Division of Finance and Business Operations

Purchasing Department
5700 Cass Avenue, suite 4200
Detroit, Michigan 48202
(313) 577-3734
FAX (313) 577-3747
February 14, 2013

Addendum #5 To
Request for Proposal
For Computer Services Center Chiller Replacement: Project 193-228857

Minutes of the Pre-bid Conference

Dated February 1, 2013

The Addendum must be acknowledged on your lump sum bid.

NOTE: You must have attended a prebid conference in order to be eligible to bid on a particular project. Receipt of minutes or addenda without being at a prebid conference does not qualify your company to bid.

The pre-bid conference for Request for Proposal for **Computer Services Center Chiller Replacement**, Project **193-228857** was held on **February 8, 2013,** at **11:00 a.m.** (local time) – at Detroit, MI 48202. **Ken Doherty** reviewed the highlights of the pre-bid package, especially concerning details such as bid due dates and who vendors may contact during the live bid process. **Thomas J. Edwards** and **Brian Runde** from **Peter Basso and Associates Inc.** discussed the technical aspects of the project and bid requirements, and conducted the Q & A session.

Numerous policies, questions and answers were addressed at the pre-bid meeting:

- A bid bond is not required for bids below $50,000. Otherwise, a bid bond (5%) will be required for the full amount of the bid.
- Performance Bond and Material & Labor Payment Bond requirements are listed in the specifications of the job. Performance & Material & Labor Payment Bonds must be provided by the awarded Vendor with the submission of the signed contract; which will then be submitted to FP&M management for counter signature.
- The awarded vendor must provide the required Certificate of Insurance in compliance with Section 800, article 11 of the bid specifications prior to commencement of any work.
- If your company has not previously done business with the University you may go to the Purchasing website at **www.purchasing.wayne.edu** and look for the “new vendor” link under “Information for Vendors” on the left. You may submit a new vendor request form and an IRS form W-9. This will register your company on our vendor list. (NOTE: this does not replace the listserv.)
- This Project Requires Vendors to use Union Labor, either their own or as labor supplied under a Project Labor Agreement. Section 00420 of the Bid Documents outlines the University’s Project Labor Requirements for this and all projects that requiring prior approval of the Board of Governors.
- 1099 workers and subcontractors using 1099 workers are **NOT** acceptable
- Certified Payroll must be provided with each of the contractor’s pay applications for all workers who worked at the job site, in compliance with the State of Michigan policy. Failure to provide certified payroll, will constitute breach of contract, and pay applications will be returned unpaid and remain so until satisfactory supporting documents are provided.
- Signed waivers from all Subcontractors and suppliers must accompany Pay Applications or they will be returned for such documentation prior to approval.
- A properly executed sworn statement is required from all tiers of contractors, and sub-contractors indicating sub-contractors and suppliers which provide services or product of $1,000.00 or greater. Sworn statements must accompany applications for payment
- All documents listed in the Front End Section 00420-2 “Wayne State Project Labor Agreements” must accompany applications for payment. Failure to do so will result in the entire application package returned for correction.
- A checklist of all Pay Application requirements can be found in Section 00430-1.

- The competency and responsibility of Bidders will be considered in making the award. The Owner does not obligate himself to accept the lowest or any other bids. The Owner reserves the right to reject any and all bids and to waive any informalities in the Proposals
- Parking on WSU campus lots and structures are $6.00/access. Vendor must build parking into their lump sum bid. Please note: lots are credit card only or cash only, plan accordingly.
- The awarded contractor may use the pay lot directly behind the Computer Service Center. A commercial vehicle may be kept in the parking lot as long as security measures are taken.
- There may be a small amount of storage space available in the project area for a couple of (locked) gang boxes.
- Section 300, Form of Proposal has changed very recently, review carefully and complete in its entirety to avoid disqualification.
- The contractors **must** fill out our prequalification form. They can attach additional information if they would like but at a minimum the information requested must be filled in on our form so that we do not have to hunt to find the information
- Contractors who have withdrawn a bid after a University bid opening and/or refused to enter into a contract with the University upon notification of award within the last 3 years are not eligible to bid on this project
- Project hours of operation are 7:00am – 5:00 pm. Anything else requires advance notice and approval.
- Prequalification meeting will be held the first business day after bid openings. Contractors must be available. The Project Manager will coordinate the meetings. Prequalification meeting includes Schedule of Values from the Contractor, including a list of Contractor's subcontractors and other qualifications required by the documents.
- An unsigned contract will be given to the successful Contractor at the conclusion of the Prequalification meeting, if all aspects of the bid are in order. The Contractor has 5 business days to return the contract to the Project Manager for University counter signature. The contractor must also submit a Performance Bond as outlined above and a Certificate of Insurance in the same 5 business day period. In the event the Contractor fails to return the documents in this 5 day period, the University reserves the right to award the contract to the next most responsive bidder.
- An Optional second walk through was scheduled for February 18, 2013 at 9:00 am. Late arrivals will not be retrieved once the walk through begins.
- Permit requirements are the responsibility of the awarded contractor as listed on Section 800 Article 4. The Computer Service Center is not considered a classroom building and will not require State permits. However, a Hot Work Permit will be required. The awarded contractor must work with the University's department of Risk Management to gain a Hot Work permit.
- The awarded contractor must work with the project manager to coordinate inspections with the Department of Risk Management as well.
- Vendor must provide their own dumpster if needed, which must be rubber or plywood padded if placed on concrete. Location and duration must be coordinated with the project manager. The dumpster must be tagged with the name of your company clearly displayed. Any lawn damage must be restored.
- Use of restrooms will be prohibited. The awarded contractor must supply a temporary facility for workers.
- Tecochill was the awarded the Chiller RFQ. The Pre-Purchased Chiller is scheduled to be delivered May 1, 2013. Chiller submittal drawings have been included with this addendum.
- Cooling Tower bids remain under review and will be shared upon approval. Results of award will be announced via an addendum and will be posted to the website. The Cooling Tower is scheduled to be delivered on May 1, 2013.
- The Chiller, Generator, generator radiator and all associated equipment (pumps, etc.) that are to be disconnected and removed will be turned over to the University and delivered to 1200 Holden for storage and future use.
- An Addendum with the new Curb Area and associated documents including Siemens documents has been posted along with this addendum.
- Peter Basso will clarify ME3.2 CRU 1 & 2 locations on the drawings.
- Siemens Controls are required. The University will contract direct with Siemens. However, low voltage wiring including conduit and terminations are the responsibility of the awarded contractor.
- The Alternate for the Transformer is for purchase and delivery to 1200 Holden for future emergency use by CSC.

- Is there a Buy American Policy, are foreign materials accepted? If quality and costs are even, buy American.
- How does the sequence work while removing the chiller? In order for no interruptions to service, disconnect, removal, and delivery to 1200 Holden should occur at the end stages of the project, in order to maintain continuity of service.
- Questions are due by **February 19, 2013** at 12:00 noon
- Bids are due no later than 2:00 p.m., **February 22, 2013,** at 5700 Cass Ave. Room 4200 AAB. No public bid opening will be held. Late proposals will not be accepted.
- Time of Completion: The Contract is expected to be fully executed on or about 15 calendar days after successful bidder qualification and recommendation of award. The successful bidder (Contractor) agrees to start construction **immediately after** receipt of a fully executed contract and Purchase Order, and to complete the work as follows: Substantial Completion, and State Approved Inspections (if appropriate), no later than **June 15, 2013.**
- **Vendors were cautioned to not bid unless they can absolutely meet the Substantial Completion date of June 15, 2013.**
- A copy of the sign in sheet is available for downloading from the University Purchasing Web Site at http://www.forms.purchasing.wayne.edu/Adv_bid/Adv_bid.html.
- This is an occupied area. The awarded contractor must be considerate of environment (noise, cleanliness, etc.)

We will require two copies each of your lump sum proposals, vendor qualification questionnaire and your bid bond documents.

All questions concerning this project must be emailed to: Paula Reyes, Purchasing Department. Email: bb2709@wayne.edu, copy Ken Doherty, AVP of Procurement, at ac0578@wayne.edu.

Do not contact either FP&M or the Design Firm directly as this may result in disqualification of your proposal.

Thank you for interest shown in working with Wayne State University.

Paula Reyes
Strategic Sourcing Manager

CC: Thomas J. Edwards (Project Manager), Ken Doherty, AVP of Procurement, Attendee list.

Peter Basso Associates Inc
CONSULTING ENGINEERS

Mechanical
Electrical
Energy Management
Communication Technologies
Commissioning

ADDENDUM

Project Name: Wayne State University
C&IT Chiller Replacement
Installation Bid Pack
WSU Project No. 193228857

PBA Project Number: 2012.0389

Addendum Number: 5

Date: February 18, 2013

Each Bidder's proposal shall include the work described herein.

Unless otherwise indicated, the work described herein shall comply with, and be equal in all respects to, the original Specifications and the Drawings accompanying same. Include incidental work required to properly complete the work, whether stated herein or not.

Drawings Issued: A1.2, S1.1, SPEC1, SPEC2, SPEC3 AFTRM, ABAC, TTRM1, TTRM2, TWIR, 001, 002, 003, 004, 005.

Specifications Issued: 311000, 312000, and 321216.

Item No.	Description
1.	Asbestos test reports are issued for reference.
2.	Chiller shop drawing is issued for reference.
3.	Refer to Drawing A1.2 (Issued)
	A. New Drawing
4.	Refer to Drawing S1.2 (Issued)
	A. Modified footing depth/details.
5.	Refer to Drawings ME2.1, ME2.2 (Not Issued)
	A. Add the requirement to remove existing concrete equipment pads with equipment to be demolished, and to remove existing abandoned equipment pad in new chiller room.
6.	Refer to Drawing ME2.2 (Not Issued)

3960 Howard Hughes Parkway, Ste. 500
Las Vegas, NV 89169
Tel: 702-990-3879
Fax: 866-613-3461

2440 West Mission Lane, Ste. 9
Phoenix, AZ 85021-2807
Tel: 602-314-8095
Fax: 602-943-1241

5145 Livernois, Ste. 100
Troy, MI 48098-3276
Tel: 248-879-5666
Fax: 248-879-0007

2001 Commonwealth Blvd., Ste 203
Ann Arbor, MI 48105
Tel: 734-913-4749
Fax: 734-913-4957

www.PeterBassoAssociates.com

A. Add requirement to Alternate 3 to remove air handling unit, ductwork, and associated piping including two condensate return units complete flush with the mechanical room walls. Cap piping and ductwork at the walls.
B. Add requirement to Alternate 2 to infill existing roof opening with 1 1/2" thick 20-gauge roof deck to match existing. Maximum span of deck to be 6'-0". Provide additional structural members as required to limit roof deck span to acceptable lengths. Submit structural details to Engineer for review and approval.
C. Add requirement to Alternate 2 provide 2" double wall insulated blank-off panels to close off cooling tower air intake openings, and seal weather tight.

7. Refer to Drawing ME3.1 (Not Issued)

A. Add requirement to support catalytic converter, exhaust silencer, and exhaust piping from supplementary steel mounted on the floor, rather than hanging from steel above.

8. Refer to Drawing ME3.2 and ME6.1 (Not Issued)

A. Note that CRU-1 is the only condensate return unit on the project, and the electrical one line diagram indicates there are two pumps on the one unit.

8. Refer to Drawings SPEC1, SPEC2, SPEC3 AFTRM, ABAC, TTRM1, TTRM2, TWIR, 001, 002, 003, 004, and 005 (Issued).

A. Added Drawings.

9. Refer to Specification Sections 311000, 312000, and 321216 (Issued)

A. Added Specifications.

193 Computing Service
11-17-86

PROJ. 8628A

AAA DRILLING & TESTING INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

AAA Report Number: 11554-1
Date Issued: 17 November 1986

Wayne State University
Facilities Planning & Management
Design Service
5454 Cass Avenue - First Floor
Detroit, Michigan 48202

Attention: Mr. Doug Hamborsky

Re: Material Sampling and Identification of Asbestos Containing Materials,
REF: Computer Services Center

Dear Mr. Hamborsky:

In accordance with your request, on 7 November, 1986 AAA Drilling & Testing, Inc. performed a building survey for the above referenced project to determine the presence of friable asbestos containing building materials. Bulk samples were obtained in accordance with departmental guidelines and analyzed according to EPA "Interim Method for the Determination of Asbestos in Bulk Insulation Samples".

The survey data and analytical results for those areas specified at the time of inspection are as follows:

SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	PERCENT ASBESTOS
D-1	Mechanical Room 179; Duct Insulation at Connection	Non-Friable; No Deterioration	No	Cellulose and Glass Fibers
D-2	Mechanical Room 179; Duct-Corner Insulation at Right Hand of Unit Seam	Non-Fibrous, Friable; No Deterioration	Yes	5-15% Amosite

.....continued

SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	PERCENT ASBESTOS
D-3	Mechanical Room 179; Duct Insulation at Connection	Non-Friable; No Deterioration	No	Cellulose and Glass Fibers
D-4	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #3	Fibrous, Friable; Slight Deterioration	Yes	25-35% Chrysotile
D-5	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #2	Fibrous, Friable; Severe Deterioration	Yes	20-30% Chrysotile
D-6	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #1	Fibrous, Friable; Severe Deterioration	Yes	20-30% Chrysotile

DISCUSSION

Analytical test results indicate that fibrous asbestos is present in sampled pipe joint insulating materials. Fibrous asbestos is also present in a sample of heat duct insulation material (Sample D2).

Straight pipe insulation material was observed to be glass fiber wrap.

RECOMMENDATIONS

The above referenced sample, D2, in the Mechanical Room 179 is an asbestos-containing material (ACM). However, this ACM is adjacent to, but not part of the proposed alteration work, i.e., removal of connection duct between the right and left hand units as indicated on your drawings. The samples of insulation on the connector duct showed no fibrous asbestos present.

Persons who enter this area should take care not to disturb any pipe or duct insulating materials or debris. Persons who must work in the immediate vicinity of this area should wear appropriate respiratory protection.

.....continued

A visual inspection was made of the East-West Duct above the ceiling in Computer Room 180 Area No. 1, Ref: Section Line "K" on your drawings. No insulation was observed to be present on this duct run.

The piping system servicing the EDPAC Units #1, 2, 3, and 4 were also inspected. No friable materials were observed to be present. A "rubber" type insulation is present on these systems.

The piping system servicing the "BLAZER" units is insulated with friable ACM on the joints, i.e., tees, valves, elbows, etc. This ACM is in poor physical condition and poses a potential exposure hazard. Remedial action should be undertaken promptly.

Renovation/Demolition projects which directly involve asbestos containing materials are subject to governmental regulations. Personal respiratory protection, work area isolation, removal technique, atmospheric monitoring and proper notification and disposal are of the utmost importance in any abatement operations. Copies of EPA regulations and guidelines are included with this report.

ASBESTOS REMEDIATION PROCEDURES

Removal Procedures - Pipe Insulation

Small amounts of pipe insulation may be removed by thorough wetting of the insulation with an amended water solution. This is typically a 90/10 mix of water and common liquid detergent. Once thoroughly wetted, the material can then be removed without release of asbestos fibers. Waste materials should be placed in thick, (6 mil.), well-sealed plastic bags and labeled as containing-asbestos waste. Waste materials can then be transported to a landfill licensed to accept asbestos waste.

Areas where asbestos remediation procedures are anticipated should be isolated from the rest of the building. This is commonly effected by construction of visqueen barriers which, if properly erected, provide an airtight chamber.

All floors should be thoroughly wet mopped after completion of the project and before removal of barriers. The mop head and other materials should be disposed in the same manner as asbestos waste.

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An alternative method for removal of deteriorated pipe insulation is through the use of commercially available polyethylene bags designed to be temporarily taped to the pipe. The interior of the bags provide an airtight chamber in which to effect removal operations. This obviates the need for erection of isolation barriers and also requires significantly less manpower. Workers using containment bags should wear respirators in the event of containment bag failure.

Worker Protection

All workers removing asbestos-containing materials should wear approved respirators, gloves and disposable body suits. Workers should shower on-site after completing the work for the day. Atmospheric monitoring is recommended. Please note that untrained personnel should not attempt a large scale removal or encapsulation project. Also, proper notification should be given as required (EPA, OSHA, State and Local).

Legal Requirements

Prior to the removal of friable asbestos-containing material, notification must be submitted to Federal and State government authorities. Notification form has been enclosed with this report. If the removal project is located in Wayne County, a copy of this notification must also be submitted to:

Michael D. Maillard
Engineering and Enforcement Director
Wayne County Health Department
2211 East Jefferson
Detroit, Michigan 48226

Supplemental Services

Testing Engineers & Consultants, Inc. offers additional asbestos services in the areas of:

(1) Specifications and Bid Preparations

(2) Remediation/Removal Procedures
-Regulation Compliance (EPA, OSHA, State & Local)
-Management of Hazardous Materials
-Atmospheric Monitoring/Supervision during Encapsulation/Removal
-Inspection of Completed Project

.....continued

If you are in need of these or other consulting services, please contact us for additional information.

We are pleased to have been of service. If you have any questions or require further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA DRILLING & TESTING, INC.

David Mueller
Environmental Engineer

Steve Kulpanowski
Staff Geologist

Stuart Yankee
Staff Engineer

DM/SK/SY/kr
Enclosure

193 (Computing Service)
3-19-87

AAA DRILLING & TESTING INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

AAA Report Number: 12005-1
Date Issued: 03-19-87

Wayne State University
F P & M 5454 Cass Avenue
Detroit, Michigan, 48202

Attention: Dave Reitzel

Re: Air Monitoring During the Asbestos Abatement Project at Wayne State University-Computer Center, Detroit, Michigan
Your P.O.#:

Dear Dave Reitzel,

Monitoring for airborne fiber levels was performed at the above referenced location during removal of asbestos-containing materials on 03-03-87.

The samples were analyzed in accordance with NIOSH Method #P&CAM 239, "Asbestos Fibers in Air". Only fibers >5um long with an aspect ratio greater than 3:1 are counted. We note that a minimum count of 10 fibers per 100 fields is considered by NIOSH to be acceptable for reliable quantitation. Samples containing less than 10 fibers per 100 fields are reported as less than (<) the value of the minimum reliable detection limit at the given air volumes.

Sampling locations are designated below and the corresponding numbers are used in the report. The results are tabulated on the proceeding page(s).

SAMPLING STATION	LOCATION
1	Computer Center, Work Area, East
2	Computer Center, Work Area, South
3	Computer Center, Adjacent To Work Area
4	Personal Sample, Mark Kovac

contd.....

AAA DRILLING & TESTING, INC.

AAA REPORT #: 12005-1 DATA PAGE #1

DATE SAMPLED	SAMPLE STATION	TYPE	SAMPLING TIME PERIOD	LITERS OF AIR SAMPLED	FIBERS COUNTED	FIELDS COUNTED	FIBER CONC. (f/cc)
03-03-87	1	B	8:30AM-10:25AM	1093	5.0	100	<.010
03-03-87	2	B	8:30AM-10:25AM	920	10.0	100	.028
03-03-87	3	B	8:40AM-10:30AM	990	.5	100	<.001
03-03-87	1		10:25AM-12:35PM	1235	8.5	100	<.017
03-03-87	2		10:25AM-*V1	0			
03-03-87	3		10:40AM-12:55PM	1215	3.0	100	<.005
03-03-87	4	P	10:50AM-12:35PM	305	10.5	100	.088
03-03-87	1	C	12:50PM-2:50PM	1140	5.0	100	<.010
03-03-87	2	C	12:50PM-2:50PM	960	2.5	100	<.004

----------COMMENTS----------

Q.C. Duplicate Analysis:
03-03-87 8:30AM-10:25AM 10.0fibers/100fields = .028f/cc
Q.A. Blank Count = 1.0
*V1 - Cassette Damaged
"B" Indicates Background
"P" Indicates Personal Monitor
"C" Indicates Clean Check

We are pleased to be of service. If there are any questions or need of further assistance, feel free to contact us at your earliest convenience.

Respectfully submitted,
AAA DRILLING & TESTING INC.

Stuart Yankee

Donald Kliebert
Environmental Services

Stuart Yankee
Staff Engineer

AAA and ASSOCIATES, INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

WESTERN REGIONAL OFFICE:
2834 East Grant Road
Tucson, Arizona 85716

Independent Consultants Specializing in Environmental Services.

AAA Report Number: 13111-1
Date Issued: 2 November 1987

Wayne State University
Facilities Planning & Management
5454 Cass
Detroit, Michigan 48202

Attention: Mr. David Reitzel

Re: Bulk Sample Analysis;
Computer Services Building

Dear Mr. Reitzel:

In accordance with your request, herein presented are the analytical test results of the bulk insulation samples taken by our field personnel per your request to determine the presence of fibrous asbestos.

The method of analysis used was the EPA's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples".

The test results are as follows:

DATE AND LABORATORY SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION ASBESTOS
9-02-87 9922	Mechanical Room #130; Northeast Corner; 2" Steamline; Pipe Joint Insulation	Orange/White; Fibrous, Friable; Slight Deterioration	Yes	5% Chrysotile
9-02-87 9923	Mechanical Room #130; Northeast Corner; 2" Steamline; Straight Pipe Insulation	Orange/White; Fibrous, Friable; Slight Deterioration	No	Cellulose, Fibrous Glass

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DATE AND LABORATORY SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION ASBESTOS
9-02-87 9924	Mechanical Room #130; Northeast Corner; 4" Steamline; Pipe Joint Insulation	White/White; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9925	Mechanical Room #130; West Wall, South End; Pipe Joint Insulation	White/White; Fibrous, Friable; Slight Deterioration	No	Cellulose, Fibrous Glass
9-02-87 9926	Mechanical Room #130; Furnace, South Wall; Other Ceiling and/or Wall Insulation	White Wall; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9927	Mechanical Room #331; Furnace, East Side Center; Pipe Joint Insulation	White; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9933	Mechanical Room #179; (Fan Room); North Side of Fan, Hot Water Lines (1 1/2" Line); Pipe Joint Insulation	Yellow/White; Fibrous, Friable; Intact	Yes	4% Amosite 96% Non-Fibrous Particulates
9-02-87 9934	Mechanical Room #179; (Fan Room); North Side of Fan, Hot Water Lines (1 1/2" Line); (8' Elevation); Straight Pipe Insulation	Yellow/White; Fibrous, Friable; Intact	Yes	80% Chrysotile 17% Non-Fibrous Particulates 3% Fibrous Glass
9-02-87 9935	Mechanical Room #179; (Fan Room); North Wall, 1" Domestic Water; Pipe Joint Insulation	Green/Blue/White; Fibrous, Friable; Intact	Yes	7% Chrysotile 73% Non-Fibrous Particulates 20% Fibrous Glass

.....continued

Wayne State University
Mr. David Reitzel
2 November 1987

We are pleased to provide this service. Should you have any questions or desire further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA AND ASSOCIATES, INC.

Steve Kulpanowski

Steve Kulpanowski RD
Staff Geologist

Richard Doherty

Richard Doherty
Staff Engineer

SK/RD/kr

1936 Computing Services Center 11-11-87

AAA and ASSOCIATES, INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

WESTERN REGIONAL OFFICE:
2834 East Grant Road
Tucson, Arizona 85716

Independent Consultants Specializing in Environmental Services.

AAA Report Number: 13111-1
Date Issued: 2 November 1987
Reissued Date: 11 November 1987

Wayne State University
Facilities Planning & Management
5454 Cass
Detroit, Michigan 48202

Attention: Mr. David Reitzel

Re: Bulk Sample Analysis;
Computer Services Building
Project Number: 8707 F

Dear Mr. Reitzel:

In accordance with your request, herein presented are the analytical test results of the bulk insulation samples taken by our field personnel per your request to determine the presence of fibrous asbestos.

The method of analysis used was the EPA's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples".

The test results are as follows:

DATE AND LABORATORY SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION ASBESTOS
9-02-87 9922	Mechanical Room #130; Northeast Corner; 2" Steamline; Pipe Joint Insulation	Orange/White; Fibrous, Friable; Slight Deterioration	Yes	5% Chrysotile
9-02-87 9923	Mechanical Room #130; Northeast Corner; 2" Steamline; Straight Pipe Insulation	Orange/White; Fibrous, Friable; Slight Deterioration	No	Cellulose, Fibrous Glass

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DATE AND LABORATORY SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION ASBESTOS
9-02-87 9924	Mechanical Room #130; Northeast Corner; 4" Steamline; Pipe Joint Insulation	White/White; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9925	Mechanical Room #130; West Wall, South End; Pipe Joint Insulation	White/White; Fibrous, Friable; Slight Deterioration	No	Cellulose, Fibrous Glass
9-02-87 9926	Mechanical Room #130; Furnace, South Wall; Other Ceiling and/or Wall Insulation	White Wall; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9927	Mechanical Room #331; Furnace, East Side Center; Pipe Joint Insulation	White; Fibrous, Friable; Intact	No	Cellulose, Fibrous Glass
9-02-87 9933	Mechanical Room #179; (Fan Room); North Side of Fan, Hot Water Lines (1 1/2" Line); Pipe Joint Insulation	Yellow/White; Fibrous, Friable; Intact	Yes	4% Amosite 96% Non-Fibrous Particulates
9-02-87 9934	Mechanical Room #179; (Fan Room); North Side of Fan, Hot Water Lines (1 1/2" Line); (8' Elevation); Straight Pipe Insulation	Yellow/White; Fibrous, Friable; Intact	Yes	80% Chrysotile 17% Non-Fibrous Particulates 3% Fibrous Glass
9-02-87 9935	Mechanical Room #179; (Fan Room); North Wall, 1" Domestic Water; Pipe Joint Insulation	Green/Blue/White; Fibrous, Friable; Intact	Yes	7% Chrysotile 73% Non-Fibrous Particulates 20% Fibrous Glass

.....continued

We are pleased to provide this service. Should you have any questions or desire further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA AND ASSOCIATES, INC.

Steve Kulpanowski
Staff Geologist

Richard Doherty
Staff Engineer

SK/RD/kr

Comp. Center
193

AAA & ASSOCIATES, INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

INDEPENDENT CONSULTANTS SPECIALIZING IN ENVIRONMENTAL SERVICES

AAA Report Number: 13111-10
Date Issued: 21 March 1989

Wayne State University
Facilities Planning and Management
Design Services
5454 Cass Avenue
First Floor
Detroit, Michigan 48202

Attention: Mr. Robert Chan

Re: Bulk Sample Analysis;
Computer Services, Chemistry
and Justice Buildings

Dear Mr. Chan:

In accordance with your request, herein presented are the analytical test results of the bulk insulation samples taken, per your directive, by our field personnel on 25 January 1989 to determine the presence of fibrous asbestos.

The method of analysis used was the EPA's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples". The limit of detection of asbestos by Polarized Light Microscopy is approximately one percent (1%) by area.

The test results are as follows:

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		COMPUTER SERVICES BUILDING		
T 14643 1	Basement, Northwest Corner of Chiller Unit #3 off Room, Condensate Return Line; Pipe Joint Insulation	White, Compact, Fiberweave, Painted Yellow (5%) ---------- Brown, Compact, Powdery (95%) ---------- Friable, Intact	No	100% Cotton ---------- 40% FG/MW 60% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		JUSTICE BUILDING (cont'd)		
T 14644 2	Basement, Southwest Corner, Unit #3 off of Chilled Water Line; Pipe Joint Insulation	Gray, Compact, (100%) --- Friable, Intact	No	35% FG/MW 65% NFP
T 14645 3	Basement, East Side of Chiller Unit #3, 4", Vertical Steam Line, 8 1/2' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- White, Compact, Fibrous (95%) --- Friable, Intact	Yes	100% Cotton --- 65% Amosite 35% NFP
T 14646 4	Basement, East Side of Chiller Unit #3, Pipe Joint 4' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- Gray, Compact, Fibrous (95%) --- Friable, Intact	No	100% Cotton --- 2% Cellulose 45% FG/MW 53% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14637 1	Sub-Basement, Chilled Water Pump #1, West Side of Pump, Side of Fitting 2' Above Floor (Near Elevator); Pipe Joint Insulation	White Compact, Fiberweave (5%) --- Gray, Compact, Fibrous (85%) --- Yellow, Loosely Compact, Fibrous, (10%) --- Friable, Intact	No	100% Cotton --- 45% FG/MW 55% Cellulose --- 30% FG/MW 65% Ceramic Wool 5% NFP
T 14638 2	Sub-Basement, Chilled Water Pump #1, East Side, of Pump off Vertical 8" Line 4' Above Floor, (Near Elevator); Straight Pipe Insulation	White, Compact, Fiberweave (5%) --- Brown, Compact, Fibrous, Papery with Tar on back (10%) --- Yellow, Loosely Compact, Fibrous (20%) --- Silver Foil (2%) --- White, Compact, Fibrous Papery (2%) --- White, Compact, Fibrous (2%) --- Light Gray, Compact, Fibrous (59%) --- Friable, Intact	No	100% Cotton --- 60% Cellulose 10% FG/MW 30% NFP --- 85% Ceramic Wool 10% FG/MW 5% NFP --- 100% Metal** --- 80% Cellulose 20% NFP --- 90% Ceramic Wool 5% Cellulose 5% NFP --- 55% FG/MW 45% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14639 3	Sub-Basement, East Side of South Chiller #2, off 8" Vertical Steam Line, 10', Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- Silver Foil (5%) --- White, Compact, Fibrous (2%) --- White, Compact, Fibrous, Papery (5%) --- Yellow, Loosely Compact, Fibrous (83%) --- Friable, Intact	No	100% Cotton --- 100% Metal** --- 60% Ceramic Wool 5% FG/MW 5% Cellulose 30% NFP --- 70% Cellulose 30% NFP --- 40% Ceramic Wool 53% FG/MW 2% Cellulose 5% NFP
T 14640 4	Sub-Basement, East Side of South Chiller Unit #2 off 8" Steam Line, 8 1/2" Above Floor as Pipe Enters the Unit; Pipe Joint Insulation	Yellow, Compact, Fiberweave (5%) --- Yellow, Loosely Compact, Fibrous (2%) --- Gray, Compact, Fibrous (93%) --- Friable, Intact	Yes	100% Cotton --- 45% FG/MW 45% Ceramic Wool 10% NFP --- 25% Chrysotile 40% FG/MW 35% NFP

.....continued

Wayne State University
Mr. Robert Chan
21 March 1989

AAA Report Number: 13111-10 (Page 5)

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14641 5	Sub-Basement, Southwest Corner, of South Chiller Unit #2, 10" Vertical skilled Water Line About 8' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Green (5%) --- Silver Foil (5%) --- White, Compact, Fibrous (2%) --- White, Compact, Fibrous, Papery (5%) --- Yellow, Loosely Compact, Fibrous (83%) --- Friable, Intact	No	100% Cotton --- 100% Metal** --- 60% Ceramic Wool 40% NFP --- 80% Cellulose 20% NFP --- 95% FG/MW 5% NFP
T 14642 6	Sub-Basement, Southwest Corner of South Chiller Unit #2, 10" Line 10' Above Floor; Pipe Joint Insulation	White, Compact, Fiberweave, Painted Green (5%) --- Yellow, Compact, Fiberweave (10%) --- Gray, Compact, Fibrous (30%) --- Yellow, Loosely Compact, Fibrous (55%) --- Friable, Intact	Yes	100% Cotton --- 100% Cotton --- 25% Chrysotile 30% FG/MW 45% NFP --- 95% FG/MW 5% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		JUSTICE BUILDING (cont'd)		
T 14647 1	Basement Sprinkler Room, Large fitting between Main Control Valves; Pipe Joint Insulation	White, Compact, Fiberweave (5%) ---------- Gray, Compact, Fibrous (95%) ---------- Friable, Intact	Yes	100% Cotton ---------- 55% Chrysotile 5% Fibrous Brucite 40% NFP

*NFP = Non-Fibrous Particulate
**FG/MW = Fiberglass and Mineral Wool

Types of Asbestos: Amosite
Anthophyllite
Chrysotile
Crocidolite
Tremolite-Actinolite

We are pleased to have been of service. Should you have any questions or require further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA AND ASSOCIATES, INC.

Susan V. Parcell
Asbestos Survey Coordinator

Richard T. Doherty
Manager, Asbestos Services

SVP/RTD/blh

193
(Computing Service Centre)
4-13-89

AAA & ASSOCIATES, INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

INDEPENDENT CONSULTANTS SPECIALIZING IN ENVIRONMENTAL SERVICES

AAA Report Number: 13111-10
Date Issued: 21 March 1989
Date Reissued: 13 April 1989

Wayne State University
Facilities Planning and Management
Design Services
5454 Cass Avenue
First Floor
Detroit, Michigan 48202

Attention: Mr. Robert Chan

Re: Bulk Sample Analysis;
Computer Services, Chemistry
and Justice Buildings

Dear Mr. Chan:

In accordance with your request, herein presented are the analytical test results of the bulk insulation samples taken, per your directive, by our field personnel on 16 February 1989 to determine the presence of fibrous asbestos.

The method of analysis used was the EPA's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples". The limit of detection of asbestos by Polarized Light Microscopy is approximately one percent (1%) by area.

