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Pressure Balanced, Low Hysteresis Finger Seal Test Results

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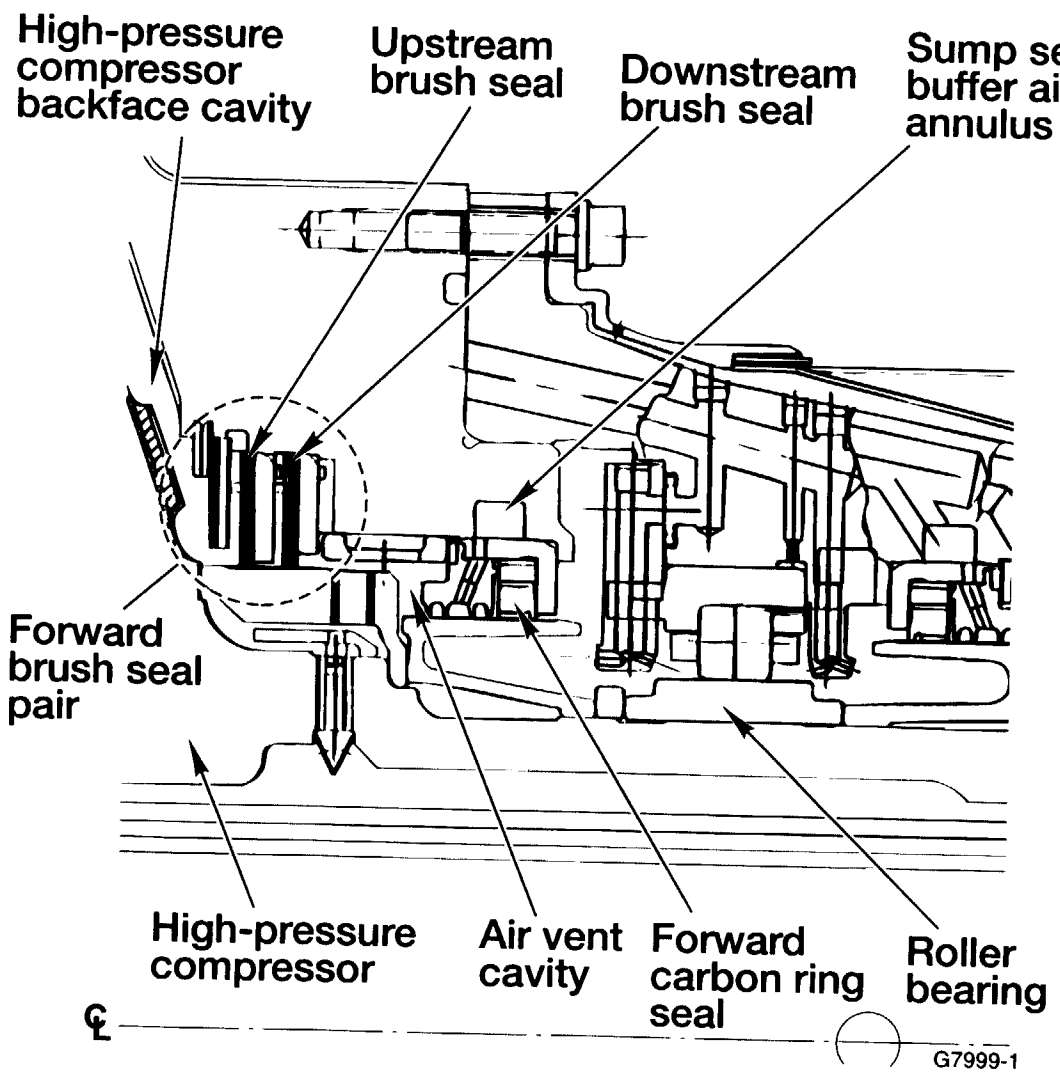
Typical Brush Seal Arrangement



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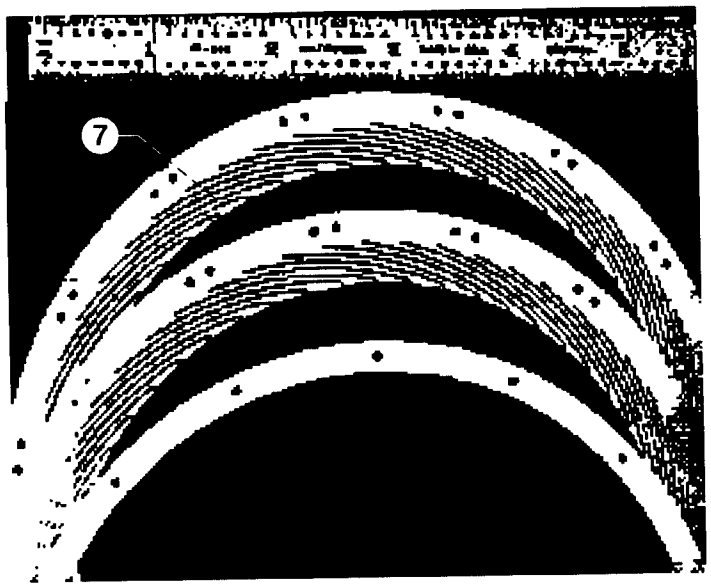
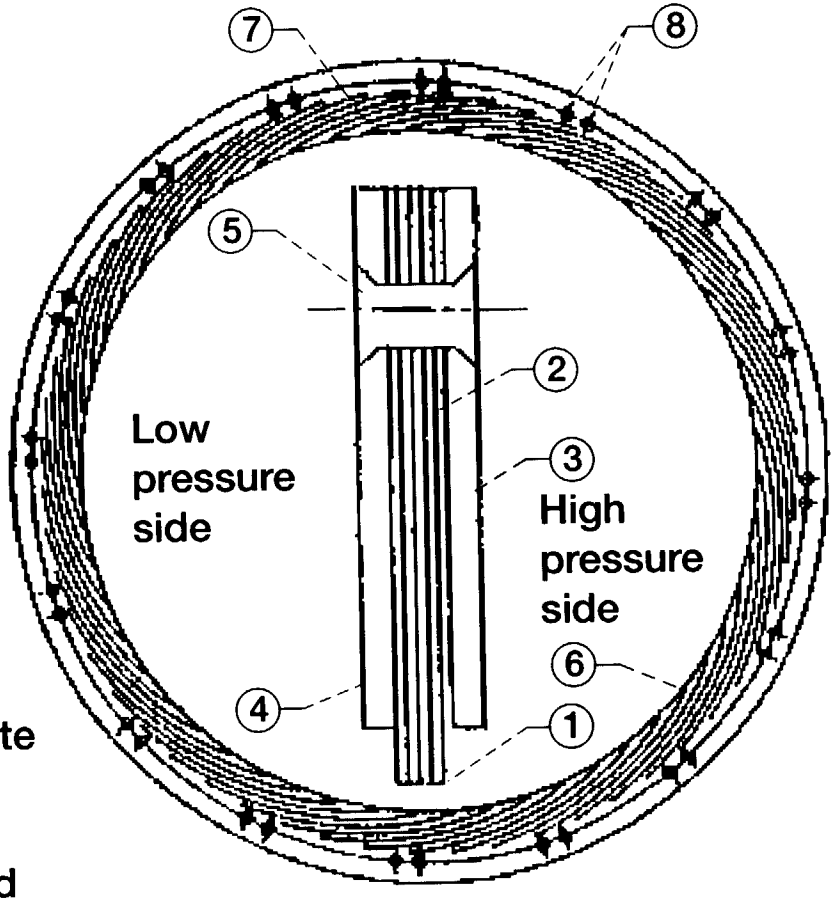
Baseline Finger Seal and Its Nomenclature





1. Finger element
2. Spacer
3. Forward cover plate
4. Aft cover plate
5. Rivet
6. Finger contact pad
7. Finger
8. Indexing and rivet holes

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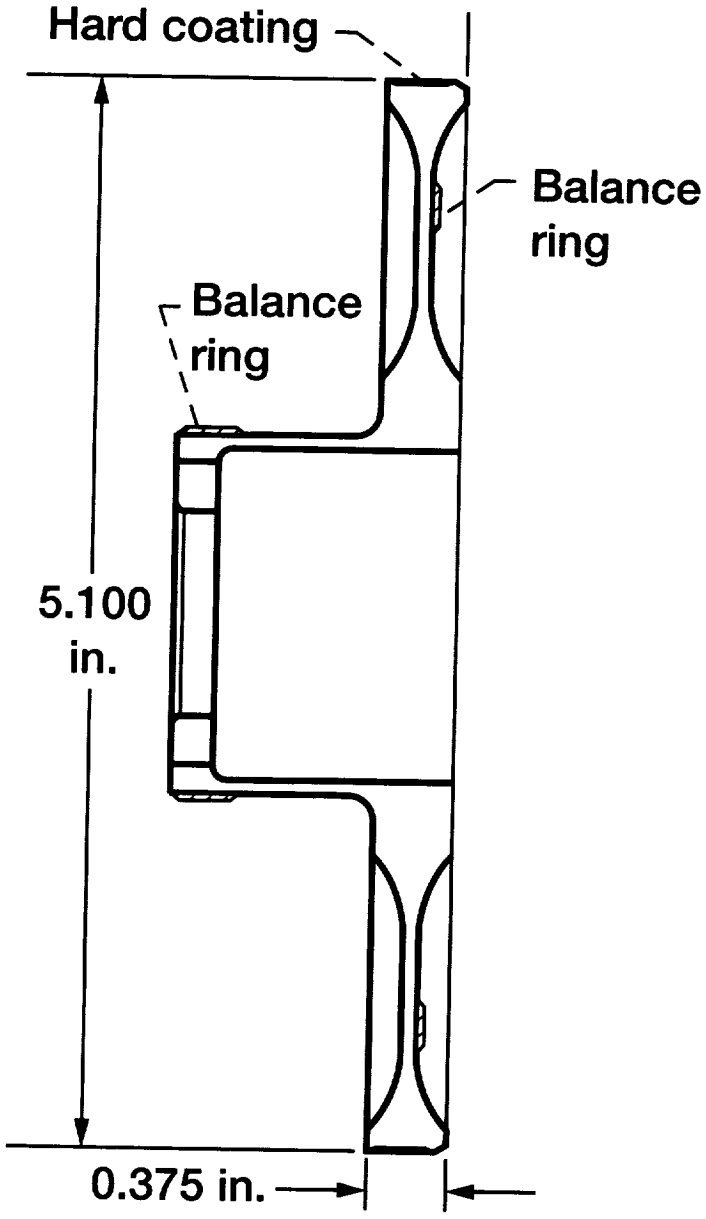
Finger Seal Test Rotor



