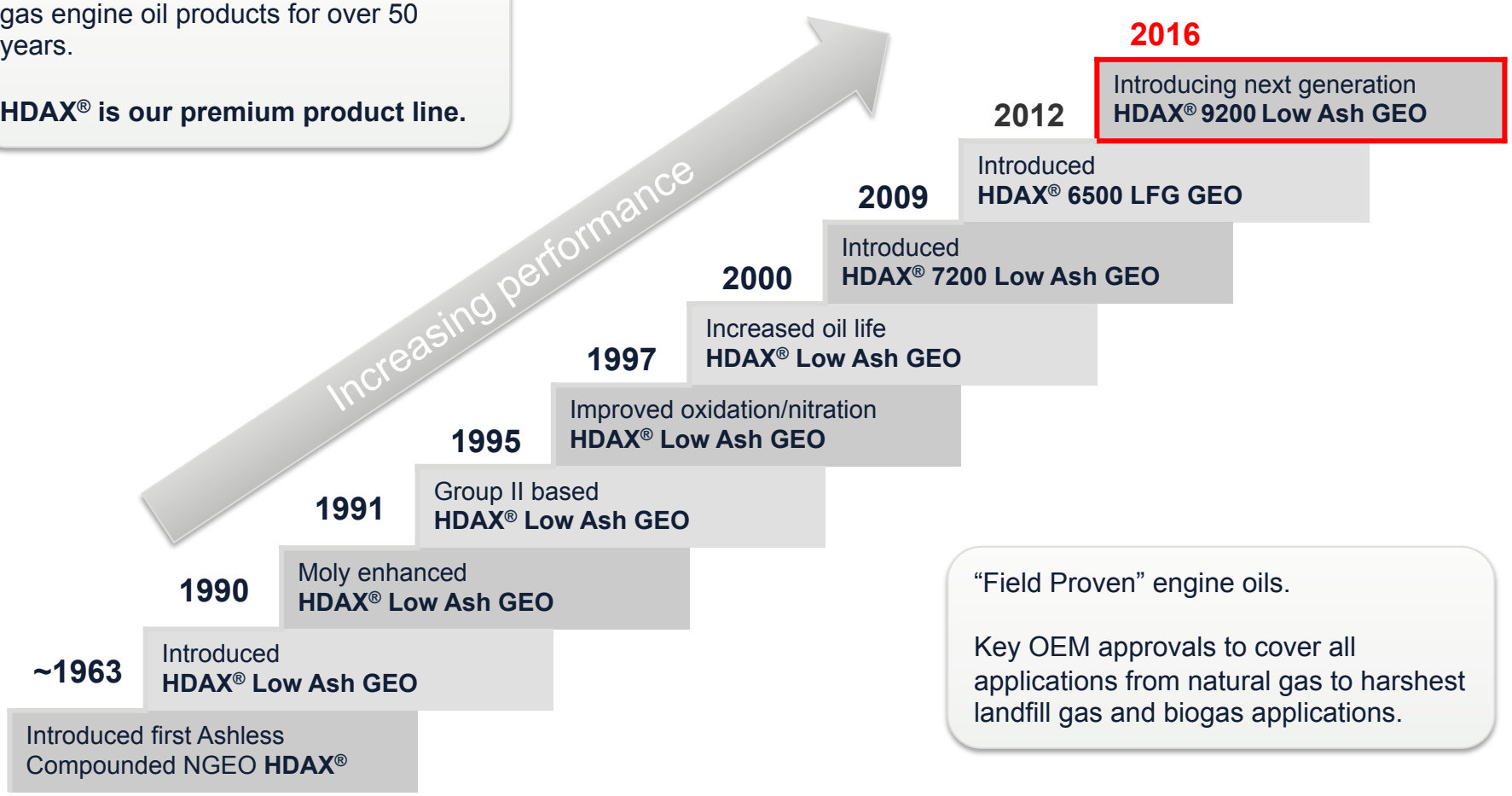
HDAX® Low Ash Gas Engine Oil

CHEVRON LUBRICANTS CAN HELP YOU **RUN BETTER LONGER**

HDAX® Industry "Firsts" in Gas Engine Oils

Chevron has developed and produced gas engine oil products for over 50 years.

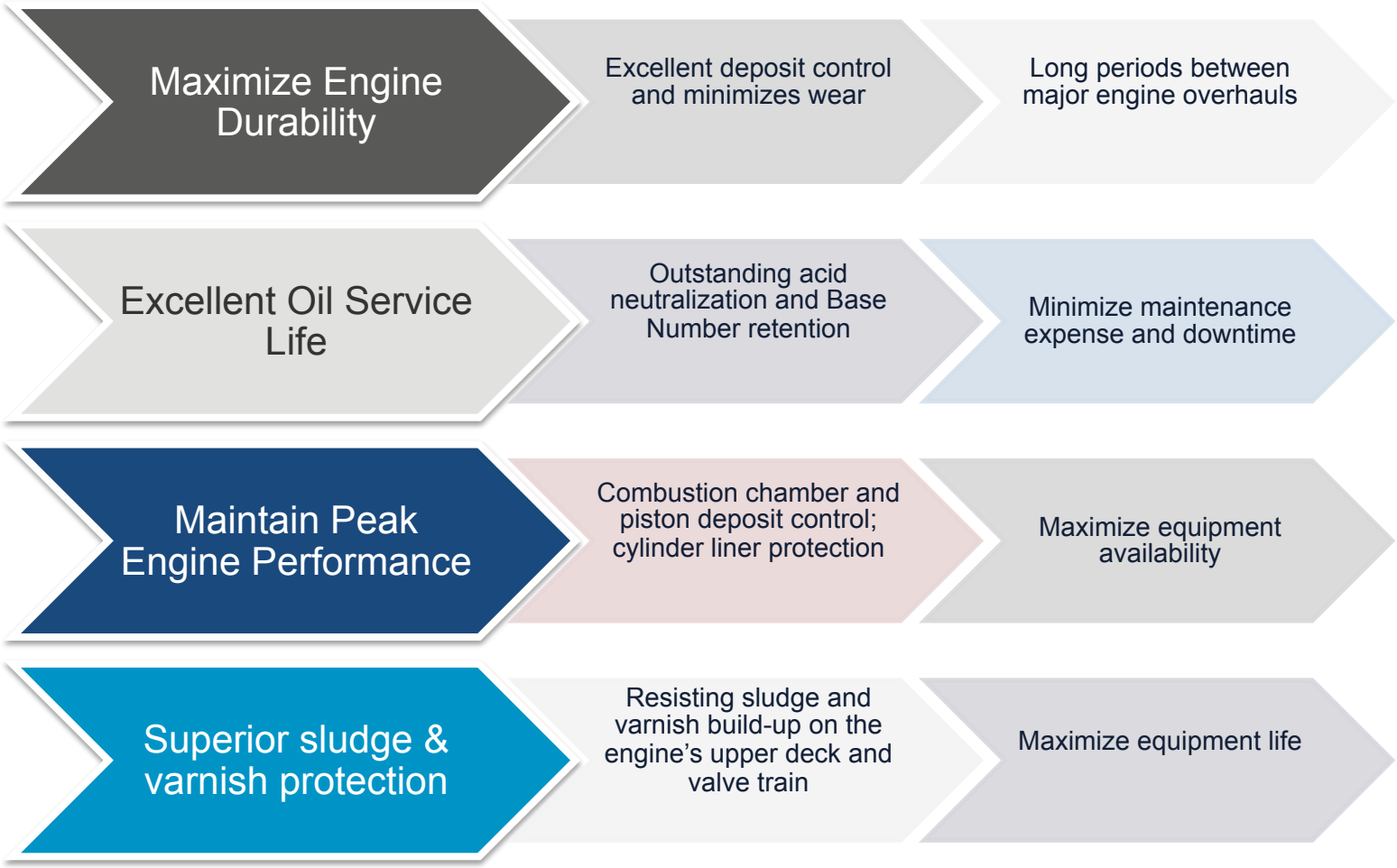
HDAX® is our premium product line.



"Field Proven" engine oils.

Key OEM approvals to cover all applications from natural gas to harshest landfill gas and biogas applications.

Formulated to Protect Engines Rated with a High BMEP (Brake Mean Effective Pressure)



Applications

- HDAX® 9200 Low Ash Gas Engine Oil is formulated to provide the ultimate in engine protection for new generation, high output four-stroke cycle engines with a steel piston design.
  - High BMEP rating
  - Medium to high psi
  - Turbocharged
  - Low emission designs
  - Lean-burn and stoichiometric burning sweet natural gas or LPG
  - Operating under high load, high temperature

Applications

- Natural gas engines in power generation and gas gathering applications
- Four-stroke cycle medium-speed stationary spark ignition and dual-fuel engines
- Four-stroke cycle gas engines in cogeneration applications
- Formulated to meet non-selective catalytic reduction (NSCR) compatibility requirements and is suited for installations requiring low phosphorus oil to help prevent exhaust catalyst poisoning. NSCR reduces the emissions of NOx, CO, and hydrocarbons (HC), by converting to carbon dioxide, nitrogen and water.
- Suitable for use with fuels containing low levels of sulfur and chloro-fluoro-carbons (CFC).

