



U.S. Department
of Transportation

**Federal Highway
Administration**

August 27, 1997

400 Seventh St., S.W.
Washington, D.C. 20590

Refer to: HNG-14

Mr. John W. Duckett
President
Barrier Systems Inc.
1100 E. William Street
Number 206
Carson City, Nevada 89701-3104

Dear Mr. Duckett:

Mr. Edwin M. Wood's June 4 letter to Mr. Gerry L. Eller requested Federal Highway Administration's acceptance of your Narrow Quickchange Moveable Barrier as meeting the performance evaluation criteria set forth in National Cooperative Highway Research Program (NCHRP) Report 350 for a test level 3 (TL-3) barrier. To support this request, you included copies of a May 1997 report prepared by E-TECH Testing Services, Inc., entitled "NCHRP Report 350 Crash Test Results for the Narrow Quickchange Moveable Barrier" and a videotape of the two full-scale crash tests that were run.

The Narrow Quickchange Moveable Barrier consists of separate sections connected together with 35-mm diameter 4140 steel pins. Each section is made from 6.4-mm thick A36 steel casing filled with 24 MPa concrete. It is 991 mm long, 813 mm tall, 305 mm wide and weighs 680 kg. The upper portion of each section is "T" shaped to accommodate the lifting rollers on the barrier transfer machine that is used to move the barrier laterally. The base of each section is made from 19-mm thick steel plate and is 610 mm wide. In addition to this basic unit, your system also includes a Variable Length Barrier (VLB) section equipped with a hydraulic mechanism which allows it to change length when it is unlocked by the transfer machine, thus ensuring that the barrier installation remains in tension as it is relocated laterally. The VLB sections are located such that one is always in the transfer machine during repositioning of the barrier. Each VLB section has the same shape as the concrete-filled sections but is made from 13-mm thick telescoping A36 steel shells connected by a 127-mm diameter bore 41.4 MPa-rated hydraulic cylinder that allows the VLB to expand or contract up to 178 mm while it is

engaged by the transfer machine. Enclosures 1 and 2 show the standard and VLB sections respectively.

You conducted two crash tests on the Narrow Quickchange system. Test 3-10 was an 820-kg automobile impacting the barrier at nearly 107-km/h and a 21.0-degree impact angle. The recommended nominal impact speed and angle for this test are 100 km/h and 20 degrees, respectively. We noted that all evaluation criteria were met even though the impact severity (IS) exceeded the recommended upper limit of 40.0 kJ. The barrier deflected 464 mm. Test 3-11 was a 2000-kg pickup truck impacting the barrier at 98.2 km/h and 24.5 degrees. Although both of these variables are below the nominal values, the overall IS of 130.68 kJ falls within the lower limit suggested in the NCHRP Report 350, and again, all evaluation criteria were well within the acceptable ranges. Total barrier deflection for this test was 877 mm. Summary test data are shown on Enclosure 3.

During our review, we noted that the VLB units were not impacted in either crash test. Since these units are not concrete-filled, we were concerned that they might constitute a "weak link" in the system, possibly causing a vehicle to crush the inner shell and snag on the exposed edge of the outer shell. In response to this concern and other questions, you provided additional information on July 1, followed on July 29 by a detailed structural analysis and information on a crash test you had previously run on a VLB incorporated into a standard (i.e., into a full-width Quickchange barrier) installation.

Finally, we noted that the anchorage system used in the tests consisted of two 150-mm square steel tubes and two 25-mm by 100-mm A36 steel straps with threaded turnbuckle connections. These were attached to two 914-mm diameter by 2438-mm deep reinforced concrete anchors. You indicated that a different anchorage system may be used in the future for actual field installations. We have no objection to a different anchorage design as long as it has equal or greater tensile strength than the one that was tested and users of the Narrow Quickchange Moveable Barrier are made aware of this requirement.

