STATE OF CALIFORNIA

SENATE TRANSPORTATION & HOUSING COMMITTEE

ASSEMBLY TRANSPORTATION COMMITTEE

SENATE SUBCOMMITTEE ON
CALIFORNIA PORTS & GOODS MOVEMENT

The Governor's Strategic Growth Plan: Expanding Technology's Role in Meeting 21st Century Challenges of California's Ports and Goods Movement System

JOINT HEARING SUMMARY REPORT

TUESDAY, FEBRUARY 28, 2006
STATE CAPITOL, SACRAMENTO

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Senate Transportation & Housing Committee
Assembly Transportation Committee
Senate Subcommittee on California Ports & Goods Movement

The Governor's Strategic Growth Plan: Expanding Technology's Role in Meeting 21st Century Challenges of California's Ports and Goods Movement System

Joint Hearing Summary Report

Tuesday, February 28, 2006
State Capitol, Sacramento

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The Governor's Strategic Growth Plan: Expanding Technology's Role in Meeting California's Ports and Goods Movement 21st Century Challenges

Introduction

On Tuesday, February 28, 2006, the Senate Transportation and Housing Committee (Senator Alan Lowenthal, Chair), the Assembly Transportation Committee (Assemblymember Jenny Oropeza, Chair) and the Senate Transportation Sub-committee on Ports and Goods Movement held a joint hearing to investigate the potential of expanding the role of technology to address California's 21st Century transportation challenges.

After more than 30 years of under investment in California's infrastructure, Senate Bill 1165 (Dutton), the Governor's infrastructure bond, offers a financial foundation to invest in California's transportation, ports, and goods movement system and a strategy to help meet 21st Century challenges. The legislation would authorize the following:

- $6,000,000,000 in state general obligation bonds with the Congestion Reduction, Clean Air, and Trade Corridor Bond Act of 2006.
- $6,000,000,000 in state general obligation bonds with the Congestion Reduction, Clean Air, and Trade Corridor Bond Act of 2008.
- $14,000,000,000 in state general obligation bonds with the Transportation Revenue Bond Act of 2012.
- Utilization of the design-build process for contracting on transportation project with certain state and local transportation entities.
- The Department of Transportation to award not more than 12 design-sequencing contracts for transportation projects.
- The Director of the Department of Transportation to award not more than 4 design-sequencing contracts for transportation projects.
- The Department of Transportation and regional transportation agencies to enter into comprehensive development lease agreements with public and private entities, or consortia of those

entities, for certain transportation projects that may charge users of those project tolls and user fees, subject to various terms and requirements.

STAFF FINDINGS

The witnesses and legislators contributed to a creative and innovative dialogue, which gave rise to the following findings:

- Although the California Department of Transportation has invested approximately $3.5 billion into Intelligent Transportation Systems (ITS) field elements, and spends approximately $30 million per year to operate and maintain them, the $200 million for ITS included in SB1165, the infrastructure bond bill, is only a down payment on the future investment that will be needed to address the $3 billion comprehensive statewide build out of the ITS field elements scheduled for completion by 2013.

- California's five university transportation centers play a key role in advancing Intelligent Transportation System research. It is vital that the research and development potential of California's public and private universities be part of the planning and implementation of a 21st Century transportation and freight system.

- Electrification of transportation and electric drive technologies are becoming important components of goods movement action plans, energy plans and regulatory compliance options. Making use of off-peak electricity supply is critical to the electrification of transportation.

- Infrastructure investment for a 21st Century California should consider and seriously investigate the full potential of new and emerging technologies such as SAFE (secure, automated, fast and environmentally clean) Freight Shuttle, the Transrapid Maglev System and the electromagnetic propulsion system.

- The United States Environmental Protection Agency's SmartWay Transport Partnership can be an important resource and partner in addressing technologies for better fuel economy and reducing emissions for both trucks and rail.

- The Burlington Northern Santa Fe and Union Pacific Railroads are investing in new locomotive technologies that will reduce the emissions of locomotive engines.

- Retrofitting on-road trucks and line-haul locomotives is a viable, economic and immediate application of technology to address the emissions problems of current engines.

LEGISLATORS' OPENING REMARKS

Senator Lowenthal, Chair of the Senate Transportation Committee, convened the hearing by posing the following questions:

- What are we investing that is going to move us towards zero emission transportation systems?
- How do we get to a sustainable society in which economic development, public health and sustainable communities coexist?
- How do we provide both jobs and a clean environment?
- How do we make the existing goods movement system work more efficiently?
- How do we promote additional capacity on those systems?
- How do we look at alternative systems and options?
- What should we be thinking about as we begin to invest into the future?
- What are the options for California? And how viable are they?
- Are these issues that really should have a bearing in the pending bond structure, or are we talking about something that is down the road?
- What are the costs involved?

The Chairman concluded that the hearing would help guide and develop a vision that could shape our transportation system into the future.

Assemblymember Oropeza, Chairperson of the Assembly Transportation Committee, stated that she was hopeful that the technologies presented in the hearing could be integrated into the pending bond proposals. She pointed out that these technologies have the potential to develop into partnerships for goods movement that would increase the efficiencies of goods movement, improve truck and auto travel times and most importantly, from her point of view, improve air quality for neighborhoods, the port areas, and the entire Los Angeles basin, where goods movement activities are centered.

Assemblymember Oropeza concluded her opening remarks by stating that the goods movement industry is an important element in California's economy and has great potential for public/private partnerships. It is critical that the partnerships already established within the goods movement industry play a key role in cleaning up the air and produce added value to the economy. She emphasized that technology is a critical component in achieving these goals.

Assemblymember Huff stated that he had worked in some aspect of goods movement all of his adult life. As an elected official for the last 10 years, he is fascinated with the technology that has become available, and looks forward to what technology could do to help California's transportation system become more efficient, save our taxpayers money, and clean-up the environment.

Assemblymember Karnette stated that she wanted the witnesses to be mindful of security issues that are facing the goods movement industry.

THE WITNESSES

The three policy committees organized the hearing into four panels. The California Department of Transportation (Caltrans) was the first panel and testified on the Administration's perspective of technology's role in the Governor's Strategic Growth Plan. The following questions were posed to the Administration:

1. What is the current level of Intelligent Transportation System (ITS) deployment in California?
2. SB 1165, the Congestion Reduction, Clean Air, and Trade Corridor Bond Act of 2006, allocates $200 million for Intelligent Transportation Systems (ITS). Is this allocation sufficient for an effective and strategic statewide ITS deployment? If so, why? If not, what kind of ITS investment is needed?
3. What is the future level of ITS deployment (2-year, 5-year, and 10-year time horizons)?
4. How is the state's ITS program organized?
5. What are the costs and benefits of ITS?

The subsequent three panels offered a private sector perspective and were asked to address the following questions:

1. Is there a role for California's university research network, federal laboratories, and community colleges in the advancement and deployment of technology?
2. By what criteria should these emerging technologies be evaluated, when assessing their strategic and cost benefit potential?

Panel 1 – The Administration's Proposal

Panelists

Will Kempton, Director, California Department of Transportation

Randell Iwasaki, Chief Deputy Director, California Department of Transportation

Director Kempton set the stage for the hearing's theme of the expanded role of technology in meeting California's 21st Century challenges with the observation that the technology that would be discussed and demonstrated at the hearing is, in fact, available today. It is a matter of deploying that technology, and the Administration is hoping to work with the state Legislature to accomplish that deployment.

Mr. Iwasaki, Chief Deputy Director of Caltrans, stated that Caltrans has invested approximately $3.5 billion into Intelligent Transportation Systems (ITS) field elements. Mr. Iwasaki identified some of these ITS field elements as large changeable message signs, highway advisory radio ramp meters (1610 AM radio frequency), and statewide weather information systems.

Caltrans spends approximately $30 million per year to operate and maintain its ITS field elements. According to the Caltrans Transportation Management System (TMS) master plan, the comprehensive statewide build out of the ITS field elements will be complete by 2013 at a total cost of $3 billion. Caltrans estimates that the return on this 20-year life cycle investment represents a benefit ratio of about 7.5 to 1, and this figure does not include the safety and efficiency benefits to the transportation system. Mr. Iwasaki also pointed out that the $200 million for ITS included in SB1165 is only a down payment on the future investment that will be needed.

Mr. Iwasaki explained Caltans' four-division ITS program as follows:

1. The Division of Planning plans programs and assesses the locations of various field elements.
2. The Division of Operation, adjusts the field elements after they are installed to assure the systems are operating at optimum performance.
3. The Division of Maintance maintains the of field elements.
4. The Division of Research and Innovation investigates and studies the latest technologies to implement into the transportation field.

Chief Deputy Director Iwasaki stated the California universities have played and will continue to play a key role in advancing ITS research. He indicated that California has five transportation centers funded by the Federal Highway Administration:

1. The Mineta Transportation Institute – San Jose State
2. MetTrans – University of Southern Californian and California State University, Long Beach
3. University of California Transportation Center – University of California, Berkeley
4. University of California Transportation Center – University of California, Davis
5. University of California Transportation Center – California State University, San Bernardino

Mr. Iwasaki observed that emerging transportation technology will be a key component in the success of the Governor's Strategic Growth Plan and indicated that there were a number of current and planned projects that employ innovative technologies to improve goods movement. With this observation, Mr. Iwasaki gave an overview of the following technologies that Caltrans is currently deploying or will deploy in the near future:

1. **Pre-Pass System** – 250,000 trucks throughout the United States are equipped with a transponder that will allow the truck, when traveling underweight or at the legal weight limits, to legally bypass compliance stations. This allows trucks to conserve fuel and adds efficiency to freight and transportation system.
2. **Virtual Weigh Station** – This technology will allow trucks to be weighed on the move. The technology will automatically ticket overweight trucks and will pull grossly overweight trucks over at the compliance station to ticket and correct the overweight load. Cordelia, at the junction of Interstate 80 and State Route 12, and a location to be proposed on Interstate 710, are the two locations Caltrans is currently considering, at a combined cost of $1billion.
3. **Smart Truck Parking** – This technology is currently deployed as Smart Parking reservation system at the Rockridge BART Station. The technology counts the number of vehicles coming in and out of the parking lot. Due to the shortage of truck parking locations in California and trucks having to park on roadway shoulders, Smart Truck Parking technology will count the number of trucks in and out of the parking location and will be able to notify truckers on the road and inform them that "The next truck parking location in front of you has 14 truck spots available. Make your reservation and go on in there."

4. **Electrification** – Caltrans will provide trucks with the ability to hook up to electrical outlets that will allow drivers to run the air conditioner, heater, radio, etc. for a long period of time and eliminate the idling of diesel engines at the ports, which will help clean the air.
5. **Free and Secure Trade Lanes (FAST)** - An electronic pre-clearance program that uses integrative technologies, such as vehicle transponders to safely and securely expedite the border clearance process, which significantly reduces truck idling at the border. This technology is being deployed in the San Diego region.
6. **Open Rolling Tolling** – This technology allows electronic toll collection transactions to occur under normal highway driving speeds. This will help to reduce queing, idling and air emissions.
7. **Vehicle Infrastructure Integration Initiative (VII)** - This is a cooperative effort between automobile manufacturers and transportation officials to deploy vehicle-to-vehicle and vehicle-to-infrastructure communication. The Vehicle Infrastructure Integration Initiative works off a frequency that was recently allocated by the FCC at the 5.9 gigahertz and has a 75 megahertz of spectrum.
8. **Changeable Message Signs** – This technology allows for timely travel and traffic information to be displayed on large electronic message signs. The technology has been deployed in Los Angeles and the San Francisco Bay Area, and is planned for implementation in San Diego.
9. **511 System** – The 511 technology allows one to dial on the telephone or cell phone to get real-time information on traffic congestion, road work, weather delays, and transit opportunities. It is currently up and running in the San Francisco Bay Area and the Sacramento region, and will it be deployed next in the San Diego region.
10. **Regional Communication System (RCS)** –This is a fully interoperable radio system technology that safety, fire, highway, and emergency vehicles can use to communicate with each other—one-to-many, or one-to-one. The system is currently deployed in San Diego County and will be expanded to Imperial County.
11. **Crash-Less Intersection** – This is radar technology that senses how fast an oncoming car is traveling. If a car is stopped waiting to make a left turn and there is an oncoming vehicle, this technology will calculate in a nanosecond whether or not the driver can safely make the turn, and if not, it will tell the driver "don't make that left turn." This technology is currently being tested.
12. **Curve Speed Warning** – This technology informs a trucker that there is a curve ahead; the truck is going too fast: and it needs to slow down. The Curve Speed Warning system is currently deployed on Interstate 5 in Northern California.

13. **Bay Area Security System** – This technology is a wireless transmitter mounted on top of the Bay Bridge and Bay Area tunnels that signals and coordinates all the terrorist activity detection systems. All the piers on the seven Bay Area toll bridges have detection systems. The cameras monitor activity near the anchorages on the bridges, in an effort to thwart potential terrorist acts. The information is relayed wirelessly back to the transportation management center in the Bay Area District 4 Caltrans headquarters.

In the legislators' discussion that followed Panel 1, **Assemblymember Mountjoy** asked **Mr. Iwasaki** about the Pre-Pass qualifications. **Mr. Iwasaki** informed the Assemblymember that an Arizona company, Help, Inc., administers the Pre-Pass application system to individually qualified motor carriers and trucking companies.

Assemlymember Karnette asked, how does an enforcement agency know who is driving the Pre-Pass certified truck? **Mr. Iwasaki** responded that the Pre-Pass program is voluntary and subject to state safety qualification standards. He also pointed out that Europe uses a system called "tack-a-graph." The "tack-a-graph" system requires that each driver have a card and each driver must physically put that card into that "tack-a-graph" to monitor how far one has driven, how long one has driven, and who is driving. So, at any time, a police officer can access the "tack-a-graph" and get a readout of one's driving record.

Senator Ducheny and **Senator Torlakson** asked **Mr. Iwasaki** about data regarding accidents, accidents that were avoided, healthcare costs, deaths, injuries and property damage. **Mr. Iwasaki** informed the Senators that he did not have that information readily available, and he would provide this information to the staff at a later date.

Panel 2 – Electrification

Given the fact that the President Bush has acknowledged the country's "oil addiction," and an increasing national concern about air quality, the electrification of transportation offers great possibilities to reduce emissions, particulates and petroleum usage.

<u>Panelist</u>

Ed Kjaer, Director, Electric Transportation, Southern California Edison

Mr. Kjaer opened his remarks with the following rhetorical question and statement:

What is changing the way we think about transportation, energy security, energy storage, energy efficiency, emissions and the gas station?

Electricity and the grid: What we are really beginning to see is this fundamental convergence of transportation and the grid. And more and more, transportation is moving electrons around onboard the vehicle, or is using electricity in one form or another. We're seeing it with the hybrid vehicles today, the engine hybrids that you're seeing successfully marketed, sold, operated on the road. And the emergence of plug-in hybrids—we've heard a lot of discussion about plug-in hybrids over the last couple of weeks, particularly with President Bush's reference to our oil addiction and the need to get off imported oil as quickly as we can, and the promise of plug-in hybrid technology, battery technology, battery UVs; electrification of marine ports; truck facilities, airports; rail yards; and the emergence of technologies for communication, navigation, entertainment; the use of ITS onboard the vehicle in terms of communication. All transportation requires electricity in one form or another.

So increasingly, the state is focusing on electrification to reduce emissions, particulates and petroleum usage....

Along with petroleum reduction, comes significant emissions reduction and greenhouse gas reduction, depending on the kinds of emerging new technologies that we use.

Mr. Kjaer observed that the electrification of transportation and electric drive technologies are becoming important components in any number of goods movement action plans, energy plans and policy reports, and compliance options that the California Air Resources Board (CARB) has established. He cited last year's passage of SB 467 (Lowenthal), which expanded the Carl Moyer program grants to include forklifts and other non-road electric drive technology.

Mr. Kjaer presented the following benefits of powering transportation from electricity the grid:

- 100 percent domestic-based.
- 100 percent petroleum-free.
- Multiple feed stocks.
- Excess off-peak capacity.
- Electricity is about 20 to 30 percent the cost of a gallon of gasoline.

Mr. Kjaer added that as more transportation energy is derived from the grid, the benefits will also include a reduction in urban air pollution.

Mr. Kjaer outlined the near-term and long-term opportunities for electrification. He presented modeling that projects the potential of emerging electrification technologies through 2020. In order to demonstrate the benefits, the model framed the benefits in terms of the number of vehicles (model year 2005) that the technology will potentially remove from the road.

- Electrification of 100 hundred ships coming into the ports annually would result in Nitrogen Oxide (NOx), Reactive Organic Gases (ROg), and Sulphur Oxide (SOx) reductions equivalent to taking 535 vehicles (model year 2005) off the road.

- There are 76,000 sleeper cabs in the state today. Only about 400 truck parking spaces are electrified. There is the potential to electrify approximately 35,000 spaces, and that could be equal to removing about 360,000 vehicles (model year) 2005 from the road by 2020.

- There are about 70,000 electric truck refrigeration units (ETRUs) on container ships worldwide. The container ships, when they are at sea are electric, and put electricity through their own onboard grid into the containers to provide the necessary power. When the ships come into port, the containers are offloaded and connected to the grid. The containers are then loaded onto trucks, and a diesel generator is then attached to the vehicle that provides the electricity needed for the container as it drives along the roads.

- In California, there are approximately 4,000 to 7,000 electric auxiliary power units (APUs). If large distribution centers were electrified, trucks could drive in, shut down the auxiliary power units, and connect to the grid.

  Projecting to 2020, electrification of transportation could potentially result in air pollution reductions equivalent to the removal of 400,000 cars (model year 2005) from the road.

Mr. Kjaer cited the following additional electric options: electric gantry cranes at the port, freight rail, light duty rail, heavy duty rail, high speed rail and Maglev.

In closing, Mr. Kjaer stated that, "the benefits of the transportation and goods movement electrification are very large in reducing the air pollution particulates and it's that petroleum dependency that I think is so critical to this nation. And again, with significant reductions in petroleum, comes the reductions in emissions and greenhouse gases."

During the legislators' discussion that followed Panel 2, **Senator Lowenthal** asked **Mr. Kjaer**, how off-peak hour usage would work? **Mr. Kjaer** responded:

> …smart meters, or Advance Meter Initiative through the Public Utilities Commission, …is a technology that will give customers the ability to know and understand what they're paying for electricity hour by hour, or at certain times throughout the day. And at that point, they will be able to modify their behavior and understand what they need to do to modify their behavior.

As a follow-up question, **Senator Lowenthal** asked if this could be applied to trucks and cars. **Mr. Kjaer** stated the following:

> Customers will be able to understand the impacts of that exactly at any given time throughout the day. The other issue is that the pricing signals have to be clear…the off-peak rate has to be cheaper than the on-peak rate so…it is cheaper to make the electricity off-peak than it is with making the electricity on-peak.

Senator Margett asked "are we adding to the dilemma that we have with our energy now in introducing this at this moment in time, or are we just kind of tantalizing everybody with what you had to say?" **Mr. Kjaer** gave the following response:

> …if more transportation is going to connect to the grid, if regulation is going to drive to more and more near zero and zero emission technologies, significant petroleum reduction, greenhouse gases, etc., and transportation starts to connect more and more to the grid, we have to make sure it soaks up the excess capacity first. We have to make sure that the market structure is in place to use the excess off-peak capacity first. We do not, to your point, want to exacerbate the on-peak situation. And in a lot of cases, with truck stops and truck idling at night, that's good because it's off-peak. With plug-in hybridization, again…you can be putting in the electricity fuel at night off-peak when the rates are cheaper

Assemblymember Pavley asked **Mr. Kjaer** if he could compare and contrast the value of plug-in hybrids and other technologies. **Mr. Kjaer** stated the following:

> …electrification is not the only solution. There is not a silver bullet out there. I think we need to have a mixture of solutions to meet both the state and the federal goals.
>
> Biofuel, a combination of biofuel with plug-in hybridization is, on the surface, extremely attractive. The question is going to be, how is the electricity made and how is the biofuel made? Do you use food and land to make fuel for transportation? That's a big debate at the moment. How much coal is there in the generation mix on a regional basis, and what implications does that have from a greenhouse gas perspective or emissions?
>
> There's no simple solution. There is a wealth of work and evaluation and research going on at the moment to study these very issues.

Panel 3 – Emerging Goods Movement Transportation Technologies

Panelists

Dr. Stephen Roop, Texas Transportation Institute
Dr. Kenneth James, Professor of Electrical Engineering and Computer Engineering and Computer Science, California State University, Long Beach
Bruce Dahnke, President, Skytech Transportation Corporation

SAFE (secure, automated, fast and environmentally clean) Freight Shuttle

Mr. Roop began by stating that the emerging freight transportation systems of the 21st century must move beyond the two modes, rail and truck, that currently form the backbone of today's freight transportation system. Emerging freight transportation systems must be: low cost, secure, safe, rugged and simple, based on known and understood technology, reliable, offer capacity and velocity, interconnected with the existing intermodal transportation system, and environmentally clean.

Mr. Roop introduced the legislators at the hearing to a new approach to intermodal freight transportation, SAFE (secure, automated, fast and environmentally clean) Freight Shuttle. Mr. Roop outlined the following features of the SAFE Freight Shuttle in the following way:

> …it is a single unit transport and it has an aerodynamic leading edge that cuts down wind resistance and improves the economics of the operation considerably. It operates straddling a center guide way. And this center guide way serves four fundamental purposes

in the design. It serves to guide the vehicle; it serves to deliver power to the motor elements that reside on the vehicle; it serves as a braking system; and it serves as the power pickup for the unit.

In many respects this is a hybrid system. It borrows features from rail transportation that are proven to be sound and effective, like steel wheels and a steel running surface, and it borrows features from the trucking industry, like the single unit moves. So as soon as a container is loaded on a freight shuttle, it can exit the terminal and be on its way, which means there is absolutely no delay. The other benefit of that is you can keep your cranes at the destination terminal operating with a constant interval of containers arriving, very much like machines operate on a factory floor. The timing of the delivery is such that your cranes can stay in continuous operation… The propulsion system is a linear induction motor. It's very similar to a rotating ceiling fan that you may have in your home.

It operates on a flat steel rail, which is a departure from traditional railroad engineering designs. It further reduces the rolling friction involved. A unique feature of ours is, it's a derailment proof system. The center guideway will not allow the vehicle to come off the track. And so we're not relying on the rail to serve as the guideway, merely as the surface upon which the vehicle rolls. A very small number of moving parts in an automated control system make up the balance of the vehicle design.

Transrapid Maglev System

Dr. James began his testimony by stating that the Maglev technology is a proven and demonstrated technology in both Germany and Shanghai, China.

Dr. James presented the following overview of the Maglev technology:

The Transrapid Maglev System, an entirely new train system, is the first to overcome the limitations of wheel and rail. Because the vehicle moves entirely without contact, it makes train travel faster, easier on the environment, and more economical. In any case, the Maglev systems guideway requires less land and space than other transportation systems.

Transrapid has very favorable alignment parameters with small curve radii and a grade climbing ability of 10 percent. The Transrapid guideway can therefore be adapted to the landscape instead of the other way around.

The Maglev system requires significantly less energy than other transportation systems. Used under similar conditions, the specific primary energy requirement of a car is three times higher than that of an airplane, five times higher than the Transrapid.

It has no moving parts—zero. No wheels; nothing. It floats on a magnetic field. There are a lot of advantages besides the fact that it's a very low polluter because it uses fixed sources. One is, it replaces the steel wheels with a raise of magnets.

Maglev uses a linear synchronous motor, which is similar to a linear induction motor. The difference is that, instead of putting the power onto the vehicle itself, the power is in the entire length of the track. And there were studies done at the Los Alamos Laboratory that show that when you use a Maglev....you can use either a linear induction motor or a linear synchronous motor. If you have a fairly long track and only a few vehicles on it you use a linear induction motor because the motor is then on the vehicle itself and the track is passive. But if you have a lot of vehicles, such as we would have in a container conveyor system, then the power source is actually on the track itself and all the vehicles themselves are passive. That really reduces the cost of that system.

It has a very small footprint...which gives you a lot of options for right-of-way, and it is elevated. This is a real difference. Instead of worrying about digging trench for a rail, or instead of having to worry about elevating highway or widening highways, this has a number of rights-of-way, such as long riverbeds, interstate medians, and along unused rail.

Another point is the security. The security is there. And as you're talking about a system that is elevated, it's moving relatively fast all the time and it's totally automated—all done by computer.

...while the track is powered, it's only powered at the place where the computers recognize there is a carriage, so you don't sit there and electrify the entire track—only that place that is used by the vehicle. ...that brings down the cost of operation.

Dr. James concluded his remarks by stating that the Maglev approach has the potential to concurrently address economic growth, zero impact on pollution, and zero impact on neighborhoods.

Skytech Technology

Mr. Dahnke described the Skytech technology as a fully automated cargo handling system that can eliminate the dock use of trucks and is pollution free.

The technology uses electromagnetic propulsion (linear induction). It is an elevated container transfer "grail" system for efficiency and better land utilization. The grail system allows for the simultaneous loading and unloading of cargo ships. The Skytech system can handle 25,000 to 30,000 containers per acre.

Mr. Dahnke concluded with the following overview of the Skytech system:

> It reduces truck traffic, noise and air pollution, and it increases the through-put which makes the containers more secure, because the security problem with containers is dwell time.

During the legislators' discussion that followed Panel 3, **Assemblymember Horton** asked **Mr. Dahnke** whether his technology has ever been used. **Mr. Dahnke** replied that the people mover in the Disneyland parking lot uses his technology on a daily basis.

Panel 4 – Upgrading Existing Technologies

Panelists

Cheryl Bynum, Technical Manager for the United States Environmental Protection Agency
Mike Iden, General Director of Car & Locomotive Engineering, Union Pacific Railroad
Mark Stehly, Assistant Vice President Environment and Research Development, Burlington Northern Santa Fe Railroad

Ms. Bynum gave the following overview of the U.S. Environmental Protection Agency SmartWay Transport Partnership:

> What is the SmartWay Transport Partnership? It's a pro-business, pro-environment approach to significantly reduce fuel consumption and emissions from freight transport by accelerating the deployment of new and emerging technologies that are currently in the market, but for various reasons have not yet achieved a significant market share. SmartWay started in 2004. We had 15 charter partners when we started. We worked with the Business for Social Responsibility and the American Trucking

> Associations. By the time we launched it in February of 2004, we already had 50 partners. It is a public-private partnership.
>
> In just two years we already have had 323 companies that currently are SmartWay Transport Partners, and these represent some of the largest multi-national companies operating in the United States. Together, our partners represent all of the class one railroads and four percent of the rolling truck stock in the United States, responsible for seven percent of the total amount of fuel consumed by the trucking industry in the United States.

Ms. Bynum outlined the following technologies that SmartWay is advancing:

- **Idle reduction** technologies include auxiliary power units that go onboard or plug-in systems. These systems supply electrical power and/or heating and cooling to the truck or locomotive so the main engine can be shut off, which saves fuel and considerably reduces emissions.
- **Trailer aerodynamics** are emerging technologies. Approximately 75 percent of all trucks on the road already have tractor aerodynamics. Trailer aerodynamics have not been well recognized. Some of the technologies involve side skirts, gap reducers, which cut the amount of space between the trailer and the tractor and avoid turbulence. Another is air deflectors that help move the air up over the trailer.
- **Single wide tires -** On a class-8 tractor trailer there are two tires at the end of each axel except for the steer axel. These are replaced with one single wider tire made of much more fuel efficient materials and architecture, which significantly reduces rolling resistance and cuts weight, both of which contribute to significant fuel savings.

Ms. Bynum concluded her testimony with the following remarks:

> California has led the nation in innovative retrofits for emission reductions with your Carl Moyer program. And California is again stepping forward with its Strategic Growth Plan. And this growth plan, I believe, could and should take advantage of the technical support that EPA offers to states and to industry through SmartWay with fuel saving SmartWay upgrade kits for trucks, innovative financing concepts, like the low-interest loans to fleets for retrofits, and our outreach program.

Mr. Iden began by observing that the Los Angeles area is the hub for nationwide rail freight and outlined the following three points for consideration:

> The first is a key requirement in goods movement to reduce in-route delays and to reduce emissions. And going from one mode to another in transporting a container, for example, from Los Angeles to Chicago or New York, will increase the transit time and the delays in handling that traffic.
>
> The second is that the railroads operate around the clock and cannot be linked to off-peak sources of energy, which is a point that the Chairman brought up in one of the previous commentaries.
>
> …the third point is that railroad intermodal transportation is already three to four times more energy efficient and therefore less polluting emissions-wise than over-the-road trucking.

Mr. Iden indicated that the Union Pacific railroad deals with three different types of locomotives in the Los Angeles basin:

1. A small fleet of passenger locomotives operated by MetroLink and Amtrak California that are essentially very high speed shuttle type operations.
2. Switching locomotives, which are low speed locomotives that do local work in and around the rail yards, are operated by Union Pacific and the Burlington Northern Santa Fe Railroad on the Pacific Harbor line.
3. The haul line locomotives, which operate the transcontinental trains.

In addition, Mr. Iden stated that the Union Pacific railroad is in the process of acquiring 71 ultra low emitting locomotives. Eleven of them will be the "green goat" hybrid locomotives, and 60 will be the new Gen-set locomotive.

Mr. Iden described the green goat hybrid and Gen-set locomotives as follows:

> The green goat is a simple hybrid. It uses a small 290 horse power truck type diesel engine to charge two very large batteries which then provide power to the traction motors on the wheels. The emissions reductions that the green goat is capable of producing come not from the fact that it has large batteries, but from the fact

> that it uses a very small truck derivative diesel engine, which is very low on emissions.
>
> The Gen-set is a larger locomotive which uses three very large truck derivative diesel engines. And it will achieve an 80 to 90 percent reduction in locomotive emissions, vis-à-vis the existing switching locomotives and save up to 40 percent of the fuel required.

Mr. Iden gave the following overview of locomotive technology:

> The first is a diesel electric locomotive such as we currently now operate, roughly 4,400 horsepower...cost about $2 million. They are physically about as big a locomotive as we can get. They are currently manufactured and sold to the railroads in the U.S., Canada and Mexico at about 1,000 locomotives per year. These are not mass produced machines. Anything that is manufactured at a rate of 1,000 a year can not be defined as mass produced. But they are, essentially, standardized products.
>
> The next is a straight electric locomotive. And using some of the previous cost estimates, these locomotives would cost about $6 million per piece. The technology is feasible, but in the past 30 years, only 30 straight electric freight locomotives have been manufactured for service in the U.S. and Canada.
>
> The next is what I call a dual mode diesel and electric locomotive, and this was referred to during one of the previous presentations. And we're making a rough estimate that this would cost between $6 and $10 million each, which is three to five times the cost of a conventional diesel locomotive. And this would be an extremely complex locomotive and a very large engineering challenge.
>
> The last technology that I want to bring to your attention is what I call a regenerative line haul diesel battery locomotive. One of our locomotive manufacturers is working on this technology. In fact, they had a prototype locomotive of this design which operated an intermodal train from Chicago to Los Angeles in 2004. They are currently trying to commercialize this technology.
>
> What this technology would allow, for example, is a train descending from Cajon Summit into the Los Angeles Basin. In dynamic braking or electric braking, instead of dissipating that energy to the atmosphere as heat, we would be able to pump that electrical energy into high efficiency batteries onboard the locomotive, and then when propulsion is needed, instead of using

> the diesel locomotive, we could, for example, substitute power from the batteries at the rate of 4,400 horsepower, the same rating of the diesel engine, for up to 20 minutes. This is truly a regenerative form of technology which is very comparable to, for example, the Toyota Prius, as a true regenerative motor vehicle.

In Mr. Iden's concluded with the following observation:

> The challenge facing California today in this particular issue is not necessarily finding machines which think, but gathering responsible business leaders, technology innovators and community leaders to make intelligent decisions on transportation technologies which are readily implementable and have a high probability of success.

