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National Standard of Canada

Methods of testing petroleum and associated products

Standard test method for the identification of components in automotive gasoline using gas chromatography

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Methods of testing petroleum and associated products

Standard test method for the identification of components in automotive gasoline using gas chromatography

1 Scope

This test method is a standard procedure for the determination of paraffins, olefins, naphthenes, aromatics and unknowns (P.O.N.A.U.) in automotive gasolines using gas chromatography and flame ionization detection (GC/FID). Group types are determined by summing individual components.

Individual hydrocarbon components greater than or equal to 0.01% by mass are determined.

Oxygenated components including alcohols and ethers may be determined by this test method. See Annex A, Table A2 for example of retention times and response factors for oxygenates at concentrations typically found in automotive gasoline.

This method applies to automotive gasoline, ethanol-blended gasoline and denatured ethanol.

Liquefied petroleum gas (LPG), naphtha, reformate, alkylate, blendstocks, and typical petroleum or petrochemical product may also be analyzed, however precision may not apply.

The final boiling point of samples as defined by ASTM D86 should not exceed 225°C, however individual hydrocarbons eluting to nC15 can be determined.

Components such as water which do not elute from the gas chromatograph or which have little or no response in a FID are not determined. The water content can be determined by using ASTM D6304, Procedure A.

The separation of individual hydrocarbons and oxygenated compounds by the procedure described in this test method is not absolute and will result in some peaks that represent coeluting components (see Annex A, Table A2). Due to the possibility of coeluting peaks, the user is cautioned in the interpretation of the data.

Toluene and 2,3,3-trimethylpentane may coelute. If isooctane (2,2,4-trimethylpentane) and 2,3,4-trimethylpentane are present in the gasoline sample, it is probable that the sample contains 2,3,3-trimethylpentane. The concentration of 2,3,3-trimethylpentane is almost certain to be less than the concentration of 2,3,4-trimethylpentane. When determining the concentration of toluene and 2,3,3-trimethylpentane, it is essential that the gas chromatographic integrator has individual peak processing capabilities including peak expansion and perpendicular drop. To detect 2,3,3-trimethylpentane and toluene, it is essential for these components to be within a 5:1 ratio of each other with either component having the greater concentration. If these components are present in a greater than 5:1 ratio, the toluene and 2,3,3-trimethylpentane may appear as a coeluted peak, thus causing the component in the smallest concentration to be integrated with the more concentrated component.

Typically forty components with concentrations greater than 1% by mass constitute an average of approximately 80% by mass of automotive gasoline. From these forty components, this method identifies coeluting peaks for toluene, 2-methylhexane, methylcyclopentane and n-hexane (see Annex A, Table A1). The forty components are identified in Table 5 by an asterisk beside its identification number.

The number of coeluting peaks depends on the total number of individual components and the number of olefinic components present. The possibility of coeluting components increases with the increase of components detected after n-octane. Supplementary analytical techniques such as ASTM D1319 for olefins, D5580 and D5769 for aromatic components, D4815 and D5599 for oxygenates may assist in interpretation of data obtained by this method.

The testing and evaluation of a product against this method may require the use of materials and/or equipment that could be hazardous. This document does not purport to address all the safety aspects associated with its use. Anyone using this method has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this method. The referenced documents may be obtained from the sources noted below.

NOTE The addresses provided below were valid at the date of publication of this method.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this method. A dated reference is to the specified revision or edition of the reference or document in question.

2.1 Canadian General Standards Board (CGSB)

CAN/CGSB-3.5 — *Automotive gasoline*

CAN/CGSB-3.14 — *Propane for fuel purposes*

CAN/CGSB-3.27 — *Naphtha fuel*

CAN/CGSB-3.511 — *Oxygenated automotive gasoline containing ethanol (E1-E10)*

CAN/CGSB-3.512 — *Automotive ethanol fuel (E50-E85)*

CAN/CGSB-3.516 — *Denatured fuel ethanol for use in automotive spark ignition fuels*.

2.1.1 Source

The above may be obtained from the Canadian General Standards Board, Sales Centre, Gatineau, Canada K1A 1G6. Telephone 819-956-0425 or 1-800-665-2472. Fax 819-956-5740. E-mail ncr.cgsb-ongc@tpsgc-pwgsc.gc.ca. Web site www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html.

2.2 ASTM International

Annual Book of ASTM Standards (see Annex B).

2.2.1 Source

The above may be obtained from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A., telephone 610-832-9585, fax 610-832-9555, Web site www.astm.org, or from IHS Markit, 200-1331 MacLeod Trail SE, Calgary, Alberta T2G 0K3, telephone 613-237-4250 or 1-800-267-8220, fax 613-237-4251, Web site www.global.ihs.com.

3 Summary of test method

3.1 A sample is introduced into a gas chromatograph equipped with a fused silica, open tubular capillary column coated with a bonded methyl silicone liquid phase. The sample passes through the column and is separated into its individual components. The eluted components are detected using a flame ionization detector and recorded using an integrator or an integrating computer.

3.1.1 The use of computer software for the identification and quantitation of peaks is highly recommended.

3.1.2 The peak areas are measured, and the concentration of each component in percent by mass is determined by normalization of the peak areas after correction with detector response factors (see ASTM D4626).

3.2 The mass percentage of unknown components is calculated using a response factor of 0.86 (equivalent to higher C10 and C11 aromatic, napthenes and paraffins). The volume percentage of unknown components is calculated assuming an average relative density of 0.82 kg/L at 20°C. The mole percentage of unknown components is calculated assuming an average relative molecular mass of 150.

4. Significance and use

4.1 This method may be used to identify and quantify individual or groups of hydrocarbon components, and oxygenated components in products such as automotive gasoline, ethanol-blended gasoline, naphtha fuel, liquefied petroleum gas (LPG) and denatured ethanol (CAN/CGSB-3.14, CAN/CGSB-3.27, CAN/CGSB-3.5, CAN/CGSB-3.511, CAN/CGSB-3.512 and CAN/CGSB-3.516).

5. Apparatus

5.1 Gas chromatograph: any chromatographic instrument capable of three temperature program ramps from 0°C to at least 300°C. For sample introduction, the instrument should be equipped with a capillary inlet system designed to provide a linear split of the sample injected. A hydrogen flame ionization detector designed for capillary use is required (see ASTM E355).

5.2 Column[1]**:** a fused silica, open tubular column, 100 m in length by 0.25 mm inside diameter, coated with a 0.5 µm thick film of bonded methyl silicone.

5.3 Signal integrator: an electronic integrating device or computer capable of measuring peak areas and retention times. The integrating device shall be capable of processing a minimum of five hundred peaks using a corrected area normalization technique. The integrating device should be capable of measuring peaks eluting as fast as 0.04 s width at half height and have the capability of peak processing parameters tailored to individual peaks. The electronic ranges of the integrating device shall be within the linear range of the detector/electrometer systems used. Common ranges are 1 V or 10 V.

5.4 Sample introduction: any method of sample introduction capable of delivering 0.1 to 0.5 µL to the split injector. Micro syringes, automatic liquid samplers, or valves may be used if the injection produces a linear split of the sample.

6. Materials

6.1 Carrier gas: helium[2] 99.999% Pure

6.2 Air: 99.999% Pure

6.3 Hydrogen: 99.999% Pure

6.4 Make-up gas (helium or nitrogen): 99.999% Pure

6.5 Reference standards: hydrocarbons and oxygenated components of interest and known purity.[3]

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[1] A proven high quality column designed for the high resolution of this method is required (see 7.1.5).

[2] The use of hydrogen carrier gas requires additional safety considerations. Hydrogen carrier may change the elution order of some components. Hydrogen carrier will require method optimization and demonstration of equivalency to helium carrier gas. The precision of individual components has been determined for helium carrier gas only.

[3] The reference gasoline and its gas chromatogram, with and without oxygenates, is available from InnoTech Alberta, Fuels and Lubricants Group, 250 Karl Clark Road, Edmonton, Alberta, Canada T6N 1E4. Telephone (780) 450-5108. Fax (780) 988-9053. Website www.innotechalberta.ca.

7. Procedure

7.1 Preparation of apparatus and establishment of conditions

7.1.1 Install the column in the gas chromatograph oven and condition the column according to the manufacturer's instructions. Adjust the gas chromatograph parameters according to those recommended in Table 1. These parameters will elute all components up to and including pentadecane (nC15).

Instrument parameters can be marginally changed to optimize for sample types and to optimize each gas chromatograph system. The performance requirements listed in 7.1.5 should not be compromised.

Table 1 — Recommended instrument parameters

Detector	
Type	Hydrogen flame ionization
Temperature, °C	300
Inlet system	
Type	Split
Temperature, °C	275
Column	
Length, m	100
Internal diameter, mm	0.25
Film thickness, µm	0.5
Stationary phase	Bonded methyl silicone
Temperature program	
Initial temperature, °C	0
Initial hold time, min	15
First program rate, °C/min	1
Final temperature, °C	50
Hold time, min	0
Second program rate, °C/min	2
Final temperature, °C	130
Hold time, min	0
Third program rate, °C/min	4
Final temperature, °C	270
Carrier gas	
Gas type	Helium
Linear velocity at 0°C, cm/s	25.6[a]
Column head pressure, kPa (psi)	Approx. 270 (35 to 50)
Split ratio	Approx. 270:1
Sample size, µL	0.1 to 0.5
Total run time, min	Approx. 142

[a] The use of constant flow is recommended.

7.1.2 Determine the carrier gas flow rate by injection of methane or natural gas. Calculate the linear gas velocity in centimetres per second using Equation A.

Equation A:

$$\text{linear gas velocity} = \frac{\text{Column length (cm)}}{\text{retention time of methane (s)}}$$

A retention time of 6.51 min for methane at an oven temperature of 0°C, yielding a linear velocity of 25.6 cm/s, was found to be satisfactory.[4]

7.1.3 Calculate and adjust the split ratio using Equation B.

Equation B:

$$\text{split ratio} = \frac{\text{split vent flow rate} + \text{column flow rate}}{\text{column flow rate}}$$

Measure the volumetric flow rate at the column outlet. Alternatively, the volumetric flow rate through a capillary column can be calculated using Equation C.

Equation C:

$$F = \left[60\pi r^2\right]\left[T_{ref} / T\right]\left[2\left(p_i^3 - p_o^3\right) / 3\, p_{ref}\left(p_i^2 - p_o^2\right)\right]\bar{\mu}$$

where:

F = calculated column flow rate at standard temperature and pressure, in mL/min

r = column radius, in cm

p_i = inlet pressure (absolute), in dyn/cm^2

p_o = outlet pressure (absolute), in dyn/cm^2

p_{ref} = reference pressure, typically 1 atm (1.03 × 10^6 dyn/cm^2)

T = column temperature, in K

T_{ref} = reference temperature, typically 298 K (25°C)

$\bar{\mu}$ = average linear velocity, in cm/s

60 = to convert seconds to minutes

7.1.4 Make a blank baseline run to ensure that no stray peaks are detected and that the baseline signal at the upper temperature limit is steady and reasonably close to that of the initial signal. The baseline rise at the end of the chromatographic temperature program should not exceed 1% of full scale. Further conditioning of the column may be required to meet these criteria.

[4] The time to elute methane from the column at 0°C can range from 6.5 to 7.5 min.

7.1.5 Initial evaluation and performance of the column

7.1.5.1 The column shall meet the resolution requirements value for:

a) Benzene and 1-methyl-1-cyclopentene peaks (see Figure 1). The resolution (*R*) value for these two peaks should have a value greater than 1.0.

b) *m*-Xylene and *p*-xylene peaks (see Figure 2). The resolution (*R*) value for these two peaks should have a value greater than 0.40.

Calculate resolution (*R*) by using Equation D.

Equation D:

$$R = \frac{2\left(t R_2 - t R_1\right)}{1.699\left(Wh_2 + Wh_1\right)}$$

where:

tR_1 = retention time of the first peak, seconds

tR_2 = retention time of the second peak, seconds

Wh_1 = peak width at half height for the first peak, seconds

Wh_2 = peak width at half height for the second peak, seconds

It is recommended that the resolution of the column be checked every 200 samples or a minimum of three times a year to assure column performance.

7.1.5.2 The sensitivity of the system may be determined by analyzing a 100 mg/kg (0.010 mass %) heptane standard (see ASTM D4307).[5] The heptane content measured should be 0.010 ± 0.002 mass %.

7.1.5.3 The percent separation of m-xylene and p-xylene may be calculated. Measure the distance from the valley between the two peaks to the apex of the m-xylene peak (a). Divide this value by the height of the m-xylene peak (b), and multiply by 100 (see Figure 3). The separation for gasoline is typically greater than 75%.[6]

7.1.5.4 The identification of components is based on retention times (see 7.2.1). To verify the system performance, it is recommended that the reference gasoline[7] be run at six-month intervals, or when there is a change with the instrument. The purpose is to ensure that retention time drift has not resulted in misidentifications of the components and that the analytical system is continuing to produce accurate peak identifications. A chromatogram of the reference gasoline is provided in Figure 4. The reference gasoline may also be used to verify the requirements of resolution (see 7.1.5.1) and xylene separation (see 7.1.5.3).

7.1.5.5 A quality control (QC) sample shall be representative of samples being analyzed and run at regular intervals. ASTM D6596 may be used as a guidance document in the preparation of these samples. The QC sample should contain oxygenated components at concentrations similar to the oxygenated components in the test samples. An interval of once per week or after every 15 samples is suggested. The quantitation results for benzene can be

[5] Run individual standards to ensure that hydrocarbons of interest meet the detection limit criteria.

[6] Low aromatic or aromatic-extracted gasoline may not be suitable for this purpose.

[7] The quality assurance samples and the reference gasoline used in this method are different. The quality assurance samples may be prepared directly or obtained from InnoTech Alberta, Fuels and Lubricants Group, 250 Karl Clark Road, Edmonton, Alberta, Canada T6N 1E4. Telephone (780) 450-5108. Fax (780) 988-905. Website www.innotechalberta.ca

tracked by statistical quality control charts. Other components of interest in the reference sample can be tracked in a similar manner. By monitoring these components over an extended period of time, the performance of the column and chromatographic system can be determined.[8]

7.2 Identification and standardization

7.2.1 Identification

Create a reference table similar to that of Table 5 by running the reference gasoline and/or calibration standards and adjusting the retention time or Kovats indices to match the identifications in Figure 3. Pay special attention to peak patterns as retention times for different columns, head pressure, etc.,[9] will vary from instrument to instrument.

7.2.2 It is recommended that the retention times for all oxygenated components be determined by analyzing calibration standards (see ASTM D4626). Retention times for oxygenated components typically found in automotive gasoline are available in Table A2. Determine the retention times for ethanol and methanol by running concentrations expected in the test sample of both (either together or separately).

7.2.2.1 The split vent ratio may need to be adjusted in order to minimize ethanol peak tailing at high concentration but still be able to detect the ethanol peak at low concentration.

7.2.3 Standardization

7.2.3.1 The response factors for all components listed in Table 5, except oxygenated components, are theoretical response factors and have been calculated using Equation E.[10] All response factors may also be determined by analyzing standards (see ASTM D4626).

Equation E:

$$F_i = \frac{\frac{\left[C_{aw} \times C_n\right] + \left[H_{aw} \times H_n\right]}{C_n} \times 0.7487}{C_{aw}}$$

where:

F_i = relative response factor for a hydrocarbon type group of a particular carbon number

C_{aw} = relative atomic mass of carbon

C_n = number of carbon atoms in the group

H_{aw} = relative atomic mass of hydrogen

H_n = number of hydrogen atoms in the group

0.7487 corrects the response of methane to unity

In this case, methane will be considered to have a unity (1) response factor.

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[8] Refer to ASTM D6299, ASTM D6792 and ASTM MNL7A for guidance on quality assurance practices.

[9] Greater consistency in peak identification can be achieved when software packages are used to automate this process. Such packages look for major reference peaks (normal paraffins and/or several aromatics) and then make appropriate adjustments to the retention indices of other peaks.

[10] Equation E for calculating theoretical response factors obtained from Scientific References:
a) Jiri Sevcik, Detectors in Gas Chromatograph, Elsevier Scientific Publishing Co., New York, 1976, p. 94.
b) D.J. David, Gas Chromatographic Detectors, John Wiley & Sons, New York, 1976, pp. 64-68.

7.2.3.2 It is recommended that the response factors for all oxygenated components, other than ethanol and methanol, be determined by analyzing calibration standards (see ASTM D4626). Example response factors for oxygenated components are available in Table A2.

7.2.3.3 The response factors for ethanol and methanol shall be determined by performing a single point calibration at concentrations dependent on the fuel being analyzed. See Table 2 for suggested calibration standard concentrations.

7.2.3.4 The calibration standard methanol concentration (mass %) for the response factor determination shall be within ±20% of the test sample methanol concentration (mass %).

7.2.3.5 The calibration standard ethanol concentration (mass %) for the response factor determination when analyzing denatured ethanol (see CAN/CGSB-3.516) shall be in the range of 90 to 99 %, preferably within ±2% of the test sample ethanol concentration (mass %).

7.2.3.6 The calibration standard ethanol concentration (mass %) for the response factor determination when analyzing automotive ethanol fuel, E50-E85 (see CAN/CGSB-3.512) shall be within ±20% of the test sample ethanol concentration (mass %).

7.2.3.7 The calibration standard ethanol concentration (mass %) for the response factor determination when analyzing oxygenated automotive gasoline containing ethanol, E1-E10, (see CAN/CGSB-3.511) shall be within ±20% of the test sample ethanol concentration (mass %).

Table 2 — Suggested calibration standards for ethanol and methanol

Calibration standard methanol concentration (mass %)	Lowest sample methanol concentration (mass %)	Highest sample methanol concentration (mass %)
0.05	0.04	0.06
0.1	0.08	0.12
0.2	0.16	0.24
0.3	0.24	0.36
0.4	0.32	0.48
0.5	0.40	0.60
0.6	0.48	0.72
Calibration standard ethanol concentration (mass %)	**Lowest sample ethanol concentration (mass %)**	**Highest sample ethanol concentration (mass %)**
1	0.8	1.2
5	4	6
10	8	12
20	16	24
50	40	60
75	60	90
95	93	97

7.2.3.8 Gravimetrically prepare a standard containing ethanol and/or methanol at the concentration expected in the test sample (see ASTM D4307) and a known concentration of n-heptane using n-octane or iso-octane as the diluent. Correct for impurities and water content in the oxygenate stocks before preparing standards. Where available, commercial standards or certified reference materials may be used. Analyze the standard and calculate the RRF relative to n-heptane. Convert the RRF from relative to n-heptane to relative to methane using the factor 0.892. Methane will be considered to have a unity (1) response factor. Refer to ASTM D4626 and the example below for guidance.

$$\text{RF (n-heptane)} = \frac{\text{mass \%}}{\text{area}}$$

$$\text{RF (ethanol)} = \frac{\text{mass \%}}{\text{area}}$$

$$\text{RRF (ethanol)} = \frac{\text{RF (ethanol) x 0.892}}{\text{RF (n-heptane)}}$$

7.2.3.9 Insert the retention times and relative response factors determined for oxygenated components into Table 5.

7.3 Analysis

7.3.1 Obtain a representative sample following the guidelines of ASTM D4057 and ASTM D5842. Precaution should be taken wherever possible to minimize the loss of light ends from volatile samples like automotive gasolines.

