DEVELOPMENT & CERTIFICATION OF PRATT & WHITNEY'S FUEL & LOX PUMPS

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HAS BEEN REVISED
JMP
4/20/01

William S. Mitchell

DEVELOPMENT & CERTIFICATION

OF

PRATT & WHITNEY'S SSME

FUEL & LOX PUMPS

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Space Shuttle Launch at Kennedy Space Center

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Outline

- Background on SSME
- Experiences
- Summary / Conclusion

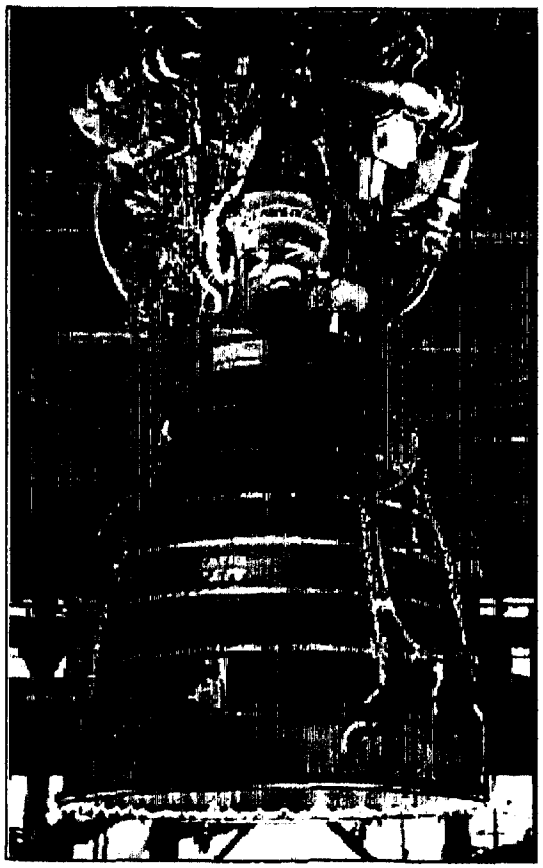
DEVELOPMENT & CERTIFICATION OF PRATT & WHITNEY'S SSME FUEL & LOX PUMPS

Objective

- Familiarize MIT Staff and Students on important development and accomplishments of the SSME turbopumps

DEVELOPMENT & CERTIFICATION OF PRATT & WHITNEY'S SSME FUEL & LOX PUMPS

SSME Is the First Reusable Large Liquid Rocket Engine



• Propellants	Oxygen/ Hydrogen
• Rated power level (RPL) 100%	469,450 lb
• Nominal power level (NPL) 104.5%	490,850 lb
• Full power level (FPL) 109%	512,270 lb
• Chamber pressure (109%)	2,994 psia
• Specific impulse at altitude	452 sec
• Throttle range (%)	65 to 111
• Weight	7,480 lb
• Total program hot-fire time	> 2,660 starts > 832,500 sec

