

NASA Ames Arc Jet Complex

Providing ground-based hypersonic environments in support of the Nation's Research & Development activities in Thermal Protection Materials, Vehicle Structures, Aerothermodynamics, and Hypersonics.

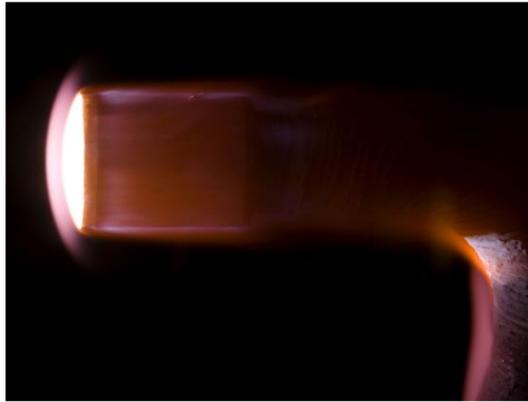
Background

Innovative TPS materials and systems will be required to support Exploration. Future missions; in particular, crewed Moon or Mars return missions, will involve high velocity aerocapture or direct entry at Earth. These high stress missions will induce heating environments too severe for existing reusable Thermal Protection Systems (TPS). Qualifying a new TPS material requires extensive testing to explore the limits of material performance, to validate reliability and repeatability of material response models, to investigate the effects of material damage, and to develop a full database of material properties. Arc-heated facilities are critical to such a process, and to any other TPS developments required for exploration missions, by providing the only ground-based simulation of flight entry conditions. The facilities of the Arc Jet Complex are used to simulate the aerothermodynamic heating that a spacecraft endures throughout atmospheric entry, and to test candidate TPS materials and systems. The duration of such testing can range from a few seconds to more than an hour and from one exposure to multiple exposures of the same samples.

Research in Hypersonic Entry

The arc jets provide a hypersonic flow for testing materials and experimental measurement techniques in support of aerospace research carried on at Ames for Science Mission, Human Exploration and Operations, and Space Technology Program. Arc jets are being used to provide material response data on new, advanced TPS concepts being developed at NASA Ames Research Center, other NASA centers, Department of Defense, and in private industry. These materials are at the forefront of concepts for hypersonic entry into planetary atmospheres. Additionally, the arc jets have proven to be a valuable tool for DARPA and the U.S. Air Force in studies of thermal protection of hypersonic cruise vehicles.

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Thermal Protection test in NASA Ames Arc Jet complex

NASA Ames arc jets also support sensor development such as Mars Entry Decent and Landing Instrumentation and experimental capabilities as part of research into hypersonic entry and basic hypersonic flow. Whether it is advanced thermometry, recession rate sensors, pressure sensors, or LIF investigation of the gas state before or after the shock front, the arc jets are providing investigators with usable test environments that match the important parameters of hypersonic flow.

Ames Arc Jet Complex

The Ames Arc Jet Complex has seven available test bays. At the present time, four bays contain Arc Jet units of differing configurations, serviced by common facility support equipment. These are the Aerodynamic Heating Facility (AHF), the Turbulent Flow Duct (TFD), the Panel Test Facility (PTF and Truncated PTF), and the Interaction Heating Facility (IHF). The support equipment includes two D.C. power supplies (20 MW and 150 MW), a steam ejector-driven vacuum system, a water cooling system, high-pressure gas systems, data acquisition system, and other auxiliary subsystems.

The magnitude and capacity of these systems makes the Ames Arc Jet Complex unique in the world. The largest power supply can deliver 75 MW for 30 minute duration or 150 MW for 15 second duration. This power capacity, in combination with a high-volume 5-stage steam ejector vacuum-pumping system, enables facility operations to match high-altitude atmospheric flight conditions with test articles of relatively large size.

The Arc Jet Complex offers unique facilities. The Interaction Heating Facility (IHF), with an available power of over 60-MW, is one of the highest-power arc jets available. It is a very flexible facility, capable of long run times of up to one hour, and able to test large samples in both a stagnation and flat plate configuration. The Panel Test Facility (PTF) uses a unique semielliptical nozzle for testing panel sections. Powered by a 20 MW arc heater, the PTF can perform tests on samples for up to 20 minutes. The Turbulent Flow Duct (TFD) provides supersonic, turbulent high-temperature air flow over flat surfaces. The TFD is powered by a 20 MW Hül's arc heater and can test samples 203 mm by 508 mm in size. The Aerodynamic Heating Facility (AHF) offers a wide range of operating conditions, samples sizes and extended test times. A cold-air-mixing plenum allows for simulations of ascent or high-speed flight conditions. Catalcity studies using air or nitrogen can be performed in this flexible arc heater. A 5-arm model support system allows the user to maximize testing efficiency. The AHF can be configured with either a Hül's or two styles of segmented arc heater, up to 20-MWs.

Arc Heater

An arc jet is a device in which gases are heated and expanded to very high temperatures and supersonic/hypersonic speeds by a continuous electrical arc between two sets of electrodes. The gases (typically air) pass through a nozzle aimed at a test sample in vacuum, and flow over it, producing a reasonable approximation of the surface temperature and pressure and the gas enthalpy found in a high velocity, supersonic flow of the kind experienced by a vehicle on atmospheric entry. The Ames Arc Jets began in the 1950's with the founding of a permanent facility in 1961. A breakthrough-patented design in 1964 by Stein, Shepard and Watson of NASA Ames produced a high-enthalpy constricted-arc heater, which enabled TPS development for Mercury and Apollo missions.

History

The Ames Arc Jet Complex has a rich heritage of over 50 years in Thermal Protection System (TPS) development for every NASA Space Transportation and Planetary programs including Apollo. The Ames Arc Jets began in the 1950's with the founding of a permanent facility in 1961. A breakthrough patented design in 1964 by Stein, Shepard and Watson of NASA Ames produced a high-enthalpy constricted arc heater, which enabled TPS development for Mercury and Apollo missions and all NASA programs since then.

Ames heritage includes development and certification tests for Space Shuttle, Viking, Pioneer-Venus, Galileo, Mars Pathfinder, Genesis, X-38, Stardust, NASP, X-33, X-34, SHARP-B1 and B2, X-37, Mars Exploration Rovers, Phoenix, and most recently Orion and Mars Science Laboratory. Such a history has fostered the growth of extensive local expertise in the development and refinement of the arc jet

Website

<http://www.nasa.gov/centers/ames/thermophysics-facilities-home>

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