



Hydrogen Hybrid Internal Combustion Engine (HHICE) Bus

Prime Contractor: ISE Corporation

Partners: Ford Motor Company, SunLine Transit

Cosponsors: California Energy Commission, USDOT Federal Transit Administration, Natural Resources Canada, CALSTART

Background: The program objective is the development of a hydrogen fueled hybrid electric transit bus.

For environmental and national security reasons, hydrogen fueled vehicles offer unique advantages and have thus become a focal point of long range development attention in industry as well as government. The SCAQMD was an early leader in these developments, noting not only the hydrogen advantages but how bus vehicles would yield the most “bang for the buck” in offering clean transport to large numbers of riders. The SCAQMD not only funded the early development of fuel cell buses, but was a leader in supporting hydrogen engine and vehicle development starting some eleven to twelve years ago.

More recently, the District participated in funding¹ the first hybrid electric fuel cell bus, which successfully demonstrated these new technologies at several sites over the past three years.

Technical Description: In the subject contract (04027) the hybrid electric hydrogen bus technologies have been

¹ With ISE as prime contractor.

implemented with a hydrogen-fueled internal combustion engine (HICE). The resulting bus has been termed HHICE, for its Hybrid Hydrogen ICE drive system. ISE serves as systems integrator and prime contractor for the HHICE program.

But for the hydrogen version of the V10 engine and the fuel storage on the roof, this HHICE bus is similar to gasoline fueled hybrid electric buses produced by ISE². Hydrogen vehicles offer the best opportunity for supplying clean, competitively priced ZEV or near-ZEV vehicles, as with zero-carbon fuel the carbon oxides and hydrocarbon emissions are virtually eliminated. This hydrogen fueled bus, although it has no exhaust gas treatment,



will have less toxic emissions than the gasoline fueled hybrid-electric bus, which was recently certified as an alternative fueled bus.

² The gasoline fueled hybrid electric is certified in California as an alternative (to diesel) fuel vehicle, and is being produced at the rate of over 100 hybrid electric buses per year.

The addition of emissions controls (e.g., NOx Absorption) will further reduce emissions that can meet NZEV expectations.

Status: The prototype HHICE bus was delivered to the customer, SunLine Transit, (on November 30, 2004) and put into revenue service December 16 following a “rollout” ceremony. The bus was in service from dawn through the evening for the following three weeks, accumulating over 200 miles in service every day, with service interruptions only for planned maintenance and upgrades. In January the revenue service at SunLine was interrupted to ship the bus to Winnipeg, Manitoba, such that winter testing of the bus could be done in partnership with Winnipeg Transit. The bus returned to SunLine Transit at the beginning of April following a series of demonstrations in Michigan, New York, New Jersey and Washington DC, and is now in daily service again with SunLine Transit.

Performance: Performance of the bus has met and exceeded expectations:

- Drivers appreciate the improved acceleration, as compared to conventional drive buses,
- Fuel consumption has been 4-6 mpg, with a range of well over 200 miles,
- Passengers note the bus is exceptionally quiet, and appreciate the environmental advantages of use of hydrogen fuel.
- Despite the interruptions for travel and shows, the bus has accumulated over 7,000 miles in the first five months of revenue service. SunLine Transit is an enthusiastic customer, and has indicated interest in adding to its hydrogen fleet.

The winter testing included a survey of riders done by the University of Manitoba Vehicle Technology Centre. The HHICE bus was run in scheduled for-fare service on a route running approximately 30 kilometers,

from the Red River College campus in Northwest Winnipeg to the Southeast



parts of Winnipeg at temperatures as low as -27 C (-17 °F). The objective of the study was to obtain rider-level feedback regarding the HHICE bus “experience”. Riders reported significant advantages of the bus: Its quiet operation was appreciated, 69% of the respondents reported improved temperature comfort, and 80% of respondents considered the HHICE bus to be superior in terms of smooth acceleration

Applications: ISE offers the bus for US and Canadian transit agency service.