

Indiana Heat Transfer Projection Information

Revisions

Indiana Heat Transfer

Sales Engineer	Wm. Harris	
Project Engineer		
Request For Estimate No.	1392	RFE
RFQ Number		
BM Number		Part Number
Sales Representative		

Initial Date	2-Feb-03
Revision Date	20-Feb-03
Revision Level	3

Rev 3 Bolted Tank series O/C and CAC

Model - Project # Or Name	Pelican LNG	
Engine Manufacturer	Cummins	
Engine Configuration	FR 91134 2000 2000 RPM	
Engine Configuration No.	2	Used for Lookup Tbl
Horsepower	130	
Fan Diameter	26.0	inches
Transmission Model		
Transmission Oil Flow		GPM
Print Number		
Est.'d Annual Usage	20	

Customer Address	
City State	
Telephone	
FAX	
Contact	
Email Address	
Engineer	
Email Address	

Cooling System Envelope Size

Maximum Height	34.00	in
Maximum Width	29.00	in
Maximum Depth	8.00	in

Engine Operating Speed	2,000	RPM
Coolant Flow Rate	38.0	GPM
Fan Drive Ratio	1.00	:1
Heat Rejection to Coolant	4,120	Btu/min
Max. Top Tank Temp.	212	F
Max. Ambient Temp.	110	F

Radiator Heat Loading from Additional Components in the Upstream

Air Flow	
Charge Air Cooler	1,000.0 BTU/Min
Condenser	BTU/Min
Hydraulic Cooler	BTU/Min
Air to Oil Trans Cooler	1,246.9 BTU/Min
Bottom Tank Trans Cooler	BTU/Min
Fuel Cooler	BTU/Min
Engine Oil Cooler	BTU/Min

Fan Manufacturer	ECS 412702
Fan Part Number	
Blower or Suction Fan	Blower

Projected Radiator Performance

Velocity	988	ft/min
Air Flow Volume	5,130	ft ³ /min
Air Side Resistance	1.126	inches H2O
SAE Air to Boil Temp.	147.1	F
Internal Delta P	0.24	PSI
Radiator % of Requirement	4.72%	Heat Rej Capacity
Cummins LAT or ATB	113.1	F

Fan Correction Factors

Fan Sweeps >65% of Core	Y	(Y or N)
Sucker or Blower Fan	B	(S or B)
Fan to Core Face Distance	4.00	inches
Shroud Type	Box	(Box, Ring, Venturi)
Fan Diameter	26.0	inches
Fan Tip Clearance	1.00	inches
Type of Engine	In-Line	(In-Line, Small V, Large V)
Engine Compartment Restriction Factor	50%	% Closed
Fan Shroud Derate Factor	57.89%	

Engine Performance Data Chart

Engine Config #	Engine FR Number	Heat Rej (BTU/min)	Engine RPM	Coolant Flow Rate (GPM)	Fan Drive Ratio :1	Maximum Top Tank Temperature (F)	HP
1	FR 91134 1600	3,675	1,600	29	1.00	212	127
2	FR 91134 2000	4,120	2,000	38	1.00	212	130
3	FR 91134 2800	5,886	2,800	51	1.00	212	195
4							
5							
6							
7							
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9							
10							

