Research Report UKTRP-84-16

ANALYSIS OF ACCIDENTS INVOLVING
BREAKAWAY-CABLE-TERMINAL END TREATMENTS

bу

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accident records for the year	ears 1980-82:	with selected	accidents included before			
1980 and after 1982. An att	empt was made	to document e	ach accident with a police			
report, photographs, and a	maintenance r	epair form.	-			
Results showed that the	hreakaway-ca	ble-terminal e	nd treatment performed			
properly in most accidents	(72 percent):	that is, the	end treatment performed as			
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the vehicle. Only four impa	cts were know	n to involve s	mall cars and the BCT			
performed properly in three	of those acc	idents. If tru	cks are excluded from the			
analysis, the BCT performed	l properly in	63 percent of	the collisions.			
The MBCT end treatment	performed pro	perly in 50 pe	rcent of the accidents.			
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TABLE OF CONTENTS

						Page
Introduction .		• • • •				• 1
BCT's and MBCT'	's Used in	Kentucky				• 5
Data Collection	n					. 6
Results						. 7
BCT End-Tr	reatment Ac	cidents .				. 8
MBCT End-7	Preatment A	Accidents			• •	• 11
Conclusions .						. 12
Recommendations	3					• 13
References						• 15
Appendix A. St	tandard Dra	wings for	Kentucky	's BCT		
an	nd MBCT .					• A-1
Appendix B. De	tailed Des	scription c	of End-Tr	eatment		
Ac	cidents .					• B-1

INTRODUCTION

The performance of guardrail end treatments has been a subject of concern to highway engineers for many years. A concentrated effort was begun in the mid 1960's to evaluate guardrail design and recommend warrants for guardrail usage. The work was funded through the National Cooperative Highway Research Program's (NCHRP) Project 15-1 and a review of current practice was performed by Connell Aeronautical Laboratory (1). The next study funded by NCHRP was a compilation of recommended practices for locating, designing, and maintaining guardrails and median barriers (2). Results reported from the study were based on a comprehensive literature review, a state-of-the-art survey, and the advice of a selected group of experts. It was noted that ramped end treatments were found to cause test vehicles to launch, roll, and tumble.

The next study in the series under NCHRP Project 15-1 included results of 25 full-scale crash tests and summarized the relative performance of the designs tested (3). Eight full-scale tests were performed on endterminal designs; six involved ramped designs, one was performed on a flared end treatment, and one on a blunt end terminal. With the exception of one test, the vehicles were launched, rolled, and tumbled in the ramp-terminal tests. In the flared-terminal test, the vehicle penetrated the rail and decelerated in an acceptable manner. For the blunt-terminal test, the vehicle sustained major front-end damage, was launched, and landed on top of the rail. It was concluded that all designs tested as part of the research were hazardous and development of a safer end treatment was the highest priority item for subsequent research.

The fourth in a series of studies as a part of NCHRP Project 15-1 was a synthesis of information on warrants, service requirements, and performance criteria for all traffic-barrier systems (4). Emphasis was placed on the center section or "length of need" section rather than the terminal sections.

The last of five documents reporting on research that originated as NCHRP Project 15-1 dealt with guardrail end design and included results of full-scale tests on hydraulic-post guardrail design and concepts for improved end designs Results included in NCHRP Report 129 were 12 new guardrail terminal and (5).transition concepts, one of which was the "breakaway-cable-terminal" (BCT). Three full-scale crash tests were performed to evaluate the dynamic performance of the The BCT concept was shown to be an effective terminal for W-beam guardrail systems and appeared to be a significant improvement over either the turned-down or blunt-nose terminal. It was noted that for end-on impacts, the BCT performed in a manner similar to crash cushions. Maximum average vehicle deceleration permissible for crash cushions is 12 g and average deceleration values for end-on impacts into the BCT were only 2.5 g and 3.4 g. Those tests were conducted with 4,100-pound test cars, and it was noted that higher deceleration values should be experienced for smaller test vehicles. Advantages of the flared over the nonflared terminal for end-on impacts were demonstrated in the crash tests. Stabilization of the end-nose was achieved by using either steel diaphragms or vermiculite concrete to spread the beam loads over a large frontal area. As a result of the tests conducted and documented in NCHRP Report 129, the BCT was recommended for immediate installation for field evaluation.

Southwest Research Institute's work on guardrail end treatments was extended as NCHRP Project 22-2. Included were 25 full-scale crash tests to develop prototype end designs with emphasis on the breakaway-cable terminal (6). Three tests of the BCT using subcompact cars also were performed. High rates of deceleration were measured during impacts with the small cars. Results indicated that the BCT neither eliminated nor increased the danger during small-car end-terminal collisions. Modifications to the end treatment were made to include a concrete footing and a drilled hole in the second post. Additional modifications

were made to increase the size of the concrete footing which had failed in one of the earlier tests. Overall results confirmed the recommendation for immediate trial implementation.

Development of the breakaway-cable terminal for median barriers followed the research on BCT's for guardrails (7). Test results showed the median barrier performed acceptably for the steel box-beam median barrier and the blocked-out W-beam median barrier with both steel and wood posts. It also was noted that installation of the BCT for guardrails was encouraged by the Federal Highway Administration as part of the National Experimental and Evaluation Program (Notices HNG-32, December 11, 1972, and HHO-31, May 24, 1973).

Additional research conducted as part of NCHRP Project 22-2 included component testing, analytical simulation, and full-scale crash testing to further develop earlier BCT designs (8). Several modifications were made including the use of slip-base steel posts, a reduction in the size of wood posts from 8 x 8 inches to 6 x 8 inches, and elimination of use of diaphragms in the nose section. It was noted that more than 12 states had installed BCT's as of March 1976.

An update on development of the BCT was reported by NCHRP in May 1978 (9). Several problems were reported, both in service and during subsequent experimental programs. Those problems included removal of the fractured wood post from the concrete footing, excessive cost of BCT components, and snagging of a subcompact vehicle's underside by steel-post BCT's. Modifications were made such that the BCT was judged to perform satisfactorily for most vehicle impact conditions. It was noted that 30 states had adopted the guardrail BCT as a standard, with less widespread use of the median barrier BCT.

By November 1980, it was reported by NCHRP that nearly 100,000 BCT end treaments had been installed in over 40 states (10). Problems continued to occur with the removal of broken posts and installations where the 4-foot flare was not

obtained. It was emphasized that lack of the 4-foot flare could result in spearing of vehicles during head-on impacts.

Documentation of field performance of BCT and median-breakaway-cable-terminal end treatments (MBCT) has been relatively scarce since the testing by the Southwest Research Institute. A study by the New Jersey Department of Transportation had the objective of evaluating in-service performance of BCT's (11). A total of 13 vehicular impacts into BCT's was evaluated and results were compared with full-scale crash tests previously conducted by Southwest Research. The in-service experience was similar to the initial tests by Southwest Research, and the BCT was recommended for flared guardrail installations. A significant problem was spearing of small cars during end-on impacts when the end had not been flared. Reinforcement of the unstiffened buffer end on straight guardrail sections was recommended. Replacement of the two 12.5-foot sections with one 25-foot section also was recommended.

The median-breakaway-cable end treatment as designed and tested by Southwest Research has had limited use. Installations are known to have been made in New Jersey and North Carolina. New Jersey has installed approximately 40 of the MBCT's and there has been only one reported accident (12). A large automobile struck the device, and it performed as designed. Only one accident has been reported involving a MBCT in North Carolina (13). The terminal was impacted end-on by a full-size sedan and performed properly, even though it was damaged extensively.

A recently completed survey by the Transportation Research Program revealed that the BCT was the most common end treatment used, with 40 states listing use of this treatment to some degree (14). In 24 states, only the BCT is used for terminating roadside steel-beam guardrail. Some form of the MBCT was used in 16 states.

BCT'S AND MBCT'S USED IN KENTUCKY

Kentucky was one of the first states to install BCT's with the first installations made in 1974. Through 1983, the total number of installations made and included in the Kentucky Department of Highway's summary of unit bid prices was 3,633. The average cost for each of those BCT's was \$515. A summary of BCT installations and costs for 1974 through 1983 is presented in Table 1. The current recommended standard in Kentucky for all fills and solid rock cut sections having an adequate recovery zone behind the guardrail is the BCT. Figure 1 illustrates a typical installation of a BCT in Kentucky. Details of the BCT are shown in the Standard Drawing for Kentucky's Type 4 End Treatment (Appendix A). As noted previously, significant problems may occur when the end is not flared the recommended distance of 4 feet. An example of a BCT without flare is shown in Figure 2. However, when the BCT end treatment is installed as designed, impacts with the end may result in very acceptable performance as shown in Figure 3.

The MBCT has not been installed in Kentucky as extensively as the BCT. For the period 1974 through 1983, a total of 573 were installed as a part of new construction or reconstruction projects and the average cost was \$627 per installation (Table 1). Kentucky's design utilizes two BCT's joined together at the end section as shown in Figure 4. Details of this design are shown in Kentucky's Standard Drawing for Type 6 End Treatment (Appendix A). It was noted earlier that head-on impacts into unflared BCT's could result in spearing of the vehicle. Similar problems are associated with head-on impacts into Kentucky's MBCT design (Figure 5). There appears to be little uniformity nationwide in the types of designs used for MBCT end treatments (14). Only a few states adopted the MBCT for use as it was designed and tested by Southwest Research. A typical installation using that design is shown in Figure 6.

DATA COLLECTION

Data collection for this study involved several phases. Initially, reports of accidents involving all types of safety barriers were collected for the year 1980. Those barriers included crash cushions, earth mounds, concrete median barriers, and four types of guardrail end treatments (BCT, MBCT, buried (turned down), and blunt). Accident reports were made available through the Accident Surveillance Section of the Division of Traffic of the Kentucky Transportation Cabinet. It was decided to search for BCT and MBCT accidents for 1981 and 1982. An inventory of all Kentucky routes having BCT and MBCT installations was used; accident reports pertaining to those routes were reviewed and appropriately selected. That established a three-year data base for accidents involving BCT and MBCT end treatments.

The next step involved correspondence with maintenance officials for Kentucky Highway Districts 1 through 4 and 8 through 12. A liaison was appointed for each highway district to supply information concerning guardrail end-treatment installations and repairs. Meetings were held with Maintenance Engineers in Districts 5, 6, and 7 to arrange a notification procedure. The objective of that procedure was to notify the study team of accidents involving BCT and MBCT end treatments such that on-site investigations could be made before the guardrail was repaired. Photographs were taken to document the performance and damage of the end treatment. In some instances, photographs of the accident site and vehicle were made available through police or other agencies.

A follow-up inquiry was made to the Operations Managers in the highway districts. They were asked to supply the study team with documentation of BCT and MBCT accidents that may have occurred since their first installation in each highway district. The data contained any available information such as photographs, accident reports, repair forms, etc. If an accident report was not

available from the District Office, the location and date of the accident were obtained and records were again searched through the Accident Surveillance Section.

Finally, some guardrail hits were discovered while on trips or while searching accident reports for other purposes. An effort was made to combine photographs with the accompanying accident reports. However, some accidents involving guardrail ends went unreported. In other cases, the guardrail was repaired before photographs could be taken.

The resulting data base consisted of all known accidents involving BCT and MBCT end treatments since the beginning of those installations. This consisted of a search of accident records for the years 1980, 1981, 1982, and selected accidents before 1980 and after 1982. There were a total of 69 accidents identified. Time did not permit the investigation of all accidents before 1980 on routes containing BCT and MBCT installations. Correpondence with the District Offices eliminated the need to search all accidents occurring after 1982. Information obtained for the other types of safety barriers listed earlier was used in another phase of the study.

