminal spaces to be conditioned. EPH's conditioned air is conveyed through the use of central fans located in the Air Handling Units located on the roof of the building. The remote distance between the AHU and the terminal space to be conditioned can create considerable wasteful energy losses or gains throughout the ductwork distribution system. As a result, a supply volume of air above the minimum ventilation air may be supplied to the space to achieve occupant comfort. In addition when certain climatic conditions arise a supply air quantity may not satisfy occupant ventilation requirements to achieve thermal comfort. In such cases a reheat coil is supplied to the VAV boxes. VAV with reheat is typically discouraged since it can increase a Heating Ventilation and Air Conditioning's system energy consumption significantly due to waste associated with the reheat process. As was shown in the simulation data in Figure 18, VAV systems can be particularly wasteful in transition periods where the climatic conditions are more variable. This additional waste is primarily due to the timing of the switch-over period where either the cooling plant is turned off and the heating plant is turned on or vice versa. However VAV systems can excel in constant and or extreme loading conditions, especially in the cooling season.

Hydronic based systems however are able to deal effectively with transition periods and typically excel at part load conditions. One of the main reasons for these advantages is the of energy delivery medium of such systems. Hydronic systems use the ideal fluid, water, which can deliver, or remove heat from a conditioned space more effectively and more efficiently than Air Systems. Water has approximately 3.5 times the specific heat capacity and nearly 1000 times the density of air. As a result, less heating or cooling of the water is required. Moderate temperature ranges are acceptable in the case of Water Source Heat Pumps and heat transmission losses or gain can be more easily minimized during its’ distribution to terminal units. In addition, the natural advantages of hydronic systems are their ability to achieve occupant comfort by simultaneous heating and cooling without the use addition energy. Many core and perimeter buildings may have cooling loads year round. The WSHP can use this waste heat to balance the perimeter heating needs by transferring energy from the core terminal spaces into the water supply then extract that same energy and supply demand at the perimeter. This energy scavenging process will reduce the need to chill or heat circulating water and that does not require central controlling. The energy scavenging can be modulated by the difference in each terminal space temperature and their respective zone thermostats settings. Furthermore, the integration of heat recovery systems such as enthalpy wheels, and water based economizers with hydronic systems can increase energy efficiency beyond that which was simulated in this study (see Table 1).

FCU and the WSHP eQUEST simulations were virtually identical in terms of potential energy intensity savings (see Figure 17). However, the simulated FCU system was a Four Pipe system rather than a Two Pipe system. EPH/SHE is already configured to a two pipe system, one supply and one return pipe with condensate tubing. Renovation costs could possibly be prohibitive to for a Four Pipe system in this circumstance. If a Two Pipe FCU system was implemented, the expected saving if any, would likely be less than 21% calculated by eQUEST. The loss in efficiency in the Two Pipe system is based on the inability to perform simultaneous heating and cooling. However, Water Source Heat Pump System only require two pipes and condensate return which is already installed to support the current VAV with hot water reheat.

Eric Palin Hall has been undergone two major renovations in the last four decades. It may be worthwhile to consider upgrading the secondary HVAC system to improve whole building energy efficiency. Based on the preliminary findings any future renovation proposal should consider the inclusion of a WSHP as a viable alternative to further reduce Eric Palin Hal energy consumption.

Glossary

AHU: Air Handling Unit

BTU: British Thermal Units

DX: Direct Expansion

EPH: Eric Palin Hall

FCU: Fan Coil Unit

GJ: Giga Joules

HVAC: Heating Ventilation and Air Conditioning

KWH: Kilowatt Hours

MUA: Make Up Air

SHE: Sally Horsfall Eaton

VAV: Variable Air Volume

WSHP: Water Source Heat Pump

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Appendix A: Steam and Electricity Consumption Calculations

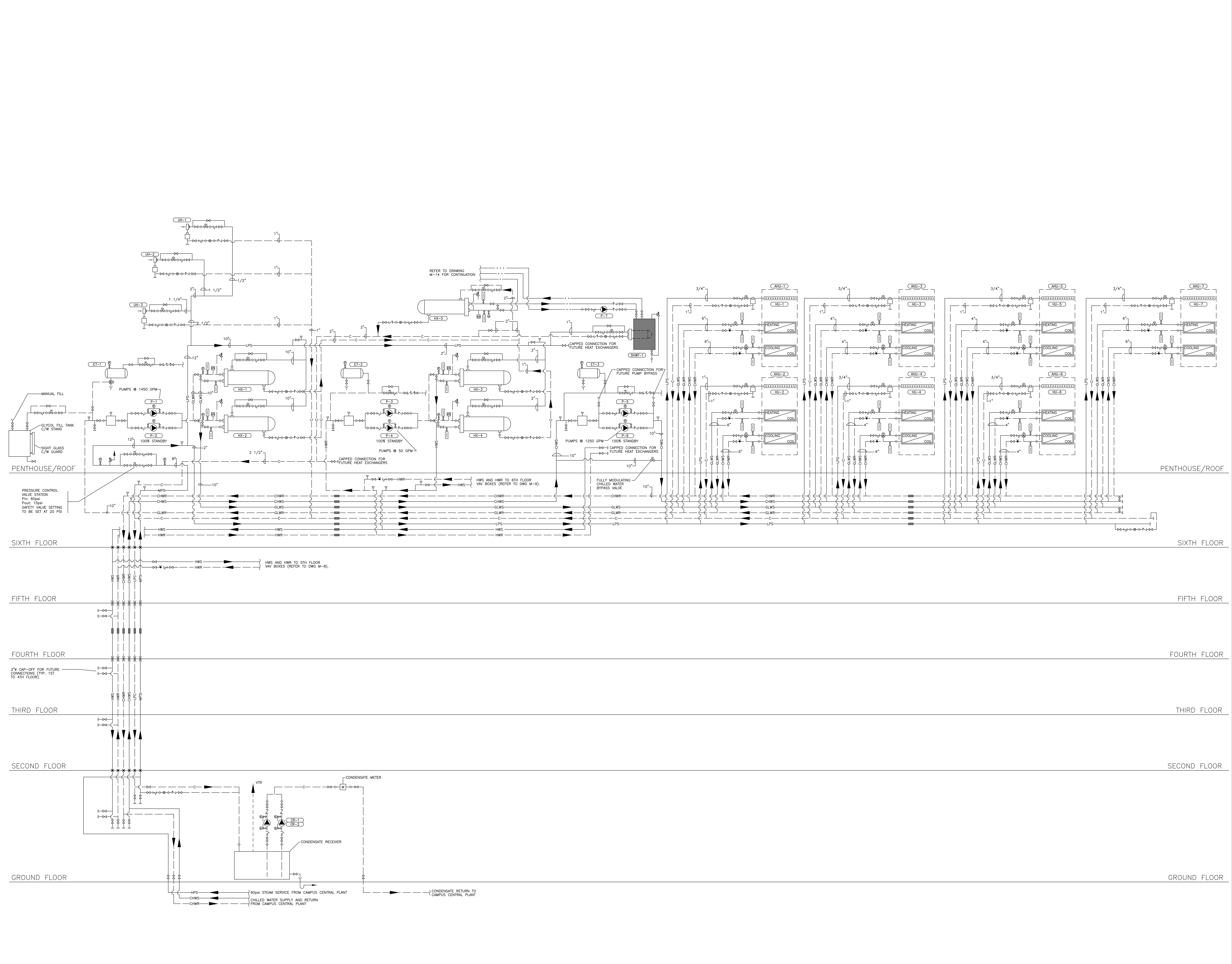
ANNUAL AND MONTHLY ELECTRICITY CONSUMPTION EPH/SHE IN KWH AND ENERGY INTENSITY GJ/M2

Fiscal Year	Total (kwh)	Jan (kwh)	Feb (kwh)	Mar (kwh)	Apr (kwh)	May (kwh)	Jun (kwh)	Jul (kwh)	Aug (kwh)	Sep (kwh)	Oct (kwh)	Nov (kwh)	Dec (kwh)
2010	3,943,569	353,961	310,576	349,726	316,249	362,191	322,446	329,510	309,592	297,820	327,467	352,265	311,766
2009	4,002,950	372,067	344,096	383,887	349,995	319,209	295,397	302,919	305,796	319,923	345,725	343,502	320,434
2008	3,928,861	403,257	343,021	385,581	349,995	289,198	273,710	283,358	276,509	293,439	325,829	338,307	366,658
2007	3,299,371	N/A	295,368	328,519	283,210	317,088	286,514	302,048	284,447	293,332	310,197	304,702	293,947
2006	4,057,548	376,883	355,154	369,834	350,260	343,365	324,324	317,563	295,695	303,012	347,744	337,210	336,505
2005	3,822,132	342,311	335,910	353,253	346,734	302,175	291,105	288,713	274,667	291,430	318,456	346,591	330,787
2004	3,966,272	342,910	312,038	356,031	330,301	335,959	310,592	356,811	338,551	309,187	326,690	324,101	323,100
	Total (GJ/m2)	Jan (GJ/m2)	Feb (GJ/m2)	Mar (GJ/m2)	Apr (GJ/m2)	May (GJ/m2)	Jun (GJ/m2)	Jul (GJ/m2)	Aug (GJ/m2)	Sep (GJ/m2)	Oct (GJ/m2)	Nov (GJ/m2)	Dec (GJ/m2)
2010	0.68	0.06	0.05	0.06	0.05	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.05
2009	0.69	0.06	0.06	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05
2008	0.67	0.07	0.06	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
2007	0.57	N/A	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2006	0.69	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.06
2005	0.65	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06
2004	0.68	0.06	0.05	0.06	0.06	0.06	0.05	0.06	0.06	0.05	0.06	0.06	0.06

STEAM CONSUMPTION CONVERSION FROM ANNUAL AND MONTHLY TO ENERGY INTENSITY (Enthalpy vapourisation 2108 KJ/KG @4bar)

Year	Campus Total (lbs steam)	Jan (lbs steam)	Feb (lbs steam)	Mar (lbs steam)	Apr (lbs steam)	May (lbs steam)	Jun (lbs steam)	Jul (lbs steam)	Aug (lbs steam)	Sep (lbs steam)	Oct (lbs steam)	Nov (lbs steam)	Dec (lbs steam)
2006	97313777	16884195	15851593	9161666	10763171	7651590	2719484	2532838	1554106	2997085	6567065	10503550	10127434
2007	97346985	17619732	16397608	16025397	9538753	3566440	2801018	2411719	2224515	2401000	3786249	4793000	15781554
2008	112996288	19176725	15488841	15349795	10677152	7249496	3026709	2260656	2298366	2138684	6694544	12669623	15965697
2009	108101866	18248192	14584815	11838424	7416941	6212756	3346834	2437583	2171951	2264653	6879012	18248192	14452513
2010	107084701	18689876	16505627	15409202	10835586	4601647	2262190	2039358	2296950	2669532	5690529	10473455	15610749
	Campus Total (kg steam)	Jan (kg steam)	Feb (kg steam)	Mar (kg steam)	Apr (kg steam)	May (kg steam)	Jun (kg steam)	Jul (kg steam)	Aug (kg steam)	Sep (kg steam)	Oct (kg steam)	Nov (kg steam)	Dec (kg steam)
2006	44140839	7658551	7190170	4155667	4882098	3470707	1233539	1148877	704931	1359457	2978774	4764336	4593732
2007	44155902	7992186	7437839	7269006	4326711	1617712	1270522	1093939	1009024	1089077	1717416	2174071	7158401
2008	51254315	8698426	7025628	6962558	4843080	3288320	1372894	1025418	1042523	970092	3036598	5746851	7241927
2009	49034240	8277251	6615569	5369825	3364272	2818062	1518100	1105670	985182	1027231	3120271	8277251	6555557
2010	48572861	8477595	7486835	6989505	4914945	2087274	1026113	925038	1041880	1210881	2581184	4750685	7080925
	EPH Total (KJ)	Jan (KJ)	Feb (KJ)	Mar (KJ)	Apr (KJ)	May (KJ)	Jun (KJ)	Jul (KJ)	Aug (KJ)	Sep (KJ)	Oct (KJ)	Nov (KJ)	Dec (KJ)
2006	8746595577	1517557224	1424746603	823453675	967397493	687727528	244428153	227652346	139683579	269379025	590250049	944062668	910257233
2007	8749580323	1583667541	1473822618	1440368166	857346384	320552848	251756456	216766129	199940169	215802702	340309356	430796480	1418451474
2008	10156145032	1723610605	1392142329	1379644827	959666075	651587181	272041641	203188535	206577923	192225650	601707906	1138750051	1435002310
2009	9716232708	1640153741	1310888163	1064041600	666637195	558404635	300814585	219090794	195215699	203547787	618287952	1640153741	1298996814
2010	9624809569	1679852450	1483531403	1384984349	973906178	413597607	203326411	183298195	206450652	239938450	511466694	941357719	1403099462
	EPH Total (GJ/m2)	Jan (GJ/m2)	Feb (GJ/m2)	Mar (GJ/m2)	Apr (GJ/m2)	May (GJ/m2)	Jun (GJ/m2)	Jul (GJ/m2)	Aug (GJ/m2)	Sep (GJ/m2)	Oct (GJ/m2)	Nov (GJ/m2)	Dec (GJ/m2)
2006	0.42	0.07	0.07	0.04	0.05	0.03	0.01	0.01	0.01	0.01	0.03	0.04	0.04
2007	0.42	0.08	0.07	0.07	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.07
2008	0.48	0.08	0.07	0.07	0.05	0.03	0.01	0.01	0.01	0.01	0.03	0.05	0.07
2009	0.46	0.08	0.06	0.05	0.03	0.03	0.01	0.01	0.01	0.01	0.03	0.08	0.06
2010	0.46	0.08	0.07	0.07	0.05	0.02	0.01	0.01	0.01	0.01	0.02	0.04	0.07

Appendix B: EPH/SHE CAD Drawings



NOTES
1. The Contractor shall check all dim- discrepancies to the Architect before proceeding.
2. ...r any other purpose than that for which it was issued.
3. Written dimensions shall govern where they differ from scaled measurements. The Architect accepts no responsibility for measurements scaled from the drawings.

No.	Description	Date
23	AS BUILTS	AUG. 23, 2002
22	ISSUED W/ SI M-16	OCT 23, 2001
21	ISSUED W/ SI M-14	OCT 23, 2001
20	ISSUED W/ SI M-13	OCT 11, 2001
19	ISSUED W/ CCN M-6	OCT 2, 2001
18	ISSUED W/ CCN M-5	SEPT 26, 2001
17	ISSUED W/ CCN M-3	AUG 27, 2001
16	ISSUED W/ SI M-9R1	AUG 25, 2001
15	ISSUED W/ SI M-9	AUG 17, 2001
14	ISSUED W/ SI M-8	AUG 14, 2001
13	ISSUED W/ CCN M-2	AUG 14, 2001
12	ISSUED W/ SI M-7	AUG 9, 2001
11	ISSUED W/ SI M-4 & SI M-5	JULY 13, 2001
10	ISSUED W/ SI M-3	JULY 12, 2001
9	ISSUED W/ SI M-2	JULY 9, 2001
8	ISSUED W/ SI M-1	JULY 6, 2001
7	ISSUED W/ CCN M-1	JULY 3, 2001
6	ISSUED FOR CONSTRUCTION	JUN. 20, 2001
4	ISSUED FOR TENDER	MAY 09, 2001
3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

CONSTRUCTION NORTH

Ontario SuperBuild

Project Manager

Cansult Hanscomb Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

NOVEL MECHANICAL INC.
CONTRACTORS/ENGINEERS

131 Whitmore Road, Unit #2
Woodbridge, Ontario
L4L 6E2
Tel. (905) 850-2047
Fax (905) 850-6148

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

HEATING AND COOLING PIPING SCHEMATIC

Graphic Scale		Sheet no.
Printed AUG. 23, 2002	Scale N.T.S.	M-13
Date AUG. 23, 2002	Job No. 200004	

P in C	PM	JC	Des	Dr
–	–		–	–

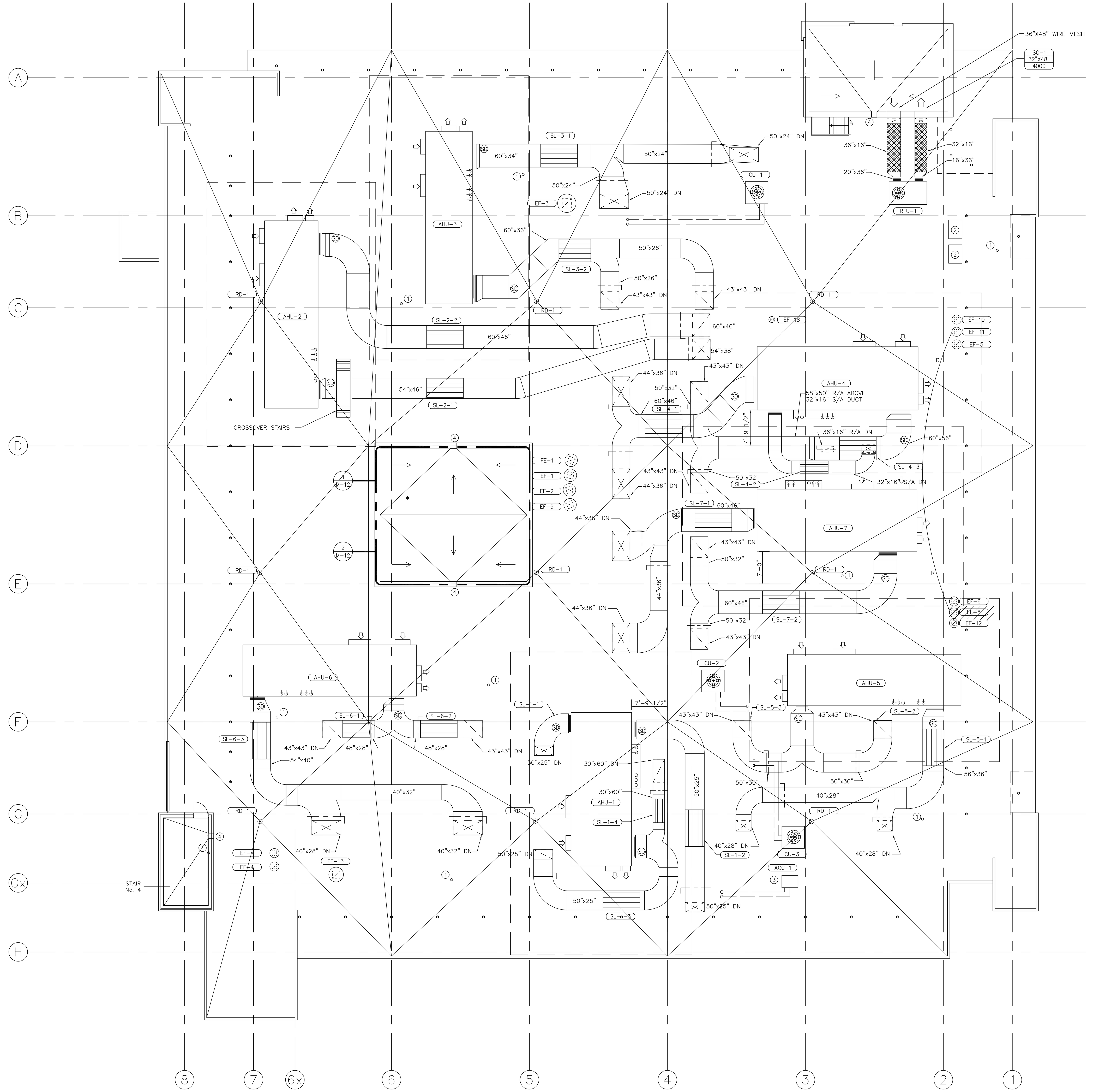
A0 841x1189

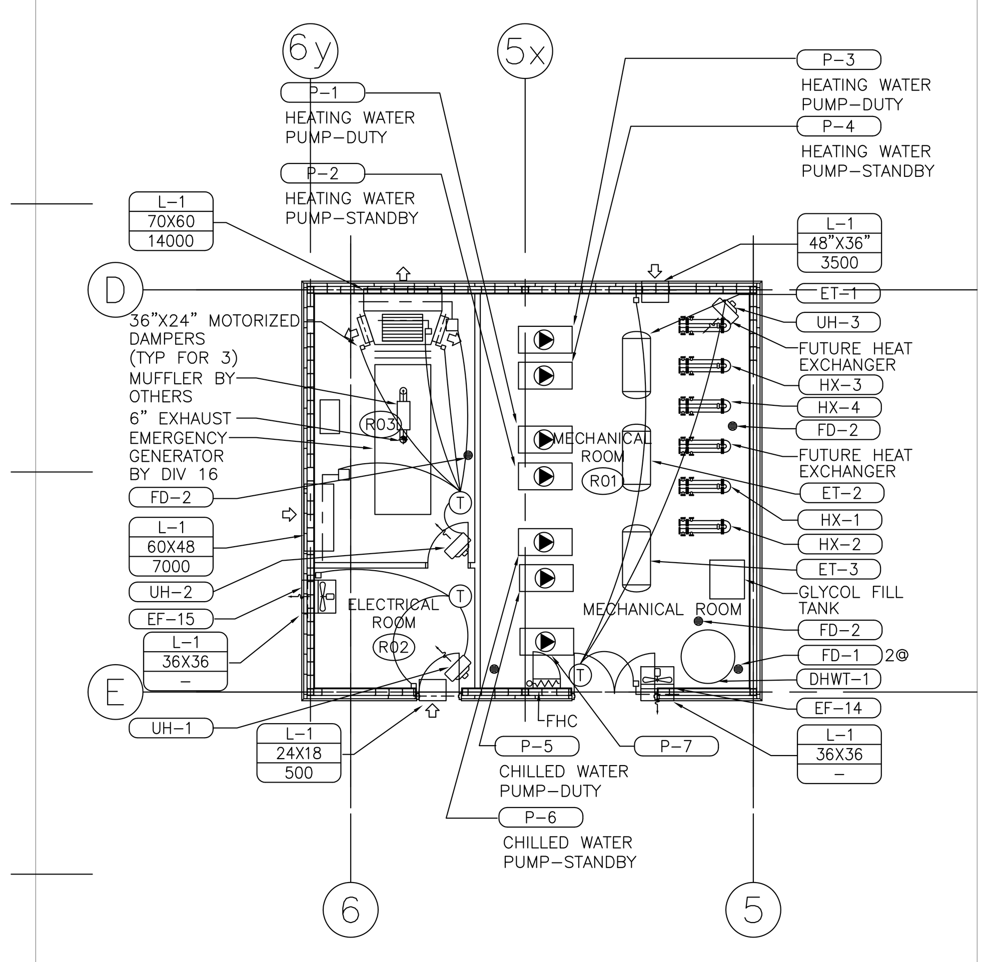
KEYNOTES

1. 3"ø SANITARY VENTS
2. EXISTING CONDENDING UNITS.
3. AIR COOLED CONDENSING UNIT (SERVING FCU IN ROOM 431) REFRIGERANT LINES DOWN TO TO FCU.
4. ROOF SCUPPER
5. 3/4"ø MAKE UP WATER TO HEAT EXCHANGERS.

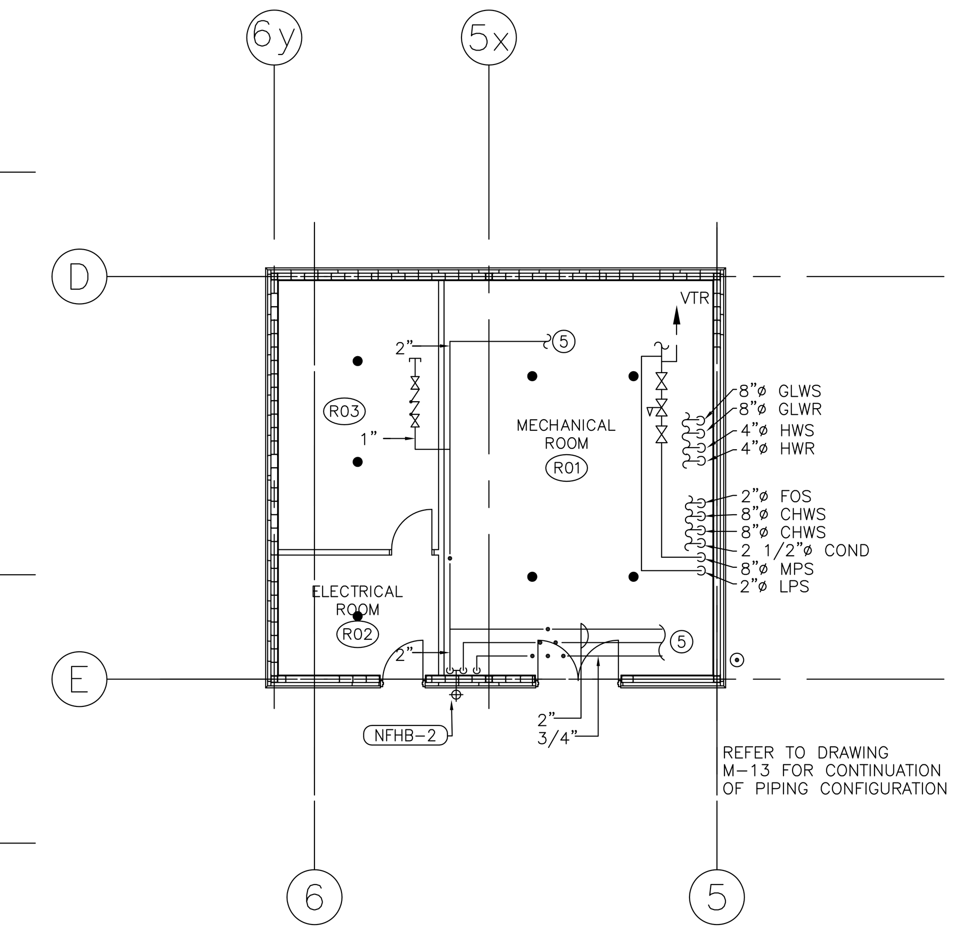
GENERAL NOTES

1. NEW ROOF DRAINS SHALL BE 3"ø, 1 WEIR CONTROL FLOW ROOF DRAINS. 30GPM EA.
2. EXHAUST FANS EF 1–6, EF 8–14, AND KEF–1 ARE NEW EXHAUST FANS SERVING EXISTING EXHAUST SYSTEMS.
3. GENERAL CONTRACTOR TO PROVIDE 4" CONCRETE PAD UNDER ALL ROOFTOP UNITS
4. BOTTOM OF ALL LOUVRES IN EXTERIOR WALLS TO BE AT LEAST 18" ABOVE ROOF.
5. REFER TO "DUCT PENETRATION THRU ROOF DETAIL" ON DWG M–9 FOR ALL CONNECTIONS TO EXISTING RISERS

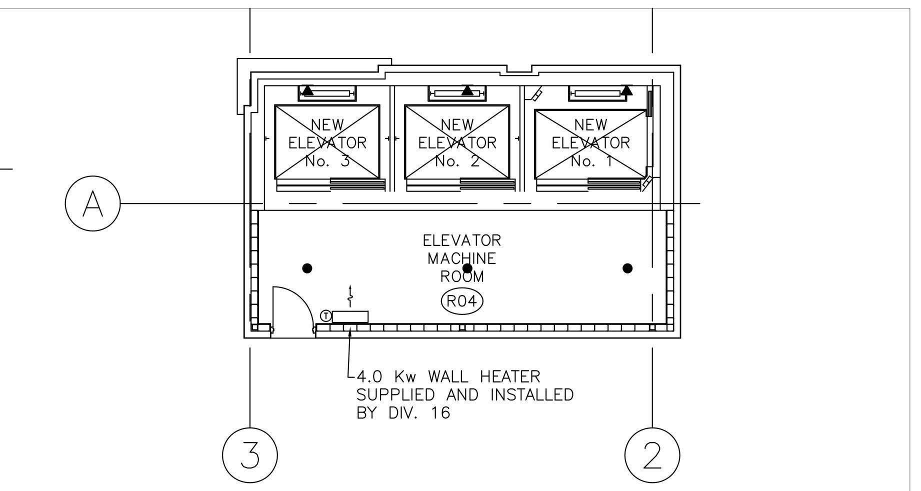




1 / M-12 PARTIAL PLAN – PENTHOUSE EQUIPMENT
AS NOTED



2 / M-12 PARTIAL PLAN – PENTHOUSE PIPING & SPRINKLER LAYOUT
AS NOTED



3 / M-12 PARTIAL PLAN – PENTHOUSE ELEVATOR ROOM SPRINKLER LAYOUT
AS NOTED

NOTES
1. The Contractor shall check all dimensions of the work and shall report discrepancies to the Architect before proceeding.
2. All drawings and specifications are the property of Rounthwaite, Dick and Hadley Architects, who reserve their architect's copyright with respect to this document. It shall not be duplicated, used or circulated for any other purpose than that for which it was issued.
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7	ISSUED W/ CCN M–1	JULY 3, 2001
6	ISSUED FOR CONSTRUCTION	JUN. 20, 2001
4	ISSUED FOR TENDER	MAY 09, 2001
3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

CONSTRUCTION NORTH

Ontario SuperBuild

Project Manager
Cansult Hanscomb Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204–1399 FAX 416 204–1321
E–MAIL: rdharch@idirect.com

Associate Architect
Lett/Smith Architects
385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743–3311 | FAX 705 743–0056

NOVEL MECHANICAL INC.
CONTRACTORS/ENGINEERS

RYERSON UNIVERSITY AND GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

MECHANICAL ROOF PLAN

Graphic Scale		Sheet no.
Printed AUG. 23, 2002	Scale 1/8" = 1'–0"	M-12
Date AUG. 23, 2002	Job No. 200004	

P in C	PM	JC	Des	Dr
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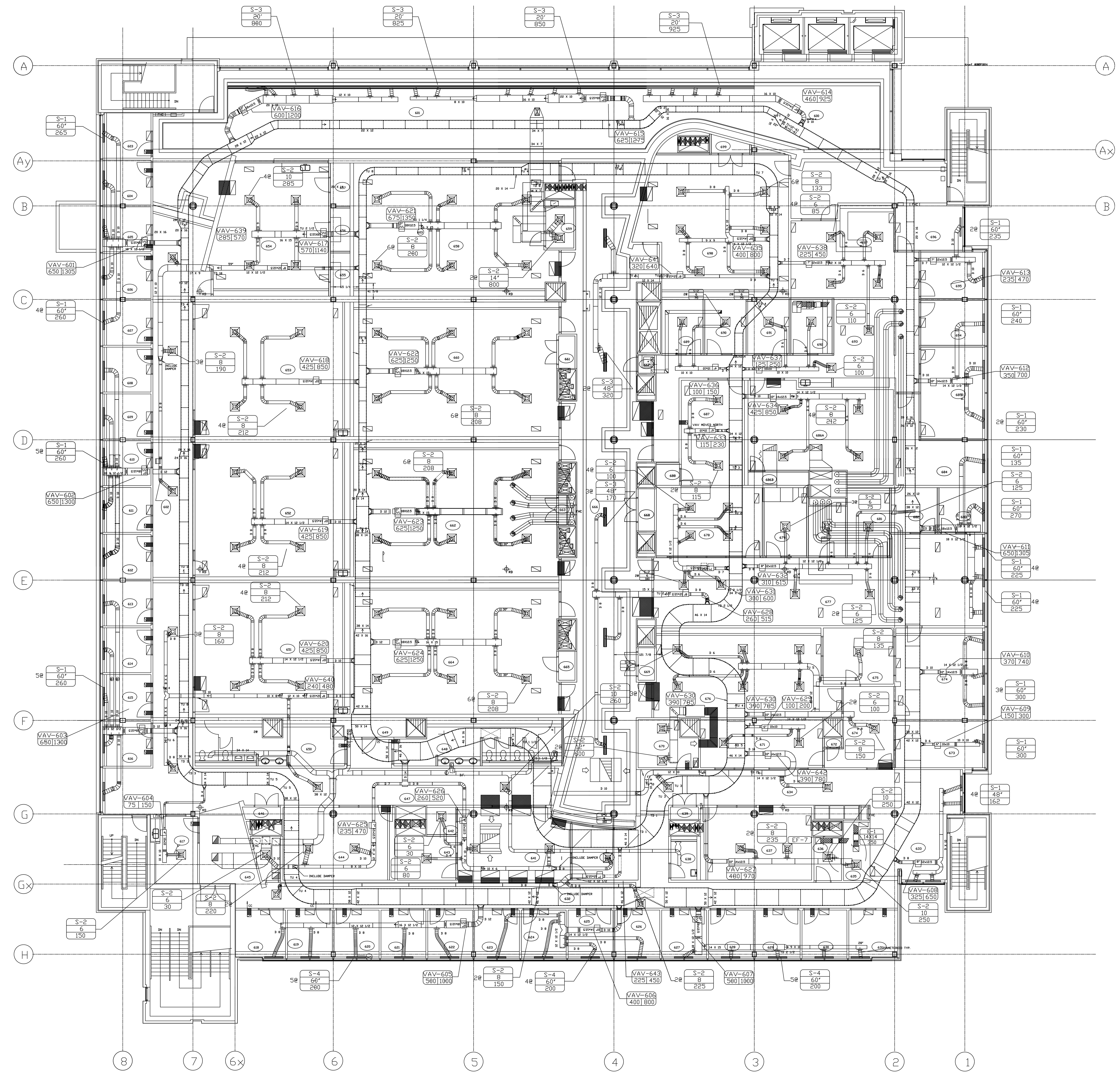


Leslie Danhart

AS BUILT

NO.	DESCRIPTION	DATE
2.	AS BUILT	07-02
1.	ISSUED FOR SITE	03-02
	REVISION	

LESLIE DANHART INC.
35 PULLMAN CRT.
SCARBOROUGH, ONT. M1X 1E4
TEL. 291-8200 FAX 291-2282

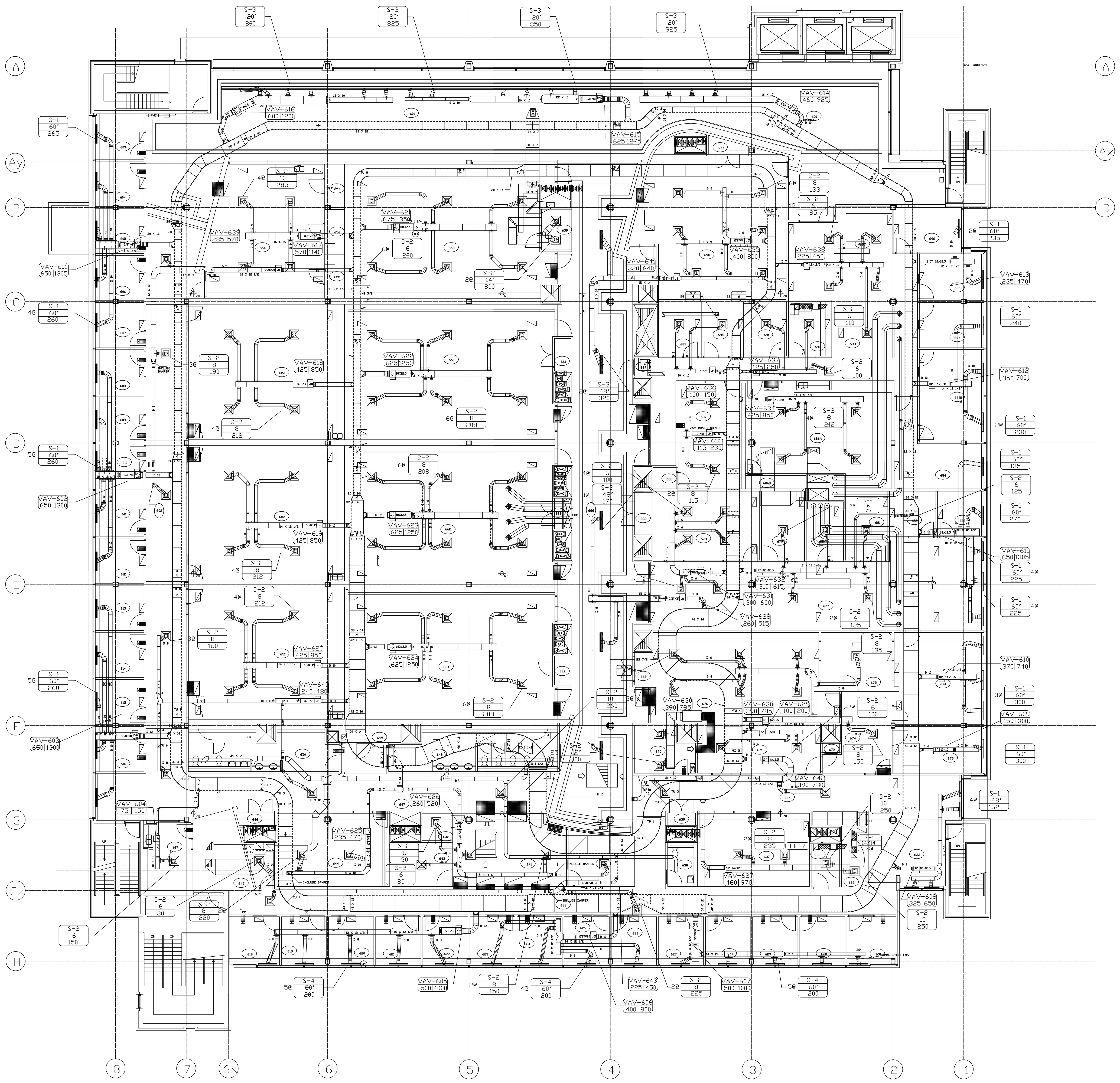
PROJECT:

RYERSON ERIC PALIN HALL

DATE: 11-05-01
SCALE: 1/8" = 1'-0"
DRAWN: MSB
CHECKED BY:

DESCRIPTION: HVAC PLAN
6TH FLOOR

DWG. NO. LDI-4900-M9
REV. NO. 2.



Leslie Danhart

AS BUILT

NO.	DESCRIPTION	DATE
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REVISION

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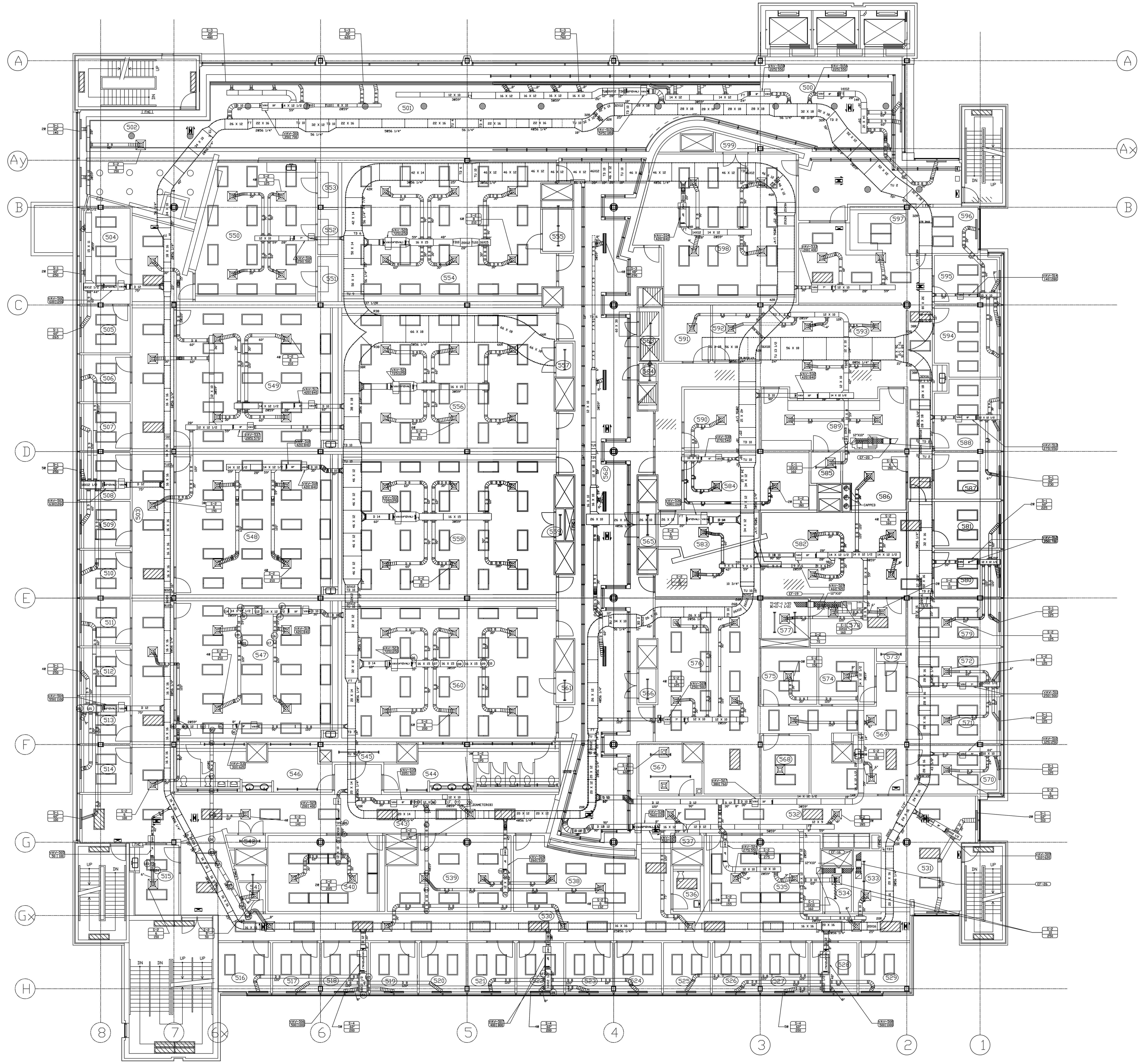
PROJECT:

RYERSON ERIC PALIN HALL

DATE: 11-05-01	DESCRIPTION: HVAC PLAN
SCALE: 1/8" = 1'-0"	
DRAWN: MSB	6TH FLOOR
CHECKED BY:	
DWG. NO. LDI-4900-M9	REV. NO. 2



Leslie Danhart

NO.	DESCRIPTION	DATE
2	AS-BUILT	JULY 24/02
1	ISSUED FOR SITE	ARPIL 15/02
	REVISION	

LESLIE DANHART INC.
35 PULLMAN CRT.
SCARBOROUGH, ONT. M1X 1E4
TEL. 291-8200 FAX 291-2282

PROJECT:

RYERSON
ERIC PALIN HALL

DATE: 08/27/01

SCALE: 1/4" = 1'-0"

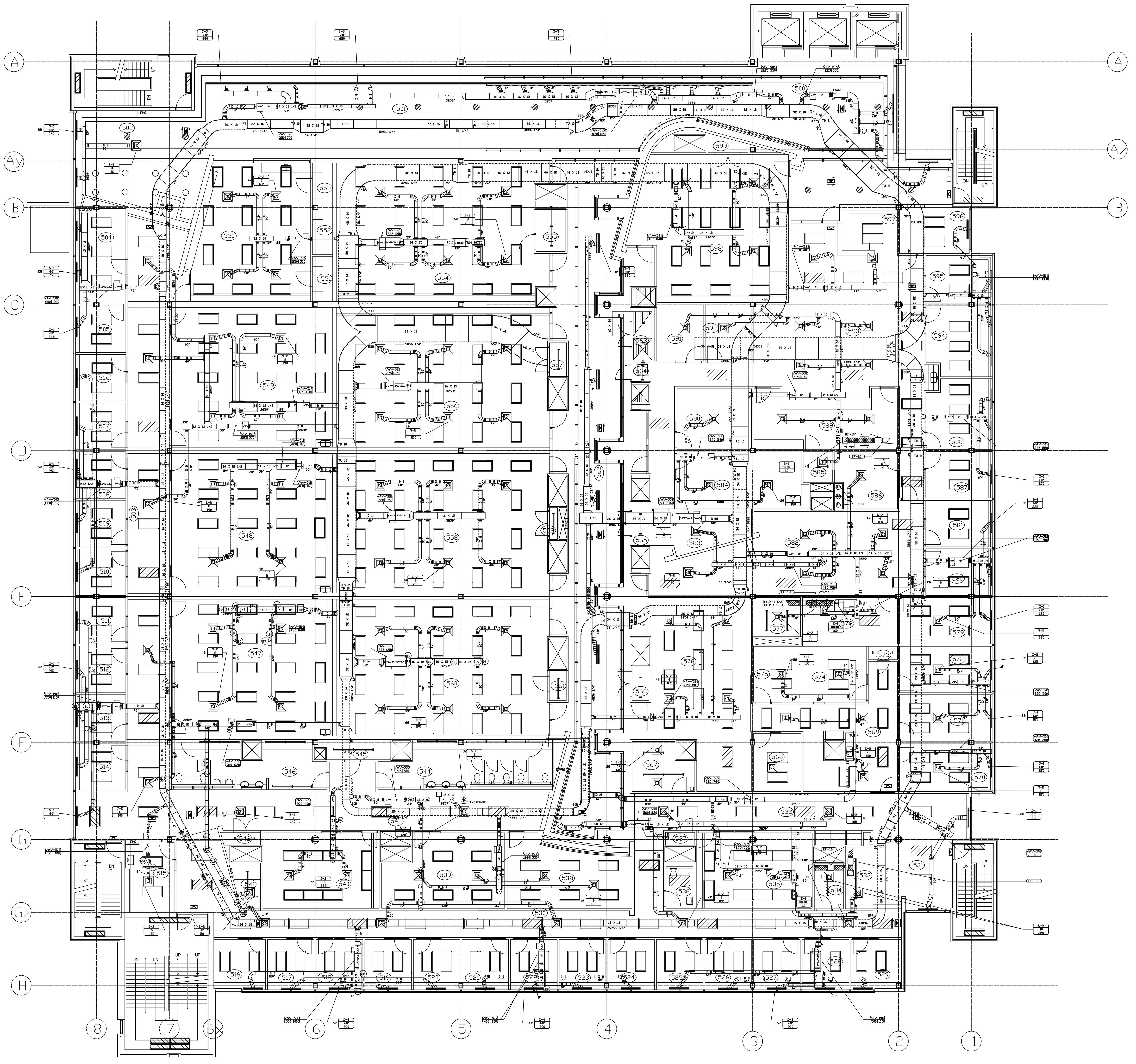
DRAWN: P.L.

CHECKED BY:

DESCRIPTION: 5TH FLOOR HVAC

DWG. NO. LDI-4900-M8

REV. NO. 2



Leslie Danhart

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	REVISION	

LESLIE DANHART INC.
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SCARBOROUGH, ONT. M1X 1E4
TEL. 291-8200 FAX 291-2282

PROJECT:

RYERSON
ERIC PALIN HALL

DATE: 08/27/01	DESCRIPTION: 5TH FLOOR HVAC
SCALE: 1/4" = 1'-0"	
DRAWN: P.L.	
CHECKED BY:	
DWG. NO. LDI-4900-M8	REV. NO. 2

SYMBOL SCHEDULE

SYMBOL	DESCRIPTION
	CHECK VALVE
	PRESSURE REDUCING VALVE
	MOTORIZED CONTROL VALVE
	MOTORIZED THREE-WAY CONTROL VALVE
	GATE VALVE
	GLOBE VALVE
	BUTTERFLY VALVE
	RELIEF VALVE
	DOMESTIC COLD WATER
	DOMESTIC HOT WATER
	DOMESTIC HOT RECIRCULATING WATER
	SANITARY VENT
	SANITARY ABOVE GRADE
	SANITARY BELOW GRADE
CO	CLEANOUT
CO	CLEANOUT UP TO FINISHED FLOOR/GRADE
	STORM SEWER ABOVE GRADE
	STORM SEWER BELOW GRADE
	DIRECTION OF FLOW
	GRADE DOWN
G	NATURAL GAS, LOW PRESSURE
G	NATURAL GAS, HIGH PRESSURE
HWS	HEATING WATER SUPPLY
HWR	HEATING WATER RETURN
C	CONDENSATE DRAIN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
GLWS	GLYCOL WATER SUPPLY
GLWR	GLYCOL WATER RETURN
R	REFRIGERANT
LPS	LOW PRESSURE STEAM
MPS	MEDIUM PRESSURE STEAM
FOS	FUEL OIL SUPPLY
F	FIRE STANDPIPE LINE
SP	SPRINKLER LINE
	STRAINER
	BALANCING VALVE
	PIPE GUIDE
	PIPE ANCHOR
	UNION
	EXPANSION JOINT
	PRESSURE GAUGE
	THERMOMETER
	AIR CHAMBER AND VENT
	PIPE VIBRATION ABSORBER
X	DRAIN TILE
	SUPPLY OR OUTSIDE AIR DUCT UP
	RETURN OR EXHAUST AIR DUCT UP
	RETURN OR EXHAUST AIR DUCT DOWN
	SUPPLY OR OUTSIDE AIR DUCT DOWN
	TURNING VANES
	FLEXIBLE DUCT CONNECTION
	ACOUSTICALLY INSULATED DUCT
	BALANCING DAMPER
	FIRE DAMPER
	OPEN WASTE
	FIRE DEPARTMENT SIAMESE CONNECTION
	PIPE ELBOW DOWN
	PIPE ELBOW UP
	HOSE BIBB
RWL	RAIN WATER LEADER
MH	MANHOLE
CB	CATCH BASIN
	DIFFUSER TYPE GRILLE OR NECK SIZE – INCHES CAPACITY – CFM
	EQUIPMENT LABEL/PLUMBING FIXTURE LABEL
	SMOKE DETECTOR
	TEMPERATURE SENSOR
	CARBON DIOXIDE SENSOR
	ROOF DRAIN
	FLOOR DRAIN
D/G	DOOR GRILLE
S/A	SUPPLY AIR
R/A	RETURN AIR
E/A	EXHAUST AIR
O/A	OUTSIDE AIR
CTE	CONNECT TO EXISTING
VTR	VENT THROUGH ROOF
SCS	SPRINKLER CONTROL STATION
	FIRE EXTINGUISHER C/W WALL MOUNTING BRACKET
FE	FIRE EXTINGUISHER C/W CABINET
	FIRE HOSE CABINET
	SIDEWALL SPRINKLER HEAD
	PENDANT SPRINKLER HEAD
	UPRIGHT SPRINKLER HEAD
	EXISTING EQUIPMENT/MATERIAL

SANITARY LOAD

EXISTING	266
NEW	129
TOTAL FIXTURE UNITS	395

STORM LOAD BASED ON STORM WATER MANAGEMENT DESIGN.

DESCRIPTION	FLOW RATE, USGPM
BUILDING ROOF	180
OVERLAND / WEEPERS	20
TOTAL SITE	200

NATURAL GAS

ITEM	DESCRIPTION	LOAD (CFH)
1	EXISTING ROOFTOP UNITS	3325
2	EXISTING DHWT (4th FLOOR)	120
3	EXISTING STEAM BOILER (4th FLOOR)	1950
4	EXISTING EMERGENCY GENERATOR (2nd FLR)	200
5	MISCELLANEOUS	900
TOTAL		6500

NOTE: EXISTING GAS LOADS ARE ESTIMATES ONLY.
ALL EXISTING GAS FIRED EQUIPMENT NOTED ABOVE SHALL BE REMOVED.

WATER SERVICE

ITEM	DESCRIPTION	USGPM
1	EXISTING BUILDING (602 Fixture Units)	144
2	INSIDE/OUTSIDE HOSE ALLOWANCE	100
3	DOMESTIC WATER (288 Fixture units Total)	83
4	FIRE PROTECTION (0.1 USGPM per 1500SF)	150
5	FUTURE	N/A
MAXIMUM NEW BUILDING WATER LOAD		477

SPRINKLER DESIGN INFORMATION

THIS BUILDING IS FULLY SPRINKLERED TO NFPA 13 BASED ON LIGHT HAZARD WITH THE FOLLOWING EXCEPTIONS

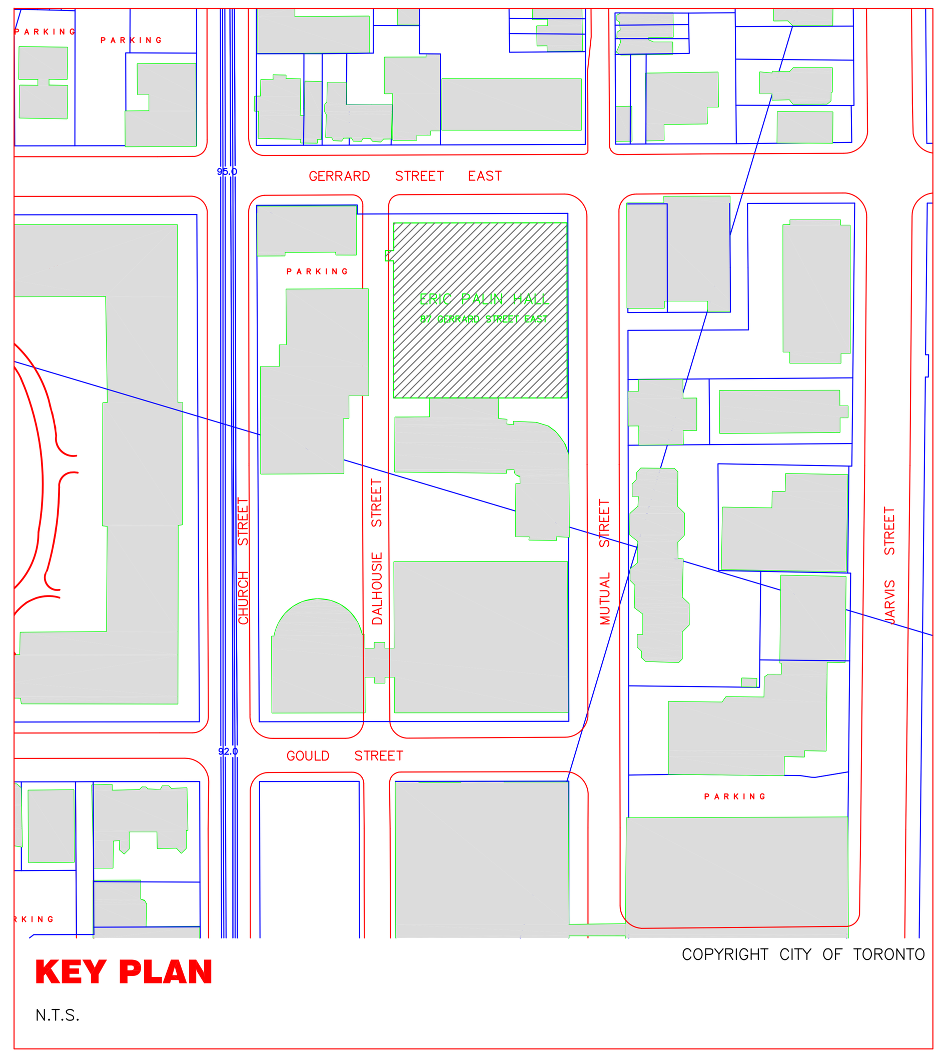
ITEM	DESCRIPTION	HAZARD
1	ALL MECHANICAL AND ELECTRICAL ROOMS	ORDINARY I
2	–	–
3	–	–

GENERAL NOTES

1. CONTRACTOR TO SITE CONFIRM ALL PIPE INVERTS, SIZES, AND LOCATIONS WITH THE CITY OF TORONTO PRIOR TO INSTALLATION OF NEW SITE SERVICES

DRAWING LIST

DRAWING NO.	DESCRIPTION
M-1	SYMBOL SCHEDULE & DRAWING LIST
M-2	FIRST FLOOR MECHANICAL DEMOLITION PLAN
M-3	SECOND FLOOR MECHANICAL DEMOLITION PLAN
M-4	THIRD FLOOR MECHANICAL DEMOLITION PLAN
M-5	FOURTH FLOOR MECHANICAL DEMOLITION PLAN
M-6	FOURTH FLOOR MECHANICAL NEW CONSTRUCTION PLAN
M-7	ROOF PLAN MECHANICAL DEMOLITION
M-8	FIFTH FLOOR MECHANICAL PLAN – H.V.A.C.
M-9	SIXTH FLOOR MECHANICAL PLAN– H.V.A.C.
M-10	FIFTH FLOOR MECHANICAL PLAN – PLUMBING & FIRE PROTECTION
M-11	SIXTH FLOOR MECHANICAL PLAN– PLUMBING & FIRE PROTECTION
M-12	ROOF PLAN MECHANICAL
M-13	HEATING & COOLING SCHEMATIC
M-14	FIRE PROTECTION & PLUMBING PIPING SCHEMATIC



KEY PLAN
N.T.S.

NOTES
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No.	Description	Date
23	AS BUILTS	AUG. 23, 2002
22	ISSUED W/ SI M-16	OCT 23, 2001
21	ISSUED W/ SI M-14	OCT 23, 2001
20	ISSUED W/ SI M-13	OCT 11, 2001
19	ISSUED W/ CCN M-6	OCT 2, 2001
18	ISSUED W/ CCN M-5	SEPT 26, 2001
17	ISSUED W/ CCN M-3	AUG 27, 2001
16	ISSUED W/ SI M-9R1	AUG 25, 2001
15	ISSUED W/ SI M-9	AUG 17, 2001
14	ISSUED W/ SI M-8	AUG 14, 2001
13	ISSUED W/ CCN M-2	AUG 14, 2001
12	ISSUED W/ SI M-7	AUG 9, 2001
11	ISSUED W/ SI M-4 & SI M-5	JULY 13, 2001
10	ISSUED W/ SI M-3	JULY 12, 2001
9	ISSUED W/ SI M-2	JULY 9, 2001
8	ISSUED W/ SI M-1	JULY 6, 2001
7	ISSUED W/ CCN M-1	JULY 3, 2001
6	ISSUED FOR CONSTRUCTION	JUN. 20, 2001
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TELEPHONE 705 743-3311 | FAX 705 743-0056

NOVEL MECHANICAL INC.
CONTRACTORS/ENGINEERS
131 Whitmore Road, Unit #2
Woodbridge, Ontario
L4L 6E2
Tel. (905) 850-2047
Fax (905) 850-6148

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

SYMBOL SCHEDULE & DRAWING LIST

Graphic Scale

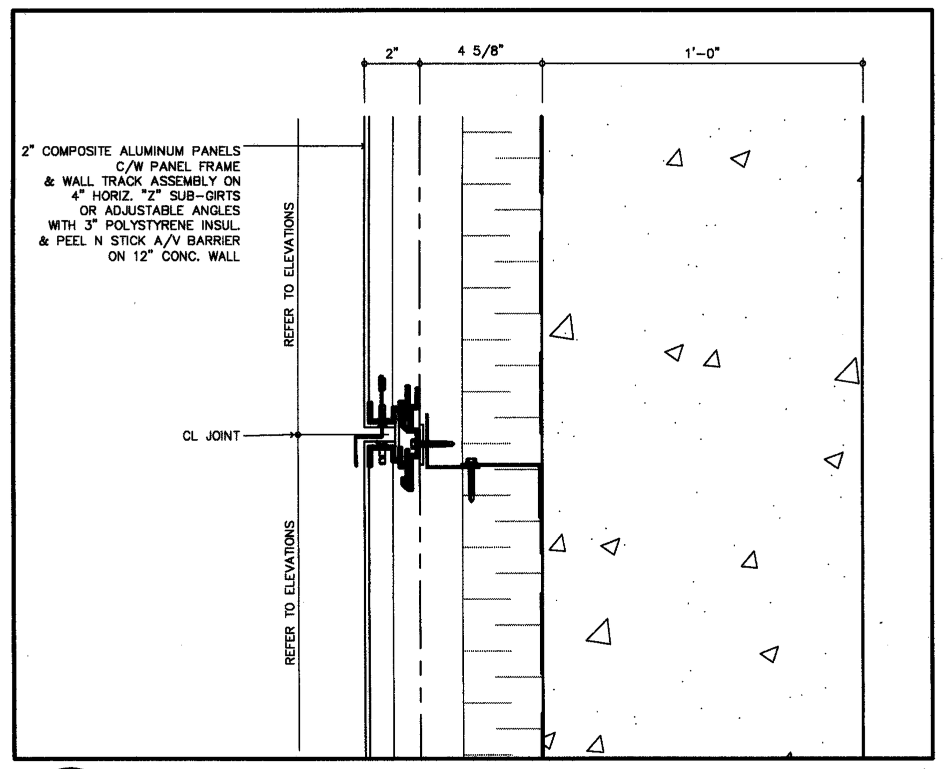
Sheet no.

