Fuel cell technology: a promising alternative for extended back-up power run time for Telecommunication Sites

Infobatt2007 – Toronto
October 22-23

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Who is MTS Allstream?

- One of Canada's oldest telecommunications companies with a proud history of many innovation firsts
- More than 6,000 dedicated employees across Canada
- A world-class IP multi-protocol label switching network infrastructure that spans the country
- Offering a comprehensive portfolio of unique IP-based communications solutions including connectivity, managed services and professional services to help the business customers from coast to coast compete more effectively
- Serving small business clients nationally and residential customers in Manitoba with a full suite of high-speed Internet and data, next generation wireless, digital television, wire-line voice security and alarm monitoring services

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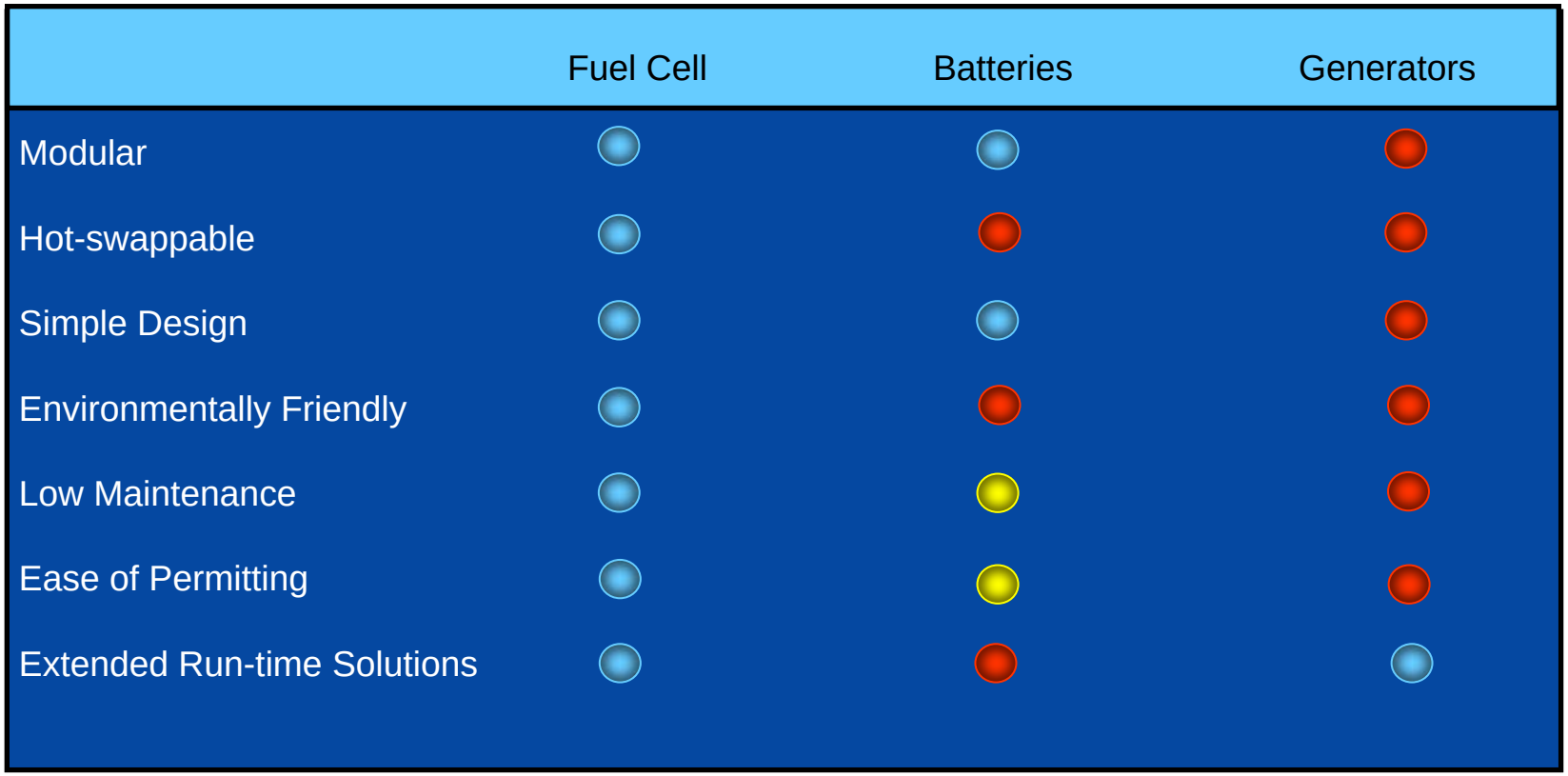
Industry Overview