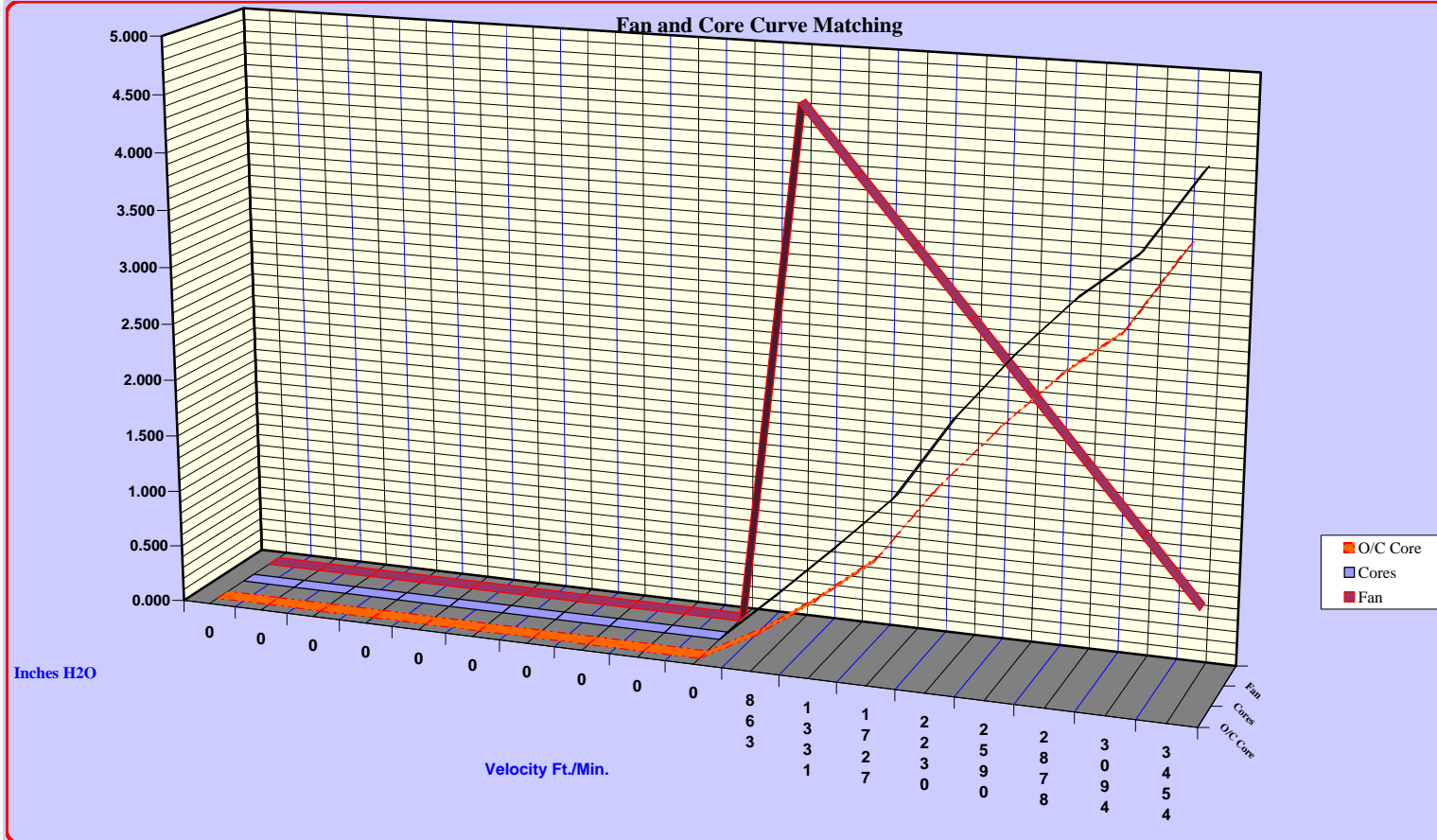
Performance

Projection Based On Ethylene Glycol	Y	7 Deg. Change for E/G	Radiator Sizing Parameters		
Overall Width (Over Channels)	29.00	inches	Environment		
Overall Height (Across Tanks)	34.00	inches	Max Tank Length 26.75 in.		
Max. Overall Depth (Front to Back)	8.00	inches	Max Tank Depth (frt to back) 5.750 in.		
Core Type (RC, RFN, STCB, LCM...)	RC		Max Core Width 26.75 in.		
No. of Rows	8	OK	Typical Application		
Maximum Core Depth Allowed	5.538	inches	Agricultural RC Max. Core Width 26.875 in.		
Calculated Core Depth	4.810	inches	Proposed Tanks		
Maximum Calculated Core Width	26.875	inches	Soldered or Bolted (S or B) B Bolted Dim is		
Max. Distance Between Headers	27.810	inches	If Tanks are to be Fab.'d or Drawn (F or D) F Over Tank Body		
Fins/inch	12		Fabricated, enter Stock Top Tank P/N Add 2" for Over		
Calculated Radiator Frontal	5.19	ft^2	Dimensions in the Stock Bottom Tank P/N Channel Dim.		
Deaeration & Drawdown Req.'d (YorN)	Y	(Y or N)	Height 3.000 Depth 6.000 Length 27.000		
Engine Coolant Capacity	10	Quarts	Top Tank Dim.'s 3.000 Bottom Tank Dim.'s 3.000		
Req.'d Drawdown as % of System	1.023	Quarts	Will Top Tank Have Fab.'d Tank is Similar to:		
% of Total System Req'd for Drawdown	3.00%		Draw Down Capacity Inlet ID 1.75 in.		
Tank Side ByPass Tube Diameter	0.75	inches	Outlet ID 2.00 in.		
Customer Engineering Data			Works Fine		
Engine Speed	2,000	RPM	LINKS		
Radiator Coolant Flow Rate	38	GPM	Transmission Oil Cooler Hydraulic Oil Cooler BTU/Min/F Air Side Delta P		
Customer Estimated Air Velocity		ft/min	Fan Curve Link IHTC Tested % of Standard 100.00% 100.00%		
Engine Heat Rejection to Coolant	4,120	BTU/min	Duty Cycle 100.00%		
Bottom Tank Oil Cooler Heat Rejection	0	BTU/min	Temp. Rise (F) From Other Coolers in Sy.		
Engine Heat Rejection to Air		BTU/min>	0.00		
Charge Air Cooler In Front	1,000	BTU/min>	10.83		
A/C Condensor in Front	0	BTU/min>	0.00		
Hydraulic Oil Cooler in Front	0	BTU/min>	0.00		
Air to Oil Trans. Oil Cooler in Front	1,247	BTU/min>	13.50		
Fuel Cooler In Front	0	BTU/min>	0.00		
Engine Oil Cooler in Front	0	BTU/min>	0.00		
After Cooler or other Cooler in Front		BTU/min>	0.00		
Heat Rejection of Side by Side Cooler		BTU/Min	Total 24.3F Rise		
Additional Resistance From Coolers	0.77	inches H2O			
Any Additional Heat	10	F	Width Height		
