New Technology Alternatives for Line-Haul Freight

Technology Review

Presented to Regional Stakeholder Committee

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• Introduction
• Families of Technology
  – Self-Contained Power
  – Wayside Power
  – Intelligent Transportation System
• Findings
The **Purpose** of the Technology Review

...is to summarize recent literature regarding new and alternative technologies that may be applicable to a zero-local-emissions container freight network for the Los Angeles Basin.
Purpose of Technology Review (continued)

- Focus is on technologies applicable to the electric/battery truck system envisioned in the Interstate 710 (I-710) Corridor EIR/EIS.
- The review also covered information on new technologies to reduce the emissions of conventional railroad locomotives.
**Definition of Electric/Battery Truck Technology**

- **Zero-local-emissions** electric/battery truck system
- Two operating modes:
  - **Independent** operation (Ports and Terminals)
    - Off-guideway using battery or other energy storage device
    - Human operation
  - **Line-haul** operation
    - Dedicated or shared guideway
    - Electric power from **fixed distribution system** (overhead catenary, third rail, embedded linear induction, or other) while charging batteries – **OR**
    - Battery power or other **stored energy alone**
**Definition of E/B Truck Technology (continued)**

- Match technology solutions to **performance requirements** (e.g. operations, capacity, interfaces, emissions)
- “Existing” or proposed **products** may not themselves be responsive, but may have desirable features
- Responsive technologies and components may be incorporated in systems developed for **other applications**
- Don’t discount technologies that are not commercially available today, but identify technologies that **may be suitable** for a new container transport application.
Applicable Technologies Reviewed

- Vehicles with Self-Contained Power (Electric Motor, Hybrid, Battery)
- Vehicles Powered from Wayside Distribution Systems
- Intelligent Transportation Systems (ITS)
Self-Contained Power: **100% Battery Truck**

- Electric motor propulsion
- Energy storage battery
- Battery re-charged via temporary connection to electric grid
- Overnight or rapid charging

**Balquon-Nautilus XE30 Electric Tractor**

**Optare Solo EV**
Self-Contained Power: **100% Battery APM**

- Evolution of conventional APM technology
- Electric motor propulsion
- On-board energy storage battery
- Operates entirely on batteries; quick-charges during every station stop

*Mitsubishi Heavy Industries “Crystal Mover”*
Self-Contained Power: **Fuel Cell / Electric**

- Electric motor propulsion
- Hydrogen fuel cell energy storage
- Hydrogen refueling stations required
- By-products of energy conversion are heat and water
Self-Contained Power: **Hybrid Diesel / Electric**

- Diesel motor/generator powers electric traction motor
- Batteries charge by diesel engine and regenerative braking

- Battery power supplements diesel engine in response to demand for additional torque
- Hybrid operation evens energy consumption and enhances efficiency
Wayside Power: **OCS - Electric Trolley Coach**

- Electric motor propulsion
- Traction power via overhead catenary system (OCS)
- Wayside power may be paired with battery, motor/generator or combustion auxiliary power
- Regenerative braking returns residual energy to power grid
Wayside Power: OCS - Trolley Truck

- Electric propulsion; diesel motor generator with trolley assist, OR
- Entirely electric
- Auxiliary battery might be added for off-OCS operation
Wayside Power: Third Rail / Dual-Mode Truck

- Electric motor propulsion
- Traction power delivered via third rail
- Batteries can be charged from the third rail to allow independent operation off guideway
- Third rail limits shared uses of guideway
Wayside Power: **Linear Motor (LIM / LSM)**

- Propulsive force from electric current run through linear stator in the guideway, which creates an electro-magnetic field
- EM field interacts with magnets on the vehicle to create thrust.
- Lateral guidance requires constrained, exclusive, grade-separated guideway

LIM Passenger Transport Application

LSM Precision Machining Application
Wayside Power: **Electromagnetic Induction**

- Electric traction power delivered by current conductor embedded in the roadway
- Power delivered directly to traction motor, to battery, or to both
- Lateral guidance less critical than for linear motor

**Conceptual Highway Application - IAV Automotive Engineering**

**Korean Advanced Institute of Science and Technology - Seoul Grand Amusement Park**
Intelligent Transportation Systems (ITS)

- Platooning technology aims to increase roadway capacity and enhance safety
- 1997: UC Berkeley PATH demonstration of automated operate in close formation
- Combination of radar, video, wireless communications technologies to coordinate spacing, speed, steering
The Review of Technology Alternatives for Line-Haul Freight (Task 8) yields these findings:

- There is no proven, available product or system that represents the zero-emission alternative technology envisioned in the I-710 Corridor Project EIR/EIS.
- A zero-local-emission container transport system will likely be a synthesis of technologies used in transportation and other applications.
- Terminal, near-dock, off-dock, and regional container transportation are differing missions, with differing criteria and technical solutions.
Findings (continued)

- Currently evolving truck technologies (e.g. battery, fuel cell, hybrid) may offer greater benefit at lower cost and risk than a single application of a new, untried solution.

- Flexibility and adaptability should be a criterion for defining any zero-emission container transport solution.

- The complete work has not yet been done to define the entire range of functionalities, interfaces and solutions necessary for a successful zero-local-emission container transport application.
Findings

Task 8: New Technology Alternatives for Line-Haul Freight

Technology Review

Questions and Discussion