

Designation: D5134 - 13

# Standard Test Method for Detailed Analysis of Petroleum Naphthas through n-Nonane by Capillary Gas Chromatography<sup>1</sup>

This standard is issued under the fixed designation D5134; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon  $(\varepsilon)$  indicates an editorial change since the last revision or reapproval.

#### INTRODUCTION

Despite the many advances in capillary gas chromatography instrumentation and the remarkable resolution achievable, it has proven difficult to standardize a test method for the analysis of a mixture as complex as petroleum naphtha. Because of the proliferation of numerous, similar columns and the endless choices of phase thickness, column internal diameter, length, etc., as well as instrument operating parameters, many laboratories use similar *but not identical* methods for the capillary GC analysis of petroleum naphthas. Even minute differences in column polarity or column oven temperature, for example, can change resolution or elution order of components and make their identification an individual interpretive process rather than the desirable, objective application of standard retention data. To avoid this, stringent column specifications and temperature and flow conditions have been adopted in this test method to ensure consistent elution order and resolution and reproducible retention times. Strict adherence to the specified conditions is essential to the successful application of this test method.

# 1. Scope\*

- 1.1 This detailed hydrocarbon analysis (DHA) test method covers the determination of hydrocarbon components paraffins, naphthenes, and monoaromatics (PNA) of petroleum naphthas as enumerated in Table 1. Components eluting after *n*-nonane (bp 150.8 °C) are determined as a single group.
- 1.2 This test method is applicable to olefin-free (<2 % olefins by liquid volume) liquid hydrocarbon mixtures including virgin naphthas, reformates, and alkylates. Olefin content can be determined by Test Method D1319 or D6839. The hydrocarbon mixture must have a 98 % point of 250 °C or less as determined by Test Method D3710 or D7096 or equivalent.
- 1.3 Components that are present at the 0.05 mass % level or greater can be determined.
- 1.4 This test method may not be completely accurate for PNA above carbon number C7; Test Method D5443 or D6839 may be used to verify or complement the results of this test method for carbon numbers >C7.
- <sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.04.0L on Gas Chromatography Methods.
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- 1.5 Detailed hydrocarbon components in olefin containing samples may be determined by DHA Test Methods D6729, D6730, or D6733.
  - 1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.
  - 1.7 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific warning statements are given in Section 7.

## 2. Referenced Documents

- 2.1 ASTM Standards:<sup>2</sup>
- D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D3700 Practice for Obtaining LPG Samples Using a Floating Piston Cylinder
- D3710 Test Method for Boiling Range Distribution of Gasoline and Gasoline Fractions by Gas Chromatography
- D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

<sup>&</sup>lt;sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

# TABLE 1 Typical Retention Characteristics of Naphtha Components

Note 1—The abbreviations N and P refer to unidentified naphthenes and paraffins respectively.

