GE INDUSTRIAL TURBINE ADVANCED SEAL DEVELOPMENT

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Research & Development Center - Advanced Seals

GE Industrial Turbine Advanced Seal Development

Objective:

Advanced Seals Development Applications

Overview:

Sealing Areas Being Developed
Types of Sealing
System Level Analyses/Adjustments
Applications
Field Validation
Summary

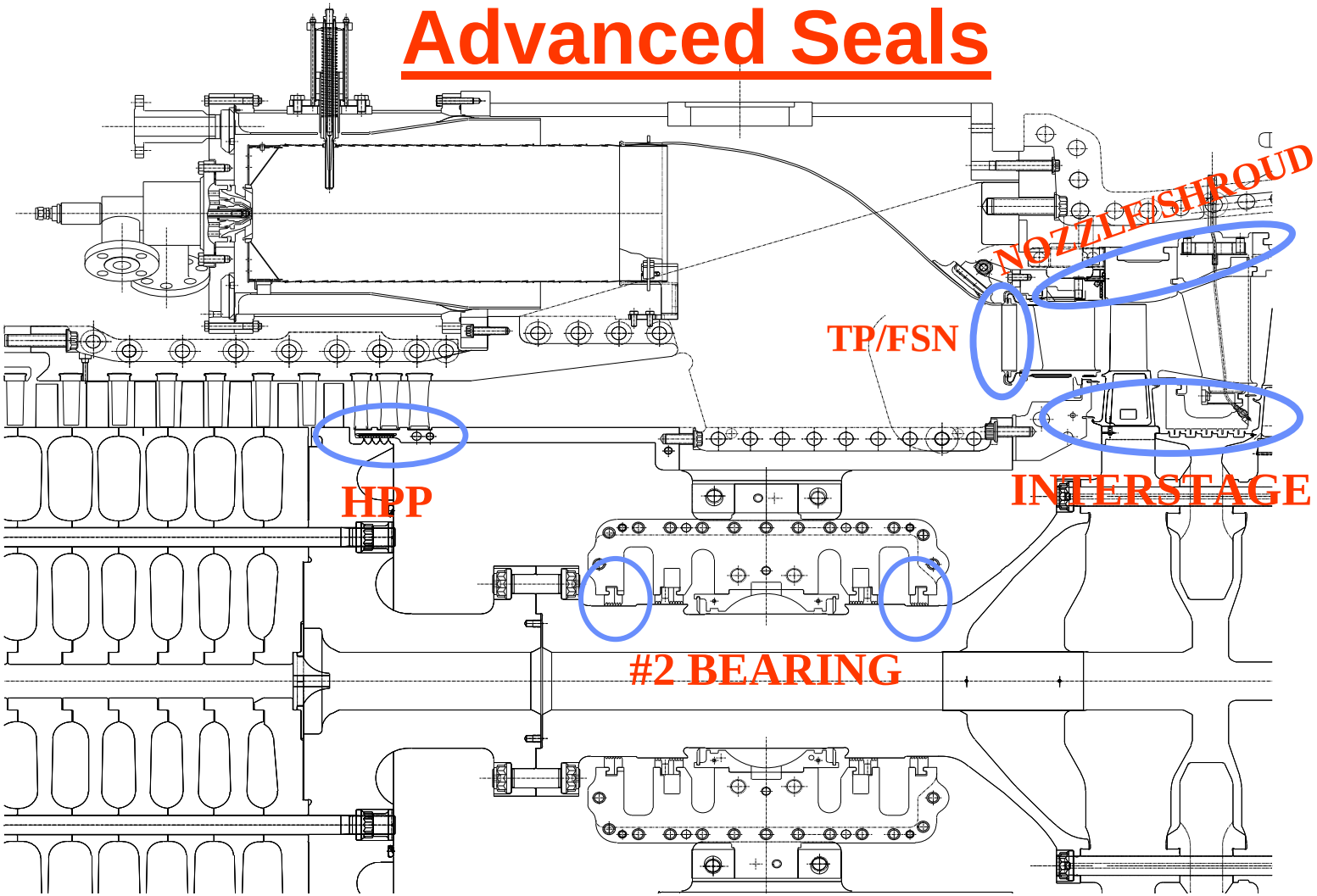
GE Participating Groups:

- **CRD**
- **GE Power Systems--**
  Gas Turbines--new products and services
- **GE Power Systems--**
  Steam Turbines

Presenters:

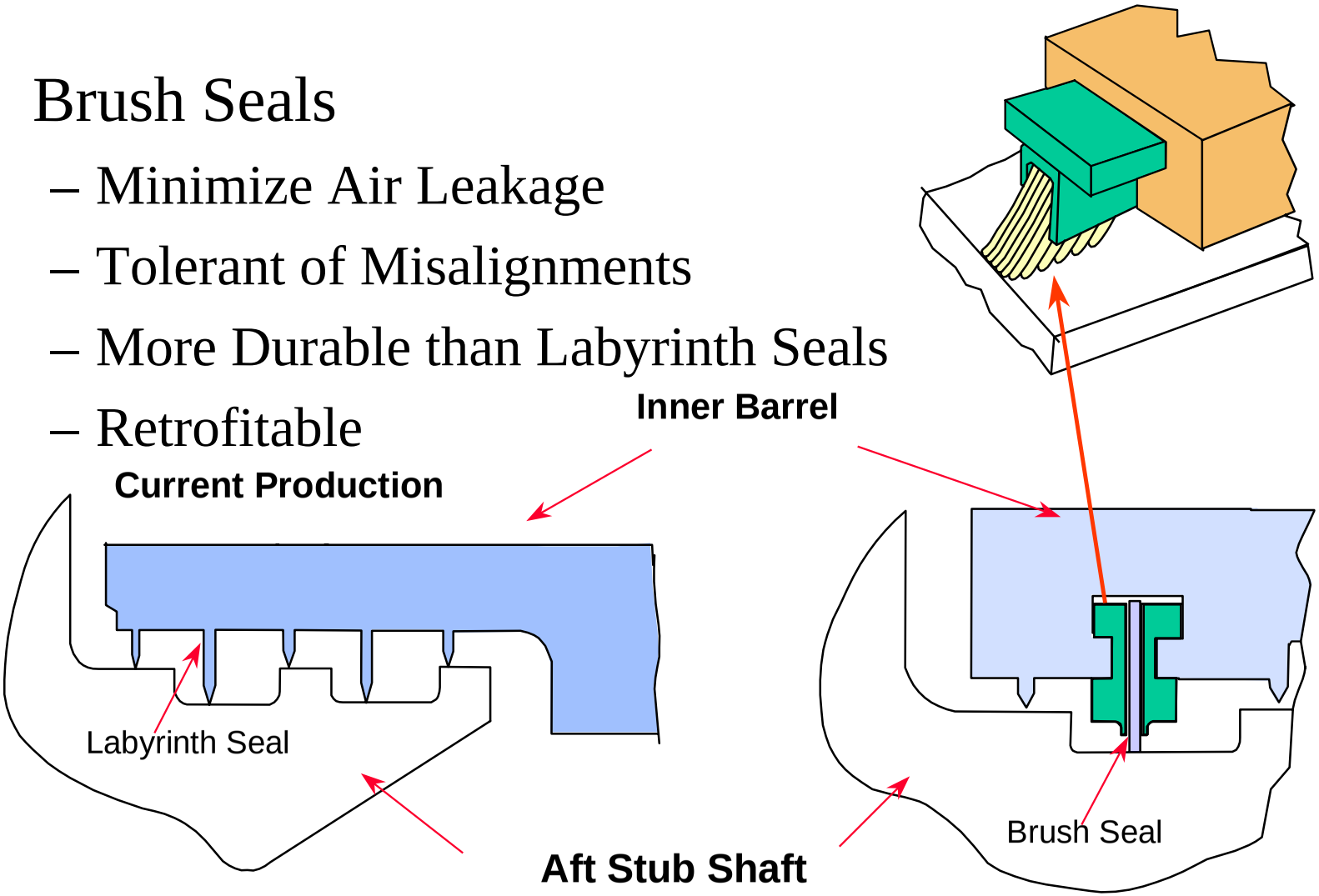
- **Ray Chupp**
- **Saim Dinc**
- **Norm Turnquist**

Advanced Seals



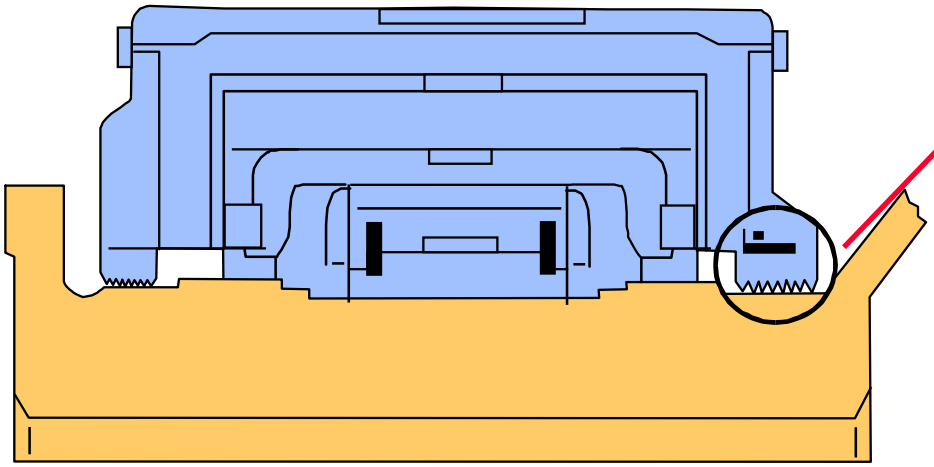
High-Pressure Packing / Inner Barrel

- Brush Seals
  - Minimize Air Leakage
  - Tolerant of Misalignments
  - More Durable than Labyrinth Seals
  - Retrofitable