Caterpillar Gas Engine Brands

- Caterpillar Inc
  - Markets CAT, MWM and Perkins brands of gas engines
    - CAT
      - The Cat brand is the cornerstone of the Caterpillar brand portfolio
    - MWM
      - MWM gas engines can operate on a wide range of gaseous fuels and have power outputs between 400 kW and 4,300 kW.
    - Perkins
      - A global supplier of gas and diesel engines in the 4-2000 kW/5-2800 hp range.
      - The largest portion of sales is into the European market.

GE Gas Engine Brands

- GE
  - Markets Jenbacher and Waukesha brands of gas engines
    - Jenbacher
      - Jenbacher gas engines have a power range of 250 kW to 10 MW with fuel flexibility to run either on natural gas or a number of other gases.
      - More than 15,500 Jenbacher gas engines are operating in 100-plus countries.
    - Waukesha
      - Designs for both rich-burn and lean-burn.
      - Capable of operating on a wide range of fuels, from 400 to 2,350 BTU/sq.ft

GE Gas Engine Brands

- GE
  - Owns Ajax
    - Two-stroke engine-compressors
    - Ajax engines are rated 22 to 845 hp (16 to 630 KW)
  - Owns Superior
    - Four-stroke cycle engines rated 400 to 2700 hp (300 to 2000 KW)

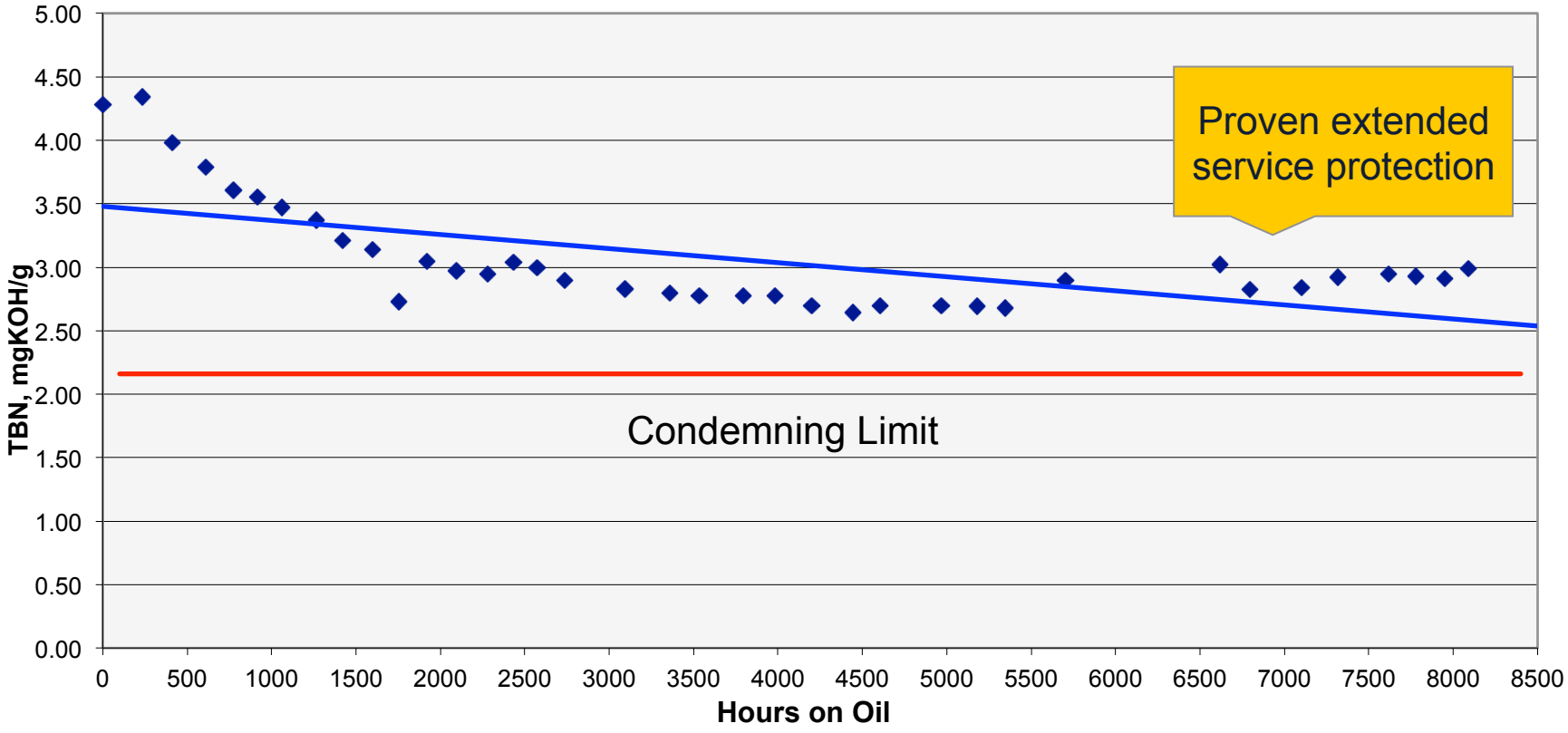
Chevron HDAX® 9200 Low Ash Gas Engine Oil

Caterpillar Field Test
Cat G3516 TALE E+

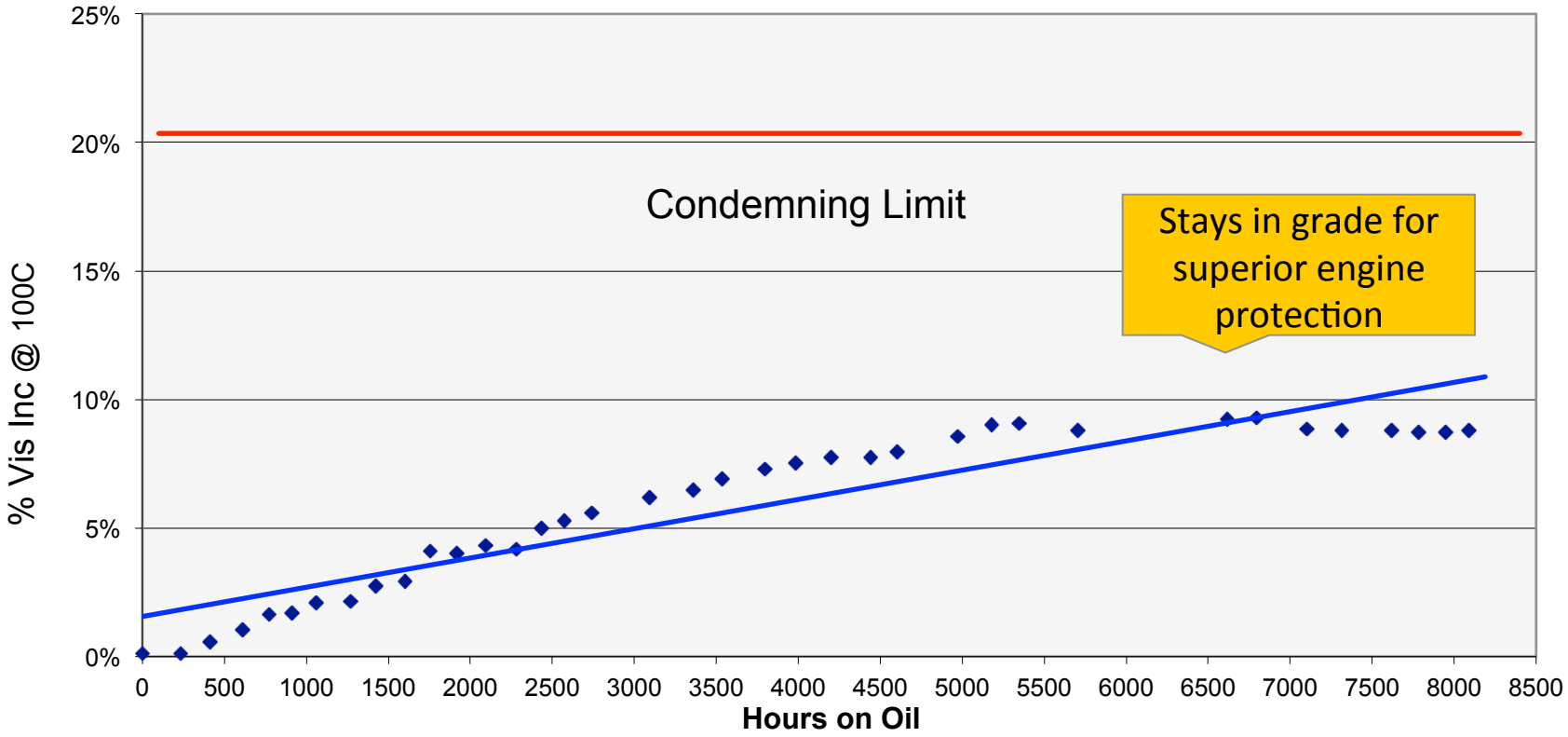
Caterpillar Field Test Engine Parameters

- Test Duration: 1 year
- Site : Loughborough, England
- Engine Type : Caterpillar 3516 TALE E+
- Gas Type : Natural
- Power Per Displacement: 30.9 basis 2132 BHP
- Displacement: 69 Liter
- Engine ran at 100% load for over 8,000 hours
- Oil in service for over 8,000 hours with no oil change
- After 8,089 field test hours, the engine was in overall excellent condition with low deposits and low wear

