

PROGRAMS AT WRIGHT PATTERSON AIR FORCE BASE
WL/POSL

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The Lubrication Branch has two active programs that are developing gas turbine engine mainshaft air/oil seals. Both of these programs, one of which is with General Electric Aircraft Engines and the other with Pratt & Whitney Aircraft, are addressing counter-rotating intershaft applications which involve very high rubbing velocities. My presentation will briefly address the objectives and requirements of both of these efforts.

HIGH SPEED AIR/OIL SEAL DEVELOPMENT

CONTRACTOR: UNITED TECHNOLOGIES (PRATT & WHITNEY)

CONTRACT NUMBER: F33615-88-C-2822

START / DURATION: SEP 88 / 45 MONTHS

OBJECTIVE: CONDUCT A COMBINED ANALYTICAL AND EXPERIMENTAL PROGRAM TO DEVELOP AND ENDURANCE TEST COUNTER-ROTATING INTERSHAFT SEALS FOR RELIABLE OPERATION UP TO 1200 FT/SEC PITCH LINE VELOCITY

- GOALS:
- * 4000 HOUR SEAL LIFE
 - * 1200 FT/SEC PITCH LINE VELOCITY
 - * 50 LB/HR MAX AIR LEAKAGE @ 50 PSID & 750 F
 - * 500 LB/HR MAX AIR LEAKAGE AFTER PRIMARY SEAL MALFUNCTION
 - * MISALIGNMENT TOLERANCE

HIGH SPEED AIR/OIL SEAL DEVELOPMENT

APPROACH:

- * DEFINE THE SEAL APPLICATION AND ESTABLISH REQUIREMENTS
- * SELECT TWO SEAL CANDIDATES THROUGH AN ANALYTICAL ASSESSMENT OF PERFORMANCE POTENTIAL FROM A MINIMUM OF FIVE SEAL DESIGNS
- * FABRICATE AND EVALUATE THE PERFORMANCE CAPABILITIES OF BOTH SEAL DESIGNS
- * SELECT THE BETTER OF THE TWO SEAL DESIGNS FOR ENDURANCE TESTING
- * ENDURANCE TEST THIS SEAL FOR AN ADDITIONAL 80 HOURS
- * EVALUATE TEST RESULTS TO IDENTIFY IMPROVEMENTS NEEDED AND POSSIBILITY OF TRANSITION INTO THE JTDE PROGRAM

HIGH SPEED AIR/OIL SEAL DEVELOPMENT

STATUS:

- * SEAL DESIGN REQUIREMENTS WERE BASED ON AN ADVANCED FIGHTER-TYPE AIRCRAFT WITH A 60% INCREASE IN THE THRUST-TO-WEIGHT CAPABILITY OF CURRENT STATE-OF-THE-ART SYSTEMS
- * TWO SEAL DESIGNS, A CONTROLLED GAP SEAL CONCEPT AND A SEGMENTED HYDRODYNAMIC CIRCUMFERENTIAL SEAL, WERE SELECTED FROM 25 CANDIDATES
- * FABRICATION OF THE CONTROLLED GAP SEAL DESIGN IS IN PROGRESS
- * FABRICATION OF THE SEGMENTED SEAL IS COMPLETE
- * SHAKEDOWN TESTING OF THE EG&G SEALOL TEST RIG HAS BEEN COMPLETED

COUNTER-ROTATING INTERSHAFT SEAL DEVELOPMENT

CONTRACTOR: G.E. AIRCRAFT ENGINES

CONTRACTOR NUMBER: F33615-90-C-2000

START/DURATION: APR 90/29 MONTHS

OBJECTIVE: DEVELOP AN ADVANCED DESIGN INTERSHAFT SEAL FOR PHASE II IHPTET ENGINE CONFIGURATIONS THAT UTILIZE COUNTER-ROTATING TWIN SPOOLS

GOALS:

- 900 FT/SEC PITCH LINE VELOCITY
- ΔP UP TO 50 PSID
- 900°F SEAL AIR INLET TEMPERATURE

COUNTER-ROTATING INTERSHAFT SEAL DEVELOPMENT

APPROACH:

- ADVANCED DESIGN BASED ON AN AIR BEARING-SUPPORTED CONTINUOUS RING CONFIGURATION
- THREE MATERIAL APPROACHES FOR CRITICAL SEALING INTERFACE:
 - (1) CONCURRENTLY DEVELOPED ADVANCED HIGH STRENGTH CARBON ($> 100\text{KSI PER LB/IN}^3$)
 - (2) STATE-OF-THE-ART METALLIC MATERIALS
 - (3) INLAID ARRANGEMENTS OF CARBON, METAL, AND/OR CERAMICS

COUNTER-ROTATING INTERSHAFT SEAL DEVELOPMENT

APPROACH (CON'T):

- CONDUCT PHYSICAL AND TRIBOLOGICAL CHARACTERIZATION TESTS TO SELECT BEST MATERIAL APPROACH
- FOR SELECTED APPROACH, DESIGN AND FABRICATE FULL-SIZE PROTOTYPE SEAL
- CONDUCT SEAL TESTS IN TWO PHASES:
 - (1) PERFORMANCE MAPPING
 - (2) ENDURANCE FOR UP TO 200 HRS
- BASED ON TESTS, DESIGN SEAL FOR THE PH II DEMONSTRATOR ENGINE

COUNTER-ROTATING INTERSHAFT SEAL DEVELOPMENT

STATUS:

- MATERIAL CHARACTERIZATION TESTS UNDERWAY
- PROMISING RESULTS OBTAINED WITH ADVANCED CARBON MATERIALS
 - (1) HIGH STRENGTH
 - (2) GOOD OXIDATIVE RESISTANCE