



SECTION M

ENGINEERING DATA

SERIES	PAGE
FLOW DATA	M-3 & M-4
CAUTIONARY STATEMENT	M-5
TORQUE CONSTANTS	
APOLLO AR™ TWO PIECE ACTUATOR READY VALVES	M-6
APOLLO END ENTRY VALVES	M-6
APOLLO PEEK SEATED 83B/86B	M-7
APOLLO FLANGED VALVES	M-7
APOLLO CLASS 600 FULL PORT FLANGED VALVES	M-8
PRESSURE-TEMPERATURE RATINGS	
CLASS 150 CARBON AND STAINLESS STEEL FLANGE BALL VALVES	M-9
400 CWP AND 600 CWP BRONZE BALL VALVES	M-10
CLASS 300 CARBON AND STAINLESS STEEL FLANGE BALL VALVES	M-11
1000 CWP CARBON AND STAINLESS STEEL BALL VALVES	M-12
1500 CWP CARBON AND STAINLESS STEEL BALL VALVES	M-13
2000 CWP CARBON AND STAINLESS STEEL BALL VALVES	M-14
3000 CWP CARBON STEEL BALL VALVES	M-15
REFRIGERATION VALVES	M-15
400 CWP CARBON STEEL BALL VALVES	M-16
CLASS 150 ALLOY 20 FLANGE BALL VALVES	M-16
1500 CWP ALLOY 20 BALL VALVES	M-17
2000 CWP ALLOY 20 BALL VALVES	M-17
800 CWP STAINLESS STEEL BALL VALVES	M-18
800 CWP NICKEL BALL VALVES	M-18
1500 CWP CARBON STEEL 3-PIECE BALL VALVES	M-19
1500 CWP STAINLESS STEEL 3-PIECE BALL VALVES	M-19
CLASS 600 CARBON STEEL 3-PIECE BALL VALVES	M-20
CLASS 600 STAINLESS STEEL 3-PIECE BALL VALVES	M-20
CLASS 600 ALLOY 20 3-PIECE BALL VALVES	M-21
CLASS 600 HASTELLOY C 3-PIECE BALL VALVES	M-21
60A AND 60B METAL SEATED, VEE-TIP, NEEDLE VALVES (GLOBE AND ANGLE PATTERNS)	M-22
CLASS 150 CARBON STEEL ASTM A352-LCC FLANGE BALL VALVES	M-23
CLASS 300 CARBON STEEL ASTM A352-LCC FLANGE BALL VALVES	M-23
CLASS 600 CARBON STEEL ASTM A352-LCC FLANGE BALL VALVES	M-24
CLASS 600 STAINLESS STEEL AND CARBON STEEL FLANGE BALL VALVES	M-25 & M-26
CLASS 600 CARBON STEEL ASTM A352-LCC FLANGE BALL VALVES	M-26 & M-27
CLASS 150 DUPLEX ASTM A995 - CD3MN & SUPER DUPLEX CD3MWCUN FLANGE BALL VALVES	M-28
CLASS 300 DUPLEX ASTM A995 - CD3MN & SUPER DUPLEX CD3MWCUN FLANGE BALL VALVES	M-28
CLASS 600 DUPLEX ASTM A995 - CD3MN & SUPER DUPLEX CD3MWCUN FLANGE BALL VALVES	M-29
2000 CWP DUPLEX & SUPER DUPLEX BALL VALVES	M-29
1500 CWP DUPLEX & SUPER DUPLEX BALL VALVES	M-30
1000 CWP DUPLEX & SUPER DUPLEX BALL VALVES	M-30
CLASS 300 ASTM A351-CF3	M-31
MATERIAL REFERENCE DATA	M-31 & M-32
APOLLO BALL VALVE SEAT APPLICATION GUIDE	M-33
CONVERSION FACTORS	M-34 & M-35



SECTION M

ENGINEERING DATA



FLOW DATA

FLOW DATA

The listed C_v “factors” are derived from actual flow testing, at Apollo’s Pageland, South Carolina factory. These tests were completed using standard “off the shelf” valves with no special preparation and utilizing standard schedule 40 pipe. It should be understood that these factors are for the valve only and also include the connection configuration. The flow testing is done utilizing water as a fluid media and is a direct statement of the gallons of water flowed per minute with a 1 psig pressure differential across the valve/connection unit. Line pressure is not a factor. Because the C_v is a factor, the formula can be used to estimate flow of most media for valve sizing.

FLOW OF LIQUID

$$Q = C_v \sqrt{\frac{\Delta P}{SpGr}}$$

$$\text{or } \Delta P = \frac{(Q)^2 (SpGr)}{(C_v)^2}$$

WHERE:

- Q = Flow in US gpm
- ΔP = Pressure drop (psig)
- SpGr = Specific gravity at flowing temperature
- C_v = Valve constant

FLOW OF GAS

$$Q = 1360 C_v \sqrt{\frac{(\Delta P) (P_2)}{(SpGr) (T)}}$$

$$\text{or } \Delta P = \frac{5.4 \times 10^{-7} (SpGr) (T) (Q)^2}{(C_v)^2 (P_2)}$$

WHERE:

- Q = Flow in SCFH
- ΔP = Pressure drop (psig)
- SpGr = Specific gravity (based on air = 1.0)
- P2 = Outlet pressure-psia (psig + 14.7)
- T = (temp. °F + 460)
- C_v = Valve constant

CAUTION: The gas equation shown, is valid at very low pressure drop ratios. The gas equation is NOT valid when the ratio of pressure drop (ΔP) to inlet pressure (P1) exceeds 0.02.

NOTE: Only use the gas equation shown if (P1-P2)/P1 is less than 0.02.

CV FACTORS FOR APOLLO VALVES (CONTINUED ON M-4)

VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
70B-140 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
70-100/200 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
70-300/400 Series	--	--	15	30	43	48	84	108	--	--	--	--	--	--	--
70-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
70-800 Series	8.4	7.2	15	30	43	48	84	--	--	--	--	--	--	--	--
71-AR Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
71-100/200 Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
72-100/900 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
72-1xx-A/72-9xx-A Series	--	--	26	48	65	125	170	245	--	--	--	--	--	--	--
73A-100 Series	8.4	7.2	15	30	43	48	84	108	--	--	--	--	--	--	--
73-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
74-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
75-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76F-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FJ-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FK-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
76-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
76J-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76J-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76K-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76K-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
7K-100 Series	--	--	15	51	68	125	177	389	503	--	--	--	--	--	--
77-AR Series	8.1	15	15	51	68	--	177	389	--	--	--	--	--	--	--

REV. 21APR17



FLOW DATA

FOR APOLLO BALL VALVES

CV FACTORS FOR APOLLO VALVES (CONTINUED FROM M-3)

VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
77C-100/200 Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77D-140 Series	4.5	7.2	16	36	68	125	177	389	--	--	--	--	--	--	--
77D-640 Series	--	--	--	11	24	35	--	--	--	--	--	--	--	--	--
77G-UL Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77W Series	--	--	16	36	68	125	177	389	--	--	--	--	--	--	--
77-100/200 Series	8.1	15	15	51	68	125	177	389	503	--	--	--	--	--	--
79 Series	8.5	8.5	9.8	32	44	66	148	218	440	390	--	--	--	--	--
80 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
82-100/200 Series	8.1	14	26	51	68	120	170	376	510	996	1893	--	--	--	--
83A/83B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
83R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
86A/86B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
86R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
87A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
87B-100 Series	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--	--
87J-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87J-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
88B-100 Series	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--	--
89-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
9A-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
90-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
92-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
93-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
94A-100/200 Series	6	7	19	34	50	104	268	309	629	1018	1622	--	--	--	--
96-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
399-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
489-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--



CAUTION

ENGINEERING DATA

IT IS THE RESPONSIBILITY OF THE INSTALLER AND/OR SYSTEM DESIGNER TO ENSURE THAT THESE VALVES ARE INSTALLED IN ACCORDANCE WITH APPLICABLE AND CURRENT ANSI B31 STANDARDS.

Following, are some safeguards that must be considered prior to installation.

EASE OF OPERATION:

Ball Valves are easier to operate than other types of shut-off valves, when these valves are installed so that there is a possibility that the handles can be hooked or snagged, appropriate action to prevent accidental or unwanted opening or closing of the valve must be taken. Vibrations in, through or around the valve can also cause accidental or unwanted opening or closing of the valve.

PRESSURE RELIEF:

Determine and provide corrective action against excessive pressure build up in the valve or piping system due to thermal expansion. Thermal expansion can create extreme pressures well above the working pressure limit of the valve which can cause leaking or bursting of the valve.

SUPPORTS:

If you choose to connect a flexible hose or other non-ridged conduit to the valve, the design of such installation must prevent any "whipping action" that could injure or damage personnel or equipment. Valve must be immobile.

FITTINGS:

Use only those fittings or piping that are compatible with the valves being used to prevent breakage and/or leakage. (As for one example, it is poor practice and never recommended to use plastic pipe or fittings with metallic valves since thermal expansion, external forces or other situations can cause breakage or leakage at or near the joint).

PRESSURE/TEMPERATURE LIMITS:

The maximum cold working pressure limit of the valve is marked on the valve body. Never exceed this "CWP" rating which is specified up to 100°F. Temperatures higher than 100°F decrease the maximum working pressure limit. Refer to the appropriate pressure/temperature chart that is published in the catalog.

FREEZING:

Provide means to protect the valve from freezing and bursting when used with liquids.

FLUID COMPATIBILITY:

Consider the corrosive, erosive and adhesive effects of fluids on the valve and piping components. It is your responsibility to ensure that the valve is compatible with the materials used in the system.

INSTALLATION:

The use of TFE pipe tape as a sealant is recommended for threaded valves when making joints. Correct lubrication of stainless steel pipe threads is especially important to prevent thread galling. Do not apply excessive torque when installing the valve. To prevent distortion or damage to the valve, do not apply torque through the valve. Use wrench hex adjacent to the thread connection being tightened. Use proper supports in handling pre-fabricated sections and in final installation. Always test the system before using.

MAINTENANCE:

Do not disassemble the valve while under pressure. Request a maintenance manual before attempting repairs to the valve.

FOR BRONZE AND BRASS VALVES - PROPOSITION 65 WARNING:

This product is made from bronze alloys which contain lead; a chemical known to the state of California to cause cancer and birth defects and other reproductive harm. (Plumber California law requires that this warning be given to the consumer).

LEAD FREE:

The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.



TORQUE CONSTANTS

ENGINEERING DATA

APOLLO AR™ 2-PIECE ACTUATOR READY VALVES

TORQUE CONSTANT (LB-IN) AT DIFFERENTIAL PRESSURE INDICATED PSIG

VALVE MODEL	SIZE	WORKING PRESSURE (PSIG)								LSST*** (IN.-LB.)	-24 ADDER (IN.-LB.)
		100	200	400	600	800	1000	1500	2000		
**STANDARD PORT **71-ARX-64 89-ARX-64 76-ARX-64	1/4 - 1/2	25	26	27	28	30	32	35	38	50	45
	3/4	50	50	52	54	57	60	64	72	100	45
	1	85	86	88	90	94	97	110	138	170	56
	1.25	140	140	145	156	160	172	194		280	96
	1.5	160	164	173	186	195	201	235		320	96
	2	220	230	258	270	310	350	460		440	96
	2.5	450	495	596	680	790	900			900	96
3	500	540	700	820	920	1030			1000	96	
*FULL PORT **77-ARX-64	1/4 - 1/2	25	50	52	54					100	45
	3/4	50	86	88	90					170	56
	1	140	148	160	180					280	56
	1.5	290	300	310	340					580	96
	2	340	355	420	563					680	96

* Torques tested with multiffilled seats. Does not require torque adjustment of -20%.

** 71-ARX-64 and 77-ARX-64 rated to 600 psig maximum.

*** LSST - Long Stand Still Torque

APOLLO END ENTRY VALVES (1), (2)

TORQUE CONSTANT (LB-IN) AT DIFFERENTIAL PRESSURE INDICATED PSIG

VALVE MODEL	SIZE	WORKING PRESSURE (PSIG)						LSST*** (IN.-LB.)	-24 ADDER (IN.-LB.)
		200	400	600	800	1000	1500		
STANDARD PORT 70-64X 71-14X 76-10X 76-60X 89-14X 399-10X	1/4 - 1/2	35	35	40	43	46	48	70	45
	3/4	50	50	54	59	62	64	100	45
	1	101	101	103	106	116	130	202	56
	1.25	171	171	205	216	246	286	342	96
	1.5	192	192	216	265	280	311	384	96
	2	271	271	276	300	309	354	542	96
	2.5 & 3	715	715	790		1200		1430	96
	1/4 - 1/2	35	35	40				70	45
FULL PORT BRONZE 77-14X	3/4	74	74	84				148	56
	1	234	234	250				468	56
	1.25	286	286	321				552	56
	1.5	357	357	398				714	96
	2	650	650	722				1300	96
	2.5 & 3	715	715	790				1430	111
	1/2	25	25	25	25			50	
FULL PORT BRONZE 77D-14X	3/4	55	55	55	55			110	
	1	87	87	87	87			174	
	1.5	120	120	120	120			240	
	2	280	280	280	280			560	
	1/4 - 1/2	78	78	90				156	56
FULL PORT 3-PIECE 82-14X & 24X	3/4	156	156	178				312	56
	1	208	208	230				416	96
	1.25	234	234	276				468	96
	1.5	350	350	390				700	96
	2	715	715	755				1430	96
	3	710						1100	292
	4	1052						1540	292
FULL PORT 3-PIECE 83A-14X & 24X 83B-14X & 24X 86A-10X & 20X 86B-10X & 20X	1/4 - 1/2	38	39	41	42	43	49	75	45
	3/4	61	62	63	63	67	79	121	68
	1	97	104	110	117	124	141	180	68
	1.25	182	198	213	228	243	281	335	96
	1.5	182	198	213	228	243	281	335	96
	2	275	338	402	466	529	688	422	127
	2	715	715	755	800	912	1024	1430	96
FULL PORT 3-PIECE 83R-108-01 & 83R-100-01 86R-108-01 & 86R-100-01	3	1030	1030	1087	1148	1212		2060	201

*** LSST - Long Stand Still Torque



TORQUE CONSTANTS

ENGINEERING DATA

APOLLO 83B/86B PEEK SEATED W/ GRAPHITE STEM PACKING TORQUE CONSTANT (LB-IN) AT DIFFERENTIAL PRESSURE INDICATED PSIG

VALVE MODEL	SIZE	WORKING PRESSURE (PSIG)								LSST (IN.-LB.)
		200	400	600	800	1000	1200	1400	1500	
FULL PORT 3-PIECE 83B/86B	1/4 - 1/2	75	80	86	91	98	105	111	118	112
	3/4	130	150	170	177	185	194	204	210	195
	1	250	263	276	289	302	315	328	345	375
	1.25	420	463	506	549	592	635	678	720	630
	1.5	420	463	506	549	592	635	678	720	630
	2	840	922	1004	1086	1168	1250	1332	1410	1260

Caution: 2" PEEK seated valves operating at pressures higher than 1000 psig, should be automated or have a gear operator installed.
Lever operation is not suggested. All values are stated in (in.-lb.)

APOLLO FLANGED BALL VALVES

TORQUE CONSTANT (LB-IN) AT DIFFERENTIAL PRESSURE INDICATED PSIG

VALVE SERIES	SIZE	WORKING PRESSURE (PSIG)									LSST (IN.-LB)	-24 ADDER (IN.-LB)	-EF ADDER (IN.-LB)
		0	100	200	300	400	500	600	700	740			
87A-100s 88A-140s 87B-100s 88B-100s	1-1/2" SP 150	132	144	155	167						264	68	68
	2" SP 150	176	193	211	228						352	96	96
	2-1/2" SP 150	231	254	277	300						462	127	127
	3" SP 150	253	327	402	476						506	127	127
	4" SP 150	850	860	875	890						1700	292	292
	6" SP 150	1325	1345	1370	1400						2650	292	292
	8" SP 150	2200	2494	2788	3081						4400	661	895
87A-200s 88A-240s	10" SP 150	3300	3580	3860	4140						6600	661	895
	1/2" FP 150	22	22	22	22						44	45	45
	3/4" FP 150	39	43	47	51						77	68	68
	1" FP 150	132	144	155	167						264	68	68
	1-1/2" FP 150	176	193	211	228						352	96	96
	2" FP 150	231	254	277	300						462	127	127
	2-1/2" FP 150	253	327	402	476						506	127	127
	3" FP 150	850	860	875	890						1700	292	292
	4" FP 150	1325	1345	1370	1400						2650	292	292
	6" FP 150	2200	2494	2788	3081						4400	661	895
87A-700s 88A-740s	8" FP 150	3300	3580	3860	4140						6600	661	895
	10" FP 150	4400	5059	5718	6377						8800	988	1625
	12" FP 150	4950	8300	11650	15000						9900	988	1625
	1-1/2" SP 300	132	144	155	167	178	190	201	213	217	264	68	68
	2" SP 300	176	193	211	228	245	262	280	297	304	352	96	96
	2-1/2" SP 300	231	254	277	300	323	346	369	392	401	462	127	127
	3" SP 300	253	327	402	476	551	625	700	774	804	506	127	127
87A-900s 88A-940s	4" SP 300	850	860	875	890	910	950	1030	1110	1142	1700	292	292
	6" SP 300	1325	1345	1370	1400	1430	1474	1615	1756	1812	2650	292	292
	8" SP 300	2200	2494	2788	3081	3375	3669	3963	4257	4374	4400	661	895
	10" SP 300	3300	3580	3860	4140	4420	4700	4980	5260	5372	6600	661	895
	1/2" FP 300	22	22	22	22	23	23	23	23	23	44	45	45
	3/4" FP 300	39	43	47	51	55	59	63	67	69	77	68	68
	1" FP 300	132	144	155	167	178	190	201	213	217	264	68	68
	1-1/2" FP 300	176	193	211	228	245	262	280	297	304	352	96	96
	2" FP 300	231	254	277	300	323	346	369	392	401	462	127	127
	2-1/2" FP 300	253	327	402	476	551	625	700	774	804	506	127	127
87A-900s 88A-940s	3" FP 300	850	860	875	890	910	950	1030	1110	1142	1700	292	292
	4" FP 300	1325	1345	1370	1400	1430	1474	1615	1756	1812	2650	292	292
	6" FP 300	2200	2494	2788	3081	3375	3669	3963	4257	4374	4400	661	895
	8" FP 300	3300	3580	3860	4140	4420	4700	4980	5260	5372	6600	661	895
	10" FP 300	4400	5059	5718	6377	7036	7696	8355	9014	9277	8800	988	1625
	12" FP 300	4950	8300	11650	15000	18349	21699	25049	28399	29739	9900	988	1625

REV. 04MAY17



TORQUE CONSTANTS

ENGINEERING DATA

APOLLO TOP ENTRY BALL VALVES

- See Top Entry Ball Valve Section (BVBI Section N) for top entry torque constants.

