AVONDALE / IRVING PARK AREA

ELEMENTARY SCHOOL

3231 North Springfield
Chicago, Illinois 60618

For

CHICAGO PUBLIC SCHOOLS
CAPITAL PROGRAM NEW CONSTRUCTION

ISSUED FOR BID
2008 NOVEMBER 20

The following listed documents comprise the Project Manual for the project listed above. Where numerical sequence of sections is interrupted, such interruptions are intentional.

The complete Project Manual for this Project consists of this entire Volume, which must not be separated for any reason. The Architect and Owner disclaim any responsibility for any assumptions made by a Contractor or Subcontractor who does not receive a complete Project Manual, including all sections listed in the table of contents.

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SECTION 11400
FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. The plans and specifications as written are inclusive of known quantities, and quality standards that meet the minimum performance standards of the school lunch program for the city of Chicago public schools, the architectural limitations of the new building and the enrollment capacity of the new school.

B. All equipment shall be provided in strict accordance with the plans and specifications. All contractors, subcontractors, and sub-tier subcontractors shall be bound to the specifications as well as the general contract conditions, supplemental conditions and section one of the contract documents.

C. The naming of manufacturers in the specifications or on the drawings shall not be construed as an intention to eliminate the products of other manufacturers having equivalent products that meet or exceed the performance and quality standards of the named manufacturer.

D. Other manufacturer's products will be considered subject to meeting the performance criteria specified herein.

E. Any necessary modifications of the equipment, building, piping, ductwork, electrical or any other work including architectural costs resulting from the use of substituted equipment or material shall be at the sole costs of the contractor and specifically not the building owner.

F. The approval of substituted material or equipment by owner or the architect will not relieve the contractor from sole responsibility for the proper installation and original performance requirements nor will the approval and or review by the owner or architect be considered as a basis for any additional monies or an extension of time in the performance of the contract work.

1.2 DESCRIPTION

A. Furnish and install all food service equipment indicated on the drawings and as specified herein. The work includes but is not necessarily limited to the following;

1. Custom fabricated equipment.
2. Prefabricated equipment.
    a. Where more than one manufacturers name is listed you may select one of the named manufacturers as long as all options and accessories are included to meet the performance criteria.
3. Necessary appurtenances and accessories.

B. It is the intention of these specifications to designate an inclusive job, complete, ready for use, except plumbing rough-in, electrical rough-in, (all ductwork and fans up stream from the hood collars) and final connections which will be made by other contractors as noted equipment shall be set in place, leveled, ready for use except for the final connections by the respective building trades.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. The following sections contain requirements that relate to this section.

1. Division 15
    a. Waste, water and vent piping rough in for and make all final connections to all equipment.
    b. Pressure reducing valves, "P" traps, floor drains and grease traps.
    c. All indirect connected waste lines and condensate drainlines.

2. Division 16
    a. All wiring, conduit and fittings shown on the electrical drawings and final connection to the equipment.
    b. Receptacles for all equipment furnished with cords and plugs.
    c. Any miscellaneous disconnects, transformers, switches and other related equipment, which are required for a complete operating assembly.

1.4 QUALITY ASSURANCE

A. General Provisions

1. The Food Service Equipment Contractor will be referred to in the specifications and on the drawings as the "K.E.C." or the Kitchen Equipment Contractor, or the Food Service Equipment Contractor.
2. Kitchen Equipment Contractor shall carefully read all the Contract Documents and furnish the equipment to conform to the construction limitations of the building as set forth in all of the Contract Documents.

B. Uniformity of Construction

1. All custom-fabricated equipment shall be made by one manufacturer and shall be uniform throughout as to method and type of construction used. All equipment shall carry a nameplate identifying the manufacturer.

C. Contractor Qualifications

1. The Food Service Equipment Contractor shall have been regularly engaged in this work for the past five years, and use only skilled craftsmen completely familiar with the methods and materials called for herein.
2. The Contractor, upon demand, shall submit to Architect written evidence of having executed contracts of a comparable size and evidence of sufficient financial resources, which will enable him to perform the work in an expeditious manner, without delay to the project or to other trades.
3. Fabrication of items other than standard catalog items shall be fabricated by a food service equipment fabricator, which has the plant, personnel, and engineering facilities to properly design, detail, and fabricate high quality equipment. The fabricator shall be acceptable to the Architect and the Owner. Furthermore, all work in above category shall be standard unit assembly manufactured by one manufacturer and of uniform design, material, and finish equal to the specification as written.

D. Deviations of Specifications and Substitutions

1. The Contractor shall furnish equipment in strict accordance with the Specifications.
2. Any and all substitutes shall be in strict accordance with the conditions and procedures of the section one contract documents. Any requests not meeting the qualification and procedures as written will be cause for rejection by the Owner and or the Architect.

E. Standard Manufactured Equipment

1. All standard catalog items shall be furnished as specified in regard to brand name, item type, accessories, scheduled options and quantities.
2. All equipment shall be new and of the latest current model.
3. All equipment shall be delivered to the job site in the manufacturer's original shipping container or packaging, sealed and unopened.
4. All equipment shall be N.S.F. labeled.

F. Codes, Regulations and Standards

1. All equipment shall be constructed in strict conformance with the standards of the National Sanitation Foundation as outlined in its bulletin on food service equipment entitled

"Standard No. 2" dated July and October, 1952 with its most current revision. Each piece of equipment shall have a "seal of approval" label of the National Sanitation Foundation.

2. Installation of all food service equipment shall comply fully with Illinois State Department of Public Health Regulations and with other current applicable City, County, State and Federal regulations and code requirements.
3. The Contractor shall submit all notices required by law to authorities having jurisdiction and shall obtain and pay for all required permits or certificates of inspection. Submit to the Owner permits and certificates of inspection prior to the request for final payment.
4. All refrigeration shall meet the requirements of the City of Chicago Refrigeration Department and meet or exceed the requirements of the 1995 Montreal Convention.

G. Field Dimensions

1. The K.E.C. shall take all field dimensions as required to fit its equipment to the building conditions and shall coordinate with the other building trades in locating the utility service connections.
2. Trim will not be acceptable to fit the equipment to the building where the K.E.C. has failed to verify all field dimensions.

1.5 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings in compliance with section one documents.

B. Equipment Data

1. Submit catalog sheets of standard manufactured equipment in compliance with section one documents.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials and equipment shall be delivered and handled on the job site in a manner to prevent damage or loss, and stored in a place protected from damage, moisture and exposure to elements.

B. In the event of damage, immediately make all repairs and replacements necessary to meet the approval of the Architect and at no additional cost to the owner.

C. No equipment shall be delivered to the job site until the site is ready to receive the equipment.

1.7 JOB CONDITIONS

A. Coordinate work with the work of other contractors to insure proper roughing-in and final connections to equipment and that adequate openings and bases for equipment are provided.

B. Establish the exact size of openings to be left for all built-in work, and verify all measurements at the job site and be responsible for same.

C. Kitchen Equipment Contractor shall provide a representative at the job site during the installation of his equipment, who shall supervise the installation of the equipment and coordinate the connection of the equipment.

D. Protect all surfaces and structure in the area of installation from damage during the execution of work.

E. Schedule delivery of food service equipment so that areas to receive it are ready for installation.

F. Final tests of all equipment and demonstration of use shall be made in compliance with section one documents.

1.8 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Furnish complete portfolios in compliance with section one documents.

1.9 GUARANTEE

A. The contractor is required to place all equipment in perfect operating order inclusive of each particular system or parts thereof, which are part of his work, ready for continuous use and satisfactory operation, in a manner acceptable to the Architect and Owner.

B. The contractor shall guarantee all furnished work and materials and equipment are in compliance with section one documents.

C. This guarantee shall not be constitute to abrogate other specified guarantees or usual guarantees against work that has been defective when supplied or that has been improperly cared for or protected during the construction period.

D. In addition to the normal testing and repair, which are required for the completion of his work during the guarantee period, the Contractor shall visit the building at the Owner's request to clarify any questions for the operating personnel concerning the proper operation and maintenance of the equipment.

E. All compressors furnished as part of the food service equipment shall have a five (5) year warranty commencing from date as stipulated above. This warranty shall be as provided by the manufacturer of the compressor.

F. Provide extended warranties where specified.

PART 2 - PRODUCTS

2.1 QUALITY AND CONDITION OF MATERIALS

A. All materials shall be new, first quality, and without flaws. Equipment shall be delivered upon completion in an undamaged condition. The K.E.C. shall protect from damage, clean, and put into operating condition before acceptance by Owner.

2.2 MATERIALS AND GAUGES

A. Unless otherwise specified or shown on drawings, all surfaces shall be fabricated of stainless steel, including exposed underbracing below tops of dish tables and open base tables and sinks. The gauges used shall be as follows:

1. 12 ga. (Special construction where specified) Wide tops, sinks, underbracing, drip pans and floor troughs.
2. 14 ga. (Standard construction unless otherwise noted) Table tops, sinks, underbracing and special overshelves.
3. 16 ga. (Standard construction, unless otherwise noted) Undershelves, interior shelves, overshelves, wall shelves, body panels for base cabinets and counters.
4. 18 ga. (Standard construction, unless otherwise noted) Body panels for wall cabinets, partitions, back wall panels, drawer and door fronts and canopies.
5. 20 ga. (Standard construction, unless otherwise noted) Liners for refrigerators, interior

panels for drawers and doors.

2.3 MATERIALS

A. Non-Corrodible Alloy

1. Non-corrodible alloy, or stainless steel, specified hereinafter shall be Type 304 stainless steel, having a standard analysis of 18% chromium and 8% nickel. Sheets shall be stretcher leveled, free of buckles, warps and surface imperfections.
2. All gauges, where specified United States Standard gauges. All exposed surfaces shall be given a finish equal to #4 or 180 grit. Where manufacturing process and welding disturb the original finish, it shall be carefully reground, polished and restored to match balance of surface.

B. Galvanized Iron: Where galvanized iron is specified, furnish hot-dip galvanized, copper bearing steel. Use in largest possible sheets with as few joints as necessary. All sheets shall be commercial quality, stretcher leveled, and re-rolled to insure a smooth surface.

C. Faucets, Valves, Fittings: Sinks fitted with faucets as called for under each or as a separate item listed as faucets. All basin type faucets, Chicago #51, T&S #B202, or Fisher #3110. All splash mount faucets, Chicago #445, T&S #B237, or Fisher #3210. All special faucets for kettles, pre-wash, etc., shall be listed under Item Specifications.

D. Motors: Up to and including 1/2 HP shall be wired for 120 volts, single phase. Motors over 1/2 HP shall be wired for 208 volts, coordinate with electrical contractor.

E. Switches and Controls: The equipment contractor shall supply each motor-driven appliance or electrically heated unit a suitable control switch or starter of proper type in accordance with Underwriter's Laboratories and code requirements. Controls that are mounted on vertical surfaces of fabricated fixtures shall be set into recessed die stamped stainless steel cups or otherwise indented to prevent damage.

F. Electrical Elements:

1. Fabricated items requiring dry heat, such as plate warmers, urn stands shall be fitted with strip or ring heaters of sufficient wattage to provide specified heat. Unless otherwise specified, these heaters shall be installed directly below bottom shelf. Mount in suitable channels and interconnect with hard copper wire in accordance with Electrical Code. Provide each fixture with one or more thermostatic controls, each with pilot light indicator(s).
2. Properly protect all wiring in metal enclosures in accordance with the National Electrical Code, the Chicago Electrical Code and UL Standards.

2.4 FABRICATION

A. Open Type Bases

1. Pipe standards and frames: All pipe stands for open base tables or dish tables shall be constructed of 1-5/8 OD stainless steel tubing, with stringers and cross braces of the same material. All joints between legs and cross braces shall be welded and ground smooth. Legs shall not be spaced more than 5'6" on center.
2. Feet: Fit all pipe legs with sanitary, die-stamped stainless steel bullet shaped feet, fully enclosed, with a slightly rounded bottom to protect the floor. Fit top of these feet with a male threaded stem to fit into the end of the pipe legs specified and provide a total adjustment of 1". Stem shall be extra long so threads are not exposed. Finish off bottom on pipe leg smoothly and overlap stem to provide sanitary fitting and prevent accumulation of grease or other debris at this joint.
3. Undershelves: Unless otherwise specified in item Specifications, undershelves shall be

constructed of 16 gauge stainless, turned down front, sides and back 1-1/2" with edges deburred. Shelf shall have rounded corners and be provided with die-stamped raised ferrules to receive legs. Reinforce shelf with 14 gauge stainless steel closed inverted hat type channels. Dish table shelves shall be removable.

B. Enclosed and Semi-Enclosed Bases:

1. Body: Body shall be constructed of fronts, and ends and backs of 18 gauge stainless steel formed and reinforced to create a rigid, welded structure.
2. Tops: When metal tops are specified, reinforced with 14 gauge stainless steel closed inverted hat-type channel bracing.
3. Shelves: intermediate shelves shall be welded in place, unless otherwise specified. Bottom shelves shall be made removable is sections. Both types of shelves shall be constructed of 16 gauge stainless steel turned down fronts, sides and back 1-1/2" with deburred edges. Shelves shall be braced with 12 gauge stainless steel closed inverted hat-type channels. Provide pipe chase openings for utility lines when required. Intermediate shelves shall be turned up 1-1/2" in back and sides and feathered along wall surfaces of base.
4. Legs: Unless otherwise specified, or detailed, bases shall be mounted on 6" high, 1-5/8" OD stainless steel seamless tubular legs, each fitted with a stainless steel closed bottom, vermin-proof, adjustable bullet shaped foot. Legs shall be welded to 14 gauge stainless steel closed inverted hat-type channel welded to body under lower shelf.
5. Drawers: Drawers, unless otherwise specified, shall be 20" x 20" x 5" deep. Drawer front shall be pan-type, fabricated of 14 gauge stainless steel, fitted with a S.S. recessed pull and shall be flush with enclosure. Drawer insert shall be fabricated of 28 gauge stainless steel with all interior coved 1/2" radius. Insert shall be removable and shall be at least three-quarter exposed when drawer is opened fully. Drawer shall operate on heavy-duty stainless steel extension slides with stainless steel ball-bearing rollers. Drawer shall be enclosed fully and shall be self-closing except when fully extended. Provide stainless steel hasp fully welded to all drawers.

C. Table Tops (Metal):

1. Metal table tops of 14 gauge stainless steel with all horizontal and vertical corners coved on 5/8" radius. Shop seams and corners welded, ground smooth and polished. Working tops enclosed base fixtures reinforced on the underside with a framework of 1-1/2" x 4" x 1-1/2" inverted closed hat channel. Cross angle members placed at each pair of legs. Additional cross angle members between legs on not less than 48" centers. One angle runner, running lengthwise, provided on top so here will not be any noticeable deflection. Studweld reinforcements to underside of top. Do not use rivets or bolts through top.
2. Provide field joints in top where necessary and locate for practical construction, consistent with sizes convenient for shipping and accessibility into building. See paragraph entitled "Field Joints" for description of these joints.
3. Turn metal tops down 1-3/4" in a bullnose roll except where adjacent to walls or other pieces of equipment. Turn wall side up and back 2" unless otherwise specified in schedule.

D. Dish Table Tops:

1. Construct tops of dish tables of 14 gauge stainless steel with all free edges turned up 3" and finished with die-formed sanitary rolled rim. Flange sides adjacent to walls or higher fixtures up 6" and back 2" at up 45 degrees then down 3/4". All interior horizontal and vertical corners shall be coved on 5/8" radius. Outside radius of rolled rim corners shall be concentric with side cove.
2. Mount dish table tops on stainless steel tubing legs and connecting rails same as specified for open base tables.
3. Ends of splash shall be closed. Free corners of tops shall be spherical.

E. Sinks, Drainboards and Sink Insets:

1. Unless otherwise specified in Item Specifications shall be fabricated of 14 gauge stainless steel with 1-1/2" rim of front and sides and shall be of one-piece welded construction. All interior corners shall be coved a minimum of 3/4" radius, horizontally and vertically, with all intersections meeting in a spherical section. Solder filling shall not be acceptable. All exposed corners shall be bullnosed. Unless otherwise specified, backsplash shall be turned up 8", back on a 45 degree angle and down 3/4" with exposed ends closed. Bottom shall be pitched and fitted with 1-1/2" waste outlet with stainless steel removable strainer plate, lever handle valve and connected overflow. The use of die drawn bowls will not be accepted.
2. Multiple Compartments: All sinks having two or more compartments adjacent shall be of double thickness continuously welded to form a continuous front. Each compartment shall be pitched and fitted with a 1-1/2" I.P.S. waste outlet with stainless steel removable strainer plate, lever handle valve and connected overflow.
3. Drainboards: Where drainboards with sink compartments are specified they shall be fabricated of the same material as sink and shall be welded integrally with sink to form one-piece welded construction. Drainboards shall be pitched 1/8" per foot minimum. However, drainboards rim shall be kept level with sink. The front end shall be turned up 3" and finished with a 1-1/2" channel rim, with edges deburred. All exposed corners shall be rounded. Unless otherwise specified, backsplash shall be turned up 8", back on a 45 degree angle and down 3/4" with all exposed ends closed. Drainboards shall be reinforced with a 14 gauge stainless steel closed inverted hat-type channel bracing. Undersides of sinks and drainboards shall be coated with 1/8" thick hard-drying, sound-deadening mastic material and sprayed with aluminum paint.
4. Sink Insets: Sinks built into tops of fixtures, unless otherwise specified in Item Specifications, shall be fabricated of 14 gauge stainless steel. All interior corners shall be coved a minimum of 3/4" radius, horizontally and vertically with all intersections meeting in a spherical section. Sinks shall be welded integral to table tops. Riveted, spot-welded, and soldered joints between sink and top of table or in sink proper shall not be acceptable. Bottom shall be pitched and fitted with 1-1/2" I.P.S. waste outlet with stainless steel crumb strainer waste outlet. All sizes of sinks specified are inside dimensions.

F. Field Joints:

1. All field joints shall be welded.
2. All welded parts shall be non-porous and free of imperfections, free of pits, cracks, or discoloration. All welds of galvanized metal on dish tables and sinks shall be ground smooth, sandblasted, and sprayed with molten zinc at 1,200 degrees F to a minimum thickness of .004". Tinning of welds shall not be acceptable. All welds of stainless steel shall be ground and polished to original finish.

G. Sound Deadening:

1. Underside of all tops at contact of body and bracing shall be sound deadened with high quality asphalt mastic: Philip Cary "Hush Mush", Daubert Chemical "Quiet Tape", or approved equal.
2. Underside of drawers and shall be sound deadened.
3. Double walled sliding and swing doors shall be fitted with sound deadening insulation between the walls.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish to the architect a purchase order log with the following information:

1. Line item equipment number
2. Quantity of each line item
3. Manufacturer name
4. Model number of line item
5. Date ordered
6. Scheduled delivery date
7. Purchase order number

B. Furnish the general contractor with the following items.

1. A delivery schedule compatible with their construction schedule.
2. All items of equipment that would require early installation dates, i.e. hoods, floor troughs, etc.
3. Copies of all delivery receipts and bill of ladings for all items delivered to the job site. Copy shall bare the written name and signature of receiving person.
4. All loose, small component items shall be clearly taped with the corresponding item number.
5. The general contractor shall distribute all components that are scheduled for installation by others to each respective trade.

C. Trash and crating

1. Remove all debris generated by k.e.c. to job site dumpsters on a daily basis.
2. Do not allow any debris to accumulate in any work area that would impede the work of others or would in any way create a hazard.

3.2 SITE INSPECTIONS

A. Report to the general contractor in writing verification of all rough locations that are not located per the drawing or the requirements of the specified equipment.

B. Field verify actual as built dimensions of all walls, rough-ins, structurals, etc. That effect your work.

C. Field verify that all areas are ready to receive equipment prior to delivery to site.

3.3 INSTALLATION

A. Deliver all equipment in strict accordance with the specifications.

B. Deliver, uncrate, assemble, set in place, and level all equipment to be ready for final m.e.p. connections.

C. Cover all equipment work surfaces with, a thickness equal to the original packaging material, a cover to protect the equipment until the job site is ready for final clean up. All covers shall be securely fastened to the equipment.

D. Silicone seal all equipment to walls where equipment abuts walls. Seal shall be neat, clean and coved so as to create an easily cleanable surface.

E. Securely fasten with concealed fastener all scheduled trim after all final connections are completed.

F. Field verify that all exposed edges of all equipment is free of all burrs, sharp edges and all exposed surfaces are free of any and all fabrication irregularities. Where necessary repair, grind and polish irregularities to a quality finish consistent with the specification standards.

G. Remove all protective covering from all equipment and clean all equipment ready for final sanitizing when the job site is ready for final inspection by the architect.

3.4 TESTING

A. Verify that all equipment is connected as per the manufacturer requirements.

B. Lubricate, start-up, test and adjust all equipment prior to the architect's and owner's inspection.

C. Notify the architect in writing that all equipment is ready for inspection and demonstration.

3.5 CONTRACT CLOSE OUT

A. Deliver to the architect all required copies of owner's manuals, operating instructions and warranty documents prior to scheduling architect acceptance review.

B. Demonstrate all items of equipment to architect and owner.

C. Deliver all keys clearly tagged, miscellaneous loose accessories to the owner via schedules bill of lading and secure signature for same.

PART 4 - LINE ITEM SPECIFICATION

KEC contractor shall install all equipment level and plumb. All necessary field modifications to equipment to achieve a level and plumb installation shall comply with all applicable codes and (NSF) sanitation requirements.

ITEM 1 STOREROOM SHELVING

Quantity and size as shown on the drawings.

CAMBRO MFG. CO.
7601 CLAY AVE.
HUNTINGTON BEACH,
CALIFORNIA 92648-2219
800-854-7631
FAX 714-842-3430
MODEL: CAMSHELVING

INTERMETRO INDUSTRIES CORP.
NORTH WASHINGTON ST.
WILKES-BARRE,
PENNSYLVANIA 18705
717-825-2741
FAX 717-825-2852
MODEL: METROMAX

AMCO INDUSTRIES
901 N. KILPATRICK AVE
CHICAGO, IL 60651
800-621-4023
FAX 312-379-5183
MODEL: PLASTIC PLUS

Steel core posts and traverse supports polypropylene coated. Open grid, removable shelf mats capable of being washed in a commercial dishwasher. A 48" shelf section shall support 800 lbs. Each unit to be sized per plan and adjusted per field conditions and to be approximately 84" – 87" high and to have three (3) tiers equally spaced. Each section to be fitted with 5" high premium swivel casters with brakes suitable for corrosion resistant applications.

NOTE: ALL SHELVING FOR ITEMS 1 - 3 SHALL BE BY THE SAME MANUFACTURER

ITEM 2 KOLD LOCKER (F)

Quantity and size as shown on drawings.

KOLPAK/McCALL
641 N. McCORKLE PARK
PARSONS, TN 38363
901-847-5306
901-847-9013 (FAX)
Model #P6-066-FT

W. A. BROWN & SON
209 LONG MEADOW DRIVE
SALISBURY, NC 28147
800-438-2316
704-637-0919 (FAX)
Model #QF-76-66.I

NOR-LAKE
727 SECOND ST.
HUDSON, WI 54016
800-955-5253
715-386-6149 (FAX)
MODEL #KL-66

Cooler shall be exterior sized per the drawing for nominal 6’-0” x 6’-0” width and length, and shall be 6'-6" high. Failure of the Kitchen Equipment Contractor to provide the correct size, as specified that results in changes to the building architectural and mechanical electrical and plumbing system shall pay all costs to alter same.

Walls panels, interior and exterior shall be a minimum 26 gauge, pebble pattern finish aluminum, with 4" thick closed-cell foamed-in-place polyurethane construction, standard cam-lock connection system, to insure a sealed enclosure when erected. Ceilings to be white baked enamel.

Stainless steel insulated floor set in building slab depression.

Doors and door panel sections shall be positioned as shown on the drawings. Each door shall fit flush with box exterior; shall be equipped with a minimum of 2 cam-lift, self-closing hinges securely fastened to door frame; magnetic sealing door gasket, recessed light switch with pilot light, door frame heater, 14 gauge stainless steel threshold plate, 2" dial thermometer, cam-action locking handle with interior safety release, heated pressure relief port and audio alarm. Door to be a nominal 26” wide and stainless steel finished.

Interior lighting shall include one (1) standard 100 watt shielded vaporproof light fixture provided at the door opening, installation and for inter-connection to door light switch. Refrigeration system shall consist of self-
contained, top mounted air-cooled unit; refer to drawings for operation voltage and amperage.

1. Coils shall be flush, ceiling mounted.
2. Provide unit with sight glass, drier and liquid line assembly, and pressure relief valve. Pressure relief valve and all piping shall meet the Chicago Mechanical Code.
3. Condensate evaporator.
4. Flame spread rating to be 25 or less.

Refrigeration systems shall be provided by same manufacturer as the walk-in cooler. Furnish a letter of certification that the compressor and coil system is sized correctly to operate and hold product at 0 degrees F. with a maximum run time of 80% and as a working cooler. Assume that product load will be room ambient; door open thermal loss of 10% for 4 hours per day, five out of seven days.

Refrigeration system shall consist of furnishing and installing complete refrigeration system. Furnish complete with permits, hook-ups, valves, building coves, controls, disconnects, start-up, and 1 year service after Final Acceptance. All work shall be performed in accordance with the City of Chicago Refrigeration Code and meet the minimum standards as set by the 1995 Montreal Convention.

Insulate refrigeration and drain lines with "Armaflex" insulation or approved equal. Coil condensate lines shall be extended to the condensate evaporators. Provide electric defrost heater on drain line from the freezer coil.

Submit complete shop drawings and details for review prior to fabrication and installation.

Provide hi/low temperature alarm system.

NOTE: ITEMS 2 AND 3 SHALL BE THE SAME MANUFACTURER

ITEM 3 KOLD LOCKER (R)

Quantity and size as shown on drawings.

KOLPAK/McCALL	W. A. BROWN & SON	NOR-LAKE
641 N. McCORKLE PARK	209 LONG MEADOW DRIVE	727 SECOND ST.
PARSONS, TN 38363	SALISBURY, NC 28147	HUDSON, WI 54016
901-847-5306	800-438-2316	800-955-5253
901-847-9013 (FAX)	704-637-0919 (FAX)	715-386-6149 (FAX)
Model #P6-066-FT	Model #QF-76-66.I	MODEL #KL-66

Same as specified for Item #2 except provide refrigeration to maintain +38 degrees Fahrenheit.

ITEM 4 HAND SINK

Quantity as shown on the drawings.

EAGLE GROUP	ADVANCE TABCO	UNVERSAL STAINLESS
100 INDUSTRIAL BLVD.	200 HEARTLAND BLVD. SUITE T	2801 HUTCHINSON-MCDONALD
CLAYTON, DE 19930	EDGEWOOD, NY 11747	CHARLOTTE, NC 28269
800-441-8440	1-800-645-3166	1-800-925-1909
FAX 302-653-2065	FAX 1-516-242-6900	FAX 1-704-599-1909
MODEL HSA-10-F	MODEL 7-PS-60	MODEL CHS-1

Handsink shall be complete with faucet/strainer and wall mounting bracket. Handsink bowl shall measure nominal 12" x 10" x 5-1/2" overall with marine edge, made of 20 gauge, type 300 series stainless steel. Corner shall be minimum 1-3/4" coved; ends shall be turned back for safe, no-cut edges. Backsplash shall be 8" high with 2-3/4" turnback at 45 degree angle, with all welded end caps. Welded areas shall be blended to match adjacent surfaces, then polished to No. 4 finish. Hand sink shall include splash-mounted, chrome-plated Chicago, T&S or Fisher faucet with wrist handles and swivel gooseneck spout with .5 GPM aerator.

ITEM 5 ROLL-THRU REFRIGERATOR

Quantity as shown on the drawings.

TRAULSEN	VICTORY	TRUE MFG
11-402 15TH AVE.	110 WOODCREST RD.	PO BOX 970
COLLEGE POINT, NY	CHERRY HILL, N.J. 08003	O'FALLON, MO 63366
1-800-825-8220	856-428-4200	800-325-6152
FAX 1-718-961-1390	FAX 856-428-7299	FAX 314-272-2408
MODEL ARI (1) 32-LUTFHS	MODEL RISA-1D-S7	MODEL #TA1-RRT-1S1S

ITEM 6 OVEN CARTS

Mfg: Blodgett or approved equal
Quantity as shown on drawings.

- Two (2) #CTRE-2 transport carts for each oven (four total).
- Four (4) #DBR-1L roll-in basket dollies for each oven (eight total).
- Porcelain finish for oven interiors.

BASKET REQUIREMENTS, each basket dolly shall be provided with fourteen (14) #136-12 wire baskets as manufactured by Marlin Steel Wire Products (#410-644-7456). Baskets shall be constructed of nickel chrome plated cold rolled steel wire. Basket top and bottom frame to be ¼" diameter cold rolled steel. Crosswires of #11 gauge cold rolled steel shall be welded for form a 2" grid pattern and corner Vs for extra strength. The entire basket assembly is then to be nickel chrome plated. Basket shall measure 13-3/8" x 25-7/8" x 2-5/8". Total quantity baskets required is one hundred twelve (112).

ITEM 7 UTILITY CARTS

Quantity and size as shown on drawings.

LAKESIDE	WILDER MFG CO.	USECO
1977 S. ALLIS ST.	41 MECHANIC ST., P.O. BOX 1112	1152 PARK AVE.
MILWAUKEE, WI 53207	PORT JERVIS, N.Y. 12771	MURFREESBORO, TN 37129
1-414-481-3900	1-914-856-5188	1-800-251-3398
FAX 1-414-481-9313	FAX 1-914-856-1950	FAX 1-877-876-9665
MODEL #543	MODEL #C21335-2-NF	MODEL #TR-32-2

ITEM 8 ROLL-THRU FOOD WARMER

Quantity as shown on the drawings.

TRAULSEN	VICTORY	TRUE MFG.
11-402 15TH AVE.	110 WOODCREST RD.	P.O. BOX 970
COLLEGE POINT, NY	CHERRY HILL, N.J. 08003	O'FALLON, MO 63366
1-800-825-8220	856-428-4200	800-325-6152
FAX 1-718-961-1390	FAX 856-428-7299	FAX 314-272-2408
MODEL AIH-132-L-FHS	MODEL HISA-1D-S7	MODEL #TA1HRT-1S1S

Items 5 & 8 to be the same manufacturer.

ITEM 9 MOBILE WORKTABLE

Quantity and size as shown on the drawings.
Custom Fabricated, NSF, general construction per standard details

TOP, 14 gauge stainless steel, type 304 (18/8) with edge per detail 5d.
UNDERSTRUCTURE, 14 gauge galvanized channeling rigidly braced to top with studs and dome caps.
UNDERSHELF, 16 gauge stainless steel, type 304 (18/8) with edge to match top welded to legs.
LEGS, 1-5/8" diameter S/S, type 304 (18/8) (8) legs required.
GUSSETS, stainless steel conical type with inner sleeve and set screw.
CASTERS, 5" diameter polyurethane tires, all swivel, two (2) w/brakes.
DRAWERS, 20" x 20" x 5" deep, stainless steel drawer and housing.

ITEM 10 THREE COMPARTMENT SINK

Quantity and size as shown on drawings.

Custom fabricated, NSF, general construction per standard details.

SINK, 14 gauge stainless steel, type 304 (18/8) with 3/4" radius corners. Backsplash per details 3b and 4a against walls. Rim per detail 5b on free sides. Include lever wastes.
PARTITIONS, 14 gauge S/S, 5/8" thick double wall construction totally flush welded to sink body.
DRAINBOARDS, 14 gauge S/S integrally welded and of same construction as sink, sized per plan to have built in pitch to sink compartments, install disposer cone of Item #35 where shown.
UNDERSTRUCTURE, 14 gauge S/S triangular channeling welded to bottom.
LEGS, 1-5/8" diameter S/S, type 304 (18/8).
GUSSETS, stainless steel conical type with inner sleeve and set screw.
FEET, stainless steel adjustable bullet type.

FAUCETS - Two (2) required

- Chicago or T&S 15" minimum double jointed nozzle with 2.2 GPM aerator.

ITEM 11 ROLL-IN CONVECTION OVEN

BLODGETT OVEN CO. (OR APPROVED EQUAL)
50 LAKESIDE AVE.
P.O. BOX 586
BURLINGTON, VT 05402
802-860-3700
802-864-0183 (FAX)
MODEL #ZEPHAIRE-G, DOUBLE (ELECTRIC)

STANDARD EXTERIOR FINISH, shall consist of #430 stainless steel front, #3 finish and a dull heat resistant black enamel finish on the top, sides and back of oven.
CONTROL PANEL, shall be of stainless steel with independent controls. Control panel shall be completely removable for servicing.
STANDARD BAKING COMPARTMENT INTERIOR, including baffle to be of steel. Dimensions 29" wide x 20" high x 28-1/4" deep to front of baffle.
INSULATION, top, back and sides to be insulated with 1" thick, high temperature mineral fiber sheet.
DOORS AND HANDLES, a single handle mounted on each door to operate each door individually.
TRACKS, shall consist of stainless steel-formed guides mounted on the liner bottom.
DOCKING AND LOCKING ASSEMBLY, to be mounted on oven base to facilitate alignment for docking and locking of transport cart.
VENTING, oven baking chamber is continuously vented to oven exterior.
THERMOSTATS, each section shall be equipped with an electric, direct acting thermostat which shall have a snap action mechanism and integral off-on switch. Range shall be 200 degrees F to 500 degrees F.
TIMER, 60-miute mechanical timer with bell.
LISTING, ovens are listed Underwriters Laboratories and National Sanitation Foundation. Each Convection Oven shall be provided with the following optional features:

- 6" stainless steel legs, solid doors in lieu of doors with windows.
- Docking and locking assembly.

ITEM 12 EXHAUST HOOD(S)
Quantity and size as shown on drawing.

AVTEC INDUSTRIES
120 KENDALL POINT DR.
OSWEGO, IL 60543
708-851-4800
FAX 708-851-5777
MODEL #AXWO

GREENHECK
P.O. BOX 410
SHOFIELD, WI 54476
715-359-6171
FAX 715-355-2399
MODEL GKEW

CAPTIVE-AIRE
245 W. ROOSEVELT RD.
WEST CHICAGO, IL 60185
1-630-231-3380
FAX 1-630-231-8721
MODEL 5124CND

CADDY
509 SHARPSTOWN RD.
BRIDGEPORT, NJ
1-609-467-4222
FAX 609-467-5511
MODEL SHC

The exhaust hood[s] construction and specifications shall meet or exceed the minimum standards as set forth by the following agents and authorities:

1. The City of Chicago Building Code

2. Underwriter's Laboratories
3. The National Sanitation Foundation
4. The National Fire Protection Agency
5. Illinois Department of Public Health

The exhaust hood[s] shall be sized as per the Food Service and architectural drawings and the mechanical drawings; both of which allow for a minimum overhang of 6" in rear for the mechanical connection of the equipment under the hood, 12" in front of equipment, and the length by 6" at each side beyond the equipment as it is spaced under the exhaust canopy, except against a building wall.

The exhaust air shall be sized as per the mechanical drawings.

Where the mechanical requirements of the exhaust hood[s] provided by the Food Service Equipment Contractor do not meet the values as set forth by the Contract Documents, all costs for altering the duct and fan system, altering the H.V.A.C. system of the room, general construction modification, including any required architectural and/or engineering review shall be borne by the Kitchen Equipment Contractor.

The entire hood shall be constructed of a minimum of number 18 gauge, Type 304 stainless steel, No. 4 finish on all exposed areas. The entire unit shall be integrally welded and liquid-tight with all exposed welds ground and polished to a No. 4 finish.

1. UL classified and NFPA 96 stainless steel removable cartridges. Baffle and mesh filters will not be acceptable.
2. Concealed, full-length grease trough with removable collection cups at each end.
3. Recessed fluorescent light fixtures, quantity as follows. Light fixtures shall be interconnected to a single point connection within hood sections.
   a. Hood under 8'-0" long to include (1) 4'-0" fixture.
   b. Hood between 8'-0" and 10'-0" long to include (2) 4'-0" fixture.
   c. Hood between 10'-0" and 16'-0" long to include (3) 4'-0" fixtures.
   d. Hood larger than 16'-0" long to include (4) 4'-0" fixtures.
4. 20 gauge, Type 304 stainless steel enclosure panel to enclose area above the canopy from the top of the canopy to the building ceiling.
5. Provide 18 gauge, Type 304 stainless steel wall flashing with a No. 4 finish to wall or walls under exhaust canopy. Wall flashing shall extend from the cove base to the underside of hood. Provide clean, tight knockouts for all utility rough-ins.
6. Provide light and fan switches on the face of the hood.

ITEM 13 MILK CASE COOLERS

Quantity and size as shown on the drawings.

MOD-U-SERVE	BEVERAGE-AIR	NOR-LAKE
2320 PEYTON	P.O. BOX 5932	727 SECOND ST.
HOUSTON, TX 77032	SPARTANBURG, SC 29304	HUDSON, WI 54016
888-955-5463	800-845-9800	800-955-5253
FAX 281-442-3351	FAX 864-582-5083	FAX 715-386-6149
MODEL #MCT-DM2	MODEL #ST49N	MODEL #AR-122

ITEM 14 FROST TOP SERVING COUNTER

Quantity as shown on the drawings.

All serving counter components to be by the same manufacturer. 32" working counter top height all units.

DELFIELD	RANDALL MANUFACTURING	MOD-U-SERVE
P.O. BOX 470	520 S. COLDWATER RD.	2320 PEYTON
MT. PLEASANT, IL	WEIDMAN, MI 48893	HOUSTON, TX 77032
1-800-733-8821	1-800-621-8560	888-955-5463
FAX 1-800-669-0619	FAX 1-800-634-5369	FAX 281-442-3351
MODEL #SE-F5	MODEL #RAN-FTA-5S	MODEL #MCT-FR5

TOP, fabricated of 16 ga., type 302 polished stainless steel, turned down 2" on edges, with all corners welded.
APRON, full length x 10" high stainless steel apron.
CASTERS, mount on four (4) 5" diameter, heavy-duty, double ball bearing swivel casters with non-marking rubber tires. Two casters fitted with brakes adjust height to accommodate 32" work.
LOCKING DEVICE, Cam-action latches with trigger releases to join multiple units together at the top to form a unitized serving line.

Include the following accessories:

1. Full length x 12" wide, solid, stainless steel, ribbed type tray slide set on stainless steel folding brackets.
2. Full length minimum 6" wide stainless steel work shelf on stainless steel folding brackets.
3. Full front panel and end enclosure panels with vinyl, laminate or fiberglass finish.
4. Full length x full width stainless steel undershelf.
5. Full length double-deck display stands with plexiglas sneeze guards and end panels and stainless steel shelves. Each shelf to be fitted with a fluorescent light interwired with compressor cordset.

ITEM 15 HOT FOOD SERVING COUNTER

Quantity as shown on the drawings.

DELFIELD	RANDALL MANUFACTURING	MOD-U-SERVE
P.O. BOX 470	520 S. COLDWATER RD.	2320 PEYTON
MT. PLEASANT, IL	WEIDMAN, MI 48893	HOUSTON, TX 77032
1-800-733-8821	1-800-621-8560	888-955-5463
FAX 1-800-669-0619	FAX 1-800-634-5369	FAX 281-442-3351
MODEL #SC-72	MODEL #RAN-ST-5S	MODEL #MCT-FT6

Same general materials, accessories, specifications and details to match Item #14.

ITEM 16 CHECKER STAND

Quantity as shown on the drawings.

DELFIELD	RANDALL MANUFACTURING	MOD-U-SERVE
P.O. BOX 470	520 S. COLDWATER RD.	2320 PEYTON
MT. PLEASANT, IL	WEIDMAN, MI 48893	HOUSTON, TX 77032
1-800-733-8821	1-800-621-8560	888-955-5463
FAX 1-800-669-0619	FAX 1-800-634-5369	FAX 281-442-3351
MODEL #SCS-30	MODEL #RAN-CA	MODEL #MCT-CRSG

Same general materials, specifications and details to match Item #43.

1. Full length x 12" wide, solid, stainless steel, ribbed type tray slide set on stainless steel folding brackets.

ITEM 17 TRAY DRYING RACK

Quantity and size as shown on the drawings.

INTERMETRO INDUSTRIES CORP.
NORTH WASHINGTON ST.
WILKES-BARRE,
PENNSYLVANIA 18705
717-825-2741
FAX 717-825-2852
MODEL: PR48VX

AMCO INDUSTRIES
901 N. KILPATRICK AVE
CHICAGO, IL 60651
800-621-4023
FAX 312-379-5183
MODEL: PP4824

Four (4) tiers high, all shelves equipped with removable shelf mats, tray drying inserts, and 5” diameter polyurethane tired casters, two (2) swivel with brakes.

ITEM 18 ANGLE RACKS
Quantity as shown on the drawings.

NEW AGE
P.O. BOX 384
NORTON, KS 67654
800-255-0104
FAX 913-817-2616
MODEL #1337

CRES-COR
5925 HEISLEY ROAD
MENTOR, OH 44060
877-273-7267
FAX 440-350-7267
MODEL #207-1811C

LOCKWOOD
31251 INDUSTRIAL DRIVE
LIVONIA, MI 48150
734-425-5330
FAX 734-427-5650
MODEL #RA-64-ER11E

Frame and cross supports shall be of 1" square tubing, extruded aluminum alloy, all welded construction with corner bumpers. Bottom shall be of solid aluminum alloy with aluminum hat channels welded underneath for recessing of casters. Tray slides shall be of extruded aluminum angles 5"± O.C. welded to the frame. Units shall be furnished with 5" diameter heavy duty, plate type casters two supplied with brakes and to be sized to fit into Items #5 and #8.

ITEM 19 SPARE NUMBER

ITEM 20 TRAY CARTS
Quantity as shown on the drawings.

DELFIELD
P.O. BOX 470
MT. PLEASANT, IL
1-800-733-8821
FAX 1-800-669-0619
MODEL DT-3SS

CADDY
711 CADDY DRIVE
PITMAN, NJ 08071
609-589-1550
FAX 609-589-0220
MODEL T-145

FRAME, constructed of 1" O.D. 16 ga. stainless steel tubing, with 3/4" O.D. integrally welded cross rails.
CABINET, constructed of all-welded 18 ga. stainless steel, with edges flanged. Include a canted shelf with enclosed ends and full height back at an angle to support trays, with all interior corners coved to a 1/2" radius. Shelf to be set 14" above the floor and provide a 1/2" diameter hole to permit drainage.
CASTERS, mounted on four (4) 4" diameter heavy-duty, double ball bearing swivel casters, two [2] with brakes. Unit may be custom fabricated per the specifications.

ITEM 21 FLOOR TROUGHS
Quantity as shown on the drawings.

ADVANCE TABCO
200 HEARTLAND BLVD
EDGEWOOD, NY 11747
800-645-3166
FAX 516-242-6900
MODEL #FFTG-1236

IMC TEDDY
PO BOX 206
COPIAGUE, NY 11726
631-789-8881
FAX 631-789-3633
MODEL #FT-1236

Fiberglass "egg crate" style grate.
Unit may be custom fabricated to comply with the specifications of the above.

ITEM 22 RECYCLING COUNTER

Custom fabricated, size and quantity per plan x 34" high.

- General construction per details 1, 2, 6, and 7
- Backsplash per details 3e and 4a
- Rim per detail 5e
- Integral sink approximately 40" x 20" x 12" deep fitted with T&S or Chicago deck mounted faucet with 12" nozzle with loose keyed stops and 2.2 GPM aerator spout, and lever handled drain. Provide hinged double pan door per detail 7. Omit bottom shelf in the cabinet base.
- Support top with Walsh-Simmons seating #BAS 30WL cantilevered table brackets spaced to accommodate the recycling bins, Item #23.
- Provide cutout in top with 1" turndown at rear and ends and 1" turn-up at front with radiused corners. Cutouts to be centered over recycling bins between top supports.

ITEM 23 RECYCLING BINS

Quantity and size as shown on the drawings.

RUBBERMAID COMMERCIAL PRODUCTS
3124 VALLEY AVENUE
WINCHESTER, VA 22601
540-667-8700
FAX 540-542-8821
MODEL #3958

ITEM 24 DUNNAGE RACKS

Quantity and size as shown on drawings.

INTERMETRO INDUSTRIES CORP.
NORTH WASHINGTON ST.
WILKES-BARRE,
PENNSYLVANIA 18705
717-825-2741
FAX 717-825-2852
MODEL: A1460NK3/13PK3

AMCO INDUSTRIES
901 N. KILPATRICK AVE
CHICAGO, IL 60651
800-621-4023
FAX 312-379-5183
MODEL: A1260/P08 Polygard

Steel core posts and traverse supports polypropylene coated. Open grid, removable shelf mats capable of being washed in a commercial dishwasher. A 48" shelf section shall support 800 lbs. Each unit to be sized per plan and adjusted per field conditions and to be approximately 84" – 87" high and to have three (3) tiers equally spaced. Each section to be fitted with 5" high premium swivel casters with brakes suitable for corrosion resistant applications.

ITEM 25 FREEZER SHELVING

CAMBRO MFG. CO.
7601 CLAY AVE.
HUNTINGTON BEACH,
CALIFORNIA 92648-2219
800-854-7631
FAX 714-842-3430
MODEL: CAMSHELVING

INTERMETRO INDUSTRIES CORP.
NORTH WASHINGTON ST.
WILKES-BARRE,
PENNSYLVANIA 18705
717-825-2741
FAX 717-825-2852
MODEL: METROMAX

AMCO INDUSTRIES
901 N. KILPATRICK AVE
CHICAGO, IL 60651
800-621-4023
FAX 312-379-5183
MODEL: PLASTIC PLUS

Provide shelving sections same as specified for Item #1. Sections to be sized per plan x 64" high, three (3) tiers high with shelf clips across aisle units.

ITEM 26 REFRIGERATOR SHELVING

CAMBRO MFG. CO.

INTERMETRO INDUSTRIES CORP.

AMCO INDUSTRIES

7601 CLAY AVE.
HUNTINGTON BEACH,
CALIFORNIA 92648-2219
800-854-7631
FAX 714-842-3430
MODEL: CAMSHELVING

NORTH WASHINGTON ST.
WILKES-BARRE,
PENNSYLVANIA 18705
717-825-2741
FAX 717-825-2852
MODEL: METROMAX

901 N. KILPATRICK AVE
CHICAGO, IL 60651
800-621-4023
FAX 312-379-5183
MODEL: PLASTIC PLUS

Provide shelving sections same as specified for Item #1. Sections to be sized per plan x 64" high, three (3) tiers high with shelf clips across aisle units.

ITEM 27 TRASH CONTAINERS

Quantity and size as shown on the drawings.

RUBBERMAID COMMERCIAL PRODUCTS
3124 VALLEY AVENUE
WINCHESTER, VA 22601
540-667-8700
FAX 540-542-8821
MODEL #2655/2654

ITEM 28 WASTE BASKETS

Not in Division 11400

ITEM 29 DISH WASHER

Quantity as shown on the drawings.

CHAMPION INDUSTRIES
P.O. BOX 4149
WINSTON-SALEM, NC 27115
336-661-1556
FAX 336-661-1979
MODEL #UH-170B

CMA
12700 KNOTT AVE.
GARDEN GROVE, CA 92841
800-854-6417
FAX 714-895-2141
MODEL #180U.C

HOBART
701 S. RIDGE
TROY, OHIO 45374
888-4HOBART
FAX
MODEL: LXi

- Detergent and rinse aid pumps
- 6" legs
- Hot water sanitizing

ITEM 30 DISH TABLE

Quantity as shown on the drawings.

ADVANCE TABCO
200 HEARTLAND BLVD.
EDGEWOOD, NY 11719
800-498-6634
FAX 631-586-2933
MODEL #DTU-U60-48L

EAGLE
100 INDUSTRIAL BLVD.
CLAYTON, DE 19938
800-441-8440
FAX 302-653-2065
MODEL #UDT-4R-16/3

SELECT STAINLESS
11145 MONROE ROAD
MATTHEWS, NC 28105
888-843-2345
FAX 704-841-1590
MODEL 52UD-L STANDARD

- 16 gauge, #304 stainless steel construction
- Extended height legs to accommodate 6" legs on Item #29.
- T&S, Chicago Faucet or Fisher backsplash mounted pre-rinse spray.

END OF SECTION 11400

SECTION 15950

BUILDING AUTOMATION SYSTEM (BAS) GENERAL

PART 1. PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Description of Work

C. Quality Assurance

D. System Architecture

E. Distributed Processing Units/Quantity and Location

F. Demolition and Reuse of Existing Materials and Equipment

G. Sequence of Work

1.2 RELATED DOCUMENTS

A. Division 1

B. Division 15

C. Division 16

1.3 DESCRIPTION OF WORK

A. The distributed digital control (DDC) and building automation system (BAS) defined in this specification shall furnish and install a complete LONMARK® OR Native BACnet®Building Automation System (BAS) for all mechanical systems and other facility systems as included in the project documents. The contractor shall provide a complete and operational system to perform all sequences of operations stated in the Sequence of Operation Section or shown on the control drawings.

B. The BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified. The BAS for this project will generally consist of monitoring and control of systems listed below. Also reference the control drawings, the sequences of operation, and the points list.

C. The BAS system will include a webserver (control system server CSS), a separate operator work station (OWS), a laptop (portable operator terminal POT), all the software tools required to maintain or configure the server, OWS and any local devices.

D. This Section defines the manner and method by which these controls function.

E. All interlock wiring for mechanical system equipment shall be by this contractor unless specifically stated otherwise. This shall include (but not be limited to) items such as thermostats for unit heaters, interlock wiring to central boiler control panels, chiller flow switches, duct smoke detectors etc.

1.4 APPLICATION OF OPEN PROTOCOLS

A. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing the following standards:

B. BACnet: System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all BACnet building controllers (B-BC), advanced application controllers (B-AAC) and all application specific controllers (B-ASC). Gateways to other communication protocols are not acceptable. All controllers must be BACnet Testing Labs listed for their required profile (B-BC, B-AAC or B-ASC) .

OR

C. LonTalk: Provide control products and systems that comply with the latest version of the ANSI/EIA standard 709.1 and the LonTalk protocol of the Interoperability Standards as published by the LONMARK™ Association. All architectures involving tunneling the LonTalk protocol across an IP network must incorporate ISO Layer 3 transparent routing.

D. Throughout these specifications, there are parallel requirements for BACnet or LonWorks systems. Such requirements shall be interpreted in light of whether the contractor is installing a BACnet, LonWorks, or hybrid system.

1.5 QUALITY ASSURANCE

A. **Contractor Qualifications**: The following contractors have been ratified in previous Board of Education's qualification processes and have been active as part of those qualification. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification. All the BAS system provided by the Contractor shall be web based and shall meet all the requirements stated in the specifications

- Automatic Building Control, Inc
  1580 N. Northwest Highway
  Park Ridge, IL 60068
  Contact: Mark Bevil
  (847)-296-4000
  Vendor # 22627

- Control Engineering Corp.
  2000 York Rd, Ste 102
  Oakbrook, IL 60523
  Contact: Dave G. Dickerson

(630)-954-1300
Vendor #23101

- Environmental Systems, Inc.
  W223 N603 Saratoga Drive.
  Waukesha, WI 53186
  Contact: Paul Oswald
  (262) 544-8860
  Vendor #95503

- Johnson Controls, Inc..
  3007 Malmo Drive
  Arlington Heights, IL 60005
  Contact: Nick Hecimovich
  (847)-364-1500
  Vendor #11409

- Siemens Building Technologies Inc.
  1000 Deerfield Parkway
  Buffalo Grove, IL 60089
  Contact: Mark Sheehan
  (847)-493-7863
  Vendor #14664

- Automated Logic
  811 Ogden Ave.
  Lisle, IL 60
  Contact: George Biskup
  (630) 852-1700
  Vendor #35461

1.6 CODES AND STANDARDS

A. The following codes and standard intended to apply as applicable as not all will apply to all installations

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards:

1. 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
2. 62.1 Ventilation for Acceptable Indoor Air Quality
3. 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. current version including all annexes and addenda.
4. 55 Thermal Environmental Conditions for Human Occupancy

C. Electronics Industries Alliance

1. EIA-709.1-A-99: Control Network Protocol Specification

2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
3. EIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
10. EIA-852: Tunneling of Component Network Data over IP Channels

D. Underwriters Laboratories

1. UL 916: Energy Management Systems.

E. NEMA Compliance

1. NEMA 250: Enclosure for Electrical Equipment
2. NEMA ICS 1: General Standards for Industrial Controls.

F. NFPA Compliance

1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
2. NFPA 70 National Electrical Code (NEC)

G. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN

1.7 DEFINITIONS

A. **Acknowledged**: The data is broadcast repeatedly until an acknowledgement is received. This type of service should be used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.