Methan	Compound	Retention Time, min	Adjusted Retention Time, min	Kovats Retention Index @ 35 °C	Linear Retention Index
Ethane	Methane	3.57	0.00	100.0	
	Ethane		0.08	200.0	
κ-Bulane         4.59         0.82         40.0         —           Lagoentane         5.33         1.76         4.75.0         —           - Pertante         5.33         1.76         4.75.0         —           - Pertante         6.84         2.2         5.00         —           - Pertante         7.83         4.26         564.1         —           - Cycloperitarie         7.83         4.26         564.1         —           - Sy-Dimethylbutane         8.06         4.49         565.5         —           - Methylpertane         8.06         4.49         569.5         —           - Methylpertane         8.07         7.51         680.5         —           - Methylpertane         1.62         7.65         600.5         —           - Methylpertane         11.68         8.11         630.3         —           - All Controllypertane         11.68         8.11         630.3         —           - All Controllypertane         11.69         8.52         605.4         —           - All Controllypertane         11.69         8.11         630.3         —           - All Controllypertane         11.69         8.51         — </td <td>Propane</td> <td></td> <td></td> <td></td> <td></td>	Propane				
2.2-Dimethylpropane	Isobutane	4.14	0.57	367.3	
Isopentane	<i>n</i> -Butane	4.39	0.82	400.0	
r-Pentane         5.84         2.27         500.0            2-2-Dimethylbutane         6.81         3.24         556.2            Cyclopentane         7.83         4.22         565.5            2-Monthylportane         6.06         6.08         50.5            2-Methylportane         6.06         6.06         80.0            1-Hearne         9.63         6.06         80.0            2-Dimethylportane         11.22         7.55         684.2            Herbylpycytopathane         11.88         8.11         630.3            2-4-Dimethylportane         11.88         8.11         630.3            2-4-Dimethylportane         12.09         8.52         635.4            Berozene         13.29         9.72         649.1            Berozene         13.29         19.22         649.1            2-Jünnethylportane         15.05         11.69         667.8            2-Jünnethylportane         15.61         12.04         671.4            2-Jünnethylportane         15.61         1	2,2-Dimethylpropane	4.53	0.96	415.5	•••
2.2-Dimethylpulane	Isopentane	5.33	1.76	475.0	
Cycloperatine	<i>n</i> -Pentane	5.84	2.27	500.0	•••
2.5 Dimetrylputane	2,2-Dimethylbutane				
Methylporitane					•••
Methylopentane					•••
n-Hozaine					•••
2.2 Dimethylpentane	71				•••
Methycyclopentane					
2-4-Dimethylpontane					
2,2,3 Frimethylutatine   12,09   8,52   635,4					
Benzene					
3.3-dimethylpentane (Cyclohexane 14.19 10.62 654.8 2-Methylhexane 15.20 11.63 667.8 3. 3 3.Dimethylpentane 15.20 11.63 667.8 3. 3.Dimethylpentane 15.61 12.04 671.4 3.Methylpentane 15.61 12.04 671.4 3.Methylpentane 16.18 12.61 676.2 3.Dimethylcyclopentane 17.22 13.65 684.8 3.31 681.8 3.31 681.8 3.2- 3.Embylopentane 17.42 13.87 686.1 3.2- 3.Embylopentane 17.44 13.87 686.1 3.31 681.8 3.31 681.8 3.32 3.Embylopentane 17.44 13.87 686.1 3.33 681.8 3.34 3.88 681.1 3.34 3.88 3.34 3.88 3.34 3.38 3.38 3.38					
Cyclohexane					
2.4 Methylpeatane					
2.3-Dimethylpentane       15.35       11.78       669.1         1.1-Dimethylcyclopentane       16.18       12.01       671.4	•				
1,1-Dimethylcyclopentane         15.61         12.04         671.4           3,8-Methylkexane         16.88         13.31         681.8           1,1-Dimethylcyclopentane         17.22         13.65         684.4           3-Ethylpentane         17.44         13.87         686.1           3-Ethylpentane         17.57         14.00         687.0           1,1-2 Trimethylpentane         17.80         14.23         688.7           Methylcyclopexane + cis-1,2-Dimethylcyclopentane         12.53         18.96         770.0           1,1-3 Trimethylcyclopentane         22.53         18.96         770.6           1,1-3 Trimethylcyclopentane         24.59         21.02         729.3^4           1,1-3 Trimethylcyclopentane         24.59         21.02         729.3^4           2,5 Dimethylhoxane + 2,2-3 Trimethylpentane         25.12         21.55         731.9^4           2,5 Dimethylhoxane + 2,2-3 Trimethylpentane         25.47         21.90         733.5^4            1,1-1,1-1,1-1,1-2-2,1-3-3-1-1,1-1,1-1,1-2-1         22.40         21.90         733.5^4            2,3-1-1,1-2-1-1,1-1,1-2-1         28.70         25.13         74.8^4            2,3-3-1-1,1-1,1-1,1-1         28.70         25.13<	· · ·				
3. Allethylpexane					
cis-1,2-Dimethylocyclopentane         16.88         13.31         681.8            trans-1,2-Dimethylocyclopentane         17.44         13.87         686.1            #Ethylopentane         17.57         14.00         687.0            2.2.4-Trimethylocyclopentane         17.50         14.23         688.7            #Helptane         19.43         15.85         700.0            Methylocyclopentane e isi-1,2-Dimethylocyclopentane         22.53         18.96         718.6^4            #Hylocyclopentane e isi-1,2-Dimethylocyclopentane         22.50         19.48         718.6^4            1,1,3-Trimethylocyclopentane e isi-1,2-Dimethylocyclopentane         24.99         21.02         729.3^4            2,5-Dimethylhexane e 2,2,3-Trimethylocyclopentane         25.47         21.90         733.5^4            2,5-Dimethylhexane         26.79         23.22         739.6^4            1,trans-2,cis-3-Trimethylocyclopentane         28.01         24.44         744.9^4            2,3-Dimethylhexane         28.01         24.44         744.9^4            1,1-Trimethylocyclopentane         28.01         24.44         7					
Irans-1,3-Dimethyloyolopentane	· · ·				
### 17.44   13.87   686.1					
trans-1/2-Dimethylcyclopentane         17.57         14.00         687.0           2.2-4-Trimethylpentane         17.80         14.23         688.7           r-Heptane         19.43         15.86         700.0            Methylcyclopentane - 2.2-Dimethylcyclopentane         22.53         18.96         718.6^A            21.7-Trimethylcyclopentane         22.53         18.96         718.6^A            21.7-Trimethylcyclopentane         22.51         21.02         729.3^A            2.5-Dimethylhexane         22.3-Trimethylcyclopentane         25.12         21.55         731.9^A            2.5-Dimethylhexane         22.4-Trimethylcyclopentane         26.43         22.86         738.0^A            3.3-Dimethylhexane         26.79         23.22         739.6^A            1.1.4 Trimethylocyclopentane         28.01         24.44         744.9^A            2.3-Limethylhexane         29.49         25.92         751.1^A         730.2°           1.1.2-Trimethylcyclopentane         31.49         27.94         25.92         751.1^A         730.2°           1.1.2-Trimethylocyclopentane         31.69         28.12          741.9° </td <td></td> <td></td> <td></td> <td></td> <td></td>					
