Diagnosis and Solution for High-Speed Turboexpander Thrust Loading Issue

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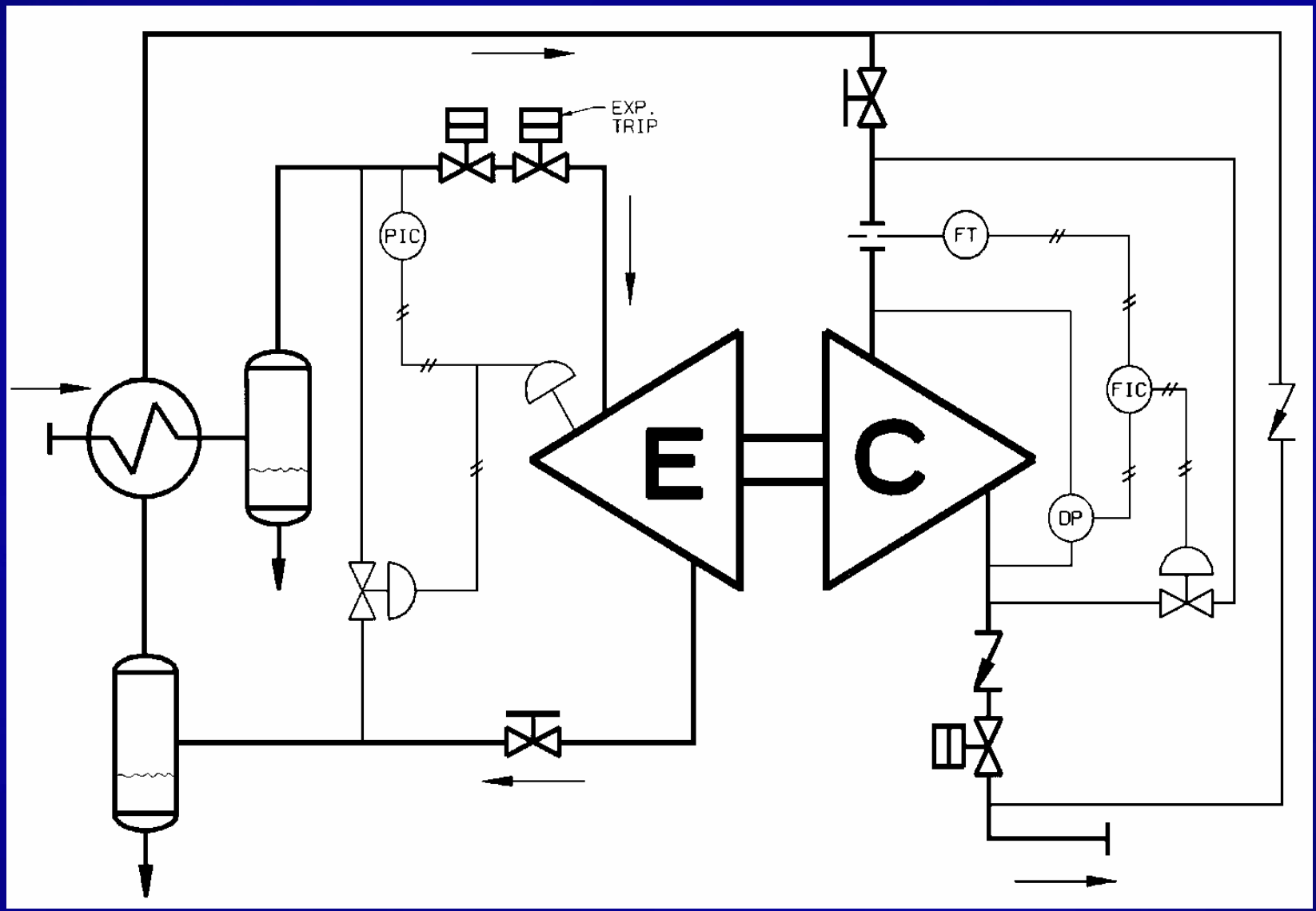
1st Middle East Turbomachinery Symposium

Roadmap

- Background
- Problem Identification
- Analysis
- Scope
- Testing
- Conclusions

Bab Turboexpander Plant



Plant Visit 2007

- Plant Personnel described problem during vendor site visit in 2007
- High Compressor Thrust
- Thrust Balancer Full Open
- Operation Limited

