LIM/LSM ELECTRIC RAIL CONVERSION SENARIO

Global warming is a fact that we must face and act responsibly or our existence as we know it will cease. Freight and passenger transportation has been determined to be a major contributor to the warming of the environment. The impacts of our current practices are just now being recognized.

The use of trains for freight transport has doubled in the last 35 years. According to the EPA's most recent data, by 2030, trains will emit almost twice as much soot as trucks: 25,000 tons for trains compared to 14,000 tons from trucks. . By 2030, the EPA estimates that trains will be responsible for about one-third of all particulate pollution in the air from the transportation sector, unless more protective solutions are found and standards are put in place.

Communities located near Ports and rail yards experience the highest levels of pollution. Today trains release levels of smog-forming oxides of nitrogen (NOX) comparable to 120 coal-fired power plants. In Chicago, for example, locomotives discharged as much NOX into the air in one year as 25 million cars meeting today's automotive emission standards.

According to the Texas Commission on Environmental Quality, marine vessels and trains in the Houston-Galveston area, accounted for 41 percent of the region's off-road nitrogen oxide pollution in 2002.

The California Air Resources Board analyzed diesel pollution from the Roseville Rail Yard, the largest service and maintenance rail yard in the West. The study found that the cancer risk level nearly doubled for these residents. Many trains idle three-quarters of the time they are in rail yards.

According to the Natural Resources Defense Council… “locomotives are among the most dangerous and pervasive sources of air pollution in the United States”.

The following EPA chart shows that emissions from Diesel trains in the six major cities listed is equal to the emissions created by 55 million cars meeting today's automotive emission standards. This amounts to 37% of all automobiles driven in the United States today.

Table: Smog-Forming Emissions from Locomotives in Six Major Cities and Comparable Number of Today's Automobiles (i)

Urban area	Locomotive NOx emissions (tons/year)	Equivalent number of automobiles (ii)
Chicago	23,000	25,000,000
Los Angeles (iii)	12,000	13,000,000

Houston-Galveston	6,500	7,000,000
Dallas–Fort Worth	4,500	4,900,000
Baltimore	2,600	2,800,000
Detroit	2,100	2,300,000

(i) Emissions data for Houston and Dallas is from 2002. Emissions data for the other cities is from 2003.

(ii) Calculations based on Tier 2 NOx emissions standard (0.07gNOx/mile) for highway vehicles and 12,000 vehicle miles/year. Bureau of Automotive Repair, Engineering and Research Branch, State of California, "Methodology for Calculating Vehicle Miles Traveled (VMT)", September 30, 2000, Report 2000-06 [PDF].

(iii) Emissions data is for the South Coast Air Quality Management District

It wasn't until the year 2000 that the EPA began to regulate locomotive pollution. Three sets of emission standards have been adopted. The first set of standards called Tier 0
apply to locomotives originally manufactured from 1973 through 2001. The second set of standards called Tier 1 apply to locomotives manufactured from 2002 through 2004. The final set of standards called Tier 2 apply to locomotives manufactured in 2005 and later. Locomotives originally manufactured before 1973 are not included in this rulemaking.

Recognizing the extreme health hazards caused by diesel locomotives, in March 2007, the EPA proposed a three part program that would require further reduction of emissions from diesel locomotives of all types; line-haul, switch, and passenger rail. The proposal aims to cut particulate matter emissions by 90 percent and NOx emissions by 80 percent. The proposal would set new, Tier 3 exhaust emissions standards and idle reduction requirements for locomotives that would begin in 2009. Finally, the proposal would set long-term, Tier 4 standards for newly-built engines based on the application of high-efficiency catalytic after treatment technology, beginning in 2015 for locomotives.

Currently diesel locomotives are really nothing more than mobile electric generating plants burning diesel fuel to run electric generators that drive electric motors connected to the locomotives wheels. These rolling electric power plants consume three times more fossil fuel per kilowatt hour of electric energy produced than a stationary power plant. In addition diesel locomotives produce 273 times more NOX and particulate pollution than a power plant.

