ADDENDUM NO. 3

1.1 PROJECT INFORMATION

A. Project Name: Target Center Ice Replacement Project

B. Owner: City of Minneapolis

C. Owner Project Number: OP8331

D. Architect: Leo A Daly

E. Architect Project Number: 023-10188-006

F. Date of Addendum: 2016-08-15

1.2 NOTICE TO BIDDERS

A. This Addendum is issued to all registered plan holders pursuant to the Instructions to Bidders. This Addendum serves to clarify, revise, and supersede information in the Project Manual, Drawings, and previously issued Addenda. Portions of the Addendum affecting the Contract Documents will be incorporated into the Contract by enumeration of the Addendum in the Owner/Contractor Agreement.

B. The Bidder shall acknowledge receipt of this Addendum in the appropriate space on the Bid Form.

C. The date for receipt of bids is **changed to the following** same time and location:

1. Bid Date: Tuesday August 23, 2016

1.3 ATTACHMENTS

A. This Addendum includes the following attached Documents, Specification Sections, and Sheet:
1. Specification Section 00 01 00 Table of Contents **(Reissued).**

2. Specifications Section 00 41 13 Bid Form – Stipulated Sum **(REISSUED, VERSION 3).**

3. Specification Section 13 18 12 Ice Rink Refrigeration System **(reissued).**

4. Specification Section 23 23 00 Refrigerant Piping **(reissued).**

1.4 REVISIONS TO PREVIOUS ADDENDA

A. Addendum No. 2, Specification Section 00 41 13 Bid Form – Stipulated Sum, **(reissued version 3).**

1. Paragraph 1.6.A.6: Unit Price Form is not required to be submitted with the Bid Form.

2. Paragraph 1.6.A.7: Alternate Form is not required to be submitted with the Bid Form.

B. Addendum No. 2, Specification Section 00 01 00 Table of Contents, **(reissued).**
   1. Delete 01 40 00a Qualifications and Quality Requirements Form. These requirements are still required. They have been transferred to the Bid Form.

1.5 REVISIONS TO DIVISION 00 PROCUREMENT REQUIREMENTS AND CONTRACTING REQUIREMENTS

A. Specification Section 00 41 13 Bid Form
   1. Requirement to submit the following separate forms have been removed. All information required to be indicated by the Bidder is located on the Bid Form.
      a. Qualifications and Quality Requirements Form.
      b. Unit Price Form.
      c. Alternate Form.

B. Specification Section 00 01 00 Table of Contents
   1. Delete 01 40 00a Qualifications and Quality Requirements Form. These requirements are still required. They have been transferred to the Bid Form.

1.6 REVISIONS TO DIVISION 01 GENERAL REQUIREMENTS

A. None.

1.7 REVISIONS TO DIVISIONS 02 - 49 SPECIFICATION SECTIONS

A. Specification Section 13 18 12 Ice Rink Refrigeration System
   1. Add Article 2.1.A.3 Control System
   2. Revise Article 2.6 Refrigerant Leak Detector.

B. Specification Section 23 23 00 Refrigerant Piping
   1. Revise Article 2.6.C.
   2. Add Articles 2.6.E-H.

1.8 REVISIONS TO DRAWING SHEETS

A. None.

END OF DOCUMENT 00 91 13

Division	Section Title

PROCUREMENT AND CONTRACTING DOCUMENTS GROUP

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 01 01	PROJECT TITLE PAGE
00 01 07	SEALS PAGE
00 11 13	ADVERTISEMENT CALL FOR BIDS
00 21 13	INSTRUCTIONS TO BIDDERS
00 22 13	SUPPLEMENTARY INSTRUCTIONS TO BIDDERS
00 25 13	PREBID MEETINGS
00 26 00	PROCUREMENT SUBSTITUTION PROCEDURES
00 31 43	PERMIT APPLICATION
00 41 13	BID FORM (STIPULATED SUM)
00 43 13	BID SECURITY FORMS
00 43 22	UNIT PRICES FORMS **[Addendum No. 1, 2016-08-11]**
00 43 23	ALTERNATES FORMS **[Addendum No. 2, 2016-08-12]**
00 60 00	FORMS, AGREEMENTS AND CONDITIONS
00 73 00	GENERAL AND SUPPLEMENTARY CONDITIONS
EXIHIBITS	
	QUALITY PROGRAM REQUIREMENTS
	PRIME CONTRACT SUPPLEMENTARY TERMS AND CONDITIONS
	SAFETY PROGRAM REQUIREMENTS
	NHL FACILITIES STANDARDS (*for reference*)

SPECIFICATIONS GROUP

General Requirements Subgroup

DIVISION 01 - GENERAL REQUIREMENTS

01 10 00	SUMMARY
01 11 00	WORK SCOPE SUMMARY
01 21 00	ALLOWANCES
01 25 00	SUBSTITUTION PROCEDURES
01 26 00	CONTRACT MODIFICATION PROCEDURES
01 29 00	PAYMENT PROCEDURES
01 31 00	PROJECT MANAGEMENT AND COORDINATION
01 32 33	PHOTOGRAPHIC DOCUMENTATION
01 33 00	SUBMITTAL PROCEDURES
01 40 00	QUALIFICATIONS AND QUALITY REQUIREMENTS
~~01 40 00a~~	~~QUALIFICATIONS AND QUALITY REQUIREMENTS FORM~~ **[Addendum No.**

