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Impacts of Low-Speed Vehicles on Transportation Infrastructure and Safety

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FINAL REPORT

OREGON
TRANSPORTATION
RESEARCH AND
EDUCATION CONSORTIUM

Impacts of Low-Speed Vehicles on Transportation Infrastructure and Safety

OTREC-RR-10-19
December 2010

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IMPACTS OF LOW-SPEED VEHICLES ON TRANSPORTATION INFRASTRUCTURE AND SAFETY

Final Report

OTREC RR-10-19

by
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16. Abstract

There are increasing numbers of low-speed electric vehicles (LSVs) on public roadways. These vehicles are designed to be used within protected environments and on roadways with a maximum posted speed of 25 mph. Currently these vehicles are not subject to the same federal requirements for occupant protection as passenger cars. This research project investigated safety standards, operating regulations, and LSV manufacturer materials from sources around the world. The purpose of the research was to determine positive and negative impacts that LSVs, including Neighborhood Electric Vehicles (NEVs) and Medium Speed Electric Vehicles (MSEVs), are likely to have for the Oregon Department of Transportation (ODOT) and Oregon communities, and whether adjustments in current state regulations are needed to ensure that LSVs do not negatively impact road safety and traffic operations, or expose the LSV operators to undue risk. The U.S. and Canadian federal motor vehicle safety agencies have harmonized their regulations and stipulated the maximum operating speed of these vehicles, however state and local roadway authorities have regulated the maximum speed of roadways and intersection characteristics on which these vehicles can operate. The significant recommendations of this research are: (i)The State of Oregon regulations for LSVs should be amended such that LSVs are limited to public roadways with a maximum operating speed of 25 mph, and they are restricted to crossing higher speed roadways at four-way Stop or traffic controlled intersections,
(ii) local transportation authorities should develop parallel or secondary low-speed transportation networks that connect residential neighborhoods with major activity centers.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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DISCLAIMER

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1.0 EXECUTIVE SUMMARY

There are increasing numbers of low-speed electric vehicles (LSVs) on public roadways. While small electric vehicles have been in common use for many years in gated communities and on industrial and college campuses, they are becoming more common on public roadways as a short-range alternative to fossil-fueled autos. These vehicles are not classified as passenger cars, and are not subject to the same federal requirements for occupant protection as passenger cars. It is also important to note that LSVs are not in the same vehicle classification as the new all-electric passenger cars and trucks that are currently being introduced in North America. This research project investigated safety standards, operating regulations, and LSV manufacturer materials from sources around the world. The purpose of the research was to determine positive and negative impacts that LSVs, which include Neighborhood Electric Vehicles (NEVs) and Medium-Speed Electric Vehicles (MSEVs), are likely to have for the Oregon Department of Transportation (ODOT) and Oregon communities. In addition, the research explores whether adjustments in current state regulations are needed to ensure that LSVs do not negatively impact road safety and traffic operations, or expose the LSV operators to undue risk.

There were several important issues that were identified in conducting this research:

- LSVs were designed to be used in controlled or protected environments and on roadways with a maximum posted speed of 25 mph.
- The safety standards that were developed in Europe and North America were developed with the underlying premise that LSVs would be operating on low-speed roadways in protected environments. Thus the regulations pertaining to these vehicles do not have any provisions for occupant crash protection other than the use of a seat belt.
- The U.S. and Canadian federal motor vehicle safety agencies have harmonized their regulations and stipulated the maximum operating speed of these vehicles, and state and local roadway authorities have regulated the maximum speed of roadways and intersection characteristics on which these vehicles can operate.
- In North America, states, provinces and local governments have the legal authority to set regulations pertaining to motor vehicles operating on the roadways under their jurisdictions. In many circumstances, these regulations significantly increase the risk exposure to users of LSVs. In many jurisdictions throughout the world, the vehicle safety and roadway operating regulations are inconsistent.

The results of the research included three major recommendations:

- The State of Oregon’s regulations for LSVs should be amended such that LSVs are limited to public roadways with a maximum operating speed of 25 mph, and they are restricted to crossing higher-speed roadways at four-way stops or traffic-controlled intersections.
- Local transportation authorities should work with LSV users and members of the bicycle community to develop parallel or secondary low-speed transportation networks that

connect residential neighborhoods with major activity centers that include education, employment, retail, medical and recreational facilities.
- LSV users need to be educated about the safety risks of LSVs, in particular those that have a "car-like" appearance, and the safety risks of modifying the speed regulator on LSVs.

2.0 INTRODUCTION

There are increasing numbers of low-speed electric vehicles on public roadways. While small electric vehicles have been in common use for many years on golf courses and as mobility aids, their manufacture for use on public roadways as a short-range alternative to fossil-fueled autos has been increasing in recent years. The U.S. Energy Information Administration estimates that the number of electric vehicles in use nationwide has increased from 6,964 in 1999 to 53,526 in 2006 – a seven-fold increase in seven years (EIA, 2007). While this number is still very small relative to the overall fleet of automobiles, it is expected to increase significantly in the coming years due to increases in fossil fuel prices and new priorities for reducing dependence on fossil fuels (i.e., developing more sustainable transportation technologies, and taking positive steps to reduce greenhouse gases).

Low-speed electric vehicles (LSVs), also referred to as Neighborhood Electric Vehicles (NEVs), are limited to a maximum speed of 25 mph. In recent years manufacturers have introduced Medium-Speed Electric Vehicles (MSEVs), which are essentially LSVs capable of faster speeds – usually 35 mph. Both NEVs and MSEVs are expected to become more popular in the coming years for local commuting and personal errands. In this report, NEVs that are limited to a maximum speed of 25 mph will be referred to as Low-Speed Vehicles (LSVs); and MSEVs will refer to NEVs that are capable of faster speeds. MSEVs are defined in Oregon regulations, but there are currently no MSEVs registered in Oregon and in many states they are prohibited. Thus this research has primarily focused on LSVs that are limited to a maximum speed of 25 mph.

As of December 31, 2009, there were 265 LSVs and no MSEVs registered in Oregon. There are other types of electric vehicles registered (such as electric motorcycles), bringing the total number of Oregon registrations to approximately 400 electric vehicles (Tucker, 2008). Given that Portland appears to have the highest per capita ownership of hybrid cars of any American city (OSPIRG, 2006), the adoption of all-electric vehicles in Oregon may also be significant in the coming years. It is important to note that LSVs are not in the same vehicle classification as all-electric passenger cars. The new all-electric passenger cars and trucks have met or exceeded the Federal Motor Vehicle Safety Standards for occupant protection, and these vehicles are not speed restricted or limited to low-speed roadways. Both LSVs and all-electric passenger cars and trucks have the potential to significantly reduce greenhouse gases.

LSVs are already in use on many college and industrial campuses and in gated communities in the major retirement communities in Florida and Arizona. In Europe and Asia, these vehicles are increasing in number as an extended mobility and independence option for seniors and people with disabilities.

As a class of motor vehicles, LSVs differ from conventional passenger cars in significant ways. Although federal motor vehicle safety standards require that they be equipped with headlights, taillights, brake lights, turn signals, seat belts and other safety features, LSVs are nonetheless smaller and lighter than conventional cars. A University of California study notes that such vehicles are typically shorter in length, width and wheelbase than the American Association of State Highway and Transportation Officials (AASHTO) design for passenger cars, and they have slower acceleration (Stein, et al., 1994). Consequently, LSVs have inherent safety risks associated with their use on public roadways and where these roadways intersect with high-speed facilities. Thus, as LSVs continue to become more numerous on public roads, the need arises to investigate the impacts of their use to ensure the safety of the traveling public.

A brief examination of other state laws shows a range of restrictions pertaining to LSVs. The basis of these state regulations, however, is not clear. With such vehicles likely to come into more common use, there is a need to investigate a rational basis for regulations that would protect the public and also provide for the use of this energy-efficient, sustainable alternative to the conventional fossil-fueled passenger car for local, short-range travel.

2.1 PROJECT OBJECTIVES

The goal of this research was to determine positive and negative impacts that LSVs, which include Neighborhood Electric Vehicles (NEVs) and Medium-Speed Electric Vehicles (MSEVs), are likely to have for the Oregon Department of Transportation (ODOT) and Oregon communities. In addition, this research explores whether adjustments in current state regulations are needed to ensure that LSVs do not negatively impact road safety and traffic operations, or expose LSV operators to undue risk. The research project investigated international and North American operating and safety practices that support the use of these vehicles. The research was considered timely, since LSVs have the potential to reduce greenhouse gas emissions and thus potentially improve the quality of community life. The objectives included the following:

1. Conduct a comprehensive review of literature on the safety of LSVs and their regulation on public roadways in the North American, European, Asian and Australian continents.
2. Obtain technical specifications from LSV manufacturers to aid in the determination of the limitations and capabilities of these vehicles, and to identify potential safety issues related to their operation on public roadways.
3. Compile and analyze laws and regulations for LSV operations in all states, particularly as they relate to minimum and maximum operating speeds.
4. Collect information from state departments of transportation (DOTs) and the U.S. Department of Transportation (USDOT) on any crash data they have collected pertaining to LSVs.
5. Identify safety and regulatory issues on roadway infrastructures by analyzing the effects and impacts of LSV operations on public roadways, given their operational characteristics relative to other types of vehicles on the road.
6. Identify connectivity issues within roadway infrastructures where there are gaps between low-speed roadway connections within urban (growth) boundaries. For example, some connectivity issues may force these vehicles to use higher-speed roadways that they are not designed for, or to use multiuse paths, which is problematic for other path users.

7. Develop recommendations for ODOT and local governments to address the safety and regulatory issues identified in the research.

The outcome of this research was a set of recommendations that provide direction for state regulators on the use of LSVs on Oregon's public roadways. In addition, the research results should assist Oregon communities in developing local safety and traffic operation ordinances for LSVs that protect all road users. This evidence-based research is timely, and it permits ODOT and Oregon communities to be proactive rather than reactive towards the increased use of LSVs as another transportation mode, improve safety and achieve Oregon's sustainability goals. The research results will be added to the multimodal data warehouse for future policy and planning use by ODOT and local agencies.

