Program:	Cover-Gas Seals	DOE/SF/71011--T8	
ERDA Task:	11-Cover-Gas-Seal Components		MASTER
Program Manager:	R. W. Keaten	**Project Manager:**	L. Baurmash
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AT03-76SF71011

I. PROJECT OBJECTIVES

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The objectives of the Cover Gas Seal Components Test Program are to develop and demonstrate the performance of commercial and custom-designed head region cavity seals for LMFBR reactors, to develop and evaluate advanced seal concepts capable of achieving improvement in radioactive gas containment and seal temperature-life capabilities, and to establish operational safety margins for head region seals for nominal and extraordinary LMFBR plant conditions.

Current activities include testing the CRBRP sodium dip seal configuration to determine its performance characteristics, proving techniques to increase the radial compliance and decrease the rotational drag of the CRBRP rotating plug seal design, and developing the technology to improve static inflatable seal designs.

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DISCLAIMER

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II. MAJOR ACCOMPLISHMENTS DURING THE FISCAL YEAR 1977

Wetting of the dip seal blade has been successfully accomplished by two techniques: 1) plating a 2.5 μm (0.0001 in) layer of tin on the blade, and 2) using ultrasonic techniques, both at 204C (400F). The dynamic plug seal upgrade tests have been initiated and results to date indicate drag values are decreased significantly with the narrow blade assembly.

III. PROGRESS DURING THE REPORTING PERIOD

A. CRBRP SODIUM DIP SEAL BLADE

During December 1976 (AI-ERDA-13189) the dip seal blade surface was plated with a 2.5 μm (10^{-4} in) layer of tin and a gas attenuation run initiated. The run was completed in early January and wetting of the blade verified as there was no measurable increase in the cover gas region helium concentration. A visual inspection showed minimal, but uniform wetting of all tinned surfaces and no wetting of untinned surfaces, including the SA508 coupon. The wetted surfaces had a dull, frozen appearance, rather than being bright and shiny, and this was attributed to the presence of an oxide film on the sodium surface which adhered to the wetted surface of the blade as it was raised out of the sodium. Following reimmersion, the oxide film provided a diffusion path for the helium and further gas attenuation runs were postponed until the next phase of testing.

The plug assembly was removed from the dip seal test vessel, sand blasted, and tin-plated on one half of the blade perimeter in preparation for the ultrasonic wetting tests. The ultrasonic horn was checked out and installed with an $\sim$0.5 cm ($\sim$3/16 in) gap between the horn and the dip seal blade. A 16^{0} test section of the blade was exposed to ultrasonics, the blade was raised and the area observed to be wetted. The entire 180^{0} untinned blade surface was then exposed to ultrasonics by advancing the blade $\sim 2^{0}$ ($\sim$1/3 the width of the ultrasonic horn) every minute. The blade was again raised and the full perimeter was observed to be wetted. A gas attenuation run was initiated and helium leakage across the blade was observed. The entire perimeter of the blade was then exposed to ultrasonics and the gas attenuation run reinitiated without raising the blade for observation. Gas chromatograph measurements through 72 hours show no measurable helium leakage across the blade. It is postulated that raising the blade to verify wetting allowed some oxide to adhere to the wetted surfaces, either during raising or lowering of the blade, and provided a gas leak path.

The oxygen meter for use in the cleaning demonstration tests has been received and preparations are being made for its installation.

B. CRBRP INFLATABLE SEAL VENDOR QUALIFICATION

A Test Plan, N707TP810015, "CRBRP Head Assembly Inflatable Seal Qualification Test Plan (DRS 32.06, Addendum 2)" has been prepared documenting the planned test sequence for the vendor seal qualification tests and is being circulated for approval. A detailed Test Procedure is being prepared, based on that Test Plan.

The inflatable seal molds have been shipped to the first seal supplier, Seal Master Corp., Kent, Ohio. The first set of seals is expected to be delivered in late April.

