

API 661 Air-Cooled Heat Exchanger - Specification Sheet

APPROVED

By Todd Harvey at 12:52 pm, Sep 30, 2013

Job No. <u>18680-3</u>	Item No. <u>HE-2720</u>
Page <u>Page 1</u>	By <u>D.HOLK</u>
Date <u>9/24/2013</u>	Revision <u>2</u>
Proposal No. _____	Contract No. _____
Inquiry No. _____	Order No. _____

Manufacturer <u>TEX-FIN, INC</u>	Heat exchanged (Btu/hr) <u>7598170</u>
Model no. <u>13-34-D11-H25-FVD</u>	Surface/Item-Finned tube (ft2) <u>50064</u>
Customer <u>OBERON FUELS</u>	Bare tube (ft2) <u>2328.5</u>
Plant location _____	MTD, Eff. (Deg. F) <u>39.7</u>
Service <u>PURIFICATION COLUMN CONDENSER</u>	Transfer rate-Finned (Btu/ft2-hr-F) <u>4.704</u>
Type draft <u>FORCED</u>	Bare tube, service (Btu/ft2-hr-F) <u>101.15</u>
Bay size (WxL) (ft) <u>13.083 x 34.000</u>	Bare tube, clean (Btu/ft2-hr-F) <u>133.53</u>
No. of bays/Items <u>1</u>	

Basic design data

Pressure design code <u>ASME</u>	Structural code <u>UBC/AISC</u>
Tube bundle code stamped <u>YES</u>	Flammable service <u>NO</u>
Heating coil code stamped <u>NO</u>	Lethal/toxic service <u>NO</u>

Performance Data - Tube Side

Fluid name	Methanol		In	Out
Total fluid entering (lb/hr)	<u>15775</u>	Total flow rate (Liq/Vap) (lb/hr)	<u>0.0 / 15775</u>	<u>15775 / 0.0</u>
Dew/bubble point (Deg. F)	<u>/</u>	Water/Steam (lb/hr)	<u>0.0 / 0.0</u>	<u>0.0 / 0.0</u>
Latent heat (Btu/lb)	<u>/</u>	Noncondensables (lb/hr)	<u>0.0</u>	<u>0.0</u>
Inlet pressure (psia)	<u>24.696</u>	Molecular Wt. (Vap/Non-cond)	<u>/</u>	<u>/</u>
Pressure drop (All/Calc) (psi)	<u>0.500 / 0.257</u>	Density (Liq/Vap) (lb/ft3)	<u>46.188 / 0.1222</u>	<u>46.262 / 0.1226</u>
Velocity (Allow/Calc) (ft/sec)	<u>/ 17.82</u>	Specific heat (Liq/Vap) (Btu/lb-F)	<u>0.7146 / 0.4129</u>	<u>0.7119 / 0.4123</u>
Inside fouling resistance (ft2-hr-F/Btu)	<u>0.00200</u>	Thermal cond. (Liq/Vap) (Btu/hr-ft-F)	<u>0.1078 / 0.0119</u>	<u>0.1079 / 0.0118</u>
		Viscosity (Liq/Vap) (cP)	<u>0.2937 / 0.0117</u>	<u>0.2974 / 0.0116</u>
Temperature (Deg. F)	In <u>168.76</u> Out <u>166.69</u>			

Performance Data - Air Side

Air inlet temperature (Deg. F) <u>112.00</u>	Face velocity (SFPM) <u>567.03</u>
Air flow rate/item (SCFM) <u>250627</u>	Minimum design ambient temp. (Deg. F) <u>10.02</u>
Mass velocity (lb/hr-ft2) _____	Altitude (ft) <u>0.000</u>
Air outlet temperature (Deg. F) <u>140.00</u>	Static pressure (inH2O) <u>0.573</u>
Air flow rate/fan (ACFM) <u>135438</u>	