7.3.2 Prior to analysis, it may be necessary to obtain a sample aliquot. The original sample should be cooled to less than +4°C prior to taking a sample aliquot or prior to filling autosampler vials. The sample aliquot container and/or the autosampler vial should also be cooled prior to the transfer of the original sample. The sample aliquot or autosampler vial should then be refrigerated at less than +4°C until ready for analysis or autosampler loading. The syringe can be cooled with the sample when using a manual injection technique.

7.3.3 For LPG samples, obtain a representative sample following the guidelines of ASTM D1265 or ASTM D3700. It is recommended that samples stored in pressurized sample containers be kept away from direct heat or light. Avoid storage at temperatures greater than 25°C. Store pressure containers in accordance with the manufacturer's instructions. No other sample preparations are necessary for samples stored in pressurized containers. The LPG sample may be injected directly into the Gas Chromatography (GC) system through a liquid sampling valve.

7.3.4 Introduce a representative sample into the injection port and start the analysis. Obtain a chromatogram and a data report from the integrator.

7.3.5 Identify each peak by matching its retention time with the retention times listed in the peak table (see Table 5). Comparison to a reference chromatogram or known hydrocarbon mixture may be helpful. Retention times may differ because of slight variations in oven temperature and column flow rate. Retention times may also differ because of peak size, i.e. column overload. Allow for differences in retention times of sample peaks with retention times of the reference peaks in the peak table (see Table 5). A computing integrator may be used for automatic peak identification; however, the chromatogram and report shall be carefully examined to ensure proper identification of components.[11]

[11] The repeatability of retention times is critical to peak identification, absolute across the entire chromatogram. Retention time variability for the same peak on a retention time variability should be investigated and corrected.

7.3.6 Toluene and 2,3,3-trimethylpentane can coelute (see 1.5). In some cases, it may be desirable to obtain more accurate quantitation data. The following non-mandatory options are allowed. When toluene and 2,3,3-trimethylpentane coelute and integration using perpendicular drop cannot be performed, the amount of each component may be estimated. The amount of 2,3,3-trimethylpentane can be estimated based on a fixed ratio to 2,3,4-trimethylpentane. The ratio of 2,3,3-trimethylpentane to 2,3,4-trimethylpentane in alkylated gasoline is approximately 0.75. Analyze the sample as per section 7. Multiply the concentration of 2,3,4-trimethylpentane (mass, volume and mole percent) by 0.75 and subtract this amount from the toluene concentration. Alternatively, analyze the alkylate stream as per section 7 and experimentally determine the exact 2,3,4-trimethylpentane to 2,3,3-trimethylpentane ratio. Use the calculated ratio for the toluene correction. The amount of toluene may also be determined by a suitable alternative aromatics analysis, such as ASTM D5769 or ASTM D5580. Subtract the amount of toluene determined from either of these methods from the coeluted toluene/2,3,3-trimethylpentane peak to obtain corrected values for these components. Report the concentration of toluene and 2,3,3-trimethylpentane as “corrected” and state the correction method.

8. Calculation

8.1 Calculate the normalized mass percentage of individual components using Equation F.

Equation F:

$$\text{i, \% by mass} = \frac{\text{area (i)} \times \text{rf (i)} \times 100}{\sum[\text{area (i)} \times \text{rf (i)} + \text{area (j)} \times \text{rf (j)} + \text{area (k)} \times \text{rf (k)} + \ldots]}$$

where:

area (i), area (j), area (k) = area of component i, j, k, etc.

rf (i), rf (j), rf (k) = mass relative response factor for components i, j, k, etc., from Table 5, or determined experimentally for the component of interest

8.2 Calculate the normalized volume percentage of individual components using Equation G (see ASTM D4307).

Equation G:

$$\text{i, \% by volume} = \frac{(C_i / D_i) \times 100}{\sum[(C_i / D_i) + (C_j / D_j) + (C_k / D_k) + \ldots]}$$

where:

Ci, Cj, Ck = % by mass of components i, j, k, etc.

Di, Dj, Dk = relative density of components i, j, k, etc., all determined at the same temperature

8.3 Calculate the normalized mole percentage of individual components using Equation H.

Equation H:

$$\text{i, \% by mole} = \frac{(C_i / M_i) \times 100}{\sum[(C_i / M_i) + (C_j / M_j) + (C_k / M_k) + \ldots]}$$

where:

C_i, C_j, C_k = % by mass of components i, j, k, etc.

M_i, M_j, M_k = relative molecular mass of components i, j, k, etc.

9. Report

9.1 Report the total concentration of paraffins, olefins, naphthenes, aromatics and unknowns on an absolute basis as % by mass to two significant figures.

9.1.1 Where coelution occurs with two different hydrocarbon types, the summary will use the first component as the carbon type.[12]

9.1.2 Individual components may be reported as % by mass to three significant figures.

9.1.3 For reporting purposes, abbreviated component names may be used.

9.1.4 Commercial software packages provide calculated correlations for parameters such as boiling point distribution, D86 distillation, E200 and E300, vapour pressure, average molecular weight, octane numbers, etc. The accuracy of these correlations has not been determined through interlaboratory studies. If these correlations are included in a report of analysis, the report shall contain a statement warning the user that precision and bias have not been determined.

9.1.5 If the concentration of toluene and 2,3,3-trimethylpentane has been estimated as per 7.3.5, report the concentration of toluene and 2,3,3-trimethylpentane as “corrected” and state the correction method.

10. Precision and bias

10.1 Precision

The precision information, presented in **Table 3A**, is obtained from a 1996 interlaboratory study comprising nine participants testing ten gasoline samples. The study[13] was conducted under the auspices of ASTM D02.04, Subcommittee on Hydrocarbon Analysis, with participation from both CGSB and ASTM members. The statistical analysis was performed by ASTM D02.CS91.B, Statistical Methodology.

10.1.1 Repeatability

The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on the identical test materials would, in the long run, in the normal and the correct operation of the test method, exceed the following values only in one case in twenty (see Table 3A).

10.1.2 Reproducibility

The difference between two single and independent results obtained by different operators working in different laboratories on the identical test materials would, in the long run, in the normal and the correct operation of the test method exceed the following values only in one case in twenty (see Table 3A).

10.2 Bias

The bias of this method cannot be determined since an appropriate standard reference material is not available.

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[12] Where coeluting hydrocarbons are listed, the first component has been verified by GC/MS to be the dominating component in the Reference Gasoline.

[13] ASTM Research Report, “Detailed Analysis of Gasoline by High Resolution Gas Chromatography,” dated November 20, 1997, authored by Sherman Parr of Imperial Oil Sarnia Research Department. Permission to reproduce excerpts was granted by ASTM.

Information related to Tables 3A and 3B

The components listed in Tables 3A and 3B were selected based on the following requirements:

1. Each component shall be present in at least six samples, and detected by at least six laboratories, at least once, in accordance with ASTM D02-1007 requirement.

2. The [(repeatability standard deviation) ÷ mean] value for each component/sample combination shall be less than or equal to 0.1, based on limit of quantitation (LOQ) requirements recommended by ASTM D02.CS91.B.

The terms and symbols used in Table 3A and 3B are explained below:

****** component verified by Gas Chromatography/Mass Spectrometry (GC/MS) by one of the participants on one of the samples in study

r repeatability (see 10.1.1)

r = (standard deviation estimate under ASTM repeatability conditions) × 2.77

R reproducibility (see 10.1.2)

R = (standard deviation under ASTM reproducibility conditions) × 2.77

C concentration of analyte in mass % (equation F)

r_prop proportional coefficient, used to estimate repeatability (r) as follows:

r = r_prop × C

r_root square root coefficient, used to estimate repeatability (r) as follows:

r = r_root × $\sqrt{C}$

R_prop proportional coefficient, used to estimate the reproducibility (R) as follows:

R = R_prop × C

R_root square root coefficient, used to estimate reproducibility (R) as follows:

R = R_root × $\sqrt{C}$

rmin lower 95% confidence limit of the corresponding r_prop, r_root, or r

rmax upper 95% confidence limit of the corresponding r_prop, r_root, or r

Rmin lower 95% confidence limit of the corresponding R_prop, R_root, or R

Rmax upper 95% confidence limit of the corresponding R_prop, R_root, or R

Cmin lower concentration limit that the precision estimate is applicable to

Cmax upper concentration limit that the precision estimate is applicable to

Table 3A ─ Precision information for individual component

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	6	iC4	0.098	0.134	0.177	0.249	0.307	0.373	0.04	2.86
**	9	1C4=	0.104	0.167	0.251	0.28	0.36	0.454	0.01	0.14
**	11	nC4	0.1	0.12	0.142	0.271	0.317	0.366	0.92	8.51
**	12	t2C4=	0.121	0.157	0.198	0.282	0.368	0.471	0.03	0.31
**	14	c2C4=	0.142	0.154	0.167	0.252	0.311	0.379	0.03	0.29
**	20	3M1C4=	0.073	0.096	0.123	0.172	0.199	0.227	0.02	0.11
**	22	iC5	0.046	0.054	0.063	0.134	0.155	0.179	2.39	12.09
**	26	1C5=	0.059	0.075	0.094	0.17	0.206	0.247	0.06	0.4
**	28	2M1C4=	0.044	0.063	0.086	0.145	0.175	0.209	0.14	0.8
**	30	nC5	0.042	0.062	0.087	0.139	0.161	0.185	1	5.18
**	34	t2C5=	0.041	0.063	0.091	0.13	0.173	0.226	0.27	1.08
**	38	c2C5=	0.052	0.077	0.11	0.144	0.183	0.229	0.15	0.59
**	40	2M2C4=	0.039	0.062	0.092	0.152	0.181	0.214	0.44	1.78
**	42	t13C5=,=	0.045	0.102	0.196	0.221	0.311	0.422	0.01	0.05
**	52	22DMC4	0.029	0.037	0.047	0.098	0.129	0.166	0.07	2.16
**	54	cyC5=	0.046	0.09	0.155	0.156	0.203	0.259	0.07	0.25
**	56	4M1C5=	0.112	0.148	0.19	0.226	0.318	0.432	0.02	0.1
**	58	3M1C5=	0.083	0.121	0.17	0.371	0.505	0.668	0.04	0.12
**	62	cyC5	0.025	0.047	0.077	0.118	0.134	0.151	0.07	0.69
**	64	23DMC4	0.017	0.027	0.039	0.086	0.098	0.111	0.53	1.91
**	66	MTBE	0.019	0.032	0.05	0.091	0.123	0.162	0.12	15.73
**	70	c4M2C5=	0.051	0.071	0.097	0.274	0.437	0.654	0.02	0.09
**	74	2MC5	0.022	0.029	0.038	0.093	0.11	0.129	1.03	5.62
**	76	t4M2C5=	0.049	0.063	0.079	0.169	0.202	0.239	0.05	0.26

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	80	3MC5	0.02	0.027	0.035	0.077	0.091	0.107	0.58	3.25
**	84	2M1C5=	0.036	0.051	0.07	0.096	0.125	0.161	0.09	0.45
**	86	1C6=	0.039	0.064	0.099	0.151	0.199	0.257	0.04	0.26
**	96	nC6	0.025	0.046	0.077	0.11	0.133	0.158	0.25	3.23
**	98	c3C6=	0.044	0.065	0.091	0.125	0.163	0.209	0.08	0.48
**	102	t3C6=+C6=,=	0.029	0.052	0.084	0.094	0.124	0.159	0.17	0.93
**	103	2M2C5=	0.027	0.047	0.074	0.099	0.12	0.144	0.15	0.77
**	104	3McyC5=	0.078	0.113	0.159	0.227	0.252	0.28	0.02	0.11
**	105	t3M2C5=	0.043	0.069	0.102	0.101	0.125	0.154	0.1	0.48
**	106	c2C6=	0.041	0.067	0.102	0.143	0.174	0.21	0.07	0.4
**	109	c3M2C5=	0.031	0.045	0.064	0.091	0.105	0.121	0.14	0.75
**	112	McyC5	0.024	0.033	0.044	0.091	0.101	0.111	0.36	2.34
**	117	24DMC5	0.018	0.027	0.039	0.08	0.101	0.124	0.2	1.93
**	119	223TMC4	0.005	0.041	0.143	0.209	0.352	0.548	0.01	0.06
**	124	C7=,=	0	0.031	0.166	0.113	0.191	0.299	0.01	0.04
**	128	methylenecyC5	0.055	0.091	0.141	0.149	0.203	0.268	0.01	0.03
**	130	Benzene	0.026	0.047	0.078	0.115	0.138	0.165	0.15	1.86
**	131	1McyC5=	0.043	0.063	0.089	0.185	0.241	0.307	0.17	0.92
**	133	c2M3C6=	0	0.012	0.068	0.17	0.291	0.459	0.01	0.06
**	134	33DMC5+5M1C6=	0.023	0.039	0.062	0.085	0.148	0.236	0.02	0.22
**	136	cyC6	0.033	0.044	0.057	0.113	0.128	0.145	0.04	0.87
**	138	t2M3C6=	0.042	0.084	0.147	0.842	1.032	1.248	0.02	0.32
**	146	t2e3m1C4=	0.032	0.057	0.091	0.208	0.296	0.408	0.02	0.19
**	148	4M1C6=	0.001	0.024	0.115	0.168	0.293	0.466	0.01	0.05
**	154	4M2C6=	0.03	0.045	0.064	0.159	0.187	0.218	0.03	0.29

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	156	2MC6+C7=	0.014	0.021	0.03	0.062	0.077	0.095	1.09	3.54
**	160	cyC6=	0.039	0.072	0.121	0.301	0.454	0.652	0.02	0.13
**	166	3MC6	0.013	0.02	0.028	0.085	0.099	0.115	0.36	2.38
**	172	t13DMcyC5	0.017	0.024	0.033	0.105	0.113	0.122	0.12	0.6
**	174	c13DMcyC5	0.019	0.027	0.036	0.098	0.107	0.116	0.09	0.49
**	176	t12DMcyC5	0.022	0.032	0.043	0.076	0.091	0.108	0.05	0.46
**	180	3EC5	0.028	0.048	0.076	0.1	0.134	0.176	0.02	0.21
**	184	5M1C6=	0.018	0.05	0.106	0.241	0.352	0.491	0.03	0.19
**	186	224TMC5	0.023	0.034	0.049	0.076	0.132	0.211	0.09	23.25
**	188	1C7=	0.043	0.068	0.101	0.158	0.209	0.269	0.02	0.13
**	189	C7=	0.052	0.078	0.111	0.151	0.183	0.22	0.02	0.13
**	194	C7=	0.033	0.048	0.068	0.166	0.207	0.252	0.02	0.16
**	196	C7=,=	0.037	0.05	0.065	0.125	0.172	0.228	0.04	0.31
**	197	C7=,=	0.056	0.073	0.093	0.195	0.23	0.269	0.04	0.26
**	198	C7=	0.038	0.047	0.057	0.429	0.604	0.821	0.05	0.45
**	200	nC7	0.015	0.022	0.032	0.074	0.089	0.107	0.13	1.55
**	202	c3C7=	0.021	0.03	0.042	0.142	0.182	0.23	0.04	0.36
**	204	2M2C6=	0.021	0.03	0.043	0.144	0.165	0.187	0.05	0.43
**	206	c3M3C6=	0.033	0.045	0.061	0.21	0.249	0.293	0.03	0.29
**	208	t2C7=	0.018	0.027	0.04	0.129	0.152	0.178	0.04	0.35
**	210	3E2C5=	0.001	0.012	0.054	0.134	0.166	0.204	0.02	0.13
**	212	1,5DMcyC5=	0.03	0.05	0.078	0.103	0.162	0.24	0.03	0.27
**	214	t2M3C6=	0.028	0.036	0.047	0.138	0.179	0.229	0.04	0.33
**	218	23DM2C5=	0.031	0.04	0.05	0.091	0.13	0.178	0.04	0.56
**	222	McyC6	0.019	0.026	0.036	0.085	0.099	0.115	0.16	1.44

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	224	113TMCyC5	0.017	0.051	0.115	0.108	0.144	0.187	0.01	0.09
**	226	22DMC6	0.047	0.092	0.159	0.129	0.232	0.381	0.01	0.07
**	234	EcyC5	0.025	0.036	0.05	0.096	0.135	0.184	0.04	0.3
**	240	223TMC5	0.022	0.049	0.093	0.141	0.273	0.467	0.02	0.54
**	245	25DMC6+C8=	0.015	0.028	0.047	0.063	0.081	0.103	0.17	1.58
**	250	24DMC6	0.018	0.029	0.045	0.061	0.081	0.104	0.25	2.19
**	260	tc124TMcyC5	0.024	0.037	0.054	0.108	0.151	0.205	0.03	0.16
**	265	3,3DMC6+C8=	0.013	0.054	0.141	0.087	0.148	0.232	0.01	0.07
**	278	tc123TMcyC5	0.061	0.115	0.195	0.409	0.7	1.103	0.03	0.09
	290	C8='S	0.003	0.032	0.118	0.155	0.203	0.261	0.02	0.23
**	292	234TMC5	0.019	0.032	0.05	0.087	0.12	0.16	0.09	9.14
**	294	C7=,=	0.029	0.042	0.058	0.192	0.411	0.752	0.06	0.51
**	300	Toluene	0.017	0.031	0.053	0.087	0.166	0.282	2.52	13.14
	312	C8=	0.039	0.06	0.087	0.26	0.357	0.476	0.02	0.2
**	314	23DMC6	0.022	0.035	0.052	0.161	0.306	0.519	0.18	2.06
	316	2M3EC5	0.023	0.045	0.079	0.213	0.4	0.672	0.03	0.31
**	318	112TMcyC5+C7=,=,=	0.004	0.033	0.118	0.266	0.337	0.42	0.02	0.23
**	326	2MC7	0.033	0.044	0.059	0.084	0.112	0.145	0.14	0.93
**	328	4MC7	0.035	0.056	0.083	0.125	0.244	0.424	0.15	0.5
**	334	c13DMcyC6	0.037	0.048	0.062	0.187	0.326	0.521	0.04	0.25
**	336	3MC7	0.023	0.033	0.045	0.178	0.219	0.265	0.15	1.04
**	338	3EC6	0.041	0.064	0.094	0.348	0.53	0.767	0.04	0.21
**	352	c1E3McyC5	0.031	0.043	0.057	0.086	0.232	0.487	0.09	2.32
**	356	t1E3McyC5	0.038	0.051	0.067	0.244	0.355	0.497	0.03	0.21
**	360	t1E2McyC5	0.045	0.077	0.123	0.323	0.541	0.841	0.02	0.11