2.2 DEFINITIONS

2.2.1 Introduction

The Office of Legislative Research of the Connecticut General Assembly conducted a survey of LSV regulation in states throughout the U.S. (Fazzalaro, 2008). The report summarized federal and state regulations pertaining to LSVs, including operating speeds, roadway type and regulatory authority. LSVs are not permitted on Connecticut public roadways. The Connecticut study was reviewed and updated to reflect changes in state laws in the past two years.

2.2.2 Federal Definitions

On June 17, 1998, the National Highway Traffic Safety Administration (NHTSA) officially included low-speed vehicles as a motor vehicle category of the Federal Motor Vehicle Safety Standards and defined LSV in 49 CFR 571.3. According to the definition in this rulemaking, "Low-Speed Vehicle (LSV) is a four-wheeled motor vehicle whose attainable speed in 1 mile is more than 20 miles per hour and not more than 25 miles per hour on a paved level surface and has a gross vehicle weight rating (GVWR) of less than 3000 lbs." This group includes NEVs and speed-modified golf carts with top speeds of more than 20 mph but less than 25 mph (NHTSA, 1998).

2.2.3 Oregon Definitions

Current Oregon Revised Statutes (ORS) are consistent with 40 other states. ORS 801.331 defines a low-speed vehicle as a four-wheeled motor vehicle with a top speed of more than 20 mph but not more than 25 mph. This type of vehicle is permitted to operate on public roads posted at no more than 35 mph (ORS 811.512). Addressing the case of three-wheeled LSVs, ORS 814.518 limits the speed of three-wheeled "motorized scooters" to 25 mph. ORS 814.520 provides that these vehicles are in violation of the law if they are driven "at less than the normal speed of traffic using the roadway at that time and place."

ORS 801.341 defines a Medium-Speed Electric Vehicle (MSEV), as "an electric motor vehicle with four wheels that is equipped with a roll cage or a crushproof body design, can attain a maximum speed of 35 miles per hour on a paved, level surface, is fully enclosed, and has at least one door for entry" (ORS, 2009). The presence of a roll cage or crushproof body does not guarantee that the vehicle is crashworthy, however.

2.2.3.1 Three-wheeled vehicles

In Oregon, a three-wheeled vehicle that is not a human-powered tricycle is defined as a motorcycle (ORS 801.365). This report does not address motor-assisted scooters or three-wheeled electric vehicles; however, many of the issues discussed in this report may pertain to motor-assisted scooters. People who ride motorcycles have special licenses and many take special training in motorcycle safety. Traditional motorcycles do not experience the speed differentials that are discussed in Section 4.0, Safety Considerations.

> **Motorcycle**. A motorcycle includes any self-propelled vehicle other than a moped or farm tractor that:
>
> (1) Has a seat or saddle for use of the rider;
>
> (2) Is designed to be operated on the ground upon wheels; and
>
> (3) Is designed to travel with not more than three wheels in contact with the ground.

Figure 2.1 shown below is a flow chart to assist ODOT and law enforcement staff in identifying these special vehicles.

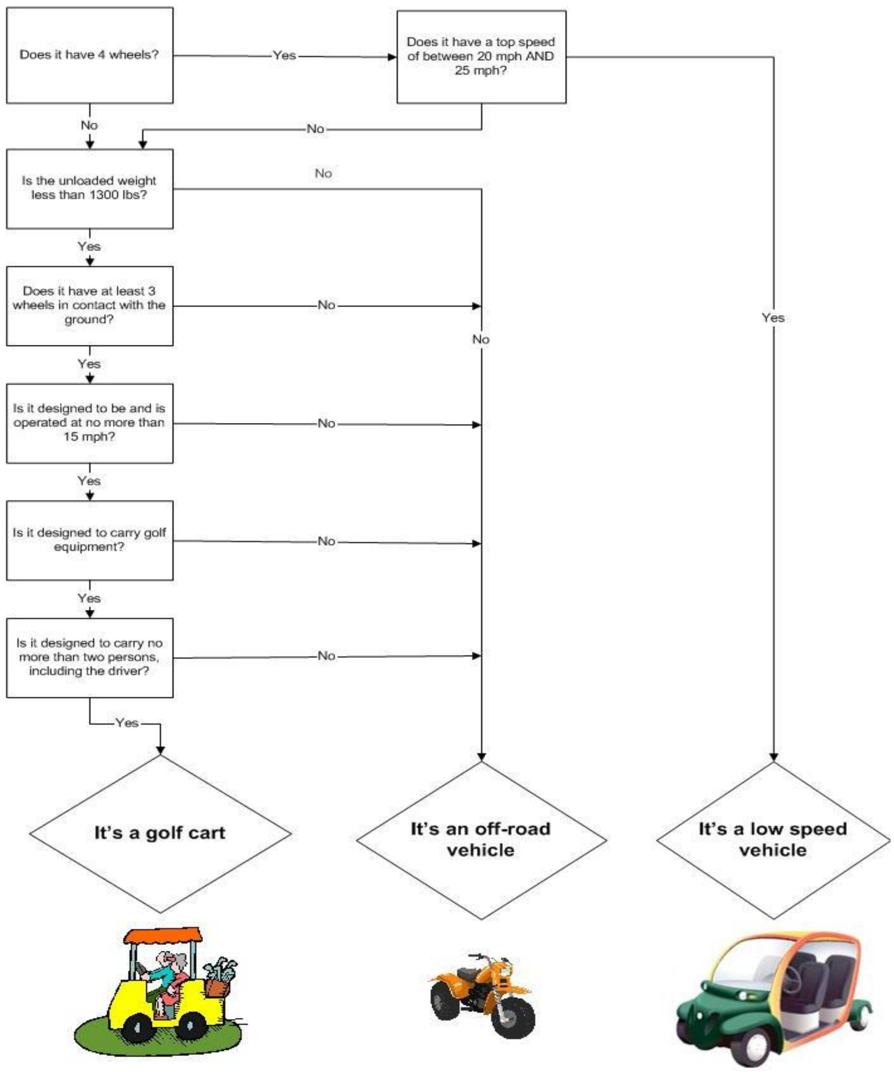

Figure 2.1: Flow chart to assist with identification of LSVs (Courtesy of Michele O'Leary , ODOT Safety Division)

3.0 LITERATURE REVIEW

Literature pertaining to "Light Electric Vehicles" from Australia, New Zealand, Europe and Canada was reviewed, and a short summary is provided below. New Zealand and Australia currently do not permit these vehicles on public roads as a result of concerns for occupant safety.

The Government of Canada's Transport Canada has worked in partnership with the United States Department of Transportation to harmonize regulations so that LSV manufacturers can build LSVs for the North American marketplace (NHTSA, 1998).

In Europe and other parts of the world, these vehicles are defined as electric or motorized quadricycles. The European definition, which has been adopted by many nations, was developed by the European Union and is eligible for European Community Whole Vehicle Type Approval (ECWVTA) (UK Department of Transport, 1999). An expansion of the definition for powered two- and three-wheel vehicles (including some quadricycles) includes vehicles that are capable of more than 6 km/h (3.75 mph), and came into effect on June 17, 1999. "*Any newly designed, mass produced, model or type of vehicle within the scope of ECWVTA and first introduced and placed on the market of an EU Member State from that date must have ECWVTA, and a Certificate of Conformity issued by the manufacturer must be made available. To be valid in the UK, the Certificate of Conformity should indicate that the vehicle is suitable for use in left hand rule of the road traffic and has a speedometer calibrated in miles per hour."* (UK Department of Transport, 1999*).*

The ECWVTA definitions are as follows:

Category L6e -	***Light quadricycle*** *- Four wheels, with a maximum unladen mass of 350kg (not including the mass of the batteries in an electrically powered vehicle), a maximum speed of 45km/h, a maximum spark ignition internal combustion engine capacity of 50cm^3, or maximum power of any other internal combustion engine of 4kW or maximum electric motor power of 4kW. The construction requirements are those for a three wheel moped unless otherwise specified in a particular Directive.*
Category L7e -	***Quadricycle*** *- Four wheels, with a maximum unladen mass of 400kg or 550kg for a goods carrying vehicle (not including the mass of the batteries in an electrically powered vehicle) and a maximum net power, whatever the type of engine or motor, of 15kW. The construction requirements are those for a motor tricycle unless otherwise specified in a particular Directive.*

Note - The Masses and Dimensions Directive, 93/93/EEC, applies controls on maximum dimensions and laden/unladen masses for vehicles" (UK Department of Transport, 1999).

Construction standards for quadricycles are harmonized at the European level, the main instrument being European Parliament and Council Directive "2002/24/EC - the Framework Directive." This Directive requires compliance with a number of individual Directives that set *out requirements for particular vehicle systems: brakes, lighting, wheels, and other components. These harmonized requirements are recognized by all 27 Member States of the European Community. Once the vehicle is approved to the standards of the Directive by any member state, the manufacturer has access to all 27 markets.*" (UK Department of Transport, 1999).

The UK Department of Transport issued a news release on May 8, 2007, indicating that the government was seeking a review of the European regulations for quadricycles after initial tests of their safety performance raised concern, and following their growth in popularity as a more environmentally friendly alternative to cars. Current safety standards, set at the European level, were established at a time when it was never envisaged that this type of product would be used as a mainstream road vehicle. The UK Department of Transport began simulated impact tests once this growth in popularity had been determined. The vehicle that was tested passed all the European requirements applicable to quadricyles, but when it was subjected to the same impact test expected of normal cars, serious safety issues were revealed (UK Department of Transport, 1999).

