EVALUATION OF SUPPLEMENTAL SHIELDS AT RAILROAD CROSSINGS

Final Report

State Research Project #523

by

Rob Edgar, P.E.
Research Unit
Oregon Department of Transportation
Salem, OR 97301

prepared for

Rail Section
Oregon Department of Transportation
Salem, OR 97310

December 1998

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
OR-RD-99-17		

4. Title and Subtitle	5. Report Date
Evaluation of Supplemental Shields at Railroad Crossings	December 1998
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Rob Edgar, P.E.	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Oregon Department of Transportation Research Unit 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192	11. Contract or Grant No. SRS 523

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Oregon Department of Transportation Research Unit and Rail Section 200 Hawthorne SE, Suite B-240 · 555 13th St NE, Suite 3 Salem, Oregon 97301-5192 · Salem, OR 97301-4179	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Oregon Department of Transportation evaluated the use of a supplemental shield for use at passive railroad crossings. These shields used reflective sheeting materials in a modified chevron pattern, attached below the railroad crossing sign. Differing color combinations and types of reflective sheeting were reviewed. The study evaluated whether the devices could decrease vehicle-train accidents at highway-rail crossings, and to determine an appropriate traffic control device that could be effective at reducing accidents and be acceptable for inclusion in ODOT's Sign Policy and Guidelines.

The research also evaluated the use of reflective tape and measured the reflectivity of the tape and shields. The report contains review team findings and recommendations for sign improvements and use of the shields.

17. Key Words	18. Distribution Statement
railroad crossings, sign reflectivity, safety, accident reduction	Available from the Oregon Dept. of Transportation Research Unit

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	13 + appendices	

Technical Report Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

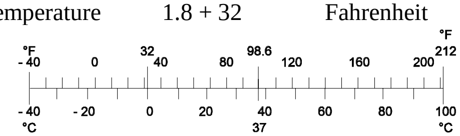
SI* (MODERN METRIC) CONVERSION FACTORS

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 temperature	5(F-32)/9	Celsius temperature	°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
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 temperature	1.8 + 32	Fahrenheit	°F



***** SI is the symbol for the International System of Measurement

(4-7-94 jbp)

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EVALUATION OF SUPPLEMENTAL SHIELDS AT RAILROAD CROSSINGS

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1.0 INTRODUCTION

In 1996, there were 3,612 motor vehicle related highway-rail crossing accidents reported in the United States, resulting in 1,428 injuries and 377 fatalities. The Federal Railroad Administration reported 1,817 of those accidents occurred at passive railroad crossings. There are 96,759 of these crossings, which typically have railroad crossbuck signs, but lack crossing gates or flashing signals. Each year, about 14 accidents occur at passive crossings in Oregon.

Locomotives present a unique element in crossing issues. Trains require considerable stopping distances, are unable to alter course and have considerable mass that can inflict heavy damage to vehicles. Unlike other vehicles, locomotives are incapable of making evasive moves, other than to brake and sound a whistle. Thus, accident avoidance is controlled largely by the motorist.

This is a concern, as observations at some passive crossings revealed that half of the motorists failed to stop or look for trains. Although these motorists may seldom encounter a train, their total or occasional disregard for the crossing could eventually lead to a serious accident. If current conditions are left unchanged, the accident rates are not expected to decrease.

In 1996, the Oregon Department of Transportation (ODOT) was asked to evaluate a supplemental shield for use at passive railroad crossings. The shield consists of a three-sided sign with reflective stripes in a modified chevron pattern, to be mounted below the crossbuck sign. The intent of the shield is to alert the motorist of a crossing with the hope they will cross with more caution and reduce the risk of accidents.

A study conducted in Idaho reported a substantial increase in response and compliance when the shield is present. Although Oregon ranks below the national average for accidents (11 accidents per 1,000 crossings verses 19 per 1,000 nationwide), reducing the risk should always be considered, especially if it can be done at a relatively low cost.

The purpose of this report is to document the views of an evaluation team.

1.1 OBJECTIVES

The objectives of the review were to:

- Determine if a supplemental reflective shield could decrease vehicle-train accidents at highway-rail crossings.

- Determine an appropriate traffic control device that could be effective at reducing accidents and be acceptable for inclusion in ODOT's Sign Policy and Guidelines.

