

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. The requirements of the General Conditions, Supplementary Conditions and the following Specification sections apply to all Work herein:
1. Section 23 00 10 - General Requirements
 2. Section 23 00 20 - HVAC Scope of Work
 3. Section 23 05 07 - Design Conditions
 4. Section 23 05 30 - Miscellaneous Equipment
 5. Section 23 21 13 - Pipes, Valves, Fittings, and Accessories
 6. Section 23 21 23 - Pumps
 7. Section 23 31 00 - Ductwork and Sheet Metal
 8. Section 23 41 00 - Tanks and Vessels
 9. Section 23 57 19 - Liquid-to-Liquid Heat Exchangers for HVAC
 10. Section 23 64 16 - Centrifugal Water Chilling Units

1.2 SUMMARY

- A. Furnish and install thermal insulation as specified herein and as indicated on the Drawings.

1.3 REFERENCE STANDARDS

- A. All thermal insulation shall be designed, manufactured and tested in accordance with the following latest applicable standards:
1. ASTM B209, C34, C177, C355, C533, C547, C552, C585, E-84 and E-96
 2. NFPA 225
 3. UL 723
 4. Council of American Building Officials Report No. NER - 332
 5. ADA
- B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

- A. The following submittal data shall be furnished according to the General Conditions and Section 23 00 10 and shall include, but not be limited to:
1. Thermal Insulation complete with materials, thermal properties, adhesives, installation details, etc. Certification required as specified herein for flame spread and smoke developed.
 2. Factory Test Reports
- B. Specification compliance review required. Refer to Section 23 00 10.

1.5 WARRANTY

- A. Comply with the requirements of the General Conditions and Section 23 00 10.

PART 2 PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. If they comply with these Specifications and have the same thermal properties, density, fire rating, etc., as the types specified herein, products by the following manufacturers will be acceptable.
1. Adhesives and mastics shall be as manufactured by Armstrong, Childers, Foster Products Corporation, Johns Manville or 3M.

2. Aluminum jacketing shall be as manufactured by Childers, Pro-Tec-T-Kotes, Inc., RPR Products Inc. (Houston, TX) or Johns Manville.
3. Calcium silicate non-asbestos insulation materials shall be as manufactured by Owens-Corning, Pabco or Johns Manville.
4. Cellular glass insulation materials shall be as manufactured by Pittsburgh Corning, ICA-H Block or approved equal.
5. Elastomeric piping insulation materials shall be as manufactured by Armstrong, Rubatex or Nomaco.
6. Glass fiber insulation materials shall be as manufactured by Certain Teed, Knauf, Owens-Corning, Johns Manville, or Manson.
7. Polyurethane foam insulation materials shall be as manufactured by Dow Plastics - Trymer 2000, Dupont, or approved equal.
8. PVC insulated fitting covers shall be as manufactured by Knauf (Proto), Foster Products Corporation (Speedline), or Johns Manville.
9. High temperature blanket type insulation materials shall be as manufactured by Calsil, Nelson Fire-Master High Temp FSB Flameshield Blanket, or Johns Manville Firetemp Wrap SL, FyreWrap Elite 1.5, or 3M Fire Barrier Duct Wrap 615+ or 15A.

2.2 GENERAL

- A. All insulation exposed within ducts or in return and supply air plenums shall have a composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard rating as tested by Procedure ASTM E84, NFPA 225, UL 723 and UBC Standard 8-1 not exceeding:
1. Flame Spread 25
 2. Smoke Developed 50
 3. Accessories, such as adhesives, mastics and cements, shall have the same component ratings listed above. All insulation materials, together with adhesives and finishes, shall be submitted for review. It shall be certified in writing that all products to be used on this Project comply with the above criteria. All products or their shipping cartons shall bear labels indicating that flame and smoke ratings do not exceed above requirements.