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	362	1M1EcyC5	0.002	0.031	0.125	0.241	0.333	0.447	0.01	0.08
	366	C8=	0.072	0.099	0.133	0.271	0.37	0.49	0.01	0.08
**	368	t12DMcyC6	0.022	0.048	0.09	0.639	0.973	1.406	0.02	0.15
	372	C8=’s	0.034	0.053	0.079	1.093	1.244	1.41	0.02	0.26
	374	t3C8=	0	0.015	0.094	0.508	0.672	0.869	0.02	0.12
	380	C8=	0.036	0.054	0.079	0.211	0.389	0.647	0.03	0.33
**	385	t13DMcyC6	0.031	0.054	0.084	0.341	0.485	0.665	0.04	0.31
**	400	nC8	0.03	0.037	0.045	0.088	0.119	0.156	0.1	0.89
	406	t2C8=	0.03	0.065	0.122	0.456	0.725	1.084	0.02	0.28
	408	iPrcyC5	0.058	0.074	0.093	0.317	0.508	0.765	0.03	0.36
	416	C9=	0.003	0.029	0.099	0.469	0.638	0.844	0.02	0.14
	422	C9=’s	0.048	0.08	0.124	0.305	0.432	0.589	0.02	0.17
**	432	c12DMcyC6	0.034	0.049	0.068	0.221	0.393	0.638	0.04	0.39
**	434	24DMC7	0.056	0.099	0.159	0.545	1.055	1.812	0.02	0.09
	436	C9=	0.019	0.06	0.137	0.347	0.475	0.631	0.01	0.07
	438	C9=	0.041	0.066	0.1	0.19	0.277	0.387	0.02	0.11
**	440	EcyC6	0.027	0.05	0.082	0.141	0.22	0.325	0.03	0.28
**	444	2M4EC6	0.077	0.111	0.153	0.202	0.274	0.36	0.01	0.03
**	446	26DMC7	0.059	0.073	0.089	0.219	0.277	0.344	0.03	0.14
**	450	114TMcyC6	0.059	0.082	0.11	0.28	0.421	0.603	0.03	0.21
**	458	25&35DMc7	0.037	0.059	0.087	0.105	0.149	0.205	0.07	0.25
	460	C9=’s	0.033	0.084	0.171	0.401	0.564	0.766	0.01	0.07
	462	33DMC7	0.001	0.033	0.157	0.25	0.44	0.709	0.01	0.05
**	475	EBenzene	0.028	0.039	0.054	0.072	0.089	0.109	0.66	3.12
**	480	t124TMcyC6	0.069	0.109	0.163	0.847	1.093	1.382	0.02	0.15

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	500	m-Xylene	0.027	0.037	0.05	0.075	0.092	0.11	1.67	7.93
**	502	p-Xylene	0.031	0.044	0.059	0.088	0.116	0.148	0.63	3.26
**	503	23DMC7	0.051	0.076	0.109	0.453	0.735	1.115	0.03	0.16
	504	35DMC7	0.072	0.098	0.13	0.441	0.828	1.392	0.02	0.07
	506	34DMC7	0.065	0.101	0.15	0.425	0.677	1.014	0.02	0.07
	510	3M3EC6	0.063	0.1	0.15	0.38	0.61	0.92	0.02	0.14
**	518	4MC8+C9=	0.041	0.059	0.081	0.124	0.143	0.163	0.05	0.3
**	520	2MC8	0.044	0.059	0.077	0.124	0.159	0.201	0.07	0.38
	522	C9=	0.068	0.106	0.157	0.223	0.333	0.474	0.01	0.1
**	528	3EC7	0.045	0.068	0.098	0.247	0.344	0.463	0.02	0.11
**	530	3MC8	0.05	0.08	0.12	0.124	0.179	0.249	0.08	0.45
**	550	o-Xylene	0.021	0.03	0.041	0.077	0.098	0.123	0.92	4.18
**	564	C9P	0.031	0.066	0.12	0.311	0.504	0.763	0.01	0.37
**	568	t1E4McyC6	0.065	0.097	0.138	0.263	0.461	0.741	0.02	0.13
**	570	c1E4McyC6	0.047	0.074	0.108	0.221	0.358	0.542	0.02	0.15
	572	C9P	0.045	0.072	0.107	0.287	0.557	0.959	0.03	0.6
	582	C9P	0.075	0.111	0.156	0.169	0.231	0.308	0.02	0.24
	586	t3C9=	0.046	0.091	0.16	0.273	0.388	0.532	0.01	0.16
	590	c3C9=	0.071	0.111	0.164	0.235	0.361	0.527	0.01	0.17
**	600	nC9	0.058	0.072	0.087	0.183	0.3	0.458	0.1	0.51
**	606	1M1EcyC6	0.004	0.031	0.107	0.462	0.758	1.16	0.02	0.11
	608	1M2PrcyC5	0.002	0.03	0.122	0.192	0.301	0.445	0.01	0.1
**	616	iPrbenz	0.043	0.069	0.104	0.112	0.189	0.296	0.04	0.41
**	626	iPrcyC6	0.044	0.077	0.124	0.218	0.402	0.669	0.01	0.35
	636	sBucyC5	0.005	0.045	0.161	0.229	0.367	0.551	0.01	0.06

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
**	638	PrcyC6	0.04	0.073	0.12	0.779	0.968	1.186	0.02	0.12
	644	26DMC8	0.046	0.086	0.144	0.412	0.682	1.05	0.03	0.23
**	646	36DMC8	0.045	0.077	0.123	0.316	0.404	0.508	0.03	0.11
**	651	nPrbenz	0.035	0.058	0.09	0.116	0.173	0.246	0.21	0.83
**	655	1E3Mbenz	0.028	0.045	0.069	0.065	0.083	0.103	0.85	2.8
**	656	1E4Mbenz	0.031	0.045	0.063	0.078	0.097	0.119	0.36	1.26
**	658	135TMbenz	0.034	0.058	0.091	0.085	0.125	0.177	0.46	1.53
**	660	5MC9	0.109	0.129	0.151	0.767	1.047	1.388	0.02	0.13
**	661	4MC9	0.071	0.102	0.14	0.297	0.445	0.635	0.02	0.13
**	662	2MC9	0.044	0.071	0.109	0.149	0.242	0.366	0.1	2.07
**	663	1E2Mbenz	0.036	0.055	0.081	0.103	0.159	0.232	0.3	1.1
**	668	3MC9	0.072	0.129	0.21	0.418	0.59	0.803	0.04	0.19
	671	C10P	0.005	0.054	0.195	0.303	0.521	0.826	0.01	0.47
**	673	124TMbenz	0.028	0.047	0.074	0.093	0.125	0.164	1.29	4.65
	674	C10	0.071	0.129	0.214	0.356	0.812	1.551	0.01	0.32
	675	C10P	0.026	0.062	0.123	0.252	0.551	1.024	0.01	0.34
	684	C10A	0.052	0.093	0.151	0.228	0.382	0.594	0.01	0.3
	688	naphthene	0.048	0.075	0.11	0.402	0.632	0.937	0.03	0.27
**	700	nC10	0.073	0.089	0.107	0.143	0.295	0.528	0.07	0.29
**	705	123TMbenz	0.04	0.063	0.092	0.182	0.232	0.291	0.28	1.15
**	708	1M4iPrbenz	0.03	0.066	0.121	0.22	0.342	0.501	0.01	0.08
	709	C11P	0.051	0.089	0.141	0.349	0.682	1.181	0.02	0.12
**	712	indan	0.04	0.066	0.101	0.157	0.236	0.338	0.15	0.4
	714	sBucyC6	0.087	0.127	0.176	0.467	0.702	1.005	0.01	0.06
	718	1M2iPrbenz	0.046	0.084	0.137	0.48	0.881	1.46	0.02	0.33

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
	723	C11P	0.05	0.078	0.114	0.296	0.607	1.083	0.02	0.19
**	724	13DEbenz	0.046	0.061	0.08	0.111	0.195	0.315	0.07	0.22
**	725	1M3Prbenz	0.035	0.052	0.073	0.085	0.13	0.188	0.18	0.71
**	727	1M4Prbenz	0.048	0.078	0.117	0.167	0.228	0.302	0.1	0.35
**	728	Bubenz	0.072	0.11	0.161	0.158	0.218	0.293	0.04	0.14
**	729	35DM1EBenz	0.035	0.064	0.105	0.091	0.14	0.203	0.18	0.56
**	730	12DEbenz	0.064	0.097	0.14	0.386	0.574	0.814	0.02	0.09
**	740	1M2PrBenz	0.068	0.107	0.158	0.273	0.417	0.604	0.06	0.21
**	746	5MC10	0.071	0.115	0.175	0.308	0.445	0.618	0.02	0.08
**	748	4MC10	0.042	0.069	0.104	0.153	0.321	0.579	0.01	0.68
**	750	2MC10	0.065	0.095	0.133	0.527	0.689	0.882	0.02	0.15
**	756	14DM2Ebenz	0.041	0.061	0.087	0.174	0.263	0.379	0.12	0.42
**	758	13DM4Ebenz	0.045	0.062	0.083	0.185	0.229	0.278	0.12	0.54
**	762	3MC10	0.109	0.157	0.217	0.358	0.545	0.788	0.02	0.17
**	764	12DM4Ebenz+C1indane	0.031	0.053	0.085	0.082	0.125	0.182	0.27	0.75
	768	13DM2Ebenz	0.062	0.096	0.14	0.379	0.689	1.133	0.03	0.35
	780	1M4tBubenz	0.061	0.103	0.161	0.458	0.835	1.377	0.03	0.11
**	785	12DM3Ebenz	0.041	0.073	0.117	0.282	0.453	0.682	0.09	0.2
**	800	nC11	0.087	0.111	0.139	0.312	0.402	0.506	0.04	0.21
**	806	1245tetraMbenz	0.054	0.068	0.086	0.123	0.168	0.222	0.12	0.39
**	810	1235tetraMbenz	0.047	0.077	0.116	0.127	0.199	0.293	0.16	0.56
	824	C11A	0.087	0.113	0.142	0.329	0.556	0.869	0.02	0.07
	826	1E2Prbenz?	0.05	0.075	0.107	0.142	0.252	0.408	0.09	0.44
	828	C11A	0.085	0.118	0.157	0.234	0.351	0.503	0.02	0.1
	830	C11A	0.088	0.123	0.167	0.357	0.499	0.675	0.02	0.1

GC/MS	Peak ID	Component abbreviation	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
	832	C11A	0.097	0.134	0.178	0.229	0.396	0.63	0.02	0.1
**	834	1M3Bubenz	0.056	0.079	0.109	0.111	0.148	0.192	0.08	0.35
**	836	1234tetraMbenz+C11A	0.068	0.093	0.125	0.244	0.365	0.521	0.1	0.28
	840	t1M2(4MC5)cyC5	0.102	0.155	0.223	0.41	0.567	0.758	0.02	0.11
**	844	C11A	0.091	0.135	0.19	0.34	0.547	0.825	0.02	0.07
**	846	C11A	0.096	0.136	0.185	0.656	0.964	1.355	0.02	0.08
	854	1tBu35DMbenz	0.112	0.155	0.207	0.366	0.623	0.977	0.02	0.1
**	858	naphthalene	0.049	0.067	0.089	0.153	0.258	0.403	0.12	0.52
**	862	C11A	0.097	0.144	0.205	0.465	0.665	0.914	0.02	0.16
**	870	16DMINDANE	0.09	0.123	0.163	0.257	0.426	0.658	0.02	0.17
**	875	C11A	0.156	0.194	0.238	0.438	0.684	1.009	0.02	0.09
**	884	2ETHYL INDANE	0.058	0.098	0.154	0.184	0.29	0.429	0.03	0.19
**	888	2ETHYL135TMBZ	0.079	0.128	0.195	0.394	0.599	0.866	0.01	0.07
**	895	nC12	0.134	0.167	0.206	0.534	0.739	0.991	0.02	0.15
**	915	24DMINDANE	0.103	0.163	0.242	0.272	0.4	0.562	0.02	0.05
	925	1tBu4Ebenz	0.077	0.131	0.207	0.602	1.018	1.592	0.04	0.16
**	930	13DM INDANE	0.053	0.103	0.179	0.313	0.43	0.573	0.01	0.18
	940	HEXYLbenz	0.098	0.151	0.219	0.612	0.96	1.418	0.01	0.13
**	942	2Mnaphthalene	0.064	0.089	0.121	0.17	0.216	0.27	0.04	0.64
**	947	1Mnaphthalene	0.075	0.116	0.169	0.25	0.298	0.352	0.02	0.27

Table 3B – Precision information for totalized component types

Component type	rmin	r_prop	rmax	Rmin	R_prop	Rmax	Cmin	Cmax
Total paraffin	0.056	0.065	0.076	0.125	0.186	0.373	1.00	20.00
Total isoparaffin	0.021	0.024	0.028	0.047	0.065	0.102	20.00	65.00
C2Benzene	0.033	0.038	0.045	0.057	0.073	0.102	3.00	20.00
Total oxygenate	0.042	0.049	0.060	0.104	0.141	0.221	3.00	20.00
NOTE The precision information on the total oxygenate was primarily based on MTBE.								
Component type	**rmin**	**r_root**	**rmax**	**Rmin**	**R_root**	**Rmax**	**Cmin**	**Cmax**
Total cycloparaffin	0.073	0.084	0.098	0.286	0.384	0.586	2.00	10.00
Total olefins	0.156	0.179	0.210	0.382	0.555	1.012	2.00	25.00
Component type	**rmin**	**r(wt.%)**	**rmax**	**Rmin**	**R(wt.%)**	**Rmax**	**Cmin**	**Cmax**
Total aromatics	0.855	0.982	1.155	2.151	2.706	3.651	15.00	50.00
NOTE The precision of the total aromatics was not observed to be related to concentration.								

10.3 Precision

The precision information for methanol and ethanol is obtained from a 2015 interlaboratory study comprising ten participants testing nine samples. The data were analyzed for mass % methanol and ethanol in accordance with ASTM D6300 and ASTM E691 respectively. The range of data used to establish equations is:

Methanol: 0.006 – 0.68 mass %

Ethanol: 0.033 – 99.6 mass %

10.3.1 Repeatability

The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on the identical test materials would, in the long run, in the normal and the correct operation of the test method, exceed the following values only in one case in twenty (see Table 4).

Methanol: $r = 0.061 \times \sqrt{C}$

Ethanol: $r = 1.05 * \{[C/100] * [1 - (C/100)]\}^{0.5}$

where:

C = concentration of analyte in mass % (equation F)

10.3.2 Reproducibility

The difference between two single and independent results obtained by different operators working in different laboratories on the identical test materials would, in the long run, in the normal and the correct operation of the test method exceed the following values only in one case in twenty (see Table 4).

Methanol: $R = 0.214 \times \sqrt{C}$

Ethanol: $R = 4.94 * \{[C/100] * [1 - (C/100)]\}^{0.5}$

where:

C = concentration of analyte in mass % (equation F)

Table 4 — Precision values for methanol and ethanol (from equation)

Methanol (mass %)	Repeatability	Reproducibility	Ethanol (mass %)	Repeatability	Reproducibility
0.050	0.014	0.048	1.00	0.10	0.49
0.100	0.019	0.068	5.00	0.23	1.08
0.200	0.027	0.096	10.0	0.3	1.5
0.300	0.033	0.117	50.0	0.5	2.5
0.400	0.039	0.135	85.0	0.4	1.8
0.500	0.043	0.151	95.0	0.2	1.1

Table 5 — Hydrocarbon data table

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
1	Methane	Methane	6.74	0.26	E	16.04	1.000
2	Ethene	C2=	7.1	0.28	E	28.05	0.874
3	Ethane	C2	7.21	0.34	E	30.07	0.937
4	Propene	C3=	7.41	0.514	A	42.08	0.874
5	Propane	C3	7.87	0.505	A	44.1	0.916
6*	Isobutane	iC4	8.26	0.557	A	58.12	0.906
7	Methanol	Methanol	8.64	0.791	B	32.04	3.100
8	Isobutene	iC4=	8.95	0.594	A	56.11	0.874
9	1-Butene	1-C4=	8.99	0.595	A	56.11	0.874
10	1,3-Butadiene	13C4=,=	9.17	0.621	B	54.09	0.843
11*	n-Butane	nC4	9.28	0.579	A	58.12	0.906
12*	trans-2-Butene	t2C4=	9.7	0.604	A	56.11	0.874
13	2,2-Dimethylpropane	22DMC3	9.82	0.591	A	72.15	0.899
14*	cis-2-Butene	c2C4=	10.33	0.621	A	56.11	0.874
16	1,2-Butadiene	12C4=,=	11.88	0.652	A	54.09	0.843
18	Ethanol	Ethanol	11.39	0.789	B	46.07	2.300
20	3-Methyl-1-butene	3M1C4=	12.21	0.632	A	70.13	0.874
22*	Isopentane	iC5	13.57	0.620	A	72.15	0.899
24	1,4-Pentadiene	14C5=,=	14.25	0.667	A	68.12	0.849
25	Dimethylacetylene	DMacetylene	14.57	0.691	B	54.09	0.843
26	1-Pentene	1C5=	15.03	0.64	A	70.13	0.874
27	Isopropanol	iPropanol	15.28	0.785	B	60.11	1.950
28*	2-Methyl-1-butene	2M1C4=	15.76	0.65	A	70.12	0.874
30*	n-Pentane	nC5	16.24	0.626	A	72.15	0.899

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
32	2-Methyl-1,3-butadiene	Isoprene	16.73	0.681	A	68.12	0.849
34*	trans-2-Pentene	t2C5=	17.23	0.648	A	70.13	0.874
36	3,3-Dimethyl-1-butene	33DM1C4=	17.86	0.653	A	84.16	0.874
38*	cis-2-Pentene	c2C5=	18.17	0.656	A	70.13	0.874
39	tert-Butanol	tButanol	18.51	0.789	A	74.12	1.286
40*	2-Methyl-2-butene	2M2C4=	18.76	0.662	A	70.13	0.874
42	trans-1,3-Pentadiene	t13C5=,=	19.12	0.676	A	68.12	0.849
44	3-Methyl-1,2-butadiene	3M12C4=,=	19.48	0.68	B	68.12	0.849
46	Cyclopentadiene	cyC5=,=	19.76	0.802	B	66.09	0.837
48	cis-1,3-Pentadiene	c13C5=,=	20.25	0.691	A	68.12	0.849
50	1,2-Pentadiene	12C5=,=	20.51	0.693	A	68.12	0.849
52*	2,2-Dimethylbutane	22DMC4	20.69	0.649	B	86.18	0.895
54	Cyclopentene	cyC5=	23.16	0.772	A	68.12	0.849
56	4-Methyl-1-pentene	4M1C5=	24.3	0.667	B	84.16	0.874
58	3-Methyl-1-pentene	3M1C5=	24.38	0.668	A	84.16	0.874
60	n-Propanol	nPropanol	24.68	0.803	B	60.11	1.770
62*	Cyclopentane	cyC5	24.86	0.745	A	70.14	0.874
64*	2,3-Dimethylbutane	23DMC4	25.57	0.662	A	86.18	0.895
66	Methyl-tert-butylether	MTBE	25.99	0.741	B	88.15	1.397
68	2,3-Dimethyl-1-butene	23DM1C4=	26.18	0.778	F	84.16	0.874
70	cis-4-Methyl-2-pentene	c4M2C5=	26.48	0.669	E	84.16	0.874
74*	2-Methylpentane	2MC5	26.66	0.653	A	86.18	0.895
76	trans-4-Methyl-2-pentene	t4M2C5=	27.09	0.669	E	84.16	0.874
80*	3-Methylpentane	3MC5	29.15	0.664	A	86.18	0.895