The UK Roads Minister Dr. Stephen Ladyman said: "*The safety regulations that govern this type of vehicle were designed at a time when it was thought they would cover four-wheeled motorcycles and some small, specialized commercial vehicles. Not city run-abouts that resemble small cars. But, given increasing environmental concerns, new vehicles that qualify as quadricycles have come to the market and are becoming more popular for urban use. Therefore it is right that we reconsider the regulations for this type of vehicle and whether safety regulations should be made more stringent. Now*[*that*] *we have the initial findings of our tests we will be taking this up with the European Commission and manufacturers, and will publish more information when the full programme of tests is complete. The Department for Transport is undertaking further tests on another make of quadricycle to help its discussions with the European Commission, and is now in urgent contact with the relevant manufacturers. Once the full analysis is complete further information will be made available.*" (BBC News, 2007).

The occupant protection of a quadricycle is assessed by a frontal impact test where the vehicle is propelled into a deformable barrier (to simulate striking another vehicle) at a velocity of 56 km/h (~35 mph). The impact takes place at a 40% overlap with the barrier and is concentrated on the driver's side of the vehicle. The UK department tested two quadricycles. The first test, which involved a REVA G-Wiz electric vehicle, took place in 2007 (BBC News, 2007). Currently for quadricycles and LSVs, as opposed to passenger cars, there are no requirements for occupant protection tests.

3.1 SUMMARY OF CURRENT OREGON LAWS AND STATUTES FOR LSVS

Table 3.1 Summarizes current Oregon laws and statutes for LSVs.

Table 3.1: Current Oregon Laws and Statutes for LSVs

ORS Number	TITLE	Brief Description
801.331 http://www.leg.state.or.us/ors/801.331	Low-speed vehicle	Low-speed vehicle means a four-wheeled motor vehicle with a top speed of more than 20 miles per hour but not more than 25 miles per hour.
801.341 http://www.leg.state.or.us/ors/801-341	Medium-speed electric vehicle	Medium-speed electric vehicle means an electric motor vehicle with four wheels that is equipped with a roll cage or a crushproof body design, can attain a maximum speed of 35 miles per hour on a paved, level surface, is fully enclosed, and has at least one door for entry.
803.300 http://www.leg.state.or.us/ors//803.300	Failure to register: Penalty	A person commits the offense of failure to register a vehicle if the person owns a vehicle in this state and the person does not register the vehicle in this state. This is a Class D traffic violation.
803.420 http://www.leg.state.or.us/ors/803.420	Registration fee	The registration fee for a low-speed vehicle and medium-speed vehicle is $43 for each year of the registration period.
811.512 http://www.leg.state.or.us/ors//811.512	Unlawfully operating low-speed vehicle on highway; penalty	A person commits the offense of unlawfully operating a low-speed vehicle on a highway if the person operates a low-speed vehicle on a highway that has a speed limit or posted speed of more than 35 miles per hour; it is a Class B traffic violation. However, a city or county may adopt an ordinance allowing operation of low-speed vehicles on city streets or county roads that have posted speeds of more than 35 miles per hour.
811.513	Unlawfully operating medium-speed electric	A person commits the offense of unlawfully operating a medium-

http://www.leg.state.or.us/ors/811.513	vehicle on highway; penalty	speed electric vehicle on a highway if the person operates a medium-speed electric vehicle on a highway with a posted speed limit that is greater than 45 miles per hour; it is a Class B traffic violation. However, a city or county may adopt an ordinance allowing operation of medium-speed electric vehicles on city streets or county roads that have speed limits or posted speeds of more than 45 miles per hour.
820.220 http://www.leg.state.or.us/ors/820.html	Operation of low-speed vehicle in prohibited area; penalty	A person commits the offense of operation of a low-speed vehicle in a prohibited area if the person is a person with a disability and the person operates a golf cart or substantially similar motor vehicle on any highway with a speed designation greater than 25 miles per hour; it is a Class D traffic violation.
807.010 http://www.leg.state.or.us/ors/807.html	Operating vehicle without driving privileges or in violation of license restrictions; penalty	A valid driver license is required
811.435 http://www.leg.state.or.us/ors/811.435	Operation of motor vehicle on bicycle trail	A person commits the offense of operation of a motor vehicle on a bicycle trail if the person operates a motor vehicle upon a bicycle lane or a bicycle path; it is a Class B traffic violation.
811.130 http://www.leg.state.or.us/ors/811.130	Impeding traffic; penalty	The operator may be cited for impeding traffic.

3.2 SUMMARY OF LAWS GOVERNING LSVs IN OTHER U.S. STATES

The regulations of LSVs in almost all of the states have been reviewed. All the references for this section are included in Appendix A. To date, Alabama, Arkansas and Connecticut do not have any laws permitting low-speed electric vehicles on public roadways. Nebraska has passed LSV regulations, but the detailed information of the laws could not be further located. The states that do have regulations governing LSVs may be summarized into one of the following categories: the maximum roadway speed limit to legally operate an LSV, and the intersection speed limit that an LSV can cross.

3.2.1 Classification based on maximum roadway speed limit

3.2.1.1 States that specify a speed limit greater than the speed of an LSV

Among the 50 states, approximately 35 states have specified the maximum roadway speed limit of 35 mph for allowing an LSV, whereas the maximum operating speed of an LSV in those states is 25 mph. This creates a potential speed differential of 10 mph between LSVs and other motor vehicles. The states belonging to this group are as follows: Alaska, Arizona, California, Colorado, Delaware, Florida, Georgia, Hawaii, Idaho, Iowa, Kentucky, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

There are some variations. Kansas has specified the maximum roadway speed limit as 40 mph, creating a potential speed differential of 15 mph. Texas has specified that an LSV may not be operated on a street or highway at a speed that exceeds the lesser of two measures: the posted speed limit or 35 miles per hour. The maximum potential speed differential is thus 10 mph.

The states of Illinois, Maryland and Massachusetts have specified the maximum roadway speed limit as 30 mph, whereas the maximum operating speed of LSVs in those states is 25 mph, resulting in a potential speed differential of 5 mph.

3.2.1.2 States that specify a speed limit as the same as the speed of an LSV

The states of New Jersey, West Virginia and Rhode Island have restricted LSVs to roadways with the maximum speed limit of 25 mph, which is same as the maximum operating speed of an LSV. However, the New Jersey legislature has given the approval to state authority or local ordinance to increase the roadway speed limit to 35 mph if required.

Indiana and New York have specified both the roadway speed limit on which LSVs may operate and the maximum operating speed of LSVs to be 35 mph.

3.2.2 Classification based on intersection speed limit

3.2.2.1 States that allow LSVs to cross roadways with higher speed limits

Thirty states allow LSVs to cross at the intersection of roadways having higher speed limits. This group can be further divided into two categories: states that specify the type and control of the intersection, and states specifying no intersection controls.

3.2.2.2 States that specify the type of intersection

California specifies that an LSV may cross a roadway with a speed limit in excess of 35 mph if the crossing begins and ends on a roadway with a speed limit of 35 mph or less and occurs at an intersection of approximately 90 degrees. Also, the operator of an LSV may not traverse an uncontrolled intersection with any state highway unless that intersection has been approved and authorized by the agency having primary traffic enforcement responsibilities for that crossing by a low-speed vehicle.

In Illinois, LSVs may not cross a street with a speed limit in excess of 45 mph unless the crossing is at an intersection controlled by a traffic light or four-way stop sign. However, the transportation department or a municipality, township, county, or other unit of local government has the authority to prohibit the operation of LSVs on streets if public safety is jeopardized.

In Kentucky, the legislation states that LSVs may cross an at-grade intersection with a roadway having a speed greater than 35 mph if the intersection is equipped with traffic signals.

In Maryland, a person may not drive an LSV across a highway for which the posted maximum speed limit exceeds 45 mph, except at an intersection that is controlled by a traffic signal or a stop sign at each approach to the intersection.

In Massachusetts, an LSV may cross an intersection of a roadway with a posted speed limit of 45 mph if it is controlled by traffic signals or stop signs.

New Jersey legislation states that if the road is more than two lanes, divided, or has a speed limit over 35 mph, an LSV must cross only at a signalized intersection. Crossing at a non-signalized intersection can occur if approved by the state transportation agency.

In Vermont, LSVs may cross a highway that has a speed limit of up to 50 mph if the crossing begins and ends on a highway authorized for use by LSVs, and if the intersection is controlled by traffic signals.

In Wisconsin, an LSV can cross those intersections where the highway under the jurisdiction of the municipality or county crosses a major state highway or a connecting highway only if the major state highway or connecting highway has a speed limit at the intersection of 35 mph or less and is controlled by traffic signals.

In Wyoming, an LSV can cross a state highway or a roadway with a speed limit over 35 mph if the crossing begins and ends on a roadway with a speed limit of 35 mph or less, occurs at an intersection of approximately ninety (90) degrees, and the local authorities have authorized the crossing.

3.2.2.3 States with no description of intersection

The following states mention that LSVs can cross the highway with a speed limit greater than 35 mph, but they do not specify whether the intersection should be controlled or uncontrolled: Alaska, Arizona, Colorado, Delaware, Florida, Hawaii, Iowa, Louisiana, Kansas, Maine, Michigan, Minnesota, Missouri, Nevada, New Hampshire, New York, New Mexico, North Carolina, North Dakota, Oklahoma, Rhode Island, South Carolina, Tennessee, Texas, Utah, Virginia, and West Virginia.

3.2.2.4 States that specifically prohibit crossing roadways with higher speed limits

In Washington, LSVs cannot cross a highway with a posted speed limit greater than 35 mph unless the following criteria are met: " NEVs cannot cross a roadway with a speed limit in excess of thirty-five miles per hour, unless the crossing begins and ends on a roadway with a speed limit of thirty-five miles per hour or less and occurs at an intersection of approximately ninety degrees, except that the operator of a neighborhood electric vehicle must not cross an uncontrolled intersection of streets and highways that are part of the state highway system subject to Title 47 RCW unless that intersection has been authorized by local authorities provided elsewhere in this section"(Title 46 RCW).

In Idaho, LSVs are not authorized to cross any highway with a posted speed limit greater than 45 mph.