Printed AUG 23, 2002 | Scale
Date AUG. 23, 2002 | Job No. 200004
P-i-C – | PM – | JC | Des – | Dr

M-1

A0 841x1189
KEEN PROJECT #875309

[redacted] SHE055



1 TYPICAL HORIZONTAL JOINT: ALUMINUM COMPOSITE PANELS
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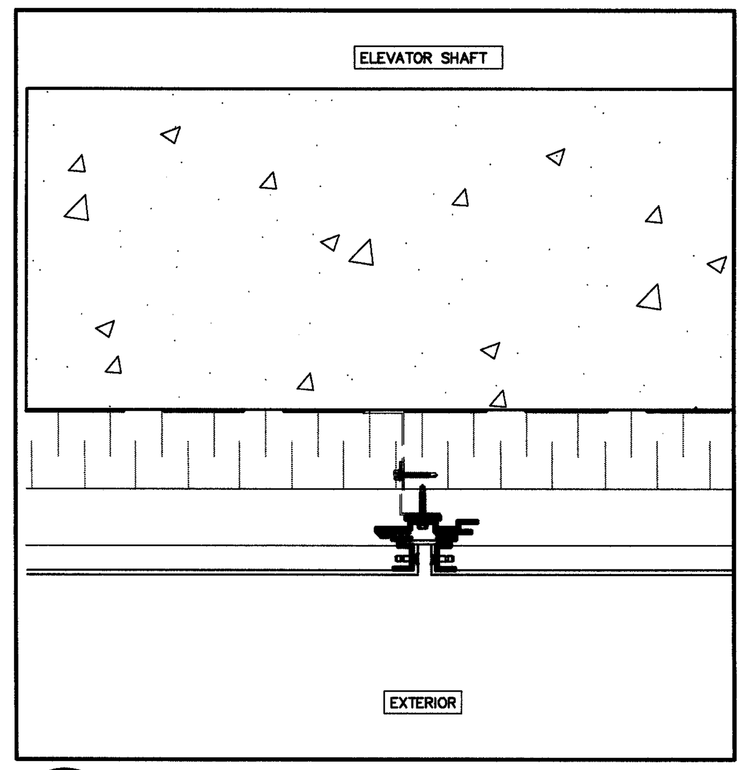

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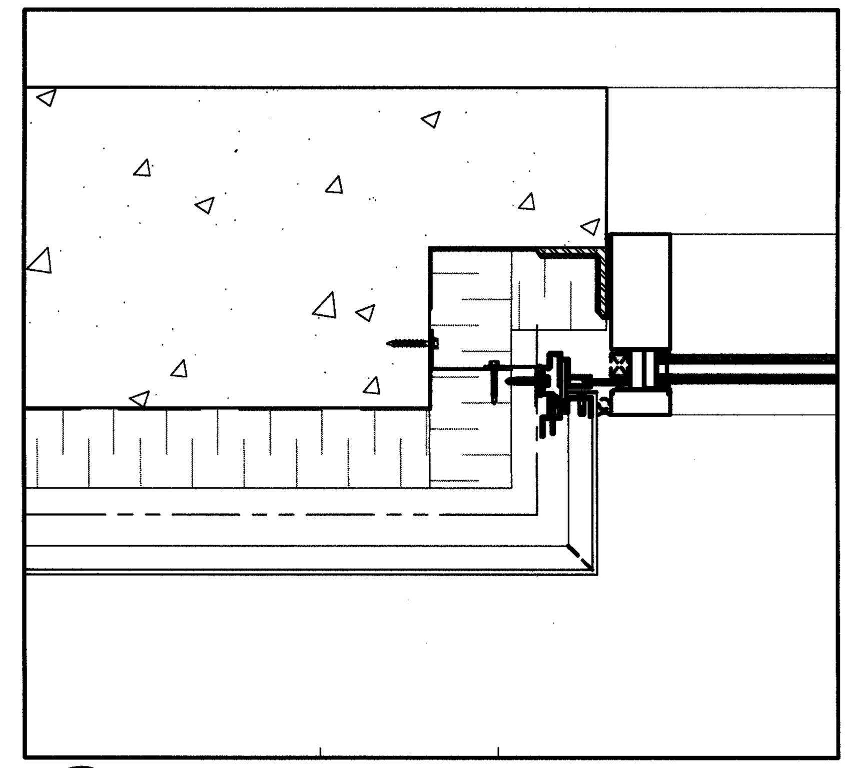

3 WINDOW JAMB AT STAIR 5
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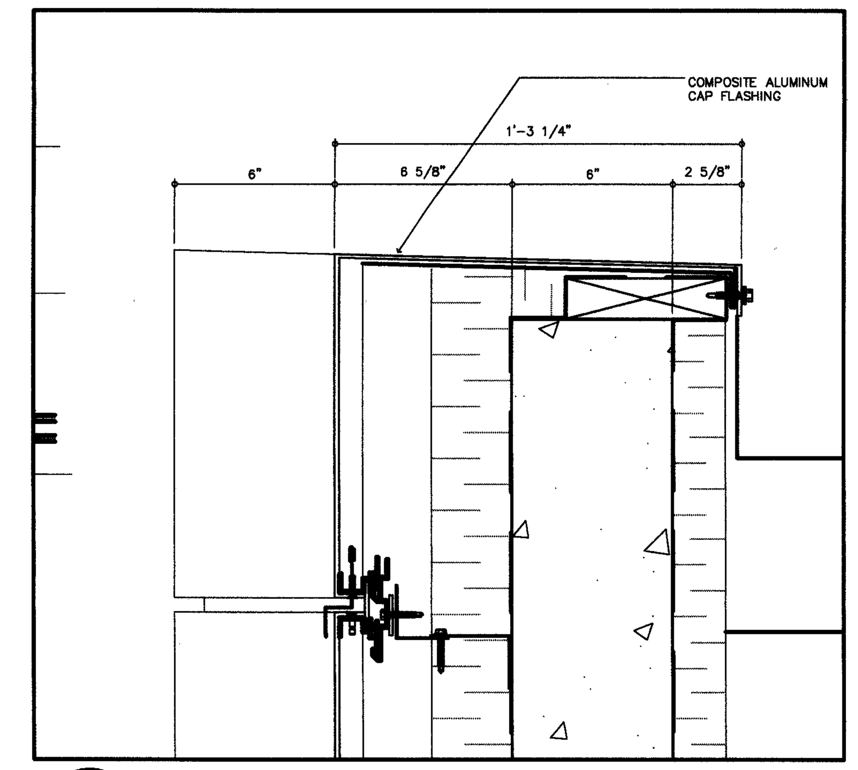

4 PARAPET DETAIL AT FEATURE BANDS
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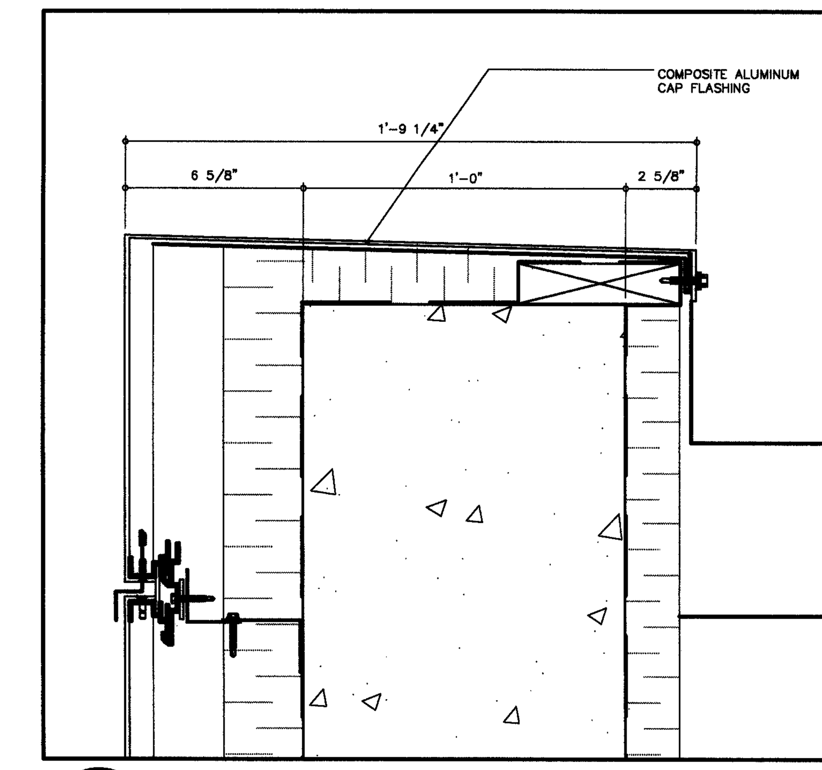

5 TYPICAL PARAPET DETAIL: ALUMINUM COMPOSITE PANELS
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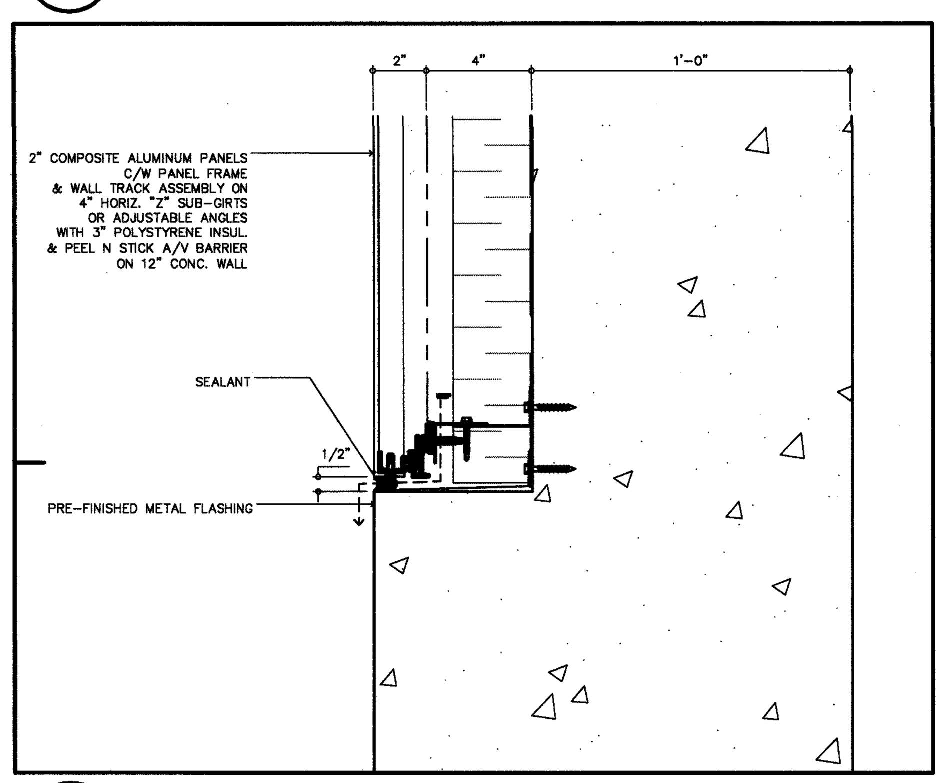

6 FOUNDATION WALL DETAIL: ALUMINUM COMPOSITE PANELS
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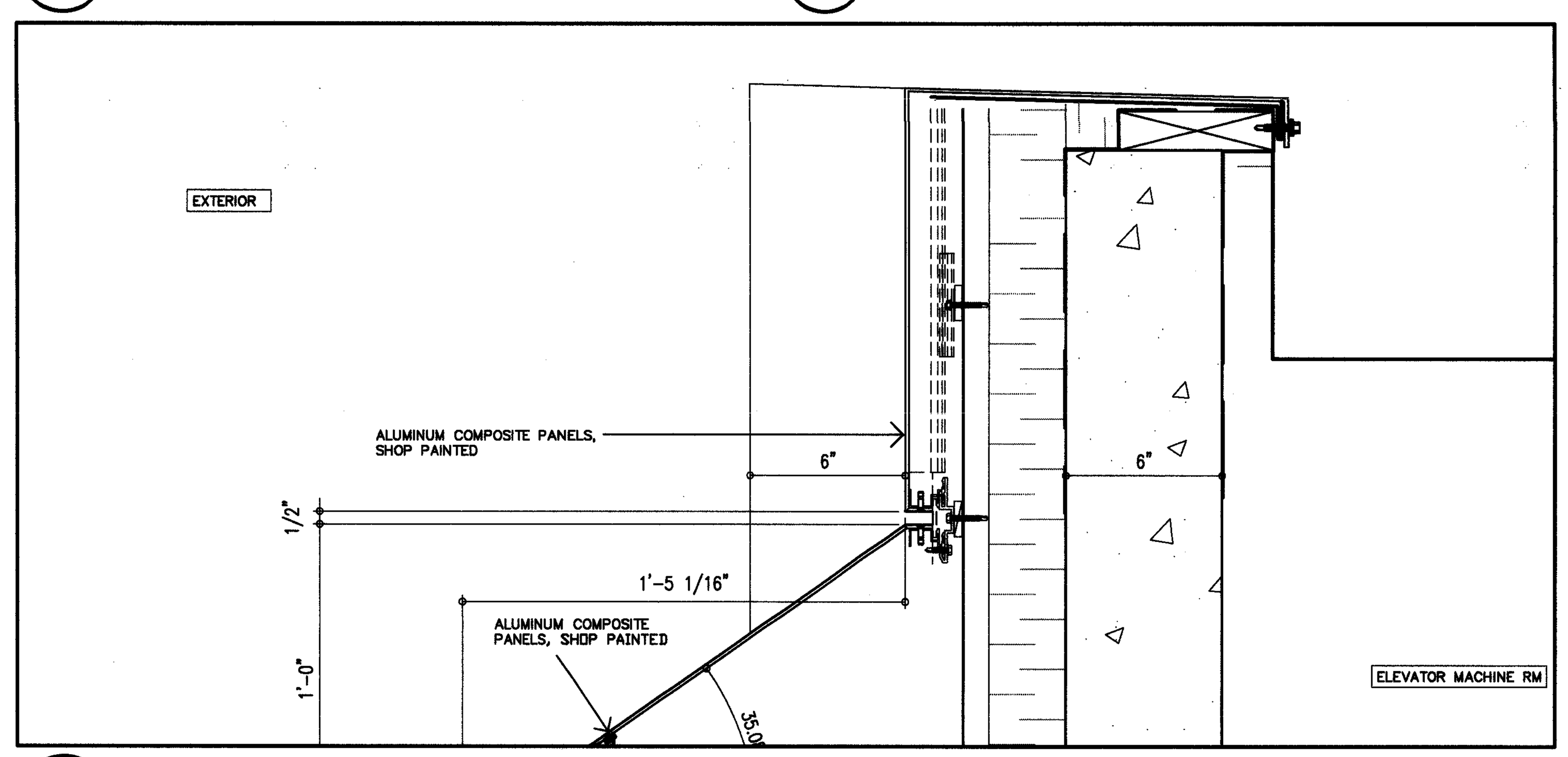

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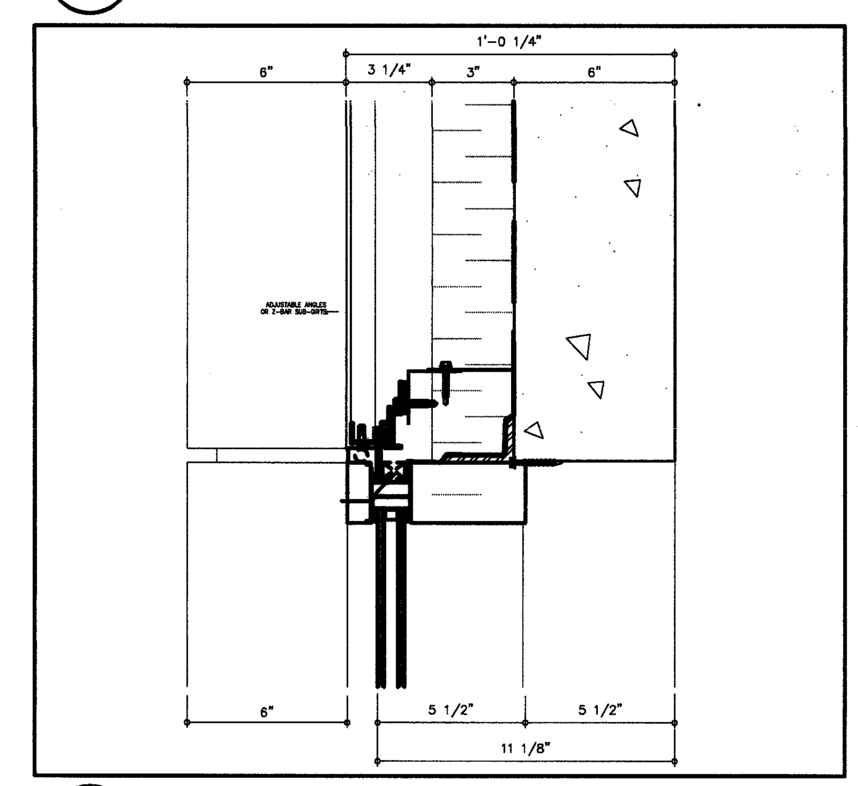

8 WINDOW HEAD AT STAIR 5
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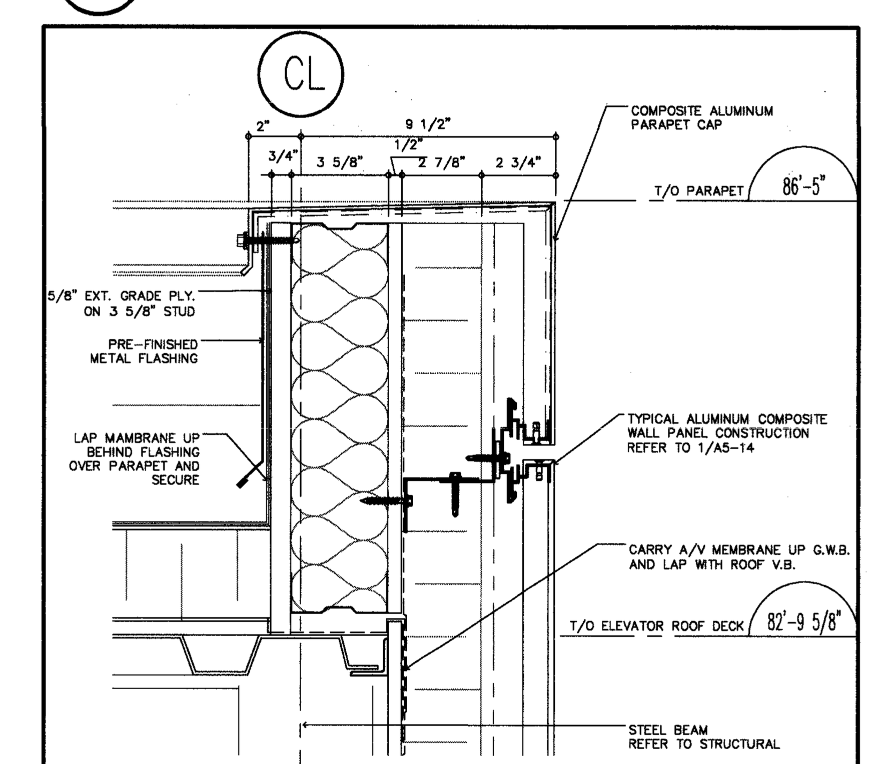

9 ELEVATOR RM. PARAPET SECTION
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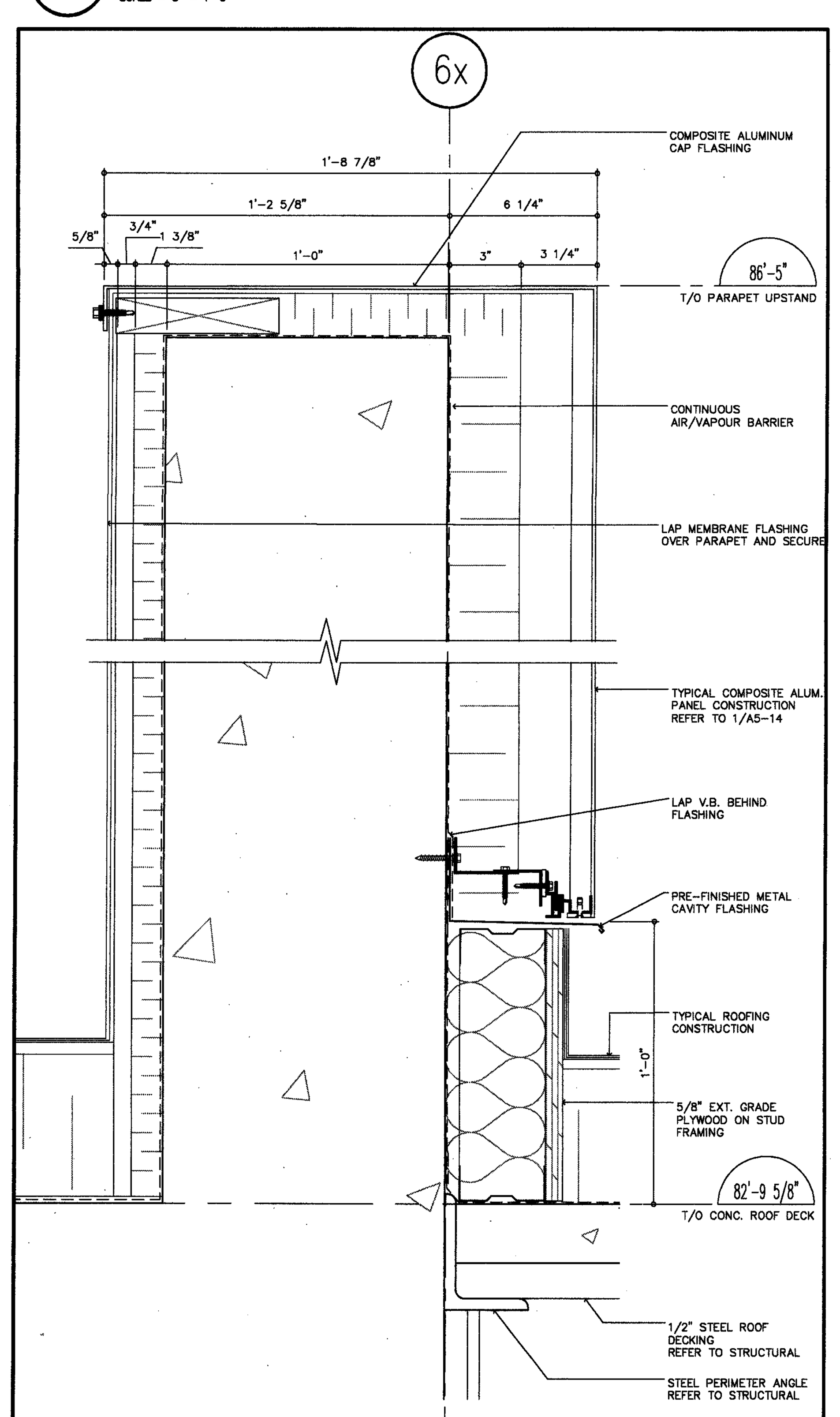

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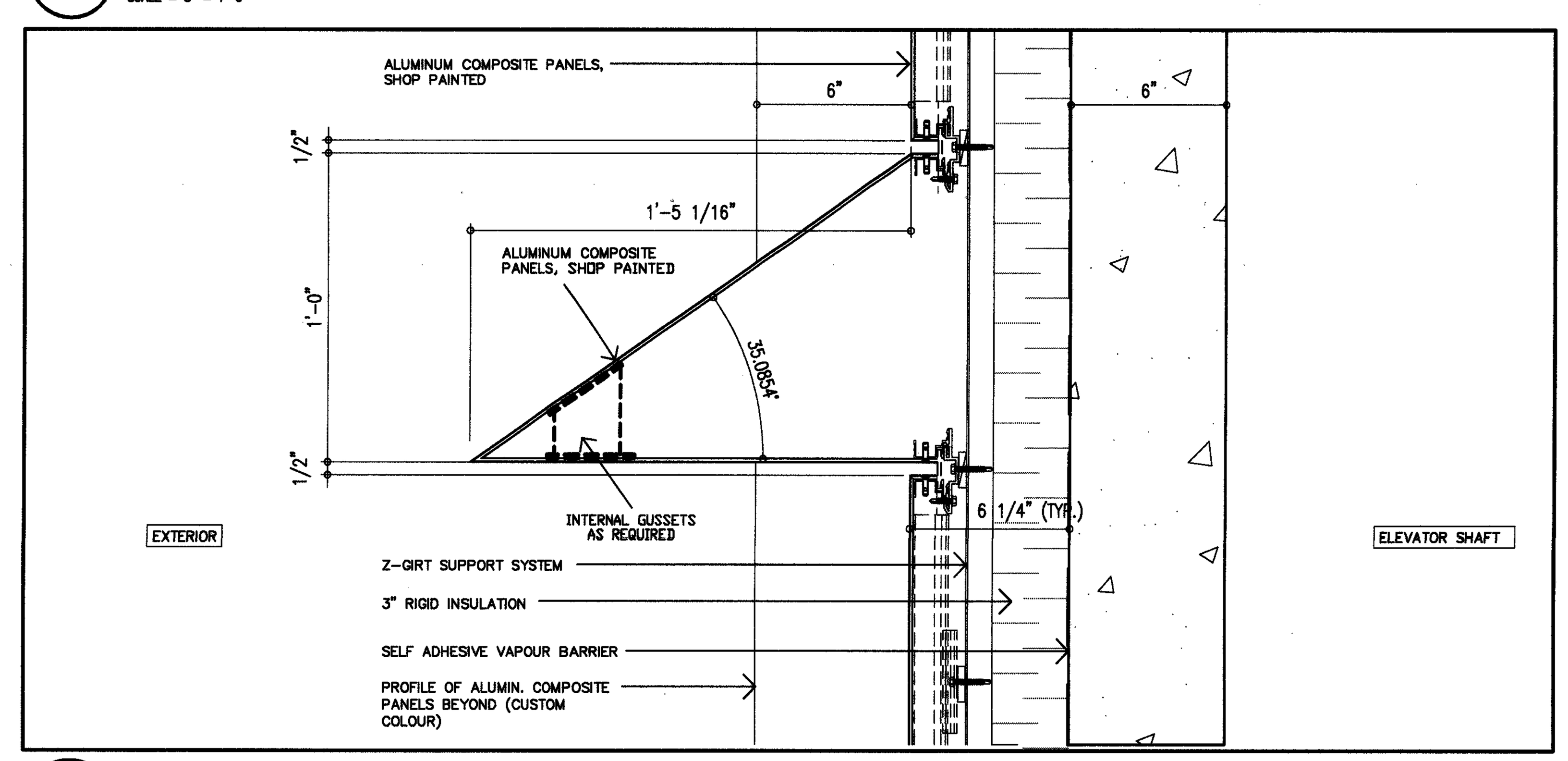

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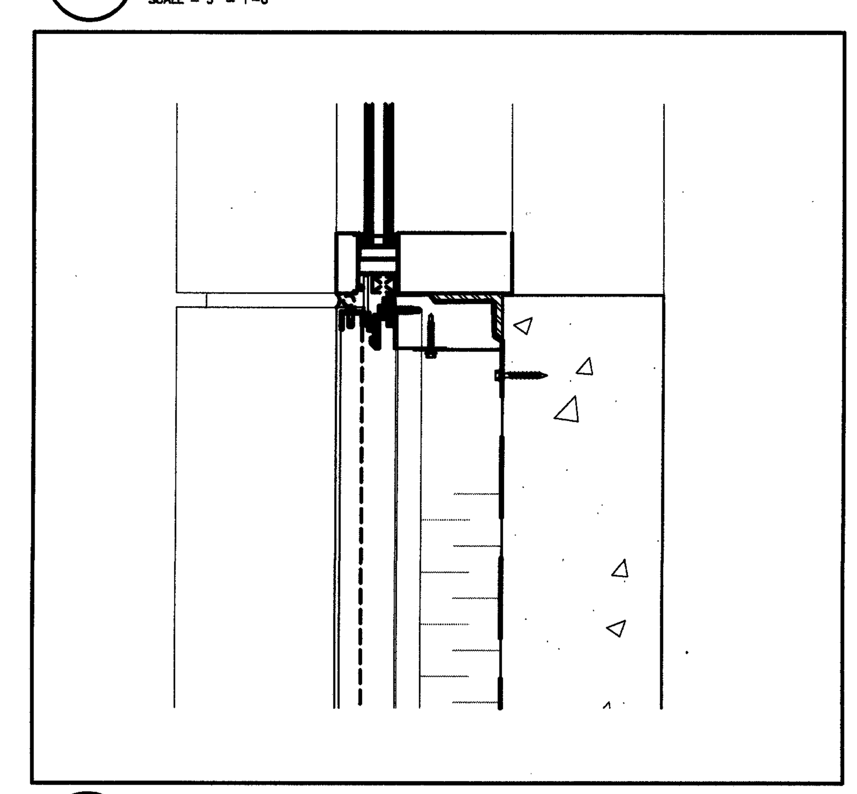

12 WINDOW SILL AT STAIR 5
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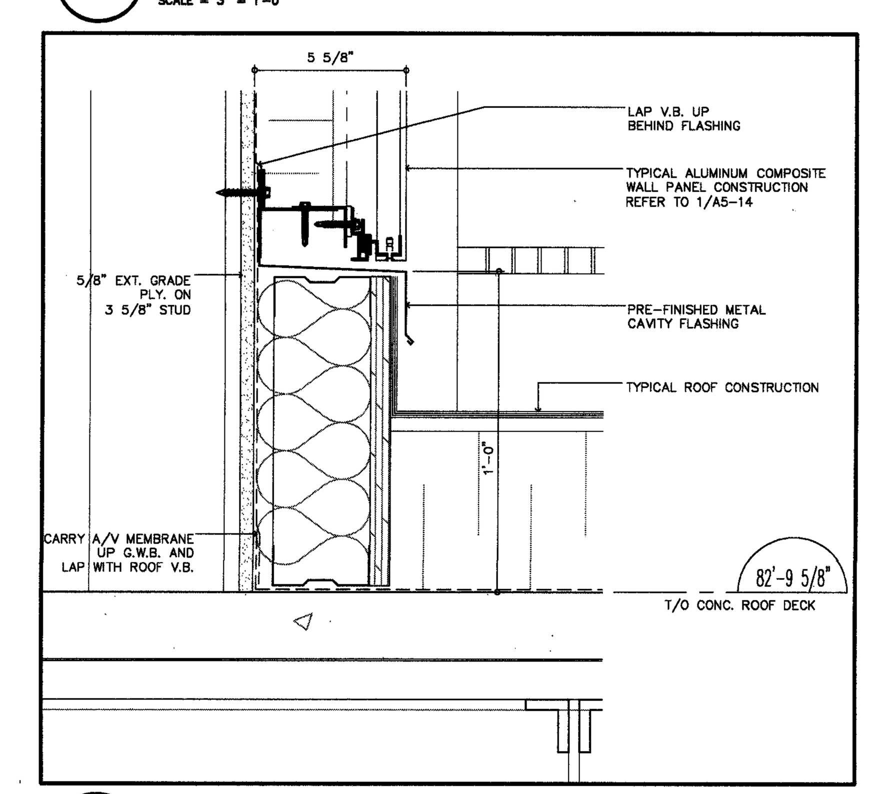

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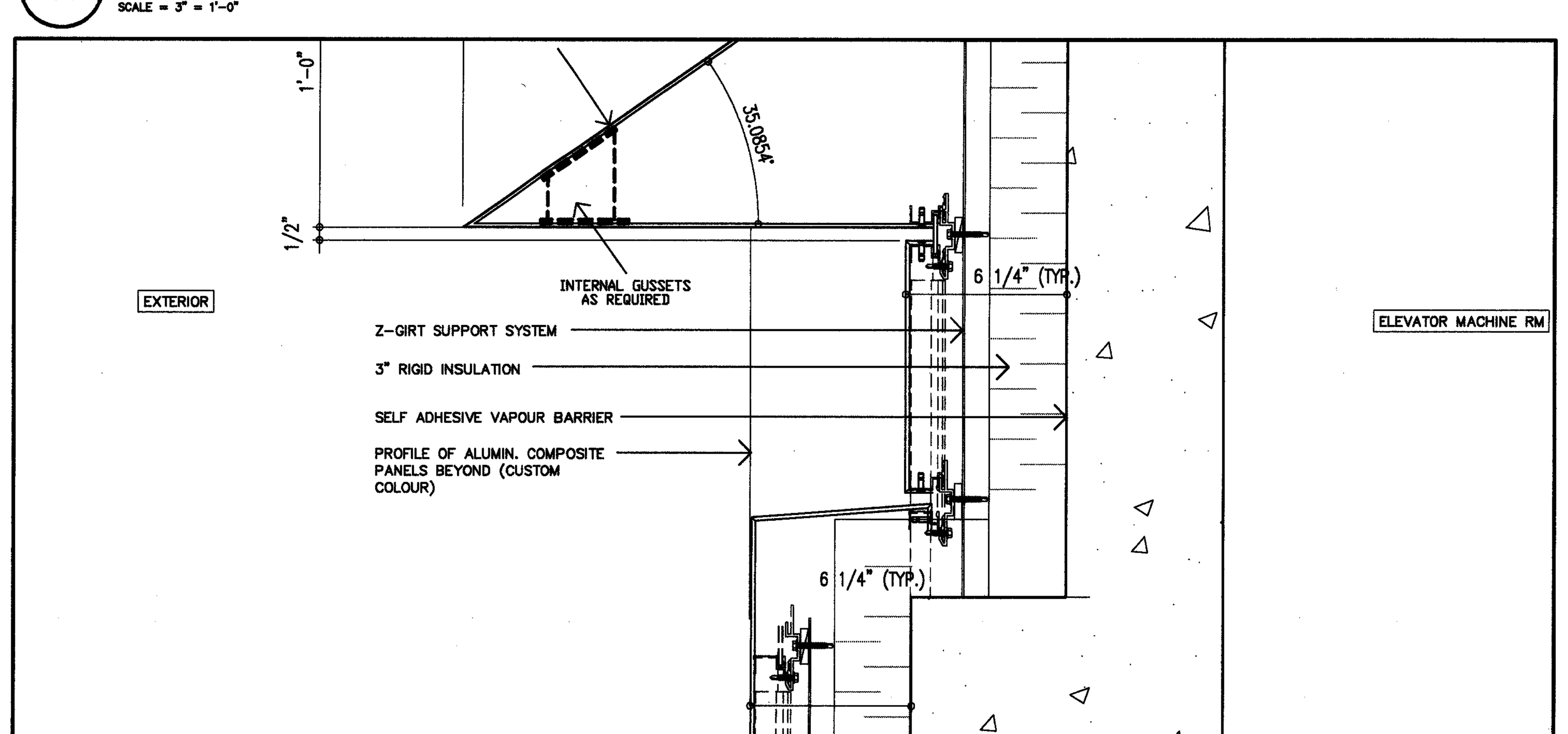

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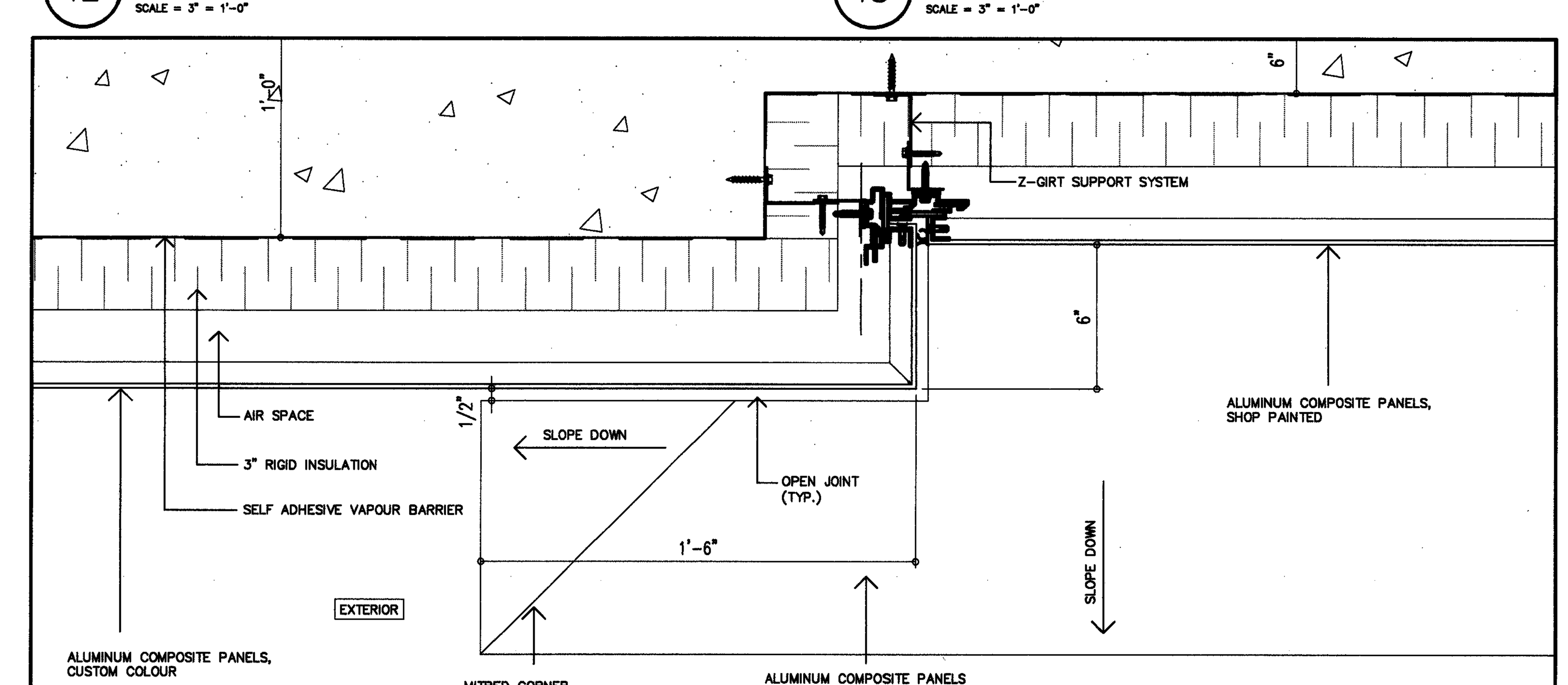

16 PLAN DETAIL AT ARCHITECTURAL FINS
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A0 841x1189

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REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. G?YECHE
LICENCE 4666

Ontario
SuperBuild

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ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

ALUMINUM COMPOSITE PANEL DETAILS

Graphic Scale		Sheet no.
Printed	Scale 3" = 1'-0"	A5-14
Date MAY 07, 2001	Job No. 200004	

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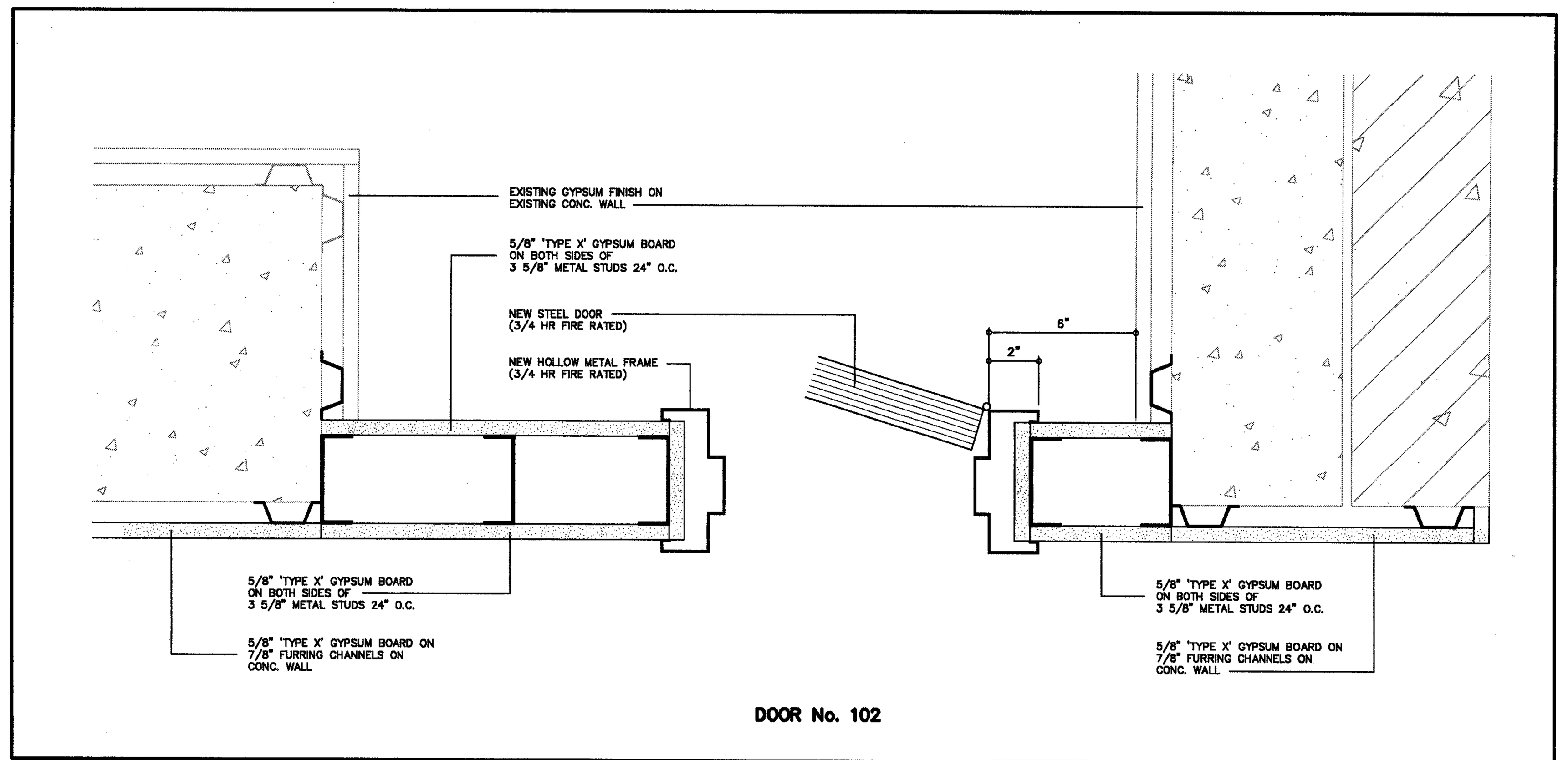
EPH/SHE 052



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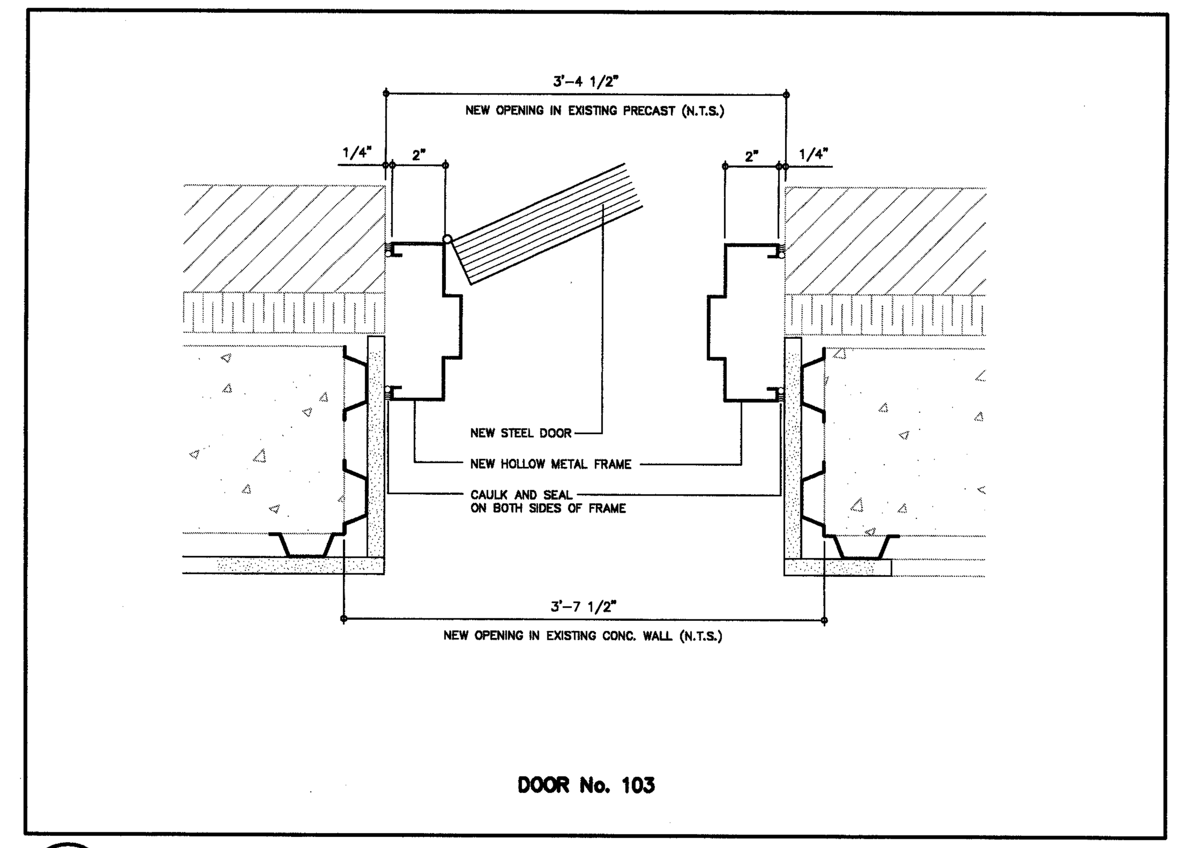

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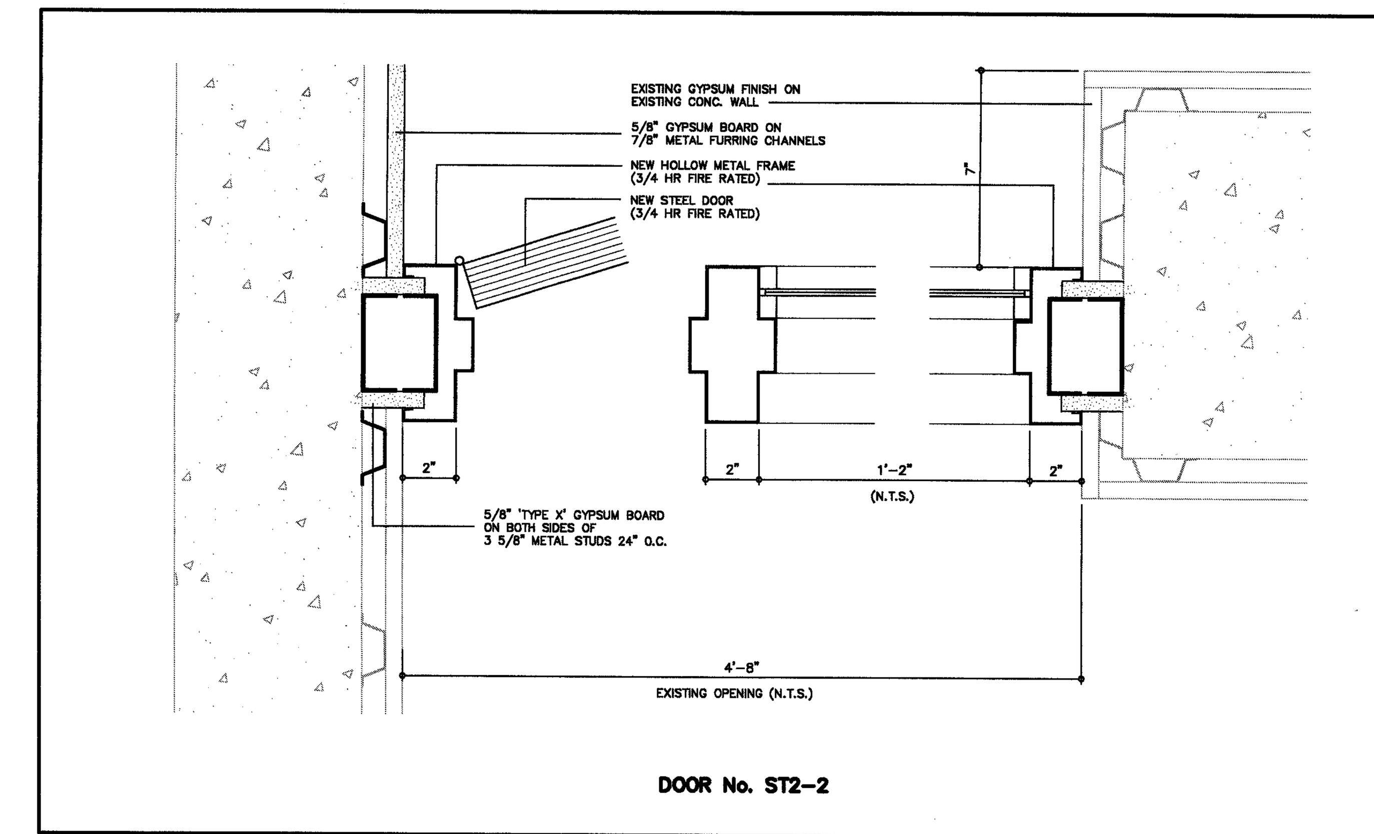

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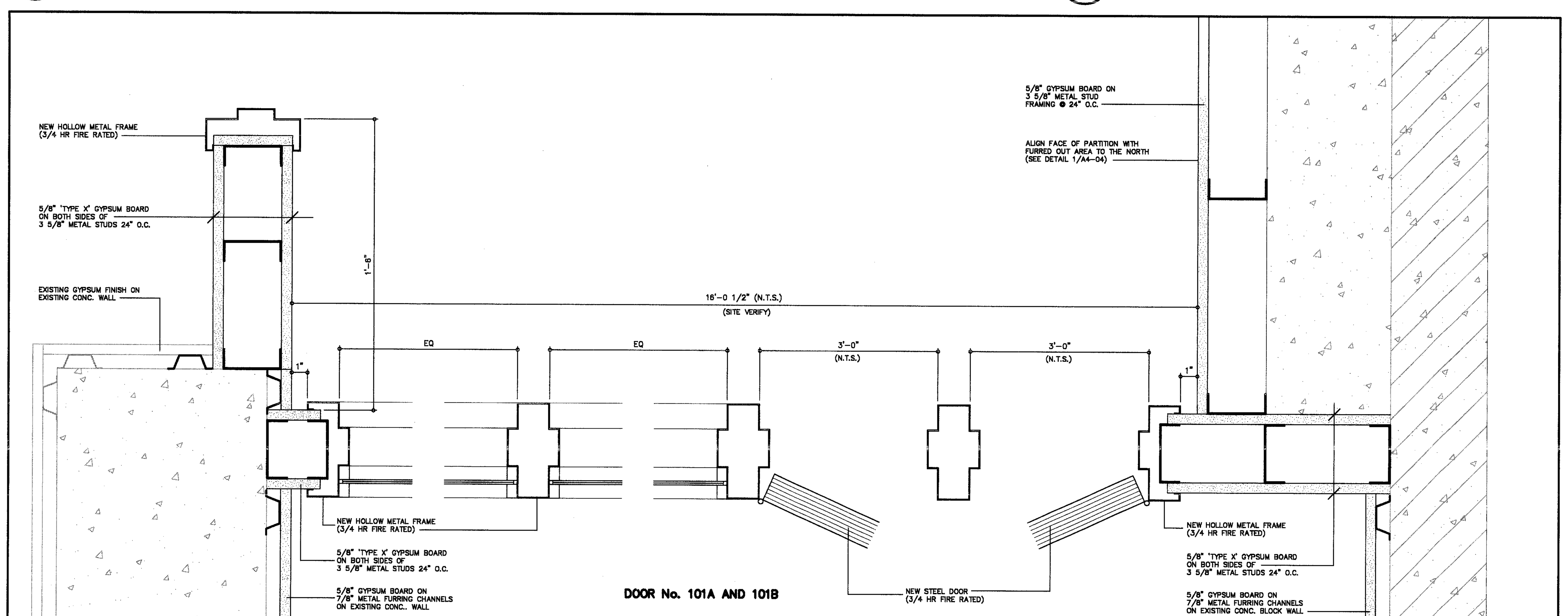

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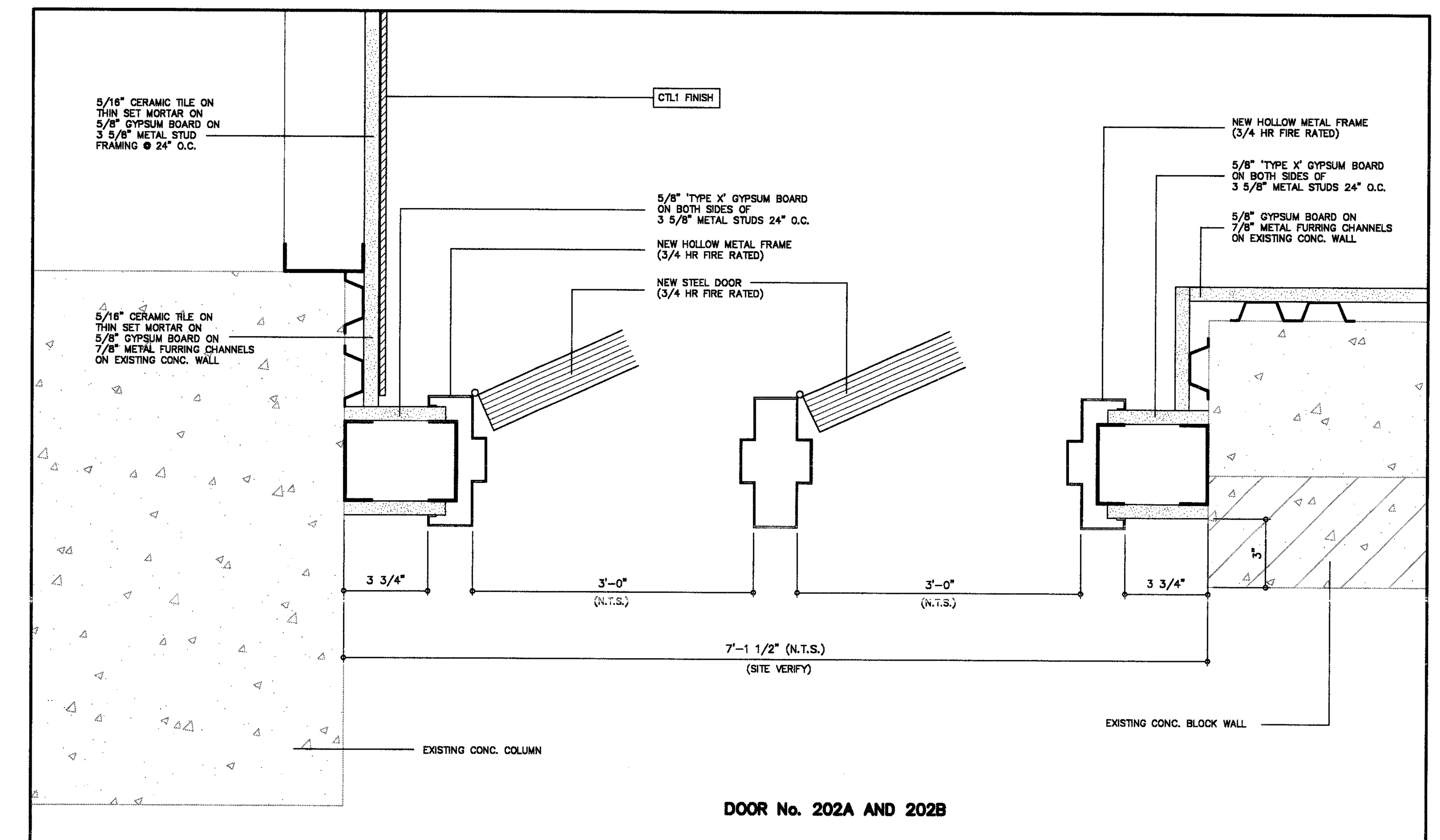

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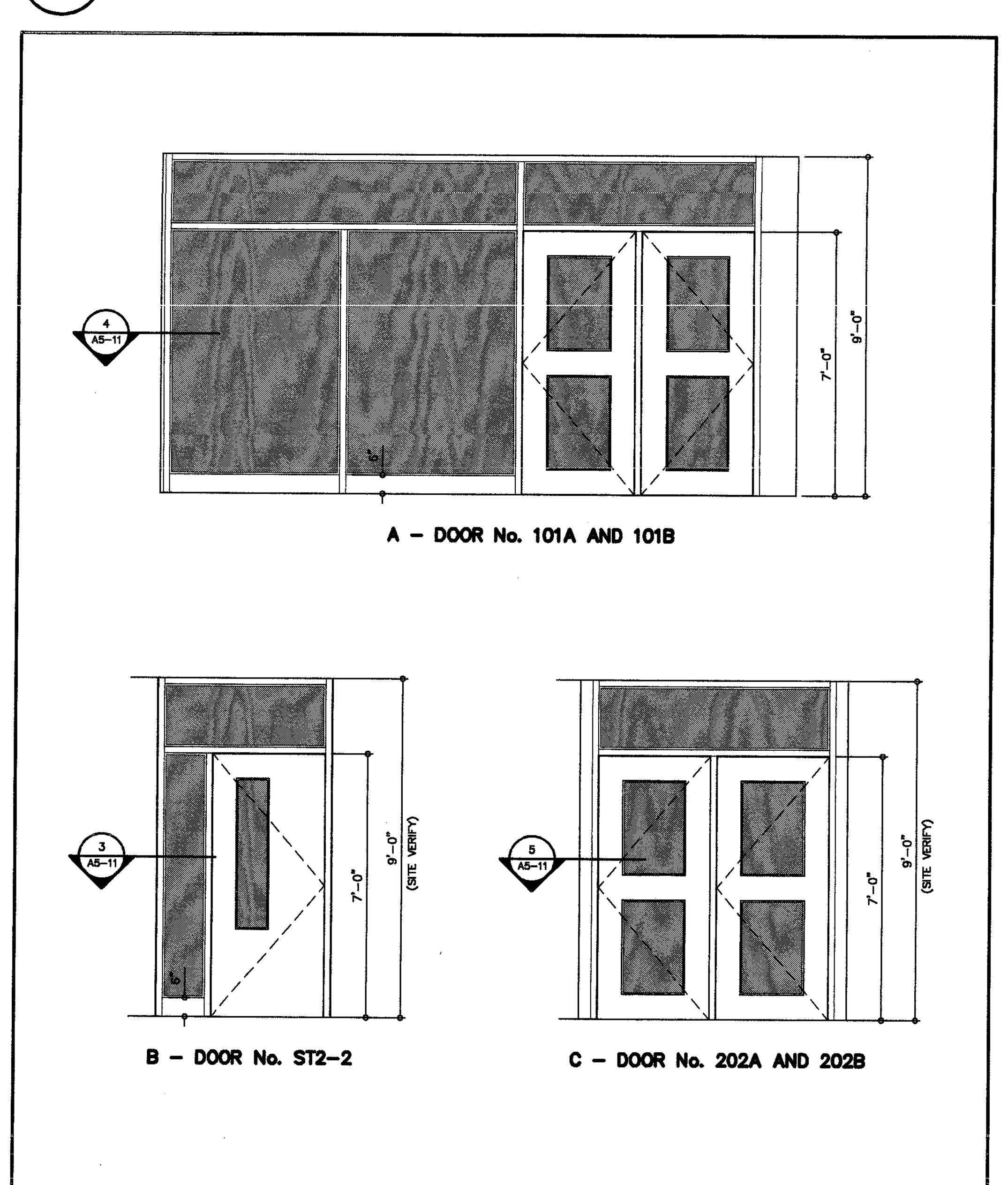

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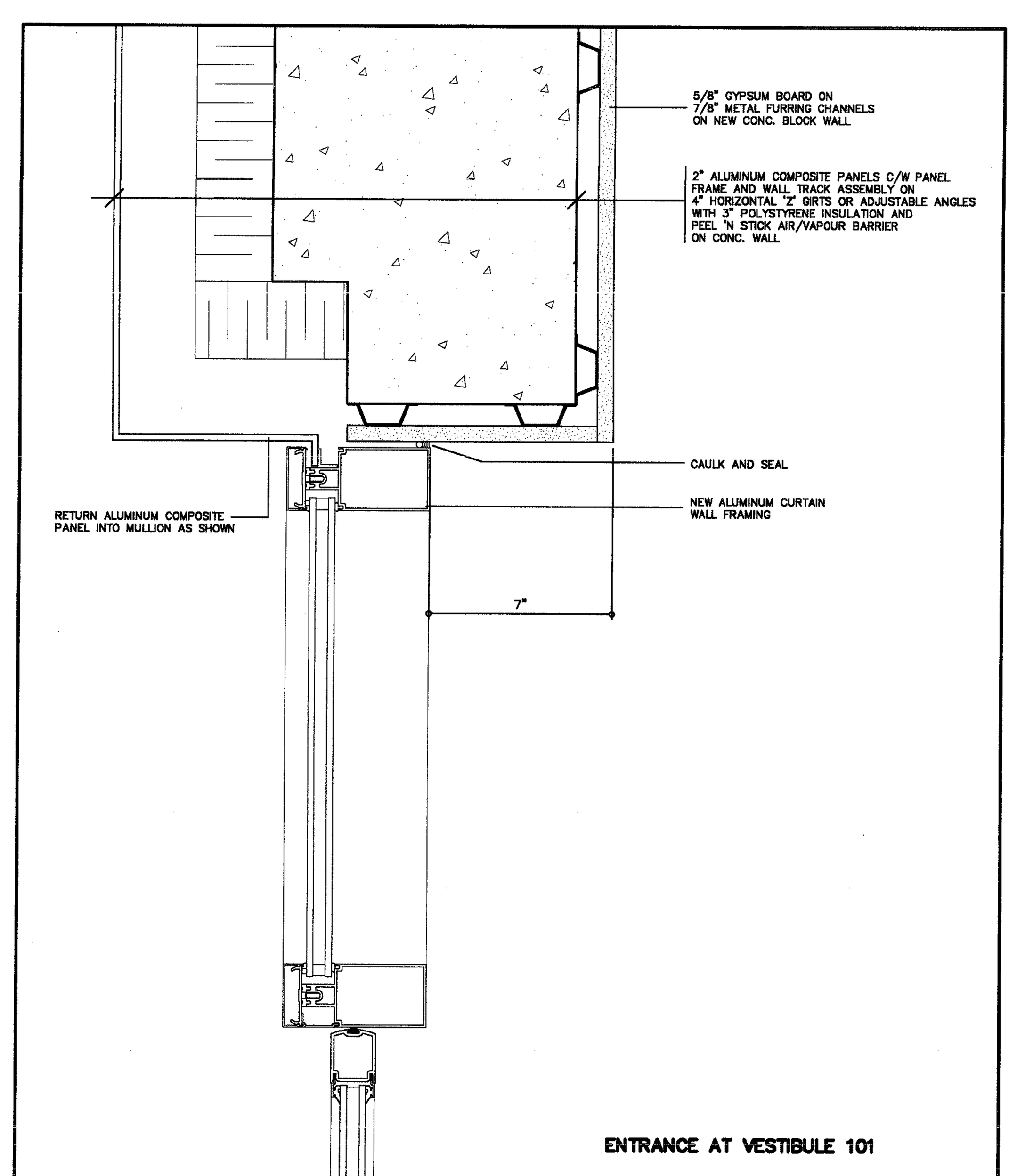

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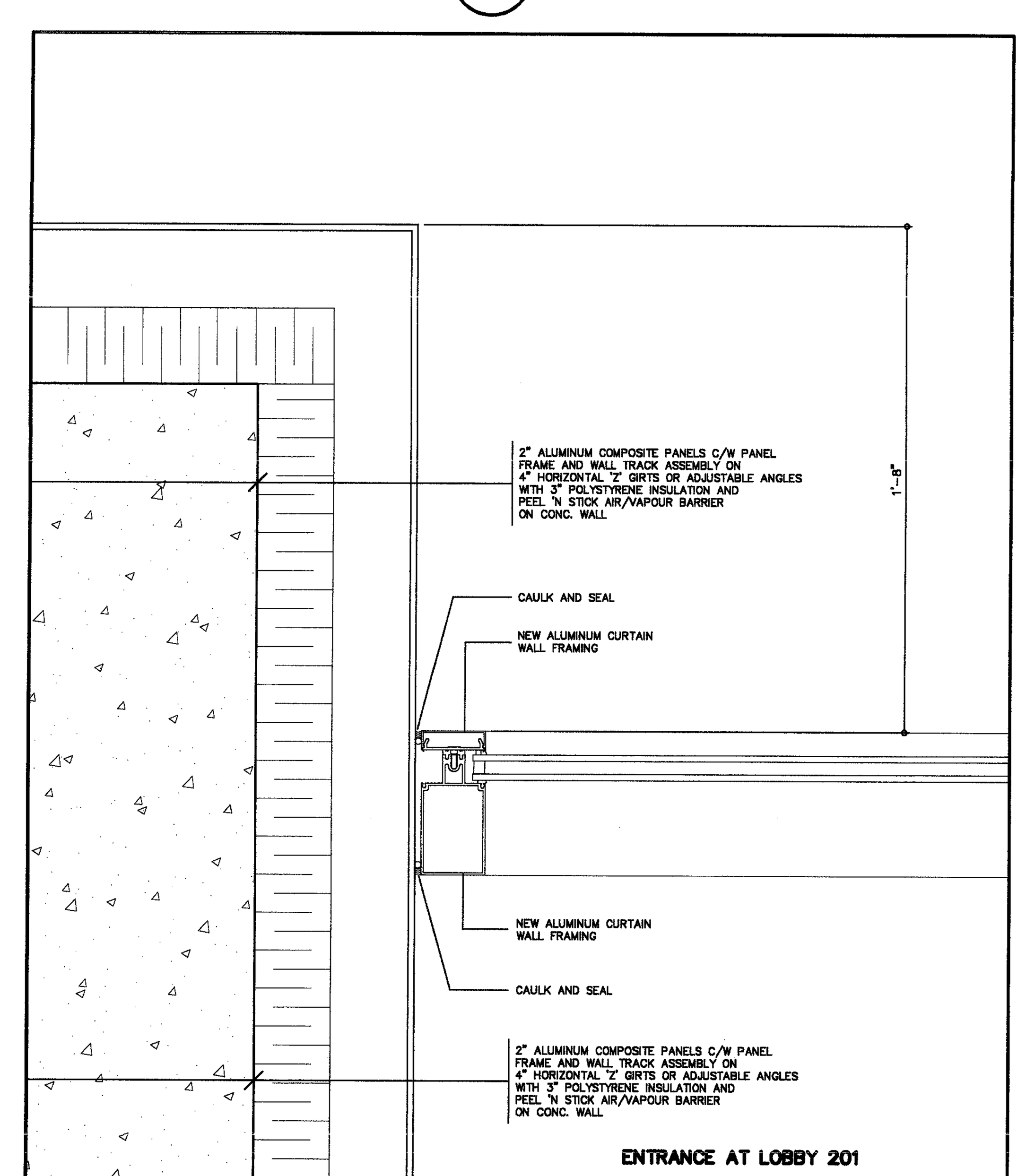