Mr. Stehly's opening observation concerned air quality nationwide. Although the Los Angeles basin has the worst air quality in the nation, Mr. Stehly pointed out that the San Joaquin Valley has poor air quality, as does Houston, Texas, and any number of regions and municipalities throughout the United States. He indicated that the Burlington Northern Santa Fe (BNSF) railroad has thousands of employees who live and work in these areas with poor air quality. He stated that BNSF, however, was spending more time in California, and especially Southern California, than in the rest of the United States.

Mr. Stehly indicated that the Department of Energy is spending approximately $90 million a year to reduce the emissions from trucks and spending essentially zero on locomotive engines. He stated that technology does reduce emissions on locomotives and that the switch engines that Mr. Iden had presented are good examples. The railroads are using truck derivative engine technology. Locomotives, however, run at different speeds and the pistons are a different size, so some of the truck technologies are not applicable to locomotives.

Mr. Stehly concluded with the following overview of BNSF's efforts to reduce emissions from switch engines and cargo handling equipment:

> ...One thing that we're looking at . . . is the road locomotive - the hybrid concept, the one that was on our railroad in 2004. . . and that we're helping GE bring to light. And you can see it is very much like the Honda Civic. It's the same sort of concept of regenerative braking, storing it in a battery and using it for motoring power. And we're hopeful that some time this year or the first quarter of next year, that there will be a production type prototype rather than a proof of concept type prototype.

> In three decades there have only been 21,000 locomotives sold, where there have been 22 million trucks. So we are on the tail end of a lot of the technology as it gets cascaded down, but we are applying it and we are making big reductions. It's just that reductions come first on trucks, then on off-road truck-type engines, and then they are applied to locomotives.
>
> In the SmartWay Program, we are putting on a lot of Automax start, stop equipment, so our locomotives don't idle. They are on all of our new locomotives that we buy. They have been retrofitted onto half of our line haul fleet. And then most of the smaller engines, almost our entire funding on automatic start/stop, is going to locomotives in California. It is how much money we can apply to it, and it's all going to the benefit of California.
>
> Then you can see the basic efficiencies of rail. We know we are part of the problem. We do have emissions and we need to solve it, but we are part of the solution. Under the grams per ton mile, we're much better than the competition.

During the legislators' discussion for Panel 4, **Assemblymember Oropeza** asked **Ms. Bynum** of the U.S EPA what the fuel savings were for the single wide tires on class 8 tractor trailer trucks. **Ms. Bynum** stated that the fuel savings ranged from four to eight percent. **Ms. Bynum** pointed out that retrofitting a truck with idle reduction, single wide tires and aerodynamic equipment can significantly improve fuel economy and reduce emissions by up to 20 percent or greater.

Assemblymember Oropeza asked **Ms. Bynum** if the SmartWay Transport Partnership Program was available in Spanish. Ms. Bynum indicated that SmartWay was working with the federal government of Canada to translate many of its driver training materials into Spanish and offer it as a web-enabled package and that the project was scheduled for deployment during this fiscal year.

Senator Lowenthal asked **Mr. Stehly** of the Burlington Northern Santa Fe Railroad if the new emerging technologies such as the SAFE Freight Shuttle, the Maglev system or the Skytech system that were presented earlier in the hearing could help address the goods movement short haul problem? Mr. Stehly gave the following response:

> …We construct new lines every year; expand our sidings; construct triple track; we know what it costs. And they're built because it works for our cost model. We can compete with trucks and provide service to our customers. And I would be very leery of people that come in. Sometimes the deals sound like they're too

> good to be true, it's because they probably are too good to be true. They may fit in certain niches. There may be some economies of scale in doing things. There may be some manufacturing improvements in the future to bring it down. We'd be willing to look at their costs…

Public Testimony

Following the four organized panels, Senator Lowenthal invited the audience to come to the podium for public comments.

Henry Hogo from South Coast Air Quality Management District gave the following statement:

> We (South Coast Air Quality Management District) are supportive of all of the technologies that are coming online that would help move goods movement, but we're also look for technologies that are the cleanest technologies that can be implemented as early as possible. And we believe that what you heard today about having cleaner engines, are a good move, but today's clean engines are tomorrow's dirty engines. So we look at accelerating the cleanest technology earlier than mandates. So for instance, on the on-road side, we believe that a lot of alternative fuel engines are going be much cleaner beginning in 2007 compared to diesel engines in 2007, because they're going to come out with engines meeting future standards.
>
> Similarly, we believe that the rail operations should be the same way. They're looking at Tier 2 engines today, but the U.S. EPA is going to have Tier 3 engines coming out with regulations for those, and we believe that if we look towards technologies that could move in that direction, we can get these newer engines on faster.
>
> You heard a lot about switcher locomotives and new engines, but there was not that much discussion about retrofitting existing locomotives. As you look to the future of a zero emission network, there's going to be a transition needed. And we need to clean-up the emissions from the current engines.
>
> …We believe that retrofit is the viable way to go. Alternative fuels, low sulfur fuels, cleaner fuels, hybrids, this is the diverse portfolio that you need to put into the program in order to have a transition to zero emission goods movement.
>
> …In the meantime, retrofitting in terms of on-road trucks is a good way to go. Alternative fuels, where they fit into the operation are a

good way to go. Hybrids are a good way to go. But we believe that retrofitting line-haul locomotives is a very viable technology. We believe that the technology in Europe can be adapted to the U.S. for these locomotives, as well as for the switcher locomotives that are still going to be running for a long time.

With that, I just want to conclude that we would like to work closely with you and your committee on looking at technologies in the future.

Moss Bittner, consultant for the Humboldt Bay Rail and Infrastructure Taskforce, offered the following public comment:

It's encouraging to see the Joint Committee considering all the options for making the freight system more effective, more cost-effective, more efficient, and most of all, to cause fewer impacts on the health and residents and the environment. You heard a number of proposals today, and I'm sure it's clear that no single proposal is going to fulfill the expectations of the state for improving its transportation infrastructure over the next 20, 30 or 40 years.

…the right thing to do might be to make massive daring investments, like Maglev or other things which really do break with the historical expectations of private enterprise, of the people who build things. Because who is in the better position than the state to start pushing towards that future? But since it's my generation who will be working for the next 40 years and paying off these projects, which I'm led to believe can only be paid for with bond obligations, it would be very encouraging to see the low cost options be considered fully. And even if the bulk of the money goes to big projects, a significant part of the discussion should go towards those low cost options.

…Because I work with a small port and its connecting railroad, it would be encouraging to see those facilities used. Because these are under utilized assets that could fulfill some of the expectations rather than focusing on the bottlenecks, which are inevitably going to be very expensive problems, to focus some of the energy on the under utilized assets, takes the pressure off those bottlenecks.

Conclusion

The challenges for California's ports and goods movement are complex and immense. In order to address the challenges and needs facing a 21st Century California, technology must be leveraged to its fullest potential.

The presentations given at the hearing demonstrated the potential for technology to address the challenges and issues facing California's ports and goods movement system. The deployment of Intelligent Transportation Systems (ITS) statewide can increase the effective capacity, efficiency and safety of the ports, goods movement and highway system. California's university transportation centers are an important resource and asset that can play a vital role in the advancement of technological research and development. Electrification of transportation systems can reduce air pollution, particulates and petroleum dependency. Finally, the advancement, development and implementation of the innovative and emerging technologies presented could be a significant contributing force in achieving the balance between economic development and a zero emissions environment.

The advancement and effective deployment of as well as strategic short and long term investment in technology can improve the efficiency, reliability, capacity, safety and security in California's ports and goods movement system. In addition to these benefits, technology can enhance the environment and quality of life for a 21st California.

Senate Transportation and Housing Committee
Assembly Transportation Committee
Senate Transportation Sub-Committee on Ports & Goods Movement
Informational Hearing
Senator Alan Lowenthal, Chair
Assemblywoman Jenny Oropeza, Chair

THE GOVERNOR'S STRATEGIC GROWTH PLAN: EXPANDING TECHNOLOGY'S ROLE IN MEETING 21ST CENTURY CHALLENGES

February 28, 2006
1:30 PM
State Capitol, Room 4203

BACKGROUND PAPER

During the late 1950s and early 1960s, California built a world-class transportation system to address the freight and people mobility for a fast growing state and national economy. California's transportation system was further enhanced by three Class I railroads (Burlington Northern & Santa Fe, Southern Pacific, and the Union Pacific), three major seaports and two international airports. Geographically positioned on the Pacific Rim, California's strategic position in the global economy has placed it at the intersection of the world's two largest markets – the U.S. and Asia. And, in a post-North American Free Trade Agreement (NAFTA) world, California has become the nexus between Asia and its number one trading partner, Mexico.

The economic significance of this extensive transportation network and strategic geographic position is that California is the single largest trading entity in the United States.

However, California's deferred investment in its infrastructure over the last three decades has created enormous challenges for the state's transportation system and environmental quality.

Gill Hicks, Chairman of the California Marine and Intermodal Transportation Advisory Council (CALMITSAC), in his testimony at the November 15, 2005, hearing of the Senate Sub-Committee on California Ports and Goods Movement, identified the following elements as contributing to California's transportation and goods movement crisis:

- Cargo growth
- Population growth
- Air and noise pollution
- Traffic congestion
- Community concerns ("How much is enough?)
- Safety and security
- Capacity constraints
- Funding limitations
- Equipment/labor shortages
- Soaring fuel prices
- Hours of service rules

The Administration and Legislature are in the process of crafting legislation that has the potential for historic short and long term infrastructure investment. Given the magnitude of investment needed to address California's 21st century challenges for economic growth, enhancing the environment and quality of life for all Californians, it is important that this opportunity harness the greatest potential of existing technologies and Intelligent Transportation Systems (ITS). These examples of existing technologies and ITS applications include:

- Real-Time large scale transportation systems
- Geo-Positioning Systems (GPS)
- Geographic Information Systems (GIS)
- Radio-based and other communications systems
- Arterial Management Systems
- Crash Prevention and Safety
- Commercial Vehicle Operations
- Intermodal Freight Operations

In addition, accelerating the development of emerging technologies that will be discussed at today's hearing by Texas Transportation Institute (TTI), Center for the Commercial Deployment of Transportation Technologies (CCDoTT), and Skytech, can offer critical components to the strategic implementation of a statewide comprehensive and integrated infrastructure investment plan. Moreover, technological innovation could be a signifigant contributing force in achieving the balance between economic growth and a zero emissions environment for California's future.

The following excerpt from the executive summary of the US Department of Transportation Freight Management and Operations 2005 report, "The Freight Technology Story: Intelligent Freight Transportation and Their Benefits," offers an overview of the process of taking a technology from idea to market application:

The Innovation and Implementation Process

Successful technology innovations follow a four-step process: (1) A *bright idea* that sets the stage for (2) *tests and demonstrations*. Successful results and a strong business case then combine to move market leaders to (3) *initial adoption and deployment.* Once the viability of a new technology is well established and its benefits are clear, (4) *wide adoption* will occur. Step 4 cements the transition of the bright idea to market penetration. However, the biggest hurdle in the process is building sufficient confidence in the technology, through tests and demonstrations, to prompt initial adoption—the move to step 3.

Three principal triggers move businesses to implement intelligent freight technologies:

1. **Pursuit of competitive advantage** is likely to be the main trigger for market leaders and innovators as they seek to improve their firm's standing and profitability in the marketplace. The critical element is a credible business plan.
2. **Keeping up with competitors** is the apparent catalyst for market followers. Success by market leaders progressively erases doubt and skepticism about new solutions and shifts the debate in other firms from *whether* to *when and how.*
3. **Compliance** may arise from customer demands or government regulations. Commercial compliance comes into play when customers demand innovation as a condition of doing business. Regulatory compliance is self explanatory.

There are also several barriers to the acceptance of new technologies and operating practices:

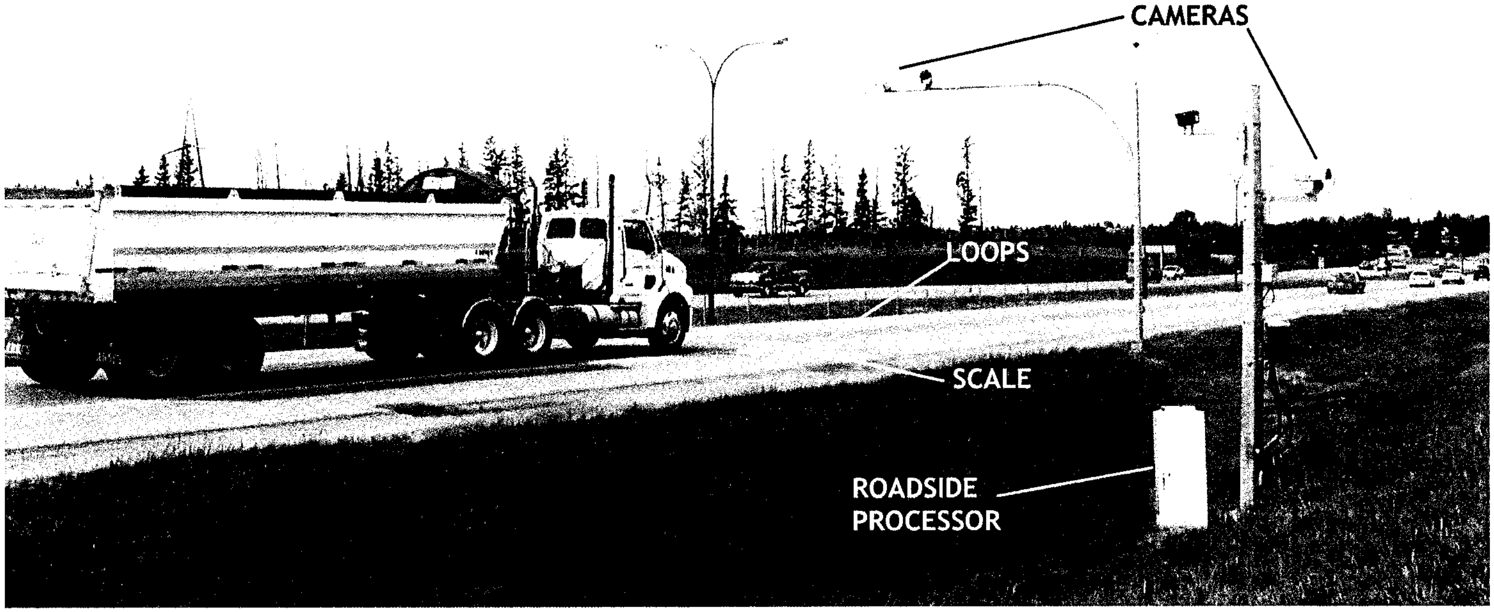
- Skepticism about **efficacy** is the fundamental concern.
- Immature **standards** can deprive vendors and users of a common and fair template for deployment.
- Concerns about **negative operational impacts**, such as the need to replace batteries in the field, may mobilize opposition from service providers.
- The **credibility of the business case** is often the dominant concern, with the strongest skepticism reserved for estimates of benefits.

Innovation and knowledge are and will continue to be vital for sustained economic growth and quality of life. Advancing technology, with strategic investment, can be cost effective and potentially provide a driving force that can help efficiently address California's increased congestion, doubling of trade volume, environmental mitigation, and land use challenges.

The Joint Committee may want to explore the following questions (Questions 1-5 suggested for the Administration).

1. What is the current level of ITS deployment in California?
2. SB 1165 the Congestion Reduction, Clean Air, and Trade Corridor Bond Acts of 2006 allocates $200 million for Intelligent Transportation Systems (ITS). Is this allocation sufficient for an effective and strategic statewide ITS deployment? If so, Why. If not, what kind of ITS investment is needed?
3. What is the future level of ITS deployment (2 year, 5year, and 10 year horizons)?
4. How is the state's ITS program organized?
5. What are the costs and benefits of ITS?
6. Is there a role for California's university research network, federal laboratories, and community colleges in the advancement and deployment of technology?
7. What criteria would best be applied to vetting emerging technologies?

Pre-Pass



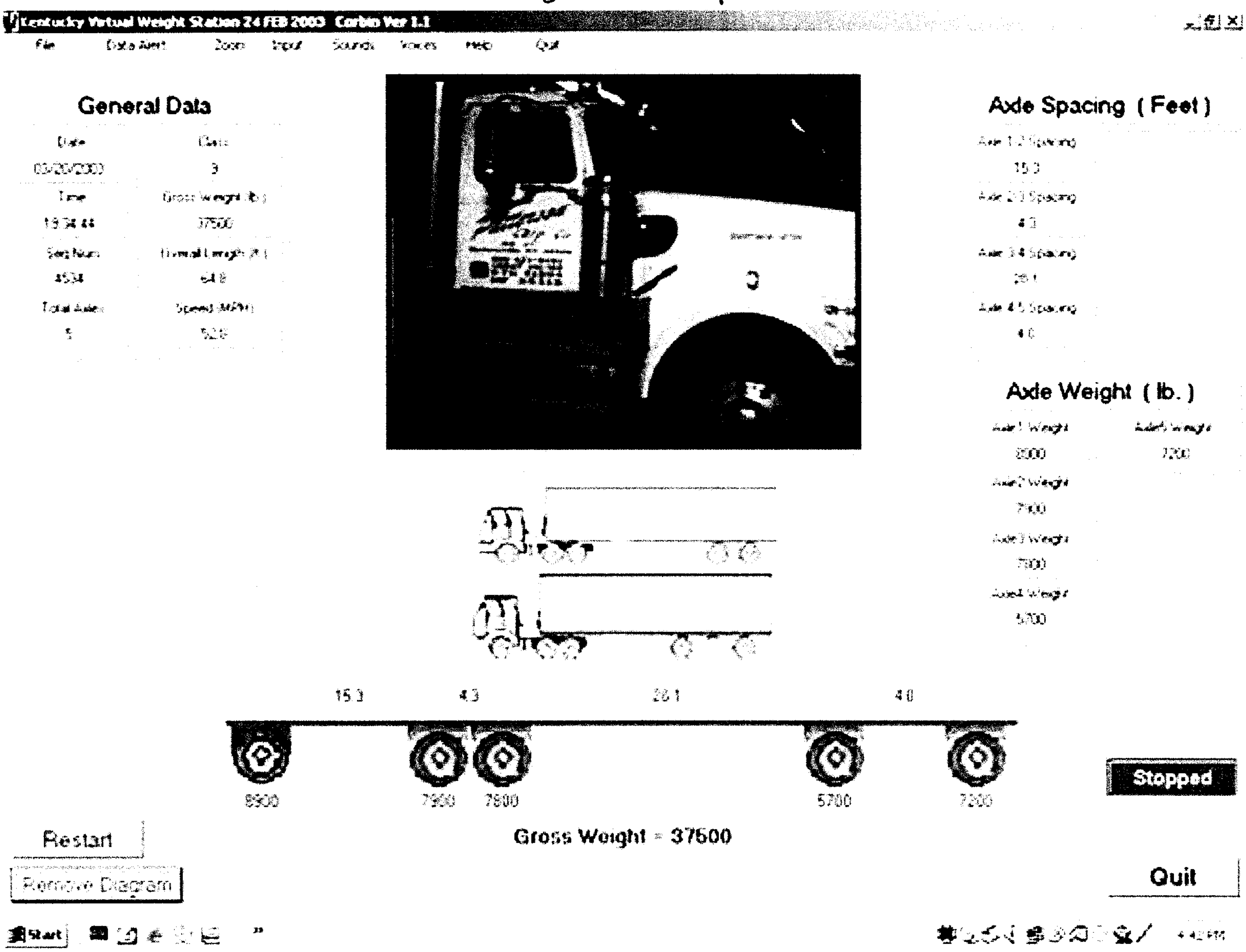
ROADSIDE EQUIPMENT

TYPICAL DATA COLLECTED TODAY

(6339) LANE NB#2 TYPE 9 GVW 71.7 kips LENGTH 69 ft
18-KESAL 2.184 SPEED 55 mph MAX GVW 80.0 kips Thu Sep 29 11:52:57:51 2005

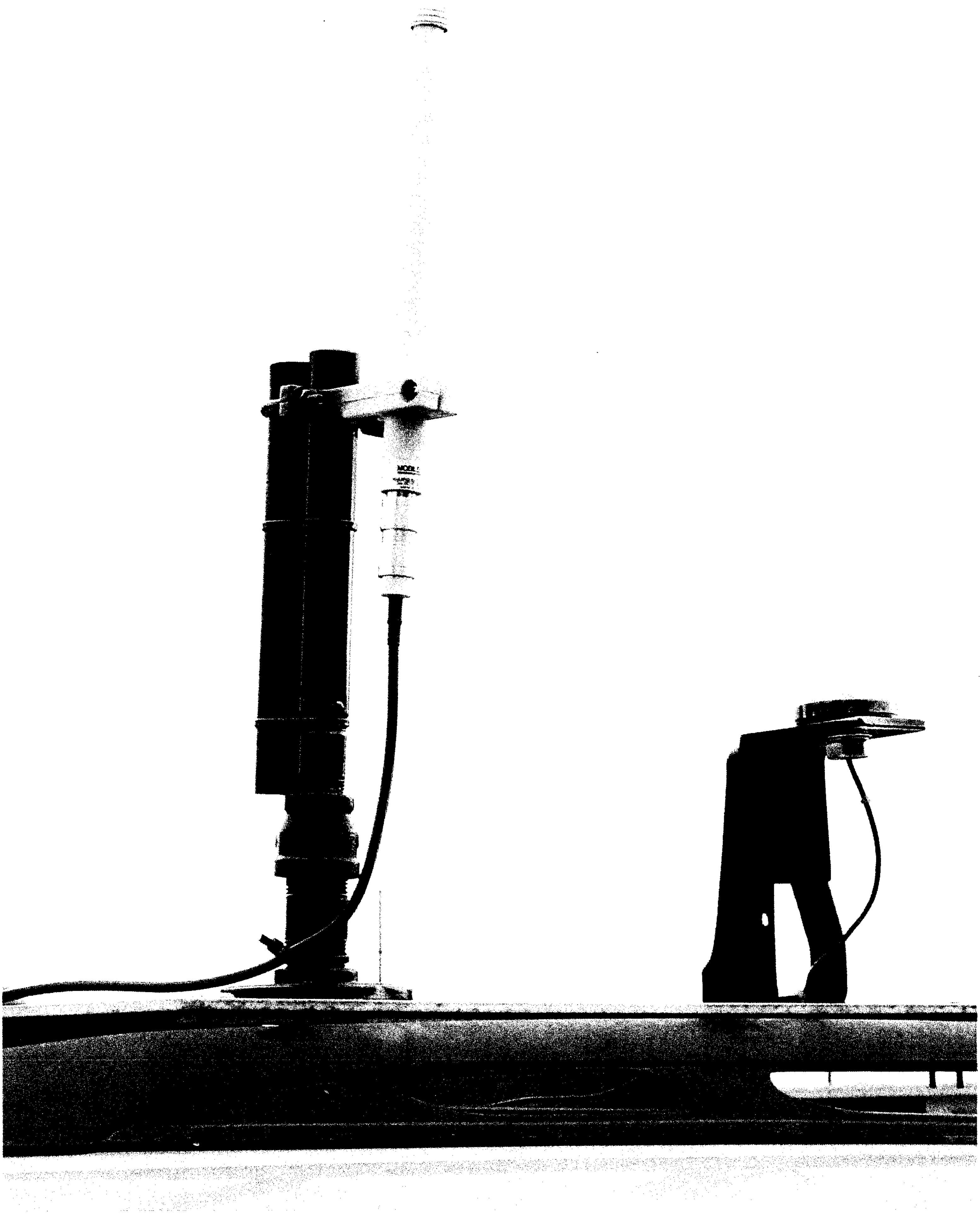
UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1		4.5	5.0	9.6	20.0
2	18.3	7.2	7.8	15.0	17.0
3	4.3	6.4	7.7	14.1	17.0
4	30.1	8.7	8.4	17.0	20.0
5	10.3	7.3	8.7	16.0	20.0

Virtual Weigh and Compliance Station



Open Road Tolling

Vehicle-Infrastructure Integration (VII)



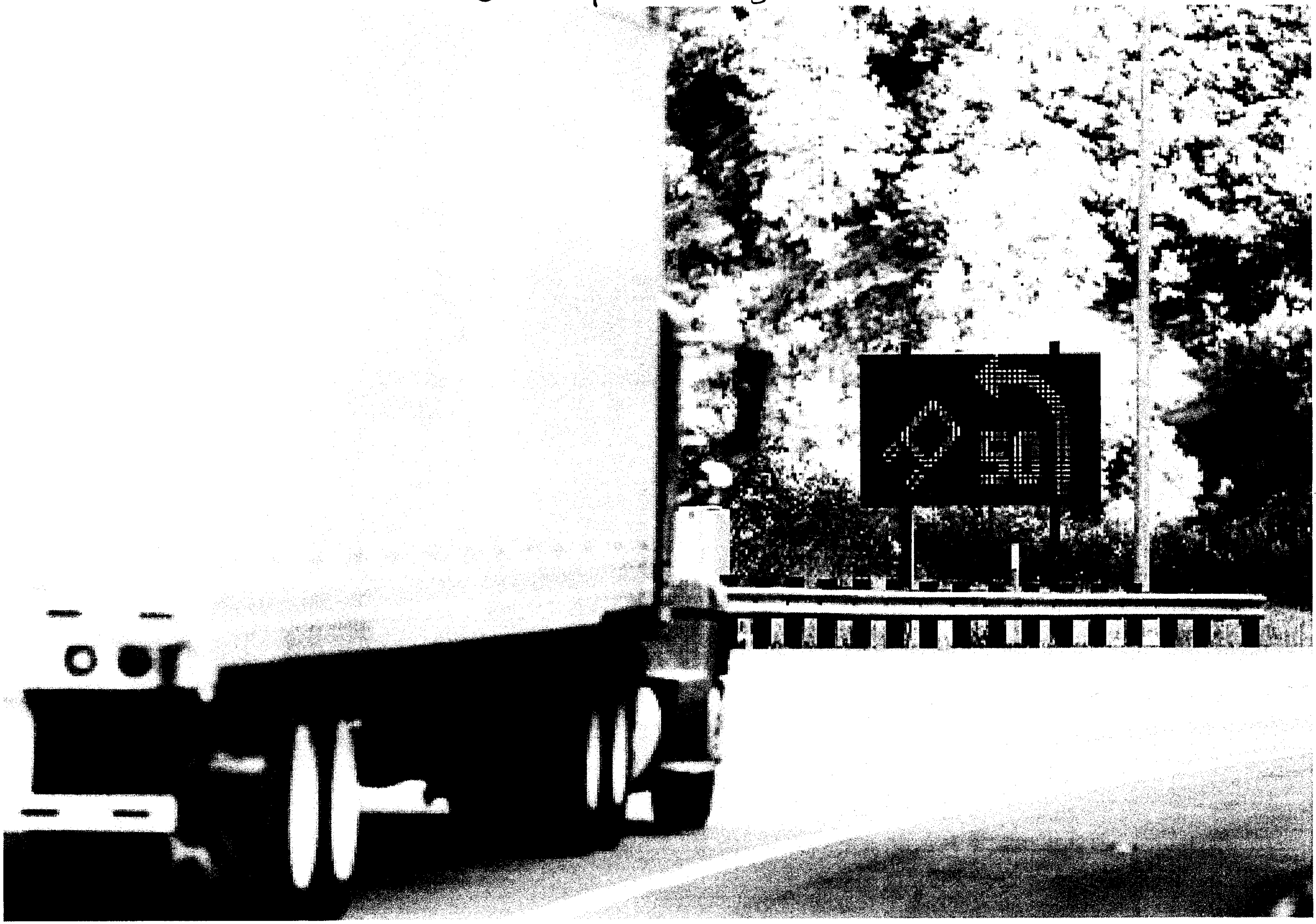
Travel Times on CMSs

511


511
TRAVEL
INFO
CALL 511
Caltrans Photography
04-12192-0-012

Crash-Less Intersections

Curve Speed Warning



BASE

Trends in Transportation and Goods Movement Electrification

Economic Development AND Reduced Emissions

Ed Kjaer

Director, Electric Transportation

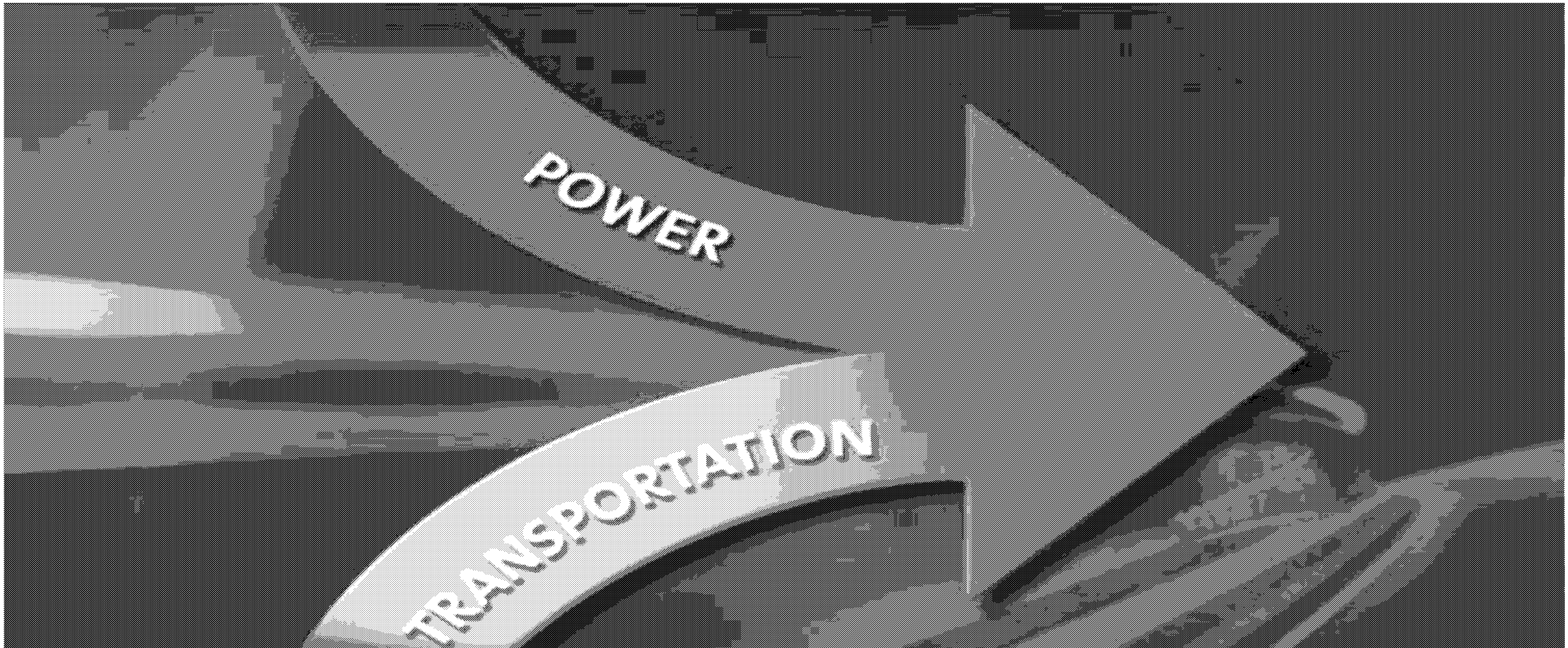
Southern California Edison

SOUTHERN CALIFORNIA EDISON®

An EDISON INTERNATIONAL® Company

What is changing the way we think about transportation and energy security, energy storage, energy efficiency, emissions and gas stations?

