High Pressure Turbocharging for SOFC/ Hybrid Fuel Cell Systems

Steve Berenyi
Rolls-Royce
Allison Mobile Power Systems

3rd Annual DOD/U. N. Hybrid Power Systems Conference and Workshop

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Allison Mobile Power Systems (AMPS) Organization

Organization
- Integral part of Rolls-Royce
- Off-site location in Indianapolis
- UAW-integrated team
- Marketing/design/procure
- Fab/assembly/test

Technologies
- Ceramics
- Combustion
- Rotor/bearing systems
- High speed generators
- Small components
- Insulation
- Systems

Configurations
- 10-300 kW
- 1 & 2 shaft
- Turbogenerators
- Shaft power
- APUs

Customers
- Dept of Energy
- NASA
- US Military
- Commercial
- RR Fuel Cell Systems

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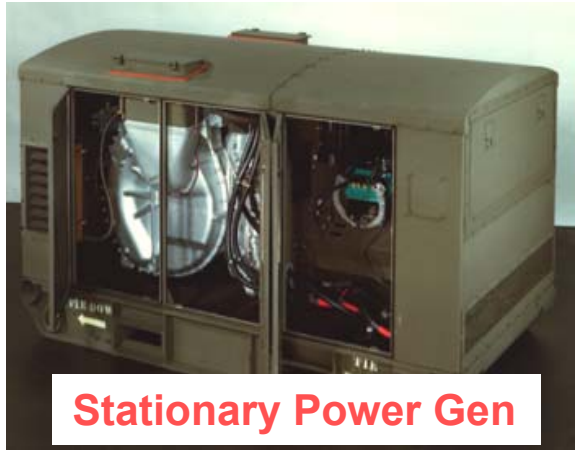
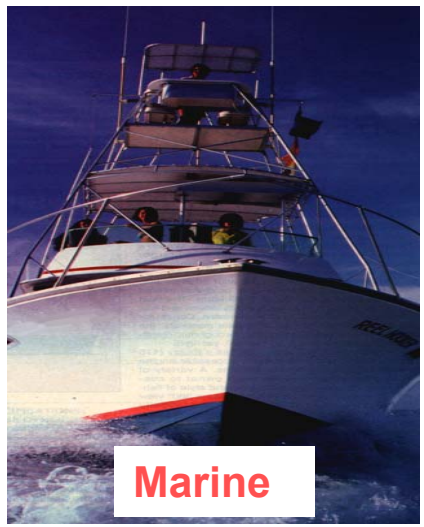
Allison Mobile Power Systems (AMPS) Markets





Military Mobile

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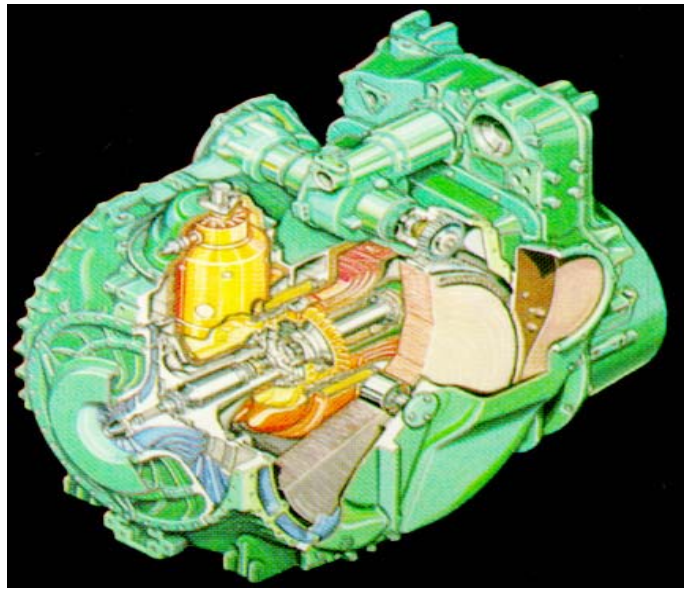
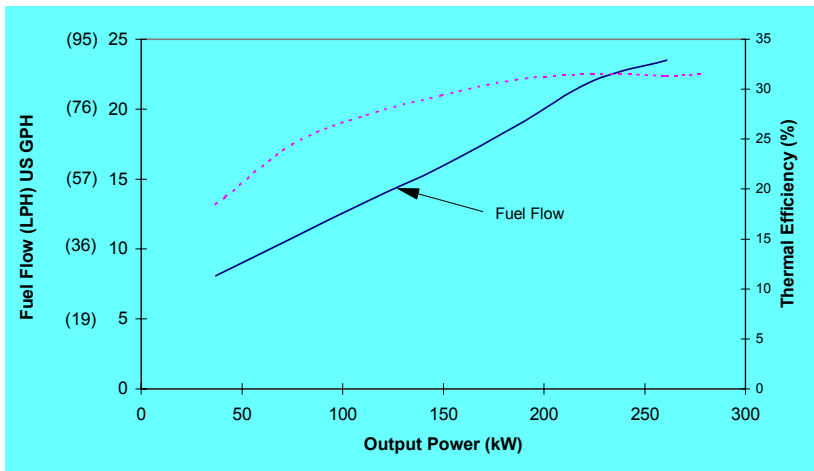
Industrial -- IGT 404 Engine