8 PLAN DETAIL
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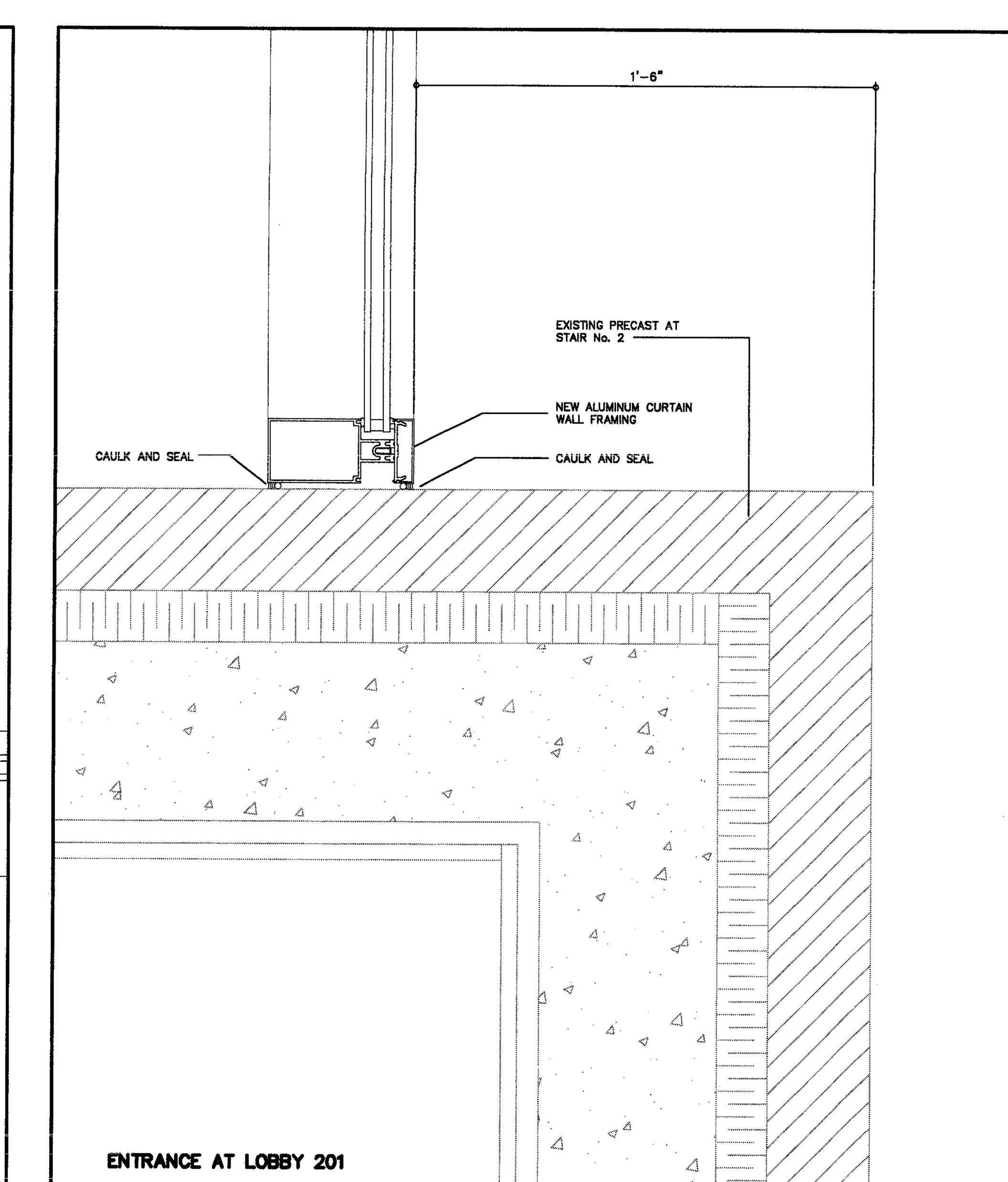

9 PLAN DETAIL
SCALE = 3" = 1'-0"

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NOTE: REFER TO DRAWING A2-08 AND A2-09 FOR LIST OF WALL AND FLOOR FINISHES

No.	Description	Date
4	ISSUED FOR TENDER	MAY 09, 2001
3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE 4666

Ontario SuperBuild

Project Manager
Cansult Hanscomb Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect
Lett/Smith Architects
385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

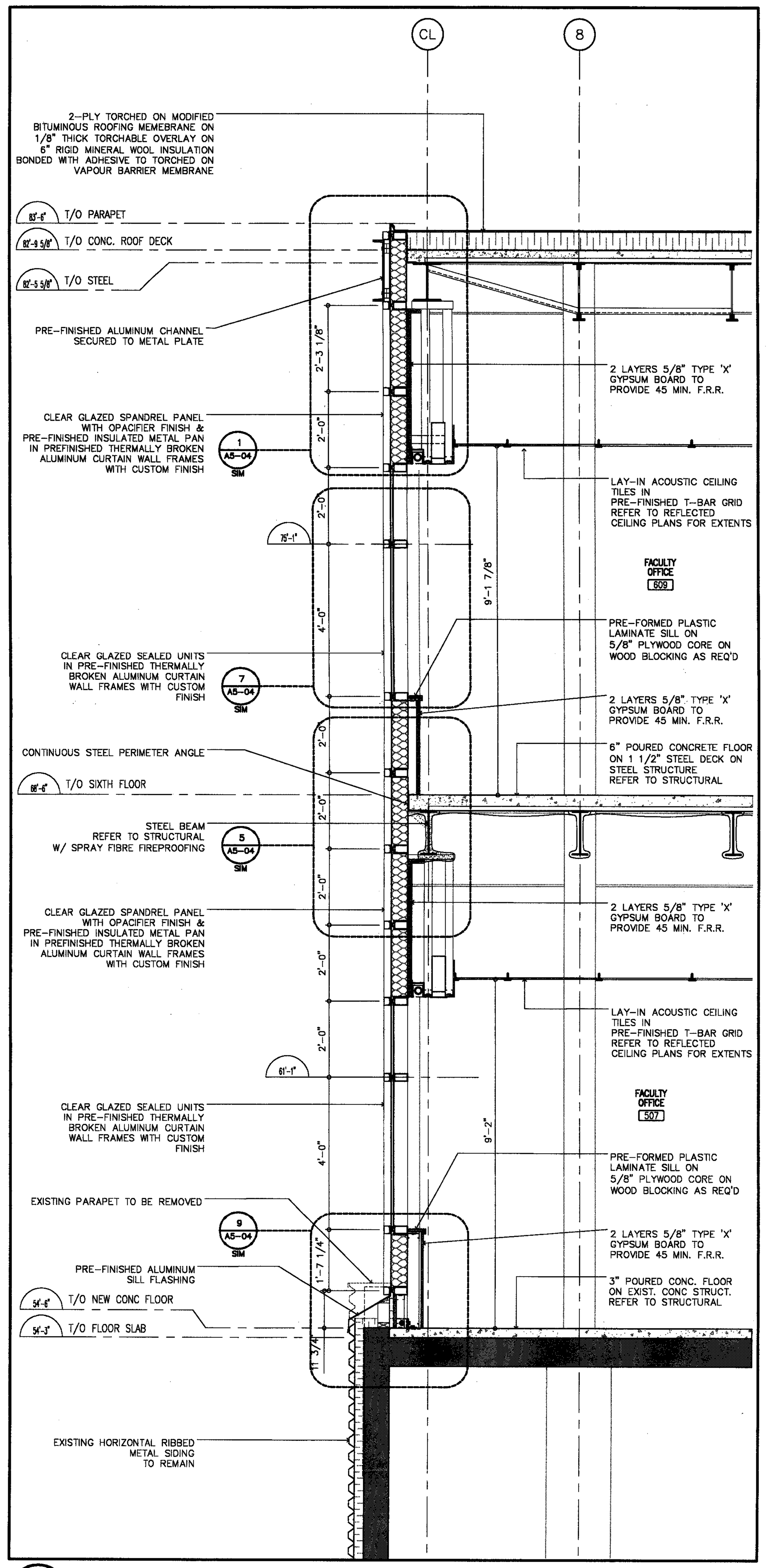
DOOR AND FRAME DETAILS

Graphic Scale		Sheet no.
Printed	Scale: AS NOTED	A5-11
Date: MAY 07, 2001	Job No.: 200004	

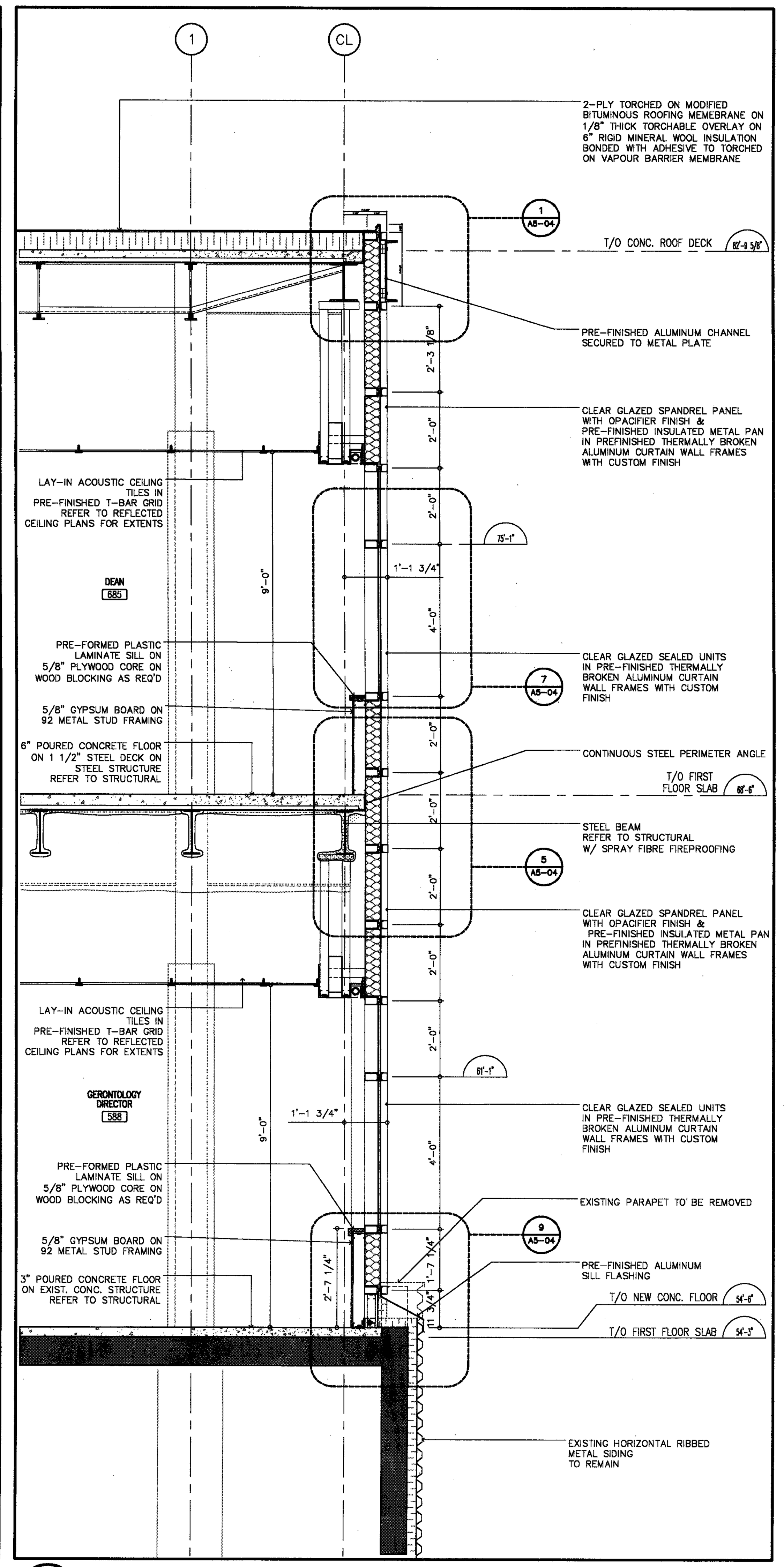
P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	CAT

A0 841x1189

EPH/SHE 051



1 WEST WALL SECTION
SCALE = 1/2" = 1'-0"



2 EAST WALL SECTION
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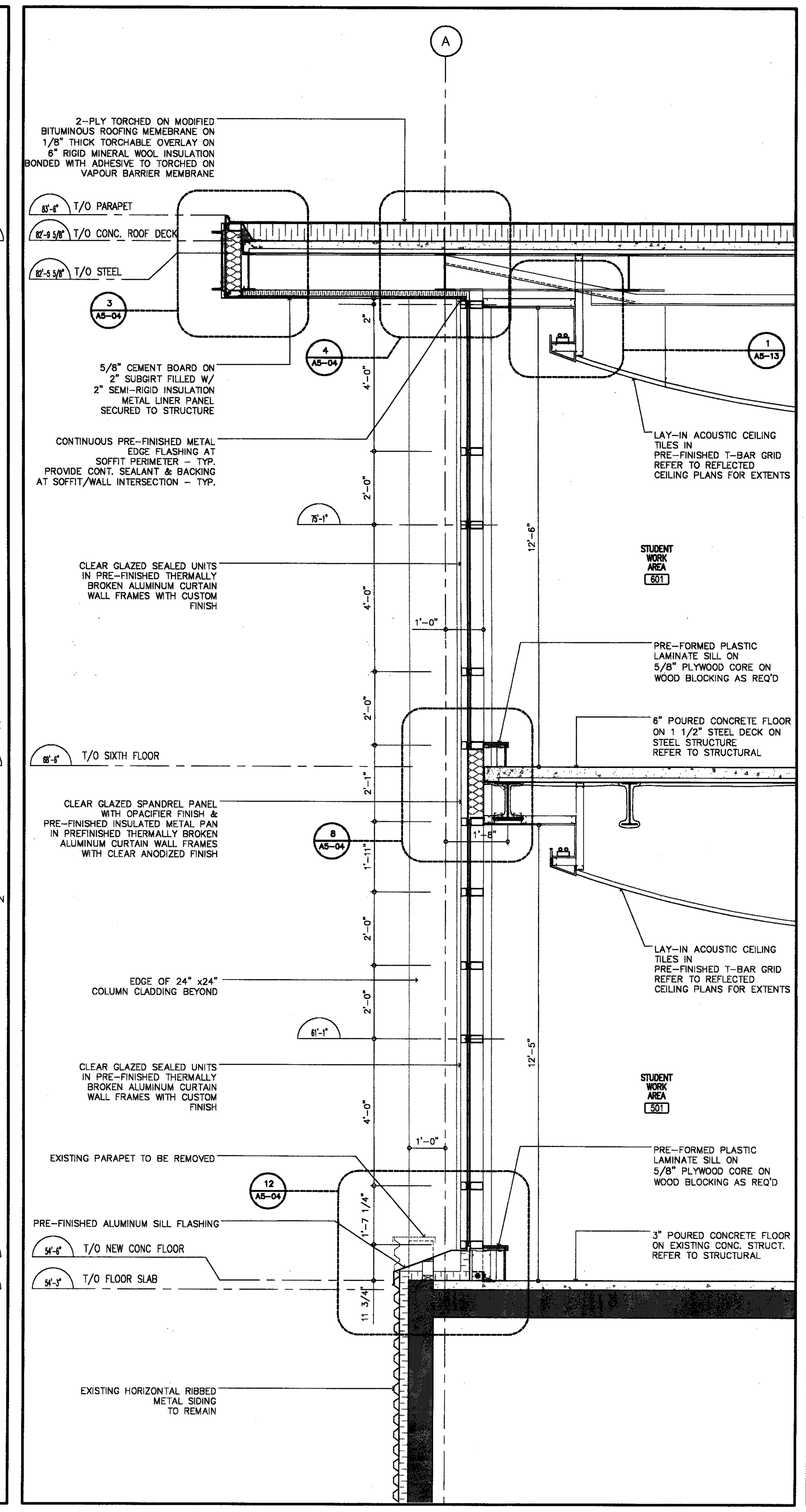

3 NORTH WALL SECTION
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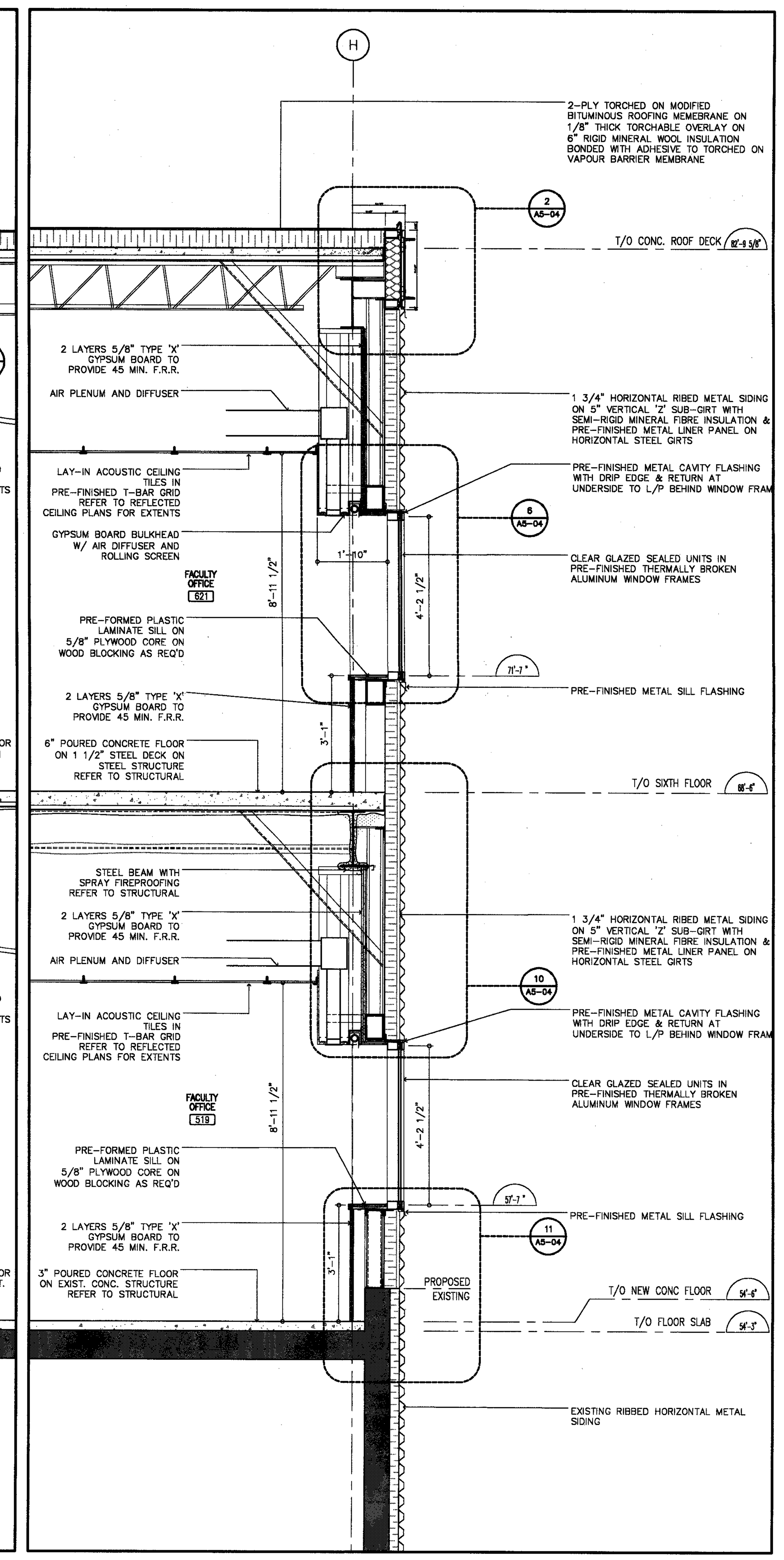

4 SOUTH WALL SECTION
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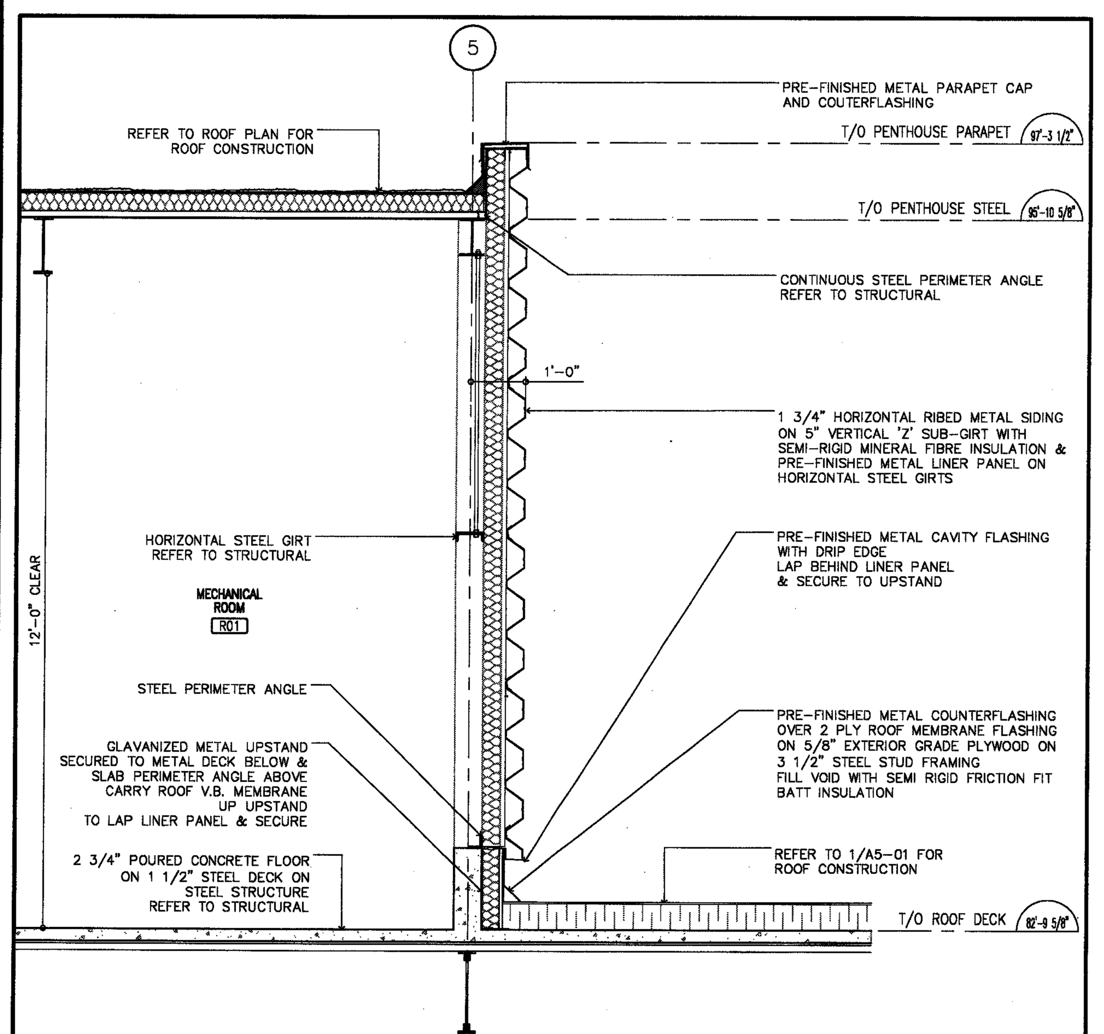
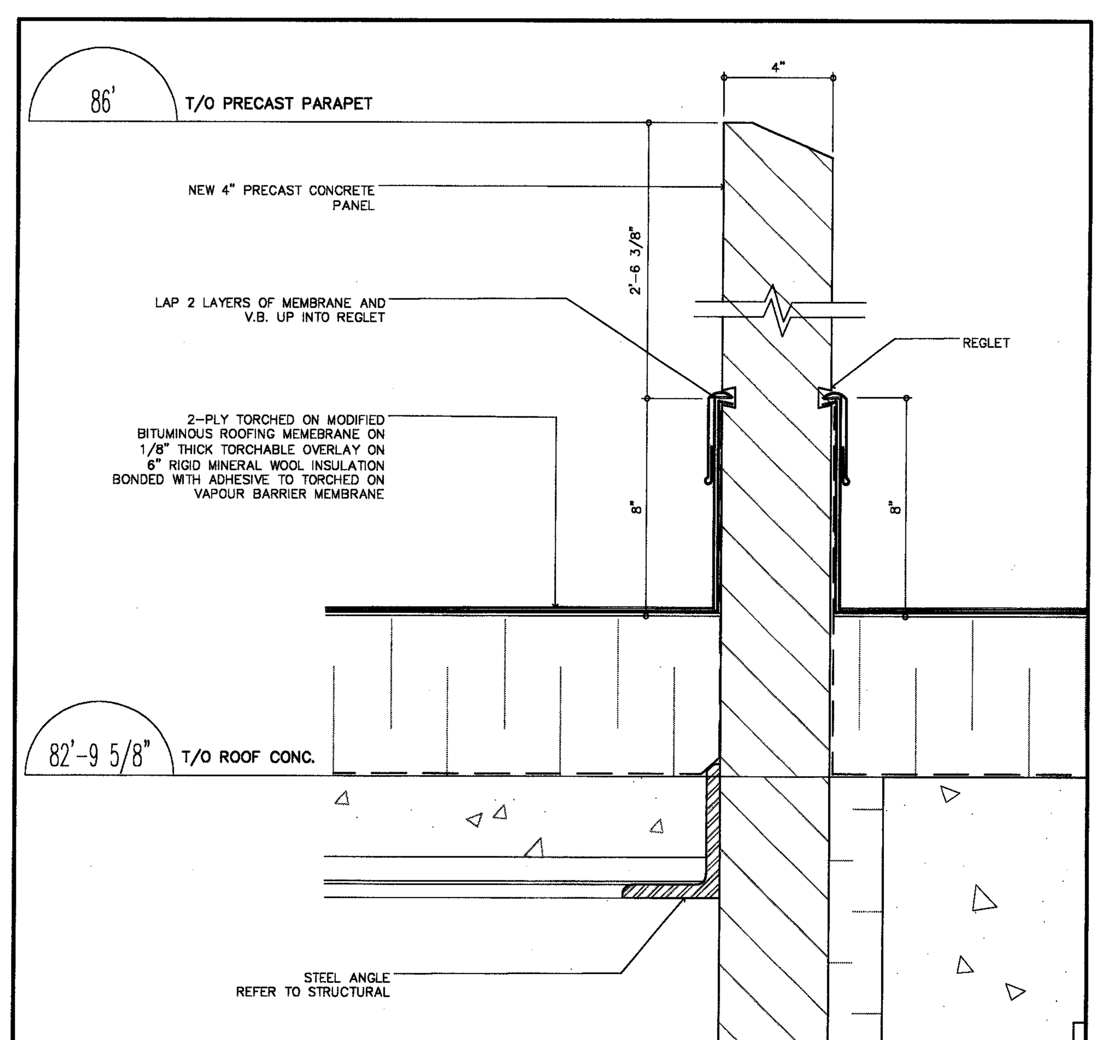


5 PENTHOUSE WALL SECTION
SCALE = 1/2" = 1'-0"



6 PRECAST PARAPET SECTION
SCALE = 3" = 1'-0"

A0 841x1189

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ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

EXTERIOR
WALL SECTIONS

Graphic Scale		Sheet no.
Printed	Scale 1/2" = 1'-0"	A5-01
Date MAY 07, 2001	Job No. 200004	

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	DH

ROOF TOP AIR CONDITIONING UNIT SCHEDULE

ROOF TOP UNIT Nº	SERVICE	LOCATION	MANUFACTURER'S (CLIMATE MASTER) MODEL Nº	SUPPLY AIR C.F.M.	SUPPLY AIR EXT. S.P. "W.G.	EVAP. FAN H.P. (MAX.)	RETURN AIR C.F.M.	RETURN AIR EXT. S.P. "W.G.	RETURN AIR FAN H.P.	TOTAL COOLING LOAD M.B.H.	TOTAL COOLING LOAD TONS	GAS HEATING LOAD (OUTPUT) M.B.H.	Nº OF ZONE HEADS	Nº OF ZONES	FILTERS	REMARKS
MZ-1	1ST FLOOR EAST	ROOF	FLMR-55	15,000	0.65	10	13,900	0.50	5	420	35	262	12	4	2" MEDIUM EFFICIENCY THROW AWAY	
MZ-2	1ST FLOOR SOUTH & WEST		FLMR-35	13,000	0.65	7½	11,900	0.50	5	400	33.3	228	12	6	"	
MZ-3	1ST FLOOR NORTH		FLMR-35	11,500	0.65	5	10,500	0.50	3	403	33.6	211	8	10	"	
MZ-4	2ND FLOOR EAST		FLMR-30	10,700	0.65	5	10,000	0.50	3	316	26.3	228	12	8	"	
MZ-5	2ND FLOOR SOUTH & WEST		FLMR-35	2,500	0.65	7½	10,900	0.50	5	387	32.3	230	12	5	"	
MZ-6	2ND FLOOR NORTH	"	FLMR-35	12,000	0.65	7½	11,000	0.50	5	369	30.8	230	12	8	2" MEDIUM EFFICENCY THROW AWAY	
MZ-7	3RD FLOOR NORTH		FLMR-55	8,000	0.80	5	16,500	0.35	7½	600	50.0	360	12	6	PREFILTER & BAG MEDIUM EFFICIENCY	
MZ-8	3RD FLOOR SOUTH		FLMR-55	8,000	0.80	5	16,500	0.35	7½	600	50.0	360	12	5	"	
MZ-9	4TH FLOOR NORTH		FLMR-55	8,000	0.75	5	16,500	0.35	7½	600	50.0	520	12	6	"	
MZ-10	4TH FLOOR SOUTH	ROOF	FLMR-55	18,000	0.75	5	16,500	0.35	7½	600	50.0	520	12	5	PREFILTER & BAG MEDIUM EFFICIENCY	
SZ-1		ROOF	LENNOX GCS11-1853	6,500	1.0	7½	4,000	0.40	–	180	15.0	176	1	1	PREFILTER & BAG MEDIUM EFFICIENCY	

EXHAUST FAN SCHEDULE

FAN Nº	SERVICE	LOCATION	MANUFACTURER'S (ACME) MODEL Nº	DESIGN C.F.M.	DESIGN S.P. W.G.	FAN CLASS / ARRG'T.	FAN R.P.M.	FAN B.H.M.	MOTOR R.P.M.	MOTOR H.P.	REMARKS
EF-1	LAB. EXH. ELECT. SHOP RM. 287	ROOF	PN 135 F	1,000	0.86		1340			1/3	PRE-FAB SOUND ATTENUATION CURB (MODEL RF) COMPLETE WITH BACKDRAFT DAMPER. MOTOR: FACTORY WIRED TO JUNCTION BOX AND COMPLETE WITH SAFETY SWITCH AND BIRDSCREEN. PROVIDE STARTER WITH THERMAL OVERLOAD AS INDICATED ON PLANS. (NOTE TYPICAL FOR EF-1 TO EF-6 AND EF-8 TO EF-14).
EF-2	LAB. EXH. TAPE ETCH. RM. 289	"	PN 135 F	1,000	0.86		1340			1/3	
EF-3	NORTH SANITARY EXHAUST	"	PN 165 E1	1,475	0.38		860			1/4	
EF-4	SOUTH SANITARY EXHAUST	"	PN 200 G	2,425	0.50		800			1/2	
EF-5	CAMERA RM. EXHAUST RM. 273	"	PN 135 E	1,200	0.50		1200			1/4	
EF-6	VAP. DEGREASER EXH. RM. 280	ROOF	PN 135 E4	800	0.50		1000			1/6	
EF-7	LECTURE RM. EXH. RM. 212	2ND FLOOR CEILING SPACE	PX9D4	1,115	0.50		1750			1/6	IN-LINE CENTRIFUGAL FAN (DIRECT DRIVE)
EF-8	SERVICE SHOP EXH. RM. 242	ROOF	PN 165 E	1,500	0.63		995			1/4	
EF-9	FURNACE EXHAUST RM. 278	"	PN 135 E4	800	0.5		1000			1/6	
EF-10	LAB. EXH. AUDIO RM. 289	"	PN 135 F	1,000	0.86		1340			1/3	
EF-11	AMBER RM. EXH. RM 271	"	PN 135 E4	800	0.50		1000			1/6	
EF-12	CLEAN RMS. 275 & 277	"	PN 135 E	1,000	0.75		1250			1/4	
EF-13	DARKROOM EXH. RM 460	"	PN 135 E2	300	0.25		700			1/4	
EF-14	FUME HOOD EXH. RM. 466	ROOF	PN 135 E	1,000	0.86		1300			1/4	

DIFFUSER & GRILLE SCHEDULE

SYMBOL	MANUFACTURER'S (TITUS) MODEL	BORDER	FRAME	FASTENING	DAMPER	FINISH	REMARKS
A	TMS	–	3	–	AG-75	TO ARCH. SPECIFICATION	FOR 'T'-BAR CEILING
B	TMS	–	1	–	AG-75		FOR DRY WALL CEILING
C	CORE STYLE # 272	C	–	A	#5		SUPPLY AIR SIDEWALL
D	CORE STYLE #3	C	–	A	#5		RETURN AIR SIDEWALL
E	CORE STYLE #3	ED	–	A	#5		RETURN AIR DUCT MTD.
F	CORE STYLE #59	CH	–	–	–		RETURN AIR FOR 'T'-BAR CEILING
G	CORE STYLE #50	TB	–	–	#5		EXHAUST FOR 'T'-BAR CEILING
H	CORE STYLE #50	C	–	A	#5		EXHAUST FOR DRYWALL CEILING
I	CORE STYLE # 272	ED	–	A	#5		SUPPLY AIR DUCT MTD.

STEAM HUMIDIFIERS

SYMBOL	SERVICE	LOCATION	MANUFACTURER'S (DRI-STEEM) MODEL Nº	STEAM PRESS. PSIG	STEAM FLOW LBS/HR.	REMARKS
HU-1	MULTI-ZONE UNIT #1	4TH FLOOR (SEE FL. PLAN)	5-60	10	90	SINGLE DISPERSION TUBE HUMIDIFIERS COMPLETE WITH TWO (2) - TWO PIECE ESCUTCHEON PLATES, NORMALLY CLOSED ELECTRIC STEAM VALVE MODULATING TYPE HAVING LINEAR STEAM FLOW CHARACTERISTICS, FLOAT, THERMOSTATIC STEAM TRAP AND STRAINER. DISPERSION TUBE DISCHARGE OPENINGS SHALL BE LOCATED WITHIN INDIVIDUAL ZONE DUCTS AND PROPERLY SIZED BY THE MANUFACTURER TO PASS STEAM QUANTITY IN A UNIFORM PATTERN AND PROPORTIONALLY ALONG THE ENTIRE INDIVIDUAL ZONE DUCT.
HU-2	" " " #2		"		80	
HU-3	" " " #3		"		70	
HU-4	" " " #4		"		65	
HU-5	" " " #5		"		75	
HU-6*	" " " #6		"		75	
HU-7	" " " #7		"		105	
HU-8	MULTI-ZONE UNIT #8		5-60		105	
HU-9	MULTI-ZONE UNIT #9		CV= E		15	MINI-BANK PRE-ASSEMBLED MULTIPLE DISPERSION TUBE HUMIDIFIERS FOR SMALL DUCTS COMPLETE WITH ESCUTCHEON PLATES, NORMALLY CLOSED ELECTRIC STEAM VALVE MODULATING TYPE HAVING LINEAR FLOW CHARACTERISTICS, FLOAT, THERMOSTATIC STEAM TRAP AND STRAINER.
HU-10	" " " #9		CV= E		15	
HU-11	" " " #9		CV= E		15	
HU-12	" " " #10		CV= G		25	
HU-13	" " " #10		CV= F		20	
HU-14	MULTI-ZONE UNIT #10		CV= F		20	
HU-15	SZ #1	4TH FLOOR (SEE FL. PLAN)	5-60	10	50	SEE REMARKS FOR HU-1 TO HU-8

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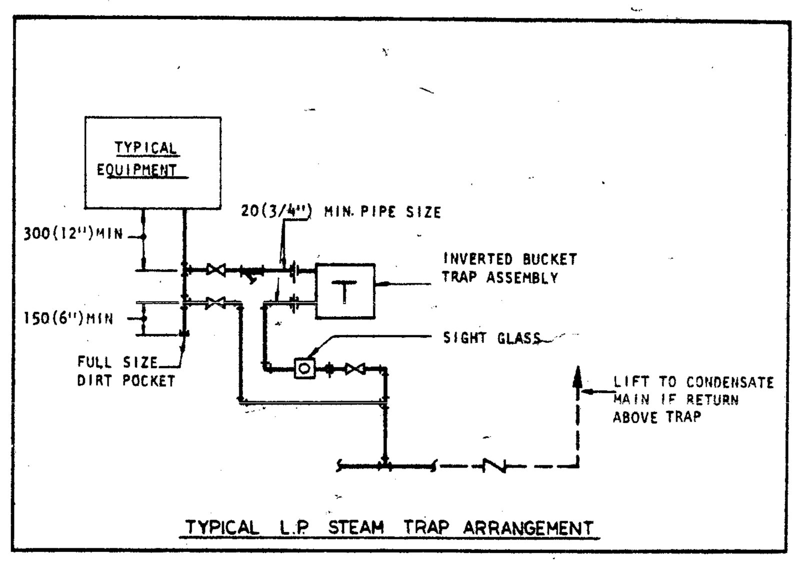
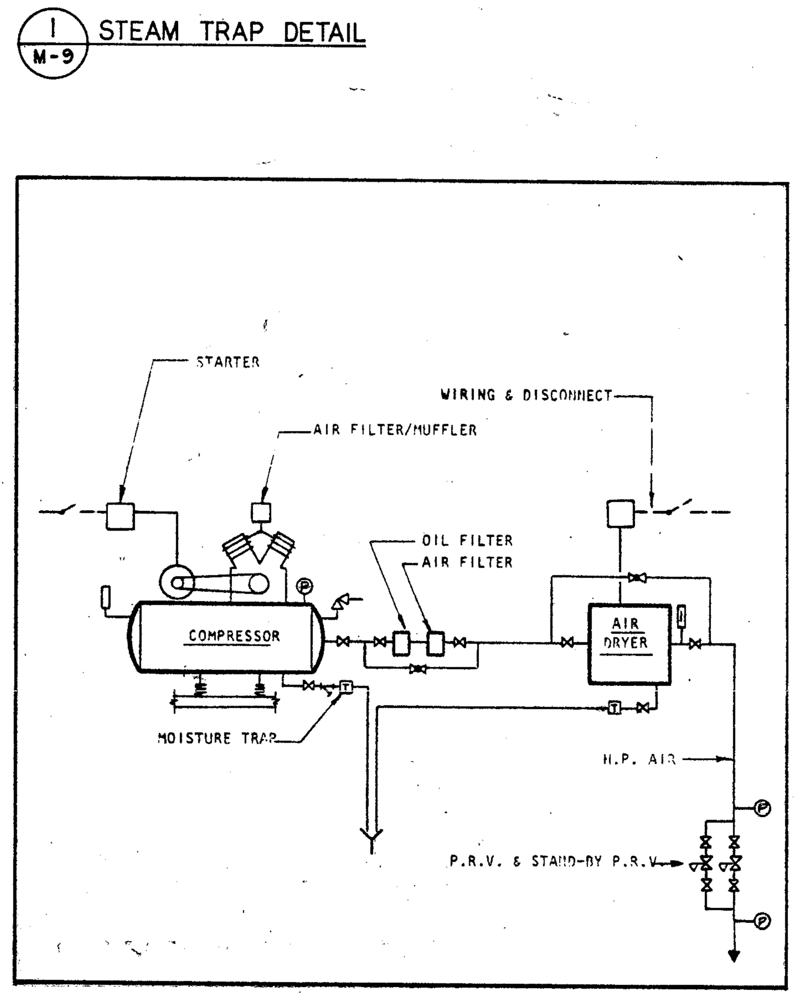
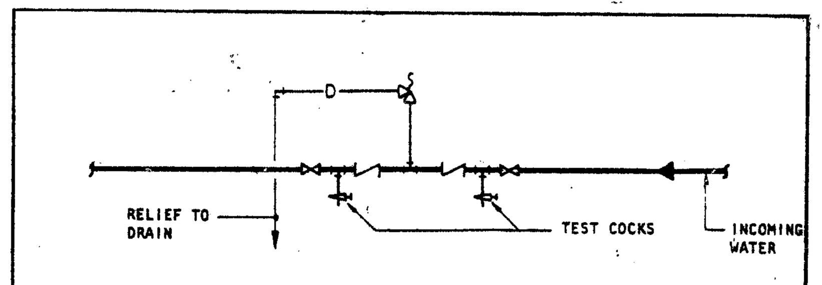


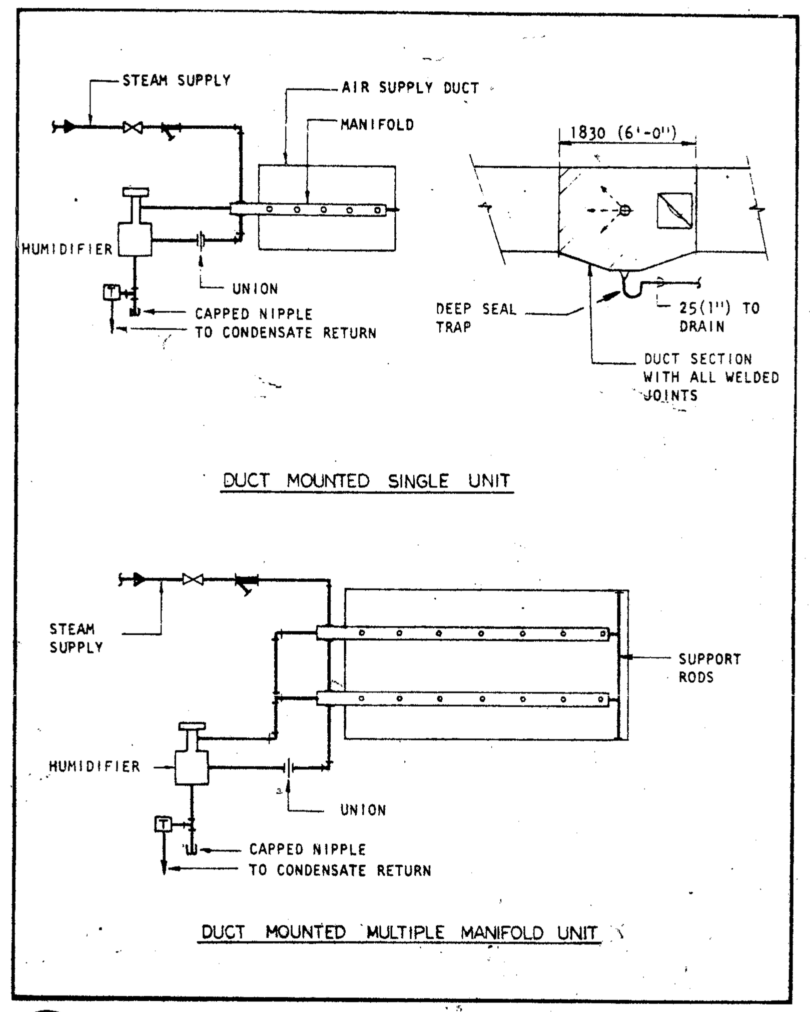
1 / M-9 STEAM TRAP DETAIL



2 / M-9 SMALL CAPACITY COMPRESSED AIR SYSTEM



3 / M-9 BACKFLOW PREVENTOR



4 / M-9 STEAM HUMIDIFIER INSTALLATION DETAIL

AIR CONDITIONING UNIT FOR ELECTRICAL ROOM (431)

Provide as shown on plans one(1) Carrier compact roof-top air-cooled condensing unit(ACCU-1). ACCU-1 shall be Model No. 38CB size 036, 40 F sat. suction temperature, 95 F temperature air entering condenser, 125 F sat. condenser temperature. Capacity = 34.9 MBH. Refrigerant R-12.

Unit shall be complete with factory wired controls. Compressor motor shall have both thermal and current sensitive overload devices. Protective devices shall include crankcase heater and high-pressure safety switch. Accessories shall include head pressure control, tubing packages, thermostat with subbase, indoor fan relay and filter-drier. Electrical: 208v/60/3ø

Provide as shown on plans one(1) Carrier Direct-Expansion Fan Coil Unit (FCU-1) FCU-1 shall be Model 40AQ 036 (Horizontal) to match condensing unit. 1300 cfm, 32.7 MBH sens. heat cap., 34.3 MBH total capacity at 80 F dbt/62 wbt temperature air entering coil. refrigerant 12.

Evaporator fan- Centrifugal direct drive, 1/3 hp. PSC motor. Unit shall be complete with 1-in. thick permanent filter, factory installed refrigerant metering device, refrigerant line fittings which permit mechanical connections, condensate pans with primary and auxiliary drain connections on each side, cooling control kit, 60-va control circuit transformer, line voltage terminal block and low voltage terminal strip. Electrical: 208v/60/3ø

LENNOX, TRANE are acceptable alternates.

FUME HOOD

Provide as shown on plans one (1) CANADIAN CABINETS STANDARD Fume Hood Model No. CC-70-SD (70" x 30" Deep x 83" High, work top 35" above finish floor) Exhaust requirement = 1200 cfm, 10" diam. exhaust collar size. Static pressure loss = 0.50 " w.c.

Fume hood shall be constructed of particle board, glue, and screw/nail fastened. The exterior front and sides finished in heavy duty plastic laminate. Rear exterior surface painted white and interior linings materials are of asbestos cement board. Angled front mullions shall be finished in stainless steel.

Provide a vapour proof light fixture pre-wired to an on/off switch located on the front left hand mullion. Provide a fully counter balanced laminated safety glass faceshield set into a stainless steel frame with full width handle.

Provide an on/off switch for connection to a remote exhaust fan.

Provide fume hood with a type 316, 10" diam. stainless steel duct stub approximately 2" high located central to hood. Work tops shall be Colorceran.

Provide the following item:
a) 6" diameter round stainless steel (type 316) cup sink (14-100-R)

b) Duplex electrical outlet located on front mullion of hood with stainless steel cover plate (14-300-L)

c) Sidewall mounted petcock with remote type operator to front mullion of hood.
14-600-R compressed air
14-600-R vacuum
14-600-R spare

d) Sidewall mounted cold water faucet (gooseneck type) with remote type operator to front mullion of hood (14-900-R)

e) Motor starting switch located on front mullion of hood (14-1100-L)

All components shall comply with the requirements of the following:
1. Ontario Occupational Health and Safety Act.
2. CSA
3. NFPA
4. All Local Codes
5. Inspection requirements of the Hydro Electric Power Commission.

PACKAGED STEAM BOILER

Provide as shown on the plans one (1) Cleaver-Brooks Model M4S Series 700, Size 2000, 47 hp./ 15 psi steam boiler. Operating pressure=10 psi.
Output = 1,600,000 Btu/hr. Gas fired, 1000 Btu/cft. Electrical Power 600/3ø/60 and 115v/1ø/60 for the control circuit.
Boiler shall be constructed in accordance with ASME Boiler Code.
Entire boiler base frame and other components shall be factory-painted before shipment, using a hard-finish enamel.
Steam boiler trim shall be complete with water column, feedwater pump control, low water cut off, auxiliary low water cut off, pressure gauge, steam pressure control and safety relief valve. A minimum of (3) controls shall be provided, of which one shall be manual reset.
Forced draft blower motor hp. = 2 hp., 600v/3ø/60.

Burner shall be integral with the boiler, of typed approved for operation with natural gas and shall operate on the High-Low-Off principle.

Combustion air damper and butterfly gas valve shall be controlled by a damper motor which shall regulate the burning rate according to load demand.

Gas burner piping shall be complete with primary gas shut off valve of the fluid power type, controlled by the program relay, high and low gas pressure switches, two lubricated plug cocks and a gas pressure regulator.

Boiler shall be complete with Burner Flame Failure Controller and NEMA 1A enclosure control panel. The control panel shall contain the electronic programming relay blower motor starter and control switches.

A manual-automatic switch shall be provided to permit continuous firing at the low fire or high fire rate when automatic firing is not desired.

The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit.

After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.

UNILUX is acceptable alternate.

BLOW DOWN TANK

Provide all welded steel tank in accordance with the ASME Code and Provincial regulations.

Blowdown Tank shall be Clemmer Industries Model No. 40001V, 24" O.D., 36" O.L. 100 psig Working Pressure, 1500 lbs. per hour maximum Boiler Steam Evaporative Capacity, 60 USgal. tank.

Tank shall be complete with legs, 11"x15" manhole, nameplate with ASME and Provincial Stamp, pressure gauge connection, 1" cold water connection with copper spray pipe, 3" vent connection, 1-1/2" drain connection, 1" inlet connection, 2" outlet connection with inlet pipe down to within 6" of tank bottom, dished heads, one coat of red primer, temperature well, and temperature controller well.

Solidly anchor blowdown tank to boiler room floor slab.

Insulate blowdown tank with 2" thick glass fibre metal mesh blanket, 2.5 lbs. density and cover with close weave smooth finish, 6 oz./sq.yd. canvas. Fasten canvas to insulation with fire resisting lagging adhesive. Coat with one heavy brush coat of undiluted lagging adhesive.

O'CONNOR TANKS is acceptable alternate.

TWIN PACKAGED WATER SOFTENERS

Provide as shown on the plans one(1) Cleaver-Brooks Twin Packaged water softeners Model No. ACC-SAB 30-1.

Exchange capacity - max. grains = 30,000, min. grains = 20,000
Maximum continuous service flow = 7 USgpm, max. pressure loss = 10 psi.

Tank Dimensions: Softener (2) - 9" ø x 48" High, Brine tank - 18"ø x 31" high
Packaged unit shall be fully automatic with option for manual regeneration, complete with "altwinator", water meters, automatic cycle controller and automatic backwash control. Secure all components of the twin packaged water softeners.

Supply a complete set of instructions for installation and operation of the equipment.

PACKAGED BOILER FEEDWATER TANK SYSTEM

Provide as shown on plans, one(1) Cleaver Brooks model number DP-E4-1/3 Duplex Packaged Boiler Feed System consisting of 30 USgal. receiver of galvanized steel with dished heads, turbine pumps, 1/3 hp., 1750 rpm motor, 115v/1ø/60 built in a standard NEMA frame, 3 way strainer valves, steel base and supports, and all necessary suction piping factory installed.
The system shall be suitable for returning 7 gpm at a pressure of 15 psi for 200 F water to supply a 47 hp. boiler.

The receiver shall contain all necessary openings, float operated automatic make-up water feeder, water level sight glass with shut off valves and back angled thermometer. The receiver shall be 3/16" galvanized steel and shall be mounted on structural steel legs attached to the pump base. Receiver shall have one(1) only feedwater preheater to heat 3.0 gpm supply water from 50 F to 200 F when supplied with steam at 10 psig. Provide steam control valve to maintain feedwater temperature at desired temperature.

Unit shall be complete with starter for 1/3 hp., 115v/1ø/60, transfer switch to provide standby operation mounted and wired in the panel.

Provide pumps with chemical pot feeder as shown on drawings.

DOMESTIC HOT WATER HEATER

Provide Dom. Hot Water Heater as shown on plans. Domestic hot water heater shall be Rheem/Ruud Model GL67-120 having gas input of 120,000 btu/hr and recovery rate of 101 gph at a 100 F temperature rise. Water heater shall have the CGA seal of approval.

Tank shall have a working pressure rating of 150 psi, and shall be equipped with a boiler-type hand-hole cleanout. Water heater shall be of external flue design, and completely factory assembled, including a pressure regulator properly adjusted, stainless steel burner, and an ASME rated, temperature and pressure relief valve. Controls will be arranged for 100% safety shut-off in event of pilot failure. Complete unit shall be insulated with a 2" blanket of Fiberglas.

DOMESTIC HOT WATER RECIRCULATING PUMP

Provide as indicated on plans, Armstrong In-Line Circulating pump, Model No. H-41, all bronze construction, having a capacity of 5 USgpm handling water at 140 F against a total head of 16 feet. Pump shall be equipped with a 1/6 hp. motor, 115v/60/1ø, 1750 rpm, drip-proof, resilient mount, sleeve bearing motor. Pump to be equipped with a water-tight, long-life mechanical seal. Provide unit complete with manual starter and pilot light.

ELEVATOR PUMP Nos. P1-01 and P1-02

Provide as indicated on plans Submersible Duplex Pumping System consisting of:
Hydromatic submersible SP-50MH 1 pumps, complete with 1/2 hp., 115 volt, 1 phase, 60 cycle motors with 40 ft. power cord, 2" N.P.T. discharge, delivers 35 US gpm at 35 ft. total head.

Unit shall be complete with the following:
DP 0051 duplex alternator, starter and control panel, 115 volt, 1 phase, 60 cycle, c/w HOA switches, run lights, reset button, 3-leg thermal overload heaters to suit pump motors, and disconnect switches in CEMA 1 enclosure.

ME 40 mercury float switches with 40 ft. cords, 1 for pump "on", 1 for pump "off", 1 for both pumps "on" levels.
HW 101 high water alarm panel, 115 volt, c/w bell, pilot light, silencing switch and 24 volt transformer, in CEMA enclosure.

ME 40 mercury float switch with 40 ft. cord for alarm level.

Provide 36" Diameter curb frame and cover plate in 2 sections, 1 section for inspection and access, and other section c/w all openings as required for pump discharge pipes and controls.

GENERAL NOTES

REF.	DATE	DESCRIPTION	CH'D
	SEPT 24/84	ISSUED FOR TENDER	F.N.

REVISIONS

CHECK AND VERIFY ALL DIMENSIONS BEFORE PROCEEDING WITH THE WORK.

MN
CONSTR'N NORTH

PROFESSIONAL [redacted] PROVINCE OF ONT

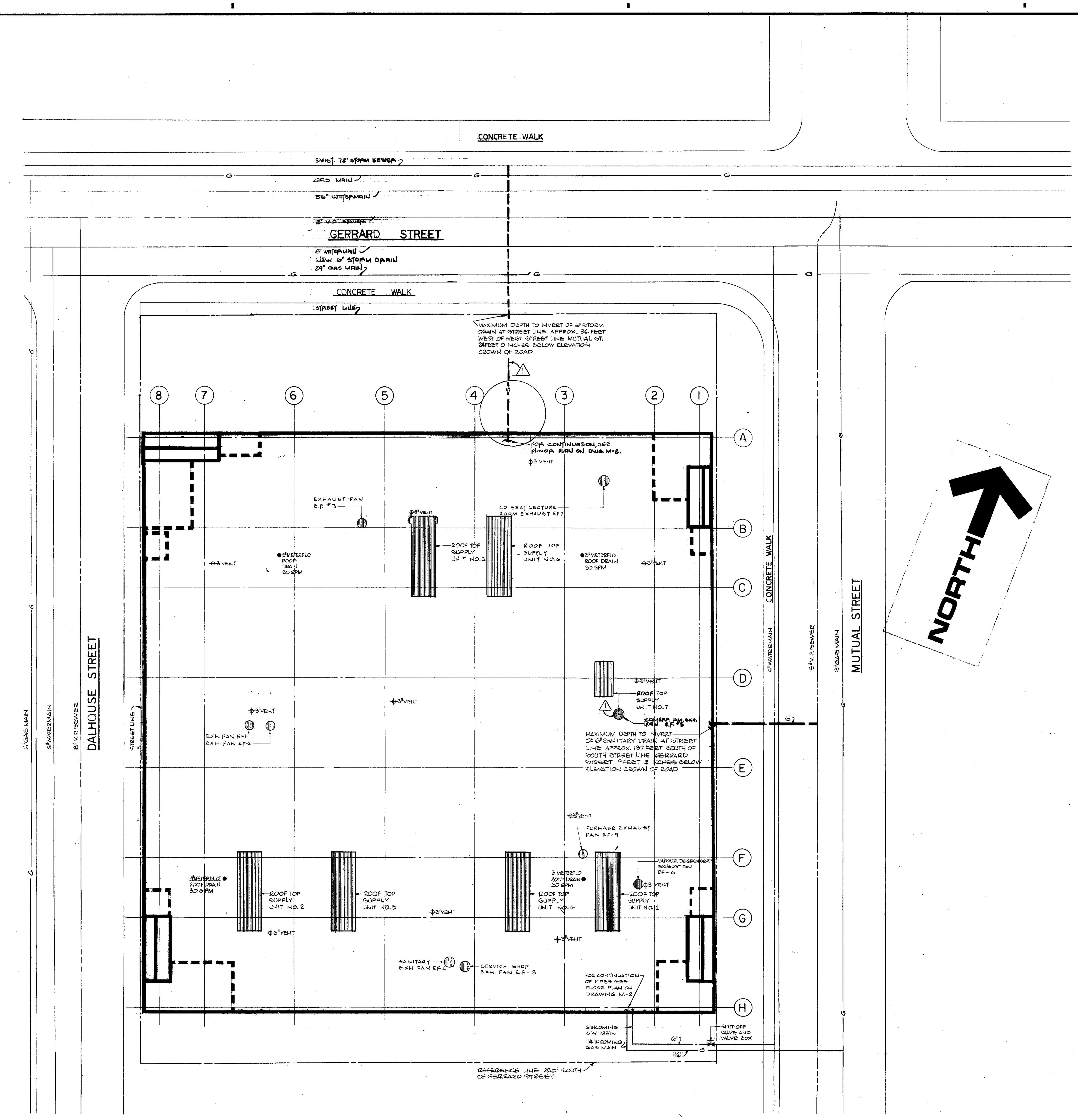
DUNLOP FARROW AITKEN CANSFIELD
architects engineers

THE ECE GROUP LTD.
CONSULTING ENGINEERS
205 Lesmill Road
Don Mills, Ontario M3B 2V1

PROJECT NAME:
CENTRE FOR ADVANCED TECHNOLOGY EDUCATION
ADDITION TO TECHNOLOGY ANNEX
RYERSON
87 Gerrard Street E., Toronto

DRAWING TITLE:
SCHEDULES AND DETAILS

SCALE: N.T.S.	PROJECT NUMBER: architect's: 8371
DATE: SEPT. 24, /84	owner's:
DRAWN BY: T.K.	DRAWING NUMBER: architect's: M-9
CHECKED BY: F.N.	owner's:



SITE AND ROOF PLAN 1/16"=1'-0"

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	SANITARY DRAIN ABOVE GROUND	F.L.D	FLOOR DRAIN
S	STORM DRAIN ABOVE GROUND	F.D	FIRE DAMPER
PD	POLYPROPYLENE DRAIN	C.O.	CLEANOUT
	VENT	R.D.	ROOF DRAIN
	COLD WATER	S.S.	SOIL STACK
	HOT WATER	W.C.	WATER CLOSET
	HOT WATER RECIRC	LAV	LAVATORY
DW	DE-IONIZED WATER	UR	URINAL
G	GAS MAIN	DF	DRINKING FOUNTAIN
F	FIRE MAIN	H.D.	HUB DRAIN
	STEAM SUPPLY	FHC	FIRE HOSE CABINET
	GATE VALVE		SANITARY DRAIN BELOW GROUND
	GLOBE VALVE	S	STORM " " "
	CHECK VALVE		
	STRAINER		
	THERMOMETER		
	PRESSURE GAUGE		
T	THERMOSTAT		
	STARTER		

ROOF TOP HEATING AND COOLING UNIT SCHEDULE

UNIT NO.	CFM	TOTAL COOLING LOAD BTU/HR.	ELECTRIC HEATING LOAD K.W.	SUPPLY AIR S.P. "W.G.	EVAPORATOR FAN H.P.	RETURN AIR S.P. "WG.	RETURN AIR FAN HP	CONDENSER FAN MOTORS	CONDENSER FAN HP	COMPRESSORS AND TONS	UNIT MODEL	NO. OF ZONES	REMARKS
1	15,000	420,000	40	0.5	10	0.4	5	3	1	3-11	DMS3-415	4	12 ZONE HEAD
2	13,000	400,000	30	0.5	7.5	0.4	5	3	1	3-11	DMS3-415	6	12 ZONE HEAD
3	11,500	403,000	25	0.5	5	0.4	3	3	1	3-11	DMS 3-415	10	18 ZONE HEAD
4	10,700	315,200	30	0.5	5	0.4	3	3	1	3-11	DMS 3-415	8	12 ZONE HEAD
5	12,500	387,000	50	0.5	7.5	0.4	5	3	1	3-11	DMS3-415	6	12 ZONE HEAD
6	13,000	368,500	50	0.5	7.5	0.4	5	3	1	3-11	DMS 3-415	8	12 ZONE HEAD
7	6,500	161,200	20	1.0	7.5	0.4	—	2	1	2-8	CHA 8-1853	1	WITH POWER SAVER RD3-185

NOTE: ALL UNITS SHALL BE COMPLETE WITH ELECTRICAL SPLITTER PANEL IN THE UNIT SUPPLIED & INSTALLED IN THE FACTORY. SPLITTER SHALL BE OF SUFFICIENT SIZE TO FEED ALL POWER EQUIPMENTS OR UNITS

ELECTRIC HEATING SCHEDULE

HEATING UNIT	TYPE	CAPACITY WATTS	CAPACITY KW	VOLTS	PHASES	CYCLE	THERMOSTAT LOCATION	REMARKS
BASEBOARDS								
B B (A)	B-2	500		208	1	60	BUILT-IN	
B B (B)	B-2	750		208	1	60	BUILT-IN	
B B (C)	B-2	1000		208	1	60	BUILT-IN	
B B (D)	B-2	1250		208	1	60	BUILT-IN	
B B (E)	B-2	1500		208	1	60	BUILT-IN	
CONVECTORS								
CONV (A)	FCH7230-10T	3000		208	3	60	BUILT-IN	
CONV (B)	FCH7220-10T	2000		208	3	60	BUILT-IN	
CONV (C)	FCH 7215-10T	1500		208	3	60	BUILT-IN	
CONV (D)	KCIW-33C1	3000		208	3	60	BUILT-IN	
FORCE FLOWS								
F F (A)	CUH 320 RGWB		20	600	3	60	REMOTE	
F F (B)	CUH 320 RGWB		15	600	3	60	REMOTE	
F F (C)	CUH 320 RB		20	600	3	60	REMOTE	
UNIT HEATERS								
U H (A)	BUH 153		15	600	3	60	REMOTE	

REHEAT COIL SCHEDULE

REHEAT COIL NO.	CFM	LOAD	DUCT SIZE	VOLTAGE	REMARKS
1	435	2.0 K.W	12"x8"	1/60/208	
2	170	1.0 K.W	8"x6"	1/60/208	2 REQUIRED
3	440	2.0 K.W	12"x8"	1/60/208	
4	380	2.0 K.W.	10"x8"	1/60/208	
5	190	1.0 K.W	8"x6"	1/60/208	2 REQUIRED
6	480	2.5 K.W	12"x8"	1/60/208	
7	1450	5.0 K.W	16"x14"	1/60/208	
8	120	.75 K.W.	8"x4"	1/60/208	
9	450	2.0 KW	10"x8"	1/60/208	

SUPPLY & EXHAUST FAN SCHEDULE

FAN NO.	MODEL	C.F.M.	S.P	R.P.M.	HP	SYSTEM	REMARKS
EF-1	15R 1B	1000	3/8"	960	1/8	LAB EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-1	15R 1B	1000	3/8"	960	1/8	LAB EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-3	15R 1B	1125	1/4"	900	1/8	SANITARY EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-4	15R 1B	1025	1/4"	900	1/8	SANITARY EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-5	15R 3B	1200	1/4"	1180	1/4	CAMERA ROOM EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-6	15R01B	800	1/4"	800	1/12	VAPOUR DEGREASER EXH.	WITH BACKDRAFT DAMPER TYPE L
EF-7	15R 1B	1200	1/4"	960	1/8	LECTURE ROOM EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-8	18R 2B	1500	1/4"	800	1/8	SERVICE-SHOP EXHAUST	WITH BACKDRAFT DAMPER TYPE L
EF-9	15R 1B	800	1/4"	800	1/12	FURNACE EXHAUST	WITH BACKDRAFT DAMPER TYPE L
SF-1	CB&F SIZE 28	9000	1/4"	1040	2	ELECT. ROOM SUPPLY	WITH MB WHEEL

NOTE: PROVIDE TYPE V.C.A. PREFABRICATED CURB WITH EXHAUST FANS

DIFFUSER, REGISTER & TROFFER SCHEDULE

TYPE	MODEL	REMARKS
A	DM SERIES WITH PANEL	DIFFUSER PANEL 30"X30" FOR T-BAR
B	DM	DIFFUSER
C	CRE 508	REGISTER
D	T 70	GRILLE C/W MODEL FD-20-V COMB. BALANCING & FIRE DAMPER
E	A980 WF	GRILLE
F	TD	TROFFER
G	CRE 500	GRILLE

PIPE SIZING TABLE

FIXTURE	DRAIN	VENT	C.W.	H.W
WC 'A'	4"	1½"	1	
WC B	4"	1½"	½"	
URINAL	2"	1½"	¾"	
LAV 'A'	1¼"	1¼"	½"	½"
LAV 'B'	1¼"	1¼"	½"	½"
SINK (1 COMP)	1½"	1¼"	½"	½"
SINK (2 COMP)	1½"	1¼"	½"	½"
D.F.	1¼"	1¼"	½"	
SERV. SINK #1	3"	1½"	½"	½"
SERV. SINK #2	3"	1½"	½"	½"

NO.	DATE	REVISION	D'WN	CH'D
1	OCT 5/71	REVISED AS-BUILT	B.A.	

THE GENERAL CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND REPORT ERRORS AND OMISSIONS TO THE ARCHITECTS

DRAWINGS MUST NOT BE SCALED.

THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS COUNTERSIGNED BY:

ARCHITECTS
CRANG AND BOAKE

R.T. TAMBLYN & PARTNERS
CONSULTING ENGINEERS

CRANG & BOAKE — ONTARIO ASSOCIATION OF ARCHITECTS — MEMBERS — ARCHITECTS

REGISTERED PROFESSIONAL ENGINEER — R. K. SYLVESTER — PROVINCE OF ONTARIO

TECHNOLOGY ANNEX
PROJECT 115

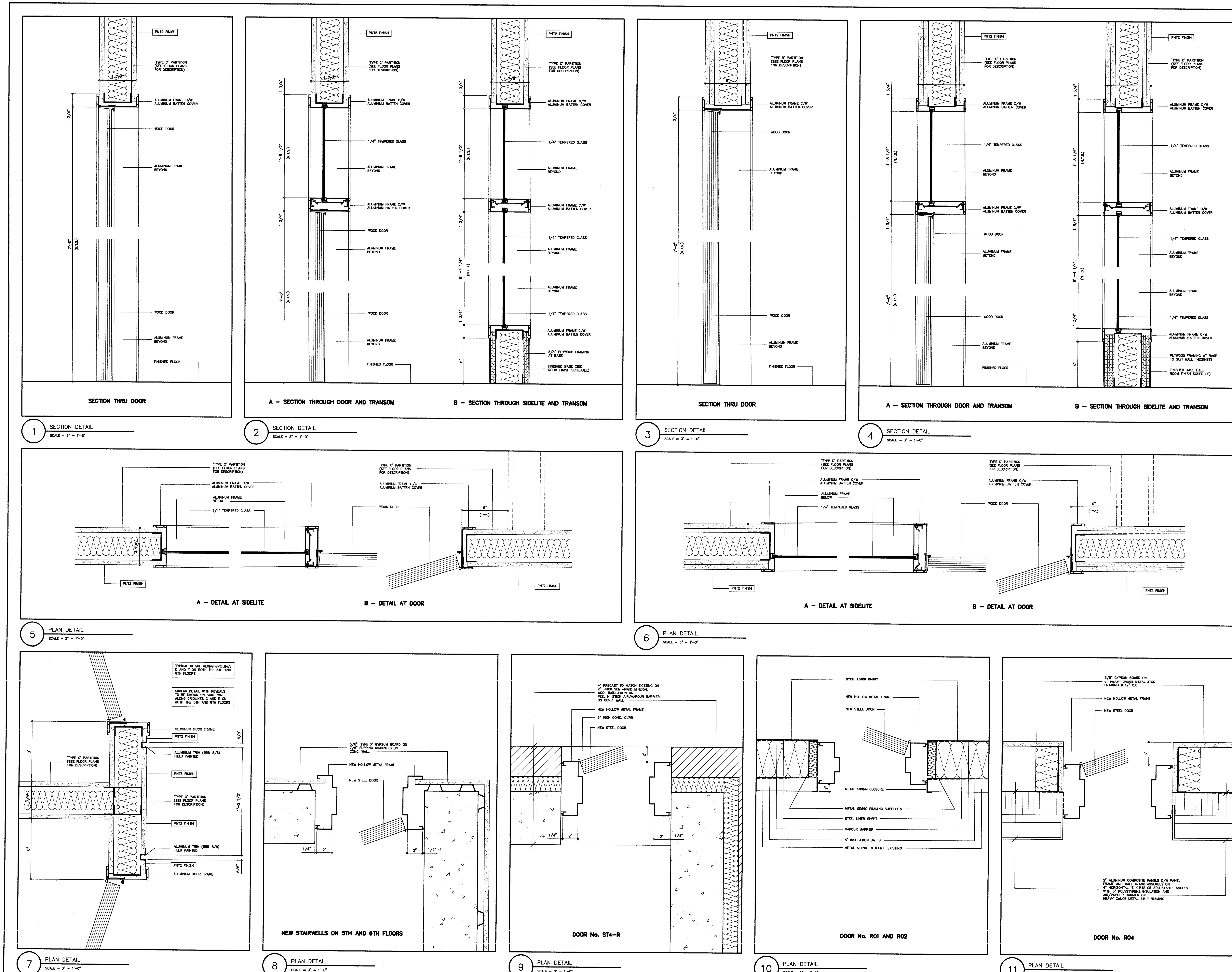
RYERSON POLYTECHNICAL INSTITUTE TORONTO ONTARIO

SITE PLAN

SCALE: AS NOTED	DATE: JUNE 121/70
CHECK'D: R.K.S. & R.G.B.	DRAWN: W.S.
COMM. NO.: 723	DRAWING NO.: M-1

109-70

EPH/SHE 053



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NOTE: REFER TO DRAWING A2-08 AND A2-09 FOR LIST OF WALL AND FLOOR FINISHES

No.	Description	Date
4	ISSUED FOR TENDER	MAY 09, 2001
3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE
4666

Ontario
SuperBuild

Project Manager

Cansult Hanscomb
Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY
ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

DOOR AND FRAME DETAILS

Graphic Scale

Sheet no. A5–12

Printed	Scale	Date	Job No.
	3" = 1'-0"	MAY 07, 2001	200004

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	CAT

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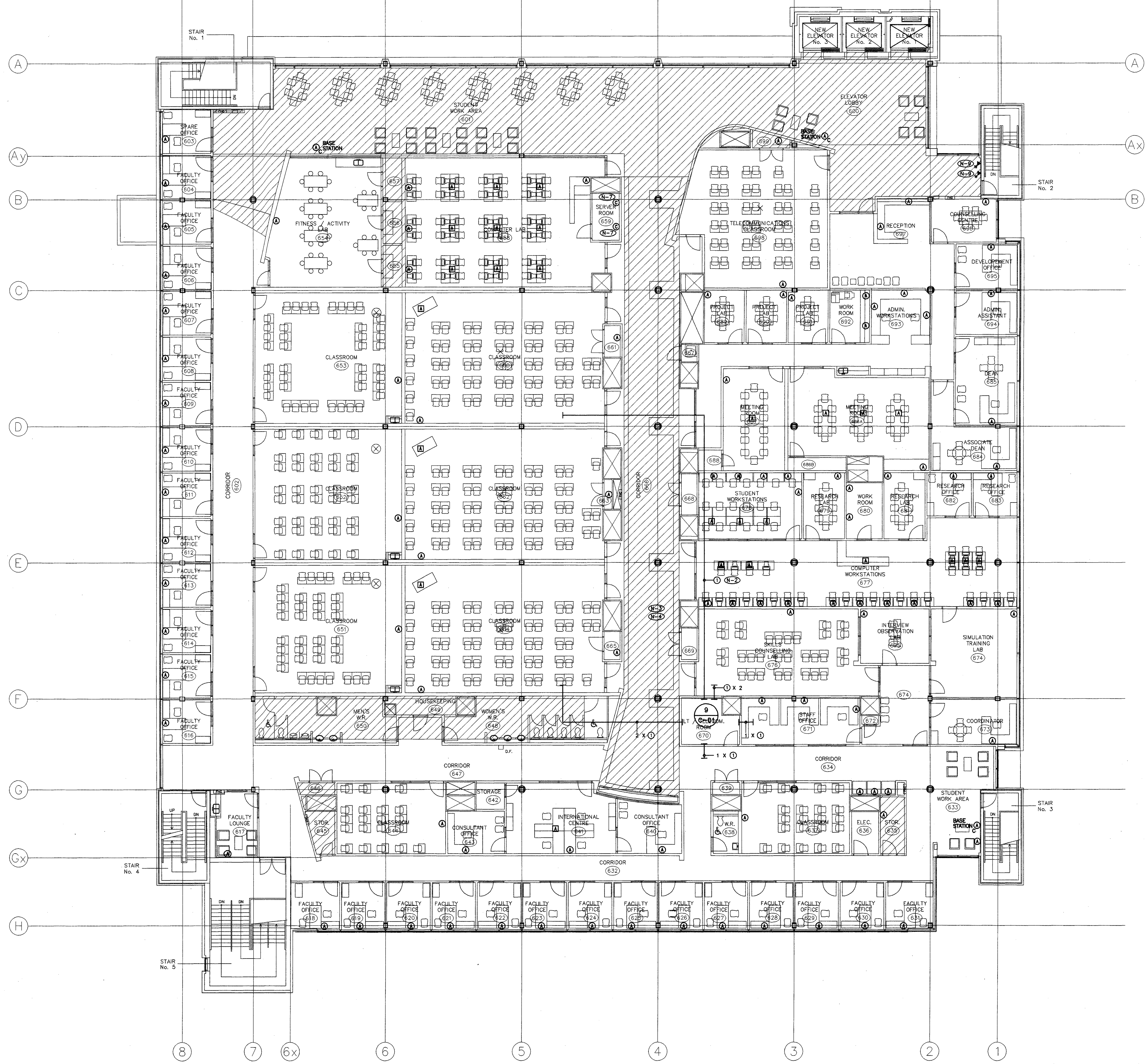
SHE131



① EMPTY 4" ZONE CONDUIT PROVIDED BY ELECTRICAL CONTRACTOR

N-1 EXACT LOCATION OF DEVICES TO BE COORDINATED WITH ELECTRICAL CONTRACTOR.

N-2 ZONE CONDUIT INDICATED FOR FUTURE USE ONLY. DO NOT UTILIZE.

N-3 DO NOT RUN CABLES FREE AIR THROUGH DRYWALL CELING AREAS. UTILIZE ZONE CONDUITS PROVIDED BY ELECTRICAL CONTRACTOR.

N-4 HATCHING DENOTES AREAS OF DRYWALL CEILING.

N-5 UTILIZE ZONE CONDUITS TO ROUTE HORIZONTAL CABLES TO IT/TELECOMMUNICATIONS ROOM.

N-6 PROVIDE 5' OF SLACK FOR ALL HORIZONTAL CABLES AT WORKSTATION END.

N-7 PROVIDE CUSTOM METAL BRACKETS TO FASTEN PATCH PANELS ONTO OWNER SUPPLIED RACKS.

N-8 ALL PARTITIONS TIGHT TO SLAB. COMMUNICATIONS CONTRACTOR TO PROVIDE ALL PENETRATIONS AND SEALS FOR REQUIRED OPENINGS. SEAL MUST BE SUITABLE TO MINIMIZE SOUND TRANSMISSION. REFER TO ARCHITECTURAL DRAWING A3-05 AND A3-06 FOR ADDITIONAL DETAILS.

N-9 IN ADDITION TO THE VOICE CABLE INDICATED, PROVIDE TWO (2) DATA CABLES AND ONE (1) ADDITIONAL VOICE CABLE. TERMINATE ON DATA AND VOICE HORIZONTAL TERMINATION FIELDS AT THE TELECOM. ROOM END RESPECTIVELY.

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No.	Description	Date
7.	FOR TENDER	05/09/01
6.	FOR COORDINATION	04/30/01
5.	TO CLIENT FOR 100% REVIEW	04/27/01
4.	FOR BUILDING PERMIT	04/18/01
3.	FOR 70% REVIEW	03/30/01
2.	FOR COORDINATION	03/10/01
1.	FOR REVIEW	03/09/01

REVISIONS ISSUES

Ontario SuperBuild

Project Manager

Cansult Hanscomb Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

HCC ENGINEERING
DESIGN AND TECHNOLOGY SERVICES GROUP
HCC ENGINEERING LIMITED
111 EGLINTON AVENUE EAST, SUITE 401
TORONTO, ONTARIO, M4P 1H4
Tel: (416) 932-2428 Fax: (416) 932-2156

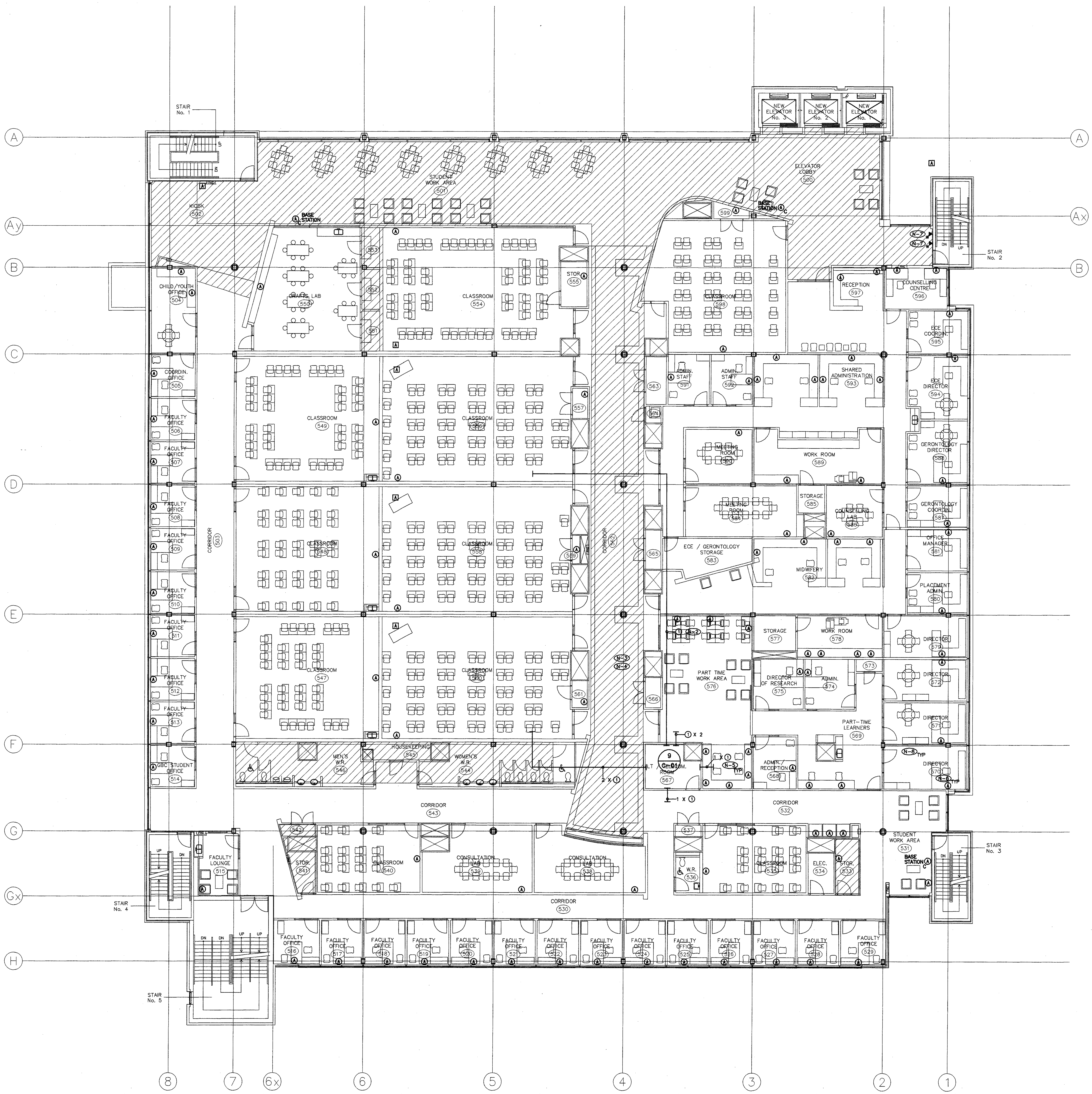
RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

COMMUNICATIONS SIXTH FLOOR PLAN

Graphic Scale 1/8" = 1'-0"		Drawn by: GCP/MSG
Printed	Scale	Checked by: HDC
Date JAN 04/01	Job No. 00160	Sheet no. C-06



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4.	FOR BUILDING PERMIT	04/18/01
3.	FOR 70% REVIEW	03/30/01
2.	FOR COORDINATION	03/10/01
1.	FOR REVIEW	01/23/01

REVISIONS ISSUES

BICSI EXPIRES 12/31/01 Regis. No. 20101

LICENSED PROFESSIONAL ENGINEER H. D. COHEN PROVINCE OF ONTARIO

Ontario SuperBuild

Project Manager

Cansult Hanscomb Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

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TELEPHONE 705 743-3311 | FAX 705 743-0056

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RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

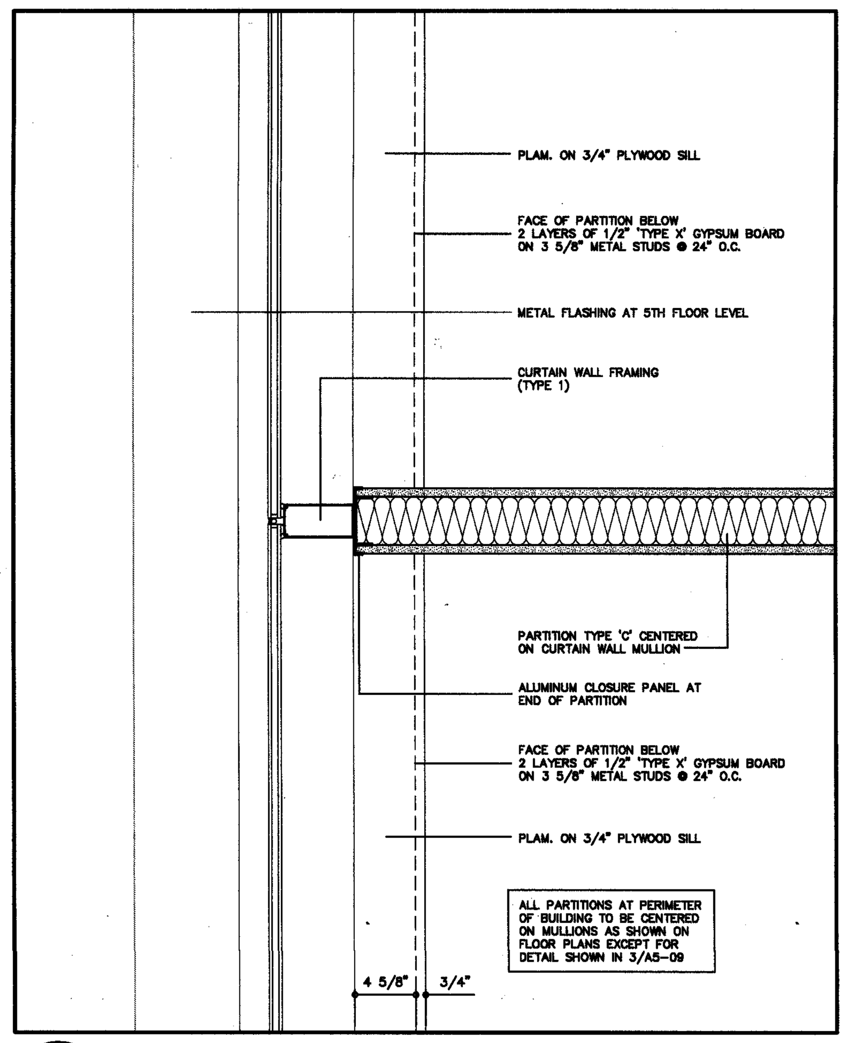
ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

COMMUNICATIONS FIFTH FLOOR PLAN

Graphic Scale		Drawn by:
1/8" = 1'-0"		GCP/MSG
Printed	Scale	Checked by: HDC
Date JAN 04/01	Job No. 00160	Sheet no. C-05

EPH/SHE 050 [redacted]



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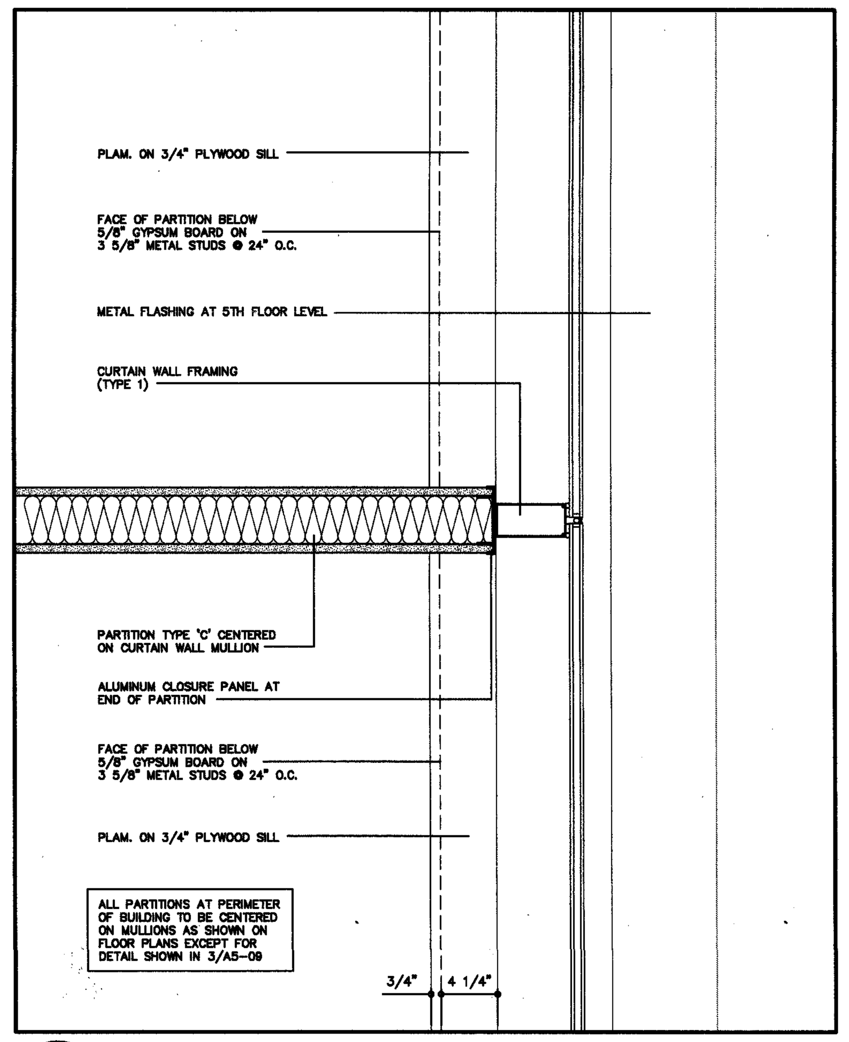

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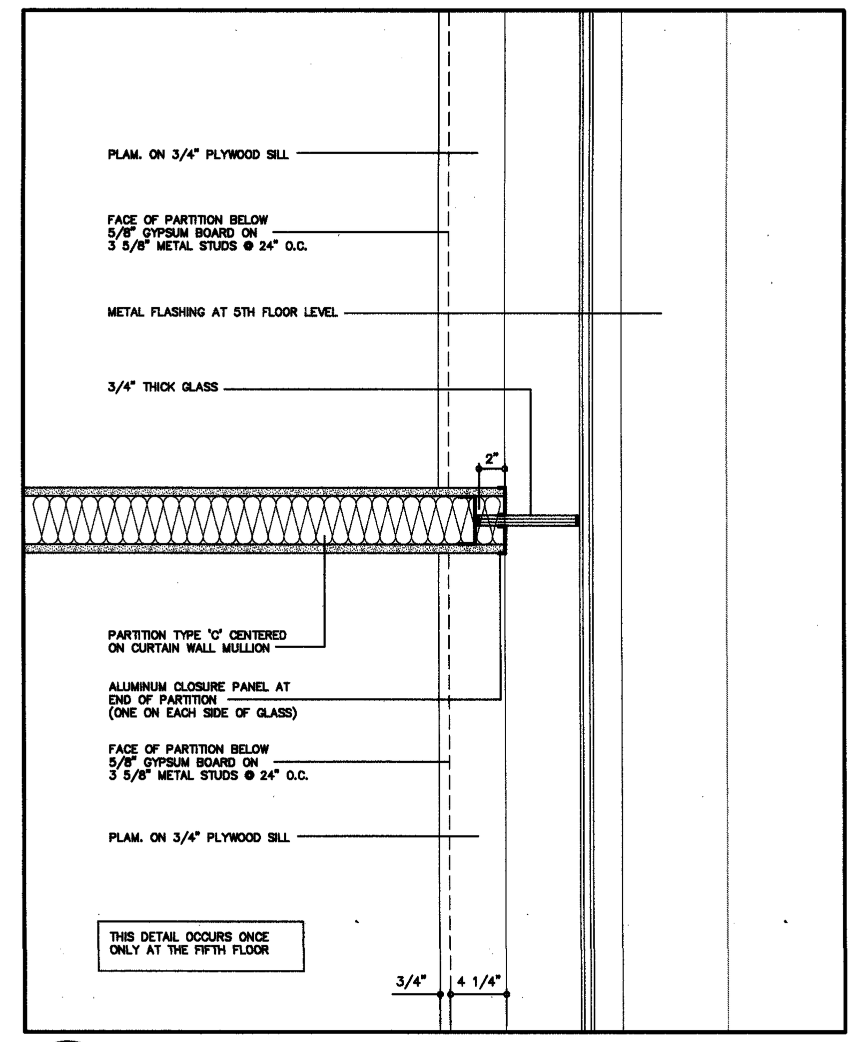

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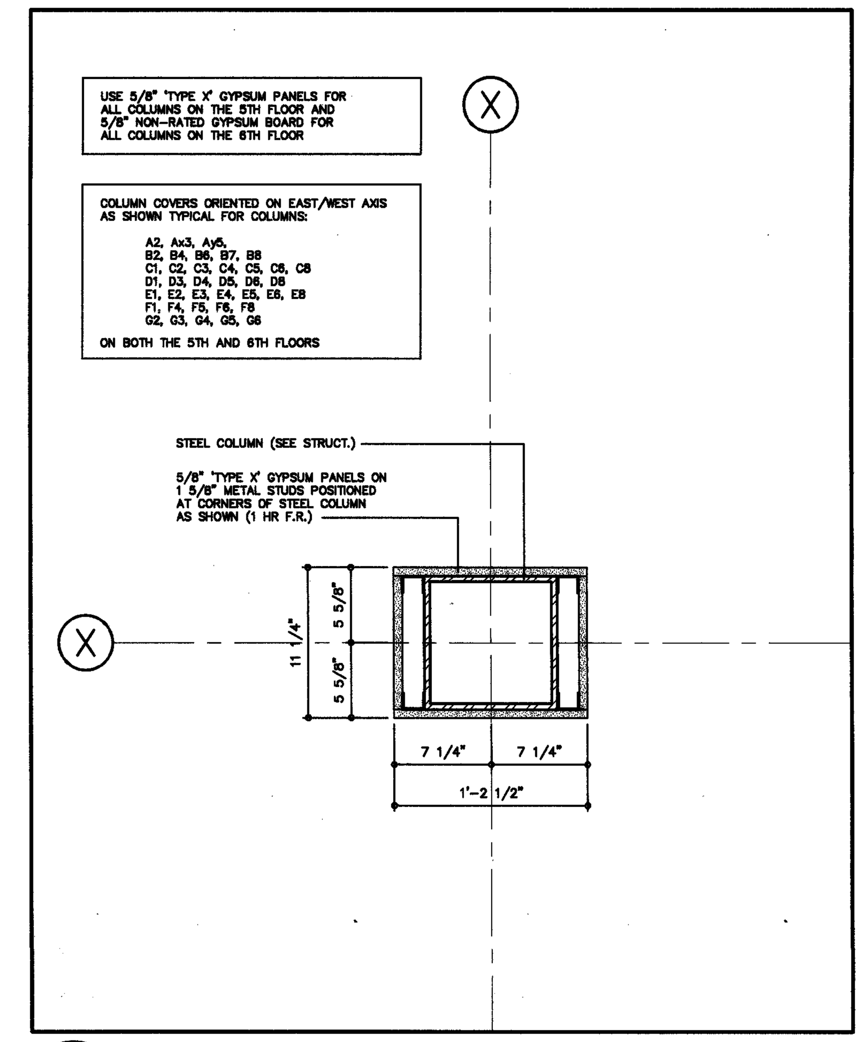

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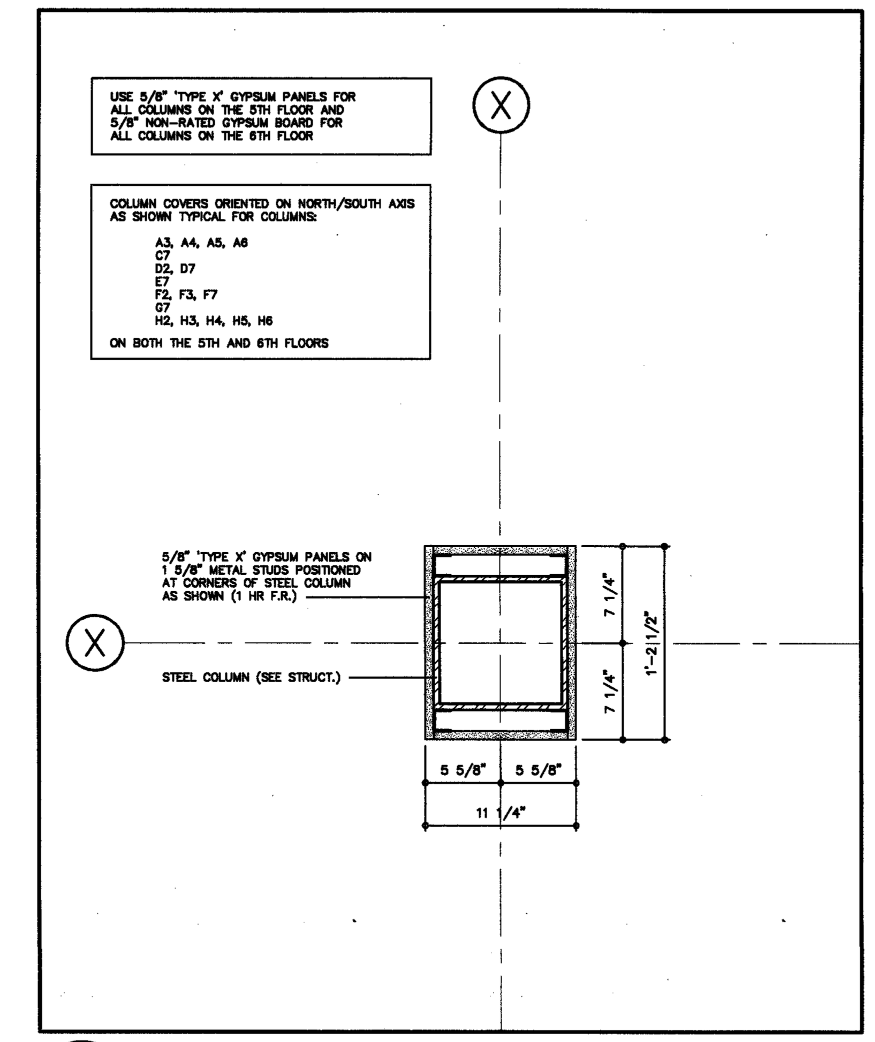

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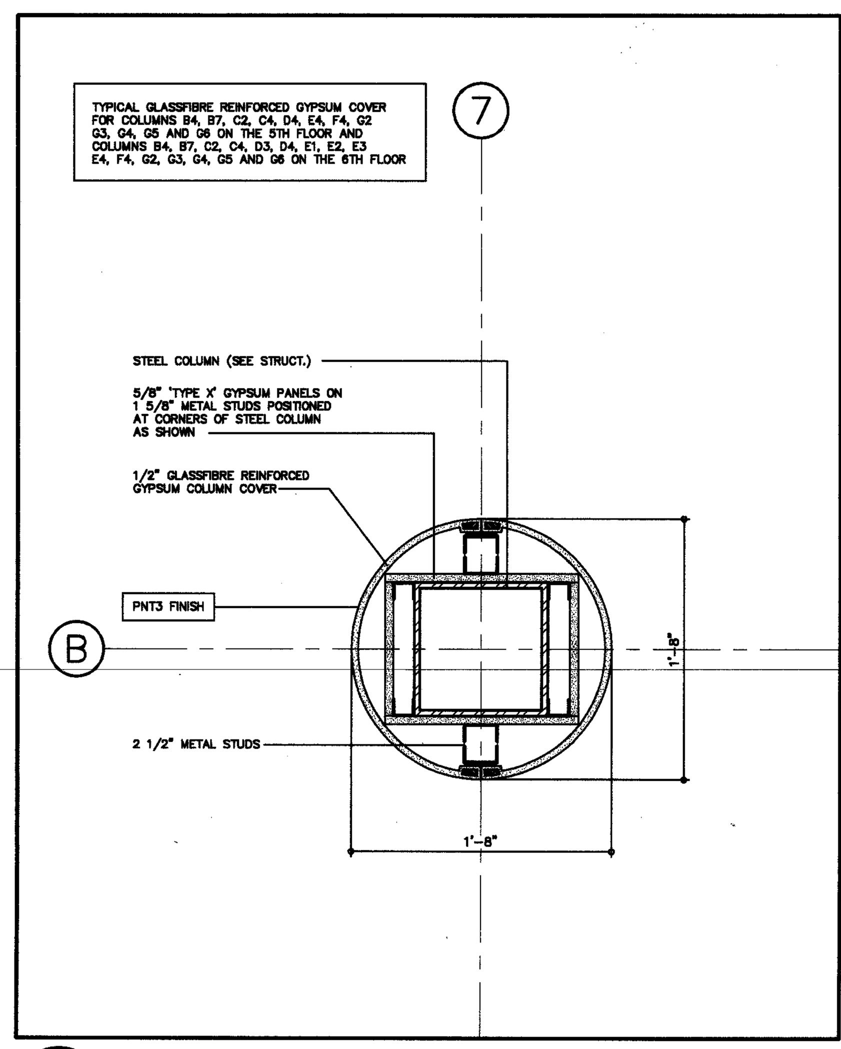

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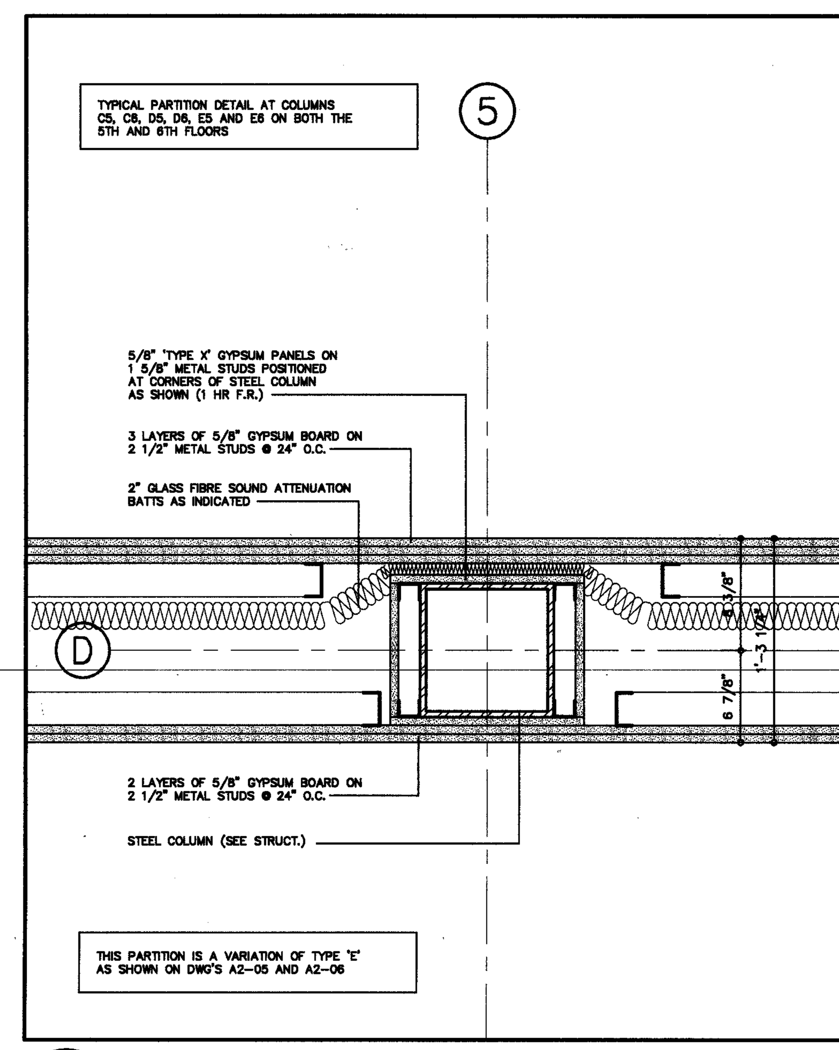

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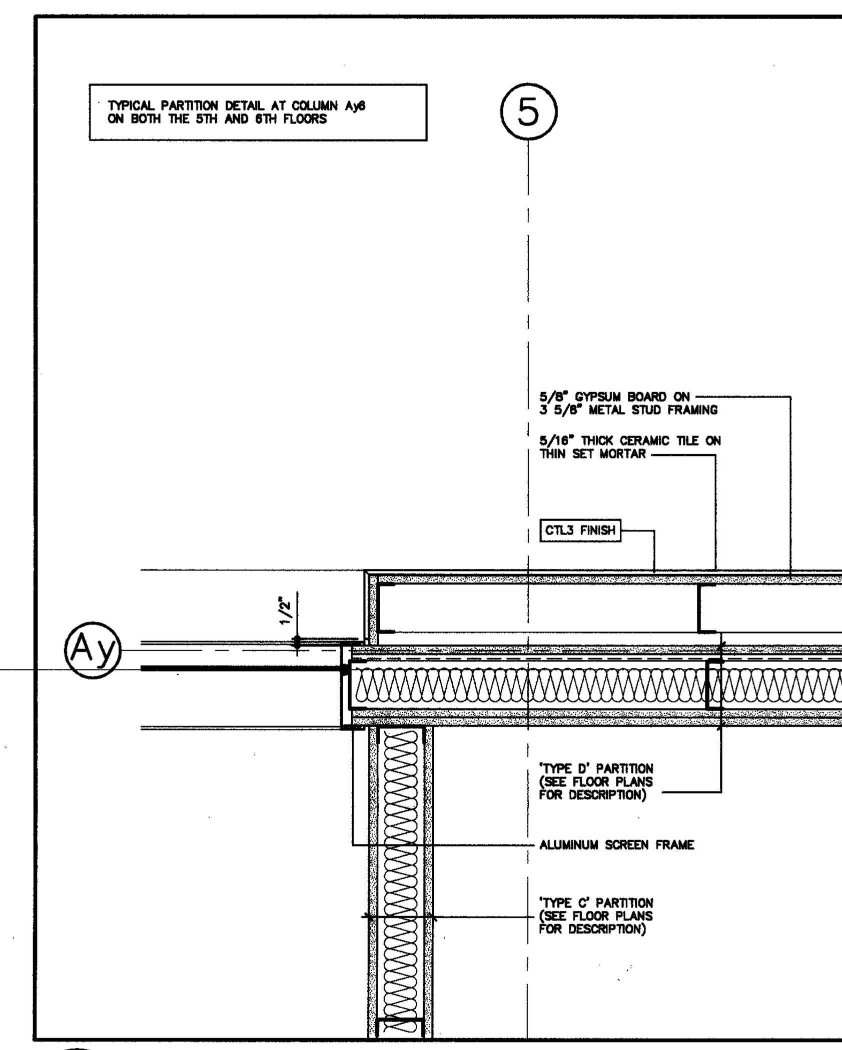

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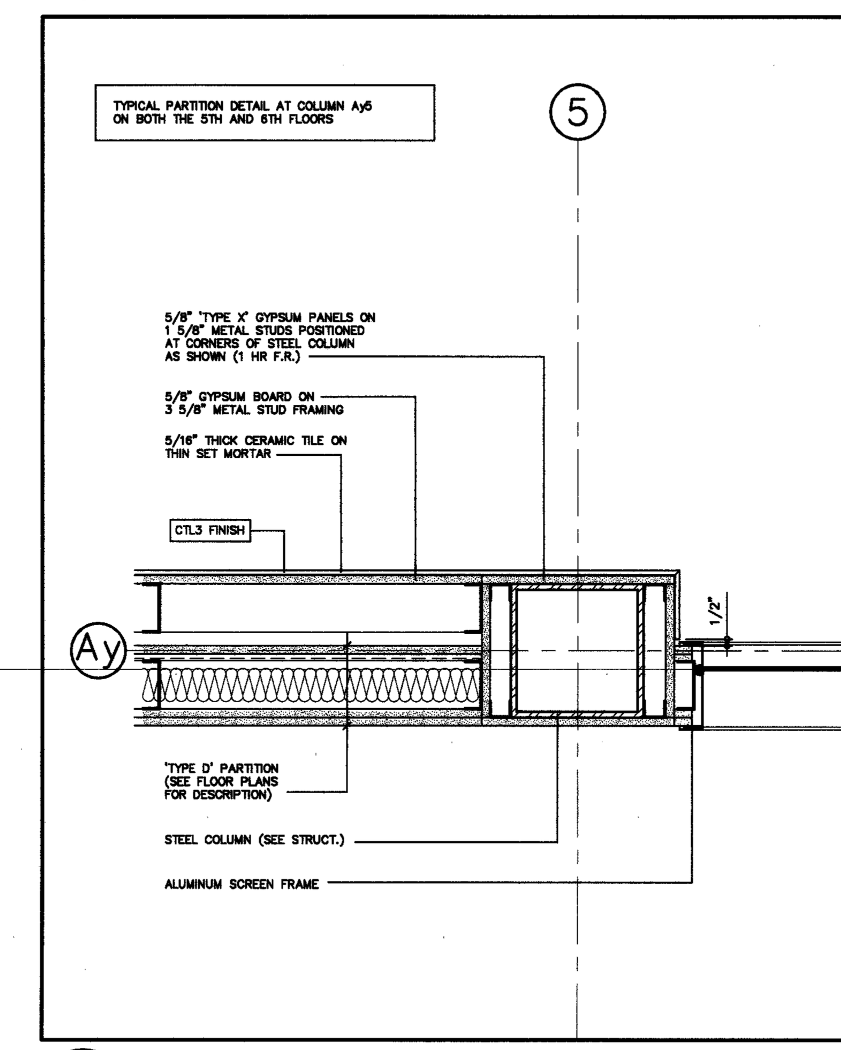

9 PLAN DETAIL
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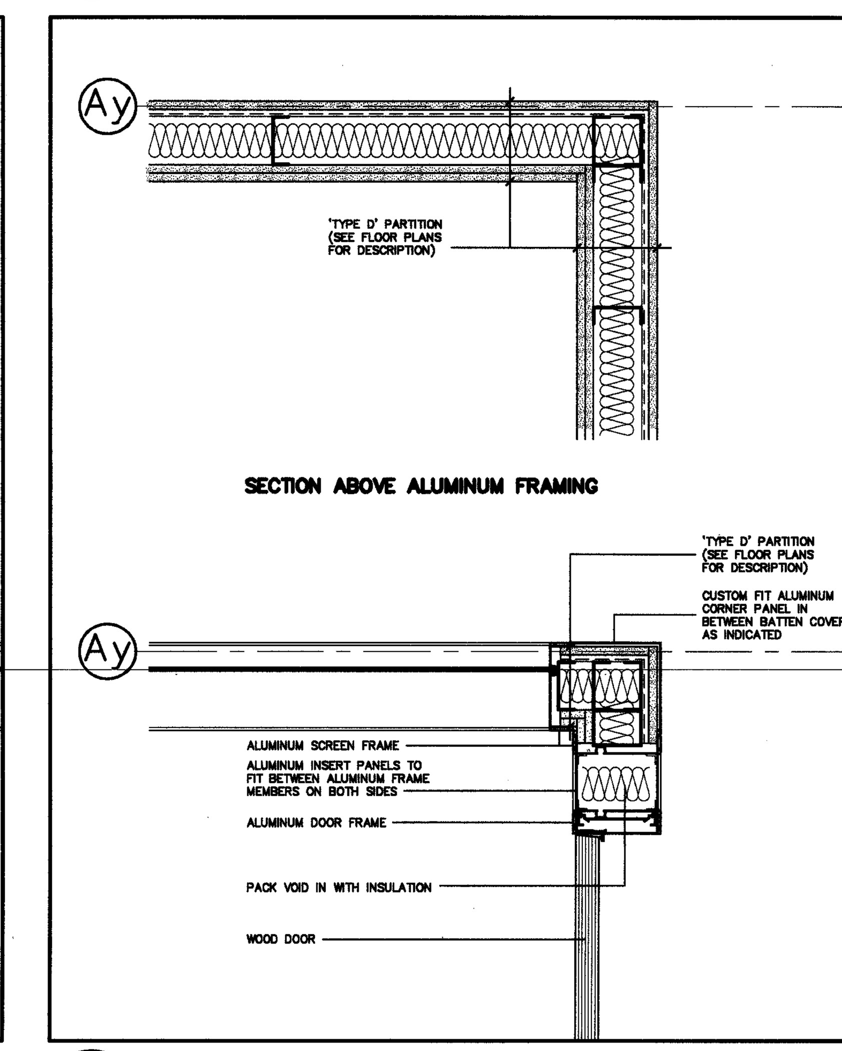

10 PLAN DETAIL
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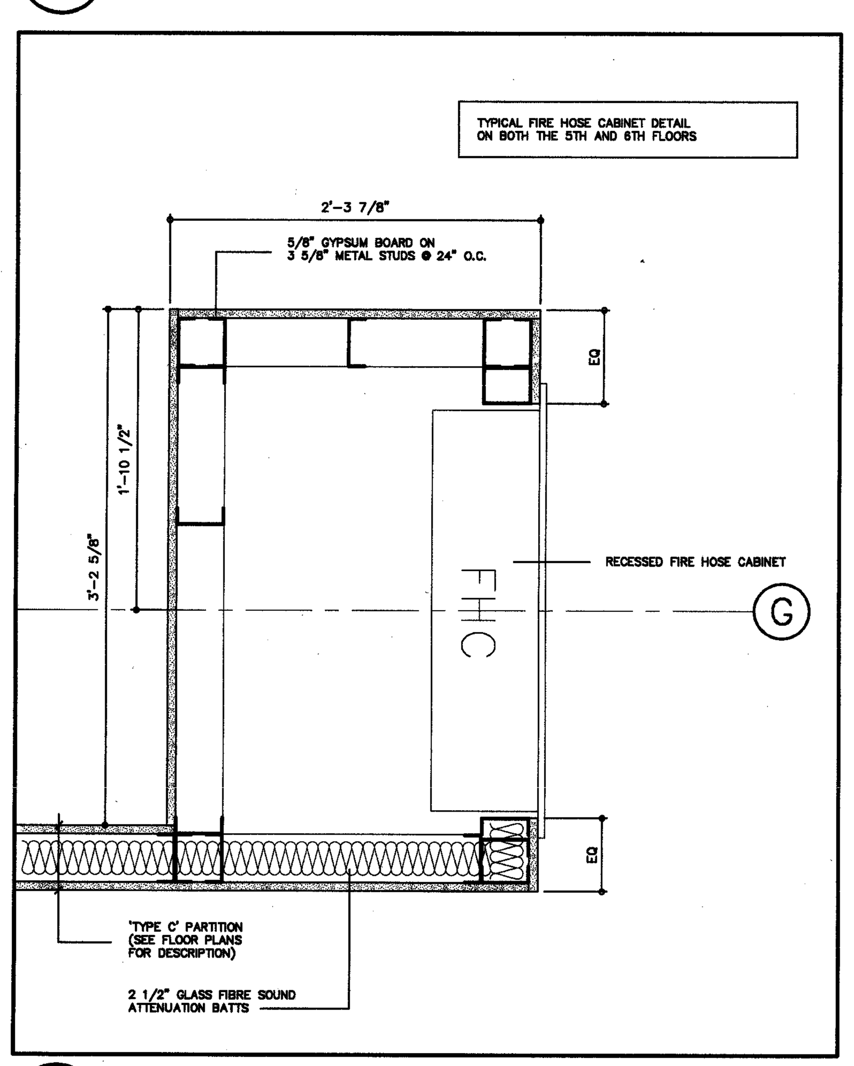

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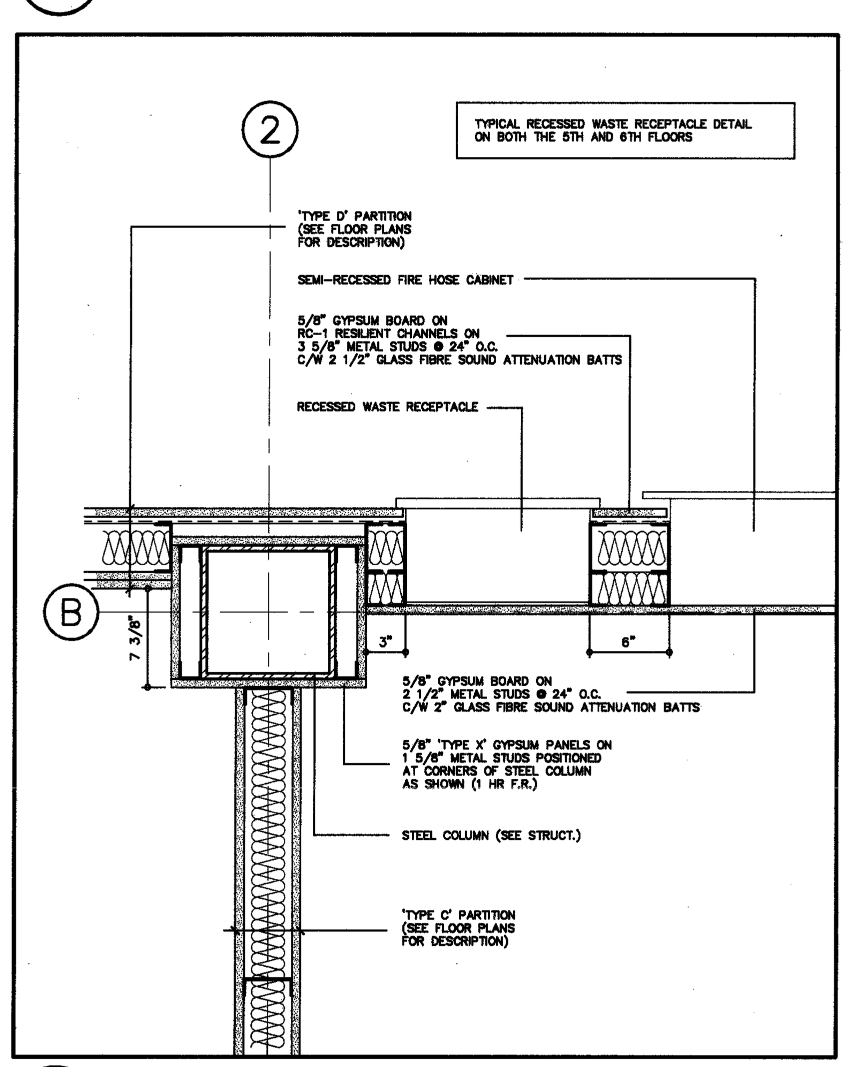
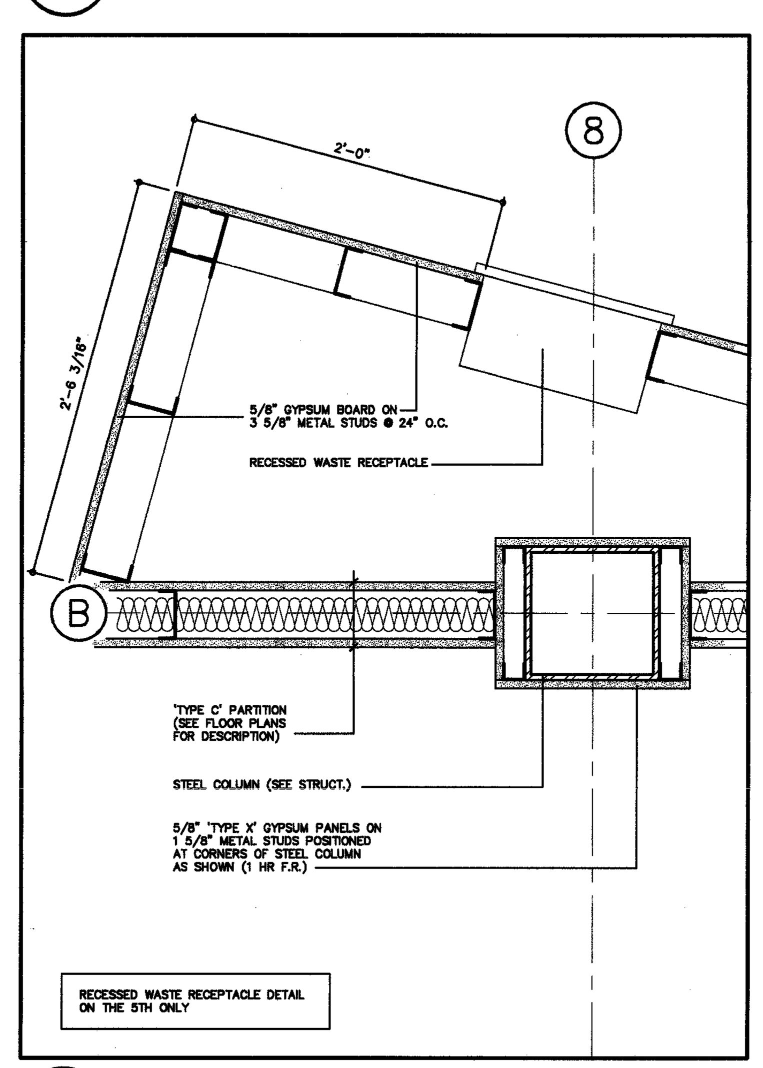


12 PLAN DETAIL
SCALE = 1 1/2" = 1'-0"



13 PLAN DETAIL
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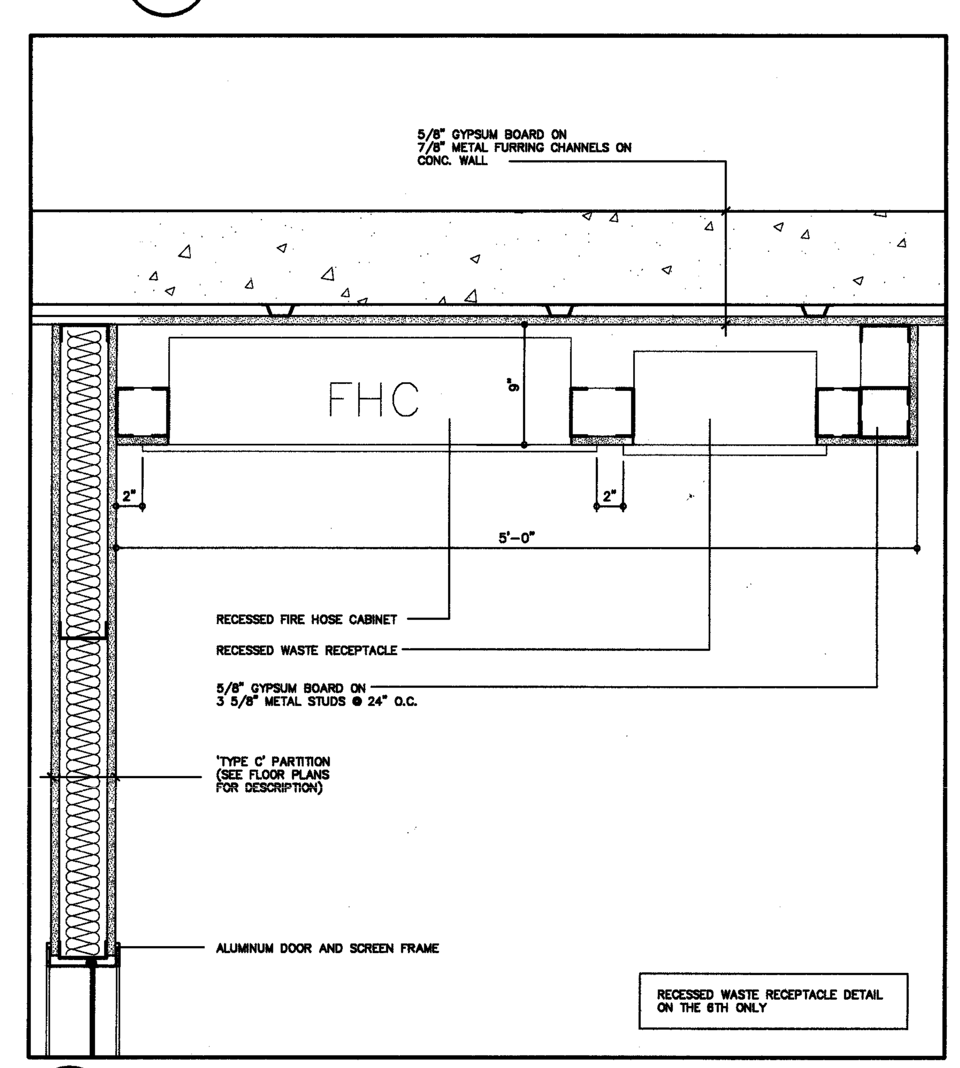

14 PLAN DETAIL
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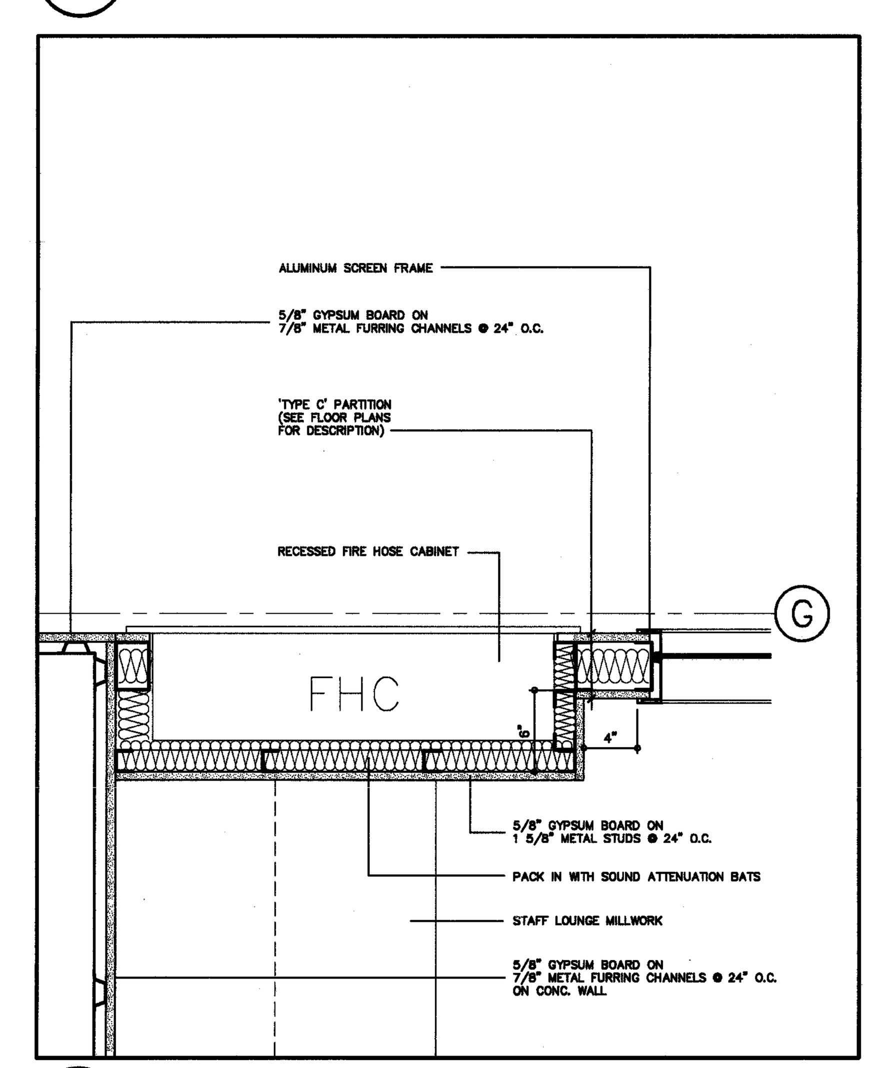

15 PLAN DETAIL
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1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

CONSTRUCTION NORTH

ONTARIO ASSOCIATION OF ARCHITECTS ROBERT C. GREDE LICENCE 4668

Ontario SuperBuild

Project Manager
Cansult Hanscomb Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321

Associate Architect
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RYERSON UNIVERSITY AND GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

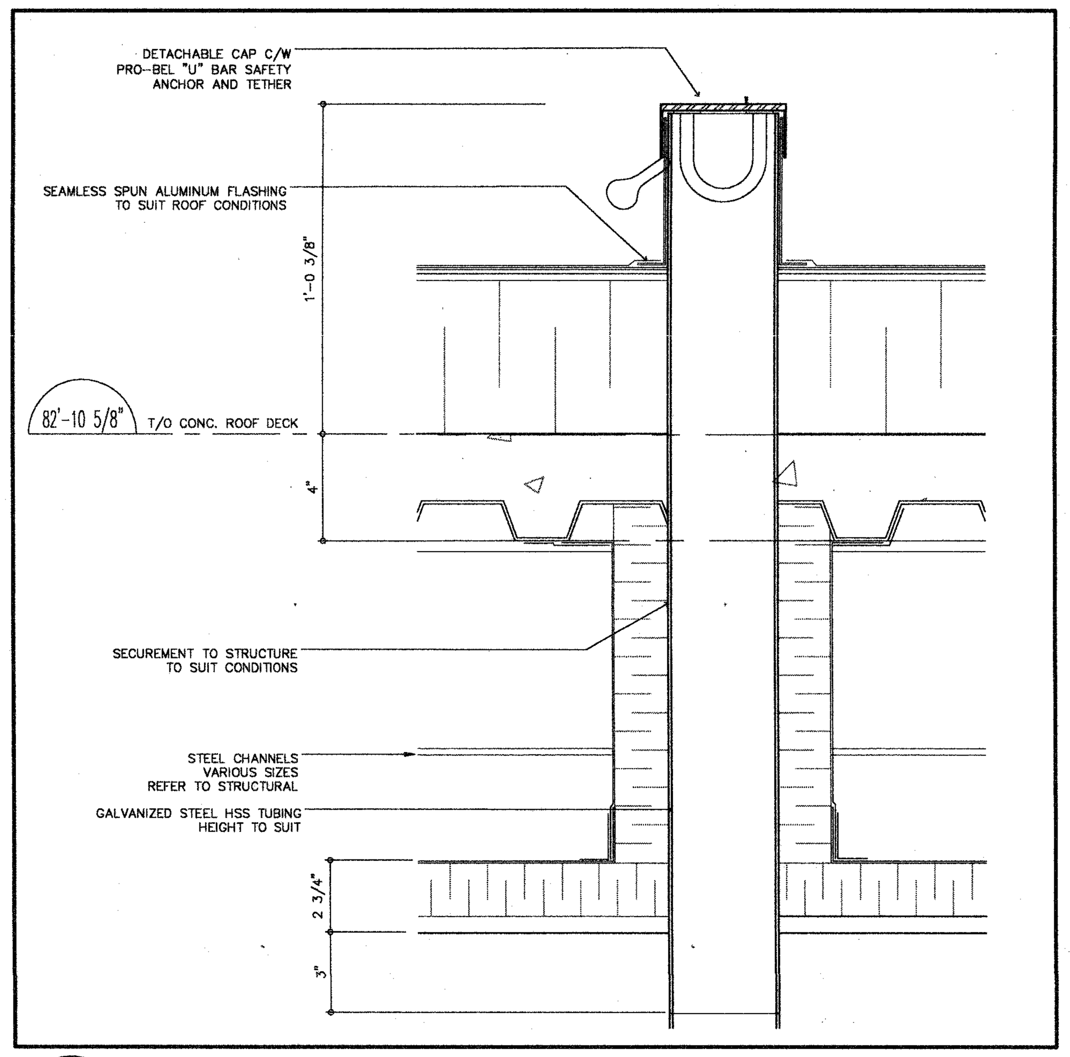
87 GERRARD STREET EAST

MISCELLANEOUS PLAN DETAILS

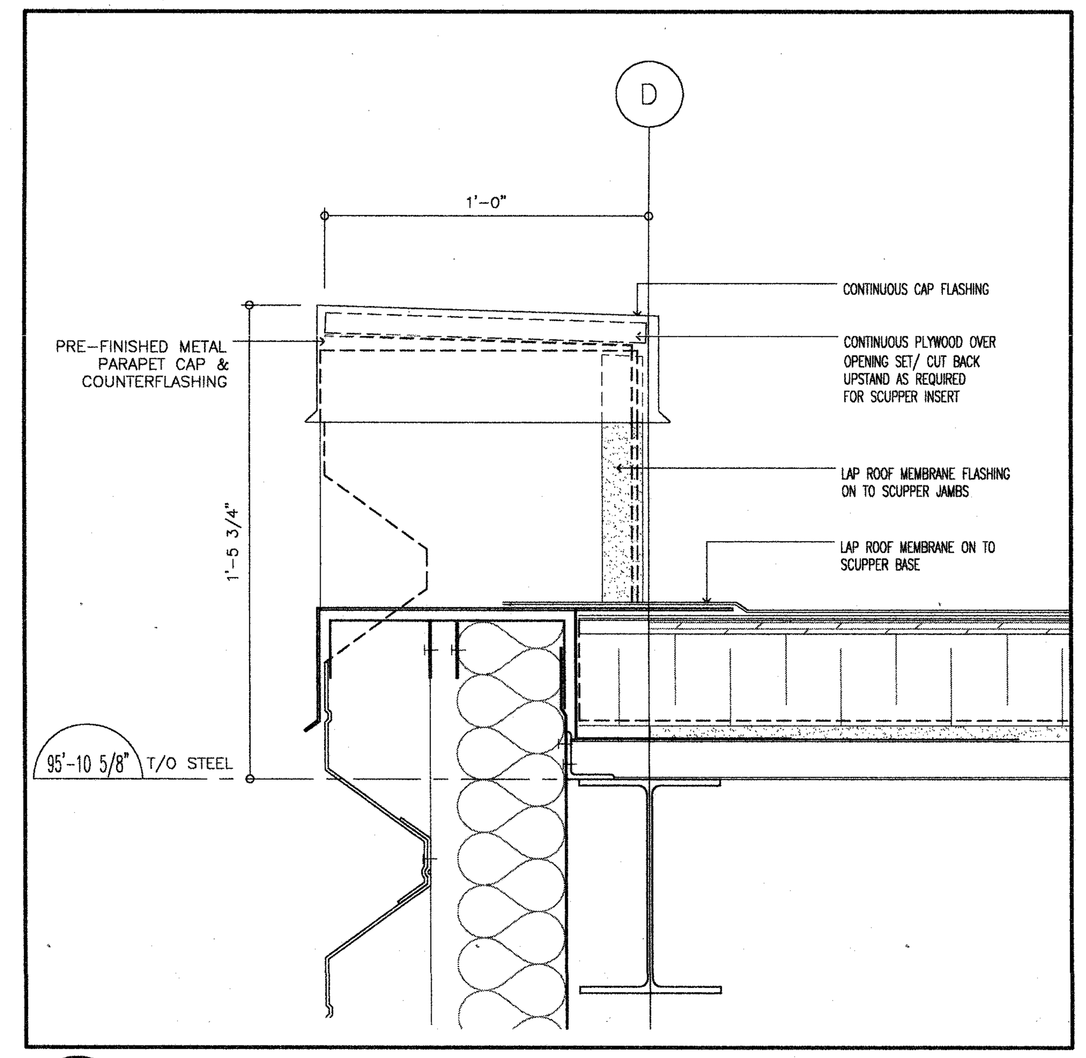
Graphic Scale		Sheet no.
Printed	Scale 1 1/2" = 1'-0"	A5-09
Date MAY 07, 2001	Job No. 200004	

