

**FORMING A TURBOMACHINERY SEALS WORKING GROUP:
AN OVERVIEW AND DISCUSSION**

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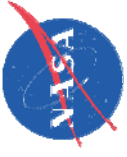
Forming a Turbomachinery Seals Working Group:
An Overview and Discussion

By
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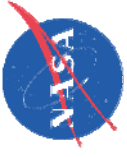
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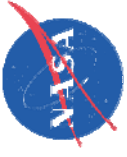
Purposes

- Identify technical challenges to improving turbomachinery seal leakage and wear performance, reliability and cost effectiveness
- Develop a coordinated effort to resolve foundational issues for turbomachinery seal technologies
- Identify and foster opportunities for collaboration
- Advocate for funding



Membership

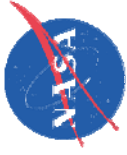
- Open to industry, academia, and government
- Ideally there would be representation from:
 - NASA
 - Other government agencies (DOD, DOE)
 - Engine companies –both aero and space
 - Seal companies
 - University researchers
- Questions:
 - U.S. only or open to foreign interests?
 - How many people does a working group need to be viable and functional?



Survey Response

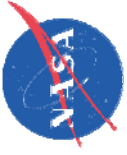
- Number of responses: 6 as of 10/31/06

	Interest?	
	<u>Yes</u>	<u>No</u>
– Industry:	5	5
• No. Engine companies	2	2
• No. Seal Companies		
• Other		
– Government:	1	1
– Academia:		



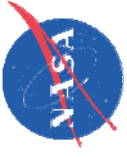
Survey Response - Purpose

Ways to serve community	Yes	1 st	2 nd	3 rd
Identify Technical Challenges to improving turbomachinery seal leakage and wear performance, reliability, and cost effectiveness	6	5	1	
Develop coordinated effort to resolve foundational issues for turbomachinery seal technologies	5		2	2
Identify & foster opportunities for collaboration	5		1	1
Serve as agent to coordinate technical investment in seal technology across government agencies with vested interest in turbomachinery	4	1		1
Serve as a catalyst for technical discussions	5		2	1
Advocate for funding	3			1



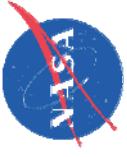
Survey Response – Meeting Frequency

Annually	1
Semi-annually	4
Quarterly	
Biennially	1
Never	
Other	



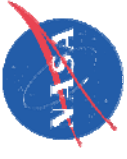
Survey Response – Areas of Experience & Expertise

- Submarine Design
- Machinery Operation & Maintenance
- High temperature/high pressure rotor-stator sealing
- Fluid-dynamics & heat transfer in rotating systems (jet engines – internal air; turbogenerators)
- Experimental methods in fluid dynamics & heat transfer
- Two-phase (air/oil) flow & heat transfer
- Air systems, seals, heat transfer, gas turbine design
- Development & application of labyrinth, brush, carbon, & rope seals
- Cryogenic and high temperature shaft seals – brush, finger, non-contacting film riding concepts



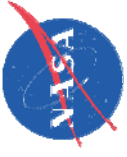
Survey Responses – Currently working on

- Seals for centrifugal compressors in O & G industry
- High pressure ratio seals in rotating cavities
- Labyrinth seals
- Brush seals
- Carbon face seals
- Advanced sealing, DOE High Hydrogen Turbine Program
- Large industrial gas turbines
- Low leakage, non-contacting finger seals
- Sealing in dusty lunar environment



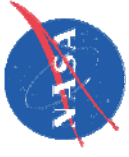
Survey Responses – Types of seals you use, design, or sell

- Labyrinth - 5
- Brush - 4
- Carbon Face
- Cloth seals for many static applications
- Finger
- New concepts



Survey Responses – Your Biggest Technical Challenges related to turbomachinery seals

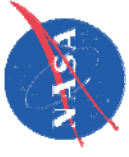
- Sealing pressure; dry gas seal failures
- Durability
- Low leakage, durable, long life, low cost, easily installed seals
- Reduced heat up while reducing leakage
- Wear of brush seals
- Achieving low leakage and long life seals at high temperature and high speed



Survey Response – technical challenges related to

Analysis

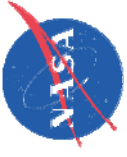
- Acoustic stability
- Dynamic tracking
- Validation of physics-based models for performance and durability
- Predicting wear
- Fluid-structure interactions particularly for compliant, non-contacting designs



Survey Response – technical challenges related to

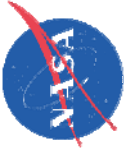
Materials

- Creep resistance of high strength alloys
- Temperature limitations on carbons & metals rub tolerance
- Scaling of capabilities
- High temperature applications
- Lack of material property data
- High temperature materials
- Friction coefficient data



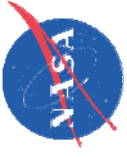
Survey Response – technical challenges related to Geometry

- Size of mechanical seal assemblies
- Scaling of seal assemblies
- Controlling leakage at circumferential splits in seal
- Scaling up from prototypes to actual hardware



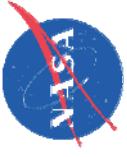
Survey Response – technical challenges related to Manufacturing

- Cost -2
- Repairability
- Low cost, reliable techniques



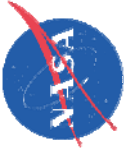
Survey Response – technical challenges related to Maintenance

- Wear
- Cost
- Excessive wear of rub damage



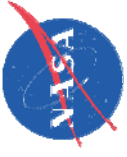
Survey Response – technical challenges related to Testing

- Realistic subscale testing
- Rotordynamics testing
- Full-scale prototype testing
- Cost of engine testing
- Dynamic testing
- Off-design conditions i.e. demo of durability during system failure modes
- Lack of facility for testing large, near full-scale parts
- Resources for test articles



Survey Response – technical challenges related to **Incorporation into Engine System**

- Understanding closure between rotor and stator during start and shutdown transients
- Access to engine systems



Where do we go from here?

- Accept additional survey responses until November 30, 2006.
 - Blank copies can be found at the registration table
- Decide if sufficient interest exists to establish the working group.
- Respondents to survey will receive a summary of results via e-mail as well as notification of future plans.