ASTM and UL Biodiesel in Heating Oil Update

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Future of Liquid Heating Fuels
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Biodiesel At ASTM

- Biodiesel Task Force in Subcommittee E diesel section (E2) covers:
  - ASTM D6751: B100
  - Biodiesel aspects of D975 diesel: Up to B5
  - ASTM D7467: B6-B20 for on/off road
- Jointly do D396 heating oil with Section E1
  - D396 B5, B6-B20 grade; higher blends in future
- Jointly do D2880 gas turbine w/new Section E3
- Railroads generally use one of the above specs
- Liaison jet fuel D1655, ISO 8217 marine fuel

Continuous Updates to D6751: Feb 2013

Originally published in 2002: ASTM D6751-02

-03: **Added 15 ppm sulfur grade**
-03a: Modified 'middle distillate' term, lubricity note
-06: Reduced AV from 0.8 to 0.5; added limit on Na+K.
-06a: Added limit on Ca+Mg
-06b: Addition of oxidation stability
-07: Modified language and added test methods
-07a: Added alcohol control and modified flashpoint
-07b: Added DCN and sulfur test methods
-08: Addition of cold soak filterability

Introduction of B5 into D975 and publication of D7467 (B6 to B20 Standard)

-09: Added cloud point test methods
-09a: Added cloud point test methods
-10: Added EN15751 as referee method for stability
-11: Added test methods and appendix on low temperature operability
-11a: Replaced cold soak filterability annex with D7501
-11b: Added new test methods
-12: Addition of 1B Grade, updated scope, new test methods

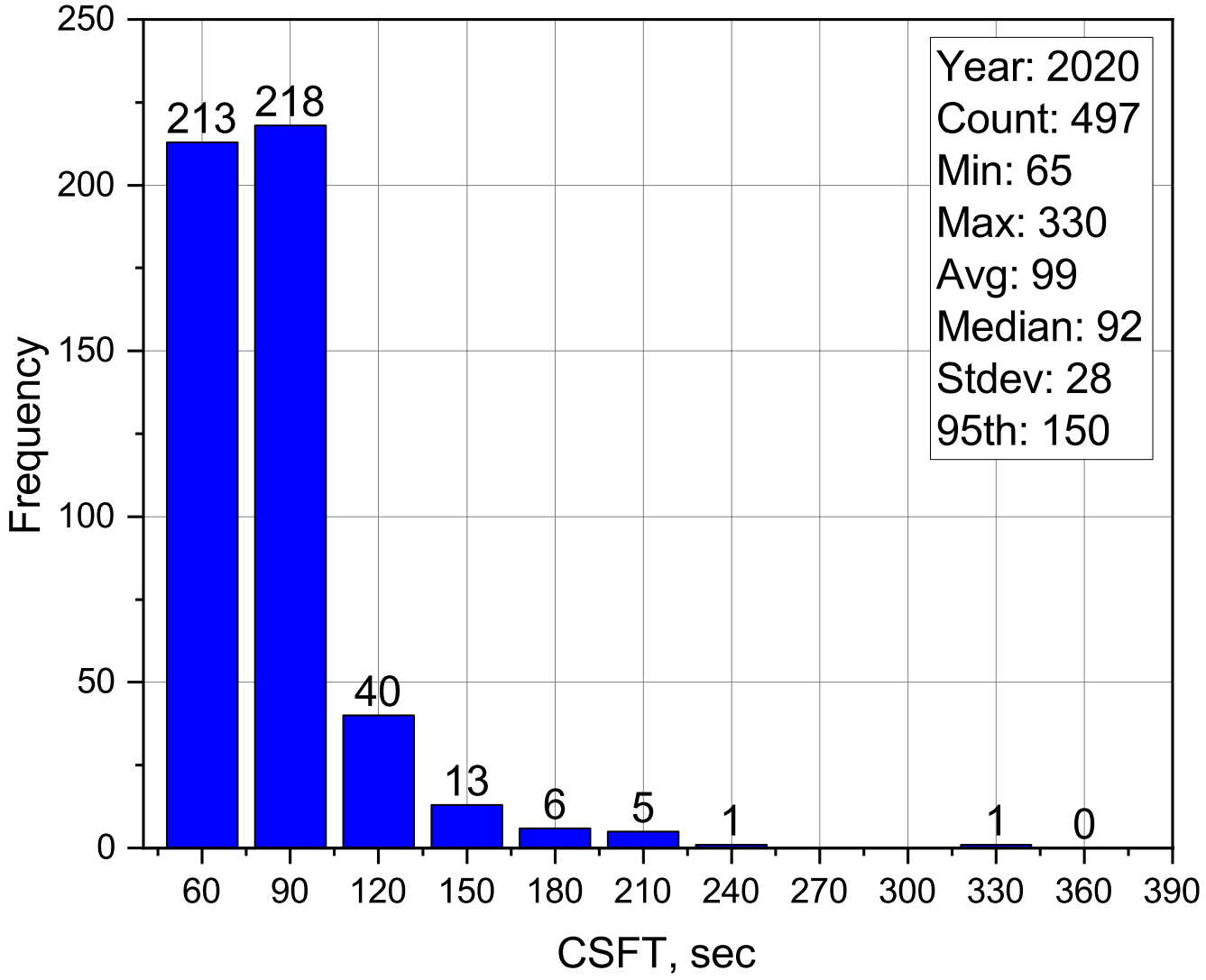
Continuous evolution to address OEM and end-user concerns

