H-265A

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: September 9, 1981

Forwarded to:

Honorable Ray A. Barnhart, Jr.
Administrator
Federal Highway Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

SAFETY RECOMMENDATION(S)

H-81-54

About 4:36 p.m., on February 18, 1981, a D&J Transportation Company commuter bus occupied by the driver and 23 passengers was southbound in the median traffic lane of I-95 near Triangle, Virginia. As the bus approached the Chopawamsic Creek bridge, it veered to the driver's right, traveled across the right traffic lane, an acceleration lane, and off the pavement. The right front of the bus struck and overrode a W-section guardrail 59 feet north of the Chopawamsic Creek bridge parapet. After the left front of the bus struck the north end of the parapet, the bus became airborne and vaulted about 84 feet horizontally before landing on its right front in the creek, about 25 feet below the highway surface. The bus came to rest on its right side, roughly perpendicular to and facing the bridge, in about 2 feet of water. Eleven bus occupants, including the driver, were killed and 13 passengers were injured. 1/

Interstate 95 is a north-south Federal-aid arterial highway which runs from southern Florida to northern Maine. The highway is a major transportation corridor through eastern Virginia and serves commuter traffic between Washington and communities to the south. The accident occurred about 31 miles south of Washington, D.C., on a highway right-of-way passing through the Quantico U.S. Marine Corps Reservation.

A project (Project I-95-2(179)155), which is scheduled to be advertised for bid in November or December of 1981, will widen this section of highway from 4 to 6 lanes. The existing concrete pavement will receive a 4-inch asphalt concrete overlay. New guardrails will be installed in accordance with the Virginia Department of Highways and Transportation's (VDHT) 1978 Road Designs and Standards.

A 12-inch W-section guardrail was installed 8 feet west of and parallel to the west edge line of the road and was supported by 6-inch I-beam posts. In the transition section approach to the parapet, the posts had 8-inch I-beam blockouts. Post spacing in the transition section was: one post 1 foot 6 inches north of the parapet end; two posts at 3-foot 1 1/2-inch intervals; and four posts at 6-foot 3-inch intervals. The last of the four posts was not blocked out; post spacing to the north of that post was 12 feet 6 inches.

1/ For more detailed information, read: Highway Accident Report--"D&J Transportation Company Commuter Bus Run-off-Roadway, I-95 Near Triangle, Virginia, February 18, 1981" (NTSB-HAR-81-6).

The guardrail height at its connection with the bridge parapet was 24 inches. When the highway was improved in 1971 and 72, the guardrail height standards were 25 inches, as specified by the Virginia Department of Highways' Road Designs and Standards, dated January 1, 1970. National Cooperative Highway Research Program (NCHRP) Report 54 recommended a 27-inch guardrail height. Even though it was generally recognized at that time (1968) that a 27-inch guardrail height and a 6-foot 3-inch post spacing were more effective in preventing passenger vehicle penetration, the Virginia Department of Highways decided that such a modification would not be a cost-effective improvement. Guardrail height measurements of existing undisturbed guardrails were made at points 80 feet, 100 feet, 120 feet, and 140 feet north of the parapet and ranged from 20 1/2 inches to 22 inches above soil level.

The guardrail at the accident site was not designed to contain or redirect large vehicles, such as the bus, traveling at highway speeds. Before 1975, extensive performance evaluations of guardrails were not made for heavy vehicles. The limited empirical data do not permit an accurate assessment of the extent to which a 25- or 27-inch guardrail might be expected to have deflected the bus before failure and penetration occurred. Also, there are no computer simulation programs currently validated which would provide an accurate evaluation of how a 25- or 27-inch guardrail would have performed under the circumstances of this accident. Therefore, the Safety Board is unable to assess the role of the reduced guardrail height in the crash dynamics.

