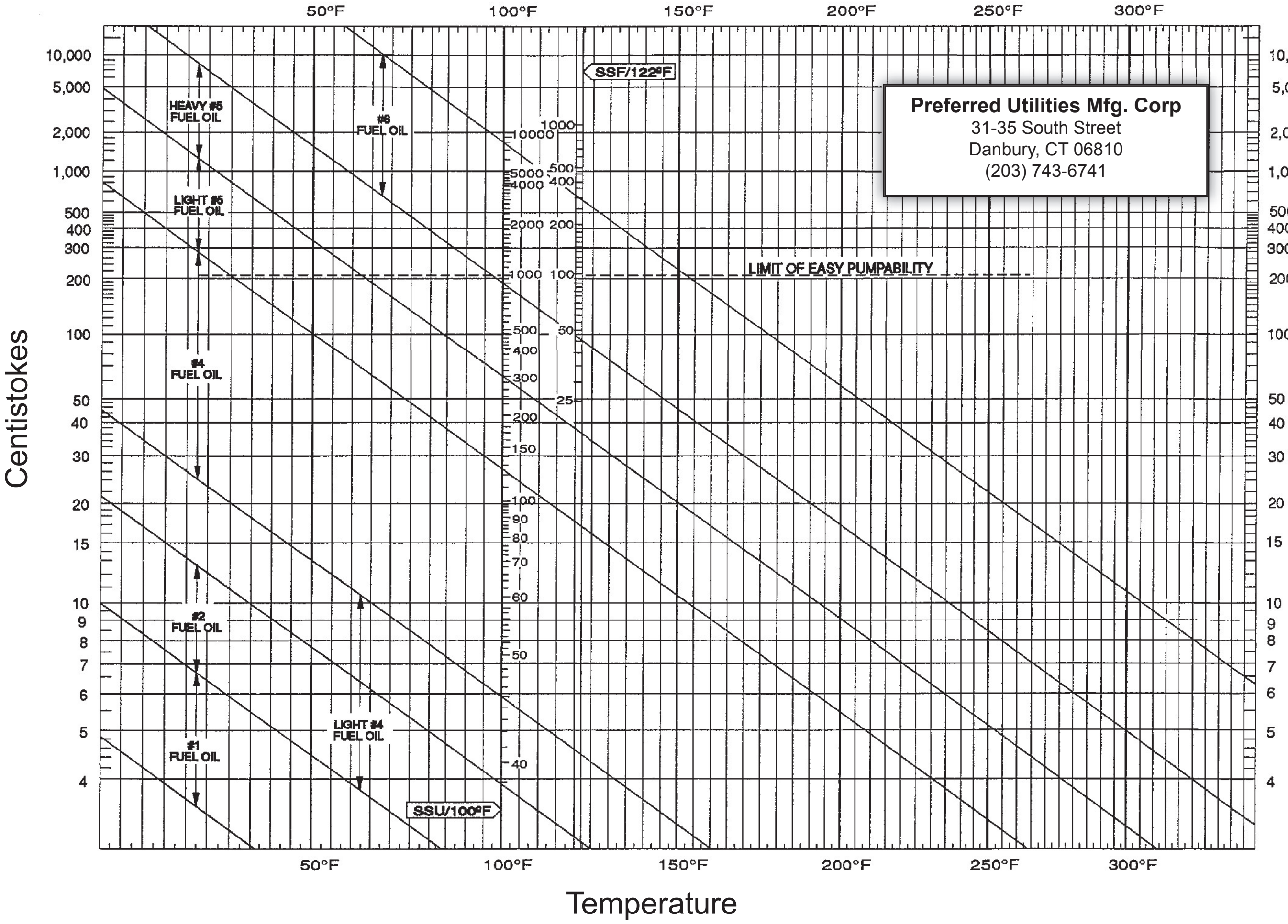
"Pressure Gauge" Name:	"Compound"	"Gauge"	"Absolute"	"Gauge"	"Absolute"	"Gauge"
Units	**psig**	**psig**	**psia**	**" Hg**	**" Hg**	**" H20**
	20	20	34.7	40.72	70.649	554.2
	19	19	33.7	38.684	68.613	526.49
	18	18	32.7	36.648	66.577	498.78
	17	17	31.7	34.612	64.541	471.07
	16	16	30.7	32.576	62.505	443.36
	15	15	29.7	30.54	60.469	415.65
	14	14	28.7	28.504	58.433	387.94
	13	13	27.7	26.468	56.397	360.23
	12	12	26.7	24.432	54.361	332.52
	11	11	25.7	22.396	52.325	304.81
	10	10	24.7	20.36	50.289	277.1
	9	9	23.7	18.324	48.253	249.39
	8	8	22.7	16.288	46.217	221.68
	7	7	21.7	14.252	44.181	193.97
	6	6	20.7	12.216	42.145	166.26
	5	5	19.7	10.18	40.109	138.55
	4	4	18.7	8.144	38.073	110.84
	3	3	17.7	6.108	36.037	83.13
	2	2	16.7	4.072	34.001	55.42
	1	1	15.7	2.036	31.965	27.71
Atmospheric	0	0	14.7	0	29.92	0
	2	-0.982	13.718	-2	27.929	-27.22
	4	-1.965	12.735	-4	25.929	-54.44
	6	-2.947	11.753	-6	23.929	-81.66
	8	-3.929	10.771	-8	21.929	-108.9
	10	-4.912	9.7884	-10	19.929	-136.1
	12	-5.894	8.8061	-12	17.929	-163.3
	14	-6.876	7.8238	-14	15.929	-190.5
	16	-7.859	6.8415	-16	13.929	-217.8
	18	-8.841	5.8591	-18	11.929	-245
	20	-9.823	4.8768	-20	9.9292	-272.2
	22	-10.81	3.8945	-22	7.9292	-299.4
	24	-11.79	2.9122	-24	5.9292	-326.6
	26	-12.77	1.9299	-26	3.9292	-353.9
	28	-13.75	0.9475	-28	1.9292	-381.1
Outer Space Vacuum	29.92	-14.7	0	-29.92	0	-407.2
Units	**" Hg**	**psig**	**psia**	**" Hg**	**" Hg**	**" H20**
	Traditional Compound Pressure Gauge	Reading is Relative to Local Atmosphere	Reading is Relative to Outer Space Vacuum			(60° F)

