Kelvion

Output Summary

Released to the following HTRI Member Company:
GEA Group
Windows User

Xace 7.2 8/19/2016 11:32 SN: 00620-1224069614 **US Units**

AIR-COOLED CONDENSER

Rating-Incline air-cooled heat exchanger forced draft countercurrent to crossflow

See Data Check Messages Report for Informative Messages.

See Runtime Message Report for Warning Messages.

Process Conditions			Outside	Tubeside
Fluid name				STEAM
Fluid condition			Sens. Gas	Cond. Vapor
Total flow rate	(1000-lb/hr)		3425.760	84.500
Weight fraction vapor, In/Out			1.0000 1.0000	1.0000 0.0000
Temperature, In/Out	(Deg F)		97.00 195.61	226.80 225.43
Skin temperature, Min/Max	(Deg F)		112.98 217.91	117.19 224.86
Pressure, Inlet/Outlet	(psia)		13.079 13.051	19.687 19.084
Pressure drop, Total/Allow	(inH2O)	(psi)	0.764 0.000	0.603 0.500
Midpoint velocity	(ft/sec)		23.75	69.24
- In/Out	(ft/sec)			125.77 0.10
Heat transfer safety factor	(--)		1.0000	1.0000
Fouling	(ft2-hr-F/Btu)		0.00000	0.00100

Exchanger Performance					
Outside film coef	(Btu/ft2-hr-F)	10.38	Actual U	(Btu/ft2-hr-F)	6.998
Tubeside film coef	(Btu/ft2-hr-F)	1613.6	Required U	(Btu/ft2-hr-F)	6.990
Clean coef	(Btu/ft2-hr-F)	8.535	Area	(ft2)	177092
Hot regime		Cond. Vapor	Overdesign	(%)	0.11
Cold regime		Sens. Gas			
EMTD	(Deg F)	65.7			
Duty	(MM Btu/hr)	81.348			

Unit Geometry			
Bays in parallel per unit		3	
Bundles parallel per bay		1	
Extended area	(ft2)	177092	
Bare area	(ft2)	8444.6	
Bundle width	(ft)	13.000	
Nozzle		**Inlet**	**Outlet**
Number	(--)	2	2
Diameter	(inch)	9.5620	7.6250
Velocity	(ft/sec)	160.74	0.21
R-V-SQ	(lb/ft-sec2)	1261.0	2.56
Pressure drop	(psi)	0.150	0.000

Fan Geometry		
No/bay	(--)	2
Fan ring type		Flanged
Diameter	(ft)	12.000
Ratio, Fan/bundle face area	(--)	0.5437
Driver power	(hp)	28.90
Tip clearance	(inch)	0.7200
Efficiency	(%)	70.000

Airside Velocities		Actual	Standard
Face	(ft/min)	721.43	610.00
Maximum	(ft/sec)	21.39	18.09
Flow	(1000 ft3/min)	900.35	761.28
Velocity pressure	(inH2O)	0.093	
Bundle pressure drop	(inH2O)	0.684	
Bundle flow fraction	(--)	1.000	

Tube Geometry		
Tube type		GEA BTT Groovy Fin
Tube OD	(inch)	1.0000
Tube ID	(inch)	0.8340
Length	(ft)	32.000
Area ratio(out/in)	(--)	25.732
Layout		Staggered
Trans pitch	(inch)	2.7500
Long pitch	(inch)	2.3815
Number of passes	(--)	1
Number of rows	(--)	6
Tubecount	(--)	336
Tubecount Odd/Even	(--)	56 / 56
Material		Carbon steel

Fin Geometry		
Type		None
Fins/length	(fin/inch)	10.0
Fin root	(inch)	1.0000
Height	(inch)	0.6250
Base thickness	(inch)	0.0157
Tip thickness	(inch)	0.0079
Over fin	(inch)	2.2500
Efficiency	(%)	88.3
Area ratio (fin/bare)	(--)	21.460

Material	
Material	Aluminum 1100-a
Air	67.41
Tube	11.16
Fouling	18.01
Metal	3.42
Bond	0.00

		Airside Pressure Drop, %			
Bundle	89.52			Louvers	2.80
Ground clearance	1.61	Fan guard	0.00	Hail screen	0.00
Fan ring	6.07	Fan area blockage	0.00	Steam coil	0.00

