Safety Effectiveness of Regulatory Headlights Signs in Wyoming (Phases I and II)

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Introduction

The use of Daytime Running Lights (DRLs) may have a demonstrable impact on increasing the vehicle conspicuity during daytime, dusk, and dawn; however, their effect on the overall safety for different road users is still up for debate. There are contradicting findings regarding whether the use of DRLs has significant safety benefits to reduce certain types of crashes. Elvik 1996 (1), utilized the Log-odds meta-analysis method to evaluate the safety effectiveness of DRL using 17 studies. The use of DRLs was estimated to result in 10 to 15 percent reduction in the number of multivehicle daytime crashes. A study by the National Highway Traffic Safety Administration (NHTSA) in 2004 revealed some safety benefits of DRLs (2). The generalized simple odds, a conventional statistical technique, was used to analyze 1995-2001 data from NHTSA Fatality Analysis Reporting System (FARS) and the General Estimate System (GES); DLRs were proven to reduce opposite direction daytime fatal crashes and opposite direction/angle daytime non-fatal crashes by 5 percent each. The study also found a 12 percent reduction in crashes involving non-motorists, i.e. pedestrians and cyclists, and a 23 percent reduction in opposite fatal crashes of a passenger vehicle with a motorcycle. It is worth mentioning that none of these results were found to be statistically significant using odds ratio when controlling for a variety of factors other than the presence or absence of DRLs. In a recent contradicting large-scale study by NHTSA (2008), DRLs were found to be statistically insignificant in reducing the types of crashes studied, except for a 5.7 percent reduction in the involvement of light trucks/vans in two-vehicle crashes (3).

Inclement weather events such as fog, snow, ground blizzard, slush, rain, and strong wind, etc., affect roadways by impacting pavement conditions, vehicle performances, visibility, and drivers' behavior. Road-user characteristics are among the most important elements influencing the driving task; the ability to see objects that are in motion relative to the eye "dynamic visual acuity" and the reaction process are of utmost importance for safe driving. Daytime Running Lights (DRLs) are a low-cost safety feature that increases visual contrast between vehicles and their background, enhancing their conspicuity and detectability. There are two main ways to implement DRLs; 1) manually requiring drivers to turn on their low-beam headlamps or, 2) DRLs that automatically switched on when a vehicle's ignition is started.

It should be mentioned that there are functional issues with using the automatic DRLs only; drivers with automatic DRLs often do not turn on their low beam headlights in adverse weather conditions and at dusk or dawn. This is especially dangerous because the taillights do not come on until the low beam headlights are turned on. This becomes more important at hazardous roadway sections that require both headlights and taillights.

While DRLs may be beneficial for certain scenarios, previous studies have been unable to document overall safety of using DRLs due inadequacy of superior statistical techniques used (3). NHTSA suggested to re-examine the safety effectiveness of DRLs using alternative approaches. Moreover, the issue of mandating a regulation to use low-beam headlights on certain rural 2-way 2-lane roadways sections at certain times of year and weather conditions needs further investigation. The DRL laws are considered to be behavior-based standards that require drivers to turn headlamps on during applicable time periods. These behavior-based strategies are different from the newly technology-based DRL standards.

The main goal of this project is to investigate the safety benefits of using regulatory Headlight Signs in Wyoming and to provide guidelines of the best implementation strategy of control devices (e.g. signs with flashing beacons) to increase the use of DRLs and reduce fatalities and injuries.

Background

The use of DRLs has become a mandatory road safety measure in several countries. In early 1990, Canada, Denmark, Finland, Hungary, Norway and Sweden required vehicles to turn on their headlights at all times. Various studies have shown that DRLs are a statistically significant measure to reduce daytime, dawn and dusk multiple-vehicle crashes. The use of low-beam headlights is encouraged during the winter in Ireland due to daytime low ambient light levels. Italy, Hungary and Romania require the use of DRLs outside populated areas (rural areas) at all times. In the past, many European countries including Germany, Spain, and France among others required daytime use of low-beam headlamps on certain roads at certain times of year (4-9).