Based on the information you have presented, we consider the Narrow Quickchange Moveable Barrier to be acceptable as an NCHRP Report 350 TL-3 barrier for use on the National Highway System (NHS) when such use is requested by a State agency. Since your product is proprietary, its use on Federal-aid projects (except

exempt, non-NHS projects) is subject to the conditions stated in Title 23, Code of Federal Regulations, Section 635.411, a copy of which is enclosed as Enclosure 4.

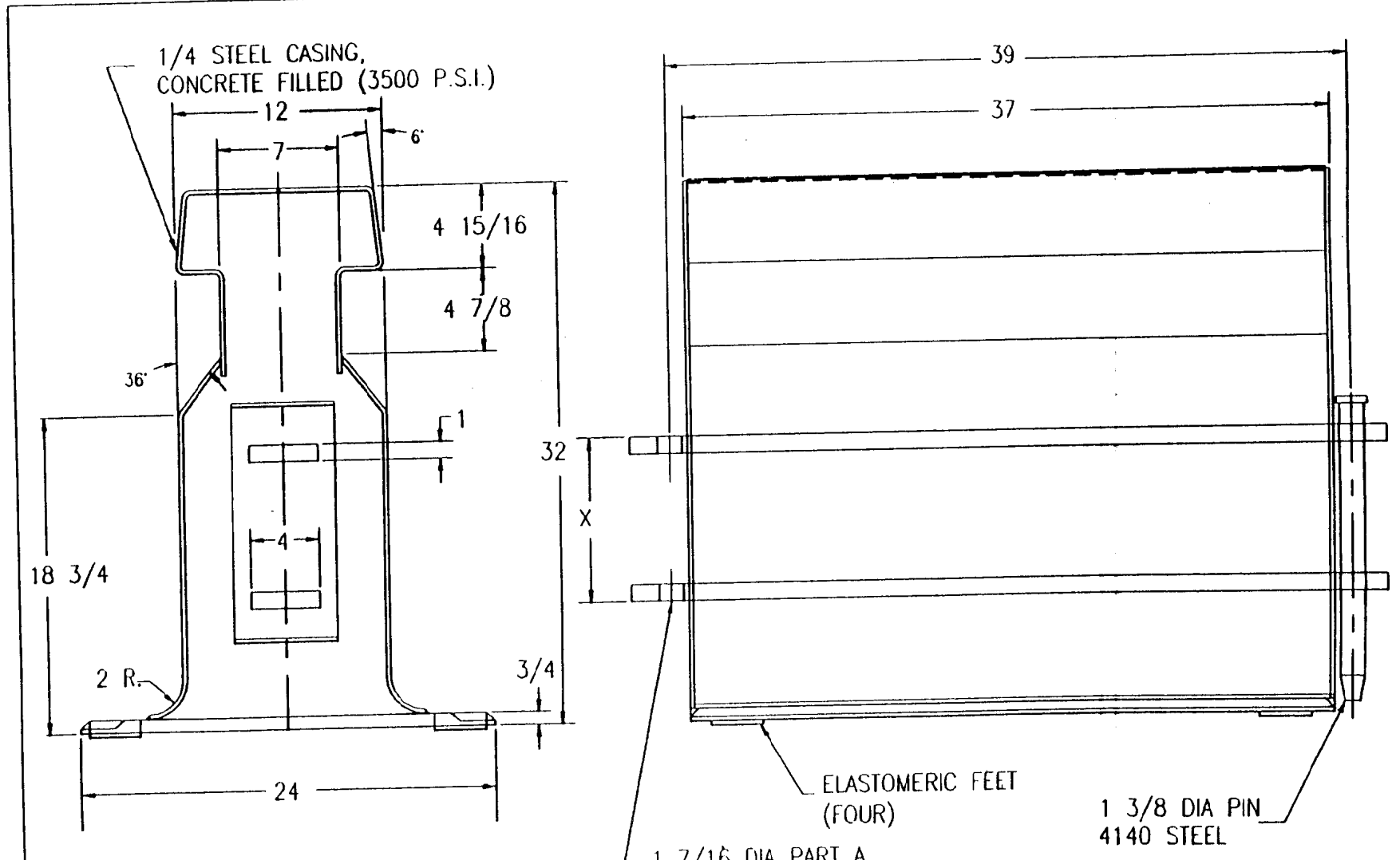
Sincerely yours, .

