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OREGON DEPARTMENT OF TRANSPORTATION

SPR Quarterly Progress Report

October 1, 2016 through December 31, 2016

Date December 30, 2016

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1. Project

Title: Use of Additional Lighting for Traffic Control and Speed Reduction in Work Zones
SPR #791

2. Project Investigator

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3. Project Coordinator

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4. Key Dates

Project start date: September 8, 2015
Project completion date: June 30, 2017

First Fiscal Year: [year]
Final Fiscal Year: [year]
[List revised dates and corresponding amendment numbers]

5. Project Status

Task 1: Documentation of Lighting Systems
Deliverable Due Date: 10/1/2015
The researchers will collect and review archival literature on the types and capabilities of currently available lighting systems that have high potential for being used for additional lighting in work zones. To collect the literature, the researchers will conduct a comprehensive search of archival publications and the Internet using on-line search engines. All documents found that are germane to the research topic will be accessed and reviewed. Task 1 will lead to the creation of a catalog of the available lighting systems for use during the research and in the future by ODOT. The catalog will contain a description of each light system along with associated benefits, limitations to its use, and summaries of findings from prior research on the technology.

Percent completed reported in last quarterly report: 100%

Task 2: Survey of Current Practice
Deliverable Due Date: 11/1/2015
The researchers will conduct a survey of state DOTs and state-wide construction and traffic control contractors to document current and recommended practices, barriers, enablers, and impacts associated with work zone lighting systems. The survey instrument will be a questionnaire. The researchers will create a questionnaire that addresses the aims listed above. The TAC will be asked to review the questionnaire and provide feedback prior to its dissemination. The questionnaire will be revised to incorporate the TAC's input, and then distributed by the researchers to the entities listed above. The survey sample will be developed based on input from the TAC, the researcher's personal contacts, and the companies and organizations identified in Task 1. The researchers will collect, record, and analyze the responses to the survey. Task 2 will lead to the identification of the status quo of the construction industry and its current best practices in terms of work zone lighting and the use of lighting systems.

Percent completed reported in last quarterly report: 100%

Task 3: Documentation of Work Operations
Deliverable Due Date: 2/1/2016
This task is intended to provide an understanding of typical work patterns and lighting needs on highway preservation projects. In consultation with the TAC, the researchers will select 2-3 current ODOT preservation projects to study. The researchers will visit the projects and monitor the work operations, especially with regard to those workers who are on the roadway a long distance from lighting and large equipment. The researchers will record the operations, monitor worker movements and locations, and document the equipment utilized and reflective clothing worn by the workers. The researchers will also measure the level of illumination at the work locations. This task is expected to reveal situations in which workers are especially in need of additional lighting and opportunities for additional lighting.

Percent completed reported in last quarterly report: 100%

Task 4: Identify Potential Lighting Strategies
Deliverable Due Date: 5/1/2016

Task 4 will involve conducting focus group sessions with ODOT personnel and construction contractors. The objective of this task to identify and develop promising lighting strategies to implement and test in an active work zone. The TAC will be asked to recommend focus group participants from within ODOT and construction companies. The researchers will plan, schedule, and conduct the focus group sessions. A total of 2-3 focus group sessions is assumed. Prior to the focus group meetings, the researchers will develop possible strategies for additional lighting to present at the meetings. In each session, feedback on each of the lighting systems will be solicited. The evaluation of possible strategies will consider lighting system availability, cost, ease of implementation, potential for improving safety, and potential for incorporating the strategies in typical traffic control plans. Those lighting strategies that are deemed promising by the focus group participants, and fit within the research budget, will be selected for testing.

