

SHELL OIL COMPANY

DEER PARK MANUFACTURING COMPLEX

REFINERY OPERATIONS BUILDING

A/C REVISIONS

April 30, 1987

Thomas E. Lightfoot & Associates, Inc. Consulting Engineers
3817 Richmond Avenue, Suite 110, Houston, Texas 77027
1-(713)-627-7640

LAM 016245

DPMC-13011

TEB

Thomas E. Lightfoot and Associates, Inc. / consulting engineers

3817 Richmond Suite 110 Houston, Texas 77027 (713) 627-7640

June 3, 1987

Shell Oil Company/Shell Chemical Company
Deer Park Manufacturing Complex
P. O. Box 100
Deer Park, Texas 77536

Attn: Jim Dyal

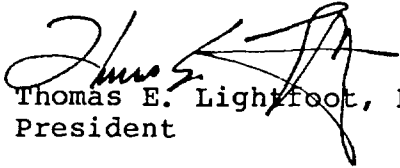
Re: Shell Operation Bldg. A/C Revisions

Dear Jim:

As requested by you, we have prepared the enclosed documents to locate the Air Cooled Packaged Chiller on the North side of the building, and indicate a single chiller in lieu of dual chillers. This change affected the Mechanical and Electrical Scope of Work, and will reduce our estimated construction cost by approximately Eighty Thousand Dollars (\$80,000.00) as outlined in the enclosed Cost Estimate. .

Sincerely,

THOMAS E. LIGHTFOOT AND ASSOCIATES, INC.


Thomas E. Lightfoot, P.E.
President

LAM 016246

DPMC-13012

PRELIMINARY
ESTIMATED CONSTRUCTION COST
The Refinery Operations Building

PHASE I

1. One new 90 ton Air Cooled Packaged Chiller w/herasite coating.	<u>\$ 54,000.00</u>
2. New chill water supply and return piping.	<u>10,000.00</u>
3. Two new Chill Water Pumps.	<u>5,000.00</u>
4. Final connection to existing chill water lines.	<u>2,000.00</u>
5. Remove two existing chillers, pumps & piping.	<u>4,000.00</u>
6. Remove existing outside air unit and louver.	<u>1,000.00</u>
7. Install new 2500 cfm outside air unit, complete with new louver, automatic damper, flat filter, purafill filter, pre-heat steam coil, cooling coil, and hydrogen sulfide gas analyzer.	<u>8,000.00</u>
8. Remove existing wall ventilation fan, and install a new louver and install a pressure relief damper.	<u>3,000.00</u>
9. Remove existing wall louver and seal wall openings.	<u>3,000.00</u>
10. Demolition (Electrical)	<u>2,000.00</u>
11. Extend Electrical service to new chiller.	<u>4,000.00</u>
12. Extend Electrical service to new pumps.	<u>3,000.00</u>
13. Concrete chiller pad.	<u>2,000.00</u>
14. Concrete pump pads.	<u>1,000.00</u>
15. Pipe Supports.	<u>2,000.00</u>
16. Close opening in exterior wall.	<u>1,000.00</u>
SUBTOTAL PHASE I	\$105,000.00

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PHASE II

1.	Replace existing suspended ceiling for replacement of mixing boxes (60 total).	<u>16,000.00</u>
2.	Air balance the existing system.	<u>8,000.00</u>
3.	Remove 60 existing double duct boxes and install new boxes.	<u>80,000.00</u>
4.	Remove 63 existing pneumatic thermostats and 3 temp. sensors and install new controls.	<u>8,000.00</u>
	SUBTOTAL PHASE II	112,000.00

