BRUSH SEALS FOR TURBINE ENGINE FUEL CONSERVATION

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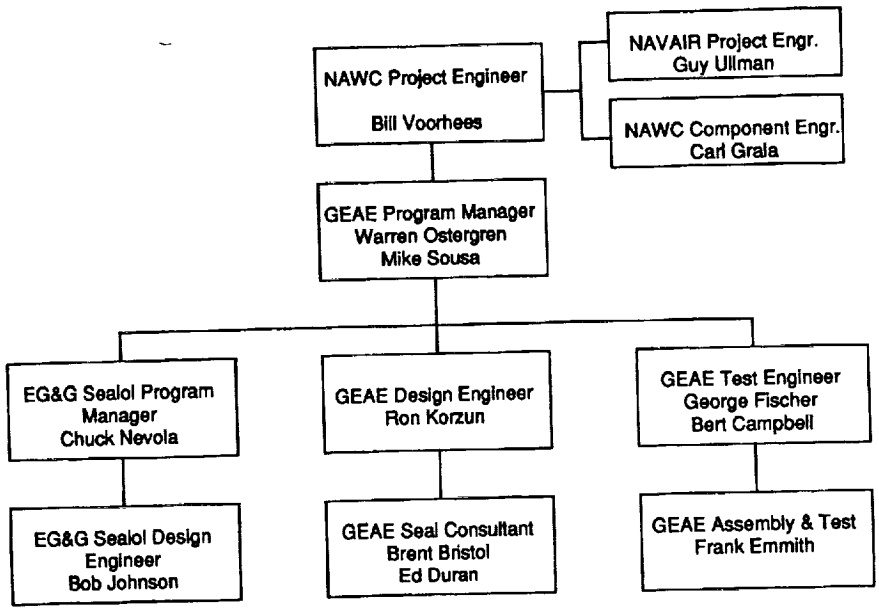
Program Objective