FUEL OIL HANDLING SYSTEM DATA

Typical Fuel Oil Temperature-Viscosity Curves



The above chart should be used as a guide to determine the proper or minimum temperature to be maintained in oil storage tanks and pipe lines to ensure reliable oil pumping. It can also be used for establishing the required fuel temperature to maintain fuel oil viscosity at the level prescribed by the burner manufacturer.

When using the chart for determining the proper oil temperature for atomization, the operator should obtain from his fuel oil supplier (or by an independent laboratory analysis) the viscosity of the fuel expressed in Centistokes, Saybolt Seconds Universal (SSU) or Saybolt Seconds Furol units. (NOTE: All are expressed referenced to a specific temperature) With this information, the application-specific fuel oil "viscosity vs. temperature" line can be drawn by plotting the one point provided by the oil supplier and drawing a line through it which is parallel to the others on the graph. At the point where this diagonal line crosses the horizontal line marked with the burner manufacturer's recommended viscosity, read vertically down and note the proper temperature at which this oil should be burned.

When using the chart as a basis for the design of storage tank and piping layouts, a similar minimum temperature can be determined by reading vertically down from that point where the diagonal line crosses the horizontal line marked "Limit of Easy Pumpability." For example, a fuel oil having a viscosity of 30 Centistokes at 154° F should be kept in storage and in the pipe lines at a minimum temperature of 99.5° F to assure reliable pumping of the fuel.