PHC	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	CAT

AO 841x1189



1 RIGGING SLEEVE ANCHOR SECTION DETAIL
SCALE = 3" = 1'-0"



2 PENTHOUSE SCUPPER SECTION DETAIL
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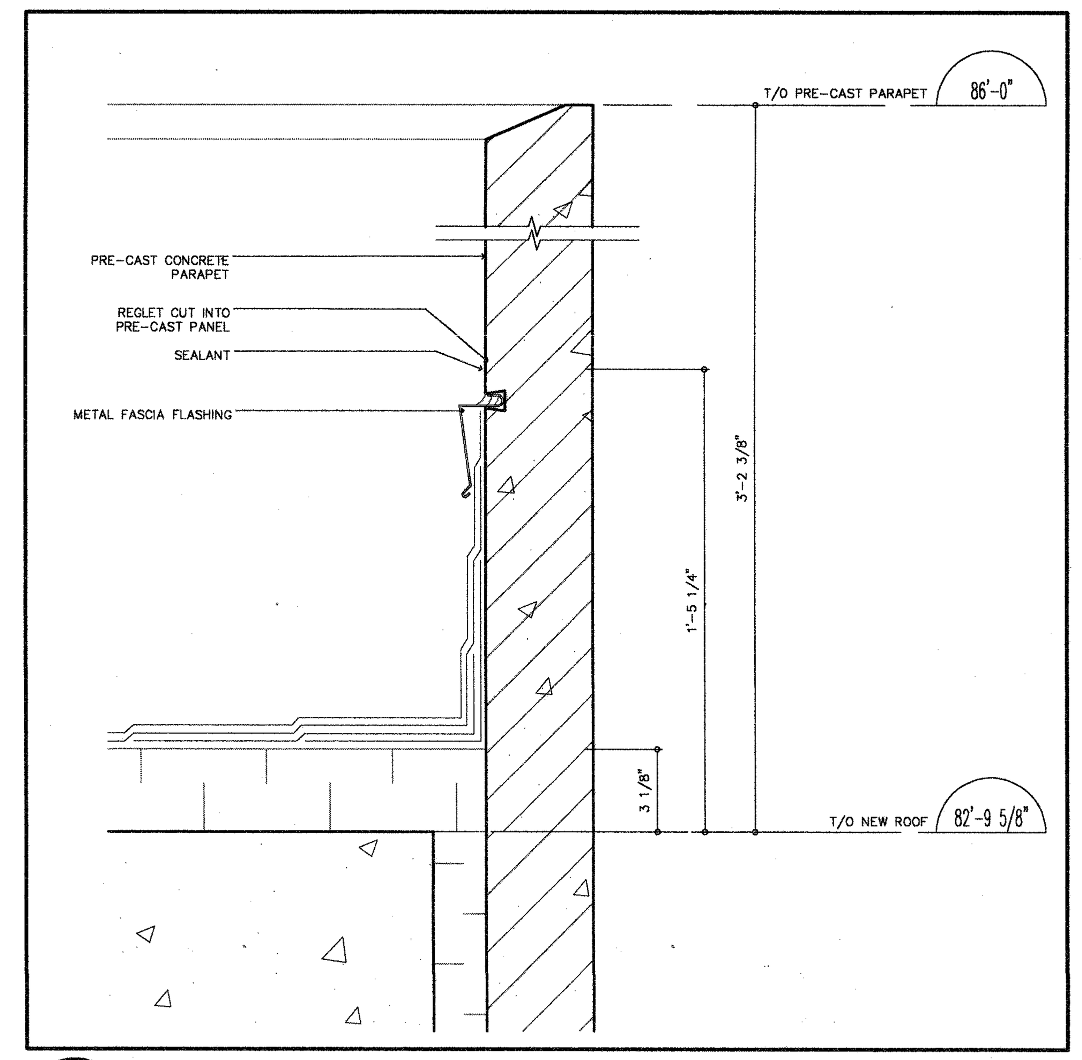

3 NEW PRE-CAST SECTION DETAIL
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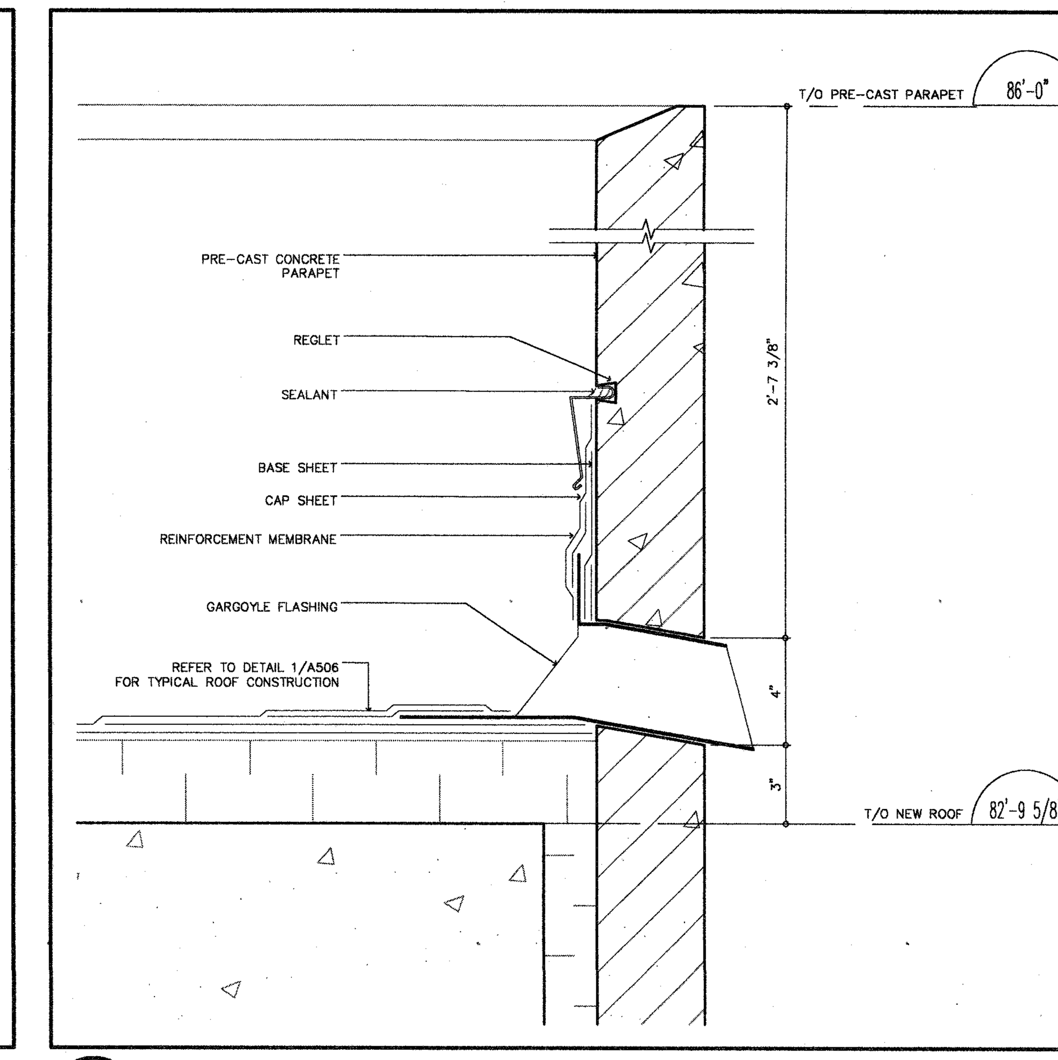
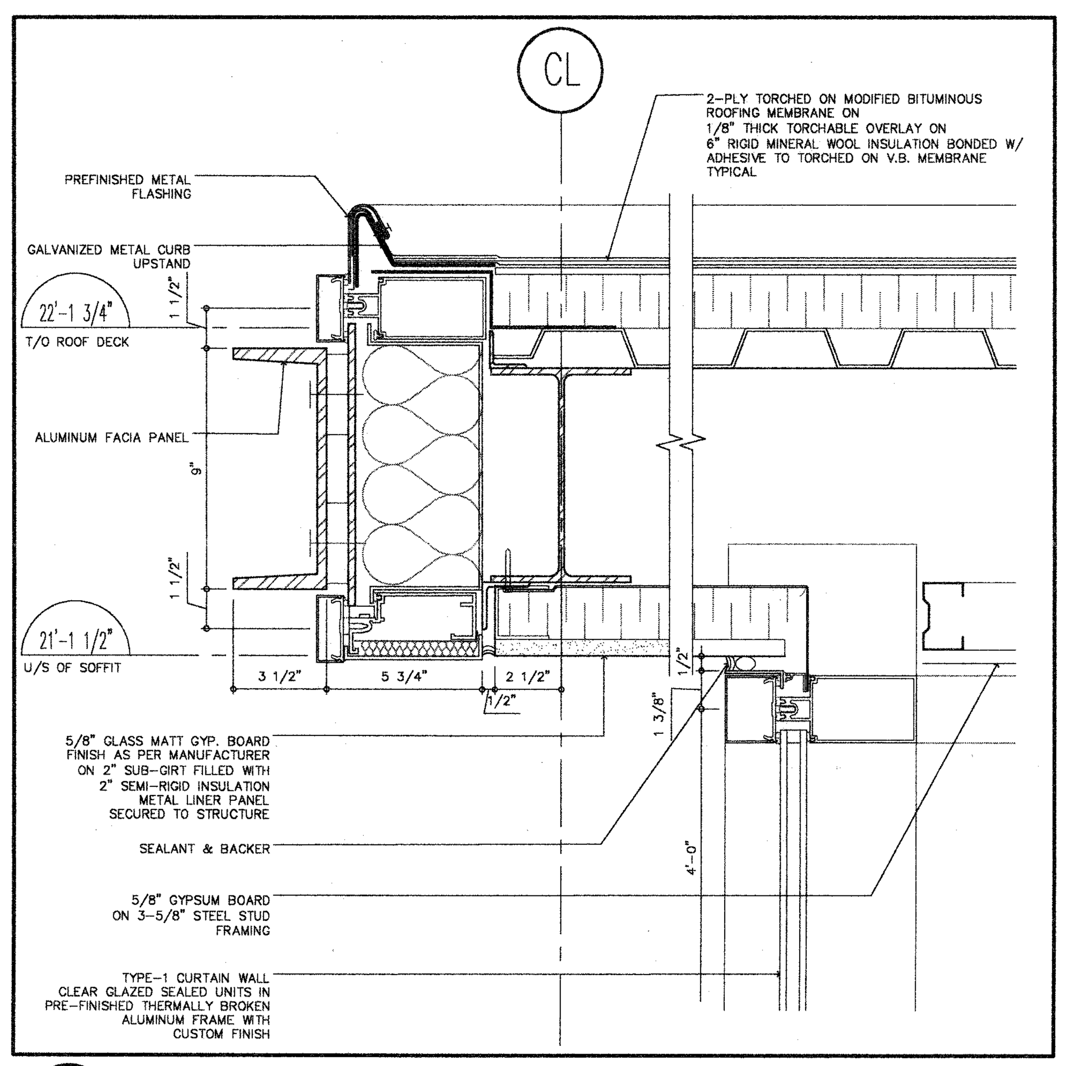


4 SECTION DETAIL
SCALE = 3" = 1'-0"



5 VESTIBULE CANOPY SECTION DETAIL
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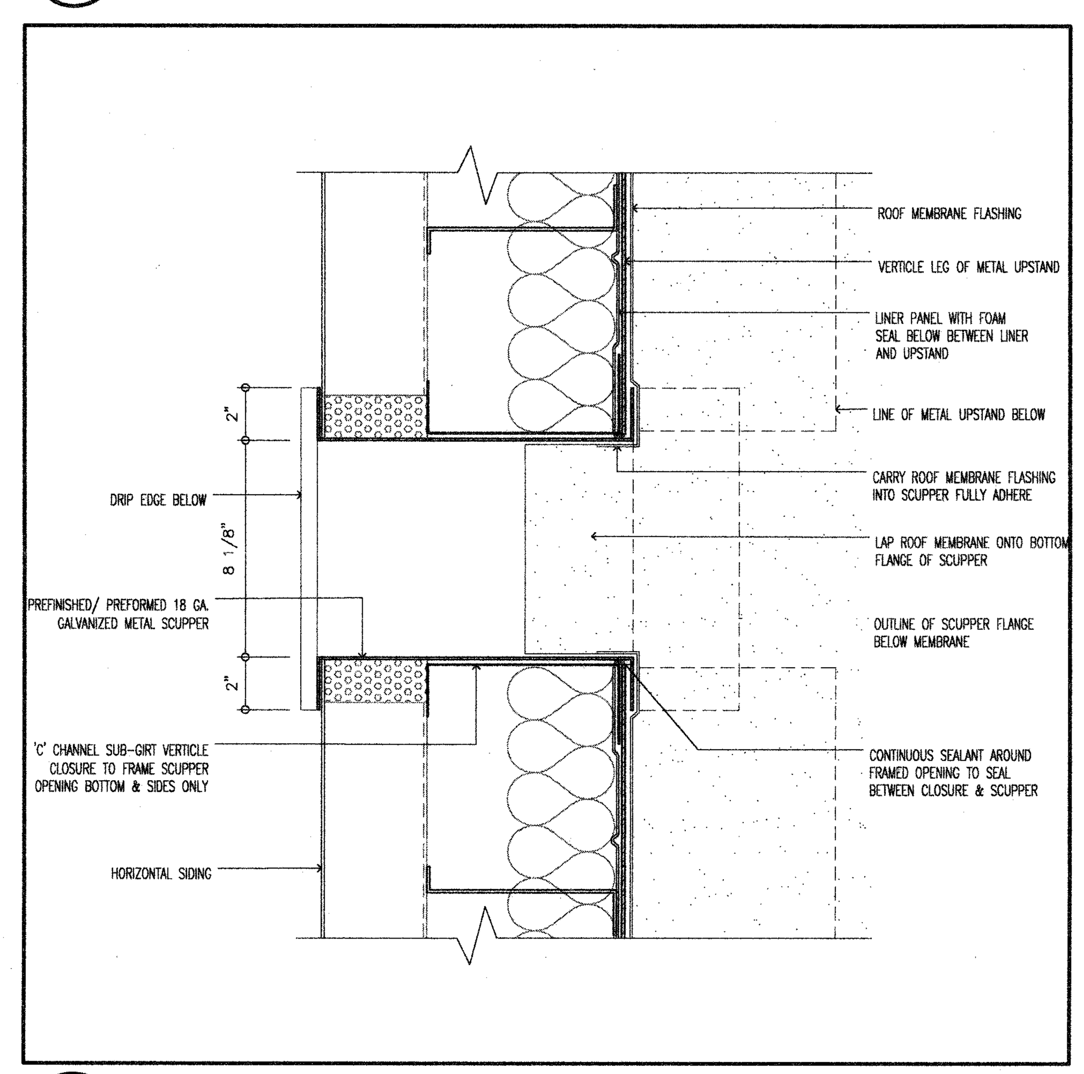

6 PENTHOUSE SCUPPER PLAN DETAIL
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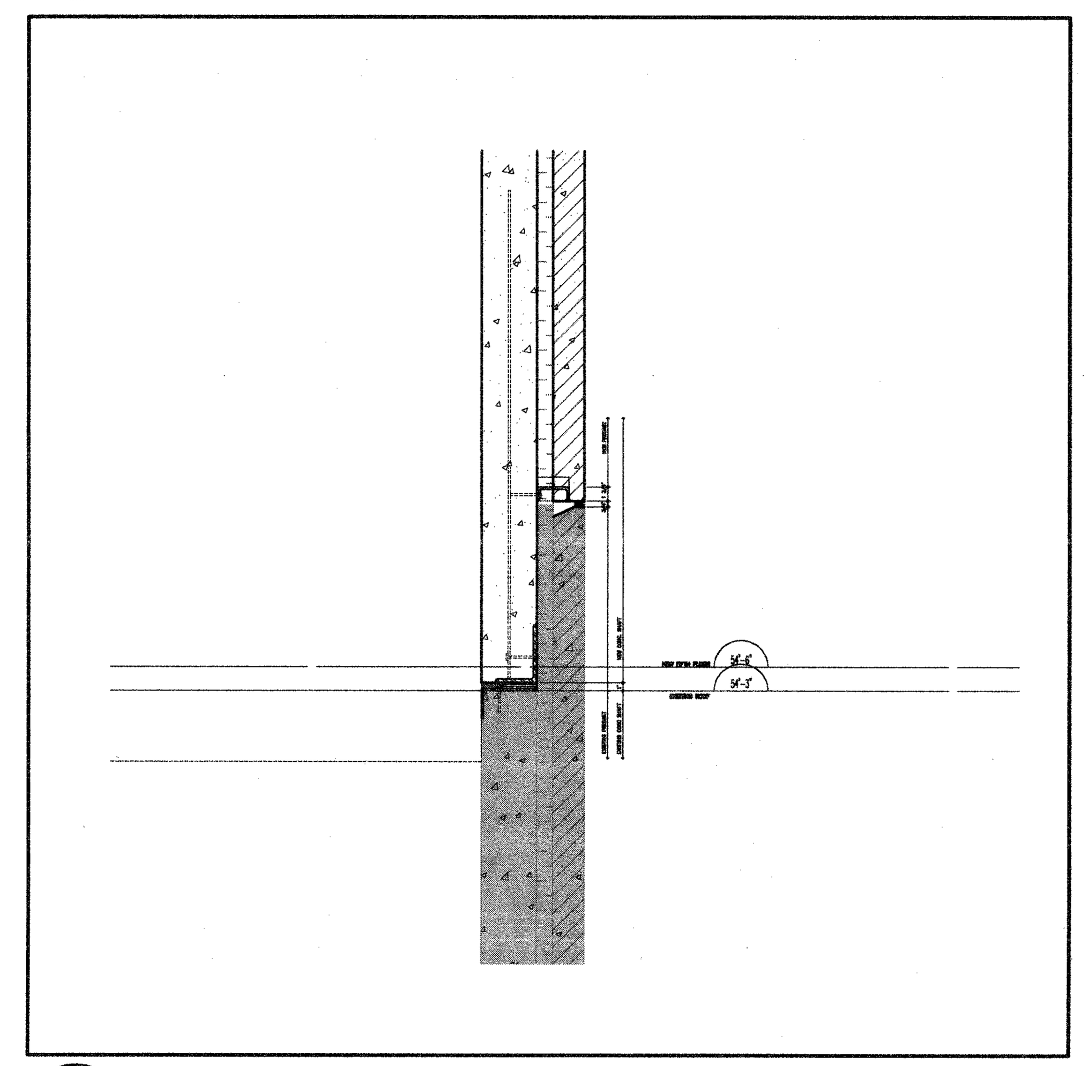

7 PRE-CASTSECTION DETAIL
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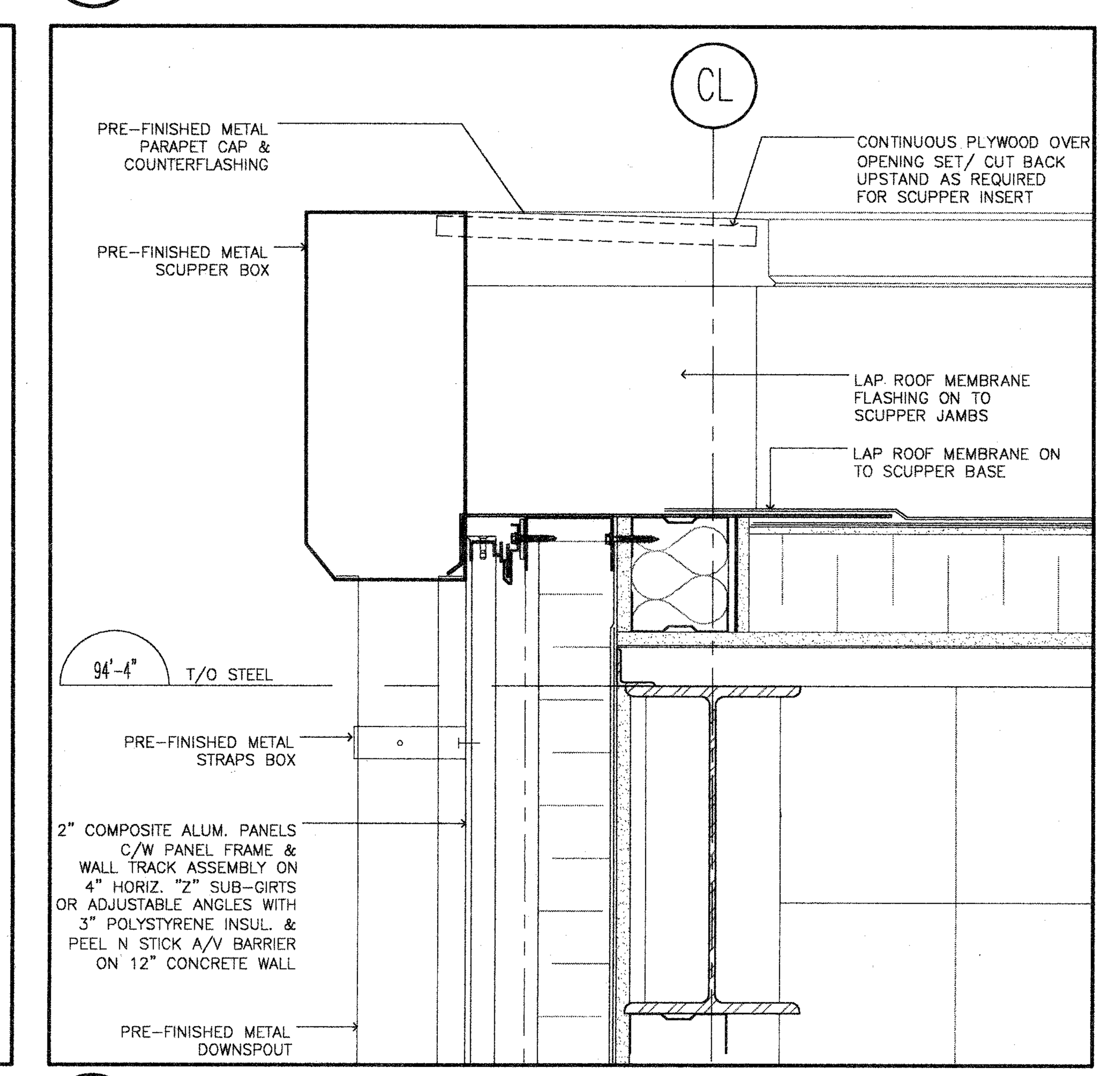
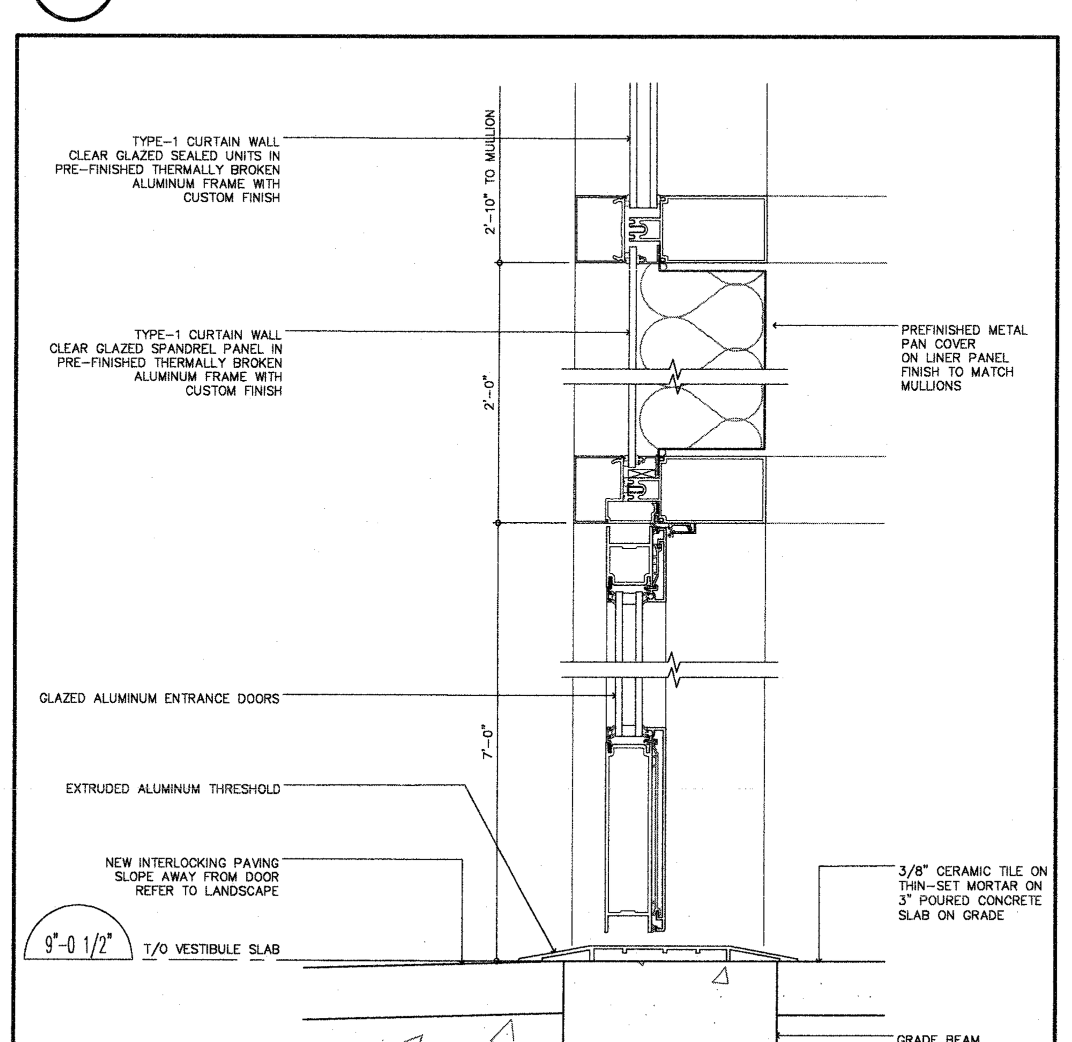


8 SCUPPER SECTION DETAIL
SCALE = 3" = 1'-0"



9 VESTIBULE ENTRY SECTION DETAIL
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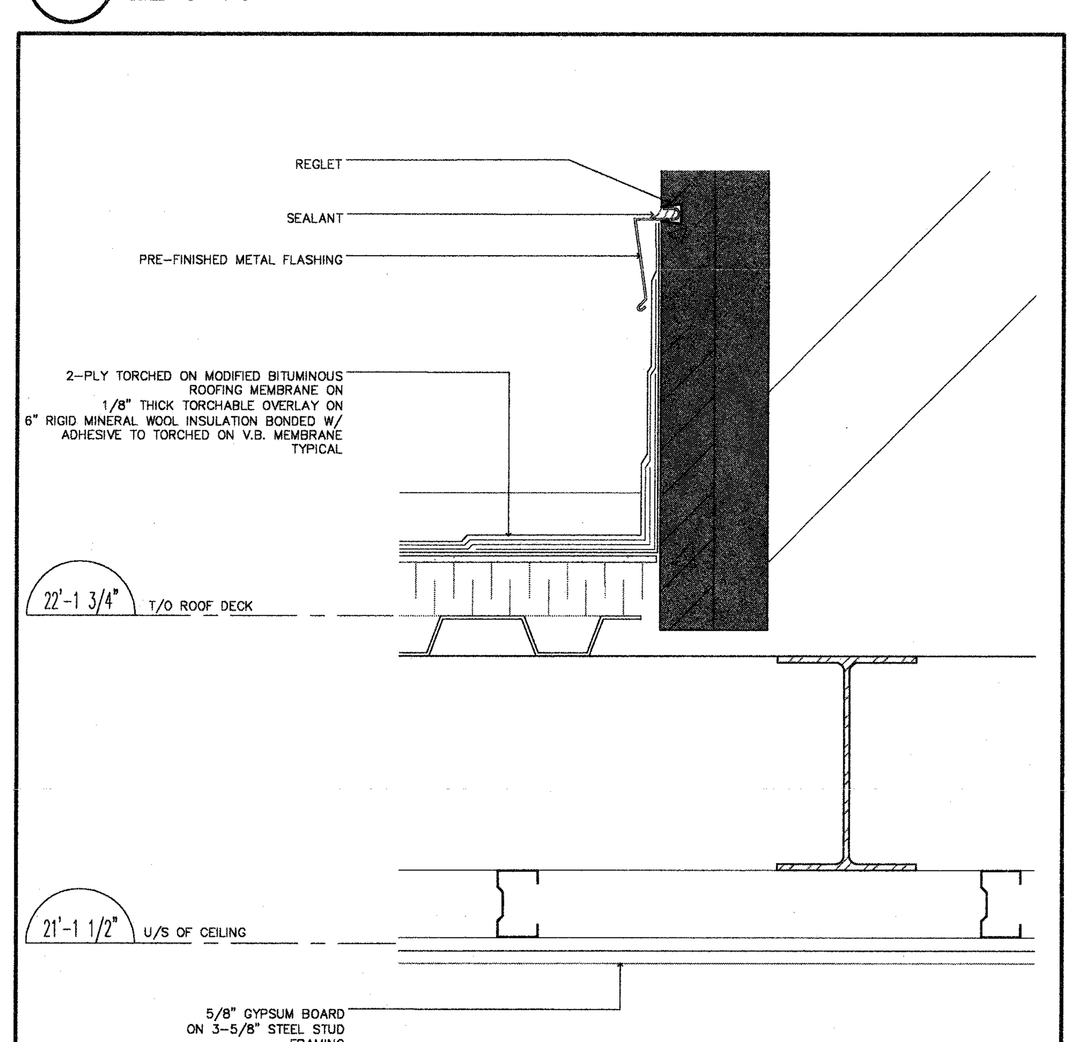

10 VESTIBULE ROOF SECTION DETAIL
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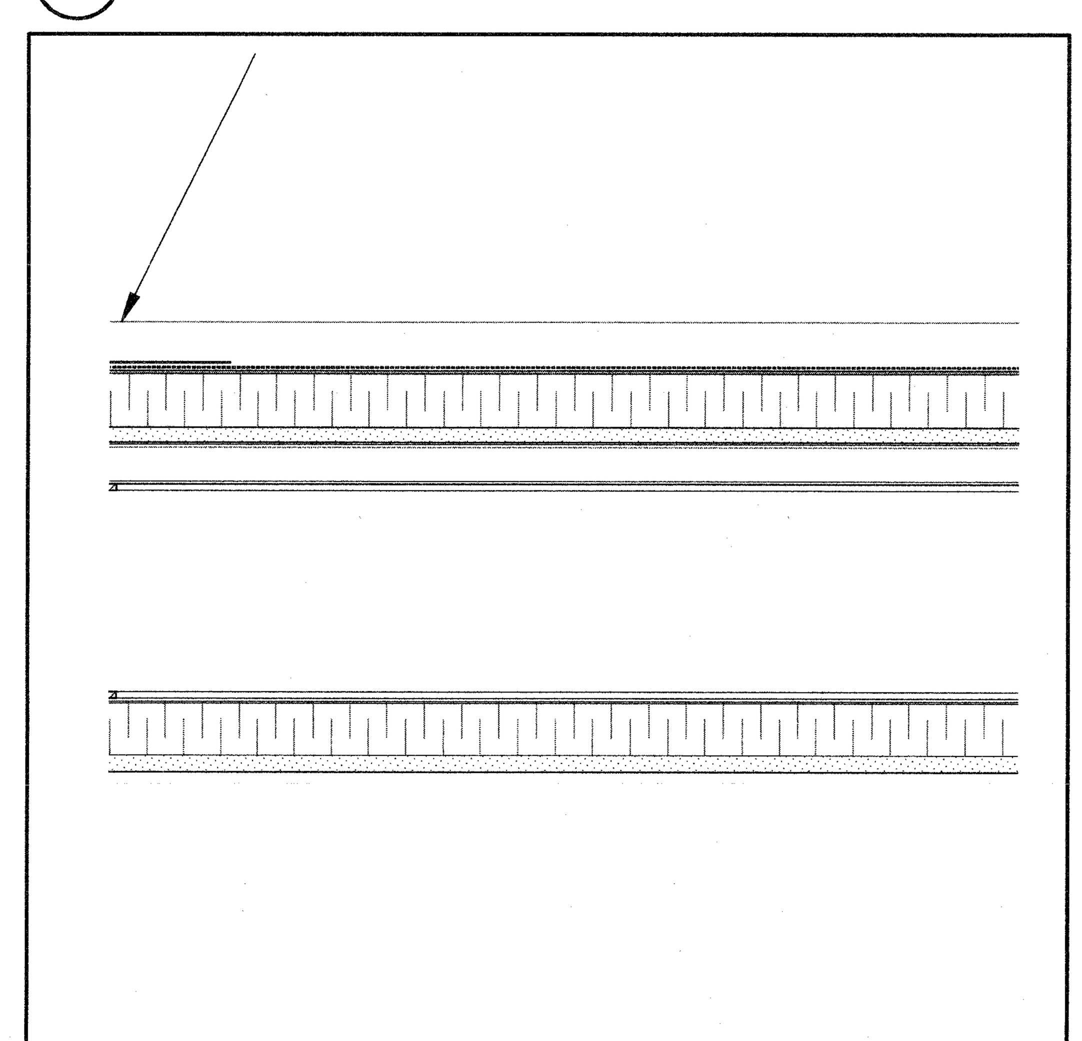

11 EXIST PRECAST SECTION DETAIL
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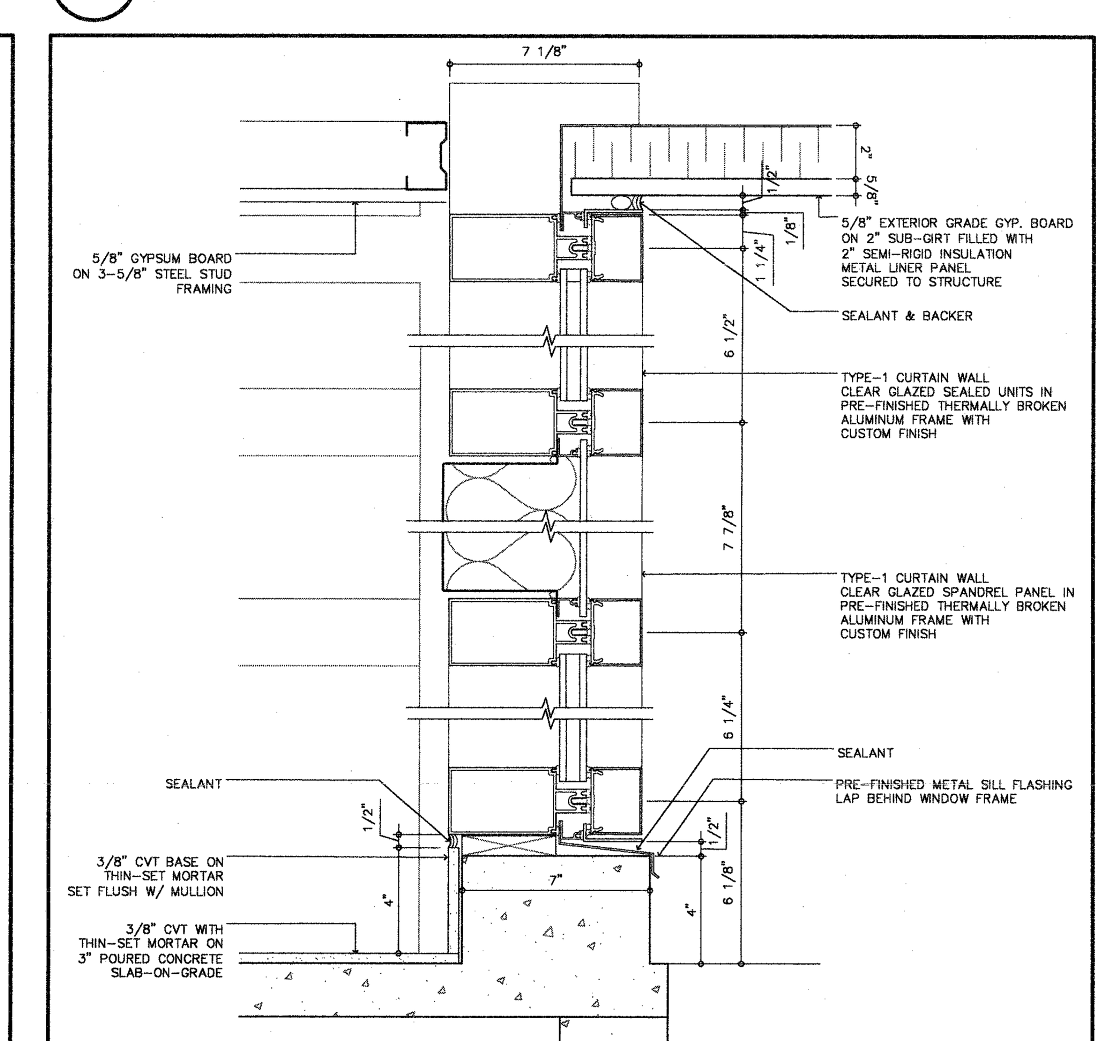

12 VESTIBULE CURTAIN WALL SECTION DETAIL
SCALE = 3" = 1'-0"

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3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE 4686

Ontario
SuperBuild

Project Manager
Cansult Hanscomb Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect
Lett/Smith Architects
365 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY AND GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

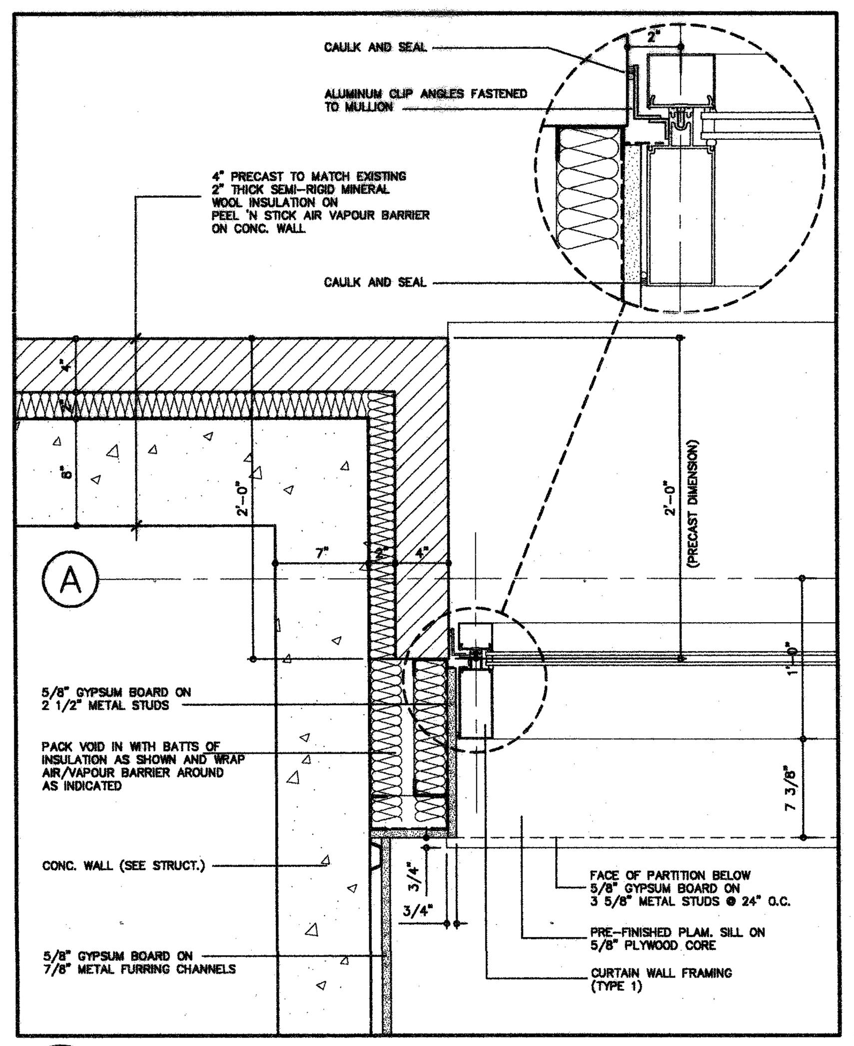
87 GERRARD STREET EAST

EXTERIOR WALL SECTION DETAILS

Graphic Scale		Sheet no.
Printed	Scale 1" = 1'-0"	A5-06
Date MAY 07, 2001	Job No. 200004	

P In C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	DH

EPH/SHE 048



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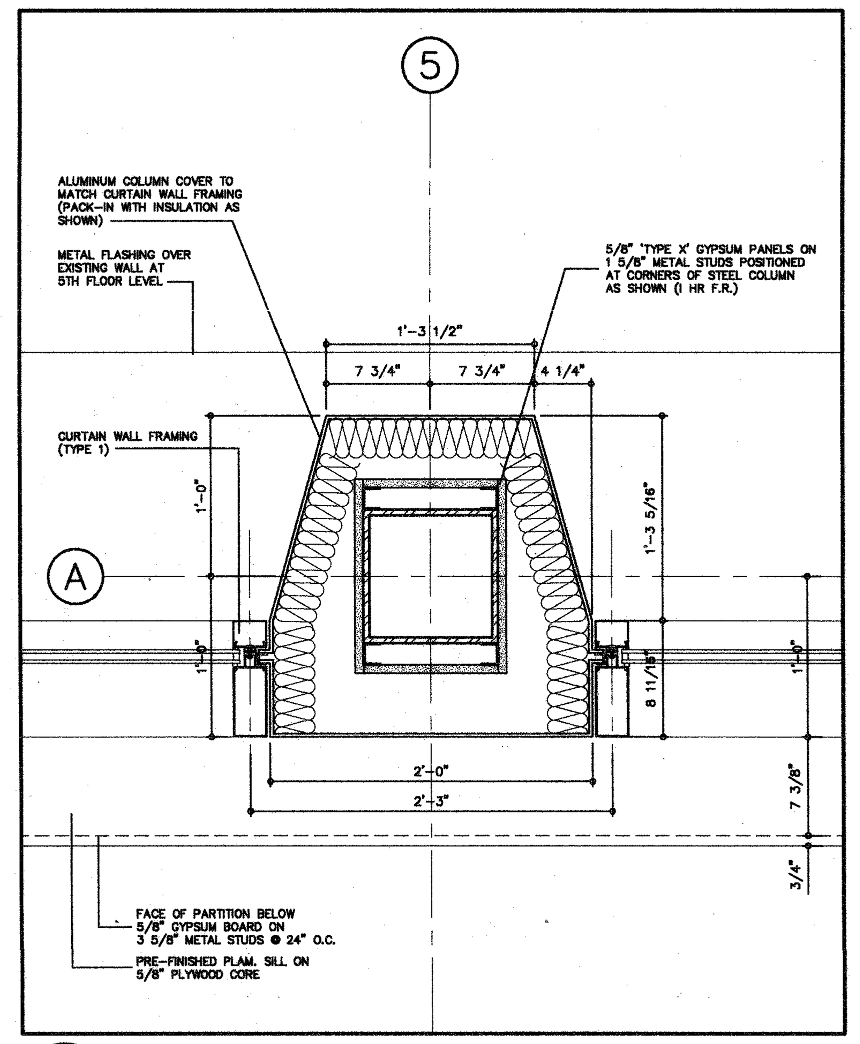

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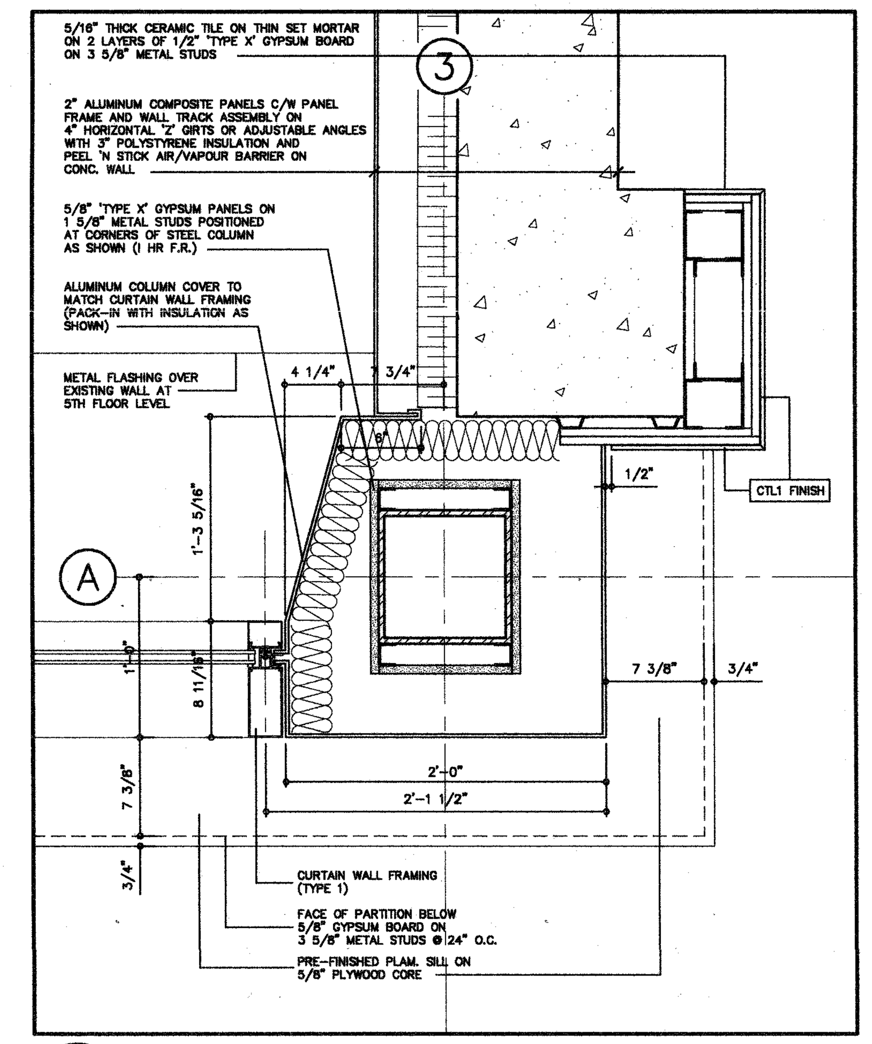

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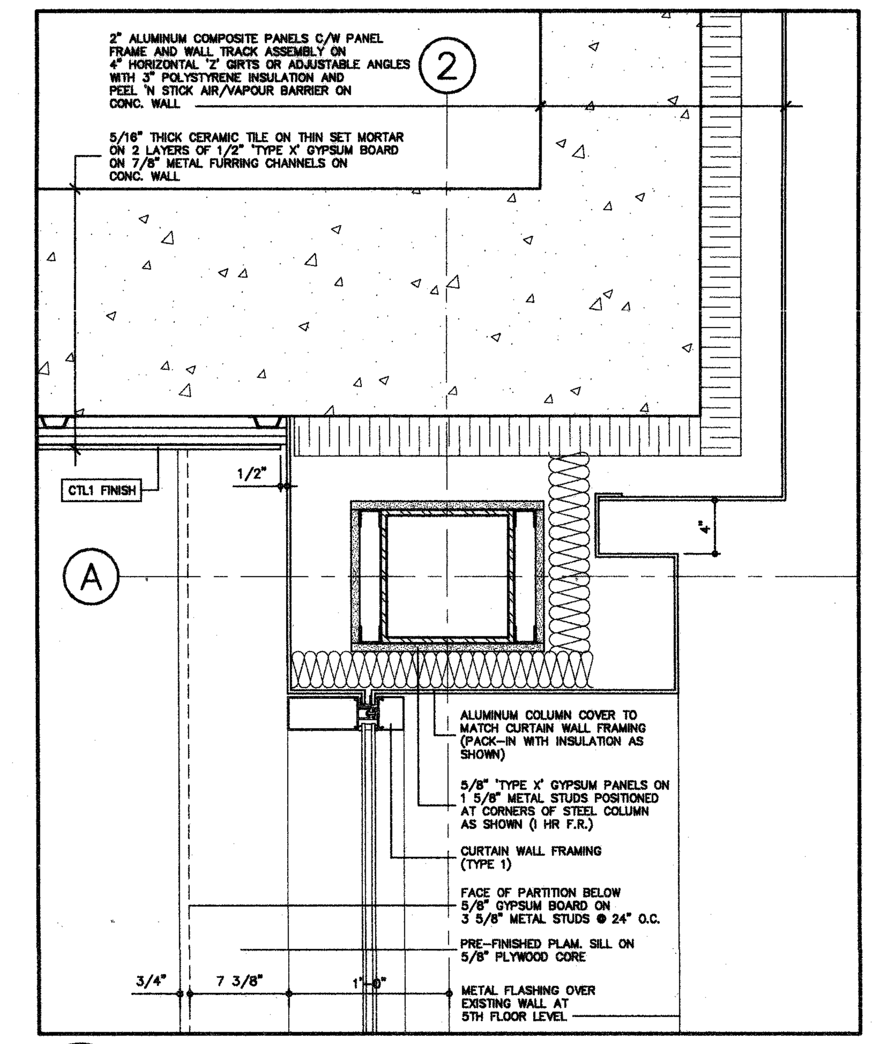

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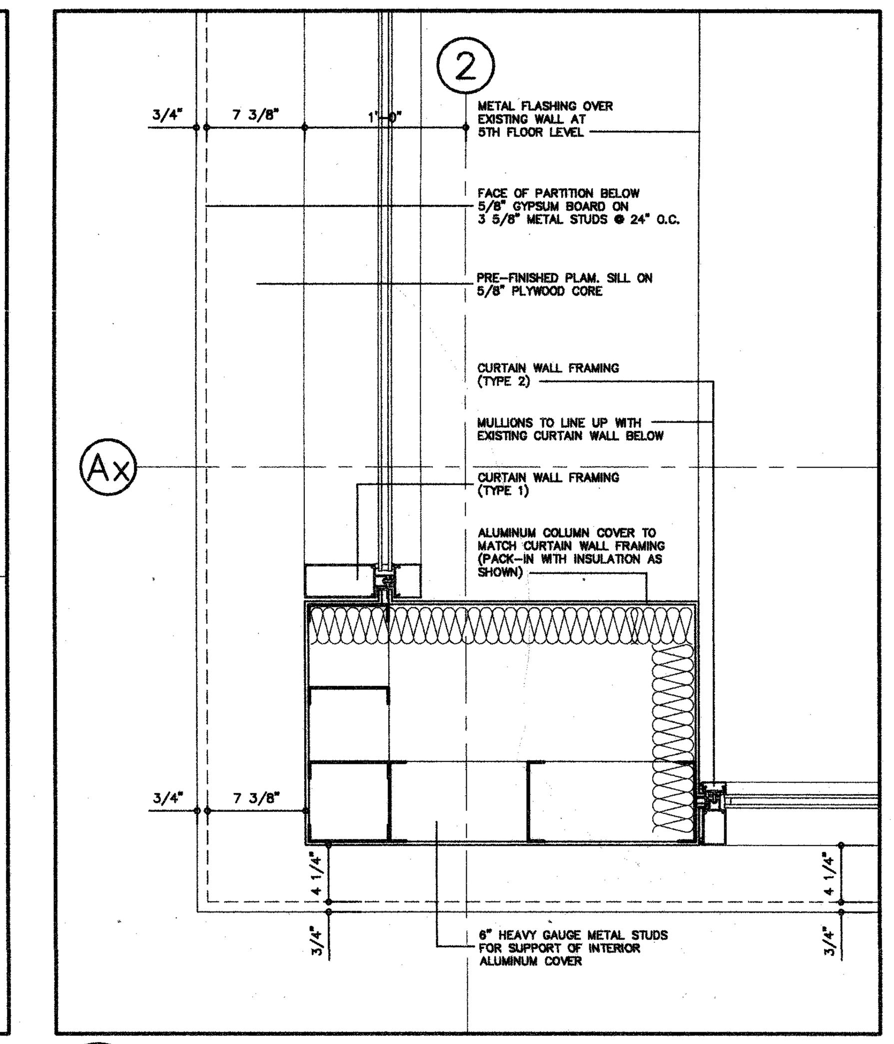

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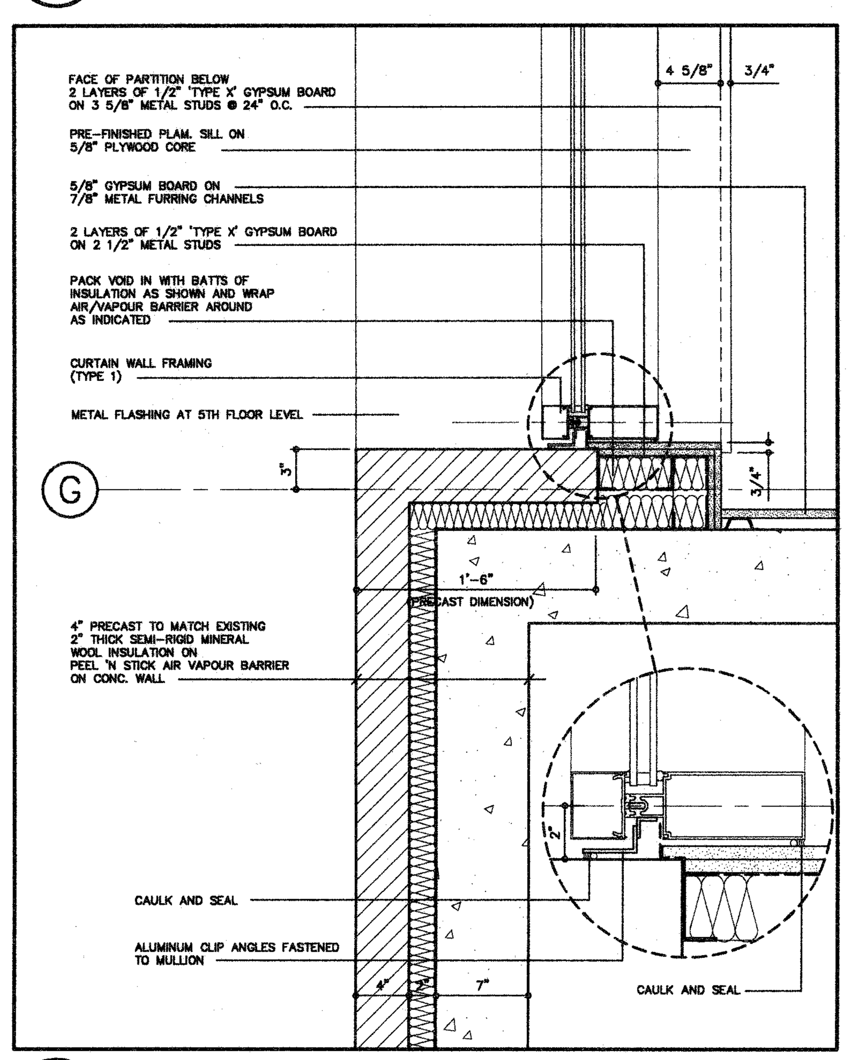

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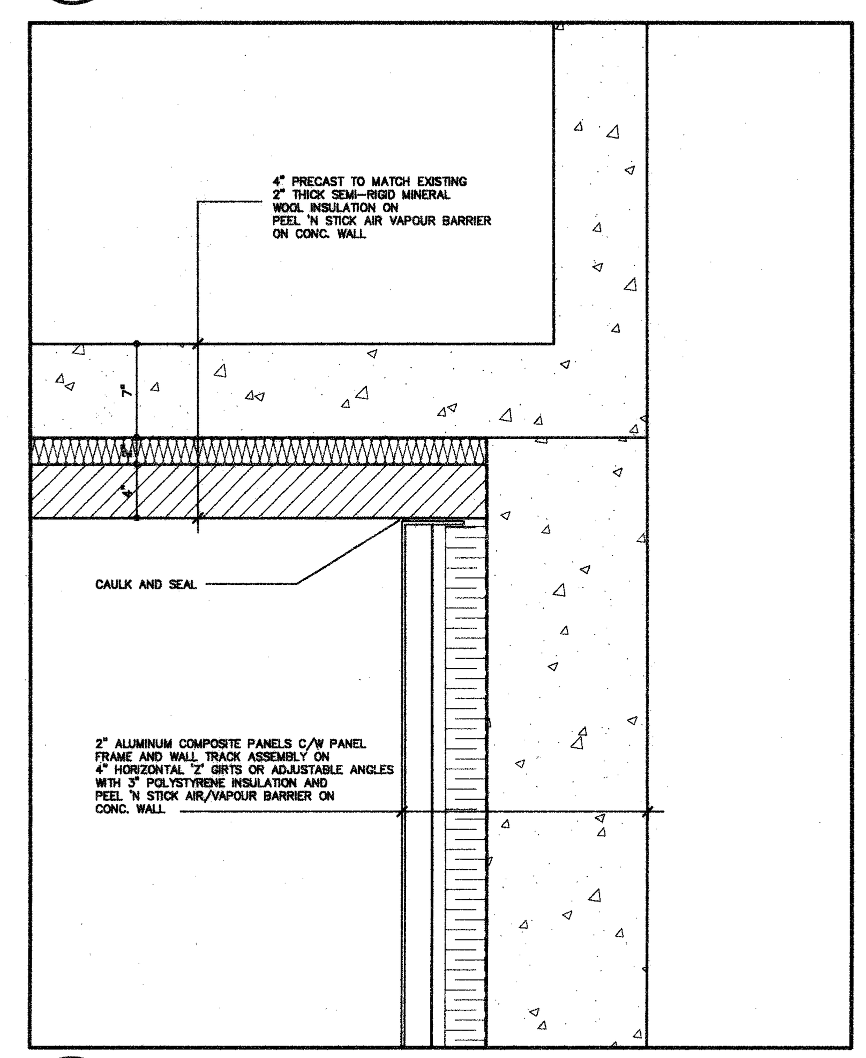

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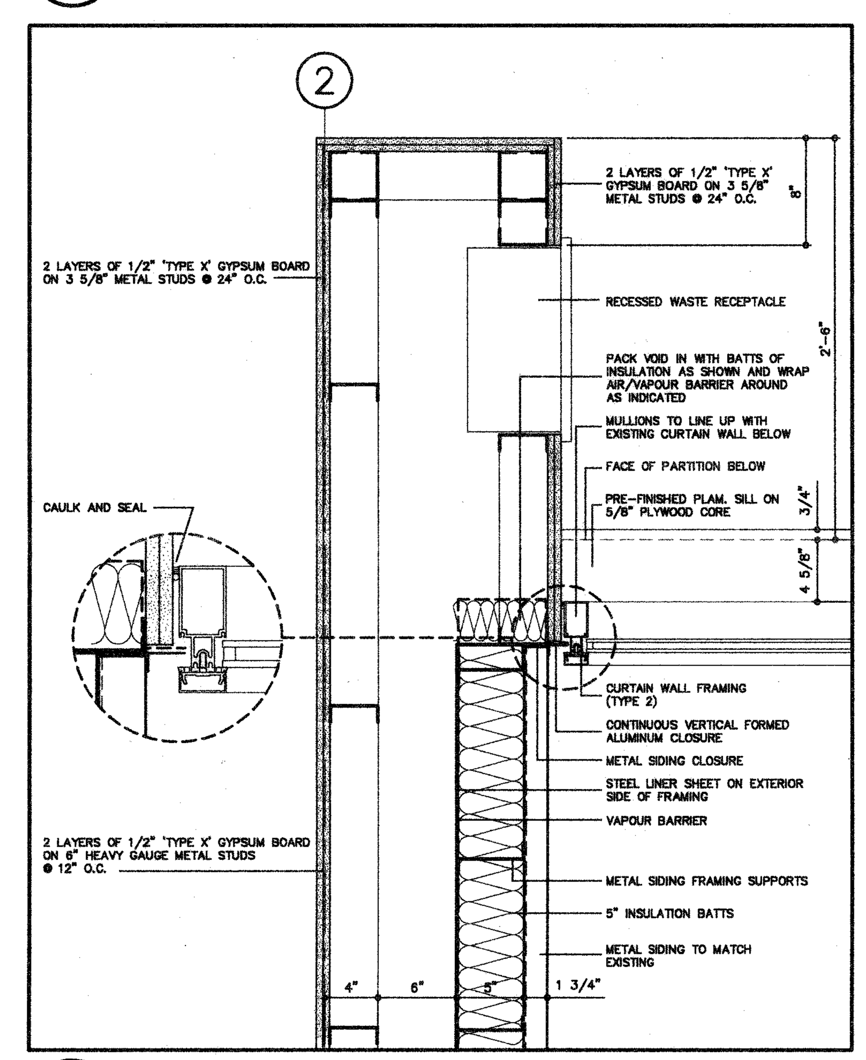

