



INTERMEDIATE REFERENCE LOCATION SIGNS



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INTRODUCTION

Finding the location of an accident on a roadway can be difficult, especially on roadways with few points of reference. Motorists and emergency responders need a tool to be able to communicate where an emergency has occurred. To aid with incident location and management, many states have installed reference signs every 1/10th mile along roadways. The Manual for Uniform Traffic Control Devices (MUTCD) defines these 1/10th mile markers as **Intermediate Reference Location Signs**.

Reference Location Signs or RLS (*Figure 1*) provide more location description than the mileposts (*Figure 2*) that appear on most state and interstate highways. Motorists are more aware of the RLS because they are seen multiple times in every mile. These signs mark regular 1/10th mile intervals indicating the distance traveled on a given roadway from a certain point (usually the southernmost or westernmost point on the highway).



Figure 2 – Milepost

Reference Location Signs provide a “street address” along a roadway that makes finding a location along a roadway easier. In the event of an emergency, disabled vehicle, roadway maintenance problem, or even a lost driver, RLS can be used consistently by respective agencies for preventing problems in information exchange. A study done by research engineer Jerry Pigman (University of Kentucky) has shown that these signs have been undeniably helpful to first responders (*Figure 3*).



Figure 1 – RLS showing direction, route, and mileage

This report provides information for developing a RLS system by describing:

- The benefits of having a RLS System;
- Existing designs and standards for RLS;
- The costs of establishing and maintaining a RLS system; and
- Adapting a RLS to Delaware’s roadways.

BENEFITS

The benefits of RLS affect many different people including emergency responders, maintenance crews, and ordinary motorists. The most important advantages of RLS are outlined below in four categories: incident response and management, motorist knowledge and safety, roadway maintenance, and intelligent transportation systems coordination.

Incident Response and Management

- RLS make the location of emergencies easier to pinpoint on the roadway
- Dispatchers can send emergency crews from the closest available agency
- Faster incident response and management keeps roadways safe and running smoothly
- Accident and police reports are consistent and accurate



Figure 3 – RLS aiding an incident

Motorist Knowledge and Safety

- Motorists can easily communicate their locations to emergency personnel
- Distance awareness prevents unfamiliar drivers from making dangerous maneuvers
- In the event of an incident, detour information can be communicated more effectively

Roadway Maintenance

- Road maintenance and service requirements are easier to locate and catalogue
- Removing debris, aiding disabled vehicles, and roadway servicing is more efficient because more time can be spent fixing the problem, not finding it
- Agencies like AAA and towing companies can use the signs to service their customers more efficiently
- By communicating exact locations of construction zones along roadways to motorists, construction crews and maintenance workers can be kept safe

Intelligent Transportation Systems (ITS) Coordination

- Dynamic Message Signs and Highway Advisory Radio broadcasts can refer to the RLS for important and precise information
- Knowing a precise location allows traffic management technicians to observe incidents with nearby traffic cameras
- Precise locations of permanent and temporary ITS equipment can be logged by using the RLS as a standard

STATE ADOPTED REFERENCE LOCATION SIGN SYSTEMS

Benefits to marking highways with RLS every tenth of a mile are proven. States throughout the nation have adopted Reference Location Signing systems to help keep their highways moving safely and smoothly, notably Pennsylvania, New York, and Indiana.

Pennsylvania

Recently the exits along the Pennsylvania Turnpike were renumbered to match the nearest milepost. At the same time, improved 1/10th mile markings were installed on delineator posts (*Figure 4*). These delineator markings are small (20 x 3 inches), and do not have the reflectivity that ordinary road signs do.

Figure 4 – Delineator post mile marker



Other roads in Pennsylvania including US 202, US 422, and I-76 are marked with a different 1/10th mile reference signs. The design in *Figure 5* is specific to the PENNDOT's District 6 (Philadelphia area).

Figure 5 – PENNDOT District 6 1/10th mile marker



New York

New York State uses smaller 1/10th mile markers (see *Figure 6*) placed on all NYSDOT maintained roads. The state calls these small placards Reference Signs. They are only 8 inches wide by 10 inches tall and are mounted on posts, guardrails, and permanent structures along the roads.

Figure 6 – NYSDOT reference sign



Indiana

Indiana has installed markers every 2/10th of a mile (*Figure 7*) in major urban areas as part of its advanced incident management system, *TrafficWise*. The *TrafficWise* system combines its own service personnel with emergency services and Intelligent Transportation Systems (ITS). RLS are an important piece in this very advanced roadway control network. Motorists utilize RLS to accurately identify the location of an incident which will be managed by *TrafficWise*. In addition to mile location, the Indiana RLS include route shield and direction of travel.