2.3 THERMAL INSULATION FOR PIPE, VALVES, FITTINGS, AND ACCESSORIES

- A. Insulation Materials (see Paragraph 3.6: Mechanical Piping Insulation Schedule):
1. Type A: ASTM C547 glass fiber pipe insulation with thermal conductivity (k factor) not exceeding 0.23 (Btu x In) / (Hr x Ft² x °F) at 75°F mean temperature. Insulation shall be jacketed with white reinforced all service vapor retarding jacketing. Vapor barrier mastic shall be Foster 30-80 or Childers CP-35. Adhesive shall be Foster 85-75 or Childers CP-82. At the Subcontractor's option, self-sealing lap jacketing with adhesive release strips on both the lap and the jacket may be used. No exposed staples will be allowed. Fiberglass insulation shall be installed in all areas where the piping system is exposed within ducts or in return and supply air plenums.
 2. Type B: ASTM C518 polyurethane foam pipe insulation with thermal conductivity (k factor) not exceeding 0.14 (Btu x In) / (Hr x Ft² x °F) at 75°F mean temperature. Insulation shall be jacketed with white reinforced all service vapor retarding jacketing. Insulation shall have a fire and smoke hazard rating as tested by procedure ASTM E84 and UL-723 not exceeding:
 - a. Flame Spread 25
 - b. Smoke Developed 55-80 - 1" thickness
 - c. Smoke Developed 90 - 2" thickness and up
 - d. Vapor barrier mastic shall be Foster 30-80 or Childers CP-35. Adhesive for laps shall be Foster 85-75 or Childers CP-82. Fittings shall be the molded type with 20X20 glass fabric sealed with Foster 80-20 vapor barrier mastic. Type B polyurethane foam insulation shall be installed only on chilled and heating hot water piping (not exceeding 300°F), which is not within ducts or areas that are not exposed to return or supply air plenums and in accordance with local codes and regulations of the authorities having jurisdiction.
 3. Type C: Armstrong Type AP Armaflex or Rubatex R-180-FS 25/50 rated flexible elastomer pipe insulation. Insulation shall have a thermal conductivity (k factor) of not more than 0.28 (Btu x In) / (Hr x Ft² x °F) at 75°F mean temperature when tested by ASTM C177 and a water vapor permeability of 0.20 or less when tested by ASTM C355 water method. Adhesive shall be Armstrong 520 or Rubatex R-373.
 4. Type D: (ASTM C533) Hydrous calcium silicate non-asbestos insulation similar or equal to Schuller Thermo-12 Gold. The insulation shall have an average thermal conductivity (k factor) not exceeding 0.44 (Btu x In) / (Hr x Ft² x °F) at a mean temperature of 300°F. Insulation shall be finished with

Ramcote 1200 or Pro-Tec-T-Kotes "V" One Coat high temperature finishing cement. All materials shall be suitable for 1200°F service.

5. Type E: ASTM C547 glass fiber pipe insulation with thermal conductivity (k factor) not exceeding $0.23 \text{ (Btu} \times \text{In)} / \text{(Hr} \times \text{Ft}^2 \times \text{°F)}$ at 75°F mean temperature. Insulation shall be internally lined with a hydrophilic wicking cloth material extending to rows of evaporation holes in the outer jacket. Exposed evaporator area shall not be less than 0.1 sq. ft. / linear ft. of insulation. Insulation shall be jacketed with white reinforced all service vapor retarding or polymer facing jacket with self-sealing lap (SSL) release strips on both the lap and the jacket. No exposed staples will be allowed. Insulation shall be Owens Corning VaporWick®, Knauf PermaWick™, or approved equal pipe insulation.

