Florida Department of Transportation

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STEPHANIE C. KOPELOUSOS
SECRETARY

April 23, 2008

Mr. Scott Wainwright, P.E.
Office of Transportation Operations (HOTO)
Federal Highway Administration, Mail Stop: E84-402
1200 New Jersey Avenue, S.E.
Washington, DC 20590

Re: Request for Interim Approval Status
Rectangular-shaped Rapid Flashing LED Crosswalk Beacon
PTE No. 4-4305(E)

Dear Mr. Wainwright:

The Florida Department of Transportation endorses the City of St. Petersburg, Florida's request to the Federal Highway Administration (FHWA) to have the Rectangular-Shaped Rapid Flashing LED Crosswalk Beacon (Enhancer) device approved as an Interim Approval device, per the Manual of Uniform Traffic Control Devices. We have been directly involved in the development, testing and evaluation of this new device with the City of St. Petersburg for the past two years. Our experimentation of this new device has proven to be extremely effective to increase motorist's compliance to yield to pedestrians in marked crosswalks.

I attended the last National Committee on Uniform Traffic Control Devices, Traffic Signal Committee Meeting in January 2008 with Michael Frederick, City of St. Petersburg, and we requested the Committee to recommend to the FHWA that this new device be approved as an Interim Approval device. As you know, this was unanimously endorsed by the committee by a show of hands.

This new device provides traffic engineers with an extremely effective low-cost solution to a problem with many marked pedestrian crosswalks that do not meet MUTCD warrants for the installation of a traffic signal; which is most of the motorist do not stop or yield to the pedestrian crossing in the crosswalk. Where this device has been installed, independent evaluations have recorded that after 1-year over 85% of the motorist stop or yield to the crossing pedestrian with zero rear-end conflicts. In addition we were always able to induce a safe gap. This is what we have been looking for to improve crosswalk safety and what traffic engineer's need to be able to install, without having to under take the Request for Experiment process.

We are encouraged that the FHWA will approve this request for Interim Approval status in a timely manor as there are numerous other agencies waiting to take advantage of this device.

Please call me or e-mail directly if you have any questions or need to discuss this issue more.

Sincerely,

Mark C. Wilson, P.E.
Deputy State Traffic Operations Engineer
mark.wilson@dot.state.fl.us
(850) 410-5419

/mcw

cc: Michael Loysells, FHWA Florida Division
Michael Frederick, City of St. Petersburg

CITY OF ST. PETERSBURG

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January 22, 2008.

Mr. Scott Weinwright
Federal Highway Administration
Office of Traffic Operations
400 Seventh Street, S.W., HOTO
Washington, DC. 20590

Re: Request for Interim Approval -
The City of St. Petersburg - PTE No. 4-305(E)
"Rectangular-shaped Rapid Flashing LED Beacons" at Marked Crosswalks

Dear Mr. Weinwright,

The City of St. Petersburg is requesting that FHWA terminate Experimental Permit "PTE No. 4-305(E)" and move it forward into an interim approval. This request is due to the direct results of the experimentation with Rectangular-shaped Rapid Flashing LED Beacons at marked pedestrian crosswalks while following the guidelines that were set forth in the authorization for experimentation granted to the State of Florida and our city, the City of St. Petersburg. The use of this device has delivered verifiable results through successful experimentations and studies which have proven the overall safety effect of the device.

Extensive data collected to date, both here and in Miami, illustrate that the Rectangular-shaped Rapid Flashing LED Beacons have no negative risk and only positive safety and cost benefits. Copies of our analysis as well as independent studies conducted by Dr. Ron Van Houten, of the University of Western Michigan and The Center for Education in Safety Inc., verify that to date no other amber flashing beacon has obtained and sustained for over one-year from the date of installation, the high rate of motorist yielding compliance we have with this device.

The attached application, as required, includes all supporting documentation including research, evaluations as well as suggested wording for rulemaking. We have proposed a new chapter to detail this new traffic control device that complements existing language of the 2003 MUTCD and incorporates many suggestions from the NCUTCD Traffic Signal Committee.