Heat Rise Associated with a Pusher Fan (F)					
Additional Frontal (Side by Side) ft^2	0.00		Fan Tip Speed		
Max Ambient Temperature Allowed	110	F	13,614 ft/min		
Max Allowable Top Tank Temperature	212	F	Live Tubes		
Fan Drive Ratio	1.00	:1	340		
Installed Fan System Efficiency	57.89%	Estimate			
Oil Cooler Resistance At Air Velocity	0.77	inches H2O			
Oil Cooler Heat Rejection at Velocity	1,247	BTU/Min			
Total Direct Heat Rejection	4,120	BTU/min			
Rise From Other Coolers & Engine	24.3	F			
System ITD	67.7	F			
Cooler efficiency Ca/Cw	56.09%				
Revision Date February 20, 2003			Projected Installed Performance		
Customer Address City State Telephone FAX			Tube Coolant Velocity 0.80 ft/s		
Contact Engineer			Derated Air Velocity Rate 988.5 ft./min		
RFE: 1392 BM No:			Rad. BTU/min-F Required 60.88 BTU/min-F		
Model - Project # Or Name Pelican LNG revision 3			Projected BTU/min-F 63.76 BTU/min-F		
Engine Manufacturer Cummins			% of Requirement 4.72%		
Engine Configuration FR 91134 2000 2000 RI			Total Radiator Capability 4,314.6 BTU/min		
Engine Configuration No. 2 Manufacturer & Model			Radiator ITD Capability 64.62 F		
Fan Info. (Dia., Mfg., Model) 26 in. ECS 412702			Top Tank Temperature 208.95 F		
Transmission Model			System Air Temp. Out 188.95 F		
Transmission Oil Flow			Radiator Coolant Out Temp. 195.50 F		
			Oil Cooler Heat Rejection 1,247 BTU/min		
			Oil Cooler Air Resistance 0.77 Inches H2O		
			Oil Cooler Oil Side Delta P PSI		
			Military Spec. Method 148.1 F Air To Boils		
			John Deere Method 119.8 F		
			Max Top Tank Method 113.1 F (Cummins LAT)		
			SAE Air to Boil Method 147.1 F		
			System Cavitation Temp. 246.1 F		
			Air To Boil Notes:		
			Cummins Std. and Mil. Spec. Air to Boil is Specified by		
			Coolant Boiling Point (212(F)) - Top Tank (F) + Ambient (F)		
			(Test must be run with water)		
			John Deere Air to Boil is Specified by		
			Max. Allowable Top Tank Temp. - 5(F) - Delta T - 6(F) for		
			50/50 EG - 2(F)/1000' of elevation - Any Preheating (F)		
			Delta T = Heat Rejection to Coolant (BTU/Min)		
			Divided by Radiator Heat Rej (BTU/Min/F)		
			Max Top Tank Method		
			1. Max Allowable Top Tank - Projected Top Tank + Ambient		
			SAE Air to Boil Method		
			2. SAE ATB = 226F+(2*sys press.)-Pcj Top Tank+Ambient.		
			Boiling Point of 50% Water & Glycol is 226F at Sea Level.		

