Testing Procedure
Both the origional and new testing machines measure the wear life of dry film lubricants by measuring the coefficient of friction between a rectangular sample coated with the lubricant and a circular rider. A normal force is applied through a rider of known dimensions to the surface of the sample. The sample is then forced to slide back and forth under the rider. The ratio of the force required to move the sample and the force applied to the surface of the sample gives the friction coefficient.

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\mu_k = \frac{F_{\text{friction}}}{F_{\text{normal}}}
\]

A cutoff friction coefficient is designated (0.15 in old tests) to recognize when the lubrication has worn off. The number of times the sample reciprocates under the normal load before the cutoff friction coefficient is reached provides a measure of the wear life of the lubrication.

Project Purpose
The purpose of this project is to aid Boeing in testing the wear life of dry film lubricant coatings using Boeing Process Specification "Application of Bonded Solid Lubricants for High Temperature Service" BAC 5814 Section 12.5 "Wear Life and Friction Coefficient" as a baseline. Boeing previously had a machine used for this purpose which has since been sold as surplus. The new machine features digital data acquisition, the ability to test multiple samples, and is able to operate at higher temperatures than the origional machine.

Testing Machine
The origional machine was capable of testing one sample at a time up to a temperature of 500ºF at 33 cycles per minute. The output from this machine was a hard copy record, which made data analysis and storage problematic. The new machine has the following capabilities:

- Test 2 independent samples simultaneously
- Apply normal load up to 20,000 psi
- Heat samples to at least 600ºF
- Control load and temperature via computer
- Record results to computer

Horizontal Motion
The sample moves back and forth under force from a horizontally mounted double acting hydraulic cylinder. This ram is controlled using a four-way, three-position, computer controlled valve. Position feedback is given to the computer through a linear variable differential transformer (LVDT), which translates the position of the ram into a voltage. This combination allows precise control of the position, velocity, and acceleration of the sample.

Normal Load
The normal load is applied by a hydraulic cylinder which is controlled using a solenoid operated, computer controlled pressure valve. Pressurized oil from Boeing’s central hydraulic system applies force through the hydraulic ram to the sample through the rider. Friction creates forces normal to the ram’s actuating axis. The ram extends through a sleeve bearing to prevent these forces from destroying the ram’s gaskets.

Sample Heating and Temperature Measurement
In order to reach temperatures beyond 600ºF, three cartridge heaters are inserted into a steel plate directly beneath the sample. These cartridge heaters are controlled by a computer which is given feedback from a T-type thermocouple mounted to the top of each sample. The cart and its bearings are isolated from the hot plate by a ceramic tile placed between the hot plate and the cart.