- Today's networks demand long duration ,highly reliable and cost effective back-up power solutions
- Traditional solutions for back-up power are batteries (VRLA, flooded, NiCd,) and standby generators (generator sets)
- Fuel cell technology is an emerging solution for back-up power to replace or supplement the traditional solutions
- Unlike a battery a fuel cell does not run flat or require recharging and much like a generator it will produce electricity and heat as long as fuel is supplied.
- Unlike a diesel generator no combustion take place and therefore no harmful pollutants are produced resulting in the supply of "green" energy.

Fuel Cell vs. Incumbent Technologies



Industry Overview

- Fuel Cells 2000 reported that there are more than 2000 fuel cell installations all over the world. Most of the installations are test and demonstration sites. There are more than 40 fuel cell companies that compete for standby power market.
- Better known fuel cell companies are Plug Power, Relion, Ballard, Hydrogenics and Intelligent Energy.
- Most of the fuel technology vendors are marketing the fuel cells as a replacement of VRLA batteries or of standby generators
- MTS Allstream is taking an innovative approach of selecting fuel cell technology to rather supplement and extend the existing traditional back-up power.

Fuel Cell Technology

- MTS Allstream is actively researching new technologies that can support the company in improving its performance in achieving its targets without jeopardizing reliability and quality of supply to the customer.
- The many benefits offered by fuel cell technology prompted MTS Allstream to investigate the feasibility of this technology in the telecommunication environment.
- Over the last decade various companies have entered the fuel cell market and a great deal of R&D has been conducted to make the technology more reliable ,affordable and safe for use in applications
- A fuel cell is an electrochemical energy conversion device that converts the chemicals hydrogen and oxygen into water,

Fuel Cell Technology

and in the process in the system ,the catalyst (usually platinum) on the surface of the proton exchange membrane splits hydrogen gas molecules into protons and electrons.

- The protons pass through membrane and the electrons flow through electrical circuit creating the source of DC electricity
- The electrons and protons produces electricity and heat.
- The fuel cell construction consists of a fuel electrode (anode) and an oxidant electrode (cathode) separated by an ion-conducting membrane (the electrolyte).
- As shown on Figure 1 ,when hydrogen gas is introduced react with oxygen in the air on the cathode side of the fuel cell and forms water.