270 kW turbogenerator

- Generator set
- Used in Patriot Missile System
- 40”H x 32”W x 47”L
  (1016 x 813 x 1192mm)
- 1800 lb (815kg)

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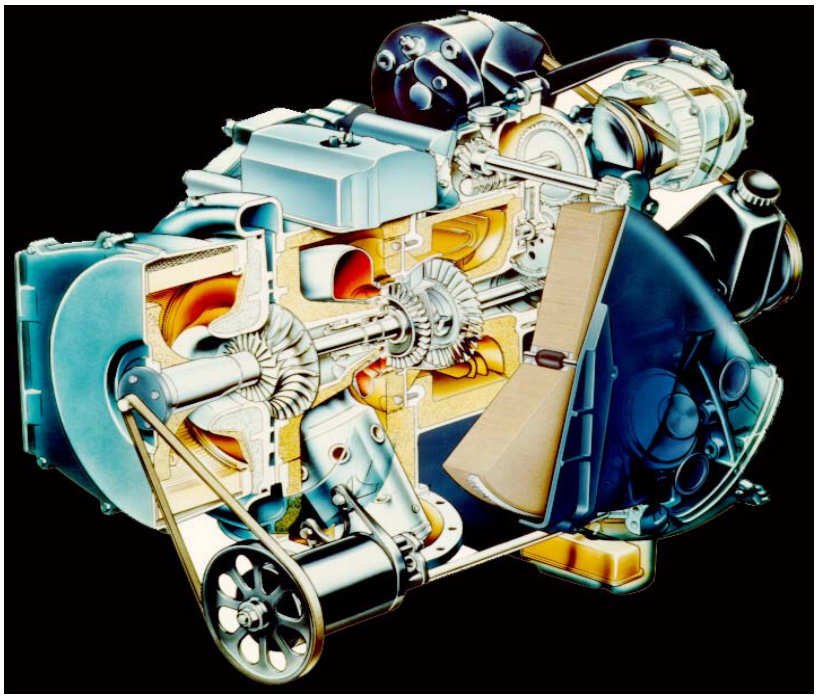
Automotive -- AGT-5 Engine



150 kW turboshaft

- Prime power source
- Automotive application
- 23”H x 27”W x 28”L (584 x 685 x 711 mm)
- 250 lb (114 kg)