Grade of Fuel Oil	No. 1	No. 2	No. 4 Light	No. 4 Heavy	No. 5 Light	No. 5 Heavy	No. 6
Percent by Weight							
Sulphur	0.01 to 0.5	0.05 to 1.0	0.2 to 2.0	0.2 to 2.0	0.5 to 3.0	0.5 to 3.0	0.7 to 3.5
Hydrogen	13.3 to 14.1	11.8 to 13.9	10.6 to 13.0	10.6 to 13.0	10.5 to 12.0	10.5 to 12.0	9.5 to 12
Carbon	85.9 to 86.7	86.1 to 88.2	86.5 to 89.2	86.5 to 89.2	86.5 to 89.2	86.5 to 89.2	86.5 to 90.2
Nitrogen	0.0 to 0.1	0.0 to 0.1	---	---	---	---	0.0 to 0.5
Oxygen	---	---	---	---	---	---	0.0 to 1.5
Ash	---	---	0.0 to 0.1	0.0 to 0.1	0.0 to 0.1	0.0 to 0.1	0.0 to 0.5
Gravity							
Degrees API	40 to 44	30 to 40	25 to 30	20 to 28	17 to 22	14 to 18	8 to 15
Specific Gravity @ 60° F	0.825 to 0.806	0.887 to 0.825	.904 to .876	.934 to .887	.953 to .922	.972 to .947	1.014 to .9659
lb/gal at 60° F	6.87 to 6.71	7.39 to 6.87	7.529 to 7.296	7.778 to 7.387	7.935 to 7.676	8.099 to 7.882	8.448 to 8.043
Pour Point, °F	0 to -50	0 to -40	-10 to +30	-10 to +50	-10 to +50	-10 to +80	+15 to +85
Viscosity							
Centistokes at 104° F	1.3 to 2.1	1.9 to 3.4	1.9 to 5.5	5.0 to 24.0	24.0 to 58.0	58.0 to 168.0	260 to 750
SSU at 100° F	---	32.6 to 37.9	32.6 to 45.0	45 to 125	125 to 300	300 to 900	900 to 9000
SSF at 122° F	---	---	---	---	---	23 to 40	45 to 300
BS&W	---	0.0 to 0.1	0.01 to 1.0	0.01 to 1.0	0.05 to 1.0	0.05 to 1.0	0.05 to 2.0
(% by vol)							
HHV, Btu/gal, calculated							
Max.	137,000	141,800	145,000	148,100	150,000	152,000	155,900
Min.	132,900	135,800	143,100	145,000	146,800	149,400	151,300

Grade of Fuel Oil: The American Society for Testing and Materials (ASTM) has standardized on five basic grades, designated as Nos. 1, 2, 4, 5, and 6. Grades Nos. 4 and 5 are subdivided into light and heavy. The oil's viscosity determines into which subdivision it is classed.

Percent by Weight: The fuel's elements are expressed as a percentage of the fuel's total weight.

Gravity: The unit weight of a liquid in lbs./gal. is the density of that liquid. The ratio of unit weight, or density of any liquid to the density of water is the Specific Gravity (SG) of that liquid. The density of water at 60° F is 8.328 lbs. The oil industry uses the API Gravity or "Gravity" scale. The relationship between API Gravity and specific gravity is as follows:

Degrees API Gravity = (141.5 ÷ SG at 60° F) - 131.5.

Thus, an oil with a specific gravity of 1.0 would have an API Gravity of (141.5 ÷ 1.0) - 131.5 = 10.0 degrees API.

Pour Point: The Pour Point temperature is 5° F above the point where the oil congeals into a semi-fluid or a solid.

Viscosity: Viscosity is the measure of the oil's resistance to flow, or simply expressed as its "thickness" or "thinness." Kinematic Viscosity is usually given in terms of Centistokes, SSU (Saybolt Seconds Universal at 100° F) or SSF (Saybolt Seconds Furol at 122° F). Absolute viscosity is given in terms of Centipoises and can be used to calculate Kinematic Viscosity as follows:

Kinematic viscosity (centistokes) = Absolute viscosity (centipoises) ÷ specific gravity (SG)

AND

Kinematic viscosity (SSU) = Kinematic viscosity (centistokes) x 4.6347

OR

Kinematic viscosity (SSF) = Kinematic viscosity (centistokes) x 0.4717

BS&W or Bottom Sediments and Water: BS&W are non-petroleum contaminates sometimes found in fuel oils. Some of the problems that can be associated with high levels of BS&W are erratic and unsteady combustion, sparking and spitting of the flame, flashback, plugging of burner tips and screens, loss of heat release and/or erosion of burner tips and mechanical parts.

HHV or Higher Heating Value: The HHV is the total heat content of a given measure of fuel including the latent heat of evaporation of the water vapor formed during combustion. The Lower Heating Value assumes that the latent heat is not recovered because the water vapor is not condensed. When performing calculations for combustion or appliance sizing, always use the HHV.

FUEL OIL HANDLING SYSTEM DATA

Typical Fuel Oil Temperature-Viscosity Curves

Due to the thermal expansion and contraction of petroleum products, all are purchased and sold based on its volume at 60° F. Therefore, all petroleum products are corrected to this temperature by using a “correction factor”. This factor converts quantities of oil at different temperatures to a comparable volume at a standard temperature.

When mechanical flow meters or differential pressure type flow elements are used for determining usage or for efficiency calculations, the reading must be temperature compensated to provide an accurate reading.