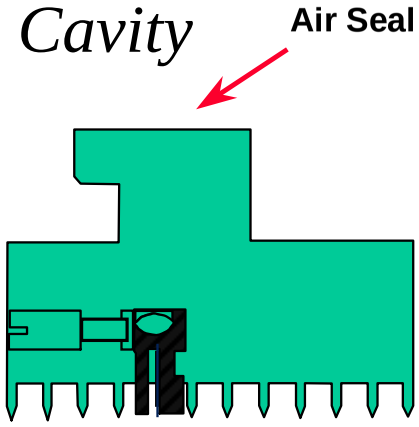


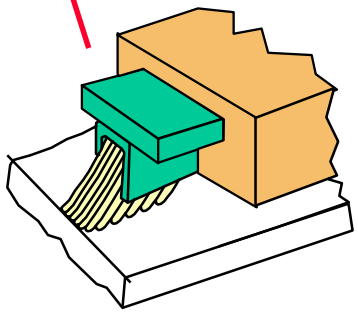
No. 2 Bearing Brush Seals

- *Minimize Air Leakage to Bearing Cavity*
- *Reduce Oil Mist*
- *Retrofitable*

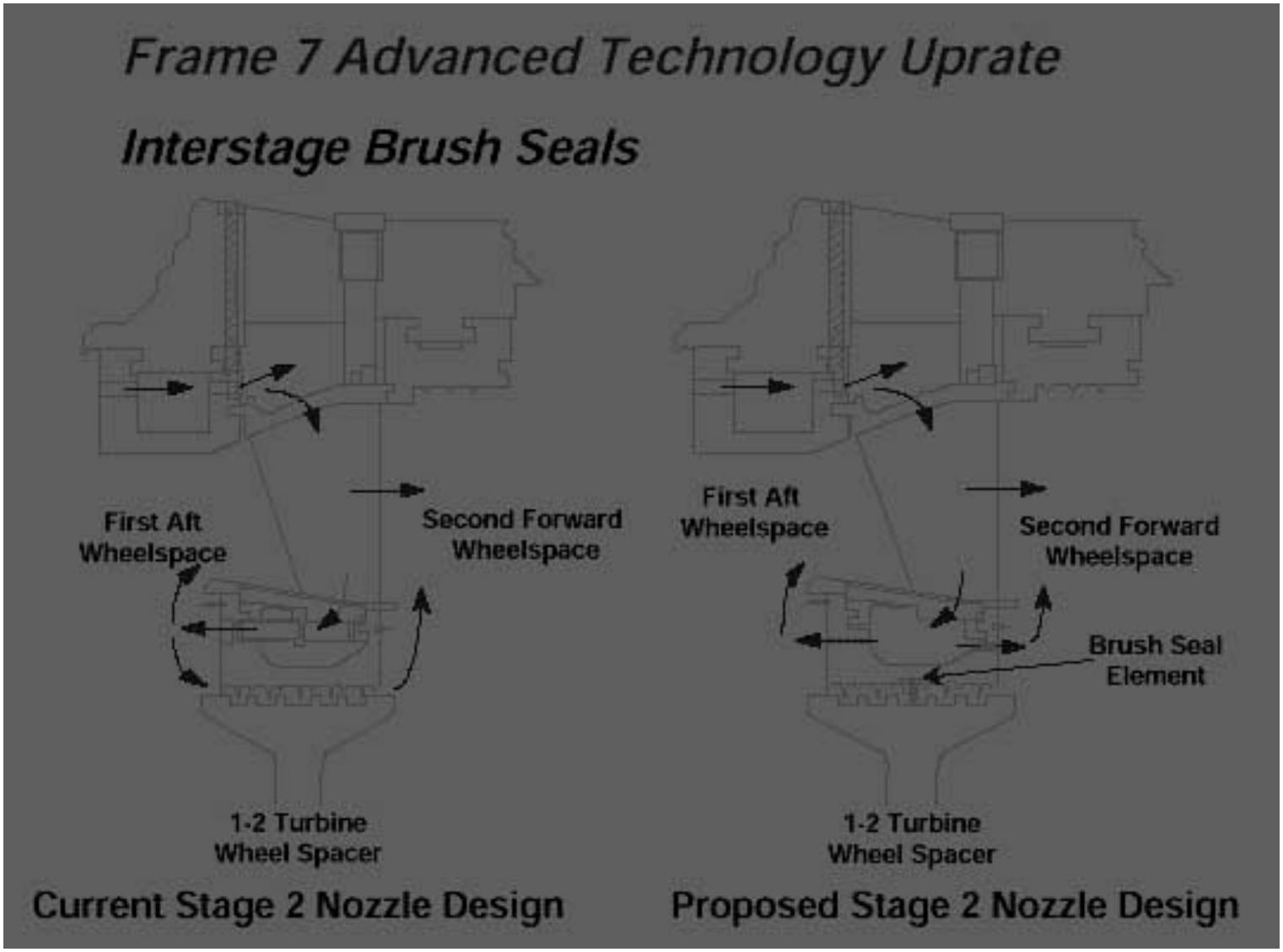


Cross-Section Bearing Housing

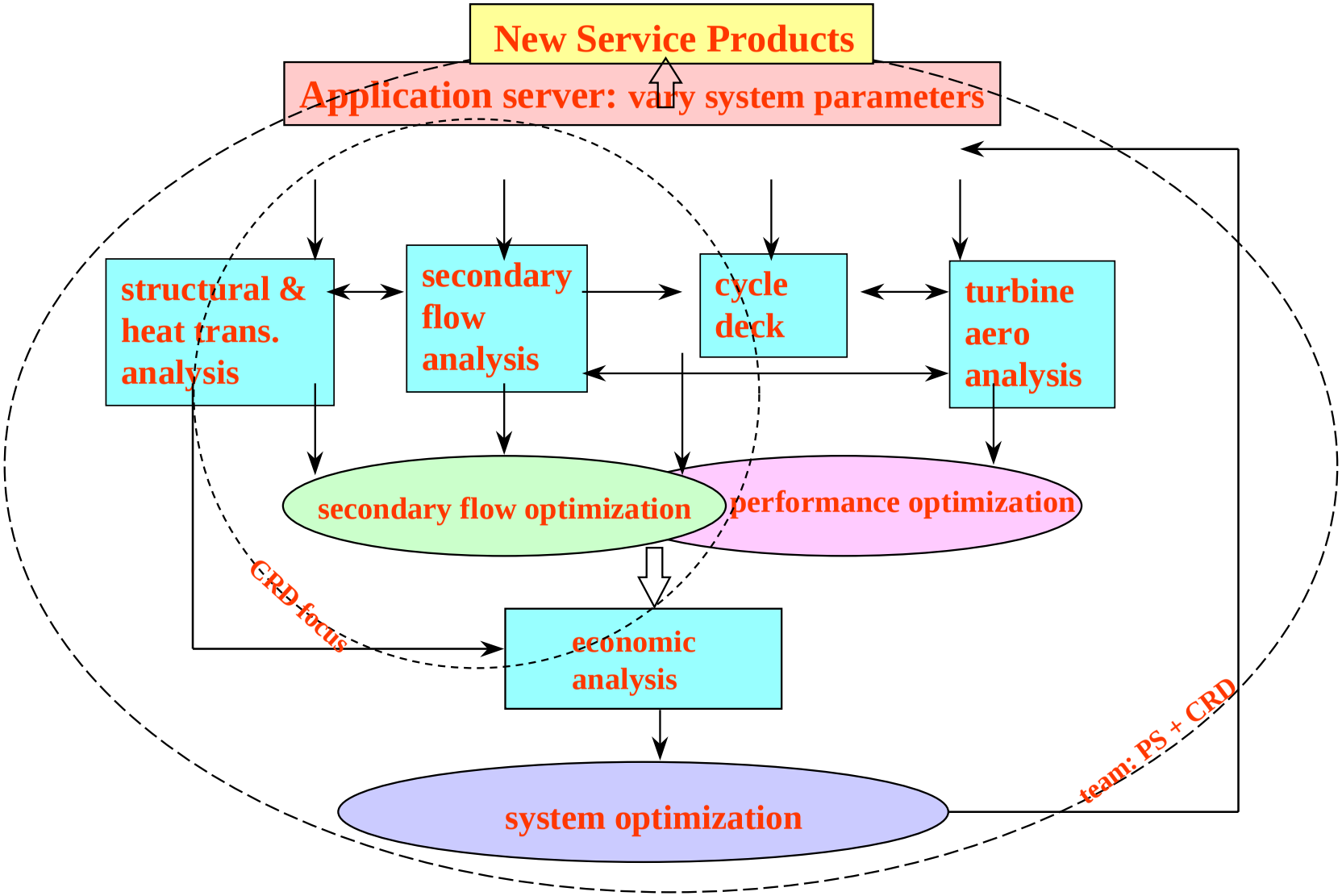




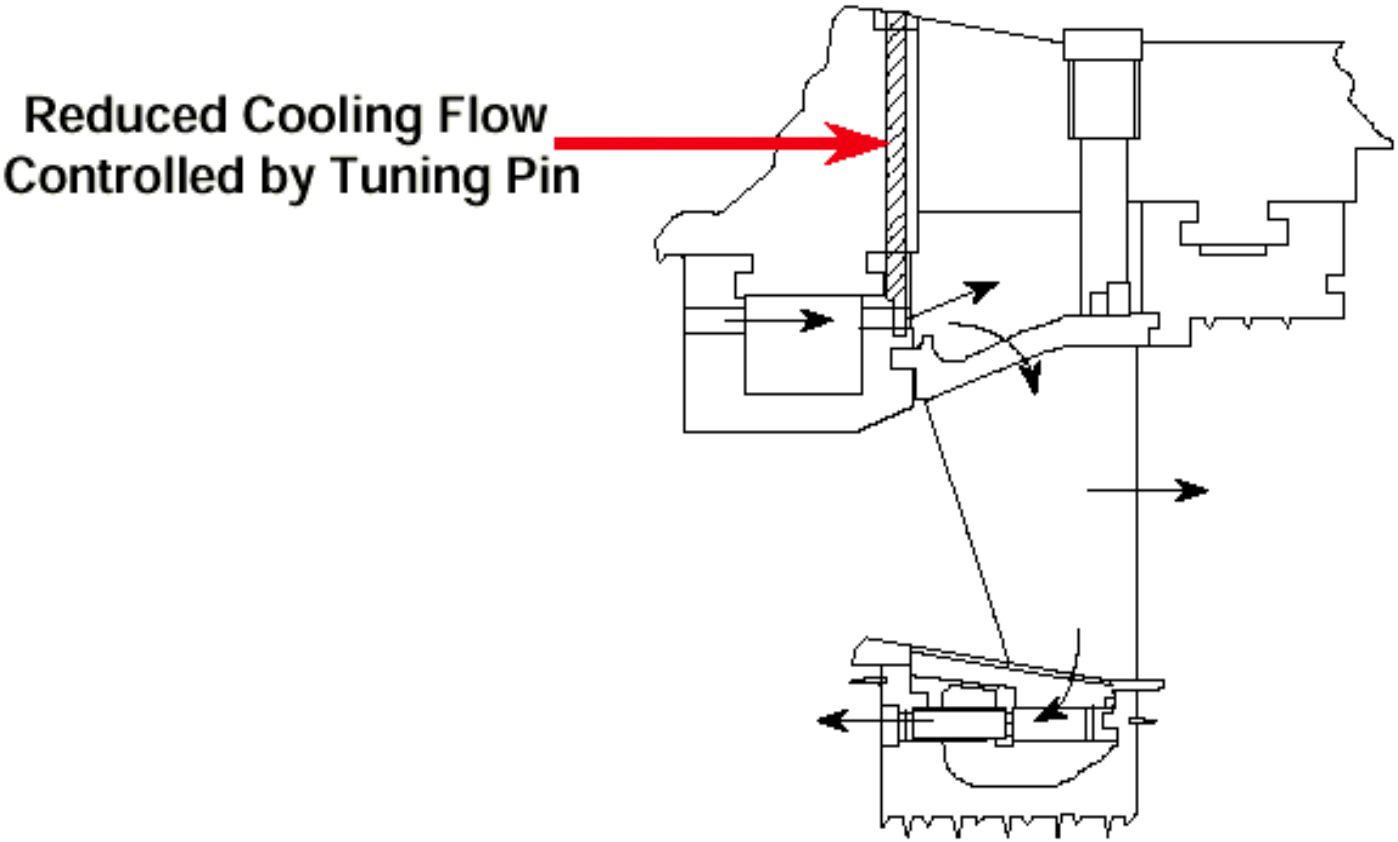
Brush Seal


Frame 7 Advanced Technology Uprate
Interstage Brush Seals
First Aft Wheelspace
Second Forward Wheelspace
1-2 Turbine Wheel Spacer
Current Stage 2 Nozzle Design
First Aft Wheelspace
Second Forward Wheelspace
Brush Seal Element
1-2 Turbine Wheel Spacer
Proposed Stage 2 Nozzle Design

