FACILITY DESCRIPTIONS

This attachment, J.1(a)11 describes facilities listed in the statement of work.

TEST FACILITIES

UNITARY PLAN WIND TUNNEL FACILITY (UPWT)

The Unitary Plan Wind Tunnel Facility is comprised of three separate closed return wind tunnel circuits with individual test sections sharing a common power source and other auxiliary subsystems. The three research test sections are the 11-Foot TWT, the 9 x 7 Foot SWT, and the 8 x 7 Foot SWT. The facility also has Model Preparation Rooms used for buildup, calibration and checkout of models prior to wind tunnel test entry.

The three wind tunnels are unique in operating characteristics: the 11-Foot TWT has a Mach number range of 0.3 to 1.5, the Mach number range of the 9 x 7 Foot SWT is 1.5 to 2.5 and that of the 8 x 7 Foot SWT is 2.5 to 3.5. The tunnels are variable density with a total pressure range from approximately 10" to 60" Hg absolute. Only one test section can be utilized for wind tunnel testing at a time due to the sharing of a common main drive system. The airflow for the tunnels is provided by coupling the drive motors to one of the two axial flow compressors: a three-stage for the 11-Foot TWT; and an eleven-stage common to both the 9 x 7 Foot SWT and 8 x 7 Foot SWT (air flow diversion valves are used to select the 9 x 7 Foot SWT or 8 x 7 Foot SWT tunnels).

The Auxiliary Equipment is comprised of the equipment within the Unitary Plan Wind Tunnel Facility that is shared by all three wind tunnels. This includes the main drive motors and their couplings, the emergency electrical power, the Make-Up-Air (MUA) system, the lubrication systems for the motors and compressors, the diesel generator set, vacuum systems, instrument air system, and the main cooling water system. Controls for the shared systems are duplicated at each test section's control room and at control panels in the Auxiliary Equipment building. A key interlock system limits control to one control console at a time.

ARCJET COMPLEX

The Arcjet Complex is used for thermal protection systems evaluation, materials characterization, and design validation. Computer models can be used in conjunction with data provided by the Arcjet tests to predict the thermal performance of Thermal Protection Systems concepts in various flight trajectories. The facilities consist of five separate operational units: the Aerodynamic Heating Facility (AHF), the 2X9 in. Turbulent Flow Duct Facility, the 20-MW Panel Test Facility (PTF), the 60-MW Interaction Heating Facility (IHF), and the Direct Connect Arcjet Facility (DCAF). The Giant Planet Facility is currently being readied for reactivation. The arc-heated facilities are powered by either a 20-MW direct current power supply or a separate 60-MW dc power supply. The effluent gas stream discharges into five stage steam-ejector-driven vacuum system. All the facilities have high-pressure water available at flow rates up to 8000 gallons/min. The vacuum system, power supplies, and high-pressure water are common to test facilities in both Building N-234 and N-238.

FACILITY DESCRIPTIONS

HYPERVELOCITY FREE-FLIGHT FACILITY (HFFF)

The HFFAF is an aeroballistic range used to measure aerodynamic and aerothermodynamic characteristics of small-scale models in free flight, at extremely high speeds (up to 8 km/s). It consists of three main sections: (1) an arsenal of model launching guns (light gas and powder), (2) a test section with receiver tank, and (3) a counterflow-producing shock tube (see below) with a variable area ratio nozzle. Testing can be conducted using the gun and test section only (standard aeroballistic or hypervelocity impact testing); or with the shock tube and test section (Mach 10 - 16, fixed-model, shock-tunnel testing); or with the gun, test section, and shock tube simultaneously (counterflow aeroballistic testing). In counterflow mode of operation, the HFFAF is capable of producing relative velocities up to 11 km/sec. Note, the shock tube has been mothballed since 1995, and there are no immediate plans to reactivate this section of the facility. The facility can conduct tests (in all modes of testing) in atmospheres other than air (i.e. carbon dioxide, nitrogen, helium, xenon, krypton, argon, etc.), and at sub-atmospheric conditions.

Each of four available light-gas guns uses smokeless gunpowder to launch a plastic piston into a tube filled with hydrogen. The subsequent rapid compression process produces a reservoir of extremely high-pressure and high-temperature gas, which then acts upon the launch package (model and carrier) accelerating it down the gun barrel and into the test section at hypervelocity flight conditions. Variations in gun size enable launching models ranging in size from 7 mm to 38 mm in diameter.