Thank you in consideration of this request and please do not hesitate to contact either Mr. Joe Kubicki, Director, at 727/892-5274 or Mr. Michael Frederick, Manager at 727/893/7843 should you have any questions.

Sincerely,

Rick Baker

Rick Baker, Mayor

JK/mjf

cc: Lap Hoang, P.E. - State Traffic Operations Engineer
Mark C. Wilson, P.E. - Deputy State Traffic Operations Engineer
Don Skelton, Secretary – FDOT District Seven
R.D. Jones, President – Stop Experts, Incorporated

CITY OF ST. PETERSBURG
Department of Transportation & Parking

Request for Interim Approval

PTE No. 4-305(E)

"Rectangular-shaped Rapid Flashing LED Beacons"

at Pedestrian Crosswalks

Submitted to: Federal Highway Administration

January 22, 2008.

FORWARD

Interim Approvals allow FHWA to grant authority to State and local highway agencies to use on an interim basis, "proven successful" and "proven safe" new traffic control devices or device applications that are not specifically described in the MUTCD. Such approvals are based on the results of successful experimentation, studies, or research, and an intention to place the new or revised device into a future notice of proposed amendment to the MUTCD. This process allows the traveling public and/or operating agencies to more quickly realize the safety and operational benefits associate with such devices.

CONTENTS

SUMMARY

Interim Approvals

Standard:
Requests for any interpretation, permission to experiment, interim approval, or change shall be sent to the Federal Highway Administration (FHWA), Office of Transportation Operations, 400 Seventh Street, SW, HOTO, Washington, DC 20590.

Support:
Requests for interim approval include consideration of allowing interim use, pending official rulemaking, of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in this Manual. If granted, interim approval will result in the traffic control device or application being placed into the next scheduled rulemaking process for revisions to this Manual. The device or application will be permitted to remain in place, under any conditions established in the interim approval, until an official rulemaking action has occurred.

Interim approval is considered based on the results of successful experimentation, results of analytical or laboratory studies, and/or review of non-U.S. experience with a traffic control device or application. Interim approval considerations include an assessment of relative risks, benefits, and costs. Interim approval includes conditions that jurisdictions agree to comply with in order to use the traffic control device or application until an official rulemaking action has occurred.

Guidance:
The request for permission to place a traffic control device under interim approval should contain the following:

A. A statement indicating the nature of the problem.

It is often the situation that motorists fail to yield right-of-way to pedestrians in crosswalks. Thus, being a pedestrian can be extremely dangerous. In 2004 and 2005 there were a total of 9,556 pedestrian fatalities and 132,000 pedestrian injuries resulting from pedestrian-automobile crashes nation-wide. Decreasing the occurrence of these crashes would increase the safety and overall experience of walking for pedestrians. The majority of pedestrian crashes occur at marked crosswalks. Any thing less than a traffic signal have historically had minimal effect on motorist yielding behavior on multilane roads. An inexpensive and effective solution is the pedestrian crossing aid with added rectangular-shaped rapid-flash LED beacons.

One significant barrier to creating safe crossings of roadways at marked crosswalks is the lack of guidance on what, and under what particular circumstances, treatments (grade separation, signalization, signage, or striping) should be used. Currently, the *Manual on Uniform Traffic Control Devices (MUTCD)* provides several options for mid-block crossings, including: crossing advance and crossing signs, round flashing beacons, in-roadway flashing lights, and signalized crossings. However, the guidance for use of signage and other treatments is in the form of "when used, do the following" and not "under these circumstances, use these devices." The *MUTCD* does provide specific guidance in the form of signal warrants for the application of mid-block traffic signals for pedestrians.

