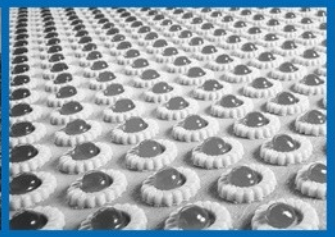
BEL-RAY

TOTAL PERFORMANCE LUBRICANTS®

FLEX YOUR OPERATION



Field Trial of Synthetic Gear Lubricant in Electric Wheel Motors
Oil Analysis Data Interpretation and Contamination Management

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HAULAGE AND LOADING CONFERENCE
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WIGWAM GOLF RESORT AND SPA

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Test Equipment

Terex MT3700AC

- 205 Short Ton capacity
- GE B25B traction motor

Terex MT4400AC

- 240 Short Ton capacity
- GE B25 traction motor

Oil Properties

Characteristics of Test Oil

Property	Typical Data
Kinematic Viscosity, cst @ 40°C	683
Kinematic Viscosity, cst @ 100°C	65.0
Viscosity Index, D2270	167
Fluid Types	PAO and ester
Timken EP Test, D2782, OK Load, lb	100
Micropitting Protection	Yes
ISO 4406:1999, 4µ/6µ/14µ, new oil	16/14/11
Copper Strip Corrosion, D130	1b
Rust Test, D665 Method A and B	Pass/Pass

Goals and Parameters

Gear Oil Performance Criteria

1.Sample at each oil change or filter interval (OEM Interval=500 hours/3000 hours; Actual filtration interval=1000 hours)

1. Elemental analysis by ICP with trending
2. PQA (Fe mg/ml) (added by Bel-Ray)
3. Kinematic Viscosity @ 40°C and 100°C
4. Infrared Analysis (oxidation)
5. Inspect wheels for indications of foaming
6. ISO 4406:1986 or 1999 Particle Count

2.Sun Pinion Diameter-Over-Pins (at start and at each 5000 hours)

Goals and Parameters

OEM Pass-Fail Criteria

1.Zero failures in 12 wheel motor years

1. Gear or bearing stress due to lubrication (wear, polishing, scoring, spalling)
2. Abnormal oil analysis trends that cannot be explained
3. Sun pinion diameter-over-pins wear >0.0064”

Contamination Control

Contamination Concerns:

1. Total Deleterious Particles (dirt and wear debris)
2. Air inducted abrasives
    1. Silicon : Aluminum=3.4:1
        1. Total Dirt (ppm) ≈ Silicon (ppm) x 3.6

Particles (dirt and wear debris) can be abrasive and lead to gear and bearing damage.

Contamination Control

Filter Cart

(kidney loop filtration at maintenance interval)

Filter Cart:

- Pump equipped
- Heater equipped
- 10-micron absolute
- Quick-Connects to form kidney-loop