APOLLO CLASS 600 FULL PORT FLANGED VALVES

TORQUE CONSTANTS

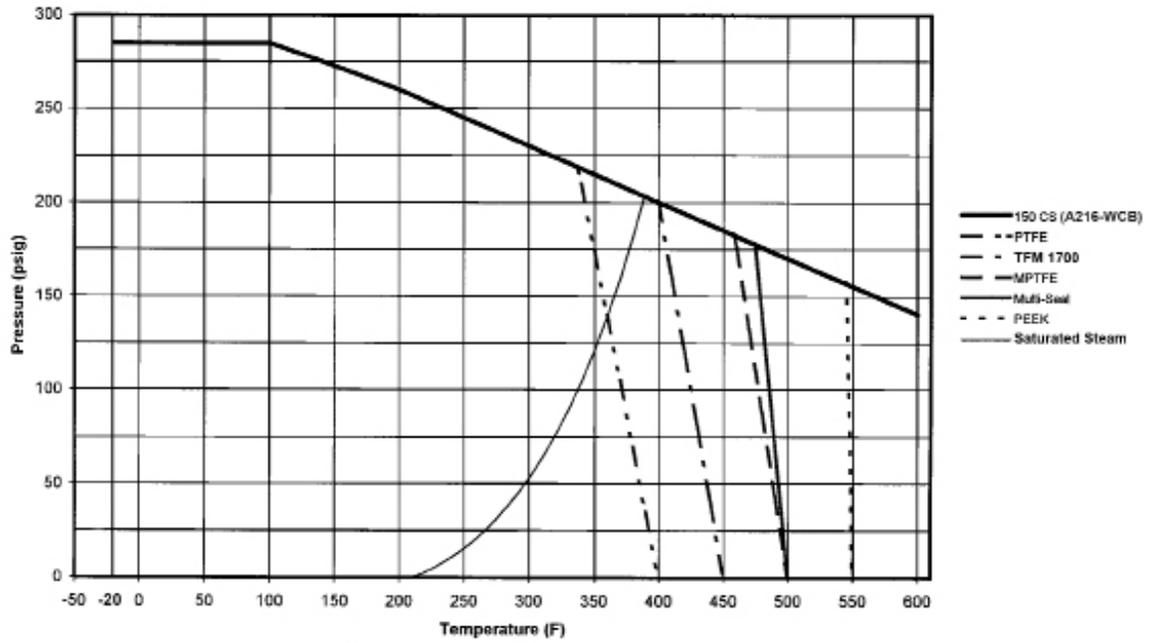
SEAT MATERIAL	SIZE	WORKING PRESSURE (PSIG)								LSST*	-24 ADDER	-EF ADDER
		200	400	600	800	1000	1200	1400	1500			
Devlon V-API (-95)	1"	166	189	211	233	256	275	292	300	288	N/A	N/A
	1.5"	253	273	292	312	331	351	370	380	468	N/A	N/A
	2"	686	698	710	721	732	744	755	761	1350	N/A	N/A
	2.5"	1150	1190	1231	1272	1313	1353	1395	1415	2256	N/A	N/A
	3"	1893	2030	2167	2304	2440	2577	2714	2782	3512	N/A	N/A
	4"	2406	2681	2957	3232	3508	3784	4060	4197	4260	N/A	N/A
	6"	7935	8280	8625	8970	9135	9660	10005	10178	13638	N/A	N/A
	8"	8282	8868	9454	10041	10627	11213	11799	12092	15978	N/A	N/A
PEEK (-38)	1"	184	204	224	245	264	283	304	314	328	N/A	N/A
	1.5"	379	399	420	439	460	479	500	509	468	N/A	N/A
	2"	882	968	1054	1140	1225	1313	1399	1481	1323	N/A	N/A
	2.5"	1256	1320	1384	1448	1512	1576	1640	1672	2384	N/A	N/A
	3"	2378	2588	2797	3007	3217	3427	3637	3741	4336	N/A	N/A
	4"	5771	6832	7892	8952	10012	11073	12133	12663	9422	N/A	N/A
	6"	6983	8675	10368	12061	13753	15446	17139	17985	10580	N/A	N/A
	8"	8586	12822	17058	21294	25531	29767	34003	36121	12936	N/A	N/A
UHMWPE (-21)	1"	155	178	201	219	222	224	228	228	264	N/A	N/A
	1.5"	211	245	280	305	310	315	318	318	352	N/A	N/A
	2"	428	454	479	505	531	556	582	594	806	N/A	N/A
	2.5"	447	467	486	506	525				875	N/A	N/A
	3"	1139	1224	1310	1396	1482				2106	N/A	N/A
	4"	1506	1638	1820	2002	2184				2600	N/A	N/A
	6"	3133	3487	3842						5558	N/A	N/A
	8"	3814	4354	4894						7088	N/A	N/A
MULTISEAL (-80)	1"	155	180	205	222	227	231	233	234	264	102	102
	1.5"	213	245	280	308	316	322	326	326	354	144	144
	2"	313	356	400	444	487	531	575	597	538	191	191
	2.5"	410	437	465	493	520				791	191	191
	3"	875	890	1030	1151	1228				1112	292	292
	4"	1506	1584	1683	1781	1880				2776	292	292
	6"	2788	3375	3963						4824	661	895
	8"	4836	5175	5514						8993	988	1625

Caution: For torque constants in the highlighted areas, manual valve operation is not suggested. Automated and gear operated assembly options are available. All values are stated in (in-lb)

CLASS 150

(CS) ASTM A216-WCB

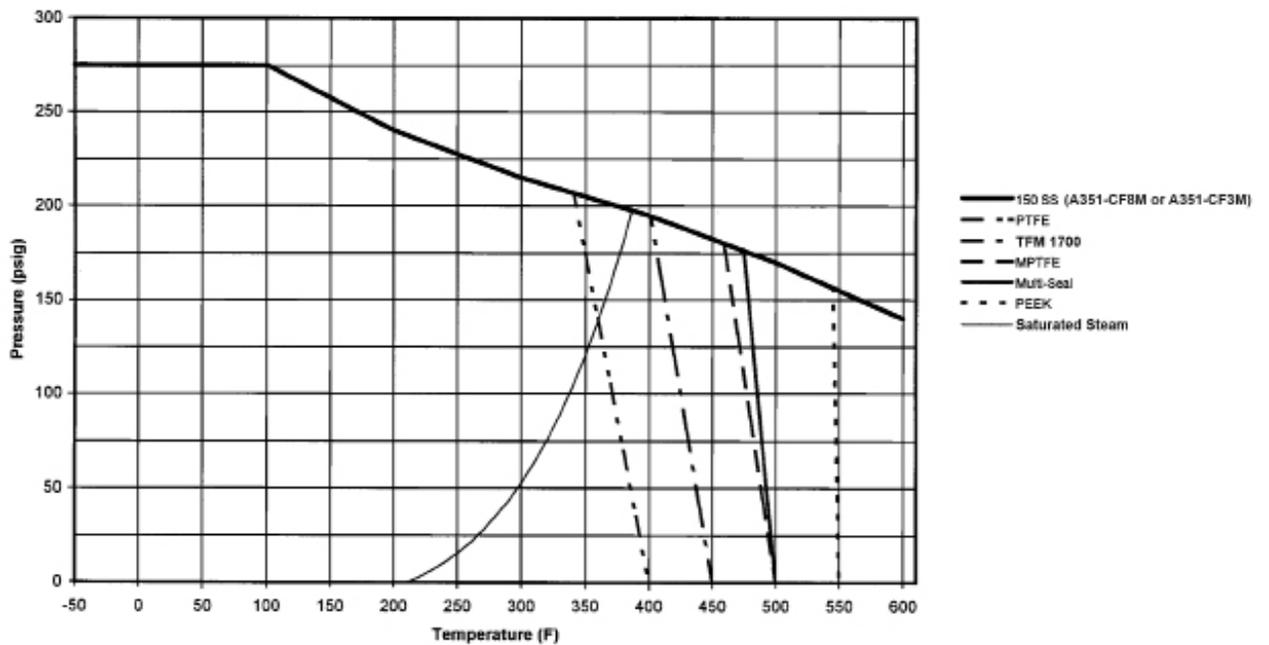
GRAPH 1



CLASS 150

(SS) ASTM A351-CF8M OR ASTM A351-CF3M

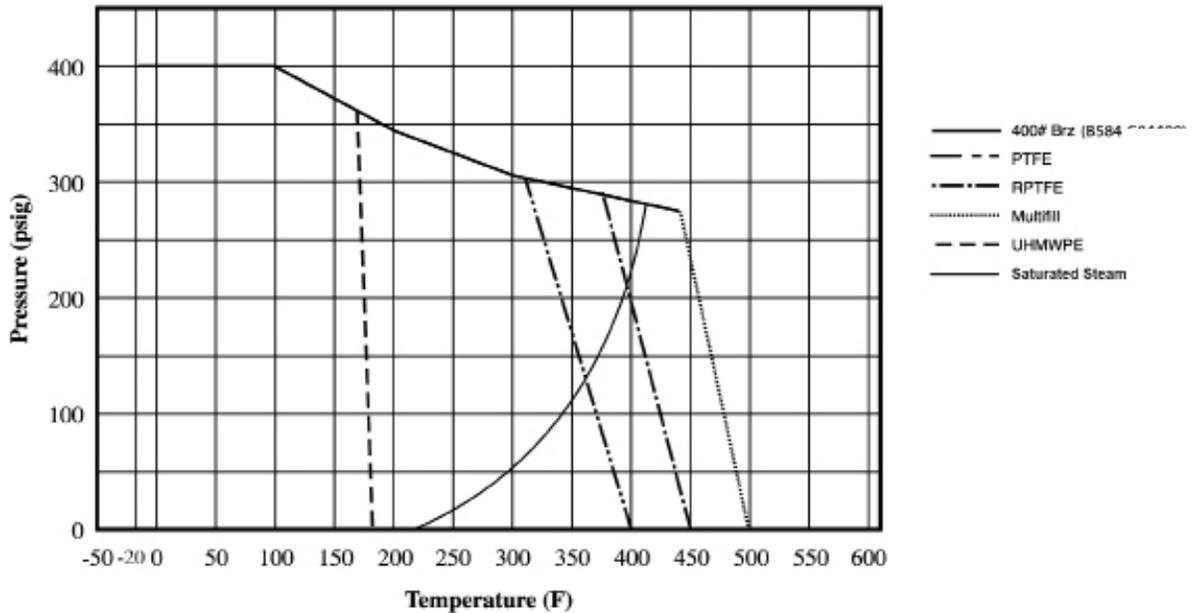
GRAPH 2



400 CWP

BRONZE ASTM B584

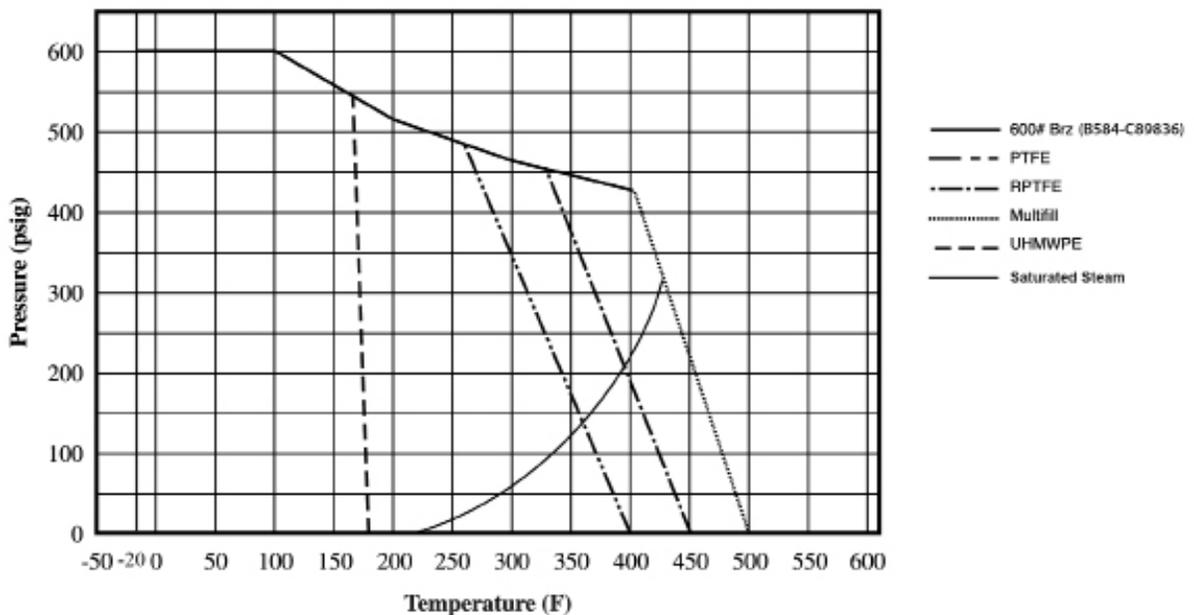
GRAPH 3



600 CWP

BRONZE ASTM B584

GRAPH 4



PRESSURE/TEMPERATURE RATINGS FOR AUTOMATIC DRAIN OPTIONS ONLY

LEAKAGE PERFORMANCE

TEMPERATURE	AUTO DRAIN (-41)	SAFETY VENT (-SV)
Below -20° F	Not recommended	Full performance to rated pressure
Below 0° F	Not recommended	Full performance to rated pressure
Between 0° and 50° F	Marginal, some leakage may occur	Full, to rated pressure
Between 50° and 200° F	Full, to rated pressure	Full, to rated pressure
Above 200° F	Not recommended	Not recommended

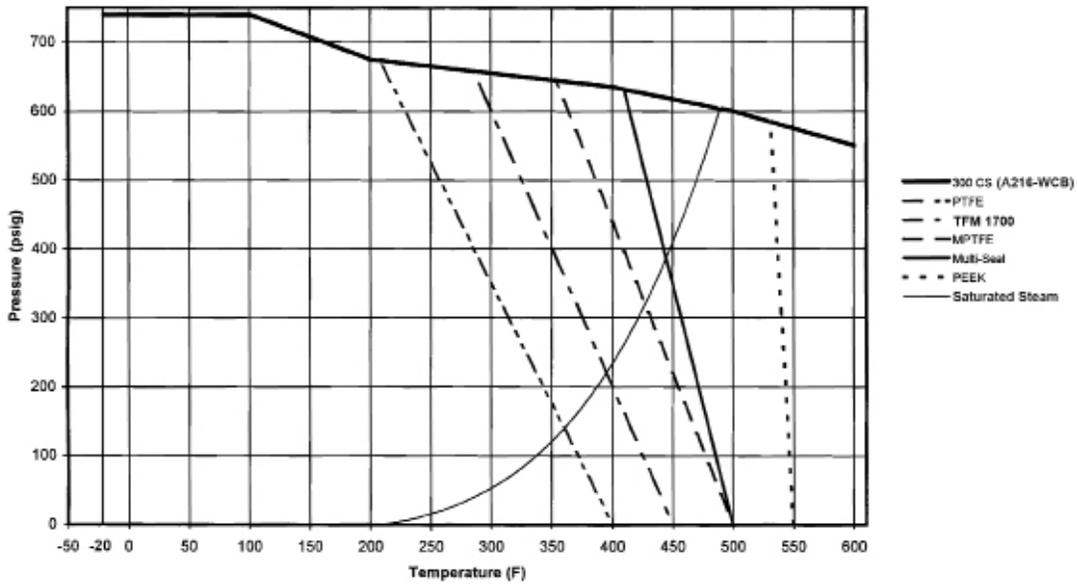
MAX PRESSURE (PSIG)