...Electricity and The Grid

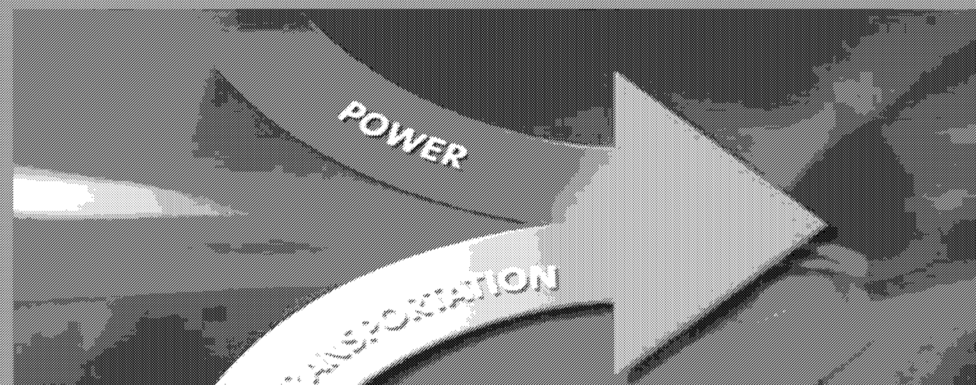


Transportation Is Becoming "Electricity" Powered

- Hybrid vehicles today; Plug-in-Hybrids and fuel cell vehicles tomorrow
- Electrification at marine ports, truck facilities, airports, and rail yards
- Electric goods movement equipment.

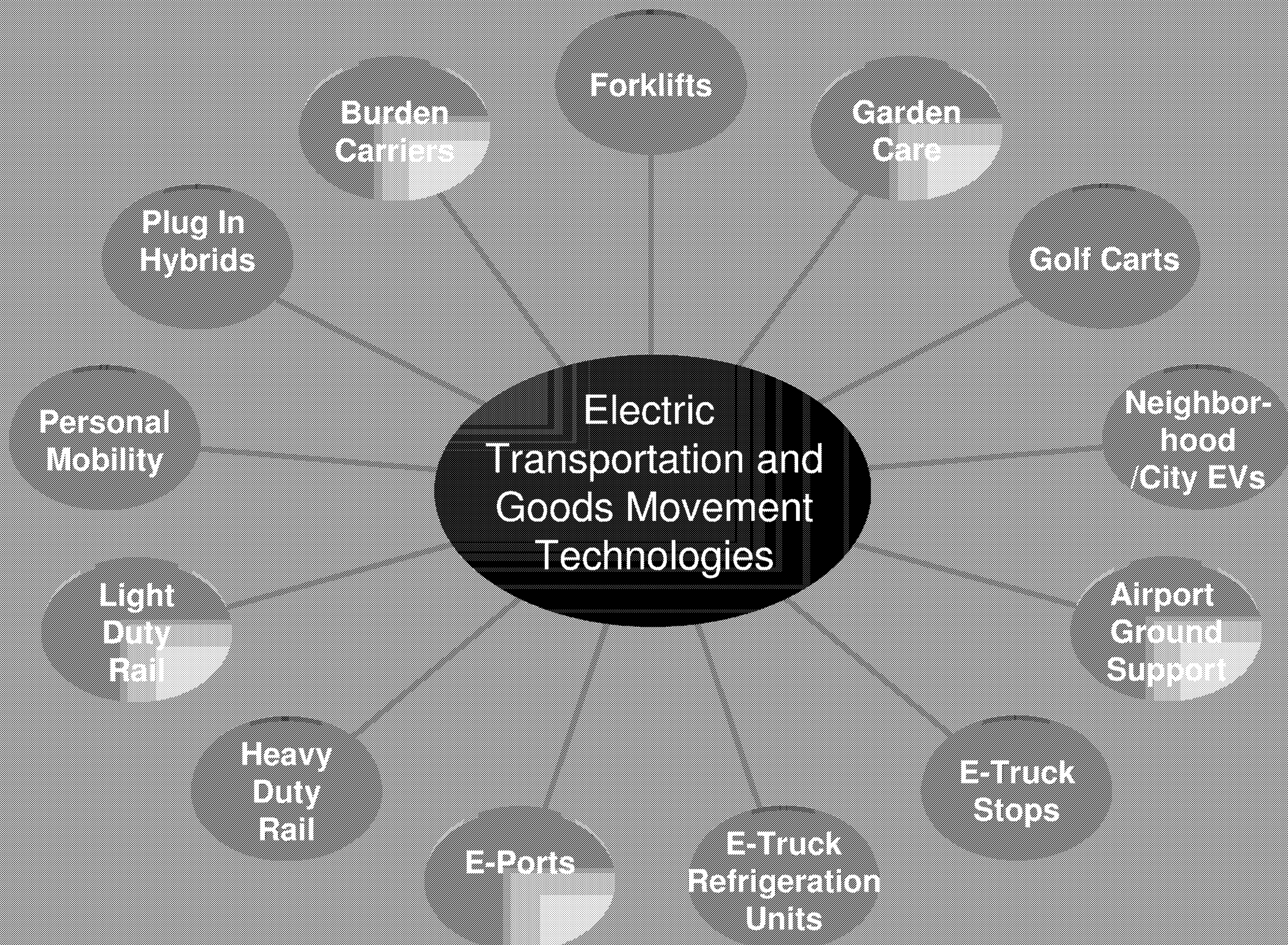
Increasingly, State Focusing On Electrification To Reduce Emissions, Particulates and Petroleum Usage

- Draft Goods Movement Plan (partial)
- Draft Climate Action Plan (partial)
- Energy Action Plan
- Integrated Energy Policy Report
- Compliance option in many CARB rules
- Eligible in most Moyer grant categories



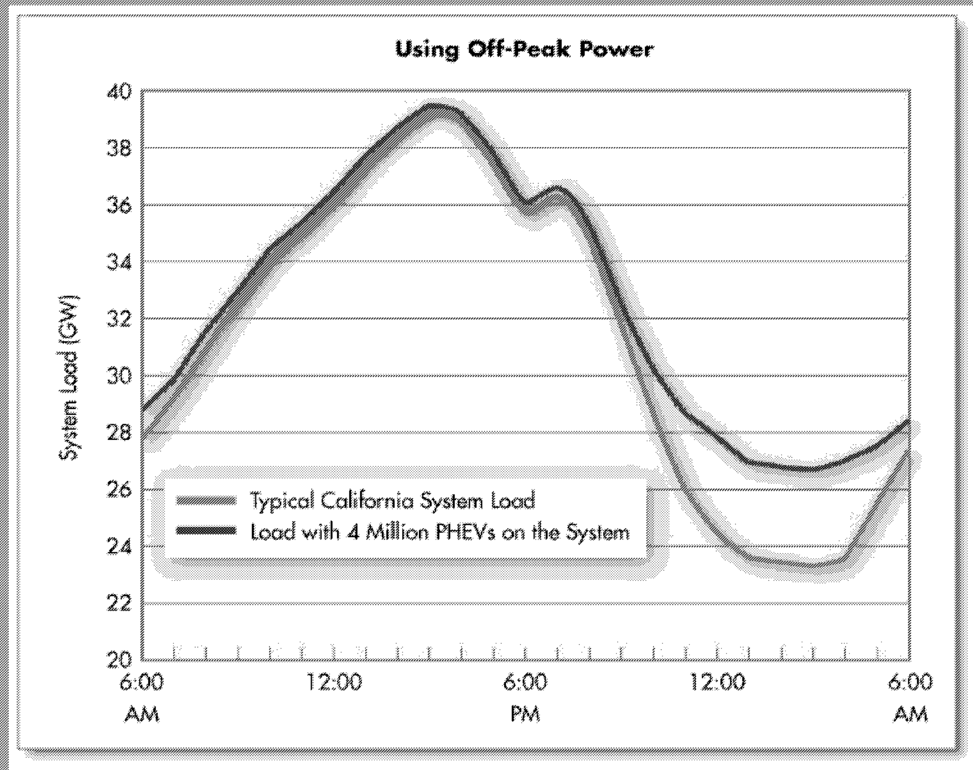
Sustaining Our Transportation Future
(Battery, hybridization, hydrogen fuel cell powered)

And Its More Than Just Our Cars Today… and Tomorrow



Benefits From The Grid

- Domestic, petroleum free, multiple feed stocks
- Excess off-peak capacity
- 20 – 30 % cost of petroleum (gge)
- Reduces urban air pollution (ZEV miles)
- Generation only getting cleaner over time (regulations, technology)



Source EPRI

Near Term Infrastructure Opportunities

Alternative Marine Power Or "Cold Ironing"

- LA / Long Beach = 43% nation's goods entrance
- If 100 ships electrified; = to removing 535,000 MY 2005 cars (NO_x + ROG+ SO_x)

Navy has used "cold ironing" for 50 + years.
Commercial examples in Alaska, Seattle, Bay Area, Los Angeles, Europe

Source: TIAX - "2020 Achievable"

Near Term Infrastructure Opportunities

Truck Idling Reduction with Electrification

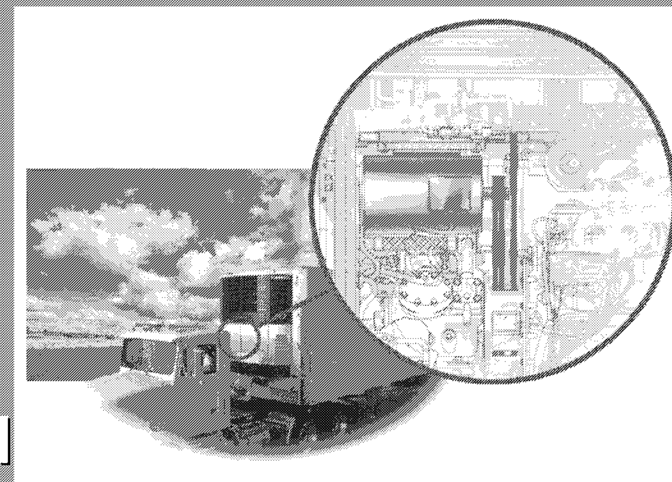
- Est. 76,000 sleeper cab trucks in California today and growing very fast
- If electrified through 2020; = to removing 360,000 MY 2005 cars (NOx + ROG)

Source: TIAX -- "2020 Achievable"

NOTE: above numbers are conservative - based on small diesel APU. They would be much larger if based on main truck engine idling.

Near Term Infrastructure Opportunities

E-Truck Refrigeration (eTRUs)



- About 4,000 – 7,000 in CA today
- Plug in at distribution centers, warehouses or ports, but use diesel on road
- 31,000 diesel TRUs (semis, bob tails, & vans) could switch to e-TRUs
- Additional electrification through 2020;

  = to removing 400,000 MY 2005 cars (NO_x + ROG)

Source: TIAX – "2020 Achievable"

Near Term Infrastructure Opportunities

Non-road EVs

- About 300,000 electrics in CA today
- Wide range of electric equipment
  - large units such as forklifts
  - small units such as burden carriers
  - emergence of small utility trucks for ports
- Additional electrification through 2020;

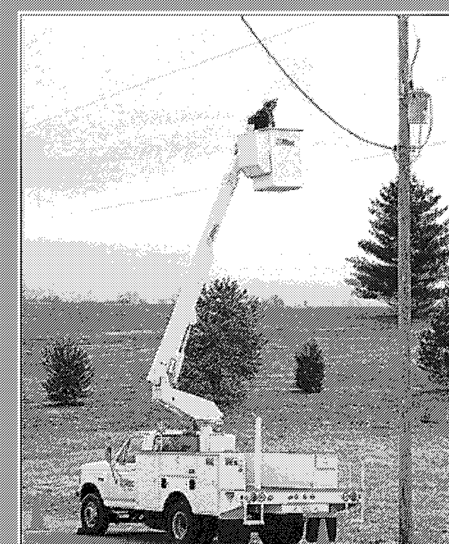
  = to removing 580,000 MY 2005 cars (NOx + ROG)

NOTE: conservative – assumes CARB passes new rules this year to clean up diesel and propane versions of this equipment. Source: TIAX "2020 Achievable"

Mid Term Opportunities

Plug-in-Hybrids

- Fully functional battery EV and conventional hybrid inside one car
- Battery breakthroughs and cost reductions from existing hybrids is "enabling" Plug-in-Hybrids
- Plug-in-Hybrids will "enable" fuel cells.
- Light/Medium/Heavy duty applications
- Large potential in medium and heavy duty goods movement.
- Large economic development potential for CA



Near Term to Mid-Term Infrastructure Opportunities

- Other electric options
  - Electric Gantry Cranes - examples today in ports
  - Electric Short Rail - 100 year old technology.
  - Dual-mode Electric Freight Rail - 100 year old tech
  - High Speed Rail and Maglev
- RD&D
  - Heavy duty plug-in hybrid EVs – e.g. yard hostlers and larger forklifts

Long Term Infrastructure Opportunities

Hydrogen and Fuel Cell EVs

DaimlerChrysler

Hyundai

Issues of; range, infrastructure, cost, etc

Bringing it all Together: Potential for California in 2020

Electric-Drive Technology	Estimated Reductions in NOx + ROG (tons per day)	Est. Reductions in Petroleum (billions of gasoline gallon equiv)
Alternative Marine Power (cold ironing)	16.9 tpd (with SOx)	0.03 billion gallons /yr
Truck Stop Electrification	11.7 tpd (w/ new CARB rule)	0.06 billion gallons/yr
Electric Truck Refrigeration Units	12.8 tpd	0.04 billion gallons/yr
Non-road Electric Equipment	18.8 tpd	0.25 billion gallons/yr
Plug-in Hybrid EVs	7.1 tpd	1.15 billion gallons/yr
Hydrogen Fuel Cell EVs	1.0 tpd	0.07 billion gallons/yr
Others	17.9 tpd	0.17 billion gallons/yr
High Speed Rail, Freight Rail, Light Rail, Gantries, Heavy Duty Hybrids, Buses, Bikes, Segways, Boats	Not calculated	Not calculated
Total - Average reductions	***86 tons per day statewide***	***1.77 billion gge per year***

Note: All figures are "well-to-wheels" calculations

Source: TIAX

NOTE: the total particulate matter (PM) reduction for 2020 is 7.5 tpd

Summary

- Benefits of transportation and goods movement electrification are very large in reducing air pollution, particulates, and petroleum dependency
- California grid has excess “fuel” capacity off-peak
- Near, mid, and long-term solutions exist
- Can have strong economic growth and reduce emissions at the same time
- Challenges of cost and funding

Exploring A 21st Century Alternative for Container Transport

Presented to the

California

Senate Transportation Committee

And the

House Transportation Committee

Stephen S. Roop, Ph.D.
Assistant Director,
Texas Transportation Institute

February 2006

EXPLORING transportation ALTERNATIVES

21st Century Freight Transportation Challenges

- Public Safety
- Environmental Impact
  - Air
  - Noise
- System Capacity
- System Maintenance & Preservation
- Adverse Impact on Quality of Life
- Oil Dependency
- Security

EXPLORING Transportation ALTERNATIVES

Maintaining Freight Movement: The Challenge at Ports

- Significant levels of national and regional trade
  - Significant percent of import containers are destined for the regional economy
  - Results in chronic truck traffic problems on local/regional highways

21st Century Freight Transportation System Requirements

- VIABLE FREIGHT TRANSPORTATION SYSTEMS MUST BE:
  - Low-cost and have a long operating life – rugged and simple
  - Based on known-understood technology
  - Well-suited to the task at hand
  - Reliable – reduce supply-chain uncertainty
  - High Capacity – increases throughput
  - Interconnected with the existing intermodal system
  - Environmentally Clean
    - Air
    - Noise
  - Segregated; freight from passenger traffic
    - Reduces roadway congestion
    - Improves safety
  - Secure

Freight Transportation is a Cost Minimizing Industry

The SAFE Freight Shuttle

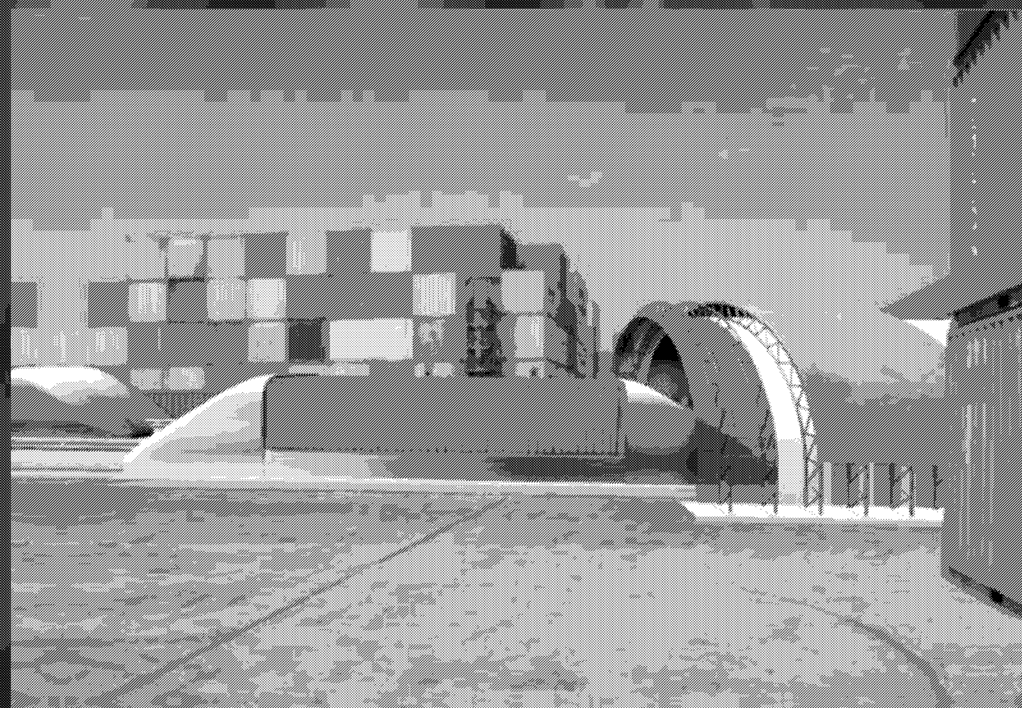
- A new approach to regional Intermodal Freight transport
  - Concept developed over the last 6 years at the Texas Transportation Institute
  - Based on known and understood technology
  - May effectively address both community and commercial needs

Combines technology and innovation to meet basic freight transportation requirements in an environmentally responsible manner

EXPLORING Transportation ALTERNATIVES

The SAFE Freight Shuttle

- **S**ecure
- **A**utomated
- **F**ast
- **E**nvironmentally-clean



Hybrid System Combining the Best Features of Rail and Trucks

The SAFE Freight Shuttle

EXPLORING
ALTERNATIVES

The SAFE Freight Shuttle

- Automated Freight Shuttles
  - Single-container transports
  - Linear induction motors (LIMs)
  - Designed for steel wheels-on-steel running surface
  - Dedicated, small footprint guide way
  - Surface operations, elevated, or subterranean

24/7 operations offer an option that may overcome throughput, capacity, and impact issues affecting marine terminals

Technology

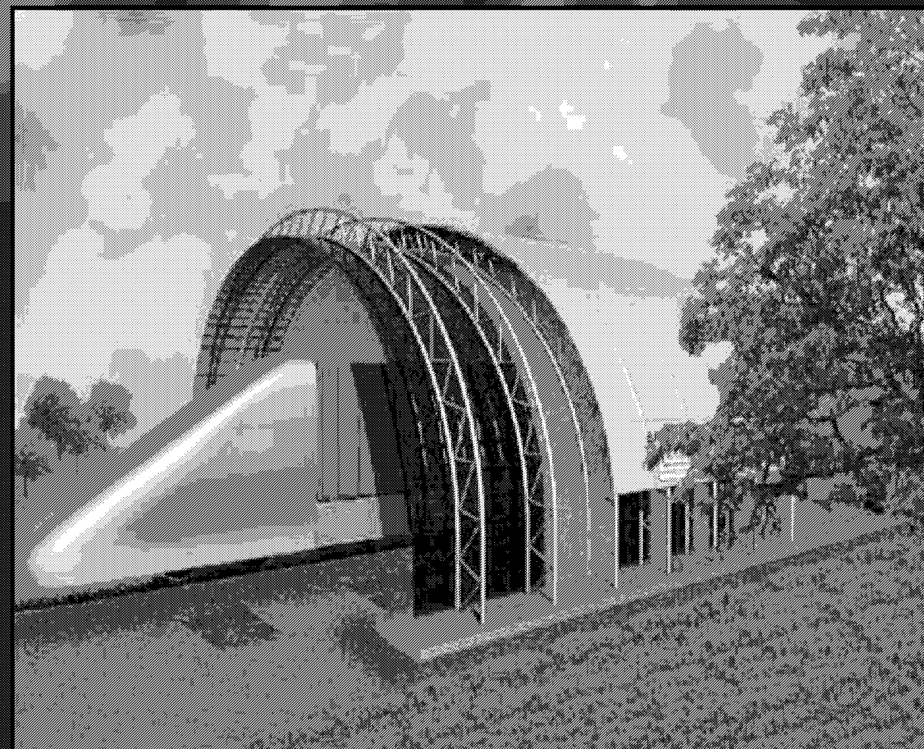
- Four systems interact to provide functionality:
  - 1. Vehicle
  - 2. Guide way
  - 3. Communications/ command/ control
  - 4. Terminal layout and design

EXPLORING

ALTERNATIVES

Technology

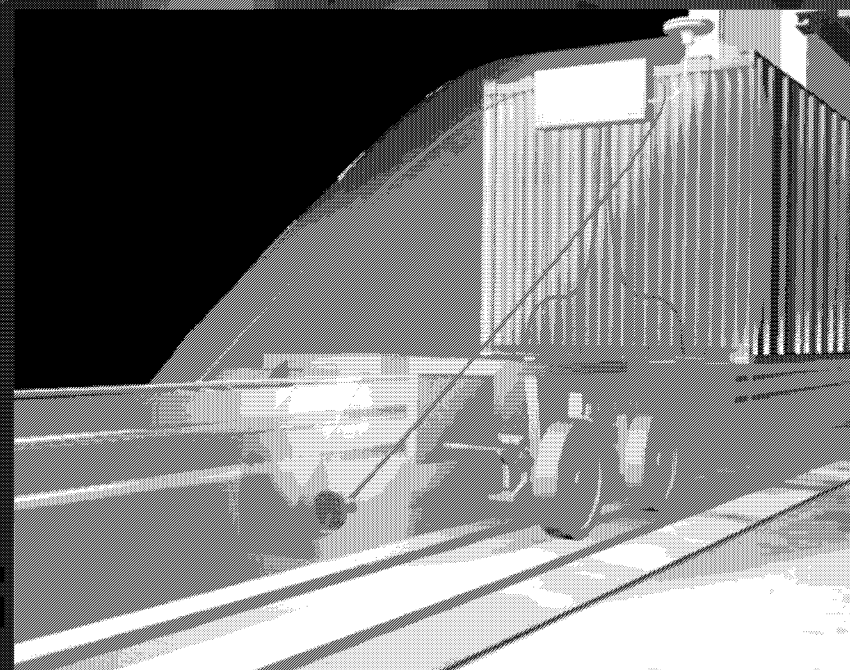
1. Vehicle
   - Automated
   - Aerodynamic leading and trailing ends
   - Moderate speeds (30-70 mph)
   - Electric LIM propulsion
   - Design simplicity – few moving parts
   - Built/tailored specifically for container transport
     - Minimize cost



EXPLORING
ALTERNATIVES

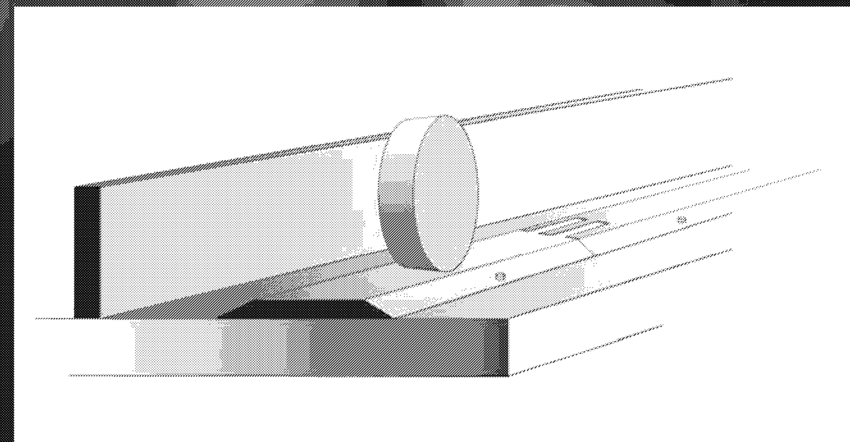
Technology

- High reliability
  - LIM – linear motion from vehicle-track interaction
  - Small number of moving parts
  - Automated control system
  - Steel-on-steel for low rolling friction/low cost



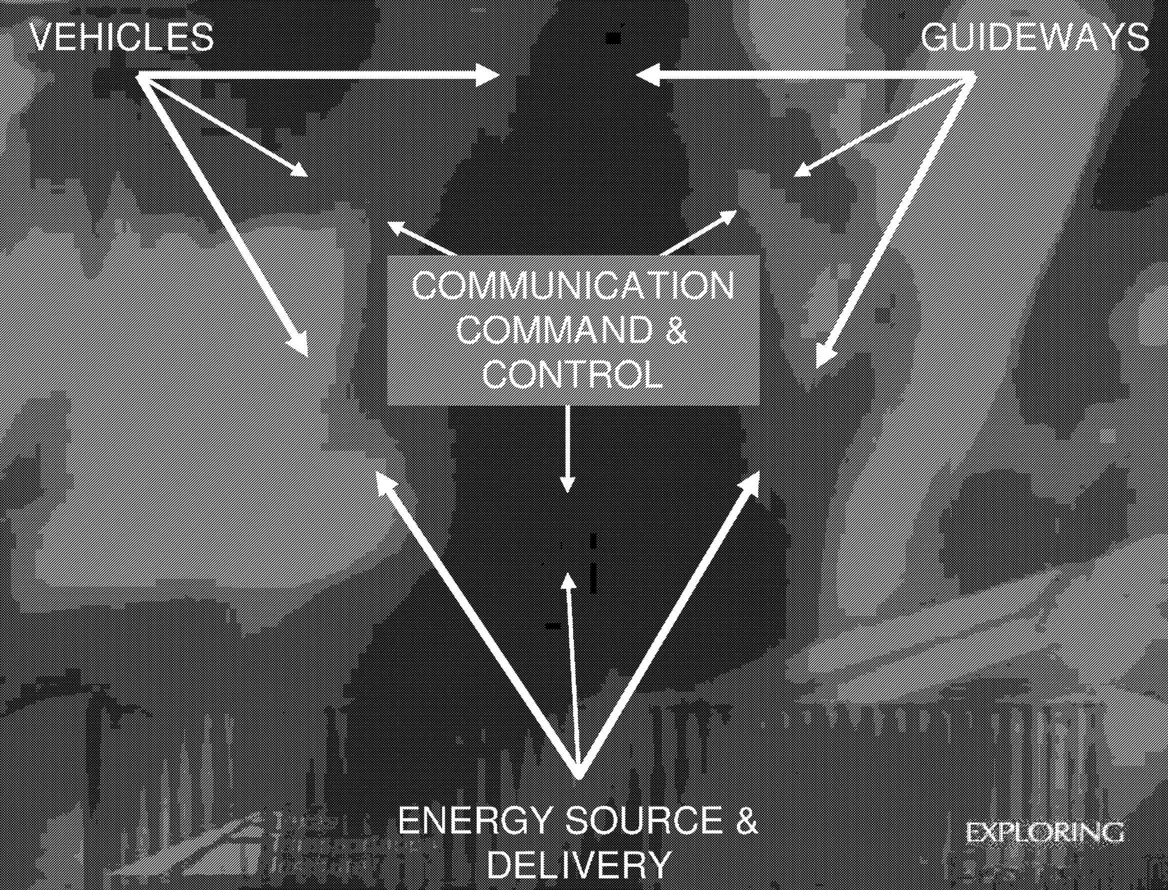
Technology

2. Guide way
   - Concrete track bed
   - Steel running surface
   - Small footprint
   - Rail expansion joints
   - Low-cost infrastructure



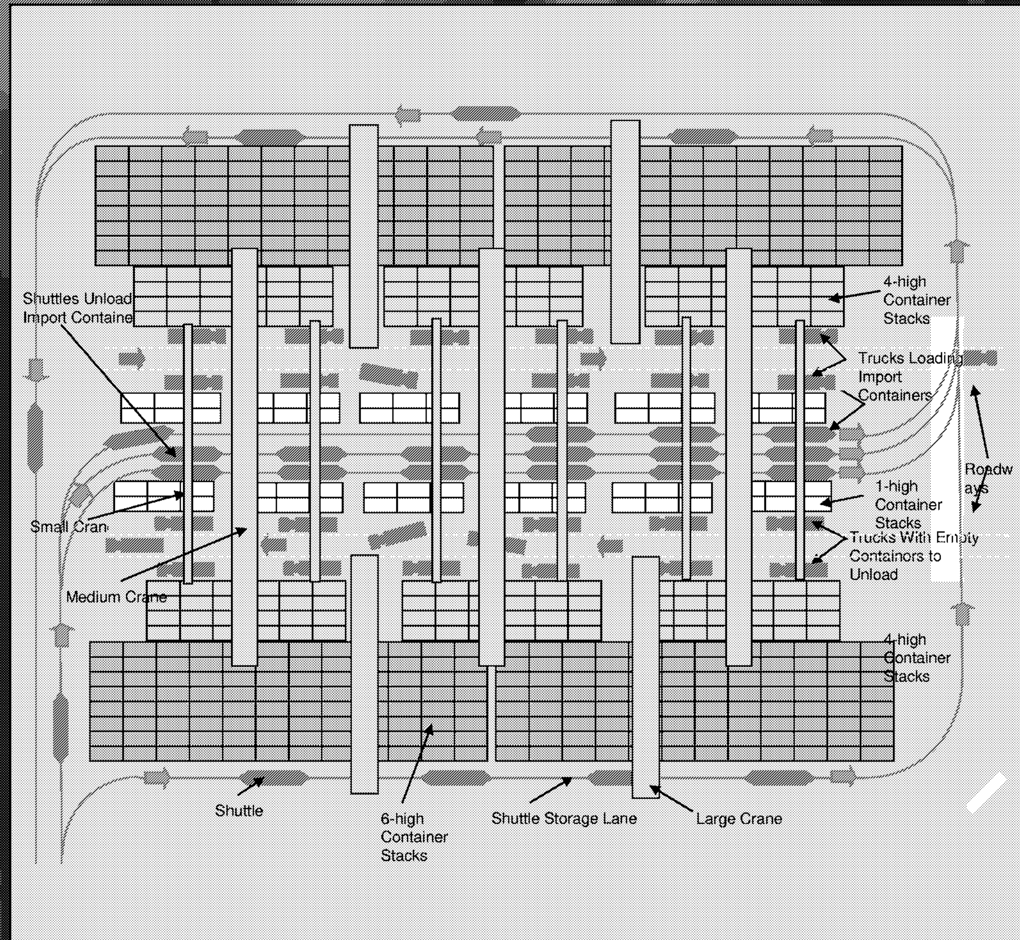
Technology

3. Communications Command Control (C3)



Technology

4. Inland Terminal Layout and Design
   - High capacity
     - 3000 containers/day
   - Automated
   - Crane configurations
   - Small footprint
     - 25 acres



EXPLORING
ALTERNATIVES

The SAFE Freight Shuttle

EXPLORING

ALTERNATIVES

Economics

- Low infrastructure costs
- Low operating cost
  - Low rolling friction
  - Aerodynamic leading/trailing fixtures
  - LIMs

<u>Results in operating costs of < $0.10 per mile</u>

(based on S. Cal electrical rates)

EXPLORING

ALTERNATIVES

Economics

Cost per Mile By Comparison to Rail Infrastructure

- Track
  - ROW acquisition
    - Ballast
    - Ties
    - Rail
  - Signal System
- Vehicles
  - Number required
  - Estimated cost
- Grade Separation Structures
- Command and Control Systems
  - Centralized Dispatch
- Terminal requirements
  - Land
  - Equipment