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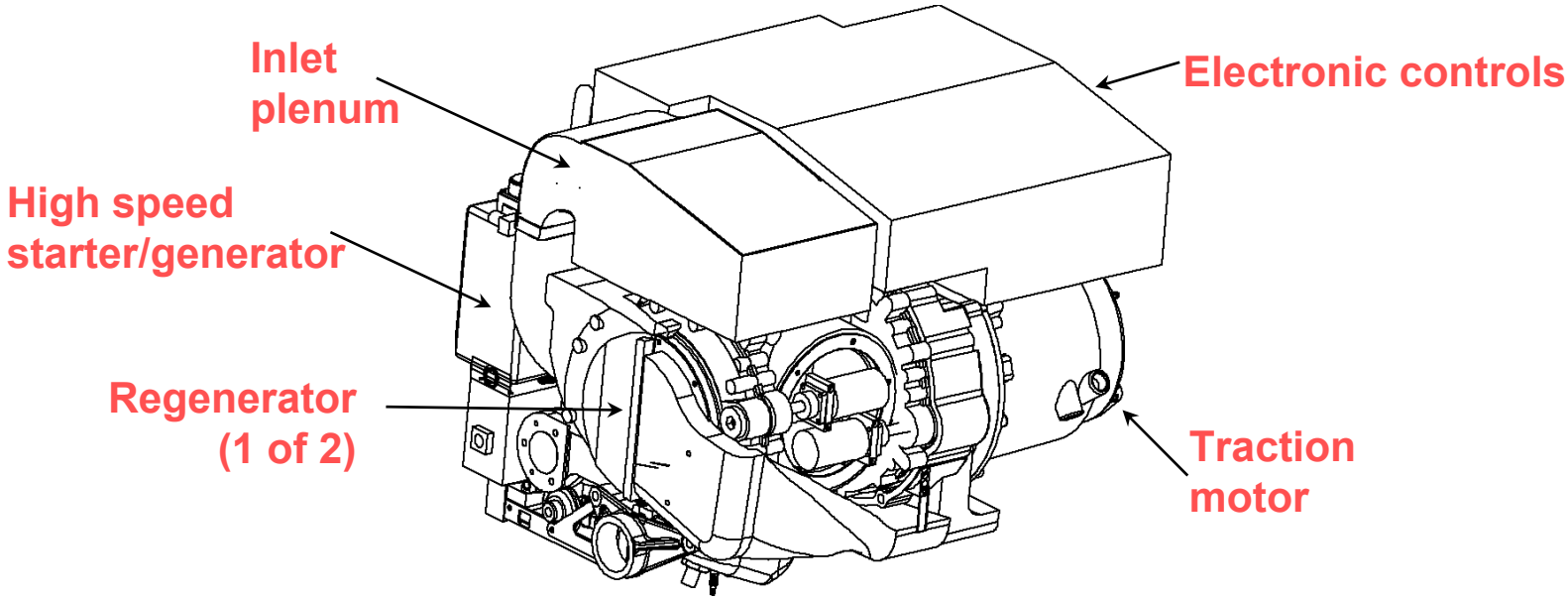
Automotive Turbo Generator -- TG1140 Engine



30 kW turbogenerator

- High speed starter/generator
- Hybrid vehicle application
- 26”H x 21.5”W x 19”L (661 x 546 x 483mm)
- 220 lb (100kg)

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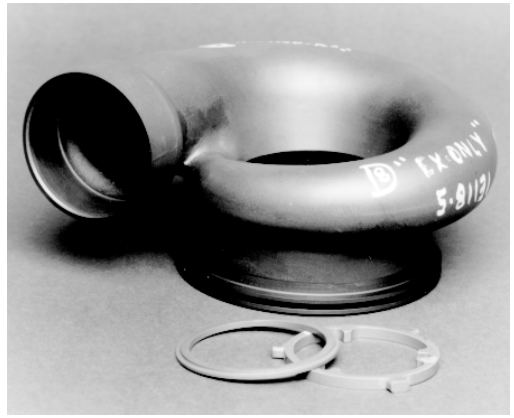
High Temperature Ceramic Materials Applications

