Volatility Updates to ASTM D4814 Standard Specification for Spark Ignition Engine Fuel

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What is ASTM D4814?

ASTM D4814 *Standard Specification for Automotive Spark-Ignition Engine Fuel*

- Gasoline and Gasoline-Ethanol blend specification used by regulators, refiners, pipelines, terminals, and retail sites.
- Identifies various characteristics of automotive fuels over a wide range of operating conditions
- Composition of fuel is limited by economic, legal, and technical consideration, but its properties, including volatility, are defined by this specification.
- ASTM D4814, Table 4 specifies a schedule of U.S. Seasonal and Geographical Volatility Classes

The specification is under continuous review, and can include revisions based on changes in fuel, automotive requirements, or test methods, or a combination.

Gasoline Volatility

What is Gasoline Volatility?

- Volatility quantifies a gasoline's tendency to vaporize.
  - For winter cold weather, gasoline has higher volatility to allow cold starting and warm-up.
  - For summer hot weather, gasoline has lower volatility to prevent engine vapor-lock, hot fuels handling problems and control evaporative emissions.
- Good *driveability*, how an engine starts, warms up and runs, depends on having the right volatility gasoline for the temperature and altitude conditions.
- ASTM Volatility Classes Specify:
  - Vapor Pressure
  - Distillation temperatures at 10%, 50%, 90% and end-point evaporation
  - Driveability Index
  - Vapor-liquid ratio properties

Why is it changing in ASTM D4814?

Multiple reasons:

- CRC Report No. 668 "Mother-of-All-Driveability-Projects" substantiated a proposal for ethanol blended fuels to have:
  - Lower T50
  - Vapor Pressure Increase
- Ambient Temperature Data update, "Donor 2":
  - CRC Project CM-138-16-2 provided U.S. Regional average temperature data from 1996 to 2015
  - ASTM WK#66903 Task Force of fuel, auto and regulatory experts to update Table 4
- Enhance clarity:
  - Provide documentation of setting vapor class requirements for future efforts.
  - Improve language on applicability timing at bulk facilities and retail sites.
  - Better define transitions provided by multi-class designations.

Final step: ASTM review of ballot process, final editorial validation

Expecting changes to ASTM D4814 volatility to be published shortly.

ASTM Technical Report in publication review and will be issued in tandem with the changes.

- Volatility changes proposed to ASTM D4814 have passed balloting at ASTM!
  - Updated minimum T50 distillation for Classes E and D to 145°F
  - Adds clarity to monthly transitions at terminals and retail sites
  - Updates Table 4 – schedule of seasonal and geographic volatility classes based on modern average temperature data
- At the December 2023 ASTM D02.A meeting issues were raised regarding the publication timing for volatility changes:
  - Some states adopt the most recent version
  - Concern with spring season transitions:
    - Risk of a revised class specification change when product is in distribution – no grace period.
    - Volatility transitions are planned months in advance by refiners and fuels blenders.
    - Pipelines and terminals need to update their product schedules, inform customers.
  - Starting in April, the gasoline supply chain begins transition to Class A for EPA Summer VOC