The sample used in the final analysis of data contained verified accidents involving BCT and MBCT end-treatments. It was desirable to document each accident with a police report, photographs, repair report, and any other pertinent information. However, not all information could be obtained for every accident.

RESULTS

Data for a total of 69 BCT or MBCT end treatment accidents were obtained. A summary of accident locations and information available is given in Table 2. A detailed description of each end-treatment accident is given in Appendix B. Those descriptions include a narrative describing the accident, an accident diagram

(when sufficient information was available), and photographs, when available.

The majority of accidents (50) involved a BCT. The earliest accident date was August 1977 while the latest was April 1984. There were three accidents in 1977, one in 1978, five in 1979, nine in 1980, eight in 1981, nineteen in 1982, fifteen in 1983, and nine in 1984 (through April).

The highest number of reported accidents (20) occurred in District 6 followed by 15 in District 5 and 11 in District 7. It would be expected that those more populated districts would have the largest number of accidents. Four of 12 districts had no reported accidents involving a BCT or MBCT.

Limited repair cost data were available. The average repair cost at eight BCT locations was approximately \$700, with a range of from about \$430 to \$920. A wide range of repair costs would be expected because of the difference in damage. The cost to repair one MBCT end treatment was about \$890. The repair costs are higher than the original installation costs.

The possible sources of information concerning the accidents included accidents reports, photographs, and repair forms. An accident report was obtained for 50 of the 69 accidents while photographs were obtained for 33 accidents and a repair form was found for 21 accidents. All three sources of information were found for only six accidents. Both an accident report and photographs were found for 18 accidents. Following is a discussion of the results from the analysis of BCT and MBCT end treatment accidents.

BCT End-Treatment Accidents

A summary of the performance of BCT end treatments for each accident is given in Table 3. In addition to end-treatment performance, information concerning vehicle size, impact severity, impact angle, guardrail placement, initial vehicle contact area, vehicle action after impact, and end-treatment damage are included. Subjective judgment was used to determine many of those variables. A description

of the variable categories is given in Figure 7.

End-treatment performance, when it could be determined, was defined as either proper or improper. Proper performance resulted when the end treatment performed as designed, with the wooden posts breaking away or the guardrail redirecting the vehicle. Performance was rated for 46 of the 50 BCT accidents. Of those 46 accidents, the BCT end treatment was judged to have performed properly in 33 accidents (72 percent). A photograph showing the end treatment after proper performance in an accident is shown in Figure 3.

A detailed analysis of the data given in Table 3 is summarized in Table 4. BCT end-treatment performance was related to impact severity, impact angle, endtreatment damage, and vehicle size. Proper performance was found to be slightly higher for non-severe impacts compared to severe impacts. Impact angle was related to performance with a higher percentage of improper performance for shallow impact angles (15 degrees or less). Improper performance also was related more to either slight or moderate damage to the end treatment. For heavy or extensive damage to occur, both wooden posts must break, which is generally related to proper performance. Improper performance typically occurred when a severe impact did not break the wooden posts. Also, in some cases of improper performance, a concrete footing moved significantly, which hampered proper breaking of the wooden posts. Performance also was found to be related to vehicle size. Only four impacts involved small cars and the end treatment performed properly in three of the collisions (75 percent). This small percentage of small cars in the data sample probably was related to the procedure for identifying vehicle size. Many of the large cars could be identified from information on the accident report. Small cars could not be as easily identified and many small cars were probably placed in the unknown category. Performance was rated proper in 14 of the 23 impacts (61 percent) involving large automobiles. For the six collisions

involving trucks, performance was rated proper five times (83 percent). In most accidents involving trucks, the posts were broken away and the vehicle continued on which was considered proper performance. It should be noted that the BCT was not designed to accommodate impacts by large trucks. Therefore, collisions of large trucks into BCT's may not be valid performance measures. In addition, the BCT has failed to perform properly when impacted head-on by small cars and performance statistics should also reflect this exception.

Improper performance was generally associated with one of the following occurrences: 1) the vehicle hit the end treatment and was stopped when the posts did not break, 2) the vehicle overturned as it hit the end and the post did not break as designed, or 3) a concrete footing moved which prevented the posts from breaking. There were no instances in which the BCT end treatment speared the vehicle (this was a problem reported by others). Instances of spearing are usually the result of an impact with an end treatment having no flare, and this was not the case in the sample of accidents. As will be shown, such a problem may occur when impacting an MBCT end treatment installed in a gore location.

Data showing a comparison of vehicle size and impact severity are given in Table 5. Information concerning the vehicle year, vehicle make, and vehicle style or model is given. Impact severity was equally severe for all vehicle sizes. Impact was judged to be severe in 76 percent of the accidents (38 of 50). Also, the large majority of vehicles (independent of size) received disabling damage (87 percent). The three fatal accidents each involved a large automobile. The majority of the accidents (71 percent) resulted in an injury. A substantial number of accidents (29 percent) resulted in either a fatality or incapacitating injury. Vehicle size was related to end-treatment damage with accidents involving small automobiles resulting in less damage. The majority of the accidents (66 percent) resulted in either heavy or extensive damage to the guardrail.

MBCT End-Treatment Accidents

A summary of the performance of MBCT end treatments for each accident is given in Table 6. This table gives the same information as Table 3 gives for BCT accidents. Performance was determined for 12 of the accidents, with six (50 percent) rated as proper performance.

Only two of eight severe impacts (25 percent) resulted in proper performance while all four non-severe impacts were termed proper. Impact angles were classified as either shallow or moderate. For both impact angles, only two of five accidents (40 percent) resulted in proper performance. All accidents (three) in which heavy or extensive guardrail damage resulted and in which performance was also rated resulted in improper performance. Only two accidents of known vehicle size involved a small vehicle. Both vehicles involved collision with an MBCT placed in a gore and resulted in improper performance with the end spearing the vehicle (Figure 5).

Data concerning vehicle size and impact severity are given in Table 7, which is identical to the information given in Table 5 for BCT accidents. Of 12 accidents with known injury severity, nine (75 percent) resulted in an injury and five (42 percent) resulted in either a fatality or incapacitating injury. There were two fatal accidents, both the result of spearing when a small vehicle impacted a MBCT in a gore area. The vehicle received disabling damage in 11 of 12 accidents (92 percent). Impact severity was classified as severe in 14 of the 19 accidents (74 percent). Collisions with either small or large automobiles resulted in severe impacts. There were no known accidents involving either a single unit or combination truck. Six of the ten accidents (60 percent) having known damage resulted in either heavy or extensive guardrail damage.

The MBCT end treatment has been used in medians and at least one gore location. For those accidents in which performance could be rated, both gore

accidents were classified as giving improper performance while four of ten medianlocation accidents were classified as resulting in improper performance.

CONCLUSIONS

The analysis of the accidents that were investigated shows any accident involving collision with a guardrail end is potentially severe. The BCT end treatment performed properly in most accidents (72 percent); that is, the end treatment performed as it was designed with the wooden posts breaking away or the guardrail redirecting the vehicle. Only four impacts involved small cars and the BCT end treatment performed properly in three of these accidents. If trucks are excluded, the BCT end treatment performed properly is 63 percent of the Improper performance of the BCT was generally related to either collisions. failure of the posts and guardrail to break away as designed, causing the vehicle to stop abruptly or overturn; or excessive movement of a concrete footing that prevented the posts from breaking. Performance was not as good when the impact angle was shallow. The BCT end treatments involved in these accidents were flared. Poor performance for shallow impact angles and the problem exhibited by MBCT end treatments impacted head-on show that a flare is necessary. installation of a BCT end treatment without proper flare provides a potential to spear a vehicle during a shallow-angle impact.

The MBCT end treatment performed properly only 50 percent of the time. The problem appears to be related to the stiffness of the end treatment. This problem is most apparent when it is used in a gore area where impact angles are shallow. Two fatal accidents occurred when the end treatment speared a small vehicle after a head-on collision in a gore area. If these two accidents involving a MBCT placed in a gore area are excluded, then 6 of the 10 accidents (60 percent) involving MBCT'S in medians performed properly.

RECOMMENDATIONS

Evaluation of the performance of the BCT end treatment (Kentucky's Type 4) indicates that it may be used where geometrics permit; that is, when a 4-foot flare can be obtained with a 10:1 slope in advance and a sufficient recovery area, not exceeding a 3:1 slope, behind. Where those geometrics are not present, the turned-down end treatment proposed in the previous report should be used (14).

Evaluation of Kentucky's MBCT end treatment (Type 6) shows an unsatisfactory performance in gore locations. Accident investigations indicate that, for impacts at shallow angles, there is a potential for spearing similar to that experienced for a BCT installed without a flare.

The old MBCT design should be removed from gore locations. The recommended replacement at gore locations would be a crash cushion. Because of the stiffness of the MBCT and the problems associated with impacts at shallow angles, consideration should be given to use of a turned-down end-treatment design for median applications. A turned-down design should be used in medians for new installations or when old end treatments must be replaced. However, data do not justify removal of existing installations.

A proposed median turned-down end treatment is shown in Figure 10. It is based on the turned-down end treatment previously proposed (14). This design consists of two modified turned-down end treatments (Kentucky Type 7 End Treatment) placed side-by-side. The total end-treatment length is 50 feet. Two rails are placed back-to-back and twisted 90 degrees and anchored over the last 25 feet with no posts in that section of rail. The two rails are twisted side-by-side and both are attached to the same anchor. The first two guardrail post spacings should be 12.5 feet followed by posts at the regular 6.25-foot spacing. The first two posts should be of a type that will break during an end impact. Also, the connection between those two posts and the guardrail should be such that

the guardrail would separate from the post during an end impact.

The question as to the best end treatment that may be used for shoulder and median installations has not been resolved. A continued in-field performance evaluation of the BCT, MBCT, and new turned-down end treatments through in-depth analysis of accidents is warranted. This type of performance evaluation would provide valuable information for future decisions concerning the most crashworthy end treatment to use.

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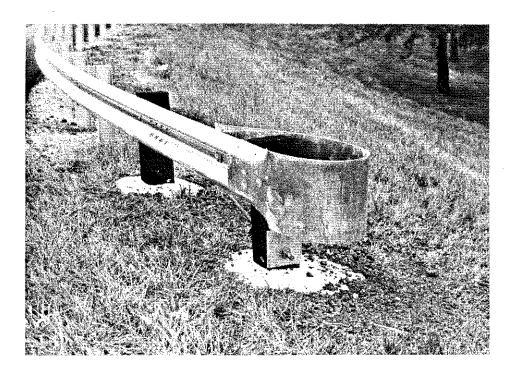


Figure 1. Breakaway-Cable-Terminal (BCT) End Treatment (Kentucky's Type 4).



Figure 2. BCT End Treatment Without Proper Flare.



Figure 3. Proper Performance of a BCT End Treatment.



Figure 4. Median-Breakaway-Cable-Terminal (MBCT) End Treatment (Kentucky's Type 6).



Figure 5. Spearing of Vehicle by a MBCT End Treatment.

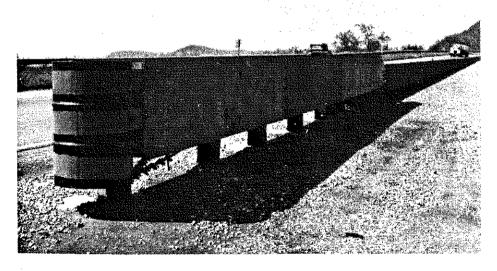


Figure 6. Median-Breakaway-Cable-Terminal End Treatment (Similar to Design Tested by Southwest Research Institute).

