VIRGINIA DEPARTMENT OF TRANSPORTATION

TRAFFIC ENGINEERING DIVISION

MEMORANDUM

GENERAL SUBJECT: Engineering & Administration	**NUMBER:** 370.0 **SUPERSEDES:** N/A
SPECIFIC SUBJECT: Variable Speed Limit Implementation Requirements and Guidance	**DATE:** 12/12/11 **SUNSET DATE:** N/A
DIRECTED TO: District Administrators Regional Operations Directors Regional Traffic Engineers Regional Transportation Operations Managers	**SIGNATURE:** State Traffic Engineer

Background

Variable Speed Limits (VSL) are speed limits that change based on road, traffic, and weather conditions. VSL systems enable transportation managers to dynamically change the posted speed limit to a more appropriate speed in response to prevailing conditions. This change in posted speed may be either regulatory or advisory in nature. This policy applies to regulatory VSL systems and may be used as guidance for advisory VSL systems. Typically, VSL are implemented for two reasons: congestion and weather. In congested conditions, variable speed limits have been used to successfully harmonize traffic such that throughput can be maintained without a degradation to stop and go traffic. The reduction in speed prior to a queue can also reduce rear end crashes.

Where visibility is diminished or poor weather conditions prevail, speed limits are reduced to suggest or require a safe driving speed. This is particularly helpful where the weather condition is not expected, such as in a sudden fog situation, and where the drivers need guidance in selecting a safe speed which is often indicated by wide variations in operating speeds.

The authority to set VSL is given in the *Code of Virginia Section 46.2-881.* This memorandum outlines the requirements and provides general guidance on how that authority is to be implemented for new installations. Given the complex nature of traffic management, it is not meant to consider every situation that may occur. The engineer must utilize his or her best judgment.

Governing Documents

Code of Virginia Section 46.2-881. It shall be unlawful to drive any motor vehicle, trailer, or semitrailer on any public bridge, causeway, viaduct, or in any tunnel, or on any interstate at a speed exceeding that indicated as a maximum by signs posted thereon or at its approach by or on the authority of the Commonwealth Transportation Commissioner.

The Commonwealth Transportation Commissioner, on request or on his own initiative, may conduct an investigation of any public bridge, causeway, viaduct, tunnel, or interstate and, on the basis of his findings, may set the maximum speed of vehicles which such structure or roadway can withstand or which is necessitated in consideration of the benefit and safety of the traveling public and the safety of the structure or roadway. The Commonwealth Transportation Commissioner is expressly authorized to establish and indicate variable speed limits on such structures or roadways to be effective under such conditions as would in his judgment, warrant such variable limits, including but not limited to darkness, traffic conditions, atmospheric conditions, weather, emergencies, and like conditions which may affect driving safety. Any speed limits, whether fixed or variable, shall be prominently posted in such proximity to such structure or roadway as deemed appropriate by the Commonwealth Transportation Commissioner. The findings of the Commissioner shall be conclusive evidence of the maximum safe speed which can be maintained on such structure or roadway.

The 2009 Manual of Uniform Traffic Control Devices (MUTCD) Section 2B.13, Paragraph 18: states that "A changeable message sign that changes the speed limit for traffic and ambient conditions may be installed provided that the appropriate speed limit is displayed at the proper times." In order to display the appropriate speed limit at the proper times, much thought and consideration must go into development of the VSL system. Speed limit influencing factors must be collected and evaluated to determine the appropriate regulatory speed limit and to display that speed limit at the proper time.

Investigation: The investigation, as required by the Code of Virginia, shall analyze and document corridor wide traffic flow characteristics and any related safety concerns. In addition, it shall provide an explanation as to how the use of VSL will impact both those traffic flows and safety concerns.

Requirements:

Operational Capabilities:

- The VSL subsystem shall be fully integrated into the Traffic Operations Center (TOC's) current operating software platform.
- A combination sign consisting of a static sign, continuously flashing lights and a changeable message board shall be placed prior to entering the VSL corridor. The static message shall read "Speed Limit May Vary Next XX Miles" with the changeable message board identifying the reason for the varied speed. Additional combination signs should be installed immediately after each interchange access point. A static sign with the message "End Variable Speed Limit" shall be placed prior to exiting the VSL corridor. The ROD should work with public affairs representatives and the local media to educate and inform the motorists of the system's purpose and their legal responsibilities as motorists driving within its boundaries.
- VSL signs shall use amber LED display technology when posting variable speed limits in response to low-visibility, fog-related conditions.

