****

NAVFAC **IGS-15741 (MAY 2002)**

Preparing Activity: LANTNAVFACENGCOM **Based on UFGS-15741N**

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

****

SECTION 15741

WATER SOURCE HEAT PUMP SYSTEMS
05/02

****

NOTE: This guide specification is issued by the Atlantic Division, Naval Facilities Engineering Command for regional use in Italy.

****

****

NOTE: This guide specification covers the requirements for water source heat pump systems and ground source closed-loop heat pump systems. Use the most efficient equipment for which there are at least two products available for the indicated ranges. System requirements must conform to MIL-HDBK-1003/3, "Heating, Ventilating, Air Conditioning, and Dehumidifying Systems," ASHRAE CIGSHP (ISBN1-883413-21-4), and IGSHPA Design Manuals.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Design parameters for each item of equipment including capacity, efficiency, sound ratings, motor speeds, electrical characteristics, and special features.

****

****

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer

choices or locations where text must be supplied by the designer.

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ITALIAN ELECTROTECHNICAL COMMITTEE STANDARDS (CEI)

****

NOTE: A CEI Norm is an Italian technical normative for electrical systems recognized by Italian Law, submitted by a private organization "Comitato Electrotecnico Italiano" for the Italian territory, available in the Italian language and only in some cases in English.

****

CEI 64-8	(1998) Electrical installations of buildings

ITALIAN LAWS AND NORMS (D.M.)(LAW)(CIRC.)

****

NOTE: Italian laws and normatives are the legislative regulations and decrees issued by the Italian government in the form of laws, norms, decrees, circulars, and letters. These Laws and Decrees concur together with Norms and Standards in forming the governing directives for construction.

****

D.P.R. 1391	22/12/70, Regulation for the Implementation of Law 615, 13 July 1966, Regarding Environmental Pollution Provisions, Limited to a Thermal Systems Connection
D.M. 1/1/75 (ISPESL)	Superior Italian Institute for Prevention and Safety for Thermal Systems
D.M. 1/12/75	Safety Norms for Equipment Containing Hot Liquids Under Pressure
Circolare 29	5/12/77, Safety Norms for Hot Liquids Under Pressure
D.P.R. 412	26/8/93, Norm Regulation for Installation

and Maintenance of Thermal Systems

ITALIAN NATIONAL ASSOCIATION FOR UNIFICATION OF STANDARDS (UNI)

****

NOTE: A UNI Norm is a technical normative recognized as Italian Law, submitted by a private organization "Ente Nazionale Italiano di Unificazione" for Italy and is available only in the Italian language. It is the National Standard.

****

UNI 663/7	(1968) Unalloyed steel seamless tubes - Plain end tubes for general purposes - Qualities, requirements and tests
UNI 3158	(1977) Cast unalloyed quality steels for general engineering purposes - Qualities, requirements and tests
UNI 6884	(1987) Shutting and regolation valves for fluids - Supply and test conditions
UNI 7125/FA 109	(1972/82) Flanged gate valves for water pipelines - Technical conditions of delivery
UNI 7990	(1979) Low density polyethylene pipes for the transport of fluids under pressure - Types, dimensions and requirements
UNI 8365	(1986) Pumps of current production for heating plants - Tests
UNI 9157	(1988) Water supply - Back flow preventer - Characteristics and tests
UNI 9245/A1	(1988/88) Interception devices for gas distribution and/or transportation systems - Butterfly valves
UNI 9760/1	(1990) Nuclear plants - Supports, attachments and anchors for piping - Nomenclature and definitions
UNI 9760/2	(1990) Nuclear plants - Supports, attachments and anchors for piping - Materials
UNI 9760/3	(1990) Nuclear plants - Supports, attachments and anchors for piping - Design
UNI 9760/4	(1990) Nuclear plants - Supports, attachments and anchors for piping -

	Fabrication and installation
UNI 9760/5	(1990) Nuclear plants - Supports, attachments and anchors for piping - Testing
UNI 9760/6	(1990) Nuclear plants - Supports, attachments and anchors for piping - Certification and documentation
UNI 9760/7	(1990) Nuclear plants - Supports, attachments and anchors for piping - Supports
UNI 9760/8	(1990) Nuclear plants - Supports, attachments and anchors for piping - Anchors

ITALIAN/EUROPEAN HARMONIZATION STANDARDS (UNI EN)(UNI ENV)(CEI EN) (UNI EN ISO)(UNI ISO)

****

NOTE: A UNI EN, UNI ENV, CEI EN, UNI EN ISO or UNI ISO is a European Standard with a coincident Italian National Standard or International Standard. The two standards are identical, with most (but not all) EN's available in the English language and the UNI available only in the Italian language.

****

UNI EN 255-1	(1998) Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors - Heating mode - Terms, definitions and designations
UNI EN 288-1/A1	(1993/99) Specification and qualification of welding procedures for metallic materials - Part 1: General rules for fusion welding
UNI EN 378-1	(2000) Refrigerating systems and heat pumps - Safety and environmental requirements - Basic requirements
UNI EN 779/AC	(1995) Particulate air filters for general ventilation - Requirements, testing, marking
UNI ISO 888	(1986) Bolts, screws and studs - Nominal lengths, and thread lengths for general purpose bolts
UNI EN 1057	(1997) Copper and copper alloys -

	Seamless, round copper tubes for water and gas in sanitary and heating applications
UNI EN 1092-2	(1999) Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges
UNI ISO 1182	(1995) Fire Tests - Building Materials - Non-combustibility tests
UNI ISO 5256	(1998) Steel pipes and fittings for onshore and offshore pipelines - External coating by bitumen or coal-tar derived material
UNI EN 10242	(2001) Threaded pipe fitting in malleable cast iron

1.2 SYSTEM DESCRIPTION

****

NOTE: Select fourth sentence for water source heat pump systems and fifth sentence for ground source closed loop heat pump systems.

****

D.P.R. 1391, D.P.R. 412, UNI EN 255-1. Provide [new] [and modify existing] heating and cooling systems complete and ready for operation. HVAC systems include equipment and condenser. [Provide water source heat pump condenser piping under Section 15181, "Chilled, Condenser, or Dual Service Water Piping."] [Provide ground coupled condenser loop piping by the requirements of this section.]

1.4 SUBMITTALS

****

NOTE:

Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item is required.

A “G” following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within

the submittal tags may be used following the "G" designation to indicate the approving authority. Recommended codes for Army projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval. Codes following the "G" typically are not used for Navy projects.
Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

****

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Air-Conditioning/Heat Pump System; G

SD-03 Product Data

System manufacturers catalog data

Spare parts data

SD-06 Test Reports

Water-source water-to-air heat pumps; G

Water-source water-to-water heat pumps; G

SD-07 Certificates

Qualifications of ground heat exchanger fabricators; G

Qualifications of ground heat exchanger installers; G

Field test plan; G

SD-08 Manufacturer's Instructions

Installation manual

SD-10 Operation and Maintenance Data

Water-source water-to-air heat pumps;, Data Package 2

Water-source water-to-water heat pumps;, Data Package 2

Submit in accordance with Section 01781, "Operation and Maintenance Data."