Dwight A. Horne

Dwight A. Horne, Chief
Federal-Aid and Design Division

4 Enclosures

Geometric and Safety Design Acceptance Letter BB-40



WT. = 1500 LBS. ±
 ALL MATERIAL IS ASTM A36 STEEL
 UNLESS SPECIFIED OTHERWISE

X = 9 3/4 PART A
 X = 12 1/4 PART B

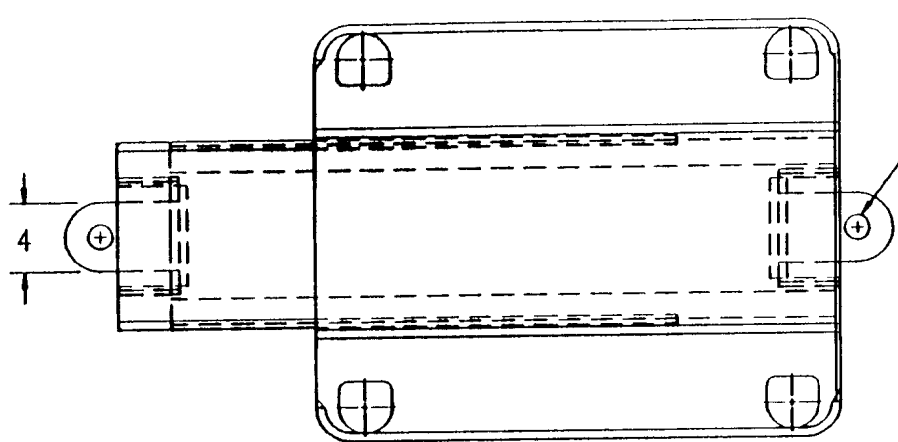
| | | | | | | |
|---|--|---------------------------------|---------------------|---------|----------------|------|
| The information herein is proprietary to Barrier Systems, Inc. and shall not be disclosed, duplicated or used otherwise without the express written approval of Barrier Systems, Inc. | | SCALE: NONE | TOLERANCE NOT SHOWN | MODEL | DRAWING NUMBER | REV. |
| © 1987 Barrier Systems, Inc. | | TITLE: GOLDEN GATE BARRIER TYPE | | C970412 | | |

