Second Test of a C-141 Pitch Trim Actuator (PTA) Using Electrical Signature Analysis (ESA)

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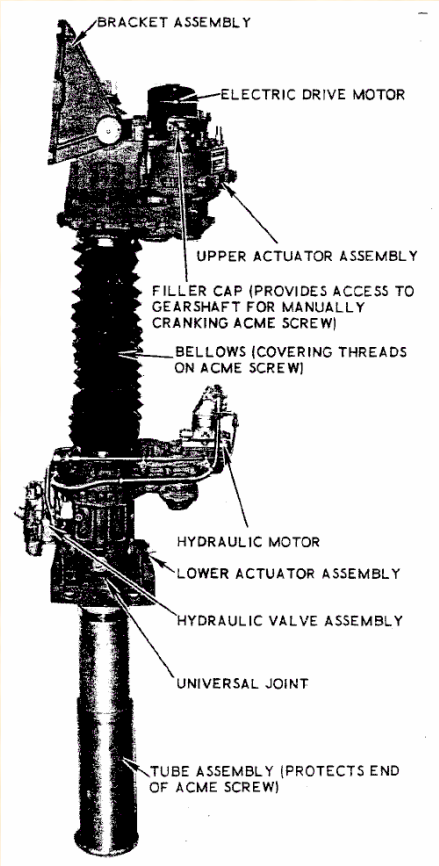
On April 16, 2003, Tests Were Performed on a C-141 Pitch Trim Actuator (PTA) at Ogden Air Logistics Center (OO-ALC)

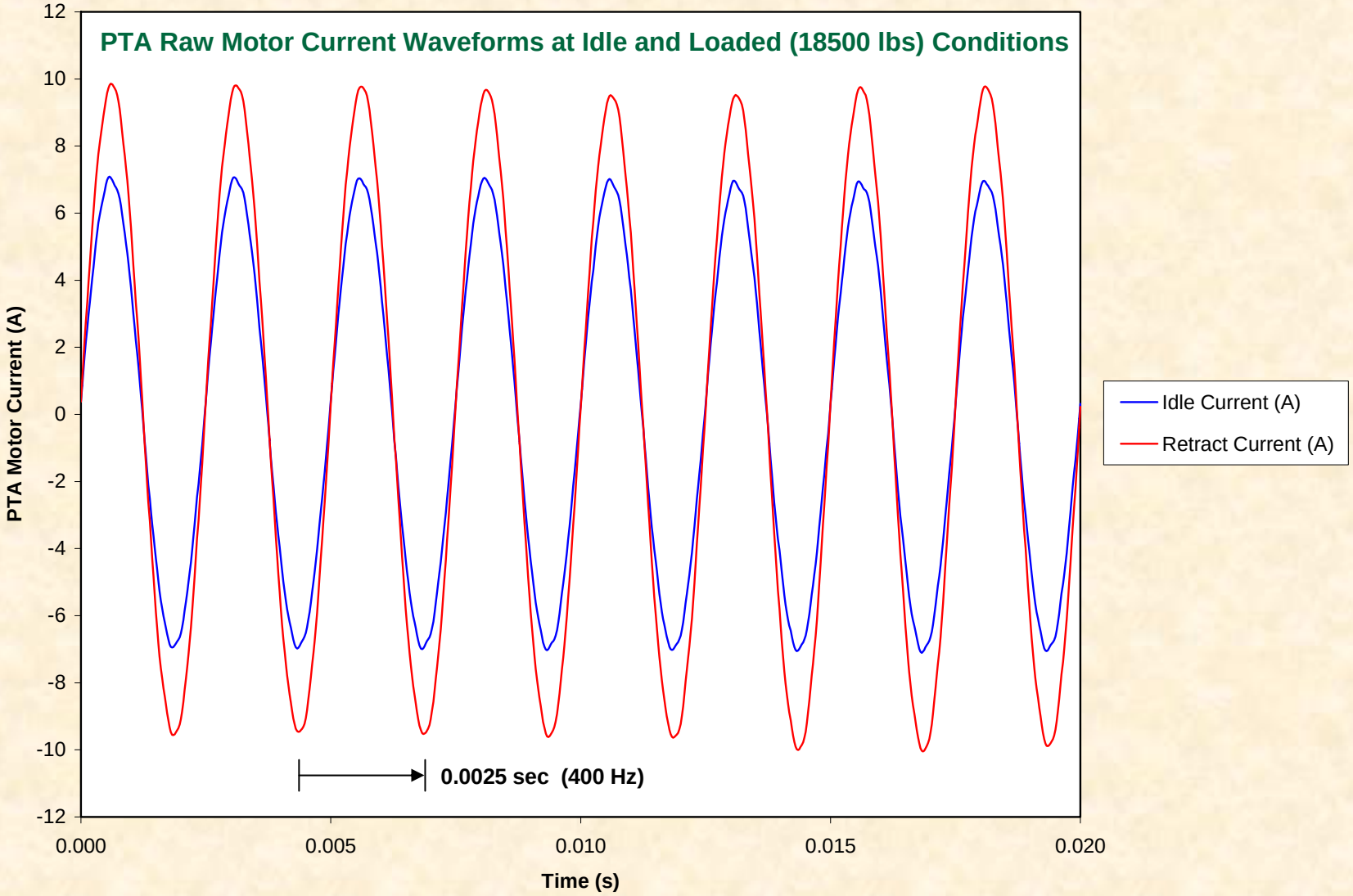


Horizontal Stabilizer Actuator Assembly (from T.O. 9H2-4-153-3)