Design, Material, and Construction

Design pressure (psig) <u>150.00</u>	Heating Coil	
Test pressure (psig) <u>195.00</u>	No. of tubes	<u>N/A</u>
Design temperature (Deg. F) <u>250.00</u>	Tube outside diameter (inch)	_____
Min. design metal temp. (Deg. F) <u>-20.00</u>	Tube material	_____
Tube bundle	Fin material and type	_____
Size (WxL) (ft) <u>13.000 X 34.000</u>	Fin thickness (inch)	_____
No./Bay <u>1</u>	ASME Code, Sec. VIII, Div. 1	_____
Number of tube rows <u>4</u>	Heating fluid	_____
Bundles in parallel <u>1</u>	Heating fluid flow rate (lb/hr)	_____
Bundles in series _____	Temperature (In/Out) (Deg. F)	<u>/</u>
Structure mounting <u>ABOVE GRADE</u>	Inlet pressure (psia)	_____
Pipe rack beams <u>NO</u>	Pressure drop (All/Calc) (psi)	<u>/</u>
Ladders, walkways, platforms <u>NO</u>	Design temperature (Deg. F)	_____
Structure surface prep. <u>GALV</u>	Design pressure (psia)	_____
Header surface prep. <u>TAN EPOXY</u>	Inlet/Outlet nozzle	<u>/</u>
Louver	Header	
Material <u>ALUM</u>	Type	<u>WELDED BOX</u>
Action control <u>MANUAL</u>	Material	<u>SA516-70</u>
Action type _____	Corrosion Allowance (inch)	<u>0.125</u>
	No. of passes	<u>1</u>

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Design, Material, and Construction (continued)

Header (continued)				No./Bundle	266
Slope	NONE			Length (ft)	34.000
Plug material	SA105			Pitch (inch)	2.3125
Gasket material	SI			Layout	Triangular
Nozzle				Fin	
Inlet	No. 2	Size, (inch) 6.0000	Rating/Facing 150# RFWN	Type	L-FOOTED
Outlet	1	3"	150# RFWN	Material	Aluminum 1060 - H14
Vent	1	2"	150# RFWN	Thickness (inch)	0.0150
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	YES
Material	SA214			Customer Specifications	NONE
Tube outside diameter (inch)	1.0000				
Average wall thickness (inch)	0.0830				

Mechanical Equipment

Fan				RPM	1750
Manufacturer	MOORE			Service factor	1.15
No./Bay	2			Enclosure	TEFC
RPM (Revs/min.)	303			Voltage	460
Diameter (ft)	11.000			Phase	3
No. of blades	6			Cycle	60
Angle (degrees)	19.9			Fan noise level (dB)	79.3
Pitch adjustment	MANUAL			Speed Reducer	
Blade material	ALUM			Type	V-BELT
Hub material	ALUM			Manufacturer	
BHP@design temp	19.83			No./Bay	2
BHP@min. ambient temp				Service factor	1.4
Tip speed	10462			Speed ratio	4.7:1
Driver				Support	
Type	ELEC MOTOR			Vib. switch	MURPHY
Manufacturer				Enclosure	2VSEX
No./Bay	2				
Driver (hp)	25				

Controls - Air Side

Air recirculation	NONE			Louvers	
Degree control of outlet process temp. (Max. Cooling), +/-	/			Positioner	
Action on control signal failure				Signal air pressure (psia)	
Fan pitch				From	To
Louvers				From	To
Actuator air supply				Supply air pressure (psia)	
Fan				From	To
				From	To

Shipping

Plot area (WxL) (ft)	13.083 x 34.000		Total (lb)	33466
Bundle weight (lb)	15989		Shipping (lb)	
Bay (lb)				

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A.S.M.E. M E C H A N I C A L D E S I G N C A L C U L A T I O N S

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All calculations in complete accordance with
ASME, Section VIII, Div 1, 2010 Edition, 2011 Addenda