2.2.4.Trimethylpentane					
## The plane					•••
Methytoyclohexane + cis-1,2-Dimethylicyclopentane   22.53   18.96   718.6°   1.1.3-Timethyloyclopentane + 2,2-Dimethylicyclopentane   24.59   21.02   729.3°	2,2,4 minetry pentane	17.00			
1,1,3-Timethylcyclopentane       22.05       19.48       72.14°         Ethylcyclopentane       24.59       21.02       729.34°          2,5-Dimethylhexane       25.12       21.55       731.94°          2,4-Dimethylhexane       25.47       21.90       733.54°          1,1-Bras-2,6:5-4-Timethylcyclopentane       26.43       22.86       738.04°          3,3-Dimethylhexane       26.79       23.22       739.64°          2,3-4-Timethylpoentane       28.01       24.44       744.94°          2,3-4-Timethylpentane       28.70       25.13       747.84°          1,12-Timethylcyclopentane       29.49       25.92       751.14       730.26°         1,1.2-Timethylcyclopentane       31.21       27.64        741.78°         2,3-Dimethylhexane       31.69       25.12        743.6°         2,4-Methyl-3-ethylpentane       33.06       29.49        755.0°         4-Methylheptane + 3-Methyl-3-ethylpentane       33.34       29.97        755.0°         4-Methylheptane + 3-Methyl-3-ethylpentane       33.49       29.92        755.0°         3,4-Dimethylkeyan	•				
Ethylcyclopentane					•••
2.5-Dimethylhexane       25.12       21.55       731.9^A         2.4-Dimethylhexane       25.47       21.90       733.5^A          1.trans-2.cis-4-Trimethylcyclopentane       26.43       22.86       738.0^A          3.3-Dimethylhexane       26.79       23.22       739.6^A          1.trans-2.cis-3-Trimethylcyclopentane       28.01       24.44       744.9^A          2.3-4 Trimethylpentane       28.70       25.13       747.8^A          1.tue       2.3-Trimethylcyclopentane       28.99       751.1^A       730.2°         1.1.2-Trimethylcyclopentane       31.49       27.92       751.1^A       730.2°         2Bimethylhexane       31.69       28.12        741.7°         2Bimethylhexane       33.06       29.49        741.7°         2Methyl-3-ethylpentane       33.06       29.49        751.0°         4.Methylheptane - A-Methyl-3-ethylpentane       33.40       29.92        750.0°         4.Hethylheptane - 4-Jois-2-Lrans-3-Trimethylcyclopentane       33.43       29.97        756.0°         3.4-Dimethylhexane - 4-Jois-2-Lrans-3-Trimethylcyclopentane       34.45       30.88	(				
2.4-Dimethylhexane       25.47       21.90       733.5 <sup>A</sup> 1.trans-2.cis-4-Trimethylcyclopentane       26.43       22.86       738.0 <sup>A</sup> 3.3-Dimethylpexane       28.01       24.44       744.9 <sup>A</sup> 1.trans-2.cis-3-Trimethylpentane       28.01       24.44       744.9 <sup>A</sup> 1.0-Trimethylpertane       29.49       25.52       751.1 <sup>A</sup> 730.2 <sup>B</sup> 1.12-Trimethylcyclopentane       29.49       25.92       751.1 <sup>A</sup> 730.2 <sup>B</sup> 2.3-Dimethylhexane       31.49       27.92        741.7 <sup>B</sup> 2.3-Dimethylhexane       31.69       28.12        744.9 <sup>A</sup> 2.Methylheptane       33.06       29.49        754.1 <sup>B</sup> 2.Methylheptane       33.34       29.77        756.0 <sup>B</sup> 1.cis-2.trans-4-Trimethylcyclopentane + 1,cis-2.cis-4-Trimethylcyclopentane       33.73       30.16        758.6 <sup>B</sup> 3.4-Dimethylhexane + 4-A-Dimethylcyclopentane       34.64       31.07        766.0 <sup>B</sup> 3.6-Larans-4-Timethylcyclopentane       34.63       31.26        763.4 <sup>B</sup> 3-Methylheptane + 1,cis-2.trans-3-Trimethylcyclopentane       36.7					***
1.trans-2.cis-4-Trimethylcyclopentane					•••
3.3-Dimethylhexane   26.79   23.22   739.64       1,trans-2,cis-3-Trimethylocylopentane   28.01   24.44   744.94       2,3-Trimethylpentane   25.02   25.13   747.64       Toluene + 2,3,3-Trimethylpentane   29.49   25.92   751.14   730.26     1,12-Trimethylocylopentane   1 catalog standards sist Sociol   31.21   25.92   751.14   741.76     2,3-Dimethylhocylopentane   1 catalog standards sist Sociol   31.21   25.92   751.14   741.76     2,3-Dimethylhocylopentane   1 catalog standards sist Sociol   31.21   25.92   751.14   741.76     2,3-Dimethylhocylopentane   1 catalog standards sist Sociol   31.21   25.92   751.14   741.76     2,3-Dimethylhocylopentane   1 catalog standards sist Sociol   31.21   25.92   751.14   741.76     2,3-Dimethylhocylopentane   31.49   27.92   751.04   27.04   27.04     2,4-Methylh-3-ethylpentane   31.69   28.12     744.94     2,4-Methylheptane   3-Methyl-3-ethylpentane   33.34   29.77     756.06     3,4-Dimethylhocylopentane   4 .cis-2,cis-4-Trimethylcyclopentane   33.73   30.16     758.66     3,4-Dimethylhocylopentane   34.45   30.88     758.66     3,4-Dimethylocylopentane   34.64   31.07     764.76     3-Methylheptane   4 .cis-2,trans-3-Trimethylcyclopentane   34.64   31.07     760.07     3-Ethylmethylocylopentane   34.83   31.26     770.07     3-Ethylmethylocylopentane   35.81   32.24     772.57     2,2,5-Trimethylhocylopentane   37.39   33.82     781.46     4 rans-1,2-Ethylmethylocylopentane   39.91   36.34     36.50     5 rans-1,3-Ethylmethylocylope					•••
1,11ms+2,cis-3-Trimethylocyclopentane					•••
2.3.4-Trimethylpentane					•••
Toluene + 2,3,3-Trimethylpentane         29,49         25,92         751.14         730.28           1,1,2-Trimethyleyclopentane         31.49         27.92          743.68           2,3-Dimethylhexane         31.69         28.12          744.94           2-Methylheptane         33.06         29.49          754.18           4-Methylheptane + 3-Methyl-3-ethylpentane         33.34         29.77          756.08           4-Methylhexane         33.34         29.77          757.08           4-Methylhexane         33.49         29.92          757.08           4-Methylhexane-trimethylcyclopentane + 1,cis-2,cis-4-Trimethylcyclopentane         33.73         30.16          758.68           4,6is-2,trans-4-Trimethylcyclopentane         34.45         30.88          763.49           3-Ethylhexane + trans-1,4-Dimethylcyclopentane         34.83         31.26          766.08           3-Ethylhexane + trans-1,3-Ethylmethylcyclopentane         35.81         32.24          772.58           2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane         37.14         33.57          781.49           2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane					