SD-11 Closeout Submittals

Posted operating instructions

1.5 QUALITY ASSURANCE

1.5.1 Qualifications of Ground Heat Exchanger Fabricators

****
NOTE: The experience clause in this section has been approved by a Level 1 Contracting Officer, and may be used without further approval or request for waiver.
****

The only acceptable method for joining buried pipe systems is by a heat fusion process. Ground heat exchanger fabricators shall have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of an approved manufacturing certification program. Certified technicians shall attend a retraining school annually.

****
NOTE: The experience clause in this section has been approved by a Level 1 Contracting Officer, and may be used without further approval or request for waiver.
****

1.5.2 Qualifications of Ground Heat Exchanger Installers

Installers shall have completed an approved manufacturer's certification program and shall have successfully completed at least two projects with ground heat exchanger work similar to that required for this project within the last 4 years.

1.5.3 Installation Manual

Furnish for each item of equipment.

1.5.4 System Manufacturers Catalog Data

Manufacturer's standard catalog data, prior to the purchase or installation of a particular component, shall be highlighted to show brand name, model number, size, options, performance charts and curves, etc. in sufficient detail to demonstrate compliance with contract requirements. Data shall be submitted for each specified component. Data shall include manufacturer's recommended installation instructions and procedures.

1.5.5 Spare Parts Data

Spare parts data for each different item of equipment specified, after approval of detail drawings prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit

prices and source of supply, a recommended spare parts list for one year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

1.5.6 Air-Conditioning/Heat Pump System Drawings

Drawings shall provide detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.

b. Piping layouts which identify valves and fittings. Prepare dimensioned as-built drawings of the complete ground heat exchanger piping systems depicting its relationship to other utilities and buildings in its proximity before burying, covering, or concealing. The as-built drawings of the installed ground heat exchanger piping system shall be laminated or stored in a clear plastic envelope and affixed visibly [to the heat pump unit] [on the wall in the mechanical room serving a system of multiple heat pump units]. A permanent label shall be affixed to each heat pump unit indicating basic information for that unit. The information shall include: nominal flow rate l/s, pressure drop kPa, temperature drop/rise degree C, and capacity W.

c. Plans and elevations which identify clearances required for maintenance and operation.

d. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences. Drawings shall include point-to-point electrical wiring diagrams.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

1.5.7 Posted Operating Instructions

Provide framed instructions for posting, at least 2 weeks prior to start-up of system.

PART 2 PRODUCTS

2.2 SOURCE MANUFACTURERS

2.2.1 Water to Air Heat Pumps

The following manufacturers provide water source water to air heat pumps that generally comply with these specifications:

Delchi-Carrier SpA
Via Raffaello Sanzio 9
20058 Villasanta Mi
Italy

YORK

2.2.2 Water to Water Heat Pumps

The following manufacturers provide water source water to water heat pumps that generally comply with these specifications:

Delchi-Carrier SpA
Via Raffaello Sanzio 9
20058 Villasanta Mi
Italy

EMICON
Via A. Dragoni 59
47100 Forli, Italy
Tel: 0543/50790
Fax: 0543/50629

2.2.3 Closed Circuit Coolers

The following manufacturers provide closed circuit cooler equipment that generally complies with these specifications:

EVAPCO EUROPE SRL
Via Ciro Menotti 10
I-20017 Passirana di RHO
Milan, Italy
Tel: 02.9399041
Fax: 02.93500840
Web: www.evapco.com
e-mail: evapcoeurope@evapco.it

BALTIMORE AIRCOIL
Sondrio, Italy
Tel: 0342.485111
Fax: 0342.485190
Web: www.baltimoreaircoil.com

GREEN BOX
Via G. Galilei, 2
35028 Plove de Sacco
Padova, Italy
Tel: 39.049.9703319
Fax: 39.049.9701968

2.2.4 Plate Heat Exchangers

The following manufacturers provide plate heat exchanger equipment that generally complies with these specifications:

CIPRIANI SCAMBIATORI
Via XXI Aprile, 35
37020 Corrubio di Negarine
Verano, Italy
Tel: 39.045.6859012
Fax: 39.045.6859040

ALFA LAVAL
Via Pusiano, 2
20052 Nonza
Tel: 039.27041
Fax: 039.2704403

2.2.5 Ground Heat Exchanger Piping Systems

The following manufacturers provide ground heat exchanger piping systems that generally comply with these specifications:

COES MILANO
Via Martiri, 27
25010 San Felice (Brescia)
Tel: 0365.557022
Fax: 0365.557022
Web: www.coes.it

CENTRAL TUBI
Via dell 'Artigianato
61020 Lunano
Pesaro - Urbino
Tel: 0722.70011
Fax: 0722.70402
Web: www.centraltubi.it

2.3 STANDARD PRODUCTS

****

NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each Air-Conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

****

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years

experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.4 NAMEPLATES

****
NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.
****

Major equipment including unitary heat pumps shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum or stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.2 EQUIPMENT

Equipment using refrigerants R-11, R-12, R-22, R-113, R-114, R-115, R-500, or refrigerants with ozone depletion factor (ODF) greater than 0.05 will not be permitted.

2.2.1 Water-Source Water-to-Air Heat Pumps (WAHP)

****
NOTE: Units rated below 39,560 W cooling shall have minimum cooling performance EER of 12.0 and minimum heating performance COP of 3.0.
****

Provide water-source water-to-air heat pump units factory assembled, designed, tested, and rated in accordance with UNI EN 255-1. Units shall be D.M. 1/1/75 (ISPESL) certified. Units shall include fans, refrigerant-to-air heat exchangers, filters, dampers, compressor, reversing valve, expansion valve, refrigerant-to-water heat exchangers, [desuperheater], hose kits, and controls.

a. Cabinet: Provide manufacturer's standard galvanized steel cabinet finished with corrosion resistant epoxy coating or lacquer acrylic. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 20 mm, 48 kg per cubic meter density, fiberglass insulation with exposed edges sealed or tucked under flanges to prevent introduction of fibers

into the airstream. Where exposed to airstream, provide double-wall insulated construction with minimum 20 mm, 48 kg per cubic meter density fiberglass insulation between inner and outer casing materials. Penetrations of cabinet surfaces, including the floor, shall be sealed. Female threaded pipe condensate drain connections, supply water connections, and return water connections shall be copper threaded fittings mechanically fastened to the cabinet. Water piping shall be insulated. Construct cabinet with compartments and locate the compressor, reversing valve, and water coil out of the airstream. Insulate the divider between the compressor and fan sections. The control box shall be located within the unit.

b. Fans: Provide centrifugal type, direct drive fans with permanently lubricated motors. Motors shall be [multi-speed,] [variable speed,] permanent split capacitor (PSC) type with thermal overload protection.

c. Refrigerant-to-Air Heat Exchanger: Provide coil constructed of copper tubes with plate aluminum fins designed for refrigerant working pressure of 3100 kPa. The condensate drain pan shall be stainless steel or epoxy coated galvanized steel and insulated. Provide internal traps on vertical units. Provide drain pan with overflow protection.

d. Filter Section: Provide [replaceable (throwaway) [25 mm] [50 mm] thick fiberglass] [permanent washable] type filters with [standard dust-holding capacity]. Mount filters in filter frames and provide access panels or doors for removal and replacement of filters. Filters shall have a mean efficiency of [30] [___] percent when tested in accordance with UNI EN 779/AC.

e. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, low suction temperature cut-out, motor thermal overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide capability to reset compressor lockout circuit at the remote thermostat and at the disconnect. [Provide units with factory installed sound attenuation package.]

f. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and designed to fail in the heating position.

g. Refrigerant-to-Water Heat Exchangers: Provide refrigerant-to-water heat exchangers of coaxial type, with inner cupronickel water tube and outer steel refrigerant tube. Heat exchanger shall be tested and rated for 3102 kPa refrigerant working pressure. A parallel capillary tube/thermal expansion valve assembly shall provide superheat over [one to 43 degree C] [7 to 32 degree C] liquid temperature range.