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AIR-COOLED CONDENSER

Xace 7.2 8/19/2016 11:32 SN: 00620-1224069614 **US Units**

Rating-Incline air-cooled heat exchanger forced draft countercurrent to crossflow

Process Data		Airside		Tubeside	
Fluid name				STEAM	
Fluid condition			Sens. Gas		Cond. Vapor
Total flow rate	(1000-lb/hr)		3425.760		84.500
Weight fraction vapor, In/Out	(--)	1.0000	1.0000	1.0000	0.0000
Temperature, In/Out	(Deg F)	97.00	195.61	226.80	225.43
Skin temperature, Min/Max	(Deg F)	112.98	217.91	117.19	224.86
Wall temperature, Min/Max	(Deg F)	112.98	217.91	113.66	219.02
Pressure, In/Out	(psia)	13.079	13.051	19.687	19.084
Pressure drop, Total/Allowed (inH2O)	(psi)	0.764	0.000	0.603	0.500
Pressure Drop, A-frame reflux section	(psi)				
Velocity - Midpoint	(ft/sec)	23.75		69.24	
- In/Out	(ft/sec)			125.77	0.10
Film coefficient, Bare/Extended	(Btu/ft2-hr-F)	222.79	10.38	1613.6	
Mole fraction inert	(--)				0.0000
Heat transfer safety factor	(--)		1.0000		1.0000
Fouling resistance	(ft2-hr-F/Btu)		0.00000		0.00100

Overall Performance Data

Overall coef, Design/Clean/Actual	(Btu/ft2-hr-F)	6.990 / 8.535 /	6.998	
Heat duty, Calculated/Specified	(MM Btu/hr)	81.348 / 0.0000		
Effective mean temperature difference	(Deg F)	65.71		

See Runtime Message Report for Warning Messages.

Unit and Bundle Construction Information

Bays in parallel per unit	(--)	3	Bundles in parallel/bay	(--)	1
Extended area per unit	(ft2)	177092	Bare area/unit	(ft2)	8444.6
Extended area per bundle	(ft2)	59031	Bare area/bundle	(ft2)	2814.9
Tubepasses/Tuberows	(--)	1 / 6	Number of tubes/bundle	(--)	336
Tubecount, Odd rows/Even rows	(--)	56 / 56	Edge seals	(--)	Yes
Bundle width	(ft)	13.000	Fan guard	(--)	No
Clearance	(inch)	0.3750	Louvers	(--)	Yes
Header - depth	(inch)	10.000	Steam coil	(--)	No
Header Box			Hail screen	(--)	No
- Plate thickness	(inch)	1.2500	*Tube support information*		
- Tubesheet thickness	(inch)	1.8750	Number	(--)	5
Plenum type		Box	Width	(inch)	1.0000
Bundle(s) weight	(lb)	25489	Orientation (from horiz.)	(deg)	1.19
Structure weight	(lb)	67457	Tubeside volume	(ft3)	69.615
Total weight, Dry / Wet	(lb)	177150 / 190177			
Ladder/walkway weight	(lb)	33226	Cost Factor	(--)	167.95

Tube Information

Straight length	(ft)	32.000	Tube type		GEA BTI Groovy Fin
Unfinned length	(inch)	0.0000	Unheated length	(inch)	8.7500
Layout	(--)	Staggered	Area ratio (fin/bare)	(--)	21.460
Transverse pitch	(inch)	2.7500	Fins per unit length	(fin/inch)	10.0
Longitudinal pitch	(inch)	2.3815	Fin root diameter	(inch)	1.0000
Tube form	(--)	Straight	Fin height	(inch)	0.6250
Outside diameter	(inch)	1.0000	Fin thickness at base	(inch)	0.0157
Inside diameter	(inch)	0.8340	Fin thickness at tip	(inch)	0.0079
Area ratio (out/in)	(--)	25.732	Fin type	(--)	--
Over fin diameter	(inch)	2.2500	Fin efficiency	(%)	88.3
Tube material		Carbon steel	Internal tube type		None
Fin material		Aluminum 1100-annealed			

