LSM Technology Demonstration

Clean Fuels Program Advisory Group Meeting

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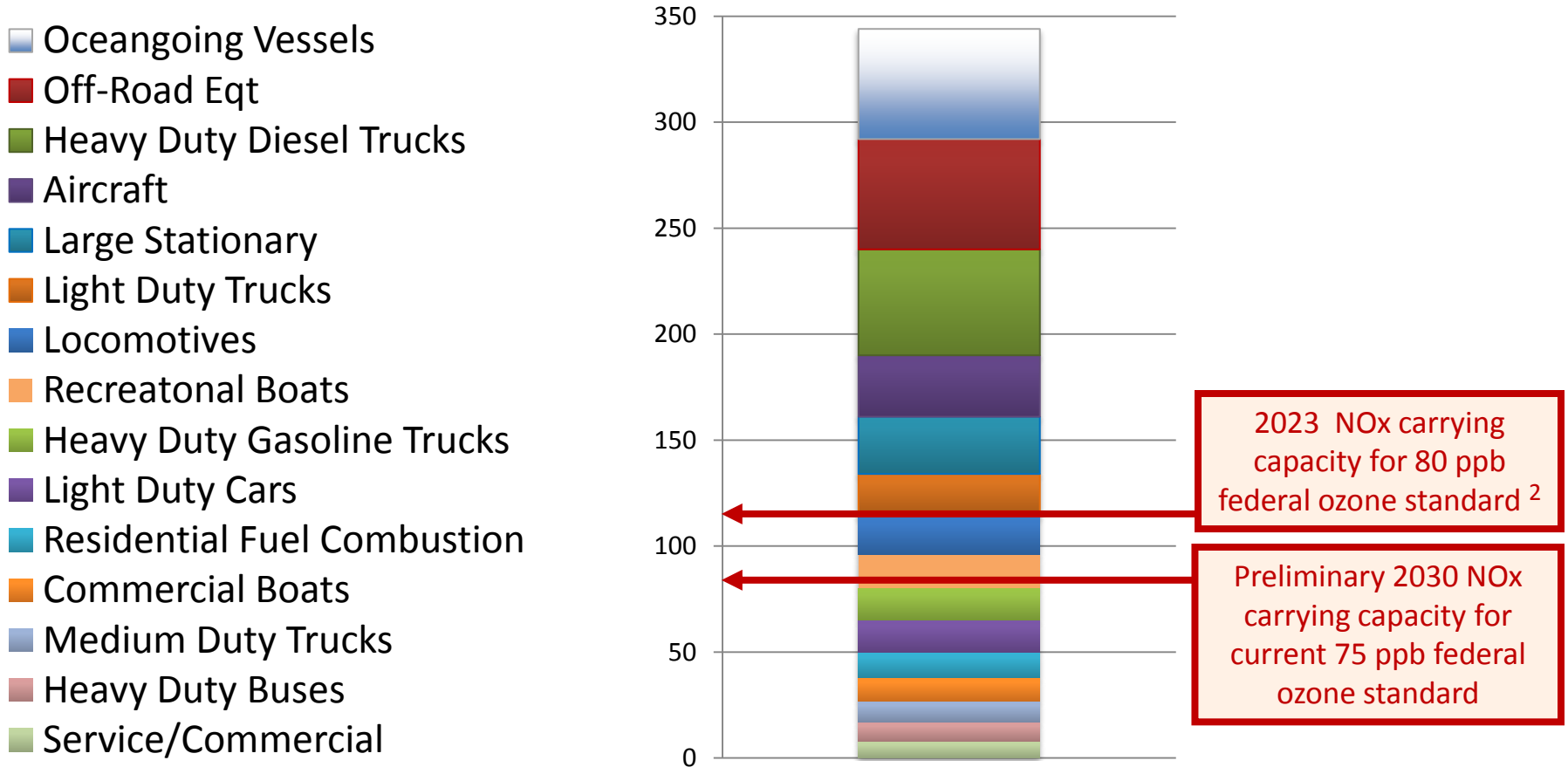
South Coast Air Basin

Top 15 NOx Categories: 2023 NO_x Emissions

With Adopted Rules

Preliminary SCAQMD Estimates[1]



1 Preliminary emissions estimates based on data updated from 2007 AQMP where available: CARB 2010 emissions projections for trucks and off-road equipment; IMO Tier 1 – 3 for ocean vessels; EPA 2008 rule for locomotives; 2007 AQMP short-term measures for other categories. Range for oceangoing vessels (20 -52) based on varying deployment assumptions for IMO Tier 2 and 3 vessels and range of ports' cargo forecasts.

