

# NASA Glenn Research Center Creek Road Complex— Cryogenic Testing Facilities

John M. Jurns<sup>a,\*</sup>, Maureen T. Kudlac<sup>b</sup>

<sup>a</sup> QSS Group Inc., 21000 Brookpark Road, Cleveland, OH 44135, USA

<sup>b</sup> NASA Glenn Research Center, 21000 Brookpark Road, Cleveland, OH 44135, USA

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## Abstract

Due to expansion at neighboring Cleveland Hopkins Airport, several NASA Glenn Research Center (GRC) facilities have been relocated to the Creek Road Complex. The complex consists of the Small Scale Multi-purpose Research Facility (SMiRF), Cryogenic Components Lab Cell 7 (CCL-7), and a shop building. The facilities have been updated and include state-of-the-art technology. SMiRF is a liquid hydrogen/liquid nitrogen (LH<sub>2</sub>/LN<sub>2</sub>) test facility used to conduct research in a 7400 L vacuum chamber. The chamber simulates space environment and launch vehicle ascent profile. SMiRF handles 5680 L of LH<sub>2</sub>. CCL is a LH<sub>2</sub>/LN<sub>2</sub> facility to perform small scale proof of concept tests for components and processes. It handles 1130 L of liquid hydrogen. Both facilities handle cryogenics at sub-atmospheric pressures.

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## 1. Introduction

In space, extremely low temperatures, pressures, and gravitational forces make storing and transferring propellants difficult. Since 1945, NASA's Glenn Research Center has been studying cryogenic propellants for use in space applications. Glenn's two cryogenic propellant research facilities, the Small Multipurpose Research Facility (SMiRF) [1] and the Cryogenic Components Lab Cell 7 (CCL-7), have long track records of safely handling liquid hydrogen (LH<sub>2</sub>) and liquid nitrogen (LN<sub>2</sub>). Due to expansion at neighboring Cleveland Hopkins Airport, these two research facilities have been relocated to the Creek Road Complex. The facilities, shown in Fig. 1, have been updated to include a state-of-the-art LabView<sup>®</sup> based data collection system, programmable logic controller (PLC)

facility controls that features Wonderware<sup>®</sup> HMI (human machine interface), and many new vacuum system and piping components. The facilities provide a low-cost venue for small scale tests to evaluate ways to manage cryogenic fluids, test components and subsystems, and test long-term cryogenic storage.

Propellant testing is safely conducted from a remote, state-of-the-art control room shown in Fig. 2. Blast walls and natural terrain isolate the test areas from each other as well as from public areas at the GRC main campus as recommended by the Department of Defense (DOD) for propellant test facilities. The facilities are equipped with combustible gas, low oxygen, and fire detectors.

Due to the flexible nature of the facility, tests with other propellants (liquid methane, liquid propane, liquid natural gas (LNG), etc.) can easily be accommodated. Although the facilities were originally designed for LH<sub>2</sub> testing, liquid oxygen (LO<sub>2</sub>) testing capacity has recently been added to augment the research capabilities.

For safety reasons, the gaseous hydrogen vent rate at the facility is limited to 0.11 kg/s, steady state for both

\* Corresponding author. Tel.: +1 216 977 7416; fax: +1 216 977 7545.  
E-mail address: [John.M.Jurns@nasa.gov](mailto:John.M.Jurns@nasa.gov) (J.M. Jurns).



Fig. 1. The Creek Road Complex. The SMiRF test building is shown on the right. The shop building is shown on the left. The roof of CCL-7 is visible behind the barrier walls at the left.



Fig. 3. Interconnect room. The interconnect room located within the test building at SMiRF is used for checkout of the control and data systems for SMiRF and CCL-7.



Fig. 2. Creek Road Complex Control Room. Controls and data acquisition for SMiRF are located to the left of the center console. CCL-7 data acquisition and control are to the right.

SMiRF and CCL-7. All vents stacks are grounded and discharge at 15 ft. above the roof peak.

### 1.1. SMiRF

SMiRF provides the ability to simulate space, high altitudes and launch pressure environments, to conduct calorimetric tests on prototype insulation systems and to safely handle gaseous and cryogenic propellants. The staff at the Creek Road Complex has an established track record of safely handling 5680 L LH<sub>2</sub> and 7570 L LN<sub>2</sub> simultaneously. LO<sub>2</sub> testing capabilities will enhance the facility in 2005. Gaseous hydrogen (GH<sub>2</sub>), gaseous oxygen (GO<sub>2</sub>), gaseous helium (GHe) and gaseous nitrogen (GN<sub>2</sub>) are also available on-site.

The test facility consists of an interconnect room (used for instrument and control terminations and check out), a shop area (for build up and bench work), and the test cell. The test cell has been designed to National Electric Code (NEC) Class 1, Division 2, Group B and is suitable for propellant testing. The interconnect room and shop area are pressurized during tests to meet NEC requirements. The interconnect room is shown in Fig. 3. An exterior view of the test facility is shown in Fig. 4.



A



B

Fig. 4. The SMiRF test building. The test area is at the rear of the building. The interconnect room is located at the front. A work area separates the test cell and interconnect room. A—Front view. B—Rear view.

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