3.2.2.5 No mention of crossings

There are four states with no regulations concerning the speed limit of an intersection where LSVs may cross. These are the District of Columbia, Indiana, Oregon, and South Dakota.

3.2.3 Other State Regulations

3.2.3.1 States that include three-wheeled motor vehicles in the state definition of LSVs:

In C.R.S. 42-1-102(48.6), Colorado has defined an LSV as a self-propelled electric vehicle that has at least three wheels in contact with the ground.

3.2.3.2 Class B or Medium-Speed Electric Vehicles (MSEVs):

In 1998, a petition was made to NHTSA by Environmental Motors, Porteon Electric Vehicles, Inc., and Mirox Corporation for a rulemaking to create a new class of motor vehicles known as medium-speed vehicles, which would be limited to a maximum speed of 35 mph. A number of reasons were cited in favor of this petition, but the most significant reason was related to potential environmental benefits, including facilitating the development of electric vehicles and fuel savings. The petitioners also mentioned that this new class of vehicle would meet a set of safety standards greater than those that apply to LSVs, but substantially less than the full set of safety standards that apply to other light passenger cars (NHTSA, 2008).

NHTSA, however, denied the petition, mainly due to safety concerns. According to NHTSA, with a 35 mph speed limit, an MSEV would likely travel with high-speed, regular, urban traffic. In such a traffic environment, NHTSA requires the full set of Federal Motor Vehicle Safety Standards (FMVSS) to prevent fatalities and serious injuries in motor vehicle collisions, which an MSEV likely would not have met (given the petitioners' proposed MSEV criteria). The presence of a roll cage or crushproof body would not guarantee that the vehicle is crashworthy and would meet the FMVSS for passenger cars (NHTSA, 2008).

In its denial of the petition NHTSA stated, "The concept of establishing such a class of motor vehicles with limited safety features that would be likely to intermingle with larger, higher speed vehicles in urban environments would result in significantly greater risk of deaths and serious injuries." NHTSA also said, "While we appreciate the importance of environmental issues, NHTSA does not believe that it is necessary or appropriate to significantly increase the risk of deaths and serious injuries to save fuel by introducing a new class of motor vehicles that does not provide adequate safety protection" (NHTSA, 2008).

The NHTSA action does not preclude states from registering MSEVs and regulating their operation on public roadways (IIHS, 2010). Accordingly, several states have specified maximum allowable speeds for MSEVs, as described below:

- Montana was the first state to enact MSEV regulations on April 23, 2007. It has defined an MSEV as a motor vehicle having a maximum speed of 45 mph that can be operated on a roadway having posted a speed limit of no higher than 45 mph.

- Colorado has defined an MSEV as a "Class B low-speed electric vehicle" that is speed-limited at more than 25 mph but less than 45 mph and can be operated only on a roadway that has a maximum posted speed limit of 45 mph. However, it can directly cross a roadway that has a speed limit greater than 35 mph at an at-grade crossing.

- In Georgia, Minnesota, Oklahoma, North Carolina and South Carolina, the allowable speed of MSEVs ranges from 30 to 35 mph, and the maximum speed limit of the roadway on which these can be operated is 35 mph.

- In Iowa, the allowable speed of an MSEV ranges from 25 to 50 mph, and the speed limit of roadways for operating an MSEV is 55 mph.

- The Maryland legislature has redefined an MSEV as a Limited-Speed Vehicle that has a maximum speed of more than 25 mph but less than 55 mph, and it cannot be operated on a highway if the maximum speed capability of the vehicle does not exceed the posted maximum speed limit for the highway by at least 5 mph.

- In New Mexico, the allowable speed of an MSEV is 30 to 40 mph, but the roadway speed limit for this vehicle is 45 mph.

- In Oklahoma and Oregon, the maximum speed of an MSEV is limited to 35 mph, and the roadway speed limit for operating an MSEV is 45 mph.

- Tennessee has specified the allowable speed of an MSEV at 30 to 35 mph, and it can be operated on a roadway with a speed limit of 40 mph.

- In Washington, the allowable speed of an MSEV is 25 to 35 mph, and the roadway speed limit on which they can be operated is 35 mph. However, an MSEV can be also operated on a roadway having a speed limit of 45 mph if the operator meets certain criteria mentioned the legislative bill.

3.2.3.3 States where regulations of LSVs are in process

As of the date of this report, Ohio and Pennsylvania were still in the process of developing regulations for LSV types of vehicles for their state legislatures to consider. In Alabama, Arkansas and Connecticut, there was no legislation found regarding LSVs.

3.3 FEDERAL MOTOR VEHICLE SAFETY STANDARDS: FMVSS 500

The NHTSA has a legislative mandate – under Title 49 of the United States Code, Chapter 301, Motor Vehicle Safety – to issue Federal Motor Vehicle Safety Standards (FMVSS) and regulations, to which manufacturers of motor vehicles and equipment items must conform and certify compliance. FMVSS 209 was the first standard to become effective on March 1, 1967. A number of FMVSS became effective for vehicles manufactured on or after January 1, 1968. Subsequently, other FMVSS have been issued. New standards and amendments to existing standards are published in the Federal Register.

These federal safety standards are regulations written in terms of minimum safety performance requirements for motor vehicles or motor vehicle equipment. These requirements are specified in such a manner "that the public is protected against unreasonable risk of crashes occurring as a result of the design, construction, or performance of motor vehicles and is also protected against unreasonable risk of death or injury in the event crashes do occur" (NHTSA, 1998).

Federal Motor Vehicle Safety Standard No.500 (49 CFR 571.500, which became effective June 17, 1998, is a summary of the final rule of NHTSA which classified "Low-Speed Vehicle (LSV)" as a new group of motor vehicles. The rulemaking established the definition for LSVs, and specified the minimum requirements those LSVs must have in terms of speed limit and vehicle equipment to ensure the safety of the vehicle occupant and other roadway users (NHTSA, 1998). The rulemaking proceeding was initiated in response to a request by one of the LSV manufacturers, Bombardier, Inc. (NHTSA, 1998).

3.3.1 Definition

The FMVSS No.500 has classified "Low-Speed Vehicle" as a small, four-wheeled motor vehicle with a top speed of more than 20 mph and not more than 25 mph. Conventional golf carts are not included in this classification, but a "Neighborhood Electric Vehicle" (NEV) is included in this classification.

3.3.2 Requirements

3.3.2.1 Speed

The maximum attainable speed of an LSV in one mile shall be not more than 25 miles per hour.

3.3.2.2 Equipment

Each vehicle shall be equipped with headlamps; stop lamps; turn signal lamps; tail lamps; reflex reflectors, one red on each side as far to the rear as practicable and one red on the rear; an exterior mirror mounted on the driver's side of the vehicle; either an exterior mirror mounted on the passenger's side of the vehicle or an interior mirror; a parking brake; a windshield that conforms to the federal motor vehicle safety standard on glazing materials (49 CFR 571.205); a VIN that conforms to the requirements of part 565 Vehicle Identification Number; and a Type 1 or Type 2 seat belt assembly conforming to Sec. 571.209.

3.3.2.3 General test conditions and procedures

Each vehicle must meet the performance limit for the above two requirements under the test condition and test procedure specified by the Standard No.500.

Transport Canada has harmonized the Federal Canada Motor Vehicle Safety Standards with the U.S. Motor Vehicle Safety Standards (Transport Canada, 2008).

3.4 DOMESTIC MANUFACTURERS

Some of the U.S. companies that manufacture or distribute LSVs have been studied in the research. The major brands available in the U.S. are discussed below. The web references for this section are included in the Vehicle Manufacturer Web Link part of the Reference Section 8.0. Appendix B in Section 10 includes a summary table of LSV characteristics by manufacturer.

3.4.1 Dynasty Electric Vehicles Limited

Dynasty Electric Vehicles Ltd., located in Delta, B.C., Canada, is a designer and manufacturer of LSVs. The company first designed the IT line of electric LSVs in fall 1999; it produced the first Sedan model in April 2001. In addition to the basic equipment requirements specified by

NHTSA for LSVs, Dynasty Electric vehicles also offer an enclosed driver compartment, heater and de-mist facilities. Currently, the company has five models available in the market, as shown in Table 3.2. (*http://www.itiselectric.com/index.htm*)

Table 3.2: Models available from Dynasty Electric Vehicles

Model	Maximum speed (mph)
Sedan	25
Sport	24
Tropic	24
Van	24
Utility	24

3.4.2 ZENN

The name ZENN stands for "Zero Emission No Noise." The Zenn Motor Company is also a Canadian-based company that sells two models of LSVs in the U.S. They first released a car, the Dauphine Electric, in 2000. ZENN is an electric car that has a regulated maximum speed of 25 mph and a range of 35 miles on a full charge (INL, 2010). According to ZENN electric car reviews, the vehicle can be modified to go up to 40 miles per hour by changing out a computer chip (ZENN, 2010).
(*http://peswiki.com/index.php/Directory:Electric_Cars*.
http://www.carsdirect.com/electric-cars/the-zenn-electric-car-understanding-the-facts)

3.4.3 Frazer Nash

Frazer Nash Research, located in Surrey, UK, is the flagship company of the Kamkorp group. Kamkorp is a British company with headquarters in Singapore. However, Kamkorp Microelectronics, the producer of the Frazer Nash electric vehicles, is registered in Switzerland (INL, 2010). Table 3.3 shows the models of the Frazer Nash LSV.