[h. Factory-Installed Domestic Hot Water Desuperheater: Provide

desuperheater of vented double-wall construction and factory installed within indoor heat pump cabinet.]

[i. Field-Installed Domestic Hot Water Desuperheater: Provide units factory assembled, designed, tested, and rated. Units shall include double-wall vented refrigerant-to-water heat exchanger, water pump powered by a sealed magnetic drive motor, water line thermostat, secondary safety thermostat to prevent scalding, internal fuse, internally mounted disconnect switch, air bleed port, and refrigerant ports. Units shall be UNI EN 255-1 listed. Units shall be provided by the ground source closed loop heat pump manufacturer.]

j. Emergency Heater: Provide UL or ETL listed, electric resistance heater with internal fusing integral with heat pump unit; fan shall run until heater cools. Locate downstream of indoor coil.

k. Hose Kits: Kits shall include two 600 mm long metal braided hoses with swivel connectors on one end, [an automatic flow control valve with test ports,]two shutoff ball valves with memory stops (one with test port), blow down ball valve, and Y-strainer. Hoses shall be fire rated to meet UNI ISO 1182. Hoses shall have a maximum working pressure of 2000 kPa.

l. Hanger Kits: Provide horizontal units with hanger kits consisting of galvanized steel brackets, bolts, washers, and vibration isolators. The hanger kit shall be designed to support the unit from below and suspend from threaded rods.

****
Note: Microprocessor based controls should normally be utilized on large projects. Electromechanical controls should be used on small installations, housing, and remote location projects.
****

m. Controls: Controls and safety devices shall be factory wired and mounted within the control box of the unit cabinet.

(1) Provide a microprocessor based controller that communicates with an electronic multi-stage space thermostat. The microprocessor shall control sequencing, high and low pressure switch monitoring, freeze protection, lockout control, night setback, emergency shutdown, short cycle protection, random start, LED mode and fault indicators, fault memory, input and output diagnostics, and a communications port. Provide a factory-installed low voltage terminal block for field control wiring and a low voltage transformer. [Provide communications capability for remote direct digital control (DDC).] [Provide a hand held, remote service terminal from the heat pump manufacturer capable of interfacing with heat pump unit microprocessor controller to perform diagnostics, data retrieval, and calibration functions.]

[(2) Provide 24 volt electromechanical controls supplied with a low voltage transformer, controls for compressor, reversing valve, and fan motor operation. Controls shall include a random start relay, a night setback relay, a compressor cycling relay for demand load shedding, and a condensate overflow switch. Provide a low voltage terminal block for field control wiring.]

n. Space Temperature Controls: Provide electronic multi-stage, auto-changeover, adjustable thermostats with OFF-HEAT-AUTO-COOL-EMERGENCY system switch and AUTO-ON fan switch. Thermostats shall be furnished by the unit manufacturer. Provide relays, transformers, contractors, and control wiring between thermostats and unit. Thermostats shall read out in degrees C.

****

NOTE: Plate heat exchangers are required in systems using closed circuit coolers or cooling towers to isolate the ground heat exchanger loops from the building terminal loops.

****

2.2.2 Water-Source Water-to-Water Heat Pumps (WWHP)

****

NOTE: Units rated below 39,560 W cooling shall have minimum cooling performance EER of 12.0 and minimum heating performance COP of 3.0. Select first sentence for open loop systems and second sentence for closed loop assisted cooling.

****

[Provide water-source water-to-water heat pump units factory assembled, with performance ratings verified by tests at the factory prior to shipment.] [Provide ground-coupled closed-loop water-to-water heat pump (extended range) units factory assembled, with performance ratings verified by tests at the factory prior to shipment.] Units shall be in accordance with UNI 8365. Units shall include compressor, reversing valve, expansion valve, refrigerant-to-water condensing coil, refrigerant-to-water evaporator coil, [desuperheater], hose kits, and controls.

a. Cabinet: Provide manufacturer's standard galvanized steel cabinet finished with corrosion resistant epoxy coating or lacquer acrylic. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 20 mm, 48 kg per cubic meter density, fiberglass insulation. Provide copper or stainless steel female threaded pipe connections for supply water and return water connections; these connections shall be mechanically fastened to the cabinet. Water piping shall be insulated.

b. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, low suction temperature cut-out, motor thermal overload protection, 5

minute anti-recycle timer, and start capacitor kit. Provide capability to reset compressor lockout circuit at the remote thermostat and at the disconnect. [Provide units with factory installed sound attenuation package.]

c. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and designed to fail in the heating position.

d. Refrigerant-to-Water Heat Exchangers: Provide refrigerant-to-water heat exchangers of coaxial type, with inner cupronickel water tube and outer steel refrigerant tube. Heat exchanger shall be tested and rated for 3100 kPa refrigerant working pressure. A parallel capillary tube/thermal expansion valve assembly shall provide superheat over [one to 43 degree C] [7 to 32 degree C] liquid temperature range. Refrigerant-to-water heat exchangers and refrigerant piping shall be insulated to prevent condensation on the piping containing low temperature water.

[e. Factory-Installed Domestic Hot Water Desuperheater: Provide desuperheater of vented double-wall construction and factory installed within indoor heat pump cabinet.]

f. Hose Kits: Kits shall include two600 mm long metal braided hoses with swivel connectors on one end, [an automatic flow control valve with test ports,] two shutoff ball valves with memory stops (one with test port), blow down ball valve, and Y-strainer. Hoses shall be fire rated to meet UNI ISO 1182. Hoses shall have a maximum working pressure of 2000 kPa.

g. Hanger Kits: Provide units with hanger kits consisting of galvanized steel brackets, bolts, washers, and vibration isolators. The hanger kit shall be designed to support the unit from below and suspend from threaded rods.

****
Note: Microprocessor based controls should normally be utilized on large projects. Electromechanical controls should be used on small installations, housing, and remote location projects.
****

h. Controls: Controls and safety devices shall be factory wired and mounted within the control box of the unit cabinet.

(1) Provide a microprocessor based controller. The microprocessor shall control sequencing, high and low pressure switch monitoring, freeze protection, lockout control, night setback, emergency shutdown, short cycle protection, random start, LED mode and fault indicators, fault memory, input and output diagnostics, and a communications port. Provide a factory-installed low voltage terminal block for field control wiring and a low voltage transformer. [Provide communications

capability for remote direct digital control (DDC).] [Provide a hand held, remote service terminal from the heat pump manufacturer capable of interfacing with heat pump unit microprocessor controller to perform diagnostics, data retrieval, and calibration functions.]

