Initial Project Description Report for Application of Fuel Cell Technology

Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

242nd Combat Communications Squadron, Geiger Field, WA

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Introduction

Background

The Construction Engineering Research Laboratory (CERL) is a division of the U.S Army Engineer Research and Development Center. CERL's mission is to assist the military in addressing existing needs, directing research, and developing products utilizing experimental technologies. The Residential Fuel Cell Program is intended to advance the development of PEM fuel cells and promote their penetration into the marketplace by providing long-term test data to Department of Defense personnel as well as fuel cell manufacturers.

The Avista Labs SR-72 modular Proton Exchange Membrane (PEM) fuel cell is a 3kW fuel cell utilizing Avista Labs' modular approach to PEM fuel cells. The SR-72 will be installed at the 242nd Combat Communications Squadron, Geiger Field, WA, an Air National Guard facility. The fuel cell will be installed in building 401. It will be utilized to power the bay lighting, large bay doors, and the base LAN switch. The lighting load will provide a constant load while the east bay door opener will provide a transient load. The LAN switch will demonstrate the potential of PEM fuel cells to provide highly reliable power to mission critical equipment. Figure 1 is a functional block diagram of the installation.

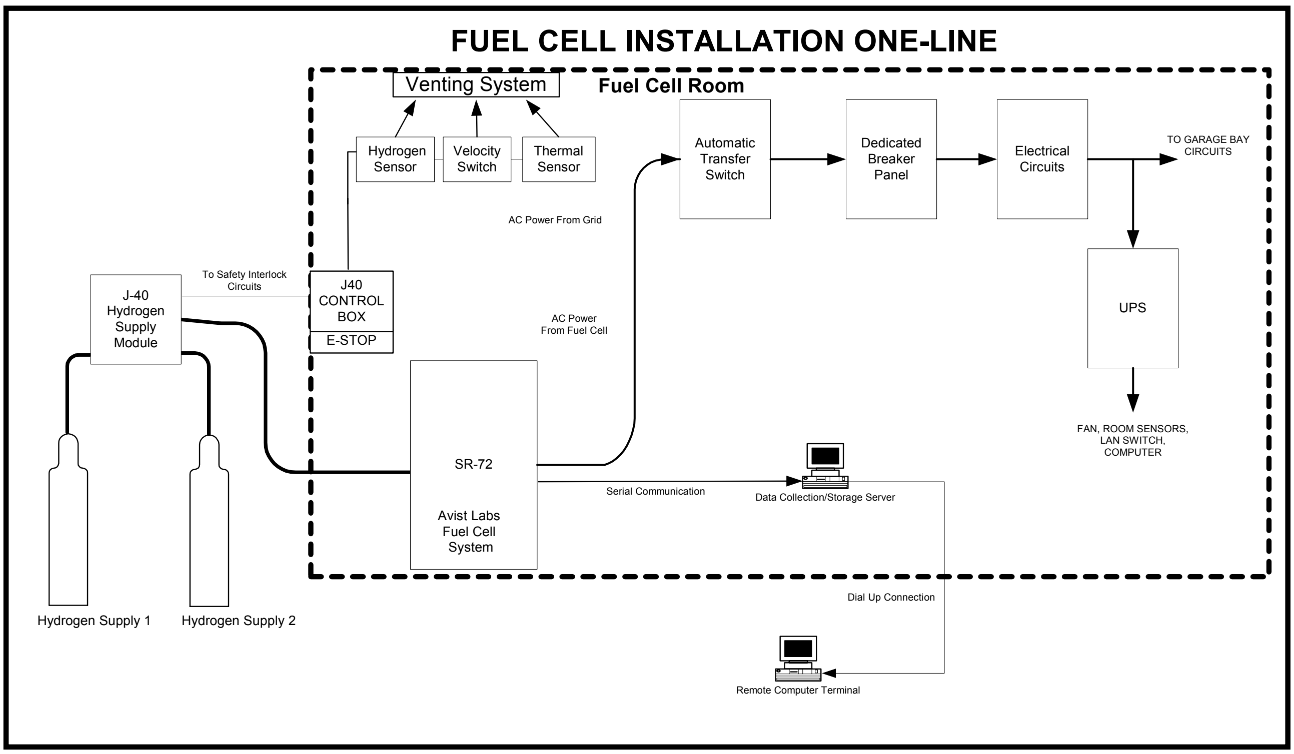

Figure 1

Objective

The objective of this project is to study the reliability, characteristics and cost of operating the SR-72 PEM fuel cell. Data to be collected will include total operating hours, kilowatt-hours of power produced, fuel consumption, maintenance logs, system availability, outages and operating temperature. Additionally, this project will serve to familiarize local approval agencies with PEM fuel cells, and further increase the