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Impact Testing is exempt to -20 DegF per UHA-51
All Loadings Per UG-22 Have Been Considered and Included Where Applicable

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CUSTOMER : OBERON FUELS

P.O. NUMBER : TEX-16SEP13

ITEM NUMBER : HE-2720

JOB NUMBER : 18680-3

SIZE & TYPE : 13-34-D11-H25-FVD

QUANTITY : ONE

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Please provide column loading calcu

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Header Calculations per Appendix 13			
Calculations per Fig. 13-2(a) Sketch (1)			
PRESSURE (P) =	150	ALLW. STRESS =	20000
TUBE DIA =	1	TUBE PITCH (p) =	2.3125
CORR. ALLW. =	0.125		
h SPAN (h) =	7.75	H Span (H) =	3
Top and Bottom Wrapper Calculations		SA516-70	T1 = 0.5
alpha = a =	(H / h)		0.406
K =	a * (t2 * t2 * t2) / (t1 * t1 * t1)		5.161
Membrane Stress			
Sm =	(P * h) / (2 * t1)		1600
(Sb)N =	$\frac{(P * (t1 / 2))}{(t1^3)} \left[\begin{matrix} (-1.5 * H^2) + h^2 \\ (1 + (a^2 * K)) \end{matrix} \right]$		1809
(Sb)Q =	$\frac{(P * h^2 * (t1 / 2))}{(t1^3)} \left(\frac{1 + (a^2 * K)}{1 + K} \right)$		10259
Total Stress			
(ST)N =	Eq.(1) + Eq.(3)		3409 30000
0			
(ST)Q =	Eq.(1) + Eq. (4)		11859 30000
TubeSheet & PlugSheet Calculations		SA516-70	T2 = 1
LIG Effec= e =	(p - d) / p		0.537
alpha = a =	(H / h)		0.406
K =	a * (t2 * t2 * t2) / (t1 * t1 * t1)		5.161
Membrane Stress			
Sm =	(P * H) / (2 * t1 * e)		519
Bending Stress			
(Sb)M =	$\frac{(P * h^2 * (t2 / 2))}{(e * t2^3)} \left[\begin{matrix} -1.5 + \\ (1 + (a^2 * K)) \end{matrix} \right]$		14006
(Sb)Q =	$\frac{(P * h^2 * t2 / 2)}{(t2^3)} \left(\frac{1 + (a^2 * K)}{1 + K} \right)$		1884
Total Stress			
(ST)M =	Eq.(2) + Eq.(5)		14524 30000
(ST)Q =	Eq.(2) + Eq. (6)		2403 30000
End Plate Calculations		SA516-70	T5 = 0.5
alpha = a =	(H / h)		0.406
K =	a * (t2 * t2 * t2) / (t1 * t1 * t1)		5.161
Z (2.5 max) =	3.4 - 2.4 * (Short Span / Big Span) =		2.425
S =	$\frac{\text{Short Span}^2 * Z * .2 * P}{t5^2}$		5464 20000

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<u>Nozzle Calculations per UG-27/Appendix 1, 1-1</u>					
Pressure (P)	150	Allow Stress (S)	17100		
Nozzle O.D. (D)	6.625	Nozzle Wall (T)	0.432		
Corr Allow (CA)	0.125	Joint Efficiency (E)	0.7		
Material	SA106-B	Std Wt Pipe (SW)	0.28		
T Required (tr)	$\frac{P * (D/2)}{(S * E + .4 * P)}$		0.0413		
Mill Tolerance (MT)	.125 * T		0.0540		
Tmin	tr + MT + CA		0.2203	<	0.4320
	SW + CA		0.4050	<	