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
82	C6-Olefin	C6=	29.61	0.669	E	84.16	0.874
84	2-Methyl-1-pentene	2M1C5=	30.29	0.682	A	84.16	0.874
86	1-Hexene	1C6=	30.52	0.673	A	84.16	0.874
90	C6-Olefin	C6=	30.94	0.689	E	84.16	0.874
92	2-Butanol	2Butanol	31.56	0.808	B	74.12	1.600
94	2-Ethyl-1-butene	2E1C4=	32.47	0.689	F	84.16	0.874
96*	n-Hexane	nC6	32.75	0.66	B	86.18	0.895
98	cis-3-Hexene	c3C6=	33.41	0.680	A	84.16	0.874
100	Diisopropylether	DIPE	33.58	0.726	A	102.18	1.600
102	trans-3-Hexene + Hexadiene	t3C6=+C6=,=	33.86	0.678	B	84.16	0.874
103	2-Methyl-2-pentene	2M2C5=	34.33	0.686	A	84.16	0.874
104	3-Methylcyclopentene	3McyC5=	34.57	0.762	F	82.14	0.853
105	trans-3-Methyl-2-pentene	t3M2C5=	34.71	0.694	F	84.16	0.874
106	cis-2-Hexene	c2C6=	35.62	0.687	B	84.16	0.874
108	3,3-Dimethyl-1-pentene	33DM1C5=	36.04	0.697	F	84.16	0.874
109	cis-3-Methyl-2-pentene	c3M2C5=	36.92	0.699	A	84.16	0.874
110	Ethyl-tert-butyl ether	ETBE	37.07	0.742	E	102.18	1.400
111	2,3-Dimethyl-1,3-butadiene	23DM13C4=,=	37.19	0.728	F	82.14	0.853
112*	Methylcyclopentane	McyC5	37.4	0.749	A	84.16	0.874
112.1	2,2-Dimethylpentane	22DMC5	37.6	0.674	F	100.21	0.892
113	4,4-Dimethyl-1-pentene	44DM1C5=	37.91	0.683	F	98.19	0.874
114	Isobutanol	iButanol	38.06	0.802	B	74.12	1.500
115	2,3-Dimethyl-2-butene	23DM2C4=	39.3	0.708	A	84.16	0.874
116	Tert Amyl Alcohol	TertC5-OH	38.6	0.8089	A	88.15	1.300

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
117*	2,4-Dimethylpentane	24DMC5	38.99	0.673	A	100.21	0.892
118	1,3,5-Hexatriene	135C6=,=,=	39.31	0.718	E	80.06	0.832
119	2,2,3-Trimethylbutane	223TMC4	39.48	0.69	A	100.21	0.892
120	Methylcyclopentadiene	McyC5=,=	40.17	0.712	F	80.06	0.832
121	C7-Olefin	C7=	40.3	0.705	E	98.19	0.874
122	C7-Olefin	C7=	40.68	0.705	E	98.19	0.874
124	C7-Diolefin	C7=,=	41.2	0.707	E	96.18	0.856
126	4-Methylcyclopentene	4McyC5=	41.44	0.78	A	82.14	0.853
128	Methylenecyclopentane	methylenecyC5	42.08	0.781	E	82.13	0.853
130*	Benzene	Benzene	42.3	0.879	B	78.12	0.812
131	1-Methyl-1-cyclopentene	1McyC5=	42.46	0.78	A	82.14	0.853
132	C7-Olefin	C7=	43.06	0.705	E	98.19	0.874
133	cis-2-Methyl-3-hexene	c2M3C6=	43.37	0.694	A	98.19	0.874
134	3,3-Dimethylpentane + 5-Methyl-1-hexene	33DMC5+5M1C6=	43.81	0.694	B	100.21	0.892
136*	Cyclohexane	cyC6	44.07	0.779	A	84.16	0.874
138	trans-2-Methyl-3-hexene	t2M3C6=	44.82	0.694	A	98.19	0.874
140	3,3-Dimethyl-1,4-pentadiene	33DM14C5=,=	45.44	0.7	E	96.18	0.856
142	n-Butanol	nButanol	45.58	0.81	B	74.12	1.500
144	Dimethylcyclopentadiene	DMcyc5=,=	45.69	0.7	E	94.14	0.838
146	trans-2-Ethyl-3-methyl-1-butene	t2E3m1C4=	45.97	0.714	A	98.19	0.874
148	4-Methyl-1-hexene	4M1C6=	46.27	0.699	F	98.19	0.874
150	C7-Olefin	C7=	46.55	0.702	E	98.19	0.874
152	3-Methyl-1-hexene	3M1C6=	46.78	0.695	F	98.19	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
154	4-Methyl-2-hexene	4M2C6=	46.92	0.698	F	98.19	0.874
156*	2-Methylhexane + C7-Olefin	2MC6+C7=	47.29	0.679	B	100.21	0.892
158	2,3-Dimethylpentane	23DMC5	47.51	0.695	A	100.21	0.892
160	Cyclohexene	cyC6=	47.65	0.811	F	82.14	0.853
161	tert-Amyl-methyl ether	TAME	48.1	0.77	B	102.18	1.154
162	C7-Olefin	C7=	48.46	0.7	E	98.19	0.874
164	C7-Olefin	C7=	48.64	0.7	E	98.19	0.874
166*	3-Methylhexane	3MC6	49.05	0.686	B	100.21	0.892
168	C7-Olefin	C7=	49.47	0.7	E	98.19	0.874
170	C7-Olefin	C7=	49.62	0.7	E	98.19	0.874
172	trans-1,3-Dimethylcyclopentane	t13DMcyC5	49.83	0.745	A	98.19	0.874
174	cis-1,3-Dimethylcyclopentane	c13DMcyC5	50.4	0.749	A	98.19	0.874
176	trans-1,2-Dimethylcyclopentane	t12DMcyC5	51.01	0.751	A	98.19	0.874
180	3-Ethylpentane	3EC5	51.21	0.698	A	100.21	0.892
184	3-Methyl-1-hexene	5M1sC6=	51.43	0.697	F	98.19	0.874
186*	2,2,4-Trimethylpentane	224TMC5	51.61	0.692	A	114.23	0.890
188	1-Heptene	1C7=	52.05	0.697	A	98.19	0.874
189	C7-Olefin	C7=	52.18	0.697	E	98.19	0.874
190	2,4-Dimethyl-1,3-pentadiene	24DM13C5=,=	52.69	0.737	F	96.16	0.874
192	C7-Diolefin	C7=,=	53	0.711	E	96.16	0.856
194	C7-Olefin	C7=	53.36	0.709	E	98.19	0.874
196	C7-Diolefin	C7=,=	53.81	0.708	E	96.16	0.856
197	C7-Diolefin	C7=,=	54.13	0.707	E	96.16	0.856

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
198	C7-Olefin	C7=	54.28	0.706	A	98.19	0.874
200*	n-Heptane	nC7	54.59	0.684	A	100.21	0.892
202	cis-3-Heptene	c3C7=	54.81	0.703	A	98.19	0.874
204	2-Methyl-2-hexene	2M2C6=	55.1	0.708	F	98.19	0.874
206	cis-3-Methyl-3-hexene	c3M3C6=	55.35	0.713	F	98.19	0.874
208	trans-2-Heptene	t2C7=	55.73	0.698	A	98.19	0.874
210	3-Ethyl-2-pentene	3E2C5=	55.88	0.720	A	96.16	0.856
212	1,5-Dimethylcyclopentene	1,5DMcyC5=	56.06	0.78	F	96.16	0.856
213	C7-Olefin	C7=	56.32	0.705	E	112.13	0.874
214	trans-2-Methyl-3-hexene	t2M3C6=	56.58	0.712	F	98.19	0.874
216	C7-Diolefin + C7-Triolefin	C7=,=+C7=,=,=	57.01	0.701	E	96.16	0.856
217	cis-2-Heptene	c2C7=	57.18	0.708	A	112.13	0.874
218	2,3-Dimethyl-2-pentene	23DM2C5=	57.35	0.727	A	98.19	0.874
220	3-Ethylpentene	3EC5=	57.57	0.696	F	98.19	0.874
222*	Methylcyclohexane	McyC6	57.79	0.769	A	98.19	0.874
223	C7-Olefin	C7=	58.28	0.71	E	98.19	0.874
224	1,1,3-Trimethylcyclopentane	113TMCyC5	58.79	0.748	F	112.22	0.874
226	2,2-Dimethylhexane	22DMC6	59.29	0.695	A	114.23	0.890
228	3,3-Dimethyl-1,5-hexadiene	33DM15C6=,=	59.45	0.725	F	110.21	0.859
230	C8-Diolefin	C8=,=	59.79	0.71	E	110.21	0.859
232	C8-Diolefin	C8=,=	60.12	0.71	E	110.21	0.859
234	Ethylcyclopentane	EcyC5	60.6	0.766	A	98.19	0.874
236	3-Methylcyclohexene	3McyC6=	60.99	0.801	F	96.19	0.856
238	Methylcyclohexadiene	McyC6=,=	61.14	0.71	E	94.14	0.838

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
240	2,2,3-Trimethylpentane	223TMC5	61.22	0.716	B	114.23	0.890
245	2,5-Dimethylhexane + C8-Olefin	25DMC6+C8=	61.59	0.694	A	114.23	0.890
250*	2,4-Dimethylhexane	24DMC6	61.98	0.7	A	114.23	0.890
255	C7-Triolefin + C8-Olefin	C7=,=,=+C8=	62.28	0.711	E	96.16	0.856
260	trans,cis-1,2,4-Trimethyl-cyclopentane	tc124TMcyC5	62.68	0.747	A	112.22	0.874
265	3,3-Dimethylhexane + C8-Olefin	3,3DMC6+C8=	63.13	0.71	F	114.23	0.890
270	C7-Triolefin + C8-Olefin	C7=,=,=+C8=	63.39	0.711	E	96.16	0.856
274	C8-Olefins	C8=’s	63.69	0.711	E	112.22	0.874
278	trans,cis-1,2,3-Trimethyl-cyclopentane	tc123TMcyC5	64.27	0.753	A	112.22	0.874
282	C8-Olefins	C8=’s	64.52	0.712	E	112.22	0.874
286	C8-Olefins	C8=’s	64.73	0.712	E	112.22	0.874
290	C8-Olefins	C8=’s	64.82	0.712	E	112.22	0.874
292*	2,3,4-Trimethylpentane	234TMC5	64.94	0.719	A	114.23	0.890
294	C7-Diolefin	C7=,=	65.25	0.712	E	96.16	0.856
300*	Toluene	Toluene	65.5	0.867	B	92.15	0.821
302*	2,3,3-Trimethylpentane	233TMC5	65.76	0.726	A	114.23	0.890
304	C8-Olefin	C8=	65.9	0.713	E	112.22	0.874
306	C8-Diolefin	C8=,=	66.12	0.713	E	110.21	0.859
308	C8-Olefin	C8=	66.48	0.713	E	112.22	0.874
310	C8-Olefin	C8=	66.65	0.713	E	112.22	0.874
312	C8-Olefin	C8=	67.08	0.713	E	112.22	0.874
313	C8-Diolefin + C8-Olefin	C8=,=+C8=	67.3	0.713	E	110.21	0.859

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
314*	2,3-Dimethylhexane	23DMC6	67.47	0.712	A	114.23	0.890
316	2-Methyl-3-ethylpentane?	2M3EC5?	67.71	0.719	A	114.23	0.890
318	1,1,2-Trimethylcyclopentane + C7-Triolefin	112TMcyC5+C7=,=,=	68.04	0.773	F	112.22	0.874
320	C8-Diolefin + C8-Isoparaffin	C8=,=+iC8	68.31	0.713	E	110.21	0.859
322	C8-Olefins	C8='s	68.41	0.713	E	112.22	0.874
324	C8-Olefins	C8='s	68.64	0.713	E	112.22	0.874
326	2-Methylheptane	2MC7	68.86	0.698	B	114.23	0.890
328	4-Methylheptane	4MC7	69.11	0.705	A	114.23	0.890
330	C7-Diolefin + C8-Olefin	C7=+C8=,=	69.41	0.71	E	112.22	0.874
333	C8-Olefins	C8='s	69.7	0.714	E	112.22	0.874
334	cis-1,3-Dimethylcyclohexane	c13DMcyC6	69.91	0.766	F	112.22	0.874
335	trans-1,4-Dimethylcyclohexane	t14DMcyC6	70.01	0.783	A	112.22	0.874
336*	3-Methylheptane	3MC7	70.23	0.706	A	114.23	0.890
338	3-Ethylhexane	3EC6	70.38	0.714	A	114.23	0.890
340	C8-Diolefin	C8=,=	70.51	0.714	E	110.21	0.874
342	C8-Olefins	C8='s	70.72	0.714	E	112.22	0.874
344	C8-Olefin	C8=	70.92	0.714	E	112.22	0.874
346	1,1-Dimethylcyclohexane	11DMcyC6	71.18	0.781	A	112.22	0.874
348	C8-Olefin	C8=	71.43	0.714	E	112.22	0.874
350	C8-Olefin	C8=	71.7	0.714	E	112.22	0.874
352	cis-1-Ethyl-3-methylcyclopentane	c1E3McyC5	72.1	0.772	F	112.22	0.874
354	2,2,5-Trimethylhexane	225TMC6	72.23	0.707	F	128.26	0.888
356	trans-1-Ethyl-3-methyl-cyclopentane	t1E3McyC5	72.46	0.762	F	112.22	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
360	trans-1-Ethyl-2-methylcyclopentane	t1E2McyC5	72.68	0.769	F	112.22	0.874
362	1-Methyl-1-ethylcyclopentane	1M1EcyC5	72.96	0.781	F	112.22	0.874
364	1-Octene	1C8=	73.16	0.715	A	112.22	0.874
366	C8-Olefin	C8=	73.26	0.715	E	112.22	0.874
368	trans-1,2-Dimethylcyclohexane	t12DMcyC6	73.36	0.776	A	112.22	0.874
370	C8-Olefins	C8=’s	73.48	0.716	E	112.22	0.874
372	C8-Olefins	C8=’s	73.68	0.716	E	112.22	0.874
374	trans-3-Octene	t3C8=	74.08	0.715	F	112.22	0.874
380	C8-Olefins	C8=’s	74.45	0.717	E	112.22	0.874
385	trans-1,3-Dimethylcyclohexane	t13DMcyC6	74.66	0.784	F	112.22	0.874
390	cis-1,4-Dimethylcyclohexane	c14DMcyC6	74.79	0.783	F	112.22	0.874
400	n-Octane	nC8	74.98	0.703	A	114.22	0.890
402	C8-Olefin	C8=	75.33	0.72	E	112.22	0.874
404	C8-Olefin	C8=	75.49	0.72	E	112.22	0.874
406	trans-2-Octene	t2C8=	75.62	0.72	A	112.22	0.874
408	Isopropylcyclopentane	iPrcyC5	75.72	0.776	A	112.22	0.874
410	C9-Olefin	C9=	75.85	0.721	E	126.24	0.874
412	C9-Olefin	C9=	75.89	0.721	E	126.24	0.874
414	C9-Olefin?	C9=?	75.9	0.722	E	126.24	0.874
416	C9-Olefin?	C9=?	76.08	0.722	E	126.24	0.874
418	2,2,4-Trimethylhexane	224TMC6	76.36	0.716	A	128.26	0.888
420	2,4,4-Trimethylhexane	244TMC6	76.62	0.724	A	128.26	0.888
422	C9-Olefins	C9=’s	76.86	0.723	E	126.24	0.874
424	2,3,5-Trimethylhexane	235TMC6	77.29	0.722	A	128.26	0.888

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
426	cis-2-Octene	c2C8=	77.53	0.724	A	112.22	0.874
428	2,2,3,4-Tetramethylpentane	2234tetraMC5	77.77	0.739	A	128.26	0.888
430	2,2-Dimethylheptane	22DMC7	78.02	0.711	A	128.26	0.888
432	cis-1,2-Dimethylcyclohexane	c12DMcyC6	78.36	0.796	A	112.22	0.874
434	2,4-Dimethylheptane	24DMC7	78.74	0.714	B	128.26	0.888
436	C9-Olefin	C9=	78.9	0.725	E	126.24	0.874
438	C9-Olefin	C9=	79.08	0.725	E	126.24	0.874
440	Ethylcyclohexane	EcyC6	79.24	0.788	A	112.22	0.874
442	Propylcyclopentane	PrcyC5	79.39	0.776	A	112.22	0.874
444	2-Methyl-4-Ethylhexane	2M4EC6	79.59	0.728	F	128.26	0.888
446	2,6-Dimethylheptane	26DMC7	79.74	0.72	E	128.26	0.888
449	C9-Olefin	C9=	79.85	0.725	E	126.24	0.874
450	1,1,4-Trimethylcyclohexane	114TMcyC6	80.05	0.772	F	126.24	0.874
452	C9-Olefins	C9=’s	80.28	0.726	E	126.24	0.874
454	C9-Olefins	C9=’s	80.38	0.726	E	126.24	0.874
456	1,1,3-Trimethylcyclohexane	113TMcyC6	80.52	0.779	F	126.24	0.874
458	2,5 & 3,5-Dimethylheptane	25&35DMC7	80.69	0.72	B	128.26	0.888
460	C9-Olefins	C9=’s	80.88	0.726	E	126.24	0.874
462	3,3-Dimethylheptane	33DMC7	81	0.725	B	128.26	0.888
466	C9-Isoparaffin	C9-iP	81.13	0.72	E	128.26	0.888
468	C9-Olefins	C9=’s	81.34	0.727	E	126.24	0.874
470	2,3,3-Trimethylhexane	233TMC6	81.56	0.738	A	128.26	0.888
472	C9-Olefins	C9=’s	81.68	0.727	E	126.24	0.874
475*	Ethylbenzene	EBenzene	81.96	0.867	B	106.18	0.827

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
480	trans-1,2,4-Trimethylcyclohexane	t124TMcyC6	82.31	0.781	A	126.24	0.874
482	C9-Olefins	C9=’s	82.33	0.728	E	126.24	0.874
485	2,3,4-Trimethylhexane	234TMC6	82.63	0.739	A	128.26	0.888
490	C9-Olefins	C9=’s	82.73	0.728	E	126.24	0.874
495	3,3,4-Trimethylhexane?	334TMC6?	82.89	0.745	A	128.26	0.888
500*	m-Xylene	m-Xylene	83.3	0.864	B	106.17	0.827
502*	p-Xylene	p-Xylene	83.43	0.861	B	106.17	0.827
503	2,3-Dimethylheptane	23DMC7	83.57	0.726	B	128.26	0.888
504	3,5-Dimethylheptane	35DMC7	83.83	0.723	F	128.26	0.888
506	3,4-Dimethylheptane	34DMC7	83.91	0.731	A	128.26	0.888
508	C9-Olefin	C9=	84.08	0.729	E	126.24	0.874
510	3-Methyl-3-ethylhexane	3M3EC6	84.26	0.741	A	128.26	0.888
514	C9-Olefin	C9=	84.41	0.73	E	126.24	0.874
516	4-Ethylheptane	4EC7	84.52	0.73	F	128.26	0.888
518	4-Methyloctane + C9-Olefin	4MC8+C9=	84.7	0.72	A	128.26	0.888
520	2-Methyloctane	2MC8	84.84	0.711	B	128.26	0.888
522	C9-Olefin	C9=	85.01	0.73	E	126.24	0.874
524	C9-Isoparaffin	C9-iP	85.18	0.721	E	128.26	0.888
526	C9-Olefin	C9=	85.36	0.73	E	126.24	0.874
528	3-Ethylheptane	3EC7	85.51	0.728	F	128.26	0.888
530	3-Methyloctane	3MC8	85.69	0.722	A	128.26	0.888
535	C9-Isoparaffin	C9-iP	85.87	0.721	E	128.26	0.888
540	cis-1,2,4-Trimethylcyclohexane	c124TMcyC6	85.91	0.786	A	126.24	0.874
545	1,1,2-Trimethylcyclohexane	112TMcyC6	86.05	0.764	F	126.24	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
550*	o-Xylene	O-Xylene	86.27	0.88	B	106.17	0.827
560	C9-Olefin	C9=	86.47	0.733	E	126.24	0.874
562	C9-Olefin	C9=	86.57	0.733	E	126.24	0.874
564	C9-Olefin	C9=	86.75	0.733	E	126.24	0.874
566	C9-Isoparaffin	C9-iP	86.9	0.725	E	128.26	0.888
568	trans-1-Ethyl-4-methyl-cyclohexane?	t1E4McyC6?	87.07	0.797	A	126.24	0.874
570	cis-1-Ethyl-4-methyl-cyclohexane?	c1E4McyC6?	87.23	0.797	A	126.24	0.874
572	C9-Isoparaffin	C9-iP	87.49	0.725	E	128.2	0.888
575	1-Nonene	1C9=	87.79	0.729	F	126.24	0.874
580	Isobutylcyclopentane	iBucyC5	88	0.782	F	126.24	0.874
582	C9-Isoparaffin	C9-iP	88.45	0.725	E	128.26	0.888
586	trans-3-Nonene	t3C9=	88.65	0.729	A	126.24	0.874
590	cis-3-Nonene	c3C9=	88.82	0.729	A	126.24	0.874
595	C9-Isoparaffin	C9-iP	89.09	0.725	E	128.26	0.888
600	n-Nonane	nC9	89.24	0.718	A	128.26	0.888
602	C10-Olefin	C10=	89.41	0.736	E	140.27	0.874
604	trans-2-Nonene	t2C9=	89.74	0.738	A	126.24	0.874
606	1-Methyl-1-ethylcyclohexane	1M1EcyC6	89.61	0.806	F	126.24	0.874
608	1-Methyl-2-propylcyclopentane	1M2PrcyC5	89.96	0.792	B	126.24	0.874
610	C10-Olefin	C10=	90.09	0.738	E	140.27	0.874
612	C10-Isoparaffin	C10-iP	90.18	0.725	E	142.28	0.887
614	C10-Isoparaffin	C10-iP	90.29	0.725	E	142.28	0.887
616	Isopropylbenzene	iPrbenz	90.46	0.862	B	120.2	0.833