Ceramic insulation

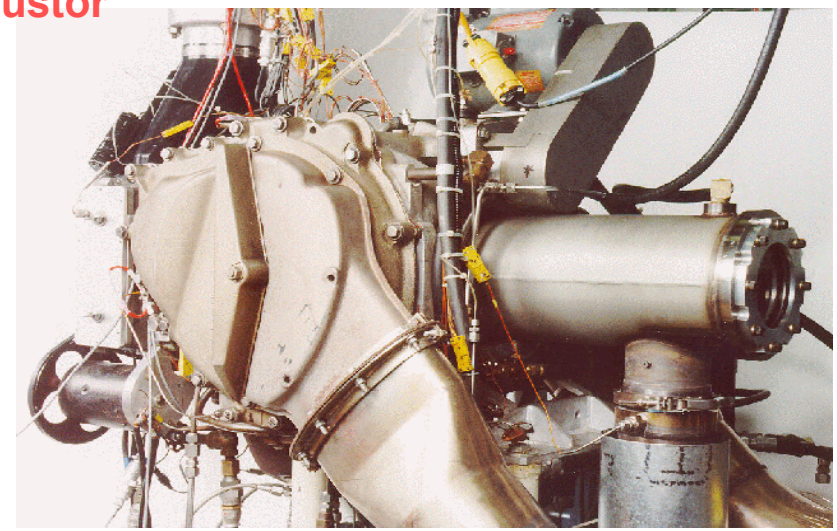
AS 800 silicon nitride combustor



SN 252 silicon nitride scroll

Kyocera rotor

MAS regenerator



Ceramic engine test rig

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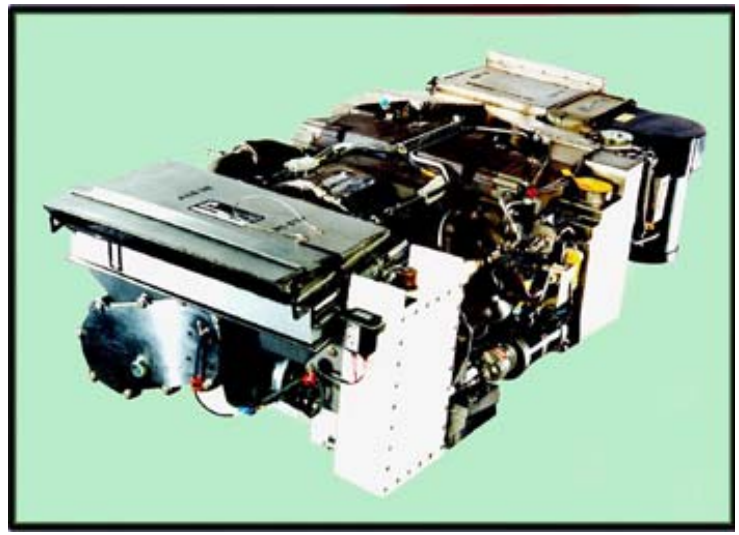
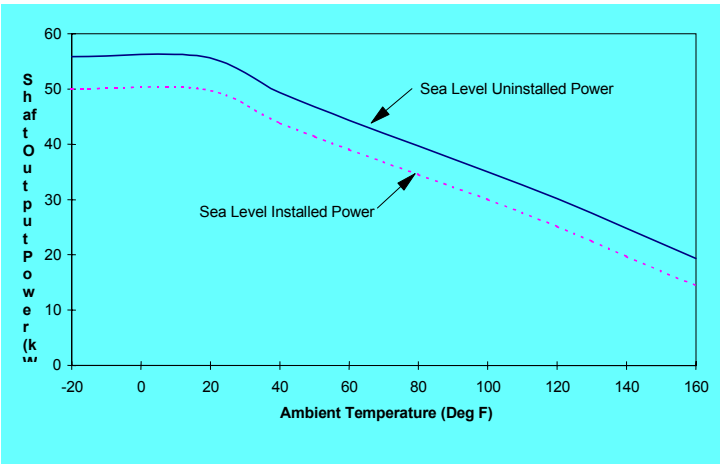
Military Turboshaft APU -- TS1230A Engine





20 kW turboshaft

- Auxiliary power unit
- M1A2 tank application
- 24VDC & hydraulic output
- 12”H x 22”W x 49”L (305 x 533 x 1244mm)
- 550 lb (200kg)

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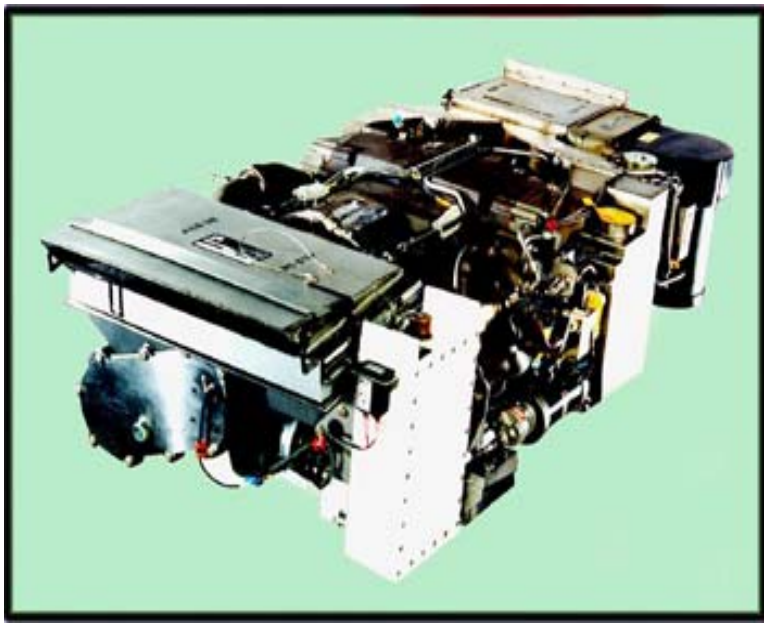
M1 Auxiliary Power Unit (TS1230A Engine)