C. DYNAMIC PLUG SEAL UPGRADE

The modified (narrow blade) seal track was delivered to AI (1-28-77). A Test Procedure, N707DTP810016, was issued detailing specifics of the: 1) radial compliance, and 2) low friction seal coating test phases. The initial test phase, obtaining base-line data on the existing seals and nominal width blade with a horizontal offset of 0.10 cm (0.04 in) total indicated runout (TIR) was completed and included 1) drag vs speed vs inflation pressure, 2) dynamic leakage, and 3) static leakage tests at ambient and 66C (150F). These tests verified there was no change in performance characteristics of the seal since last use, and provided reference data for all narrow blade and low-friction coating test series.

The narrow blade track assembly, with 0.32 cm (0.12 in) wide seal blades as opposed to the nominal 0.64 cm (0.25 in) wide blades, was then installed with a horizontal offset of 0.10 cm (0.04 in) TIR and all drag, static leakage, and dynamic leakage tests repeated at ambient and 66C (150F). In addition, the seal was operated through 100 cycles (1 cycle = 1.5 rev. CW + .5 rev. CCW) of continuous rotation at the nominal operating parameters of 1.47 x 10^5 Pa (7.5 psig) inflation pressure, 1.0 x 10^5 Pa (1.0 psig) buffer pressure, and 0.07 m/s (15 fpm) rotational velocity.

The seal track horizontal offset was increased to 0.46 cm (0.18 in) TIR and all tests were repeated at 66C (150F). Data correlation and repeatability was judged sufficient to delete the duplicate tests at ambient.

Figures 1 and 2 show a summary of drag vs inflation pressure and drag vs speed respectively for: 1) the nominal width blade at 0.10 cm offset, 2) the narrow blade at 0.10 cm offset, and 3) the narrow blade at 0.46 cm offset. Of significant interest is the fact that drag with the narrow blade is considerably lower than with the nominal blade for all cases tested. Drag vs time (100 cycles) data also reflects this trend. The static and dynamic leakage are also substantially less with the narrow blade.

The seal track horizontal offset was increased to 0.97 cm (0.38 in) TIR and the fixture is being heated to 66C (150F) prior to repeat of the various test phases.

D. STATIC INFLATABLE DEVELOPMENT

Request for Quotations (RFQ) issued in November, 1976, for development of fabrication techniques to incorporate 1) a metal foil permeation barrier, and 2) a steel reinforcing fabric in the walls of elastomer seal bodies were "no-bid" by two suppliers and positive responses were not received from the two prime bidders until late March. Both companies had stated they needed considerable time to evaluate the problems, as both proposals involve advancing the state-of-the-art in elastomer seal manufacturing technology. Evaluation of the responses will be completed by the first week in April and, based on proposed schedules of ~ 16-18 weeks, the final test bladders will not be available for test before mid-August. First phase delivery of metal foil and steel mesh reinforced test slabs will be about mid-June. These must be evaluated by AI Engineering prior to go-ahead on the bladder fabrication.