Economics

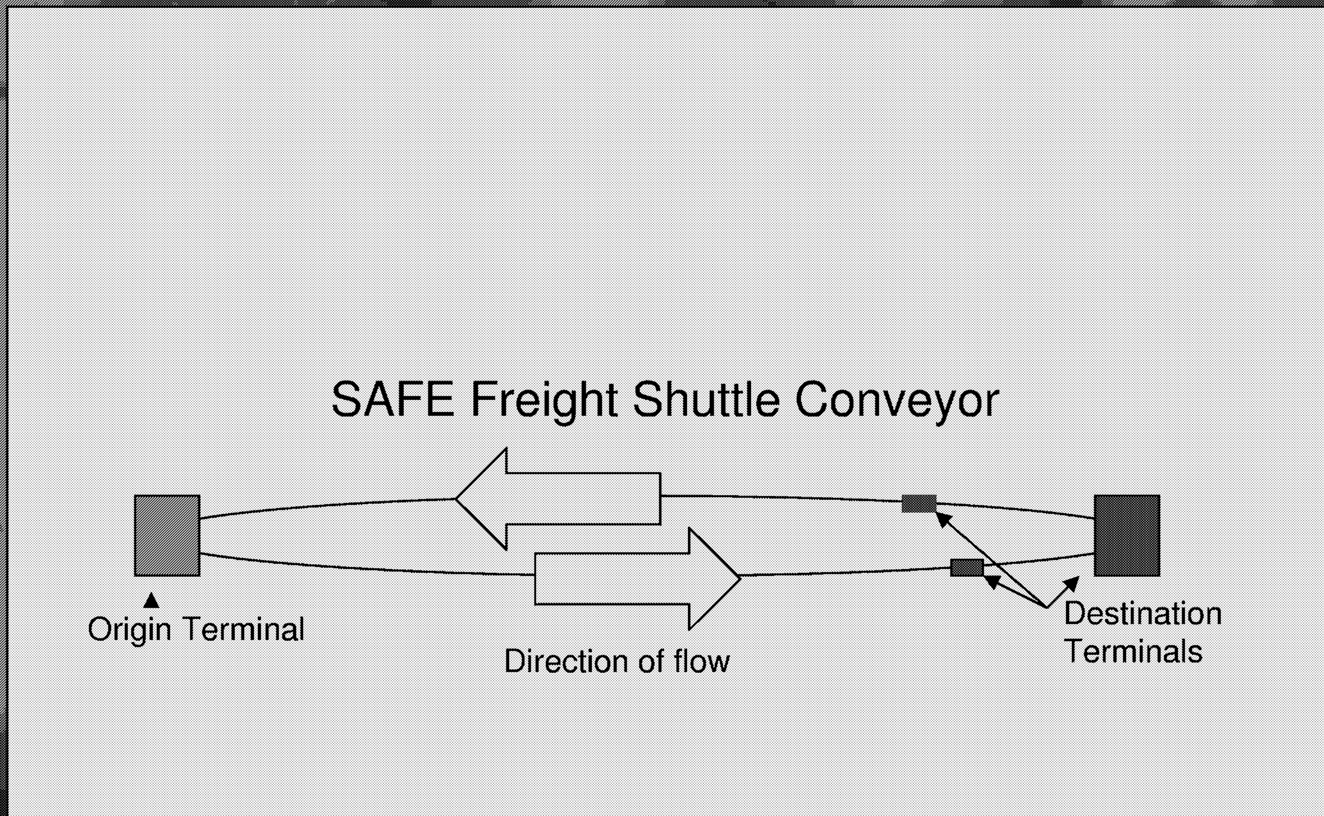
- Public financial benefits*

	per mile cost
– Congestion	$.2006
– Pavement/infrastructure damage	$.4090
– Air quality	$.0449
– Safety	$.0115
– Noise	$.0304

Accruing at a net rate of $0.62 per mile for fully loaded trucks on urban roadways, relocation of truck VMT creates a real opportunity for public-private collaboration

* Federal Highway Administration

SAFE Freight Shuttle System Operations



EXPLORING
ALTERNATIVES

Operations

- Operations
  - Single unit transports
  - Continuously circulating system
  - 6000 containers per day
  - Interfaces with existing intermodal system(s)
  - Short, intermediate distances
  - Low operating cost (< $0.10 / mile)

Operations

- High capacity
  - Provides the means to redesign terminals and landside logistics
  - Multiple origins/destinations
  - Uninterrupted flow
  - Interfaces with existing intermodal equipment

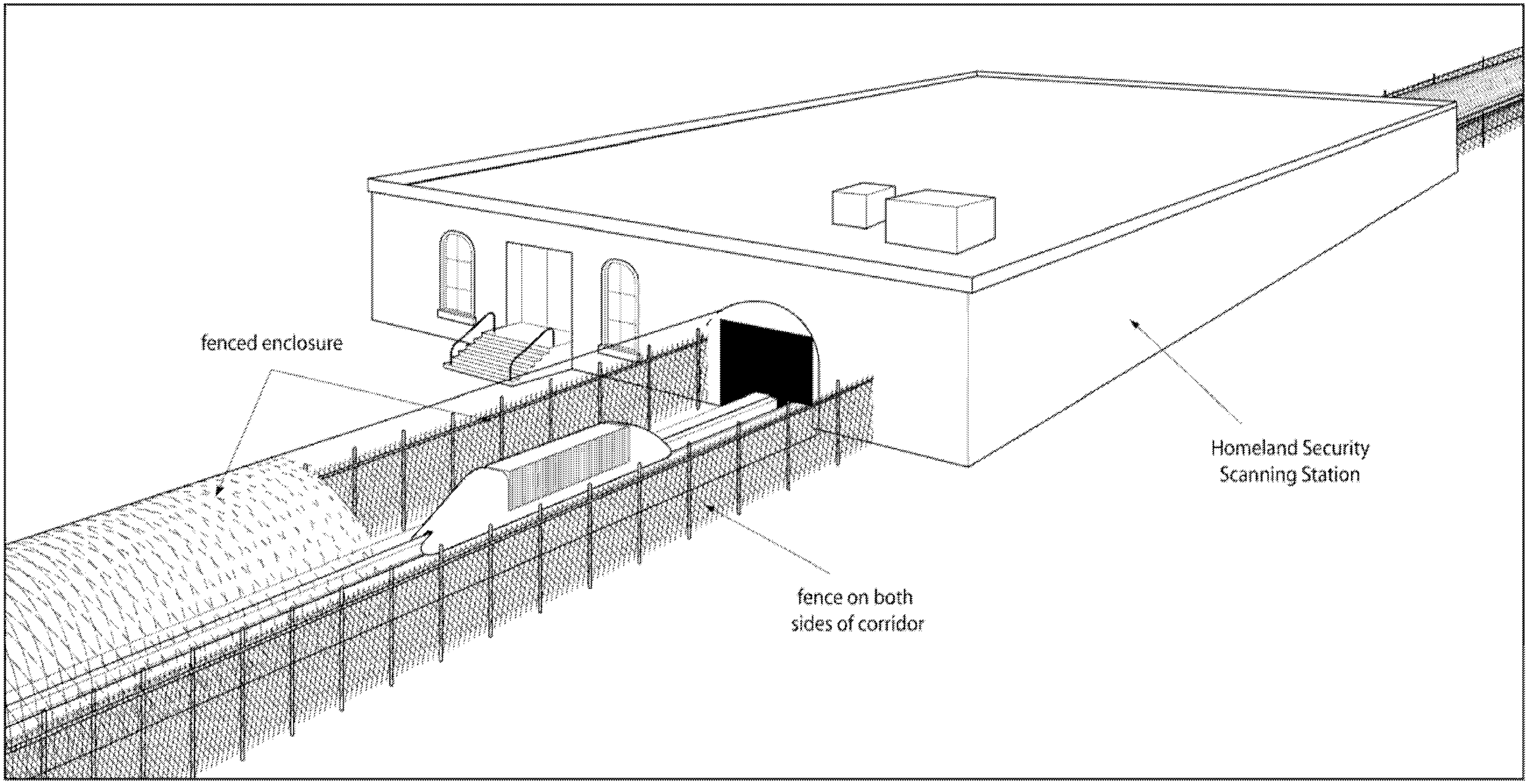
Capacity determined by terminal design and space

EXPLORING Freight Transportation ALTERNATIVES

Operations

- Security
  - Operates on a secure corridor
  - Inspect-in-motion
  - Vehicle tracking
  - Container tags/locks
  - Vehicle design precludes tampering

DHS initiatives will support approaches that enhance security



Inspect-in-Motion Concept within a Secure SAFE Freight Shuttle Corridor

EXPLORING
ALTERNATIVES

The SAFE Freight Shuttle

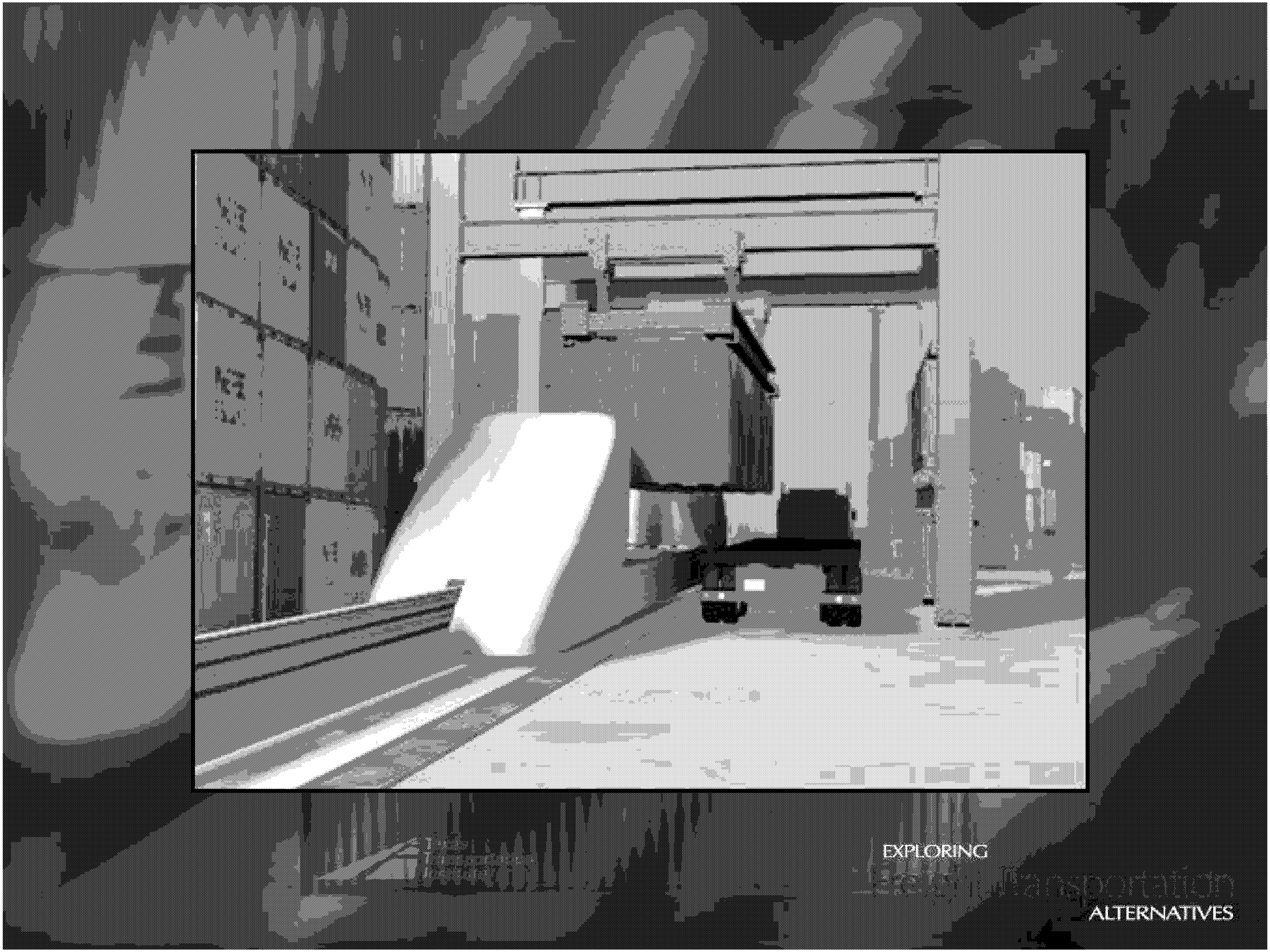
- Design features enhance system viability
  - High capacity / continuous operation
  - Simplicity of design / system reliability
  - Energy efficiency / low operating cost
  - Reduce supply-chain uncertainty / increase control

- And mitigate the most pressing adverse impacts of high levels of truck traffic
  - Grade separation of alignment
  - Segregation of freight from passenger traffic
  - Non-polluting propulsion system

The SAFE Freight Shuttle

EXPLORING

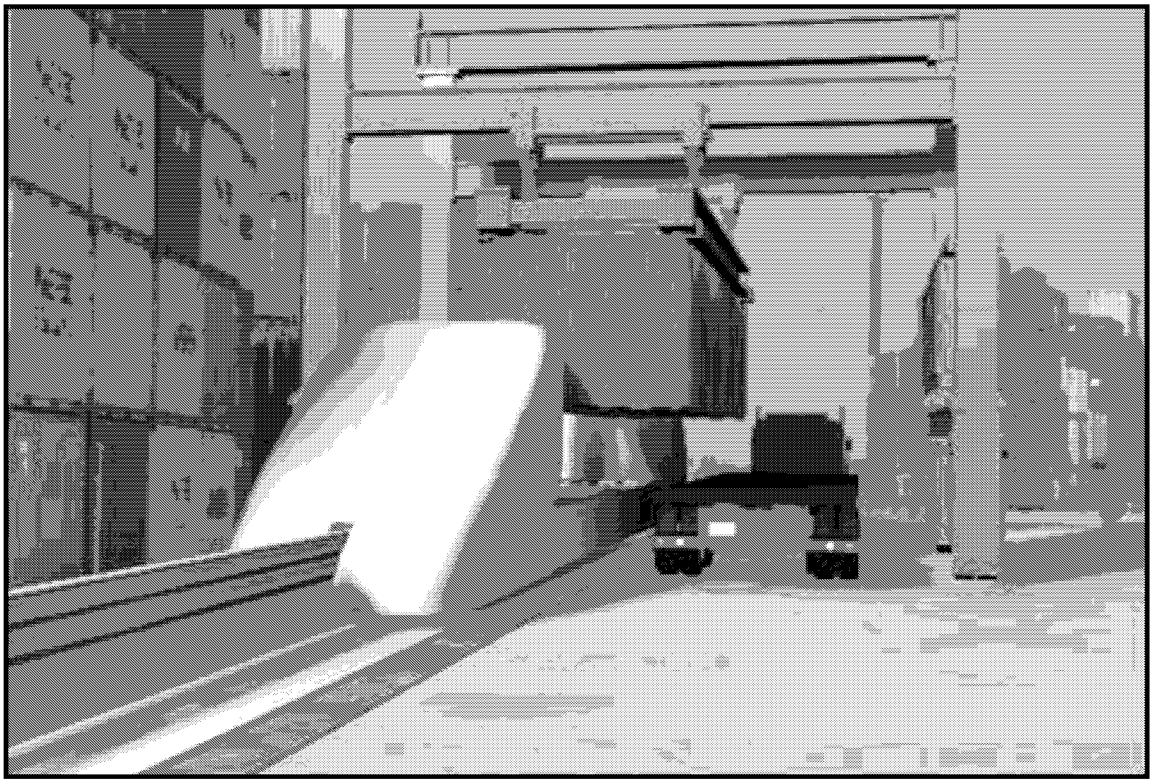
ALTERNATIVES


EXPLORING
ALTERNATIVES

THE SAFE FREIGHT SHUTTLE:

The Crisis in Freight Transportation

And the Opportunity for a Green Alternative



A Concept for 21st Century Freight Movement

Stephen S. Roop, Ph.D.

Texas Transportation Institute

The Texas A&M University System

College Station, Texas

February 2006

SUMMARY

The convergence of several individual problems is creating the conditions for a transportation crisis of unprecedented scope and magnitude. It will result from sky-rocketing demand for transportation services and the capacity crisis on our highways, from complete dependence on oil for transportation, and from highway infrastructure deterioration. Of central concern – without innovative approaches, it may take shape in a funding atmosphere insufficient to avoid the consequences.

The crisis will result in unpredictable changes in the way we as a country do business. But it also creates an opportunity in freight transportation that is the subject of this paper. It describes an opportunity to move freight transportation systems into the 21st century by employing technological innovation to solve the pressing problems facing the public and private transportation sectors, shippers, consumers, and those government agencies charged with providing transportation services – and to do so in a way that is environmentally responsible.

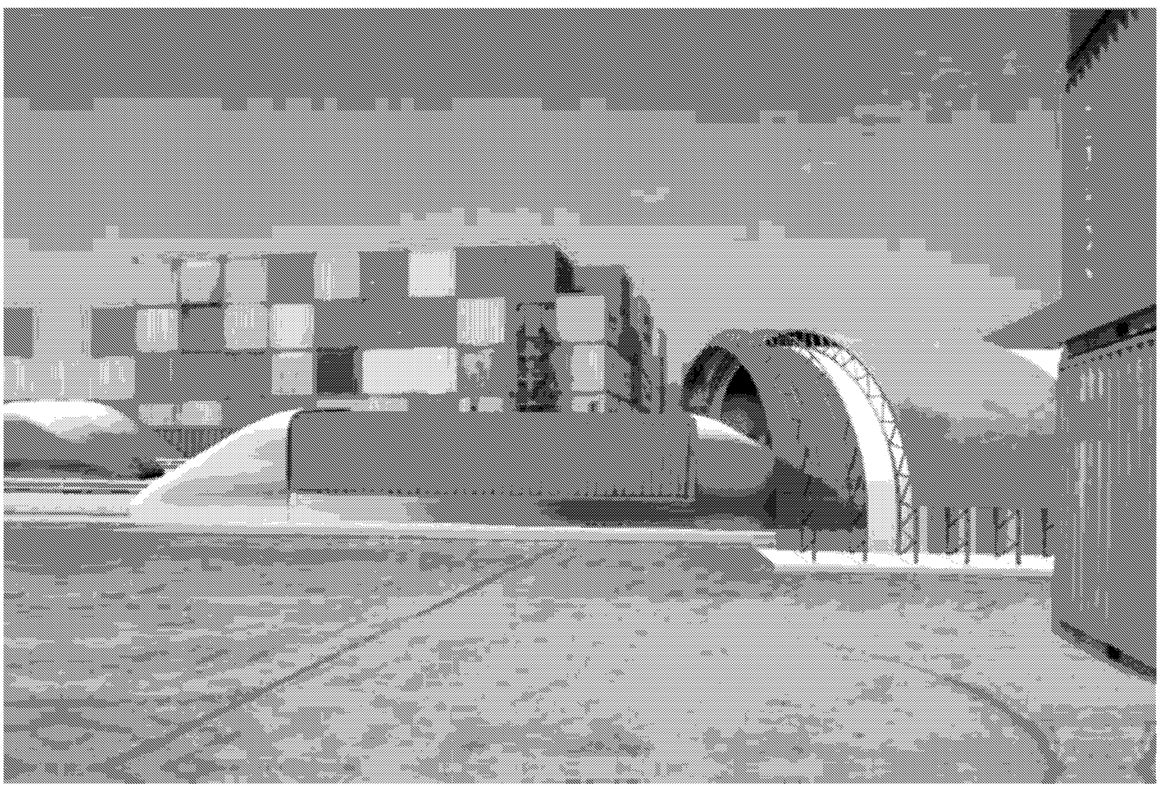


Figure 1 – The SAFE Freight Shuttle

INTRODUCTION

The transportation of freight is the life-blood of the economy. Goods and material flow in vast quantities from manufacturers to customers in a highly complex system. Container ships, trucks, and double stack container movements by rail operate in concert to provide a seamless transportation network that can move cargo from overseas suppliers to distribution centers or retail outlets in sealed containers. This transportation system, which has developed over many decades, has achieved high levels of efficiency and responsiveness that in turn has fueled economic growth in both domestic and international markets.

However, for all of the accomplishments of the modern freight transportation industry, there are very real and significant problems emerging that threaten to constrain trade and limit future economic development. Among them are growing roadway congestion on a deteriorating highway infrastructure, escalating fuel costs and a completely oil-dependent transportation sector, air quality concerns, a capital and capacity-constrained railroad system, safety concerns resulting from mixing freight and passenger transportation on highways, port congestion, and sky-rocketing infrastructure maintenance costs. These problems provide an opportunity for the entry of an innovative transportation system that combines the best features of trucks and railroads with advanced command and control technology, robotics, and an environmentally sound propulsion system.

This paper introduces an approach to freight transportation that addresses the limitations and constraints of the existing systems and presents a new, hybrid system that draws attributes from both trucking and railroads and adds new technological elements that enable the system to achieve high performance and capacity levels along with lower costs and fewer adverse impacts. The concept, called the *"SAFE Freight Shuttle,"* (Secure-Automated-Fast-Environmentally-clean.) offers a new method to transport containerized, intercity or port-to-terminal freight. It consists of an automated vehicle, a specially designed guide-way, a linear induction propulsion system, and a control system that negates the need for an on-board driver. The propulsion system involves the vehicle and the guide-way working in concert as inherent components of the motor assembly. As a result it has virtually no moving parts to wear out or fail. The vehicle with its containerized cargo is designed to operate over a grade separated right-of-way, reducing the burden on highways in terms

of safety, wear, and capacity while offering increased reliability and lower costs. These benefits are achieved by maintaining compatibility with existing intermodal systems.

Most freight travels by trucks. The dominance of the trucking industry is due in large measure to the flexibility, speed and responsiveness of the mode. But as importantly, this dominance is due to the benefit derived from the publicly subsidized infrastructure over which trucks operate. Railroads enjoy no such benefit, paying for the construction and maintenance of their facilities. These factors result in a clear dividing line between freight moved by truck and that moved by rail. Figure 2 displays the quantity of freight relative to the distance that freight is transported. As can be readily seen, the target distance for an alternative system need not be extensive in order to attract significant traffic levels and positively impact highway congestion, air quality, and urban quality of life.

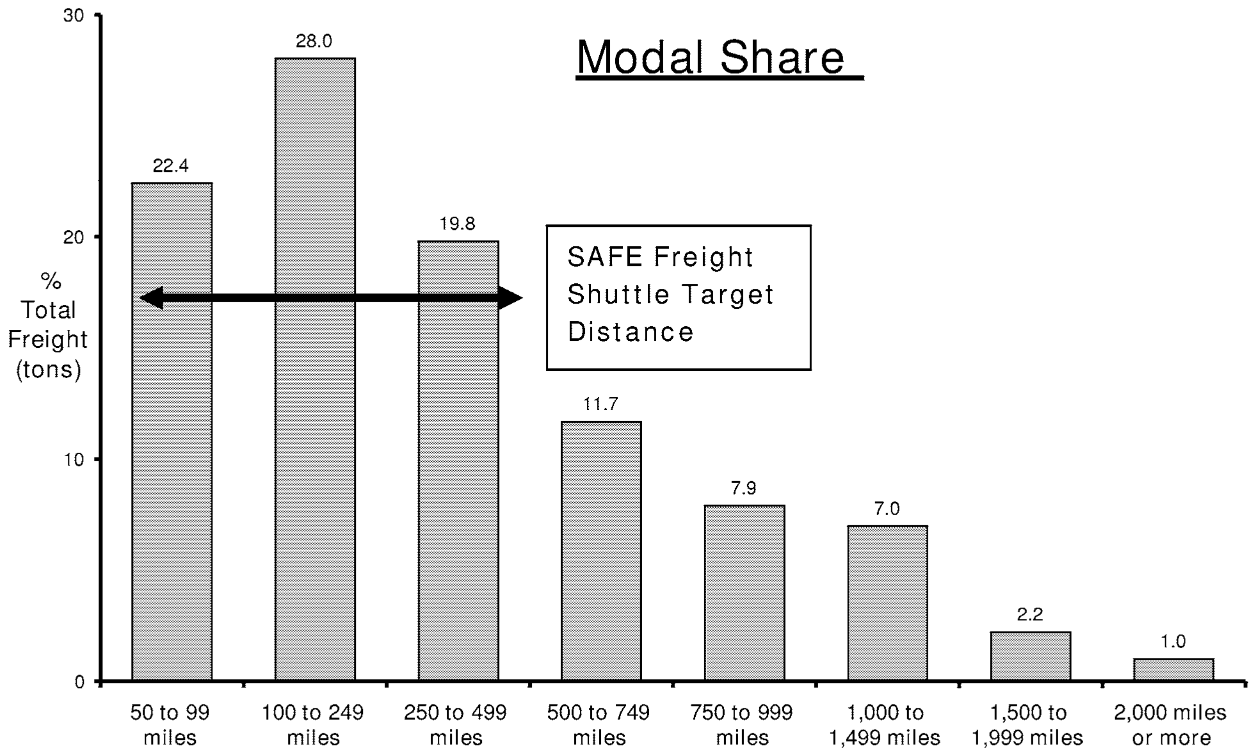


Figure 2 – Quantity of Goods and Material Moved By Distance
(Bureau of Transportation Statistics (USDOT) and U.S. Census Bureau, 2002)

The Greener Alternative

The SAFE Freight Shuttle represents a more environmentally friendly alternative to the existing modes. It has three compelling attributes:

1. It is a more reliable and a higher-performance system – the grade separated, dedicated infrastructure, automated vehicles, and operations predicated on immediate dispatching means that the SAFE Freight Shuttle will provide a system that supports increasing transport capacity.
2. The system, given its flexible, electric energy source, will positively impact air quality in the region, reducing emissions and reducing reliance on oil.
3. The design of the system means that the adverse impacts of trucking on the transportation system – congestion, safety, and pavement damage – are directly avoided.

The use of linear induction motors results in a system that relies on remotely generated electrical power to operate the system. This power can be generated with a variety of fuels and with emissions controlled at the source – a clear air quality benefit for the communities suffering from increasing diesel emissions. Furthermore, the energy requirements stemming from the Fright Shuttle's design are significantly lower than over-the-road transport. Projections for the energy requirements of the SAFE Freight Shuttle suggest that, at current PG&E electrical rates, a 60-mile transit would cost roughly $20 in power use – the only variable cost in the SAFE Freight Shuttle cost structure – far lower than the variable costs associated with trucking.

COMPETITIVE ANALYSIS

The freight transportation industry is a highly competitive and cost-constrained industry. The SAFE Freight Shuttle system fits into this industry by fulfilling the growing need to move freight in a cost effective, efficient, and environmentally sound manner. The SAFE Freight Shuttle has several advantages and solves several major freight transportation problems. The system has been developed with the intention of providing a winning scenario for all major freight transportation stakeholder groups. Among these stakeholders are State Departments of Transportation, the existing freight transportation industry, the shipper community, and, perhaps most importantly, citizens that are both the ultimate customer of freight transport and that group who must also contend with the dis-benefits that freight movement systems inadvertently, but unavoidably, create.

Improvements over Conventional Rail

The SAFE Freight Shuttle's design provides improvements over freight transport by rail in the following important categories:

- Intermediate (short haul) distances – the nature of freight rail, which involves complex sorting of cars in terminals as well as the strategic placement of locomotives and crews, is not competitive with trucking at distances under 500 miles. Rail has virtually no share of this "short haul" market. The SAFE Freight Shuttle will allow individual containers to be sent as they are received in a "just-in-time" shipping system and interact efficiently with existing modes.

- Technology – the railroads use technology that, while effective for their market, is difficult to change. Certain features of rail technology, such as steel wheel on steel rail, form the basis for the historical success of rail, other facets of the technology, namely rail serving as a guideway as well as a rolling surface, create problems (e.g. derailments). Further, railroads contend with complex and expensive locomotives, poor braking systems, wheel and bearing failure, etc. The SAFE Freight Shuttle has been designed to minimize or eliminate most of the technology issues railroads find themselves working to overcome. The linear induction propulsion system means there are virtually no moving parts related to motive power and propulsion.
- Crew – A major operational expense and logistical problem for railroads is found with the on-board crew. The SAFE Freight Shuttle will be automated and unmanned.
- Grade Separated Right-of-Way – Railroads operate over a system that has developed in concert with the highway system. As a result, the railroad network crosses thousands of streets and highways at grade level. While the railroads maintain the right of way at grade crossings, these intersections are a significant safety, operational, and financial issue for the railroads. The SAFE Freight Shuttle requires grade separation throughout any corridor over which service is contemplated. This requirement enables many of the positive benefits identified for the system. In Texas, the Trans Texas Corridor offers the opportunity to develop a fully grade separated system free of the impediments posed by crossing other transportation infrastructure.
- Oil Dependency – The railroads are a major user of oil (diesel) and highly dependent on both the availability and price of this fuel. Fuel represents about one-half of the variable operating costs for railroads and virtually the entire domestic fleet of locomotives is diesel powered. Restricted availability, increased prices, or limitations on emissions may impact the railroad's ability to serve key markets. The SAFE Freight Shuttle is designed to operate on electricity, a power source that provides the system considerable flexibility in terms of basic fuel (or system; solar, wind, etc.) used to generate the energy and is a step away from dependency on foreign oil.

Improvements over Intercity Trucking

The SAFE Freight Shuttle's design provides improvements over freight transport by trucks in the following important categories:

- Operational Cost – The cost of intra-city drayage by truck has been estimated at more than $4.00 per mile, depending on the location of the operation. This figure includes the cost of the driver, fuel, maintenance, and depreciation on equipment.
- Performance – The transit time for intercity trucking is on the increase. TTI's annual congestion assessment shows increases in delay for motorists for every community size surveyed. Average speeds, which are impacted by traffic

densities, rest and fuel breaks, and roadway incidents, are falling in some corridors to pre-interstate highway levels. Recent history suggests that new highway capacity is as rapidly consumed as it is provided. In fact, some contend that additional highway infrastructure has the affect of encouraging more trucking operations.

- Hours of service – Trucking companies and independent truckers are restricted by hours of service laws that limit driving and mandate rest periods. The SAFE Freight Shuttle, operating on dedicated right-of-way, will be able to run on a 24 hour per day, 7-days a week basis and be largely immune from delays caused by inclement weather, traffic congestion, or disruptive roadway occurrences. This feature will provide improved service and high capacity levels.
- Driver training and retention – a significant and growing problem for trucking companies that, as noted above for railroads, is not an issue with the SAFE Freight Shuttle. The system will allow truckers to operate in settings that provide greater revenue-generating potential.
- Greener option – the SAFE Freight Shuttle system will be compatible with the introduction of "urban dray" vehicles that are designed with short-haul and medium-haul capabilities and air-quality-friendly propulsion systems using alternative fuels such as propane or natural gas, reducing the use of heavy diesel tractors in urban areas and positively impacting air quality beyond the direct effects of transport by the SAFE Freight Shuttle.

Public Benefits

The SAFE Freight Shuttle provides large public benefits in terms of avoided social costs in areas such as safety, pavement damage, congestion, and air quality. The Federal Highway Administration (FHWA) suggests that trucking operations create discernable costs to the public sector in 5 major categories, as noted in Table 1, below (Federal Highway Administration, 2000).

Table 1 – FHWA Unit Costs for Trucking on Rural and Urban Highways

in Dollars per Truck Mile

Cost Category	Rural	Urban
Collision Damage	$0.0088	$0.0115
Pavement Damage	$0.1270	$0.4090
Highway Congestion	$0.0223	$0.2006
Air Pollution	$0.0385	$0.0449
Noise Pollution	$0.0019	$0.0304
Total	$0.1985	$0.6964

These figures are derived from work performed in the 1980s. The actual costs are highly dependent on the region being evaluated. Regardless of the exact value placed on these categories, the understanding that the public sector bears significant costs associated with the transportation alternatives available to them supports the movement toward lower-impact alternatives.

