VII.13 Demonstration of SOFC Generator Fueled by Propane to Provide Electrical Power to Real World Applications

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Objectives

- Develop a 1,000-W Cart-Based Portable Generator (fueled by propane) for powering multi-camera sites and in-field auxiliaries
- Develop a 250-W Man-Portable Generator (fueled by propane) for powering single camera sites
- Deliver two 1,000-W and two 250-W Generators
- Demonstrate the unit at several NASCAR races

Relevance to the American Recovery and Reinvestment Act (ARRA) of 2009 Goals:

- This project provided job growth as well as reinforce high-tech engineering and technician jobs by expanding the product line of remote power solid oxide fuel cell (SOFC) units.
- This project helps the DOE meet its goals of emission reduction and widespread adoption of fuel cells as a viable commercial remote power product.
- This project is funding development activities that will lead to near-term commercialization of fuel cell technology in multiple applications where internal combustion engine-based generators have significant drawbacks.

Technical Barriers

This project addresses the following technical barriers for SOFCs outlined by the DOE:

- Specific power and energy density
- Transportability
- Use of commercially available fuel
- Improved ruggedness and shock and vibration capabilities

Technical Targets and Milestones

The following were the technical targets for the project:

- Demonstrate propane consumption at or below 2 lbs/10 hr operational period.
- Allow powering of television cameras for entire 4-day race period.
- Demonstrate near 50% reduction in volume and weight of present SOFC remote power product.

Accomplishments

During this abbreviated project the following accomplishments were achieved:

- A remote power 250-W (RP250) unit was designed, built, and tested with nearly 50% reduction in weight and volume.
- Two RP1000 and RP250 units were delivered to NASCAR for powering of television cameras.
- Operation of over 4 days on a single 20-lb propane bottle was demonstrated.
- Powering of multiple broadcast cameras was demonstrated with no resulting delays or interference in broadcast.

INTRODUCTION

Small gasoline generators tend to be noisy and low in efficiency with excessive emissions. In addition, they tend to have a low reliability which limits their effectiveness in powering the latest generation of high-tech equipment. A perfect example of such is the powering of broadcast cameras for NASCAR events held throughout the year. Presently, NASCAR has 38 races in a season where each race can require 30 cameras for broadcast which are presently powered by Honda gasoline generators. These generators are very inefficient and require frequent refueling throughout a race event making them both an environmental and safety risk.

Acumentrics Corporation, after years of support from the DOE, has been fielding remote power generators that are highly efficient and provide high power quality to power just such equipment. The challenge for the Acumentrics product is it normally is a stationary product and operates its entire life in one location. Likewise, the unit is somewhat large and heavy for a continual redeployment type of operation. This project demonstrated the advancements to overcome these two barriers and allow this product to now be deployed for more mobile applications.

APPROACH

This project was focused on size reduction and ruggedization of the existing Acumentrics remote power products which have been substantially supported by DOE over the years. The remote RP250 unit was put through the most aggressive redesign with a goal of nearly 50% in volume and weight. All components from balance of plant, electronics, and enclosure to fuel cell stack had to be considered. The design also had to be accommodating for a remote propane tank to allow for fueling at any NASCAR site as well as provide multiple electrical output connections and configurations.

The RP1000 unit had to be modified for trailer mount capability as well as onboard fuel storage. The unit required electrical changes as well as integration of a rugged uninterruptable power source to assure power to critical camera equipment was never compromised. Ease of onboard fuel change and refueling was also needed to be considered in the design as well as ease of transportability from one NASCAR race to another.

RESULTS

To achieve the desired replacement of gasoline generators for sensitive camera equipment at NASCAR events, the Acumentrics RP family of units needed to be redesigned and modified for size, weight, and ruggedness. This objective was achieved in slightly less than 12 months time with high satisfaction from NASCAR personnel. Figure 1 shows the resulting size of the new RP250 unit next to the older RP250 unit as well as the RP1000 unit.

Table 1 shows the resulting size and weight of each of the resulting units. As one can see, the RP250 lite (RP250L) is now 47% reduced in volume than its predecessor as well as 58% lighter. This reduction from 300 lbs to 127 lbs now allows it to fall into the two-man portable range as opposed to requiring some form of material handling equipment.

What is also worth noting is the comparison of size and weight of the RP250L to the incumbent unit utilized at races, the Honda 3000. The Honda 3000 has a volume of 17.5” x 21.9” x 25.8” or 5.72 cubic feet while the RP250L comes in at 20” x 15.5” x 32” or 5.74 cubic feet and therefore taking up the same volume. The weight of the Honda is 134 lbs while the RP250L comes in at 127 lbs or 5% less.

FIGURE 1. Size Reduction of the RP250L

TABLE 1. Size and Weight of RP Units

Model	L (in)	W (in)	H (in)	Wt(lbs)
RP250L	32	20	15.5	127
RP250	39	22	22	300
RP1000	39	28	25	350

Upon completion of the design and internal testing, the unit next needed to be demonstrated at a NASCAR event and proven to adequately power broadcast cameras. This was first demonstrated at a NASCAR event in January called the Rolex24 which is a 24 hour non-stop race. Figure 2 shows the unit in operation with a standard propane tank found on similar propane appliances. This unit powered the broadcast camera as well as the articulating arm at the end of the boom crane as well as an LCD display for the video operator. All associated in-rush currents as well as other transients were handled with ease and the operator never knew there was a different power source. The NASCAR operators were also impressed that when the noise died down on the race track they could not hear the generator and only knew they still had power by looking at their monitor screen.