To convert gross gallons at the loading and unloading temperature to net gallons at 60° F, the temperature, the API Gravity of the oil and the coefficient of expansion factor must be known. A “rough approximation” of net gallons can be obtained from the equation provided. For a more precise conversion consult the Factory or the “Manual of Petroleum Measurement Standards” jointly issued by the American Society for Testing and Materials, the American Petroleum Institute and the Institute of Petroleum. Included in these Standards are Table 5B (Correction of Observed API Gravity to API Gravity at 60° F) and Table 6B (Correction of Volume to 60° F against API Gravity at 60° F). Table 5B is used to correct the observed gravity and temperature to the gravity at 60° F. Table 6B is used to obtain the coefficient of expansion factor from the observed gravity and temperature and is used to convert gross to net gallons.

“Rough Approximation” Method:
Correction Factor = 1 - (ΔT x Multiplier)

Oil API	Multiplier
0° to 14.9° API	0.00035
15° to 34.9° API	0.0004
35° to 50.9° API	0.0005

Example:
Oil having 17° API is clocked through a positive displacement meter at 565 GPH. The oil is 190° F at the meter. Find the corrected (i.e. 60° F) volumetric flow.

190 - 60 = 130° ΔT
Correction Factor = 1 - (130 x 0.0004) = 0.9480
Corrected Volumetric Flow = 565 x 0.9480 = 535.62 GPH

Energy Required To Heat #6 Oil

Electric

Watts = 1.25 x GPH x ΔT (°F)

Amps (single phase) = $\dfrac{\text{watts}}{\text{volts}}$

Amps (three phase) = $\dfrac{\text{watts}}{\text{volts x 1.73}}$

Example:
To heat 600 GPH of #6 oil from 90° F (32° C) to 150° F (65.5° C):

ΔT = 60° F (15.5° C)
Watts = 1.25 X 600 X 60 = 45,000
KW = 45
Amps at 460/3/60 = 56.5

Steam

lbs/hr steam = $\dfrac{\text{lbs/hr oil x } \Delta \text{ T}}{1920}$ (#6 oil & 5 psi steam)

= $\dfrac{\text{gph x lb/gal x } \Delta \text{ T}}{1920}$

Example:
To heat 600 GPH of #6 oil from 90° F (32° C) to 150° F (65.5° C):

lbs/hr steam = $\dfrac{600 \times 8 \times 60}{1920}$ = 150

FUEL OIL HANDLING SYSTEM DATA

Simplex Strainer Model No. 72
Approximate Strainer Pressure Drops in Inches of Mercury
(1" Hg = 0.49 PSI = 13.622" H_2O)

Number 2 Fuel Oil
(with clean 40 mesh baskets)

FLOW GPH	½"	¾"	1"	1 ¼"	1 ½"	2"
25	***	***	***	***	***	***
45	***	***	***	***	***	***
90	0.1	***	***	***	***	***
160	0.4	0.2	***	***	***	***
350	0.9	0.4	0.2	***	***	***
700	2.8	1.1	0.5	0.3	***	***
1100	6.1	2.4	1.2	0.6	0.3	***
1900	*xxx*	7.1	3.2	1.7	0.9	0.4
3000	*xxx*	*xxx*	8.1	4	2.4	1
5000	*xxx*	*xxx*	*xxx*	11.2	6.1	2.5
7500	*xxx*	*xxx*	*xxx*	*xxx*	11.2	4.2
10000	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	8.1

Number 6 Fuel Oil at 5000 SSU
(with clean 3/64" perforated baskets)

FLOW GPH	½"	¾"	1"	1 ¼"	1 ½"	2"
25	***	***	***	***	***	***
45	***	***	***	***	***	***
90	0.9	***	***	***	***	***
160	1.0	0.4	***	***	***	***
350	1.3	0.7	0.5	***	***	***
700	2.0	0.8	0.6	0.2	***	***
1100	5.7	2.5	1.0	0.6	0.3	***
1900	*xxx*	5.7	2.8	1.7	0.8	0.3
3000	*xxx*	*xxx*	7.7	4.0	2.2	0.9
5000	*xxx*	*xxx*	*xxx*	9.8	5.1	2.1
7500	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	11.2
10000	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*

*** Indicates insignificant pressure loss
xxx Indicates excessive pressure loss

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FUEL OIL HANDLING SYSTEM DATA

Duplex Strainer Model No. 53
Approximate Strainer Pressure Drops in Inches of Mercury

Number 2 Fuel Oil
(with clean 40 mesh baskets)