Fuel Cell Technology

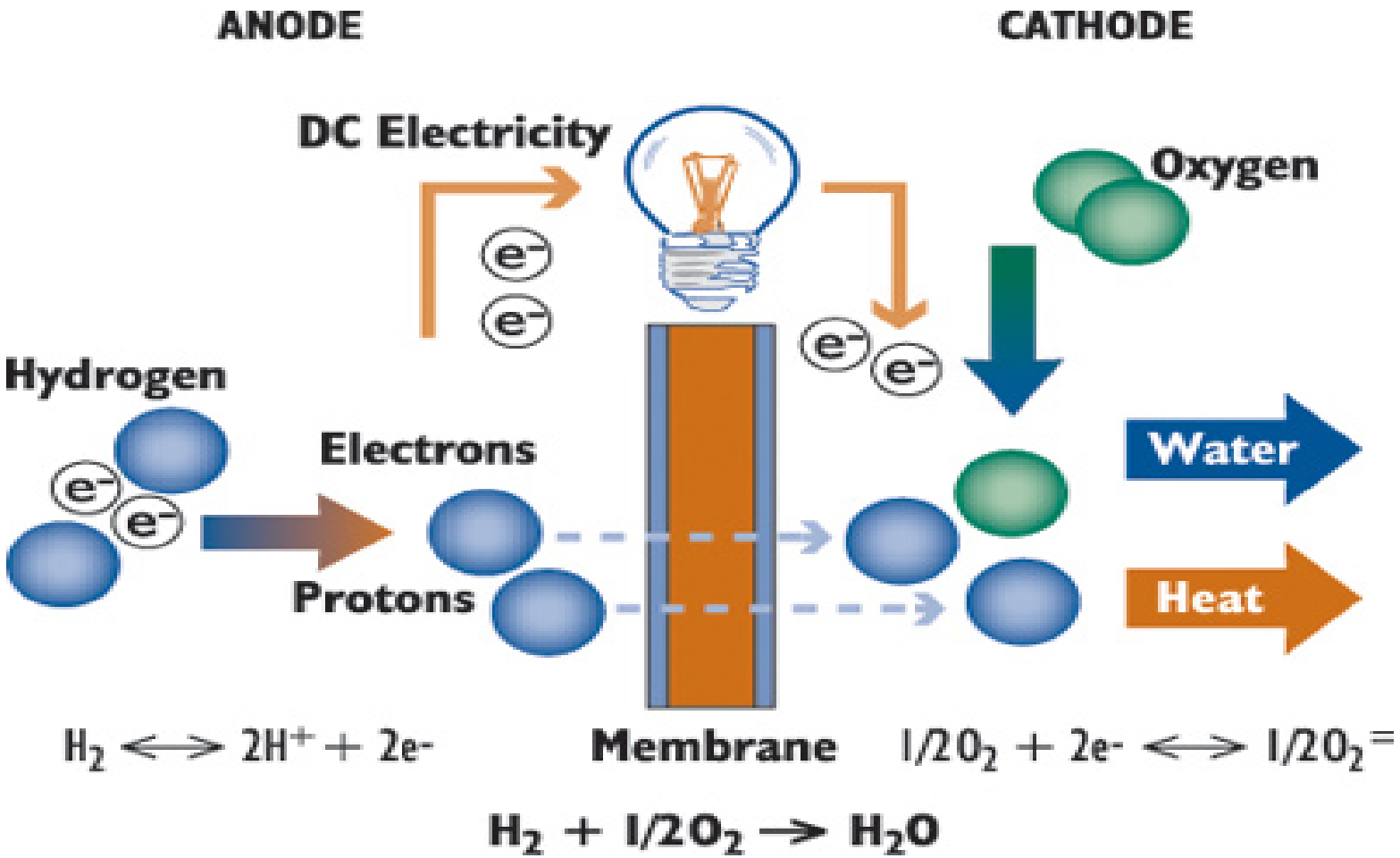


Figure 1 - PEM Fuel Cell: How It Works

Fuel Cell Technology

- Fuel cells are classified by their electrolyte material
- The five major types of fuel cells include:
- Alkaline Fuel Cell (AFC)
- Proton Exchange Membrane (PEM)
- Phosphoric-Acid Fuel Cell (PAFC)
- Molten Carbonate Fuel Cell (MCFC)
- Solid-Oxide Fuel Cell (SOFC)

- MTS Allstream has selected PEM for following reasons:

- Technological maturity
- Local technical support offered
- Simplicity- requires hydrogen, oxygen from the air
- Low operating temperature 60-100C
- Rapid start-up and good load capability

Prototype Project Criteria

- **The Program Objective** is to prove the viability of the Hydrogen Fuel cell housed outdoor to extend back-up power of pre-existing VRLA batteries to a Telecommunications Remote Office for a period of six month

- The design must provide extended back-up power run time to a total load of 11 amps in the event of loss of AC over the operating temperature range in a control environment of -40C – +46 C
- **Site selection** criteria was to select a site representative for remote sites with a nominal load of 11 amps at -48V and geographically easy access for the three main participants namely MTSAllstream, Emerson Network Power and Relion

Prototype Project Criteria

- The selected site has a -48V 60amps DC Power Plant with VRLA batteries, (6) years old, 330 AH with 30 hours reserve time
- **The objective** of installing fuel cells is two fold :
- The first 2-3 years extend battery reserve time by 150 hours until batteries health is maintained to their full rating
- The second objective is to postpone replacement of VRLA batteries by at least 2-3 years once their reserve time is deteriorating

Prototype Project Criteria

- **High level of reliability** – very important because the energy storage device needs to be able to deliver power when grid fails and battery voltage drops to the fuel cell set start-up voltage
- **High life expectancy** – ideally should last beyond its expected design life which reduces refurbishment costs
- **Cost of ownership –** lifecycle costs should at least compare with existing employed technologies