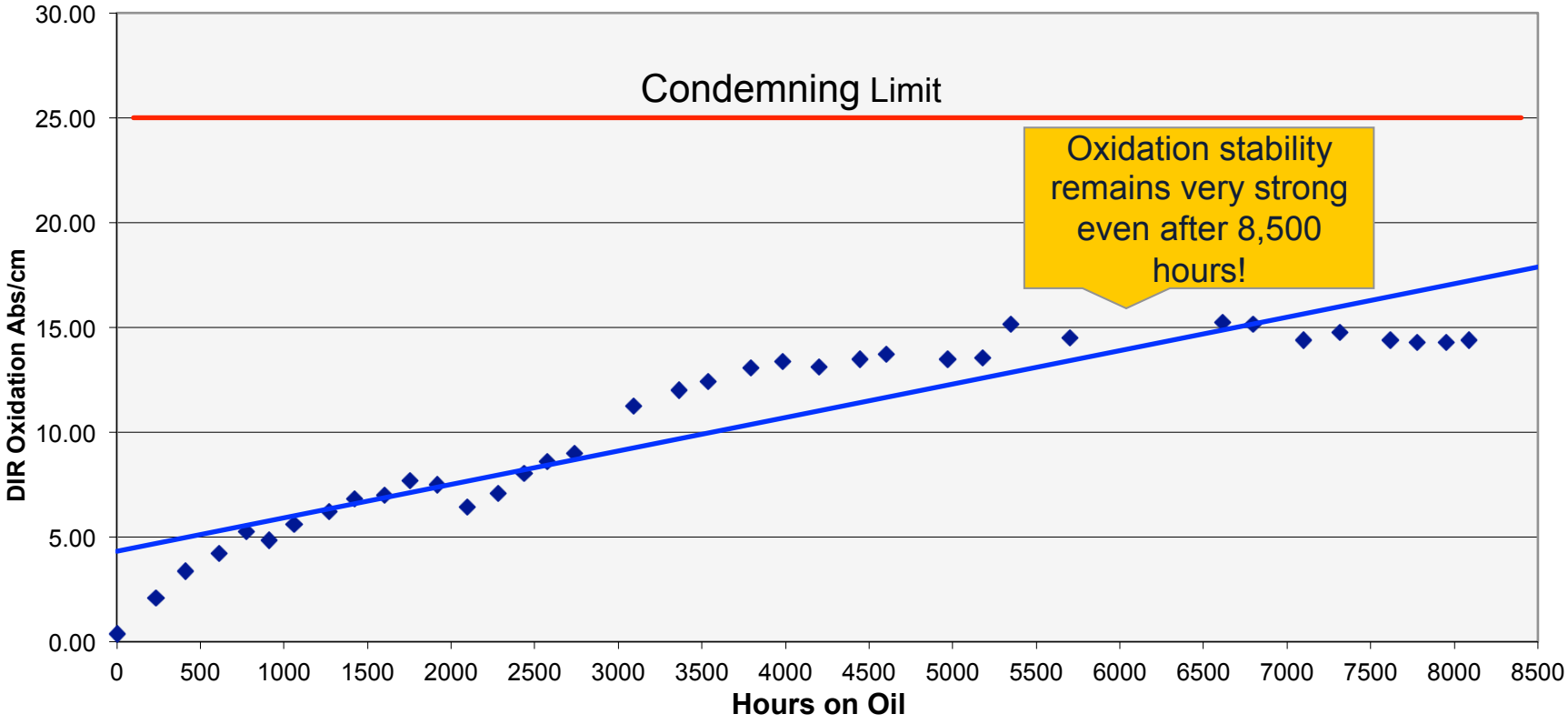
Caterpillar G3516 TALE E+ Field Test:
Total Base Number Retention (ASTM D2896)



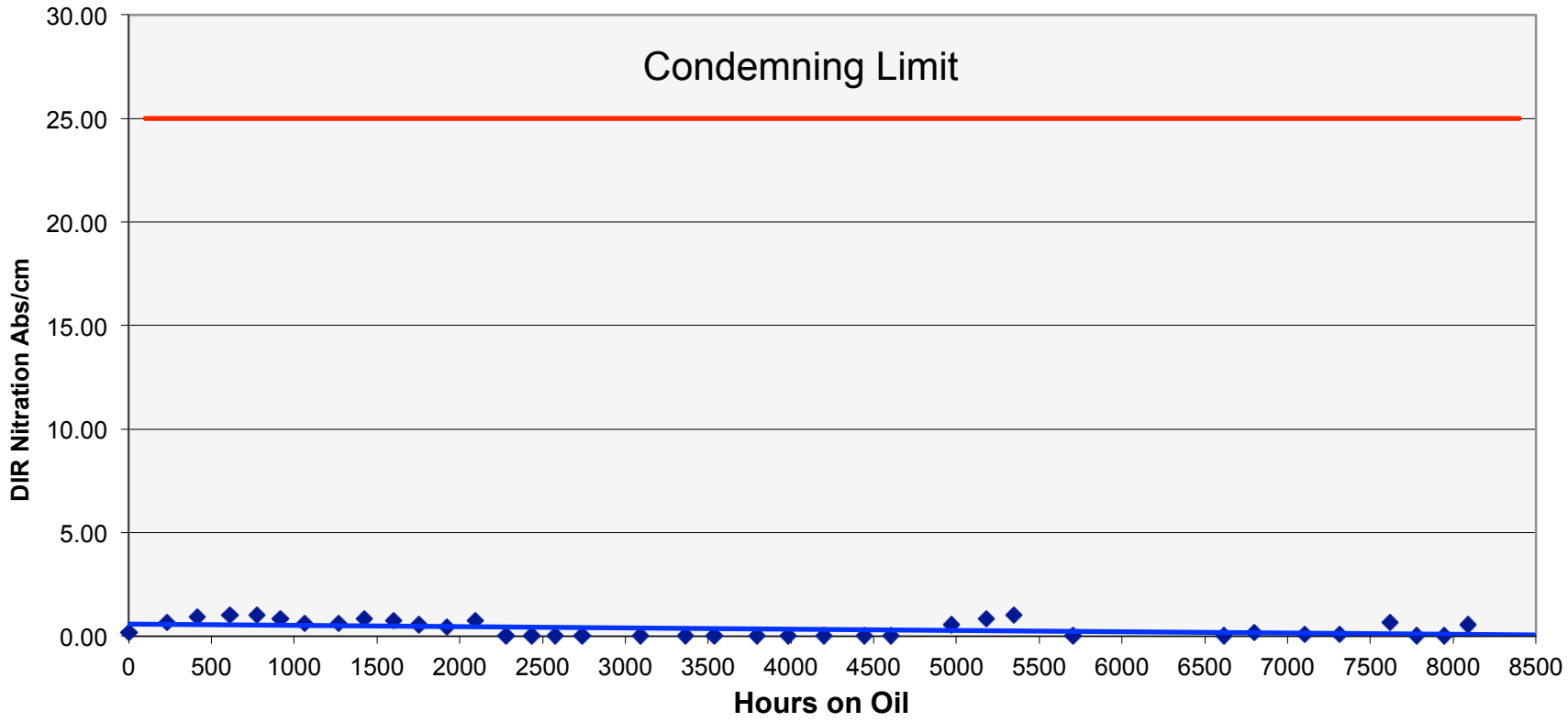
Caterpillar G3516 TALE E+ Field Test: Viscosity Increase