Narrow GAB Crack Test Results

D-2

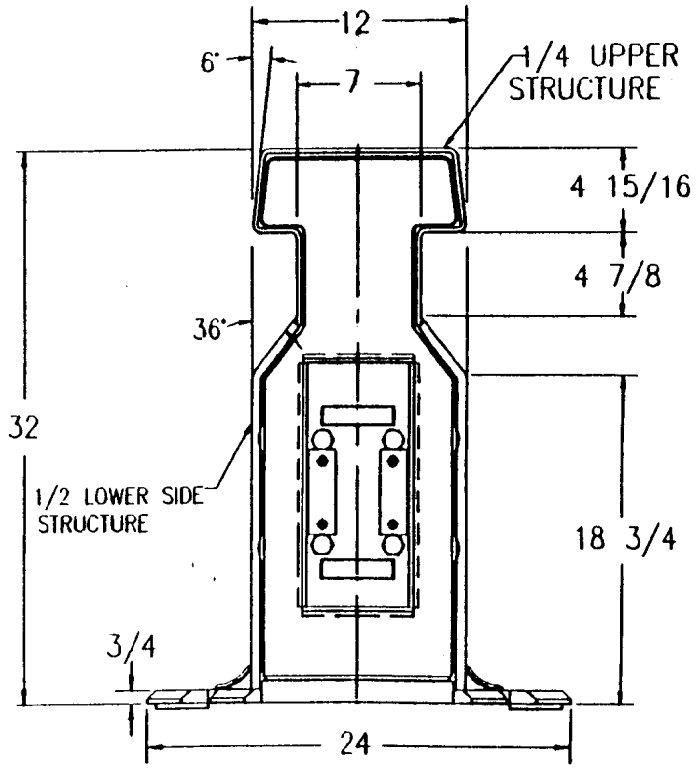
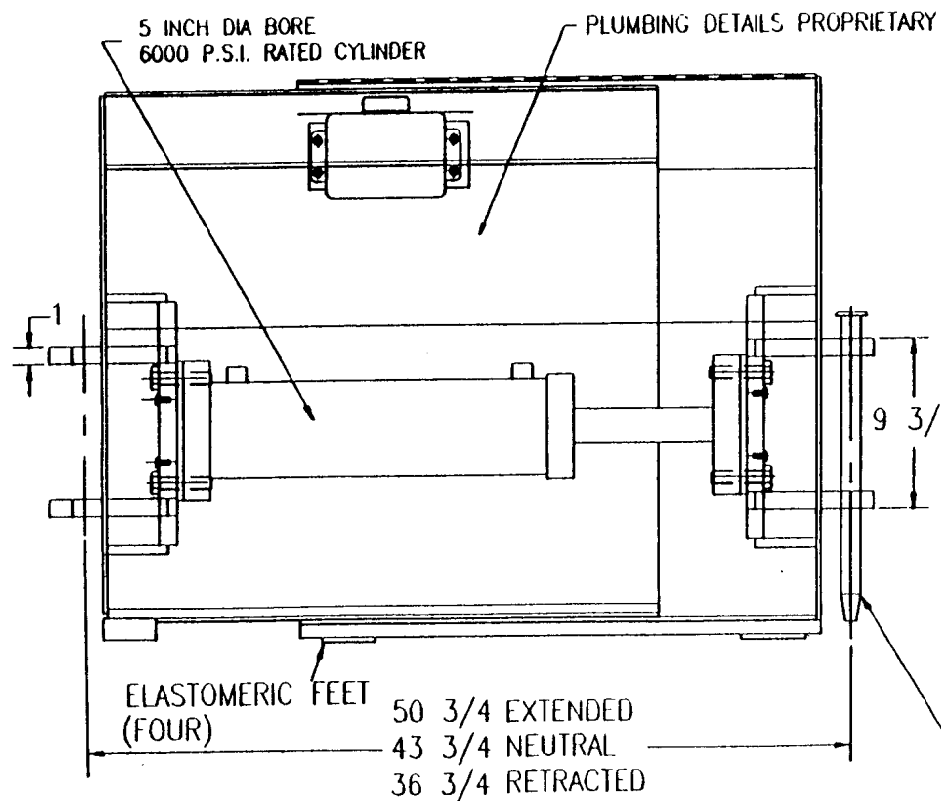
C-15007 ISSUING SERVICE, INC.

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1 7/16 DIA
WT. = 1000 LBS. ±

