North Corridor Commuter Rail Project

Powered By Hydrogen Fuel Cell Technology?

3rd International Hydrail Conference

August 13, 2007

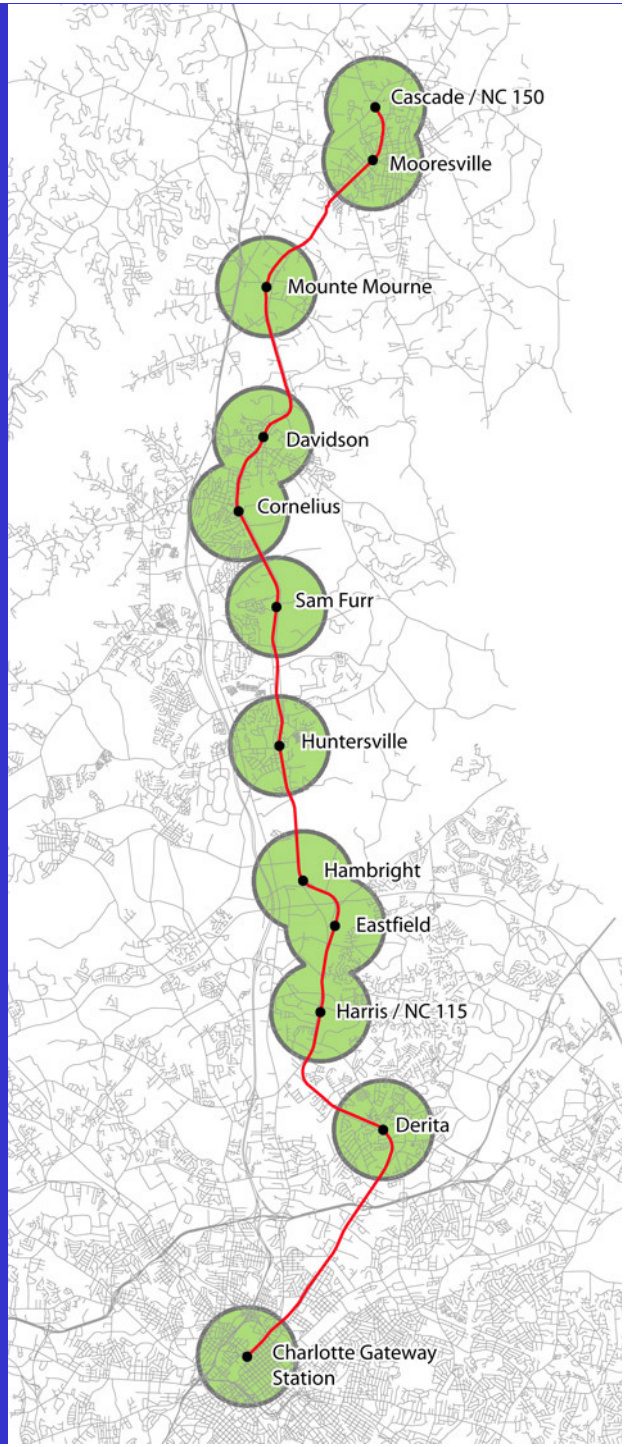
CATS
CHARLOTTE AREA TRANSIT SYSTEM

Commuter Rail
A Growing Market

- 21 Commuter Rail Agencies
- 10-15 New Lines Under Planning
- 622 revenue locomotives in 2004 (10% of total locos in US)
- 72 million gallons of diesel (2004)
  - .29 miles/gallon average

North Corridor Commuter Rail Overview

- Route
  - 25 miles from Charlotte Gateway Station to Mount Mourne
  - Existing Norfolk Southern Railroad right-of-way
  - 10 stations
  - Possible future extension to downtown Mooresville
- Service
  - 22-40 trains per day
  - 30 minute headway during rush
  - Hourly service off-peak
  - Top Speed: 60 - 79 mph