The evaluation was based largely on the subjective views of an evaluation team. However, objectively evaluating the changes in driver behavioral response is preferred, and could be considered if funds are available.

1.2 BACKGROUND

Oregon has about 5,780 rail crossings in the state, as shown below:

Table 1.1: Number of Rail Crossings in Oregon

Crossing Type	Public Roads	Private Roads	Pedestrian
At-grade	2300	2810	90
Grade-separated	460	110	10
Total	2760	2920	100

Of the 2,300 at-grade public crossings, 1,460 are passive crossings, including 430 crossings with STOP signs, 870 with crossbucks, and 40 with other signs. Each year, about 14 accidents occur at the passive crossings and about 11 at active crossings (e.g., those with crossing gates or flashing signals).

Current standards call for high intensity grade crossbuck signs (R15-1) and high intensity advance warning signs (W10-1). In Oregon, the supplemental shields are not a recognized traffic control device. Recognized devices are those found in the Manual on Uniform Traffic Control Devices (MUTCD), Oregon Supplements to the MUTCD, or ODOT Sign Policy and Guidelines, and devices approved for experimental use.

A study conducted in Idaho reported driver reaction (looking for trains prior to crossing tracks) improved from 64% to 89% with the added shields, and compliance (coming to a full stop) improved from 52% to 74%. At this time, Idaho has installed the shields at 90% of their crossings. The shields are still treated as a test program. Further studies are planned for 1998.

Oregon and Idaho's accident history is as follows:

Table 1.2: Number of Vehicle-Train Accidents at Public, At-Grade Railroad Crossings

Year	Number of Accidents*	
	Oregon	**Idaho**
1992	N/A	45 (36)
1993	29 (19)	54 (42)
1994	30 (20)	47 (39)
1995	23 (9)	35 (27)
1996	24 (14)	50 (38)
1997	18 (9)	30 (20)
Number of Crossings	2,300 (1,460)	1,412 (1,098)

* Accidents include active and passive crossings. Number in parenthesis is for passive crossings only. Pedestrian and trespass incidents are not included.

Shield installation drawings from Idaho Transportation Department are shown in Appendix B.

2.0 EVALUATION OF SHIELDS

Two separate evaluations of sample shields and materials were conducted: the first in 1997 at a vacant yard and the second in 1998 at a mainline rail crossing. Each evaluation is discussed below.

2.1 1997 EVALUATION

On December 2, 1997, an evaluation team met to review four different color combinations of shields intended to supplement the railroad crossbuck signs (see Figure A.1 in Appendix A). The evaluation was conducted between 5:15 and 6:00 PM in a vacant paved yard. Sunset was at 4:32 PM. The weather was cold and clear. Temperature and relative humidity were not recorded, but the temperature was estimated to be between 2° and 5° C. During the evaluation, dew formed on some of the signs and had a significant affect on the reflectivity. The signs were wiped down once during the evaluation.

The evaluation team was comprised of the following ODOT employees:

Craig Reiley - Rail Division
Larry Christianson - Transportation Safety Division
Mark Joerger - Policy Unit, Transportation Development
Orville Gaylor - Traffic Management Unit, Technical Services
Rob Edgar - Research Unit, Transportation Development
Bruce Armstrong - Support Services

2.1.1 Materials Evaluated

Four shields of different configurations were prepared for the December evaluation. Shields 1, 2 and 3 were provided by 3M Traffic Control Materials Division. Shields 2 and 3 were modified by covering the red sheeting (material “B” shown in Figure A.1) with either black or yellow sheeting material. The sheeting was applied with masking tape at the edges and the protective peel-off backing remained in place to protect the original sign face from damage.