- **Installation,commissioning and maintenance** – should not require highly skilled individuals and use of sophisticated test/maintenance equipment. Should be quick and easy with minimal maintenance

Prototype Project Criteria

- **Robust design** – both physical (Withstand minor impacts due to handling and transportation) and technical (resilient against environmental influences like ambient temperature and ripple components from rectifier equipment).
- **Operational performance** – deliver long duration low level discharges with good load following capabilities
- **Interface with energy station's pre-existing devices** : It is fundamental that fuel cell system to be compatible with MTS Allstream standards and that connection with other devices (rectifiers, battery banks) is simple to implement.
- **Safe to operate –** well being of the personnel, equipment and the environment during operation of equipment

Prototype Project Criteria

- The fuel cell is required to meet all test criteria required by the telecommunication industry
- Therefore all appropriate aspects of MTS Allstream standards will have to be considered
- AC electrical approval will be achieved through site inspection as performed by Electrical Safety Authority or CSA
- The following standards will be taken into considerations:
- NFPA 853 (National Fire Protection Association) (Stationary Fuel Cell)
- NFPA 855 (Storage of Fuel Cell) Canadian Building Codes and Local Fire Codes
- TSSA (Technical Standards and Safety Authority)
- MTS Allstream – DC Power Plants standards

Field Trial Prototype

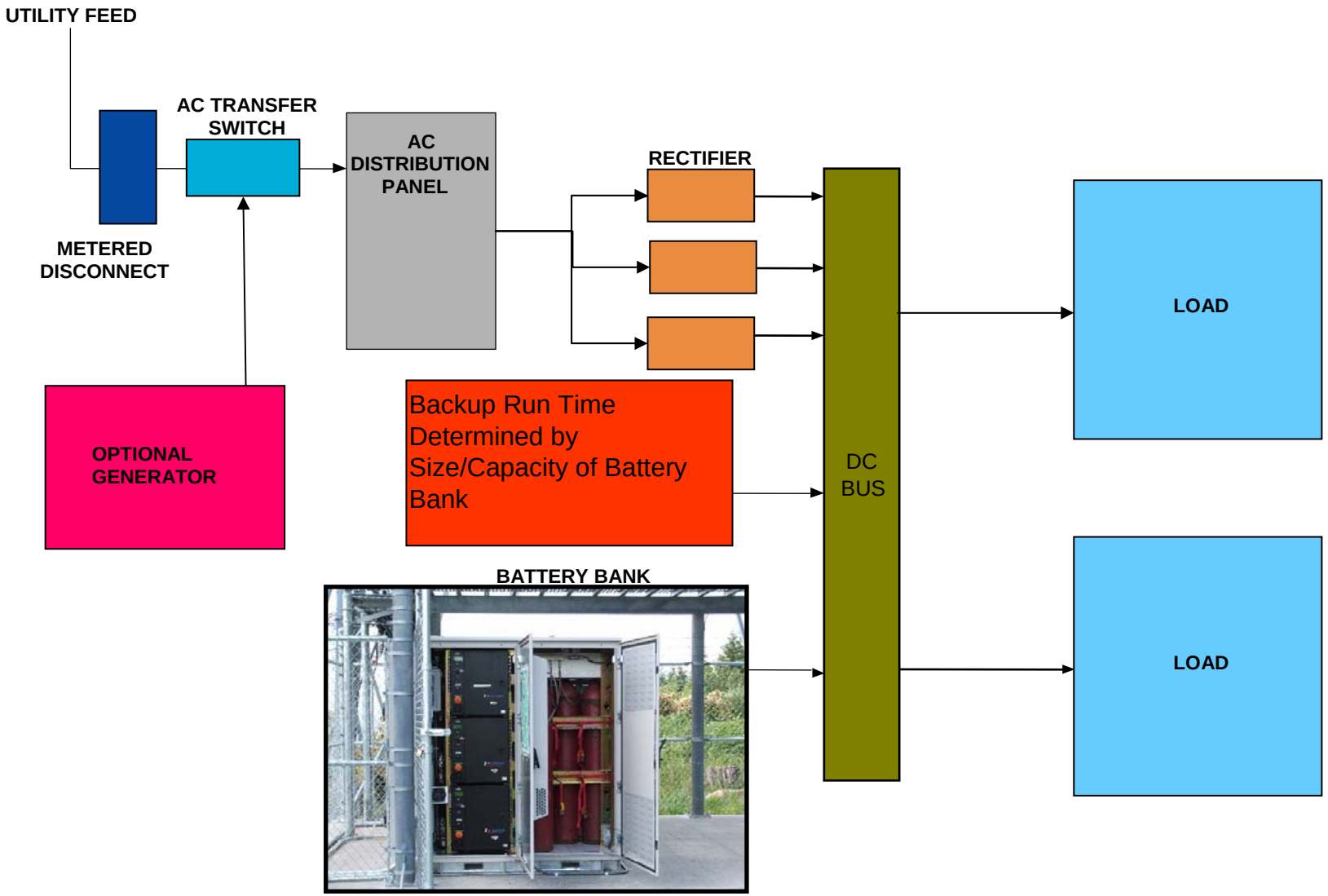
- MTS Allstream is in the process of selecting for evaluation RELION T- 1000 Fuel cell system. Emerson Network Power is RELION's Primary distributor in Canada
- Emerson Network Power will provide overall EF&I
- Site visits by the three parties have been completed and one (1) site has been selected
- Relion T-1000 is a modular 1,2KW PEM hydrogen fuel cell utilizing RELION's patented hot-swappable Modular Cartridge Technology. –Figure 2
- Provides parallel redundancy and very high reliability, simple,air-cooled, self –hydrating solution with very few moving parts