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
618	cis-2-Nonene	c2C9=	90.78	0.738	A	126.24	0.874
620	tert-Butylcyclopentane	tertBucyC5	90.8	0.791	F	126.24	0.874
622	C9-Olefins	C9=’s	90.88	0.738	E	126.24	0.874
624	C9-Olefin	C9=	91.16	0.738	E	126.24	0.874
626	Isopropylcyclohexane	iPrcyC6	91.32	0.802	A	126.24	0.874
628	3,3,5-Trimethylheptane	335TMC7	91.44	0.743	A	142.28	0.887
630	2,2-Dimethyloctane	22DMC8	91.6	0.725	A	142.28	0.887
632	2,4-Dimethyloctane	24DMC8	91.67	0.726	A	142.28	0.887
634	1-Methyl-4-isopropylcyclohexane?	1M4iPrcyC6?	91.82	0.793	A	140.27	0.874
636	sec-Butylcyclopentane	sBucyC5	92.2	0.795	F	126.24	0.874
638	2,6-Dimethyloctane	26DMC8	92.4	0.729	A	142.28	0.887
640	2,5-Dimethyloctane?	25DMC8?	92.59	0.736	A	142.28	0.887
642	Butylcyclopentane	BucyC5	92.89	0.785	A	126.24	0.874
644	Propylcylohexane	PrcyC6	93.04	0.794	A	126.24	0.874
646	3,6-Dimethyloctane	36DMC8	93.43	0.736	A	142.28	0.887
648	1-Methyl-2-ethylcyclohexane	1M2EcyC6	93.59	0.81	F	126.24	0.874
650	C10-Olefin	C10=	93.79	0.74	E	140.27	0.874
651	Propylbenzene	nPrbenz	93.96	0.862	B	120.2	0.833
652	3,3-Dimethyloctane	33DMC8	94.27	0.739	A	142.28	0.887
653	3-Methyl-5-ethylheptane	3M5EC7	94.54	0.737	A	142.28	0.887
654	C10-Olefin	C10=	94.66	0.74	E	140.27	0.874
655*	1-Ethyl-3-methylbenzene	1E3Mbenz	94.88	0.865	A	120.2	0.833
656*	1-Ethyl-4-methylbenzene	1E4Mbenz	95.09	0.861	A	120.2	0.833
657	C10-Naphthene	naphthene	95.3	0.79	E	126.24	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
658*	1,3,5-Trimethylbenzene	135TMbenz	95.73	0.865	A	120.2	0.833
659	2,3-Dimethyloctane	23DMC8	95.94	0.738	A	142.28	0.887
660	5-Methylnonane	5MC9	96.13	0.733	A	142.28	0.887
661	4-Methylnonane	4MC9	96.29	0.732	F	142.28	0.887
662	2-Methylnonane	2MC9	96.49	0.728	A	142.28	0.887
663*	1-Ethyl-2-methylbenzene	1E2Mbenz	96.77	0.881	A	120.2	0.833
664	3-Ethyloctane	3EC8	97.01	0.74	A	142.28	0.887
666	C10-Naphthene	naphthene	97.14	0.79	E	140.27	0.874
668	3-Methylnonane	3MC9	97.47	0.733	A	142.28	0.887
670	C10-Olefin	C10=	97.69	0.741	E	140.27	0.874
671	C10-Isoparaffin	C10-iP	97.83	0.733	E	142.28	0.887
672	C10-Isoparaffin	C10-iP	98.16	0.734	E	142.28	0.887
673*	1,2,4-Trimethylbenzene	124TMbenz	98.49	0.876	A	120.2	0.833
674	C10-Isoparaffin	C10-iP	98.74	0.734	E	142.28	0.887
675	C10-Isoparaffin	C10-iP	98.9	0.734	E	142.28	0.887
676	Isobutylcyclohexane	iBucyC6	99.1	0.795	B	140.27	0.874
677	C10-Isoparaffin	C10-iP	99.02	0.734	E	142.28	0.887
678	C10-Isoparaffin	C10-iP	99.22	0.734	E	142.28	0.887
679	1-Decene	1C10=	99.52	0.741	A	140.27	0.874
680	C10-Isoparaffin	C10-iP	99.66	0.735	E	142.28	0.887
682	C10-Isoparaffin	C10-iP	99.7	0.735	E	142.28	0.887
684	C10-Aromatic	C10A	99.75	0.85	E	134.22	0.837
686	C10-Isoparaffin	C10-iP	99.82	0.735	E	142.28	0.887
688	C10-Naphthene	naphthene	99.93	0.91	E	140.27	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
690	Isobutylbenzene	iBubenz	100.06	0.853	A	134.22	0.837
692	trans-1-Methyl-2-propyl-cyclohexane?	t1M2PrcyC6?	100.09	0.813	A	140.27	0.874
694	C10-Isoparaffin	C10-iP	100.19	0.737	E	142.28	0.887
696	sec-Butylbenzene	sBubenz	100.28	0.862	A	134.22	0.837
700	n-Decane	nC10	100.4	0.73	A	142.28	0.887
702	C11-Isoparaffin	C11-iP	100.67	0.738	E	156.32	0.886
704	C11-Isoparaffin	C11-iP	100.85	0.738	E	156.32	0.886
705	1,2,3-Trimethylbenzene	123TMbenz	101.28	0.894	A	120.09	0.833
706	1-Methyl-3-isopropylbenzene	1M3iPrbenz	101.4	0.861	A	134.22	0.837
707	C11-Isoparaffin	C11-iP	101.55	0.738	E	156.32	0.886
708	1-Methyl-4-isopropylbenzene	1M4iPrbenz	101.73	0.854	A	134.22	0.837
709	C11-Isoparaffin	C11-iP	102.06	0.739	E	156.32	0.886
710	C11-Isoparaffin?	C11-iP?	102.05	0.739	E	156.32	0.886
712	2,3-Dihydroindene	indan	102.42	0.965	A	118.17	0.819
714	sec-Butylcyclohexane	sBucyC6	102.57	0.818	F	140.16	0.874
716	C11-Isoparaffin	C11-iP	102.87	0.739	E	156.32	0.886
718	1-Methyl-2-isopropylbenzene	1M2iPrbenz	103.03	0.877	A	134.22	0.837
720	3-Ethylnonane	3EC9	103.26	0.748	F	156.32	0.886
721	C11-Isoparaffin	C11-iP	103.37	0.74	E	156.32	0.886
722	C10-Naphthene	naphthene	103.55	0.813	E	140.27	0.874
723	C11-Isoparaffin	C11-iP	103.88	0.74	E	156.32	0.886
724	1,3-Diethylbenzene	13DEbenz	104.08	0.864	A	134.22	0.837
725	1-Methyl-3-propylbenzene	1M3Prbenz	104.35	0.861	A	134.22	0.837
726	1,4-Diethylbenzene	14DEbenz	104.57	0.862	A	134.22	0.837

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
727	1-Methyl-4-propylbenzene	1M4Prbenz	104.73	0.858	A	134.22	0.837
728	Butylbenzene	Bubenz	104.85	0.86	A	134.22	0.837
729	3,5-Dimethyl-1-ethylbenzene	35DM1EBenz	105	0.865	A	134.22	0.837
730	1,2-Diethylbenzene?	12DEbenz?	105.26	0.88	A	134.22	0.837
732	C11-Isoparaffin	C11-iP	105.39	0.74	E	156.32	0.886
734	C10-Aromatic	C10A	105.49	0.87	E	134.22	0.837
736	C10-Aromatic	C10A	105.64	0.87	E	134.22	0.837
738	C10-Aromatic	C10A	105.75	0.87	E	134.22	0.837
740	1-Methyl-2-propylbenzene	1M2PrBenz	105.85	0.874	A	134.22	0.837
744	C10-Aromatic	C10A	105.95	0.87	E	134.22	0.837
746	5-Methyldecane	5MC10	106.11	0.742	F	156.32	0.886
748	4-Methyldecane	4MC10	106.26	0.74	F	156.32	0.886
750	2-Methyldecane	2MC10	106.39	0.736	F	156.32	0.886
754	C11-Isoparaffin	C11-iP	106.55	0.74	E	156.32	0.886
756	1,4-Dimethyl-2-ethylbenzene	14DM2Ebenz	106.76	0.877	A	134.22	0.837
758	1,3-Dimethyl-4-ethylbenzene	13DM4Ebenz	106.93	0.876	A	134.22	0.837
760	C11-Isoparaffin	C11-iP	107.06	0.74	E	156.32	0.886
762	3-Methyldecane	3MC10	107.27	0.743	F	156.32	0.886
764	1,2-Dimethyl-4-ethylbenzene + C1-Indan	12DM4Ebenz+ C1indan	107.46	0.875	A	134.22	0.837
766	C11-Isoparaffin	C11-iP	107.76	0.74	E	156.32	0.886
768	1,3-Dimethyl-2-ethylbenzene	13DM2Ebenz	108.01	0.89	A	134.22	0.837
770	C11-Isoparaffin	C11-iP	108.58	0.74	E	156.32	0.886
775	C11-Isoparaffin	C11-iP	108.75	0.74	E	156.32	0.886
780	1-Methyl-4-tert-butylbenzene	1M4tBubenz	108.98	0.861	A	148.25	0.840

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
781	1-Undecene	1C11=	109.08	0.750	A	154.29	0.874
785	1,2-Dimethyl-3-ethylbenzene	12DM3Ebenz	109.17	0.892	A	134.11	0.837
790	1-Ethyl-2-isopropylbenzene	1E2iPrbenz	109.5	0.888	A	148.25	0.840
800	n-Undecane	nC11	109.62	0.74	A	156.32	0.886
802	1-Ethyl-4-isopropylbenzene	1E4iPrbenz	109.8	0.859	A	148.25	0.840
804	C12-Isoparaffin	C12-iP	109.96	0.75	E	170.2	0.885
806	1,2,4,5-Tetramethylbenzene	1245tetraMbenz	110.15	0.888	F	134.22	0.837
808	2-Methylbutylbenzene	2MBubenz	110.27	0.872	A	148.25	0.840
810	1,2,3,5-Tetramethylbenzene	1235tetraMbenz	110.43	0.89	B	134.22	0.837
812	C11-Aromatic	C11A	110.55	0.88	E	148.25	0.840
814	C12-Isoparaffin	C12-iP	110.64	0.75	E	170.2	0.885
816	C11-Aromatic	C11A	110.88	0.882	E	148.25	0.840
818	C11-Aromatic	C11A	111.05	0.885	E	148.25	0.840
820	C11-Aromatic	C11A	111.12	0.887	E	148.25	0.840
822	1-tert-Butyl-2-methylbenzene	1tBu2Mbenz	111.56	0.89	A	148.25	0.840
824	C11-Aromatic	C11A	111.65	0.881	E	148.25	0.840
826	1-Ethyl-2-propylbenzene	1E2Prbenz	111.76	0.874	A	148.25	0.840
828	C11-Aromatic	C11A	112	0.88	E	148.25	0.840
830	C11-Aromatic	C11A	112.22	0.88	E	148.25	0.840
832	C11-Aromatic	C11A	112.34	0.88	E	148.25	0.840
834	1-Methyl-3-butylbenzene	1M3Bubenz	112.52	0.859	A	148.25	0.840
836	1,2,3,4-Tetramethylbenzene + C11-Aromatic	1234tetraMbenz+ C11A	112.79	0.905	F	134.22	0.840
838	Pentylbenzene	C5benz	113.17	0.859	A	148.25	0.840
840	trans-1-Methyl-2-(4-methylpentyl)-cyclopentane	t1M2(4MC5)cyC5	113.44	0.82	E	168.33	0.874

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
842	C11-Aromatic	C11A	113.74	0.88	E	148.25	0.840
844	C11-Aromatic	C11A	113.85	0.88	E	148.25	0.840
846	C11-Aromatic	C11A	114.02	0.88	E	148.25	0.840
848	C12-Isoparaffin	C12-iP	114.12	0.75	E	170.34	0.885
850	1,2,3,4-Tetrahydronaphthalene	Tetralin	115.17	0.97	A	132.21	0.824
854	1-tert-Butyl-3,5-dimethylbenzene	1tBu35DMbenz	114.32	0.865	A	162.3	0.843
858	Naphthalene	naphthalene	114.65	1.025	B	128.19	0.799
862	C12-Isoparaffin?	C12-iP?	114.94	0.75	E	170.34	0.885
865	C11-Aromatic	C11A	115.19	0.88	E	148.25	0.840
870	C11-Aromatic	C11A	115.33	0.88	E	148.25	0.840
875	C12-Isoparaffin	C12-iP	115.55	0.75	E	170.34	0.885
880	C12-Isoparaffin	C12-iP	115.65	0.75	E	170.34	0.885
884	C11-Aromatic	C11A	115.88	0.88	E	148.25	0.840
885	1-Dodecene	1C12=	115.94	0.758	A	168.32	0.874
888	C12-Isoparaffin	C12-iP	116	0.753	E	170.34	0.885
890	1,3-Dipropylbenzene	13DiPrbenz	116.21	0.914	F	162.34	0.843
895	n-Dodecane	nC12	116.55	0.749	A	170.34	0.885
898	C12-Isoparaffin?	C12-iP?	116.69	0.75	E	170.34	0.885
900	C11-Aromatic?	C11A?	117.07	0.88	E	148.13	0.840
905	C11-Aromatic	C11A	117.19	0.88	E	148.25	0.840
910	1,3,5-Triethylbenzene	135TEbenz	117.55	0.863	E	162.3	0.843
915	C11-Aromatic?	C11A?	117.99	0.88	E	148.25	0.840
920	C11-Aromatic	C11A	118.13	0.88	E	148.25	0.840
925	1-tert-Butyl-4-ethylbenzene	1tBu4Ebenz	118.59	0.864	E	162.3	0.843

Peak ID	Component name	Abbreviation	Retention time	Relative density	Note[a]	Molecular mass	Theoretical mass (RRF) C1
930	1,2,4-Triethylbenzene	124TEbenz	119.07	0.882	F	162.3	0.843
935	1-Methyl-4-pentylbenzene	1M4C5benz	119.6	0.857	F	162.3	0.843
940	Hexylbenzene	C6benz	119.87	0.858	A	162.3	0.843
941	1-Tridecene	1C13=	120.02	0.766	A	182.35	0.874
942	2-Methylnaphthalene	2Mnaphthalene	121.42	1	B	142.2	0.806
945	n-Tridecane	nC13	122.06	0.756	A	184.37	0.884
947	1-Methylnaphthalene	1Mnaphthalene	122.28	1.02	B	142.2	0.806
950	trans-7-Decene	t7C10=	126.34	0.773	F	140.2	0.874
955	2,6-Dimethylnaphthalene	26DMnaphthalene	126.84	1.003	E	156.3	0.812
956	1-Tetradecene	1C14=	126.21	0.771	A	196.37	0.874
960	2,7-Dimethylnaphthalene	27DMnaphthalene	126.97	1.003	E	156.3	0.812
965	n-Tetradecane	nC14	127.1	0.763	A	198.34	0.883
966	1,3-Dimethylnaphthalene	13DMnaphthalene	127.52	1.006	F	156.3	0.812
968	1,6-Dimethylnaphthalene	16DMnaphthalene	127.69	1.003	F	156.3	0.812
970	1,5-Dimethylnaphthalene	15DMnaphthalene	128.31	1.003	E	156.3	0.812
972	1,4-Dimethylnaphthalene	14DMnaphthalene	128.44	1.017	F	156.3	0.812
974	Acenaphthalene	acenaphthalene	129.05	1.005	E	156.3	0.801
976	1,2-Dimethylnaphthalene	12DMnaphthalene	129.92	1.012	F	156.3	0.812
980	n-Pentadecane	nC15	131.1	0.768	F	212.34	0.883

NOTE 1 The identification of components which have a question mark appended to the name have not been verified.
NOTE 2 In some instances, the chemical group is known, but the chemical structure is not known (e.g. C6-Olefin; the position of the double bond is not known).

[a] Notes A, B, E and F (column 6) are defined below:

A Density obtained from CRC Handbook of Tables for Organic Component Identification, 3rd Edition.
B Density obtained from Handbook of Chemistry and Physics, 51st Edition.
E Density estimated.
F Density obtained from Handbook of Hydrocarbons by S. W. Farris, Chief, Industrial Products Section, Research and Development Production Department, Sun Oil Company, Marcus Hook PA, 1st edition, 1955.