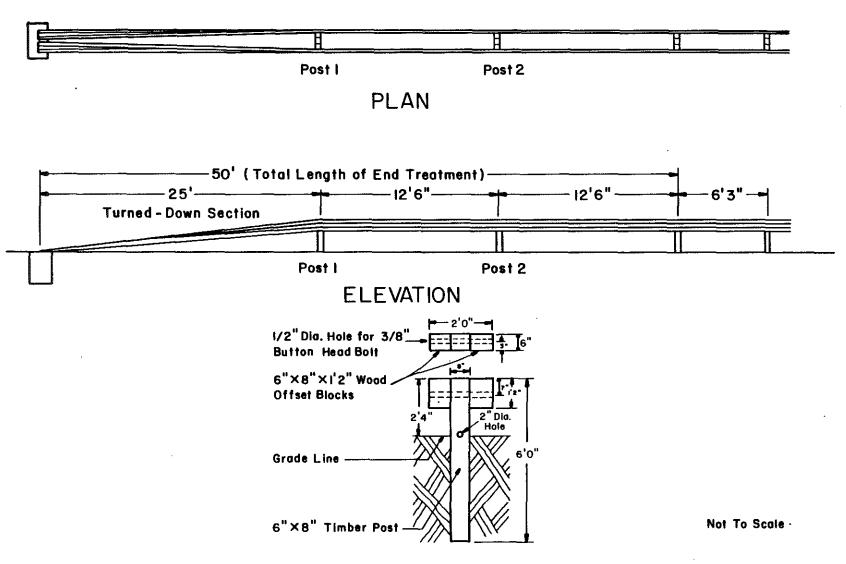
FIGURE 7. DESCRIPTION OF VARIABLE CATEGORIES

VARIABLE	CATEGORY	DESCRIPTION
Vehicle Size	Auto-L	Full or mid-sized passenger car; full-sized pickup truck; vans
	Auto-S	Compact or sub-compact cars; small pickup trucks
	Auto-U SUT	Automobile, size unknown Single-unit trucks (2-axle, 6 tires or larger)
	Comb	Combination tractor and semi- trailer or full trailer
	Unknown	Type of vehicle unknown
Impact Severity	Severe	Impact sufficient to cause heavy or extensive damage to guardrail; disabling damage to vehicle; and/or injury severity of fatal or incapacitating injury.
	Non-Severe	Functional or non-functional damage slight or moderate damage to guardrail; and/or slight or no injury (Injury 3, 4, or 5)
Impact Angle	Shallow	O - 15 degrees
	Moderate Sharp	16 - 45 degrees > 45 degrees
Guardrail	RHS	Right-hand shoulder (mainline)
Placement	RHS/R LHS	Right-hand shoulder (ramp) Left-hand shoulder (mainline)
	LHS/R	Left-hand shoulder (ramp)
	Gore	Area between roadway split
	Median	Area between divided, multilane
		highway
Vehicle Contact	1	Front
Area	2	Right front
	3	Right side
	4	Left front
	5	Left side
Vehicle Make	AMC	American Motors
	Buick	Buick
	Dodge	Dodge
	Chev	Chevrolet
	Ford	Ford
	GMC	General Motors
	Intl	International
	Merc	Mercury
	Olds	Oldsmobile Plymouth
	Plym Pont	Pontiac
	Suba	Subaru
	Volks	Volkswagen
	Volvo	Volvo
	White	White Truck

FIGURE 7. DESCRIPTION OF VARIABLE CATEGORIES (continued)

Vehicle Style 2-DR-SD 4-Door sedan	VARIABLE	CATEGORY	DESCRIPTION
Truck Van Truck Van Truck Van Injury Severity 1 1 Fatal 2 Incapacitating injury 5 Non-incapacitating injury 4 Possible injury 5 No injury Vehicle Action After Impact SP-CW-D SP-W-D SP-CW-D SP-W-D SP-W-D SP-W-D SP-W-D SPUN clockwise D number of degrees Overturned RAMP Ramped BT SS Sideswiped guardrail RB-L RB-B Rebounded left RB-B RB-B Rebounded right RB-B RB-B Rebounded back Guardrail end speared vehicle End Treatment Performance Improper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Damage Noderate Noderate Noderate Noderate Noderate Noderate Proposts worstly intact (but not broken); concrete footing moved. Noderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Extensive Extensive Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Wehicle Damage 1 No damage Non-Functional Damage Punctional Damage Punctional Damage	Vehicle Style	4-DR-SD SW PU SD	4-Door sedan Station Wagon Pickup Sedan
Van Van			trailer
Incapacitating injury Sometimes Non-incapacitating injury Sometimes Non-incapacitating injury Sometimes Sometime			
Vehicle Action After Impact SP-CW-D Spun counterclockwise D number of degrees	Injury Severity		
Vehicle Action STOP Stopped immediately upon contact After Impact SP-CW-D Spun clockwise D number of degrees SP-CCW-D Spun counterclockwise D number of degrees Spun counterclockwise D number of degrees Overturned RaMMP Ramped BT Broke through SS Sideswiped guardrail Rebounded left RB-R Rebounded left RB-B Rebounded left RB-B Rebounded back Guardrail end speared vehicle End Treatment Proper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper Performance other than as designed. End Treatment Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Extensive Both posts broken away; rail bent to second post. Vehicle Damage 1 No damage 7 Non-Functional Damage Functional Damage			
Vehicle Action After Impact SP-CW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D SP-CCW-D Spun clockwise D number of degrees SP-CW-D Spun counterclockwise D number of degrees Coverturned RAMP Ramped BT Broke through SS Sideswiped guardrail Rebounded left RB-R Rebounded left RB-B Rebounded back Guardrail end speared vehicle End Treatment Proper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Damage Moderate Moderate Moderate Moderate Heavy End Treatment Both posts broken away; rail bent to second post. Extensive Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage Functional Damage			
Vehicle Action After Impact SP-GW-D SP-CCW-D Spun counterclockwise D number of degrees Spun counterclockwise D number of degrees Coverturned Ramped Rampe			¥ •
After Impact SP-CW-D SP-CCW-D SP-CCW-D SPUR counterclockwise D number of degrees OVER RAMP RAMP Ramped BT Broke through SS Sideswiped guardrail RB-L RB-R Rebounded left RB-R Rebounded right RB-B Rebounded back SPEAR Guardrail end speared vehicle End Treatment Proper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Damage Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Vehicle Damage 1 Non-Functional Damage Functional Damage Functional Damage		כ	No injury
SP-CCW-D OVER OVER OVER RAMP RAMP BT BF BF BF Rebounded left RB-L RB-B Rebounded back SPEAR End Treatment Proper End Treatment Damage End Treatment Slight End Treatment Damage Moderate Moderate SP-CCW-D Spun counterclockwise D number of degrees Overturned Ramped Ramped Ramped BT Broke through Schewinged guardrail Rebounded left Rebounded back Guardrail end speared vehicle End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper Performance other than as designed. End Treatment Damage Moderate Moderate Moderate One posts mostly intact (but not broken); concrete footing moved. One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Punctional Damage Functional Damage Functional Damage	Vehicle Action	STOP	
OVER RAMP RAMP RAMP RAMP RAMP RAMP RAMP RAM	After Impact		Spun counterclockwise D number of
BT SS Sideswiped guardrail RB-L Rebounded left RB-R Rebounded right RB-B Rebounded back Guardrail end speared vehicle End Treatment Proper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Damage End Treatment Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage		OVER	-
SS RB-L Rebounded left RB-R Rebounded right RB-B Rebounded back SPEAR Rebounded back Guardrail end speared vehicle End Treatment Performance End Treatment Performance Improper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper Performance other than as designed. End Treatment Damage Moderate Moderate Moderate Heavy Solight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Extensive Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage		RAMP	Ramped
RB-L RB-R RB-B RB-B REbounded right Rebounded back SPEAR Guardrail end speared vehicle End Treatment Performance End Treatment Performance Improper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Performance other than as designed. End Treatment Damage Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage		${f BT}$	Broke through
RB-R RB-B RB-B SPEAR End Treatment Performance End Treatment Performance End Treatment Performance End Treatment Performance Improper End Treatment performed as designed; posts broke away or guardrail redirected vehicle. Performance other than as designed. End Treatment Damage End Treatment Damage Moderate Moderate Moderate Description Heavy Both posts severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage		SS	
RB-B SPEAR Rebounded back Guardrail end speared vehicle End Treatment Proper End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper Performance other than as designed. End Treatment Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage		RB-L	Rebounded left
End Treatment Performance End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Performance other than as designed. End Treatment Damage End Treatment Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage			-
End Treatment Performance End treatment performed as designed; posts broke away or guardrail redirected vehicle. Improper End Treatment Damage End Treatment Damage Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage			
Performance designed; posts broke away or guardrail redirected vehicle. Improper Performance other than as designed. End Treatment Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage Functional Damage		SPEAR	Guardrail end speared vehicle
End Treatment Damage End Treatment Damage Moderate Heavy Heavy Extensive Vehicle Damage Improper Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Both posts broken away; rail bent to second post. Extensive No damage Non-Functional Damage Functional Damage Functional Damage		Proper	designed; posts broke away or
End Treatment Damage Slight Slight deflection of rail; one or both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage Non-Functional Damage Functional Damage		T	
Damage both posts mostly intact (but not broken); concrete footing moved. Moderate One post severely damaged or completely broken; other post mainly intact; rail bent between first and second posts. Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage 2 Non-Functional Damage 5 Functional Damage		Improper	
completely broken; other post mainly intact; rail bent between first and second posts. Heavy Both posts broken away; rail bent to second post. Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage 2 Non-Functional Damage 3 Functional Damage	_	Slight	both posts mostly intact (but not broken); concrete footing
to second post. Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage 2 Non-Functional Damage 3 Functional Damage		Moderate	completely broken; other post mainly intact; rail bent between
Extensive Both posts broken away; damage to rail beyond second post. Vehicle Damage 1 No damage 2 Non-Functional Damage 3 Functional Damage		Heavy	
Non-Functional Damage Functional Damage		Extensive	Both posts broken away; damage to
3 Functional Damage	Vehicle Damage	1	No damage
			Non-Functional Damage
		3	Functional Damage
			Disabling Damage

Figure 8. Proposed Median Turned-Down End Treatment



POST DETAIL

TABLE 1. SUMMARY OF BCT AND MBCT INSTALLATIONS BY YEAR (NUMBERS AND UNIT PRICES TABULATED FROM CONTRACTS AWARDED)

TYPE OF END TREATMENT

	ı	BCT		MBCT
YEAR	NUMBER	AVERAGE UNIT PRICE (DOLLARS)	NUMBER	AVERAGE UNIT PRICE (DOLLARS)
1974	285	668	2	700
1975	443	617	98	742
1976	421	446	63	590
1977	54 1	423		
1978	229	444	73	545
1979	350	482	101	574
1 980	244	516	10	680
1981	160	519	14	657
1982	498	572	90	636
1983	462	487	122	631
TOTALS	3,633	515 *	573	627*

^{*} Weighted average.