3, 2016-08-15] included on bid form.
01 73 00 EXECUTION
01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
01 77 00 CLOSEOUT PROCEDURES
01 78 39 PROJECT RECORD DOCUMENTS

Facility Construction Subgroup

DIVISION 02 - EXISTING CONDITIONS
02 41 19 SELECTIVE DEMOLITION

DIVISION 05 - METALS
05 50 00 METAL FABRICATIONS

DIVISION 07 – THERMAL AND MOISTURE PROTECTION
07 16 16 CRYSTALLINE WATERPROOFING **[ADDENDUM NO. 1, 2016-08-11]**

DIVISION 13 - SPECIAL CONSTRUCTION
13 18 11 ICE RINK GENERAL REQUIREMENTS
13 18 12 ICE RINK REFRIGERATION SYSTEM
13 18 13 ICE RINK FLOOR SYSTEM
13 18 14 ICE RINK PIPING, VALVES AND ACCESSORIES
13 18 16 ICE RINK DASHER BOARD SYSTEM AND ACCESSORIES

Facility Services Subgroup

DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING
23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 07 19 HVAC PIPING INSULATION
23 09 23.11 CONTROL VALVES
23 22 13 STEAM AND CONDENSATE HEATING PIPING
23 22 16 STEAM AND CONDENSATE PIPING SPECIALTIES
23 23 00 REFRIGERANT PIPING
23 57 00 HEAT EXCHANGERS FOR HVAC

DIVISION 24 - INDUSTRIAL REFRIGERATION
24 61 00 INDUSTRIAL REFRIGERATION COMPRESSORS

END OF TABLE OF CONTENTS

DOCUMENT 00 41 13 – [REISSUED, VERSION NO. 3] BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

1.1 BID INFORMATION

A. Bidder: _____.

B. Project Name: Target Center – Ice Replacement Project.

C. Project Location: 600 1st Avenue North, Minneapolis, MN 55403.

D. Owner: City of Minneapolis.

E. Architect: Leo A Daly.

F. Architect Project Number: 023-10188-006/017.

1.2 CERTIFICATIONS AND BASE BID

A. Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Leo A Daly and Architect's consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, necessary to complete the construction of the above-named prime contract, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:

B. Lump Sum:

1. _____ Dollars ($_____).
   a. Bid Break Down
   1) Demolition _____Dollars ($_____).
   2) Concrete Ice Slab _____ Dollars ($_____).
   3) Structural Repairs (ALLOWANCE)_____ Dollars ($ 100,000).
   4) Mechanical _____ Dollars ($_____).
   5) Electrical _____ Dollars ($_____).
   6) Refrigeration and Piping _____Dollars ($_____).

C. Unit Price No. 1: Removal of and recycling of the existing R-22 refrigerant. Refer to Specification Section 00 43 22 Unit Prices for further information. [Addendum No. 1, 2016-08-11], **[Addendum No. 3, 2016-08-15]**

1. _____ Dollars ($_____) per pound [Addendum No. 2, 2016-08-12].
2. The undersigned Bidder proposes the amounts above be deducted from the Contract Sum on performance and measurement of the individual items of Work.

D. Alternate No. 1 Suction Trap and Liquid Transfer System. Refer to Specification Section 00 43 23 Alternates for further information. **[Addendum No. 2, 2016-08-12], [Addendum No. 3, 2016-08-15]**

1. ADD____ DEDUCT____ NO CHANGE____ NOT APPLICABLE_____.
2. _____ Dollars ($_____).
3. ADD____ DEDUCT____ calendar days to adjust the Contract Time for this alternate.

1.3 BID GUARANTEE

A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 days after a written Notice of Award, if offered within 60 days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached cash, cashier's check, certified check, U.S. money order, or bid bond, as liquidated damages for such failure, in the following amount constituting two percent (2%) of the Base Bid amount above:

1. _____ Dollars ($_____).

B. In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return to the undersigned the cash, cashier's check, certified check, U.S. money order, or bid bond.

1.4 TIME OF COMPLETION

A. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on or around April 8, 2017, and shall be substantially complete by August 15, 2017.

1.5 ACKNOWLEDGEMENT OF ADDENDA

A. The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of this Bid:

1. Addendum No. 1, dated _____.
2. Addendum No. 2, dated _____.
3. Addendum No. 3, dated _____.
4. Addendum No. 4, dated_____.

1.6 BID SUPPLEMENTS <u>REQUIRED WITH BID.</u>

A. The following supplements **<u>Must Be Submitted With this Bid Form</u>**.

~~1. Bidder Qualifications: See Section 01 40 00 Qualifications and Quality Requirements.~~ Qualifications and Quality Requirements Form not required with Bid. These requirements are still required. They have been transferred to this Bid Form. **[Addendum No. 3, 2016-08-15].**

2. Bid Form Supplement – Refer to Section 00 43 13 Bid Security Forms

3. Contract (SUBP) Participation Form: Refer to Section 00 22 13 Supplementary Instructions to Bidders.
4. Responsible Contractor Form: Refer to Section 00 22 13 Supplementary Instructions to Bidders.
5. Prevailing Wage Form: Refer to Section 00 21 13 Supplementary Instructions to Bidders.
6. ~~Unit Price Form: Refer to Section 00 43 22 Unit Prices Form~~ [Addendum No. 1, 2016-08-11] Bid Supplement Form not required with Bid. **[Addendum No. 3, 2016-08-15].**
7. ~~Alternate Form: Refer to Section 00 43 23 Alternates Form~~ [Addendum No. 2, 2016-08-12] Bid Supplement Form not required with Bid. **[Addendum No. 3, 2016-08-15].**

1.7 CONTRACTOR'S LICENSE

A. The undersigned further states that it is a duly licensed contractor, for the type of work proposed, in the City of Minneapolis, and that all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

1.8 BIDDER QUALIFICATIONS

A. Prime Contractor:
1. Contractor must have successfully completed three (3) ice rink construction projects that serve professional, Olympic, or collegiate athletics with a minimum seating capacity of 5,000 spectators. These projects must have been completed within the past five (5) years.