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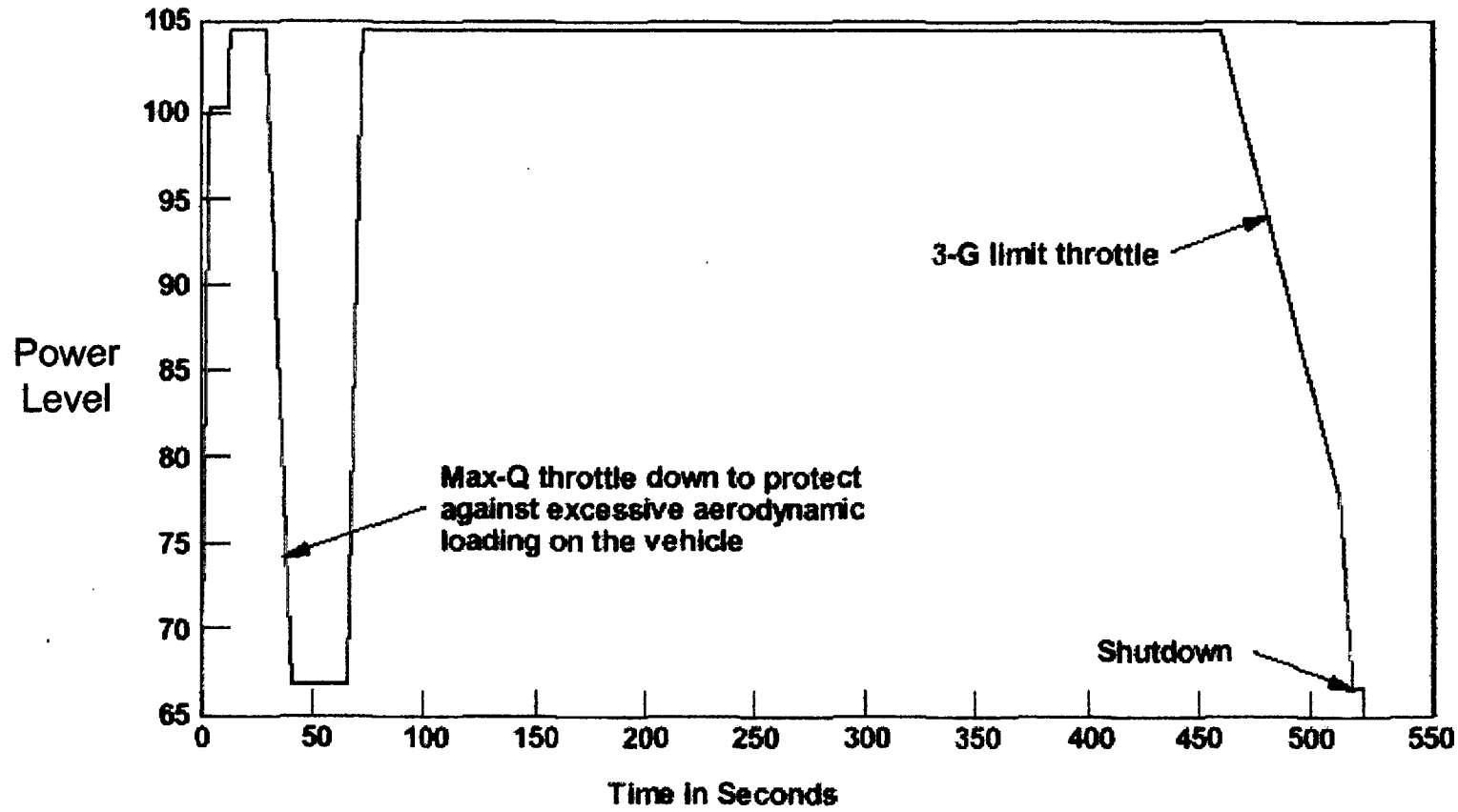
SSME Typical Throttling Profile