TOTAL ESTIMATED CONSTRUCTION COST \$217,000.00

ADD FOR COOLING TOWER DEMOLITION

TOTAL DIRECT COST

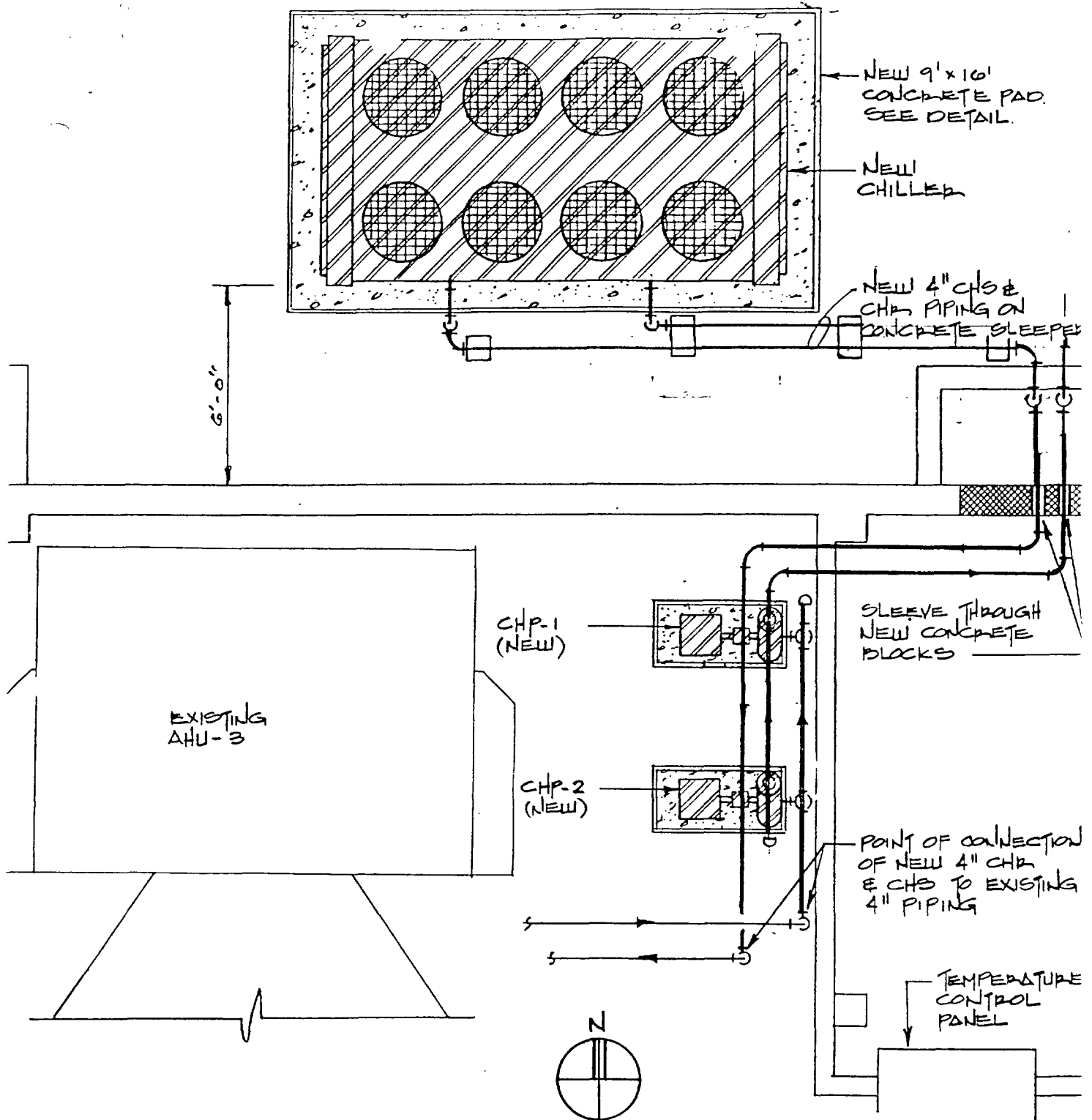
4,000

223,000

TOTAL ESTIMATE \$ 300,000

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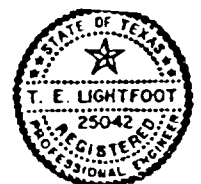
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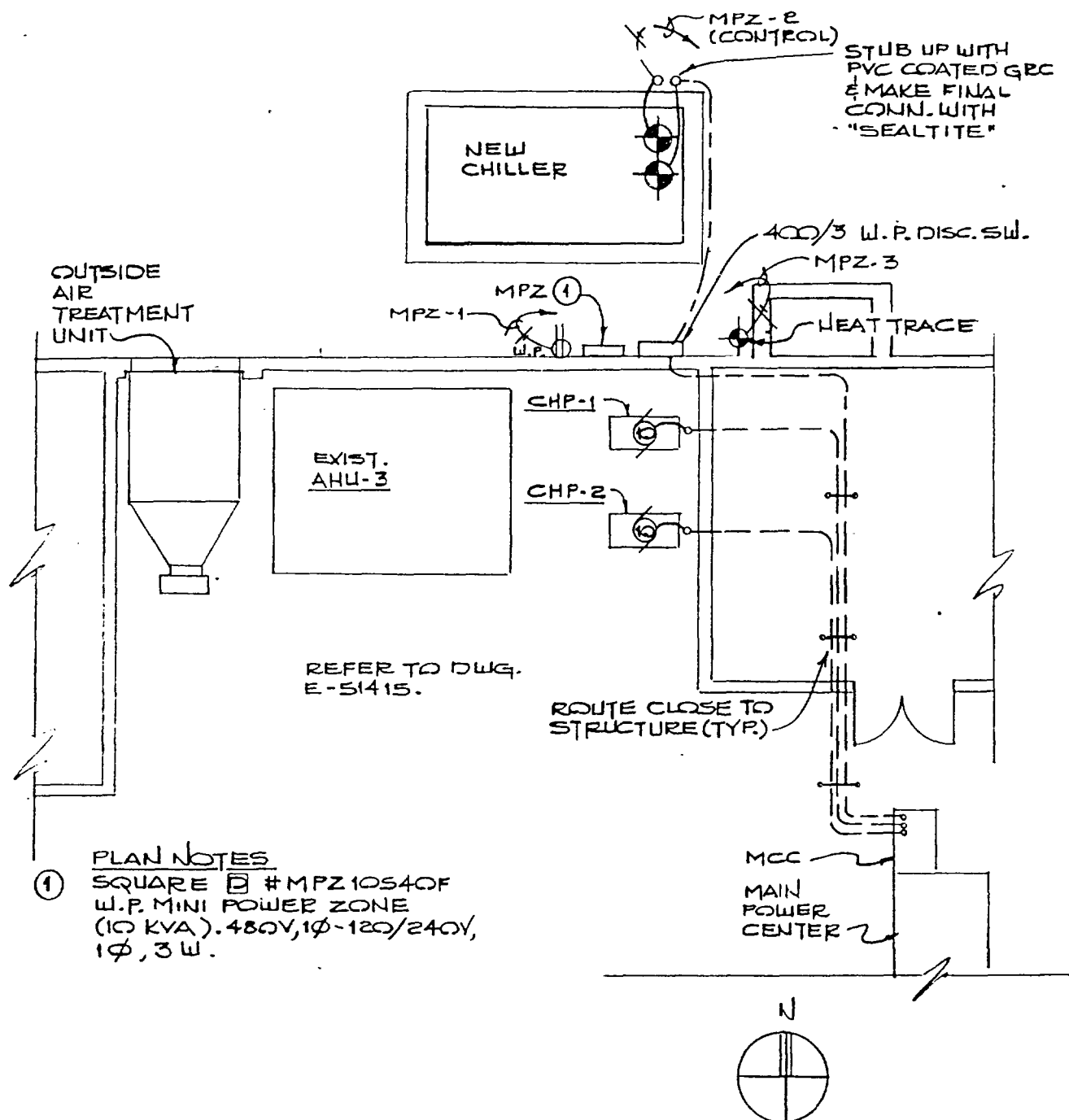
PARTIAL MECHANICAL BASEMENT PLAN

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



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CONSULTING ENGINEERS
HOUSTON, TEXAS

DPMC-13015



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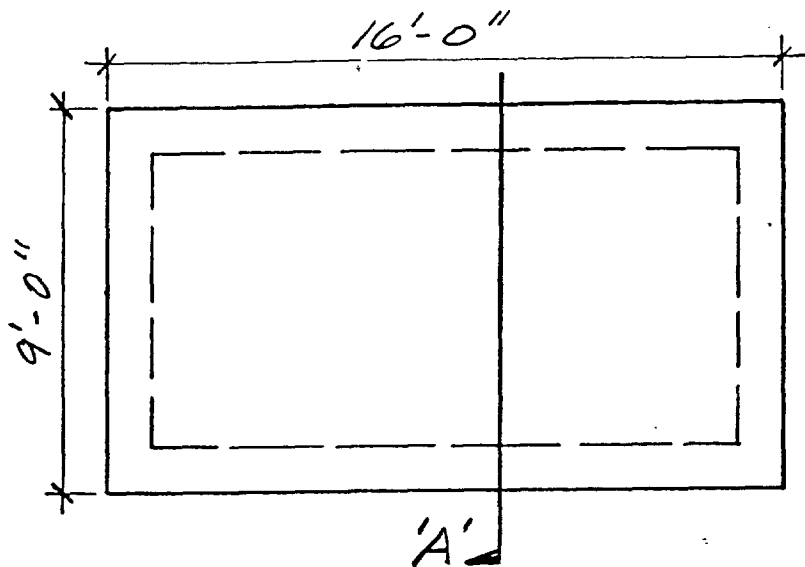
PARTIAL ELECTRICAL BASEMENT PLAN

SCALE: 1/8" = 1'-0"



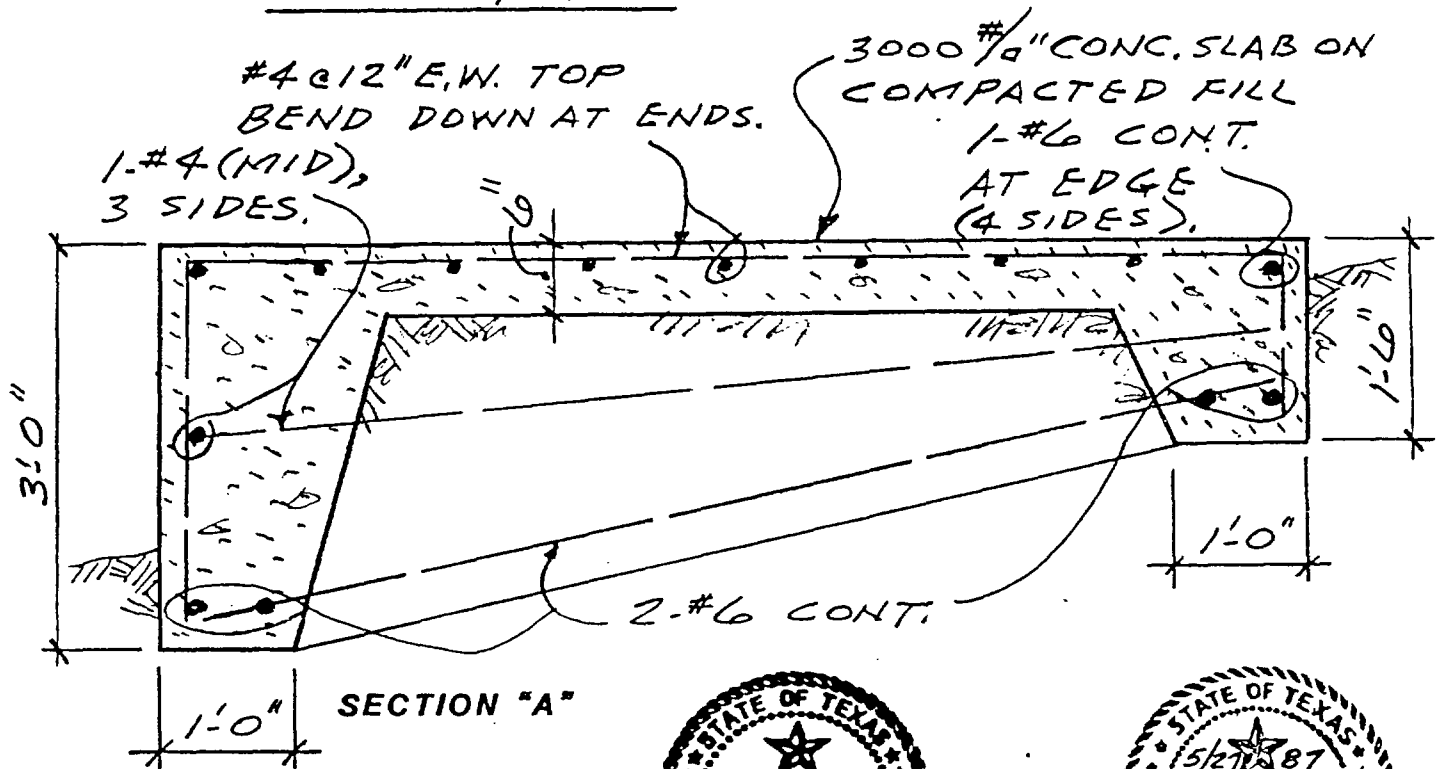
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CONSULTING ENGINEERS
HOUSTON, TEXAS