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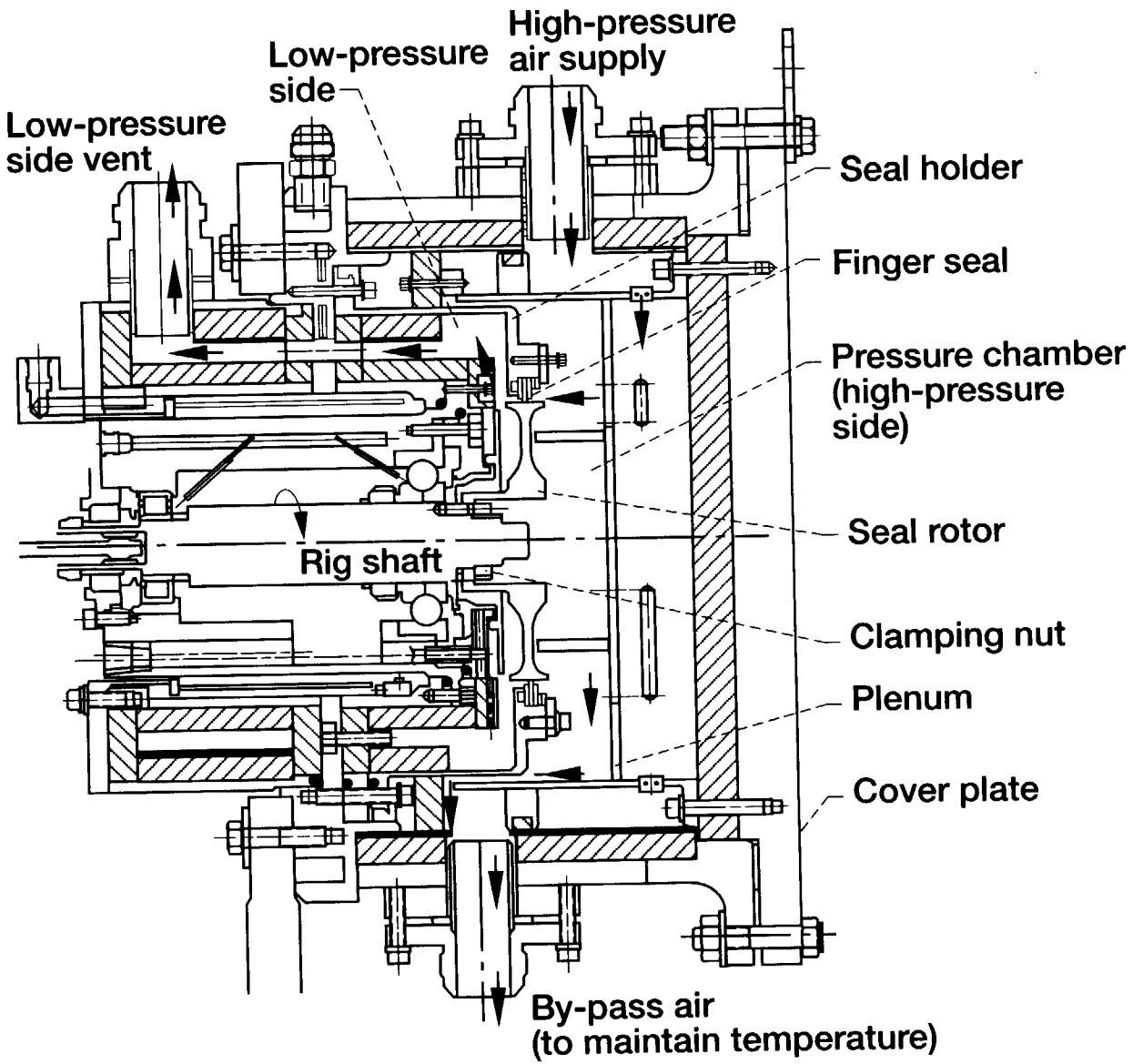
NASA Glenn Seal Rig Cross Section



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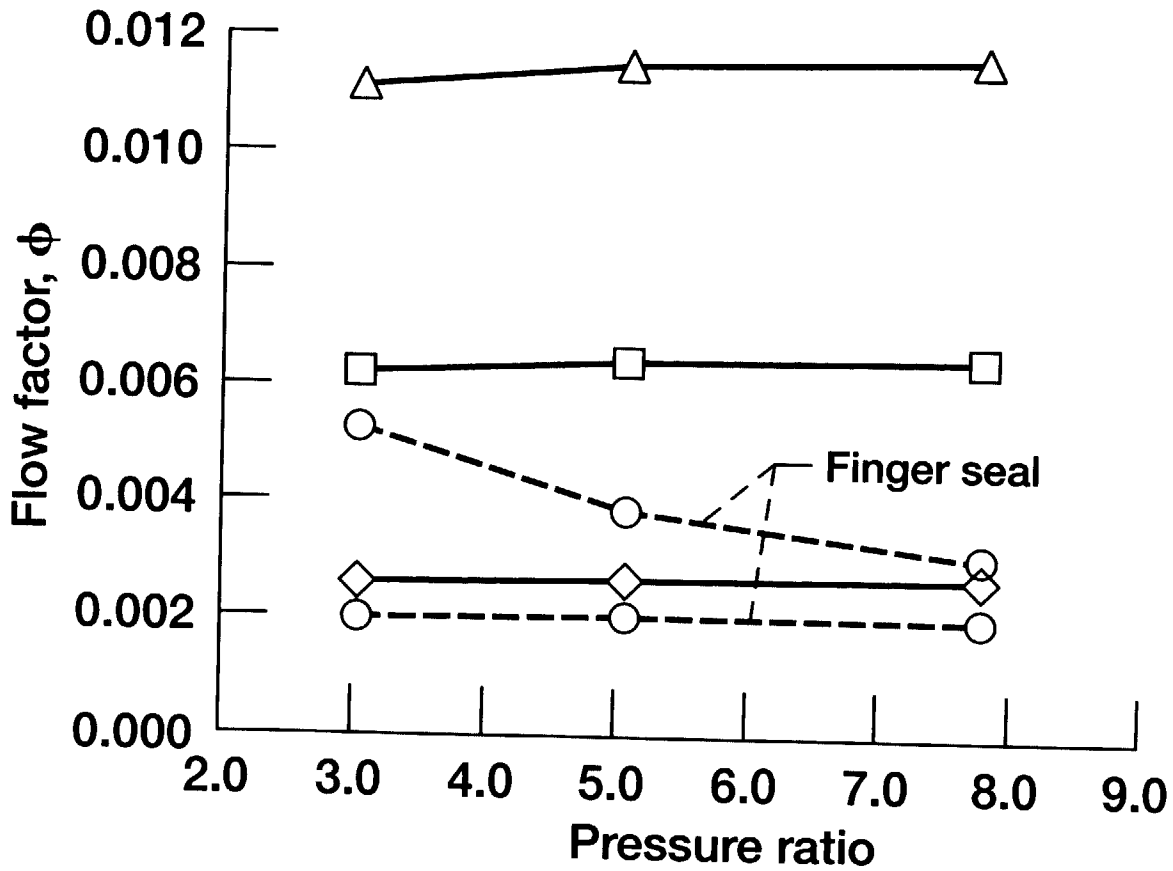
Comparison of Finger and Labyrinth Seal



4-knife labyrinth seal, radial clearance

- 0.002 in.
- 0.005 in.
- 0.010 in.