2.4 THERMAL INSULATION FOR EQUIPMENT

A. Insulation Materials (see Paragraph 3.7: Equipment Insulation Schedule):

1. Type A: Armstrong Armaflex II or Rubatex R-180-FS 25/50 rated flexible elastomeric sheet insulation (ASTM C34). Insulation shall have a thermal conductivity (k factor) of not more than $0.28 \text{ (Btu} \times \text{In)} / \text{(Hr} \times \text{Ft}^2 \times \text{°F)}$ at 75°F mean temperature when tested by ASTM C177 and a water vapor permeability of 0.20 perm-inch or less when tested by ASTM C355 Water Method. Adhesive shall be Armstrong 520 or Rubatex 373. The insulation shall be finished with two (2) coats of Armstrong WB Armaflex finish or Rubatex 374 coating.
2. Type B: ASTM C547 glass fiber insulation with thermal conductivity (k factor) not exceeding $0.23 \text{ (Btu} \times \text{In)} / \text{(Hr} \times \text{Ft}^2 \times \text{°F)}$ at 75°F mean temperature. Open ends of the pipe insulation shall be insulated with cellular glass insulation. Insulation shall be thoroughly vapor sealed with Foster 30-35 or 30-80 or Childers vapor CP-35 barrier mastic. Adhesive shall be Foster 85-75 or Childers CP-82.
3. Type C: Enclosure shall be constructed of Pittsburgh Corning Foamglas cellular glass insulation. All seams and joints shall be of lapped construction and bonded with Foster 85-75 or Childers CP-82 mastic. All seams shall be coated with Foster 30-35 or Childers CP-35 vapor barrier mastic. The entire insulation surface shall be coated with two coats of Foster 45-00 or Childers CP-9 mastic reinforced with 20x20 glass fabric.
4. Type D: Hydrous calcium silicate non-asbestos block, similar and approved equal to Schuller Thermo-12 Gold as required to provide the specified minimum thickness. The insulation shall have an average thermal conductivity (k factor) not to exceed $0.44 \text{ (Btu} \times \text{In)} / \text{(Hr} \times \text{Ft}^2 \times \text{°F)}$ at a mean temperature of 300°F. Block shall be held in place with 1/2" x 0.15" galvanized steel bands on 12" centers. Point up with an approved equal insulating cement. Cover with expanded metal lath. Attach metal lath with wiring to bands and lace all edges. Finish with 1/4" thick cement troweled over the metal lath to form a smooth surface. Final finish shall be suitable for painting. At the Subcontractor's option and as approved by the Engineer and the authorities having jurisdiction, lightweight, non-asbestos, high temperature inorganic ceramic fiber blanket duct wrap similar and approved equal to Nelson Firestop Products, Flameshield Blanket ("FSB") with Nelson Firestop Putty ("FSP"), or Johns Manville Firetemp Wrap SL and other accessory products including but not limited to tapes, banding materials and insulation pins, as required for a complete system may be provided for kitchen exhaust ducts in lieu of the hydrous calcium silicate insulation system specified above. Duct Wrap shall be a two (2) hour fire resistive enclosure system, shaft enclosure, with zero (0) clearance to combustibles when used with a listed and approved through penetration fire stop system complying with ASTM E 119/UL 263, ASTM 136, ASTM E 814/UL 1479, ASTM 84/UL 723, and UL 1978. The insulation system shall be installed in accordance with all manufacturer requirements and recommendations as well as the requirements of the applicable codes, rules, regulations and standards.
5. Type E: Factory insulated.

2.5 EXTERNAL THERMAL INSULATION FOR DUCTWORK

A. Insulation Materials (see Paragraph 3.8: Ductwork Insulation Schedule):

1. Type A: Fiberglass flexible blanket type insulation 0.75 pound density, 1-1/2" thick with a reinforced foil vapor barrier facing. The insulation shall be secured to the ducts with Childers CP-85, Foster 85-20 or Minnesota Mining EC-1329 adhesive applied in 6" wide strips on approximately 12" centers. Where rectangular ducts are 24" in width or greater, duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18" centers (maximum) to prevent sagging of insulation. Seal all joints with minimum 3" wide FSK Tape with identical vapor barrier facing. At the Subcontractor's option the blanket type insulation may be secured to the rectangular ducts with mechanical fasteners, such as pins and speed chip washers, on the sides and on the underside of the duct. The mechanical fasteners spacing shall not exceed 12" and spaced 3" (maximum) from the butt joint. All butt joints shall have the factory lap sealed with adhesive