B. **Adjustable (Adj):** A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program. See also initial value.

C. **Analog Calibration Offsets**: For all analog input measured variables with the exception of velocity pressure, there is a requirement to adjust the value measured by the hardware based analog input point to match the value reported by a certified test instrument. An analog calibration offset is a parameter that can be added or subtracted from the raw value measured by the sensor to produce a calibrated value that will be use by the control logic and reported to the operator workstations. The

initial value of this parameter is set at zero and it is adjusted when the calibration process is executed. This adjustment is referred to as a single point calibration. These parameters are mandatory for all analog inputs except velocity pressure sensors (requirements for velocity pressure sensors are presented elsewhere). These offset values are configuration parameters and as such shall be written to EEPROM. It shall be possible to change the value of these parameters from a graphic page.

D. **Advanced Application Controller (AAC):** A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications. A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet. A BACnet device to be used as an AAC will meet the requirements of ASHRAE 135 Annex L and will be listed as an AAC by BACnet Testing LABs. A BTL listed device will carry the BTL Mark

E. **Application Programming Tool**: A vendor unique software tool used to create applications for programmable controllers.

F. **Application Protocol Data Unit (APDU)**: A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).

G. **Application Specific Controller (ASC):** A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications. An ACS is a pre-programmed control module, which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions. A BACnet device to be used as an ASC will meet the requirements of ASHRAE 135 Annex L and will be listed as an ASC by BACnet Testing LABs. A BTL listed device will carry the BTL Mark.

H. **BACnet/BACnet Standard**: BACnet communication requirements as defined by ASHRAE/ANSI 135 current version including all annexes and addenda.

I. **Bandwidth Utilization**: The average utilization of the network capacity. . Network loading is controlled by the use of event driven broadcast based data propagation and the use of appropriate binding services.

J. **Binding Services**: When the network management tool within Niagara or Plexus is used to establish a binding, the programmer selects one of three types of binding services:

a) Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. This type of service shall be used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.

b) Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. This type of service shall be used for most process control related data requiring timely receipt of the data.

c) Acknowledged: The data is broadcast repeatedly until an acknowledgement is received. This type of service should be used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.

K. **Binding**: The concept of associating an output network variable from one device to the input network variable of a second device. There are three types of bindings:

a) One to One: A single output network variable is bound to a single input network variable

b) One to Many: A single output network variable is bound to input network variables on multiple devices.

c) Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

L. **Broadcasting**: The propagation of data from a device to the control network. Software objects that broadcast data to the network shall include the following parameters:

M. **Building Automation System (BAS)**: The entire integrated energy management and control system

N. **Building Controller (BC)**: A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller. A BACnet device to be used as a BC will meet the requirements of ASHRAE 135 Annex L and will be listed as a BC by BACnet Testing LABs. A BTL listed device will carry the BTL Mark

O. **Bus Topology**: A term used to describe the sequential connection of devices on a LON segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device.

P. **Change of Value (COV)**: An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-1995).

Q. **Channel**: A LON network consisting of two segments connected by a physical layer repeater or router configured as a repeater. Each segment can support a theoretical limit of 64 connections.

R. **Client:** A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.

S. **Configuration Parameter**: An input network variable to a controller (nci) that is written to the EEPROM. Configuration parameters can be changed periodically from the HMI but are not changed routinely as a function of control logic.

T. **Connection**: A connection is made when a device is physically connected to the FTT-10 communication cable. Devices that count against the number of connections limit include LON Talk Adapters (PCLTA, PCC 10 etc.), any sensor, actuator or controller with a FTT-10 transceiver and Neuron chip and a router or repeater. Terminators are not considered to be a connection.

U. **Continuous Monitoring**: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state)

V. **Control System Server,Web Server (WS)**: A device that is provides access to the control system. This device will allow access to the control system with a web browser over the CPS WAN. As the BAS network devices are stand-alone, the CSS is not required for communications to occur. The webserver will have two NIC cards so that is functions as the bridge between the local supervisory LAN and the CPS LAN.

W. **Controller or Control Unit (CU)**: Intelligent stand-alone control panel. Controller is a generic reference and is a PCU.

X. **CPS WAN:** Reference to Chicago Public Schools Information Technology network, used for normal business-related e-mail and Internet communication.

Y. **Direct Digital Control (DDC)**: Microprocessor-based control including Analog/Digital conversion and program logic

Z. **Enumerated SNVT**: An enumerated SNVT defines the format of a single piece of data using a state description concept. The data will consist of a series of integers and each integer shall convey a defined condition or state. The list of available enumerated SNVT types is defined in the LonMark Standard Enumeration Master List, dated May 2002. This document is available on the Echelon.com web site.

AA. **Error Rate**: A measurement of communication quality that assesses the number of defective data packets as a percentage of the total number of data packets. Defective data packets are generally the result of poor installation practices or improper cable selection.

BB. **Event Driven Communication**: A term used to describe the propagation of data from a device to the network based on broadcasting rather than polling. The send on delta parameter is used to define the event and the data propagation is further controlled by the minimum and maximum send time parameters.

CC. **Free Topology**: A data wiring topology that allows for loops, tees, y-connections etc. When this topology is used only one terminator of a specific design is required and allowable cable lengths are significantly reduced.

DD. **Functional Profile:** A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.

EE. **Gateway (GTWY)**: A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-1995).

FF. **Hand Held Device (HHD)**: Manufacturer's microprocessor based device for direct connection to a Controller.

GG. **Host-Based Controller**: A term applicable only to Lon-based controllers where the on-board Neuron chip is used solely as the Communications Interface and a processor independent from the Neuron chip to is used to execute Application control and I/O processes.

HH. **JACE**: Java Control Engine. A term used within the Niagara Framework to describe a component that serves several key functions:

- Serve as the LANID
- Collection of data from a FTT-10 LonTalk channel
- Transmission of data to operator workstations on the TCP/IP network
- Location for time schedules to support all of the devices on the LonTalk channel
- Support for 1 LonTalk channel (two segments, 40 nodes each)
- Location for trend logs for all data to be trended from the devices on the LonTalk channel
- Location for alarm handling software. The JACE shall process event broadcasted data from the devices (alarm indication) and enter the appropriate alarm information in the alarm reporting system at the TCP/IP level.

II. **Local Supervisory LAN Interface Device (LANID)**: Device used to facilitate communication and sharing of data throughout the BAS and CPS WAN

JJ. **LonMark Profile**: To enhance interchangeability of control components at the sensor, actuator, terminal unit controller and package equipment controller level, the LonMark Association has created profiles that define the network image for these devices. These profiles define mandatory input and output variables and configuration parameters and a required format for each. Conformance to a LonMark profile provides to the facility owner the opportunity to replace a control component manufactured by one vendor with a similar component manufactured by a different vendor provided the embedded application of the replacement controller meets the sequence of control requirements.

KK. **Media Access Control address (MAC)** , a hardware address that uniquely identifies each node of a network.. Each different type of network medium requires a different MAC layer.

LL. **Managed Communication**: The transmission of data from a controller to a data manager, which in turn re-broadcasts the data to a second controller. In some systems the data manager is referred to a Network Controller.

MM. **Manual Control**: A concept where the operator from the operator workstation takes control of an end device and forces a specific position or state. From a software perspective, the value produced by the control logic is not allowed to affect the position or state of the end device. The manual mode and the desired manual position or states are parameters that are set by the operator.

NN. **Many to One**: Output network variables from multiple devices are bound to a single input network variable on a different device.

OO. **Maximum Send Time Parameter**: A parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of the variable, a re-broadcast of the current value shall be executed. See also send on delta and maximum send time parameter definitions.

PP. **Maximum Send Time**: An adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.

QQ. **Minimum Send Time Parameter**: A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also send on delta and maximum send time parameter definitions.

RR. **Minimum Send Time**: An adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.

SS. **Multiple Controller Integrated Control (MCIC)**: A concept where multiple controllers with I/O are used to control a single mechanical system such as an air handling unit. Under this concept the mechanical system is sub-divided into a collection of processes to be controlled such as the fan start stop circuit, the fan variable speed drive, the mixed air section, the cooling coil section etc. With this concept all primary measured variables and the end device associated with a single process along with the primary control logic for the process shall be contained within a single controller. Secondary data from one process that affects the control of another process may be sent from one controller to the primary controller controlling the process. When data is sent from one controller to another controller, broadcasting concepts as defined above must be used. If the data being received over the network only affects the general thermodynamic or psychometric performance of the process but does not have a significant affect on safety or equipment protection then unacknowledged repeated binding services shall be used. If the data being received over the network does have a safety or equipment protection impact, then acknowledged repeated binding services shall be used. In both cases peer to peer communication is mandatory. All of the controllers must be on the same channel. Managed communication shall not be used to move data between the multiple controllers.

TT. **One to Many**: A single output network variable is bound to input network variables on multiple devices.

UU. **One to One**: A single output network variable is bound to a single input network variable

VV. **Open Database Connectivity (ODBC)**: An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make

it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.

WW. **Operator Interface (OI)**: A device used by the operator to manage the BAS including OWSs, and POTs,.

XX. **Operator Workstation (OWS)**: The user's interface with the BAS system via the internet or the Local Supervisory LAN. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.

YY. **Peer to Peer Communication**: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.

ZZ. **Polling Communication**: The concept of a control device requesting a network variable from a second control device at a specified interval. Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.

AAA. **Portable Operators Terminal (POT):** Laptop PC used both for direct connection to a controller and for remote dial up connection.

BBB. **Primary Control Unit (PCU)**: A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems.

CCC. **PICS - Protocol Implementation Conformance Statement (PICS):** A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

DDD. **Repeater**: A physical device used to connect two segments. A repeater does not filter any message traffic. A repeater does isolate physical problems such as short circuits to a single segment and is typically required to allow the use of additional devices or additional cable length.

EEE. **Router**: A device that connects two or more networks at the network layer.

FFF. **Segment**: A single section of a LON network that contains no routers or repeaters.

GGG. **Send on Delta Parameter**: A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an output variable shall not occur unless the output variable has changed by an amount equal to or greater than the value of this parameter and the minimum send time has expired since the last broadcast. See also minimum send time and maximum send time parameter definitions. For binary data the send on delta parameter is assumed to be a change of state. Logic to support the send on delta concept may be imbedded in the configurable structure of an output point or programmed as part of the logic.

HHH. **Send on Delta**: An adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data this parameters defaults to a change of state.

The broadcast of data is initiated when this criteria and the minimum send time requirement have been met.

III. **Simple SNVT**: A simple SNVT defines the format of a single piece of data. The definition of a simple SNVT in the master list of SNVTs will include the type of variable being measured (temperature, electric current, power etc.), the data type (signed integer, unsigned integer, floating point etc.), the data range, the resolution of the data and the engineering units.

JJJ. **Smart Device**: A control I/O device such as a smart sensor (SS) or smart actuator (SA) that can directly communicate with the controller network to which it is connected rather than through a binary or analog signal. This differs from an PCU in that it typically deals only with one variable.

KKK. **SNVT**: An acronym for STANDARD NETWORK VARIABLE TYPE. A SNVT is a data format statement for implicit (open) communication on a LonTalk network. The current master list of SNVTs is available from Echelon.com in a document defined as SNVT Master List, Version 11, Revision 2, dated May 2002.

LLL. **SQL**: Standardized Query Language, a standardized means for requesting information from a database.

MMM. **Stand-Alone Controller**: A stand alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.

NNN. **Structured SNVT**: A structured SNVT defines the format of a network variable that contains several different data elements. A simple SNVT or an enumerated SNVT may define each data element within a structured SNVT.

OOO. **Supervisory Logic**: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices. Examples: Are any of the VAV terminals supported by a particular AHU operating the reheat processes? Is there an indication from any of the control zones that an occupant has requested the temporary operation of the air delivery system?

PPP. **Terminator**: An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment. On a bus topology, a terminator is connected to each end of a segment. For a channel consisting of two bus topology segments, a total of 4 terminators are required, one at each end of each segment.

QQQ. **Test Mode**: A concept where the operator from the operator work-station can interrupt the flow of data from a sensor to the control logic and insert a mandatory test value or test state to be used by the control logic. The test mode and the desired test value or states are parameters that are set by the operator.

RRR. **Unacknowledged Repeated**: The data being broadcast is sent three times and an acknowledgement of receipt is not required. This type of service shall be used for most process control related data requiring timely receipt of the data.

SSS. **Unacknowledged**: The data being broadcast is sent one time and an acknowledgement of receipt is not required. This type of service shall be used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.

TTT. **Web Server** See Control System Server

UUU. **XIF File**: A file indicating the interface specifications for LonMark devices.

VVV. **XML (Extensible Markup Language)**: A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.8 FUNCTIONAL INTENT

A. Throughout Division 15 Sections detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these products must be submitted and approved by CPS in accordance with Division 1..

1.9 SUBMITTALS

A. Submit under provisions of Conditions of the Contract and Division 1 Specification Sections.

B. **Electronic Submittals**: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.

1. **Drawings and Diagrams**: Shop drawings shall be provided on electronic media as an AutoCAD 2000 or later version drawing file and/or Adobe Portable Document Format file. All ‘x reference’ and font files must be provided with AutoCAD files.
2. **Other Submittals**: All other submittals shall be provided in Adobe Portable Document Format. There are a few documents including the Cheat Sheets, Trouble Shooting Guide and Sequence of operation that will also be submitted in rich text format or MS Word.

C. **Product Line Demonstrated History**: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of 1 year since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.

D. **Qualifications**: Manufacturer, Contractor and Key personnel qualifications as indicated for the appropriate item above.

E. **Product Data**: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities,

performance and electrical characteristics, and material finishes. Also include installation and start-up instructions. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other meansGeneral catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

F. **Shop Drawings**: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:

1. System Architecture and System Layout:
   a) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. For LonTalk systems indicate all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, terminators, ground locations etc. shall be located on the diagram.

   b) Provide floor plans locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. For LonTalk systems provide as-built network architecture drawings showing all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.

2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include contractor written description of sequence of operation.
3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Division 15 Section BAS Software and Programing - Part III for additional requirements.
5. Label each control device with setting.
6. Label each input and output with the appropriate range.
7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering

number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable. Also identify the spec section and spec reference.

8. Provide a valve or damper and the associated actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal (fail) positions of spring return valves and dampers. This is the valve or damper position with no power to the actuator.
9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, boiler burner, chiller, RTU, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed. For all devices with safety circuits, incuding burners and chillers, field wiring will be labeled and all added devices will be properly mounted. Any internal wiring changes shall be approved by the manuafacturer in writing. If for example a gas booster needs to be tied into the burner circuit the manaufacturer shall identify the terminal points and provide an updated control diagram.
10. Sample Operator Interface Graphic Screens for each unique type of system, with final screens to be received 60 days prior to system startup.
11. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
12. Sheets shall be consecutively numbered.
13. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
14. Table of Contents listing sheet titles and sheet numbers.
15. Legend and list of abbreviations.
16. Provide an operating schedule for review. The schedule will have a schedule for each AHU/RTU and the associated equipment. Terminal units serving the principals office and associated administrative areas will have a separate schedule from the classrooms.

G. Checkout and Testing Forms

Submit a blank copy of the forms that will be used during Point-to-Point Checkout, Prefunctional Checkout, and Functional Performance Testing as outlined in Division 15 Section BAS Commissioning. Those forms should be structured to capture the following information at a minimum during each particular testing phase:

1. Point-to-Point Checkout Form contain the following information
   a) Each point is addressed, labeled and that proper communication exists between the controller and the field device.
   b) Documents that installed condition match the control drawings and that any changes or differences are noted on the drawings.
2. Prefunctional Checkout Forms contain the following information

a) Documents correct voltage and or current present as well as verifying circuits are free from grounds or faults for each control device.

b) Obtain and Record Test and Balance settings and incorporate into the BAS. The information from the TAB contractor includes:

   1) Water and air system differential pressure and flow settings

   2) AHU minimum outside air control point or damper setting.

c) As left calibration data for all sensing and actuating devices recording final measured and displayed value. For analog inputs an independent meter will determine the measured value. Record the type and model of the meter.

d) For analog outputs record both the displayed output as well state of the receiving device.

e) For digital input/outputs record the signal at the controller and the state of the sensing/control device.

f) For actuators:

   1) Check to insure that actuated device moves smoothly and results are repeatable thru full range and seals tightly when the appropriate signal is applied to the operator.

   2) Check for appropriate fail position, and that the stroke and range is as required.

   3) For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges. Record final settings

g) For all valves and actuators, verify the actual position against the Operator Interface readout. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to a few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator.

h) Valve leak check: Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit.

i) For air and water flow measuring stations the data recorded will include the independent flow measurement, area and the independently measured output of the flow station. The BAS input from the flow station and any factors used to calculate the flow including area and any constants used in the calculation of flow. There will be two sets of data collected. The first at design flow and the second at 50% of design flow. It is not acceptable to simply add a correction factor to address differences between the flow station and the independent reading.

j) For Operator Interfaces and Web accessible display:

   1) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.

2) Output all specified BAS reports for review and approval.

3) Verify that the alarm pop ups, printing and logging is functional and per requirements.

4) Verify that all points are trended and are archiving to disk and provide a sample to the Commissioning Authority and CPS for review.

5) Verify that paging/dial-out alarm annunciation is functional.

6) Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.

7) Verify that required third party software applications required with the bid are installed and are functional.

k) For all actuating devices record final settings for device. For example the setpoint and reset values for differential pressure switches.

l) Document verification of point to graphics binding for all points displayed on the workstation and that webserver display have been mapped correctly, and display the correct information.

m) Document that the webserver is on the CPS LAN and can be viewed from off site (another school) and that the modem is connected and the BAS is accessible via modem by the contractor.

3. Functional Performance Forms contain:

a) List of all sequences, modes of operation and setpoint that initiates each sequence and/or mode. For each confirm that proper sequence of operation. Document any variance between designed sequence and actual condition.

b) Record tuning parameters and response time for each control loop.

c) Document all alarm and safeties test and final results.

d) Results of trends including controlled points, setpoints, actual readings and other point defined by the Boards Authorized Representative.

H. The Testing Plan

1. Contractor is to submit their plan for executing all phases of testing and completion of checkout forms. This included the following: manufacturers' normal testing, point-to-point testing, pre-functional testing, and functional performance testing. "The Testing Plan" will show the overall milestones of the controls work and testing of the controls system.
2. Provide the schedule for completing each phase of testing for each system or set of equipment: air handlers, chillers, boilers, unit-vents, vav boxes, network wiring, operators workstation, etc. Schedules are to have no dates at this point, but should show the time frame needed to complete the tasks.
3. The testing plan shall identify other trade milestones that impact the successful completion of during each phase of testing.

4. This plan is not meant to take precedence over any other plan but is intended to provide coordination assistance to all trades as the project is scheduled.

I. **Open Protocol Information**

1. General
   a) Provide all of the information necessary for review of the proposed system such that it can be determined that the product chosen for implementation meets all of the protocol standards within this specification and as determined by the authority maintaining the protocol standard.
2. LonWorks Systems:
   a) Binding table indicating all Network Variables used in the project, Neuron ID and domain, subnet and channel address, and associated bound variables. Clearly indicate which parameters of a functional profile are bound and can be overridden.
   b) A point binding diagram shall be provided with each control schematic depicting all bound network variables along with the associated functional profiles.
   c) LonMark functional profile certifications.
   d) For Host-Based Controllers: Controller programming and configuration tool and or plug in required for all controllers with a minimum of 3 licenses as applicable.
   e) For non-host Controllers: LonTalk Neuron C source code and/or Neuron C application programming interface tool (3 licenses) and associated files required for all controllers.
   f) Backup of systems configuration database on CD. This shall be provided at preliminary acceptance and at the end of the warranty period.
   g) Documentation of all explicit messaging.
   h) XIF files for all LonMark components.
3. BACnet Systems:
   a) BACnet object description, object ID, and device ID, for each I/O point.
   b) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
   c) Submit PICS indicating the standardized BACnet device profile, functionality and configuration of each controller along with proof of BTL listing.

J. **Framed Control Drawings**: After completion of installation and check out, but prior to training, laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.

K. **Control Logic Documentation** (All documentation to be received and updated prior to training)

1. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.
2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
3. Include written description of each control sequence.
4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.
5. Sheets shall be consecutively numbered.
6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
7. Include Table of Contents listing sheet titles and sheet numbers
8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below.

L. Training Plan;

1. Training shall be structured as follows: Format shall be an outline broken up into eight 4 hour sessions. The training plan for the Opposite Season or Refresher training will not be provided.
2. The material to be covered shall then be further sub divided into descriptions of the material to be covered in every 15 minutes. See Division 15 *BAS SYSTEM COMMISSIONING* for specific items to be addressed.
3. The descriptions shall include not only the material to be covered but also its location in the Operation and Maintenance Manual or the Training Manual including section and page number.

M. Operation and Maintenance Manual: (All documentation to be received and updated prior to training)

1. Submit under provisions of Conditions of the Contract and Division 1 Specification Sections. One copy of the materials shall be delivered directly to Chicago Publics School's (CPS) operation staff, in addition to the copies required by other Sections.
2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
3. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
4. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
5. Include all as built submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.

N. TRAINING MANUAL:

Submit training manual electronically for review. Once accepted, provide three hard copies and one electronic copy of the training manual shall be provided at the start of training and shall contain the following. Note only the initial 8 hours of training which include the Cheat Sheets will occur before the demonstration is completed.

1. Cheat Sheets or quick reference section with step-by-step guidance with a level of detail that will allow someone with no experience with the control system to follow the instructions. The quick reference guidance can be provided one of two ways. Screen prints with bubbled text describing the navigation required or written description of the steps to be taken with screen prints provided to facilitate the written explanation. In either case the document will be provided in rtf or doc format (see Exhibit A for a sample). The required cheat sheets include:
   a) Login and logoff to control system as well as Microsoft XP login;
   b) Adjust Setpoints and restore setpoints
   c) Overrides and releasing overrides as well as running a report to list all points currently overriden.
   d) Start, group, plot and export Trends
   e) Adjust schedules and add holidays
   f) Processing of alarms including acknowledgement, review of alarm report and clearing of alarm history.
   g) Backup and restoration of system data
   h) Demonstrate how to clear/reset all field devices that may require manual intervention. For example if a building controller is not responding show how to reset/reboot the controller or the manual operation of a damper or valve actuator. (see Exhibit F for a sample)
   i) Demonstrate how to reset motor starter and the significance of Hand-Off-Auto switch position on motor starters. (see Exhibit F for a sample)
   j) Demonstration of each input and output device. Provide a picture of each input or output device with a brief narrative on its operation. For example while displaying a picture of a modulating and 2-position damper actuator describe how to tell the difference and who fast it takes to go full stroke. (see Exhibit F for a sample)
   k) Demonstrate how to place the boiler, or chiller system in manual control and boiler control and how to restore the system to BAS control. (see Exhibit F for a sample)
2. Operating instructions including system startup & shutdown, seasonal and emergency instruction (see Exhibit B for a sample).
3. Trouble Shooting Guide. The guide will address actions to be taken to trouble shoot problems with the OWS, PCU's CSS and local control devices (see Exhibit E for a sample)
4. Setpoint Table (see Exhibit C for a sample).
5. Preventative maintenance instructions (see Exhibit D for a sample).

6. Color print of each unique screen.
7. Final Sequence of Operations. This document shall be printed but shall also be provided electronically in rich text format (rtf). The sequence shall provide not only the original design sequence from the specifications and drawings but also the any changes to the sequence.
8. Complete set of the design control drawings (provided by the AOR on 11”X17” sheets. The manual will have a TAB for these drawings. The printed drawings will come from the AOR/EOR.
9. List of all alarm points and alarm priority

O. Video Training: The following training shall be recorded on a CD using screen capture software. Any files required to run the CD will be provided along with a file with the instruction on how to view the CD. The cadence of the video training shall be such that an inexperienced person can listen to the narrative and execute those steps on controls system while watching the the CD. The training recording must include a screen view recording the actual video feed to the monitor for the work station penetration while narrating the associated steps.

1. Quick reference procedures. The taping of these procedures must include both a screen view preferably recording the actual video feed to the monitor while narrating the associated steps.
   a) Login and logoff to control system as well as Microsoft XP login;
   b) Adjust Setpoints and restore setpoints
   c) Overrides and releasing overrides as well as running a report to list all points currently overriden.
   d) Start, group, plot and export Trends
   e) Adjust schedules and add holidays
   f) Processing of alarms including acknowledgement, review of alarm report and clearing of alarm history.
   g) Backup and restoration of system data
   h) Demonstrate workstation menu penetration and broad overview of the various workstation features
   i) Demonstrate all operations and functions that can be performed at the supervisory or local controllers as well as system display artifacts such as the indication that a point has failed or lost communication.

P. Demonstration of portable operator interface device display capabilities

Q. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance. Include all LonMark functional profiles certifications for systems used on this project.

R. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

1.10 PROJECT RECORD DOCUMENTS

The Project Record documents that have not already been submitted as part of the Operating and Maintenance Manual or Training Manual are to be submitted with the Record Documents. Any documents in the Operating and Maintenance Manual or Training Manual that have changed since they were submitted will need to be re-submitted as part of the Project record documents. All of these documents maybe submitted electronically.

A. Submit under provisions of Conditions of the Contract and Division 1 Specification Sections.

B. Record copies of product data and control shop drawings updated to reflect the final installed condition.

C. Record copies of approved control logic programming and database on CD's. The CD's will contain all information required to reinstall the control system program. It will include actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing. One set of CD's will be stored at the school in the main control panel and the second set will be provided to CPS Operations.

D. Record copies of approved project specific graphic software on CDs.

E. For LonTalk systems provide as-built network architecture drawings showing all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. For BACnet systems provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description and location information.

F. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.

G. Provide record riser diagram showing the location of all controllers.

H. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

1.11 BUILDING AUTOMATION SYSTEM OPERATOR INTERFACE (OI)

A. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, remote monitoring, and trend reporting. . Refer to Section 15952 – BAS Operator Interfaces.

1.12 SYSTEM ARCHITECTURE

A. Application of Open Protocols

1. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing the following standards:

   a) LonTalk: Provide control products and systems that comply with the latest version of the ANSI/EIA standard 709.1 and the LonTalk protocol of the Interoperability Standards as published by the LONMARK™ Association. All architectures involving tunneling the LonTalk protocol across an IP network must incorporate ISO Layer 3 transparent routing.

   b) BACnet or hybrid system: The system architecture shall consist of a BACnet IP Router, a single Local Area Network (LAN) or two-level LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. In no event shall there be more than two levels of LAN topology within the system, excluding wiring to sensors with no control intelligence.

B. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

C. The system shall be configured as a distributed processing network(s) capable of expansion as specified below. Refer to the network architecture on the BAS drawings for other requirements and details.

D. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled LANs that support PCU's, Operator Workstations (OWS), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. **CPS WAN**: Intranet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and contractor is not required to configure any components of this WAN.

2. **Local BAS Supervisory LAN**: The Local BAS Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSs. The LAN serves as the inter-PCU gateway and OWS-to-PCU gateway and communications path and as the connection point for the CPS WAN. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power-line carrier communication shall not be acceptable for communications. The higher level layers of this network shall be the following:

1) LonWorks Supervisory LAN: Individual Primary Control LonTalk Networks routed over IP using LonTalk to IP routers.

2) BACnet Local Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet. .

3. **Primary Controller LAN ('Primary LAN')**: High-speed, peer-to-peer communicating LAN used to connect and Primary Control (PCUs) and communicate exclusively control information. Acceptable technologies include:

a) LonTalk: The LonTalk standalone BAS shall be comprised of a network of PCU's supporting LonTalk protocol (EIA 709.1) and twisted pair, bus topology transceivers (EIA 709.3). The network shall communicate at 78 kbps. The network shall be installed utilizing the Bus Topology. The network shall consist of a single channel with 2 segments. Each segment shall be limited to a maximum of 40 nodes or as required to meet performance and standalone requirements, and to meet the requirements for response time, trending and bandwidth utilization as specified elsewhere in the specifications. A terminator shall be installed at both ends of each segment.

b) BACnet: Network used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, or ARCnet in accordance with IEEE 802.4, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements. The primary network shall communicate at a minimum of 38 kbps. Each secondary network may support up to 32 communicating devices without segmentation or repeaters subject to the requirements for response time, trending and bandwidth utilization.

E. **Dynamic Data Access**: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

F. **Remote Data Access**: The system shall support the following methods of remote access to the building data.

1. Dial-in via minimum of a 56k modem. The purpose of the remote access via phone is to allow for the contractor to access the control system. Dial-in connection shall allow access to all control system facilities and graphics with appropriate password. Chicago Public Schools shall provide and pay for the voice grade phone line to support this remote connection.

a) Browser-based access: A remote user, connecting via the CPS WAN and using a standard browser shall be able access all control system facilities and graphics with proper password. The remote access user will not need to load Java or other applications to view the web pages.

G. **Network Performance**: The communication speed between the controllers, control LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the

guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. The performance will also include the trending of all AI, AO and DI points at 15 minute intervals. Generally requirements do not apply when a remote connection must be established via modem:

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at operator workstation.
4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
7. Graphic Display, 10 seconds between an operator selection of a graphic and it completely painting the screen and updating all points.
8. Graphic Refresh, every 15 seconds the graphic shall automatically refresh all graphic data.

H. **Control Systems Server (CSS) and Operator Work Station (OWS):** These are two separate computers that maintain the systems configuration and programming database and is the operating platform for the operator interface (OI). It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall be located within each facility. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Division 15 Section BAS Operator Interfaces for its requirements.

I. The PCU's, shall monitor, control, and provide the field interface for all points specified. Each PCU shall be capable of performing all specified energy management functions, and all DDC functions, independent of other PCU's and operator interface devices as more fully specified in Division 15 Section - BAS Field Panels.

J. **Systems Configuration Database**: The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. User tools provided to Chicago Public Schools shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.

1. Database Schema shall be published and provided to Chicago Public Schools to facilitate easy access to the data.
2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

3. For a LON system: The SCD and associated network services shall be Echelon LonWorks Network Services (LNS) (latest version) compliant, no exceptions allowed. The Network Management Application shall be LonMaker™ for Windows (latest released version) service tool (including hardware, software and any peripheral devices required) and is to be used for commissioning and management of the LonTalk control architecture, no exceptions allowed. The network management service tool shall remain on the project as the property of Chicago Public Schools. A copy of the LonTalk network database shall be archived on the service tool and the operator interface, documenting system bindings and node addressing. In addition all system variables shall have a plain English language description for each variable. This service tool shall be used for all system maintenance and expansion, so that the network database backup remains current

K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

L. All line drivers, repeaters, terminators, signal boosters, signal conditioners etc. shall be provided as necessary for proper data communication.

M. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the OWS and CSS.

1.13 WARRANTY MAINTENANCE

A. Contractor shall warrant all products and labor for a period of one (1) year after Final Acceptance.

B. Chicago Public Schools reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by CPS, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between CPS and the Contractor on such matters shall be subject to resolution through the contract 'Disputes' clause.

C. At no cost to CPS, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in Division 15 BAS sections. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.
2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by CPS to the Contractor.
    a) Response by telephone to any request for service shall be provided within two (2) hours of CPS's initial telephone request for service.

b) In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within eight (8) hours of the CPS's initial telephone request for such services, as specified.

c) Emergency service shall be available on a 24-hour, 7-day-a-week basis.

3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by CPS to the Contractor.

a) Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr per week normal working period) of CPS’s initial telephone request for service.

b) In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within three (3) working days of the initial telephone request for such services, as specified.

4. CPS’s Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for CPS to call in the event of a need for service. At least one of the lines shall be attended at any given time at all times. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.

5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.

6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.15 LISTING AND LABELING

A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

B. BACnet controllers, B-BC, B-AAC, B-ASC etc will carry the BTL Mark for their device profile.

PART 2. PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

2.2 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

PART 3. PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to contractor.

3.2 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Refer to additional requirements in other sections of this specification.

3.3 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this specification.

B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Division 15 : BAS Field Panels. This Contractor shall extend power to the DCS from an acceptable power panel. If the contractor wishes to further distribute panels to other locations, contractor is responsible for extending power to that location also. Furthermore, contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

C. Contractor shall locate DCSs as referenced. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list, trending requirements and sequence of operations.

D. Contractor shall provide a minimum of the following:

1. One DCS (including at least one controller) in each heating water and chilled water plant mechanical room
2. One DCS (including at least one controller) for each air handler located in an applicable mechanical room
3. One controller shall be provided for each terminal unit unless indicated otherwise

3.4 SURGE PROTECTION

A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all PCU's, operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

3.5 CONTROL POWER SOURCE AND SUPPLY

A. Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Division 15 BAS Sections and Sequences of Operation.

1. Control panels will not share a power circuit. Power supplied to the panels will have dedicated circuits and the circuit location will be documented in the panel.

3.6 BAS START UP, COMMISSIONING AND TRAINING

A. Refer to Division 15 BAS Commissioning

3.7 SEQUENCE OF OPERATION

A. Refer to Division 15 - Sequences of Operation

3.8 IDENTIFICATION STANDARDS

A. Controller Identification. All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.

B. Panel Identification. All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.

C. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.

D. Panel Devices. All panel devices shall be identified by a typed label securely fastened to the backplane of the local control panel.

E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.

F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed

3.9 EXHIBITS

A. Exhibits A through E attached

END OF SECTION 15950

SECTION 15951

BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pneumatic Tubing

B. Wiring

C. Control Valves and Actuators

D. Control Dampers and Actuators

E. BAS Field Panels

F. Sensors

G. Flow Meter

H. Pneumatic Control Components (Gauges, switches, relays, etc.)

I. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)

J. Transducers

K. Air Flow Measuring Stations

L. Current Switches

M. Nameplates

N. Testing Equipment

1.2 RELATED DOCUMENTS

A. Division 1

B. Division 15

C. Division 16

1.3 DESCRIPTION OF WORK

A. Refer to Division 15 Building Automation System General for general requirements.

B. Refer to other Division-15 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

C. Provide the following electrical work as work of this section, complying with requirements of Division-16 sections:

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.

4. All other necessary wiring for fully complete and functional control system as specified.
5. Power wiring from spare circuits in electrical panels to BAS Field Panels. WORK BY OTHERS

D. Control Valves furnished under this section shall be installed under the applicable piping section under the direction of Section 15951 Contractor who will be fully responsible for the proper operation of the valve.

E. Control Dampers furnished under this section shall be installed under the applicable air distribution or air handling equipment section under the direction of Section 15951 Contractor who will be fully responsible for the proper operation of the damper

F. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of Section 15951 Contractor who will be fully responsible for the proper installation and application.

G. Controlled Equipment Power Wiring shall be furnished and installed under Division 16. Where control involves 120V control devices controlling 120V equipment, Division 16 Contractor shall extend power wiring to the equipment. Section 15951 Contractor shall extend it from the equipment to the control device.

PART 2. PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Instrument Pipe and Tube

1. Hydronic and Instruments

a) **Connection To Main Piping**: Provide ½ inch minimum size threadolet, ½" x 2 inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.

b) **Remote Instruments**: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.

c) **Line Mounted Instruments**: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve

outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.

d) **Instrument Tubing**: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.

e) **Rigid Piping For Line Mounted Instruments**: Schedule 40 threaded brass, with threaded brass fittings.

2. Low Pressure Air Instrument Sensing Lines

a) **Connections**: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.

b) **Tubing**: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

C. **Communication Wiring**: All wiring shall be in accordance with National Electrical Codes and Division 16 of this specification.

1. Contractor shall supply all communication wiring between Building Controllers (BC), Routers, Gateways, Advanced Application Controllers (AAC), Application Specific Controllers (ASC) and local and remote peripherals (e.g., operator workstations, printers, and modems).
2. **Local Supervisory LAN**: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5 of standard TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
3. **Primary and Secondary Controller LANs**: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

D. **Signal Wiring**: Contractor shall run all signal wiring in accordance with National Electric Codes and Division 16 of this Specification.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. **Low Voltage Analog Output Wiring**: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification.

1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

F. **Control Panels**: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.

1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
2. Provide UL-listed cabinets for use with line voltage devices.
3. All gauges and control components shall be identified by means of nameplates.
4. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
5. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

2.2 CONTROL VALVES

A. **General**: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

B. **Plug-Type Globe Pattern for Water Service**:

1. **Valve Sizing**: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. **Single Seated (Two-way) Valves**: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on ‘top-and-bottom’ guided plugs.
3. **Double Seated (Three-way) Valves**: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on ‘top-and-bottom’ guided plugs.
4. **Temperature Rating**: 25°F minimum, 250°F maximum
5. **Body**: Bronze, screwed, 250 psi maximum working pressure for 1/2” to 2”; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2” and larger.
6. **Valve Trim**: Bronze; Stem: Polished stainless steel.
7. **Packing**: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. **Plug**: Brass, bronze or stainless steel, Seat: Brass
9. **Disc**: Replaceable Composition or Stainless Steel Filled PTFE.
10. **Ambient Operating Temperature Limits**: -10 to 150°F
11. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:

a) Johnson Controls

b) Invensys

c) Warren

d) Delta

e) Belimo

C. **Plug-Type Globe Pattern for Steam Service**:

1. **Valve Sizing**: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. **Characteristics**: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
   a) Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
3. **Body**: Bronze, screwed, 250 psig steam working pressure for 1/2” to 2”; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2” and larger for applications of 50 psig or less.
4. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
5. **Packing**: Spring Loaded Teflon.
6. **Disc**: Replaceable Composition or Stainless Steel Filled PTFE.
7. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
   a) Johnson Controls
   b) Invensys
   c) Warren
   d) Delta
   e) Belimo

D. Butterfly Type: Valve will be sized for 50 to 100% of branch pressure drop. For valves sized at 3way less than 90 degree position for pressure drop are to have the linkage for full closed when the open port is at the design point.

1. **Body**: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. **Seat**: EPDM, except in loop bypass applications where seat shall be metal to metal
3. **Disc**: Bronze or stainless steel, pinned or mechanically locked to shaft
4. **Bearings**: Bronze or stainless steel
5. **Shaft**: 416 stainless steel
6. **Cold Service Pressure**: 175 psi

7. **Close Off**: Bubble-tight shutoff to 150 psi
8. **Operation**: Valve and actuator operation shall be smooth both seating and unseating. Should more that 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Government.
9. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
   a) Jamesbury WS815
   b) Bray Series 31
   c) Belimo

E. Ball Type: Valve will be sized for 50 to 100% of branch pressure drop.

1. **Body**: Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. **Seat**: Reinforced Teflon
3. **Ball**: Stainless steel.
4. **Port**: Standard or 'V' style.
5. **Stem**: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. **Cold Service Pressure**: 600 psi WOG
7. **Steam working Pressure**: 150 psi
8. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
   a) Belimo
   b) Jamesbury
   c) Delta

F. Segmented or Characterized Ball Type

1. **Body**: Carbon Steel (ASTM 216), one-piece design with wafer style ends.
2. **Seat**: Reinforced Teflon (PTFE).
3. **Ball**: Stainless steel ASTM A351
4. **Port**: Segmented design with equal-percentage characteristic.
5. **Stem**: Stainless steel.
6. **Cold Service Pressure**: 200 psi WOG
7. **Cavitation Trim**: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
8. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
   a) Jamesbury R-Series
   b) Fisher
   c) Belimo

2.3 CONTROL DAMPERS

A. **General**: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. Provide parallel blade dampers for dampers providing two-position control (for multi zone dampers a parallel blade application with lower torque requirements should be submitted as an alternate). For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service.

B. For zone dampers and other applications with duct or opening areas less that 5 square feet that do not provide isolation to out doors and function in a general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm , differential pressure not greater than 2.5" w.c. :

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. **Blades**: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts with set screws, 16 gauge minimum thickness.
4. **Blade Seals**: Synthetic elastomer, mechanically attached, field replaceable.
5. **Jamb Seals**: None.
6. **Shaft Bearings**: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
7. **Linkage**: Concealed in frame if parallel.
8. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
9. **Leakage**: Less than one percent based on approach velocity of 1500 ft./min. and 1 inches wg. .
10. **Maximum Pressure Differential**: 2.5 inches wg.
11. **Temperature Limits**: -40 to 200 °F .
12. Where two dampers are to be mechanically interlocked such as a face and bypass arrangement, the manufacturer will provide required torque values for the combined damper assembly.
13. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a) Johnson Controls D-1100
    b) Ruskin CD36
    c) Vent Products 5800

C. For applications with duct or opening areas greater than 5 square feet that do not provide isolation to out doors and function in a general isolation and modulating control

service in rectangular ducts at velocities exceeding 1500 fpm , differential pressure greater than 2.5" w.c. :

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. **Blades**: Galvanized steel or extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts, 14 gauge minimum extrusion thickness.
4. **Blade Seals**: Synthetic elastomeric, mechanically attached, field replaceable.
5. **Jamb Seals**: Stainless steel.
6. **Shaft Bearings**: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
7. **Linkage**: Concealed in frame if parallel.
8. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
9. **Leakage**: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1 inches wg. .
10. **Maximum Pressure Differential**: 6 inches wg.
11. **Temperature Limits**: -40 to 200 °F .
12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple dampers driven by a jackshaft the shaft will rigid in torsion and driven by at least two actuators located at either end of the shaft.
13. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a) TAMCO 1000
    b) Ruskin CD60
    c) CESCO Products AGA or AGB

D. For all outside air intake or exhaust control dampers that provide isolation to out doors or otherwise need to provide thermal isolation:

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. **Blades**: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts, 14 gauge minimum extrusion thickness.
4. **Blade Seals**: Synthetic elastomeric, mechanically attached, field replaceable.
5. **Jamb Seals**: Non-metallic seal.
6. **Shaft Bearings**: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.

7. **Linkage**: Concealed in frame if parallel.
8. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
9. **Leakage**: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1 inches wg. .
10. **Maximum Pressure Differential**: 6 inches wg.
11. **Temperature Limits**: -40 to 200 °F .
12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple dampers driven by a jackshaft the shaft will rigid in torsion and driven by at least two actuators located at either end of the shaft.
13. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a) TAMCO 9000
    b) Ruskin CDTI50

E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm , differential pressure not greater than 4" w.c. :

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.
3. **Blades**: Steel construction, 12 gauge minimum thickness for dampers less than 18 inches in size, 10 gauge minimum thickness for larger dampers.
4. **Blade Seals**: Full circumference neoprene.
5. **Shaft**: ½ inch diameter zinc or cadmium plated steel.
6. **Shaft Bearings**: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
7. **Leakage**: Less than 0.2 percent based on approach velocity of 4000 ft./min. and 1 inches wg. differential pressure.
8. **Maximum Pressure Differential**: 4 inches wg.
9. **Temperature Limits**: -40 to 300 °F .

F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1492 Pa):

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch thick steel channel for larger sizes, galvanized or aluminum finish.
3. **Blades**: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch minimum thickness for larger dampers.
4. **Blade stops**: ½ inch x ¼ inch full circumference steel bar.
5. **Blade Seals**: Full circumference neoprene.
6. **Shaft**: zinc or cadmium plated steel, angle reinforcing as necessary.

7. **Shaft Bearings**: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
8. **Leakage**: Less than 0.4 percent based on approach velocity of 4000 ft./min. and 1 inches wg. differential pressure.
9. **Maximum Pressure Differential**: 6 inches wg.
10. **Temperature Limits**: -40 to 250 °F .

2.4 ACTUATORS

A. **General**: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Damper Actuators

1. Ambient Operating Temperature Limits: -10 to 122°F
2. **Two Position Electric Actuators**: Line voltage with spring return
3. **Electronic Actuators**: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds, unless prior approval is obtained. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override . Modulating actuators for valves shall have minimum rangeability of 40 to 1.
   a) **Close-Off Pressure**: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent. When shutoff does not apply the actuator will be sized based on the manufactures required torque plus 30%.
   b) **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
      1) Belimo
      2) Delta
      3) Invensys

C. Quarter-Turn Actuators (for ball and butterfly valves):

1. Electric

a) **Motor**: Suitable for 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.

b) **Gear Train**. Motor output shall be directed to a self locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.

c) **Wiring**: Power and control wiring shall be wired to a terminal strip in the actuator enclosure

d) **Failsafe Positioning**: Actuators shall be spring return type for failsafe positioning.

e) **Enclosure**: Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.

f) **Limit Switches**: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.

g) **Mechanical Travel Stops**: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.

h) **Manual Override**: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.

i) **Valve Position Indicator**: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.

j) **Torque Limit Switches**: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.

k) **Position Controller**: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.

l) **Ambient Conditions**: Actuator shall be designed for operation from –10 to 150 °F ambient temperature with 0 to 100 percent relative humidity.

2.5 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall

furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. **Accuracy**: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

2.6 TEMPERATURE SENSORS (TS)

A. **Sensor range**: When matched with A/D converter of BC, AAC/ASC, or Smart Sensor (SS), sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. **Matched Sensors**: The following applications shall require matched sensors:

1. **Building Loop Connections**: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).
2. **Hydronic Temperature Difference Calculations**: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.
3. **Air Handling Unit Sequencing:** Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

C. **Room Temperature Sensor:** Shall be an a stainless steel wall plate sensor. An electronic thermostat with manual override will be provided in the principal and main office areas and in select administrative areas as approved by CPS. Provide ¼" medical grade closed cell foam insulating material. The following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point.

D. **Single-Point Duct Temperature Sensor:** Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point

E. **Averaging Duct Temperature Sensor**: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3°F accuracy at calibration point.

F. **Liquid immersion temperature sensor** shall include thermowell, sensor and connection head for wiring connections. Provide thermally conductive paste in well to ensure good contact with the well. Temperature range shall be as required for resolution of 0.15°F.

1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.

G. **Pipe Surface-Mount Temperature Sensor**: Sensor are only for use in applications specifically identified on the drawings. Normally only used on condensate return piping for steam systems. Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as required for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

H. **Outside air sensors** shall consist of a sensor, an aspirated enclosure, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as required for resolution indicated in Paragraph A

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

2. **Acceptable Manufacturers**: Kele A21 or equal

2.7 TEMPERATURE TRANSMITTERS

A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

2.8 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy(% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
3. Sensor Operating Range: As required by application
4. Long Term Stability: Less than 1% drift per year.

B. **Acceptable Manufacturers**: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series, Kele H_20K.

2.9 PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. **General Purpose - Water**: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.

1. Acceptable units shall be Kele & Associates Model 360 C

B. **Liquid, Steam and Gas**:

1. **General**: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
2. **Environmental limits**: –40 to 250 °F , 0 to 100% RH..
3. **Accuracy**: less than 0.1 percent of span.
4. **Output Damping**: Time constant user selectable from 0 to 36 seconds.
5. **Vibration Effect**: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
6. **Electrical Enclosure**: NEMA-4, -4X, -7, -9.
7. **Approvals**: FM, CSA.
8. **Acceptable Manufacturers**: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac.

C. **General Purpose Low Pressure Air**: Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered two-wire differential capacitance cell-type transmitter.
2. **Output**: two wire 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 1% of reading.
4. **Minimum Range**: 0.1 in. w.c.
5. **Maximum Range**: 10 inches w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Modus T30.
8. **Static Sensing Element**: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. **Range**: Select for specified setpoint to be between 25% and 75% full-scale.

D. **General Purpose Low Pressure/Low Differential Air**: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered, two-wire differential capacitance cell type transmitter.
2. **Output**: Two-wire 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 1% of reading.
4. **Minimum Range**: 0 in. w.c.
5. **Maximum Range**: 0.1, 0.25, or 0.5 inches w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Modus T30 or Setra.

8. **Static Sensing Element**: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. **Range**: Select for specified setpoint to be between 25% and 75% full-scale.

E. **Velocity Pressure**: Generally for use in air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered two-wire differential capacitance cell type transmitter.
2. **Output**: Two-wire, 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 0.25%
4. **Minimum Range**: 0 in. w.c.
5. **Maximum Range**: 1 inch w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Setra 264 with optional FS accuracy above or equal. .
8. **Range**: Select for minimum range that will accept the maximum velocity pressure expected.

2.10 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, and a bypass valve contained in a NEMA-1 enclosure.

2.11 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. **General Service - Air**: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing

B. **General Service - Water**: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

2.12 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. **Acceptable Manufacturers**: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.13 TRANSDUCERS

A. **Standard Capacity Electronic-to-Pneumatic (E-P) Transducers**: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type,:

1. **Electrical Power Supply**: 24 Vac or 24 Vdc.
2. **Pneumatic Air Supply**: 30 psig (2.07 bar) maximum.
3. **Air Capacity**: 1100 scim @ 20 psig (300 cm^3/sec @ 1.4 bar).

4. **Air Consumption**: Zero at steady state.
5. **Output Span**: 0-20 psig (0-1.4 bar).
6. **Input**: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input.
7. **Enclosure**: Polymer designed for surface or panel mount.
8. **Air Connections**: ¼" (6.35 mm) barbed.
9. **Failure Mode on Power Loss**: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
10. **Acceptable Manufacturers**: RE Technologies Model UCP-522.

B. **Binary to Analog Transducers or Tri-State-to-Voltage or -Current**:

1. Adjustable zero and span.
2. **Failure Mode on Power Loss**: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
3. **Accuracy**: ± 1% of span
4. **Output Span**: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
5. **Input**: 4-20 mA, pulse width modulated or tri-state input.
6. **Tri-state Input Time Base:** Dip switch selectable.
7. **Enclosure**: Polymer designed for surface or panel mount.
8. **Failure Mode on Power Loss**: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
9. **Acceptable Manufacturers**: RE Technologies Model PWA Series.

C. Electronic-to Electronic (Voltage or Current to Current or Voltage):

1. Adjustable zero and span.
2. **Failure Mode on Power Loss**: Memory feature to allow the transducer to return to last value on power failure.
3. **Accuracy**: ± 1% of span.
4. **Output Span**: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
5. **Input**: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
6. **Enclosure**: Polymer enclosure designed for surface or panel mount.
7. **Acceptable Manufacturers**: RE Technologies Model PWA Series.

2.14 CURRENT SWITCHES (CS)

A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)

1. **Range**: 1.5 to 150 amps.
2. **Trip Point**: Adjustable.
3. **Switch**: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. **Lower Frequency Limit**: 6 Hz.
5. **Trip Indication**: LED
6. **Approvals**: UL, CSA

7. **Max. Cable Size**: 350 MCM
8. **Acceptable Manufacturer**s: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED.

B. **Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors)**: Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150.

1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication

1. **Range**: 1.5 to 135 Amps.
2. **Trip Point**: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. **Switch**: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. **Frequency Range**: 5-75 Hz
5. **Trip Indication**: LED
6. **Approvals**: UL, CSA
7. **Max. Cable Size**: 350 MCM
8. Acceptable Manufacturers: Veris Industries, Inc. H-904.

D. **Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors)**: Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934.