SIZE	AUTO DRAIN (-41)	SAFETY VENT (-SV)
1/4", 3/8", 1/2"	175	200
3/4"-2"	125	200

CLASS 300

(CS) ASTM A216-WCB

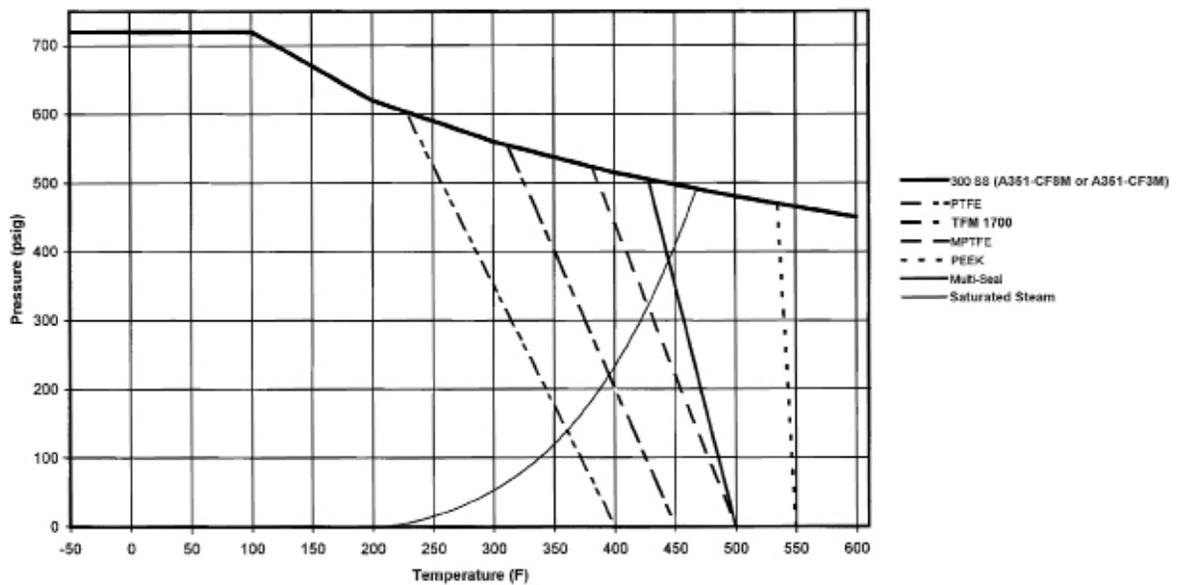
GRAPH 5



CLASS 300

(SS) ASTM A351-CF8M OR ASTM A351-CF3M

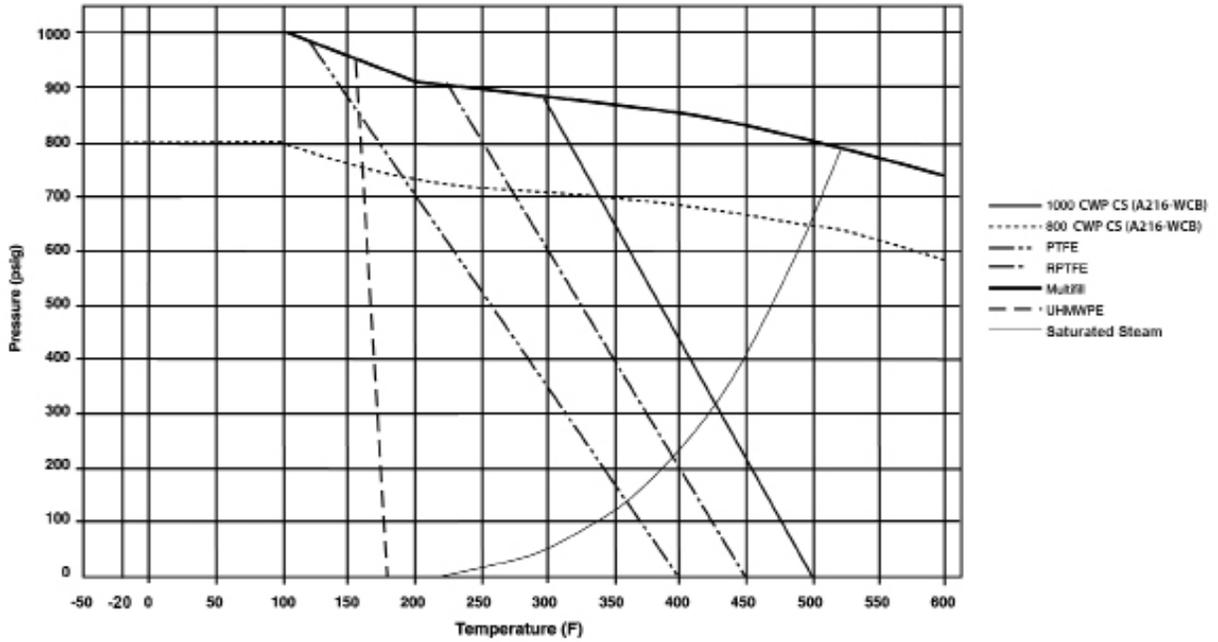
GRAPH 6



1000 CWP

(CS) ASTM A216-WCB

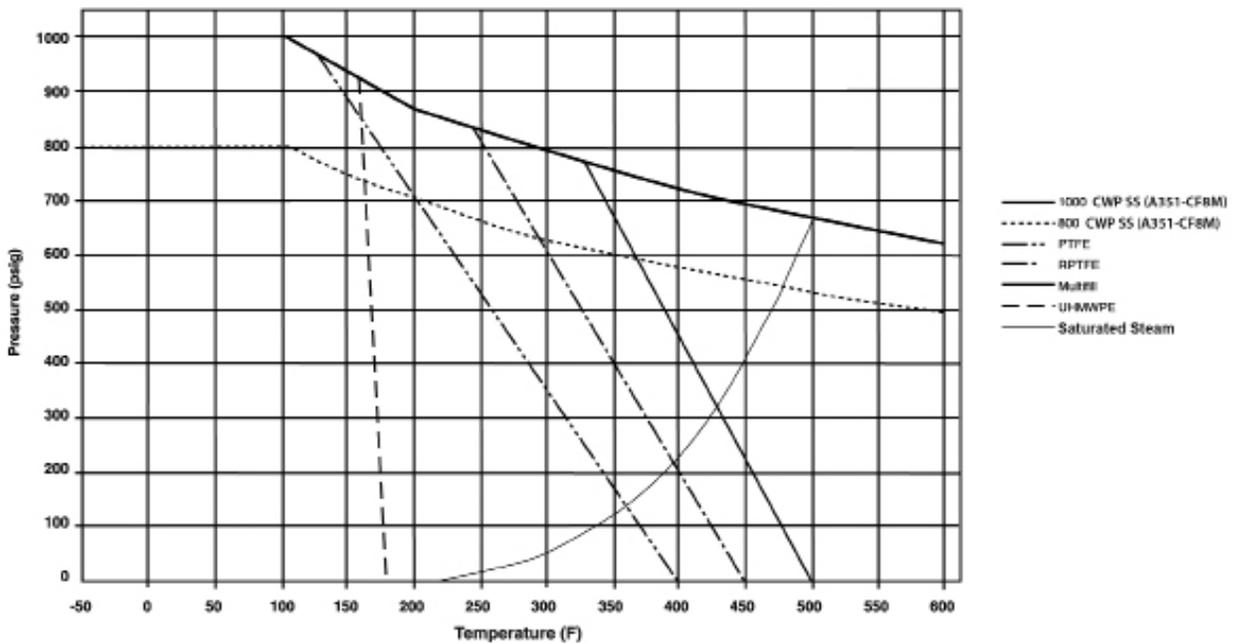
GRAPH 7



1000 CWP

(SS) ASTM A351-CF8M

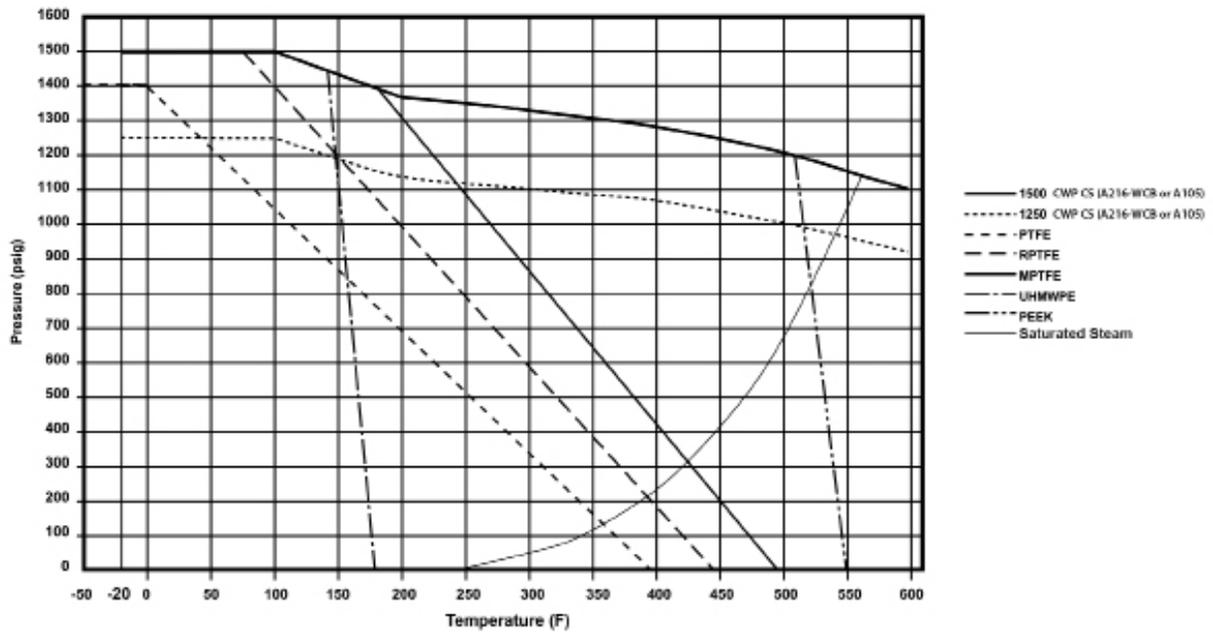
GRAPH 8



1500 CWP

(CS) ASTM A216-WCB OR ASTM A105

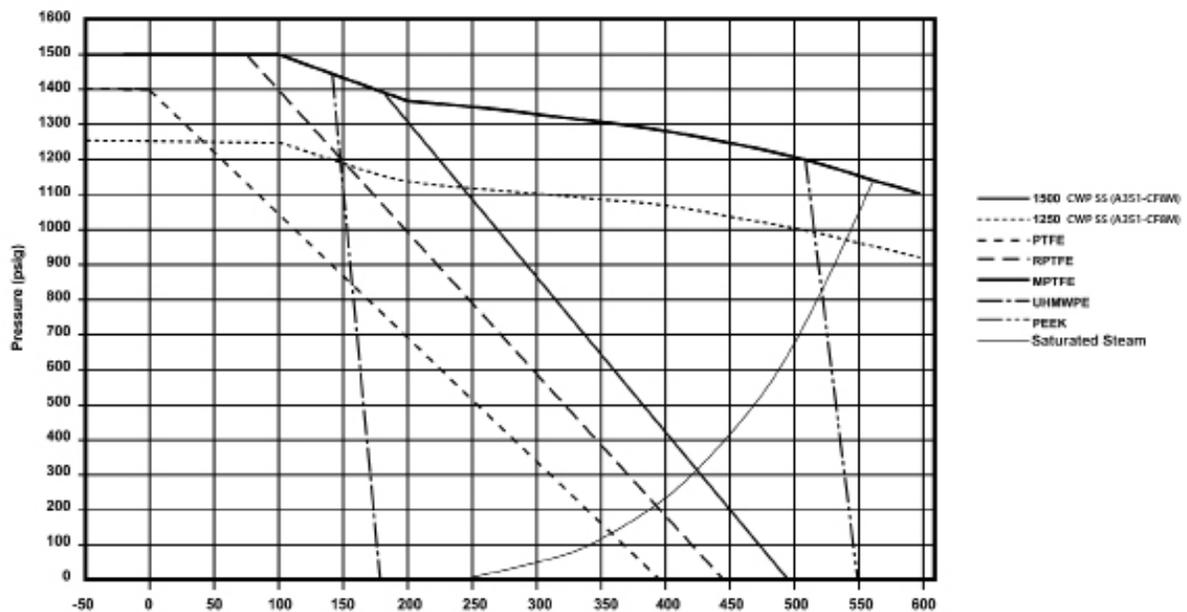
GRAPH 11



1500 CWP

(SS) ASTM A351-CF8M

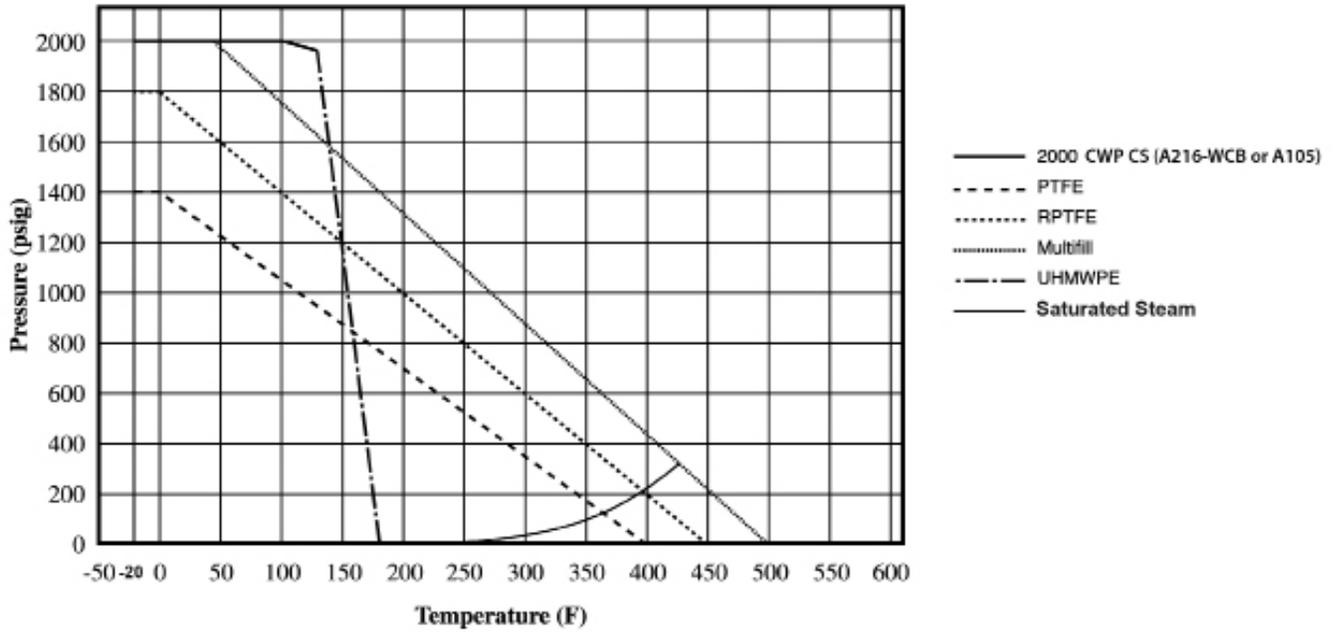
GRAPH 12



2000 CWP

(CS) ASTM A216-WCB OR ASTM A105

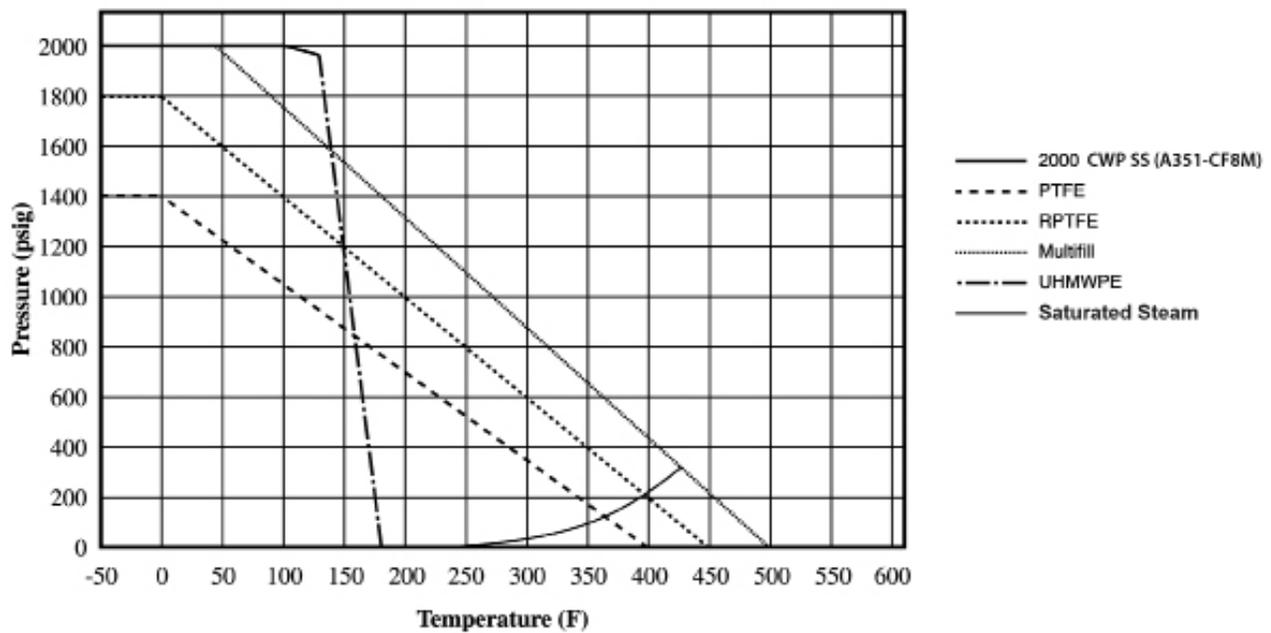
GRAPH 13



2000 CWP

(SS) ASTM A351-CF8M

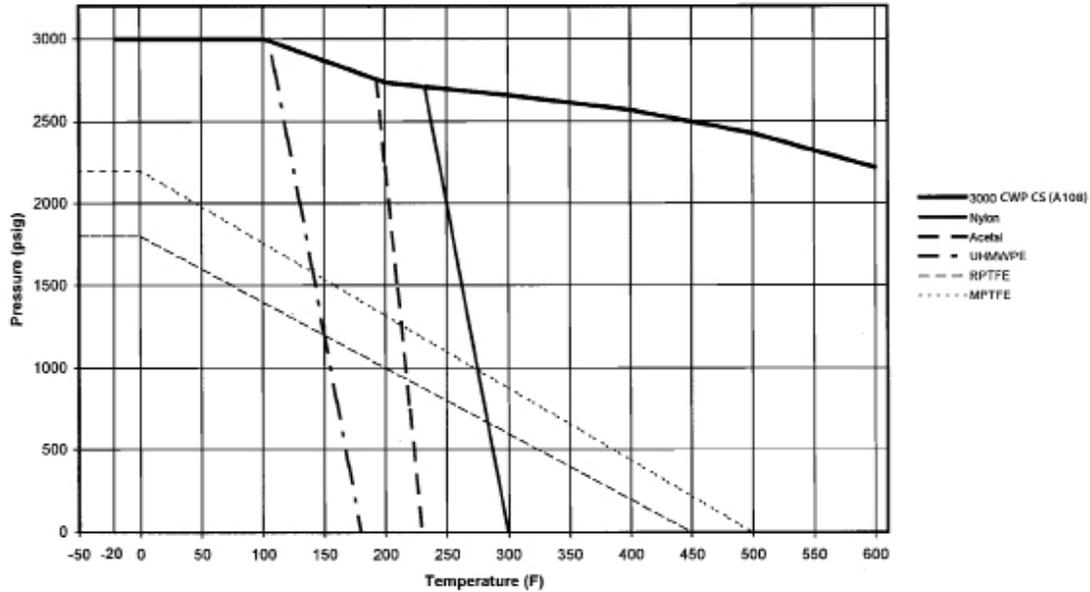
GRAPH 14



3000 CWP

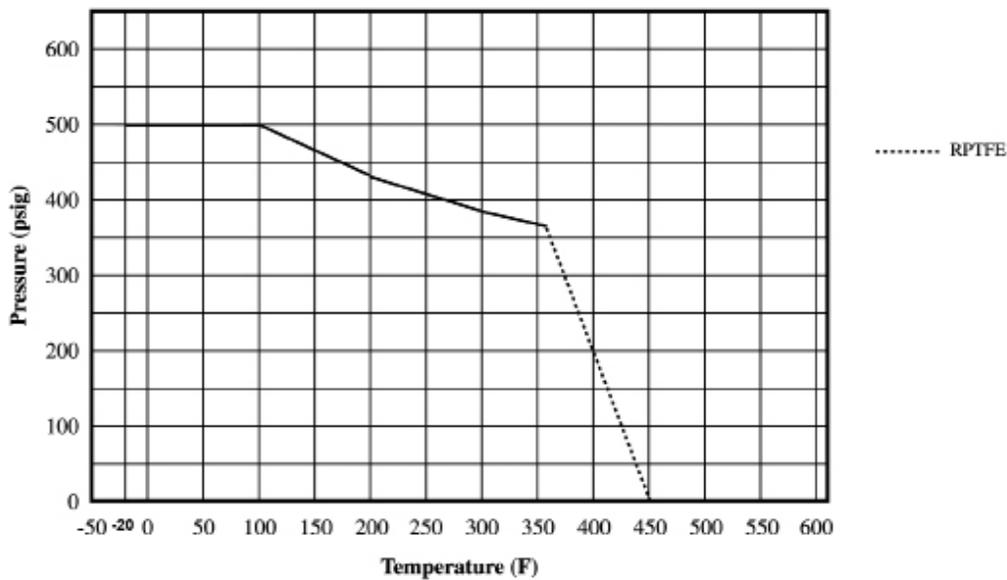
(CS) ASTM A216-WCB OR ASTM A105 OR ASTM A108