efficiency of the approval process for installing PEM fuel cells. The test information will be utilized to obtain a better understanding of how fuel cells perform under load conditions similar to residential or small commercial applications. This data will be used to improve current fuel cell products and will also be incorporated into future fuel cell product designs.

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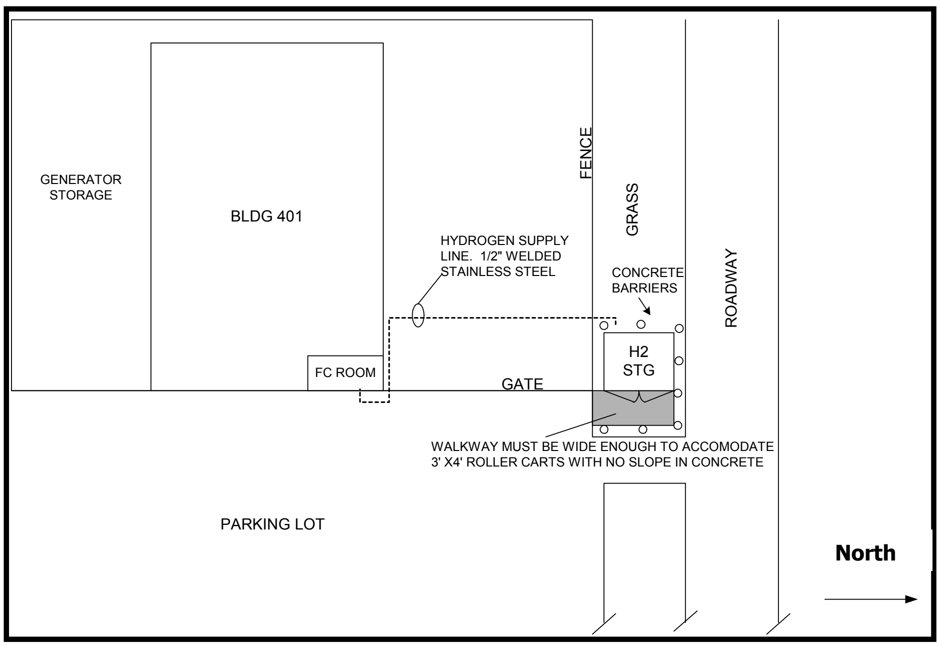
Site Information

The 242 Combat Communications Squadron is a division of the Washington State Air National Guard. The squadron is located in Spokane, Washington at the south end of Spokane International Airport. The fuel cell is to be located in Building 401 of the Power Production Group of the 242nd. Building 401 serves as a maintenance shop for Air National Guard equipment and generators. There are Air National Guard personnel on site 40 hours per week.

Site Layout

Figure 2 details the proposed location for the fuel cell and associated hydrogen fuel supply. The fuel cell will be located in Building 401, Figure 3. The site will require the installation of a hydrogen supply system for the fuel cell. The main storage location is to be located on the north side of Bldg. 401, Figure 4, at a distance of 50 feet from the building. It shall be installed on the north side of the fence to allow easy access.



Room layout

Figure 2

Figure 3

Figure 4

The fuel cell is to be installed inside Building 401. In Building 401 there is currently a storage closet that will serve as the fuel cell room. The fuel cell, a data-logging computer with associated sensors, power transfer equipment, and safety sensors will be installed in the room. The data-logging computer and sensors will be connected to the fuel cell for continuous monitoring and logging of data. The data-logging computer will have access to an analog phone line to allow for a periodic download of test data to an off-site server located at Avista Labs.