Table 3.3: Models available from Frazer Nash

Model	Maximum speed (mph)
2001 Frazer Nash City Car NEV	25
2001 Frazer Nash truck 4XLSV NEV	25

These vehicles comply with the mandatory requirements of the NHTSA LSV technical specifications. In addition, the City Car has features such as 4-wheel drive; an odometer and speedometer; a state-of-charge meter; back-up alarm; roof-mounted solar assist array; AM/FM/CD audio system; air conditioning; tilt wheel; remote-control locking; and remote-control immobilizer. In a nutshell, the City Car has many features of a motor vehicle except that the highest operating speed is limited to 25 mph.
(*http://www.electrifyingtimes.com/think_kamkorp.html*)

3.4.4 GEM

Global Electric Motorcars, a Chrysler company, started producing battery-electric LSVs in 1998 in Fargo, ND. According to the company, almost 38,000 GEM cars have been placed into service since then. In addition to the standard requirements of the NHTSA technical specifications for LSV safety equipment, GEM cars also offer doors, heated seats, and a heater/defogger for cooler climates with a minimum impact on range. There are seven models of GEM cars – three passenger models and three utility models - as shown in Table 3.4. In 2009, the Chrysler LLC GEM brand launched its latest model, a next-generation design – the GEM Peapod NEV - which can cover a range of up to 30 miles at a top speed of 25 mph without recharging.
(INL, 2010, *http://www.gizmag.com/chrysler-introduces-gem-peapod-neighborhood-electric-vehicle/10060/*)

Table 3.4: Models available from Global Electric Motorcars

Model	Maximum speed (mph)
GEM e2 (two passengers)	25
GEM e4 (four passengers)	25
GEM e6 (six passengers)	25
GEM eS (short-back utility vehicle)	25
GEM eL (long-back utility vehicle)	25
GEM e2 (extra-duty long-back utility vehicle)	25
2009 Peapod	25

3.4.5 Miles Electric Vehicles

Miles Electric Vehicles, founded in 2004, is a manufacturer and distributor of electric vehicles. Its LSVs are manufactured in China and distributed from Los Angeles, CA. It is owned by Miles Rubin, known as the “Green” magnate. Miles Electric Vehicles were the world’s first crash-tested LSVs and are built on a steel unibody chassis. The results of the crash tests conducted in China have not been published. Miles was awarded “Electric Car Company of 2007” by Good Clean Tech. The vehicles meet DOT/NHTSA Federal Standard 500 compliance. Table 3.5 shows the models available from Miles Electric Vehicles (lNL, 2010).

Table 3.5 Models available from Miles Electric Vehicles

Model	**Maximum Speed (mph)**
ZX40	25
ZX40S	25
ZX40S Advanced Design	25
ZX40ST Electric Truck	25
OR70 (not legal on public roads)	35

(*http://www.milesev.com*)

3.4.6 Columbia ParCar

Columbia ParCar Corporation, established in 1984, manufactures a line of electric and gas-powered golf carts as well as utility, industrial, commercial and passenger vehicles. The successor to Harley-Davidson Golf Car Company, Columbia ParCar Corp. is a member of the Nordic Group of Companies, and its headquarters and manufacturing facility is located in Reedsburg, WI.

The Columbia ParCar Summit model of LSV offers soft-sided weather enclosures, hard-sided doors with windows, heater/defroster, rear-facing passenger seats, and an hour meter in addition to the standard requirements of the NHTSA LSV technical specifications. The models available from Columbia ParCar Corp. are shown in Table 3.6 (*lNL*, *2010*). (*http://resources.bnet.com/topic/columbia+parcar+corp.html*)

Table 3.6: Models available from Columbia ParCar Corp.

Model (Passenger Vehicle)	Maximum Speed (mph)
Electric Eagle-P4E	19
Summit-SM-2	25
Summit-SM-4	25
Summit-SUV-S	25
Summit-SUV-L	25

3.4.7 ZAP

ZAP (Zero Air Pollution) is a U.S.-based electric vehicle distributor. Many of the ZAP products are designed to go up to 40 mph; however, there are two products with speed restricted to 25 mph. The ZAP Xebra Sedan Car and Xebra Truck are three-wheeled electric vehicles and are therefore classified as motorcycles in some states, including Oregon. Table 3.7 shows the available models of ZAP cars and trucks.

Table 3.7: Models available from ZAP

Model	**Maximum Speed (MPH)**
Electric Car-ZAPTRUCK XL (4 wheeler)	25
Electric Car-ZAPVAN SHUTTLE (4 wheeler)	25

(*http://www.zapworld.com/*)

3.4.8 Ruff and Tuff Electric Vehicles

Ruff & Tuff Electric Vehicles introduced its first line of electric vehicles under its own brand in 2005. The company's headquarters is located in Winnsboro, SC. All of the models have features such as headlights, taillights, brake lights, hazard and turn signals, mirrors, horn, reverse indicator and wipers. The models available from Ruff and Tuff are shown in Table 3.8.

Table 3.8: Models available from Ruff and Tuff

Model	Maximum Speed (mph)
NEV 2	<25
NEV4	<25
CRUISER EV2	<25
CRUISER LX2	<25
CRUISER LX4	<25
HUNTER 4x4	<25

(*http://www.ruffandtuff.net/models.php*
https://inlportal.inl.gov/portal/server.pt/community/lightduty_vehicles/468/neighborhood_electric/4146)

3.4.9 Ford Th!nk Neighbor

TH!NK Mobility was an LSV enterprise of the Ford Motor Company that manufactured the Th!nk Neighbor in 1999. The LSVs were available in three models – a two-seater and a four-seater car, and a two-passenger utility truck model. Covering a range of up to approximately 30 miles, the Th!nk Neighbor had a low speed setting of 15 mph and a high speed setting of 25 mph. It met all the NHTSA FMVSS 500 requirements of low-speed vehicles (lNL, 2010).

(*http://media.ford.com/article_display.cfm?article_id=3559*

http://en.wikipedia.org/wiki/Ford_TH!NK#TH.21NK_Neighbor
http://en.wikipedia.org/wiki/Think_Global)

This research project identified two other LSV manufacturing companies: NEVCO, which produces the Gizmo, and NICE, which produces the MegaCity car. The Gizmo is a three-wheeled electric vehicle and thus classified as a motorcycle, so it was not included in the group of manufacturers developed for this study (*http://www.nevco-ev.com/gizmo-review.html*). The MegaCity car has maximum speed of 40 mph, which does not qualify it as an LSV since it exceeds the maximum operating speed specified in the FMVSS 500 requirements for low-speed vehicles. (*http://nicecarcompany.co.uk/index.php/home-2/*)

4.0 SAFETY CONSIDERATIONS

4.1 CRASH TESTING

4.1.1 Introduction

The North American regulations for LSVs currently do not require that these vehicles meet any of the crash-test requirements of conventional passenger cars, since these vehicles are designed to be used on low-speed and low-volume roadways such as in gated communities or on educational or industrial campuses. LSVs are becoming more prevalent, however, on higher speed and more highly congested public roadways in Europe, Canada and the United States (BBC, 2007). Crash tests of LSVs have been conducted by Transport Canada, the Insurance Institute for Highway Safety in the U.S., the Department of Transport in the UK, and in China (IIHS, 2010). Videos of these tests are available in the public domain. LSVs were never designed to meet the additional crash and energy-attenuation requirements of passenger vehicles and therefore did not perform well in any of the crash tests (IIHS, 2010). The Canadian crash test video can be viewed at the Transport Canada link http://www.tc.gc.ca/eng/roadsafety/safevehicles-lowspeed-video-index-503.htm, and the Insurance Institute for Highway Safety video can be viewed at the following website: http://www.iihs.org/news/rss/pr052010.html

4.1.2 U.S. and Canada Crash Tests

The NHTSA vehicle category of "Low-Speed Vehicle" has emerged as part of the sustainable green transportation system. NHTSA regulations restrict the top speed of these vehicles to 25 mph in the intended operating environment of planned, gated communities. NHTSA also states that this new classification of vehicle does not need to conform to the safety standards of a conventional passenger car and consequently does not require any crash testing, due to its restricted operating environment. According to the agency, "the safety requirements of LSVs are determined by the combination of three factors – vehicle design and performance, operator training and ability; and the operating environment" (NHTSA, 1998). The agency believes that the low speed and size of the vehicle, its limited operating environment and also the operator skill in combination with the Safety Standard No. 500 ensures the appropriate safety to the occupants of these vehicles, and also provides the vehicle with required crash avoidance and crash-protection characteristics as well (NHTSA, 1998). For these reasons, the LSVs do not need to meet any crash test program in the U.S., unlike other conventional passenger cars. However, given that their use has increased on public roadways among regular auto and truck traffic operating at higher speeds, these vehicles are becoming increasingly susceptible to risk even with the FMVSS 500 safety features and limited operating speed.

Transport Canada first conducted a series of crash tests on LSVs to determine the risks of mixing low-speed vehicles with high-speed and high-volume urban traffic. In one crash test, an LSV was subjected to a frontal crash impact test with a rigid barrier at a speed of 40 km/hr (25 mph). In another crash test, a stationary LSV was subjected to a side crash test with a "Smart" microcar

(Daimler AG), operating at a speed of 50 km/hr (31 mph). The results of both of the crash tests revealed that the impact forces resulting from the collisions were directly transmitted to the occupants of the LSV, which would result in severe injuries or death to the passenger and driver (Transport Canada, 2008). The Canadian crash test video may be viewed at the Transport Canada website at the following URL link: http://www.tc.gc.ca/eng/roadsafety/safevehicles-lowspeed-video-index-503.htm.

In the United States, the Insurance Institute for Highway Safety (IIHS) performed a crash test on low-speed vehicles to identify the impact of the operation of LSVs on public roadways. The IIHS was very concerned about the severe consequences of operating LSVs simultaneously with high-volume regular traffic. The institute's chief research officer, David Zuby, said, "By allowing LSVs and mini-trucks on more and more kinds of roads, states are carving out exceptions to 40 years of auto safety regulations that save lives. It's a troubling trend that flies in the face of the work insurers, automakers, and the federal government has done to reduce crash risk." (IIHS, 2010)

To perform the crash test, the IIHS used two electric LSVs, both GEM e2 models produced by Global Electric Motorcars of the Chrysler Group. According to the statement of the Chrysler Group – "GEM vehicles offer customers an inexpensive, clean solution for low speed environments and comply with the National Highway Traffic Safety Administration standards for low speed vehicles which limit the maximum speed of the vehicle to 25 miles per hour." (*Valdes-Dapena 2010*). In the test, the two GEM e2 LSVs were subjected to 31 mph side crashes – one using a moving deformable barrier representing a pickup or SUV, and the other using a "Smart Fortwo" (Daimler AG) as the striking vehicle. The "Smart" is currently the smallest passenger vehicle on U.S. roads that meets crashworthiness standards (IIHS, 2010). The Insurance Institute for Highway Safety video may be viewed at the IIHS website, at the following URL link: http://www.iihs.org/news/rss/pr052010.html.

