American Industrial
Heat Transfer Inc.
Manufacturer of Quality Heat Exchangers

AB2000 SERIES

Fixed Tube Bundle / Liquid Cooled

HEAT EXCHANGERS

- High thermal capacity.
- Large flow capacity.
- Operating pressure for tubes 150 PSI.
- Operating pressure for shell 300 PSI.
- Operating temperature 300 °F.
- Computer generated data sheet available for any application
- Can be customized to fit any applications.
- As an option, available in ASME code and certified

AB 2000 Series *selection*

STEP 1: Calculate the heat load

The heat load in BTU/HR or (Q) can be derived by using several methods. To simplify things, we will consider general specifications for hydraulic system oils and other fluids that are commonly used with shell & tube heat exchangers.

Terms

- GPM = Gallons Per Minute
- CN = Constant Number for a given fluid
- $\triangle$T = Temperature differential across the potential
- PSI = Pounds per Square Inch (pressure) of the operating side of the system
- MHP = Horsepower of the electric motor driving the hydraulic pump
- Kw = Kilowatt (watts x 1000)
- T_{in} = Hot fluid entering temperature in °F
- T_{out} = Hot fluid exiting temperature in °F
- t_{in} = Cold fluid temperature entering in °F
- t_{out} = Cold fluid temperature exiting in °F
- Q = BTU / HR

For example purposes, a hydraulic system has a 250 HP (186Kw) electric motor installed coupled to a pump that produces a flow of 200 GPM @ 2000 PSIG. The temperature differential of the oil entering the pump *vs* exiting the system is about 4.3°F. Even though our return line pressure operates below 100 psi, we must calculate the system heat load potential (Q) based upon the prime movers (pump) capability. We can use one of the following equations to accomplish this:

To derive the required heat load (Q) to be removed by the heat exchanger, apply ONE of the following. Note: The calculated heat loads may differ slightly from one formula to the next. This is due to assumptions made when estimating heat removal requirements. The factor *(v)* represents the percentage of the overall input energy to be rejected by the heat exchanger. The *(v)* factor is generally about 30% for most hydraulic systems, however it can range from 20%-70% depending upon the installed system components and heat being generated (ie. servo valves, proportional valves, etc…will increase the percentage required).

	Formula	Example
A)	Q = GPM x CN x actual $\triangle$T	Q =200 x 210 x 4 .3°F = 180,600 BTU/HR
B)	Q = [(PSI x GPM) / 1714] x (*v*) x 2545	Q =[(2000x200)/1714] x .30 x 2545 = 178,179 BTU/HR
C)	Q = MHP x (*v*) x 2545	Q =250 x .30 x 2545 = 190,875 BTU/HR
D)	Q = Kw to be removed x 3415	Q =186 x .30 x 3415 = 190,557 BTU/HR
E)	Q = HP to be removed x 2545	Q =75 x 2545 = 190,875 BTU/HR

Constant for a given fluid (CN)

1) Oil .... CN = 210
2) Water......................... CN = 500
3) 50% E. Glycol........... CN = 450

STEP 2: Calculate the Mean Temperature Difference

When calculating the MTD you will be required to choose a liquid flow rate to derive the Cold Side $\triangle$T. If your water flow is unknown you may need to assume a number based on what is available. As a normal rule of thumb, for oil to water cooling a 2:1 oil to water ratio is used. For applications of water to water or 50 % Ethylene Glycol to water, a 1:1 ratio is common.

Formula

HOT FLUID $\triangle$T Oil $= \dfrac{Q}{\text{CN x GPM}}$

COLD FLUID $\triangle$t Water $= \dfrac{\text{BTU / hr}}{\text{CN x GPM}}$

Example

$\triangle T = \dfrac{\text{190,875 BTU/hr}}{\text{210 CN x 200GPM}}$ (from step 1,item c) = 4.54°F = $\triangle$T Rejected

$\triangle t = \dfrac{\text{190,875 BTU/hr}}{\text{500 CN x 100GPM}}$ (for a 2:1 ratio) = 3.81°F = $\triangle$t Absorbed

