U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: ACTION: Requests for Public Interest Findings for 3M Prismatic Retroreflective Sign Sheeting Materials

Date: December 6, 2007

From: Jeffrey A. Lindley
Associate Administrator for Safety

In Reply Refer To: HSA

To: Division Administrators

As many of you are already aware, earlier this summer 15 Division Offices received requests for public interest findings (PIFs) from their respective State Departments of Transportation for a new prismatic retroreflective sign sheeting material manufactured by 3M called Diamond Grade Cubed (DG3). These PIF requests were submitted pursuant to 23 CFR 635.411(c), which allows Division Administrators to approve the use of a proprietary product upon request by a State when it is in the public interest to do so. In these PIF requests, each State asserts that DG3 offers superior performance primarily because of its higher brightness (luminance level) in many situations. The States have requested public interest findings allowing DG3 to be specified on a sole source basis on Federal-aid projects for all guide signs, chevrons, markers and delineators for a period of three years. A detailed technical justification outlining performance advantages for DG3 over other commercially available sign sheeting products was included with each request.

Due to the unique nature of this situation – i.e. multiple, identical requests for PIFs using a common set of technical documentation – we requested that the Divisions forward these requests to Headquarters so that our agency response would be consistent. Upon receiving these requests, we performed an evaluation involving FHWA technical experts in sign retroreflectivity issues, as well as other staff in the Offices of Safety, Infrastructure, Operations, Research & Technology, and the Chief Counsel's office. A detailed review of the technical justification of safety benefits has been performed, as well as a preliminary evaluation of the claimed benefits versus the higher cost for DG3 material, including consideration of the potential impact that approving the PIFs as requested could have on the marketplace for traffic sign sheeting products and traffic sign fabrication in the States making PIF requests.

MOVING THE AMERICAN ECONOMY

Based on our review, we have determined that additional information is needed before a full approval of the PIFs could be granted. However, we believe that an approval on a more limited basis for experimental purposes under 23 CFR 635.411(a)(3) is appropriate as outlined below. Our review confirms some of the claimed benefits of DG3. However, it also raises questions about the magnitude and significance of others, as well as noting that many of the estimated benefits are based on computer modeling instead of experimental data. Our evaluation also raises concerns about the possibility that use of DG3 on chevrons in rural areas could create disability glare and recommends further study of the potential adverse impacts of this application. Accordingly, since we feel that more information is needed, a broad finding that the use of DG3 is in the public interest pursuant to 23 CFR 635.411(c) is not warranted at this time.

Under 23 CFR 635.411(a)(3), States are permitted to experiment with new products on a more limited basis in order to produce experimental data to better understand performance characteristics and perhaps support more widespread specification of a product. Such a request was not made regarding DG3. We encourage any interested State, including the 15 States that submitted the PIF requests, to consider such experimentation on as extensive a level as they deem appropriate as a means to develop an adequate justification for a full PIF. In order to support production of relevant and reliable data, we have prepared the attached guidance on how such experimentation should be pursued. Because States may find the experimental approach required to produce relevant data to be costly and complicated if pursued on a State by State basis, we encourage States to pool resources to support experimental evaluations. FHWA is willing to help facilitate this process, if so desired and requested by the States. States interested in specifying DG3 on a more widespread than experimental basis continue to have the option to do so as a non-participating item, as outlined in the existing regulations.

As a final note, the decision to make a conditional determination of FHWA's position on the requests for PIFs in this case is due to the unique circumstances surrounding this situation – namely, multiple and simultaneous requests regarding a single product. The consolidated review used in this case is not intended to set a precedent for action in handling future requests. However, given the determination made regarding the need for additional justification for PIFs involving DG3, ongoing review of that product will continue to be handled by Headquarters. We are also currently reviewing options to ensure that our processes to review PIF requests are effective in promoting innovation and advancing the state of the practice in the highway industry.

For further information on the technical aspects of this issue, please contact Messrs. Carl Anderson in the Office of Safety Research at (202) 493-3366 or Greg Schertz, Retroreflectivity Team Leader, at (720) 963-3764.