Commuter Rail
Air Quality Challenges

- Projected Locomotive Emissions (2030)
  - 855,000 tons/year (all locos)
  - 24,000 tons/yr diesel PM
- EPA Tier II
  - Applies to new locomotives
  - .10 g/hp-hr PM
  - 5.5 g/hp-hr NOx
  - 21 Commuter Rail Agencies
- EPA Tier III (2012)
  - .03 g/hp-hr PM
  - 1.3 g/hr-hr NOx
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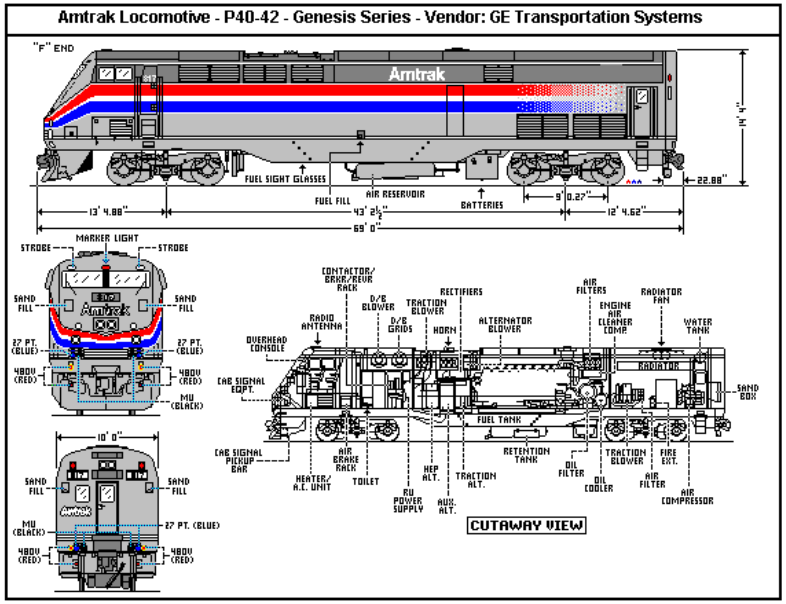
Why Commuter Hydrail?

- Single fueling point
- Short, repetitive route with easy access to rail line & maintenance facility
- Protected crossings
- Serves urban market with air quality compliance problems
- Less demanding on locomotives than freight rail service

Operating Characteristics

- Prime Mover
  - Horsepower: 3,000 – 5,000
  - Top speed: 79 mph
  - Acceleration: 2.5 mphps
  - Weight: 290,000
- Head-end Power Generator
  - 3-Phase; 480 volt; 60 Hz
  - Typical: 1050 hp
  - 250-600 kW
  - On-board power; heat & AC



Manufacturers – Locomotives & Head-End Power Generators

- Locomotives
  - General Electric
  - EMD
  - Motive Power (Wabtec)
- Generators Used For Head-end Power
  - Caterpillar 3412
  - Cummins K-Series Inline 6s
  - Typical:
    - Caltrans: Cat 3412 rated at 1050 hp, operating 5,000 hours/year; average 300 kW load
    - MBTA Spec: 600 kW at 0.8-1.0 power factor; 660 kW overload for 15”

Hydrogen Fuel Cell HEP Generator
A Way To Advance Hydrail?

- Continue Development Of Hydrail Freight Locomotive
  - Large, growing market for freight & passenger
  - Many railroads interested in advancing “green” agenda
- Develop Prototype Hydrogen-powered HEP Generator
  - Stand-alone unit capable of installation on new passenger locomotives
  - EPA Tier III or IV compliant
  - Enables Hydrail to side-step prime-mover performance & safety issues
  - Commuter agencies eager to adopt pro-environmental strategies
  - May be able to attract FRA and/or FTA research funding

One Small Step . . . .

- Climate Change, Energy Crisis Are Driving World To Hydrogen Economy
- Transit Agencies Already Strongly Support "Green" Initiatives
- Performance, Safety & Regulatory Approvals Will Delay Use of Hydrogen-Powered Prime Mover For Transit
- Initial Use of Hydrogen To Power Head-End Generators Would Demonstrate Safety, Reliability & Performance
- North Corridor Commuter Rail Will Proactively Support This Effort

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