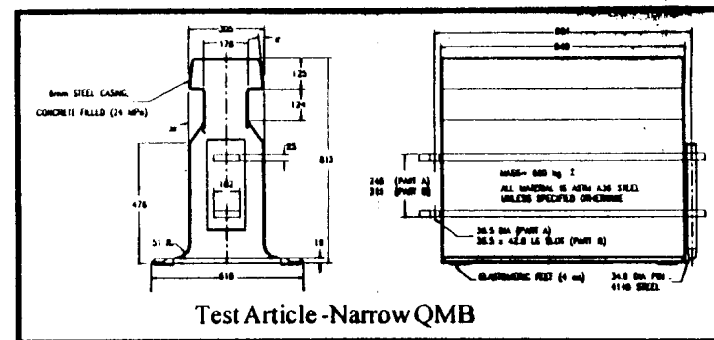
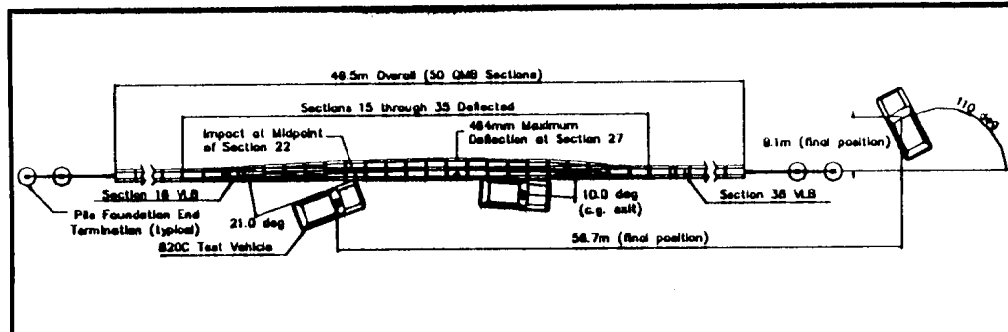
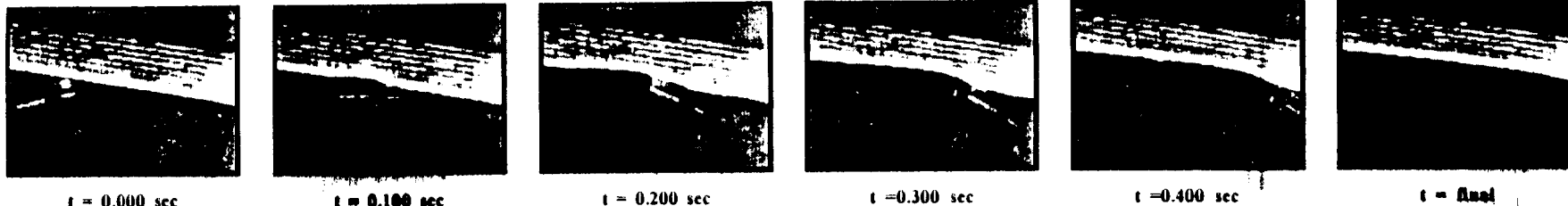
ALL MATERIAL IS ASTM A36 STEEL
UNLESS SPECIFIED OTHERWISE



| | |
|-------------------------|---------------------|
| SCALE: NONE | TOLERANCE NOT SHOWN |
| TITLE: GOLDEN GATE VLB | MODEL: C970413 |
| DRAWING NUMBER: C970413 | REV. |

Narrow QMB Crash Test Results

D-3



| | | | |
|------------------------------------|---------------------------------|---|-----------|
| General Information | | Exit conditions | |
| Test Agency | E-TECH Testing Services, Inc. | Speed (km/h) | 84.60 |
| Test Designation | NCHRP 350 Test 3-10 | Angle (deg) | 10.0 |
| Test No. | 04-0228-001 | Occupant Risk Values | |
| Date | 3/26/97 | Impact Velocity (m/s) | |
| Test Article | | x-direction | 3.99 |
| Type | Barrier Systems, Inc. | y-direction | 7.49 |
| | Narrow Quickchange Barrier | Ridedown Acceleration (g's) | |
| | (QMB) | x-direction | -11.59 |
| Installation Length | 49.5m overall (50 QMB sections) | y-direction | 18.29 |
| Size and/or dimension and material | | THIV (m/s) | 8.31 |
| of key elements | Section length 991mm, height | PHD (g's) | 12.71 |
| | 813mm, width 305mm, mass | ASI | 1.77 |
| | 680kg | Test Article Deflections (mm) | |
| Test Vehicle | | Dynamic | 464 |
| Type | Production Model | Permanent | 464 |
| Designation | 820C | Vehicle Damage | |
| Model | 1989 Ford Festiva | Exterior | |
| | Hatchback | VDS | LFQ-4 |
| Mass (kg) | | CDC | 11LDEW2 |
| Curb | 764 | Interior | |
| Test inertial | 803 | OCDI | AS0000000 |
| Dummy(s) | 75 | Post-Impact Vehicular Behavior (deg - gyro @ c.g.) | |
| Gross Static | 878 | Maximum Roll Angle | -14.21 |
| Impact Conditions | | Maximum Pitch Angle | -14.36 |
| Speed (km/h) | 106.98 | Maximum Yaw Angle | 41.27 |
| Angle (deg) | 21.0 | | |
| Impact Severity (kJ) | 45.53 | | |