DPMC-13016



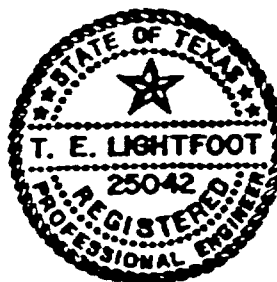
CHILLER PAD PLAN

SCALE: 4"=1'-0"



CHILLER PAD DETAIL

SCALE: 3/4"=1'-0"



THOMAS E. LIGHTFOOT & ASSOC. INC.
CONSULTING ENGINEERS
HOUSTON, TEXAS



LEE W. JONES INC.
STRUCTURAL CONSULTANTS

CHILLER PAD FOR REFINERY OPERATIONS BUILDING
SHELL OIL COMPANY - DPMC

DPMC-13017

LAM 016251

Mechanical Specification

LAM 016252

DPMC-13018

SECTION 15A - MECHANICAL

1. GENERAL

- A. The General and Special Conditions of these Specifications shall both be considered as a part of this Section, insöfar as they may be termed applicable, whether attached or not.
- B. Cooperation for work of this Section of the Specifications with all other trades is mandatory, so that all phases of work may be properly coordinated without delays or damage to any parts of any work.
- C. Provide all labor, items, articles, materials, operations, or methods listed, mentioned or scheduled on the drawings and/or herein, required to perform the work described.

2. SCOPE OF WORK

- A. Modify and/or recondition the HVAC systems as depicted and specified in these contract documents.
- B. Abandoned old ductwork in place.
- C. The four mixing boxes inside the tile chase wall at the stair lobby will not be replaced.
- D. Base bid will be to replace all mixing boxes except the four addressed in Paragraph C above. Alternate bid will be to replace internal and external components in all the boxes as required to bring them up to a status that the Contractor will warrant them for one year.
- E. Give the Owner a one year warranty on all remodeled terminal boxes. (Alternate Bid)
- F. The existing cooling tower and condenser water pump will be removed by the Owner after the new chiller is in operation.
- G. Existing dual chillers, dual chilled water pumps, etc. located in the basement shall be removed by the Contractor and delivered on the site as directed by the Owner.
- H. The existing condenser water piping located in the crawl space shall be capped at the basement wall and abandoned in place.
- I. The Contractor shall notify the Owner is any asbestos material is encountered during construction. The Owners personnel will be responsible for the removal of any asbestos.

- J. Install two new air cooled water chillers and chilled water pumps as shown on the drawings. Install new piping as shown on drawings, in order to connect the new chiller into the existing AHU piping system.
- K. The existing AHU- 1, 2 & 3 and their associated coils and control valves and piping, back to the point of tie-in will remain in place and will be reused.
- L. Remove and replace the existing outdoor air pretreating unit in its entirety, including controls. Install a new outdoor air pretreating unit to meet the specifications shown on the drawings. Replace all controls with new ones, to accomplish the original sequence of operation.
- M. The building will be fully occupied during the construction phase. Outdoor work and work in the basement Mechanical Room can be performed during business hours. Work in the occupied spaces must be performed at other than normal business hours, which shall include week-ends. Contractor shall base their bids on the above conditions.
- N. Phase I work shall include installing the chillers, all chilled water piping, pumps, replacing the outside air unit, all basement mechanical work, including control revisions to basement equipment.
- O. Phase II work shall include all work done on the occupied floor, to the mixing boxes and their controls.

3. CONSTRUCTION PHASING

- A. The building will be fully occupied during the construction period. The contractor is required to work at other than regular office hours, which includes working during weekends and at night, as required, in order to complete the work in occupied spaces.
- B. The air cooled water chiller, new pumps and all chilled water piping up to the point of tie-in to the existing piping system shall be completed prior to removal of the existing cooling tower. See Drawings for details.
- C. See Phase I and Phase II work explained in paragraph 2 above, and as outlined on the Drawings.

4. GENERAL REQUIREMENTS

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- A. The work described herein and shown on the accompanying drawings shall be a finished and working job. Work performed under this Section of the specifications shall be coordinated with work performed by other trades so as not to delay or damage any part of this installation. Be informed on all matters and conditions concerning the site, location of utility connections, the construction

and finish of the project, and other phases of construction which might affect the work. No consideration will be granted for any alleged misunderstanding of the material to be furnished or work to be done. In case of doubt, do not proceed with the work without first obtaining from the Architect such additional instructions as may be necessary for the proper execution of the work.

- B. If a conflict exists between the drawings and/or specifications and any aforementioned authority, advise the Architect in writing prior to presenting your bid proposal.
- C. The purpose of these drawings and specifications is to represent the general design and construction limitations and requirements for all mechanical work. The drawings and specifications do not include exact equipment dimensions and locations, accessory items, control wiring devices, etc., required for each manufacturer's equipment. However, the intent of the general design and the design of component parts is to provide complete and properly functioning systems.
- D. Alternate Equipment, other than that named in these specifications, will be considered provided:
 - 1) Complete descriptive data in Shop Drawing form is submitted to the Engineer at least 5 days prior to bid date.
 - 2) Bid must be based on plans and specifications as published. Alternate bid must be included, indicating the amount of the deduct. The deduct shall include price adjustments to all other trades involved.
 - 3) Equipment not having prior approval shall not be submitted and will not be considered as an alternate.
- E. Equipment substituted for that used as a basis of design and as scheduled, must be compatible to all other systems and trades, even though it is listed as an acceptable manufacturer. If substitute equipment is not compatible with other systems and/or trades, it shall be the responsibility of the contractor to design and submit all modifications required to make the substitute equipment compatible and to pay all costs incurred regardless of the trade or Profession affected.
- F. Equipment, ductwork and piping arrangements shall provide adequate and acceptable clearances for entry, servicing, filter replacement and maintenance. Access panels shall be provided in the housings of the air terminal boxes and

shall be the type that will permit servicing or replacement of the components of the unit as installed in the space. The air conditioning system and equipment shall be installed in conformance with the requirements of NBFU Standard No. 90B and American Standard B9.1.

- G. Field check all dimensions and clearances. While such dimensions and clearances may be shown on the contract drawings for convenience, these are only approximate and the verification of these dimensions shall be the responsibility of the Contractor. Be responsible for satisfactory adjustment or fit of piping and equipment to conform to configurations of structures.

5. GENERAL EQUIPMENT REQUIREMENTS

- A. Starters packaged with equipment shall have three-coil overload protection with manual reset overload relays. Furnish and install Timemark #258 phase failure protection for all three phase starters. One point of connection shall be made under the Electrical Section. Disconnect switches will be furnished and installed under Division 16, for all three phase motors.
- B. All equipment and component parts shall be of domestic manufacture. Equipment shall bear standard name plates bearing the manufacturer's name, address, trade name and catalog number, securely affixed to the equipment in a conspicuous place. Care shall be taken not to damage the name plate in any manner.
- C. Identify each piece of equipment with a two color engraved phenolic or bakelite nameplate one inch wide and letters at least one half inch high, with the same designation as shown on the drawings. Permanently affix nameplate to each piece of equipment in a conspicuous place.
- D. Furnish and install sound isolating flexible connections on the inlet and outlet of fans and air conditioning units where ductwork connections are made to same. Flexible connections are to be fabricated with Elgen "Zipper Lock," ZLN-4 neoprene coated 3202 fiberglass with 24 gauge galvanized iron side connectors.
- E. Furnish and install vibration isolation mounts for all motor driven equipment.
- F. All piping shall be routed as high as possible to the structure above. Drawings do not show all drops and rises required to clear beams and/or other structural features. Ductwork shall be installed to give a minimum of 8" clear between bottom of ductwork and top of ceiling grid. Flatten seams if necessary. Routings shown on Drawings are general in nature and are to be followed as closely as possible. Contractor is responsible for

final routing of piping and ductwork in order to obtain a neat workable system and to coordinate and cooperate with other trades.