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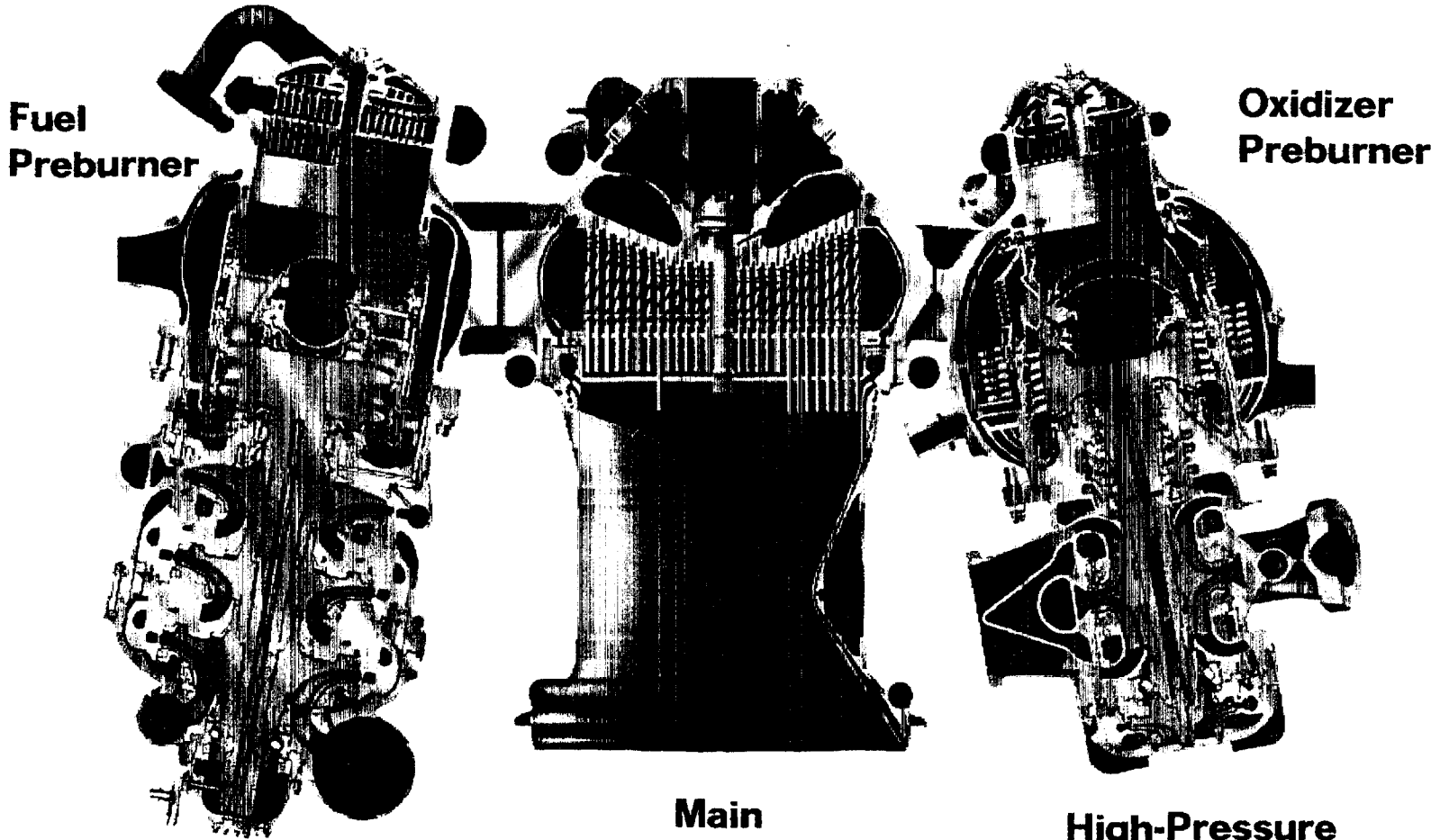
SSME Powerhead Component Arrangement



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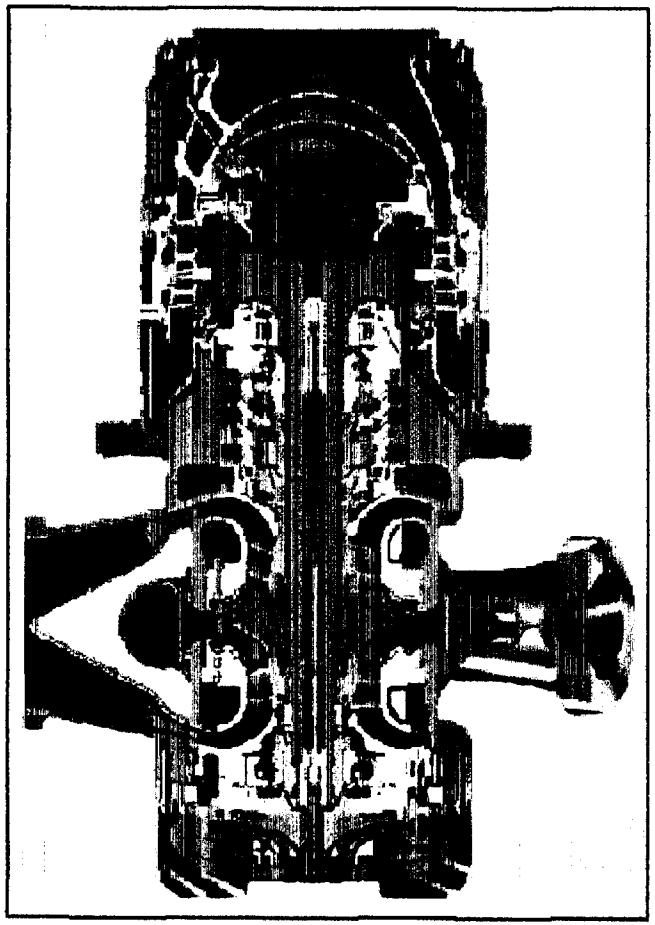
High-pressure Oxidizer Turbopump