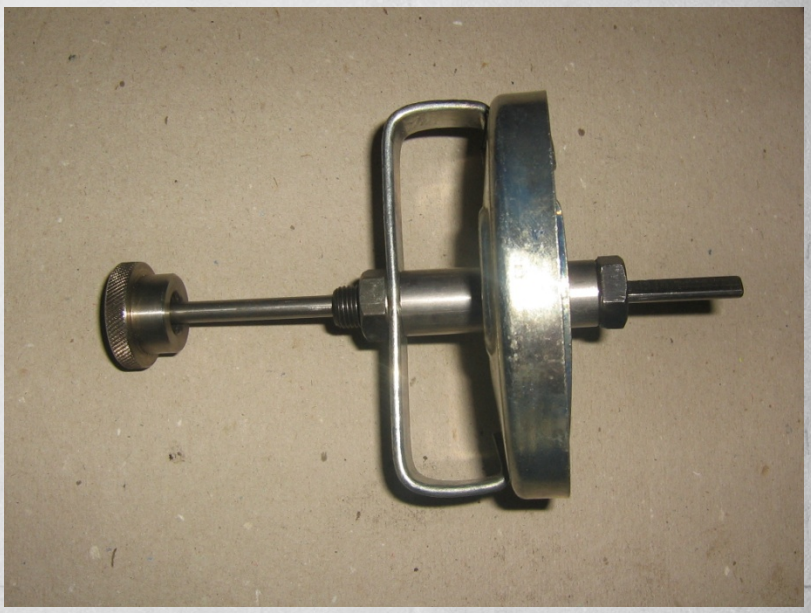
Contamination Control

Filter Cart

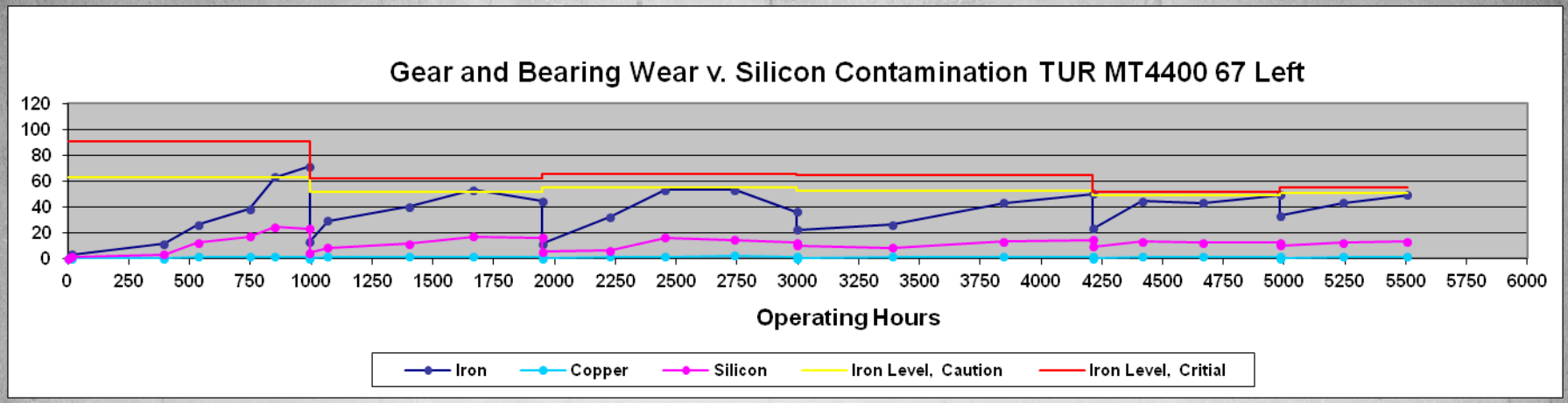
(kidney loop filtration at maintenance interval)

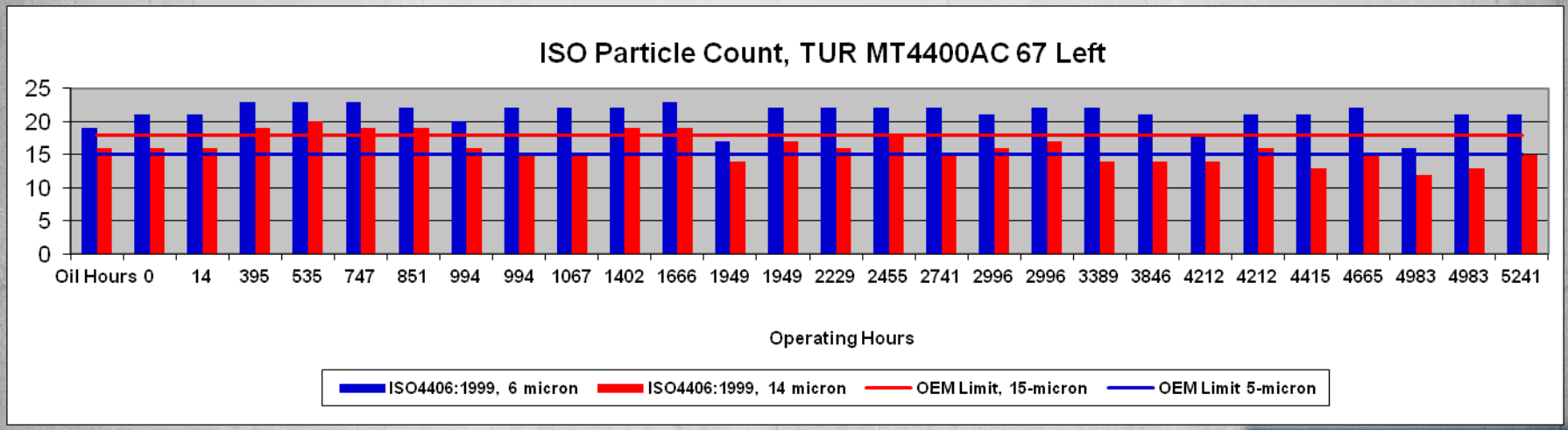
Contamination Control

Dipstick Design with Clean Sampling Port



Effects of Contamination





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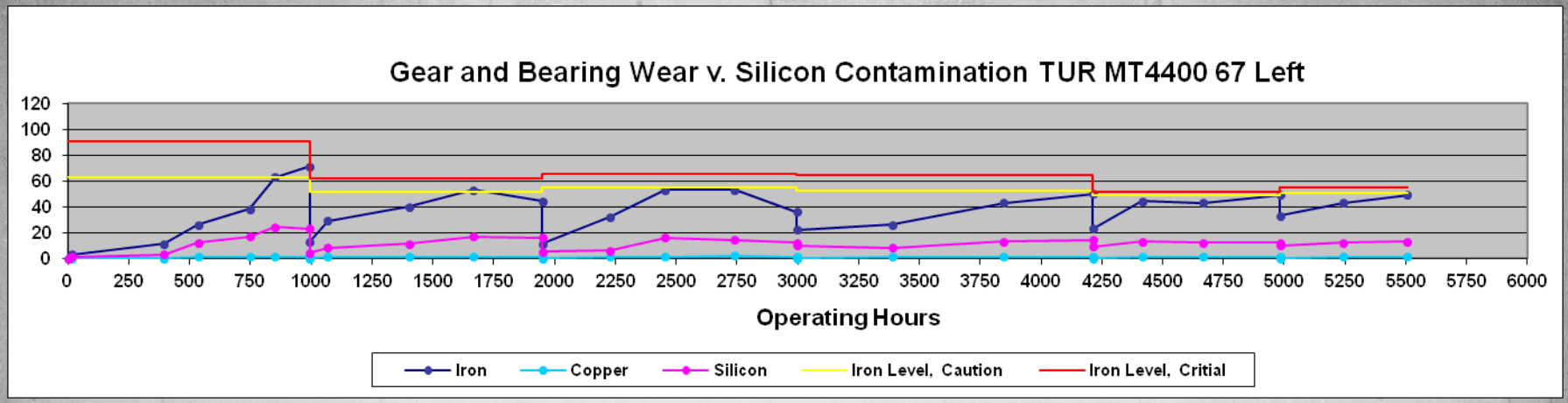