The test results are as follows:

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		COMPUTER SERVICES BUILDING		
T 14643 1	Basement, Northwest Corner of Chiller Unit #3 off Room, Condensate Return Line; Pipe Joint Insulation	White, Compact, Fiberweave, Painted Yellow (5%) --- Brown, Compact, Powdery (95%) --- Friable, Intact	No	100% Cotton --- 40% FG/MW 60% NFP

.....continued

Wayne State University
Mr. Robert Chan
21 March 1989

AAA Report Number: 13111-10 (Page 2)

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		JUSTICE BUILDING (cont'd)		
T 14644 2	Basement, Southwest Corner, Unit #3 off of Chilled Water Line; Pipe Joint Insulation	Gray, Compact, (100%) --- Friable, Intact	No	35% FG/MW 65% NFP
T 14645 3	Basement, East Side of Chiller Unit #3, 4", Vertical Steam Line, 8 1/2' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- White, Compact, Fibrous (95%) --- Friable, Intact	Yes	100% Cotton --- 65% Amosite 35% NFP
T 14646 4	Basement, East Side of Chiller Unit #3, Pipe Joint 4' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- Gray, Compact, Fibrous (95%) --- Friable, Intact	No	100% Cotton --- 2% Cellulose 45% FG/MW 53% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14637 1	Sub-Basement, Chilled Water Pump #1, West Side of Pump, Side of Fitting 2' Above Floor (Near Elevator); Pipe Joint Insulation	White Compact, Fiberweave (5%) --- Gray, Compact, Fibrous (85%) --- Yellow, Loosely Compact, Fibrous, (10%) --- Friable, Intact	No	100% Cotton --- 45% FG/MW 55% Cellulose --- 30% FG/MW 65% Ceramic Wool 5% NFP
T 14638 2	Sub-Basement, Chilled Water Pump #1, East Side, of Pump off Vertical 8" Line 4' Above Floor, (Near Elevator); Straight Pipe Insulation	White, Compact, Fiberweave (5%) --- Brown, Compact, Fibrous, Papery with Tar on back (10%) --- Yellow, Loosely Compact, Fibrous (20%) --- Silver Foil (2%) --- White, Compact, Fibrous Papery (2%) --- White, Compact, Fibrous (2%) --- Light Gray, Compact, Fibrous (59%) --- Friable, Intact	No	100% Cotton --- 60% Cellulose 10% FG/MW 30% NFP --- 85% Ceramic Wool 10% FG/MW 5% NFP --- 100% Metal** --- 80% Cellulose 20% NFP --- 90% Ceramic Wool 5% Cellulose 5% NFP --- 55% FG/MW 45% NFP

.....continued

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14639 3	Sub-Basement, East Side of South Chiller #2, off 8" Vertical Steam Line, 10', Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Orange (5%) --- Silver Foil (5%) --- White, Compact, Fibrous (2%) --- White, Compact, Fibrous, Papery (5%) --- Yellow, Loosely Compact, Fibrous (83%) --- Friable, Intact	No	100% Cotton --- 100% Metal** --- 60% Ceramic Wool 5% FG/MW 5% Cellulose 30% NFP --- 70% Cellulose 30% NFP --- 40% Ceramic Wool 53% FG/MW 2% Cellulose 5% NFP
T 14640 4	Sub-Basement, East Side of South Chiller Unit #2 off 8" Steam Line, 8 1/2" Above Floor as Pipe Enters the Unit; Pipe Joint Insulation	Yellow, Compact, Fiberweave (5%) --- Yellow, Loosely Compact, Fibrous (2%) --- Gray, Compact, Fibrous (93%) --- Friable, Intact	Yes	100% Cotton --- 45% FG/MW 45% Ceramic Wool 10% NFP --- 25% Chrysotile 40% FG/MW 35% NFP

.....continued

Wayne State University
Mr. Robert Chan
21 March 1989

AAA Report Number: 13111-10 (Page 5)

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		CHEMISTRY BUILDING (cont'd)		
T 14641 5	Sub-Basement, Southwest Corner, of South Chiller Unit #2, 10" Vertical skilled Water Line About 8' Above Floor; Straight Pipe Insulation	White, Compact, Fiberweave, Painted Green (5%) --- Silver Foil (5%) --- White, Compact, Fibrous (2%) --- White, Compact, Fibrous, Papery (5%) --- Yellow, Loosely Compact, Fibrous (83%) --- Friable, Intact	No	100% Cotton --- 100% Metal** --- 60% Ceramic Wool 40% NFP --- 80% Cellulose 20% NFP --- 95% FG/MW 5% NFP
T 14642 6	Sub-Basement, Southwest Corner of South Chiller Unit #2, 10" Line 10' Above Floor; Pipe Joint Insulation	White, Compact, Fiberweave, Painted Green (5%) --- Yellow, Compact, Fiberweave (10%) --- Gray, Compact, Fibrous (30%) --- Yellow, Loosely Compact, Fibrous (55%) --- Friable, Intact	Yes	100% Cotton --- 100% Cotton --- 25% Chrysotile 30% FG/MW 45% NFP --- 95% FG/MW 5% NFP

.....continued

Wayne State University
Mr. Robert Chan
21 March 1989

AAA Report Number: 13111-10 (Page 6)

DATE AND LABORATORY SAMPLE #	LOCATION	PHYSICAL DESCRIPTION/ MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	APPROXIMATE PERCENTAGE COMPOSITION
		JUSTICE BUILDING (cont'd)		
T 14647 1	Basement Sprinkler Room, Large fitting between Main Control Valves; Pipe Joint Insulation	White, Compact, Fiberweave (5%) ---------- Gray, Compact, Fibrous (95%) ---------- Friable, Intact	Yes	100% Cotton ---------- 55% Chrysotile 5% Fibrous Brucite 40% NFP

*NFP = Non-Fibrous Particulate
**FG/MW = Fiberglass and Mineral Wool

Types of Asbestos: Amosite
Anthophyllite
Chrysotile
Crocidolite
Tremolite-Actinolite

We are pleased to have been of service. Should you have any questions or require further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA AND ASSOCIATES, INC.

Susan V. Parcell

Susan V. Parcell
Asbestos Survey Coordinator

Richard T Doherty

Richard T. Doherty
Manager, Asbestos Services

SVP/RTD/blh

Peter Basso Associates Inc
CONSULTING ENGINEERS

Mechanical
Electrical
Energy Management
Communication Technologies
Commissioning

SHOP DRAWING SUBMITTAL REVIEW COMMENTS

Project Name: WSU Comp Svcs Chiller Replacement

PBA Project Number: 2012-.389

Submittal: Pre-Purchase 1

Date Submitted: 1/28/2013

Date Reviewed: 2/5/2013

General Comments

Refer to supplemental 200 ton chiller performance sheet attached.

Review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for: Dimensions, which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of his work with all other trades and the satisfactory performance of his work.

☐ NO EXCEPTIONS TAKEN ☒ NOTE MARKINGS
☐ NOTE MARKINGS-RESUBMIT ☐ REJECTED

PETER BASSO ASSOCIATES, INC.

ELEC. BY _____ DATE _____
MECH. BY BAM DATE 2/5/13
T.C. BY _____ DATE _____

G:\2012\2012-0389-00\Shop_Dwg\Comments Sheets\chiller pre-purchase 1.docx

3960 Howard Hughes Parkway, Ste. 500
Las Vegas, NV 89169
Tel: 702-990-3879
Fax: 866-613-3461

2440 West Mission Lane, Ste. 9
Phoenix, AZ 85021-2807
Tel: 602-314-8095
Fax: 602-943-1241

5145 Livernois, Ste. 100
Troy, MI 48098-3276
Tel: 248-879-5666
Fax: 248-879-0007

2001 Commonwealth Blvd., Ste 203
Ann Arbor, MI 48105
Tel: 734-913-4749
Fax: 734-913-4957

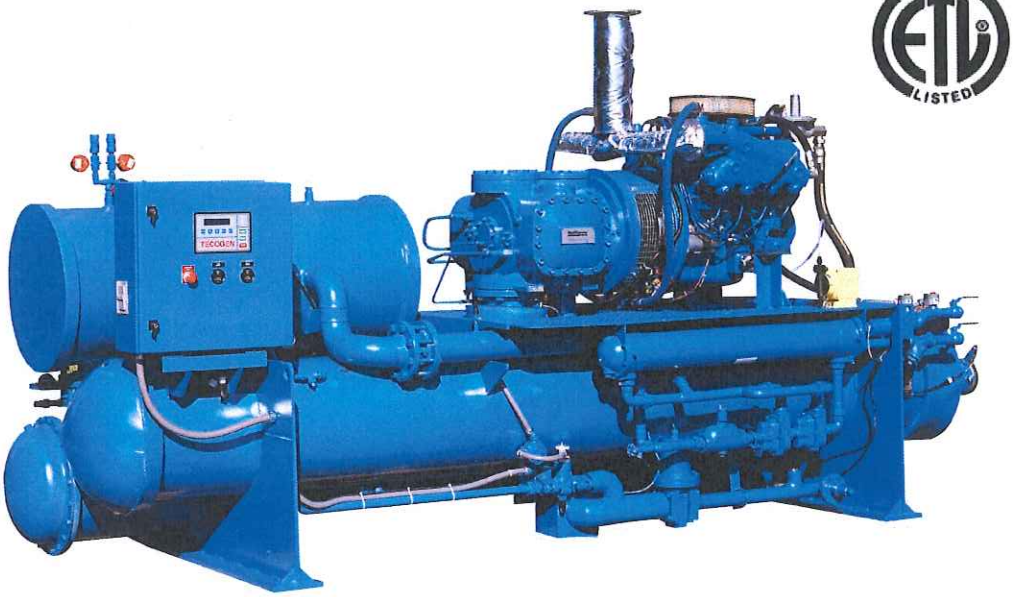
www.PeterBassoAssociates.com

Engineering Submittal

For Approval

STx Series

Gas Engine-Driven Chiller



Wayne State University
Computer Services Center
Detroit, Michigan

Submitted To:

Wayne State University
42 West Warren Avenue
Detroit, MI 48202

Prepared By:

Tecogen
45 First Avenue
Waltham, MA 02451

Tecogen

Advanced Modular CHP Systems

Table of Contents

Disclaimer

1. Equipment Submittal

1.1 Sale Information

Sold To:	Wayne State University 42 W. Warren Avenue Detroit, MI 48202
Project:	Wayne State University Computer Services Center
Purchase Order Number:	WSU Project No. 193-228857
Submittal Date:	January 28, 2013
Sale Number:	6553
Engineer:	Peter Basso Associates Inc.
Mechanical Contractor:	
Tecogen Representative:	
Equipment Submitted	One (1) CH-200x, Natural Gas Engine-Driven, Water-Cooled Chiller
Built-In Options Supplied:	Acoustic Enclosure Engine Bulk Oil System Engine Heat Recovery Direct Computer Connection Evaporator Marine Water Box Condenser Marine Water Box
Accessories Supplied:	(4) Neoprene pads, per chiller (1) Expansion Tank (1) 4" Hospital Grade Stainless Steel Silencer (1) Level 2 Catalytic Converter (1) Chilled Water DP Switch
Additional Options:	Startup by Tecogen Three-Year Complete Maintenance Contract P/N 75814, Engine Lube Oil Filter P/N 76882, Engine Air Filter Element
Standard Warranty:	Three-Year Parts and Labor Warranty
Additional Warranty:	
Shipment Terms:	F.O.B. Factory, First Destination

1.2 General Specifications

Output:	180 Tons Chilled Water at 44 °F
Input:	1331 Mbtu/hr at 1020 Btu/scf, 13 -28 in wc gas pressure 208-230 VAC, single phase with neutral, 60 Hz, 30 amp
Efficiency:	COP (Full Load) = 1.62 COP (NPLV) = 2.36
Physical Dimensions:	Length = 13' 10" Width = 4' 4" Height = 7' 1" (6' 5" with exhaust connection removed) Rigging Weight = 10,450 lbs. (Includes 550 lbs of refrigerant). Operating Weight = 11,250 lbs.
Refrigerant:	R-134a, 550 lbs.
Acoustic Emissions:	89 dBa at 1 meter (with acoustic enclosure option)[1]

[1] Average free-field rating at full load

1.3 Performance Specifications

WAYNE STATE UNIVERSITY
Actual Part Load Performance
TECOCHILL® CH-200x

	Spec	100%	75%	50%	25%
Tons	180	180	135	90	45
COP	1.62	1.62	2.16	2.60	2.18
COP with Engine Heat Recovery	1.93	1.93	2.46	2.83	2.28
Weighting for NPLV COP (%)		1	42	45	12
NPLV COP			2.36		
NPLV COP with Engine Heat Recovery			2.60		
TECODRIVE 7400LE LEVEL 2 ENGINE					
RPM	3,194	3,194	2,206	1,387	1,000
Hot Gas Bypass Run Time (%)	0.0	0.0	0.0	0.0	31.3
Power (HP)	143	143	80	42	21
Gas Consumption, HHV (MBTU/hr)	1,331	1,331	750	415	248
Specific Fuel, LHV (BTU/HP-hr)	8,234	8,234	8,274	8,625	10,317
Exhaust Temperature (°F)	1,213	1,213	1,033	743	407
Exhaust Flow (lbs/hr)	1,015	1,015	561	285	166
Exhaust Flow (ACFM)	689	689	340	139	58
Intake Air Flow (SCFM)	210	210	116	58	34
NOx (g/HP-hr)	0.5	0.5	0.5	0.5	0.5
CO (g/HP-hr)	1.0	1.0	1.0	1.0	1.0
NMHC (g/HP-hr)	1.5	1.5	1.5	1.5	1.5
HEAT RECOVERY					
Heat Available, Engine Recovery (MBTU/hr)	415	415	224	93	26
Recovery Loop Flow (gpm)			30		
Supply Temp, Engine Recovery (°F)	208	208	195	186	182
Return Temperature (°F)			180		
EVAPORATOR					
Chilled Water Supply Temperature (°F)			44.0		
Chilled Water Return Temperature (°F)	54.0	54.0	51.5	49.0	46.5
Chilled Water Flow (gpm)			432		
Chilled Water Pressure Drop (Feet)			12.3		
Saturated Suction Temperature (°F)	41.4	41.4	42.0	42.6	43.2
CONDENSER					
Requested Condenser Inlet Temperature (°F)	85.0	85.0	75.0	65.0	65.0
Revised Condenser Inlet Temperature (°F)	85.0	85.0	75.0	68.6	72.3
Leaving Condenser Water Temperature (°F)	94.3	94.3	81.7	73.0	74.5
Condenser Water Flow (gpm)			540		
Condenser Water Pressure Drop (Feet)			16.5		
Saturated Discharge Temperature (°F)	97.5	97.5	84.4	74.9	75.5
COOLING TOWER LOADS					
Dump HX Flow (gpm)			40		
Dump HX Heat Rejection (MBTU/hr)	415	415	224	93	26
Dump HX Outlet Temp (°F)	105.7	105.7	86.2	73.3	73.6
Total Tower Flow (gpm)			580		
Total Heat Rejected (MBTU/hr)	2,938	2,938	2,047	1,281	620
Return Water Temperature to Tower (°F)	95.1	95.1	82.0	73.1	74.5

All specifications are +/- 5% and are subject to change without notice.
One or more condenser temperatures have been changed to provide adequate compressor oil pressure.

Last Revision: Jeffrey Glick, Tecogen, Inc. on 01/28.8/13 (Version 2008.0.0)

SUPPLEMENTAL INFORMATION

1.3 Performance Specifications (cont.)

WAYNE STATE UNIVERSITY (200 Tons)
Actual Part Load Performance
TECOCHILL® CH-200x

	Spec	100%	75%	50%	25%
Tons	200	200	150	100	50
COP	1.57	1.57	2.12	2.61	2.29
COP with Engine Heat Recovery	1.88	1.88	2.43	2.86	2.41
Weighting for NPLV COP (%)		1	42	45	12
NPLV COP			2.35		
NPLV COP with Engine Heat Recovery			2.61		
TECODRIVE 7400LE LEVEL 2 ENGINE					
RPM	3,587	3,587	2,468	1,543	1,000
Hot Gas Bypass Run Time (%)	0.0	0.0	0.0	0.0	23.7
Power (HP)	161	161	90	47	24
Gas Consumption, HHV (MBTU/hr)	1,532	1,532	850	460	262
Specific Fuel, LHV (BTU/HP-hr)	8,381	8,381	8,333	8,607	9,798
Exhaust Temperature (°F)	1,250	1,250	1,080	811	425
Exhaust Flow (lbs/hr)	1,163	1,163	642	324	171
Exhaust Flow (ACFM)	807	807	401	167	61
Intake Air Flow (SCFM)	240	240	133	67	35
NOx (g/HP-hr)	0.5	0.5	0.5	0.5	0.5
CO (g/HP-hr)	1.0	1.0	1.0	1.0	1.0
NMHC (g/HP-hr)	1.5	1.5	1.5	1.5	1.5
HEAT RECOVERY					
Heat Available, Engine Recovery (MBTU/hr)	480	480	262	113	30
Recovery Loop Flow (gpm)			30		
Supply Temp, Engine Recovery (°F)	212	212	197	188	182
Return Temperature (°F)			180		
EVAPORATOR					
Chilled Water Supply Temperature (°F)			44.0		
Chilled Water Return Temperature (°F)	54.0	54.0	51.5	49.0	46.5
Chilled Water Flow (gpm)			480		
Chilled Water Pressure Drop (Feet)			15.2		
Saturated Suction Temperature (°F)	41.0	41.0	41.8	42.5	43.3
CONDENSER					
Requested Condenser Inlet Temperature (°F)	85.0	85.0	75.0	65.0	65.0
Revised Condenser Inlet Temperature (°F)	85.0	85.0	75.0	68.3	72.2
Leaving Condenser Water Temperature (°F)	94.3	94.3	81.7	72.7	74.4
Condenser Water Flow (gpm)			600		
Condenser Water Pressure Drop (Feet)			20.0		
Saturated Discharge Temperature (°F)	98.0	98.0	84.8	74.8	75.5
COOLING TOWER LOADS					
Dump HX Flow (gpm)			40		
Dump HX Heat Rejection (MBTU/hr)	480	480	262	113	30
Dump HX Outlet Temp (°F)	108.9	108.9	88.1	74.0	73.8
Total Tower Flow (gpm)			640		
Total Heat Rejected (MBTU/hr)	3,290	3,290	2,291	1,433	690
Return Water Temperature to Tower (°F)	95.3	95.3	82.1	72.8	74.4

All specifications are +/- 5% and are subject to change without notice.
One or more condenser temperatures have been changed to provide adequate compressor oil pressure.
Rating includes 17 tons of peaking capacity (available up to 100 hours/year).

Last Revision: Jeffrey Glick, Tecogen, Inc. on 01/31/13 (Version 2008.0.0)

2. Unit Component Specifications

The TECOCHILL STx Series chiller is a packaged, indoor, water-cooled chiller with a single engine/compressor driveline. The following sections identify the specifications of the primary components of the STx Series chiller.

2.1 Engine

The STx Series chiller is equipped with one (1) TecoDrive 7400 engine. Table 2.1 presents the detailed engine specifications. The following sections describe the subsystems of the engine.

2.1.1 Coolant System

The coolant system is a pressurized, closed loop, direct jacket cooling circuit that cools the engine jacket, exhaust manifolds, and engine oil cooler. The coolant fluid is water. The system includes an electric motor-driven pump, a pressure relief valve, a thermostatic control valve, an air removal device with a vent, and a shell-and tube heat exchanger. This heat exchanger is referred to as the dump heat exchanger and it rejects the engine's heat to the cooling tower. (Specifications on the dump heat exchanger vessel are presented in Section 2.3).

It is the responsibility of the installing contractor to provide one city-water make-up line, regulated to 12 - 15 psig, with a pre-charged bladder type expansion tank to maintain the coolant system pressure. To simplify this installation, an integral expansion tank/regulator is available from Tecogen as an accessory (refer to Section 1.1 for job-specific information).

2.1.2 Fuel and Exhaust System

The natural gas fuel system, for the STx chiller engine, includes a manual shut-off valve, two(2) electric solenoid shut-off valves for redundant safety, a gas regulator, a carburetor, and a throttle body assembly. For units equipped with emission controls, the engine fuel components are slightly different (refer to Section 2.1.6).

It is the responsibility of the installing contractor to design and construct a low pressure gas supply line to the STx chiller. Tecogen provides recommendations and guidelines in Section 3.4.

The combustion air inlet for the engine is equipped with an air filter. The pressurized gas is mixed with the naturally aspirated – filtered air within the carburetor. The TECOCHILL precisely controls the engine throttle to modulate the fuel/air flow to the engine cylinders. The exhaust from the cylinders is directed through two water-cooled manifolds to a common 4" outlet pipe. It is the responsibility of the installing contractor to design and construct an exhaust system from the TECOCHILL unit to the outside. Tecogen provides recommendations and guidelines in Section 3.5.

WARNING

Exhaust piping temperatures can exceed 1300°F (un-insulated). Proximity of the exhaust piping (and other hot surfaces) to an automatic sprinkler system should be reviewed by the installing contractor and engineer.

The engine is also equipped with a Positive Crankcase Ventilation system that removes corrosive gases from the engine crankcase and directs them back into the intake manifold to be burned along with the regular fuel charge.

Table 2.1 Engine Specifications

Model	CH-150x	CH-200x
Type	Spark Ignition, Gaseous Fueled	
Manufacturer	GM, Configuration by Tecogen	
Model	TecoDrive 7400	
Nominal Rated RPM[1]	2620	3600
BHP at Rated RPM[1]	116	161
Aspiration	Natural	
Configuration	V-8 (90°)	
Displacement	454 Cu. Inches	
Bore and Stroke (Inches)	4.251 x 4.00	
Compression Ratio	9.2 to 1	
Weight	1100 lbs	
Ignition System	Electronic	
Firing Order	1-8-4-3-6-5-7-2	
Air/Fuel Mixture (Std)	2% Oxygen[2]	
Fuel Supply Pressure	13-28 Inches W.C.[4]	13-28 Inches W.C.
Lubrication System		
- Type	Full Pressure, Full Flow, Cooled by Engine Coolant	
- Oil Type	ExxonMobil XD-3 SAE 30 (Consult Factory For Substitutes)[3]	
Cooling System		
- Type	Direct Jacket Cooling, Closed Loop	
- Expansion Tank	Precharged Bladder Type , Externally Mounted (optional or provided by others)	
- Cooling Fluid	Water or Propylene Glycol Mixture (Where Required for Freeze Protection)	
Starting System		
- Type	12 Volts DC	
- Battery	Delco Freedom II 87a-60 or Equivalent rated to 485 Cold Cranking Amps	
- Starter	Delco Automotive Special Heavy Duty	
- Battery Charger		
* Type	Electronic - Constant Voltage Supply	
* Rating	3.5 Amp DC	

Notes:

1. This is the rating for the CH-200x at nominal ARI conditions. For specific application rating, see Section 1.3.

2. Engines equipped with emission control option will operate at approximately 0.5% Oxygen.

3. Engines equipped with emission control option use a low ash oil; ExxonMobil Busguard GEO 15W-40.

4. Units without the emission control option may have a minimum gas pressure of 7 in wc.

2.1.3 Lubrication System

The lubrication system for the engine includes an internal engine driven oil pump, an oil pressure regulator, an oil filter, and an oil cooler that rejects heat to the engine coolant.

The engine also comes equipped with a Bulk Oil system. This is an external oil reservoir, with a circulation system, that extends the oil sump capacity of the engine to 55 gallons, thus increasing the maintenance interval. The circulation pump and some piping are factory - mounted on the unit. The oil drum and some additional piping are shipped loose.

Refer to Section 3.2 for installation guidelines for the Engine Bulk Oil System.

2.1.4 Engine Heat Recovery *(Use is Optional)*

The engine rejects waste heat to the coolant system from the engine block and exhaust manifolds. Rather than dumping this waste heat to the cooling tower (via the dump heat exchanger), this heat may also be recovered and used by the customer for domestic hot water heating or other process load. The STx chiller provides two connections, one for supply and one for return, to a remote heat recovery (load) heat exchanger. The chiller is also equipped with a set of thermostatic valves to ensure that coolant is directed to the engine dump heat exchanger when the heat recovery is not required. It is the responsibility of the installing contractor to provide the customer's load heat exchanger, as well as the design of the piping to and from the chiller. However, Tecogen provides recommendations and guidelines for designing the heat recovery system in Section 3.3.

2.1.5 Exhaust Heat Recovery *(Option)*

☐ Supplied ☒ Not Supplied

In addition to engine heat recovery, waste heat may be recovered from the engine exhaust products. Exhaust heat recovery is a factory-installed option. An exhaust-to-coolant heat exchanger is mounted on the outlet of each exhaust manifold (2 per engine). The design of the customer's side of the heat recovery system is the same as when there is only engine heat recovery, except for the fact that there is additional heat.

Note

The factory-installed exhaust heat recovery option is not available on units equipped with the emission control system option.

2.1.6 Emission Control System *(Option)*

☒ **Supplied** ☐ Not Supplied

The emissions control system option is required in regions with increased restrictions on exhaust gas emissions. It is based upon a method of controlled combustion with exhaust gas treatment. A microprocessor-based, closed-loop, feedback control system maintains tight control over the air/fuel ratio. The rich-burn engine's exhaust is treated with a catalytic converter. The key factor to catalyst efficiency is maintaining the air/fuel ratio within a tight window, slightly rich of stochiometric, which is where the exact quantity of air is available so the oxygen completely combusts with the fuel. This effectively reduces emissions to very low levels.

The level of emission reduction is a function of the catalyst used. There are two alternative grades of catalyst available for the TECOCHILL, Level 1 and Level 2, and their respective reduction levels are presented in Table 2.2.

The TECOCHILL's microprocessor-based control system directly operates a stepper motor-controlled fuel control valve to precisely modulate the fuel flow. This is a closed-loop control system with the feedback signal coming from an O_2 sensor in the exhaust system that measures air/fuel ratio. (Note: The O_2 sensor is installed in the engine exhaust "wye" flex connector on the unit.) Other monitored parameters include engine speed, manifold pressure, intake air temperature, and engine coolant temperature.

Table 2.2 Catalyst Emission Levels

	Level 1* After Catalyst [g/bhp-hr]	Level 2* After Catalyst [g/bhp-hr]
NOx	1.5	0.5
CO	1.5	1.0
NMHC	1.5	1.5

**Refer to Table 1.3 for job-specific information*

The primary safety of the emission control system is an exhaust system thermocouple that will initiate an engine shutdown when a catalyst outlet over-temperature is detected. This protects against a fault when fuel/air ratio is maintained too rich. There is also a thermocouple on the inlet of the catalyst for diagnostics.

The operator interface with the Emission Control System is through the unit's main control panel. The status and alarms can be read on the display and the operator can verify the function of the emission control system. Monitoring of the exhaust stack emissions is not included in this option.

The catalytic converter is shipped loose in a separate box along with its own thermally insulated blanket. It is the responsibility of the installing contractor to install the catalytic converter in the exhaust system. The inlet and outlet thermocouples are also shipped loose and need to be installed in the catalytic converter, and wired in to the control panel, prior to start-up. Refer to Figure 3.6 for exhaust system design recommendations.

Also, the factory-installed exhaust heat recovery option is not available on units equipped with the emission control option. The reason for this is that the exhaust heat can not be removed until the exhaust gas has been through the catalytic converter since the catalyst requires elevated exhaust temperatures to function properly. Therefore, a remote heat exchanger must be used.

Note

If Tecogen does the start-up, the final electrical connections for the thermocouples will be done by the Tecogen start-up technician.

2.2 Compressors

The STx Series chiller is equipped with one (1) open-drive, single screw compressor of the oil injected type. Table 2.3 presents the detailed compressor specifications and the subcomponents are described below.

2.2.1 Housing

The housing is a single piece casing with removable side covers to give accessibility for inspection and service without disturbance of associated piping.

2.2.2 Rotors

The main rotor is the input shaft that meshes with two diametrically opposed star wheels (gate rotors).

2.2.3 Bearings

The bearings are roller element bearings throughout. The main bearings have a minimum L_{10} design life of 100,000 hours.

2.2.4 Shaft Seal

The mechanical shaft seal consists of a carbon face in rotating contact with a hardened steel ring. The seal remains flooded with oil during operation and shutdown of the compressor. Lubrication is provided to ensure proper cooling.

Table 2.3 Compressor Specifications

Model	CH-150*x*	CH-200*x*
Type	Oil Flooded Single Screw	
Manufacturer	J & E Hall	
Model	HS2024GED	
Weight (lb.)	882	
Maximum Operating Working Pressure		
- Suction (PSIG)	87	
- Discharge (PSIG)	420	
Full Load Drive RPM[1]	2620	3600
Theor. Displacement @ Full Rated RPM	441	606
Lubrication System		
- Oil Type	*Elf Planetelf* ACD68AW	
- Oil Separator Type	External Two-Stage Horizontal Tank	
- Oil Capacity	18 Gallons	
- Oil Pump Type	None	
Load Modulaton (RPM)[2,]		
- RPM Range	1000-2620	1000-3600
- Approx. Capacity Range (Tons)	57-150	56-200
- Approximate Minimum Capacity (Tons)[2,3]	~ 28	~ 28

Notes:

1. This is the rating at nominal ARI conditions. For specific application rating, see Section 1.3.

2. Capacity ranges are approximate values only. Actual capacity ranges are dependent also on condenser and chilled water conditions.

3. Hot Gas Bypass, at minimum rpm, further reduces load.

2.3 Vessels

Each STx Series chiller has an evaporator, condenser, oil separator and engine dump heat exchanger. Table 2.4 presents the specifications of the vessels used on the STx Series chiller.

2.3.1 Evaporator

The evaporator is of a shell-and tube design with water in the tube side and refrigerant on the shell side. The tubing is the high-efficient type with integral fins rolled into tube sheets. The refrigeration side design is in accordance with ASME Section VIII Unfired Pressure Vessel Code and is rated at 225 psig. This vessel contains one (1) relief valve. It is equipped with a rupture disc and pressure gage for indication of a previous relief valve discharge. It is the responsibility of the installing contractor to pipe the relief valves to the outdoors (see Section 3.6).

The water side is two-pass and is rated for 150 psig. Each end bell is equipped with a vent and drain. The shell is insulated with 3/4" thick closed-cell insulation.

2.3.2 Condenser

The condenser is of a shell-and tube design with water in the tube side and refrigerant on the shell side. The tubing is the high-efficient type with integral fins rolled into tube sheets. The refrigeration side design is in accordance with ASME Section VIII Unfired Pressure Vessel Code and is rated at 250 psig. This vessel contains two (2) relief valves so that a valve can be replaced without removing the refrigerant charge. Each relief valve is equipped with a rupture disc and pressure gage for indication of a previous relief valve discharge. It is the responsibility of the installing contractor to pipe the relief valves to the outdoors (see Section 3.6).

The water side is two-pass and rated at 150 psig. Each end bell is equipped with a vent and drain.

2.3.3 Oil Separator

The oil separator is an ASME Section VIII pressure vessel that separates the mixture of refrigerant and compressor oil at the exit of the compressor. It is a horizontal, two-stage, design, that also serves as an oil reservoir. Flow from the compressor discharge enters the separator. The first stage of separation is direct impingement against the separator wall where much of the oil falls to the sump below. Then the flow is directed through a demister pad that filters out the remaining oil. The refrigerant gas then discharges into the condenser. Two(2) 1200 watt immersion heaters maintain elevated oil temperatures during chiller shutdowns to ensure proper oil viscosity at start-up. The separator is also equipped with a site glass to monitor oil sump level.

The oil separator has two(2) relief valves so that a valve can be replaced without removing the refrigerant charge. Each relief valve is equipped with a rupture disc and pressure gage for indication of a previous relief valve discharge. It is the responsibility of the installing contractor to pipe the relief valves to the outdoors (see Section 3.6).

2.3.4 Engine Dump Heat Exchanger

The engine dump heat exchanger is a shell-and-tube heat exchanger that rejects the heat of the engine to the cooling tower. Engine coolant is on the shell side and cooling tower water is on the tube side. The tubes are made of copper and are 3/8" O.D. The cooling tower water side rating is 150 psig. The shell is carbon steel and has a pressure rating of 250 psig.

The cooling tower water side of the dump heat exchanger is equipped with a strainer and isolation valves for service. It is the responsibility of the installing contractor to pipe cooling tower water to the dump heat exchanger. However, Tecogen provides recommendations and guidelines for designing this piping in Section 3.3.

2.4 Refrigerant Flow Control

The chiller is equipped with a microprocessor-controlled metering valve for regulating the flow of refrigerant from the condenser to the evaporator. It has a stepper motor operator which is a digitally controlled device that provides small incremental, rotational, movement of the valve stem. This control valve reduces the pressure of the liquid refrigerant exiting the condenser while maintaining the proper liquid level in both the condenser and evaporator under both full and part load conditions.

Table 2.4 Vessel Specifications

Model	CH-150*x*	CH-200*x*
Evaporator		
Manufacturer	Standard Refrigeration	
Model	FEV1812TE1	
Size	18" D x 12' L	
Code	ASME VIII	
Max Press. (psig) - Refrig. Side	225	
Max Press. (psig) - Water Side	150	
Maximum Water Flow [gpm]	840	
Tube Velocity [ft/sec]	2.3 ft/sec @ 480 gpm	
Volume (gallons)	57	
Tube length (feet)	12	
# of Tubes	226	
Tube I.D. (inches)	0.694	
Condenser		
Manufacturer	Standard Refrigeration	
Model	HSE1812TE1	
Code	ASME VIII	
Max Press. (psig) - **Refrig. Side**	250	
Max Press. (psig) - **Water Side**	150	
Maximum Water Flow [gpm]	840	
Tube Velocity [ft/sec]	6.5 ft/sec @ 600 gpm	
Volume (gallons)	50	
Tube length (feet)	12	
# of Tubes	194	
Tube I.D. (inches)	0.694	
Oil Separator		
Code	ASME VIII	
Max Pressure (psig)	250	
Sump volume (gallons)	18	
Engine Dump Heat Exchanger		
Manufacturer	Thermal Transfer Products	
Model	B-1205-80380	
Max Press. (psig) - **Tower Side**	150	
Required Flow (gpm)	40 gpm	
Pressure Drop (psi)[1]	4.5 psi @ 40 gpm	
Maximum Water Flow [gpm]	112	
Volume (gallons)	2.0	
Tube I.D. (inches)	0.331	

Notes:

1. This pressure drop includes the dump heat exchanger vessel and the piping on the TECOCHILL unit.

Table 2.5 Control Panel Functions and Alarms

Control Panel Functions	Alarms
Start chiller	Analog Card Failure
Stop chiller (normal & emergency)	Compressor Oil Filter[1]
Adjust chilled water setpoint	Engine Oil Level (low or high)
Adjust max engine speed setting	Evaporator Pump Failure
Clear alarms	High Acceleration Time
Clear prealarms	High Compressor Oil Temperature
Schedule Start/Stop sequence	High Coolant Pressure
Schedule chilled water setpoint	High Coolant Temperature
Set time and date	High Discharge Pressure
Energize individual outputs for diagnostics	High Discharge Temperature
Calibrate transducers	High Dump HX Outlet Temperature[1]
Calibrate analog card	High Enclosure Temperature
Change control gains	High Engine Oil Temperature
Change cycle restart temperature	Ignition Power Failure
Change remote setpoint input signal range	Keypad Failure
	Low Chiller Temperature
	Low Compressor Oil Level
	Low Compressor Oil Pressure
	Low Compressor Oil Temperature
	Low Coolant Pressure
	Low Coolant Temperature
	Low Engine Oil Pressure
	Low Injection Oil Pressure
	Low Suction Pressure
	Overspeed
	Processor Error
	Start Failure
	Starter Failure
	Underspeed
	Check Emission System[1,2]
	Engine Emission Failure[2]
	High Catalyst Temperature[2]

[1] Prealarm only

[2] Emission Control System option only

2.5 Control System

The TECOCHILL STx Series chiller has a microprocessor based control system that provides precision PID control of the chilled water outlet temperature. It has a pre-programmed operating scheme that monitors the chilled water temperature and uses this feedback signal to modulate the speed of the engine. At very low loads, hot gas bypass is used for further load reduction. The performance table in Section 1.3 presents a load profile that illustrates how the control system decreases the engine speed and cycles the Hot Gas Bypass as the load is reduced.