The results of both side crash tests revealed that the impact of the collision on the low-speed vehicle would likely cause serious or fatal injury to the LSV user. The test results also indicated that the safety features such as the airbag and the side body panel of the "Smart Fortwo" conventional passenger car protected its occupant from severe injury during the crash. From the crash test results, it was concluded that LSVs with safety features such as safety belts and thermoplastic body panels (sometimes accompanied by doors) provide a substantially lower level of crash protection to their occupants during a collision than passenger cars in urban traffic (IIHS, 2010). According to Zuby, "GEMs and other LSVs weren't designed to protect people in a crash with a microcar like the Smart Fortwo, let alone larger cars, SUVs, and pickups in everyday traffic." (IIHS,2010)

It should be noted that crash tests conducted in Europe all used very small, conventional passenger cars. No standard size or larger vehicles have been crash tested with LSVs.

4.2 OPERATING ENVIRONMENT

4.2.1 Speed

A study conducted in Quebec reported that drivers of LSVs feel more vulnerable. They reported that, while traveling on two-lane, two-way roadways, other drivers expressed frustration at the lack of sufficient roadway for them to overtake the slow-moving vehicle. This should not be a problem on roadways posted at 25 mph or less; however, LSV drivers have mentioned that other vehicle operators like to drive 5 to 10 mph over the posted speed limit (Lamy, 2002).

In Oregon, it is legal to operate LSVs with a maximum operating speed of 25 mph on public roadways with posted speeds of 35 mph, and in some locations even 45 mph (ORS 801.331). These operating conditions increase the frustration of operators of other motor vehicles and the feeling of vulnerability by LSV users. In Oregon, there has also been a lack of consistent information when LSVs are licensed from the ODOT Driver and Motor Vehicle (DMV) Division about the posting of the "Slow Moving Vehicle" emblem in the rear of an LSV under the provisions of ORS 815.110 (ODOT/DMV, 2010).

4.2.2 Speed differential

The theory of minimizing speed differential on roadways is one of the basic tenets in the traditional transportation engineering discipline. A speed differential occurs when there is a vehicle moving faster or slower than the general traffic stream. One of the goals of traffic engineering is to have uniform traffic flow, as this increases the capacity of a roadway and improves overall safety but reduces speed fluctuations. This theory is applied to a number of situations such as the design of off- and onramps, and the design of driveways to improve safety and access management. There are a number of safety issues associated with slow-speed operations. This is depicted in Solomon's Curve, shown in Figure 4.1. It shows that a 10-20 mph speed differential increases the collision rate (Solomon, 1964; Cirillo, 1968; West, 1971).

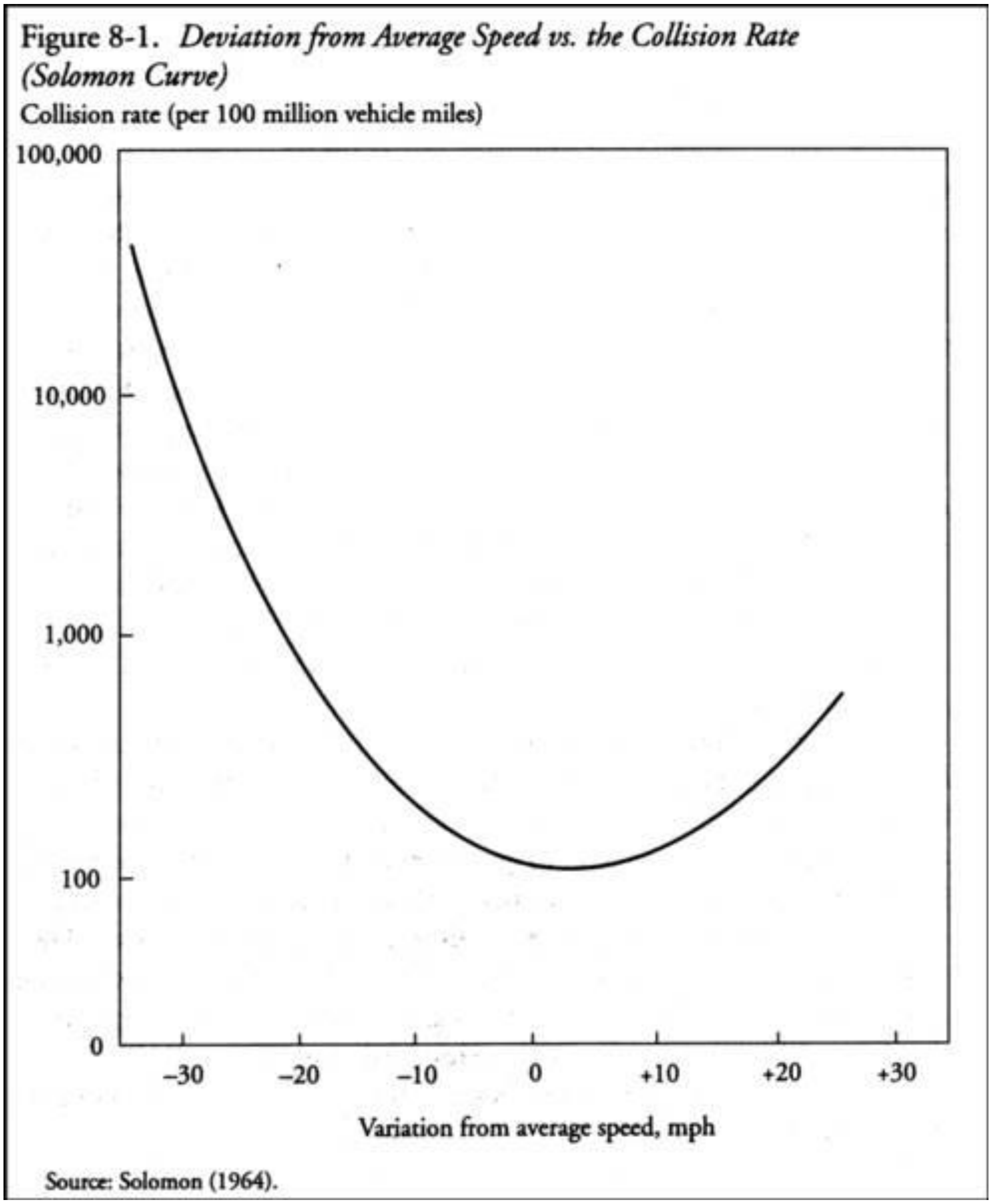

Figure 4.1: Solomon's Curve Deviation from Average Speed and Collision Rate

4.3 VEHICLE WEIGHT

In 1998, when NHTSA established Federal Motor Vehicle Safety Standard (FMVSS) No. 500, the definition of an LSV was established as, "a 4-wheeled motor vehicle, other than a truck, whose speed attainable in 1.6 km (1 mile) is more than 32 kilometers per hour (20 miles per hour) and not more than 40 kilometers per hour (25 miles per hour) on a paved level surface" (NHTSA, 1998). But in 2005, NHTSA amended the definition of LSVs by dropping the restriction on trucks, and instead establishing a 2,500 pound maximum gross vehicle weight rating (GVWR). This amendment allowed small vehicles designed for work-related applications within the intended communities (such as landscaping or delivery) to be included within the definition of an LSV without opening the category to unintended vehicles, such as street sweepers or speed-modified passenger cars. Also, the GVWR limit prevents attempts to circumvent the FMVSS for cars, trucks and multipurpose passenger vehicles by applying the LSV classification to vehicle types that are able to meet the standards. Defining an LSV as having a maximum GVWR of less than 2,500 pounds also provides an objective means for delineating between the vehicles for which the LSV requirements are appropriate and those vehicles that can be designed to meet the FMVSS for passenger cars and trucks. This approach also ensures that heavier, slow-moving trucks (e.g., street sweepers) continue to be excluded from the LSV definition (NHTSA, 1998).

In 2006, in response to petitions for reconsideration from Dynasty Electric Car Corporation and Global Electric Motorcars (GEM) – both manufacturers of electric LSVs – NHTSA increased the maximum GVWR for LSVs to 3,000 pounds. This was done, in part, to “level the playing field” between electric and gasoline-powered LSVs, by allowing for the additional weight in batteries required by electric vehicles. A 3,000-pound GVWR limit was selected because it was lighter than all FMVSS-compliant passenger cars and SUVs, with the exception of the Honda Insight. In addition, NHTSA limited the GVWR of an LSV to 3,000 pounds in combination with the maximum speed limit of 25 mph for the purpose to restricting the use of these vehicles in mixed vehicle traffic for other than very short trips, and to encourage their transportation within a planned, limited environment, such as retirement and gated communities (NHTSA, 2008).

The GVWR was selected by NHTSA as one of the criteria to define LSVs, rather than curb weight, because curb weight describes only the weight of the vehicle and not its capacity. But GVWR is a description of the maximum possible weight of the fully loaded vehicle. So GVWR is more pertinent to safety. Limitation of GVWR to “less than 3,000 pounds” in addition to the other limiting attributes of the definition of LSVs negates the need to specify a minimum-rated cargo load (RCL) to prevent the operation of these vehicles in overloaded conditions for safety purposes (NHTSA, 2008).

Transport Canada, in the spirit of regulatory harmonization, also made similar amendments to its regulation and defined a low-speed vehicle as having a GVWR of less than 1,361 kg. (MVSA C.R.C.C 1038).