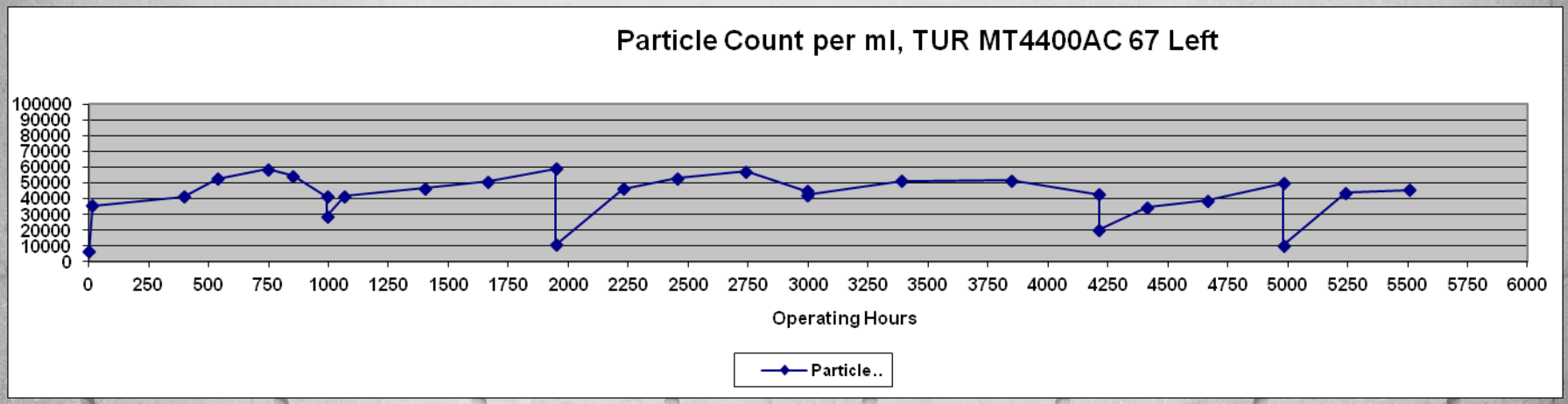

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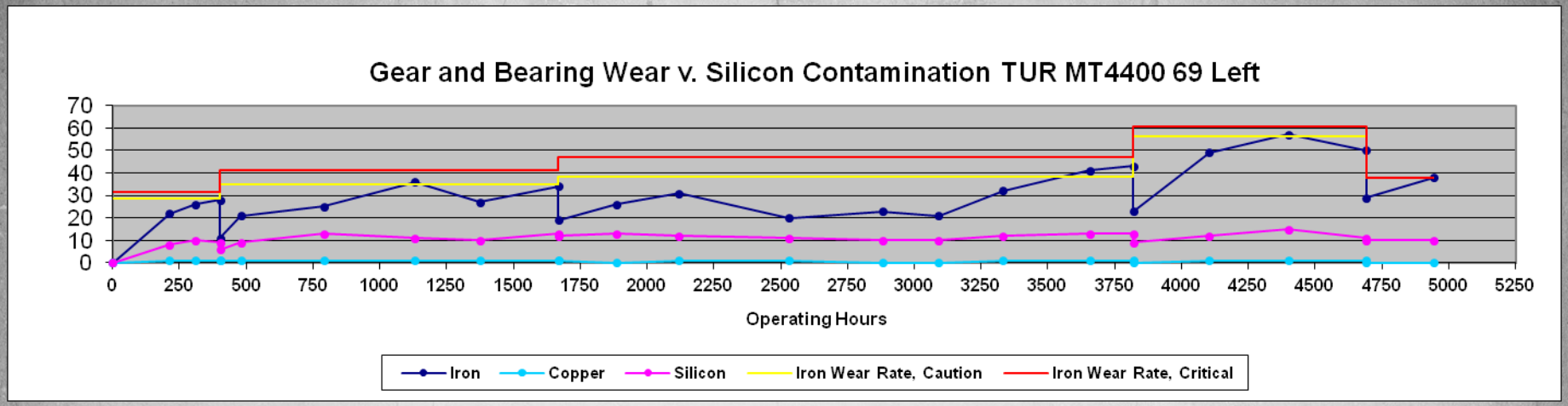