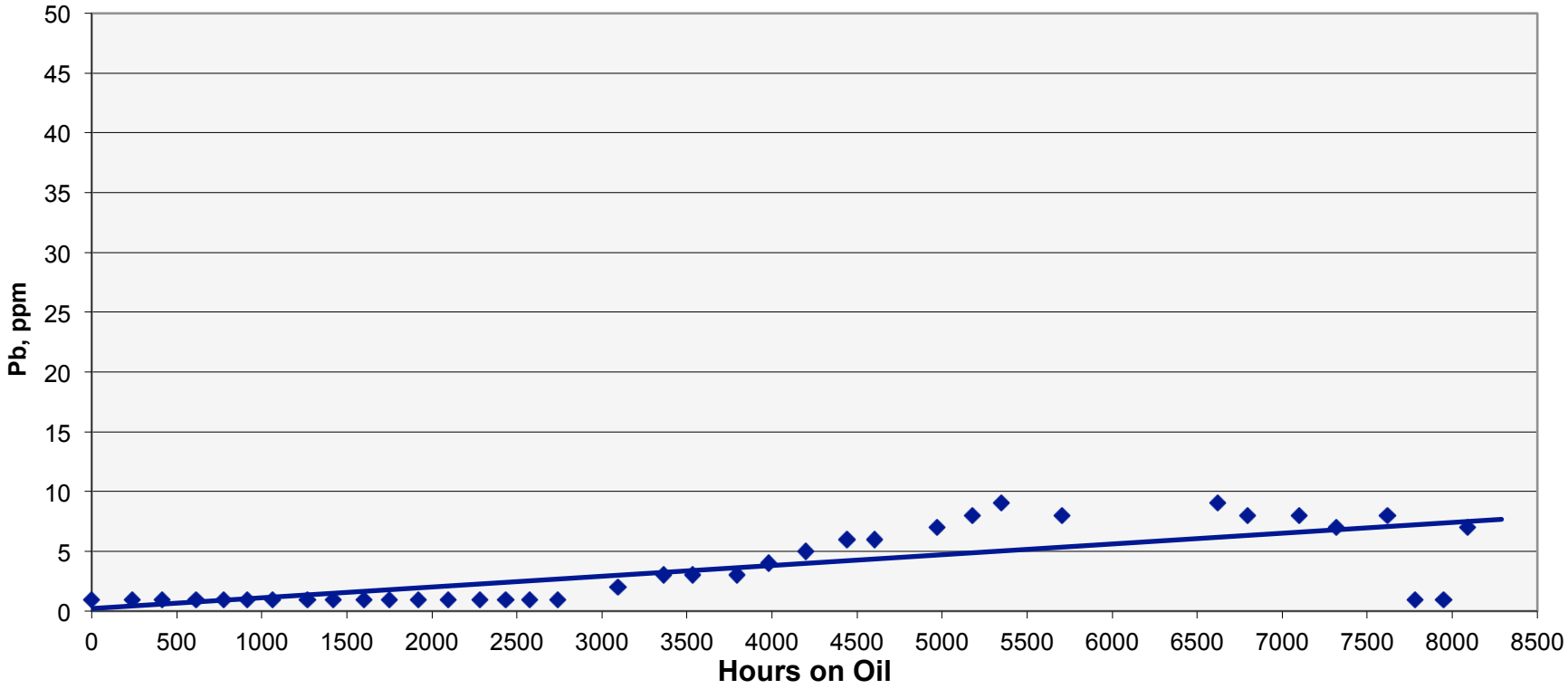
Caterpillar G3516 TALE E+ Field Test: Oxidation



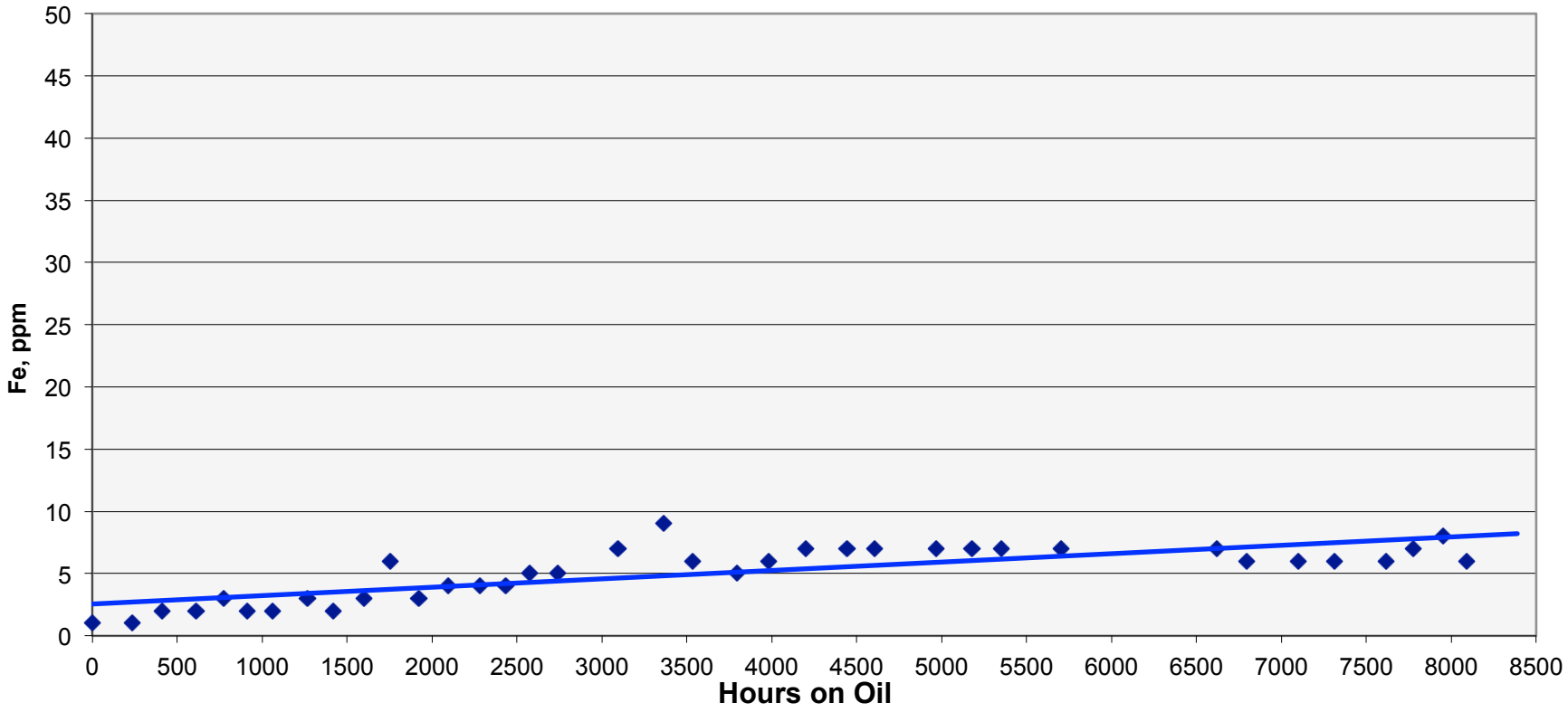
Caterpillar G3516 TALE E+ Field Test: Nitration



Caterpillar G3516 TALE E+ Field Test: Wear Elements (Lead)



Caterpillar G3516 TALE E+ Field Test: Wear Elements (Iron)



Chevron HDAX® 9200 Low Ash Gas Engine Oil

Caterpillar G3516 TALE E+ Field Performance

Top Ring Turn Around Thrust-Side

Excellent protection with cross hatch pattern retained.

Mid-stroke Thrust-Side

Piston Ring Land

Connecting Rod Bearing

Photos are from the 8,000 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

Caterpillar G3516 TALE E+ Field Performance

Rocker Assembly

Rocker Cover

Crankcase Cover

Spark Plugs

Photos are from the 8,000 hour end of test engine inspection

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Caterpillar G3516 TALE E+ Field Performance