Canada Motor Vehicle Safety Standard (CMVSS) required all new vehicles made or imported after January, 1990 to come equipped with automatic DRLs. Automakers battled the DRLs new regulation because of the increased cost of adding a new front lighting device and warranty (increased bulb replacement) to run the low beam. The standard was updated to allow the use of reduced-wattage high beam headlamps and permitting any light color from white to amber or yellow (10).

The automatic DRLs has become a standard safety feature in many countries; in 2011, European Union Directive requires all passenger cars and vans to come equipped with daytime running lights, the mandate was extended to include trucks in 2012. As stated earlier that the automatic DRLs are different than switching the low-beam headlights on manually. A daytime running light is an automotive lighting device, automatically switched on when a vehicle's ignition is started, emitting white, yellow, or amber light to increase the conspicuity of the vehicle during daylight times, the automatic DRLs equipped in newer cars do not turn taillights on automatically when they are on, drivers are becoming more dependent on new technologies, i.e., automatic low-beam headlights with light sensor that may fail them in certain conditions. Automatic DRLs can be categorized according to the type of lamp used into four different types;

1. Low-beam headlamps or fog lamps operated at full or reduced intensity.
2. High-beam headlamps operated at reduced intensity.
3. Steady-burning operation of the front turn signals.
4. Low-wattage Light Emitting Diode (LED).

In 1993, the National Highway Traffic Safety Administration (NHTSA) permitted the use of automatic DLRs in the United States (11). NHTSA objected to the use of high-intensity DRLs however on grounds of potential glare issues and problems with turn signal masking. General Motors (GM) equipped most of its vehicles starting 1995 to reduce the automotive manufacturing variation in the North American market, by 1997, all GM vehicles come equipped standard with DRLs. GM complied with the Federal Motor Vehicle Safety Standard (FMVSS) No. 108 which limits the maximum light intensity output of DRLs to 7,000 candela (10 percent of the standard high-beam headlamp intensity). The DRL intensity output was further reduced in

1998 to 1,500 candela because of numerous complaints regarding DRL glare. In addition to glare, there are concerns that DRLs might make motorcycles, pedestrians, and bicyclists less conspicuous and that DRLs would have environmental impact (12).

Beyond any doubt, many studies have found that DRLs increase vehicle conspicuity during inclement weather conditions such as rain, sleet or snow (13). The use of vehicle headlights whenever conditions also require the use of windshield wipers led to the proposal and enactment of many state laws as shown in Figure 1, legislation of “wipers-on, headlamps-on” (14-15). Headlight usage laws vary by state, drivers must use their headlights when there is little sunlight. Nevertheless, fifteen states in fact require drivers to turn on their headlights when their windshield wipers are on. California, Ohio, and New York are among the states that instituted a law requiring drivers to use their headlights whenever they use their windshield wipers. In 2008, California used Dynamic Message Signs to warn motorists of the new law because of poor compliance. As of January, 2010, Ohio State permitted law enforcement officers to issue a citation for violators of windshield wipers-on headlights-on law.

Figure 1: Wipers-on Headlights-on (Source: www.autoinsurancequotes.org left, and http://www.cleveland.com right)

Lighting Research Center (LRC) conducted a recent *Before-After* "wipers-on headlights-on" study using crash data from seven states (i.e., California, Kansas, Main, Maryland, Missouri, Pennsylvania, and Virginia). The study focused on multiple-vehicle crashes by the time of day (daytime, dawn/dusk, and nighttime) and by weather condition (clear or rainy weather only). The main findings suggested that the wipers-on legislation resulted in a significant reduction in fatal rainy-weather multiple-vehicle crashes during daytime, and an even larger reduction during dawn and dusk times. It is worth mentioning that the study did not consider other weather conditions such as fog, snow, etc.

According to the Synthesis on Non-MUTCD Traffic Signs study conducted by FHWA (16), there is a wide variation in the legend and wording of signs that require road users to turn on their vehicle headlights under certain conditions. These signs regulations depend on laws that vary from State to State, e.g., Wyoming Stature requires headlights to be on half hour before sunset to half hour after sunrise, when visibility is below 1000 feet, or in adverse weather conditions of insufficient light. Therefore, the FHWA added a new section titled "Headlight Use Signs" in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) 2009 (17) to provide increased uniformity of the messages for road users as illustrated in Figure 2. The FHWA did not adopt the "TURN OFF HEADLIGHTS" sign because it might communicate an inappropriate message to road users during nighttime conditions. Table 1 lists locations of headlight signs in Wyoming and some crash data. The lack of effectiveness found at headlight signs' sections can be explained by fact that only one sign is installed at each location, and the white color signs might be blended with the snowy white background which may make them less visible during adverse weather.