GRAPH 15



REFRIGERATION VALVE

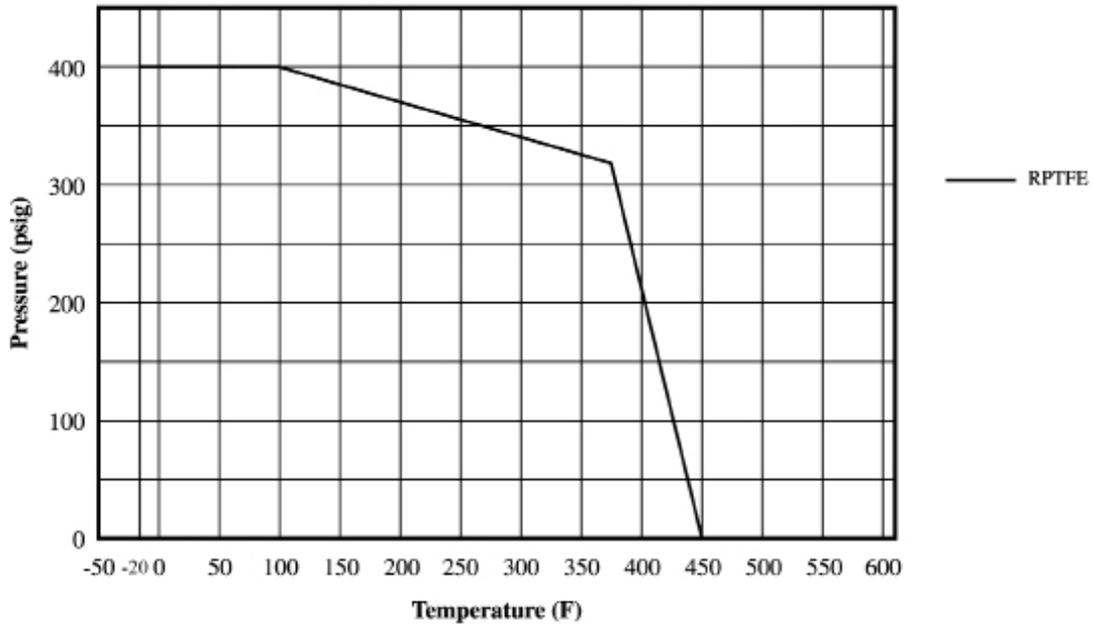
GRAPH 16



400 CWP

(CS) ASTM A216-WCB

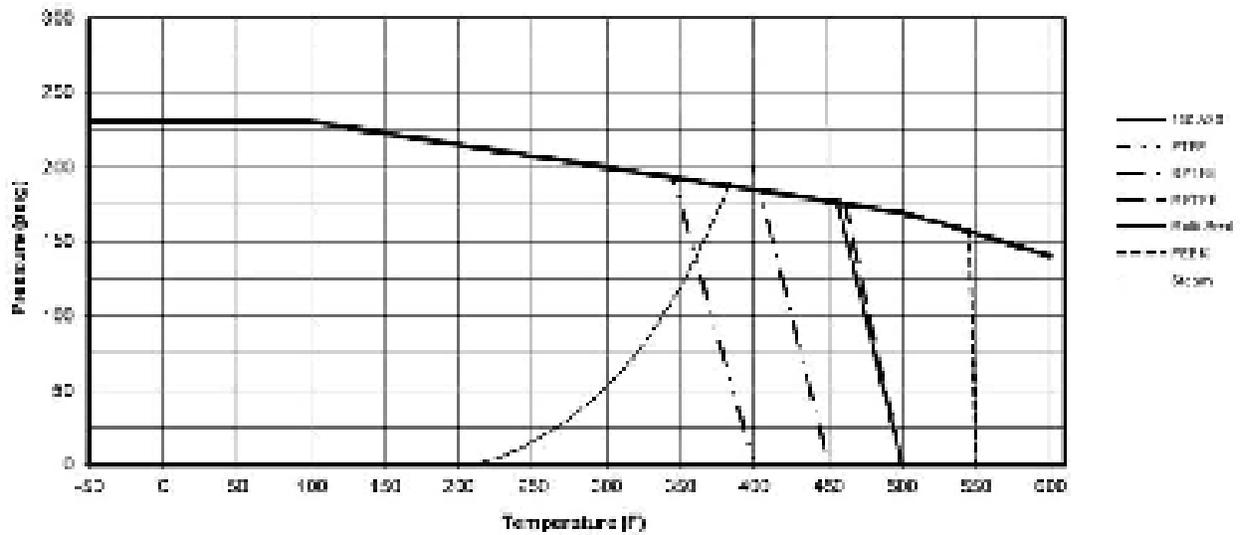
GRAPH 17



CLASS 150

(ALLOY 20) ASTM A351-CN7M

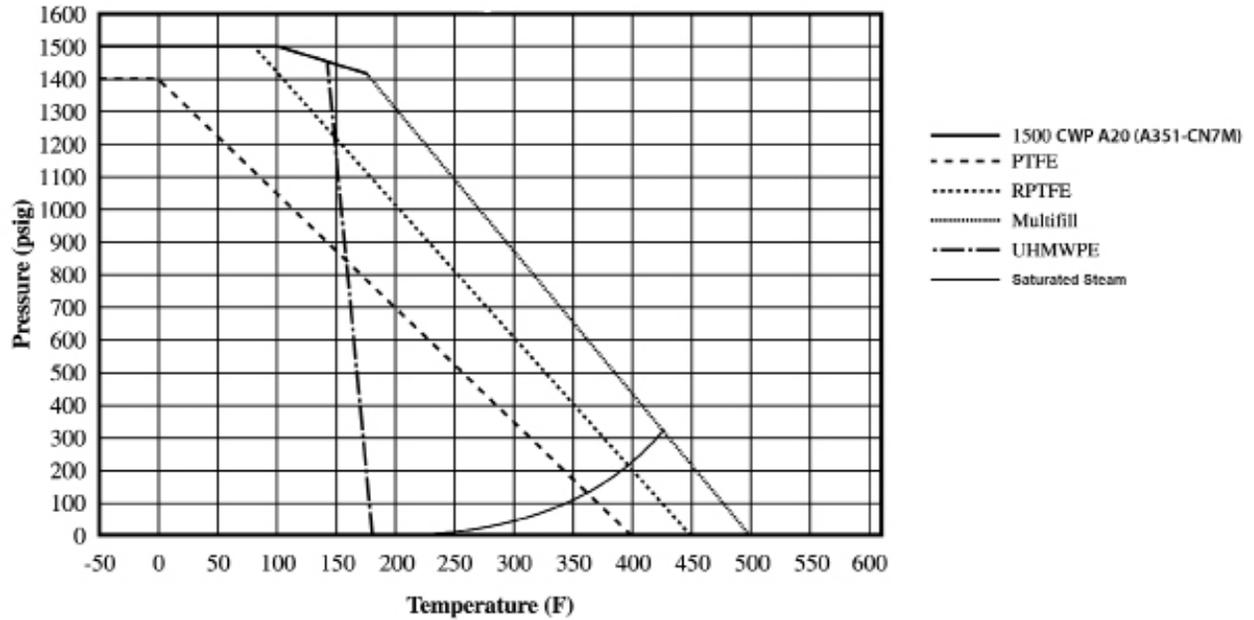
GRAPH 18



1500 CWP

(ALLOY 20) ASTM A351-CN7M

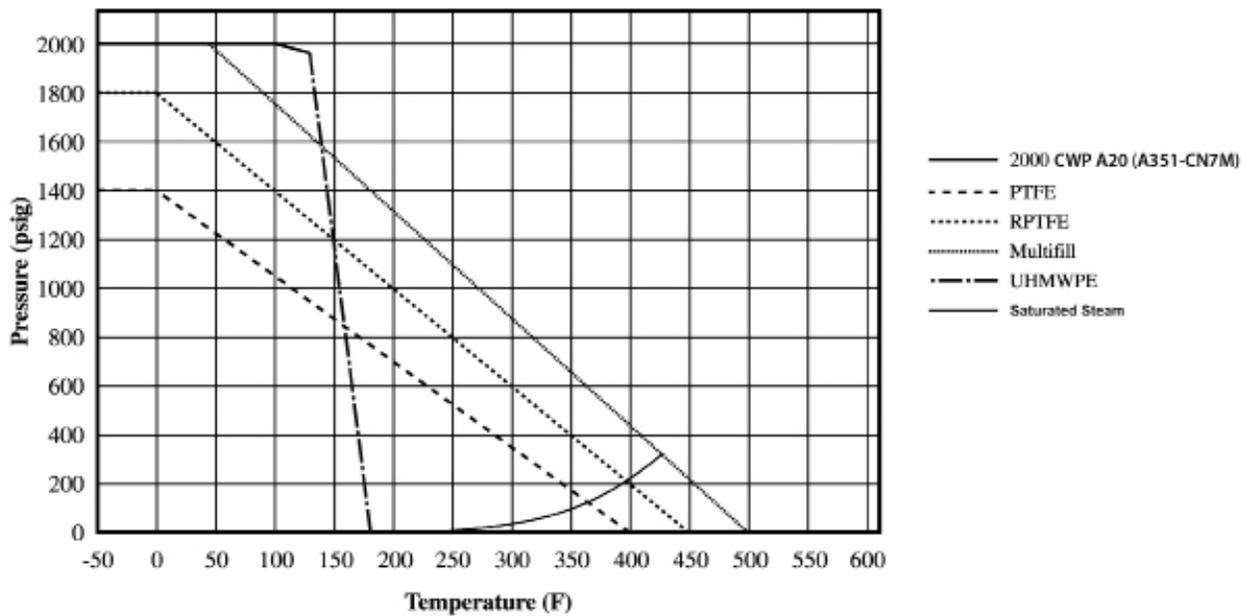
GRAPH 19



2000 CWP

(ALLOY 20) ASTM A351-CN7M

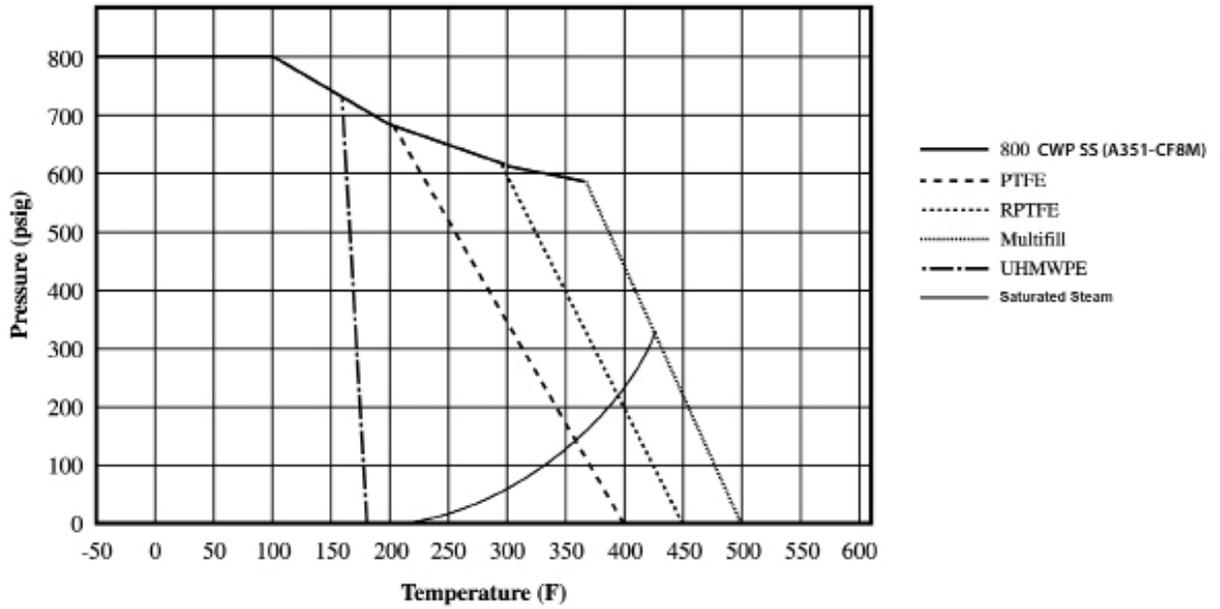
GRAPH 20



800 CWP

(SS) ASTM A351-CF8M

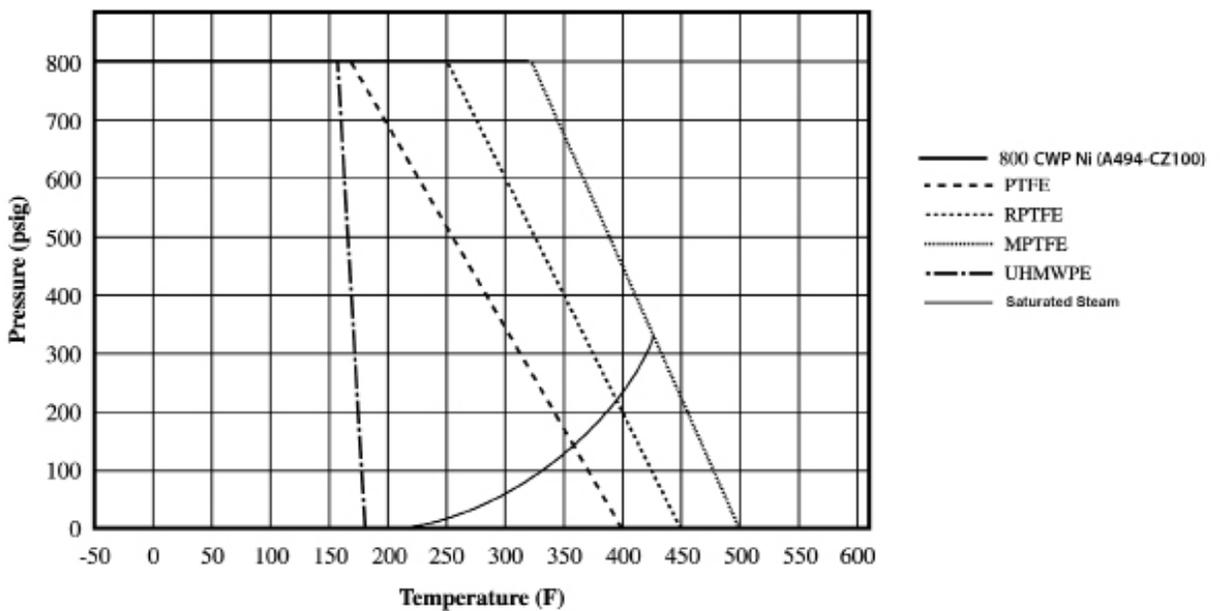
GRAPH 21



800 CWP

(NICKEL) ASTM A494-CZ100

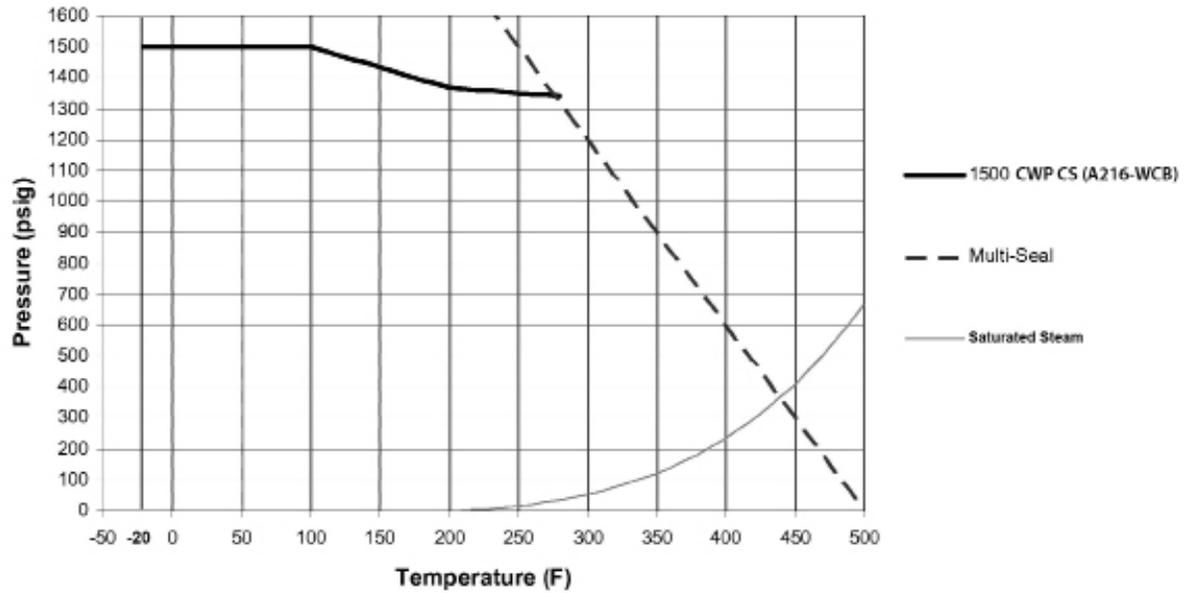
GRAPH 22



1500 CWP

(CS) ASTM A216-WCB

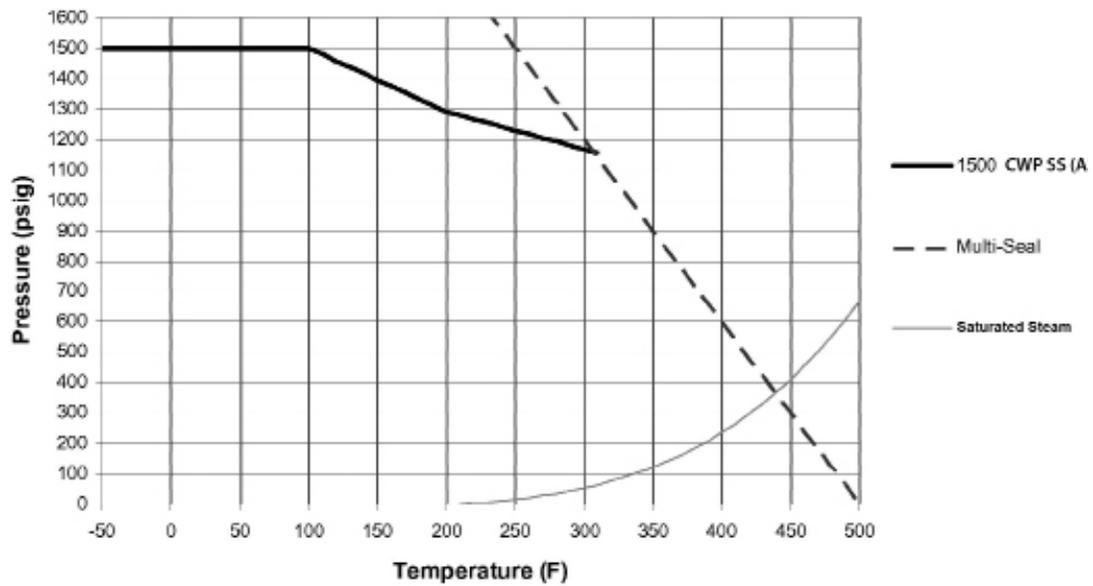
GRAPH 23



1500 CWP

(SS) ASTM A351-CF8M

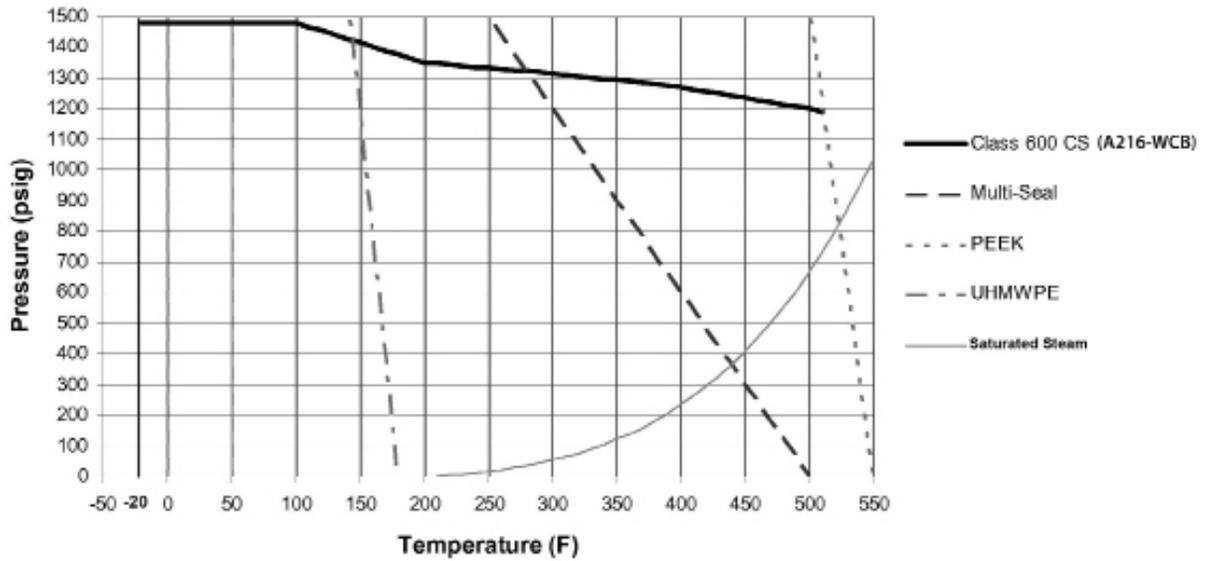
GRAPH 24



ASME CLASS 600

(CS) ASTM A216-WCB

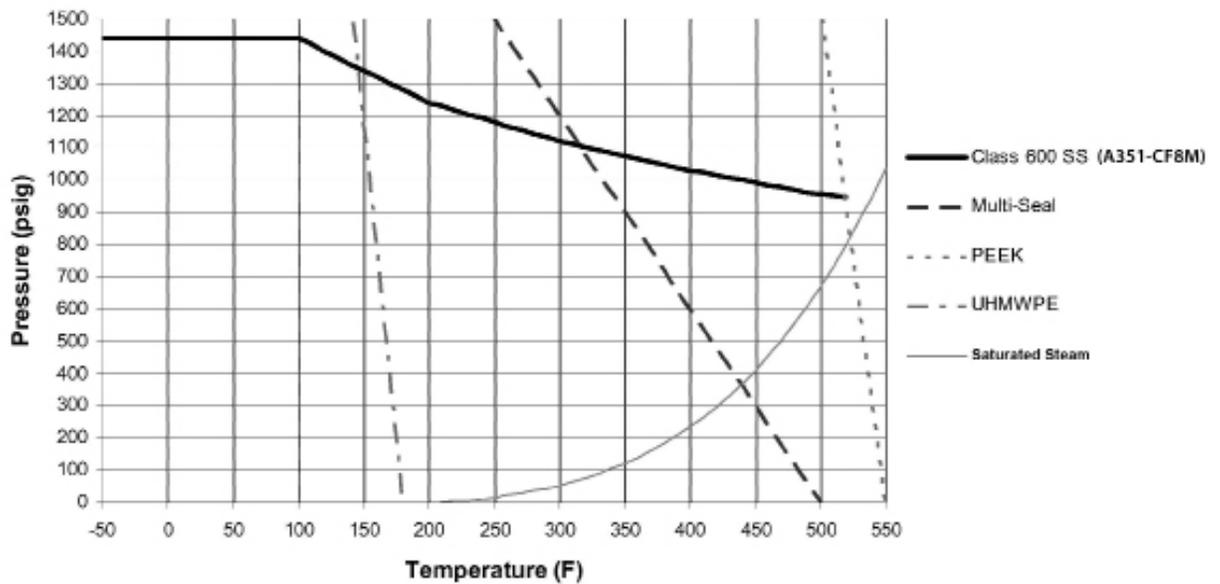
GRAPH 25



ASME CLASS 600

(SS) ASTM A351-CF8M