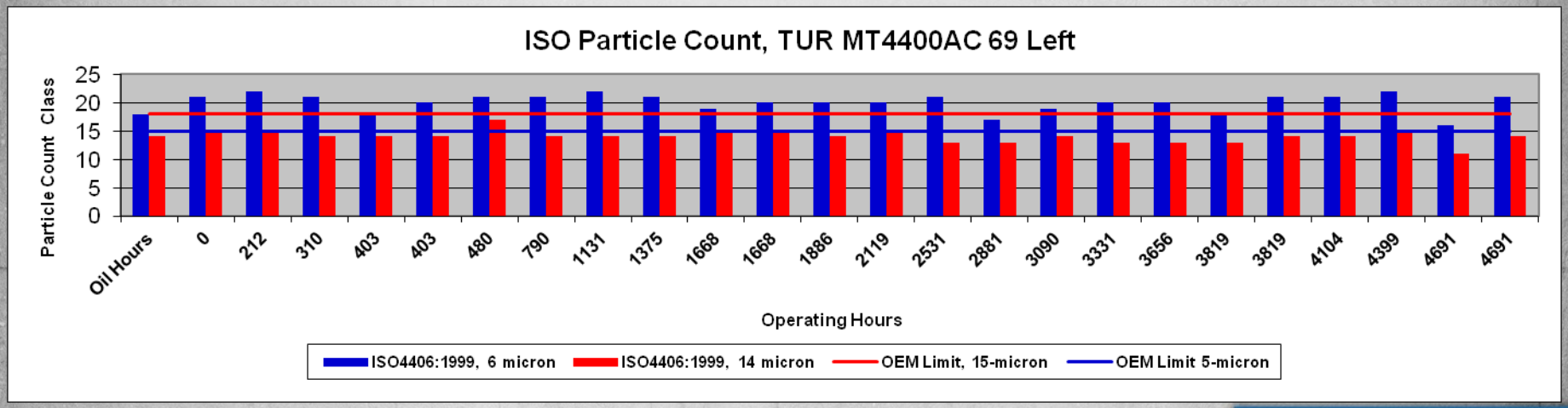

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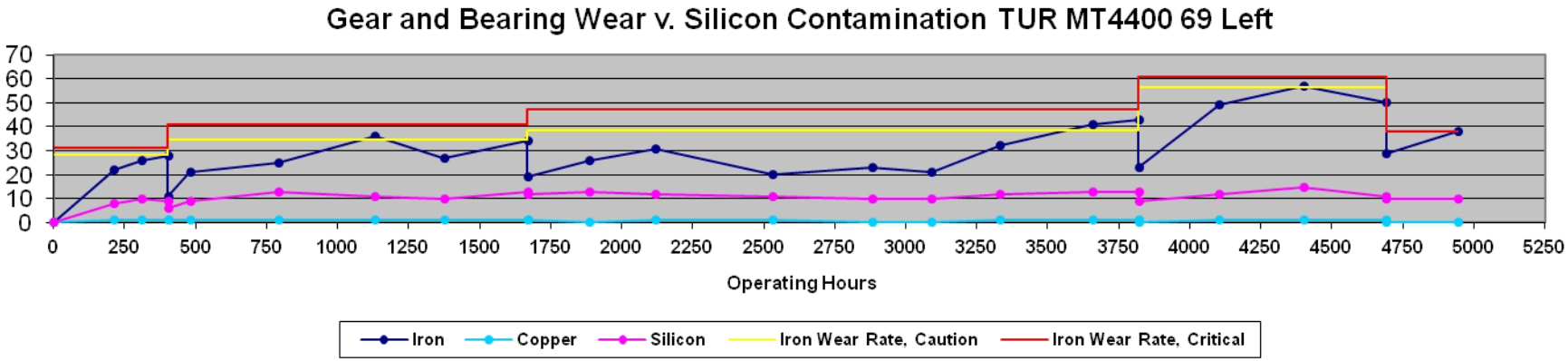
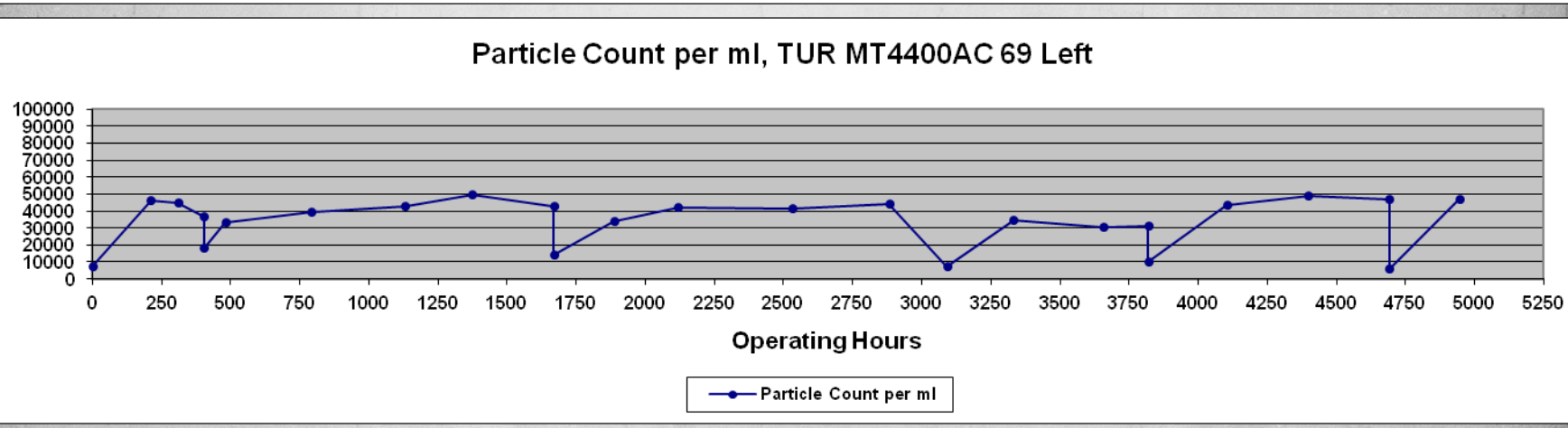
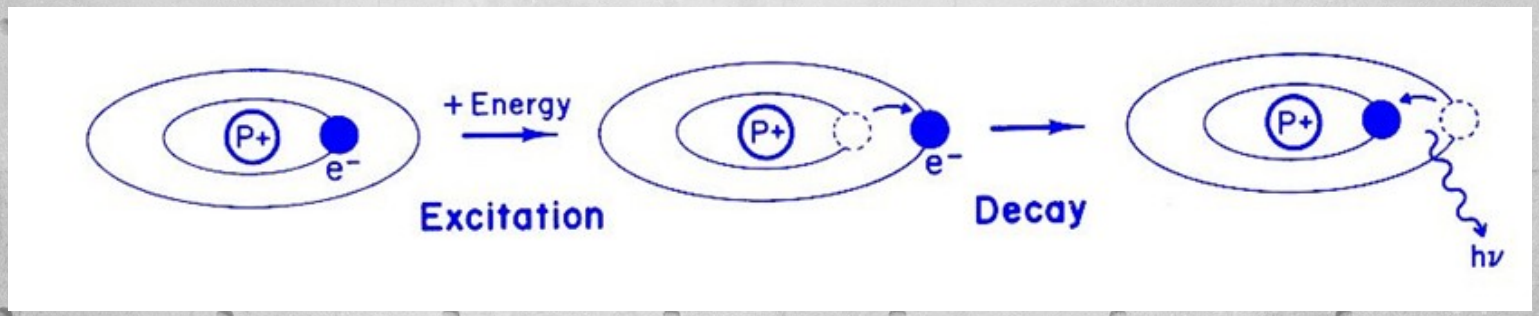




