LARGE-SCALE CRYOGEN SYSTEMS AND TEST FACILITIES

R. G. Johnson[1], J. P. Sass[1], and W. H. Hatfield[2]

[1]NASA, KT-E
Kennedy Space Center, FL, 32899, USA

[2]Sierra Lobo, Inc.
Kennedy Space Center, FL, 32899, USA

ABSTRACT

NASA has completed initial construction and verification testing of the Integrated Systems Test Facility (ISTF) Cryogenic Testbed. The ISTF is located at Complex 20 at Cape Canaveral Air Force Station, Florida. The remote and secure location is ideally suited for the following functions: (1) development testing of advanced cryogenic component technologies, (2) development testing of concepts and processes for entire ground support systems designed for servicing large launch vehicles, and (3) commercial-sector testing of cryogenic- and energy-related products and systems. The ISTF Cryogenic Testbed consists of modular fluid distribution piping and storage tanks for liquid oxygen/nitrogen (56,000 gal) and liquid hydrogen (66,000 gal). Storage tanks for liquid methane (41,000 gal) and Rocket Propellant 1 (37,000 gal) are also specified for the facility. A state-of-the-art blast proof test command and control center provides capability for remote operation, video surveillance, and data recording for all test areas.

KEYWORDS: Cryogen, liquid oxygen, liquid nitrogen, liquid hydrogen, RP-1, liquid methane, test facility

INTRODUCTION

As demonstrated by many aerospace programs, overall program costs are greatly affected by the application, or the lack, of comprehensive planning and advanced technology development during the formulation period. The more resources that are applied to planning and technology development during the formulation period, the better the chances are that the program will meet its goals within projected cost targets. It is the technology development arm of the up-front planning that is addressed by ISTF. The more we know about an advanced technology, the more we raise its individual technology readiness level (TRL) and the more successfully we will apply that technology to a new project. That increased knowledge also promotes our ability to assess a technology's integration readiness level (IRL), which indicates the relative maturity of a technology to the subsystem to which it applies and helps decrease the technology risk for the program manager.

APPLICATIONS

Much of the previous planning for the next-generation launch technologies has focused on the development of individual technologies that enable or enhance the next-generation launch architecture. An ISTF can demonstrate, within ever increasing maturity of integrated subsystems and systems, all future technologies required to support the Spaceport of the future while maintaining the ability to adapt quickly and efficiently to new technologies. Everyday goals of enhanced reliability, availability, supportability, adaptability, scalability, maintainability, and safety are to be improved and demonstrated in the ISTF. Operability, fast turnaround time, and low cost are the desired results for the next-generation launch architecture and will be the product of the ISTF at Kennedy Space Center.

The ISTF can be thought of as a prototype spaceport where Industry, Government, and Academia can work in partnership to improve the technology and safety of future space initiatives and commercial product lines. One goal of the ISTF is to provide a cost-effective, highly flexible, and capable test bed for a broad scope of activities ranging from individual component development and test to integration and testing of a wide variety of high-fidelity "iron birds" equipped with prototype systems that function as a complete flight system and can simulate various operational scenarios. The ISTF will also concentrate on proving new processing technologies that will reduce the operations cost of launch processing activities. The ISTF will provide a national proving ground for the development, integration, demonstration, testing, and qualification of spaceport and range technologies, alternate and renewable energy technologies. Commercial customers can capitalize on theses NASA assets and intellectual property to quickly and efficiently construct, test, and qualify their cryogenic and advanced energy-related products and systems for commercialization.

FACILITY ASSETS AND SPECIALIZED EQUIPMENT

The ISTF can accommodate a large variety of test activities. A listing of facility assets and specialized equipment can be found in TABLE 1.

CAPABILITY SUMMARY

The ISTF has a current cryogenic capacity of 56,000-gal LOX/LN2 with flows up to 2000 gpm at up to 350 psi for a duration of up to 6 hours. The procurement and permitting of a 66,000-gal LH2 tank, a 41,000-gal LCH4 tank, and a 37,000-gal RP-1 tank have all been completed.