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Fan No. & Mfg.	KYSAIR - Borg W.	Fan Application Factor	1.0680	CFM
Fan Curve RPM	2,500	Fan Application Factor	1.1406	Resistance
Frontal Surface	1.48	Elevation	0.00	Ft.
Application RPM	2,670	Elevation Adjust	1.00	Delta P %
	<<-If 0 enter engine speed & drive ratio on Performance Page			

Fan Curve Data			Adjusted For Application RPM				LINKS	Adjustment for Air Side Delta P Based on Wind Tunnel Test of Radiator
Enter Either SCMS or CFM from Fan Curve			Adjusted Fan CFM	Adj. Fan Delta P	Velocity ft/min	Inches H2O Delta P Fan	Inches H2O Delta P all Cores	Inches H2O of Oil Cooler
m^3/s	ft^3/min	Delta P in Water						
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
0	0.00				0			0.000
1,200	4.00		1,282	4.562	863	4.562	0.448	0.268
1,850	3.50		1,976	3.992	1331	3.992	0.911	0.616
2,400	3.00		2,563	3.422	1727	3.422	1.396	1.016
3,100	2.50		3,311	2.852	2230	2.852	2.124	1.662
3,600	2.00		3,845	2.281	2590	2.281	2.715	2.215
4,000	1.50		4,272	1.711	2878	1.711	3.227	2.713
4,300	1.00		4,592	1.141	3094	1.141	3.633	3.117
4,800	0.50		5,126	0.570	3454	0.570	4.351	3.851



Calculate Intersection of Radiator Curve	
Upper Tick Point Value	
Lower Tick Point Value	
Est.'d % Between Tick Points	
Calculated Intersection Point	2.453 2.48
Installed Velocity	1,516 61.79%

Core Information	
Type	RC
Rows	5
Fins/Inch	8
REVISION	2

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Automated Match Values
 Velocity: 2,453 Resistance: 2.50
 Note: If Automated values for the intersection point appear invalid, you can manually estimate the intersection point.

Calculate Intersection of Oil Cooler Curve	
Upper Tick Point Value	
Lower Tick Point Value	
Est.'d % Between Tick Points	
Calculated Intersection Point	2,607 2.25
Installed Velocity	1,611 61.79%

Automated Match Values
 Velocity: 2,607 Resistance: 2.25

In-Line Oil Cooler Performance Curves And Project Information

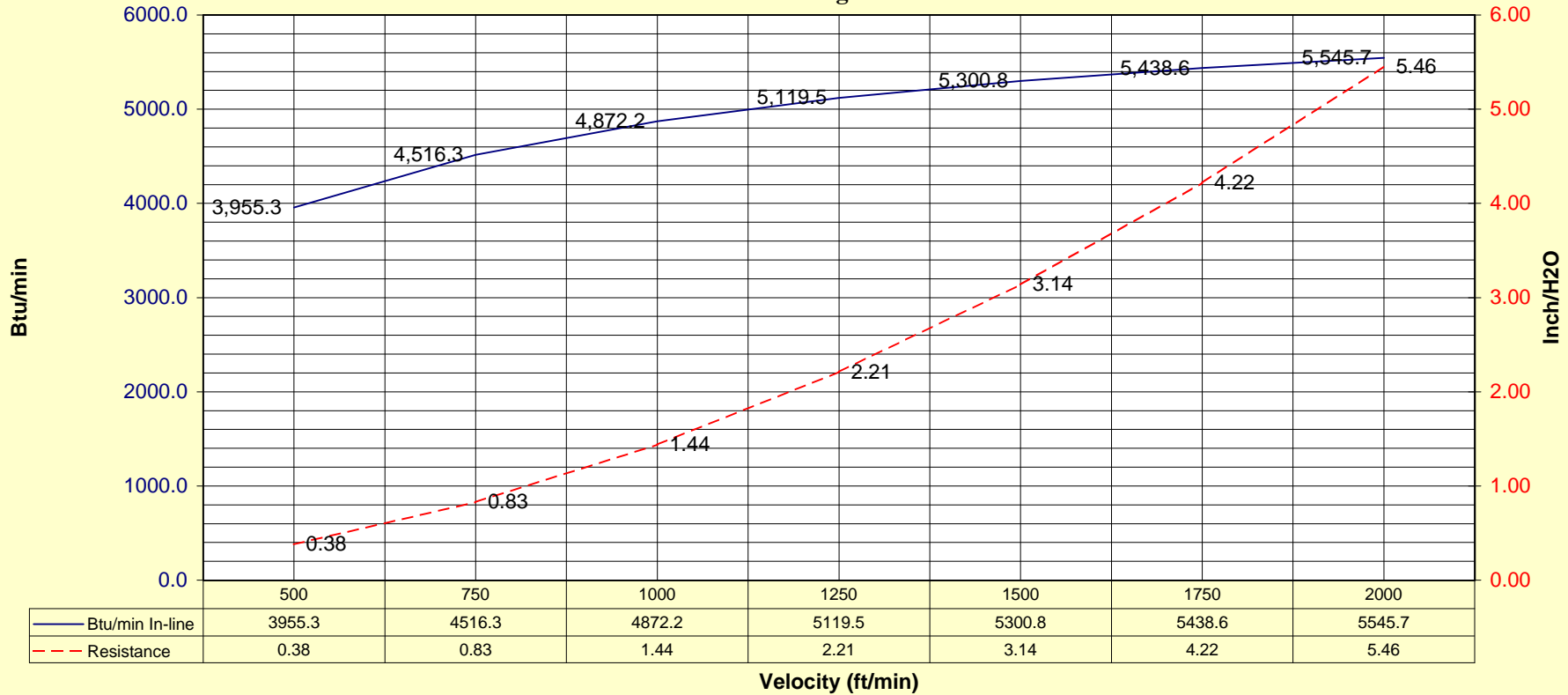
Core Width (in)	22.00
Core Fined Height (in)	38.50
Rows of Tubes	6

