

Best Practices for DX Piping

Greg Drensky – Jacco & Associates

Established 1968

Hudson, Ohio
Columbus, Ohio
Toledo, Ohio



Focused on the Engineered Environment

Systems Knowledgeable
 HVAC Systems
 Service & Maintenance
 Parts



Purpose Statement

The purpose of our Company is to solve our customers problems, in the most economical way, at all times optimizing the owning experience.



Operations
 Brenda Homjak
 Mike Spangler
 Chad Russell
 Mike Mueller
 Hana Lee

Contractor Owning Experience
 Dan Duignan
 Rick Baker

Engineering Owning Experience
 Greg Drensky
 Jerry Cohen

Owning Experience
 Beth Plazak
 Jeff Watson

30 Minute Pledge
Design
Questions
Problems
Answers



Upcoming Seminars & Events:

Aaon Split System Trailer

□July 11th – Birthday Party at Alley Cat (5-7)

```
□August 15<sup>th</sup> – DBA Akron (5-7)
```

September 12th: Applying Adiabatic and Steam Humidification Systems

December 12th: Applying Low Dewpoint OA Systems Using DX and Desiccant Technology

Why Line Sizing Matters?

- Refrigerant Vapor, Liquid, Reheat Line Guidelines
- AAON Line Sizing Programs
 - Split System Line Sizing in ECat
 - AAON Engineering Toolkit EES 307 AAON Refrigerant Line Sizer
- Different Scenarios & Applications
 - Air Cooled w/ Hot Gas Reheat CU below AHU (suction down)
 - Air Cooled w/ Hot Gas Reheat CU above AHU (suction up)
 - Air Cooled w/ Tandem Compressors CU above AHU (suction up)
 - Heat Pump w/ On/Off Compressors CU below AHU (suction down & up)









Why Line Sizing Matters?



□ SAVE THE COMPRESSORS!!

- Design for Proper Liquid Refrigerant Control
- Design for <u>Proper Oil Management</u>
 - Return oil to compressor
 - Ensure that only liquid refrigerant enters the expansion device.
- Minimize system capacity loss



Why Line Sizing Matters?



What is my Design Priority???

- Design for <u>Maximum Capacity</u> (saves operating costs)
- Design for <u>Minimum Cost</u> (saves installation costs)
- Design for <u>Minimum Power Consumption (low pressure drop)</u>
- Design for Minimum Refrigerant Charge (smaller liquid lines)

Line Sizing Considerations



- Equipment Location Affects Refrigerant Line Sizing
 - Total length of lines, number of elbows, & accessories
 - Vertical lift
 - Orientation of equipment



Line Sizing Considerations



System Type is IMPORTANT!

- Cooling Only?
- Cooling with MHGR?
- Single Circuit, Dual Circuit, or 4 Circuits?
- On/Off, Digital, VFD, or Tandem Compressors?
- Heat Pump?

Heat Pump with MHGR?



Tandem Compressors

Heat Pump Lines





General Piping Requirements

- Use clean Type L copper tubing (ACR)
 - Copper-to-copper joints: BCuP-6 without flux
 - Copper-to-steel (or brass) joints: BAg-28, non-acid flux
- Properly support piping to account for expansion, vibration, and weight
- Avoid installing piping underground
 - Dirty installation and hard to leak test
 - If required: insulate separately, waterproof and protect with hard casing like PVC.
- Test entire refrigerant circuits for leaks

General Line Sizing Guidelines

Equivalent Line Length (ELL)

- ELL = vertical length + horizontal length + equivalent length of components (valves, elbows, etc.)
- *Maximum allowable suction line temperature loss = 6°F
- Vertical Rise
 - *Maximum allowable = 70ft
- Use Air Conditioning and Refrigeration (ACR) Tubing and Long Radius Fittings





Short Radius Elbow

*Additional length and vertical rise may be allowed upon AAON review and approval.