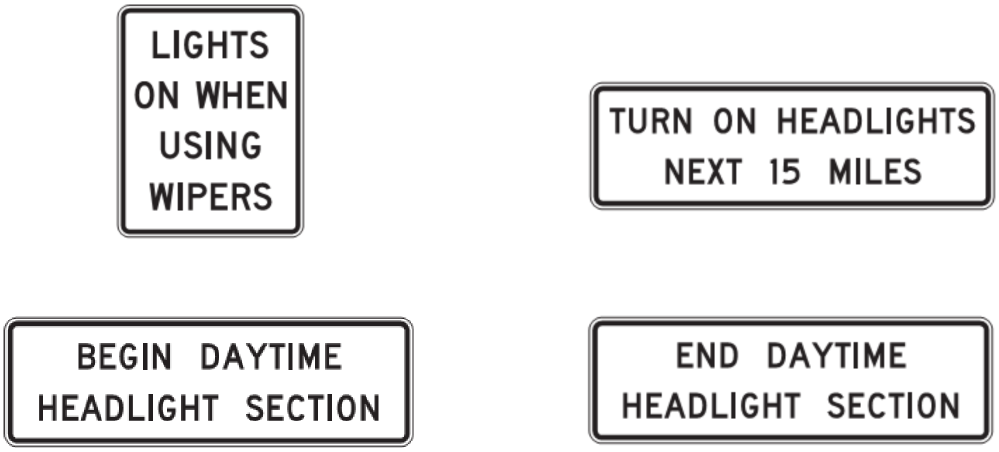

Figure 2: Headlight Use Signs (MUTCD 2009)

Table 1: Headlight Signs in Wyoming

District	# of Sign/ Locations	Location	Implementation Dates	Message on Signs/ Notes
1	7	US 287, MPs 402.59N, 414.83N, 414.92S, 424.81S	2001	• Turn Headlights On For Safety Next ___ Miles.
		US287/WY-789, MPs 2.4S, 13.37S, 13.59N	1994	MP 13.37 removed.
2	2	WY 287 from milepost 23 to 33	2001	• Turn Headlights On For Safety Next ___ Miles. • 2 Lane Road - Pass With Care • Buckle Up - It's the Law
		WY 220 from milepost 88 - 102	2012	
4	4 sign sets each direction	On Wright to Gillette Corridor - WYO 59 from RM 76.0 to RM 101.0	October 2012	• "Headlights On for Safety Next 25 Miles" • "2 Lane Road - Pass With Care" • "Buckle Up - It's The Law" • "End Daytime Headlight Section"
5	2	US 20/26, Shoshoni to Waltman	October 2002	Total number of accidents reduced from 9 to 8 and number of fatal crashes remained the same at 3. Study period - 9 years
		WY 28, South Pass	2010	Total number of accidents increased from 5 to 7 and the number of fatal crashes decreased from 1 to 0.

According to the Federal Highway Administration (FHWA) (18), 53 percent of annual fatal crashes are attributed to lane and road departures. A roadway departure crash includes those where a vehicle leaves its lane and runs off the road, opposite direction sideswipe crashes and head-on crashes. The Wyoming SHSP 2012 (19) indicated that lane departure crashes comprised 72 percent of all severe crashes for the years 2008 – 2010. These types of crashes were targeted in the Wyoming Strategic Highway Safety Plan (SHSP) as a first priority to reduce fatal and serious injury crashes. These types of crashes are considered the most severe crashes and are often dominated by distracted driving, failure of a driver to notice another vehicle and poor visibility during inclement weather conditions.