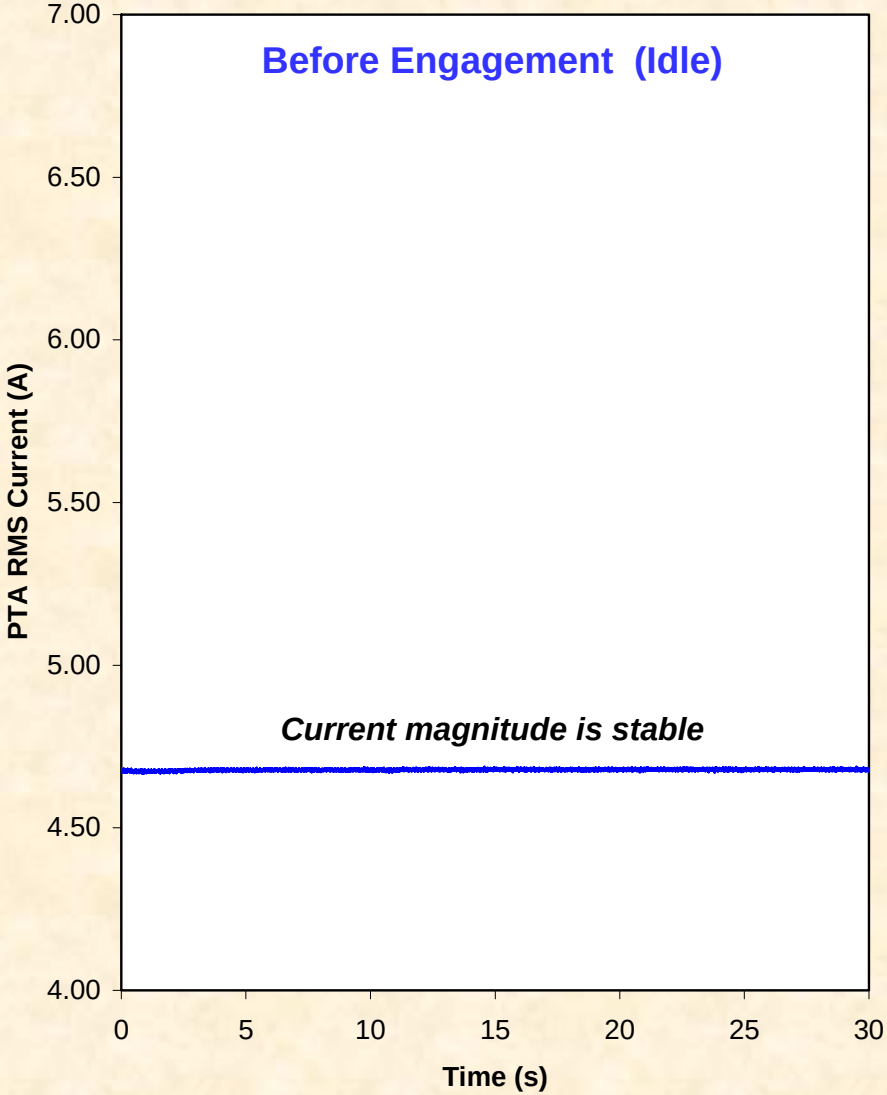
- **Motor current signals from a C-141 Pitch Trim Actuator (Horizontal Stabilizer Actuator) were obtained using clamp-on current probes, recorded on a digital audio tape (DAT) recorder, and later analyzed in Oak Ridge.**
- **The PTA was tested under 0 lb, 2000 lb, and 18500 lb loads. Only partial strokes were done at the 18500 lb load due to motor temperature rise concerns.**
- **The test results included in this presentation document the continued evaluation and demonstration of ESA methods on the C-141 PTA and should be used in conjunction with the results from the first PTA test performed at WR-ALC on February 4, 2003*.**

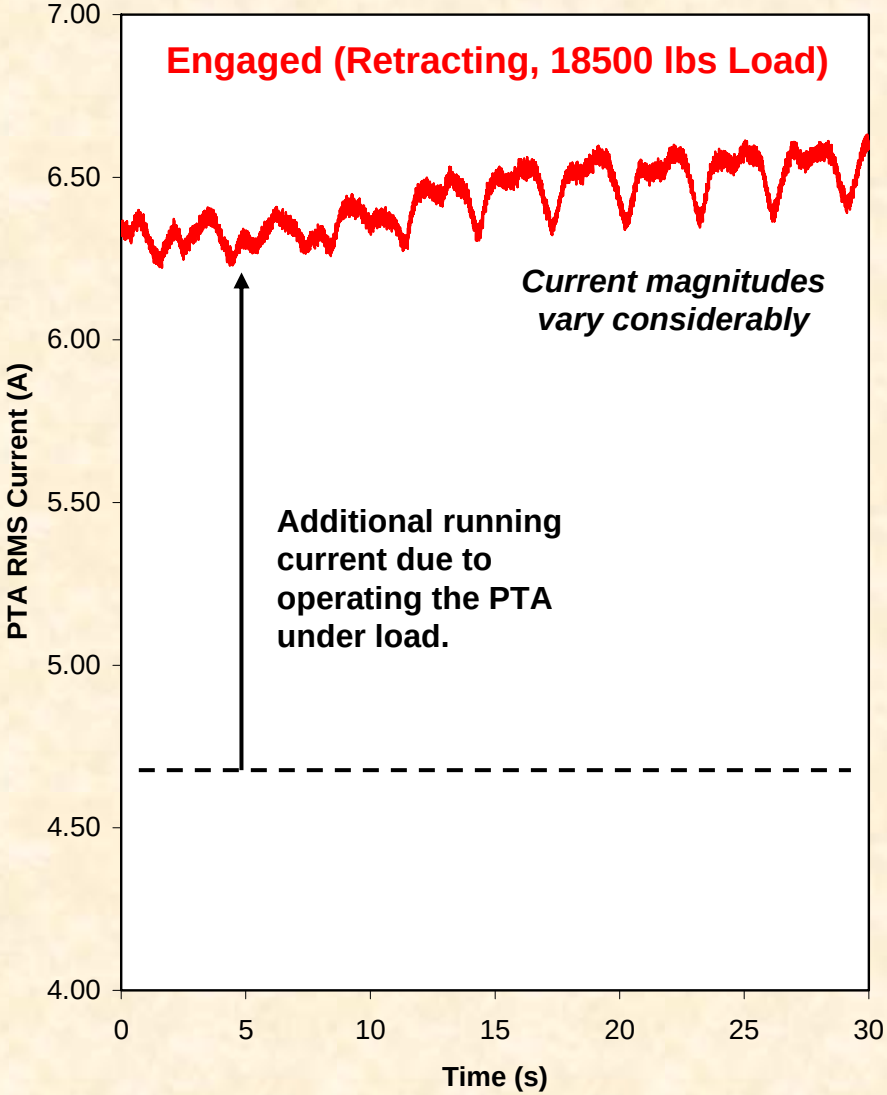
** Initial Testing of a C-141 Pitch Trim Actuator (PTA) Using Electrical Signature Analysis (ESA), dated February 11, 2003.*

