U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

June 23, 2011

In Reply Refer To:
HSST/LS-73

Mr. Dean L. Sicking, Ph.D., P.E.
Director, Midwest Roadside Safety Facility
University of Nebraska - Lincoln
2200 Vine Street
130 Whittier research Center
Lincoln, NE 68583-0583

Dear Mr. Sicking:

This letter is in response to Mr. Scott Rosenbaugh's request for the Federal Highway Administration (FHWA) acceptance of a design for the Illinois DOT breakaway brass couplings for use with luminaire supports on the National Highway System (NHS).

Name of system: Brass Breakaway Couplings
Type of system: Breakaway Hardware for Aluminum and Steel Luminaire Supports
Test Level: NCHRP Report 350 Test Level 3 (Pendulum Testing)
Testing conducted by: Midwest Roadside Safety Facility
Date of requests: December 23, 2010
Date of completed package: December 23, 2010
Request initially acknowledged: December 27, 2010

You requested that we find a brass breakaway coupling acceptable for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

Requirements
Roadside safety devices should meet the guidelines contained in the National Cooperative Highway Research Program (NCHRP) Report 350 if tested prior to December 31, 2010, and the American Association of State Highway and Transportation Officials' (AASHTO) Manual for Assessing Safety Hardware (MASH) if tested after that date. Requirements for breakaway supports are contained in both of these documents and in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.

Decision
The following component was found acceptable, with details provided below:

- Brass Breakaway Coupling Hardware for Aluminum and Steel Luminaire Supports

FHWA: HSST: WLongstreet: ms: x60087:6/15/11
File: h://directory folder/HSST/LS-73MwRSFCouplings#6.docx
cc: HSST Will Longstreet

Test Descriptions

A total of seven tests were performed (i.e., Test Nos. BBC-1 through BBC-7) to verify the crash performance of the breakaway couplings. Since the occupant risk factors in the first two tests (BBC-1 and BBC-2) exceeded the allowable maximum values, the brass couplings were redesigned for the next three tests.

Tests BBC-3 and BBC-4 both tested heavy steel poles, the first test using the modified brass couplers (Version 2) and the second using a previously-accepted double-neck coupling for comparison purposes. While both of these tests satisfied the low-speed pendulum occupant risk values, both exceeded the extrapolated maximum allowable change in velocity.

Test BBC-5 tested the crashworthiness of a 30-foot (9.1-meter) aluminum pole with a single mast arm mounted on the modified brass breakaway couplings (Version 2). The low-speed change in velocity (ΔVL) and the extrapolated high-speed change (ΔVH) were believed to be conservative estimates for the final (Version 3) breakaway brass coupling design. The only difference between Version 2 and the Version 3 couplings was the distance between the notch and top of the coupling as well as the overall coupling height. This change lowered its impact resistance and effectively shortened the time to fracture. Therefore, a test of the same pole/mast arm configuration using the Version 3 breakaway brass couplings would result in lower ΔVL and ΔVH values than those in test BBC-5. Subsequently, the Version 3 brass couplings were deemed to meet the TL-3 impact safety standards when utilized with a 30-foot (9.1-meter) nominal height, aluminum luminaire pole system.

Test BBC-6 specified Version 3 brass couplings used to support a 45-foot (13.7-meter) nominal height, steel luminaire pole system. During the impact event, all four couplings fractured, leaving stub heights of 1¾ inch (38 millimeter). In the test, the pole system rotated away from its initial attachment location. The measured ΔVL was 13.25 feet/second (4.04 meters/second), which satisfied the NCHRP Report No. 350 maximum allowable limit of 16.4 feet/second (5.0 meters/second). However, the extrapolated ΔVH was calculated to be 16.85 feet/second (5.14 meters/second). As a result, the 45-foot (13.7-meter) nominal height, steel luminaire system did not meet the TL-3 evaluation criteria.

Test BBC-7 used an aluminum luminaire pole with a 55-foot (16.8-meter) nominal mounting height. The pole shaft was 50-foot (15.2-meter) long, 5/16-inch (8-millimeter) thick, and had top and bottom diameters of 6 inches (152 millimeters) and 10 inches (254 millimeters), respectively. The base plate was 1¼-inch (32-millimeters) thick by 14-inch (356-millimeters) square. The bolt circle was 15 inches (381 millimeters) in diameter. Dual 15-foot (4.6-meter) truss arms were attached to top of the pole. The pole weighed 536 pounds (243 kilograms), while the arms with simulated luminaire weighed 219 pounds (99 kilograms). The total weight of the luminaire pole system was 755 pounds (343 kilograms). In this test, the breakaway brass couplings (Version 3) fractured and allowed the aluminum pole system to rotate away from its initial ground attachment location. The remaining coupling stub heights were 1¾ inch (38 millimeter), satisfying the 4-inch (100-millimeter) limit. Both the measured ΔVL and the extrapolated ΔVH satisfied the NCHRP Report No. 350 maximum allowable limit of 16.4 feet/second (5.0 meters/second). Therefore, based on the results of tests BBC-5 and BBC-7, aluminum luminaire poles of nominal heights between 30 feet (9.1 meters) and 55 feet

(16.8 meters), with minimum wall thicknesses of ¼-inch (6.4 millimeters), and weighs equal to or less than 755 pounds (343 kilograms) should be acceptable for use with the Version 3 breakaway brass couplings.