1.1.2-Trimethylcyclopentane       31.49       27.92       .743.6 <sup>8</sup> 2.3-Dimethylhexane       31.49       27.92       .743.6 <sup>8</sup> 2-Methyl-3-ethylpentane       31.69       28.12	Z,3,4-Tillietilyiperitarie	20.70			
2,9-Dimethylhexane       31.49       27.92	1 1 2 Trimethylovelenentene	/8 dec06b92f2tc-/d			
2-Methyl-3-ethylpentane       31.69       28.12       .744.9A         2-Methylheptane       33.06       29.49       .754.18         4-Methylheptane + 3-Methyl-3-ethylpentane       33.34       29.77       .756.08         3,4-Dimethylhexane       33.49       29.92       .757.08         1,cis-2-trans-4-Trimethylcyclopentane + 1,cis-2,cis-4-Trimethylcyclopentane       33.73       30.16       .756.08         2s-1,3-Dimethylcyclohexane       34.45       30.88       .763.48         3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.64       31.07       .764.78         3-Hillylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.83       31.26       .766.08         3-Ethylhexane + trans-1,4-Dimethylcyclopentane       35.81       32.24       .772.88         2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18       .778.88         2,2,5-Trimethyllocyclopentane       37.39       33.82       .781.48         trans-1,2-Ethylmethylcyclopentane       37.68       34.11       .785.18         trans-1,2-Dimethylcyclopentane       37.86       34.11       .785.18         trans-1,2-Dimethylcyclopentane       39.21       35.64       .795.38         trans-1,2-Dimethylcyclopentane + cis-1,4-Dimethylcyclopentane       39.94					
2-Methylheptane       33.06       29.49       754.16         4-Methylheptane + 3-Methyl-3-ethylpentane       33.34       29.77       756.08         3,4-Dimethylhexane       33.34       29.92       757.06         1, cis-2,trans-4-Trimethylcyclopentane + 1,cis-2,cis-4-Trimethylcyclopentane       33.73       30.16       758.68         cis-1,3-Dimethylcyclohexane       34.45       30.88       763.48         3-Methylheptane + 1, cis-2,trans-3-Trimethylcyclopentane       34.64       31.07       764.76         3-Ethylhexane + trans-1,4-Dimethylcyclopentane       34.83       31.26       760.08         3-Ethylhexane + trans-1,4-Dimethylcyclopentane       35.81       32.24       772.56         2,2-5-Trimethyllexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18       778.88         cis-1,3-Ethylmethylcyclopentane       37.14       33.57       781.48         trans-1,2-Ethylmethylpexane + 1,1-Ethylmethylcyclopentane       37.88       34.11       785.18         trans-1,2-Dimethylcyclopentane       39.21       35.64       795.38         trans-1,3-Dimethylcyclopentane       39.21       35.64       795.38         trans-1,3-Dimethylcyclopentane       39.21       35.64       797.5         trans-1,3-Dimethylcyclopentane       49.25       35.					
4-Methylheptane + 3-Methyl-3-ethylpentane       33.34       29.77        756.0 <sup>8</sup> 3,4-Dimethylhexane       33.49       29.92        757.0 <sup>8</sup> 1,cis-2,trans-4-Trimethylcyclopentane + 1,cis-2,cis-4-Trimethylcyclopentane       33.73       30.16        758.6 <sup>8</sup> cis-1,3-Dimethylcyclohexane       34.45       30.88        763.4 <sup>8</sup> 3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.64       31.07        764.7 <sup>8</sup> 3-Ethylhexane + 1,cis-2,trans-3-Trimethylcyclopentane       34.83       31.26        766.0 <sup>8</sup> 3-Ethylhexane + 1,rans-1,4-Dimethylcyclopentane       35.81       32.24        772.5 <sup>8</sup> 2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.8 <sup>8</sup> cis-1,3-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> 2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcyclopentane       39.21       35.64        785.3 <sup>8</sup> trans-1,3-Dimethylcyclopentane + cis-1,4-Dimethylcyclopentane       39.91       36.34        805.7         to-Octane       39.91 </td <td></td> <td></td> <td></td> <td></td> <td></td>					
3,4-Dimethylhexane       33.49       29.92       757.08         1,cis-2,trans-4-Trimethylcyclopentane + 1,cis-2,cis-4-Trimethylcyclopentane       33.73       30.16       758.68         3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.45       30.88       763.48         3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.64       31.07       764.78         3-Ethylhexane + trans-1,4-Dimethylcyclopexane       34.83       31.26       766.08         3-Ethylhexane + trans-1,4-Dimethylcyclopexane       35.81       32.24       772.58         2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18       778.88         cis-1,3-Ethylmethylcyclopentane       37.14       33.57       781.48         trans-1,2-Ethylmethylcyclopentane       37.68       34.11       785.18         2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       39.81       34.57       785.18         1,cis-2,cis-3-Trimethylcyclopexane       39.21       35.64       795.38         1,cis-2,cis-3-Trimethylcyclopexane + cis-1,4-Dimethylcyclohexane       39.54       35.97       797.5         n-Octane       39.91       36.34       800.0         lsopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19					
1, cis-2, trans-4-Trimethylcyclopentane       33.73       30.16        758.6 <sup>8</sup> cis-1,3-Dimethylcyclohexane       34.45       30.88        763.4 <sup>8</sup> 3-Methylheptane + 1, cis-2, trans-3-Trimethylcyclopentane       34.64       31.07        764.7 <sup>8</sup> 3-Ethylhexane + trans-1, 4-Dimethylcyclohexane       34.83       31.26        766.0 <sup>8</sup> 1, 1-Dimethylcyclopentane       35.81       32.24        772.5 <sup>8</sup> 2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.8 <sup>8</sup> cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.4 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcyclopentane       39.21       35.64        785.1 <sup>8</sup> trans-1,3-Dimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclopentane + cis-1,4-Dimethylcyclopentane       39.91       36.34        800.0         lsopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19 <td></td> <td></td> <td></td> <td></td> <td></td>					