As Expected, Motor Current Magnitudes Increase Significantly When the PTA Is Engaged and Loaded to 18500 lbs

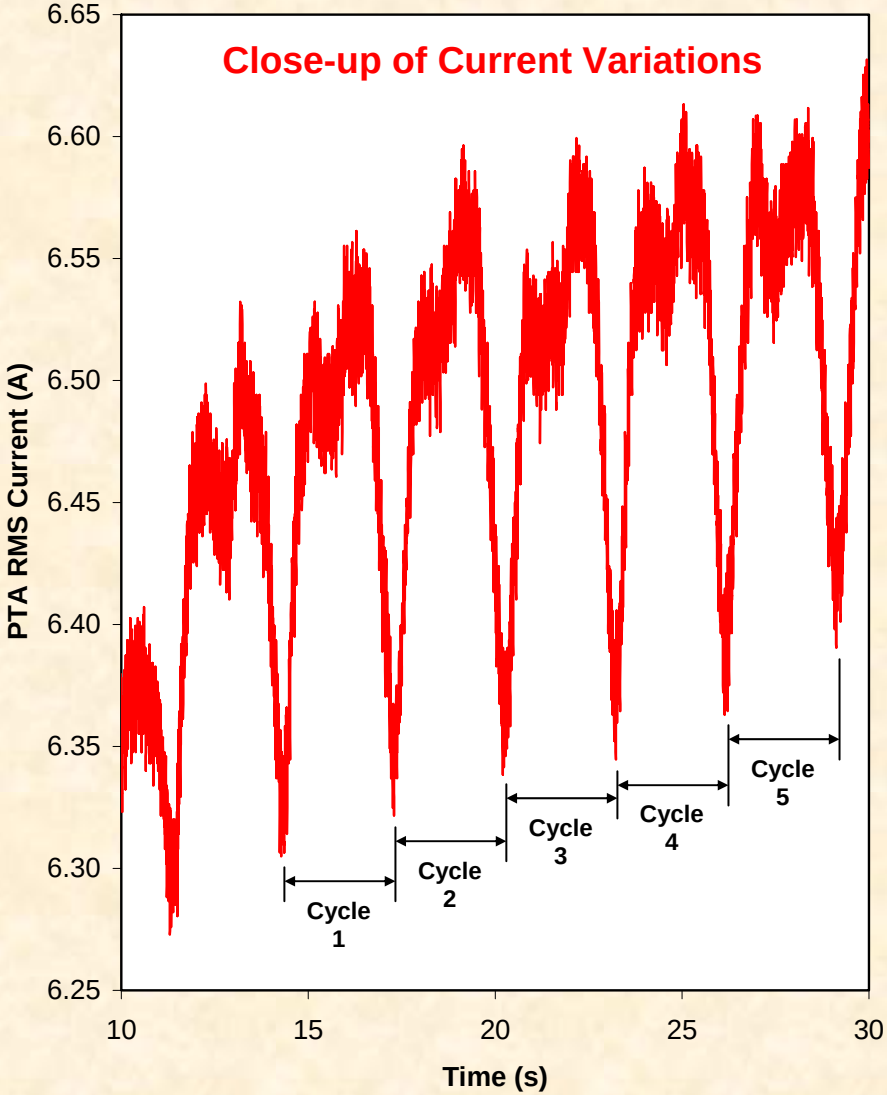


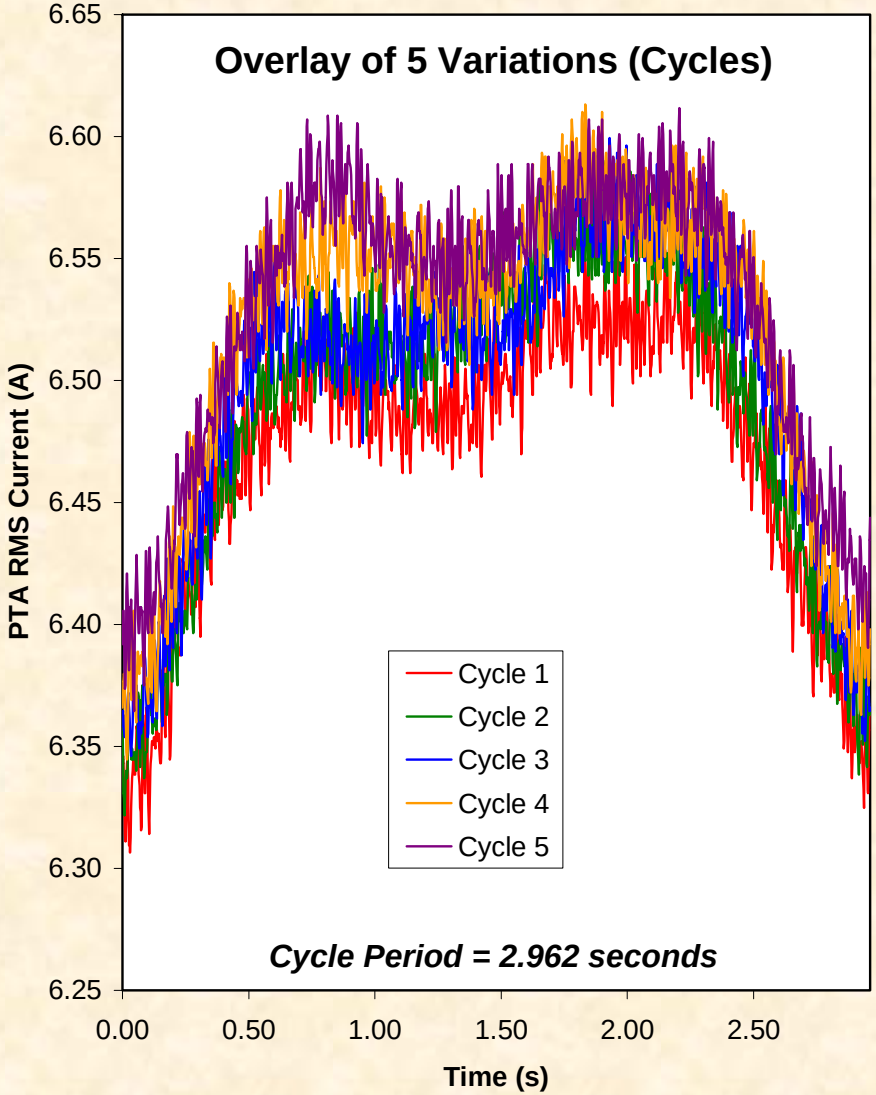
When the PTA Was Operated With a 18500 lb Load, Significant Fluctuations in the RMS Motor Current Were Detected