- VSL signs, cameras and communication equipment shall be designed and equipped with an uninterruptable power supply to minimize disruption during power outages. UPS shall be configured to operate the above equipment for a period of at least 6 hours.
- VSL sign structures can be installed on either span or shoulder mounted sign structures. If shoulder mounted structures are used then VSL signs shall be installed on both the right and left shoulders to increase visibility to drivers. When displaying variable speeds the same speed limit shall be displayed on both adjacent shoulder mounted signs.
- Differential speeds by lane are not recommended due to enforceability, compliance, and safety concerns, but will be considered for congestion management purposes provided the effect of such speeds on corridor operations and safety are thoroughly analyzed and the State Traffic Engineer approves their use. Additionally, deployment of differential speed limits shall require the use of sign structures capable of displaying an individual overhead VSL sign for each lane of travel.
- In order to generate higher levels of compliance, LED changeable message signs shall be used throughout the VSL corridor to inform motorists of the condition causing the change in speed. Changeable message signs shall be installed on either span or shoulder mounted sign structures.
- An algorithm shall be developed to determine the appropriate speed limit. The algorithm shall consider all relevant variables such as, but not limited to: data collection points, VSL sign locations, travel times between signs, posted speed limits, operating speeds, roadway geometry, roadway grade, visibility profiles, stopping distances and typical traffic flow variables. These inputs shall be used to determine the appropriate variable speed limits, duration times and change intervals. The algorithm shall be signed and sealed by the licensed PE developing it.
- When operationally feasible, speed limits should not be changed by more than 10 mph increments. The maximum VSL shall never exceed the roadway's previously posted maximum speed limit as documented in the below resolution.
- The locations and spacing of VSL and changeable message signs will be directly influenced by the algorithm parameters. However, it is expected that spacing should be between 0.5 and 2 miles. Signs should be located close enough to the detection device(s) triggering the speed limit so the speed accurately reflects the condition but far enough in advance to provide sufficient time for the driver to react to the message being displayed and reduce their speed accordingly.
- VSL corridors should be equipped with low light, pan, tilt, zoom cameras located to verify the event causing the change in speed. This imagery should be transmitted back to the local TOC for real time operator viewing and verification.
- VSL systems shall be designed to operate either automatically or semi-automatically and shall include operator concurrence and override capabilities.
- All regulatory VSL systems shall be capable of providing the actual posted speed limit to the Virginia State Police or other primary law enforcement agency in near real-time so that the posted speed limit can be enforced. Advisory VSL systems are not required to have this capability.
- All changes in displayed speed shall be documented in an easily searchable database. Documentation shall include reason for the speed limit change, speed limit change, duration of speed limit change, and VSL sign location(s) displaying change. *The Code of Virginia Section 46.2-878* requires the documentation to be filed in the Central Office. However, an acceptable alternative is to provide Central Office Traffic Engineering staff with readily available access.

Concept of Operations: Prior to developing a VSL system, an approved Concept of Operations is required in accordance with the latest versions of ANSI/AIAA G-043-1992 as detailed in Systems Engineering Guidebook for ITS V3.0-Section 8.4.5 Concept of Operations Template as provided in the US DOT, FHWA website at http:// www.fhwa.dot.gov/cadiv/segb/index.htm. This includes but is not limited to

- Scope – overview of system to be built.
- Referenced Documents – list of supporting documentation & other resources useful in understanding operations of system.
- User oriented operational description – how goals and objectives are accomplished. It describes strategies, tactics, policies and constraints.
- Operational needs – describes what the system needs to do that is not currently being done.
- System overview – describes scope of system to be developed, users of system, what it interfaces with, its states and modes, the planned capabilities, its goals and objectives and system architecture.
- Operational environment – describes physical operational environment in terms of facilities, equipment, computing hardware, software, personnel, operational procedures and support necessary to operate deployed system.
- Support Environment – describes physical support environment of the operational environment.
- Operational scenarios – Each scenario describes a sequence of events, activities carried out by the user, the system, and the environment.

Systems Requirements: Requires an approved System Requirements document in accordance with the latest version of IEEE Standard 1233 Guide for Developing System Requirement Specification as detailed in Systems Engineering Guidebook for ITS V3.0 –Section 8.4.6 Requirements Template as provided in the US DOT, FHWA website at http:// www.fhwa.dot.gov/cadiv/segb/index.htm. This includes but is not limited to:

- Scope of system or subsystem – full identification of system or subsystem.
- Requirements – functional, performance, interface, data, non-functional, enabling and constraints.
- Verification methods – identification of method for each requirement. (Demonstration, test, analyze, inspection)
- Supporting documentation – reference section for understanding of the requirements.
- Traceability matrix – table that traces requirements to higher level requirements or user requirements.

Approvals:

- VSL Documentation - Roadway Investigation, the Concept of Operations, the Systems Requirements and the algorithm to control the VSL system shall be approved by the Regional Traffic Engineer.
- The use of differential speeds by lane, if used, shall be approved by the State Traffic Engineer.
- Resolution - A resolution describing the VSL project, project limits, existing posted speed limits and referencing the approved roadway investigation, concept of operations,

systems requirements document and algorithm, shall be signed by the Commissioner. If VSL are advisory in nature then a resolution is not required.

References

- *Code of Virginia*, §§ 2.2-604 and 33.1-8
- *Code of Virginia*, §§ 46.2-870, 46.2-873.1, 46.2-873.2, 46.2-874, 46.2-878

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