	Project #1	Project #2	Project #3
Project Description:			
Portion of Project Completed by the Company:			
Location:			
Construction Cost:			
Completion Date:			
Owner's Name:			
Owner's Representative:			
Phone Number:			
Completion Date of Work:			

B Welding:

1. Submit the name of at least one (1) person employed by the company that will supervise the welding process along with certificates, training and qualifications.

Supervisor's Name:	
Certifications:	
Training:	
Qualifications:	

C Concrete Ice Rink Floor Slab:

1. Concrete ice rink floor slab work shall be performed by an established concrete floor finishing contractor with a proven track record of satisfactory, consistent quality workmanship within the past five years related to refrigerated rink floor slab floor slab.

Concrete Floor Contractor:	
Refrigerated Rink Floor Slabs Experience:	

D Concrete Supplier:

1. Concrete ice rink floor slab work shall be performed by an established concrete floor finishing contractor with a proven track record of satisfactory, consistent quality workmanship within the past five years related to refrigerated rink floor slab floor slab.

	Project #1	**Project #2**	**Project #3**
Concrete Floor Supplier:			
Project Description:			
Refrigerated Rink Floor Slabs Experience:			

1.9 STATEMENT OF AWARD

A. This bid will be awarded to the low, responsive, responsible bidder meeting all specifications.

B. The Low Bid will be based upon the Base Bid listed in Article 1.2.B Lump Sum.

C. The amount indicated for Unit Price No. 1 will modify the amount of the Lump Sum indicated by the Bidder only after the Awarded Contractor has verified the quantity of R-22 Refrigerant.

D. The amount indicated for Alternate No. 1 will be evaluated within 120 days of the Notice of Award. Only if accepted will the Lump Sum amount be modified.

1.10 SUBMISSION OF BID

A. Respectfully submitted this ____ day of _____, 2015.

B. Submitted By: _____(Name of bidding firm or corporation).

C. Authorized Signature: _____(Handwritten signature).

D. Signed By: _____(Type or print name).

E. Title: _____(Owner/Partner/President/Vice President).

F. Witness By: _____(Handwritten signature).

G. Attest: _____(Handwritten signature).

H. By: _____(Type or print name).

I. Title: _____(Corporate Secretary or Assistant Secretary).

J. Street Address: _____.

K. City, State, Zip: _____.

L. Phone: _____.

M. Email: _____.

N. License No: _____.

O. Federal ID No.: _____(Affix Corporate Seal Here).

END OF DOCUMENT 00 41 13

SECTION 131812 - ICE RINK REFRIGERATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. General system description, design criteria and control criteria.

B. Other Electrical Components, (enclosures, emergency switch, dialer, etc.)

C. Compressor Renovation

D. Chiller Replacement

E. Condenser System

F. Refrigerant Leak Detection System

G. Primary Refrigerant

H. Secondary Refrigerant

1.3 RELATED SECTIONS

A. Section 131811 - Ice Rink General Requirements

B. Section 131813 - Ice Rink Floor

C. Section 131814 - Ice Rink Piping, Valves and Accessories

D. Section 131815 - Ice Rink Waste Heat Recovery Systems

E. Division 23.

F. Division 24.

1.4 GENERAL REQUIREMENTS

A. General Refrigeration System Description:
   1. Modify existing ice rink refrigeration system including, but not limited to, chiller replacement, compressor renovation, condenser system renovations as necessary, piping, valves, controls, and all related electrical components and connections necessary for the refrigerant detection system and the new steam pressure regulating station.

B. Refrigeration System Design Criteria:
   1. Design criteria: See drawing for design conditions.
   2. New refrigeration piping, valving, and accessories shall be sized for the connected capacity by the Contractor unless otherwise specified or indicated on the drawings.
   3. Furnish and install all isolation valves and unions required for servicing equipment and system components whether or not they are shown on the drawings.
   4. Substitutions or additional modifications required to convert the system shall be identified and included in the Contractor's bid to the Owner with revised clearly identified on the bid drawings (DWG format).
   5. The Contractor shall provide all electrical (power & control) work, materials and equipment necessary for a complete, operational refrigeration system renovation. All work, materials and equipment shall meet the required electrical codes for the Project's location.
   6. Refer to 00 73 00 General and Supplementary Conditions, article 1.21 E & O Insurance for further information.**]**
   7.

1.5 SUBMITTALS

A. Shop Drawings. All submittals shall conform to the requirements of the General Conditions and these specifications including, but not limited to, the following
   1. Equipment data sheets.
   2. Equipment ratings.
   3. Update plans (DWG format).
   4. Updated schematic (DWG format).
   5. Updated control wiring diagrams (DWG format).
   6. Pressure testing.
   7. Operational and control setpoints.
   8. MSDS sheets.