[(2) Provide 24 volt electromechanical controls supplied with a low voltage transformer, pump relay, controls for compressor, reversing valve coil, and lock out relay. Controls shall include a random start relay, a night setback relay, and a compressor cycling relay for demand load shedding, and a condensate overflow switch. Provide a low voltage terminal block for field control wiring.]

i. Space Temperature Controls: Provide electronic multi-stage, auto-changeover, adjustable thermostats with OFF-HEAT-AUTO-COOL-EMERGENCY system switch and AUTO-ON fan switch. Thermostats shall be furnished by the unit manufacturer. Provide relays, transformers, contractors, and control wiring between thermostats and unit. Thermostats shall read out in degrees C.

****

NOTE: Plate heat exchangers are required in systems using closed circuit coolers or cooling towers to isolate the ground heat exchanger loops from the building terminal loops.

****

[2.2.3 Closed Circuit Coolers

a. Fan and Casing: Construct the fan section (up to top of intake louvers) of heavy gage stainless steel and construct casing of G-235 hot-dip galvanized steel for long life and durability. Standard pan accessories shall include louver access, overflow, drain, stainless steel strainers, and brass make-up valve with plastic float.

b. Axial Propeller Fans: Fans shall be heavy duty axial propeller type statically balanced. Construct fans with aluminum alloy blades, and install in a closed fitted cowl with venturi air inlet.

c. Fan Motors: Motors shall be totally enclosed, ball bearing type, and suitable for outdoor service.

d. Drive: Fan drive shall be multi-groove, solid V-belt type with taper lock sheaves designed for 150 percent of nameplate kW. Fan and motor sheave shall be aluminum alloy construction. Belt adjustment shall be accomplished from exterior of unit.

e. Heat Transfer Coil: The coil shall be steel, encased in steel framework with the entire assembly hot-dip galvanized after fabrication. Arrange tubes in a self-spacing, staggered pattern in the direction of airflow for maximum heat transfer efficiency and minimum pressure drop, without the use of additional spacers

between the coil tubes. Design coil with sloping tubes for free drainage of liquid and test to 2400 kPa air pressure under water.

f. Water Distribution System: The system shall provide a water flow rate of not less than 0.38 liters per second over each square foot of unit face area to ensure proper flooding of the coil. Construct spray header of Schedule 40 polyvinyl chloride (PVC) pipe (SDR-11) for corrosion resistance. Spray branches shall be removable for cleaning. Distribute water over the entire coil surface by spray nozzles (380 by 8 mm orifice) with internal sludge ring to eliminate clogging. Thread nozzles into spray header to provide easy removal for maintenance.

g. Water Recirculation Pump: The pump shall be close-coupled, centrifugal type with mechanical seal, installed vertically at the factory to allow free drainage at shutdown.

h. Eliminators: Construct eliminators of inert PVC in easily handled sections. The eliminator design shall incorporate three changes in air direction to ensure complete removal of entrained moisture from the discharge airstream. Maximum drift rate shall be less than 0.001 percent of the circulating water rate.

i. Construct Louvers From PVC: Mount louvers in easily removable frames for maintenance access to the pan. Louvers shall have a minimum of two changes in air direction to prevent splash out and block direct sunlight.

j. Finish: Apply corrosion protection system to the outside of galvanized surfaces. Construct non-stainless metal components of mill hot-dip galvanized steel. Coat component edges and welds with a 95 percent pure zinc-rich compound. Preparation for coating shall include degreasing, cleaning, and a light surface burnishing. The coating shall be suitable for field repair with the same original coating material applied in the same manner.

k. Electric Pan Heater Package: Electric pan heater package consists of electric immersion heaters, heater thermostat, and low water cutout, all installed in pan. Size heaters to maintain plus 5 degrees C pan water temperature with the fans off at design conditions indicated on drawings. Control the heaters with a thermostat, and provide water cutout to prevent heaters from cycling on unless they are completely submerged. Provide heater contactor and wiring under Section 16402, "Interior Distribution System."

l. Discharge Hood With Positive Closure Dampers: Provide unit with discharge hood, positive closure dampers, and 120-volt actuator for reduction of heat loss during idle periods of winter time operation. Construct the discharge hood and dampers of hot dipped galvanized steel. Equip hoods with access panels to facilitate maintenance on the eliminators and water distribution system. Factory assemble the dampers, damper actuator, and linkage.

][2.2.4 Cooling Towers

Provide in accordance with Section 15601, "Central Refrigeration Equipment for Air Conditioning."

][2.2.5 Plate Heat Exchangers

****

Note: Provide the following flat plate heat exchanger information on the drawing:

1. Maximum water pressure drop through clean plates and headers in kPa at the flow rates and temperatures indicated.

2. Minimum rate of turbulent flow in l/sec through any two plate segment.

3. Minimum plate thickness in mm.

****

Plates, frames, and gaskets shall be designed for a working pressure of 2.07 MPa and factory tested at 31.0 MPa. Medium temperature water, low temperature water, and pressure relief valve connections shall be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm shall be ASME 2.07 MPa flanged. Plates shall be corrugated [stainless steel] [nickel-iron-chromium alloy conforming to UNI 3158] [nickel-molybdenum alloy conforming to UNI EN 1057].

][2.2.6 [Oil-Fired Heating Boilers] [Gas-Fired Boilers]

[Provide in accordance with Section 15514, "Low Pressure Water Heating Boilers (Under 235 kW Output)."] [Provide in accordance with Section 15515, "Low Pressure Water Heating Boilers (Over 235 kW Output)."]

]2.2.7 Pumps

[Provide in accordance with Section 15181, "Chilled, Condenser, or Dual Service Water Piping."]

2.2.7.1 Pump Modules

Provide pump module units factory designed, assembled, and pressure tested. Units shall include flanged pumps, brass fill and purge valves, quick release fill and purge ports, pressure/temperature (Pete's) plug, wiring, and fuse protection. Pumps shall be the wet rotor and single stage types, with pump casings thermally insulated. Provide manufacturer's standard galvanized steel cabinet, finished with corrosion resistant epoxy paint. Pump module units shall be provided by the ground source, closed loop heat pump manufacturer.

2.3 ELECTRICAL

2.3.1 Electrical Motors, Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 16402, "Interior Distribution System." Provide electrical connections under Section 16402, "Interior Distribution System." Provide controllers and contactors with maximum of 220-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

2.3.2 Electrical Work

Provide in accordance with Section 16402, "Interior Distribution System." [Provide control wiring in accordance with Section 15901, "Space Temperature Control Systems."] [Provide control wiring in accordance with Section 15910, "Direct Digital Control Systems."] [Provide control wiring in this section, in accordance with CEI 64-8.]

2.4 METAL DUCT SYSTEMS

Provide in accordance with Section 15720, "Air Handling Units."