<u>Nozzle Calculations per UG-27/Appendix 1, 1-1</u>					
Pressure (P)	150	Allow Stress (S)	17100		
Nozzle O.D. (D)	4.5	Nozzle Wall (T)	0.337		
Corr Allow (CA)	0.125	Joint Efficiency (E)	0.7		
Material	SA106-B	Std Wt Pipe (SW)	0.237		
T Required (tr)	$\frac{P * (D/2)}{(S * E + .4 * P)}$		0.0281		
Mill Tolerance (MT)	.125 * T		0.0421		
Tmin	tr + MT + CA		0.1952	<	0.3370
	SW + CA		0.3620	<	

OUTLET NOZZLE TO B

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Tube Calculations per UG-27 / Appendix 1, 1-1

Pressure (P)	150	Allow Stress (S)	11400
Tube O.D. (D)	1	Tube Wall (T)	0.083
Corr Allow (CA)	0	Joint Efficiency (E)	1
Material	SA214		
T Required (tr)	$\frac{P * (D/2)}{(S * E + .4 * P)}$	0.0065	< 0.0830

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STRESSES DUE TO NOZZLE LOADINGS/WRC BULLETIN 107

(ALL LOADS ARE IN LBS.; ALL MOMENTS ARE IN FT-LBS.; ALL STRESSES ARE IN PSI)

HEADER WIDTH. = 6.0000 WRAPPER THICKNESS = 0.5000 CA=0.1250
 NOZZLE O.D. = 6.6250 PAD THICKNESS = 0.0000 P= 150.00
 RADIAL LOAD P = 2400. SHEAR LOAD VC = 1900. SHEAR LOAD VL = 2400.
 CIRC. MOMENT MC= 3300. LONG MOMENT ML= 2500. TORSIONAL MOMENT MT= 4600.
 STRESS CONCENTRATION FACTORS: MEMBRANE LOAD = 1.0000 BENDING LOAD = 1.0000
 GEOMETRIC PARAMETERS; GAMMA = 7.5000 BETA = 1.0306

VALUE								
AU	AL	BU	BL	CU	CL	DU	DL	FROM CURVE
946.	946.	946.	946.	285.	285.	285.	285.	0.611/ 0.184
1366.	-1366.	1366.	-1366.	3210.	-3210.	3210.	-3210.	0.020/ 0.046
0.	0.	0.	0.	287.	287.	-287.	-287.	0.0326
0.	0.	0.	0.	26050.	-26050.	-26050.	26050.	0.0657
-41.	-41.	41.	41.	0.	0.	0.	0.	0.0062
-972.	972.	972.	-972.	0.	0.	0.	0.	0.0032

SUMMATION

1298. 511. 3325. -1351. 29833. -28687. -22842. 22838. CIRC. STRESSES

285.	285.	285.	285.	946.	946.	946.	946.	0.184/ 0.611
3210.	-3210.	3210.	-3210.	1366.	-1366.	1366.	-1366.	0.046/ 0.020
0.	0.	0.	0.	1619.	1619.	-1619.	-1619.	0.1838
0.	0.	0.	0.	11674.	-11674.	-11674.	11674.	0.0295
-92.	-92.	92.	92.	0.	0.	0.	0.	0.0137
-2178.	2178.	2178.	-2178.	0.	0.	0.	0.	0.0073

SUMMATION

1226. -839. 5765. -5010. 15605. -10474. -10981. 9635. LONG. STRESSES

2135.	2135.	2135.	2135.	2135.	2135.	2135.	2135.	2135.
487.	487.	-487.	-487.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-615.	-615.	615.	615.	615.

SUMMATION

2622. 2622. 1648. 1648. 1520. 1520. 2750. 2750. SHEAR STRESSES

COMBINED STRS.

5244. 5415. 6595. 5643. 29994. 28813. 23449. 23388. INTENSITY

MAXIMUM STRESS = 29994.
 YIELD = 38000.
 YIELD FACTOR = 0.8000
 ALLOWABLE STRESS = 30400.