TABLE 2. SUMMARY OF ACCIDENT LOCATIONS AND INFORMATION AVAILABLE

INFORMATION AVAILABLE

ACCIDENT NUMBER	DISTRICT	COUNTY	ROUTE	MILEPOINT	TYPE OF END TREATMENT	DATE	ACCIDENT REPORT	PHOTOGRAPHS	REPAIR FORM
001 002 003 004	1	Livingston McCracken McCracken Marshall	I 24 I 24 I 24 I 24	30.9 2.8 13.4 27.7	MBCT BCT MBCT MBCT	12/19/80 2/13/79 2/13/79 11/09/80	x x x		
005 006 007 008	.2222233	Christian Christian Christian Christian	I 24 I 24 I 24 I 24 I 24 I 24	85.6 85.6 85.9 0.1	MBCT BCT BCT BCT BCT MBCT	3//82 7/28/84 9/04/80 6/18/77	x x x		x
009 010 011 012	22.33.	Henderson Hopkins Todd Todd	9005* 9004* US 68 US 68	0.1 44.1 1.3 3.6 2.2	MBCT BCT BCT BCT BCT BCT BCT	1//84 1/27/84 1/31/80 9/21/79	x x x	x x	х х х
013 014 015 016	35555 5	Todd Bullitt Bullitt Bullitt Bullitt	ÚS 68 I 65 I 65 I 65	Unknown 11.6 117.8 105.0	MBCT MBCT MBCT BCT BCT	11/29/78 Unknown 1//84 3/30/81 5/11/81	x x	x x	x
017 018 019 020 021	95 555	Bullitt Jefferson Jefferson Jefferson	11111111111111111111111111111111111111	104.8 128.3 128.3 128.2	BCT BCT BCT BCT BCT	6/16/80 4//83 4/18/83 4/04/81	x	x	
021 022 023 024 025 026	5555	Jefferson Jefferson Jefferson Jefferson	US 31E US 42	4.0 17.9 1.9 5.5	BCT BCT BCT BCT	9/03/82 10//82 12//83 4/02/83	ж	X X X	X X
026 027 028 029 030	55566	Shelby Shelby Shelby Boone	I 64 I 64 I 75 I 75	29.0 30.0 34.0 181.3	MBCT BCT BCT BCT	12//83 8//83 11/19/83 8/19/83	X X	x x	
031 032 033 034	66666	Boone Boone Boone Boone Boone	III 64 64 75 775 775 775 775 775	175.8 181.4 175.4 181.3 175.3	BCT BCT BCT BCT BCT	5/06/83 5/07/83 4/05/83 5/29/82 7/22/81	X X X X	x	
035	Ğ	Boone	Ī 75	178.1	мВст	1/01/81	x		

^{* 9005 -} Audubon Parkway 9004 - Pennyrile Parkway

TABLE 2. SUMMARY OF ACCIDENT LOCATIONS AND INFORMATION AVAILABLE (continued)

INFORMATION AVAILABLE

ACCIDENT NUMBER	DISTRICT	COUNTY	ROUTE	MILEPOINT	TYPE OF END TREATMENT	DATE	ACCIDENT REPORT	PHOTOGRAPHS	REPAIR FORM
036 037 038	66666666	Boone Campbell	I 275 I 275	10.6 74.8	BCT BCT	1/10/84 2/04/84	X X	X X	
038 039	6 6	Carroll Kenton	I 71	43.0 184.7	BCT BCT	2/26/84 4/01/84	X	X X	
039 040	ě	Kenton Kenton	I 75 I 75 I 75 I 75	184.5 184.5	MBCT MBCT	11/05/83	X X	X X	
041 042		Kenton	İ 75	184.5	MBCT	6/23/82	4		X
043 044	6666667	Kenton Kenton	I 75 I 75 I 275	184•5 184•5 82•5	MBCT MBCT	4//82 2//82 7//83			X X
045 046	6	Kenton Kenton	I 275	82•5 0•0	BČT BCT	7//83 12//82		X X	
040	6	Kenton	I 275 I 275 KY 1501	79.0	BCT	1709783	x	A	
047 048	6	Kenton	KY 1501	2.4	BCT BCT	1/09/82 4/18/82	X X	X X	x
049 050	7	Fayette Fayette	I 64 I 64	85•0 84•9	BCT	1/21/79	X	A	A
051 052	7	Favette		84.9 106.3	MBCT MBCT	1//84 10/30/83	n.P.	x	
052 053	$\frac{7}{7}$	Fayette Fayette	1 75	110.0 103.9	ВСТ	12/07/82	X X		x
053 054		Fayette	I 75 I 75 I 75 I 75	103.9 116.1 105.8	BČT BCT	7/09/82 6/12/80	X	x	x
0556 0556 057 059 060	7	Fayette Fayette	KY 4 KY 4	4.8	MBCT BCT	11/05/82	X X	24	x
057	Ż	Fayette	KY 4 KY 4	9.3	BCT BCT	3/30/82 12/ - -/82	x	T.P.	X
058 059	7	Madison Woodford	I 75 US 60	90.0 11.7	BCT	4/21/84	x	X X	
060	8 8 11	McCreary	ŪS 60 KY 92 I 75	17.6	BCT BCT	12/ /83 1/16/82	x	X X	
061 062	11 11	Rockcastle Harlan	US 119	69•2 18•7	BCT	9/27/80	X	A	
063 064	11	Harlan	KY 113	0.9	BCT BCT	12/10/81 8/12/77	X	X	x
065	11	Wayne Whitley	I 75	13.7 2.7	MBCT	9/22/82	X X		x
065 066 067	11	Whitley	KÝ 75 I 75 I 75 I 75 I 75 I 75	2.0 2.0	BCT BCT	7/01/81 12/18/80	X X	X X	X X
067 068	11	Whitley Whitley	i 75	6.4	MBCT	12/16/80 12/16/79	x	24	
069	11	Whitley	I 75	6•4	MBCT	12/16/79	x		X

ACCIDENT NUMBER	VEHICLE SIZE	IMPACT SEVERITY	IMPACT ANGLE	GUARDRAIL PLACEMENT	VEHICLE INITIAL CONTACT	VEHICLE ACTION AFTER IMPACT	END TREATMENT PERFORMANCE	END TREATMENT DAMAGE
002 005	Auto-U	Non-Severe	Shallow	RHS	1	Stop	Proper	Unknown
005	Unknown	Severe	Unknown	Unknown	Unknown	Unknown	<u>U</u> nkñown	Heavy
006	Auto-L	Severe	Shallow	RHS/R	1	SP-CW-15	${\tt Improper}$	Unknown
007	Auto-L	Severe	Shallow	LHS/R] [[]	Over	Improper	Unknown
009 010	Unknown Auto-L	Severe Non-Severe	Moderate Moderate	RHS LHS/R	Unknown	BT RB-R	Proper	Heavy Moderate
011	Auto-D Auto-U	Severe	Shallow	RHS	7	SP-CCW-45	Proper Proper	Heavy
011	Auto-U Auto-U	Severe	Moderate	LHS	4 5 2 5	SP-CCW-45	Proper	Heavy
012 013 016	Auto-U	Severe	Sharp	LHS	3	BT BT	Proper	Heavy
Ŏ16	Auto-L	Non-Severe	Shallow	ĩĤŠ	5	SP-CCW-45	Proper	Unknown
017	Auto-U	Severe	Moderate	${ t Gore}$	ĺ	BT	Proper	Heavy
018	Auto-L	Severe	Shallow	Gore	1	$\overline{ ext{BT}}$	Proper	Extensive
019	Unknown	Severe	Moderate	LHS/R	Unknown	ĒĪ	Unknown	Heavy Unknown
020	SUT	Severe	Shallow	LHS/R	4	Over	Improper	Unknown
021	Auto-L	Severe	Moderate	RHS LHS	2 3	Ramp BT	Improper	Unknown
022	Auto-L Auto-U	Severe Non-Severe	Moderate Unknown	RHS/R	Unknown	Unknown	Proper Proper	Heavy Moderate
021	Unknown	Non-Severe	Shallow	RHS	Unknown	Stop	Improper	Moderate
025	Unknown	Severe	Shallow	RHS	1	Sto	Proper	Extensive
ŏ27	Unknown	Non-Severe	Unknown	RHS	Unknown	Unknown	Proper	Slight
028	Auto-S	Severe	Moderate	RHS LHS/R	1	BT-Over	Improper	Moderate
029	Auto-L	Severe	Shallow	LHS/R	1	Stop	Improper	Moderate
030	Auto-L	Severe	Moderate	RHS	4	BT 1	Proper	Heavy
022 0224 02257 0229 0230 0331 03337 03337 03339 0447	Auto-S	Severe	Shallow	RHS	1	BT SP-CW-150	Proper	Heavy
032	Auto-L Auto-L	Severe Severe	Shallow Shallow	Gore Gore	4	BT BT	Improper Proper	Slight Heavy
037	Comb	Severe	Shallow	RHS/R	,	Bu DI	Proper	Extensive
036	Comb	Severe	Moderate	RHS	<u> </u>	BT BT	Proper	Extensive
ŎŹŽ	Auto-S	Severe	Moderate	RHS	4	ВТ	Proper	Moderate
038	Auto-L	Severe	Moderate	RHS RHS	Ż	BT. Over	Improper	Extensive
039	SUT	Severe	Shallow	RHS	1	BT, Over	Proper	Extensive
045	Unknown	Non-Severe	Unknown	RHS	Unknown	Unknown	Proper	Slight
046	Comp	Non-Severe	Unknown	LHS	4	SS 	Proper	Slight
047	Auto-L	Severe	Unknown	UNK		Unknown Unknown	Unknown	Extensive Slight
048	Unknown Auto-L	Non-Severe Severe	Shallow Shallow	RHS RHS	5	BT	Improper Proper	Extensive
048 049 050 053 0555 0557 059 060	Auto-L	Severe	Moderate	RHS	2 2 2	Unknown	Proper	Slight
050	Auto-L	Severe	Shallow	RHS RHS	โ	BT	Proper	Heavv
Ŏ 5 4	Auto-L	Severe	Moderate	RHS	1	Unknown	Improper	Slight
Ŏ55	Comb	Severe	Moderate	RHS	1	BT. SP-CCW-150	Improper Proper **	Moderate
057	Auto-L	Severe	Unknown	UNK	2	RB-R, SP-CCW-30	Proper	Unknown
058	Unknown	Non-Severe	Unknown	LHS	Unknown	BT	Proper	Extensive
059	Auto-L	Severe	Shallow	RHS] 	SS DD D Owen	Proper	Slight
060	Unknown	Non-Severe	Unknown	RHS RHS	Unknown	RB-R, Over SP-CCW-180	Proper **	Extensive Moderate
061 062	Auto-L Auto-L	Severe Severe	Moderate Sharp	rns LHS	7	Over	Improper Improper	Heavy
063	Auto-L Auto-L	Severe	Unknown	RHS	7	RB-L	Proper	Unknown
064	Auto-L	Non-Severe	Shallow	RHS .	ż	Unknown	Unknown	Unknown
064 066	Auto-L	Severe	Shallow	LHS/R	1	BT	Proper	Extensive
067	Auto-S	Severe	Shallow	LHS/R	1	Unknown	${ t Proper}$	Extensive
				·				

^{*} Refer to Figure 7 for explanation of codes.
** End treatment broke away as designed, but fatality occurred.

TABLE 4. DETAILED ANALYSIS OF BCT END TREATMENT PERFORMANCE

PERFORMANCE

		PR	OPER	IMPR	OPER
VARIABLE	CATEGORY	NUMBER	PERCENT	NUMBER	PERCENT
Impact Severity	Severe Non-Severe	24 9	71 75	10 3	29 25
Impact Angle	Shallow Moderate Sharp	11 13 2	58 72 100	8 5 0	42 28 0
End Treatment Damage	Slight Moderate Heavy Extensive	5 4 10 10	62 50 91 91	3 4 1 1	38 50 9 9
Vehicle Size Category	Small Auto Large Auto Truck	2 1 4 5	50 61 83	2 9 1	50 39 17

^{*} Refer to Figure 7 for explanation of codes.