In a bid to reduce the number of critical crashes on Wyoming's highways, the Wyoming Strategic Highway Safety Plan (SHSP) analyzed Wyoming State crash data to identify six areas where there are opportunities to reduce critical crashes. The identified areas were Roadway Departure Crashes, Use of Safety Restraints, Impaired Driving, Speeding, Young Drivers, and Curve Crashes. Of the six areas determined from the data, lane departure consistently produced the highest number of crashes from 2002 to 2010 as illustrated in Figure 3.

Crashes associated with lane departures/run-off-the-road result from driver fatigue, impaired driving, speeding, and distracted driving. These crashes were determined to have contributed to 72 percent of all critical crashes.

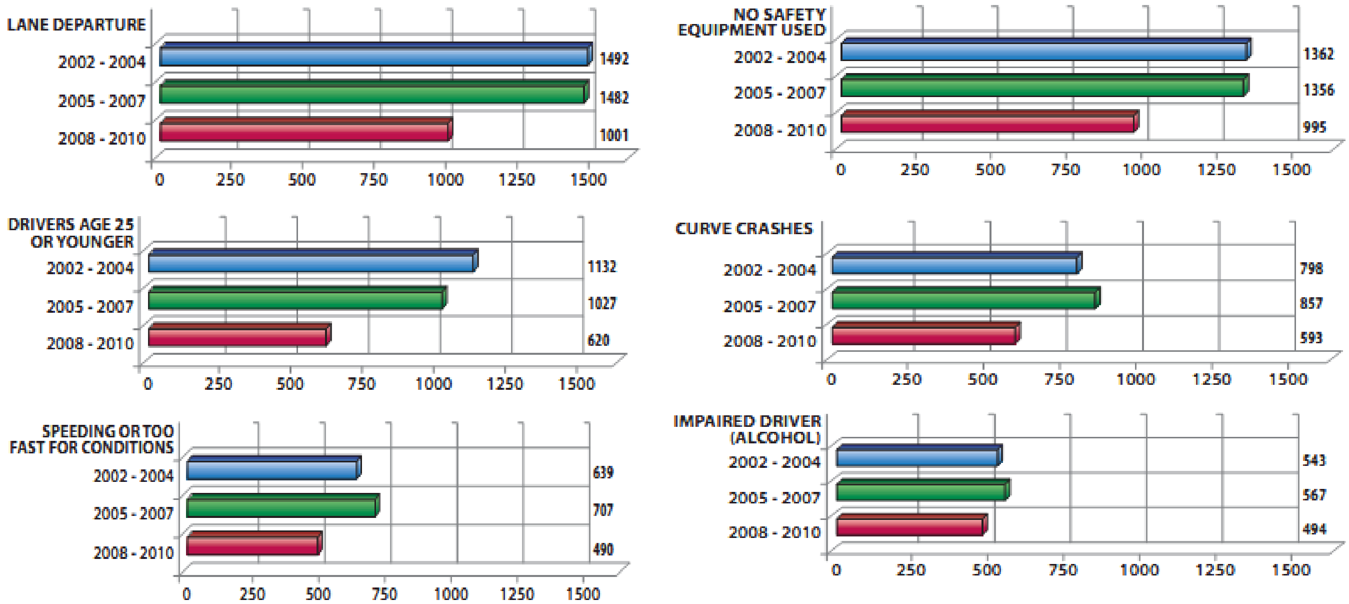

Figure 3: Crash Emphasis Areas Based on Wyoming Crash Data
(Source: Wyoming Strategic Highway Safety Plan, 2012)

Study Benefits

The WYDOT staff recognized the importance of examining the benefits of using regulatory signs to require road users to turn on their headlights under certain conditions and on some challenging roadway sections in improving safety and therefore recommended this study. The objective of this study is to evaluate the safety effectiveness of regulating the use of daytime running lights under certain scenarios and weather conditions on specific type of crashes. Although the safety effectiveness of daytime running lights has been researched by various transportation agencies around the world, the findings of the various studies are not consistent. In addition, most of the studies did not address the use of Headlight Signs and did not consider the adverse weather conditions (e.g., snow, strong wind, ground blizzard, and whiteout conditions) and the challenging geometrical characteristics experienced in Wyoming.

This study will also consider the recommendations from NHTSA regarding the use of advanced statistical methodologies in order to overcome the limitations of conventional techniques used in previous studies.