Room Preparation

The fuel cell room previously served as a storage closet, a telecom room, and a compressor room. This room will be renovated for the fuel cell installation. The compressor-Figure 6, the sink, and the air heater currently in the room have been relocated. An existing wall air exhaust fan will be replaced with an explosion-proof fan and associated ductwork. The room will be cleaned and painted. See Figure 5 and Figure 6 below.

Figure 5

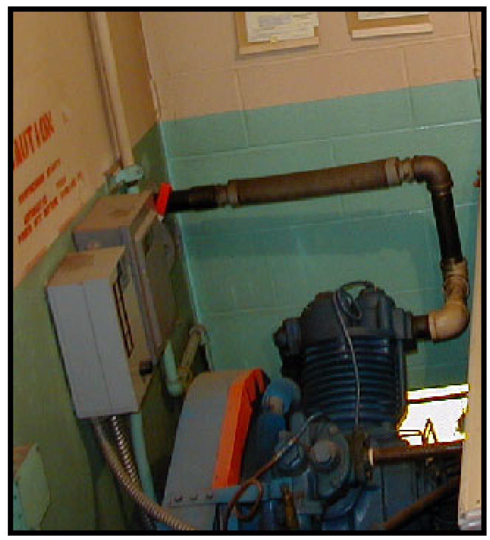


Figure 6

Figure 5

Hydrogen Supply System

Hydrogen Storage Shed

The hydrogen will be housed in an open-air storage shed with chain link walls and a tin roof. To limit access to the hydrogen, the shed doors will be locked. The storage shed will be erected on a concrete pad. See Figure 7.