Air Temperature: 800 °F
Shaft Speed: 40 000 rpm
Seal I. D.: 5 Inch

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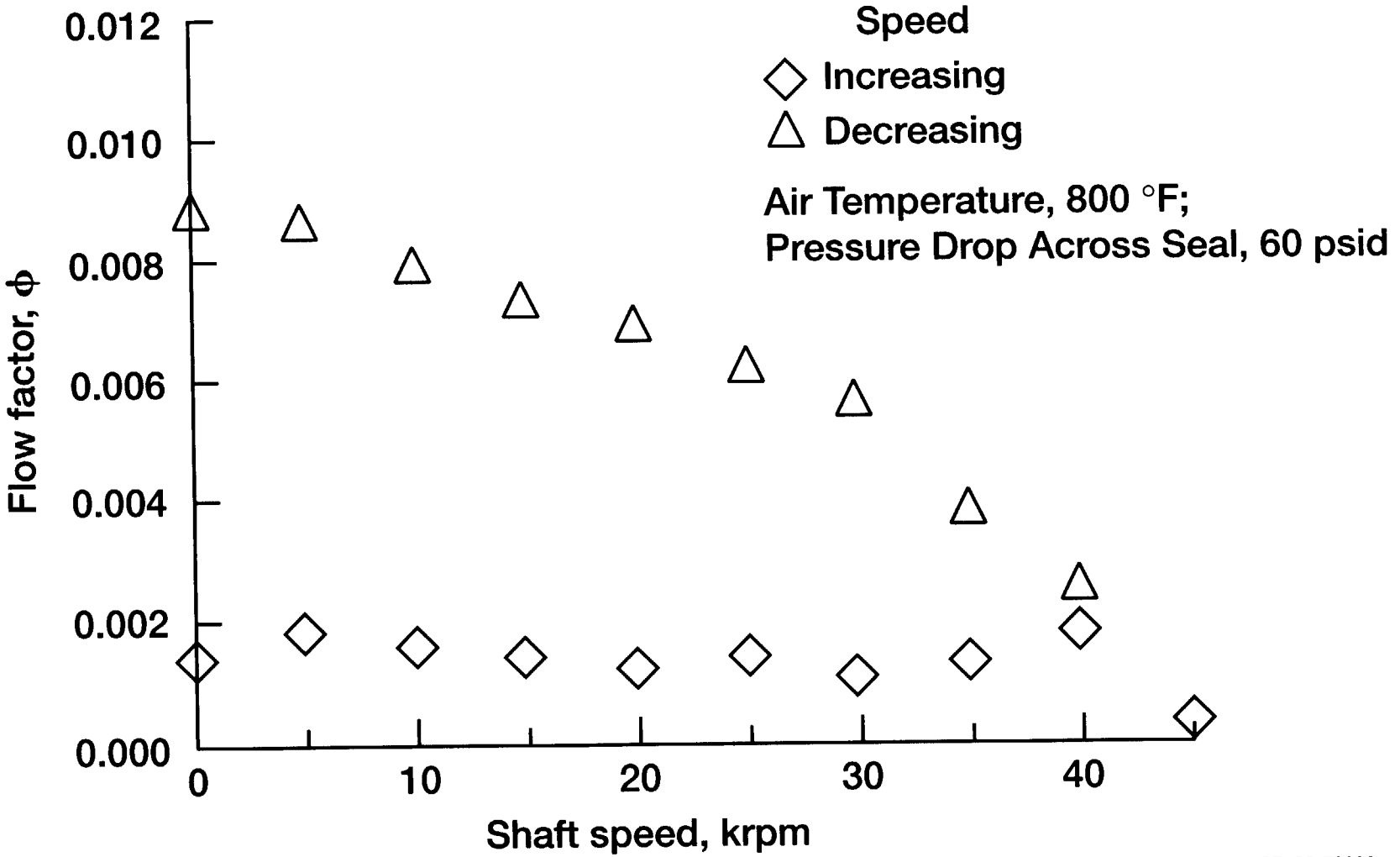
Baseline Finger Seal Hysteresis Test

Speed Ramp Cycle 1



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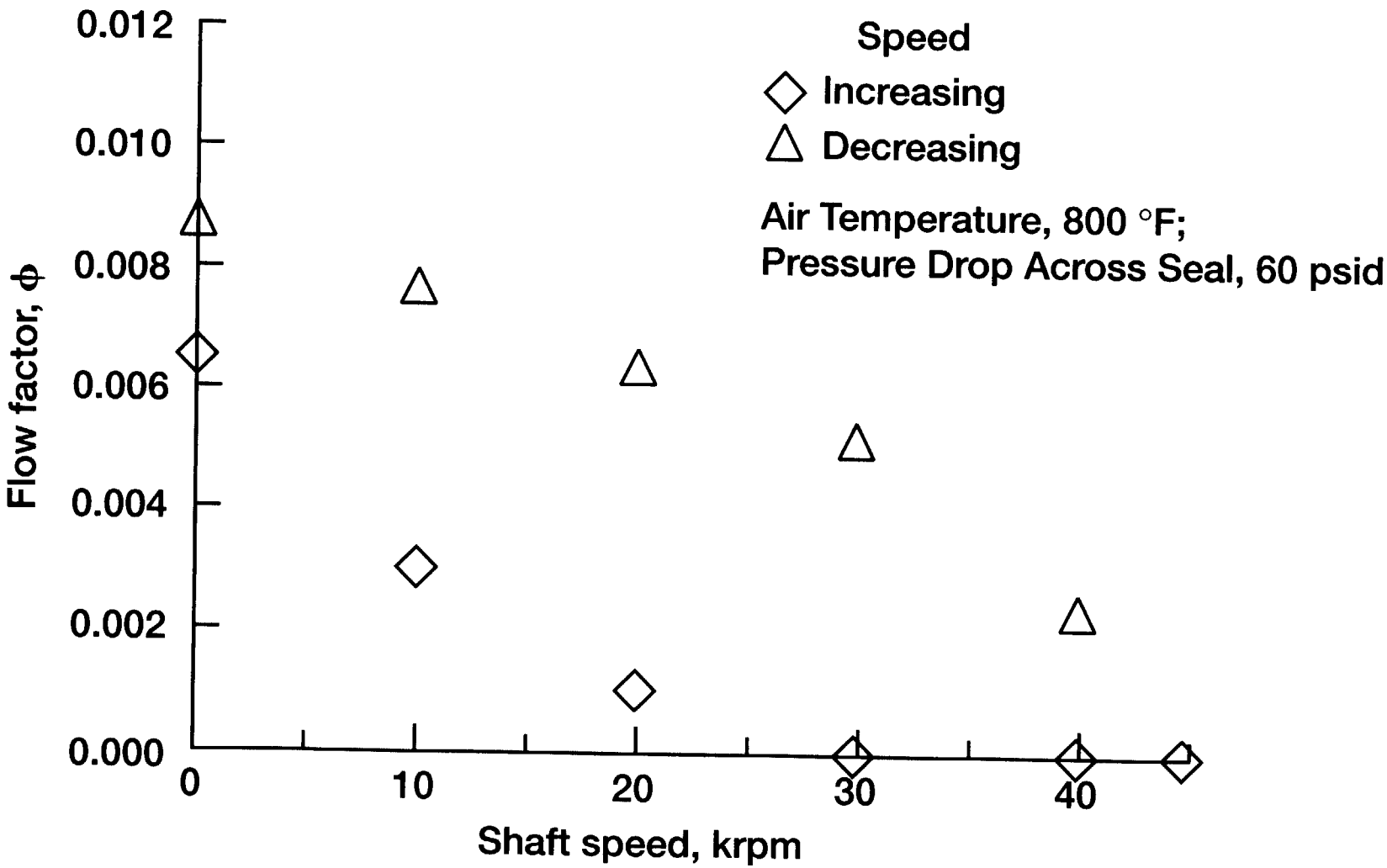
Baseline Finger Seal Hysteresis Test

Speed Ramp Cycle 2



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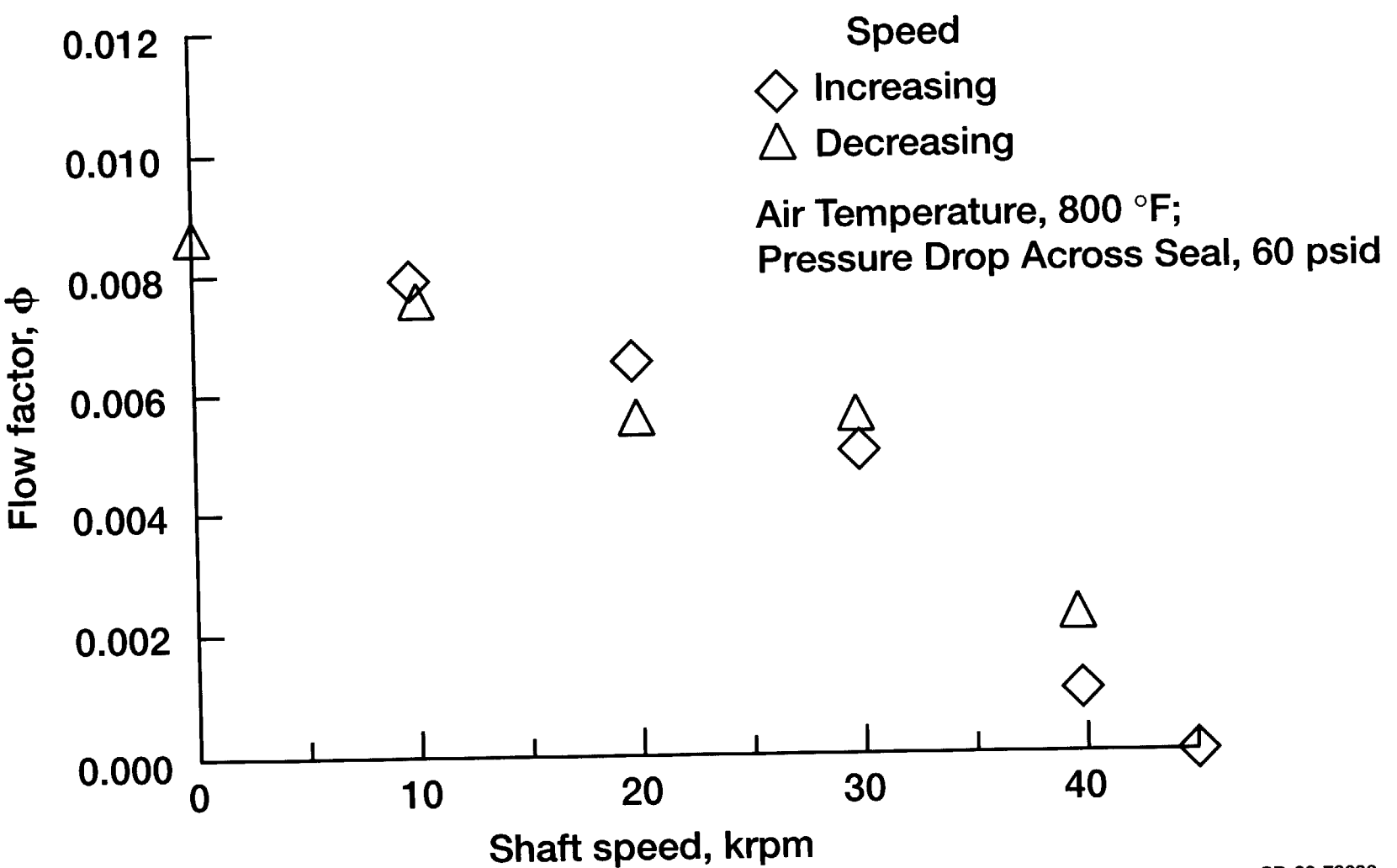
Baseline Finger Seal Hysteresis Test