- G. Furnish all equipment concrete house-keeping pads. Pads shall extend a minimum of 6 inches beyond equipment on all sides. Pads shall be poured in place but separated from structure and shall be not less than 4 inches high. Pump pads shall be raised with vibration isolation below pad.
- H. All pieces of equipment such as valves, pumps, chillers, air handling unit coils, etc., shall be piped with unions or flanges placed in the system in such a manner that the piping can be disconnected and the equipment removed without having to cut the piping. Valves shall be installed to facilitate closing off the system to allow equipment removal without draining the system.
- I. Only new materials shall be used. Pipes shall be neatly arranged; straight, parallel or at right angles to walls and cut accurately to established measurements. Pipes shall be worked into place without springing or forcing. Arrangement shall be such that lighting fixtures, duct work, sprinkler heads, aisles, passageways, windows, doors, etc.; are cleared. Pipes shall not interfere with access to equipment.
- J. Pipes shall be clean, free of cuttings and foreign material. Exposed ends of piping shall be covered during site storage and installation. Split, bent, flattened or otherwise damaged pipe or tubing shall not be used. Full lengths of pipe shall be used whenever possible. Short lengths with couplings are not to be used in concealed areas.
- K. Horizontal pipe lines shall be sloped downward in the direction of flow. A drain shall be provided at each low point in the systems so that each system can be completely drained. Automatic air vents shall be installed at all high points of all hydronic systems to relieve air from the lines.
- L. Isolate all copper pipes and tubing from steel structural members.
- M. Prior to final inspection, furnish a composite control wiring diagram mounted under glass in a frame and hang on main mechanical room wall. Diagram shall show all control wiring, identify all control devices and all pieces of equipment.

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- N. Furnish and install all pneumatic or electric controls required for all mechanical equipment and meet the requirements of the sequence of operation. Control wiring shall be furnished and installed under this Division of the specifications.
- O. The pressure rating of all components such as valves, strainers, fittings, etc. of each hydronic or pneumatic system shall be at least 1.5 times the maximum working pressure of the system, at the system operating temperature.

6. OTHER WORK INCLUDED IN THIS CONTRACT

- A. This Section shall be responsible for keeping all equipment furnished under this Section clean and free from rust and corrosion. Touch up paint if damaged in installation.
- B. This Section shall be responsible for the location of openings and pouring of all concrete equipment pads.
- C. Electrical power wiring, and electrical connections to all equipment shall be furnished under another Division. Starters for all mechanical equipment, not furnished integral with the equipment, shall be furnished under another Division.

7. PERMITS, FEES AND CODE REGULATIONS

- A. Obtain all necessary permits, pay fees and charges pertaining to work under this Section, and comply with all national, state and municipal laws, codes, ordinances and regulations relating to building and public safety.

8. OPERATION AND MAINTENANCE MANUAL

- A. This manual shall be furnished in triplicate and shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operation and Maintenance Manual" with additional cover display of the names and location of the building, the Owner, the Architect, the Engineer, the General Contractor, and the Sub-Contractor responsible for installing the equipment represented in the brochures. Submit manuals to the Architect prior to receiving final payment.
- B. Contents of the manual shall be grouped in sections according to type of equipment, and shall be listed in a table of contents, preceded by a copy of these pages of specifications.

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C. The manual shall include the following:

- 1) Complete HVAC submittals as reviewed by Architect/Engineer.
- 2) Manufacturer's installation instruction brochures.
- 3) Manufacturer's local representative and/or distributor's name, address, and telephone number.
- 4) Manufacturer's operation and maintenance brochures.
- 5) Manufacturer's internal wiring diagram.
- 6) Contractor's installation wiring diagrams.
- 7) Control system installation Drawings.
- 8) Replacement part number listing and/or descriptions.
- 9) Lubrication materials required, with instructions.

D. One set of Special servicing tools shall be furnished to the Owner as part of this Contract.

E. Physically go through all operating procedures (one time), on equipment furnished under this Section of the specifications with the Owner's representative.

9. SHOP DRAWINGS

A. In general, shop drawings shall consist of published ratings of capacity data, detailed construction drawings, wiring and control diagrams where applicable, performance curves, installation instructions, other pertinent data.

B. The following items require shop drawings:

Fans
Insulation
Controls
Terminal Boxes
Chillers
Pumps
Valves, Strainers, etc.
Vibration Isolation

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C. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out and relevant material is clearly labelled or marked.

10. RECORD DRAWINGS

- A. Maintain a complete set of Record Prints of the project at the jobsite. Keep prints current by making dated notations of any changes from the original Drawings including all Addenda, Change Orders and Field Changes. When installation of concealed work shown on any of these Drawings is complete, correct the prints according to field notes. At substantial completion, submit all prints completely corrected, to the Architect. Refer to Division 1 for additional stipulations.

11. GUARANTEE

- A. The guarantee provision of the specifications requires prompt replacement of defective equipment, workmanship or material occurring within one year after Certificate of Substantial Completion. Remove and replace the defective items and provide all necessary labor, adjustments, equipment, material and refrigerant, etc. to restore the entire installation to the originally specified operating condition and finish. Warrant all reconditioned terminal boxes (Alt. Bid) for a period of one year, for all materials, labor, etc.

12. DESIGN CONDITIONS

- A. The system design conditions listed in the following are for determining the minimum requirements for satisfactory system operation in air conditioned spaces.

	<u>SUMMER</u>	<u>WINTER</u>
Outside	97 deg.FDB - 80 deg.FWB	20 deg.F
Inside	75 deg.FDB - 63 deg.FWB	75 deg.F

- B. Be able to produce the above conditions with equipment furnished under this Section.

13. MOTORS

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- A. Furnish, install and align all electric motors for all the equipment specified in Division 15. All motors shall be of current NEMA design "B" classification with 1.15 service factor. All three phase motors shall be TEFC and shall have Class F insulation. Single phase motors less than 1/2 HP shall have Class A insulation. All motors shall have a maximum noise level of 65 DB in equipment rooms, 50 DB in fan rooms, and 45 DB in General Office areas. All single phase motors 1/4 HP thru 1/2 HP shall be permanent split capacitor (P.S.C.), 1750 RPM ball bearing type motors with resiliently mounted bases with 1.15 service factor. Single phase motors smaller than 1/4 HP may be shaded pole type as required. All three

phase motors shall be Reliance XE high efficiency with 1.15 service factor; and shall be tested in accordance with NEMA MG1-12.53a and the motor nameplate shall be labeled in accordance with NEMA 12.53b as reproduced below. Motor starters and disconnect switches, not mounted integral with the equipment, shall be provided and installed by Division 16.

Motor HP	NEMA Nom. Full Load Efficiency %	NEMA Min. Full Load Efficiency %	Reliance Motor Type
1/2	80.0	77.0	TEFC-SXT
3/4	82.5	80.0	TEFC-SXT
1	84.0	81.5	TEFC-SXT
1-1/2	85.5	82.5	TEFC-SXT
2	86.5	84.0	TEFC-SXT
3	88.5	86.5	TEFC-XE
5	88.5	86.5	TEFC-XE
7-1/2	90.2	88.5	EFC-XE
10	90.2	88.5	TEFC-XE
15	91.7	90.2	TEFC-XE

- B. Motors manufactured by Reliance, G.E., Westinghouse, Century, Balder or Marathon are acceptable.