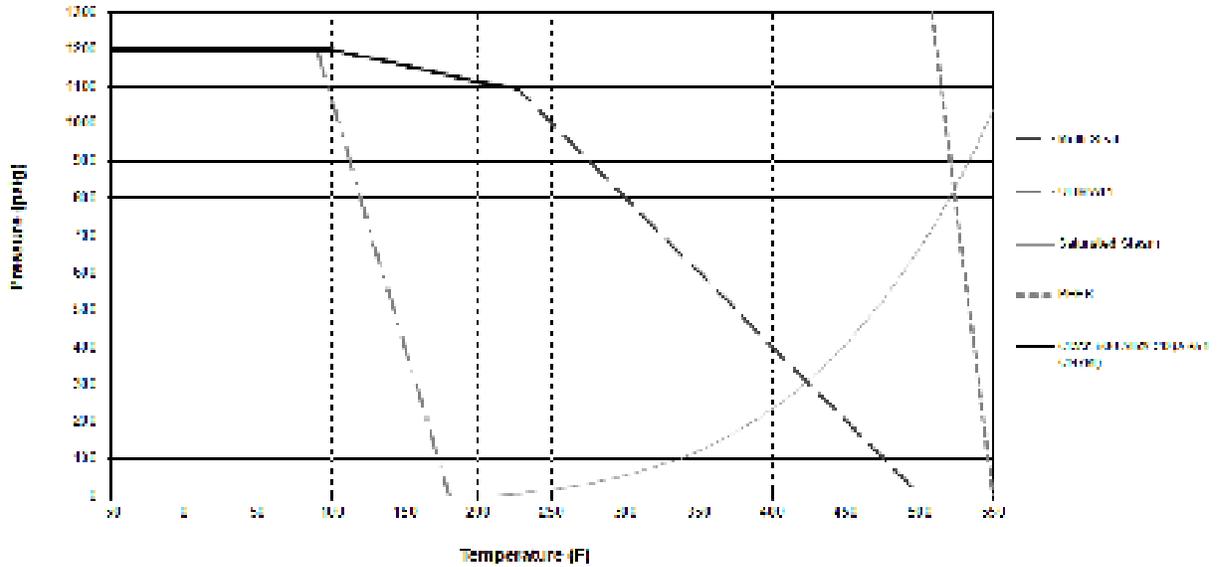
GRAPH 26



ASME CLASS 600

(ALLOY 20) ASTM A351-CN7M

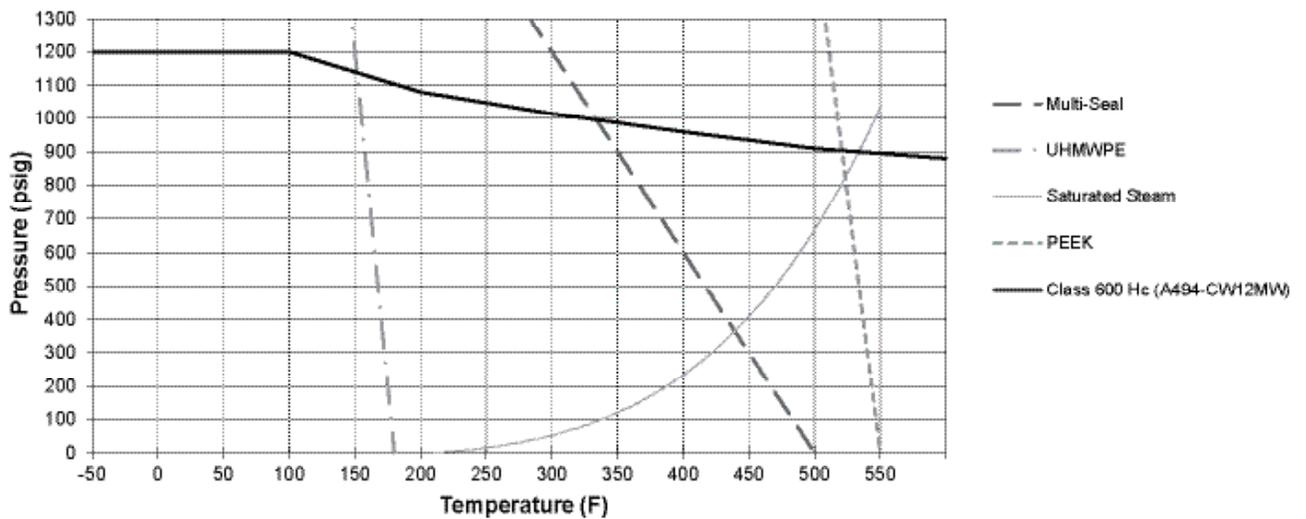
GRAPH 27



ASME CLASS 600

(HASTELLOY C) ASTM A494-CW12MW

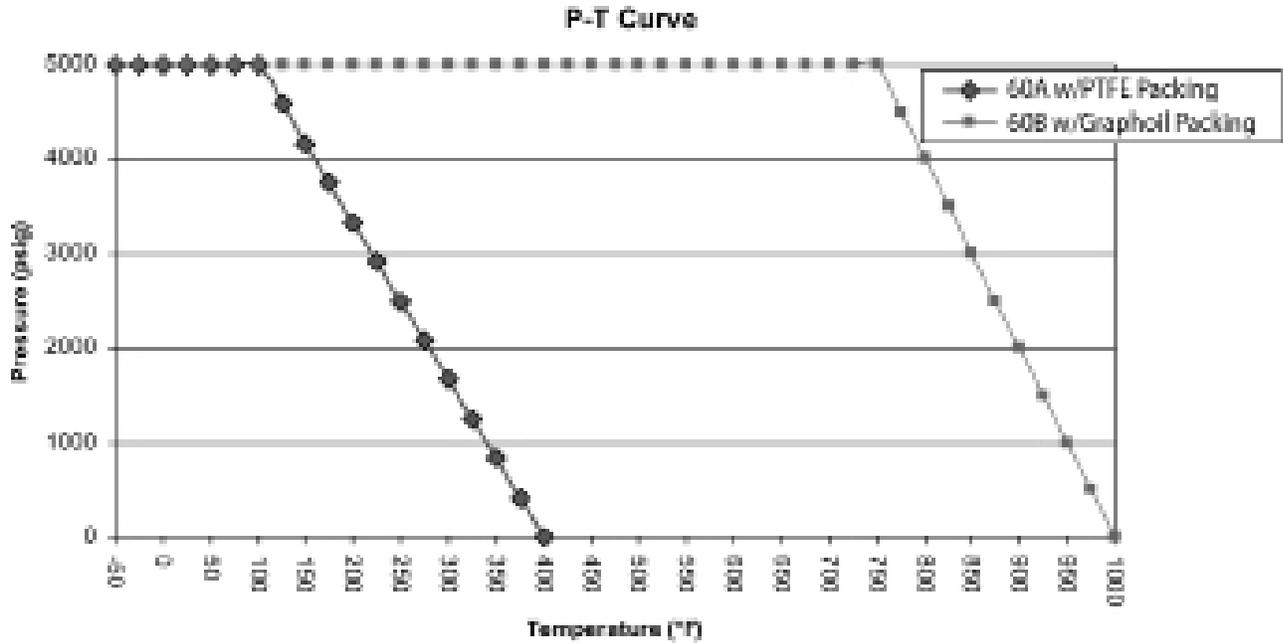
GRAPH 28



60A

METAL SEATED, GLOBE PATTERN VEE-TIP, NEEDLE VALVES

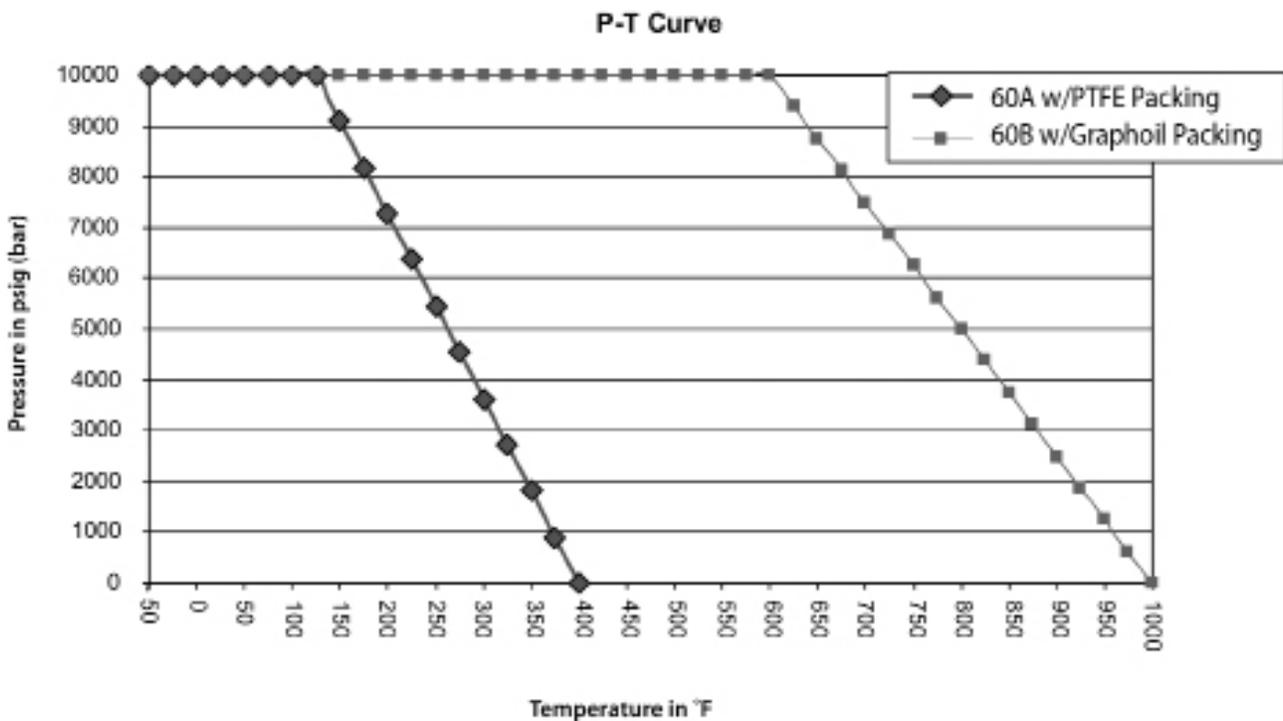
GRAPH 29



60B

METAL SEATED, GLOBE PATTERN VEE-TIP, NEEDLE VALVES

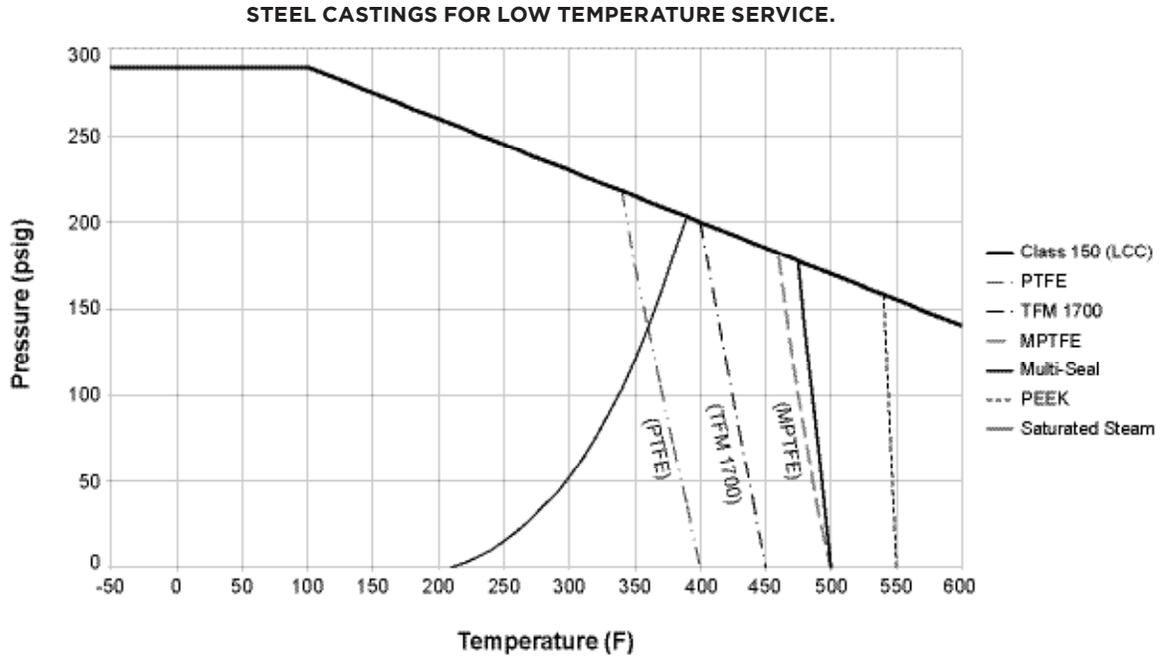
GRAPH 30



CLASS 150

(CS) ASTM A352-LCC

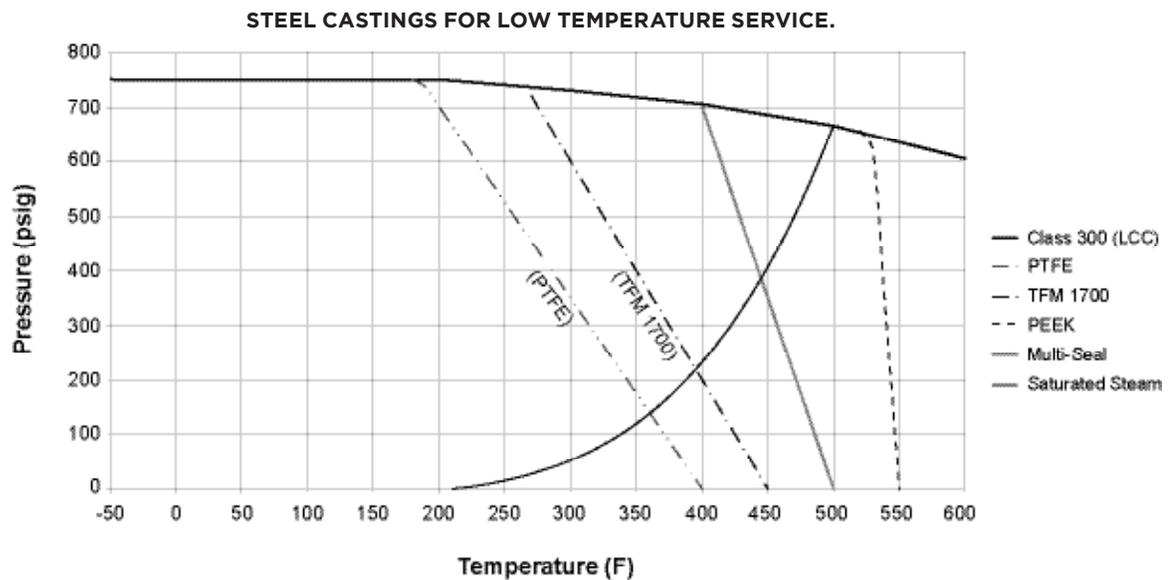
GRAPH 31

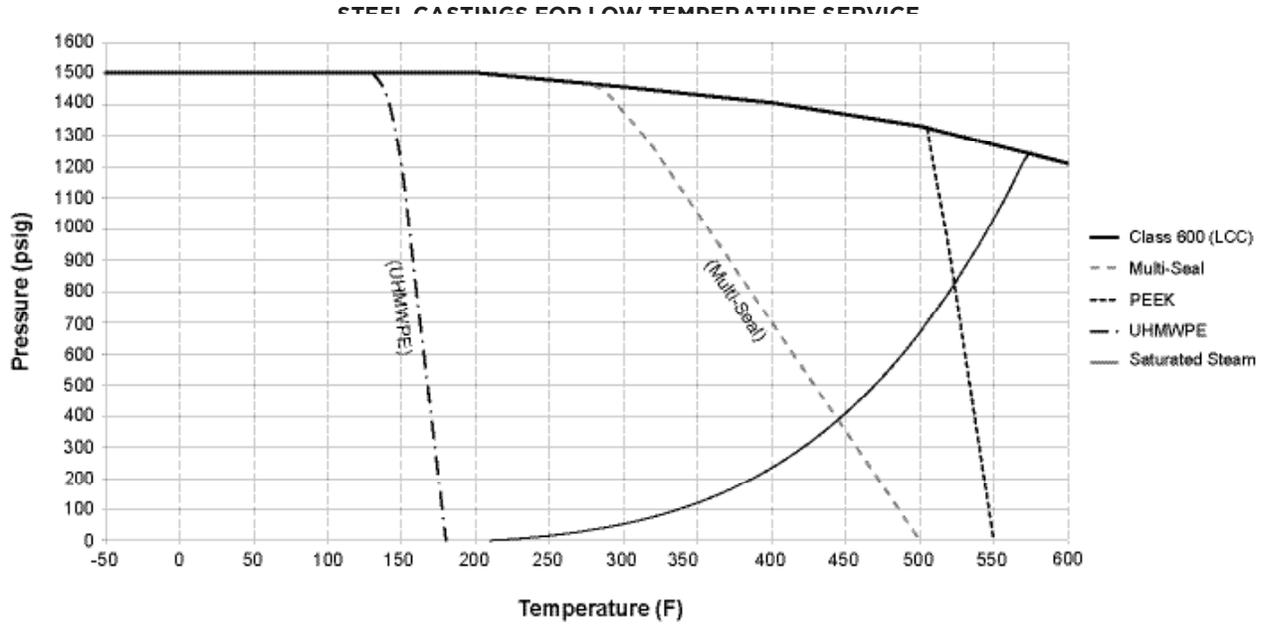


CLASS 300

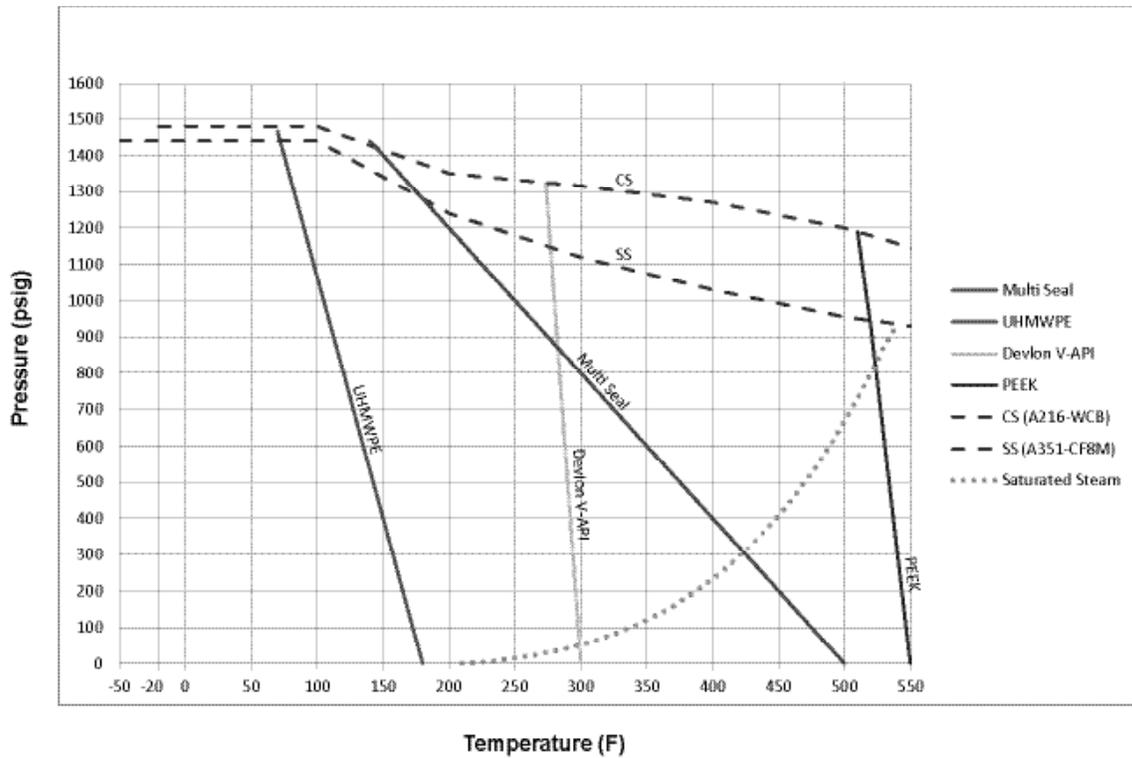
(CS) ASTM A352-LCC

GRAPH 32

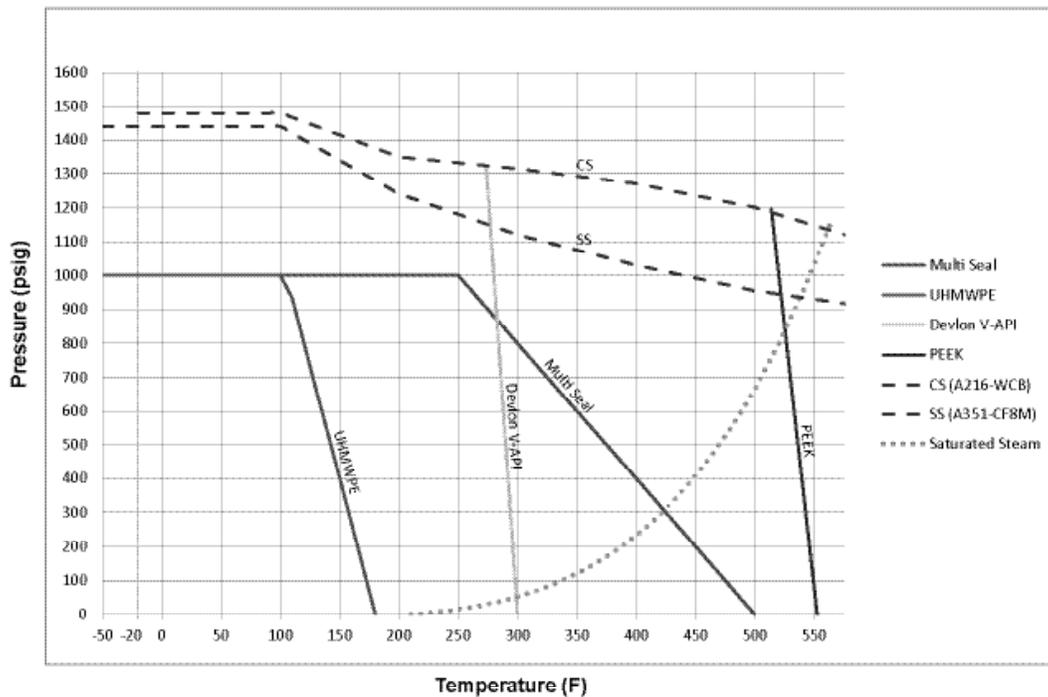




CLASS 600 (SS) ASTM A351-CF8M & (CS) ASTM A216-WCB : 1" - 2" GRAPH 34



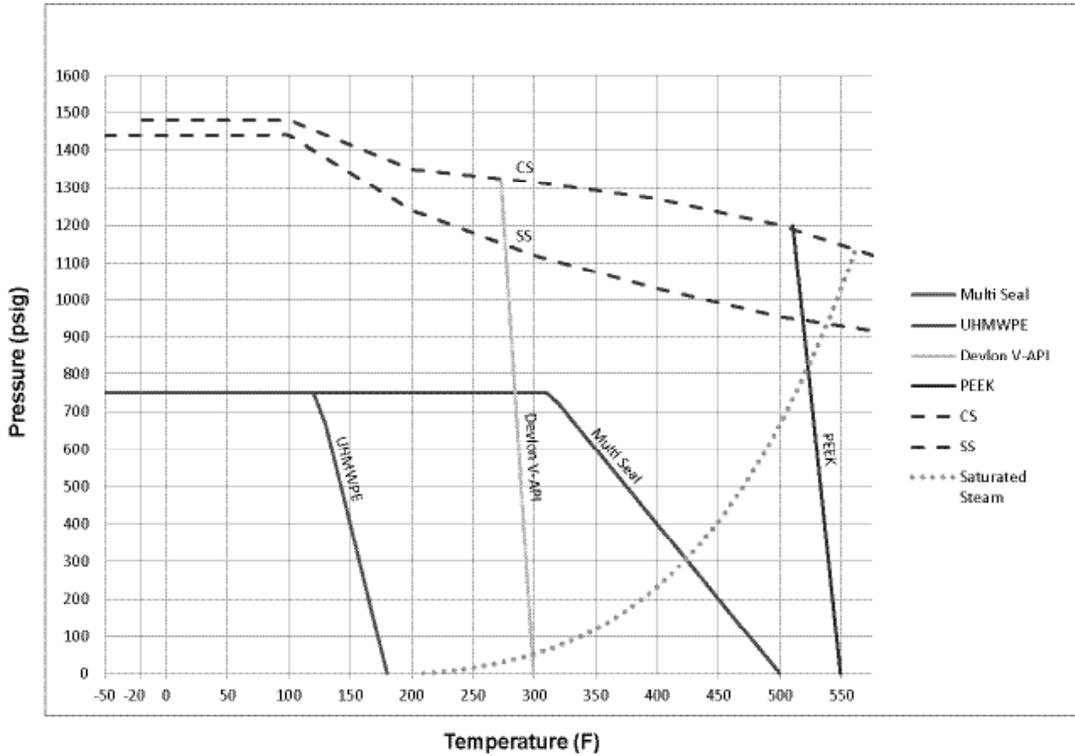
CLASS 600 (SS) ASTM A351-CF8M & (CS) ASTM A216-WCB : 2.5" - 4" GRAPH 35