Inlet Airside Velocities		Actual	Standard
Face velocity	(ft/min)	721.43	610.00
Maximum velocity	(ft/sec)	21.39	18.09
Volumetric flow	(1000 ft3/min)	900.35	761.28
Maximum mass velocity	(lb/s-ft2)	1.357	
Air humidity	(%)		
Volumetric flow per fan at fan inlet	(1000 ft3/min)	150.06	
Velocity at fan inlet	(ft/sec)	22.11	

Fan Description and Fan Power

Number of fans per bay	(--)	2
Diameter	(ft)	12.000
Tip clearance	(inch)	0.7200
Ratio, fan area to bay face area	(--)	0.5437
Fan ring type	(--)	Flanged
Percent open area - in fan guard	(%)	0.0000
- in hail screen	(%)	0.0000
Ratio, ground clearance to fan diameter	(--)	1.833
Percent blockage, other obstruction	(%)	0.0000
Bundle pressure drop/ Velocity pressure	(inH2O)	0.684 / 0.093
Fan and drive efficiency	(%)	70.000
Motor power/fan-design air temperature	(hp)	28.90
Motor power/fan-min air temperature	(hp)	32.47
Ambient temperature, Max / Min	(Deg F)	97.00 / 25.00

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
RPM	An-Mist	Trans	Gravity	0.8610
Bundle flow fractio	(--)	1.000		

Heat Transfer and Pressure Drop Parameters			Tubeside	Outside
Midpoint j-factor		(--)		0.0079
Heat transfer	Wall Correction	(--)	1.0000	1.0000
	Row Correction	(--)		1.0000
Midpoint f-factor		(--)	0.0000	0.0000
Pressure drop	Wall Correction	(--)	0.0000	1.0000
	Row Correction	(--)		1.0000
Reynolds number	Inlet	(--)	48074	8768
	Midpoint	(--)	27932	8325
	Outlet	(--)	5430	7927
Fouling layer thickness		(inch)	0.0000	0.0000
Input minimum velocity		(ft/sec)		
Input maximum velocity		(ft/sec)		
Input minimum wall temperature		(Outlet F)		
Input maximum wall temperature		(Deg F)		

Thermal Resistance (Percent)					Over
Air	Tube	Fouling	Metal	Bond	Design
67.41	11.16	18.01	3.42	0.00	0.11

Airside Pressure Drop (Percent)			
Across bundle	89.52	Other obstruction	0.00
Fan ring	6.07	Steam coil	0.00
Fan guard	0.00	Louvers	2.80
Ground clearance	1.61		

Tube Nozzle (Perpendicular)		Inlet	Outlet
Number of nozzles	(--)	2	2
Diameter	(inch)	9.5620	7.6250
Velocity	(ft/sec)	160.74	0.21
Nozzle R-V-SQ	(lb/ft-sec2)	1261.0	2.56
Pressure drop	(psi)	0.150	0.000

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Final Results

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AIR-COOLED CONDENSER

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Mean Metal Temperatures

Mean tube metal temperature in each tubepass, (Deg F)

Tuberow	Tubepass	Inside	Outside	Radial
1	1	217.2	215.9	216.5
2	1	214.4	212.8	213.6
3	1	210.0	207.9	208.9
4	1	200.8	198.4	199.5
5	1	189.7	186.9	188.2
6	1	178.5	175.2	176.7

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US Units

Problem-
Case- :
Rating-Incline air-cooled heat exchanger forced draft countercurrent to crossflow