- T_{in} = Hot Fluid entering temperature in degrees F
- T_{out} = Hot Fluid exiting temperature in degrees F
- t_{in} = Cold Fluid entering temperature in degrees F
- t_{out} = Cold Fluid exiting temperature in degrees F

- T_{in} = 104.54 °F
- T_{out} = 100.0 °F
- t_{in} = 90.0 °F
- t_{out} = 93.81 °F

$$\frac{T_{out} - t_{in}}{T_{in} - t_{out}} = \frac{\textbf{S}\text{[smaller temperature difference]}}{\textbf{L}\text{ [larger temperature difference]}} = \left(\frac{S}{L}\right)$$

$$\frac{100.0°F - 90.0°F = 10.0°F}{104.54°F - 93.81°F = 10.73°F} = \frac{10.0°F}{10.73°F} = .931$$

STEP 3: Calculate Log Mean Temperature Difference (LMTD)

To calculate the LMTD please use the following method;

$LMTD_i$ = L x M (L = Larger temperature difference from step 2.) x (M = S/L number (LOCATED IN TABLE A))

$LMTD_i$ = 10.73 x .964 (FROM TABLE A) = 10.34

To correct the $LMTD_i$ for a multipass heat exchangers calculate **R** & **K** as follows:

Formula

$$\mathbf{R} = \frac{T_{in} - T_{out}}{t_{out} - t_{in}} \qquad \mathbf{K} = \frac{t_{out} - t_{in}}{T_{in} - t_{in}}$$

Example

$$\mathbf{R} = \frac{104.54°F - 100°F}{93.81°F - 90°F} = \frac{4.54°F}{3.81°F} = \mathbf{\{1.191=R\}}$$

$$\mathbf{K} = \frac{93.81°F - 90°F}{104.54°F - 90°F} = \frac{3.81°F}{14.54°F} = \mathbf{\{0.262=K\}}$$

Locate the correction factor CF_B (FROM TABLE B)

$LMTD_c = LMTD_i$ x CF_B

$LMTD_c$ = 10.34 x .98 = **10.13**

TABLE C

U	TUBE FLUID	SHELL FLUID
400	Water	Water
350	Water	50% E. Glycol
100	Water	Oil
300	50% E. Glycol	50% E. Glycol
90	50% E. Glycol	Oil

TABLE E- Flow Rate for Shell & Tube

Shell dia . Code	Max. Liquid Flow - Shell Side Baffle Spacing A	B	C	D	E	Liquid Flow - Tube Side SP Min.	SP Max.	TP Min.	TP Max.	FP Min.	FP Max.
2000	–	–	190	370	550	90	650	45	320	25	160

STEP 4: Calculate the area required

$$\textbf{Required Area sq.ft.} = \frac{Q\ (BTU / HR)}{LMTD_c \times U\ (\text{FROM TABLE } C)} \qquad \frac{190{,}875}{10.13 \times 100} = \textbf{188.4 sq.ft.}$$

STEP 5: Selection

a) From TABLE E choose the correct series size, baffle spacing, and number of passes that best fits your flow rates for both shell and tube side. Note that the tables suggest minimum and maximum information. Try to stay within the 20-80 percent range of the indicated numbers.

Example

Oil Flow Rate = 200 GPM = Series Required from Table E = **2000 Series**
Baffle Spacing from Table E = **D baffle**
Water Flow Rate = 100 GPM = Passes required in 2000 series = **4 (FP)**

b) From TABLE D choose the heat exchanger model size based upon the sq.ft. or surface area in the series size that will accommodate your flow rate.

Example

Required Area = 188.4 sq.ft Closest model required based upon sq.ft. & series = **AB-2007-D6-FP**

If you require a computer generated data sheet for the application, or if the information that you are trying to apply does not match the corresponding information, please contact our engineering services department for further assistance.

