ILSAC GF-7 Specification Development

June, 2023

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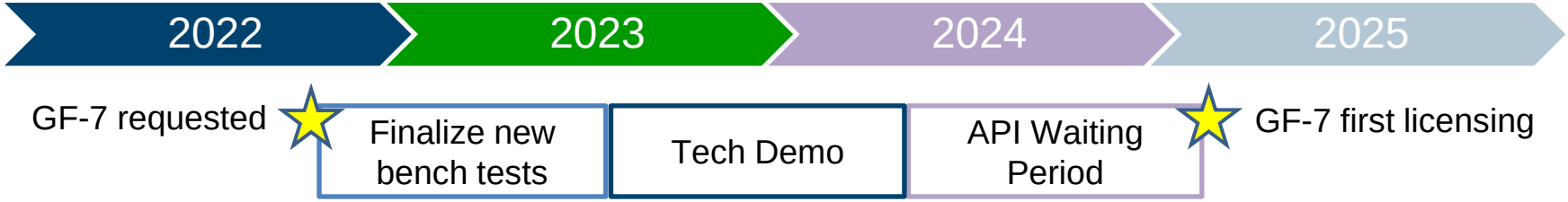
Multiple API and ILSAC Categories Proposed in 2022

- API wanted **SAE 0W-8 and 0W-12** added into ILSAC GF-6B in 2022
- OEMs wanted **API SP PLUS** to include Aged Oil LSPI in 2023
- OEMs wanted a comprehensive new **ILSAC GF-7** category in 2028



Afton proposed to streamline these efforts, align the timing with U.S. CAFE regulations and focus on critical performance needs

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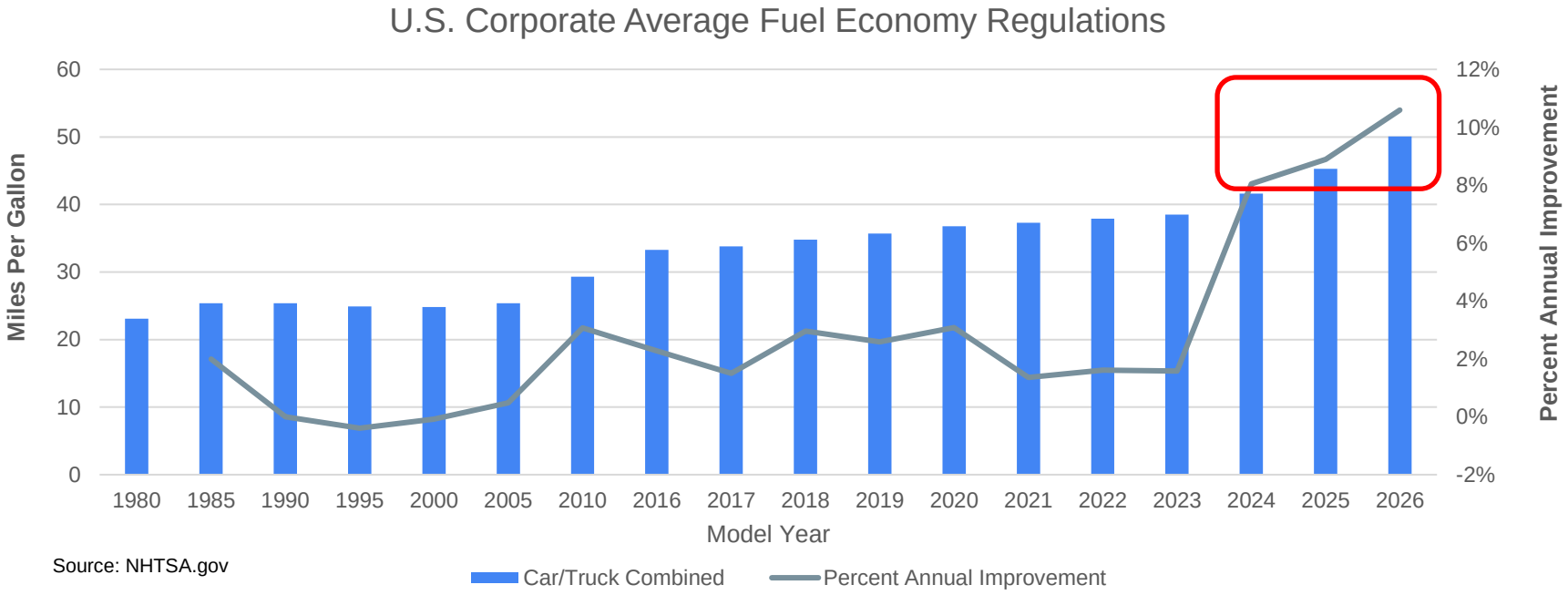
Why Introduce ILSAC GF-7 in 2025?