Propellant:	Liquid Oxygen
Speed:	23,700 rpm
Discharge Pressure (max):	7,630 psi
Flow:	1,180 lb/sec (7,680 gpm)
Shaft Horsepower:	27,500 hp
Turbine Inlet Temperature:	1,500 °R
Service Life:	60 Missions
Design Life:	240 Missions

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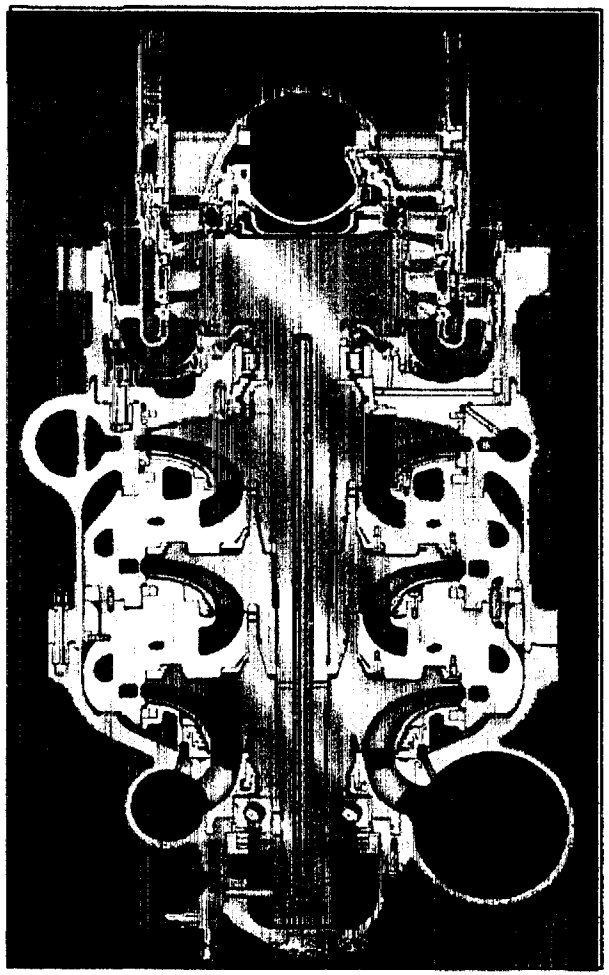
High-pressure Fuel Turbopump



Propellant:	Liquid Hydrogen
Speed:	36,200 rpm
Discharge Pressure (max):	6,400 psi
Flow:	164 lb/sec (6,900 gpm)
Shaft Horsepower:	75,000 hp
Turbine Inlet Temperature:	1,900 °R
Service Life:	60 Missions
Design Life:	240 Missions