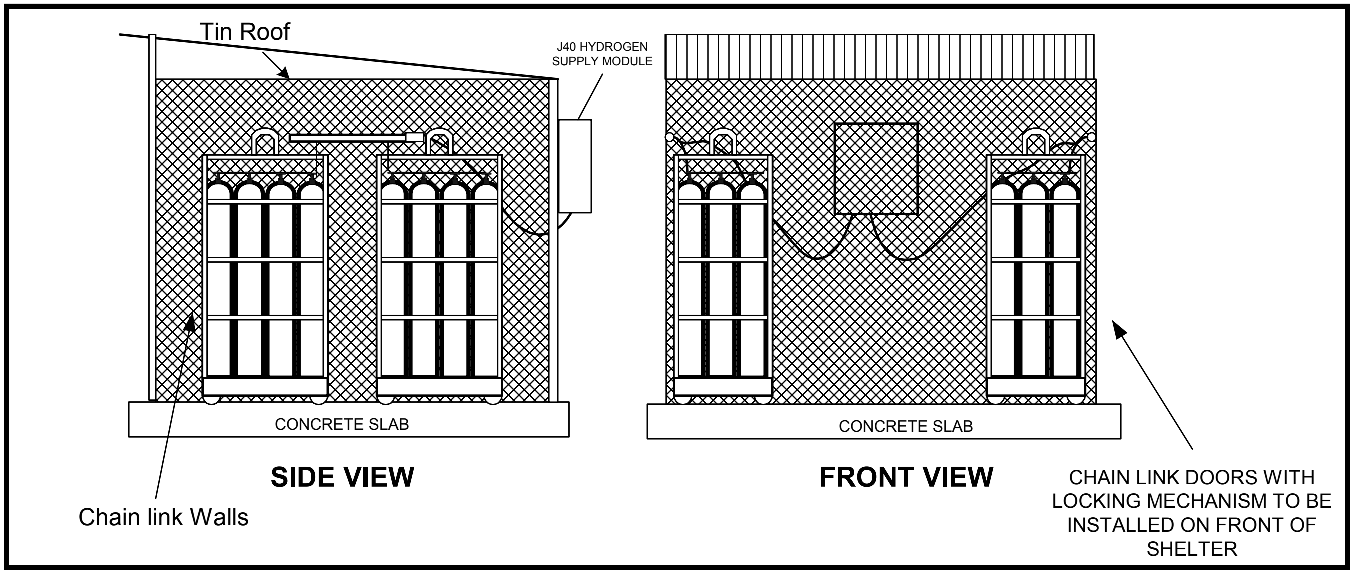


Figure 7

Hydrogen System Piping

Two hydrogen supplies will be connected to an Avista Labs Inc. J-40 hydrogen supply module. The output of the J-40 will be connected to ½″ stainless steel piping. The piping will connect to a fireman's shutoff valve prior to entering Building 401. Inside Bldg. 401 a manual shutoff valve, low pressure regulator, hydrogen gas flow meter and low pressure transducer will be installed in series before connecting to the SR-72 fuel cell. The bleed line from the SR-72 will be vented to the outside of the building using 3/16″ stainless steel piping. See Figure 8.

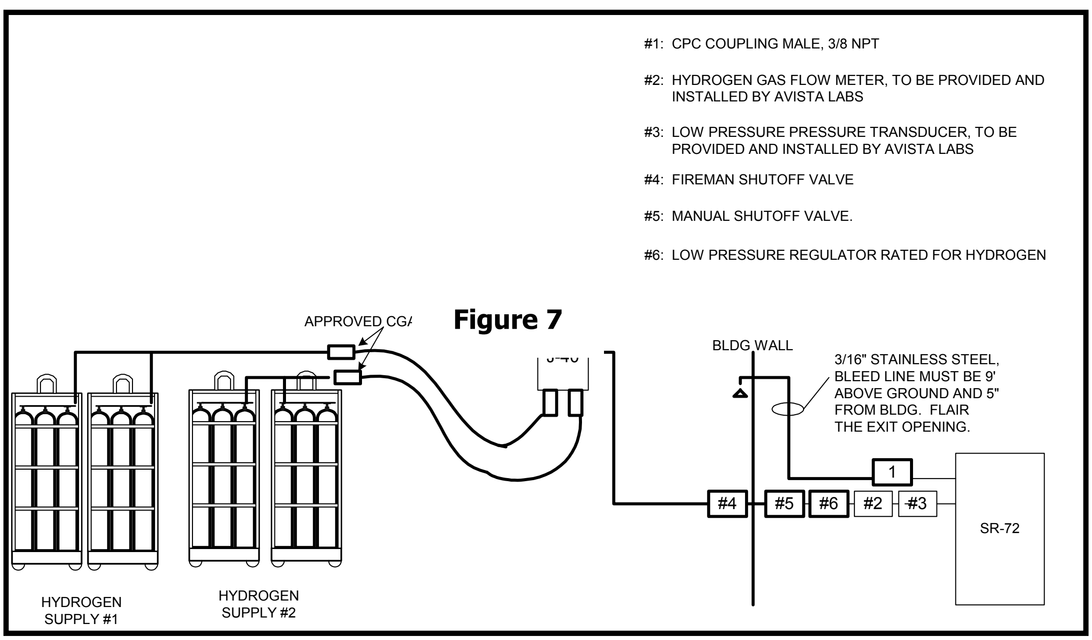


Figure 8

Hydrogen Supply Safety Circuit

The hydrogen supply system will utilize the Avista Labs J-40 hydrogen supply system. This system consists of a control panel to be located in the fuel cell room and a valve assembly panel located at the hydrogen supply shelter. The J-40 valve assembly panel has 2 normally closed solenoids that when de-energized will close. Any alarm condition will de-energize the J-40 and therefore, the 2 hydrogen supply solenoids. The conditions that will trigger an alarm condition are a high heat alarm, the presence of hydrogen in the room air, or a loss of airflow in the air exhaust fan for the room.

To re-activate hydrogen flow to the fuel cell, the alarm condition must have cleared, and an operator must manually re-energize the system. Additionally, the hydrogen supply line utilizes a velocity fuse to limit the flow of hydrogen to 2 cubic feet/minute. The safety circuit shown in Figure 9 details how the alarms are to be connected to the power circuit of the J-40 hydrogen supply system.