Analytical Methods

Inductively Coupled Plasma (ICP)

- Determines metallic particles up to 10µ
  - normal rubbing wear

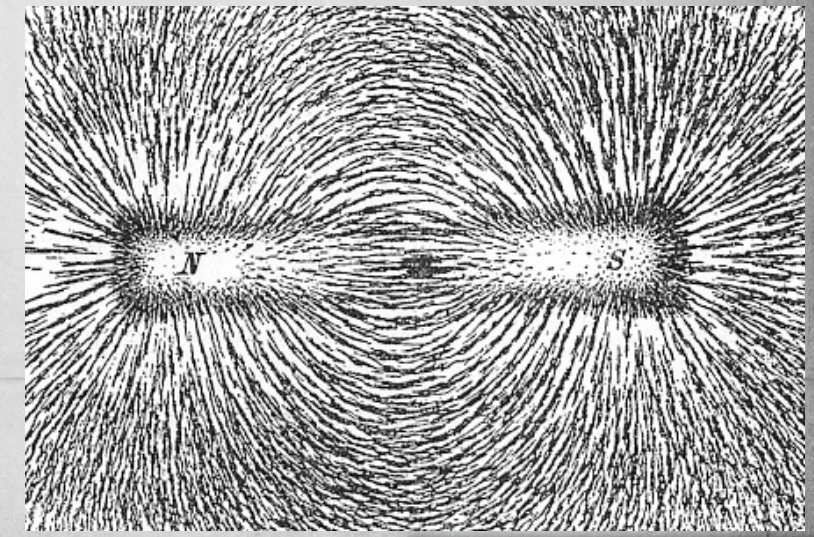


Analytical Methods

Particle Quantity Analysis or PQA

- Determines metallic particles' effect on a magnetic field and assigns an index value

- Looking at iron
- Not effected by particle size
- Reflects total iron content
- Small Particles = normal wear
- Large Particles = abnormal wear