CLASS 600

(SS) ASTM A351-CF8M & (CS) ASTM A216-WCB : 6" & 8"

GRAPH 36

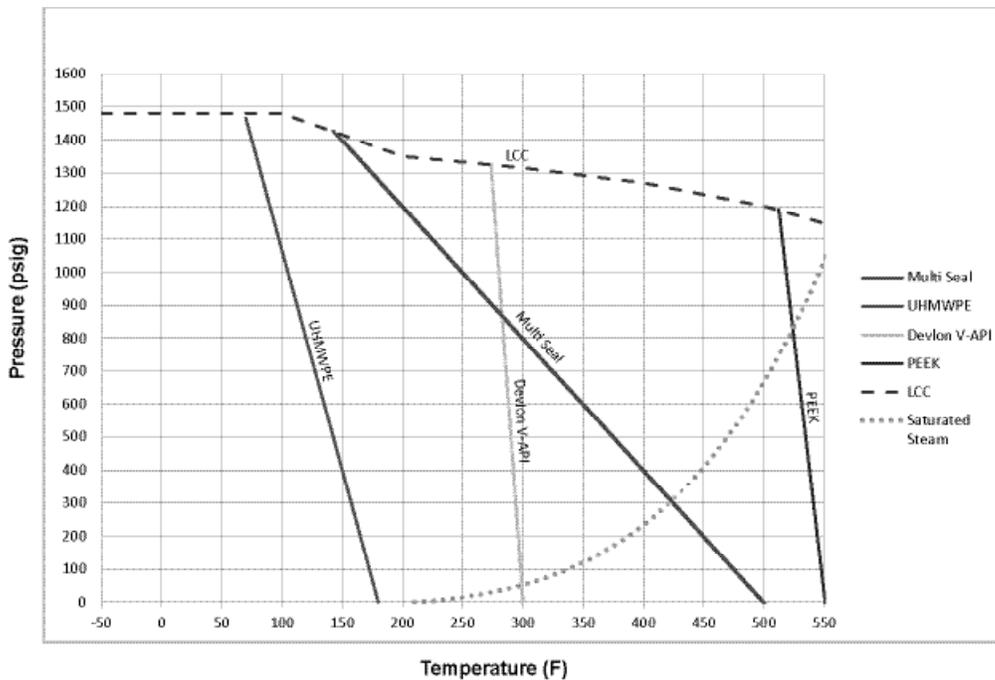


CLASS 600

ASTM A352-LCC : 1" THRU 2"

GRAPH 37

STEEL CASTINGS FOR LOW TEMPERATURE SERVICE.

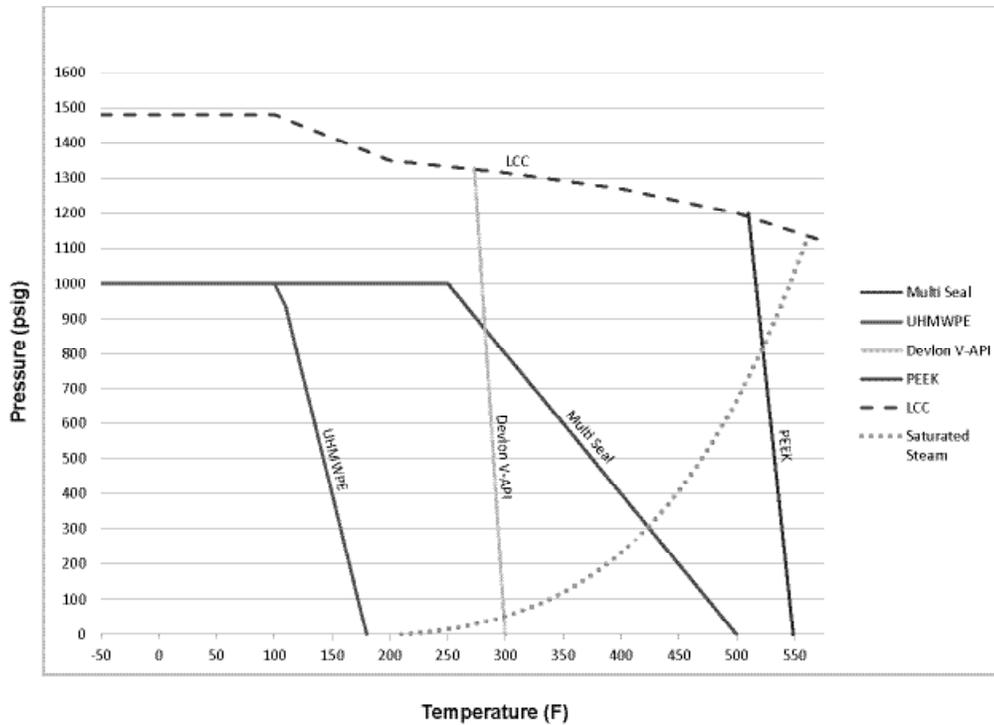


CLASS 600

(CS) ASTM A352-LCC : 2.5" THRU 4"

GRAPH 38

STEEL CASTINGS FOR LOW TEMPERATURE SERVICE.

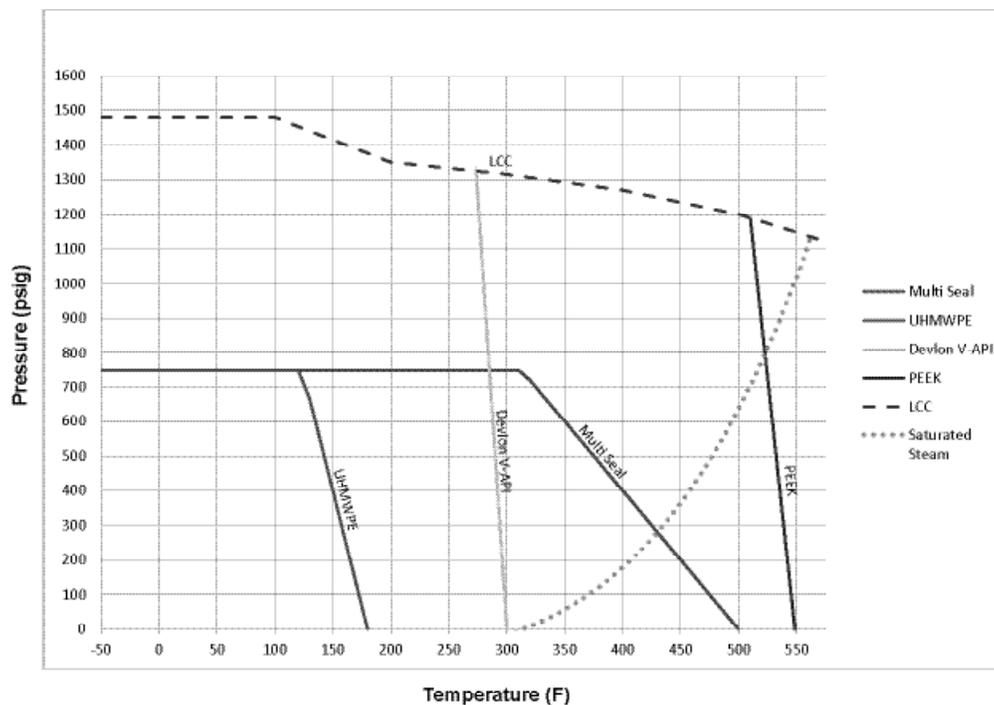


CLASS 600

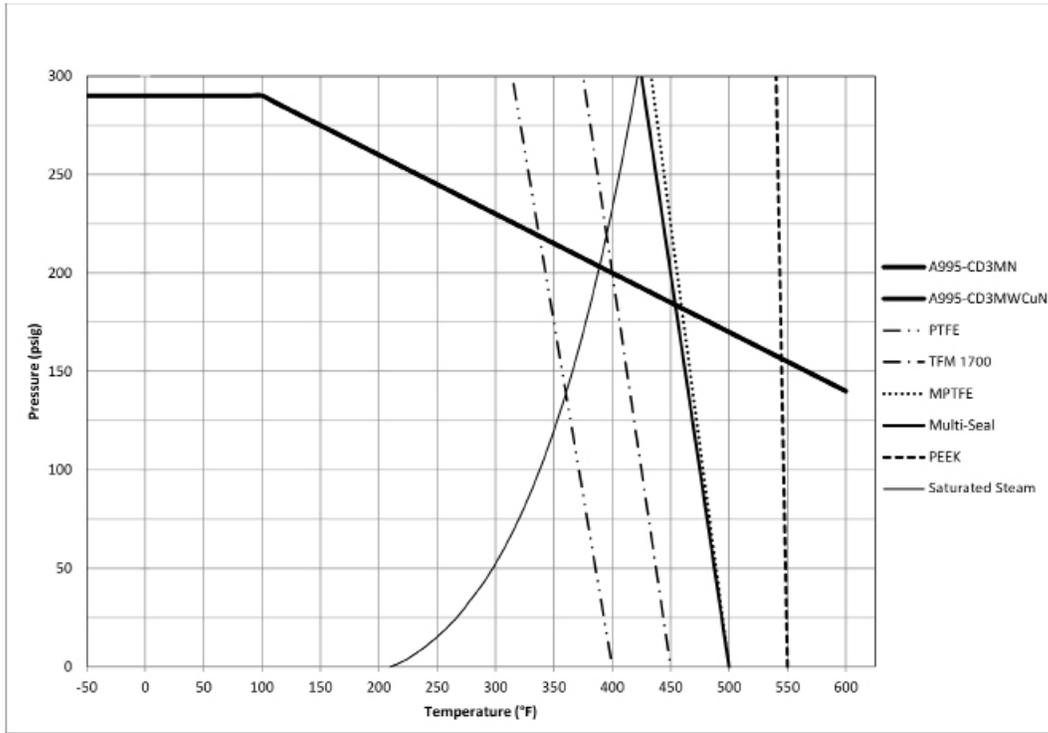
(CS) ASTM A352-LCC : 6" & 8"

GRAPH 39

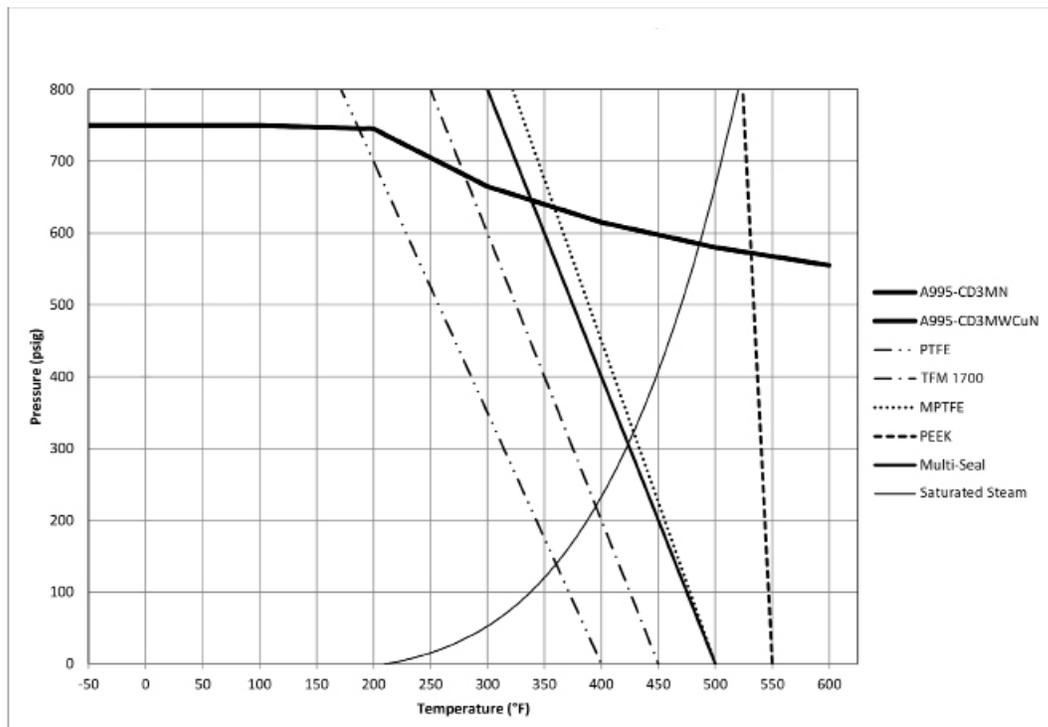
STEEL CASTINGS FOR LOW TEMPERATURE SERVICE.



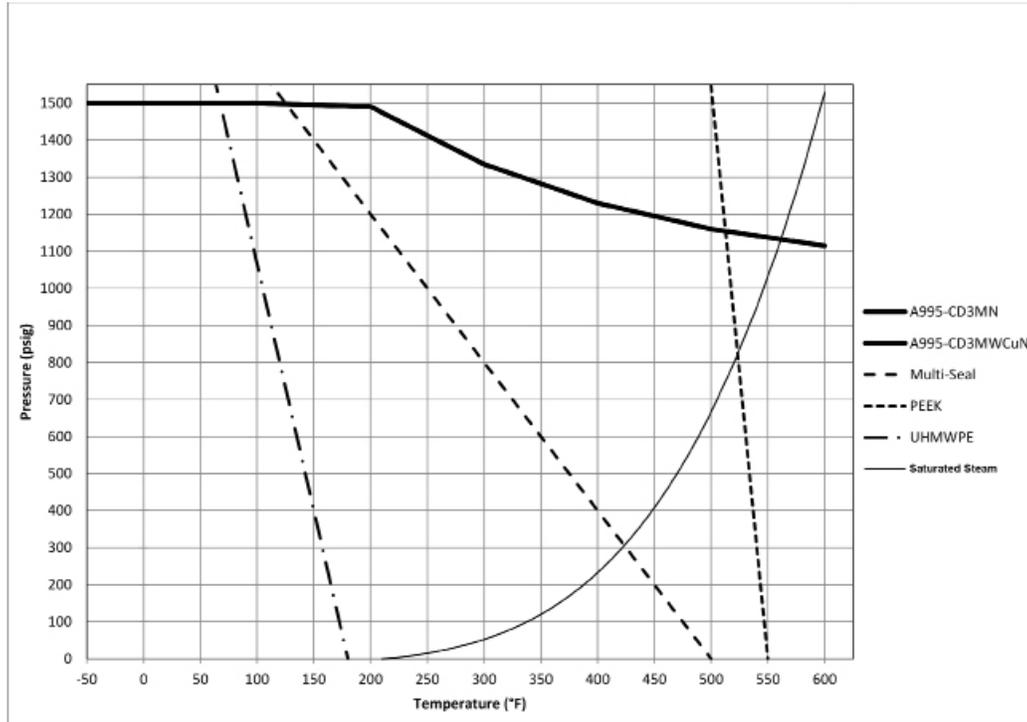
CLASS 150 (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 40



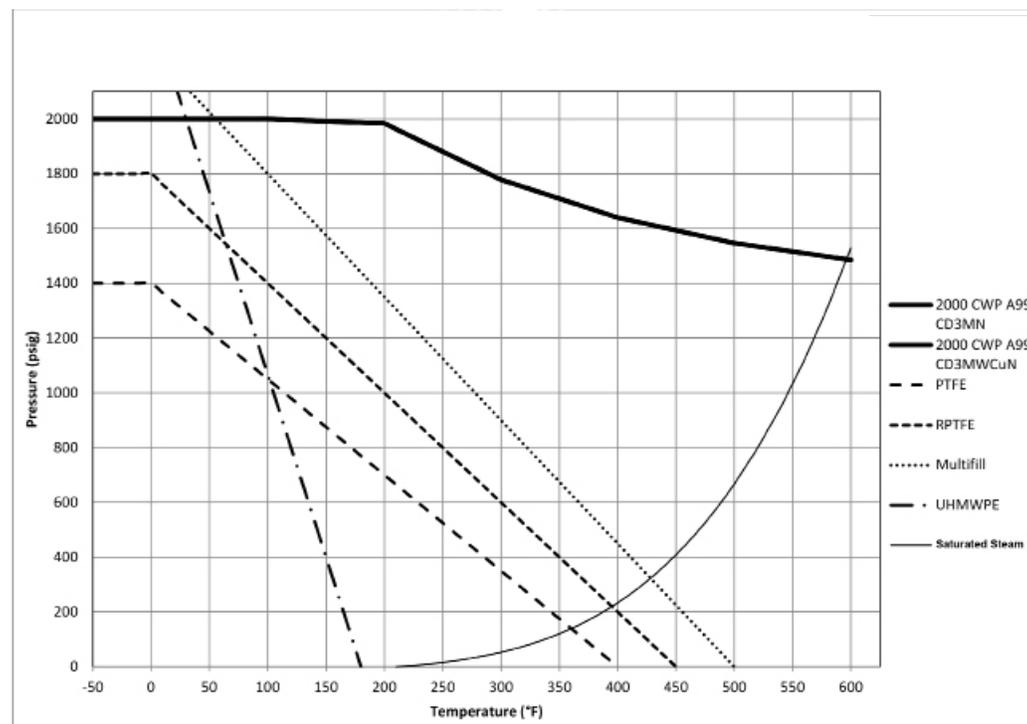
CLASS 300 (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 41



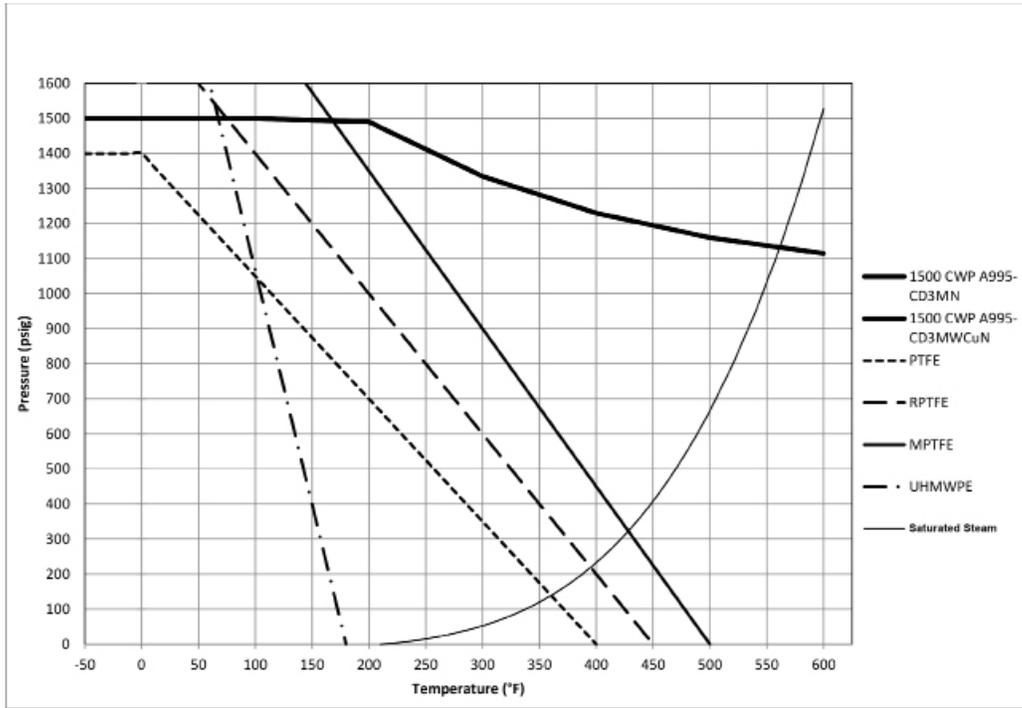
CLASS 600 (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 42