Field Trial Prototype

- Relion's modular cartridge approach normally operates with six cartridges connected to a common BUS. Each cartridge supplies a nominal power of 200W.
- In case a cartridge is damaged, the replacement procedure can be performed in a few seconds while the fuel cell continues to provide power to the load.

- Figure 2 –Relion's T-1000 hydrogen fuel cell

Fig 3-Typical Back-up Power



Field Trial Prototype

- Advantages of the RELION T -1000 system
- **Modular system –** allows to purchase the power capacity needed and do not pay for unused capacity High reliability due to internal modular design meets fundamental specification
- **High redundancy** :all the auxiliary components of the system (management cards,air blowers) are redundant in the unit.
- **Air cooled system –** the simplicity of the design eliminates the need for water pumps and other cooling devices
- LAN and Remote monitoring – maintenance and control procedures are reduced with an Internet remote connection
- The fuel cell systems will be connected in parallel with the pre-existing VRLA batteries directly on the rectifier bus bar.

Field Trial Prototype

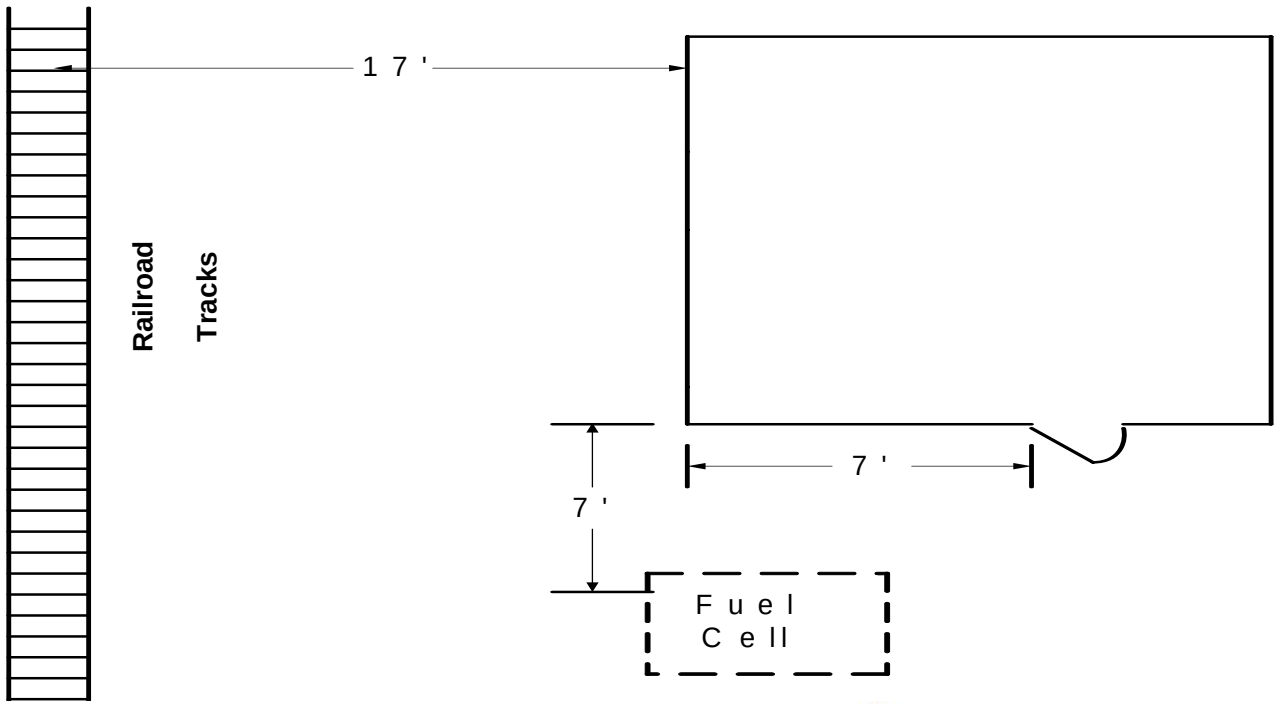
- One unit Relion T-1000 will be installed
- The fuel cell system will be configured for startup on low back-up battery voltage due to loss of utility power or rectifier failures.
- The T-1000 allows to configure fuel cell start at different voltages (46.2,5,7 to 52.2,5,7DC)
- If the battery voltage drops below this fixed value, the fuel cells are turned on and continue to supply energy until the float voltage is reached. If the float voltage is reached and stable for twenty minutes , the fuel cells shutdown and return to standard operation
- For this project the low voltage start will be set at 48VDC

Field Trial Prototype

- The Relion unit will be installed on an outdoor enclosure.
- The Outdoor Enclosure is designed for installation on a stand alone concrete pad with connection to existing indoor DC bus
- The enclosure has two separate compartments :
- The main compartment houses the T-1000 fuel cell and 1-U rack-mounted signal & control box for signal aggregation and I/O connectivity.
- The hydrogen compartment houses the (6) hydrogen cylinders and hydrogen delivery system: high pressure feed hoses, check valves, high pressure manifold,2ea single stage regulators, etc per Site Details and Fig 4