At the present time technology being developed and implemented in the railroad industry like the auto industry is primarily being directed toward *reducing the rate of increase* not eliminating it.

Examples of such pollution reducing technologies as the dual load locomotive or hybrid include the Green Goat a small yard switching locomotive. Yard-switching locomotives can sit idling for hours while waiting to move rail cars from track to track.

The Green Goat locomotive couples a small 268-horsepower diesel engine with 30 tons of lead-acid batteries. It cuts the use of diesel fuel by more than 40% in a typical day over a normal all-diesel yard-switcher.

Other approaches include yard switching locomotives known as gen-sets with multiple engines that are turned on when more horse power is needed and shut down during idling.

Like the automotive industry, If the EPA proposal is implemented Tier 4 locomotives beginning 2015 will be required to install catalytic convertors and other pollution reducing technology. All of these current advances do not solve the problem they only slow down the growth in green house gases but things continue to decline.

WHAT IS REQUIRED IS A 100% SOLUTION.

Innovative Transportation Systems Corporation-ITSC as a part of its overall plan has reviewed currently proven technologies used in many different industries. It is ITSC'S belief that there have been many good technologies, practices and procedures developed

and implemented as a solution to certain challenges in one industry but not known or considered by a separate industry facing challenges that the industry could solve by adaptation of these best practices. From a pollution standpoint, trains powered by electricity from a central power plant produce less than one 250^{th} the amount of pollution that diesel trains produce and operate at one third the fuel cost.

ITSC initially determined the feasibility of utilizing linear induction motors that launch fighter aircraft from aircraft carriers and applying it to moving railroad cars.

Linear induction and linear synchronous type electric systems can completely resolve the pollution issue (THE ONE HUNDRED % SOLUTION) with the least disruption to the environment, with lowest installed costs and with substantially lower operating costs than any other known electric system. These systems operate on magnetic fields and therefore are noiseless, pollution free and have no moving parts to wear out. There is no need for electrified third rails nor is there a need for unsightly overhead catenary wires, or safety fencing.

And the system is fully compatible and can operate concurrently with existing rail operations. Like hybrid automobiles the systems actually produce electricity for operations from regenerative braking while reducing the wear and tear on the wheels and rails because the propulsive force is magnetic not friction.

There is a small 6” by 12” plastic box that mounts on the railroad cross ties that houses the induction windings which consists simply of an iron core with several other metal windings wrapped around it. The magnetic wave reacts with an iron plate or magnet array mounted on the bottom of an existing railroad car or hooked to a small helper car with the plate or array attached. Every half mile or so is along the track is a power pick up connected to the power grid. In addition to the simple conversion of existing railroad cars, new light weight passenger vehicles can be constructed at lower costs than current passenger diesel or electric locomotives because they contain no motors.

The concept of the linear induction motor (LIM) was invented in 1912 by Robert Goddard who is also the father of liquid fuel rockets. Since then the technology has grown beyond linear induction motors to include linear synchronous motors (LSM). Linear induction motors (LIM) react against a conducting plate under the vehicle, however by adding an array of magnets in place of the conducting plate the level of sophistication, economy and safety that can be achieved is recognized as superior in linear synchronous motors (LSM).

A propulsion system can be created that allows for both LIM and LSM operations. In this way freight train cars can be moved using the LIM technology with the need to only add a metal plate on to the bottom of the vehicle, or alternatively using helper cars to push the trains powered by LSM’s. Independent point to point

Because the black boxes mounted on the cross ties only control one rail car at a time and will not let a second enter that track section until the first has left, there is no chance of collision. In fact very short headway can be achieved and with the computerized control system can result in a virtual train consisting of unattached rail cars that can join or leave a virtual train as the off-board or on-board control systems proscribe. The resulting efficiencies are self evident.

One third the energy cost, zero emissions and the lowest capital cost makes this approach the solution to be developed.