Several techniques and technologies have been used in the past to increase driver yielding to pedestrians at marked crosswalks. Some examples are represented by different uses of signage. There is a range of static signs from traditional "pedestrian signs" to "Yield here to Pedestrians" signs, each placed on the side of the roadways. Some older technologies include flashing over-head round amber beacons. In-road advance yield markings as well as in-roadway signage have also been employed. Ellis, Van Houten, and Kim (2006) experimented with in-road signs placed vertically in center-lanes. The signs were placed at intervals of 0 (at crossing), 20 feet in advance of crosswalk and 40 feet in advance of the crosswalk. These signs showed results of two to three times the yielding over baseline with maximum yielding at about 61%. However a study by Turner et al. showed that these devices do not work well on multilane roads.

A study conducted by Turner et. al. (1) jointly funded by the Transit Cooperative Research Program and the National Cooperative Highway Research Program compared several treatments to improve motorist yielding to pedestrians at unsignalized intersections. The research team collected data on motorist yielding behavior at 42 crosswalks in different regions of the United States. The results indicated that only devices with a red indication were effective at increasing yielding behavior at marked crosswalks on multilane roads to obtain compliance rates greater than 90%.

The Turner et. al. study also found that amber flashing beacons produced driver yielding levels of 47% and 31% on multilane roads. Similar results have been obtained in other studies. For example, Van Winkler and Neal (2) found that pedestrian activated overhead flashing beacons increased yielding from 8.5% to 42% and that yielding remained at 50% at long term follow-up. An alternative amber indication involves the use of in-roadway flashing lights. A comprehensive study in California (3) found that in-roadway lights increased daytime yielding from 28% to 53% and a Florida study (4) obtained increases from 28% to 53%. Van Houten et. al. (5) directly compared a pedestrian activated overhead amber flashing beacon with a yellow LED sign that included animated eyes that looked from side to side and a white pedestrian icon showing the direction the pedestrian crossed the street at a single location. The amber beacon was associated with an increase in yielding from 15% to 36% while the LED sign increased yielding to 40%.

These data show that amber indications can produce intermediate levels of yielding behavior. It is therefore apparent that additional protection for the pedestrian crossing at marked crosswalks is required.

B. A description of the proposed change to the traffic control device or application of the traffic control device, how it was developed, the manner in which it deviates from the standard, and how it is expected to be an improvement over existing standards.

"Rectangular-shaped Rapid Flashing LED Beacons" are special types of highway traffic signals installed to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop. This includes, but is not necessarily limited to, situations warning of marked school crosswalks, marked mid-block crosswalks, marked crosswalks on uncontrolled approaches, marked crosswalks in advance of roundabout intersections as described in Sections 3B.24 and 3B.25, of the MUTCD and other roadway situations involving pedestrian crossings. Rectangular-shaped LED Beacons do not utilize one or more signal sections of a standard traffic signal face.

This traffic control device was developed to examine the effects of installing pedestrian activated rectangular-shaped rapid flashing amber LED beacons to the bottom of the pedestrian sign located at marked crosswalks. The rectangular-shaped LED beacons are only installed at marked crosswalks with applicable warning signs. They shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals. Standards currently only allow the crosswalk sign to stand alone or to be supplemented with a round flashing amber beacon, installed adjacent to the sign.

This traffic control device deviates from the approved standard in size, shape location and flash rate. Specifically:

- The Rectangular-shaped LED Beacons shall be located at the nearest edge of the bottom of the crosswalk sign.
- The Rectangular-shaped LED Beacons at crosswalks shall be installed facing all approaches of traffic to the crosswalk.
- The Rectangular-shaped LED Beacons at crosswalks shall initiate operation based on pedestrian actuation and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
- The Rectangular-shaped LED Beacons at crosswalks shall display two flashing yellow signal indications in an alternating flashing sequence when actuated. The flash rate of the alternating flashing sequence and per LED housing shall not be between 5 and 30 flashes per second to avoid frequencies that might cause seizures.
- The Rectangular-shaped LED Beacons shall consist of two rectangular beacons aligned horizontally on or within a rectangular shaped housing. The housing shall be twenty four inches (24 in) to thirty inches (30 in) wide, a maximum of five inches (5 in) high, and a maximum of six inches (6 in) deep. There shall be a minimum space of seven inches (7 in) between the two rectangular beacons.
- Two additional alternating flashing Rectangular-shaped LED Beacons may be used on the opposite side of the rectangular shaped housing facing opposing traffic.
- When a supplemental plaque is installed in conjunction with the W11-1 Pedestrian Traffic sign or S1-1 School sign, the Rectangular-shaped LED Beacons shall be installed between the W11-1 Pedestrian Traffic sign or S1-1 School sign and the associated plaque.
- Based on an engineering judgment, to increase compliance levels, a momentary illuminating light bar (MILB) may be attached to the LED Rectangular-shaped Beacons. The MILB is a narrow row of LED light housings which produce a steady horizontal light emission. The housing shall be twenty four inches (600mm) to thirty inches (700mm) wide, a maximum of two inches (50mm) high, and a maximum of 3 inches (75mm) deep.

