Ohio | Public Utilities Commission

Application to Commit Energy Efficiency/Peak Demand Reduction Programs (Mercantile Customers Only)

Case No.: 12-2590-EL-EEC

Mercantile Customer: **Oak Hills Local School District (Delshire School)**

Electric Utility: **Duke Energy**

Program Title or Description: **Chiller**

Rule 4901:1-39-05(F), Ohio Administrative Code (O.A.C.), permits a mercantile customer to file, either individually or jointly with an electric utility, an application to commit the customer's existing demand reduction, demand response, and energy efficiency programs for integration with the electric utility's programs. The following application form is to be used by mercantile customers, either individually or jointly with their electric utility, to apply for commitment of such programs in accordance with the Commission's pilot program established in Case No. 10-834-EL-POR

Completed applications requesting the cash rebate reasonable arrangement option (Option 1) in lieu of an exemption from the electric utility's energy efficiency and demand reduction (EEDR) rider will be automatically approved on the sixty-first calendar day after filing, unless the Commission, or an attorney examiner, suspends or denies the application prior to that time. Completed applications requesting the exemption from the EEDR rider (Option 2) will also qualify for the 60-day automatic approval so long as the exemption period does not exceed 24 months. Rider exemptions for periods of more than 24 months will be reviewed by the Commission Staff and are only approved up the issuance of a Commission order.

Complete a separate application for each customer program. Projects undertaken by a customer as a single program at a single location or at various locations within the same service territory should be submitted together as a single program filing, when possible. Check all boxes that are applicable to your program. For each box checked, be sure to complete all subparts of the question, and provide all requested additional information. Submittal of incomplete applications may result in a suspension of the automatic approval process or denial of the application.

Any confidential or trade secret information may be submitted to Staff on disc or via email at ee-pdr@puc.state.oh.us.

Section 1: Mercantile Customer Information

Name: **Oak Hills Local School District**

Principal address: **3200 Ebenzer Road Cincinnati, Ohio 45248**

Address of facility for which this energy efficiency program applies:

4402 Glenhaven Road Cincinnati, Ohio 45233 (Delshire School)

Name and telephone number for responses to questions:

Grady Reid Jr, 513-287-1038

Electricity use by the customer (check the box(es) that apply):

✓ **The customer uses more than seven hundred thousand kilowatt hours per year at the above facility**. (**Refer to Appendix A for documentation**)

Section 2: Application Information

A) The customer is filing this application (choose which applies):

□ Individually, without electric utility participation.

✓ **Jointly with the electric utility.**

B) The electric utility is: **Duke Energy**

C) The customer is offering to commit (check any that apply):

□ Energy savings from the customer's energy efficiency program. (Complete Sections 3, 5, 6, and 7.)

□ Capacity savings from the customer's demand response/demand reduction program. (Complete Sections 4, 5, 6, and 7.)

✓ **Both the energy savings and the capacity savings from the customer's energy efficiency program. (Complete all sections of the Applicatio**n.)

Section 3: Energy Efficiency Programs

A) The customer's energy efficiency program involves (check those that apply):

- ✓ Early replacement of fully functioning equipment with new equipment. (Provide the date on which the customer replaced fully functioning equipment, and the date on which the customer would have replaced such equipment if it had not been replaced early. Please include a brief explanation for how the customer determined this future replacement date (or, if not known, please explain why this is not known)).

- □ Installation of new equipment to replace equipment that needed to be replaced The customer installed new equipment on the following date(s):

- □ Installation of new equipment for new construction or facility expansion. The customer installed new equipment on the following date(s): _____.

- □ Behavioral or operational improvement.

B) Energy savings achieved/to be achieved by the energy efficiency program:

1) If you checked the box indicating that the project involves the early replacement of fully functioning equipment replaced with new equipment, then calculate the annual savings [(kWh used by the original equipment) – (kWh used by new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

   Annual savings: **22,348 kWh** (**Refer to Appendix B for calculations and supporting documents).**

2) If you checked the box indicating that the customer installed new equipment to replace equipment that needed to be replaced, then calculate the annual savings [(kWh used by less efficient new equipment) – (kWh used by the higher efficiency new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

   Annual savings: _____kWh

   Please describe any less efficient new equipment that was rejected in favor of the more efficient new equipment.

3) If you checked the box indicating that the project involves equipment for new construction or facility expansion, then calculate the annual savings [(kWh used by less efficient new equipment) – (kWh used by higher efficiency new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

Annual savings: _____kWh

Please describe the less efficient new equipment that was rejected in favor of the more efficient new equipment.

4) If you checked the box indicating that the project involves behavioral or operational improvements, provide a description of how the annual savings were determined.

_____

Section 4: Demand Reduction/Demand Response Programs

A) The customer's program involves (check the one that applies):

- ✓ **Coincident peak-demand savings from the customer's energy efficiency program.**
- □ Actual peak-demand reduction. (Attach a description and documentation of the peak-demand reduction.)
- □ Potential peak-demand reduction (check the one that applies):
  - □ The customer's peak-demand reduction program meets the requirements to be counted as a capacity resource under a tariff of a regional transmission organization (RTO) approved by the Federal Energy Regulatory Commission.
  - □ The customer's peak-demand reduction program meets the requirements to be counted as a capacity resource under a program that is equivalent to an RTO program, which has been approved by the Public Utilities Commission of Ohio.

B) On what date did the customer initiate its demand reduction program?

August 2010

C) What is the peak demand reduction achieved or capable of being achieved (show calculations through which this was determined):

11.4 kW Refer to Appendix B for calculations and supporting document

Section 5: Request for Cash Rebate Reasonable Arrangement (Option 1) or Exemption from Rider (Option 2)

Under this section, check the box that applies and fill in all blanks relating to that choice.

Note: If Option 2 is selected, the application will not qualify for the 60-day automatic approval. All applications, however, will be considered on a timely basis by the Commission.

A) The customer is applying for:

✓ **Option 1: A cash rebate reasonable arrangement.**

OR

□ Option 2: An exemption from the energy efficiency cost recovery mechanism implemented by the electric utility.

OR

□ Commitment payment

B) The value of the option that the customer is seeking is:

Option 1: A cash rebate reasonable arrangement, which is the lesser of (show both amounts):

✓ A cash rebate of **$900.00 Refer to Appendix C for documentation.**

Option 2: An exemption from payment of the electric utility's energy efficiency/peak demand reduction rider.

□ An exemption from payment of the electric utility's energy efficiency/peak demand reduction rider for ____ months (not to exceed 24 months). (Attach calculations showing how this time period was determined.)

OR

□ A commitment payment valued at no more than $_____. (Attach documentation and calculations showing how this payment amount was determined.)

OR

□ Ongoing exemption from payment of the electric utility's energy efficiency/peak demand reduction rider for an initial period of 24 months because this program is part of the customer's ongoing efficiency program. (Attach documentation that establishes the ongoing nature of the program.) In order to continue the exemption beyond the initial 24 month period, the customer will need to provide a future application establishing additional energy savings and the continuance of the organization's energy efficiency program.)

Section 6: Cost Effectiveness

The program is cost effective because it has a benefit/cost ratio greater than 1 using the (choose which applies):

□ Total Resource Cost (TRC) Test. The calculated TRC value is: _____ (Continue to Subsection 1, then skip Subsection 2)

✓ Utility Cost Test (UCT). The calculated **UCT value is 17.30 (Refer to Appendix D for calculations.**

)

Subsection 1: TRC Test Used (please fill in all blanks).

The TRC value of the program is calculated by dividing the value of our avoided supply costs (generation capacity, energy, and any transmission or distribution) by the sum of our program overhead and installation costs and any incremental measure costs paid by either the customer or the electric utility.

The electric utility's avoided supply costs were _____.

Our program costs were _____.

The incremental measure costs were _____.

Subsection 2: UCT Used (please fill in all blanks).

We calculated the UCT value of our program by dividing the value of our avoided supply costs (capacity and energy) by the costs to our electric utility (including administrative costs and incentives paid or rider exemption costs) to obtain our commitment.

Our avoided supply costs were **$25,012.**

The utility's program costs were **$546.**

The utility's incentive costs/rebate costs were **$900.00.**

Refer to Appendix D for calculations and supporting documents.

Section 7: Additional Information

Please attach the following supporting documentation to this application:

Narrative description of the program including, but not limited to, make, model, and year of any installed and replaced equipment.

A copy of the formal declaration or agreement that commits the program or measure to the electric utility, including:

1) any confidentiality requirements associated with the agreement;
2) a description of any consequences of noncompliance with the terms of the commitment;
3) a description of coordination requirements between the customer and the electric utility with regard to peak demand reduction;
4) permission by the customer to the electric utility and Commission staff and consultants to measure and verify energy savings and/or peak-demand reductions resulting from your program; and,
5) a commitment by the customer to provide an annual report on your energy savings and electric utility peak-demand reductions achieved.

Refer to Offer Letter following this application

A description of all methodologies, protocols, and practices used or proposed to be used in measuring and verifying program results. Additionally, identify and explain all deviations from any program measurement and verification guidelines that may be published by the Commission.

DUKE ENERGY
Mercantile Self Direct Program
139 East Fourth Street
Cincinnati, OH 45202

513 629 5572 fax

September 7, 2012

Mr. John Beckemeyer
Oak Hills Local Schools District - **Delshire**
6325 Rapid Run Road
Cincinnati, Ohio 45233

Subject: Your **(CUSTOM)** Application for a Duke Energy Mercantile Self-Direct Rebate

Dear Mr. Beckemeyer:

Thank you for your Duke Energy Mercantile Self Direct **(CUSTOM)** rebate application. As noted in the Energy Conservation Measure (ECM) chart on page two, a total rebate of $900.00 has been proposed for your **new chiller project** completed in the 2010 calendar years. **All Self Direct Rebates are contingent upon approval by the Public Utilities Commission of Ohio (PUCO).**

At your earliest convenience, please indicate if you accept this rebate by

- providing your signature on page two
- completing the PUCO-required affidavit on page three.

Please return the documents to my attention via fax at 513-629-5572 or e-mail to SelfDirect@Duke-Energy.com. Upon receipt, Duke Energy will submit the necessary documentation to PUCO. Following PUCO's approval, Duke Energy will remit payment.

At Duke Energy, we value your business and look forward to working with you on this and future energy efficiency projects. We hope you will consider our Smart $aver® incentives, when applicable. Please contact me if you have any questions.

Sincerely,

Grady Reid, Jr
Product Manager
Mercantile Self Direct Rebates

cc: Michelle Kolb, Duke Energy
Rob Jung, WECC
Ms. Cory Feldkamp, Feldkamp Enterprises, Inc

Please indicate your response to this rebate offer within 30 days of receipt.

☐ Rebate is accepted. ☐ Rebate is declined.

By accepting this rebate, Oak Hills Schools affirms its intention to commit and integrate the energy efficiency projects listed on the following pages into Duke Energy's peak demand reduction, demand response and/or energy efficiency programs.

Additionally, Oaks Hills Schools also agrees to serve as joint applicant in any future filings necessary to secure approval of this arrangement as required by PUCO and to comply with any information and reporting requirements imposed by rule or as part of that approval.

Finally, Oaks Hills Schools affirms that all application information submitted to Duke Energy pursuant to this rebate offer is true and accurate. Information in question would include, but not be limited to, project scope, equipment specifications, equipment operational details, project costs, project completion dates, and the quantity of energy conservation measures installed.

If rebate is accepted, will you use the monies to fund future energy efficiency and/or demand reduction projects?

☐ YES ☐ NO

If rebate is declined, please indicate reason (optional):

MT Yohey — Customer Signature

TODD YOHEY — Printed Name

9/10/12 — Date

Proposed Rebate Amounts

Measure ID	Energy Conservation Measure (ECM)	Proposed Rebate Amount
ECM-1	Air Cooled Chiller – 97.3 Ton; Full Load 1.100 kW/ton; IPLV 0.805 kW/ton	$900.00
Total		$900.00

Ohio | Public Utilities Commission

Application to Commit Energy Efficiency/Peak Demand Reduction Programs (Mercantile Customers Only)

Case No.: ____-____-EL-EEC

State of Ohio :

Todd Yohey, Affiant, being duly sworn according to law, deposes and says that:

1. I am the duly authorized representative of:

   Oak Hills Local School District
   [insert customer or EDU company name and any applicable name(s) doing business as]

2. I have personally examined all the information contained in the foregoing application, including any exhibits and attachments. Based upon my examination and inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete.

3. I am aware of fines and penalties which may be imposed under Ohio Revised Code Sections 2921.11, 2921.31, 4903.02, 4903.03, and 4903.99 for submitting false information.

MT Yohey
Signature of Affiant & Title

Sworn and subscribed before me this 10th day of September, 2012
Month/Year

Lisa M Hauser
Signature of official administering oath

Lisa M. Hauser, Notary Public
Print Name and Title

My commission expires on 7-22-2017

NOTARIAL SEAL STATE OF OHIO

LISA M. HAUSER
Notary Public, State of Ohio
My Commission Expires 07/22/2017

Appendix A - Oak Hills School History

20302153 01		
Electric Meter # 104804771		
OAK HILLS SCHOOL DISTRICT		
3200 EBENEZER RD		
CINCINNATI, OH 45248		
Date	Days	Actual KWH
8/9/2012	29	307,777
7/11/2012	30	303,536
6/11/2012	32	429,396
5/10/2012	29	378,536
4/11/2012	30	386,763
3/12/2012	31	354,526
2/10/2012	29	329,744
1/12/2012	31	336,868
12/12/2011	33	375,955
11/9/2011	29	359,521
10/11/2011	29	385,917
9/12/2011	32	411,399
Total		**4,359,938**

00402046 01		
Electric Meter # 106008062		
OAK HILLS SCHOOL DISTRICT		
4402 GLEN HAVEN RD		
CINCINNATI, OH 45238		
Date	Days	Actual KWH
8/13/2012	31	33,869
7/13/2012	30	32,562
6/13/2012	30	37,913
5/14/2012	31	34,813
4/13/2012	30	31,150
3/14/2012	29	34,378
2/14/2012	29	35,396
1/16/2012	33	35,936
12/14/2011	33	35,422
11/11/2011	29	31,348
10/13/2011	29	33,527
9/14/2011	30	39,805
Total		**416,119**

Appendix B - Delshire School - Energy Savings Achieved

	Baseline Used[1]			Post Project Actual				Savings	
	Description	Annual kWh	Summer Coincident kW	Description	Annual kWh	Summer Coincident kW	Hours of Operation	Annual kWh	Summer Coincident kW
ECM- 1	Air Cooled Chiller Per Code	68,995	122	New Air Cooled Chiller and Refrigerant Monitors	48,193	107.0	615	20,802	15.0

Application of 7.43% line losses yields **22,348 kWh savings** and **11.4 summer coincident kW.** These values may also reflect minor DSMore modeling software rounding error.

Notes: 1. Energy consumption baseline, demand baseline and post-project energy consumption basis are outlined in the following pages.

DETAILED CALCULATIONS

JAN 2012 V2.0

	Oak Hills Schools - Delshire chiller	Application #	12-499 MSD	Rev.	0
Project Name	*Oak Hills Schools - Delshire chiller*			State	OH

ENERGY SAVINGS	Code min IPLV =	1.153	kW/ton	Per ASHRAE 90.1-2004, for air cooled chiller . This value was used since information re existing chiller could not be found or verified.
	Proposed Eqpt IPLV =	0.805369128	kW/ton	
	Est'd annl operation =	615	h/year	
	Nominal capacity =	97.3	ton	
	Base case annl kWh =	68,995	kWh/year	
	Proposed annl kWh =	48,193	kWh/year	
	Annl kWh Savings =	**20,802**	**kWh/year**	

DEMAND SAVINGS	Code min Full Load =	1.256	kW/ton	Per ASHRAE 90.1-2004, for air cooled chiller . This value was used since information re existing chiller could not be found or verified.
	Proposed Full Load =	1.100	kW/ton	
	Base case annl kW =	122.21	kW	
	Proposed annl kW =	107.03	kW	
	Annl kW Savings =	**15.1788**	**kW**	

DEGREE DAY NORMALS(Total)

NO.	STATION NAME	ELEMENT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	check
29	CINCINNATI	HDD	1,060	841	640	334	135	11	0	4	47	300	595	916	4,883	4,883
LUNKEN	AP	CDD	0	0	0	4	95	224	352	305	131	20	0	0	1,131	1,131

Monthly Cooling %-age (usage) =	0.00	0.00	0.00	0.00	0.08	0.20	0.31	0.27	0.12	0.02	0.00	0.00		1.00
Monthly Cooling %-age (demand) =	0.00	0.00	0.00	0.01	0.27	0.64	1.00	0.87	0.37	0.06	0.00	0.00		

MAX DEGF	39.2	44.2	54.6	65.3	74.8	82.7	86.7	85.1	78.7	67.5	54.7	43.7	64.8
MEAN DEGF	30.8	35	44.4	54	63.8	72.1	76.4	74.7	67.8	56	45.2	35.5	54.6
MIN DEGF	22.4	25.7	34.1	42.7	52.7	61.5	66	64.3	56.9	44.5	35.6	27.2	44.5

Appendix C -Cash Rebate Calculation

Chiller

Measure	Quantity	Cash Rebate Rate	Cash Rebate
Air Cooled Chiller – 97.3 Ton; Full Load 1.100 kW/ton; IPLV 0.805 kW/ton	1	50% of incentive that would be offered by the Smart $aver Custom program	**$900**

Appendix D - Oak Hills Schools (Delshire) UCT Value

Chiller

Measure	Total Avoided Cost	Program Cost	Incentive	Quantity	Measure UCT
Air Cooled Chiller – 97.3 Ton; Full Load 1.100 kW/ton; IPLV 0.805 kW/ton	$25,012	$546	$900	1	**17.30**
Totals	**$25,012**	**$546**	**$900**	**1**	

Total Avoided Supply Costs	$25,012	***Aggregate Application UCT***	***17.30***
Total Program Costs	$546.00		
Total Incentive	$900		

Ohio Mercantile Self Direct Program

Application Guide & Cover Sheet

Questions? Call 1-866-380-9580 or visit www.duke-energy.com.

Email this form along with completed Mercantile Self Direct Prescriptive or Custom applications, proof of payment, energy savings calculations and spec sheets to SelfDirect@Duke-Energy.com. You may also fax to 1-513-629-5572.

Mercantile customers, defined as using at least 700,000 kWh annually are eligible for the Mercantile Self Direct program. Please indicate mercantile qualification:

- ☐ a single Duke Energy Ohio account
- ☒ multiple accounts in Ohio (energy usage with other utilities may be counted toward the total)

Please list Duke Energy account numbers below (attach listing of multiple accounts and/or billing history for other utilities as required):

Account Number	Annual Usage	Account Number	Annual Usage
00402046 01	400,000 kWh	20302153 01	4,000,000 kWh

Self Direct rebates are available for completed Custom projects that have not previously received a Duke Energy Smart $aver® Custom Incentive. Self Direct incentives are applicable to Prescriptive measures that were installed more than 90 days prior to submission to Duke Energy and have not previously received a Duke Energy Prescriptive rebate.

Self Direct Program requirements dictate that certain projects that may be Prescriptive in nature under the Smart $aver program must be evaluated using the Custom process. Use the table on page two as a guide to determine which Self Direct program fits your project(s). Apply for Self Direct projects using the appropriate application forms in conjunction with this cover sheet. Where Mercantile Self Direct Prescriptive applications are listed, please refer to the measure list on that application. If your measure is not listed, you may be eligible for a Self Direct Custom rebate. Self Direct Custom applications, like Smart $aver Custom applications, should include detailed analysis of pre-project and post-project energy usage and project costs. Please indicate which type of rebate applications are included in the table provided on page two.

Please check each box to indicate completion of the following program requirements:

☒ All sections of appropriate application(s) are completed	☒ Proof of payment.*	☒ Manufacturer's Spec sheets	☒ Energy model/calculations and detailed inputs for Custom applications

* If a single payment record is intended to demonstrate the costs of both Prescriptive & Custom projects, please include an additional document with an estimated breakout of costs for each Prescriptive and Custom energy conservation measure.

Application Type	Replaced equipment at end of lifetime or because equipment failed**	Replaced fully operational equipment to improve efficiency***	New Construction
Lighting	MSD Custom Part 1 ☐ Custom Lighting Worksheet ☐	MSD Prescriptive Lighting ☐	MSD Prescriptive Lighting ☐
		MSD Custom Part 1 ☐ Custom Lighting Worksheet ☐	MSD Custom Part 1 ☐ Custom Lighting Worksheet ☐
Heating & Cooling	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Prescriptive Heating & Cooling ☐
			MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐
Window Films, Programmable Thermostats, & Guest Room Energy Management Systems	MSD Custom Part 1 ☐ MSD Custom General and/or EMS Worksheet(s) ☐	MSD Prescriptive Heating & Cooling ☐	MSD Custom Part 1 ☐ MSD Custom General and/or EMS Worksheet(s) ☐
Chillers & Thermal Storage	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Custom Part 1 ☒ MSD Custom General Worksheet ☒	MSD Prescriptive Chillers & Thermal Storage ☐
			MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐
Motors & Pumps	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Prescriptive Motors, Pumps & Drives ☐
			MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐
VFDs	Not Applicable	MSD Prescriptive Motors, Pumps & Drives ☐	MSD Custom Part 1 ☐ MSD Custom VFD Worksheet ☐
		MSD Custom Part 1 ☐ MSD Custom VFD Worksheet ☐	
Food Service	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Prescriptive Food Service ☐
			MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐
Air Compressors	MSD Custom Part 1 ☐ MSD Custom Compressed Air Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom Compressed Air Worksheet ☐	MSD Prescriptive Process ☐
			MSD Custom Part 1 ☐ MSD Custom Compressed Air Worksheet ☐
Process	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	MSD Prescriptive Process ☐	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐
		MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐	
Energy Management Systems	MSD Custom Part 1 ☐ MSD Custom EMS Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom EMS Worksheet ☐	MSD Custom Part 1 ☐ MSD Custom EMS Worksheet ☐
Chiller Tune-ups	MSD Prescriptive Chiller Tune-ups ☒		
Behavioral** & No/Low Cost**	MSD Custom Part 1 ☐ MSD Custom General Worksheet ☐		

** Under the Self Direct program, failed equipment and equipment at the end of its useful life are evaluated differently than early replacement of fully functioning equipment. **All equipment replacements due to failure or old age will be evaluated via the Custom program.**

*** Please ensure that you include the age of the replaced equipment for measures classified as "Early Replacement" in your application as well as the estimated date that you would have otherwise replaced the existing equipment if you had not chosen a more energy efficient option.

**** Behavioral energy efficiency and demand reduction projects must be both measurable and verifiable. Provide justification with your application.

Mercantile Self Direct
Nonresidential Custom Rebate Application
PART 1

Proposed energy efficiency measures may be eligible for Self-Direct Custom rebates if they clearly reduce electrical consumption and/or demand as compared to the appropriate baseline.