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STRESSES DUE TO NOZZLE LOADINGS/WRC BULLETIN 107

(ALL LOADS ARE IN LBS.; ALL MOMENTS ARE IN FT-LBS.; ALL STRESSES ARE IN PSI)

HEADER WIDTH. = 6.0000 WRAPPER THICKNESS = 0.5000 CA=0.1250
 NOZZLE O.D. = 4.5000 PAD THICKNESS = 0.0000 P= 150.00
 RADIAL LOAD P = 1300. SHEAR LOAD VC = 1600. SHEAR LOAD VL = 1600.
 CIRC. MOMENT MC= 1300. LONG MOMENT ML= 1300. TORSIONAL MOMENT MT= 1900.
 STRESS CONCENTRATION FACTORS: MEMBRANE LOAD = 1.0000 BENDING LOAD = 1.0000
 GEOMETRIC PARAMETERS; GAMMA = 7.5000 BETA = 0.7000

OUTLET NOZZ

VALUE
 AU AL BU BL CU CL DU DL FROM CURVE
 1044. 1044. 1044. 1044. 543. 543. 543. 543. 0.847/ 0.440
 1086. -1086. 1086. -1086. 2089. -2089. 2089. -2089. 0.020/ 0.038
 0. 0. 0. 0. 1829. 1829. -1829. -1829. 0.2435
 0. 0. 0. 0. 24350. -24350. -24350. 24350. 0.0720
 -2034. -2034. 2034. 2034. 0. 0. 0. 0. 0.2707
 -3945. 3945. 3945. -3945. 0. 0. 0. 0. 0.0117

 SUMMATION
 -3848. 1868. 8109. -1953. 28811. -24067. -23547. 20974. CIRC. STRESSES

543. 543. 543. 543. 1044. 1044. 1044. 1044. 0.440/ 0.847
 2089. -2089. 2089. -2089. 1086. -1086. 1086. -1086. 0.038/ 0.020
 0. 0. 0. 0. 5336. 5336. -5336. -5336. 0.7102
 0. 0. 0. 0. 11983. -11983. -11983. 11983. 0.0354
 -1450. -1450. 1450. 1450. 0. 0. 0. 0. 0.1930
 -7549. 7549. 7549. -7549. 0. 0. 0. 0. 0.0223

 SUMMATION
 -6367. 4553. 11630. -7645. 19449. -6690. -15189. 6605. LONG. STRESSES

1911. 1911. 1911. 1911. 1911. 1911. 1911. 1911.
 604. 604. -604. -604. 0. 0. 0. 0.
 0. 0. 0. 0. -604. -604. 604. 604.

 SUMMATION
 2515. 2515. 1308. 1308. 1308. 1308. 2515. 2515. SHEAR STRESSES

COMBINED STRS.
 7920. 6061. 12063. 7931. 28990. 24165. 24246. 21402. INTENSITY

MAXIMUM STRESS = 28990.
 YIELD = 38000.
 YIELD FACTOR = 0.8000
 ALLOWABLE STRESS = 30400.