Road users' responses to various countermeasures including the use of DRL and rumble strips among others can be examined through a variety of approaches including questionnaire surveys, simulations and real-life observations. Questionnaire surveys and driving simulations are considered relatively affordable compared to real-life experiments.

Driving Simulators have been used in many prior studies as it is a very economical and a safer option compared to field studies. The Driving simulator has been also proven as a very cost effective tool to examine a broad variety of drivers' behavior experiments that will not be safe to test in the real world.

UW allocated a fair amount of funding to build its first Driving Simulation Lab, the additional support from WYDOT will enable UW to add necessary features to the driving simulator required for this study. The role of a good simulator is to reproduce real-world scenarios and elicit from participants responses that are similar to those expected under real-world conditions. The driving simulation lab will help WYDOT safety office to meet their goals and will facilitate additional future research for years to come. This lab could be used to assess truck performance and driver behavior under adverse weather conditions among other prospective research ideas.

Project Goals

As mentioned earlier, the main goal of this research proposal is to examine the safety effectiveness of using regulatory Headlight Use Signs on certain sections in the State of Wyoming. With the increase of automatic daytime running lights and automatic low-beam headlights, many drivers forget to manually override the automatic headlights setting and manually turn on their headlights. Unlike previous studies that were directed towards evaluating the safety effectiveness of automatic DRLs using aggregate crash data, this study will focus on quantifying the potential safety benefits of headlight signs to enhance vehicles' conspicuity during adverse weather conditions on certain challenging mountainous roadways. An emphasis will be directed toward events with inclement weather (rain, fog, slush, snow, strong wind, white out, etc.). A comparison of low-wattage headlights that turn on automatically when a vehicle's ignition is started and manual headlamps will be addressed in the analysis. Guidelines of where, when and what are the best messages to be used in order to encourage the use of daytime low-beam headlights will be provided. These tasks will be carried out in Phase –I.

In order to examine the effectiveness of various types, contents, sizes of signs and their frequencies and to ensure higher level of compliance, a driving simulation and field experiments will be performed in Phase -II. There are two main goals to be achieved in Phase -II; 1) to examine various scenarios of static and Dynamic Message Signs (DMSs) using driving simulation approach, and 2) to perform a *Before-After* safety analysis on test sections.
To achieve the abovementioned goals, the following tasks will be performed;

<u>Phase I:</u>

The effort in Phase I will be directed to tackling key issues regarding the safety benefit of using headlight signs as the following:

1. *Synthesis of existing research studies of the DRLs safety benefits*

   This will be conducted by reviewing the safety effectiveness in the literature on various crash types, and compare different statistical methodologies, e.g., Empirical Bayes *Before-After*. The review will look into regulations on the use of daytime headlights in all states in the U.S. and Europe. The review of literature will be performed concurrently as other phases are progressing.

2. *Identify and rank hotspot locations of lane departure crashes, head-on and opposite sideswipe crashes on Wyoming roadways*

   In this task, locations on Wyoming 2-way 2-lane roads with increased risk of head-on and opposite sideswipe crashes will be identified and mapped using GIS.

3. *Evaluate the safety effectiveness of DRL using Wyoming crash data for DRL-equipped and non-DRL vehicles, and motorcycle*

   The safety effectiveness of DRL use for certain types of crashes will be examined using Wyoming crashes during different time periods and weather conditions. In order to thoroughly understand the safety benefit of Headlight Signs with the presence and absence of automatic DRLs, simple odds and ratio of odds ratios will be utilized to adjust for a variety of exogenous factors. As discussed earlier that there is a difference between the newly DRL-equipped vehicles and requiring drivers to turn on their headlights manually, there are four different scenarios that should be considered in analyzing Wyoming crash data as illustrated in the two-way contingency Table 2. Only specific make-models for each year are equipped with DRLs, a case-control method will be used to compare crashes for a set of passenger vehicles equipped with DRLs and vehicles manufactured in the same years without DRLs - Vehicle Identification Numbers (VIN) will be used for identification - on roadways sections with and without Headlight Signs. Advanced statistical techniques will be attempted. The analysis will be extended to include various severity levels comprising fatal, injury and all severity if possible.