SUMMARY

The positive indicators for the SAFE Freight Shuttle are numerous and compelling:

- The Ports of LA and Long Beach are currently the largest container ports in the US and serve as the gateway for the exploding trade with the pacific-rim countries and China. The ports must develop a viable land-side transportation strategy to maintain growth.
- The public sector will be unable to meet the mobility needs of the region through highway expansion, particularly if new capacity is consumed by trucks as soon as it becomes available. Proposals for new highway infrastructure in the region exceed $20 billion over the next two decades, $4 billion of which would be to expand the I-710 freeway leading to the ports – for which there is strong public opposition (Alameda Corridor Transportation Authority, 2004).
- The environmental concerns associated with diesel emissions are shared by a growing number of supporters of the Ports. The desire to increase trade and simultaneously decrease emissions will require a radical change in the approach to container transport.
- Shippers will support the proposed approach due to the direct advantage offered by a system that can operate efficiently at or below today's costs. The energy efficiency of the SAFE Freight Shuttle, the automated vehicles, and the potential for 24-hour operations, will attract significant support from a private sector dedicated to maintaining the competitive advantage and economic growth of the region.
- The trucking industry and owner-operators will support the SAFE Freight Shuttle due to its ability to transport containers to a region that is less capacity constrained. Since trucking revenues are usually earned on a per-mile basis, it will offer drivers the ability to net a higher income, expend fuel more efficiently, and reduce wear on equipment. Driver recruitment and retention is a major ancillary problem indirectly addressed by the SAFE Freight Shuttle which will not eliminate the need for trucks, but rather will allow trucking operations to take place in more suitable locations.

The SAFE Freight Shuttle represents a rare opportunity to fill a rapidly expanding vacuum in freight transportation. The problems emerging in this transportation sector are immense and the solutions that are offered seldom provide more than an incremental improvement in the manner in which freight is transported. The SAFE Freight Shuttle offers a radical departure from today's standard practice that combines 21st century technology with the design simplicity necessary to accommodate the low-cost, high-reliability demands of the freight transportation industry while still improving emissions.

Serious problems exist today in the transport of freight - problems ranging from the environmental impacts of trucks to the shipper's bottom line. Historically, the freight transportation industry sees a significant shift in technology or approach about once every 50 years; the replacement of wagons by rail in the mid-19th century, the introduction of trucks at the turn of the 20th century, and the dominance of trucks over rail in the mid-20th century are cases in point. The explosion of containerized freight and advancements in automation has provided the foundation for yet another shift in the way America moves its goods.

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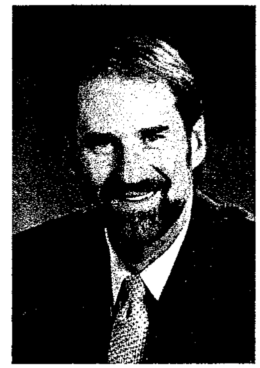

BIOGRAPHICAL SUMMARY

Dr. Roop is an Assistant Agency Director overseeing the Transportation Safety Center and the Multimodal Freight Transportation Programs; Rail, Center for Ports &Waterways, and the National Pipeline Safety Center, at the Texas Transportation Institute (TTI). He is responsible for guiding transportation safety research in the areas of rail, ports and waterways, intermodal trucking, and pipelines at TTI with the goal of establishing these areas as a national focal point for innovative research. Dr. Roop has served as the Director of Texas A&M's Association of American Railroads Affiliated Laboratory since its establishment in 1994, working closely with A&M's College of Engineering to identify research of interest to the railroad industry. He is the chairman of the bi-annual National Conference on Highway-Rail Grade Crossing Safety, sponsored by TTI. He is also a member of the National Science Foundations High-Speed Rail IDEA Committee, and most recently a member of the Transportation Research Board Committee on Intermodal Freight Transport (AT045).

PROFESSIONAL INTERESTS

Rail transportation
Optimization
Freight transportation
Logistics

CCDoTT

CENTER FOR THE COMMERCIAL DEPLOYMENT OF TRANSPORTATION TECHNOLOGIES (CCDoTT)
California State University, Long Beach

Date: February 22, 2006

From: Center for the Commercial Deployment of Transportation Technologies

To: Business Transportation and Housing Agency
California Environmental Protection Agency

Subject: Recommended changes to Page VI-4 of the Goods Movement Action Plan, Phase II Progress Report: Draft Framework for Action (Draft (12/20/05)

Attachments:

(1) *Urban Maglev Freight Container Movement at the Ports of Los Angeles/Long Beach Paper by Dr. Ken James and Dr. Sam Gurol*
(2) Recommended changes to Page VI-4 of the Goods Movement Action Plan, Phase II Progress Report: Draft Framework for Action (Draft (12/20/05)

1. In review of the Goods Movement Action Plan, Phase II Progress Report: Draft Framework for Action (Draft (12/20/05), we found Table VI-3: System Technology Enhancements, to be a very inaccurate representation of the capabilities of a Freight system based on Maglev technology.
2. Attachment (1) provides background information on two potential systems that could be applied to cargo movement within and from the Ports of LA and LB to a remote port site. The systems use currently available Maglev systems that are either in operation or have working prototypes.
3. It is assumed that the evaluation provided in Table VI-3 is based on the assessment of passenger maglev system done by the FRA in its Report to Congress. A dedicated freight maglev system is a very different system and must be assessed in a dedicated commercial freight environment and not as a passenger system being used for freight.
4. In Attachment (2) we have applied the criteria established in the Goods Movement Action Plan to the capabilities of the system discussed in Attachment (1) and provided short explanations for the changes to the original table.
5. It is request that the tables be reviewed with the capabilities discussed in Attachment (1) considered.
6. If you have any questions, please contact Steve Hinds at CCDoTT, 562.985.2259 or shinds@csulb.edu

Thank you for your consideration,

Steve Hinds
Program Administrator

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Urban Maglev Freight Container Movement at the Ports of Los Angeles/ Long Beach[1]

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Abstract: Existing sea-based ports are typically surrounded by major metropolitan areas, which require movement of shipping containers through those areas and places unwelcome strains on the existing infrastructure. A case in point is the Port of Los Angeles/Long Beach (LA/LB), the nation's largest and most important port. Almost one-half of the nation's port-related traffic passes through the Los Angeles metropolitan area on its way into the interior. The Alameda rail corridor–developed to help accommodate the unprecedented growth of container traffic coming to and from the Port–has not significantly reduced the impact of freight movement on the Los Angeles community. A number of terminals at the Port must truck containers to the terminus of the Alameda corridor, four (4) miles from the Port, causing significant congestion and diesel pollution in the surrounding community. Costly proposals to expand the area's existing highway system in conjunction with a growing recognition of the dangers of Diesel Particulate Emission (DPE) have prompted a novel approach to the container movement challenge. This approach utilizes a proven Maglev "conveyor belt" technology that shows promise for both short-haul urban freight movement and interstate-bound containers. The application of this technology to container freight movement at the Port and beyond will reduce both highway congestion and pollution throughout the Los Angeles area.

[1]Work sponsored by the Center for the Commercial Deployment of Transportation Technology (CCDoTT) through funding from the Office of Naval Research (ONR)

1-Introduction: Over the past several years the Center for the Deployment of Transportation Technologies (CCDoTT) has developed the *agile port concept* (CCDoTT, 2003) that involves moving containers from the port, where storage space is scarce, to inland ports or Intermodal Container Transfer Facilities (ICTFs) where containers can be redirected to local trans-shippers, or organized into transcontinental trains. The weakest link in this scenario is the dedicated link between the port and remote facility. Thus, for the last three years, CCDoTT has prioritized the definition of a new paradigm in moving containers out of the Ports of LA/LB. The approach CCDoTT pursued uses freight optimized Maglev technology for a variety of supply chain applications. This is very different from the concept of passenger Maglev, in that freight Maglev has a known ridership—container volume—and the containers are all going to the same places—ICTFs.

This container movement paradigm has several requirements. The first is to accommodate projected port growth so the economic base of the Southern California region, and the entire county, can continue to grow. The second is to relieve pressure on the existing highway infrastructure which cannot well handle its current load. The third is to improve the quality of life, not just at the port, but throughout the region. An adage attributed to Einstein, appropriate to the CCDoTT paradigm shift is: "You cannot solve problems with the same technologies that caused them." These three (3) requirements define the parameters of a new container transport approach.

Growth of the Ports of LA/LB is essential because it provides jobs and produces wealth within the region. A recent study shows that newly created logistics jobs have in fact more than made up for manufacturing jobs lost due to industry moving from Southern California, and they are higher paying than manufacturing jobs requiring similar skills (Husing, 2005). Acreage at the port rents for upwards of $250,000/acre/year producing income for cities and state (CCDoTT (2), 2005) Supplies for military sustainment have historically passed through the port, and military planners need to continue to be able to count on the port as a means of shipping supplies to military depots overseas. And, most strategically, almost one half of all the imports to this country come through the Ports of LA/LB (Aschemeyer, 2005) An increase in the size of the Ports is not possible; there clearly is not room to expand. To meet the projected container influx, port throughput must be increased. A container movement approach should have the capability of moving an additional five (5) million or more forty foot containers per year from the port.

Traffic problems on Southern California freeways are legendary. The estimate of 11 $Billion/year in productivity losses in Los Angeles and Orange counties, due to freeway congestion is not surprising (Schrank, 2005). Adding more containers from the Ports of LA/LB year after year will likely bring the region to a standstill. Even if local governments, political action groups, and community leaders could agree on how and where rail or highway could be expanded, these means of container transport still have a wide footprint (surface area utilized) and cannot easily be elevated. To reduce the stress on the existing Southern California infrastructure a container movement approach should be capable of high throughput but have a smaller footprint than road or rail.

Stationary sources of pollution such as electrical power plants have made great strides in reducing air pollution with massive "scrubbers", and automobiles have continued improving over the years; air quality for the Southern California region has markedly improved as a result. One pollutant, however, remains problematic: Diesel Particulate Emissions or DPE. This pollutant is different from gaseous pollutants in that it is localized to areas where diesel engines operate such as the port, truck/train intermodals, and along freeway and rail corridors. The effects of DPE are devastating. More than thirty (30) human epidemiological studies have found that diesel exhaust increases cancer risks, and a 1999 California study found that diesel exhaust is responsible for seventy (70) percent of cancer risks from air pollution (Bailey, 2005). Only recently has the danger of having homes and schools close to sources of DPE been recognized. Figure 1 shows an Air Quality Management District (AQMD) (MATES II, 2000) study of how DPE is concentrated around the port and transport paths. To alleviate the severity of the DPE problem for the entire community, a container movement approach should exploit fixed power sources that produce minimal pollution

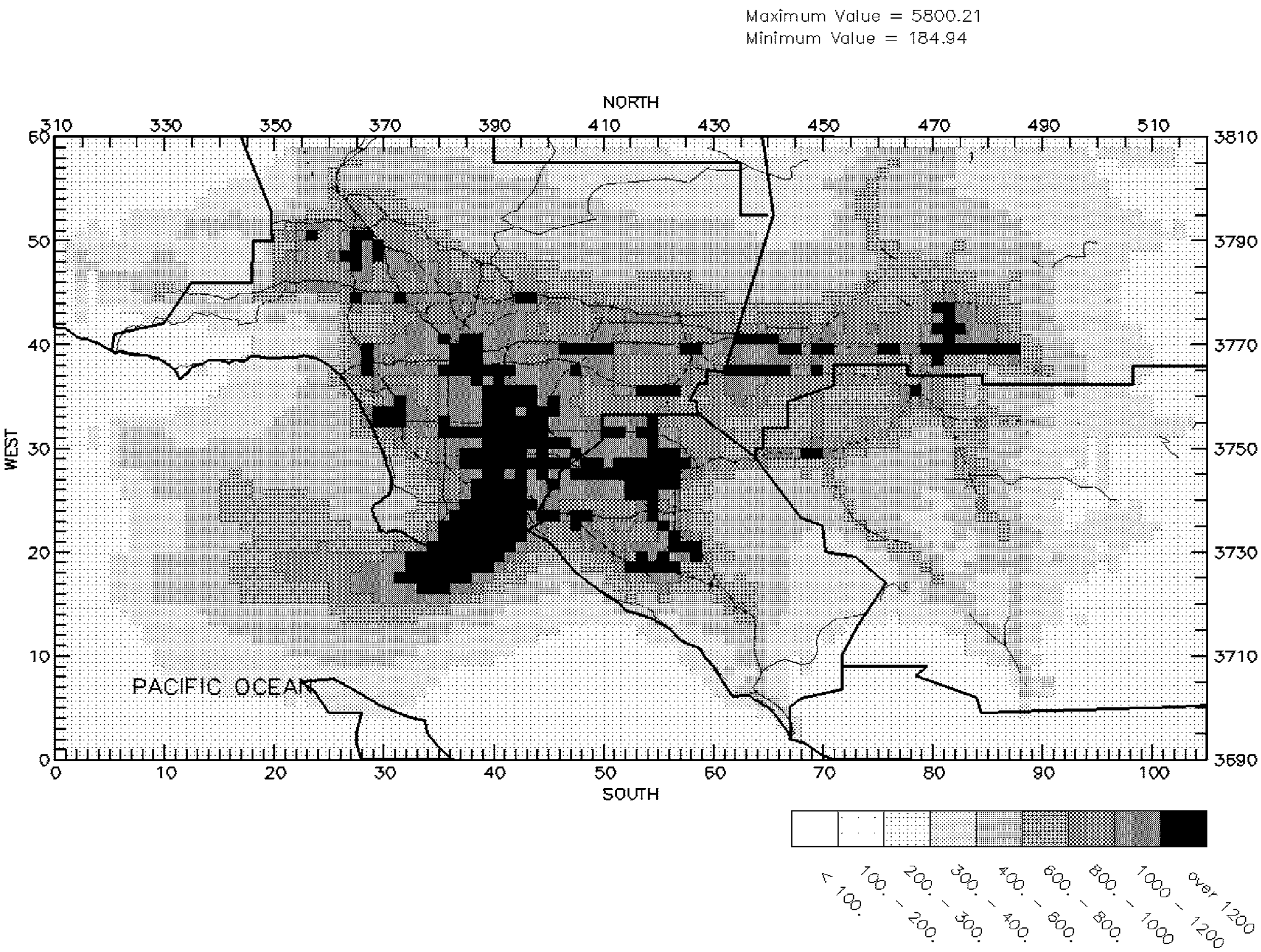


Figure 1. Model Estimated Cancer Risk/Million Population For The Los Angeles Basin

The aforementioned economic, congestion and pollution issues facing urban freight movement from the Ports produce conflicting constraints to balancing Southern California's economic future with the region's quality of life. The international trade industry (ships, trucks and trains) has been identified as a major source of pollution due to the heavy use of diesel power. Port expansion plans have run into a community environmental "road block;" more rigorous Environmental Impact Reports (EIRs) are being demanded. Responding to community pressures, some elected officials are discussing limits on port emissions; these would also serve to limit port growth. California state legislators have fired off a barrage of bills aimed at regulating and changing the way goods are handled, workers are compensated, and pollution is curbed at California ports and transportation hubs. Several of these bills add constraints to operations while others add costs to the movement of containers both within and beyond the Ports' region. From an economic perspective, these bills impact the economies of the Ports and cargo movement and therefore affect the cost of doing business. Maglev presents a "win-win" solution; moving containers in sufficient number and speed to allow continued economic growth, while alleviating congestion and pollution throughout the Southern California basin.

2-New Paradigm for Container Movement: Maglev technology is a solution that can help solve the problems created by the technology responsible for the congestion and pollution Southern California is faced with today. It provides the needed balance between more and better jobs of an expanding economy and a quiet, clean, and safe environment for the people who have those jobs. Again, "one cannot solve problems with the same technologies that caused them."

Maglev is not a new concept. Recently, the world's first commercial urban Maglev and high-speed Maglev passenger lines have gone into service in Japan and China, respectively. Application of Maglev technology to a freight-only system is an innovative alternative to conventional road or rail infrastructure. The environmental and community constraints on expanding conventional means of container transport through the Los Angeles basin indicate that a Maglev freight system will have similar capital costs and lower operational costs than highway and rail, thus providing a cost-competitive solution for urban areas (TransRapid, 2004). The referenced study involved an Electromagnetic System (EMS) design by TransRapid, the German developer of the world's first commercial Maglev system. Recent work at Lawrence Livermore Laboratory and General Atomics (GA) has shown that an Electrodynamic System (EDS) Maglev also has significant potential benefits for transporting containers.

3-Maglev Urban Freight Technologies: Maglev technology is a way of floating container carriages utilizing a magnetic field to move them along a guideway without any moving parts. It is not a new technology; Maglev was conceived decades ago. Only in the last fifty (50) years has it been applied to real world situations. There are two (2) forms of Maglev. ElectroMagnetic Suspension (EMS) uses electronic feedback control to lift the carriage with *attractive* magnetic force. This system was developed by the German firms Siemens and Krupp in a joint venture named TransRapid. The TransRapid carriage is pulled forward by a Linear Synchronous Motor (LSM) that is similar to a typical electric motor, but unwound and laid lengthwise along the guideway.

The second Maglev form is ElectroDynamic Suspension (EDS) which was conceived in the United States during the 1960s, and later developed by Japan. EDS employs a magnet moving above a conductive plane producing an opposite image of the magnet and generating magnetic *repulsion* that causes the carriage to lift away from the guideway. Fifty years ago the only magnets powerful enough to be used for this form of Maglev were superconducting magnets, which at that time were laboratory oddities. It was not until the late 1980's with the development of rare-earth magnets such as Neodymium Iron Boron (NbFeB) that EDS technology became realizable without cryogenics. EDS still had to wait until the 1990s for the development at Lawrence Livermore Laboratories of Halbach array technology (Heller, 2005). Today General Atomics has licensed the technology, and built a full-scale 400-ft. EDS Maglev test track at their headquarters in San Diego. This system also uses a linear synchronous motor for propulsion. The advantage of the EDS magnetic suspension system is its passive nature: there are no on-board power supplies to generate the lift forces (all that is needed is forward motion, generated by the LSM windings in the track). In addition, an EDS suspension leads to significantly greater air gaps resulting in more lenient guideway construction tolerances, with resultant cost savings potential.

Maglev technology can accommodate port container growth with on-dock service, reduce stress on the existing infrastructure (since it has a small footprint and can be elevated), and, by using fixed power sources, produce negligible air and noise pollution. In addition, economic projections of Maglev usage are considerably more straightforward for freight compared with moving passengers. The amount of freight moved per day is known, and the system can be designed to accommodate current and future needs. By contrast, a passenger system relies on a minimum (and sometimes difficult to project) ridership for economic viability. Two years ago, CCDoTT approached TransRapid with the concept of freight Maglev. TransRapid recognized the economic advantages of CCDoTT's "conveyor" approach and began working with CCDoTT on a first-order model from a port to inland intermodal system. Figure 2 shows the TransRapid freight-optimized design with attracting magnets lifting the carriage.

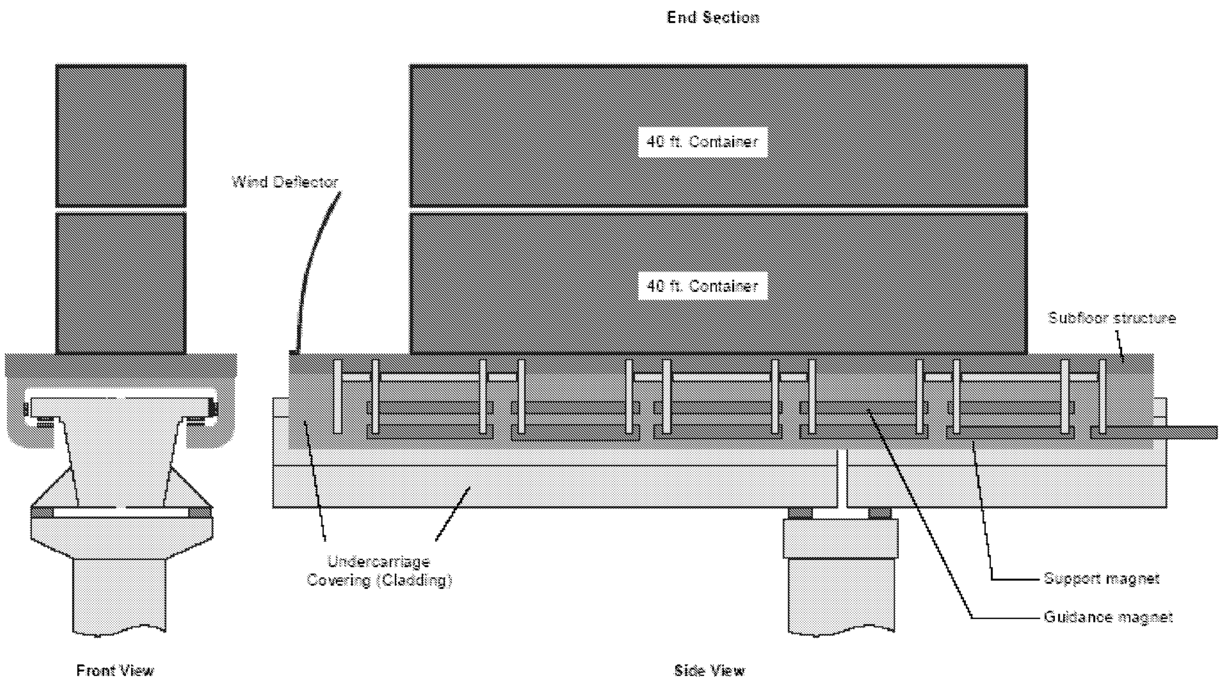


Figure 2 TransRapid Freight Optimized Maglev Carriage

TransRapid engineers also performed a propulsion power, system architecture analysis, as shown in Figure 3 (TransRapid, 2004).

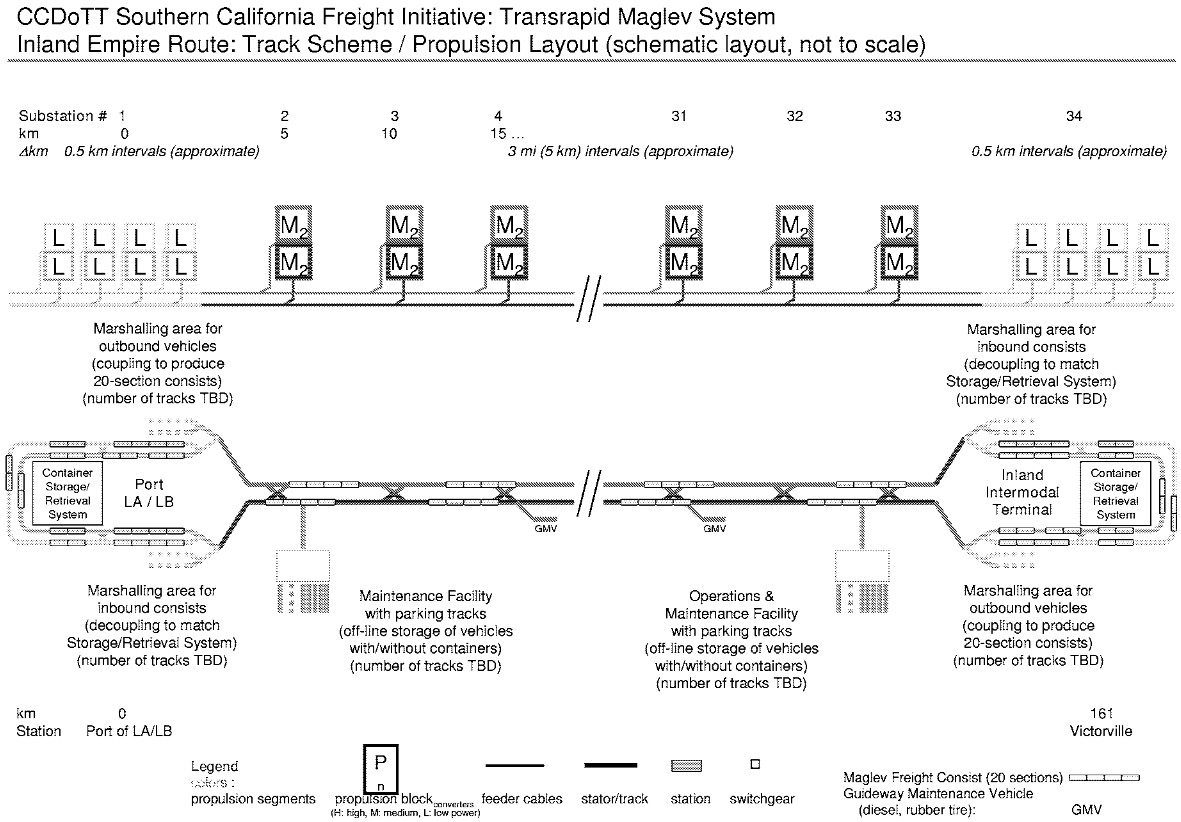


Figure 3 TransRapid's Port to Inland Intermodal Layout

The ElectroDynamic Suspension approach, developed by General Atomics, is passive in that once the carriage, which initially rests on wheels, is propelled by the linear synchronous motor to a velocity of around 5 to 10 miles/hour, when lift is achieved. Figure 4 shows a schematic of the passive magnet, Halbach array configuration relative to the transposed conductor guideway. General Atomics has built a full-scale prototype of a passenger EDS Maglev system at its facility in San Diego consisting of a carriage, guideway and power distribution system. Experimental results from system tests show the magnitude of the required velocity for "lift-off" as well as the measured drag as a function of velocity.

Like TransRapid, General Atomics proposes enhancing their passenger Maglev carriage to carry shipping containers. Figure 5 is a detailed sketch of the existing passenger carriage used for system evaluation.

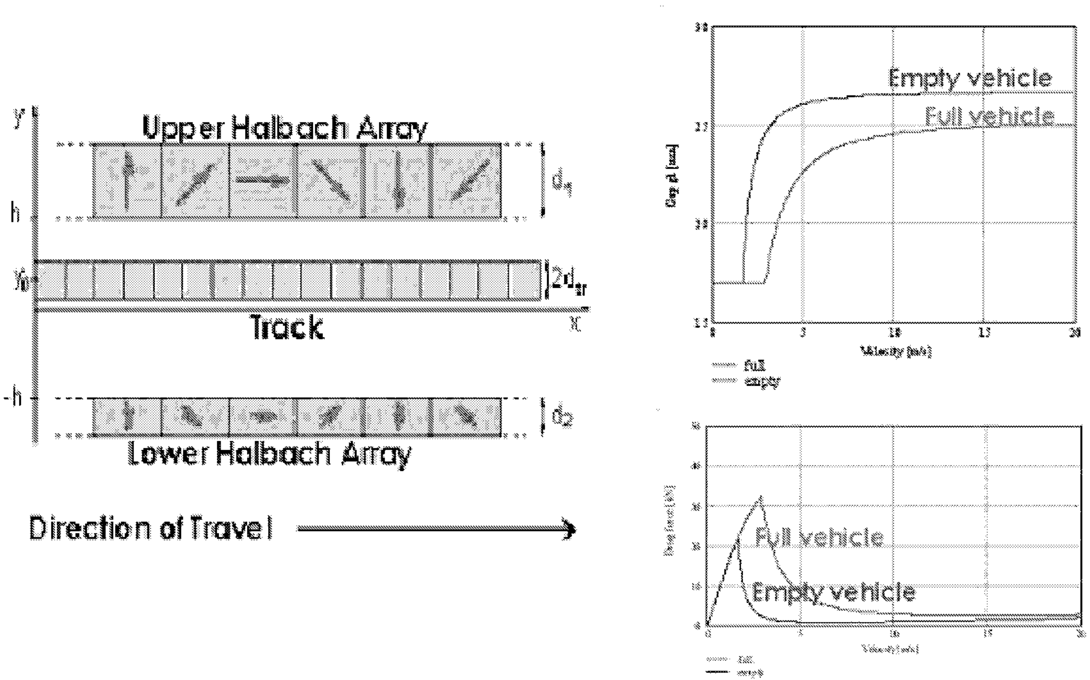


Figure 4 General Atomic's EDS schematic with Results for Full-Scale Freight Prototype

An area where significant Maglev system cost optimization can be realized involves the guideway and associated components. The EMS system with its electronic feedback control, operating with a nominal air gap on the order of 10 millimeters, has inherently tight tolerances, on the order of millimeters—between the lifting magnets and the guideway. Camphor and support spacing of an elevated guideway for an EMS system are critical design factors. An EDS system lifts away from the guideway—on the order of 20 to 30 millimeters—allowing more versatility in guideway design, with more lenient tolerances in component fabrication and assembly. General Atomics has considered various forms of prefabricated guideway sections as shown in Figure 6.

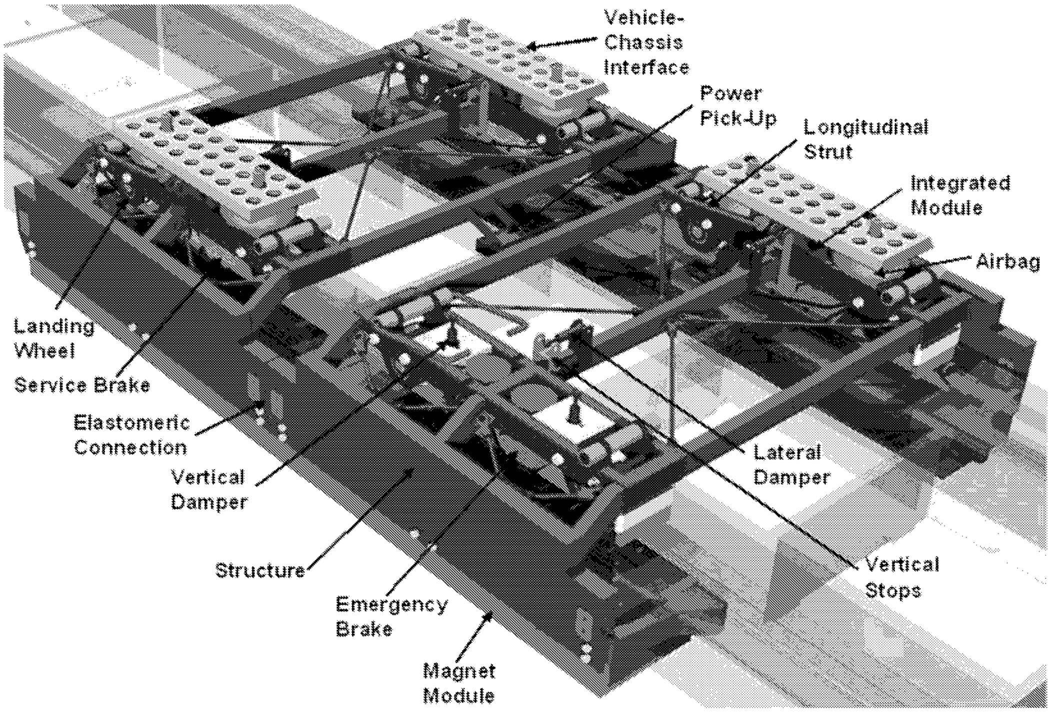
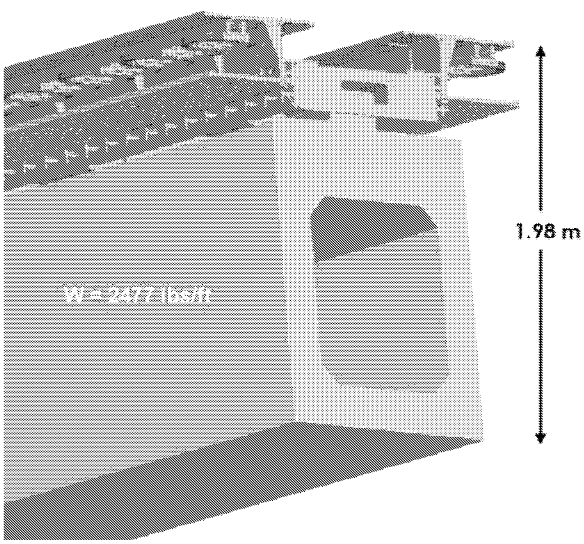
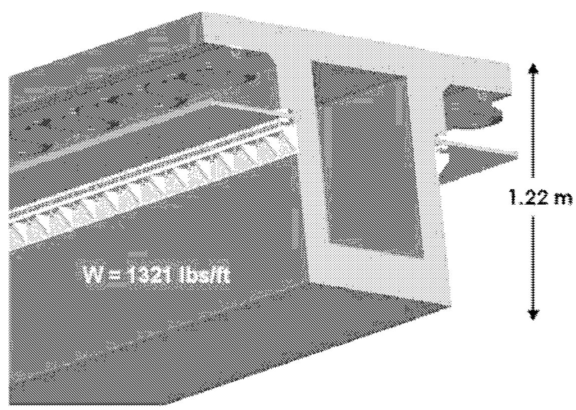


Figure 5 Detailed View of GA's EDS Maglev Carriage





GIRDER LENGTH (Meters)	FREQUENCY (Hz)	
	SINGLE SPAN	DOUBLE SPAN
18	10	10.4
24	5.67	5.92
30	3.45	3.87
36	2.52	2.61

Figure 6 Two forms of EDS Maglev Guideway Considered by General Atomics

4-CCDoTT's FY'04 Freight Maglev Program: As described previously, CCDoTT initialized its investigation into freight optimized Maglev with TransRapid, the only commercially available Maglev manufacturer in the world at that time. That company provided CCDoTT with a preliminary freight system design and approximate operational and capital costs, based on their experience in Shanghai. CCDoTT also worked with Automation Associates to develop a 1st order model of the Southern California rail and road infrastructure to determine the impact of a Maglev system on the transportation arteries in the region. Manalytics Inc. provided cost data for moving containers through Southern California by road and rail as well as existing and projected container traffic.