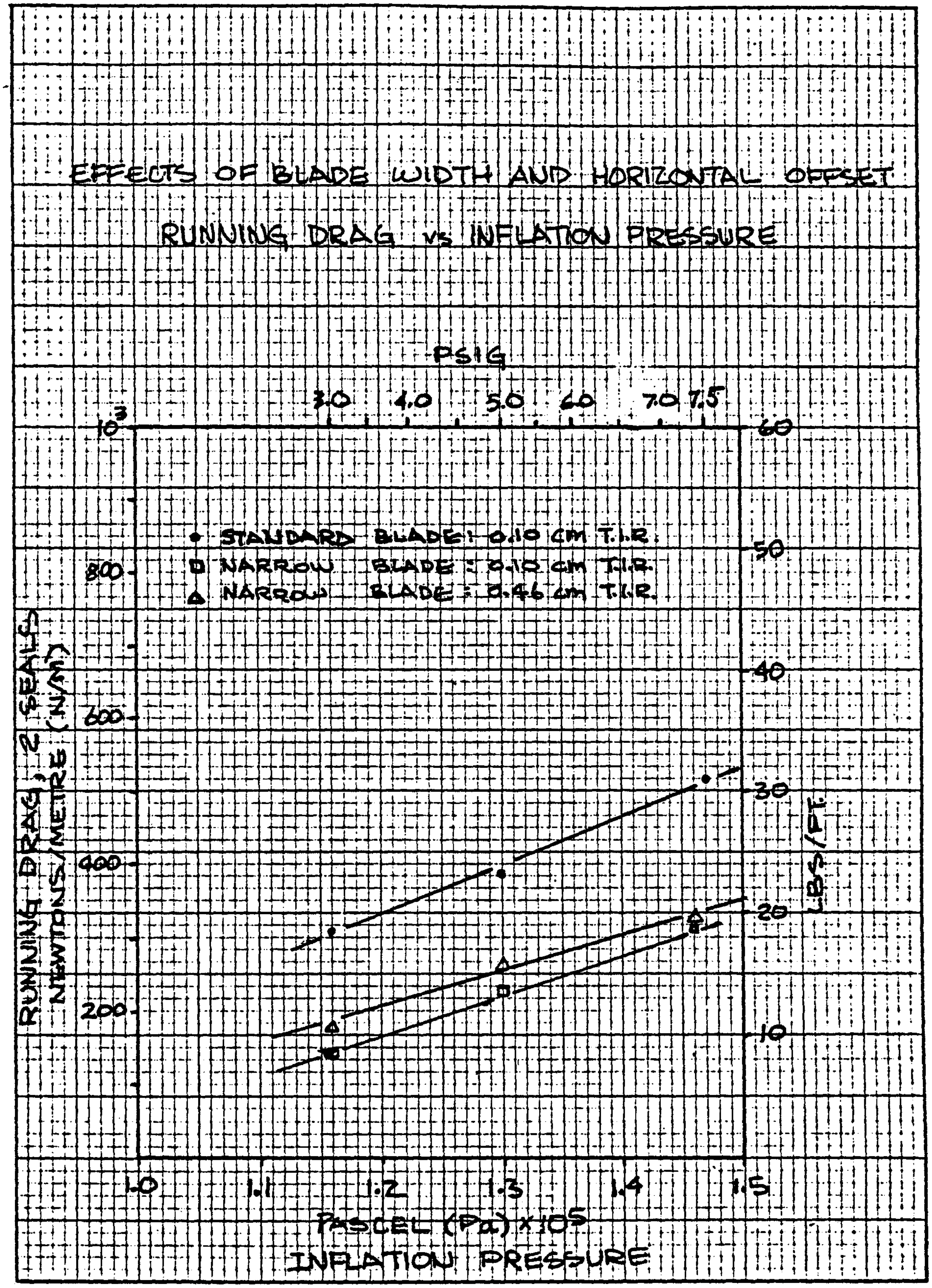
EFFECTS OF BLADE WIDTH AND HORIZONTAL OFFSET
RUNNING DRAG vs INFLATION PRESSURE
PSIG
3.0
4.0
5.0
6.0
7.0
7.5
10³
800
600
400
200
60
50
40
30
20
10
• STANDARD BLADE: 0.10 CM T.I.R.
□ NARROW BLADE: 0.10 CM T.I.R.
△ NARROW BLADE: 0.46 CM T.I.R.
RUNNING DRAG, 2 SEALS
NEWTONS/METRE (N/M)
LBS/FT.
1.0
1.1
1.2
1.3
1.4
1.5
PASCEL (Pa) x 10⁵
INFLATION PRESSURE