Demonstrate Brush Seals For Replacing
Labyrinth Seals In Turboprop Engines

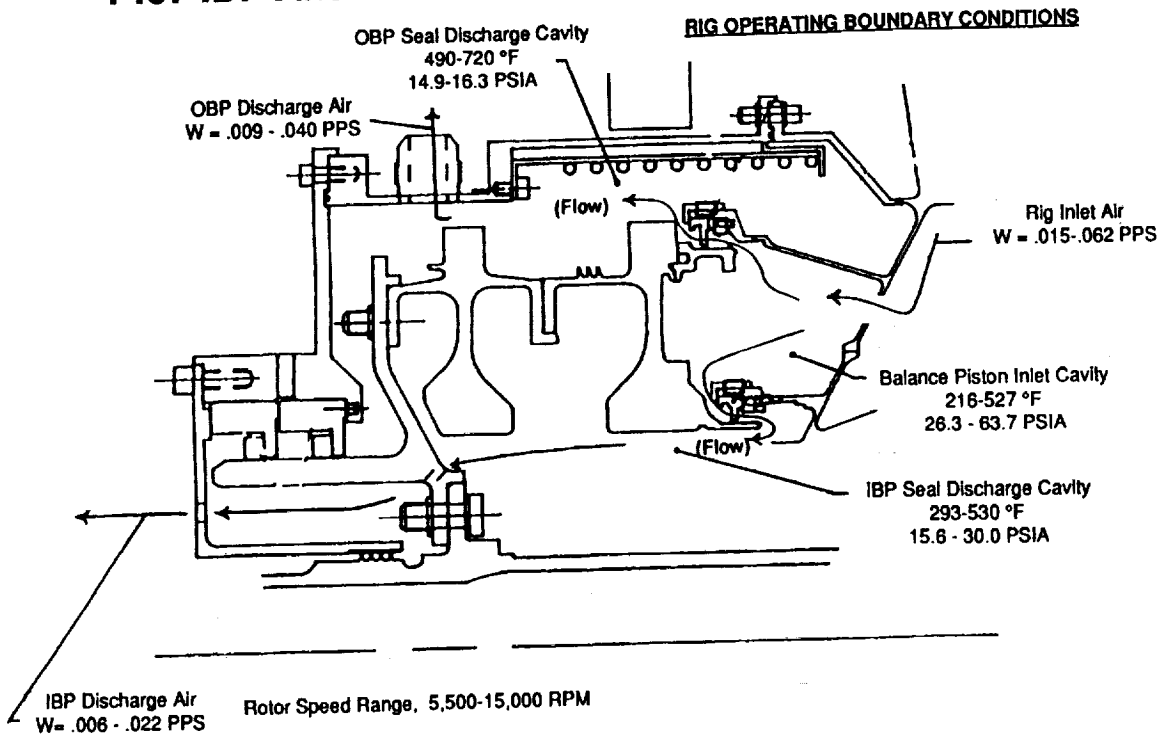
Program Approach

- Design And Procure Brush Seals With Assistance From Sealol
- Modify And Instrument An Existing T407 Low Pressure Turbine Test Rig
- Replace Inner Balance Piston And Outer Balance Piston Labyrinth Seals With Brush Seals