Table 2: Two-Way Contingency Table for a Possible Crash Scenario

	Non-DRL Vehicles	DRL-equipped Vehicles
Roadway Sections with Headlight Signs	Π_{11}	Π_{12}
Roadway Section without Headlight Signs	Π_{21}	Π_{22}

DRLs may affect other road users, there are contradicting conclusions about the effect on motorcycle and other road users; some studies claim that the increasing use of vehicles' DRLs degrade the conspicuity of other road users, more specifically, the previously unique DRL signal used by motorcycles. This task will investigate the effect of the increasing use of DRL on motorcycle using Wyoming crash data.

4. *Conduct a field study on current headlight signed hotspot locations to collect data about the compliance of DRL use and the newly 24-hour low beam lights in newer vehicles*

The use of DRL on certain roadway locations and during specific time periods and weather conditions requires simple behavior measure. Drivers of old vehicles are required to switch-on their headlights manually to comply with this regulation. Some select motor vehicle models come standard with the 24-hour low beam lights. This task will identify the compliance rate of older vehicles at locations where information is provided for drivers to turn their headlights on. Furthermore, this task will identify the percentage of vehicles with the new 24-hour low-beam lights on those locations. A field study will be designed to collect data during multiple weekdays, weekend days, and different weather conditions on locations where signs to turn-on headlights are posted. Two video cameras will be used for each direction to capture the front and rear of vehicles, vehicles with only headlights on would be considered DRL-equipped, vehicles with both headlights and taillights on would be considered compliant Non-DRL, vehicle with no headlights neither taillights would be considered non-compliant Non-DRL. The effect on adjacent sections will be examined.

5. *Preliminary development of a plan for state wide sign implementation and conduct a cost/benefit analysis*

   Depending on the hotspot analysis, locations on Wyoming 2-way 2-lane roads with increased crash risk will be ranked. A preliminary analysis of the cost effectiveness will be performed to assess whether the benefit of the proposed alternatives outweighs the cost.

6. *Implementation and Technology Transfer*

   By the end of Phase I, preliminary conclusions will be provided depending on the available data. The final findings, recommendations, and guidelines will be presented to WYDOT staff, the Safety Management System Committee, and the RAC which will determine if an update is necessary to Headlight Sign Use in Wyoming at this stage. In addition, the research results will be disseminated through technical paper publications and presentations in academic venues and press releases using media outlets.

Phase II:

Phase II is focused on testing various signs in driving simulation controlled environment, and in real-life field testing, the following tasks are to be carried out:

1. *Purchasing, Installation, and Calibration of the Driving Simulator*

   This task will start as soon as Phase I starts. UW will contact at least 3 vendors to get price quotes for driving simulators. The PIs will review the technical specifications and the capability of each simulators and will choose the most suitable one. The best chosen simulator will be ordered and installed in the UW transportation lab, the driving simulator will be calibrated to ensure accurate outcomes.

2. *Training for D.S. Operators*

   In this task, a graduate student will receive the required information and training to safely and efficiently run the driving simulator, and scenario developer software.

3. *Acquiring UW Approvals to use Human Subjects*

   The PIs will work with UW to get approvals to use human subjects in the driving simulation experiments. The first three tasks will be performed at no cost to WYDOT.

4. *Comprehensive Driving Simulation Experiment*

   Multiple simulation scenarios will be designed and developed, a preliminary experiment of driver perception and reaction to various road side information will be performed. Other issues of examining different types of messages, contents, size, and the frequency of headlight messages will be addressed.

   In addition, the driving simulator will be used to assess various types of static and dynamic message signs. These assessments will be performed in controlled-environment of similar roadway and weather conditions in Wyoming. In this task, a driving simulator experiment will be developed for different advisory scenarios using: 1) regular DRLs signs; 2) updated version of static DRL with flags and/or flashing beacons; 3) Dynamic Message Signs (DMSs); and 4) no information present. For different age groups and driving experience, the judgment and recognition of signs and other vehicles with and without DRLs under inclement weather will be examined.