The control cabinet has a 40 character alpha-numeric display, start/stop keys, status lights, reset buttons, function keys, and an emergency stop pushbutton for operator interface.

The control system has a complete safety monitoring and shutdown system including a redundant engine overspeed safety device independent of the microprocessor. It also has a diagnostic mode that allows all output devices (i.e. pumps, solenoids, heaters, etc.) to be energized individually when the system is shutdown for the purpose of troubleshooting.

Table 2.5 lists the functions available on the TECOCHILL control panel as well as the list of alarms.

The following sections present specific customer interface features of the control system.

2.5.1 Mandatory Chiller Flow Verification Input

It is a mandatory requirement of the customer to furnish a chilled water flow verification switch input to the STx chiller control panel. The chiller will not start until this switch closes confirming chilled water flow. The chiller will shut down immediately upon loss of flow. It is the responsibility of others to obtain, install, and wire the chilled water flow verification switch. Details on the wiring of this switch is presented in Figure 3.6.

Important

Freeze damage to the chiller, caused by insufficient flow through the evaporator, is not covered under warranty.

Condenser flow verification wired into the TECOCHILL is not recommended because it would preclude using the TECOCHILL safety check for chilled water flow. This safety feature of the control system checks the position of the chilled water flowswitch when the chiller pump is "off" to ensure that the switch is open. If the circuit is closed when the pump is off, the control system will assume that the switch is broken, or there is another problem with the circuit, and cause an alarm to prevent the unit from starting. This provides a safeguard against freezing the evaporator. If a condenser flowswitch is used is series with the chilled water flowswitch, it will mask a chilled water flowswitch failure by opening the circuit and satisfying the safety check. Moreover, the TECOCHILL discharge pressure cutout will protect the unit on loss of condenser flow.

2.5.2 Optional Inputs

The customer has the option of providing the inputs that are listed below to the STx chiller control system. It is the responsibility of the installing contractor to provide the devices and wiring for these electrical connections. Details on the wiring of these inputs is presented in Figure 3.6.

Setpoint Input

The customer may input a 0-10 vDC signal to the control panel so that the chilled water temperature may be controlled by a remote energy management system.

Remote Start

The customer may input a contact that will close to initiate the start of the chiller and open to initiate the shutdown.

Counter
The customer may input a pulsing signal that will be totaled and displayed on the chiller control panel. This is typically used for gas meters.

Thermistor
The customer may input a temperature sensing thermistors for the chiller inlet temperature and condenser outlet temperature. These readings will be displayed on the chiller control panel. It is necessary to obtain these thermistors from Tecogen.

2.5.3 Optional Outputs
The customer has the option of utilizing the outputs that are listed below. It is the responsibility of the installing contractor to provide the devices and wiring for these electrical connections. Details on the wiring of these outputs is presented in Figure 3.6.

Chiller Pump Start
The customer has the option of having the STx chiller control panel provide the signal to start the chilled water pump(s). There are two sets of dry contacts available on a relay within the chiller control panel. Tecogen strongly recommends that customers use this output to ensure that the chilled water pump(s) synchronizes properly with the start-up and shutdown of the chiller. Having the STx chiller control this pump (s) also enables an added safety feature against freezing. This safety, within the chiller's control algorithm, verifies that the chilled water flow switch is working properly by checking that it is open prior to the pump starting. If the control of the pump(s)s is not interconnected to the STx chiller control panel, then this safety is disabled.

Important

Freeze damage to the chiller, caused by insufficient flow through the evaporator, is not covered under warranty.

Condenser Pump Start
The customer has the option of having the STx chiller control panel provide the signal to start the condenser water pump(s). There are two sets of dry contacts available on a relay within the chiller control panel. Tecogen recommends that customers use this output to ensure that the condenser water pump(s) synchronizes properly with the start-up and shutdown of the chiller.

Alarm Output
The customer has the option of obtaining a remote indication of when the chiller is in alarm. There are two sets of dry contacts available on a relay within the chiller control panel. This relay does not activate for Prealarms.

2.5.4 RMCS
The Remote Monitoring and Communications System, or RMCS, gives the customer the ability to monitor the chiller, as well as have some limited control, from a remote location via a phoneline. It also facilitates factory-reprogramming of the chiller software for updates or customizations. The STx chiller is equipped with the software and modem. It is the responsibility of the installing contractor to provide a dedicated phoneline to the chiller (for multiple unit installations, a telephone line switchbox, for up to 4 chillers, is available from Tecogen). The customer's remote computer must be an IBM compatible PC running *Windows 95* or higher, or *Windows NT*.

Tecogen strongly recommends that all customers utilize the RMCS. It is valuable to a site because it is an excellent tool for remote site personnel, a local service provider, or Tecogen factory service support to diagnose problems. It also allows the factory to readily download operational software revisions. The RMCS can also be set-up to dial-out to a modem or pager to alert off-site personnel of a fault condition.

The features of the RMCS is as follows:

- Review the real-time status of the unit
- Review the alarm history
- Review the load profile of the unit
- Review the current hardware set-up (DIP switch settings) for the various control options.
- Retrieve historical data
- Retrieve data in the minutes preceding an alarm.
- Start and stop the chiller.
- Change the chilled water setpoint.
- Change the engine's maximum speed setting.
- Clear an Alarm or PreAlarm

2.5.5 Modbus Networking
The TECOCHILL control system has Modbus networking capability. Modbus is a standard interface used throughout the controls industry to network devices. This networking can be used to interface to building management systems, or programmable controllers, or communicate between multiple chillers if only one RMCS phoneline is desired. However, only one of these alternatives can be utilized; in other words, all of these capabilities are not available together.

The Modbus networking can be implemented with RS-232, RS-422, or RS-485 protocol. It will allow the customer-supplied master device to be able to individually start, stop, and change the setpoint of any chiller installed on the network, as well as read all of its inputs and outputs. If planning to utilize the Modbus networking feature, it is necessary to purchase the Direct Computer Connection option, presented below in Section 2.5.7. For further details on setting up the TECOCHILL for Modbus networking, refer to TECOCHILL Application Note 98-002.

2.5.6 Other Optional Features
The features listed below are available to a customer by setting a DIP switch within the control cabinet.

Setpoint and Run Scheduling
Allows the user to program a customized scheme for automatic scheduling of both start/stop sequencing and chilled water setpoint adjustment. It is a seven-day clock that allows up to 64 schedule changes per week.

Automatic Restart
Allows the chiller to restart automatically 15 minutes after a power outage.

Auto Alarm Reset
Allows the control system to automatically reset pre-selected alarms 5 minutes after the unit is shut down and try to start again.

Cycling
Allows the chiller to automatically shut down after it has operated at low load for more than 3 hours. It will not restart until the chilled water temperature has reached a programmed value, between 5 °F and 15 °F, above the setpoint.

2.5.7 Direct Computer Connection
The Direct Computer Connection is a standard DB-25 female connector, mounted on the side of the control panel, for directly connecting a PC to the STx chiller (refer to Figure 3.6). The user must supply a standard RS-232 serial cable, with a male DB-25 connector on the TECOCHILL end, to connect the PC to the chiller. The standard RMCS software, that comes with the chiller, is used for communication.

2.6 Acoustic Enclosure *(Option)*

[X] Supplied [ ] Not Supplied

The acoustic enclosure is a sound-attenuating fiberglass housing for the engine and compressor that reduces the sound by 7 dBa. It is equipped with a 560 cfm ventilation fan.

2.7 Factory Witness Test *(Option)*

☐ Supplied ☒ Not Supplied

The buyer of the chiller, along with others of their choice, may visit Tecogen in Waltham, MA for a factory witness test of the chiller. The test facility is capable of operating the chiller from 25% to 100% load measuring tons and gas consumption. The chiller will be tested in accordance with ARI 550/590-98, but the test facility is not ARI certified. The number of test points and the operating conditions are negotiable.

Tecogen will give a one week notification to confirm the test date. It is the responsibility of others to coordinate transportation and accommodations for those witnessing the test. Tecogen is not responsible for losses incurred by a change in the witness test date unless Tecogen requests the change within the one week confirmation time.

2.8 Accessories

The accessories are items used by the installing contractor on the foundation and piping peripheral to the STx chiller. The installation of the accessories is the responsibility of others. However, Tecogen does provide guidance with this Engineering Submittal, the TECOCHILL Application /Installation Manual, factory engineering support, and the local factory representative.

The only standard accessory, included with the chiller, is the Neoprene pads. All other items are purchased options. These items are typically shipped with the chiller in a separate box. They are as follows:

2.8.1 Neoprene Pads

☒ Supplied (4 per chiller)

Each ST chiller is shipped with four (4) neoprene pads, two (2) for each rail. These pads are 6" x 18" x 3/4" and are made of 50 durometer rubber. They should be placed on the each end of both rails. Each pad has the weight capacity of 4860 lbs. Using four pads, the deflection is approximately .06".

2.8.2 Engine Expansion Tank

☒ Supplied ☐ Not Supplied

The engine coolant system is a pressurized hydronic piping system that requires an expansion tank. The expansion tank furnished by Tecogen is pre-pressurized, and has an integral pressure regulator/fill valve. It serves the additional purpose of providing a fill location for the city water make-up line (supplied by the installing contractor), as well as keeping this water supply regulated down to12 psi (cold). The valve will automatically shut off the flow when the system is filled and pressurized to 12 psi, matching the air charge of the tank.

The specifications for the expansion tank are as follows:

Model	AMTROL FILL-TROL 112
Tank Volume (gallons)	14
Accept Volume (gallons)	11.3
Diameter (inches)	15
Length (inches	23.5
Shipping Weight (lbs)	24
Allowable System Volume[1]	144

[1] STx Chiller volume is approximately 10 gallons

2.8.3 Exhaust Expansion Joints

☒ Supplied ☐ Not Supplied

The exhaust expansion joints, supplied by Tecogen, consist of a stainless steel bellows with carbon steel flanges. They are available with either 4" or 6" flanges. It is the responsibility of the installing contractor to determine how many expansion joints are required, and their location within the exhaust piping. However, guidelines on thermal expansion and anchoring locations are presented below.

Listed below are the expansion joint specifications:

Supplied	Flange Size	Axial Compression (inches)	Axial Extension (inches)	Lateral Offset From C/L (inches)	Axial Spring Rate (lbs/per inch)	Overall Length (inches)	Wt [lb]
X	4"	3	1.5	.75	37	13	26
	6"	3	1.5	.75	82	13	33

Important

As of 1/1/2010, all expansion joints are directional. The expansion joints are wrapped with a removable tape noting the directional flow. If the tape is removed, please consult the factory for additional instruction.

Presented below are guidelines for the number of joints required for a piping system:

Pipe Material	# of Expansion Joints Per 100 Feet
Low Carbon Steel	4 (1 every 25')
Stainless Steel	6 (1 every 18')

It is also important to properly anchor and guide the pipes to ensure the expansion joint absorbs the motion for which it was designed. Inadequate anchoring and improper guiding can cause stresses that reduce the expansion joint's life, cause pipe buckling, and system failure. Anchors in a piping system are generally of two kinds, main anchors to absorb full pressure thrust forces generated by the expansion joint, and intermediate anchors to absorb forces generated by the expansion joint bellows spring forces. Figure 2.1 presents the recommendations for anchoring when there is a span of pipe between two main anchors, as well as when there is an intermediate anchor.

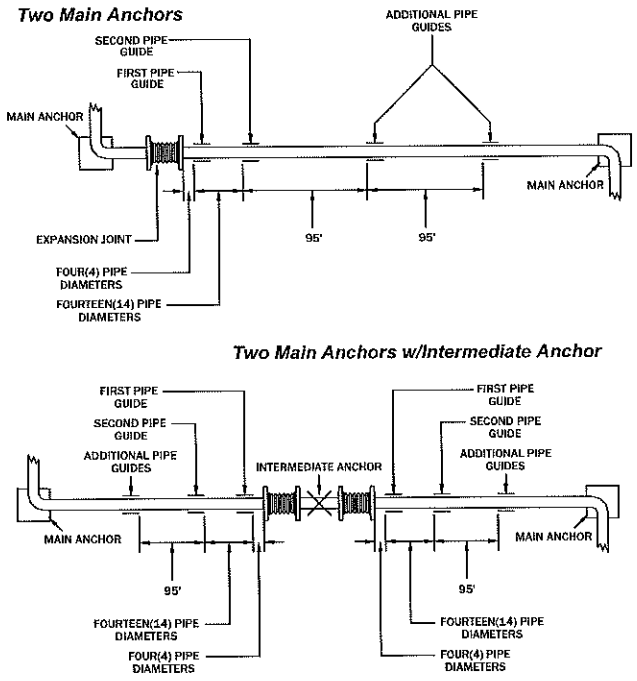


Figure 2.1 Expansion Joint Anchoring Guide

Important

Failure of an exhaust expansion joint can cause leakage of CO into the mechanical room or present a fire hazard. It is important that these joints are installed as per manufacturer's guidelines, the guidelines listed above, and local codes. Provisions should be made to allow for periodic inspection of the joints (i.e. removable insulation).

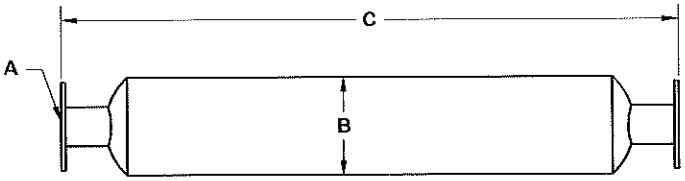
2.8.4 Exhaust Silencers

[X] Supplied [ ] Not Supplied

Each STx chiller engine requires one exhaust silencer, available in either carbon steel or stainless steel. Stainless steel silencers are typically used on units with exhaust heat recovery or emission controls. The silencer is also available in Critical Grade or Hospital Grade. Hospital grade has a higher noise reduction capability. Table 2.6 presents the dimensional information on the silencers. Also presented are the sound attenuation levels for the two different grades (Figure 2.2) and the pressure loss curves for the silencers (Figure 2.3).

Table 2.6 Silencer Dimensional Information

Supplied	Grade	Material	Flange Size (150 lb)	A [in]	B [in]	C [in]	Wt [lb]
	Critical	Carbon Steel	4"	4	10	56	72
	Critical	Stainless	4"	4	10	56	72
	Critical	Carbon Steel	6"	6	12	68	84
	Critical	Stainless	6"	6	12	68	84
	Hospital	Carbon Steel	4"	4	14	60	115
X	Hospital	Stainless	4"	4	14	60	115
	Hospital	Carbon Steel	6"	6	18	68	185
	Hospital	Stainless	6"	6	18	68	185



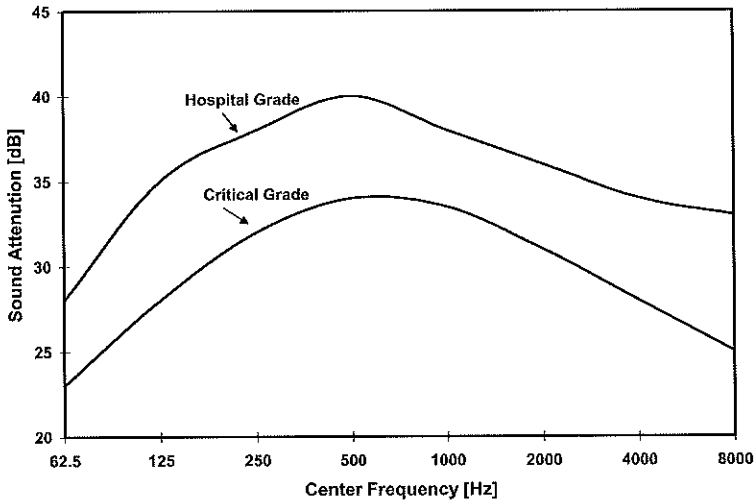


Figure 2.2 Silencer Sound Attenuation

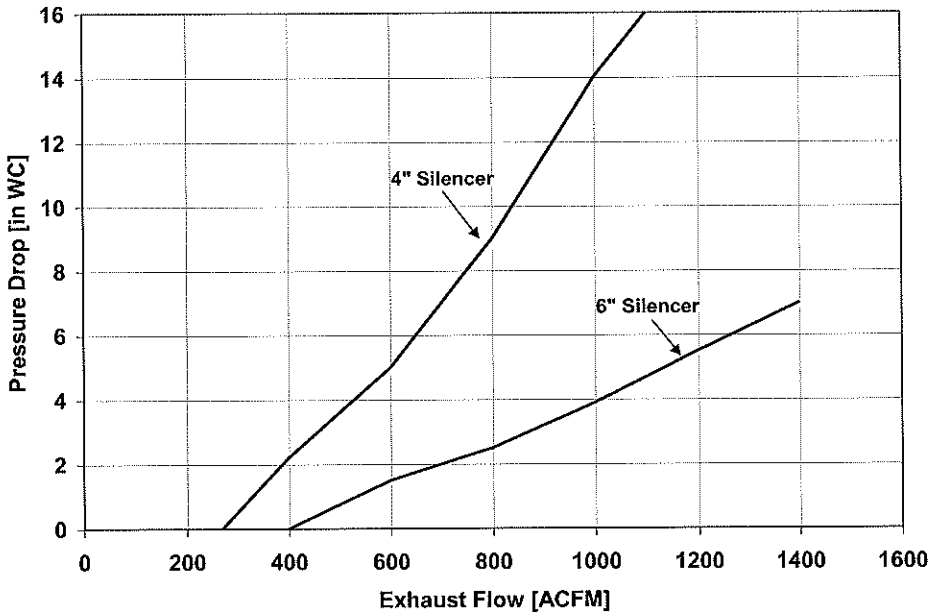


Figure 2.3 Silencer Pressure Drop (Both Critical and Hospital Grade)

2.8.5 Catalytic Converter

[X] Supplied [ ] Not Supplied

The catalytic converter takes the untreated exhaust flow from the engine and converts it into naturally occurring compounds. The catalyst is a three-way or NSCR (Non-Selective Catalyst Reduction) catalyst, designed to simultaneously reduce NO_x, CO, and HC levels from a natural gas engine. It requires inlet temperatures of 700 °F to 1250 °F to chemically react the NO_x, CO, and HC and convert them into environmentally safe nitrogen, carbon dioxide, and water vapor.

There are two levels of catalyst available with the TecoDrive 7400 engine, Level I and Level II. The Level II has more catalyst surface for increased emission reduction (refer to Section 2.1.6 for further details).

Table 2.7 presents the dimensional information on the catalyst. (Refer to Figure 2.4). Figure 2.5 presents the pressure loss information.

The catalytic converter is shipped loose in a separate box along with its own thermally insulated blanket. It is the responsibility of the installing contractor to install the catalytic converter in the exhaust system.

Important

Piping connections must be welded to avoid leaking hazardous exhaust gas into the space.

The inlet and outlet thermocouples are also shipped loose and need to be installed in the catalytic converter, and wired in to the control panel, prior to start-up.

Note

If Tecogen does the start-up, the final electrical connections for the thermocouples will be done by the Tecogen start-up technician.

Table 2.7 Catalyst Dimensional Information

Supplied	Type	Wt [lb]	Dim. A	Dim. B	Dim. L
	Level I JM CXX-6-4	25	4 9/16"	12 5/8"	18 5/8"
X	Level II JM CXX-8-4	36	4 9/16"	15 7/8"	20 5/8"

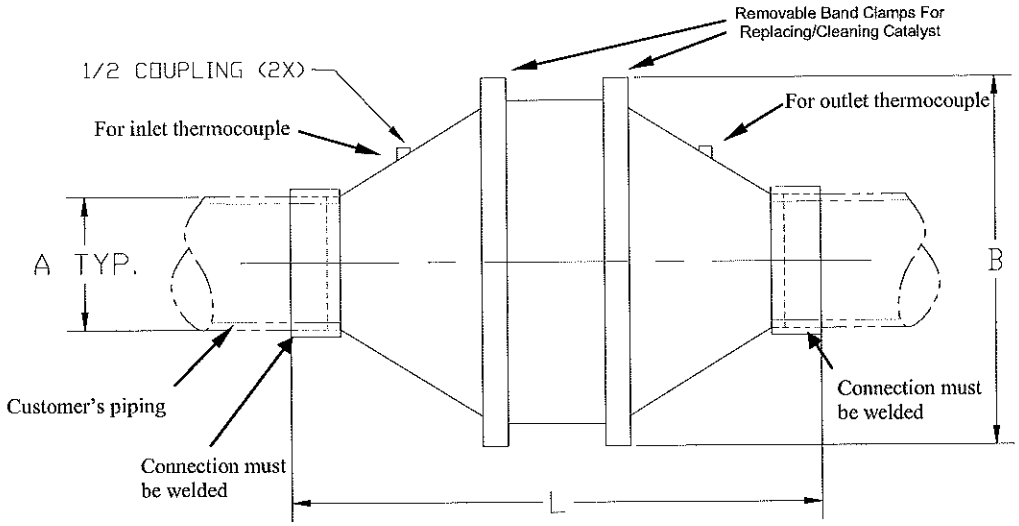


Figure 2.4 Catalytic Converter

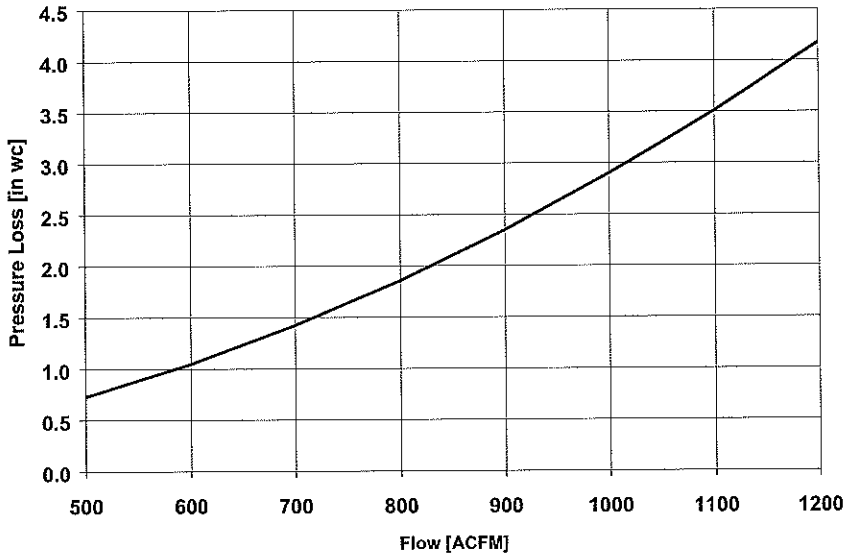


Figure 2.5 Catalytic Converter Pressure Loss

3. Installation

The installation of the TECOCHILL STx chiller is the responsibility of others. However, Tecogen does provide guidance with this Engineering Submittal, the TECOCHILL Application/Installation Manual, factory engineering support, and the local factory representative.

When piping to a STx chiller, typical industry standards apply, as well as local building and mechanical codes. Piping should be self-supporting and not limit service access to the unit nor interfere with the opening of control panel doors. Materials should be appropriate for the conditions of use.

The additional considerations with a gas engine chiller are a natural gas supply, an exhaust system, extra cooling tower capacity for engine cooling, and a heat recovery water system if this option is utilized.

Important

Installation of this equipment should be performed only by personnel qualified in the areas of refrigeration, mechanical piping, natural gas plumbing, hot exhaust piping, and wiring.

All piping and wiring should conform to local and national codes.

3.1 Unit Delivery and Placement

For rigging guidelines and point loads, refer to Figure 3.1.

Once the unit is offloaded, ensure that it is stored indoors if it is not going to be put into place immediately.

Standard units are shipped with a full charge of refrigerant, isolated in the condenser, and a holding charge of refrigerant in the remainder of the system. Therefore, precautions need to be taken before opening any refrigeration system valves. All units are delivered with a full charge of compressor oil and a full engine oil pan.

The machine should be protected from construction dirt and moisture. The shipping cover should be kept in place until the machine is ready for installation.

The unit should be placed in a well-lighted, indoor equipment room, away from noise sensitive areas and with adequate space for service. Unit dimensions, weights, and service access guidelines can be found on the Installation Layout, Figure 3.2(a-e). Local code requirements may take precedence.

Adequate ventilation should be provided to keep the air temperature in the space below the maximum (115 °F without enclosure, 105 °F with enclosure), as well as to provide make-up air flow for the combustion air. The specifications are listed in Table 3.1.

Table 3.1 Ambient Condition Requirements

	STx Series	
Model	CH-150*x*	CH-200*x*
Max Temperature Without Enclosure (°F)	115	115
Max Temperature With Enclosure (°F)	105	105
Combustion Air Requirement (SCFM)	180	257
Heat Rejected to Ambient (MBtu/hr)	16	23
Minimum Ventilation Requirement* [CFM @ 90 °F]	1026	1517

** The minimum ventilation requirement is for the TECOCHILL unit only.*

If the ambient temperature in the placement area can drop below 32 °F, precautions should be taken to avoid freezing of the chiller's water systems. Keep humidity to a minimum to prevent corrosion and damage to electrical components.

A base or foundation is recommended, but is not required if the placement area is level and capable of supporting the chiller's full operating weight. Elastomeric or neoprene isolation pads are shipped loose with the unit to be used to support the chiller base as a way to reduce low frequency noise emitted by the engine and compressor.

Figure 3.3, Piping and Wiring Layout, is an isometric presentation of the customer interface points with the STx chiller.

3.2 Engine Bulk Oil System

It is necessary to allow for floor space adjacent to the chiller for the engine bulk oil system's 55 gallon drum (Refer to Figure 3.2c). It is the responsibility of the installing contractor to put the drum in place and provide proper secondary containment.

The final connections between the chiller and the oil drum need to be made prior to, or as part of, start-up. The hoses and fittings required to do this are shipped strapped to the chiller. There is an oil pick-up tube that is inserted in the drum inside a tube straightener. A hose is connected from this pick-up tube to the oil circulation pump that is mounted on the deck near the engine. A return oil hose is connected from the oil drain to a stand pipe within the drum that returns the oil to the bottom of the drum.

Note

If Tecogen does the start-up, these final connections will be done by the Tecogen start-up technician.

3.3 Water Piping

The water piping systems to the STx Chiller are as follows:

- Evaporator
- Condenser
- Dump Heat Exchanger
- Make-up Water
- Engine Coolant Relief (1 total)
- Heat Recovery (Option)

Water-based piping should contain properly located air vents and water drains as well as strainers and gauges for pressure and temperature at the inlet and outlet of the unit. Refer again to Figure 3.3

Consult the TECOCHILL Product Manual for detailed information on the water piping. A few important points are highlighted below.

- Condenser water flow control, used in conjunction with tower fan control, is strongly recommended on STx units to prevent nuisance shutdowns due to cold cooling tower water (See Figure 3.3). Cold tower water causes low compressor discharge or head pressure which can lead to improper expansion valve operation and inadequate compressor lubrication. Like most screw chillers, the TECOCHILL STx Series relies on compressor discharge pressure to force oil to the important compressor lubrication ports. Therefore, it is recommended that the cooling tower water is maintained above the minimum temperatures listed in Table 3.2. Failure to comply with these requirements will depress the compressor discharge pressure. This can cause reduced capacity or cause the unit to trip its safety circuits and stop operation.

  In order to maintain control of the cooling tower water temperature, it is recommended that the condenser piping system be

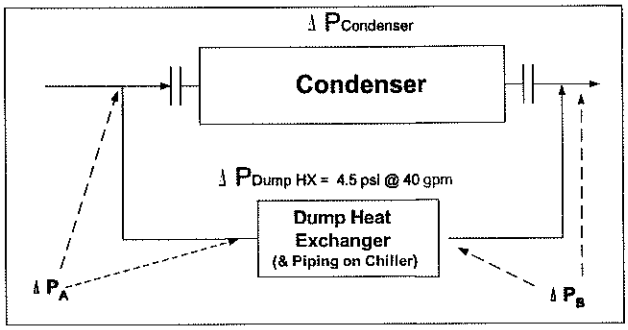
Table 3.2

Chilled Water Building Supply Temperature	Minimum Cooling Tower WaterTemperature Supplied to Condenser
1. 50-85 °F (Start-up/Pulldown)	78 °F
2. 45-50 °F (High Setpoints)	75 °F
3. Less than 45 °F (Normal Setpoints)	70 °F

equipped with an active temperature control system. In some cases, tower fan control is adequate for this purpose. In general, and to assure operation in cooler ambient conditions, Tecogen recommends faster acting, and more accurate methods such as a 3 -way modulating condenser flow control valve with an electrical actuator. The TECOCHILL control system can control the actuator and supply the control signal (discharge or head pressure). The valve should be installed so that it bypasses flow around the cooling tower and directs flow back to the condenser to elevate the temperature (refer to Figure 3.3). This maintains a constant condenser and dump heat exchanger flow, allowing for the most stable operation of the chiller. Refer to the inset in Figure 3.3 for further details. Consult the factory for alternative methods or refer to Application Bulletin 98-004.

The engine dump heat exchanger is plumbed, by the installer, in parallel to the condenser. Therefore, the piping from the main condenser feed, to the dump heat exchanger and back, should be sized properly to maintain the 40 gpm required to cool the dump heat exchanger. Referring to the schematic below, the pressure drop in the customer's piping to and from the dump heat exchanger, defined as ($\Delta P_A + \Delta P_B$), should be as follows :

$$\Delta P_A + \Delta P_B < \Delta P_{condenser} - 4.5 \text{ psi}$$



Important

Failure to provide sufficient flow to the dump heat exchanger can cause ALARM shutdowns due to engine overheating. *Symptoms may not be apparent initially. Low water flow causes high outlet temperatures. This results in excessive liming /fouling within the heat exchanger that builds up over time.*

- Water treatment for the cooling tower should include consideration of the high cooling tower water temperatures of the engine dump heat exchanger and its tube surfaces. The recommendations for cooling tower water treatment includes, but is not limited to, the items listed below. Since make-up water quality to a condenser water system varies greatly throughout the country, it is the owner's responsibility to seek guidance from a local, reputable water treatment firm.

Important

Failure to provide proper water treatment to the dump heat exchanger can cause excessive liming resulting in ALARM shutdowns from engine overheating.

1. Chemical treatment program can consist of an alkaline, pH controlled, or softened water program. The program must utilize EPA approved cooling tower biocide(s).
2. The cooling tower water calcium hardness should not exceed 240 mg/l as $CaCO_3$.
3. The cooling tower water total alkalinity should not exceed 220 mg/l as $CaCO_3$.
4. The cooling tower water pH should not be below 7.0 or exceed 8.7.
5. The cooling tower water should not have a Langlier Saturation Index (LSI) greater than 2.5 or less than -0.3. Calculations for the LSI should be performed at the maximum design bulk water operating temperature of 128 °F (LMTD of approximately 88 °F).
6. The quality of the make-up water should be regularly monitored for of Ca, Mg, Si, Fe, Al, PO_4, CO_3, HCO_3, Cl, SO_4, and pH.
7. The total plate counts (TPC) should be monitored at least once per month and should not exceed 10^5 colonies/ml.
8. The following water analyses should be performed at a minimum; Calcium or Total Hardness, Total Alkalinity, Conductivity, pH, Phosphonate, and Molybdate (based on inhibitor treatment program).

For further details, refer to Tecogen Application Note 99-001.

- A chilled water flow verification switch, furnished by others, needs to be installed and wired into the TECOCHILL control panel. The chiller will not start until this switch closes confirming chilled water flow. Refer to Section 2.5.1 and Figure 3.7 for further details.

Important

Freeze damage to the chiller, caused by insufficient flow through the evaporator, is not covered under warranty.

- The engine coolant relief valve needs a discharge pipe installed to a suitable drain in accordance with the National Plumbing Code and/or any applicable local codes.
- A city water make-up line, regulated to 12 to 15 psi, needs to be hooked up to the engine coolant system along with an expansion tank. To simplify this installation, an integral expansion tank/ regulator is available from Tecogen as an accessory.
- The recommended piping for engine heat recovery is presented in Figure 3.4.

3.4 Fuel Supply Piping

The STx chiller is designed for a low-pressure natural gas supply system. The gas pressure requirement at the inlet to the chiller is indicated in Table 1.2. It is important that the piping be adequately sized to deliver the full rated fuel flow at the design gas pressure. Refer to the TECOCHILL Application/Installation Manual for guidelines on the recommended fuel pipe size as a function of the equivalent feet of piping required.

If the building gas pressure exceeds 28", it is necessary for the customer to install a gas regulator upstream of the STx chiller. This regulator needs to be a "Dead-end Lock-up" type regulator which means that it will not equalize to incoming line pressure when the unit is off. This equalization of pressure would cause engine starting problems by flooding the engine with gas at start-up.

In general, piping should be constructed of malleable iron and be free of any solid debris that could become lodged in the unit's solenoid valves. Referring to Figure 3.3, a dirt leg trap, just before the unit connection, is recommended for collecting any solid objects. A manual shut-off valve to the unit should be included as well. Piping should comply with local and national codes.