TABLE A- FACTOR M/LMTD = L x M

S/L	M	S/L	M	S/L	M	S/L	M
		.25	.541	.50	.721	.75	.870
.01	.215	.26	.549	.51	.728	.76	.874
.02	.251	.27	.558	.52	.734	.77	.879
.03	.277	.28	.566	.53	.740	.78	.886
.04	.298	.29	.574	.54	.746	.79	.890
.05	.317	.30	.582	.55	.753	.80	.896
.06	.334	.31	.589	.56	.759	.81	.902
.07	.350	.32	.597	.57	.765	.82	.907
.08	.364	.33	.604	.58	.771	.83	.913
.09	.378	.34	.612	.59	.777	.84	.918
.10	.391	.35	.619	.60	.783	.85	.923
.11	.403	.36	.626	.61	.789	.86	.928
.12	.415	.37	.634	.62	.795	.87	.934
.13	.427	.38	.641	.63	.801	.88	.939
.14	.438	.39	.648	.64	.806	.89	.944
.15	.448	.40	.655	.65	.813	.90	.949
.16	.458	.41	.662	.66	.818	.91	.955
.17	.469	.42	.669	.67	.823	.92	.959
.18	.478	.43	.675	.68	.829	.93	.964
.19	.488	.44	.682	.69	.836	.94	.970
.20	.497	.45	.689	.70	.840	.95	.975
.21	.506	.46	.695	.71	.848	.96	.979
.22	.515	.47	.702	.72	.852	.97	.986
.23	.524	.48	.709	.73	.858	.98	.991
.24	.533	.49	.715	.74	.864	.99	.995

TABLE B- LMTD correction factor for Multipass Exchangers

R (rows), K (columns)

	.05	.1	.15	.2	.25	.3	.35	.4	.45	.5	.6	.7	.8	.9	1.0
.2	1	1	1	1	1	1	1	.999	.993	.984	.972	.942	.908	.845	.71
.4	1	1	1	1	1	1	.994	.983	.971	.959	.922	.855	.70		
.6	1	1	1	1	1	.992	.980	.965	.948	.923	.840				
.8	1	1	1	1	.995	.981	.965	.945	.916	.872					
1.0	1	1	1	1	.988	.970	.949	.918	.867	.770					
2.0	1	1	.977	.973	.940	.845	.740								
3.0	1	1	.997	.933	.835										
4.0	1	.993	.950	.850											
5.0	1	.982	.917												
6.0	1	.968	.885												
8.0	1	.930													
10.0	.996	.880													
12.0	.985	.720													
14.0	.972														
16.0	.958														
18.0	.940														
20.0	.915														

STANDARD CONSTRUCTION MATERIALS & RATINGS

Standard Model	AB-2000 Series	Standard Unit Ratings
Shell	Steel	Operating Pressure Tubes
Tubes	Copper	150 psig
Baffle	Steel	Operating Pressure Shell
Tube Sheet	Steel	300 psig
End Bonnets	Cast Iron	Operating Temperature
Mounting Brackets	Steel	300 °F
Gasket	Hypalon Composite	

TABLE D- Surface Area

Model Number	Surface Area in Sq.ft. 1/4" O.D Tubing	3/8" O.D Tubing	5/8 O.D Tubing
AB-2004	155.43	110.69	60.84
AB-2005	194.29	138.36	76.05
AB-2006	233.15	166.03	91.26
AB-2007	272.00	193.70	106.47
AB-2008	310.86	221.37	121.68
AB-2009	349.72	249.04	136.88
AB-2010	388.58	276.71	152.09
AB-2011	427.43	304.38	167.30
AB-2012	466.29	332.06	182.51
AB-2013	505.15	359.73	197.72
AB-2014	544.01	387.40	212.93
AB-2015	582.86	415.07	228.14

Example Model

Options

AB - 2008 - C 6 - TP - CNT - B - Z

Model
AB 2000

Shell Diameter
2000 = 10.75"

Effective Tube Length
(9" increments)

Baffle Spacing Code
C = 4 1/2"
D = 9 "
E = 18 "

Cooling Tube Diamenter
4 = 1/4"
6 = 3/8"
10 = 5/8"

Tube Side Passes
SP = 1 pass
TP = 2 pass
FP = 4 pass

Tubing
Blank = Copper
Options
CNT= 90/10 Cu Ni
STS = Stainless Steel

End Bonnets
Blank = Cast Iron
Options
B = Bronze
SB = Stainless Steel

Zinc Anode
Z = 1 Zinc Anode
2Z = 2 Zinc Anode etc.