5. *Field Testing*

   In this task, finding from the driving simulation analysis will be implemented and tested in the field. The recommended type of signs, contents, colors, and frequency will be installed in a selected roadway section, compliance and traffic parameters will be collected using video cameras and traffic detectors respectively. The collected data will be analyzed to determine compliance rates and the effect on traffic.

The identified hotspot locations from Phase I will be used as test sections, at least two homogenous test sections will be selected based on similarity in geometrical characteristics, weather conditions, and crash history. One section will be used to examine the effectiveness and compliance of only using an updated version of "For Safety Turn Headlight on Next xx miles" signs and another section testing "Wipers-on, Headlights-on" regulations.

6. *Finalize of state wide sign implementation and cost/benefit analysis*

   A finalized analysis of the cost effectiveness will be performed to assess whether the benefit of the proposed alternatives outweighs the cost.

7. *Before-After Analysis*

   In order to conduct a proper *Before-After* analysis, at least 3 years are needed after implementing countermeasures. Data will be collected from the identified sites after implementing the aforementioned strategies, there will be no cost associated with this 36-month period. Other safety surrogate measures will be used to examine the effect of the new proposed regulations and compliance rates. Effect on traffic parameters for the proposed strategies will be monitored and assessed using video cameras and traffic detectors.

8. *Implementation and Technology Transfer*

   The final findings, recommendations, and guidelines will be presented to WYDOT staff, the Safety Management System Committee, and the RAC. They will decide if an update is necessary to Headlight Sign Use in Wyoming. This updated policy will incorporate all findings and results from Phase I and II. In addition, the research results will be disseminated through technical paper publications and presentations in academic venues and press releases using media outlets. The technology transfer activities in this project will benefit both the scientific community and authorities responsible for traffic safety and decision making, and will be a key to the implementation of new regulations of Headlights Signs in Wyoming.

Deliverables

Quarterly progress report will be submitted. In addition, any major achievement, i.e., the completion of tasks will be reported to the project managers.

Project Kickoff Meeting

A kick-off meeting shall be scheduled to occur within the first 30 days of execution by the university. As a minimum, the project manager and the principal investigators will attend. Other parties may be invited, as appropriate. The subject of the meeting will be to review and discuss the project's tasks, schedule, milestones, deliverables, reporting requirements, and deployment plan. A summary of the kick-off meeting shall be included in the first progress report.

Progress Reports

The university will submit quarterly progress reports to the Research Center. The first report will cover the activity that occurred in the 90 days following the issuance of the task work order.

Draft Final Report

The Draft Final Report is due 90 days prior to the end date of the task work order. The draft final report will be submitted to the WYDOT Research Center. It should be edited for technical accuracy, grammar, clarity, organization, and format prior to submission to the Department for technical approval.

Final Report

Once the draft final report has been approved, the university shall prepare the final report. The university will deliver a CD or DVD containing the final report in PDF as well as MS Word format.

Project Closeout Presentations

The findings of this study will be presented to WYDOT staff, the SMS committee, as well as the WYDOT RAC at the conclusion of the project.

Timeline

It is envisioned that total time required for Phase I including the submission of the final report would be 16 months beginning June 1st, 2014. The review of literature will be carried out over the first 12 months to insure up-to-date information. The draft final report for phase I will be ready for review by the end of the 13th month as shown in Table 3.

Table 3: Work Plan Schedule – Phase I

Research Task	Month															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Task 1: Review of Literature	■	■	■	■	■	■	■	■	■	■	■	■				
Task 2: Hotspots Identification and Ranking			■	■	■	■	■									
Task 3: Safety Evaluation of DRLs				■	■	■	■	■	■	■	■	■				
Task 4: Driver Compliance Field Study							■	■	■	■	■	■				
Task 5: Preliminary State Wide Implementation Plan and Cost/Benefit Analysis									■	■	■	■				
Task 6: Technology Transfer														■	■	
Documentation and Deliverables Schedule			Quarter Report			Quarter Report			Quarter Report			Quarter Report	Draft Final Report			Final Report

Quarter Reports   Draft Final Report   Final Report

The timeline for Phase II is shown in Table 4. The first 8 months will be utilized to purchase and setup the driving simulator. The actual research activities of Phase II will start on the 9th month. The driving simulation, field experiments, and the cost/benefit analysis will take 10-month to be completed. After implementing the different countermeasures on two roadway sections, minimal activities will take place for 3 years. Three months at the end of the 3-year *After* period will be needed to perform *Before-After* analysis. The total active time for Phase II including the submission of the final report and technology transfer would be 18 months.