E. **Variable Speed Status**: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.15 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. **Range**: 1-10 amps minimum, 20-200 amps maximum
2. **Trip Point**: Adjustable
3. **Output**: 0-5 VDC.
4. **Accuracy**: ±0.2% from 20 to 100 Hz.
5. **Acceptable Manufacturers**: KELE SA100, Veris Hawkeye 720.

2.16 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. **Pressure sensor**: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306.

B. **Low Air Pressure Surge Dampener**: 30-second time constant. Acceptable manufacturer shall be Modus SD030.

2.17 CONTINUOUS LEVEL TRANSMITTERS

A. Capacitance Type

1. Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. **Output**: 4-20 mA.
3. **Probe**: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. **Electrical Enclosure**: NEMA-4, -7.
5. **Approvals**: UL or CSA.
6. **Accuracy**: ±1% of calibrated span.
7. **Process Connection**: MPT or ANSI Flange as required.
8. **Acceptable Manufacturers**: Drexelbrook, Endress & Hauser.

B. Hydrostatic Pressure

1. Two wire smart d/p cell type transmitter
2. 4-20 mA or 1 to 5 volt user selectable linear or square root output
3. Adjustable span and zero
4. Stainless steel wetted parts
5. Environmental limits: –40 to 250 °F (-40 to 121°C), 0 to 100% RH
6. Accuracy: less than 0.1 percent of span
7. Output Damping: time constant user selectable from 0 to 36 seconds
8. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7, 9
10. Approvals: FM, CSA
11. **Acceptable Manufacturers**: Rosemount Inc. 3051 Series, Foxboro, and Johnson-Yokagawa.

2.18 INSERTION TYPE TURBINE METER FOR WATER SERVICE

2.19 VORTEX SHEDDING FLOW METER FOR STEAM AND GAS SERVICE:

A. **Output**: Pulse output, field selectable pulse per units selected

B. **Maximum Fluid Temperature**: 800 °F

C. **Wetted Parts**: Stainless Steel

D. **Housing**: NEMA 4X

E. **Turndown**: 10:1 minimum.

F. **Accuracy**: 0.5% of calibrated span for liquids, 1% of calibrated span for steam and gases.

G. **Body**: Wafer style or ANSI flanged to match piping specification.

H. **Acceptable Manufacturers**: Foxboro 83 series, Johnson-Yokagawa, and Rosemount.

2.20 VENTURI FLOW METER FOR WATER SERVICE

A. **Flow Sensing Element**: Differential-pressure Venturi-type designed for installation in piping.

B. **Construction**: Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2" and smaller and flanged or welded for larger than 2".

C. Accuracy: Differential transmitter shall be dual range industrial grade as specified above.

1. Under the reference conditions of a 68 °F media temperature, a 68 °F ambient temperature, a +/- 1% nominal power supply voltage, 10 diameters up stream and 5 down of straight piping and a fully developed flow profile; the meter must meet the following requirements:
2. +/- 0.8% of reading accuracy in the flow range of 1.65 - 33 ft/sec +/- (0.66/Velocity actual ft/s +0.4)% of reading accuracy in the flow range of 0-1.65 ft/sec.
3. Meter repeatability shall be +/- 0.1% of rate at velocities > 1.65 ft/sec.

D. Connect differential pressure to venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.

E. Apply Venturi-type flow meters where minimum flow range is no less than 40% of maximum flow.

2.21 AIRFLOW MEASURING STATIONS (AFMS)

A. General Requirements

1. **Sensor Accuracy**: ±1.5%
2. **Electronics Accuracy**: ±0.5%
3. **Range**: Select minimum range to accommodate the expected flow range of the project
4. **Temperature Limits**: 20-140°F
5. **Velocity Range**: 750 to 9000 fpm
6. **Operating Range**: Select minimum range to accommodate the expected flow range of the project

B. **Pitot Tube Grids**: Provide an array of velocity pressure sensing elements with averaging manifolds and air straightening vanes packaged in a sheet metal casing. Distribute sensing elements in accordance with ASHRAE for traversing ducts. Provide

taps to connect tubing from instrumentation. Label AFM with drawing number designation, design flow, velocity pressure, and pressure drop. Application of pitot grids shall be allowed only where minimum expected flow is greater than 30% of maximum flow and greater than manufacturer's minimum flow to achieve accuracy.

1. **Acceptable Manufacturer**:
   a) Tek-Air TFP-5000
   b) Kele KMS-DS flow station

C. **Hot Wire Grid**: Provide an array of hot wire anemometer with air straightening package in a sheet metal casing. Provide averaging circuitry and transmitter to transmit a linear signal proportional to airflow.

1. **Acceptable Manufacturer**:
   a) Ebtron
   b) Dybek
   c) Kurtz

D. **Vortex Shedding Grid**: Provide an array of vortex shedding elements designed to produce stable 'Karmen Vortices' that are linear with air velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma.

1. **Acceptable Manufacturer**: Tek-Air Systems Inc. 'Vortek' Model.

E. **Fan Inlet**: Provide multi-sensor probes which are installed in the inlet of the fan. Individual sensors on the probe provide direct proportional and linear signals to airflow velocity.

1. **Acceptable Manufacturer**: Tek-Air Systems Inc. 'Vortek' Model 7000, 8000, or Approved Equal.

2.22 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

A. **Single or Multi-Point Averaging** (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

2.23 CO_2 SENSORS/TRANSMITTERS (CARBON DIOXIDE)

A. CO_2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.

B. **Range**: 0-2000 ppm

C. **Accuracy**: ±36ppm at 800 ppm and 68°F.

D. **Stability**: 5% over 5 years.

E. **Output**: 4-20 mA, 0-10 Vdc or relay.

F. **Mounting**: Duct as indicated

G. **Acceptable Manufacturer**: Vaisala, Inc. GMD20 (duct) or GMW20 (wall), MSA, Inc, Kele 8000 series.

2.24 CO SENSORS/TRANSMITTERS (CARBON MONOXIDE)

A. CO sensors shall use electrochemical sensor.

B. **Accuracy**: 3% at 0-250 ppm

C. **Display & Horn**: Progressive or digital display and audible alarm, 65dBA @ 3'.

D. **Output**: 4-20 mA, 0-10 Vdc .

E. **Mounting**: Wall mounted between 3' and 5' above the floor in the boiler room.

F. **Acceptable Manufacturer**: Kele GMT-CO-S1A, MSA, Inc.

2.25 PNEUMATIC CONTROL COMPONENTS

A. **Analog Pressure Gauges**: Gauges shall be pneumatic type, minimum 1-1/2" in (38 mm) diameter, with white face and black numerals. Surface-mounted gauges shall have chrome plated trim and be a minimum of 2-1/2" in (64 mm) diameter.

B. **Pneumatic Actuated Pressure Switches (PE)** (for 30 psig max pressure control systems): Pressure ranges and sensitivity of PEs shall match control system sequence of operation. Switch operation shall be externally adjustable over the operating pressure range (nominal 0-20 psig, 0 to 138 KPa). PE switches shall be SPDT type, rated for the particular application, and shall be UL listed. PE shall be as manufactured by Penn. Substitutions shall be allowed as per Division 1

C. **Pilot Positioners**: Operating span adjustment range is from 3 to 13 psi (21 to 91 kPa). Positioner shall be furnished with a mounting bracket for attachment directly to the actuator.

2.26 ELECTRIC CONTROL COMPONENTS

A. **Limit Switches (LS):** Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. **Electric Solenoid-Operated Pneumatic Valves (EP)**: EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure.. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. **Coil Enclosure**: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
2. **Fluid Temperature Rating**: Valves for compressed air and cold water service shall have 150 °F (66 °C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
3. **Acceptable Manufacturers**: EP valves shall be as manufactured by ASCO or Parker.
4. **Coil Rating**: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. **Low Temperature Detector ('Freezestat') (FZ)**: Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20', junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F , factory set at 38°F.

D. **High Temperature Detectors ('Firestat') (FS)**: High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F.

E. **Surface-Mounted Thermostat**: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150°F , and a minimum 10°F fixed setpoint differential.

F. **Low Voltage Wall Thermostat**: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F , switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

G. **Control Relays**: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
   a) AC coil pull-in voltage range of +10%, -15% or nominal voltage.
   b) Coil sealed volt-amperes (VA) not greater than four (4) VA.
   c) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
   d) Pilot light indication of power-to-coil and coil retainer clips.
   e) Coil rated for 50 and 60 Hz service.
   f) **Acceptable Manufacturers**: Relays shall be Potter Brumfield, Model KRPA.
2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

H. **General Purpose Power Contactors:** NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.

I. **Control Transformers**: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.

1. Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson.

J. **Time Delay Relays (TDR)**: TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
2. TDRs shall be UL and CSA listed, Crouzet type.

K. **Electric Push Button Switch**: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley.

L. **Pilot Light**: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley.

M. **Alarm Horn**: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory.

N. **Electric Selector Switch (SS)**: Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley.

2.27 DUCT SMOKE DETECTOR

A. Photoelectric detector with sampling tube that spans the entire width of duct. .

B. **Velocity Rating** : 100 to 4000 fpm or 500 to 4000fpm depending on the minimum velocity in the duct. Provide the 100 to 4000 fpm detector if the min duct velocity is below 550 fpm.

C. **Output Contact**: . Alarm, two sets form “C” rated at 10amps 115V resistive. One set of alarm contacts for BAS monitoring and fan shutdown. Trouble, one set of contacts.

D. **Temperature & RH limits:** 32 to 120°F and 10 to 85% relative humidity..

E. **Acceptable Manufacturer**:

1. Invensys FIREX model 2650
2. Sensor Systems DH100ACDCLP
3. Air Products and Controls SL-2000

2.28 ELECTRICAL SUBMETERING

A. The submetering device will monitor current and voltage on all three phases and provide a pulse output..

B. Accuracy: ±1% from 7% to 100% of rated current (temperature range 0-60C)

C. Transducer : Conform to ANSI C12.1 metering accuracy standards.

D. Output: Pulse with field selectable pulse per kWh.

E. Mounting: In panel or as indicated on the drawing

F. Acceptable Manufacturer: Veris. H8053 for 3 phase loads and Veris H8051 for 1 phase loads**.**

2.29 REFRIGERANT MONITOR

A. **General**: Contractor shall provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect refrigerants used in chiller or other refrigeration equipment. The alarm system shall comply with ANSI/ASHRAE 15-1994 and local code requirements.

B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through 100 PPM. Readings above 100 PPM must be accurate to within ±5% of reading. Accuracy shall be maintained within ambient environmental ranges of 0ºC. through 50ºC., (32ºF. through 122ºF.) and 5% through 90% relative humidity, non-condensing.

C. The refrigerant monitor shall automatically and continuously monitor the areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufactures instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacture. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.

D. The analyzer will be based on infrared detection technology, and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. . The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.

E. The monitor shall be equipped with 4 outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a liner scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.

F. The monitor shall have a NEMA-4 moisture resistant enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.

G. The following alarm modes will be provided by the refrigerant monitor:

1. An audible alarm shall be placed directly outside the machinery room.

2. A visual alarm, a flashing yellow light, shall be placed directly over the above the door or doors to the machinery room.
3. A sign, with 2" high letters, shall shall be provided at each door that states

DANGER
DO NOT ENTER WHEN LIGHT IS FLASHING
PELIGRO
NO ENTRAR CUANDO LA LUZ ESTE

4. ALARM LEVEL ONE – Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adj.) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BAS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.
5. ALARM LEVEL TWO – This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25% below the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992. This alarm will be displayed on the monitor interface, and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BAS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared
6. ALARM LEVEL THREE – This alarm shall be set at the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992 whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event and will de-energize the energy source for any hot surface (850°F or 454°C) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BAS through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

H. All alarm conditions shall be report to the BAS system as follows:

1. ALARM LEVEL ONE - The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BAS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.
2. ALARM LEVEL TWO - The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BAS system

indicating a high level alarm on the BAS operator terminal(s). This BAS alarm shall state that high levels of refrigerant have been detected in the designated area.

3. FAULT ALARM – Reports a high level alarm to the BAS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.

2.30 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.31 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 3. EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.2 INSTALLATION OF CONTROL SYSTEMS

A. **General**: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. **Main Control Air Piping**: All main air piping between the compressors and the control panels shall be copper, run per ASTM B88

C. **Branch Control Air Piping**: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels; across roofs, in pipe chases, etc. Inaccessible tubing is defined as that tubing run in concrete slabs; furred walls; or ceilings with no access.

1. Provide copper tubing with maximum unsupported length of 3'-0", for accessible tubing run exposed to view. Polyethylene tubing may be used in lieu of above, when run within adequately supported, rigid enclosure, such as metallic raceways,

or EMT. Terminal single-line connections less than 18 in length may be copper tubing, or polyethylene tubing run inside flexible steel protection. Accessible tubing run in concealed locations, such as pipe chases, suspended ceilings with easy access, etc. may be copper or polyethylene bundled and sheathed tubing.

2. Provide copper or polyethylene tubing for inaccessible tubing, other than in concrete pour. If polyethylene tubing is used, install in EMT or vinyl-jacketed polyethylene tubing.
3. Polyethylene piping may be used above suspended ceiling without conduit provided it is run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tubing shall not be laid on the ceiling or duct.
4. Pressure test control air piping at 30 psi (207 kPa) for 24 hours. Test fails if more than 2 psi loss occurs.
5. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
6. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

D. **Control Wiring**: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. **Wiring System**: Install complete wiring system for electric control systems. Install all control wiring external to panels in electric metallic tubing or raceway. On Renovation projects, wiring in finished areas shall be routed in wire mold. The routing of wiring in finished areas must be specifically approved by the AOR/EOR. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. **Control Wiring Conductors**: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 16 of this Specification.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals. All WAN and LAN cabling shall comply with applicable Division 16 requirements.
5. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

E. **Control Valves**: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

F. **Freezestats**: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. The length of element not just down stream of the coil will not be included in the coverage calculation. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips such that sensor is not in direct contact with equipment. Coordinate the location of the switch such that it is normally accessible.

G. **Room Temperature Sensors**: Install sensors as shown on the drawings. Provide approved security screws for mounting, matching those installed in other areas of the project. Provide 3 tools to the Owner for installation and removal of the security screws. Seal conduit penetrations at the wall box airtight. Install batt insulation in the wall box to completely fill the box. Electrical connections shall be made using a twist-on sealant filled connectors suitable for the installation.

H. **Averaging Temperature Sensors**: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally the sensor will be located where flow is sufficiently homogeneous/adequately mixed , consult AE for requirements.

I. **Airflow Measuring Stations**: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

J. **Fluid Flow Sensors**: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

K. **Relative Humidity Sensors**: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

L. **Differential Pressure Transmitters**: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

M. **Flow Switches**: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

N. **Current Switches for Motor Status Monitoring**: Adjust so that setpoint is below minimum operating current and above motor no load current.

O. **Supply Duct Pressure Transmitters**:

1. **General**: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
2. **VAV System 'Down-Duct' Transmitters**: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

P. **Cutting and Patching Insulation**: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

3.3 REFRIGERANT MONITOR

A. Install in accordance with the manufacturer's instructions. Place sensing tips in locations to maximize effectiveness.

B. Hard wire interlocks to the emergency ventilation and shutdown of combustion devices.

END OF SECTION 15951

SECTION 15952 - BAS OPERATOR INTERFACES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Site Control System Server (CSS)/ Operator Workstation (OWS)

B. Portable Operator Terminal (POT)

C. Printers

1.2 RELATED DOCUMENTS

A. Division 1

B. Division 15

C. Division 16

1.3 DESCRIPTION OF WORK

A. Furnish and install all Operator Interfaces and Control System Servers as required for the BAS functions specified. All computers shall be warranted by the manufacturer for a period of one year after final acceptance. The CPS strategic supplier of Microsoft based computers is Dell so all OWS and POT computers will be Dell. CSS computers will also be Dell unless the BAS system manufacturer manufactures the computer.

B. All computers shall meet the requirements of Chicago Public School's Office of Technology Services as published in the "Minimum Hardware, Software, and Network Standards". The most current document can be found at the following website, www.cps.k12.il.us/Network_Standards.pdf.

C. Refer to Division 15 Section "Building Automation System (BAS) General", for general requirements.

PART 2 - PRODUCTS

1.4 SITE WEB SERVER, CONTROL SYSTEM SERVER (CSS)/

A. The CSS web server shall support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).

B. The server will have two, (2), LAN network cards compatible with the CPS WAN and BAS LAN systems or as shown on the BAS control riser diagram. The server computer will not function as the workstation. The web server will provide the link between the CPS WAN and BAS LAN.

C. All information exchanged over Internet shall be optionally encrypted and secure via SSL.

D. E-mail – The system will be able to generate e-mails automatically for alarming using a "MS – Outlook" or similar platform that meets the requirements of Chicago Public School's Office of Technology Services as published in the "Minimum Hardware,

Software, and Network Standards". The most current document can be found at the following website, www.cps.k12.il.us/Network_Standards.pdf.

E. The web server licensing options will allow concurrent access by an unlimited number of browser connections.

F. Provide software registration cards to CPS for all included software.

G. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable. For example, a webserver that requires a Java script to load would not be acceptable nor would the use of an alternate to a webserver such as Microsoft Terminal Services.

H. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMS, shall not be acceptable.

I. The Web server shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

J. Provide all software, cables, peripherals etc. for a complete system.

K. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.

L. For CSSs that provide web services for presentation of data across the Internet, all Web components and services shall be installed with required licensing. CSS shall be configured to secure it to the extent practical inside the Local Supervisory LAN. CSS shall always function from behind a firewall provided either by the CPS network administrators in the case where they provide the LAN infrastructure, or by this contractor where the LAN is provided under this Division of the specifications.

M. Provide network card approved by BAS manufacturer to support Supervisory LAN communications (100 Mbps Ethernet TCP/IP)

N. Control System Server shall be placed as indicated on the drawings or as directed by CPS.

O. The CSS will meet or exceed the requirements for the OWS hardware.

1.5 OPERATOR WORKSTATION (OWS)

A. The computer hardware will meet Chicago Public School's Office of Technology Services requirements for as published in the "Minimum Hardware, Software, and Network Standards". The most current document can be found at the following website, www.cps.k12.il.us/Network_Standards.pdf. The computer will be a Dell computer "CPS Ready" with the current CPS image.

B. Provide software registration cards to CPS for all included software.

C. Provide (as a minimum) a personal computer (PC) with Intel Pentium 4 processor operating at 3.0GHz minimum speed. Include 2 GB RAM and minimum of two (2) 160GB, 7,200 RPM hard disk drives. These drives will operate as a set of mirrored RAID 1 hard drives with the associated software and/or hardware provided. These drives and the associated controllers supplied and warranted by Dell. Provide a 128 MB graphics card, four USB ports, 10/100 Base-T network card, 48x/24x/48x\16x CD-RW/DVD ROM Combo Drive.

D. Provide 17 in flat panel Monitor.

E. Provide detachable keyboard with standard typewriter layout, function keys, and separate numeric keypad. Provide an optical mouse and mouse pad with the system. Provide one open serial port after configuration of the workstation to meet the requirements of the rest of these specifications.

F. Workstation PC shall have the capability of changing serial port interrupt vectors and IOBASE addresses through software.

G. Provide an uninterruptible power supply system providing battery backup for the operator workstation and peripheral devices, excluding the printer.. UPS shall protect against blackouts, brownouts, surges and noise. UPS shall include LAN port and modem line surge protection. UPS shall be sized for a 4-minute full load runtime, 12-minute ½ load runtime, with a typical runtime of up to 30 minutes. Transfer time shall be 2-4 milliseconds. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90% recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts. UPS shall be provided with phone and datasurge suppression and LAN port connections. Provide all software, cables, peripherals etc. for a complete system including software to automatically shutdown the computer .

H. Operating system for operator workstation shall be Microsoft Windows 2000 Professional or Office XP. Provide Microsoft Office 2000 Professional or Office XP Professional Software. All software shall be at least the latest version available as of the date of contract completion.

I. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.

J. Provide network card approved by BAS manufacturer to support Supervisory LAN communications (100 Mbps Ethernet TCP/IP)

K. Provide additional hardware, video drivers, etc., to facilitate all control functions and software requirements specified for the BAS.

L. OWS shall be placed as indicated on the drawings or as directed by CPS.

1.6 PORTABLE OPERATORS TERMINAL (POT) / REMOTE WORKSTATION

A. Portable Operators Terminal shall support system management by connection to the controllers, by connection via the Internet, and by dial-up communications while serving as the remote workstation. The computer will be a Dell computer “CPS Ready” with the current CPS image.

B. Provide (as a minimum) one notebook personal computer (PC) with Intel 4 processor, 2.66GHz, 14.1 XGA display, Include 1GB RAM and one 60GB/7200 RPM hard disk

drive. Provide 32 MB graphics card, , Two USB ports, 10/100 Base-T network card and 24X/24X/24X/8X CD-RW/DVD ROM Combo Drive.

C. Provide a 10/100 LAN+56K CardBus Type III PC Card

D. Provide minimum 14.1" XGA active matrix display.

E. Provide carrying case and extra battery.

F. Operating system for operator workstation shall be Microsoft Windows 2000 Professional. Provide Microsoft Office 2000 Professional or Office XP Professional Software.

G. Provide software, graphics and programming as specified in Division 15 Section "BAS Software and Programming".

H. Provide additional hardware, video drivers, serial ports, etc., to facilitate all control functions and software requirements specified for the building automation system.

I. Provide all controller configuration and interface software and/or plug ins for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs etc.

1.7 PRINTERS

Provide the following Printer:

A. 1200x1200 dpi, min 15pages per minute color, 21 pages per minute black. 8-1/2" x 11" paper tray. HP Deskjet 5650 or equal

PART 2 - EXECUTION

2.1 INSTALLATION

A. Set up the workstations and printers as indicated. Install all software and verify that the systems are fully operational. Ensure licensing is provided for all software.

B. No license, software component, key, etc or any piece of information required to install, configure, operate, diagnose and maintain the system shall be withheld from CPS.

C. Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, control shop drawings etc on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.

D. Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is fully operational.

E. Install systems and materials in accordance with manufacturer's instructions.

END OF SECTION 15952

SECTION 15953

BAS FIELD PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Building Controllers (BC)

B. Application Specific Controllers (ASC)

C. Advanced Application Controllers (AAC)

1.2 RELATED DOCUMENTS

A. Division 1

B. Division 15

C. Division 16

1.3 DESCRIPTION OF WORK:

A. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

B. Refer to Division 15 Section “Building Automation (BAS) General” for general requirements.

PART 2 - PRODUCTS

2.1 STAND-ALONE FUNCTIONALITY

A. **General**: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in Part 3. This item refers to acceptable paradigms for associating the points with the processor.

B. **Functional Boundary**: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller’s standalone functionality:

1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
4. I/O point expansion devices connected to the main controller board via wiring and as such shall be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices. All wiring to interconnect the I/O expander board shall be:
   a) Contained in the control panel enclosure;
   b) Or run in conduit. Wiring shall only be accessible at the terminations.
5. General purpose LonMark I/O devices or Smart Devices racked with a processor module in the same contiguous physical enclosure. The controller shall also include its own dedicated processor module and bridge or router making the controllers LAN communication a subnet or LAN segment dedicated to that controller as specified under Application Categories below. The following are additional requirements of this configuration:
   a) Configuration must meet the requirements for battery back up.
   b) If processor fails, the I/O devices shall go to their fail condition.
   c) Contractor shall provide a network bandwidth analysis of the controller segment or subnet. The analysis shall document network bandwidth utilization does not exceed 30% for a continuous one hour period.
   d) Logic must provide for orderly sequencing of I/O during a power interruption and restart of program logic upon restoration of power.
   e) Programming must facilitate a robust uploading scheme using LONMark File Transfer Protocol and limit available bandwidth during upload.
   f) Trending shallshall be buffered in the processor or dedicated data logging module and uploaded to the Tridium JACE, or buffered in the Tridium JACE.

2.2 BUILDING CONTROLLER (BC)

A. **General Requirements**:

1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.
2. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN. Each unit

shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure. BCs shall be programmable from an operator workstation, portable operator's terminal, or hand held operating device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.

3. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN.
4. All BCs shall be protected from any memory loss due to a loss of power by one or a combination of the following:
   a) Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five years. Self-diagnostic routine shall report an alarm for a low battery condition.
   b) EEPROM, EPROM, or NOVROM non-volatile memory
5. In addition BCs shall provide intelligent, standalone control of HVAC functions. Each BC shall be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.
6. The BC shall provide for point mix flexibility and expandability. This requirement shall be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.
7. All BC point data, algorithms and application software shall be modifiable from the Operator Workstation.
8. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the OWS and/or CSS.
9. BC shall provide buffer for holding alarms, messages, trends etc.
10. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
11. Each BC shall contain software to perform full DDC/PID control loops.
12. For systems requiring end-of-line resistors those resistors shall be located in the BC, if it has I/O capability.
13. Input-Output Processing
    a) Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
    b) Analog Inputs (AI): AI shall be O-5 Vdc, 0-10 Vdc, 0-20 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input.

Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.

c) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors shall only be done in non-critical applications and only with prior approval of Architect/Engineer.

d) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

e) Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Chicago Public Schools (CPS) approval (PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. PWM controlled devices will have an automatically initiated function that resets the device position tracking on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to recalibrate the position tracking to assure the device will open and close completely when commanded. Each AO shall be discrete outputs from the PCU's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 10 bits.

f) Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

g) Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.

14. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.
15. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.
16. Slope intercepts and gain adjustments shall be available on a per-point basis.
17. BC Power Loss:

a) Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.

b) Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours.

c) Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.

d) Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the owner shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

18. BC Failure:

a) Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.

b) BC Hardware Failure: BC shall cease operation and terminate communication with other devices.

19. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).

20. BCs shall include LAN communications interface functions for controlling secondary controlling LANs Refer to Section 15954 - BAS System Communications Devices for requirements if this function is packaged with the BC.

21. A minimum of four levels of password protection shall be provided at each BC.

22. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure.

B. **BACnet Building Controller Requirements**:

1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.
2. BCs shall communicate over the BACnet Building Controller LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

C. **LonTalk Building Controller Requirements**:

1. All products shall be LonMark certified, and shall be designed according to the LonMark Interoperability Guidelines. Product documentation and devices shall display the LonMark symbol, indicating conformance to the LonMark Interoperability Standards.
    a) In those instances in which LonMark devices are not available, the Network Integrator shall provide LonWorks devices with application source code, device resource files, and external interface definitions. The software tools required to install and commission the device shall be provided for non-LonMark devices.
2. All products shall support and be certified to an appropriate LonMark functional profile. Where published profiles do not exist, use draft profile standards or submit a proposed draft as part of the submittal package. All drafts shall also be submitted simultaneously to the LonMark Interoperability Association for certification.
3. An external interface file (*.XIF) shall be provided for each LonTalk device describing network variables, configuration parameters and other parameters supported.
4. All products shall utilize standard configuration parameter types for all product configuration parameters. Do not use network variables for this purpose.
5. The use of manufacturer-defined network variables and configuration parameters shall be limited to factory-configured parameters. All data and configuration parameters that shall be required for field installation, service and maintenance shall be represented using standard LonMark network variables and configuration parameters. Modification of LonMark certified network variables and configuration parameters is unacceptable.
6. Provide LonTalk bridge or routers and repeaters as required to combine different secondary (TP/FT-10) networks onto the primary Ethernet/IP network, or as required to segment groups of LonTalk devices to meet minimum throughput requirements.
7. Provide all necessary bridge or routers and gateways in order to connect TP/FT-10 devices to the primary network, and to connect the primary network to the GEMnet.
8. The network services for the BAS shall be the latest version of LonWorks Network Services (LNS).
9. Device to device communication shall be event driven and peer to peer.
10. Propagation of data from a PCU to a Router for the execution of supervisory control logic shall be event driven at the device and not based on polling from the Router.
11. Propagation of data from a PCU to a Router to support non-alarm dynamic data display or for trending purposes shall be based on polling from the Router.
12. Propagation of data from a PCU to a Router to support the reporting of alarm conditions shall be event driven at the device and not based on polling from the Router.
13. The programming of all output network variables shall include the send on delta concept; minimum send time and maximum send time parameters.
    a) Send on delta parameters shall be non-zero values selected to ensure efficient use of the available bandwidth but not exceeding the following:

1) Temperatures: 0.36 Degrees Fahrenheit
2) Pressures In Air Systems: 0.025 Inches Of Water
3) Building Static Pressure: 0.0125 Inches Of Water
4) Flow: Approximately 10 Cfm or 2% of the system operating range
5) Relative Humidity: 3%
6) Analog Position: 2%
7) Enthalpy: Approximately 0.2 Btu Per Lb
8) Binary Alarm Data: Change of State

b) If the minimum send time parameters can be set on a point by point basis, they shall not exceed the following:
1) Alarms: 1 second
2) Temperatures at Zone Level: 60 seconds
3) Temperatures at Central Station Level: 10 seconds for data reporting, 5 seconds for control purposes
4) Pressures: 5 seconds for data reporting, 1 second for control purposes.

c) If the minimum send time parameters can only be set on a controller basis, set the parameter at a value of 5 seconds.

14. The error rate for each channel shall be verified by a one hour test using the network analysis tool. The error rate shall not exceed 1%.
15. The bandwidth utilization for each channel shall be verified by a one hour test using the network analysis tool. The utilization shall not exceed 30%.
16. All products shall be LonMark certified, and shall be designed according to the LonMark Interoperability Guidelines. Product documentation and devices shall display the LonMark symbol, indicating conformance to the LonMark Interoperability Standards.
    a) In those instances in which LonMark devices are not available, the Network Integrator shall provide LonWorks devices with application source code, device resource files, and external interface definitions. The software tools required to install and commission the device shall be provided for non-LonMark devices.
17. All products shall support and be certified to an appropriate LonMark functional profile. Where published profiles do not exist, use draft profile standards or submit a proposed draft as part of the submittal package. All drafts shall also be submitted simultaneously to the LonMark Interoperability Association for certification.
18. An external interface file (*.XIF) shall be provided for each LonTalk device describing network variables, configuration parameters and other parameters supported.
19. All products shall utilize standard configuration parameter types for all product configuration parameters. Do not use network variables for this purpose.
20. The use of manufacturer-defined network variables and configuration parameters shall be limited to factory-configured parameters. All data and configuration

parameters that shall be required for field installation, service and maintenance shall be represented using standard LonMark network variables and configuration parameters. Modification of LonMark certified network variables and configuration parameters is unacceptable.

21. Provide LonTalk bridge or routers and repeaters as required to combine different secondary (TP/FT-10) networks onto the primary Ethernet/IP network, or as required to segment groups of LonTalk devices to meet minimum throughput requirements.
22. Provide all necessary bridge or routers and gateways in order to connect TP/FT-10 devices to the primary network, and to connect the primary network to the GEMnet WAN.
23. The network services for the BAS shall be the latest version of LonWorks Network Services (LNS), no exceptions allowed.
24. The Network Management Application shall be LonMaker™ for Windows (Latest Released Version) service tool (including hardware, software and any peripheral devices required) and is to be used for commissioning and management of the LonTalk control architecture, no exceptions allowed. The network management service tool shall remain on the project as the property of GSA. A copy of the LonTalk Network Database Shall Be Archived on the service tool and Site Control System Server (CSS)/ Operator Workstation (OWS), documenting system bindings and node addressing. In addition all system variables shall have a plain English language description for each variable. This service tool shall be used for all system maintenance and expansion, so that the network database backup remains current.

2.3 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. **General Requirements**:

1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN. Refer to standalone requirements by application specified in Part 3 of this section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.
2. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.
3. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.
4. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum 8 bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty- (50) hrs with a battery life of five years.
5. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.

6. AAC and ASC Input-Output Processing

   a) Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

   b) Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.

   c) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors shall only be done in non-critical applications and only with prior approval of Architect/Engineer

   d) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

   e) Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Chicago Public Schools (CPS) approval (PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. PWM controlled devices will have an automatically initiated function that resets the device position tracking on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to recalibrate the position tracking to assure the device will open and close completely when commanded. Each AO shall be discrete outputs from the PCU's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 10 bits.

   f) Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the AAC /ASC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

B. **BACnet AAC(s) and ASC(s) Requirements**:

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.

2. AAC(s) and ASC(s) shall communicate over the BACnet Building Controller LAN or the ASC LAN or sub-LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

C. **LonTalk AAC(s) and ASC(s) Requirements**:

1. Refer to LonWorks requirements under BC. All apply also to the AACs and ASCs.

D. **Terminal Box Controllers**:

1. Terminal box controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

PART 3 EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.2 SYSTEM ACCESS:

A. Provide an Ethernet connection and 5 port hub at each panel housing a controller or controllers, that provides access to the Local Supervisory LAN and to the Control System Server for all Controllers, other than an Application Category 1 Controllers. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

3.3 INSTALLATION OF CONTROL SYSTEMS:

A. General: Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings. Contractor shall install all controllers in accordance with manufacturer’s installation procedures and practices.

3.4 HARDWARE APPLICATION REQUIREMENTS

A. **General**: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. Specific requirements indicated below are required

for the respective application. Manufacturer shall apply the most cost-effective unit that meets the requirement of that application.

B. **Standalone Capability**: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.

C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

D. **Application Category Type 0** (Distributed monitoring)

1. Applications in this category include the following:
   a) Monitoring of variables that are not used in a control loop, sequence logic, or safety.
2. Points on BCs, AACs, and ASCs may be used in these applications as well as Ds and/or general-purpose I/O modules.
3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
4. **LAN Restrictions**: These points may reside on any controller

E. **Application Category Type 1**

1. Applications in this category include the following:
   a) Fan Coil Units
   b) Airflow Control Boxes (VAV and Constant Volume Terminal Units)
   c) Terminal Control Dampers/Reheat Vales
   d) Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, and Water-Source Heat Pumps)
   e) Induction Units
2. **Standalone Capability**: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Value
Scheduling Period	Normal
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Summer/Winter	Winter

Trend Data	N/A

3. **Mounting**:
   a) ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b) ASCs that control equipment mounted in a mechanical room shall either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c) ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
   d) Section 15953 contractor may furnish ASCs to the terminal unit manufacturer for factory mounting.
4. **LAN Segment Restrictions**:
   a) LonTalk systems: Limit the number of nodes servicing any one of these applications on the LAN Segment to 40. VAV terminals or zone dampers/reheat coils served by a single air handler are to be located on the same segment of the LAN with the AHU. Multiple AHU's may reside on a LAN segment if all the associated/served terminal boxes and zone dampers/reheat coils are located on the same LAN segment. If more than 40 VAV terminals or zone dampers/reheat coils are served by a single air handler, then one LAN segment shall be fully populated with the parent air handler and terminal unit Nodes with the balance of the served terminal units Nodes located on the other segment located on the single channel JACE.
   b) BACnet Systems: Limit the number of AAC's/ASC's servicing any one of these applications on the LAN Segment to 32.

F. Application Category Type 2

1. Applications in this category include the following:
   a) Constant Volume Air Handlers
   b) Unitary Equipment >= 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
   c) Constant Volume Pump Start/Stop
   d) Misc. Equipment (Exhaust Fan) Start/Stop
   e) Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
   f) Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device
   g) Multizone Air handlers with fewer than 5 zones
2. **Standalone Capability**: Only the following data (as applicable) may be acquired from other AACs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay

time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value
Outside Air Temperature	3 minutes	80°F
Outside Air Humidity	3 minutes	60%RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Trend Data		N/A
Cooling/Heating Requests	3 minutes	None

3. **Mounting**:
   a) AACs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b) AACs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c) AACs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
4. **LAN Segment Restrictions**:
   a) LonTalk systems: Limit the number of nodes servicing any one of these applications on the LAN Segment to 40.
   b) BACnet Systems: Limit the number of AAC's servicing any one of these applications on the LAN Segment to 32.

G. Application Category Type 3

1. Applications in this category include the following:
   a) VAV Air Handlers
   b) Dual Duct Air Handlers
   c) Multizone Air Handlers with 5 or more zones
   d) Self Contained VAV Units
   e) Central Cooling Plant
   f) Central Heating Plant
   g) Cooling Towers
   h) Sequenced or Variable Speed Pump Control
   i) Local Chiller Control (unit specific)
   j) Local Free Cooling Heat Exchanger Control
2. **LAN Segment Restrictions**:
   a) LonTalk systems: Limit the number of PCU's servicing any one of these applications on the LAN Segment to 20. Only PCU's associated with equipment for the applications in this category shall reside on the LAN segment of this application category type, with the exception of Application Category Type 0 points.

3. BACnet Systems: BCs shall be used in these applications.

3.5 CONTROL UNIT REQUIREMENTS

A. Refer to Division 15 Building Automation System for requirements pertaining to control unit quantity and location.

END OF SECTION 15953

SECTION 15955

BAS SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Software

B. Programming Description

C. Control Algorithms

D. Energy Management Applications

E. Password Protection

F. Alarm Reporting

G. Trending

H. Data Acquisition and Storage

I. Point Structuring

J. Dynamic Color Graphics

1.2 RELATED DOCUMENTS

A. Division 1

B. Division 15

C. Division 16

1.3 DESCRIPTION OF WORK:

A. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.

B. Refer to Division 15 - *Building Automation System (BAS)* for general requirements.

C. Refer to Division 15 - *Sequence of Operation* for specific sequences of operation for controlled equipment.

1.4 LICENSING

A. Include licensing for all software packages at all required Control System Server (CSS Operator Work Stations (OWS) and Portable Operator Terminal (POT).

B. Any operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

C. Include licensing for all software packages at all required Web Server and OWS's and POT's. Licensing shall allow access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

D. All software should be available on all Web Servers and OWS's provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that CPS may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses. These backup disks will include a backup of all program data files, graphics etc. and shall allow the owner to completely restore the system in the case of a computer malfunction

E. Provide evidence of licensing including version and original software copies for each WEB Server OWS's and POT's. Licenses shall allow for access to any site device and shall not be restricted to accessing, database management, configuring, etc. the LANs included in this project. The licensing and registration proof will be provided when the system is installed on site.

F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period and provide a letter indicating the current release/version date at the end of the warrenty.

G. Refer to Division 15 - *Building Automation System (BAS) General* for further requirements.

PART 2 - PRODUCTS

2.1 SYSTEM SOFTWARE-GENERAL

A. **Functionality and Completeness**: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

2.2 CONTROLLER SOFTWARE

A. All bindings, SNVT's, configuration values, addresses, calibration values, parameters, variables, tuning values, gains, test values, etc. for all software, programs, network configurations etc. shall be exposed and be available for setup, manipulation, adjustment, calibration, testing, etc. at all workstations, CSS's/OWS's, POT's for use as allowed via applicable password protection for all controllers and devices throughout all networks and the entire BAS.

B. **Building Controller (BC) Software Residency**: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software
2. Real-Time Clock/Calendar and network time synchronization
3. BC diagnostic software
4. LAN Communication software/firmware
5. Direct Digital Control software
6. Alarm Processing and Buffering software
7. Energy Management software
8. Data Trending, Reporting, and Buffering software
9. I/O (physical and virtual) database
10. Remote Communication software

C. **Advanced Aplication Controller (AAC) Application Specific Controller (ASC) Software Residency**: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Section 15954) with the restrictions/exceptions per application provided in Section 15953:

1. Real-Time Operating System software
2. AAC/ASC diagnostic software
3. LAN Communication software
4. Control software applicable to the unit it serves that will support a single mode of operation
5. I/O (physical and virtual) database to support one mode of operation

D. **Stand Alone Capability**: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 15953 for other aspects of stand alone functionality..

E. **Operating System**: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Section 15953 for other aspects of the controller's operating system.

F. **Network Communications**: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

1. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
2. LonTalk - Provide a network bandwidth analysis tool. The tool for determining bandwidth utilization shall be the LoyTech protocol analyzer LPA-IP network

analysis tool, no exceptions allowed. Turn the tool over to CPS as part of the Project Closeout requirements.

3. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Gateways and LAN Interface Devices or CSS's/OWS's. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

G. **Point Database/Summary Table**: All points included in the typical equipment point list must be represented in a common, open protocol format. Naming conventions for these points and network addressing are discussed in Part III of this section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in Part III of this section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.

H. **Diagnostic Software**: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

I. **Alarm/Messaging Software**: Controller software shall support alarm/message processing and buffering software as more fully specified below.

J. **Application Programs**: CUs shall support and execute application programs as more fully specified below:

1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) CPS programming.
2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

K. **Security**: Controller software shall support multiple level password access restriction as more fully specified below.

L. **Direct Digital Control**: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:

1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
2. Two Position control (Hi or Low crossing with deadband)
3. Single-Pole Double-Throw relay
4. Delay Timer (delay-on-make, delay-on-break, and interval)
5. Hi/Low Selection

6. Reset or Scaling Module
7. Logical Operators (And, Or, Not, Xor)

M. **Psychrometric Parameters**: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

N. **Updating/Storing Application Data**: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

O. **Restart**: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

P. **Time Synchronization**: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.

Q. **Misc. Calculations**: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.3 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. **Point Definition**: provide templates customized for point type, to support input of individual point information. For LON systems use standard LonWorks SNVTs.
2. **Graphical Block Programming**: Manipulation of graphic icon ‘blocks’, each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
3. **Functional Application Programming**: Pre-programmed application specific programs that allow/require limited customization via ‘fill-in-the-blanks’ edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
4. **Line Programming**: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for

energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.4 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Time-of-Day Scheduling
2. Calendar-Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
7. Economizer Control (enthalpy or dry-bulb)
8. Peak Demand Limiting and Load Shedding. The demand limiting function will use demand data as the basis for the function and the load shedding program will use space temperature adjustment or means acceptable to CPS to provide load shedding response. The function selected for a given school will be made by CPS.
9. Dead Band Control

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. For exmaple the load shedding program will allow the operator to determine the spaces to be included in the load shed as well as the duration of the event. Programs shall be applied to building equipment as described in the Section 15958 entitled '*Sequence of Operation'*.

2.5 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow the CPS's authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as deemed appropriate for each user, based upon an assigned user name with a unique password.

B. All passwords for the system shall be provided to CPS including administrator, dealer, or factory level passwords for the systems provided under this project.

C. Passwords shall restrict access to all Control Units.

D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 20 user names shall be supported and programmed per CPS's direction. Provide abilty to deactivate passwords without removal of the login and password. CPS

will be provided with the highest level login and password so that CPS controls the administrative passwords.

F. Operators shall be able to perform only those commands available for the access level assigned to their user name.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line. This timer will not be the windows system screen saver feature.

2.6 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BC's ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. **Alarm Descriptor**: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
2. **Alarm Prioritization**: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with CPS on establishing alarm priority definitions.
3. **Alarm Report Routing**: Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
4. **Auto-Dial Alarm Routing**: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.
5. **Alarm Acknowledgment**: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm

acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.

6. **Alarm Display**: All alarms will popup as described in Alarm Acknowledgement. The owner will have the option to limit the pop up alarms based on alarm priority.

B. It shall be possible for any operator to receive a summary of all alarms, regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. **Alarm Historical Database**: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

2.7 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

1. Trends may be buffered in the BC as long as the trend data in the BC and the historical data stored on hard disk is displayed seamlessly.
2. Provide trends for all physical points, virtual points and calculated variables.
3. Trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
4. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
5. The sample rate and data selection shall be selectable by the operator.
6. The trended value range shall be selectable by the operator.
7. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. **Control Loop Performance Trends**: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. **Data Buffering and Archiving**: Trend data may be buffered at the BC, and uploaded to hard disk storage for archiving as needed based on the BC's memory constraints. All archived trends shall be transmitted to the on-site OWS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.

D. **Time Synchronization**: Provide a time master that is installed and configured to synchronize the clocks of all devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

2.8 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

2.9 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.

B. Data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

2.10 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.11 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

C. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

D. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

E. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.12 POINT STRUCTURING AND NAMING

A. **General**: The intent of this section is to require a consistent means of naming points across the CPS Enterprise. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The interface shall always use this naming convention. The naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by CPS.

B. **Point Summary Table**

1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
2. With each schematic, Contractor shall provide a Point Summary Table listing:
   a) Building number and abbreviation
   b) System type
   c) Equipment type
   d) Point suffix
   e) Full point name (see Point Naming Convention paragraph)
   f) English language point description
   g) Ethernet backbone network number,
   h) Network number
   i) Device ID
   j) Device MAC address
   k) Engineering units
3. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).
4. Point Summary Table shall also illustrate Network Variables/LonWorks Bindings.
5. The Contractor shall coordinate with the CPS's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project

closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to CPS the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.

7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.
8. Point Summary Table shall also illustrate Network Variables/BACnet Data Links/LonWorks Bindings.

Point Summary Table Example

Row Headers and Examples

(Transpose for a single point per row format)

Building Number	0006 (CPS 4 digit Building Code)
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
*Point Name (Object Name)	0006.COOLING.CHILLER.CHLR1KW
*Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Point Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006

* Represents information that shall reside in the property for the point

C. **Point Naming Convention**

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS point, a specific and unique name shall be required.
2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a

period to form the entire object name. Reference the paragraphs below for an example of these descriptors.

3. CPS shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the CPS WAN. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.

Point Name Requirements

Descriptors		**Comment**
Building Number	0006	The Master Building List also has the correct number for each building.
System	AIRHANDLING EXHAUST HEATING COOLING UTILITY ENDUSE MISC	 Boilers and ancillary equipment Chillers and ancillary equipment Main electrical and gas meters Specific building loads by type
Equipment	AHU-1 BOILERS CHILLERS FACILITY TOWERS WEATHER	 Non-specific boiler system points Non-specific chiller system points
Point Suffix	See Input/Output point summary table for conventions	

5. **Examples**: Within each point name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:
   a) 0006.COOLING.CHILLERS.CHWP1ST
   b) 0006.HEATING.BOILERS.BLR1CFH

D. **Device Addressing Convention**:

1. Lontalk - Network numbers and SNVT's shall be unique throughout the network.
2. BACnet - Network numbers and Device Object IDs shall be unique throughout the network.

3. BACnet - For each BAS object, a specific and unique BACnet object name shall be required.
4. All assignment of network numbers and Device Object IDs shall be coordinated with CPS.
5. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:
   BBBFF, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.
6. Each Device Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:
   XXFFBBB, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.
7. The Contractor shall coordinate with CPS or a designated representative to ensure that no duplicate Device Object IDs occur.
8. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by CPS.

2.13 OPERATOR INTERFACE GRAPHIC SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be Microsoft Windows 2000 Professional or Microsoft Windows XP Professional.

E. The software shall allow for CPS creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

F. **Screen Penetration**: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or 'button' icons. All screens will be accessible out the use of outline type selection screens. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.

G. **Dynamic Data Displays**: Dynamic physical point values shall automatically updated at a minimum frequency of 6 updates per minute without operator intervention. Point

value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

H. **Point Override Feature**: Provide the following:

1. An Operator from a work-station shall have the capability to place an end device under manual control, which shall prevent the control logic from making changes to the end device status, and provide the operator with the ability to position the end device. It must be possible to put a point under manual control and command the point to a specific state or value from a graphic page. Once under manual control the point will be able to be realeased to automatice operation from the same graphics page. See the definition of Manual Control in the definition of terms section.
2. An Operator from the operator work-station shall have the capability to place a sensor input into test mode. When in test mode, any changes from the physical sensor will no longer be recognized and the value reported to control logic shall take a value that is assigned to it by the operator from the operator work-station. It must be possible to put a point in test and assign a test value from a graphic page. See the definition of Test Mode in the definition of terms section.
3. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection.

I. **Dynamic Symbols**: Provide a selection of standard symbols that change in appearance based on the value of an associated point.

1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.
2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.
3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.

J. **Graphics Development Package**: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays. The application of the graphic editing will be controlled by password level at the programmer level or higher.

1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
2. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:
   a) Define symbols
   b) Position items on graphic screens
   c) Attach physical or virtual points to a graphic

d) Define background screens

e) Define connecting lines and curves

f) Locate, orient and size descriptive text

g) Define and display colors for all elements

h) Establish correlation between symbols or text and associated system points or other displays.

i) Create hot spots or link triggers to other graphic displays or other functions in the software.

PART 3 - EXECUTION

3.1 SYSTEM CONFIGURATION

A. Contractor shall thoroughly and completely configure the BAS software, supplemental software, network communications, CSS, OWS, printer, and remote communications for a fully complete operational system.

3.2 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequences of operation. If a sequence is not clear, in the contractors opinion, it is the Contractor's responsibility to request clarification..

B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.

All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of CPS and shall remain on the workstation(s)/server(s) at the completion of the project.

3.3 PASSWORD SETUP

A. Set up the following password levels to include the specified capabilities:

1. Level 1: (CPS's BAS Administrator)
   a) Level 2 capabilities
   b) View, add, change and delete user names, passwords, password levels
   c) All unrestricted system capabilities including all network management functions.
2. Level 2: (Programmer)
   a) Level 3 capabilities
   b) Configure system software
   c) Modify control unit programs

d) Modify graphic software

e) Essentially unrestricted except for viewing or modifying user names, passwords, password levels

3. Level 3: (Chief Engineer)
   a) Level 4 capabilities
   b) Override output points
   c) Change all setpoints and reset schedules.
   d) Exit BAS software to use third party programs
4. Level 4: (Assitant)
   a) Level 5 capabilities
   b) Acknowledge alarms
   c) Change equipment schedules
   d) Change room temperature setpoints
5. Level 5: (Veiw only Access)
   a) Display all graphic data
   b) Trend point data
   c) Unless otherwise directed the Login will the school name and the password will be “cpswebaccess”.

B. Contractor shall assist CPS’s operators with assigning user names, passwords and password levels. There may be multiple login name and passwords for a given password level. The contractor will be responsible for changing BAS administrator and Programmer level passwords if those are accidentally provided to other contractors or the school engineer.

3.4 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:

1. Name
2. Address
3. Scanning frequency or COV threshold
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure

of any network over which the point value is transferred. All default values will be provided in list format for evaluation by CPS.

9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:

1. Name
2. Address
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay
5. Message and alarm reporting as specified
6. Reporting of each change of state, and memory storage of the time of the last change of state
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on-time
7. Minimum off-time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.5 TRENDS

A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point. All dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like will be trended as directed by the CPS.

B. CPS will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (±) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When outputting to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by CPS, or their representative, upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system. The trend limit is 1 year from demonstration for LEED projects that require trend data for M&V purposes. The limit on the length of trend data will be a function of the storage capacity of the computer.

3.6 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Provide a legend identifying the line color and symbol along side the point noun name for each point in the trend. Aslo, indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.

D. The y-axis scales shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended except for control loop performance trends.

F. Allow point groups to be saved for future trends. For example HW supply and return temperatures along with HX stm valve position and pump status.

3.7 ALARMS

A. **Override Alarms**: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. **Analog Input Alarms**: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Space temperature, except as otherwise stated in sequence of operation: Level 3
   a) Low alarm: 64°F
   b) Low return-to-normal: 68°F
   c) High alarm: 85°F
   d) High return-to-normal: 80°F
2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)
   a) Low alarm: 3°F below setpoint
   b) Low return-to-normal: 2°F below setpoint
   c) High alarm: 3°F above setpoint
   d) High return-to-normal: 2°F above setpoint.
3. AHU mixed air temperature: Level 4
   a) Low alarm: 45°F
   b) Low return-to-normal: 46°F
   c) High alarm: 90°F
   d) High return-to-normal: 89°F
4. Duct Pressure:
   a) Low alarm: 0.5"w.g. below setpoint
   b) Low return-to-normal: 0.25"w.g. below setpoint
   c) High alarm: 0.5"w.g. above setpoint
   d) High return-to-normal: 0.25"w.g. above setpoint
5. Space humidity:
   a) Low alarm: 35%
   b) Low return-to-normal: 40%
   c) High alarm: 75%
   d) High return-to-normal: 70%

C. **Status versus Command Alarms**: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the 'Auto' position. BAS shall enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present or vice versa:

1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. **Maintenance Alarms**: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator.