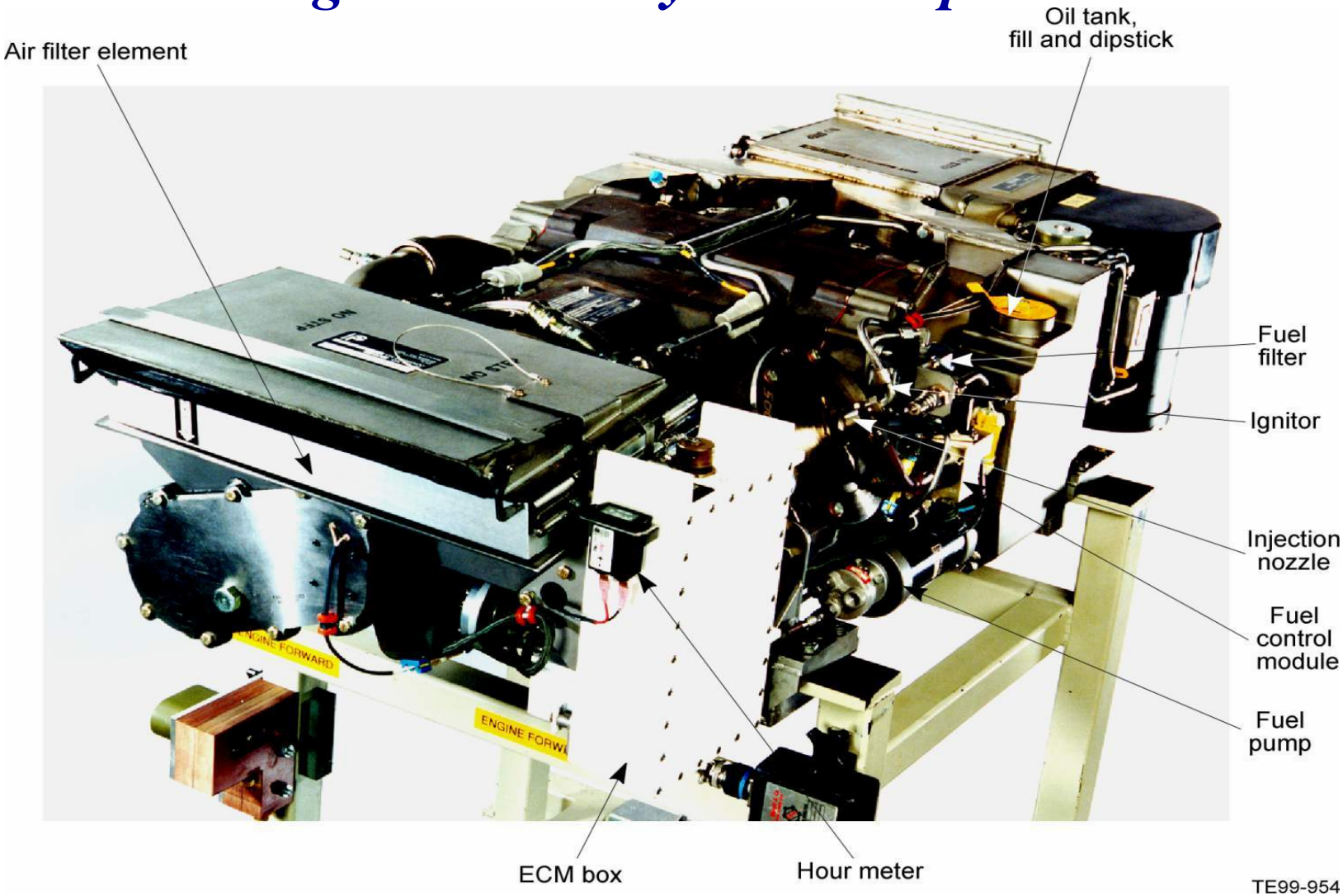
Rolls-Royce APU major components

- Regenerated turbine engine power
- Eaton/Vickers hydraulic pump
- Niehoff military qualified electrical generator
- Donaldson precleaner and air filter

