Ames Arc Jets in Support for Planetary Defense

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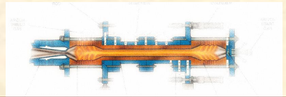
Arc Heater Background

- An arc heater uses a constant electric discharge between two sets of electrodes to heat a gas (nominally air), increasing total pressure and temperature (>6000 K). The gas is expanded out a supersonic/hypersonic nozzle and onto a test article at heat rates & pressures matching high altitude entry.
- Used since the mid 1950s to provide conditions on a test sample that closely match those of hypersonic entry of a space craft.



Nominal Arc Jet Capabilities

Test gas	Air, N_2, O_2, CO_2, Argon		**Test duration (min)**	≤ 60	
Nozzle exit (mm)	Conical , Ø 76, 152, 330, 533, 762 &1041	Semielliptical, 203x813	**Test article type**	Stagnation point	Wedge/Flat plate
Input power (MW)	60		**Test article size (mm)**	Ø 380	610 x 610
Bulk enthalpy (MJ/kg)	2 to 28		**Surface pressure, kPa**	1- 600	0.01-2
Flow rates (kg/s)	0.03 to 1.7		**Heating rate (W/cm^2) ***	25-2000	6-400

- Cold wall, fully catalytic heating on a 102-mm Φ hemisphere

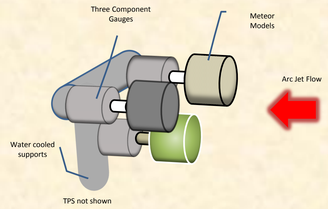
1. Meteor Ablation Studies

Contribute data to a thermal response model of meteoritic materials

- 3” nozzle convective heating series
  - Convective heating promotes melting & creation of fusion crust
  - Up to 8000 W/cm^2 on a 0.5” Φ (1.3 cm) sample at 400 kPa
  - High speed video, pyrometry, IR imagery, spectrometry
  - Insertion times ~1-2 sec
- Add radiative heating circa mid-late 2016
  - Between 100 and 150 kW available

#2. Multi-Body Breakup in Arc Jet Convective Heating Environment

- Two to three bodies on special strut with temperature and force measurements of each body
- Strut would have individual supports for each body
- Insert multi-body model into flow and record movements, forces and sample temperatures
- High speed video, IR imagery
- Complement data from ballistic range tests



Diagnostics

Thermal performance @ known pressure, heat flux, enthalpy, time

- Recession & mass loss
- Surface temperature history, back face temperatures, cold trap option
- High-speed video, photographic data, IR imagery
- Post test dissection/inspection

Spectrographic

- Focus on stagnation point and/or wake
- Look for presence and intensity of possible species in the visible/near IR range
  - Si, SiO, Si+, Mg, MgO, Fe, FeO, S, Na, Ca, K
- Validate radiative and thermal models

End Result

Result would improve and validate material response and radiative models to better predict meteor behavior at entry to Earth.

References

- C. Shepard, J. Vorreiter, H. Stine, W. Winovich, “A Study of Artificial Meteors as Ablators,” NASA TN D-3740, March 1967
- J. Kesselring, R. Maurer, G. J. Hartman, “Code Validation Tests in Arc Heater Facilities with Application to Outer Planet Entry,” Aerotherm Report TM-76-106, NASA ARC NAS2-8529, March 1976