TURBINE EXIT DIFFUSER CRACKING

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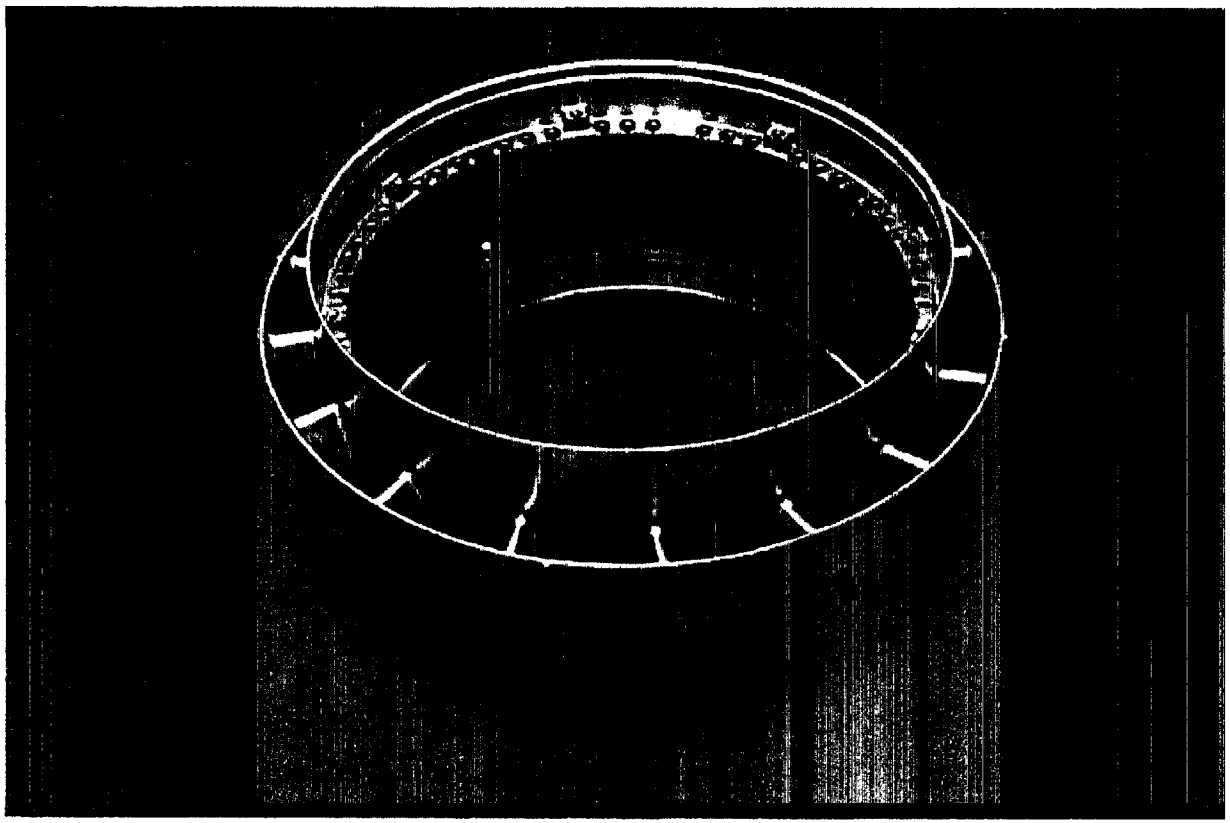
HPFTP/AT Turbine Exit Diffuser (TED)



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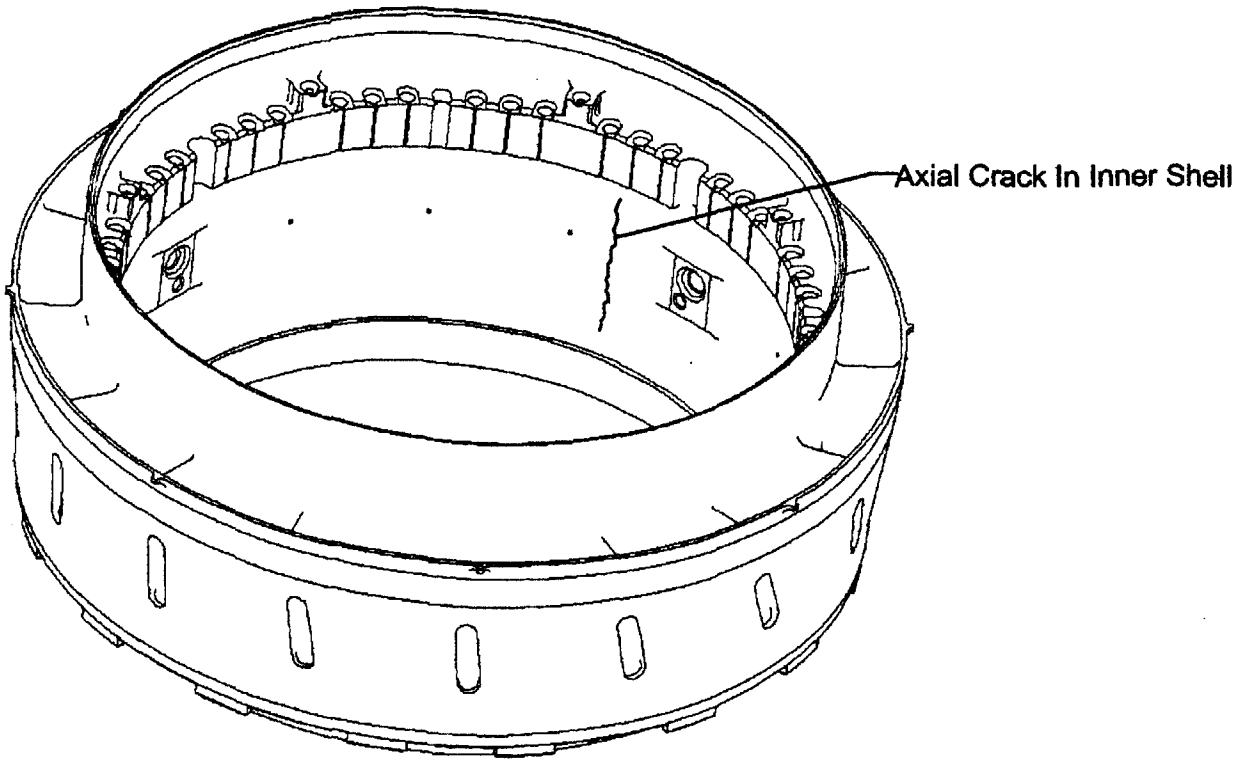
HPFTP/AT Turbine Exit Diffuser (TED) Inner Shell Cracking