2.5 ABOVEGROUND PIPING SYSTEMS

Provide the following pipe and fittings. Provide dielectric fittings, unions, or flanges between steel piping and copper tubing for all piping sizes; except that copper alloy valves and strainers may be used without dielectric fittings, unions, or flanges. Water piping sizes 100 mm and smaller shall be copper tubing. [Water piping sizes larger than 100 mm shall be copper tubing or steel piping.]

2.5.1 Copper Tubing Systems

Provide copper tubing for the following systems.

a. Copper condensate drain piping from drain pans.

b. Copper refrigerant tubing.

[c. Condenser water piping aboveground or within mechanical space.]

[d. Chilled/Hot Water Piping.]

2.5.1.1 Copper Condensate Drain Piping

Provide copper tubing in accordance withUNI EN 1057, Type L or M for piping sizes 25 mm and smaller. Provide UNI EN 1057 copper tubing and UNI EN 1057 solder joint fittings for piping sizes larger than 25 mm. In lieu of copper tubing, 32 mm Schedule 40 polyvinyl chloride (PVC) plastic pipe, fittings, and solvent cement may be provided.

2.5.1.2 Copper Refrigerant Tubing

Provide UNI EN 1057, cleaned, dehydrated, and sealed. Provide UNI EN 1057

solder joint refrigerant fittings and adapters. Provide silver brazing alloy solder and silver brazing alloy flux. During brazing operations bleed a small amount of dry oil-free nitrogen continuously through the refrigerant tubing. Provide UNI EN 1057 flared fittings.

2.5.1.3 Soldered Joint Copper Tubing Systems

For condenser water piping and chilled/hot water piping, provide UNI EN 1057, Type L or K for aboveground piping, Type K for buried piping, with UNI EN 1057 solder joint fittings, unions, and flanges; provide adapters as required. Provide UNI EN 1057 copper pipe nipples with threaded end connections. Provide UNI EN 1057, 95-5 tin-antimony (Sn-Pb) solder.

2.5.2 Steel Piping Systems

Provide steel piping for the following piping systems.

[a. Condenser water piping aboveground or within mechanical spaces.]

[b. Ground heat exchanger piping within valve pits.]

[c. Chilled/Hot Water Piping.]

2.5.2.1 Steel Pipe

Provide UNI 663/7 or UNI ISO 5256 steel pipe; except UNI 663/7, steel pipe may be provided for water pipe sizes larger than 100 mm. Provide Weight Class STD or Schedule No. 40 black steel pipe for welding end connections. Provide Weight Class XS or Schedule No. 80 black steel pipe for threaded end connections.

2.5.2.2 Steel Pipe Fittings

Provide UNI EN 10242 threaded fittings, and UNI EN 10242 threaded unions. Provide UNI ISO 5256 buttwelding fittings of the same material and weight as the piping in which fittings are installed; provide backing rings compatible with piping materials being buttwelded.

2.5.2.3 Steel Pipe Unions

Provide UNI EN 10242 unions with threaded end connections on one side of threaded valve in steel piping systems.

2.5.2.4 Steel Pipe Flanges

Provide UNI EN 1092-2 welding neck flanges. Extend bolts no less than two full threads beyond the nut with the bolts tightened to the required torque.

a. Gaskets: Provide one piece factory cut gaskets suitable for the intended service. Provide full-face gaskets for flat-face flanged joints, and ring gaskets for raised-face flanged joints.

b. Bolts: UNI ISO 888.

c. Nuts: UNI ISO 888.

d. Washers: Provide steel flat circular washers under bolt heads and nuts.

2.5.3 Valves

****
NOTE: Boiler type service valves are not to be used.
****

Valves shall have flanged end connections, except valves smaller than 65 mm may have threaded end connections with a union on one side of the valve. Solder end connections on tube sizes smaller than 65 mm, with a union on one side of valve, may be used for connections between copper alloy valves and copper tubing.

2.5.3.1 Gate Valves

UNI 6884, except sizes 65 mm and larger shall conform to UNI 7125/FA 109.

2.5.3.2 Globe and Angle Valves

UNI 6884.

2.5.3.3 Check Valves

UNI 6884.

2.5.3.4 Butterfly Valves

UNI 9245/A1, except sizes 65 mm and larger shall have lugged or wafer body designed for installation between ASME Class 1034 flanges. Valves shall have two-position lever handles.

2.5.3.5 Ball Valves

Full port design, copper alloy body, except sizes 65 mm and larger shall be cast-iron body. Valves shall have two-position lever handles unless indicated otherwise. Ball valves may be provided in lieu of butterfly valves and gate valves.

2.5.3.6 Vent Valves

Provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 6 mm NPS connection. The valve material shall be compatible with the working fluid (antifreeze).

2.5.3.7 Water Relief Valves

Provide water relief valves as indicated, and in accordance with D.M. 1/12/75. Bronze body, test level, D.M. 1/12/75. Pressure relief at 207 kPa.

2.5.4 Specialty Valves

2.5.4.1 Combination Pressure and Temperature Relief Valves

UNI 7125/FA 109, copper alloy body, automatic reseating, with test lever. Discharge capacity pressure relief setting shall be 862 kPa and temperature setting of 85 degrees C based on AGA temperature steam rating.

2.5.4.2 Water Pressure Reducing Valves

UNI 7125/FA 109, copper alloy body, automatic reseating, with test lever.

2.5.4.3 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.5.4.4 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy, or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 862 kPa (gage) at 87.8 degrees C hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the liters per second flow for each differential pressure reading.

2.5.4.5 Backflow Prevention Assemblies

Provide reduced pressure principle type backflow prevention assemblies which are approved by and have a current "Certificate of Approval" from the UNI 9157. Listing of the particular make, model/design, and size in the current UNI 9157 will be acceptable as the required proof.

2.6 GROUND HEAT EXCHANGER PIPING SYSTEMS

Provide polyethylene pipe and fittings for the underground portions of the ground heat exchanger. Use of polyvinyl chloride (PVC) pipe and fittings is not permitted.

2.6.1 Polyethylene Pipe

Pipe shall be manufactured from virgin high density polyethylene extrusion material in accordance with UNI 7990. Provide UNI 7990 pipe with a standard dimension ratio (SDR) of 11.0 for pipe less than 32 mm diameter; Schedule 40 or pipe with a minimum SDR of 13.5 for pipe 32 mm diameter or greater, and pipe with a minimum SDR of 17.0 for pipe 75 mm diameter or greater. Provide UNI 7990 pipe in vertical bores greater than 60 m deep with a SDR of 11.0.

2.6.3 Fittings

Provide butt and saddle fusion fittings and UNI 7990 socket fusion fittings

manufactured in accordance with UNI 7990. Barbed fittings and hose clamps are not permitted in polyethylene pipe systems.

2.6.3.1 U-bends

Provide factory-fused, injection-molded 3.141 rad. U-bend assemblies equipped with anti-buoyancy devices.

2.6.3.2 Threaded Transition Fittings

Provide ANNCC approved reinforced threaded steel-to-polyethylene fittings. Fittings shall have a factory applied external epoxy coating.