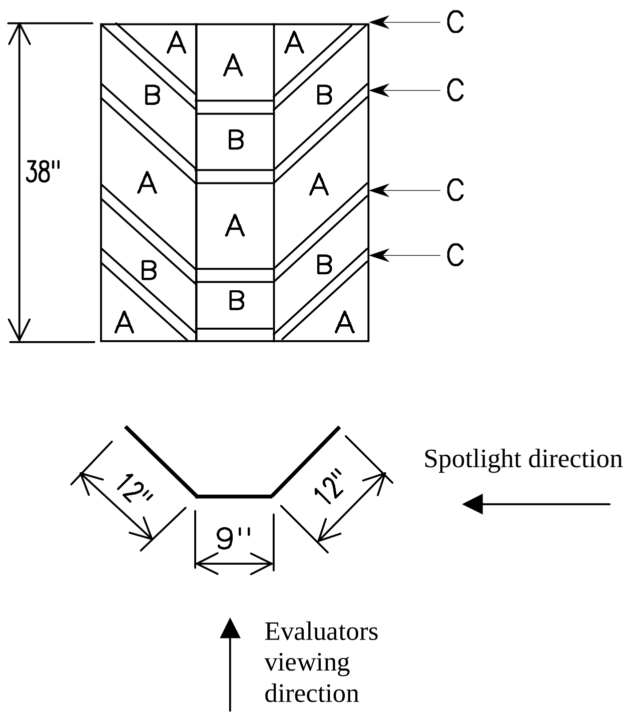
Shield 4 used two type-3 object markers (OM-3) mounted side by side. This configuration was selected because materials were readily available from the ODOT sign shop. It should be noted that the intent was to evaluate the sign colors and reflective material, and not the shape.

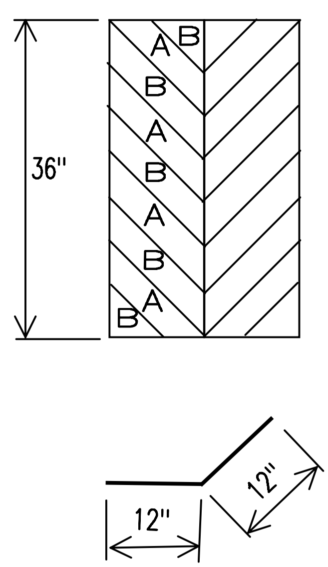
All shields were constructed with an aluminum substrate. The reflective materials were as follows:

Table 2.1: Configuration of Tested Shields

Material Code	Shield 1	Shield 2	Shield 3	Shield 4
A	White DG	White DG	White DG	Yellow HI
B	Red DG	Yellow DG	Black	Black
C	SR	SR	SR	N/A

DG = 3M diamond grade
HI = 3M high intensity grade
SR = 3M specular reflective tape





Note: 1 inch = 25.4 mm

Figure 2.1: Configuration for Shields 1, 2 and 3

Figure 2.2: Configuration for Shield 4

2.1.2 Evaluation Method

All four shields were placed at ground level about 1 m apart. A diamond grade crossbuck sign provided by 3M was mounted about 2 m above the ground. By comparison, Oregon's standard uses high intensity sheeting material centered 2.74 m above the roadway surface. Shields 1, 2 and 3 had reflective sheeting material on the back side of the wings, however, only the front three faces of the shield were evaluated.

Placing the shields at ground level for the test affects the illumination (entrance) angle compared to a typical installation where the shield would be mounted about 1.8 m above the ground and about 4 m to the right of the driver. For a 150 m viewing distance, the difference in the illumination angle would change from about 0° to 1.7° and the observation angle would remain about the same at 0.23°.

Evaluations were conducted from within a sedan passenger car positioned about 150 m directly in front of the shields. A 200,000-candlepower spotlight was positioned perpendicular to the shield, to simulate an approaching locomotive. The spotlight was positioned at several locations during the course of the evaluation. It was not directly visible to the evaluators.

The shields were evaluated with the sedan headlights in low beam, high beam and off positions. Portable radios were used to communicate with the spotlight operator. With each headlight setting, the spotlight was also powered on and off. It was noted during the evaluation that the right low beam headlight of the sedan was not operational.

2.2 1998 EVALUATION

On March 18, 1998, a team evaluated a red/white shield mounted under a crossbuck sign at a mainline rail crossing in Albany (see Figure A.5, Appendix A). Todd Johnson with 3M Traffic Control Material Division and Chris Arvas of Operation Lifesaver coordinated the review, which occurred from 1:30 to 2:00 PM, under dry and clear conditions and mild temperatures. A night evaluation followed, from 7:00 to 8:00 PM under dry and mild conditions. Dew was not present.