Piston: Thrust & Anti-Thrust

Piston Front & Rear

Piston Ring Land:Thrust & Anti-Thrust

Piston CrownTop & Undercrown

Photos are from the 8,000 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

Caterpillar G3516 TALE E+ Field Performance

Valves

Valves

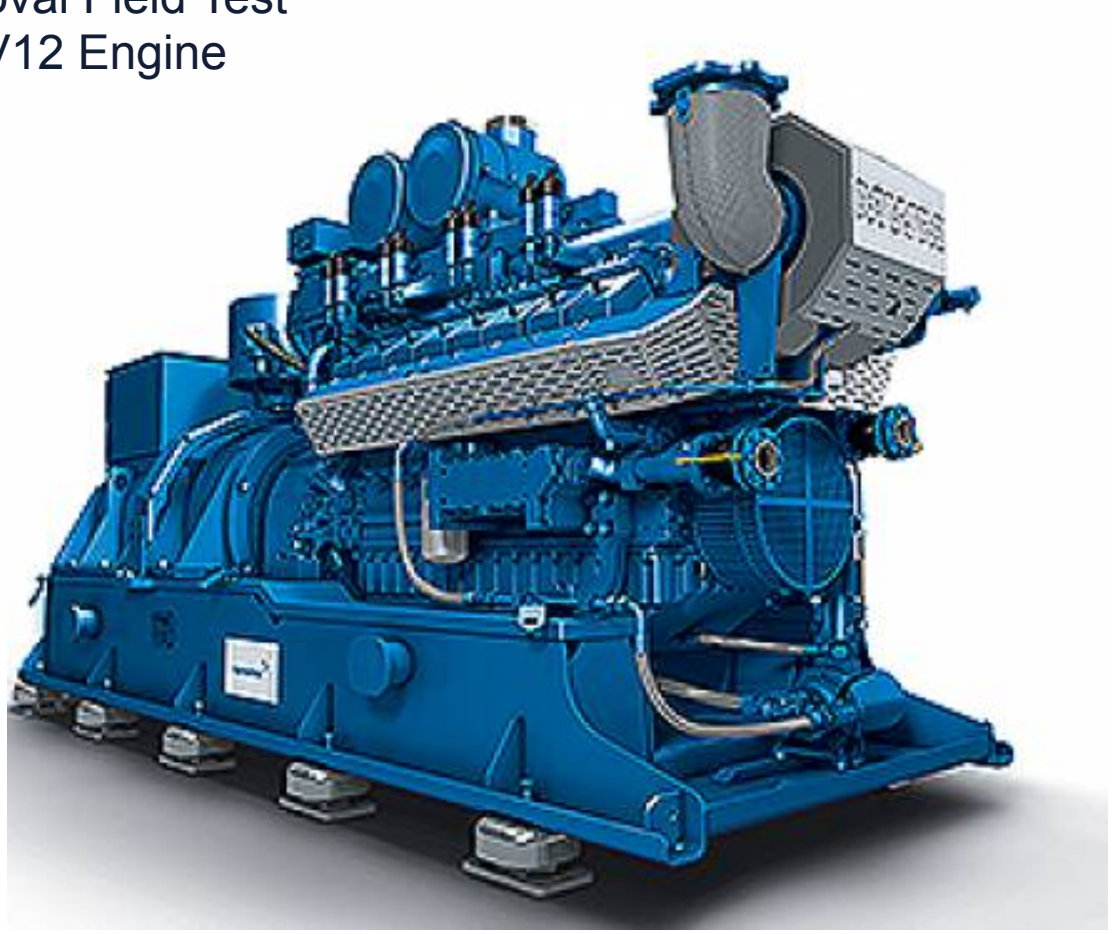
Cylinder Head Fire Face

Valve Deck

Photos are from the 8,000 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

MWM Approval Field Test
TCG 2016 V12 Engine



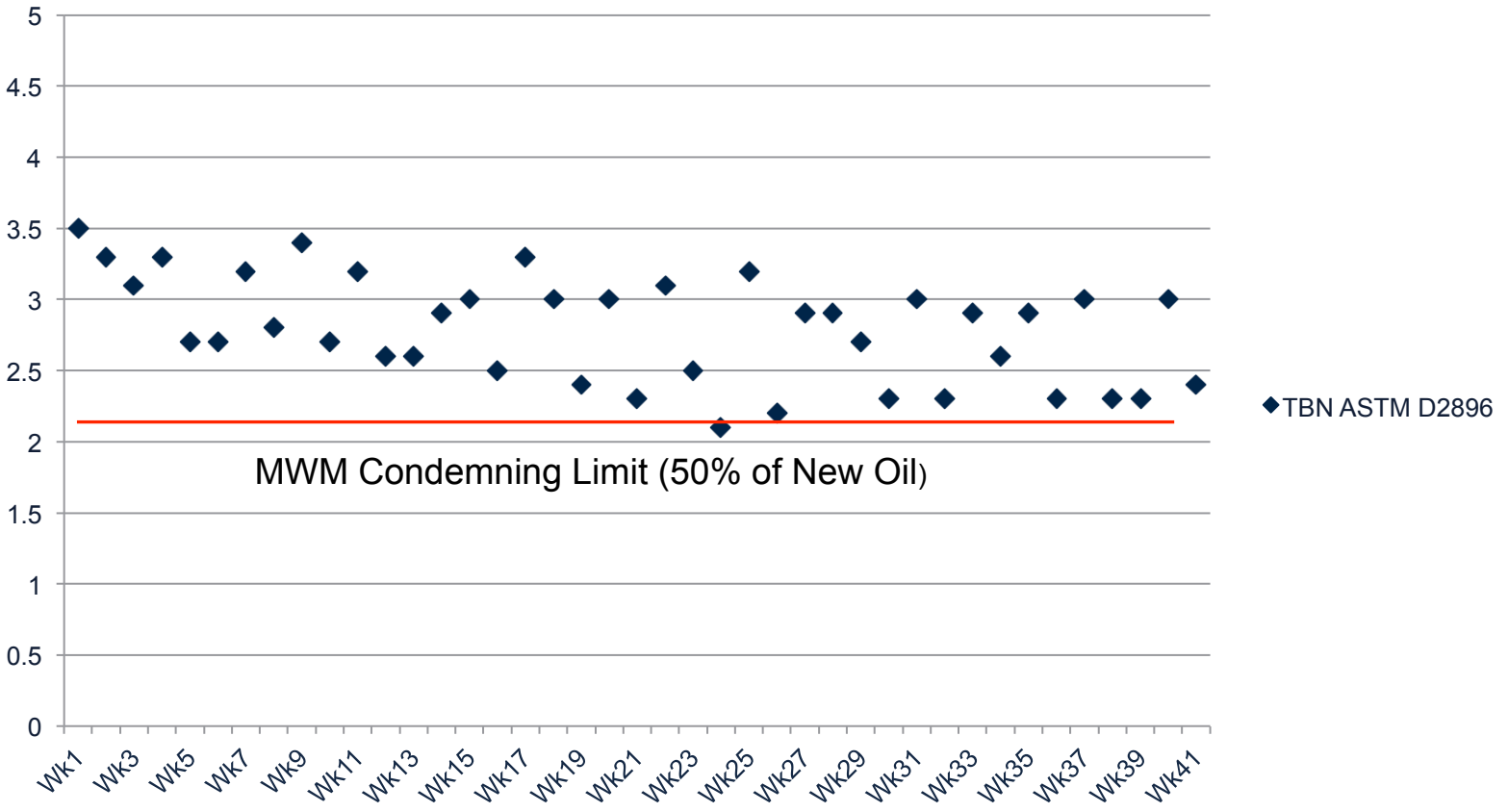
MWM Approval Field Test Engine Parameters

- Test Duration: 18 Months
- Site: The Netherlands
- Engine Type: MWM TCG 2016 12 cylinder
- Gas Type: Natural
- Rated Output: 600kW
- Power output: 570 kW (95%)
- Average oil drain interval (filled to 70 Liters/18 gallons): 400 hours
- Oil sump size: 90 Liters/24 gallons
- Operating hours at End of Test inspection: 9,644 hours
- 3 identical engines participated in the trial
  - One engine was refilled with Chevron HDAX® 9200 Low Ash Gas Engine Oil

MWM Approval Field Test Results

- This particular MWM engine has a relatively small sump size (90 liters/24 gallons) and experiences higher thermal loading than larger engines, which typically have sump sizes from 200 to 950 liters (55 to 250 gallons).
- The MWM approval condemning limit for TBN based on ASTM D2896 is 2.0.
- Oil drain intervals for this engine are typically 300 to 500 hours.
- The MWM TCG 2016 engine experiences much thermal loads than other engine types.

MWM TCG 2016 V12 Field Test
Total Base Number Retention (ASTM D2896)