Before you complete this application, please note the following important criteria:

- Submitting this application does not guarantee a rebate will be approved.
- Rebates are based on electricity conservation only.
- Electric demand and/or energy reductions must be well documented with auditable calculations.
- Incomplete applications cannot be reviewed; all fields are required.

Refer to the complete list of Instructions and Disclaimers, beginning on page 6.

Notes on the Application Process

If you have any questions concerning how to complete any portion of the application or what supplementary information is required, please contact your Duke Energy Ohio, Inc account manager or the Duke Energy Smart $aver® team at 1-866-380-9580.

Every application must include calculations of the baseline electrical usage and the electrical usage of the proposed high-efficiency equipment/system. Monthly calculations are best. You, the Duke Energy Ohio customer, or your equipment vendor / engineer should perform these calculations and submit them to Duke Energy for review. *We strongly encourage the use of modeling software (such as eQuest or comparable) for complex projects.*

Upon receipt of your application, an acknowledgement email will be sent to you with an estimated response time based on an initial assessment of your application. The application review may include some communication to resolve any questions about the project or to request additional information. Applications that are received complete without missing information have a faster review time.

There are two ways to submit your completed application.

Email your scanned form to: SelfDirect@duke-energy.com

Or, fax your form to 513-629-5572

Mercantile Self Direct
Nonresidential Custom Rebate Application
PART 1

1. Contact Information (Required)

Duke Energy Customer Contact Information						
Company Name	Oak Hills Local School District					
Address	6325 Rapid Run Rd.					
Project Contact	John Beckemeyer					
City	Cincinnati	State	OH	Zip Code	45233	
Title	Operations Coordinator					
Office Phone	513- 598-2941	Mobile Phone	513-519-3237	Fax		
E-mail Address	beckemeyer_j@ohlsd.org					

Equipment Vendor / Contractor / Architect / Engineer Contact Information					
Company Name	Feldkamp Enterprises, Inc.				
Address	3642 Muddy Creek Rd.				
City	Cincinnati	State	OH	Zip Code	45238
Project Contact	Cory Feldkamp				
Title	Director of Service				
Office Phone	513-347-4500	Mobile Phone		Fax	513-347-4506
E-mail Address	cory@feldkamphvac.com				
Describe Role					

Payment Information					
Payee Legal Company Name (as shown on Federal income tax return):	Oak Hills Local School District				
Mailing Address	6325 Rapid Run Rd.				
City	Cincinnati	State	OH	Zip Code	45233
Type of organization (check one) ☐ Individual/Sole Proprietor ☐ Corporation ☐ Partnership ☐ Unit of Government ☒ Non-Profit (non-corporation)					
Payee Federal Tax ID # of Legal Company Name Above:	316000742				
Who should receive incentive payment? (select one) ☒ Customer ☐ Vendor (Customer must sign below)					
If the vendor is to receive payment, please sign below: I hereby authorize payment of incentive directly to vendor: Customer Signature _____ Date____/___/_____ (mm/dd/yyyy)					

Mercantile Self Direct
Nonresidential Custom Rebate Application
PART 1

2. Project Information (Required)

A. Please indicate project type:
- ☐ New Construction
- ☐ Expansion at an existing facility
- ☐ Replacing equipment due to equipment failure
- ☒ Replacing equipment that is estimated to have remaining useful life of 2 years or less
- ☐ Replacing equipment that is estimated to have remaining useful life of more than 2 years
- ☐ Behavioral, operational and/or procedural programs/projects

B. Please describe your project, or attach a detailed project description that describes the project.
Installed new York Air-Cooled Chiller, Refrigerant Monitors

C. When did you start and complete implementation?
Start date 07 / 2010 (mm/yyyy) End date 08 / 2010 (mm/yyyy)

D. Are you also applying for Self-Direct Prescriptive incentives and, if so, which one(s)[1]?
Yes

E. Please indicate which worksheet(s) you are submitting for this application (check all that apply):
- ☐ Lighting
- ☐ Variable Frequency Drive (VFD)
- ☐ Compressed Air
- ☐ Energy Management System (EMS)
- ☒ General (for projects not easily submitted using one of the above worksheets)

F. Please tell us if there is anything about your electrical energy projections (either for the baseline or the proposed project) that you are either unsure about or for which you have made significant assumptions. Attach additional sheets as needed.

Required: Attach a supplier or contractor invoice or other equivalent information documenting the Implementation Cost for each project listed in your application. (Note: self-install costs cannot be included in the Implementation Cost)

[1] If your project involves some equipment that is eligible for prescriptive incentives and some equipment that is likely eligible for custom incentives, and if it is feasible to separate the equipment for the energy analysis, then the equipment will be evaluated separately. If it is not feasible to separate the equipment for analysis, then the equipment will be evaluated together in the custom application.

3. Signature (Required – must be signed by Duke Energy customer)

Customer Consent to Release of Personal Information

I, (insert name) John Beckemyer , do hereby consent to Duke Energy disclosing my Duke Energy Ohio, Inc Account Number and Federal Tax ID Number to its subcontractors solely for the purpose of administering Duke Energy Ohio's Mercantile Self-Direct Program. I understand that such subcontractors are contractually bound to otherwise maintain my Duke Energy Ohio, Inc Account Number and Federal Tax ID Number in the strictest of confidence.

I realize that under the rules and regulations of the public utilities commission, I may refuse to allow Duke Energy Ohio, Inc to release the information set forth above. By my signature, I freely give Duke Energy Ohio, Inc permission to release the information designated above.

Application Signature

I certify that I meet the eligibility requirements of the Duke Energy Ohio, Inc Mercantile Self Direct Custom Incentives Program and that all information provided within this application is correct to the best of my knowledge. I agree to the terms and conditions set forth for this program. I certify that the numbers, energy savings, and responses shown on this form are correct. Further, I certify that the taxpayer identification number is current and correct. I am not subject to backup withholding because: (a) I am exempt from backup withholding; or (b) I have not been notified by the IRS that I am subject to backup withholding as a result of a failure to report all interest or dividends; or (c) the IRS has notified me that I am no longer subject to backup withholding. I am a U.S. citizen (includes a U.S. resident alien).

Duke Energy Ohio, Inc Customer Signature

Print Name John Beckemyer

Date 8-15-12

Mercantile Self Direct
Nonresidential Custom Rebate Application
PART 1

Duke Energy®

Checklist for completing the Application

INCOMPLETE APPLICATIONS WILL RESULT IN DELAYS IN DUKE ENERGY PROCESSING YOUR APPLICATION AND NOTIFYING YOU CONCERNING AY REBATES. Before submitting the application and the required supplementary information, use the following checklist to ensure that your application is complete and the information in the application is accurate. (Note: this checklist is for your use only – do not submit this checklist with your application)

Section No. & Title	Have You:
1. Contact Information	☒ Completed the contact information for the Duke Energy customer? ☒ Completed the contact information for the equipment vendor / project engineer that can answer questions about the technical aspects of the project, if that is a different person than above?
2. Project Information	☒ Answered the questions A-E, including providing a description of your project. ☐ Completed and attached the lighting, compressed air, VFD, EMS and/or General worksheet(s)?
3. Signature	☒ Signed your name? ☒ Printed your name? ☒ Entered the date?
Supplementary information (Required)	☒ Attached a supplier or contractor's invoice or other equivalent information documenting the Implementation Cost for projects listed in your application? (Note: self-install costs cannot be included in the Implementation Cost) ☐ (If submitting the General Worksheet) attached calculations documenting the energy usage and energy savings for **each** project listed in your application?

If you have any questions concerning how to complete any portion of the application or what supplementary information is required, please contact:

- your Duke Energy account manager
  or,
- the Duke Energy Smart $aver® team at 1-866-380-9580.

Mercantile Self Direct
Nonresidential Custom Rebate Application
PART 1

Instructions/Terms/Conditions

Note: Please keep for your records- do not submit with the application

1. Energy service companies or contractors may assist in preparing the application, but an authorized representative of the customer must sign this application to be eligible to participate in the Mercantile Self Direct Program. Completion of this application does not guarantee the approval of a Self Direct Custom Rebate.

2. Once all documentation requested in this application is received by *Duke Energy Ohio, Inc,* and any follow-up information requested by *Duke Energy* is received, the rebate amount for each Energy Conservation Measure (ECM) will be communicated to the customer. The rebate amount will be based on ECM energy savings and ECM incremental installation cost.

3. All rebates require approval by the Public Utilities Commission of Ohio. *Duke Energy Ohio, Inc* will submit an application for rebate on the customer's behalf upon customer attestation to program terms, conditions and requirements as outlined in the rebate offer letter and upon customer completion of attestation documents required by the Public Utilities Commission of Ohio.

4. *Duke Energy Ohio, Inc* will issue a Self Direct Custom Rebate check, based on the approved rebate amount for each ECM, upon receiving approval from the Public Utilities Commission of Ohio. *Duke Energy* Ohio, Inc does not guarantee PUCO approval.

5. With the application, the customer must provide a list of all sites where the ECMs were installed. *Duke Energy Ohio, Inc* requests that sites of similar size, hours of operation and energy consuming characteristics be grouped together in one application for the determination of the rebate amount. The application should identify the site where each unique ECM was installed.

6. Based on the information submitted with the application and the information gathered both before and after the initial installation of the ECM, *Duke Energy Ohio, Inc* will calculate the rebate amount for each ECM.

7. *Duke Energy Ohio, Inc* may conduct random site inspections of a sample of the locations where the ECMs are installed to verify installation and operability of the ECMs and to obtain information needed to calculate the Approved Incentive Amount.

8. Customers are encouraged to retain copies of all forms, invoices and supporting documentation for their records.

9. Approved rebates are valid for 6 months from the date communicated to the customer by *Duke Energy Ohio, Inc,* subject to the expiration of measure eligibility based on project completion dates and application submission deadlines as defined by PUCO. Customers are encouraged to execute their rebate offer contracts and PUCO-required affidavits promptly to ensure eligibility is not forfeited.

10. *Duke Energy Ohio, Inc* reserves the right to recover all unrecoverable costs associated with the project approval if the customer decides not to execute the rebate contract, after the project is approved by *Duke Energy Ohio, Inc.*

11. Projects financially supported by other funding sources will be evaluated on a case-by-case basis for potential partial funding from *Duke Energy Ohio, Inc.*

12. Participants must be *Duke Energy Ohio, Inc* nonresidential, mercantile customers with the project sites in the *Duke Energy Ohio, Inc* service territory.

13. Customers or trade allies may not use any *Duke Energy* logo without prior written permission.

14. Only trade allies registered with *Duke Energy* are eligible to participate.

15. All equipment must be new. Used or rebuilt equipment is not eligible for incentives. All old existing equipment must be removed on retrofit projects.

16. Disclaimers: *Duke Energy Ohio, Inc*
    a. does not endorse any particular manufacturer, product or system design within the program;
    b. will not be responsible for any tax liability imposed on the customer as a result of the payment of incentives;
    c. does not expressly or implicitly warrant the performance of installed equipment. (Contact your contractor for details regarding equipment warranties.);
    d. is not responsible for the proper disposal/recycling of any waste generated or obsolete or old equipment as a result of this project;
    e. is not liable for any damage caused by the installation of the equipment nor for any damage caused by the malfunction of the installed equipment; and
    f. reserves the right to change or discontinue this program at any time. The acceptance of program applications is determined solely by *Duke Energy Ohio, Inc.*

Ship To: DELSHIRE ELEMENTARY
4402 GLENHAVEN ROAD
CINCINNATI, OH 45238
US

Johnson Controls

YORK BY JOHNSON CONTROLS

ORIGINAL INVOICE

Direct Inquires To: Johnson Controls
Ginger Hittle
7863 Palace Dr.
Cincinnati, OH 45249
Federal ID#: 39-0380010

Phone: 513 605 6302
Fax: 513 605 6301

Mail Check To: Johnson Controls
PO Box 905240
Charlotte, NC 28290-5240

Attn: RONDA C. JOHNSON, TREASURER
Bill To: OAK HILLS LOCAL SCHOOL DISTRICT
6325 RAPID RUN RD
CINCINNATI, OH 45233

Project Name / Project Site / Tax Loc	Purchase Order / Date / Authorized By	JCI Project / CO	JCI Project Manager
OAK HILLS DELSHIRE ELEMENTARY 4402 GLENHAVEN RD., CINCINNATI, OH 45238 OH4523800	510079 05/06/10 TODD YOHEY	0E320043 000	HAMPTON, DAVID S

Period Covered	Application #	Invoice Number	Invoice Date	Terms
07/01/10 - 07/31/10	1	00027821442	07/29/10	Due On Receipt

Original Contract Amount:	$55,950.00
Approved Change Orders:	$0.00
New Contract Amount:	$55,950.00
Work Completed To Date:	$55,950.00
Less Retention:	$0.00
Total Less Retention:	$55,950.00
Less Invoiced To Date:	$0.00
Total Amount Due This Invoice:	**$55,950.00**

The Project Manager named above submits this application with knowledge, information, and belief that the work covered by this application for payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous applications for payment were issued and for which payments were received from the Owner and that current payment shown herein is now due.

Item A	Work Description B	Scheduled Value C	Previous Application D	Work In Place E	Stored Material F	Total Complete and Stored G (D+E+F)	Percent H (G/C)	Balance To Finish I (C-G)	0% Retention J
1	York Air Cooled Chiller CH-1	$55,950.00	$0.00	$55,950.00	$0.00	$55,950.00	100%	$0.00	$0.00
	Totals	$55,950.00	$0.00	$55,950.00	$0.00	$55,950.00	100%	$0.00	$0.00

RECEIVED
SEP 22 2010
OAK HILLS SCHOOL DIST.

Received By
AUG 02 2010
Oak Hills Local School District
Business Department

Please reference our invoice number and amount with your payment. Send only to the address on this invoice.

The General Worksheet is part 2 of the application. Do not submit this file without submitting a completed Part1 Custom Application document file, which can be found at www.duke-energy.com. This worksheet is for all projects that are not easily submitted through one of the other worksheets

Before you complete this application, please note the following important criteria:

- Submitting this application does not guarantee an incentive will be approved.
- Incentive already decided to proceed.
- Electric demand and/or energy reductions must be well documented with auditable calculations.
- Incomplete applications will not be reviewed; all fields are required.

Refer to the complete list of Instructions and Disclaimers, found in the Mercantile Self Direct Custom Application Part 1 document.

Please enter your information and data into the cells that are shaded.
Cells in white are locked and cannot be written over.

Duke Energy Customer Contact Information (Match the information in Application Part 1):

Name	John Beckemeyer
Company	Oak Hills Local School District

Equipment Vendor / Project Engineer Contact Information

Name	Cory Feldkamp
Company	Feldkamp Enterprises, Inc.

Before proceeding with the custom application, please verify that your project is not on the Self-Direct Prescriptive application.
The prescriptive incentive applications can be found at:
http://www.duke-energy.com/ohio-large-business/smart-saver/mercantile-self-direct.asp
Prescriptive rebate amounts are pre-approved.

List of Sites (Required)

App No.	
Rev.	

Provide a list of sites addressed by this custom incentive application

Site ID (see note 1)	Duke Energy Electric Account Number(s) (see note 2)	Facility Address	List of Proposed Projects at each site	Annual Hours of Operation	Gross Square Footage	Conditioned Square Footage	Facility Age (years)
225	*12345678 01*	*Example: 123 Main Street, Anywhere USA 12345*	*Project Name(s)*	*5,840*	*42,000*	*38,000*	*12*
	00402046 01	*4402 Glenhaven Rd., Cincinnati OH 45233*	*Delshire Chiller*	*2,184*			

1 Site ID
Can be a store number, building name or other way to identify the location. If there is only one site involved in this application, then a Site ID is not necessary.

2 Account Numbers
Must match the facility of the proposed project(s). If there are multiple meters at a site, only include the meters that pertain to the project(s).

For each project, answer the following questions (use one worksheet per project)

App No.	0
Rev.	0

Project Name: Delshire Elementary School

How would you classify this project? (Place an x in all boxes that apply.)

Lighting		**Heating/Cooling**		**Air Compressor**		**Energy Management System**	X
VFD		**Motors/Pumps**		**Process Equipment**		**Other, describe below:**	

Brief Project Description

Describe the Baseline (see note 3) Equipment/System	Describe the Proposed High Efficiency Project

If Existing Equipment is the Baseline, how many years of useful life remain or how many years until scheduled replacement? <2

Detailed Project Description Attached? Yes (Required)

Operating Hours (see note 4)

	Weekday		Saturday		Sunday		Weeks of Use in Year (see note 5)	Total Annual Hours of Use
24 x 7	**Start Hour**	**End Hour**	**Start Hour**	**End Hour**	**Start Hour**	**End Hour**		
No	***6AM***	***6PM***					***26***	***2,184***

Energy Savings

	Baseline (see Note 3)	Proposed	Savings	Describe how energy numbers were calculated
Annual Electric Energy	400,000 kWh	0 kWh	#VALUE!	
Electric Demand	0 kW	0 kW	0 kW	
Calculations attached	Yes	Yes	(Required)	Received annual electric usuage from Duke representative

Simple Payback

Average electric rate ($/kWh) on the applicable accounts (see note 6)			$0.10
Estimated annual electric savings			#VALUE!
Other annual savings in addition to electric savings, such as operations, maintenance, other fuels			
Incremental cost to implement the project (equipment & installation) (see note 7)			
Copy of vendor proposal is attached (see note 8)			Yes
Simple Electric Payback in years (see note 9)	#VALUE!	**Total Payback in years**	#VALUE!

3 Baseline
Retrofit projects: the existing equipment is the baseline.
New construction projects: the baseline is the standard option in today's market, taking into account any applicable organizational, local, state or federal codes or standards currently in effect.

4 Operating Hours
Describe when the equipment is typically used. If the project is proposed for more than one site, provide any variations in operating hours between the sites on a separate sheet.

5 Weeks of Use in Year
If the equipment is not in use 52 weeks during the year (for example, during holiday or summer break), provide an explanation of when usage is not expected and why: Used during the spring/summer months - boilers run during winter

6 Average electric rate ($/kWh)
If you do not know your average electric rate, use $0.10/kWh.

7 Incremental cost to implement the project
Costs exclude self installation costs. Retrofit projects, incremental cost is the total cost of the proposed project. New construction or where the existing equipment must be replaced anyway, then incremental cost is the premium of the proposed high efficiency project over baseline.

8 Copy of vendor invoice is attached
Vendor invoices detailing costs of the project are always required.
New construction projects or where the existing equipment must be replaced anyway, vendor proposal of baseline must also be attached.

9 Simple Electric Payback
If the simple electric payback is less than 1 year, the rebate structure is affected. Double check average electric rate for correct payback.

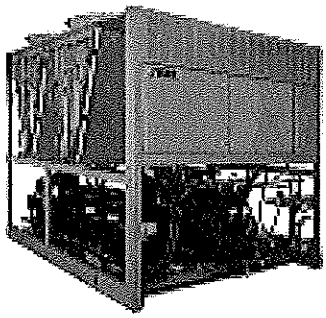
Johnson Controls

Equipment Submittal For Approval

Project:

OAK HILLS SCHOOL DISTRICT
DELSHIRE CHILLER

AIR COOLED SCROLL CHILLER w/ REMOTE EVAPORATOR BARRELL (TAG:CH-1)



SUBMITTED TO:
HAWA INCORPORATED
980 OLD HENDERSON ROAD
COLUMBUS, OHIO 43220

Attn: JIM LOCKARD

DATE:
May 21, 2010

SUBMITTED BY:

DAVID HAMPTON
PROJECT ENGINEER
JOHNSON CONTROLS
8918 BECKETT ROAD
WEST CHESTER, OHIO 45069

TABLE OF CONTENTS

AIR COOLED SCROLL CHILLER (TAG:CH-1)

UNIT SUBMITTAL NOTES

1. A strainer, preferably 40 mesh, should be installed in the cooler and condenser inlet lines, and located where it will protect the circulating pump and the heat exchanger tube bundles. Provide and installed by others.

2. A Differential Pressure switch will be provided (BY YORK) and need to be installed in the piping and wired back to the control panel **(BY OTHERS)** to prove flow through the chiller.

3. The chiller will be provided with a 200/3/60 voltage code.

4. Please note that the following items will NOT be included by York: rigging, field wiring, controls, valves and piping. Proper rigging must be present upon receiving of equipment. Detention Charges will be applied if shipment is refused upon arrival or not unloaded within the allowable (3) hour time slot.

5. Mechanical Contractor shall complete the entire pre-startup checklist included in this submittal and send it to the local York Service group two (2) weeks prior to desired startup date. Please feel free to contact Randy Weekley at 513-616-3775 to coordinate. A second year startup has been added per specs, please allow (2) weeks prior notice to when startup should occur.

6. York International/JCI will provide a (24) month Parts and Labor warranty for the entire unit. Warranty is effective from date of shipment. An additional 5 year (66) months compressor parts warranty is also included.

7. The current lead-time for a York YLAA chiller is ten (10) weeks after the receipt of approved submittals. An additional (1-2) weeks will be added to the current lead time for the remote evaporator configuration of the chiller.

8. York International/JCI will provide a BACnet Micro Gateway for the Non-Opt view chiller panel

9. With the current application, Hot Gas Bypass is advised by JCI but not specified. Please advise prior to returned submittals if this selection is needed.

10. JCI to provide and install refrigerant during commissioning and start up. Installing contractor to advise JCI two weeks prior to needing the refrigerant as the current lead time is two weeks for R-410a.

11. Please be advised that the JCI chiller does not have as many circuits, compressors or fans as TRANE's BOD does. If you have any questions or concerns, please feel free to contact D.J. Hampton

12. As mentioned in the previous note, JCI will provide a YLAA chiller per the selection provide at time of quote in lieu of Division 2.5, Section B that references the need for 3 compressors per circuit. The selected JCI chiller has two circuits with 2 compressors per each circuit required to meet the design conditions.

13. JCI will not be providing a remote control panel with the remote evaporator. Remote evaporator will be provided with standard JCI controls interface for connection to the control panel on the outdoor

condenser. All functionality and control will be at the control panel on the outdoor unit. No additional interface or control sensors are being provided

14. JCI will be providing the standard YORK compressor housing as mentioned in the Division 2.7, Section 3. If additional items of attenuation are needed, please advise prior to returned submittal.

15. Please read and follow all of the DX piping Guide information. See attached Form 50.40-ES2.

16. If the design of the piping layout is altered from the original layout in reference to the existing piping layout on drawing H2.00 plot dated 5/14/10 (11:53AM) then a new piping layout design must be resubmitted to the York factory for approval. Failure to do so may void factory warranties. Design intent to reuse same path as existing piping layout (hashed lines) and NOT preferred piping layout (solid lines). If this is incorrect please note upon return submittals.