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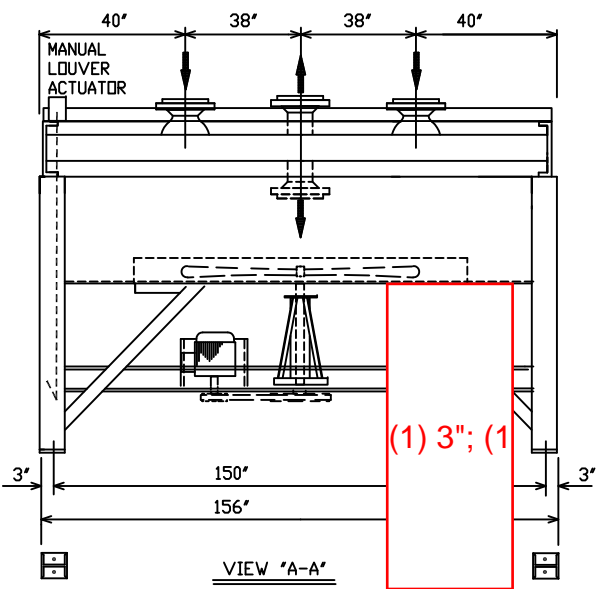
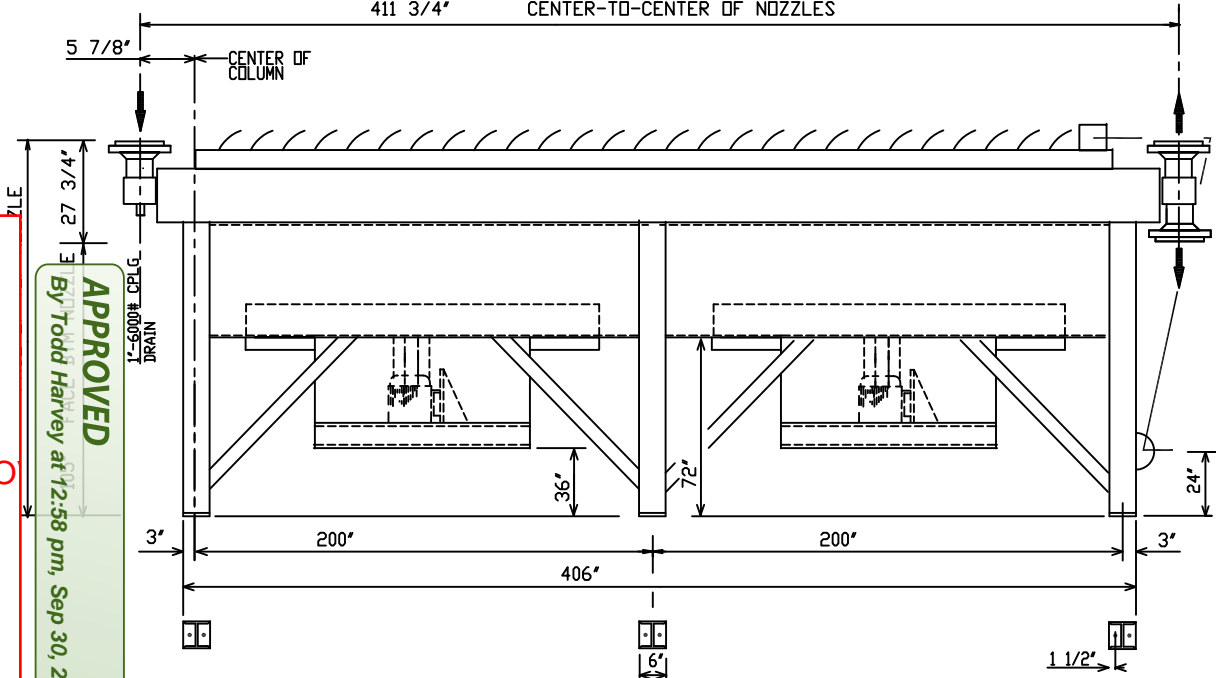
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MAX NOZZLE LOADS		
	6"	4"
P (L.B)	2400	1300
VC (L.B)	1900	1600
VL (L.B)	2400	1600
MC (FT.LB)	3300	1300
ML (FT.LB)	2500	1300
MT (FT.LB)	4600	1900