Chevron HDAX® 9200 Low Ash Gas Engine Oil

MWM Approval Field Test
TCG 2016 V12 Engine

Piston Ring Land

Cylinder Liner

Photos are from the 9,644 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

MWM Approval Field Test
Deposit Control

Piston crown / combustion chamber

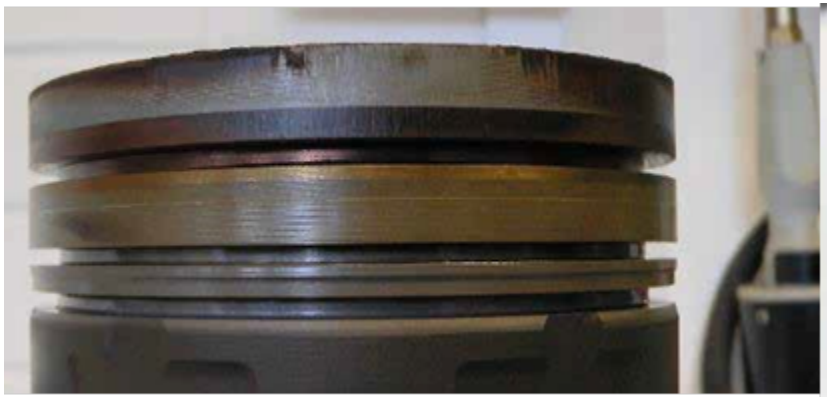
Piston undercrown

Photos are from the 9,644 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

MWM Approval Field Test
Deposit Control

Piston Ring Land



Piston Ring Land

Photos are from the 9,644 hour end of test engine inspection

Chevron HDAX® 9200 Low Ash Gas Engine Oil

Waukesha Approval Field Test
Waukesha VHP L7044GSI Engine

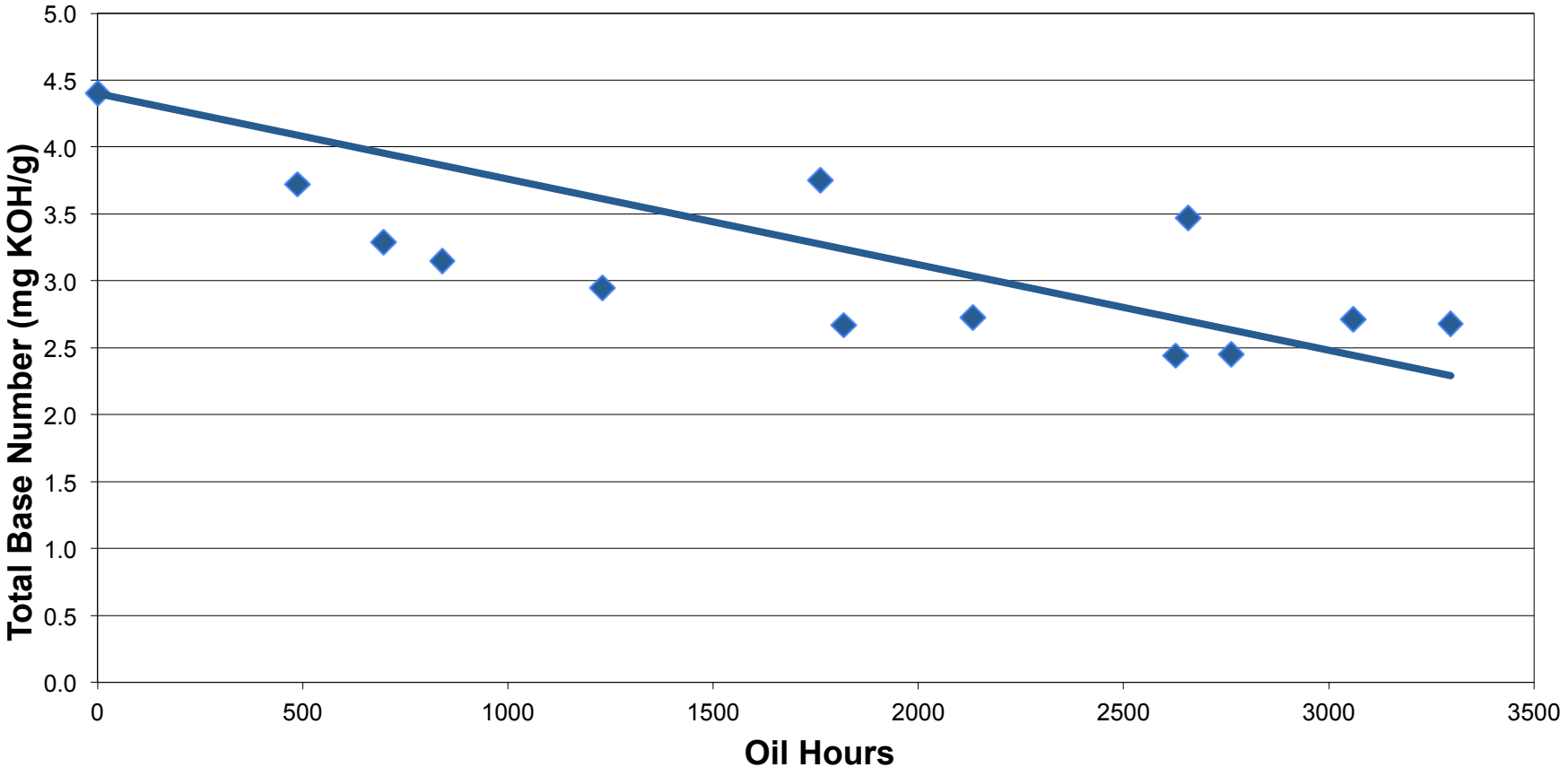
Waukesha Approval Field Test Engine Parameters

- The purpose of this field test was to meet the test requirements established by Waukesha in order to gain Waukesha's approval, based on actual field experience.
- The testing was conducted at a natural gas processing plant in Texas, USA over a one year period.
- **The Chevron HDAX® 9200 Low Ash Gas Engine Oil used in the field test was replaced every 2,896 hours (on average).**
  - This surpasses the Waukesha normal operation recommendation 1,000 hour oil change interval and the extended interval of 1,500 hours (the engine's filtration must meet certain conditions).

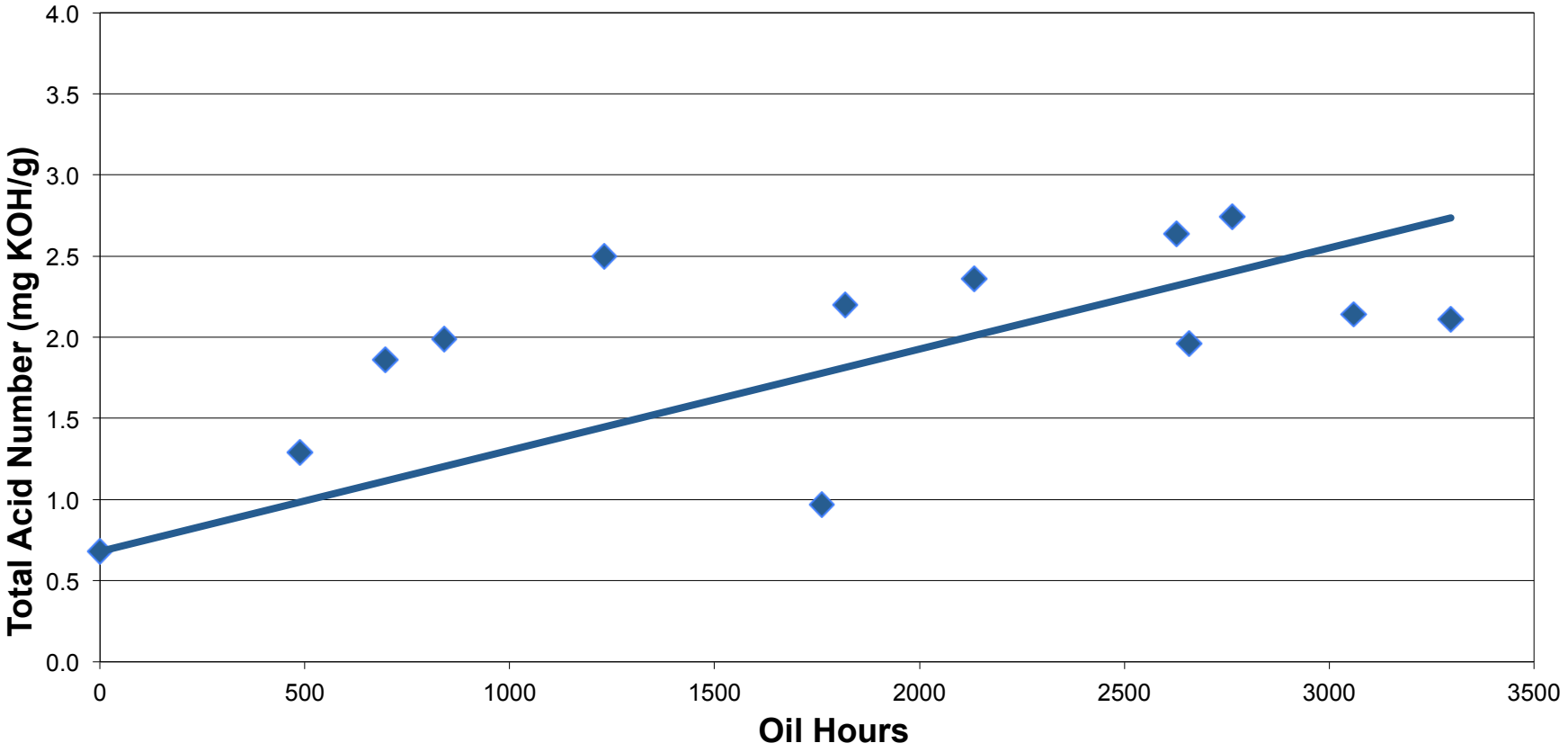
Waukesha Approval Field Test Engine Parameters

- Test Duration: One year
- Site: Texas, USA
- Engine Type: Waukesha VHP L7044GSI 12 cylinder
- Gas Type: Natural
- Rated Output: 1680 BHP (1253 kW) @ 1200 rpm
- Average load was at 92% at 1188 rpm
- Average Emissions: O2% 0.19; Nox: 2,478 (ppm)
- Oil consumption averaged 2.5 gallons per day
- Average oil drain interval was 2,896 hours
- The engine accumulated 8,839 test hours at end of test inspection

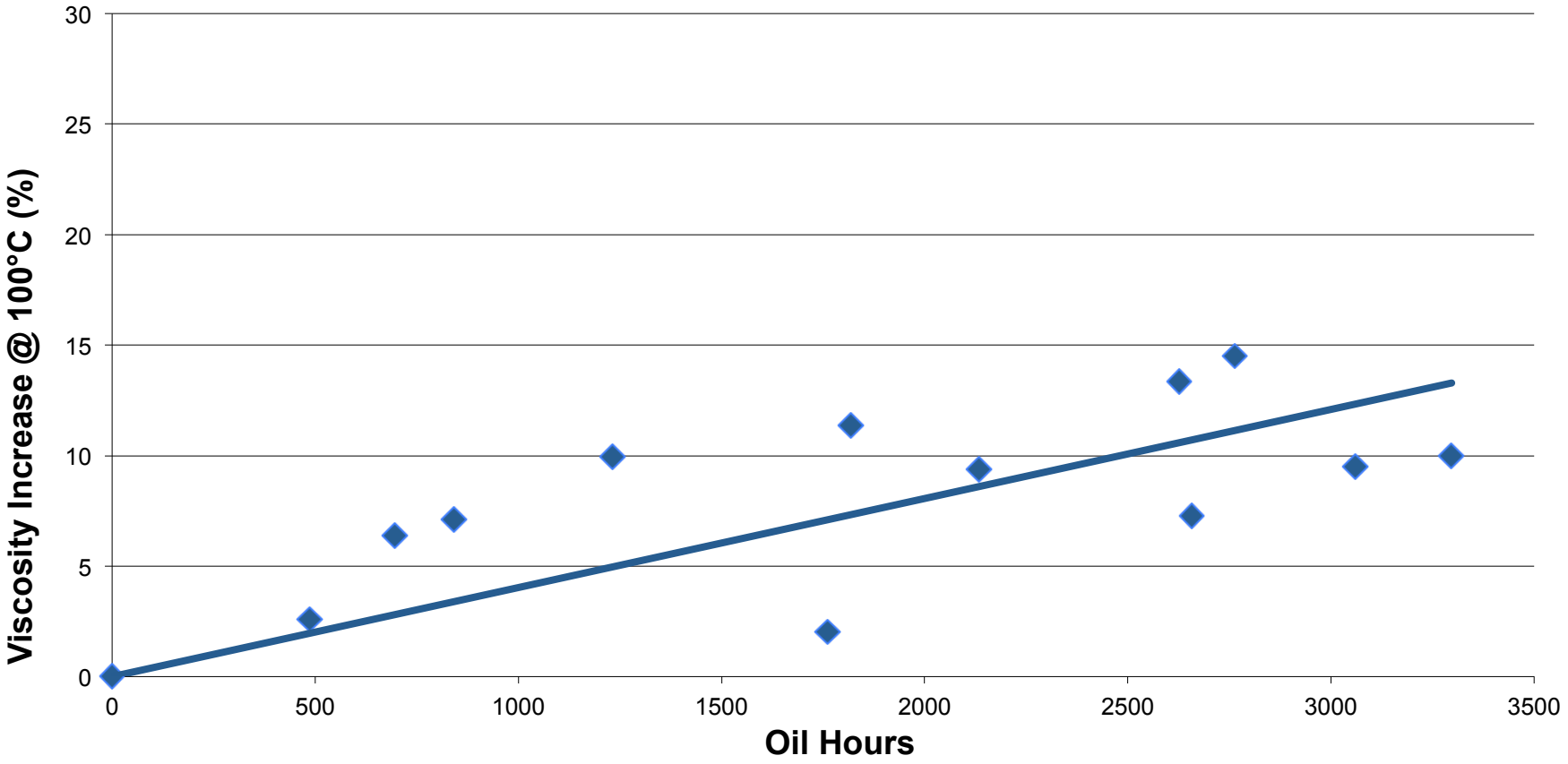
Waukesha VHP L7044GSI Field Test
Total Base Number Retention (ASTM D2896)