Speed Ramp Cycle 3



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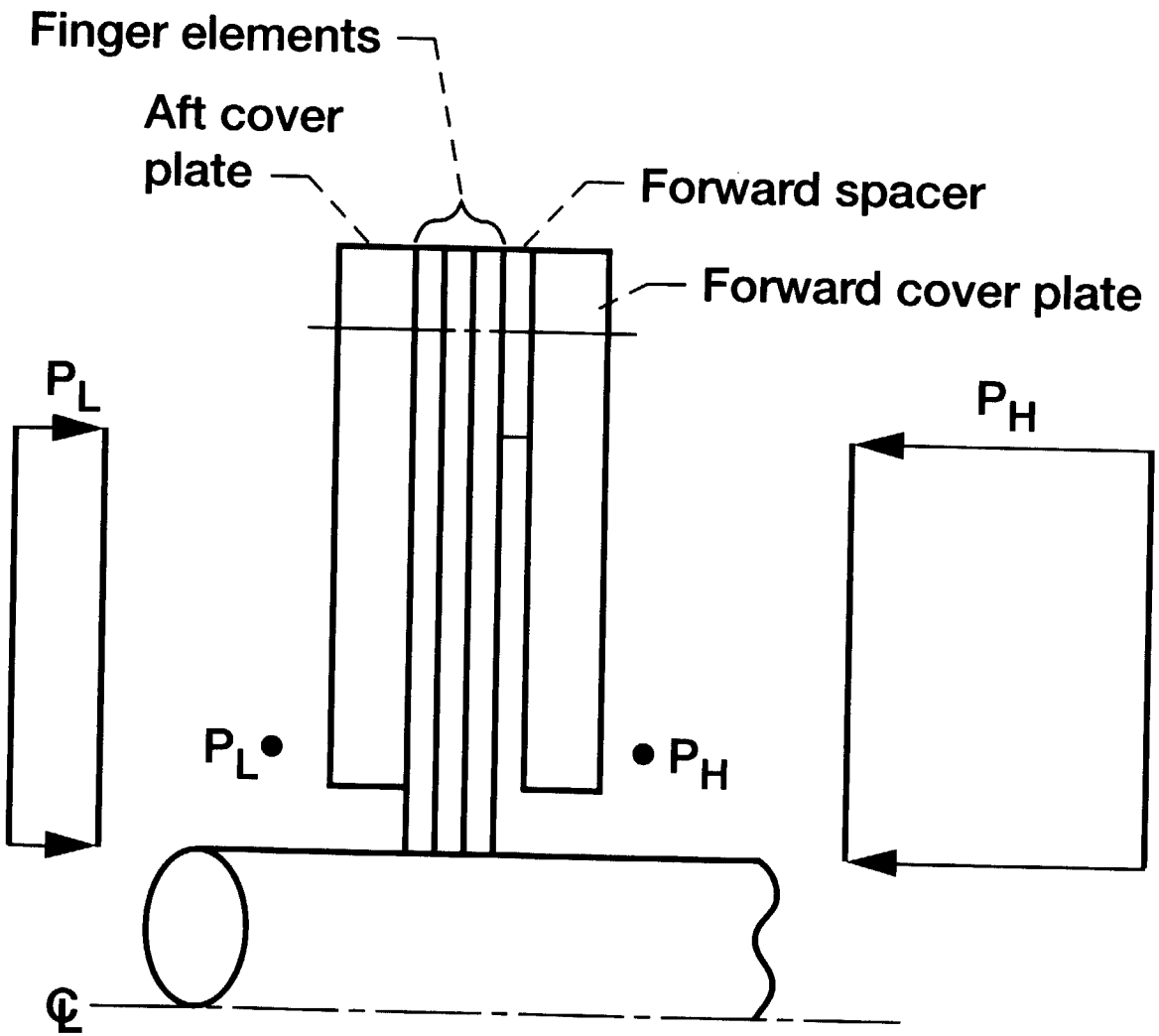
Baseline Finger Seal Force Balance



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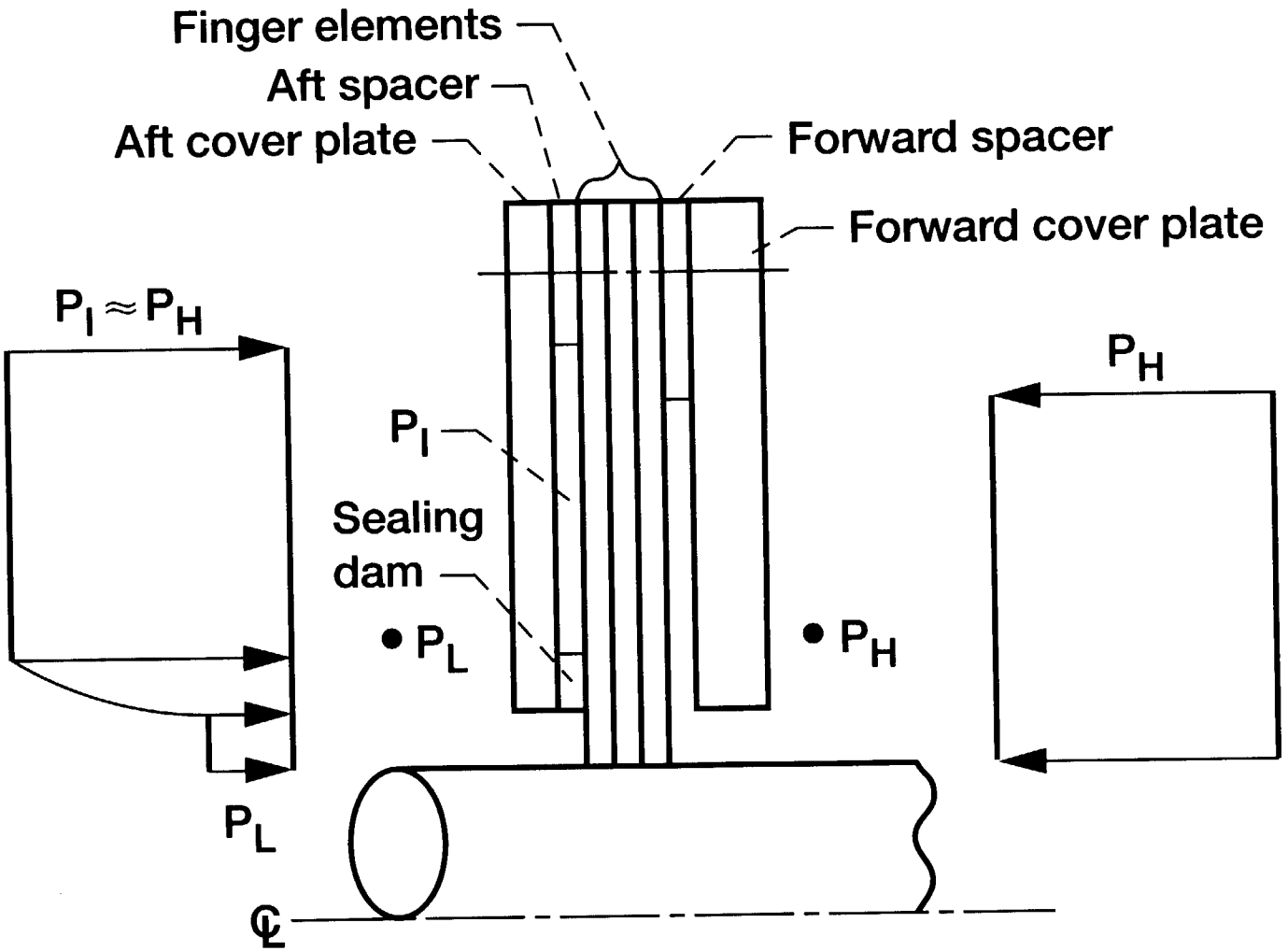
Pressure Balanced Finger Seal Force Balance