History of Bab Plant Turboexpander

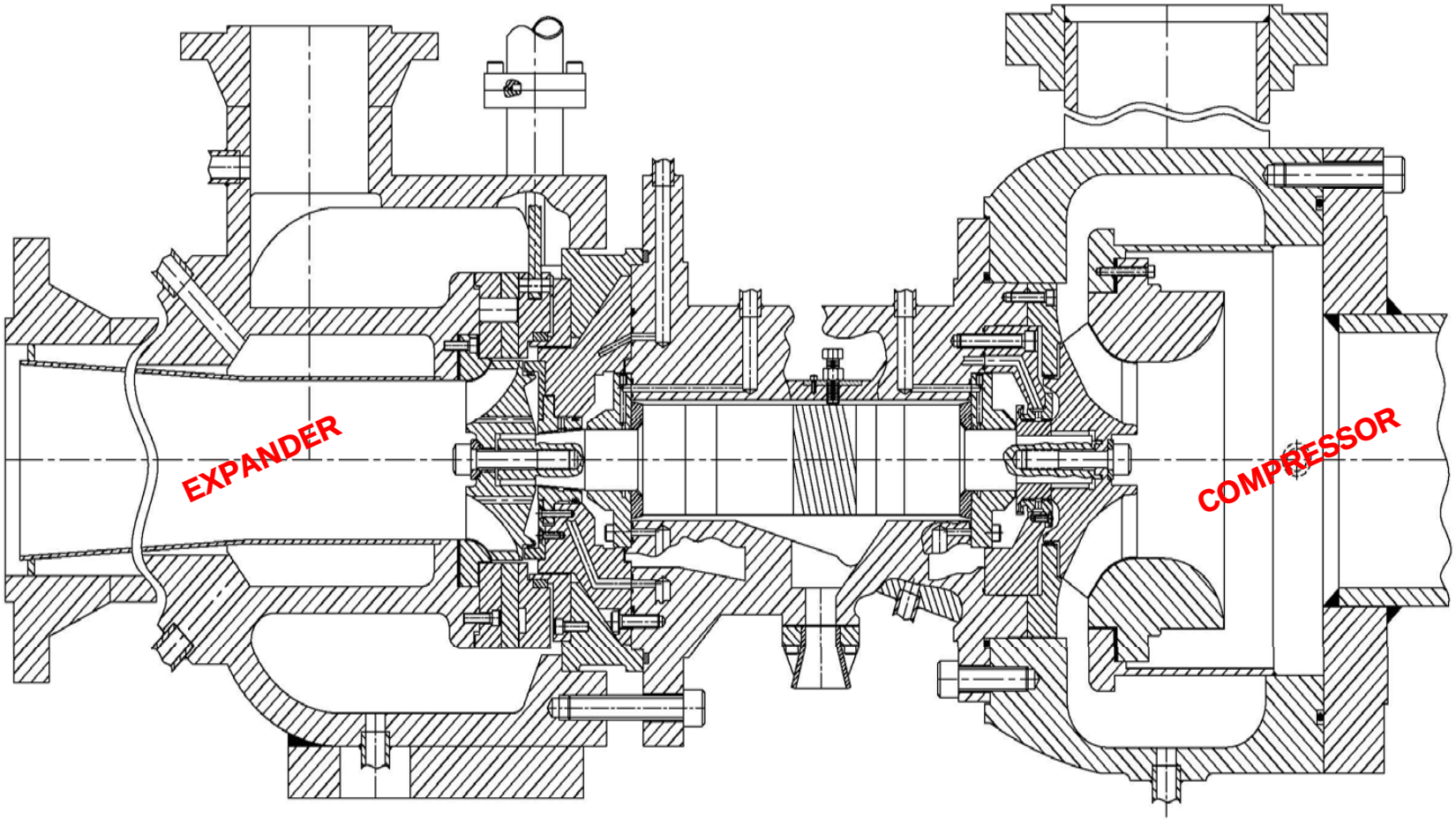
- 1991 re-rate for higher capacity
- Re-rate not factory tested
- At commissioning, high compressor thrust observed
- Flow bypassed to allow unit operation within thrust limits