The instrumented test section has a length of approximately 23 meters and diameter of roughly 1.07 meters, and contains 16 evenly spaced, orthogonal, imaging stations capable of producing 32 shadowgraph images (16 horizontal and 16 vertical). Each station is equipped with a pair of Kerr cell shutters (40 nanosecond exposure) and spark gap (capacitive discharge) light sources. Alternatively, visible ICCD and IR cameras can be substituted at any of the stations to obtain model surface temperature profile images at different points along a model's fight path. Aerodynamic coefficients are derived from the shadowgraph images and the corresponding recorded time history of the model flight. Aerothermal quantities such as heat transfer rates and transition to turbulent flow locations are obtained from thermal imagery data. The test section is serviced by four, mechanical vacuum pumps, and one Roots blower. Minimum pressure achievable is on the order of 40-microns of Hg (40 millitorr) absolute.

Although the Counter Flow Shock Tube has been mothballed for more than a decade, the following descriptive information is worth mentioning for completion purposes. The shock tube (combustion driven) is used to produce a hypervelocity slug of test gas within the test section that persists for several to tens of milliseconds in duration. The driver tube is 20 meters in length and 0.43 meters in diameter and was constructed from breech sections of 16-inch (406 mm) WW-II era naval cannons. The shock, or driven, tube is 26 meters long and 0.30 meters in diameter and was fabricated from 14-inch (356 mm) WW-I naval cannons. The shock tube is rated for a maximum operating pressure of 10,000 psi.

ANECHOIC TEST CHAMBER/ACOUSTICS LABORATORY

The Anechoic Test Chamber is a specialized facility for acoustics measurements. The walls are treated with various attachments designed to reduce sound wave refelections. The chamber also contains a blower jet facility. The acoustics laboratory is used for instrumentation development, calibratio0n and testing.

FACILITY DESCRIPTIONS

ELECTRIC ARC SHOCK TUBE (EAST)

The EAST is a unique facility featuring a capacitive electric-arc driver and the option of a 102 mm high-pressure driven tube or a 610 mm low-pressure driven tube. The facility is used for investigations such as radiation and ionization studies for outer planet entries, chemical reaction rate measurements, and diagnostics in high-energy flows requiring a high performance shock tube facility.

Shock velocities up to 40 km/sec can be attained with quick succession operation (3 - 5 tests per day) utilizing the conical arc chamber. Energy for the driver is supplied by a one megajoule capacitive storage system. It can be charged to a preset energy at either a 0 to 40 kV (1250 micro f) mode or a 0 to 20 kV mode (5000 micro f). The 102 mm high-pressure driven tube is 11 meters long and is designed for a 6000 psi working pressure. The 610 mm low-pressure driven tube is 21 meters long and designed for a working pressure of 200 psi. The facility has a variety of instrumentation with high speed oscilloscopes being the primary data recording devices, and is serviced by several vacuum pumps and a gas loading system for pressurizing the driver. The facility is operated through an automatic sequencer once the preliminary facility preparation is completed.

AMES VERTICAL GUN RANGE (AVGR)

The AVGR is a unique ballistic facility used to simulate and study the physics and mechanics of planetary impact cratering phenomena. Ballistic technologies, utilizing light gas and gun powder, enable the acceleration of projectiles up to 2-centimeters diameter at relative velocities of approximately 8 km/sec. By varying the gun's angle of elevation with respect to the target vacuum tank, impact angles from 0 to 90 degrees with respect to the gravitational vector are possible.

Various photographic techniques are employed to document the experiments. The 16-mm movie cameras are capable of 104 frames per second and constitute the major means of recording. Additional capabilities include a framing camera (permitting 4,500,000 frames per second) and a pair of 35-mm framing cameras capable of recording movies in stereo at a mechanically synchronous rate of 60 frames per second. These recordings provide a highly accurate analytical growth history of the impact and cratering phenomena.

Experimental targets are contained within a 2.5 meter diameter vacuum chamber and can be accelerated vertically downward to change the net gravitational effect experienced by the target during crater formation. Variations of target construction include the placement of colored substrates to be used as markers prior to crater formation, thus providing information pertaining to the flow of subsurface materials.

SENSOR DEVELOPMENT LABORATORY

The NASA Ames Research Center Thermophysics Facilities Branch Sensor Development Lab's mission is to design, develop, implement, manufacture, and deliver instrumentation related to the study of thermal protection systems and aerothermal environments. Consisting of a diverse team of engineers and technicians, the group has developed sensors to measure properties such as temperature, TPS recession, and heat flux. Among the programs that the Sensor Development Lab has supported include the Mars Science Laboratory Entry, Descent, and Landing Instrumentation (MEDLI) project, the Crew Exploration Vehicle Advanced Development Project (CEV ADP), and calorimetry support for the Ames Arc Jet Facilities. Instrumentation designed and manufactured by the Sensor Development Lab is scheduled to be launched with the Mars Science Laboratory arriving at Mars in 2010.

