HYPERVELOCITY IMPACT TESTING FACILITY

FACILITIES

The White Sands Test Facility (WSTF) Hazardous Hypervelocity Impact Facility is a remote, access-controlled test area capable of simulating micrometeoroid and orbital-debris impacts on spacecraft materials and components. The facility was designed to safely handle and test hazardous targets, making it unique within NASA. Three two-stage light gas launchers propel 0.05 to 22.2 mm (1/512 to 7/8 in.) diameter projectiles to velocities in excess of 7.5 km/s (24,600 ft/s). A site-wide hazardous fluid handling and disposal network allows toxic, reactive, and explosive targets (such as pressurized containers and aerospace fluids) to be safely evaluated. Release energies up to 2.3 kg (5 lb) TNT equivalent can be accommodated within the facility's sealed target chambers. An external concrete pad was designed to accommodate a shaped charge launcher and is approved for free-air energy releases up to 11.3 kg (25 lb) TNT equivalent.

EQUIPMENT

The equipment used in this facility currently consists of:

- 25.4-mm (1-in.) two-stage light gas launcher
- 12.7-mm (0.50-caliber) two-stage light gas launcher
- 4.3-mm (0.17-caliber) two-stage light gas launcher
- 75-m^3 cylindrical target chamber, 3.0 m (10 ft) diameter by 9.1 m (30 ft) long
- 10-m^3 cylindrical target chamber, 1.5 m (5 ft) diameter by 5.5 m (18 ft) long
- Two underground instrumentation/control bunkers for remote test control
- WSTF-designed laser intervalometers for projectile velocity measurement
- Hypervelocity impact imaging capabilities:
  - 150-µV flash x-ray imaging
  - 450-µV flash x-ray imaging
  - color digital x-ray imaging system
  - ultra high-speed cameras
  - high-speed video/cinema
- 100 MHz data acquisition system to collect data from:
  - strain gauges
  - accelerometers
  - flash detectors
  - acoustic emission sensors
  - pressure transducers
  - thermocouples
  - laser intervelometer stations

CAPABILITIES

Facility personnel work closely with the customer and with other WSTF test support groups to design and safely implement test programs that best fit the customer's needs in the following areas:

- Simulating micrometeoroid and orbital-debris impacts on spacecraft materials and components
- Hypervelocity impact testing of toxic targets such as batteries and aerospace fluids
- Hypervelocity impact testing of energetic targets such as pressurized containers and aerospace fluids, with release energies up to 2.3 kg (5 lb) TNT equivalent
- Shot rates exceeding 450 impact tests per year

PAST PROJECTS

A few of the hypervelocity impact test programs completed at this facility are:

- Radiator Panel Test
- Avionic Cable Test Verification
- Nickel-Hydrogen Cell Test
- Advanced Thermal Materials Test
- Space Station Habitation Module
- Shield Development and Testing

- Assured Crew Return Vehicle Tile Test
- Energized P6 Cables
- Impact Penetration Sensor System/Wing Leading Edge

DESCRIPTION OF THE WSTF TWO-STAGE LIGHT GAS LAUNCHERS

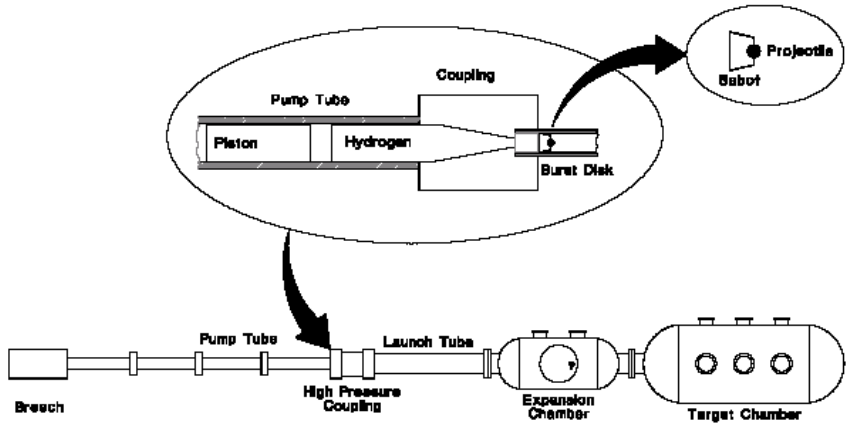
Two-stage light gas launchers typical of those at the WSTF Hazardous Hypervelocity Impact Facility have five major components (see launcher schematic below):