- The MILB shall have a maximum operating sequence of one to two seconds in a steady illuminating sequence. The MILB shall only be illuminated after the two main alternating flashing LED signal indications have been energized and operational for at least two to three seconds and only one MILB sequence shall be used per the operational cycle of the LED Rectangular-shaped Beacons.
- The Rectangular-shaped LED Beacons and MILB shall be maintained so as to be capable of being visible on a sunny day when viewed without the sun directly on or behind the device from a distance of 1,000 ft.
- The period of operation of the Rectangular-shaped LED Beacons following each actuation should be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb or shoulder and travel at a normal walking speed of 3.5ft per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait. Where pedestrians who walk slower than normal, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3 ft per second should be considered in determining the period of operation. Where the period of operation is sufficient only for crossing from a curb or shoulder to a median of sufficient width for pedestrians to wait, additional measures should be considered, such as median-mounted pedestrian actuators.
- Rectangular-shaped LED Beacons at crosswalks may use pedestrian detectors to determine the duration of the operation instead of ceasing operation after a predetermined time.
- Unidirectional Rectangular-shaped LED Beacons installed at crosswalk locations may have an optional, additional amber light indication in each unit that is visible to pedestrians in the crosswalk to indicate to pedestrians in the crosswalk that the Rectangular-shaped LED Beacons are in fact flashing as they cross the street. These lights may flash with and at the same flash rate as the light module in which each is installed.

The analysis conducted by the City of St. Petersburg and others has proven that the rectangular–shaped rapid flashing LED beacons will better attract motorist's attention to the marked crosswalk and pedestrians crossing, over conventional round beacons because of its rapid flash rate, location and directionality of the rectangular shaped LEDs. This treatment delivered verifiable results through experimentation better than the standard overhead or side mounted flashing round beacon or in-roadway lighting and produced clear safety and cost benefits, clearly illustrates it to be a viable alternative to use of these treatments.

C. The location(s) where it will be used and any illustration that would be helpful to understand the traffic control device or use of the traffic control device.

See Appendix A.'

D. A legally-binding statement certifying that the concept of the traffic control device is not protected by a patent or copyright.

Be it Stated: The City of St. Petersburg will not be using, to our full knowledge, a patented or copyrighted rectangular-shaped beacon unit which when energized shall flash rectangular yellow LED beacons to approaching motor vehicles, and have them operate until they have timed out and turned off. (See Appendix B)

E. A detailed completed research or evaluation on this traffic control device.

The purpose of this research was specifically to increase the safety of pedestrians crossing at marked crosswalks in the City of St. Petersburg, FL. The approach and intervention used was comprised from the knowledge of human behavior, traffic engineering, and recent advances in technology.

One alternative to in-roadway lighting and amber flashing round beacons are LED rapid flash amber beacons that are comparable in operation to emergency flashers on police vehicles. This study consisted of three experiments. The first experiment compared installing these beacons on pedestrians signs on both sides of the crosswalk (2 sets of beacons) with installing them on both sides of the crosswalk plus on the median island (4 sets of beacons). The second experiment compared LED rapid flashing beacons with a traditional overhead flashing beacon and traditional beacons mounted beside the pedestrian signs. The third experiment examined the long-term effects of the rapid flashing beacons at 18 marked crosswalks.