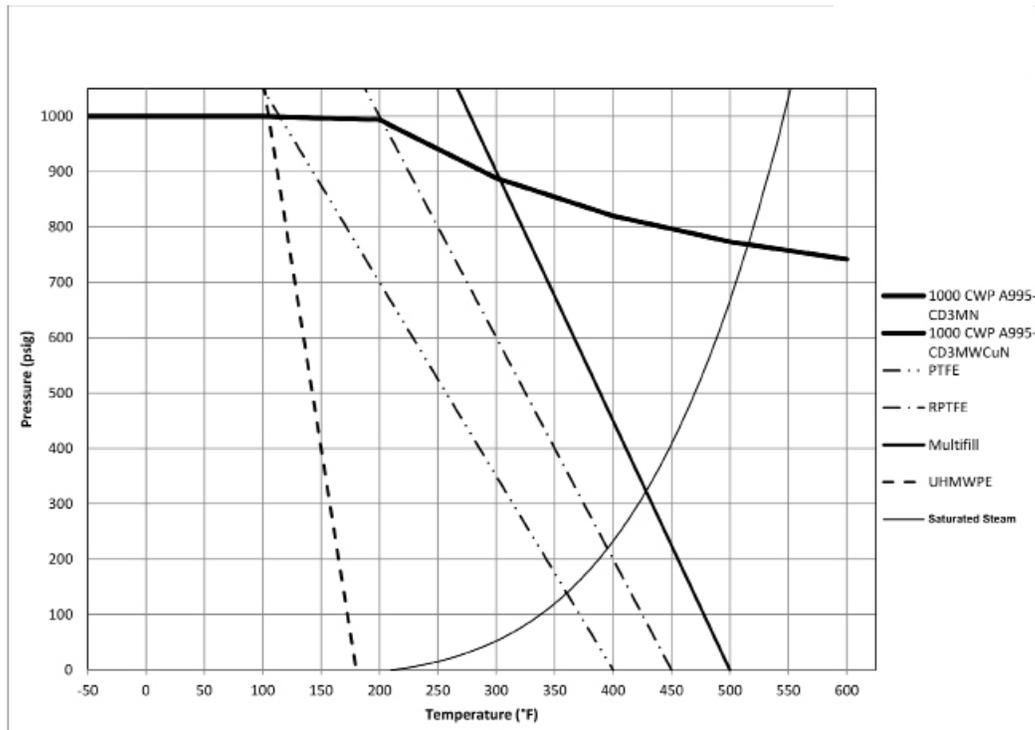
2000 CWP (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 43



1500 CWP (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 44



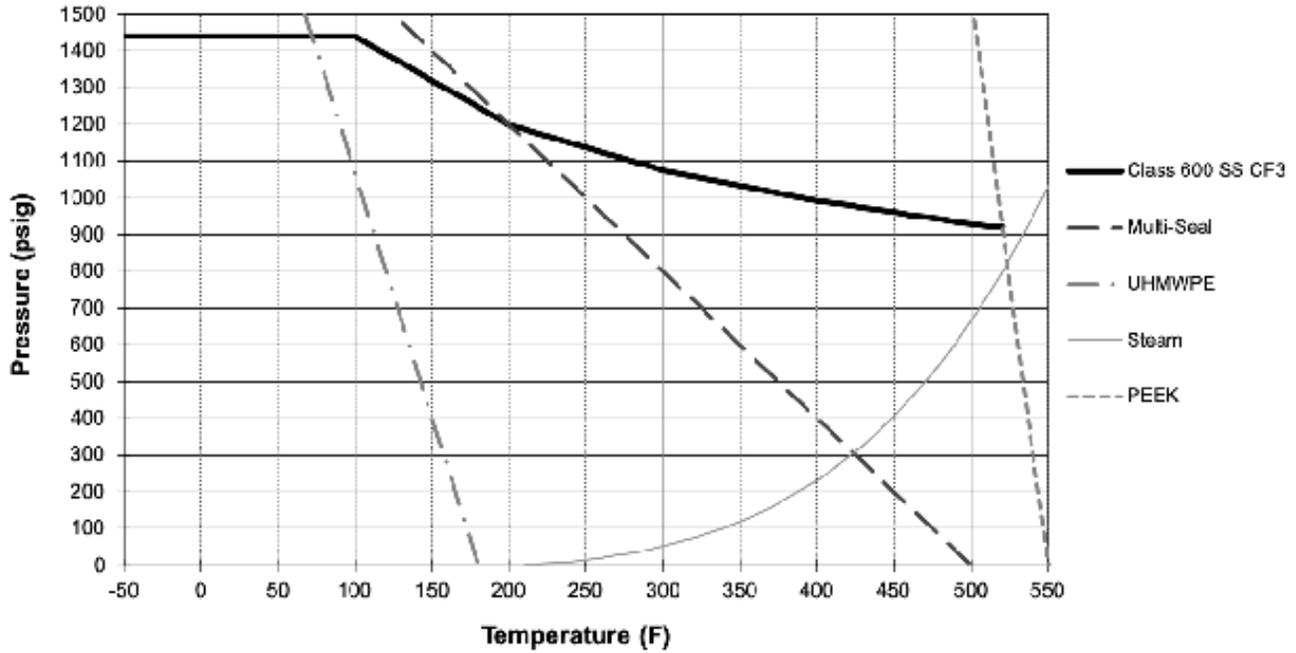
1000 CWP (DUPLEX) ASTM A995-CD3MN & (SUPER DUPLEX) CD3MWCuN GRAPH 45



ASME CLASS 600

(SS) ASTM A351-CF3

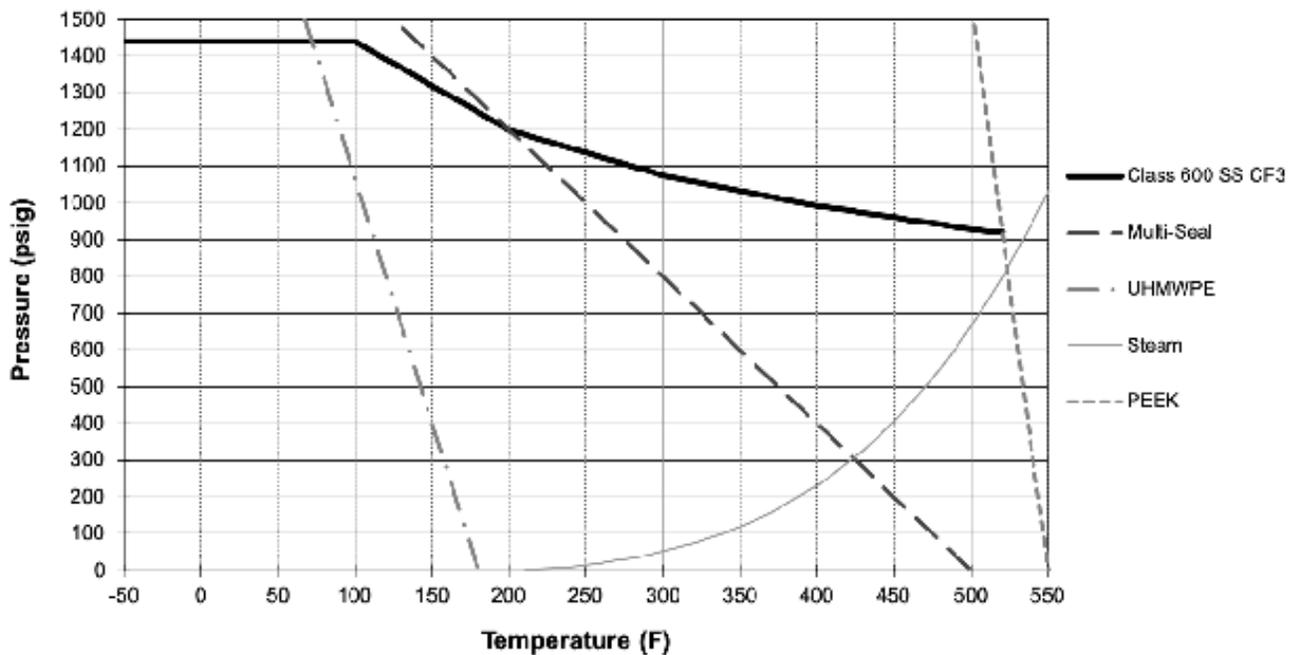
GRAPH 46



ASME CLASS 300

(ALLOY 20) ASTM A351-CN7M

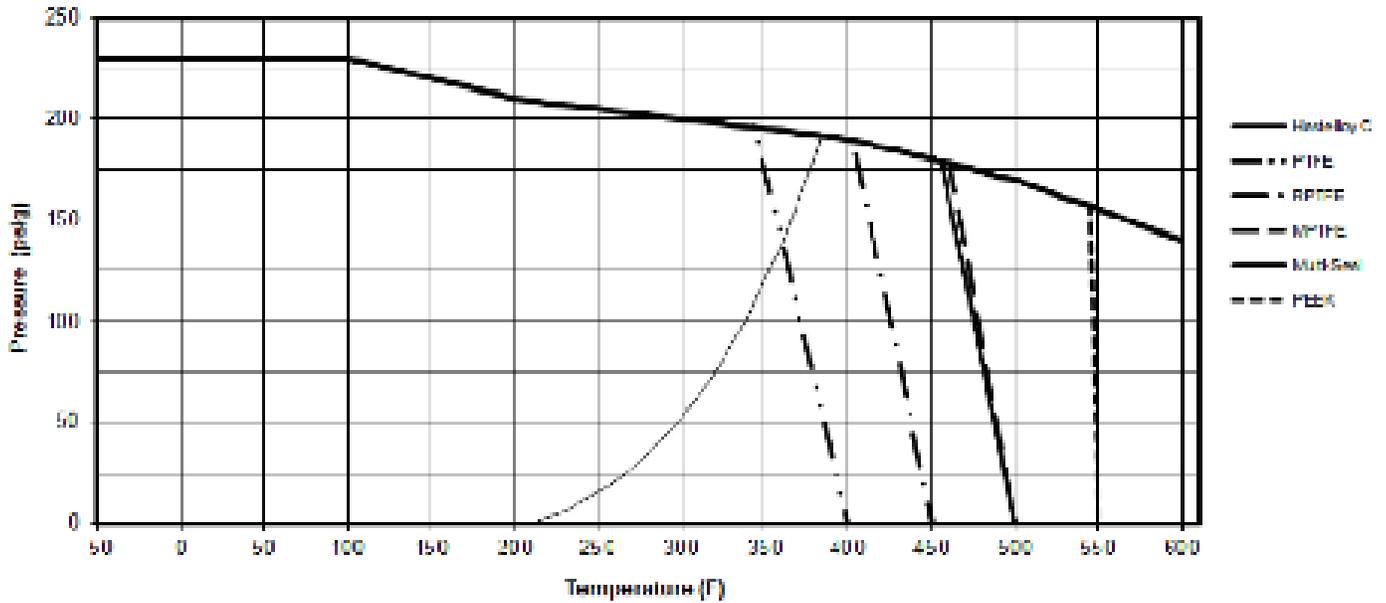
GRAPH 47



ASME CLASS 150

(HASTELLOY C) ASTM A494-CW12MW

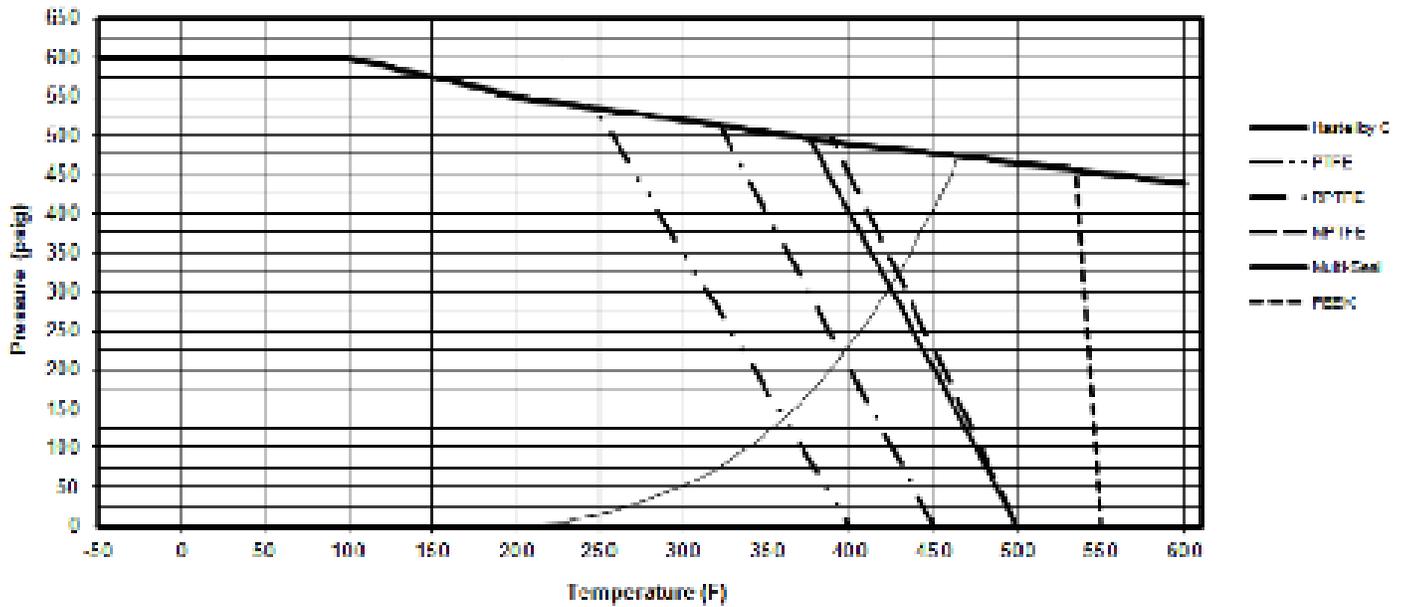
GRAPH 48



ASME CLASS 300

(HASTELLOY C) ASTM A494-CW12MW

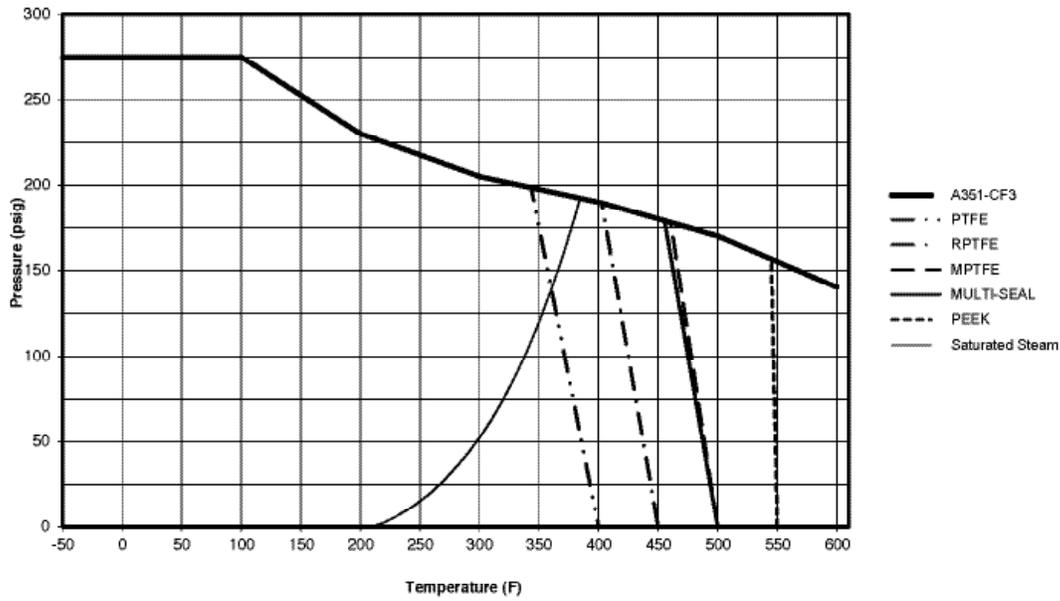
GRAPH 49



ASME CLASS 150

(304/304L) ASTM A351-CF3

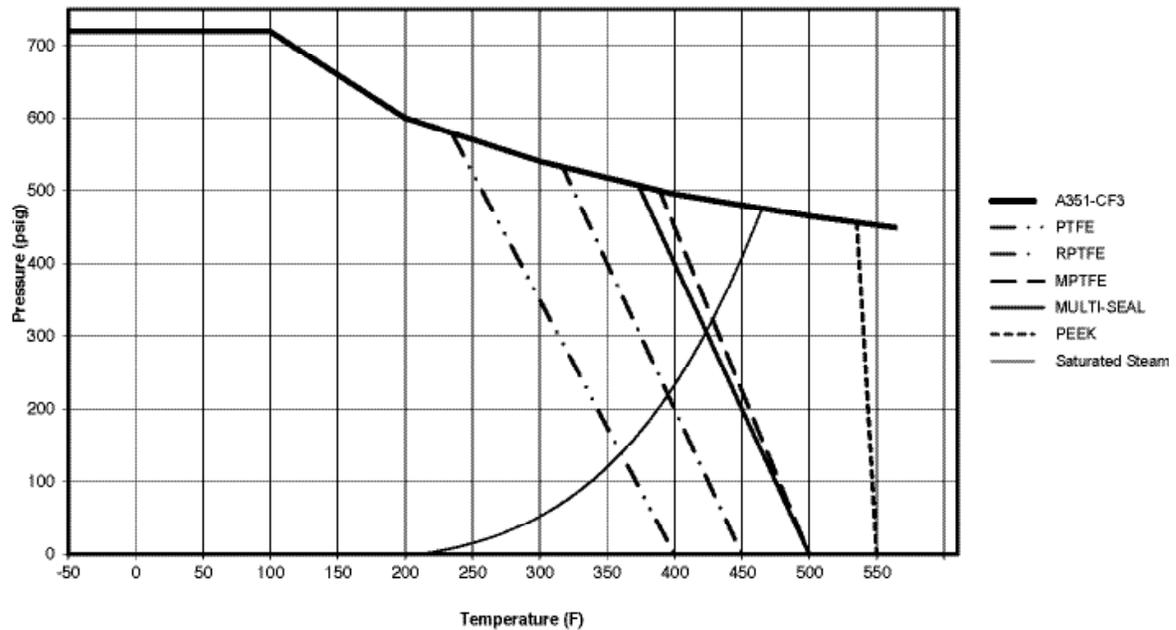
GRAPH 50

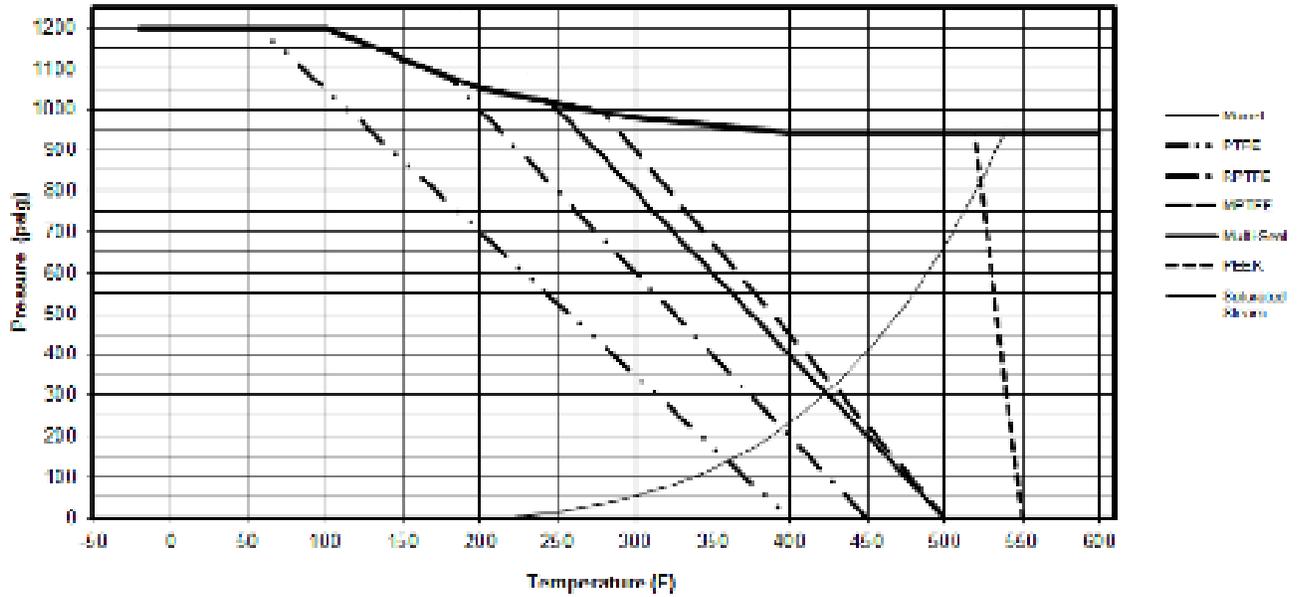


ASME CLASS 300

(304/304L) ASTM A351-CF3

GRAPH 51





CARBON STEEL

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	A108-1215	A216-WCB	A105
Unified Numbering System	G12150	J03002	K03504
MAJOR ELEMENTS			
Carbon	0.09% max.	0.30% max.	0.35% max.
Manganese	0.75 - 1.05%	1.00% max.	0.60 - 1.05%
Phosphorus	0.04 - 0.09%	0.035% max.	0.035% max.
Sulfur	0.26 - 0.35%	0.035% max.	0.04% max.
Silicon	-	0.60% max.	0.10 - 0.35%
MECHANICAL PROPERTIES			
Tensile Strength	70,000 psi min.	70,000 psi min.	70,000 psi min.
Yield Strength	36,000 psi min.	36,000 psi min.	36,000 psi min.