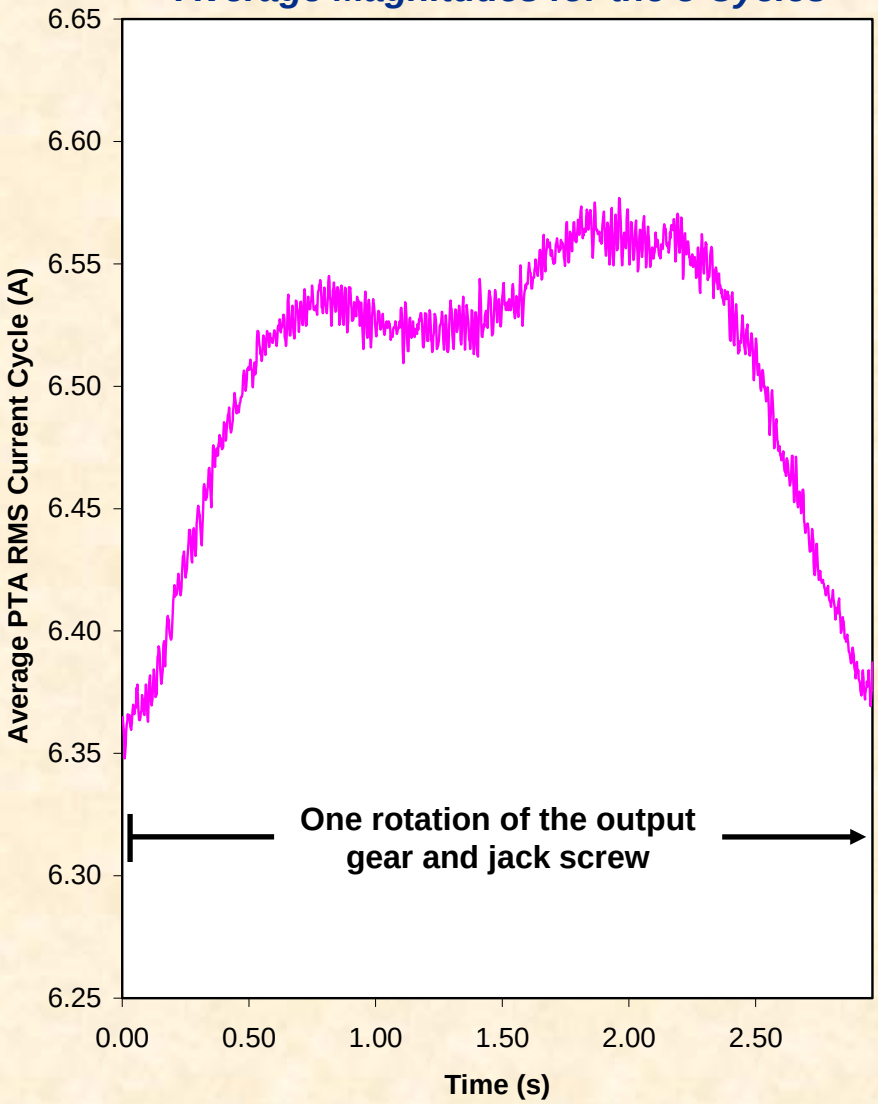
The PTA Motor Current Fluctuations Were Periodic and Repeatable