4.4 IMPACT RESISTANT CABS AND OTHER SAFETY EQUIPMENT

In 1998, when NHTSA first defined the LSV class, the main purpose of these vehicles was to make short trips for shopping, social and recreational purposes primarily within retirement or other planned, self-contained communities. Maintaining this goal, when NHTSA redefined the GVWR-based definition of LSVs in 2003, the agency limited the GVWR to 3,000 pounds. NHTSA’s rationale for this decision was that this special class of vehicles, when provided with additional amenities and characteristics of a traditional passenger car, would be driven outside the planned communities and would regularly mix with high-volume traffic on roadways, even with a 25 mph speed limit. These special vehicles do not have any safety features such as air bags, energy-attenuating bumpers or crash resistant cabs. The FVMSS 500 for LSVs does not require any crash safety amenities (NHTSA, 2008). None of the LSVs running on the road or available on the market to date, have any of these safety features. A study by Transport Canada revealed that a traditional passenger car needs to meet over 40 safety standards, whereas LSVs are required to meet only four standards. (Transport Canada, 2009)

4.5 VULNERABILITY

LSVs are lighter than the FMVSS-compliant passenger cars. Also, they do not meet all the safety standards of motor vehicles in the United States, Canada or the European Union. So they are less crash protective than any conventional car, even less than the smallest “Smart” passenger car. The forces and energy generated from the collision of an LSV with any rigid barrier or any other vehicle while operating in mainstream traffic is directly transmitted to the occupants of the LSV. Thus there is the potential for serious injuries or death to LSV occupants. With an increase in speed, the kinetic energy increases proportionally with the square of the speed. For example, with a 3,000 pounds GVWR, the kinetic energy generated from a collision at 35 mph is almost twice the kinetic energy generated from a collision at 25 mph. Therefore, operating an LSV on a roadway having a posted speed limit of 35 mph with high-speed traffic makes the occupants of the LSV more vulnerable to the risk of serious injury or death. Table 4.1 shows the kinetic energy associated with increasing speeds of a 3,000-pound vehicle (including driver and cargo). The steep increase in the kinetic energy with increasing speeds provides an idea of the increase of risk in an LSV collision.

Table 4.1: Kinetic energy associated with increasing speeds

Vehicle Weight (lbs)	**Kinetic Energy (ft-lbs) at Different Speeds**		
3000	25 mph	35 mph	45 mph
	63021	123,520	204,187.5

The energy generated during the collision of a conventional passenger car, which meets all the safety standards of motor vehicles in either the U.S. or Canada, is dissipated to a great extent before it is transmitted to the occupants inside the car. This occurs due to the occupant protected body and internal crash protecting design attributes of the passenger car. But LSVs lack all these crash protecting attributes. So the risk of fatal injury during a collision in an LSV increases dramatically with increasing speed (Transport Canada, 2008).

4.5.1 Street Infrastructure

Every mode of transportation has its own right-of-way, or it can share the path with other transportation modes. Passenger vehicles run on residential, collector or arterial streets; bicycles are used on bicycle lanes or multiuse paths; and pedestrians walk on sidewalks and crosswalks. There are no dedicated rights-of-way for low-speed vehicles other than in communities that are specifically designed and built to accommodate these vehicles.

When LSVs use the same right-of-way with high-speed passenger vehicles and trucks, it imposes a great risk to the LSV's operator and passengers due to the speed differential and the construction of the two different types of vehicles. Also, the use of the "slow-moving vehicle" emblem for LSVs (like golf carts) is too limited to make faster-moving vehicles aware of and accustomed to LSVs on roadways. All these factors make the operators of LSVs more vulnerable when they run simultaneously on high-speed roadways (Stein, et al., 1996).

4.5.1.1 Sharing the roadway

LSVs were designed to be used in protected environments such as gated communities and industrial and college campuses, but not on public roadways. An increased public awareness of climate change, the environment and sustainable transportation has increased the popularity of these vehicles as a new mode of private transportation; consequently, they are becoming part of the mix of vehicles on public roadways. Some of these vehicles look like passenger cars, and many consumers are not aware of their operating and safety limitations. In the next five years, there will be a number of all-electric passenger vehicles coming on the market that do meet the safety requirements and performance levels of passenger vehicles. It is very important in the interim that operating guidelines for LSVs are developed to protect all road users and also to recognize the environmental advantages of these vehicles.

4.5.1.2 Multiuse paths

Multiuse paths are typically shared-use paths of pedestrians, bicyclists, equestrians and wheeled-mobility aids that are operated by people with disabilities. These paths are typically not very wide and are not striped for two-way traffic. The rules of operation are that all users yield to pedestrians. LSVs are much wider, heavier and faster than pedestrians and the other devices used by people of shared-use paths. Thus there is the potential to put all the other multiuse path users at risk, unless the path is designed specifically to accommodate LSVs. It is not recommended that LSVs share multiuse paths unless the paths are specifically designed for that purpose.

4.5.1.3 Civic interconnectivity

One of the challenges for LSV operators is navigating the urban roadways that meet all speed restrictions. In many communities, LSV operators are not able to complete a trip from origin to destination without violating either speed or crossing restrictions. One solution to this problem would be for communities to identify roadway networks that accommodate LSVs as well as other road users who operate mopeds and human-powered vehicles, and who do not want to travel on high-speed, high-volume arterials.

An example of this situation is in the city of Corvallis, OR, where one of the major north-south roadways is 9^{th} Street – a major five-lane arterial with a center two-way, left-turn lane, which carries a high volume of traffic that includes trucks. The roadway does include bike lanes, but many of the regular bicycle riders in Corvallis prefer to ride on 10^{th} Street, a residential street which runs parallel to 9^{th} Street and has a much lower speed and traffic volume but still connects major activity centers. LSV owners and the local bicycle community could work together to identify a low-speed street network that connects the major residential and activity centers. The result of this work may include the necessary modification of intersection control and the designation of certain roadways.

Using Corvallis as an example, the Campus Way bike path between 35th Street and 53rd Street is currently a multiuse path for agricultural vehicles, bicycles and pedestrians that provides east-west access between the Benton County Fairgrounds and Oregon State University. It has a posted speed limit of 15 mph and all road users must yield to pedestrians. It is a wide roadway with space to accommodate all users. If this roadway were designated for LSVs, then LSV operators would have access to the fairgrounds and a county park. This example of Campus Way does mix pedestrians with the other road users. This practice is not generally advised, however. The recommended parallel roadway networks should have separate pedestrian facilities.

4.5.2 Crash Data

ODOT's Crash Code manual and the federal Fatal Accident Reporting Systems (FARS) currently do not include any listing for low-speed vehicles. As a consequence, there is no crash data available for Oregon.

5.0 INSURANCE

In almost every jurisdiction, to be qualified as a street-legal vehicle each vehicle on the roadway, including low-speed vehicles, must have insurance. The concept of electric low-speed vehicles is still relatively new to the auto insurance industry, and as a result not all of the insurance companies provide coverage for LSVs. GEICO, one of the leading U.S. insurance companies, only insures LSVs in California, North Carolina and Rhode Island (because it is bound by law to do so). Progressive, another well-known insurance company, does not insure LSVs at all, as it insures only those vehicles capable of maintaining a speed of 55 miles per hour. State Farm Insurance and the Allstate Insurance Company do offer insurance coverage for low-speed electric vehicles, but this does not include any collision coverage (Johannsen, 2010).

Among all the auto insurance companies identified by the published information on the Internet, only Foremost Insurance Group offers specialized insurance coverage for off-road and licensed on-road neighborhood electric vehicles. Their insurance policy includes important standard and optional coverage such as collision coverage, liability coverage, medical payments coverage, coverage for accessories and optional equipment (including towable trailers, solar panels and aftermarket accessories), and coverage on transport trailers valued up to $7,500. (Foremost, 2010).

Some other companies may offer insurance coverage for an electric low-speed vehicle that is purchased from that company. One such example is Gatormoto Utility Vehicles (Gatormoto, 2010)

Some LSV owners in Oregon have indicated that their LSVs are insured under their homeowner’s policy.

6.0 CONCLUSIONS

Low-speed vehicles have become increasingly popular due to their reduced environmental impact and lower operating cost. These vehicles need to be recognized as a unique classification of vehicle with related regulations for their safe use and operation on public roadways. The transportation and safety operating parameters for this classification of vehicle need to be developed to insure the safety of all roadway users.

This project investigated safety standards, operating regulations, and LSV manufacturer materials from sources around the world. There were several important issues that were identified in the course of this research:

- LSVs were designed to be used in controlled or protected environments and roadways;

- The safety standards that were developed in Europe and North America were developed with the underlying premise that LSVs would be operated on low-speed roadways in protected environments. Therefore, the regulations do not have any provisions for occupant crash protection other than seat belts; and

- In North America, states, provinces and local governments have the legal authority to set regulations pertaining to motor vehicles operating on the roadways under their jurisdictions. In many circumstances, these regulations significantly increase the risk exposure to LSV users.

In many jurisdictions throughout the world, the vehicle safety and roadway operating regulations are inconsistent.

6.1 SAFETY PARAMETERS

In Europe and North America, national vehicle safety organizations have worked together to harmonize the safety regulations for LSVs, and in all cases with the underlying premise that these vehicles operate on protected low-speed roadways. However, the reality is that these vehicles are operating on public roadways with posted speed limits that, in a few states, are 10 to 20 mph higher than the maximum speed of the vehicle. Safety research has shown that speed differential is likely to increase collision frequency (Solomon, 1964). Furthermore, crash testing has shown that the occupants of LSVs are at risk of serious or fatal injury if they are involved in a collision with an impact speed of as low as 25 mph (IIHS, 2010).

The roadway regulations only address the posted speed limit, not the actual speed of the vehicles on the roadway. In general, roadway speed regulations are based on the roadway geometrics, such as number of lanes, traffic volume, and access points, and the roadway classification (collector, arterial or highway). Other than specific truck speed regulations, roadway speeds do not consider the type, size or weight of vehicles.