AIR-COOLED CONDENSER

							Fan Rating				
			Fan Size	Number of	Blade angle	Noise PWL	Efficiency		Fan speed	Tip speed	Driver power
	Manufacturer	Type	(ft)	blades	(deg)	(dbA)	Total	Static	(RPM)	(ft/min)	(hp)
4	Moore	M49.0	12.000	5	46.80	102.15	65.9		318.00	11988	28.77
5	Moore	M49.0	12.000	6	46.80	102.15	65.9		318.00	11988	28.77
6	Moore	M49.0	12.000	7	48.30	101.38	67.5		302.10	11389	28.11
7	Moore	M49.0	12.000	8	49.80	100.57	69.1		286.20	10790	27.43
8	Moore	A49.0	12.000	5	46.80	102.15	65.9		318.00	11988	28.77
9	Moore	A49.0	12.000	6	46.80	102.15	65.9		318.00	11988	28.77
10	Moore	A49.0	12.000	7	48.30	101.38	67.5		302.10	11389	28.11
11	Moore	A49.0	12.000	8	49.80	100.57	69.1		286.20	10790	27.43
12	Moore	E49.0	12.000	5	46.80	102.15	65.9		318.00	11988	28.77
13	Moore	E49.0	12.000	6	46.80	102.15	65.9		318.00	11988	28.77
14	Moore	E49.0	12.000	7	48.30	101.38	67.5		302.10	11389	28.11
15	Moore	E49.0	12.000	8	49.80	100.57	69.1		286.20	10790	27.43
16	Moore	M60.0	12.000	6	41.30	101.59	65.5		302.10	11389	29.50
17	Moore	M60.0	12.000	7	44.50	99.949	68.5		270.30	10190	28.20
18	Moore	M60.0	12.000	8	46.20	99.052	70.2		254.40	9590.7	27.52
19	Moore	M60.0	12.000	9	48.00	98.099	72.1		238.50	8991.3	26.82
20	Moore	M60.0	12.000	10	48.00	98.099	72.1		238.50	8991.3	26.82
21	Moore	M60.0	12.000	11	50.00	97.083	74.0		222.60	8391.8	26.11
22	Moore	A60.0	12.000	6	41.30	101.59	65.5		302.10	11389	29.50
23	Moore	A60.0	12.000	7	44.50	99.949	68.5		270.30	10190	28.20
24	Moore	A60.0	12.000	8	46.20	99.052	70.2		254.40	9590.7	27.52
25	Moore	A60.0	12.000	9	48.00	98.099	72.1		238.50	8991.3	26.82
26	Moore	A60.0	12.000	10	48.00	98.099	72.1		238.50	8991.3	26.82
27	Moore	A60.0	12.000	11	50.00	97.083	74.0		222.60	8391.8	26.11
28	Moore	E60.0	12.000	6	41.30	101.59	65.5		302.10	11389	29.50
29	Moore	E60.0	12.000	7	44.50	99.949	68.5		270.30	10190	28.20
30	Moore	E60.0	12.000	8	46.20	99.052	70.2		254.40	9590.7	27.52
31	Moore	E60.0	12.000	9	48.00	98.099	72.1		238.50	8991.3	26.82
32	Moore	E60.0	12.000	10	48.00	98.099	72.1		238.50	8991.3	26.82
33	Moore	E60.0	12.000	11	50.00	97.083	74.0		222.60	8391.8	26.11
34	Moore	M73.0	12.000	6	37.20	100.17	67.4		270.30	10190	29.70
35	Moore	M73.0	12.000	7	37.20	100.17	67.4		270.30	10190	29.70
36	Moore	M73.0	12.000	8	38.80	99.285	68.9		254.40	9590.7	29.04
37	Moore	M73.0	12.000	9	40.70	98.341	70.5		238.50	8991.3	28.35
38	Moore	M73.0	12.000	10	42.60	97.333	72.3		222.60	8391.8	27.65
39	Moore	M73.0	12.000	11	44.70	96.253	74.3		206.70	7792.4	26.94
40	Moore	M73.0	12.000	12	44.70	96.253	74.3		206.70	7792.4	26.94
41	Moore	M73.0	12.000	13	47.00	95.094	76.3		190.80	7193.0	26.22

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US Units

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AIR-COOLED CONDENSER

						Fan Rating					
			Fan Size	Number of	Blade angle	Noise PWL	Efficiency		Fan speed	Tip speed	Driver power
Manufacturer	Type		(ft)	blades	(deg)	(dbA)	Total	Static	(RPM)	(ft/min)	(hp)
Moore	M73.0		12.000	14	47.00	95.094	76.3		190.80	7193.0	26.22
Moore	M73.0		12.000	15	49.50	93.846	78.3		174.90	6593.6	25.54

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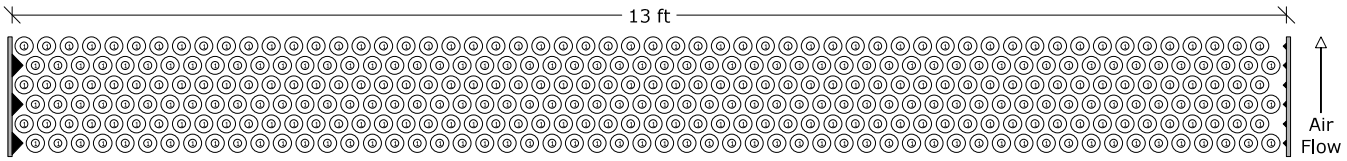