After successfully demonstrated the capabilities of the unit at this race, the units were returned to Acumentrics and some minor modifications were made for mobility and transportability based on NASCAR recommendations. The units were then redeployed for what NASCAR calls their “speed weeks” which culminated in the racing of the Daytona 500 in late February. Figures 3 and 4 show the units in operation powering a camera high above the race track on the infield. During this two-week period all units deployed ran flawlessly with no interruptions in broadcasts.

FIGURE 2. Powering a Broadcast Camera at the Rolex24

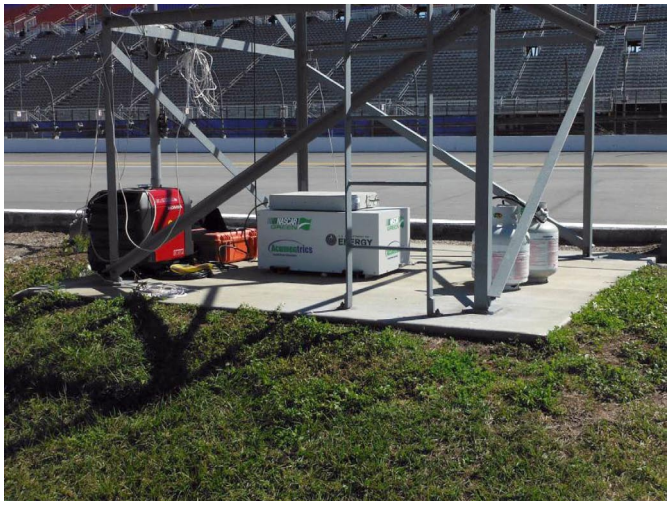

FIGURE 3. Daytona 500 Camera Power

Performance of these units was also exceptional and well above that achieved by the standard Honda 3000. During normal race events, staff are required to refuel each generator after every 4-5 hours during the day. Over a 4-day race period this can result in 8-10 total refuel calls on a fleet of up to 30 generators. These generators also consume over 20 gallons of gasoline each during that four day event. This results in a high price as well as safety concern considering the transport of gasoline in close proximity to spectators.

The RP250L gave NASCAR a huge increase in energy efficiency and emission reduction as well as reduced need for labor support. Each of these units demonstrated the capability to operate over 4-day race periods on a single 20-lb propane bottle normally seen on gas grills. This also allowed for fueling only at the start of the broadcast period and removal after the 4-day event. Considering just fuel costs, a fleet of

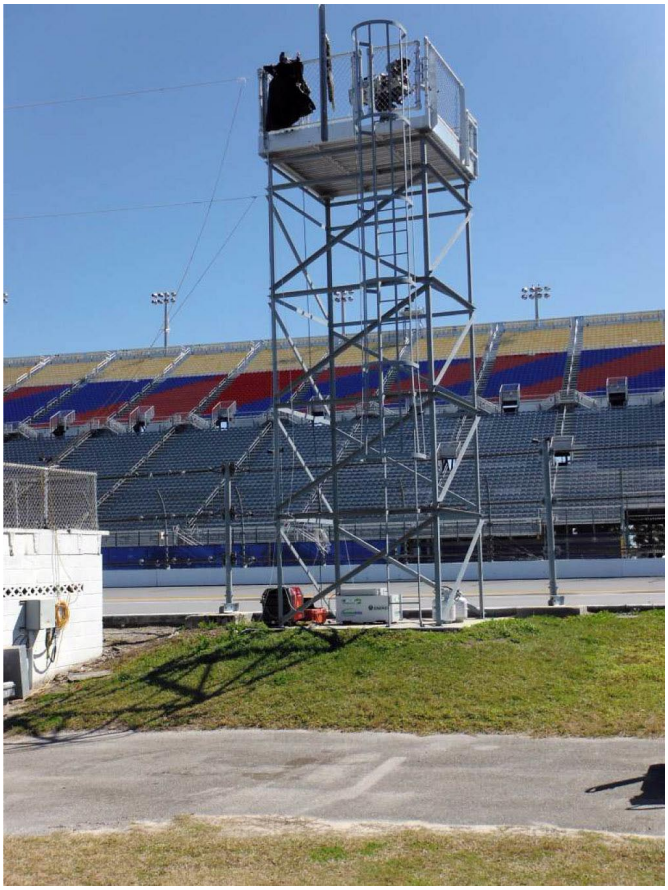

FIGURE 4. Daytona 500 Camera Power

30 units would consume close to $2,200 in gasoline for the Honda while only needing $150 of propane for the RP250L. This translates into close to $100,000 savings for a NASCAR Sprint series season.

This RP250L has now been added to the family of products offered by Acumentrics for remote power generation and is now being considered by those with mobile power needs as well as federal agencies involved in surveillance and monitoring.

CONCLUSIONS AND FUTURE DIRECTIONS

The newly re-designed Acumentrics remote power product has been successfully demonstrated to power sensitive broadcast equipment in real world conditions. Size and weight reductions have been realized as well as the specified fuel savings have been demonstrated. Future work would entail a more integrated fueling system as well as refinement of remote monitoring. Further data on market conditions and customer needs will drive refinement and sales in other remote power markets.

FY 2014 PUBLICATIONS/PRESENTATIONS

1. Demonstration of SOFC Generator Fueled by Propane to Provide Electrical Power to Real World Applications (AMR Presentation 6/19/2014).