AB 2000 Series *performance*

Instructions

The selection chart provided contains an array of popular sizes for quick sizing. It does not provide curves for all models available. Refer to page 14 & 15 for detailed calculation information.

Computer selection data sheets for standard or special models are available through the engineering department of American Industrial. To use the followings graphs correctly, refer to the instruction notes "1-5".

1) HP Curves are based upon a 40°F approach temperature; for example: oil leaving a cooler at 125°F, using 85°F cooling water (125°F – 85°F = 40°F).

2) The oil to water ratio of 1:1 or 2:1 means that for every 1 gallon of oil circulated, a minimum of 1 or 1/2 gallon (respectively) of 85°F water must be circulated to match the curve results.

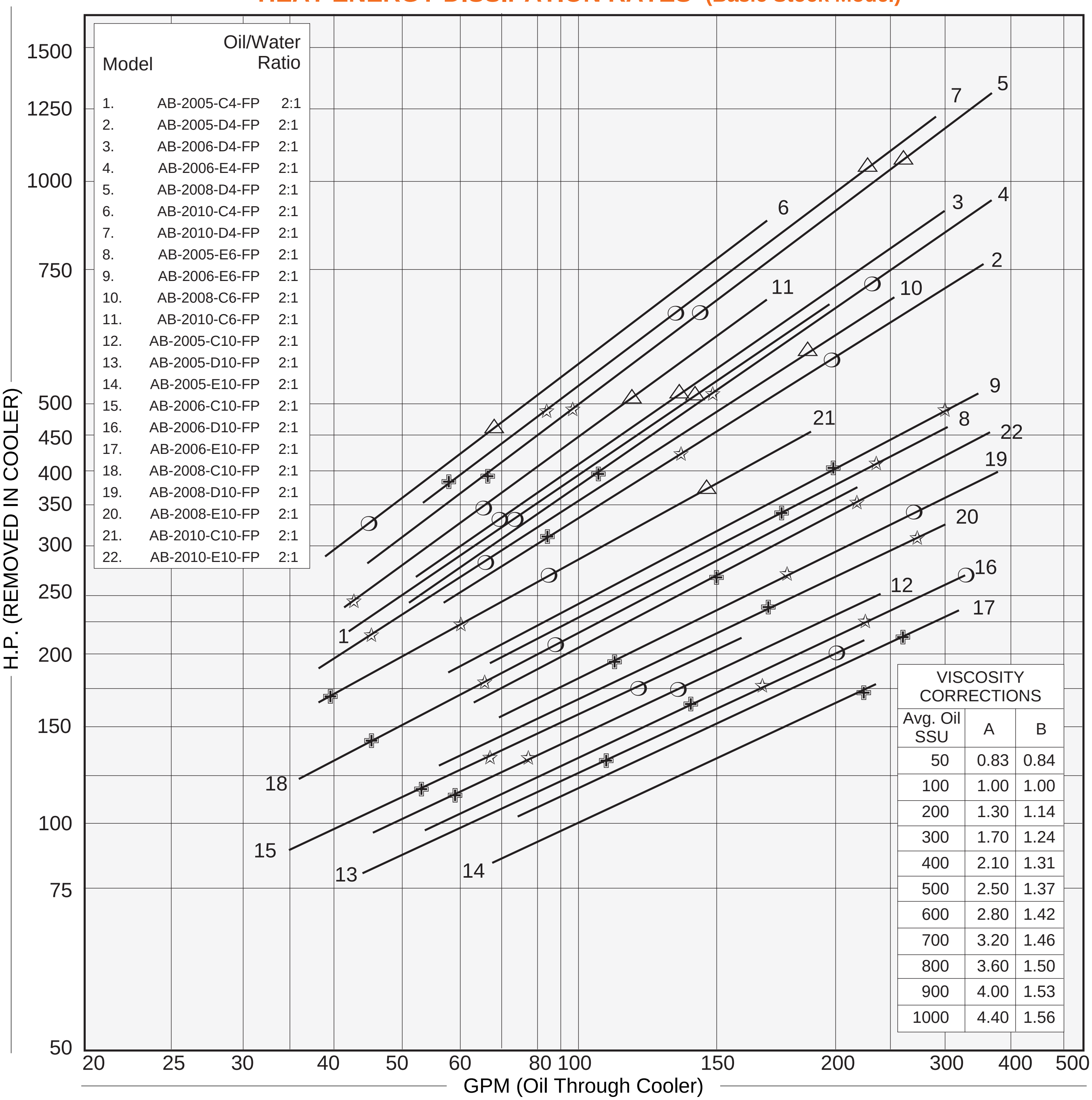
3) OIL PRESSURE DROP CODING: ✙ = 5 psi; ☆= 10 psi; ❍ = 20 psi; △ = 50psi. Curves that have no pressure drop code symbols indicate that the oil pressure drop is less than 5 psi for the flow rate shown.