Figure 7 – Enhanced RLS



Other States

Tennessee and Ohio have established similar unified highway incident management systems and have installed Enhanced RLS in 1/10th and 2/10th mile intervals along interstate and state roads in urban areas. Their programs have experienced similar success to Indiana's *TrafficWise*, and

both states are beginning to expand their use outside of urban areas. In New Jersey, both the New Jersey Turnpike and the Garden State Parkway are marked with 1/10th mile markers.

Interstate routes in Maryland are signed every 1/10th mile with reference signs. A separate system in Maryland called the Highway Location Reference logs specific roadway features like pavement type, drainage structures, intersections, bridge structures, and railroad crossings by mile point. These features are organized by their decimal mile distances on their roadway. These Highway Location Reference mile points are not posted however.

SIGN PLACEMENT

Pennsylvania, New York, and New Jersey all place their markers on the right shoulder of the road. This helps prevent drivers from crossing a roadway in order to read a sign and makes sign maintenance easier and less disruptive to traffic flow.

Tennessee and Indiana have many of their markers placed “back to back” on highways with narrow medians, sometimes fixing them to the concrete barriers. This is advantageous because a motorist traveling in either direction may find their location by looking in front of or behind them.

The MUTCD (2003 edition) defines standards for Reference Location Signs. It provides guidance to the nation as more states install RLS and includes placement detail and sign styles. The MUTCDs standards are followed in many states for road signs and pavement markings, and its options and suggestions allow flexibility based on each state’s roadway conditions. Examples from the MUTCD of a standard, option, and guidance for RLS are:

“Standard: Except as provided in the option below, reference location signs shall be installed on the right side of the roadway.

Option: Where conditions limit or restrict the use of Reference Location Signs on the right side of the roadway; they may be installed in the median...

Guidance: If a reference location sign cannot be placed within 15 m (50 ft) of the correct location, it should be omitted.”

The MUTCD also provides specifications for the numbering of RLS. On north/south routes, the MUTCD recommends starting at the south end of a road (with mile 0) and increasing as the driver travels northbound. On east/west routes, the MUTCD recommends beginning with the westernmost point (with mile 0) and increasing as the driver moves eastward. This means that RLS on SR 1 should increase in numerical value moving from Fenwick Island towards I-95.

It should also be noted that Reference Location Signs are normally only placed on limited-access roadways. Ohio, Tennessee, Indiana, and Maryland have only installed RLS on limited-access or interstate highways. New York State is an exception with markers installed on all NYS DOT maintained roads. Full-access roadways have existing points of reference such as street addresses, commercial buildings, and roadway intersections. These natural reference points take the place of RLS. US 202 is a limited-access road that becomes full access south of West Chester, PA, comparable to SR 1 becoming a full-access road south of Dover. PENNDOT did not install RLS on the full-access portion of US 202 because it passes through a commercially populated area with many intersections and street addresses.

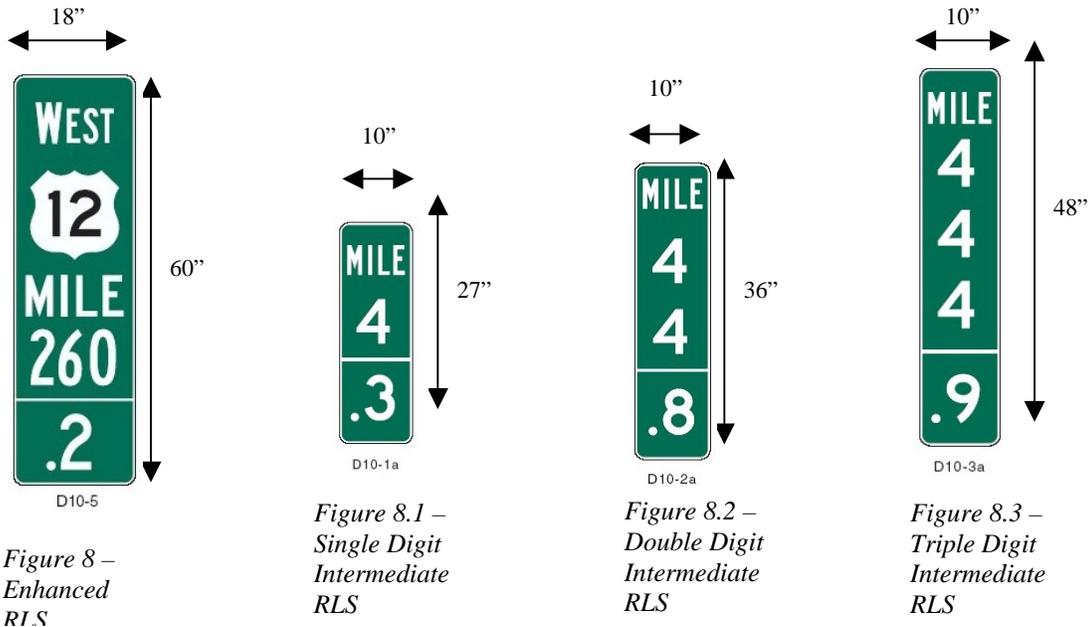
If it is desired to place RLS along a full-access road, smaller signs (like the delineator posts) could be used, or an increased sign interval could also be utilized to save money. New York State's reference markers are much smaller than the Enhanced or Intermediate Reference Location signs used in Ohio and Indiana, and they are less expensive. However, increasing the interval of placement decreases the location precision dispatchers can provide. Delineator post markers, though small and inexpensive, have a high maintenance cost because they need to be replaced often (see page 11).