Line Sizing Procedure



- 1) Determine total length of piping
- 2) Calculate refrigerant velocity at maximum & minimum capacities
- 3) Select largest pipe diameter that results in acceptable velocity at both maximum & minimum capacities
- 4) Calculate total equivalent length of straight pipe & fittings
- □ 5) Determine pressure drop due to pipe & fittings
- 6) Add pressure drop due to accessories

Suction Line Sizing



- Ensure adequate velocity to return oil to compressor at all steps of unloading.
- Avoid excessive noise
- Minimize system capacity and efficiency loss

Suction Line Guidelines Air-Cooled Only



CU below AHU (Suction Down)

- Fluid Velocity < 4000 fpm</p>
 - Fluid Velocity > minimum velocity for oil return
- Temperature Loss = up to 6°F
- Insulation = Recommend 1" insulation

CU above AHU (Suction Up)

- Fluid Velocity < 4000 fpm</p>
 - On/Off Compressor > minimum velocity for oil return
 - Digital Compressor > 1500 fpm
 - Tandem Compressor > minimum velocity for oil return with one compressor
 - Digital Tandem Compressor > 1500 fpm with one compressor or 3000 fpm for both
- Temperature Loss = up to 6°F
- Insulation = Recommend 1" insulation
- Oil Return = Suction line traps for every 20ft of vertical rise

Suction Line Guidelines Air-Cooled Only







- If compressor only cycles on & off only maximum system capacity need to be considered.
- If variable speed unloading or manifolded compressors are used, minimum & maximum system capacities need to be considered.
- If more than 1 independent refrigeration circuit, each circuit requires its own set of refrigerant lines; capacity of each circuit must be considered separately.

Minimum Velocity for Oil Return



 Table 3 - Minimum Velocity & Tons for R-410A Oil Return

 This table does not apply to digital scroll compressors.

Line	Minimur	n Velocity	Minimum Tons for Oil		
OD	for Oil Re	eturn (fpm)	Return (tons)		
(in)	Suction	Discharge	Suction	Discharge	
(111)	Line*	Line**	Line*	Line**	
3/8	253	223	0.09	0.15	
1/2	320	261	0.23	0.33	
5/8	377	292	0.44	0.60	
3/4	427	317	0.72	0.95	
7/8	476	341	1.11	1.41	
1-1/8	569	384	2.26	2.72	
1-3/8	646	419	3.79	4.36	
1-5/8	723	451	6.01	6.66	
2-1/8	873	512	13.04	13.58	
2-5/8	735	559	16.52	22.29	
3-1/8	830	606	27.29	35.35	
3-5/8	914	646	40.62	50.95	
4-1/8	993	682	57.38	69.97	
5-1/8	1142	748	102.80	119.6	

These are absolute minimum velocities for oil return. Do not design lines at the minimum velocities due to the many possible operating conditions.





A. The P-trap is necessary on any vapor line where refrigerant is traveling up (2) Short Redius 45"



B. This S-shaped trap is necessary Every 20 ft suction line up

Suction Line Other Considerations



- Suction line traps are not required by ASHRAE
 - Oil droplets are moved inside a pipe by the force of mass flow, not by turbulence
 - AAON still requires traps if over 20' in height
- Pitch horizontal sections to drain toward evaporator
- Insulate entire suction line
 - Prevents condensation
 - Minimizes loss of capacity due to heat gain
- Install suction-line filter close to compressor
 - Manual shutoff valves allow isolation for replacement
- Install access ports to measure suction pressure and superheat

Discharge Line Sizing



Design of Discharge line is less critical than Suction line

- Refrigerant vapor is at a higher temperature
- Allows oil to be carried more easily

- Ensure adequate velocity to return oil to compressor at all steps of unloading.
- Avoid excessive noise
- Minimize efficiency loss

Discharge Line Guidelines Heat Pumps & Remote Condenser

CU above AHU (Discharge Down)

- Fluid Velocity < 3500 fpm</p>
 - Fluid Velocity > minimum velocity for oil return
- Temperature Loss = up to 6°F
- Insulation = Recommend 1" insulation

CU below AHU (Discharge Up)

- Fluid Velocity < 3500 fpm</p>
 - On/Off Compressor > minimum velocity for oil return
 - Digital Compressor > 900 fpm
 - Tandem Compressor > minimum velocity for oil return with one compressor
 - Digital Tandem Compressor > 900 fpm with one comp. or 1800 fpm with both
- Temperature Loss = up to 6°F
- Insulation = Recommend 1" insulation
- Oil Return = Suction line traps for every 12ft of vertical rise