- and staples or minimum 3" wide FSK tape with identical vapor barrier facing. Longitudinal joints shall be lapped and folded and securely stapled in place. Longitudinal joint staples spacing shall not exceed 6".
2. Type B: Owens-Corning Thermal Insulating Wool (TIW) Type II, with a density of 2.4lb. per cubic foot and suitable for at least 85°F service temperature. Furnish a shop attached vapor barrier, reinforced, FSK jacket secured to the wool with Foster 85-75. Secure insulation to duct with weld pins and washers. Seal all joints (longitudinal and transverse) and weld pin penetrations with 3" wide strips of the vapor barrier jacket adhered with Foster 85-75. All outside ductwork must be waterproofed and shall be covered with 20 x 20 glass fabric sealed with two heavy coats of Foster 60-38 or Childers Encacel X vapor barrier mastic.
 3. Type C: Pabco "Super Fire Temp" (SFT), non-asbestos, press molded Xonolite calcium silicate board or 6 lb. density, 1-1/2" thick lightweight, non-asbestos, high temperature inorganic ceramic fiber blanket duct wrap similar and approved equal to Nelson Fire Stop Products, Flameshield Blanket ("FSB") with Nelson Fire Stop Putty ("FSP") and other accessory products including but not limited to tapes, banding materials and insulation pins, as required for a complete system. Duct Wrap shall be fire resistive enclosure system, shaft enclosure, with zero (0) clearance to combustibles when used with a listed and approved through penetration fire stop system complying with ASTM E 119, ASTM 136, ASTM E 814, UL 723, UL 1479 and UL 1978. The insulation system shall be installed in accordance with all manufacturer requirements and recommendations as well as the requirements of the applicable codes, rules, regulations and standards. Entire kitchen exhaust duct from grease removal range hood outlet collar as indicated on the drawings shall be enclosed by the insulation. Enclosure shall provide a minimum of two (2) hour fire resistive rating. Enclosure shall be constructed in accordance with the manufacturer's instructions and the Council of American Building Officials Report No. NER-332 for 0" clearance from duct enclosure to combustibles. The insulation system shall be installed in accordance with all manufacturer requirements and recommendations as well as the requirements of the applicable codes, rules, regulations and standards.
 4. Type D: Factory insulated equipment. Additional field insulation not required.
 5. Type E: Rigid Board Fiberglass. Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612 Type IB, without facing and with FSK jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. The complete thermal insulation installation shall be in accordance with the manufacturer's written standards and recommendations and as indicated by the Contract Documents.
- B. No insulation shall be applied until the surfaces of equipment to be insulated are thoroughly cleaned and until pipes and equipment to be insulated have been hydrostatically tested and proven tight by the HVAC Subcontractor and accepted by the Engineer. Any leaking pipes or equipment shall be brought to the attention of the HVAC Subcontractor who shall cause these conditions to be corrected. All surfaces shall be thoroughly dry before application of any insulation.
- C. The execution of the insulation work shall be in strict accordance with the best practices of the trade and with the Specifications herein.
- D. The insulation shall be handled and applied in a manner that will not adversely affect its structural or insulating properties.
- E. The installation instructions provided by the insulation material manufacturer of all materials specified in this Section shall be followed when installing these materials. Where these Specifications are in conflict with manufacturer's instructions, such conflicts shall be brought to the attention of the Engineer for a decision.

3.2 INSTALLATION OF THERMAL INSULATION FOR PIPE, VALVES, FITTINGS, AND ACCESSORIES

- A. All pipes, valves, fittings, flanges, specialties, etc., including system trim items such as gauge cocks, thermometer wells, etc., shall be insulated as specified herein. Unless specified elsewhere in this Section, equipment such as meters, automatic air vents, circulating pumps, etc., shall be insulated as specified for the adjoining piping.

