

Best Practices for Optimal Use

RoadQuake[®]

Temporary Portable Rumble Strip



Innovations for Safety™



Best Practices: An Introduction

Evolution of RoadQuake® Temporary Portable Rumble Strip:

In 2009, Plastic Safety Systems (PSS) introduced a revolutionary traffic safety countermeasure, RoadQuake® Temporary Portable Rumble Strip (RQ TPRS).

RQ TPRS, designed to reduce accidents and save lives, alerts drivers, especially distracted drivers, to changing road conditions, like upcoming work zones.

RQ TPRS is one of the very few traffic control devices that communicates to several senses. Unlike an arrow board, portable changeable message sign, or traffic control sign, which communicate to drivers through sight only, RQ TPRS alerts drivers through sight, feel, and sound.

RQ TPRS is a transverse rumble strip, installed perpendicular to the direction of travel, with the purpose of alerting the drivers' three senses, as follows:

- **See** an array of strips across the road
- **Feel** the vibration caused by tires travelling over strips that measure ¾" tall
- **Hear** the familiar bumpety-bump, thumpety-thump sound of tires travelling over rumble strips

Sound and vibration generated by RQ TPRS are significant: a 2009 study by the University of Kansas Transportation Center determined that RQ TPRS conveys sound and vibration at levels similar to ground-in, or milled, permanent rumble strips.

From the earliest days of product development, PSS strove to design a temporary countermeasure that alerts drivers. Meaning, the temporary device must alert drivers and conform to the surface of the road, without the need for adhesives or fasteners. The temporary countermeasure must also show little movement when in use. Last, it must perform effectively in the extremes of hot and cold temperatures.

As of this writing, August, 2015, PSS has tested 65 different versions of RQ TPRS. We continually seek to improve a device that is already an effective countermeasure, so that its implementation is near-universal.

However, even revolutionary life-saving countermeasures have their limits.

Best Practices: An Introduction, continued:

We have discovered those limits from testing RQ TPRS in hundreds of thousands of vehicle impacts:

- at various speed limits
- on different types of road surfaces
- in hot and cold, dry and rainy weather
- in a multitude of daily traffic counts
- and the mix of truck to passenger vehicle therein

From our continual testing procedures, we've developed an extensive body of knowledge, and consider ourselves a leading authority in the manufacture, design and performance of transverse TPRS.

From that knowledge, we have developed and now present our **"Best Practices" Guide** for the optimal use of RQ TPRS.

Purpose of our Guide Book:

We produced our Best Practices Guidebook to provide users with:

- the safest-known methods to deploy RQ TPRS
- the information necessary to achieve optimum performance

In our guidebook, the reader will find information PSS has obtained through internal field-testing. To that knowledge, we have added information derived from users' field experiences in active work zones.

That said, our recommendations are just that. They may not be appropriate for all applications. State DOT Traffic Plans and engineering judgment should prevail, with worker safety always the foremost priority.

We trust users will consider our guidebook an accurate source of practical information for the optimal use of RQ TPRS, and a worthy complement to the personal field training we offer.





Best Practices for Optimal Use of RQ TPRS:

Engineering judgment, as defined in *MUTCD*, 2009 Edition, is “the evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device.”

PSS recommends that engineering judgment prevail in any decision to use RQ TPRS.



I.) Prior to Deployment:

A.) Examine the deployment site:

Determine whether RQ TPRS will perform effectively at the site.

- Identify the road surface: Use RQ TPRS on asphalt or concrete, free of stone, gravel and debris.
- Do not use RQ TPRS on these roads or surfaces:
 - Surface with fresh seal coat
 - Bleeding asphalt
 - Soft pavement, like fresh asphalt
 - Heavily rutted road
 - Gravel or stone road
- Do not use RQ TPRS on horizontal curves. The force and angle of the vehicle traveling in the curve could force strips to move to the outside of the curve.
- Identify traffic speeds in advance of, and at, the work site. RQ TPRS should perform effectively in speeds up to 80 MPH.
- RQ TPRS will perform on roads with slopes, but the strips will move more when downhill than when on relatively flat roads. And, the steeper the slope, the more the strips will move. Engineering judgment should prevail in this application.