CCDoTT's findings for FY'04 were most encouraging. The increased speed and density of a dedicated express container transporter connecting the port to the Inland Empire as well as Victorville, a railhead for the Burlington Northern Santa Fe (BNSF), and Beaumont, a railhead for the Union Pacific (UP), showed Maglev technology could accommodate port growth and carry an additional five (5) million containers per year (TransRapid, 2004). Why the elevated Maglev with its narrow footprint can carry more containers than a much wider freeway, involves the consistent 70 mph speed of the containers on the conveyor system. The benefits of the port-to-inland corridor approach are numerous. Container traffic bound for the continental U.S. is separated from commuter traffic and trucks servicing distributors and manufacturers within this region, making freeways more useful. Reduced congestion lessens the need to expand freeways. Less congestion also allows more reliable military movement to the ports. As a side benefit, there are plans for a military staging area at the Southern California Logistics Center, the former George Air Force Base, which would benefit from the use of commercial Maglev. The land in these inland areas is cheaper for warehouse trans-shippers: $250,000/acre/year at the Ports vs. $250/acre/year in Hesperia (CCDoTT (2), 2005). Since Maglev is computer controlled and carriages are operated without on–board personnel, security is also improved. Most importantly, the projected Maglev system can move five (5) million or more containers with minimal air and noise pollution.

CCDoTT considered a number of rights-of-way as shown on the map in Figure 7. Perhaps the most promising route is the one that follows I-15 through the Cajon pass. Another attribute of Maglev freight optimized systems is their ability to climb steep grades. Both the EMS and EDS freight-optimized Maglev systems are projected to be able to carry containers up a 6% grade, while rail can only handle 3%. This is why trains must take a circuitous route through the pass and require expensive tunneling. The 6% maximum grade for freight Maglev matches the maximum grade allowed on the Interstate highway system, suggesting Maglev rights-of-way along interstate medians.

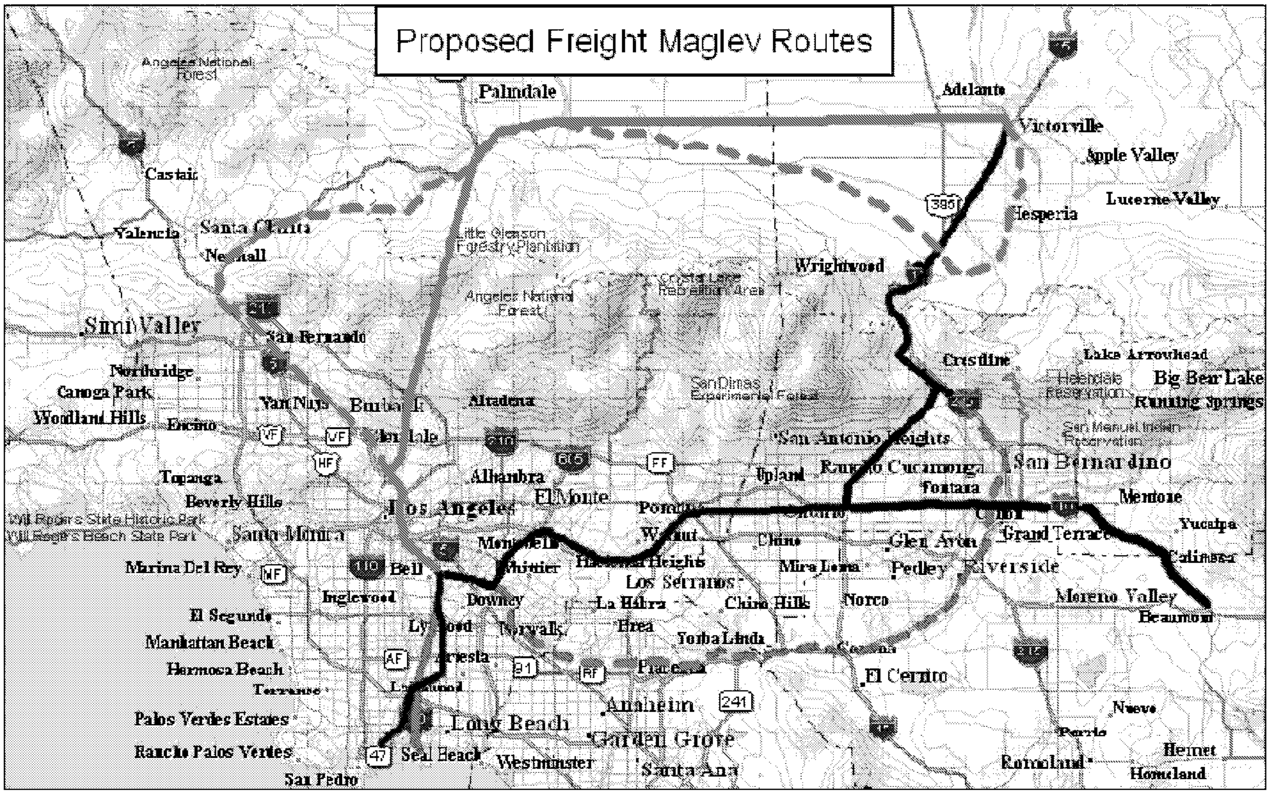
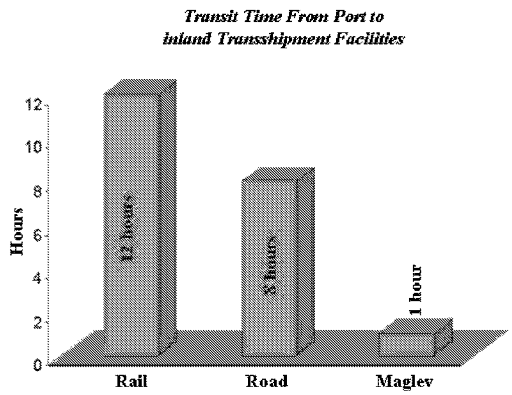
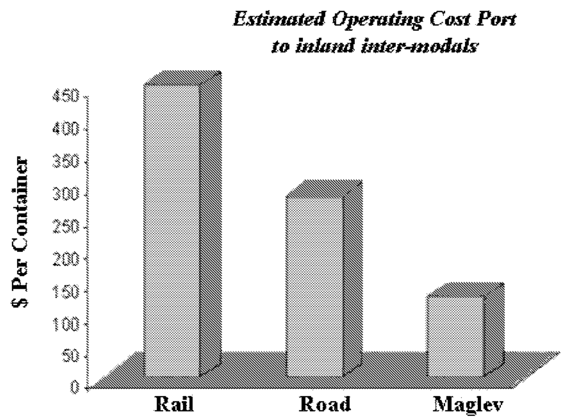


Figure 7 A Number of Proposed Rights-of-Way for the Port to Inland Intermodal Maglev

The charts in Figures 8,9 show the projected transit time and operational costs of sending a container from the port to an inland intermodal terminal. The one-way cost and time projections for the three container transport methods were determined by quotes from trucking firms (R & C Trucking, 2005), the trial Alameda Corridor "shuttle train" (CCDoTT(1)), and TransRapid power analysis. The energy required per trip for Maglev was estimated to be approximately five hundred (500) kWh per forty (40) foot container (TransRapid, 2004). Conventional lift-on/lift-off handling costs were added to this energy expense to arrive at the Maglev freight operational cost. Maglev costs fare very well when compared to shuttle trains presently under evaluation, to conventional truck portage, and includes the added benefit of negligible air and noise pollution.

An examination of capital costs must include the small footprint and the ease of elevation of the Maglev freight system, which makes its construction cost competitive with the costs of expanding highway and rail in the crowded Los Angeles basin. Highway costs are based on construction of a four lane elevated truck expressway with on and off ramps (MTA 2005) transitioning to widened freeways to allow for dedicated truck lanes. Rail costs are based on having to "trench" (drop below road level) several miles to eliminate grade crossings through east Los Angeles (Southern 2005). These are all very expensive propositions; Maglev technology can lead to very significant system cost savings.





Figures 8,9 Comparison of Rail, Highway, and Maglev Time to Delivery and Operational Cost per One-Way Trip from Port to Inland Intermodal, 100 miles Away

Maglev possesses operating cost margins that would encourage private investment. Figure 10 shows projected capital cost comparisons.

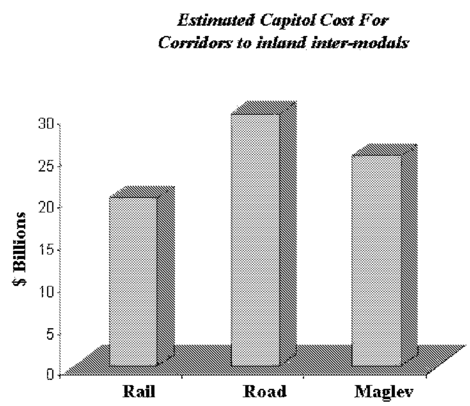


Figure 10 Comparison of Rail, Highway, and Maglev Capital Costs to Carry an Additional 5+ Million Containers per Year

For these capital expenditures, Maglev needs a freight system demonstration. Due to increased attention to the million+ truck trips per year moving containers from the gates of the terminals to the proposed new BNSF ICTF and existing truck traffic to the existing UP ICTF, the opportunity to put the first phase of the Maglev system into effect has materialized.

5-CCDoTT's Ongoing FY'05 Freight Maglev Program: The immediate application for Maglev Technology is the feeder system from terminals to ICTFs, which in reality eliminate short haul trucking from terminal to Alameda Corridor ICTFs and railheads. It provides a feeder system to get containers out of the Ports and will eventually be part of the larger and more comprehensive Maglev freight system.

What can happen with an automated Maglev conveyor increasing container throughput and port productivity? (1) Maglev would greatly enhance the economic viability of the Alameda Corridor. (2) Large reductions in harmful Diesel Particulate Emissions (DPE) would be attained. (3) Present trucking costs from terminals to ICTF of approximately $125 (+$90 lift costs) could be reduced by $100 with freight Maglev, more if terminal container movement vehicles are outfitted with Maglev hardware to reduce lift-on/lift-off costs. Capital cost studies are presently the subject of a joint GA/CSULB proposal, as well as more detailed operating costs.

California State University is conducting a study on the engineering design and subsequent cost of the General Atomics (EDS) approach for container freight movement at the Ports. The EDS Maglev design will be projected onto the Port of Los Angeles / Long Beach / Alameda Corridor infrastructure to determine its feasibility as a means of transporting containers from the Port's terminals to the (ICTF) at the Alameda Corridor (Gurol, 2005). Comparisons of the Maglev system with a number of proposed, conventional solutions to Port throughput will be made. Resultant community impact will also be addressed.

CSULB working with GA, will address a number of tasks in this initial feasibility study. First, we will develop a list of operational and site-specific requirements for a cargo Maglev system. These requirements will be used to flow down requirements for the guideway, vehicles, levitation and propulsion magnets, propulsion power systems, and communication and signaling system. The existing GA Maglev test chassis, seen in Figure 11, will be used as the basis for modifying the magnetic systems to handle the loading requirements. The approach uses the dynamic data from the on-going GA chassis testing to scale to the required magnetic footprint area. Initial projections appear very promising that the magnetic system can easily handle the maximum loading. The guideway will also be re-configured to handle the maximum loading imposed by project cargo loads. We will evaluate the structure based on maximum allowable deflections in the girders (a large air gap can allow larger deflections, leading to potentially cheaper structures), and then design an overall system architecture based on the throughput requirements for cargo.

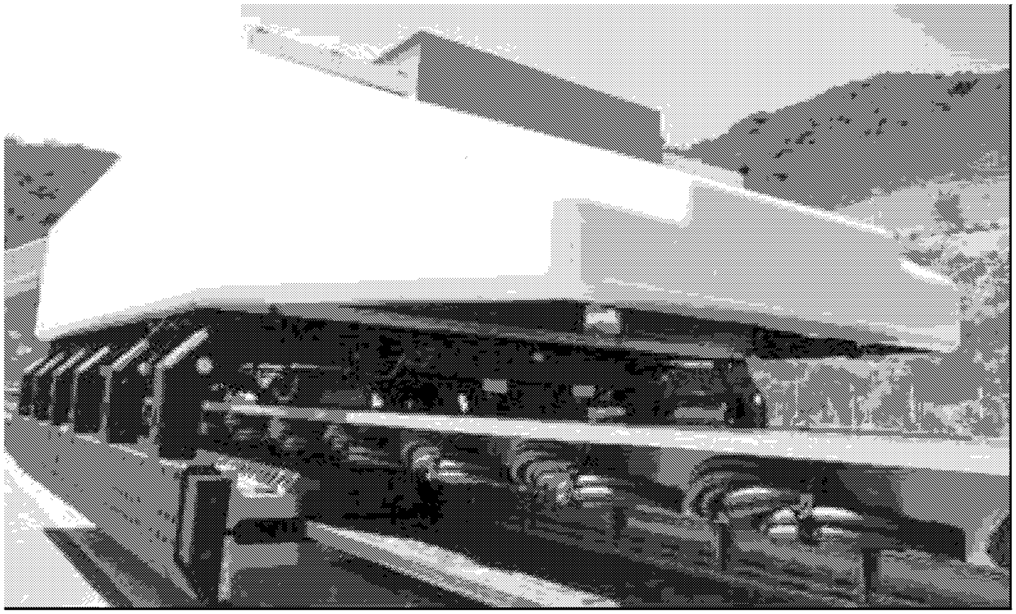


Figure 11 EDS Maglev Prototype at General Atomics, Diego, California.

Maglev technology has unique enabling features, which make it ideal for carrying cargo. First, the linear synchronous motor and friction-free magnetic suspension will result in a system which can accelerate much faster than conventional wheeled systems (0.15 g acceleration is typical); this leads to high throughput (short headways). In addition, the magnetic propulsion system can handle much greater grades (Maglev design is for 10%; 6% is needed for cargo). During the study, we will develop an architecture that takes full advantage of these features. The next steps will be to develop a cost estimate and schedule for the construction and operation of an initial 5-mile Maglev cargo demonstration system at the Port of Los Angeles.

6-Conclusions: Moving large numbers of containers quickly and efficiently from the Ports of LA/LB to transcontinental trains, trans-shippers, and Inland Empire warehouses is vital to the health of the Southern California economy. Equally important is the physical health of the region's citizens. A technology that moves containers with markedly reduced pollution as well as reduced traffic congestion is desperately needed (Press Telegram, 2005). This paper presents such a technology--Maglev, and describes how that technology can be projected onto the region's goods movement infrastructure; including possible routes, container throughput volume, capital expenditures, and operational costs.

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Recommended changes to Page VI-4, Table VI-3, of the *Goods Movement Action Plan, Phase II*
Progress Report: Draft Framework for Action (Draft (12/20/05)

CCDoTT originated the concept of a freight dedicated maglev system in its 2003 cycle of projects. For the last two years, extensive research and development, including work with several national laboratories and the Department of Transportation Volpe Research Center, have defined a maglev, cargo conveyor systems. These studies have also produced categorized comparisons of maglev conveyors with existing and proposed technologies for removing containers from the port and into the Southern California goods movement arena.

As the acknowledged leader by maglev technology providers (Transrapid America Inc, and General Atomics) in maglev freight, conveyor concepts, we submit added resolution to Table VI-3: "System Technology Enhancements" for the draft "Goods Movement Action Plan"

Technology Enhancement Measures	Operations	Equipment	Infrastructure Implications	Improves Velocity	Throughput Enhancing	Reliability	Reduces Congestion		Reduces Environmental Impact	Commercially Available	Homeland Security Applications	System Compatibility	Costs	Responsibilty	Term
							Terminal	Regional							
Near-Port Maglev Cargo Conveyor	√	√	√	√(1)	√ (1)	√(2)	√		√ (3)	√(4)	√ (5)	√(6)	TBD	P, TO	IT
Inland Port Maglev Cargo Conveyor	√	√	√	√(1)	√ (1)	√(2)		√	√ (3)	√(4)	√ (5)	√(6)	TBD	P,O	LT

Notes—from recently delivered paper (attachment (1)) to the "Urban Freight Conference"

(1) Maglev systems have demonstrated speeds up to 350 mph. CCDoTT funded studies with the world's first maglev manufacturer indicate that container consorts of 20 containers each will move non-stop at 90 mph. A single bidirectional, maglev container conveyor is capable of a throughput of 5 million+ TEU out of the port per year. Expansions to the system can accommodate projected container volumes for the next fifty years.
(2) Maglev cargo containers have no moving parts and make no contact with the guideway. Maglev's reliability far exceeds "steel wheel systems" since the weight of the cargo is distributed over several square meters rather than a few square centimeters. Also, the first embodiment of maglev technology has been in passenger travel. Over 20 million people have used the first commercial maglev in Shanghai without a single incident. Thus, maglev cargo conveyors will have a reliability exceeding any existing or proposed freight system.
(3) Simply put, maglev is the most environmentally acceptable (pollution, noise, vibration, footprint) of any cargo transport known.
(4) Maglev systems are commercially available from CCDoTT's two, aforementioned technology providers
(5) Since maglev cargo conveyors are totally automated and run on an elevated guideway at significant speed, they are inherently secure. The conveyor nature of the system allows for organized passage though several, parallel x-ray portals, and automated selection and transport for quarantine measures. Additionally, the Maglev system, using empty containers, could be utilized as a rapid evacuation system from the port if a mass evacuation of the port became necessary and normal transportation means were overloaded or blocked.
(6) Maglev cargo containers are not only compatible with rail and highway at the port and in goods movement processes, but also complement these existing infrastructures by easing congestion and serving as feeder systems to Inter-modal Container Transfer Facilities (ICTF) and railheads.

CENTER FOR THE COMMERCIAL DEPLOYMENT OF TRANSPORTATION TECHNOLOGIES (CCDoTT)

CCDoTT is California State University, Long Beach sponsored, government approved and supported R&D center dealing with maritime-related transportation issues on behalf of both commercial and military interests. It was established in 1995 to address dual-use issues relating to emerging High-Speed Ships and their related Agile Port Systems. CCDoTT has since assumed an expanded role to also address the issues of Rapid Deployment, Decision Support Tools (Command & Control), and was involved with programs improving Security associated with marine related cargo movements before 9/11/2001. Additional efforts are now being directed towards the military interests and requirements associated with emerging Sea Basing support systems.

The objectives of the CCDoTT program include:

- Evaluation of problems, requirements and opportunities associated with commercial and military transportation issues.
- Development and implementation of marine related, dual-use technologies in support of commercial and military interests to enhance the competitive position of U.S. flag commercial carriers and related transportation interests.
- Oversight of select military and commercial program interdependency issues and required actions associated with technology transfer and project validation through the demonstration and operational implementation of dual-use marine related technologies.
- Linking University research capabilities to commercial and military research capacity to advance national transportation technology requirements.

CCDoTT's program initiatives are within the 6.3 category (applied research) associated with government R&D program designators. Further in the technology development process, CCDoTT assures that program results are of such quality and quantity as to ensure productive commercial and/or military demonstration and validation in advance of direct transition to final product market development and operational implementation.

The ability to identify and act on the configuration and management of these innovative and transitional technical development efforts is highly dependent on the professional understanding of the current and emerging issues, understanding of suitable technical support services available and the interest and willingness of prospective end-users to actively participate in the developmental efforts.

As a whole, CCDoTT combines these efforts to tap into the maritime research and validation potential of the largest port in the United States, the combined Port of Los Angeles and Long Beach, to create a program of unparalleled potential and capability. CCDoTT is unique in its focus on maritime research and access to the greatest local resources and facilities.

Since its inception, CCDoTT has managed more than 100 contracts dealing with the various sectors within the program. In reviewing recent past program efforts we note the following accomplishments:

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In the area of Agile Ports and Terminal Systems:

- The Efficient Marine Terminal (EMT) program addresses the improvement in marine terminal productivity and is the baseline program for the Agile Port sector.
- The Hazardous Material Detection system will be interfaced with the ongoing Inspection Technology systems development. These programs will in turn interface with cargo and equipment identification systems associated with container surveillance and management.
- Chassis Tag, RIFD and E-seal technologies.

In the High-Speed Ship area:

- The CFD Design Tool Development program is the design precursor to the Blended Wing Body Design and Construction program.
- The Trimaran High-speed Ship system is recognized as a prime candidate for designation as a Maritime Prepositioning Ship or support vehicle system to be associated with the emerging Sea Basing concepts.
- Waterjet Propulsor Concept for HSS is intended to produce the next generation of high power density waterjet systems that will be suitable for the inordinate power requirements of future high-speed commercial and military ocean vehicles.
- Short sea shipping for coastal and inland waterways.
- On-demand hydrogen fuel system for prototype marine demonstration.
- The HSS/AP logistics assessment is directed towards the prospective market for commercial high-speed ships operating in the Pacific trade routes.

In Rapid Deployment:

- The assessment of goods movement in the Los Angeles/Long Beach regional area identifies the ways and means to more effectively employ the existing port, terminal, and intermodal cargo transport systems in view of the projected continual increases in trade through these two port areas.
- The Transportation Internet Portal system has been initiated as a means for military cargo movement planners to have real time access to the status of U.S. flag ocean carriers operating within the VISA community or otherwise.

In Command and Control:

- The Decision Support Tools program has been undertaken in direct support of USTRANSCOM rapid deployment efforts. CSULB has undertaken an assessment to show how collaborative visualization technology could be employed within the Ports of Los Angeles/Long Beach and its potential utilization in conjunction with the Alameda corridor.

The High-Speed Ship and Agile Port programs were in a sense visionary at the time of their original implementation and have since emerged as leading activities in support of transitional military deployment requirements and commercial efforts to enhance the competitive position of the U.S. flag fleet. CCDoTT has successfully demonstrated the ability to integrate highly skilled technical personnel and related organizations within the commercial and military communities in support of current and emerging marine related transportation issues.

Over the past nine years the Department of Defense, through the Defense Appropriation process, appropriated funding in support of CCDoTT in conjunction with the U.S. Transportation Command, the Maritime Administration, and most recently the Office of Naval Research.

Efforts are in progress to identify related technical programs and suitable funding for FY ‘06.

NOTES AND COMMENTS
ON MAGLEV CONTAINER CONVEYER SYSTEM
Ports of Los Angeles and Long Beach
By
George Gillow
ARINC Engineering Services
February, 2006

This paper contains some brief notes on the proposed Magnetic Levitation (MagLev) container conveyer system that was presented by CCDoTT at the recent IMPACT 2005 conference. The MagLev system will have "driverless" container vehicles/platforms that move at speeds of 60 to 90 mph from the ports of Los Angeles and Long Beach to an inland Intermodal Interface Center (IFC) at a location such as Victorville and/or Beaumont. The MagLev conveyer system is similar to train systems being developed and tested in various locations around the world. Advantages, disadvantages and recommendations are presented below. A list of questions that need to be addressed are listed as part of the disadvantage section.

Advantages

1. Cargo congestion at the ports would be greatly alleviated. The MagLev system would provide for an infrastructure that could transport up to 6 million containers a year from the ports to the IFC.

2. Railroad and truck traffic, in and around the ports, would be greatly reduced.

3. MagLev is a mechanically frictionless system, so less energy is required.

4. The MagLev system will greatly reduce air pollution—mostly diesel particulate—in the port areas. Air pollution is greatly reduced in the port areas but will increase at electrical power generating stations that generate the power to operate the MagLev system. Generating stations may be petroleum, natural gas or coal generating stations. Some of the electrical power required to operate the MagLev might come from nuclear or renewable sources that do not produce air pollution.

5. The system is more reliable since there is no physical contact of moving parts and there is less wear and tear on components.

6. The system may be less expensive to operate than conventional railroad or truck systems.

7. MagLev is quieter than trucks and railroad trains.

8. MagLev trains can operate on steeper grades than conventional railroad trains.

Disadvantages and Questions

1. There are three possible MagLev technologies being considered. Each one of these is still in the early stages of development and each has disadvantages:

   i) A system utilizing cryogenically cooled superconducting coils to create magnetism: This allows for heavier lift and air gaps of over 6". This larger air gap results in lower design tolerances than other technologies. However, super-cooling is required with temperatures as low as -400^0 Fahrenheit. It takes a lot of energy for refrigeration and costs for maintenance and installation would be high.

ii) A system using inductive electromagnetism: This is a system using heavy duty electromagnets. The air gap is less than an inch so it is difficult to achieve the tight tolerance. Operating and maintenance costs are high.

iii) A system using Halbach Array permanent magnets: This system requires less energy since levitation does not require generated electricity. The air gap is small, at about one (1) inch (2.54cm). This air gap is better than with inductive electromagnetic systems, but is still small and results in difficult design tolerances. As with the other technologies, the vehicle must be in motion to achieve levitation.

2. Switching vehicles from track to track (guideway to guideway) is very difficult with MagLev systems. This is because either the vehicle chassis unit "wraps" around the guideway, or the guideway "wraps" around the under-part of the vehicle chassis unit. So switching from one guideway to another requires a bulky, complex mechanism. Experimental and early MagLev systems are point-to-point where trains do not have to switch. However, for container movement in and out of ports, large, multiple marshaling/staging areas are required at each end of the conveyer. A large amount of switching will be required before the cargo reaches the main line conveyer. This will be technically difficult and costly.

3. No large scale systems have been tested that cover a large geographic area. There could be unknown risks of this new technology.

4. MagLev systems are designed to work at high speeds. The Japanese superconducting system must achieve a speed of over 60 mph before levitation occurs. The Los Angeles, Long Beach system would operate at only 60 mph to 90 mph. So the superconducting option may not result in enough speed to achieve levitation.

5. Theoretically, less energy is required for MagLev compared to trucks and conventional trains. But this may only be true for vehicles moving at a constant speed. Varying speeds may result in using considerably more energy. Speed variations are required for curves and steep grades.

6. The high level electromagnetism created by electro-magnets could be harmful to humans.

Suggested Questions

1. CCDoTT is proposing the Halbach array approach which is being tested by General Atomics in San Diego (the system is called Inductrack). Will the field strength diminish and will the magnets wear out since the permanent magnets are constantly interacting and air friction could cause high temperatures?

2. The cost for the construction of MagLev systems is about \$80 million to \$100 million per mile. This is claimed to be less than highway construction and slightly more than for railroads. Are there hidden costs such as for electrical power inverter stations?

3. Maintenance costs could be \$1million to \$2million per mile, per year. This would be \$100 million to \$200 million per year for a 100 mile system. Will yearly maintenance costs be even higher?

4. How complex are the marshalling areas at the ports, due to the difficulty in switching MagLev vehicles?

5. How much does the marshalling area increase the expense of the MagLev system?

6. There are other technologies been considered in other port areas in addition to MagLev. Proposed systems will move containers at 50 to 80 mph. Have other alternatives been considered, such as listed below? (See the Backup Information, page B4, for pictures.)

   a. Self propelled, driverless, railroad container freight cars: These could travel on existing railroads modified to provide electrical power. It could be the least expensive alternative.

   b. Fixed guideways where containers are carried by driverless vehicles that have rubber tires.

   c. Monorail type overhead guideway where containers are carried by an overhead handling system: Propulsion is by linear inductive motors.

   All of these technologies will result in greatly reducing air pollution, just as with MagLev. They may be less expensive to install and maintain. They are all further along in development and have less risk of success than MagLev systems.

Recommendations

1. We recommend that all of the development and deployment of new and experimental MagLev systems be monitored. Issues of concern need to be identified.

2. We recommend that a physicist--with experience in magnetism and no biases concerning MagLev--should look at the issues of superconducting, electromagnetism and permanent magnetism for MagLev.

3. If possible, engineers who have worked on MagLev systems should be interviewed. Preferably they should no longer be working for a MagLev supplier.

4. Once a decision is made, a detailed specification should be completed and a careful bidding process conducted.

5. Other alternatives, such as those listed in this paper, should be compared to the MagLev option.

BACKUP INFORMATION

MagLev Technology Notes

1. Some systems use the cryogenically cooled superconductive magnets. Some systems use coupled servo controller, powered electro-magnets.

2. Work is being done in the development and testing of higher temperature superconductive magnets.

3. The Halbach Array is a special configuration of permanent magnets that produces strong magnetic fields without the need for external electrical power to create levitation. External power is required to move the vehicles.

4. Halbach Array technology is advertised to achieve a 50-to-1 lift ratio. Therefore, one pound of magnets lifts 50 pounds of cargo. Lifting 100 tons or more is possible.

5. The proposed Halbach Array magnets are rare-earth, neodymium-iron-boron permanent magnets—no electricity is needed.

6. The Halbach Array system has a guideway containing coils of wire. When a vehicle's permanent magnets pass over the coils, an electrical current is created causing a magnetic field. The magnetic field repels the permanent magnetic field causing the vehicle to lift. Movement is necessary to achieve levitation, but only at a speed of four (4) to five (5) mph.

7. For all technologies, greater levitation is achieved as the vehicles move faster.

8. Magnetic field strength is measured in "Gause (G)" and "Tesla (T)". 1T=10,000G.

Additional Comments

1. CCDoTT stated that the Texas Transportation Institute concluded that business productivity lost due to freeway congestion in Los Angeles is estimated at $14Billion/year. A MagLev conveyer system would reduce trucks on freeways resulting in less traffic congestion.

2. Cargo transported to the IFC by the MagLev system will be transferred to trucks and conventional railroads for long distance transportation.

3. Cargo, other than containers, could also be carried by the MagLev conveyor system. These include cars, fruit, bulk, and break-bulk freight.

4. The German TransRapid Corp. is developing the non-superconducting, standard electro-magnetic system.

5. The estimated price of $25 billion for a MagLev conveyer system from the ports of Los Angeles/LongBeach to an inland IFC is a realistic estimate. (Some MagLev cost estimates are $80 million to $100 million per mile for construction.)

6. Container vehicles would travel in "consists" of about 20 vehicles. Each "consist" is controlled by a computer, therefore is driverless.

7. Railroad companies will likely support the MagLev system since intercontinental movement is much more lucrative than feeder rails.

8. MagLev trains, currently in development, have safety features in case of power failure. These include internal batteries and auxiliary wheels.

9. Two MagLev systems are in operation as of Feb. 2006. These are located in Shanghai, China and Nagoya, Japan. Each is a single track/guideway system that extends a few miles. A short (less than a mile) test system is being installed at Old Dominion University in Virginia.

References and Resources

New Jersey Institute of Technology, *"Study to Determine the Need for Innovative Concept of Container Transportation System*", Paper presented to 6th Annual NJDOT Research Showcase, October 2004.