ULSD related Spec changes have significantly improved the quality of B100 in the U.S. market

- Cold Soak Filtration Test (CSFT) specification has brought on significant lowering of:
  - Mono-glycerides, which also helped improved cold flow
  - Metals content

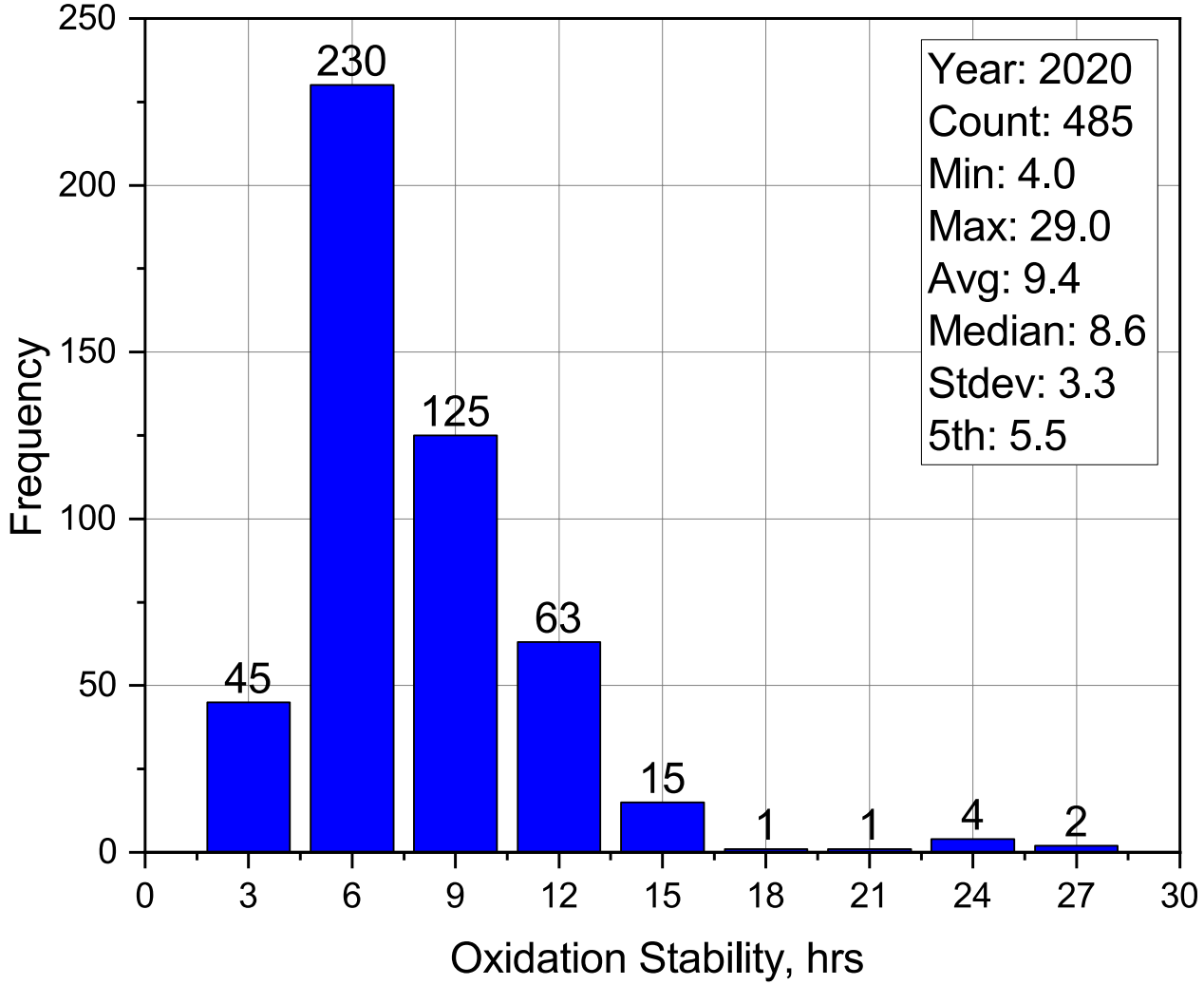
- CSFT, combined with BQ-9000 and RFS related spec enforcement, has brought on:
  - A significant increase in oxidative reserve of B100….
  - And corresponding increase in shelf life of B20