17. Chiller unit drawings are preliminary drawings and may change slightly after final production drawings configured for remote evaporator application. HVAC contractor to coordinate all piping connections with York Manufacture Project Engineer.

UNIT OPTIONS

AIR COOLED SCROLL CHILLER, WITH THE FOLLOWING OPTIONS:

- High Efficiency
- Copper Tube/ Aluminum fin condenser coils
- Voltage Code-(200/3/60)
- Across-the-Line Start
- SP Supply TB
- Control Transformer(factory)
- Both Low & High Ambient Kits (2 Circuits)
- Discharge Pressure Readout Kit
- BAS/EMS Temperature Reset/Offset
- Suction Pressure Readout
- N. American Safety Code (cETL)
- Motor Current Module
- Compressor Crankcase Heater
- Victaulic Flange Kit (150 psig Cooler)
- 1 Differential Pressure switch in lieu of Paddle Flow switch
- ASME Pressure Vessel & Associated Codes
- Wire/ Louvered Enclosure Panels (factory)
- Acoustic Sound Blankets
- Special Quotes- Remote Evaporator option for model YLAA0101YE
- Shipped on Truck From Monterrey to Customer- W/Bag
- 30 Months Parts and Labor (2year) (entire unit) Warranty
- 66 Months Parts (5year) (Compressor only) Warranty
- Initial Factory Start-Up w/ Second Year Start-Up included

UNIT SPECIFICATION TEXT

AIR COOLED SCROLL LIQUID CHILLER
YORK YLAA 60 HZ GUIDE SPECIFICATIONS

PART 1 — GENERAL

1.01 SCOPE

A. The requirements of the General Conditions, Supplementary Conditions, Division 1, and Drawings apply to all work herein.

B. Provide Microprocessor controlled, multiple-scroll compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:
   1. Chiller package with ZERO Ozone Depletion Potential Refrigerant R-410A
   2. Electrical power and control connections
   3. Chilled water connections
   4. Factory start-up

1.02 QUALITY ASSURANCE

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and installed in compliance with applicable sections of the following Standards and Codes:
   1. ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration
   2. ASHRAE 90.1 – Energy Efficiency compliance.
   3. ANSI/NFPA Standard 70 – *National Electrical Code* (NEC).
   4. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
   5. ARI Standard 550/590 – Positive Displacement Compressors and Air Cooled Rotary Screw Water-Chilling Packages.
   6. Conform to Intertek Testing Services, formerly ETL, for construction of chillers and provide ETL/cETL Listing label.
   7. Manufactured in facility registered to ISO 9002.
   8. OSHA – Occupational Safety and Health Act

B. Factory Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization that is within a 50 mile radius of the site.

D. Warranty: Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen (18) months from date of shipment, whichever occurs first.

1.03 Delivery and Handling

A. Unit shall be delivered to job site with a Nitrogen holding charge

B. Unit shall be stored and handled per Manufacturer's instructions.

C. Protect the chiller and its accessories from the weather and dirt exposure during shipment.

D. During shipment, provide protective covering over vulnerable components. Fit nozzles and open ends with plastic enclosures.

PART 2 — PRODUCTS

2.01 CHILLER MATERIALS AND COMPONENTS

A. General: Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air

cooled scroll compressor chiller(s) as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD - 34 Number Designation and Safety Classification of Refrigerants. Chiller shall include, but is not limited to: a complete system with a single refrigerant circuit 35 tons (123kW) and below, and not less than two refrigerant circuits above 35 tons (123kW), scroll compressors, direct expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.

B. Cabinet: External structural members shall be constructed of heavy gage, galvanized steel coated with baked on powder paint which, when subjected to ASTM B117, 1000 hour 5% salt spray test, yields minimum ASTM 1654 rating of "6".

C. Service Isolation valves: Service discharge (ball type) isolation valves are added to unit per system. This option also includes a system high-pressure relief valve in compliance with ASHRAE15. (Factory-mounted.)

D. Pressure Transducers and Readout Capability
   1. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
   2. Suction Pressure Transducers: Permits unit to sense and display suction pressure.

2.02 COMPRESSORS

Compressors: Shall be hermetic, scroll-type, including:
1. Compliant design for axial and radial sealing
2. Refrigerant flow through the compressor with 100% suction cooled motor.
3. Large suction side free volume and oil sump to provide liquid handling capability.
4. Compressor crankcase heaters to provide extra liquid migration protection.
5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
6. Initial Oil charge.
7. Oil Level sightglass.
8. Vibration isolator mounts for compressors.
9. Brazed-type connections for fully hermetic refrigerant circuits.
10. Compressor Motor overloads capable of monitoring compressor motor current. Provides extra protection against compressor reverse rotation, phase-loss and phase imbalance

2.03 REFRIGERANT CIRCUIT COMPONENTS

Each refrigerant circuit shall include: liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.

2.04 HEAT EXCHANGERS

A. Evaporator: YLAA
   1. Direct expansion type with refrigerant inside high efficiency copper tubes, chilled liquid forced over the tubes by galvanized steel baffles.
   2. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 450 psig (3103 kPa)refrigerant side design working pressure and150 PSIG (1034 kPa) water side design working pressure.
   3. Shell covered with ¾" (19mm), flexible, closed cell insulation, thermal conductivity of 0.26k ([BTU/HR-Ft_2-°F]/in.) maximum. Water nozzles with grooves for mechanical couplings, and insulated by Contactor after pipe installation.
   4. Provide vent and drain fittings, and thermostatically controlled heaters to protect to -20°F (29°C) ambient in off-cycle.

B. Air Cooled Condenser

1. Coils. Condenser coils are made of a single material to avoid galvanic corrosion due to dissimilar metals. Coils and headers are brazed as one piece. Integral sub cooling is included. The design working pressure of the coil is 650 PSIG(45 bar).
2. Low Sound Fans Shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise, full-airfoil cross section, providing vertical air discharge and low sound. Each fan in its own compartment to prevent cross flow during fan cycling. Guards of heavy gage, PVC (polyvinylchloride) coated or galvanized steel.
3. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class "F", current protected, Totally enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

2.05 CONTROLS

A. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

B. Microprocessor Enclosure: Rain and dust tight NEMA 3R/12 (IP55) powder painted steel cabinet with hinged, latched, and gasket sealed door.

C. Microprocessor Control Center:
1. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pumpdown shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from 0°F to 125°F (-18°C to 52°C) ambient. Automatic reset to normal chiller operation after power failure.
2. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real time clock (RTC) memory for minimum 5 years.
3. Forty character liquid crystal display, descriptions in English (or Spanish, French, Italian, or German), numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.
4. Programmable Setpoints (within Manufacturer limits): display language; chilled liquid temperature setpoint and range, remote reset temperature range, set daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, number of compressors, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
5. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, discharge pressure (optional), liquid temperature reset via a YORK ISN DDC or Building Automation System (by others) via a 4-20milliamp or 0-10 VDC input with optional BAS interface, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.
6. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. Includes: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
7. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.
8. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.

D. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.06 POWER CONNECTION AND DISTRIBUTION

A. Power Panels:

1. NEMA 3R/12 (IP55) rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.
2. Power supply shall enter unit at a single location, be 3 phase of scheduled voltage, and connect to individual terminal blocks per compressor. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.

B. Compressor, control and fan motor power wiring shall be located in and enclosed panel or routed through liquid tight conduit.

2.07 ACCESSORIES and OPTIONS

Some accessories and options supersede standard product features. Your YORK representative will be pleased to provide assistance.

A. Microprocessor controlled, Factory installed Across the-Line type compressor motor starters as standard.

B. Outdoor Ambient Temperature Control

Low Ambient Control (Factory mounted):
Permits unit operation to 0°F ambient. Standard unit controls to 25°F ambient.

High Ambient Control (Factory Mounted):
Permits unit operation above 115°F ambient.

C. Power Supply Connections:

Single Point Power Supply: Single point Terminal Block for field connection and interconnecting wiring to the compressors. Separate external protection must be supplied, by others, in the incoming power wiring, which must comply with the National Electric Code and/or local codes.

D. Control Power Transformer:

Converts unit power voltage to 120-1-60 (500 VA capacity). Factory-mounting includes primary and secondary wiring between the transformer and the control panel.

E. Protective Chiller Panels (Factory or Field Mounted)

1. Louvered/Wire Panels: Louvered steel panels on external condenser coils painted as per remainder of unit cabinet. Heavy gauge, welded wire-mesh, coated to resist corrosion, around base of machine to restrict unauthorized access.

F. Flow Switch (Field-mounted): Vapor proof SPDT, NEMA 4X switch (___150 PSIG or ___300 PSIG), -20°F to 250°F.

G. Service Isolation valves: Service suction and discharge (ball type) isolation valves are added to unit per system. This option also includes a system high pressure relief valve in compliance with ASHRAE15. (Factory-mounted.)

H. Hot Gas By-Pass: Permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity (depending on both the unit & operating conditions) by introducing an artificial load on the cooler. Hot gas by-pass is installed on only one refrigerant circuit.

I. Thermal Storage: Leaving chilled liquid setpoint range for charge cycle from 25° F to 20° F minimum with automatic reset of the leaving brine temperature up to 40° F above the set point.

J. Low Temperature Process Brine: Leaving chilled liquid setpoint range 20° F to 50° F.

K. Building Automation System (EMS) Reset Interface: Chiller to accept 4 to 20mA, 0 to 10 VDC, input to reset the leaving chilled liquid temperature.

L. Vibration Isolation (Field-mounted): 1. Elastomeric (Neoprene) Pad Isolators.

M. Sound Reduction (Factory-mounted):

1. Provide the following options as required to meet scheduled sound performance data at all load points.
   a. Low speed, reduce noise fans (Factory-mounted).

   b. Compressor Sound Blankets (Factory-mounted).

SOUND POWER LEVELS (In Accordance with ARI 370) – Octave Band Center Frequency, Hz YLAA0101YE17 (Equipped with Acoustic Sound Blanket kit)										
Load %	Ambient (°F)	63	125	250	500	1K	2K	4K	8K	LWA
100.0	95.0	102.0	99.0	96.0	95.0	90.0	87.0	83.0	81.0	96.0
86.1	89.3	101.0	98.0	96.0	94.0	90.0	87.0	83.0	80.0	96.0
57.0	75.2	101.0	98.0	95.0	94.0	90.0	86.0	83.0	80.0	96.0
43.0	65.7	98.0	95.0	93.0	91.0	87.0	84.0	80.0	77.0	93.0
13.9	55.0	95.0	91.0	89.0	87.0	82.0	79.0	76.0	73.0	89.0

SOUND PRESSURE LEVELS in dB at 30.0 (ft.) ** YLAA0101YE17 (Equipped with Acoustic Sound Blanket kit)										
Load %	Ambient (°F)	63	125	250	500	1K	2K	4K	8K	dBA
100.0	95.0	75.0	72.0	69.0	68.0	63.0	60.0	56.0	54.0	69.0
86.1	89.3	74.0	71.0	69.0	67.0	63.0	60.0	56.0	53.0	69.0
57.0	75.2	74.0	71.0	68.0	67.0	63.0	59.0	56.0	53.0	69.0
43.0	65.7	71.0	68.0	*** UNASS IGNED ***	64.0	60.0	57.0	53.0	50.0	66.0
13.9	55.0	68.0	64.0	62.0	60.0	55.0	52.0	49.0	46.0	62.0

** Chiller is assumed to be a point source on a reflecting (hemispherical radiation)

PART 3 — EXECUTION

3.01 INSTALLATION

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure. If equipment provided exceeds height of scheduled chiller, installing contractor is responsible for additional costs associated with extending the height of parapet or screening walls/enclosures.

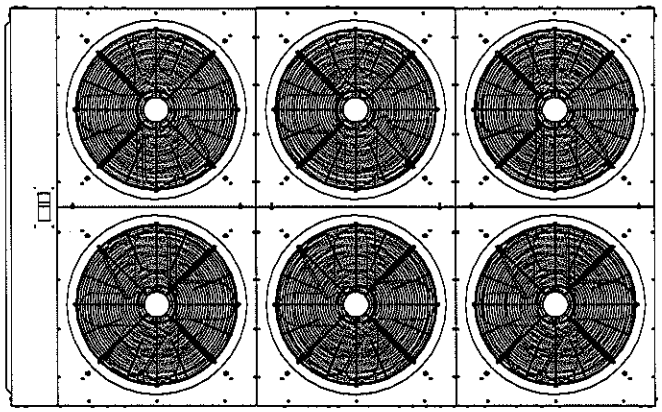
C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

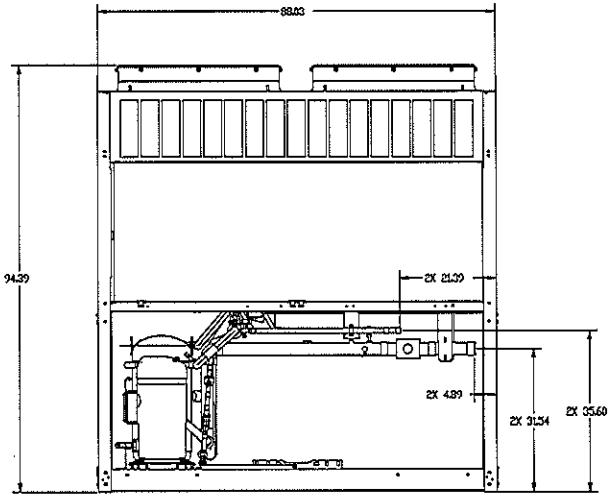
D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 16).

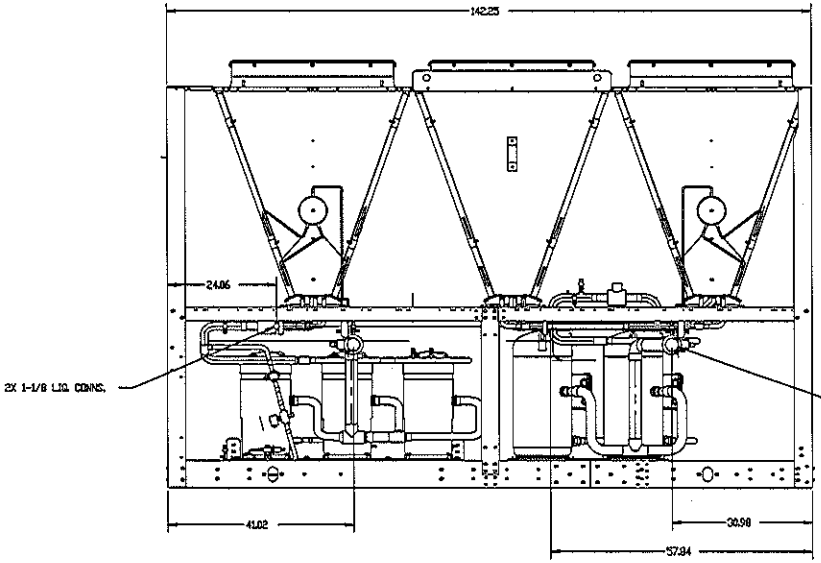
E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

UNIT DRAWING







REVISION	REV.	DATE	ECL NO.	BY	CHK.	ENG.
CONTINUED						

ALL TECHNICAL DATA IN THIS SUBJECT MATTER HEREOF ARE RESERVED AND NO PERMISSION IS GRANTED TO REPRODUCE, THIS PRINT IN WHOLE OR IN ANY PART, OR DISCLOSE ANY OF THE INFORMATION UPON IT TO OTHERS WITHOUT WRITTEN

INTERNATIONAL CORPORATION

DIMENSIONS ARE IN INCHES
DO NOT SCALE
TOLERANCES FOR ENG. STD. M-FSP
DRAWN
CHECKED
ENG
ENG

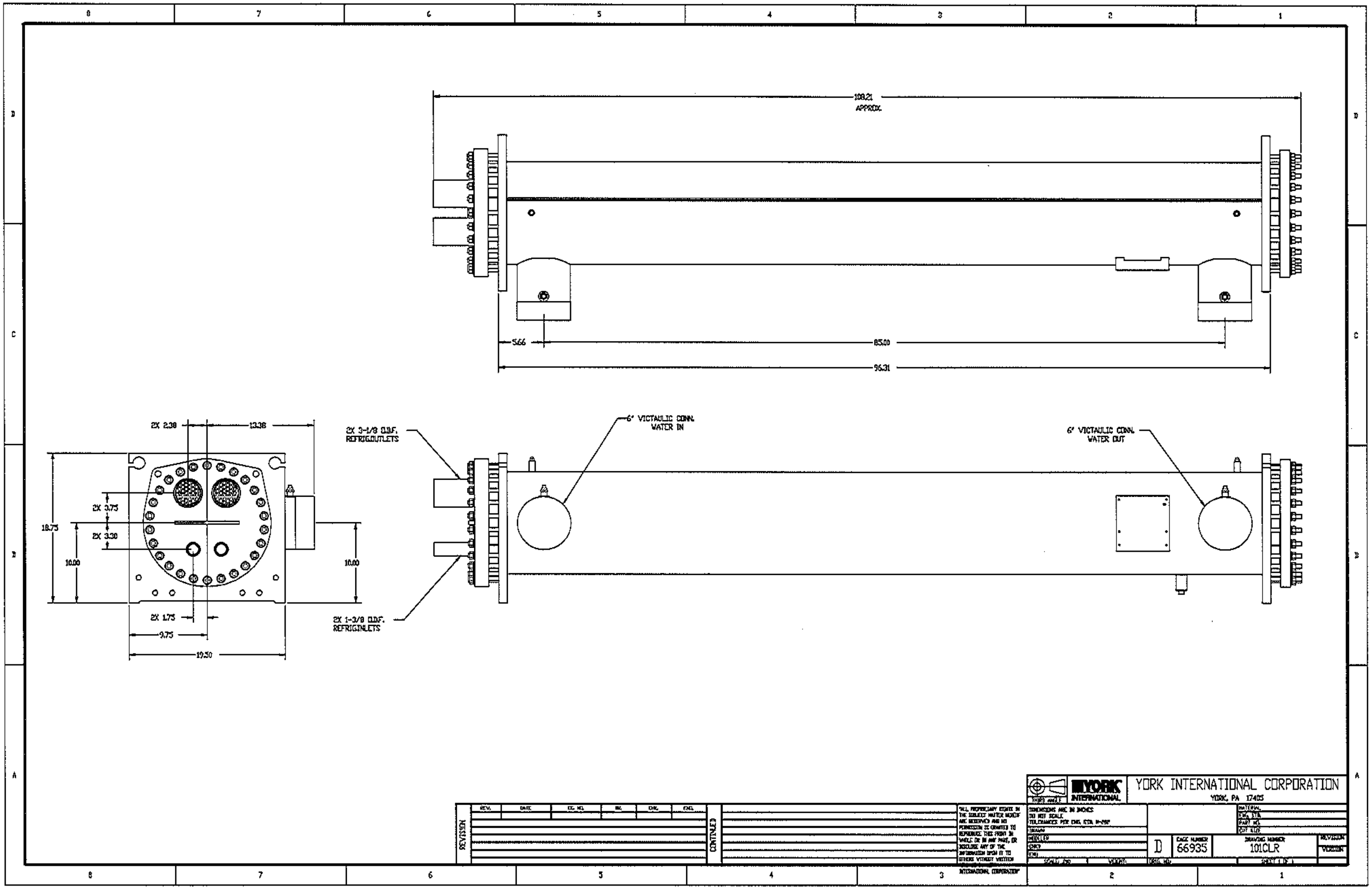
YORK INTERNATIONAL CORPORATION
YORK, PA 17405

THIRD ANGLE

MATERIAL
ENG. APP.
PART NO.
CAT. KEY

SIZE	CAGE NUMBER	DRAWING NUMBER	REVISION
D	66935	YLAA0101	VERSION

SCALE: NONE | WEIGHT: | DRWG. NO. | SHEET 1 OF 1


108.21
APPROX.
5.66
85.00
96.31
6" VICTAULIC CONN.
WATER IN
6" VICTAULIC CONN.
WATER OUT
2X 3-1/8 O.D.F.
REFRIG.OUTLETS
2X 1-3/8 O.D.F.
REFRIG.INLETS
2X 2.38
13.38
2X 3.75
2X 3.30
18.75
10.00
10.00
2X 1.75
9.75
19.50
YORK
INTERNATIONAL
YORK INTERNATIONAL CORPORATION
YORK, PA 17405
DIMENSIONS ARE IN INCHES
DO NOT SCALE
D
66935
101CLR
REVISION
CONTINUED
REV.
DATE
EC. NO.