1.6 WARRANTY

A. As required in Section 131811 - Ice Rink General Requirements.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING REQUIREMENTS

A. As required in Section 131811 - Ice Rink General Requirements.

PART 2 - PRODUCTS

2.1 ICE SYSTEM CONTROLS

A. General Design Criteria:
1. In general, the refrigeration system shall automatically maintain a set ice rink floor temperature by sensing the return secondary refrigerant temperature. This set point shall be easily adjustable.
2. In general, the individual components of the refrigeration system shall be controlled as follows:
   a. Compressors: By secondary refrigerant temperature returning from rink floor(s). Typical starting set points may be as follows. These may vary slightly depending on the desired ice temperature.

Compressor	ON (F)	OFF (F)
No. 1	18	16
No. 2	19	16
No. 3	23	18

   b. Chiller: Direct expansion thermostatic control, maintain a suitable level of superheat in the refrigerant suction.
   c. Condenser: By compressor discharge head pressure. Condensing pressure shall be controlled by modulation of the City of Minneapolis municipal chilled water supply presently serving the system.
3. Control system by Logix, M&M Systems, or approved equal. **[Addendum No. 3, 2016-08-15]**
   a. Compressor / Engine Room: Control Panel Software Equipment Monitoring / Control Description.
      1) Compressor Stager: Stage a total of three (3) reciprocating compressors, each with a remote start input and a motor starter auxiliary to provide a read back for motor failure detection. All safety interlocks shall be provided by the existing Vilter on-board pressure switches. No communication shall be provided.
      2) Condenser Pressure Control: Maintain discharge pressure on two (2) water-cooled condensers with 3-way water-regulating valves.
      3) Compressor Jacket Cooling Water Pump: Control one (1) (1.5 HP) water pump to run whenever a compressor is in operation. Monitor and alarm based upon a user defined set point for supply and return temperature. Monitor the water pump motor starter auxiliary to provide a read back for motor failure detection.
      4) Ice Slab Heat Exchangers: Monitor liquid feed of Six (6) Danfoss motorized feed valves and solenoid valves. Control temperature on one (1) ice slab with up to four (4) ice slab temperature sensors, one (1) brine supply and one (1) return temperature sensors, one pump pressure transducer and two (2) fixed-speed brine pumps (Brine Pumps #1 and #2). Operate in conjunction with Ice Rink Temperature Scheduler. Stop Compressor Stagers upon high level detection.

5) Ice Rink Control based upon an average of the four (4) slab temperatures and an operator adjustable slab temperature set point.
6) Underfloor Frost Heat Exchanger: Control underfloor temperature for one (1) rink with one (1) underfloor temperature sensor, one (1) glycol supply and one (1) glycol return temperature sensors, and one (1) glycol pump with an auxiliary read back for failure detection.
7) Snowmelt Pit: Control one (1) pump and allow remote operation via remote switch.
8) Monitor one (1) Engine Room Temperature sensor and run one (1) Ventilation fan upon temperature exceeding a user-adjustable set point.
9) Provide Primary RCS Alarm/Failure indication with three (3) 120 vac contacts (RCS Alarm, RCS Failure, RCS Operational) for field wiring to external customer-supplied strobe light/horn alarm annunciation device, fire or security alarm system.
10) Monitor one (1) Power Phase Loss input (indication supplied by others).
11) Provide a secondary Emergency Stop input for field wiring to remote switch.
12) Software for one (1) Intel Pentium-class Windows XP computer location with the following features/capabilities:
    a) Graphical User-Interface displays current operating conditions of all controlled equipment and sensors using animation and color-coded on/off status and provides one-click links to set points and features. No special programming or computer operation skills are necessary.
    b) Trend Logging records all system operating parameters at a user-adjustable interval and is saved to hard-disk daily (20-30 years storage is typical).
    c) Report Printing of Trend Log Reports with optional automatic time of day/day of week printing feature.
    d) Reports may be exported directly to Microsoft Excel.
    e) Graphical Trend Log Plotting provides visual analysis of up to eight (8) items on one plot.
    f) Maintenance Manager: organizes and forecasts impending maintenance tasks based upon Runtime and Periodic time intervals. Creates works orders with description and check list, maintenance date, parts needed and personnel assigned to the task. Includes a Maintenance History Log for recording all maintenance activity.
    g) On-Line Operations Manual instantly display on-screen "How to Use" information for all equipment set point and system features. Includes printable RCS documentation (wiring diagrams, channel assignments and system specification) and a hardware Troubleshooting section.
13) MODEM communications for complete off-site control system access.
14) Building-Plant Network/Internet Access: This feature allows PC’s to securely access the RCS through the facility's network infrastructure and/or the Internet.
15) A flexible Alarm Email Messaging utility is provided to notify personnel by cell phone, email, or pager In the event on an unacknowledged problem

(should not be used in lieu of the primary RCS Alarm, RCS Failure and RCS Operational contacts).