Discharge Line Trap Guideline



A. The P-trap is necessary on any vapor line where refrigerant is traveling up



- B. This S-shaped trap is necessary Every 12 ft discharge line up
- C. This inverted trap is necessary to prevent liquid refrigerant from entering the compressor

Liquid Line Guidelines



Liquid Line

- Fluid Velocity < 300 fpm if a liquid line solenoid valve is field installed
- Temp loss = 8°F (w/o additional subcooling)
- Insulation = normally not required but recommended on heat pump units



Liquid Line Guidelines



Charge weight of R-410A in 100ft of liquid line
 @ 110F liquid temperature

Line Size (OD)	Ibs of R-410A
3/8"	3.2
1/2"	6.2
5/8"	10.0
3/4"	14.5
7/8"	20.1
1 1/8"	34.3

Reheat Line Guidelines



Reheat Line

- Must be sized for 100% mass flow
- Insulation = Recommend 1" minimum
- Purge circuit required for oil return

Hot Gas Bypass

- Size for a maximum of 67% mass flow
- Purge circuit required for oil return



Reheat Line Guidelines



Purge Circuit

- Required on hot gas reheat or hot gas bypass lines
- Consists of a drain leg & oil return line



Purge Circuit is to be field furnished & installed at the lowest point of the line set.

With this installation, oil drains into the drain leg, where the pressure difference forces the oil through the oil return line into the suction line.

Additional Components



- Suction Line Accumulator
 - Prevent

 compressor
 damage from
 sudden surge of
 liquid refrigerant
 (compressor
 floodback)
 - AAON installs accumulators on all heat pump units



- Liquid Line
 Receiver
 - Stores liquid refrigerant after it leaves the condenser
 - AAON installs receivers on
 - Units with Reheat
 - Units with Heat Pump
 - Units with
 Floodback
 Condenser Low
 Ambient Control



AAON ECat Split System Selection Software

H3/V3 Series air handling units paired with CF/CB Series

condensing units



Split System	Configurator				
H3 Units V3 Units V3 A	V3-C			CF-013	CB Units CF Units CF-004
V3-B	Air Handling Unit Condensing Unit	V3-CRB-2-0-1620 CFA-013-B-0-2-D	C-000:ACDA-PG0-000-0A0-00A C00K:0-A0-L0-00-000-D-A000-	00w0-00-000000 0000000-0A0000	CF-005
V3-C	Construction Cond System Type Heat Pump Modulating Hot Hot Gas Bypass	itions Line Sizing Gas Reheat			CF-006
V3-E	Air Handling Unit Opt Tagging: Split AHU # 2 Voltage: 230V/30/60Hz Coil Sizing: 6 Row Coil	ions 	Condensing Unit Options Tagging: Split CU # 2 Voltage: 230V/30/60Hz Compressor Type: Variable Capacity Compres	v sor v	CF-009 CF-011 CF-011 CF-013
	Coil Fins Per Inch: 12 fpi Wattmaster Control Wattmaster MHGF	• •	Staging: 1 Variable Refrig System + System Quantity:	1 On/Off	CF-015 CF-016
			Preview Save	Cancel	

Split System Configurator Screen



AAON ECat Split System Selection Software

Advanced Selection for V3-C with CFA-013 dual circuit with digital compressor

Split System Configurator	- • ×	Basic Advanced
Split System Configurator H3 Units V3 Units V3A Air Handling Unit V3-C Condensing Unit V3-C Condensing Unit CF-013 Air Handling Unit V3-C Condensing Unit CF-013-002-0000-00-000000-0A0000 V3-B Constantion Constantion Constantion Line Sizing Basic Advanced Juction Liquid	CF-004 CF-005 CF-006 CF-006	Basic Advanced Reheat Suction Liquid Image: Suction Elbow Quantity: 10 Suction Line Flow: Down Line Length: 75 Vertical Lift: 20
V3-D Elbow Quantity: 10 Suction Line Flow: Down ▼ Line Length: 75 75 V3-E V3-E V3-E Suction Line Selections ▼ 10 Inc. Inc. <td>CF-007</td> <td>Advanced Selection</td>	CF-007	Advanced Selection
	CF-015	Suction Line Selections
Calculate Defaults	CF-016	Pipe Equiv. Temp. Vel Min. Tons Qty. of OD Length Loss(F) (fpm) For Oil Return Req. Traps
Preview Save Cancer		0.75 87 5.69 2940 0.7 0
		▶ 1.125 32 U.78 1241 2.27 U