3.5 Exhaust Piping

An exhaust system is required for the STx chiller engine to direct the exhaust products outside. Typically, we do not recommend that engines in a multiple-unit installation share a common exhaust. If this type of shared exhaust is being considered, please consult the factory.

This exhaust system must have a silencer and thermal expansion joints. It may contain other optional accessories like a catalytic converter or an exhaust heat exchanger. Because of the safety aspects of hot ex-

haust products, it is especially important that this piping system be free of leaks and be constructed of appropriate materials. Compliance to local and national codes (NFPA 37 and NFPA 211) is essential, especially regarding piping connections, support, insulation, termination, and clearance from combustible materials.

It is recommended that high-grade stainless bolts be used on all exhaust flange connections to prevent stretching due to the high temperatures. Care should be taken not to overtorque the bolts which can also cause stretching problems. Spiral-wound gaskets, such as the *Flexitallic CG* type, are also recommended because they utilize an external ring which accurately centers gasket on flange face. This provides additional radial strength to prevent gasket blowouts and acts as a compression stop.

Note

If in compliance with local codes, it is desirable to leave exhaust flanges un-insulated if possible. This reduces the build-up of heat which can cause bolts to stretch, resulting in leaks or gasket blow-outs.

Figure 3.5 presents the recommended exhaust system design. The drawing *Notes* should be read carefully, as they include many important design guidelines. If the unit is equipped with an emission control system option, refer also to Section 2.1.6 for information pertaining to the exhaust system.

Important

It is the responsibility of the site and/or installing contractor (and not Tecogen) to determine and obtain any needed air emissions permits from local authorities. Any needed controls equipment fees, coordination, permits, testing , monitoring systems, etc. are not included with the standard STx chiller.

3.6 Refrigerant Relief Valve Discharge Piping

Referring to Figure 3.2(a-e), dual refrigerant relief valves are located on the condenser and oil separator and a single relief valve is located on evaporator. Dual reliefs have two redundant relief valves connected on a manifold to the vessel. Only one valve is open to the system while the other is isolated. This allows safe removal and replacement of either relief valve while the vessel is protected and under pressure.

Each relief valve is equipped with a rupture disc and pressure gage for indication of a previous relief valve discharge.

As per industry standard, the discharge piping to the outside atmosphere should comply to the latest version of ASHRAE 15 and with local code requirements.

Listed below are the specifications for the relief valves:

3.7 Electrical Connections

The STx chiller requires power at 208-230 volts, single phase with a neutral, and 30 amps. In addition to main electrical power, the other mandatory field connection is the chilled water flow switch input.

Control cabinet penetrations are to be made by the installing contractor. There is a gland plate on top of the control cabinet that should be removed when drilling to prevent metal shavings from getting into the control cabinet.

Figure 3.6 presents a Field Wiring Diagram. A description of all of the available interconnections between the site and the STx chiller is described in Section 2.5.

All field wiring should be in accordance with the National Electric Code and must comply with state and local codes.

	Condenser	Evaporator	Oil Separator
Quantity:	2	1	2
Manufacturer:	Cyrus Shank	Cyrus Shank	Cyrus Shank
Model:	803	803	803
Connection Size:	1" FPT	1" FPT	1" FPT
Pressure Setting:	225 psig	225 psig	225 psig
Discharge Flow:	39.8 lb air/min	39.8 lb air/min	39.8 lb air/min

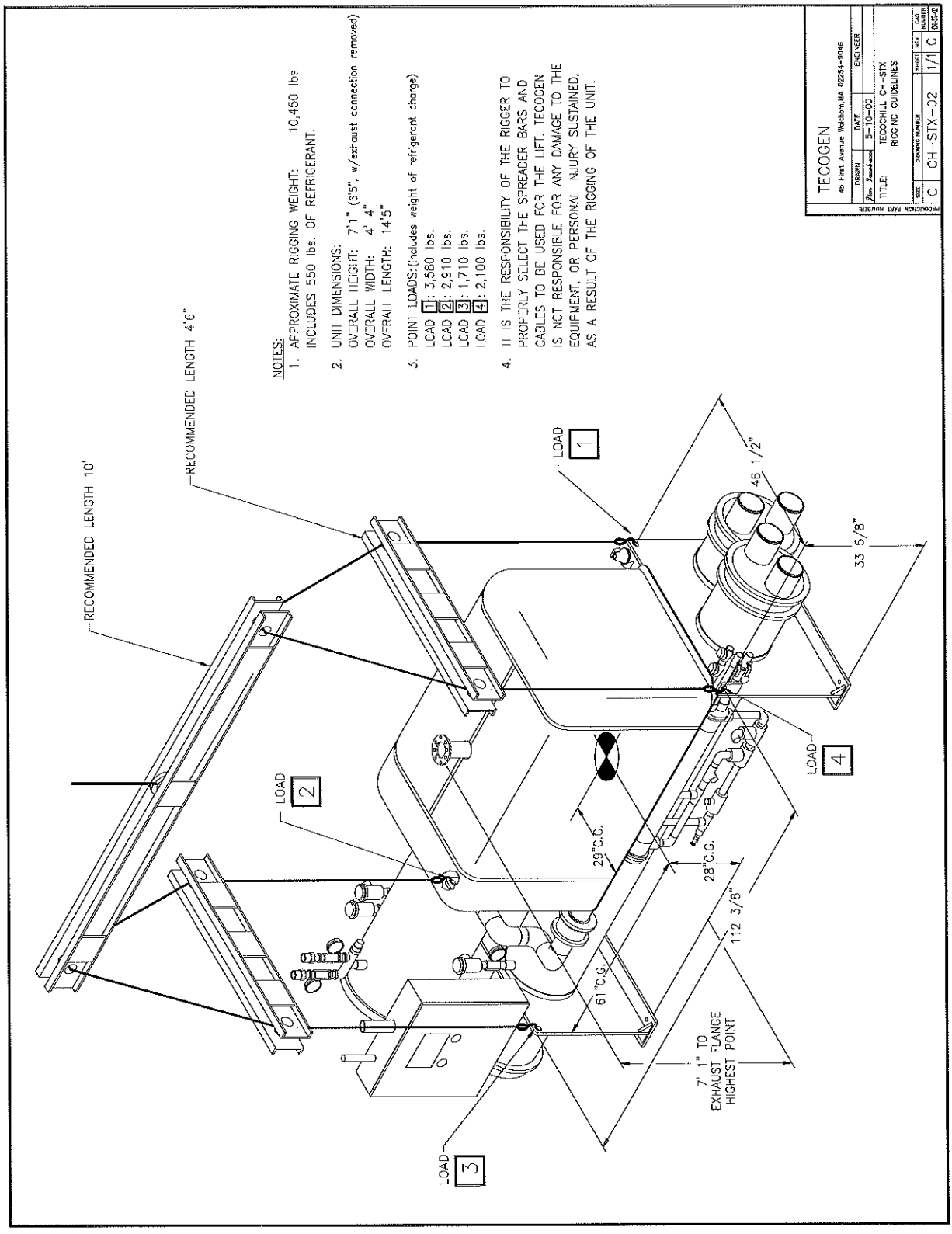


Figure 3.1 STx Rigging Drawing

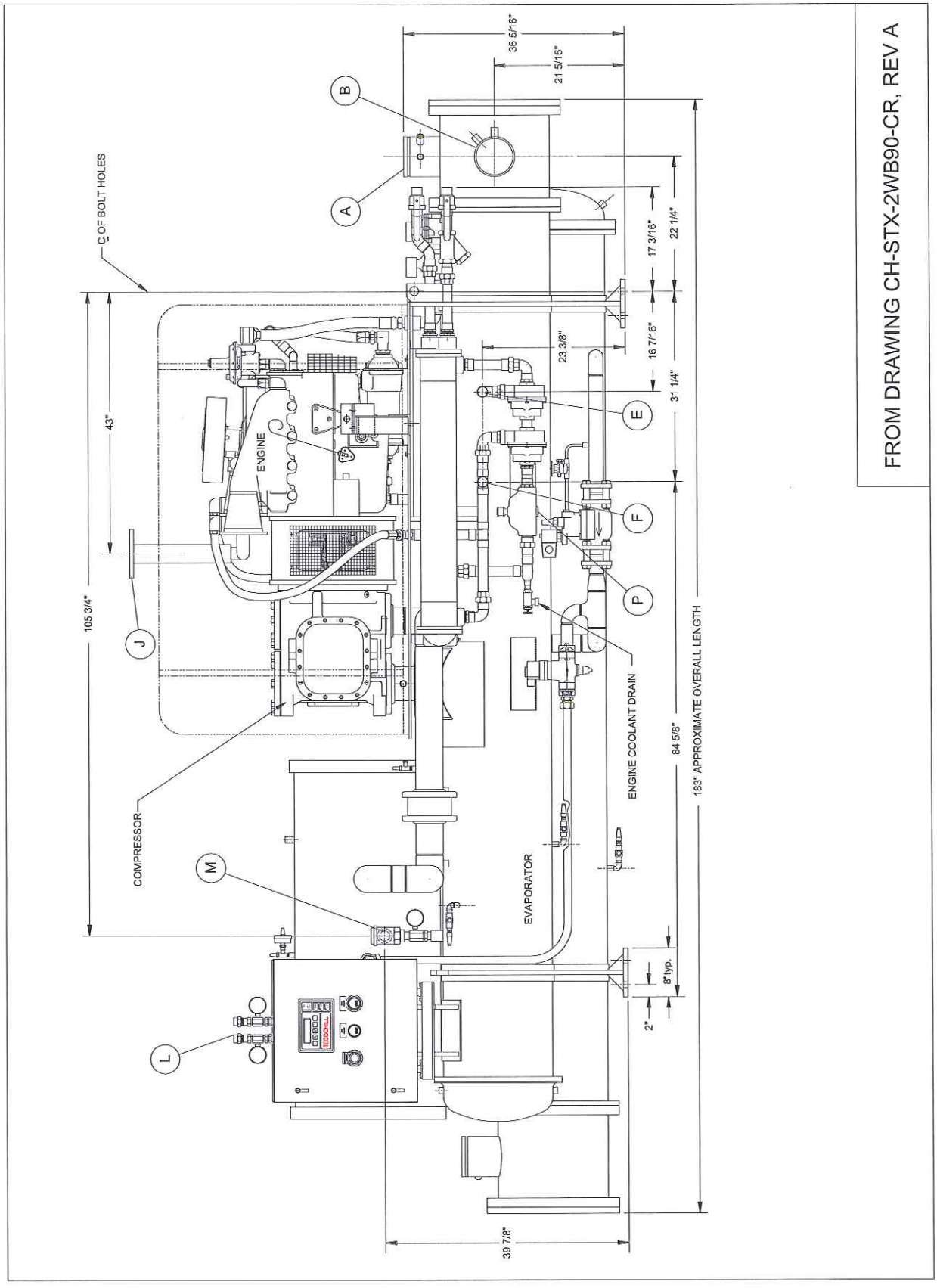


Figure 3.2a STx Installation Drawing—View 1

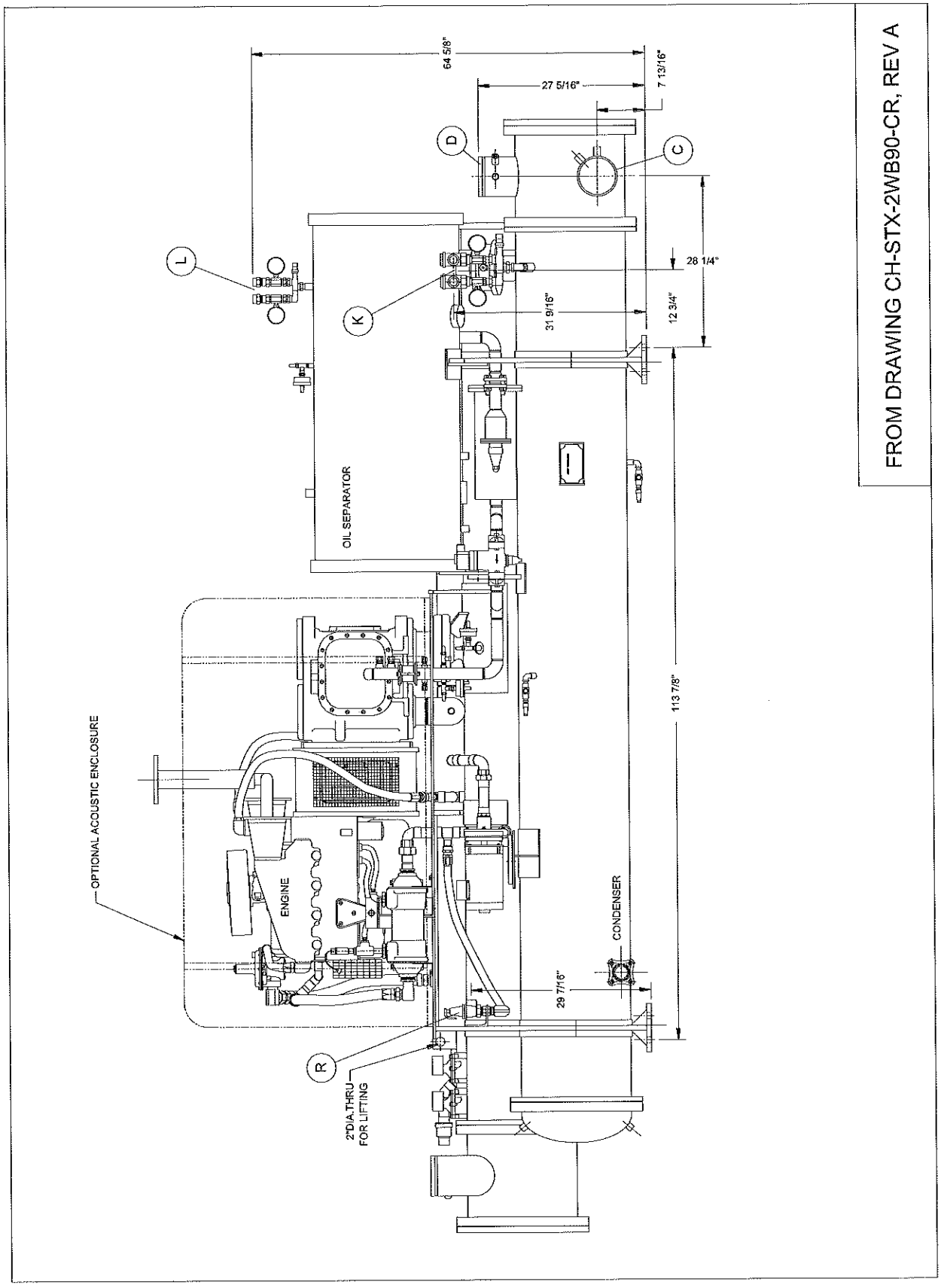


Figure 3.2b STx Installation Drawing—View 2

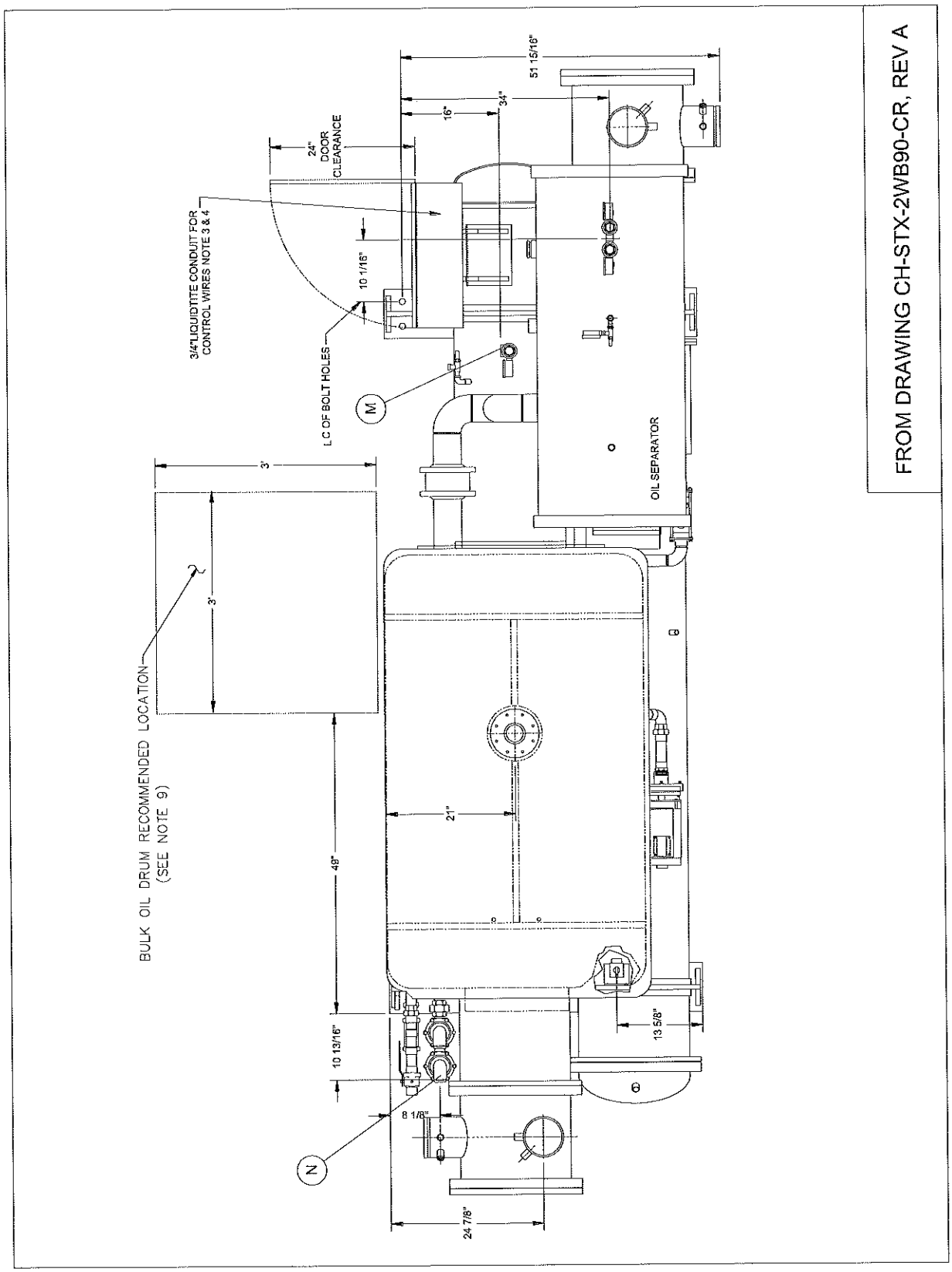


Figure 3.2c STx Installation Drawing—View 3

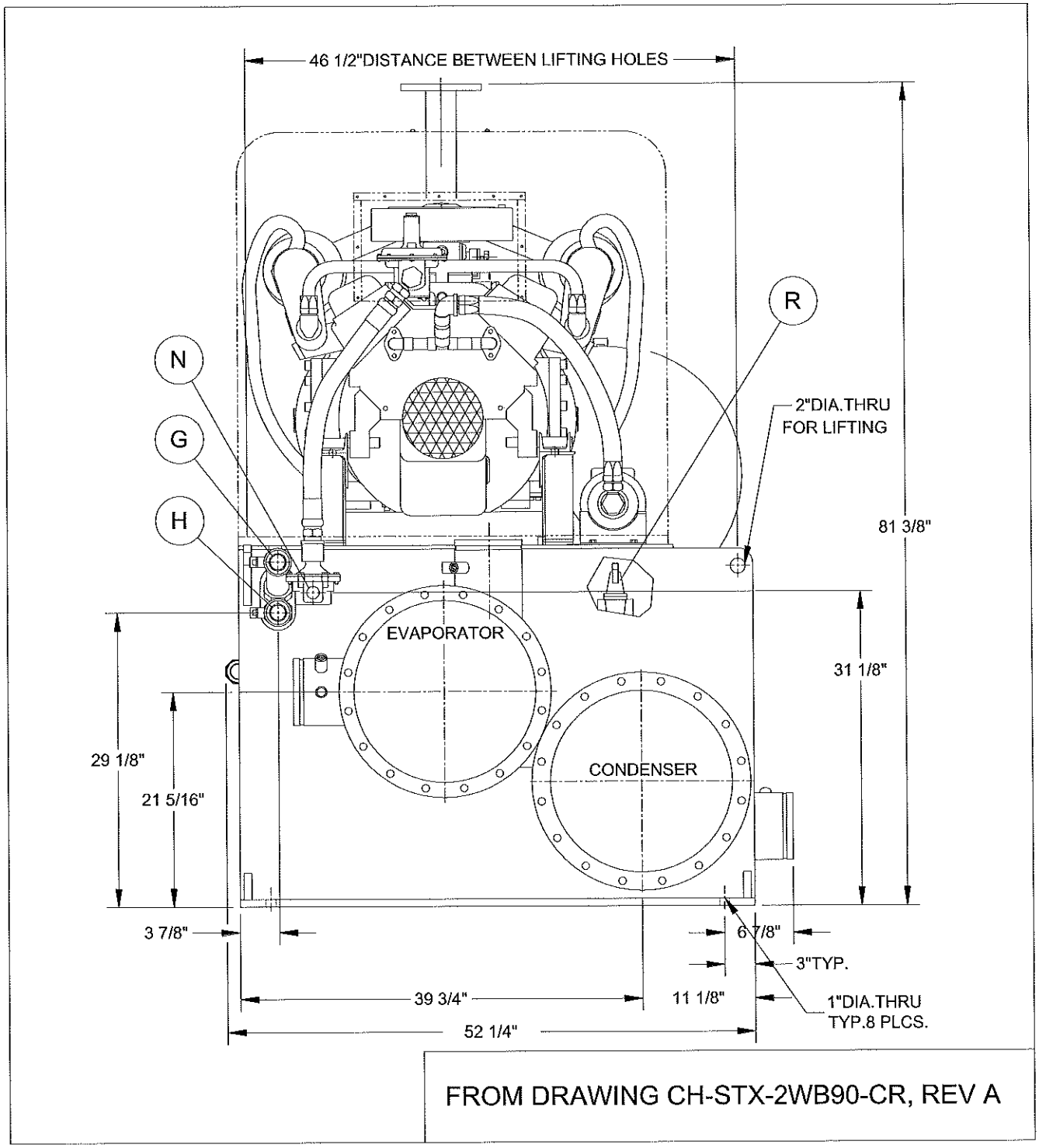


Figure 3.2d STx Installation Drawing - View 4

CONNECTION TABLE			
CONN.	DESCRIPTION	SIZE	TYPE
A	CHILLED WATER IN	6"	VICTAULIC
B	CHILLED WATER OUT	6"	VICTAULIC
C	CONDENSER WATER IN	6"	VICTAULIC
D	CONDENSER WATER OUT	6"	VICTAULIC
E	HEAT RECOVERY LOOP WATER RETURN	1 1/2"	COPPER
F	HEAT RECOVERY LOOP WATER SUPPLY	1 1/2"	COPPER
G	DUMP HEAT EXCHANGER WATER OUT	1 1/2"	COPPER
H	DUMP HEAT EXCHANGER WATER IN	1 1/2"	COPPER
J	ENGINE EXHAUST CONNECTION	4"	125# FLANGE
K	DUAL REFRIGERANT RELIEF (CONDENSER)	1"	FPT
L	DUAL REFRIGERANT RELIEF (OIL SEPARATOR)	3/4"	FPT
M	REFRIGERANT RELIEF (EVAPORATOR)	1"	NPT
N	GAS INLET	1 1/4"	FPT
P	MAKE-UP WATER	1/2"	FPT
R	ENGINE COOLANT WATER RELIEF VALVE DRAIN	1"	NPT

NOTES:

1. APPROXIMATE RIGGING WEIGHT 11,000 POUNDS (INCLUDES 550 lbs. OF REFRIGERANT).
2. REFRIGERANT RELIEF LINES TO BE PIPED TO OUTSIDE ATMOSPHERE PER ASHRAE 15-78 (ANSI B9.1).
3. ELECTRIC POWER CONNECTIONS: 208-230 VOLT, SINGLE PHASE, WITH NEUTRAL, 30 AMP. CONTROL CABINET PENETRATIONS ARE TO BE MADE BY INSTALLING CONTRACTOR. THE GLAND PLATE ON TOP OF THE CONTROL CABINET SHOULD BE REMOVED FOR DRILLING TO PREVENT METAL SHAVINGS FROM ENTERING CONTROL CABINET.
4. CONTROL CONNECTIONS:
   - OPTIONAL INPUTS: SET POINT INPUT (2-WIRE)
     SIGNAL RUN (2-WIRE).
     GAS METER COUNTER (2-WIRE).
   - MANDATORY INPUT: CHILLER WATER FLOW VERIFICATION SWITCH (2-WIRE).
     (DIFFERENTIAL SWITCH RECOMMENDED).
   - OPTIONAL OUTPUTS: CHILLER PUMP START (2-WIRE).
     CONDENSER PUMP STARTER (2-WIRE).
     DUMP HEAT EXCHANGER BOOST PUMP (2-WIRE).
     ALARM (2-WIRE).
5. ALLOW 3' CLEARANCE ALL AROUND UNIT FOR ROUTINE MAINTENANCE. 13 1/2 FT. CLEARANCE EITHER END REQUIRED FOR CONDENSER TUBE PULLING. ALLOW 2' CLEARANCE ABOVE THE UNIT FOR ENGINE OR COMPRESSOR REMOVAL.
6. EXPANSION TANK AND PRESSURE REDUCING VALVE ARE REQUIRED TO MAINTAIN ENGINE COOLANT MAKE-UP WATER PRESSURE OF 12 PSIG COLD, AND 15 PSIG HOT.
7. EXHAUST MUST BE PITCHED AWAY FROM ENGINE (1" PER 40' MINIMUM) AND AN ACTIVE DRAIN (DRIP LEG) MUST BE PROVIDED AT THE LOW POINT. FOR MULTIPLE UNIT INSTALLATION, EACH ENGINE SHOULD HAVE ITS OWN EXHAUST SYSTEM.
8. ALL DIMENSIONS INCLUDING THOSE ON FIELD CONNECTED NOZZELS ARE WITHIN ±3/4"TOLERANCE. IT IS RECOMMENDED THAT FIELD PIPING ALLOW FOR SOME PLAY IN FITTING PACKAGE NOZZLES. ESPECIALLY IF FIELD PIPING IS STARTED BEFORE UNIT IS IN PLACE.
9. BULK OIL SYSTEM NOTES:
   A. ALLOW FOR A 3'X 3' SPACE, ADJACENT TO THE UNIT, FOR BULK OIL SYSTEM 55 GALLON DRUM.
   B. SECONDARY CONTAINMENT IS THE RESPONSIBILITY OF THE INSTALLING CONTRACTOR.
   C. FINAL CONNECTIONS BETWEEN THE CHILLER AND THE OIL DRUM NEED TO BE MADE PRIOR TO START-UP. THIS WILL BE DONE BY THE TECOGEN START-UP TECHNICIAN.
10. REFER TO STATE AND LOCAL CODES FOR EXHAUST PIPING, FUEL PIPING, REFRIGERANT VENTS, DRAINS, AND WIRING.
11. ALL PIPING TO UNIT MUST BE SELF SUPPORTING. FLEXIBLE CONNECTIONS ARE REQUIRED.

