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7. AUTHOR  Stan Chow		8. PERFORMING ORGANIZATION REPORT NO.
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16. ABSTRACT  
 California Department of Transportation (Caltrans) has recently made a new style, orange-based, retroreflective personal protective equipment (PPE) available to its employees. This research project was to evaluate whether the new orange-based PPE is as visible and effective as the replaced, yellow-based retroreflective PPE. To make the comparisons, the Division of Research, Innovation & System Information planned to take in comparison pictures of each PPE style at set distances and vary in lighting sources to simulate night working conditions.

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# DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION (DRISI)

## WORKER VISIBILITY

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*September 2016*

*Task 3043, Visibility Standards for Field Worker Apparel and Personal Protective  
Equipment*

*Project P1163, Worker Visibility Project*

*Compiled by Stan Chow*



## ABSTRACT

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California Department of Transportation (Caltrans) has recently made a new style, orange-based, retroreflective personal protective equipment (PPE) available to its employees. This research project was to evaluate whether the new orange-based PPE is as visible and effective as the replaced, yellow-based retroreflective PPE. To make the comparisons, the Division of Research, Innovation & System Information planned to take in comparison pictures of each PPE style at set distances and vary in lighting sources to simulate night working conditions.



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## ACRONYMS

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The following is a list of acronyms used in the document.

Caltrans	California Department of Transportation
DRISI	Division of Research Innovation and System Information
PPE	Personal Protective Equipment

## INTRODUCTION

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Caltrans values the importance of safety by making it as one of their primary goals; to provide a safe transportation system for workers and users. To achieve this goal, Caltrans provides personal protective equipment (PPE) to all employees performing their duties on the transportation system. Personal protective equipment with retroreflective material is important because it makes employees and workers more visible to the travelling public. It is extremely dangerous for onsite employees and workers without proper PPE while on the transportation system. Caltrans has recently made a new style of PPE available to its employees which is orange-based, retroreflective, and has a high visibility. This research was conducted to determine if the new orange based PPE was as visible as the old yellow-based PPE.

## VISIBILITY TEST

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To make comparisons and simulate night working conditions, the Division of Research, Innovation and System Information, (DRISI) requested help from Caltrans photography department to take photos of Caltrans Division of Maintenance employees at night. The Caltrans employees were provided with new orange-based PPE, old yellow-based PPE, and normal clothing. The employees stood at varying distances from the light balloon and vehicles. The research plan was to simulate conditions of a car approaching a work zone at night with headlights. The entire process was repeated at different distances (0, 10, 20, 50, 100, 150, 200, and 300 feet). The testing site was held at Caltrans's Sacramento Maintenance Equipment Training Academy (META) facility located at McClellan Park.

## RESULTS

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The photo results from the testing can be found in the Appendix.

## CONCLUSION

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During the testing phase, the researchers came across multiple issues that were not considered during the planning phase. The test plan did not take into account the viewing angle. The test plan also did not have a standardized test subject size. Due to these unforeseen issues, the research was not able to conclude any significant difference between the two PPEs. The only confirmable result was that wearing retroreflective PPE resulted in better worker recognition than not wearing retroreflective PPE.

## RECOMMENDATIONS

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DRISI recommends further research on this subject. Some recommendations are:

1. At a minimum, have the camera placed at the driver's point of view.
2. Consider comparing multiple viewing angles.
3. Use same size mannequins to compare clothing retroreflectivity.
4. Test with multiple light sources at similar distances.
5. Use a light meter for better comparisons.

## APPENDIX

25 Feet from Light Plant

Only Car Lights

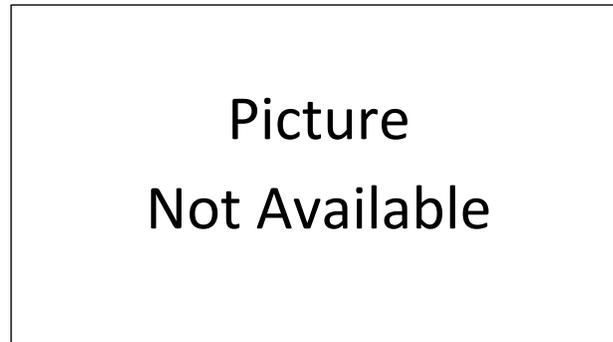


Picture 1-0: (left to right) Old PPE Rain Jacket ; New PPE Rain Jacket; Non-retroreflective Maintenance Clothing; Old PPE Vest; and New PPE Vest and Pants Combo.