Bab Plant

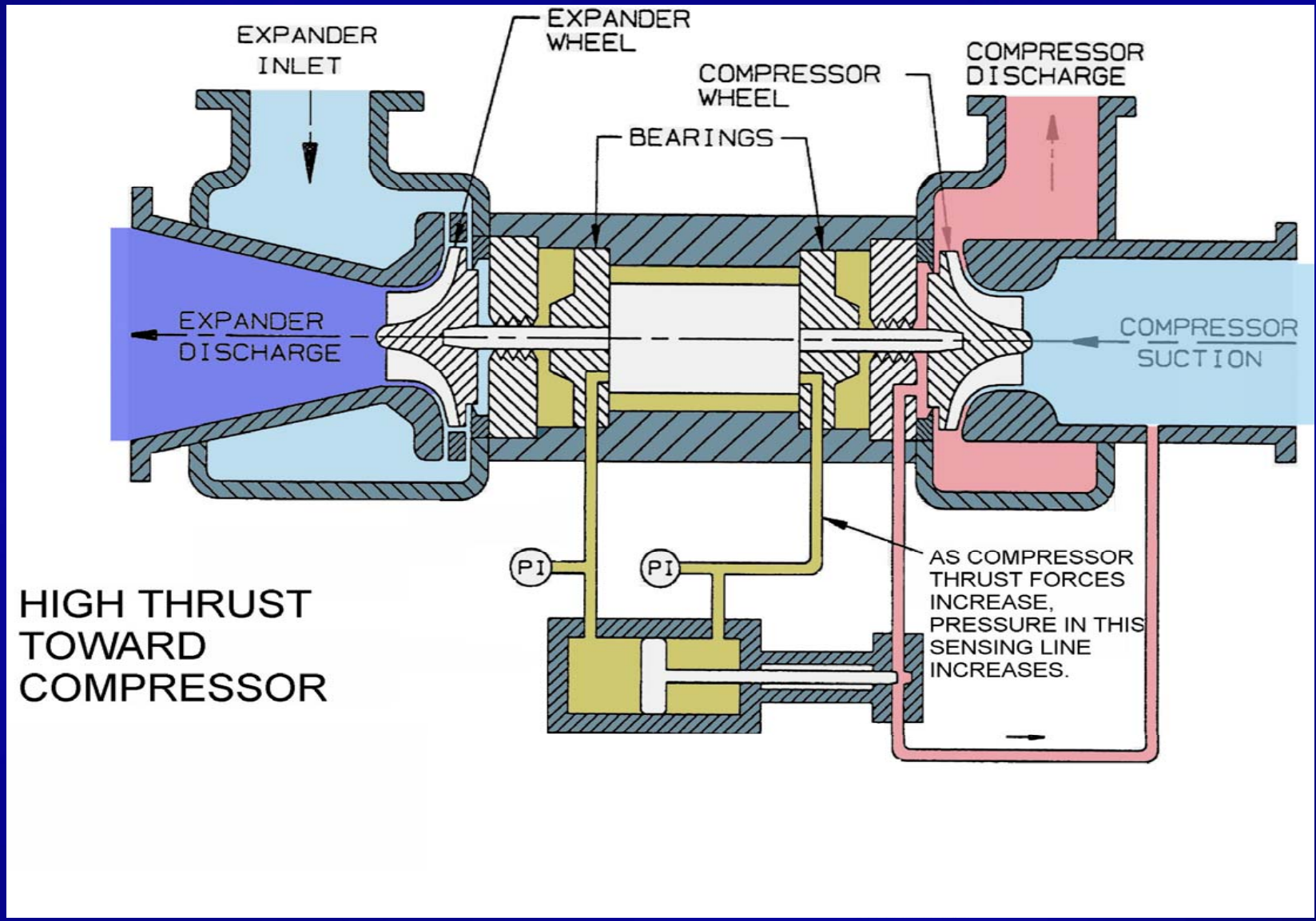
Turboexpander Data

- **Speed:** Design Speed = 24,000 RPM
- **Power:** Rated = 1,595 kW
- **Pressure:** Expander = 44 barg; 17 barg
- **Temperature:** Expander = -50.3 C; -83.9 C
- **Flow:** Expander = 105,674 Kg/Hr
- **Gas Handled:** Natural Gas = 17.5 Mol. Wt.
- **Manufactured:** 1979; re-rated in 1991