The evaluation team included the following:

Craig Reiley – Rail Section, Transportation Development
Mike Dunning – Operations, Technical Services
Rob Edgar – Research Unit, Transportation Development
Orville Gaylor - Traffic Management Unit, Technical Services
Tori Kinne – Federal Highway Administration

2.3 EVALUATOR COMMENTS

The comments below are a compilation of views from both the 1997 and 1998 evaluation teams. In general, the teams shared similar views, although it should be noted that the 1998 team did not have opportunity to view the four different color combinations or experience the dew problems as discussed in paragraphs 2.3.3 and 2.3.10. In addition, the 1997 team did not view the post-mounted tape as discussed in paragraph 2.3.7.

2.3.1 General Appearance

The shield uses patterns, colors and shapes that are not normally seen on the highway. This mixture gives the shield an unusual and conspicuous appearance. While the shield does not give the motorist any specific direction, it could draw their attention. If the motorist is an alert, prudent driver, they should detect the shield and crossbuck sign, and respond by looking for trains before crossing or stopping if a STOP sign is present.

2.3.2 Modified Chevron Pattern

The modified chevron pattern consists of three sections: two chevron sections separated by a center section of horizontal stripes as shown in Figures 2.1 and A.1. Chevron patterns are normally used to warn motorist of fixed objects (such as bridge ends), lane/street closures or the end of a street. Standard color combinations include black/yellow, red/white and orange/white. Chevrons used at gore points (OW19-1) are of an inverted “V”, whereas the shield tested in this study was a right-side-up “V.” Chevrons are generally located at the point of a hazard or road closure, whereas, the shield is used slightly in advance and to the right of the railroad crossing. It is unknown if motorists would confuse the modified “V” for a gore point (OW19-1) or object (OM-3) marker.

2.3.3 Colors

The team reviewed four color patterns: red/white; black/white; yellow/white and black/yellow.

The red/white pattern had good contrast and was one of the most effective in attracting attention. However, the team was concerned that perhaps the red color should be reserved for regulatory signs. The color could give a conflicting message to the motorist who associates red with STOP or DO NOT ENTER signs. This would not be a problem where STOP signs are posted, but may cause confusion if the shield is mounted only with the crossbuck sign. It should be noted, however, that red used in regulatory YIELD signs has been found effective and acceptable.

The black/white pattern was not as unusual as red/white, but could still be effective in drawing the motorist attention. Although black and white are also used on regulatory signs, it may not be as confusing to motorists. The black/white pattern was formerly used for street closures.

The yellow/white pattern appeared to have a similar effect as the black/white pattern. Yellow is a warning color and could be appropriate in this situation.

The black/yellow pattern also had a similar effect as the black/white pattern even though its high intensity sheeting had lower retro-reflective properties. Black/yellow are standard colors for obstruction markers.

2.3.4 Specular Reflective Tape

The specular reflective tape has “mirror-like” properties and contributes to giving the shield an unusual appearance. While this may be effective in the daylight, at night the tape appears as a dark band and is not as effective.

Under limited circumstances, the tape could reflect light from the locomotive to the motorist, or reflect the motorist’s own headlights back. To be effective, the locomotive and motorist would need to be located at very precise angles. Since this occurrence would seldom happen, it is not considered effective for this purpose.

2.3.5 Wings

The two bent “wings” on each side of the sign provide several benefits. On crossings where a roadway runs parallel to the railroad and has an intersection within close proximity to the tracks, the wings provide a visual target for motorists approaching from the side. The wings can also assist the locomotive engineer to locate crossings at night using the retro-reflected light from the train, supplementing the “whistle” boards the railroad has posted 400 m in advance of crossings.

The evaluation team did not see any reflected light from the spotlight (simulating an approaching locomotive) during the night test, largely because of the signs retro-reflective properties. Therefore, the wings are not considered effective for warning motorists of approaching trains.

2.3.6 Recognition

The shield provides a better visual target area than the crossbuck alone. But the shield is also another traffic control device a motorist must recognize and interpret. If a motorist is familiar with the shield, they will have little difficulty recognizing its intent. If the shield is unfamiliar to the motorist, they may lose response time as they identify both the shield and the crossbuck. It should be remembered that the more objects in the motorist's field of view, the more time it takes them to respond. This should not be a problem where there is adequate sight distance and response time.