Axial crack attributed to high frequency excitation caused by flow separation.

1ST STAGE TURBINE BLADE TIP CRACKING

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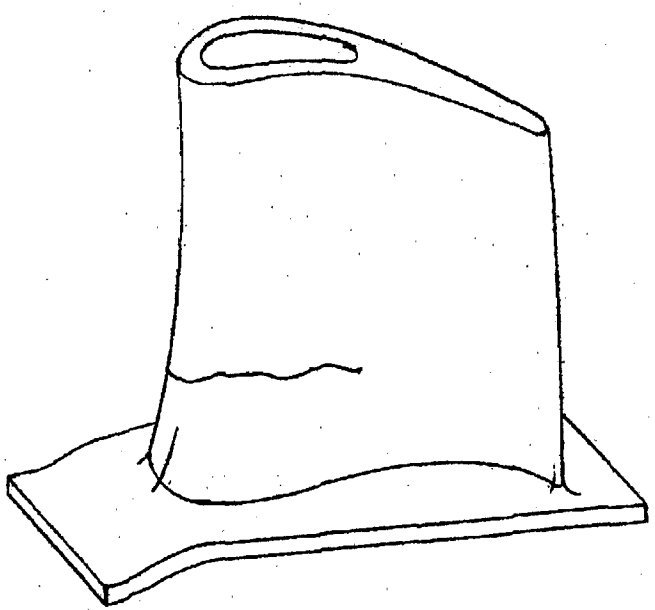
Airfoil Distress Overview

Fuel Pump suffered a 1st blade failure liberating a significant portion of the airfoil above the platform. Adjacent blade received damage from impact of liberated pieces.



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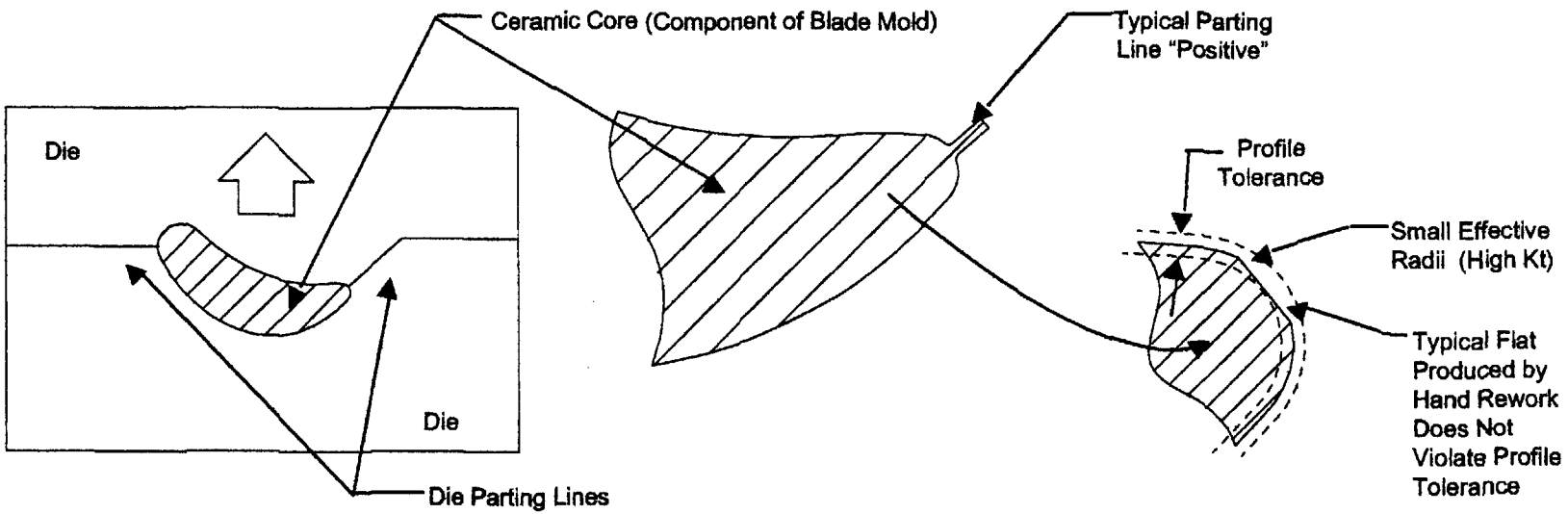
Typical Core Deviation Resulting From Parting Line Removal