The 1977 American Association of State Highway and Transportation Officials' (AASHTO) "Guide for Selecting, Locating, and Designing Traffic Barriers" summarized knowledge gained through additional research and in-service experience. It lists the types of barriers available, strength and safety characteristics, selection criteria, and placement. Among the recommended standards for W-section guardrails are a 27-inch height and 6-foot 3-inch post spacing. The use of the AASHTO guide is acceptable to the Federal Highway Administration (FHWA), and the States have generally adopted standards and specifications to conform with it. Standards and specifications promulgated by the VDHT to be used with respect to barriers installed in the forthcoming widening project on I-95 conform with the AASHTO guide recommendations.

Full-scale crash testing of barrier systems, including guardrails, using large vehicles has been limited. A test of the W-section guardrail, as specified in the 1977 AASHTO guide, was conducted in June 1980 by the Texas Transportation Institute (TTI). The vehicle used was a 20,050-pound ballasted school bus . The W-Beam guardrail failed to satisfactorily contain the school bus. Tests with school buses were run in June 1980 using a Thrie-Beam guardrail and in January 1981 using a Modified Thrie-Beam guardrail. The modified system performance was the best of the three tests. The conclusion section of the report states: "Another question is related to the maximum vehicle size the Modified Thrie-Beam guardrail can accommodate. Intercity buses weigh roughly twice as much as school buses and apply loads to nondeformable structures much higher than do school buses. Conversely, intercity buses are generally more stable in guardrail or bridgerail collisions than school buses, having a center of gravity position significantly lower than that of a school bus. These somewhat compensating factors may allow an intercity bus to be redirected in a stable condition."

Additional tests of a newly developed Self-Restoring Traffic Barrier (SERB) have been conducted by the Southwest Research Institute. Test vehicles included a minicar (2,083 lbs, 54.7 mph, and 17.1-degree angle); a school bus (20,000 lbs, 60.5 mph, and 13.8-degree angle); and a scenicruiser intercity bus (40,000 lbs, 57 mph, and 15.8-degree angle). In each test, the vehicle was "smoothly redirected." Barrier systems are available which can redirect large vehicles even under dynamic circumstances more severe than those experienced in this accident. Currently, the high performance barrier systems are at a premium cost which might inhibit widespread usage.

The report further states: "The original design of this barrier (SERB) was accomplished using BARRIER VII computer simulations. It is noteworthy that no changes were made to the beam, post, or post spacing of the guardrail system during its development. Comparisons of experimental and simulation values demonstrated that the SERB barrier performed much as predicted. The predictable behavior of the SERB concept would allow other barriers to be readily designed for either higher or lower service conditions."

The FHWA has developed three computer simulation programs; "BARRIER VII," "GUARD," and "CRUNCH", which could be effectively used in the advancement of barrier design. As noted, BARRIER VII has been effectively utilized. The "GUARD" is a three-dimensional program which could be used to predict vehicle dynamics in barrier collisions as various vehicle, barrier, and dynamics parameters are adjusted. Additional development is needed to validate these programs.

Full-scale crash testing is costly and, therefore, will probably be limited. These computer simulation programs, when validated, could accomplish much in terms of advance design of barriers at a significantly reduced cost. Additionally, technology gained through computer simulations can make a limited amount of full-scale crash testing more productive.

The Safety Board has expressed its concern that current trends to downsize passenger vehicles and the increasing size and weight dimensions of commercial vehicles will create highway safety problems not heretofore experienced. Some of these problems will undoubtedly involve highway barriers. Therefore, the Safety Board encourages the FHWA to continue and to expedite the validation and usage of computer simulation programs and full-scale testing in developing cost-effective, high-performance guardrails and barriers.

Therefore, as a result of its complete investigation of this accident, the National Transportation Safety Board recommends that the Federal Highway Administration:

> Expedite the completion, validation, and utilization of the BARRIER VII, GUARD, and CRUNCH computer simulation programs in the advancement of guardrail technology. (Class II, Priority Action) (H-81-54)

KING, Chairman, DRIVER, Vice Chairman, and McADAMS, GOLDMAN, and BURSLEY, Members, concurred in this recommendation.

By: James B. King
Chairman