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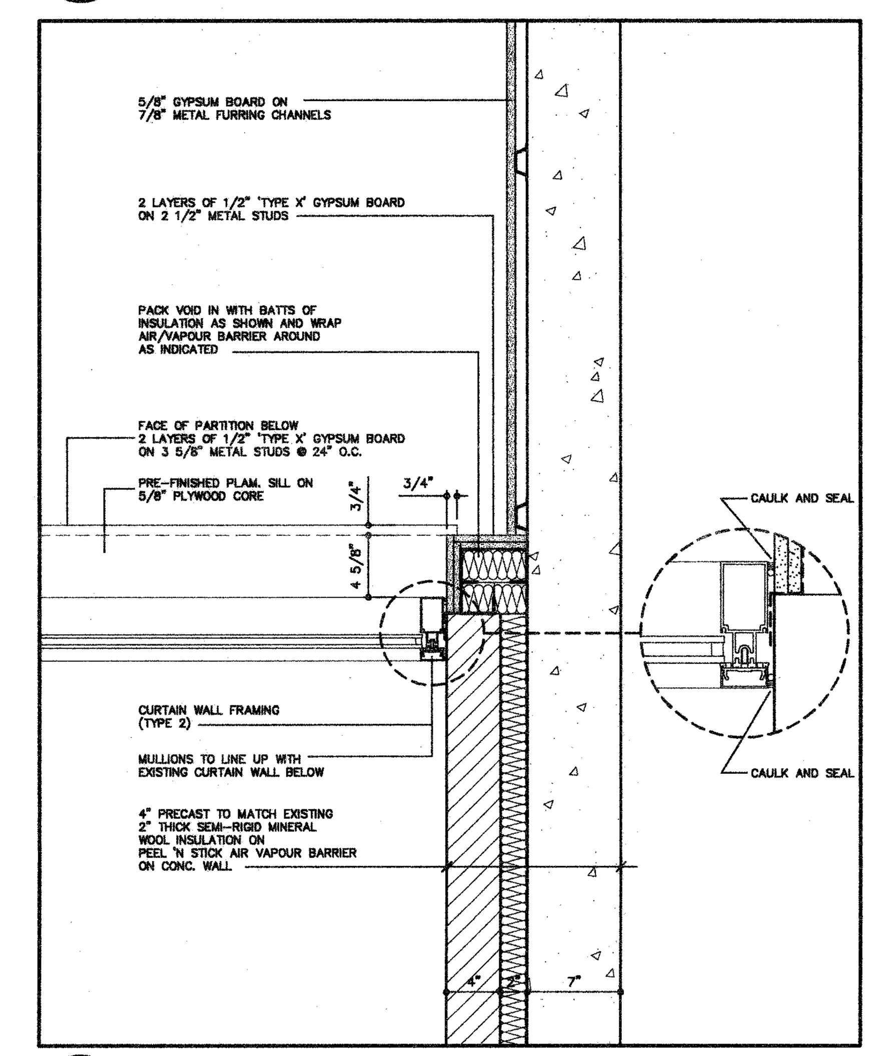

9 PLAN DETAIL
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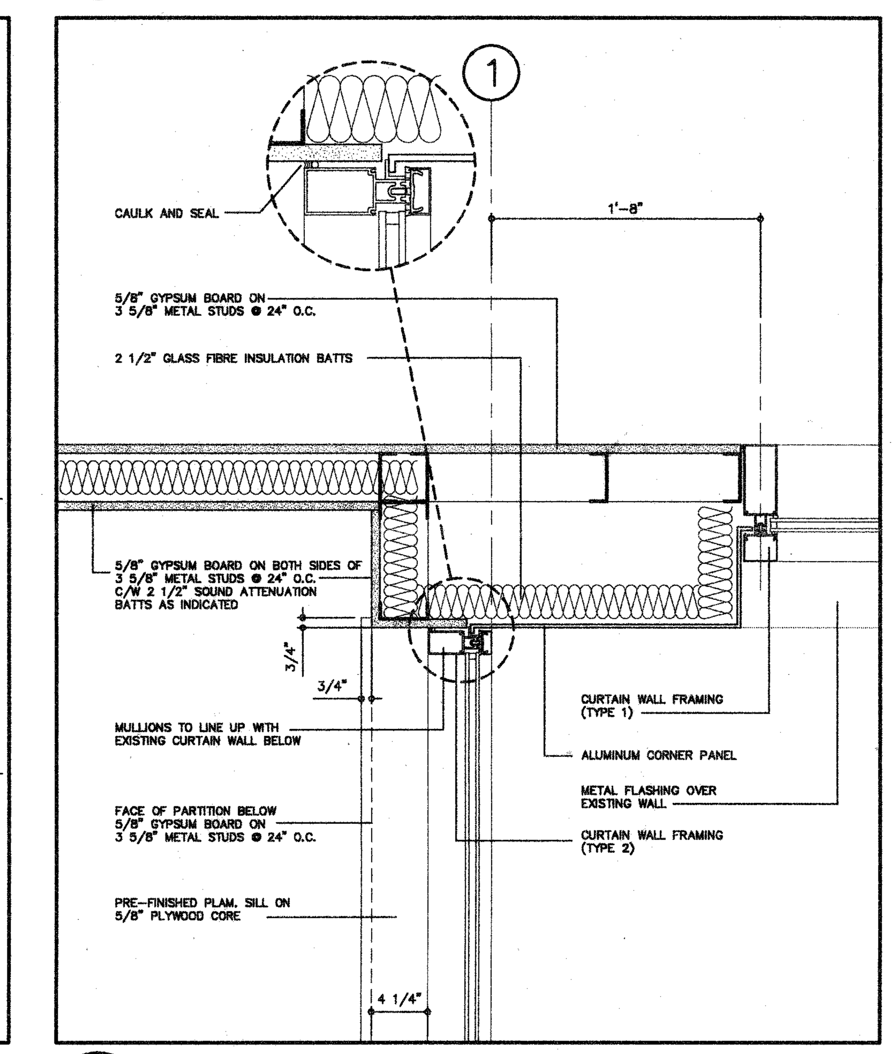

10 PLAN DETAIL
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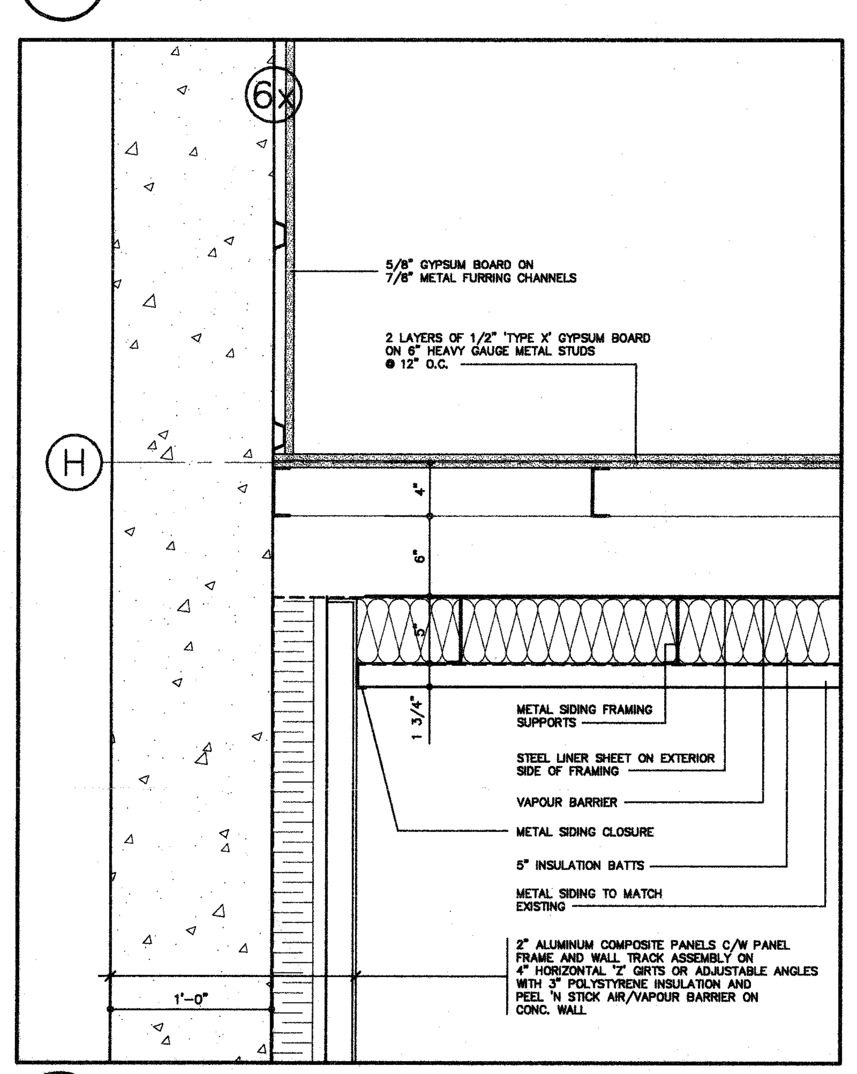

11 PLAN DETAIL
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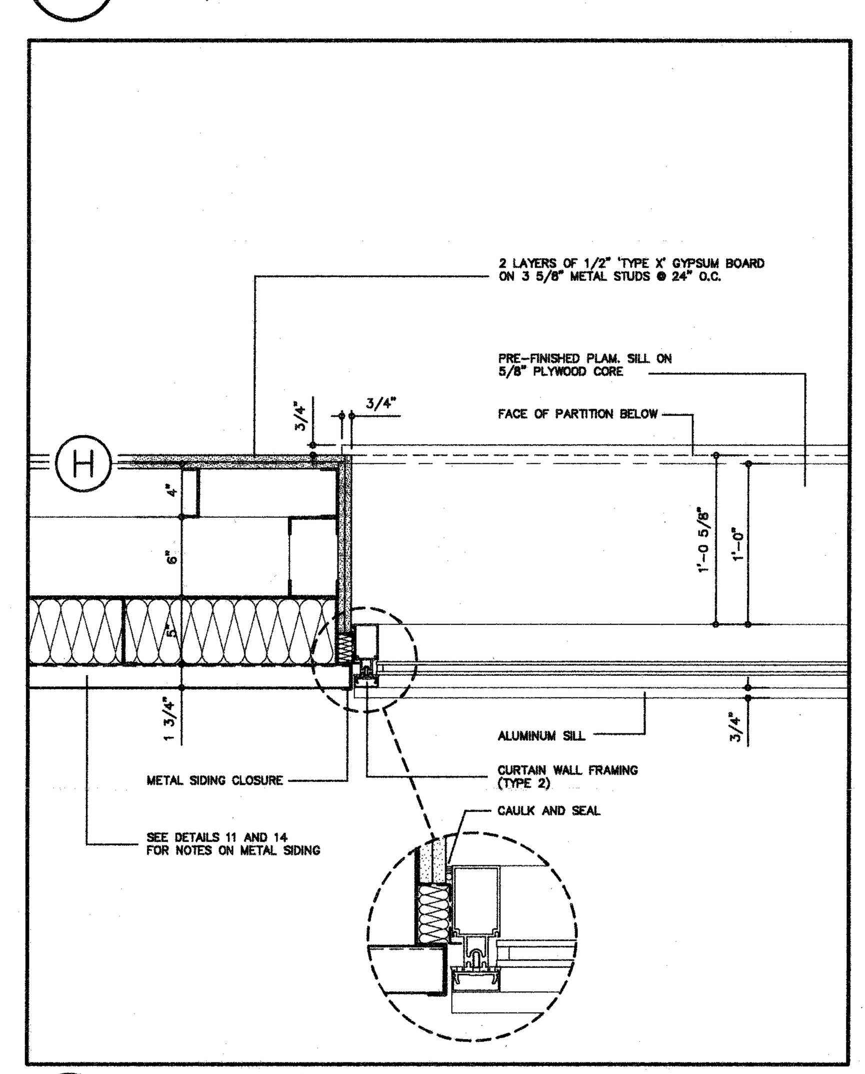

12 PLAN DETAIL
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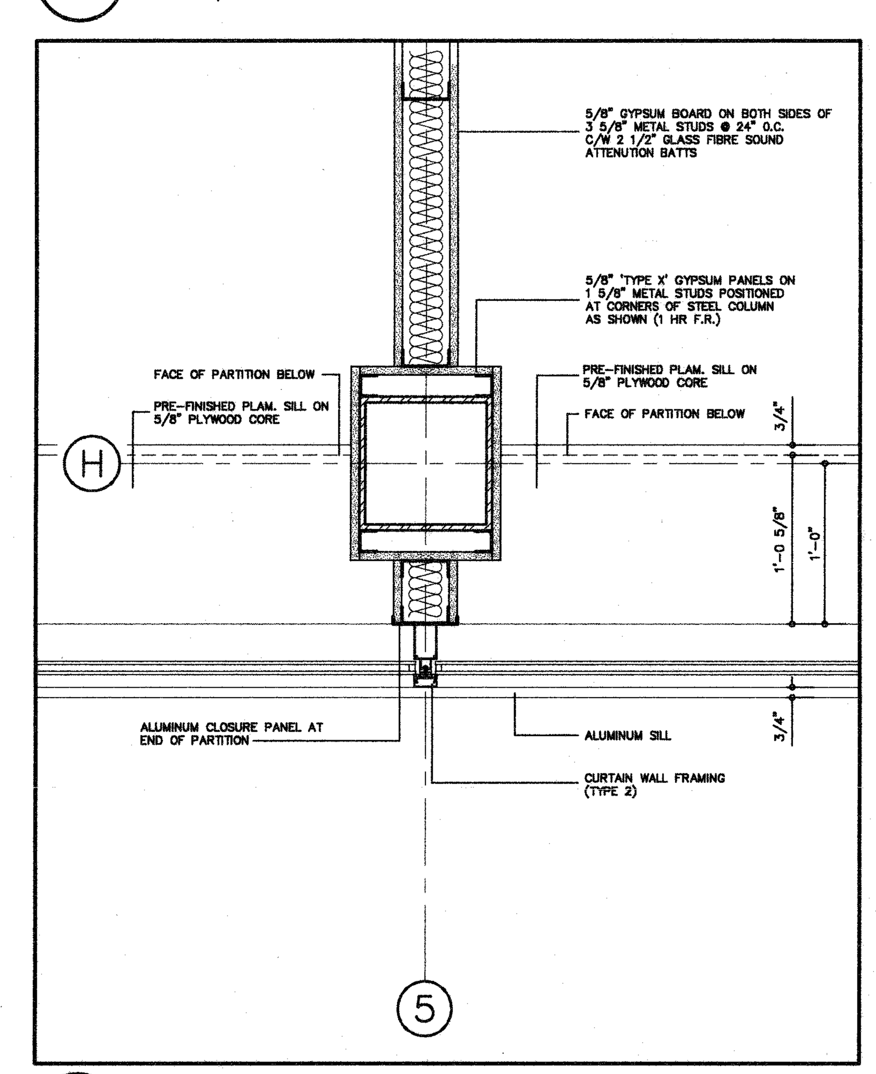

13 PLAN DETAIL
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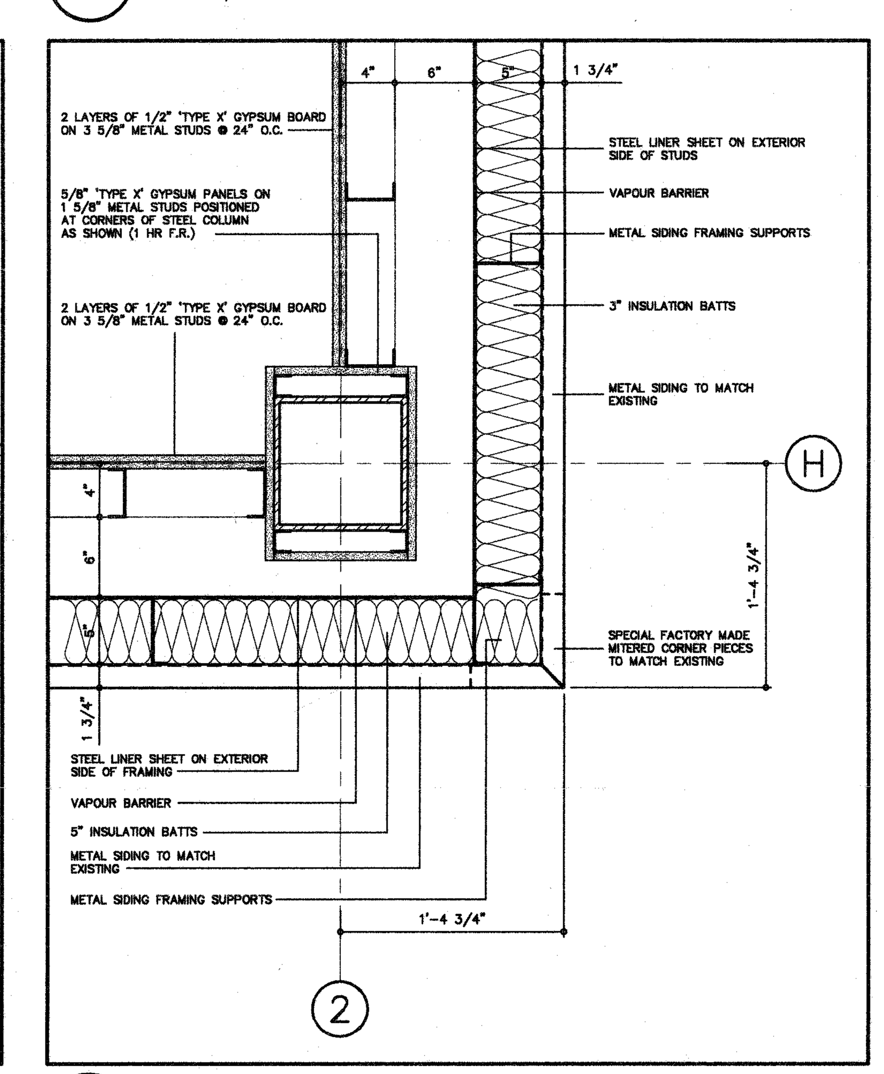

14 PLAN DETAIL
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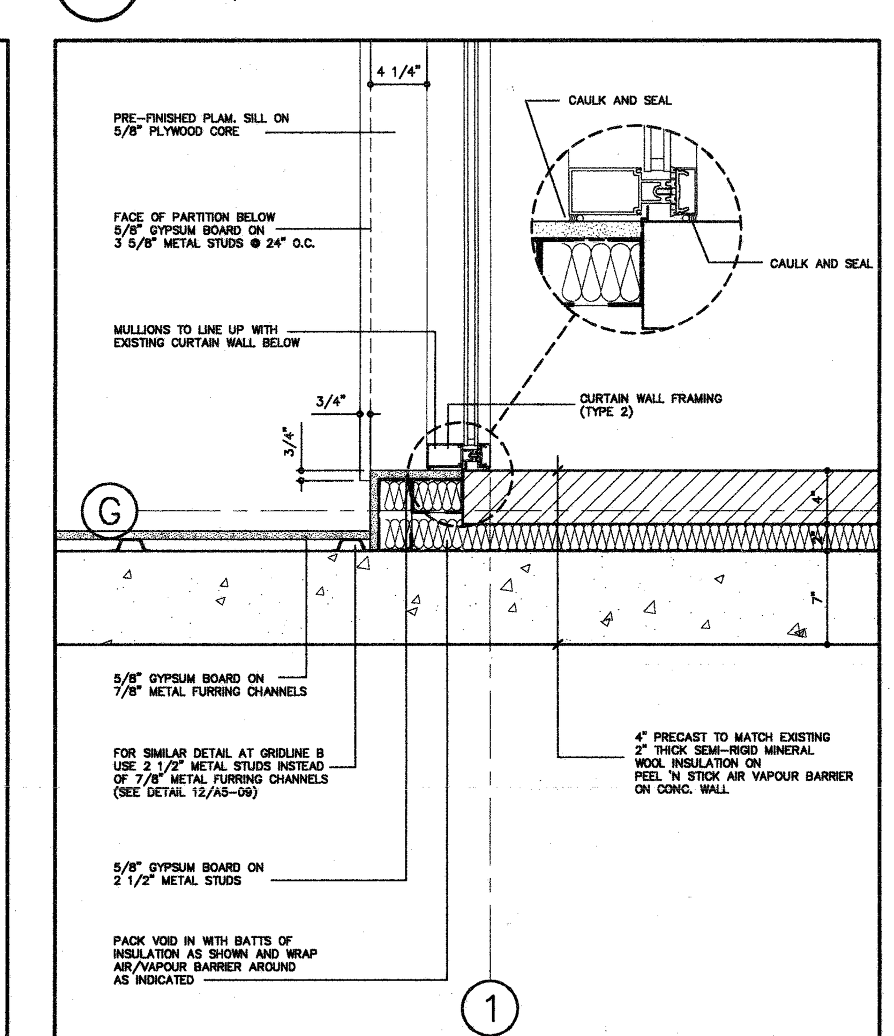

15 PLAN DETAIL
SCALE = 1 1/2" = 1'-0"

A0 841x1189

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NOTE: REFER TO DRAWING A2-08 AND A2-09 FOR LIST OF WALL AND FLOOR FINISHES

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REVISIONS ISSUES

CONSTRUCTION NORTH

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE
4666

Ontario
SuperBuild

Project Manager

Cansult Hanscomb
Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY
ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

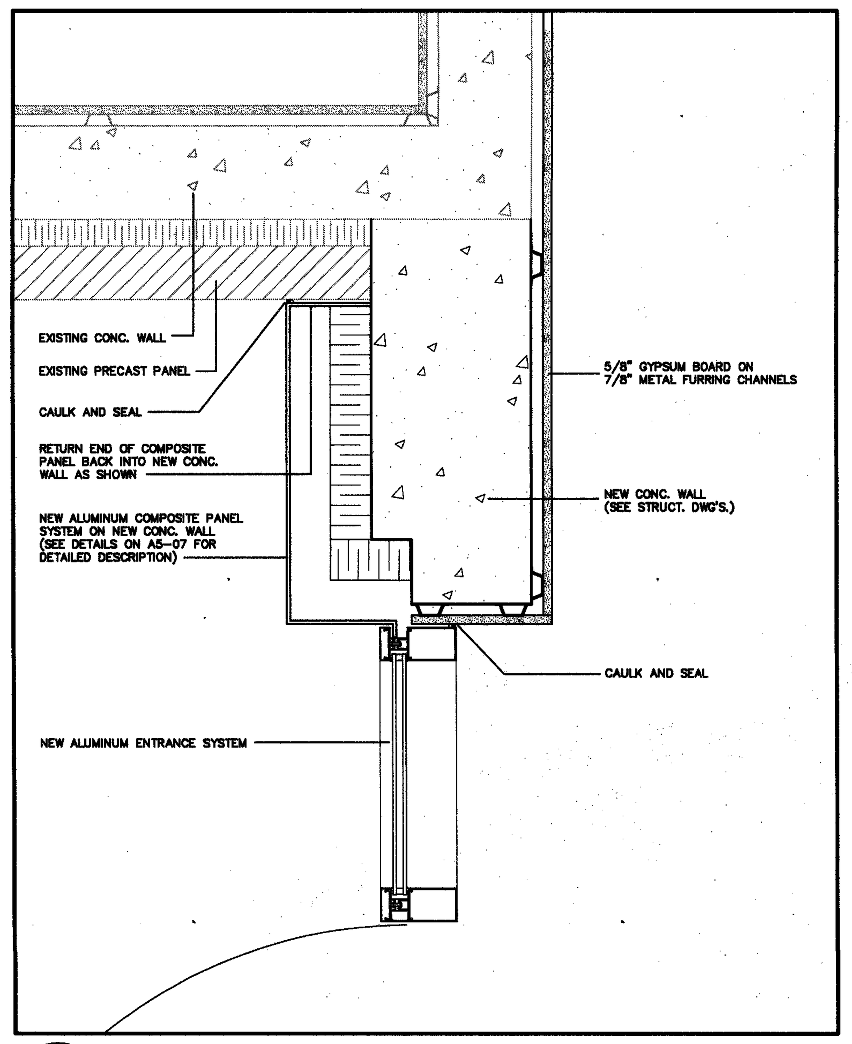
EXTERIOR WALL PLAN DETAILS

Graphic Scale		Sheet no.
Printed	Scale 1 1/2" = 1'-0"	A5-07
Date MAY 07, 2001	Job No. 200004	

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	CAT

[redacted]

EPH/SHE 049



1 PLAN DETAIL
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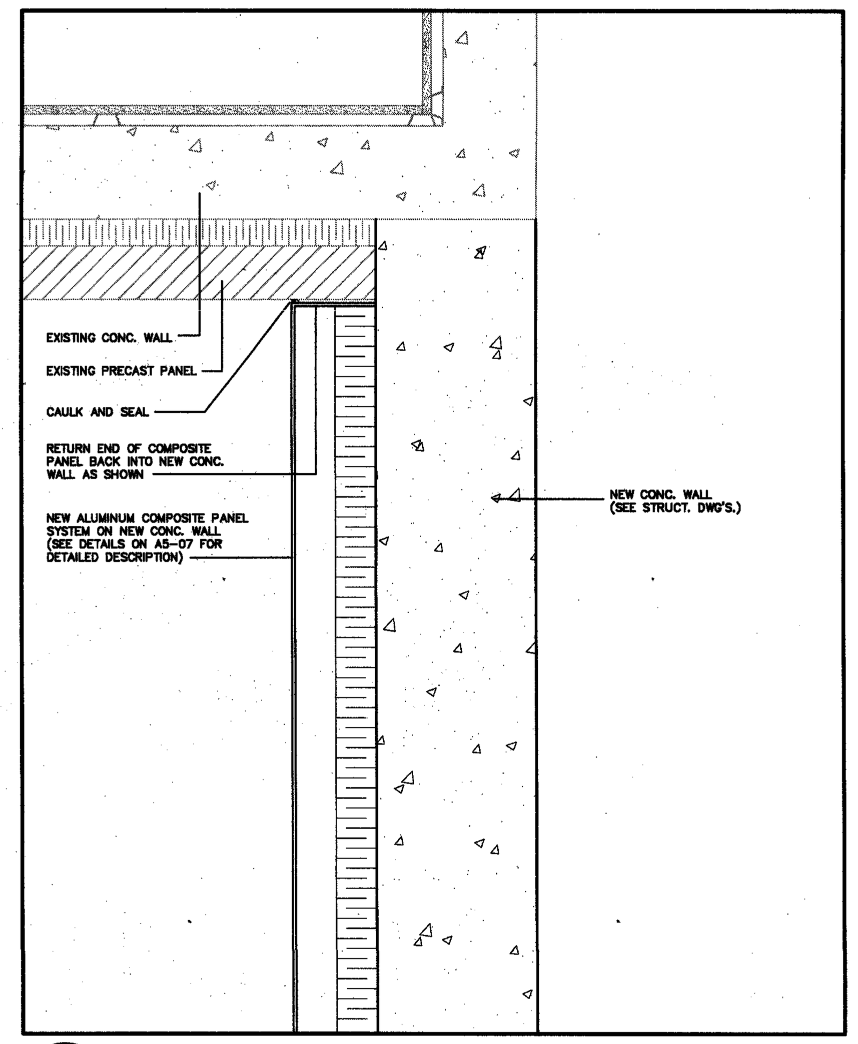

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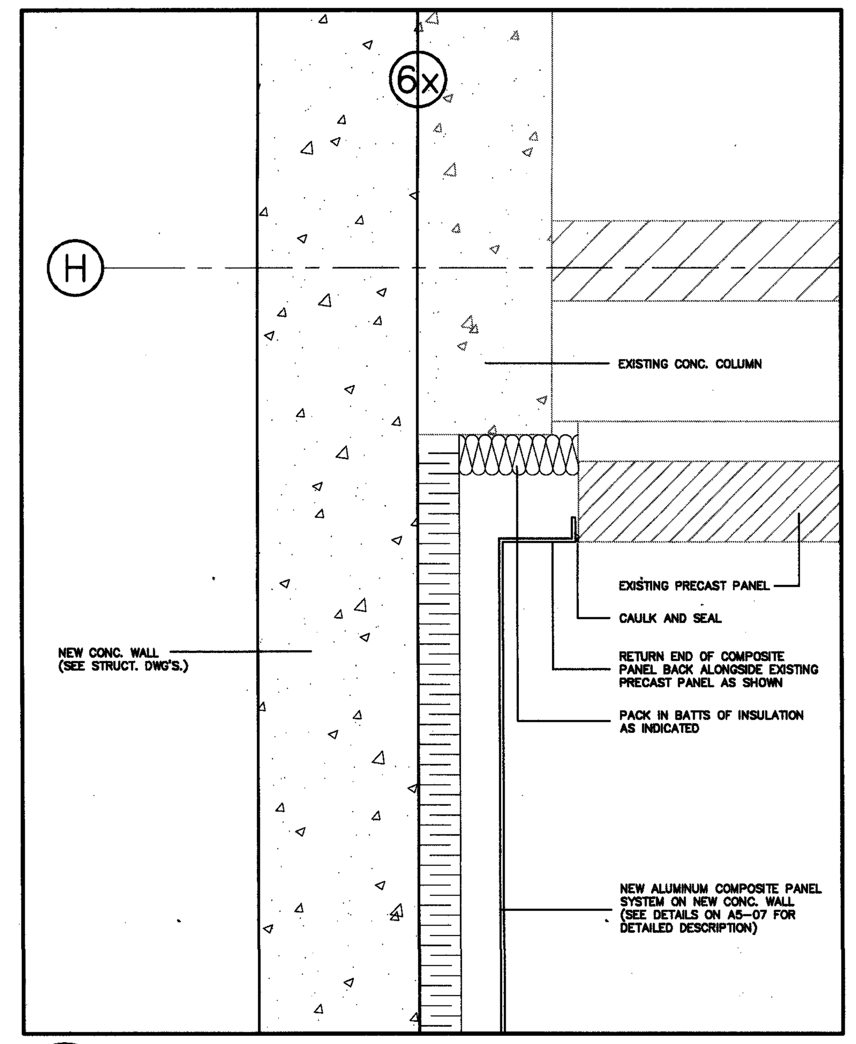

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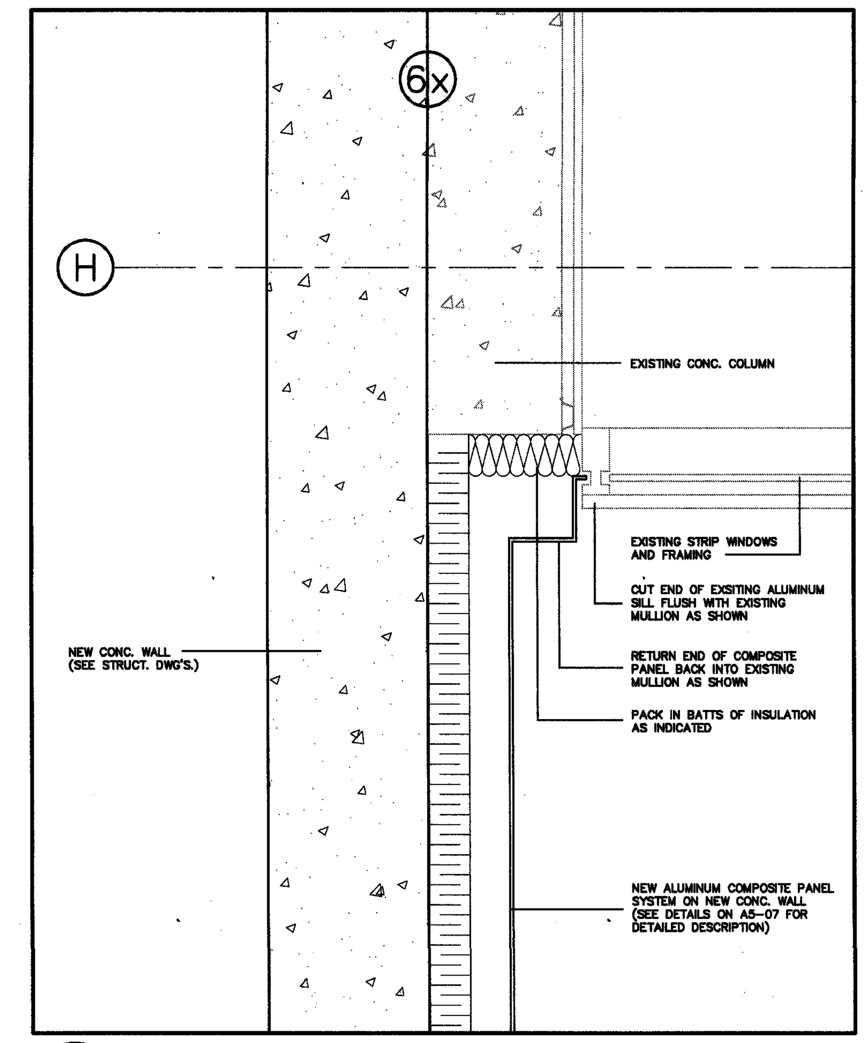

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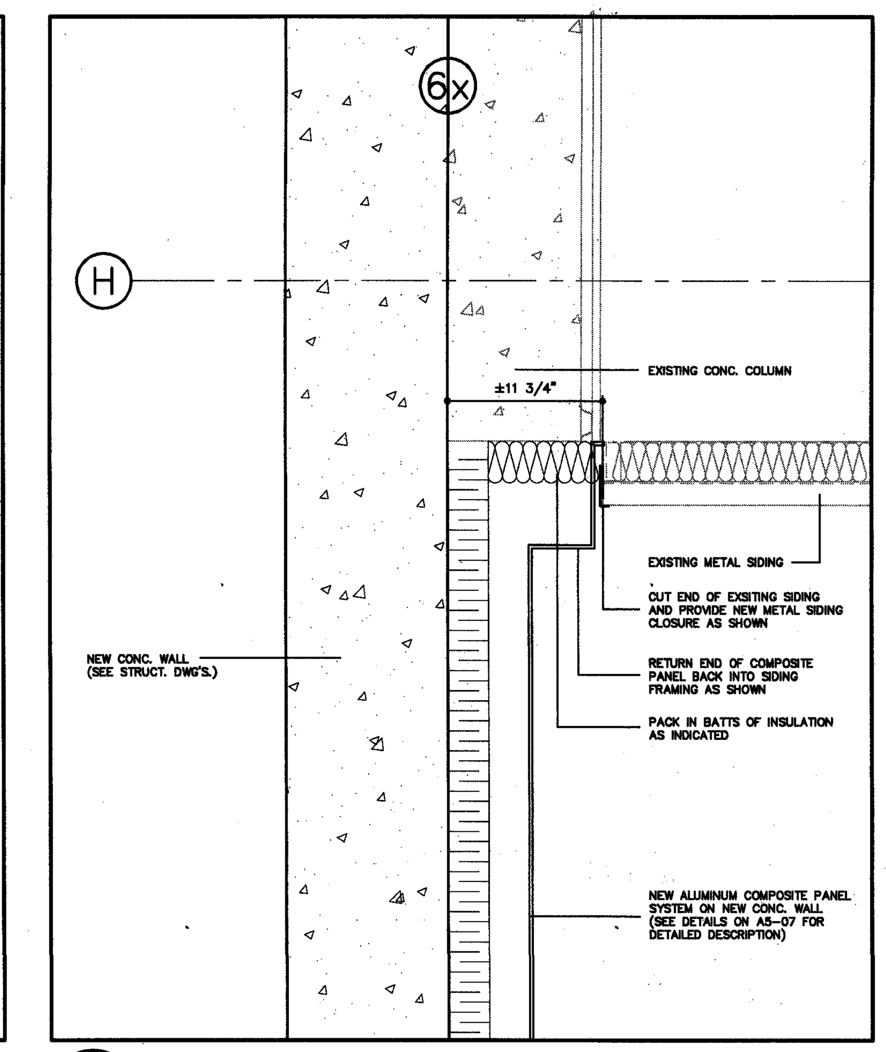

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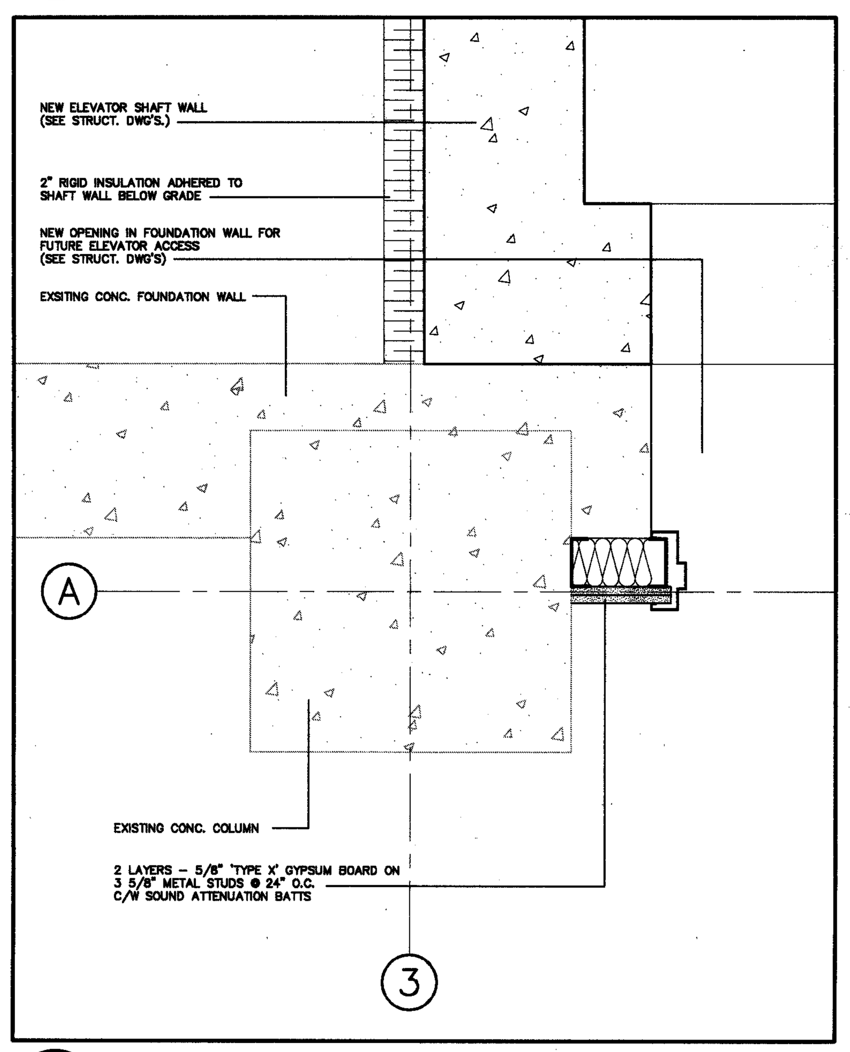

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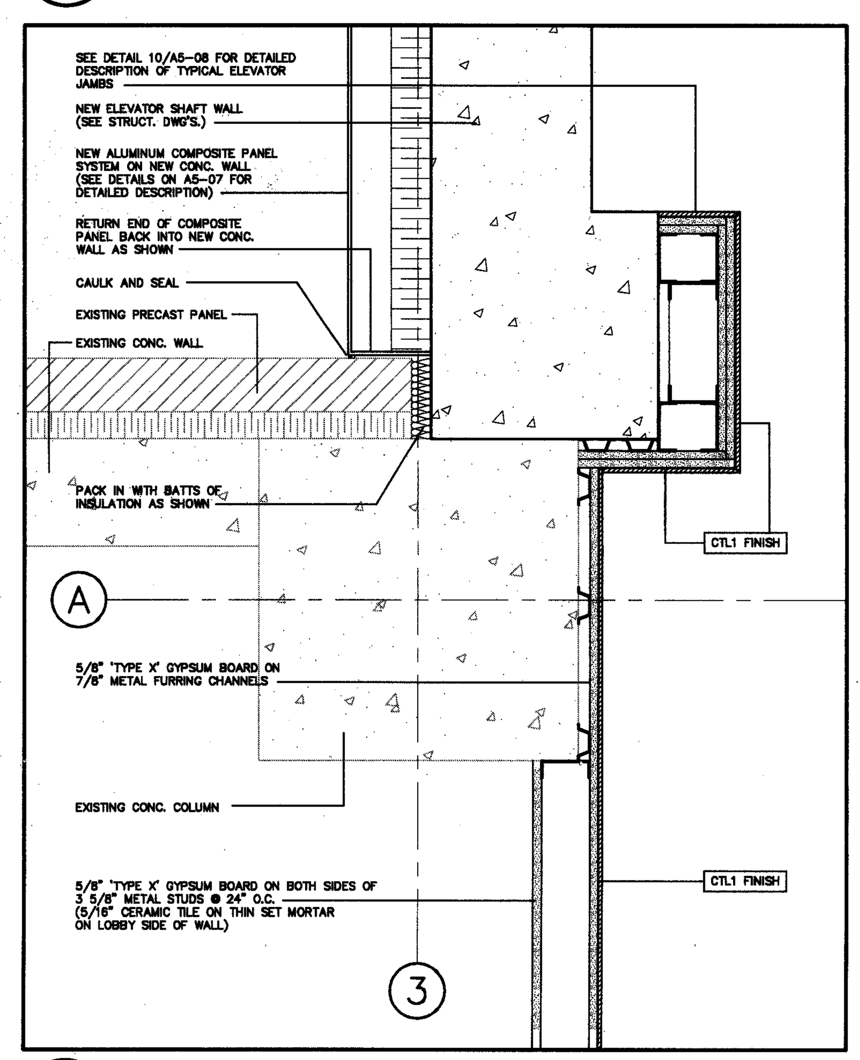

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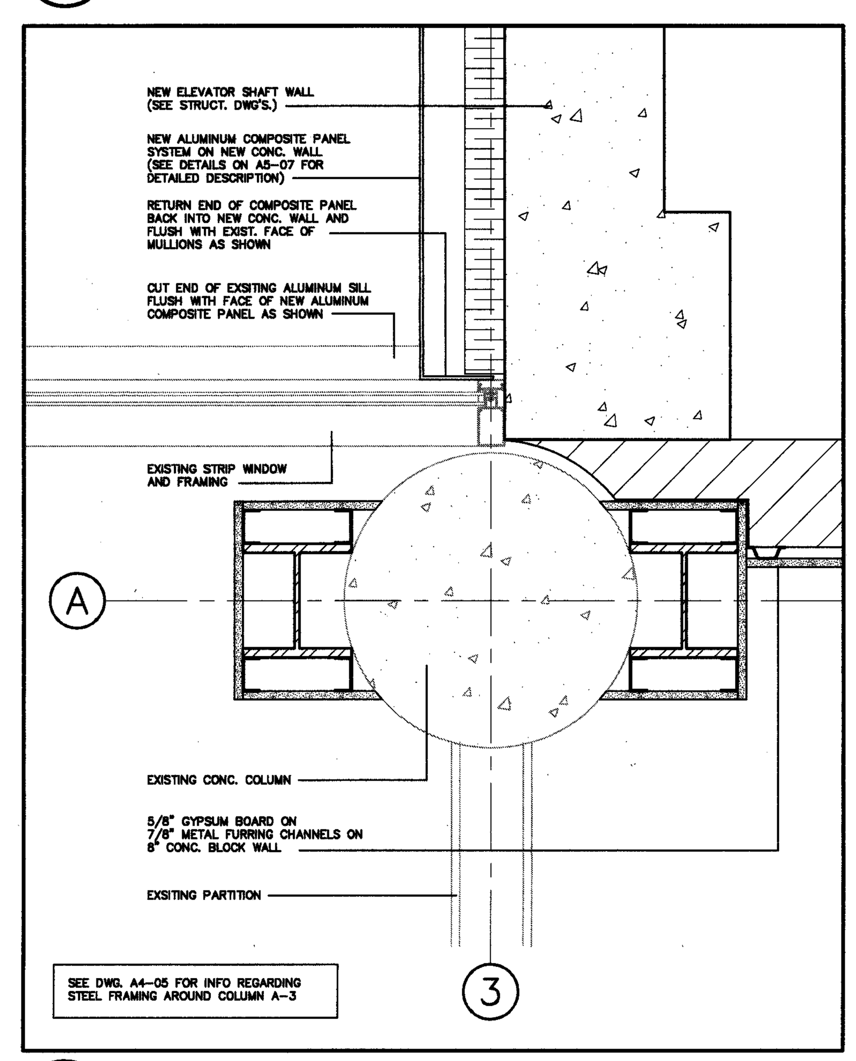

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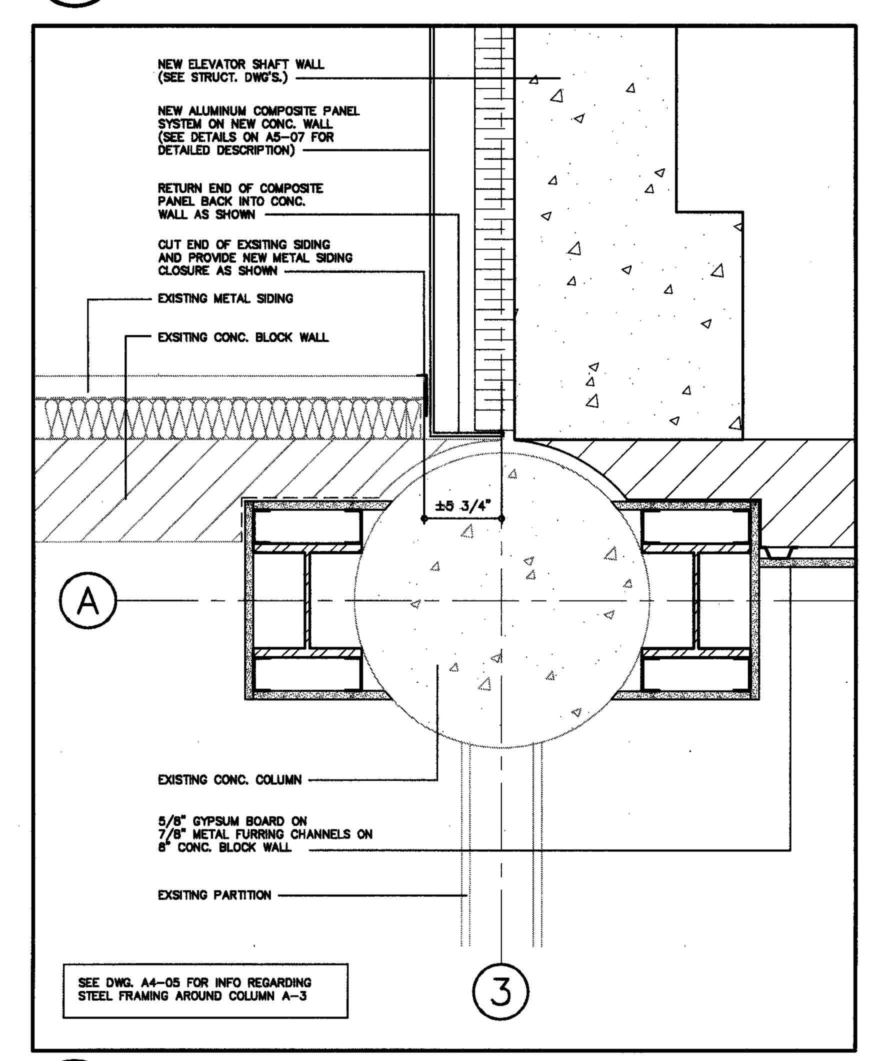

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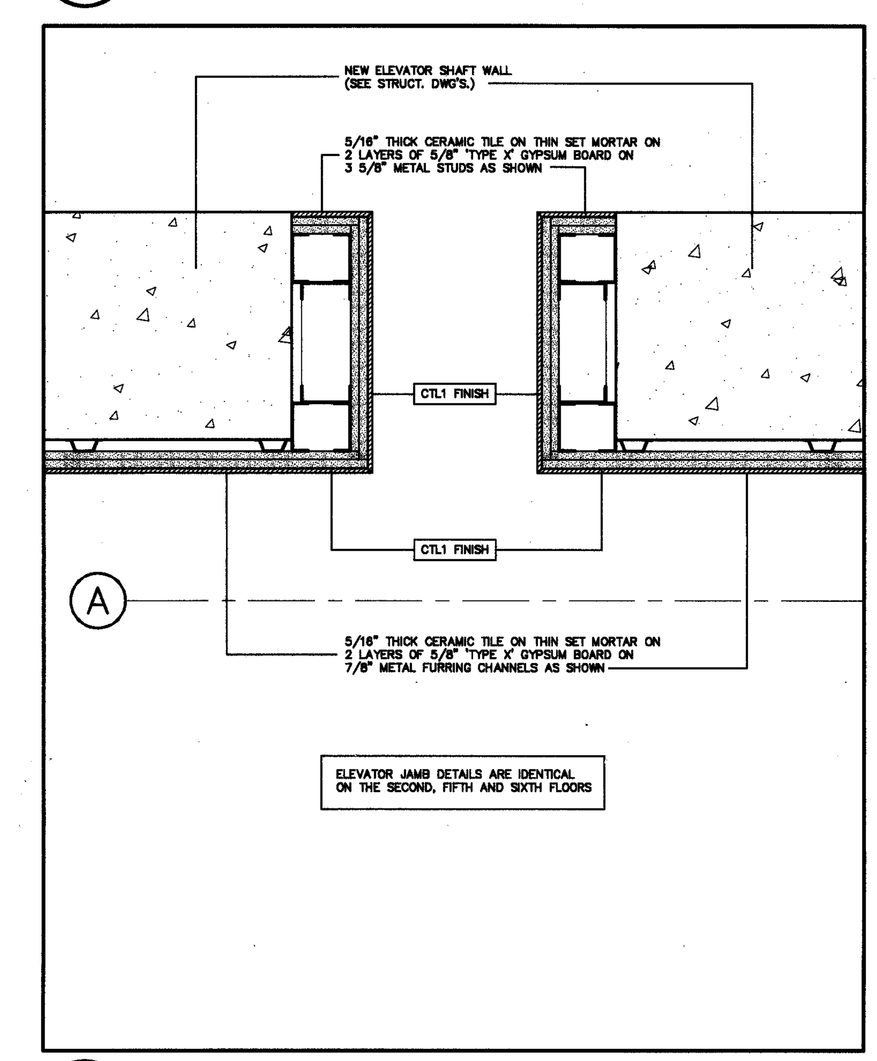

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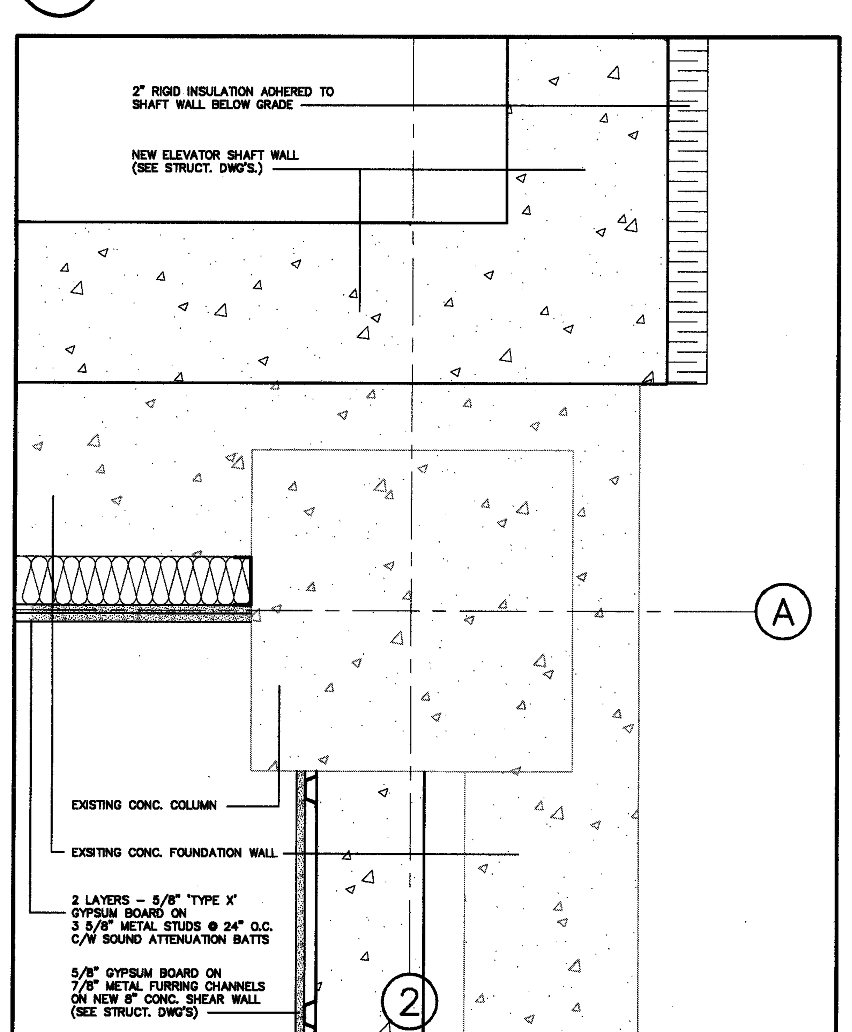

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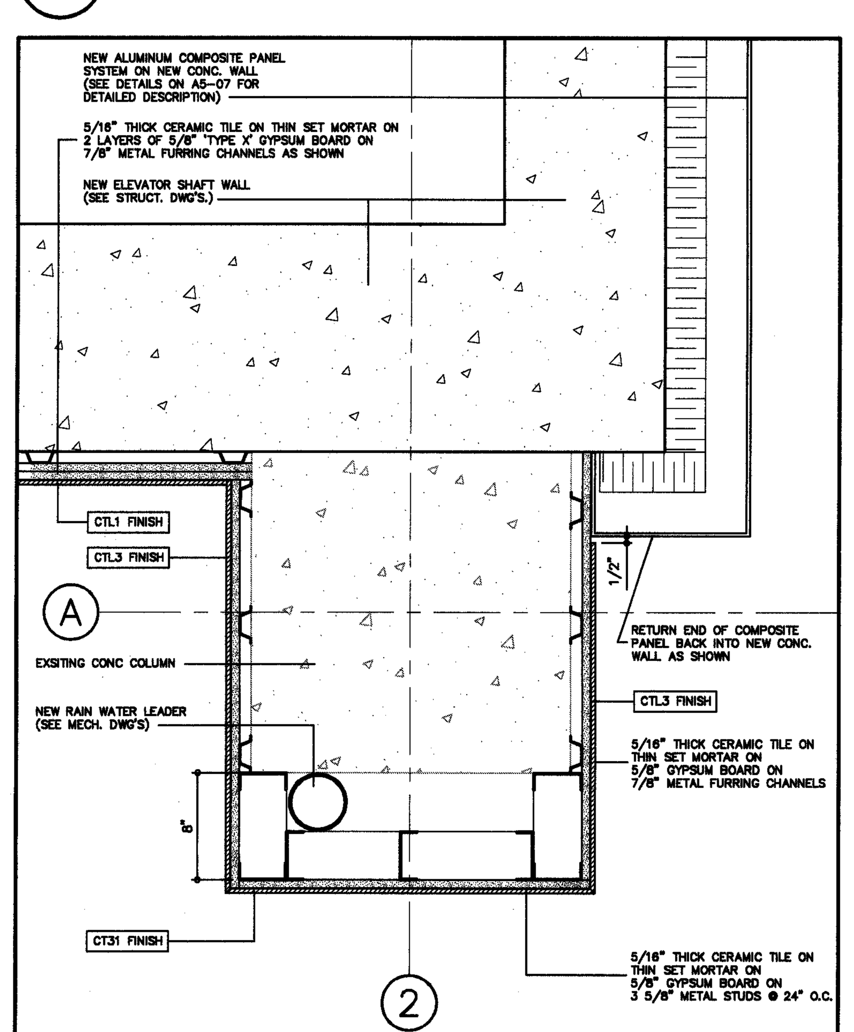

12 PLAN DETAIL
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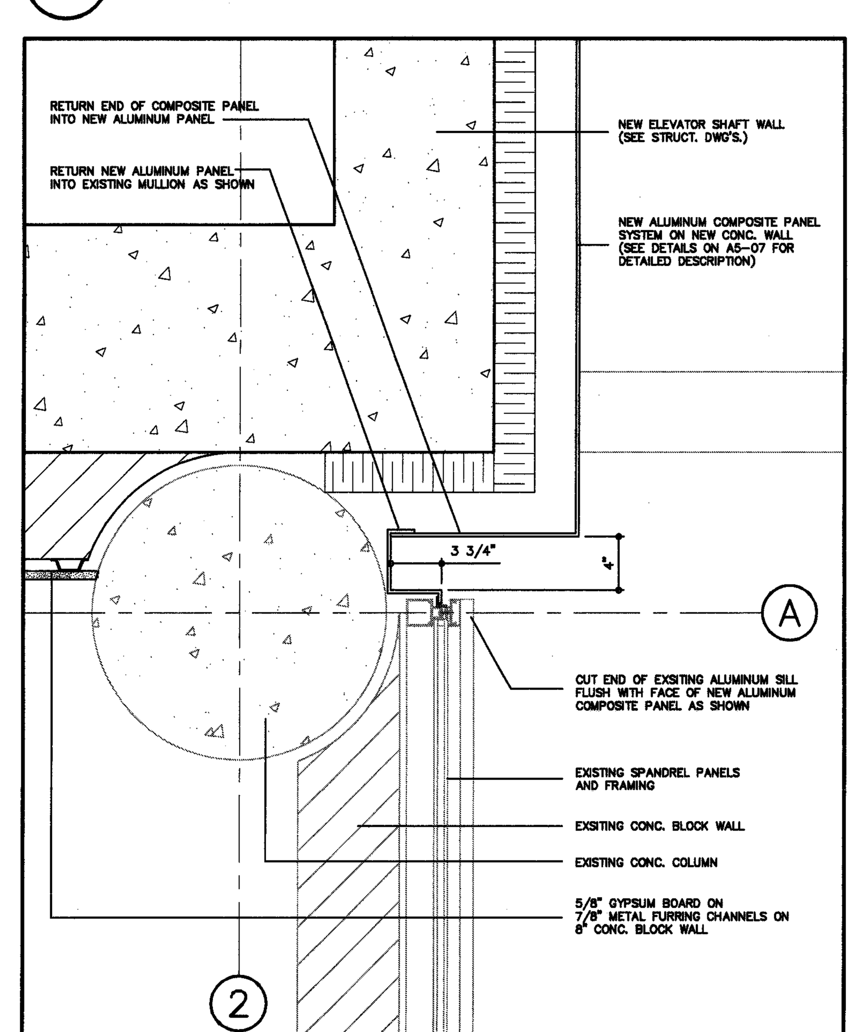

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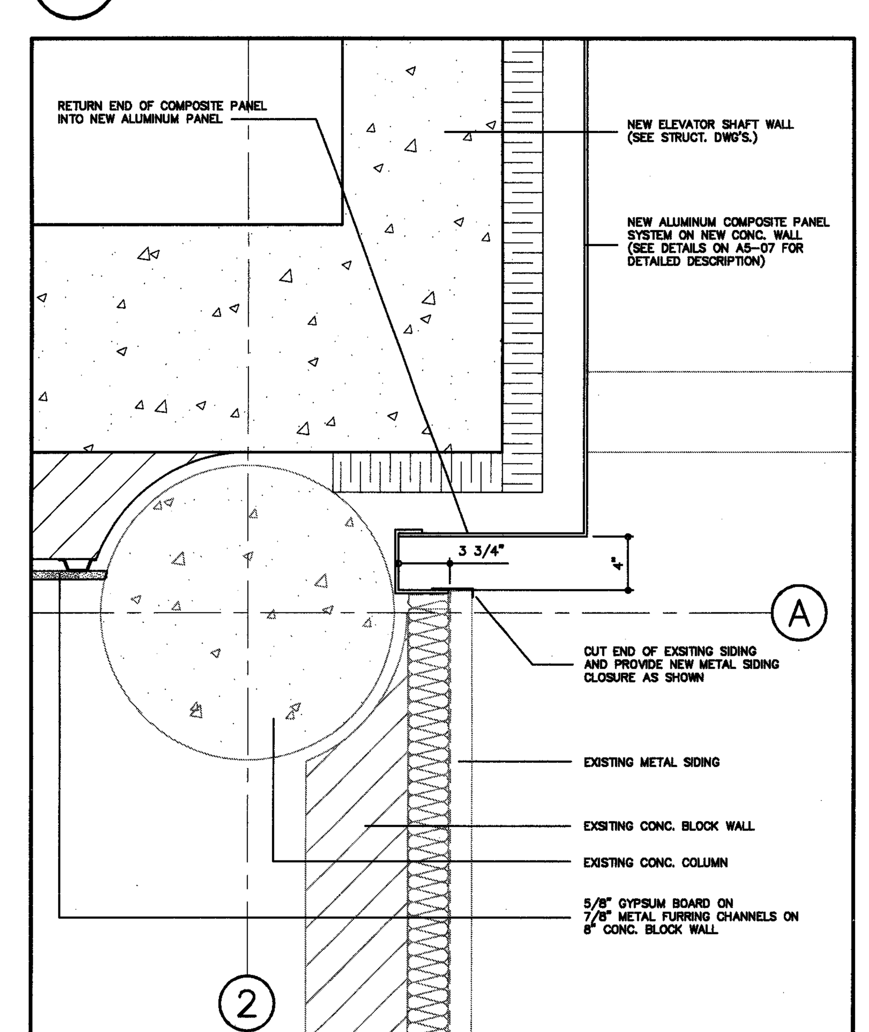

14 PLAN DETAIL
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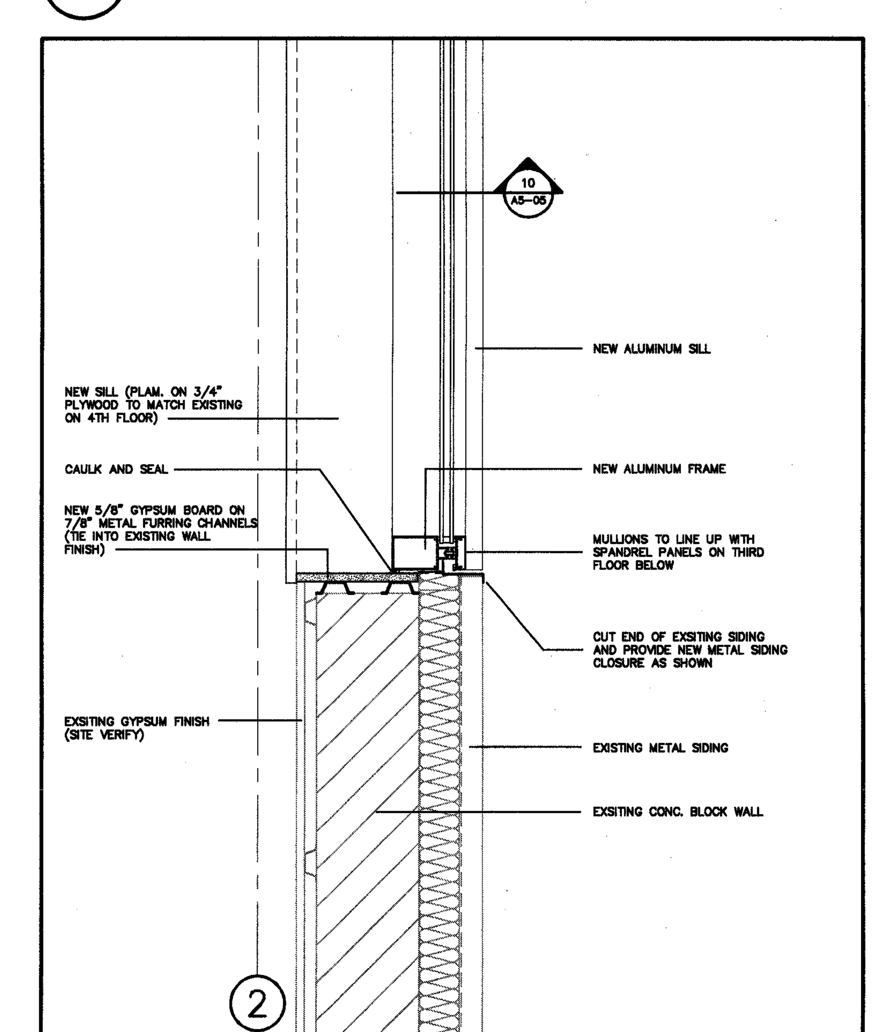

15 PLAN DETAIL
SCALE = 1 1/2" = 1'-0"

A0 841x1189

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REVISIONS ISSUES

CONSTRUCTION NORTH

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GAYECHE
LICENCE
4686

Ontario
SuperBuild

Project Manager

Cansult Hanscomb
Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY
ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

MISCELLANEOUS
PLAN DETAILS

Graphic Scale					Sheet no.
Printed		Scale 1 1/2" = 1'-0"			A5-08
Date MAY 07, 2001		Job No. 200004			
P in C BG	PM DP	JC CAT	Des BG/BL	Dr CAT	