TABLE 6. MBCT END-TREATMENT PERFORMANCE*

						VEHICLE			
	ACCIDENT	VEHICLE	IMPACT	IMPACT	GUARDRAIL	INITIAL	VEHICLE ACTION	END TREATMENT	END TREATMENT
	NUMBER	SIZE	SEVERITY	ANGLE	PLACEMENT	CONTACT	AFTER IMPACT	PERFORMANCE	DAMAGE
	001	Auto-L	Severe	Shallow	Median	4	SP-CCW-135	Unknown**	Unknown
	003	Auto-U	Non-Severe	Shallow	Median	Unknown	SS	Proper	Unknown
	004	${\tt Auto-L}$	Severe	Moderate	Median	4	RAMP	Improper	Unknown
	800	$\mathtt{Auto-L}$	Severe	Moderate	Median	1	BT	Proper	Unknown
	014	Unknown	Non-Severe	Unknown	Median	Unknown	Unknown	Proper	Moderate
	015	Unknown	Non-Severe	Unknown	Median	Unknown	Unknown	Proper	Moderate
	026	Unknown	Non-Severe	Shallow	Median	Unknown	Unknown	Proper	Moderate
29	035	Auto-U	Severe	Moderate	Median	2	\mathtt{BT}	Proper	Unknown
w.	040	Auto-S	Severe	Shallow	\mathtt{Gore}	1	Spear	Improper	Extensive
	041	Auto-S	Severe	Shallow	${ t Gore}$	1	Spear	Improper	Moderate
	042	Unknown	Severe	Unknown	${ t Gore}$	Unknown	Unknown	Unknown**	Heavy
	043	Unknown	Severe	Unknown	${ t Gore}$	Unknown	Unknown	Unknown**	Heavy
	044	Unknown	Severe	Unknown	\mathtt{Gore}	Unknown	Unknown	Unknown**	Heavy
	051	Unknown	Severe	Moderate	Median	4	Unknown	Unknown**	Moderate
	052	$\mathtt{Auto-L}$	Severe	Moderate	Median	1	Over	Improper	Unknown
	056	$\mathtt{Auto-L}$	Severe	Moderate	Median	1	Over	Improper	Heavy
	065	Auto-U	Severe	Shallow	Median	4	Stop	Unknown **	Moderate
	068	Auto-U	Severe	Shallow	Median	, 1	Stop	Unknown **	Unknown
	069	Auto-L	Severe	Shallow	Median	1	Over	Improper	Heavy

^{*} Refer to Figure 7 for explanation of codes.

^{**} Assessment of performance not possible because of insufficient data.

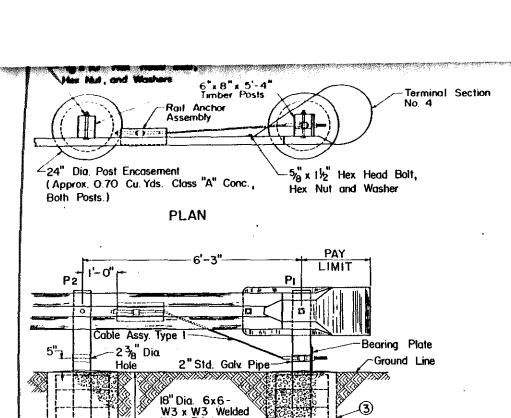
30

TABLE 7. VEHICLE SIZE VERSUS IMPACT SEVERITY (MBCT)*

ACCIDENT	VEHICLE	VEHICLE	VEHICLE STYLE	VEHICLE SIZE	IMPACT	SEVERITY	DEGREE OF	DAMAGE TO END
NUMBER	YEAR	MAKE	OR MODEL	CATEGORY	SEVERITY	OF INJURY	VEHICLE DAMAGE	TREATMENT
001	76	Olds	4-DR-SD	Auto-L	Severe	2	4	Unknown
003	75	Chev	2-DR-SD	Auto-U	Non-Severe	5 , 5	4	Unknown
004	69	Ford	2-DR-SD	Auto-L	Severe	2	4	Unknown
800	75	Chev	4-DR-SD	$\mathtt{Auto-L}$	Severe	5,5,5,5	4	Unknown
014	Unknown	Unknown	Unknown	Unknown	Non-Severe	Unknown	Unknown	Moderate
015	Unknown	Unknown	Unknown	Unknown	Non-Severe	Unknown	Unknown	Moderate
026	Unknown	Unknown	Unknown	Unknown	Non-Severe	Unknown	Unknown	Moderate
035	75	Chev	2-DR-SD	Auto-U	Severe	5	4	Unknown
040	77	\mathtt{Chev}	PU	Auto-S	Severe	1,2	4	Extensive
041	73	Volks	Beetle	Auto-S	Severe	1	4	Heavy
042	Unknown	Unknown	Unknown	Unknown	Severe	Unknown	Unknown	Heavy
043	Unknown	Unknown	Unknown	Unknown	Severe	Unknown	Unknown	Heavy
044	Unknown	Unknown	Unknown	Unknown	Severe	Unknown	Un <u>kn</u> own	Heavy
051	Unknown	Unknown	Unknown	Unknown	Severe	Unknown	Unknown	Moderate
052	67	Plym	2-DR-SD	Auto-L	Severe	2	4	Unknown
056	74	Ford	SW	$\mathtt{Auto-L}$	Severe	3	4	Unknown
065	79	Amc	2-DR-SD	Auto-U	Non-Severe	3	3	Unknown
068	7 9	Buick	SD	Auto-U	Severe	3,5	4	Unknown
069	70	Pont	SD	Auto-L	Severe	3	3	Heavy

^{*} Refer to Figure 7 for explanation of codes.

APPENDIX A STANDARD DRAWINGS FOR KENTUCKY'S BCT AND MBCT



ELEVATION

Wire Fabric

3-0"

P8 P7 P6 P5 P4B P4A P3 P2 P1 Tangent Line—

Typical Post Spacing 37'-6" PARABOLA

TRAFFIC

DETAIL "A"

- End Treatment Type 4 shall be to the pay limits as detailed and the contract unit price each shall include Terminal Section No. 4 (Alternate 1 or 2), Cable Assembly Type 1, Rail Anchor Assembly, Timber Posts, Class A Concrete, Reinforcement, Extra Steel Posts and all other incidentals necessary to complete the installation.
- Promed 6½" x 8½" socket to receive 6" x 8" post, the void shall be filled with sand or place concrete around the post wrapped with one layer of ½" thick expanded polystyrene foam sheeting. The sand or foam sheeting shall extend to within 1" of the top, this shall be filled with Butyl Rubber Caulking (commercial grade) or other approved waterproof material.
- Form the top 4" of the concrete encasement and crown \(\frac{1}{2} \) to drain. A construction joint will not be permitted in the concrete anchor.
- 4. End Treatment Type 4 shall always be constructed with a 4' offset in a 37'-6" Parabola as shown in Detail "A". When End Treatment Type 4 is to be offset greater than 4'-0" the last 37'-6" shall be flared as shown in Detail "A" and the remainder shall be offset in accordance with the chart shown on current Standard Drawing No. RBI-001.
- 5 The rectangular plate washer shall be eliminated on Post P2 to Post P8.
- When the guardrail system is installed with Steel Posts the space between Post P3 and P5 shall be divided into 3 spaces with posts 4'-2" O.C. as shown in Detail "A". If the guardrail system is installed with wood posts, all the posts shall be spaced 6'-3" O.C.

GUARDRAIL SYSTEM WITH WOOD POSTS

WOC	D POSTS
Post	Offset to Face of Guardrail
Pι	4.0'
P2	2.78'
Р3	1.78
P4	1.0'
P5	0.44
P6	0.11'
P7	0'
$\overline{}$	

GUARDRAIL SYSTEM WITH STEEL POSTS

	Post	Offset to Face of Guardrail
	Ρı	4.0 ^t
	P2	2.78
	Р3	1.78'
	P4A	1.23
	P4B	0.79
	P5	0.44
	P6	0.11
	Pγ	ď

METRIC CONVERSIONS

1 FT. = 0.3048 m

1 IN. = 25.4 mm

USE WITH CURRENT STANDARD DRAWINGS: RBR-005, RBR-010, RBR-015, RBR-016, RBI-001, RBI-002, RBI-003

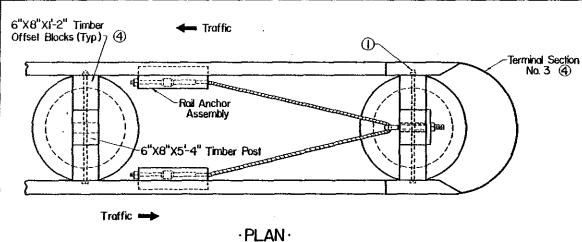
KENTUCKY BUREAU OF HIGHWAYS

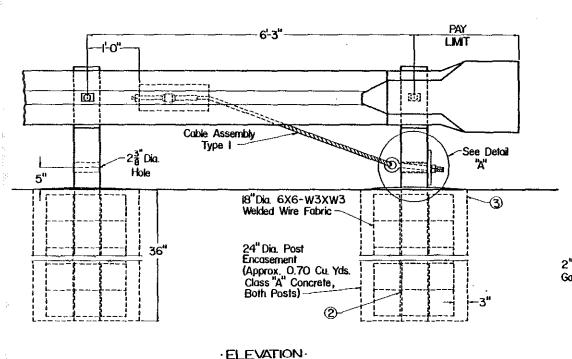
END TREATMENT
TYPE 4

STANDARD DRAWING No. RBR-035-02

BURNITIES BIRICION SUITION OF CELLY

APPROVED CHARACTER STANDARD COLUMN SAIS

APPROXIMATE


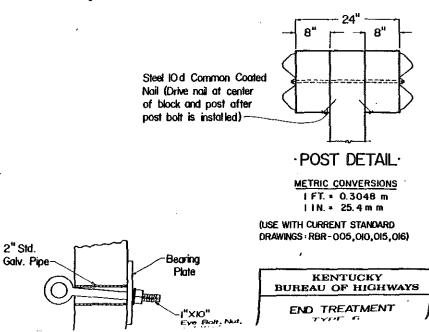


· NOTES ·

End Treatment Type 6 shall be to the pay limits as detailed and the contract unit price each shall include Terminal Section No. 3, Cable Assembly Type I, Rail Anchor Assembly, Timber Posts, Class A Concrete, Reinforcement, and all other incidentals necessary to complete the installation.

- \bigcirc $\frac{5}{8}$ X Post and Block width plus $2\frac{1}{4}$ Steel Threaded Rod, Nuts, and Washers or $\frac{5}{8}$ X Post and Block width plus 2" Button or Hex Head Bolt, Nut, and Washer. Threaded Rod shall have same strength requirements as bolt.
- ② Formed 6½"x8½" socket to receive 6"x8" post, the void shall be filled with sand or place concrete around the post wrapped with one layer of ¼" thick expanded polystyrene foam sheeting. The sand or foam sheeting shall extend to within 1" of the top, this shall be filled with Butyl Rubber Caulking (commercial grade) or other approved waterproof material.
- Form the top 4" of the concrete encasement and crown ½" to drain. A construction joint will not be permitted in the encasement.
- Use Term. Sect. with 1-3" radius when adjoining system has wood or concrete posts. Use Term. Sect. with 1-1" radius when adjoining system has steet posts. With adjoining steet post system the wood offset blocks shall be turned with 8" dimension parallel to traffic.