2.7 PIPING ACCESSORIES

2.7.1 Pipe Hangers and Supports

Provide UNI 9760/1, UNI 9760/2, UNI 9760/3, UNI 9760/4, UNI 9760/5, UNI 9760/6, UNI 9760/7, and UNI 9760/8, with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with clamps and retaining straps. Attach to Steel W or S beams with clamps. Attach to steel angles and vertical web steel channels with clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with insert or drilled expansion anchor. Provide insulation protection shields for insulated piping.

2.7.2 Strainers

UNI EN 1092-2, flanged iron body, for 65 mm and larger. UNI EN 288-1/A1, cast iron or bronze for 50 mm and smaller. Provide basket or Y type. Tee type is acceptable for water service. Provide blowdown assembly consisting of 20 mm pipe nipple, ball valve, hose connection, and cap for each strainer. Provide screens constructed of bronze, monel metal, or stainless steel, free area not less than 2.5 times pipe area, with perforations as follows:

a. 80 mm and smaller: 1.1 mm diameter perforations for liquids.

b. 100 mm and larger: 3.2 mm diameter perforations for liquids.

****

NOTE: To minimize the potential for leaks, install pressure gage taps in ground heat exchanger loop; do not install pressure gages.

****

2.7.3 Pressure Gages

Provide single style pressure gage with 115 mm dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and syphon. Provide scale range at 1.5 to 2 times intended service pressure.

2.7.4 Pressure/Temperature Test Provisions

2.7.4.1 Pete's Plug

Provide 15 mm MPT by 75 mm long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

2.7.4.2 Testing Accessories

Provide one each of the following test items to the Contracting Officer:

a. 8 mm FPT by 3.2 mm diameter stainless steel pressure gage adapter probe for extra long test plug.

b. 90 mm diameter, one percent accuracy, compound pressure gage, 0 to 1378 kPa range.

c. minus 29 to plus 49 degree C pocket thermometer one-half degree accuracy, 25 mm dial, 127 mm long stainless steel stem, plastic case.

2.7.5 Thermometers

Provide bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; 75 mm diameter dial with glass face gasketed within the case; and accuracy within 2 percent of scale range. Provide scale range for intended service.

2.7.6 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid where indicated. Connectors shall be suitable for the intended service.

****

NOTE: Residential ground coupled heat pump systems do not require expansion tanks, vents, or make-up water systems.

****

2.7.7 Expansion Tanks

Construct of steel for minimum working pressure of 862 kPa (gage). Tank shall have polypropylene or butyl lined diaphragm which keeps the air charge separated from the water.

2.7.8 Air Separators

[Provide tangential inlet and outlet connections, blowdown connections, and internal perforated stainless steel air collector tube to direct released air to automatic air vent. Construct of steel for minimum working pressure of 862 kPa (gage).] [Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one

air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Unit shall be for minimum working pressure of 862 kPa (gage).]

2.7.9 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide 25 mm minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

2.7.9.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or Schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.7.9.2 Sleeves Not in Masonry and Concrete

Provide 0.55 mm thick galvanized steel sheet or PVC plastic pipe sleeves.

2.7.10 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.8 HEAT TAPE

Provide UL listed parallel conduction type heat tape, with electrical characteristics indicated, and adjustable thermostat for outdoor aboveground winterized piping. The heat trace system shall meet requirements of the CEI 64-8. The tape shall not be affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere.

2.8.1 Heat Tape Construction

Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.

a. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

b. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 1.1 degrees C minimum during winter outdoor design temperature as indicated, but not less than the following:

(1) 80 mm pipe and smaller with 25 mm thick insulation, 4 watts/0.3 m.

(2) 100 mm pipe and larger 38 mm thick insulation, 8 watts/0.3 m of pipe.

2.8.2 Electrical Accessories

a. Power supply connection fitting and stainless steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.

b. 13 mm wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 305 mm intervals.

c. Pipe surface temperature control thermostat shall be cast aluminum, NEMA 4 (watertight) enclosure, 15 mm NPT conduit hub, SPST switch rated 20 amperes at 480 volts ac, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 1.1 degrees C.

d. Signs shall be manufacturer's standard (NEC), stamped "ELECTRIC TRACED" located on the insulation jacket at 3 mm intervals along the pipe on alternating sides.

2.9 ACCESS DOORS FOR VALVES

Provide factory fabricated and primed flush face steel access doors including steel door frame equipped with continuous hinges and turn-screw-operated latch. Provide door frame installation in plaster and masonry walls.

2.10 AUXILIARY DRAIN PAN, DRAIN CONNECTIONS, AND DRAIN LINES

Provide galvanized steel auxiliary drain pans under units where indicated. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the bottom to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points shall conform to Section 15400, "Plumbing Systems."

****

NOTE: Antifreeze solutions may be necessary in colder climates where the temperature of the ground heat exchanger fluid falls below the freezing point of water.

****

2.11 ANTIFREEZE PROTECTION

Provide [ethylene glycol] [acetate potassium] [propylene glycol] antifreeze solution which meets local and State requirements and is acceptable to heat pump component manufacturers. The antifreeze shall be used in closed-loop ground source heat pump systems for the transfer of energy to provide heating and cooling. The fluid shall contain the necessary corrosion inhibitors to protect pipe and equipment from attack by the antifreeze solution utilized.

2.11.1 Biodegradability

The fluid shall not be less than 90 percent biodegradable.

2.11.2 Properties

The fluid shall conform to the following requirements, and tests shall be performed in accordance with specified test methods on the fluid.

2.11.2.1 Flash Point

The flash point shall not be lower than 90 degrees C.

2.11.2.2 Biological Oxygen Demand (BOD)

For 5 days the BOD, at 10 degrees C, shall not exceed 0.2 gram oxygen per gram nor be less than 0.1 gram oxygen per gram.

2.11.2.3 Freezing Point

The freezing point shall not exceed [minus 9 degrees C], determined in accordance with Circolare 29.

2.11.2.4 Toxicity

The toxicity shall not be less than LD 50 (oral-rats) of 5 grams per kilogram. The NFPA hazardous material rating for health shall not be more than 1 (slight).

2.11.2.5 Storage Stability

The fluid, tested in accordance with D.M. 1/12/75, shall neither show separation from exposure to heat or cold nor show an increase in turbidity.

2.11.3 Quality

The fluid, shall be homogeneous, uniform in color, and free from skins, lumps, and foreign materials detrimental to usage of the fluid.

2.12 CHEMICAL FEED TANK

Construct of steel for minimum working pressure of 862 kPa (gage). Provide chemical pipe, fittings, and valves as specified for water piping.

2.12.1 Aboveground Condenser Water Piping System

Add borate-nitrite corrosion inhibitors, acceptable to heat pump component manufacturers, to initial fill water for heating and cooling water systems in concentrations of [0.0039 liter/liter][____] of system water if corrosion inhibitors are not contained in freeze protection solution in the ground heat exchanger loop.

2.12.1 Chilled/Hot Water Piping System

Add borate-nitrite corrosion inhibitors, acceptable to heat pump component manufacturers, to initial fill water for heating and cooling water systems in concentrations of [0.0039 liter/liter][____] of system water if corrosion inhibitors are not contained in freeze protection solution in the ground heat exchanger loop.

2.12.2 Ground Heat Exchanger Piping

Provide corrosion inhibitors acceptable to heat pump manufacturers with concentrations suitable for each system [and appropriate for the antifreeze used.]