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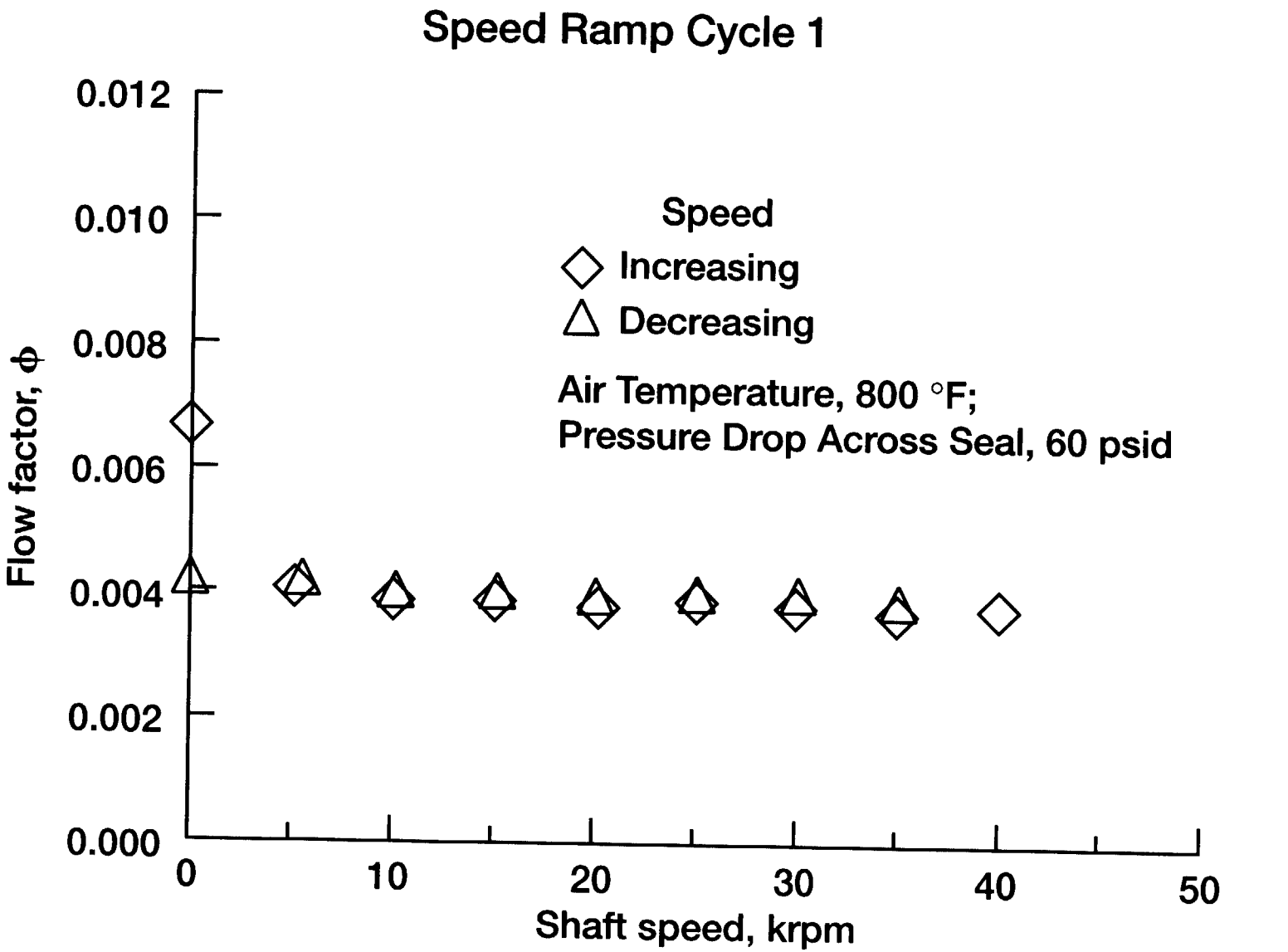
Pressure Balanced Finger Seal Hysteresis Test



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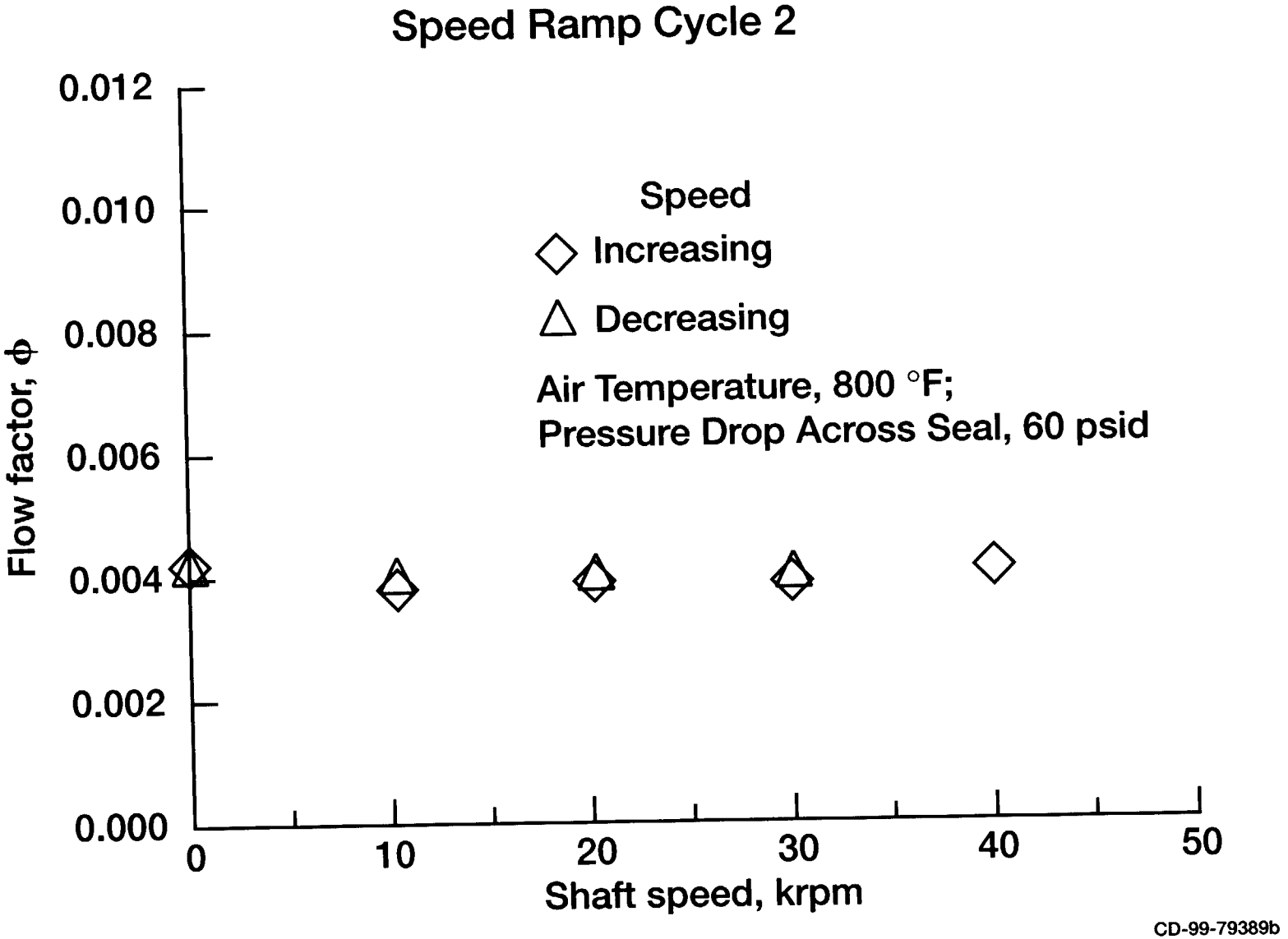
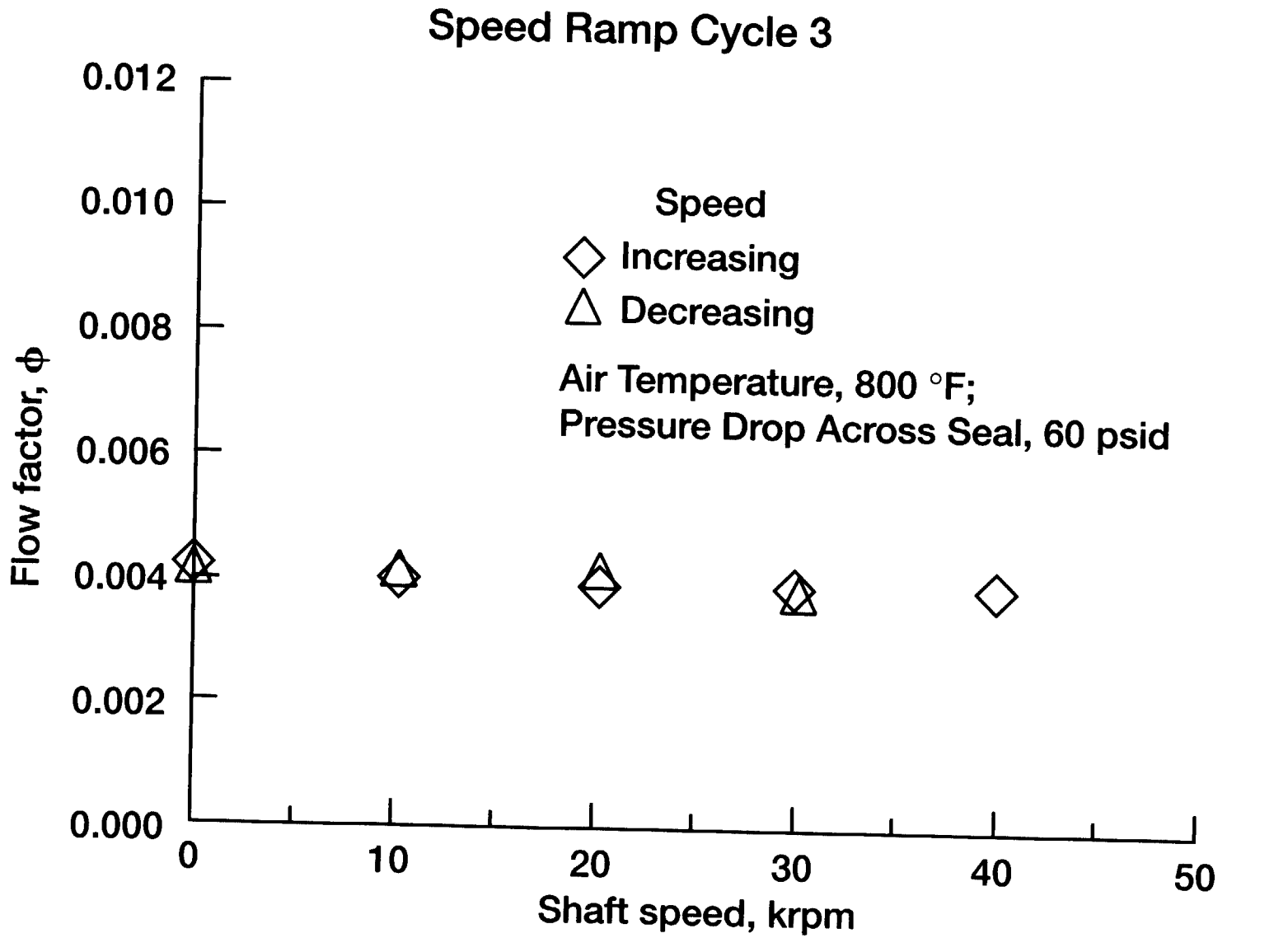
Pressure Balanced Finger Seal Hysteresis Test