ID	Name	Type	Outer Diameter (inch)	Wall Thickness (inch)	Transverse Pitch (inch)	Longitudinal Pitch (inch)	Fin Height (inch)
T1	TubeType1	GEA BTT Groovy Fin	1.0000	0.0830	2.7500	2.3815	0.6250

Bundle Information

Bundle width	13.000	ft
Number of tube rows	6	
Number of tubes	336	
Minimum wall clearance		
Left	0.3750	inch
Right	0.7500	inch
Number of tubes per pass		
○ Tubepass # 1:	336	

Row From Top	Number of Tubes	Tube Type Name	Wall Clearance (inch)	Row From Top	Number of Tubes	Tube Type Name	Wall Clearance (inch)
1	56	TubeType1	0.3750	4	56	TubeType1	1.7500
2	56	TubeType1	1.7500	5	56	TubeType1	0.3750
3	56	TubeType1	0.3750	6	56	TubeType1	1.7500

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API 661 Air-Cooled Heat Exchanger - Specification Sheet

AIR-COOLED CONDENSER

Job No.		Item No.	
Page	Page 7	By	
Date	8/19/2016	Revision	
Proposal No.		Contract No.	
Inquiry No.		Order No.	

Manufacturer			Heat exchanged	(Btu/hr)	8.13e+7
Model no.			Surface/Item-Finned tube	(ft2)	177092
Customer			Bare tube	(ft2)	8444.6
Plant location			MTD, Eff.	(Deg. F)	65.7
Service			Transfer rate-Finned	(Btu/ft2-hr-F)	6.998
Type draft		FORCED	Bare tube, service	(Btu/ft2-hr-F)	146.76
Bay size (WxL)	(ft)	13.208 x 32.000	Bare tube, clean	(Btu/ft2-hr-F)	178.99
No. of bays/Items		3			

Basic design data

Pressure design code		Structural code	
Tube bundle code stamped		Flammable service	
Heating coil code stamped		Lethal/toxic service	

Performance Data - Tube Side

					In		Out	
Fluid name		STEAM						
Total fluid entering	(lb/hr)	84500	Total flow rate (Liq/Vap)	(lb/hr)	0.0 /	84500	84500 /	0.0
Dew/bubble point	(Deg. F)	/	Water/Steam	(lb/hr)	0.0 /	84500	84500 /	0.0
	(Deg. F)		Noncondensables	(lb/hr)		0.0		0.0
Latent heat	(Btu/lb)		Molecular Wt. (Vap/Non-cond)		/		/	
Inlet pressure	(psia)	19.687	Density (Liq/Vap)	(lb/ft3)	59.451 /	0.0488	59.487 /	0.0476
Pressure drop (All/Calc)	(psi)	0.500 / 0.603	Specific heat (Liq/Vap)	(Btu/lb-F)	1.0105 /	0.5050	1.0102 /	0.5041
Velocity (Allow/Calc)	(ft/sec)	/ 62.94	Thermal cond. (Liq/Vap)	(Btu/hr-ft-F)	0.3933 /	0.0148	0.3932 /	0.0148
Inside fouling resistance	(ft2-hr-F/Btu)	0.00100	Viscosity (Liq/Vap)	(cP)	0.2592 /	0.0126	0.2611 /	0.0125
		In / Out						
Temperature	(Deg. F)	226.80 / 225.43						

Performance Data - Air Side

Air inlet temperature	(Deg. F)	97.00	Face velocity	(SFPM)	610.00
Air flow rate/item	(SCFM)	761280	Minimum design ambient temp	(Deg. F)	25.00
Mass velocity	(lb/hr-ft2)		Altitude	(ft)	3191.0
Air outlet temperature	(Deg. F)	195.61	Static pressure	(inH2O)	0.764
Air flow rate/fan	(ACFM)	150058			