UNIT PERFORMANCE

YORK®
A JOHNSON CONTROLS COMPANY

Air Cooled Scroll Chiller Performance Specification

Unit Tag	Qty	Model No.	Capacity (Tons)	Volts/Ph/Hz	Refrigerant
CH-1	1	YLAA0101YE17	97.3	200/3/60	R410A
Pin No: YLAA0101YE17XBASXTXATXBLXCXX44SXXXXXHXXVSAQXXXX3BXXXXNOXXXXX					

Evaporator Data		Condenser Data		Performance Data	
EWT (°F)	54.0	Ambient Temp. (°F)	95.0	EER / COP	10.0 / 2.9
LWT (°F)	44.0	Altitude (ft.)	0	EER IPLV/COP IPLV	14.9 / 4.4
Design Flow Rate (gpm)	233.2			Physical Data	
Pressure Drop (ft.)	12.0			Rigging Wt. (lbs.)	6539
Fluid	Water			Operating Wt. (lbs.)	6967
Fouling Factor	0.00010				
Water Volume. (gal)	51.0				

Electrical Data				
Circuit	1	2	3	4
Compressor RLA	55.8/55.8/55.8	109.6/109.6		
Compressor Start Current (LRA)	425.0/425.0/425.0	599.0/599.0		
Fan QTY/FLA (each)	2/7.6	4/7.6		

Single Point				
Min. Circuit Ampacity	459.6			
Min. Non-Fused Disconnect (Amps)	600			
Min. Dual Element Fuse Size (Amps)	500			
Max. Dual Element Fuse Size (Amps)	500			
Min. Circuit Breaker (Amps)	500			
Max. Circuit Breaker (Amps)	500			
Wire Lugs Per Phase*	1			
Wire Range (Lug Size)	(1)#4 - 500			
Total Amps	432.2		Operating Condition Electrical Data	
Inrush (PW) Amps	599.0		Compressor kW	106.6
Starter Type	Across the Line		Total Fan kW	10.1
			Total kW	116.7

Notes:	RATED AND CERTIFIED IN ACCORDANCE WITH ARI STANDARD 550/590. * Use Copper Conductors only

Part Load Rating Data				
Load %	Ambient (°F)	Capacity (Tons)	Compressor kW	Unit Efficiency
100.0	95.0	97.3	106.6	10.0 / 2.9
86.1	89.3	88.1	84.0	11.2 / 3.3
57.0	75.2	65.2	45.2	14.1 / 4.1
43.0	65.7	49.8	32.1	16.1 / 4.7
13.9	55.0	15.9	9.2	17.5 / 5.1

YORK®
A JOHNSON CONTROLS COMPANY

Air Cooled Scroll Chiller Performance Specification

SOUND POWER LEVELS (In Accordance with ARI 370) – Octave Band Center Frequency, Hz YLAA0101YE17 (Equipped with Low Sound Fans and Acoustic Sound Blanket kit)										
Load %	Ambient (°F)	63	125	250	500	1K	2K	4K	8K	LWA
100.0	95.0	102.0	99.0	96.0	95.0	90.0	87.0	83.0	81.0	96.0
86.1	89.3	101.0	98.0	96.0	94.0	90.0	87.0	83.0	80.0	96.0
57.0	75.2	101.0	98.0	95.0	94.0	90.0	86.0	83.0	80.0	96.0
43.0	65.7	98.0	95.0	93.0	91.0	87.0	84.0	80.0	77.0	93.0
13.9	55.0	95.0	91.0	89.0	87.0	82.0	79.0	76.0	73.0	89.0

SOUND PRESSURE LEVELS in dB at 30.0 (ft.) ** YLAA0101YE17 (Equipped with Low Sound Fans and Acoustic Sound Blanket kit)										
Load %	Ambient (°F)	63	125	250	500	1K	2K	4K	8K	dBA
100.0	95.0	75.0	72.0	69.0	68.0	63.0	60.0	56.0	54.0	69.0
86.1	89.3	74.0	71.0	69.0	67.0	63.0	60.0	56.0	53.0	69.0
57.0	75.2	74.0	71.0	68.0	67.0	63.0	59.0	56.0	53.0	69.0
43.0	65.7	71.0	68.0	66.0	64.0	60.0	57.0	53.0	50.0	66.0
13.9	55.0	68.0	64.0	62.0	60.0	55.0	52.0	49.0	46.0	62.0

** Chiller is assumed to be a point source on a reflecting surface (hemispherical radiation)

YLAA0101YE17	Performance at AHRI Conditions				
Evaporator Data		Condenser Data		Performance Data	
EWT (°F)	54.0	Ambient Temp. (°F)	95.0	EER / COP	10.0 / 2.9
LWT (°F)	44.0	Altitude (ft.)	0	EER IPLV/COP IPLV	14.9 / 4.4
Flow Rate (gpm)	233.2			Capacity (Tons)	97.3
Pressure Drop (ft.)	12.0				
Fluid	Water				
Fouling Factor	0.00010				
Water Volume (gal)	51.0				

DX PIPING GUIDE

YORK®	DX PIPING GUIDE	
ENGINEERING SUPPLEMENT	New Release	Form No. 050.40-ES2 (102)

DX PIPING GUIDE

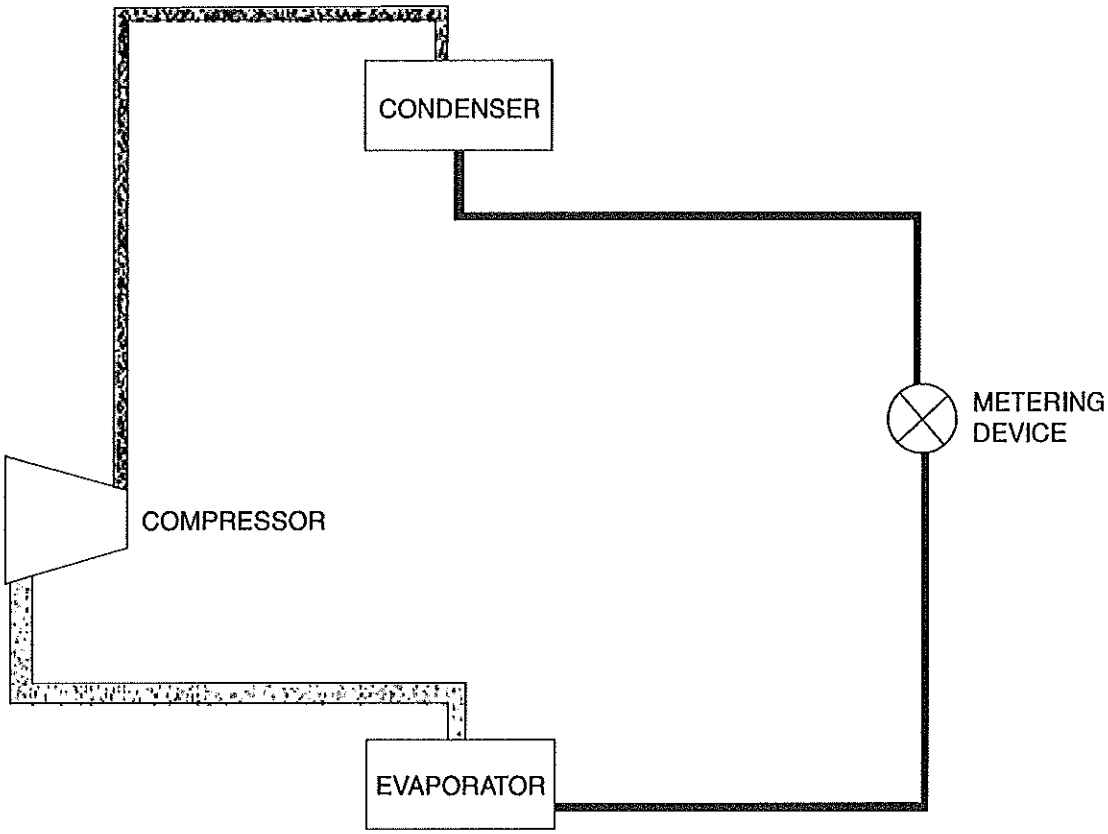


TABLE OF CONTENTS

LIST OF TABLES

1.0 OVERVIEW

The current best practices for DX system piping are outlined in this document for systems using R-22, R-134a and R-407C refrigerants.

The objectives that influence the design of piping systems for refrigeration systems are to:

- Ensure proper refrigerant feed to evaporators
- Provide economical pipe sizes without excessive pressure drop
- Ensure lubricating oil return to the compressor by preventing excessive amounts of oil from being trapped in the system
- Minimize the loss of oil from the compressors
- Prevent liquid refrigerant or excessive amounts of oil from entering the compressor either during operation or during idle time

Improper design and sizing of refrigerant piping may result in loss of system efficiency and/or eventual failure of the system. Factors that must be considered in a piping design are the inter-relationships between velocity, pressure, friction, as well as, economics. Economics favor the use of the smallest possible line sizes. However, high suction and discharge line pressure drops will cause loss in capacity and increased power consumption. Another important design criterion is oil return to the compressor. The refrigerant line velocities have to be sufficiently high to carry oil up suction or hot gas risers at all operating capacities.

Sections 2.0 and 3.0 deal with refrigerant line sizing from a frictional pressure drop and oil return point of view. Section 5.0 discusses hot gas bypass arrangements. Losses in valves and fittings are discussed in Section 6.0. Multiple compressor piping recommendations are covered in Section 7.0. Tables are provided with factors for proper refrigerant line sizing.

2.0 REFRIGERANT LINE SIZING

The pressure drops (line losses) are typically presented as a given change in the corresponding saturation temperature. The effect of line losses on the capacity and energy consumption (kW/ton) is illustrated in Figure 1. Line sizing is a balance between pressure drop (reflected in system performance) and oil return (for system reliability).

Pressure drop issues are addressed in Section 3.1 while oil return considerations are dealt with in Section 4.0.

3.0 PRESSURE DROP CONSIDERATIONS

As mentioned previously, pressure drop calculations are determined as pressure changes associated with a change in saturation temperature of the refrigerant. Systems are typically sized for pressure losses of 2°F or less for the discharge, suction and liquid lines. This is the conventional method for sizing and is accepted practice throughout the industry (ASHRAE).

Tables 1 through 6 show capacities for R-22, R-134a and R-407C at specified pressure drops for the various refrigerant lines.

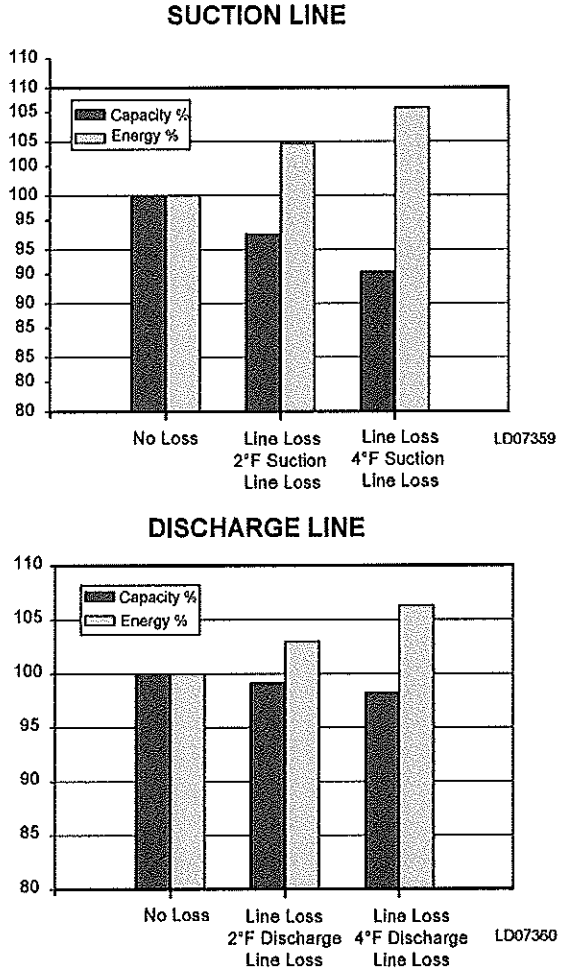


FIG. 1 – EFFECT OF SUCTION AND DISCHARGE LINE PRESSURE DROP ON CAPACITY AND POWER (ASHRAE). (R-22 system operating at 100°F saturated condensing and 40°F saturated evaporating temperature. Energy percentage is rated at kW/ton.)

Section 3.1 will address suction line sizing while discharge and liquid line sizing will be discussed in Sections 3.2 and 3.3, respectively.

3.1 SUCTION LINES

Pressure drop in the suction line reduces a system's capacity by forcing the compressor to operate at a lower suction pressure in order to maintain the desired temperature in the evaporator. The suction line is normally designed to have pressure drop no more than 2°F change in saturation temperature due to friction. Tables 1, 3 and 5 contain suction line sizing data for refrigerants 22, 134a and 407C, respectively. Capacities for Type L copper and steel tubes at three different pressure drops of 2, 1 and 0.5°F at various saturated suction temperatures and condensing temperature of 105°F are provided. Correction factors for capacity for condensing temperatures other than 105°F is given in the notes at the bottom of Tables 2, 4 and 6 for the above mentioned refrigerants.

For low pressure drops, the suction riser must be properly sized to ensure oil entrainment up the riser thereby assuring oil is always returned to the compressor. This is dealt with in detail in Section 4.0. When pipe size needs to be reduced to ensure sufficient velocities for oil return at partial loads, the pressure drops may get excessive at full load. This can be compensated for by over sizing the horizontal and down run lines.

3.2 DISCHARGE LINES

Pressure loss in the discharge line increases the power to capacity ratio (kW/ton) of the system and decreases the compressor capacity. This is illustrated in Figure 1. ASHRAE recommends a saturation temperature change of 1°F based on frictional pressure drop for discharge line sizing. Tables 2, 4 and 6 contain discharge line sizing data for refrigerants 22, 134a and 407C, respectively. Capacities are for a condensing temperature of 105°F and correction factors are given at the bottom of the tables for other condensing temperatures.

3.3 LIQUID LINES

Pressure drop in liquid lines causes flashing of the refrigerant and reduction in pressure at the liquid feed device. ASHRAE recommends that systems be designed so that the pressure drop be no more than 1 to 2°F change in saturation temperature. Tables 2, 4 and 6 contain liquid line sizing data for refrigerants 22, 134a and 407C, respectively, based on frictional pressure drop causing a 1°F change in saturation temperature. Liquid subcooling is the only means of overcoming the liquid line pressure loss to ensure liquid entering the expansion device. Insufficient subcooling may lead to flashing of liquid refrigerant in the liquid line, which may result in degradation of system performance. Liquid line risers are an additional source of pressure loss. The loss in the risers is approximately 0.5 psi per foot of liquid lift (ASHRAE). Other losses include those caused by accessories like solenoid valves, filter driers, hand valves, etc.

Liquid lines from the condensers to the receivers should be sized for a refrigerant velocity of 100 fpm or less to ensure positive gravity flow without backup of liquid flow (ASHRAE). Sizing data is provided in Tables 2, 4 and 6.

4.0 OIL CIRCULATION CONSIDERATIONS

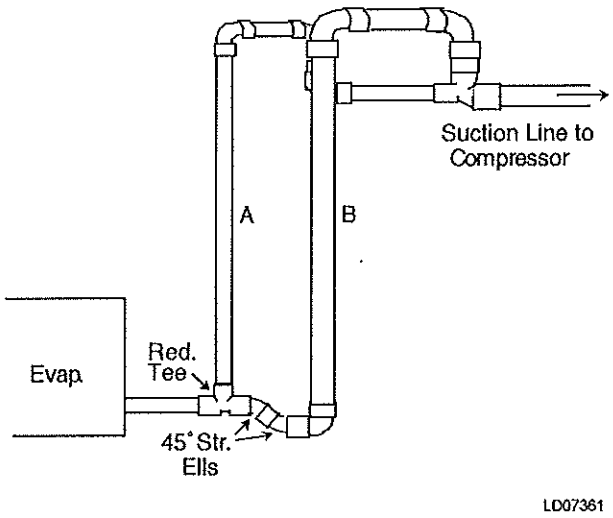
All compressors inevitably lose some oil during normal operation. The oil leaving the condenser is dissolved in the liquid refrigerant and oil return through the liquid line to the evaporator usually poses no problem. The oil separated in the evaporator returns to the compressor by gravity or by shear forces induced by the suction vapor. Some systems utilize oil separators, but they are not 100% effective, and hence the oil that finds its way into the system needs to be returned to the compressor. In systems where the capacity can be modulated, the system piping needs to be designed to return oil at the lowest load condition, while not imposing excessive pressure drop at full load.

Section 4.1 describes the methodology used for sizing of single and multiple suction risers as well as their construction. Suction piping at multiple evaporator coils is illustrated in Figures 3 and 4 of Section 4.2. Hot gas riser sizing details are addressed in Section 4.3.

4.1 SUCTION LINE SIZING

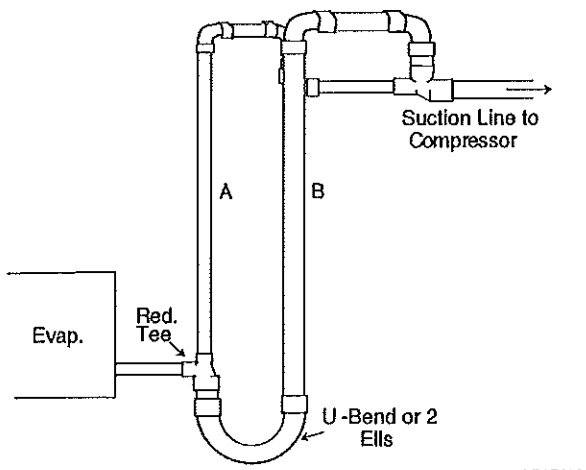
Many systems contain a suction riser because the evaporator is located at a lower level than the compressor. Oil circulating in the system returns up the suction riser with the returning gas. The principal factors that govern the transport of oil by refrigerant vapor are the vapor velocity, vapor density, and inside pipe diameter.

Suction risers must be sized for the minimum capacity. Table 7 lists minimum refrigeration capacity for various pipe sizes at various saturated suction and suction gas temperatures for refrigerants 22, 134a and 407C.



Method A

FIG. 2A – DOUBLE SUCTION RISER DESIGN



Method B

FIG. 2B – DOUBLE SUCTION RISER DESIGN

When a suction riser is sized to allow oil return at minimum load condition, the pressure drop in this line may be too high when operating at full load. If a correctly sized suction riser causes excessive pressure drop at full load, a double riser should be used. Figures 2A and 2B shows two methods of riser construction. The operation of the double riser is as follows:

Riser A is designed for the minimum load possible.

Riser B is sized for satisfactory pressure drop through both risers at full load. Riser B is sized such that the combined cross sectional area of A and B is equal to or slightly greater than that of a single pipe sized for an acceptable pressure drop at full load without any consideration for oil return at minimum load. The combined cross sectional area, however, should not exceed that of a single pipe that would return oil in an upflow riser under maximum load conditions.

During minimum operation, the gas velocity is not sufficient to carry oil up both the risers. Oil tends to accumulate in the trap between the two risers until riser B is completely sealed off. The gas velocity is now sufficient to carry oil along riser A.

The trap capacity should be maintained to a minimum by close coupling fittings otherwise the oil hold-up could lower the oil level in the compressor crankcase, thereby impairing compressor operation. The two risers form an inverted loop and enter the horizontal line. This prevents oil drainage into risers that may be idle during part load operation. Another situation that warrants the use of double suction risers is when multiple compressors are used in a circuit. In this case, one continues to operate while the others may shut down, and the ratio of maximum to minimum capacity becomes large.

4.2 MULTIPLE EVAPORATOR COILS

Suction lines should be designed such that oil from the active evaporator does not drain into an idle one. Figures 3A through 3D show the recommended piping construction for multiple evaporators and their relative positions with respect to the compressor. Figure 4 shows the typical piping for evaporators above and below a common suction line. All horizontal runs should be level or pitched approximately 1/4" per linear foot toward the compressor to ensure oil return.

The traps after the evaporator suction outlets are recommended to prevent erratic functioning of the thermal expansion valve. The expansion valve bulbs are located on the suction lines between the evaporator and these traps. The traps serve as drains for refrigerant and helps prevent accumulation of liquid under the valve bulbs during compressor off cycles.

Multiple Evaporators Stacked on Same Level – Compressor Above

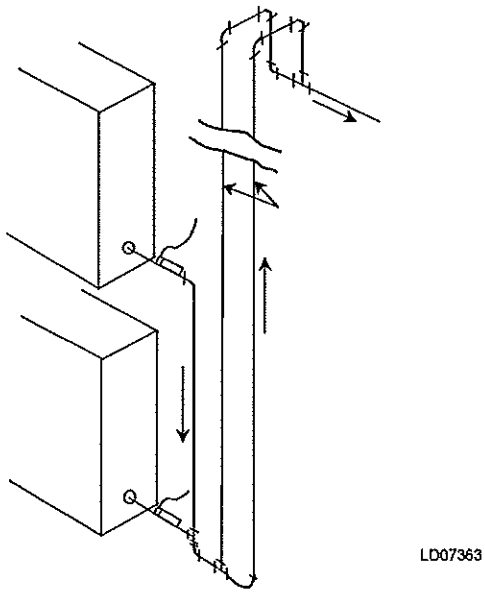


FIG. 3A – SUCTION LINE PIPING ON MULTIPLE EVAPORATOR

Multiple Evaporators Stacked on Same Level – Compressor Above Arangement "A" Preferred

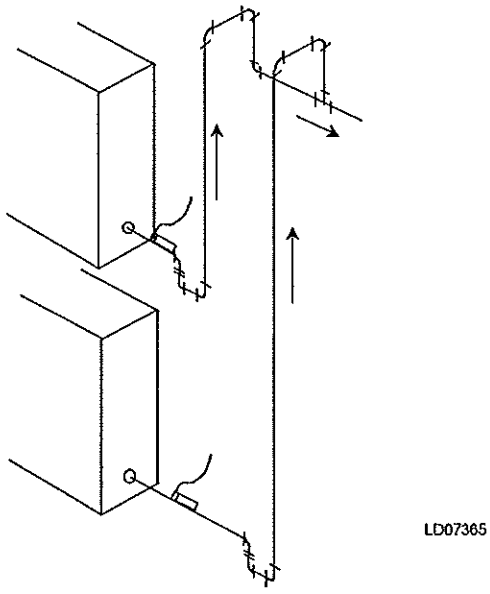


FIG. 3B – SUCTION LINE PIPING ON MULTIPLE EVAPORATOR

Multiple Evaporators on Same Elevation – Compressor Below

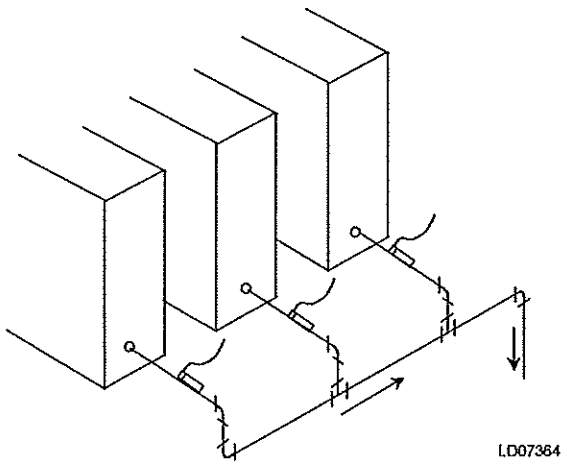


FIG. 3C – SUCTION LINE PIPING ON MULTIPLE EVAPORATOR COILS

Multiple Evaporators on Same Level – Compressor Above

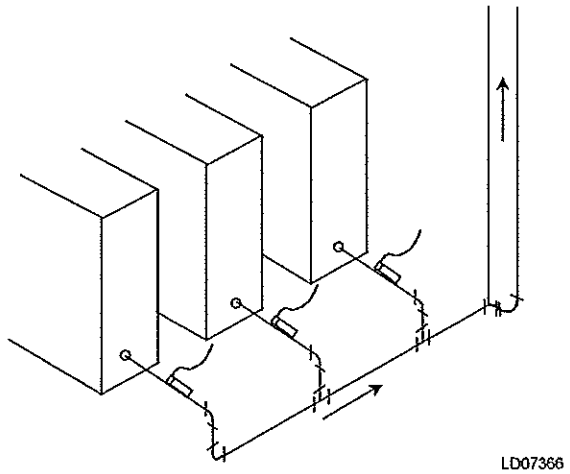


FIG. 3D – SUCTION LINE PIPING ON MULTIPLE EVAPORATOR COILS

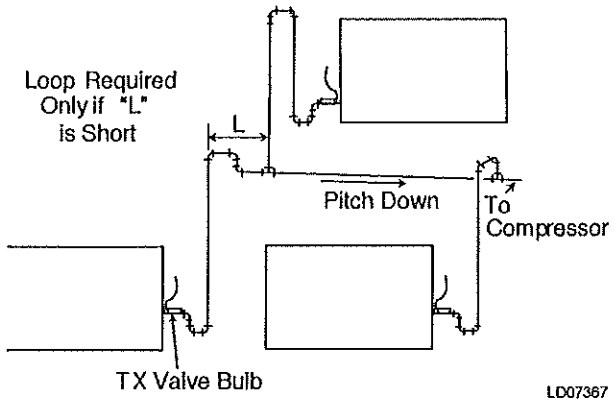


FIG. 4 – TYPICAL PIPING FOR EVAPORATORS LOCATED ABOVE AND BELOW SUCTION LINE

4.3 HOT GAS LINE SIZING

Low pressure drops are desired in hot gas lines. However, oversized lines can reduce gas velocities to the extent that oil is not transported by the refrigerant. Therefore, when using multiple compressors with capacity control, a hot gas riser should be appropriately sized to transport oil at all possible load conditions. Table 8 lists the minimum capacity in tons for oil transport up hot gas risers of different sizes for refrigerants 22, 134a and 407C. The capacities are given for various saturated condensing temperatures and discharge gas temperatures.