Line Sizing Options

Line Specific Characteristics



AAON ECat Split System Selection Software Outputs of selection

Cooling Section		
	Gross	Net
Total Capacity:	<u>152.75</u>	149.88 MBH
Sensible Capacity:	105.80	102.93 MBH
Latent Capacity:	$46.95 \ MBH$	
Mixed Air Temp:	95.00 °F DB	75.00 °F WB
Entering Air Temp:	95.00 °F DB	75.00 °F WB
Lv Air Temp (Coil):	58.48 °F DB	58.28 °F WB
Lv Air Temp (Unit)	$59.41~^\circ\!FDB$	58.63 °F WB
Evap Suction Temp:	47.74 °F	
Supply Air Fan:	1 x 450AQ @ 0.97	7 BHP
SA Fan RPM / Width:	1283 / 8.030"	
Evaporator Coil:	7.1 ft² / 6 Rows /	/ 12 FPI
Evaporator Face Velocity:	393.8 fpm	

Split System Rating

			Sucti	ion Line Se	lections	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps
	0.75	87	5.69	2940	0.7	0
	0.875	89	2.66	2117	1.09	0
D	1.125	92	0.78	1241	2.27	0

	Suction Line Loss (F)	Resulting Gross Capacity (MBH)	% Capacity Loss from 0.50
	0.50	153.2	0
/	70.78	152.8	0.3%
	2.01	150.7	1.6%
	4.01	147.4	3.8%
	6.00	144.1	5.9%



AAON ECat Split System Selection Software Outputs of selection

Reheat Line Data							
Elbow Qty:	10		Line Length:	75'			
					<u> </u>		
Pipe	Equiv.	Temp.	Velocity	Min Tons	Qty. of		
OD	Length	Loss (°F)	(fpm)	For Oil Return	Req. Traps		
0.625"	94'	3.32	1843	0.63	3		
T 11		Suction	Line Data				
Elbow Qty:	10		Flow Direction of St	uction Line: Down			
Pipe	Equiv.	Temp.	Velocity	Min Tons	Qty. of		
OD	Length	Loss (°F)	(fpm)	For Oil Return	Req. Traps		
1.125"	92'	0.78	1241	2.27	0		
Elbow Qty:	10	Liquid I	Line Data Line Length: Vertical Lift:	75' 20'			
Pine	Foniy	Temp	Velocity	Min Subcooling			
OD	Length	Loss (°F)	(frm)	For Vertical Lift			
0.5"	S4'	1.93	264	3.24			
0.0	04	1.20	204	0.24			