Gas Turbine System Level Secondary Flow/Performance Analysis



Air System Adjustments to Achieve Reduced Leakage with Sealing Changes



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Frame Size	Output (MW) (approx)	Brush Seal Location	Commercial -ization Date
9E	123	HPP,#2 Bearing Seal	1996
7EA	85	HPP,#2 Bearing Seal	1996
6B	38	HPP	1996
52D	32	HPP,#2 Bearing Seal	1997
52C	28	HPP,#2 Bearing Seal	1997
51P	27	HPP	1997
32J	11	HPP	1997
32G	6	HPP	1997
7EA	**85**	**Interstage Diaphragm**	**1998**

CM&U Performance Enhancement Update 1999 GTUA

	3/2H & J	5/1N & P	5/2 B & C	6/1B	7/1 B&E	9/1 B & E
HPP Brush Seal	X	X	X	X	X	X
#2 Bearing Brush Seal	-	-	X	-	X	X
Stage 2&3 Honeycomb Shroud Seals	X	X	X	X	X	X
Stage 1 Shroud Seals	X	X	X	X	X	X
Inner Stage Brush Seal	-	X	-	X	X	X

Brush Seal Activities

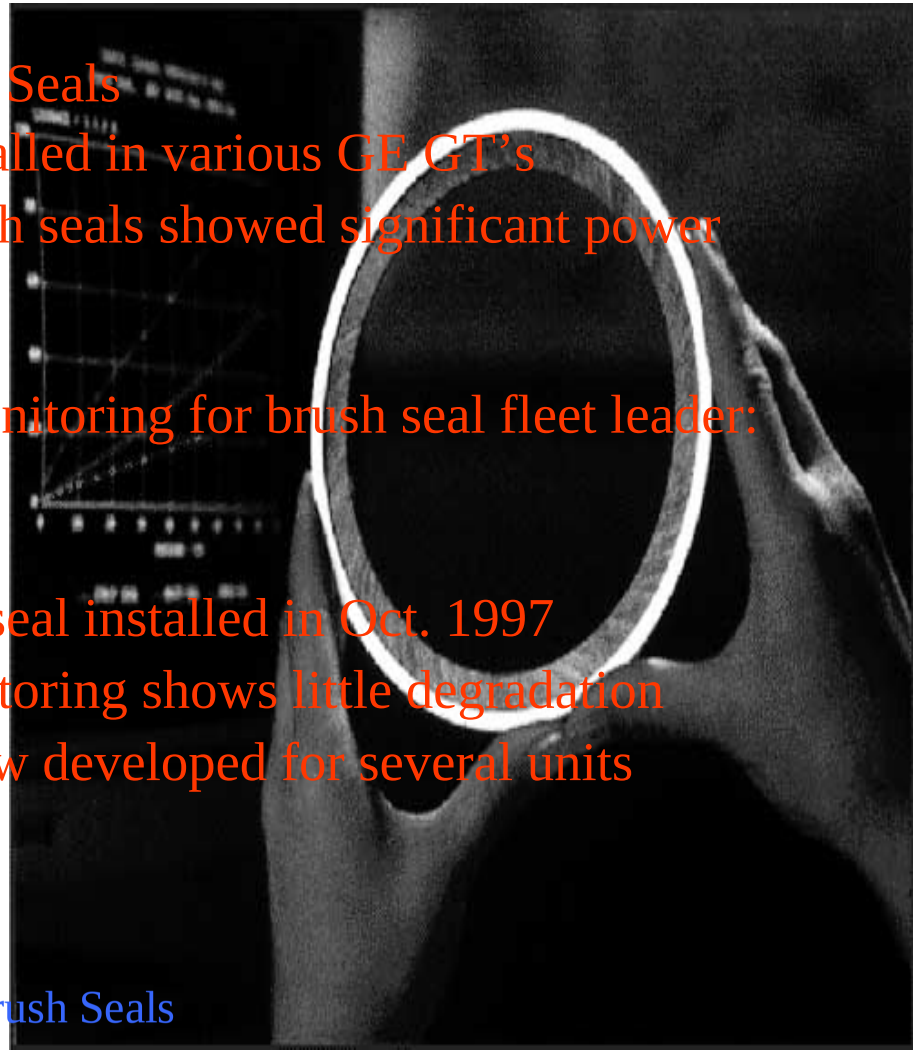
- Gas Turbine
  - –HPP and #2 Bearing Brush Seals
    - 120+ brush seal sets installed in various GE GT's
    - HPP and #2 bearing brush seals showed significant power increase in August 1996 test
    - 4 years field data and monitoring for brush seal fleet leader: 30,000 hours
  - –Interstage Brush Seal
    - Prototype 2nd stg brush seal installed in Oct. 1997
    - 10 Months of close monitoring shows little degradation
    - Interstage brush seals now developed for several units