Overview of Changes

Table 4: Schedule of Seasonal and Geographic Volatility Classes

Table 1: Vapor Pressure and Distillation Class Requirements

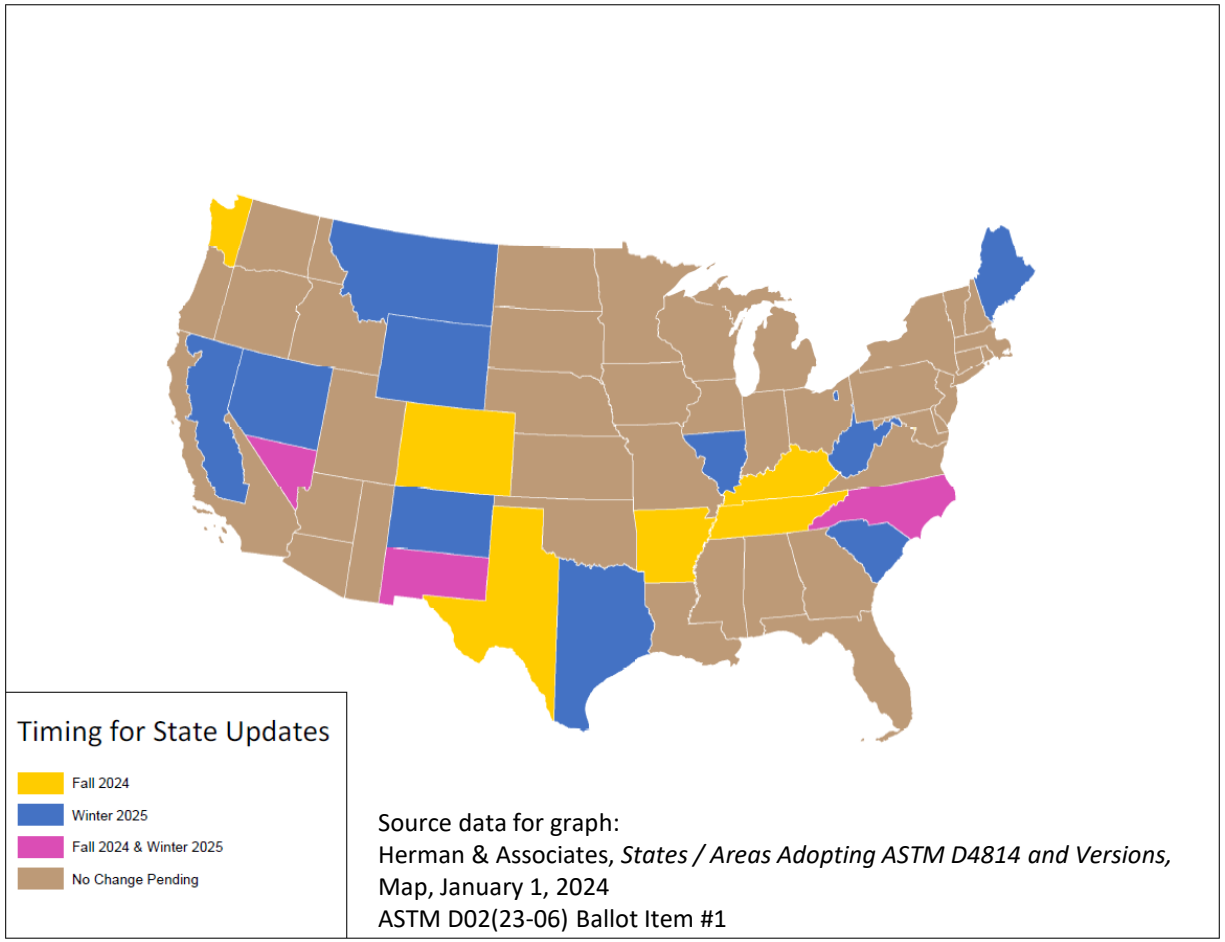
Section 5. Performance Requirements

Changes to ASTM Table 4: *Schedule of Seasonal and Geographic Volatility Classes*

Change	States	Examples
Fall transition to higher volatility is slower	Arizona*, Arkansas, Dist. of Columbia, Kentucky, New Mexico*, Tennessee, Texas*, Virginia	Arkansas transitions to D-4 in November instead of October
Fall transition to higher volatility is faster	Idaho*, Nevada*, Washington*	Idaho Latitude S46° transitions to D-4 in October instead of November
Winter volatility is lower	Colorado, North Carolina, New Mexico*	Colorado in January stays at D-4 instead of E-5
Winter-Spring transition to lower volatility is faster	Arizona*, California*, Colorado, Illinois*, Indiana, Iowa, Maryland, Montana, Nevada*, New Mexico, Ohio, South Carolina, Texas*, Utah, West Virginia, Wyoming	California Interior begins its D-4/C-3 transition in March instead of April
Winter-Spring transition to lower volatility is slower	Maine	Maine begins its transition from E-5 in April instead of March
Only Summer Months	Alabama, Arizona*, California*, Florida, Georgia, Illinois*, Kansas, Louisiana, Mississippi, Missouri, New Hampshire, New Jersey, North Dakoda, Oklahoma, Oregon, Rhode Island, Vermont, Washington*	EPA Summer VOC requirements for Vapor Pressure dominate. Vapor Class A is expected to meet the minimum temperature for other Vapor Lock Protection Classes
No Changes	Alaska, Connecticut, Delaware, Hawaii, Massachusetts, Michigan, Minnesota, Nebraska, South Dakota,	

* Partial Region of State Changes

Implications to State Gasoline Volatility



Source data for graph:
Herman & Associates, *States / Areas Adopting ASTM D4814 and Versions,* Map, January 1, 2024
ASTM D02(23-06) Ballot Item #1