Functions

- Provides electrical and hydraulic power
- Reduces main engine operating hours and vehicle fuel consumption
- Provides electrical power to charge main batteries
- Provides power for the thermal management cooling system
- Provides 6 kW (214 A at 28 Vdc) electrical power
- Provides 10 kW (1650 psig at 14.1 gpm) hydraulic power

Integrated APU System Components



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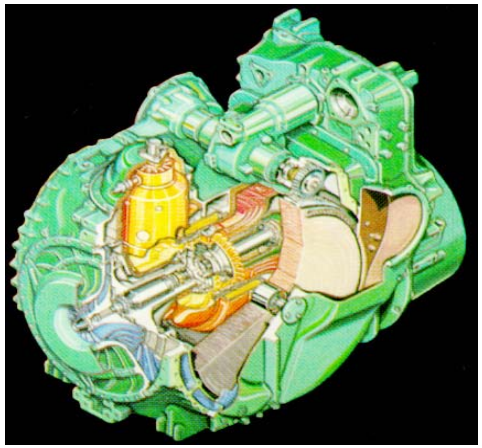
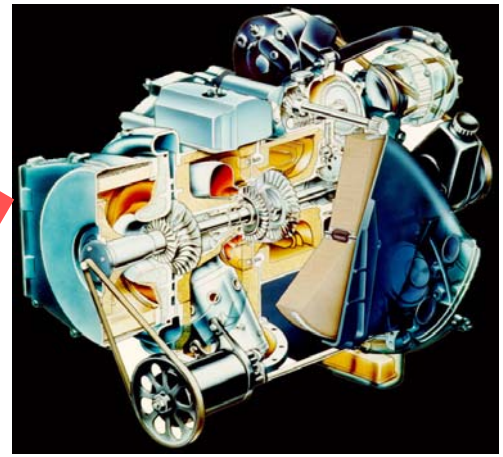
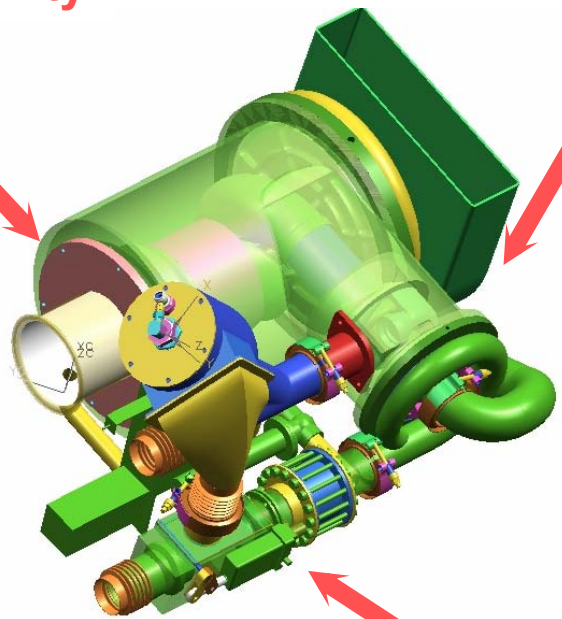
Rolls-Royce Fuel Cell Hypercharger's Heritage