Site Details

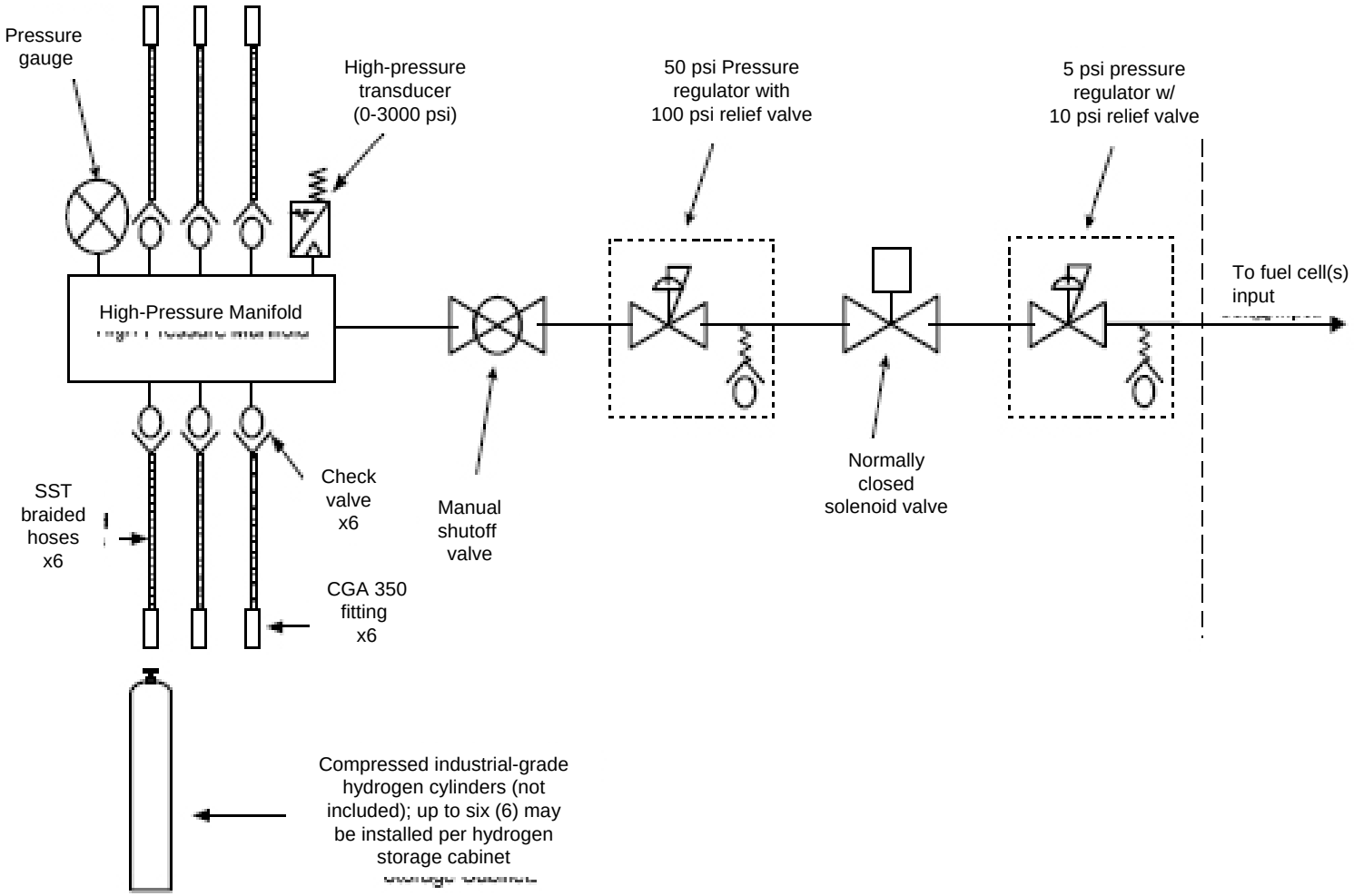
Site Name:	**Bradley**
Application	**Fiber Optic Re-generation**
DC Voltage	**48 VDC**
DC Amperage (max)	**11.5 amps**
ReliOn Recommendation	**(1) T1 Extended Run**
ReliOn Capacity @ nom 48 VDC	**25 amps**
Estimated Run Time @ avg. load	**75.5 hours with 6 cylinders**



Site Details - Continue

Fuel Cell Here

Fig 4 - Hydrogen Delivery System



Field Trial Prototype

- The cabinet doors are louvered and promote passive ventilation which prevents build-up of hydrogen gas should a minor leak occur due to the high-pressure hydrogen fuel delivery system.
- The T-1000 fuel cell has been certified to ANSI/CSA FC1-2004 Stationary Fuel Cell Power systems by CSA . Additionally the Outdoor Enclosure system has completed NEBS (Network Equipment Building Standards, Level 3 compliance testing (brush fire,seismic zone IV,gunfire,EMI/RFI/salt fog, etc)
- The system will be connected to MTSAllstream central alarm network as fuel cell system.
- The alarms will be “System ON” , Major Alarm , Low Fuel and End of Fuel

Conclusions

- MTS Allstream is taking an innovative approach of selecting fuel cell technology to extend the site back-up power run time rather than replace pre- existing batteries or generators
- This field trial will be considered successful if will prove fuel cell reliability – when start-up is requested all fuel cells performed 100% as designed and interacted with pre-existing batteries and rectifiers to extend back-up power run time.
- This approach should be considered for a transition period of 2-3 years until technology and fuel cell financial benefits are proven
- Pilot site test and evaluation results should provide direction of future developments

Future Developments

- In case the field trials are positive we will extend the project to other sites in order to gain additional field experience.

- Sites to be considered in the future will be for fuel cell installation housed within indoor and outdoor enclosures

- Other possible sites to be considered are small Data centers without generators

Questions

Questions ???????

The End!