FROM DRAWING CH-STX-2WB90-CR, REV A

Figure 3.2e Installation Drawing - Notes and Connection Table

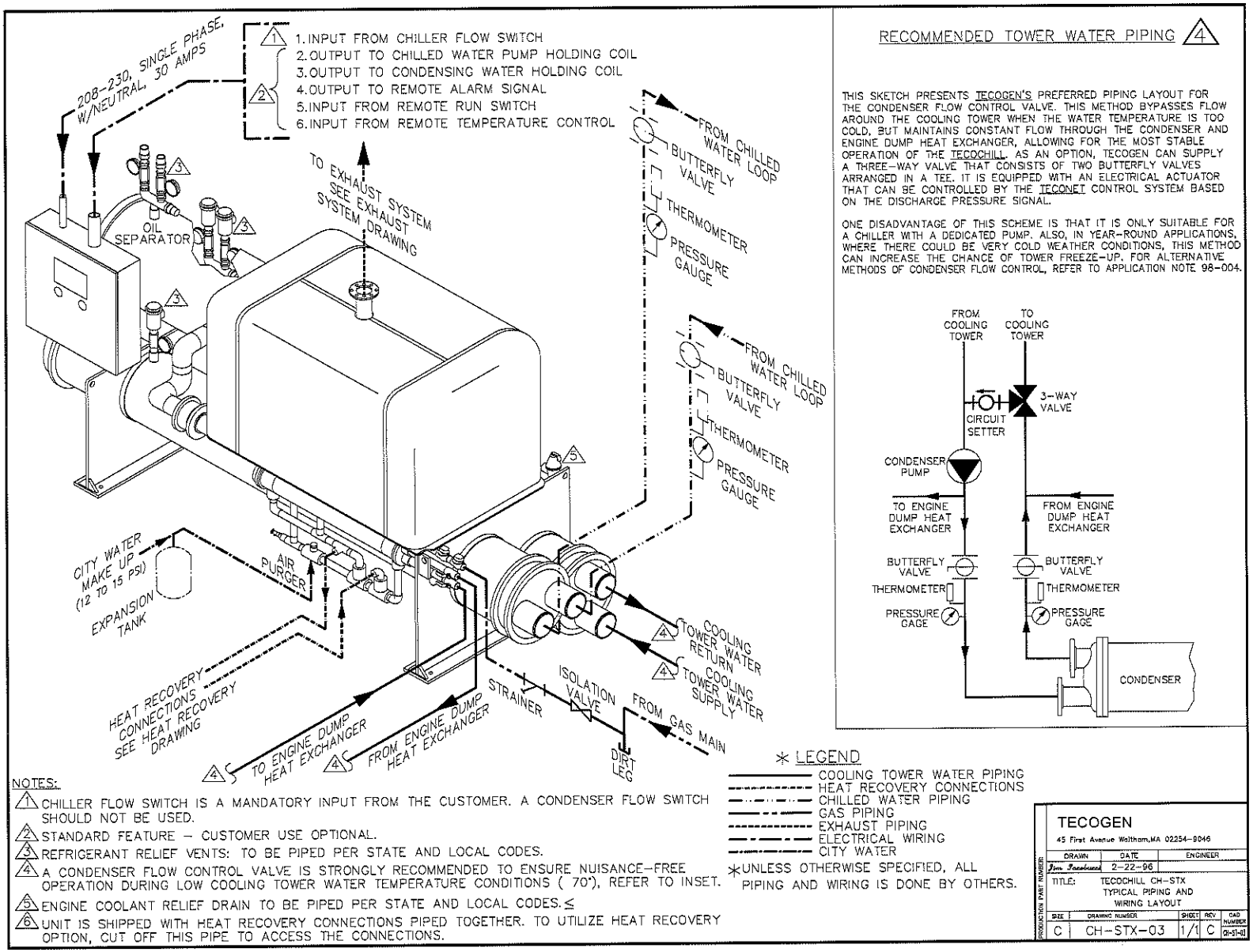


Figure 3.3 STx Piping and Wiring Layout Drawing

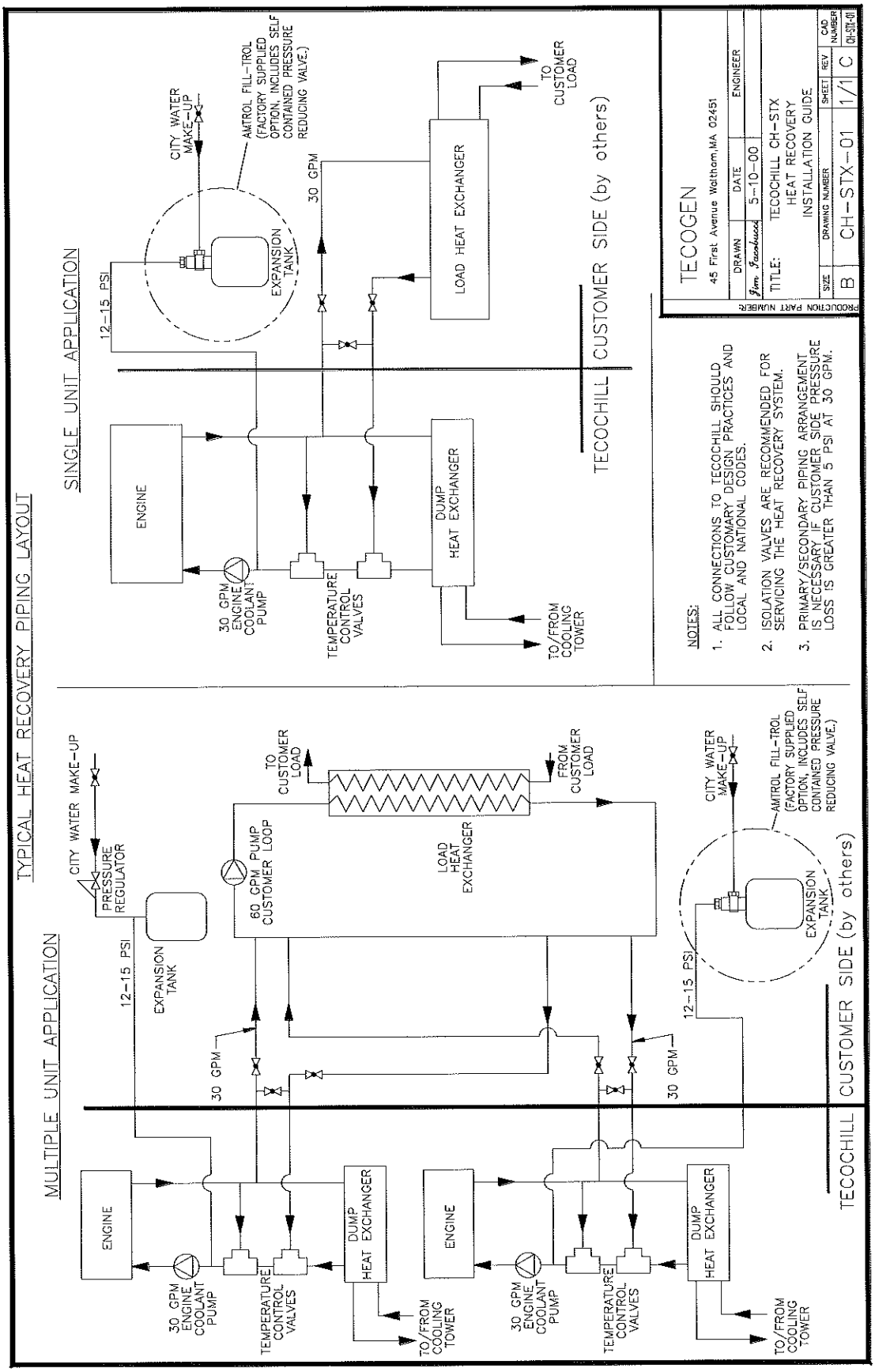


Figure 3.4 STx Heat Recovery Piping Drawing

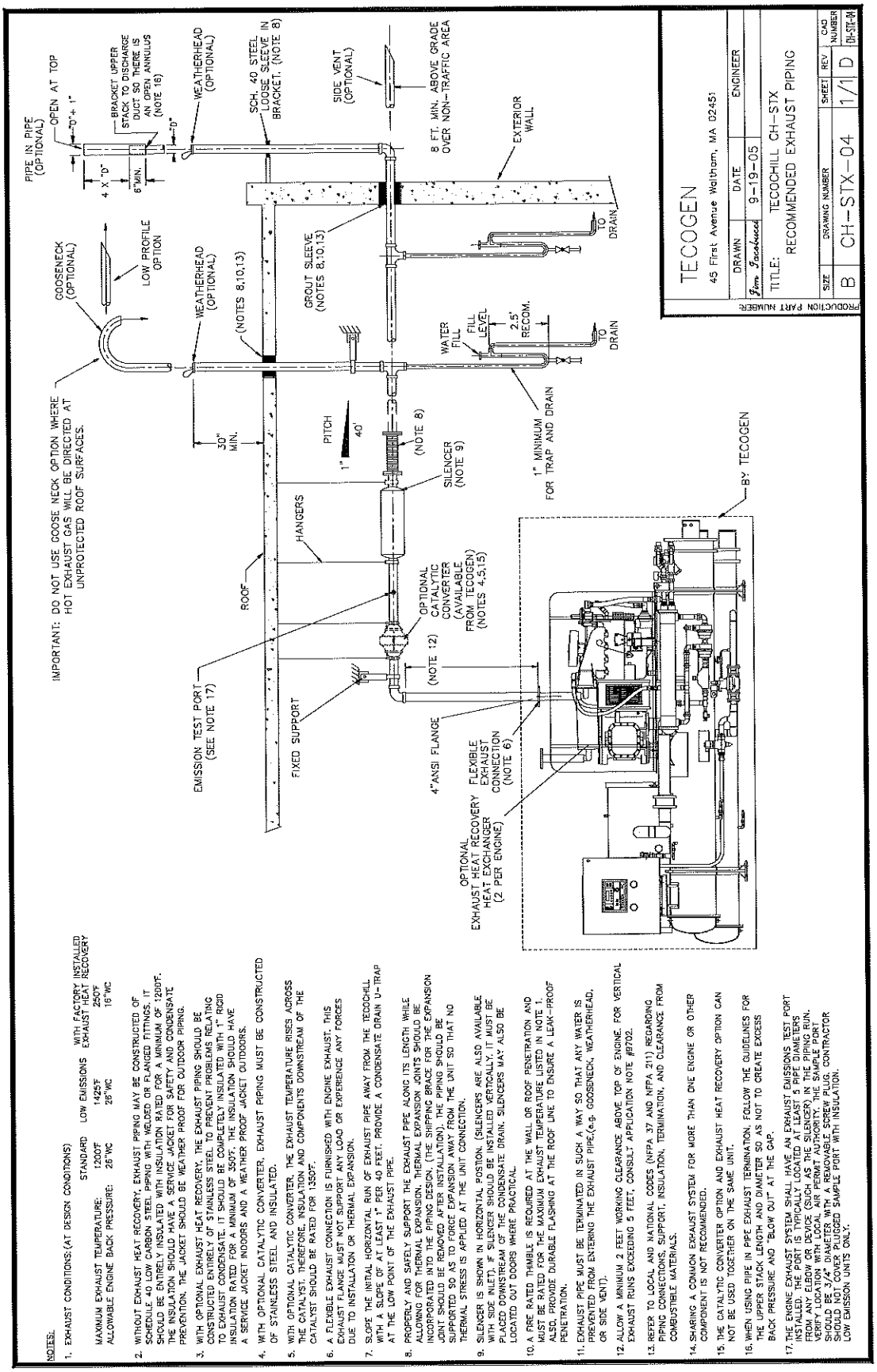


Figure 3.5 STx Exhaust Piping Drawing

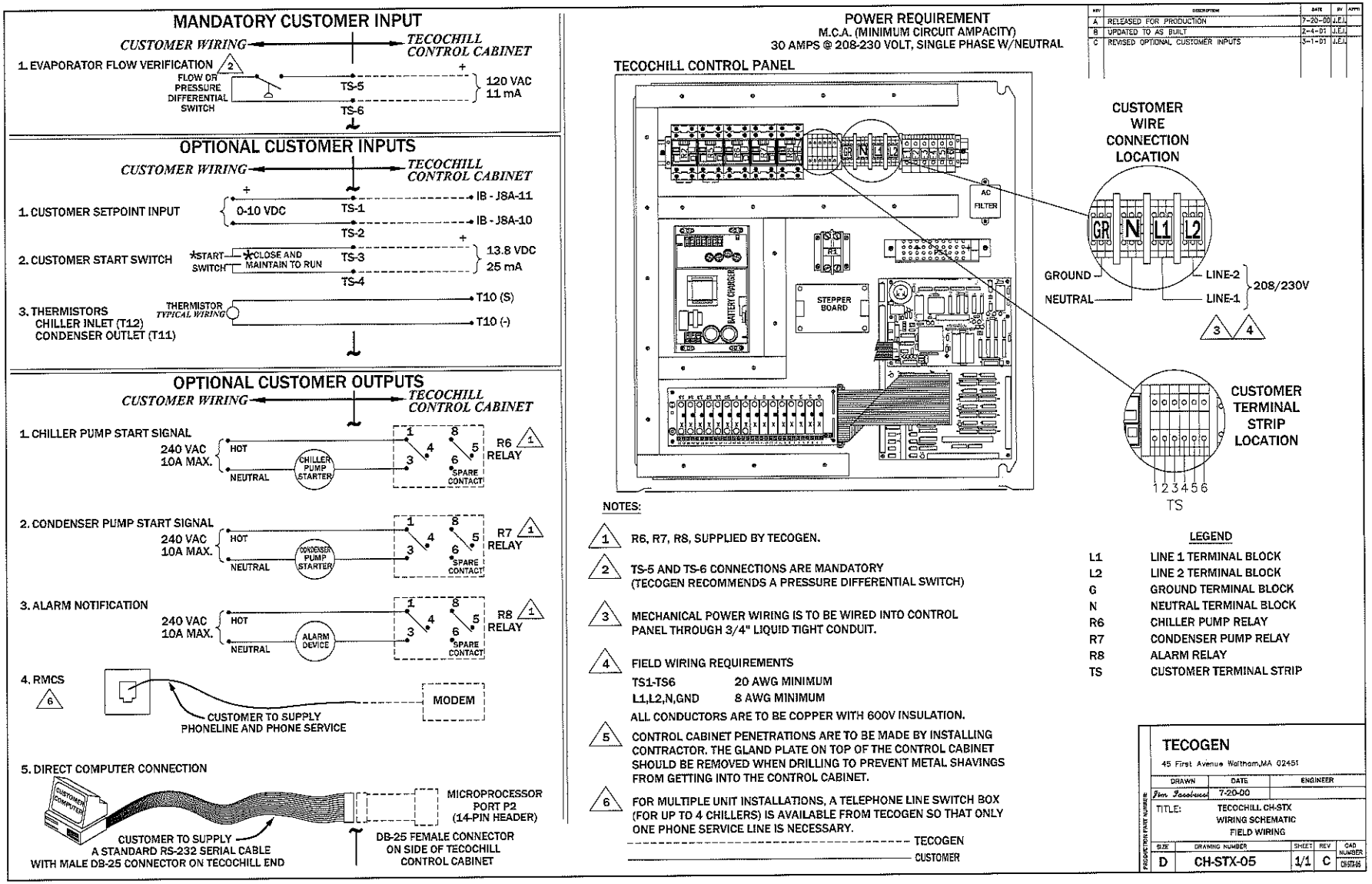


Figure 3.6 STx Field Wiring Connections

4. Start-up [x] Supplied [ ] Not Supplied

Note

Tecogen strongly recommends that the start-up of the STx chiller be done by Tecogen factory personnel. It is typically priced into the sale of the chiller. (Refer to Section 1.1 for job-specific information). If it is not done by Tecogen, it is necessary that those responsible obtain and follow a STx Start-up Procedure. This procedure should be completed and sent back to the Tecogen in order to initiate the warranty coverage. Operating units, that do not have this STx Start-up Procedure completed, will not be covered under warranty.

4.1 Pre-Start Checklist

Prior to start-up, Tecogen requires that the customer (or installing contractor) complete a Pre-start checklist before scheduling a start-up date. The checklist must be received and approved by Tecogen ten(10) working days before the start-up. Some of the items included in the checklist are as follows:

1. Water piping to the evaporator, condenser, and engine dump heat exchanger must be complete and flows balanced.
2. Engine coolant system city water make-up line must be complete and there should be 12 - 15 psi of pressure at the unit. Also, the expansion tank must be installed.
3. Exhaust piping must be complete and built to proper codes and Tecogen guidelines.
4. Gas piping must be complete and there should be adequate gas pressure at the unit (13" to 28"). For units equipped with the emission control system option, 20 in wc is ideal.
5. Electrical power wiring to the unit must be complete. The chilled water flow safety switch must also be interconnected.
6. Refrigerant relief vents must be installed.
7. Engine coolant relief valve drain must be installed.
8. There must be sufficient building load to run the chiller.

4.2 Start-up Scope

The Tecogen Service person, who administers the start-up, will complete a STx Start-up Procedure. The scope of this includes the following:

1. Site inspection.
2. Verification of site parameters such as flows, gas pressure, city water pressure, and electrical power.
3. Verification of electrical interconnections, specifically the chilled water flow safety switch.
4. Installation of engine bulk oil system.
5. Pre-start check of chiller functions.
6. Verification that the phoneline and modem are working properly. Download of updated software if necessary.
7. Operation and set-up of engine.
8. Running the unit at various loads and verifying that operating parameters are within specification.
9. Recording data.
10. Write-up of any follow-up action items required by the site.
11. Obtaining responsible site person's signature that start-up is complete.

Once the start-up is complete, the warranty period will commence. Tecogen will send out a letter confirming the completion of start-up and reiterating any action items required.

5. Maintenance

The Maintenance Schedule for the STx chiller is presented below. Maintenance agreements and contracts are available from Tecogen and may be included in the sale of the chiller. (Refer to Section 1.1 for job-specific information). Further details on maintenance can be found in the STx Operation and Maintenance Manual, available from Tecogen.

Category	Interval	Item	Action
A	750 EFLH[1] Or 1500 Operating Hours (Whichever Occurs First)	Air Filter Battery Timing Carburetor Engine Oil Filter Spark Plugs Ignition Wires Coupling Engine Mounts Compressor Shaft Seal Compressor Oil Level Dump HX Strainer General Chilled Water Flow Switch Safety Circuit[2]	Replace Inspect Check & Adjust if Necessary Check & Adjust if Necessary Replace Replace Replace Inspect Inspect Monitor Leakage Rate Check Clean Check for Leaks, Check Electrical Connectors Verify Operation Verify Operation (HTS1, HTS2, ETS)
B	1500 EFLH or 3000 Operating Hours (Whichever Occurs First)	A Items Engine Lube Oil Distributor Cap Rotor PCV Valve Engine Evaluation Compressor Lube Oil Condenser Dump Heat Exchanger Engine Valves O2 Sensor[4]	 Replace 55 Gal Drum, Drain Oil Pan Replace Replace Replace Blowby & Compression Test (Omit on First Service) Check Level, Take Sample and Log Check, Clean if Necessary Check, Clean if Necessary Adjust (Every other "B" Service 3000 EFLH / 6000 Operating Hours) Replace
C	6000 EFLH or 12000 Operating Hours	Cylinder Heads Catalyst[4] "A" & "B" Items	Replace Inspect, Wash or Replace See Above
D	Typical Life[3]	Engine, Partial	Replace as indicated by Blowby and Compression Tests
E	Seasonal	Startup & Shutdown "A" & "B" Items	Follow Procedure See Above
F	As Required	Compressor Shaft Seal Compressor Oil Compressor Oil Filter Thermostatic Valves	Replace Replace Replace Replace Elements

Notes

1. *EFLH= Equivalent Full Load Hours*
2. *The safety circuit acts as a redundant safety to ensure safe shutdown in the event of a microprocessor failure.*
3. *Typical engine life with proper service is 7500-10,000 EFLH or 15,000-20,000operating hours, (whichever comes first).*
4. *Applies only to units equipped with the TecoDrive Emission Control System.*

6. Warranty

6.1 Three Year Parts and Labor Warranty

All STx units are furnished with a standard TECOCHILL First Year Parts and Labor Warranty Statement. This is presented below.

Note

If a service call is initiated by the customer, where it is determined that the problem is not covered by this warranty, the customer will be billed for labor and expenses at our standard rates.

TECOCHILL THREE YEAR PARTS AND LABOR WARRANTY STATEMENT

Tecogen warrants the product to be free of defects in material and workmanship under normal use and service for forty-two (42) months from the date of shipment, or thirty-six (36) months from the date of installation, whichever occurs first. Tecogen warrants the engine to be free of defects under normal use and service for eighteen (18) months from the date of shipment, or twelve (12) months from the date of installation, or 4000 hours of operation, whichever occurs first. Engine warranty (TecoDrive only) can be extended to five (5) years, or 15,000 hours, whichever comes first, for a nominal cost. Service parts replaced under this warranty are covered for twelve (12) months from the date of shipment or ninety (90) days from the date of installation, whichever occurs first. The product is covered if properly installed and maintained and operated under normal conditions.

Any item which within the warranty period is promptly reported in writing to Tecogen as being defective and which is found to Tecogen's reasonable satisfaction to be defective upon examination by Tecogen will, at the option of Tecogen and within a reasonable time period, be repaired or replaced with a new item or factory rebuilt item of at least the same quality as new.

Defective items replaced under this warranty, shall upon Tecogen's request, be returned to and shall become the property of Tecogen. Labor will be either by a factory technician or an authorized agent at Tecogen's option. Labor will only be furnished for the replacement of defective part or parts and does not cover the cost incurred in shipping or handling. In addition, an allowance will be made for a maximum of (4) hours, for total diagnostic and travel time, and will only be paid if it results in a replacement of a warranty part.

Warranty does not cover, and Tecogen makes no warranty with respect to, any defect or failure resulting in whole or in part from: ordinary wear and tear, abuse, misuse, corrosion, chemical damage, negligence, accident, changes in government regulation, fire, theft, improper operation, overloading, war, riots, civil commotion, flood, storm, earthquake, or any similar event beyond the control of Tecogen. This warranty excludes liability for corrosion, erosion, algae, scaling or slime do to improperly treated or untreated water in this equipment.

Warranty is invalid if buyer: fails to protect product from weather or elements; removes product from its place of original installation; removes, defaces or alters serial number; uses a provider not authorized by Tecogen to maintain, repair, or alter product; fails to follow good and acceptable engineering specifications and trade practices and Tecogen's specifications and instructions for installation; or fails to provide reasonable, necessary, and required maintenance and replacement of scheduled replacement parts, and follow Tecogen's operation and maintenance instructions.

Warranty of items furnished by Tecogen, but not manufactured by Tecogen, shall not extend beyond those transferable to buyer from the manufacturer of such items. Warranty does not cover any components not furnished by Tecogen. Tecogen is not liable for any damage to buildings or property (except damage to the product resulting from a defect covered by this warranty), loss of time or pay, personal injury, or for the cost of lost refrigerant or oil, or for any consequential incidental or special damages or expenses resulting from the product or its performance or failure to perform.

Tecogen is not responsible for any expenses incurred without prior authorization in writing from Tecogen.

Page 1 of 2

All warranty claims must be sent to Tecogen in writing to the following address:

c/o Service Manager
Tecogen
45 First Avenue
Waltham, MA 02451

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. NO IMPLIED WARRANTY ARISING BY USAGE OR TRADE, COURSE OF DEALING OR COURSE OF PERFORMANCE IS GIVEN BY TECOGEN OR SHALL ARISE BY OR IN CONNECTION WITH THE SALES AGREEMENT AND/OR TECOGEN'S AND/OR BUYER'S CONDUCT IN RELATION THERETO OR TO EACH OTHER, AND IN NO EVENT SHALL TECOGEN BE LIABLE ON ANY SUCH WARRANTY WITH RESPECT TO ANY PRODUCT.

Warranty gives buyer specific legal rights; however, buyer's actual legal rights may vary depending on the state of purchase.

6.2 TECOPLUS 5/15 Plan *(Option)*

☐ Supplied ☒ Not Supplied

The TECOPLUS 5/15 Plan Extended Engine Warranty is an optional plan that extends the engine warranty (parts only) for a total of 5 years or 15,000 hours on a pro-rated basis. The complete description is presented below:

TECOPLUS 5/15 PLAN
EXTENDED ENGINE WARRANTY

Plan Period

The TecoPlus 5/15 Plan ("Plan") extends the standard warranty for specific items of the TecoDrive natural gas engine used in the TECOCHILL engine driven chillers to sixty (60) months from the date of installation, sixty-six (66) months from the date of shipment, or 15,000 hours of cumulative operation, whichever occurs first, and not to exceed 7500 EFLH. For chillers with more than 5,000 hours of cumulative operation but fewer than 15,000 hours, the plan will provide warranty credit toward the purchase of a new TecoDrive 7400 Series engine from Tecogen on a pro-rated basis as follows:

$$\text{Credit} = \frac{15{,}000 - \text{Actual Operating Hours}}{(15{,}000\text{-}5000)} \times \text{Purchase Price}$$

Covered Items

The Plan warrants all items on the TecoDrive Replacement Engine ("Engine") consisting of a basic engine block with pistons, crankshaft, connecting rods, camshaft, intake manifold, head assembly, engine oil system and oil pan to be free of defects in material and workmanship under normal use and service.

The Engine does not include the carburetor, gas supply system, engine coolant supply and return system, exhaust system, engine/compressor coupling system, ignition system, engine starter system and engine mount system. Warranty does not include labor or other costs incurred for diagnosing, repairing, removing, installing, shipping, servicing or handling the product, or damage during transportation.

The plan covers the original TecoDrive engine only. Any engine replaced under this plan regardless of operating hours will only be covered for the remaining term of the original engine .

The above description of components is meant as a guide and is not a complete list. For details, please contact the Tecogen Service Manager.

Warranty Claims

The cost of any covered items which are promptly reported in writing to Tecogen as being defective, barring any exclusions, will be credited to the Plan customer. Upon contacting Tecogen, the customer will be requested to order the required parts and authorize service work with a purchase order, against which the warranty will credit covered items. Customer will provide Tecogen with any requested documentation, service logs, etc. to supplement claim.

Plan does not include labor or other costs, such as parts not covered by Plan, incurred for diagnosing, repairing, removing, installing, insuring, shipping, servicing, handling the chiller. Defective items shall, at Tecogen's request, be returned to and become the property of Tecogen. Tecogen will cover the return freight for the returned items.

Tecogen is not responsible for any expenses incurred without prior authorization in writing from Tecogen.

Page 1 of 2
Engine Warranty
March 2001

All plan claims must be sent to Tecogen in writing at the following address:

TECOPLUS 5/15 PLAN
c/o Service Manager
Tecogen
45 First Avenue
Waltham, MA 02451

Exclusions

Plan does not cover any defect or failure resulting in whole or in part from: ordinary wear and tear, abuse, misuse, corrosion, chemical damage, negligence, accident, changes in government regulation, fire, theft, improper operation, overloading, war, riots, civil commotion, flood, storm, earthquake, or similar event beyond the control of Tecogen.

Plan is invalid if customer: fails to protect chiller from weather or elements; removes chiller from its place of original installation; removes, defaces or alters serial number; uses a service provider not trained and officially authorized by Tecogen (TECOCHILL Authorized Service Provider) to maintain, repair, or alter chiller; fails to use authorized TECOCHILL parts; fails to follow Tecogen's specifications for installation; or fails to provide required maintenance and follow Tecogen's operation and maintenance instructions.

Tecogen is not liable for any damage to buildings, property or equipment, loss of time or pay, personal injury, or for the cost of lost refrigerant or oil, or for any consequential, incidental or special damages or expenses resulting from the chiller or its performance or failure to perform. Tecogen is not responsible for any expenses incurred without prior authorization in writing from an officer of Tecogen.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. NO IMPLIED WARRANTY ARISING BY USAGE OR TRADE, COURSE OF DEALING OR COURSE OF PERFORMANCE IS GIVEN BY TECOGEN OR SHALL ARISE BY OR IN CONNECTION WITH THE SALES AGREEMENT AND/OR TECOGEN'S AND/OR BUYER'S CONDUCT IN RELATION THERETO OR TO EACH OTHER, AND IN NO EVENT SHALL TECOGEN BE LIABLE ON ANY SUCH WARRANTY WITH RESPECT TO ANY PRODUCT.

Warranty gives buyer specific legal rights; however, buyer's actual legal rights may vary depending on the state of purchase.

6.3 Five-Year Extended Compressor Warranty *(Option)*

☐ Supplied ☒ Not Supplied

The Five-Year Extended Compressor Warranty is an optional plan that extends the compressor warranty (parts only) for a total of 5 years. The complete description is presented below:

TECOCHILL FIVE-YEAR
EXTENDED COMPRESSOR WARRANTY

Tecogen warrants its compressor, so far as manufacture, to be free from defects of material and workmanship, and will replace at its option, free of charge, any part or parts which prove to the satisfaction of Tecogen to be defective within a period of sixty (60) months from the date of start-up or exposed to a designated gas, or to a maximum of sixty six (66) months from the date of delivery. The warranty applies to all components of the compressor. Tecogen shall have the sole right to specify the manner and the person by whom repairs of said part or parts is to be done. This warranty is subject to the following:

1) The defective part must be returned freight prepaid to Tecogen and will, in the event of replacement, become the property of Tecogen;

2) The warranty does not include the cost of removing the defective part or the cost of installation of the new part;

3) Tecogen, unless otherwise stated, does not warrant any part of the machinery will resist the action of corrosive or erosive gases, liquids, or solids, and no part will be deemed affected by reason of its failure to resist such action;

4) This extended warranty excludes the shaft seal and bearings. They remain covered for twelve (12) months from the date of start-up or eighteen (18) months from the date of delivery.

Tecogen is not liable for any damage to the buildings, property or equipment, loss of time or pay, personal injury, or for the cost of lost refrigerant or oil, for any consequential, incidental or special damages or expenses resulting from the chiller or its performance or failure to perform. Tecogen is not responsible for any expenses incurred without prior authorization in writing from an officer of Tecogen. This warranty applies to air conditioning applications only and is limited to 20,000 operating hours.

Warranty of items furnished by Tecogen, but not manufactured by Tecogen, shall not extend beyond those transferable to buyer from the manufacturer of such items. Warranty does not cover any components not furnished by Tecogen. Tecogen is not liable for any damage to buildings or property (except damage to the product resulting from a defect covered by this warranty, loss of time or pay, personal injury, or for the cost of lost refrigerant or oil, or for any consequential incidental or special damages or expenses resulting for the product or its performance or failure to perform.

Plan does not include labor or other costs, such as parts not covered by Plan, incurred for diagnosing, repairing, removing, installing, insuring, shipping, servicing, handling the chiller. Defective items shall, at Tecogen's request, be returned to and become the property of Tecogen. Tecogen will cover the return freight for the returned items.

Tecogen is not responsible for any expenses incurred without prior authorization in writing from Tecogen.

Page 1 of 2
Compressor Warranty
March 2001

All warranty claims must be sent to Tecogen in writing to the following address:

c/o Service Manager
Tecogen
45 First Avenue
Waltham, MA 02451

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. NO IMPLIED WARRANTY ARISING BY USAGE OR TRADE, COURSE OF DEALING OR COURSE OF PERFORMANCE IS GIVEN BY TECOGEN OR SHALL ARISE BY OR IN CONNECTION WITH THE SALES AGREEMENT AND/OR TECOGEN'S AND/OR BUYER'S CONDUCT IN RELATION THERETO OR TO EACH OTHER, AND IN NO EVENT SHALL TECOGEN BE LIABLE ON ANY SUCH WARRANTY WITH RESPECT TO ANY PRODUCT.

Warranty gives buyer specific legal rights; however, buyer's actual legal rights may vary depending on the state of purchase.

6.4 Five-Year Extended Parts Warranty *(Option)*

☐ Supplied ☒ Not Supplied

The Five-Year Extended Parts Warranty is an optional plan that extends the parts warranty for a total of 5 years. This option does not include the extended engine or compressor warranty. The complete description is presented below:

TECOCHILL EXTENDED PARTS WARRANTY STATEMENT
(Excludes Engine and Compressor)

Tecogen warrants the product to be free of defects in material and workmanship under normal use and service for a total of 5 years. This warranty excludes the engine and compressor. They are covered under seperate extended warranty policies. Parts replaced under this warranty are covered for the term of this warranty. The product is covered if properly installed and maintained and operated under normal conditions.

Any item which within the warranty period is promptly reported in writing to Tecogen as being defective and which is found to Tecogen's reasonable satisfaction to be defective upon examination by Tecogen will, at the option of Tecogen and within a reasonable time period, be repaired or replaced with a new item or factory rebuilt item of at least the same quality as new.

Defective items replaced under this warranty shall, upon Tecogen's request, be returned to and shall become the property of Tecogen. Labor will be either by a factory technician or an authorized agent at Tecogen's option.

Warranty does not cover, and Tecogen makes no warranty with respect to, any defect or failure resulting in whole or in part from: ordinary wear and tear, abuse, misuse, corrosion, chemical damage, negligence, accident, changes in government regulation, fire, theft, improper operation, overloading, war, riots, civil commotion, flood, storm, earthquake, or any similar event beyond the control of Tecogen. This warranty excludes liability for corrosion, erosion, algae, scaling or slime do to improperly treated or untreated water in this equipment.

Warranty is invalid if buyer: fails to protect product from weather or elements; removes product from its place of original installation; removes, defaces or alters serial number; uses a provider not authorized by Tecogen to maintain, repair, or alter product; fails to follow good and acceptable engineering specifications and trade practices and Tecogen's specifications and instructions for installation; or fails to provide reasonable, necessary, and required maintenance and replacement of scheduled replacement parts, and follow Tecogen's operation and maintenance instructions.

Warranty of items furnished by Tecogen, but not manufactured by Tecogen, shall not extend beyond those transferable to buyer from the manufacturer of such items. Warranty does not cover any components not furnished by Tecogen. Tecogen is not liable for any damage to buildings or property (except damage to the product resulting from a defect covered by this warranty), loss of time or pay, personal injury, or for the cost of lost refrigerant or oil, or for any consequential incidental or special damages or expenses resulting from the product or its performance or failure to perform.

Tecogen is not responsible for any expenses incurred without prior authorization in writing from Tecogen.

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TECOCHILL Extended Parts Warranty

All warranty claims must be sent to Tecogen in writing to the following address:

c/o Service Manager
Tecogen
45 First Avenue
Waltham, MA 02451

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. NO IMPLIED WARRANTY ARISING BY USAGE OR TRADE, COURSE OF DEALING OR COURSE OF PERFORMANCE IS GIVEN BY TECOGEN OR SHALL ARISE BY OR IN CONNECTION WITH THE SALES AGREEMENT AND/OR TECOGEN'S AND/OR BUYER'S CONDUCT IN RELATION THERETO OR TO EACH OTHER, AND IN NO EVENT SHALL TECOGEN BE LIABLE ON ANY SUCH WARRANTY WITH RESPECT TO ANY PRODUCT.

Warranty gives buyer specific legal rights; however, buyer's actual legal rights may vary depending on the state of purchase.

7. Pre-Start Checklist

TECOGEN
45 First Avenue
Waltham, MA 02451
(781) 466-6400
FAX: (781) 466-6466 or 6456

STx SERIES

CH-150x - CH-200x

TECOCHILL PRE-START CHECK LIST

Verification of the following items is required prior to start-up. Please complete and mail or fax to Tecogen ten (10) working days before requested start-up. Check item if it is complete. Start up for unit(s) will not be scheduled until the following form is complete. If any are not complete when factory start-up person arrives on site, and additional days or an extra trip is required due to incomplete installation, additional labor and expenses will be charged.

Note: *If multiple units are included in one package this check list applies to all units. Note any variations.*

Site Address:

_____

_____

_____

_____

_____

Site Contact & Phone Number:

_____

_____

_____

_____

_____

Installer Contact & Phone No.:

_____

_____

List Completed By:

_____
(Name & Title)

_____
(Date)

A. CHILLED WATER PIPING

1. Pumps installed, tested, and balanced. Flow directions are correct as specified on chiller nozzles. ☐
2. Pump controls are operational (interconnect to TECOCHILL panel is recommended). ☐
3. Flow rate and pressure drop are as specified on unit nameplate. ☐
4. Thermometers and pressure gauges installed on entering /leaving side of the evaporator. ☐
5. Chilled water flow switch is installed and operational. ☐

B. CONDENSER WATER PIPING

1. Pumps installed, tested, and balanced. Flow directions are correct as specified on condenser nozzle. ☐

2. Pump controls are operational (interconnect to TECOCHILL panel is recommended. ☐

3. Flow rates and pressure drop are as specified on unit nameplate. ☐

4. Thermometer and pressure gauges installed on the entering/leaving side of the condenser. ☐

5. Piping for Engine Coolant Dump HX is operational. ☐

6. Cooling tower has been filled, tested, and balanced. ☐

7. Condenser flow control valve (if applicable) is operational. ☐

C. ELECTRICAL SUPPLY

1. All electrical connections have been made. Voltage and amperage to unit is as per unit nameplate. ☐

2. All external controls and interlocks have been checked and are operational (time clocks, pump controls, etc.). ☐

D. GAS SUPPLY

1. Proper gas pressure (13" to 28" WC) at the TECOCHILL inlet connection. (Note: 7" wc is acceptable for a CH-200x or CH-150x without the emission control option. ☐

2. Strainer is installed in gas supply line. ☐

E. EXHAUST PIPING

1. Installed with appropriate condensate drains and properly sloped away from the unit. ☐

2. Appropriate flex connections, constant supports, pipe guides, pipe supports, and insulation properly installed. ☐

3. Fire rated roof/wall penetration. ☐

4. Emission Control Option:
   - Catalyst installed ☐
   - Piping rated for 1350°F, stainless steel mandatory upstream of the catalyst ☐

F. ENGINE COOLANT MAKE-UP WATER

1. City water make-up and expansion tank properly installed with 12 to 15 psi on system. ☐

G. HEAT RECOVERY MODELS

1. Heat recovery piping balanced and tested with proper flow rates. ☐
2. Temperature and pressure gauges are installed on inlet and outlet of unit. ☐
2. Heat recovery bypass line installed with shut-off valves installed. ☐
4. System isolation valves installed. ☐

H. GENERAL

1. One 55 gallon drum of engine oil is on site. ☐
    - Standard units: ExxonMobil XD3 SAE 30
    - Emission Control units: ExxonMobil Busguard GEO 15W-40

2. Building air handlers are optional as long as there is an adequate building load for full load testing during start-up. ☐

3. Contractor will be available to assist and guide our start-up personnel. ☐
    Contact: _____.
    Cell Phone or Pager: _____.

4. All parts shipped loose with the unit are available at start-up. Check packing list to verify. ☐

5. Operating and or service personnel scheduled for training. ☐

6. Telephone line available at control panel for RMCS connection. ☐
    Number:_____

DESIRED START UP DATE:_____

DIRECTIONS TO JOB SITE:

HOTELS (AND PHONE NUMBERS) NEAR JOB SITE:

E-Mail/Mail/Fax to:

Tecogen
Attention: Application's Engineer
45 First Avenue
Waltham, MA 02451

Phone: (781) 466-6400
Fax: (781) 466-6466

8. Material Delivery

The following form is to be completed by an authorized representative of the purchasing company. Return this sheet to:

Tecogen
45 First Avenue
Waltham, MA 02451
Attn: Applications' Engineer

Requested Date of Delivery: _____

Signed: _____

Print: _____

Title: _____

Date: _____

TECOGEN
45 First Avenue
Waltham, MA 02451

(781) 466-6400
(781) 466-6466 (Fax)

SECTION 311000 - SITE CLEARING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities and/or abandoning site utilities in place.
7. Temporary erosion- and sedimentation-control measures.
8. Tree protection fencing.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

B. Utility Locator Service: Notify “Call Before You Dig” for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag with blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Do not stockpile topsoil within protection zones.
2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, plants and other site amenities.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

B. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

C. Do not direct vehicle or equipment exhaust towards protection zones.

D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups and Geotechical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course/Crushed Aggregate: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Crushed stone: Open graded crushed limestone: MDOT 6AA.

J. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; screened to be free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

L. Sand: ASTM C 33; fine aggregate.

M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit or as indicated on drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.5 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or

conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of [subbase material] [satisfactory soil], free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under walks and pavements, use satisfactory soil material.
2. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Pavement: Plus or minus 1 inch.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course 6 inches or less in compacted thickness in a single layer.
2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Construction Manager will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Standard Specification: Michigan Department of Transportation, 2003 Standard Specification for Construction.
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Qualification Data: For manufacturer.

E. Material Test Reports: For each paving material.

F. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

1. Regulatory Requirements: Comply with Michigan Department of Transportation, 2003 Standard Specification for Construction for asphalt paving work.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of subgrade and preparatory work.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

E. All work shall meet specifications of the City of Detroit.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Bonding and Tack Coats: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO MP 1, PG 58 degree C-28 degree C.