I.) Prior to Deployment, continued:

B.) Educate and train the on-site work force:

Topics to cover about RQ TPRS:

- Purpose of RQ TPRS: features and benefits
- How RQ TPRS serves as an audible warning device for workers
- Why motorcycles can safely traverse RQ TPRS
- How to deploy and remove RQ TPRS, per our *Best Practices Guide* book

Please contact your PSS Roadway Safety Consultant to schedule training.

II.) Transport of RQ TPRS:

Several options are of course available for the transport of RQ TPRS to and from the job site. PSS recommends that users plan in advance, as TPRS devices can occupy significant space in a service vehicle.

To alleviate any space limitations, PSS designed the RoadQuake® 2F CRIB™ Cargo Carrier. Introduced in June, 2015, CRIB is a fully integrated cargo carrier designed specifically for the transport, deployment, removal and storage of RoadQuake® 2F TPRS.

At the same time, PSS introduced RoadQuake® T-Handle™, a tool with which workers can more easily lift and carry RQ TPRS.

Please contact your PSS Roadway Safety Consultant for a demonstration of CRIB and T-Handle.



III.) Array Configuration and Placement:

A.) Number of Strips in An Array:

PSS developed the first RQ TPRS in 2006, and introduced the first production version in early 2009.

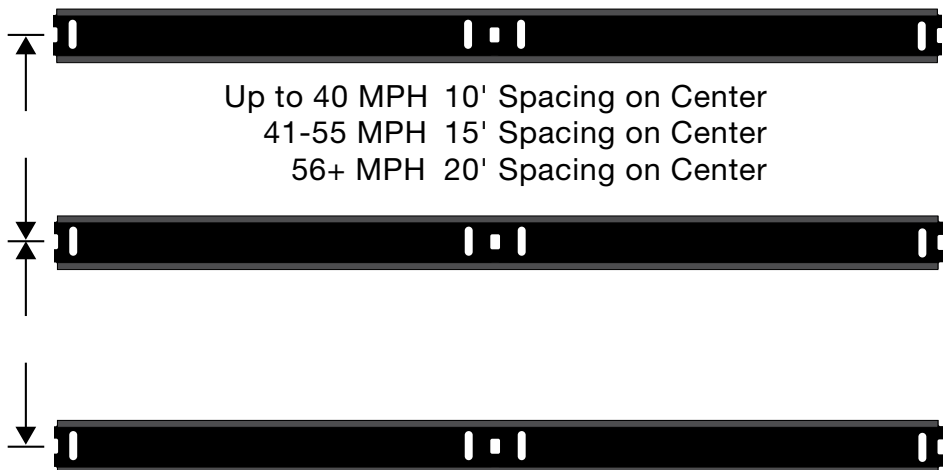
With almost 10 years of experimentation and testing, 6 years of observation in active work zones, and with 2 university studies as support, PSS has determined that 3 rumble strips per array are sufficient to alert drivers to changing road conditions. Three strips, properly spaced, alert drivers with sufficient sound and vibration so that they refocus on their driving.

As always, follow state DOT Traffic Control (TC) Plans as to the number of strips per array. Absent a TC plan, PSS recommends 3 rumble strips per array.

B.) Spacing of Strips in an Array:

In the absence of a TC plan, PSS recommends spacing between strips, based on posted speed limits at the deployment location, as shown below:

Spacing between Strips



III.) Array Configuration and Placement, continued:

C.) Number of Arrays in a Work Zone:

With the experience stated above, PSS recommends the placement of 2 each RQ TPRS arrays **per travel direction** in advance of changes in road conditions. Two arrays should sufficiently alert drivers, especially distracted drivers, to those changing road conditions.