- B. Prefabricated sectional insulation for straight pipes shall fit the respective type of pipe indicated on Drawings. Longitudinal laps and 3" wide butt strips of the insulation jacket shall be adhered neatly in place with the specified adhesive. The use of staples will not be acceptable.
- C. A protection saddle or shield similar to Buckaroo Insulation Saddles with galvanized finish shall be provided by the Subcontractor at each hanger or support as specified in Section 23 21 13 titled "Pipe, Valves, Fittings, and Accessories". Pittsburgh Corning 8.5# cellular glass blocking (ASTM C552) or ICA H-Block (20 lbs./cu. ft. density) shall be installed between the pipe and the protection shield to prevent crushing of the insulation. Insulation blocking shall be not less than the same length and circumference as the pipe protection shield. The blocking material shall be finished to match adjoining pipe insulation.
- D. Fittings, flanges, valves, mechanical couplings and specialties shall be insulated with preformed covers or shop fabricated covers the same thickness as the adjoining pipe insulation. All insulation not covered with insulation jacketing shall be thoroughly sealed with the specified mastic coating. Preformed glass fiber covers, which comply with the 25/50 fire and smoke ratings may be used on all systems for grooved pipe fittings as manufactured by Pro-Tec-T-Kotes Inc., Knauf Proto PVC fittings or approved equal. At the Subcontractor's option, PVC fitting covers with fiberglass inserts, which comply with the 25/50 fire and smoke ratings may be used on all systems if approved by the authorities having jurisdiction.
- E. All joints and fittings shall be sealed with the specified mastic. Where required, oversized pipe sections or board type insulation may be used to fabricate and install insulation around pipe specialties. All void space must be firmly filled with flexible insulation to support oversized pipe insulation.
- F. All applications of the specified mastic coating shall be applied reinforced with white 10 x 20 glass fabric.
- G. Piping insulation exposed to weather or as specified elsewhere by the Drawings shall be covered with 0.016" thick smooth aluminum jacket (ASTM B209). Provide 1/2" wide aluminum bands applied on 12" centers. Jacket shall have a 2" overlap at each joint. Jacket seams shall be located on the bottom side of all horizontal piping.
- H. In addition to the above requirements, insulation for chilled water piping shall comply with the following:
1. Where chilled water piping is interrupted by fittings, flanges, mechanical couplings or valves and at intervals not exceeding 30' or two floors on vertical continuous runs, an isolating seal shall be formed between the vapor barrier jacket and the bare pipe by liberal applications of Foster TITE-FIT 30-35 flexible vapor barrier joint sealant to the ends of the pipe insulation. This seal requirement is in addition to regular joint vapor seal specified hereinbefore. The seal location on vertical chilled water pipes shall be identified by an orange color 3/4" wide press tight tape around the circumference of the insulation. The Owner or Engineer shall select four (4) locations in the Project for the completed seal procedure to be reviewed. The seal area inspected by the Owner or Engineer shall be resealed after review and approval.
 2. All system components subject to condensation must be insulated including vertical riser supports and equipment supports.
 3. Control valve bodies shall be insulated and thoroughly vapor sealed where the valve actuator penetrates the insulation.
 4. Insulation at chilled water ball valves shall be vapor sealed to the ball valve insulation sleeve. Refer to Section 23 21 13 for ball valve specifications.
 5. Where chilled and heating hot water piping is installed in unheated garages and/or in non air conditioned spaces Type "B" or Type "E" insulation shall be installed. The insulation thickness scheduled shall be increased based on the manufacturer's written recommendations to protect condensation on the insulation jacket for the project Design Conditions listed in Section 23 05 07 entitled "Design Conditions".
- I. In addition to the above requirements, diesel engine muffler and exhaust piping insulation shall comply with the following:
1. Insulation shall be composed of three (3) layers of 1-1/2" thick material for an overall thickness of 4-1/2". The joints for the first, second and third layers shall be staggered. The insulation shall be installed over spacers to provide a 1" air space between the pipe and the first layer of insulation.
 2. All protrusions through the insulation shall be wrapped and/or packed with refractory fiber. All joints and cracks over 1/8" wide shall be sealed with the specified finishing cement.

3. Aluminum jacket shall be installed over the outer layer of insulation as specified herein for piping exposed to weather.
4. Provide expansion joints in the insulation and aluminum jacket as recommended by the manufacturer to allow for differential expansion between the exhaust pipe, insulation and jacket at the maximum operating temperature leaving the engine while operating at continuous full load conditions.
5. The entire exhaust system from the expansion connection to the building wall or roof at the outside termination shall be insulated. The muffler shall be insulated in the same manner as specified for exhaust piping.

3.3 INSTALLATION OF THERMAL INSULATION FOR EQUIPMENT (TYPE A)

- A. Insulation shall be applied directly to the contoured surfaces of the equipment unless specified otherwise. The entire surface of the equipment shall be coated with adhesive.
- B. Insulation shall be applied to all equipment in such a manner as to allow removal of access plates, manholes, casing sections, etc., without destroying the insulation.
 1. Insulation on split case pumps shall allow removal of the upper section without destroying the insulation.
 2. Insulation of plate fin heat exchangers shall be installed to allow the removal of the plate pack enclosure without destroying the insulation on the enclosure or end plates.
- C. Unless specifically specified herein, equipment such as water meters, automatic air vents, flow meters, backflow preventers, etc., shall be insulated as specified for the respective piping system.