This investigation supported by a grant from FHWA and funding from the City of St. Petersburg, FL evaluated the efficacy of a rectangular rapid flashing duel LED beacons installed below the pedestrian signs (W11-2) installed at the crosswalk. The two rectangular beacons flash in a wigwag flashing sequence. The signs in combination flash 76 times in the wig-wag flashing sequence during a 30 second cycle. Of the 2 large LED's, the Left LED, flashes 2 times (in a slower type of a rapid flash) each time it is energized followed by the Right LED which flashes rapidly 3 times when energized. The total number of flashes during a 30 second cycle in this combination is 190.

In all cases advance yield markings and "Yield Here for Pedestrian" signs (R1-5) were installed 30 feet in advance of the crosswalk. In addition each approach to the crosswalk had a solid line from the dilemma zone to the advance yield marking to discourage drivers from passing vehicles that yielded to pedestrians. These signs and marking treatments were present during baseline (pre-treatment) and post treatment data collection.

Under the supervision and participation of Dr. Ron Van Houten, four sites were selected in St. Petersburg for detailed study of the system and another 14 sites were installed and evaluated for long-term maintenance of results. At the sites receiving detailed evaluation all had systems installed on each side of the crosswalk and on the median island.

The primary measure in this study was the percentage of drivers yielding to pedestrians and how far the vehicles yielded from the crosswalk. For a vehicle to be considered as not yielding, by Florida law, a strict crossing/observing protocol was followed. A pedestrian must have placed one foot into the crosswalk for an approaching vehicle to be recorded as yielding or not yielding. In addition, the motorist had to be beyond the dilemma zone when the pedestrian actuated the flashing beacons to be scored as not yielding. The location of the dilemma zone was empirically determined using the ITE signal timing formula and the posted speed limit. This procedure insured that the motorist had adequate time to stop taking into consideration reaction time, speed of the roadway, safe braking distance, and grade. Distance at which yielding occurs is an important variable in reducing the occurrence of multiple threats. Distance from the crosswalk was measured and marked in each direction of traffic in the following divisions: <10ft., 10ft.-20ft., 20ft.-30ft., 30ft.-50ft., 50ft.-70ft., 70ft.-100ft., and >100ft. Baseline sessions consisted of the first site (of four) being recorded for five data sheets, the next site seven, then nine, and then eleven. Each alternation of two and four systems received five data sheets of observation. This produced a total of 82 data sheets comprised of 1,640 crossings.

The results show average yielding of 18% during baseline, 81% with two systems (side systems alone), and 88% with four systems (side and median mounted beacons). These changes represent a 63% increase in yielding over baseline for the two-system treatment and a 70% increase from baseline for the four-system treatment.

Average Yielding Percentage per Site Across Conditions

Location	Baseline	2 RF Beacons	4 RF Beacons
Site 1	28%	84%	93%
Site 2	11%	81%	89%
Site 3	18%	86%	90%
Site 4	15%	73%	80%

The system also had a significant effect on yielding distance. In particular, yielding at >100ft. doubled when median systems were installed (this difference was significant at the .05 level). The increase of both yielding compliance and increase in distance serve to greatly reduce the multiple threat incidents. Note that the greatest number of drivers yielded just beyond the yielding markings placed at 30 feet during all conditions.

Average Yielding Distance Across Conditions

Configuration	30ft-50ft	50ft-70ft	70ft-100ft	>100ft
Baseline	36.60%	15.30%	11.00%	7.70%
2 RF Beacons	32.90%	15.80%	12.30%	12.70%
4 RF Beacons	34.50%	17.20%	11.50%	15.40%

Of important concern was whether or not the additional cost of installation of the fourth system, the median system, for multi-lane roadways is feasible. Thus, the difference between the yielding compliance of two and four-systems are compared. A two-sample T-test was used to test the significance of the difference. Results show the difference to be significant at the .001 level.