With new ASTM D4814 Table 4 requirements, acute impacts are mitigated after April:

- Gasoline supply moves to EPA Summer VOC, Vapor Class
  - Gasoline meeting a Class A designation for vapor pressure are also expected to be above the minimum T (V/L=20) for other Vapor Lock Protection Classes
- Time to plan for fall volatility schedule changes, starting October 16th.
- Many States may have No Pending Changes:
  - ASTM D4814 Table 4 does not change for the state.
  - ASTM D4814 Table 4 changes occur only during the EPA Summer VOC period.
  - State does not adopt the most recent version of ASTM D4814.
    - If these states adopt a version of ASTM D4814 after the Table 4 updates, their volatility class requirements may change.
- Review Federal and State Rules for specific timing and changes.

Federal and State Rules make the final determination!

Table 1: Vapor Pressure and Distillation Class Requirements

Table 1 Footnote F:

[F] **For** Gasolines that may be blended with 1 % to 15 % by volume ethanol or all other gasolines whose disposition with ethanol blending is not known**, the** ~~**shall meet a**~~ minimum 50 % evaporated distillation temperature **shall be** ~~**of**~~ 77 °C (170. °F) prior to blending with ethanol. **For** Gasoline-ethanol blends that contain 1 % to 15 % by volume ethanol**, the** ~~**shall meet a**~~ minimum 50 % evaporated distillation temperature ~~**of**~~ **shall be** 66 °C (150. °F) **for volatility classes AAA through C. For Classes D and E fuels containing 1% to 15% by volume ethanol, the minimum 50% evaporated distillation temperature shall be 62.8 °C (145.0 °F). For the 62.8 °C (145.0 °F) minimum 50 % evaporated distillation temperature, no allowance shall be made for the precision of the test methods.**

Updated Distillation Specification:

- For Class E and D gasoline-ethanol blends, changes the minimum 50% evaporation temperature (T50) to 145.0°F.
- Added clarification that for the 145.0 °F limit, no allowance shall be made for the precision of the test methods.

Section 5. Performance Requirements

5.2.2 – Table 4 Development – This volatility schedule was developed based on two decades (1996 - 2015) of 90th percentile 1 h maximum and 6 h minimum temperatures from approximately 300 weather stations and adjusted for altitude. The 90th percentile 1 h maximum temperature and 10th percentile 6 h minimum altitude adjusted temperatures were used to define the volatility classes (vapor pressure class and temperature for a Vapor/Liquid Ratio of 20) for a state or area within a state for each month. While this table was designed for the U.S., the approach utilized can be applied to other geographical areas for seasonal gasoline volatility adjustments.

5.2.2.1 In addition to the ambient temperature determinations, other factors that were considered, included but were not limited to, governmental regulations, geographic proximity, altitude correction per 5.2.1.1, and regional supply concerns. These recommended classes were then reviewed by a panel of experts to determine if the infrastructure and distribution systems could support the recommended class. Adjustments were made when necessary.

Provides reference for development of table 4:

- Provides brief description of the analysis of average temperature data and how it was applied to the volatility schedule.
  - This was missing before WK#66903!
  - More details will be published in the Technical Report.
- Consideration was given to regulatory periods, geographic proximity, altitude correction factors and regional supply concerns.

Section 5. Performance Requirements

5.2.3 Table 4 Application – In the U.S., spark-ignition engine fuel volatility shall meet the schedule and limits in Tables 3 and 4 on the first day of the month at the point of bulk distribution intended for sale to sites dispensing fuel to the end user during the month. For example, terminals loading tanker trucks should be dispensing fuel in conformance with the in-month volatility requirements on the first day of the month. Refiners, importers, shippers, and distributors should anticipate this schedule for conformance with this specification.

5.2.3.1 At sites dispensing fuel to the end user, including retail locations, conformance with the in-month volatility requirements shall occur no later than the 16th day of the month (see below for summer exceptions in the U.S.). From the 1st through the 15th day of the month, the prior or current month volatility properties may be used (see exception for U.S. summertime below). This recognizes the variable turnover time needed for supplies to the end user to be depleted and replenished.