FIGURE 1

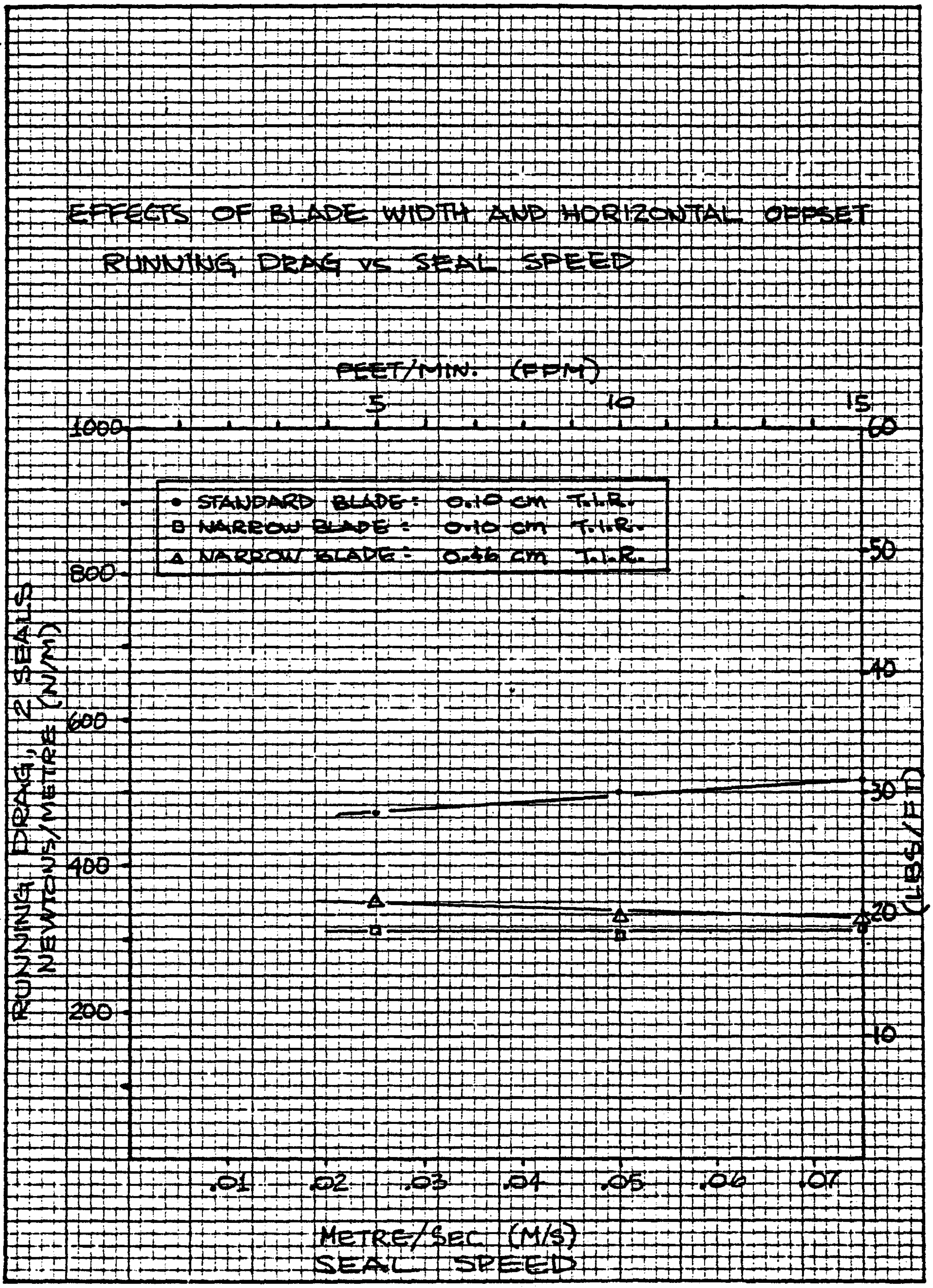
EFFECTS OF BLADE WIDTH AND HORIZONTAL OFFSET
RUNNING DRAG vs SEAL SPEED
FEET/MIN. (FPM)
5
10
15
1000
800
600
400
200
60
50
40
30
20
10
• STANDARD BLADE: 0.10 cm T.I.R.
□ NARROW BLADE: 0.10 cm T.I.R.
△ NARROW BLADE: 0.46 cm T.I.R.
RUNNING DRAG, 2 SEALS
NEWTONS/METRE (N/M)
(LBS/FT)
.01
.02
.03
.04
.05
.06
.07
METRE/SEC (M/S)
SEAL SPEED

FIGURE 2

IV. IMPACT ON LMFBR PROGRAMS

Elastomer and sodium dip seals developed under this program provide the primary radioactive gas containment barrier for LMFBR systems. Advances in sealing efficiencies and seal thermal capabilities will increase reactor safety margins and relax thermal restraints in seal containing machines.

V. NEXT REPORTING PERIOD ACTIVITIES

The sodium dip seal wetting and gas attenuation performance tests will be completed and the cleaning demonstration tests initiated. The Seal Upgrade tests will be completed and the first vendor CRBRP seal qualification tests initiated. Metal foil and steel mesh reinforced test slabs will be delivered for evaluation of Phase I accomplishments of the Static Inflatable Seal development tests.