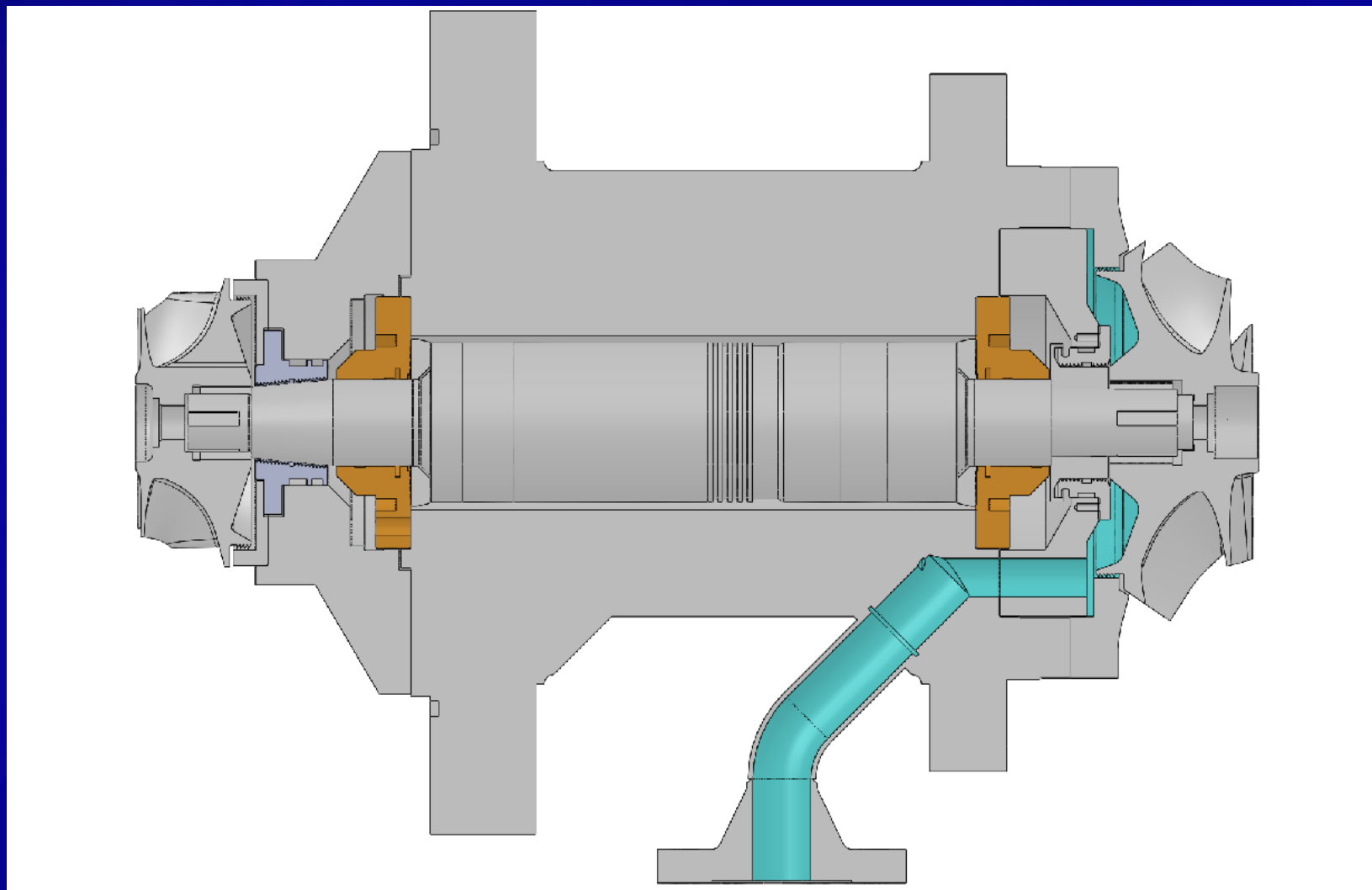
Turboexpander Layout



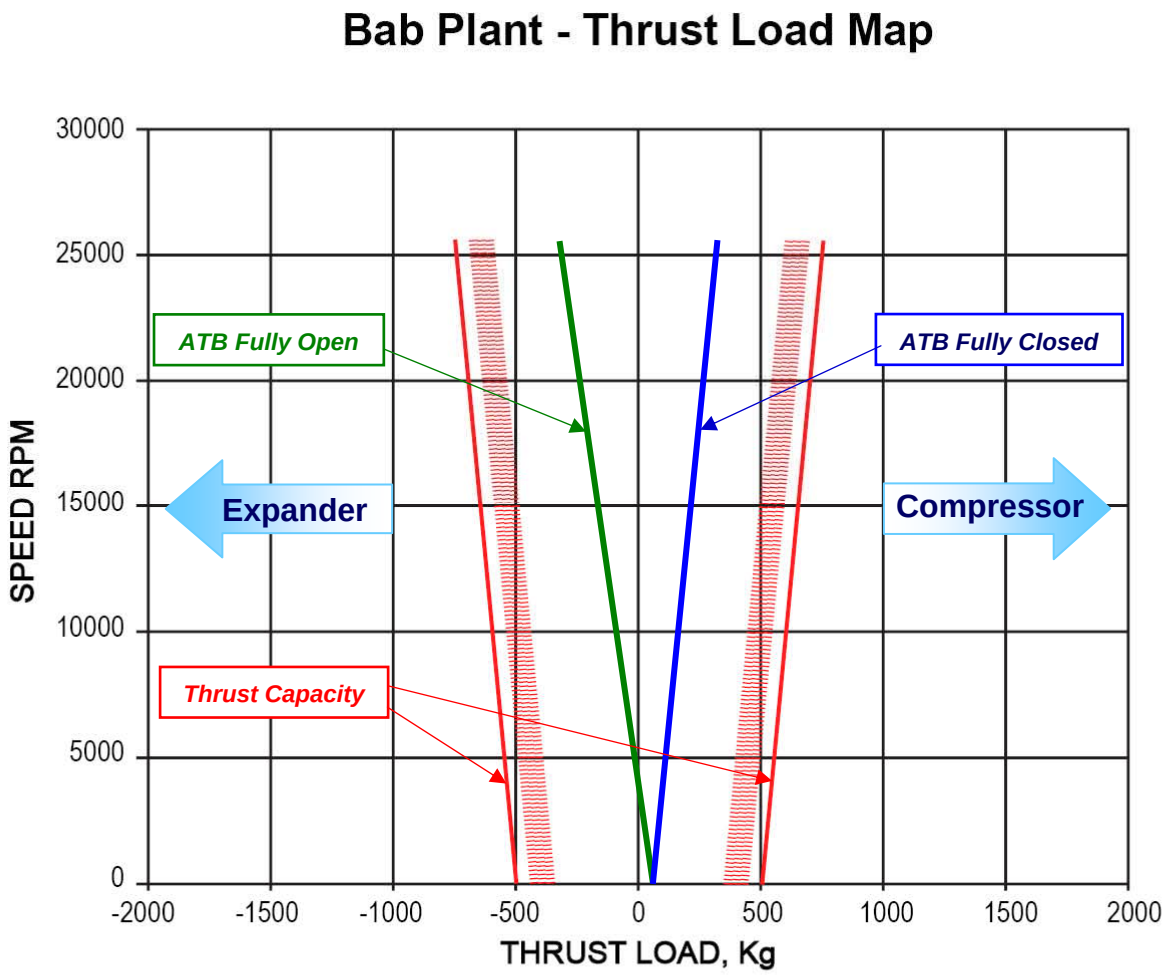
Automatic Thrust Balancer (ATB)