FACILITY DESCRIPTIONS

SUPPORT FACILITIES

STEAM VACUUM SYSTEM (SVS)

The SVS provides the high mass flow vacuum conditions required for the operation of the Arc-Jet wind tunnel facilities. The steam is produced by a natural gas fired boiler with a capacity of 250,000 pounds of steam per hour and SVS pumping is accomplished by five steam ejector stages. Other major components of the SVS are two cooling towers, an effluent-air pollution control system, and a 160,000 gallon de-ionized water system.

ARC JET AIR SYSTEM (AJAS)/High Pressure Air Distribution System (HPADS)

The AJAS consists of two parts: the air generation and storage subsystem and the High Pressure Air Distribution System (HPADS) network. The air generation and storage subsystem consists of four reciprocating compressors (from 900 HP to 5500 HP), three storage units (500,000 SCF to 6,000,000 SCF at 3000 psig), the interconnecting piping and valving, and all the associated pumps, heat-exchangers, water towers, motors, blowers, driers, etc. The high-pressure air distribution system network supplies air to twenty user facilities located throughout Ames Research Center. Three of the compressors are equipped with cylinders to evacuate five 75-foot diameter vacuum spheres for three user facilities.

HIGH VOLTAGE ELECTRICAL SYSTEMS

The High Voltage Electrical System consists of the power distribution equipment used to provide electricity to the aerospace test and support facilities.

BLADE INSPECTION/STORAGE FACILITY (BISF)

The Blade Inspection/Storage Facility, located in N207A, is used for the reconditioning of wind tunnel compressor blades after removal from a compressor and for the proper storage of the blades in preparation for reinstallation into a compressor. The facility houses the sanding equipment, balancing equipment, and storage of the wind tunnel compressor blades. The function of this facility is to restore/repair blades, balance them, and store them in preparation for use. Also, the maintenance of records for the blades is a function of this facility.

STING ASSEMBLY/STORAGE FACILITY (SASF)

Sting Assembly/Storage Facility, located in N207A, is used for the storage and assembly of stings prior to entry into wind tunnel test sections. The function of this facility is to store in functional condition the stings and adapters used in the wind tunnels and to assemble, document, and deliver functional assemblies to the test section. The facility inspects and repairs these components and maintains a database on all items in the facility.

BALANCE CALIBRATION LABORATORY (BALCAL)

The BCL performs calibrations on all types of strain gage balances used to measure forces on aerodynamic models installed in the test facilities. The BCL is equipped with two semi-automatic calibration machines, hand load rigs to calibrate unusual configurations, and data acquisition/reduction computers. The outputs of the facility are the gage constants and interactions that are used in a wind tunnel test to reduce the measured gage output to engineering units of force and moment.

FACILITY DESCRIPTIONS

INDUSTRIAL WASTEWATER TREATMENT FACILITY

The Industrial Wastewater Treatment Facility (IWTF), N271, provides microfiltration and reverse osmosis treatment of industrial wastewater effluent from the Unitary cooling tower, the ArcJet cooling tower, and the ArcJet boiler. Treated groundwater is also processed through N271. The treated waters are then reused as make-up water for the ArcJet boiler. The IWTF is operated primarily by the Thermophysics Facilities Branch (Code TSF).

ANTICIPATED TEST FACILITIES

LUNAR ENVIRONMENT ARCJET FACILITY (LEAF)

The Lunar Environment Arcjet Facility (LEAF) will be a new ground test facility specifically designed to simulate the peak aero-thermal heating environments that the Orion vehicle will encounter during Earth atmospheric entry from a lunar direct return (LDR) trajectory, (the most severe trajectory anticipated in terms of aerodynamic heating to the heat shield). The LEAF will consist of a new electric-arc gas heater, a new vacuum test chamber, and a new high-power radiant heat source, and it will use the existing supporting subsystems in the Ames arc jet complex. A major risk to the Orion project is the uncertainty in thermal protection system (TPS) performance during the aerodynamic heating of Earth atmospheric entry: how well will the heat shield material protect the craft and its crew during the fiery reentry? The main purpose of the new LEAF arc jet facility will be to perform tests on heat shield material samples at much higher heating conditions than any current arc jet facility can provide today. Material samples will incorporate gaps/seams that are similar to the flight vehicle, and will incorporate assemblies of materials built to flight-like thickness to better understand their response to the intense heating environment. The LEAF materials tests will produce data on TPS performance that will not only lead to a reduction of the risks to the Orion program, but will provide the necessary data to qualify and certify the design of the heat shield. The LEAF support systems (power, cooling water, vacuum, etc) will be shared with three other operational arc jets at Ames, and must be compatible. It is anticipated that LEAF will use nearly all of the available power capacity of the arc jet rectifier power supply, or approximately 75 MW.