Cold Soak Filtration Test (CSFT)



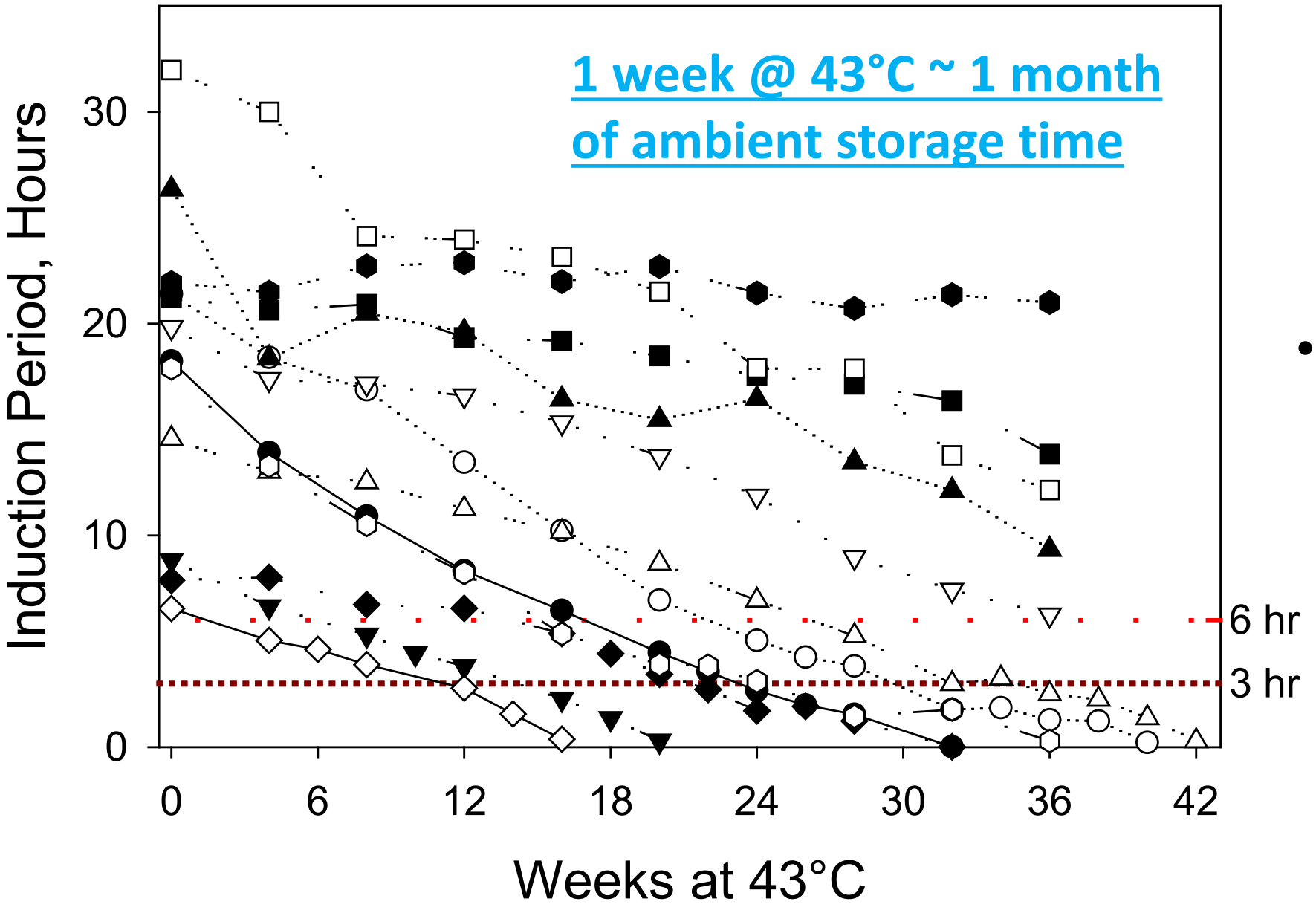
Most values are of the No. 1-B grade of 200 maximum