It is assumed that protected low-speed environments are also low-volume roadways such as cul de sacs and neighborhood streets. There is strong evidence, however, from cities in North America and Europe, such as London, that LSVs are operating on high-volume roadways with heavy vehicles. For the protection of all road users, there is a need to make the federal vehicle safety standards and the state and local roadway vehicle regulations consistent. If LSVs are limited to roadways with the maximum posted speed limit set to equal the maximum speed of the LSV – and in most regions this is 25 mph – then the current safety regulations are appropriate, but only if the roadway does not have heavy traffic volumes or heavy vehicles.

Medium-speed vehicles, which were denied a petition by NHTSA under FVMSS 500.571, should be required to meet the additional safety requirements of the federal motor vehicle safety standards for conventional vehicles, including passing crash tests. Or they should be limited to operation on roadways with a posted speed of 25 mph or less. As stated previously, a roll cage and crushproof body is an improvement, but is not equivalent to the crash protection on a conventional passenger car.

It is widely recognized by owners of certain models of LSVs that the speed governor can be modified so that the LSVs can operate at much higher speeds than 25 mph. It should be noted that this is in violation of federal and state regulations. In this situation there is a need to either enforce existing federal and state regulations, or change the occupant safety requirements for these vehicles to provide a similar level of occupant protection as that which is provided in a conventional passenger car.

Since many of these LSVs have the outward appearance of a conventional car, some of the owners may be unaware of the safety risks of these vehicles. Consumer education is needed to inform LSV owners of the safety limitations of their vehicles. It should be noted that the lack of occupant protection in most LSVs also is reflected in the lighter weight of the vehicles, the increased power efficiency and the environmental benefit of these vehicles.

6.2 OPERATING ENVIRONMENT

Low-speed vehicles were developed for use in protected environments, but many people see the environmental benefit of these vehicles and are operating them on public roadways. These vehicles can be operated safely on certain public roadways such as low-speed neighborhood streets, local streets and some collector streets with posted speed limits less than or equal to 25 mph. It would be prudent for state and local authorities to work with their local LSV users and bicycle advocates to develop local networks of low-speed roadways that provide street connectivity between major residential neighborhoods and public transportation facilities and activity centers such as schools and colleges, business centers, shopping facilities, medical services, and recreational centers. These roadways would provide a secondary transportation network for other types of road users who do not want to travel on higher-speed corridors.

6.3 REGULATORY AND SPEED HARMONIZATION

As stated previously, the national vehicle safety organizations have worked together to harmonize safety regulations so that LSV manufacturers only need to meet either North American or European standards for their vehicles. The challenge is that state and local authorities set the operating regulations for motor vehicles on the roadways under their jurisdictions. There is compelling evidence from the domains of roadway safety and LSV testing that LSVs should be limited to roadways with maximum posted speed limits that do not exceed the maximum operating speed of the LSV. In general this is 25 mph.

LSVs also should be restricted to crossing higher-speed roadways at controlled intersections or intersections with stop controls on all approaches. Unfortunately, many U.S. states have regulations that permit these vehicles to travel on roadways with higher posted speed limits and therefore increase the vulnerability and safety risks to LSV users. Harmonization of the local and state roadway speed regulations and federal vehicle safety regulations for LSVs would be a step towards improving safety for all roadway users.

7.0 RECOMMENDATIONS

LSV is a new vehicle classification that has the potential for many environmental benefits, such as reduced air pollution and noise. These environmental benefits, however, must be balanced by the need for the safety of all road users. Following are several recommendations from this research.

7.1 STATE AND LOCAL LSV REGULATIONS

State and local authorities need to understand the safety implications for all users when LSVs are permitted to operate on roads with posted speed limits that are higher than the maximum operating speed of the vehicles. In Oregon, it is recommended that a revision be made to the current LSV legislation that was enacted in February 2010. Specifically, this would entail revising ORS 811.512 (Unlawfully operating low-speed vehicle on the highway) and/or ORS 811.513 (Unlawfully operating medium-speed electric vehicle on highway). In the spirit of regulatory harmonization, the recent Oregon legislation granting authority to local jurisdictions to set regulations for LSVs operation should be amended to require local operating regulations to be consistent with state and federal regulations.

It is also recommended that medium-speed vehicles, which were denied a petition by NHTSA under FVMSS 500.571, should be required to meet the additional safety requirements of the federal motor vehicle safety standards for conventional vehicles or be limited to operation on roadways with a posted speed of 25 mph or less.

7.2 STATE AND LOCAL PLANNING

It is recommended that state and local authorities work with their local LSV users and bicycle advocates to develop local networks of low-speed roadways that provide street connectivity of major residential neighborhoods and activity centers that provide employment, education, medical services, recreation, and retail shopping. These low-speed roadways would provide a secondary transportation network for multiple types of other road users who should not travel on higher-speed corridors, such as human-powered vehicle users who prefer low-speed roadways. The low-speed roadways should also have separate pedestrian facilities. This recommendation does not have to involve construction of new facilities. It would entail the identification and signage of existing roadways that provide complementary connections between residential neighborhoods and activity centers.

7.3 CONSUMER EDUCATION

It is recommended that LSV operators be informed of the safety limitations of their vehicles, especially for models that look like cars. LSV consumers need to understand their personal safety risk if they change the speed governors of their LSVs. LSV users also should be educated about the risk factors of driving a vehicle that does not provide crash protection on public roadways.

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South Dakota: (South Dakota Legislature 32-3-71, 32-5-152, 32-25-27, 32-6B-12.1, 32-35-125, 32-12-4.8, 32-3-1)
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-3-1&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-3-71&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-5-152&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-25-27&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-6B-12.1&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-35-125&Type=Statute
http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=32-12-4.8&Type=Statute

Tennessee: (Tennessee Code 55-8-101 and 55-8-191)
http://state.tn.us/sos/acts/105/pub/pc0959.pdf
http://www.tn.gov/revenue/notices/titlereg/08-20.pdf
http://www.tn.gov/revenue/forms/titlereg/f1314301Fill-in.pdf

Texas: (Texas Statutes, Transportation Code 551.301-551.303)
http://www.statutes.legis.state.tx.us/Docs/TN/htm/TN.551.htm#551.301

Utah: (Utah legislature 41-6a-1508)
http://le.utah.gov/~2010/bills/hbillamd/hb0238.htm

Vermont: (Vermont Statutes Title 23, Chapter 1, Section 4, and Chapter 13, Sections 1007a and 1043)
http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=23&Chapter=001&Section=00004
http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=23&Chapter=013&Section=01007a
http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=23&Chapter=013&Section=01043

Virginia: (Virginia Code 46.2-100, 46.2-908.2, and 46.2-908.3)
http://www.vsp.state.va.us/downloads/Golf_Carts_and_Utility_Vehicles_2008.pdf
http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+46.2-908.2
http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+46.2-908.3

Washington: (Revised Code of Washington 46.04.295, 46.04.357 and 46.61.723-46.61.725)
http://apps.leg.wa.gov/RCW/default.aspx?cite=46.04.357
http://apps.leg.wa.gov/documents/billdocs/2009-10/Pdf/Bill%20Reports/Senate/6207%20SBR%20TRAN%2010.pdf
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.04.295
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.61.723
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.61.725

West Virginia: (Reference West Virginia Code 17A-3-1, 17A-3-2)
http://www.legis.state.wv.us/WVCODE/17a/code/WVC%2017%20A-%20%201%20%20-%20%20%201%20%20.htm
http://www.legis.state.wv.us/WVCODE/17a/code/WVC%2017%20A-%20%203%20%20-%20%20%202%20%20.htm

Wisconsin: (Wisconsin Statutes 349.26)
http://www.legis.state.wi.us/2009/data/SB321-ASA1.pdf

Wyoming: (Wyoming Statutes 31-5-1701, 31-1-101)
http://legisweb.state.wy.us/2006/Introduced/SF0078.pdf

10.0 APPENDIX B TABLE OF MANUFACTURERS

Manufacturer	Model/Year	no of passenger	no of doors	Seatbelts positions	curb weight (lb)	GVW (lb)	Payload Capacity (lb)	length (in)	Height (in)	Width (in)	Wheelbase (in)	range (miles)	Maximum Speed (mph)
Ford Th!nk	Ford Th!nk Neighbor/02	4	none	4	Design 1392 Delivered 1431	2300	899	114.1	67.7	56.4	77.9	38.6	25
Frazer-Nash	Fazer-Nash CityCar/01	4	4	4	Design 1954 Delivered 1961	2593	640	122	62	66	86.6	30.9	24.6
GEM	GEM e4/05	4	2	4	Design 1271 Delivered 1539	2100	561	131.1	69.1	57.7	102.1	40.5	24
Miles Electric Vehicles	Miles ZX40S-AD/08	4	4	4	Design 2350 Delivered 2365	2998	633	134	67	58	92.9	63	24.9
Columbia Parcar	Parcar 4-pasenger/02	4	none	4	Design 1362 Delivered 1452	2460	1100	119	74	44.3	89	47.1	23.3
ZENN Motor company	ZENN 2 passenger/08	2	2	2	Design 1200 Delivered 1404	1807	403	120.8	55.9	58	81.8	64.6	25
Dynasty electric vehicles ltd	IT' Sport	4	4	4	1450	2495	1150	140	63	60	90	30.4	24
Dynasty electric vehicles ltd	IT' Tropic	4	none	4	1450	2495	1045	140	63	60	90	30.4	24
GEM	2009 Peapod NEV	4	4	4	1290	2200	910	143.6	70.5	56.5	102	30	25
ZAP Truck (Utility vehicle)	ZAPTRUCK XL/09	2	2	-	-	2998	1900	159	76	60	82.5	30	25
Ruff and Tuff electric vehicles	NEV 4	4	none	-	1385	-	1000	132	73	50	102	-	25

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