REFERENCE LOCATION SIGN STYLES

The 2003 MUTCD specifies dimension and formatting standards for two styles of 1/10th mile markers: the **Intermediate RLS** and the **Enhanced RLS**. The first sign in *Figure 8* is an Enhanced RLS. It is called Enhanced because not only does it display a decimal mile distance but it also features a colorized route shield and indicates the direction of travel. The three signs shown to the right are variations of the Intermediate RLS, each with a single, double, or triple whole mile digits (*Figures 8.1 to 8.3*). Ohio, Tennessee, and Indiana have based their signs on the Enhanced RLS example.

The MUTCD specifies the bottom of the sign must be mounted at least 4 ft above the road surface, therefore establishing that the smallest sign be over 6 feet tall. The manual also mentions the sign color. Enhanced Reference Location Signs can be either green or blue but Intermediate Reference Location Signs can only be green. Complete design details can be found in a FHWA publication, the Standard Highway Signs Book.

MUTCD Specified Signs



The Enhanced RLS provides the most information to the motorist including the route number, direction of travel, and location by 1/10th mile. In an emergency situation the driver can read directly down the sign to an operator to provide his or her exact location. This is especially useful for motorists who are unfamiliar with the area they are traveling in or for those who may be panicking from the experience of an accident.

The Intermediate RLS is a simpler sign that provides only the location by 1/10th mile. This sign assumes that the motorist knows the road he or she is traveling on, or can rely on other signs in the area for this information. Pennsylvania and New Jersey use signs

that resemble the Single, Double, or Triple Digit Intermediate Reference Location Signs. Both states claim success at identifying incident location with these signs.

Figures 9 and 10 represent the MUTCD’s two styles of Reference Location Signs with descriptive tags. The first is the single digit Intermediate RLS and the second is the slightly modified Enhanced RLS used by Ohio.

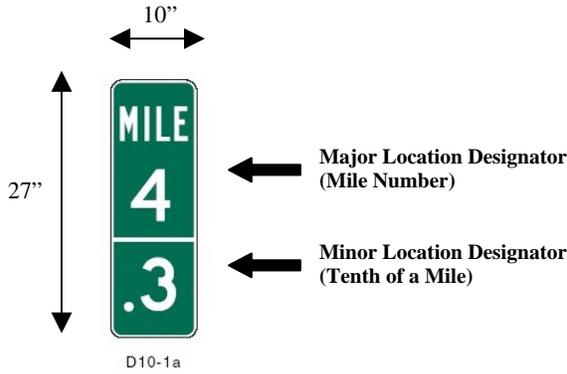


Figure 9 – Intermediate RLS



Figure 10 – Ohio’s Enhanced RLS

Another style example is the one used by New York State. New York uses a sign that differs from those specified in the MUTCD on some of their roads (Figure 11). In addition to the mile and 1/10th mile, these markers include route number, New York State region number, county number, and county route division number. These signs are more difficult for the motorist to see and read than the signs specified in the MUTCD. The meanings of the numbers shown are not intuitive and they are difficult to distinguish at a distance or when moving. While emergency personnel or roadway crews may understand this sign, motorists may find it challenging to interpret.



Figure 11 –
NYSDOT
Reference Sign

SIGN COSTS

Sign costs vary depending on the style of sign desired. The following figures show the cost of the sign and materials, construction, as well as installation fees:

- The Ohio Department of Transportation spent \$800,000 installing 10,000 Enhanced RLS on over 700 miles of highway (**\$1,140 per mile**).
- Tennessee's Department of Transportation provided that \$429,000 was spent installing Enhanced RLS for 226 miles of highway (**\$1,902 per mile**).
- The Indiana Department of Transportation spent \$182,000 installing 1190 Enhanced RLS over 120 miles of highway (**\$1,530 per mile**).