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 HVAC System

Installation of HVAC system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with UNI EN 378-1, D.P.R. 1391, and D.P.R. 412, and in accordance with the manufacturer's recommendations. Maintenance access to heat pump units shall not be compromised by any type of piping, electrical conduit, or any other utility. Provide unions in piping to facilitate removal of heat pump for maintenance or replacement.

3.1.2 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems. Flush existing systems in accordance with paragraph entitled "Flushing the Ground Heat Exchanger" prior to making connections.

3.2 ABOVEGROUND PIPING

Test, inspect, and approve piping before covering or concealing. Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Install valves with stems horizontal or above. Provide

flanges or unions at valves, traps, strainers, and connections to equipment; unions are not required in copper tubing piping systems.

a. Threaded Connections: Threaded joints shall be sealed with a sealant compatible with the circulating fluid; use of teflon tape is not permitted. Do not thread metal pipe into plastic piping.

b. Pipe Hangers and Supports: Provide additional pipe hangers and supports at in-line water pumps and flanged valves.

****
NOTE: Insulate indoor piping subject to condensation and aboveground exterior piping subject to freezing.
****

c. Piping to Receive Insulation: Provide temporary wood spacers between the pipe hangers and supports, and the pipe to properly slope the piping and establish final elevations. Provide temporary wood spacers of same thickness as insulation to be provided under Section 15080, "Mechanical Insulation." Support plastic piping every 1.22 m. Support metal piping as follows.

MAXIMUM SPACING (METERS)

Nominal Pipe Size (mm)	25 and under	32	40	50	65	80	90	100	150
Copper Tubing	1.8	2.1	2.4	2.4	2.7	3.0	3.3	3.6	4.2
Steel Pipe	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	5.1

d. Cleaning of Piping: Keep interior and ends of new piping and existing piping, affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

e. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by Contractor's operations with new work of same construction.

3.2.1 Flushing the Aboveground Piping

Before connection of the header to the polyethylene ground heat exchanger loops, flush the entire aboveground piping system thoroughly in accordance with UNI 7990 recommendations and leave filled with clean water. If the header is not immediately joined to the ground heat exchanger loop, the open ends shall be taped or capped.

3.3 GROUND HEAT EXCHANGER PIPING

Examine areas and conditions under which ground heat exchanger systems will

be installed. Prior to excavation, trenching, or drilling, locate and mark buried utilities. Do not proceed with work until approved by the Contracting Officer. Avoid sharp bends in piping. Provide fittings for changes in direction when minimum bend radius, as recommended by the pipe manufacturer, is exceeded. Use only continuous pipe in sharp bends. Make changes in piping sizes through tapered concentric fittings. Leaks shall be "cut-out" and repaired in accordance with the pipe manufacturer's recommendations. Direct buried threaded connections are not permitted.

3.3.1 Vertical Well Fields

Each U-bend loop shall be assembled, laid out straight, taped to reduce springback, and water pressure tested at 689 kPa for leaks and flow by UNI EN 255-1 recommended procedures before the hole is bored. Vertical bores shall be 1.5 m deeper than the length of the loop and shall be clean (no casing) and of sufficient diameter to facilitate the installation of the U-bend assembly and a third pipe for pressure grouting. Fill the loop with water and pressurize to 276 kPa to prevent the pipe from being crushed by backfill material. Backfill the bores from the bottom up with a high solid bentonite grout material and grouting process in conformance with UNI EN 255-1 to ensure pipe contact and compliance with local and State requirements for sealing. Bentonite grout shall be prepared in accordance with manufacturer's recommendations for water-to-mix ratio. The bores shall not contain large, sharp, or jagged rocks or debris. Take reasonable and prudent care during installation and backfilling to not crush, cut, or kink the pipe.

3.3.2 Horizontal Well Fields and Header Piping

Horizontal trenches for ground heat exchanger piping may be dug with a chain type trenching machine or a backhoe. The piping shall be buried a minimum of 1.2 m deep or as indicated. Make joints while pipe is laying beside the trench. If the soil contains rocks, dig the trench 150 mm deeper than required and install a 150 mm base of fine sand before placing the pipe. [Buried piping in systems containing antifreeze and installed within 1.5 m of any building wall, structure, or pipe shall be insulated with R-2 minimum closed cell insulation.] After the piping is installed, tested, and flushed, purged, inspected, and approved while still under pressure, backfill 150 mm above with fine sand. Complete backfill in accordance with UNI EN 255-1 recommended procedures.

3.3.3 Polyethylene Piping

Install piping in accordance with manufacturer's written instructions. During installation, keep trash, soil, and foreign objects out of the pipe. Tape or cap ends of the pipe until the pipe is joined to the circuit. The vertical loop take-off tee fittings may be made using tee fittings or the saddle fusion process on header piping 32 mm diameter and above. Completely remove the cutout on the saddle tees. Use bell reductions at pipe reductions. Use reducing socket tees when fabricating socket type reducing headers. Avoid sharp bends in piping. Consult pipe manufacturer for minimum bend radius. Install elbow fittings at changes in pipe direction that are tighter than the minimum recommended bend radius. Use only continuous pipe in vertical U-bend loops.

3.3.4 Heat Fusion Process

Joining shall be either by butt, socket, or saddle (for sidewall applications only) fusion in accordance with the manufacturer's Heat Qualification Guide. Use socket fusion joints for pipe 50 mm diameter and less. Use butt fusion joints for pipe greater than 50 mm diameter. Different plastics or grades of plastic shall not be fused together.

3.3.5 Pressurizing

After assembly of the entire ground loop system, fill the system with water and pressure test to 689 kPa. Visually inspect welds prior to backfill of the trenches.

3.3.6 Pipe Identification

Install metalized (detectable) buried warning and identification tape above each horizontal pipe run. Install tape a minimum of 150 mm below finish grade. Install mechanical identification of vertical bore holes and connecting headers.

3.3.7 Threaded Fittings

Threaded joints shall be sealed with a sealant compatible with the circulating fluid; use of lubricating tape for sealing is not permitted. Do not thread metal pipe into plastic pipe or vice versa. Direct buried threaded joints are not permitted. Use threaded joints above grade, within mechanical spaces, or within valve pits.

3.4 Flushing the Ground Heat Exchanger

Before connection of the plastic ground heat exchanger loops to the header, flush each loop thoroughly in accordance with UNI EN 255-1 recommendations and leave filled with clean water. If the loop is not immediately joined to the header, it shall be taped or capped.

3.5 ADJUSTMENTS

Adjust controls and equipment so as to give satisfactory operation. Adjust entire water temperature control system and place in operation so that water quantities circulated are as indicated. Adjust and balance air duct systems so that air quantities at outlets are as indicated and so that distribution from supply outlets is free from drafts and has uniform velocity over the face of each outlet.

3.6 INSTRUCTING OPERATING PERSONNEL

Upon completion of work and at time designated by Contracting Officer, provide services of water source heat pump manufacturer's technical representative for period of not less than one 8-hour working day for instruction of Government operating personnel in proper operation and maintenance of equipment.

3.7 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each system in service to demonstrate compliance with the contract requirements. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and filters.