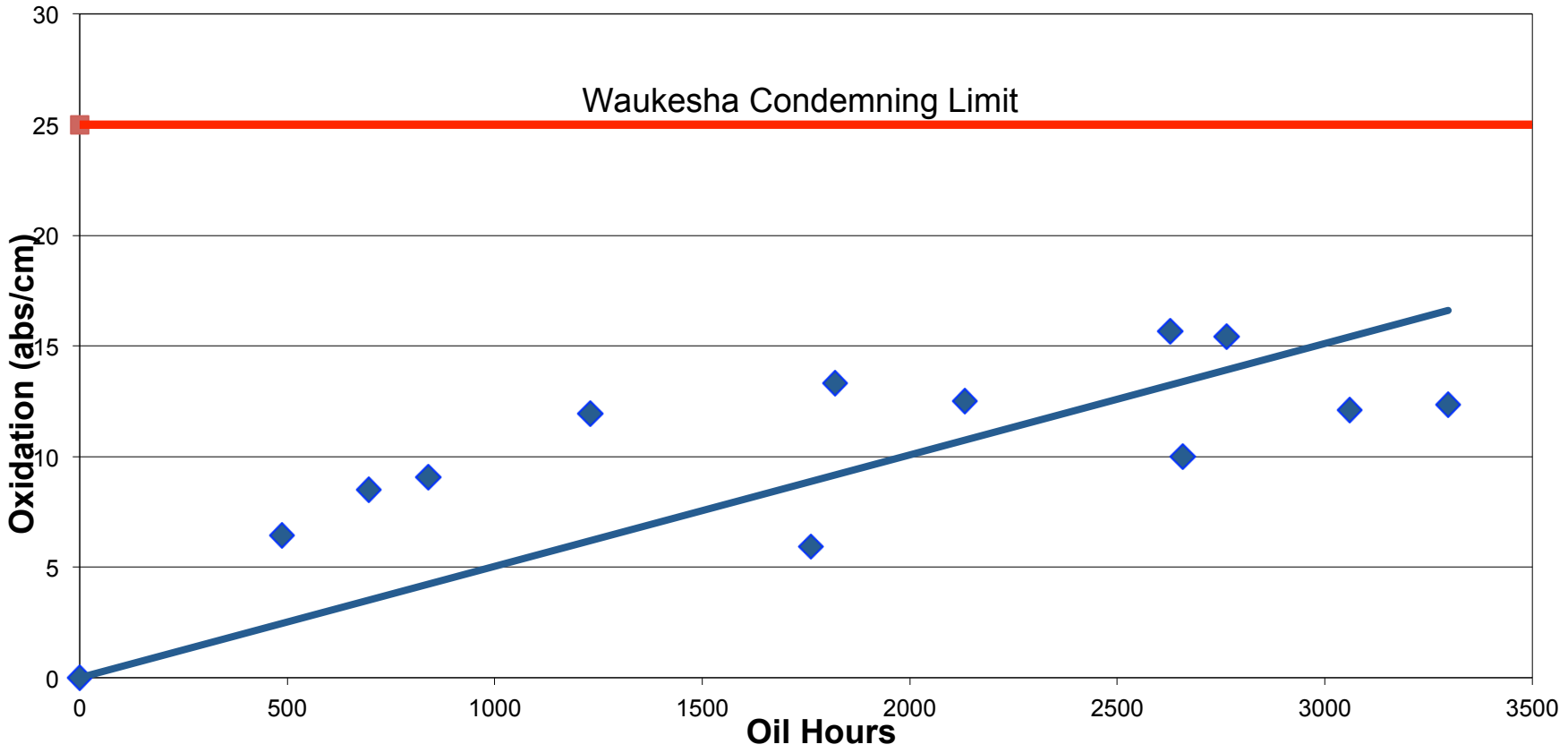
Waukesha VHP L7044GSI Field Test Acid Number



Waukesha VHP L7044GSI Field Test Viscosity Increase



Waukesha VHP L7044GSI Field Test Oxidation



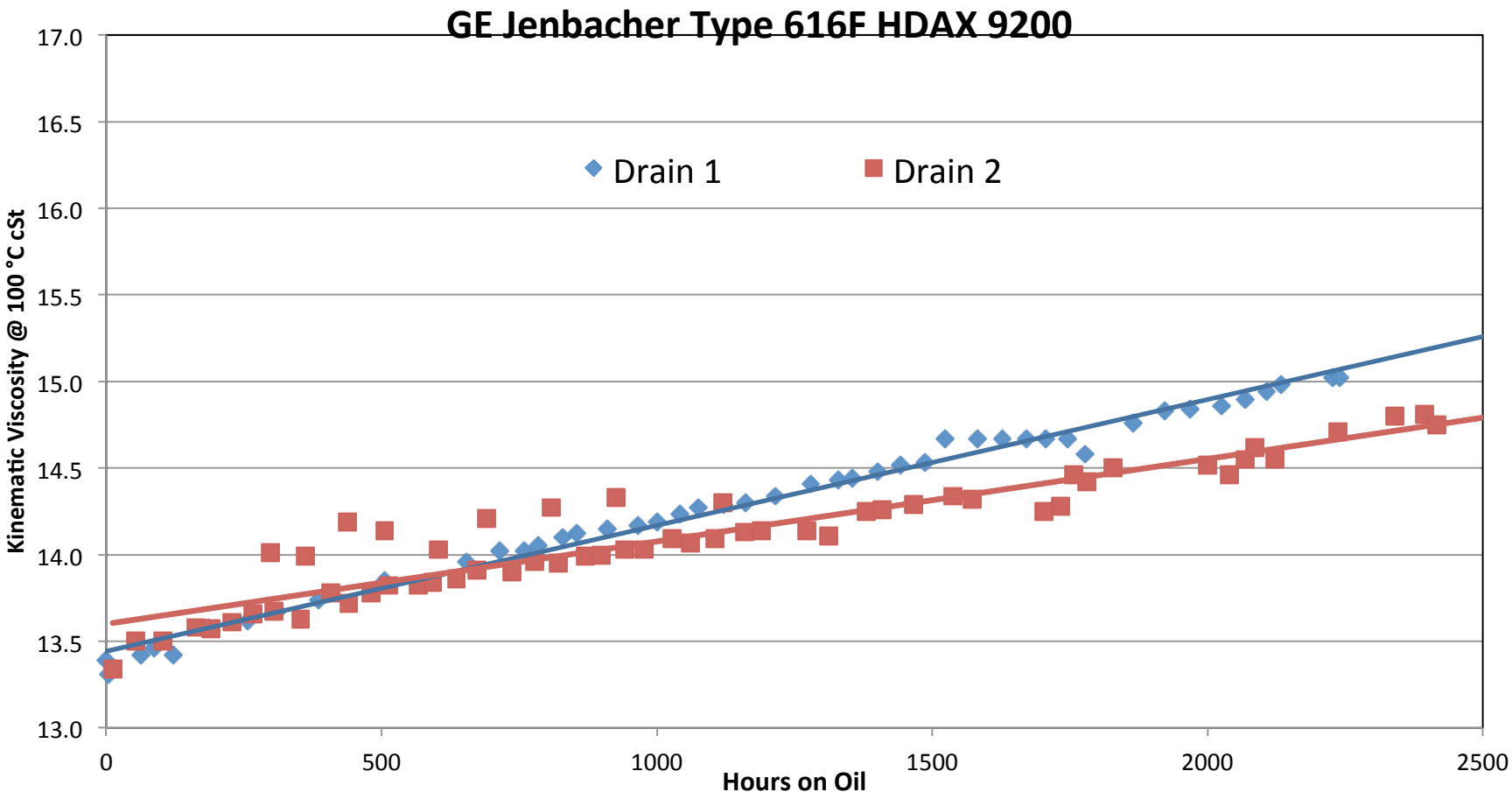
Chevron HDAX® 9200 Low Ash Gas Engine Oil