Split System Refrigerant Line Selections

AAON Engineering Toolkit



AAON Engineering Toolkit – 307 Available through ECat interface

101 AAON SENSIBLE HEAT Find LDB given Load

102 AAON SENSIBLE HEAT Find Q given EDB and LDB

100 AAON Toolki

103 AAON Mixing ACFM 104 AAON MIXING SCFM

411 AAON Useful Links

500 AAON POOL CALCULATOR VERSION 15c Toolkit Version

AAON

To Access The Toolkit Click "AAON Toolki

Psychrometrics

100 AAON Toolkit 101 AAON SENSIBLE HEAT Find LDB given Load 102 AAON SENSIBLE HEAT Find Q given EDB and LDB 103 AAON Mixing ACFM 104 AAON Mixing SCFM 105 AAON COOLING COIL 106 AAON COOLING COIL with ACFM as Input 107 AAON HUMIDIFER 108 AAON MADB CALCULATOR to Extract Fan Heat 109 AAON RL HEATWHEEL Rev 4 110 AAON RM HEATWHEEL REV 4 112 AAON Heat Wheel Defrost 114 AAON Psychrometric Properties 115 AAON Actual CFM to Std CFM Calculator System Psychrometrics 201 AAON DRAW THRU 202 AAON Reheat System RMDB -Qreheat Input 203 AAON Reheat System RMDB-RMRH Input 204 AAON 100% OA Draw Thru with Reheat 205 AAON Blow Thru System with SADB and RMDB as Inp 209 AAON Retu 206 AAON Mixed Air Bypass System 210 AAON U 207 AAON Mixed At Bypass Reheat System 208 AAON Return Air Bypass Revision 301 AAON 209 AAON Return Air Bypass with Reheat 302 A 210 AAON Under Floor System 301 AAON DUCT FRICTION CALCULATOR 302 AAON DUCT FRICTION CALCULATOR MFR as input 303 AAON Vacuum Piping 304 AAON WATER PRESSURE DROP CALCULATOR 304a AAON WATER PRESSURE DROP CALCULATOR 305 AAON WATER-Glycol PRESSURE DROP CALCULA 306 AAON STEAM PRESSURE DROP 307 AAON Refrigerant Line Sizer Rev 2 307a AAON Refrigerant Line Sizer For HGB Sizing Rev 4 308 AAON Property calculator at saturation 309 AAON Glycol Properties Calculator 310 AAON Primary and Secondary Loop Calculator 310b AAON Primary and Secondary Loop Calculator with C Miscellaneous 401 AAON Langelier Saturation Index 402 AAON Power Factor Correction 403 AAON Sump Level 404 AAON Comer Weight Calculator 405 AAON Plenum Temperature Calculation 406a AAON RM-RN-RL-HBVB Fan Analysis Program Input 406b AAON RM-RN-RL-HBVB Fan Analysis Program Input 407 AAON RL-LL condenser Sound Calculator

408 AAON Barrier Sound Attenuation Wall

500 AAON POOL CALCULATOR VERSION 15c Toolkit Ve

409 AAON Refrigerant Cycle, EES

409a AAON Refrigeration Cycle R2 410 AAON Subcooling - Cooling Coil Rev 8

411 AAON UsefulLinks

105 AAON COOLING COIL 106 AAON COOLING COIL with ACFM as input 107 AAON HUMIDIFER 108 AAON MADB CALCULATOR 109 AAON RL HEATWHEEL Rev 4 110 AAON RM HEATWHEEL REV 4 112 AAON Heat Wheel Defrost 114 AAON Psychrometric Properties 115 AAON Actual CFM to Std CFM Calculato 201 AAON DRAW THRU 202 AAON Reheat System RMDB - Orehe 203 AAON Reheat System RMDB-RMP INput 204 AAON 100% OA Draw Thru w Reheat SADB and RMDB as Input 205 AAON Blow Thru System 206 AAON Mixed Air Byna 207 AAON Mixed Air B s Reheat System 208 AAON Return A ir Bypass with Reheat r Floor System JUCT FRICTION CALCULATOR N DUCT FRICTION CALCULATOR MFR as input AON Vacuum Piping 4 AAON WATER PRESSURE DROP CALCULATOR 304a AAON WATER PRESSURE DROP CALCULATOR with (gpm, dia, PD as input 305 AAON WATER-Glycol PRESSURE DROP CALCULATOR 306 AAON STEAM PRESSURE DROP 307 AAON Refrigerant Line Sizer For Discharge and HGB Sizing Rev 7 208 AAON Property Calculato 309 AAON Glycol Properties Calculator 310 AAON Primary and Secondary Loop Calculator 310b AAON Primary and Secondary Loop Calculator with Control Valve 401 AAON Langelier Saturation Index 402 AAON Power Factor Correction 403 AAON Sump Level 404 AAON Corner Weight Calculator 405 AAON Plenum Temperature Calculation 406a AAON RM_RN_RL_HBVB Fan Analysis Program Inputs(FanModel CFM,SP,BW) Outputs (RPMBHPEff) 406b AAON RM_RN_RL_HBVB Fan Analysis Program Inputs(FanModel CFM,SP,RPM) Outputs (RPMBHPEff) 407 AAON RI -LL Condenser Sound Calculato 408 AAON Barrier Sound Attenuation Wall 409 AAON Refrigerant Cycle 409a AAON Refrigeration Cycle R2 410 AAON Subcooling - COOLING COIL Rev 8