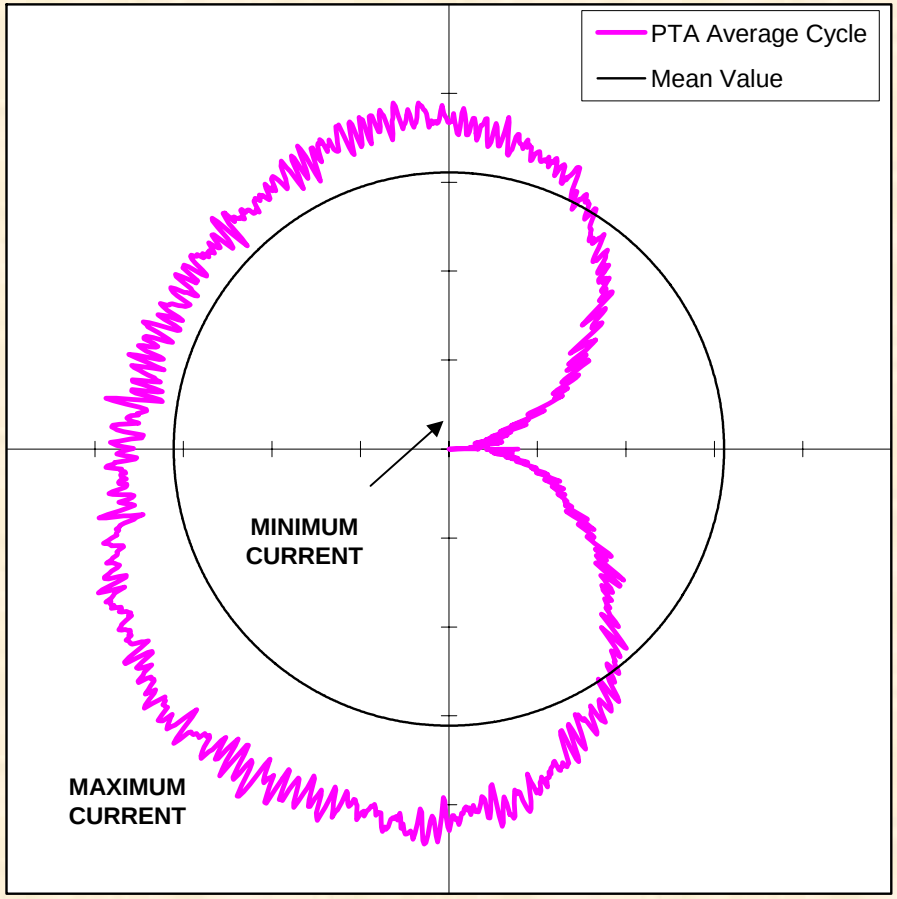


The Fluctuations Appear to Reflect Output Gear and Jack Screw Rotation

Average Magnitudes for the 5 Cycles

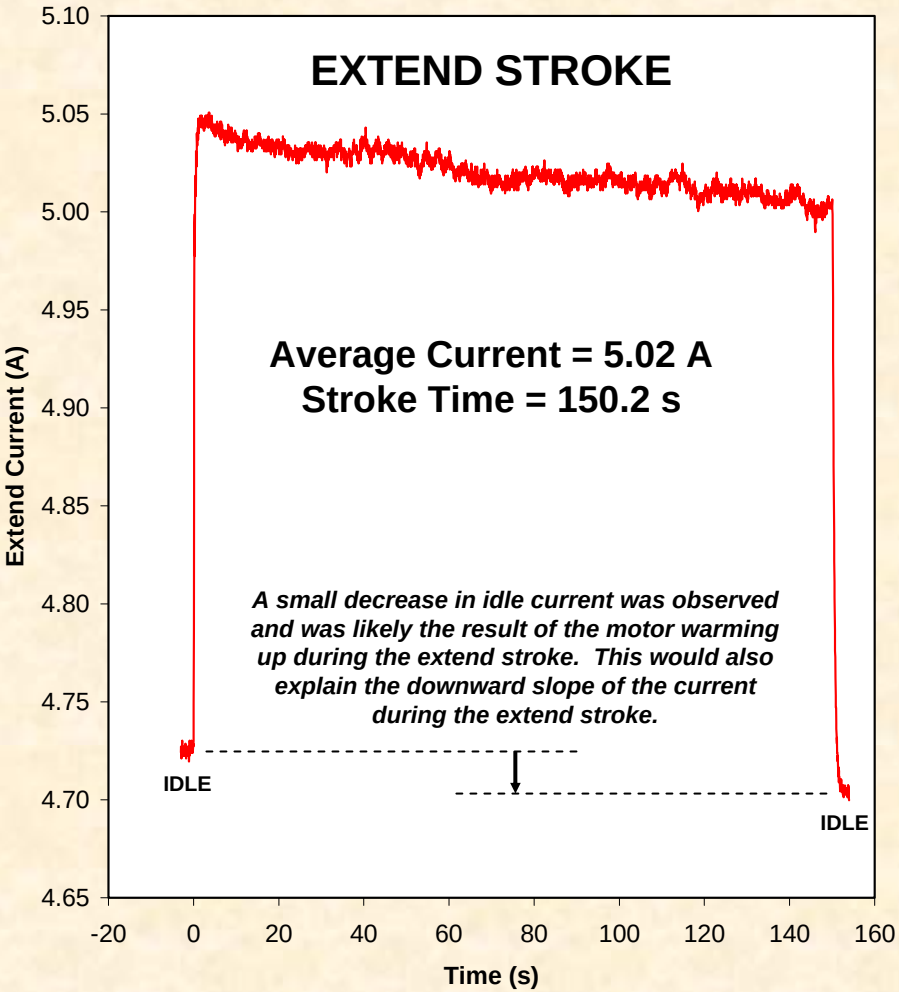


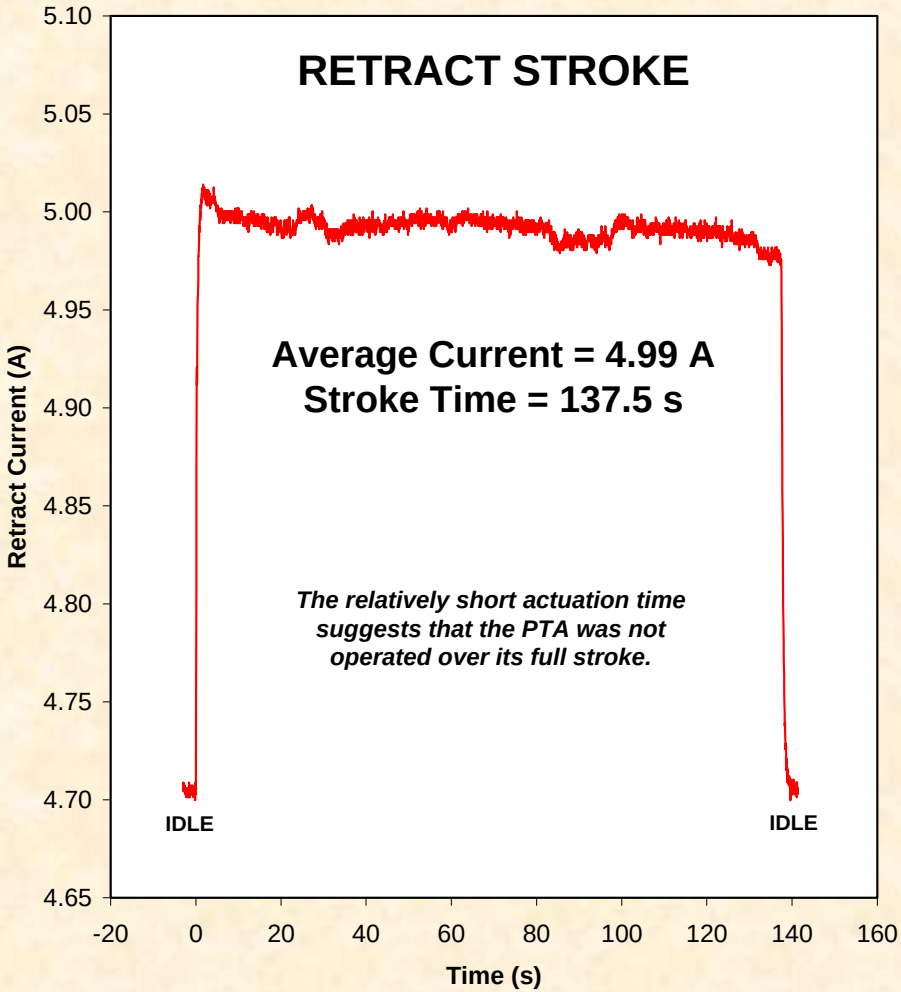
A Polar Plot Emphasizes This Relationship



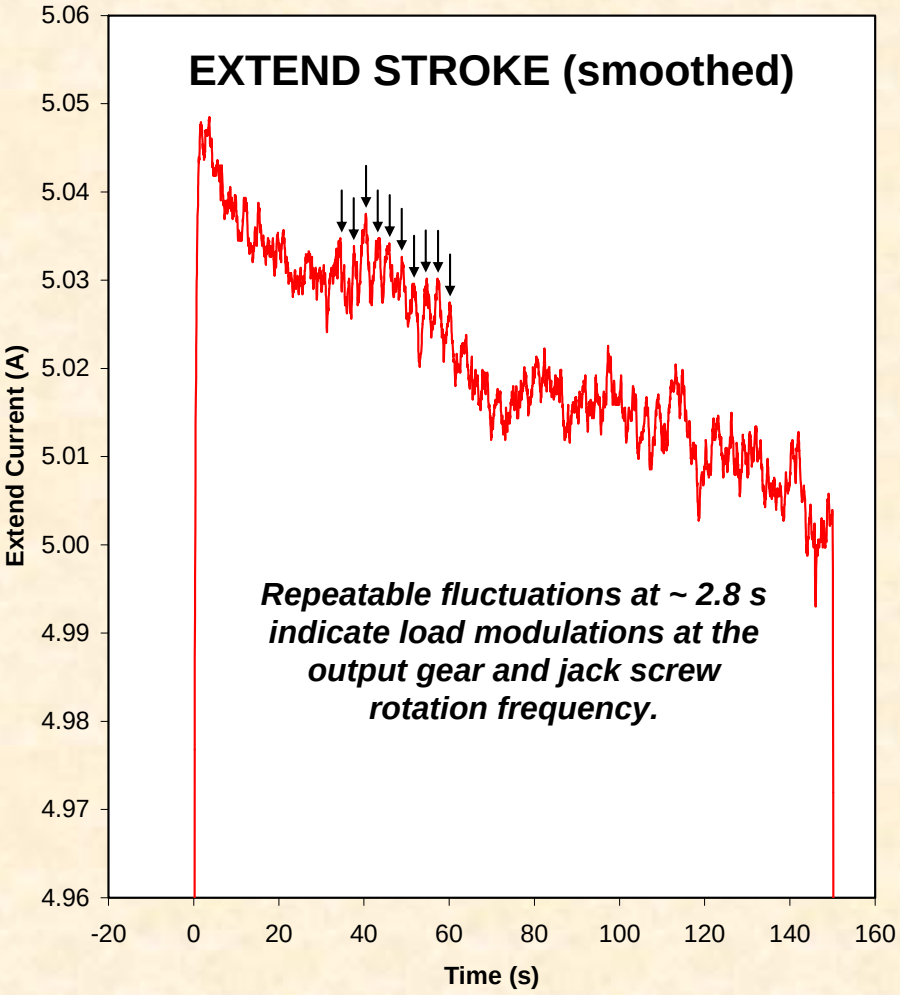
The center of the graph is the minimum RMS current for the cycle. The greater the difference between the actual current and the minimum current, the greater the distance (radius) from the center. Time has been converted to an angular dimention, with the time period for the entire cycle (2.962 seconds) equal to 360 degrees. The thin line is the mean value of the average cycle data.