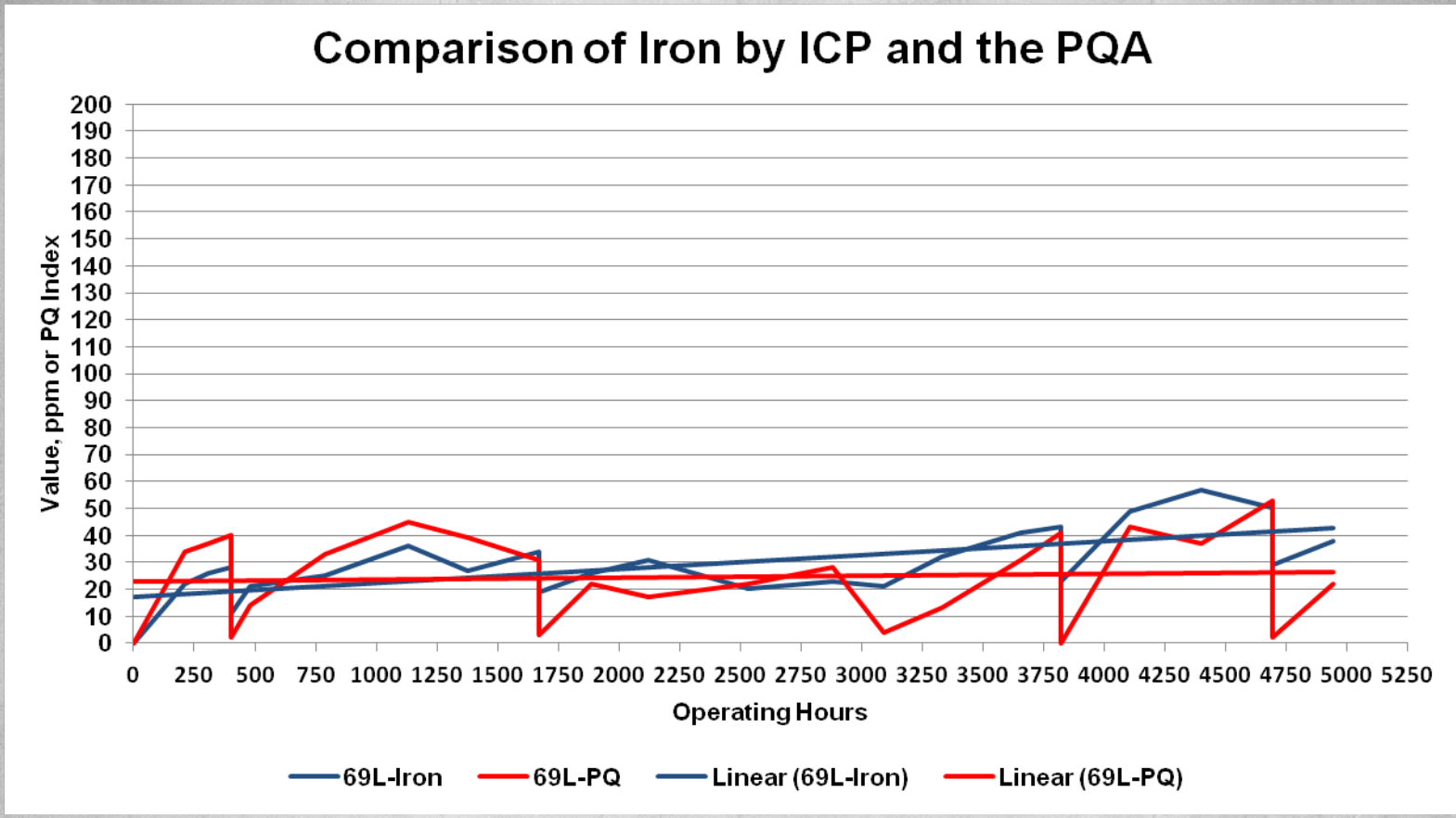


Analytical Methods

Iron Data Interpretation
ICP and PQA Correlation

PQA	ICP	Comments
66	64	PQA and ICP are the same. All wear is normal rubbing wear. No abnormal wear detected.
60	286	PQA is lower than ICP. Iron is corrosive wear.
82	12	PQA is higher than ICP suggesting that large magnetic particles are present and that an abnormal wear trend is likely.