307 AAON Refrigerant Line Sizer For Discharge and HGB Sizing Rev 7

AAON Engineering Toolkit

Satu

Cond

Min Min^{*}

vel_{fo} lbs, Pip

PipeRefrigerantLiquid, = 4.446 [lbs]



AAON Engineering Toolkit – 307

Inputs

- Refrigerant type
- System capacity
- # of elbows
- Line lengths
- Liquid line lift
- Compressor type
- Choose
 - Discharge for Hot Gas Reheat or Heat Pump Discharge line
 - HGB for Hot Gas Bypass line
- Change line size to see effects on the system

Refri	gerant Piping Calc	ulator	AAON Inc.
Saturated Condensing Temperature	Saturated Suction Temperature	Refrigerant\$= R410A	2424 South Yukon Ave Tulsa, Oklahoma 74107
SCT = 120.0 [F] SCP = 418.3 [psig]	SST = 45.00 [F] SSP = 130.11 [psig]	m _{ref.s} = 0.246 [lb/sec]	Ph: 918 583 2266 Fx: 918 583 6094
Condenser Subcooling	Suction Super heat	m _{ref,per,min,s} = 14.74 [lb/min]	
Subcool = 10.00 [F]	SH = 10.00 [F]	m _{ref,per,hr} = 884.4 [ib/hr]	Calculate
Discharge Choose Discharge	Suction Line	<u>Liquid</u>	<u>Line</u>
1/2 od HGB	3/4 od	1/2 od	
id _d = 0.436 [in.]	id _s = 0.666 [in.]	id _L = 0.436 [in.]	1
vel _{fpm,d} = 2340 [ft/min]	vel _{fpm,s} = 2646 [ft/min]	vel _{fpm,L} = 236.9	[ft/min]
dt _d = 5.866 [F]	dt _s = 4.518 [F]	dt _L = 0.8143 [F]	1
Elbow and Equivalent Length	Elbow and Equivalent Length	Elbow and Equ	ivalent Length
Quantity _d = 8	Quantity _s = 8	Quantity _L = 8	
Length _d = 75 [ft.]	Length _s = 75 [ft.]	Length _L = 75	[ft.]
Le _d = 82.2 [ft.]	Le _s = 84.6 [ft.]	Le _L = 82.2 [ft.]	l
Pd _{psia,d} = 32.48 [psi]	Pd _{psia,s} = 10.9 [psi]	Pd _{psia,L} = 4.07	6 [psi]
MinPDoilReturn _d = 0.3596 [psi]	MinPDoilReturn _s = 0.35 [psi]	Subcooling to Overcor	ne 1 Foot Liquid Lift
MinTonsOilReturn _d = 0.3324 [tons]	MinTonsOilReturn _s = 0.6272 [tons]	dF/di =	0.083 [F/ft]
vel _{fpmMin,d} = 155.6 [ft/min]	vel _{fpmMin,s} = 331.9 [ft/min]	VerticalLift = 10.0 [ft]	SubcoolForVerticalLift = 1.647 [F
lbs _{ref,d} = 0.4724	lbs _{ref,s} = 0.4178	lbs _{ref,L} = 4.667	
PipeVolume _d = 0.07776 [ft ³]			

SCT = 120.0 [F] SCP = 418.3 [psig] SST = 45.0 [F] SSP = 130.1 [psig] Tons = 5 [tons] SCT_{HGB} = 90.0 [F] SCP_{HGB} = 274.5 [psig] SST_{HGB} = 32.0 [F] SSP HGB= 101.1 [psig] Tons_{HGB} = 3.294 [tons]

CircuitTuroff	Single Compresses	
Circuit rypes-	Single Compressor	

Discharge Selected

HGB Selected







Valid Suction Line Selections

	7/8"	1 1/8"
Total Net Capacity (MBH)	146.6	150.6
Leaving Air Temp (°F)	59.1	58.5
EER (at operating conditions)	11.6	11.9
Fluid Velocity (fpm)	2117	1241