Traveling over the first array, the car produces sound and vibration designed to alert the driver and make them aware of their surroundings and changing road conditions. Independent research shows that drivers passing over RQ TPRS slow down an average of 3 to 5 MPH, as they refocus their attention on driving. And, they may even see the advanced warning signs nearby.

It could be argued that the 2nd array is even more important than the 1st:

The 2nd array warns drivers that:

- the 1st array is not debris on the road
- the 1st array has been deployed intentionally
- they will soon approach the change in road condition
- they must soon take action
- they should not accelerate as they approach the changing road condition

The 2nd array also warns on-site workers, especially flaggers, that traffic is approaching.

As always, follow state DOT TC Plans for the number of arrays in a work zone. But again, absent a TC plan, PSS recommends 2 arrays **per travel direction**.

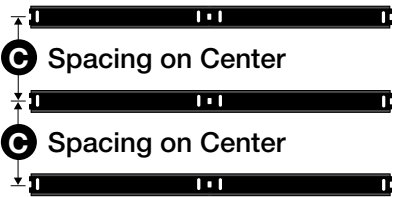


Recommended Placement of RQ TPRS Arrays

One Lane Closure on a 2 Lane Highway

Showing 1 direction only

Speed	B Distance	C Spacing
To 40 MPH	120'	10'
41-55 MPH	160'	15'
56+ MPH	200'	20'

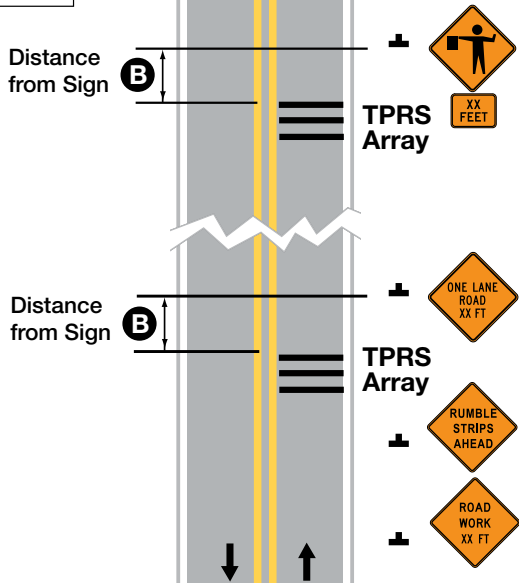


C Spacing on Center

C Spacing on Center

C Spacing on Center

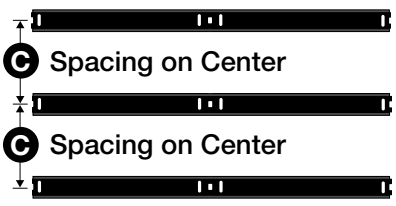
Follow state DOT Traffic Control Plans for sign and lane taper spacing.



Follow state DOT TC plans where available.

Double Lane Closure on a 3 Lane Freeway

Speed	B Distance	C Spacing
To 40 MPH	120'	10'
41-55 MPH	160'	15'
56+ MPH	200'	20'

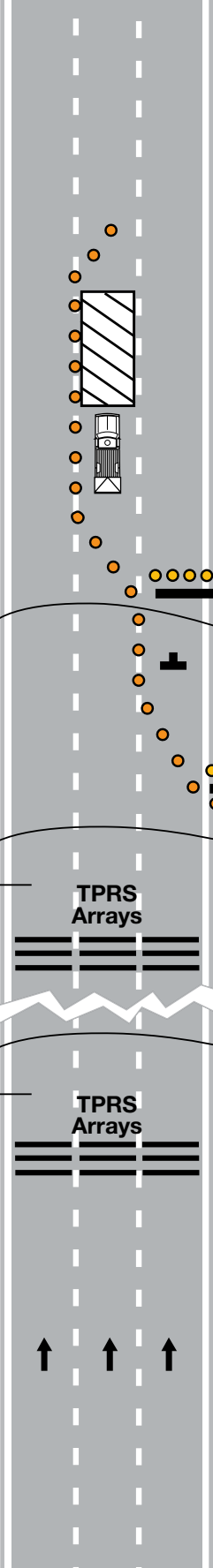


C Spacing on Center

C Spacing on Center

C Spacing on Center

Follow state DOT Traffic Control Plans for sign and lane taper spacing.