1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

E. See requirements for additional equipment-specific alarms specified in *Section 15958 - Sequences of Operation*.

3.8 GRAPHIC SCREENS

A. Main Screen: The Main screen will be the first screen displayed after login, no navigation required to get to the main screen (see Exhibit A for sample screens). This screen will have the following features:

1. CPS will have the option of providing a picture of the school as background.
2. There will be a link button to the floor plans, Summary screen, and system schematic screens. In the event that there are more 10 to 15 AHU, Boiler and Chiller screens a button to groups of AHU's will be provided.
3. Manufacturer/Installer Logo or information is not to be included in the screen.
4. Provide a global command to open heating or cooling valves to facilitate Test Adjust and Balance. The command will be grouped so that an AHU can be balanced as well as total system balancing. The same function will apply for VAV AHU's were all the boxes can be set at minimum or maximum flow.

B. **Floor Plan Screens**: The contract document drawings will be made available to the Contractor in AutoCAD format upon request. These drawings may be used only for developing backgrounds for specified graphic screens; however CPS does not guarantee the suitability of these drawings for the Contractor's purpose (see Exhibit B for sample screens). .

1. Provide graphic floor plan screens for each floor and/or wing of the building. Indicate the location of all equipment that is not located on the equipment room screens.
   a) Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.
   b) Display the space temperature point adjacent to each temperature sensor symbol along with the room set point. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct background colors for each zone to demarcate the air-handling unit to which it is associated.
   c) Indicate room numbers as provided by CPS. Verify final room number/name assignments, as these are often different than initially assigned room numbers on the contract drawings.
   d) Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding zone equipment schematic graphic screen. Because the area

available for the floor plans varies from system to system, the size of text used to display data such as room number and temperature will be at least 1/8" high on the screen when the entire floor plan section is displayed.

e) The floor plan graphics will also indicate the location of control panels. For control devices such as duct smoke detectors, system pressure or differential pressure sensors (water or air), airflow stations that are located outside the equipment rooms. All of these devices will be linked to the associated system graphic. For terminal units the link to the associated system graphic is sufficient and the associated unit control devices do not need to be located on the floor plan.

2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
3. Provide a graphic building key plan that will allow navigation at a floor level or from floor to floor. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
4. When there is more than one building, provide a graphic site plan with links to and from each building plan.

C. **System Schematic Screens**: Provide graphic system schematic screen for each HVAC subsystem (AHU) controlled with each I/O point in the project appearing on at least one graphic screen. System graphics shall be have the same look as the submittal diagrams (do not use three dimensional graphics) with status, setpoints, current analog input and output values, operator commands, etc. as applicable. Input/output devices shall be shown in their schematically correct locations with the associated value, noun name and engineering units. The position of valves or dampers will be % OPEN. For three way valves it will be %OPEN to the device. The noun name (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen. Similar AHU's will have the same organization of information. For example a single zone AHU will not put all the set points across the top and multizone put them on the side or bottom (see Exhibit C for sample screens).

1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupancy mode and heating, cooling, economizer etc based on the sequence of operations). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
2. Provide a graphic screen for each zone with the associated control devices or terminal unit with a link to the associated system schematic screen of the air handling unit that serves the zone.

3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link the chilled water and condenser water systems screens if they cannot fit onto one cooling plant graphic screen.
4. Link the heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
5. For each system schematic screen, including AHU, Boiler, Chiller and terminal unit screen, provide a button linked to a text version of the sequence of operation for the device or system. The sequence will be updated with the as-built sequence following completion of the demonstration.

D. **System Summary Screens**: On each graphic System Screen, provide drawing links to the graphic air handling unit schematic screens (see Exhibit D for sample screens).

1. Provide a chilled water valve screen showing the analog output signal of all chilled water valves with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
2. Provide a heating water valve screen showing the analog output signal of all air handling unit heating water valves with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.
3. When there are more than four AHU's on the system provide a summary screen with the following type of information for each AHU, each fan command, status, alarms (smoke, freeze, duct static), DAT and duct pressure if applicable. For the heating system provide status and supply water temp or steam pressure and for the chiller provide status and chilled water supply temperature.
4. Provide a BAS system summary screen using the control system riser diagram to show the communication status of all controllers (BC, AAC and ASC's) on the BAS as well as all interface devices such as VFD's, chillers and boiler panels etcetera. Use green board concept, green means communicating, red is not communicating.
5. Provide a terminal unit summary screen grouped by floor or AHU. If the summary is grouped by floor then the AHU will be shown for each terminal unit and vice versa. The points shown will depend on the type of terminal unit and will include room name, floor or AHU, room set point and temperature, DAT, valve position, command status, alarm and occupancy state.
6. Exhaust fans will be show in a table format showing the command signal, the status, the alarm condition, and the occupancy state.

E. **Alarms**: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a

blue color. Indicate digital values that are in alarm condition in a red color. When an alarm first occurs it shall "popup" over the current screen so that the operator is imediatedly aware of an alarm.

1. Maintenance Alarms
    a) Runtime alarm screen will list all equipment with a BAS status. For each piece of equipment the screen will display the current run time (since the last reset), the runtime alarm limit (adj.), its alarm status (red / green) and the total accumulated runtime. The total accumulated runtime would only be zeroed out if the equipment were replaced. For equipment with internal runtime meters ensure that the total accumulative runtime is synchronized.

F. **Utility Metering**: Provide a graphic for the gas, electric and water utility data required in the sequence of operations. This may entail multiple screens if submetering of the gas or electric usage is included in the project.

END OF SECTION

SPECIFICATION 15955
EXHIBITS

The following graphic screens are provided as examples that incorporate most of the requirements of Specification 15955. While few graphic screens meet all the requirements they are illustrative of the quality of graphic screen that CPS expects on projects executed under this specification.

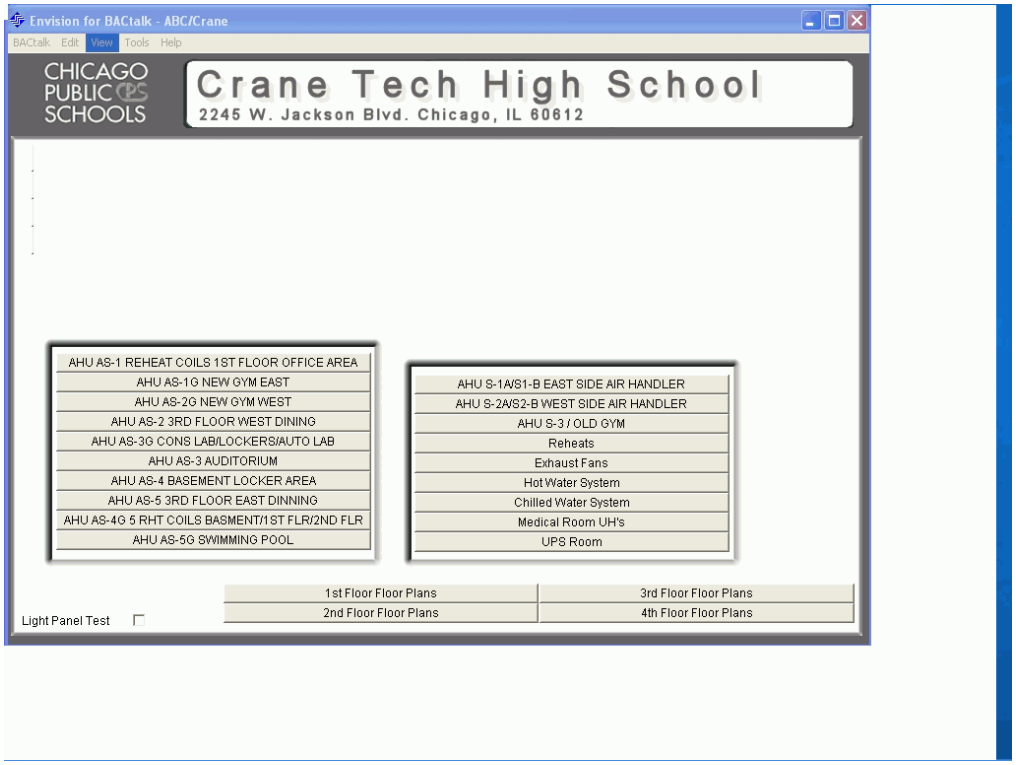
EXHIBIT A **Main Screen Example Graphics**

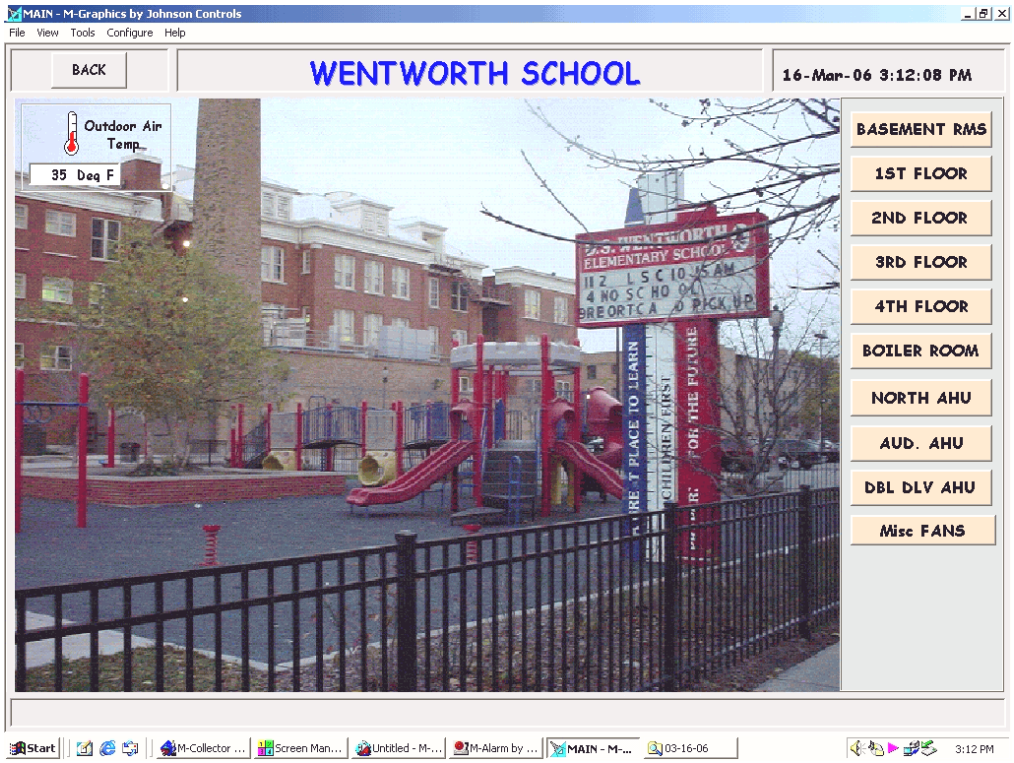
EXHIBIT B **Floor Plan Example Graphics**

EXHIBIT C **System Schematic Example Graphics**

EXHIBIT D **System Summary Example Graphics**

EXHIBIT A Main Screen Example Graphics





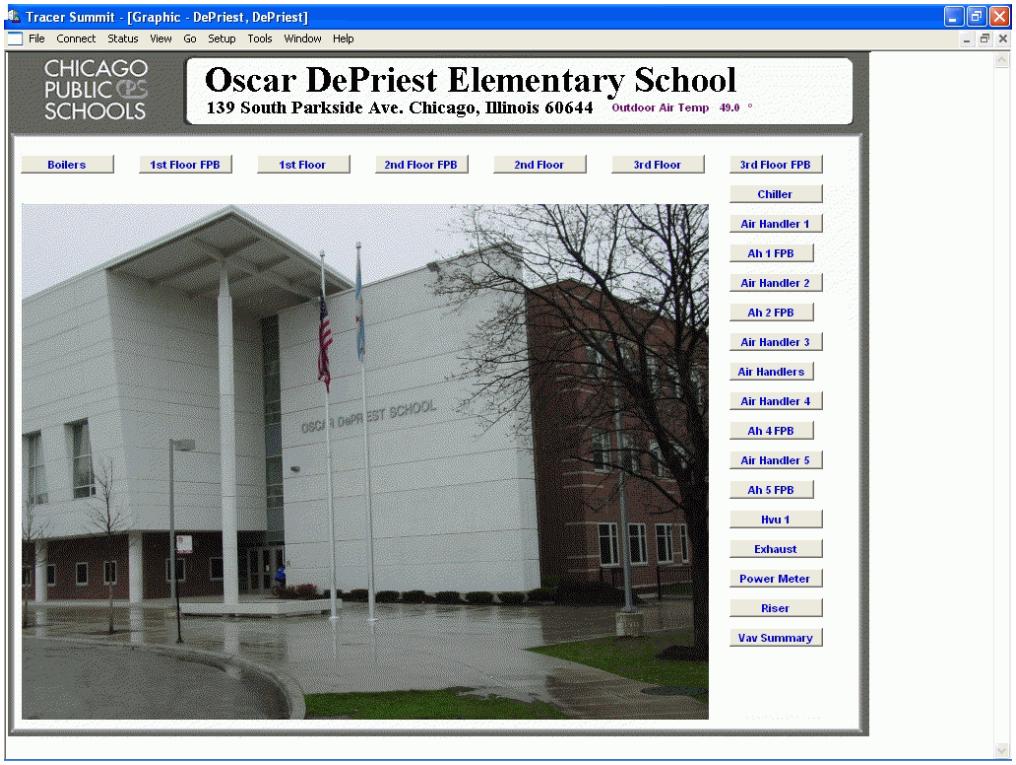
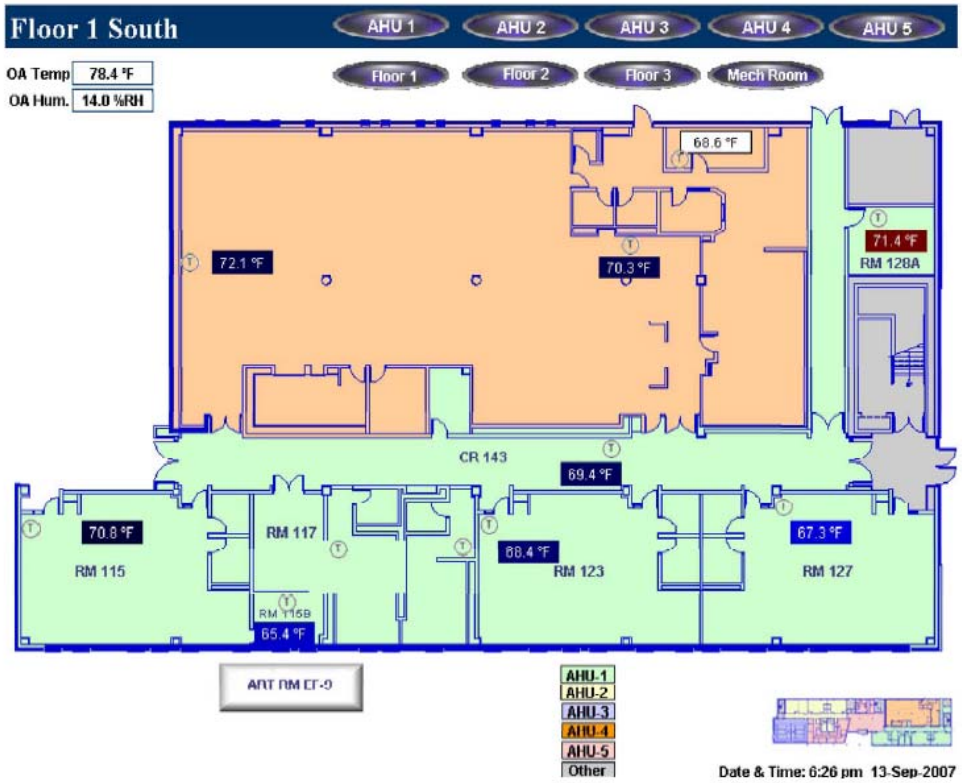
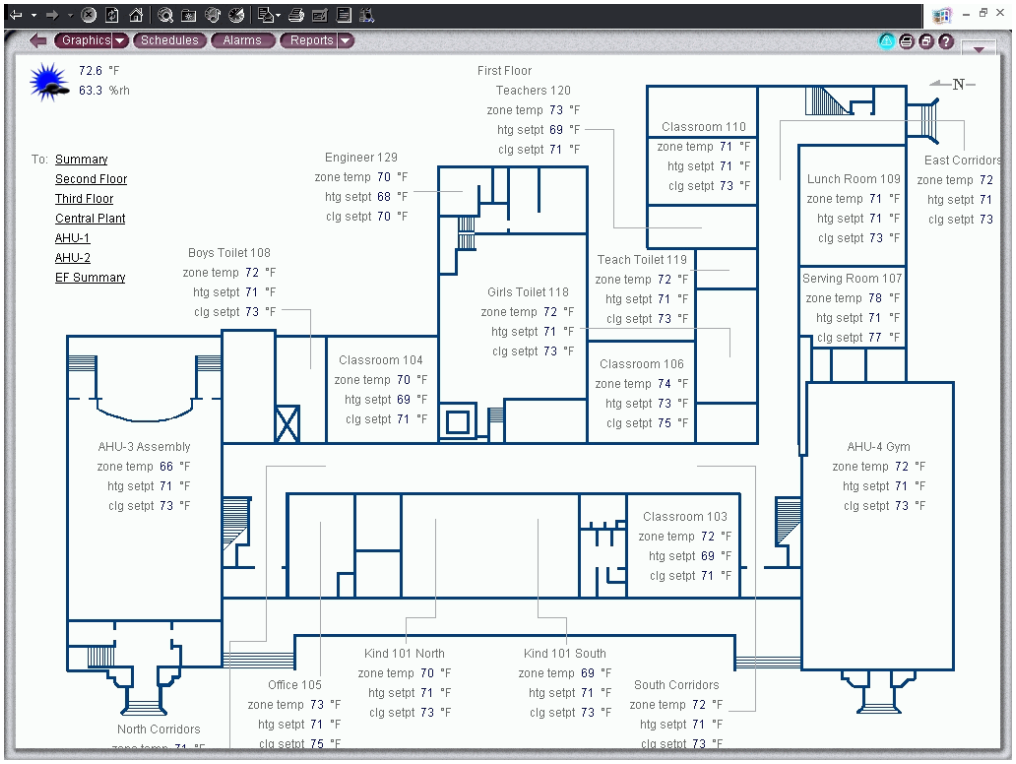
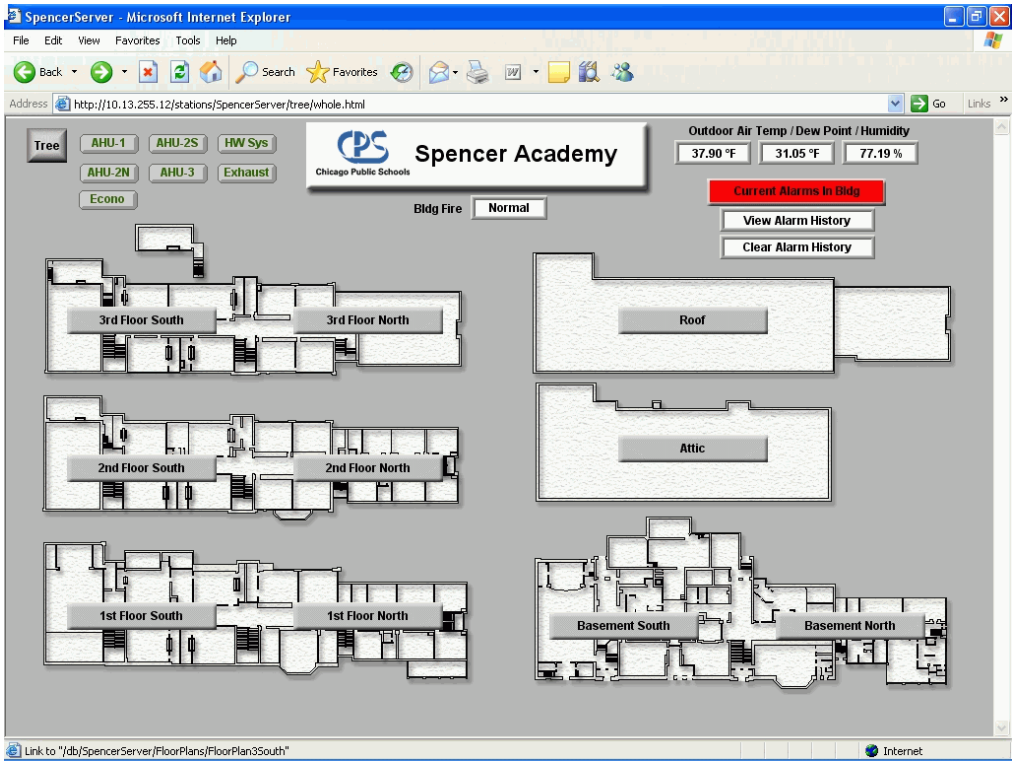

Tracer Summit - [Graphic - DePriest, DePriest]
File Connect Status View Go Setup Tools Window Help
CHICAGO PUBLIC SCHOOLS
Oscar DePriest Elementary School
139 South Parkside Ave. Chicago, Illinois 60644
Outdoor Air Temp 49.0 °
Boilers
1st Floor FPB
1st Floor
2nd Floor FPB
2nd Floor
3rd Floor
3rd Floor FPB
Chiller
Air Handler 1
Ah 1 FPB
Air Handler 2
Ah 2 FPB
Air Handler 3
Air Handlers
Air Handler 4
Ah 4 FPB
Air Handler 5
Ah 5 FPB
Hvu 1
Exhaust
Power Meter
Riser
Vav Summary

EXHIBIT B Floor Plan Example Graphics






SpencerServer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.13.255.12/stations/SpencerServer/tree/whole.html
Go Links
Tree
AHU-1
AHU-2S
HW Sys
AHU-2N
AHU-3
Exhaust
Econo
Chicago Public Schools
Spencer Academy
Bldg Fire
Normal
Outdoor Air Temp / Dew Point / Humidity
37.90 °F
31.05 °F
77.19 %
Current Alarms In Bldg
View Alarm History
Clear Alarm History
3rd Floor South
3rd Floor North
Roof
2nd Floor South
2nd Floor North
Attic
1st Floor South
1st Floor North
Basement South
Basement North
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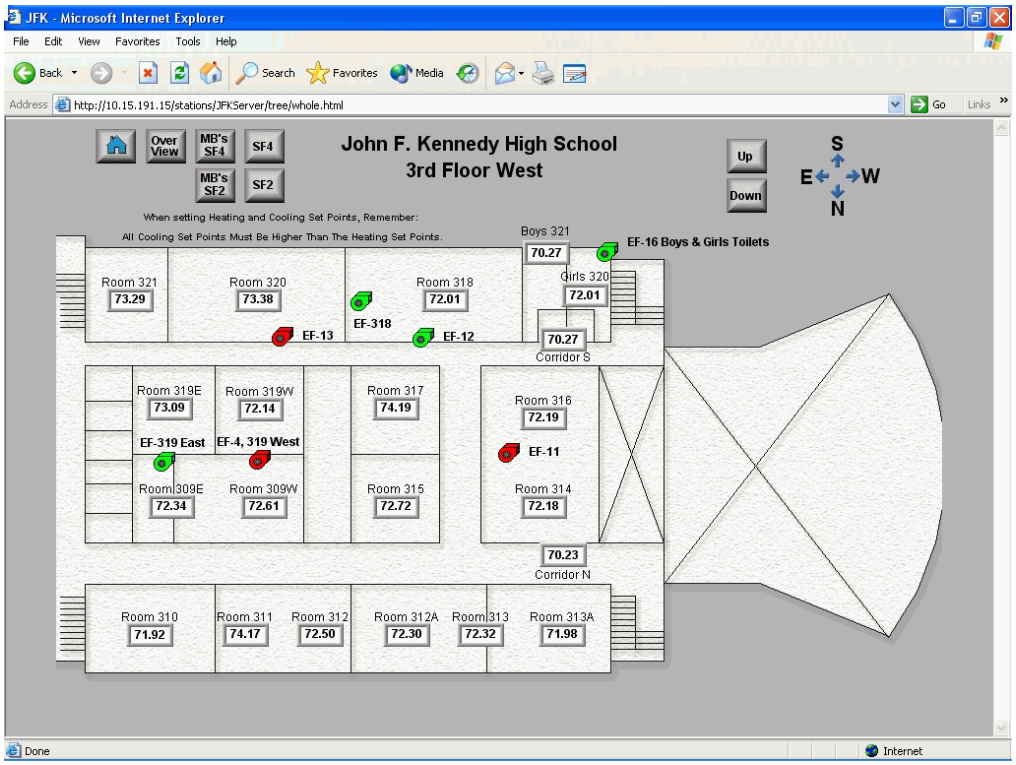
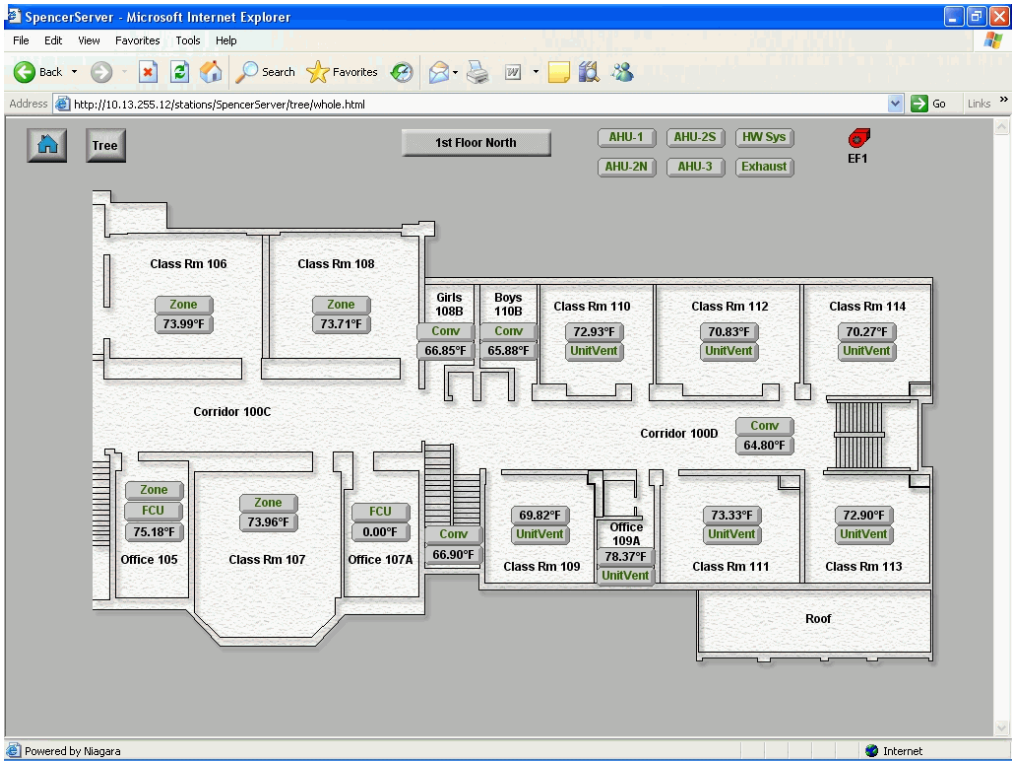
Internet


JFK - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://10.15.191.15/stations/JFKServer/tree/whole.html
Go Links
Over View
MB's SF4
SF4
MB's SF2
SF2
John F. Kennedy High School
3rd Floor West
Up
Down
S
E
W
N
When setting Heating and Cooling Set Points, Remember:
All Cooling Set Points Must Be Higher Than The Heating Set Points.
Boys 321
70.27
EF-16 Boys & Girls Toilets
Room 321
73.29
Room 320
73.38
Room 318
72.01
Girls 320
72.01
EF-318
EF-13
EF-12
70.27
Corridor S
Room 319E
73.09
Room 319W
72.14
Room 317
74.19
Room 316
72.19
EF-319 East
EF-4, 319 West
EF-11
Room 309E
72.34
Room 309W
72.61
Room 315
72.72
Room 314
72.18
70.23
Corridor N
Room 310
71.92
Room 311
74.17
Room 312
72.50
Room 312A
72.30
Room 313
72.32
Room 313A
71.98
Done
Internet


SpencerServer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.13.255.12/stations/SpencerServer/tree/whole.html
Go Links
Tree
1st Floor North
AHU-1
AHU-2S
HW Sys
AHU-2N
AHU-3
Exhaust
EF1
Class Rm 106
Zone
73.99°F
Class Rm 108
Zone
73.71°F
Girls 108B
Conv
66.85°F
Boys 110B
Conv
65.88°F
Class Rm 110
72.93°F
UnitVent
Class Rm 112
70.83°F
UnitVent
Class Rm 114
70.27°F
UnitVent
Corridor 100C
Corridor 100D
Conv
64.80°F
Zone
FCU
75.18°F
Office 105
Zone
73.96°F
Class Rm 107
FCU
0.00°F
Office 107A
Conv
66.90°F
69.82°F
UnitVent
Class Rm 109
Office 109A
78.37°F
UnitVent
73.33°F
UnitVent
Class Rm 111
72.90°F
UnitVent
Class Rm 113
Roof
Powered by Niagara
Internet

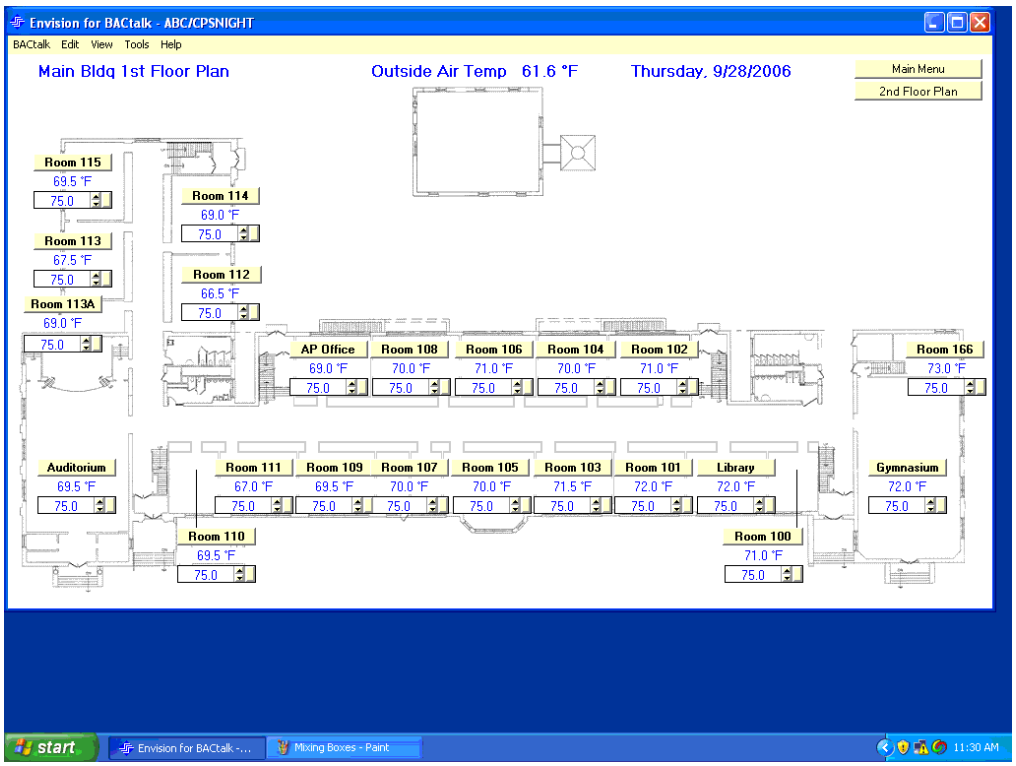
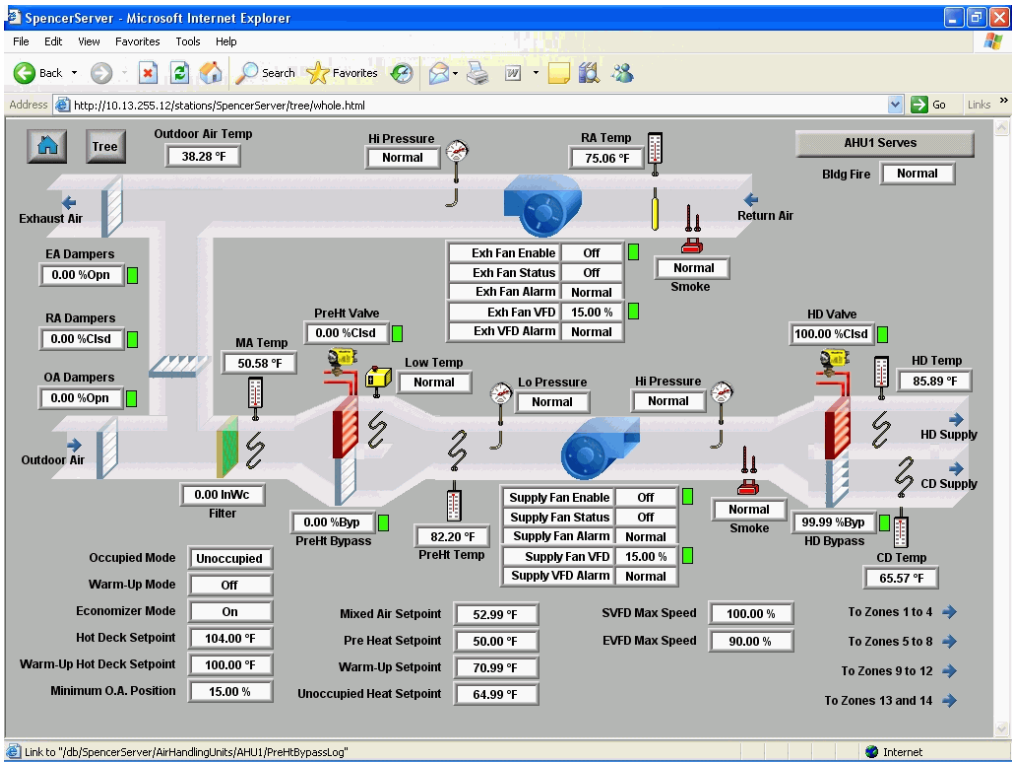
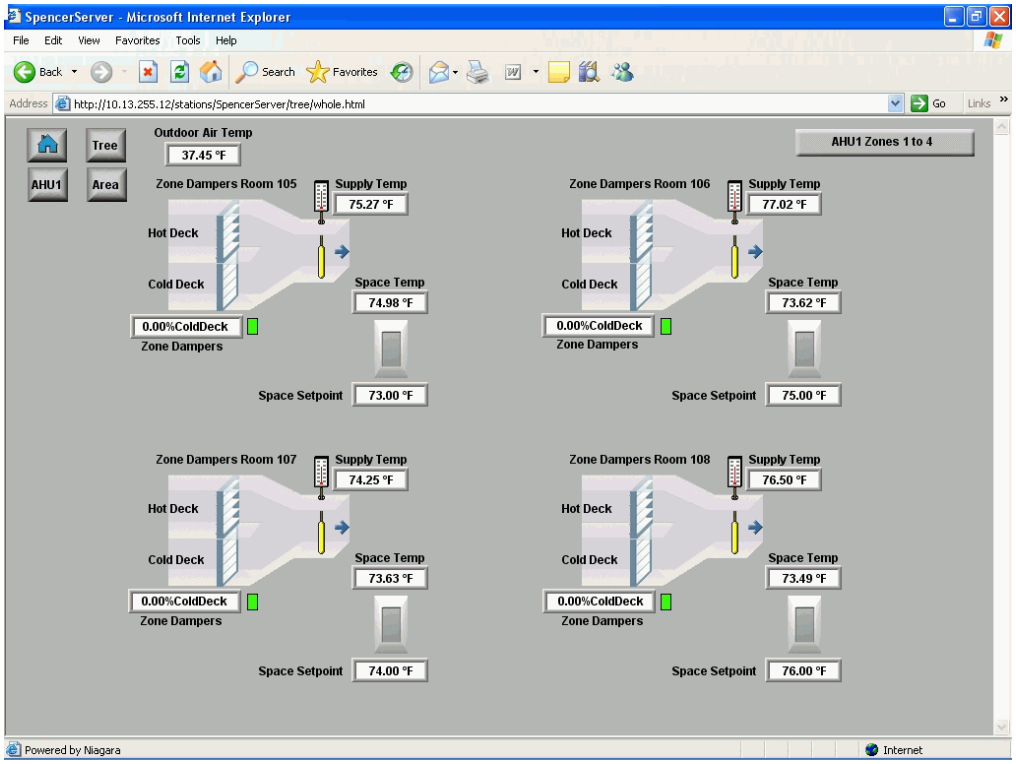
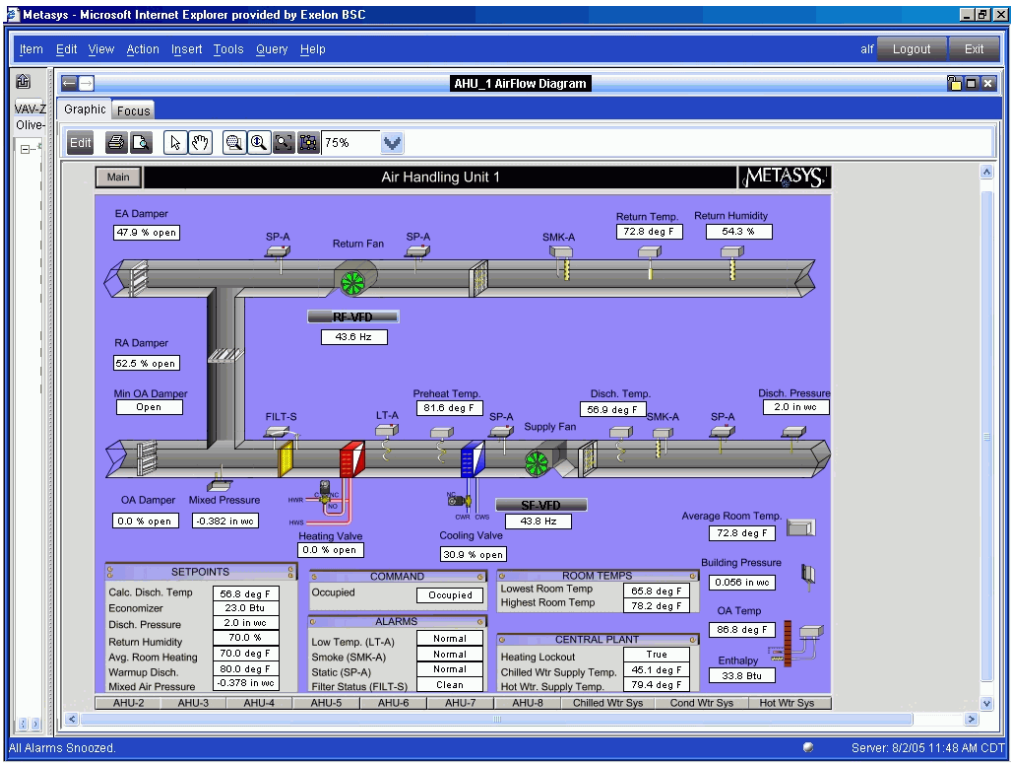
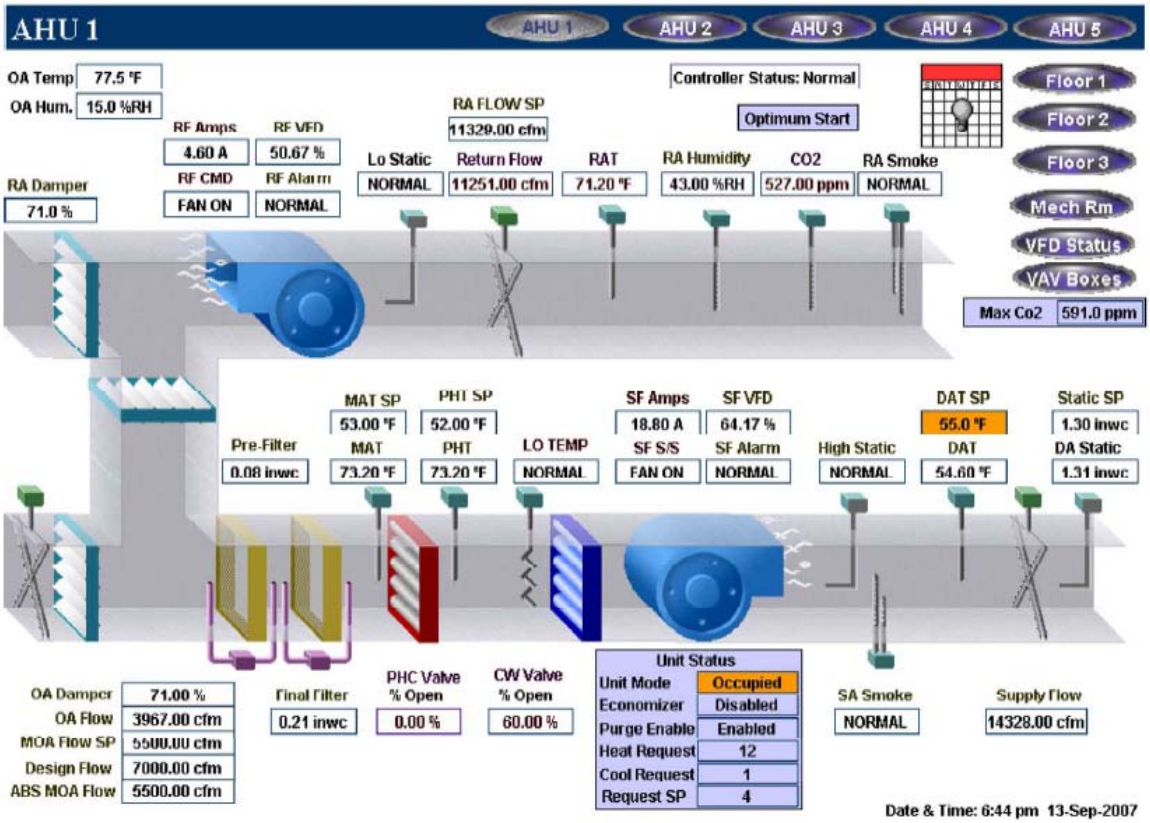

Envision for BACtalk - ABC/CPSNIGHT
BACtalk Edit View Tools Help
Main Bldg 1st Floor Plan
Outside Air Temp 61.6 °F
Thursday, 9/28/2006
Main Menu
2nd Floor Plan
Room 115
69.5 °F
75.0
Room 114
69.0 °F
75.0
Room 113
67.5 °F
75.0
Room 112
66.5 °F
75.0
Room 113A
69.0 °F
75.0
AP Office
69.0 °F
75.0
Room 108
70.0 °F
75.0
Room 106
71.0 °F
75.0
Room 104
70.0 °F
75.0
Room 102
71.0 °F
75.0
Room 166
73.0 °F
75.0
Auditorium
69.5 °F
75.0
Room 111
67.0 °F
75.0
Room 109
69.5 °F
75.0
Room 107
70.0 °F
75.0
Room 105
70.0 °F
75.0
Room 103
71.5 °F
75.0
Room 101
72.0 °F
75.0
Library
72.0 °F
75.0
Gymnasium
72.0 °F
75.0
Room 110
69.5 °F
75.0
Room 100
71.0 °F
75.0
start
Envision for BACtalk -...
Mixing Boxes - Paint
11:30 AM

EXHIBIT C System Schematic Example Graphics






Metasys - Microsoft Internet Explorer provided by Exelon BSC
Item Edit View Action Insert Tools Query Help
Logout
Exit
AHU_1 AirFlow Diagram
Graphic
Focus
Main
Air Handling Unit 1
METASYS
EA Damper
47.9 % open
SP-A
Return Fan
SP-A
SMK-A
Return Temp.
72.8 deg F
Return Humidity
54.3 %
RF VFD
43.6 Hz
RA Damper
52.5 % open
Min OA Damper
Open
FILT-S
LT-A
Preheat Temp.
81.6 deg F
SP-A
Supply Fan
Disch. Temp.
56.9 deg F
SMK-A
SP-A
Disch. Pressure
2.0 in wc
OA Damper
0.0 % open
Mixed Pressure
-0.382 in wc
Heating Valve
0.0 % open
Cooling Valve
30.9 % open
SF VFD
43.8 Hz
Average Room Temp.
72.8 deg F
Building Pressure
0.056 in wc
OA Temp
86.8 deg F
Enthalpy
33.8 Btu
SETPOINTS
Calc. Disch. Temp 56.8 deg F
Economizer 23.0 Btu
Disch. Pressure 2.0 in wc
Return Humidity 70.0 %
Avg. Room Heating 70.0 deg F
Warmup Disch. 80.0 deg F
Mixed Air Pressure -0.378 in wc
COMMAND
Occupied Occupied
ALARMS
Low Temp. (LT-A) Normal
Smoke (SMK-A) Normal
Static (SP-A) Normal
Filter Status (FILT-S) Clean
ROOM TEMPS
Lowest Room Temp 65.8 deg F
Highest Room Temp 78.2 deg F
CENTRAL PLANT
Heating Lockout True
Chilled Wtr Supply Temp. 45.1 deg F
Hot Wtr. Supply Temp. 79.4 deg F
AHU-2 AHU-3 AHU-4 AHU-5 AHU-6 AHU-7 AHU-8 Chilled Wtr Sys Cond Wtr Sys Hot Wtr Sys
All Alarms Snoozed.
Server: 8/2/05 11:48 AM CDT


AHU 1
AHU 1 AHU 2 AHU 3 AHU 4 AHU 5
OA Temp 77.5 °F
OA Hum. 15.0 %RH
Controller Status: Normal
Optimum Start
Floor 1
Floor 2
Floor 3
Mech Rm
VFD Status
VAV Boxes
Max Co2 591.0 ppm
RF Amps 4.60 A
RF VFD 50.67 %
RF CMD FAN ON
RF Alarm NORMAL
RA FLOW SP 11329.00 cfm
Lo Static NORMAL
Return Flow 11251.00 cfm
RAT 71.20 °F
RA Humidity 43.00 %RH
CO2 527.00 ppm
RA Smoke NORMAL
RA Damper 71.0 %
MAT SP 53.00 °F
PHT SP 52.00 °F
SF Amps 18.80 A
SF VFD 64.17 %
DAT SP 55.0 °F
Static SP 1.30 inwc
Pre-Filter 0.08 inwc
MAT 73.20 °F
PHT 73.20 °F
LO TEMP NORMAL
SF S/S FAN ON
SF Alarm NORMAL
High Static NORMAL
DAT 54.60 °F
DA Static 1.31 inwc
OA Damper 71.00 %
OA Flow 3967.00 cfm
MOA Flow SP 5500.00 cfm
Design Flow 7000.00 cfm
ABS MOA Flow 5500.00 cfm
Final Filter 0.21 inwc
PHC Valve % Open 0.00 %
CW Valve % Open 60.00 %
Unit Status
Unit Mode Occupied
Economizer Disabled
Purge Enable Enabled
Heat Request 12
Cool Request 1
Request SP 4
SA Smoke NORMAL
Supply Flow 14328.00 cfm
Date & Time: 6:44 pm 13-Sep-2007

Additional Info pages

	SF VFD	RF VFD
Speed	64.17 %	50.67 %
Frequency	30.40 hz	29.00 hz
RPM	1135.00 rpm	887.00 rpm
Voltage	295.00 V	176.00 V
Run Hours	1636.00 hrs	1602.00 hrs
Power	6.30 kW	0.70 kW
Current	18.80 A	4.60 A
Fault	Normal	Normal
Running Status	Running	Running

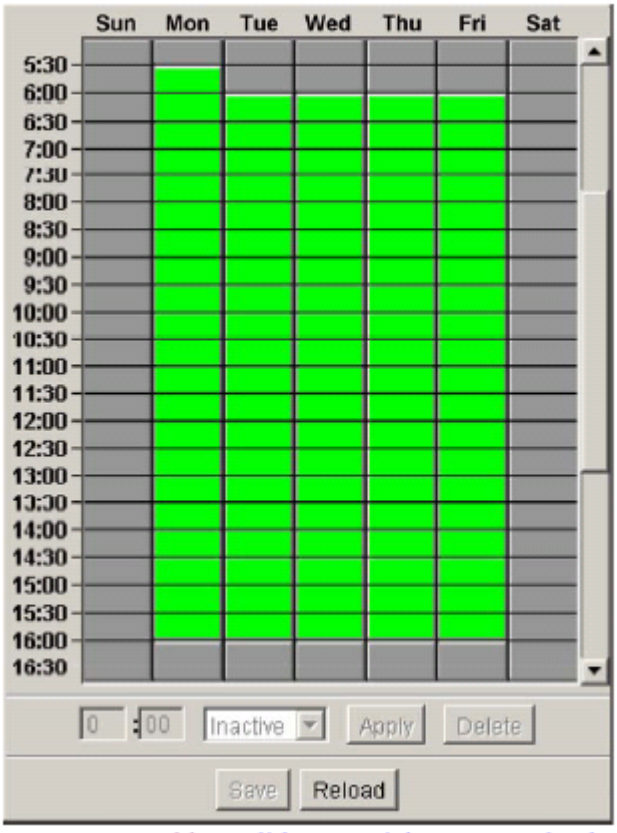
Cool Down Setpoint	74.00
Warm Up Setpoint	73.00
Selected Rm Temp	73.90
Oa Change Over	65.00
Max Space Temp	73.90
Min Space Temp	64.50