B. Asphalt Cement: ASTM D.

C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30.

1. Prime Coat: Asphalt emulsion prime complying with Michigan Department of Transportation, 2003 Standard Specification for Construction..

D. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073, Grade Nos. 2 or 3.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction, designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types." and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 1100L, 20AA – 1-1/2”
3. Surface Course: 1100T, 20AA – 1-1/2”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected and approved by Landscape Architect.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Each lift shall be installed using automated laser grade control, self propelled paving equipment, with dual slope capabilities.
3. Place hot-mix asphalt surface course in single lift.
4. Spread mix at minimum temperature of 250 deg F.
5. Begin applying mix on high side of one-way slopes, unless otherwise indicated.
6. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

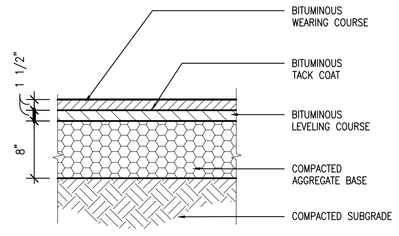
E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
   1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

      a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

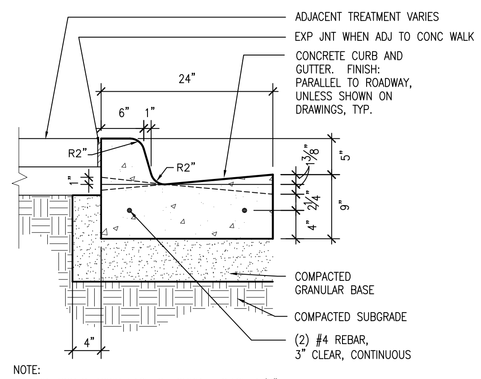
END OF SECTION 321216

THE FOLLOWING DIMENSION EQUALS ONE INCH WHEN PRINTED TO SCALE. 1"



NOTE:
ASPHALT SHALL MEET AND MATCH EXISTING PAVEMENT AND HAVE SIM. PROFILE AS EXISTING.

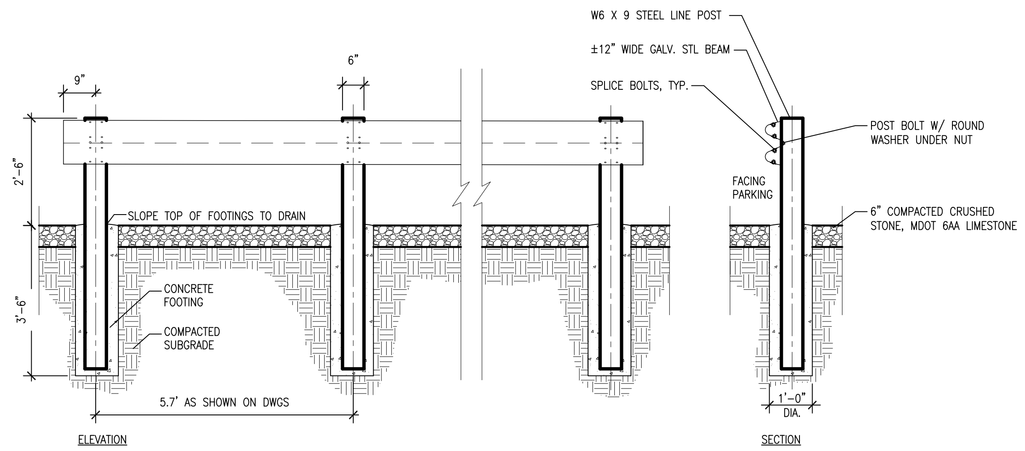
4 / A1.2 LIGHT DUTY BITUMINOUS PAVEMENT
1"=1'-0"



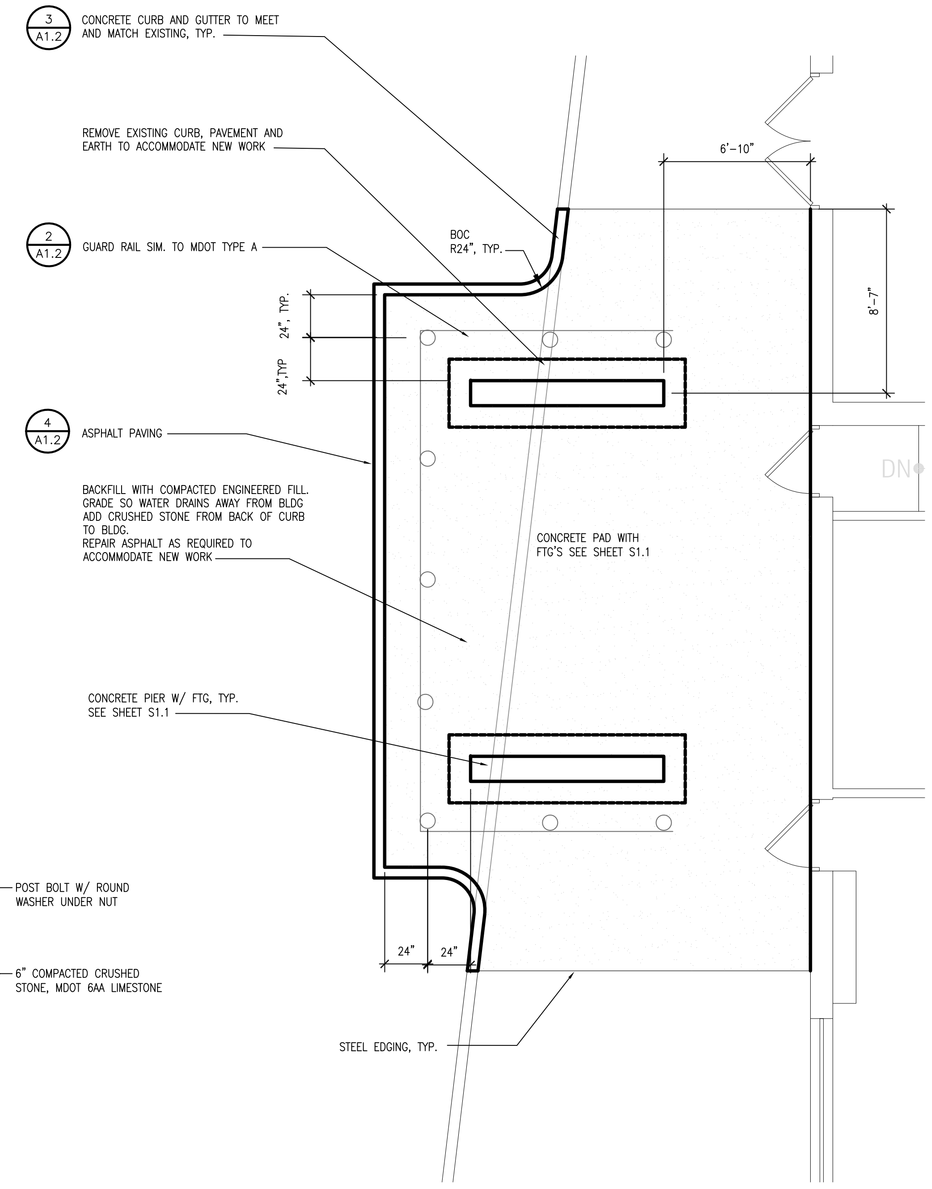
NOTE:
EXTEND JOINTS DOWN FACE OF CURB. PLACE 1/2" EXPANSION JOINT WITH PREMOLDED FILLER, HELD DOWN 1/2", AND SEALANT AT INTERVALS NOT TO EXCEED 40LF

NEW CURB AND GUTTER SHALL MATCH EXISTING

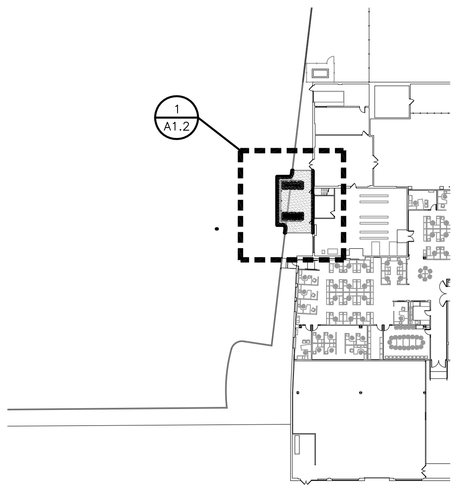
3 / A1.2 CONCRETE CURB AND GUTTER
1"=1'-0"



2 / A1.2 GUARD RAIL
1/2"=1'-0"



1 / A1.2 NEW CURB AND FENCE
SCALE:1/4"=1'-0"



KEY PLAN
SCALE: NTS

Know what's below. Call before you dig.

REVISION
2-11-13
2-18-13

REVISION
Addendum 1
Addendum 5

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Troy, Michigan 48098-3276
Tel. 248-879-5666 Fax: 248-879-0007
www.peterbasso.com
PBA Project No. 2012.0389

Peter Basso Associates Inc
CIVIL ENGINEERS

Hamilton Anderson Associates
architect

PROJECT TITLE
C&IT Building
Chiller Replacement
WSU Project No.: 193228857
5925 Woodward, Detroit MI 48202

WAYNE STATE UNIVERSITY

SHEET TITLE
ARCHITECTURAL DETAILS

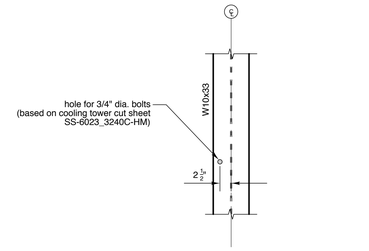
DATE
1-31-13

ISSUE
BIDS

SHEET No.
A1.2

THE FOLLOWING DIMENSION EQUALS ONE INCH WHEN PRINTED TO SCALE.

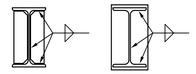
1"



cooling tower attachment location

A / S1.1 — 3/4" = 1'-0"

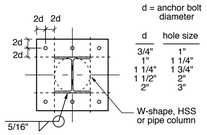
for use at plates welded to W-shapes



minimum fillet weld thickness = 1/2 thickness of plate (5/16" weld thickness maximum)

plates welded to W-shapes
no scale — typical detail **ST-10**

for use at column base plates



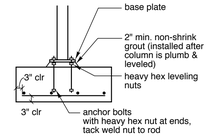
d	hole size
3/4"	1"
1"	1 1/4"
1 1/4"	1 3/4"
1 1/2"	2"
2"	3"

d = anchor bolt diameter

typical anchor bolts to be F1554 threaded rods nutted at both ends.

base plate & anchor bolt conventions
no scale — typical detail **ST-01**

for use at steel column locations



see baseplate schedule for required embedment depth to nut on anchor rod

anchor bolts at steel column locations
no scale — typical detail **FN-01**

MATERIALS

SOIL:	
Soil supporting foundations	3000 psf minimum allowable brg. capacity
CONCRETE:	
Concrete foundations	4000 psi at 28 days
Exterior foundation walls	4000 psi at 28 days, 6%±1% air entr.
Reinforcing bar	ASTM A615 (grade 60)
STEEL:	
Structural steel:	
W-shapes	ASTM A992 - Fy=50 ksi (galvanized)
Channels, Angles, Plates	ASTM A36 - Fy=36 ksi (galvanized)
HSS Square	ASTM A500 Type B - Fy = 46 ksi (galvanized)
Structural steel bolts	ASTM A325-N
Washers	ASTM F436 hardened washer
Nuts	ASTM A563
Welding electrodes (E-70 series)	ASTM A233
Grout below plates	Non-shrink, non-metallic (5000 psi)
Anchor bolts	ASTM F1554 threaded rods
Epoxy bolts:	
Epoxy	Hilti HIT HY 150 MAX Injection Adhesive
Rods	Hilti HAS/HIT Standard - ASTM A36
Cold galvanizing compound	Galvacon GC-243 by Lanco Paints

footing schedule

bottom of all exterior footings must be 42" minimum below grade.

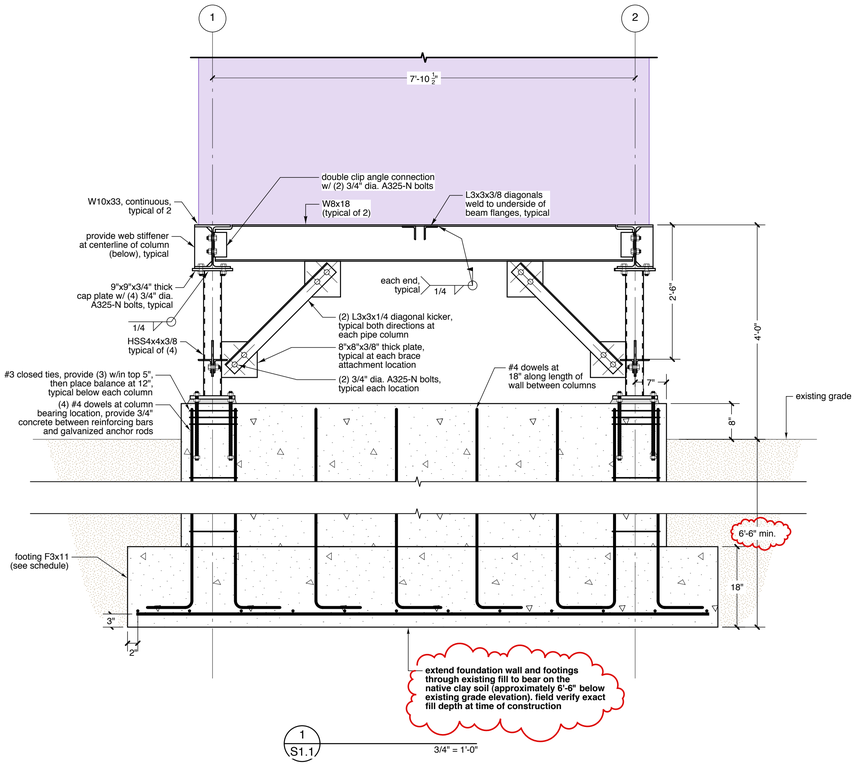
new foundations to bear on native clay soils (approximately 6'-6" below existing grade.)

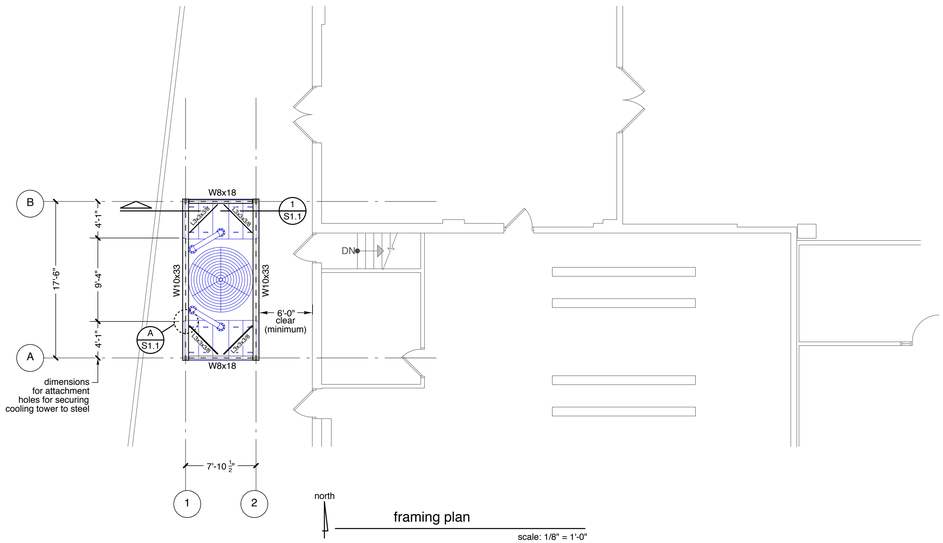
label	dimensions			reinforcement
	width	length	min. thickness	
F-3x11	3'-2"	11'-0"	18"	(4) long #5 bars + (12) short #5 bars, bottom

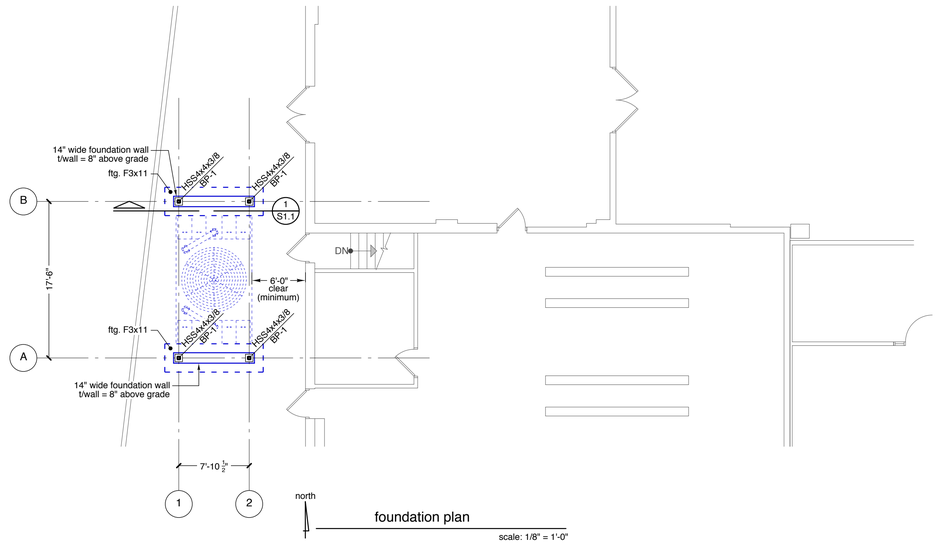
base plate and anchor bolt schedule

for base plate and anchor bolt conventions, see typical details ST-01 and FN-01.

label	plate size & thickness	anchor rods	detail
BP-1	10"x10"x3/4" (galvanized)	(4) 3/4" dia. ASTM F1554 gr. 36 (galvanized) embed 18"	10" x 10", 1 1/2"







REVISION — Addendum 5 — 2/18/2013

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www.PeterBassoAssociates.com
PBA Project No. 2012.0012

WAYNE STATE UNIVERSITY

SHEET TITLE
COOLING TOWER STRUCTURAL FRAMING PLAN, FOUNDATION PLAN AND DETAILS

sdi structures

DATE
01/29/2013

ISSUE
Bids

SHEET No.
S1.1

DWG	DESCRIPTION
	GENERAL
SPEC1	ELECTRICAL INSTALL SPEC.
SPEC2	ELECTRICAL INSTALL SPEC.
SPEC3	ELECTRICAL INSTALL SPEC.
AFTRM	ALN/FLN/BACNET TERMINATION SPEC.
ABAC	ANIXTER BUILDING AUTO. CABLES
TTRM1	TX-I/O TERMINATION SPEC.
TTRM2	TX-I/O TERMINATION SPEC. 2
TWIR	TX-I/O WIRING SPECIFICATION
	CONTROL DRAWINGS
001	DDC COMMUNICATIONS RISER
002	CHILLER CONTROL SYSTEM
003	MECH ROOM VENTILATION
004	REFRIG. & CO MONITORING SYSTEM
005	XPNL LAYOUT

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
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Table of Contents

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900 – ELECTRICAL INSTALLATION AND WIRING FOR HVAC TEMPERATURE AND LAB CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 15, Common Work Results for mechanical requirements apply to this section and will require the contractor participation on the Above Ceiling Coordination Program.

1.2 GENERAL INFORMATION

A. This specification section shall include all electrical responsibilities required for the installation & wiring of all temperature controls, as outlined on job plans, specification and temperature control drawings. Specifically, this contractor shall provide pricing direct to those general or mechanical contractors (bid to prime on project) contractors bidding this work, and will be responsibilities for installation & wiring of all automatic temperature control devices furnished by Siemens Building Technologies as outlined below and as may be required per the project plans & specifications.

B. Siemens Building Technologies, Inc. will provide the following equipment for the building automation system as shown in the temperature control drawings Bill of Materials to include but not limited to:

1. Terminal Equipment Controllers (TEC's)
2. Auxilliary TEC power panels
3. Room Temperature Sensors
4. Damper actuators
5. Relays
6. Low Voltage Transformers

The Electrical Installation & Wiring Contractor (EIWC) shall be responsible for installation of all preceding devices as applicable to this project. This list shall not be considered complete and all bidders should refer to temperature control drawings for specific equipment quantities and locations.

C. During the bidding process, the EIWC shall address all questions relative to the Siemens temperature control drawings in writing (RFI) through the tier of bidding contractors. Siemens shall respond in writing through the tier of bidding contractors.

D. EIWC shall install all control equipment provided by Siemens. The EIWC shall furnish, install, and terminate all necessary wiring, conduit, hangers, etc. to provide a complete control system installation. All controls to be installed and adjusted by a Siemens qualified electrician in the full time employ of the EIWC.

E. The EIWC must have full time project superintendent who shall attend all construction meetings after notification that their services are required onsite.

F. Upon completion of all installation and wiring by the EIWC, Siemens Building Technologies will conduct verification of point to point wiring and any pneumatic tubing. The EIWC will be responsible to make any necessary wiring corrections. At the completion of the point to point verification, approval shall be made by the Owner's Construction Inspection Department and Siemens Building Technologies, Inc.

G. Upon approval by the Owners Construction Inspection Department, Siemens shall program all DDC panels, create necessary graphics and provide any interface between the building automation system and the campus environmental control system.

H. Upon completion of the aforementioned, a performance test shall be conducted as specified in the commissioning section of the specifications.

I. Upon a successful conclusion of the final checkout, performance test and the Owner's acceptance, the EIWC's responsibility reverts to a standard warranty (12 months) for labor and material installed by the EIWC and labor only for equipment supplied by others.

J. Siemens assumes the manufacturers warranty for all equipment supplied to the EIWC for installation on this project.

K. Siemens services to include the following: Design engineering labor required to interface with WSU and the consulting engineer to design the temperature control system. Supervision of the EIWC installation and final checkout and approval.

L. Equipment provided by others may require specific cable type and terminations. It is up to EWIC to provide cable and terminations needed for a complete working system.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. BACnet: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

REVISION HISTORY	SIEMENS	WSU C&IT Chiller Replacement Detroit, MI	440P-XXXXXX 0
	Siemens Industry, Inc. Building Technologies Division 45470 Commerce Ctr. Dr. Plymouth Twp., MI 48170 USA PHONE: 734.456.3800 FAX: 866.815.0749	ENGINEER: SFM | DRAFTER: SFM | CHECKED BY: | INITIAL RELEASE: 02/18/13 | LAST EDIT DATE: 02/18/13 ELECTRICAL INSTALL SPEC.	SPEC1

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1.4 PRODUCTS & SERVICES PROVIDED BY OTHERS

A. Mechanical Contractor: Installation of flow switches, temperature or thermometer sensor wells, gage taps, pressure sensor pipe taps, final valves & tubing into pipe pressure taps and variable frequency drives.

B. Electrical Contractor: Provide 120/60 VAC power to all DDC panels, wire power to all VFD's. Furnish & install 4" x 4" trough above all control panels. Furnish & install conduit up maximum ten feet from all 4" x 4" troughs. Installation all required nipples between electrical panels and through.

C. Sheetmetal Contractor: Installing all terminal units, airflow stations and dampers.

1.5 PRODUCTS INSTALLED BY THE EIWC BUT NOT FURNISHED UNDER THIS SECTION

A. Connect control components, as shown on the plans, factory supplied as part of equipment controlled.

1.6 RELATED SECTIONS

A. Division 15 – General Mechanical Requirements.
B. Division 15 – Instrumentation and controls for HVAC.
C. Division 15 – Indoor Air Handling Units.
D. Division 15 – Air Terminal Units.
E. Division 15 – Testing and Balancing for HVAC.
F. Division 15 – Commissioning of HVAC.
G. Division 16 – Electrical Work.
H. Standard Specifications and Codes: In addition to the requirements shown or specified, comply with the following applicable standard specifications, codes or ordinances:

1. NFPA – National Fire Protection Association.
2. UL – Underwriter's Laboratories.
3. Rules and Regulations of the Michigan Department of Fire Prevention and Safety.

G. Include all items of labor and material required to comply with such standards, codes or ordinances in accordance with the contract documents. Where quantities, sizes, or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specification and drawings shall govern.

1.7 QUALIFICATIONS FOR THE EIWC

A. Controls Installation Contractor: The EIWC's will be pre approved by WSU prior to bidding this project.

Wayne State University
WSU C&IT

1.8 QUALITY ASSURANCE

A. Installer Qualifications: EIWC contractor must be able to provide references, upon request, for similar projects (in size & scope) that were completed satisfactorily, in Michigan. Project names, owner contacts and companies who awarded this work to you shall all be provided upon request to WSU and/or the AE of record. EIWC contactor must be prepared to submit a minimum of three (3) satisfactorily completed projects, annually, for the past five (5) years.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.9 SEQUENCING AND SCHEDULING

A. Sequence work to ensure installation of components is complimentary to installation of similar components in other systems.

B. Coordinate work with other Contractors and subcontractors to ensure system is completed and commissioned by the Date of Substantial Completion.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

1.10 WARRANTY

A. Provide as pre project general conditions.

1.11 CONTROL WIRING

A. The EIWC is required to use the cable below.
Refer to temperature control drawing ABAC Building Automation Cable Specification Catalog.
If a wire type is required that is not referenced on the ABAC sheet then it is up to the EWIC to provide the appropriate wire for the application.

B. The EIWC is required to tag all wiring. Wiring that is used for DDC control points should be tagged with abbreviated DDC point name from control submittal.
If wire is to be demo'd make sure the wire is labeled "spare" or "not in use".

1.12 INSTALLATION

A. Refer to project plans and DDC temperature control drawings for control wiring required and equipment locations.

B. Install control devices per installation requirements of control device. Before installing, always refer to local codes.

ELECTRICAL INSTALLATION AND WIRING FOR HVAC TEMPERATURE AND LAB CONTROLS

REVISION HISTORY

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Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
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ELECTRICAL INSTALL SPEC.

440P-XXXXXX
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SPEC2

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1.1 ELECTRICAL WIRING INSTALLATION BY THE EIWC (Project Plans and Specifications Prevail)

A. Furnish and install ALL wiring and interlock wiring as specified and as shown on the project plans DDC temperature control drawings. Connect controls in accordance with DDC temperature control drawings.

B. Installation minimum requirements:
1. Mechanical Rooms & Penthouses Areas: EMT up ten feet, then exposed plenum I/O point wiring

2. TEC Space Sensors: All cables furnished by Siemens, installed within wall construction without EMT.

3. Other Space Sensors: I/O point wire in EMT for all non-accessible walls, approved plenum open wire in accessible walls.

4. Ceiling Returns (accessible, permanent, acoustical): Approved plenum rated cable.

5. Ceiling Returns (non-accessible) and all other inaccessible areas: All wiring in EMT.

6. Power and low voltage wiring shall not be run in the same conduit.

2.0 ON-SITE TESTING

A. Provide Owner-approved operation and acceptance testing of the complete system. The following shall witness the performance test:

1. The EIWC – Electrical (controls) installation & wiring contractor
2. The equipment manufacturers representative
3. The Owner's agent
4. The Owner
5. Architect/Engineer

B. Field Test: When installation of the system is complete, all systems shall be tested to their sequence of operation including all safety circuits.

END OF SECTION 26 0900

ELECTRICAL INSTALLATION AND WIRING FOR HVAC TEMPERATURE AND LAB CONTROLS

REVISION HISTORY

SIEMENS

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Detroit, MI

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ELECTRICAL INSTALL SPEC.

440P-XXXXXX
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SPEC3

ETHERNET CABLE

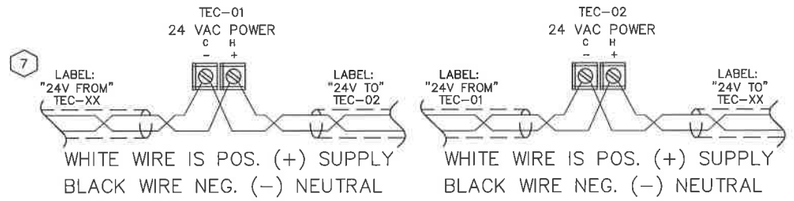
ETHERNET CABLE TERMINATED WITH RJ-45 PLUG

CONTROLLER ETHERNET CONNECTOR

RJ-45 JACK FOR ETHERNET CABLE

TELECOMMUNICATIONS CONTRACTOR TO PROVIDE 10/100 ETHERNET CABLE PULLED INTO CONTROLLER ENCLOSURE. TERMINATE WITH RJ-45 END CONNECTION.

POWER WIRING SHALL BE DAISY CHAINED.



INSTALLATION NOTES:

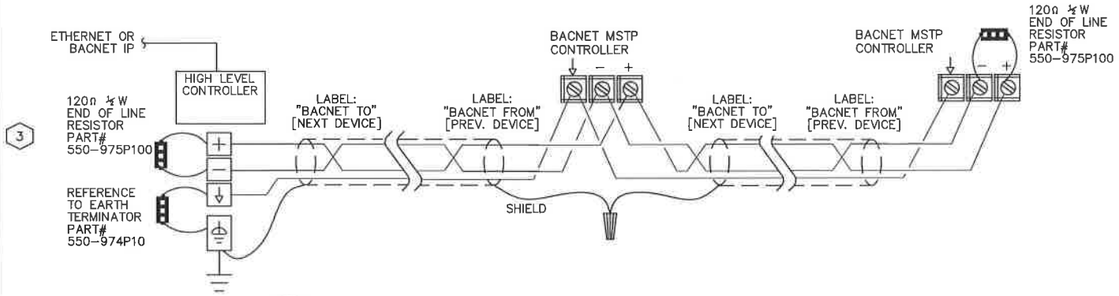
1. ONLY USE WIRE FOR ALN/FLN AS SPECIFIED ON ABAC DRAWING ANIXTER BUILDING AUTOMATION CABLES.
2. CONTROLLERS MUST BE DAISEY-CHAINED WHEN RUNNING 19.2 k BAUD OR FASTER.
3. REFER TO CONTROLLERS WIRING SPECIFICATION DRAWINGS FOR SPECIFIC WIRING DETAILS.
4. SHIELD WIRES TO FLN TRUNK. MUST BE TERMINATED AT BOTH ENDS.
5. FLN WIRING SHALL BE DAISY CHAINED ONLY.
6. 32 TECS ON ONE FLN TRUNK ADDRESSED 0-31
7. POWER TRUNK W/GROUND MUST BE USED WHEN TECS REQUIRE EARTH GROUND.

1 AFTRM CONTROLLER ETHERNET ALN

NOTE: 10/100BaseT ETHERNET PROVIDED BY TELECOMMUNICATIONS CONTRACTOR
NOTE: LABEL ALN TRUNK PER GENERAL COND.

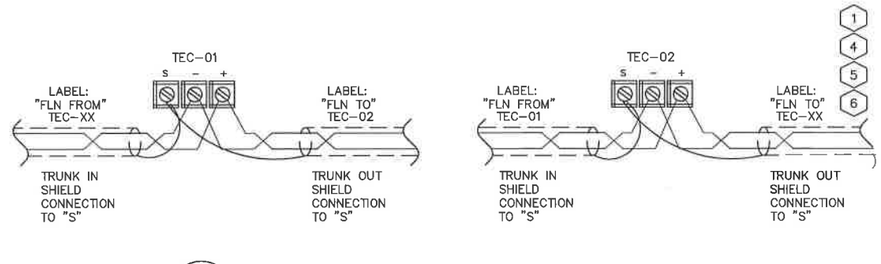
2 AFTRM TEC POWER TRUNK TERMINATION

NOTE: DO NOT GROUND TEC PWR TRUNK WIRING
NOTE: LABEL TEC PWR TRUNK PER GENERAL COND.



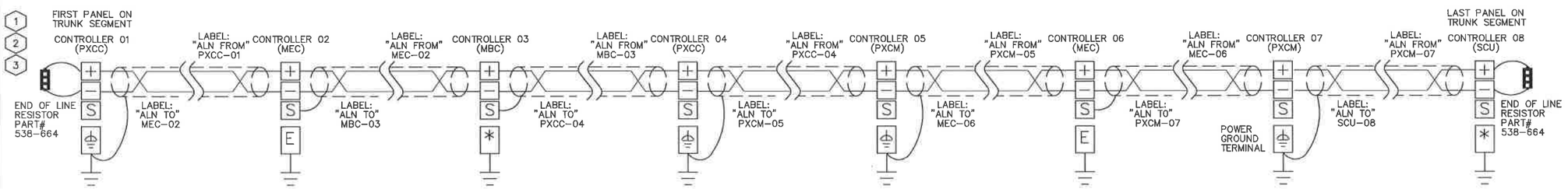
3 AFTRM BACNET MSTP TERMINATION, 3-WIRE INTERFACE

NOTE: NO SPLICES IN BACNET MSTP TRUNK
LABEL BACNET MSTP TRUNK PER GENERAL COND.
SET MSTP DEVICES EXCEPT HIGH LEVEL CONTROLLER TO SLAVE MODE



4 AFTRM TEC FLN TERMINATION

NOTE: NO SPLICES OF FLN TRUNK
NOTE: LABEL TEC FLN TRUNK PER GENERAL COND.



* MBC, SCU, & FLNC ARE INTERNALLY GROUNDED TO ENCLOSURE.

NOTES:
1. THE "S" PIN OF THE PXC-C AND PXC-M MUST BE LEFT OPEN.
2. THE "E" PIN OF THE MEC AND THE ⏚ PIN OF THE PXC-C AND PXC-M MUST BE TIED TO EARTH GROUND.
3. THE "S" PIN OF THE MEC, MBC, SCU & FLNC IS EARTH GROUNDED SO THE SHIELD CONDUCTOR CAN BE CONNECTED THERE.

5 AFTRM CONTROLLER ALN TERMINATION

NOTE: NO SPLICES IN ALN TRUNK
NOTE: LABEL ALN TRUNK PER GENERAL COND.

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WSU C&IT Chiller Replacement
Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
SFM	SFM		02/18/13	02/18/13

ALN/FLN/BACNET TERMINATION SPEC.