25 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
<p>New PPE Short Sleeves Shirt and Pants Combo (Picture 1-1, 1-2, 1-3)</p>			
<p>Old PPE Vest (Picture 1-4, 1-5, 1-6)</p>			
<p>Maintenance Clothing (Picture 1-7, 1-8, 1-9)</p>			
<p>New PPE Rain Jacket (Picture 1-10, 1-11, 1-12)</p>			
<p>Old PPE Rain Jacket (Picture 1-13, 1-14, 1-15)</p>			

50 Feet from Light Plant

Only Car Lights



Picture 2-0: Picture cannot be found

50 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
New PPE Short Sleeves Shirt and Pants Combo (Picture 2-1, 2-2, 2-3)			
Old PPE Vest (Picture 2-4, 2-5, 2-6)			
Maintenance Clothing (Picture 2-7, 2-8, 2-9,)			
New PPE Rain Jacket (Picture 2-10, 2-11, 2-12)			
Old PPE Rain Jacket (Picture 2-13, 2-14, 2-15)			

75 Feet from Light Plant

Only Car Lights



Picture 3-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

75 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
<p>New PPE Short Sleeves Shirt and Pants Combo (Picture 3-1, 3-2, 3-3)</p>			
<p>Old PPE Vest (Picture 3-4, 3-5, 3-6)</p>			
<p>Maintenance Clothing (Picture 3-7, 3-8, 3-9)</p>			
<p>New PPE Rain Jacket (Picture 3-10, 3-11, 3-12)</p>			
<p>Old PPE Rain Jacket (Picture 3-13, 3-14, 3-15)</p>			

100 Feet from Light Plant

Only Car Lights



Picture 4-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

100 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
New PPE Short Sleeves Shirt and Pants Combo (Picture 4-1, 4-2, 4-3)			
Old PPE Vest (Picture 4-4, 4-5, 4-6)			
Maintenance Clothing (Picture 4-7, 4-8, 4-9)			
New PPE Rain Jacket (Picture 4-10, 4-11, 4-12)			
Old PPE Rain Jacket (Picture 4-13, 4-14, 4-15)			

125 Feet from Light Plant

Only Car Lights



Picture 5-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

125 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
New PPE Short Sleeves Shirt and Pants Combo (Picture 5-1, 5-2, 5-3)			
Old PPE Vest (Picture 5-4, 5-5, 5-6)			
Maintenance Clothing (Picture 5-7, 5-8, 5-9)			
New PPE Rain Jacket (Picture 5-10, 5-11, 5-12)			
Old PPE Rain Jacket (Picture 5-13, 5-14, 5-15)			

150 Feet from Light Plant

Only Car Lights



Picture 6-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

150 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
New PPE Short Sleeves Shirt and Pants Combo (Picture 6-1, 6-2, 6-3)			
Old PPE Vest (Picture 6-4, 6-5, 6-6)			
Maintenance Clothing (Picture 6-7, 6-8, 6-9)			
New PPE Rain Jacket (Picture 6-10, 6-11, 6-12)			
Old PPE Rain Jacket (Picture 6-13, 6-14, 6-15)			

200 Feet from Light Plant

Only Car Lights



Picture 7-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

200 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
<p>New PPE Short Sleeves Shirt and Pants Combo (Picture 7-1, 7-2, 7-3)</p>			
<p>Old PPE Vest (Picture 7-4, 7-5, 7-6)</p>			
<p>Maintenance Clothing (Picture 7-7, 7-8, 7-9)</p>			
<p>New PPE Rain Jacket (Picture 7-10, 7-11, 7-12)</p>			
<p>Old PPE Rain Jacket (Picture 7-13, 7-14, 7-15)</p>			

250 Feet from Light Plant

Only Car Lights



Picture 8-0: (left to right) Old PPE Rain Jacket; Maintenance Clothing; Old PPE Vest; New PPE Vest and Pants Combo; New PPE Rain Jacket

250 feet from vehicle and next to light tower	All Lights Off	Car Lights Off	Car Lights On
New PPE Short Sleeves Shirt and Pants Combo (Picture 8-1, 8-2, 8-3)			
Old PPE Vest (Picture 8-4, 8-5, 8-6)			
Maintenance Clothing (Picture 8-7, 8-8, 8-9)			
New PPE Rain Jacket (Picture 8-10, 8-11, 8-12)			
Old PPE Rain Jacket (Picture 8-13, 8-14, 8-15)			