- Imperfections / deviations on core are transferred to blades in metal



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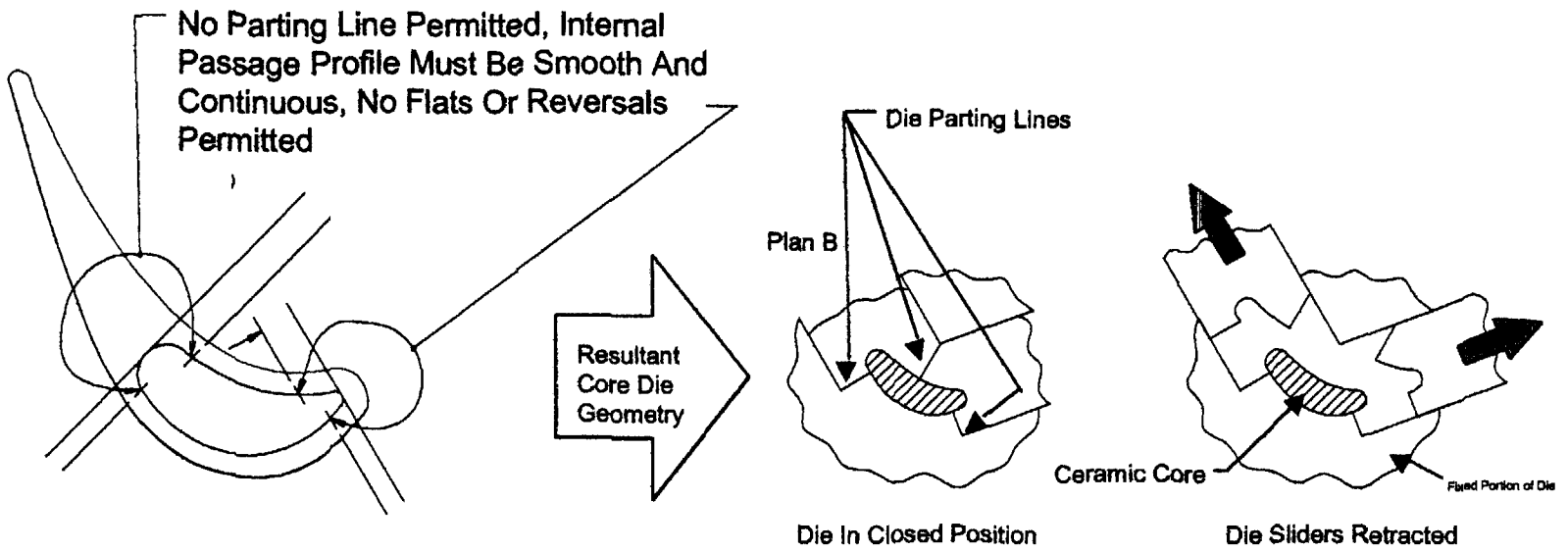
Revised Production Core Die Drawing Parting Line Controls



Production Core Die Schematic

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Summary / Conclusion

- Development testing of the Pratt & Whitney's SSME Fuel and Lox Turbopumps has proven to be extremely valuable in preparation for Certification and Flight Readiness
- Design "Lessons Learned" from this program highlights the importance of overall Systems Engineering:

  Aerodynamic - Thermal - Mechanical - Materials