Oxidation Reserve/Long Term Storage



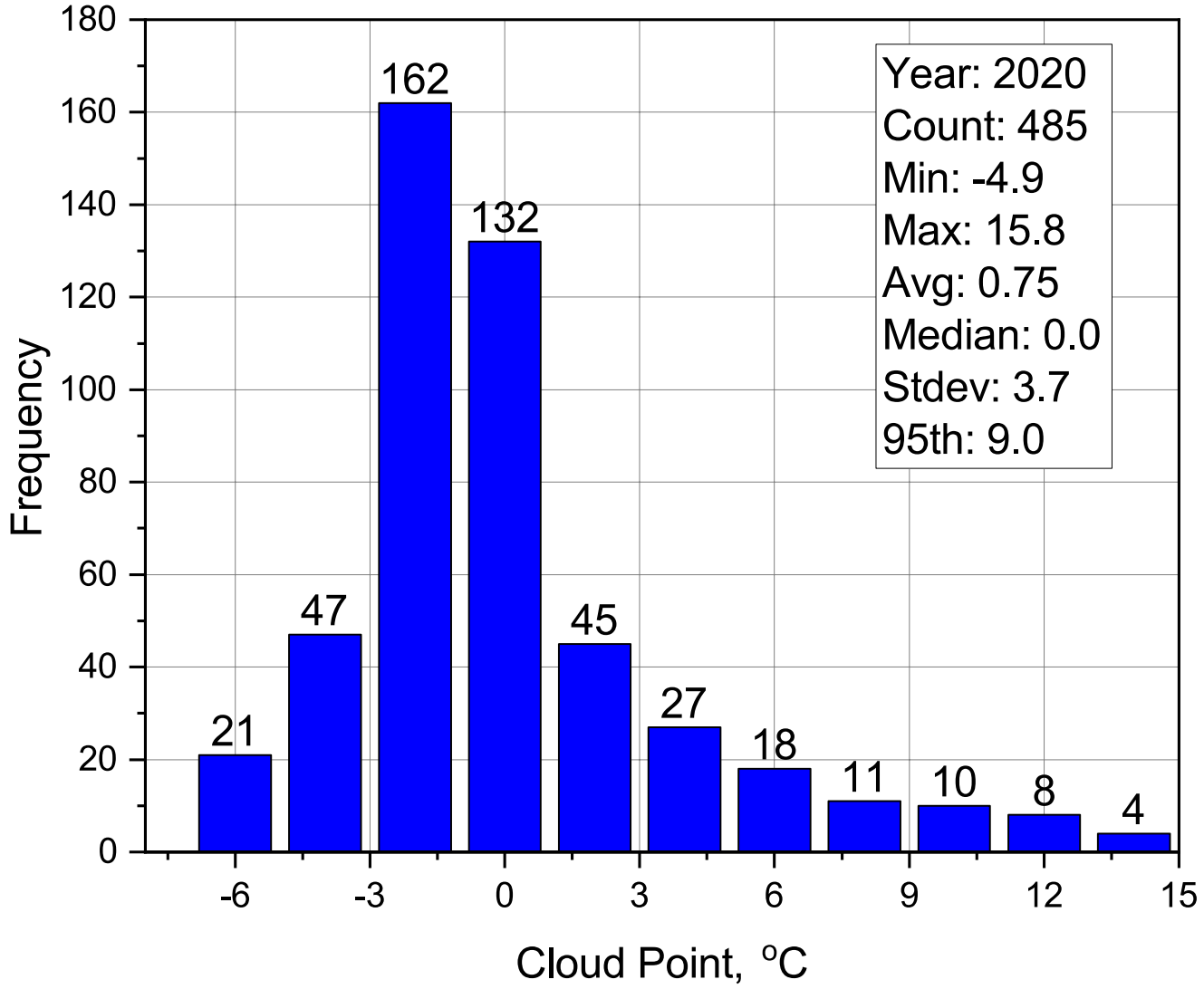
Average is over 3 times the ASTM standard for B100

D4625 Simulated Shelf Life



- All samples over the 6 hour B20 spec had over 1 year simulated storage life
- Monitoring, Re-additizing exceeded 4 years storage for all samples

Cloud Point



B100 Cloud Point is trending lower

Higher Biodiesel Blends in D396

- You can't get an ASTM industry consensus specification without lab data, bench data and field data proving the fuel actually works.
- True chicken and egg scenario:
  - Can't design equipment and do the research to prove the fuel works until you have an ASTM spec to design against and test with, but…
  - Can't get an ASTM industry consensus specification until you have lab, bench, and field data needed for a successful consensus ballot.

Addressing the Chicken and Egg Scenario

- We had ‘industry’ recommendations for B20 ‘specs’ in on/off road diesel long before ASTM had a B20 specification

- NBB worked with the Engine Manufacturers Association (EMA) who made ‘B20 Test Specifications’ available to OEMs and researchers and the technical community

- That, and lots of research and field testing, eventually turned into ASTM D7467 for on/off road diesel fuel.

‘Developmental Fuel Specification’ For Heating Oil

- To address this, NORA worked with NBB and biodiesel producers to publish ‘Developmental Fuel Specifications’ for ~B50 & B100
  - Test methods
  - Limits
- The ‘Developmental Fuel Specifications’ (DFS) serve a variety of needs:
  - Can be used by equipment companies to design equipment
  - Can be used by NORA, NBB, testing labs, and early adopters to conduct research needed to get ASTM specs
  - Can be voluntarily used by buyers and sellers while getting data for ASTM