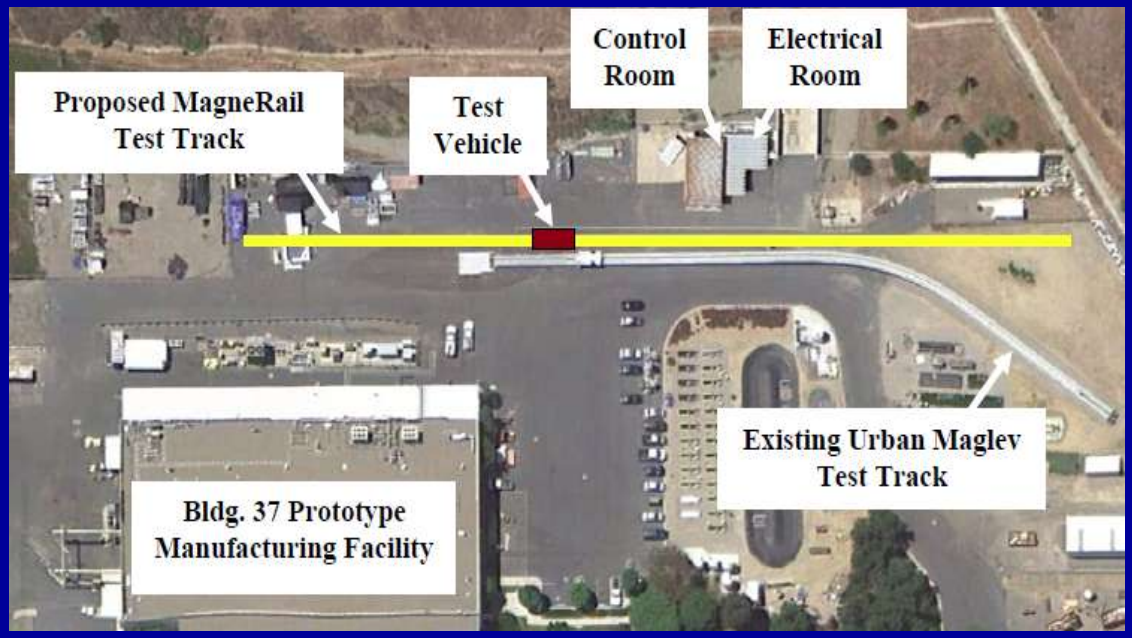
2. 1997 80 ppb federal ambient ozone standard. Source: 2007 AQMP.

Background

- One of the top three priorities for 2011 is to initiate Zero Emissions Container Movement System Projects
- Collaboration with Ports and providers to identify zero-emission technologies in freight rail and truck applications

LSM Project Proposal

- Design, construct and test Linear Synchronous Motor (LSM) technology for rail
- Phase 1 demonstration
  - 600 ft test track at GA HQ
  - Test rail car with two bogies
- Move and control fully loaded 67,000 lb 40-ft container