cis-1,3-Dimethylcyclohexane       34.45       30.88        763.48         3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.64       31.07        764.78         3-Ethylhexane + trans-1,4-Dimethylcyclohexane       34.83       31.26        766.08         1,1-Dimethylcyclohexane       35.81       32.24        772.58         2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.88         cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.48         trans-1,2-Ethylmethylcyclopentane       37.39       33.82        781.18         trans-1,2-Dimethylcyclopentane       37.68       34.11        785.18         trans-1,2-Dimethylcyclopentane       39.21       35.64        785.38         trans-1,3-Dimethylcyclopentane + cis-1,4-Dimethylcyclopexane       39.91       36.34        795.38         trans-1,3-Dimethylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        800.0         lsopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       41.88       37.31        806.5 <td></td> <td></td> <td></td> <td></td> <td></td>					
3-Methylheptane + 1,cis-2,trans-3-Trimethylcyclopentane       34.64       31.07					
3-Ethylhexane + trans-1,4-Dimethylcyclohexane       34.83       31.26        766.0 <sup>8</sup> 1,1-Dimethylcyclohexane       35.81       32.24        772.5 <sup>8</sup> 2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.8 <sup>8</sup> cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.4 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> 2,2,4-Trimethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcyclopentane       38.14       34.57        788.1 <sup>8</sup> 1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclopentane + cis-1,4-Dimethylcyclohexane       39.54       35.97        795.3 <sup>8</sup> trans-1,3-Dimethylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2 </td <td></td> <td></td> <td></td> <td></td> <td></td>					
1,1-Dimethylcyclohexane       35.81       32.24        772.5 <sup>8</sup> 2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.8 <sup>8</sup> cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.4 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> trans-1,2-Dimethylcylohexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcyclopentane       38.14       34.57        788.1 <sup>8</sup> 1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C9-Naphthene       41.88       38.31        810.8         Unidentified C9-Naphthene       41.88       38.31        817.7         2,2-Dimethylhoptane					
2,2,5-Trimethylhexane + trans-1,3-Ethylmethylcyclopentane       36.75       33.18        778.8 <sup>8</sup> cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.4 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> 2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcyclopexane       38.14       34.57        788.1 <sup>8</sup> 1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclopexane + cis-1,4-Dimethylcyclopexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C9-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopexane       42.55       38.98        817.7         2,2-Dimethylpkptane <td></td> <td></td> <td></td> <td></td> <td></td>					
cis-1,3-Ethylmethylcyclopentane       37.14       33.57        781.4 <sup>8</sup> trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.1 <sup>8</sup> 2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.1 <sup>8</sup> trans-1,2-Dimethylcylohexane       38.14       34.57        788.1 <sup>8</sup> 1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C9-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylcyclohexane       43.43       39.86        822.0         cis-1,2-Dimethylcyclohexane					
trans-1,2-Ethylmethylcyclopentane       37.39       33.82        783.18         2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.18         trans-1,2-Dimethylcylohexane       38.14       34.57        788.18         1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.38         trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylcyclohexane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylcyclobacane					
2,2,4-Trimethylhexane + 1,1-Ethylmethylcyclopentane       37.68       34.11        785.18         trans-1,2-Dimethylcyclopexane       38.14       34.57        788.18         1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.38         trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylcyclohexane       43.20       39.63        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
trans-1,2-Dimethylcylohexane       38.14       34.57        788.1 <sup>8</sup> 1,cis-2,cis-3-Trimethylcyclopentane       39.21       35.64        795.3 <sup>8</sup> trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylpheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
1, cis-2, cis-3-Trimethylcyclopentane       39.21       35.64        795.38         trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylleptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
trans-1,3-Dimethylcyclohexane + cis-1,4-Dimethylcyclohexane       39.54       35.97        797.5         n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
n-Octane       39.91       36.34        800.0         Isopropylcyclopentane + 2,4,4-Trimethylhexane       40.76       37.19        805.7         Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
Sopropylcyclopentane + 2,4,4-Trimethylhexane	<i>n</i> -Octane				
Unidentified C9-Naphthene       40.88       37.31        806.5         Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylcyclopentane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
Unidentified C8-Naphthene       41.52       37.95        810.8         Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
Unidentified C9-Naphthene       41.88       38.31        813.2         cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6	•				
cis-1,2-Ethylmethylcyclopentane + 2,3,5-Trimethylhexane       42.55       38.98        817.7         2,2-Dimethylheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6	·				
2,2-Dimethylheptane       43.20       39.63        822.0         cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6	·				
cis-1,2-Dimethylcyclohexane       43.43       39.86        823.6         2,2,3-Trimethylhexane + 9N       43.76       40.19        825.8         2,4-Dimethylheptane       43.88       40.31        826.6					
2,2,3-Trimethylhexane + 9N     43.76     40.19      825.8       2,4-Dimethylheptane     43.88     40.31      826.6					
2,4-Dimethylheptane 43.88 40.31 826.6					
4,4-Dimethylheptane + 9N 44.09 40.52 828.0	4,4-Dimethylheptane + 9N	44.09	40.52		828.0
Ethylcyclohexane + n-Propylcyclopentane 44.36 40.79 829.8					
2-Methyl- 4-Ethylhexane 44.74 41.17 832.4					