In installations with multiple compressors and with capacity control, a vertical hot gas line designed for oil transport at minimum load may cause excessive pressure drop when operating at full load. In such cases, either a double riser or a single riser with an oil separator should be used. A double hot gas riser can be applied similar to the case of the suction line. Figure 5 shows a schematic of a double hot gas riser design. Section 4.1 should be referred to for the operating principle and sizing of the risers.

As an alternative to double risers, a single riser and an oil separator can be used. The separator is located just before the riser so that any oil draining back down the riser accumulates in the oil separator. The oil is then returned to the compressor by feed mechanisms such as a pump, etc. Horizontal lines should be level or pitched approximately 1/4" per linear foot in the direction of gas flow to facilitate transport of oil through the system and back to the compressor. Mufflers are recommended to dampen discharge gas pulsations. Mufflers should be installed horizontally or in the downflow portion of the hot gas line immediately after the compressor. The gas velocity through the muffler being lower than that through the line, there is a tendency of oil to accumulate within the muffler. The muffler should be installed such that it prevents the accumulation of oil.

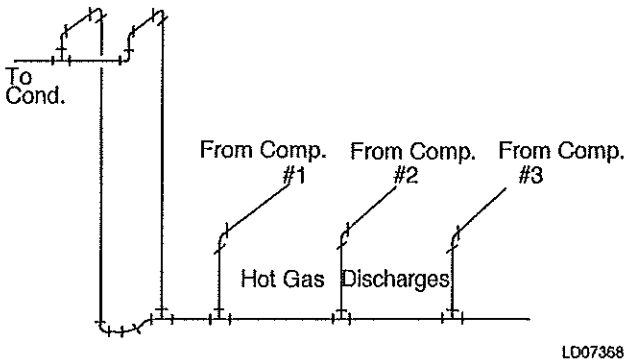


FIG. 5 – DOUBLE HOT GAS RISERS

5.0 HOT GAS BYPASS ARRANGEMENTS

Most compressors are equipped with unloaders that help the compressor start with a low starting torque and permit capacity control without stopping the compressor. Reduction of starting torque can also be accomplished by using a manual or automatic valve between the compressor discharge and suction lines. To avoid overheating the compressor, the valve is opened only during the start of the compressor and closed when the compressor attains full speed.

Figures 6(a) through 6(d) show various recommended bypass arrangements (ASHRAE). Figure 6(a) shows the simplest configuration. The compressor will overheat when used for long periods of time. The arrangement in Figure 6(b) shows the use of hot gas bypass to the exit of the evaporator. It is recommended that the expansion valve bulb be placed at least 5 feet downstream from the bypass point entrance. In Figure 6(c), the hot gas bypass enters after the thermostatic expansion valve bulb. Another expansion valve provides liquid to the bypass line for desuperheating purposes. The preferable arrangement is shown in Figure 6(d). Here, the bypass is connected into the low side between the expansion valve and the entrance to the evaporator. If a distributor is used, the bypass gas enters between the expansion valve and the distributor. The hot gas bypass line should be sized such that its pressure loss is only a small fraction of the pressure drop across the valve.

6.0 LOSSES IN FITTINGS AND VALVES

The refrigerant line capacity tables (Tables 1 through 6) are based on pressure drop per 100 equivalent feet of straight pipe, or combination of straight pipe and fittings and valves with friction drop equivalent to 100 feet of straight pipe. Pressure drop through fittings and valves is determined by establishing the equivalent straight length of pipe of the same size. Tables 9, 10 and 11 give the equivalent lengths of straight pipe for various fittings and valves based on nominal pipe sizes (ASHRAE).

7.0 MULTIPLE COMPRESSOR PIPING

Piping design for field-erected multiple compressor systems involves the need for uniform distribution of oil and refrigerant among the compressors. The design must also prevent oil and liquid refrigerant draining back to the heads of idle compressors. Suction, discharge and crankcase equalizing piping arrangements are discussed in Sections 7.1, 7.2 and 7.3, respectively.

7.1 SUCTION PIPING

Suction piping in multiple compressors operating in parallel should be designed to maintain the same suction pressure and ensure that oil is returned in equal proportions. All suction lines should be brought to a common suction header. The suction header is a means of distributing oil and suction gas as uniformly as possible between the compressors. The header should run above the level of the compressor suction inlets so that oil can return to the compressors by gravity. Figure 7 shows a pyramidal or yoke-type suction header to maximize pressure and flow equalization for three compressors piped in parallel (ASHRAE). In case of two compressors in parallel, a single feed between two compressor take offs is an acceptable configuration. The suction header should be sized such that the suction gas and oil separate. The suction flow for the compressors should be tapped off at the top of the header and devices to feed the oil back to the compressor need to be utilized.

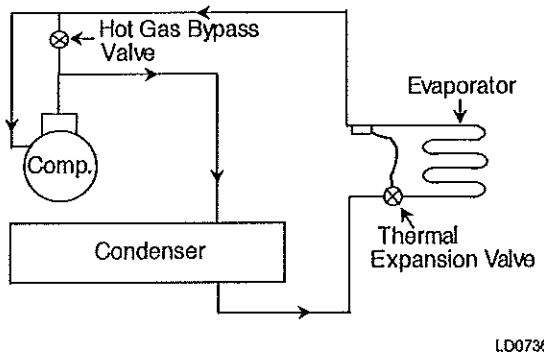


FIG. 6A – HOT GAS BYPASS ARRANGEMENTS

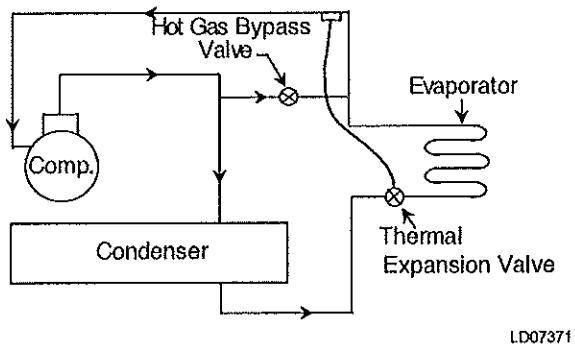


FIG. 6B – HOT GAS BYPASS ARRANGEMENTS

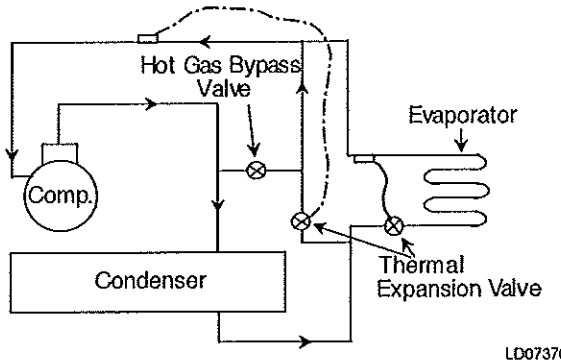


FIG. 6C – HOT GAS BYPASS ARRANGEMENTS

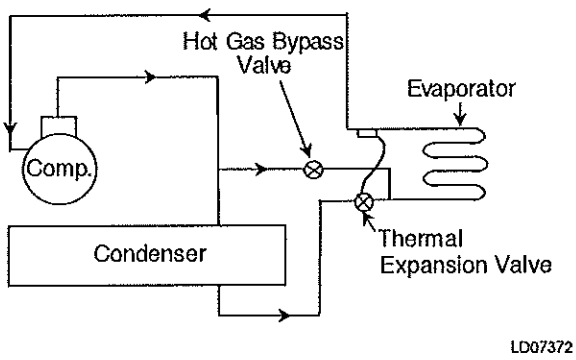


FIG. 6D – HOT GAS BYPASS ARRANGEMENTS

7.2 DISCHARGE PIPING

Figure 7 also shows the piping arrangement for the discharge piping. The arrangement is such that liquid refrigerant and oil are prevented from draining back to the heads of idle compressors. A check valve is recommended in the discharge line to prevent refrigerant and oil from migrating to the compressor heads. The piping should be routed to a lower elevation so that a trap is formed for the drainback. An oil separator, if used, may serve as the trap.

7.3 CRANKCASE EQUALIZERS

When two or more compressors are connected, the crankcases should be equalized. The compressors should be placed on foundations and all equalizer tapping locations must be maintained level. An oil equalization line should connect all crankcases to maintain uniform oil levels (refer to Figure 7).

In order to allow the oil equalizer to perform satisfactorily, a gas equalizer should be installed above the oil level (refer Figure 7). It should be piped such that oil or liquid refrigerant will not be trapped.

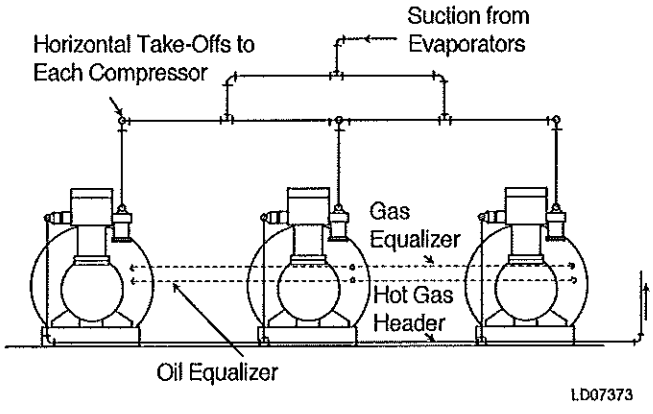


FIG. 7 – CHILLERS WITH REMOTELY INSTALLED DX COOLERS

8.0 CHILLERS WITH REMOTELY INSTALLED DX COOLERS

Outdoor chillers with remote DX water cooler applications have grown in popularity. It is prudent practice to design these systems so that the remote, indoor DX cooler is as close to the outdoor section as possible. This assures optimum performance, reduces piping pressure penalties, and promotes reliability.

To assure these, the following recommendations should be followed:

- It is suggested that the linear feet of piping be 200 feet or less.
- The total equivalent feet of piping (which includes tees, elbows, fittings, etc.) be 300 feet or less.
- The DX cooler should be no lower than 100 feet below the outdoor section.
- The DX cooler should be no more than 12 to 15 feet above the outdoor section. [The combined friction and static refrigerant liquid column penalty should be no more than 25 psi.]

The design must be based on refrigerant lines (suction and liquid) which will meet full load and provide for proper oil return at the minimum system load condition. These should follow the practices contained in this catalog. See Figure 8A, which illustrates the DX cooler at the same level as the outdoor section. Figure B. illustrates the DX cooler below the outdoor section. Figure 8C illustrates the DX cooler being above the outdoor section. Regarding Figure 8C, the suction lines should loop up 1 to 2 feet above the DX cooler suction refrigerant connections before they proceed down vertically. This will allow any suction gas which condenses to drain back into cooler. A long radius elbow should be used at the bottom of the vertical drop to transition to the horizontal suction line (pitched approximately 1/4" per linear foot toward the compressor), which should be routed directly to the compressor suction valve connection, without any traps. Thus, any small amount of refrigerant which may condense in the suction line will drain into the compressor where it will be vaporized by the compressor crankcase heater, when the compressor is not operating. It is extremely important that the compressor heater is sized to handle the amount of condensed liquid that may occur in long suction lines and that the heater is allowed to remain energized during the compressor off cycle. Start-up logic should prevent the compressor from restarting if the crankcase temperature has not risen above the saturation temperature corresponding to the pressure of the compressor crankcase. Typically, the crankcase temperature is measured against the ambient and restart is prevented if the crankcase temperature is not at least 25°F above ambient.

NOTE

Suction lines must rise above the cooler and compressor, then slope to the compressor suction inlet.

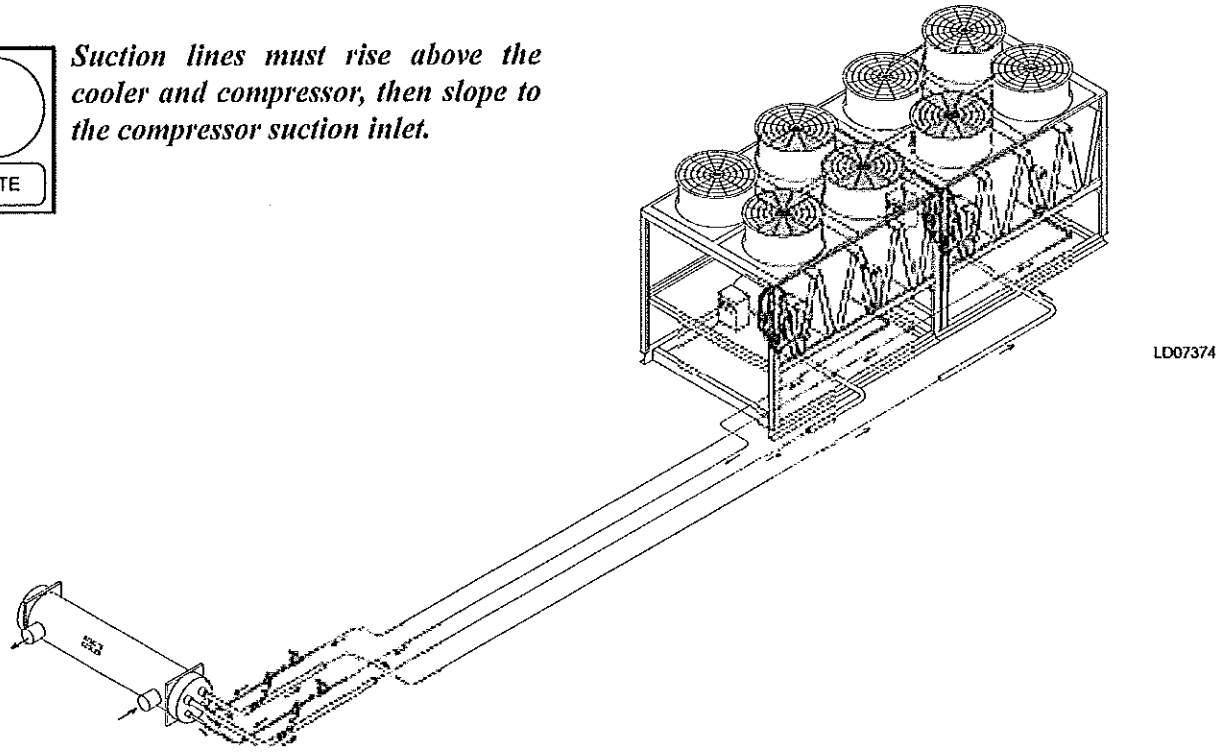


FIG. 8A – REMOTE COOLER LOCATED ON THE SAME LEVEL AS THE CONDENSING UNIT

NOTE

Suction lines must rise above the cooler and compressor, then slope to the compressor suction inlet.

The horizontal suction lines should be as short as possible.

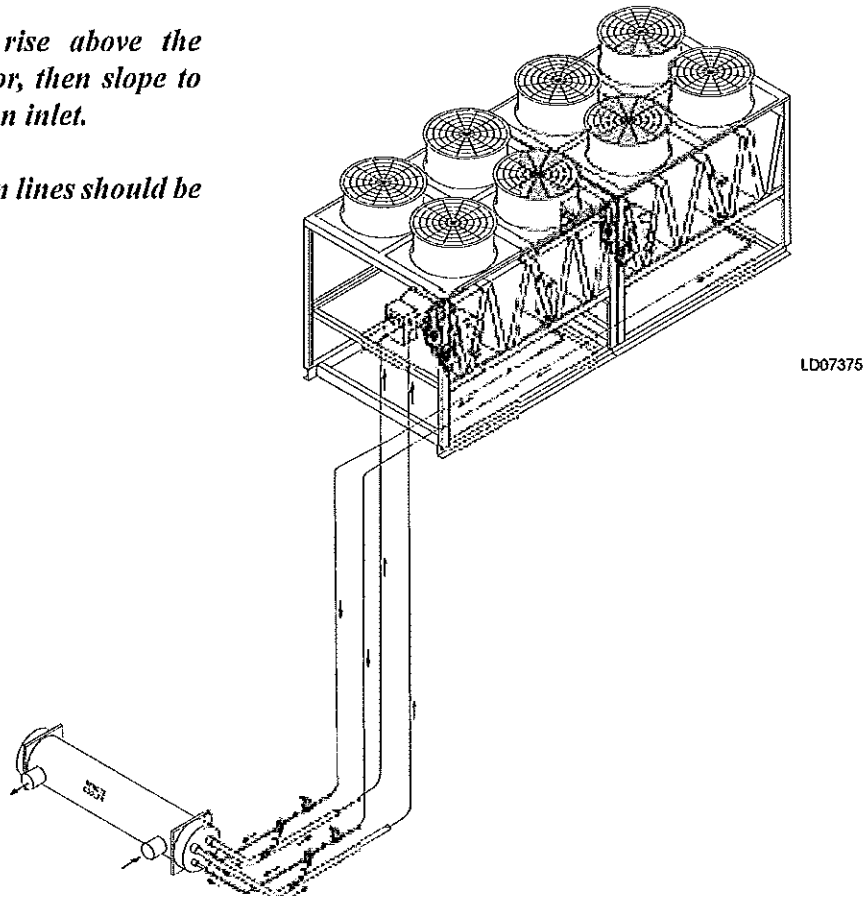


FIG. 8B – REMOTE COOLER LOCATED BELOW THE CONDENSING UNIT

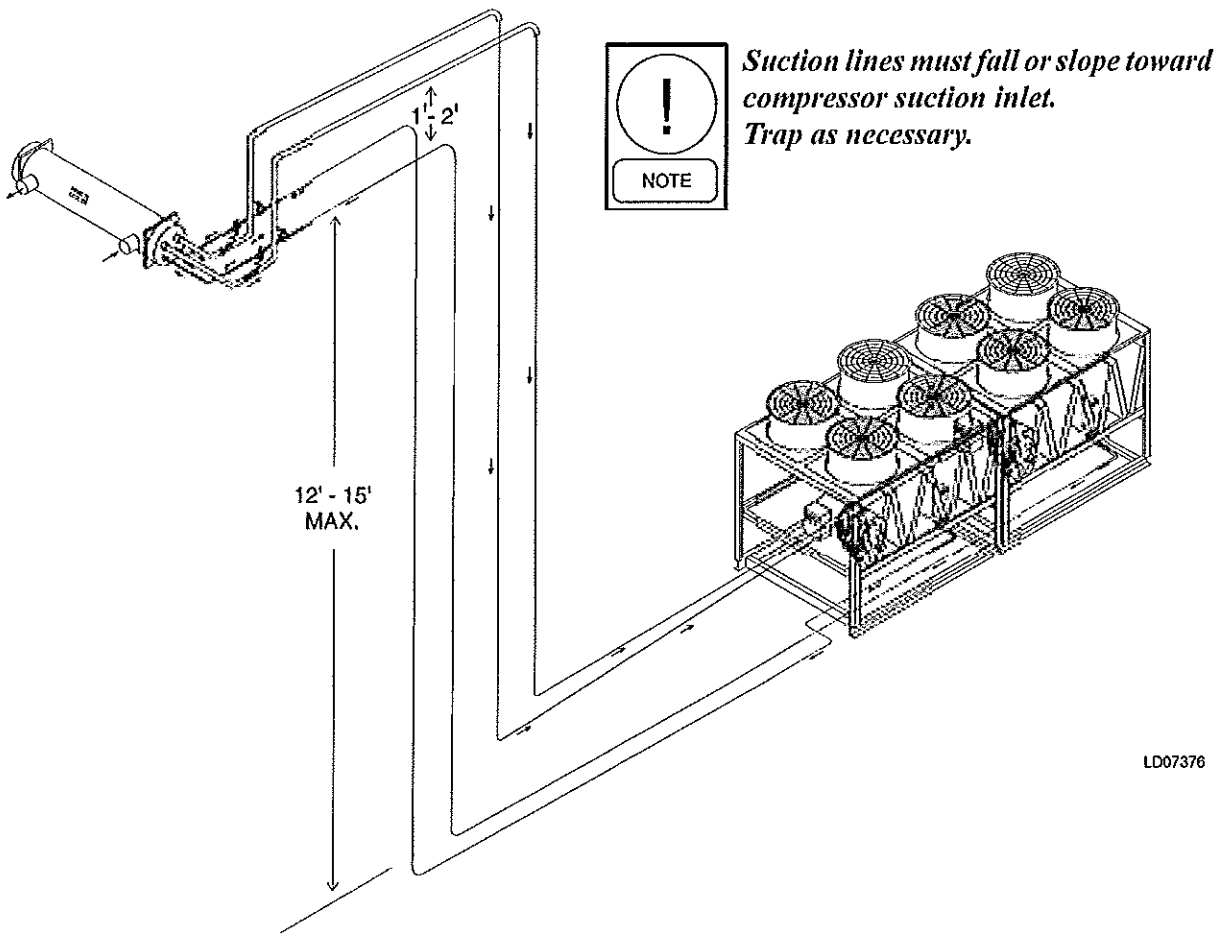


FIG. 8C – REMOTE COOLER LOCATED ABOVE THE CONDENSING UNIT

9.0 OTHER PIPING SUGGESTIONS

When vertical suction or discharge lines are greater than 25 feet, an extra oil trap is recommended for each 25 feet of vertical rise.

Suction and hot gas bypass lines must be insulated to help maintain optimum system performance.

Provisions should be made for contraction and expansion of 3/4" per 100 feet of copper piping.

Installing suction and discharge lines underground is not recommended. These have the potential to become liquid traps, which will damage compressors and reduce reliability.

Suction line accumulators may be required in certain instances where large volumes of liquid can periodically return to the compressors.

If there are reliability concerns regarding a proposed piping design, consult YORK Application Engineering personnel for advice.

10.0 SYSTEM CHARGE REQUIREMENTS

Equipment literature should be reviewed to determine the necessary system charge requirements. There are additional requirements for the suction, discharge and liquid lines. Tables 12, 13, and 14 are included to help the designer determine these piping requirements, which need to be added to the equipment requirements to determine the total operating charge requirements. However, the charge will need to be trimmed during the commissioning process by a certified technician checking both the subcooling and superheat under design conditions.