- Conduct Cyclic Tests To Evaluate Seal Leakage At Operating Pressures And Temperatures
- Evaluate Effect Of Seal Pack Width And Rotor Eccentricity

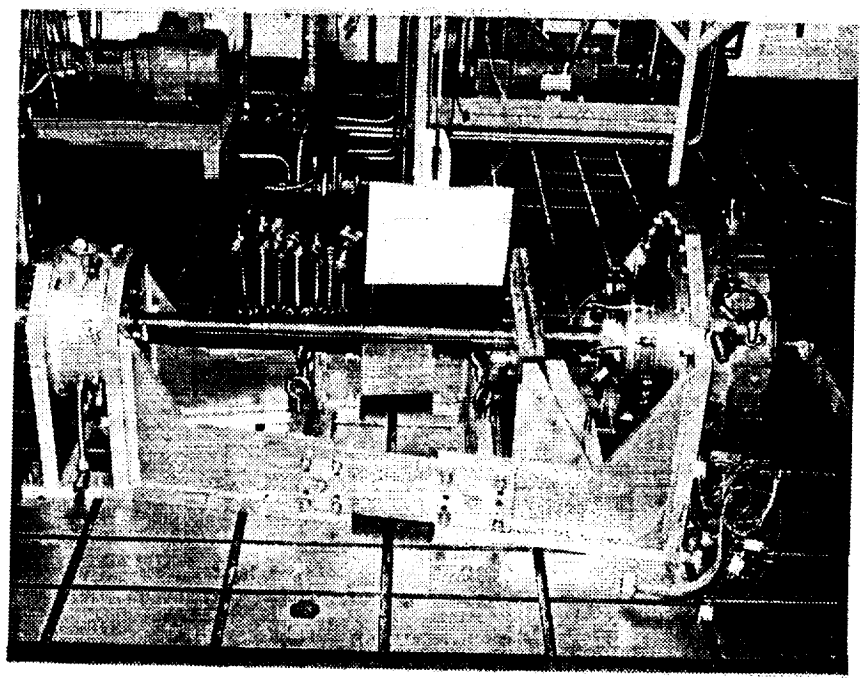
Project Organization



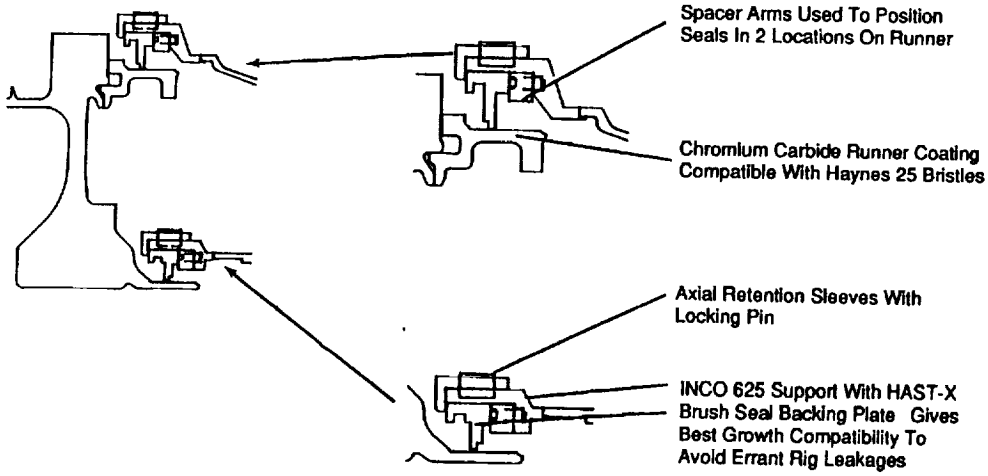
T407 IBP And OBP Brush Seal Dynamic Test Rig