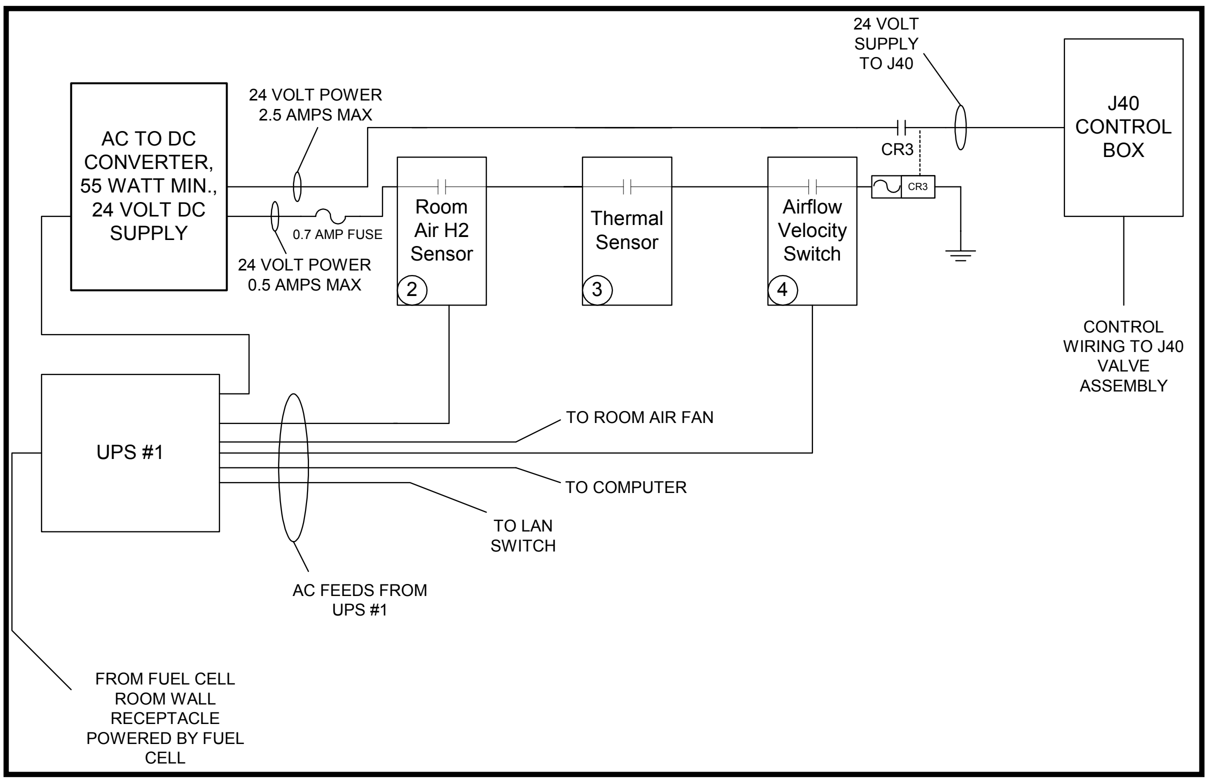


Figure 9

Electrical

The fuel cell will be connected to a 50 Amp disconnect switch and 120 VAC single-phase utility meter. From there it will be connected to an automatic transfer switch. The auxiliary power inlet of the automatic transfer switch will be connected to the grid from the existing power Panel A, Figure 11. The output of the automatic transfer switch will be connected to a 50 Amp circuit breaker panel containing the circuits for the bay lights, the east bay overhead door and the fuel cell room receptacles. The electrical schematic is detailed in Figure 10.