Steam Turbine

– Interstage Packing Brush Seals

– Shaft End packings

– HP and IP Section Bucket Tip Brush Seals



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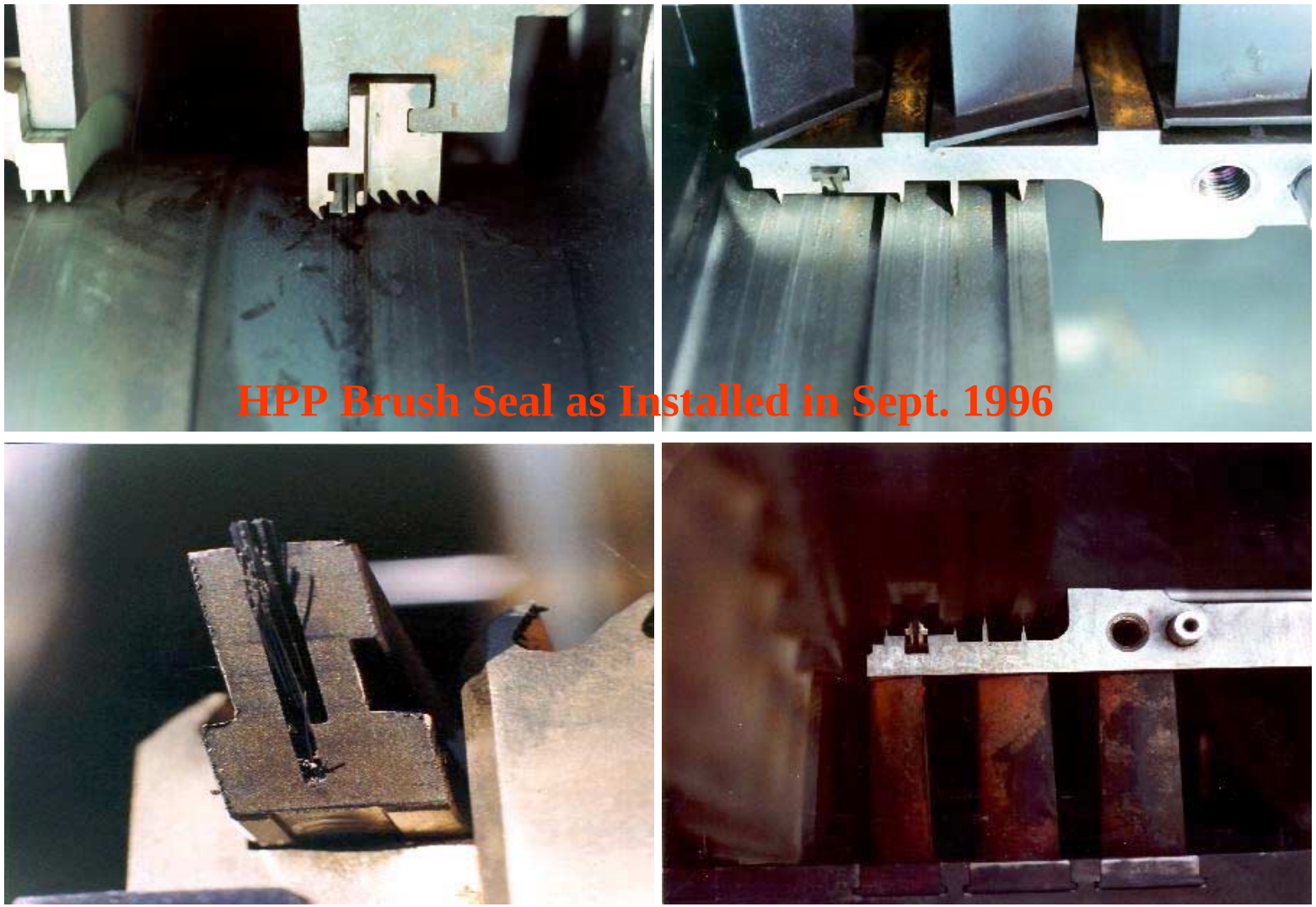