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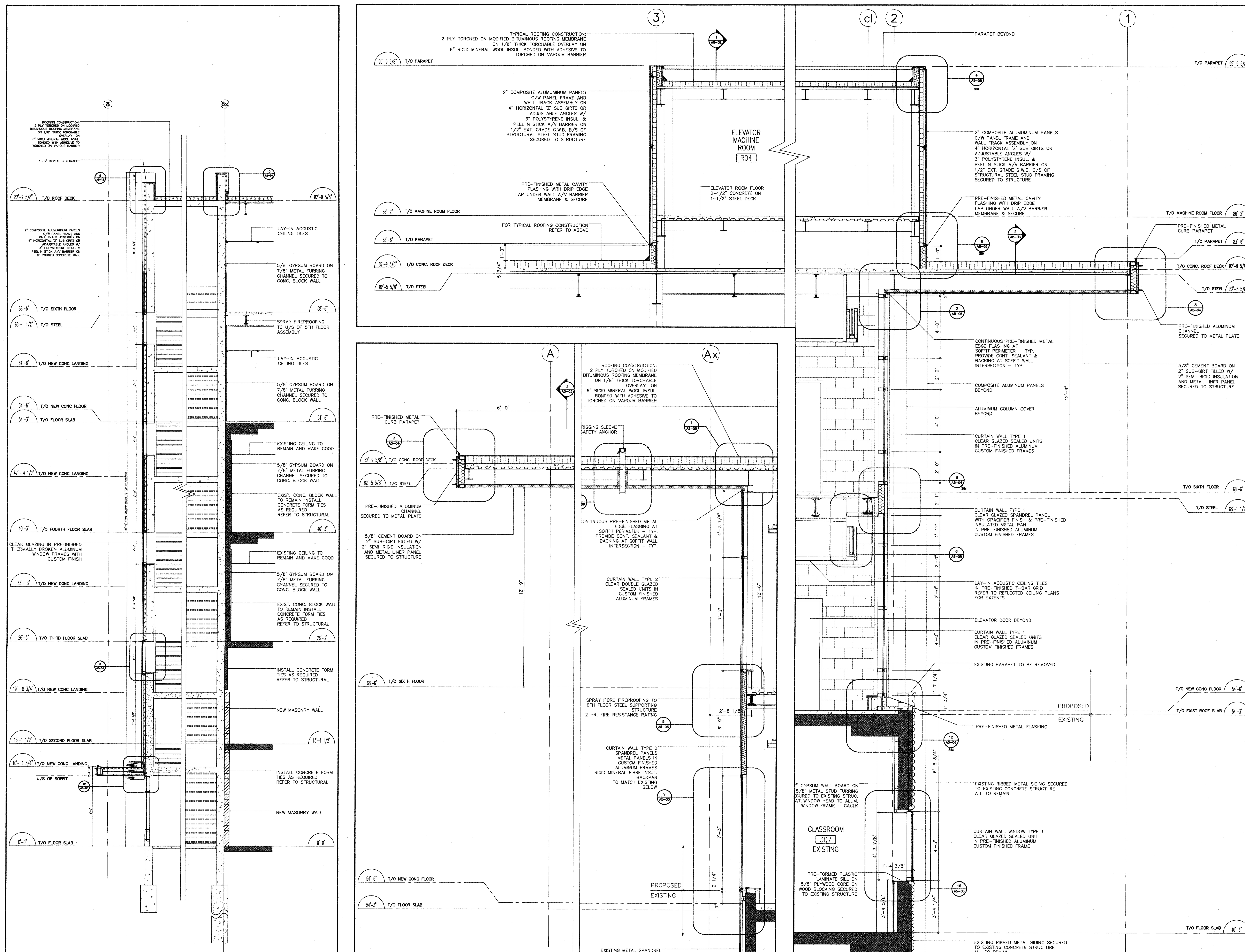

1 STAIR 5 WALL SECTION
SCALE = 1/4" = 1'-0"

2 PANEL WALL SECTION
SCALE = 1/2" = 1'-0"

3 CURTAIN WALL SECTION
SCALE = 1/2" = 1'-0"

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REVISIONS ISSUES

Ontario SuperBuild

Project Manager
Consult Hanscomb Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY ARCHITECTS
225 RICHMOND ST. W. SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1389 FAX 416 204-1321

Associate Architect
Lett/Smith Architects

Consultant

RYERSON UNIVERSITY AND GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

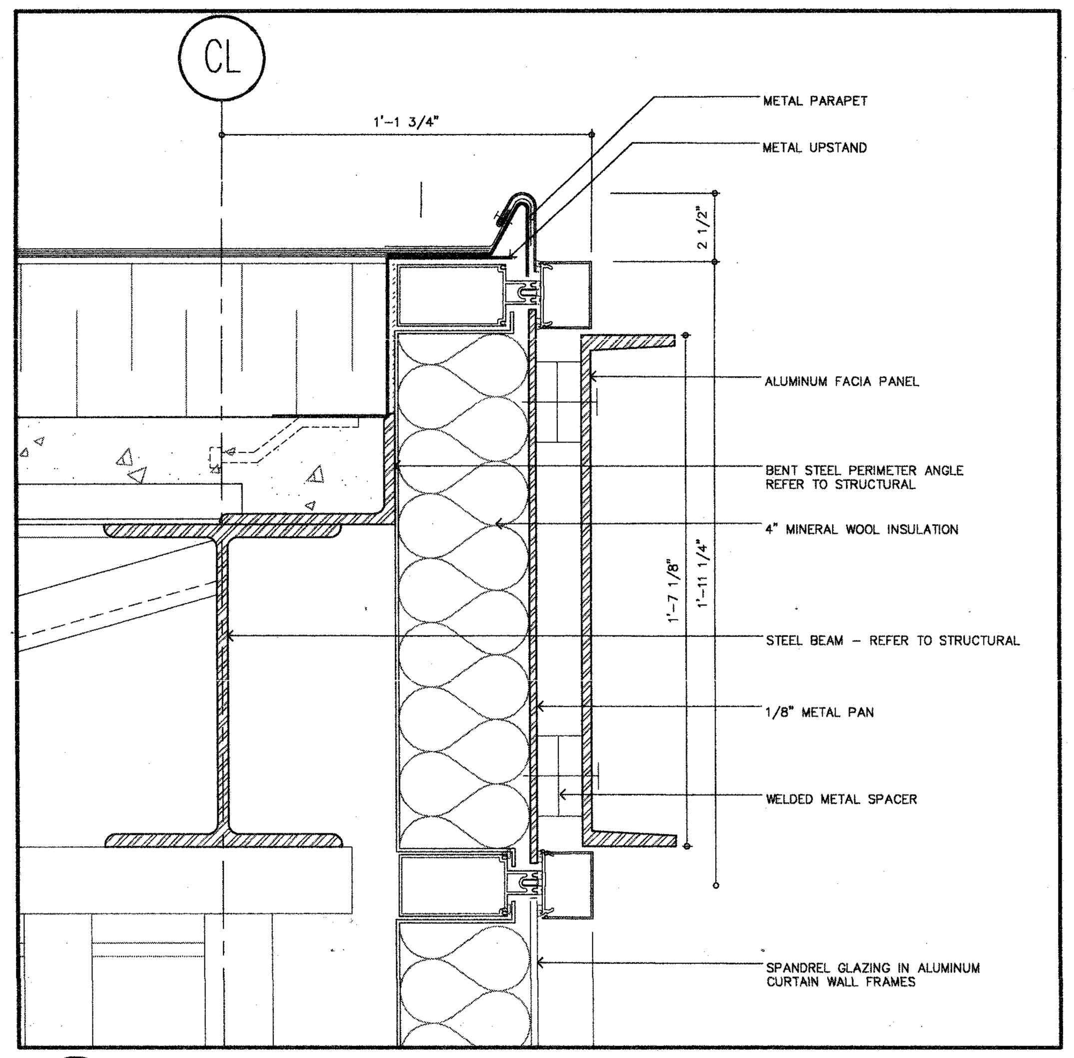
87 GERRARD STREET EAST

EXTERIOR ELEVATOR & VESTIBULE SECTIONS

Graphic Scale		Sheet no.
Printed	Scale AS NOTED	A5-03
Date MAY 07, 2001	Job No. 290004	

A0 841x1189

EPH/SHE 045



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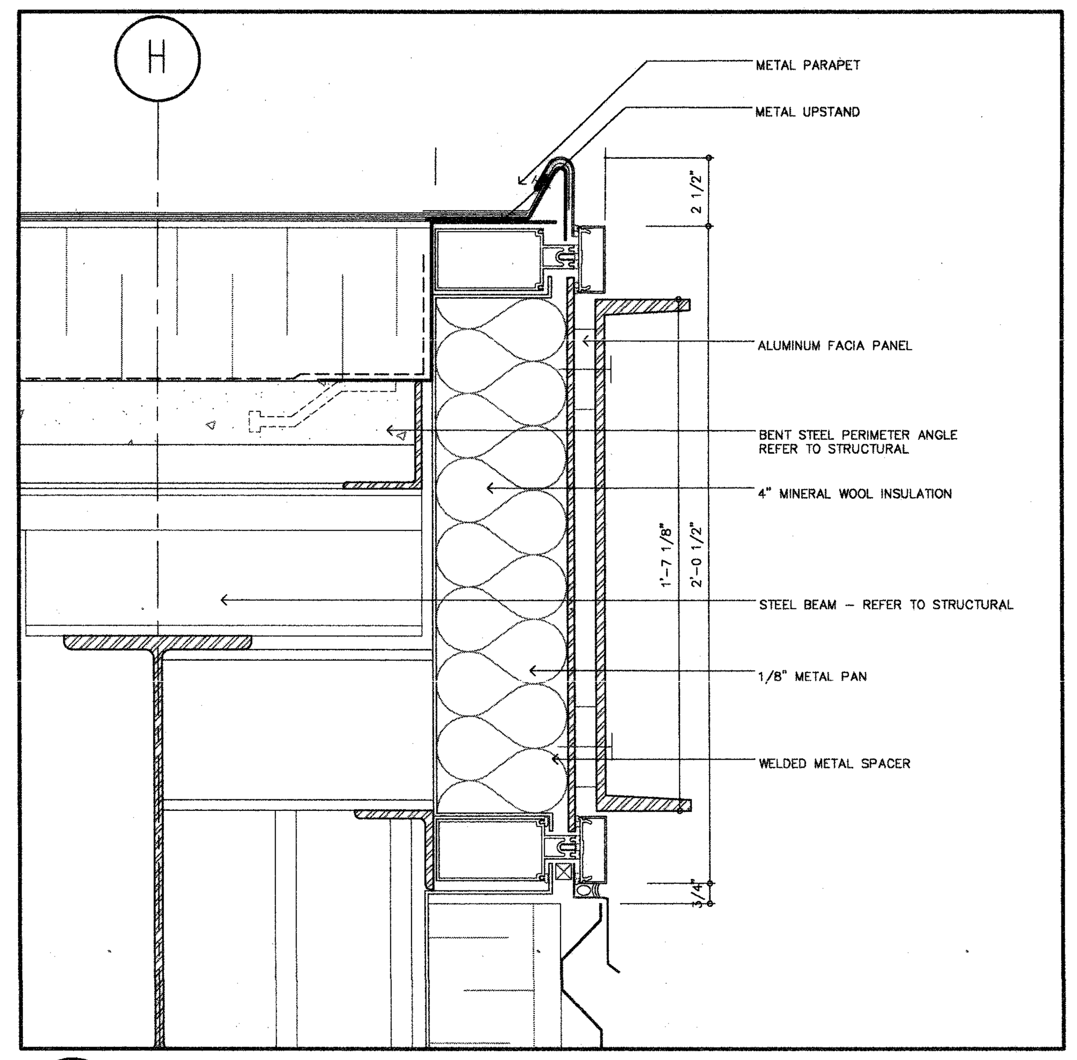

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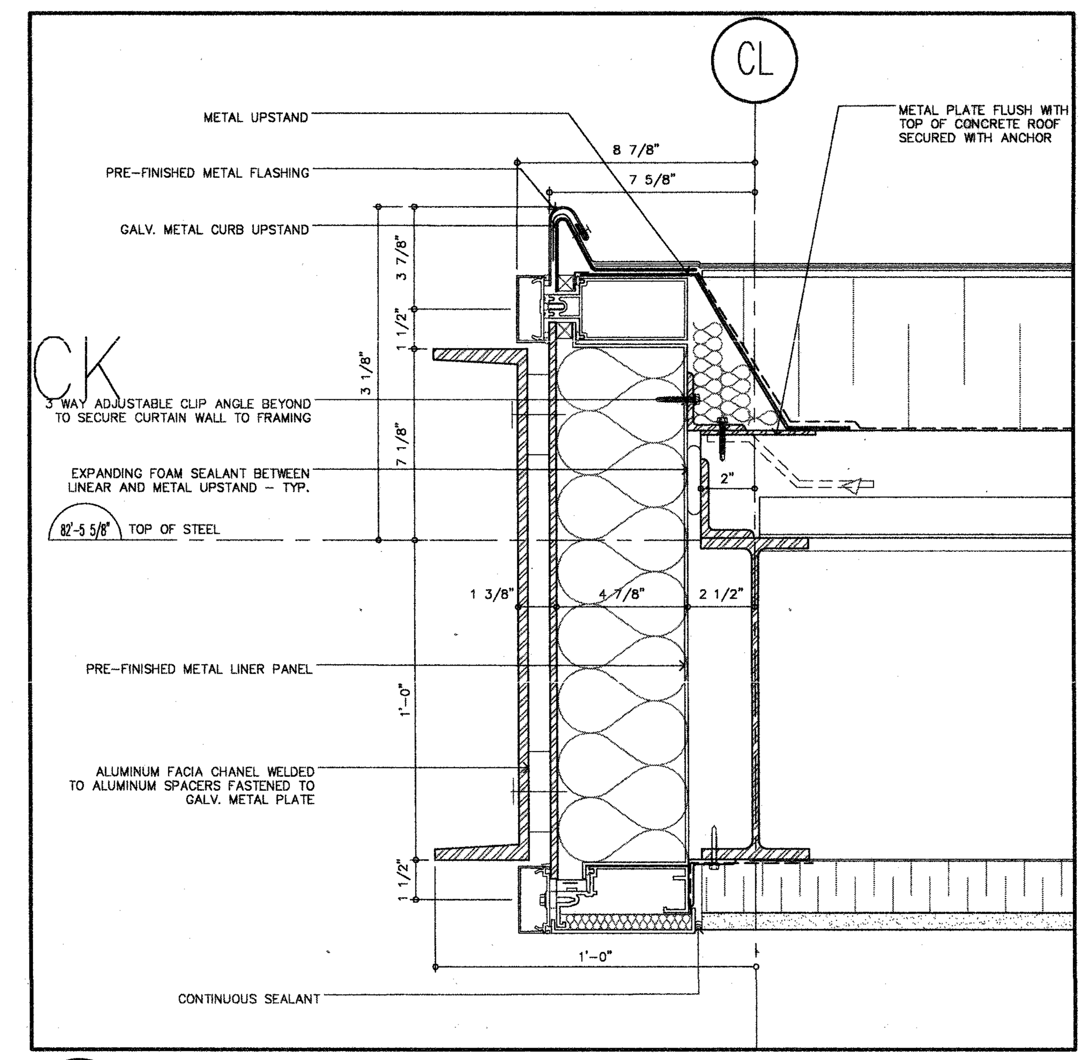

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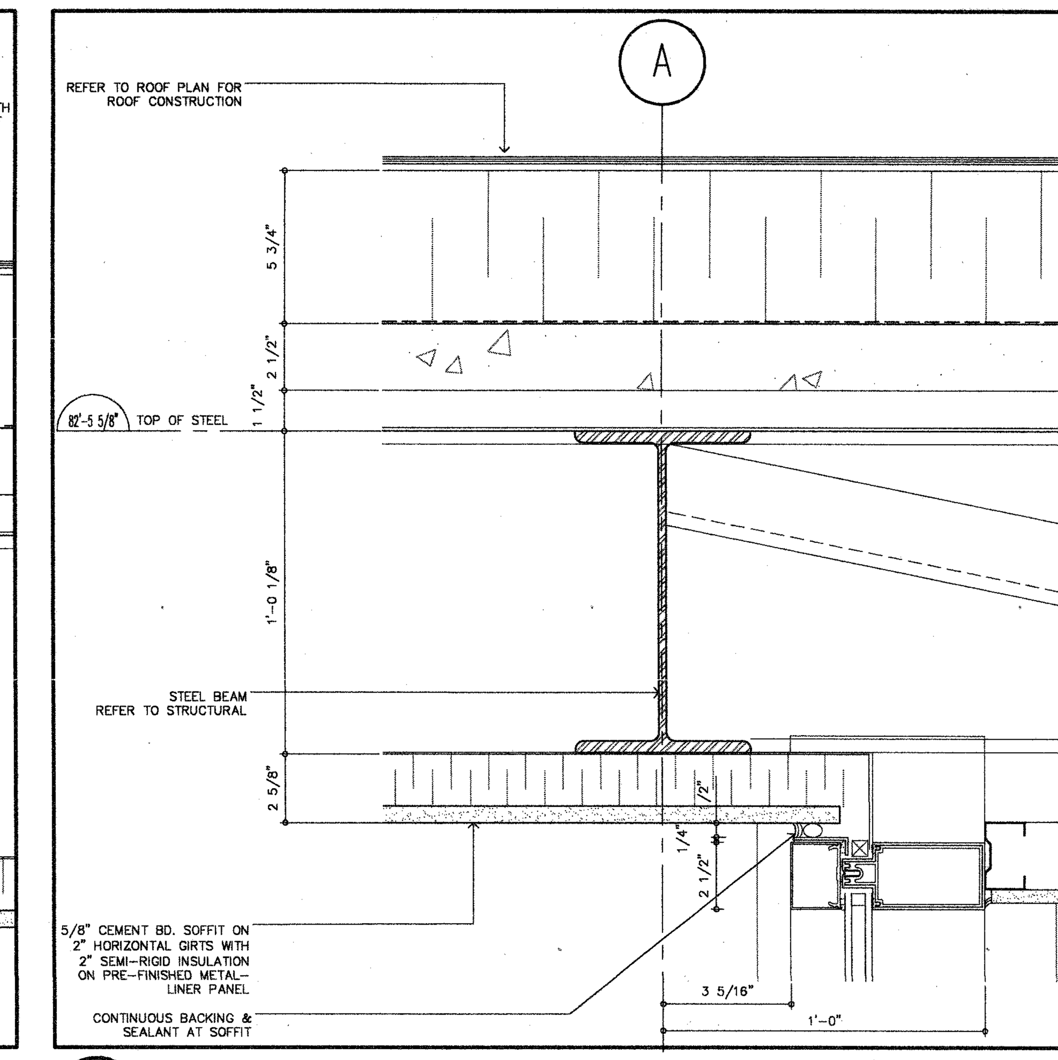

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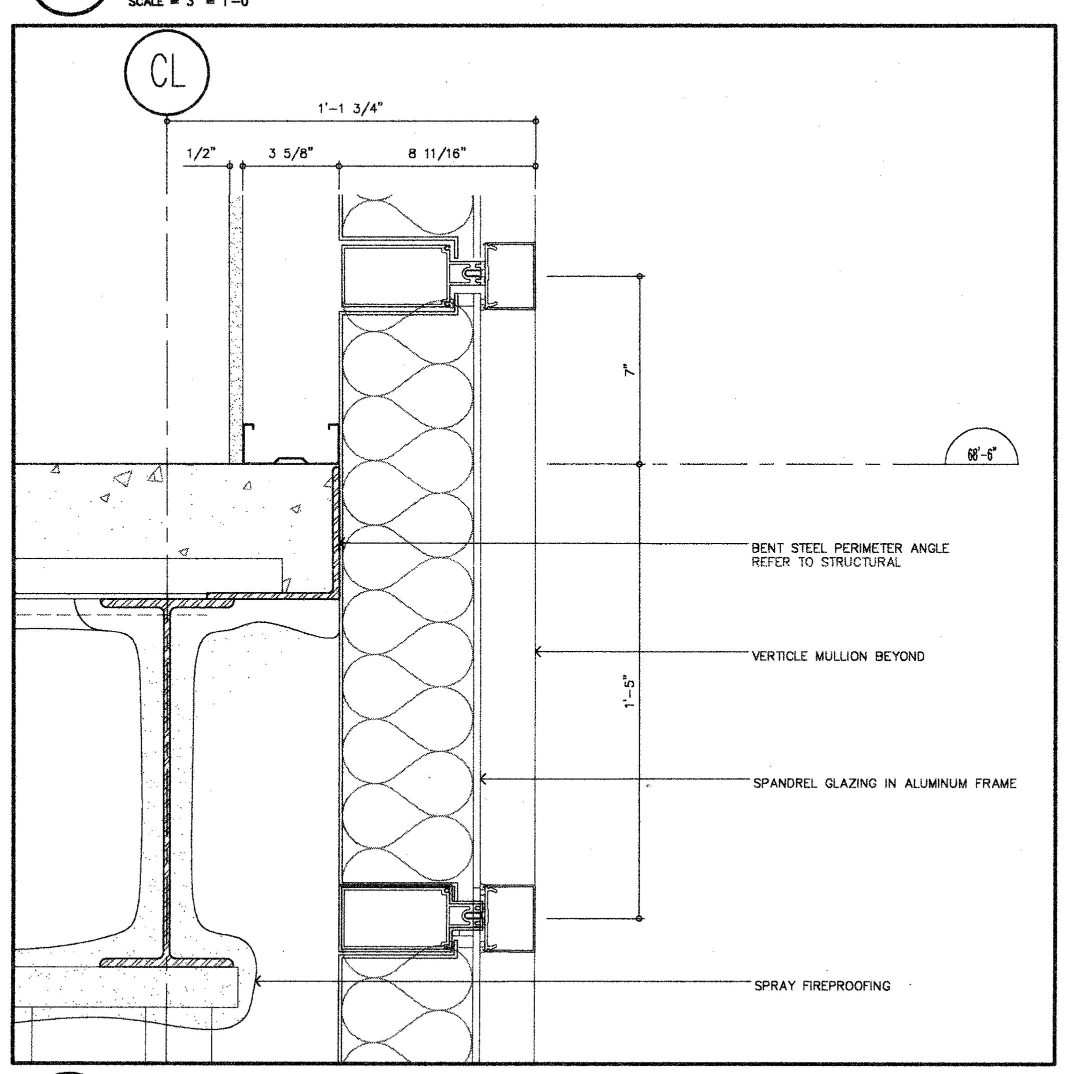
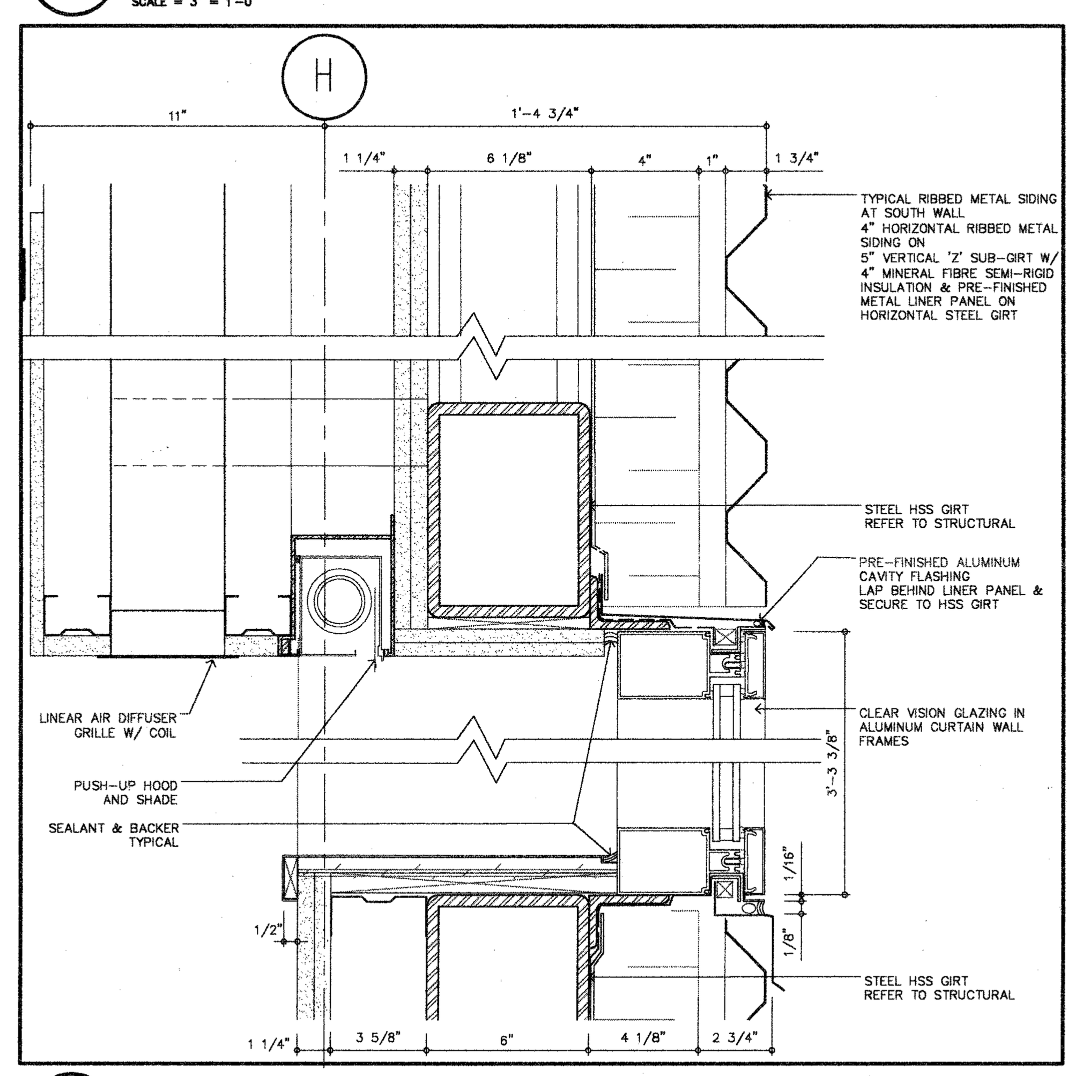
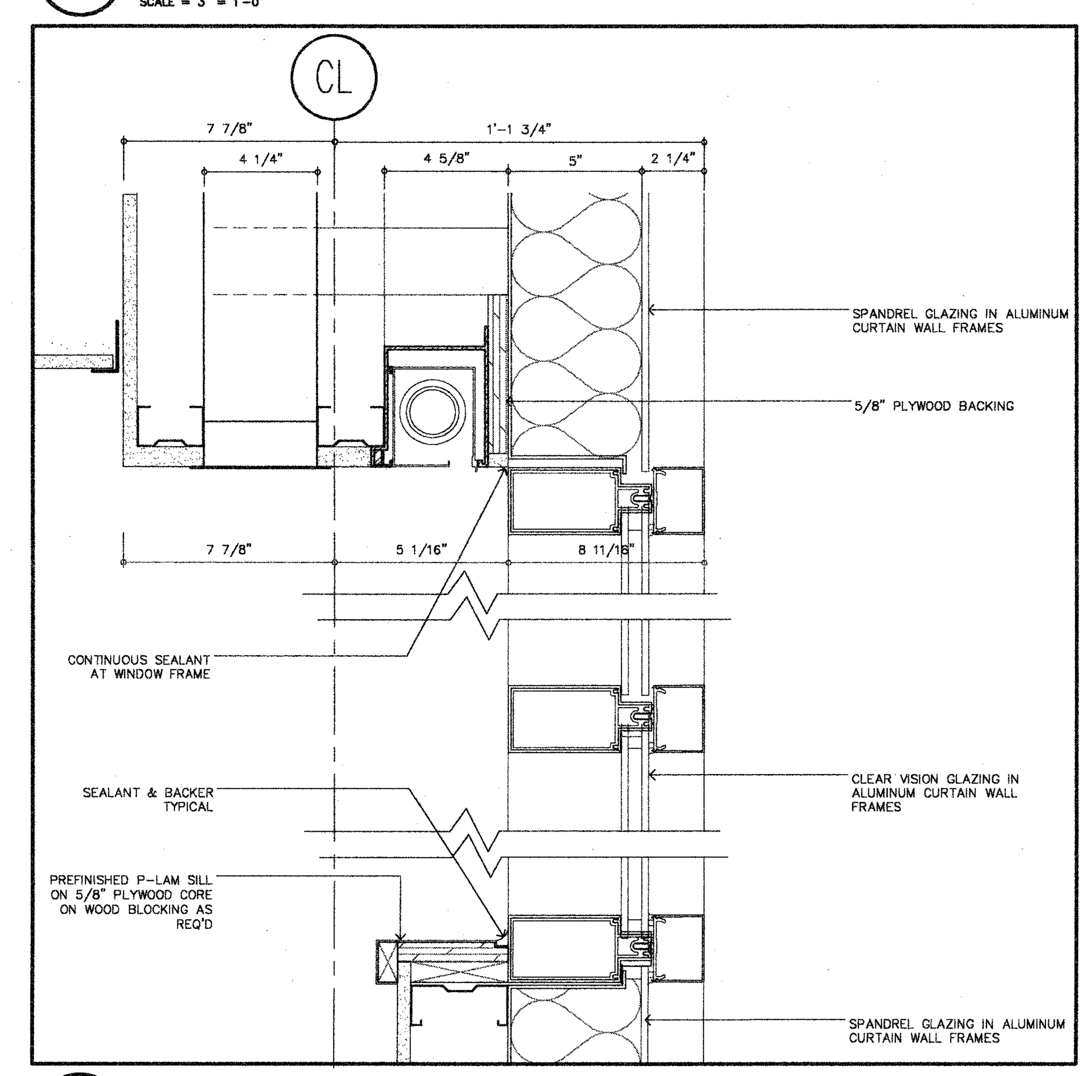


5 SECTION DETAIL
SCALE = 3" = 1'-0"



6 SECTION DETAIL
SCALE = 3" = 1'-0"



7 SECTION DETAIL
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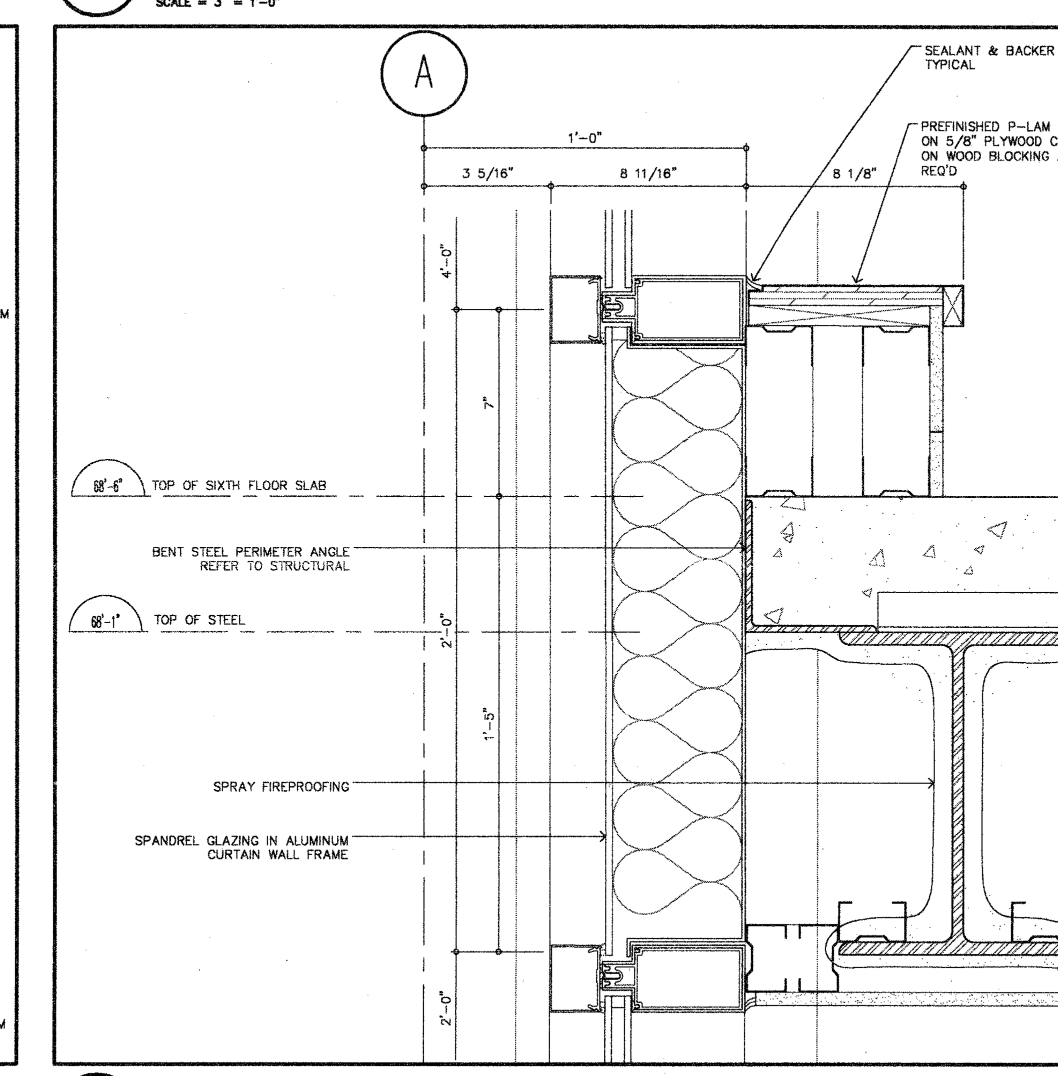
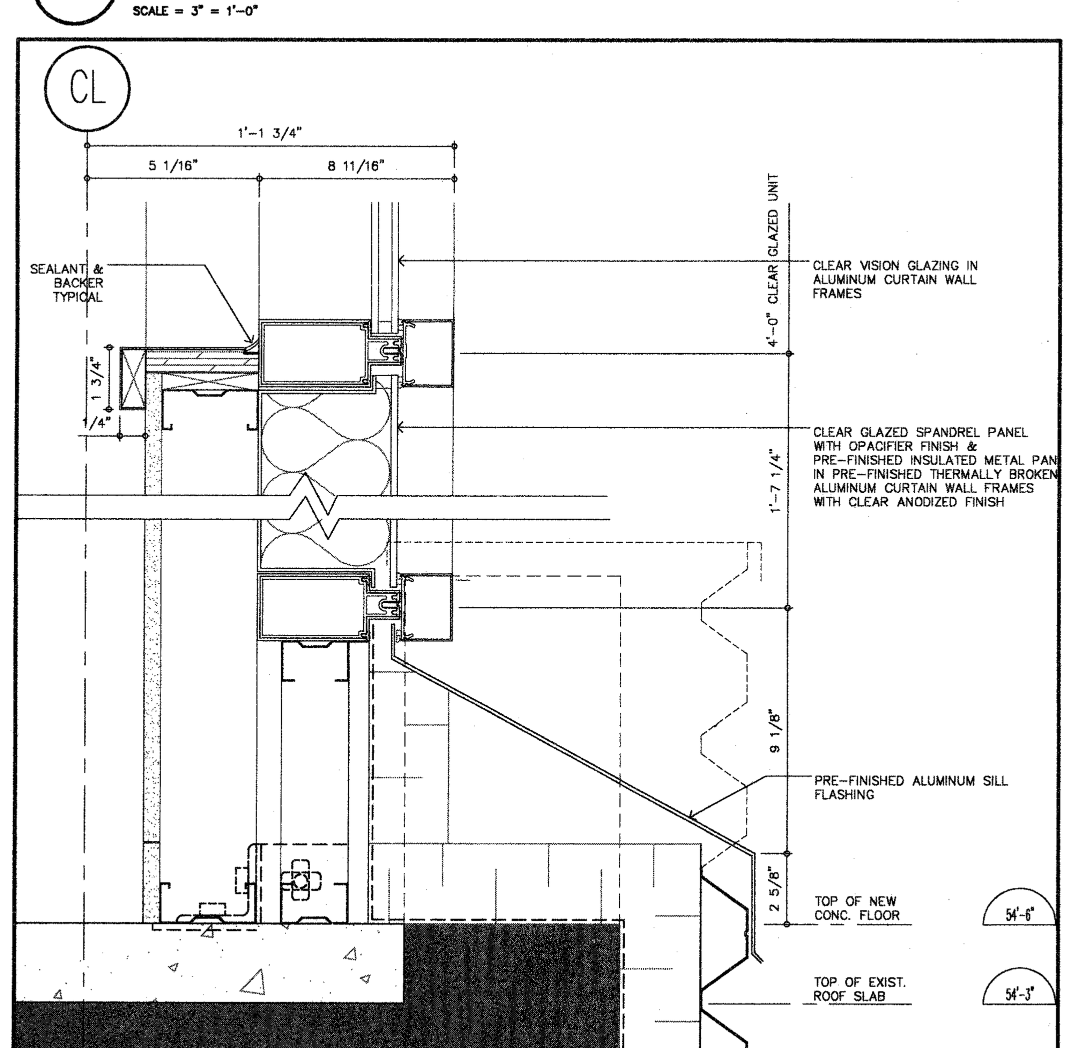
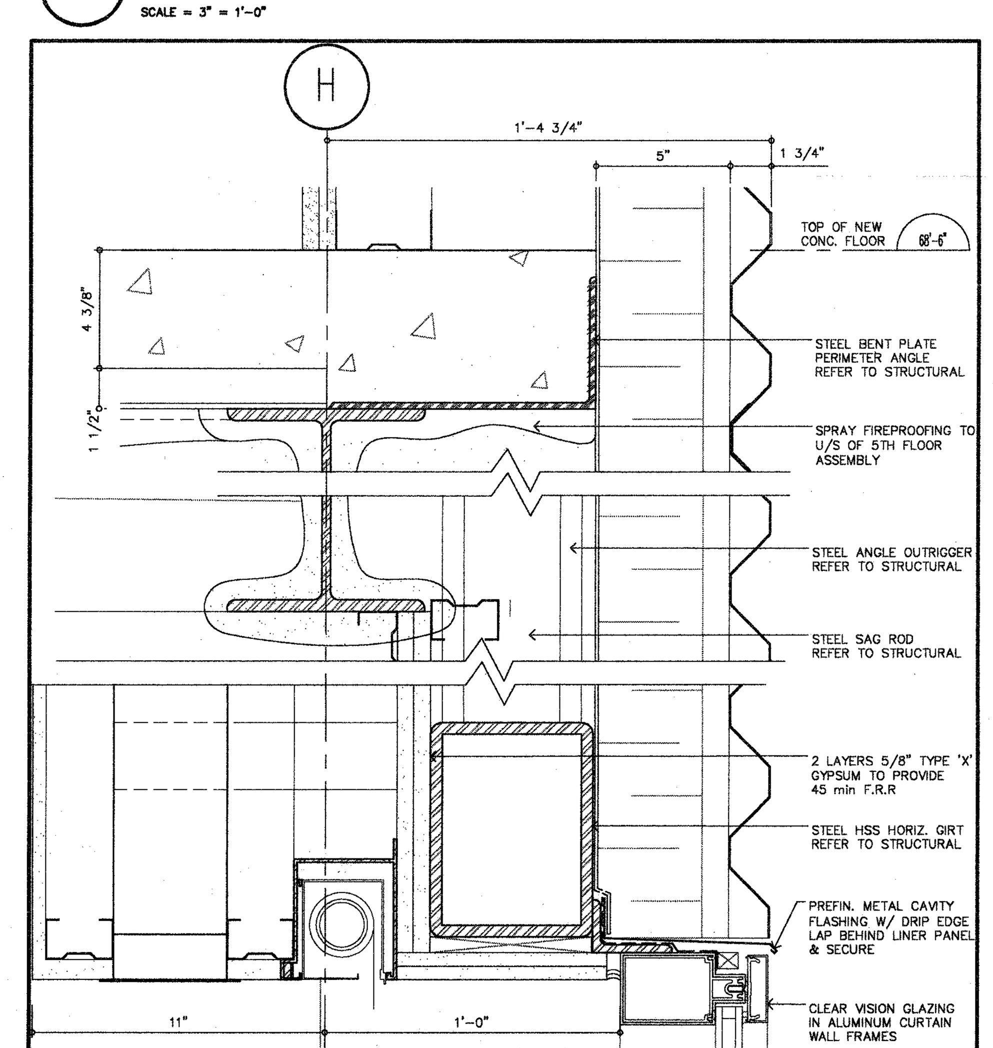


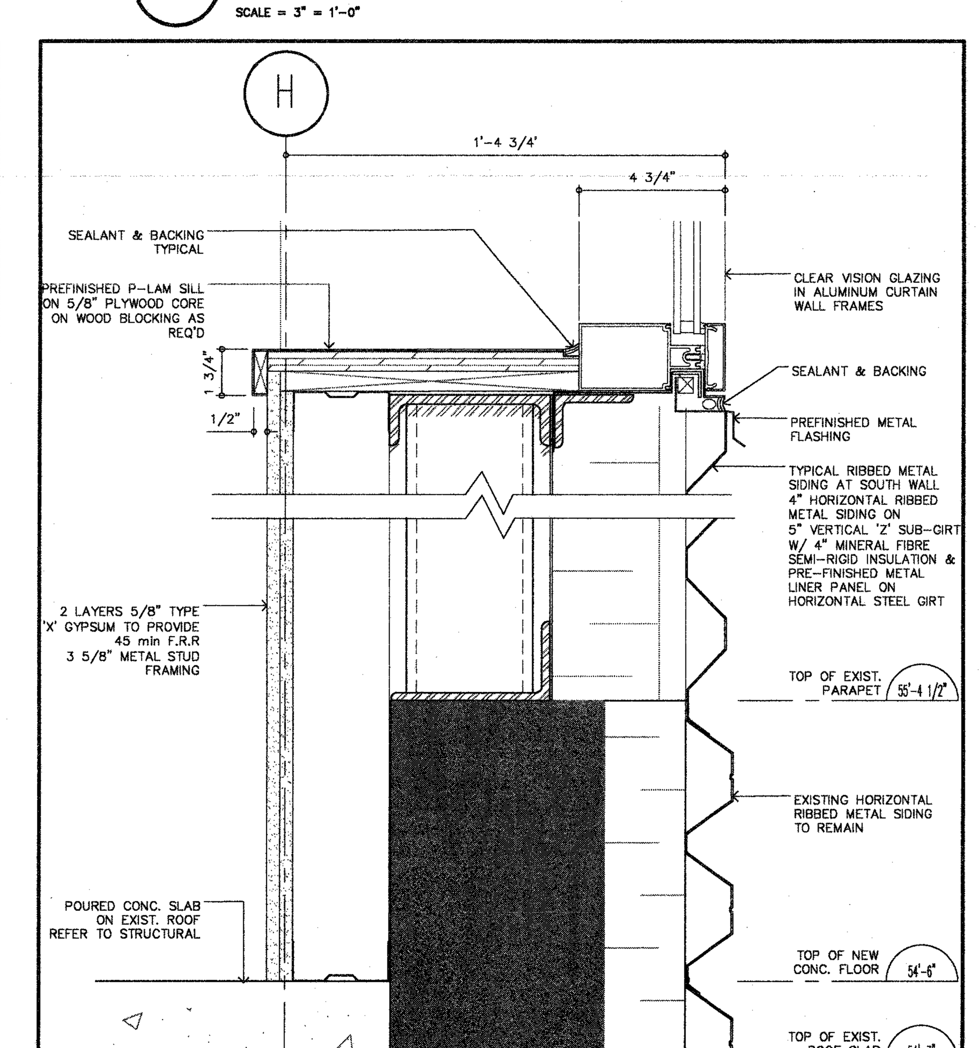
8 CURTAIN WALL SECTION DETAIL
SCALE = 3" = 1'-0"



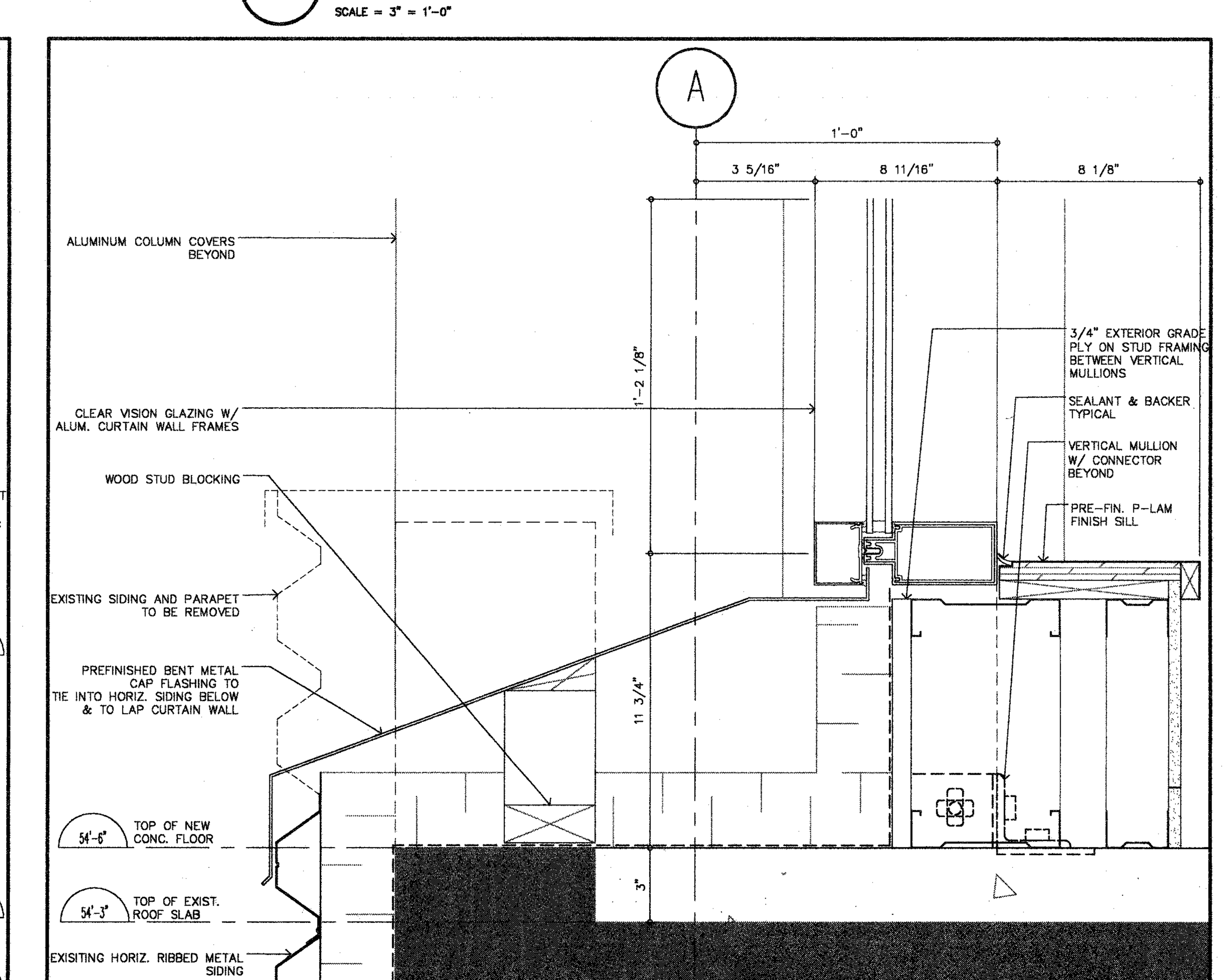
9 SECTION DETAIL
SCALE = 3" = 1'-0"



10 SECTION DETAIL
SCALE = 3" = 1'-0"



11 CURTAIN WALL SECTION DETAIL
SCALE = 3" = 1'-0"



12 CURTAIN WALL SECTION DETAIL
SCALE = 3" = 1'-0"

A0 841x1189

NOTES

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No.	Description	Date
4	ISSUED FOR TENDER	MAY 09, 2001
3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
2	ISSUED FOR BUILDING PERMIT	APR. 18, 2001
1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE
4666

Ontario
SuperBuild

Project Manager
Cansult Hanscomb
Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY
ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect
Lett/Smith Architects
385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

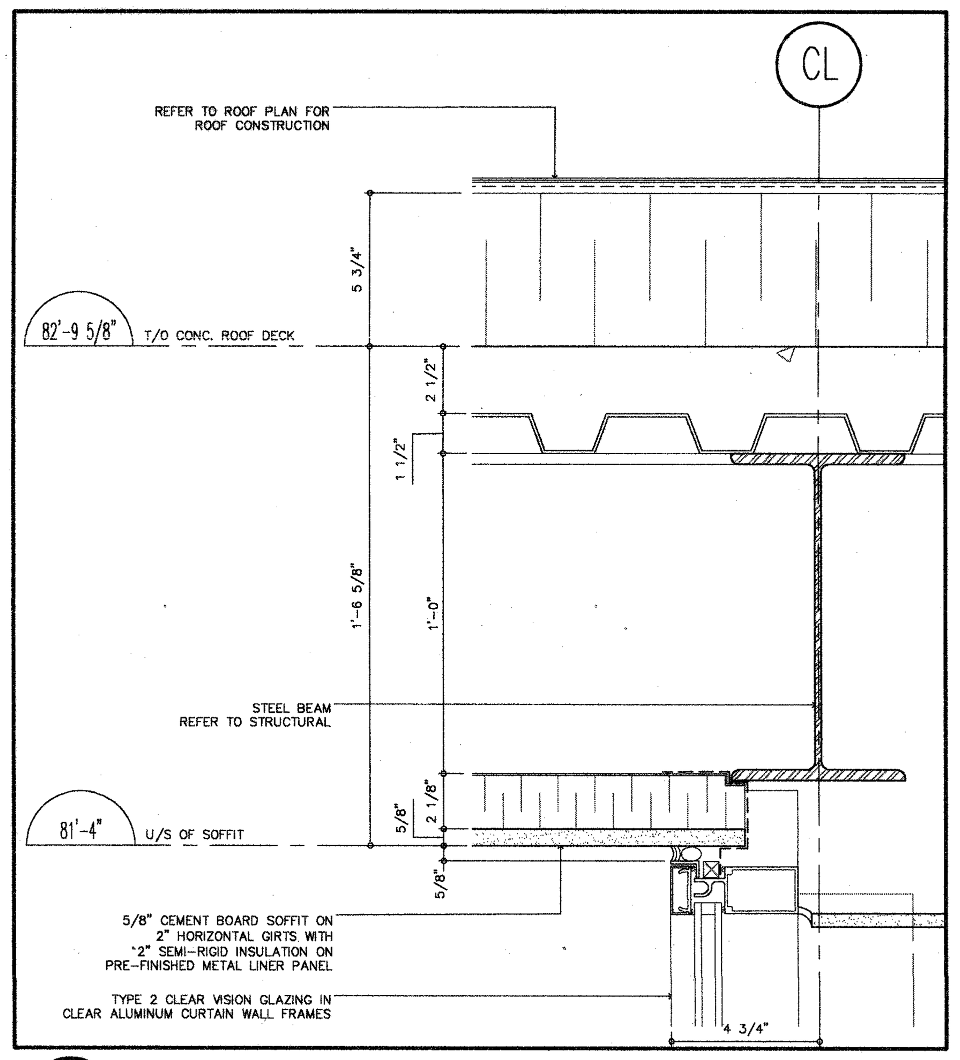
RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

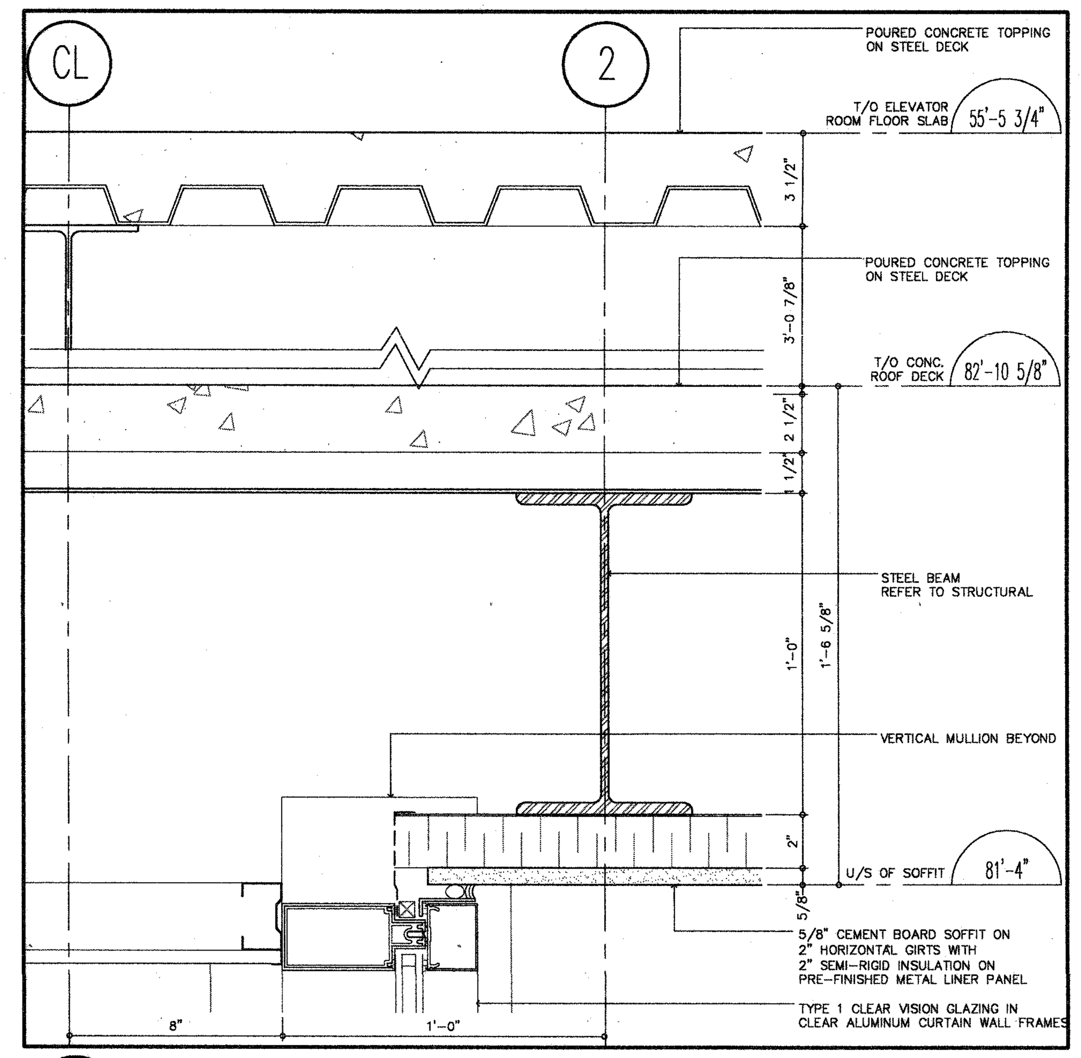
87 GERRARD STREET EAST

EXTERIOR WALL
SECTION
DETAILS

Graphic Scale					Sheet no.
Printed		Scale 1" = 1'-0"			A5-04
Date MAY 07, 2001		Job No. 200004			
P in C BG	PM DP	JC CAT	Des BG/BL	Dr DH	



1 SECTION DETAIL
SCALE = 3" = 1'-0"



2 SECTION DETAIL
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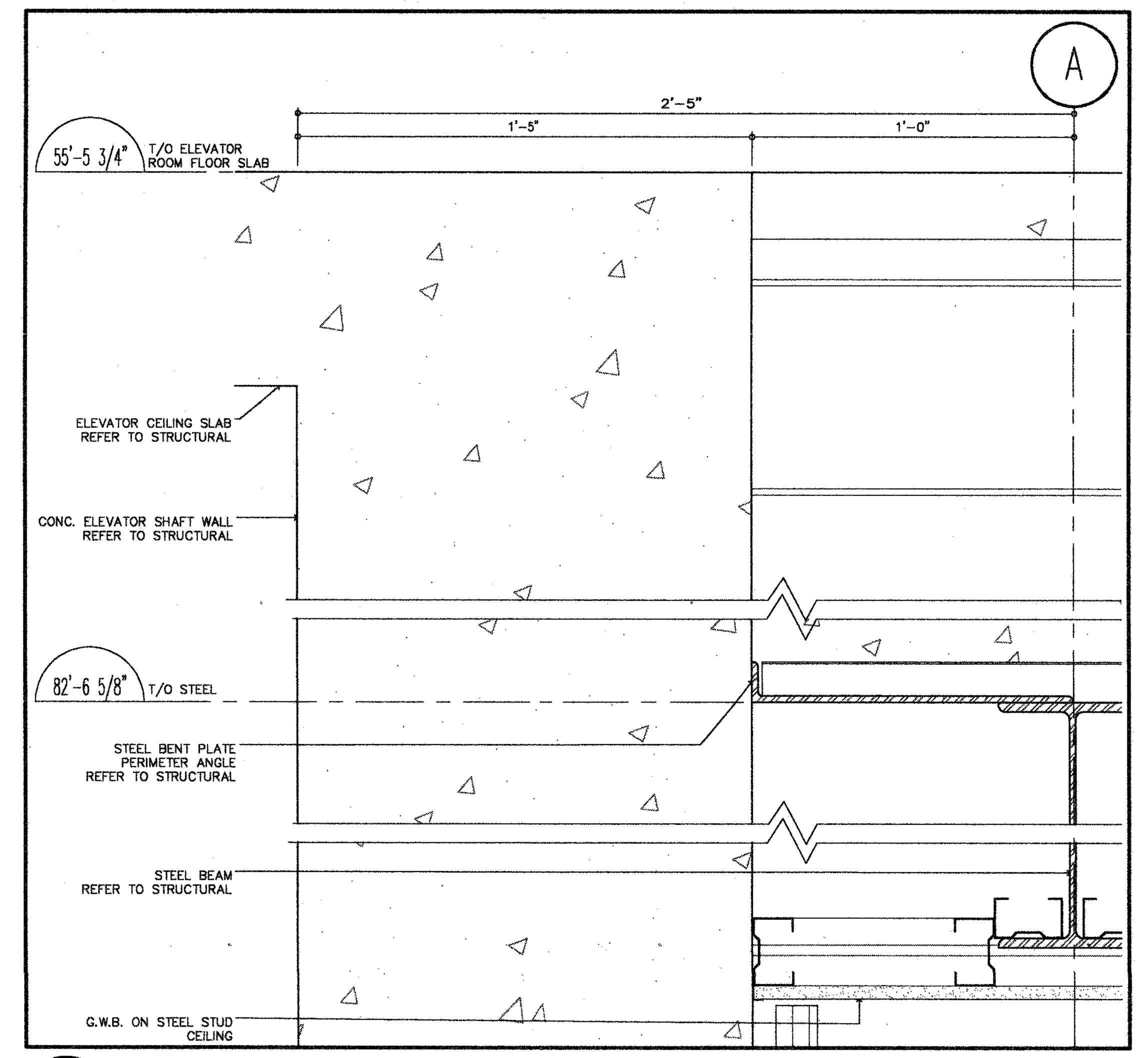

3 SECTION DETAIL
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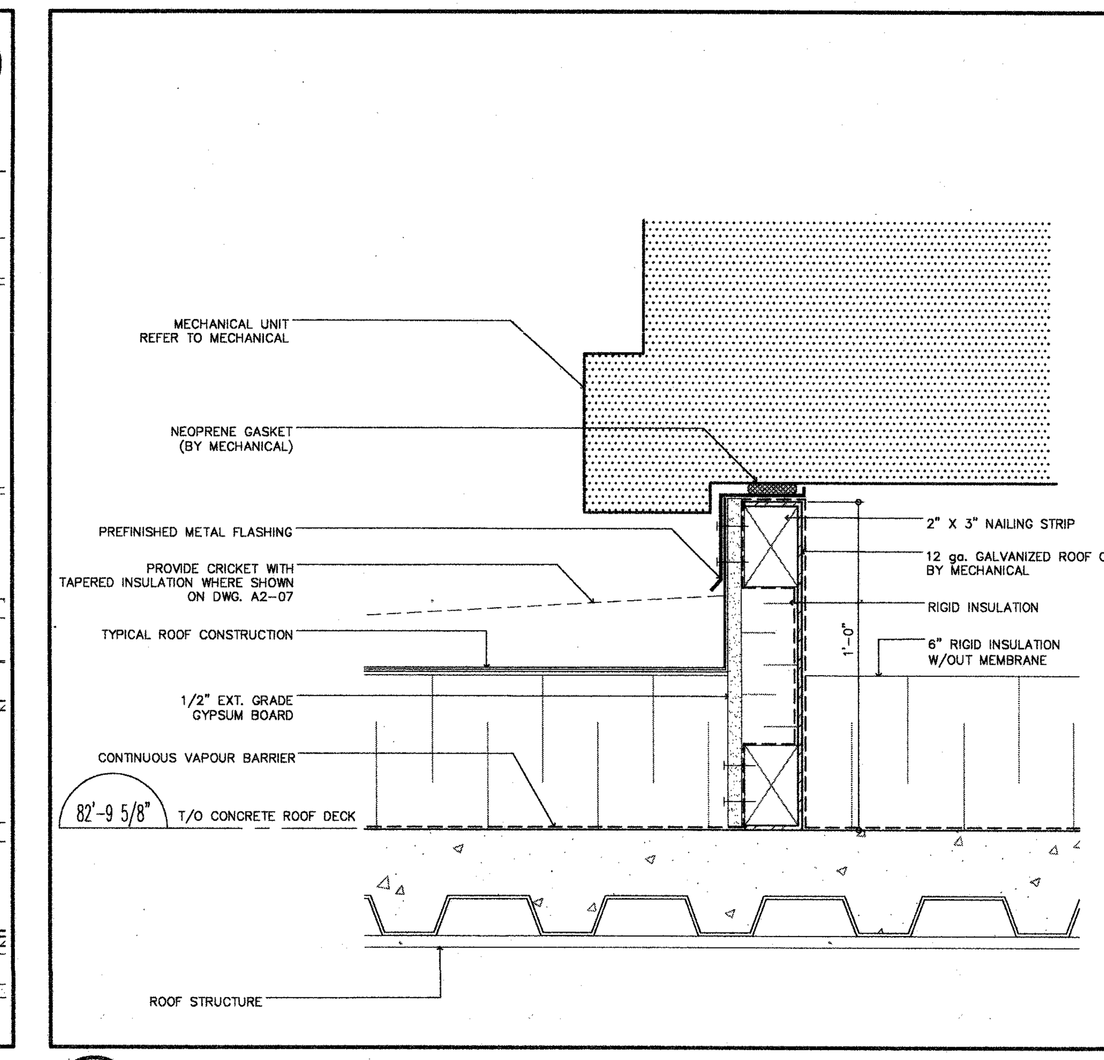

4 MECHANICAL CURB SECTION DETAIL
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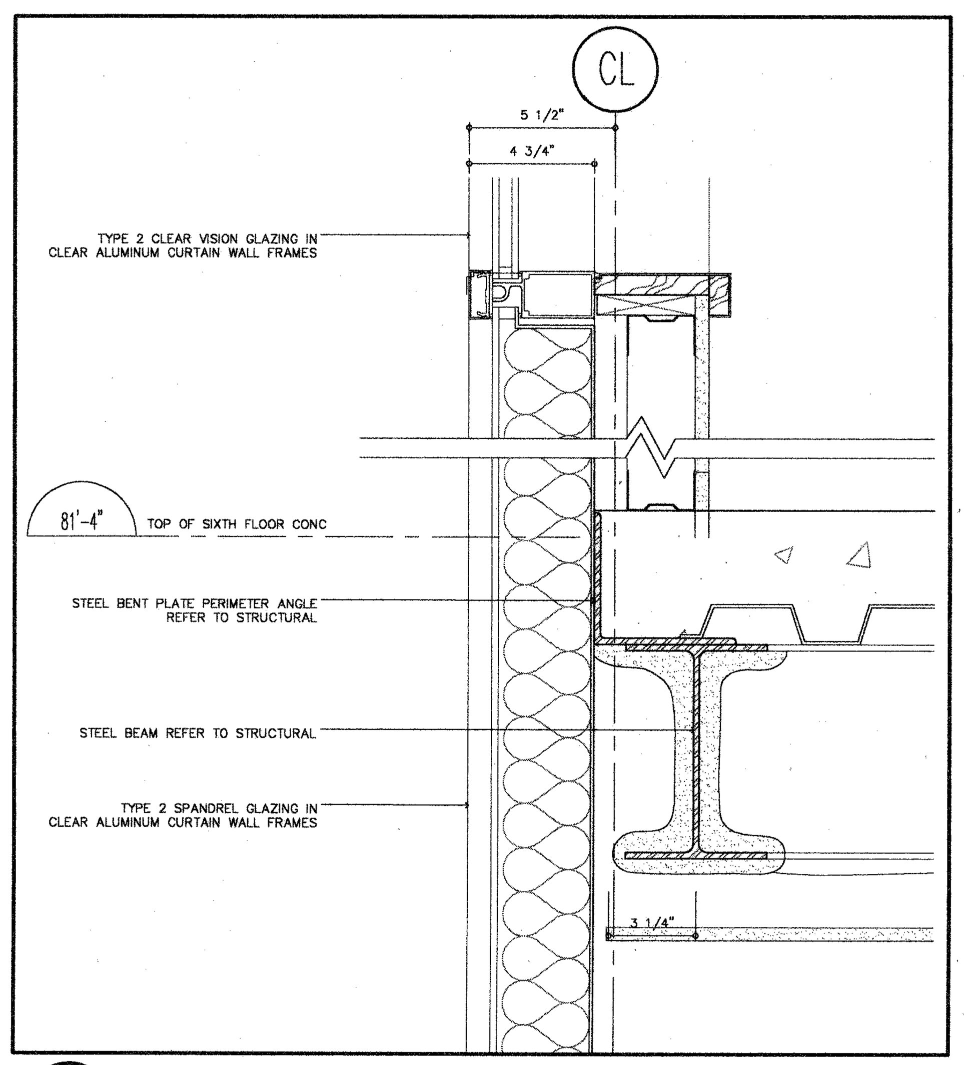
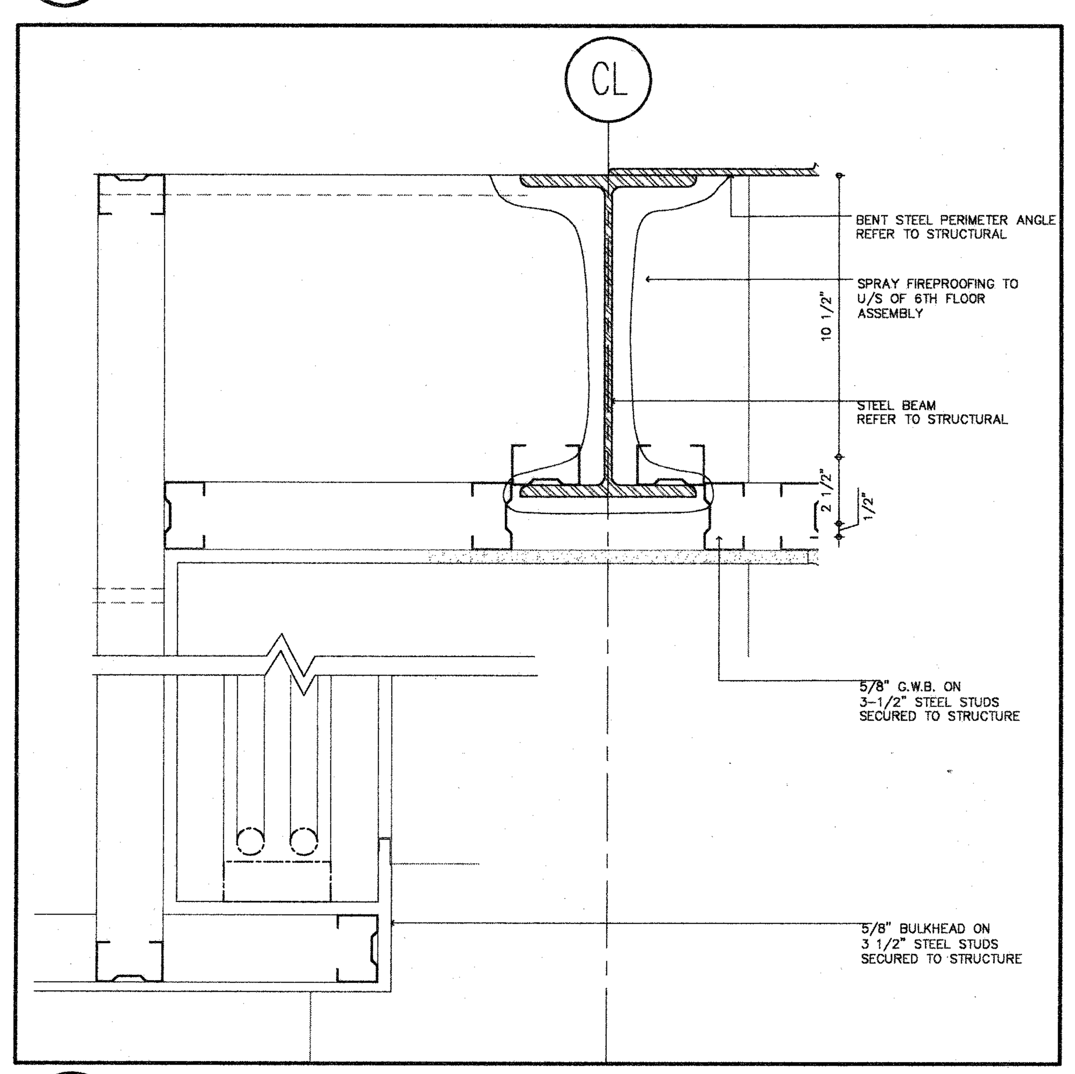