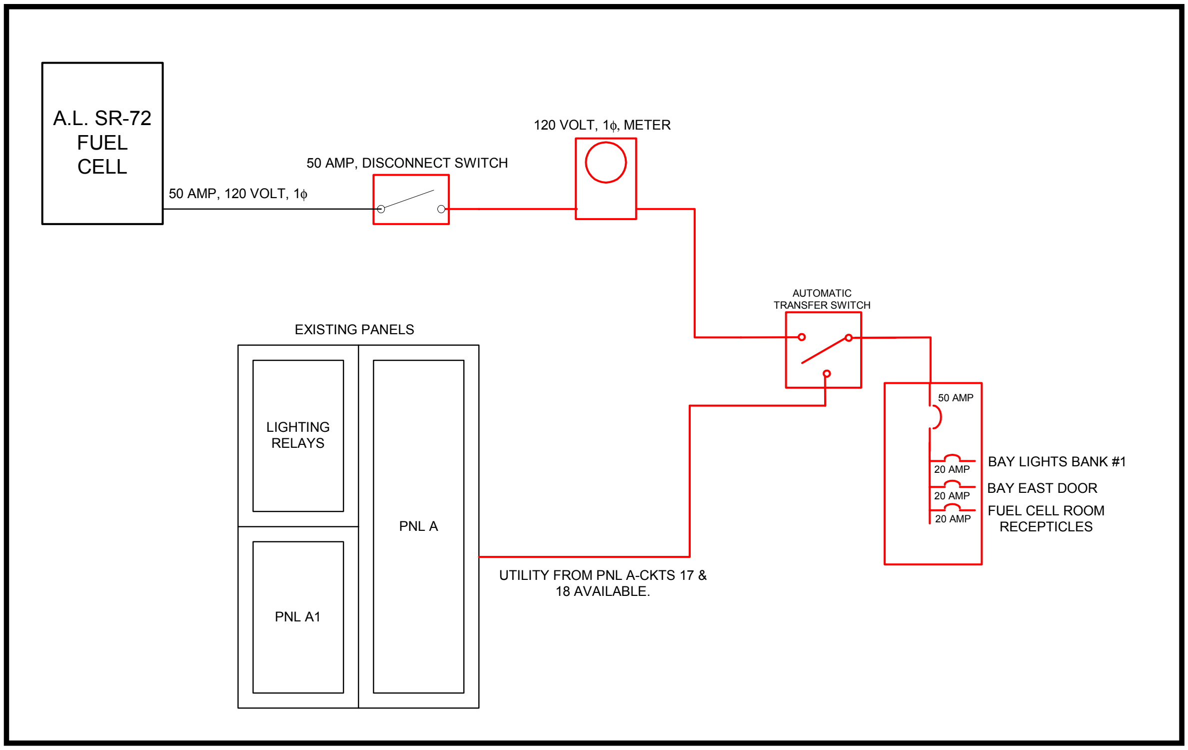


Figure 10

Figure 11

Data Acquisition

The data acquisition system is detailed in Figure 12. The data-logging computer will house the Data Acquisition unit (DAQ) which will be connected to various sensors. The data-logging computer will log total operating hours of the fuel cell, kilowatt hours produced, fuel consumption, maintenance logs, fuel cell availability, outages and operating temperature. Additionally, it will log temperature and humidity at the hydrogen storage facility, as well as pressure of the two hydrogen supplies to ensure a continuous supply is maintained. The data-logging computer will perform a periodic download of data to a dedicated server located at Avista Labs Inc.