14. VIBRATION AND SOUND ISOLATION

- A. Furnish and install vibration and sound isolation for all pieces of motor driven equipment. Vibration equipment manufacturer shall size and select all vibration isolators and shall determine proper placement of all isolators for maximum effectiveness.
- B. Pipe isolation shall be full line size connectors installed at the suction and discharge of each pump. All connectors shall be suitable for use at the pressure and temperature encountered at the point of installation. End fitting of connectors shall conform to pipe fitting schedule below, with matching bolt pattern and are to be of the following types, as applicable.
1. Flanged, Type 2800-A flanged spherical arch rubber expansion joint constructed of molded reinforced neoprene with integral steel floating flanges, suitable for pressure up to 200 psi for 1" - 4", 150 psi for 6" - 10", 100 psi for 12" to 14" and temperature up to 225°F. Connectors shall have minimum movement capability of 1/2" compression, 1/2" lateral and 15° angular. Spring loaded control units shall be furnished for sizes from 3" thru 8" diameter to limit thrust elongation to 3/8". For 10" and larger diameter, the control rods shall be fitted with neoprene bushing for isolation.
- C. Pump Isolation shall be Amber-Booth Ampad Type NR.

- D. Chiller and Air-Cooled Condensing Unit Isolation shall be Omber-Booth Ampad Type NR.
- E. Furnish supporting calculations on all isolator selections for Engineer's review before fabrication.
- F. All vibration isolators are to be of corrosion resistant construction.
- G. Comparable isolators by Korfund,; Vibration Mountings, Inc.; Mason Industries, Inc.; or Peabody are acceptable.

15. NOISE AND VIBRATION

- A. The entire system and its component items of equipment as installed shall operate without objectionable vibration or noise as determined by the Architect. If, in the opinion of the Architect, objectionable vibration or transmission thereof to the building occurs, execute such measures as are necessary to eliminate such unsatisfactory operating conditions. Material shall be furnished and labor required shall be performed at no cost to the Owner.

16. PIPE, FITTINGS AND JOINTS

- A. All pipe and fittings shall be of domestic manufacture.
- B. Plastic pipe and/or plastic pipe covering materials shall not be used.
- C. All chilled water piping shall be ASTM A-53, A-106 or A-120 seamless or butt-welded Schedule 40 black steel pipe.
- D. Underground chilled and hot water piping shall be ASTM A-53, A-106 or A-120 seamless or butt-welded Schedule 40 black steel pipe with factory applied closed cell urethane or foam glass insulation with a PVC outer jacket. Insulation shall be a minimum of 1" thick with a K value of 0.13 or less. After connecting and testing the piping system, pipe joints shall be insulated with a material equal to the pipe insulation and covered with a jacket equal to the pipe jacket. The preinsulated pipe system shall be equal to Thermafab by Thermacor Process Inc., or Insul-8 by Rovanco Corp. Minimum jacket thickness shall be as follows:

<u>Pipe Size</u>	<u>Jacket Thickness</u>
1" - 1-1/2"	60 mils
2" - 3"	70 mils
4" - 5"	80 mils
6"	100 mils

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- E. At Contractors option, copper pipe may be used for chilled water. Copper water pipe shall be Type K hard drawn, with soldered joints. Use 50-50 Tin-Lead solder.
- F. Condensate drain piping shall be ASTM A-120 screwed Schedule 40 galvanized steel pipe. Condensate drains shall be full size of equipment drain connection on each individual unit.
- G. All pipe two inches and smaller shall be screwed with malleable iron fittings. All pipe 2-1/2 inches and larger shall have plain ends, beveled for welding, with flanged connections at equipment and valves.
- H. Unions or flanged connections shall be provided to allow each item of equipment to be removed from the system without removing any main piping. Unions in screwed piping shall be Crane No. 1280 or equal. Flanges shall be 150 lb. iron with composition gasket.
- I. All nipples shall be of the same material and finish as pipe on which used.
- J. All piping shall be sloped to low points for drainage. Install a 3/4" gate valve at each low point of each system for draining the system.
- K. At connections between steel pipe and copper pipes, provide a dielectric union to prevent galvanic corrosion.

17. VALVES

- A. Valves shall be installed at the inlet and outlet of each piece of equipment and/or as required to vent, drain, balance and service the systems. All valves 2" and smaller shall be screwed; 2-1/2" and larger shall be flanged.
- B. Valves listed below shall be used for water service.

TYPE	MFGR.	2" & SMLR.	2-1/2" & LGR.
Gate	Jenkins	#47 (150#)	#651A (125#)
Globe	Jenkins	#106A (150#)	#613 (125#)
Ball	Jenkins	#900T or 901T	#1001
Butterfly	Jenkins		
	(150#/200 F.)	232 EL or EG	232 EL or EG
	Dezurik		
	(175#/250 F.)	#632L	#632L
Plug	Dezurik	#499S	#499F or 118F

- C. Gate valves 2 inch and smaller shall be bronze 150-PSI saturated steam, 300 PSI non-shock cold water, oil or gas, rising steam. Valves shall have pressure containing

parts conforming to ASTM B-62 and shall have malleable iron handwheels with a square shank connection. Gland followers shall be furnished on all bronze valves. Packing boxes shall have adequate depth to allow space for sufficient amounts of braided asbestos teflon stem packing.

- D. Gate valves 2-1/2 inch and larger shall be 125 PSI saturated steam, 200 PSI non-shock cold water, oil, or gas, bolted bonnet, non-rising stem, solid wedge, iron type with pressure containing parts conforming to ASTM A-126, Grade B. Wedge and seat ring material shall conform to ASTM B-62. OS&Y gates which fasten the wedge to the stem by threads shall be secured by a nickel alloy or monel pin. A steel lubrication fitting shall be furnished on the yoke cap of all iron body OS&Y gate valves.
- E. Globe valves 2 inch and smaller shall be bronze, 150 PSI saturated steam, 300 PSI non-shock cold water, oil, or gas and shall have pressure containing parts conforming to ASTM B-62 and malleable iron handwheels with a square shank connection. Gland followers shall be furnished on all bronze valves. Packing boxes shall have adequate depth to allow space for sufficient amounts of braided asbestos teflon stem packing. Valves shall be furnished with renewable composition disc and bronze seat.
- F. Globe valves 2-1/2 inch and larger shall be 125 PSI saturated steam, 200 PSI non-shock cold water, oil, or gas, iron valves with pressure containing parts conforming to ASTM A-126, Grade B. Disc and seat ring material shall conform to ASTM B-61 or B-62. Valves shall have regrind-renew beveled bronze disc and seat rings.
- G. Check valves 2 inch and larger shall be Mission Duo-chek, split plate, threaded lug pattern non-slam design, or Jenkins Fig. 778R 125/150 flanged, non-slam suitable for horizontal or vertical mounting between standard ANSI 125 Series cast iron or 150 Series steel flanges. Seats shall be flat to eliminate any tendency to wedge or stick, and shall have resilient seal for bubble tight shut off. Plates shall open against a fixed stop to prevent flutter, and the design shall be such as to eliminate rubbing or scuffing of the seals when opening or closing. Valve to have iron body, bronze plates, stainless steel spring and pin.
- H. Butterfly valves shall be threaded lug type, 150 lb., resilient seat, extended neck, positive shut off to 100 psi differential, throttling handle with memory stop and positive position lock through 8 inch, cast iron body, stainless steel shaft and bronze alloy disc. Wafer type valves are not acceptable.

- I. Coil water flow control valves for chilled water coils shall be reused.
- J. Equivalent valves by Crane, Jenkins, Stockham, Dezurik, Nibco or Keystone are acceptable.