Optimal Start Status

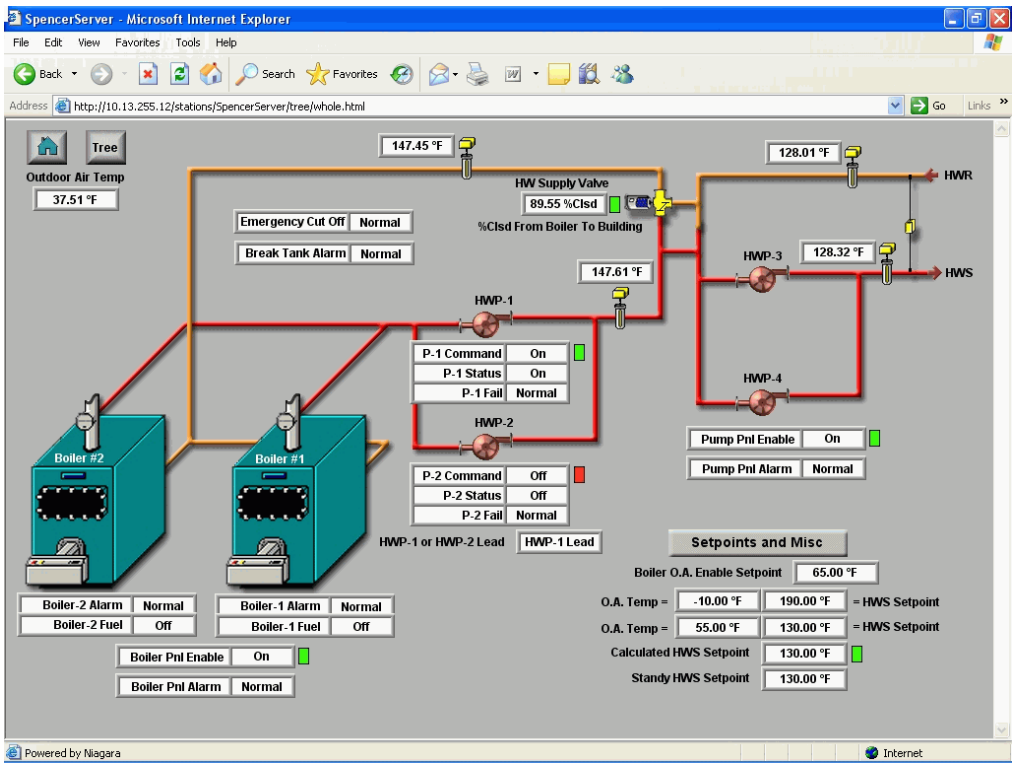
Scheduled Start: 6:00am 14-Sep-2007

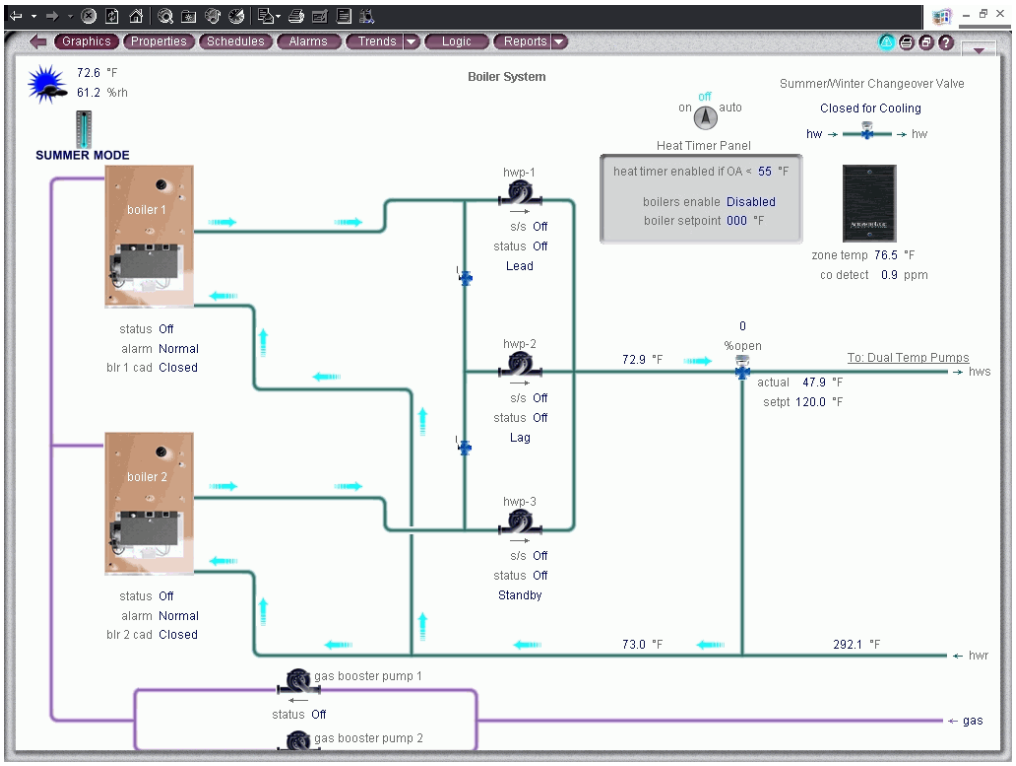
Schedule

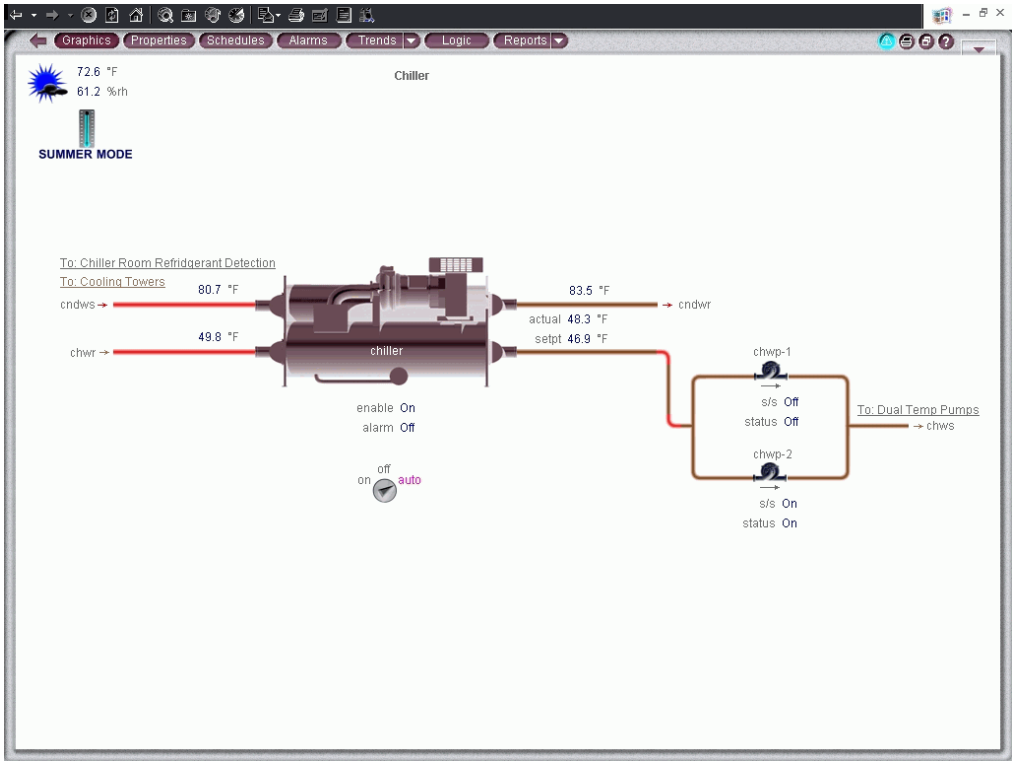
Weekly Schedule: /Albany_Park/Albany/AHU_1/Schedule

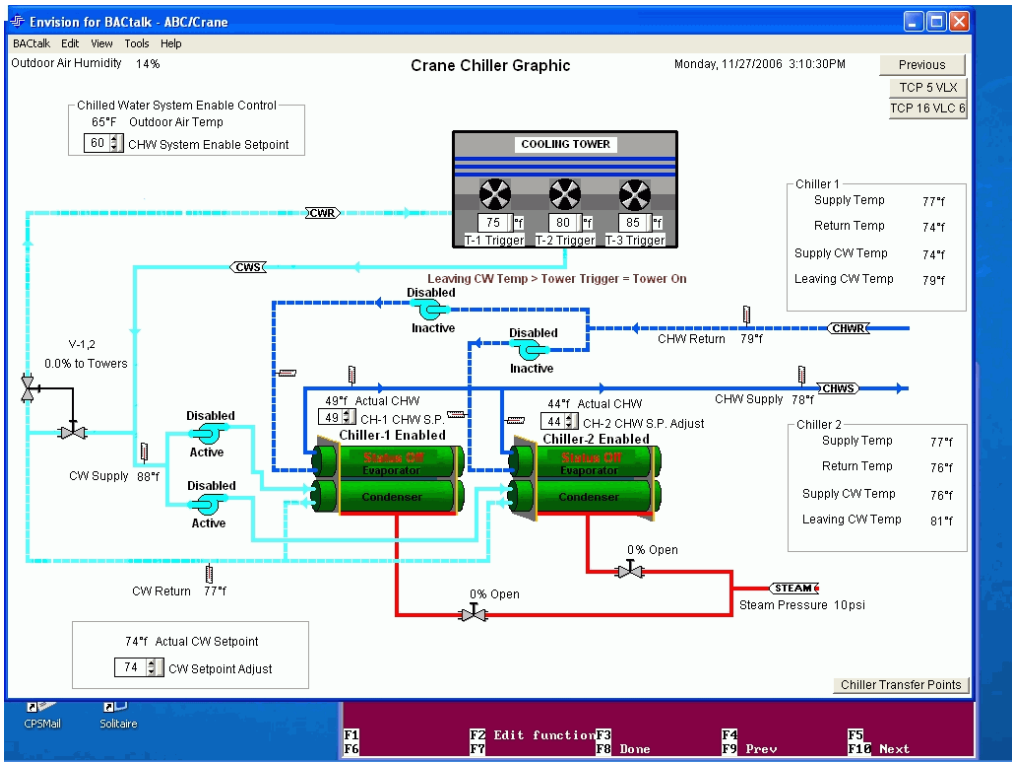


Summary Weekly Holiday Special Events Calendar


SpencerServer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.13.255.12/stations/SpencerServer/tree/whole.html
Go Links
Tree
Outdoor Air Temp
37.51 °F
147.45 °F
HW Supply Valve
89.55 %Clsd
%Clsd From Boiler To Building
Emergency Cut Off Normal
Break Tank Alarm Normal
147.61 °F
128.01 °F
HWR
HWP-3
128.32 °F
HWS
HWP-1
P-1 Command On
P-1 Status On
P-1 Fail Normal
HWP-4
HWP-2
P-2 Command Off
P-2 Status Off
P-2 Fail Normal
Pump Pnl Enable On
Pump Pnl Alarm Normal
Boiler #2
Boiler #1
HWP-1 or HWP-2 Lead
HWP-1 Lead
Setpoints and Misc
Boiler O.A. Enable Setpoint 65.00 °F
O.A. Temp = -10.00 °F 190.00 °F = HWS Setpoint
O.A. Temp = 55.00 °F 130.00 °F = HWS Setpoint
Calculated HWS Setpoint 130.00 °F
Standy HWS Setpoint 130.00 °F
Boiler-2 Alarm Normal
Boiler-2 Fuel Off
Boiler-1 Alarm Normal
Boiler-1 Fuel Off
Boiler Pnl Enable On
Boiler Pnl Alarm Normal
Powered by Niagara
Internet


Graphics Properties Schedules Alarms Trends Logic Reports
72.6 °F
61.2 %rh
Boiler System
SUMMER MODE
Summer/Winter Changeover Valve
off
on auto
Closed for Cooling
hw hw
Heat Timer Panel
heat timer enabled if OA < 55 °F
boilers enable Disabled
boiler setpoint 000 °F
zone temp 76.5 °F
co detect 0.9 ppm
boiler 1
status Off
alarm Normal
blr 1 cad Closed
hwp-1
s/s Off
status Off
Lead
hwp-2
s/s Off
status Off
Lag
hwp-3
s/s Off
status Off
Standby
boiler 2
status Off
alarm Normal
blr 2 cad Closed
0
%open
72.9 °F
To: Dual Temp Pumps
hws
actual 47.9 °F
setpt 120.0 °F
73.0 °F
292.1 °F
hwr
gas booster pump 1
status Off
gas booster pump 2
gas


Graphics
Properties
Schedules
Alarms
Trends
Logic
Reports
72.6 °F
61.2 %rh
Chiller
SUMMER MODE
To: Chiller Room Refridgerant Detection
To: Cooling Towers
cndws
80.7 °F
chwr
49.8 °F
chiller
83.5 °F
cndwr
actual 48.3 °F
setpt 46.9 °F
enable On
alarm Off
off
on
auto
chwp-1
s/s Off
status Off
chwp-2
s/s On
status On
To: Dual Temp Pumps
chws


Envision for BACtalk - ABC/Crane
BACtalk Edit View Tools Help
Outdoor Air Humidity 14%
Crane Chiller Graphic
Monday, 11/27/2006 3:10:30PM
Previous
TCP 5 VLX
TCP 16 VLC 6
Chilled Water System Enable Control
65°F Outdoor Air Temp
60 CHW System Enable Setpoint
COOLING TOWER
75 °f T-1 Trigger
80 °f T-2 Trigger
85 °f T-3 Trigger
CWR
CWS
Leaving CW Temp > Tower Trigger = Tower On
Disabled
Inactive
Disabled
Inactive
CHW Return 79°f
CHWR
V-1,2
0.0% to Towers
CW Supply 88°f
Disabled
Active
Disabled
Active
49°f Actual CHW
49 CH-1 CHW S.P.
Chiller-1 Enabled
Status Off
Evaporator
Condenser
44°f Actual CHW
44 CH-2 CHW S.P. Adjust
Chiller-2 Enabled
Status Off
Evaporator
Condenser
CHW Supply 78°f
CHWS
Chiller 1
Supply Temp 77°f
Return Temp 74°f
Supply CW Temp 74°f
Leaving CW Temp 79°f
Chiller 2
Supply Temp 77°f
Return Temp 76°f
Supply CW Temp 76°f
Leaving CW Temp 81°f
0% Open
CW Return 77°f
0% Open
STEAM
Steam Pressure 10psi
74°f Actual CW Setpoint
74 CW Setpoint Adjust
Chiller Transfer Points
CPSMail
Solitaire
F1 F6
F2 Edit function F7
F3 F8 Done
F4 F9 Prev
F5 F10 Next

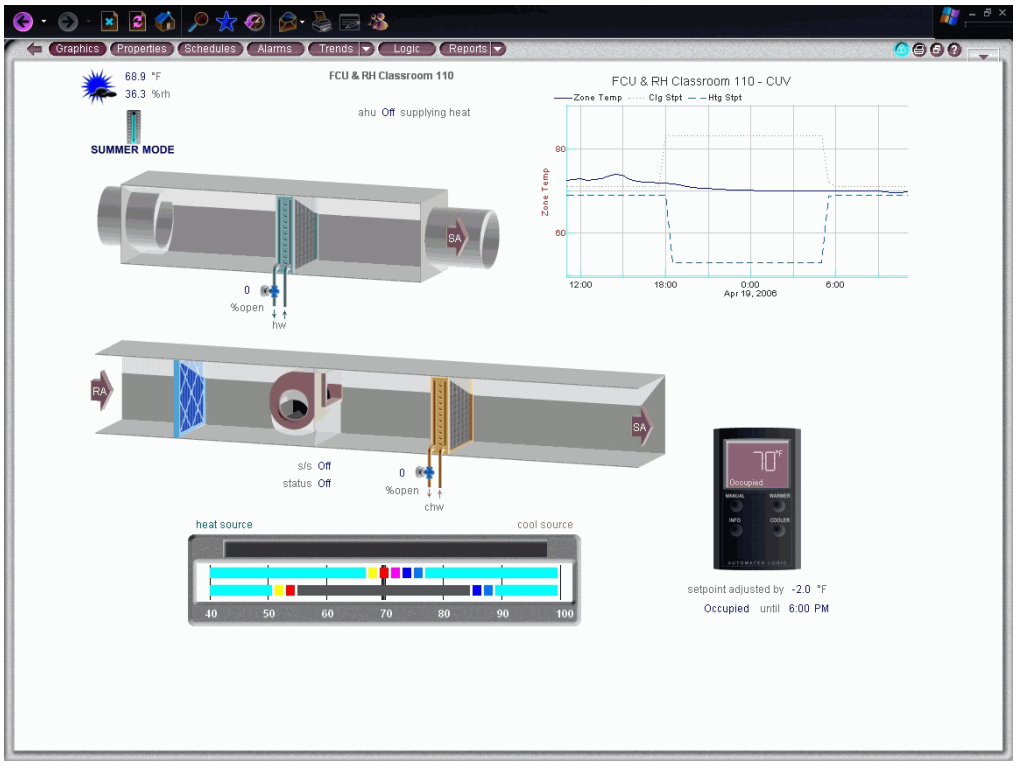
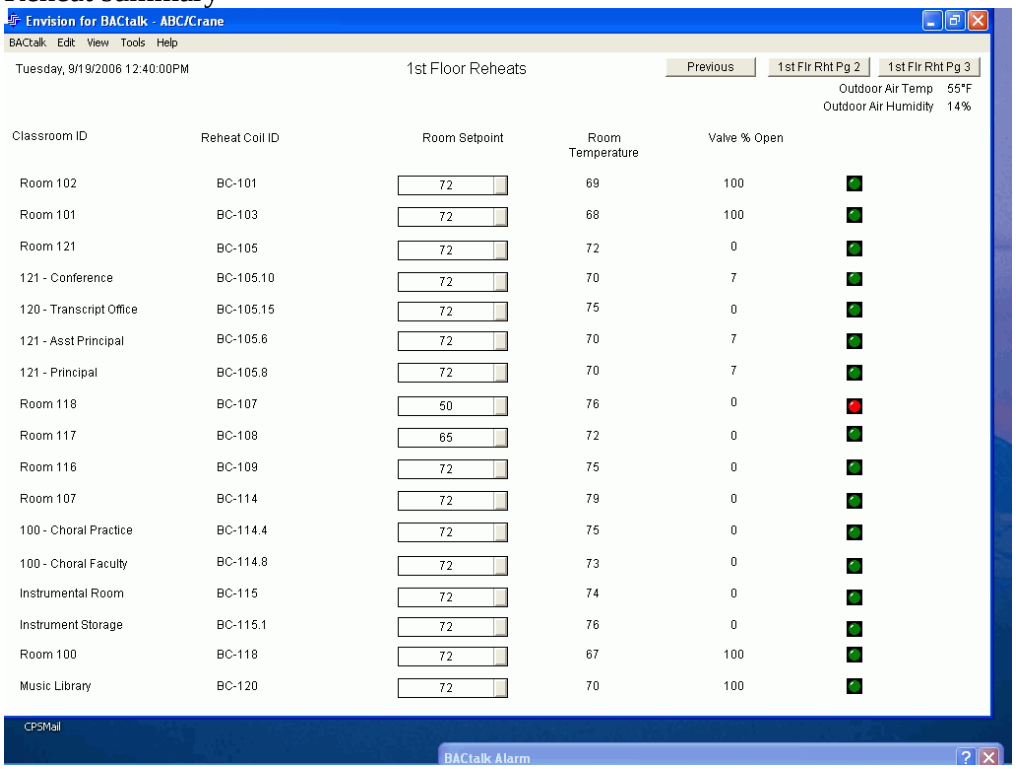
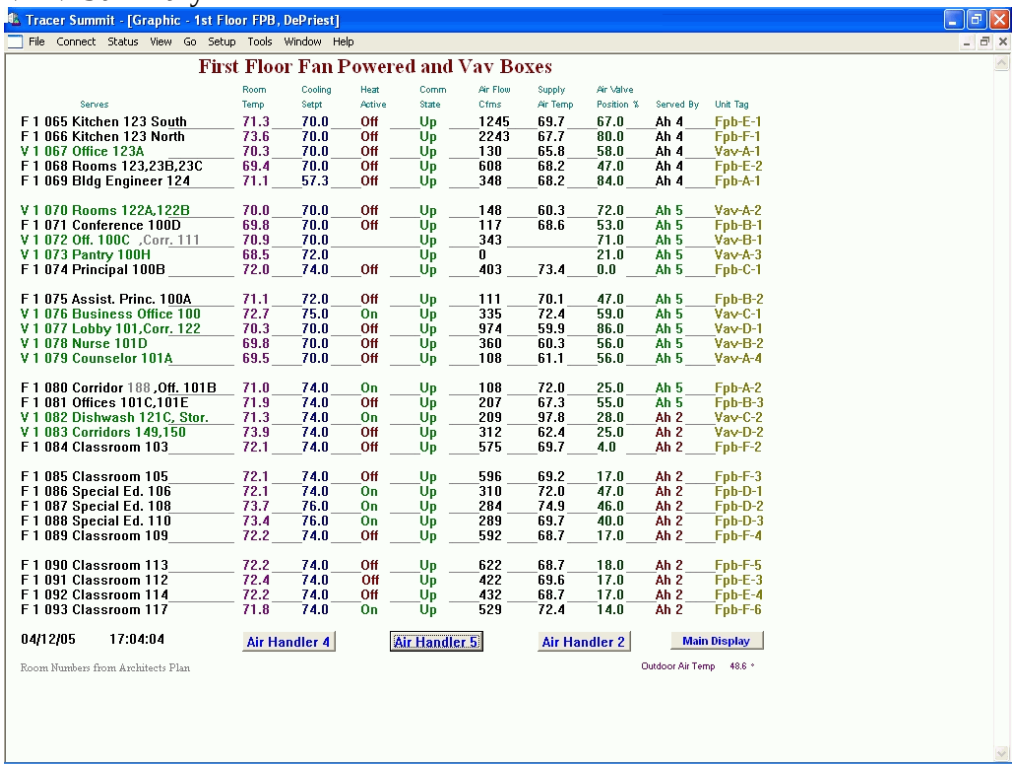

Graphics
Properties
Schedules
Alarms
Trends
Logic
Reports
68.9 °F
36.3 %rh
SUMMER MODE
FCU & RH Classroom 110
ahu Off supplying heat
FCU & RH Classroom 110 - CUV
Zone Temp
Clg Stpt
Htg Stpt
Zone Temp
80
60
12:00
18:00
0:00
Apr 19, 2006
6:00
SA
0
%open
hw
RA
SA
s/s Off
status Off
0
%open
chw
heat source
cool source
40
50
60
70
80
90
100
70°F
Occupied
setpoint adjusted by -2.0 °F
Occupied until 6:00 PM

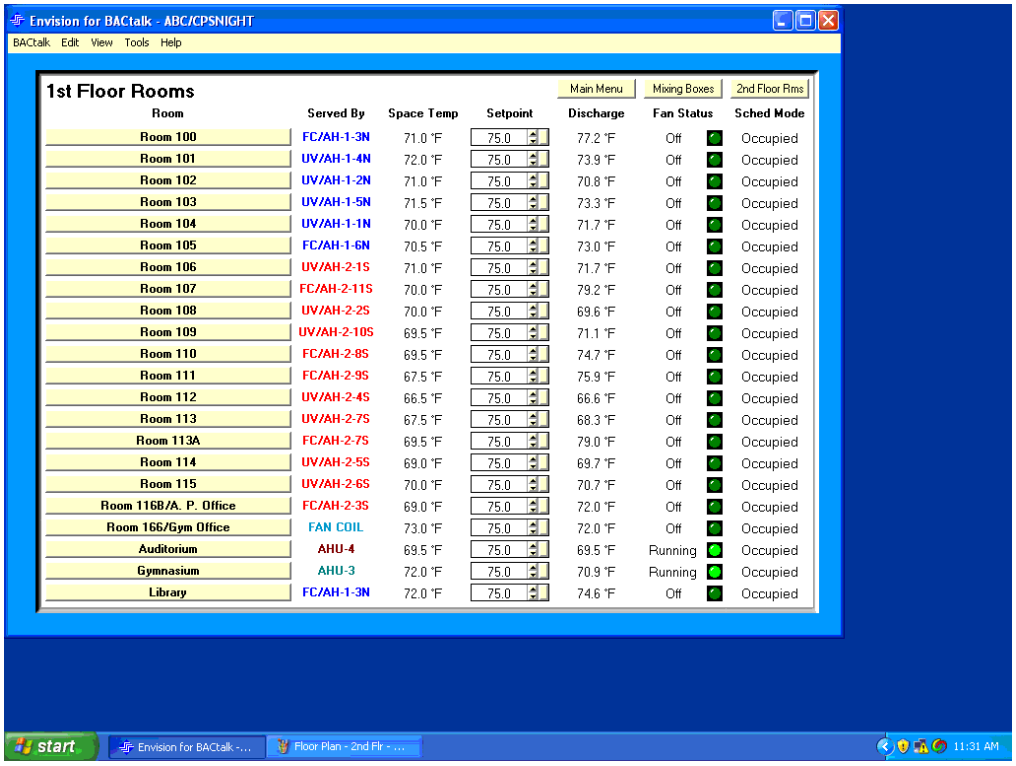
EXHIBIT D System Summary Example Graphics

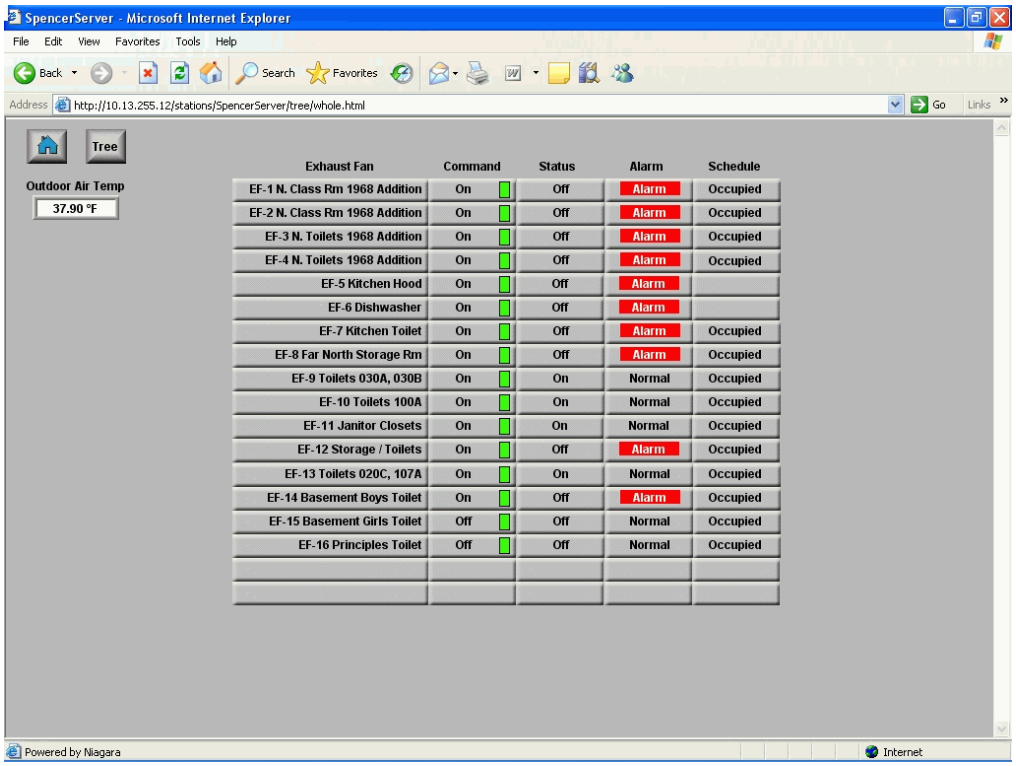
Reheat summary



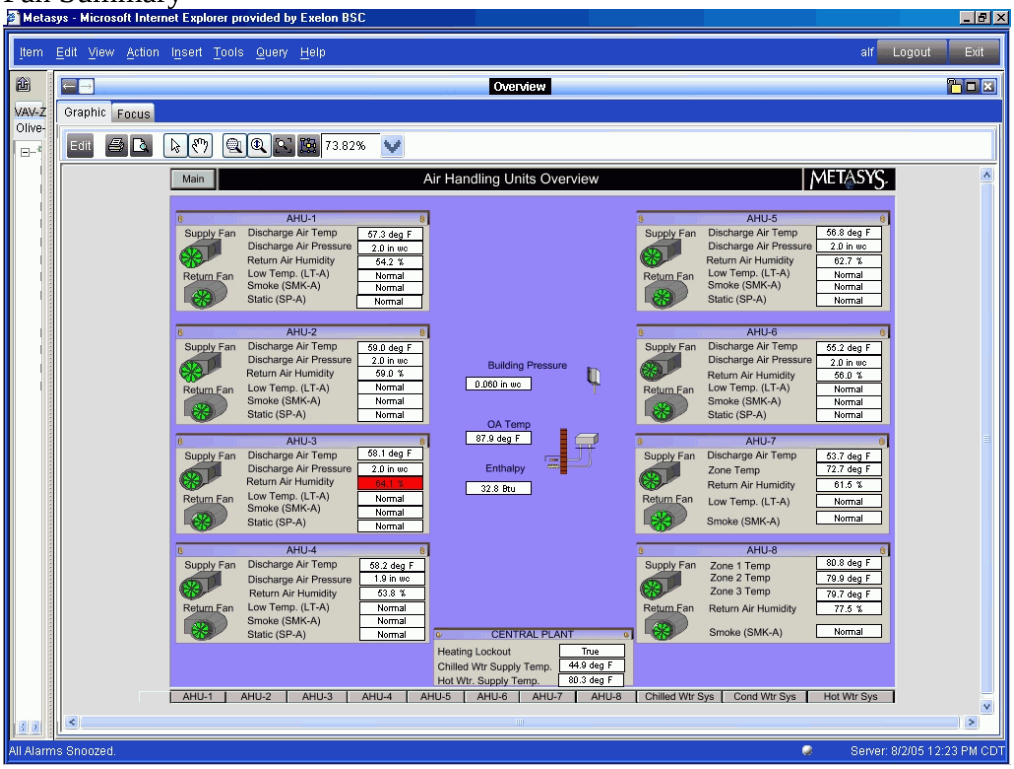
VAV Summary



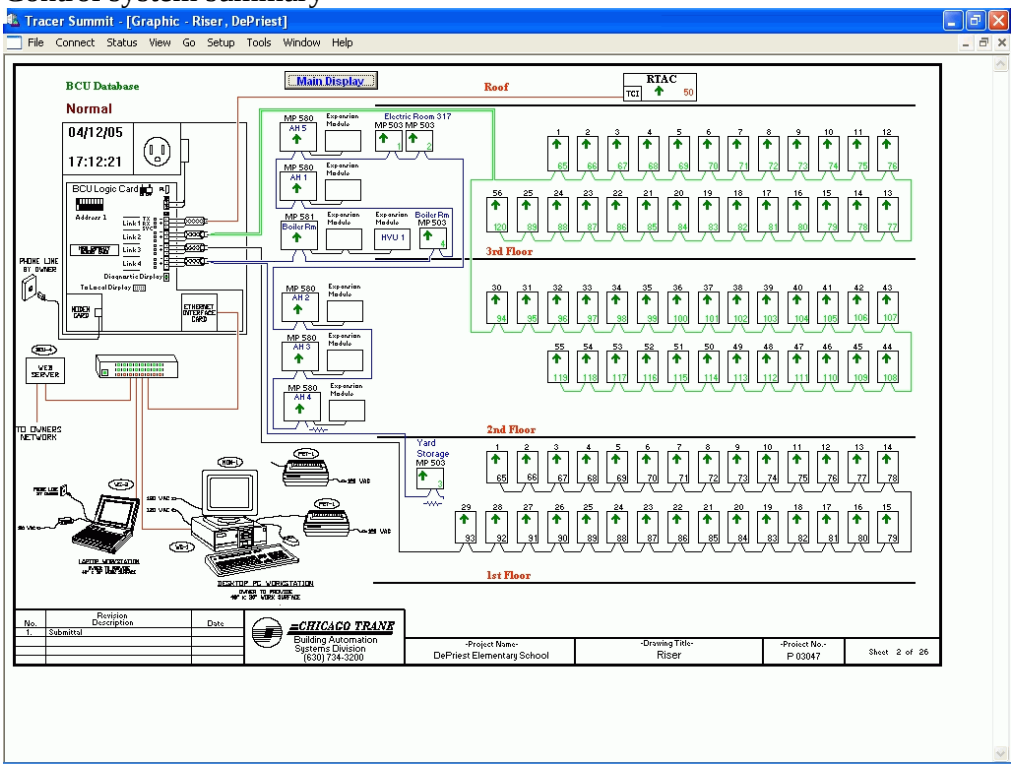

Envision for BACtalk - ABC/CPSNIGHT
BACtalk Edit View Tools Help
1st Floor Rooms
Main Menu
Mixing Boxes
2nd Floor Rms
Room | Served By | Space Temp | Setpoint | Discharge | Fan Status | Sched Mode
Room 100 | FC/AH-1-3N | 71.0 °F | 75.0 | 77.2 °F | Off | Occupied
Room 101 | UV/AH-1-4N | 72.0 °F | 75.0 | 73.9 °F | Off | Occupied
Room 102 | UV/AH-1-2N | 71.0 °F | 75.0 | 70.8 °F | Off | Occupied
Room 103 | UV/AH-1-5N | 71.5 °F | 75.0 | 73.3 °F | Off | Occupied
Room 104 | UV/AH-1-1N | 70.0 °F | 75.0 | 71.7 °F | Off | Occupied
Room 105 | FC/AH-1-6N | 70.5 °F | 75.0 | 73.0 °F | Off | Occupied
Room 106 | UV/AH-2-1S | 71.0 °F | 75.0 | 71.7 °F | Off | Occupied
Room 107 | FC/AH-2-11S | 70.0 °F | 75.0 | 79.2 °F | Off | Occupied
Room 108 | UV/AH-2-2S | 70.0 °F | 75.0 | 69.6 °F | Off | Occupied
Room 109 | UV/AH-2-10S | 69.5 °F | 75.0 | 71.1 °F | Off | Occupied
Room 110 | FC/AH-2-8S | 69.5 °F | 75.0 | 74.7 °F | Off | Occupied
Room 111 | FC/AH-2-9S | 67.5 °F | 75.0 | 75.9 °F | Off | Occupied
Room 112 | UV/AH-2-4S | 66.5 °F | 75.0 | 66.6 °F | Off | Occupied
Room 113 | UV/AH-2-7S | 67.5 °F | 75.0 | 68.3 °F | Off | Occupied
Room 113A | FC/AH-2-7S | 69.5 °F | 75.0 | 79.0 °F | Off | Occupied
Room 114 | UV/AH-2-5S | 69.0 °F | 75.0 | 69.7 °F | Off | Occupied
Room 115 | UV/AH-2-6S | 70.0 °F | 75.0 | 70.7 °F | Off | Occupied
Room 116B/A. P. Office | FC/AH-2-3S | 69.0 °F | 75.0 | 72.0 °F | Off | Occupied
Room 166/Gym Office | FAN COIL | 73.0 °F | 75.0 | 72.0 °F | Off | Occupied
Auditorium | AHU-4 | 69.5 °F | 75.0 | 69.5 °F | Running | Occupied
Gymnasium | AHU-3 | 72.0 °F | 75.0 | 70.9 °F | Running | Occupied
Library | FC/AH-1-3N | 72.0 °F | 75.0 | 74.6 °F | Off | Occupied
start
Envision for BACtalk -...
Floor Plan - 2nd Flr - ...
11:31 AM


SpencerServer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.13.255.12/stations/SpencerServer/tree/whole.html
Go Links
Tree
Outdoor Air Temp
37.90 °F
Exhaust Fan | Command | Status | Alarm | Schedule
EF-1 N. Class Rm 1968 Addition | On | Off | Alarm | Occupied
EF-2 N. Class Rm 1968 Addition | On | Off | Alarm | Occupied
EF-3 N. Toilets 1968 Addition | On | Off | Alarm | Occupied
EF-4 N. Toilets 1968 Addition | On | Off | Alarm | Occupied
EF-5 Kitchen Hood | On | Off | Alarm |
EF-6 Dishwasher | On | Off | Alarm |
EF-7 Kitchen Toilet | On | Off | Alarm | Occupied
EF-8 Far North Storage Rm | On | Off | Alarm | Occupied
EF-9 Toilets 030A, 030B | On | On | Normal | Occupied
EF-10 Toilets 100A | On | On | Normal | Occupied
EF-11 Janitor Closets | On | On | Normal | Occupied
EF-12 Storage / Toilets | On | Off | Alarm | Occupied
EF-13 Toilets 020C, 107A | On | On | Normal | Occupied
EF-14 Basement Boys Toilet | On | Off | Alarm | Occupied
EF-15 Basement Girls Toilet | Off | Off | Normal | Occupied
EF-16 Principles Toilet | Off | Off | Normal | Occupied
Powered by Niagara
Internet

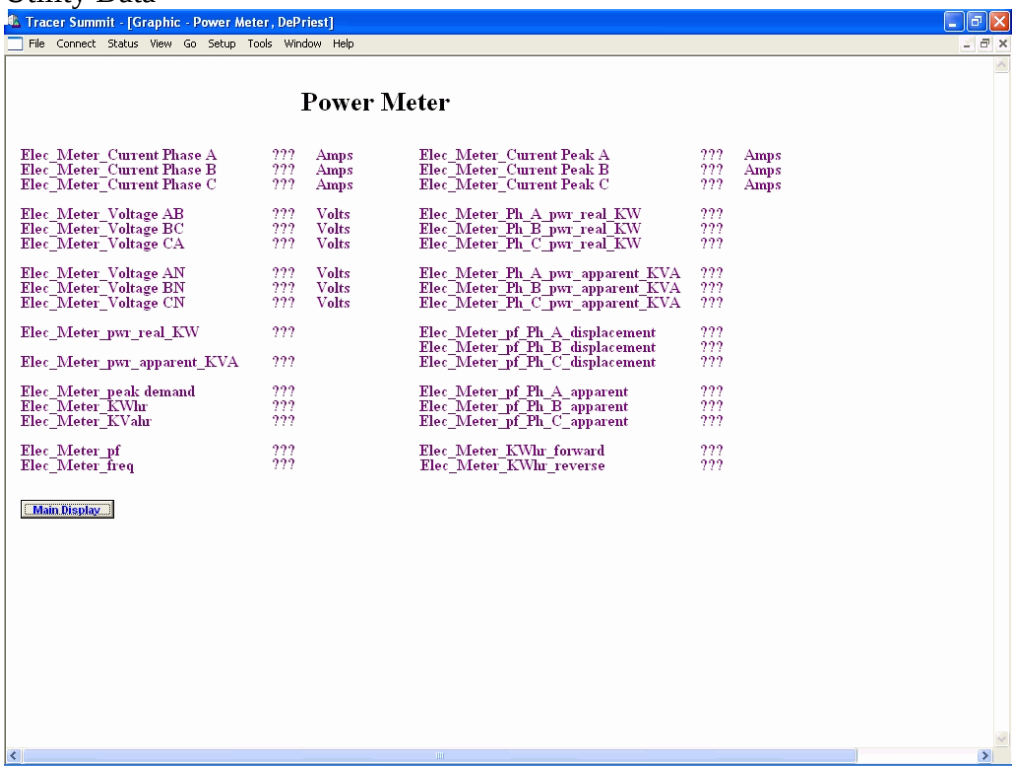
Fan Summary



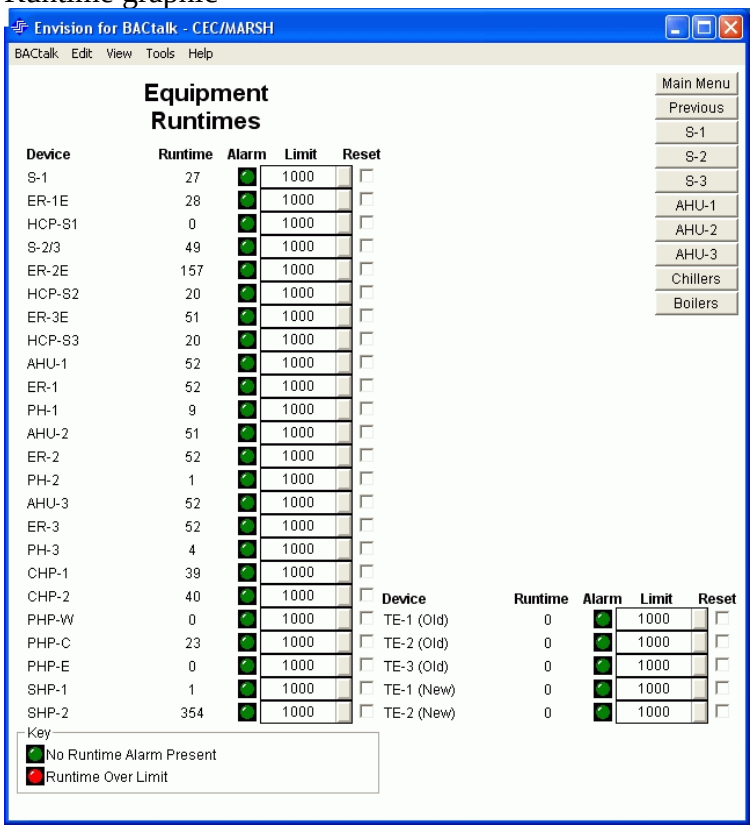
Control system summary

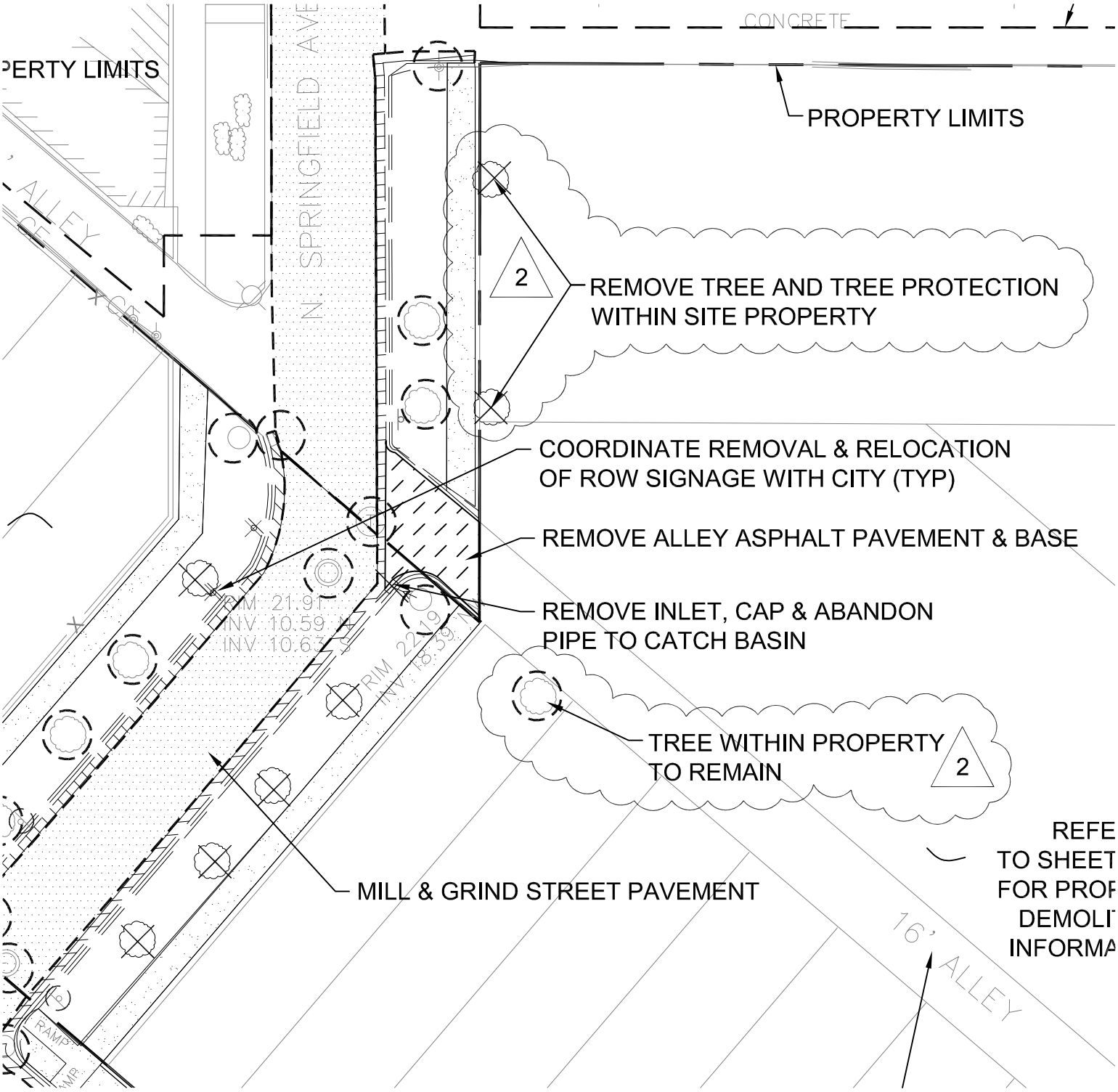


Utility Data



Runtime graphic





SMNG-A Architects, Ltd.
Schroeder Murchie
Niemiec Gazda-Auskalnis

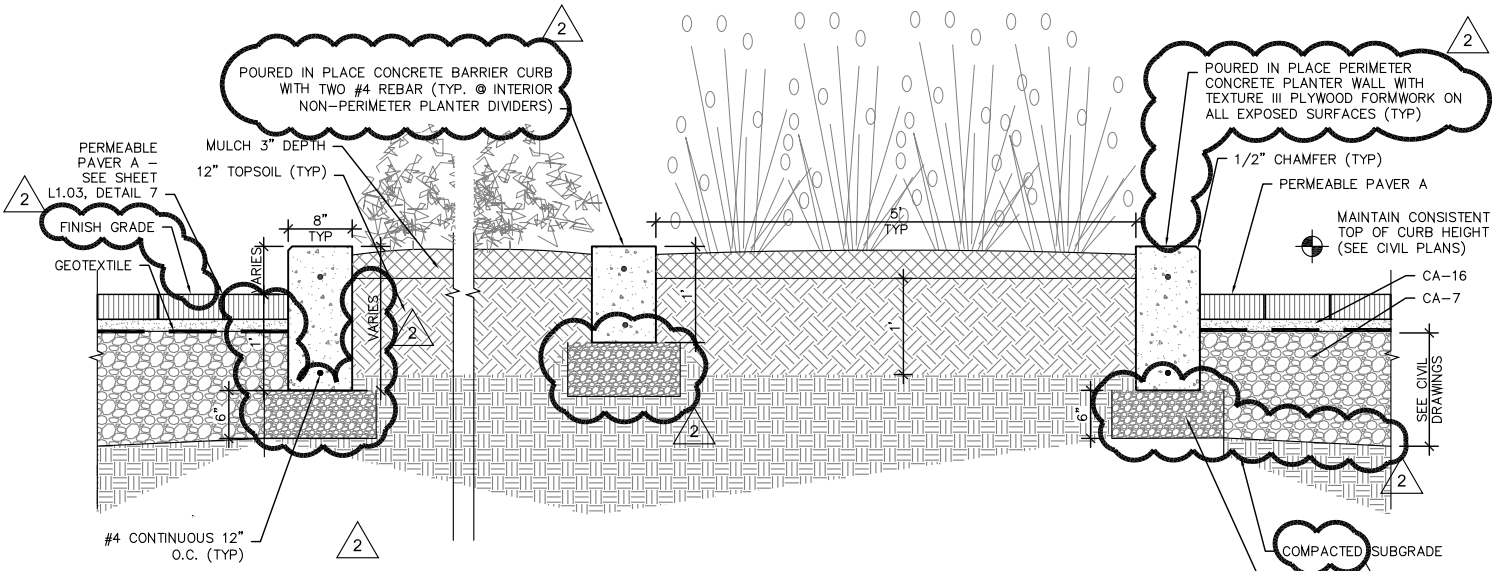
Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

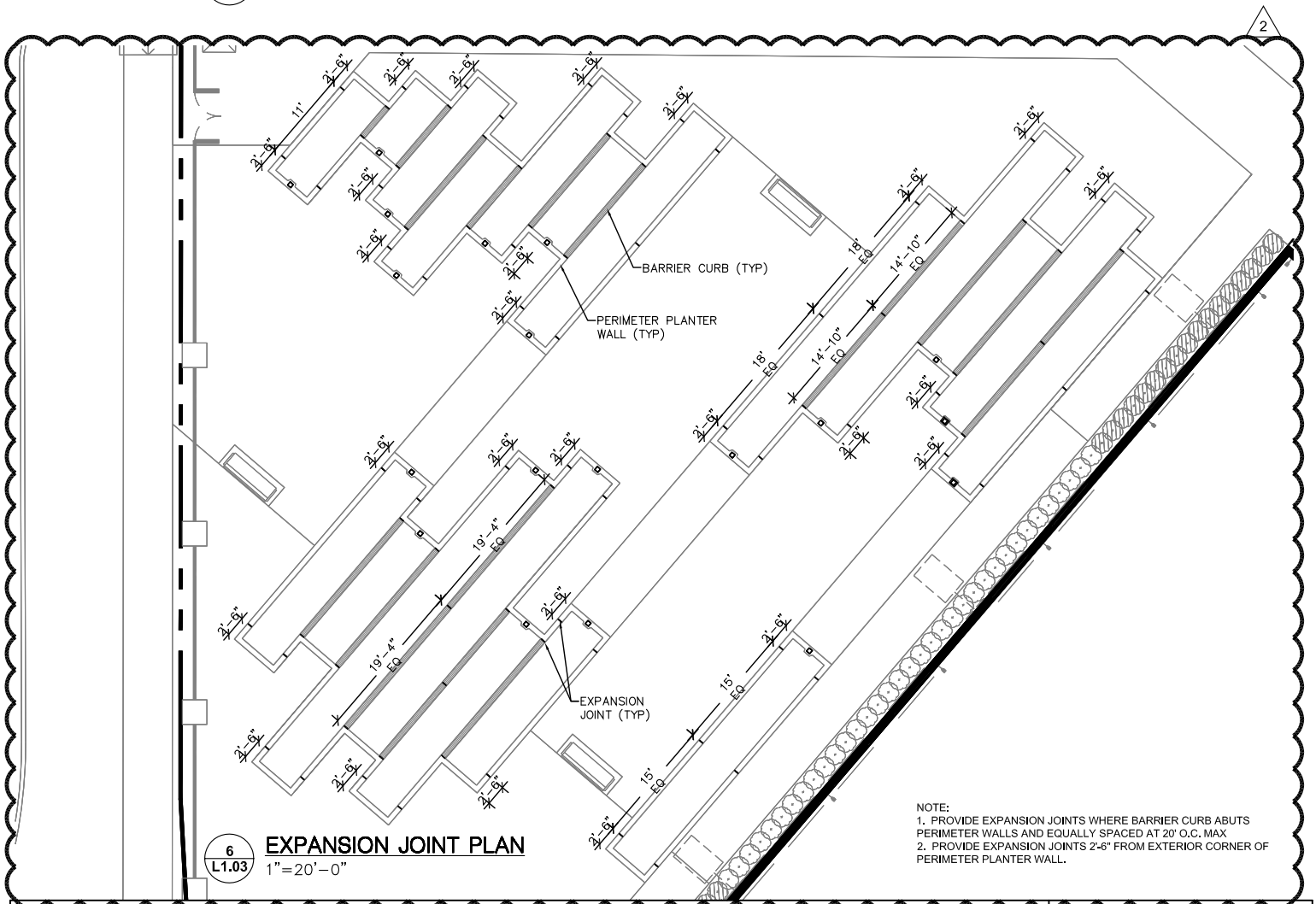
PROJECT:	AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL
SMNG-A NO.:	0732
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2
TITLE:	ADDITIONAL TREE REMOVAL SCOPE
COMMENTS:	ADDENDUM TO SHEET C1.0

ISSUE DATE: 12.09.08

CSK-01



2 / L1.02 **PRAIRIE PLANTER SECTION**
1"=1'-0"



6 / L1.03 **EXPANSION JOINT PLAN**
1"=20'-0"

NOTE:
1. PROVIDE EXPANSION JOINTS WHERE BARRIER CURB ABUTS PERIMETER WALLS AND EQUALLY SPACED AT 20' O.C. MAX
2. PROVIDE EXPANSION JOINTS 2'-6" FROM EXTERIOR CORNER OF PERIMETER PLANTER WALL.