Table 4: Work Plan Schedule – Phase II

Research Task	Month																				
	1-3	4-6	7-8	9	10	11	12	13	14	15	16	17	18	19-52	53	54	55	56	57	58	59
Task 1: Purchasing, Installation, and Calibration of the Driving Simulator																					
	■																				
Task 2: Driving Simulator Operators Training																					
		■																			
Task 3: Acquiring UW Approvals to Use Human Subjects																					
		■	■																		
Task 4: Comprehensive Driving Simulation Experiment																					
				■	■	■	■	■	■	■											
Task 5: Field Testing																					
									■	■	■	■									
Task 6: Finalize of state wide sign implementation and cost/benefit analysis																					
												■	■								
Task 7: *Before-After* Analysis												**Start of *After* Period**									
												36-Month			■	■	■				
Task 8: Technology Transfer																					
																			■	■	
Documentation and Deliverables						■			■			■					■	■			■

UW Tasks prior Phase II Start · Quarter Reports · Draft Final Report · Final Report

Budget – Phase I and II

As shown in Table 5, the WYDOT cost of phase I is $98,575. This cost will cover all data collection and analysis activities, as well as technology transfer. In addition, it will cover the salaries of one graduate student and two faculty members. Table 6 shows how the cost of Phase-II for WYDOT is $95,592. This Phase will focus on examining the effectiveness of head light signs using a driving simulation experiment, field testing, and a Before-After analysis. The driving simulator equipment will be purchased by UW. In addition, there will no WYDOT charges for the tasks performed in first 8 months. The WYDOT equipment cost will cover purchasing additional necessary equipment for the driving simulator (e.g. actuators and eye-tracking systems). The phase II budget does not include the instrumentation for the field experiments. The cost of purchasing and installing the signs will be covered by WYDOT while UW will carry out the necessary activities to analyze the field sections. The WYDOT champions recommend funding both phases concurrently to shorten the overall period of the study.

Table 5: Project Budget – Phase I

CATEGORY	Budgeted Amount from WYDOT	Explanatory Notes
Center Director Salary		
Faculty Salaries	$26,550	
Administrative Staff Salaries	$0	
Other Staff Salaries	$0	
Student Salaries	$26,500	
Staff Benefits	$12,096	
Total Salaries and Benefits	**$65,146**	
Student Support Other Than Salaries	$9,000	Tuition/No indirect
Permanent Equipment	$0	
Expendable Property, Supplies, and Services	$3,000	
Domestic Travel	$6,500	
Foreign Travel	$0	
Other Direct Costs (specify)	$0	
Total Other Direct Costs	**$18,500**	
F&A (Indirect) Costs	$14,929	
TOTAL COSTS	**$98,575**	

Table 6: Project Budget – Phase II

CATEGORY	Budgeted Amount from WYDOT	Budgeted Matching Funds - UW	Explanatory Notes
Center Director Salary			
Faculty Salaries	$16,000	$0	
Administrative Staff Salaries	$0	$0	
Other Staff Salaries	$0	$0	
Student Salaries	$24,000	$0	
Staff Benefits	$8,160	$0	
Total Salaries and Benefits	$48,160	$0	
Student Support Other Than Salaries	$9,000	$0	Tuition/No indirects
Permanent Equipment	$21,000	$120,000	No indirects
Expendable Property, Supplies, and Services	$2,000	$0	
Domestic Travel	$4,500	$0	
Foreign Travel	$0	$0	
Other Direct Costs (specify)	$0	$0	
Total Other Direct Costs	$36,500	$120,000	
F&A (Indirect) Costs	$10,932	$0	
TOTAL COSTS	**$95,592**	**$120,000**	

References

1. Elvik, R. (1996), "A Meta-Analysis of Studies Concerning the Safety Effects of Daytime Running Lights on Cars," Accident Analysis and Prevention, Vol. 28, No. 6, 1996, pp. 685–694.

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