TABLE 1. ISTF Assets and Specialized Equipment

Two 28,000-gal LOX/LN2 dewars with associated loading, distribution, test, and disposal hardware.
Two gaseous nitrogen tube banks totaling over 400,000 standard cubic feet (operated to 3,000 PSI) and associated distribution system.
Color video camera system with six fixed sites and four portable cameras. All cameras have pan, tilt, and zoom capability.
Operational intercom system, area paging, and remote fire alarm
Blockhouse containing a command and control system
Web-cam and video-streaming capabilities for video system
Fabrication building with machine shop
Horizontal Vehicle Processing facility
Two concrete test pads
Helium compressor
Liquid oxygen structural test article tank
41,000-gal Methane Dewar
66,000-gal LH2 Dewar
37,000-gal RP-1 Tanks
500L LHe Dewars

FACILITY HARDWARE

Photos of the ISTF facility and hardware available at the ISTF are shown in FIGURES 1-13.

Fig. 1 - Future Utilization of the ISTF Cryogenic Testbed


Fig. 2 – Present ISTF Configuration


Fig. 3 – ISTF LOX Skid


Fig. 4 – 1000 gpm LOX pump being readied for testing

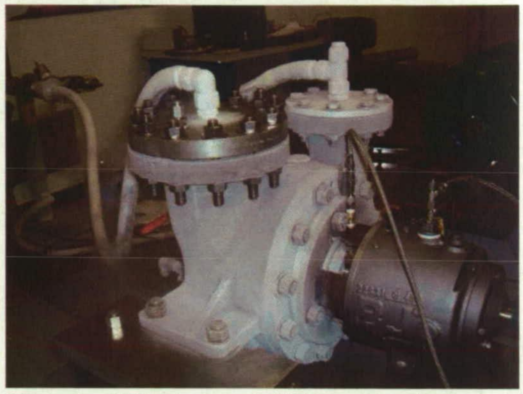
Fig. 5 - 1200 gpm LOX pump being readied for testing


Fig. 6 - Solar Concentrator being readied for testing of renewable energy technology

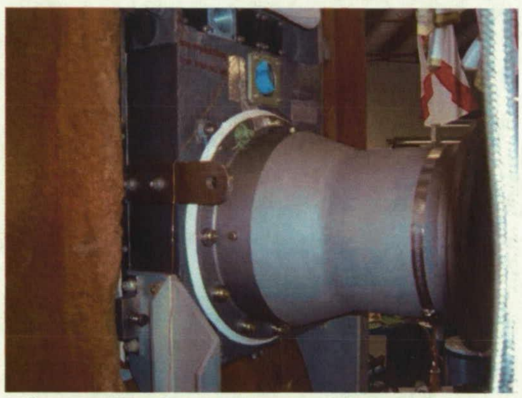
Fig. 7 - Hydrogen ground umbilical undergoing testing

Fig. 8 – ISTF Control Room

Fig. 9 – ISTF LOX tanker offload station

Fig. 10 – ISTF LOX Area during testing

Fig. 11 – SBIR LOX Pump Undergoing testing

Fig. 12 – ISTF Component test skid

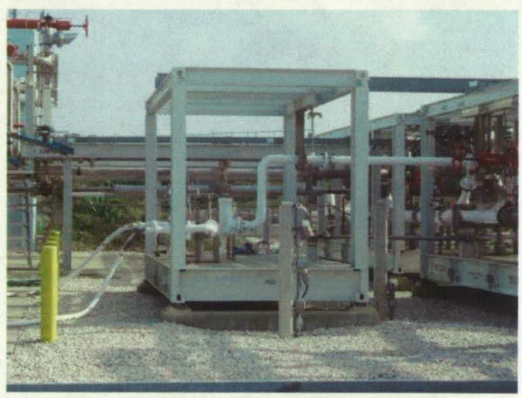

Fig. 13 – ISTF LOX offload skid