Pressure Balanced Finger Seal Hysteresis Test



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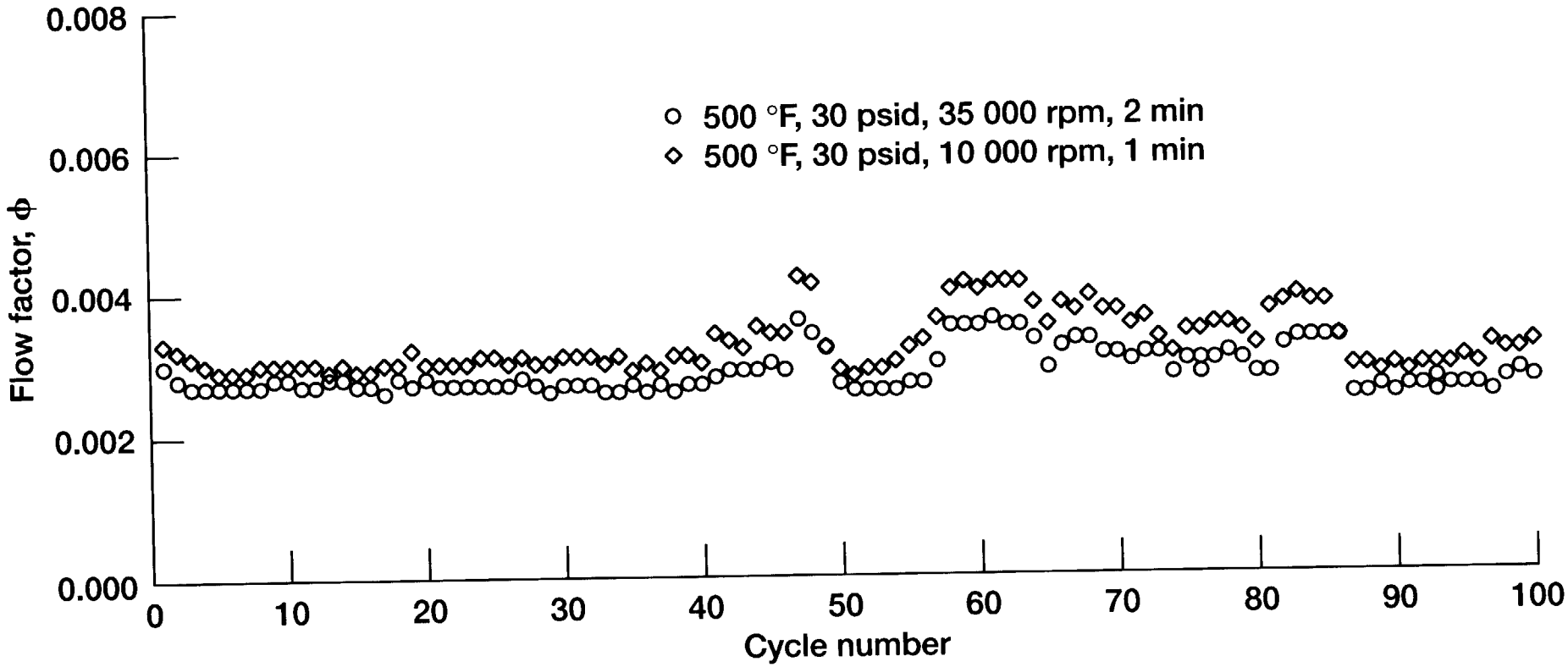
Segment 1
Pressure Balanced Finger Seal Rotor Run-Out Test



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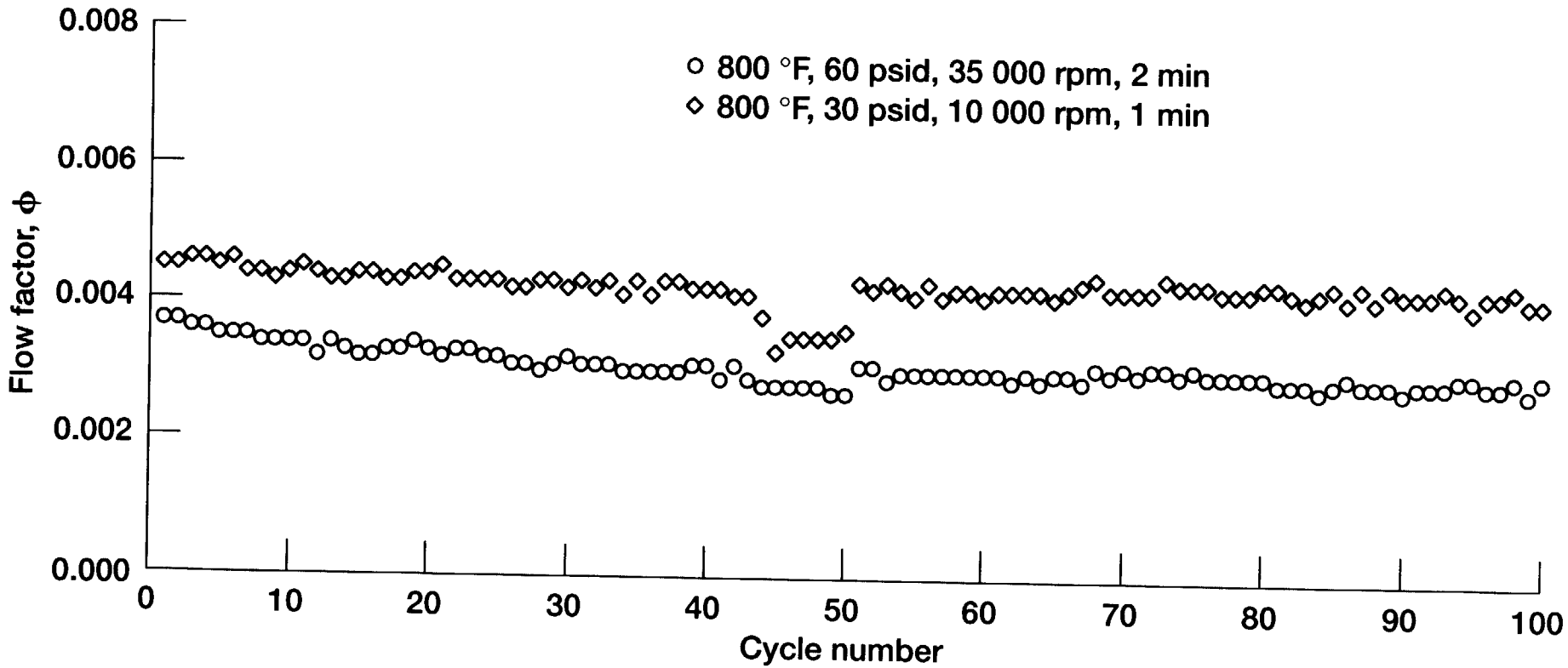
Segment 2
Pressure Balanced Finger Seal Rotor Run-Out Test