Distance from Sign **B**

Distance from Sign **B**

Follow state DOT TC plans where available.



IV.) Deployment of RQ TPRS Arrays:

A.) Protection of Workers:

- Where available, follow state DOT specifications and TC plans for the deployment and use of RQ TPRS arrays.
- Always deploy temporary traffic control (TTC) devices, specified by state DOT traffic plans, to protect workers during deployment of RQ TPRS arrays.
- PSS recommends, where appropriate, that workers use the “Rolling Stop” method to clear travel lanes for deployment of RQ TPRS arrays.
- PSS also recommends the use of police vehicles, and vehicles equipped with truck-mounted attenuators (TMA), to protect workers during deployment. Placed in the travel lanes upstream of the deployment location, both police and TMA vehicles can protect workers in the travel lanes better than service vehicles.



B.) Advance Warning Signs:

- Where available, follow state DOT specifications and TC plans for the deployment and use of RQ TPRS arrays.
- PSS recommends the deployment and use of “Rumble Strips Ahead” Warning Signs with RQ TPRS arrays. The signs alert drivers who are monitoring warning signs that the arrays are supposed to be on the road, not hazards to be avoided.
- Follow state DOT TC plans to determine proper signage placement.
- Where there is no TC plan, or where the plan does not specify “Rumble Strips Ahead” signs, please follow recommendations shown in drawings, “PSS Recommended Placement of RQ TPRS Arrays”, on pages 8 and 9.



IV.) Deployment of RQ TPRS Arrays, continued:

C.) Site Preparation:

- Determine the proper location from which to deploy RQ TPRS. The safety of the worker is paramount. PSS recommends the use of shoulder or berm whenever available.
- Prior to deployment, sweep area clear of gravel and other debris. Gravel, stone or other debris may prevent the strips from making contact with the road surface, causing excessive movement of the strips.
- Prior to deployment, determine the proper spacing between strips, as specified in the state DOT TC plan. If a plan is not available, see pages 6, 8 or 9 for PSS recommendations.
- To reduce deployment time, mark the pavement with a line, perpendicular to traffic, to identify the placement of each strip. PSS recommends temporary paint marking.

D.) Preparation of Strips:

PSS manufactures 2 versions of RQ TPRS.

RoadQuake 2F TPRS is a one-piece device, and requires no assembly.

RoadQuake 2F folds for easier transport. Workers can either unfold RoadQuake 2F and then carry strips to the deployment location, or carry strips folded to the location, and then unfold them in the travel lane.

RoadQuake 2 TPRS is a modular device; 3 sections make 1 strip. As such, RoadQuake 2 requires assembly. (See PSS publication, *Temporary Portable Rumble Strip Product Guide*, May, 2015 edition or later, for assembly instructions.)

Workers can assemble RoadQuake 2 on the shoulder of the road, or in the protected travel lane.

E.) Deployment of Strips:

With “Rolling Stop” in operation, traffic control in place, advanced warning signs installed, and the service vehicle with RQ TPRS parked adjacent to the deployment location:

- 1.) remove RQ TPRS from the service vehicle
- 2.) walk strips to the marked lines on the pavement
- 3.) lay strips in place



V.) Monitor Deployed RQ TPRS Arrays:

A.) RQ TPRS is a TTC Device:

MUTCD, 2009 Edition, Section 6B.01, Guidance, 4C, states:

“TTC zones should be carefully monitored under varying conditions of road user volumes, light, and weather to check that applicable TTC devices are effective, clearly visible, clean and in compliance with the TTC plan.”

RQ TPRS is a TTC device, and should be monitored like all other TTC devices within a TTC zone.