GE Jenbacher Approval Field Test
Type 6F Engine

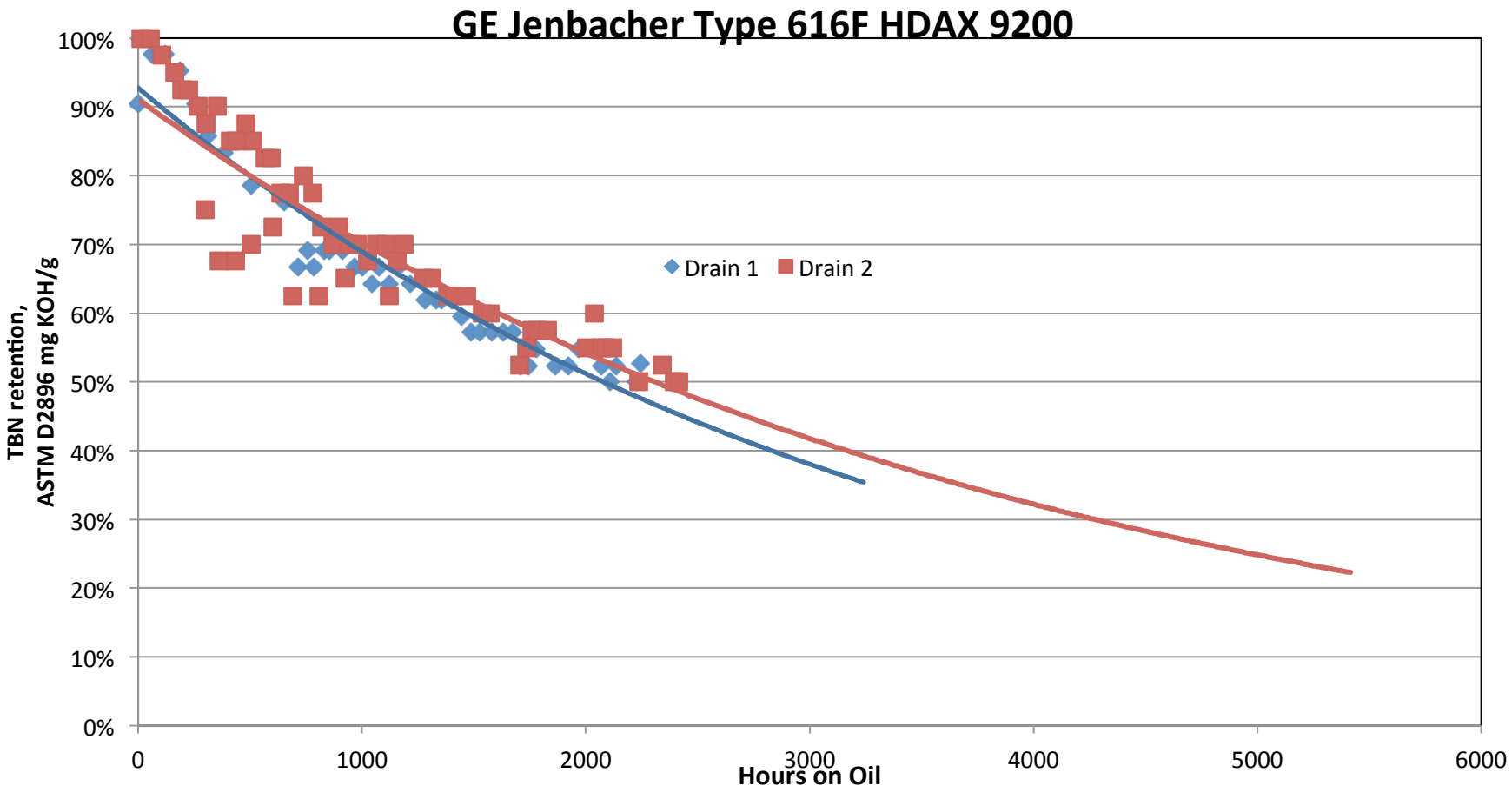
GE Jenbacher Approval Field Test Engine Parameters

- Test Duration: One year+
- Site : Antwerp, Belgian
- Engine Type: Type 6F
- Gas Type: Natural
- Oil consumption averaged gallons per day
- Average oil drain interval was 2,896 hours
- The engine accumulated 8,839 test hours at end of test inspection

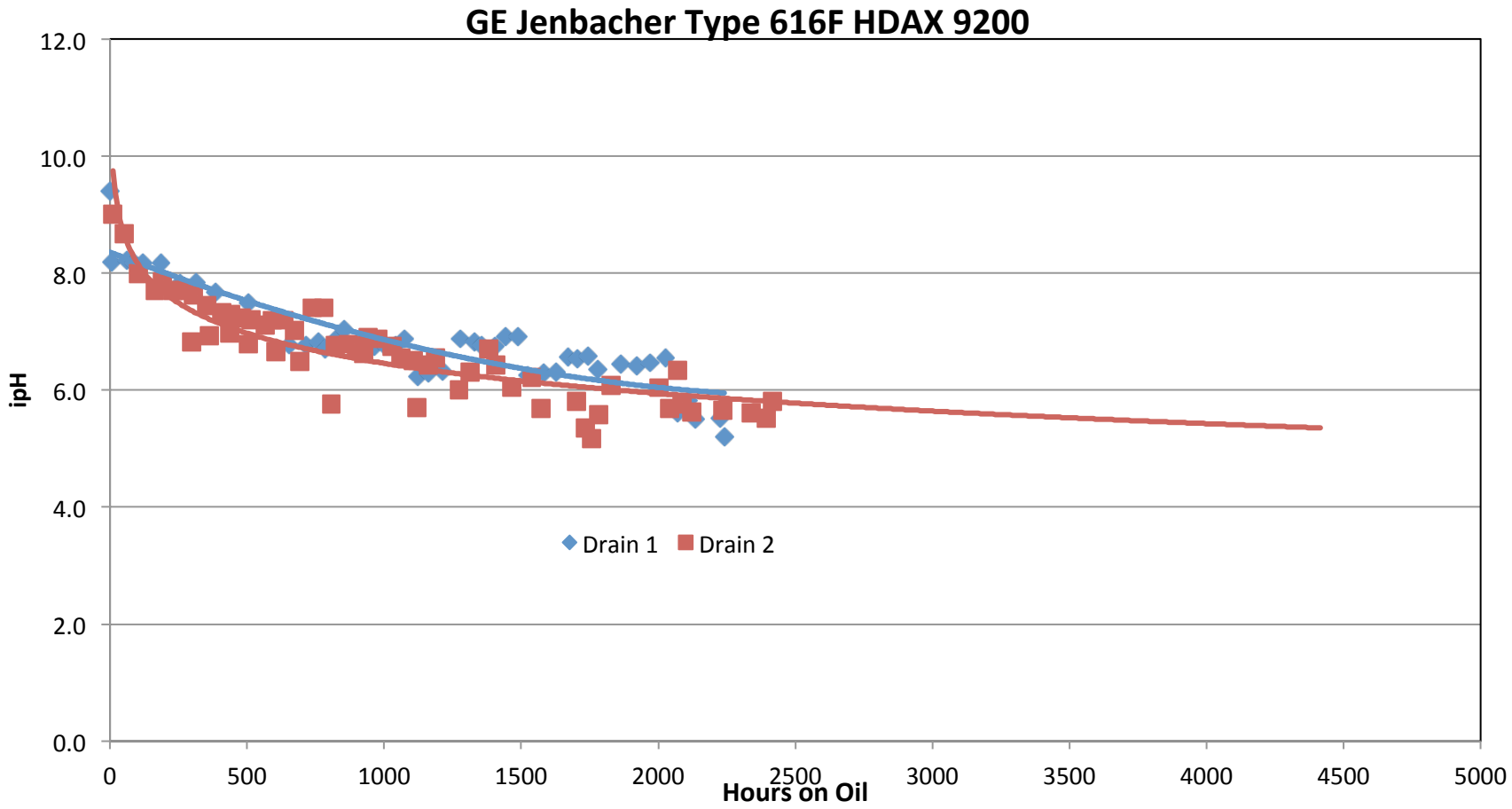
GE Jenbacher Type 6 Field Test: Wear Elements (Lead)



GE Jenbacher Type 6 Field Test: Wear Elements (Lead)



GE Jenbacher Type 6 Field Test: Wear Elements (Lead)



Thank You.

Chevron Reliability — The RBL™ Program is our commitment of business support and reliability: Chevron's lubrication expertise combined with superior products and a tailored service program work together to help your business Run Better Longer.