11.0 EXPANSION VALVE SENSING BULB PLACEMENT

TXV sensing bulb mounting is of extreme importance. The purpose of the bulb is to sense the temperature of the refrigerant flowing through the suction line. Anything that hampers the bulb from doing this accurately will adversely affect the long-term reliability of the system.

The following points must be stressed when considering how and where to mount the TXV bulb (a more detailed explanation for each point mentioned is provided below the list).

You can think of the steps as **Location, Location, Strap-it and Wrap-it!**

1. **Location:** The bulb should be mounted on a horizontal run of piping at the outlet of the evaporator.
2. **Location:** The bulb should be mounted radially on the suction line so that liquid oil returning from the evaporator does not influence the sensing bulb.
3. **Strap-it:** The bulb must be mounted to the suction line using the pair of metal straps normally supplied by the TXV manufacturer in order to provide good thermal contact with the suction line.
4. **Wrap-it:** The sensing bulb and the suction line must be thermally insulated with a vapor barrier[1] so that ambient conditions do not affect the bulb.

A general rule should be to mount the TXV sensing bulb on a horizontal run of suction line close to the outlet of the evaporator for which it is supplying liquid. In cases of multiple evaporators, especially stacked, multiple evaporators, consideration must be given to the avoidance of bulb locations subject to liquid draining from higher evaporators. Avoid mounting the bulb next to large massive items such as valves or flanges that may act as a heat sink and influence the sensing bulb. Likewise, do not mount the bulb after a suction/liquid line heat exchanger since the suction gas is going to be artificially heated at that point.

The proper radial mounting location on the suction line will vary depending on the diameter of the suction line. Since the objective is to mount the bulb where it will quickly sense liquid refrigerant traveling down the suction line, but not be falsely affected by normal amounts of liquid oil returning from the evaporator, it stands to reason that the bulb should be mounted as close to the bottom of the line as possible, but not so close to the bottom to be affected by any normal oil return through the suction line. Smaller diameter suction lines will require the bulb to be mounted more closely to the top of the line, while large suction lines should have the bulb mounted nearer to the bottom of the suction line. On suction line sizes over 1.5 inches, YORK recommends the bulb to be mounted at 4 or 8 o'clock. Mounting the bulb on sweeping inside or outside bends may also result in false sensing of liquid oil, depending on the piping geometry and consequently those locations should be avoided. The oil will travel in the area of the

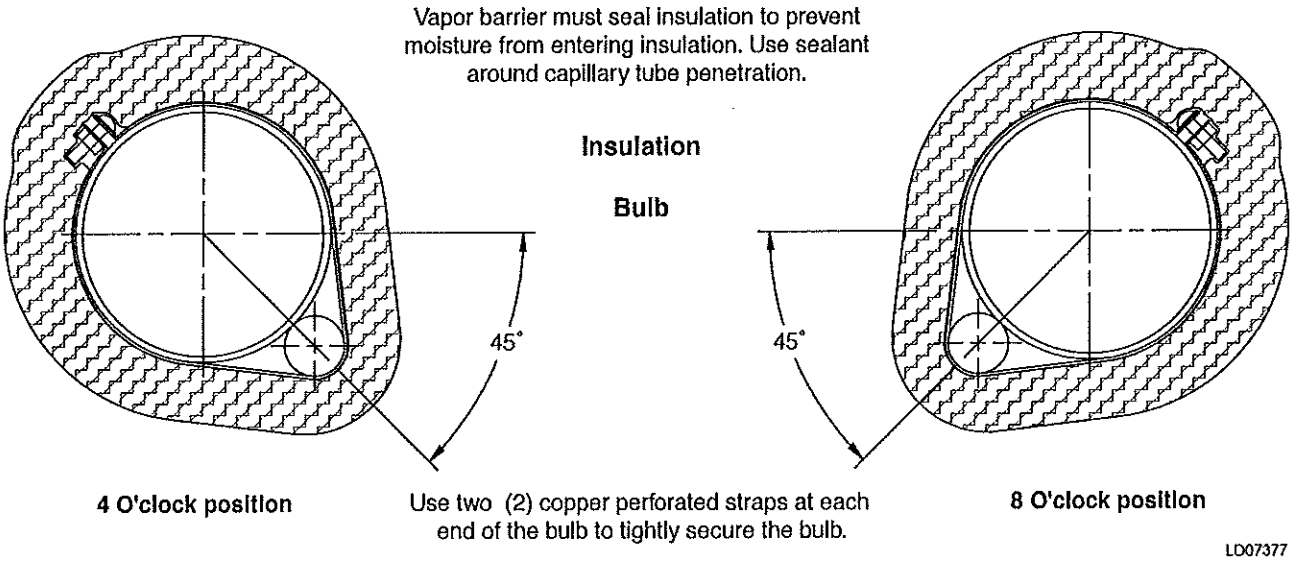


FIG. 9 – THERMAL EXPANSION VALVE BULB MOUNTED RADIALLY ON THE SUCTION PIPING AT THE 4 AND 8 O'CLOCK POSITIONS

pipe that gravity and velocity dictate. On long stretches of horizontal runs, the oil will be in the bottom of the pipe. On bends in the pipe, the oil may be forced along the outside of the piping and it may even tend to swirl around the piping under certain circumstances.

Since the sensing bulb is round and the suction line is normally round, the contact area between the bulb and the pipe is at best one single line of contact for surface mounted sensing bulbs. With that in mind, the method used to position the bulb and clamp it in place is of utmost importance. Good heat transfer between the bulb and outer surface of the suction line is critical to TXV responding quickly to low and high suction gas superheat conditions. On surface-mounted bulbs (not inserted in a thermal well), the bulb must be mounted tightly using the manufacturer's supplied mounting hardware. Normally the mounting straps are made of copper. This is not because copper straps are soft and easy to bend. It is because copper straps provide an additional path for heat transfer to occur between the suction line and the bulb. The straps should be installed tightly but not so tight as to deform the bulb or piping. In addition, if desired, heat conductive compound could be added to further increase the heat transfer. Be careful to install the bulb on a round, straight uninterrupted, section of suction line. Do not straddle braze joints and other irregularities in the piping that would prevent that single line of contact over the length of the bulb-to-pipe mating surface.

Regardless of how well the bulb is mounted, adequate insulation must cover the bulb and surrounding suction line to prevent the ambient conditions from influencing the sensing bulb. Insulation must not only be thick enough to prevent the bulb from sensing ambient temperatures, but also include a vapor barrier sufficient to prevent any moisture from condensing on or around the bulb mounting area. If the vapor barrier is compromised, moisture may condense and form a pocket under the insulation that eventually will damage the insulation as well as cause erratic TXV operation. In low ambient applications, the moisture may freeze which will further hamper TXV operation and may cause eventual damage to the piping and/or insulation system. Since the capillary line attached to the bulb will penetrate the vapor barrier, some method of sealing, such as a waterproof caulking compound, around the capillary tube should be used to keep the vapor barrier intact.

12.0 SUMMARY

Design recommendations have been provided for the design and sizing of connecting piping in DX systems.

This information is compiled for refrigerants 22, 134a and 407C, for all sizes of piping and range of capacities that encompasses all of YORK's current DX products and are consistent with the industry practices of ASHRAE. Following these recommendations will result in optimal system performance and reliability.

13.0 REFERENCES

ASHRAE Refrigeration and Fundamentals Handbooks, American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, GA.

York International, 1960, Refrigerant-12 Piping, Form 215.05-TM1 (R-12).

York International, 1960, Refrigerant-22 Piping, Form 215.05-TM1 (R-22).

York International, Refrigerant Piping – Compressors, Form 215.05-TM11.

York International, Refrigerant Piping – Suction Lines, Form 215.05-TM09.

York International, Refrigerant Piping – Suction Lines, Form 215.05-TM12.

---

[1] A vapor barrier consists of a moisture proof material such as aluminum foil, plastic tape, etc. that will prevent water vapor from passing through the insulation material around the suction line. The vapor barrier must be installed on the outside (warm side) of the insulation material and must be sealed so that water vapor cannot go around it.

TABLE 1 – SUCTION LINE CAPACITIES IN TONS FOR REFRIGERANT 22

LINE SIZE	SATURATED SUCTION TEMPERATURE, °F														
	-40			-20			0			20			40		
TYPE L COPPER O.D.	*t* = 2 F *p* = 0.77	*t* = 1 F *p* = 0.39	*t* = 0.5 F *p* = 0.19	*t* = 2 F *p* = 1.13	*t* = 1 F *p* = 0.57	*t* = 0.5 F *p* = 0.29	*t* = 2 F *p* = 1.60	*t* = 1 F *p* = 0.81	*t* = 0.5 F *p* = 0.40	t = 2 F p = 2.18	*t* = 1 F *p* = 1.1	*t* = 0.5 F *p* = 0.55	*t* = 2 F *p* = 2.87	*t* = 1 F *p* = 1.45	*t* = 0.5 F *p* = 0.73
1/2	0.10	0.07	0.05	0.17	0.12	0.08	0.27	0.18	0.12	0.40	0.27	0.19	0.58	0.40	0.27
5/8	0.19	0.13	0.09	0.32	0.22	0.15	0.50	0.34	0.23	0.75	0.52	0.35	1.10	0.74	0.51
3/4	0.33	0.23	0.15	0.55	0.38	0.26	0.86	0.59	0.40	1.30	0.88	0.60	1.80	1.30	0.87
7/8	0.52	0.35	0.24	0.85	0.58	0.40	1.30	0.91	0.62	2.00	1.40	0.93	2.90	2.00	1.30
1-1/8	1.10	0.72	0.49	1.70	1.20	0.80	2.70	1.90	1.30	4.00	2.80	1.90	5.80	4.00	2.70
1-3/8	1.80	1.30	0.90	3.00	2.10	1.40	4.70	3.20	2.20	7.00	4.80	3.30	10.00	6.90	4.80
1-5/8	2.90	2.00	1.40	4.80	3.30	2.30	7.40	5.10	3.50	11.10	7.60	5.30	15.90	11.00	7.60
2-1/8	6.10	4.20	2.90	10.00	6.90	4.70	15.40	10.70	7.30	22.90	15.90	10.90	32.80	22.80	15.70
2-5/8	10.80	7.50	5.10	17.70	12.20	8.40	27.30	18.90	13.00	40.50	28.10	19.40	58.00	40.30	27.80
3-1/8	17.30	12.00	8.20	28.20	19.50	13.40	43.60	30.20	20.80	64.60	44.80	31.00	92.30	64.20	44.40
3-5/8	25.80	17.80	12.30	42.00	29.10	20.00	64.80	44.90	31.00	96.00	66.70	46.10	137.00	95.40	66.10
4-1/8	36.50	25.20	17.40	59.30	41.10	28.30	91.40	63.40	43.80	135.20	94.00	65.10	193.00	134.40	93.20
5-1/8	65.30	45.20	31.20	106.10	73.60	50.80	163.30	113.50	78.50	241.50	168.10	116.50	344.40	240.20	166.70
6-1/8	105.20	72.93	50.30	170.70	118.50	81.90	262.50	182.60	126.40	387.90	270.30	187.50	552.70	385.80	268.10
STEEL															
1/2	0.24	0.16	0.11	0.38	0.27	0.19	0.58	0.41	0.29	0.84	0.60	0.42	1.20	0.84	0.59
3/4	0.50	0.35	0.24	0.80	0.56	0.39	1.20	0.86	0.60	1.80	1.30	0.88	2.50	1.80	1.20
1	0.95	0.66	0.46	1.50	1.10	0.75	2.30	1.60	1.10	3.40	2.40	1.70	4.80	3.40	2.40
1-1/4	2.00	1.40	1.00	3.10	2.20	1.50	4.80	3.40	2.40	6.90	4.90	3.40	9.80	6.90	4.90
1-1/2	2.90	2.10	1.40	4.70	3.30	2.30	7.10	5.00	3.60	10.40	7.40	5.20	14.70	10.40	7.30
2	5.70	4.00	2.80	9.10	6.40	4.50	13.80	9.70	6.90	20.10	14.20	10.00	28.30	20.00	14.10
2-1/2	9.10	6.40	4.50	14.50	10.20	7.20	22.00	15.50	10.90	32.00	22.60	16.00	45.10	31.90	22.50
3	16.10	11.30	8.00	25.60	18.10	12.70	38.80	27.50	19.40	56.50	40.00	28.20	79.60	56.40	39.80
3-1/2	23.50	16.60	11.70	37.40	26.50	18.60	56.80	40.20	28.30	82.70	58.50	41.30	116.50	82.50	58.30
4	32.70	23.10	16.30	52.10	36.90	26.00	79.00	55.90	39.50	115.00	81.40	57.50	162.10	114.80	81.10
5	59.20	41.80	29.40	94.10	66.60	47.00	142.60	101.00	71.30	207.60	147.00	103.80	292.60	207.20	146.40
6	95.70	67.70	47.60	152.00	07.60	76.00	230.40	163.20	115.30	335.40	237.60	167.80	472.50	334.70	236.60

NOTES:
Capacities are in tons of refrigeration.
□*p* = pressure drop due to line friction, psi per 100 feet equivalent length.
□*t* = phange in saturation temperature corresponding to pressure drop, °F per 100 feet.
All steel pipe sizes are nominal and are for schedule 40.
See notes at the bottom of Table 2.

TABLE 2 – DISCHARGE AND LIQUID LINE CAPACITIES IN TONS FOR REFRIGERANT 22

LINE SIZE	DISCHARGE LINES (Δt = 1°F, Δp = 3.03 PSI)					LINE SIZE	LIQUID LINES	
TYPE L	SATURATED SUCTION TEMPERATURE, °F					TYPE L	VEL. = 100	Δt = 1°F
COPPER, O.D.	-40	-20	0	20	40	COPPER, O.D.	FPM	Δp = 3.03
1/2	0.75	0.78	0.8	0.83	0.85	1/2	2.4	3.7
5/8	1.4	1.5	1.5	1.6	1.6	5/8	3.8	7.0
3/4	2.4	2.5	2.6	2.6	2.7	3/4	5.7	12.0
7/8	3.7	3.8	4.0	4.1	4.2	7/8	8.0	18.6
1-1/8	7.5	7.8	8.0	8.3	8.5	1-1/8	13.6	37.8
1-3/8	13.1	13.5	14.0	14.4	14.8	1-3/8	20.7	66.1
1-5/8	20.6	21.4	22.1	22.8	23.4	1-5/8	29.3	104.7
2-1/8	42.7	44.2	45.7	47.1	48.4	2-1/8	51.0	217.5
2-5/8	75.3	78.0	80.6	83.1	85.3	2-5/8	78.7	385.0
3-1/8	119.9	124.3	128.4	132.3	135.9	3-1/8	112.3	615.0
3-5/8	177.9	184.4	190.6	196.3	201.6	3-5/8	151.8	914.6
4-1/8	250.6	259.7	268.4	276.5	283.9	4-1/8	197.4	1291.0
5-1/8	447.0	463.3	478.7	493.2	506.4	5-1/8	307.6	–
6-1/8	717.1	743.2	768.0	791.2	812.5	6-1/8	442.2	–
STEEL								
IPS	SCH						IPS	SCH		
1/2	40	1.5	1.6	1.7	1.7	1.8	1/2	80	3.9	5.8
3/4	40	3.3	3.4	3.5	3.6	3.7	3/4	80	7.1	13.1
1	40	6.1	6.4	6.6	6.8	7.0	1	80	11.9	25.8
1-1/4	40	12.7	13.1	13.6	14.0	14.3	1-1/4	80	21.1	55.4
1-1/2	40	19.0	19.7	20.3	21.0	21.5	1-1/2	80	29.1	84.5
2	40	36.6	37.9	39.2	40.4	41.5	2	40	55.3	196.5
2-1/2	40	58.3	60.4	62.5	64.3	66.1	2-1/2	40	78.9	313.4
3	40	103.0	106.7	110.3	113.6	116.7	3	40	121.8	554.0
4	40	209.6	217.3	224.5	231.3	237.5	4	40	209.8	1129.0
5	40	378.3	392.1	405.2	417.4	428.6	5	40	329.7	2039.0
6	40	611.1	633.3	654.4	674.1	692.3	6	40	476.2	3294.0

Capacities are in tons of refrigeration.

Δp = Pressure drop due to line friction, psi per 100 feet equivalent length.

Δt = Change in saturation temperature corresponding to pressure drop, °F per 100 feet.

Line capacity for other saturation temperatures Δt and equivalent lengths L.

$$\text{Line capacity} = \text{Table capacity} \left(\frac{\text{Table } L_e}{\text{Actual } L_e}\right) \times \left(\frac{\text{Actual } \Delta t}{\text{Table } \Delta t}\right)^{0.55}$$

Saturation temperature Δt for other capacities and equivalent lengths L_e

$$\Delta t = \text{Table } \Delta t \left(\frac{\text{Actual } L_e}{\text{Table } L_e}\right) \left(\frac{\text{Actual Capacity}}{\text{Table Capacity}}\right)^{1.8}$$

The refrigerant cycle for determining capacity is based on saturated gas leaving the evaporator and no subcooling in the condenser. Discharge superheat is 105°F. The saturated suction temperature is 40°F for liquid line sizing.

Multiply table capacities by the following factors for condensing temperatures other than 105°F.

CONDENSING TEMPERATURE, °F	SUCTION LINE	DISCHARGE LINE
80	1.12	0.82
90	1.07	0.89
100	1.03	0.96
110	0.97	1.03
120	0.92	1.10
130	0.87	1.16
140	0.82	1.22

TABLE 3 – SUCTION LINE CAPACITIES IN TONS FOR REFRIGERANT 134a

LINE SIZE		SATURATED SUCTION TEMPERATURE, °F														
		-40			-20			0			20			40		
TYPE L COPPER, O.D.		t = 2 F p = 0.98	t = 1 F p = 0.49	t = 0.5 F p = 0.25	t = 2 F p = 1.17	t = 1 F p = 0.59	t = 0.5 F p = 0.30	t = 2 F p = 1.39	t = 1 F p = 0.70	t = 0.5 F p = 0.35	t = 2 F p = 1.63	t = 1 F p = 0.82	t = 0.5 F p = 0.41	t = 2 F p = 1.90	t = 1 F p = 0.96	t = 0.5 F p = 0.48
1/2		0.14	0.10	0.07	0.18	0.12	0.08	0.23	0.16	0.11	0.28	0.19	0.13	0.35	0.24	0.16
5/8		0.27	0.18	0.12	0.34	0.23	0.16	0.43	0.29	0.20	0.53	0.37	0.25	0.66	0.45	0.31
3/4		0.46	0.31	0.21	0.58	0.40	0.27	0.73	0.50	0.34	0.91	0.62	0.43	1.1	0.77	0.53
7/8		0.71	0.48	0.33	0.90	0.62	0.42	1.1	0.78	0.53	1.4	1.0	0.66	1.7	1.2	0.82
1-1/8		1.4	1.0	0.67	1.8	1.3	0.86	2.3	1.6	1.1	2.9	2.0	1.3	3.5	2.4	1.7
1-3/8		2.5	1.7	1.2	3.2	2.2	1.5	4.0	2.8	1.9	5.0	3.4	2.4	6.1	4.2	2.9
1-5/8		4.0	2.7	1.9	5.1	3.5	2.4	6.4	4.4	3.0	7.9	5.4	3.7	9.7	6.7	4.6
2-1/8		8.3	5.7	3.9	10.5	7.3	5.0	13.2	9.1	6.3	16.4	11.3	7.8	20.1	13.9	9.6
2-5/8		14.7	10.1	7.0	18.6	12.9	8.8	23.3	16.1	11.1	28.9	20.0	13.8	35.5	24.6	17.0
3-1/8		23.4	16.2	11.2	29.7	20.6	14.2	37.2	25.8	17.8	46.1	32.0	22.1	56.6	39.3	27.1
3-5/8		34.9	24.1	16.6	44.2	30.6	21.1	55.3	38.4	26.5	68.6	47.6	32.9	84.1	58.4	40.4
4-1/8		49.2	34.1	23.5	62.4	43.2	29.8	78.1	54.2	37.4	96.7	67.1	46.4	118.5	82.4	57.0
5-1/8		88.2	61.1	42.2	111.6	77.4	53.5	139.6	97.0	67.1	172.7	120.1	83.1	211.6	147.3	102.1
6-1/8		141.8	98.5	68.0	179.4	124.7	86.2	224.4	156.0	108.0	277.5	193.2	133.9	339.9	236.8	164.2
STEEL																
IPS	SCH															
1/2	80	0.22	0.16	0.11	0.28	0.20	0.14	0.35	0.25	0.17	0.43	0.30	0.21	0.52	0.37	0.26
3/4	80	0.50	0.35	0.25	0.63	0.45	0.31	0.79	0.56	0.39	0.97	0.68	0.48	1.2	0.83	0.59
1	80	1.0	0.70	0.49	1.2	0.88	0.61	1.5	1.1	0.76	1.90	1.3	0.94	2.3	1.6	1.1
1-1/4	40	2.6	1.8	1.3	3.3	2.3	1.6	4.1	2.9	2.0	5.0	3.5	2.5	6.1	4.3	3.0
1-1/2	40	3.9	2.8	1.9	4.9	3.5	2.4	6.1	4.3	3.0	7.5	5.3	3.7	9.1	6.4	4.5
2	40	7.6	5.3	3.7	9.5	6.7	4.7	11.8	8.3	5.9	14.5	10.2	7.2	17.6	12.4	8.8
2-1/2	40	12.1	8.5	6.0	15.1	10.7	7.5	18.8	13.3	9.3	23.1	16.3	11.5	28.0	19.8	14.0
3	40	21.3	15.1	10.6	26.7	18.9	13.3	33.2	23.5	16.5	40.7	28.8	20.3	49.6	35.1	24.7
3-1/2	40	31.2	22.1	15.5	39.1	27.7	19.5	48.5	34.3	24.2	59.6	42.2	29.8	72.5	51.3	36.2
4	40	43.5	30.7	21.7	54.5	38.5	27.2	67.6	47.8	33.7	82.9	58.7	41.4	100.9	71.4	50.4
5	40	78.5	55.5	39.2	98.4	69.6	49.1	122.0	86.4	60.9	149.7	106.0	74.9	182.1	129.0	91.1
6	40	126.9	89.8	63.3	159.0	112.6	79.4	197.1	139.6	98.5	241.9	171.3	121.0	294.2	208.4	147.2

NOTES:
Capacities are in tons of refrigeration.
Δp = pressure drop due to line friction, psi per 100 feet equivalent length.
Δt = change in saturation temperature corresponding to pressure drop, °F per 100 feet.
All steel pipe sizes are nominal and are for schedule 40.
See notes at the bottom of Table 4.