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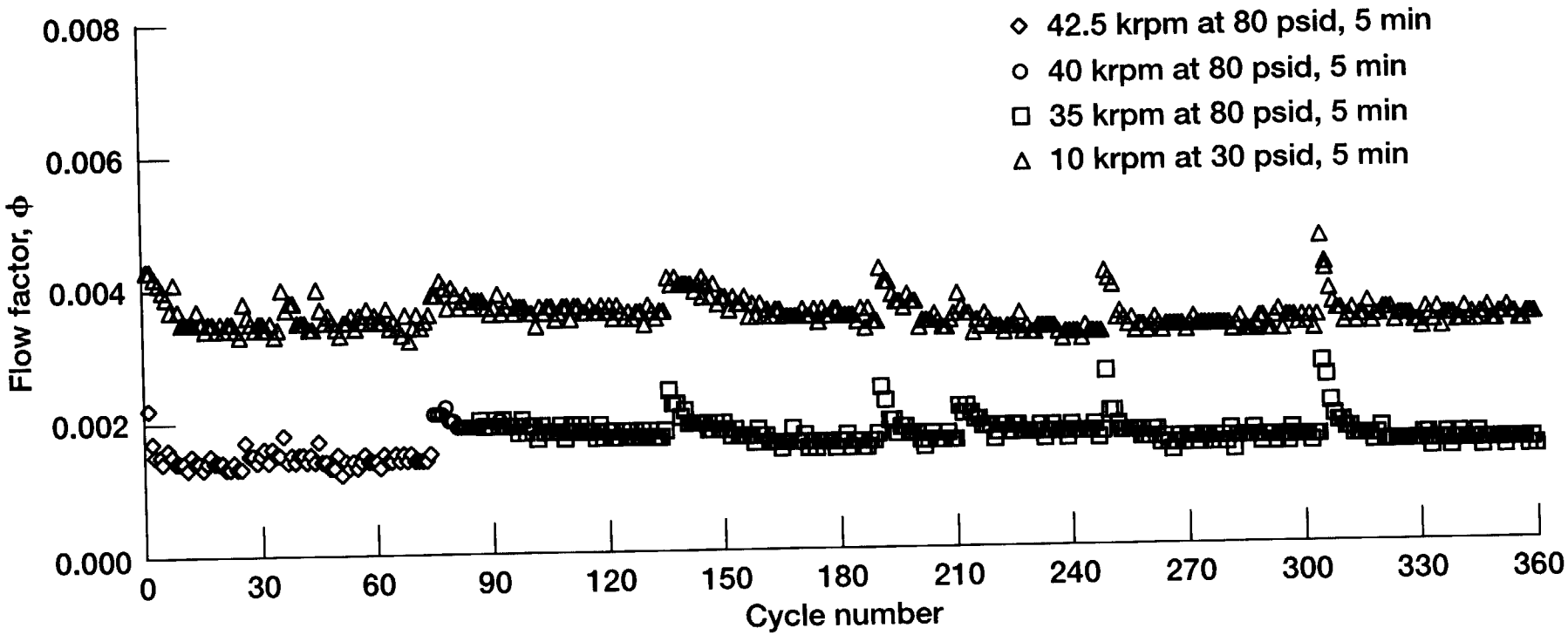
Segment 1
Pressure Balanced Finger Seal Endurance Test
Inlet Air Temperature, 800 °F



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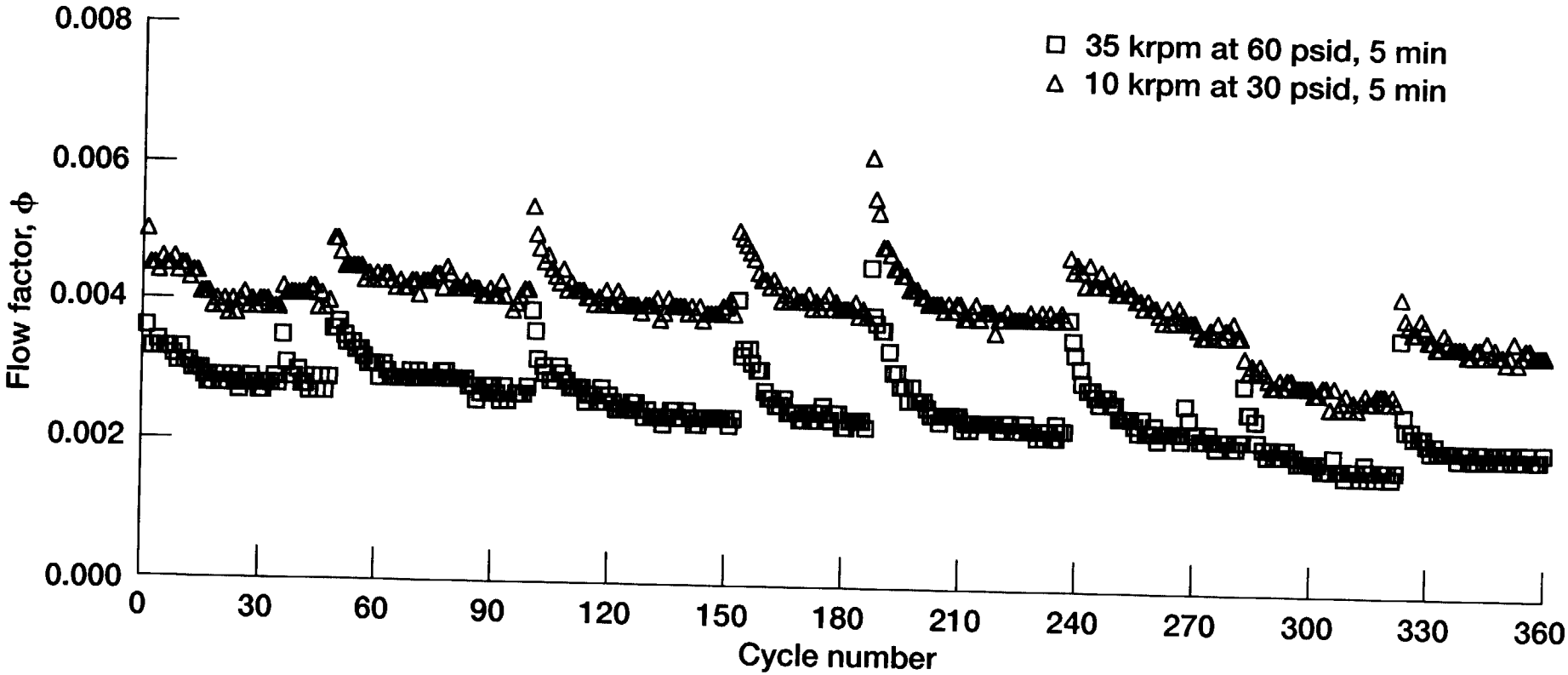
Segment 2
Pressure Balanced Finger Seal Endurance Test
Inlet Air Temperature, 1000 °F



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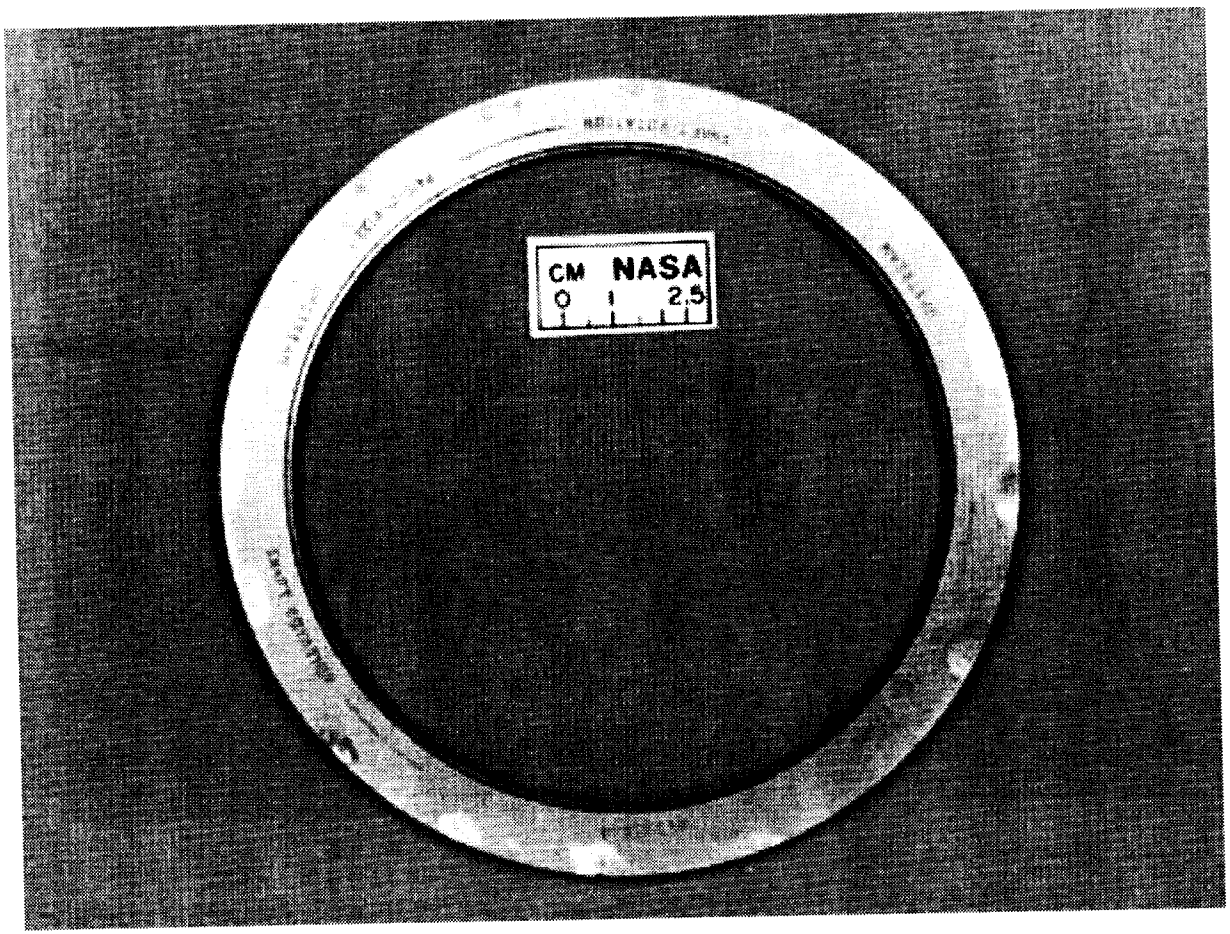
Overview of Pressure Balanced Finger Seal Prior to Endurance Test