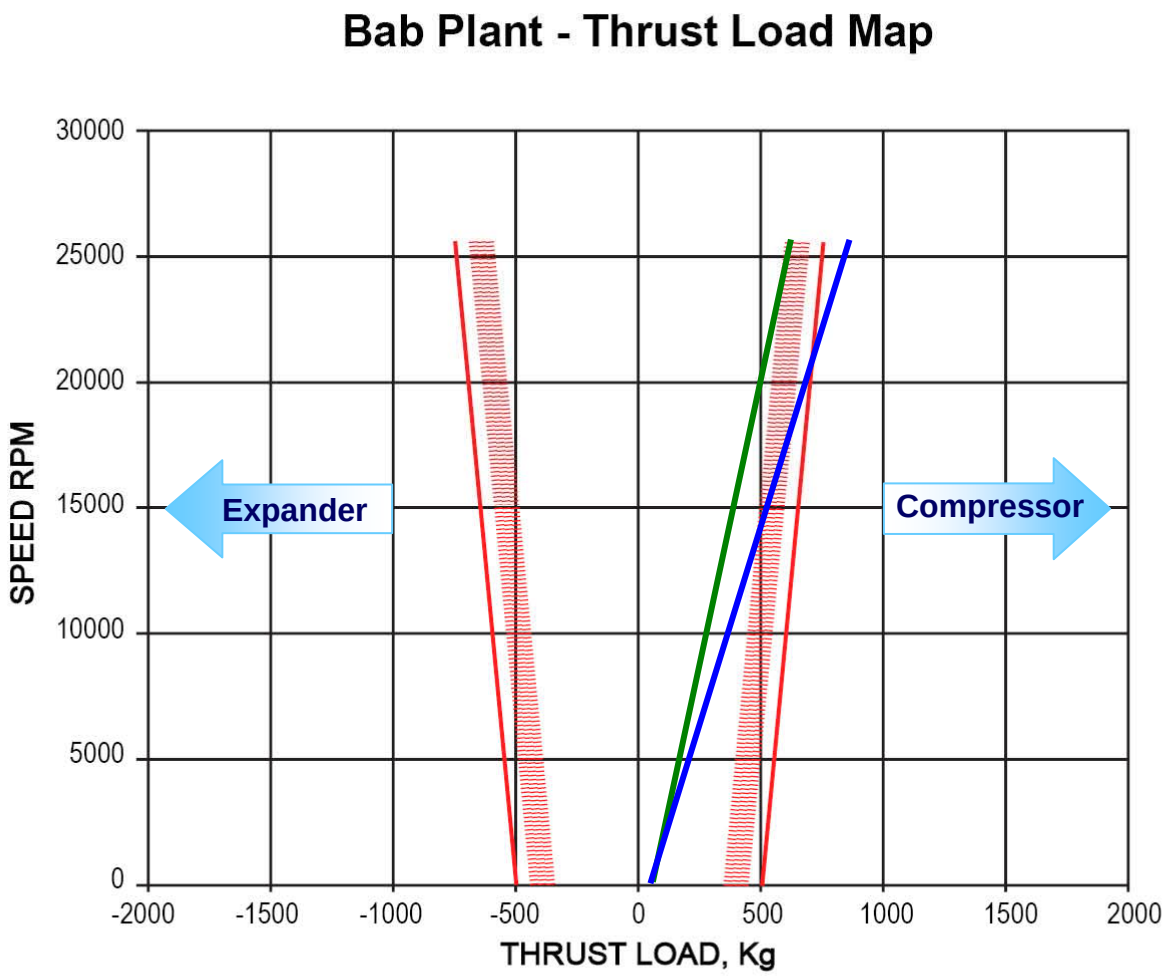
Thrust Venting Port



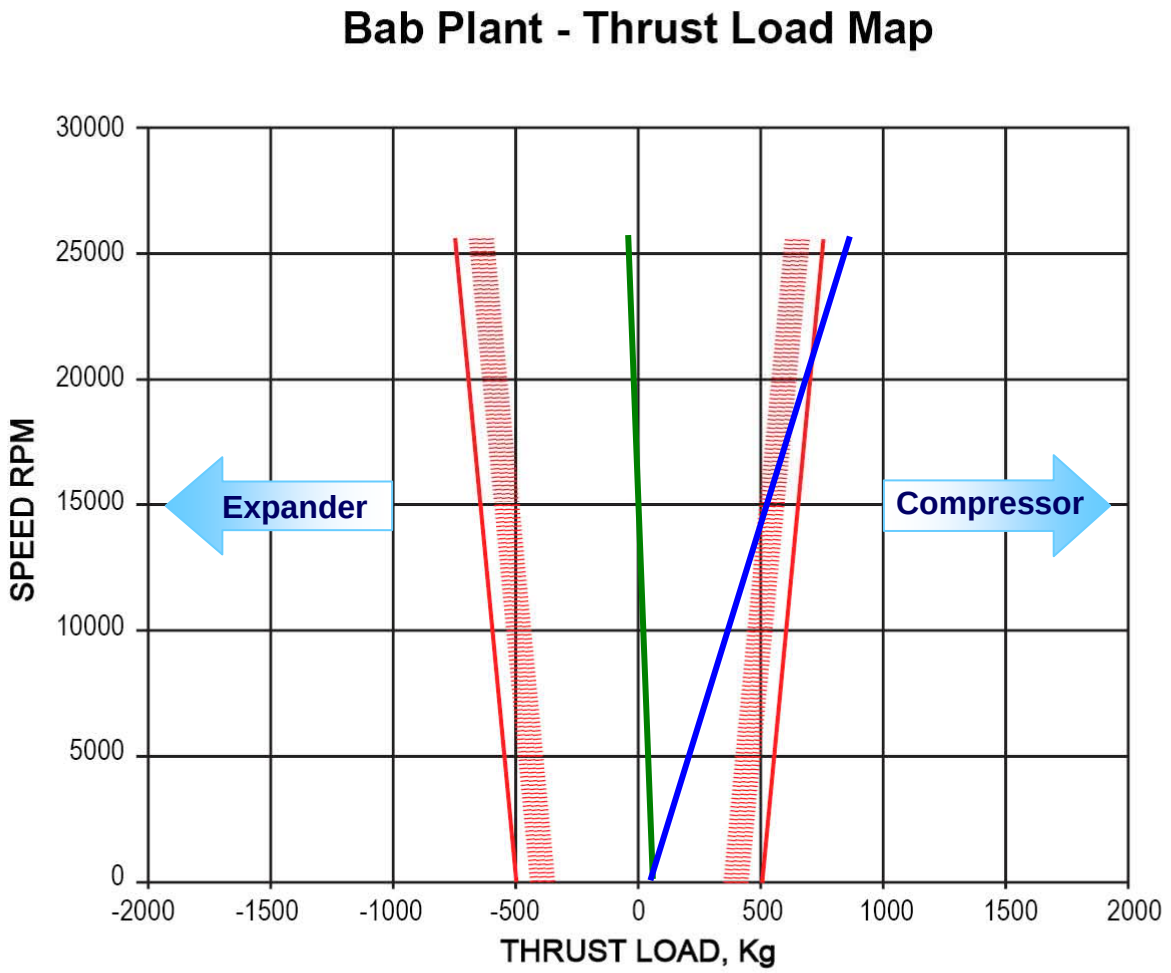
Ideal


Bab Plant - Thrust Load Map
SPEED RPM
30000
25000
20000
15000
10000
5000
0
-2000
-1500
-1000
-500
0
500
1000
1500
2000
THRUST LOAD, Kg
ATB Fully Open
ATB Fully Closed
Expander
Compressor
Thrust Capacity

1991 Design Observed



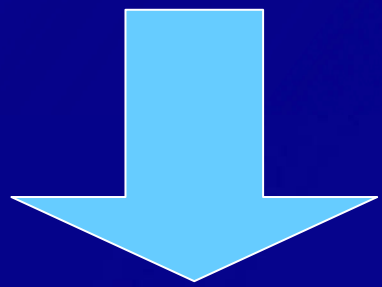
2008 Upgrade (expected)