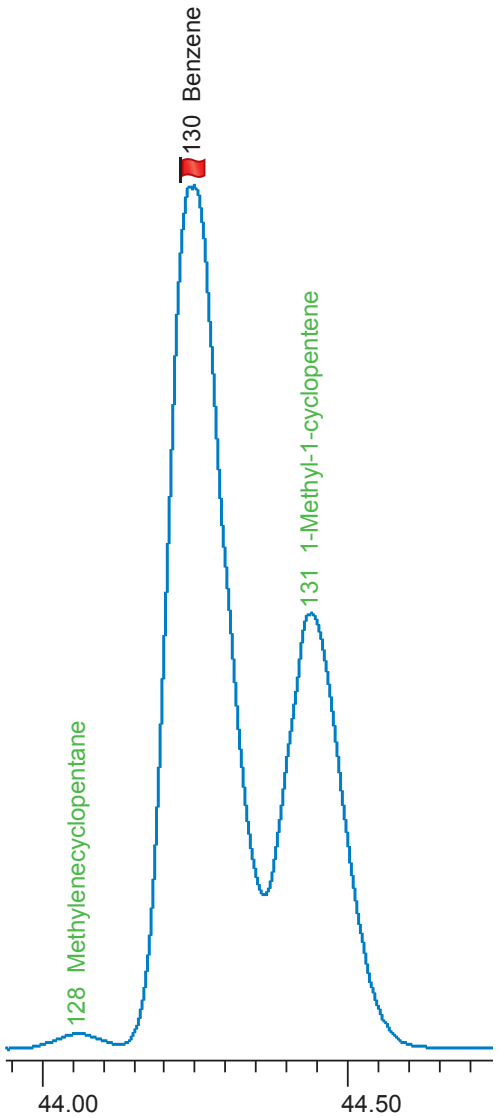

Figure 1 — Benzene/1-Methylcyclopentene

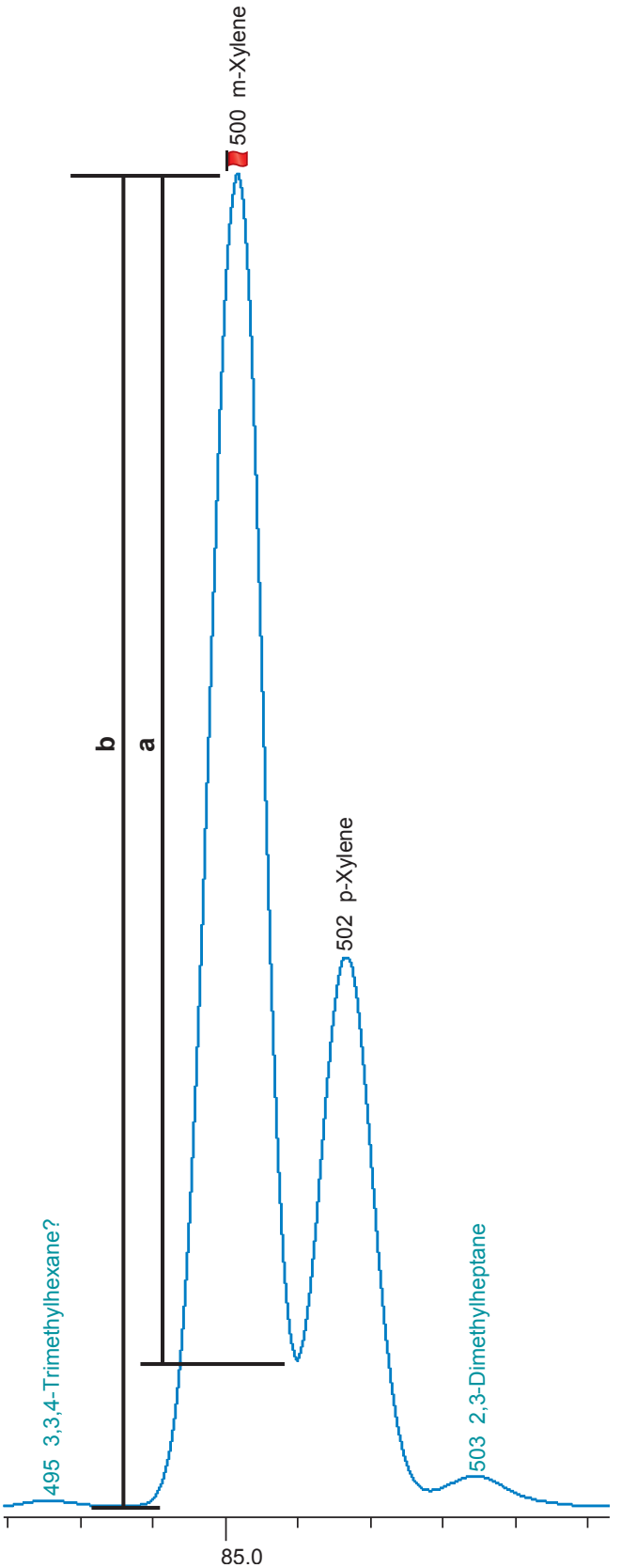

Figure 2 — m-Xylene-p-Xylene

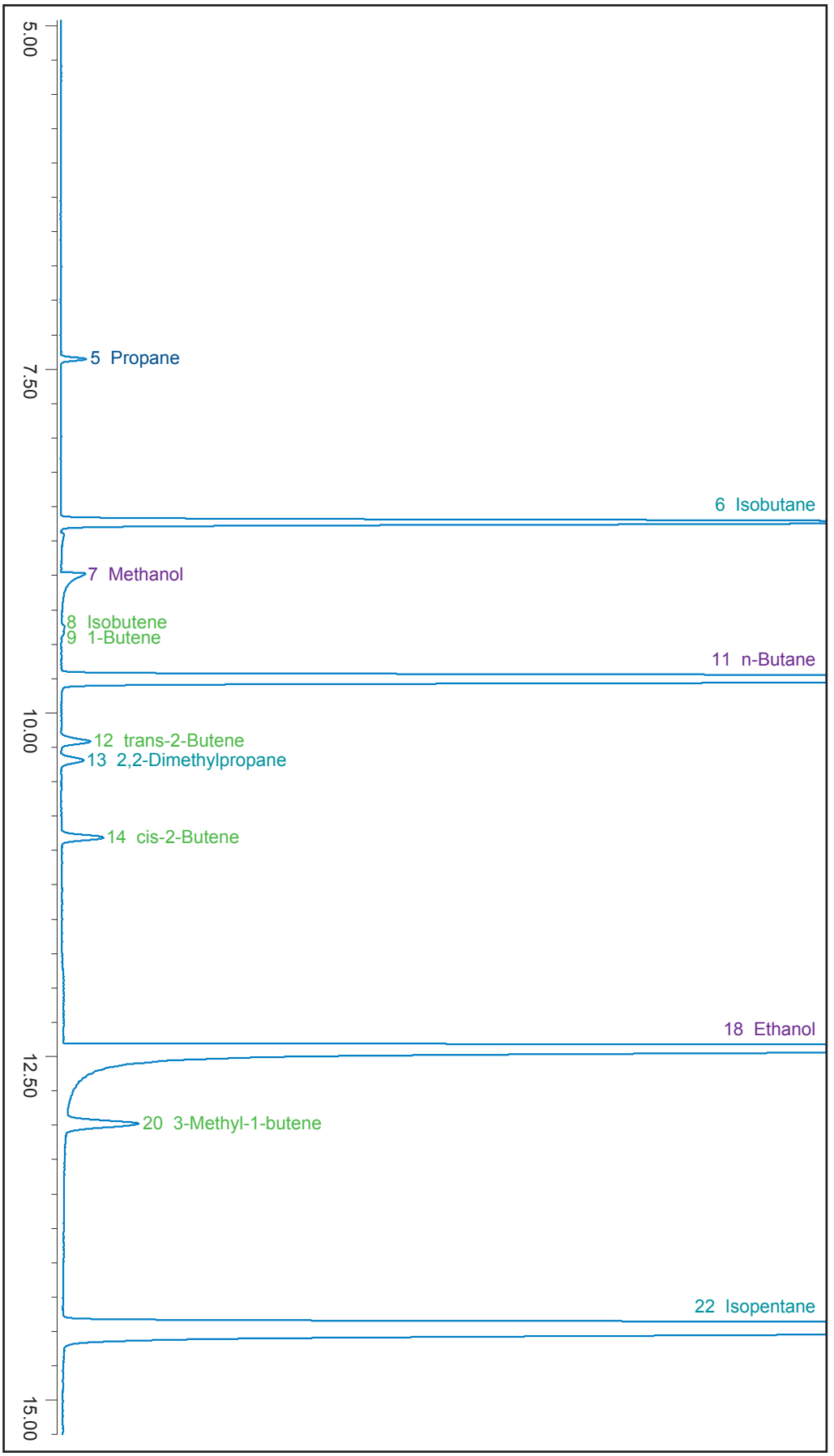

Figure 3 — Detailed chromatogram of reference gasoline

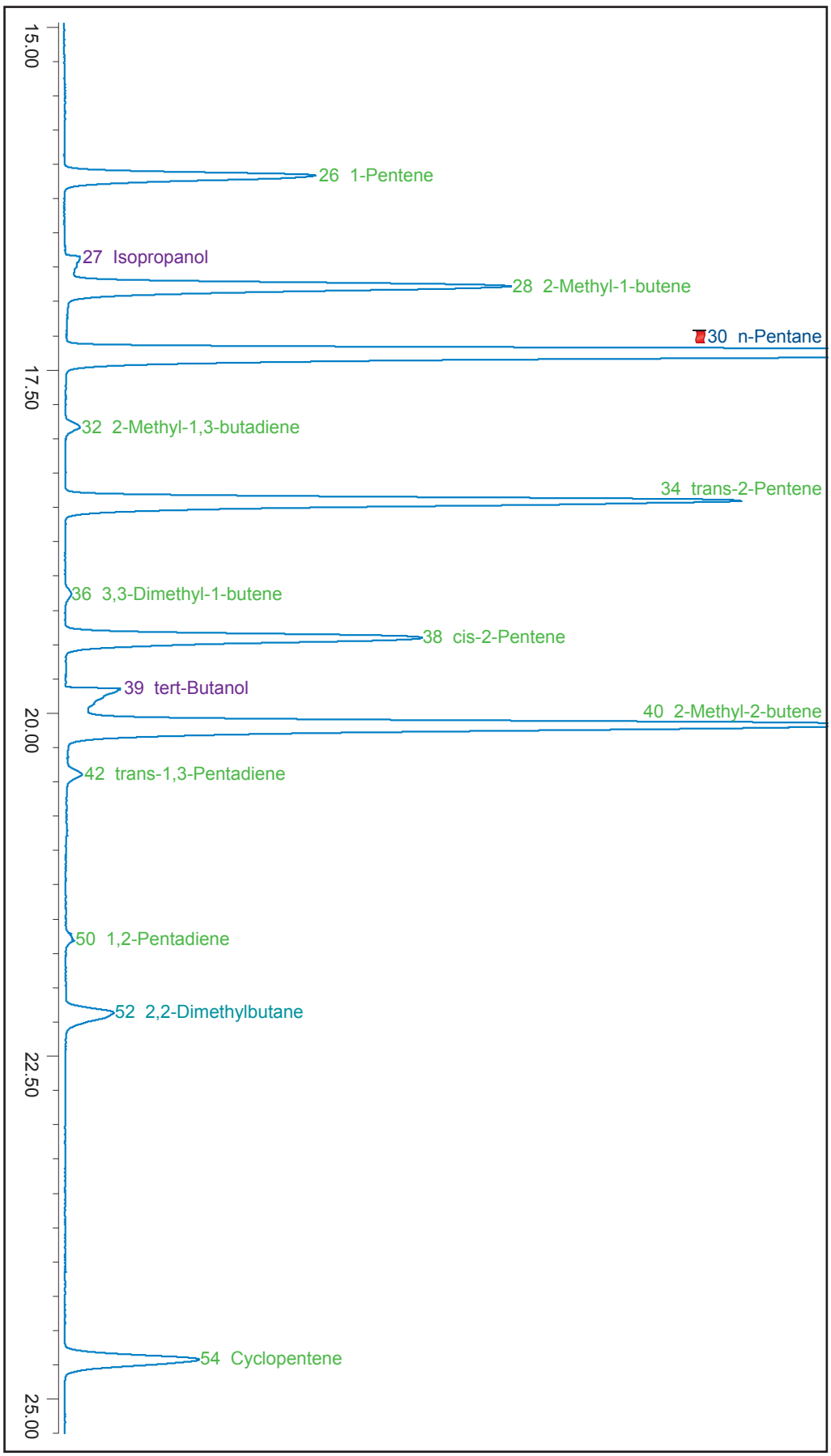

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

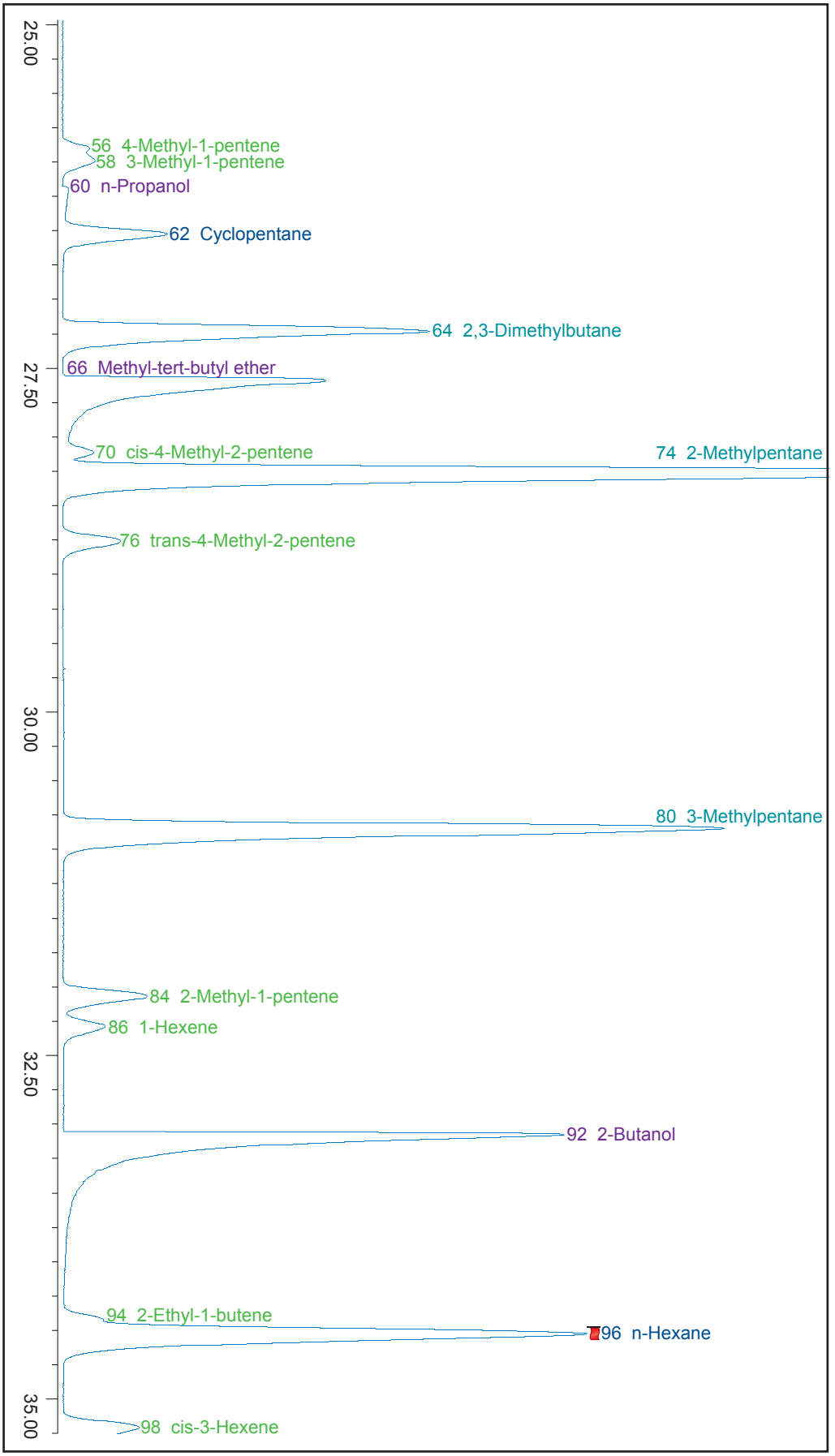

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

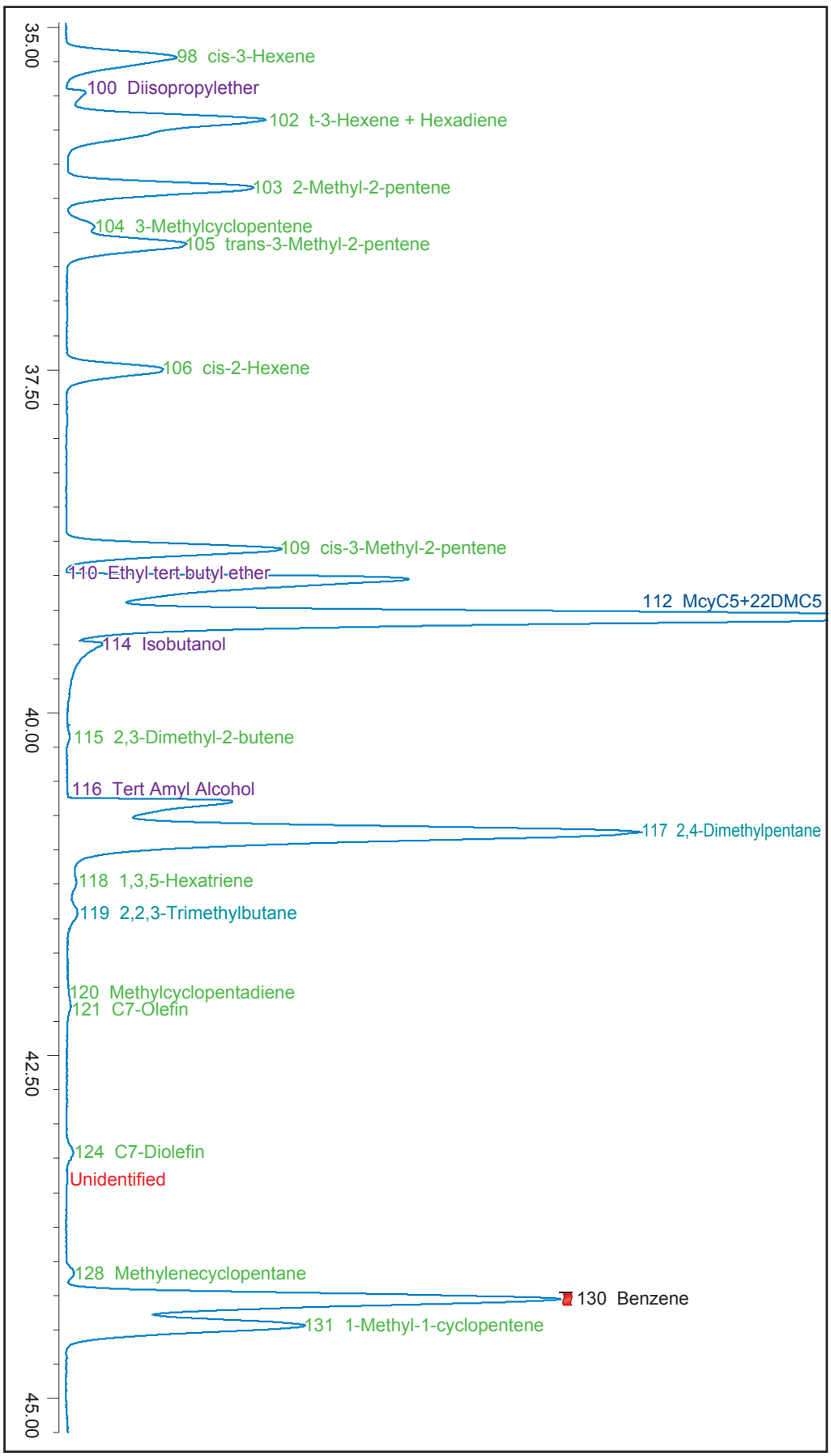

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

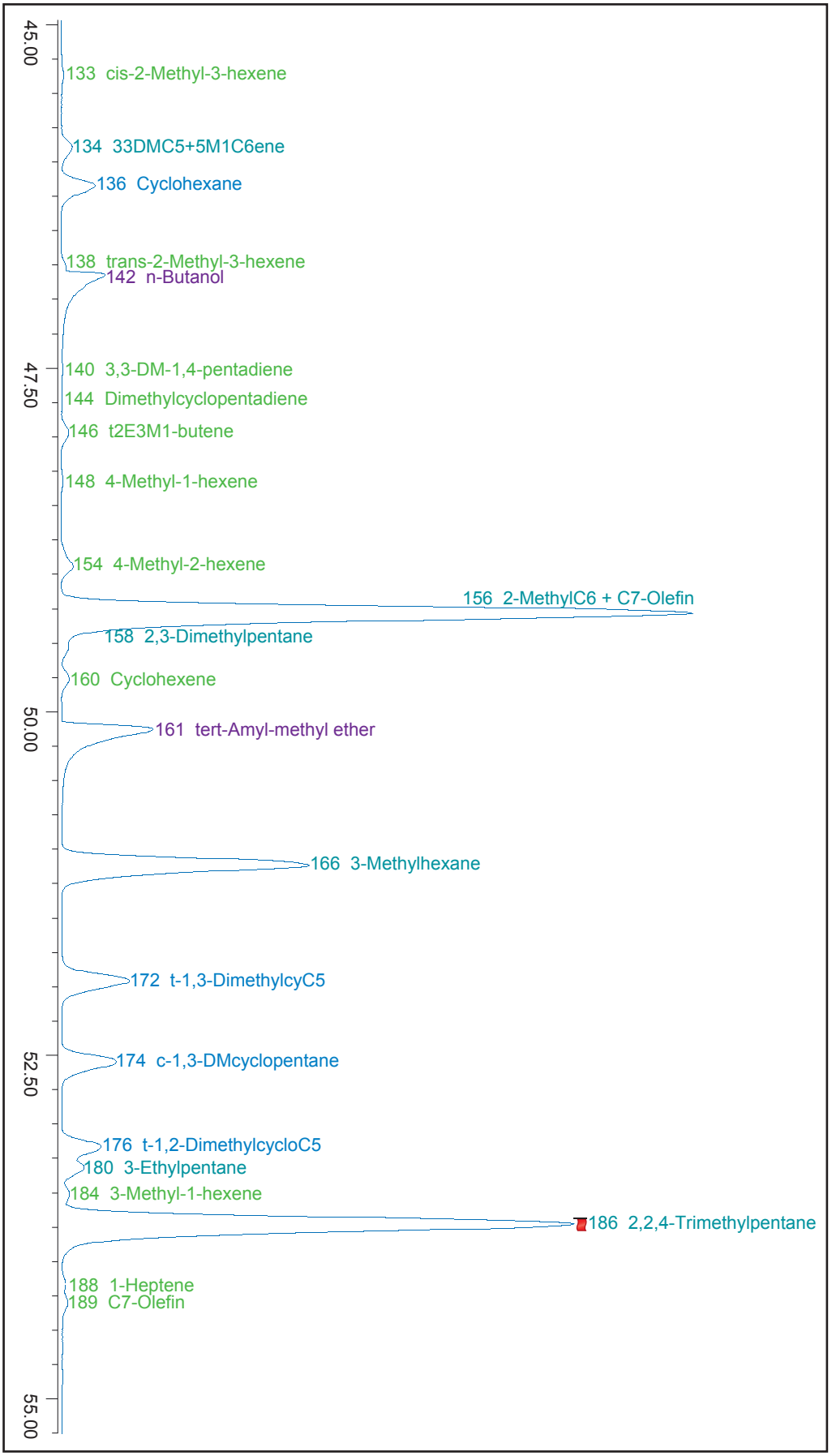

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

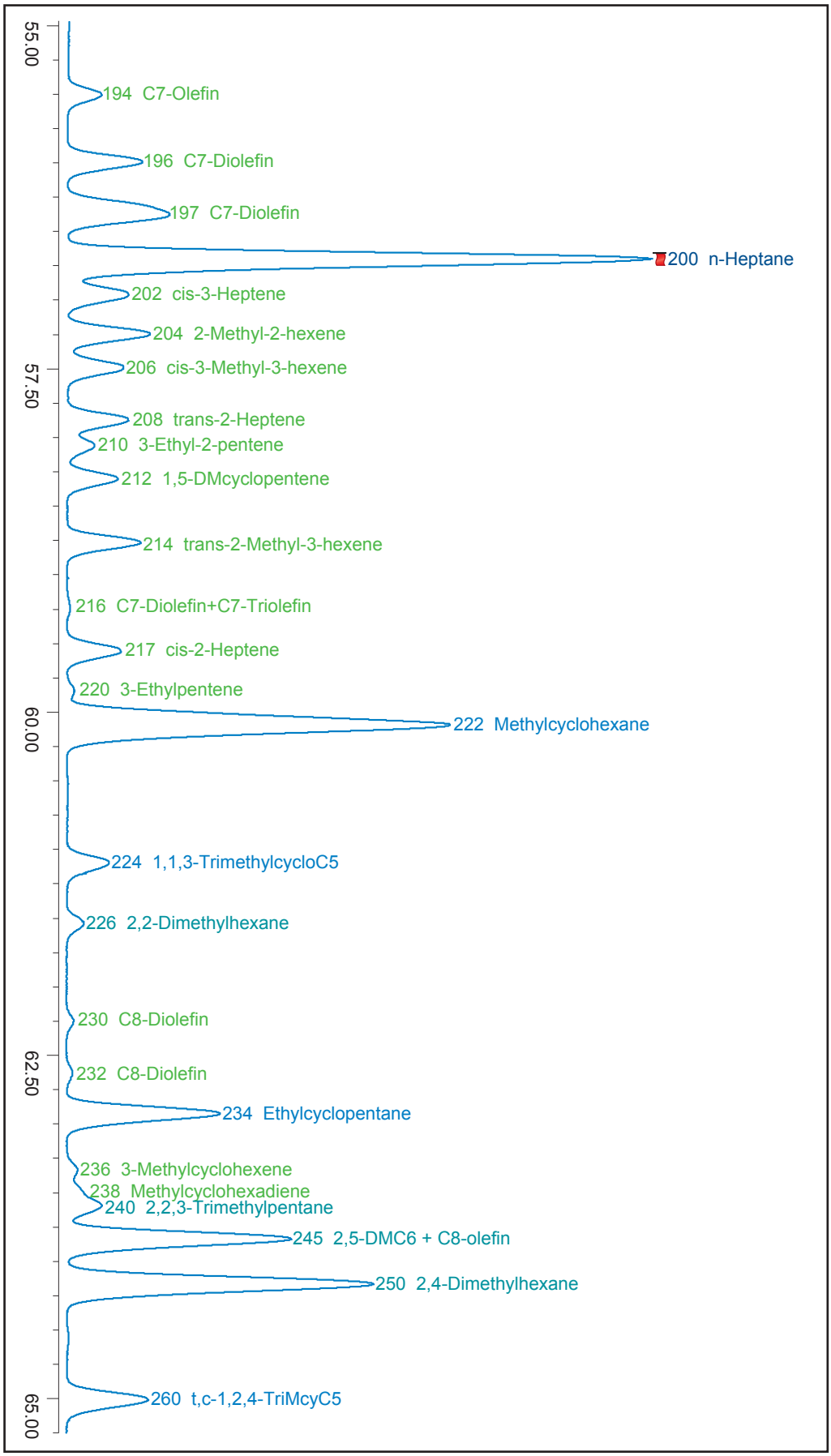

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

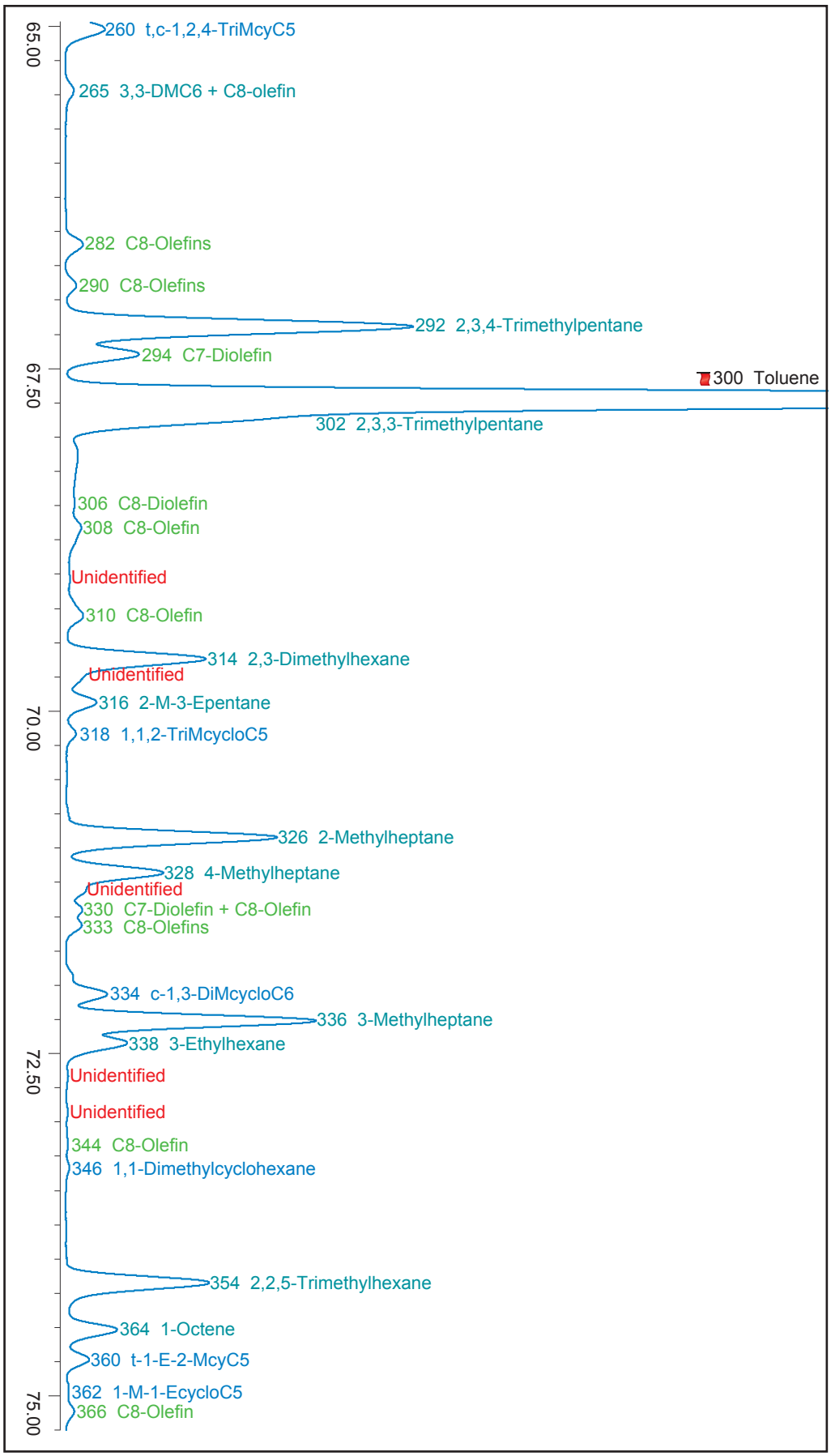

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

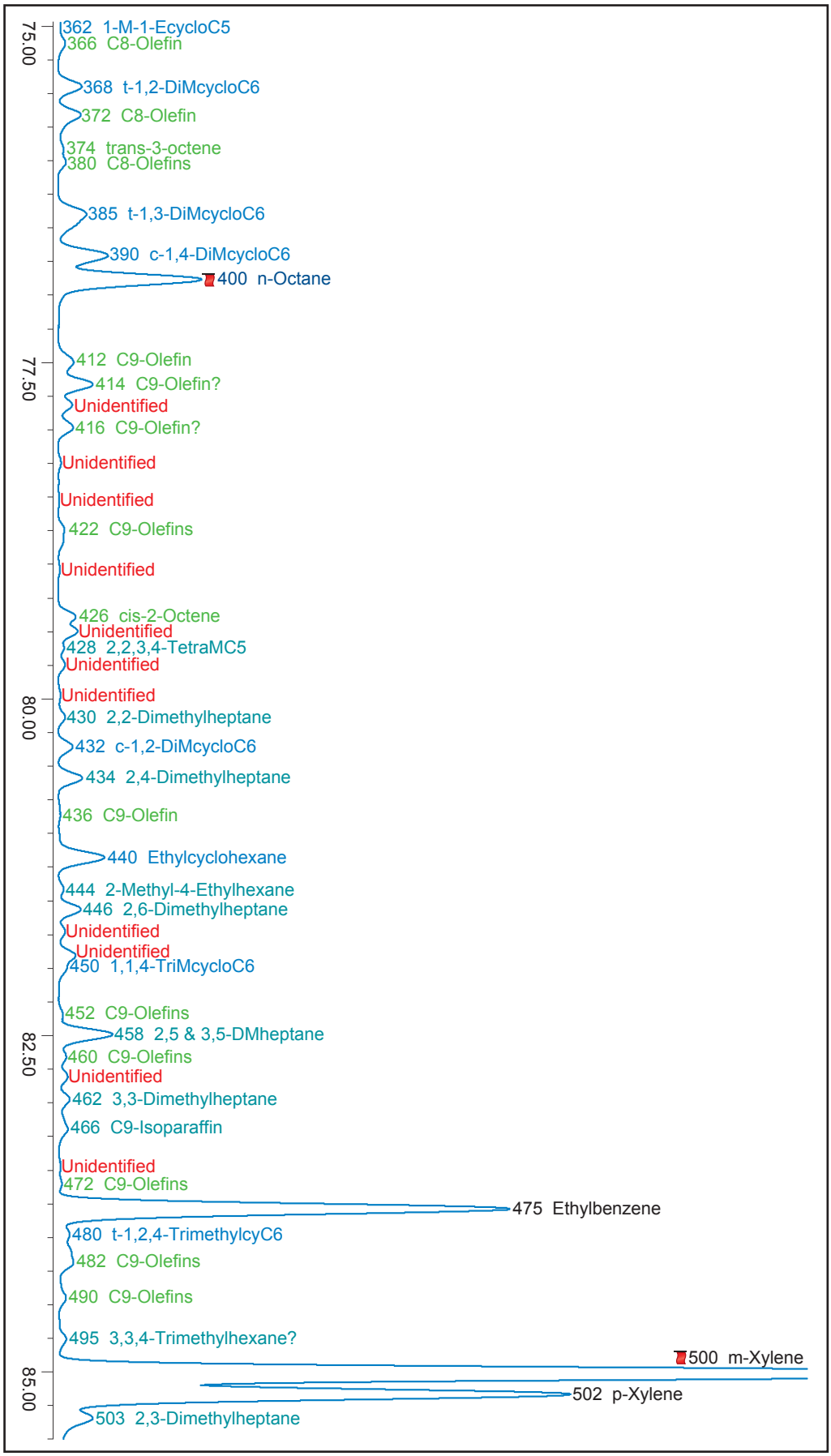

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

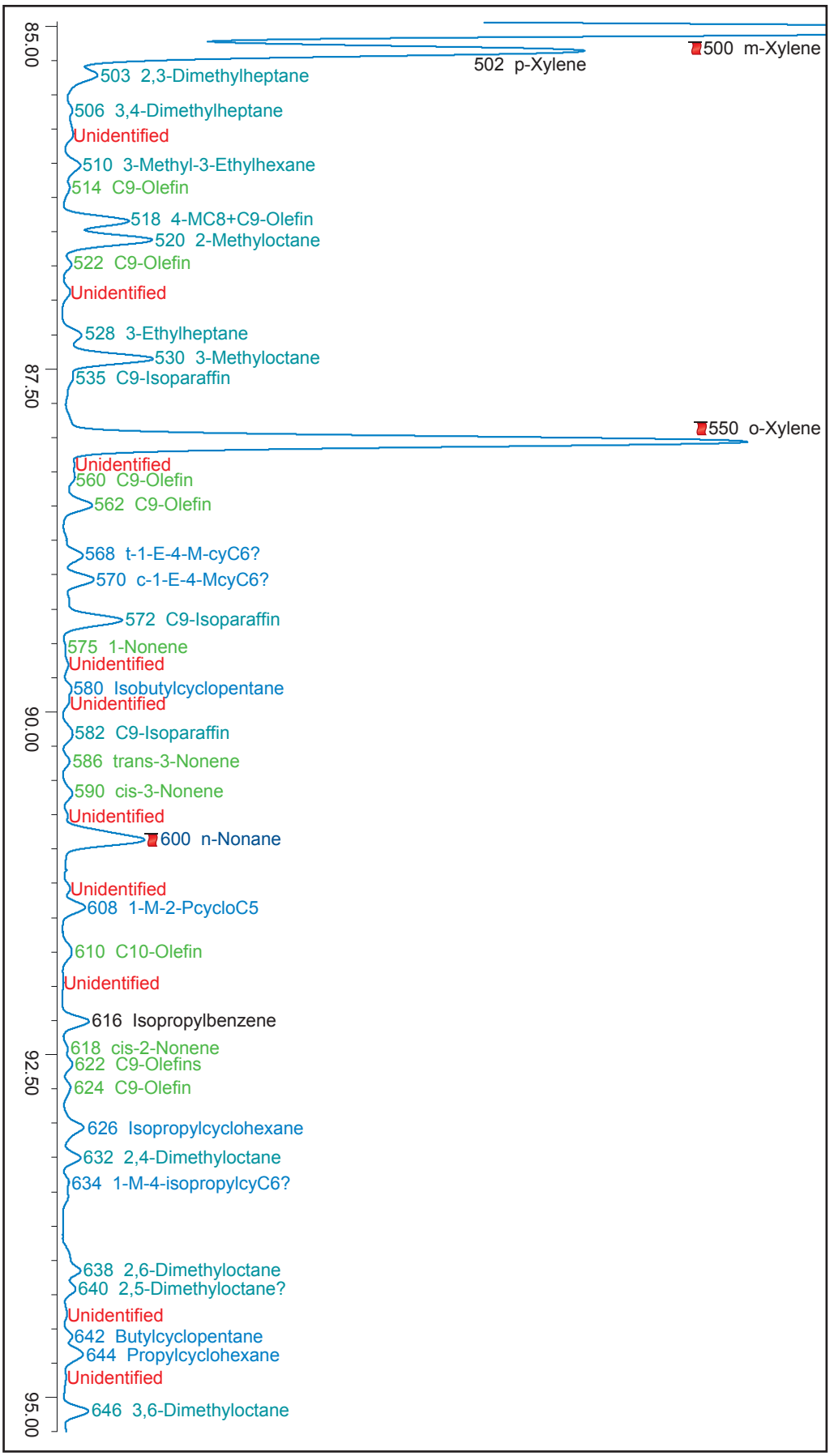

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

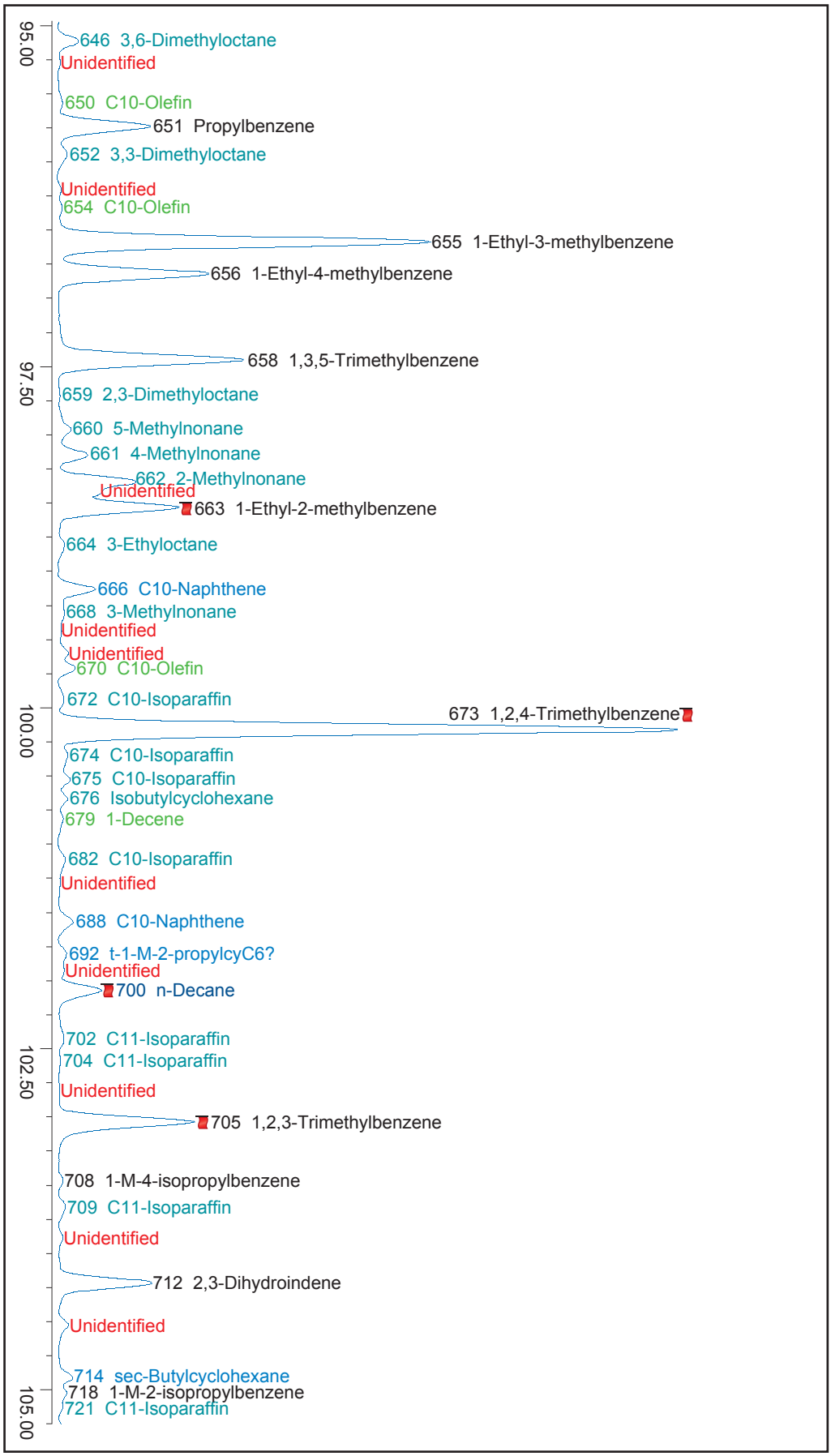

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

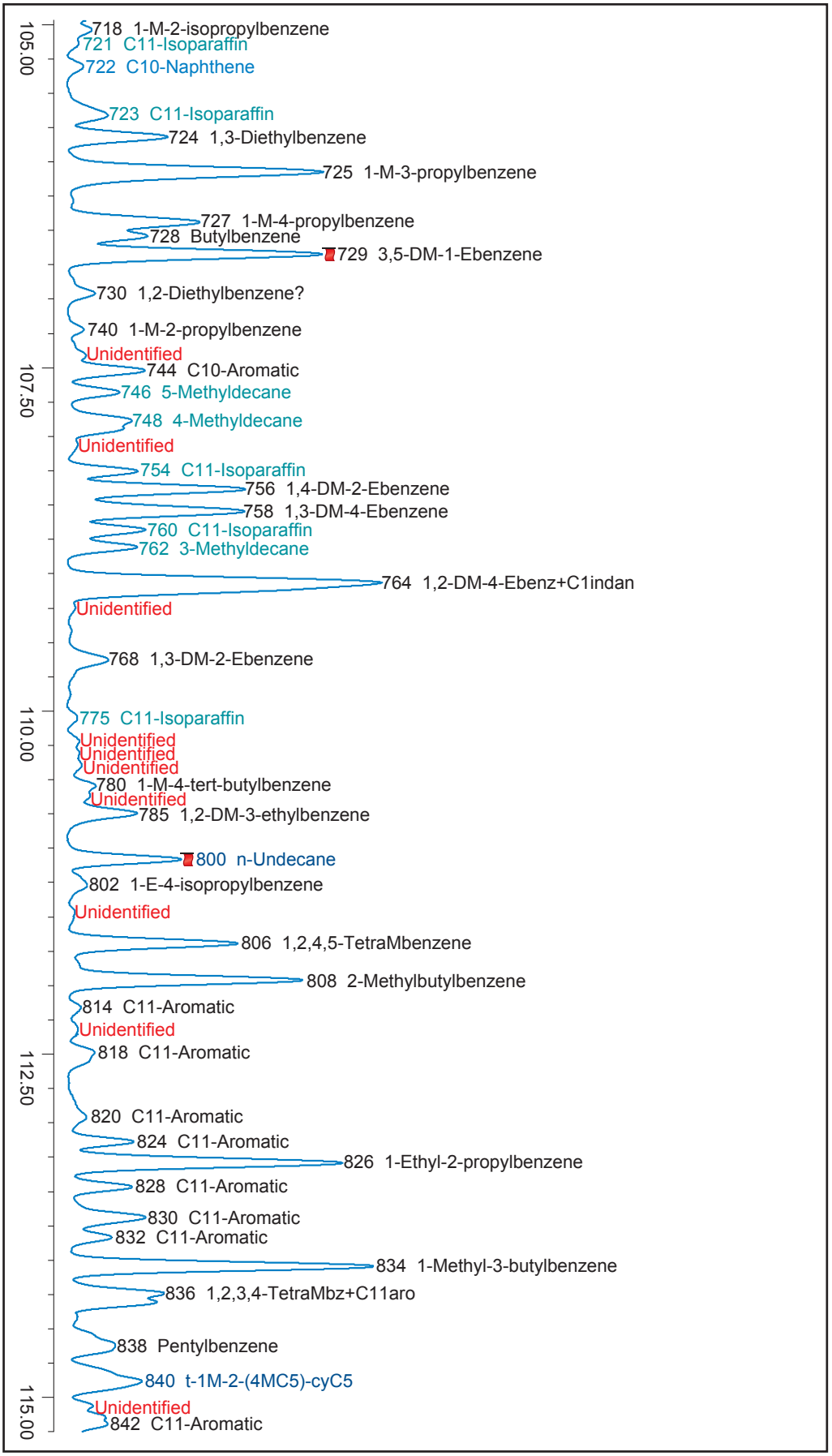

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

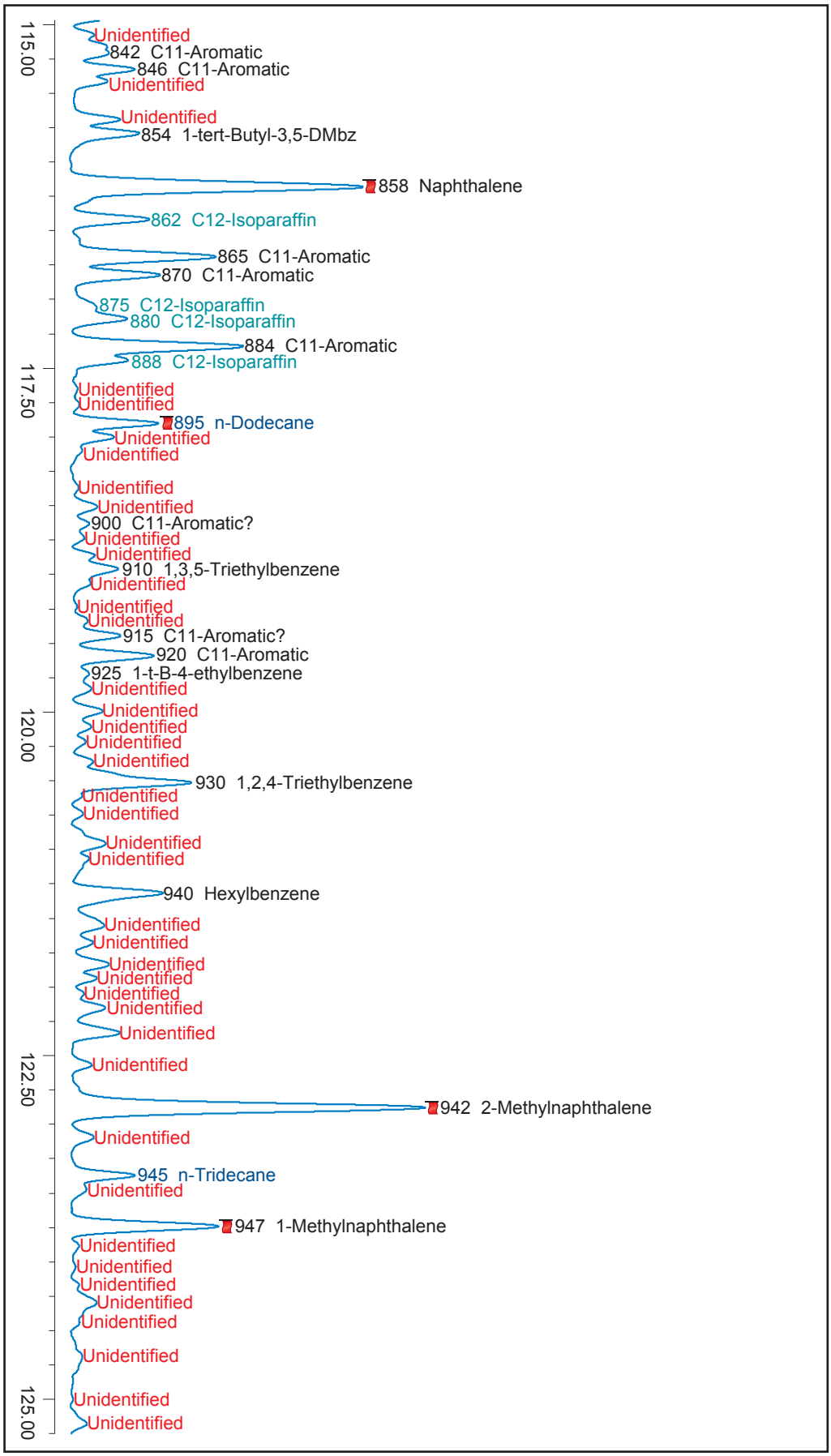

Figure 3 — Detailed chromatogram of reference gasoline (Continued)

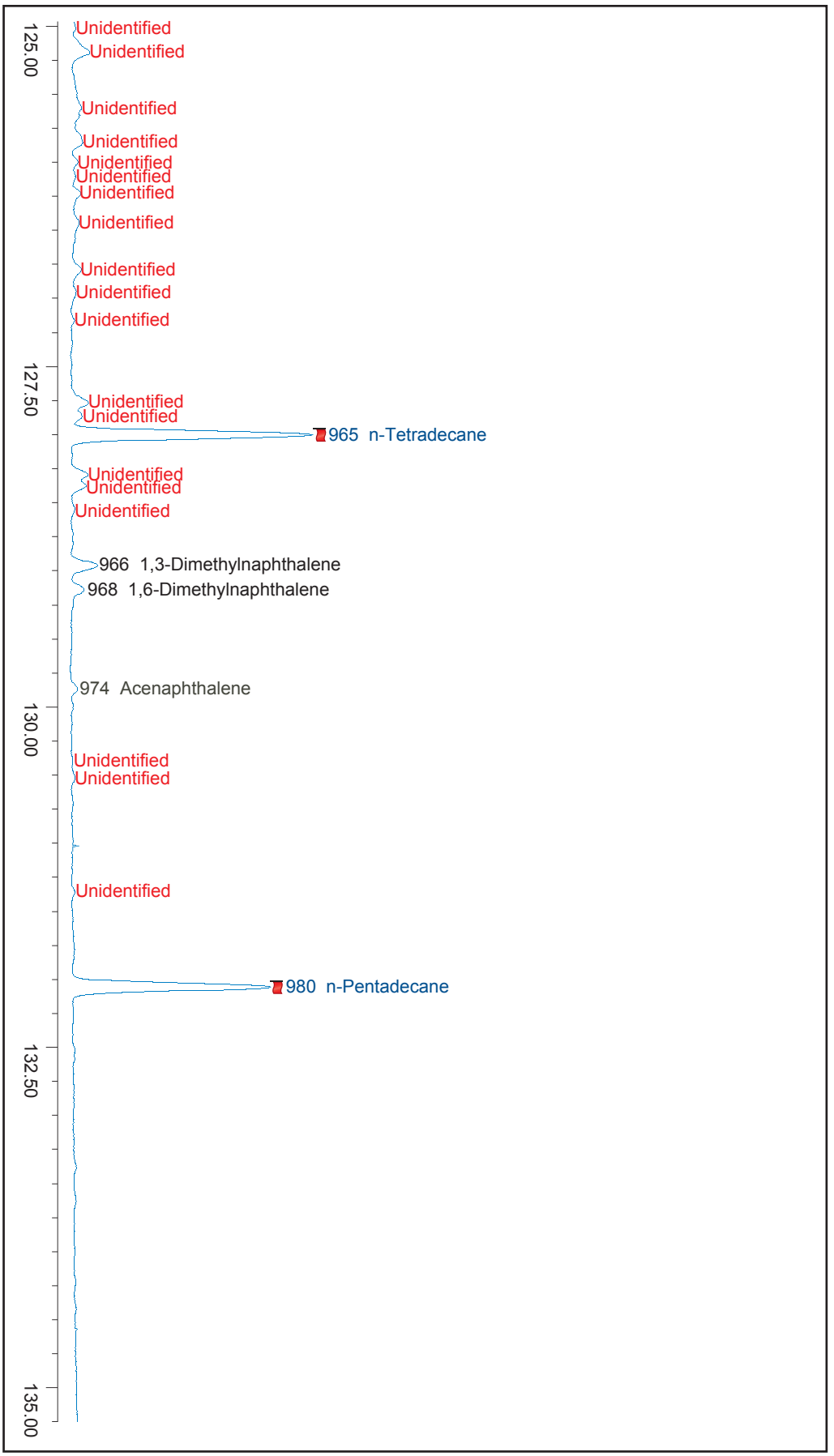

Figure 3 — Detailed chromatogram of reference gasoline (End)

Annex A
(normative)

Tables of coeluting and oxygenated components

Table A1 — Identified coeluting components [a]

Peak number (from Table 5)	Coeluting component(s)	
39	tert-Butanol	2-Methyl-2-butene
66 & 68	tert-Butyl methyl ether	2,3-DM-1-butene
96	n-Hexane	C6-Olefin
102	trans-3-Hexene	Hexadiene
112	Methylcyclopentane	2,2-Dimethylpentane
116	Tert-Amyl alcohol	2,4-Dimethylpentane
134	3,3-Dimethylpentane	5-Methyl-1-hexene
