SNTP Propellant Management System

Current SNTP Engine System Uses High Temperature Bleed Cycle

- Tank Shut-off Valve
- Boost Pump Ejector
- Turbopump Assembly
- Turbine Control Valve
- Pump Discharge Shutoff Valve
- Hydrogen Flowmeter

SNTP Cycle Selection
Full-Temperature Bleed Cycle is Lowest Engine System Mass with Minimal Isp Penalty

- No design interaction with reactor
- Allows light-weight radiation-cooled nozzle
- Lowest system complexity, potentially highest system reliability
- High-temperature, low-Z material minimize cooling in radiation environments
NTP System Components Have Unique Design Constraints

- High Ionizing Radiation Environment
- High Heat Load From Radiation Energy Absorption
- Restricts Use Of High-Z Materials
- Design Must Provide For Heat Removal

Bleed Cycle Presents Unique Design Requirements for Turbopump

- Moderate operating pressures (1350 psi)
  - Single-stage pump
  - Light pressure vessels
- High operating temperatures (2750 K)
  - Highly energetic working fluid
  - High-pressure ratio impulse turbine
  - High turbine temperatures
  - Large thermal gradients
- Environmental factors
  - Environmental heating — low-Z material
  - Limited elastomers selection
  - Hot-hydrogen embrittlement
- Use of bleed cycle and uncooled thrust nozzle results in substantial system weight savings.
Bleed-Cycle Turbopump

Uses Carbon-Carbon Components for Operation on 2750 K Gas

Carbon-Carbon Hot Section Housing
Carbon-Carbon Turbines
Titanium Shafting

Carbon-Carbon Nozzle/Plenum
Aluminum Pump and Inducer
Ceramic Rolling Element Bearings or Foil Bearings

SNTP Carbon-Carbon Turbine Wheel

Design is Based on Technology Developed on the ELITE Program

- Helical 2-D polar weave architecture
- Impulse blades
- 55,600 rpm
- 2750 K inlet temperature
- 45-percent design stress margin
- 26-percent design speed margin
Turbine Development Program

High-Temperature, Carbon-Carbon Components Are Being Fabricated and Will be Tested at 2750 K

San Tan Hydrogen Test Facility

Facility Constructed for Development of SNTP Hydrogen-Related Components

- Turbopump, valves, internal reactor components
- Hot, two-phase, and cryogenic hydrogen capability
- Dedicated facility for non-nuclear NTP testing
- Company-funded construction