Scope of Upgrade

Evaluation of Most Economical Solution

- Consider New Expander Wheel and Seal
- Consider New Compressor Wheel and Seal
- Consider New Expander AND Compressor Wheels/Seals

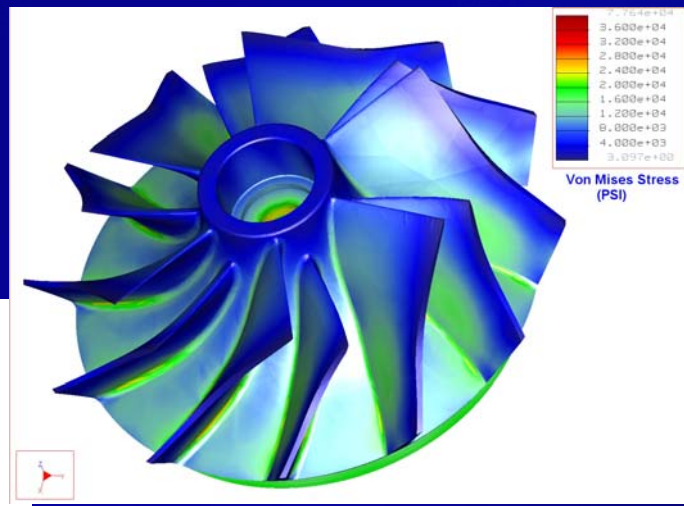


- New Compressor Wheel and Seal

New Compressor Wheel

Reverse Engineering

- 3D blading digitized from original cast wheel
- Solid model created for analysis