Attachment

cc: Director of Field Services
Federal Lands Highway Division Engineers
Resource Centers Directors
Chief Counsel
Associate Administrator for Infrastructure
Associate Administrator for Operations
Associate Administrator for Research Development, and Technology

Evaluating Experimental Plans Assessing the Safety Benefits of Retroreflective Sheeting for Traffic Control Signs in Support of Public Interest Findings

BASIC ELEMENTS OF EXPERIMENTAL PLAN

Experimental plans assessing the safety benefits of retroreflective materials (in support of a PIF for DG[3] sheeting) should include the following:

- Objective of evaluation;
- Treatments to be evaluated;
- Measures of effectiveness to be evaluated;
- Hypotheses to be tested;
- Experimental design that will allow treatment effects to be isolated;
- Sites at which treatments will be implemented;
- Locations that will be used as control sites;
- Sample sizes required to produce desired level of statistical confidence;
- Experimental protocols describing how data will be collected; and
- Statistical analysis methods.

CRITICAL ISSUES TO BE ADDRESSED IN EXPERIMENTAL PLAN

In reviewing potential State experimental plans, the following critical issues should be scrutinized:

- Selecting an appropriate measure of effectiveness (MOE);
- Selecting appropriate treatments to be evaluated, including the ability to isolate the effect of changing only the sign sheeting material;
- Selecting appropriate control sites;
- Determining the requirements for and collecting data from an adequate sample size to obtain an appropriate level of statistical confidence in the results; and
- Employing appropriate experimental design, protocols, and statistical analysis.
- Special considerations in evaluating chevrons

Appropriate MOEs

The first critical issue for the State is to identify a quantitative MOE that relates to the hypothesized impact of DG[3] sheeting on driver performance, with causal links to safety. Selecting an appropriate MOE will ensure that the State has clearly evaluated the expected improvement that will be provided by DG3 sheeting and that the results will be meaningful and useful.

Examples of acceptable MOEs include:

- A combination of legibility distance and reading time – the measure of how long it takes to acquire the information provided on a guide sign; and
- A reduction in erratic maneuvers related to desired lane position, such as late exits;

Examples of unacceptable MOEs include:

- Driver preference of signs, typically measured by installing signs with different materials on the same sign bridge or even using multiple materials on the same sign; and
- Retroreflectivity or luminance (brightness) of signs – measured either in situ or calculated from lab measurements.

Appropriate Treatments

The second critical issue is insuring that only the parameter of interest—the sign sheeting materials—will change over the duration of the evaluation. For example, if the State proposes that the use of DG[3] will permit removal of overhead guide sign lighting, the base line condition would be the existing sign materials with lighting, and experimental conditions should include the existing materials without lighting as well as alternative micropris matic sheeting (including DG[3]) without lighting.

Experimental Condition		Lighting	
	Material	Y	N
Baseline	Existing	X	
Treatment 1	Existing		X
Treatment 2	DG3		X
Treatment 3	Material X		X
Treatment n	Material Y		X

Appropriate Control Sites

The third critical issue is to insure the evaluation plan includes a description of the selection of control sites. Evaluations may be conducted as cross-sectional or before-after studies. A cross-sectional study may permit the evaluation to be performed within a shorter time period but will likely require a larger number of sites and inclusion of equivalent control sites. A before-after study would need to be carefully designed to insure that there is appropriate compensation for other changes in the roadway and roadway usage throughout the duration of the evaluation. The evaluation plan should clearly articulate the manner in which data will be collected and should describe controls that will be used. For example, if a before-after study of lane exits were

proposed, the evaluation might include upstream and downstream interchanges as control sites for the experimental site. The State would probably need to include several experimental sites and carefully select those sites to minimize the operational and geometric differences between sites. In a cross-sectional study, the evaluation might include the upstream and downstream interchanges as local controls to normalize the magnitude of observed changes in driver behavior. It should be noted that the results of an evaluation will likely not be transferable across facility types and environmental conditions. That is, the results for urban freeways, with fixed roadway lighting, high AADT, and high levels of off-road lighting, will not permit calculation of the probable impact of changing sign sheeting materials on rural freeways without fixed roadway lighting and with low levels of off-road lighting. Also, the results on divided, high speed urban freeways may not be transferable to undivided urban arterials.

Appropriate Sample Size and Statistical Significance

The fourth issue is related to the anticipated benefits of the proposed action and the anticipated impact on driver performance. The evaluation plan should include a statistical hypothesis of the impact on driver performance due to the proposed change in sign sheeting materials. A power analysis should be conducted to determine the amount of data that must be collected to make a reasonable inference, at a statistically significant level, that an observed change in the MOE is due to the sign sheeting material.