5.2.3.2 The 1.0 psi vapor pressure waiver for gasoline-ethanol blends is not incorporated into Specification D4814. Many states provide a 1.0 psi vapor pressure waiver for gasoline-ethanol blends; however, vapor pressure limits for gasoline-ethanol blends vary among states and in areas with Federally approved State Implementation Plans (SIPs). Contact specific states to determine their vapor pressure limits for gasoline-ethanol blends.

5.2.3.3 Summer Exceptions - U.S. EPA limits vapor pressure for gasoline for the regulatory control period of May 1 - September 15 at the refinery and terminal level and from June 1 – September 15 at retail. Refer to 40 CFR 1090 for specific requirements including, but not limited to, timing, gasoline-ethanol blend vapor pressure waivers, and various volatility limits for different gasoline or geographical areas. See Appendix X3. for a summary of U.S. EPA volatility and other fuel quality regulations.

Moves Table 4 Notes to Section 5, adds clarifications:

- Clarifies the timing for meeting current month's specification:
  - 1st day of the month: Fuels at bulk distribution for sale to sites dispensing to the end user. Example: Terminals
  - 16th day of the month: Fuels dispensed to the end user. Example: Retail Site
- ASTM D4814 does not include a 1-psi vapor pressure waiver.
  - Waivers can be provided by state rules.
  - EPA provides limited waiver for summer VOC months.
  - Other State and Federal rules may limit the use of vapor pressure waivers. Example: State Implementation Plans

Section 5. Performance Requirements

5.2.4 – Multi-Class Designation – Multi-class volatility designations are created to allow for transitioning or anticipating the transition for seasonal and geographical volatility changes. Allowance is made for the fuel distribution system to use up the prior month's volatility class fuel. This depletion of liquid inventory is facilitated by a multi-class option for a month with a volatility change from the prior month. For months where non-adjacent multi-class volatility designation are listed, either listed class or intermediate class designation are acceptable. The option may be exercised by the seller, but bulk inventories must still meet the required volatility at the first of the month. For example, in Table 4, the volatility for April in Alabama shows C-3/A-3 which means either a C-3, B-3, or A-3 volatility class is allowed. For March, which is D-4/C-3, either volatility class is acceptable. As storage is transitioned between different classes a blend of volatility classes is to be expected. However, for demonstrating conformance with this standard for bulk fuel, a single volatility grade's limits shall be used, not a combination of limits from several classes.

5.2.5 Tables 5-7 contain specific geographic requirements. Consult U.S. EPA regulations under 40 CFR Part 1090 for Federal 7.8 psi vapor pressure areas, RFG covered areas, and Federally approved SIP areas.

Moves Table 4 Notes to Section 5, adds clarifications:

- Explains methodology for multi-class designations
- Example: April in Alabama shows C-3/A-3
  - Either a C-3, B-3, or A-3 volatility class is allowed
  - Note that the A-3 designation is due to EPA Summer VOC requirements.
    - EPA changes the vapor pressure requirement to A, but did not change the T V/L specification.
    - For all practical purposes, the A-1 fuel should meet A-3 specifications. Fuels meeting a Class A designation for vapor pressure are also expected to be above the minimum T (V/L=20) for other Vapor Lock Protection Classes
- During multi-class months blends of volatility specifications can be expected, however, fuels should be manufactured to conform to a single volatility grade's limits.
- Additional volatility limits are found in Tables 5-7.

More Information

ASTM Standards Tracker:

https://www.astm.org/catalog/category/view/id/148/

Discuss with Trade Associations and Key Stakeholders:

Prentiss Searles
American Petroleum Institute
Email: searlesp@api.org

Appendix A

Background from ASTM Subcommittee A

CRC Studies

ASTM WG#66903

“Mother” Ballot – Background

- Started with Sub A Ballot in 2012 to Lower T50 and Add Vapor Pressure Increase from Ethanol Blending
- Additional Data to Substantiate Proposal – CRC Report No. 668 “Mother-of-All-Driveability-Projects” March 2015
- Four More Attempts in 2015 and 2016
  - Ambient Temperature Data for D4814 Table 4 was from 1970s
  - CRC Conducted Project to Update Temperature Set (Donor 2) CM-138-16-2
- Formed WK#66903 Task Force to Update Table 4 with Modern Temperature Dataset
  - 2-years/1300+ hours/multiple in-person & virtual meetings/diverse group of stakeholders
  - Included State Regulators from KY, TN, MO, CA, IL, NV, CO, and GA.
- “Mother-of-all-Volatility” ballot (T50/VP/Table 4) closed May 16, 2021 with 28 negative votes generated.
  - Much deliberation/discussion/dealing
  - Dropped Vapor Pressure from Ballot – Political Football