Gear & Bearing Wear Data



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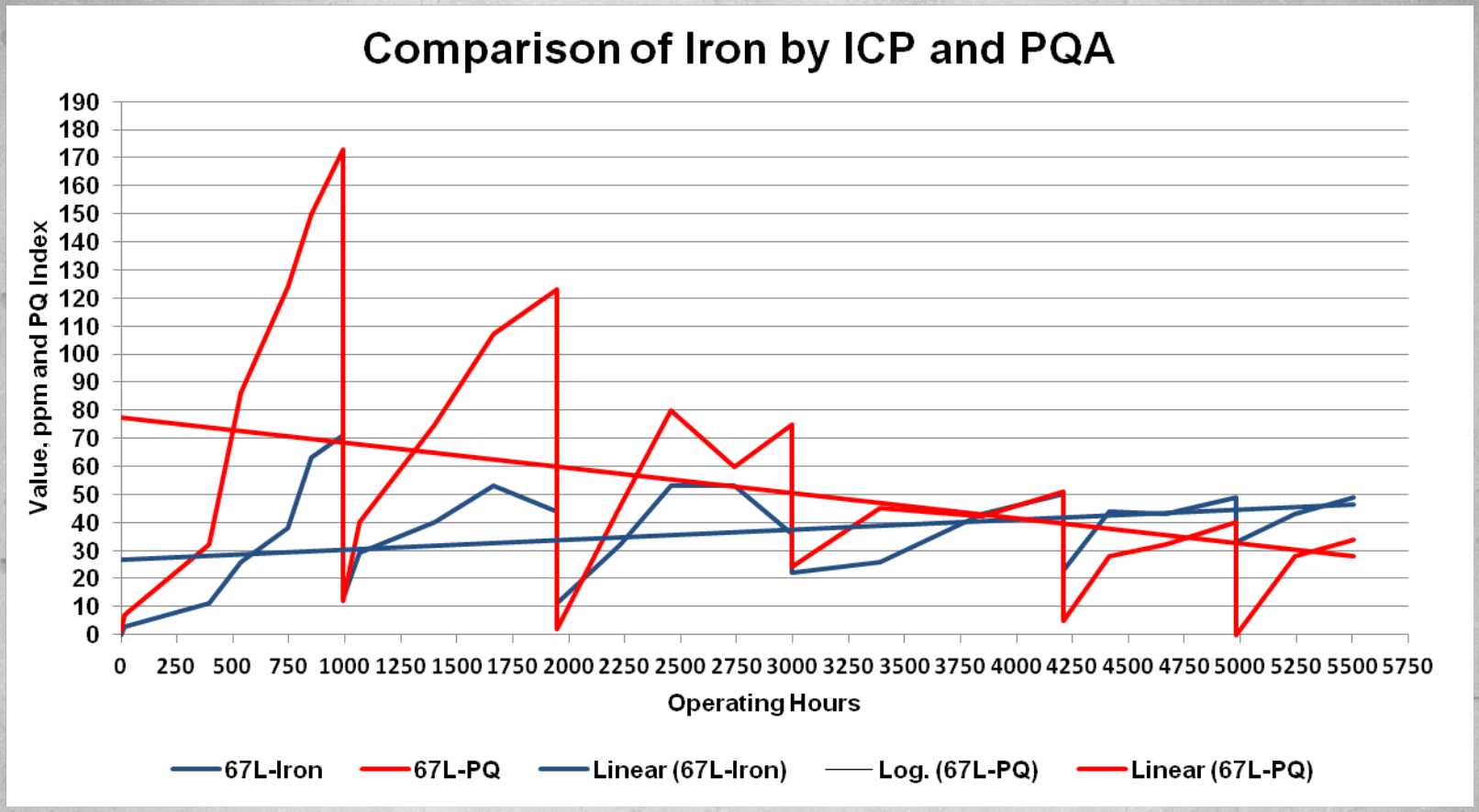

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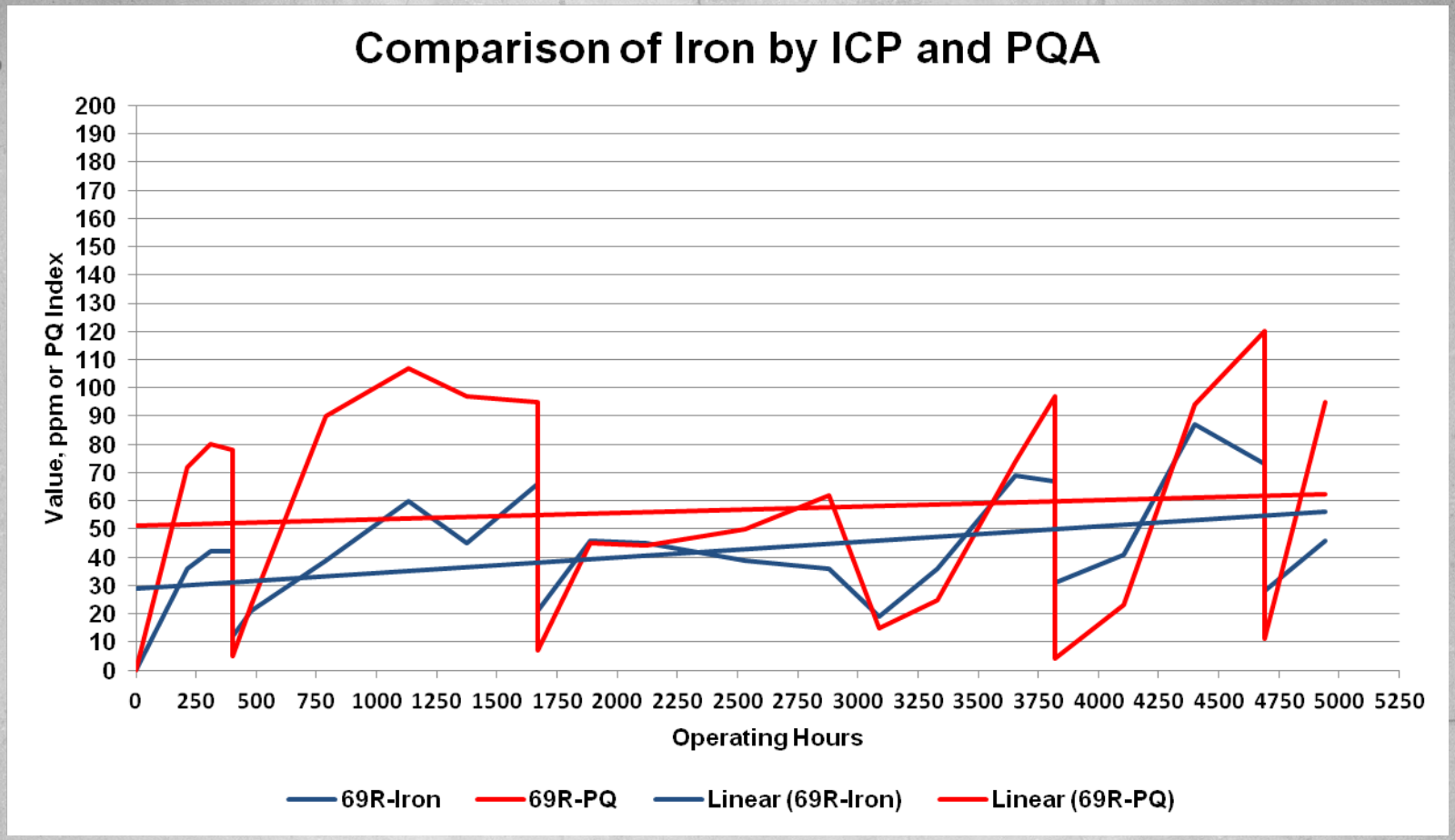