Percent completed reported in last quarterly report: 70%
Percent completed after this quarter: 95%

Key Progress-To-Date (Dec. 31)

- The ODOT TAC identified a light tower and balloon light as the types of lighting systems to focus on for the study. In addition, the TAC indicated that the study should include evaluations of the lighting systems with both Class II and Class III apparel, and with a worker wearing a Halo Light.
- The researchers have discussed potential lighting strategies with ODOT Maintenance staff to use as a starting point for discussion.
- Lists of focus group constituents have been developed that include ODOT personnel, roadway contractors, and traffic control subcontractors.
- A list of questions to ask as part of the focus groups has been developed and placed online for access by the participants.
- Lists of focus group members were developed that include key ODOT staff, roadway contractors in the Pacific Northwest, and traffic control subcontractors in the Pacific Northwest. The construction contacts were downloaded from the AGC list of highway construction members and highway council.
- A focus group questionnaire has been developed and placed on-line for distribution. The questions target gaining the perspective of the focus group members regarding the lighting systems, reflective apparel, and personal work light, especially with regard to their impact on the speed of passing vehicles. The questions also ask for suggestions on where and how to place the lighting systems in a work zone.
- IRB approval for conducting the focus groups was received, and the survey distributed to the focus group participants.

Specific Progress This Quarter

- Additional responses have been received from ODOT personnel, general contractors, and traffic control subcontractors.
- Initial analysis of the response data has been conducted.

Problems

- It has been difficult to obtain responses from traffic control subcontracting firms. If a sufficient number of responses cannot be gained from traffic control subcontracting firms, responses from personnel in general contracting firms who are dedicated to traffic control may be used for this focus group.

Work Planned for Next Quarter

- Finalize analysis if focus group responses and include results in draft of final research report.

Task 5: Pilot Testing of Lighting Strategies
Deliverable Due Date: 6/1/2016

Those lighting strategies selected will be pilot tested under controlled, off-roadway conditions to further assess their feasibility and performance. Lighting systems used in the testing will be purchased, leased, borrowed, or if possible, acquired through donations. Each selected lighting strategy will be assessed to evaluate its potential for efficient and economic implementation, its ability to provide effective lighting to illuminate workers, and associated limitations to its implementation. As part of the testing, the researchers will determine optimal location and orientation of the light systems, along with an effective amount of light emitted to illuminate the workers without creating disabling glare for drivers. Light meters will be used to measure the amount of illumination in the work area and on the worker. Standard reflective clothing will be worn by participants involved in the testing to simulate working conditions.

In conjunction with the pilot testing, the researchers will consult with ODOT to select upcoming preservation projects on which to test each of the strategies as described in Task 6. The case study projects are expected to be paving projects located on high-speed roadways with two lanes in each direction. A total of four case study projects are anticipated for the research study. ODOT will contact the paving contractor(s) regarding conducting the research on the projects, and make the needed contracting or change order requirements necessary to incorporate the research work into the paving projects. Cost impacts to the contractor(s) for conducting the work, if any, are not included in the research budget and are expected to be paid by ODOT directly to the contractor.

Percent completed reported in last quarterly report: 100%

Task 6: Implement and Test Selected Lighting Strategies
Deliverable Due Date: 10/1/2016

For Task 6, the researchers will implement one or more of the selected lighting strategies on each case study project. The researchers will consult with the TAC to determine which lighting strategies to implement on each project. Depending on the case study projects selected, it is planned to apply the lighting strategies under different work zone and traffic conditions (e.g., A-lane and B-lane, within a straight roadway section and near a horizontal curve, and different days of the week). Each selected lighting strategy will be implemented during actual work operations.

The researchers will monitor the installation, use, and removal of the light systems, videotape the operations, and monitor vehicle speeds as needed to assess each lighting strategy. For example, one night of testing will be conducted without the light systems used (baseline case for comparison) and the next night of testing will have the light systems implemented and turned on.

The testing results of each technology will be evaluated and compared based on a variety of criteria including: ease of implementation and use, and the impacts on vehicle speeds, speed variability, visibility of workers, worker productivity, and implementation cost. Upon the completion of testing, feedback on each lighting system will be collected directly from the construction personnel involved in each case study project.

Percent completed reported in last quarterly report: 100%

Task 7: Data Analysis
Deliverable Due Date: 12/31/2016
The data collected from the case study projects will be analyzed to determine the effectiveness of each of the lighting strategies tested. The researchers will compare the vehicle speeds, speed variability, visibility of the workers, worker productivity, and implementation cost associated with the baseline case (without the lighting system) to that when the light system is implemented and turned on. Where appropriate, multi criteria decision analysis will be applied to rank order the effectiveness of each light strategy. Such comparisons are expected to lead to a determination of the relative benefits provided by each light system in effectively and efficiently illuminating construction personnel.