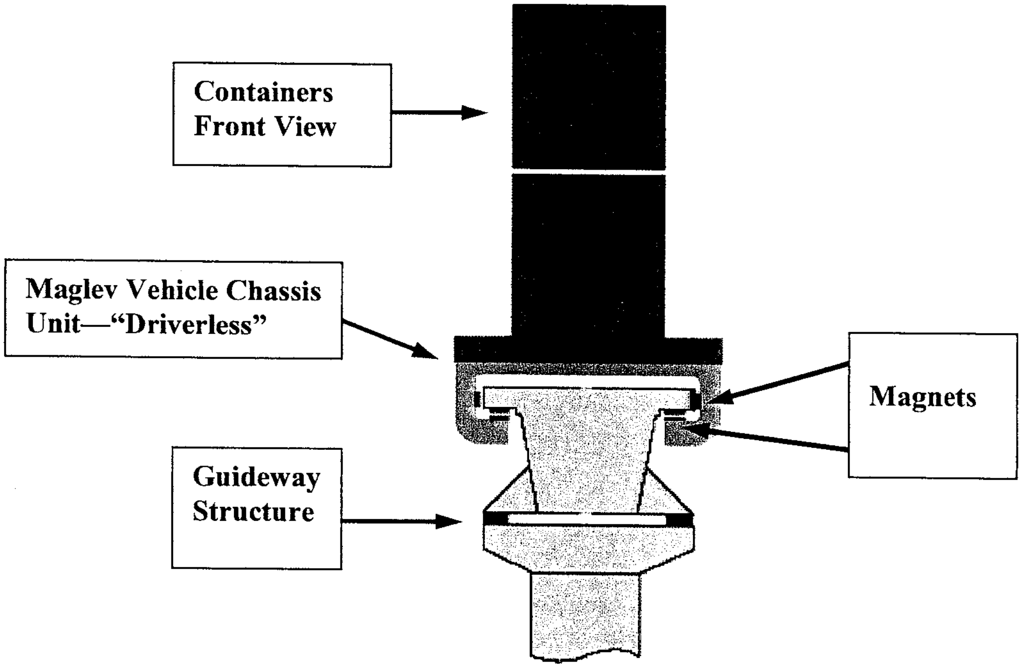
Dr. Rongfang (Rachel) Liu, AICP, PE, *"Engineering Comparison of High-Speed Rail and Maglev Systems: A Case Study of Beijing-Shanghai Corridor*", New Jersey Institute of Technology, October 2004.

Dr. Ken James, *"Evaluation and Implementation Plan for So. California Maglev Freight System"*, California State University Long Beach, Paper Presented to IMPACT 2005, November 2005.

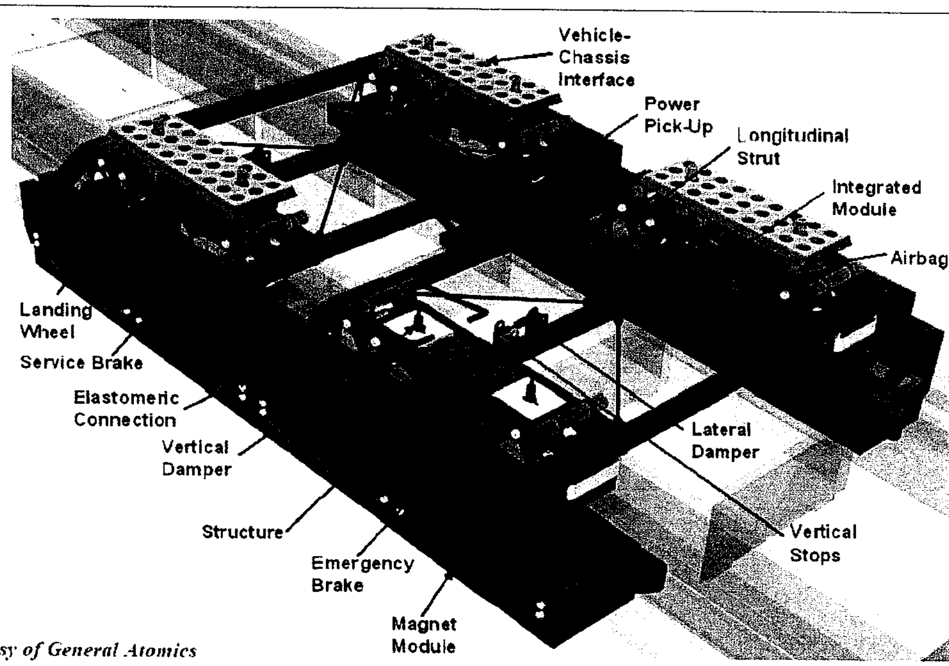
U. S. Department of Transportation, Federal Railroad Administration, "*Costs and Benefits of Magnetic Levitation*", Report to Congress, Sept. 2005.

International MagLev Board website: http://maglevboard.net

Front View of A MagLev Container Conveyer Unit



Vehicle Chassis Unit is complex

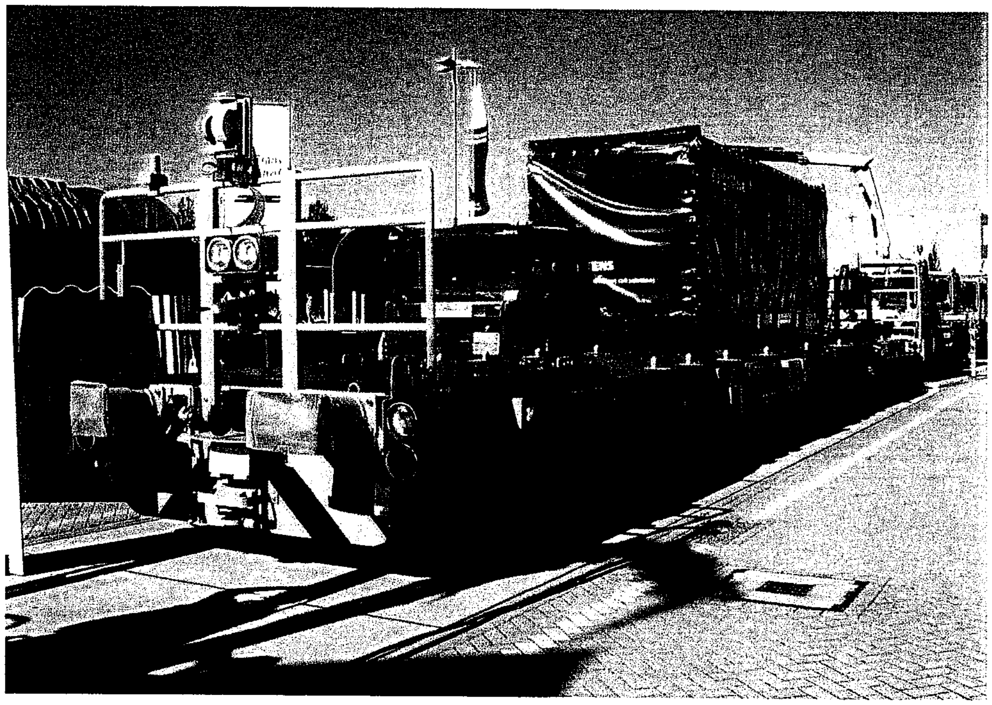


Courtesy of General Atomics

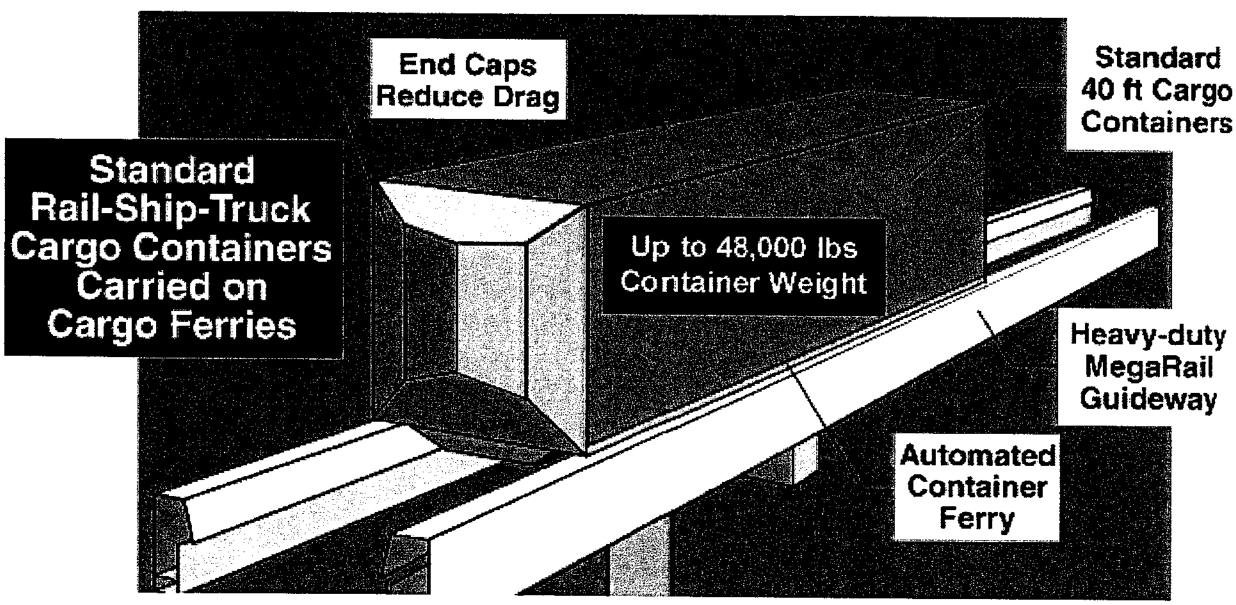
BACKUP INFORMATION—Continued

ALTERNATIVE SYSTEMS

Self Propelled, Driverless, Railroad Car (CargoMover, courtesy of Siemens Transportation)

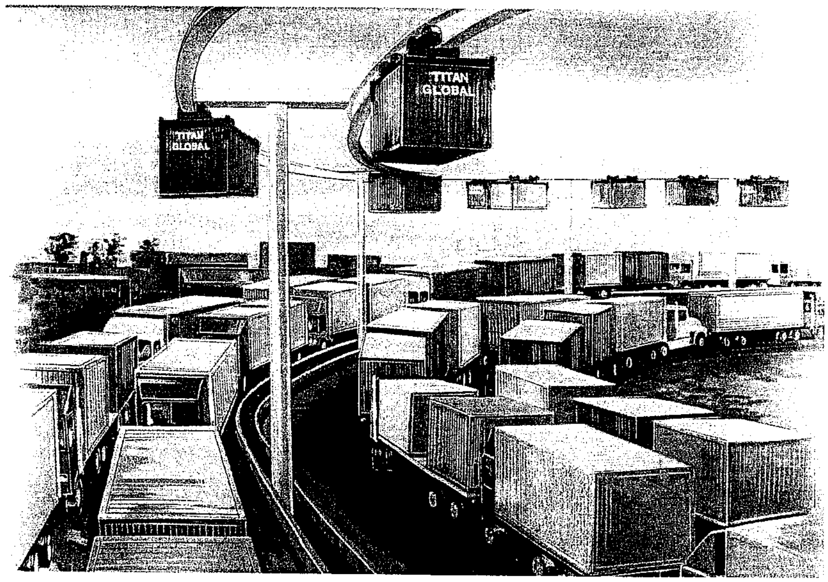


Fixed Guideway (CargoRail, courtesy of MegaRail Transportation Systems, Inc.)



ALTERNATIVE SYSTEMS

Overhead Monorail System (AutoGO system, courtesy of Titan Global Technologies, Ltd.)



Executive Summary

ONR Magnetic Levitation Research and Development Roadmap

Introduction

Magnetic levitation (Maglev) research and development in transportation started in the late 1960's and was initiated because of the developments in superconducting materials and magnets that offered very significant benefits. These very high strength superconducting magnets allowed vehicles to be magnetically levitated and propelled with large air gaps (200 - 250 mm), which mitigate many of the high speed steel wheel on rail cost and operating and maintenance issues, such as those related to power collection, weather related traction problems, wheel rail wear, and vehicle and guideway dynamic issues related to keeping the track sufficiently straight so as to maintain good ride quality and not cause derailments at high speeds (360 – 500 km/hr).

Friction independent transmission of electromagnetic propulsion by means of linear electric motors not only allows all weather operation, but also positive automatic control at short headways and the capability to climb very steep grades. This inferred that all vehicles could be electronically coupled without heavy mechanical couplers, and thereby provide more frequent service with off-line stations, direct origin-to-destination, demand responsive service, and more direct alignments. Overall, Maglev offers the highest performance and safety capability of any surface transportation system (particularly, at high speeds) at the lowest life-cycle cost. In other words, Maglev is a technological solution to high performance, lowest operating and maintenance cost, and with the highest level of safety.

In spite of this, the U.S. effort was abruptly stopped in 1974 due to the energy crisis. However, Germany and Japan had each developed long range plans. Germany, after carefully conducted studies and testing of a number of alternatives, continued their work on the high-speed Transrapid Inter-City system at Emsland. Transrapid, which was operationally demonstrated in 1978, was based on conventional electromagnetic technology with very small (7 mm) air gaps. This necessitated a very precisely fabricated guideway. At the time, the fabrication of this precise guideway was thought to far too expensive, and the U.S. started to pursue large gap Electrodynamic suspension technology. However, the Germans developed fabricating technology coupled to paperless design that allowed relatively low cost guideways to be built. This amazed the world and advanced Transrapid to the forefront.

The Japanese on the other hand launched into the development of the high-speed MLU superconducting trains, which offered a very large non-contacting air gap that was far less susceptible to earthquakes than any other surface transportation system. Japanese Air Lines also initiated development of the

High Speed Surface Transportation (HSST) technology to mitigate the enormous congestion, which caused considerable delay in getting to the airports. The HSST was demonstrated at several expositions and was inaugurated into operational service in Japan's Aichi Prefecture in 2005.

In 1989 the U.S. Congress appropriated roughly $9 Million for the National Maglev Initiative (MNI) to determine if the U.S. had leap frog technology that was better than the German Transrapid or Japanese MLU or HSST technology. The NMI concluded that there were very significant technological advantages and cost-benefit of American technology. However, in 1994, again a hiatus was initiated due to the Federal deficit.

In 1999 the Federal Transit Administration (FTA) initiated an urban maglev program. This resulted in an even greater technological leap frog forward that was primarily a manifestation of hybrid permanent magnet technology. This effort reduced the cost of maglev systems by a factor of three to five times that of the HSST or the Inter-City Transrapid.

The Federal Railroad Administration (FRA) however, has continued to cost and plan the use of Transrapid in its Commercial Feasibility Study (1997) neglecting the findings of the NMI and in more recent studies even the results of the FTA Urban Maglev Program. Although Transrapid has demonstrated operational feasibility via the Shanghai system, this technology is based on 1978 technology that was designed for high speed long distance intercity operation with European and Asian demographics. In addition, it was designed with a capability to climb only a 6 % grade. For that purpose, Transrapid can meet the stated objective, but this 1978 technology it is not the least expensive. Furthermore, life cycle costs were not used as the benefit-cost measure, rather, the system capital cost was the only determinant. This eliminated one of the most important benefit measures – the low operating and maintenance cost, which gives Maglev the capability to operate without a subsidy. Over the life of the system the low operating cost more than offsets the capital cost of the infrastructure. The lack of using life cycle costs as the benefit measure has led to the perception that maglev is too expensive. However, U.S. technology based on hybrid permanent magnets is three to five times less expensive and can be tailored to climb any steep grade.

The Office of Naval Research is developing the Agile Port (a distributed port) system for the ports of Los Angeles/Long Beach (LA/LB) to Victorville. The objective is to develop an inland inter-modal port where dual use military and civilian freight and passengers can be marshaled for rapid movement between the ports. This would alleviate congestion at the ports of Los Angeles and Long Beach and make available additional land for logistic movement at significantly lower cost. Among the key reasons for selecting maglev technology is community acceptance of this non-polluting technology, and its ability to climb steep grades greater than 10 % with flexibility to negotiate steep passes without the need for land taking or digging tunnels.

This proposed R&D program is designed to make Maglev technology more cost effective, by introducing new and emerging technologies. A key program requirement is that it is applicable to both civilian and military operations. Hence, this Maglev technology is to be designed to be dual-use, and will be applicable to passenger and freight transportation operations, as well as future military ships, weapons and launching systems.

Why Maglev

Maglev offers the highest performance and safety capability of any surface transportation system (particularly, at high speeds), and achieves this at the lowest life-cycle cost. The following are common issues related to urban and intra-city systems, passenger and freight systems, and dual use military and civilian systems.

1. Maglev offers the highest performance capability of any surface transportation system.

    a. It has the highest payload to total weight of any surface transportation system (35 – 60%). This means that any payload, including seaborne containers, can be moved by lighter vehicles, which in turn require a lighter, less expensive guideway to support the combined payload and vehicle weight.

    b. Vehicle speed and payload is not limited to 500 km/hr, where as steel wheel on steel rail system are limited by the frictional forces that can be generated.

    c. Maglev system offer greater system capacity because of friction independence that allows shorter headways with great safety thereby, allowing more passengers and tons of freight to be moved over a single guideway.

2. Maglev is a technological solution to maintenance.

    a. By its nature Maglev is a non-contacting levitation system. Therefore, there is no wear out of mechanical components such as guidance or levitation rails, because all forces are transmitted magnetically.

    b. Maglev systems typically use linear electric motors for propulsion, which also transmit all propulsion forces magnetically. Hence, there is no wear out of mechanical components. This also, results in lower maintenance cost. More importantly, it allows any grade to be negotiated and any load to be moved. For example, a 67,000 lb. seaborne container could be moved at 500 km/hr, just as a 70,000 lb aircraft could be accelerated to 160 knots, within a distance of 330 ft and in 3.5 seconds.

c. Maglev systems use less propulsion energy because electrical resistance (I^2R) losses for power transmission are minimized. This is accomplished by only turning on the linear electric motor under the vehicle, which is needed for propulsion. Electrically propelled Light and Heavy Rail Vehicles electrify the entire line, and experience resistance losses over the entire line. In addition, demand responsive operation requires that vehicles are only propelled when passengers use the transportation service. Otherwise, vehicles are in a standby mode, waiting to provide service.

d. Friction dependent systems, which includes all wheel on rail or road have large variations in the coefficient of friction of a steel wheel on a steel rail or a rubber tire on a steel or concrete road surface due to environmental conditions such as rain, snow, or ice. Many applications of brakes especially under over speed or emergency conditions result in locked brakes, which slide the wheels and wear flat spots on the wheels. In turn, these flat spots act as hammer blows to the rails each time the wheel turns. This increases the wear on rails, which in turn, causes further dynamic amplification on the guideway – resulting in poorer ride quality, increased noise, and more maintenance to regrind wheels, rails and re-align guideways to correct the condition. Friction dependent systems result in greater maintenance and cost and poorer performance in terms of headway control and grade climbing capability because of the need to account for the uncertainty of friction under all environmental conditions. This results in larger headways due to the greater uncertainty in stopping distance under all conditions and lowers safe operating speeds. It also results in lower grade climbing capability. Typically, trains operating on steel wheel on steel rail cannot climb grades in excess of 3.5 %.

e. Maglev also provides safer stopping because of its independence of friction. That is, stopping distance under all weather conditions is the same – hence more reliable. Shorter stopping distances are possible because of friction independence. Shorter stopping distances also means that Maglev can achieve higher system capacities with fewer vehicles, and operate at higher speeds with greater safety.

f. The distribution of load over the magnet surface of a Maglev vehicle results in significantly less dynamic input into the guideway vis-à-vis a wheeled vehicle. This results in less re-alignment of the and less maintenance cost. It also results in less of an effect transmitted to the earth, which has been described as the "earth quake effect" of heavy wheeled vehicles.

g. Because of this distributed loading on the vehicle, the vehicle is lighter in weight. Vehicles which are lighter in weight than their wheeled counterparts result in less material being required for the vehicle and in the supporting guideway structure. In turn, this results in less capital cost for the system. The guideway represents somewhere between 40 – 60 % of the capital cost of an urban system. This represents a very large savings in capital cost.

h. Maglev is an all weather system, which does not require heating of rails or unthawing during icing conditions. This means less energy is needed and hence less operating and maintenance cost. In addition, Maglev creates less pollution.

i. Lack of contact in a Maglev system also results in less noise.

j. Magnetic drag is comparable to the rolling resistance of steel wheel on steel rails, but is significantly less than the rolling resistance of rubber tired wheels. Therefore, magnetic drag is very small and yet the friction independent nature of Maglev offers significant improvements in safety and in increased capacity of the system all at the lowest operating and maintenance costs.

3. The "Holy Grail of Transit" is the ability to operate a system out of the fare box.

   a. Maglev in conjunction with full automatic control is one of two known system which can be operated at the cost of the fare. However, Maglev can achieve this end at lowest operating and maintenance cost.

4. In summary, Maglev is a technological solution to achieving high performance at the lowest operating and maintenance cost and with the highest level of safety.

BIOGRAPHY

Dr. Sam Gurol

Director of Maglev Systems

General Atomics

Dr. Sam Gurol currently serves as Director of Maglev Systems, in charge of GA's Urban, High-Speed Maglev, and cargo Maglev programs. He has 30 years experience in the research, development, and fabrication of high technology electromagnetic systems involving superconducting magnets, linear induction and synchronous motors, and Maglev systems. He also serves as a senior technical advisor on numerous GA programs, including the Navy's Electromagnetic Aircraft Launch System (EMALS), and the Holloman Maglev system for the Air Force with the goal of achieving Mach 10 speed at sea level. Some of his prior experience includes: Program Manager for the Navy MHD Submarine Propulsion program (1988-1996), Chief Scientist for the Lockheed Martin Energy and Power Group (1990-1998), and technical lead for magnetic field quality of the Superconducting Super Collider (SSC) dipole magnet program (1989-1993). His academic background and professional awards/recognitions include:

- Ph.D., Nuclear Engineering, University of Michigan, 1975
- M.S./B.S., Nuclear Engineering, University of Michigan, 1972/1971
- Executive Program for Scientists and Engineers, UCSD, 1994
- Member, Sigma Xi
- Winner of the "Jimmie Hamilton" award for best paper in Naval Engineering Journal, 1991
- Two patents related to achieving high field quality in accelerator magnets and one pending patent on Maglev guidance system
- Past member of the editorial advisory board of *Superconductor Industry*
- More than 60 papers and conference proceedings on electromagnetic system design and testing.
- Member of Steering Committee for International Conference on Magnetically Levitated Systems and Linear Drives

BIOGRAPHY

Dr. Kenneth James,

Professor in both Electrical Engineering and Computer Engineering/Computer Science; CCDoTT Technical Coordinator

Center for the Commercial Deployment of Transportation Technologies; California State University Long Beach College of Engineering

CSULB Professor in both Electrical Engineering and in Computer Engineering/Computer Science with research emphases in MEMS sensors and advanced ASIC design. Upon receiving his BS in Physics in 1968 from Case Institute of Technology in Cleveland, Dr. James joined the technical staff of Rockwell International Research Division in Anaheim, California. While employed with Rockwell International as a design engineer for VLSI devices and fiber-optic sensors, he completed an MS in Electrical Engineering at California State University, Fullerton in 1972 and a Ph.D. in Electrical Engineering at the University of California, Irvine, in 1982. In 1984, he formed OPCOA, Inc. in Garden Grove, California and served as CEO until 1996. The company, through funded research from NASA, produced the first micro-mechanical optical filter for fiber communications. He is the author of 13 articles and has been awarded 16 patents. He joined the faculty at California State University; Long Beach in 1978.

Since 1999, Dr. James has been Technical Coordinator for the CSULB Center for Commercial Deployment of Transportation Technology (CCDoTT), where he oversees the technical evaluation of all CCDoTT projects in the program sectors that include Agile Ports and Terminal Systems, High Speed Sealift Systems, Decision Support Tools, and Port and Cargo Security Systems Systems. Dr. James has been a major contributor to Cargo Movement and Inspection Technology projects developing an aritificial intelligence container targeting system to work with emerging non-intrusive inspection devices. Dr. James is the Principal Investigator for the College of Engineering's Distributed Inventory Management System (DIMS) project, a system to track and organize container movement and storage for the Office of Naval Research and the Defense Logistics Agency. He has been the Co – Principal Investigator for both the *Feasibility of a High-Speed Intermodal Corridor for Port of LA/LB* and *The Evaluation and Implementation Plan for Southern California Maglev Freight System*. Dr. James was the first to see the potential value Maglev technology used as a dedicated freight corridor and has been central to the development of the concept.

BIOGRAPHY

Edward F. Thicksten

Project Coordinator /Consultant

Center for the Commercial Deployment of Transportation Technologies (CCDoTT)
California State University Long Beach

Mr. Thicksten is the Project Coordinator for the CCDoTT Project: The Evaluation and Implementation Plan for Southern California Maglev Freight System. He also support the Technology Transfer and Outreach Project for CCDoTT.

He received his BS degree in 1972 from Arkansas Tech University

Mr. Thicksten served in the Arkansas State Legislature from Jan. 1975 until Jan. 1999. He was Chairman of the House Joint Budget Committee his last three terms.

He has been President of Thicksten Ent. Inc. since 1973

He was partner in the Washington DC consulting firm of Thicksten, Grimm and Burgum (1991-1997).

Since 1998, he has served as Director of Special Projects at the California State University, Long Beach Foundation.

He has served as Principal Investigator on projects totaling 8 million dollars including METRANS, the National Center For Metropolitan Transportation Research, University of Southern California and California State University, Long Beach.

BIOGRAPHY

Mr. Steven M. Hinds

Program Administrator

Center for the Commercial Deployment of Transportation Technologies (CCDoTT), California State University, Long Beach

Currently serves as Program Administrator for CCDoTT. Responsible for Program Management and Technology Transition of 10 to 18 annual and multi-year advance technology projects. Also, Co – Principal Investigator for: CCDoTT Technical Transition; Waterjet Self-Propulsion Model Test for Application to a High-Speed Sealift Ship; High Speed Trimaran Technology Development and Application for Benchmark Design Validation of Heavy Air Lift Seabasing Ship (HALSS); Pacific Northwest Agile Port System Demonstration; Rational Structural Dynamic Loads for High Speed Sealift Applications; Summary Review of Alternative Shipboard Powering Systems for Naval and Regulatory Review; Feasibility Assessment of Short Sea Shipping to Service the Pacific Coast.

Extensive experience in military logistics operations from both the operational and planning perspective (USMC/NATO). As a member of the Policy Staff, Supreme Headquarters Allied Powers Europe, responsible for the policy coordination of the NATO Military Defense Plan. As the Physical Security Officer for the United States Marine Corps, responsible for all physical security and special weapons security and inspection issues throughout the Marine Corps; and coordinated with Department of Defense to develop a single standard for physical security guidelines for all services world-wide. Served as Deputy Assistant Secretary of the Navy (FSN) (Acting).

Ten years experience as a Senior Analyst and Program Manager for Systems Planning and Analysis, Inc. providing high-level decision makers on the Navy OPNAV staff (N-80 Assessment Division) and the Marine Corps Combat Development Center with decision support analysis supporting the Navy Investment Balance Review (IBR), the Quadrennial Defense Review, and the Maine Expeditionary Forces (MEF) Combat Service Support Review.

Bruce A. Dahnke

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A high-impact executive in the fields of Transportation and Logistics, Supply Chain Management and Freight Optimization – with a strong background of creating leading edge technology solutions for transportation. A successful P & L manager -- especially skilled at making continuous improvements in service quality, reliability, teamwork, efficiency and profitability. Led the mechanical engineering and technical design of highly efficient next-generation freight optimization system for intermodal, rail, maritime, truck and port transportation.

Extensive professional skills and experience, including:

- Over-Achieving Revenue & Profit Targets
- Improving Processes & Procedures
- Hiring, Training & Team Building
- Using Statistical Analysis Methodology
- Fabricating Mechanical Assemblies
- Maximizing Customer Service & Satisfaction
- Working with Unions & Governmental Entities
- Launching Start-Up Operations
- Making Bids, Proposals & Presentations
- Using JIT & Inventory Controls
- Complying with Safety & DOT Regulations
- Designing Prototypes / R & D
- Tracking Information / Data Security
- Cutting Costs & Boosting Profits

Professional Background

President Skytech Transportation, Inc. Wood Dale, IL 2002 – present

Launched, developed, and direct day-to-day operations of startup design company for the transportation industry. Research intermodal, rail, maritime and port freight optimization techniques. Designed prototype of new technology (SkyTech Framework) for intermodal transportation systems. Develop one-of-a-kind end-to-end solutions to achieve just-in-time, cost-effective and safe automated container moves to resolve container congestion issues and realize ROI. Established IMC (Intermodal Marketing Company) to implement industry marketing and business development plans.

- Pioneered, designed, and developed next-generation, low wattage and non-polluting hybrid rail system designed for multiple transportation modes with enhanced land usage and expansion capacity for future requirements.

- Achieved industry recognition as expert on transportation logistics; serve as Advisor to multiple commercial, educational, and government agencies.

- Wrote *Next Generation Intermodal Roadmap*, a white paper on the Web outlining efficient door-to-door system for transportation security.

- Presented Skytech Framework coast to coast from Center for Clean Air Policy, Washington D.C., Upper Midwest Freight Corridor, Chicago, Illinois, Intermodal Freight Technology Working Group, Oakland, California, Intelligent Transportation Association of North America, Phoenix, Arizona and The Health and Personal Care Logistics Conference, Inc., Long Boat Key, Florida.

President Laser Express, Inc. Chicago, IL 1985 – 2001

Launched and managed daily operations of a nation-wide rail drayage carrier with 50 drivers.

- Founded company with $4,000 and sold over $6 million in revenue.
- Served as in-house carrier for GE Transportation, including a large account with GE Plastics.
- Provided logistics services to the Department of Defense, Israel.
- Created and maintained operations for transportation over a seven state area.
- Set up operations authority under D.O.T. rules and regulations.
- Set up offices in Cicero, IL, Portland OR. And Cincinnati OH.
- Successfully led the passage of the Roadability Act (Safe Container Act) in the state of Illinois.
- Was profiled in *Illinois Truck News* for accurate, predictable and on-time delivery.

Vice President, Operations Transportation Sales & Services, Inc. 1983 – 1986

Managed all aspects of maritime, rail, and trucking operations including finance, real estate, technology infrastructure, sales, regulatory affairs, public relations, asset management and human resources.

- Set up Epson account for South American distribution, providing financial analysis to facilitate change from trucking to combination of truck and rail services, saving Epson significant money while creating multiple efficiencies, including a just-in-time delivery system.
- Handled moving Epson from Bensenville, IL to Indianapolis, IN.
- Established North American logistics company to pick up and deliver anywhere in continental US, Mexico, and Canada.
- Pioneered hazardous material handling by intermodal operations in the early 1980's.

Regional Sales Representative CSX Rail Road / Chessie Motor Express 1980 – 1983

Developed new business accounts and serviced existing accounts for door-to-door delivery services for on-time delivery in territory west of the Mississippi River, excluding California.

- Recognized as #1 Sales Representative for production exceeding 200 trailers per week.
- Developed methodology for significant penetration into protective services of perishable goods.

Professional Affiliations

Advisor on Intermodal Freight Technology Working Group, U. S. Department of Transportation
Board Member, Intermodal Advisory Council of Chicago (CATS)
Intelligent Transportation Association of North America
Partners for Advanced Transit and Highways
Consultant: The Transportation Center, Northwestern University
Advisor, University of Wisconsin, U.I.C., I.I.T. & University of California at Berkeley

Improving Efficiency of Freight Movement with EPA's SmartWay® Transport Partnership

What is the SmartWay Transport Partnership?

- **Launched February 9, 2004**
- **Voluntary partnership between EPA and the freight industry:**
  - Developed jointly by EPA and 15 Charter Partners
  - Freight industry interests: reduce fuel consumption, public recognition, improved public image
  - EPA interests: reduced emissions (CO_2, NO_x, PM) and improved energy security
  - No fees to participate
  - Open to companies of all sizes

What is the SmartWay Transport Partnership?