Fins/Inch	6
Passes	1
Fin Ga	0.012

Air In Temp. F	105
Oil In Temp. F	250
Turbulator dia.	0.05

Oil Flow (GPM)	38.00
Oil Type	10W40
Oil Side Delta P (PSI)	4.47
Tube Gage	0.016

In-Line Configuration



Air Velocity (ft/min)	500	750	1000	1250	1500	1750	2000
Coolant Out Temperature (F)	222.1	218.2	215.7	214.0	212.7	211.7	210.9

03/06/01

Fan Velocity Match	1,085	ft/min
Heat Rejection at Match	4966.0	Btu/min
Resistance At Match	1.68	inches Water

Customer:	Euclid-Hitachi
Address:	22221 Saint Clair Ave.
City, State:	Cleveland, OH 44117-2522

REVISION	5
Project:	EH-650
RFE:	1081
Customer No.:	

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Charge Air Cooler Specifications RFE-1433 - Engine: FR2839 1800 RPM-1 385 HP

Measured Air Flow to Standard Air Correction

Measured Air Velocity	511	Ft/Min @ 77F
Frontal	1.00	Ft.^2
Air Flow	511	Ft.^3/Min.
Measured Air Temp.	77.0	F
Barometer	30.00	"hg
Corrected Air Flow	504	Ft.^3/Min.
Corrected Velocity	504	Ft./Min.

RFE:	1433
Engine Mfg:	Cummins
Configuration	FR2839 1800 RPM
HP:	385

Charge Air Cooler Heat Rejection Calculation

Max Heat Rise between Ambient Air and Engine Air Inlet Deg.'s F	63	F (IMTD)
Evaluation Temperature	77	F
Charge Air Flow	62	Lbs/min
Turbo Compressor Outlet Temp Deg.'s F	329	F
Turbo Compressor Outlet Pressure in Hg.	53	inches Hg
Turbo Compressor Outlet Pressure	26.0	PSI
Inlet Air Flow	838.5	CFM

Calculate CFM at Temperature

Air Flow	62	lb/min
Temperature	77	F
Barometer	30.0	"hg
Specific Wt	0.073946	lb/ft^3
Air Flow	838	ft^3/min

Inlet Flow at system Temp use above calculation and

Enter System Air Here-->	838	CFM
Delta T air	189.0	F
Heat Rej. At Std Air	2,852	BTU/min at Standard Air
Heat Rej. at System Air	2,852	BTU/min at System Air
	171,145	BTU/hr

Cummins Application Worst Case Evaluation Method

Ambient Rise F	30	F
Mass Internal Flow	3,720	Lb/hr
Maximum Ambient Temperature	135	F
Turbo Air Inlet Temp	165	F
Target Inlet Manifold Temp	198	F
Turbo Out at Max Ambient	452.2	F
Heat Rejection	3,798	BTU/min
Heat Rejection	227,895	BTU/Hr
External Air Velocity	1,208	Ft/min
External Air flow at Matching Resistance	1.02	inches of Water

Charge Air Cooler Physical Sizing & Flow

Series or Parallel (S or P)	P
Width (Stacked Height - inches)	25.00
Height (Header to Header - Inches)	35.00
Inlet Tube Diameter (inches)	4.00
Outlet Tube Diameter (inches)	4.00
Standard External Air Flow (SCFM)	7,340
Mass External Air Flow (Lb/min)	542.8
Specific Wt at Worst Case (lb/CFM)	0.06674
Mass at worst Case (Lb/min)	489.9