End Treatment Type 6 shall be modified as shown on current Standard Drawing RBI-007.





$\label{eq:appendix} \textbf{APPENDIX} \quad \textbf{B}$ $\label{eq:decomposition} \textbf{DETAILED DESCRIPTION OF END TREATMENT ACCIDENTS}$

LOCATION: COUNTY - Livingston

ROUTE - I 24

MILEPOINT - 30.900

DATE OF ACCIDENT: 12/19/80

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1976 Oldsmobile 4-door sedan ran off the left-hand side of the road (the driver stated he went to sleep) and struck the guardrail head-on with the left front fender. The vehicle then spun approximately 135 degrees counter-clockwise and stopped. The driver suffered incapacitating injuries. He was not wearing a safety belt. The vehicle received disabling damage.

It was not possible to determine from the accident report diagram specifically how the guardrail performed. Damage to the guardrail end was unknown.

<u> </u>	 Point of impact Guardrai (D) (Final position
	IZ4 WB

LOCATION: COUNTY - McCracken

ROUTE - I 24 MILEPOINT - 2.758

DATE OF ACCIDENT: 2/13/79

END TREATMENT: Type 4

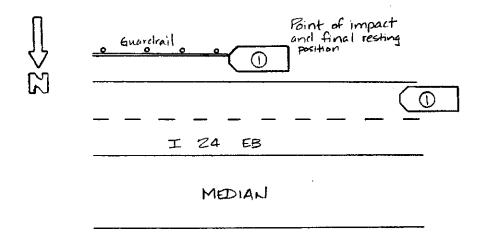
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1979 2-door Ford sedan, struck the guardrail end head-on and stopped. The vehicle remained in service, so it can be assumed that damage to the vehicle was minor. The driver was not wearing a safety belt and received a non-incapacitating injury to the head. Damage to the end treatment was unknown.

It is assumed that the speed of the vehicle just prior to impact was low, since the injury to the driver was not serious and the auto remained in service.



LOCATION: COUNTY - McCracken

ROUTE - I 24 MILEPOINT - 13.400

DATE OF ACCIDENT: 2/13/79

END TREATMENT: Type 6

PHOTOS: Not Available

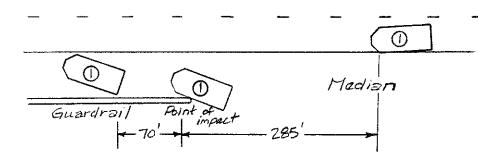
ACCIDENT REPORT: Available

COMMENTS: A 1975 2-door Chevrolet sedan struck the Type 6 end treatment at an angle with the driver's side door and continued travelling alongside the guardrail approximately 70 feet after impact. Approximately 30 feet of guardrail was damaged. The vehicle sustained disabling damage, but neither the driver nor passenger sustained injuries. Neither were wearing safety

belts. Driver cited for DUI.

DIAGRAM:

I24 WB



LOCATION: COUNTY - Marshall

ROUTE - I 24 MILEPOINT - 27.70

DATE OF ACCIDENT: 11/9/80

END TREATMENT: Type 6

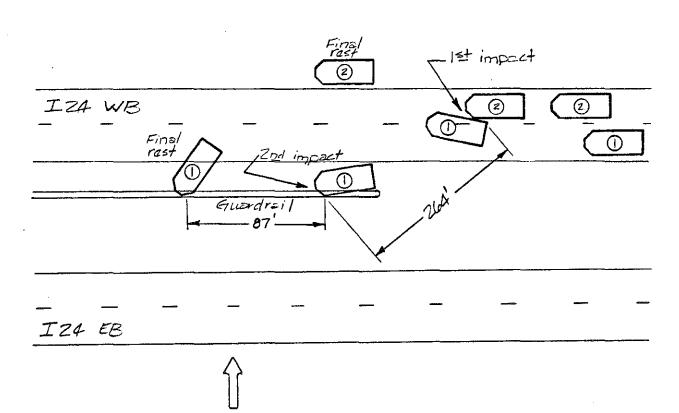
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle appears (from police diagram) to have impacted the Type 6 end treatment at an angle, striking it between the first and second wooden posts, and proceeded to ride on top of the guardrail. Alcohol involvement was noted on the accident report.

The auto, a 1969 Ford 2-door sedan, received disabling damage. The collision with the median guardrail followed a collision with another vehicle. The driver of the vehicle sustained an incapacitating neck injury. He was not wearing a safety belt.



LOCATION: COUNTY - Christian County

ROUTE - I 24 MILEPOINT - 85.5

DATE OF ACCIDENT: 3/82

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Not Available

COMMENTS: No accident report was found for this collision. The repair report indicates that the Type 4 end treatment was damaged sufficiently enough to be completely replaced. Both wood

posts did break away.

LOCATION: COUNTY - Christian County

ROUTE - I 24

MILEPOINT - 85.563 Entrance Ramp from US 41A

DATE OF ACCIDENT: 7/28/81

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1970 Ford 2-door sedan collided with the guardrail end head-on as it ran off the I 24 entrance ramp. The vehicle then spun clockwise around the guardrail end approximately 45 degrees before coming to a stop. The car sustained disabling damage to the front end. The driver of the vehicle suffered a non-incapacitating head injury. He was not wearing a safety belt. The sketch on the accident report shows that the car did not break through the end treatment, but was stopped by it.

DIAGRAM:

Entranca ramp

LOCATION: COUNTY - Christian

ROUTE - I 24

MILEPOINT - 85.563 Entrance Ramp from US 41A

DATE OF ACCIDENT: 9/4/80

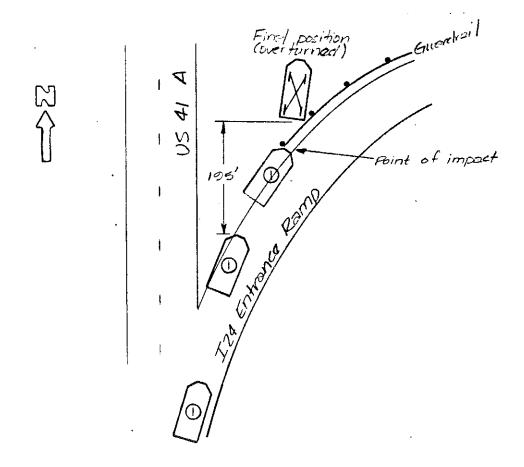
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1978 GMC pickup truck, overturned after striking the end treatment head-on. All four occupants suffered incapacitating, multiple injuries. None were wearing safety belts. The police report indicates that the guardrail end was impacted at a high rate of speed. Alcohol involvement was listed as a contributing factor.



LOCATION: COUNTY - Christian

ROUTE - I 24 MILEPOINT - 85.9

DATE OF ACCIDENT: 6/18/77

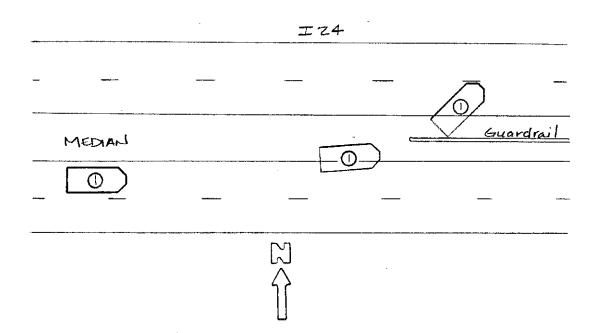
END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of the 1975 Chevrolet 4-door sedan was reported to have fallen asleep, driving into the median and striking a Type 6 end treatment with the front end of the car at a slight angle. The vehicle appears from the diagram to have broken through the end treatment, coming to rest on the other side of the median in the inside lane. None of the four passengers were injured, but the vehicle was disabled. None of the occupants were wearing safety belts.



LOCATION: COUNTY - Henderson

ROUTE - Audubon Parkway 9005

MILEPOINT - 0.1 at Southbound Off Ramp

DATE OF ACCIDENT: 1/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS:

No accident report could be found for this accident. From the photographs, it appears that the vehicle involved was initially bound for an exit ramp and swerved across the gore area back toward the mainline, striking the guardrail end from the backside in the process. Both wooden posts were broken and the guardrail was bent outward toward the roadway. Injury to vehicle occupant(s) and extent of damage to the vehicle is unknown.



Figure B1. Accident Number 009, Henderson County, Audubon Parkway, MP 0.1, at SB Off-Ramp.

LOCATION: COUNTY - Hopkins

ROUTE - Pennyrile Parkway

MILEPOINT - 44.2; Exit Ramp to KY 281

DATE OF ACCIDENT: 1/27/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1978 Chevrolet pickup was attempting to merge into the deceleration lane approaching the upcoming exit ramp when he lost control of the vehicle and left the ramp on the left-hand side, striking the exit sign and then the end of the guardrail head-on with the front of the truck. The truck broke the first post and travelled approximately 18 feet before coming to rest.

The first post broke off and the rail bent at the second post, which remained intact. The truck received non-disabling damage. The driver, who was not injured, was arrested for driving while intoxicated. He was not wearing a safety belt.

DIAGRAM: Not Available

Parkway,



Figure B2. Accident Number 010, Hopkins County, Pennyrile Parkway, MP 44.2, Exit Ramp to KY 281.

LOCATION: COUNTY - Todd

ROUTE - US 68

MILEPOINT - 1.327

DATE OF ACCIDENT: 1/31/80

END TREATMENT: Type 4

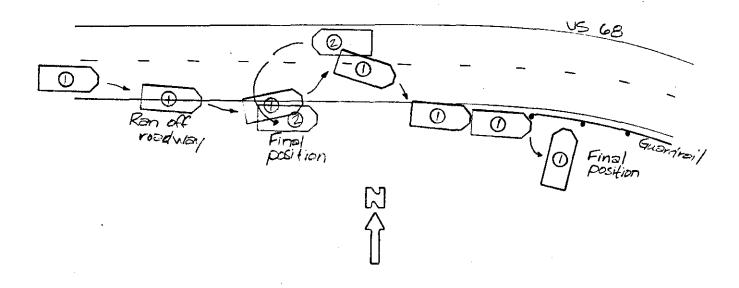
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1976 Pontiac 2-door sedan struck a guardrail end after losing control and striking another vehicle. The car struck the guardrail at the end from a slight angle. It then spun 90 degrees counterclockwise behind the guardrail and came to rest. The car struck the guardrail end with the left front and left rear fenders. The driver, who was not wearing a safety belt, sustained a possible back injury. The car received disabling damage.

It is impossible to determine from the police diagram whether the vehicle broke through the end treatment or rotated around it. However, the repair form stated that the end treatment was replaced entirely, including concrete footings, which indicates that the posts did break.



LOCATION: COUNTY - Todd

ROUTE - US 68

MILEPOINT - 3.618

DATE OF ACCIDENT: 9/21/79

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1977 2-door Chevrolet, skidded on a pool of water and left the 2-lane road on the left-hand side. The vehicle struck the guardrail end with its left side and rebounded back into the roadway before coming to a stop. The driver's side of the car was heavily damaged. The driver sustained incapacitating injuries while the passenger received a non-incapacitating back injury. Neither occupant wore a safety belt.

The injuries and auto damage were caused by the vehicle striking the guardrail end with its side which could explain the trajectory of the vehicle after impact with the end. The end treatment, including concrete footings, was completely replaced.