411 3/4" CENTER-TO-CENTER OF NOZZLES



DESIGN DATA		HE-2720
DESIGN PRESSURE P.S.I.G.	150	
VACUUM PRESSURE P.S.I.G.	15 (F.V.)	
TEST PRESSURE P.S.I.G.	195	
DESIGN TEMP. Deg.F.	250	
MDMT Deg. F.	-20	
CORROSION ALLOWANCE	1/8"	
NUMBER OF ROWS/PASSES	4 / 1	
NUMBER OF TUBES	266	
TUBE O.D.	1"	
TUBE WALL	14bwg	
TUBE LENGTH	30'-0"	
FIN HEIGHT	5/8"	
FINS/INCH	10	
FIN TYPE	L-FOOTED	
TUBE PITCH	2 5/16" TRI	
SURFACE (FIN/BARE) SQFT	50064 / 2328	
TUBE MATL	SA-214	
HEADER MATL	SA-516-70	
HEADER TYPE	WELDED BOX W/ PLUGS	
INLET NOZZLE	(2) 6"	
OUTLET NOZZLE	(2) 4"	
FLANGE RATING	150# RFWN	
VENT/DRAIN	1"-6000# CPLG	
RADIOGRAPHY	NONE	
HEAT TREAT REQUIRED	NONE	
LOUVERS	MANUAL	
BUNDLE WEIGHT, LBS	16,000	

ESTIMATED WEIGHTS, LBS. (EACH)	
DRY: 33,500	WET: 34,900

SPECIFICATIONS

ASME CODE SECT. VIII DIV.1, 2010 EDD, 2011a ADD (STAMP YES)
 WIND SPEED : 163MPH
 SEISMIC ZONE : 4

DRIVE SYSTEM	GENERAL NOTES
FANS: (2) 11'-6 BLADE, MANUAL ADJUST 303 RPM / 10462FPM TIP SPEED 2 7/16" SHAFT MOTORS: (2) 25HP, TEFC, 284T FRAME ELECTRIC, 460V/3P/60C 1 SPEED, 1750 RPM, 1.15 S.F. DRIVE: V-BELT, 5.7:1 REDUCTION RATIO 1.4 S.F. VIBRATION SWITCH (2) MURPHY 2-VS-EX 2 SPDT	ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES. PAINT: HEADERS - TAN EPOXY STRUCTURE - GALVANIZE TUBE-TO-TUBESHEET JOINT: GROOVED & EXPANDED CUST: OBERON FUELS P.O. NO.: TEX-16SEP13 ITEM NO.: HE-2720 SERVICE: PURIFICATION COLUMN CONDENSER

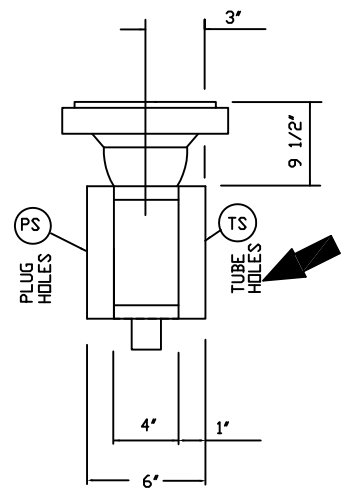
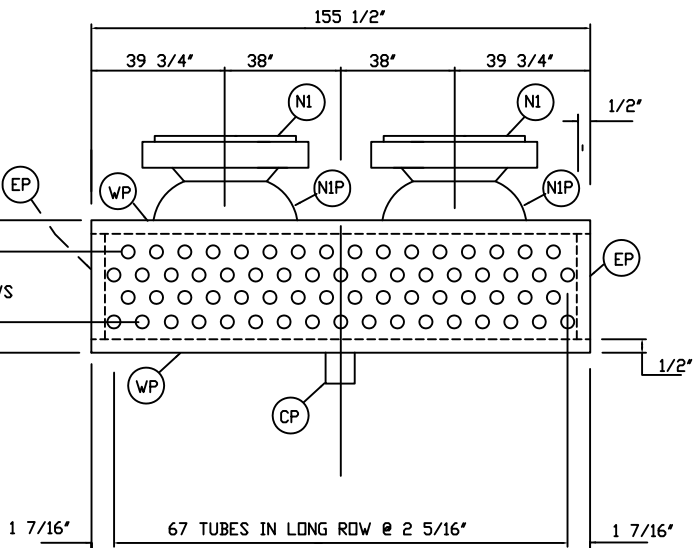
ASSEMBLY AND SPECIFICATIONS FOR	
ONE 13-34-D11-H25-FVD	
DWN. BY Eng	
DATE 9-24-13	
CKD. BY sdf	DWG.NO. 18680-3-A