156	2-Methylhexane	C7-Olefin
216	C7-Diolefin	C7-Triolefin
245	2,5-Dimethylhexane	C8-Olefin
255	C7-Triolefin	C8-Olefin
265	3,3-Dimethylhexane	C8-Olefin
270	C7-Triolefin	C8-Olefin
300	Toluene	2,3,3-Trimethylpentane [b]
313	C8-Diolefin	C8-Olefin
318	1,1,2-Trimethylcyclopentane	C7-Triolefin
320	C8-Diolefin	C7-Isoparaffin
330	C7-Diolefin	C8-Olefin
518	4-Methyloctane	C9-Olefin
764	1,2-Dimethyl-4-ethylbenzene	C1-Indan
836	1,2,3,4-Tetramethylbenzene	C11-Aromatic

[a] Due to the possibility of coeluting peaks in other areas, the user is cautioned in the interpretation of the data.

[b] 2,3,3-Trimethylpentane will coelute with toluene when its ratio with toluene is greater than 5:1. In most alkylated gasoline, a separation may occur between toluene and 2,3,3-trimethylpentane.

Table A2 — Oxygenated components [a]

Component	Retention time (Min.)	Mass response factor[f]
Methanol	9.02	3.10[g]
Ethanol	11.50	2.30
iso-Propanol	16.50	2.19
tert-Butanol	19.40	1.29[g]
n-Propanol[b]	25.65	1.98
Methyl-tert-butyl ether (MTBE)[c]	25.50	1.40[g]
2-Butanol	32.00	1.79
Diisopropyl ether	34.60	1.35
Ethyl-tert-butyl ether (ETBE)[d]	37.86	1.40[g]
iso-Butanol[e]	38.25	1.53
tert-Amyl alcohol	42.35	1.30
n-Butanol	46.00	1.59
tert-Amyl methyl ether (TAME)	47.50	1.15[g]

[a] Due to the possibility of coeluting peaks in other areas, the user is cautioned in the interpretation of the data.

[b] n-Propanol can coelute with 3-methyl-1-pentene.

[c] Methyl-tert-butyl ether(MTBE) can coelute with 2,3-dimethyl-1-butene.

[d] Ethyl-tert-butyl ether(ETBE) can coelute with 2,3-dimethyl-1,3-butadiene.

[e] Iso-butanol can coelute with 4,4-dimethyl-1-cyclopentene.

The coeluting peaks in the preceding four notes will usually be below 1000 ppm.

[f] The response factor is an estimate only. Response factors should be verified for individual chromatography systems and for linearity over the concentration range of interest.