HPP Brush Seal During Maintenance Inspection

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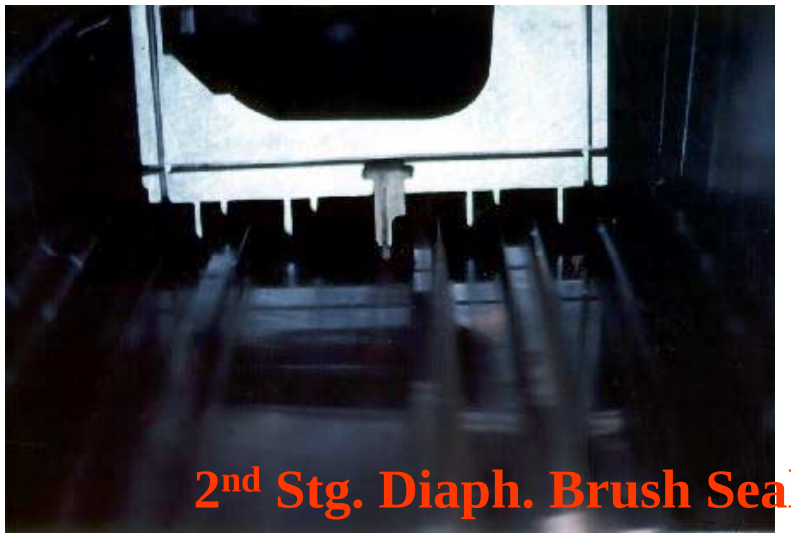
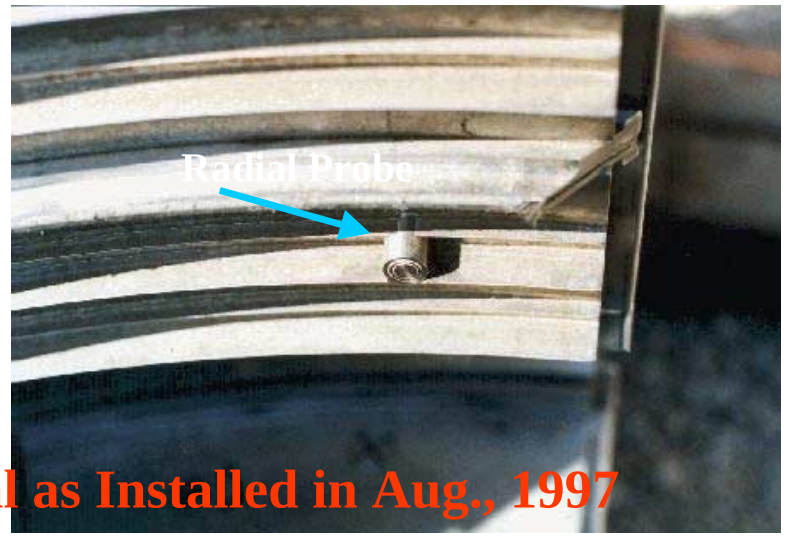
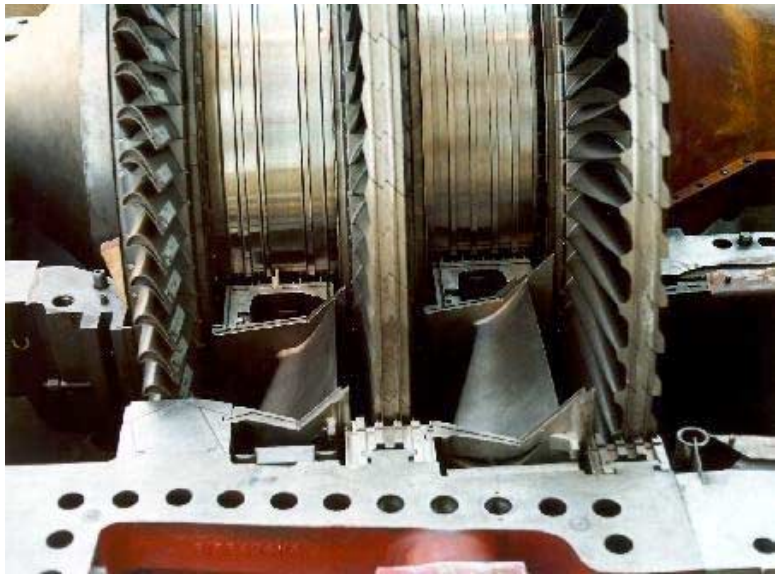
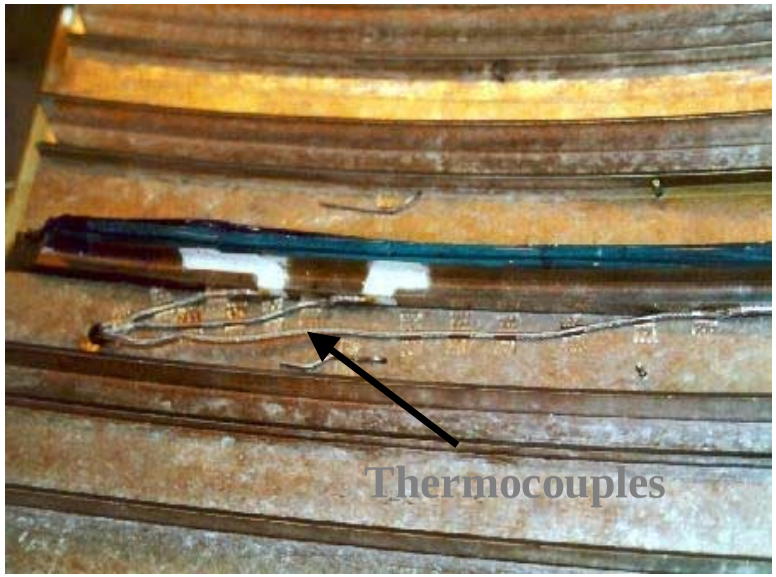