B.) RQ TPRS will move:

Several variables can contribute to the movement of RQ TPRS:

- Average Daily Traffic (ADT)
- mix of types of vehicles
- work zone speed limit
- road surface or slope



PSS recommends that users monitor RQ TPRS arrays for movement, and return strips to their original positions, as needed.

C.) Monitoring for Movement:

Each roadway is different; the variables of each roadway are different. As such, PSS will not recommend a uniform monitoring schedule. We do know that users should always, always, always monitor TPRS arrays.

PSS recommends:

- Users closely monitor the arrays at the very beginning of the project, adhering to a continual, strict schedule, with little time between visits.
- Users can then better estimate the period of time that elapses between installation and the time any strip moved beyond an allowable length. See Pages 14-15 for movement allowances.
- This time period becomes the monitoring schedule for the project. In no case, however, should the time period exceed 4 hours.
- Users should maintain a log book of their monitoring activities. A logbook will help develop history of RQ TPRS array performance on that project. That history will also provide a record if concerns about RQ TPRS array performance should arise.

V.) Monitor Deployed RQ TPRS Arrays, continued:

D.) Monitoring for Changes in Traffic Queue:

RQ TPRS arrays effectively alert drivers to changes in road conditions, like a lane closure, or slowing or stopped traffic. They lose effectiveness if the traffic queue builds downstream of their location.

Users should constantly monitor the length of queue. If the end of the queue approaches the RQ TPRS arrays, recalculate the new position for the arrays and re-deploy them.

E.) Repositioning TPRS Arrays:

If a strip requires repositioning, due to movement, workers should follow the same procedures as with the original deployment.

If engineering judgment dictates that ADT is so high that there are no gaps in traffic for workers to reposition strips, thus making that task exceptionally hazardous, then TPRS arrays should be considered inappropriate for use in that situation.

F.) Driver Avoidance:

Though rare, PSS has received reports of drivers who have attempted to avoid driving over an array by driving around it. This action by the road user may be considered unsafe, but it usually indicates a cognizant action by a driver that is not distracted.

PSS recommends the placement of at least 1 each TTC device, like a plastic traffic drum or 42" channelizer, at each side of an array. Drivers will then know they are to proceed over the array.

Do not place vehicles or workers adjacent to TPRS arrays.



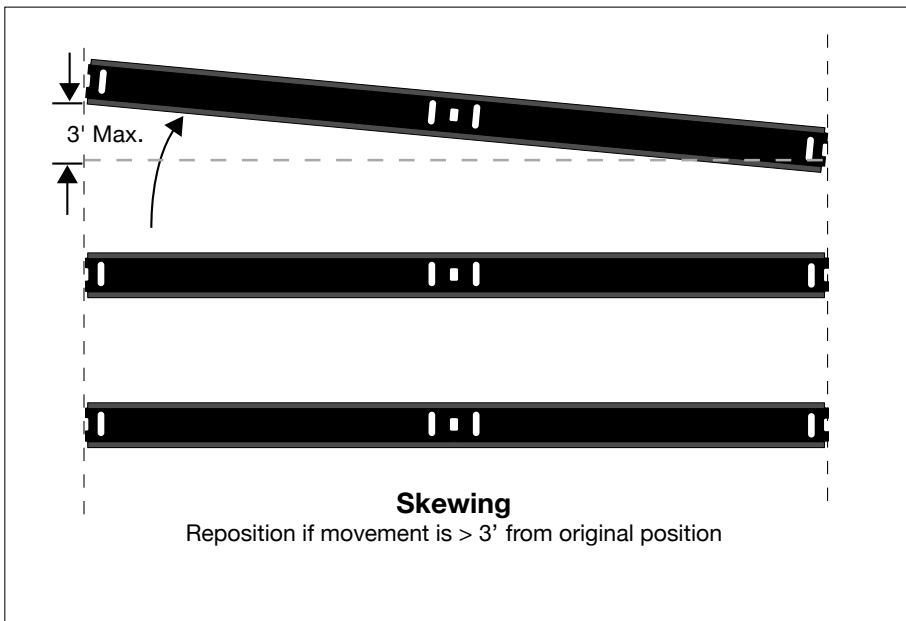
V.) Monitor Deployed RQ TPRS Arrays, continued:

G.) Types of Movement and Maximum Allowances:

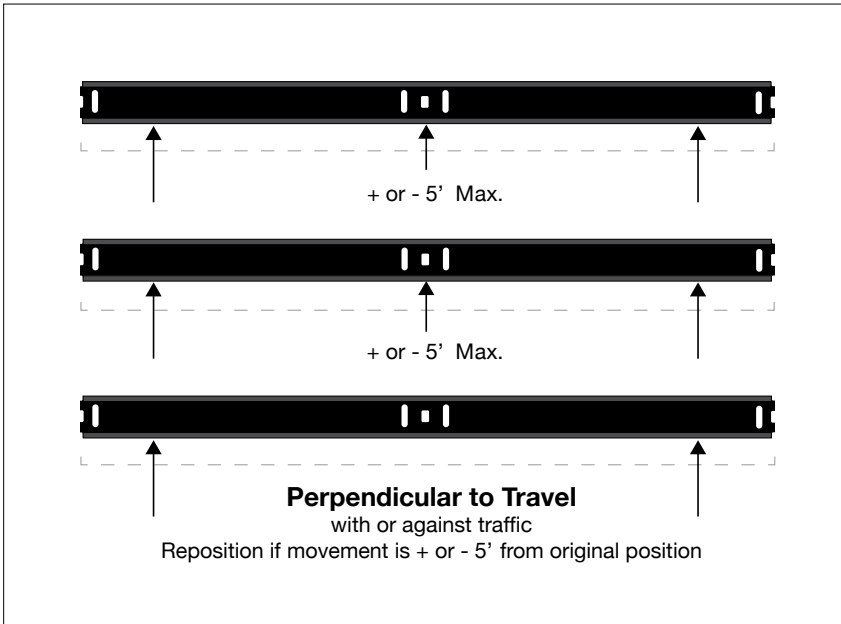
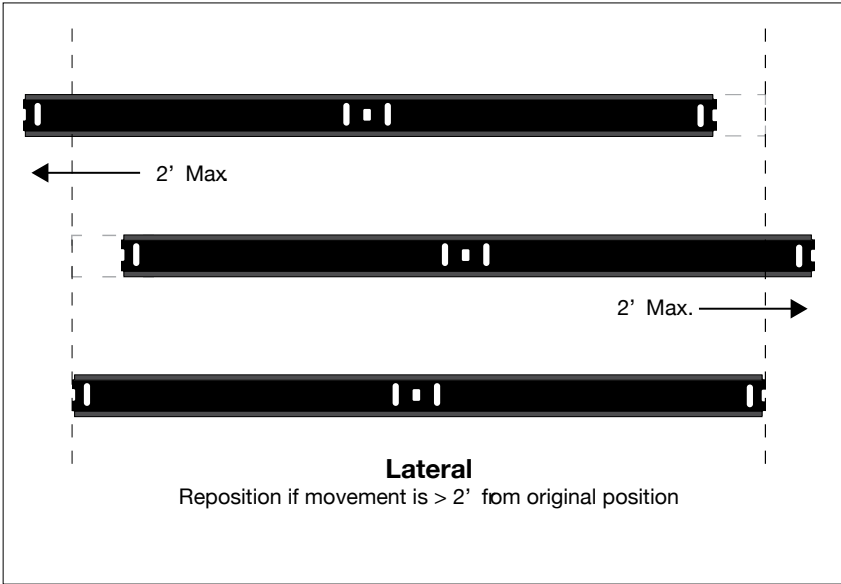
PSS has identified 3 types of movement:

- 1.) **Skewing:** TPRS may deviate from a straight line, either from the centerline of the road towards the shoulder, or vice versa.
- 2.) **Lateral movement:** TPRS may move side-to-side, from the shoulder of the road to the centerline, or vice versa.
- 3.) **Movement Perpendicular to Travel:** TPRS may move as an array in the direction of traffic, or in the opposite direction, from the original deployment position.