3.4 INSTALLATION OF THERMAL INSULATION FOR DUCTWORK AND PLENUMS

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
 1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 4. Impale insulation over anchors and attach speed washers.
 5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2 inch staples, 1 inch o.c., and cover with pressure sensitive tape having same facing as insulation.
 7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6 inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 10. Apply vapor retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
 1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3.5 FACTORY OR LABORATORY PERFORMANCE TESTING

- A. All thermal insulation shall be tested in accordance with the latest reference standards listed herein and all applicable industry standards.

3.6 MECHANICAL PIPING INSULATION SCHEDULE

	SYSTEM	PIPE SIZE	INSULATION TYPE	MINIMUM INSULATION THICKNESS
1.	Chilled Water Piping*	1/2" - 2"	A or E	1"***
2.	Chilled Water Piping*	2 1/2" - 10"	A or E	1 1/2"***
3.	Chilled Water Piping*	12" - 24"	A or E	2"***
4.	Heating Hot Water Piping	1/2" - 3/4"	A or B	1"
5.	Heating Hot Water Piping	1" - 16"	A or B	1 1/2"
6.	Chilled Water Piping	1/2" - 2 1/2"	B or E	1"
7.	Chilled Water Piping	3" - 8"	B or E	1"
8.	Chilled Water Piping	10" - 24"	B or E	1 1/2"
9.	Condensate drain piping, except in air handling unit room return air plenum unless required by local codes.	ALL	A or C	1/2"
10.	Refrigerant Suction Piping	< 2 1/2"	C	3/4"
11.	Refrigerant Suction Piping	> 2 1/2"	C	1"
12.	Diesel Engine Exhaust Piping	ALL	D	4 1/2"
13.	Insulated Heat Traced Piping	ALL	A	1"
14.	Pump Impurity Eliminator Piping	ALL	C	1/2"
15.	Cooling Tower Basin Filtration Piping	ALL	B	1"
16.	Condenser water piping for water side economizer systems (Winter Operation)	All	A or E	1"***
* Piping installed in locations where a flame and smoke rating of 25/50 is required by code.				
** Type E insulation thickness shall be as recommended by the manufacturer to prevent condensation on the jacket.				

3.7 EQUIPMENT INSULATION SCHEDULE

	SYSTEM	INSULATION TYPE	MINIMUM INSULATION THICKNESS
1.	Chilled Water Ball Valves With Insulated Handle (see detail on drawings)	B	1 1/2"
2.	Chilled Water Pumps	A	1"
3.	Chilled Water Compression Tanks	A	1"
4.	Condenser Water Pumps	None	N/A
5.	Water Chilling Units	E	N/A
6.	Water Chilling Unit Water Box	A	1"
7.	Air Handling Units	E	N/A
8.	Air Accumulating Tank	A	1"
9.	By-Pass Filter Tank	A	1"
10.	Heating Hot Water Compression Tank	A	1"
11.	Plate Fin Heat Exchangers	A	1"

3.8 DUCTWORK INSULATION SCHEDULE

	SYSTEM	INSULATION TYPE	MINIMUM INSULATION THICKNESS
1.	Outside Air Ductwork	A	1½"
2.	Supply Air Ductwork from AHUs	A	1½"
3.	All round and rectangular ductwork from the primary AHU to the fan powered terminal units	A	1½"
4.	Ductwork on the discharge of fan powered terminal units	A	1½"
5.	Return air ductwork located in non-conditioned spaces	A	1½"
6.	All Stair Pressurization Ductwork	None	N/A
7.	All Elevator Shaft Pressurization Ductwork	None	N/A
8.	All Toilet Exhaust Ductwork (Refer to Section 23 31 00 for duct liner requirements.)	None	N/A
9.	All Exhaust Ductwork other than Kitchen Exhaust Ductwork	D	N/A
10.	Smoke Control Ductwork	None	N/A
11.	Generator Exhaust Plenum	E	2"
12.	All Ductwork Located Below the Raised Floor	None	N/A
13.	All Outside Air Ductwork Installed Outdoors	E*	2"
*	Provide aluminum jacket over the board insulation sealed watertight.		
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END OF SECTION