16) The on-site computer is configured as a server allowing multiple, simultaneous, independent clients complete access to the control system. Clients obtain full-featured RCS access including historic Trend Log data through the on-site server.
17) Server-client access for maximum of two (2) network clients, is provided through a multi-layer, secure and private (non-public) and site-specific protocol which prevents unauthorized access to the control system.
18) Server-client communications are not reliant upon any network domain management: the client requires only the server's IP address.
19) Note: A TCP/IP network, capable of static IP addressing, shall be supplied and supported by others. Email messaging requires SMTP email server access, provided and configured by others.
20) Ice Rink Temperature Scheduling provides up to eight different daily set point parameters for automatically scheduling on each day of the week.
21) Password Protection provides multiple levels of access restriction to system operation and control.
22) A minimum of ten passwords are available for plant management authorization of control system operators. Clarity™ Access History records date, time, I.D. and authority level of all password protected operator accesses.
23) Hand-Off-Auto switches located inside every control panel on each digital output permit manual operation of pumps, fans, valves and other switched equipment.
24) Modular "Building Block" construction of the control system permits the flexibility to meet any site's requirements while accommodating integrated control of future equipment through simple modification or expansion to the RCS.
25) Automatic Alarm and Failure Dialing System notifies personnel of a RCS alarm or failure through the use of both a pager service (service by others) and voice over phone. The dialer acts as a secondary refrigeration system alarm and failure notification system and should not be used in lieu of the primary RCS Alarm.
26) RCS Failure and RCS Operational contacts intended for local on-site connection to UL-listed alarm annunciation devices such as strobe lights, horns, and fire or security alarm systems. The Automatic Dialing System allows personnel to acknowledge all alarms and failures from a Touch-tone phone.

b. Control Function: shall be accessed, monitored and modified through a display of menus and screens that easily facilitate data input and command execution. All information and commands are in straight-forward English and do not require any computer programming skills.

c. Control Software: shall include a graphical user interface with icons, symbols, and buttons that permit a "point and shoot" selection of features. The design emphasis on ease-of-use, comprehensive data logging, and flexible data management &

reporting features greatly improve understanding of the refrigeration system and its efficient operation.

d. RCS Quantities:
   1) 1 Intel-Pentium / 2.0GHz Computer with Windows XP Operating System, minimum 80 Gigabyte Hard disk, 256 Mb RAM, HP DeskJet Color printer, 19" VGA color monitor, CD-RW drive, optical mouse
   2) 1 UL® listed Control Panel in a powder-coated NEMA-4 enclosure
   3) 4 Pressure Transducers (1 Suction, 1 Condenser, 2 Brine Pump Discharge Pressure)
   4) 2 Pressure Transducer Snubbers
   5) 12 Temperature sensor (1 Compressor Room, 1 Condenser Water, 2 Oil Cooling Water, 4 Brine, 4 Ice Rink)
   6) 2 Underfloor Temperature Sensor (2 Underfloor)
   7) 2 Provide Infra-Red temperature devices to monitor ice slab temperature.
   8) 1 33K baud MODEM for remote RCS access and control
   9) 1 One (1) trip with no more than Three (3) Week-day days of commissioning support and training services of a RCS technician
   10) 1 One-year unlimited Normal-Business-Hours telephone support.
   11) 1 One-year Parts-Only Warranty to replace components that fail due to faulty manufacture.

2.2 OTHER ELECTRICAL COMPONENTS

A. All electrical components if not specified elsewhere shall be UL listed where possible, meet all code requirements and approved for specific application.

B. Furnish and install an emergency remote control push/pull button (off-only control) and all associated electrical for a complete system to stop the operation of all electrically energized equipment related to the refrigeration system as required by the current state and local mechanical codes. Furnish and install a clear Plexiglass protective, lockable, wall mounted case for the device. Furnish and install a strobe light inside and outside the room as required by the current state and local mechanical codes.

C. Automatic Alarm Dialer.
   1. Approved Manufacturer: Phonetics Sensaphone 1104 or approved equal.
   2. Furnish and install a complete dialer system.
   3. Monitor a minimum of three (3) different alarm conditions plus power failure.
      a. Refrigerant leak detection.
      b. High brine temperatures.
      c. Alarm condition from refrigeration control system.
   4. Dial a minimum of four (4) different phone numbers.
   5. Operate with a standard dial telephone line.
   6. Battery backup during power failure.
   7. Respond to status interrogation from any touch-tone telephone.

2.3 COMPRESSOR RENOVATION

A. Approved manufacturers: Vilter Manufacturing Corporation to be renovated to accept R-407c refrigerant and P.O.E oil.

B. Design criteria: See Ice Equipment Schedule on drawings.

C. Accessories: As directed by Vilter to include changing of all gaskets, O-rings, seals, filters, suction strainer with screen bag, internal safety relief valve, high discharge/low suction pressure switch, oil failure switch, capacity reduction switches, Tri-Micro oil filter, suction and discharge valves, initial crankcase heater and well, 150 watt crankcase heater and well, direct drive coupling, steel base and coupling guard, refrigerant oil cooler, and refrigerant cooling jackets.

D. Capacity Reduction: Verify/maintain capacity reduction for each compressor based on the following table.

No. of Cylinders	Capacity Reduction
6	33% and 66%

E. Oil Separator: Shall meet ASME code requirements for 300 psig design working pressure. Separator shall be sized for the full flow rate of the compressor and have a full line size check valve and stop valve on the outlet piping. Separator shall be complete with: a coalescing element capable of removing 99.9% of all particles larger than 1 micron; a full line size check valve and stop valve on the outlet piping, a safety relief valve, a service cover, pipe stud connections, an oil return system connected back to crankcase of compressors including float valve assembly and piping, and all other required materials for complete installation. Shall be ASME coded.