TABLE 4 – DISCHARGE AND LIQUID LINE CAPACITIES IN TONS FOR REFRIGERANT 134a

LINE SIZE	DISCHARGE LINES (Δt = 1°F, Δp = 2.2 PSI)			LINE SIZE	LIQUID LINES	
TYPE L	SATURATED SUCTION TEMPERATURE, °F			TYPE L	VEL. = 100	Δt = 1°F
COPPER, O.D.	0	20	40	COPPER, O.D.	FPM	Δp = 2.2
1/2	0.54	0.57	0.59	1/2	2.4	3.7
5/8	1.0	1.1	1.1	5/8	3.8	7.0
3/4	1.7	1.8	1.9	3/4	5.7	12.0
7/8	2.7	2.8	2.9	7/8	8.0	18.6
1-1/8	5.4	5.7	5.9	1-1/8	13.6	37.8
1-3/8	9.4	9.9	10.4	1-3/8	20.7	66.1
1-5/8	14.9	15.6	6.4	1-5/8	29.3	104.7
2-1/8	30.8	32.4	33.9	2-1/8	51.0	217.5
2-5/8	54.4	57.1	59.8	2-5/8	78.7	385.0
3-1/8	86.7	91.0	95.2	3-1/8	112.3	615.0
3-5/8	128.7	135.1	141.4	3-5/8	151.8	914.6
4-1/8	181.3	190.4	199.1	4-1/8	197.4	–
5-1/8	323.5	339.7	355.4	5-1/8	307.6	–
6-1/8	519.2	545.2	570.3	6-1/8	442.2	–
STEEL STEEL						
IPS SCH				IPS SCH		
1/2 80	0.80	0.83	0.87	1/2 80	3.2	5.6
3/4 80	1.8	1.9	2.0	3/4 80	7.1	16.0
1 80	3.5	3.7	3.9	1 80	11.9	31.5
1-1/4 40	9.2	9.7	10.1	1-1/4 80	21.1	67.9
1-1/2 40	13.8	14.5	5.2	1-1/2 80	29.1	103.7
2 40	26.6	28.0	29.2	2 40	55.3	242.0
2-1/2 40	42.4	44.6	46.6	2-1/2 40	78.9	386.7
3 40	75.0	78.7	82.3	3 40	121.8	684.8
4 40	152.6	160.2	167.6	4 40	209.8	–
5 40	275.4	289.2	02.5	5 40	329.7	–
6 40	444.8	467.1	488.5	6 40	476.2	–

Capacities are in tons of refrigeration.

Δp = Pressure drop due to line friction, psi per 100 feet equivalent length.

Δt = Change in saturation temperature corresponding to pressure drop, °F per 100 feet.

Line capacity for other saturation temperatures Δt and equivalent lengths L.

$$\text{Line capacity} = \text{Table capacity} \left(\frac{\text{Table } L_e}{\text{Actual } L_e}\right) \times \left(\frac{\text{Actual } \Delta t}{\text{Table } \Delta t}\right)^{0.55}$$

Saturation temperature Δt for other capacities and equivalent lengths L_e

$$\Delta t = \text{Table } \Delta t \left(\frac{\text{Actual } L_e}{\text{Table } L_e}\right) \left(\frac{\text{Actual Capacity}}{\text{Table Capacity}}\right)^{1.8}$$

The refrigerant cycle for determining capacity is based on saturated gas leaving the evaporator and no subcooling in the condenser. Discharge superheat is 105°F. The saturated suction temperature is 40°F for liquid line sizing.

Multiply table capacities by the following factors for condensing temperatures other than 105°F.

CONDENSING TEMPERATURE, °F	SUCTION LINE	DISCHARGE LINE
80	1.14	0.81
90	1.09	0.89
100	1.03	0.96
110	0.97	1.03
120	0.91	1.10
130	0.84	1.16
140	0.78	1.20

TABLE 5 – SUCTION LINE CAPACITIES IN TONS FOR REFRIGERANT 407C

LINE SIZE	SATURATED SUCTION TEMPERATURE, °F														
	-40			-20			0			20			40		
TYPE L COPPER, O.D.	t = 2 F p = 0.69	t = 1 F p = 0.35	t = 0.5 F p = 0.18	t = 2 F p = 1.04	t = 1 F p = 0.53	t = 0.5 F p = 0.26	t = 2 F p = 1.50	t = 1 F p = 0.76	t = 0.5 F p = 0.38	t = 2 F p = 2.08	t = 1 F p = 1.05	t = 0.5 F p = 0.53	t = 2 F p = 2.81	t = 1 F p = 1.41	t = 0.5 F p = 0.71
1/2	0.08	0.05	0.04	0.14	0.09	0.06	0.22	0.15	0.10	0.35	0.24	0.16	0.53	0.36	0.25
5/8	0.15	0.10	0.07	0.26	0.18	0.12	0.42	0.29	0.20	0.66	0.45	0.31	0.99	0.68	0.46
3/4	0.25	0.17	0.12	0.44	0.30	0.20	0.72	0.49	0.34	1.1	0.77	0.5	3 .7	1.2	0.79
7/8	0.39	0.27	0.18	0.68	0.47	0.32	1.1	0.77	0.52	1.7	1.2	0.82	2.6	1.8	1.2
1-1/8	0.80	0.55	0.37	1.4	1.0	0.6	5.3	1.6	1.1	3.5	2.4	1.7	5.3	3.6	2.5
1-3/8	1.4	1.0	0.66	2.4	1.7	1.1	4.0	2.7	1.9	6.1	4.2	2.9	9.2	6.3	4.4
1-5/8	2.2	1.5	1.0	3.9	2.7	1.8	6.3	4.3	3.0	9.7	6.7	4.6	14.5	10.0	6.9
2-1/8	4.6	3.2	2.2	8.0	5.5	3.8	13.0	9.0	6.2	20.1	13.9	9.6	29.9	20.8	14.3
2-5/8	8.2	5.7	3.9	14.2	9.8	6.7	23.0	15.9	11.0	35.6	24.6	17.0	52.8	36.7	25.4
3-1/8	13.2	9.1	6.2	22.7	15.7	10.8	36.8	25.5	17.5	56.7	39.4	27.2	84.2	58.5	40.5
3-5/8	19.6	13.6	9.3	33.8	23.4	16.1	54.6	37.9	26.1	84.2	58.5	40.5	124.9	87.0	60.2
4-1/8	27.7	19.2	13.2	47.7	33.0	22.7	77.1	53.5	36.9	118.7	82.5	57.1	176.0	122.6	85.0
5-1/8	49.7	34.4	23.7	85.3	59.2	40.8	137.8	95.7	66.2	212.1	147.6	102.3	314.1	219.0	152.0
6-1/8	80.1	55.5	38.3	137.3	95.3	65.8	221.5	154.1	106.6	340.6	237.3	164.6	504.0	351.8	244.5
STEEL															
1/2	0.18	0.13	0.09	0.31	0.21	0.15	0.49	0.34	0.24	0.74	0.52	0.37	1.1	0.77	0.54
3/4	0.38	0.27	0.19	0.65	0.45	0.32	1.0	0.72	0.51	1.6	1.1	0.77	2.3	1.6	1.1
1	0.73	0.51	0.36	1.2	0.86	0.60	1.9	1.4	1.0	3.0	2.1	1.5	4.3	3.1	2.2
1-1/4	1.5	1.1	0.74	2.5	1.8	1.2	4.0	2.8	2.0	6.1	4.3	3.0	8.9	6.3	4.5
1-1/2	2.3	1.6	1.1	3.8	2.7	1.9	6.0	4.3	3.0	9.2	6.5	4.6	13.4	9.5	6.7
2	4.4	3.1	2.2	7.3	5.2	3.6	11.6	8.2	5.8	17.7	12.5	8.8	25.8	18.3	12.9
2-1/2	7.0	4.9	3.4	11.7	8.3	5.8	18.6	13.1	9.2	28.1	19.9	14.0	41.2	29.1	20.6
3	12.3	8.7	6.1	20.7	14.6	10.3	32.8	23.2	16.4	49.7	35.2	24.8	72.7	51.5	36.3
3-1/2	18.1	12.8	9.0	30.3	21.4	15.1	48.0	34.0	24.0	72.7	51.5	36.3	106.3	75.3	53.2
4	25.2	17.8	12.5	42.2	29.8	21.0	66.8	47.3	33.4	101.2	71.7	50.6	148.0	104.8	74.0
5	45.5	32.2	22.6	76.2	53.9	38.0	120.7	85.4	60.3	182.7	129.4	91.4	267.1	189.2	133.7
6	73.6	52.0	36.6	123.2	87.2	61.5	195.0	138.1	97.5	295.1	209.1	147.7	431.4	305.6	216.0

NOTES:
Capacities are in tons of refrigeration.
□p = pressure drop due to line friction, psi per 100 feet equivalent length.
□t = change in saturation temperature corresponding to pressure drop, °F per 100 feet.
All steel pipe sizes are nominal and are for schedule 40. The saturated condensing and suction conditions are referenced to the dewpoint.
See notes at the bottom of Table 6.

TABLE 6 – DISCHARGE AND LIQUID LINE CAPACITIES IN TONS FOR REFRIGERANT 407C

LINE SIZE	DISCHARGE LINES (Δt = 1°F, Δp = 3.28 PSI)					LINE SIZE	LIQUID LINES	
TYPE L	SATURATED SUCTION TEMPERATURE, °F					TYPE L	VEL. = 100	Δt = 1°F
COPPER, O.D.	-40	-20	0	20	40	COPPER, O.D.	FPM	Δp = 3.43
1/2	0.71	0.75	0.78	0.82	0.86	1/2	2.2	4.0
5/8	1.3	1.4	1.5	1.5	1.6	5/8	3.6	7.5
3/4	2.3	2.4	2.5	2.6	2.7	3/4	5.4	12.9
7/8	3.5	3.7	3.9	4.0	4.2	7/8	7.5	19.9
1-1/8	7.0	7.4	7.8	8.2	8.5	1-1/8	12.7	40.3
1-3/8	12.3	12.9	13.6	14.3	14.9	1-3/8	19.4	70.3
1-5/8	19.3	20.4	21.5	22.5	23.5	1-5/8	27.5	111.2
2-1/8	40.0	42.2	44.4	46.5	48.6	2-1/8	47.8	230.5
2-5/8	70.5	74.5	78.3	82.1	85.6	2-5/8	73.7	407.3
3-1/8	112.3	118.6	124.8	130.7	136.4	3-1/8	105.2	649.6
3-5/8	166.6	176.0	185.1	193.9	202.3	3-5/8	142.3	965.0
4-1/8	234.7	247.8	260.7	273.1	284.9	4-1/8	185.0	1360.0
5-1/8	418.5	441.9	464.9	487.0	508.1	5-1/8	288.3	–
6-1/8	671.3	708.9	745.7	781.2	815.0	6-1/8	414.4	–
STEEL								
IPS	SCH						IPS	SCH		
1/2	40	1.4	1.5	1.6	1.7	1.8	1/2	80	4.7	8.5
3/4	40	3.0	3.2	3.4	3.5	3.7	3/4	80	8.2	17.9
1	40	5.7	6.1	6.4	6.7	7.0	1	80	13.4	34.0
1-1/4	40	11.8	12.5	3.1	13.8	14.4	1-1/4	80	23.1	70.0
1-1/2	40	17.7	18.7	19.7	20.6	21.5	1-1/2	80	31.4	105.0
2	40	34.2	36.1	38.0	39.8	41.5	2	40	51.8	202.4
2-1/2	40	54.5	57.5	60.5	63.4	66.1	2-1/2	40	73.9	322.7
3	40	96.2	101.6	106.9	112.0	116.8	3	40	114.2	570.2
4	40	195.8	206.8	217.5	227.9	237.8	4	40	196.6	1161.0
5	40	353.4	373.2	392.5	411.3	429.0	5	40	309.0	–
6	40	570.8	602.7	634.0	664.2	692.9	6	40	446.2	–

Capacities are in tons of refrigeration.

Δp = Pressure drop due to line friction, psi per 100 feet equivalent length.

Δt = Change in saturation temperature corresponding to pressure drop, °F per 100 feet.

Line capacity for other saturation temperatures Δt and equivalent lengths L.

$$\text{Line capacity} = \text{Table capacity} \left(\frac{\text{Table } L_e}{\text{Actual } L_e}\right) \times \left(\frac{\text{Actual } \Delta t}{\text{Table } \Delta t}\right)^{0.55}$$

Saturation temperature Δt for other capacities and equivalent lengths L_e

$$\Delta t = \text{Table } \Delta t \left(\frac{\text{Actual } L_e}{\text{Table } L_e}\right) \left(\frac{\text{Actual Capacity}}{\text{Table Capacity}}\right)^{1.8}$$

The refrigerant cycle for determining capacity is based on saturated gas leaving the evaporator and no subcooling in the condenser. Discharge superheat is 105°F. The saturated suction temperature is 40°F for liquid line sizing.

Multiply table capacities by the following factors for condensing temperatures other than 105°F.

CONDENSING TEMPERATURE, °F	SUCTION LINE	DISCHARGE LINE
80	1.16	0.81
90	1.09	0.89
100	1.03	0.96
110	0.97	1.03
120	0.90	1.10
130	0.83	1.16
140	0.76	1.19

TABLE 7 – MINIMUM REFRIGERATION CAPACITY IN TONS FOR OIL ENTRANMENT UP SUCTION RISERS (TYPE L COPPER TUBING)

REFRIGERANT	SATURATION SUCTION TEMP., °F	SUCTION GAS TEMP., °F	PIPE O.D., IN.											
			1/2	5/8	3/4	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8
			AREA, IN²											
				0.233	0.348	0.484	0.825	1.256	1.780	3.094	4.770	6.812	9.213	11.97
22	-40	-30	0.07	0.12	0.20	0.30	0.59	0.99	1.53	3.05	5.25	8.19	11.95	16.57
		-10	0.07	0.12	0.20	0.30	0.58	0.97	1.51	3.00	5.16	8.06	11.75	16.30
		10	0.07	0.12	0.20	0.30	0.58	0.98	1.52	3.02	5.19	8.11	11.82	16.40
	-20	-10	0.09	0.16	0.26	0.39	0.76	1.28	1.97	3.94	6.77	10.57	15.41	21.38
		10	0.09	0.15	0.25	0.38	0.74	1.26	1.95	3.89	6.68	10.42	15.20	21.09
		30	0.09	0.15	0.26	0.39	0.75	1.27	1.96	3.92	6.73	10.51	15.33	21.26
	0	10	0.11	0.20	0.33	0.49	0.96	1.63	2.52	5.03	8.63	13.48	19.65	27.26
		30	0.11	0.19	0.32	0.49	0.94	1.60	2.47	4.93	8.47	13.22	19.29	26.75
		50	0.11	0.20	0.32	0.49	0.95	1.61	2.49	4.97	8.54	13.33	19.44	26.96
	20	30	0.14	0.25	0.41	0.62	1.20	2.03	3.15	6.28	10.78	16.84	24.56	34.06
		50	0.14	0.24	0.40	0.61	1.19	2.01	3.11	6.21	10.66	16.65	24.28	33.68
		70	0.14	0.24	0.40	0.61	1.19	2.01	3.11	6.20	10.65	16.63	24.25	33.64
	40	50	0.17	0.30	0.50	0.76	1.48	2.49	3.86	7.70	13.22	20.64	30.11	41.76
		70	0.17	0.30	0.49	0.74	1.45	2.45	3.78	7.55	12.96	20.24	29.52	40.94
		90	0.17	0.30	0.49	0.74	1.45	2.45	3.78	7.55	12.97	20.26	29.54	40.98
134a	0	10	0.09	0.16	0.26	0.39	0.76	1.29	2.00	3.99	6.86	10.71	15.61	21.66
		30	0.09	0.15	0.25	0.38	0.75	1.26	1.95	3.90	6.70	10.46	15.26	21.16
		50	0.09	0.16	0.26	0.39	0.76	1.28	1.98	3.95	6.79	10.60	15.46	21.45
	10	20	0.10	0.17	0.28	0.43	0.84	1.41	2.18	4.36	7.49	11.69	17.05	23.65
		40	0.10	0.17	0.29	0.43	0.85	1.43	2.21	4.41	7.58	11.84	17.26	23.95
		60	0.10	0.18	0.29	0.44	0.86	1.45	2.24	4.47	7.68	11.99	17.49	24.26
	20	30	0.11	0.19	0.32	0.49	0.95	1.60	2.48	4.94	8.49	13.25	19.32	26.80
		50	0.11	0.20	0.33	0.49	0.96	1.62	2.51	5.01	8.61	13.44	19.60	27.19
		70	0.11	0.20	0.33	0.50	0.97	1.64	2.54	5.06	8.70	13.58	19.81	27.48
	30	40	0.12	0.22	0.37	0.55	1.08	1.82	2.82	5.63	9.67	15.10	22.02	30.55
		60	0.12	0.22	0.37	0.55	1.08	1.82	2.82	5.62	9.66	15.08	21.99	30.51
		80	0.13	0.23	0.37	0.56	1.10	1.86	2.87	5.73	9.85	15.38	22.43	31.11
	40	50	0.14	0.25	0.41	0.62	1.20	2.03	3.14	6.26	10.75	16.79	24.49	33.97
		70	0.14	0.25	0.41	0.62	1.20	2.03	3.14	6.28	10.78	16.83	24.55	34.05
		90	0.14	0.25	0.42	0.63	1.23	2.08	3.22	6.43	11.04	17.24	25.15	34.88

TABLE 7 – MINIMUM REFRIGERATION CAPACITY IN TONS FOR OIL ENTRANMENT UP SUCTION RISERS (TYPE L COPPER TUBING) (CONTINUED)

REFRIGERANT	SATURATION SUCTION TEMP., °F	SUCTION GAS TEMP., °F	PIPE O.D., IN.											
			1/2	5/8	3/4	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8
			AREA, IN²											
				0.233	0.348	0.484	0.825	1.256	1.780	3.094	4.770	6.812	9.213	11.97
407C	-40	-30	0.06	.10	0.17	0.25	0.49	0.84	1.29	2.58	4.44	6.92	10.10	14.01
		-10	0.06	0.10	0.17	0.26	0.51	0.86	1.33	2.65	4.55	7.10	10.35	14.36
		10	0.06	0.11	0.18	0.27	0.52	0.88	1.37	2.73	4.69	7.32	10.67	14.81
	-20	-10	0.08	0.14	0.23	0.34	0.67	1.13	1.75	3.49	6.00	9.36	13.65	18.93
		10	0.08	0.14	0.23	0.35	0.68	1.15	1.78	3.56	6.11	9.54	13.92	19.30
		30	0.08	0.14	0.24	0.36	0.70	1.18	1.83	3.65	6.28	.80	14.29	19.82
	0	10	0.10	0.18	0.29	0.45	0.87	1.47	2.27	4.53	7.78	12.14	17.71	24.56
		0	0.10	0.18	0.30	0.46	0.89	1.51	2.33	4.65	7.98	12.46	18.17	25.20
		50	0.10	0.19	0.31	0.47	0.91	1.54	2.38	4.76	8.17	12.76	18.61	25.82
	20	30	0.13	0.23	0.38	0.58	1.12	1.90	2.94	5.86	10.06	15.71	22.92	31.79
		50	0.13	0.23	0.39	0.59	1.14	1.93	2.98	5.95	10.22	15.95	23.27	32.28
		70	0.13	0.24	0.39	0.60	1.16	1.96	3.03	6.05	10.40	16.24	23.68	32.85
	40	50	0.16	0.29	0.47	0.71	1.39	2.35	3.64	7.26	2.47	19.46	28.39	39.38
		70	0.16	0.29	0.48	0.73	1.41	2.39	3.70	7.38	12.68	19.79	28.87	40.05
		90	0.17	0.30	0.49	0.74	1.44	2.44	3.77	7.52	12.92	20.17	29.42	40.82

Refrigeration capacity in tons is based on 90°F liquid temperature and superheat as indicated by the temperature in the table. The saturated condensing and suction conditions are referenced to the dewpoint for R-407C. For other liquid line temperatures, use correction factors to the capacity given in the table below.