Refer to the following graphics for maximum allowances of each type of movement.



Refer to the following graphics for maximum allowances
of each type of movement.





VI.) Miscellaneous:

A.) Removal and Security:

Workers should follow the same procedures for removing RQ TPRS arrays as when deploying them.

RQ TPRS is a temporary device, and subject to theft. RQ TPRS should not be left at the work site after workers leave. If users choose to leave them at the site, PSS recommends stacking the strips, and running a bicycle cable lock through the handles. Several strips locked together could weigh far more than practical to carry away.

Rather than leaving strips in an accessible area, PSS recommends that workers secure RQ TPRS in a locked vehicle or building, or in a yard behind locked security fencing. Workers may of course leave RQ TPRS in our CRIB Cargo Carrier, and lock the strips to CRIB, but the vehicle itself should be secured in a building or behind security fencing.

B.) Care and Maintenance:

The life expectancy of RQ TPRS under normal use is 3 years. Designed for road conditions, RQ TPRS nevertheless requires periodic care and attention.

PSS recommends periodic inspection of the bottom surface for gravel, mud, stones or asphalt, as they could affect performance. To remove material, we recommend using a water-based cleaner and a stiff brush to scrub the strip clean. A good cleaning should only take minutes.

We do not recommend, and caution users to avoid, oil-based cleaners and solvents. They can degrade engineered polymer products, like RQ TPRS, and affect performance.

C.) MUTCD Standard and DOT Specifications and Plans:

RQ TPRS meets Section 6F.87 of the *MUTCD*, 2009 Edition.

To date, several state DOTs have written TC plans or specifications for RQ TPRS. In addition, several states have written Personal Interest Findings (PIF) for the use of RQ TPRS.

To those interested, PSS will e-mail a file that contains those DOT documents. Please contact your PSS Roadway Safety Consultant for the file.

Proposed Specification for a Temporary Portable Rumble Strip:

The following is a proposed specification for DOTs and other specifying agencies:

1.0 Scope

This specification covers portable and temporary rumble strips designed to alert drivers of an upcoming work zone; upcoming work zone workers and/or flaggers; or any situation that will restrict or close the driving lane.

2.0 Pre-qualification

Materials (rumble strips) shall be considered for use only when sufficient evidence, from the Agency's field evaluation, exists to ensure that the materials can reliably conform to this specification.

3.0 Requirements

The Rumble Strip shall:

- have no adhesives or fasteners required for placement
- be a minimum of 5/8" and a maximum of 3/4" high
- be used in temperatures of 0°–180° F without degradation in deployment or safety
- have ergonomic handles on both ends of unfolded and folded strips
- have a grooved design to reduce the possibility of hydroplaning
- be flexible along the length of the strip so that it conforms to the road surface
- be hinged at the midpoint of the strip for ease of installation
- withstand vehicles with 80,000 lbs. maximum weight, and retain original placement with minimal movement so that performance is not compromised*
- be deemed safe for use with motorcycles
- function on roads with posted speed limits up to 80 mph, and retain original placement with minimal movement so that performance is not compromised*

*Minimal movement is defined as incidental movement of the rumble strip. Performance is compromised if the rumble strip moves inconsistently with each other and out of parallel; or if any one strip moves significantly from its original placement that would compromise performance and safety. See Pages 14-15 for movement allowances.

The Rumble Strip shall meet Section 6F.87 of the *MUTCD*, 2009 Edition.

4.0 Certification

The rumble strip manufacturer shall submit, with each lot or shipment, a certification that states the material supplied will meet all the requirements listed in Section 3.0, above.

5.0 Product Warranty

Rumble Strips stored and installed with the manufacturer's recommendations shall perform effectively for three (3) years.



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