F. Controls: As specified in this section under Ice System Controls.

G. Provide complete charge of P.O.E. oil for the compressors as recommended by the manufacturer after a complete evacuation of R-22 refrigerant oil.

2.4 CHILLER

A. Approved Manufacturers: Henry Technologies or approved equal.

B. Design criteria: See drawing for design conditions.

C. Shell and Head Construction: Steel pipe construction conforming to ASME Specifications AS-53 Grade B, seamless; or rolled steel plate conforming to ASME SA-516 Grade 70 with electric fusion welds conforming to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. Minimum design ratings on vessels shall be as follows:

Refrig.	Shell Side Pressure	Tube Side Pressure	Temperature Range
R-407c	300 PSIG	300 PSIG	-20 F to 200 F

E. Tube Construction:

1. Design Pressure & Temp: See table above.
2. Tube Material: Plain steel.
3. Outside Diameter: 0.750 inches.
4. Minimum Wall Thickness: 0.065 inches.
5. Fouling Resistance: 0.0005 hr x sf x F/BTU.

F. Direct Expansion of R407c Refrigerant:
1. Provide a dual relief valve assembly as specified and per code requirements.
2. Provide all electronic expansion valves, gauges, piping and other related materials and accessories as necessary for a fully operational system.
3. Name plate shall clearly display code compliance and capacity of vessel.
4. Furnish and install site glasses on chiller vessel for monitoring refrigerant level.

G. Vessels shall be mounted on a factory constructed steel frame system. The steel frame and vessels shall be shop painted with one coat of primer and one coat of alkyd egg-shell enamel.

2.5 RINK PUMPS

A. To remain as-is.

2.6 REFRIGERANT LEAK DETECTOR [Addendum No. 3, 016-0815]

A. Approved Manufacturers: Draeger Technologies, Genesis International, Cool Air Calibration Technologies, MSA, or approved equal.

B. Provide complete refrigerant leak detection system for R-407c refrigerant. System shall continuously monitor the ice mechanical room and relief main for refrigerant leaks and meet ASHRAE Standard 15 current edition. Install per manufacturer's installation guidelines. Especially take into consideration height of sensors in machinery room.

C. There shall be three (3) refrigerant sensors:
- Vent line sensor (solid state, 0-10,000 ppm)
- Low PPM alarm and exhaust sensor (Infrared, 0-500 ppm)
- High PPM alarm and equipment shutdown (Infrared, 0-10,000 ppm)

D. Include a minimum of a 4 channel remote control panel with display

E. Functions and Accessories:

1. Remote PPM displays refrigerant concentrations, alarm status, and alarm lights.
2. Microprocessor based system.
3. Solid state and infrared sensor modules.
4. At least two (2) SPDT relays contacts for remote alarming to exhaust fan in room and others to be specified later
5. 4-20 mA analog output.
6. Adjustable alarm levels.

7. Service mode for avoiding nuisance alarms
8. NEMA 4X, UL-listed, CSA, IEC, IP66 enclosure.
9. Automatic reset.
10. Unit shall not require calibration more than every 12 months.
11. Ethernet gateway for remote monitoring

F. Additionally Required:
1. Remote refrigerant sensor and cable up to 500 feet.
2. Remote stacklights and horns units inside and outside each of two entrances to the ice equipment room. Alarm shall annunciate visual and audible alarms.

2.7 PRIMARY REFRIGERANT

A. Furnish and install a complete operating charge of R-407c refrigerant and P.O.E oil to fill entire charge refrigeration system.

2.8 SECONDARY REFRIGERANT

A. Dowtherm SR-1 Glycol:
1. Furnish and install a complete operating charge of Dowtherm SR-1 Glycol at 35% concentration and deionized water. The fluid shall be an industrial heat transfer fluid specifically designed for HVAC systems.
2. The solution shall have a factory mixed corrosion inhibitor. The inhibitor shall be as recommended by the closed hydronic system chemistry provider.

B. Submit a product data sheet and MSDS sheet for the solution including the inhibitor and/or neutralizing agent.

C. Provide a weather resistant tag on the fill valve for the system that includes description of fluid, freezing and burst point, total gallons of system, Material Safety Data Sheet reference and date of original charge.

D. Provide a certified test result of the final mixture.

2.9 SIGNAGE

A. Furnish and install a legible permanent sign on the outside of the ice rink mechanical room door indicating name and address of the installer, the refrigerant number and amount of refrigerant, the lubricant identity and amount and the field test pressure applied. Sign shall be in accordance with the International Fire Code.

PART 3 - EXECUTION

3.1 EVACUATION, TESTING, AND CHARGING PROCEDURE

A. Prior to modifying existing system:
   1. Evacuate, recover, record charge, and dispose of existing R-22 from the system in a legal manner.
   2. Drain existing oil, oil filters, and filter driers from the system and dispose of in a legal manner.

B. After modification are complete:
   1. Evacuate the entire system down to 250 microns, hold for no less than 24 hours, record pressure readings, and submit to Owner for acceptance before proceeding.
   2. Pressure test the entire system at pressure of 200 psig using dry nitrogen for a period of no less than 24 hours, record pressure readings, and submit to Owner for acceptance before proceeding.
   3. Replace the existing oil filters and filter/driers prior to charging the system.
   4. Leak test the system and repair any leaks prior to charging the system.