LOCATION: COUNTY - Todd

ROUTE - US 68 MILEPOINT - 2.233

DATE OF ACCIDENT: 11/29/78

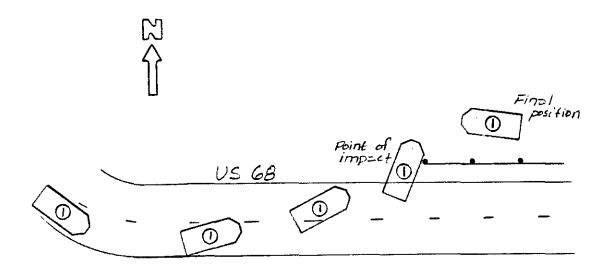
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1977 Pontiac 2-door sedan left the 2-lane roadway on the left-hand side and struck the guardrail end at an angle with its right front fender. It appears from the police diagram that the car broke through the end treatment before coming to rest. The right front fender and passenger-side door were heavily damaged, disabling the vehicle. The driver sustained incapacitating multiple injuries. He was not wearing a safety belt. Police report indicates a high rate of speed prior to impact. The guardrail end was replaced entirely, including concrete footings.



LOCATION: COUNTY - Jefferson Built

ROUTE - I 65 MILEPOINT - 1-28

DATE OF ACCIDENT: Unknown

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: No accident report was found. An unknown vehicle

impacted this Type 6 end treatment at a shallow angle, breaking the first post. Vehicular action after impact is

unknown.





Figure B3. Accident Number 014, Bullitt County, I 65.

LOCATION: COUNTY - Bullit

ROUTE - I 65 MILEPOINT - 116

DATE OF ACCIDENT: 1/84

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: No accident report could be found. The photographs

indicate impact sufficient to break the first wooden post. It appears that a new buffered end was installed for safety purposes until the post could be replaced. Extent of injury

or damage to the vehicle remains unknown.



Figure B4. Accident Number 015, Bullitt County, I 65, MP 116.

LOCATION: COUNTY - Bullitt

ROUTE - I 65

MILEPOINT - 117.8

DATE OF ACCIDENT: 3/30/81

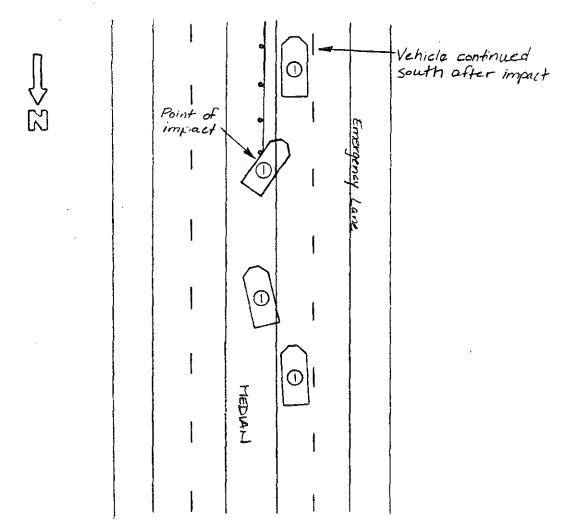
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1977 Pontiac Grand Prix struck a guardrail end on the shoulder of the median. The vehicle had run off into the median when the driver fell asleep and was recovering back onto the roadway when it struck the end treatment with the driver's-side door. The driver, who was not wearing a safety belt, sustained a possible head injury. After impact, the vehicle was driven to the next interstate service area.



LOCATION: COUNTY - Bullitt

ROUTE - I 65

MILEPOINT - 104.800; Lebanon Junction Exit Ramp

DATE OF ACCIDENT: 5/11/81

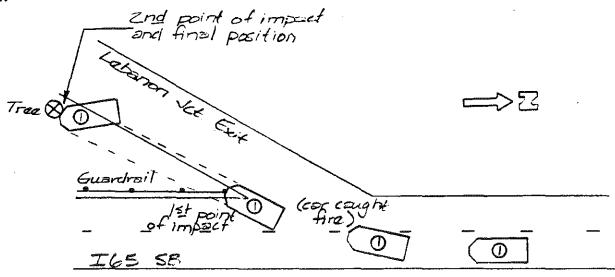
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle broke through the end treatment (at least one post was broken) and continued on, where it then struck a tree and burned. The vehicle, a 1973 2-door Chevrolet, sustained disabling damage to the front end, but it cannot be determined how severely the car was damaged by the guardrail as it subsequently struck a tree. The driver of the vehicle was not seriously injured, sustaining only a possible injury to the legs or feet. He was not wearing a safety belt. The police report suggests that the accident occurred as a result of a high speed police chase and it appears that the car caught fire just before it struck the guardrail.



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LOCATION: COUNTY - Bullitt

ROUTE - I 65

MILEPOINT - 104.800; Lebanon Junction Exit Ramp

DATE OF ACCIDENT: 6/16/80

END TREATMENT: Type 4

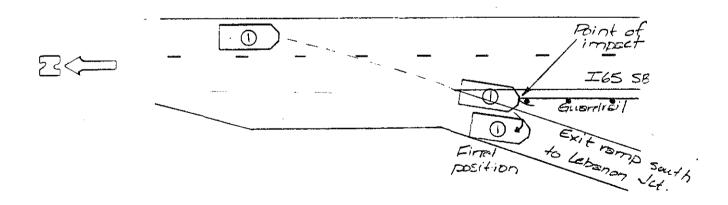
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1962 2-door Volvo, struck a guardrail at a gore area head-on, bent the end treatment back (breaking both wooden posts), and stopped. The vehicle was heavily damaged in the front end, completely disabling it. The driver, who was not wearing a safety belt, sustained an incapacitating head injury.

The police report suggests that the Volvo struck the guardrail end almost straight-on, destroying 20 feet of rail and posts. There was damage to the end treatment past the wooden posts. It appears that the guardrail end did not penetrate the front end of the vehicle but was bent back as the Volvo slid off to the right after impact.



LOCATION: COUNTY - Jefferson

ROUTE - I 65 MILEPOINT - 128.3

DATE OF ACCIDENT: Unknown

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: Impact with the Type 4 end treatment resulted in heavy damage. The angle of impact appeared to be moderate and the impact was severe. No accident report was available to

obtain additional information. Performance of the end

treatment was unknown.

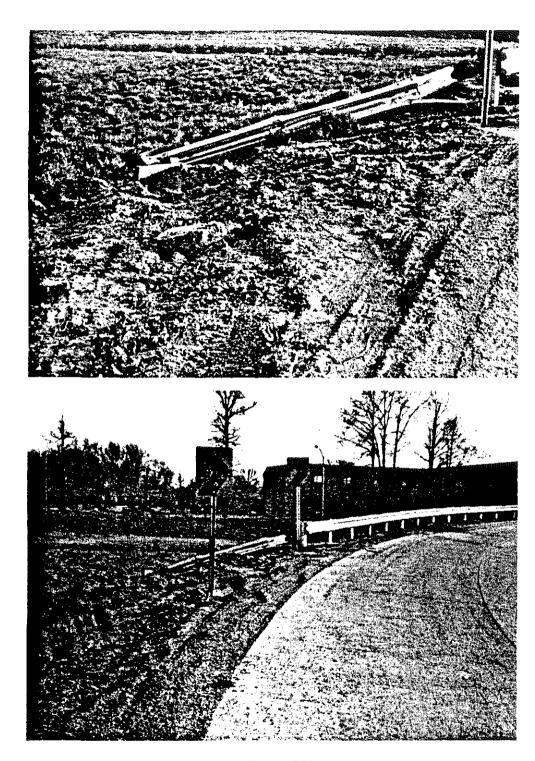


Figure B5. Accident Number 019, Jefferson County, I 65, MP 128.3

LOCATION: COUNTY - Jefferson

ROUTE - I 65

MILEPOINT - 128.330; Ramp to Fern Valley Road

DATE OF ACCIDENT: 4/18/82

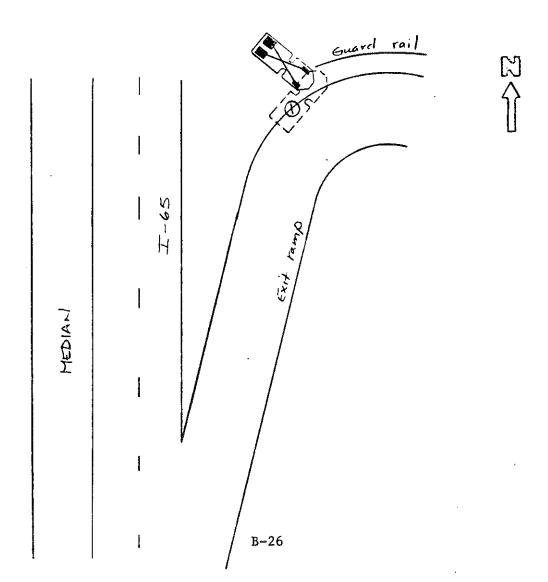
END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

A 1969 Ford single-unit truck collided with a guardrail end after entering an exit ramp too fast. It appears that the vehicle struck the guardrail with the left-front fender, then overturned. The truck was disabled and had to be removed from the scene but the driver received no injuries. None of the occupants was wearing a safety belt.



LOCATION: COUNTY - Jefferson

ROUTE - I 65 MILEPOINT - 128.302

DATE OF ACCIDENT: 4/4/81

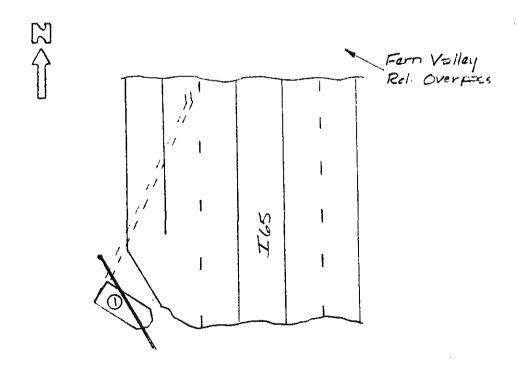
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1968 2-door Chevrolet, lost control after striking a pool of water and slid sideways into the guardrail, striking it just past the end. It is impossible to determine from the report whether the car then jumped atop the rail or the rail collapsed under the weight of the car. The diagram shows the car coming to rest on top of the rail with disabling damage to the bottom of the vehicle. The driver of the vehicle was not injured. She was not wearing a safety belt. Damage to the end treatment was not documented.



LOCATION: COUNTY - Jefferson

ROUTE - I 71

MILEPOINT - 4.000; Exit Ramp to I 264

DATE OF ACCIDENT: 9/3/82

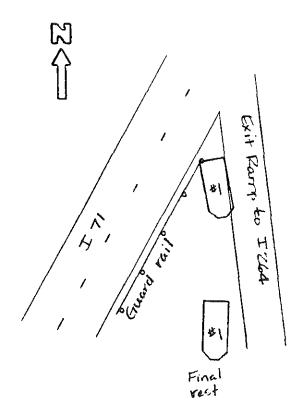
END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

A 1978 Chevrolet station wagon ran into a guardrail end at a gore area, broke through the end treatment (breaking both wooden posts) and came to rest at the bottom of the embankment behind the guardrail. The vehicle impacted the end of the guardrail at an angle with the passenger-side door and a passenger in the right rear seat received a possible leg injury. It is probable that her injury resulted from collision of the door with the guardrail end. The driver and two other passengers were uninjured. None of the occupants wore a safety belt. The vehicle was damaged on the right side but remained functional.