Property	Test Method	B100 Requirements
Cold soak filterability, seconds, max	D7501	360
Calcium and Magnesium, combined, ppm, max	EN 14538	5
Flash point (closed cup), °C, min	D93	93
Alcohol Control: One of the following shall be met: - Methanol content, mass %, max - Flash point, °C, min	 EN 14110 D93	 0.2 130
Water and sediment, % volume, max	D2709	0.050
Kinematic viscosity, mm^2/s, 40 °C	D445	1.9-6.0
Sulfated ash, % mass, max	D874	0.020
Copper strip corrosion, max	D130	No. 3
Sulfur, parts per million (ppm), max Grade S15 Grade S500	D5453	 15 500
Cloud point, °C	D2500	Report
Carbon residue, % mass, max	D4530	0.050
Acid number, mg KOH/g, max	D664	0.50
Free glycerin, % mass, max	D6584	0.020
Total glycerin, % mass, max	D6584	0.240
Phosphorus, parts per million (ppm), max	D4951	10
Distillation temperature, Atmospheric equivalent temperature, 90 % recovered, °C, max	D1160	360
Sodium and Potassium, combined, ppm, max	EN 14538	5
Oxidation stability, hours, min	EN 15751	6

Heating Oil B100 Developmental Fuels Specifications:

Current D6751 with same oxidation reserve as B6-B20 (6 hours)

Heating Oil B50 Developmental Fuels Specifications:

Property	Test Method	B50 Requirements
Distillation Temperature, °C 90 % volume recovered, min 90 % volume recovered, max	D86	 282 360
Kinematic viscosity at 40 °C, mm^2/s min max	D445	 1.3 6.0
Pour Point °C, max	D97	Report
Ramsbottom carbon residue on 10 % distillation residue percent by mass, max	D524	0.35
Density at 15 °C, kg/m^3, max	D1298	Report
Oxidation Stability, hours, min	EN15751	6
Acid Number, mg KOH/g, max	D664	0.5
Biodiesel Content, percent (V/V)	D7371	45-55
Flash Point, °C, min	D93 – Proc. A	38
Sulfur, parts per million, max Grade S15 Grade S500 Grade S5000	 D5453 D2622 D2622	 15 500 5000
Water and sediment, percent by volume, max	D2709	0.05
Lubricity, HFRR @ 60 °C, micron, max	D6079/D7688	520
Copper strip corrosion rating, max, 3 h at a minimum control temperature of 50 °C	D130	No. 3
Conductivity (pS/m) or Conductivity Units (C.U.), min	D2624/D4308	25

- Performance based on values in D396 or D6751

Plans at ASTM for blends over B20 in the heating oil market

- Focus intense industry R&D over the next 1-2 years, and begin balloting consensus spec in ~ 2 years
  - Validate oxidation reserve w higher blends
    - Is 6 hours sufficient for B50/B100? Do we need different advice?
  - Field experience to confirm fuel performance is as expected
  - Equipment companies / users confirm performance
  - How best to address cold flow needs
- Ballot changes in ASTM D396 to cover higher blends
- R&D results and industry needs/direction will determine what to ballot, and when

Thoughts from the ASTM Chair: Options for Heating Oil ASTM Specs Over B20

- Use the NORA DFS as starting place

- What do fuel suppliers, regulators/legislators, and equipment companies need in terms of higher blend specifications:
  - Buy/sell fuel and design equipment
  - Monitor quality
  - Support legislation and incentives

UL Status—Higher Biodiesel Blends

- UL 296 is the safety standard for burners
- Fact Finding, Letter issued in 2008
  - No. 2 UL testing covers B5
- UL recently updated UL296 for B6-B20
  - New B20 test fuels, longer elastomer testing
- Working group on blends over B20 formed immediately after B6-B20 procedures released
  - UL staff, Beckett, Carlin, NORA, NBB
- No need for interim level, just set for B100
  - Use current D6751 as the specification for B100
- B100 testing will cover blends between B21-B100

UL Status—Higher Biodiesel Blends

- Plan is to change UL296 with use of annexes
  - Similar to that done for B6-B20
  - Keeps it all in one standard—easier for manufacturers
- UL296 working group developed language for updating the procedures:
- Currently out for ballot, due Mid November 2022