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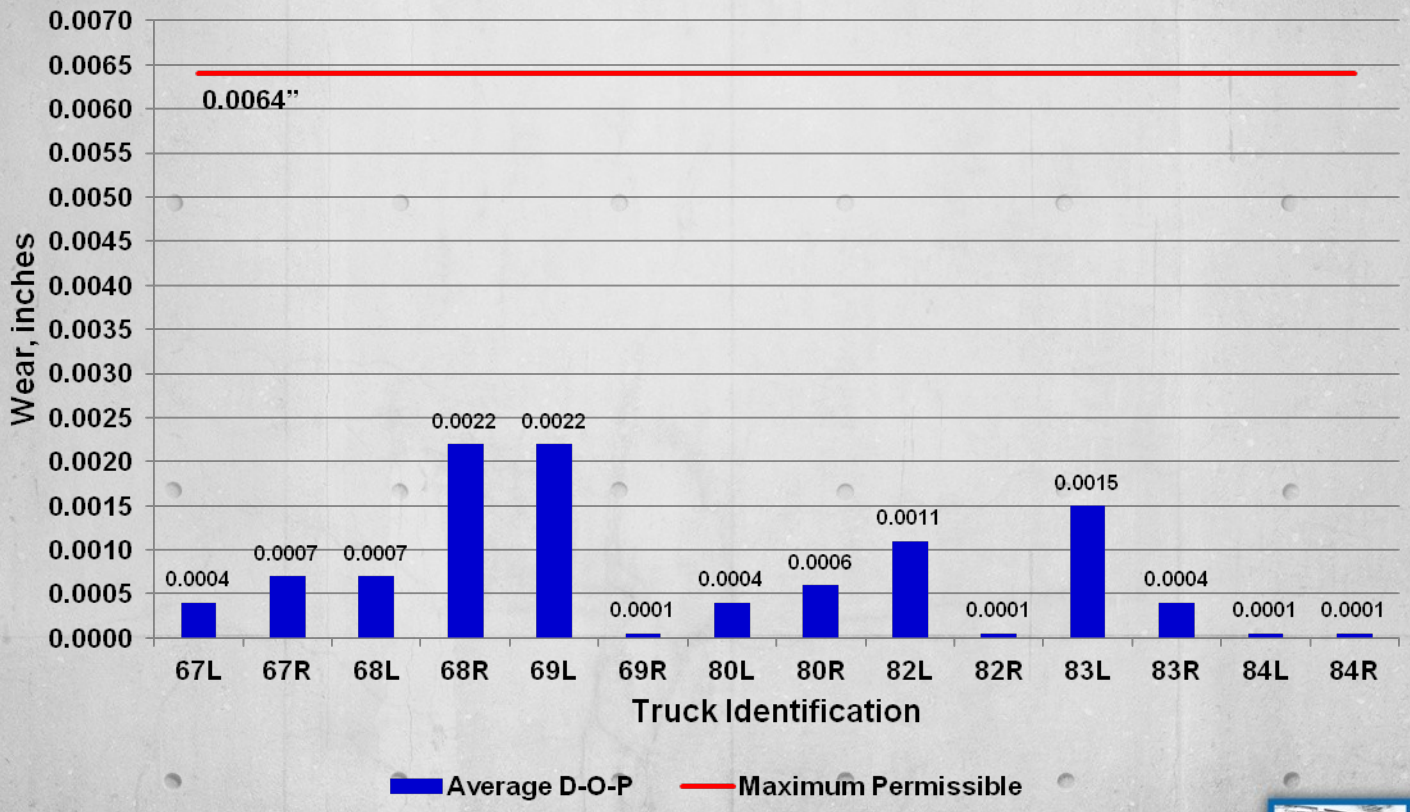
Gear Inspection

2-Year Sun Pinion Diameter Over Pins



Conclusions

1. Gear wear can be minimized in electric wheel motors of mid range sized haul trucks using a quality synthetic gear oil.

2. Solid contamination has an impact on wear metals and wear trends and the degree of severity of the impact may be controllable based on the degree of service provided to the units (regular filtration, inspections and analysis).

3. Increasing wear metal and contamination cycles seen in oil analysis data may not correspond with the actual gear condition seen during diameter over pins measurements and general inspections of gear teeth.