2.3.7 Post Mounted Tape

A 51 mm (2") wide white diamond grade tape is also available to supplement the crossing sign. The tape mounted to the crossbuck post provides additional reflective target area. The evaluation team believes the tape can enhance the nighttime recognition of the crossbuck, giving it a "post and crossbuck" outline that is more recognizable than the crossbuck alone.

2.3.8 Flicker Effect

Detecting trains at night in unlighted crossings can be a difficult task when there is no reflective material on the train. Providing fixed-mounted reflective sheeting material on the far side of the tracks can help motorists detect train movement. A flicker is created when headlights are reflected back between the passing train cars or wheels. The flicker helps alert the driver of motion at the crossing.

This method may not work well at skewed roadway crossings where the road angle obscures the opening between cars. In this case, post-mounted tape mounted low to the ground can create the flicker between the wheels. Although the target area is small, it could be enough to alert a driver. Double-sided crossbuck signs, shields and reflective posts all contribute to this flicker effect.

It should be noted that accident records were not reviewed to determine if night accidents are a significant problem. Regardless, it is believed the reflective tape is a low cost enhancement and has the potential to save lives.

2.3.9 Oversized Crossbuck Sign

An alternative approach to the shield might be to use oversized crossbuck signs. Crossbuck signs typically consist of two 229 x 1219 mm (9" x 48") panels. A larger 229 x 1524 mm (9" x 60") panel was used in the past but is seldom used today. The larger surface area would provide more target area to attract the motorist's attention.

A disadvantage may be that crossbucks don't have the contrasting colors that might otherwise attract attention. They also lack target area when approached from a perpendicular direction.

Further, the crossbuck is one of the few highway signs that lack borders. In some instances a border might help provide some contrast against a light sky or background.

2.3.10 Retro-Reflectivity and Dew

During the 1997 night evaluation, it was noted that the crossbuck sign was much dimmer than the shields. Both the sign and shield consisted of the same diamond grade reflective sheeting mounted on an aluminum substrate. Dew had formed on the surface and may have reduced some of the brightness, although wiping the surface had only a minor effect. It was also noted that the yellow sheeting on the wing of shield number 2 (see Figure A.2) was considerably dimmer than the front facing material. The cause is discussed in Section 2.4 below.

2.4 REFLECTANCE MEASUREMENTS

Retro-reflectance measurements were made on the shields using a RetroSign Reflectometer from Delta Light & Optics (see Figure A.3). The illumination (entrance) angle was -4° and the observation angle 0.2°. The instrument was calibrated to a 314 cd/lx-m² high intensity reference. Measurements are in units of cd/lx-m². Measurements were made in an office environment, having dry, clean conditions at about 20° C and with the instrument perpendicular to the surface, but parallel to the orientation marks on the diamond grade sheeting. The results are shown in Table 2.2.

Table 2.2: Retro-Reflectance of Test Materials (cd/lx-m²)

Reading Number	Shields					RR Crossbuck	
	White DG	Yellow DG	Red DG	Yellow HI	SR*	White DG (Rail Road)	White DG (Crossing)
1	1140	907	195	232	1	996	1029
2	1074	1011	190	244	0	1008	983
3	1064	923	196	232	2	1096	1135
4	1119	1014	185	229	3	973	1048
5	1126	1024	190	237	1	1166	1094
Average	**1105**	**976**	**191**	**235**	**1**	**1048**	**1058**
Std Dev	34	56	4	5.9	1	81	59

Note: DG = 3M diamond grade; HI = 3M high intensity; SR = 3M specular reflective tape.

* *Retro-reflective* surfaces reflect light back towards the direction in which it is incident upon the surface. A *specular reflective* surface is like a mirror that reflects light at an equal but opposite angle about a normal (perpendicular) axis. A specular surface has no retro-reflective properties and should have a retro-reflectance value of zero; therefore the above values of 0 to 3 are expected.