Producing the Pennsylvania Turnpike's less durable delineator post markers cost about **\$18 per sign** in 2005. PENNDOT's District 6 markers were contracted for construction and installation to be **\$45 per sign** the same year. This price can be used to represent the cost of fabricating and installing the Intermediate RLS, as the signs are similar in size, style, and construction.

Enhanced RLS are expensive to produce because of the multi-colored route shield. Four or five layers of Scotchlite are needed for the colors on one sign, making for a much more time consuming and costly production than a sign with only two colors. Though PENNDOT's District 6 marker and the Intermediate RLS use the same kind of mounting hardware as the Enhanced RLS, there exists a cost difference in this case too. A heavier gauge Channel Bar Post and other stronger hardware is required to support such a large sign as the Enhanced RLS which can be easily damaged by wind stress or snow from a plow. Installation costs are increased when lanes of traffic need to be closed or when special mounting hardware (like anchor bolts needed to mount a sign on a concrete barrier) is required.

SIGN MAINTENANCE

Common causes for sign maintenance and replacement come from mowing vehicles, snow removal, motorist impact, vandalism or other highway maintenance work. Departments of Transportation will normally replace the signs when they are struck or missing. An official of the Ohio Department of Transportation stated that typically 5 percent of the total cost is added annually for replacement signs. Pigman's research at the University of Kentucky inventoried Enhanced RLS within the study area and returned the following data:

- Cincinnati and Northern Kentucky: 71 signs missing out of 2214 (**3.2%**)
- Lexington-Fayette County: 19 signs missing out of 634 (**3.0%**)
- Louisville and southern Indiana: 32 signs missing out of 939 (**3.4%**)

On average only **3.2%** of the signs installed were found to be missing during the summer of 2000 when this inventory was taken. The Pennsylvania Turnpike Commission stated that annually as many as **25%** of the delineator post markers must be replaced. These smaller plastic markers are especially susceptible to damage from snowplows and mowing vehicles.

Installing the mile reference signs on concrete medians (like Tennessee and Indiana) or fixing them to other signs or structures eliminates their chances of being damaged by mowing vehicles. The maintenance for these signs can be challenging however, especially when mounted on a narrow concrete median. The Enhanced RLS specified by the MUTCD is 18 inches wide. When mounted on concrete barriers with a 9-inch wide top, 4.5 inches of the sign hang over on either side. This overhang makes the sign a target for oncoming trucks or other large vehicles. Ohio uses a slightly modified Enhanced RLS that is smaller than the MUTCD specified sign, helping to alleviate this problem.

CONSIDERATIONS

When determining the proper sign to use for the state of Delaware, there are many considerations including cost, appearance, and functionality. These signs need to be effective in locating incidents, cost efficient, and aesthetically pleasing on Delaware’s roadways. Signing must also be consistent throughout the state.

Installing RLS along SR 1 will serve as an example for the installation of signs across the remaining roadways in Delaware. SR 1 is 90 miles long, equating to 22% of Delaware’s interstate, freeway, and principle arterial road mileage. As signs are necessary on both the southbound and northbound sides of the road, there are 180 miles of roadway to be signed.

Deciding upon the style of the sign and the interval distance between signs will ultimately determine the cost of the project. There are advantages and disadvantages to both the Intermediate and Enhanced RLS as well as placing the signs at 1/10th mile intervals or 2/10th mile intervals. These advantages and disadvantages are listed in *Figures 12* and *13*. The state must determine the combination of Reference Location Sign options that will provide the most public benefit.

Summary of Sign Style Considerations	
Intermediate RLS	Enhanced RLS
 <ul style="list-style-type: none"> • Necessary distance information provided: mile location only • Relies on other signs for the road name and travel direction • More practical and economical due to smaller size • More easily produced and replaced 	 <ul style="list-style-type: none"> • Most descriptive information for motorists: roadway, direction, and mile location • Heavier hardware is needed to support the sign • May appear to clutter the roadway • More difficult and expensive to manufacture
<p>Recommendation: Intermediate RLS because they provide key location information in the most economical way.</p>	

Figure 12

Summary of Interval Considerations	
1/10 Mile	2/10 Mile
<ul style="list-style-type: none"> • There is a sign every 528 feet • Signs are quickly accessible in an emergency • Most accurate location identification 	<ul style="list-style-type: none"> • There is a sign every 1056 feet • Sign spacing becomes too great if a sign is missing • Half as expensive because half the signs are in place
Recommendation: 1/10 RLS because they occur more often giving the most accurate location description, even in the event of a missing sign.	