SMNG-A Architects, Ltd.
Schroeder Murchie
Niemiec Gazda-Auskalnis

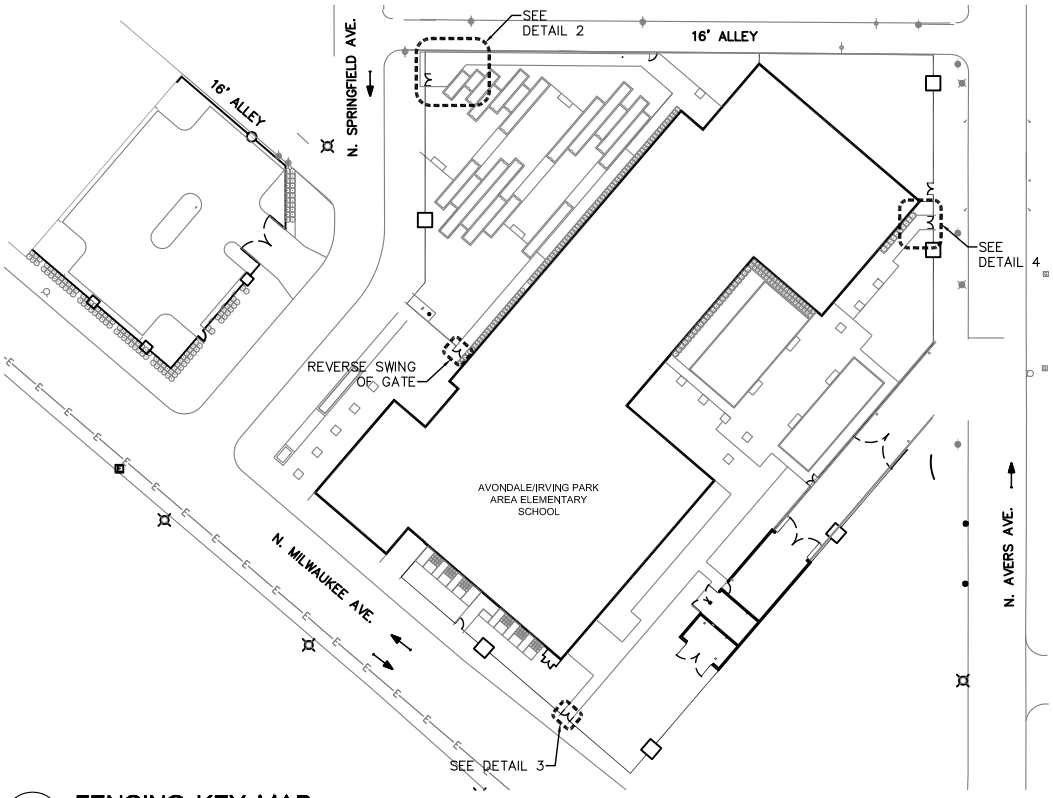
Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

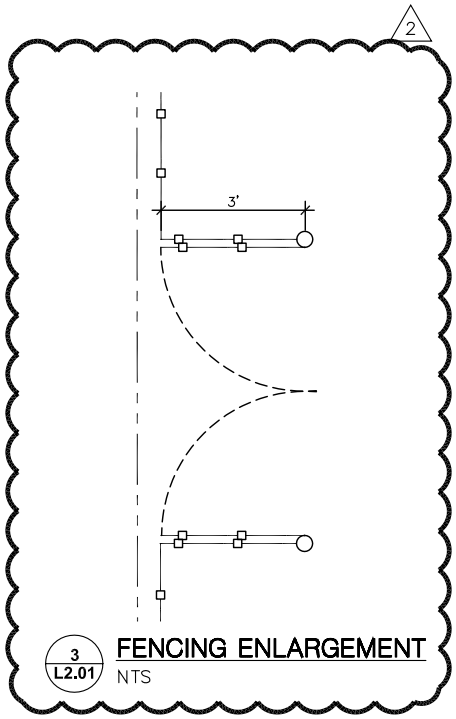
PROJECT: AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL
SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: PRAIRIE PLANTER DETAILS
COMMENTS: -

ISSUE DATE: 12.09.08

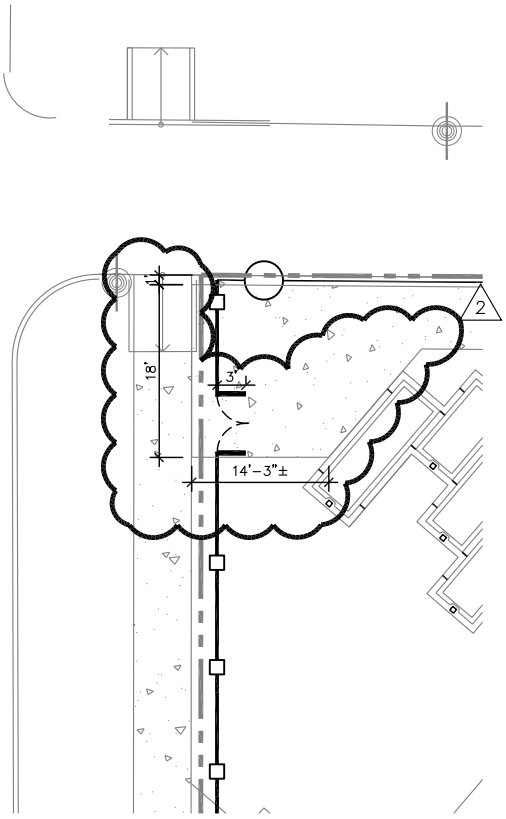
LSK-01



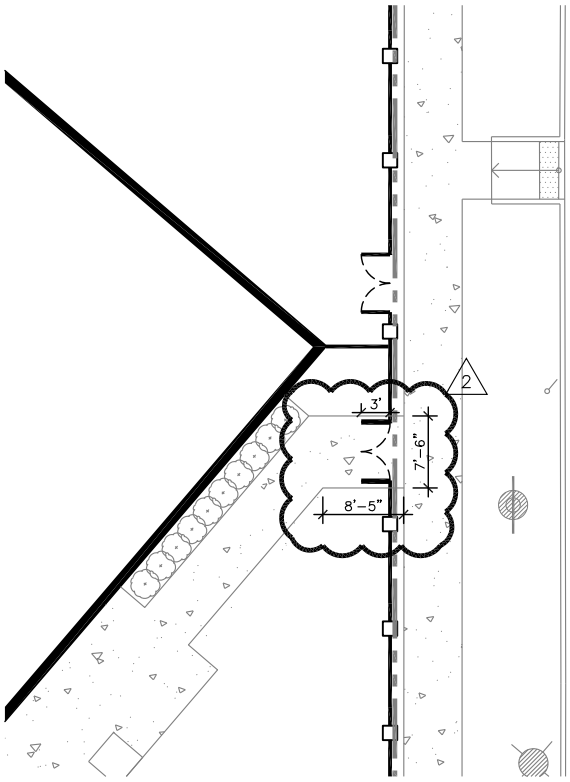
1 FENCING KEY MAP
NTS



3 / L2.01 FENCING ENLARGEMENT
NTS



2 PARTIAL FENCING & FURNISHING PLAN
1"=20'-0"



4 PARTIAL FENCING & FURNISHING PLAN
1"=20'-0"

SMNG-A Architects, Ltd.
Schroeder Murchie
Niemiec Gazda-Auskalnis

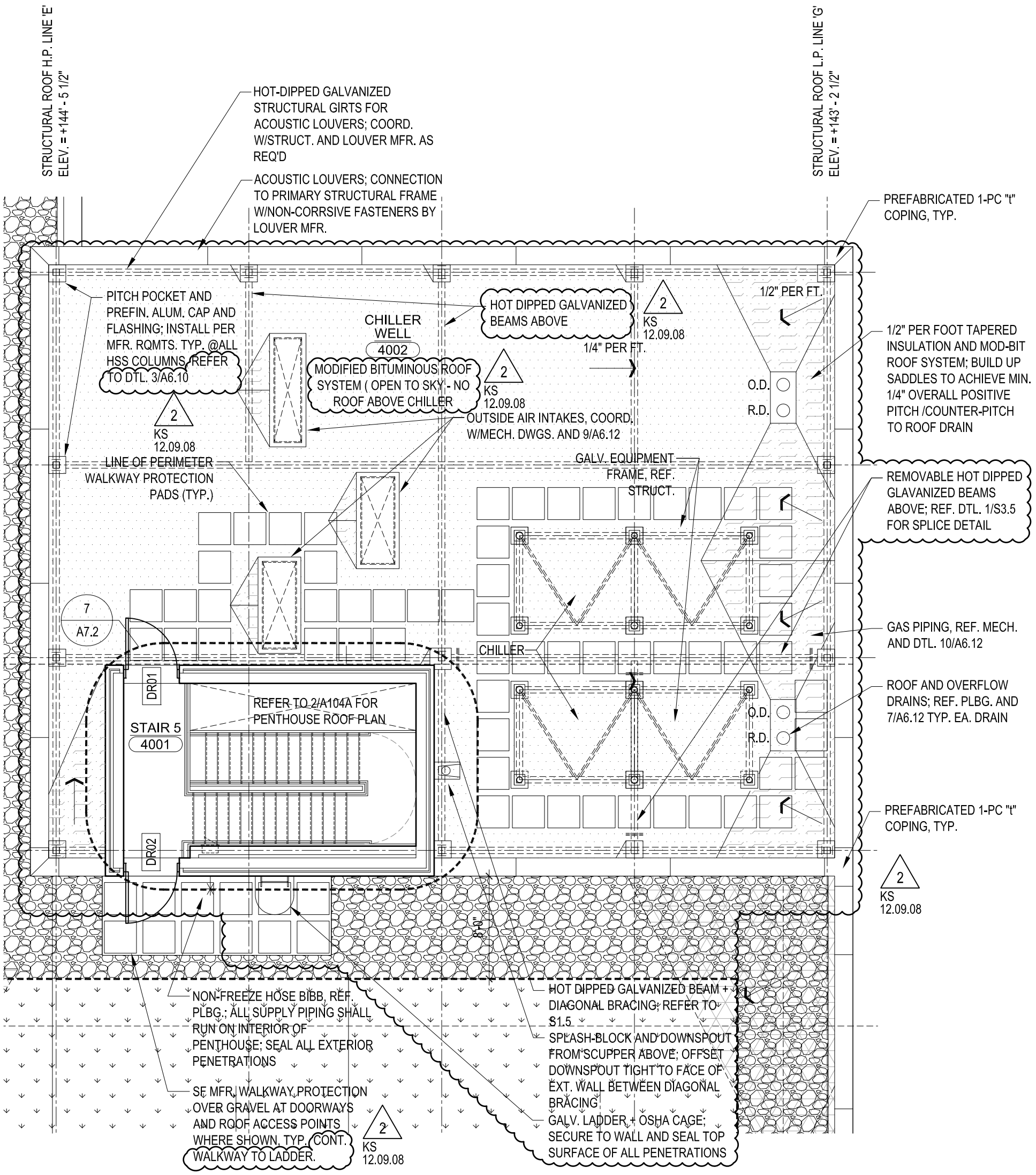
Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

PROJECT: AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL
SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: FENCING DETAILS
COMMENTS: -

ISSUE DATE: 12.09.08

LSK-02



ENLARGED PLAN

1 / A1.4A SCALE: 1/8" = 1'-0"

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Schroeder Murchie
Niemiec Gazda-Auskalnis

Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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SMNG-A NO.:	0732
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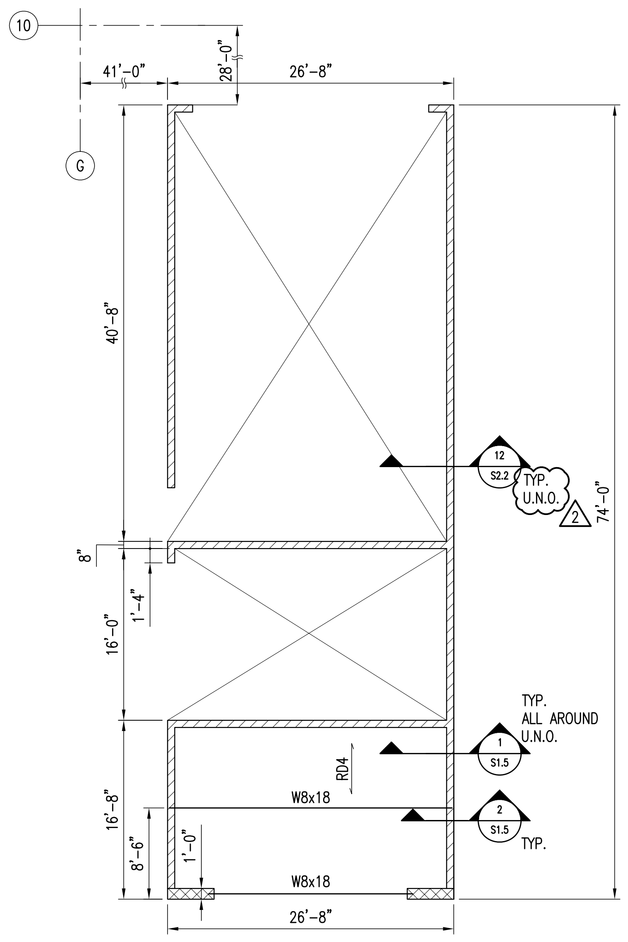
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2
TITLE:	ENLARGED PLAN
COMMENTS:	-

ISSUE DATE: 12.09.08

ASK-01

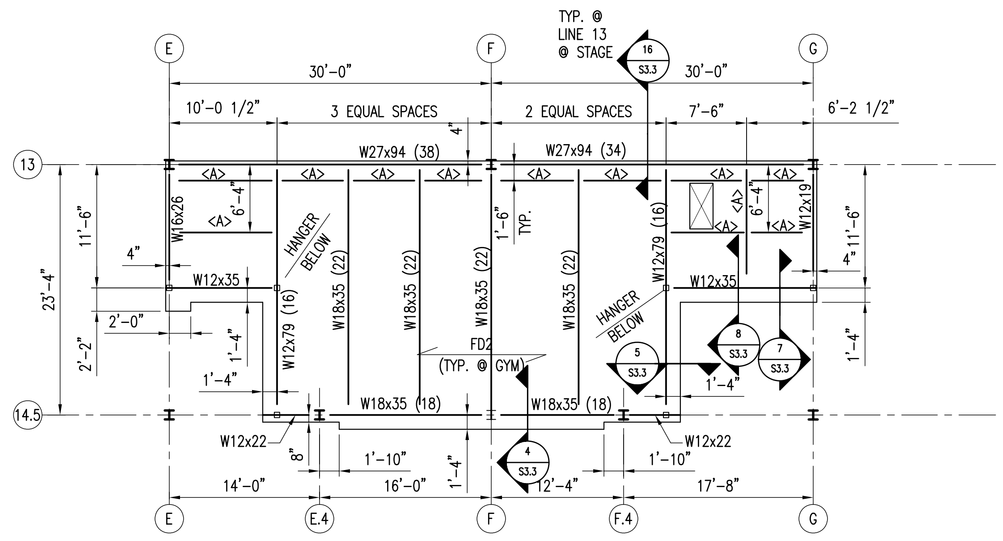


COMPACTOR/GEN./TRANS. ENCLOSURE ROOF PLAN

1/8"=1'-0"

NOTES:

1. VERIFY ALL DIMENSIONS AND ELEVATIONS WITH ARCH. DWGS.
2. SEE S0.1 FOR GENERAL STRUCTURAL NOTES.
3. _RD4_ INDICATES 2 1/4" GALV. METAL GRATING. GRATING TO BE SECURED TO STRUCTURAL STEEL SUPPORTS WITH GRATING CLAMPS TO ALLOW GRATING TO BE REMOVED AS NEEDED DURING TRANSFORMER INSTALLATION.
4. ALL EXPOSED STRUCTURAL STEEL AND GRATING AT TRANSFORMER ENCLOSURE TO BE HOT DIP GALVANIZED.
5. ▨ INDICATES 8" CMU WITH REINFORCEMENT AS SHOWN IN DETAIL 12/S2.2.
6. ▩ INDICATES 12" CMU WITH REINFORCEMENT AS SHOWN IN DETAIL 12/S2.2.

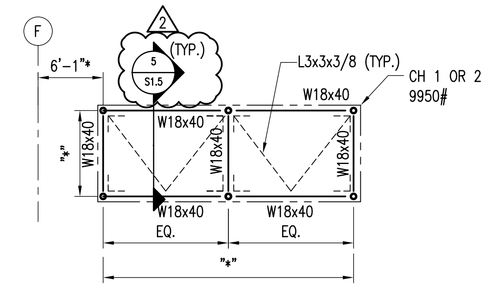


STAGE PLATFORM FRAMING PLAN

1/8"=1'-0"

NOTES:

1. VERIFY ALL DIMENSIONS AND ELEVATIONS WITH ARCH. DWGS. PRIOR TO CONSTRUCTION.
2. SEE S0.1 FOR GENERAL STRUCTURAL NOTES.
3. _FD2_ INDICATES 2"x18 GA. GALV. COMPOSITE FLOOR DECK W/3 1/4" LIGHT-WEIGHT CONCRETE (5 1/4" TOTAL THICKNESS) W/6x6 W1.4xW1.4 WWF. FLOOR DECK IS TOPPED WITH 4" LIGHT WEIGHT CONC. FLOATING SLAB W/ 4LBS. OF MACRO FIBER MESH REINFORCEMENT PER ONE CUBIC YARD OF CONCRETE. T/SLAB EL. +116'-8 1/2". SEE DETAIL 8/S3.2. FOR MORE INFORMATION.
4.<A> INDICATES W12x19 NON-COMPOSITE STEEL BEAM. SEE DETAIL 1/S3.2 FOR ADDITIONAL INFORMATION AT NON LOAD BRG. MASONRY WALLS ON DECK.

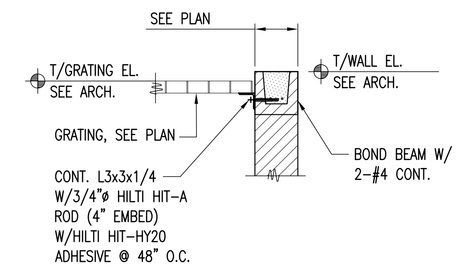


CHILLER SUPPORT FRAMING PLAN

1/8"=1'-0"

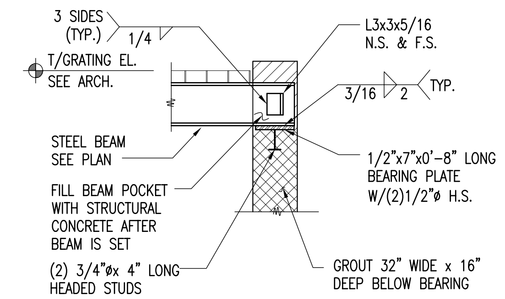
NOTES:

1. VERIFY ALL DIMENSIONS AND ELEVATIONS WITH ARCH. DWGS.
2. SEE S0.1 FOR GENERAL STRUCTURAL NOTES.
3. "*" INDICATES DIMENSIONS THAT GENERAL CONTRACTOR NEEDS TO COORDINATE WITH EXACT SIZE, PLACEMENT AND WEIGHT OF CHILLER.
4. SEE ARCH. DRAWINGS FOR T/STEEL ELEVATION.
5. ALL EXPOSED STRUCTURAL STEEL FOR CHILLER SUPPORT FRAMING TO BE HOT DIP GALVANIZED (TYP.).



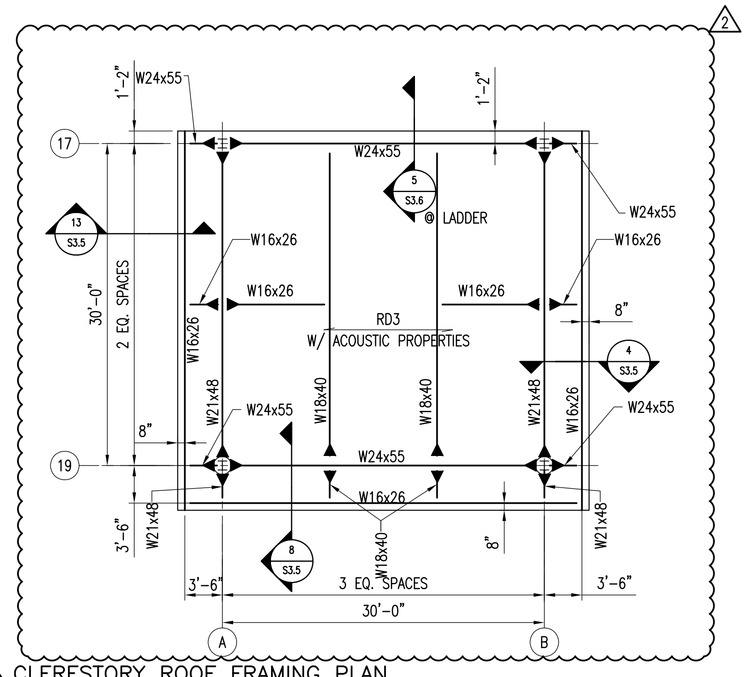
1 SECTION @ CLERESTORY ROOF

S1.5 — 3/4"=1'-0"



2 BEAM BRG. ON CMU WALL

S1.5 — 3/4"=1'-0"

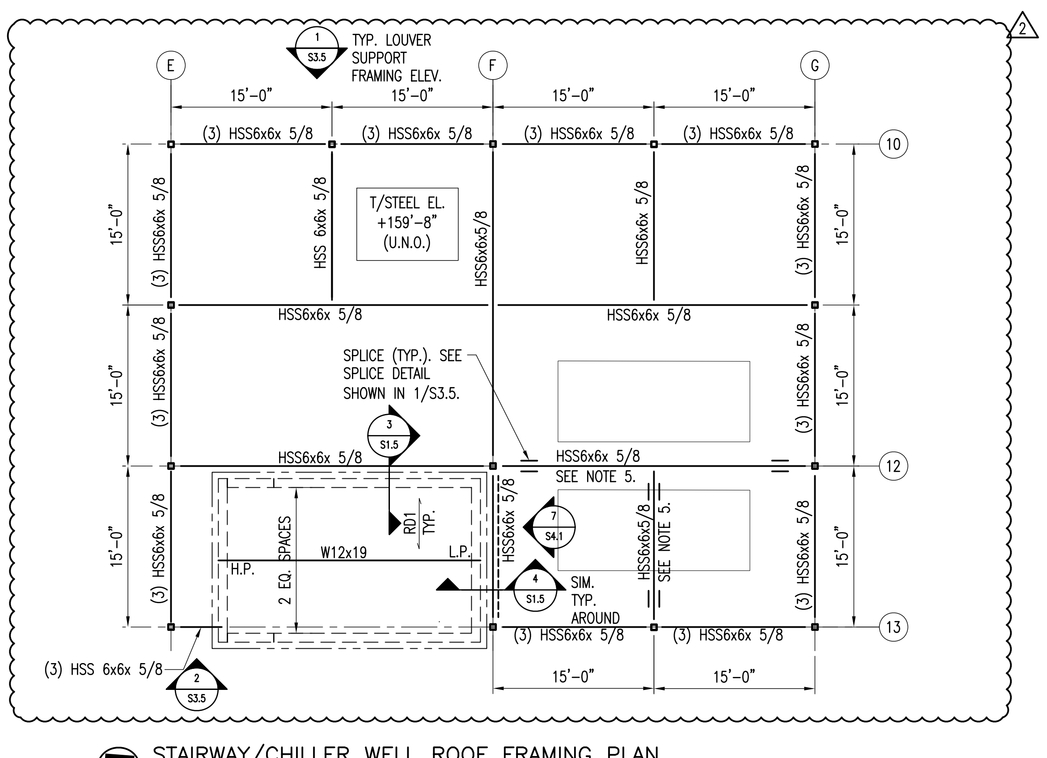


CLERESTORY ROOF FRAMING PLAN

1/8"=1'-0"

NOTES:

1. VERIFY ALL DIMENSIONS AND ELEVATIONS WITH ARCH. DWGS. PRIOR TO CONSTRUCTION.
2. SEE S0.1 FOR GENERAL STRUCTURAL NOTES.
3. _RD3_ INDICATES 2"x18 GA. GALV. CELLULAR (W/ ACOUSTIC CEILING IN AREAS INDICATED) COMPOSITE DECK W/3 1/4" LIGHT-WEIGHT CONCRETE (5 1/4" TOTAL THICKNESS) W/6x6 W1.4xW1.4 WWF. FOR TYPICAL SLAB ON DECK CONSTRUCTION & STEEL CONNECTIONS, SEE SHTS. S3.1 AND S3.2.
4. B/STEEL DECK EL. = T/STEEL EL. = +153'-8 3/4".

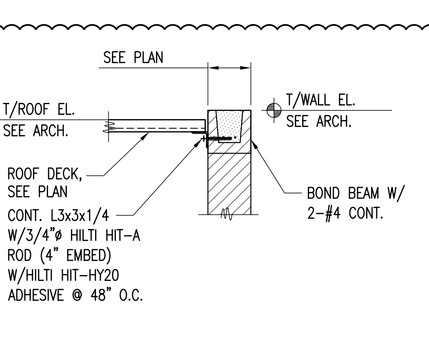


STAIRWAY/CHILLER WELL ROOF FRAMING PLAN

1/8"=1'-0"

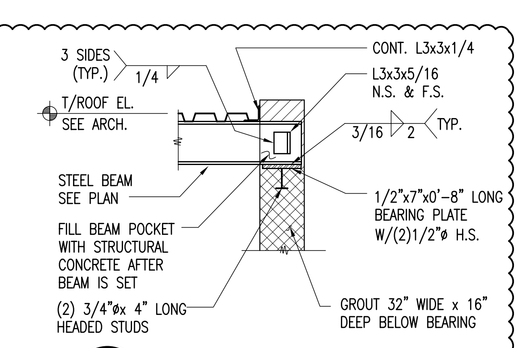
NOTES:

1. VERIFY ALL DIMENSIONS AND ELEVATIONS WITH ARCH. DWGS. PRIOR TO CONSTRUCTION.
2. SEE S0.1 FOR GENERAL STRUCTURAL NOTES.
3. _RD1_ INDICATES 1 1/2"x18 GA. GALV. WIDE RIB METAL ROOF DECK CONT. OVER THREE SPANS MINIMUM. ATTACH TO ALL SUPPORTING MEMBERS WITH 5/8"ø PUDDLE WELDS AT 12" O.C. (6" O.C. AT PERIMETER). PROVIDE MIN. (2)#10 TEK SCREW SIDE LAP FASTENER PER DECK SPAN.
4. T/STAIRWAY STEEL EL. AT H.P. +157'-11". T/STAIRWAY STEEL EL. AT L.P. +157'-5".
5. REMOVE HSS FOR INSTALLATION OF EQUIP. AND IMMEDIATELY REPLACE AFTER EQUIP. IS INSTALLED.



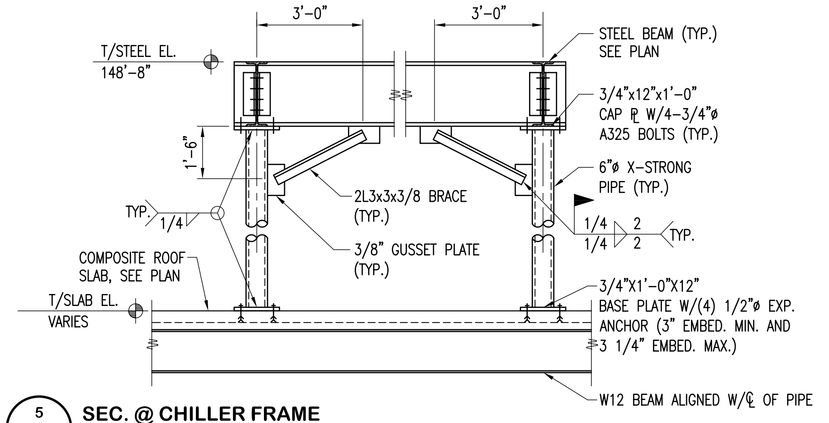
3 SECTION @ ROOF OF STAIRWAY

S1.5 — 3/4"=1'-0"



4 BEAM BRG. ON CMU WALL

S1.5 — 3/4"=1'-0"



5 SEC. @ CHILLER FRAME

S1.5 — 1/2"=1'-0"

PUBLIC BUILDING COMMISSION OF CHICAGO

Chicago Public Schools

AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL

3231 N. SPRINGFIELD
CHICAGO, IL 60618

CHICAGO PUBLIC SCHOOLS
CAPITAL PROGRAM NEW CONSTRUCTION
CITY OF CHICAGO, MAYOR RICHARD M. DALEY

SMNG-A
Schroeder Murchie Niemiec Gazda-Auskalnis Architects, Ltd.
Architect of Record

936 West Huron Street
Chicago, Illinois 60622
P: 312. 829.3355
F: 312. 829.8187

Matrix Engineering Corp.
Chicago, Illinois
Structural Engineer

Terra Engineering, Ltd.
Chicago, Illinois
Civil Engineer

Site Design Group, Ltd.
Chicago, Illinois
Landscape Architect

CCJM Engineering
Chicago, Illinois
Mechanical, Electrical, Plumbing and FP Engineer

HJKessler Assoc., Inc.
Chicago, Illinois
LEED Certification Consultant

Shiner + Assoc., Inc.
Chicago, Illinois
Acoustics Consultant

Bill Conner Assoc., LLC
Chicago, Illinois
Theater Consultant

The Concord Group
Chicago, Illinois
Cost Estimator

Issuance

Mark	Description	Date
1	ISSUE FOR BID	11.20.08
2	ADDENDUM NO.2	12.09.08

PBC Project Name: Avondale / Irving Park Area Elementary School

PBC Contract No.: CPS-37

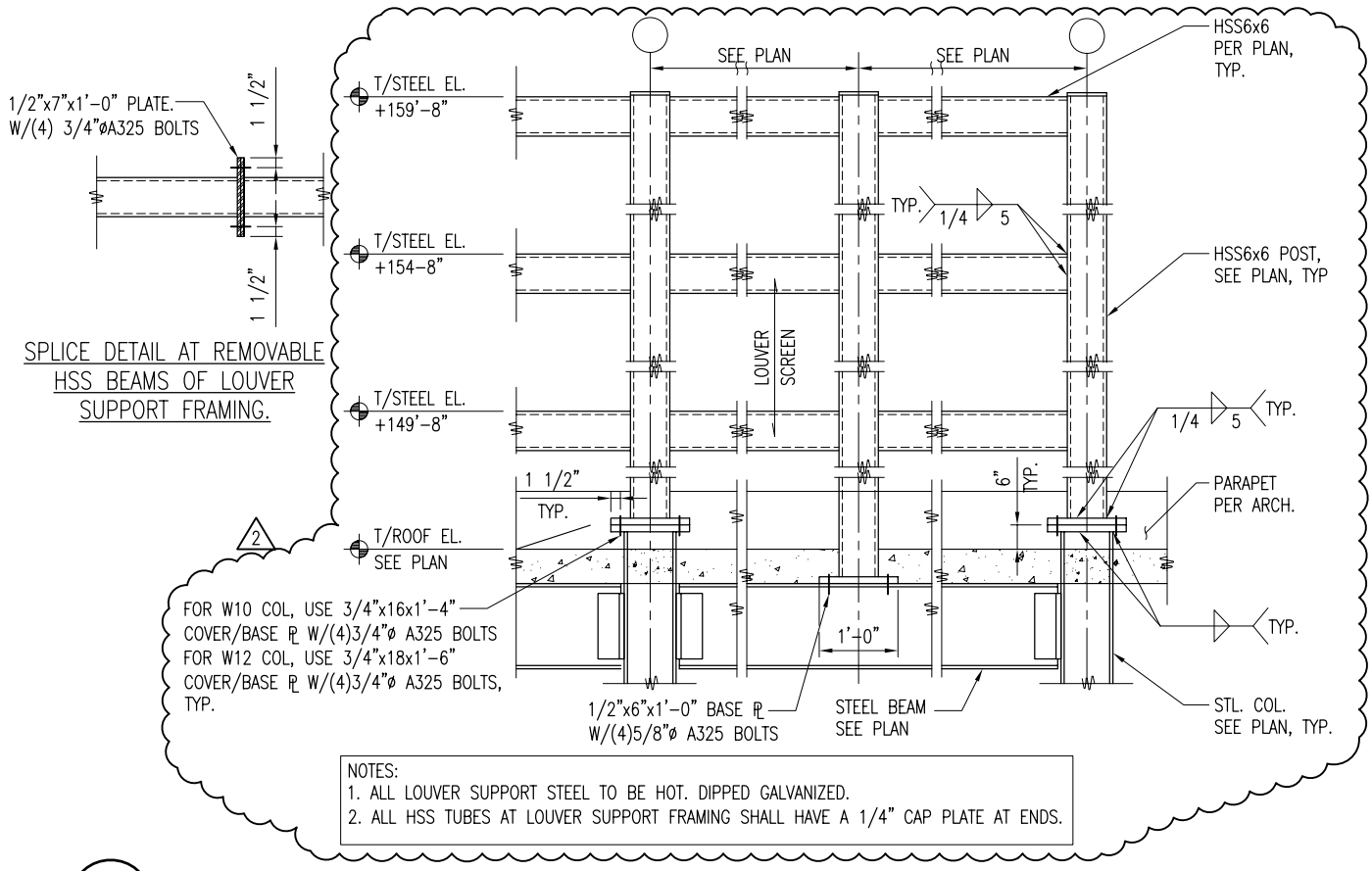
SMNG-A Project No.: 0732 MEC Project No.: 08014

Title

MISC. FRAMING PLANS

Sheet

S1.5



1 / S3.5 **TYP. ELEVATION @ LOUVER SUPPORT FRAMING**

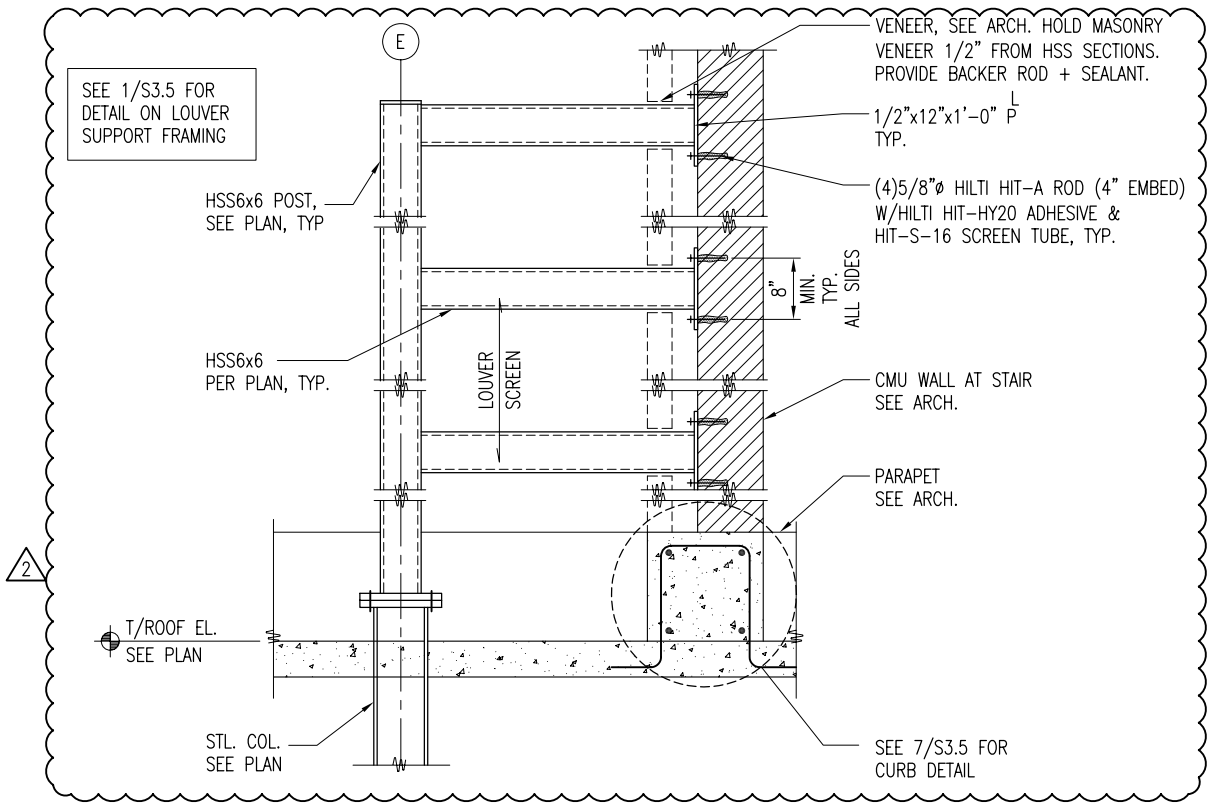
NOT TO SCALE

MATRIX
Matrix Engineering Corporation
Structural Engineers
33 W. Jackson Blvd 4th floor
Chicago Illinois 60604-3901
v 312 427 1200
f 312 427 4220

PROJECT: AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.: 08014
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2:
TITLE: TYP. ELEVATION @ LOUVER SUPPORT FRAMING
COMMENTS: REF: 1/S3.5

ISSUED DATE: 12.09.08

SSK-01



2 / S3.5 ELEVATION-LOUVER SUPPORT FRAMING

NOT TO SCALE

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Structural Engineers
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Chicago Illinois 60604-3901
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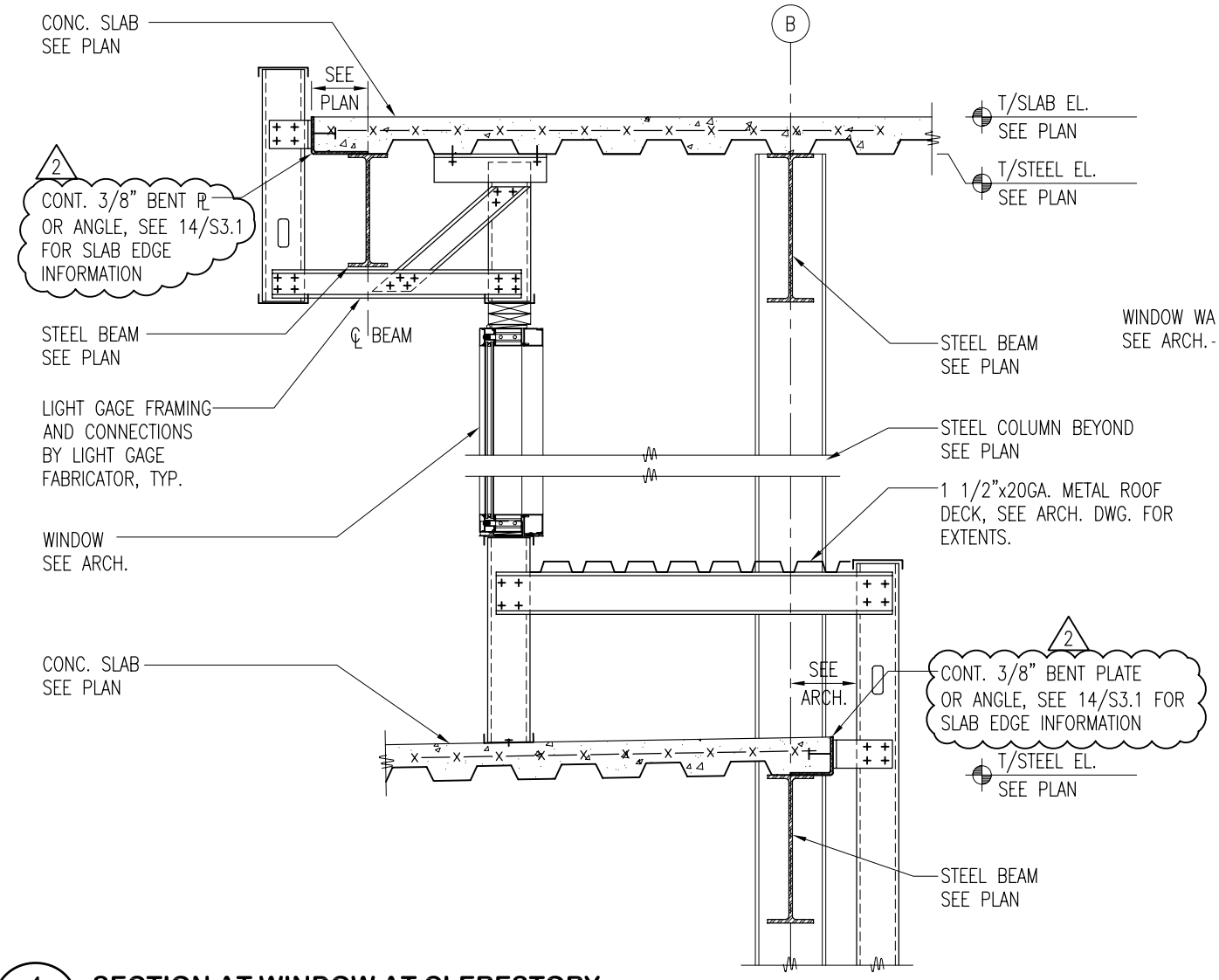
f 312 427 4220

PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	ELEVATION-LOUVER SUPPORT FRAMING
COMMENTS:	REF: 2/S3.5

ISSUED DATE: 12.09.08

SSK-02



4 / S3.5 SECTION AT WINDOW AT CLERESTORY

3/4"=1'-0"

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Structural Engineers
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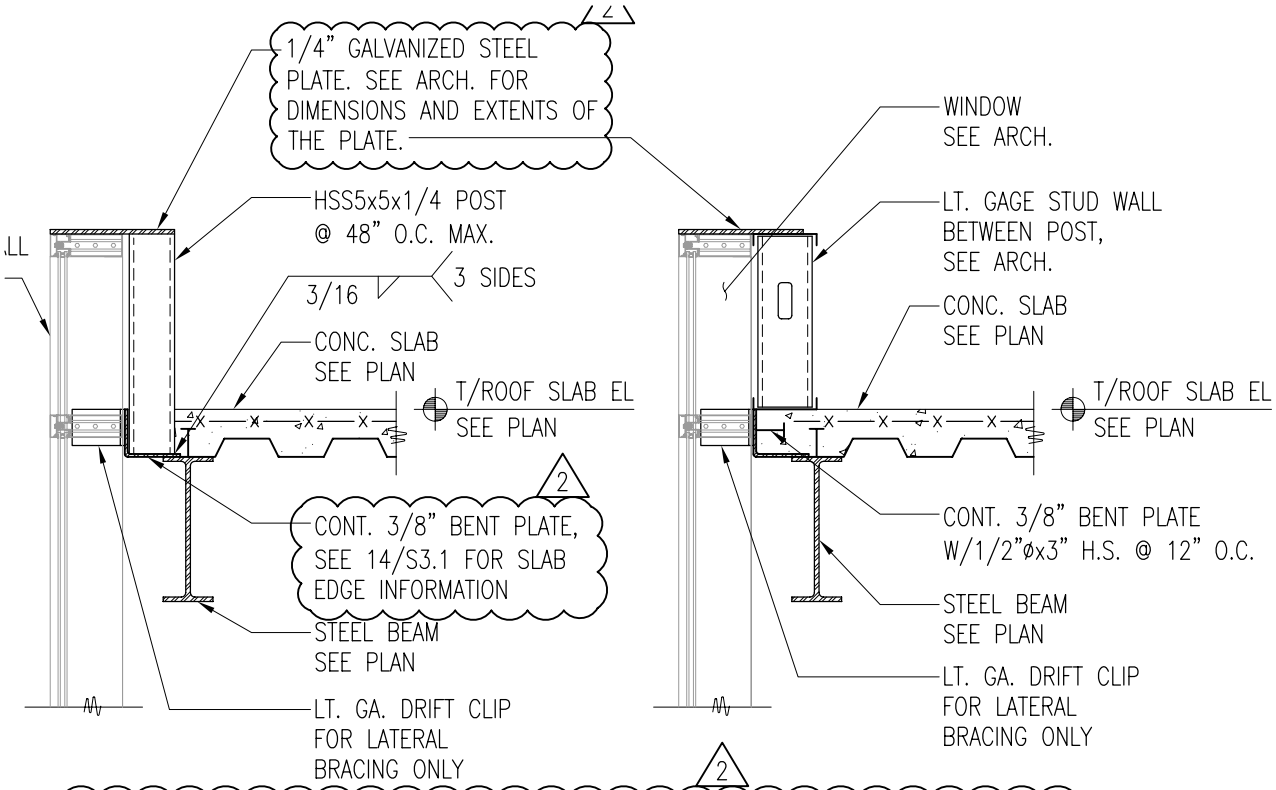
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	SECTION AT WINDOW AT CLERESTORY
COMMENTS:	REF: 4/S3.5

ISSUED DATE: 12.09.08

SSK-03



5 / S3.5 **TYP. ROOF SLAB EDGE DETAIL @ WINDOW WALL**

3/4"=1'-0"

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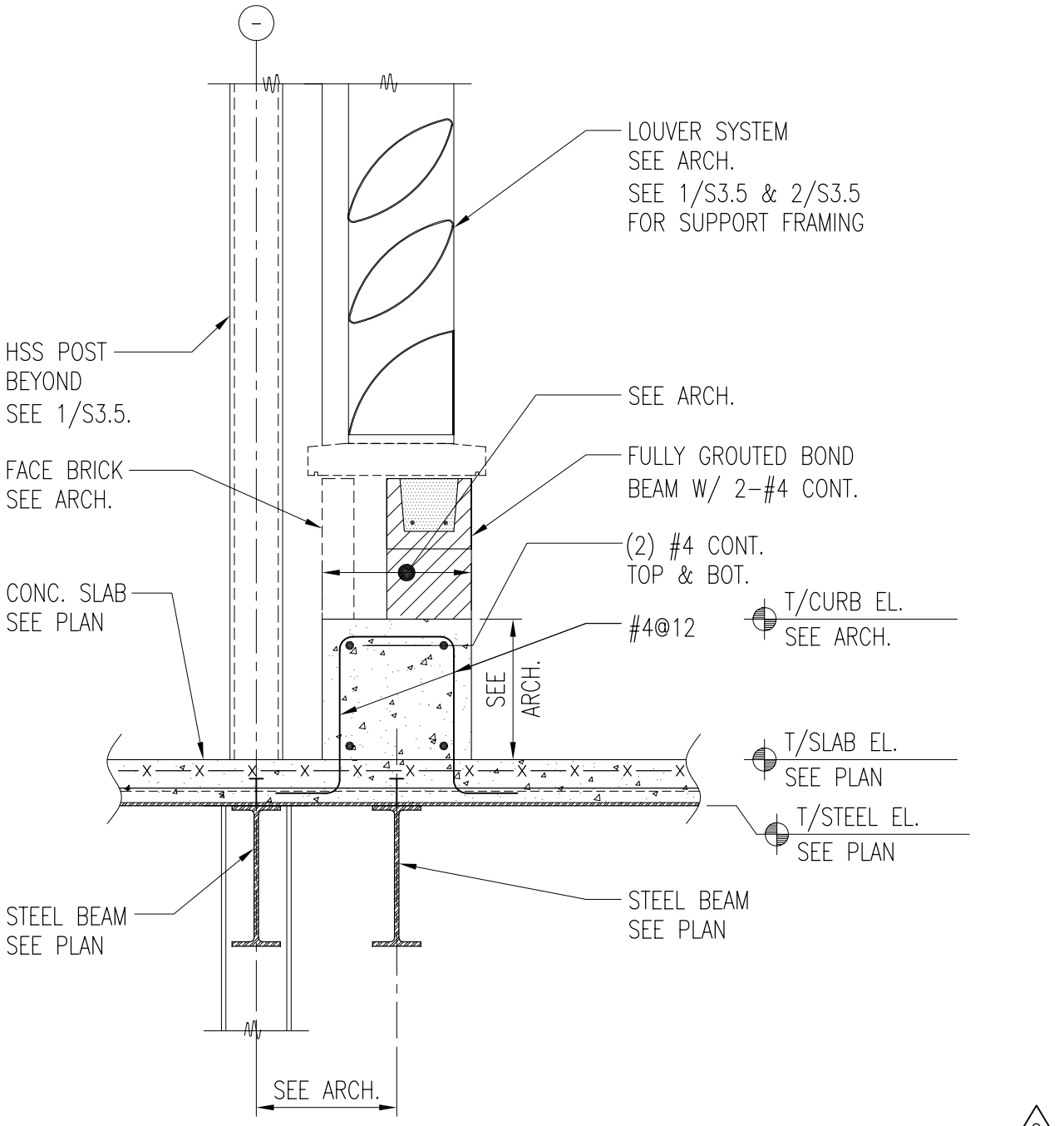
PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYP. ROOF SLAB EDGE DETAIL AT WINDOW WALL
COMMENTS:	REF: 5/S3.5

ISSUED DATE: 12.09.08

SSK-04



2

7 / S3.5

TYP. DETAIL OF CURB UNDER LOUVER SYSTEM

3/4" = 1'-0"

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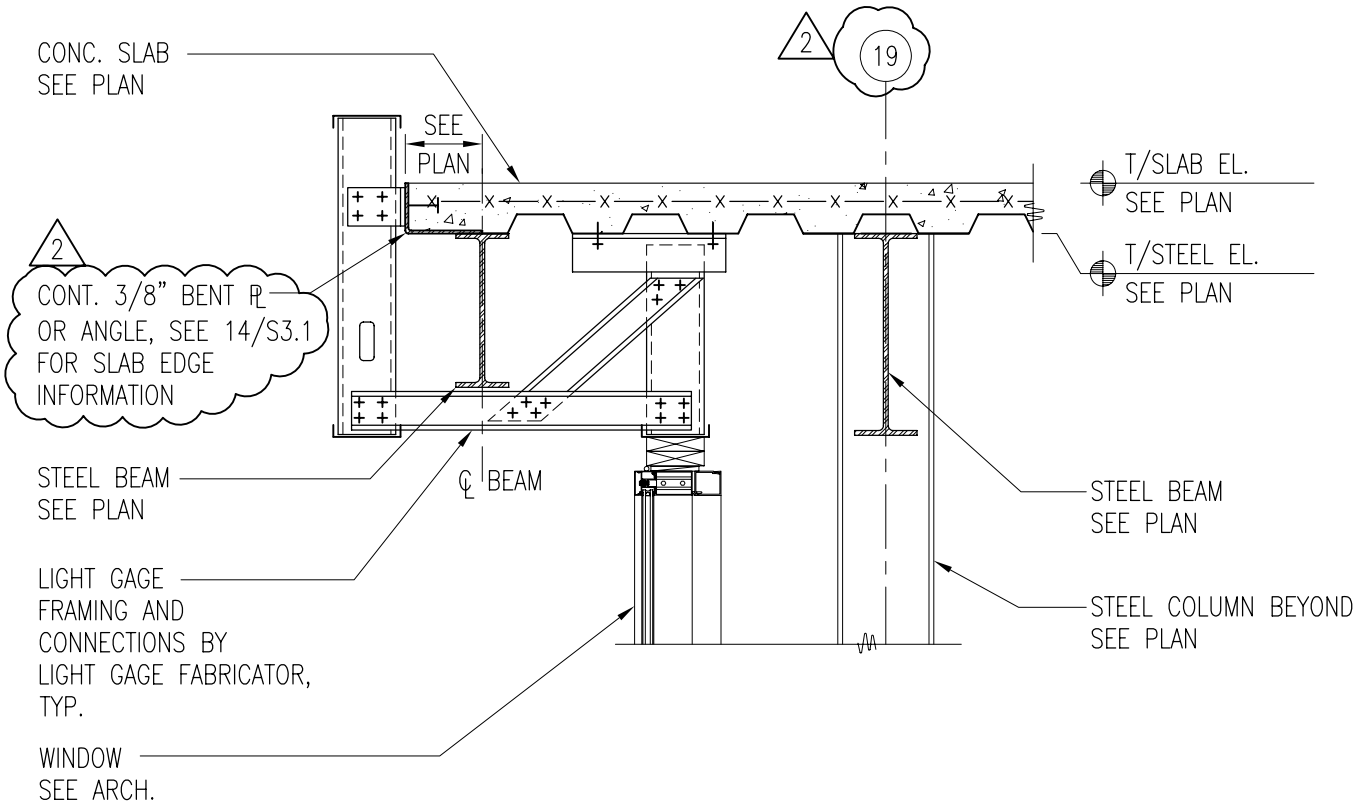
PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYP. DETAIL OF CURB UNDER LOUVER SYSTEM
COMMENTS:	REF: 7/S3.5

ISSUED DATE: 12.09.08

SSK-05



2

8 / S3.5 **SECTION AT CLERESTORY ROOF OF LIBRARY**

3/4"=1'-0"