316 STAINLESS STEEL

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	A276-316	A351-CF8M	A182-F316
Unified Numbering System	S31600	J92900	S31600
MAJOR ELEMENTS			
Carbon	0.08% max.	0.08% max.	0.08% max.
Chromium	16.00 - 18.00%	18.00 - 21.00%	16.00 - 18.00%
Molybdenum	2.00 - 3.00%	2.00 - 3.00%	2.00 - 3.00%
Nickel	10.00 - 14.00%	9.00 - 12.00%	10.00 - 14.00%
MECHANICAL PROPERTIES			
Tensile Strength	75,000 psi min.	70,000 psi min.	75,000 psi min.
Yield Strength	30,000 psi min.	30,000 psi min.	30,000 psi min.

316L STAINLESS STEEL

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	A276-316L	A351-CF3M	A182-F316L
Unified Numbering System	S31603	J92800	S31603
MAJOR ELEMENTS			
Carbon	0.03% max.	0.03% max.	0.03% max.
Chromium	16.00 - 18.00%	17.00 - 21.00%	16.00 - 18.00%
Molybdenum	2.00 - 3.00%	2.00 - 3.00%	2.00 - 3.00%
Nickel	10.00 - 14.00%	9.00 - 13.00%	10.00 - 15.00%
MECHANICAL PROPERTIES			
Tensile Strength	70,000 psi min.	70,000 psi min.	75,000 psi min.
Yield Strength	25,000 psi min.	30,000 psi min.	30,000 psi min.

ALLOY 20

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	B473-N08020	A351-CN7M	B462-N08020
Unified Numbering System	N08020	N08007	N08020
MAJOR ELEMENTS			
Chromium	19.00 - 21.00%	19.00 - 22.00%	19.00 - 21.00%
Copper	3.00 - 4.00%	3.00 - 4.00%	3.00 - 4.00%
Manganese	2.00% max.	1.50% max.	2.00% max.
Molybdenum	2.00 - 3.00%	2.00 - 3.00%	2.00 - 3.00%
Nickel	32.00 - 38.00%	27.50 - 30.50%	32.00 - 38.00%
MECHANICAL PROPERTIES			
Tensile Strength	80,000 psi min.	62,000 psi min.	80,000 psi min.
Yield Strength	35,000 psi min.	25,000 psi min.	35,000 psi min.



MATERIAL REFERENCE DATA

ENGINEERING DATA

HASTELLOY

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	B574-C276	A494-CW12MW	B564-N10276
Unified Numbering System	N10276	N30002	N10276
MAJOR ELEMENTS			
Chromium	14.5 - 16.5%	15.5 - 17.5%	14.5 - 16.5%
Molybdenum	15.0 - 17.0%	16.0 - 18.0%	15.0 - 17.0%
Nickel	51.0 - 63.5%	49.2 - 60.0%	51.0 - 63.5%
Tungsten	3.0 - 4.5%	3.75 - 5.25%	3.0 - 4.5%
MECHANICAL PROPERTIES			
Tensile Strength	100,000 psi min.	72,000 psi min.	100,000 psi min.
Yield Strength	41,000 psi min.	40,000 psi min.	41,000 psi min.

NICKEL

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	B160-N02200	A494-CZ100	B160-N02200
Unified Numbering System	N02200	N02100	N02200
MAJOR ELEMENTS			
Nickel	99.00% min.	95.00% min.	99.00% min.
MECHANICAL PROPERTIES			
Tensile Strength	55,000 psi min.	50,000 psi min.	55,000 psi min.
Yield Strength	15,000 psi min.	18,000 psi min.	15,000 psi min.

NICKEL-COPPER ALLOY (MONEL®)

ITEM PROPERTY	BARSTOCK	CASTING	FORGING
ASTM Specifications	B164-N04400	A494-M35-1	B164-N04400
Unified Numbering System	N04400	N/A	N04400
MAJOR ELEMENTS			
Copper	28.00 - 34.00%	26.00 - 33.00%	28.00 - 34.00%
Iron	2.50% max.	3.50% max.	2.50% max.
Manganese	2.00% max.	1.50% max.	2.00% max.
Nickel	63.00% min.	60.00% min.	63.00% min.
MECHANICAL PROPERTIES			
Tensile Strength	70,000 psi min.	65,000 psi min.	70,000 psi min.
Yield Strength	25,000 psi min.	25,000 psi min.	25,000 psi min.

LEADED BRASS & BRONZE ALLOYS

ITEM PROPERTY	BARSTOCK	CASTING
ASTM Specification	B16	B584
Unified Numbering System	C36000	C84400
MAJOR ELEMENTS		
Copper	60.0 - 63.0%	78.0 - 82.0%
Tin		2.3 - 3.5%
Lead	2.5 - 3.7%	6.0 - 8.0%
Zinc	33.0 - 37.5%	7.0 - 10.0%
MECHANICAL PROPERTIES		
Tensile Strength	25,000 psi min.	29,000 psi min.
Yield Strength	10,000 psi min.	13,000 psi min.

LEAD FREE ALLOYS

ITEM PROPERTY	CASTING	BARSTOCK
ASTM Specification	B30	B927
Unified Numbering System	C89836	C27451
MAJOR ELEMENTS		
87.0 - 91.0%	Copper	61.0 - 65.0%
4.0 - 6.0%	Tin	
.25% max.	Lead	0.25% max.
2.0 - 4.0%	Zinc	Rem%
MECHANICAL PROPERTIES		
33,000 psi min.	Tensile Strength	55,000 psi Typ.
15,000 psi min.	Yield Strength	35,000 psi Typ.

REV. 19MAR18

DESIGNATION	TEMP. RANGE	GENERAL DESCRIPTION
-01 (RPTFE)	to 450°F	Glass reinforced PolyTetraFluoroEthylene seat seals and packings: most commonly specified seat material. Maintains the chemical resistance of PTFE with increased resistance to wear and abrasion resulting in longer life.
-21 (UHMWPE)	to 180°F	Ultra High Molecular Weight PolyEthylene seats with graphite seals and packings: Offers good abrasion resistance making it suitable for use in high solids or slurry applications. This seat is frequently specified in services where fluorine off-gassing in even the slightest amounts is objectionable, services such as food and tobacco processing, and nuclear services. UHMWPE should be used with caution in the presence of solvents, and the operating torque can be expected to be 30% higher than RPTFE seat materials.
-35 (PTFE)	to 400°F	PolyTetraFluoroEthylene (PTFE) seats, seals and packings: general application seat material, exhibiting lowest operating torque and excellent resistance to chemical attack.
-38 (PEEK)	to 550°F	PolyEtherEtherKetone seats with graphite seals and packings: offers a high strength alternative to RPTFE, resistant to creep and cold flow. This seat offers good abrasion resistance. This material offers similar chemical resistance to PTFE but should be checked on application. For actuator sizing, consult factory.
-56 (Multifill)	to 500°F	Carbon and graphite reinforced PTFE seats, seals and packings: reduced creep and cold flow like any RPTFE but with 20% lower operating torque than the glass reinforced versions.
-64 (Multifill)	to 500°F	Carbon and graphite reinforced PTFE seats, seals and packings: reduced creep and cold flow like any RPTFE but with 20% lower operating torque than the glass reinforced versions. Includes handle graphics for 250 psig saturated steam.
-65 (Multifill)	to 500°F	Carbon and graphite RPTFE seats, graphite seals and packings: reduced creep and cold flow like any RPTFE but with 20% lower operating torque than the glass reinforced versions. This configuration is also good for steam applications.
-78 (Delrin)	to 230°F	Delrin is the homopolymer version of Acetal. The material is both strong and rigid but not brittle making it ideal for many high pressure applications. It's a preferred material for use in hydrocarbon systems, oils and gases, but should be used with caution in
-79 (Nylon)	to 300°F	Nylon is a polyamide. This material has very good mechanical properties making it ideally suited for many high pressure applications. It's a preferred material for use in hydrocarbon systems, oils and gases, but should not be used in wet systems above 120°F.
-80 (Multiseal)	to 500°F	Apollo's multiseal is modified PolyTetraFluoroEthylene (PTFE) that maintains the exceptional chemical resistance and heat resistance properties of conventional PTFE. Apollo's Multiseal has increased resistance to wear, abrasion and creep compared to PTFE.
-89 (PFA)	to 400°F	Perfluoroalkoxy seats withstand the effects of polymeric monomers such as butadiene and styrene.



CONVERSION FACTORS

ENGINEERING DATA

TO CONVERT	INTO	MULTIPLY BY
atmospheres	cms of mercury	76.0
atmospheres	ft. of water (at 4°C)	33.90
atmospheres	in. of mercury (at 0°C)	29.92
atmospheres	kgs/sq cm	1.0333
atmospheres	kgs/sq meter	10.332
atmospheres	pounds/sq. in.	14.70
Bar	newtons/sq m	105
bar	atmospheres	0.9869
bar	at (tech.)	1.0197
bar	psi	14.504
Barrels-Oil	gals-oil	42
BT Units	kg-calories	0.2520
BTU's	ft-lbs	777.9
BTU's	hp-hrs	3.927 x 10 ⁻⁴
BTU's	kgs-meters	107.5
BTU's	kw-hrs	2.928 x 10 ⁻⁴
BTU/Min	ft-lbs/sec	12.96
BTU/min	hp	0.02356
BTU/min	kw	0.01757
BTU/min	watts	17.57
Centimeters	inches	0.3937
cm	meters	0.01
cm	mm	10
Cms Mercury	atm	0.01316
cms mercury	ft water	0.4461
cms mercury	kgs/sq meter	136.0
cms mercury	lbs/sq ft	27.85
cms mercury	lbs/sq in	0.1934
Cms/Second	ft/min	1.969
cms/sec	ft/sec	0.03281
cms/sec	km/hr	0.036
cms/sec	meters/min	0.6
cms/sec	miles/hr	0.02237
cms/sec	miles/min	3.728 x 10 ⁻⁴
Cms/Sec/Sec	ft/sec/sec	0.03281
Cubic Cms	cu ft	3.531 x 10 ⁻⁵
Cu cms	cu in	6.102 x 10 ⁻²
cu cms	cu meters	10 ⁻⁶
cu cms	cu yds	1.308 x 10 ⁻⁶
cu cms	gals	2.642 x 10 ⁻⁴
cu cms	liters	10 ⁻³
cu cms	pints (liq)	2.113 x 10 ⁻³
cu cms	quarts (liq)	1.057 x 10 ⁻³
Cubic Feet	cubic cms	2.832 x 10 ⁴
cu ft	cu inches	1728
cu ft	cu meters	0.02832
cu ft	cu yds	0.03704
cu ft	gals	7.48052
cu ft	liters	28.32
cu ft	pints (liq)	59.84
cu ft	quarts (liq)	29.92
Cu Ft/min	cu cms/sec	472.0
cu ft/min	gals/sec	0.1247
cu ft/min	liters/sec	0.4720
cu ft/min	lbs water/min	62.43
cu ft/sec	gals/min	448.831
Cu Inches	cc	16.39
cu ins	cu ft	5.787 x 10 ⁻⁴
cu ins	cu meters	1.639 x 10 ⁻⁵
cu ins	cu yds	2.143 x 10 ⁻⁵
cu ins	gals	4.329 x 10 ⁻³
cu ins	liters	1.639 x 10 ⁻²
cu ins	pints (liq)	0.03463
cu ins	quarts (liq)	0.01732
Cu Meters	cc	104

TO CONVERT	INTO	MULTIPLY BY
cu M	cu ft	35.31
cu M	cu ins	61,023
cu M	cu yds	1.308
cu M	gals	264.2
cu M	liters	103
cu M	pints (liq)	2113
cu M	quarts (liq)	1057
Cu Yards	cu cms	7.646 x 10 ⁵
cu yds	cu ft	27
cu yds	cu ins	46,656
cu yds	cu meters	0.7646
cu yds	gals	202.0
Decimeters	meters	0.1
Deg (Angle)	minutes	60
degs (angle)	radians	0.01745
degs (angle)	secs	3600
Degrees/Sec	radians/sec	0.01745
degs/sec	revs/min	0.1667
degs/sec	revs/sec	0.002778
Feet	cms	30.48
ft	ins	12
ft	meters	0.3048
ft	yds	1/3
Ft of Water	atms	0.02950
ft of w	ins mercury	0.8826
ft of w	kgs/sq cm	0.03048
ft of w	lbs/sq ft	62.32
ft of w	lbs/sq in	0.4328
Feet/Min	cms/sec	0.5080
ft/min	ft/sec	0.01667
ft/min	kms/hr	0.01829
ft/min	meters/min	0.3048
ft/min	miles/hr	0.01136
Ft/Sec/Sec	cms/sec/sec	30.48
ft/sec/sec	Meters/sec/sec	0.3048
Ft-Pounds	BTU s	1.286 x 10 ⁻³
ft lbs	hp-hrs	5.050 x 10 ⁻⁷
ft lbs	kg-calories	3.241 x 10 ⁻⁴
ft lbs	kg-meters	0.1383
ft lbs	kw-hrs	3.766 x 10 ⁻⁷
Ft-lbs/Min	BTUs/min	1.286 x 10 ⁻³
ft-lbs/min	ft-lbs/sec	0.01667
ft-lbs/min	hp	3.030 x 10 ⁻⁵
ft-lbs/min	kg-calories/min	3.241 x 10 ⁻⁴
ft-lbs/min	kws	2.260 x 10 ⁻⁵
Ft-Lbs/Sec	BTUs/min	7.717 x 10 ⁻²
ft-lbs/sec	hp	1.818 x 10 ⁻³
ft-lbs/sec	kg-calories/min	1.945 x 10 ⁻²
ft-lbs/sec	kws	1.356 x 10 ⁻³
Gallons	ccs	3785
gals	cu ft	0.1337
gals	cu ins	231
gals	cu meters	3.785 x 10 ⁻³
gals	liters	3.785
gals	pints (liq)	8
gals	quarts (liq)	4
Gallons, Imp	US gals	1.20095
gallons, US	imp gals	0.83267
Gals Water	lbs water	8.3304
Gallons/Min	cu ft/sec	2.228 x 10 ⁻³
gals/min	liters/sec	0.06308
gals/min	cu ft/hr	8.0208
Horse-Power	BTUs/min	42.44
hp	ft-lbs/min	33,000
hp	ft-lbs/sec	550



CONVERSION FACTORS

ENGINEERING DATA

TO CONVERT	INTO	MULTIPLY BY
hp	hp (metric)	1.014
hp	kg-calories/min	10.70
hp	kws	0.7457
hp	watts	745.7
Hp-Hours	BTUs	2547
hp-hrs	ft-lbs	1.98 x 106
hp-hrs	kg-calories	641.7
hp-hrs	kg-meters	2.737x105
hp-hrs	kw-hrs	0.7457
Inches	cms	2.540
Inches	mms	25.4
Ins Mercury	atms	0.03342
ins mercury	ft water	1.133
ins mercury	kgs/sq cm	0.03453
ins mercury	lbs/sq ft	70.73
ins mercury	lbs/sq in	0.4912
Ins of Water	atms	0.002458
ins of w	ins mercury	0.07355
ins of w	kgs/sq cm	0.002540
ins of w	lbs/sq ft	5.202
ins of w	lbs/sq in	0.03613
Kilograms	dynes	980,665
kgs	lbs	2.205
kgs	tons (short)	1.102 x 10 ⁻³
kgs	grams	1000
Kgs/Sq Cm	atms	0.9678
kgs/sq cm	ft water	32.81
kgs/sq cm	ins mercury	28.96
kgs/sq cm	lbs/sq ft	2048
kgs/sq cm	lbs/sq in	14.22
Kilometers	cms	105
kms	ft	3281
kms	meters	103
kms	miles	0.6214
Kms/Hr	cms/sec	27.78
kms/hr	ft/min	54.68
kms/hr	ft/sec	0.9113
kms/hr	meters/min	16.67
kms/hr	miles/hr	0.6214
Kms/Hr/Sec	cms/sec/sec	27.78
kms/hr/sec	ft/sec/sec	0.9113
kms/hr/sec	Meters/sec/sec	0.2778
Kilowatts	BTUs/min	56.92
kws	ft-lbs/min	4.425 x 104
kws	ft-lbs/sec	737.6
kws	hp	1.341
kws	kg-calories/min	14.34
kws	watts	103
Kilowatt-Hrs	BTUs	3415
kw-hrs	ft-lbs	2.655 x 106
kw-hrs	hp-hours	1.341
kw-hrs	kg-calories	860.5
kw-hrs	kg-meters	3.671 x 105
Liters	ccs	103
liters	cu ft	0.03531
liters	cu ins	61.02
liters	cu meters	10 ⁻²
liters	gals	0.2642
liters	quarts (liq)	1.057
Liters/Min	gals/sec	4.403 x 10 ⁻³
Meters	cms	100
meters	ft	3.281
meters	ins	39.37
meters	kms	10 ⁻³

TO CONVERT	INTO	MULTIPLY BY
meters	mms	103
meters/min	cms/sec	1.667
meters/min	ft/min	3.281
meters/min	ft/sec	0.05468
meters/min	kms/hr	0.06
meters/min	miles/hr	0.03728
Meters/Sec	ft/min	196.8
meters/sec	ft/sec	3.281
meters/sec	kms/hr	3.6
meters/sec	kms/min	0.06
meters/sec	miles/hr	2.237
meters/sec	miles/min	0.03728
Microns	meters	10 ⁻⁶
microns	in	39 x 10 ⁻⁶
Miles/Hr	cms/sec	44.70
miles/hr	ft/min	88
miles/hr	ft/sec	1.467
miles/hr	kms/hr	1.609
miles/hr	meters/min	26.82
Millimeters	cms	0.1
mms	ins	0.03937
Minutes (Angle)	radians	2.909 x 10 ⁻⁴
Newton	kgs	0.1020
Ounces	lbs	0.0625
ozs.	gram	28.349527
Ozs (Fluid)	cu in	1.805
ozs (fluid)	liters	0.02957
Pounds	ozs.	16
LB.	kgs	0.4536
LB.	tons (short)	0.0005
LB.	newtons (N)	4.44
LB.	gram	453.5924
Pounds/Inch	newton-meters	0.113
Pounds/Foot	newton-meters	1.356
Lbs of Water	cu ft	0.01605
lbs of water	cu in	27.73
lbs of water	gals	0.1204
Lbs of Water/Min	cu ft/sec	2.679 x 10 ⁻⁴
Pounds/Cu Ft	lbs/cu in	5.787 x 10 ⁻⁴
Pounds/Cu In	lbs/cu ft	1728
Pounds/Sq In	atms	0.06804
lbs/sq in	ft water	2.311
lbs/sq in	in mercury	2.036
lbs/sq in	kgs/sq cm	0.07031
Radians	degrees	57.29578
Tons (Long)	kgs	1016
tons (long)	lbs	2240
tons (long)	tons (short)	1.12000
Tons (Short)	kgs	2000
tons (short)	kps	90718486
tons (short)	tons (long)	0.89287
tons (short)	tons (metric)	0.90718
Watts	BTUs/min	0.05692
watts	ft-lbs/min	44.26
watts	ft-lbs/sec	0.7376
watts	hp	1.341 x 10 ⁻³
watts	kg-calories/min	0.01434
watts	kws	10 ⁻³
Watts/Hours	BTUs	3.415
watts-hrs	ft-lbs	2655
watts-hrs	hp-hrs	1.341 x 10 ⁻³
watts-hrs	kg-calories	0.8605
watts-hrs	kg-meters	367.1
watts-hrs	kw-hrs	10 ⁻³



SECTION M

REVISIONS

PAGE	DATE	DESCRIPTION
M-3	21APR17	Added Cv values for 72-A (forged).
	20JAN17	Removed 1.25" 77-AR.
M-7	04MAY17	Added "-EF" torque adder.
M-8	04MAY17	Added "-EF" torque adder.
M-33	19MAR18	Updated carbon steel and alloy 20 chart.
M-34	19MAR18	Updated Hastelloy, nickel and Monel charts.
	30JUN16	Updated leaded brass & bronze alloys and lead free alloys charts.