“Mother-In-Law” Ballot – Background

- Mother-in-Law Ballot in October 2022 Item 1 D02.A0(22-03) received 8 Negatives.
  - Inadvertently left 19 modifications out of Table 4
- Concurrent Mother-in-Law Ballot with additional 19 modifications in January 2023 Item 2 D02(23-01).
  - Most negatives casts had common concern centered on Footnote F for T50
    - 9 of 10 conditionally withdrew negatives, after compromise language on T50 Footnote F developed by OEMs and Author
- 2nd Concurrent Mother-in-Law Ballot Item 1 on D02(23-06) Closed August 28, 2023 Received Two Negative Votes
  - Items 1 and 2 of D02(23-09) Closed on November 19, 2023 Action to Find Both Negatives NOT PERSUASIVE

Many Thanks to ASTM WK 66903 Task Force!

WK 66903 - D4814 Table 4 Volatility Classification Panel (Current)				
Name	**Represents**		**Name**	**Represents**
Russ Lewis	Marathon (Panel Lead)		Ron Hayes	Consultant (Missouri-retired)
Jim Simnick	Consultant (BP-retired)		Bill Striejewske	Nevada
Ryan Woordward	BP (analyst for team)		Doug Rathbun	Illinois
Scott Berkhous	ExxonMobil		Allan Morrison	California
Scott Mason	Phillips 66		Mahesh Albuquerque	Colorado
Rita Hardy	FHR		David Au	Georgia
Cinda Lohmann	Turner Mason (analyst for team)		Hannah Mann	Kentucky
Douglas Cyr	Chevron		Michael Bedwell	Colonial
Matt Sheehan	Chevron		Rod Lawrence	Consultant (Magellan-retired)
Alexander Voice	Saudi Aramco		Elizabeth Locklear	Explorer
Helen Doherty	Sunoco		Russ Kinzig	Consultant (KM-retired)
Jennifer Draper	Motiva		Kristy Moore	Consultant (ICGA)
Prentiss Searles	API		Chuck Corr	Consultant (ADM-retired)
Marie Valentine	Toyota		Shon Van Hulzen	Poet
Buster Brown	Colonial		Kelly Davis	RFA
Steve Kirby	GM		Steve VanderGriend	ICM
Jeff Jetter	Honda		Cathy Woodliff	Andersons
Beth Raney-Pablo	Ford		Lew Gibbs	Consultant (Chevron-retired)
Jeff Farenback-Brateme	Consultant (EM-retired)		Winn Gardner	Consultant (EM-retired)
			Laura Lancaster	Olympic Pipeline
Randy Jennings	Consultant (TN-retired)		John Shugart	Georgia
Erica Niner	FCA		Dale Bohn	FHR
Patrick Van Oosterwyk	Kinder Morgan		Jason Mengel	Buckeye Pipeline
Caleb Guse	Magellan		Alyson Fick	ASTM Staff Editor

Appendix B

ASTM Technical Report

Status Update

Technical Report for Revision of Table 4 in D4814

- The Report team
  - Steve Kirby
  - Russ Lewis
  - Kristy Moore
  - Doug Rathbun
  - Jim Simnick

- **80+** hours of task force meetings
- **1300+** person hours
- 2+ years of work during Covid -19 pandemic
- Determine volatility schedule for 50 states (and portions of states) for 12+1 months each = **650+** decisions, with both vapor pressure and Tv/l=20 is **1300+** entries
- Draft Report is 36 pages including appendices
- Why?
  - Current schedule based on 40+ year old weather data
  - and the right technical thing to do for our standard

Purpose of the Report

- Transparency as to what was done for update
- Make a Record for the future
- Document the revision process for future work
- Make recommendations for improvements
- Provide understanding for this complex subject

Results for Update of D4814 Table 4

- Proposing to change 161 Volatility Schedule entries
- ~97% are for reduced volatility reflecting warmer weather trends
- Revised and clarified how to use the Table 4
- What suppliers need to do for conformance is now documented into Section 5 of D4814

- Technical Report is Complete and Submitted to the ASTM Publications Group
- ASTM D02 Chair Requested the Publication be Delayed Until after the “Mother” Balloting was Finished
- Technical Report needs final Technical Review
- Questions?

THANK YOU