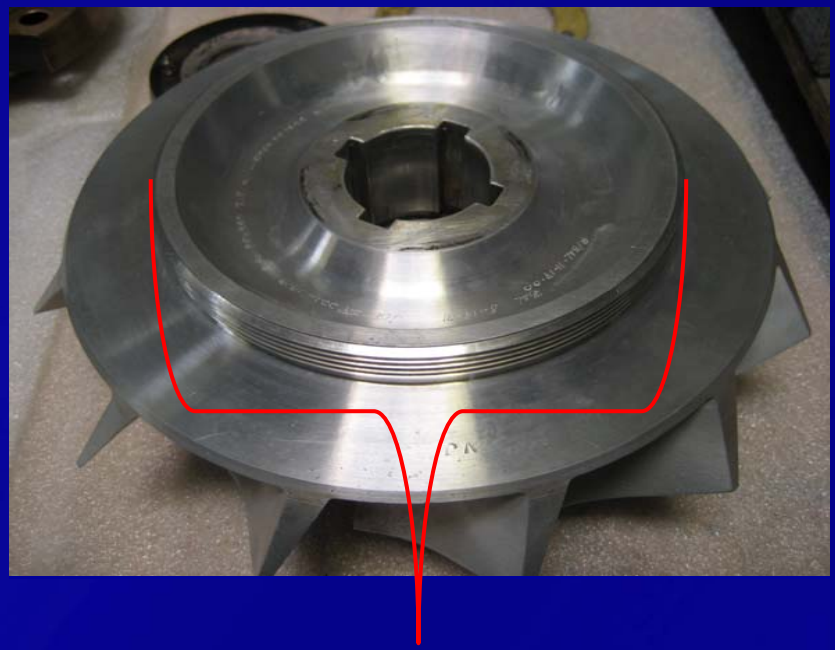


New Compressor Wheel

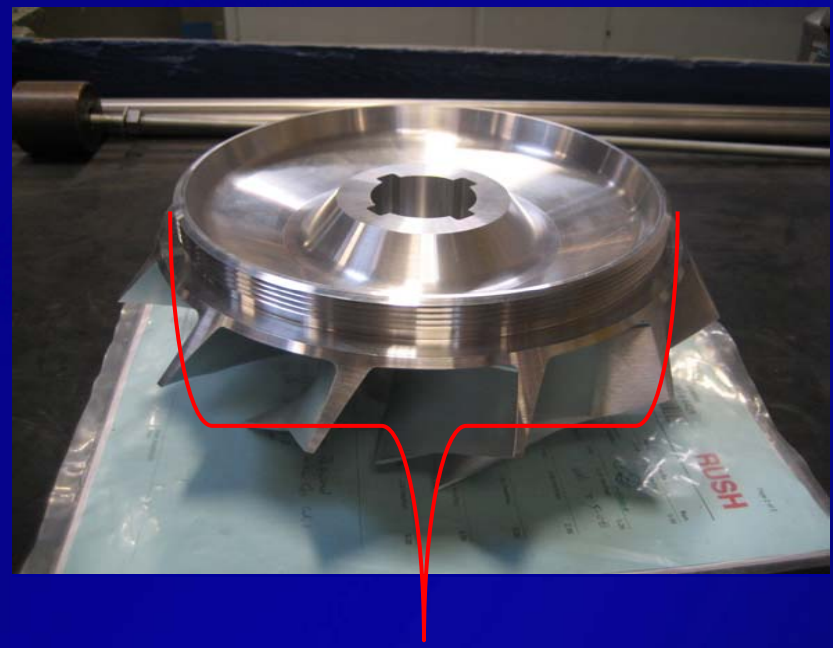
CNC Milled from Solid Forging

New Compressor Wheel

Larger Seal Area

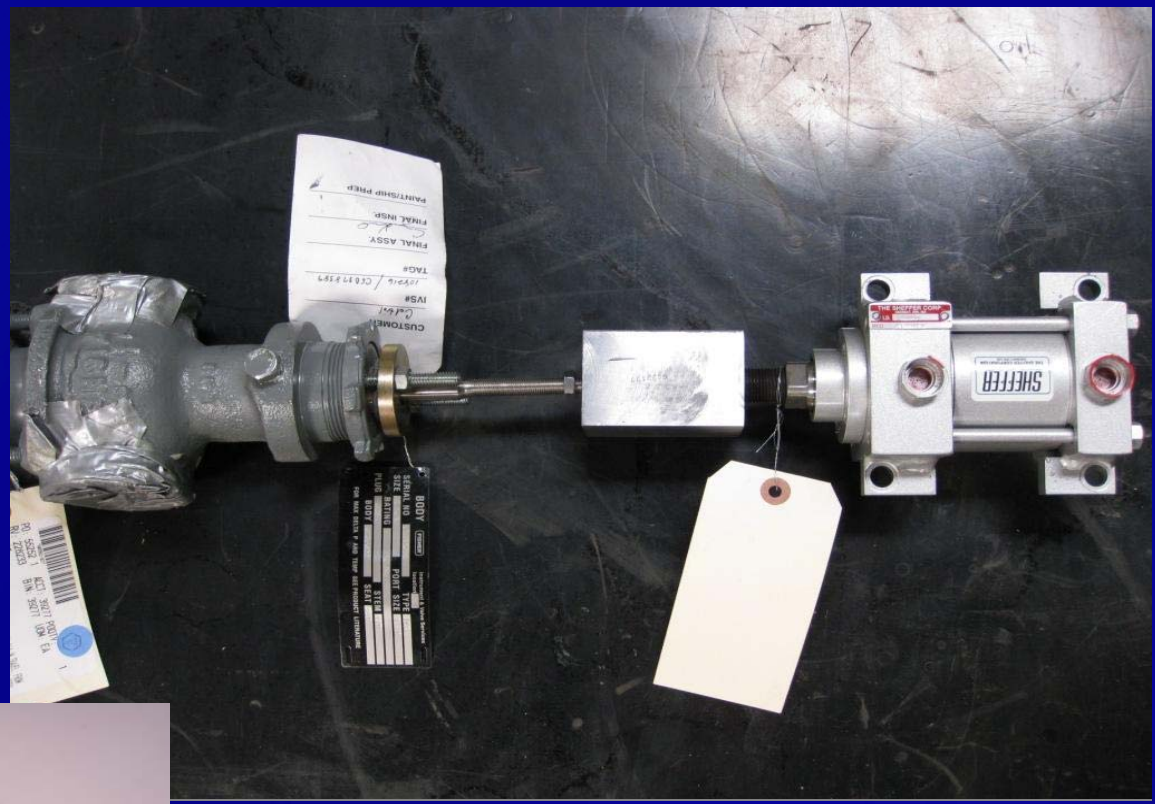


Old = 6.25 Inch

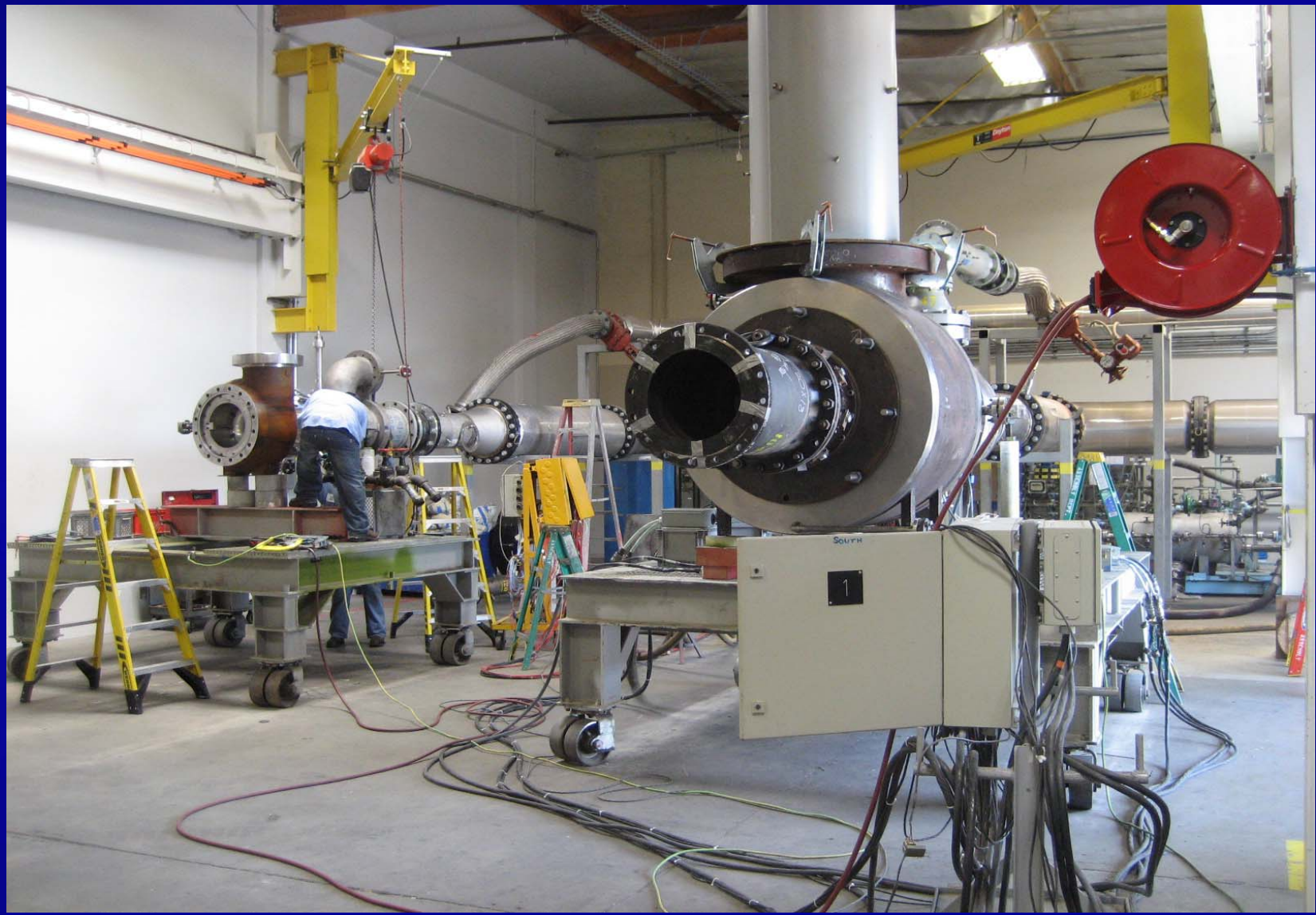


New = 8.0 Inch

Refurbished ATB Assembly



Full Speed Factory Test



Results

- Factory test confirmed successful modification
- Turboexpander restarted in December 2008
- Thrust levels reduced as predicted
- Unit now capable of full speed operation

Conclusions

- Old problems warrant periodic investigation
- Large gains possible from small investments
- Factory testing reduces risk on upgrades

Thank You