For test no. BBC-6, the Version 3 brass couplings were used to support a 45-foot (13.7-meter) nominal height, steel luminaire pole system. During the impact event, all four couplings fractured, leaving stub heights of 1¾-inch (38 millimeter). In the test, the pole system rotated away from its initial attachment location. The measured ΔVL was 13.25 feet/second (4.04 meters/second), which satisfied the NCHRP Report No. 350 maximum allowable limit of 16.4 feet/second (5.0 meters/second). However, the extrapolated ΔVH was calculated to be 16.85 feet/second (5.14 meters/second). As a result, the 45-foot (13.7-meter) nominal height, steel luminaire system did not meet the TL-3 evaluation criteria.

To identify the largest steel luminaire poles that can be used in combination with the breakaway brass couplings, further analysis was undertaken using the high-speed extrapolation equation to predict the ΔVH for different size poles. Steel luminaire pole configurations with varying thicknesses and heights were analyzed to determine the extrapolated high-speed, change in longitudinal velocity (ΔVH). These extrapolated values were compared to the maximum allowable limit of 16.4 feet/second (5.0 meters/second) in order to determine whether specific poles were acceptable for use with the brass couplings. During this study, the luminaire arms, base plate, and pole base diameter were held constant to the dimensions and weights corresponding to those used in test no. BBC-6. Thus, only the shaft thickness and heights were altered. This analysis yielded the maximum shaft height for poles with a wall thickness ranging between 7 gauge (4.55 millimeter) and 11 gauge (3.03 millimeter). For a 7-gauge (4.55-millimeter) wall thickness or the same thickness as used in test no. BBC-6, the maximum shaft height was determined to be 36 feet (11.0 m), with a nominal height of 41 feet (12.5 meters). The results from this analysis for all wall thicknesses are shown in the Table below.

Crash Testing

Pendulum testing was conducted on the test articles described above by the Midwest Roadside Safety Facility with their FHWA-approved Valmont/MwRSF-UNL pendulum. All tests were conducted according to NCHRP 350 test designation 3-60. The FHWA accepts pendulum tests as surrogates for this low-speed small car test. FHWA also allows the results of the high speed tests to be estimated using data from the low-speed pendulum test in combination with an analytical extrapolation method described in the FHWA memorandum “Identifying Acceptable Highway Safety Features” dated on July 25, 1997.

Findings

The breakaway couplings proposed by the ILDOT and subsequently modified during your research effort were fabricated from ASTM B16, free-cutting brass, drilled and tapped for 1 inch (25 millimeter) – 8UNC threaded bars, and had a circumferential notch cut around its outer surface to induce fracture.

The final design (Version 3) as developed under your testing program for the Illinois DOT is shown as an enclosure to this letter and is acceptable for use on the NHS. The applicable luminaire pole systems for use with the Brass Breakaway Couplings when used to support

aluminum or steel poles with maximum base diameters of 10 inches (254 millimeters) and within the height and weight ranges are shown in the following table.

Pole Type	Thickness	Base Diameter		Nominal Height		System Weight	
		Min.	Max.	Min.	Max.	Min.	Max.
Aluminum	≥ ¼ in. (≥ 6.4 mm)	8 in. (203 mm)	10 in. (254 mm)	30 ft (9.1 m)	55 ft (16.8 m)	259 lb (118 kg)	755 lb (343 kg)
Steel	7 gauge (4.55 mm)	NA	10 in. (254 mm)	30 ft (9.1 m)	41 ft (12.5 m)	259 lb (118 kg)	872 lb (396 kg)
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	11 gauge (3.03 mm)	NA	10 in. (254 mm)	30 ft (9.1 m)	60 ft (18.3 m)	259 lb (118 kg)	782 lb (355 kg)

The final design of the brass coupling Version 3 may be used on the NHS in combination with any of the poles as indicated in this correspondence. As noted in your test report, poles with diameters larger than 10 inches (254 millimeters) must be analyzed independently using the proposed systems' mass distribution and the extrapolation formula to calculate the high speed occupant impact velocities. Because the mast arms were held constant for all tests, any mass arm configurations other than truss-type luminaire arms also need to be analyzed on a case-by-case basis.

Therefore, the systems described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance letter provides an AASHTO/ARTBA/AGC Task Force 13 designator that should be used to create a new or updated Task Force 13 drawing.
- This acceptance is limited to the crashworthiness characteristics of the tested features and does not cover their structural features, such as resistance to wind loads.
- Any design or material changes that may adversely influence the crashworthiness of the Illinois DOT breakaway brass couplings will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.

- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number LS-73 and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- The Brass Couplings identified above are to be patented products and therefore are considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosure

U.S. Department of Transportation
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1200 New Jersey Ave., SE
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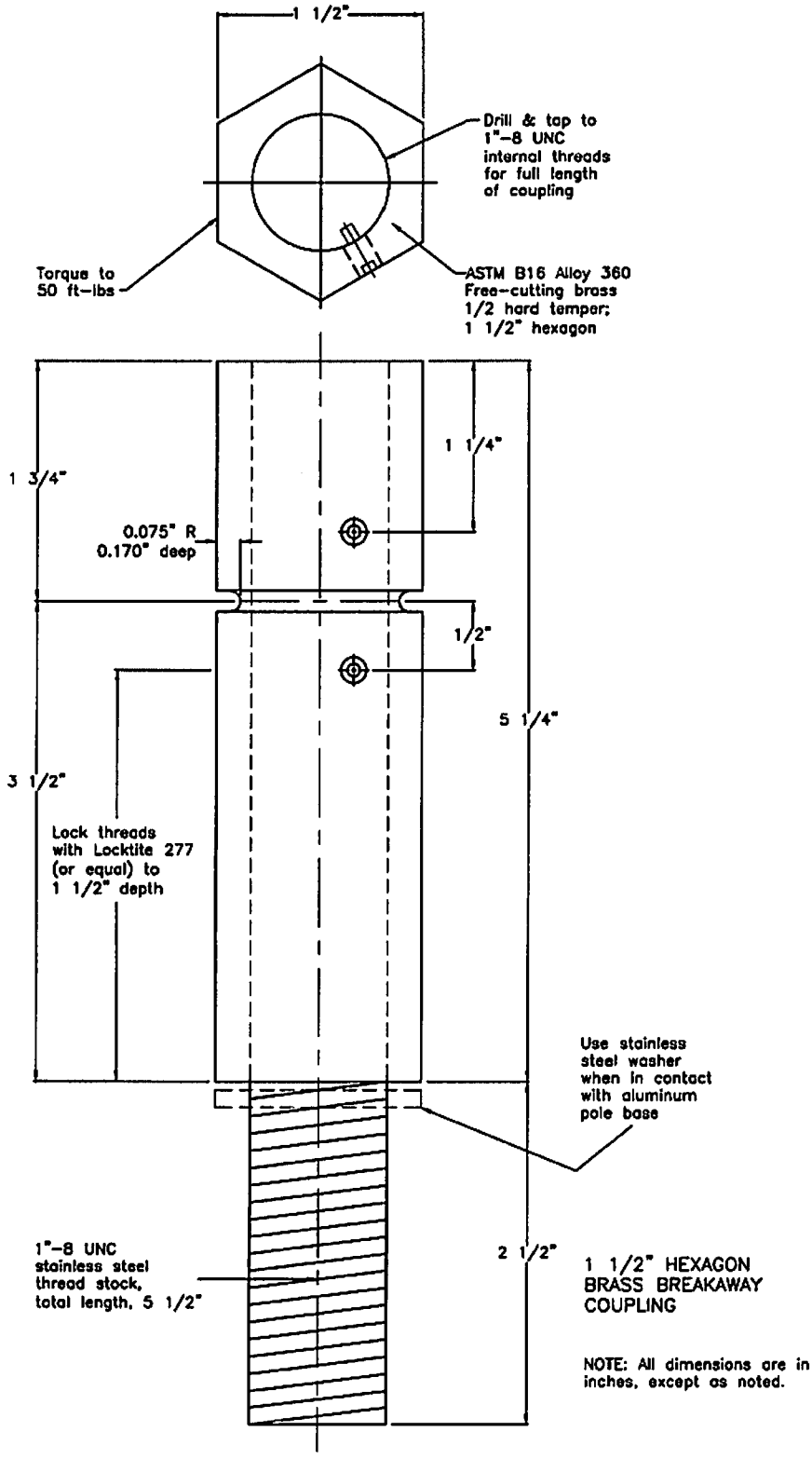
Sincerely yours,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosure


1 1/2"
Drill & tap to 1"–8 UNC internal threads for full length of coupling
Torque to 50 ft–lbs
ASTM B16 Alloy 360 Free–cutting brass 1/2 hard temper; 1 1/2" hexagon
1 1/4"
1 3/4"
0.075" R 0.170" deep
1/2"
5 1/4"
3 1/2"
Lock threads with Locktite 277 (or equal) to 1 1/2" depth
Use stainless steel washer when in contact with aluminum pole base
1"–8 UNC stainless steel thread stock, total length, 5 1/2"
2 1/2"
1 1/2" HEXAGON BRASS BREAKAWAY COUPLING
NOTE: All dimensions are in inches, except as noted.