5 SECTION DETAIL
SCALE = 3" = 1'-0"



6 SECTION DETAIL
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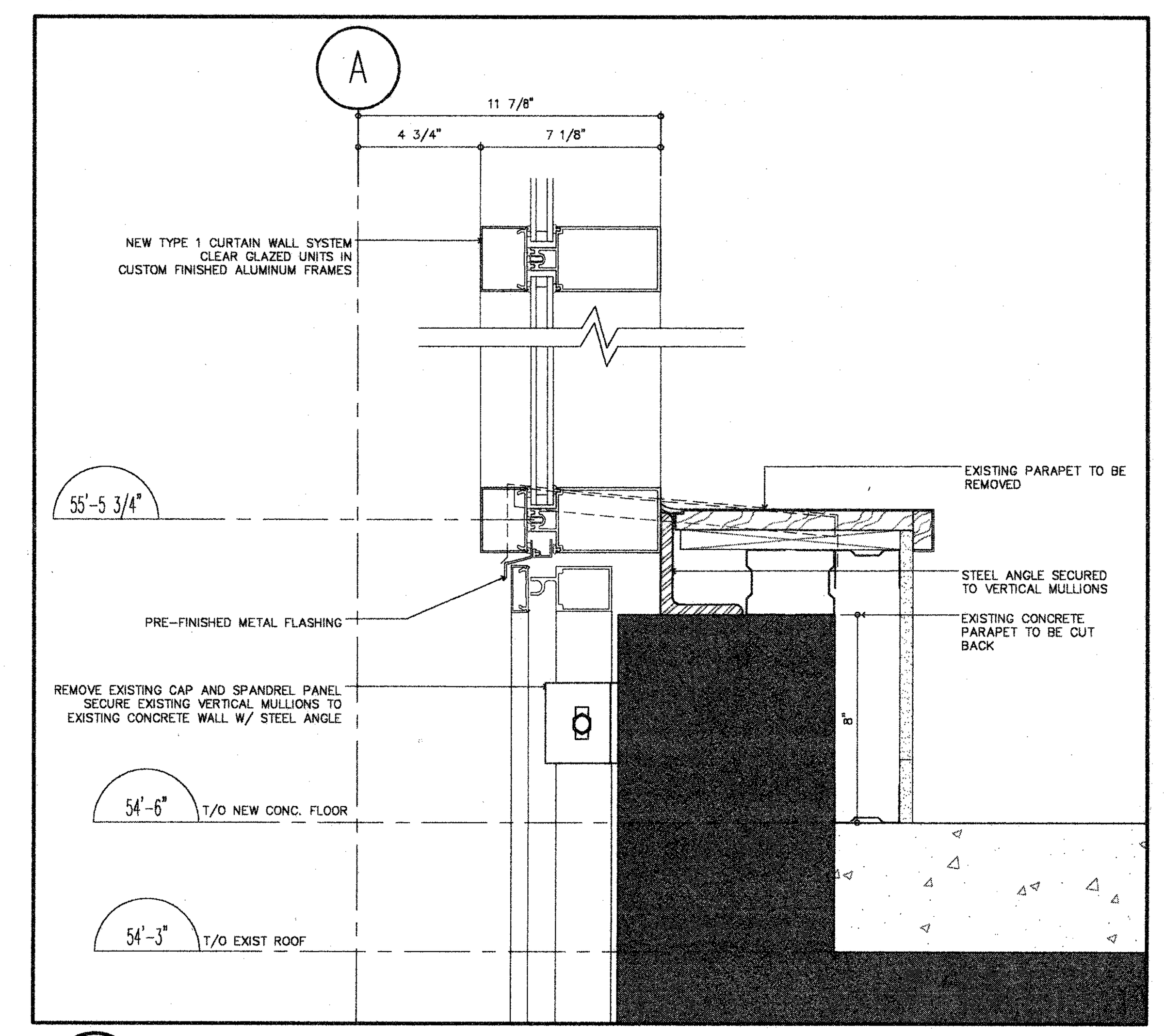
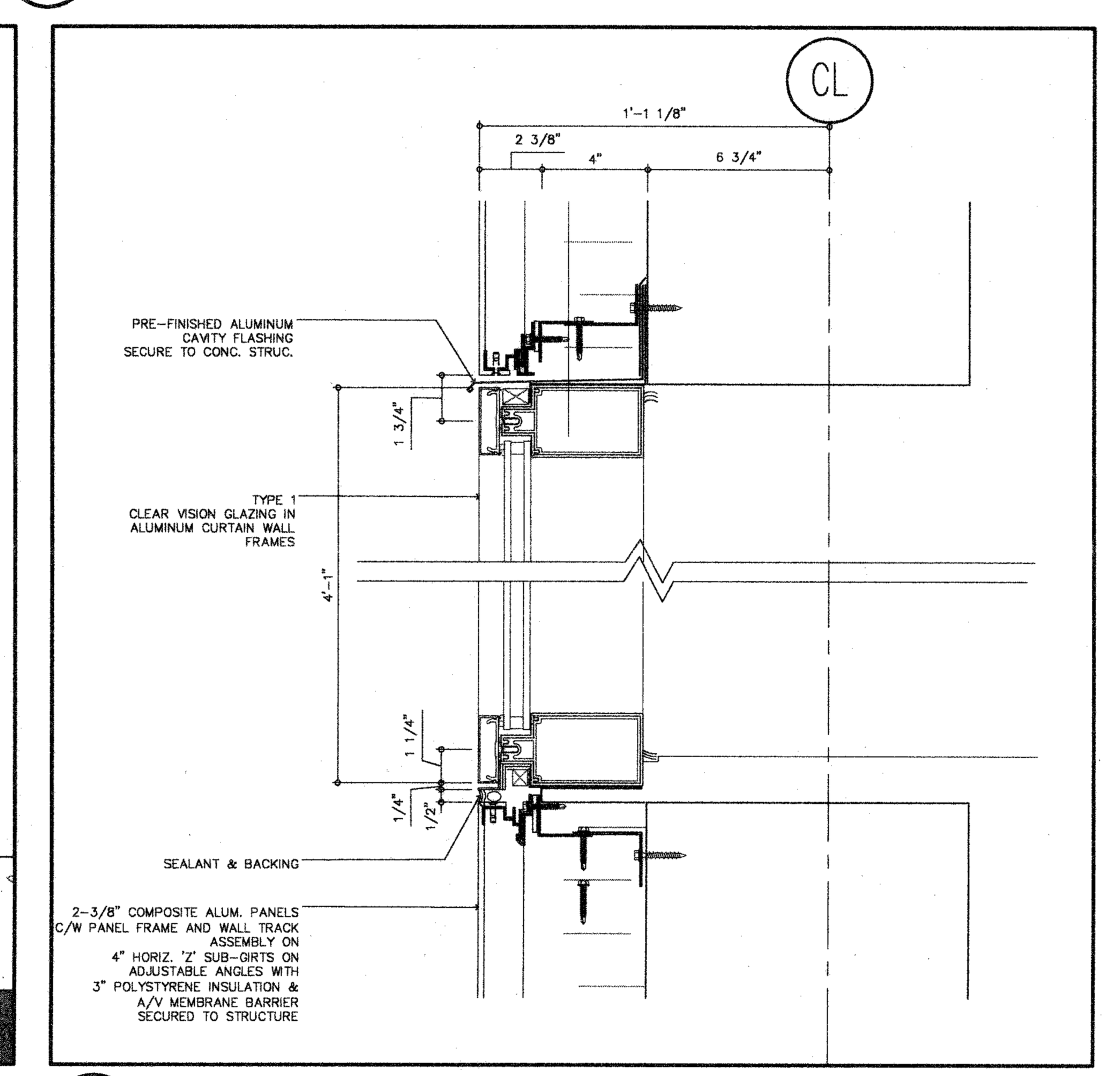
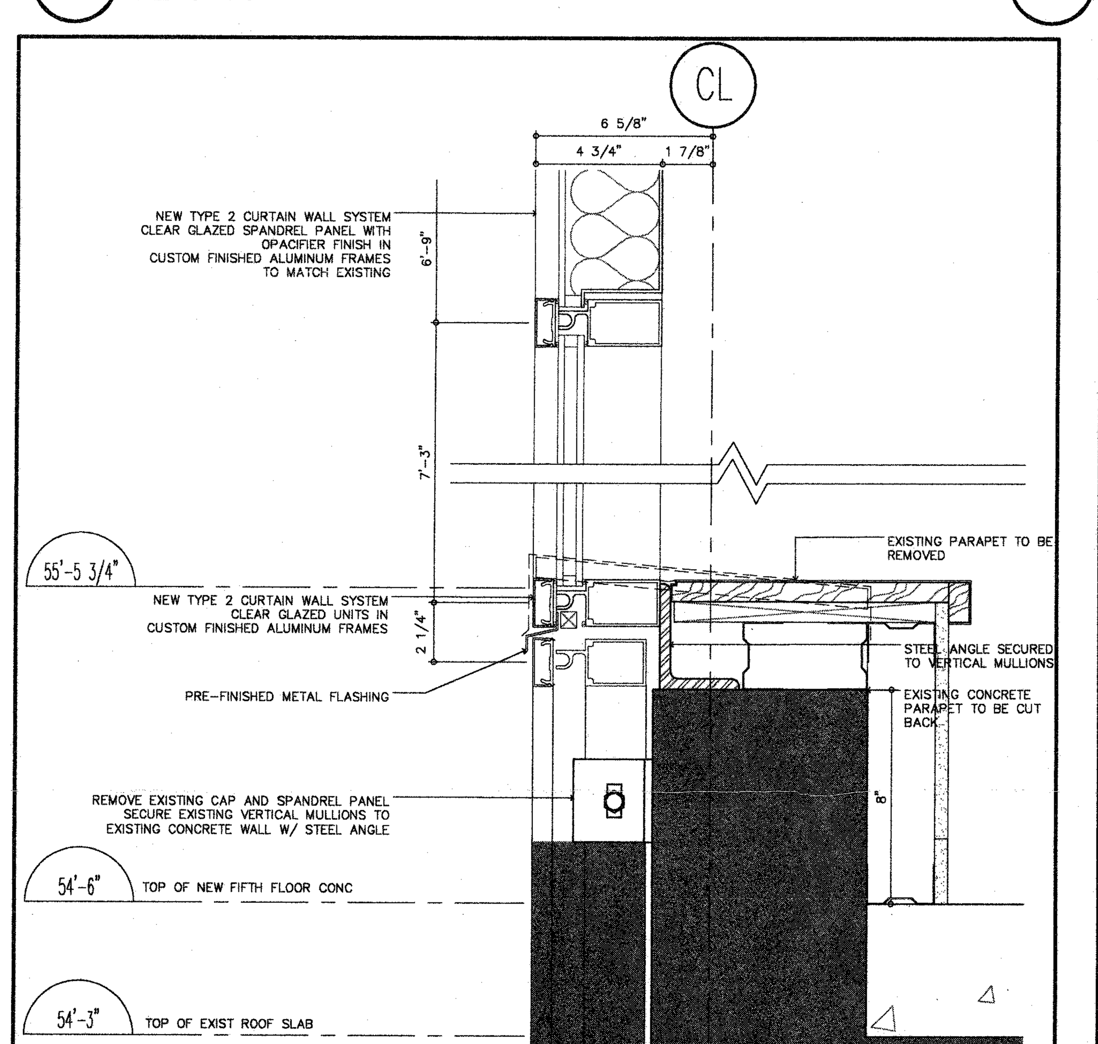


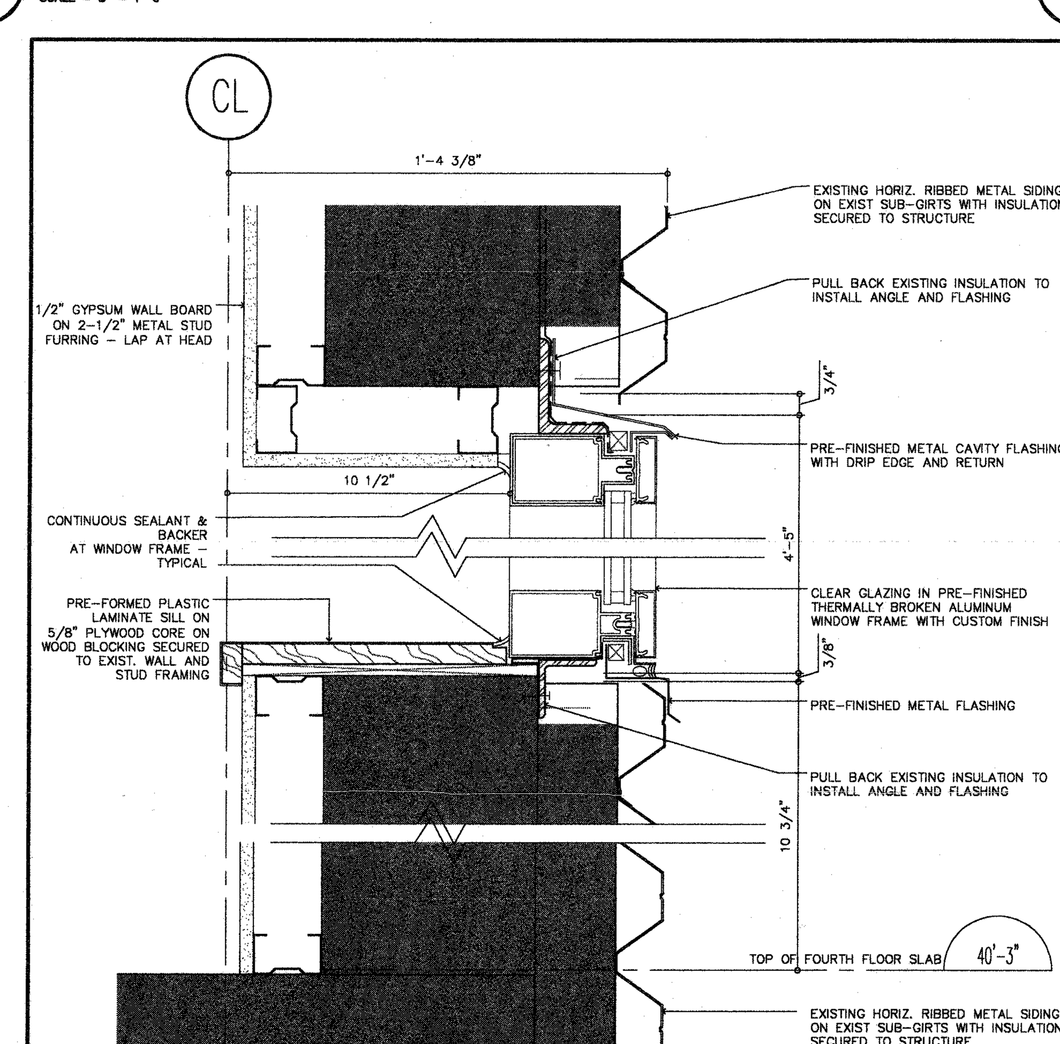
7 SECTION DETAIL
SCALE = 3" = 1'-0"



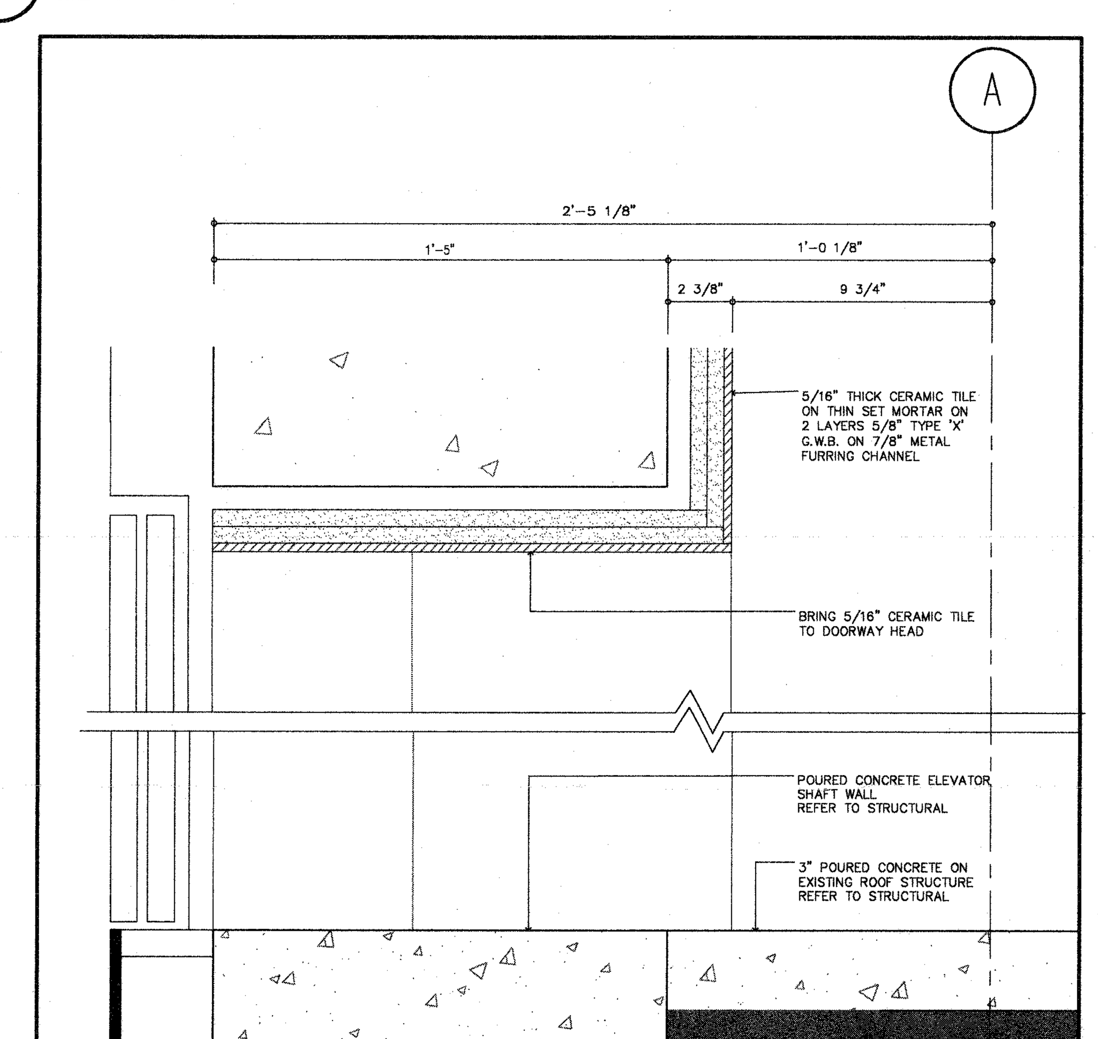
8 STAIR 5 SECTION DETAIL
SCALE = 3" = 1'-0"



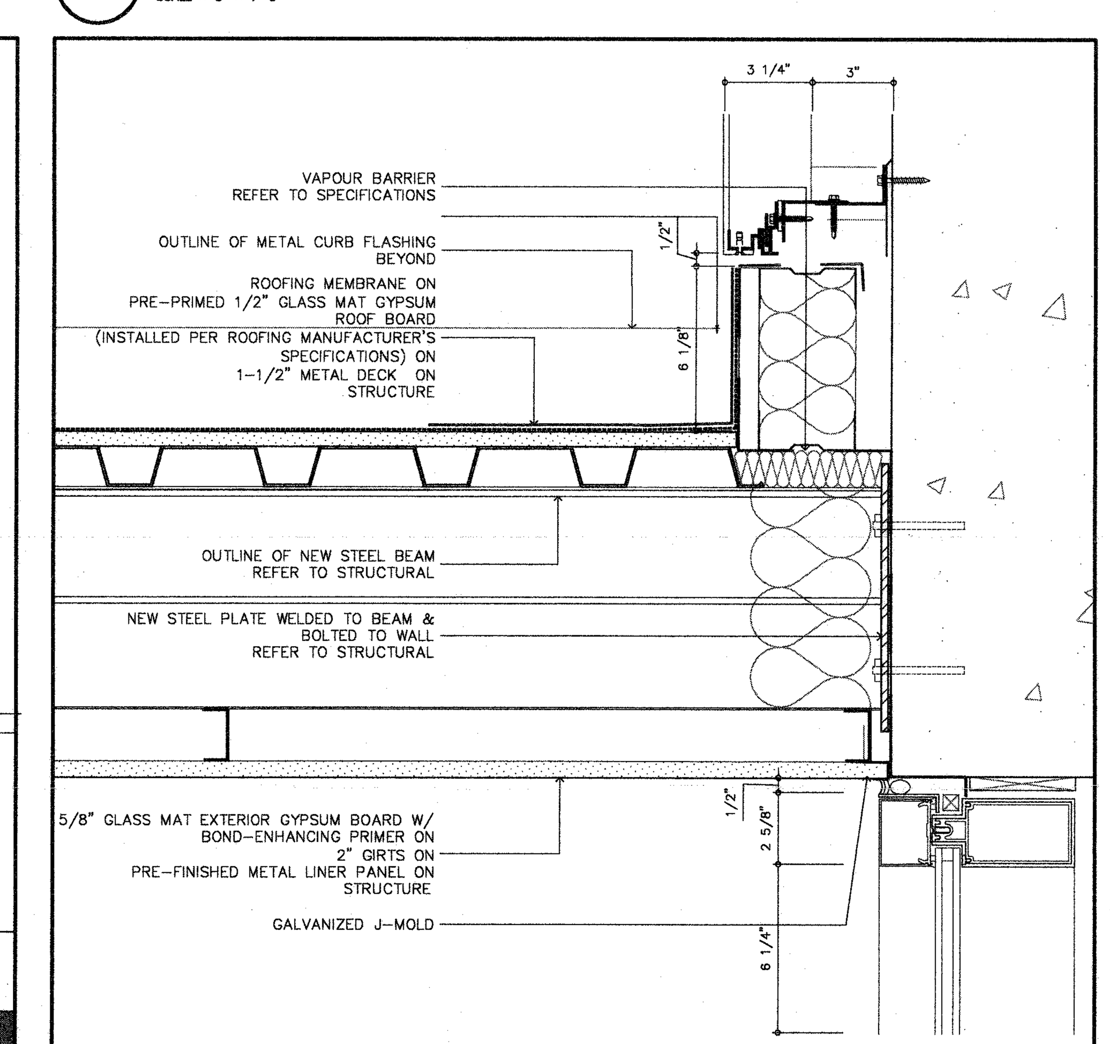
9 TYPE 2 CURTAIN WALL SECTION DETAIL
SCALE = 3" = 1'-0"



10 SECTION DETAIL
SCALE = 3" = 1'-0"



11 SECTION DETAIL
SCALE = 3" = 1'-0"



12 TYPICAL VALENCE DETAIL
SCALE = 3" = 1'-0"

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1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE
4666

Ontario
SuperBuild

Project Manager

Cansult Hanscomb
Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY
ARCHITECTS

225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

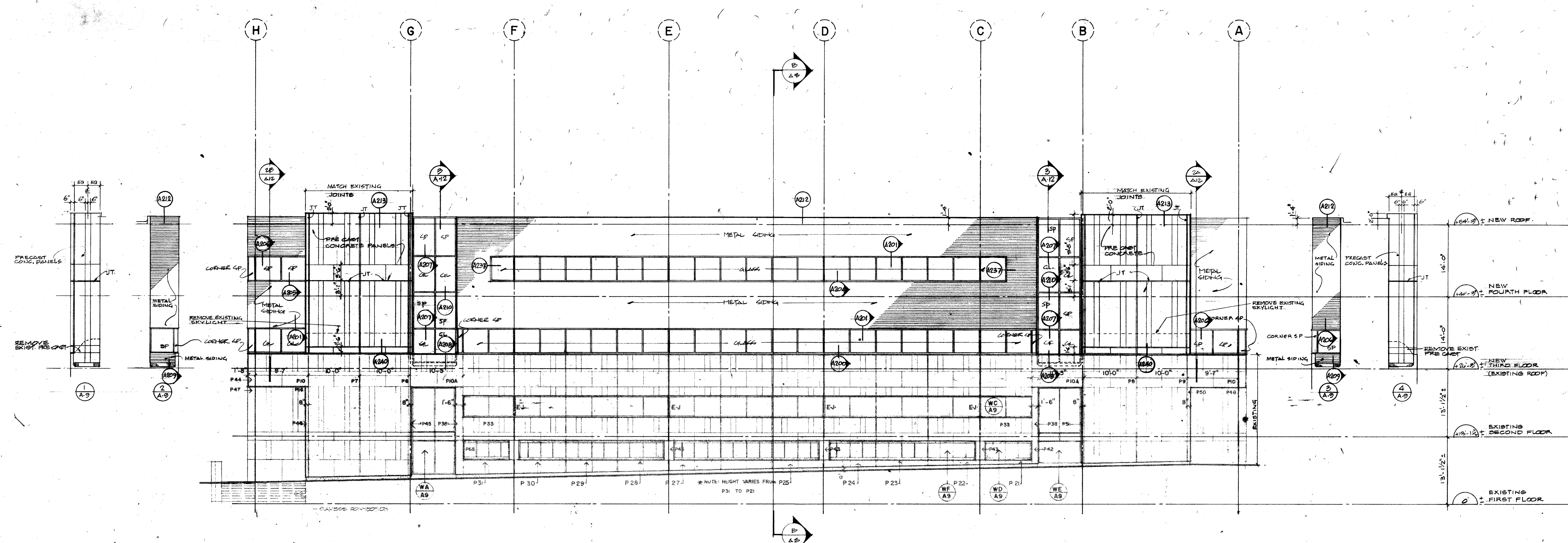
87 GERRARD STREET EAST

EXTERIOR WALL SECTION DETAILS

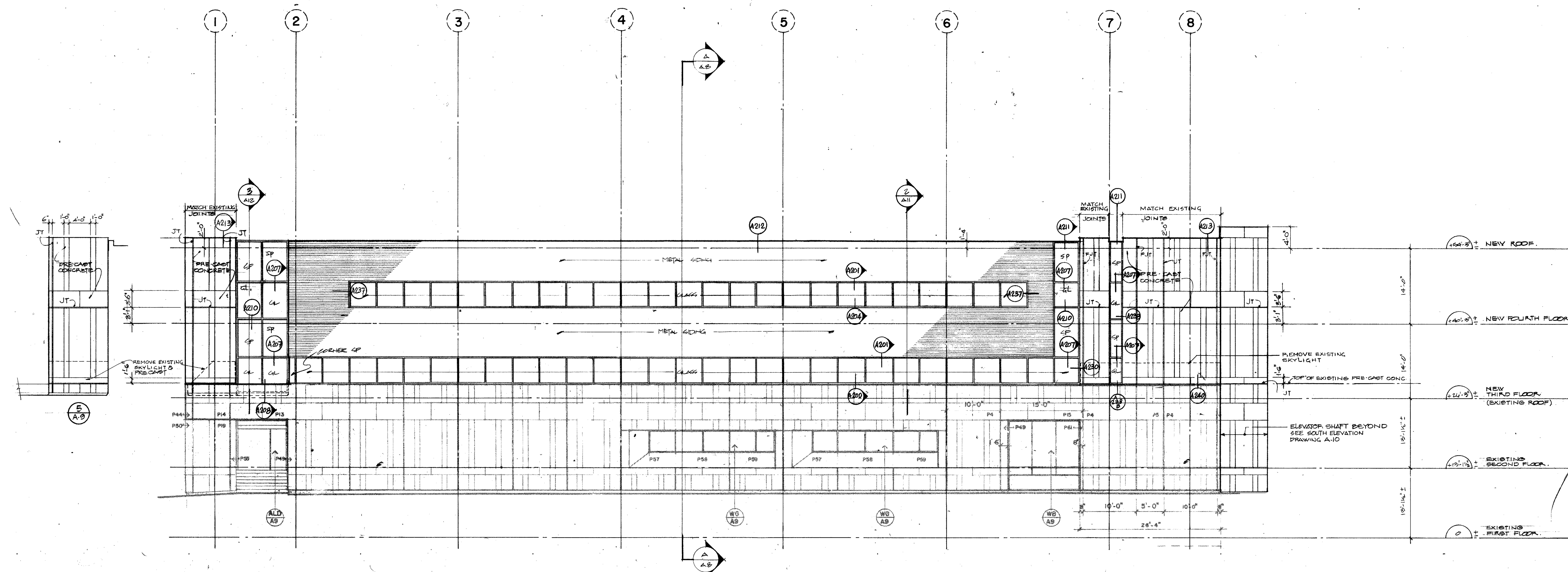
Graphic Scale		Sheet no.
Printed	Scale 1" = 1'-0"	A5-05
Date MAY 07, 2001	Job No. 200004	

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	DH

A0 841x1189



EAST ELEVATION



NORTH ELEVATION

GENERAL NOTES

1. SEE GENERAL NOTES ON DWG A-3
2. ALL NEW EXTERIOR GLASS IS INSULATED TINTED UNLESS OTHERWISE NOTED.
3. VERTICAL REVEALS IN NEW PRE-CAST PANELS TO MATCH EXISTING UNLESS OTHERWISE NOTED
4. JT = JOINT TO MATCH EXISTING
   FJT = FALSE JOINT TO MATCH PROFILE OF JOINTS.

REF.	DATE	DESCRIPTION	CH'D

REVISIONS

CHECK AND VERIFY ALL DIMENSIONS BEFORE PROCEEDING WITH THE WORK.

DUNLOP FARROW AITKEN CANSFIELD
architects engineers

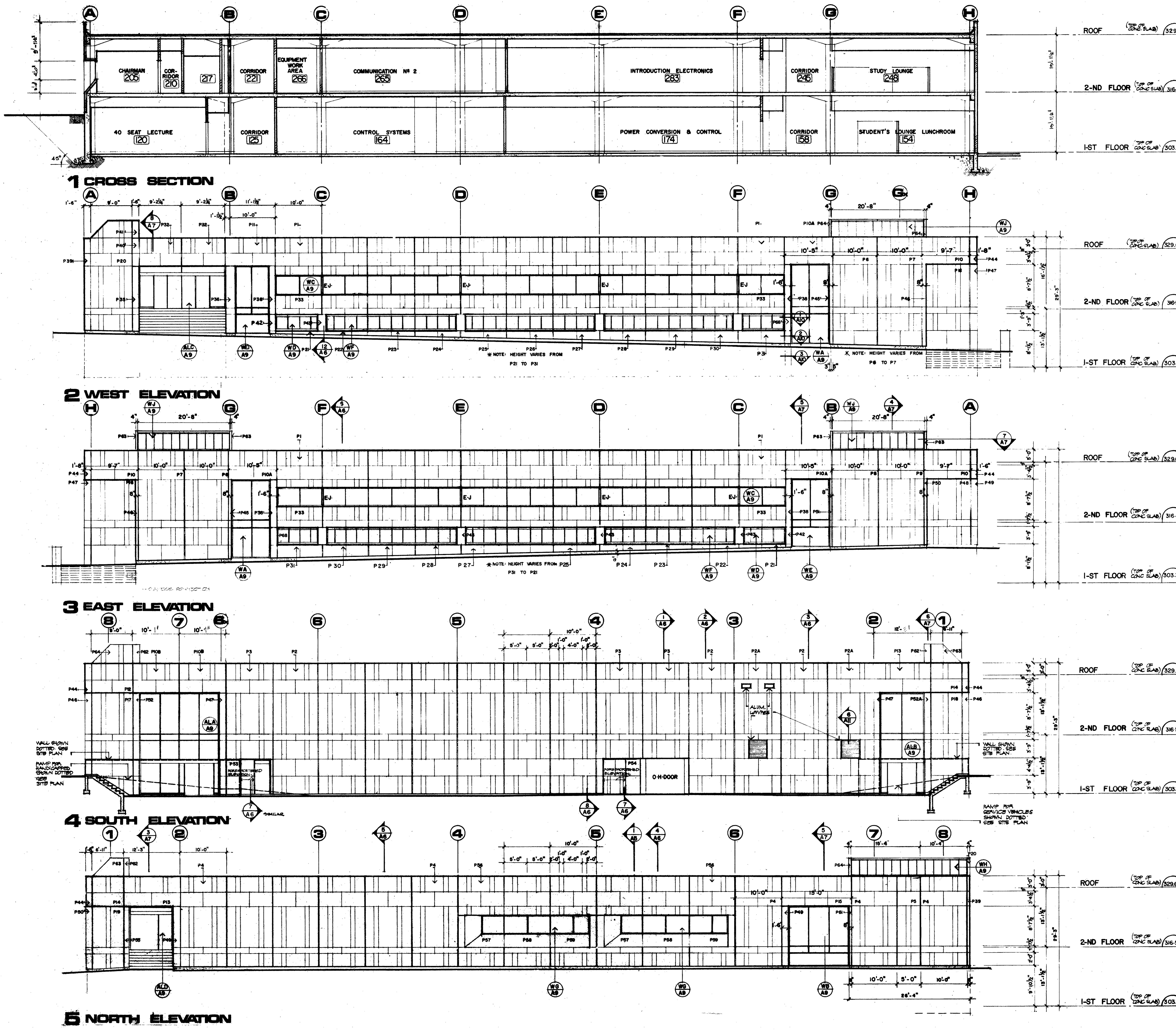
GEORGE B. P. FARROW
ONTARIO ASSOCIATION OF ARCHITECTS
MEMBER
ARCHITECT

PROJECT NAME:
CENTRE FOR ADVANCED TECHNOLOGY EDUCATION
ADDITION TO TECHNOLOGY ANNEX
RYERSON
87 Gerrard Street E., Toronto

DRAWING TITLE:
BUILDING ELEVATIONS

SCALE: 1/8" TO 1'-0"	PROJECT NUMBER: architect's: 8371
DATE: 24, SEP. 1984	owner's:
DRAWN BY: DLD	DRAWING NUMBER: architect's: A-9
CHECKED BY:	owner's:

A0 841X1189



NO.	DATE	REVISION	D'WN	CH'D

THE GENERAL CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND REPORT ERRORS AND OMISSIONS TO THE ARCHITECTS DRAWINGS MUST NOT BE SCALED.

THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS COUNTERSIGNED BY: DAVID ADAM.

ARCHITECTS
CRANG AND BOAKE

CONSULTING STRUCTURAL ENGINEERS
KAZMAR CONSULTANTS LTD.

CONSULTING MECHANICAL ENGINEERS
R.T. TAMBLYN PARTNERS LTD.

CONSULTING ELECTRICAL ENGINEERS
MULVEY ENGINEERS LTD.

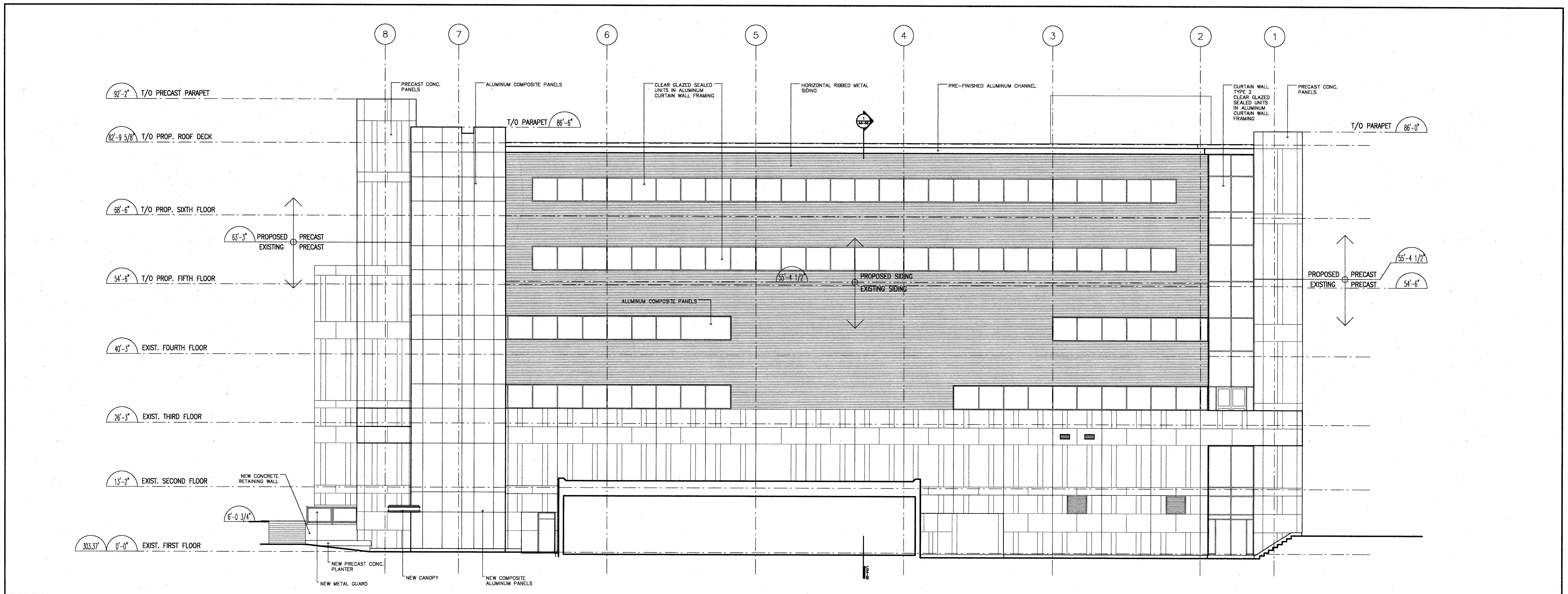
CONSULTING LABORATORY DESIGNERS
A. FAUX ASSOCIATES

CRANG & BOAKE ONTARIO ASSOCIATION ARCHITECTS MEMBERS ARCHITECTS

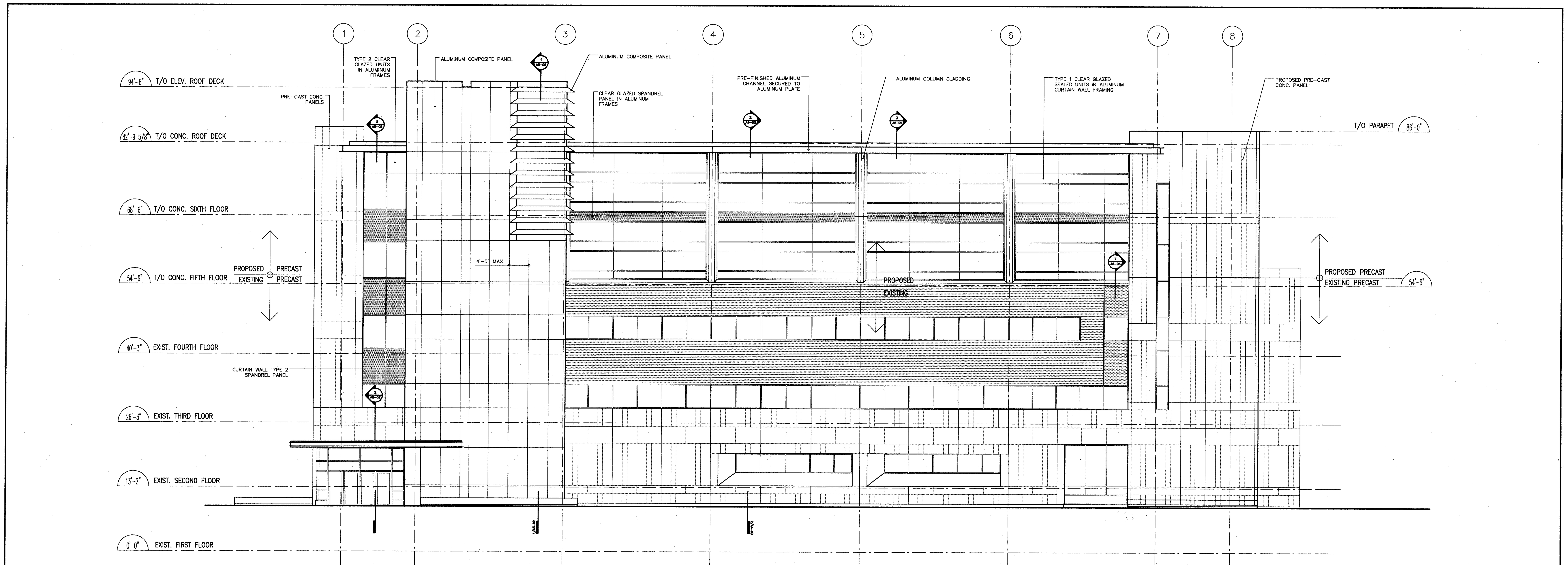
TECHNOLOGY ANNEX PROJECT
RYERSON POLYTECHNICAL INSTITUTE TORONTO ONTARIO

ELEVATIONS & SECTION

SCALE	DATE
1/8"=1'-0"	JUNE
CHECK'D D.E.A.	DRAWN K.M.
COMM. NO. 723	DRAWING NO. A.5



1 SOUTH ELEVATION
SCALE = 1/8" = 1'-0"



2 NORTH ELEVATION
SCALE = 1/8" = 1'-0"

AO 841x1189

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3	ISSUED TO CLIENT FOR 100% REVIEW	APR. 27, 2001
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1	ISSUED TO CLIENT FOR 70% REVIEW	MAR. 30, 2001

REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GOYECHE
LICENCE
4666

Ontario
SuperBuild

Project Manager
Cansult Hanscomb
Projects Inc.

Project Architect
ROUNTHWAITE, DICK & HADLEY
ARCHITECTS
225 RICHMOND ST. W., SUITE 201, TORONTO, ONTARIO, M5V 1W2
TELEPHONE 416 204-1399 FAX 416 204-1321
E-MAIL: rdharch@idirect.com

Associate Architect
Lett/Smith Architects
385 REID STREET | PETERBOROUGH, ONTARIO | K9H 4G4
TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

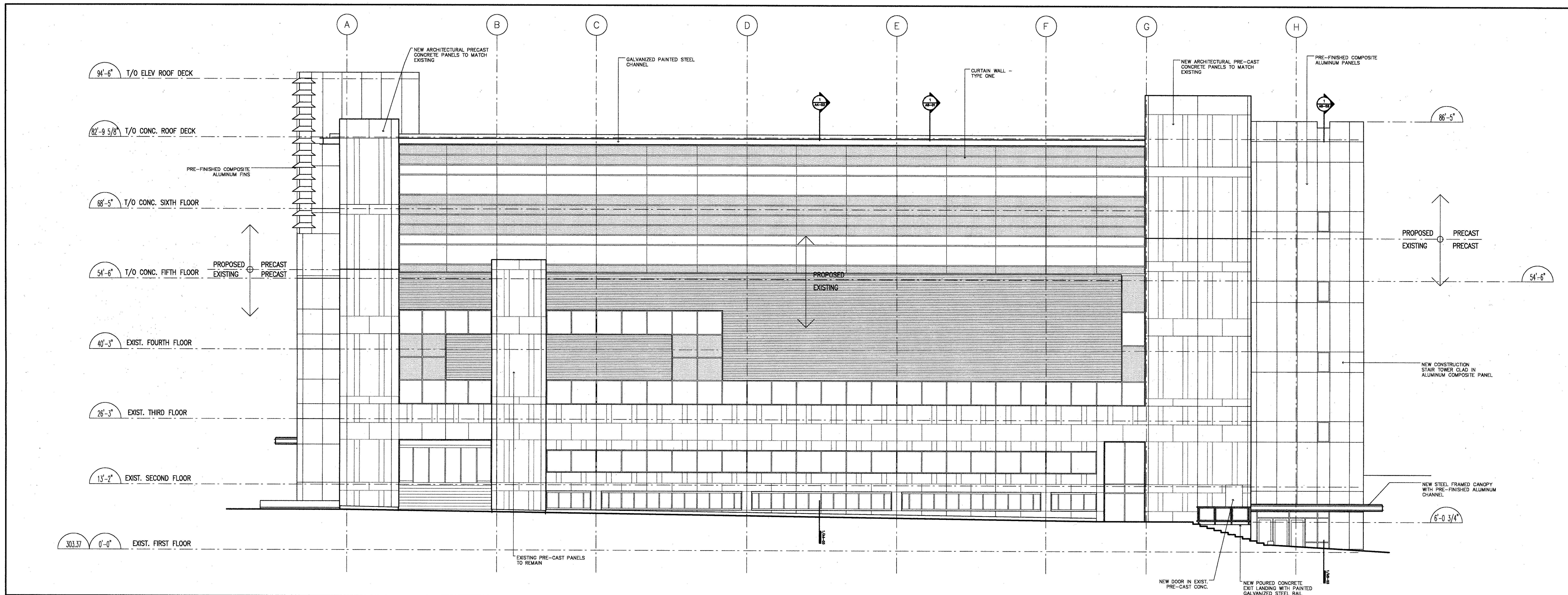
87 GERRARD STREET EAST

BUILDING ELEVATIONS

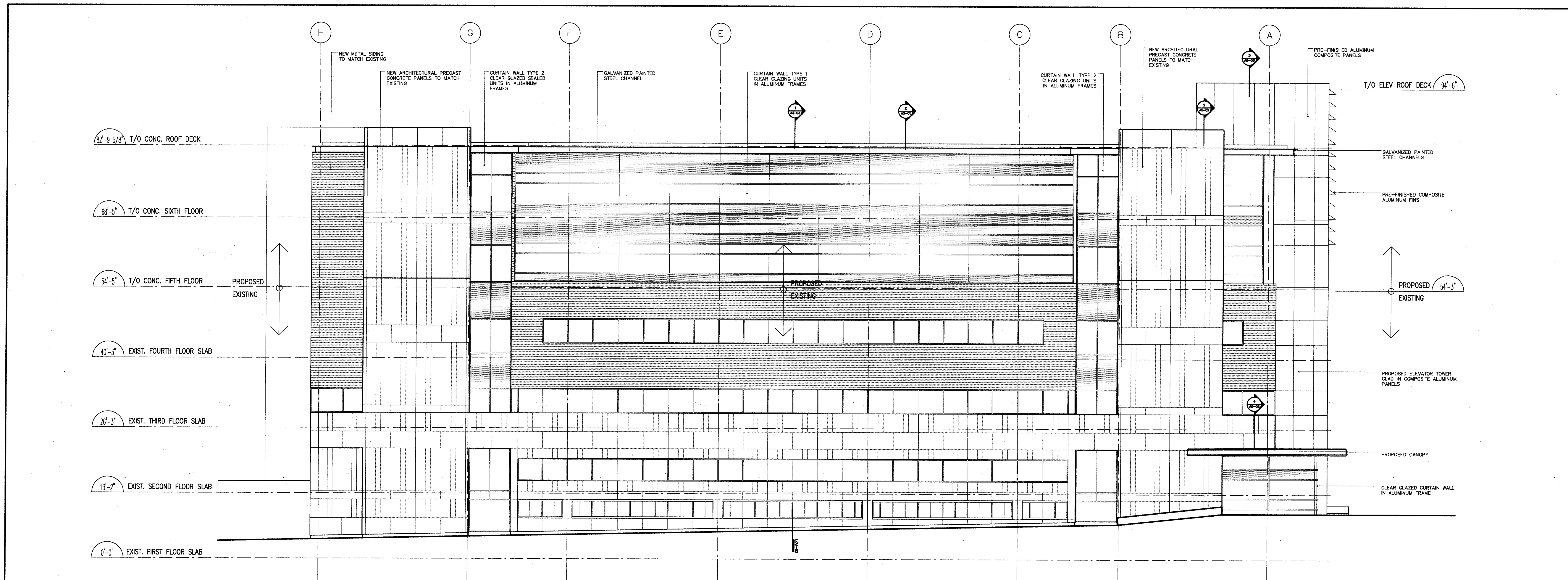
Graphic Scale		Sheet no.
Printed	Scale 1/8" = 1'-0"	A4-01
Date MAY 07, 2001	Job No. 200004	

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	DH

EPH/SHE 037



1 WEST ELEVATION
SCALE = 1/8" = 1'-0"



2 EAST ELEVATION
SCALE = 1/8" = 1'-0"

AO 841x1189

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REVISIONS ISSUES

ONTARIO ASSOCIATION OF ARCHITECTS
ROBERT C. GRYECHE
LICENCE 4666

Ontario
SuperBuild

Project Manager

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Projects Inc.

Project Architect

ROUNTHWAITE, DICK & HADLEY
ARCHITECTS

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E-MAIL: rdharch@idirect.com

Associate Architect

Lett/Smith Architects

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TELEPHONE 705 743-3311 | FAX 705 743-0056

Consultant

RYERSON UNIVERSITY
AND
GEORGE BROWN COLLEGE

ADDITION TO ERIC PALIN HALL

87 GERRARD STREET EAST

BUILDING
ELEVATIONS

Graphic Scale

Printed

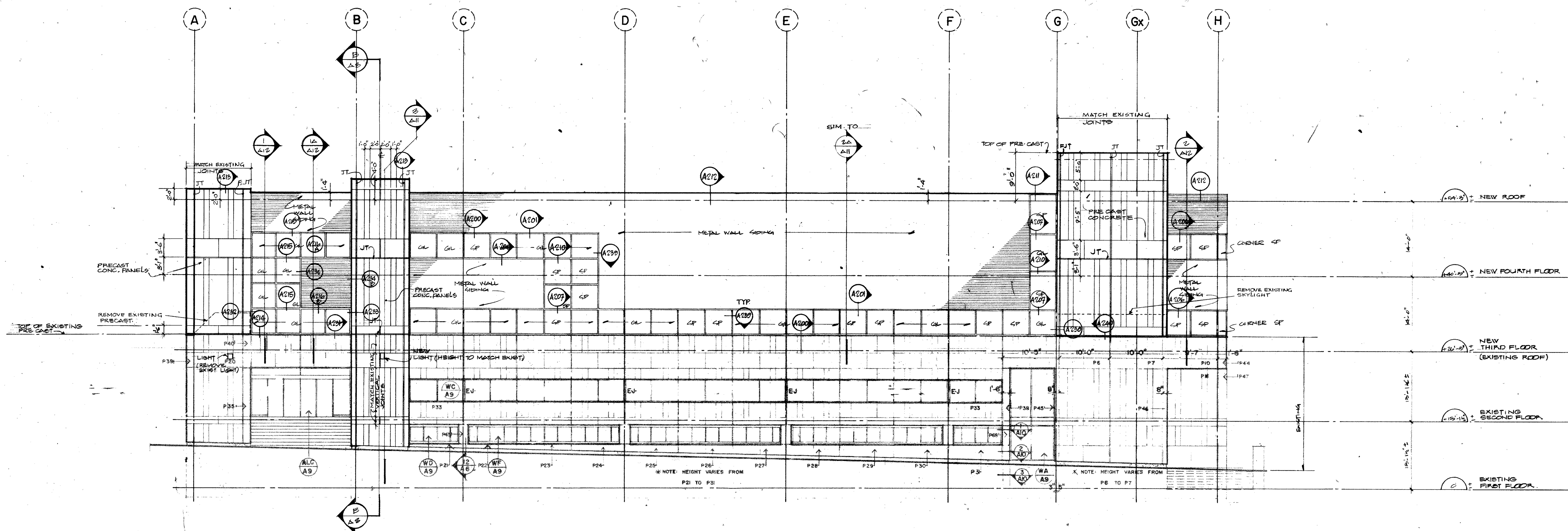
Scale 1/8" = 1'-0"

Date MAY 07, 2001

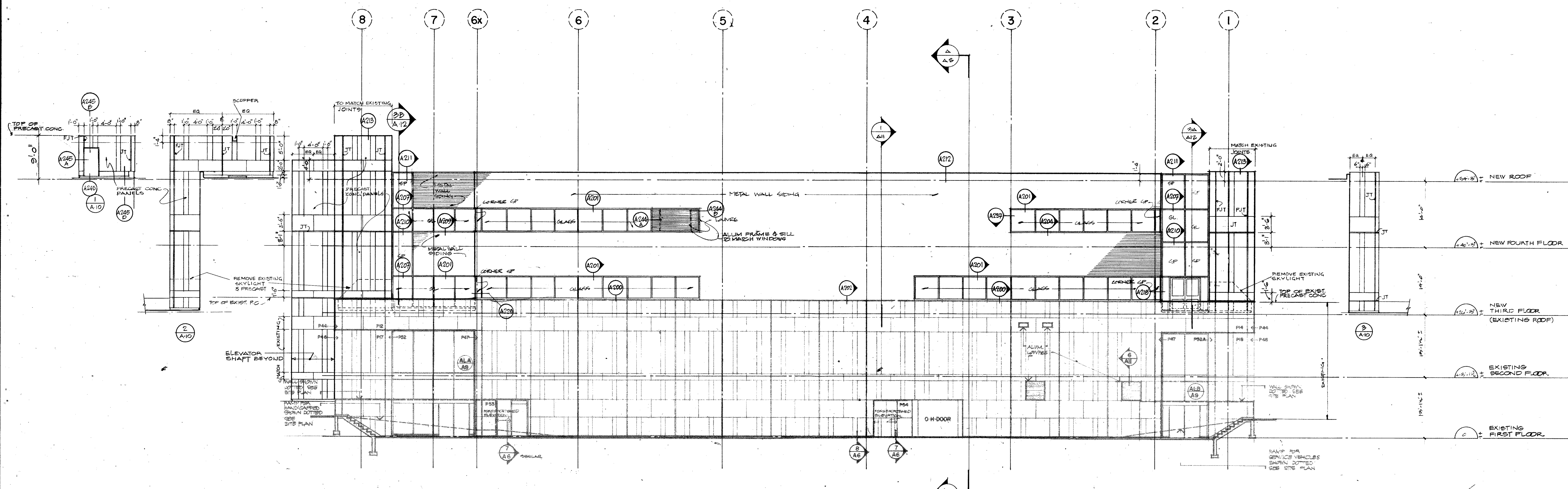
Job No. 200004

P in C	PM	JC	Des	Dr
BG	DP	CAT	BG/BL	DH

Sheet no. A4-02



WEST ELEVATION



SOUTH ELEVATION

GENERAL NOTES

1. SEE GENERAL NOTES ON DWG A-3
2. ALL NEW EXTERIOR GLASS IS INSULATED TINTED UNLESS OTHERWISE NOTED
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FJT = FALSE JOINT TO MATCH PROFILE OF JOINTS

REF.	DATE	DESCRIPTION	CH'D

REVISIONS

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DUNLOP FARROW AITKEN CANSFIELD
architects engineers

GEORGE B. P. FARROW
ONTARIO ASSOCIATION OF ARCHITECTS
MEMBER
ARCHITECT

PROJECT NAME:
CENTRE FOR ADVANCED TECHNOLOGY EDUCATION
ADDITION TO TECHNOLOGY ANNEX
RYERSON
87 Gerrard Street E., Toronto

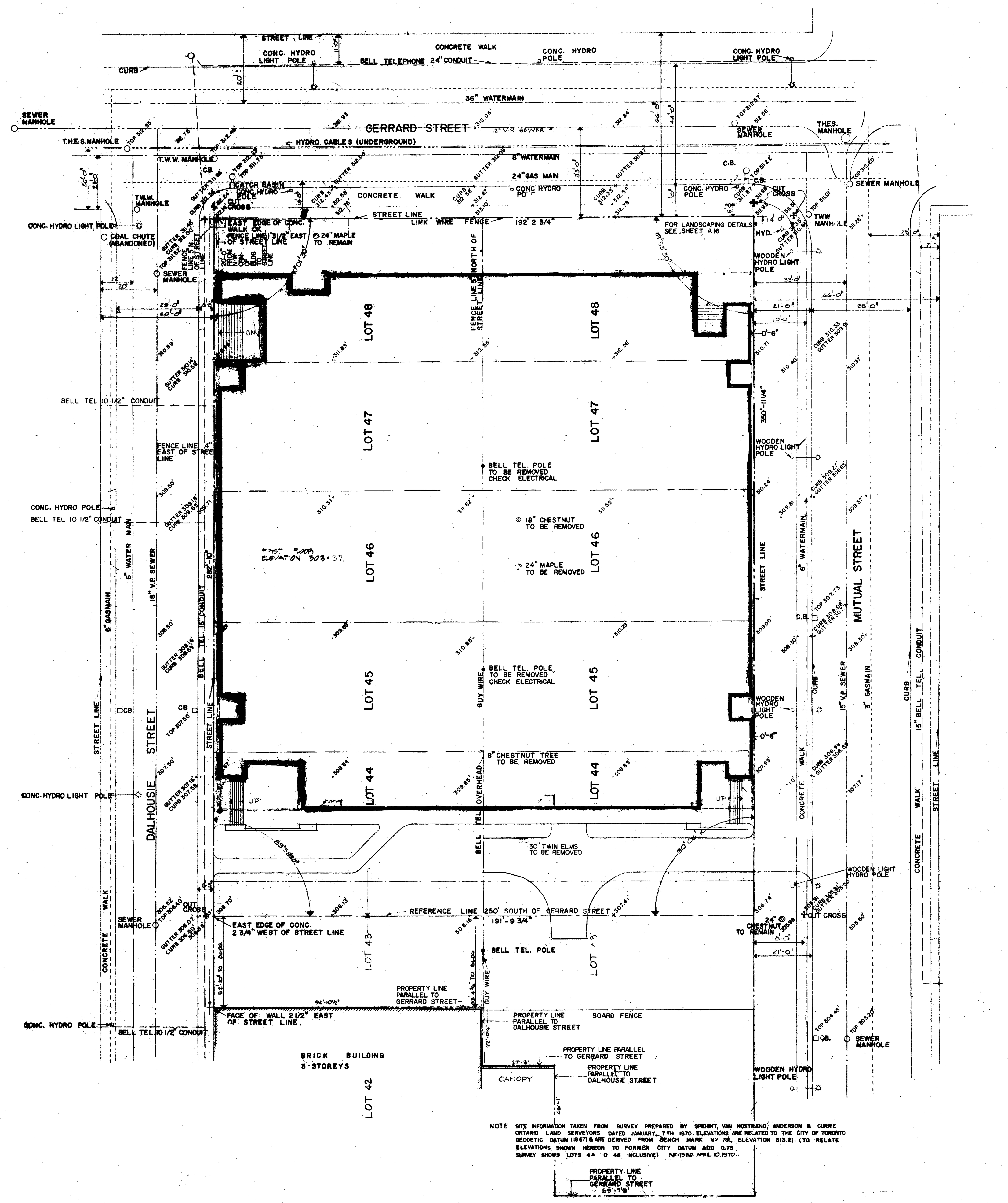
DRAWING TITLE:
BUILDING ELEVATIONS

SCALE: 1/8" = 1'-0"	PROJECT NUMBER: architect's: 8371
DATE: 24, SEP. 1984	owner's:
DRAWN BY: DLD	DRAWING NUMBER: architect's: A-10
CHECKED BY:	owner's:

A0 841X1189

EPH 001

A1 – EPH
Site plan w/ revised building location



V.P. VITREOUS PIPE
T.H.E.S. TORONTO HYDRO ELECTRIC SERVICE
T.W.W. TORONTO WATER WORKS
C.B. CATCH BASIN
HYD. HYDRANT

NOTE: NO CONSTRUCTION ACCESS WILL BE ALLOWED FROM DALHOUSIE STREET

NO.	DATE	REVISION	D'WN	CH'D
1.	JUNE 8/70	NEW BUILDING LOCATION		

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ARCHITECTS
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CONSULTING LABORATORY DESIGNERS
A. FAUX ASSOCIATES

CRANG & BOAKE ONTARIO ASSOCIATION OF ARCHITECTS MEMBERS ARCHITECTS

TECHNOLOGY ANNEX PROJECT 115

RYERSON POLYTECHNICAL INSTITUTE TORONTO ONTARIO

SITE PLAN WITH REVISED BUILDING LOCATION

SCALE	DATE
1/16"=1'-0"	JUNE 12, 1970
CHECK'D D.A.	DRAWN D.V.
COMM. NO. 723	DRAWING NO. A1