3.7.1 Piping Systems Except for Ground Heat Exchanger and Refrigerant

Before insulating, hydrostatically test each new piping system at not less than 1278 kPa. Maintain pressure for 2 hours with no leakage or reduction in gage pressure. Obtain approval before applying insulation.

3.7.2 Test of Ground Heat Exchanger Piping

Before backfilling the trenches, flush and purge systems of air and flow test to ensure all portions of the heat exchanger are properly flowing using the procedures recommended by UNI EN 255-1. Utilize a portable temporary purging unit consisting of the following:

a. High volume, high head purge pump

b. Open reservoir

c. Filter assembly with bypass

d. Flow meter

e. Pressure gage

f. Connecting piping

g. Connecting hoses

****

NOTE: In larger systems with high horsepower circulating pumps, air ejectors, and valved-off 35.2 kilowatt header systems, a portable purge pump may not be necessary if the ground heat exchanger and indoor piping is free of debris and other construction material.

****

Using a purge pump and the procedures recommended by UNI EN 255-1, flush and purge each ground heat exchanger system until free of air, dirt, and debris. A velocity of 0.6 m/sec is required in pipe sections to remove the air.

Perform the flushing and purging operation with the water source heat pumps

isolated by shutoff valves from the ground heat exchanger system. Allow purge pump to run 15 minutes after the last air bubbles have been removed. After the ground heat exchanger is completely flushed of air and debris, open the isolation valves and permit circulation through the heat pumps until the entire system is flushed and purged.

Utilizing the purging unit and the procedures recommended by UNI EN 255-1, conduct a pressure and flow test on the ground heat exchanger to ensure the system is free of blockage. If the flow test indicates blockage, locate the blockage using the manufacturer's recommendation, remove the blockage, then repeat the purge procedure and conduct the pressure and flow test again until all portions of the system are free flowing. The flow test shall be observed and approved by the Contracting Officer.

After purging has been completed, add the required amount of antifreeze to the system. [Fill the open reservoir with the quantity of antifreeze required for minus 9 degree C freeze protection and run the purge pump 15 minutes to deliver the antifreeze to the system. Test the solution with a hydrometer to determine the actual freezing point.]

Form 1, "Ground Heat Exchanger Inspection and Test Report" located below, shall be completed for each system by the [Contractor] [or QC Manager] after completion of the flow [and injection of required antifreeze to the system and] before the systems can be backfilled.

FORM 1

GROUND HEAT EXCHANGER (GHX) INSPECTION AND TEST REPORT

NOTE: Use separate form for each GHX loop system.

Building:_____ Inspection Date:_____

Ground Heat Exchanger No. or Description:_____

List the WSHP Unit No.'s served by this GHX: _____

Ground Heat Exchanger Design Water Flow - _____ liters/sec

Calculated purging flow and press to achieve 0.61 m

Purging: Flow _____ liters/sec Head _____ kPa, Duration of test _____ min.

Hydrostatic test pressure _____ kPa; Duration _____ min.

Did the system pass the pressure test? _____

Is antifreeze required in system?____ If yes, was antifreeze measured?____

Has a dimensioned drawing been prepared, completely and accurately showing the layout of the ground heat exchanger? _____

Does the layout differ substantially from the contract documents? _____
If so is the deviation approved? _____

Depth of installed vertical loops is _____m. (Design is _____ m.)

Depth of horizontal piping is _____ m. (Design is _____m.)

Are the trenches clear of sharp bends, rocks, or other sharp objects that could restrict flow?_____

Are all joints heat fused (butt-, socket-, or saddle-fusion)?_____
Do the joints have the proper amount of roll-out?_____

Has the piping material been cut-out and properly removed from saddle-fusion tees?_____

Was the system backfilled properly with good clean backfill material?_____

Comments:_____

Inspected and approved this _____ date by _____

Title: _____

3.7.3 Refrigerant Piping

Perform the following when field piping connections are provided.

a. Pressure Test: Test refrigerant piping using dry, oil-free nitrogen, and prove tight at 2068 kPa on the high side and 1027 kPa on the low side. Maintain pressure for 2 hours with no leakage or reduction in gage pressure.

b. Evacuation: Using high vacuum pump and certified micron gage, reduce absolute pressure on both sides of system simultaneously to 300 microns. After reaching this point charge system with proper refrigerant until pressure of 0 kPa is obtained. Repeat evacuation-charging procedure for two more cycles, totaling to three evacuation-charging cycles. On final evacuation, secure pump and maintain 300 microns for 2 hours before charging with required final refrigerant.

3.7.4 Equipment

3.7.4.1 Field Testing

Test each item of equipment in operation for continuous period of not less than 24 hours under every condition of operation in accordance with each equipment manufacturer's recommendation. Verify that the equipment operating parameters are within limits recommended by the manufacturer.

3.7.4.2 Field Test Plan

Furnish equipment field test plans developed by each equipment manufacturer detailing recommended field test procedures for each item of equipment. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment will not be acceptable. The Contracting Officer will review and approve the field test plan for each item of equipment prior to commencement of field testing of the equipment.

a. Equipment Items to Test: Water-source heat pumps [and closed circuit coolers].

b. Coordinated Testing: Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of equipment controls which interlock and interface with controls factory prewired or external controls for the equipment provided under [Section 15901, "Space Temperature Control Systems"] [Section 15910, "Direct Digital Control Systems"].

c. Prerequisite Testing: Equipment for which performance testing is dependent upon the completion of the work covered by Section 15950, "HVAC Testing/Adjusting/Balancing" shall have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.

d. Test Procedure: Indicate in each field test plan each equipment manufacturer's published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer. Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Structure procedures to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control. Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance Variables: Each test plan shall list performance variables that are required to be measured or tested as part of the field test. Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Furnish with each test procedure a description of acceptable results that have been verified. Identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.

f. Job Specific: Each test plan shall be job specific and shall address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized Components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.7.4.3 Field Test Report

a. Equipment Items to Test: Water-source heat pumps[and closed circuit coolers].

b. Manufacturer's Recommended Test: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field testing.

c. Operational Test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every 2 hours. Use the test report forms for logging the operational variables.

d. Notice of Tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test

report for review and approval.

e. Report Forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director[and the QC Manager]. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.

f. Deficiency Resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested to verify compliance.

[3.7.5 Additional Field Testing

Provide testing, adjusting, and balancing (TAB) of ducts, piping, and equipment as specified in Section 15950, "HVAC Testing/Adjusting/Balancing"

][3.7.6 Testing and Balancing

****
NOTE: Use this paragraph for each building which has less than 28.1 kW of cooling, less than 372 square meters of floor space, or less than 15 supply air outlets.
****

Balance airflow in accordance with Circolare 29 and flows indicated. Submit written certificate to report the following to EFA MED:

a. Water source heat pump unit nameplate data, and actual voltage and ampere consumption.

b. Supply and return terminal airflow, and equipment used to measure airflow.

c. Water source heat pump liters/sec and entering and leaving air temperatures.

d. Water source heat pump unit condenser water liters/sec and entering and leaving temperatures.

e. Ambient outside air temperature, date, and person testing, balancing, and reporting.

]

-- End of Section --