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Structural Engineers
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Chicago Illinois 60604-3901
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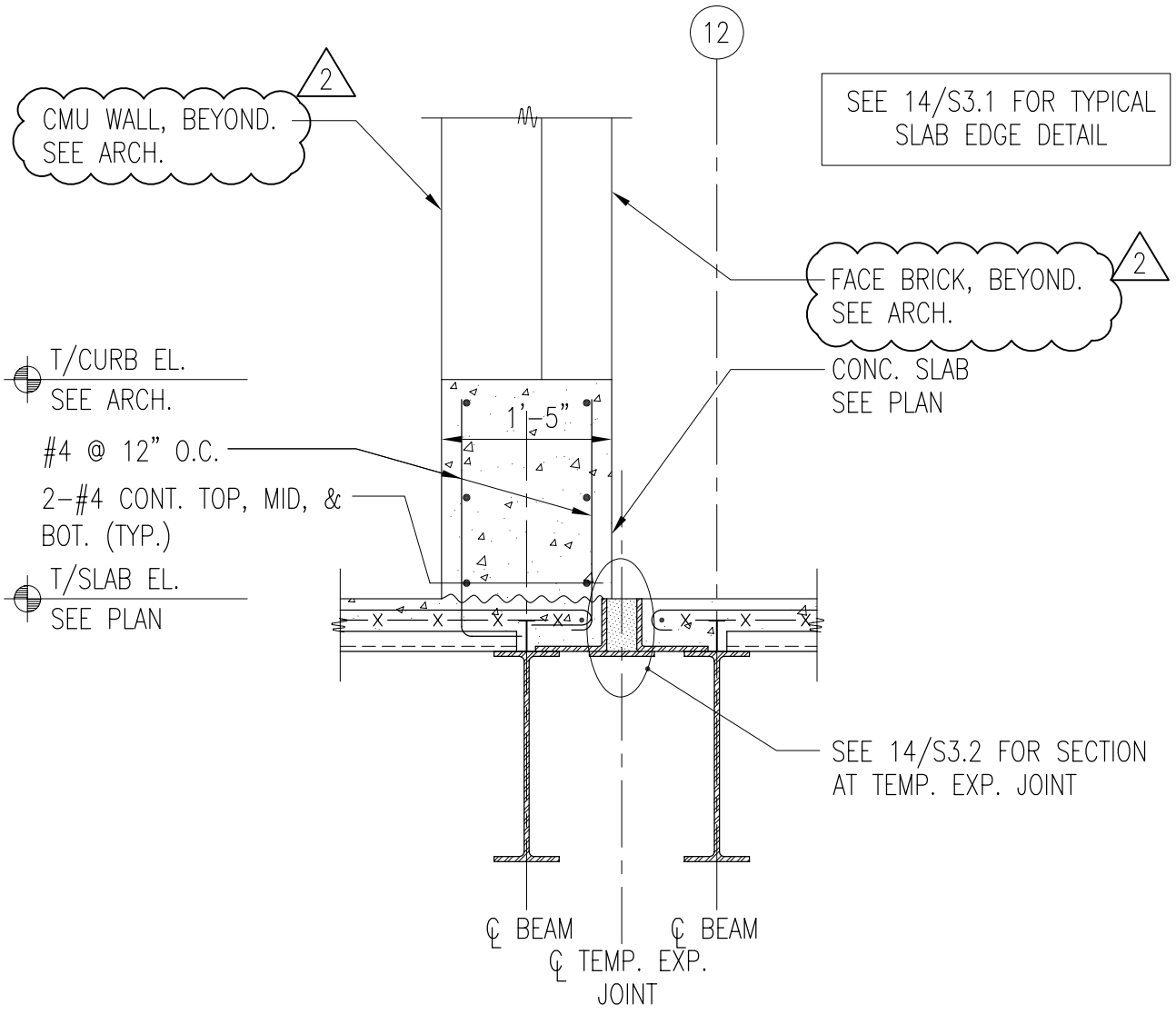
PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	SECTION AT CLERESTORY ROOF OF LIBRARY
COMMENTS:	REF: 8/S3.5

ISSUED DATE: 12.09.08

SSK-06



SECTION THRU ROOF DECK CURB AT TEMPORARY EXPANSION JOINT

10 / S3.5

3/4"=1'-0"

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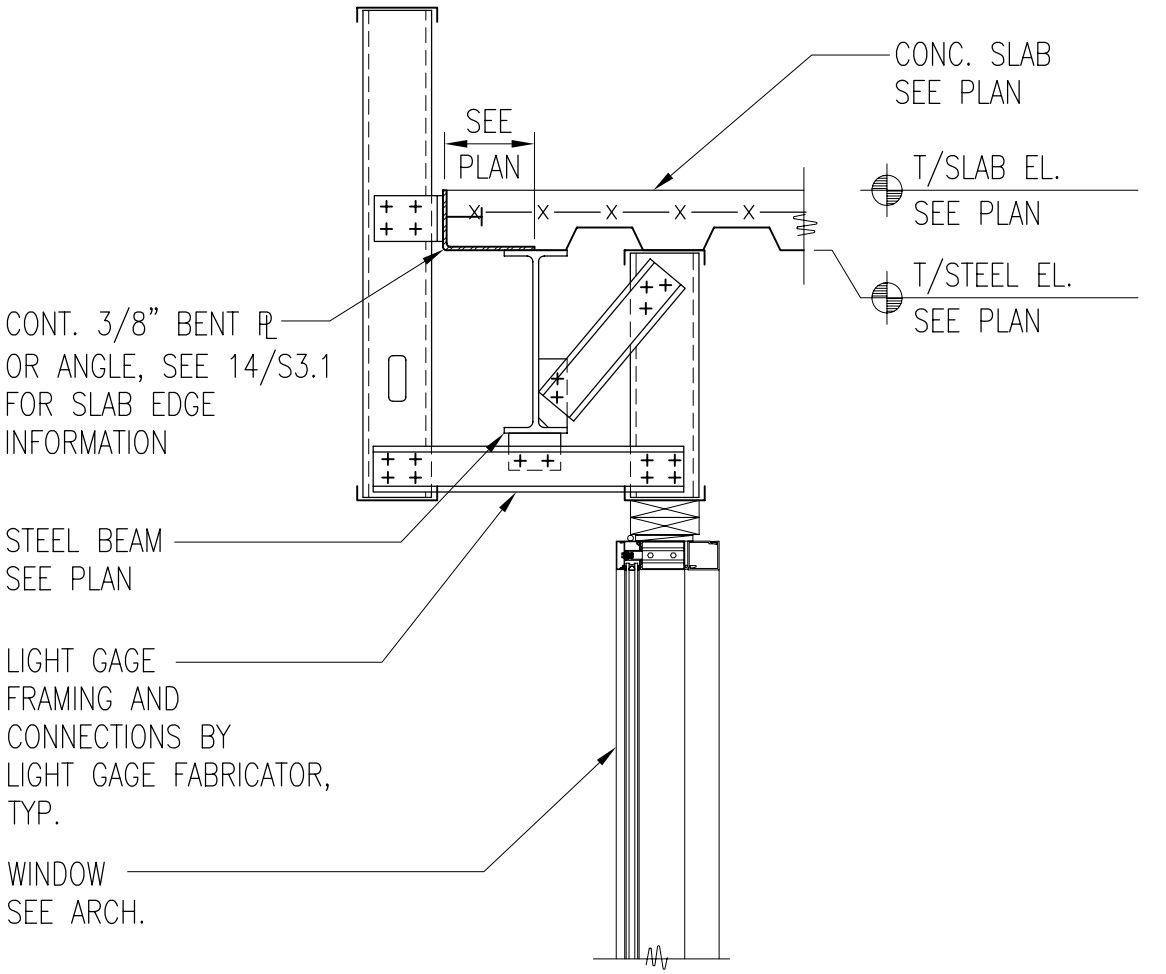
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	SECTION THRY ROOF DECK CURB AT TEMP. EXP. JT.
COMMENTS:	REF: 10/S3.5

ISSUED DATE: 12.09.08

SSK-07



2

11 / S3.5

SECTION @ CLERESTORY ROOF OF LIBRARY

3/4"=1'-0"

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Structural Engineers
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f 312 427 4220

PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	SECTION @ CLERESTORY ROOF OF LIBRARY
COMMENTS:	REF: 11/S3.5

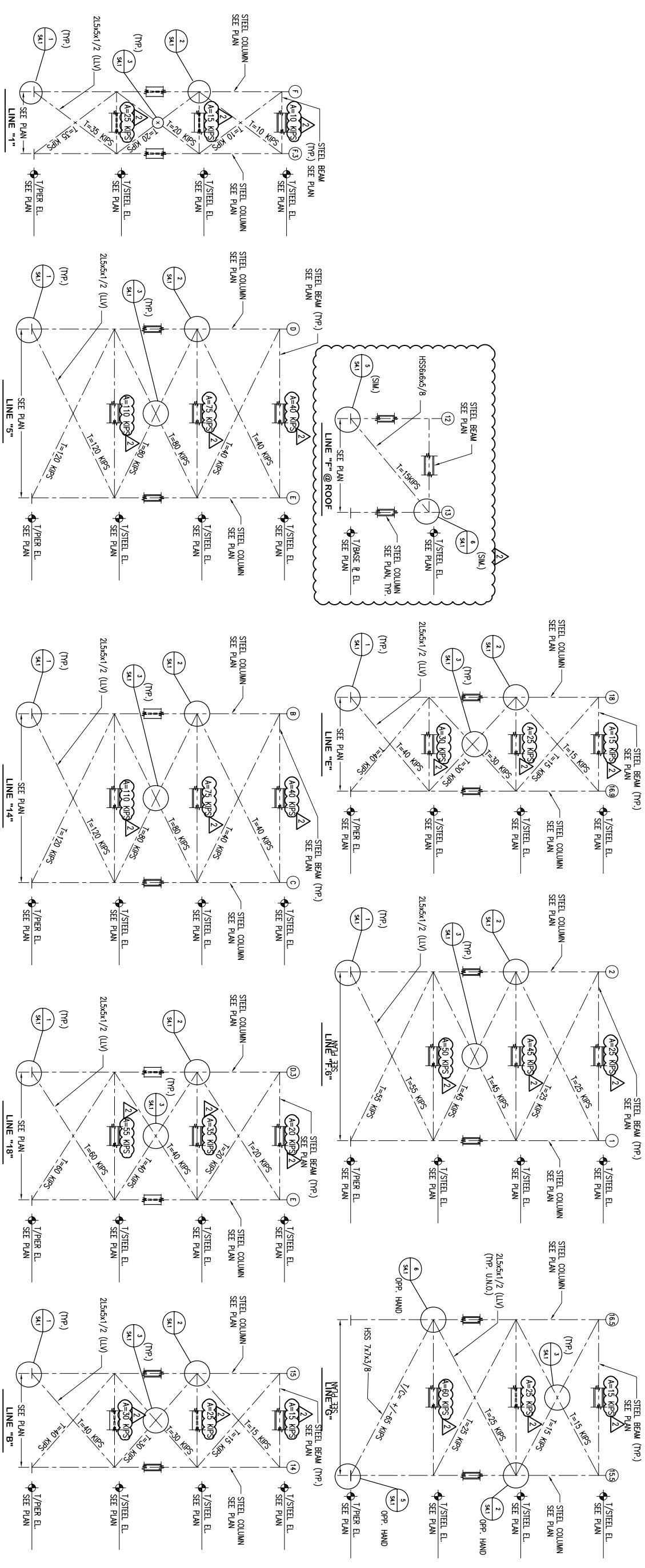
ISSUED DATE: 12.09.08

SSK-08

LATERAL BRACING ELEVATIONS

7 / S4.1 SCHEMATIC

NOTE: ALL INDICATED BRACING FORCES ARE UNFACTORED
T = TENSION
C = COMPRESSION
A = AXIAL (APPLIES TO BOTH ENDS OF BEAMS)



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PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	LATERAL BRACING ELEVATIONS
COMMENTS:	REF: 7/S4.1

ISSUED DATE: 12.09.08

SSK-09

COLUMN SCHEDULE

COLUMN MARK	C14	C13	C12	C11	C10	C9B	C9A	C8	C7	C6	C5	C4	C3B	C3A	C2B	C2A	C1B	C1A	BASE PLATE t x N x B	ANCHOR BOLTS (#) ø	ANCHOR BOLTS EMBEDMENT	REMARKS
CLERSTORY ROOF	HSS4x4x3/8	W10X77	W12X96	W12X136	W12X120	W10X88	W10X68	W10X68		W12X96	W10X49	W10X68	W10X77	W10X77	W10X68	W10X49	W10X49	W10X49	1 1/2"x16"x16"	(4) 3/4"ø	9"	
ROOF	W10X45	W10X45	W12X65	W12X79 (2)	W12X58	W10X45		W10X33	W10X33	W12X50		W10X33	W10X49	W10X45	W10X33		W10X33		1 1/2"x16"x16"	(4) 3/4"ø	9"	
THIRD FLOOR / CANOPY							SEE NOTE 1. TYP.				W10X49					TYP. SPLICE LOCATION (IF NEEDED)			1 1/2"x16"x16"	(4) 3/4"ø	9"	
SECOND FLOOR	W10X68	W10X77	W12X96	W12X136	W12X120	W10X88	W10X68	W10X68		W12X96	W10X49	W10X68	W10X77	W10X77	W10X68	W10X49	W10X49	W10X49	1 1/2"x17"x17"	(4) 3/4"ø	9"	
CANOPY																			1 1/2"x17"x17"	(4) 3/4"ø	9"	
BASE																			1 1/2"x20"x20"	(6) 1 1/2"ø	15"	

NOTES:
1. COLUMN WITH FIRETROL ENCASEMENT. SEE ARCH. DWGS FOR COLUMN LOCATIONS AND SIZE/EXTENT OF FIRETROL ENCASEMENT.
2. SEE TYPICAL BASE PLATE DETAIL 1/S2.1 FOR MORE INFORMATION.
3. SEE COLUMN BASE PLATE DETAIL 1/S2.3 FOR MORE INFORMATION.

MATRIX
Matrix Engineering Corporation
Structural Engineers
33 W. Jackson Blvd 4th floor
Chicago Illinois 60604-3901
v 312 427 1200
f 312 427 4220

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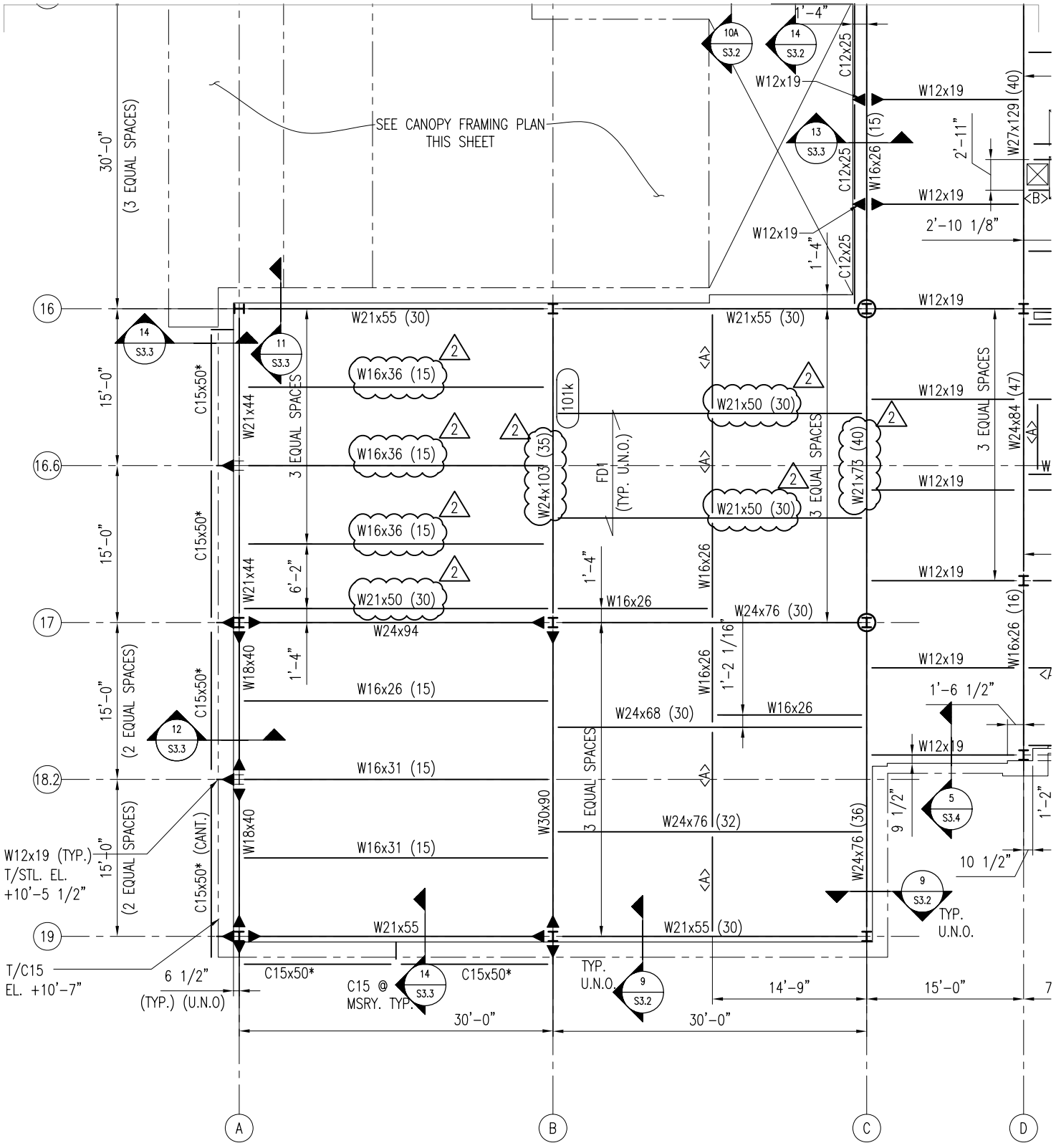
MATRIX NO.: 08014
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2:
TITLE: COLUMN SCHEDULE
COMMENTS: REF: SHEET S0.02

ISSUED DATE: 12.09.08

SSK-10



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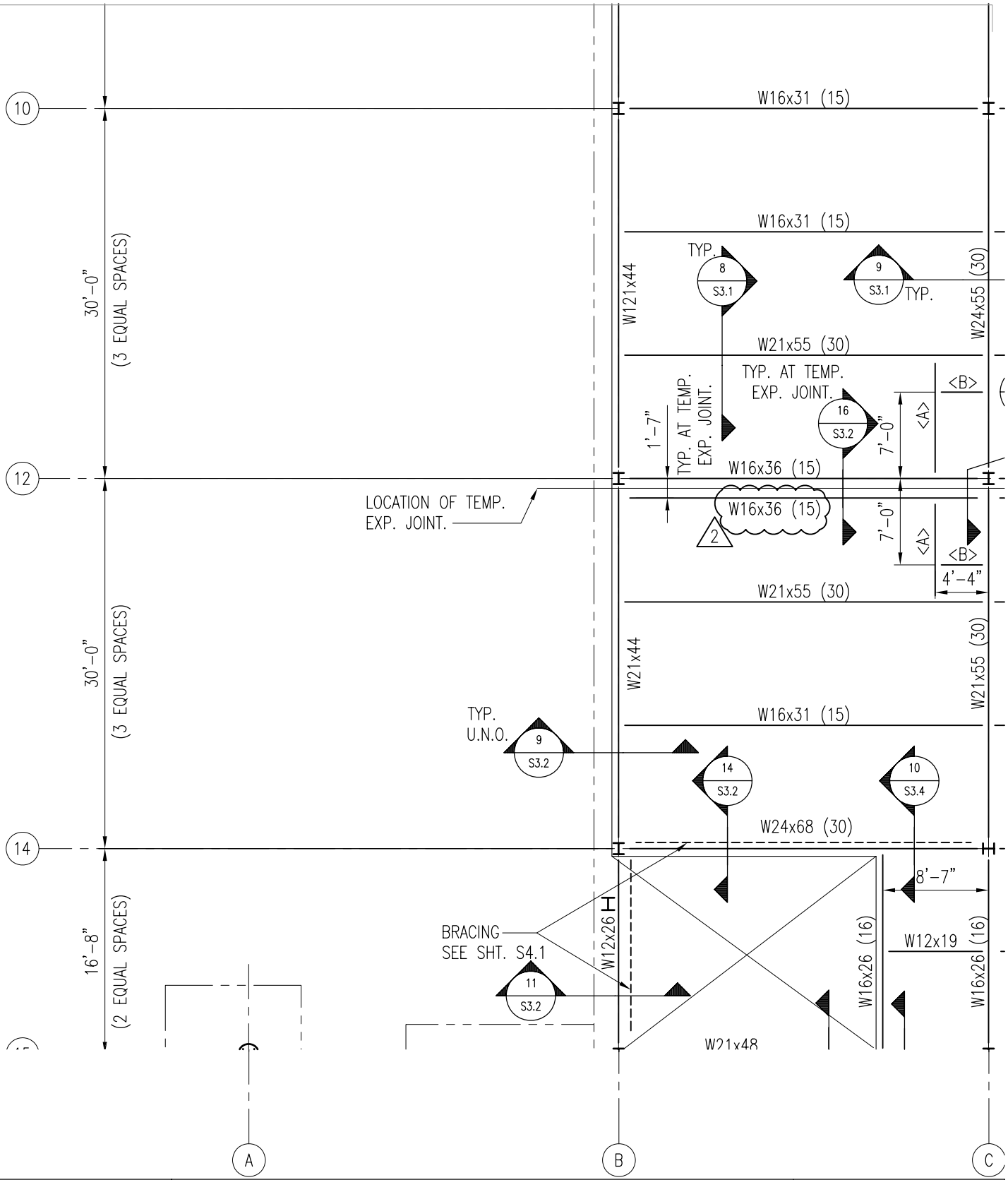
Structural Engineers
33 W. Jackson Blvd 4th floor
Chicago Illinois 60604-3901
v 312 427 1200
f 312 427 4220

PROJECT: AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.: 08014
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2:
TITLE: SECOND FLOOR FRAMING PLAN
COMMENTS: REF: SHEET S1.2A

ISSUED DATE: 12.09.08

SSK-11



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Structural Engineers
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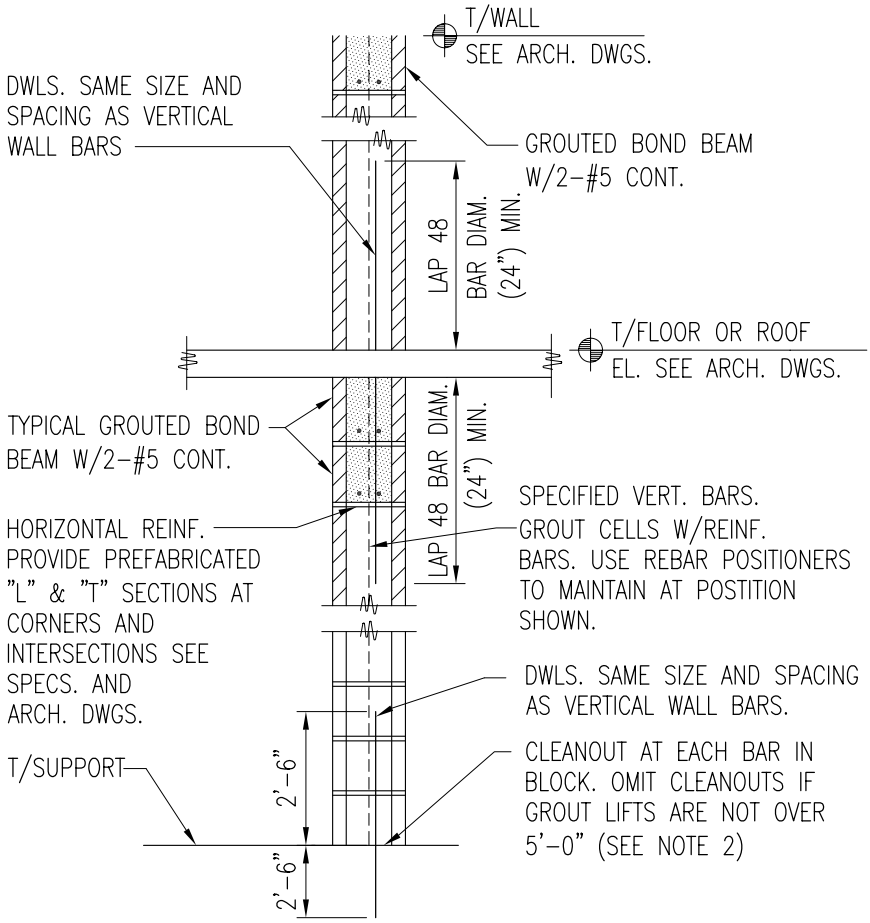
f 312 427 4220

PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	SECOND FLOOR FRAMING PLAN
COMMENTS:	REF: SHEET S1.2A

ISSUED DATE: 12.09.08

SSK-12



NOTES:

1. SEE STRUCUTRAL DETAILS AND ARCHITECTURAL DRAWINGS FOR ADDITIONAL BOND BEAMS. ALL BOND BEAMS SHALL HAVE CONT. (2)#5 REBAR U.N.O. 2
2. IF HIGHLIFT GROUTING IS USED (OVER 5'-0"), CONFORM TO THE FOLLOWING:
   a.) PROVIDE CLEANOUT AT THE BOTTOM COURSE OF EACH VERTICAL BAR. COVER SPACE W/SAND. REMOVE SAND AND MORTAR DROPPINGS PRIOR TO GROUTING. DO NOT SEAL CLEANOUT UNTIL AFTER INSPECTION.
   b.) LIMIT EACH GROUT LIFT TO 5'-0". STOP GROUT POUR 1 1/2" MAX BELOW TOP OF MASONRY. MECHANICALLY CONSLIDATE EACH LIFT. RECONSOLIDATE AFTER EXCESS WATER HAS BEEN ABSORBED INTO MASONRY (3 TO 5 MINUTES.)

6 / S5.1

TYPICAL REINF. CONCRETE MASONRY WALL SECTION

N.T.S.

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Structural Engineers
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v 312 427 1200
f 312 427 4220

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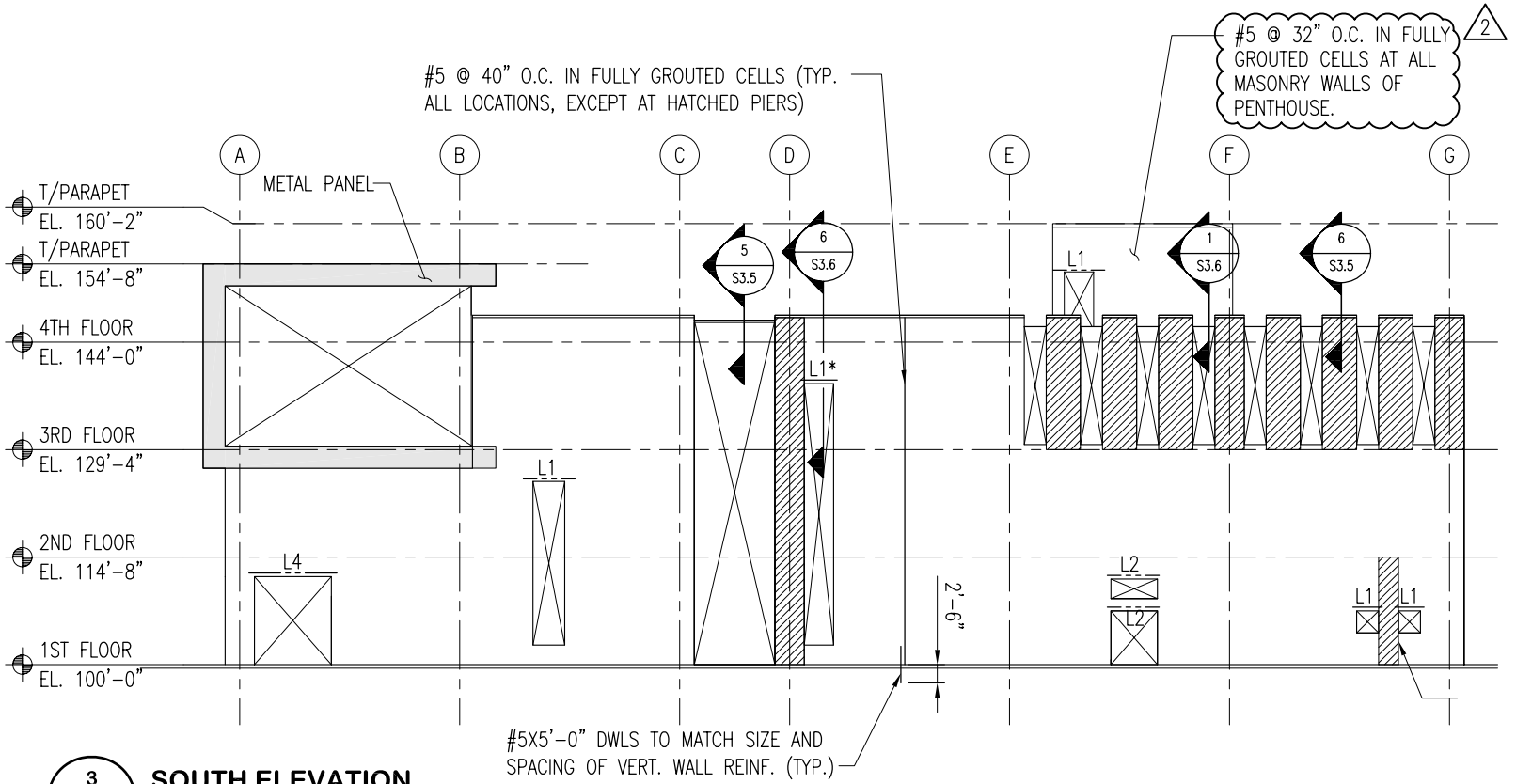
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYPICAL REINF. CONCRETE MASONRY WALL SECTION
COMMENTS:	REF: DETAIL 6/S5.1

ISSUED DATE: 12.09.08

SSK-13



3 / S5.2 **SOUTH ELEVATION**

N.T.S.

NOTE: "Lx" INDICATES LINTEL. SEE SCHEDULE ON S5.1
"L1*" INDICATES LINTEL "L1" (PER SCHEDULE ON SHT. S5.1) WITH CONCEALED LINTEL PROVIDED BY HALFEN ANCHORING SYSTEMS. SEE 6/S3.6

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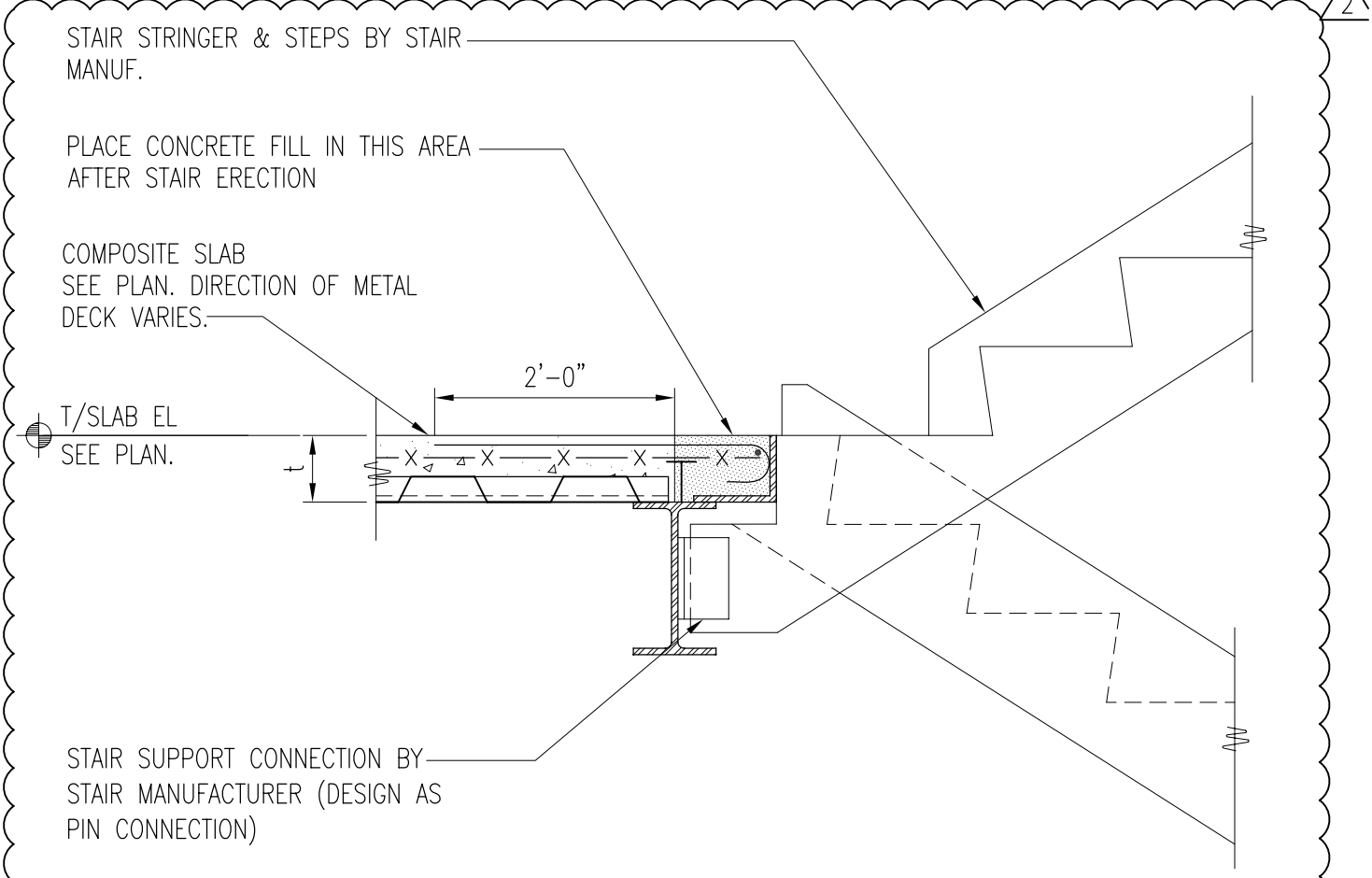
MATRIX NO.: 08014
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2:
TITLE: SOUTH ELEVATION
COMMENTS: 3/S5.2

ISSUED DATE: 12.09.08

SSK-14

2



TYP. SLAB EDGE/STRINGER CONNECTION DETAIL AT STAIR

5 / S3.2

1"=1'-0"

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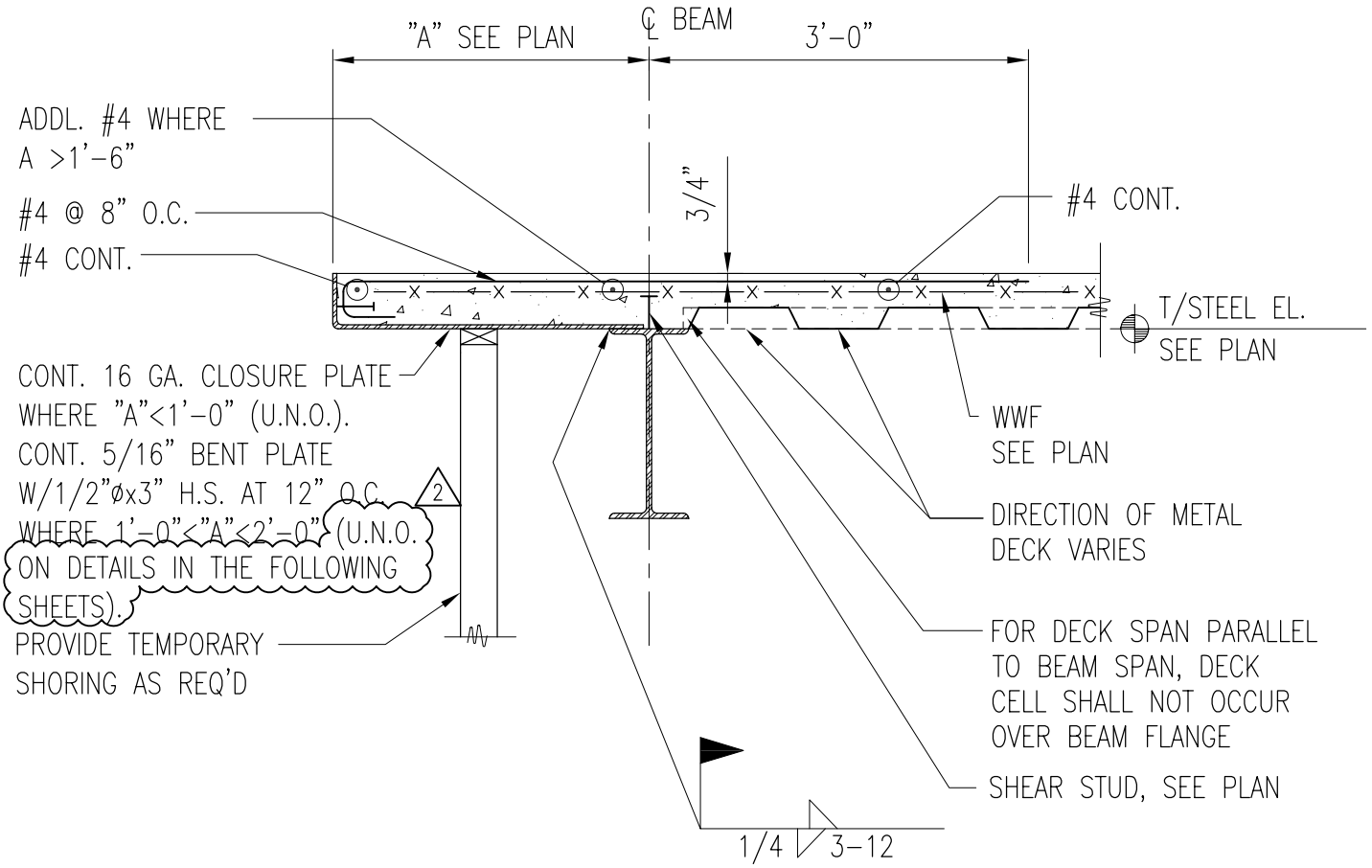
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYP. SLAB EDGE/STRINGER CONNECTION DETAIL AT STAIR
COMMENTS:	REF: DETAIL 5/S3.2

ISSUED DATE: 12.09.08

SSK-15



14 / S3.1 TYP. COMPOSITE SLAB EDGE DETAIL

1"=1'-0"

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Structural Engineers
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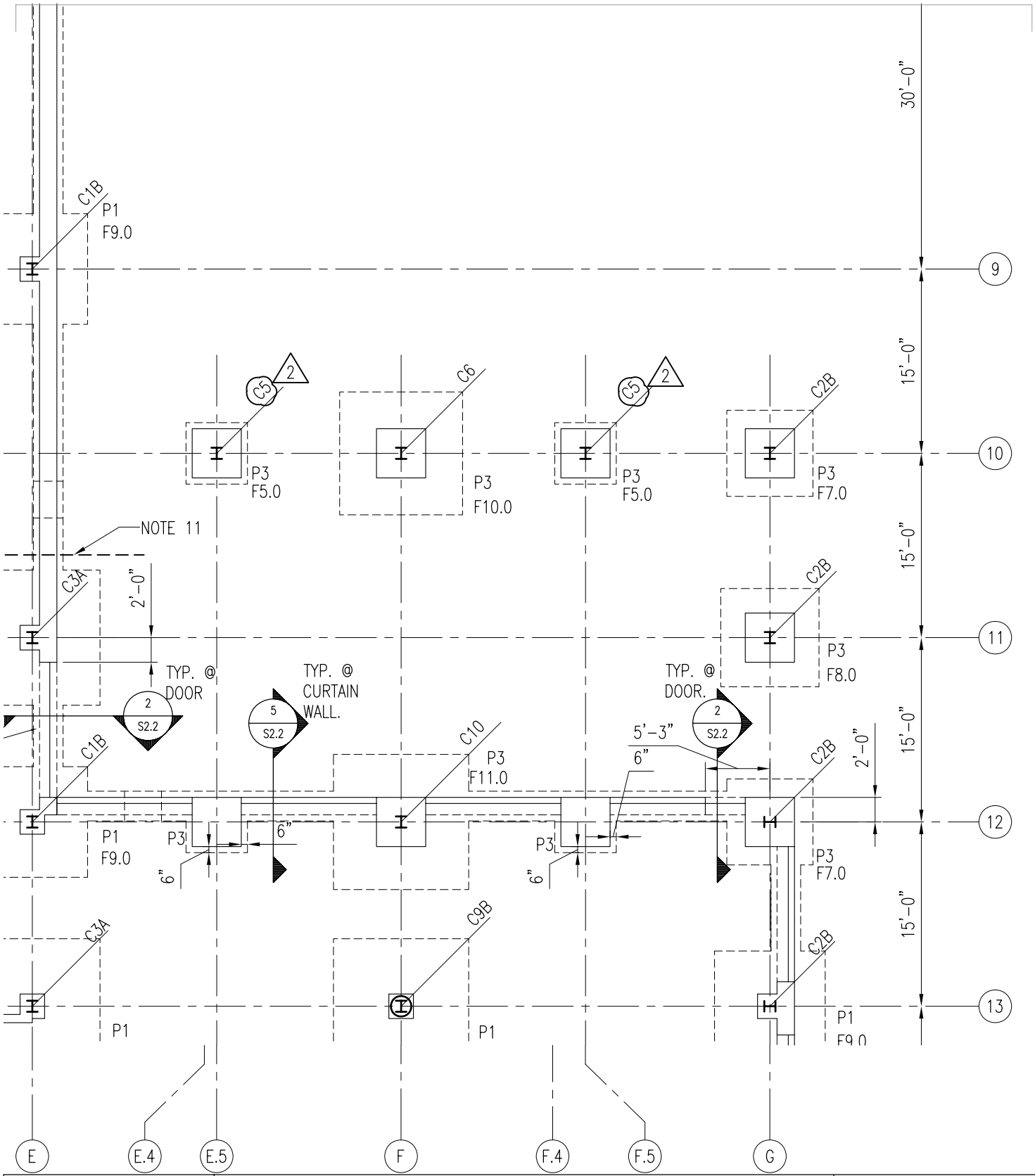
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYP. COMPOSITE SLAB EDGE DETAIL
COMMENTS:	REF: DETAIL 14/S3.1

ISSUED DATE: 12.09.08

SSK-16



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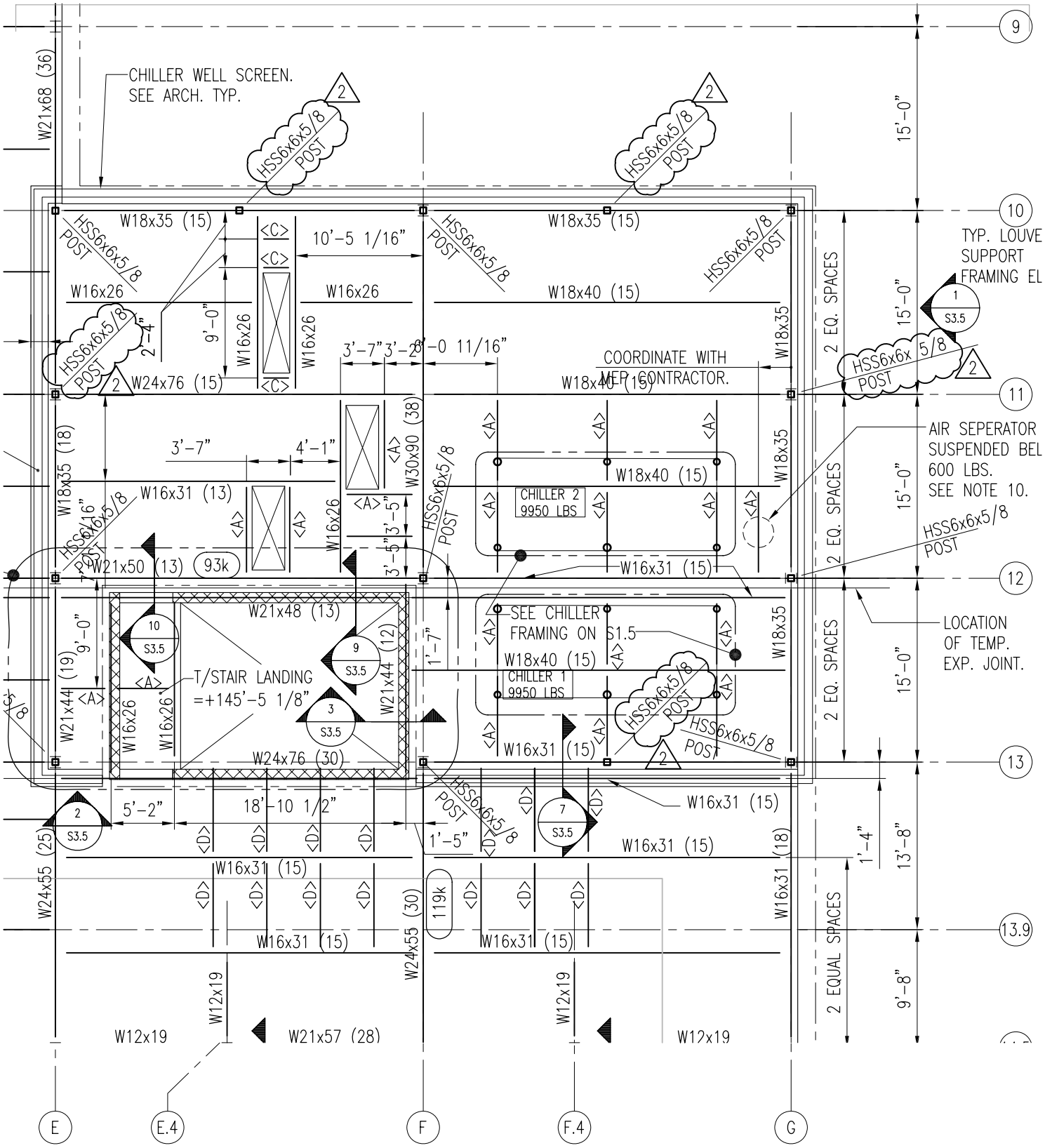
Matrix Engineering Corporation
Structural Engineers
33 W. Jackson Blvd 4th floor
Chicago Illinois 60604-3901
v 312 427 1200
f 312 427 4220

PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	FIRST FLOOR/ FOUNDATION PLAN 'A'
COMMENTS:	REF: SHEET S1.1A

ISSUED DATE: 12.09.08

SSK-17



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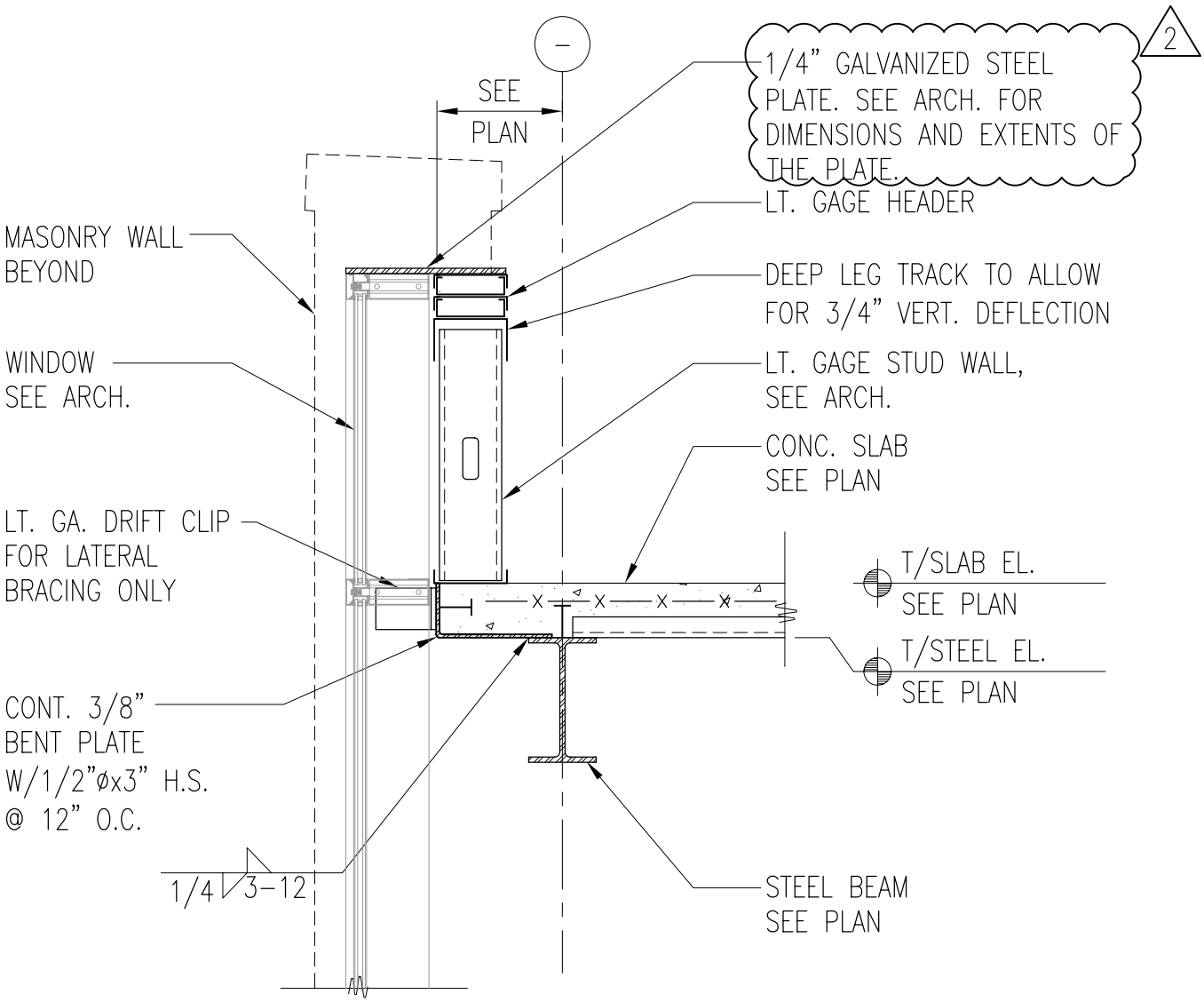
Matrix Engineering Corporation
Structural Engineers
33 W. Jackson Blvd 4th floor
Chicago Illinois 60604-3901
v 312 427 1200
f 312 427 4220

PROJECT:	AVONDALE/IRVING PARK AREA ELEMENTARY SCHOOL
MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	ROOF FRAMING PLAN "A"
COMMENTS:	REF: SHEET S1.4A

ISSUED DATE: 12.09.08

SSK-21



2

1 S3.6 **TYP. SECTION AT WINDOW WALL AT ROOF**

3/4"=1'-0"

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MATRIX NO.:	08014
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2:
TITLE:	TYP. SECTION AT WINDOW WALL AT ROOF
COMMENTS:	REF: DETAIL 1/S3.6