REFRIGERANT	LIQUID TEMPERATURE, °F								
	50	60	70	80	100	110	120	130	140
22	1.16	1.12	1.08	1.04	0.96	0.91	0.87	0.82	0.78
134a	1.19	1.15	1.10	1.05	0.95	0.90	0.84	0.79	0.73
407C	1.21	1.16	1.11	1.05	0.94	0.89	0.83	0.77	0.70

TABLE 8 – MINIMUM REFRIGERATION CAPACITY IN TONS FOR OIL ENTRANMENT UP HOT GAS RISERS (TYPE L COPPER TUBING)

REFRIGERANT	SATURATION SUCTION TEMP., °F	SUCTION GAS TEMP., °F	PIPE O.D., IN.											
			1/2	5/8	3/4	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8
			AREA, IN²											
			1.146	0.233	0.348	0.484	0.825	1.256	1.780	3.094	4.770	6.812	9.213	11.97
22	80	110	0.23	0.42	0.69	1.04	2.02	3.42	5.29	10.56	18.15	28.33	41.32	57.31
		140	0.22	0.39	0.65	0.98	1.91	3.23	5.00	9.98	17.15	26.77	39.04	54.15
		170	0.21	0.38	0.62	0.94	1.84	3.11	4.80	9.58	16.46	25.70	37.49	52.00
	90	120	0.24	0.43	0.71	1.07	2.09	3.53	5.46	10.90	18.72	29.22	42.62	59.12
		150	0.23	0.40	0.67	1.01	1.96	3.32	5.13	10.25	17.60	27.48	40.08	55.60
		180	0.22	0.39	0.64	0.96	1.88	3.17	4.90	9.78	16.81	26.24	38.27	53.09
	100	130	0.25	0.44	0.73	1.11	2.16	3.65	5.64	11.26	19.34	30.20	44.05	61.10
		160	0.23	0.41	0.68	1.03	2.01	3.41	5.27	10.51	18.05	28.18	41.11	57.02
		190	0.22	0.40	0.65	0.99	1.92	3.25	5.02	10.02	17.21	26.86	39.18	54.34
	110	140	0.25	0.45	0.75	1.13	2.21	3.73	5.77	11.52	19.79	30.89	45.06	62.50
		170	0.24	0.42	0.70	1.06	2.06	3.48	5.38	10.73	18.44	28.79	41.99	58.24
		200	0.22	0.40	0.66	0.99	1.93	3.27	5.06	10.09	17.33	27.06	39.46	54.74
	120	150	0.26	0.46	0.76	1.15	2.25	3.80	5.87	11.72	20.14	31.44	45.85	63.60
		180	0.24	0.43	0.70	1.06	2.07	3.50	5.41	10.81	18.56	28.98	42.27	58.63
		210	0.23	0.41	0.67	1.01	1.97	3.34	5.16	10.30	17.70	27.63	40.30	55.90
134a	80	110	0.20	0.36	0.59	0.89	1.73	2.93	4.52	9.03	15.51	24.22	35.32	48.99
		140	0.19	0.33	0.55	0.83	1.62	2.74	4.24	8.47	14.55	22.71	33.13	45.95
		170	0.18	0.32	0.53	0.80	1.55	2.63	4.06	8.10	13.92	21.73	31.70	43.97
	90	20	0.20	0.37	0.61	0.92	1.79	3.02	4.67	9.32	16.01	24.99	36.45	50.56
		150	0.19	0.34	0.56	0.85	1.66	2.80	4.33	8.64	14.84	23.17	33.79	46.87
		180	0.18	0.33	0.54	0.82	1.59	2.69	4.16	8.30	14.26	22.27	32.48	45.05
	100	130	0.21	0.37	0.62	0.93	1.81	3.07	4.74	9.47	16.26	25.39	37.03	51.36
		160	0.20	0.35	0.58	0.88	1.71	2.90	4.48	8.95	15.37	23.99	34.99	48.54
		190	0.19	0.34	0.55	0.84	1.63	2.76	4.26	8.50	14.61	22.80	33.26	46.13
	110	140	0.21	0.38	0.63	0.96	1.86	3.15	4.88	9.73	16.71	26.09	38.06	52.79
		170	0.20	0.36	0.59	0.90	1.75	2.95	4.57	9.11	15.66	24.44	35.65	49.45
		200	0.19	0.34	0.56	0.85	1.65	2.80	4.32	8.63	14.83	23.15	33.76	46.83
	120	150	0.21	0.38	0.63	0.96	1.87	3.16	4.88	9.74	16.73	26.12	38.10	52.85
		180	0.20	0.36	0.60	0.90	1.76	2.97	4.60	9.18	15.76	24.61	35.89	49.79
		210	0.19	0.34	0.57	0.86	1.67	2.83	4.37	8.73	14.99	23.41	34.14	47.36

TABLE 8 – MINIMUM REFRIGERATION CAPACITY IN TONS FOR OIL ENTRANMENT UP HOT GAS RISERS (TYPE L COPPER TUBING) (CONTINUED)

REFRIGERANT	SATURATION SUCTION TEMP., °F	SUCTION GAS TEMP., °F	PIPE O.D., IN.											
			1/2	5/8	3/4	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8
			AREA, IN²											
			0.146	0.233	0.348	0.484	0.825	1.256	1.780	3.094	4.770	6.812	9.213	11.97
407C	80	110	0.23	0.42	0.69	1.05	2.04	3.46	5.34	10.66	18.32	28.60	41.72	57.87
		140	0.22	0.40	0.66	0.99	1.93	3.27	5.05	10.08	17.31	27.02	39.42	54.67
		170	0.21	0.38	0.63	0.95	1.85	3.13	4.84	9.66	16.60	25.91	37.79	52.42
	90	120	0.24	0.43	0.71	1.07	2.07	3.51	5.42	10.83	18.60	29.03	42.35	58.74
		150	0.23	0.41	0.67	1.02	1.98	3.35	5.19	10.35	17.78	27.76	40.49	56.17
		180	0.22	0.39	0.65	0.98	1.90	3.22	4.97	9.93	17.06	26.63	38.83	53.87
	100	130	0.24	0.44	0.72	1.09	2.13	3.60	5.56	11.10	19.07	29.77	43.42	60.23
		160	0.23	0.42	0.69	1.05	2.04	3.44	5.32	10.62	18.25	28.49	41.55	57.63
		190	0.22	0.40	0.66	1.00	1.94	3.28	5.07	10.12	17.39	27.15	39.60	54.93
	110	140	0.25	0.45	0.73	1.11	2.16	3.66	5.65	11.28	19.38	30.25	44.12	61.21
		170	0.24	0.42	0.70	1.06	2.06	3.49	5.39	10.76	18.49	28.86	42.10	58.39
		200	0.23	0.41	0.67	1.01	1.98	3.34	5.17	10.31	17.71	27.65	40.32	55.93
	120	150	0.25	0.45	0.75	1.13	2.20	3.71	5.74	11.45	19.68	30.72	44.80	62.15
		180	0.24	0.43	0.71	1.07	2.09	3.53	5.46	10.91	18.73	29.25	42.66	59.17
		210	0.23	0.41	0.68	1.03	2.01	3.40	5.26	10.49	18.03	28.14	41.04	56.93

Refrigeration capacity in tons is based on a saturated suction temperature of 20°F with 15°F superheat at the indicated saturated condensing temperature with 15°F subcooling. The saturated condensing and suction conditions are referenced to the dewpoint for R-407C. For other saturated suction temperatures with 15°F superheat, use correction factors to the capacity given in the table below.

REFRIGERANT	SATURATED SUCTION TEMPERATURE, °F			
	-40	-20	0	40
22	0.91	0.94	0.97	1.03
134a	–	–	0.96	1.04
407C	0.88	0.92	0.96	1.04

TABLE 9 – FITTING LOSSES IN EQUIVALENT FEET OF PIPE (SCREWED, WELDED, FLANGED AND BRAZED CONNECTIONS)

Nominal Pipe or Tube Size, In.	Smooth Bend Elbows							Smooth Bend Tees		
	90° Std.[1]	90° Long Radius[2]	90° Street[3]	45° Std.[4]	45° Std.[4]	180° Std.[5]	Flow Through Branch	Straight-Through Flow		
								No Reduction	Reduced 1/4	Reduced 1/2
3/8	1.4	0.9	2.3	0.7	1.1	2.3	2.7	0.9	1.2	1.4
1/2	1.6	1.0	2.5	0.8	1.3	2.6	3.0	1.0	1.4	1.6
3/4	2.0	1.4	3.2	0.9	1.6	3.2	4.0	1.4	1.9	2.0
1	2.6	1.7	4.1	1.3	2.1	4.1	5.0	1.7	2.2	2.6
1-1/4	3.3	2.3	5.5	1.7	3.0	5.5	7.0	2.3	3.1	3.3
1-1/2	4.0	2.6	6.3	2.1	3.4	6.3	8.0	2.6	3.7	4.0
2	5.0	3.3	8.2	2.6	4.5	8.2	10.0	3.3	4.7	5.0
2-1/2	6.0	4.1	10.0	3.2	5.2	10.0	12.0	4.1	5.6	6.0
3	7.5	5.0	12.0	4.0	6.4	12.0	15.0	5.0	7.0	7.5
3-1/2	9.0	5.9	8.2	4.7	7.3	16.0	18.0	5.9	8.0	9.0
4	10.0	6.7	10.0	5.2	8.5	17.0	21.0	6.7	9.0	10.0
5	13.0	8.2	12.0	6.5	11.0	21.0	26.0	8.2	12.0	13.0
6	15.0	10.0	15.0	7.9	13.0	26.0	30.0	10.0	14.0	15.0

LD07400

TABLE 10 – SPECIAL FITTING LOSSES IN EQUIVALENT FEET OF PIPE (ASHRAE)

Nominal Pipe or Tube Size, In.	Sudden Enlargement, d/D			Sudden Contraction, d/D			Sharp Edge		Pipe Projection	
	1/4	1/2	3/4	1/4	1/2	3/4	Entrance	Exit	Entrance	Exit
3/8	1.4	0.8	0.3	0.7	0.5	0.2	1.5	0.8	1.5	1.1
1/2	1.6	1.1	0.4	0.9	0.7	0.4	1.6	1.0	1.6	1.6
3/4	2.5	1.5	0.5	1.2	1.0	0.5	2.6	1.4	2.6	2.2
1	3.2	2.0	0.7	1.9	1.2	0.7	3.7	1.9	3.7	2.7
1-1/4	4.7	3.0	1.0	2.3	1.6	1.0	5.3	2.6	5.3	4.2
1-1/2	6.6	3.6	1.2	2.8	2.2	1.2	6.6	3.3	6.6	5.0
2	8.0	4.6	1.6	4.0	3.0	1.6	9.0	4.4	9.0	6.6
2-1/2	10.0	6.1	2.0	5.0	3.6	2.0	12.0	5.6	12.0	8.7
3	13.0	8.0	2.6	6.6	4.9	2.6	14.0	7.2	14.0	11.0
3-1/2	15.0	9.2	3.0	7.7	6.0	3.0	17.0	8.6	17.0	13.0
4	17.0	11.0	3.6	9.0	6.6	3.6	20.0	10.0	20.0	15.0
5	24.0	15.0	6.0	12.0	9.0	5.0	27.0	14.0	27.0	20.0
6	29.0	22.0	8.0	15.0	11.0	8.0	33.0	19.0	33.0	25.0

LD07401

TABLE 11 – VALVE LOSSES IN EQUIVALENT FEET OF PIPE (ASHRAE)

Nominal Pipe or Tube Size, In.	Globe[a]	60° Wye	45° Wye	Angle[a]	Gate[b]	Swing Check[c]	Lift Check
3/8	17	8	6	6	0.6	5	Globe and vertical lift same as globe valve[d]
1/2	18	9	7	7	0.7	6	
3/4	22	11	9	9	0.9	8	
1	29	15	12	12	1.0	10	
1-1/4	38	20	15	15	1.5	14	
1-1/2	43	24	18	18	1.8	16	
2	55	30	24	24	2.3	20	
2-1/2	69	35	29	29	2.8	25	
3	84	43	35	35	3.2	30	Angle lift same as angle valve
3-1/2	100	50	41	41	4.0	35	
4	12	58	47	47	4.5	40	
5	140	71	58	58	6.0	50	
6	170	88	70	70	7.0	60	

NOTE:

Losses are for valves in fully open position and with screwed, welded, flanged, or flared connections.

[a] These losses do not apply to valves with needlepoint seats.

[b] Regular and short pattern plug cock valves, when fully open, have the same loss as gate valve.

[c] Losses also apply to the in-line, ball-type check valve.

[d] For Y pattern globe lift check valve with seat approximately equal to the nominal pipe diameter, use values of 60° Wye valves for loss.

TABLE 12 – REFRIGERANT CHARGE IN POUNDS PER 100 FEET OF SUCTION LINE

Line Size, O.D.	Saturated Suction Temperature, °F								
	R-22			R-134a			R-407C		
	-40	0	40	0	20	40	-40	0	40
1/2	0.03	0.07	0.15	0.05	0.07	0.11	0.02	0.06	0.14
5/8	0.05	0.12	0.25	0.08	0.12	0.17	0.04	0.10	0.22
3/4	0.07	0.18	0.37	0.11	0.17	0.26	0.06	0.15	0.33
7/8	0.10	0.24	0.51	0.16	0.24	0.36	0.08	0.21	0.46
1-1/8	0.17	0.42	0.87	0.27	0.41	0.61	0.14	0.36	0.79
1-3/8	0.26	0.64	1.33	0.41	0.62	0.92	0.21	0.55	1.20
1-5/8	0.37	0.90	1.88	0.58	0.88	1.31	0.30	0.78	1.70
2-1/8	0.65	1.57	3.27	1.00	1.54	2.27	0.53	1.35	2.95
2-5/8	1.01	2.42	5.04	1.55	2.37	3.50	0.81	2.09	4.55
3-1/8	1.44	3.45	7.19	2.21	3.38	5.00	1.16	2.98	6.50
3-5/8	1.94	4.66	9.73	2.99	4.57	6.77	1.57	4.03	8.79
4-1/8	2.52	6.06	12.65	3.88	5.94	8.79	2.04	5.24	11.42
5-1/8	3.93	9.45	19.71	6.05	9.26	13.70	3.17	8.17	17.80
6-1/8	5.65	13.58	28.34	8.69	13.31	19.70	4.56	11.74	25.59

TABLE 13 – REFRIGERANT CHARGE IN POUNDS PER 100 FEET OF DISCHARGE LINE

Line Size, O.D.	Saturated Suction Temperature, °F								
	R-22			R-134a			R-407C		
	-40	0	40	0	20	40	-40	0	40
1/2	0.22	0.33	0.48	0.17	0.27	0.40	0.21	0.33	0.50
5/8	0.35	0.53	0.77	0.27	0.43	0.65	0.34	0.53	0.80
3/4	0.53	0.79	1.15	0.41	0.64	0.97	0.50	0.78	1.19
7/8	0.73	1.10	1.60	0.57	0.89	1.34	0.70	1.09	1.65
1-1/8	1.25	1.87	2.72	0.97	1.52	2.29	1.19	1.86	2.81
1-3/8	1.90	2.85	4.14	1.48	2.31	3.49	1.81	2.83	.28
1-5/8	2.69	4.04	5.86	2.09	3.28	4.94	2.57	4.01	6.06
2-1/8	4.67	7.02	10.20	3.63	5.70	8.59	4.47	6.97	10.55
2-5/8	7.20	10.83	15.72	5.60	8.79	13.25	6.89	10.74	16.27
3-1/8	10.28	15.45	22.45	8.00	12.54	18.92	9.83	15.34	23.22
3-5/8	13.91	20.90	30.36	10.82	16.96	25.59	13.30	20.74	31.40
4-1/8	18.08	27.17	39.46	14.06	22.05	33.26	17.29	26.96	40.82
5-1/8	28.17	42.34	61.50	21.91	34.37	51.84	26.94	42.02	63.62
6-1/8	40.50	60.87	88.41	31.50	49.40	74.52	38.73	60.41	91.46

Discharge superheat is 105°F for R-22 and R-407C, and 85°F for R-134a.

TABLE 14 – REFRIGERANT CHARGE IN POUNDS PER 100 FEET OF LIQUID LINE

Line Size, O.D.	Saturated Suction Temperature, °F								
	R-22			R-134a			R-407C		
	-40	0	40	0	20	40	-40	0	40
1/2	7.47	7.03	6.50	7.56	7.13	6.64	7.11	6.64	6.11
5/8	12.01	11.29	10.44	12.15	11.46	10.66	1.42	10.67	9.81
3/4	17.93	16.86	15.59	18.14	17.11	15.92	17.05	15.93	14.65
7/8	24.91	23.42	21.66	25.20	23.78	22.11	23.69	22.14	20.35
1-1/8	42.47	39.93	36.93	42.96	40.54	37.70	40.39	37.74	34.70
1-3/8	64.69	60.82	56.24	65.44	61.74	57.42	61.52	57.49	52.85
1-5/8	91.56	86.09	79.61	92.62	87.39	81.28	87.08	81.37	74.81
2-1/8	159.30	149.80	138.50	161.10	152.00	141.40	151.50	141.60	130.10
2-5/8	245.60	231.00	213.60	248.50	234.40	218.00	233.60	218.30	200.70
3-1/8	350.60	329.70	304.80	354.70	334.60	311.20	333.40	311.60	286.40
3-5/8	474.20	445.90	412.30	479.70	452.60	420.90	451.00	421.40	387.40
4-1/8	616.40	579.60	536.00	623.60	588.40	547.20	586.20	547.80	503.60
5-1/8	960.70	903.30	835.30	971.80	917.00	852.80	913.70	853.80	784.90
6-1/8	1381.00	1299.00	1201.00	1397.00	1318.00	1226.00	1313.00	1227.00	1128.00

Discharge superheat is 105°F for R-22 and R-407C, and 85°F for R-134a.

P.O. Box 1592, York, Pennsylvania USA 17405-1592
Tele. 800-861-1001
www.york.com
Subject to change without notice. Printed in USA
Copyright © by York International Corporation 2001
ALL RIGHTS RESERVED
Form 050.40-ES2 (1201)
New Release

START UP REQUEST FORM

Johnson Controls

CONTRACTORS INSTALLATION CHECKLIST AND REQUEST FOR START-UP of Air-Cooled Equipment

TO:_____
_____
_____
PHONE NO.:_____
FAX NO.: _____

JOB NAME: _____
LOCATION:_____
YORK CONTRACT #:_____
YORK PHONE NO.: 513-605-6045
YORK FAX NO.: 513-489-7516

The following work (as checked below) is in progress and will be completed by:_____

Date that you wish for a York Certified Technician to begin the start-up process_____

THE FOLLOWING WORK MUST BE COMPLETED IN ACCORDANCE WITH INSTALLATION INSTRUCTIONS AND TWO (2) WEEKS NOTICE IS REQUIRED FOR SCHEDULING OF START-UP.

A-WATER PIPING:

- ☐ Chilled water piping installed between cooler, pumps and cooling coils
- ☐ All water piping checked for strain. Piping should not spring when connections are broken at unit
- ☐ Water piping leak tested and flushed. Water strainers cleaned after flushing. Piping systems filled with water and trapped air vented
- ☐ Chilled water flow available to meet unit design requirements
- ☐ Cooling load available
- ☐ **Pressure taps available on chiller piping (on chiller side of butterfly valves) for technician to verify design flows**
- ☐ Flow switch set at minimum flow (to be confirmed by York Service technician)

C-ELECTRICAL WIRING:

- ☐ Power wiring completed to control panel
- ☐ Flow switches piped and wired per York wiring diagram
- ☐ Power available

D-TESTING, DEHYDRATION AND CHARGING FOR SPLIT SYSTEMS (UNDER YORK SUPERVISION IF SHIPPED LESS REFRIGERANT OR DISMANTLED):

- ☐ Unit and piping pressure tested by contractor
- ☐ Unit must be dehydrated to 2000 microns and sit overnight. Vacuum confirmation will be done by York Service technician.
- ☐ Refrigerant available by contractor near unit

DATE:_____ CUSTOMER SIGNATURE:_____

Customer Print Name_____

WARRANTY

OPTIONAL 30 MONTHS (2 YEAR) PARTS & LABOR WARRANTY
FOR THE ENTIRE UNIT
YORK INTERNATIONAL CORPORATION
ENGINEERED SYSTEMS - YORK AMERICAS

PRODUCT TYPE: AIR COOLED
YORK CONTRACT NO.:
UNIT MODEL NUMBER: YLAA0101YE17
UNIT SERIAL NUMBER:
UNIT TAG ID: YLAACA
UNIT LOCATION:

COMPRESSOR SERIAL NUMBER(S):

PROJECT NAME: OAK HILLS - CHILLER
INSTALLATION ADDRESS:

Shipping Date

The term of this agreement is 30 months, commencing _____ and expires _____.

LIMITED WARRANTY

WHEN PROPERLY ENDORSED, THIS PROTECTION PLAN BETWEEN YORK INTERNATIONAL CORPORATION (YORK) AND CUSTOMER, WARRANTS, TO THE CUSTOMER NAMED HEREIN, PARTS AND LABOR FOR THE ENTIRE UNIT. IT DOES NOT COVER REFRIGERANT COST, FREIGHT CHARGES, *** UNASSIGNED ***OR ANY OTHER COSTS.

THIS WARRANTY EXCLUDES IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND WE DO NOT ASSUME, OR AUTHORIZE ANY OTHER PERSON TO ASSUME OTHER WARRANTIES FOR US. THIS WARRANTY IS OFFERED AS AN EXTENSION TO THE STANDARD LIMITED WARRANTY (FORM 50.05-NM2) AND IS SUBJECT TO THE SAME LIMITATIONS AND EXCLUSIONS, EXCEPT WHERE NOTED.

THIS PROTECTION PLAN DOES NOT COVER FAILURE OR DAMAGE RESULTING FROM FIRE, FLOOD, ABUSE, OR ACT OF GOD. ALSO EXCLUDED ARE DAMAGES OR FAILURES CAUSED BY INSTALLATION, OPERATION, OR MAINTENANCE CONTRARY TO YORK RECOMMENDATIONS, OR THOSE OF THE MANUFACTURER IF OTHER THAN YORK. IN NO EVENT SHALL YORK BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, OR INDIRECT DAMAGE, LOSS, OR INJURY. WARRANTY FOR EXCHANGE OR PARTS PROCUREMENT SERVICE SHALL BE AVAILABLE THROUGH THE SERVICER LISTED HEREIN DURING NORMAL WORKING HOURS.

DISTRICT SERVICE OFFICE: _____

OFFERED BY: _____ (York Selling Representative Print/Sign) _____ (Date)

APPROVED BY: _____ (York Area Service Manager Print/Sign) _____ (Date)

ACCEPTED BY: _____ (Customer Signature) _____ (Date)

(Manufacturer's Use Only)

AUTHORIZED BY: Robert D. Kalczynski (Manager, Warranty Administration) 05/21/2010 AT 15:20 (Date)

Product Code Ref: 8223

OPTIONAL 66 MONTHS (5 YEAR) PARTS ONLY WARRANTY
FOR THE COMPRESSORS
YORK INTERNATIONAL CORPORATION
ENGINEERED SYSTEMS - YORK AMERICAS

PRODUCT TYPE: AIR COOLED
YORK CONTRACT NO.:
UNIT MODEL NUMBER: YLAA0101YE17
UNIT SERIAL NUMBER:
UNIT TAG ID: YLAACA
UNIT LOCATION:

COMPRESSOR SERIAL NUMBER(S):

PROJECT NAME: OAK HILLS - CHILLER
INSTALLATION ADDRESS:

Shipping Date

The term of this agreement is 66 months, commencing _____ and expires _____.

LIMITED WARRANTY

WHEN PROPERLY ENDORSED, THIS PROTECTION PLAN BETWEEN YORK INTERNATIONAL CORPORATION (YORK) AND CUSTOMER, WARRANTS, TO THE CUSTOMER NAMED HEREIN, PARTS ONLY FOR THE COMPRESSORS. IT DOES NOT COVER REFRIGERANT COST, FREIGHT CHARGES, LABOR COST, OR ANY OTHER COSTS.

THIS WARRANTY EXCLUDES IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND WE DO NOT ASSUME, OR AUTHORIZE ANY OTHER PERSON TO ASSUME OTHER WARRANTIES FOR US. THIS WARRANTY IS OFFERED AS AN EXTENSION TO THE STANDARD LIMITED WARRANTY (FORM 50.05-NM2) AND IS SUBJECT TO THE SAME LIMITATIONS AND EXCLUSIONS, EXCEPT WHERE NOTED.

THIS PROTECTION PLAN DOES NOT COVER FAILURE OR DAMAGE RESULTING FROM FIRE, FLOOD, ABUSE, OR ACT OF GOD. ALSO EXCLUDED ARE DAMAGES OR FAILURES CAUSED BY INSTALLATION, OPERATION, OR MAINTENANCE CONTRARY TO YORK RECOMMENDATIONS, OR THOSE OF THE MANUFACTURER IF OTHER THAN YORK. IN NO EVENT SHALL YORK BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, OR INDIRECT DAMAGE, LOSS, OR INJURY. WARRANTY FOR EXCHANGE OR PARTS PROCUREMENT SERVICE SHALL BE AVAILABLE THROUGH THE SERVICER LISTED HEREIN DURING NORMAL WORKING HOURS.

DISTRICT SERVICE OFFICE: _____

OFFERED BY: _____ (York Selling Representative Print/Sign) _____ (Date)

APPROVED BY: _____ (York Area Service Manager Print/Sign) _____ (Date)

ACCEPTED BY: _____ (Customer Signature) _____ (Date)

(Manufacturer's Use Only)

AUTHORIZED BY: Robert D. Kalczynski (Manager, Warranty Administration) 05/21/2010 AT 15:20 (Date)

Product Code Ref: 8520