Source: NHTSA.gov

Unprecedented annual FEI in MY 2024-26 requires efficient ICE, Hybrid and electric vehicles

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Why Afton Welcomes ILSAC GF-7

- A streamlined approach to new specifications focused on key improvements
  - GF-7 delivers key performance needs, quickly
  - GF-7 is less complicated and therefore less risk of delays
  - GF-7 performance is feasible within existing capabilities
- Improved responsiveness to OEM needs
  - Target category life of 5 years, consistent with historical norm
  - Provides important protections requested by OEMs
- Aligns with U.S. government regulation (CAFE & PM)
  - Aggressive U.S. CAFE requirements, requiring 8-10% annual FEI in MY 2024-2026
  - More stringent particulate matter limits will drive GPF adoption
- Act with a sense of urgency due to longevity of OEM support

ILSAC Category	Duration, Years
GF-1	4
GF-2	5
GF-3	3
GF-4	6
GF-5	10

Accelerated. Simplified. Value-focused. OEM-Focused. Consumer-focused.

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ILSAC GF-7 Performance Requirements

- OEMs are requesting the following performance improvements in GF-7:

Test	Parameter	GF-6	GF-7
Seq. IIIH	Oxidation and deposits	WPD ≥ 4.2	WPD ≥ 4.6
Seq. VIE	Fuel economy	By grade	GF-6 + 0.5%*
Seq. IX	LSPI protection after aging	Fresh only	Fresh and Aged
Seq. X	Timing chain wear	0.085 max	0.080 max
MRV	Low temperature pumpability	60,000 cP max	40,000 cP max
Sulfated ash	GPF compatibility	1.0wt% max	0.90wt% max
Water Tolerance	Oil gelation with water contamination	EOWTT	Modified with water & CO_2
Seals	Elastomer compatibility	5 materials	+4 materials

* FEISUM proposed increase for xW-20 and xW-30 grades

- Latest EPA directives restrict combustion control options OEMs can deploy and may require even greater high temperature robustness from the engine oil.

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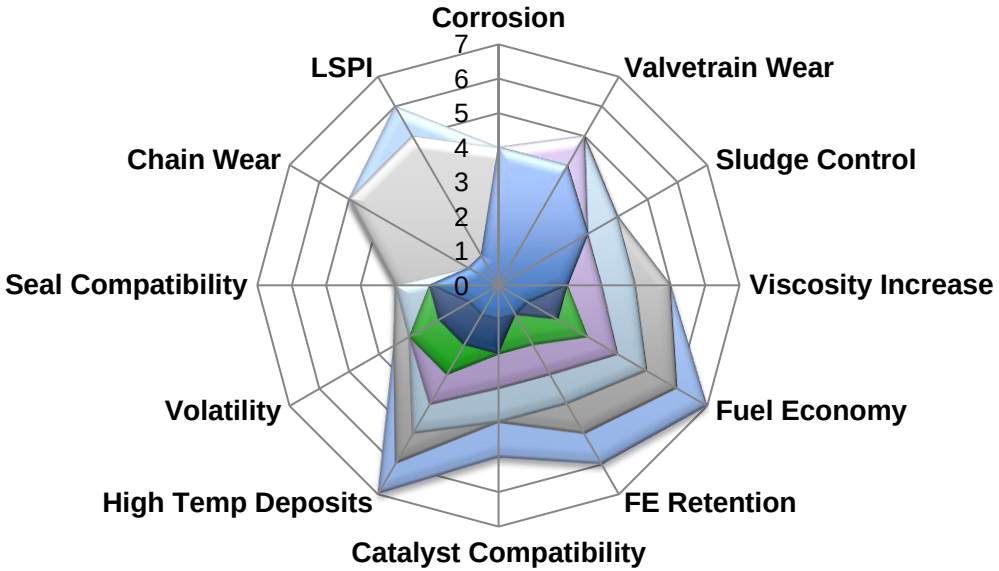
ILSAC GF-7 is Less Complicated and Achievable