Two-sample T-test

	T-Value	**P-Value**	**df**
Obtained	|-3.68|	0	78
Critical	2		

A Tukey test, among all pairwise comparisons, for confidence intervals also produced statistically significant results (intervals absent of containing 0).

Lower	**Center**	**Upper**
3.057	6.653	10.248

While the above results are very promising and favorable for daytime efficacy, to date, Dr. Van Houten and his team have only collected night data at one of the sites. The preliminary results for the efficacy of the rectangular LED beacons at night are even more promising. The average yielding percentage at night produced 4.8% (baseline), 86.72% (two beacon system), and 99.26% yielding (four beacon system).

The City of St. Petersburg, with the supervision of Mr. Michael Frederick, has been conducting similar on-going research at 18 sites including the 4 sites studied in greater detail documented above. All sites include multilane roads with 24 hour ADTs between 9,600 and 19,422. Fourteen of the city research sites have follow-up data at one year. The 365-day data for those sites report average daytime yielding compliance rates of 82.17%. The four additional sites have 270-day data with average daytime motorist yielding rates of 79.53%. After a total of 121 separate studies the average daytime yielding compliance at **81.59%** has been obtained at 18 sites.

Additional data recorded and examined include crossing distance, number of lanes, ADT, and actual speed. A correlation analysis was performed between these variables and percentage of drivers yielding to pedestrians. The only significant correlation was that of ADT plotted against yielding (positive correlation). The long term data collected to date at all city sites addresses the possibility that the increase in yielding following introduction of the rectangular-shaped rapid flashing LED beacons results from a novelty effect. (See Appendix C for details of the St. Petersburg data).

F. **An agreement to restore the site(s) of the interim approval to a condition that complies with the provisions in this Manual within 3 months following the issuance of a final rule on this traffic control device. This, agreement must also provide that the agency sponsoring the interim approval will terminate use of the device or application installed under the interim approval at any time that it determines significant safety concerns are directly or indirectly attributable to the device or application. The FHWA's Office of Transportation Operations has the right to terminate the interim approval at any time if there is an indication of safety concerns.**

It is hereby further agreed that the experimental sites will be restored within 90 days of the FHWA's ruling on this site to stay within the legal guidelines of Flashing Beacon installations according to the MUTCD. (See Appendix G).

REFERENCES.

1. Turner, S., Fitzpatrick, K., Brewer, M., and Park, E.S. Motorist yielding to pedestrians at unsignalized intersections: Findings from a national study on improving pedestrian safety. *Transportation Research Record, 1982.* Transportation Research Board, Washington, D.C., 2006, pp. 1-12.

2. Van Winkle, J.W. and Neal, D.A. Pedestrian-actuated crosswalk flashers. Paper presented at the ITE 2000 Annual Meeting, Institute of Transportation Engineers, Nashville, TN. August 2002.

3. Whitlock & Weinburger Transportation, Inc., An Evaluation of a Crosswalk Warning System Utilizing In-Pavement Flashing Lights, Santa Rosa, California, April 10, 1998.

4. Huang, H., R. Hughes, C. Zegeer, and M. Nitzburg, An Evaluation of the LightGuardTM Pedestrian Crosswalk Warning System, Highway Safety Research Center, University of North Carolina, Chapel Hill, North Carolina, June 1999.

5. R. & Malenfant, J.E.L. (2000). ITS Animated LED Signals Alert Drivers to Pedestrian Threats, ITE Journal, 71, p. 42-47.

ACKNOWLEDGEMENTS.