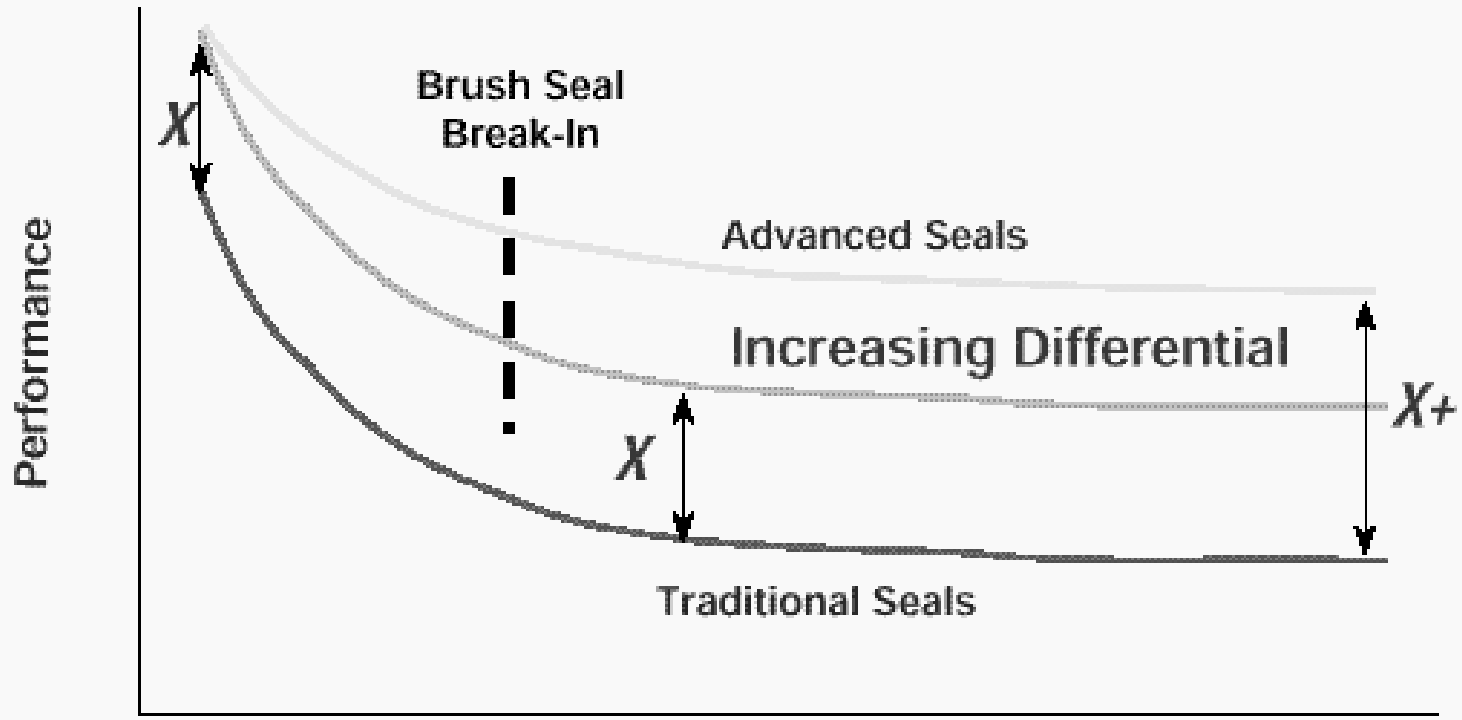
2nd Stg. Diaph. Brush Seal as Installed in Aug., 1997





Gas Turbine Advanced Seals

- Rub Tolerant Rotating Seals Provide Sustained Performance Gains That Increase Over Time



Summary

- Brush and cloth seals were installed in many GE gas turbines in 1998 & 1999
- Brush seal fleet leaders: gas turbine 35,000 hrs; steam turbine 15,000 hrs--both with minimum degradation
- Prototype brush seal testing performed in various Frame 3, 5, 6, 7 and 9 gas turbines and in steam turbines
- Exploring brush seals for:
  - New gas turbines-- F, FB, H
  - Operating & new steam turbines
  - Generators & compressors
- Cloth seals:
  - In operation in E machines (in leader unit for ~3 years)
  - In production in some F machines (in leader unit for ~2 years)
  - Being introduced in other F machines and H machines