18. PIPE HANGERS AND SUPPORTS

- A. Support horizontal runs of piping from construction above by means of hangers or clamps designed to receive hanger rods. All piping within 30 feet of a pump (including vertical runs) shall be isolated with spring hangers. All other piping may be supported by fixed hanger. Individual hangers for pipes shall be of the adjustable swivel pipe ring type equal to Grinnell No. 101 or 104. Wherever practical, banks of horizontal piping shall be supported by means of adjustable unistrut trapeze hangers spaced not more than ten (10) feet apart. Individual ring hangers shall be spaced not more than five (5) feet apart for 3/4 inch pipe; not more than six (6) feet apart for 1 inch pipe, and not more than ten (10) feet for 1-1/2 inch pipe and above. Hangers shall be adjustable. Cooperate with other trades for group piping.
- B. Insulated pipe shall have 18 inch wide galvanized iron bands not less than 16 gauge, 1/2 circle around insulation with ring hangers over this to prevent cutting insulation. Insulation shall have rigid inserts at these supports.
- C. Underground runs of piping shall be evenly supported on bedding material of firm natural earth, compacted sand or gravel as required by manufacturer's recommendations.
- D. All hangers, rods and supports shall be galvanized or cadmium plated.
- E. All pipe hanger spacing shall comply with the published recommendations of the manufacturer for the type pipe used.
- F. Copper pipe and tubing shall be isolated from hangers, supports or other dissimilar metals.

19. PIPE SLEEVES AND PLATES

- A. Furnish and install 18 gauge galvanized sheet metal sleeves sized to allow the pipe covering to pass through wall, floor, and roof construction. Seal with a Link Seal Model PL on each side of wall. Where pipes pass through floors above finished space extend sleeve one inch above finish level of upper floor.

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- B. Furnish and install heavy chromium plated steel plate, comparable to No. 1-BC and No. 10-BC as manufactured by the Crane Company, for all exposed pipes passing through floors, walls, ceiling or partitions.

20. THERMOMETERS AND GAUGES

- A. Thermometers shall be Weksler adjustable angle industrial thermometers with stainless steel front frame, cast aluminum case and chrome plated 3/4" NPT brass separable socket and extension well as required, nine inch case size. Thermometers shall have lens red-reading mercury tubes and white scales with black numerals. Locate on inlet and outlet of each boiler, chiller and each water coil handling 2000 cfm or more.
- B. Gauges shall be 4-1/2 inch dial Weksler Royal (1/2% accuracy) with aluminum case, brass screw ring, with 0 to 100 psi range, all stainless steel rotary movement, white dial, black letters and numerals in a 270° arc. Locate on the inlet and outlet of each water pump and as shown on the drawing. All gauges shall be installed complete with gauge cocks.
- C. Gauge cocks shall be polished brass, tee handle, have hydraulic ratings in excess of 300 psi and shall have hex shoulders. Gauge cocks shall be located at each item of equipment, one on the inlet and one on the outlet, and shall be 1/4 inch Weksler A10E or Nibco T-235 valve.
- D. Pete's plugs shall be installed on the inlet and outlet of each water coil handling less than 2000 cfm. Pete's plugs shall have a valve core of neoprene and body of brass. Extra length plugs shall be used where insulation thickness would cover the standard length plug. Plugs shall be rated for a minimum of 200 deg. F and 500 psig. Furnish with brass cap and gasket.
- E. Marsh, Trerice and Marshalltown are acceptable manufacturers.

21. AUTOMATIC TEMPERATURE CONTROL (PNEUMATIC)

- A. The temperature control system shall consist of pneumatic and electronic controls and shall incorporate all equipment necessary to accomplish a sequence of operation as described hereinafter and as shown on the Drawings. The Control System shall be reconditioned by personnel regularly employed by the automatic temperature control manufacturer.

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- B. All new temperature control devices shall be standard catalog products and shall essentially duplicate equipment which is on the project and has been in satisfactory service for at least 3 years and shall be essentially the products of one manufacturer. All control components shall be U.L listed and labelled.
- C. After completion of the installation, regulate and adjust all thermostats, control valve operators, damper operators and other equipment. Place the control system in operation subject to the approval of the Engineer.
- D. All wiring in connection with the temperature control system shall be provided under this contract. Furnish detailed wiring diagrams showing electrical connections, control devices and all required interlocks. All wiring shall be in conduit, regardless of voltage.
- E. Use the existing compressed air distribution system and extend it as required. New tubing shall comply with the following:
 - (1) Compressed air lines in exposed areas and mechanical equipment rooms and return air plenums shall be seamless, hard copper tubing, Type K with soldered wrought copper fittings. In inaccessible concealed areas, Type L soft copper without fittings or joints shall be installed.
 - (2) Dekoron 1219FR polyethylene tubing may be used within control device cabinets or housings, for final connection to control devices and operators, length shall not exceed 1'-0". Protect with a spiral wire spring.
 - (3) Suitable drip legs and drains shall be installed in the control air system at all low points to prevent condensation pockets and all control air piping shall be sloped to the drip legs.
 - (4) All tubing shall be properly supported at regular intervals and shall be concealed wherever possible, or when exposed, it shall be as inconspicuous as possible.
 - (5) Where pneumatic tubing is exposed in finished spaces, it shall be recessed where existing construction permits, but may be surface mounted where recessed installation is not feasible.
 - (6) The entire system shall be tested by placing it under 120 PSIG pressure for 24 hours. The pressure drop during this period shall not exceed 2 PSIG.

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- (7) Air supply pipe size calculations shall be submitted as part of the control diagrams. Also calculations and/or graphs showing the pipe size to be adequate and cause no more than 0.5 PSI drop in the supply pressure throughout the entire project. Under no circumstances shall any main air piping be less than 3/8" copper. A main air line is defined as supplying more than four controllers or handling more than 90 SCIM of control air.
 - (8) All exposed air lines shall be run in a neat and parallel manner to the building surface. Multi-lines shall be neatly arranged and hung on trapeze hangers spaced every six feet. Lines may be supported on parallel water piping as available if run in a neat, straight, workmanlike manner, concealed from view in exposed areas insofar as possible, and if securely strapped to the pipe with clear plastic or aluminum bands on six foot centers, maximum. Provide dielectric separation between copper and dissimilar metals.
 - (9) Provide brass or copper stopcocks to act as branch shut-off valves in air piping. Control tubing shall be routed to serve the main building areas in a manner paralleling the water piping. Stop cocks shall be provided in branch taps to each riser on line serving groups of units. Provide detail Drawings of the air piping layouts.
- F. Pneumatic Room Thermostats shall be two-pipe, pilot-bleed, with forced-balanced feedback principle. They shall contain low-mass, bi-metallic sensing elements insulated from the thermostat base for maximum responsiveness. They shall have an adjustable throttling range, setpoint, stops, gauge adapter and clear locking covers. They shall be provided with a setpoint indication and a thermometer. Thermostat shall control within $\pm 1^{\circ}\text{F}$ of setpoint. All thermostats shall have vandal-proof locking covers. Replace existing thermostats if required for proper operation.
- G. Use instrument air from the existing system.

- H. Temperature sensors shall employ pneumatic feedback and transmit a linear signal over the complete span with negligible hysteresis. They shall be designed for wall, duct or well mounting. They shall be of a fixed range, bimetallic type with tamper-proof construction. All wall mounting sensors shall have a range of 50°F to 100°F. All sensors which are used in liquid streams shall be furnished with separable wells to provide adequate protection and allow for accurate temperature measurements with minimum lag. Duct mounted sensors shall be of sufficient length and properly supported to average temperature throughout the cross sectional area of the air stream in which they are located. All sensors shall be corrosion and vibration resistant, factory calibrated and tamper-proof. If capillary type sensors are used in lieu of bi-metallic type, exposed capillary shall be armored or installed in protective tubing and capillary shall be ambient compensated. Replace existing sensors if required for proper operation.
- I. Electric-Pneumatic Relay shall be 3-pipe body of metal alloy with all internal operating parts of corrosion resistant stainless steel. Device shall be provided with wall mounting brackets, manifold for tubing connections, and junction box for wiring connection.
- J. Pneu-Electric Switches shall be diaphragm operated snap acting switch. Setpoint shall be adjustable from 3 to 15 PSIG and differential adjustable from 1.5 to 5 PSIG. Switches shall be rated for resistance loads with a minimum rating 7.2 amps to 277 volts AC and 8.3 amps at 120-240 volts AC. Pneu-electric switches must be U. L. tested and approved for the 100,000 cycle test. Co-ordinate voltage requirements.
- K. Water Flow Switch shall be packless construction with all wetted parts made of brass and designed for mounting in a pipe tee. Device shall be capable of being mounted in pipe tee's 1" and larger. Paddle shall be provided with removable segments to accommodate required pipe size and flow. Minimum velocity shall be factory set; velocity setting shall be field adjustable.
- L. Air Flow Switch shall detect air flow or absence of flow in ducts responding only to velocity. Paddle size shall be 2-1/8" X 6-7/8" for minimum 300 FPM velocity and 3-1/8" X 6-7/8" for minimum 175 velocity. The switch shall have a NEMA 1 enclosure with integral mounting plate and gasket. Minimum velocity shall be factory set. Velocity setting shall be increase by turning adjustment setscrew. The switch shall be single pole, double throw with a rating of 7.4 amps full load at 120 volts AC.