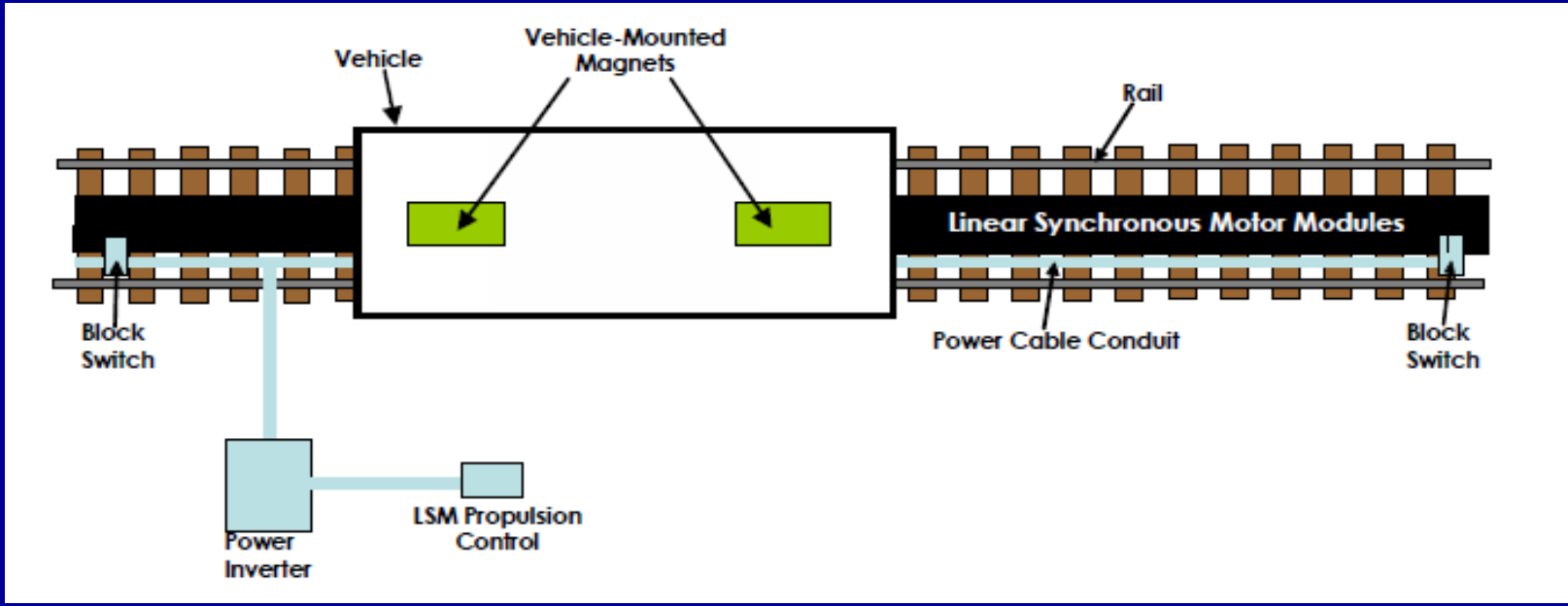
About General Atomics

- General Atomics produces world's most advanced systems in defense, energy and transportation
- Founded in 1955
- HQ in San Diego with 6,600 employees
- Maglev, Predator, EMALS

LSM Technology Overview

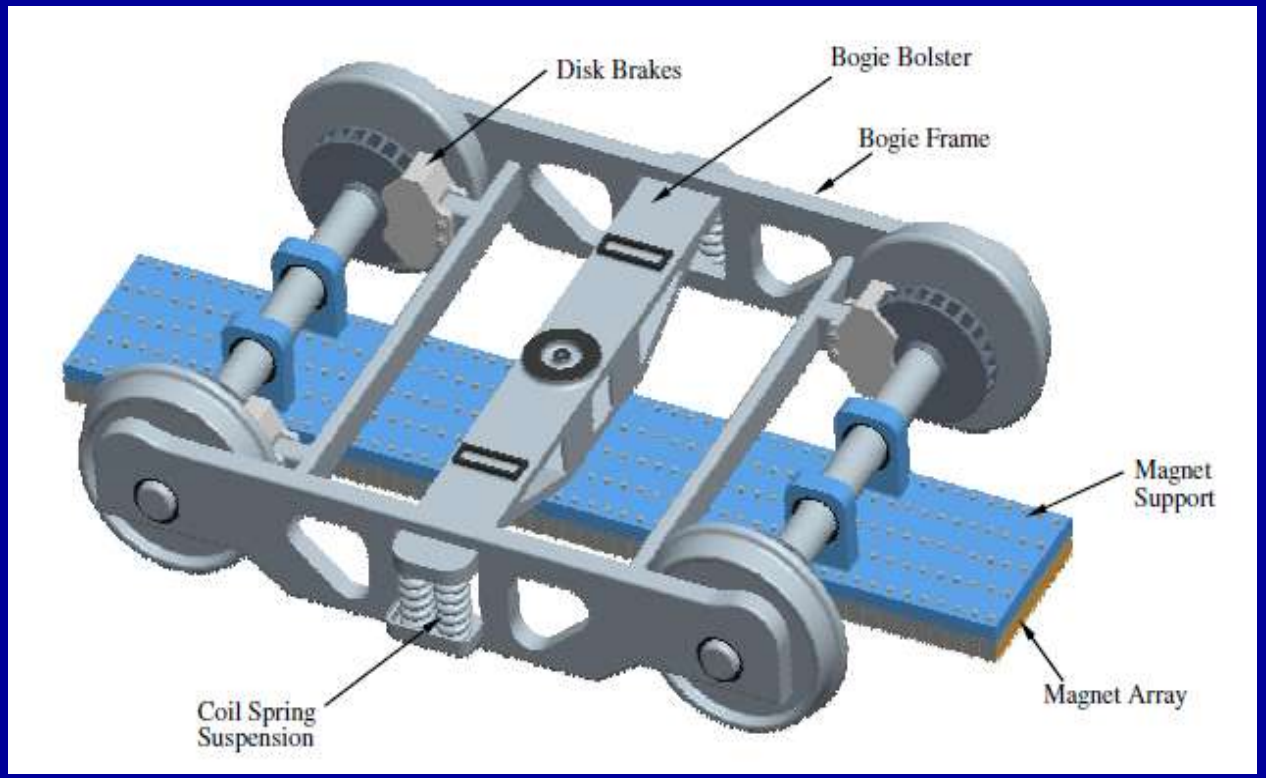
- LSM motor windings encased in concrete modules attached to railroad ties
- Permanent magnet at the bottom of a rail car interact with the magnetic field from the LSM modules