Design, Material, and Construction

Design pressure	(psig)	340.00	**Heating Coil**		
Test pressure	(psig)		No. of tubes		
Design temperature	(Deg. F)	480.00	Tube outside diameter	(inch)	
Min. design metal temp.	(Deg. F)		Tube material		
Tube bundle			Fin material and type		
Size (WxL)	(ft)	13.000 X 32.000	Fin thickness	(inch)	
No./Bay		1	ASME Code, Sec. VIII, Div. 1		
Number of tube rows		6	Heating fluid		
Bundles in parallel		3	Heating fluid flow rate	(lb/hr)	
Bundles in series			Temperature (In/Out)	(Deg. F)	/
Structure mounting			Inlet pressure	(psia)	
Pipe rack beams			Pressure drop (All/Calc)	(psi)	/
Ladders, walkways, platforms			Design temperature	(Deg. F)	
Structure surface prep.			Design pressure	(psia)	
Header surface prep.			Inlet/Outlet nozzle		/
Louver			**Header**		
Material			Type		
Action control			Material		
Action type			Corrosion Allowance	(inch)	
			No. of passes		1

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API 661 Air-Cooled Heat Exchanger - Specification Sheet

AIR-COOLED CONDENSER

Job No.		Item No.	
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Date		Revision	
Proposal No.		Contract No.	
Inquiry No.		Order No.	

Design, Material, and Construction (continued)

Header (continued)				No./Bundle		336
Slope				Length	(ft)	32.000
Plug material				Pitch	(inch)	2.7500
Gasket material				Layout		Triangular
Nozzle	No.	Size, (inch)	Rating/Facing	**Fin**		
Inlet	2	9.5620		Type		None
Outlet	2	7.6250		Material		Aluminum 1100-annealed
Vent				Thickness	(inch)	0.0157
Drain				Selection temp.	(F)	
Chemical Cleaning				Outside diameter	(inch)	2.2500
Min. Wall Thk.				Fin density	(fin/inch)	10.0
Tube				ASME Code, Sec. VIII, Div. 1		
Material			Carbon steel	Customer Specifications		
Tube outside diameter	(inch)		1.0000			
Average wall thickness	(inch)		0.0830			

Mechanical Equipment

Fan				RPM		
Manufacturer			Moore	Service factor		
No./Bay			2	Enclosure		
RPM	(Revs/min.)		0.0000	Voltage		
Diameter	(ft)		12.000	Phase		
No. of blades				Cycle		
Angle	(degrees)			Fan noise level	(dB)	
Pitch adjustment				**Speed Reducer**		
Blade material				Type		
Hub material				Manufacturer		
BHP@design temp				No./Bay		
BHP@min. ambient temp				Service factor		
Tip speed				Speed ratio		
Driver				Support		
Type				Vib. switch		
Manufacturer				Enclosure		
No./Bay						
Driver	(hp)		28.90			

Controls - Air Side

Air recirculation		Louvers	
Degree control of outlet process temp.		Positioner	
(Max. Cooling),+/-	/	Signal air pressure (psia)	
Action on control signal failure		From	To
Fan pitch		From	To
Louvers		Supply air pressure (psia)	
Actuator air supply		From	To
Fan		From	To

Shipping

Plot area (WxL)	(ft)	13.208 x 32.000	Total	(lb)	177150
Bundle weight	(lb)	25489	Shipping	(lb)	
Bay	(lb)				