The retro-reflective measurements of the crossbuck sign show the material has similar properties as the shields. However, when observed by the evaluation team, the crossbuck was noticeably dimmer. An inspection of the material found the orientation marks for the diamond sheeting were parallel with the length of the sign, thereby placing the orientation 45° from vertical. The sheeting orientation, as well as the dew conditions, are the suspected causes for the reduced brightness observed by the evaluation team.

The reflective measurements made on the yellow sheeting show it has high brightness at the illumination and observation angles used by the instrument. But, when observed by the evaluation team, the wings (at a 45° viewing angle) appeared very dim. A close inspection found the sheeting was mounted with the orientation marks at 45 degrees from vertical. This orientation combined with the 45° viewing angle caused the reduced brightness detected by the evaluation team. This observation is discussed below and shown in Table 2.4.

To better understand the reflective properties of the diamond grade sheeting, additional measurements were made. Table 2.3 shows the values for measurements perpendicular to the sheeting surface, but rotated at different angles from the orientation marks. Table 2.4 was measured by tilting the instrument sideways 45° from perpendicular, thereby changing the illumination (entrance) angle from -4° to about 45° (see Figure A.3).

When the sign is viewed at orientation angles of 0° and 180° and the illumination angle changed from -4° to 45°, the retro-reflectance drops 45%, from 992 to 543 cd/lx-m^2 (see Tables 2.3 and 2.4). Although the measurements at 45° are lower, the sheeting still provides good retro-reflective properties at these angles.

Table 2.3: Retro-Reflective Measurements at -4° Illumination Angle

Luminous Intensity (cd/lx-m^2) for White Diamond Grade Sheeting Material								
Orientation*	**0°**	**180°**	**90°**	**270°**	**45°**	**135°**	**225°**	**315°**
Reading 1	995	981	1038	1018	1307	919	1319	902
Reading 2	999	990	1042	1046	1290	895	1289	904
Reading 3	997	988	1026	1036	1288	883	1316	890
Average	997	986	1035	1033	1295	899	1308	899
	992		**1034**		**1100**			
Std Dev	2.0	4.7	8.3	14.2	10.4	18.3	16.5	7.6

Table 2.4: Retro-Reflective Measurements at 45° Illumination Angle**

Orientation*	**0°**	**180°**	**90°**	**270°**	**45°**	**135°**	**225°**	**315°**
Reading 1	555	525	203	184	35	43	43	63
Reading 2	546	529	196	191	33	44	42	66
Reading 3	554	546	227	186	38	43	44	68
Average	552	533	209	187	35	43	43	66
	543		**198**		**47**			
Std Dev	4.9	11.2	16.3	3.6	2.5	0.6	1.0	2.5

* Orientation is relative to the orientation marks found on the diamond grade sheeting material. For example, at 0° the retro-reflectometer instrument and orientation marks are both in vertical positions.

**See figure 5 in Appendix A for an example of a 0° orientation, 45° illumination angle measurement.

Similarly, for orientation angles of 90° and 270°, the retro-reflectance drops 81%, from 1,034 to 198 cd/lx-m^2. Although this is still sufficient for night visibility, it is obviously not the preferred orientation.

However, the greatest difference comes when the illumination angle is at 45° and the orientation angle is at 45°. The retro-reflectance drops 96%, from 1,100 to 47 cd/lx-m^2. This is a considerable reduction that will have significant visual effects. The measurements made at these angles confirm the low brightness that was observed on the yellow sheeting of shield number 2 by the evaluation team. This example illustrates the importance of correct orientation of the diamond grade sheeting material to avoid the “dead” zones.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

About 14 vehicle/train accidents a year occur at Oregon's 1,460 passive crossings, or about 10 per 1,000 crossings. This is currently below the 1996 national statistic from the Federal Railroad Administration of 1,817 accidents at 96,759 crossings, or 19 per 1,000 crossings. Since trains are unable to alter course and require considerable stopping distances, accident avoidance at these intersections is controlled largely by the motorist. Although the goal is to reach a zero accident rate, the poor judgement or drug impairment of drivers increases the likelihood that the goal will not be met.

This study did not address whether there is a need to improve the safety of our crossings. Oregon already ranks below the national average accident rate, and it is unknown if this rate can be further reduced. To decrease accidents, the motorist must recognize a crossing and then use good prudent judgement in making the crossing.