- Powder Breech
- High-Pressure Coupling
- Flight Range
- Pump Tube
- Launch Tube

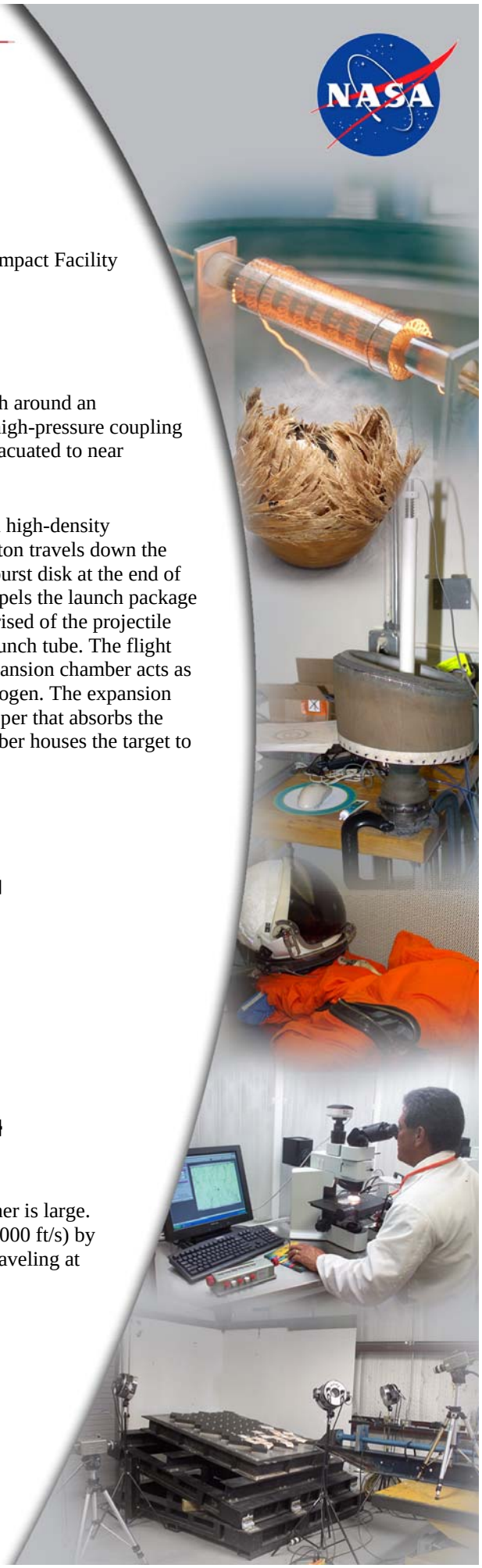
To prepare for firing the launcher, smokeless gun powder is tightly packed in the breech around an electrically controlled igniter that initiates burning of the powder. The pump tube and high-pressure coupling are charged with gaseous hydrogen and sealed. The launch tube and flight range are evacuated to near vacuum.

When the launcher is fired, expansion of the powder combustion products accelerates a high-density polyethylene piston down the pump tube toward the high-pressure coupling. As the piston travels down the pump tube, the gaseous hydrogen is compressed between the front of the piston and a burst disk at the end of the high-pressure coupling. When the burst disk opens, the high-pressure hydrogen propels the launch package down the evacuated launch tube and into the flight range. The launch package is comprised of the projectile and a plastic sabot, which positions and supports the projectile as it travels down the launch tube. The flight range is comprised of an expansion chamber and a downrange target chamber. The expansion chamber acts as an attenuating volume to buffer the target chamber from the rush of high-pressure hydrogen. The expansion chamber also houses instrumentation for measuring projectile velocity and a sabot stripper that absorbs the sabot while allowing the projectile to proceed into the target chamber. The target chamber houses the target to be impacted and instrumentation for collecting impact data.

WSTF Hazardous Hypervelocity 1-in. Light Gas Launcher



The amount of kinetic energy in a projectile launched from a two-stage light gas launcher is large. For example, a 12.7-mm (1/2-in.) diameter aluminum sphere accelerated to 7 km/s (23,000 ft/s) by a light gas launcher has the equivalent kinetic energy of a 5.5 kg (12 lb) bowling ball traveling at 164 m/s (367 mph).

CONTACT

Karen M. Rodriguez, NASA White Sands Test Facility, Project Manager
karen.m.rodriguez@nasa.gov, (575) 524-5723