C. Charge the system with R407c and replace oil with POE acceptable to the compressor manufacturer.

D. Restart the system and allow it to come to normal operating conditions. Compare the new operation data and adjust the operation as needed. Check the operation of the control valves and adjust as necessary.

E. Clean liquid line dryers and replace removable inlet screens a minimum of two times after system start-up. Confirm residual oil has been properly extracted using a refractometer and replace oil as needed. Each replacement shall be identified as a line-item on the contractor bids.

3.2 SECONDARY REFRIGERANT

A. Prior to modifying existing system:
   1. Drain and dispose of existing glycol mixture from the system in a legal manner.

B. After modification are complete:
   1. Pneumatically pressure test the entire glycol system at pressure of 75 psig for a period of no less than 24 hours, record pressure readings, and submit to Owner for acceptance before proceeding.
   2. Leak test the system and repair any leaks prior to charging the system.

C. Charge the system with ethylene glycol mixture.

D. Restart the system and allow it to come to normal operating conditions. Compare the new operation data and adjust the operation as needed. Check the operation of the control valves and adjust as necessary.

E. Remove, clean, and replace suction strainers a minimum of two times after system start-up. Identified as a line-item on the contractor bids.

3.3 EQUIPMENT INSTALLATION

A. All equipment shall be installed per manufacturer's requirements.

B. All equipment bases shall be bolted down and filled with concrete unless otherwise specified or noted.

C. All equipment shall be installed and designed such that vibration is minimal and meets acceptable limits. If the amount of vibration is in question, the Contractor shall be responsible for hiring a certified, experienced vibration company to perform the necessary test. A certified test report shall be submitted to the Engineer. If results are not satisfactory, the Contractor shall be responsible for correcting the problem and retesting for vibration as previously specified.

D. Insulate equipment to prevent condensation during normal operation.

3.4 ELECTRICAL

A. The Contractor shall provide all electrical work necessary for a complete, operational ice system. All work shall meet the required electrical codes for the Project's location. A licensed electrician shall perform all electrical work.

B. Locate the Emergency Remote Control switch, protective case and strobe light outside the ice mechanical room at a distance from the entrance door to the room as required by code. Locate a strobe light inside the room as required by code.

3.5 REFRIGERANT LEAK DETECTOR

A. Calibrate unit after final completion of project. Provide verification that the unit has been calibrated.

3.6 PAINTING AND FINISHES

A. Clean and paint exposed equipment and piping with one coat of primer and one coat of alkyd enamel to match existing.

B. Provide additional touch up paint for equipment and vessels for Owners use.

3.7 CLEANING

A. Thoroughly clean equipment of all temporary protective coatings and foreign material prior to assembly of erection.

B. After project completion thoroughly clean all equipment and piping systems.

3.8 START UP AND SHUTDOWN SERVICES

A. See Section 131811 - Ice Rink General Requirements.

END OF SECTION 131812

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Electronic expansion valves.
b. Solenoid valves.
c. Filter dryers.
d. Strainers.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
6. Pressure Rating: Factory test at minimum 400 psig.
7. Maximum Operating Temperature: 330 deg F.

2.4 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Service Valves:

1. Parker or equal.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

C. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Parker or equal.
2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.

5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 or 115-V ac coil as required by controls vendor.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.

D. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Parker or equal.
2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

E. Electronic Expansion Valves: Comply with AHRI 750.

1. Sporlan Superheat Controller.
2. Body, Bonnet, and Seal Cap: Forged brass or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: 2 deg F.
7. Superheat: Aspen Controller.
8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating: 450 psig.

F. Straight-Type Strainers:

1. Parker or equal.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

G. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

H. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Sporlan.
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: As appropriate for R-407c.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: 160.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

2.5 REFRIGERANTS

A. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

2.6 EQUIPMENT / PIPING INSULATION

A. DX Chiller. Provide equal to the following:
   1. Manufactures:
      a. Certainteed
      b. Johns Manville
      c. Knauf
      d. Owens Corning

B. Rigid Insulation:
   1. 2” preformed polyisocyanurate board insulation to fit vessel. Provide mastic sealant and ½” stainless steel bands for attachment.

C. Vapor Barrier: **[Addendum No. 3, 2016-08-15]**
   1. All insulation (straight runs, tees, and elbows shall have a vapor barrier.
   2. All straight run pipe insulation shall have a wrinkle-free factory-applied Saran 540 vapor barrier.
   3. All elbows, tees, reducers, etc. shall have a wrinkle-free field-applied Saran 540 vapor barrier.
   4. Saran 540 covering will be sealed with a vapor barrier sealing tape along all seams.
   5. It is prohibited to use staples to secure vapor barrier covering.
   6. Vapor barrier mastic will be used where required to provide vapor barrier for non-standard fittings and connections.
   7. All insulation shall be applied such that the mating surfaces are completely “buttered” at the joint.
   8. Insulation stops shall have a mastic seal, PVC or aluminum end cap, and silicone seal.

D. Recovery:
   1. Provide dimpled aluminum recovery over insulation with caulked joints and ½” stainless steel bands for attachment.