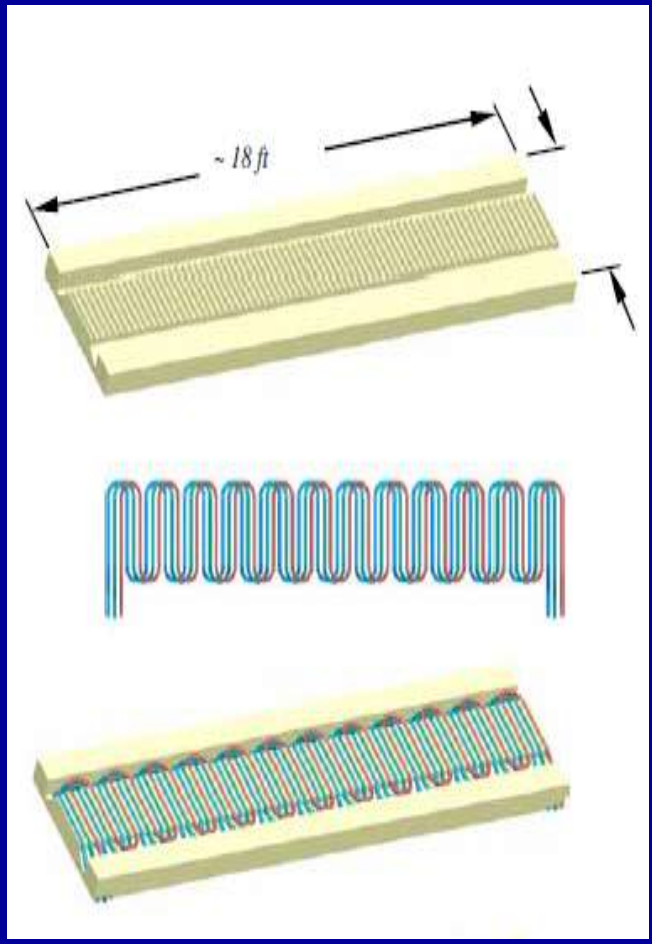
LSM Technology Overview (cont'd)



- Propulsion system controller manages the thrust level based on desired speed profile
- Block switches on the wayside to power only the section of track length desired

Rail Car Bogie & LSM Module





Performance Parameters

TABLE 1
ANTICIPATED PERFORMANCE PARAMETERS FOR FULL-SCALE MAGNERAIL DEPLOYMENT

Parameter	Value	Comment
Vehicle Weight	38,500 kg (~85,000 lb)	Fully-loaded container and vehicle
Maximum Acceleration	0.8 m/sec^2 (1.8 mph/sec)	Maximum acceleration is maintained up to a speed of 10 m/sec. (~22 mph)
Maximum Vehicle Speed	80 kph (50 mph)	Assumed maximum speed. Could be higher, depending on route
Peak Power during Acceleration	410 kW	This level of power is easily supported using existing electrical grid
Energy consumption for a fully-loaded container traveling at 80 kph (50 mph)	3 kW/hr/mile	Actual energy consumption will be determined by average weight and the chosen route (grade increases consumption)
Electricity cost per vehicle per mile @ 10 cents per kW/hr	$0.30	Peak power and average power will determine the cost of electricity