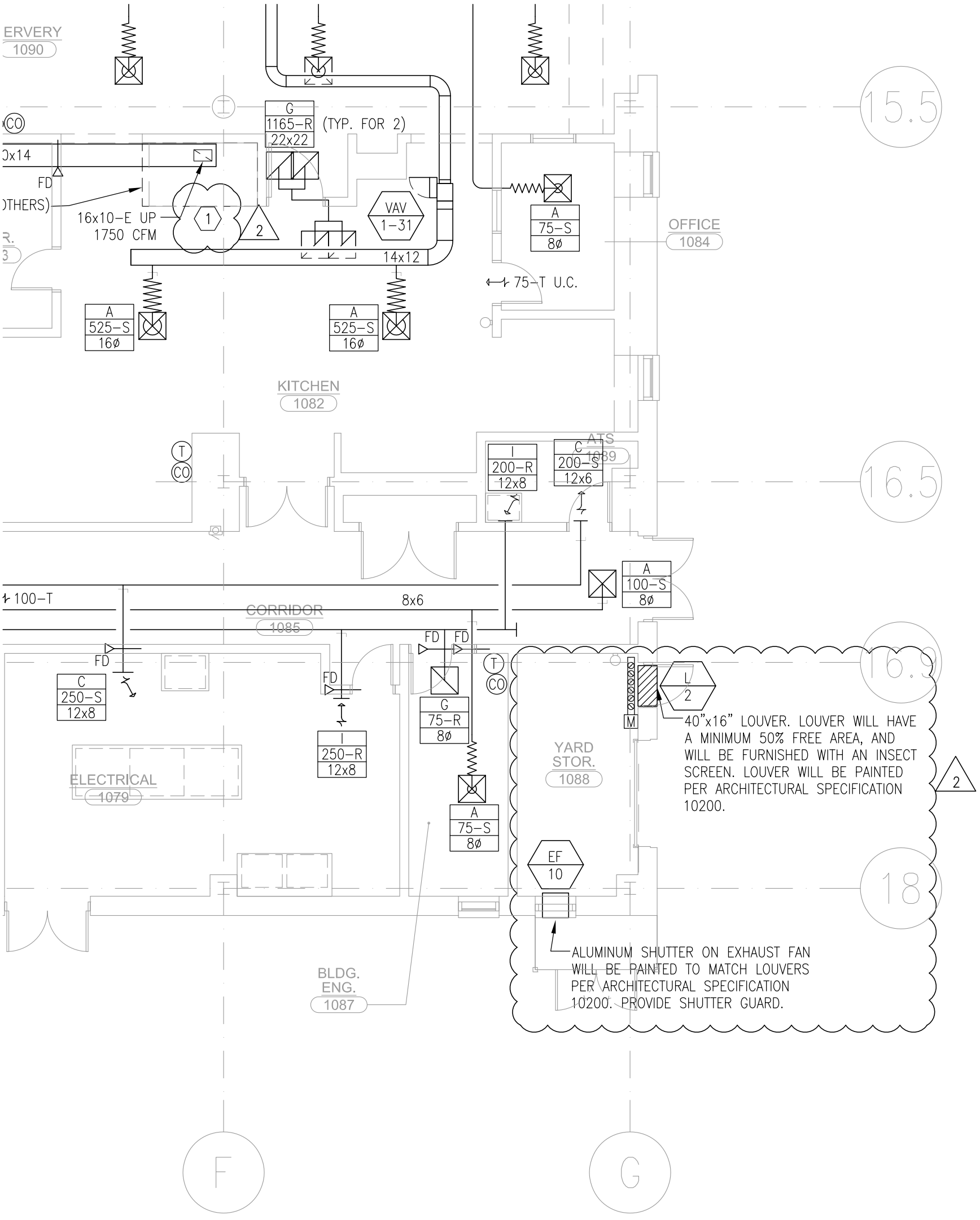
ISSUED DATE: 12.09.08

SSK-22

2

KEYED NOTES:

1 KE-1 SHALL BE SIZED AS A TYPE II HOOD WITH 3 OR LESS EXPOSED SIDES. PER CITY OF CHICAGO CODE, THE FORMULA Q=50A WHERE Q=AIR FLOW IN CUBIC FEET PER MINUTE, AND A=HORIZONTAL AREA OF KITCHEN HOOD.
Q=50(30.6317)
Q=1532 CFM



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Schroeder Murchie
Niemiec Gazda-Auskalnis

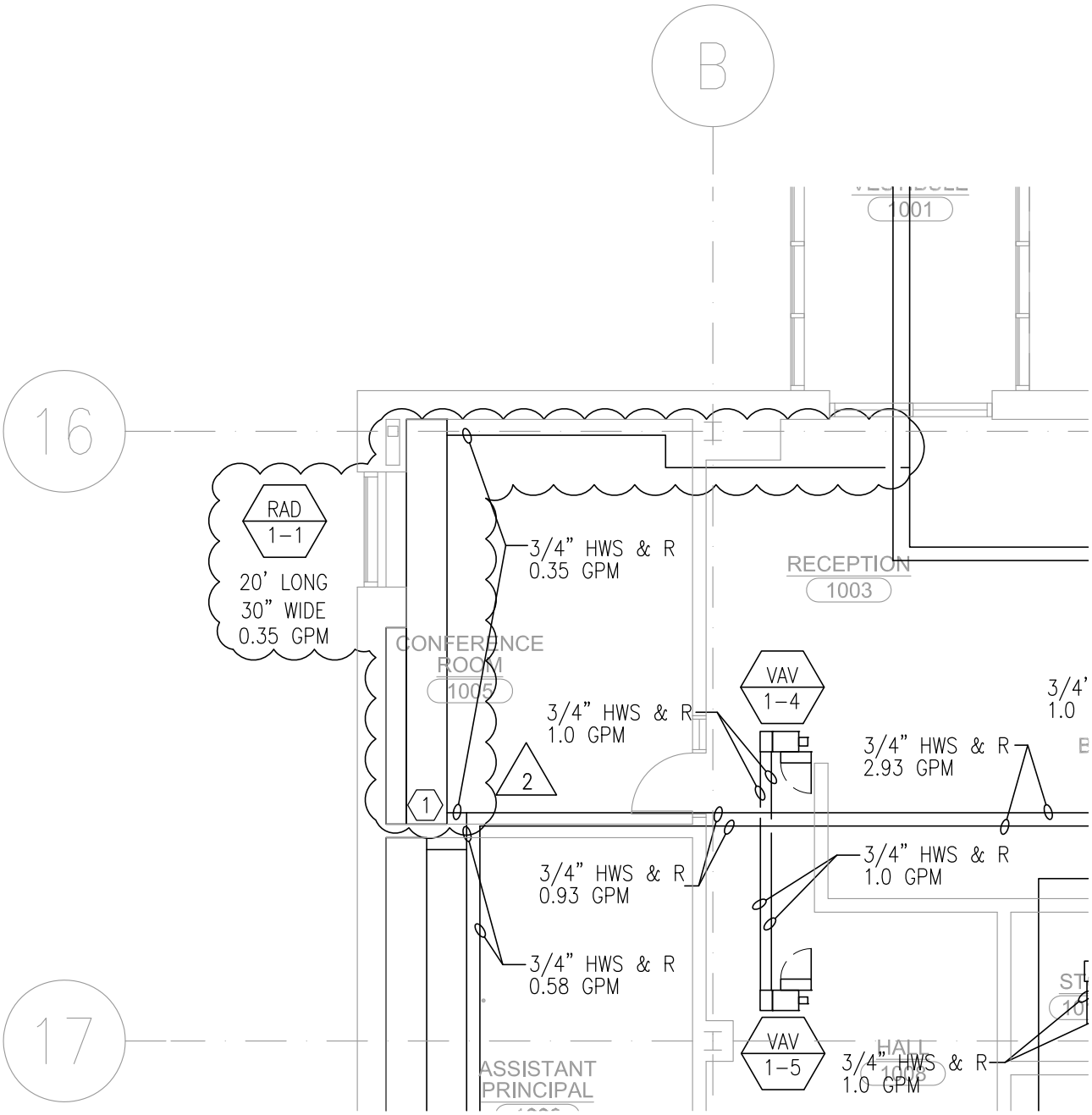
Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

PROJECT:	AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL
SMNG-A NO.:	0732
PBC NO.:	CPS-37
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2
TITLE:	FIRST FLOOR MECHANICAL PLAN - SOUTH
COMMENTS:	SHEET REFERENCE M1.1A

ISSUE DATE: 12.09.08

MSK-01



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Niemiec Gazda-Auskalnis

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936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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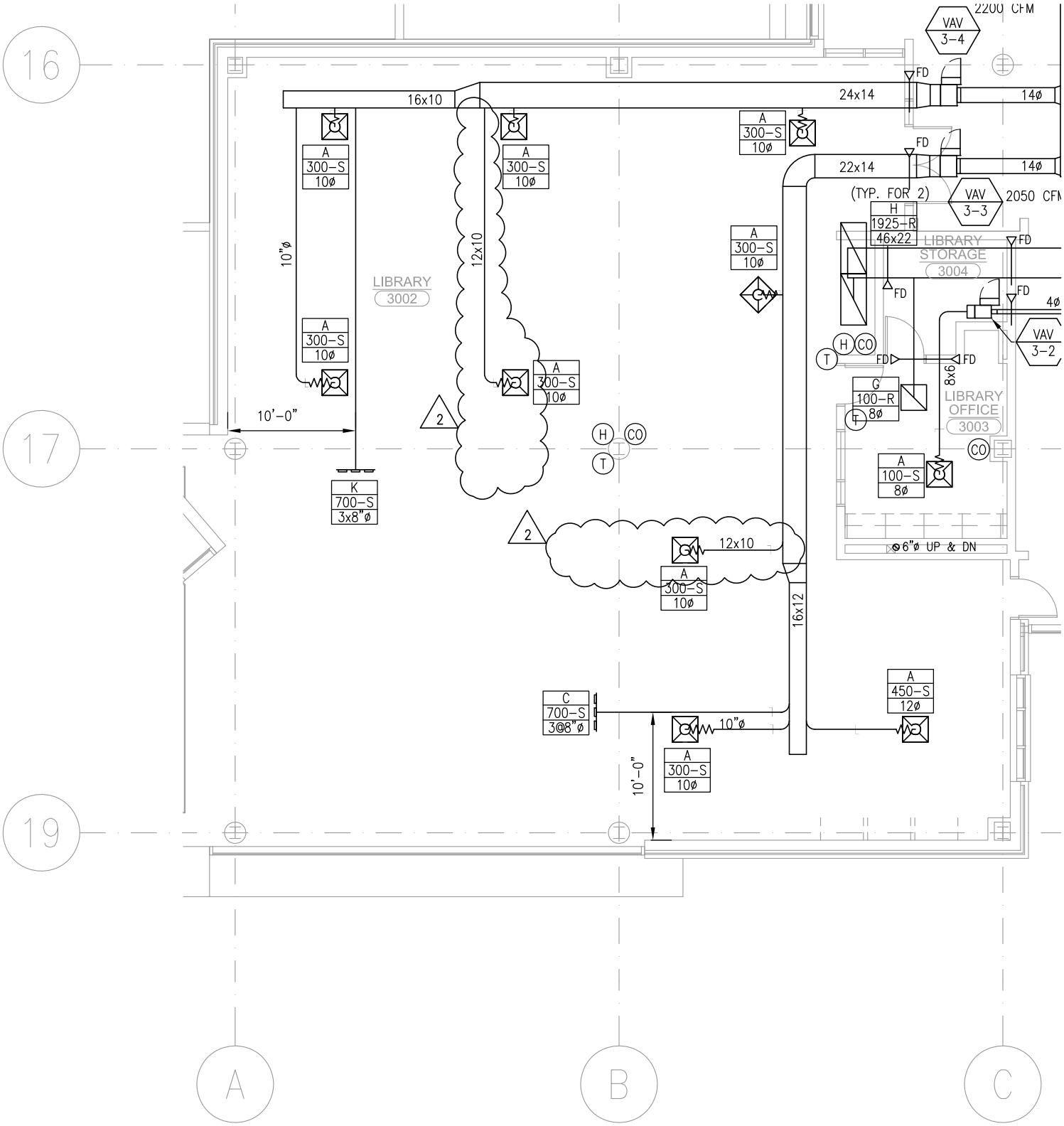
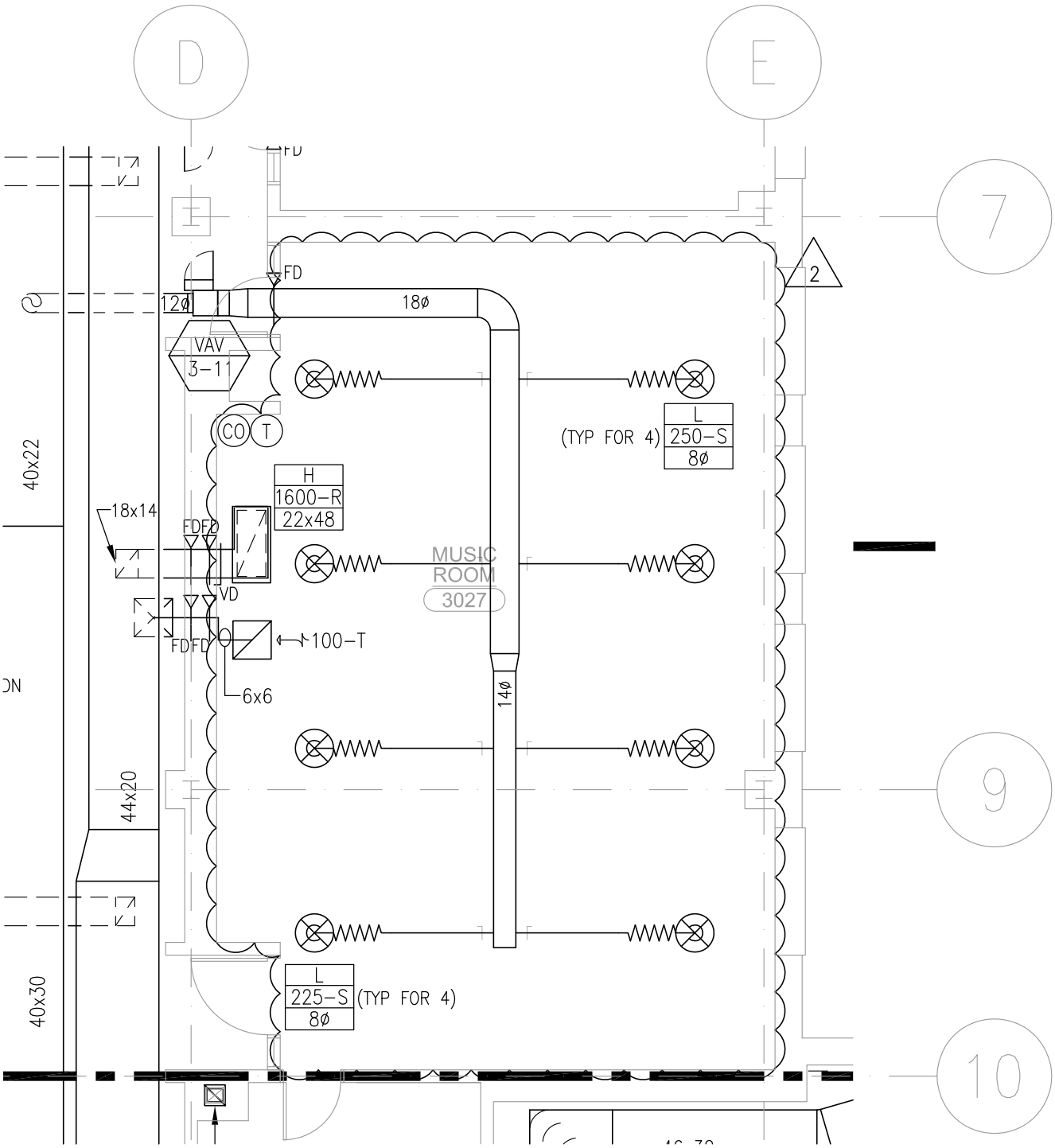
SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: FIRST FLOOR MECHANICAL PIPING PLAN SOUTH
COMMENTS: SHEET REFERENCE M1.1C

ISSUE DATE: 12.09.08

MSK-02



SMNG-A Architects, Ltd. Schroeder Murchie Niemiec Gazda-Auskalnis Architecture Planning Interior Architecture 936 West Huron Street Chicago, Illinois 60622 312. 829.3355 voice 312. 829.8187 fax	PROJECT: AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL SMNG-A NO.: 0732 PBC NO.: CPS-37 CONTRACT NO.: 1476 ISSUE: ADDENDUM 2 TITLE: THIRD FLOOR MECHANICAL PLAN SOUTH COMMENTS: SHEET REFERENCE M3.1A	ISSUE DATE: 12.09.08 MSK-03 PAGE 1 OF 1



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Niemiec Gazda-Auskalnis

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Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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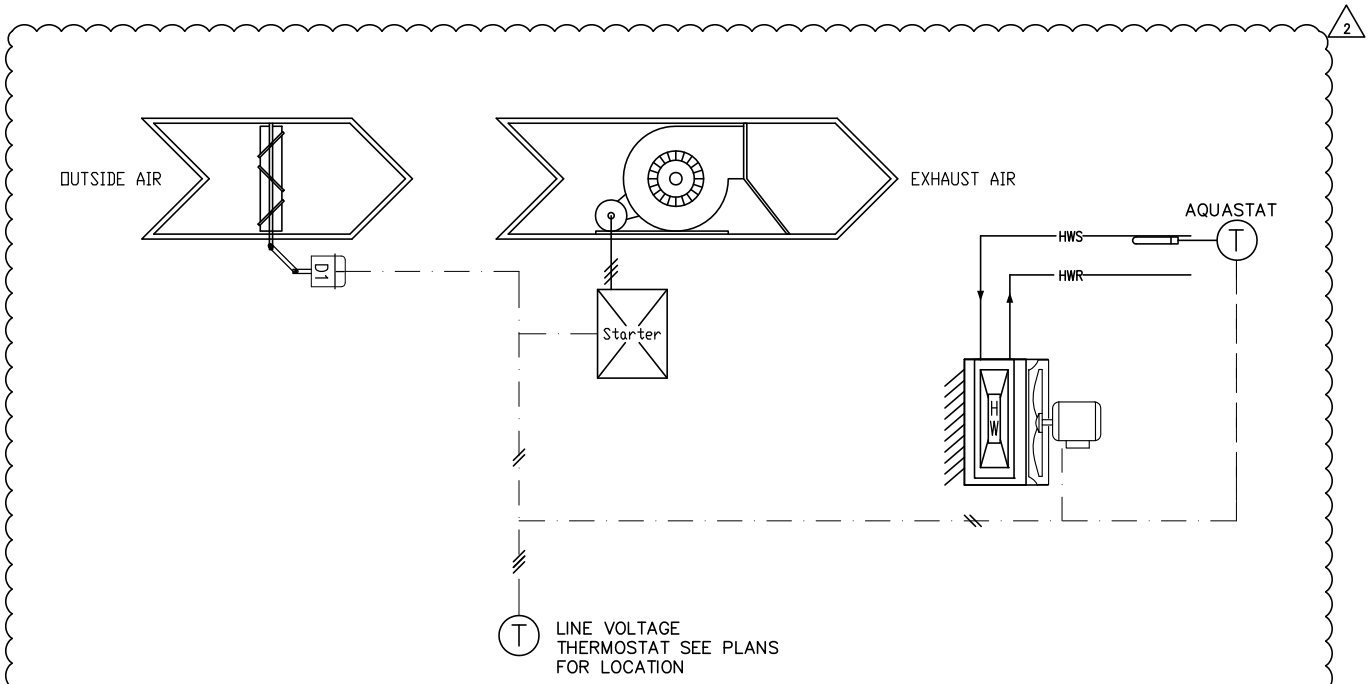
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: THIRD FLOOR MECHANICAL PLAN NORTH
COMMENTS: SHEET REFERENCE M3.1B

ISSUE DATE: 12.09.08

MSK-04



T–stat Controlled Exhaust Fan with associatied OA Damper and HW Unit Heater (EF–10, L–2, UH–1)

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Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: CONTROL DIAGRAMS
COMMENTS: SHEET REFERENCE M6.9

ISSUE DATE: 12.09.08

MSK-05

REFRIGERATION SCHEDULE

TAG NO.	NO. OF UNITS	NO. OF COMPR./ UNIT	COMPR. TONS	COMPR. HP	COMPRESSOR REFRIGERANT	# OF REFRIGERANT	REMOTE	SELF CONTAINED	LOCATION	AIR COOLED	WATER COOLED	NOTES
CH-1	1	8	20	17.5	R-407C	160		X	BLDG ROOF	X		1
CH-2	1	8	20	17.5	R-407C	160		X	BLDG ROOF	X		1
CRAC-1/CU-1	1	1	5	1	R-134A	5	X		MDF 2039	X		1
KITCHEN EQUIPMENT (BY OTHERS)												
KITCHEN EQUIP #2	2	1	0.70	1	R404A	3 LBS		X	KITCHEN 1082	X		2
KITCHEN EQUIP #3	1	1	0.49	1/2	R404A	1 LBS		X	KITCHEN 1082	X		2
KITCHEN EQUIP #5	2	1	0.51	1/3	134A	2 LBS		X	KITCHEN 1082	X		2
KITCHEN EQUIP #13	2	1	0.51	1/3	134A	2 LBS		X	KITCHEN 1082	X		2
KITCHEN EQUIP #14	2	1	0.51	1/3	134A	2 LBS		X	KITCHEN 1082	X		2

1. ACTUAL REFRIGERANT CHARGE PER INSTALLED EQUIPMENT MANUFACTURER'S SHOP DRAWING
2. REFER TO FOOD SERVICE DRAWINGS FOR KITCHEN EQUIPMENT PLAN AND FOOD EQUIPMENT SCHEDULES & NOTES.

NOTES:

1. INSTALL PRESSURE RELIEF VALVE ON HIGH PRESSURE SIDE OF SYSTEM, UPSTREAM OF ANY INTERVENING VALVES.
2. REMOVE EXPANSION VALVES, DEVICES & CONNECTIONS FROM AIR STREAM.
3. REFRIGERATION PIPING SHALL BE TYPE ACR, OR TYPE "K" COPPER, UNLESS THE PRESSURE EXCEEDS THE RATED CAPACITY OF ACR TUBING.
4. ALL CONNECTIONS AND DEVICES TO BE BRAZED.

TYPICAL REMOTE REFRIGERATION PIPING DIAGRAM

NO SCALE

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936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: VENTILATION CODE & SCHEDULES
COMMENTS: SHEET REFERENCE M7.1

ISSUE DATE: 12.09.08

MSK-06

PROVIDE LOW AMBIENT KIT TO -30

FAN SCHEDULE

TAG	LOCATION	SERVICE	CFM	F.S.P. IN WC	FAN DATA				MOTOR DATA					MANUFACTURER AND MODEL	UNIT WT LBS.	REMARKS
					FAN TYPE	CLASS	RPM	DRIVE	BHP	HP	VOLT	PH	HZ			
RF-1	RM 3029	AHU-1	15,225	1.64	PLENUM	1	963	BELT	7.11	7.5	460	3	60	MCQUAY:	–	②③
RF-2	RM 3029	AHU-2	21,250	1.63	PLENUM	1	681	BELT	6.66	10	460	3	60	MCQUAY:	–	②③
RF-3	RM 3029	AHU-3	20,375	1.64	PLENUM	1	821	BELT	6.88	10	460	3	60	MCQUAY:	–	②③
RF-4	RM 3029	AHU-4	16,675	2.47	PLENUM	2	1248	BELT	11.31	15	460	3	60	MCQUAY:	–	②③
EF-1	ROOF	TOILETS	4,625	1.0	DOWNBLAST	1	1218	BELT	1.51	2	208	3	60	COOK: 195ACEB	450	①②④
EF-2	ROOF	TOILETS	5,075	1.0	DOWNBLAST	1	926	BELT	1.42	1-1/2	208	3	60	COOK: 225ACEB	550	①②④
EF-3	ROOF	TOILETS	250	0.5	DOWNBLAST	1	2012	BELT	0.24	1/4	208	1	60	COOK: 70ACEB	150	①②
EF-4	ROOF	TOILETS	175	0.5	DOWNBLAST	1	1859	BELT	0.24	1/4	208	1	60	COOK: 70ACEB	150	①②
EF-5	TOILET	TOILETS	125	1.0	INLINE	1	1400	DIRECT	–	129W	208	1	60	COOK: GC-182	150	①②
EF-6	ROOF	KILN	400	0.5	DOWNBLAST	1	1422	BELT	0.24	1/4	208	1	60	COOK: 80ACEB	200	①②
EF-7	ROOF	MDF	750	0.5	DOWNBLAST	1	1688	BELT	0.24	1/4	208	1	60	COOK: 100ACEB	250	⑤
EF-8	ROOF	ELEV. MECH. ROOM	450	0.75	DOWNBLAST	1	1518	BELT	0.24	1/4	208	1	60	COOK: 100ACEB	200	①②
EF-9	TOILET	TOILETS	125	1.0	INLINE	1	1400	DIRECT	–	129W	208	1	60	COOK: GC-182	150	①②
EF-10	YARD STORAGE	YARD STORAGE	1000	0.25	PROPELLER	1	1725	DIRECT	.218	1/4	208	1	60	COOK: 16P17D	115	②⑥⑦⑧⑨
KE-1	ROOF	KITCHEN HOOD	1750	0.5	DOWNBLAST	1	1013	BELT	0.39	1/2	208	3	60	COOK: 165ACRUB	550	①②④

2

① FOR ALL ROOF EXHAUST FANS PROVIDE HINGE KIT. HINGED CURB CAP WITH CABLES
② PROVIDE PRE-WIRED DISCONNECT
③ CONTRACTOR TO PROVIDE VFD. ELECTRICAL CONTRACTOR WILL WIRE.
④ ELECTRICAL CONTRACTOR WILL PROVIDE STARTER WITH HOA. MECHANICAL WILL INSTALL, ELECTRICAL WILL WIRE AND POWER
⑤ EXHAUST FAN WILL SERVE AS A BACK-UP TO THE INSTALLED SYSTEM. FAN WILL OPERATE TO MAINTAIN TEMPERATURE BETWEEN 80° AND 85°
⑥ PROVIDE EXPLOSION PROOF MOTOR, AND EXPLOSION PROOF DISCONNECT
⑦ PROVIDE FAN TIMER
⑧ PROVIDE ALUMINUM SHUTTER, ALUMINUM FAN CONSTRUCTION, SHUTTER GUARD, AND INSECT SCREEN.
⑨ SHUTTER COLOR WILL MATCH LOUVER COLOR PER SPECIFICATION 10200

2

SOUND ATTENUATOR SCHEDULE

TAG	SERVICE/ LOCATION	SYSTEM CFM	NOMINAL SIZE	TOTAL CFM	MAX FACE VEL	MINIMUM REQUIRED ACOUSTICAL RATING (Dba), OCTAVE BAND/HERTZ								BASIS OF DESIGN	MODEL	REMARKS
						65 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz			
ST-1	GYMNASIUM/AUDITORIUM RETURN/FAN ROOM	6485	84"Lx30"Wx22"D	6485		11	15	25	38	32	17	15	14	IAC	7LFL	
ST-2	AUDITORIUM SUPPLY/FAN ROOM	1730	60"Lx18"Wx18"D	1730		6	10	17	25	25	14	11	11	IAC	5LFL	
ST-3	GYMNASIUM RETURN/FAN ROOM	4615	60"Lx24"Wx24"D	4615		7	12	19	27	27	14	13	13	IAC	5LFL	

DIFFUSER SCHEDULE

TAG	TYPE	DESCRIPTION	MATERIAL	FINISH	ACCESSORIES	MANUFACTURER	MODEL	REMARKS
A	SUPPLY	24x24 LAY-IN	STEEL	WHITE		TITUS	OMNI	1,2,3
B	SUPPLY	2-SLOT LINEAR BAR	STEEL	WHITE	4' LENGTHS	TITUS	ML-39	1,2,3
C	SUPPLY	SUPPLY GRILLE	STEEL	WHITE		TITUS	300RL	1,2,3
D	SUPPLY	SUPPLY GRILLE	STEEL	WHITE		TITUS	300RL	1,2,3
E	SUPPLY	DRUM LOUVER	STEEL	WHITE		TITUS	S300	1,2,3
F	SUPPLY	12x12 LAY-IN	STEEL	WHITE		TITUS	OMNI	1,2,3
G	RETURN	24x24 LAY-IN	STEEL	WHITE	OPPOSED BLADE DAMPER	TITUS	PAR	1,2,3
H	RETURN	48x24 LAY-IN	STEEL	WHITE	OPPOSED BLADE DAMPER	TITUS	PAR	1,2,3
I	RETURN	RETURN GRILLE	STEEL	WHITE	OPPOSED BLADE DAMPER	TITUS	350RL	1,2,3
J	EXHAUST	EXHAUST GRILLE	ALUMINUM	WHITE	OPPOSED BLADE DAMPER	TITUS	350RL	1,2,3
K	SUPPLY	NOZZLE DIFFUSER	STEEL	WHITE	OPPOSED BLADE DAMPER	TITUS	TBF	1,2,3
L	SUPPLY	24"ø SUPPLY DIFFUSER	STEEL	WHITE		TITUS	R-OMNI	1,2,3

2

REMARKS:
1. SEE DRAWINGS FOR INDIVIDUAL DIFFUSER NECK SIZES
2. SEE DRAWING FOR DIFFUSER SIZE
3. FINISH WILL BE SELECTED FROM STANDARD COLORS, AND WILL BE PER ARCHITECT.

SMNG-A Architects, Ltd.
Schroeder Murchie
Niemiec Gazda-Auskalnis

Architecture
Planning
Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

PROJECT: AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL
SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: MECHANICAL SCHEDULES
COMMENTS: SHEET REFERENCE M7.2

ISSUE DATE: 12.09.08

MSK-07

HYDRONIC HEATER SCHEDULE

TAG	MANUFACTURER	MODEL	MBH	LOCATION	MOTOR						COIL				ESP	FINAL AIR TEMP.	CFM @ FINAL AIR	REMARKS
					VOLT	PH	MCA	MOP	RPM	HP/W	ROWS	EWT	WPD FT.	GPM				
CUH–A	TRANE	FFBB0301A	17.29	STAIRS	115	1	1	15	1080	85W	3	150	1.86	1.15	0.1	118	277	1,2,3,4
CUH–B	TRANE	FFBB0301A	19	VESTIBULES	115	1	1	15	1087	85W	4	150	2.75	1.27	0.1	129	256	1,2,3,4
CUH–C	TRANE	FFBB0301A	5	VESTIBULES	115	1	1	15	1087	85W	3	150	2.75	1	0.1	115	277	1,2,3,4
UH–A	TRANE	UHSBA181T	65	YARD STORAGE	115	1	1	N/A	N/A	N/A	–	150	0.88	4.4	–	94	500	1,5,6,7

2

REMARKS

1. PROVIDE UNIT MOUNTED NON–FUSED DISCONNECT
2. COLOR AND FINISH BY ARCHITECT
3. PROVIDE UNIT MOUNTED TEMPERATURE SENSOR, AND SETPOINT DIAL
4. PROVIDE 2–WAY, 2 POSITION (50 PSIG) NO TWO–WAY CONTROL VALVE
5. PROVIDE TOTALLY ENCLOSED MOTOR
6. PROVIDE WALL MOUNTED TEMPERATURE SENSOR
7. PROVIDE FAN GUARD

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Schroeder Murchie
Niemiec Gazda-Auskalnis

Architecture
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Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

PROJECT: AVONDALE / IRVING PARK AREA ELEMENTARY SCHOOL

SMNG-A NO.: 0732
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE:

COMMENTS:

ISSUE DATE: 12.09.08

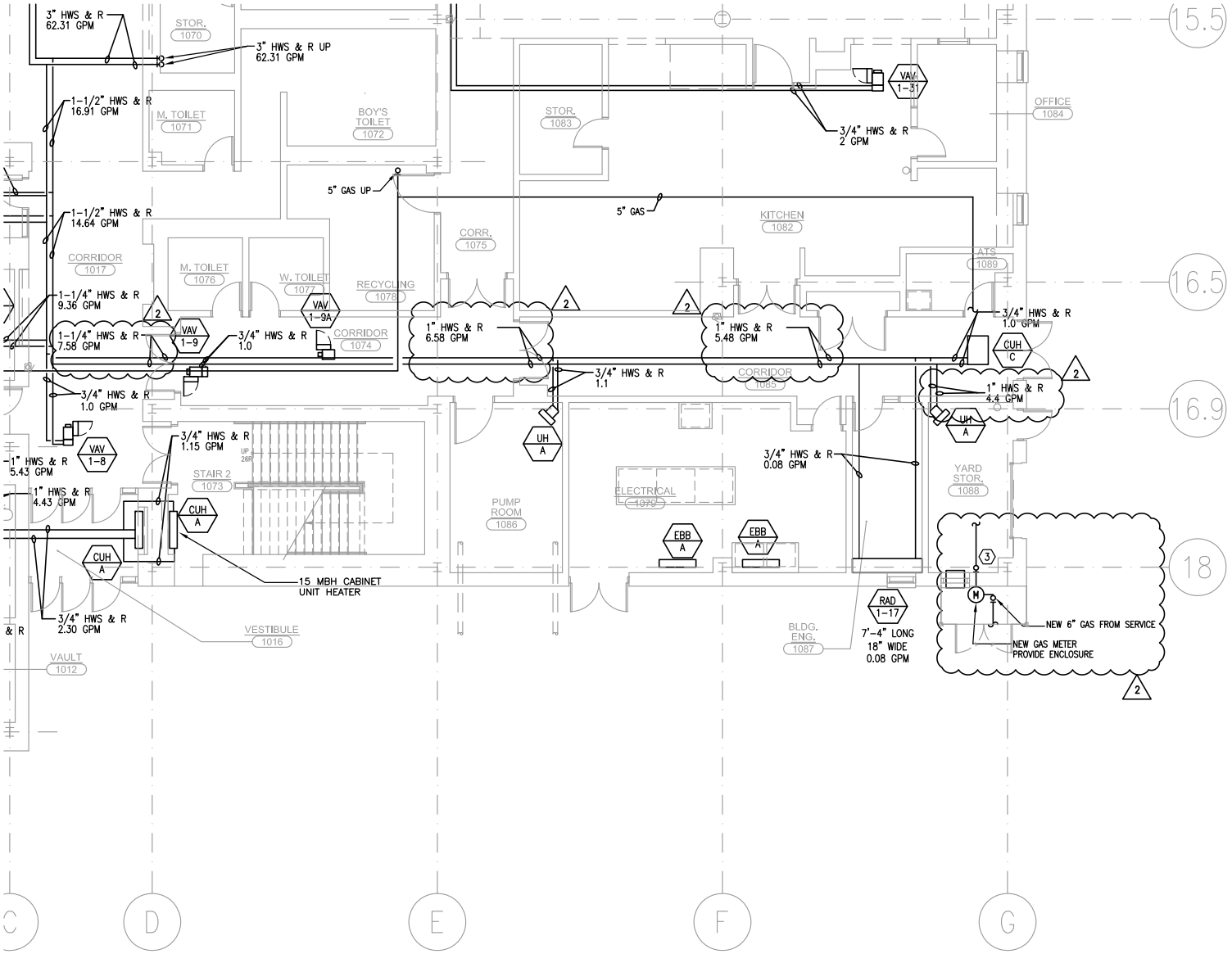
MSK-08

KEYED NOTES:

1. CONTRACTOR WILL PROVIDE A CONNECTION FROM THE MANUFACTURER TO INTERLOCK THE SEPARATE SECTIONS OF RADIANT PANELS. THE CONNECTION WILL NOT HAVE LIVE PIPING, AND WILL CONNECT THE PANELS TO GIVE THE APPEARANCE OF A "FLUSH" CONNECTION.

2. PROVIDE 1/2" GAS LINE TO TEACHERS DEMONSTRATION SINK IN LAB ON SECOND FLOOR. PROVIDE A ELECTRONIC SOLENOID, GAS COCK AND EMERGENCY DISCONNECT AT DESK. SEE DETAIL 10 ON SHEET M5.5 FOR CONNECTION AND COORDINATION. CONTRACTOR WILL COORDINATE WITH ARCHITECTURAL THE EXACT LOCATION OF THE GAS RISER THROUGH THE SECOND FLOOR. GAS WILL PENETRATE FLOOR UNDER TEACHERS DEMONSTRATION SINK ON SECOND FLOOR.

3. GAS PIPE WILL ENTER INTO YARD STORAGE, THEN THE PIPE WILL GO UP TO SLAB INSIDE OF BUILDING AND WILL BE ROUTED AS SHOWN ON DRAWINGS



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Schroeder Murchie
Niemiec Gazda-Auskalnis

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Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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SMNG-A NO.:	0732
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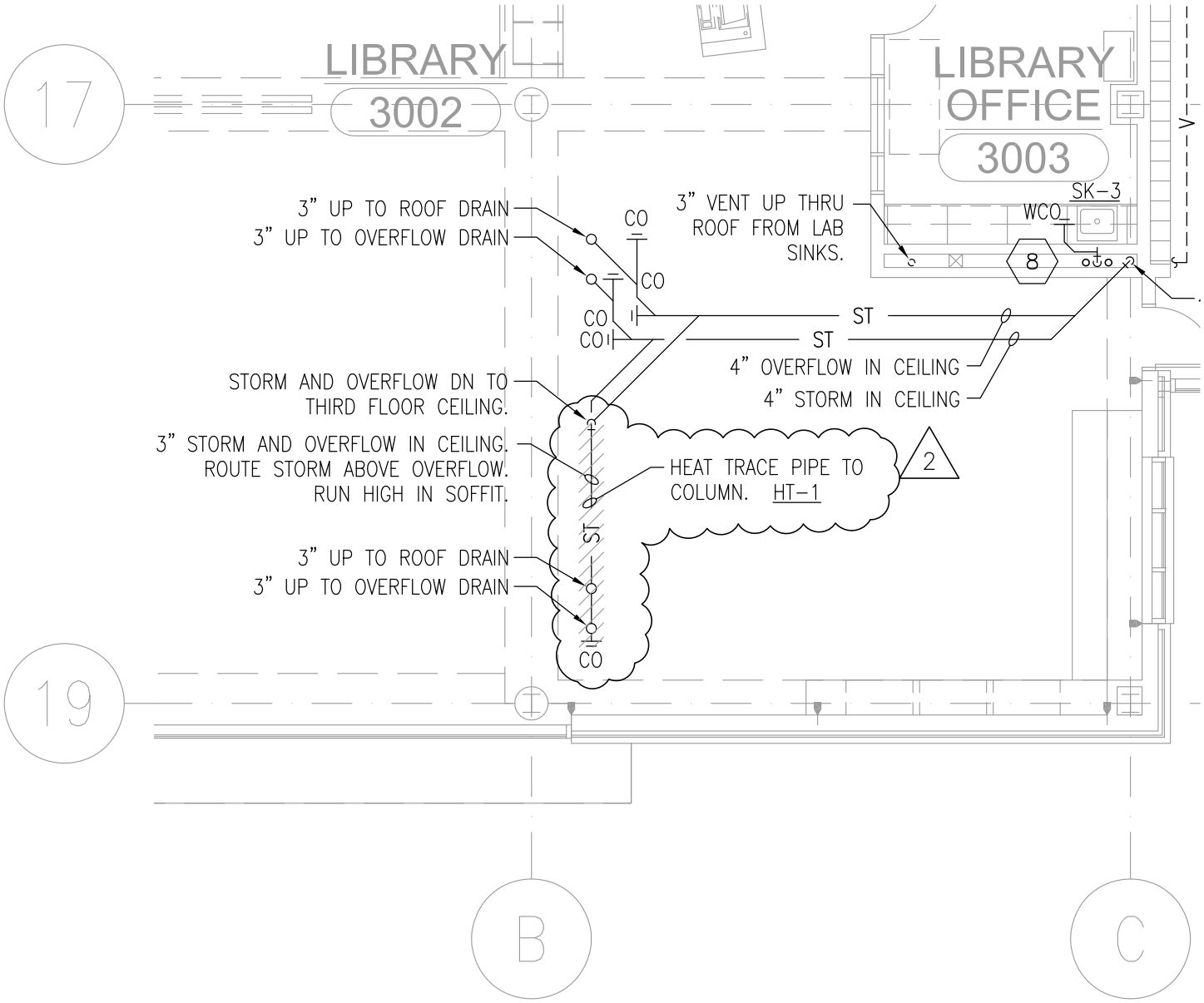
CONTRACT NO.:	1476
ISSUE:	ADDENDUM 2
TITLE:	FIRST FLOOR MECHANICAL PIPING PLAN SOUTH
COMMENTS:	SHEET REFERENCE M1.1C

ISSUE DATE: 12.09.08

MSK-09



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Schroeder Murchie
Niemiec Gazda-Auskalnis

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936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: THIRD FLOOR PLUMBING PLAN - SOUTH
COMMENTS: UNDER SOFFIT STORM HEAT TRACE, SHEET REFERENCE P3.1A

ISSUE DATE: 12.09.08

PSK-01

LABORATORY WASTE AND VENT PIPING

A. LABORATORY ACID WASTE DRAIN AND VENT PIPING SHALL BE POLYPROPYLENE PER ASTM F1412.

B. EXPOSED OR ACCESSIBLE JOINTS SHALL BE APPROVED FOR INSTALLATION WITH THE PIPING MATERIAL INSTALLED (18-29-702.4).

C. CONCEALED JOINTS SHALL BE SOCKET FUSION WELDED PER ASTM D2657.

2

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Niemiec Gazda-Auskalnis

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936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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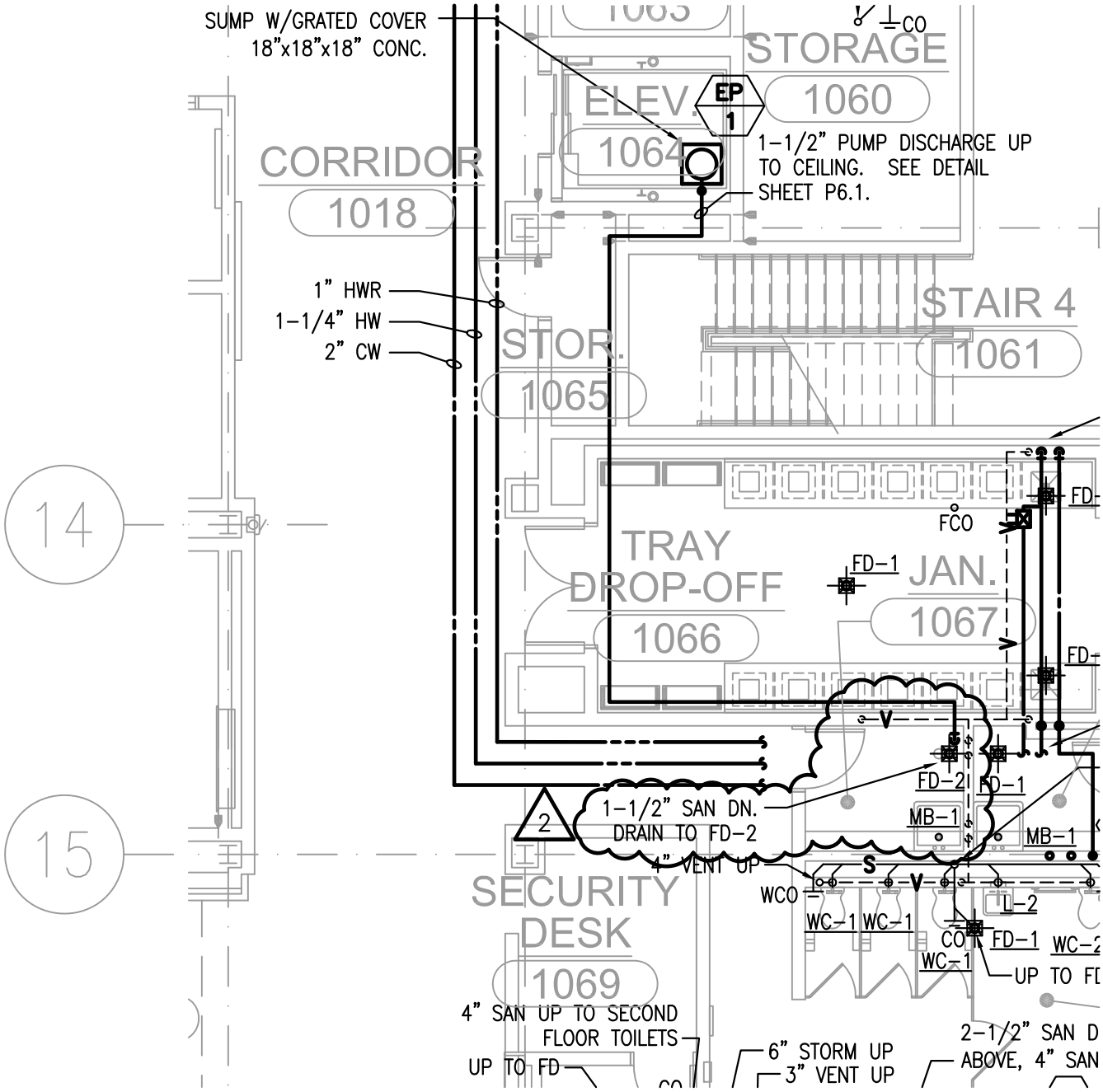
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: PLUMBING NOTES
COMMENTS: ACID WASTE PIPING, SHEET REFERENCE P5.1

ISSUE DATE: 12.09.08

PSK-02



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Schroeder Murchie
Niemiec Gazda-Auskalnis

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936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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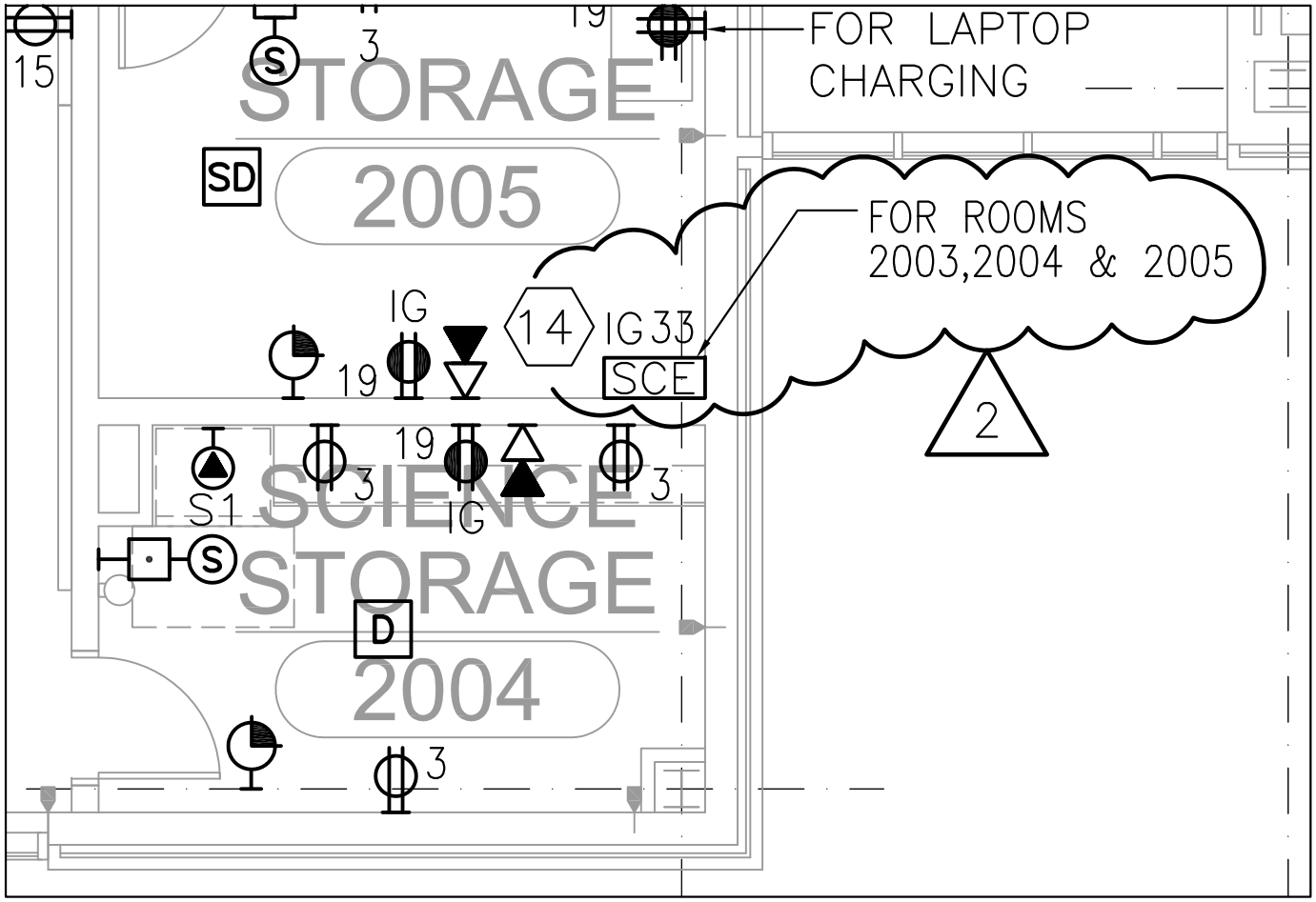
PBC NO.: CPS-37
CONTRACT NO.: 1476
ISSUE: ADDENDUM 2
TITLE: FIRST FLOOR PLUMBING PLAN - SOUTH
COMMENTS: ELEVATOR PIT PUMP DISCHARGE, SHEET REFERENCE P1.1A

ISSUE DATE: 12.09.08

PSK-03



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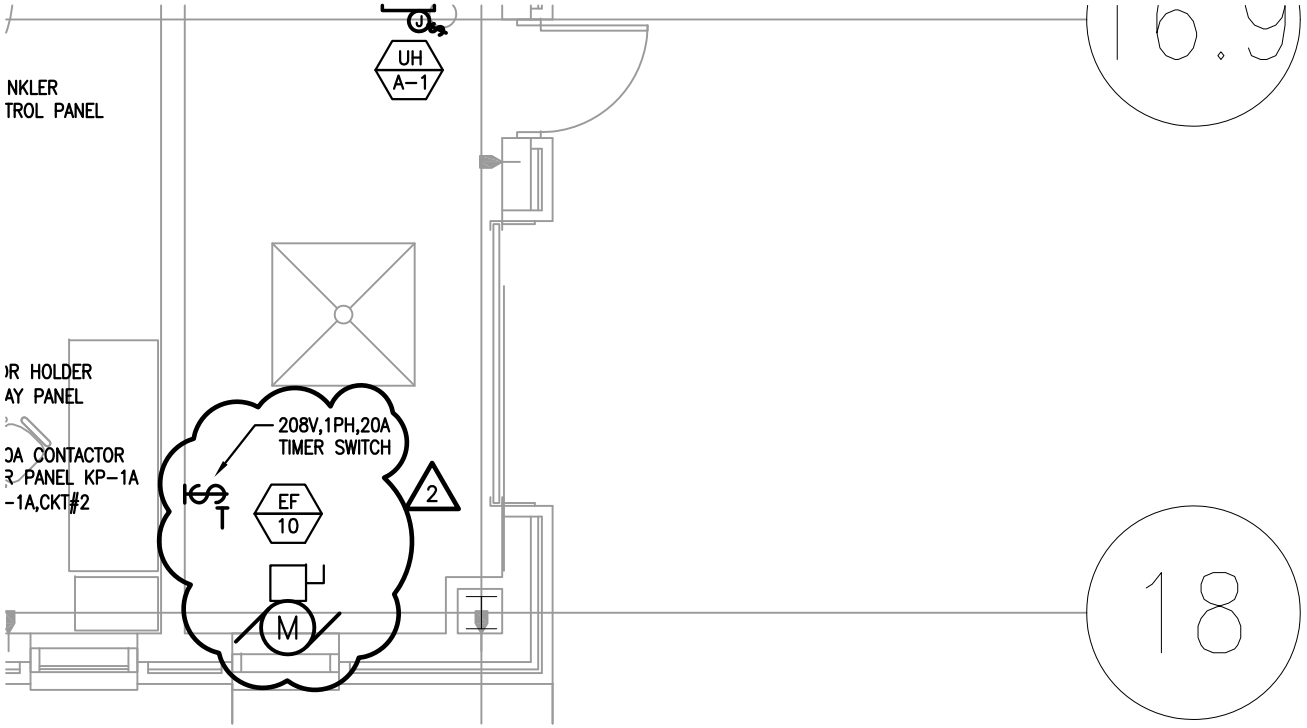

2	EF-10	EXHAUST FAN	YARD STOR.	208	1	1/4	–	2.9	RP-1B	36,38	20	1	2	12	3/4	20	2	–	–	TO	NOTE 6

SMNG-A Architects, Ltd.
Schroeder Murchie
Niemiec Gazda-Auskalnis

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Interior Architecture

936 West Huron Street
Chicago, Illinois 60622
312. 829.3355 voice
312. 829.8187 fax

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TITLE: FIRST FLOOR ELECTRICAL POWER PLAN SOUTH
COMMENTS: EF-10 EXHAUST FAN ADDED IN YARD STORAGE #1088

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ESK-02