ECat Liquid Line Selections

1/2" Liquid Line is only valid option



Changing to 50 ft vertical lift

Reheat Suction	Liquid				
Elbow Quant	ity:	10			
Vertical Lift:		50)		
		Liquid Line	Selection		
Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min Subcool For Vertical	ing Lift
▶ 0.5	109	1.59	264	6.62	





ECat Reheat Line Selection Purge circuit required

Reh	eat Suct	ion Liqu	id			
	Elbow Qua	antity: :h:	1	0		
			Hot Gas	Reheat Lin	e Selection	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps
	0.625	119	4.21	1843	0.63	3
	0.75	122.8	1.82	1280	1	3
	0.875	126.6	0.86	921	1.51	3





Valid Reheat Line Selections

	5/8"	3/4"	7/8"
Temp Loss (°F)	4.21	1.82	0.86
Fluid Velocity (fpm)	1843	1280	921



Air Cooled with Modulating Reheat

- CU above AHU
- 13 ton MUA with 95/75 EAT
- 100 ft line length, 20 ft vertical rise

DX COIL

ошт

- Suction Line Selection
 - Digital Compressor

eheat S	uction Li	quid 🗎				
Elbow	Quantity:	1	0	Suction Line Flow:	Up 💌	
Line Li Vertica	ingth: I Lift:	11	20			
Suction Line Selections						
Pipe	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps	
0.87	5 126.6	3.79	2117	1.09	3	

On / Off Compressor

rien	eat Juci	ion Liqu				
	Elbow Qua	antity:	1	0	Suction Line Flow:	Up 💌
	Line Leng	th:	10	00		
	Vertical Lif	t	2	:0		
			Suct	ion Line Se	lections	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty.of Req.Traps
	1.125	132.3	1.16	1270	2.27	3



*Optional suction line accumulator (field installed & provided)



ECat Liquid Line Selection

- 1/2" Liquid Line is only valid option
- Liquid Line flows down gain subcooling

DX COIL

Basic	Advance	d			
Rehe	eat Suction	Liquid			
	Elbow Quant	ity:	10		
	Line Length:		100		
	Vertical Lift:		20		
			Liquid Line	Selection	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min Subcooling For Vertical Lift
	0.5	109	1.59	264	3.6





ECat Reheat Line Selection

Rehe	eat Suct	ion 🗎 Liqui	id]			
	Elbow Qua	antity: :h:	1	0		
			Hot Gas	Reheat Lir	ne Selection	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps
	0.625	110	3.89	1843	0.63	0
	0.75	112	1.66	1280	1	0
	0.875	114	0.78	921	1.51	0



*Optional suction line accumulator (field installed & provided)



- Air Cooled with Tandem On/Off compressors
 - CU above AHU
 - 31 ton
 - 100 ft line length, 20 ft vertical rise

ECat Suction Line Selection

HGB	Suction	Liquid				
	Elbow Qua	antity:	1	B	Suction Line Flow:	Up 🔻
	Line Lengt	h:	10	00		
	Vertical Lif	t	2	20		
			Sucti	ion Line Se	elections	
	Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps
	1.125	128.9	5.33	3088	2.05	3
	1.375	139.1	2.28	2093	3.49	3
	1.625	144.2	1.04	1479	5.61	3

- Divide Velocity by 2
 - On/off velocity > 1000 fpm
 - Digital velocity > 2000 fpm



*Optional suction line accumulator (field installed & provided)



Heat Pump

- CU below AHU
- 20 ton with digital compressors
- **75** ft line length, 30 ft vertical rise
- No solution from ECat
 - Option 1 relocate the units HIGHLY RECOMMENDED
 - Option 2 use EES Toolkit

Suction Liqu	ji d				
Elbow Qu Line Leng	antity: th: fr:	۶ 7	5	Suction Line Flow:	Down 💌
		Sucti	on Line Se	lections	
Pipe OD	Equiv. Length	Temp. Loss(F)	Vel (fpm)	Min. Tons For Oil Return	Qty. of Req. Traps