Lack of good judgement may be a key factor in crossing accidents, considering that 11 accidents per year occur at active crossings having gates or flashing signals. To determine if judgement is a significant factor would require additional study. One approach would be to review accident records at passive railroad crossings, study the causes of the accidents and identify those that could have been prevented, assuming the driver was cognizant and driving in a prudent manner. This information could help determine if enhanced signing methods could significantly reduce the accident rate. If bad judgement is a significant cause of accidents, then safety efforts might be better spent on public awareness campaigns to educate the motorist of the potential dangers, or on converting crossings to a more expensive active crossing.

Recognizing that drivers do not always operate their vehicle with their full attention to the roadway suggests that it may be useful to provide additional visual stimuli for the driver. The stimuli must cause the driver to cross the railroad track with more awareness, and presumably in a safer manner. Determining the most effective traffic control devices would require a through study involving a variety of passive treatments. This study did not have sufficient funds to pursue this task.

Although it is desirable to have the motorist always alert at railroad crossings, there are many other road elements and hazards that drivers need to respond to when travelling, such as animals, other vehicles, road obstructions, sharp curves, intersections and STOP signs to name just a few. Warning devices, when provided, should convey a clear message to the motorist without adding confusion or compromising safety. As such, new traffic devices for augmenting railroad crossings need to be designed with the consideration of all traffic devices.

Idaho's study showed an improvement in driver compliance, which is encouraging. But the Idaho study was conducted during daylight hours and only at crossings with STOP signs. It is unknown how driver behavior would change for a dark or non-stopped crossing.

3.2 RECOMMENDATIONS

The review team recommends the following:

3.2.1 Crossbuck Sheeting Material

Crossbuck reflective sheeting should be changed to a Type A wide-angle prismatic sheeting specification as shown in subsection 02910.31 of the Special Provisions for ODOT construction projects (Appendix C). It is also suggested that existing signs be replaced with the diamond grade material over a ten year period.

Installations at skewed approaches should be especially careful of the sheeting orientation to avoid the reflective "dead" zone as discussed in Section 2.4. This phenomenon could occur when the orientation marks are installed parallel to the RAILROAD board (oriented at 45° from vertical when mounted) or when approached from a 45° or greater road angle.

3.2.2 Vertical "Flicker" Tape on Post

A 51 mm (2") wide, white, Type A wide-angle prismatic reflective tape should be installed on the front and back edge of the crossbuck post. The tape should run from the crossbuck down to an elevation one-foot above the top of rail. It is suggested that the tape be installed at all passive crossings within ten years.

The tape will add reflective target area at night and could provide a more recognizable outline shape to augment the crossbuck, alerting the driver to the railroad crossing. It is still the driver's responsibility to use good prudent judgement when crossing the railroad tracks.

3.2.3 Shields

Shields should only be used where specialized treatment is needed to change the motorist behavior. Chevron patterns do not convey a clear message to the driver, but it is interesting to note their positive effect during daylight hours on Idaho's crossings with STOP signs.

If shields are used, consideration should be given to patterns used in other states. Red/white is now used in permanent installations in at least two other states. The red/white combination is also believed to be the best for attracting attention. However, since red is a regulatory color, there is some concern that it might make STOP and DO NOT ENTER signs less effective. If not for the other states' use of red/white shields, the black/white or white/yellow pattern might have been a preferred choice. Adoption of a standard at the national level is the most desirable, but lacking this, the colors used by the other states should be considered to maintain consistency.

4.0 REFERENCES

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APPENDIX A

PHOTOGRAPHS

Figure A.1: Daylight Photograph of the Four Test Shields

Figure A.2: Night Photograph Using Electronic Flash

Figures A.3 a, b, c and d: Close-Up of Test Shields at Night Using Electronic Flash

Figure A.4: Shield Installation at Albany

Figure A.5: Close-Up of Shield Installation in Albany

Figure A.6: Night Photograph of Albany Installation Using Vehicle Headlights

Figure A.7: Retroreflectance Measurements at 0° Orientation and 45° Illumination Angle

APPENDIX B

IDAHO DRAWINGS FOR RAILROAD SHIELD

APPENDIX C

ODOT STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION: ILLUMINATION AND TRAFFIC CONTROL