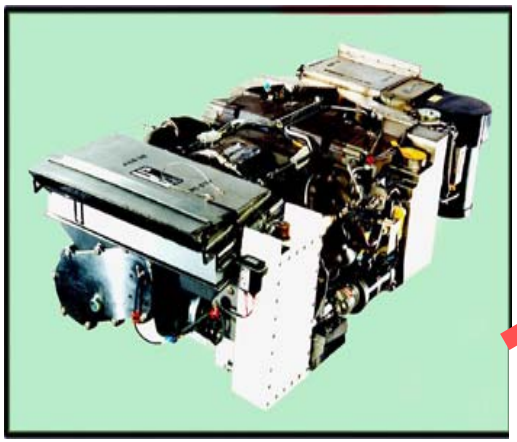


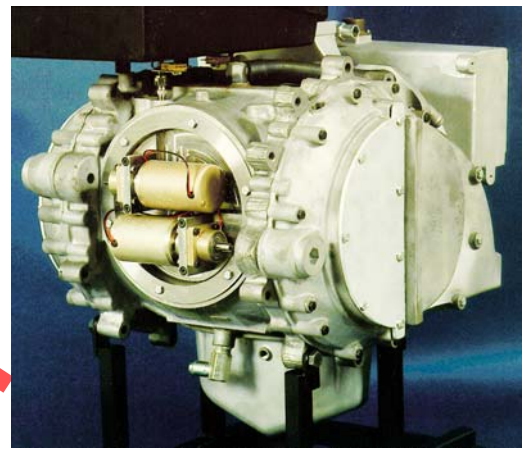
Durability

Low cost









Extreme environments

Advanced technologies

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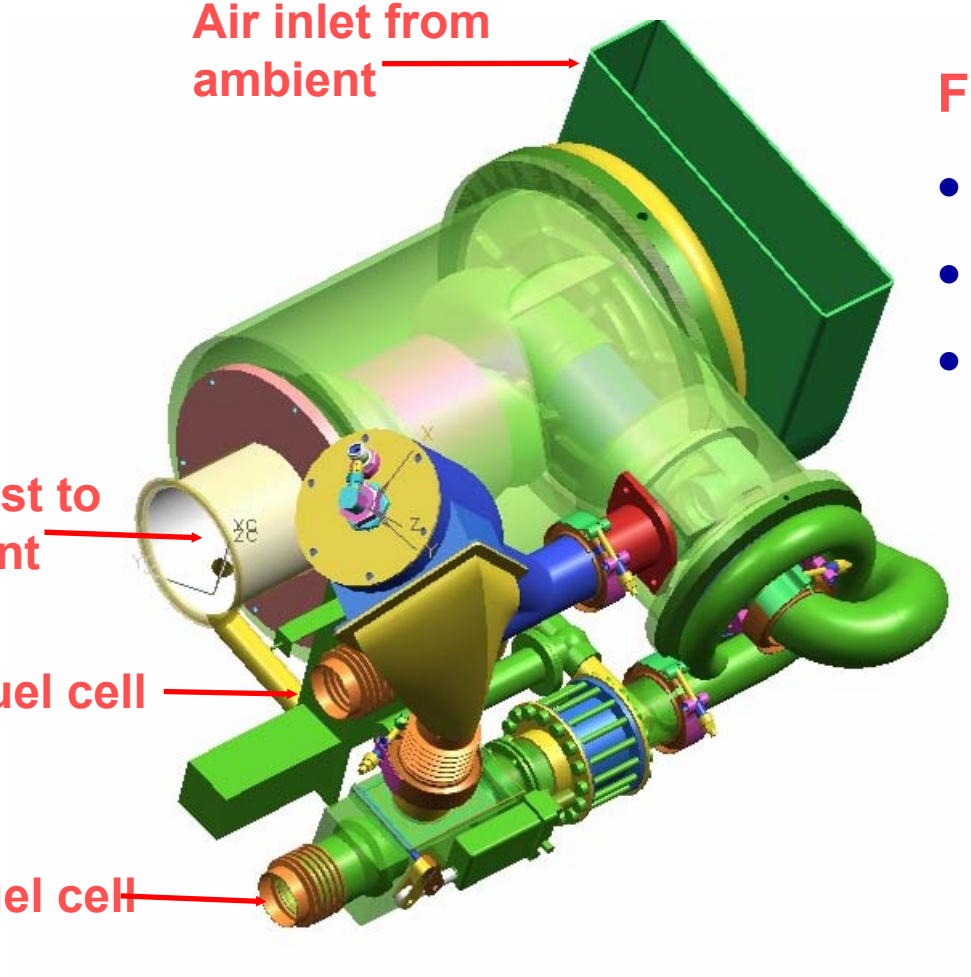
Rolls-Royce Hypercharger Configuration



Features

- Two shaft rotor system
- High pressure ratio
- Integrated package
  - High speed generator
  - Self starter
  - Start combustor
  - Thermal insulation
  - Digital controls

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Technology Transfers from Previous Programs

- Similar to industrial IGT 404
  - Rugged design features for durability
  - Serviceability
- Similar to US military M1 APU
  - Flows
  - Pressures
  - Speeds
  - Structures
  - Packaging
  - Controls
- Similar to automotive AGT 5 & 6
  - Ceramic components & insulation
  - Low cost automotive design features
  - Start system
- Similar to automotive hybrid
  - High speed generator
  - Electric power conversion
  - Auxiliary systems

Primary Remaining Challenges

- Long term operational durability
- Adaptation of “non-contact” bearing systems
- Start up and shut down transients
- Integrated fuel cell/hypercharger system packaging
- Integrated fuel cell/hypercharger control systems
- High speed generator power conversion and control