440P-XXXXXX
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AFTRM

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Anixter Building Automation Cables

Non-Plenum

SBT Part Number	Description	Print Legend
H-TP20-CM	20AWG,STR,1TP,CM,BLUE JACKET	NORTHFLEX ® H-TP20-CM "DI, DO, AI, AO" (Mfg E#) 20AWG 1P 75°C CM (UL) C(UL)
H-3C20-CM	20AWG,STR,3COND,CM,BLUE JACKET	NORTHFLEX ® H-3C20-CM "TEC V/D" (Mfg E#) 20 AWG 3C 75°C CM (UL) C(UL)
H-TP18-CMR	18AWG,STR,1TP,CMR,BLUE JACKET	NORTHFLEX ® H-TP18-CMR "DI, DO, AI, AO" (Mfg E#) 18AWG 1P 75°C CMR (UL) C(UL)
H-3C18-CMR	18AWG,STR,3COND,CMR,BLUE JACKET	NORTHFLEX ® H-3C18-CMR "TEC V/D" (Mfg E#) 18 AWG 3C 75°C CMR (UL) C(UL)
H-2C14-CL3R	14AWG,STR,2COND,CL3R,DARK BLUE JACKET	H-2C14-CL3R "LV POWER" (Mfg E#) 14 AWG 2C 75°C CL3R (UL) C(UL)
H-B-TSP24LC-CM	BLN24AWG,STR,TSP,LOCAP,CM,ORANGE JACKET	H-B-TSP24LC-CM "BLN" (Mfg E#) 24 AWG 1P 75°C CM (UL) C(UL)
H-F-TSP24LC-CM	FLN24AWG,STR,TSP,LOCAP,CM,ORANGE JACKET W/ BLUE STRIPE	NORTHFLEX ® H-F-TSP24LC-CM "FLN" (Mfg E#) 24 AWG 1P 75°C CM (UL) C(UL)
H-3P24-CMR	24AWG,SOL,3P,CMR,BLUE JACKET	NORTHFLEX ® H-3P24-CMR "TEC STAT" (Mfg E#) 24 AWG 3P 75°C CMR (UL) C(UL)
LON-1P22-CM	22AWG,STR,1PAIR,CM,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-1P22-CM "LON FLN" (Mfg E#) 22AWG 1P 75O C CM (UL) C(UL)
LON-2P22-CM	22AWG,STR,2PAIR,CM,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-2P22-CM "LON FLN" (Mfg E#) 22AWG 2P 75O C CM (UL) C(UL)
LON-1PS22-CM	22AWG,STR,1PAIR,OAS,CM,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-1PS22-CM "LON FLN" (Mfg E#) 22AWG 1P 75O C CM (UL) C(UL)
LON-2PS22-CM	22AWG,STR,2PAIR,OAS,CM,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-2PS22-CM "LON FLN" (Mfg E#) 22AWG 2P 75O C CM (UL) C(UL)
E-4TP24CAT5-CM	24AWG,SOL,4TP,CAT5,CM	NORTHFLEX ® E-4TP24CAT5-CM "ETHERNET" (Mfg E#) 24AWG 4P 75O C CM (UL C(UL)
H-A-1.5TSP24LC-CM	ALN485, 24AWG, STR, TP+1C, OAS, LOCAP, CM	NORTHFLEX ® H-A-1.5TSP24LC-CM "ALN485" 24 AWG 1P+1C 75°C CM (UL) C(UL) (Mfg E#)
H-F-1.5TSP24LC-CM	FLN485, 24AWG, STR, TP+1C, OAS, LOCAP, CM	NORTHFLEX ® H-A-1.5TSP24LC-CM "FLN485" 24 AWG 1P+1C 75°C CM (UL) C(UL) (Mfg E#)

Plenum

SBT Part Number	Description	Print Legend
H-TP20-CMP	20AWG,STR,1TP,CMP,BLUE JACKET	NORTHFLEX ® H-TP20-CMP "DI, DO, AI, AO" (Mfg E#) 20 AWG 2C 75°C CMP (UL) C(UL)
H-3C20-CMP	20AWG,STR,3COND,CMP,BLUE JACKET	NORTHFLEX ® H-3C20-CMP "TEC V/D" (Mfg E#) 20 AWG 3C 75°C CMP (UL) C(UL)
H-TP18-CMP	18AWG,STR,1TP,CMP,BLUE JACKET	NORTHFLEX ® H-TP18-CMP "DI, DO, AI, AO" (Mfg E#) 18 AWG 2C 75°C CMP (UL) C(UL)
H-3C18-CMP	18AWG,STR,3COND,CMP,BLUE JACKET	NORTHFLEX ® H-3C18-CMP "TEC V/D" (Mfg E#) 18 AWG 3C 75°C CMP (UL) C(UL)
H-2C14-CL3P	14AWG,STR,2COND,CL3P,DARK BLUE JACKET	NORTHFLEX ® H-2C14-CL3P "LV POWER" (Mfg E#) 14 AWG 2C 75°C CL3P (UL) C(UL)
H-B-TSP24LC-CMP	BLN24AWG,STR,TSP,LOCAP,CMP,ORANGE JACKET	NORTHFLEX ® H-B-TSP24LC-CMP "BLN" (Mfg E#) 24 AWG TSP 75°C CMP (UL) C(UL)
H-F-TSP24LC-CMP	FLN24AWG,STR,TSP,LOCAP,CMP,ORANGE JACKET W/ BLUE STRIPE	NORTHFLEX ® H-F-TSP24LC-CMP "FLN" (Mfg E#) 24 AWG TSP 75°C CMP (UL) C(UL)
H-3P24-CMP	24AWG,SOL,3PAIR,CMP,BLUE JACKET	NORTHFLEX ® H-3P24-CMP "TEC STAT" (Mfg E#) 24 AWG 3P 75°C CMP (UL) C(UL)
LON-1P22-CMP	22AWG,STR,1PAIR,CMP,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-1P22-CMP "LON FLN" (Mfg E#) 22AWG 1P 75O C CMP (UL) C(UL)
LON-2P22-CMP	22AWG,STR,2PAIR,CMP,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-2P22-CMP "LON FLN" (Mfg E#) 22AWG 2P 75O C CMP (UL) C(UL)
LON-1PS22-CMP	22AWG,STR,1PAIR,OAS,CMP,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-1PS22-CMP "LON FLN" (Mfg E#) 22AWG 1P 75O C CMP (UL) C(UL)
LON-2PS22-CMP	22AWG,STR,2PAIR,OAS,CMP,ORANGE JACKET W/ WHITE STRIPE	NORTHFLEX ® LON-2PS22-CMP "LON FLN" (Mfg E#) 22AWG 2P 75O C CMP (UL) C(UL)
E-4TP24CAT5-CMP	24AWG,SOL,4TP,CAT5,CMP	NORTHFLEX ® E-4TP24CAT5-CMP "ETHERNET" (Mfg E#) 24AWG 4P 75O C CMP (UL
H-A-1.5TSP24LC-CMP	ALN485, 24AWG, STR, TP+1C, OAS, LOCAP, CMP	NORTHFLEX ® H-A-1.5TSP24LC-CM "ALN485" 24 AWG 1P+1C 75°C CM (UL) C(UL) (Mfg E#)
H-F-1.5TSP24LC-CMP	FLN485, 24AWG, STR, TP+1C, OAS, LOCAP, CMP	NORTHFLEX ® H-A-1.5TSP24LC-CM "FLN485" 24 AWG 1P+1C 75°C CM (UL) C(UL) (Mfg E#)

Assemblies

SBT Part Number	Description	Print Legend
550-827	CABLE ASSEMBLY TEC TO SSB 3 POS 10 FT	N\A
550-828	CABLE ASSEMBLY TEC TO SSC 3 POS 10 FT	N\A

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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ANIXTER BUILDING AUTO. CABLES

440P-XXXXXX
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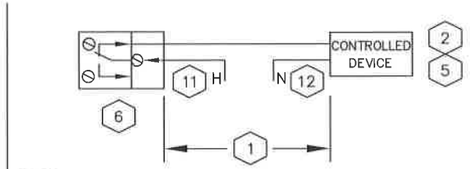
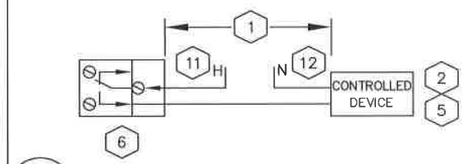
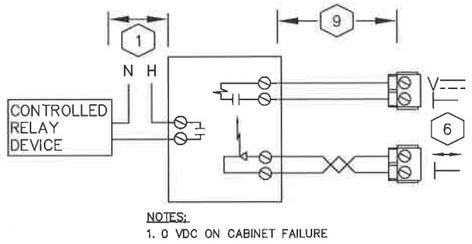
ABAC



A 00 — DIGITAL OUTPUT (6R) NC
PULSED OR LATCHED

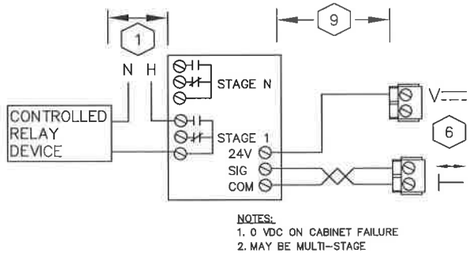


B 00 — DIGITAL OUTPUT (6R) NO
PULSED OR LATCHED



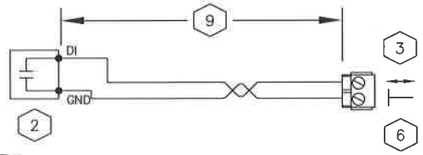
NOTES:
1. 0 VDC ON CABINET FAILURE

C 00 — DIGITAL OUTPUT (8U,8X) Latched
VOLTAGE TO SOLID STATE RELAY

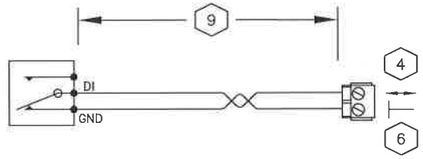


NOTES:
1. 0 VDC ON CABINET FAILURE
2. MAY BE MULTI-STAGE

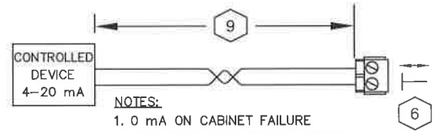
D 00 — DIGITAL OUTPUT (8U,8X) Sequenced
VOLTAGE TO SEQUENCING MODULE



E 00 — DIGITAL INPUT (8D,16D,8U,8x)
DRY CONTACT

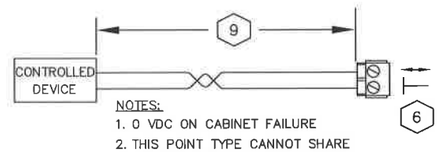


F 00 — DIGITAL INPUT (8D,16D,8U,8X)
PULSE ACCUMULATOR



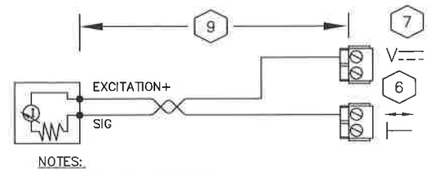
NOTES:
1. 0 mA ON CABINET FAILURE
2. THIS POINT TYPE CANNOT SHARE A MODULE WITH A SELF-POWERED TYPE INPUT POINT.

H 00 — ANALOG OUTPUT (8X) 4–20 mA



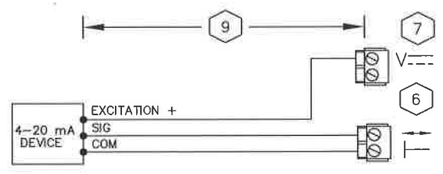
NOTES:
1. 0 VDC ON CABINET FAILURE
2. THIS POINT TYPE CANNOT SHARE A MODULE WITH A SELF-POWERED TYPE INPUT POINT.

I 00 — ANALOG OUTPUT (8U,8X) 0–10VDC

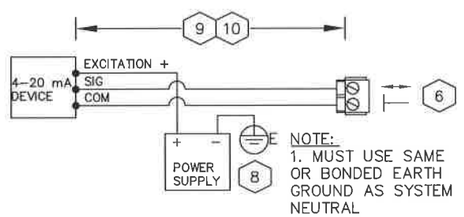


NOTES:
1. COMMON NOT CONNECTED

M 00 — ANALOG INPUT (8X) 4–20 mA
2–WIRE INTERNAL POWERED



N 00 — ANALOG INPUT (8X) 4–20mA
3–WIRE INTERNAL POWERED



NOTE:
1. MUST USE SAME OR BONDED EARTH GROUND AS SYSTEM NEUTRAL

O 00 — ANALOG INPUT (8X) 4–20mA
3–WIRE EXTERNAL POWERED

NOTES:

1. MAXIMUM WIRE RUN LENGTHS ARE BASED ON THE CURRENT DRAW AND WIRE GAGE. SEE DRAWING TWIR.
2. SEE CONTROL DRAWINGS FOR NORMAL DE–ENERGIZED CONTACT STATE
3. MAXIMUM CONTACT CLOSURE RATE IS 10 PER SECOND
   8D, 16d EXCITATION = 24VDC, 8mA
   8U, 8X EXCITATION = 24VDC, 8mA, 20ms, 100mA
4. 8D, 16D MAXIMUM PULSE RATE = 10Hz (50ms PER STATE, 100ms PER PULSE)
   8U, 8X MAXIMUM PULSE RATE = 20Hz (25ms PER STATE, 50ms PER PULSE)
5. PXC MODULAR DO CONTACT RATINGS
   AC OPERATION:
   4A @ 240VAC (RESISTIVE)
   3A @ 240VAC (INDUCTIVE)
   SIZE 4 MOTOR STARTER
   DC OPERATION:
   40W @ < 50VDC
   20W @ > 50VDC
6. REFER TO PXC MODULAR PANEL FOR ACTUAL POINT ADDRESSES. REFER TO TXMI TERMINATION TABLES FOR ACTUAL TERMINALS FOR EACH PANEL ADDRESS. COMMON TERMINAL MAY BE SHARED BY 2 POINTS.
7. REFER TO DRAWING P1 ON TWIR FOR MAXIMUM CURRENT PROVIDED BY THE 24VDC SENSOR SUPPLY ON P1 BIM OR BUS POWER SUPPLY
8. EXTERNAL POWER SUPPLY CAN EITHER BE A 24VDC POWER SUPPLY OR A 24VAC TRANSFORMER DEPENDING ON THE SENSOR SELECTED. IF NOT AN ISOLATED NC CLASS 2 CIRCUIT THEN POWER SOURCE, NEUTRAL AND PXC MODULAR COMMON MUST BE BOTH CONNECTED TO THE SAME OR BONDED BUILDING APPROVED EARTH GROUND. FOR FURTHER DETAILS SEE EARTH GROUNDING RULES (125–3002) APOGEE WIRING GUIDELINES FOR FIELD PANELS AND EQUIPMENT CONTROLLERS.
9. 50mA OR LESS – 750ft/230m
   50mA TO 100mA – 375ft/115m
10. 100mA TO 150mA – 250ft/76m
    150mA TO 200mA – 187ft/57m
    200mA TO 250mA – 150ft/46m
11. WHERE H TERMINAL IS NOT A NEC CLASS 2 CIRCUIT, RELAY COMMON TERMINAL BRANCH CURRENT MUST BE EXTERNALLY LIMITED TO 10A MAXIMUM BY AN NEC APPROVED MEANS. NOT A FUSE.
12. WHERE REQUIRED, N TERMINAL BRANCH CURRENT MUST BE EXTERNALLY LIMITED BY AN NEC APPROVED MEANS.

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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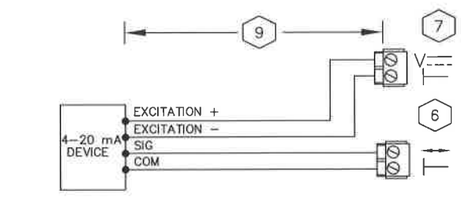
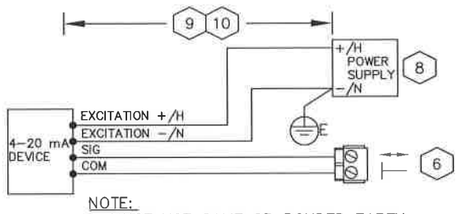
TX-I/O TERMINATION SPEC.

440P-XXXXXX
0
TTRM1

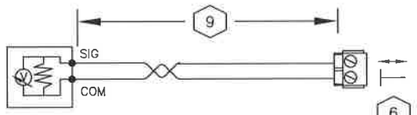


P 00 — ANALOG INPUT (8X) 4–20mA
4–WIRE INTERNAL POWERED



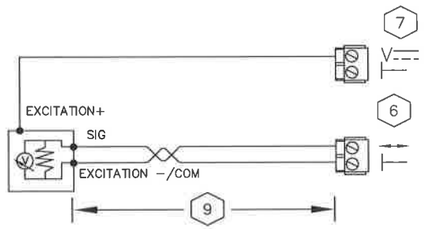
NOTE:
1. MUST USE SAME OR BONDED EARTH GROUND AS SYSTEM NEUTRAL

Q 00 — ANALOG INPUT (8X) 4–20mA
4–WIRE EXTERNAL POWERED

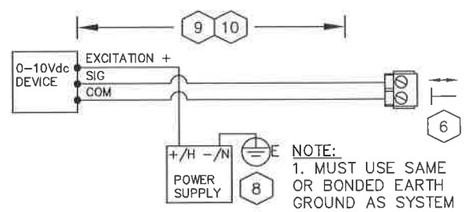


NOTES:
1. TRANSDUCER POWERED FROM ISOLATED INPUT
2. TRANSDUCER OUTPUT VOLTAGE

R 00 — ANALOG INPUT (8U,8X) 0–10 Vdc
SELF POWERED TRANSDUCER

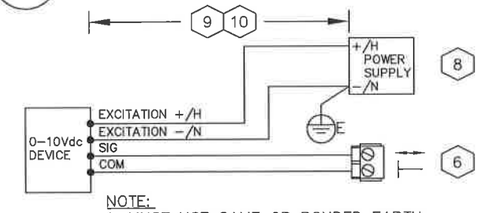


S 00 — ANALOG INPUT (8U,8X) 0–10VDC
3–WIRE INTERNAL POWERED



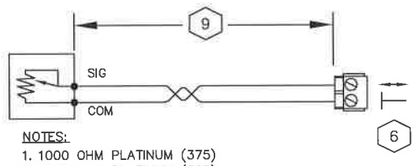
NOTE:
1. MUST USE SAME OR BONDED EARTH GROUND AS SYSTEM NEUTRAL

T 00 — ANALOG INPUT (8U,8X) 0–10VDC
3–WIRE EXTERNAL POWERED



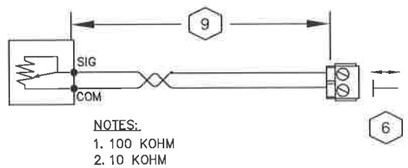
NOTE:
1. MUST USE SAME OR BONDED EARTH GROUND AS SYSTEM NEUTRAL

U 00 — ANALOG INPUT (8U,8X) 0–10VDC
4–WIRE EXTERNAL POWERED



NOTES:
1. 1000 OHM PLATINUM (375)
2. 1000 OHM PLATINUM (385)
3. 1000 OHM NICKEL
4. CUSTOM

V 00 — ANALOG INPUT (8X,8U) RTD



NOTES:
1. 100 KOHM
2. 10 KOHM
3. CUSTOM

W 00 — ANALOG INPUT (8X,8U) THERMISTOR

TXM1 TERMINATION TABLES

1. ALL TXM1 TERMINALS (MEASURING, NEUTRAL, RELAY, SUPPLY) ARE CONNECTED IN THE PLUG–IN I/O MODULE, NOT IN THE TERMINAL BUS.

	TXM1.8D, TXM1.16D							
I/O POINT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SYSTEM NEUTRAL[1] ⊥ (–)	1	3	5	7	9	11	13	15
DIGITAL INPUT	(+)	2	4	6	8	10	12	14	16

1. NEUTRAL CAN BE CONNECTED TO ANY NEUTRAL TERMINAL ON SAME MODULE AND SEVERAL CAN SHARE SAME NEUTRAL TERMINAL.

	TXM1.16D							
I/O POINT	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SYSTEM NEUTRAL ⊥ (–)	18	20	22	24	26	28	30	32
DIGITAL INPUT[1] (+)	19	21	23	25	27	29	31	33

1. NO PULSE ACCUMULATOR

	TXM1.8U, TXM1.8U–ML							
I/O POINT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SYSTEM NEUTRAL ⊥ (–)	2	6	10	14	19	23	27	31
UNIVERSAL I/O (+)	4	8	12	16	21	25	29	33
24V AC/DC ACTUATOR SUPPLY[1] ~		7		15		24		32

1. 24V DC ONLY AVAILABLE WITH BUS CONNECTOR MODULE (BCM) POWERED EXTERNALLY BY DC SUPPLY.

	TXM1.8X, TXM1.8X–ML							
I/O POINT	(1)	(2)	(3)	(4)	(5)[1]	(6)[1]	(7)[1]	(8)[1]
SYSTEM NEUTRAL ⊥ (–)	2	6	10	14	19	23	27	31
UNIVERSAL I/O (+)	4	8	12	16	21	25	29	33
24V AC/DC ACTUATOR SUPPLY[2] ~		7		15		24		32
24V DC SENSOR SUPPLY[3] ⎓	3		11		20		28	

1. 4–20 mA OUTPUT AVAILABLE ON POINTS 5–8 ONLY.

2. 24V DC ONLY AVAILABLE WITH BUS CONNECTOR MODULE (BCM) POWERED EXTERNALLY BY DC SUPPLY.

3. MAY POWER EXTERNAL SENSORS 0.6w (25mA) OR 1.2w (50mA) PER TERMINATION UP TO 2.4w (100mA) MAXIMUM FOR ALL TERMINATIONS.

	TXM1.6R, TXM1.6R–M					
I/O POINT	(1)	(2)	(3)	(4)	(5)	(6)
COMMON[1] (C)	3	9	15	20	26	32
NORMALLY CLOSED (NC)	4	10	16	19	25	31
NORMALLY OPEN (NO)	2	8	14	21	27	33

1. COMMONS ARE NOT INTERNALLY CONNECTED.

NOTE: REFER TO TERMINATION SHEET #1 FOR INSTALLATION DETAILS.

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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TX-I/O TERMINATION SPEC. 2

440P-XXXXXX
0
TTRM2

PXC MODULAR WIRING TYPE AND GAUGE REQUIREMENTS

TABLE 1

CIRCUIT TYPE	CLASS	WIRE TYPE	MAX. DISTANCE	CONDUIT SHARING [2]
AC LINE POWER [1]	POWER	#12–14 THHN	REFER TO NEC	CHECK LOCAL CODES
DIGITAL OUTPUT	1 & 2	TP not required, check job specs & local codes #18 to #24 AWG	SEE TABLE 3	CHECK LOCAL CODES
DIGITAL INPUT	2	TP not required, check job specs & local codes #18 to #24 AWG	750ft (230 m)	CHECK LOCAL CODES
ANALOG INPUT [4] 100K/10K Thermistor	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ANALOG INPUT [4] 1K Ni OR RTD	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ANALOG INPUT 0–10 V	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ANALOG INPUT 4–20 mA	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ANALOG OUTPUT 0–10 V	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ANALOG OUTPUT 4–20 mA	2	#18–#24 TP[3,6] or TSP[5] CM(FT4) or CMP(FT6)	750ft (230 m)	CHECK LOCAL CODES
ETHERNET ALN	2	#24 (4) TP[6] CAT5 OR BETTER	295ft (90 m)	CHECK LOCAL CODES
ALN TRUNK	2	#24 TSP	SEE TABLE 4	CHECK LOCAL CODES

1. WHEN DAISY–CHAINING 24VAC POWER TO CONTROLLERS USE #14 WIRE.

2. CONDUIT SHARTING RULES: ONLY WHERE LOCAL CODES PERMIT. BOTH CLASS1 AND CLASS 2 WIRING CAN BE RUN TO THE PXCC PROVIDED THE CLASS 2 WIRE IS UL LISTED 300V 75°C(167°F) OR HIGHER OR THE CLASS 2 WIRE IS NEC TYPE CM (FT4) (75°C OR HIGHER) OR CMP(FT6) (75°C OR HIGHER). NEC TYPE CL2 AND CL2P IS NOT ACCEPTABLE UNLESS ALSO UL LISTED AND MARKED 300V 75°C (167°F) OR HIGHER

3. TWISTED PAIR, NON–JACKETED UL LISTED 75°C(167°F) AND 300V, CABLE CAN BE USED IN PLACE OF CM(FT4) OR CMP(FT6)(BOTH MUST BE RATED 75°C OR HIGHER) CABLE WHEN CONTAINED IN CONDUIT PER LOCAL CODES. SEE THE FIELD PURCHASING GUIDE FOR WIRE.

4. WIRE LENGTH AFFECTS POINT INTERCEPT ENTRY. ADJUST INTERCEPT ACCORDINGLY FOR EACH WIRE GAUGE AND SENSOR TYPE.

5. SHIELDED TWISETED PAIR (TSP) IS NOT REQUIRED FOR ELECTRICAL NOISE LEVELS UPTO 10 V/M. AT HIGHER LEVELS TSP MAY BE NEEDED.TERMINATE SHIELD ON ENCLOSURE AND TAPE BACK ON POINT END.

6. FOR 24AWG INSTALL CATEGORY5 OR BETTER CABLE PER ANSI/TIA/EIA–568–B.1 OR HIGHER. USE SOLID COPPER BETWEEN JACK BOXES. USE STRANDED COPPER PATCH CABLES 13ft (4m) TO CONNECT PXCC AND 20ft (6m) TO CONNECT SWITCH OR HUB.

PXCM WIRE SPECIFICATIONS

TABLE 2

	LOW–VOLTAGE POINT APPLICATIONS	POINT USAGE	ALN TRUNK	EALN
CABLE CONFIGURATION	TWISTED PAIR OR TSP	TWISTED PAIR (UNJACKETED) OR TSP	TWISTED SHIELDED PAIR	(4) TWISTED PAIR
GAUGE	#18 TO #22 AWG (STRANDED)	#18 TO #22 AWG (STRANDED)	24 AWG (STRANDED)	24AWG(STRANDED)
CAPACITANCE	n.a.	n.a.	12.5 pf/ft OR LESS	13 pf/ft OR LESS
TWISTS PER FOOT	6 MINIMUM	6 MINIMUM	6 MINIMUM	CATEGORY 5 Min
SHIELDS	NOT REQUIRED (IN CASE OF TSP, 100% FOIL W/ DRAIN WIRE)	NOT REQUIRED (IN CASE OF TSP, 100% FOIL W/ DRAIN WIRE)	100% FOIL W/ DRAIN WIRE	NOT REQUIRED
NEC CLASS	CM, CMP (75°C OR HIGHER)	NOT SPECIFIED	CM, CMP (75°C OR HIGHER)	MM, MMP
CEC CLASS	FT4, FT6 (75°C OR HIGHER)	NOT SPECIFIED	FT4, FT6 (75°C OR HIGHER)	NOT SPECIFIED
UL VOLTAGE RATING	NOT SPECIFIED	300 VAC [2]	NOT SPECIFIED	NOT SPECIFIED
UL TEMP. RATING	NOT SPECIFIED	75°C (167°F)	NOT SPECIFIED	NOT SPECIFIED

1. UL RECOGNIZED WIRE (LABELED WITH A BACKWARDS 'RU') IS NOT FIELD INSTALLABLE. USE ONLY UL–LISTED WIRE.
2. 300 VAC WIRE CAN BE USED IN FIELD PANELS CONTAINING VOLTAGES BELOW 150 VAC.

MAXIMUM DO WIRE RUN LENGHTS

TABLE 3

NOMINAL INRUSH	STARTER SIZE	WIRE SIZE		
		#18	#16	#14
200 VA	0 1	500ft (152m)	900ft (274m)	1400ft (427m)
550 VA	2	200ft (61m)	300ft (91m)	500ft (152m)
1150 VA	3	100ft (30m)	150ft (46m)	250ft (76m)
1500 VA	4	70ft (21m)	100ft (30m)	200ft (61m)

TABLE 3 NOTES:

1. DISTANCES SHOWN ASSURE LESS THAN 10% VOLTAGE DROP ACROSS THE WIRE FOR A TYPICAL STARTER.
2. PXCM DO CONTACT RATINGS
   4A @ 250VAC & 30VDC
   SIZE 4 MOTOR STARTER

MAXIMUM NUMBER HSTIE IN SERIES ON ALN TRUNK

TABLE 4

SPEED	1200 BAUD	4800 BAUD	9600 – 38.4K BAUD	57.6K – 115.2K BAUD
SERIES TIE'S	10	7	6	6
ALN TRUNK DISTANCE	4000ft (1.2km)	4000ft (1.2km)	4000ft (1.2km)	3280ft (1km)

- TIE MUST BE USED TO ISOLATE ALN BETWEEN PXCM CONNECTED TO DIFFERENT SERVICE GROUNDS OR ON BOTH SIDES OF THE ALN CABLE THAT EXITS BUILDING.
- THE MAX ALN DISTANCE APPLIES TO EACH SIDE OF THE TIE.

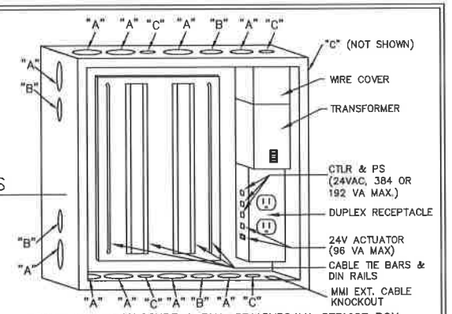
GENERAL NOTES:

- COMPLY WITH LOCAL BUILDING CODES
- SIZE WIRE FOR LOAD, CURRENT, AND VOLTAGE.
- ALL WIRE TO BE APPROVED OR LISTED FOR THE INTENDED APPLICATION BY AGENCIES SUCH AS UL, NEC, CSA.
- ALWAYS REFER TO LOCAL CODES FOR CONDUIT SHARING.
- WIRING MUST HAVE INSULATION RATED FOR HIGHEST VOLTAGE CIRCUIT IN CONDUIT.
- THE ALN TRUNK MUST BE AN UNINTERRUPTED RUN BETWEEN CABINETS. NO SPLICES ALLOWED.
- CM/CMP/MM/MMP WIRE IS NOT USABLE FOR CLASS 1 CIRCUITS.
- FOR EXTENDED TEMPERATURE INSTALLATIONS USE ONLY COPPER WIRE LISTED FOR 90°C OR HIGHER

ENCLOSURE H x W x D (IN)
PXA–ENC–19 19 x 22 x 5 3\4
PXA–ENC–34 34 x 22 x 5 3\4
PXA–ENC–18 18 x 22 x 6

KNOCKOUT TYPES
A= 1" & 1–1/4"
B= 3/4" & 1"
C= 1/2" & 3/4"

T1 00 PXCM CONDUIT PENETRATIONS



PXA–ENC19 ENCLOSURE & PXA–SB115V384VA SERVICE BOX

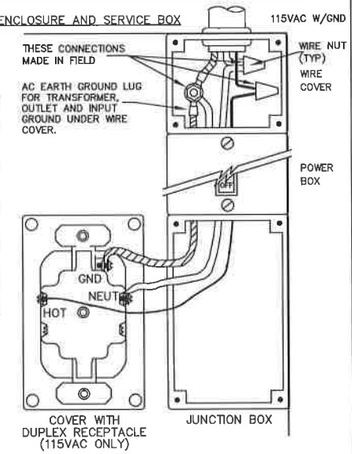
SERVICE BOX MAX POWER SOURCE REQUIREMENTS	
VOLTAGE:	102–132 VAC 204–264 VAC
LINE FREQUENCY:	50 / 60 Hz
115V OUTLETS:	200 VA (MAX.)
PXA–SB115V384VA [3]	440 VA (MAX.)
PXA–SB115V192VA [3]	220 VA (MAX.)
PXA–SB230V384VA	440 VA (MAX.)
PXA–SB230V192VA	220 VA (MAX.)

PXCM FAMILY VA RATINGS & SENSOR SUPPLY

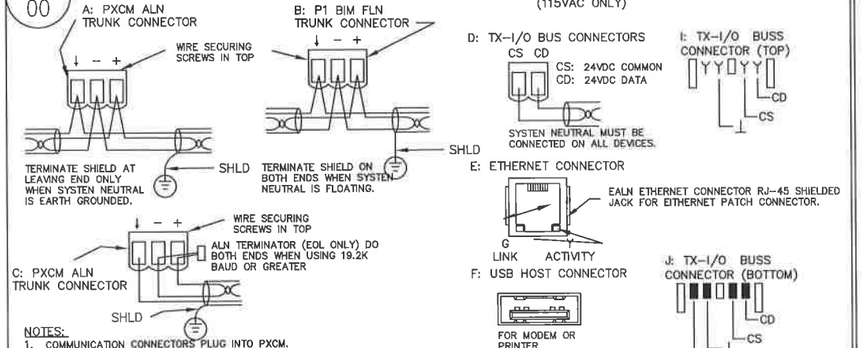
PRODUCT	24VDC (W)	24VAC INPUT VA	24VAC OUTPUT VA
PXC00–X	0	24	0
PXC100–X	0	24	0
TXB1.P1	14.4	125	96
TXS1.12F4	28.8	150	96
TXS1.EF4	0	96	96
TX–I/O MODULE	24VDC LOAD (W) MAX.		
TXM1.8D	1.1		
TXM1.16D	1.4		
TXM1.8U	1.5		
TXM1.8U–ML	1.8		
TXM1.8X	2.2		
TXM1.8X–ML	2.3		
TXM1.6R	1.7		
TXM1.6R–M	1.9		

NOTES:
1. NO MORE THAN THREE (3) 384VA OR FIVE (5) 192VA FULLY LOADED PXA CABINETS ALLOWED ON A SINGLE 3–WIRE 115V, 15A CIRCUIT.
2. RECEPTACLE IS PREWIRED AND MOUNTED IN FACTORY, FOR 115VAC SERVICE BOX ONLY.
3. DC INPUT/OUTPUT ONLY AVALABLE ON BUSS CONNECTION MODULES.