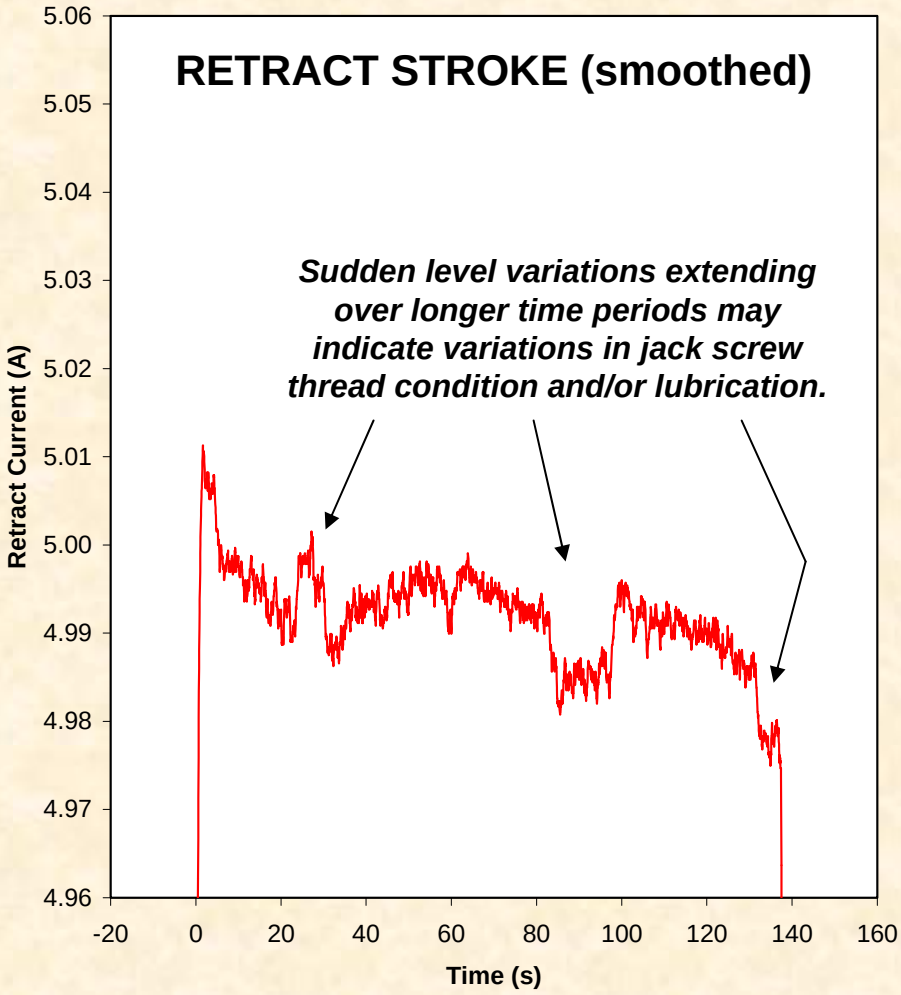
Operations at 2000 lb Loads Revealed Current Variations Across the Entire Stroke



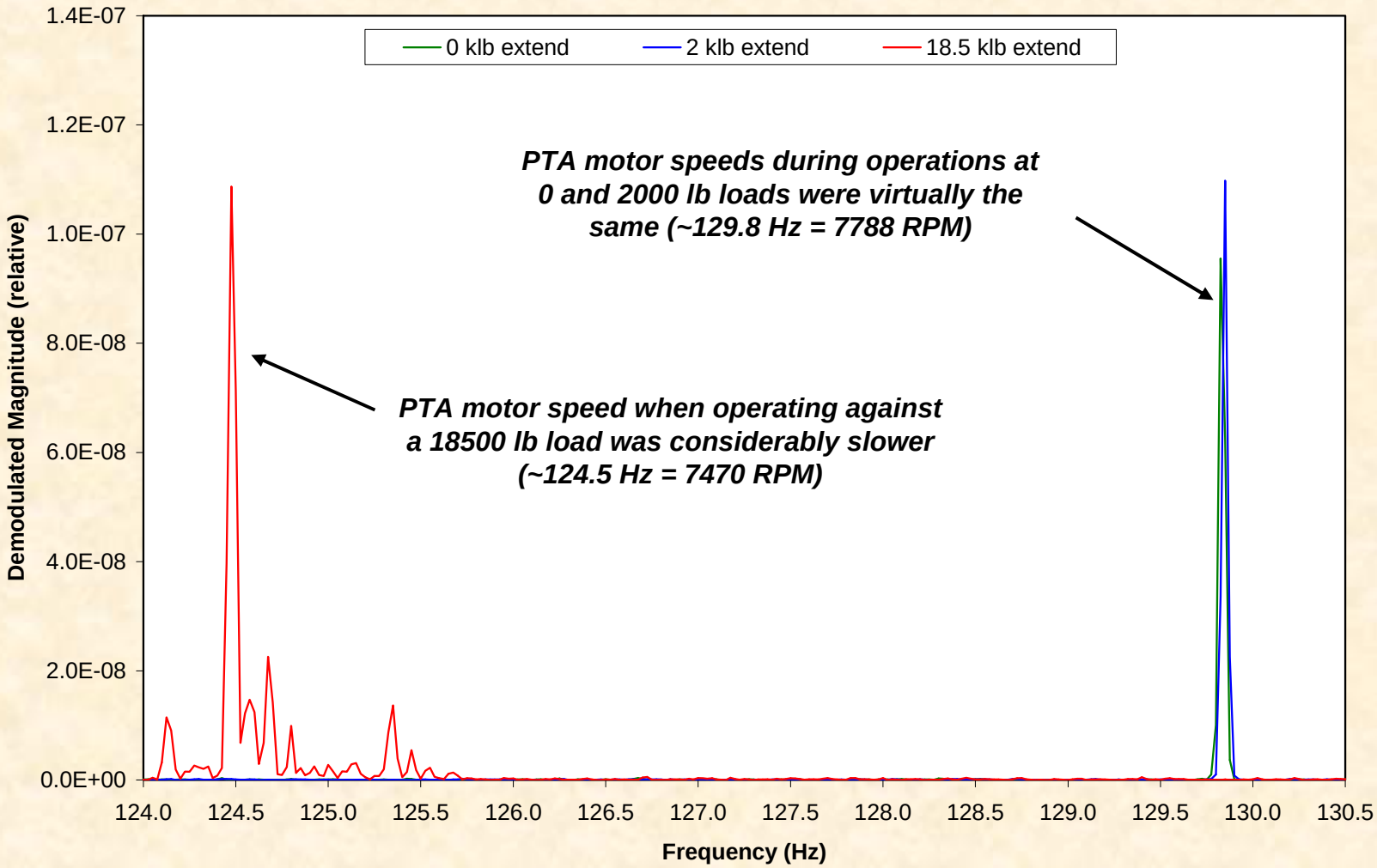


Close-up Examinations Reveal Fluctuations That May Indicate Variations In Output Gear and Jack Screw Condition