NO.	DATE	REVISIONS

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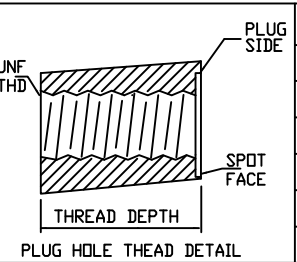
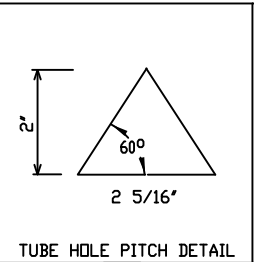
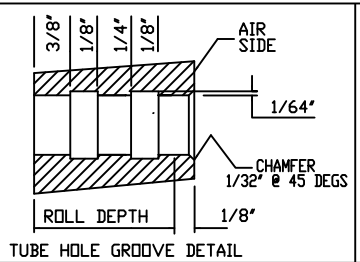
DESIGN DATA	
TUBES: (266) 1" OD	RADIOGRAPH: NONE
PLUGS: 1 1/8" SHOULDER	HEAT TREAT: ND
ROWS: 4	IMPACT TEST: NONE
PASSES: 1	FINISH: TAN EPOXY FINISH

- NOTES**
- 1) STAMP TS WITH SERIAL NUMBER
 - 2) EXAMINE ALL MATERIAL BEFORE AND DURING FABRICATION IN ACCORDANCE WITH UG-93(d)
 - 3) L.P.T. ALL PLATES FOR LAMINATION BEFORE AND AFTER WELDING AS REQUIRED BY A.S.M.E.
 - 4) L.P.T. NOZZLE HOLE CUT-OUTS AS REQUIRED BY A.S.M.E.
 - 5) L.P.T. ALL WELDS AS REQUIRED BY A.S.M.E.
 - 6) ALL BOLT HOLES TO STRADDLE NATURAL CENTERLINES
 - 7) REAM TUBE HOLES 1.012" (+/-0.002") & GROOVE PER DETAIL
 - 8) TAP PLUG HOLES FOR 1 1/8" DIA - 12UNF THD SHOULDER PLUG PER DETAIL AND SPOTFACE 1 1/2" DIA X 1/32" DEEP
 - 9) SEE DRAWING "B" FOR WELD AND BEVEL DETAILS
 - 10) CENTER PASS PLATES BETWEEN TUBE ROWS

BILL OF MATERIALS			
PART	QTY	DESCRIPTION	MATERIAL
TS	1	1" X 8 3/4" X 155 1/2"	SA516-70
PS	1	1" X 8 3/4" X 155 1/2"	SA516-70
WP	2	1/2" X 4" X 155 1/2"	SA516-70
EP	2	1/2" X 4" X 7 3/4"	SA516-70
NI	2	6" - 150# RFWN W/ SCH80 BORE	SA105
NIP	2	6" - SCH80 TRANSITION SWAGE	SA234-WPB
CP	1	1" - 6000# CPLG W/ PLUG	SA105
PLG	266	1 1/8"-12UNF-1" LG SHLD PLUG	SA105
GSK	266	FOR 1 1/8" SHOULDER PLUG	S.I.

MAX HARDNESS 225 BRINNELL

SEE DWG "A" FOR ALLOWABLE NOZZLE LOADS



NO.	DATE	REVISIONS

FRONT HEADER DETAIL

DWN. BY PLT	TEX-FIN, INC. HOUSTON, TEXAS 281-821-1750 www.tex-fin.com
DATE 9-24-13	
CKD. BY D.HOLK	DWG.NO. 18680-3-C