[g] The response factor is determined by ASTM D5599.

Annex B
(normative)

Referenced ASTM International Publications (see 2.2)

Annual Book of ASTM Standards

D86 — Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

D1265 — Standard Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method

D1319 — Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

D3700 — Standard Practice for Obtaining LPG Samples Using a Floating Piston Cylinder

D4057 — Standard Practice for Manual Sampling of Petroleum and Petroleum Products

D4307 — Standard Practice for Preparation of Liquid Blends for Use as Analytical Standards

D4626 — Standard Practice for Calculation of Gas Chromatographic Response Factors

D4815 — Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography

D5580 — Standard Test Method for Determination of Benzene, Toluene, Ethylbenzene, p/m-Xylene, o-Xylene, C9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography

D5599 — Standard Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection

D5769 — Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry

D5842 — Standard Practice for Sampling and Handling of Fuels for Volatility Measurement

D6299 — Standard Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D6300 — Standard Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products and Lubricants

D6304 — Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration

D6596 — Standard Practice for Ampulization and Storage of Gasoline and Related Hydrocarbon Materials

D6792 — Standard Practice for Quality System in Petroleum Products and Lubricants Testing Laboratories

E355 — Standard Practice for Gas Chromatography Terms and Relationships

E691 — Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

MNL7A — Manual on Presentation of Data and Control Chart Analysis, 8th edition, Section 3: Control Chart for Individuals