- Engine test development is complete
  - Only new engine test need is the Aged Oil LSPI test
  - Test development and precision matrix are complete; new test method is being published
  - Sufficient hardware for GF-7 lifetime exists for all other engine tests

- Two new bench tests are proposed
  - Modified Engine Oil Water Tolerance Test (EOWTT) for gelation
  - Introduction of four new elastomer materials
  - ASTM Surveillance Panels are working to update the new procedures

ILSAC GF-7



GF-7: The most advanced performance requirements
Increased formulation and technical challenge

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Afton GF-7 Technology Demonstration

Test	Parameter	GF-7	Afton GF-7 Demo
Seq. IIIH	Oxidation and deposits	WPD ≥ 4.6 PVIS ≤ 100	**4.6** **1.1**
Seq IVB	Intake Valve Wear	AVLI, ≤ 2.7mm^3 EOT Fe ≤ 400ppm	**1.9** **289**
Seq VH	Sludge and Varnish	AES ≥ 7.6 PSV ≥ 7.6	**7.7** **8.1**
Seq. VIE	Fuel economy (5W-30)	FEI 2 ≥ 1.8% FEI Sum ≥ 3.6%	**1.9** **3.9**
Seq. IX	LSPI protection after aging	Average # events, 5 max Max per iteration, 8 max	**0.01** **0.01**
Seq. X	Timing chain wear	CHST 0.080 % max	**0.05**
Bench tests			**Pass**

- OEMs performance requirements are achievable, within the timeline

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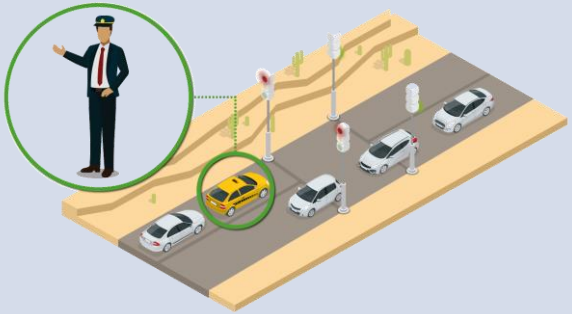
PCMO for Hybrids: New Challenges



Case 1: Cold commuter

70 mph on the highway when engine first starts

→ wear from cold
→ fuel dilution

Case 2: Short trips

Rarely leaves town. Does not often use the engine.

→ engine never gets hot
→ emulsion

Case 3: Intense usage

Taxi fleets in hot regions

→ high thermal load through a downsized engine

Hybrids and usage can increase the severity of operating conditions

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Hybrid ILSAC GF-7 Proposal

- Hybrid performance requirements could be added to GF-7:

Parameter	Test	Limit
Wear protection in low temperature operation	Seq. IVB	2.2 mm^3 300 ppm
Copper corrosion	D130 at 100°C for 3 hours	Maximum 1b
Emulsion retention	D7563 E85 Emulsion	No water separation at 0°C and 25°C 75% minimum emulsion at 0°C
Aftertreatment compatibility	Sulfated ash	0.8wt% max

Summary

- Afton proposed an accelerated approach to GF-7 that would afford meaningful improvement in performance in an acceptable timeline
  - Aligns with OEM needs and timing
  - Raises the quality of oils in the market
- We all benefit from eliminating inefficiency in the current industry process.
  - We need to support the OEMs in addressing their needs in a timely manner
  - Allow focus on replacement tests in line with GF-8 timing
- ILSAC performance requirements are achievable within the accelerated schedule
  - Demonstrated by Afton GF-7 Demo program

The Global industry is seeking to accelerate a value-adding specification upgrade
We are ready to go.

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