Appropriate Experimental Design, Protocols, and Statistical Analysis

The fifth issue is to insure that the proposed experiment will provide a realistic measurement of the anticipated impacts. A good experimental plan with well thought out protocols in concert with appropriate statistical analyses will help insure that the results of the evaluation are meaningful. It is important to consider the type of statistical analyses that will be conducted on the data that will be collected. The characteristics of the data can dictate the feasibility of certain statistical analysis methods. Since each evaluation will depend upon the actual facilities selected, the number of experimental sites, the type of evaluation and the level of control that will be exercised, it would not be practical in this document to describe all of the necessary considerations generically. Instead, for illustrative purposes, considerations are discussed below for the MOEs identified earlier as acceptable:

- Reading time – The objective is to determine if drivers use less time in reading a higher luminance overhead traffic sign and position their vehicle to exit earlier than other overhead signs with less luminance. The safety surrogate is the hypothesis that less time used by the driver in reading and recognizing a sign will result in more time to perform the driving task, especially when exiting a roadway, and better positioning for an exit. This may be very difficult to conduct on an open road. It would require eye tracking equipment, and would preferentially include constant recording of the vehicle's position. This experiment, which would involve pre-selected drivers, might include the following:
    - Drivers would be provided a specific course to follow, which would require obtaining information from guide signs.
    - Signs manufactured with different sheeting materials would provide varying levels of luminance. Note that the sign positions should be varied to control for geometric and

ambient lighting conditions. The number of observers should be large enough to control for the variance within each group when evaluating the reading time of each sign along the course (i.e., Group A might observe a sign manufactured with DG^3 at sign position 1, while for Group B it may be Type VIII and for Group C it may be Type IX).
  - It is acceptable to have an evaluation plan in which all the signs on the course are of the same material, with different observation groups used to evaluate different sign materials.
  - The time required for each observer to read each sign, and the distance at which the sign is read, would be recorded for comparison within and between subjects.

  Note that the evaluation plan should include tasks in addition to the wayfinding task to try to duplicate driver behavior on roads with traffic.

- Erratic maneuvers – The objective of this experiment is to determine if drivers observed traversing the study site position their vehicle to exit in the proper lane earlier and make fewer "last second" maneuvers to exit when guide signs are manufactured with DG^3 sheeting, as compared to driver performance with guide signs manufactured with other sheeting materials. The safety surrogate is the hypothesis that drivers will establish a proper vehicle position sooner to exit a roadway, and will make fewer "last second" exit maneuvers. An evaluation of erratic maneuvers might be conducted as a before-after study. Several comparable sites would be selected for the evaluation, along with control sites. The control sites might include the upstream and downstream interchanges adjacent to the experimental sites.
  - Observe the general traffic flow at night, and measure vehicle lane positioning when preparing to exit at the experimental sites and control sites for some period of time (determined by the power analysis of the data requirements).
  - It may be possible to record license plates (kept private) to evaluate the percentage of out-of-State vehicles that exit late (potentially indicative of unfamiliar drivers). Recording license plates might also permit identification of vehicles that repeatedly exit late.
  - After the base line is established, change sign materials at selected sites in accordance with the evaluation plan. Some site might receive DG^3 signs, while others might receive Type VIII or Type IX, while control sites would not be changed.

  To fully evaluate erratic maneuvers, the State would need to record the lane positioning of exiting vehicles from the location of the first advance guide sign to the exit. This would be possible by using low-light level or near infra-red cameras, and data reduction would likely be labor intensive.

Special Considerations in Evaluating Chevrons

The final issue pertains to an evaluation of chevrons. It is important that the potential for glare be evaluated before agencies use DG^3 sheeting on chevrons, especially in dark, rural locations. Such an evaluation should be conducted on a closed course – preferably a road course with multiple left and right turns of varying curvature. MOEs would include lane tracking and detection/ recognition of pedestrians as drivers negotiate the course with curves marked with chevrons

manufactured with different sheeting materials. The evaluation should include older drivers in sedans and SUVs and should require driving with high-beams.

FOR FURTHER INFORMATION

For further information regarding the technical content of this document, please contact Carl Andersen in the Office of Safety R&D at Carl.Andersen@fhwa.dot.gov or (202) 493-3366.