Cooling Mode
 Suction Line Down



Heating ModeDischarge Line Up





Heating ModeFunctions as Discharge Line

Heating Section

Primary Heat Type*:
Total Capacity:
OA Temp:
Entering Air Temp:
Leaving Air Temp:

Heat Pump 146.3 MBH 10.0 DB / 9.0°F WB 55.5 DB / 53.0 °F WB 85.5 DB / 64.2°F WB

Tonnage per circuit = (146.3) / 12 / 2

= 6.1 tons per circuit

Cooling Mode Functions as Suction Line

Cooling Section

	Gross
Fotal Capacity:	<u>211.76</u>
Sensible Capacity:	143.25
Latent Capacity:	68.51 MBH
Mixed Air Temp:	84.50 °F DB
Entering Air Temp:	84.50 °F DB
Lv Air Temp (Coil):	53.46 °F DB
Lv Air Temp (Unit)	54.66 °F DB
Evap Suction Temp:	43.70 °F

Tonnage per circuit = (211.8) / 12 / 2

C

= 8.8 tons per circuit



Heating Mode 6.1 tons per circuit Cooling Mode 8.8 tons per circuit Functions as Discharge Line Functions as Suction Line Saturated Condensing Temperature Saturated Suction Temperature Saturated Condensing Temperature Saturated Suction Temperature SCT = 120.0 [F] SCP = 418.3 [psig] SST = 23.90 [F] SSP = 85.32 [psig] SCT = 118.0 [F] SCP = 407.3 [psig] SST = 41.60 [F] SSP = 122.04 [psig] Condenser Subcooling Suction Super heat Condenser Subcooling Suction Super heat Subcool = 10.00 [F] SH = 10.00 [F] Subcool = 10.00 [F] SH = 10.00 [F] 7/8" line 3/4" line 3/4" line 7/8" line Choose Choose Suction Line Suction Line Discharge -Discharge -Discharge Discharge HGB HGB 7/8 od 🛛 👻 7/8 od 🔻 3/4 od 🛛 🚽 3/4 od id_d = 0.666 [in.] id_d = 0.785 [in.] id_s = 0.666 [in.] id_s = 0.785 [in.] vel_{fpm,d} = 959.3 [ft/min] vel_{fpm,d} = 1333 [ft/min] vel_{fpm,s} = 3534 [ft/min] vel_{fpm,s} = 4909 [ft/min] dt_d = 0.5287 [F] dt_d = 1.171 [F] dt_s = 6.074 [F] dt_s = 13.58 [F] Elbow and Equivalent Length **Elbow and Equivalent Length** Elbow and Equivalent Length **Elbow and Equivalent Length** $Quantity_d = 8$ $Quantity_d = 8$ $Quantity_s = 8$ $Quantity_s = 8$ Length_d = 75 [ft.] $Length_d = 75$ [ft.] Length_s = 75 [ft.] Length_s = 75 [ft.] Le_d = 86.2 [ft.] Le_d = 84.6 [ft.] Le_s = 86.2 [ft.] Le_s = 84.6 [ft.] Pd_{psia.d} = 2.94 [psi] Pd_{psia.d} = 6.513 [psi] Pd_{psia.s} = 14.04 [psi] Pd_{psia.s} = 31.39 [psi] Velocity < 1000 fpm

Velocity > 4000 fpm

STILL NO SOLUTION!!

Selection Scenario #4 (option 1)



Selection Scenario #4 (option 2)



Conclusion



Split System Refrigerant Line Design Matters!

- Vapor / Liquid / Reheat Lines should be reviewed ahead of time to understand effects on the overall system.
- Choose your Design Priority
 - Know that it comes with a compromise
- Designing Split System Refrigerant Lines saves You...
 - Time, Money, and Headaches







More information???



- AAON-Applications
 - (918) 382-6274
 - aaonapps1@aaon.com
- DX Handbook
 - https://www.aaon.com/EngineeringBook
- AAON Website
 - Product Literature and Presentations
- 2010 ASHRAE Handbook -Refrigeration Chapter 1



2016 New Sales Rep Training

Split System Selection 3.1 MB - S. Andersen

Training Materials







Questions?