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- M. Pneumatic Damper Operators shall be piston type with rolling diaphragm and die-cast aluminum body with spring return (plastic or other similar materials will not be acceptable). Each operator shall be full proportioning type to operate the damper under normal conditions and guarantee tight close-off against pressures encountered. Damper operator shall position damper normally closed. Provide operator with all required mounting bases and linkage to properly mount and connect operator to damper. Damper operator shall produce a minimum of 20 inch pounds of torque.
- N. Dampers shall be Johnson Proportion/Air dampers and shall be sized to properly control the flow of air using methods similar to control valve sizing. The dampers shall be constructed with galvanized blades and frames. Blades shall not exceed six inches in width and shall be provided with replaceable EPT rubber seals on the edge and stainless steel side seals. Blades shall be formed in a double sheet corrugated type construction for extra strength. Frames shall be channel shaped for strength and to enclose blade linkage thus keeping linkage out of the air stream. The entire construction shall be such that the leakage does not exceed 1/2% (based on 2,000 fpm and 4" static). Dampers manufactured by the Pacific Air Products Company (Model GDZ-1000 or B 1001) are acceptable. Dampers shall have opposed blades. The control manufacturer shall submit charts for sizing dampers and leakage. Provide end switch for all motorized dampers to energize the respective fan or AHU only after the motorized damper is fully open. Motorized dampers shall be installed in all outside air and exhaust air openings to outdoors.
- O. Temperature controls by Honeywell, Johnson, Robertshaw and Barber Coleman are acceptable.

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22. SEQUENCE OF OPERATION

- A. Reuse the existing automatic temperature controls for the air handlers to the extent that they are fully operational, replace if not. Revise and/or modify the control system as required to connect the new chilled water pumps and the new air cooled reciprocating water chillers into the system. Replace and put the outside air pretreatment unit into operation.
- B. A flow switch shall be installed in the chilled water system to prove chilled water flow before the chiller can start. A lead lag seven day timer shall be installed to switch chillers each week. Only one chiller shall operate at any one time. The second chiller is a back-up.
- C. When any air handling unit is turned "ON", and is calling for cooling, the selected chilled water pump shall start.

After the chilled water flow switch closes, the selected chiller shall start its cycle and come on line. The chiller shall unload through its own controls to maintain leaving chilled water temperature.

- D. The outside air unit shall be replaced. Replace all controls. Unit shall produce a constant 75°F (adjustable) leaving air temperature. When the air handling system is turned "ON", the O.A. unit shall run. When the system is "OFF" the O.A. unit shall stop and the motorized O.A. damper shall close.
- E. One chilled water pump shall serve as a back-up for the other. Install an electrical alternator to switch the pumps each time they are switched "OFF".

23. SPECIALTIES

- A. Reconnect the existing compression tank into the suction side of the new chilled water pump.
- B. Air vents shall be Bell-and-Gossett No. 7 or Maid-O-Mist No. 71 in hot water systems and Clark No. 245-V, or Maid-O-Mist No. 71, 3/4 inch or equal in chilled water systems. Air vents shall have overflow connections extended to drain points and a working pressure of not less than 150 psi. Body and cover shall be cast iron. Float shall be stainless steel and internal parts shall be bronze. Air vents at coils shall be Hoffman No. 500 or Maid-O-Mist No. 72
- C. Relief valves shall be Bell-and-Gossett, McAlear or Watts. Install relief valves for hot water systems, chilled water systems, compressed air systems, steam systems, etc., with ranges selected to meet conditions of service.
- D. Install strainers ahead of all air control valves, pressure reducing valves, pumps and all traps. Select basket mesh size to meet conditions of service.
 - (1) Cast Iron Y-type strainers with blow-off connections shall be McAlear style S screwed, and style F-1 flanged, ASTM B-61.
 - (2) Basket strainers shall be McAlear No. 528B cast iron, ASTM A 126, with bolted cover.

24. TERMINAL BOXES

- A. Terminal boxes shall be Anemostat high velocity, diffuser or end discharge as shown on drawings, constant volume, double duct units. Terminal boxes shall replace existing boxes.

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- B. Boxes shall have dual inlet valves, mechanical constant volume regulator, corrosion resistant steel casing, internal insulation, baffles for air mixing, access doors, pneumatic temperature control operators and air discharge connections as shown on the drawings.
- C. As an Alternate bid, reuse the existing terminal boxes and replace the mechanical constant volume controllers and pneumatic temperature controllers. Recondition the boxes and warrant the proper operation of all boxes for a period of one year. Should any problems occur during the one year warranty period, furnish all labor, materials, etc. required to put the boxes back into satisfactory operation at the Contractor's own expense.

25. FLEXIBLE DUCT

- A. Flexible duct shall be Flexmaster Type 3, a factory pre-insulated product designed for low to high pressure HVAC air distribution systems. Flexible duct shall be UL-181 Class 1 Air Duct. Liner shall be a trilaminate of aluminum foil, fiberglass and aluminized polyester, mechanically locked without adhesives. Helix shall be corrosion resistant galvanized steel, formed and mechanically locked to fabric. Outer jacket shall be gray fire retardant polyethylene. Insulation shall be fiberglass blanket, factory wrapped, with a thermal conductance "C" of less than 23. Flex duct shall meet the requirements of NFPA 90A & B, BOCA & ICBO.
- B. Ends of flexible duct shall be secured to diffusers and main duct with a duct strap. Strap inner liner with one duct strap and outer liner with a separate strap.
- C. Spin-ins for flexible duct connections shall have air scoops and a volume damper which is adjustable through the insulation from the outside of the duct. Spin-ins shall be Flexmaster FLDE.
- D. Products meeting the above specifications, manufactured by Thermaflex or Clevaflex are acceptable.

26. AIR COOLED RECIPROCATING WATER CHILLERS

- A. Furnish and install packaged air-cooled reciprocating liquid chillers with capacities scheduled. Chillers shall be certified in accordance with ARI Standards 590-81.
- B. Each packaged air cooled liquid chiller shall be completely factory assembled including all interconnecting refrigerant piping and internal wiring of

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controls. The unit shall be mounted on a steel base which accommodates the air cooled condenser, compressors and cooler. The unit shall be shipped with full operating charge of refrigerant.

- C. Compressors shall be accessible reciprocating serviceable type with all rotating parts statically and dynamically balanced. Compressors shall have forced feed lubrication system using a reversible positive displacement type oil pump. Compressors shall also include a suction strainer, oil strainer, crankcase oil sight glass, crankcase oil heater, and backsetting seal-cap type suction and discharge stop valves. Compressors shall be mounted on spring type vibration isolators. Provide compressors with 2nd thru 5th year extended parts replacement warranty.
- D. The motor shall be high torque, 1750 rpm, refrigerant gas-cooled and shall be protected with inherent three phase over-load protection. Motor starters shall be factory mounted and wired on the chiller. Disconnect switches shall be furnished and installed under Division 16.
- E. The capacity control system shall modulate compressor capacity automatically. Unloading shall be controlled by a solid state temperature controller.
- F. The cooler shall be direct expansion shell and tube type with refrigerant in tubes and liquid to be chilled in the shell. Refrigerant heads shall be removable. The cooler shall be equipped with a heater cable, covered with 1" of fiberglass insulation for freeze-up protection to minus 20°F ambient. The cooler shall be constructed and tested in accordance with ASME code requirements.
- G. The condenser coil shall be constructed of seamless copper tubes, arranged in staggered rows, mechanically expanded into aluminum fins. The condenser should include, as in integral part of the design, a sub-cooling circuit.
- H. The condenser fans shall be propeller type, providing vertical air discharge. Fan blades shall be statically and dynamically balanced, protected above by anodized fan blade guards. Each fan shall be driven directly by an individual motor. Fan motors shall be of the high torque type, inherently protected, ball bearing construction, permanently lubricated and equipped with 5-year lubrication plugs.