Kelvion

Drawings
Released to the following HTRI Member Company
GEA Group
Windows User

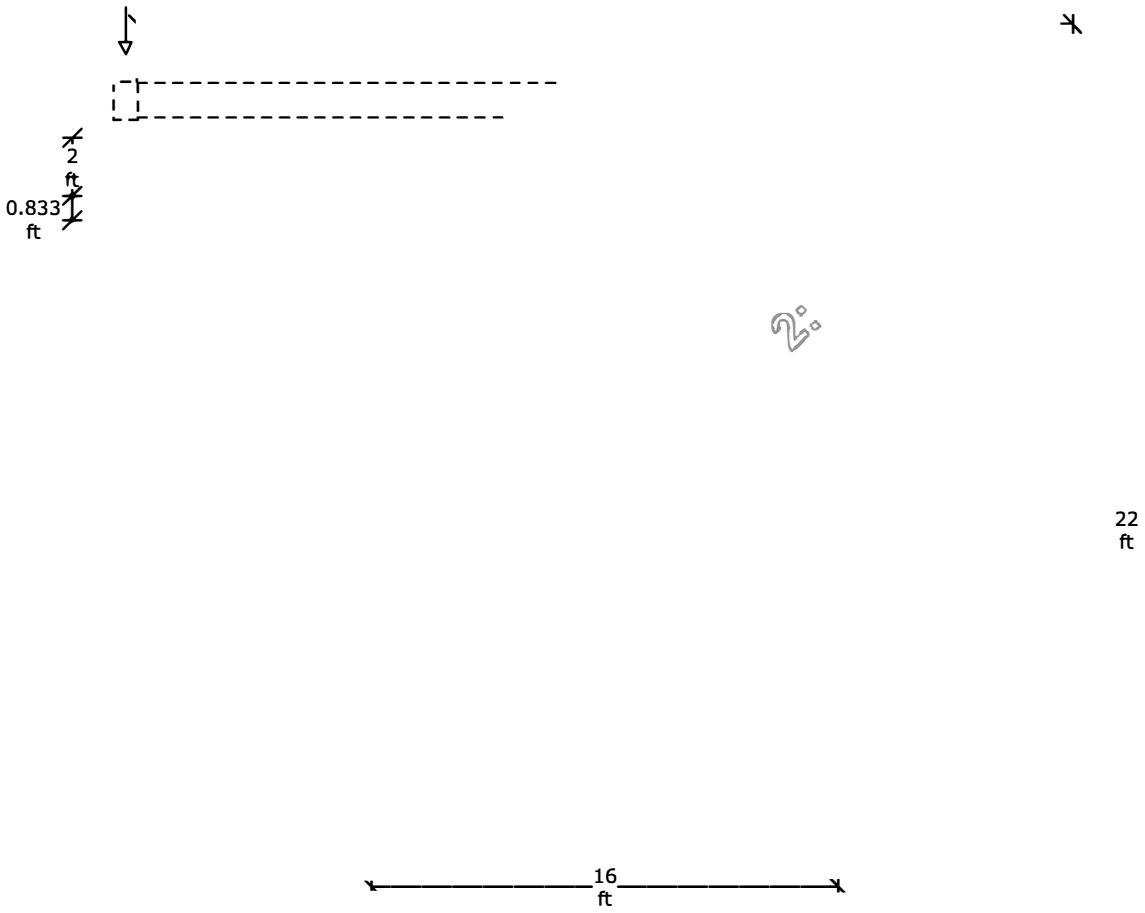
Xace 7.2 8/19/2016 11:32 SN: 00620-1224069614

AIR-COOLED CONDENSER

US Units

Rating-Incline air-cooled heat exchanger forced draft countercurrent to crossflow

Bay Width	13.208 ft	Single bundle weight	25489 lb
Bays in parallel	3	Total bundle weight	
Bundle width	13 ft	Structure weight	67457 lb
Bundles in parallel	1	Walkway ladder weight	33226 lb
Fan diameter	12 ft	Dry weight	177150 lb
Fans per bay	2	Wet weight	190177 lb
Ground clearance	22 ft		
Plenum height	2 ft		
Tube length	32 ft		