4) Pressure Drop is based upon oil with an average viscosity of 100 SSU. If the average oil viscosity is other than 100 SSU, then multiply the indicated Pressure Drop by the corresponding value from corrections table A.

5) Corrections for approach temperature and oil viscosity are as follows:

$$H.P.\left(_{\text{In Cooler}}^{\text{Removed}}\right) = H.P.\left(_{\text{Heat Load}}^{\text{Actual}}\right) \times \left(\frac{40}{\text{Actual Approach}}\right) \times B.$$

HEAT ENERGY DISSIPATION RATES (Basic Stock Model)

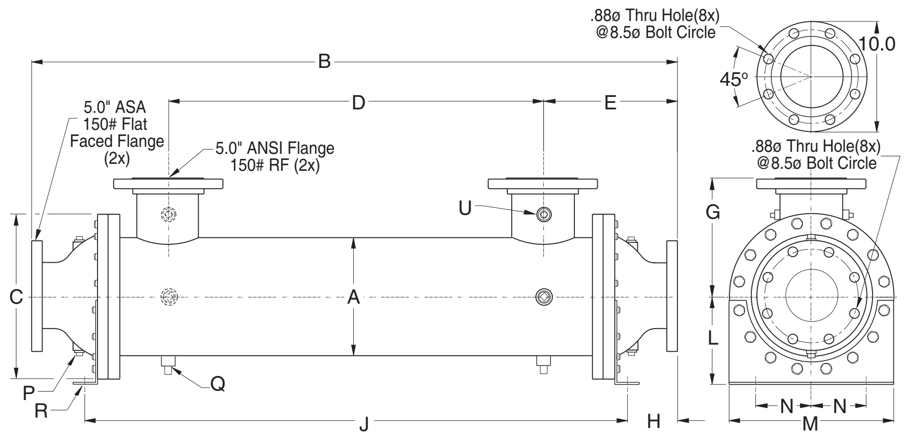


Model		Oil/Water Ratio
1.	AB-2005-C4-FP	2:1
2.	AB-2005-D4-FP	2:1
3.	AB-2006-D4-FP	2:1
4.	AB-2006-E4-FP	2:1
5.	AB-2008-D4-FP	2:1
6.	AB-2010-C4-FP	2:1
7.	AB-2010-D4-FP	2:1
8.	AB-2005-E6-FP	2:1
9.	AB-2006-E6-FP	2:1
10.	AB-2008-C6-FP	2:1
11.	AB-2010-C6-FP	2:1
12.	AB-2005-C10-FP	2:1
13.	AB-2005-D10-FP	2:1
14.	AB-2005-E10-FP	2:1
15.	AB-2006-C10-FP	2:1
16.	AB-2006-D10-FP	2:1
17.	AB-2006-E10-FP	2:1
18.	AB-2008-C10-FP	2:1
19.	AB-2008-D10-FP	2:1
20.	AB-2008-E10-FP	2:1
21.	AB-2010-C10-FP	2:1
22.	AB-2010-E10-FP	2:1