#### TABLE 1 Continued

Compound	Retention Time, min	Adjusted Retention Time, min	Kovats Retention Index @ 35 °C	Linear Retention Index
2,6-Dimethylheptane + 9N	44.95	41.38		833.8
1,1,3-Trimethylcyclohexane	45.21	41.64		835.5
Unidentified C9-Naphthene	45.56	41.99		837.8
2,5-Dimethylheptane + 9P	45.92	42.35		840.3
3,5-Dimethylheptane + 3,3-Dimethylheptane + N	46.09	42.52		841.4
Unidentified C9-Naphthene	46.31	42.74		842.9
Unidentified C9-Naphthene	46.55	42.98		844.5
Ethyl Benzene	47.15	43.58		848.5
Unidentified C9-Naphthene	47.37	43.80		850.0
Unidentified Naphthene + 2,3,4-Trimethylhexane	47.53	43.96		851.0
Unidentified Naphthenes	47.78	44.21		852.7
Unidentified Naphthene + Paraffin	48.13	44.56		855.1
<i>m</i> -Xylene	48.49	44.92		857.5
p-Xylene	48.63	45.06		858.4
2,3-Dimethylheptane	48.93	45.36		860.4
3,4-Dimethylheptane <sup>C</sup> + N	49.10	45.53		861.6
3,4-Dimethylheptane <sup>C</sup>	49.29	45.72		862.8
Unidentified Naphthene	49.41	45.84		863.6
4-Ethylheptane + N	49.65	46.08		865.2
4-Methyloctane	50.10	46.53		868.3
2-Methyloctane	50.26	46.69		869.3
Unidentified Naphthene	50.41	46.84		870.3
Unidentified Naphthene	50.73	47.16		872.5
3-Ethylheptane + N	50.96	47.39		874.0
3-Methyloctane	51.15	47.58		875.3
Unidentified Naphthene	51.35	47.78		876.6
o-Xylene + 1,1,2-Trimethylcyclohexane	51.54	47.97		877.9
Unidentified Naphthene + 2,4,6-Trimethylheptane	51.74	48.17		879.2
Unidentified Naphthene	52.12	48.55		881.8
Unidentified Paraffin	52.24	48.67		882.6
Unidentified Naphthenes	52.56	48.99		884.7
Unidentified Naphthene	52.85	49.28		886.7
Unidentified Naphthene + Paraffin	53.06	49.49		888.1
Unidentified Naphthene	53.26	49.69		889.4
Unidentified Naphthene	53.46	49.89		890.8
Unidentified Naphthene	54.02	50.45		894.5
Unidentified Naphthene	54.40	50.83		897.1
<i>n</i> -Nonane	54.84	51.27		900.0
Unidentified Naphthene	54.98	51.41		900.9

<sup>&</sup>lt;sup>A</sup>Extrapolated from n-C<sub>6</sub> and n-C<sub>7</sub>. See A1.1.3.

#### ASTM D5134-13

https://standards.iteh.ai/catalog/standards/sist/8dec06b9-fdbc-4d5f-8a71-3cd1ee779afd/astm-d5134-13

D5443 Test Method for Paraffin, Naphthene, and Aromatic Hydrocarbon Type Analysis in Petroleum Distillates Through 200°C by Multi-Dimensional Gas Chromatography

D6839 Test Method for Hydrocarbon Types, Oxygenated Compounds, and Benzene in Spark Ignition Engine Fuels by Gas Chromatography

D6729 Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100 Metre Capillary High Resolution Gas Chromatography

D6730 Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100–Metre Capillary (with Precolumn) High-Resolution Gas Chromatography

D6733 Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 50-Metre Capillary High Resolution Gas Chromatography

D7096 Test Method for Determination of the Boiling Range Distribution of Gasoline by Wide-Bore Capillary Gas Chromatography

### 3. Summary of Test Method

- 3.1 A representative sample of the naphtha is introduced into a gas chromatograph equipped with a methyl silicone bonded phase fused silica capillary column. Helium carrier gas transports the vaporized sample through the column in which the components are separated. Components are sensed by a flame ionization detector as they elute from the column. The detector signal is processed by an electronic data acquisition system or integrating computer. Each eluting peak is identified by comparing its retention index to a table of retention indices and by visual matching with a standard chromatogram. The table of retention indices has been established by running reference compounds under identical conditions or by gas chromatographic—mass spectrometric (GC/MS) analysis of reference samples under the same conditions, or both.
- 3.2 The mass concentration of each component is determined by area normalization with response factors. Peaks eluting after n-nonane are summed and reported as  $C_{10+}$ .