- **5 Major SmartWay Transport Components:**
  - **Corporate Partnerships** – carriers and shippers working to reduce fuel consumption and emissions
  - **National Transportation Idle-Free Corridors** – goal to eliminate unnecessary idling along major transportation routes
  - **Rail/Intermodal** — promote greater use of appropriate intermodal strategies
  - **Testing/Technology Verification** – evaluate fuel economy/environmental performance of innovative/emerging technologies, quantify relationship between fuel economy and NOx
  - **Capitalization** – develop innovative financing programs

SmartWay Partnership Today

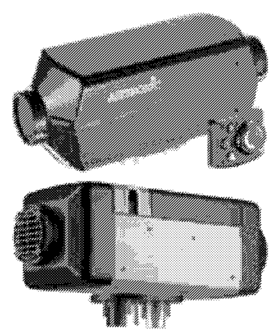
	Industry Totals	SmartWay Partners	% Industry
Total No. of Companies	500,000	**323**	0.06%
No. of Trucks	7,000,000	**272,725**	3.90%
Miles Traveled	350 billion	**16.47 billion**	4.70%
Gallons Consumed	35 billion	**2.43 billion**	6.94%
Tons CO_2	385,000,000	**27,162,717**	7.06%
Tons NO_x	2,805,659	**236,734**	8.44%
Tons PM	90,303	**5,602**	6.20%

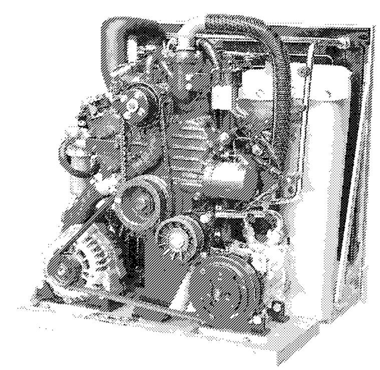
Innovative & Emerging Technologies/Strategies in the Freight System

- Idle Reduction*
- Single Wide Tires*
- Improved Aerodynamics*
- Rail Technology*
- Emission Control Devices*
- Driver Training
- Improved Freight Logistics
- Automatic Tire Inflation Systems
- Reducing Highway Speed
- Low Viscosity Lubricants
- Intermodal Shipping

Idle Reduction Technologies

- Automatic Shut-Down/Start Up System
- Battery Powered HVACs
- Direct-Fired Heater
- Auxiliary Power Unit/Generator Set
- Fuel Cell APUs
- More information on available on-board idle reduction technologies can be found at http://www.epa.gov/otaq/smartway/idlingtechnologies.htm

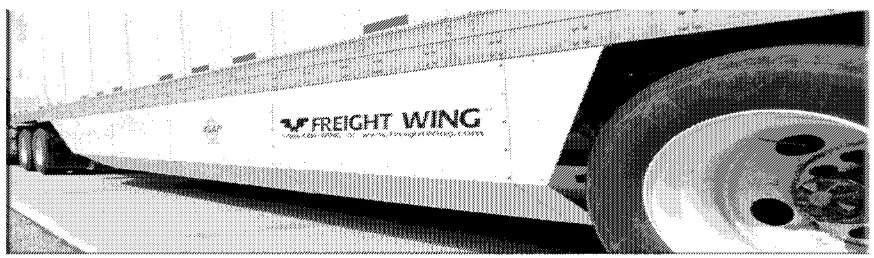




Trailer Aerodynamics

- **Gap Fairing:** Attaching aerodynamic equipment to the front of the trailer to reduce the gap between the tractor and trailer can improve fuel economy by up to 2%.
- **Side Skirt:** Attaching aerodynamics to the sides of the trailer reduces the space between the lower edge of the trailer sides and the ground, and can improve fuel economy by up to 4%.
- **Nose Cone and Trailer Tail:** Attached to front or back of trailer to reduce aerodynamic drag: fuel savings up to 3%.
- Examples - http://www.freightwing.com/; http://www.laydoncomp.com; and http://www.nosecone.com/

Gap fairing



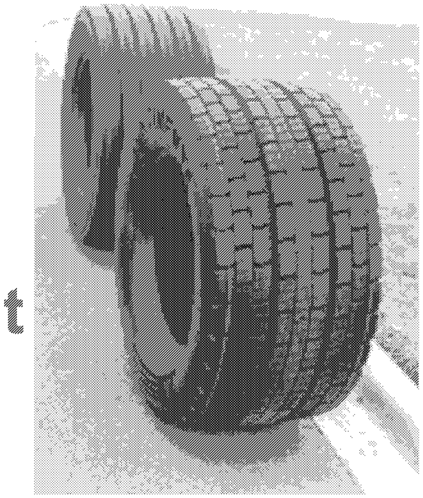
Side Skirt

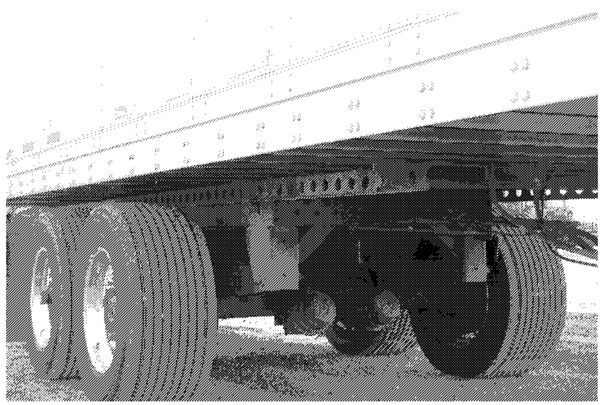
Nose Cone

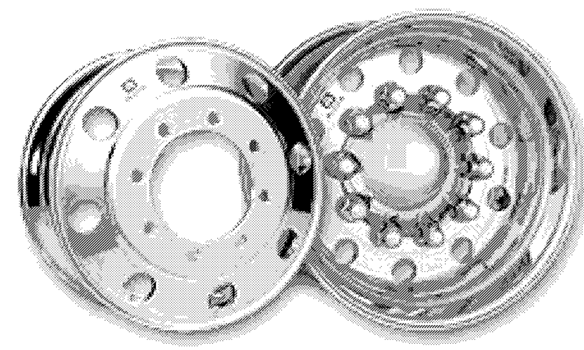
SmartWay Partners with Side Skirts and Gap Fairings

Single-Wide Tires with Aluminum Wheels

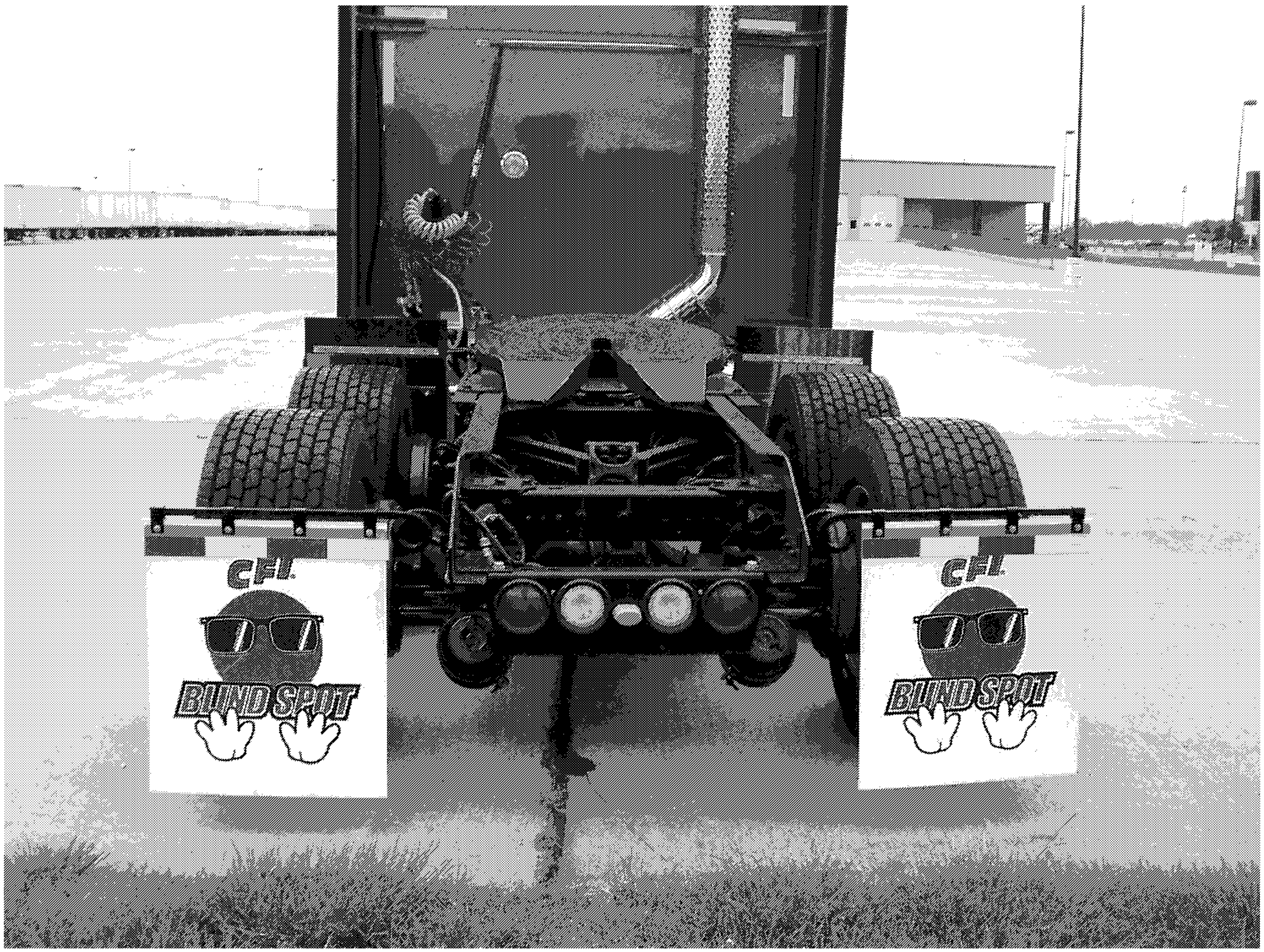
- **Single-wide tires and aluminum wheels**
  - Michelin X-One XDA - drive axles
  - Bridgestone-Firestone Greatec - trailer axles
  - Estimated cost - $3,000 for complete retrofit
- **Single-wide tires improve FE through reduced rolling resistance with improved materials and architecture and less weight**
- **Fuel savings of approx. 4% to 7%**
- **Save as much as 1,000 pounds of weight**







SmartWay Partner with Single-Wides



Rail Technology

- Auxiliary power units
  - Idle reduction
- Green goat
  - Rail hybrid
- Using on-road engines for off-road purposes
  - Better power requirements
  - Better load
  - Better fuel requirements
  - Lower emissions
- Horsepower reduction
  - Reduced fuel consumption

SmartWay Technology Verification Program

- Evaluate fuel economy/environmental performance of innovative/emerging technologies
  - → quantify relationship between fuel economy and NO_x
- Test demonstrated, for first time, link between saving fuel and reducing NO_x
- Engineering experts inside and outside EPA supported the test and the results
- Published SAE paper demonstrating results
- Test opened door to potential for innovative SIP guidance and financing programs

SmartWay Upgrade Kit

- **"SmartWay Upgrade Kit": Suite of technologies that result in significant fuel savings and substantial emission reductions**
  - Idle Reduction Device (e.g., Bunk Heater or Auxiliary Power Unit)
  - Trailer Aerodynamics
  - Single-Wide Tires with Aluminum Wheels
  - Emission Control Devices (Diesel Oxidation Catalyst or PM Filter)
- SmartWay Kits pay for themselves in 1.5 to 3 years
- In almost every case, monthly fuel savings exceed any type of monthly payment

The Technology Package:
SmartWay Upgrade Kits with Oxidation Catalysts

Some options for SmartWay upgrade kits:

1. High FE Truck w/ Oxidation Catalyst:

Device	Cost/Unit (Retrofit)	PM Reduction	NOx Reduction	FE Change
Oxidation Catalyst	$1,000	25%	--	--
Super Single Tires w/ alum. wheels	$3,000	--	3-4%*	3-4%
Trailer Aero Kit	$2,400	--	4-5%*	4-5%
Auxiliary Power Unit	$7,000	--	10-20%	9%
Totals:	**$13,400**	**25%**	**18-28%***	**17%**

For a truck traveling 100,000 miles/year @ 6 mpg (16,667 gallons /year)

Fuel savings: 2,833 gallons @ $2.55/gallon → **$7,072/year**

Payback period: $13,400 / $7,072 → **1.9 years**

Monthly loan payment (@ 6% interest) → $408

Monthly fuel savings: → $589

Money in a driver's pocket → $181

Capitalization

- Companies often lack the capital and financial flexibility to purchase these types of technologies
- SmartWay is developing innovative financing programs
  - Traditional loans loans offered with terms that are more attractive than currently available commercial loans.
  - Currently have loan programs in Arkansas and Minnesota
  - Developing loan programs in Pennsylvania and Oregon
- SmartWay has developed a simple, interactive calculator to demonstrate how purchasing these technologies will put cash in your pocket.

SmartWay Upgrade Kit Loan Calculator

Calculator for fleet owners (multiple truck):

Equipment	Total Cost	% Fuel Savings	Annual Fuel Savings	Monthly Fuel Savings	Monthly Loan Payment	**Net Monthly Savings**
Heater, Tires, Aero, DOC	$7900	13%	$5346	$446	($182)	$264*

STEP 1: ENTER YOUR TRUCK AND LOAN INFORMATION.
Enter your basic vehicle and loan numbers here. See below* for help with numbers.

Total Number of Trucks in Fleet	1	
Total Fuel Use for Fleet	18000	(Gallons)
Average Annual Fuel Use	18000	(Gallons)
Cost of Fuel	$ 2.25	
Yearly Fuel Cost	$ 40500	
Monthly Fuel Cost	$ 3375	
Average Annual Idling per Truck	2400	(Hours)
Loan Period	48	(Months)
Loan Interest Rate	5.00	%

STEP 2: SELECT TECHNOLOGIES OF YOUR TRUCK.
Check the technology box below to test at various combinations of technologies for your truck. You can check one or as many items as you want.

Technology	Quantity	Cost
☑ Bunk Heater (Heater)	1	$ 1500
☐ Auxiliary Power Unit (APU)	1	$ 7000
☑ Aluminum Wheel Sets for Single Wide Tires (Tires)**	1	$ 3000
☑ Trailer Aerodynamics (Aero)	1	$ 2400
☐ Automatic Tire Inflation (ATI)	1	$ 900
☑ Oxidation Catalyst (DOC)	1	$ 1000

*Click [load typical values] to insert "typical" number of most long-haul truck trips and loan amounts. These are just suggested numbers to help you get started. You can change these numbers as you wish.

[Savings Without Loan] [Clear]

For More Information

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http://www.epa.gov/smartway

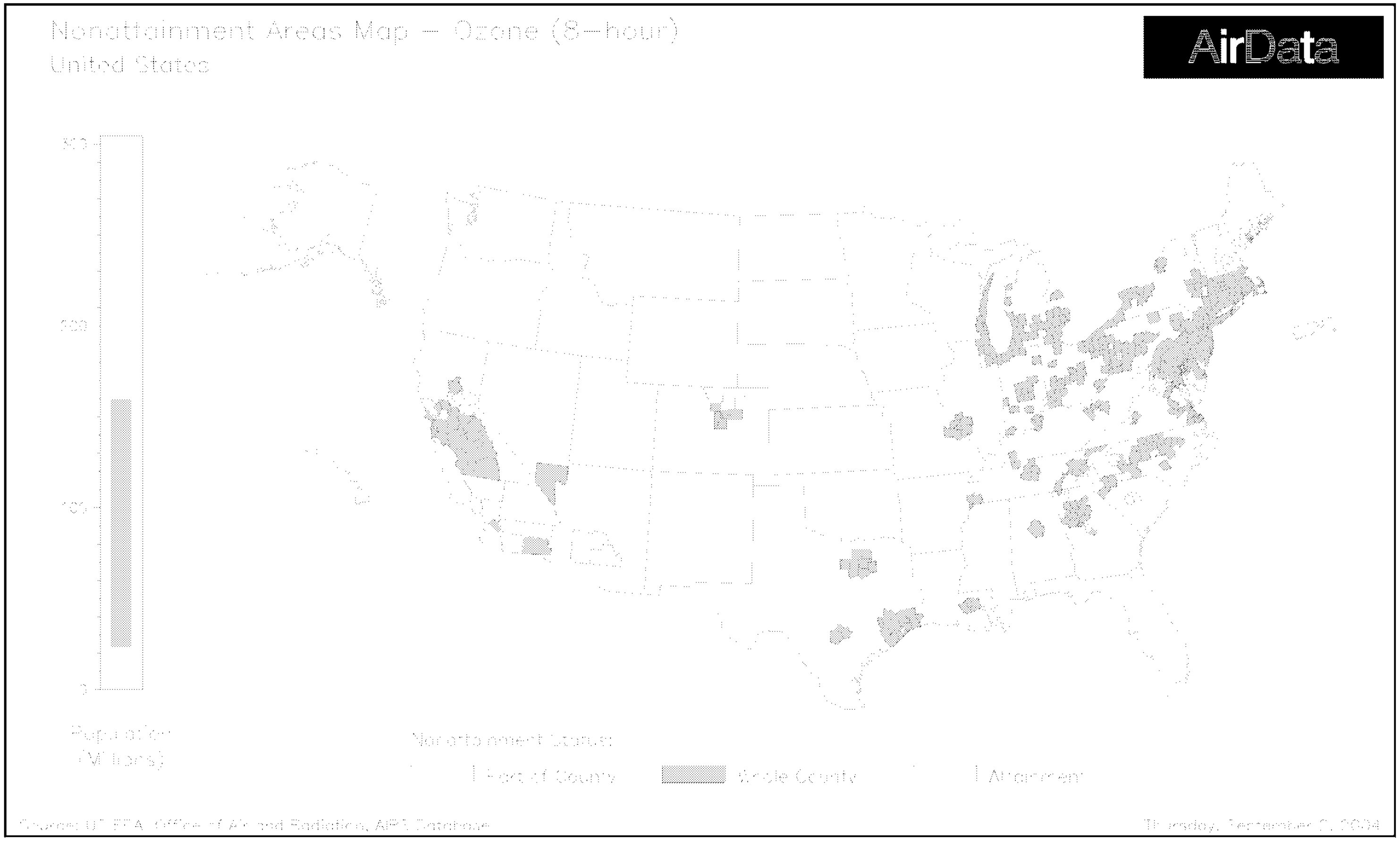
Burlington Northern Santa Fe Corporation

Railroad Emission Control Technology

Mark Stehly
Asst. Vice President Environmental and Research & Development

February 28, 2006

Ozone Non-Attainment Areas



- Statewide Problem Needs Statewide Solutions
- BNSF Operates Throughout the West

Railroad Emissions Summary

- Technology continues to reduce emissions
  - Switch locomotives using truck-like engines are leading the reductions.
  - Not all truck engine technologies are appropriate for locomotive engines and the same technologies may have different reduction performance
- If stationary sources were mobile, they could not achieve their current emission reductions
- Voluntary but enforceable agreements allow tailoring reductions to achieve the best results most economically where they are needed most
  - Congress protects interstate commerce for very good reasons
- Railroads are currently achieving large reductions in emissions from line operations and around railyards

Reductions in Rail Yard Diesel PM

Sources	EMISSIONS (tpy) & Reductions			
	2005 (Base)	2010	% Reduction	Strategy
Through Trains	10	5	50%	‘98 MOU
Switcher Locomotives	7	0.7	90%	‘98, ‘05 MOU, CARB Diesel
Loco Refueling	2	0.5	75%	‘98, ‘05 MOU
Cargo Equipment	34	13.6	60%	ARB Rule
Container Truck	7	0.7	90%	**Bond (or Moyer) Funding**
Total	60	20	65%	

Based on information the California Air Resources Board staff presented in 1/27/06 ARB Meeting

Liquified Natural Gas Switcher Locomotive

1200 sustainable horsepower, spark ignited

New Switch Locomotive Technology: *Hybrids*

2000 peak horsepower from batteries

"Hybrid" light-medium duty switcher

Batteries recharged by 290 HP EPA *off-road Tier 2* diesel gen set

significantly exceeds EPA locomotive Tier 2 requirements

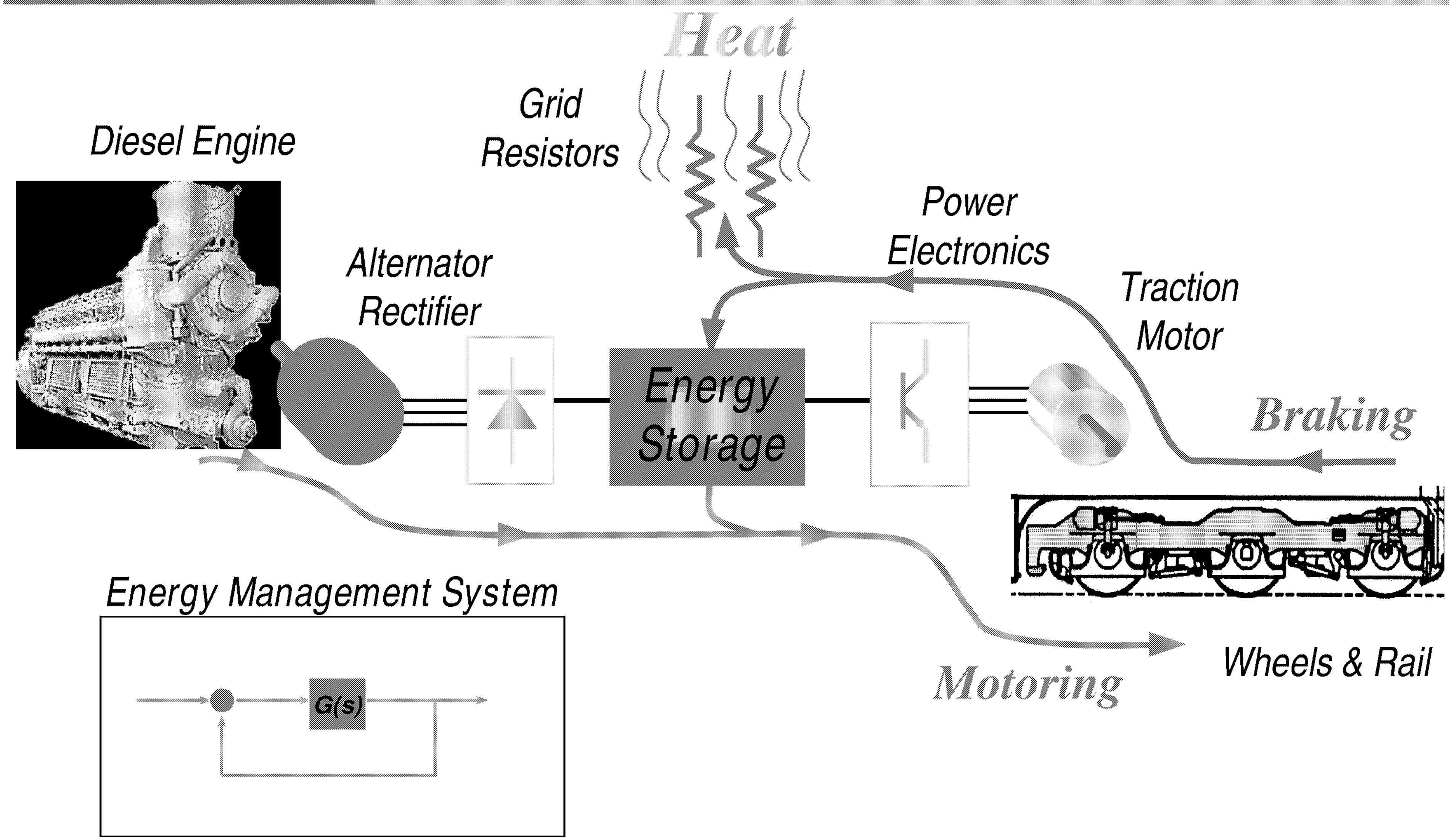
New Switch Locomotive Technology: *Truck-like engines*

(2 or 3) 700 sustainable horsepower gen sets

"Truck-like engine" heavy-duty switcher

powered by multiple diesel gen sets

Road Locomotive Hybrid Concept



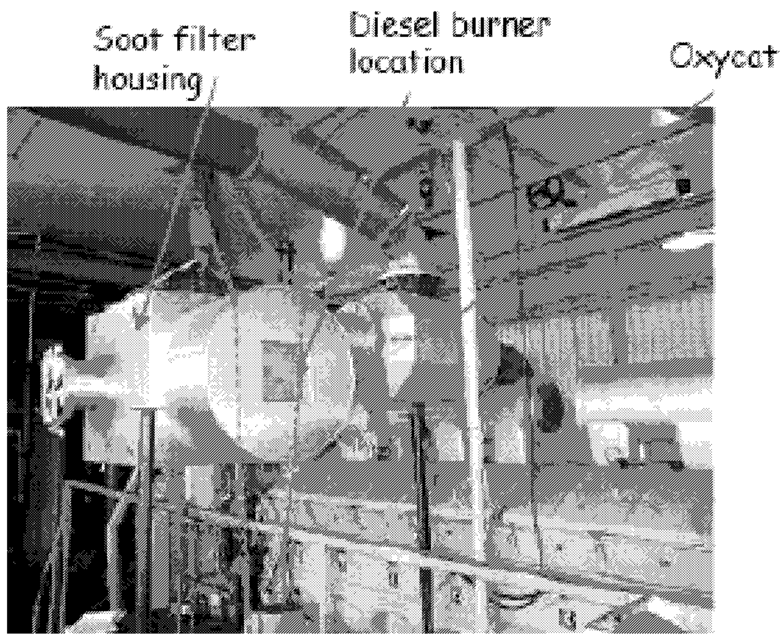
Switch Engine Emissions in g/hphr
EPA switch engine duty cycle

	1955 GP9 Style	EPA Tier 2 STDs	Green Goat	Spark Ignited LNG	Truck like Engines Now	Truck like Engines Future
NOx	17.5	8.1	3.8	1.4	2.66	1.49
PM	0.5	0.24	0.11	0.09	0.12	.014
HC	0.8	0.6	0.2	3.3	0.28	0.14
CO	2.1	2.4	0.9	2.2	1.07	1.0

Line Haul Locomotive Emissions in g/hphr
EPA line haul duty cycle

	1975 SD40-2 style	1975 SD40-2 Tier 0	Dual Fueled LNG	EPA Tier 2 STDS	GE Evo Engines 2005	EMD Engines 2005
NOx	13.1	9.0	5.0	5.5	5.2	5.1
PM	0.27	0.60	0.40	0.20	0.08	0.07
HC	0.44	0.5	1.21 nmhc	0.3	0.17	0.22
CO	1.6	2.1	10.3	1.5	0.3	1.0
BSFC	unity	3% loss	11% loss		20% gain	

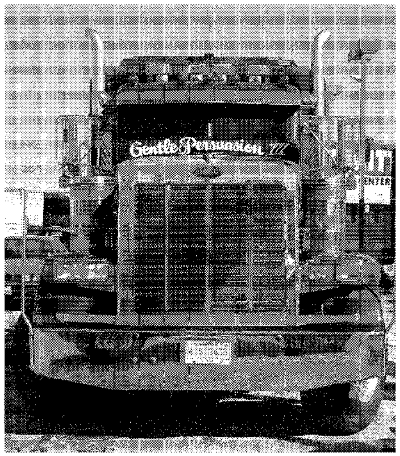
Diesel Particulate Filter (DPF) R&D



- BNSF and UP 1500 horsepower switchers will be equipped with DPF technology in 2006
- Units will be tested for maintainability, durability and performance in California

- UP and BNSF railroads have been co-funding 5-year R&D project investigating performance, durability and applicability of DPF to older switching locomotives
- R&D work being performed by Southwest Research Institute ("SwRI") through Association of American Railroads

Truck vs. Locomotive Engines



22 million ~3 decades

25+ yrs federally-funded R&D

Charge-air cooling (front rad.)

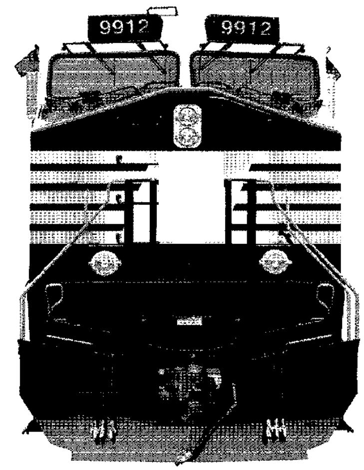
Operation dominated by transients

Hi-speed design *(lower NOx tendency)*

Lower fuel efficiency (gallons/GTM)

Mechanical transmissions

Typically 5 yr. Lifecycle



21,000 ~ 3 decades

R&D mostly by RRs & suppliers

No charge air cooling, more complex system

Operate in controlled steady-state

Medium-speed design (higher NOx tendency)

Better fuel efficiency (gallons/GTM)

Diesel-electric transmissions

20+ yr. Lifecycle

How California MOUs Have Driven Air Quality Investments & Improvements

Locomotive Technologies	First Year Available	# of Units	% of CA Fleet	NOx Reduction from base line (per unit)	Incremental Air Quality Investment Nationwide to date	CA Incremental Air Quality Investment Driven by MOUs	Are Other Mobile Sources Required to Do?
Mandatory Re-Build –Tier 0 (22% Complete Nationally)	2000	2940		30%	$147 million		NO
Buy New Units – Tier 1	2002	1655		45%			YES
Buy New Units -- Tier 2	2005	640		60%			YES
Future Additional Line-haul Units to comply with 1998 MOU	2005	80				$160 million	NO
Ultra Low-Emitting California Switchers (Today)	2000	9	6%	80%		$10.8 million	NO
Additional ULEL California Switchers (By12/07)	2005	68	45%	80%		$81.6 million	NO
Automatic Shutdown Devices							NO
Line-haul units nationally (35%Complete)	2001	4500			$17 million		
California units (Completed)		138	32%			$ 2.7 million	NO
California units (Future by 6/08)		290	68%			$ 5.8 million	NO
Total Air Quality Investment					$164 million	$ 260.9 million	

1998 MOU | 2005 MOU | 1998 and 2005 MOU

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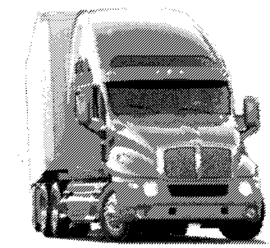
Inherent Efficiencies of Rail

	 vs. 
Capacity	1 double stack train equals up to 280 trucks
Fuel Efficiency	Trains are <u>2-4 times more fuel efficient</u> than trucks on a ton-mile basis
NOx Emissions	Trains are <u>2-3 times cleaner</u> than trucks on a ton-mile basis

BNSF℠

Comparison of Mobile Source Requirements (South Coast Inventory 2010)

	Trucks	Off-Road Equipment	Ships	Aircraft	Urban Buses	Loco-motives
Inventory NOx / PM	21% / 2.4%	17% / 7.9%	7% / 3.2%	4% / 4%	2% /	2% / 0.8%
Standards for New Units	Yes	Yes	Yes	Yes	Yes	Yes
Retrofit Existing Units	No	No	No	No	Yes	Yes (22% Done)
Rebuild to New Standards	No	No	No	No	No	Yes
NOx Fleet Avg. in SCAQMD	No	No	No	No	No	Yes
Statewide PM 2005 MOU	No	No	No	No	No	Yes

BNSF

BIOGRAPHY

Mark P. Stehly
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BNSF Railway

Mr. Stehly has thirty-one years of railroad environmental engineering and related experience. He manages the environmental and hazardous materials team for BNSF Railway. He also is responsible for their technical research and development efforts.

He has Bachelors degrees in both Forestry and Civil Engineering and a Masters degree in Water Resources. He is a Registered Professional Engineer in the State of Minnesota.

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