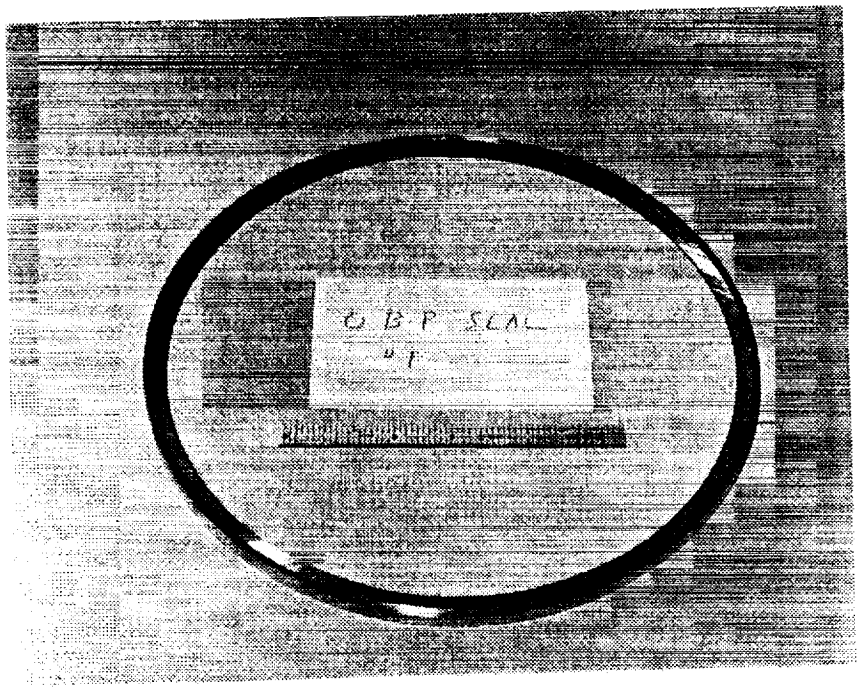
T407 Rig Assembled In Test Platform



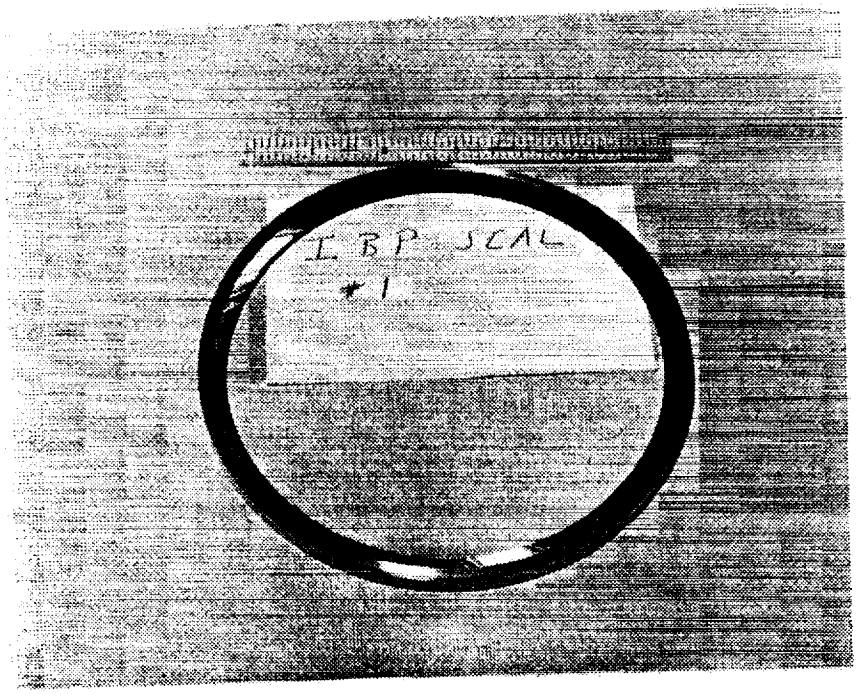
Key Brush Seal/Rig Features



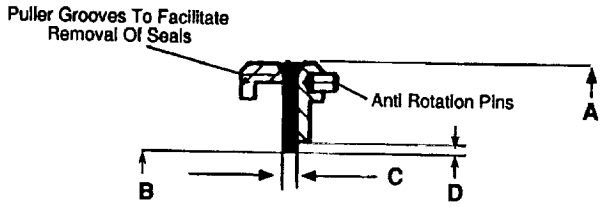
Outer Balance Piston Brush Seal



Inner Balance Piston Brush Seal



Seal Design and Fit - Ups



	OBP	IBP
Brush Seal Inner Diameter Cold (B)	10.1"	5.6"
Brush To Runner Diametral Interference - Cold (B)	.006	.008
Brush To Runner Diametral Interference - Hot (B)	.010	.010
Brush Axial Pack Width (C)	.025 (.050)	.050
Backing Plate GAP (D)	.051	.044
Diametral Interference Fit With Stator Support - Cold (A)	.006	.004
*Maximum Stress – Seal Support	18 KSI	25 KSI
*Maximum Stress –Brush Seal	13 KSI	17 KSI

* At SS IRP, Nominal Fit Up

- Brushes Maintain Contact With Rotor At All Operating Conditions
- Backing Plate Distance Sized For 'Worst Case Conditions Expected in Field
- Backing Interference Maintained At All Operating Conditions - Avoid Leakage
- Stress Is Acceptable - Below .2% Yield Strength

Brush Seal Testing

- Build #1 - 75 Hours - (Primarily-Diagnostic Testing)
  - Seal Flows Higher Than Anticipated
  - Tear Down For Review/Inspection
- Build #2 - 175 Hours - 55 Cycles (Still Running)
  - Reduce Rotor Runout
  - OBP
    - Double Pack Width
    - Increase Bristle/Runner Interference
  - IBP
    - Same Seal Endurance