<sup>&</sup>lt;sup>B</sup>Extrapolated from n- $C_8$  and n- $C_9$ . See A1.2.3.

<sup>&</sup>lt;sup>C</sup>Stereoisomers.



#### 4. Significance and Use

- 4.1 A knowledge of the hydrocarbon components comprising a petroleum naphtha, reformate, or alkylate is useful in valuation of crude oils, in alkylation and reforming process control, in product quality assessment, and for regulatory purposes. Detailed hydrocarbon composition is also used as input in the mathematical modeling of refinery processes.
- 4.2 Separation of naphtha components by the procedure described in this test method can result in some peaks that represent coeluting compounds. This test method cannot attribute relative concentrations to the coelutants. In the absence of supporting information, use of the results of this test method for purposes which require such attribution is not recommended.

#### 5. Interferences

- 5.1 If present, olefinic hydrocarbons with boiling points less than 150 °C will be separated and detected along with the saturates and aromatics. Some of the olefins will coelute with saturates or aromatics and give erroneously high concentrations for those components. Some coelutions of PNA components above C7 may occur and results may not be completely accurate. Test Method D5443 may be used for carbon number distribution above C7 to verify results from this test method.
- 5.2 Alcohols, ethers, and other organic compounds of similar volatility can also interfere by coeluting with saturate or aromatic hydrocarbons thereby causing erroneously high values to be determined.

#### 6. Apparatus

6.1 Instrumentation—A gas chromatograph capable of column oven temperature programming from 35 °C to 200 °C in 1 °C/min increments is required. A heated flash vaporizing injector designed to provide a linear sample split injection (for example, 200:1) is also required for proper sample introduction. The associated carrier gas controls must be of adequate precision to provide reproducible column flows and split ratios in order to maintain analytical integrity. A hydrogen flame ionization detector designed for optimum response with capillary columns (with the required gas controls and electronics) must meet or exceed the following specifications:

Operating temperature  $100 \, ^{\circ}\text{C}$  to  $300 \, ^{\circ}\text{C}$ Sensitivity  $>0.015 \, \text{C/g}$ Minimum detectability  $5 \times 10^{-12} \, \text{g}$  carbon/second  $>10^{7}$ 

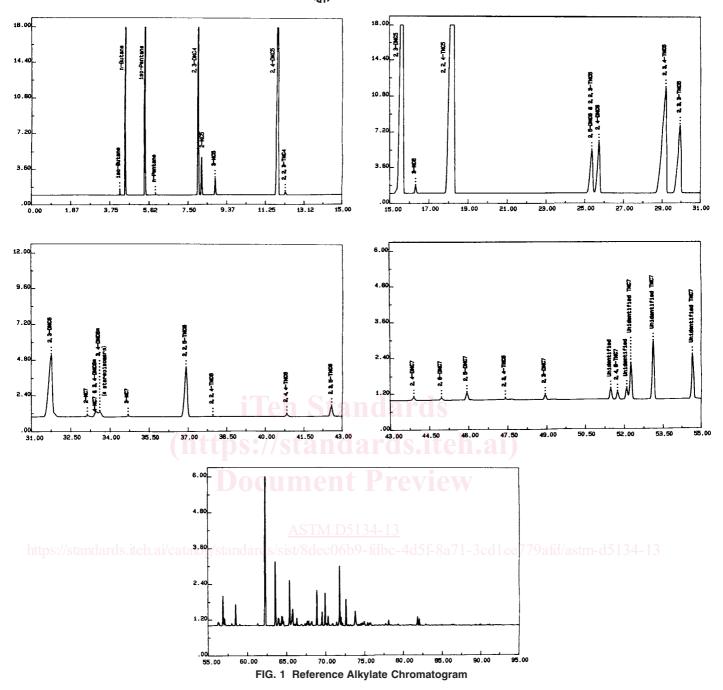
- 6.2 Sample Introduction System—Manual or automatic liquid syringe sample injection to the splitting injector may be employed. Devices capable of 0.2 µL to 1.0 µL injections are suitable. It should be noted that inadequate splitter design or poor injection technique, or both, can result in sample fractionation. Operating conditions which preclude fractionation should be determined in accordance with Section 11.
- 6.3 *Electronic Data Acquisition System*—Any data acquisition and integration device used for quantitation of these analyses must meet or exceed these minimum requirements:
  - 6.3.1 Capacity for at least 250 peaks/analysis.
- 6.3.2 Normalized area percent calculation with response factors.

- 6.3.3 Identification of individual components by retention time.
  - 6.3.4 Noise and spike rejection capability.
  - 6.3.5 Sampling rates for fast (<1 s) peaks.
  - 6.3.6 Positive and negative sloping baseline correction.
  - 6.3.7 Peak detection sensitivity for narrow and broad peaks.
  - 6.3.8 Perpendicular drop and tangent skimming as needed.
- 6.4 Capillary Column—This test method utilizes a 50 m (0.2 mm inside diameter) fused silica capillary column with bonded (cross-linked) methyl silicone phase and a film thickness ( $d_f$ ) of 0.5 µm. Other columns with these nominal dimensions may be suitable. However, all columns must meet the criteria set out in Section 10 for efficiency, resolution, and polarity.