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- I. There shall be a minimum of two complete refrigerant circuits per chiller. The refrigerant circuit shall be constructed of copper tubing with brazed joints, and shall include: shut-off valve with charging connection, sight glass, moisture-liquid indicator, direct acting thermal expansion valve, solenoid valve and replaceable core filter-drier. The entire suction line and liquid line between the expansion valve and the cooler shall be insulated with flexible closed cell insulation.
 - J. Units shall have control and power sections. All controls and motor starting equipment shall be U.L. listed and labelled components and wiring; factory wired and mounted in weatherproof compartments, and shall include: control power transformer if required, control fuse, 3-position (on-off-pump-down) selector switch, high and low refrigerant pressure safety switches, low oil safety switch, freeze protection controls, interlocks for inherent motor protectors, cooler heater thermostat, low ambient temperature control, recycling pump-down circuit, fan cycling pressure control, solid state fan speed controls, high discharge temperature safety switches, multi-solid state operating thermostat and compressor short-cycle protection. A flow switch shall be furnished as standard for field mounting. Provide Timemark #C-265 3-phase power monitor for each chiller unit, mounted within the control panel.
 - K. Refrigerant pressure control, sensing head pressure, shall be standard to maintain constant head pressure down to 25°F ambient.
 - L. Units shall be mounted on vibration isolators.
 - M. Units manufactured by Carrier, Trane, York or Bohn are acceptable.
27. PUMPS (END SUCTION)
- A. Pumps shall be end suction, flex coupled, single stage, centrifugal, bronze fitted with replaceable wearing rings, mechanical seals, and welded steel drip type base-plate with threaded condensate drain connection. Base shall extend under both pump and motor. Pumps shall be designed to allow removal of impeller from case without disturbing piping or volute. All motors shall be selected to be non-overloading throughout the entire pump curve without the use of service factor. Motors shall be minimum horsepower as scheduled on Drawings.
 - B. The diameter of the impeller at selection point shall be no greater than 90% of the maximum diameter impeller that the pump will accept.

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- C. Casing shall be close grain cast iron of hydraulic balance design and with a minimum 150 psi hydrostatic test pressure.
- D. Shaft shall be cold rolled steel machined to size. Diameter shall be adequate for operation over the entire range of the pump ultimate capacity. Pumps shall have replaceable shaft sleeves.
- E. Shaft bearings shall be Type SKF or equal with a minimum rated life of 50,000 hours. Bearings shall be locked to shaft by lock nuts.
- F. Condenser water pumps shall have packing glands.
- G. Motor shall be TEFC high efficiency motor with 1.15 service factor. Indicate on submittal the brand name of the motor being supplied with unit. Motor starters and disconnect switches shall be furnished and installed by Division 16.
- H. Pumps shall have coupling guards
- I. Pumps by Bell & Gossett, Aurora, Pacific, Peerless, Armstrong, or Allis-Chalmers are acceptable.

28. REFRIGERANT AND OIL

- A. Leave the refrigeration systems with full charges of refrigerant and oil. Maintain a full charge of refrigerant and oil in the system for a period of one year from date of acceptance. Should any leaks in the refrigeration system occur during the guarantee period, eliminate such leaks and recharge system to a full charge of refrigerant and oil at no cost to the Owner.

29. TESTING

- A. During construction all piping systems shall be tested and proven tight before finishing or insulating.
- B. Test hydronic systems hydrostatically to 150% of maximum operating pressure or 100 PSIG, whichever is greater. Test shall be maintained for 30 minutes with no indication of leakage.
- C. Test refrigerant lines with dry nitrogen with refrigerant tracer, halide torch and soap suds at 150% of maximum operating pressure. Test shall be maintained for 30 minutes with no indication of leakage.

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- D. Air and water flow systems shall be adjusted and balanced to the quantities indicated on the drawings. A tabulated report indicating final air quantities shall be prepared and presented to the Engineer prior to approval of final payment.
- E. Equipment shall be tested to prove that it is capable of delivering the specified capacities and operating properly after it is completely installed.
- F. All tests shall be witnessed by the Architect or his representative.

30. TESTING AND BALANCING - HVAC SYSTEMS

- A. Work shall include the Testing and Balancing of the complete HVAC Systems.
- B. All HVAC airside and hydronic systems shall be tested and balanced by an independent N.E.B.B. certified balancing Sub-Contractor, whose operations shall not be in any manner connected with the Mechanical Sub-Contractor who installs the HVAC Systems. The independent certified balancing Sub-Contractor shall be a Sub-Contractor to the General Contractor. The N.E.B.B. Manual for "Procedure Standards for Testing-Balancing-Adjusting of Environmental Systems", latest edition, shall be strictly adhered to.
- C. All HVAC equipment and systems shall be tested to prove that scheduled capacities have been met or exceeded and that the equipment and systems are operating properly. Test results shall be submitted to the Architect/Engineer for review prior to the final jobsite inspection. Equipment and/or systems that fail to meet scheduled capacities shall be revised and/or replaced as required to meet the scheduled capacities. All costs, including retesting, shall be done under the base contract with no increase in contract cost.
- D. Use published N.E.B.B. procedures to balance the air and hydronic systems to quantities shown on Plans. Submit eight (8) copies of a written report using published N.E.B.B. forms to the Architect/Engineer for review, indicating final air and water quantities, prior to final jobsite inspection for acceptance of the project. List all air quantities, using the room numbers shown on the contract document set of Architectural floor plans.
- E. The report shall include a complete list of the test instruments and the date of the last calibration of each test instrument.

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- F. Include in the report a certification that all volume and backdraft dampers have been installed, include motor horsepower, running load amps, and manufacturer and model number of each motor tested. List all air distribution devices, and/or HVAC equipment that operates noisily so that corrective measures may be initiated.
- G. If additional testing ports, tees or taps and balancing plug valves or dampers in air or hydronic systems are required to properly test and balance the HVAC systems, they shall be furnished and installed under the base Division 15 work, with no increase in contract cost.

31. JOB CLEAN-UP

- A. Job site shall be kept in a neat and workmanlike manner during all phases of construction. All debris shall be removed from site daily.
- B. Before cover-up, all debris shall be removed from crawl spaces, chases and from all other areas no matter how accessible. All equipment and pipes shall be thoroughly cleaned of dust and construction drippage.

32. FILTERS (OUTSIDE AIR UNIT)

- A. Prefilters shall be 2" thick disposable 25% ASHRAE efficiency filters.
- B. Chemical filters shall be 2-1/2 inch thick bed of potassium permanganate, 4% by volume, 306 stainless steel perforated trays. Trays shall be designed so they can be recharged.
- C. Final filters shall be 8" thick 80% ASHRAE efficiency filters.
- D. Filters shall be side access.

33. HYDROGEN SULFIDE GAS DETECTOR

- A. Furnish and install one single channel hydrogen sulfide gas alarm system to monitor the air in the basement mechanical room. The analyzer shall be similar to Bacharach XD502. The unit shall alarm locally in the mechanical room.

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B. Gas analyzer shall have:

- 1) Detector assembly
- 2) Detector amplifier
- 3) Bacharach XD502 control unit
- 4) Power "ON" light
- 5) H_2S ppm meter
- 6) Alarm indicator
- 7) Fail indicator
- 8) Test pushbutton
- 9) Reset pushbutton
- 10) Zero adjustment
- 11) Span adjustment
- 12) Trigger point adjustment
- 13) External annunciator relays

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