TABLE 4. DETAILED REQUIREMENTS FOR FUEL OILS[a]

Grade of Fuel Oil[b]	Flash Point F	Pour Point F	Water and Sediment % by vol.	Carbon Residue on 10% Residuum%	Ash % by wt.	Distillation Temperatures F			Saybolt Viscosity seconds				Kinematic Viscosity centistokes			
						10% Point	90% Point	End Point	Universal at 100 F		Furol at 122 F		at 100 F		at 122 F	
	Min.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1. A distillate oil intended for vaporizing pot-type burners and other burners requiring this grade A.P.I. gravity 35 (min.)	100 or Legal	0	Trace	0.15		420		625					2.2	1.4		
2. A distillate oil for general purpose domestic heating for use in burners not requiring No. 1 A.P.I. gravity 26 (min.)	100 or Legal	20°	0.10	0 35		•	675		40				(4.3)			
4. An oil for burner installations not equipped with preheating facilities	130 or Legal	20	0.50		0.10				125	45			(26.4)	5.8		
5. A residual type oil for burner installations equipped with preheating facilities	130 or Legal		1.00		0.10					150	40			32.1	(81)	
6. An oil for use in burners equipped with preheaters permitting a high viscosity fuel	150		2.00[f]								300	45			(638)	(92)

[a] Recognizing the necessity for low sulfur fuel oils used in connection with heat-treatment, nonferrous metal, glass and ceramic furnaces and other special uses, a sulfur requirement may be specified in accordance with the following table:

Grade of Fuel Oil	Sulfur, Max. Percent
No. 1	0.5
No. 2	1.0
Nos. 4, 5 and 6	No Limit

Other sulfur limits may be specified only by mutual agreement between the buyer and seller.

[b] It is the intent of these classifications that failure to meet any requirement of a given grade does not automatically place an oil in the next lower grade unless in fact it meets all requirements of the lower grade.

[c] Lower or higher pour points may be specified whenever required by conditions of storage or use. However, these specifications shall not require a pour point lower than 0 F under any condition.

[d] No. 1 oil shall pass test for corrosion made in accordance with paragraph 15 *ASTM* Tentative Specifications for Fuel Oils, D 396 - 48 T.

[e] The 10 percent point may be specified at 440 F maximum for use in other than atomizing burners.

[f] The amount of water by distillation, plus the sediment by extraction, shall not exceed 2.00 percent. The amount of sediment by extraction shall not exceed 0.50 percent. A deduction in quantity shall be made for all water and sediment in excess of 1.0 percent.

oils have the lowest paraffin content while the catalytically-cracked fuel oils are intermediate in paraffin content and stability. The hydrogen-carbon ratio of straight-run fuel oils ranges from 0.155 to 0.170, and in catalytically-cracked fuel oils ranges from 0.133 to 0.156, while it is somewhat lower for thermally-cracked fuels. The blending of straight-run oils with cracked oils is common practice to improve the paraffin content, stability, and ignition characteristics of fuel oils. A high paraffin content and a high hydrogen-carbon ratio are generally desirable characteristics for domestic fuel oils and consequently, the straight-run distillates are better suited to this use than the fuel oils produced by the various cracking processes. On the other hand, thermally-cracked fuel oils often have a lower pour point and a lower viscosity than comparable straight-run fuel oils. The color and stability of cracked fuel oils can be much improved by treatment with sulfuric aicd, by neutralization, and by redistillation.

Grade Classification of Fuel Oils

Fuel oils are most commonly classified by dividing them into grades in accordance with the *Commercial Standard* (CS12-48) entitled *Fuel Oil* published by the *U. S. Department of Commerce*. These specifications, given in Table 4, conform to *ASTM Materials Tentative Specifications for Fuel Oils* D 396 - 48 T. Oils may be classified roughly by specific gravity but it is not an adequate index of the suitability of an oil for a given purpose. Other characteristics of fuel oils which determine their grade classification in the *Commercial Standard*, and their suitability for given uses are the flash point, pour point, water and sediment content, carbon residue, ash, sulfur content, distillation characteristics, and viscosity.

The flash point of an oil is important with regard to safety in storage and ease of ignition in systems employing automatic ignition. The distillation characteristics determine whether or not the oil can be completely evaporated in some types of burners, and whether cracking will be likely to occur prior to combustion. A low pour point and low water content are desirable for outdoor storage in cold climates. Sediment, carbon residue, and ash should be low to prevent clogging of strainers and the accumulation of unburned material in the burner. A low viscosity allows the fuel oil to flow through supply lines readily and to be broken up into small droplets in atomizing type burners. The sulfur content is of importance because sulfur compounds corrode the burner and heating system or because undesirable compounds of sulfur may be formed in certain industrial processes. Some of these characteristics of a fuel oil are required to lie within certain limits for each of the grades of fuel oil listed in *Commercial Standard* CS12-48. Some fuel oils do not fall into any of the grade classifications of the *Commercial Standard* because failure to comply with all of the requirements of one grade does not automatically place the fuel oil in the next lower grade, unless it meets all of the requirements of the lower grade.

By ultimate analysis the No. 1 and No. 2 fuel oils contain 84 to 86 percent carbon, 12.0 to 13.5 percent hydrogen, one to three percent oxygen and nitrogen, and 0.5 percent or less of sulfur. The heavier grades of fuel oil, Nos. 4, 5 and 6, may contain as much as 88 percent carbon, as low as 11 percent hydrogen, and considerably more sulfur than is permissible in the domestic grades.

Due to variation in the constituents of different fuel oils and the different refining methods used, the *API* gravities and calorific values of the different grades of fuel oil cover a range in each grade with some overlapping