

# **Cummins M11 EGR Crosshead Wear Normalization**

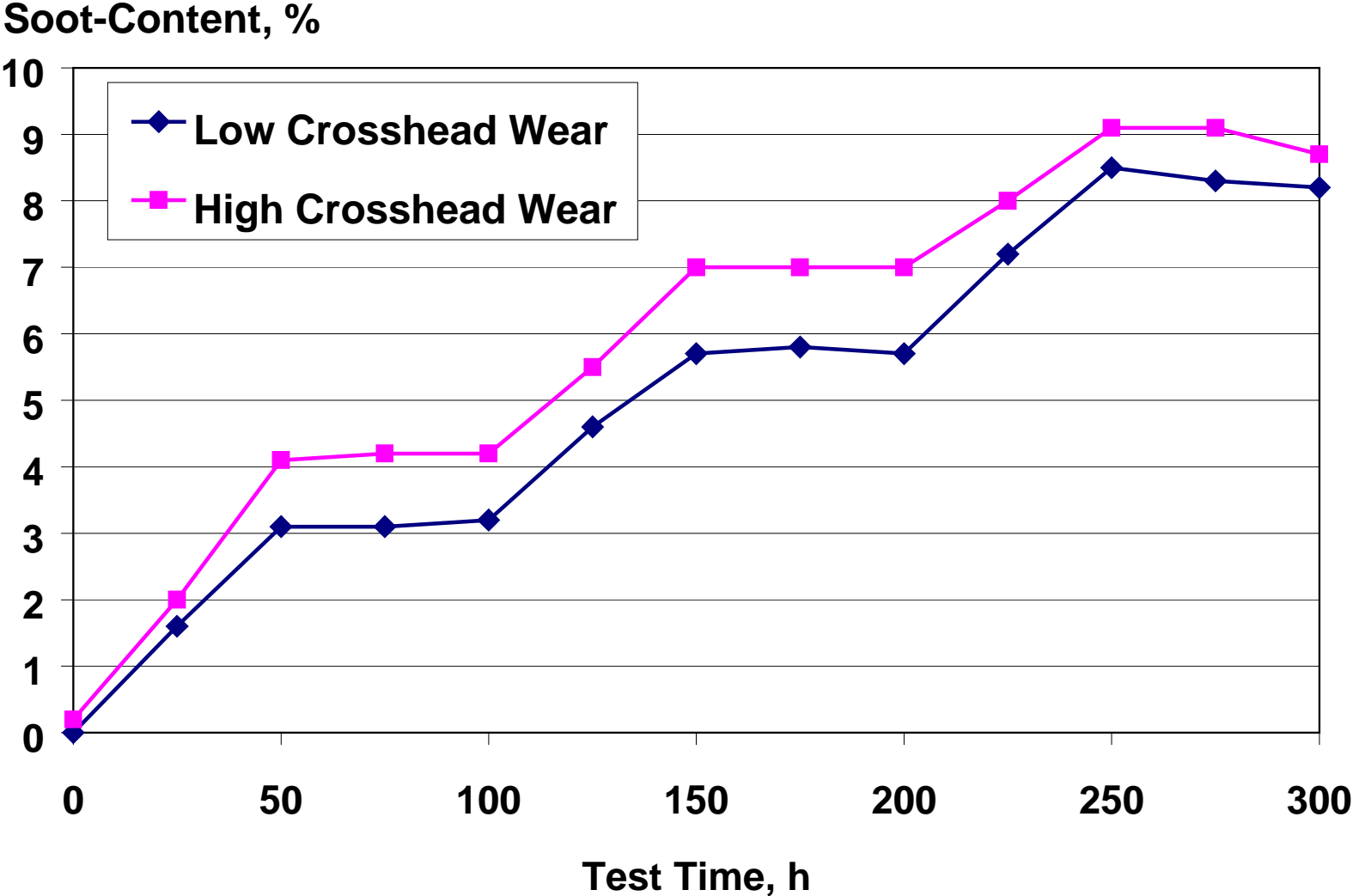
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Force Meeting in San Antonio**

# History of M11 Wear Normalization



- **Crosshead wear normalization has been applied to the M11 HST since 1996**
  - Based on exponential equation
  - Using “EOT” soot level as the basis for normalization
- **Early M11 EGR data showed similar variability of crosshead wear**
- **Use of “EOT soot” as a basis for normalization does not seem to be the proper approach**
- **The M11 EGR requires a different normalization**
  - Consider integration of soot level
  - Normalize to the “bottom of the soot window”

# Soot versus Test Time



# Normalization Equation for Matrix Oil E



- **Normalized wear =  $10^{(\text{LOG}(\text{XHW}) - 0.26 * (\text{Soot} - 5))}$**

**Where : XHW is the raw crosshead weight loss  
Soot is the integrated soot / 300**

# The Impact of Normalization

- **Before normalization the data set has :**
  - Average Wear 27.2 mg
  - Standard Deviation 11.7
  - Coefficient Of Variation 0.43
- **After normalization the data set has :**
  - Average Wear 22.4 mg
  - Standard Deviation 8.1
  - Coefficient Of Variation 0.36
- **In conclusion, the normalization has some positive impact on the precision of the test**
- **Normalizing the wear might help in identifying outliers**

# Raw and Normalized Data

CMIR	Raw Crosshead Wear	Soot	Normalized
38932	51.02	5.72	33.2
27	20.42	5.58	14.4
28	19.45	4.90	20.7
31	23.39	5.04	22.8
36	42.28	5.55	30.4
33	28.77	4.75	33.5
29	22.61	5.76	14.4
34	17.91	4.98	18.1
30	18.70	5.50	13.8