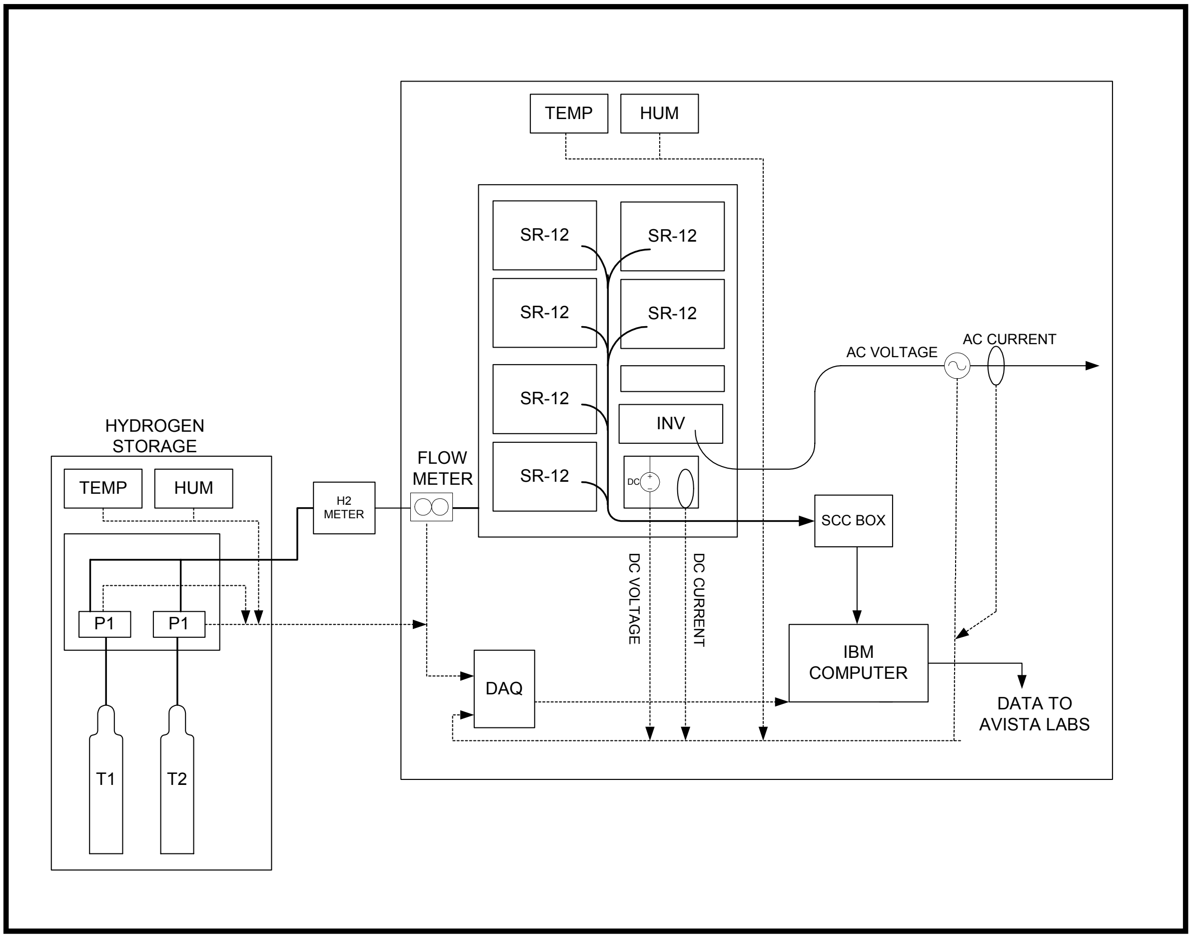


Figure 12

Economic Analysis

The current cost of local grid power is $0.05/kWh. The calculated cost of power generated by the SR-72 fuel cell is $2.55/kWh based upon the current cost of hydrogen. However, the primary purpose of this study is to obtain data from the fuel cell under residential or small commercial load applications.

It is widely acknowledged throughout the industry that the high cost of hydrogen is attributable to a lack of hydrogen infrastructure. This both restricts the supply and distribution of the fuel. Although the cost of operating a hydrogen fuel cell currently outweighs the cost of grid-based power, the market is willing to pay a premium price for reliable, clean, point of use power. When serving as backup to grid power, there is a powerful economic case in favor of fuel cells versus batteries. The development of a hydrogen industry and infrastructure and mass production of fuel cells offers economic stimulus to the country in the form of job creation and ongoing commerce. These two factors alone, in addition to social and environmental benefits, justify the costs of the hydrogen fuel to be used in the project.

The information gained during this study will be used to increase the efficiency of the fuel cell and reduce the overall cost of power generation. Although the cost of producing electricity with the fuel cell is currently higher than grid power, the future costs will likely decrease due to increased fuel cell efficiency and decreased hydrogen cost.