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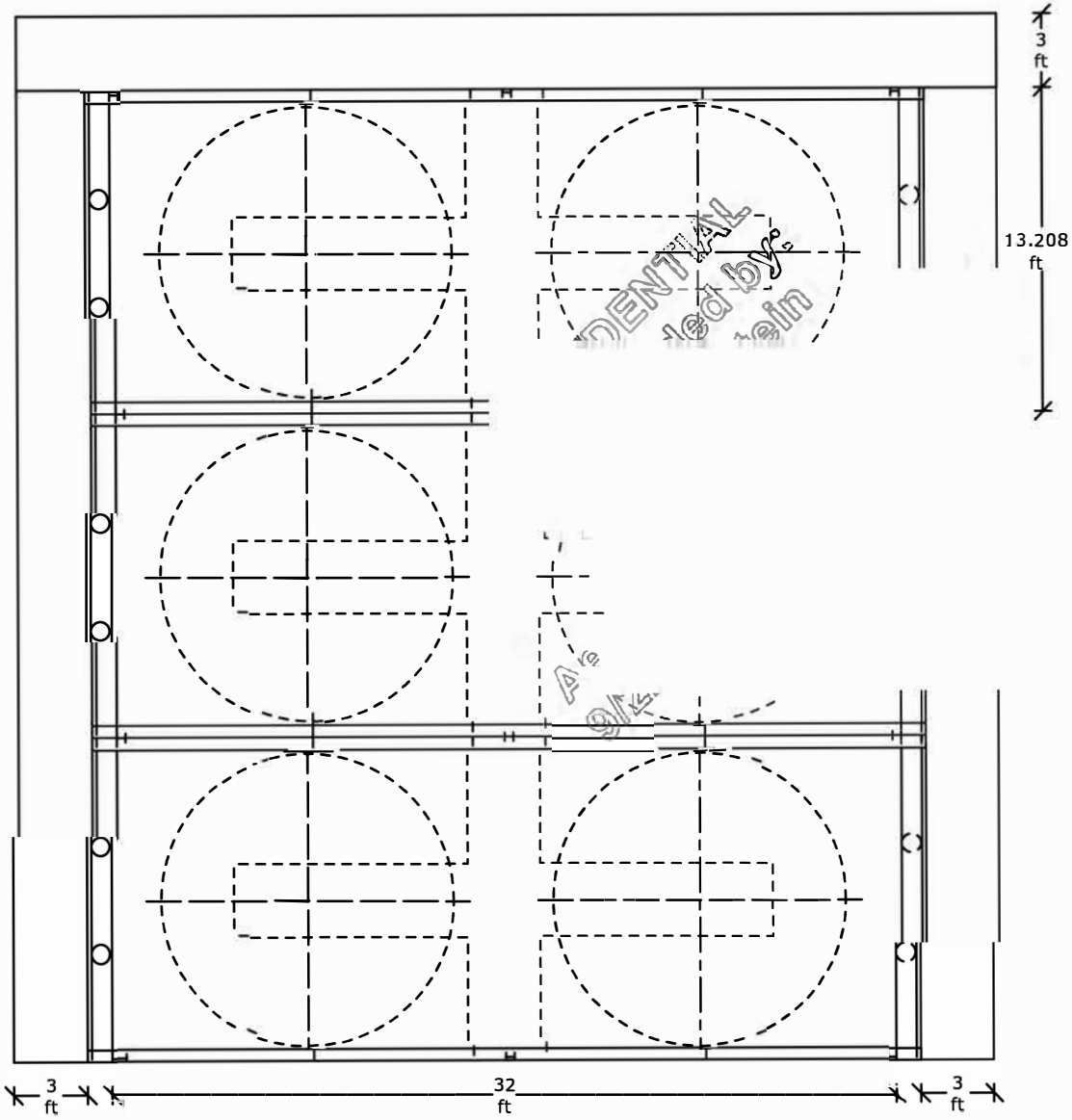

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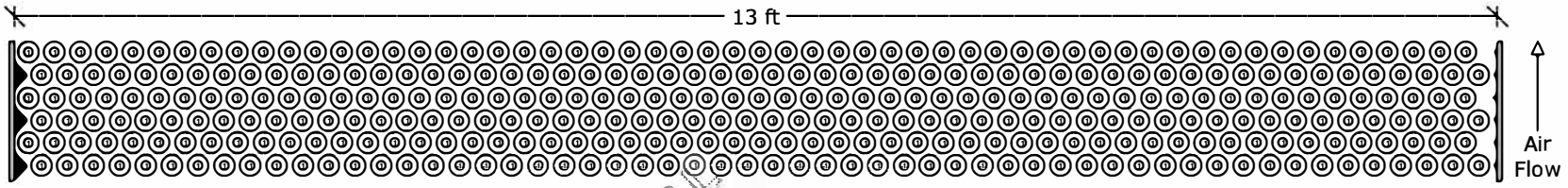

ID	Name	Type	Outer Diam	sverse	Longitudinal itch (inch)	Fin Height (inch)
T1	TubeType1	GEA BTT Groovy Fin			.3815	0.6250

Row From Top	Number of Tubes	Tube Type Name				Wall Clearance (inch)
1	56	TubeType1	0.3750		TubeType1	1.7500
2	56	TubeType1	1.7500	5	TubeType1	0.3750
3	56	TubeType1	0.3750	6	TubeType1	1.7500

Bundle Information

Bundle width	13.000	ft
Number of tube rows	6	
Number of tubes	336	
Minimum wall clearance		
Left	0.3750	inch
Right	0.7500	inch
Number of tubes per pass		
O Tubepass # 1:	336	