## 7. Reagents and Materials

- 7.1 *Carrier Gas*, helium, mol fraction is 99.99 % pure. (**Warning—**Compressed gas under high pressure.)
- 7.2 Fuel Gas, hydrogen, mol fraction is 99.9 % pure. (Warning—Extremely flammable gas under pressure.)
- 7.3 *Make-up Gas*, helium or nitrogen, 99.99 % pure. (**Warning—**Compressed gases under higher pressure.)
- 7.4 *n-Heptane*, mol fraction is 99+ %. (**Warning**—Flammable. Harmful if inhaled.)
  - 7.5 *Methane*—(Warning—Extremely flammable gas.)
- 7.6 2-Methylheptane, mol fraction is 99+ %. (Warning—Flammable. Harmful if inhaled.)
- 7.7 4-Methylheptane, mol fraction is 99+ %. (Warning—Flammable. Harmful if inhaled.)
- 7.8 2-Methylpentane, mol fraction is 99+ %. (Warning—Extremely flammable. Harmful if inhaled.)
- 7.9 *n-Octane*, mol fraction is 99+ %. (**Warning**—Flammable. Harmful if inhaled.)
- 7.10 *Toluene*, mol fraction is 99+ %. (**Warning**—Flammable. Vapor harmful.)
- 7.11 2,3,3-Trimethylpentane, mol fraction is 99+ %. (Warning—Extremely flammable. Harmful if inhaled.)
- 7.12 Column Evaluation Mixture, a qualitative synthetic mixture of pure liquid hydrocarbons with the following approximate composition: 0.5 % toluene, 1 % n-heptane, 1 % 2,3,3-trimethylpentane, 1 % 2-methylheptane, 1 % 4-methylheptane, 1 % n-octane in 2-methylpentane solvent.
- 7.13 *Reference Alkylate*, actual refinery production alkylation product used for compound identification as in Fig. 1. (Warning—Extremely flammable. Harmful if inhaled.)
- 7.14 *Reference Virgin Naphtha*, actual refinery production stream used for compound identification as in Fig. 2. (Warning—Extremely flammable. Harmful if inhaled.)
- 7.15 *Reference Reformate*, actual refinery production reformer product ('reformate') for compound identification as in Fig. 3. (Warning—Extremely flammable. Harmful if inhaled.)

Note 1—Alkylate, virgin naphtha, and reformer production refinery reference samples may be available from several vendors; alternatively,



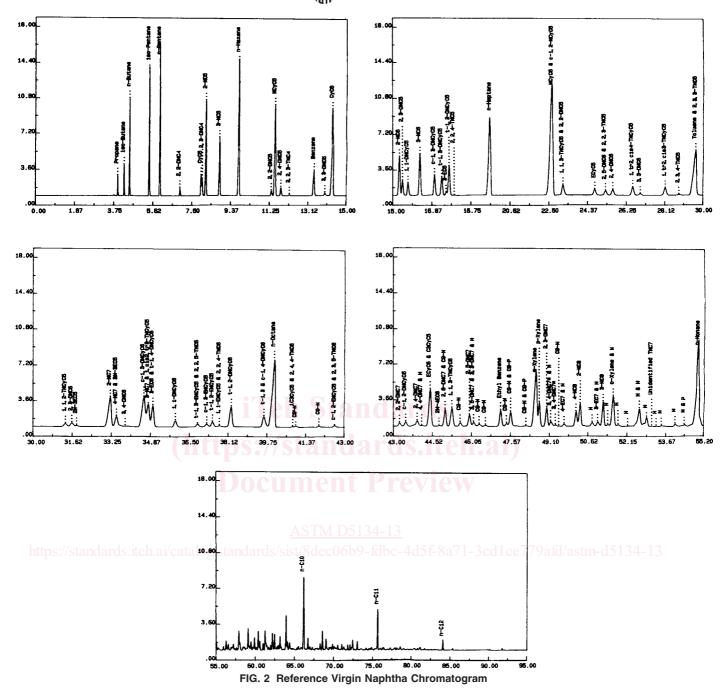
in-house production materials or equivalent that matches closely the fingerprints in the chromatograms (Figs. 1-3) may be used.

# 8. Sampling

8.1 Hydrocarbon liquids (including naphthas) with Reid vapor pressures of 110 kPa (16 psi) or less may be sampled either into a floating piston cylinder or into an open container. Samples taken into piston samplers may be sampled into a GC vial or equivalent provided that upon chilling and transfer does not lead to significant losses of light components.

Note 2—Although possible, this test method has not been evaluated for injection of pressurized samples that require high pressure liquid injection valves.

8.1.1 *Cylinder Sampling*—Refer to Test Method D3700 for instructions on transferring a representative sample of a hydrocarbon fluid from a source into a floating piston cylinder. Add inert gas to the ballast side of the floating piston cylinder to achieve a pressure of 350 kPa (45 psi) above the vapor pressure of the sample.



- 8.1.2 *Open Container Sampling*—Refer to Practice D4057 for instructions on manual sampling from bulk storage into open containers. Stopper container immediately after drawing sample.
- 8.2 Preserve the sample by cooling to approximately 4 °C and by maintaining that temperature until immediately prior to analysis.
- 8.3 Transfer an aliquot of the cooled sample into a precooled septum vial, then seal appropriately. Obtain the test specimen for analysis directly from the sealed septum vial, for either manual or automatic syringe injection.

### 9. Preparation of Apparatus

- 9.1 Install and condition column as per manufacturer's or supplier's instructions. After conditioning, attach column outlet to flame ionization detector inlet and check for leaks throughout the system. If leaks are found, tighten or replace fittings before proceeding.
- 9.2 Calibrate the gas chromatograph column oven temperature sensors using an independent, electronic temperature measuring device such as a thermocouple or platinum resistance temperature detector.