Percent completed reported in last quarterly report: 0%
Percent completed after this quarter: 50%

Key Progress-To-Date
- The data from the case study projects (sensor data, videos, GPS data, and handwritten notes) have been organized for analysis, and statistical analysis of the data has begun.

Specific Progress This Quarter
- The sensor data has been reviewed, and outliers/mis-readings removed from the data set.
- The sensor data has also been adjusted to account for the error in the sensors. Additional calibration of several sensors was conducted to ensure the accuracy of the adjustments.
- Macros have been created in MS Excel to quickly organize and sort through the data for analysis. The macros are designed to pick out the desired data for each of the analyses conducted.
- Initial analysis of the data from the I-84 Jordan Road to Multnomah Falls case study project is complete.

Problems
- No problems encountered to date

Work Planned for Next Quarter
- Complete the data analysis for all three case study projects.
- Review the analysis findings to identify conclusions that can be drawn from the study.

Task 8: Documentation and Dissemination
Deliverable Due Date: 3/31/2017

The researchers will prepare and submit a draft final research report to ODOT for review and comment. The draft report will present the findings of the research and provide recommendations to ODOT for implementation in practice. Following ODOT's review, the draft final research report will be revised based on the comments received from ODOT, and a final research report will be prepared and submitted to ODOT for publication.

Percent completed reported in last quarterly report: 0%
Percent completed after this quarter: 20%

Key Progress-To-Date
- Initial sections of the report have been drafted.

Specific Progress This Quarter
- Initial drafts of the introductory sections of the final report have been prepared, including the Introduction, Literature Review, and Research Methods.

Problems
- No problems encountered to date.

Work Planned for Next Quarter
- Following the data analysis, write the remaining chapters of the report.
- Prepare and submit the entire draft report.

6. <u>Project Coordinator's Comments</u> (Completed by ODOT)

Research lighting field-work (planned paving jobs) experienced contractor delays for the pre-selected night-time paving jobs (aka task 3). One project, which was originally scheduled early in the summer, was delayed several times and ultimately rescheduled into next year. Although data collection on that field project was missing the research team was able to collect enough data to start analysis. The TAC considered extending the project to allow further data collection, however, instead a new project idea was submitted as a stage 1 for FY18. The new idea will examine lighting aspects further focusing on observations from this project. The focus will be on high-risk (dark) situations during paving operations close to personnel, moving equipment, and traffic.

7. **Finances** (Completed by ODOT)

SPR Project Summary

VENDOR	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET	$ -	$ -	$ -	$ -	$ -
WORK PLAN BUDGET	$112,253	$62,747		$ -	$ 175,000
REVISED BUDGET	**$ 64,849**	**$ 85,151**	**$ 25,000**	**$ -**	**$ 175,000**
EXPENDITURES - VENDOR	$ 67,864	$ -	$ -	$ -	$ 67,864
BALANCE	$ (3,015)	$ 85,151	$ 25,000	$ -	$ 107,136
ODOT	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET	$ 57,600	$ 96,000	$ 38,400	$ -	$ 192,000
REVISED BUDGET	**$ 10,000**	**$ 7,000**	**$ 3,000**	**$ -**	**$ 20,000**
EXPENDITURES - ODOT	$ 12,111	$ 7,303	$ -	$ -	$ 19,414
BALANCE	$ (2,111)	$ (303)	$ 3,000	$ -	$ 586
PROJECT	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET	$ 169,853	$ 158,747	$ 38,400	$ -	$ 367,000
REVISED BUDGET	**$ 74,849**	**$ 92,151**	**$ 28,000**	**$ -**	**$ 195,000**
EXPENDITURES - PROJECT	$ 79,975	$ 7,303	$ -	$ -	$ 87,278
BALANCE	$ (5,126)	$ 84,848	$ 28,000	$ -	$ 107,722