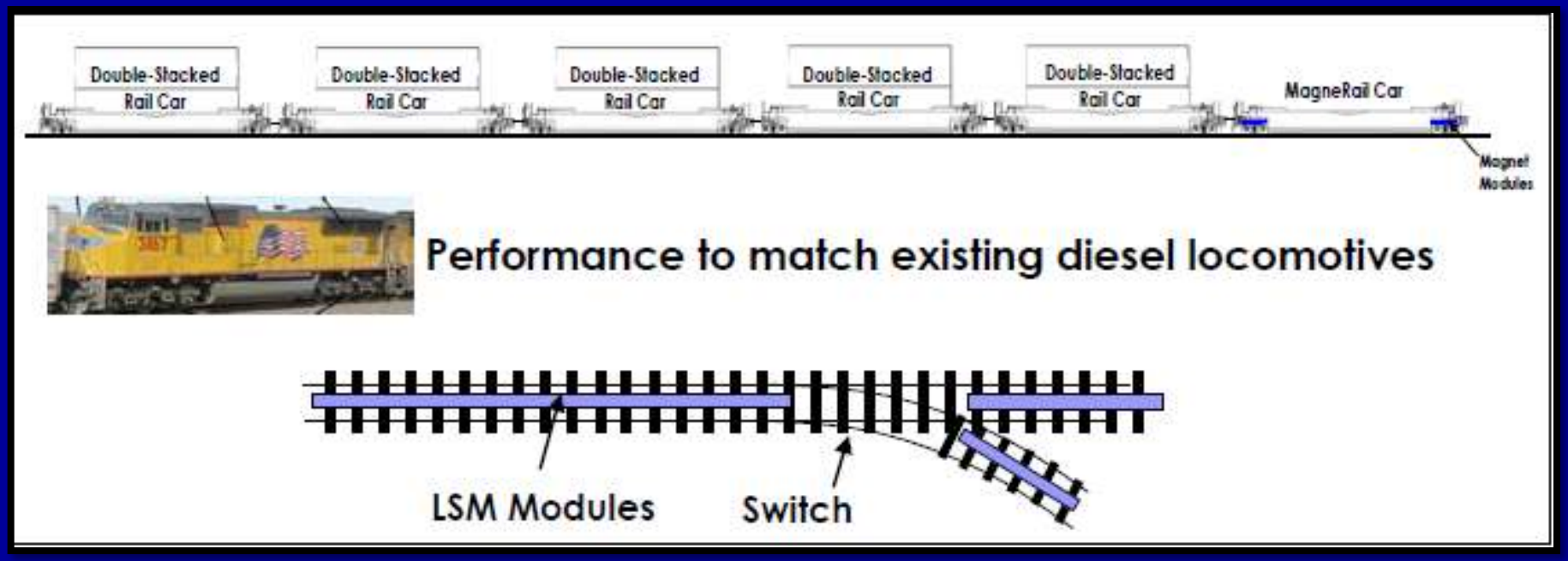
Technology Advantages

- All electric system, zero emissions on site
- Utilizes existing rail infrastructure
- No high voltage third rail or catenaries
- Twice as efficient as diesel engines
- Robust capability to handle 10% grade
- Factory-assembled LSM modules minimize onsite construction

Truck Application

- MagneTruck - electric truck application
- LSM module paved on the road to react with a retractable permanent magnet array beneath the chassis
- Applicable to both diesel and electric trucks

Phase 2 Demonstration



- Half a mile track testing including switching and multiple vehicles under typical port operating conditions

Port-Related Emissions[1]

Category	DPM (tons/yr)	NOx (tons/yr)	CO_2 Equivalent (tons/yr)[2]
Rail locomotives	52	1,725	106,159
Heavy-duty Vehicles	49	2,732	662,048
	101	4,457	768,207

1. POLA Inventory of Air Emissions CY 2010; POLB 2010 Air Emissions Inventory
2. Metric tons per year