FLOW GPH	¾"	1"	1 ¼"	1 ½"	2"	2 ½"	3"	4"	5"	6"
25	***	***	***	***	***	***	***	***	***	***
45	***	***	***	***	***	***	***	***	***	***
90	***	***	***	***	***	***	***	***	***	***
160	0.1	0.1	***	***	***	***	***	***	***	***
350	0.4	0.3	0.2	0.1	***	***	***	***	***	***
700	2	1.8	0.8	0.5	0.15	***	***	***	***	***
1100	4.2	4	1.8	1.2	0.4	0.2	***	***	***	***
1900	*xxx*	12	5	3.2	1.6	0.4	0.2	***	***	***
3000	*xxx*	*xxx*	12	7.6	2.5	1.1	0.5	0.2	***	***
5000	*xxx*	*xxx*	*xxx*	*xxx*	7.2	3	1.5	0.4	0.2	***
7500	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	6	3	0.9	0.4	0.2
10000	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	10.4	5	1.5	0.7	0.3

Number 6 Fuel Oil at 5,000 SSU
(with clean 3/64" perforated baskets)

FLOW GPH	¾"	1"	1 ¼"	1 ½"	2"	2 ½"	3"	4"	5"	6"
25	***	***	***	***	***	***	***	***	***	***
45	***	***	***	***	***	***	***	***	***	***
90	0.1	0.1	***	***	***	***	***	***	***	***
160	0.4	0.3	0.1	***	***	***	***	***	***	***
350	1.3	1.2	0.5	0.3	0.1	***	***	***	***	***
700	4.2	4	1.7	1.1	0.4	***	***	***	***	***
1100	*xxx*	9.5	4	2.5	0.8	0.4	0.2	***	***	***
1900	*xxx*	*xxx*	11.4	7.1	2.4	1.1	0.5	0.2	***	***
3000	*xxx*	*xxx*	*xxx*	16.3	5.5	2.4	1.1	0.4	***	***
5000	*xxx*	*xxx*	*xxx*	*xxx*	15.3	6.6	3.3	1	0.4	0.2
7500	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	13.9	6.5	2	0.9	0.4
10000	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	*xxx*	11.2	3.5	1.5	0.8

*** Indicates insignificant pressure loss
xxx Indicates excessive pressure loss

FUEL OIL HANDLING SYSTEM DATA

Contents of Horizontal Cylindrical Tanks
Percent of Total Volume Filled vs. Percent of Liquid Depth

Depth %	Gallons %	Depth %	Gallons %	Depth %	Gallons %	Depth %	Gallons %
0	0.00	25	19.6	50	50.0	76	81.5
1	0.2	26	20.7	51	51.3	77	82.6
2	0.5	27	21.8	52	52.5	78	83.7
3	0.9	28	22.9	53	53.8	79	84.7
4	1.3	29	24.1	54	55.1	80	85.8
5	1.9	30	25.2	55	56.4	81	86.8
6	2.4	31	26.4	56	57.6	82	87.8
7	3.1	32	27.6	57	58.9	83	88.8
8	3.7	33	28.8	58	60.1	84	89.7
9	4.5	34	30.0	59	61.4	85	90.6
10	5.2	35	31.2	60	62.6	86	91.5
11	6.0	36	32.4	61	63.9	87	92.4
12	6.8	37	33.6	62	65.1	88	93.2
13	7.6	38	34.9	63	66.4	89	94.0
14	8.5	39	36.1	64	67.6	90	94.8
15	9.4	40	37.4	65	68.8	91	95.5
16	10.3	41	38.6	66	70.0	92	96.3
17	11.3	42	39.9	68	72.4	93	96.9
18	12.2	43	41.1	69	73.6	94	97.6
19	13.2	44	42.4	70	74.8	95	98.1
20	14.2	45	43.6	71	75.9	96	98.7
21	15.3	46	44.9	72	77.1	97	99.1
22	16.3	47	46.2	73	78.2	98	99.5
23	17.4	48	47.5	74	79.3	99	99.8
24	18.5	49	48.7	75	80.4	100	100.0

Note: These figures apply only to tanks with flat ends, *not* to tanks with *dished ends*. For greater accuracy, consult the stick chart prepared by the tank manufacturer.

Example:
A 12 foot (144") diameter tank has 98.5 inches of oil as measured by the stick. Dividing the depth (98.5") by the tank inside diameter (144"), yields 68% tank depth. From the table, the volume is 72.4% of capacity. For a 20,000 gallon tank, the contents would be approximately 14,480 gallons.

Tank With Flat Ends