VISCOSITY CORRECTIONS

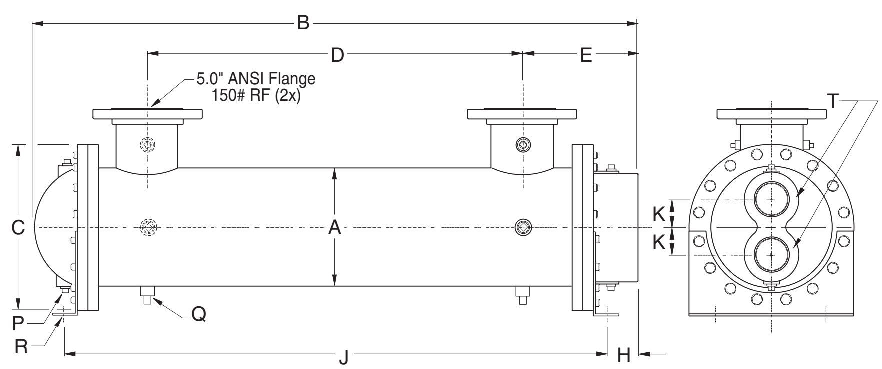
Avg. Oil SSU	A	B
50	0.83	0.84
100	1.00	1.00
200	1.30	1.14
300	1.70	1.24
400	2.10	1.31
500	2.50	1.37
600	2.80	1.42
700	3.20	1.46
800	3.60	1.50
900	4.00	1.53
1000	4.40	1.56

AB 2000 Series *dimensions*



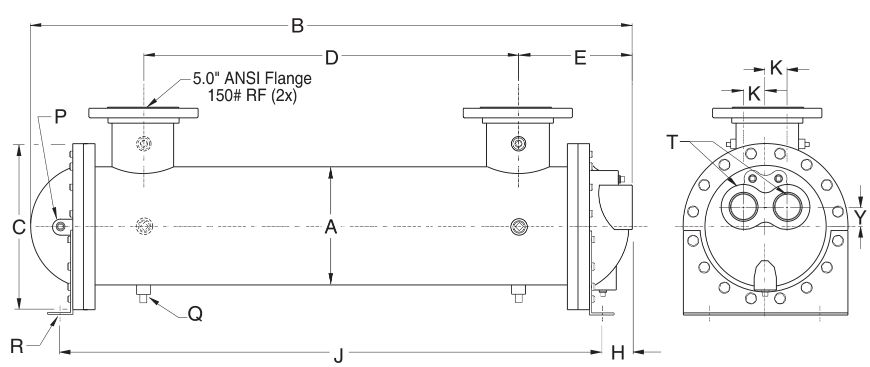
Single Pass (SP)

Model	B	E	H	P NPT
AB-2005	59.88			
AB-2006	68.88			
AB-2007	77.88			
AB-2008	86.88			
AB-2009	95.88	12.88	4.63	(4) .50
AB-2010	104.88			
AB-2011	113.88			
AB-2012	122.88			
AB-2013	131.88			
AB-2014	140.88			



Two Pass (TP)

Model	B	E	H	K	P NPT	T NPT
AB-2005	55.63					
AB-2006	64.63					
AB-2007	73.63					
AB-2008	82.63					
AB-2009	91.63	10.88	2.43	2.50	(4) .50	3.00
AB-2010	100.63					
AB-2011	109.63					
AB-2012	118.63					
AB-2013	127.63					
AB-2014	136.63					



FOUR PASS (FP)

Model	B	E	H	K	P NPT	Y	T NPT
AB-2005	55.63						
AB-2006	64.63						
AB-2007	73.63						
AB-2008	82.63						
AB-2009	91.63	10.88	2.50	2.00	(5) .50	1.75	2.50
AB-2010	100.63						
AB-2011	109.63						
AB-2012	118.63						
AB-2013	127.63						
AB-2014	136.63						

COMMON DIMENSIONS & WEIGHTS

Model	A	C	D	G	J	L	M	N	Q NPT	R	U NPT	Weight	Model
AB-2005			34.12		51.00							670	AB-2005
AB-2006			43.12		60.00							720	AB-2006
AB-2007			52.12		69.00							770	AB-2007
AB-2008			61.12		78.00							820	AB-2008
AB-2009	10.75	15.00	70.12	10.75	87.00	8.00	15.00	5.00	.50 (4x)	.75"ø x 1.25" Thru Slot	.38 (2x)	870	AB-2009
AB-2010			79.12		96.00							820	AB-2010
AB-2011			88.12		105.00							970	AB-2011
AB-2012			97.12		114.00							1020	AB-2012
AB-2013			106.12		123.00							1070	AB-2013
AB-2014			115.12		132.00							1120	AB-2014