PXA ENCLOSURE AND SERVICE BOX



T2 00 PXCM POWER WIRING



NOTES:
1. COMMUNICATION CONNECTORS PLUG INTO PXCM.
2. ALN MUST BE DAISY–CHAINED WHEN RUNNING 19.2K BAUD OR FASTERAND TRUNK TERMINATORS USED AT BOTH ENDS OF LINE T3C. 3. TERMINATE SHIELD A LEAVING END OF ALN TRUNK ONLY T3A.
4. USE ALN SHIELD TERMINATION T3A WHEN 24VAC E TERMINAL IS EARTH GROUNDED.
5. USE ALN SHIELD TERMINATION T3B WHEN 24VAC E TERMINAL IS OPEN.

T3 00 PXCM & P1 BIM COMMUNICATION TERMINATIONS
FOR PXC MODULAR, SERIES CONTROLLERS AND SUPPLY MODULES

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
SFM	SFM		02/18/13	02/18/13

TX–I/O WIRING SPECIFICATION

440P–XXXXXX
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CONTROLLER	IP ADDRESS	SUBNET MASK	GATEWAY
PXCM-1	141.217.4.164	255.255.254.0	141.217.4.1
PXCM-2	141.217.4.163	255.255.254.0	141.217.4.1

MATERIAL PROVIDED BY SIEMENS:

NEW BACNET CONTROLLER
NEW CONTROL MODULES
NEW XPNL (TRANSFORMER PANEL)

INSTALLATION NOTES:

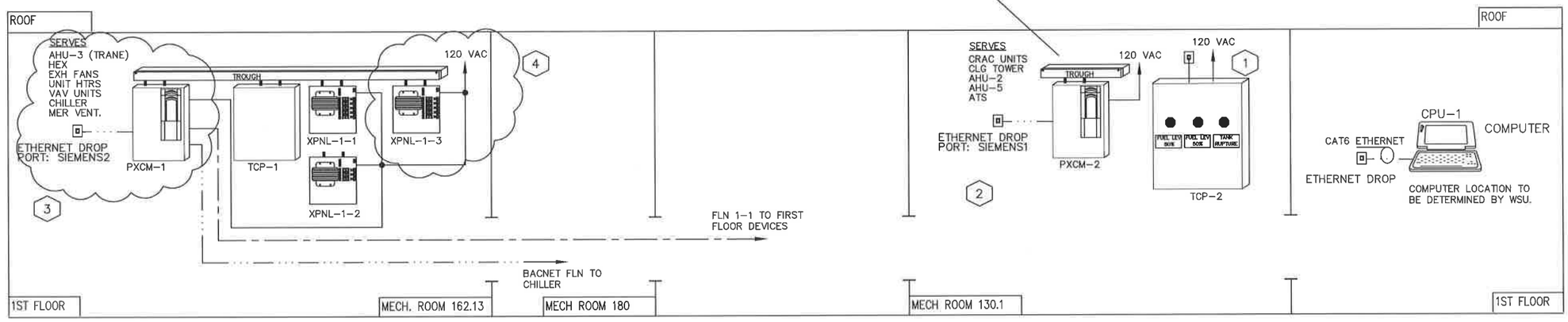
1. DDC PANELS ARE EXISTING AND TO REMAIN. NEW POINTS FOR PROJECT WILL BE PULLED TO PXCM-1.
2. OLD CHILLER DDC PONTS TO BE DELETED FROM PXCM-2 CONTROLLER.
3. NEW CHILLER DDC PONTS TO BE ADDED TO PXCM-1 CONTROLLER.
4. NEW TRANSFORMER PANEL ADDED PER NEW CHILLER PROJECT.

DRAWINGS ARE FOR REFERENCE ALSO REFER TO PROJECT BLUEPRINTS FOR BIDDING

NEW BACNET CONTROLLER TO BE ADDED TO EXISTING PXCM-1 CONTROL CABINET

NEW CONTROL MODULES TO BE ADDED TO EXISTING PXCM-1 CONTROLLER FOR NEW POINTS

ALT #1 REMOVE EXSITNG ELECTRIC CHILLER: DEMO EXISTING CHILLER POINTS FROM PXCM-2
ALT #2 REMOVE EXSITNG COOLING TOWERS: DEMO EXISTING COOLING TOWER POINTS FROM PXCM-2



CIT BUILDING

REVISION HISTORY

3	8/24/2012	KDJ	AS-BUILT DRAWING
2	5/16/2012	TAJ	PANELS ADDED PER PROJECT ALL OTHER DEVICES ARE EXSITNG.
1	8/24/2011	TAJ	AS-BUILT DRAWING

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DDC COMMUNICATIONS RISER

440P-XXXXXX
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Control Device	Qty	Product Number	Manufacturer	Document Number	Description
Field Mounted Devices					
CS 1-3	3	H608	VERIS	001-002	CUR SW SPLTCOR-ADJ SETPT W/LED
DPTE 1	1	2301050PD3V11B	SETRA	005-001	DP TRAN, WET,50PSI,4-20MA,W/MAN
RIB 1	1	RIBU1C	FUNCTIONAL DEVICES	RIBU1C	RIB120VAC 24VAC/DC SPDT
TTE 1-4	4	544-577-25	SIEMENS	149261	IMMWELL SNSR, PT 1K OHM, (375),2.5" LGTH
V					VALVE PROVIDED BY SIEMENS

REVISION HISTORY

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CHILLER CONTROL SYSTEM

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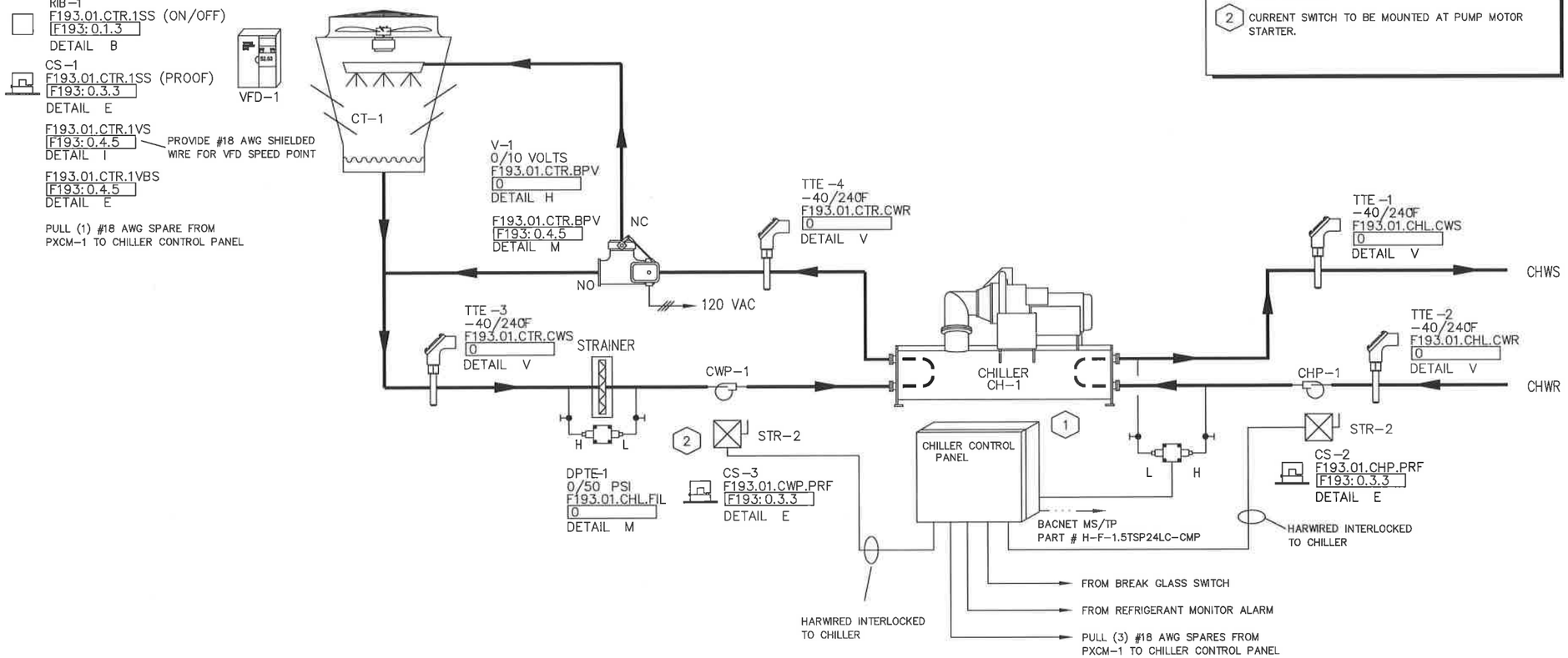

INSTALLATION NOTES:

1. BACNET INTERFACE CONNECTION PROVIDED BY UNIT MANUFACTURER.
2. CURRENT SWITCH TO BE MOUNTED AT PUMP MOTOR STARTER.

1/002 CHILLER CONTROL SYSTEM

LOCATION: MECHANICAL ROOM 180
SERVES: CHILLED WATER SYSTEM

DRAWINGS ARE FOR REFERENCE ALSO REFER TO PROJECT BLUEPRINTS FOR BIDDING

SIEMENS WILL PRODUCE FINAL TERMINATION DRAWINGS FOR CONTROL DEVICE AND DDC CONTROLLER TERMINATIONS

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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SFM	SFM		02/18/13	02/18/13

CHILLER CONTROL SYSTEM

440P-XXXXXX
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Control Device	Qty	Product Number	Manufacturer	Document Number	Description
Field Mounted Devices					
AE 1–2	2	GCA121.1P	SIEMENS	154001	2 PT SR,24V,MED.PLNM
CS 1–2	2	H608	VERIS	001–002	CUR SW SPLTCOR–ADJ SETPT W/LED
LTDE 1	1	134–1504	SIEMENS	155 016	T'STAT, LOW TEMP,15/55,MANUAL
RIB 1–4	4	RIBU1C	FUNCTIONAL DEVICES	RIBU1C	RIB120VAC 24VAC/DC SPDT
SPP 1–2	2	269–062	SIEMENS	N/A	PR269 ACCESSORY, SENSING TUBE
TTE 1	1	544–342–24	SIEMENS	149261	FLEX AVER SNSR, PT 1K OHM, 24FT PROBE
TTE 2	1	536–752A	SIEMENS	149 428	S1K RM TEMP SNSR,BEIGE,40/90F
	1	544–782A	SIEMENS	540–6XX	SINGLE GOOF MOUNTING PLATE KIT BEIGE
V					VALVE PROVIDED BY SIEMENS
Panel Mounted Devices					
DPS 1	1	141–0575	SIEMENS	155 052	AIR FLOW SWITCH.05/12 MAN REST
FSA 1	1	RIBMNLB–4	FUNCTIONAL DEVICES	013–013	AHU FAN SAFETY ALARM CIRCUIT 4–INPUT

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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SFM	SFM		02/18/13	02/18/13

MECH ROOM VENTILATION

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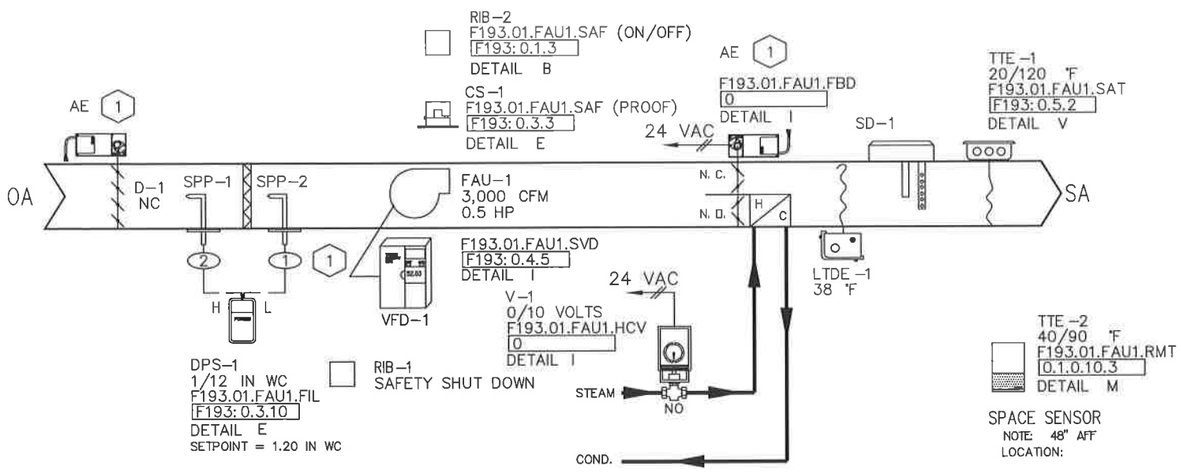

INSTALLATION NOTES:

1. PROVIDED BY UNIT MANUFACTURER.
2. SIEMENS TO PROVIDE DAMPERS THAT ARE NOT PROVIDED WITH MECHANICAL EQUIPMENT.

PXCM–1

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FSA –1

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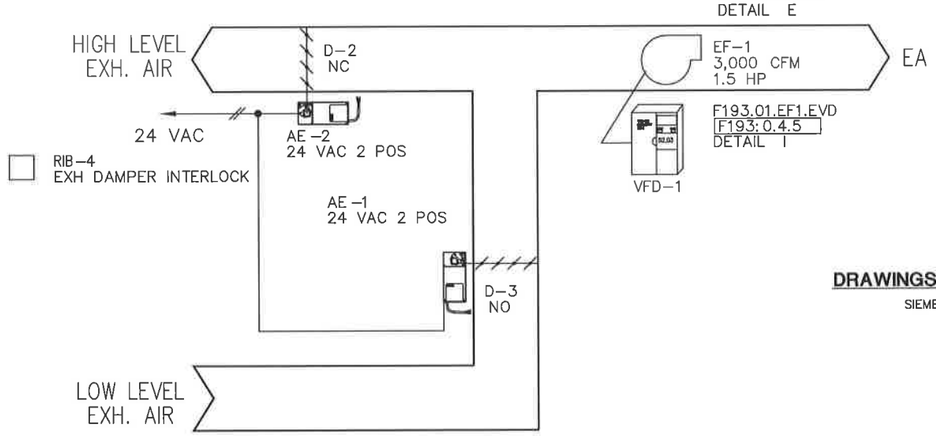

DRAWINGS ARE FOR REFERENCE ALSO REFER TO PROJECT BLUEPRINTS FOR BIDDING

SIEMENS WILL PRODUCE FINAL TERMINATION DRAWINGS FOR CONTROL DEVICE AND DDC CONTROLLER TERMINATIONS

1/003 MECH. ROOM VENTILATION

LOCATION: MECHANICAL ROOM 180
SERVES: VENTILATION SYSTEM

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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SFM	SFM		02/08/13	02/18/13

MECH ROOM VENTILATION

440P-XXXXXX
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003

Control Device	Qty	Product Number	Manufacturer	Document Number	Description
Field Mounted Devices					
LGT 1-4	4	10057844	MSA	N/A	RED/YEL/BLUE LGT TWR W/ BUZZER; 24 VAC
LGT 5	1	10057838	MSA	N/A	RED LGT TWR W/ BUZZER; 24 VAC
RMP 1-2	2	PART#_TBD	MSA	N/A	PART NUMBER TO BE DETERMINED
Panel Mounted Devices					
RE 1-3	3	RH4B-UL-AC24VKIT	IDEC	N/A	RELAY&SOC,GP 4PDT AC24V W/LED
XFMR 1-2	2	120-24-1002TFCB	CORE	300-003	TRANSFORMER 120/24 100VA 2 HUB

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Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
SFM	SFM		02/18/13	02/18/13

REFRIG. & CO MONITORING SYSTEM

440P-XXXXXX
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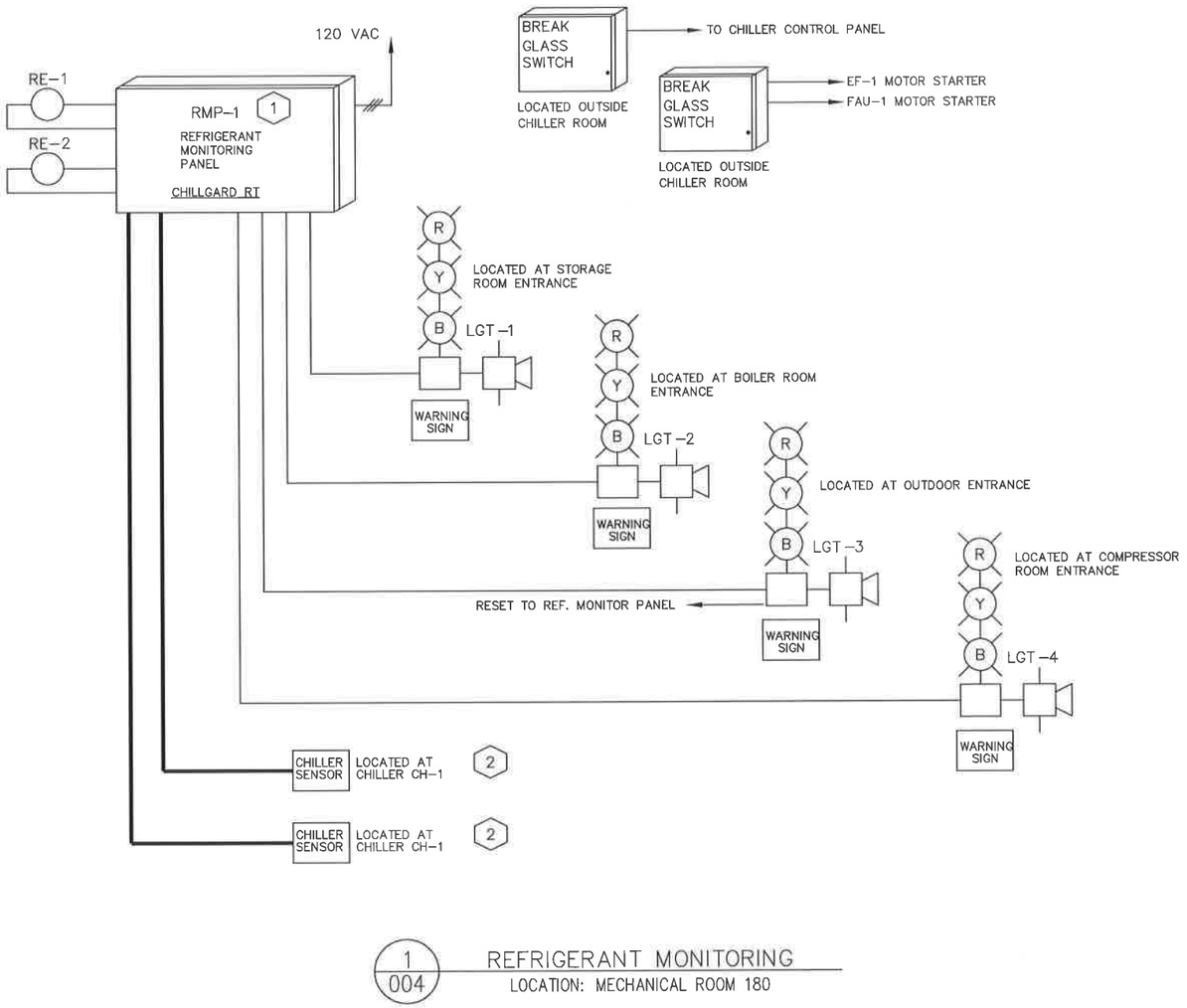
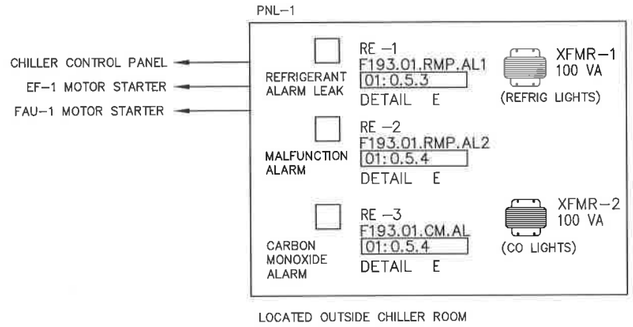
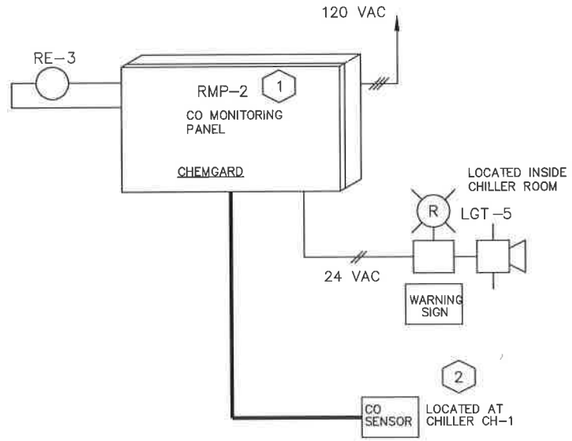


1/004 REFRIGERANT MONITORING
LOCATION: MECHANICAL ROOM 180

INSTALLATION NOTES:

1. DEVICE PROVIDED, INSTALLED AND WIRED BY SIEMENS.
2. REFRIGERANT SENSORS TO BE LOCATED AT BOTH ENDS OF THE CHILLERS. MOUNT ON STEEL SUPPORT AT VERTICAL RISE OF CHILLER.





2/004 CARBON MONOXIDE MONITORING
LOCATION: MECHANICAL ROOM 180

DRAWINGS ARE FOR REFERENCE ALSO REFER TO PROJECT BLUEPRINTS FOR BIDDING

SIEMENS WILL PRODUCE FINAL TERMINATION DRAWINGS FOR CONTROL DEVICE AND DDC CONTROLLER TERMINATIONS

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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SFM	SFM		02/18/13	02/18/13

REFRIG. & CO MONITORING SYSTEM

440P-XXXXXX
0
004

Control Device	Qty	Product Number	Manufacturer	Document Number	Description
Field Mounted Devices					
XPNL 1-3	1	PSH500A	FUNCTIONAL DEVICES	PSH500A	PS FIVE 100VA C2 120-24VAC ENC

REVISION HISTORY

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WSU C&IT Chiller Replacement
Detroit, MI

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SFM	SFM		02/18/13	02/18/13

XPNL LAYOUT

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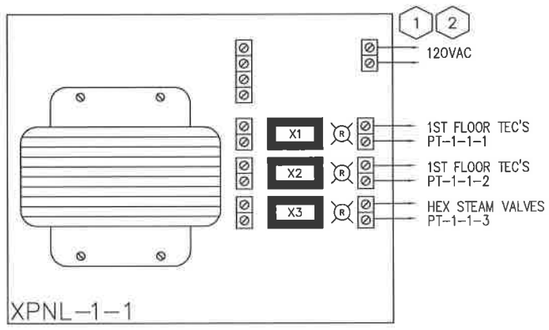
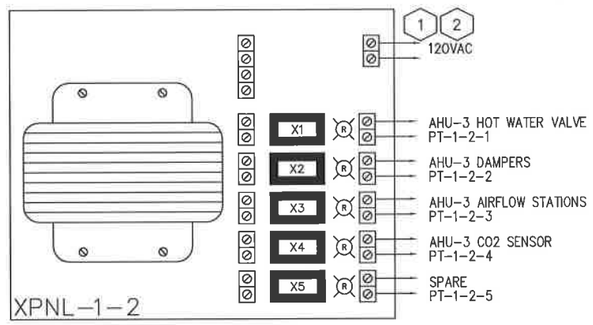
INSTALLATION NOTES:

1. 120 VAC POWER PROVIDED BY ELECTRICAL CONTRACTOR.
2. FROM EMERGENCY POWER PANEL LP-CH CIRCUIT #21.



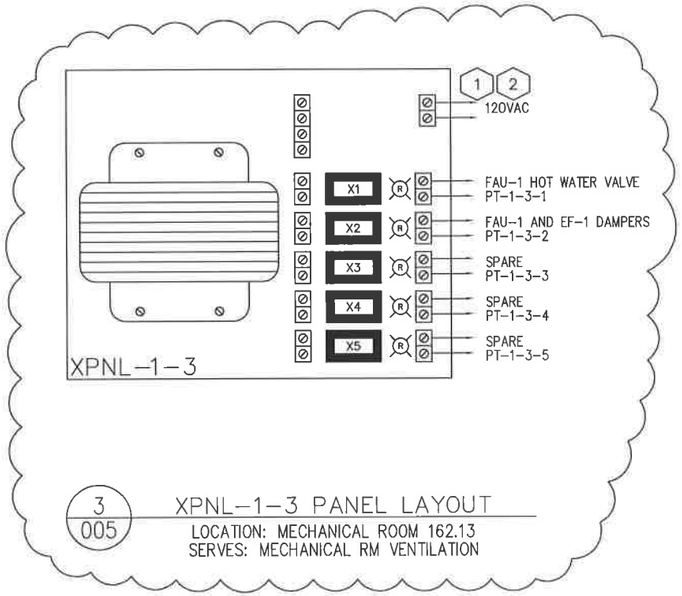
1/005 XPNL-1-1 PANEL LAYOUT

LOCATION: MECHANICAL ROOM 162.13
SERVES: VAV TERMINAL UNITS, HEX



2/005 XPNL-1-2 PANEL LAYOUT

LOCATION: MECHANICAL ROOM 162.13
SERVES: AHU-3



3/005 XPNL-1-3 PANEL LAYOUT

LOCATION: MECHANICAL ROOM 162.13
SERVES: MECHANICAL RM VENTILATION

REVISION HISTORY

2	2/7/2013	JL	PANEL ADDED PER NEW CHILLER PROJECT.
1	9/8/2011	KDJ	AS-BUILT DRAWING

SIEMENS

Siemens Industry, Inc.
Building Technologies Division

45470 Commerce Ctr. Dr.
Plymouth Twp., MI 48170
USA
PHONE: 734.456.3800
FAX: 866.815.0749

WSU C&IT Chiller Replacement
Detroit, MI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
SFM	SFM		02/18/13	02/18/13

XPNL LAYOUT

440P-XXXXXX
0

005

193 Computing Service
11-17-86

PROJ. 8628A

AAA DRILLING & TESTING INC.
1511 Michigan Mutual Bldg.
28 W. Adams
Detroit, Michigan 48226
(313) 961-4122

AAA Report Number: 11554-1
Date Issued: 17 November 1986

Wayne State University
Facilities Planning & Management
Design Service
5454 Cass Avenue - First Floor
Detroit, Michigan 48202

Attention: Mr. Doug Hamborsky

Re: Material Sampling and Identification of Asbestos Containing Materials,
REF: Computer Services Center

Dear Mr. Hamborsky:

In accordance with your request, on 7 November, 1986 AAA Drilling & Testing, Inc. performed a building survey for the above referenced project to determine the presence of friable asbestos containing building materials. Bulk samples were obtained in accordance with departmental guidelines and analyzed according to EPA "Interim Method for the Determination of Asbestos in Bulk Insulation Samples".

The survey data and analytical results for those areas specified at the time of inspection are as follows:

SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	PERCENT ASBESTOS
D-1	Mechanical Room 179; Duct Insulation at Connection	Non-Friable; No Deterioration	No	Cellulose and Glass Fibers
D-2	Mechanical Room 179; Duct-Corner Insulation at Right Hand of Unit Seam	Non-Fibrous, Friable; No Deterioration	Yes	5-15% Amosite

.....continued

SAMPLE #	LOCATION/TYPE	PHYSICAL DESCRIPTION MATERIAL CONDITION	ASBESTOS PRESENT YES/NO	PERCENT ASBESTOS
D-3	Mechanical Room 179; Duct Insulation at Connection	Non-Friable; No Deterioration	No	Cellulose and Glass Fibers
D-4	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #3	Fibrous, Friable; Slight Deterioration	Yes	25-35% Chrysotile
D-5	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #2	Fibrous, Friable; Severe Deterioration	Yes	20-30% Chrysotile
D-6	Computer Room 180; Pipe Joint Insulation, "Blazer" Air #1	Fibrous, Friable; Severe Deterioration	Yes	20-30% Chrysotile

DISCUSSION

Analytical test results indicate that fibrous asbestos is present in sampled pipe joint insulating materials. Fibrous asbestos is also present in a sample of heat duct insulation material (Sample D2).

Straight pipe insulation material was observed to be glass fiber wrap.

RECOMMENDATIONS

The above referenced sample, D2, in the Mechanical Room 179 is an asbestos-containing material (ACM). However, this ACM is adjacent to, but not part of the proposed alteration work, i.e., removal of connection duct between the right and left hand units as indicated on your drawings. The samples of insulation on the connector duct showed no fibrous asbestos present.

Persons who enter this area should take care not to disturb any pipe or duct insulating materials or debris. Persons who must work in the immediate vicinity of this area should wear appropriate respiratory protection.

.....continued

A visual inspection was made of the East-West Duct above the ceiling in Computer Room 180 Area No. 1, Ref: Section Line "K" on your drawings. No insulation was observed to be present on this duct run.

The piping system servicing the EDPAC Units #1, 2, 3, and 4 were also inspected. No friable materials were observed to be present. A "rubber" type insulation is present on these systems.

The piping system servicing the "BLAZER" units is insulated with friable ACM on the joints, i.e., tees, valves, elbows, etc. This ACM is in poor physical condition and poses a potential exposure hazard. Remedial action should be undertaken promptly.

Renovation/Demolition projects which directly involve asbestos containing materials are subject to governmental regulations. Personal respiratory protection, work area isolation, removal technique, atmospheric monitoring and proper notification and disposal are of the utmost importance in any abatement operations. Copies of EPA regulations and guidelines are included with this report.

ASBESTOS REMEDIATION PROCEDURES

Removal Procedures - Pipe Insulation

Small amounts of pipe insulation may be removed by thorough wetting of the insulation with an amended water solution. This is typically a 90/10 mix of water and common liquid detergent. Once thoroughly wetted, the material can then be removed without release of asbestos fibers. Waste materials should be placed in thick, (6 mil.), well-sealed plastic bags and labeled as containing-asbestos waste. Waste materials can then be transported to a landfill licensed to accept asbestos waste.

Areas where asbestos remediation procedures are anticipated should be isolated from the rest of the building. This is commonly effected by construction of visqueen barriers which, if properly erected, provide an airtight chamber.

All floors should be thoroughly wet mopped after completion of the project and before removal of barriers. The mop head and other materials should be disposed in the same manner as asbestos waste.

.....continued

An alternative method for removal of deteriorated pipe insulation is through the use of commercially available polyethylene bags designed to be temporarily taped to the pipe. The interior of the bags provide an airtight chamber in which to effect removal operations. This obviates the need for erection of isolation barriers and also requires significantly less manpower. Workers using containment bags should wear respirators in the event of containment bag failure.

Worker Protection

All workers removing asbestos-containing materials should wear approved respirators, gloves and disposable body suits. Workers should shower on-site after completing the work for the day. Atmospheric monitoring is recommended. Please note that untrained personnel should not attempt a large scale removal or encapsulation project. Also, proper notification should be given as required (EPA, OSHA, State and Local).

Legal Requirements

Prior to the removal of friable asbestos-containing material, notification must be submitted to Federal and State government authorities. Notification form has been enclosed with this report. If the removal project is located in Wayne County, a copy of this notification must also be submitted to:

Michael D. Maillard
Engineering and Enforcement Director
Wayne County Health Department
2211 East Jefferson
Detroit, Michigan 48226

Supplemental Services

Testing Engineers & Consultants, Inc. offers additional asbestos services in the areas of:

(1) Specifications and Bid Preparations

(2) Remediation/Removal Procedures
-Regulation Compliance (EPA, OSHA, State & Local)
-Management of Hazardous Materials
-Atmospheric Monitoring/Supervision during Encapsulation/Removal
-Inspection of Completed Project

.....continued

If you are in need of these or other consulting services, please contact us for additional information.

We are pleased to have been of service. If you have any questions or require further information, please contact this office at your earliest convenience.

Respectfully submitted,

AAA DRILLING & TESTING, INC.

David Mueller
Environmental Engineer

Steve Kulpanowski
Staff Geologist

Stuart Yankee
Staff Engineer

DM/SK/SY/kr
Enclosure

SECTION 311000 - SITE CLEARING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities and/or abandoning site utilities in place.
7. Temporary erosion- and sedimentation-control measures.
8. Tree protection fencing.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

B. Utility Locator Service: Notify “Call Before You Dig” for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag with blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Do not stockpile topsoil within protection zones.
2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, plants and other site amenities.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

B. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

C. Do not direct vehicle or equipment exhaust towards protection zones.

D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups and Geotechical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course/Crushed Aggregate: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Crushed stone: Open graded crushed limestone: MDOT 6AA.

J. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; screened to be free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

L. Sand: ASTM C 33; fine aggregate.

M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit or as indicated on drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.5 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or

conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of [subbase material] [satisfactory soil], free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under walks and pavements, use satisfactory soil material.
2. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Pavement: Plus or minus 1 inch.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course 6 inches or less in compacted thickness in a single layer.
2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Construction Manager will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Standard Specification: Michigan Department of Transportation, 2003 Standard Specification for Construction.
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Qualification Data: For manufacturer.

E. Material Test Reports: For each paving material.

F. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

1. Regulatory Requirements: Comply with Michigan Department of Transportation, 2003 Standard Specification for Construction for asphalt paving work.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of subgrade and preparatory work.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

E. All work shall meet specifications of the City of Detroit.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Bonding and Tack Coats: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO MP 1, PG 58 degree C-28 degree C.

B. Asphalt Cement: ASTM D.

C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30.

1. Prime Coat: Asphalt emulsion prime complying with Michigan Department of Transportation, 2003 Standard Specification for Construction..

D. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073, Grade Nos. 2 or 3.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction, designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types." and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 1100L, 20AA – 1-1/2”
3. Surface Course: 1100T, 20AA – 1-1/2”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected and approved by Landscape Architect.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Each lift shall be installed using automated laser grade control, self propelled paving equipment, with dual slope capabilities.
3. Place hot-mix asphalt surface course in single lift.
4. Spread mix at minimum temperature of 250 deg F.
5. Begin applying mix on high side of one-way slopes, unless otherwise indicated.
6. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
   1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

      a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216