Figure 13

Figure 14 provides estimates of the costs associated with installing RLS along the limited-access portion of SR 1 (from I-95 to Dover), a distance of approximately 40 miles. Any data represented in the figure has either previously been provided, or has been determined from data that has been provided. The cost per sign for the Enhanced RLS is an average value determined from the cost per mile data given (see page 10). Because the Intermediate and Enhanced RLS use similar mounting hardware, the same replacement percentages have been assumed. These costs are estimates only, tabulated for comparison purposes.

Cost Estimates for Limited-access SR 1 From I-95 to Dover					
Sign	Cost Per Sign	Mile Interval	Total Cost	Annual Sign Replacement Percentage	Annual Maintenance Cost
Enhanced RLS	\$153.00	1/10	\$122,400.00	3.20%	\$3,916.80
		2/10	\$61,200.00		\$1,958.40
Intermediate RLS	\$45.00	1/10	\$36,000.00	3.20%	\$1,152.00
		2/10	\$18,000.00		\$576.00
Delineator RLS	\$18.00	1/10	\$14,400.00	25.00%	\$3,600.00
		2/10	\$7,200.00		\$1,800.00

Figure 14

SUMMARY AND RECOMENDATIONS

MUTCD Standards

The MUTCD standards can be easily adapted to the needs of Delaware. Following these standards will save the state money because the signs the MUTCD specifies are already designed. They will most likely be available pre-fabricated by some contractors or other Departments of Transportation. Purchasing a manufactured template will be less expensive to the state than designing a new sign and having it produced. These standards will also help to maintain state-to-state signing consistency.

Intermediate RLS

The Intermediate RLS are recommended because of their simplicity. They are not as large as Enhanced RLS and are more cost effective to produce and replace at about \$45 per sign. The MUTCD mandates the color green, which complements a natural background while still being visible to motorists.

1/10th Mile Interval

A marker interval of 1/10th mile is recommended because it will provide the most accurate location description for a motorist who is in need of assistance. It is more expensive to place markers every 1/10th of a mile but no counterpoint can deny the placement of a marker that enables emergency personnel to arrive as quickly as possible. The spacing is also small enough that in the event of a missing sign there is still minimal distance (1056 ft) between remaining RLS.

Having stated the reasons above, it is recommended that the MUTCD specified Intermediate Reference Location Signs be installed every 1/10th mile along SR 1 (Figure 14). The installation of these markers will improve accident and emergency location and response times, assist more motorists, and keep SR 1 moving smoothly. With success on Route 1, the Reference Location Sign system will serve as an example of how these signs will benefit the entire state.



Figure 15 – Intermediate RLS

REFERENCES

- Indiana Department of Transportation. TrafficWise. *Highway Signs Help Motorists Navigate Indiana Interstates*. Retrieved July 7, 2005 from http://www.state.in.us/dot/motoristinfo/trafficwise/about_milemarker.html
- Maryland State Highway Administration. *State Highway Location Reference*. Retrieved July 26, 2005 from <http://www.sha.state.md.us/>
- Ohio Department of Transportation. *New Signs to Save Lives, Reduce Freeway Congestion*. (22 May, 2003). Retrieved July 7, 2005 from <http://www.dot.state.oh.us/news/2003/05-22-03Signs.htm>
- Pennsylvania Turnpike Commission. *PA Turnpike Interchange Renumbering*. Retrieved July 15, 2005 from <http://www.paturnpike.com/geninfo/intrenum/intrenum.aspx>.
- Perry, N. W. 2003. *Empire State Roads, Little Green Signs*. Retrieved July 7, 2005 from <http://www.empirestateroads.com/rm/>
- Pigman, Jerry G. (2000). *Evaluation of Reference Markers*. Retrieved July 14, 2005 University of Kentucky, Kentucky Transportation Center. Research Web Site: http://www.ktc.uky.edu/RepPubRecently_Authors.htm
- United States Federal Highway Administration. *Manual on Uniform Traffic Devices* 2003 ed. Pittsburg, PA: U.S. Government Printing Office, 2003. Retrieved July 7, 2005 from <http://mutcd.fhwa.dot.gov/>
- United States Federal Highway Administration. *Standard Highway Signs Book* 2004 ed. Pittsburg, PA: U.S. Government Printing Office, 2004. Retrieved July 7, 2005 from http://mutcd.fhwa.dot.gov/ser-shs_millennium.htm