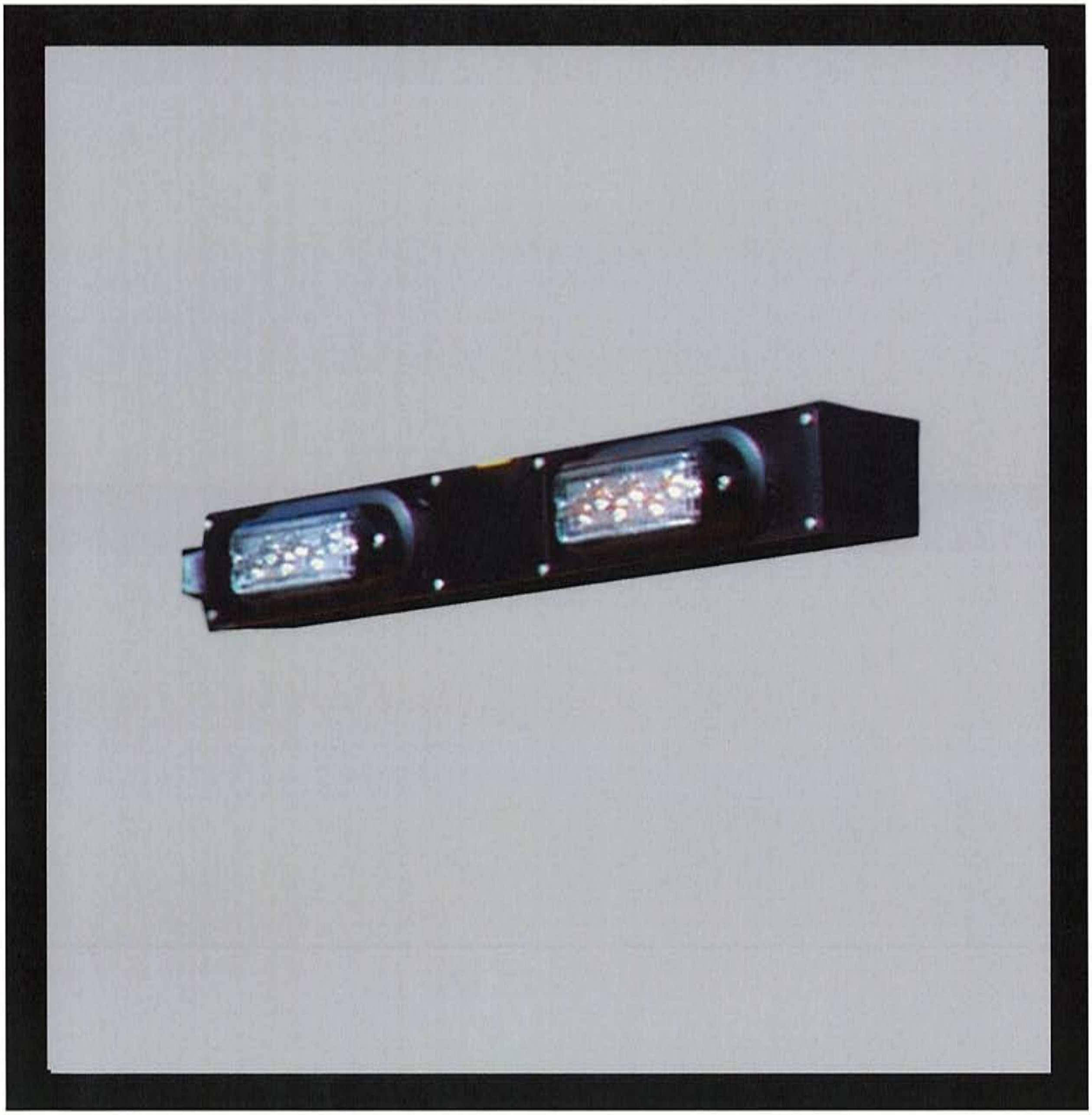
Dr. Van Houten, PhD., Western Michigan University & The Center for Education in Research and Safety Inc. for his support and efforts in conducting independent analysis and reports.

Mark C. Wilson, P.E., Deputy State Traffic Operations Engineer – State of Florida for his continued support and enthusiasm of the project.

R.D. Jones, President / CEO, Stop Experts, Incorporated for his innovation and perseverance.

APPENDIX A

Rectangular-shaped Rapid Flashing LED Beacon – Housing



Rectangular-shaped Rapid Flashing LED Beacon - - With S1-1

Rectangular-shaped Rapid Flashing LED Beacon – With W11-1