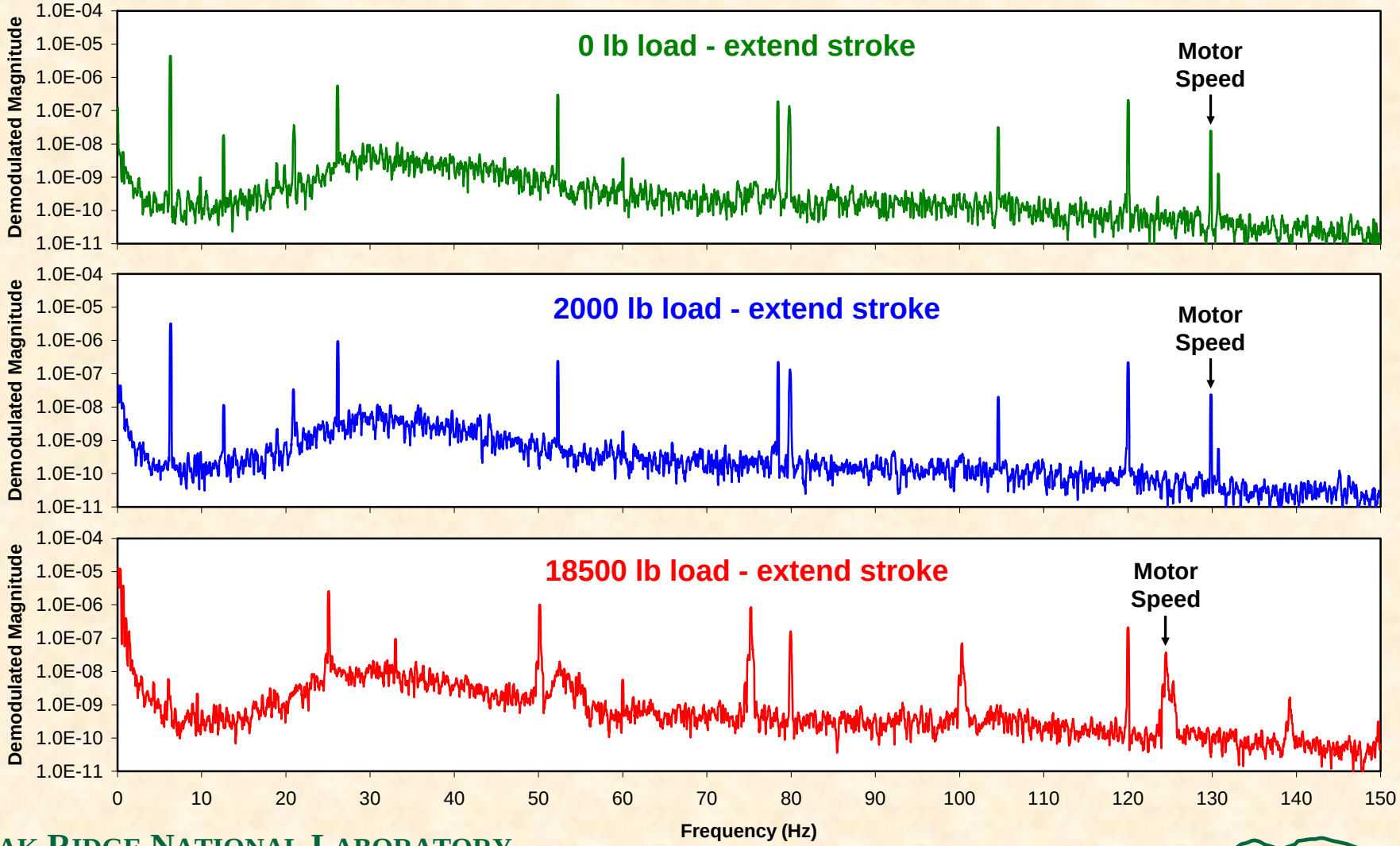




By Analyzing the PTA Demodulated Motor Current Signals in the Frequency Domain, The Motor Running Speeds Can Be Measured



In Addition to Motor Speed, the Demodulated Motor Current Spectra* Include Additional Peaks That Are Likely to Be Useful in Monitoring The Condition of the Motor, Jack Screw, and Other Components



* *Only the first 150 Hz band is shown. Many other peaks are present above 150 Hz.*

Preliminary Conclusions:

- C-141 Pitch Trim Actuator (PTA) motor current signals can be easily obtained using clamp-on sensors.
- When compared to PTA operations at unloaded conditions, the 18500 lbs load significantly increased the overall motor current magnitudes and significantly decreased the motor running speed. The tests performed at 2000 lb load had much less affect on motor speed and current.
- When the PTA was operated under load, significant fluctuations in the RMS motor current were detected. These fluctuations correspond to load modulations resulting from the output gear and jack screw rotation.
- The demodulated motor current spectrum provides a direct indication of motor speed, and also includes many additional frequency components that are likely to be useful in monitoring the condition of the motor, jack screw, and other PTA components.
- Based on the motor current signature analyses performed so far, it is clear that the PTA is an ideal component for developing ESA-based condition assessment instrumentation. ORNL has considerable experience in applying ESA as a diagnostic technology for motor-operated, rising-stem valves, which have mechanical features similar to those of the C-141 PTA.
- PTA diagnostic testing capabilities can be added to the portable ESA platform that has been developed by ORNL for initial use as a Fuel Pump Condition Monitor (FPCM).