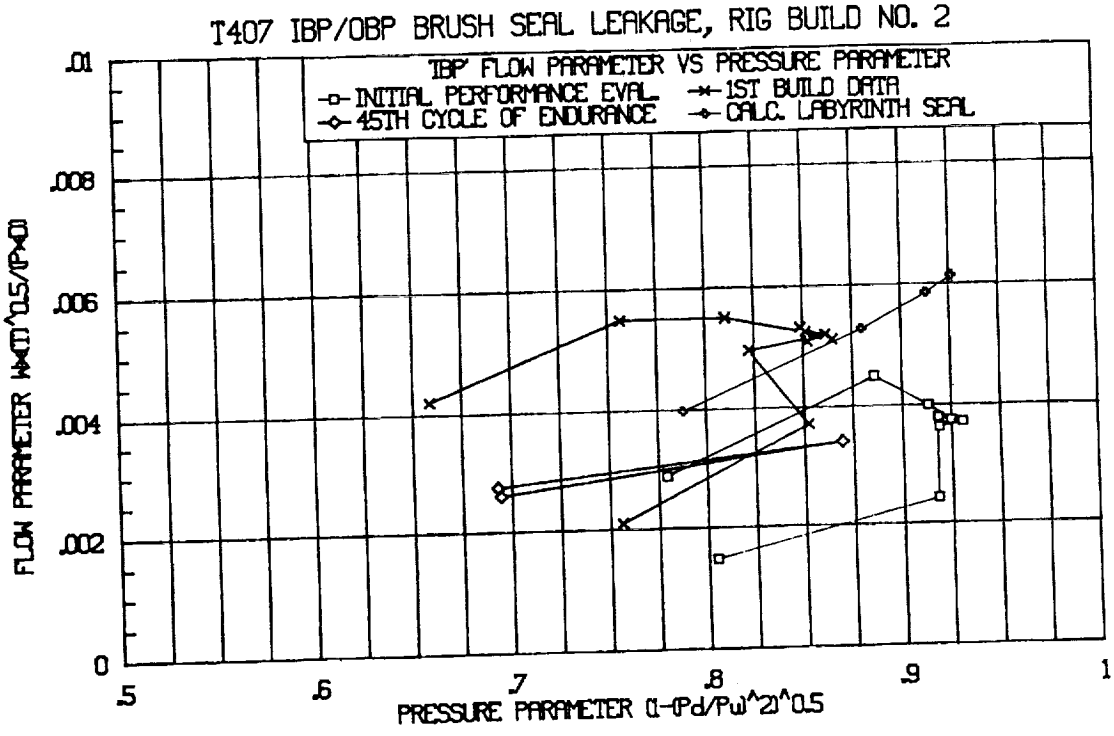
Brush Seal Performance Results

- Mixed Results For IBP And OBP Seals
  - IBP Seal Looks Promising
  - OBP Seal Needs Further Evaluation

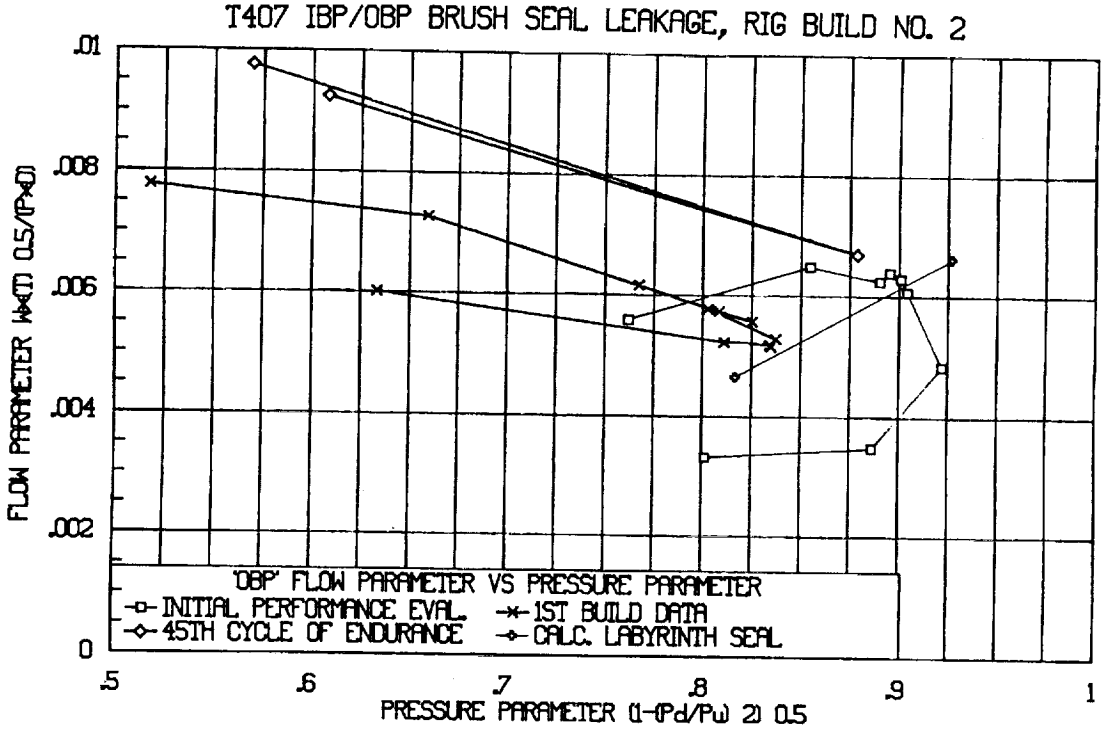
- IBP Seal
  - Second Rig Build Demonstrated Better Performance Than Calculated Labyrinth Seal
  - No Apparent Deterioration With Time (>250 Hours And >60 Cycles)

- OBP Seal
  - Second Rig Build Demonstrated Better Max Power Performance Only (Hysteresis Caused Poorer Performance At Part Power)
  - Endurance Testing Appears To Have Increased Seal Flow

IBP Performance Data



OBP Performance Data



Conclusions

- Seal Designs Currently On Test Were State Of The Art ~2 Years Ago - Seal Designs Have Evolved Since Then - As Demonstrated On Sealol Testing

- Incorporation Of Brush Seals Requires Attention To Design Details
  - Critical Parameters Include Rotor Runout

- Brush Seals Offer Performance Advantages Over Labyrinth Seals And Need To Be Pursued Further