E. Low Temperature Pipe Insulation: **[Addendum No. 3, 2016-08-15]**

1. General: The refrigeration Contractor is responsible for furnishing and installation of:
   a. All pipe and vessel insulation with vapor barrier and protective covering as required for cold service refrigerant. This includes: Suction (LSS), Sub-cooled High Pressure Liquid Piping (SCHPL), Glycol piping (GS/GR), Glycol Chillers (2) and Suction/Liquid heat exchangers (2).
   b. Pipe saddles are required at every pipe support point to allow for movement and to prevent insulation from crushing.
2. Warranty: The Refrigeration Contractor shall warrant all materials and workmanship for a period of one (1) year from the date of system commissioning. Defects in material or workmanship will be corrected at no cost to the Owner during the warranty period.
3. Application: Insulation shall be applied to all low temperature refrigerant vessels, valves, piping, and fittings, but excluding those described at or above high stage condensing temperature. All low temperature glycol piping, tanks, valves, and fittings shall also be insulated.
4. Materials: All insulation material for refrigerant lines shall be extruded polystyrene as manufactured by DOW or approved equal in accordance with ASTM C 578. Insulation will be factory fabricated from bun stock and have a minimum density of 1.8 lb/cu. Ft. Multiple layers of insulation will be installed where required with overlapping joints.
5. Thickness Schedule: Suction (HSS, HTS) and Liquid Piping (LTL, TL): Insulation Thickness for Temperature Difference (see table below)

Extruded Polystyrene Insulation Indoor use Insulation thickness in inches necessary to prevent condensation (90°F, 80% humidity)								
Nom. Pipe size (in)	Service Temperature (°F)							
	-100	-80	-60	-40	-20	0	20	40
1/2	2.5	2.5	2.5	2	2	1.5	1.5	1
3/4	2.5	2.5	2.5	2.5	2	2	1.5	1
1	3	2.5	2.5	2.5	2	2	1.5	1.5
1 1/4	3	3	3	2.5	2	2	1.5	1.5
1 1/2	3	3	3	2.5	2	2	1.5	1.5
2	3.5	3	3	2.5	2.5	2	1.5	1.5
2 1/2	3.5	3	3	2.5	2.5	2	1.5	1.5
3	3.5	3.5	3	3	2.5	2	2	1.5
4	3.5	3.5	3	3	2.5	2.5	2	1.5
5	4	3.5	3.5	3	2.5	2.5	2	1.5
6	4	4	3.5	3	3	2.5	2	1.5
8	4.5	4	3.5	3.5	3	2.5	2	1.5
10	4.5	4	3.5	3.5	3	2.5	2	1.5
12	4.5	4	4	3.5	3	2.5	2	1.5
14	4.5	4	4	3.5	3	2.5	2	1.5
16	5	4.5	4	3.5	3	2.5	2.5	1.5
18	5	4.5	4	3.5	3	3	2.5	1.5
20	5	4.5	4	3.5	3.5	3	2.5	1.5
Tank Side	5.5	5	4.5	4	3.5	3	2.5	1.5

Tank Top	5.5	5	4.5	4	3.5	3	2.5	1.5
Tank Bottom	5.5	5	4.5	4	3.5	3	2.5	1.5

F. Protective Coverings: PVC covering is acceptable for indoor use only. The jacketing will be 0.030" thick as manufactured by Ceel-Co or approved equivalent. The jacketing will be tough, all-purpose, UV resistant, and capable of frequent washing. All joints of PVC jacket will be sealed with Ceeltite PVC adhesive or approved equivalent. PVC jacketing shall be color coded per recent IIAR published standards. **[Addendum No. 3, 2016-08-15]**

G. Preparation: **[Addendum No. 3, 2016-08-15]**
1. Apply insulation to surfaces after pressure tests have been completed and approved.
2. Ensure surfaces are clean and dry prior to installation.
3. Do not apply insulation to surfaces that are wet or frosted.
4. All valves that are insulated must have insulation applied in a manner that permits complete operation of the valve-adjusting mechanisms.

H. Fittings, Valves, and Appurtenances: **[Addendum No. 3, 2016-08-15]**
1. Insulate all fittings and valves with same thickness as adjacent insulation thickness.
2. Where pre-formed insulation is unavailable, insulate fittings and valves with pipe insulation sized to fit over adjacent pipe.
3. Fill voids with urethane foam.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 1-1/2 (DN 40) for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

D. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

E. Safety-Relief-Valve Discharge Piping:
1. NPS 1 (DN 25) and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 1-1/4 to NPS 3: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.
3. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install a full-size, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install electronic expansion valves serving evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

H. Install moisture/liquid indicators in liquid line at the inlet of the expansion valves.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Expansion valves.

J. Install filter dryers in liquid line between liquid receiver and thermostatic expansion valve.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping exposed in equipment room and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping adjacent to machines to allow service and maintenance.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Select system components with pressure rating equal to or greater than system operating pressure.

H. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

I. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

J. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

K. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

L. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

N. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod, 3/8 inch (9.5 mm).
3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod, 3/8 inch (9.5 mm).
4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod, 1/2 inch (13 mm).

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust electronic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Complete all refrigeration retrofit work as recommended by Vilter.
2. Install POE oil and R-407c refrigerant.
3. Open shutoff valves in condenser water circuit.
4. Verify that compressor oil level is correct.
5. Open compressor suction and discharge valves.
6. Open refrigerant valves except bypass valves that are used for other purposes.
7. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300