Narrow QMB Crash Test Results - 5 of 19

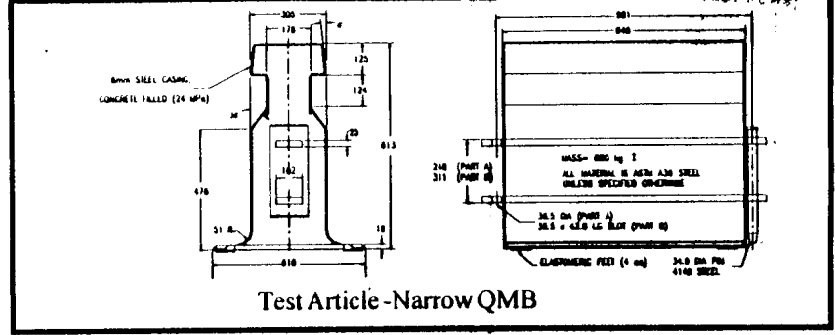
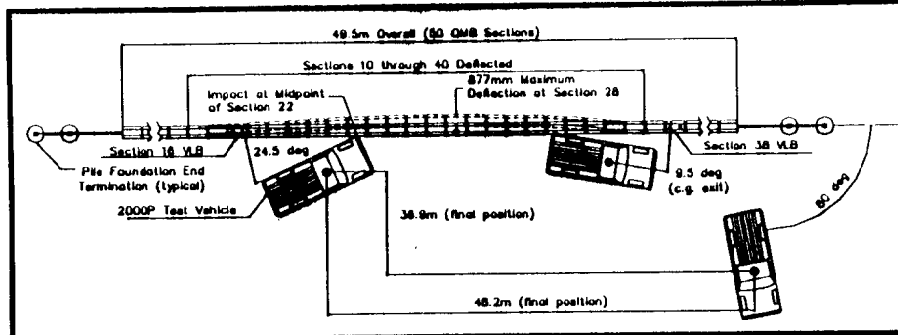
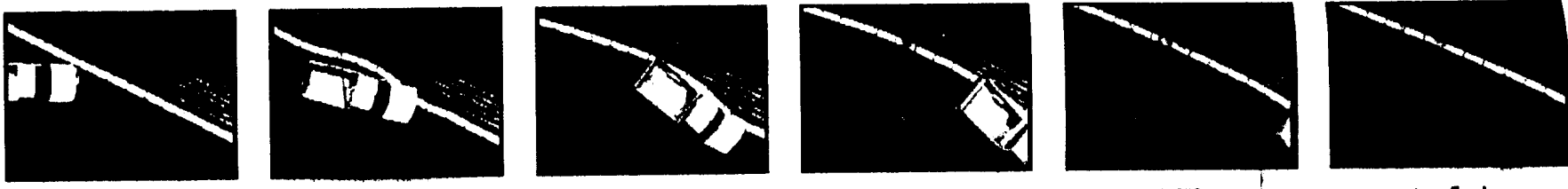


E-TECH Testing Services, Inc.

Figure 1. Summary of Results - Narrow QMB Test 04-0228-001



E-TECH Testing Services, Inc.