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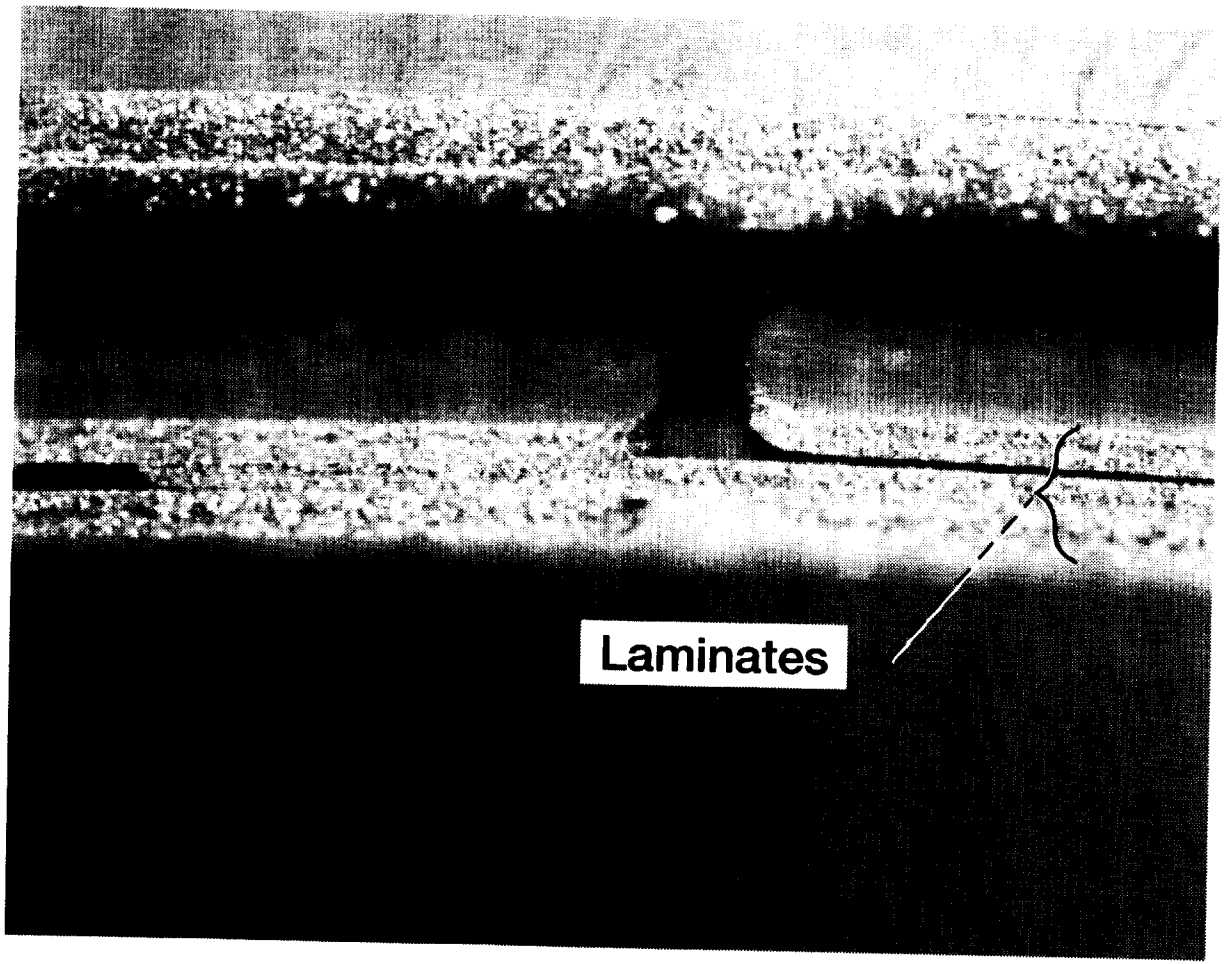
Magnified View of Upstream Finger Pad i.d. of Pressure Balanced Finger Seal Prior to Endurance Test



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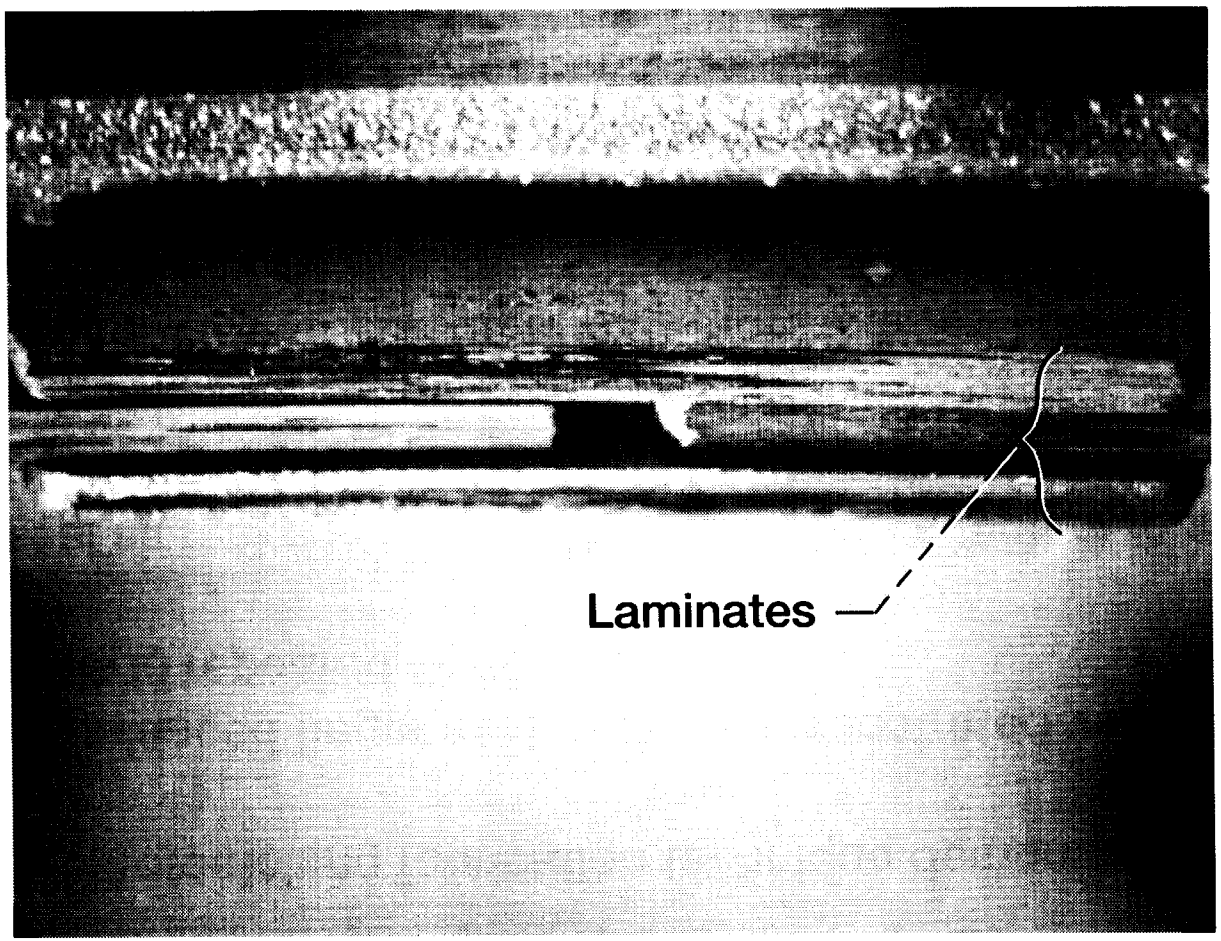
Magnified View of Upstream Finger Pad i.d. of Pressure Balanced Finger Seal After Endurance Test



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Conclusions

1. Low cost photoetching fabrication technique demonstrated.

2. Pressure balanced finger seal design demonstrated very low hysteresis in repeated rig testing.

3. Finger seal air leakage is 20 to 70% less than a typical four-knife labyrinth seal with 0.005 inch radial clearance.

4. Finger seal operation demonstrated at: 778 ft/s, 60 psid and 1000 °F. and 945 ft/s, 80 psid and 800 °F.

5. Rotor-run out and endurance test results indicate finger seals have potential for long life applications.

6. Extensive analytical work and rig testing has resulted in a finger seal design that is ready for engine testing.

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