Narrow QMB Crash Test Results -11 of 19

| | |
|--|---|
| General Information | |
| Test Agency | E-TECH Testing Services, Inc. |
| Test Designation | NCHRP 350 Test 3-11 |
| Test No. | 04-0228-002 |
| Date | 3/27/97 |
| Test Article | |
| Type | Barrier Systems, Inc. |
| | Narrow Quickchange Barrier (QMB) |
| Installation Length | 50m overall (50 QMB sections) |
| Size and/or dimension and material of key elements | Section length 991mm, height 813mm, width 305mm, mass 680kg |
| Test Vehicle | |
| Type | Production Model |
| Designation | 2000P |
| Model | 1990 GMC C2500 |
| | 3/4 Ton Pickup |
| Mass (kg) | |
| Curb | 2045 |
| Test inertial | 2041 |
| Dummy(s) | N/A |
| Gross Static | 2041 |
| Impact Conditions | |
| Speed (km/h) | 98.24 |
| Angle (deg) | 24.5 |
| Impact Severity (kJ) | 130.68 |

| | |
|---|-----------|
| Exit conditions | |
| Speed (km/h) | 60.48 |
| Angle (deg) | 9.5 |
| Occupant Risk Values | |
| Impact Velocity (m/s) | |
| x-direction | 5.11 |
| y-direction | 6.71 |
| Ridedown Acceleration (g's) | |
| x-direction | -6.12 |
| y-direction | 15.31 |
| THIV (m/s) | 8.42 |
| PHD (g's) | 11.85 |
| ASI | 1.30 |
| Test Article Deflections (mm) | |
| Dynamic | 877 |
| Permanent | 877 |
| Vehicle Damage | |
| Exterior | |
| VDS | LFQ-5 |
| CDC | 11LDEW2 |
| Interior | |
| OCDI | AS0000000 |
| Post-Impact Vehicular Behavior (deg - gyro @ c.g.) | |
| Maximum Roll Angle | -10.20 |
| Maximum Pitch Angle | -14.37 |
| Maximum Yaw Angle | 42.12 |

Figure 6. Summary of Results - Narrow QMB Test 04-0228-002

the request. The RFWA will have approval authority on the request.

(3) Requests for waivers may be made for specific projects, or for certain materials or products in specific geographic areas, or for combinations of both, depending on the circumstances.

(4) The denial of the request by the RFWA may be appealed by the State to the Federal Highway Administrator (Administrator), whose action on the request shall be considered administratively final.

(5) A request for a waiver which involves nationwide public interest or availability issues or more than one FHWA region may be submitted by the RFWA to the Administrator for action.

(6) A request for waiver and an appeal from a denial of a request must include facts and justification to support the granting of the waiver. The FHWA response to a request or appeal will be in writing and made available to the public upon request. Any request for a nationwide waiver and FHWA's action on such a request may be published in the FEDERAL REGISTER for public comment.

(7) In determining whether the waivers described in paragraph (c)(1) of this section will be granted, the FHWA will consider all appropriate factors including, but not limited to, cost, administrative burden, and delay that would be imposed if the provision were not waived.

(d) Standard State and Federal-aid contract procedures may be used to assure compliance with the requirements of this section.

[48 FR 53104, Nov. 26, 1983, as amended at 49 FR 18821, May 3, 1984; 58 FR 38975, July 21, 1993]

EDITORIAL NOTE: For a waiver document affecting §635.410, see 60 FR 15478, Mar. 24, 1995.

§635.411 Material or product selection.

(a) Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

(1) Such patented or proprietary item is purchased or obtained through com-

petitive bidding with equally suitable unpatented items; or

(2) The State highway agency certifies either that such patented or proprietary item is essential for synchronization with existing highway facilities, or that no equally suitable alternate exists; or

(3) Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.

(b) When there is available for purchase more than one nonpatented, nonproprietary material, semifinished or finished article or product that will fulfill the requirements for an item of work of a project and these available materials or products are judged to be of satisfactory quality and equally acceptable on the basis of engineering analysis and the anticipated prices for the related item(s) of work are estimated to be approximately the same, the PS&E for the project shall either contain or include by reference the specifications for each such material or product that is considered acceptable for incorporation in the work. If the State highway agency wishes to substitute some other acceptable material or product for the material or product designated by the successful bidder or bid as the lowest alternate, and such substitution results in an increase in costs, there will not be Federal-aid participation in any increase in costs.

(c) A State highway agency may require a specific material or product when there are other acceptable materials and products, when such specific choice is approved by the Division Administrator as being in the public interest. When the Division Administrator's approval is not obtained, the item will be nonparticipating unless bidding procedures are used that establish the unit price of each acceptable alternative. In this case Federal-aid participation will be based on the lowest price so established.

(d) Appendix A sets forth the FHWA requirements regarding (1) the specification of alternative types of culvert pipes, and (2) the number and types of such alternatives which must be set forth in the specifications for various types of drainage installations.

(e) Reference in specifications and on plans to single trade name materials will not be approved on Federal-aid contracts.

§635.413 Warranty clauses.

The SHA may include warranty provisions in National Highway System (NHS) construction contracts in accordance with the following:

(a) Warranty provisions shall be for a specific construction product or feature. Items of maintenance not eligible for Federal participation shall not be covered.

(b) All warranty requirements and subsequent revisions shall be submitted to the Division Administrator for advance approval.

(c) No warranty requirement shall be approved which, in the judgment of the Division Administrator, may place an undue obligation on the contractor for items over which the contractor has no control.

(d) A SHA may follow its own procedures regarding the inclusion of war-

ranty provisions in non-NHS Federal aid contracts.

[60 FR 44274, Aug. 25, 1995]

§635.417 Convict produced materials.

(a) Materials produced after July 1 1991, by convict labor may only be incorporated in a Federal-aid highway construction project if such materials have been:

(1) Produced by convicts who are on parole, supervised release, or probation from a prison or

(2) Produced in a qualified prison facility and the cumulative annual production amount of such materials for use in Federal-aid highway construction does not exceed the amount of such materials produced in such facility for use in Federal-aid highway construction during the 12-month period ending July 1, 1987.

(b) *Qualified prison facility* means any prison facility in which convicts, during the 12-month period ending July 1, 1987, produced materials for use in Federal-aid highway construction projects.

[53 FR 1823, Jan. 25, 1988, as amended at 58 FR 38975, July 21, 1993]

APPENDIX A TO SUBPART D—SUMMARY OF ACCEPTABLE CRITERIA FOR SPECIFYING TYPES OF CULVERT PIPES

| Type of drainage installation | Alternatives required | | | AASHTO designations to be included with alternatives | Application | Remarks |
|--|-----------------------|----|-----------|--|--------------------------|--|
| | Yes | No | Number | | | |
| Cross drains under high-type pavement. ¹ | | X | | | Statewide | Any AASHTO-approved material. ² |
| Other cross-drain installations. | X | | 3 minimum | M-170 and M-190. | do | Do. ² |
| Side-drain installations | X | | do | M-36 | do | Do. ² |
| Special installation conditions. | | X | | | Individual installation. | Specified to meet special conditions. |
| Special drainage systems (storm sewers, inverted siphons, etc.). | | X | | | do | Specified to meet site requirements. |

¹ High-type pavement is generally described as FHWA construction type codes I, J, K, L, and plant mix and penetration macadam segments, respectively shown in the right-hand columns of type codes G and H having a combined thickness of surface and base of 7 in. or more (or equivalent) or that are constructed on rigid bases.
² Types not included in currently approved AASHTO specifications may be specified if recommended by the State with adequate justification and approved by FHWA.

Subpart E—Interstate Maintenance Guidelines

SOURCE: 45 FR 30793, Mar. 31, 1980, unless otherwise noted.

§635.501 Purpose.

To prescribe Interstate maintenance guidelines and establish the policy and procedures to insure that the condition of Interstate routes is maintained at the level required by the purposes for which they were designed.