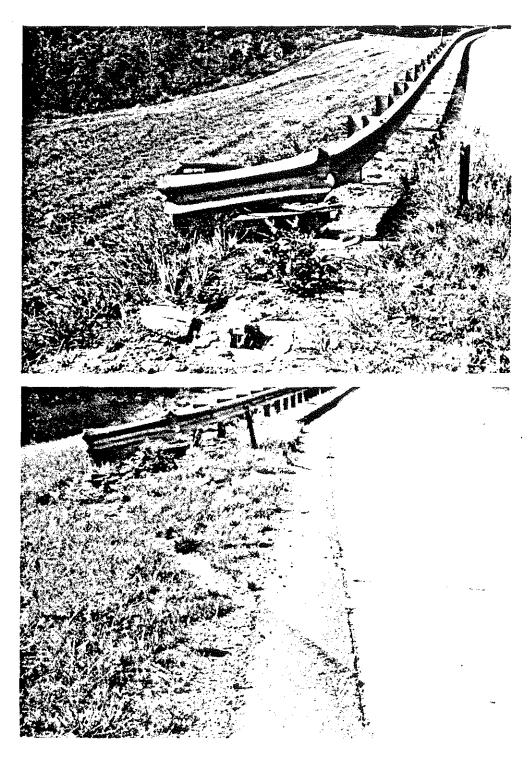


Figure B6. Accident Number 022, Jefferson County, I 71, MP 4.000, Exit Ramp to I 264 WB.

LOCATION: COUNTY - Jefferson

ROUTE - I 264

MILEPOINT - 17.9; Ramp from Breckenridge Lane

DATE OF ACCIDENT: 10/28/82

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: No report could be found for this location. The photographs indicate impact at a moderate angle which caused the first post to break away. The second post remained intact as the guardrail bent around it. No other information was available. Evidence indicates a non-severe impact with the possibility that no accident report was filed.

DIAGRAM: Not Available

MP 4.000,



Figure B7. Accident Number 023, Jefferson County, I 264, MP 17.9, Ramp from Breckenridge Lane.

LOCATION: COUNTY - Jefferson

> ROUTE - US 31E

MILEPOINT - 1.9

DATE OF ACCIDENT: 12/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

No accident report could be found. The photographs show COMMENTS: a slight or moderate hit. The first post was not broken, but the concrete footing was knocked loose. The second post broke completely. The concrete footing containing the first post was partially pulled out and did not allow the post to break.

No other information was available.

DIAGRAM: Not Available

, MP 17.9,

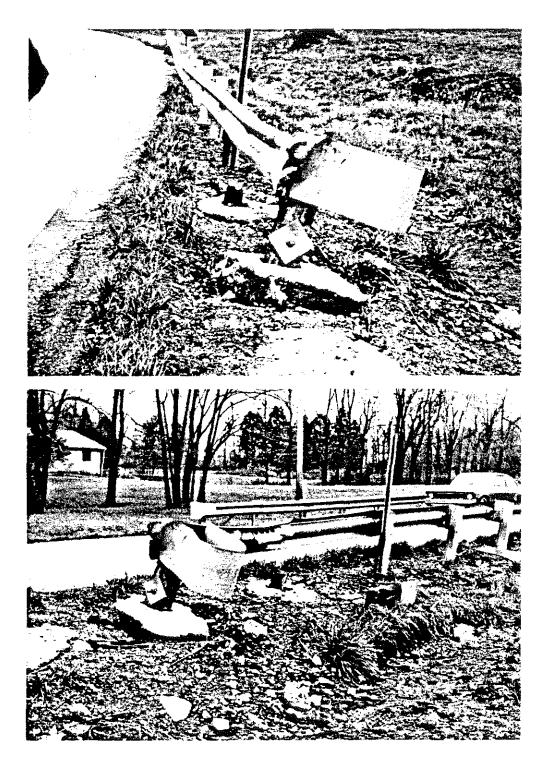


Figure B8. Accident Number 024, Jefferson County, US 31E, MP 1.9.

LOCATION: COUNTY - Jefferson

ROUTE - US 42

MILEPOINT - 5.5; at Lime Kiln Lane

DATE OF ACCIDENT: 2/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: No accident report could be found for this accident.

Photos show that both wooden posts were completely broken off at ground level. It also appears that one or two of the steel posts were either broken or knocked over. The angle of impact appears to be shallow, with extensive damage to the guardrail. The extent of vehicle occupant injury and vehicle damage are unknown. However, damage to the guardrail indicates a severe

impact.

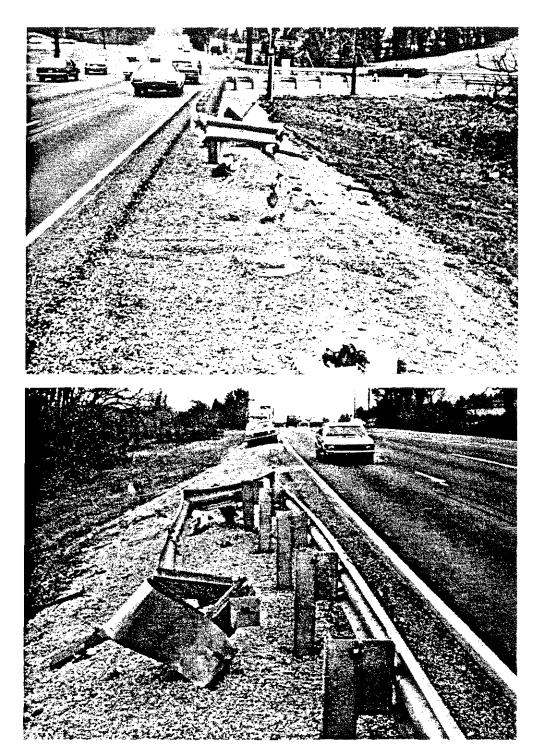


Figure B9. Accident Number 025, Jefferson County, US 42, MP 5.5, at Lime Kiln Lane.

LOCATION: COUNTY - Shelby

ROUTE - I 64 MILEPOINT - 29.0

DATE OF ACCIDENT: 12/83

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Not Available

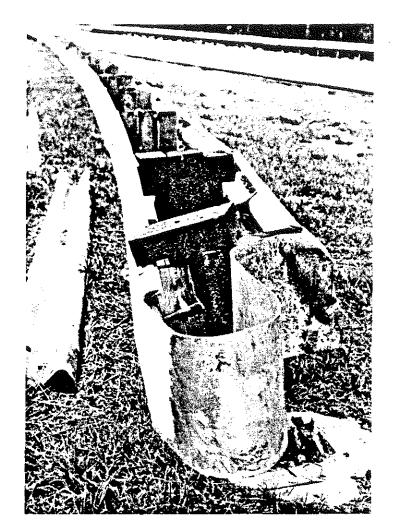
COMMENTS:

No accident report was found. Photos show that the impact was at a shallow angle. Collision was probably with the left-front end of the vehicle. Impact resulted in the first post breaking but the second post remained intact and there was little damage to the guardrail. The only major deformation was to the right front of the nose. Damage to the vehicle and occupant injuries

are unknown.

DIAGRAM: Not Available

MP 5.5,



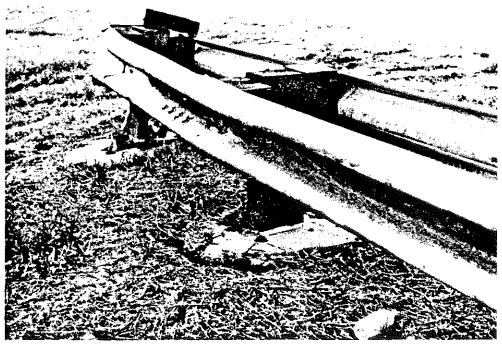


Figure B10. Accident Number 026, Shelby County, I 64, MP 29.

LOCATION: COUNTY - Shelby

ROUTE - I 64

MILEPOINT - 30

DATE OF ACCIDENT: 8/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: Only slight damage was done. The second wooden post was cracked and the concrete anchor moved. No accident report could be found. Initial site investigation revealed tire marks indicating that the vehicle had run off the road and was re-entering the roadway when it struck the end treatment. Rubber deposits along the guardrail suggest that the vehicle sideswiped the end treatment, probably contacting with rubber on the bumper or fender. The vehicle probably continued on

and no accident report was filed.

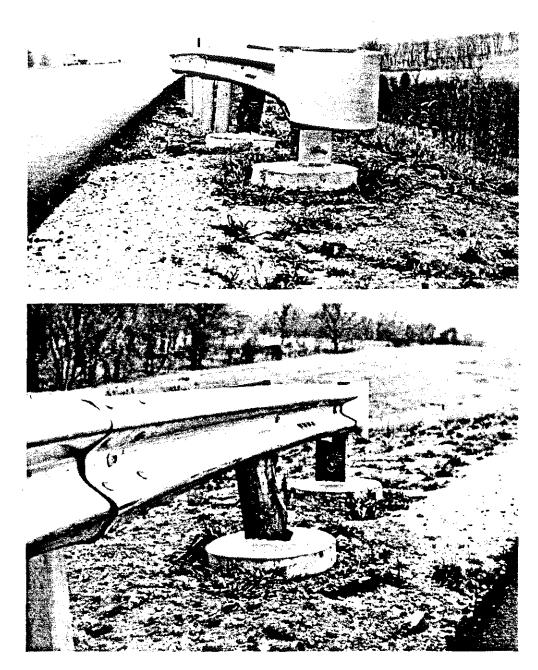


Figure Bll. Accident Number 027, Shelby County, I 64, MP 30.

LOCATION: COUNTY - Shelby

> ROUTE - I 64

> MILEPOINT - 33.980

DATE OF ACCIDENT: 11/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1981 Chevrolet Chevette lost control of his car after attempting to dodge an animal in the roadway. The car left the road and ran onto the median shoulder. It then came back onto the road, crossed both traffic lanes and ran off the right-hand shoulder where it struck a guardrail end, broke through the end treatment and rolled over once before coming to rest in an upright position. Contact with the guardrail end was made with the front of the car, but the police report states that heavy damage to the top from overturning caused the car to be disabled. Impact was at a sharp angle with the first post. The second post did not break.

The driver and right front passenger both received nonincapacitating head injuries. A passenger in the rear was uninjured. None of the occupants were wearing safety belts.

DIAGRAM: Vahicla overturned Final Rest	·	
Impact with guardrall IC4 WB		0
MEDIAN	0	
	.comp comm.	Althon





Figure B12. Accident Number 028, Shelby County, I 64, MP 33.980.

LOCATION: COUNTY - Boone

ROUTE - I 75

MILEPOINT - 181.257; Exit Ramp to KY 18

DATE OF ACCIDENT: 8/19/83

END TREATMENT: Type 4

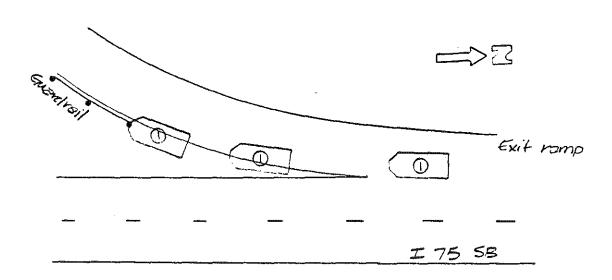
PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1982 4-door Chevrolet Caprice, left the roadway on the left-hand side of the exit ramp from I-75, impacted the guardrail end head-on and stopped. The first post was broken while the second was cracked but not broken. The car came to rest at the second post.

The driver of the car received incapacitating leg injuries. He was not wearing a safety belt. The car suffered disabling damage to the front end.



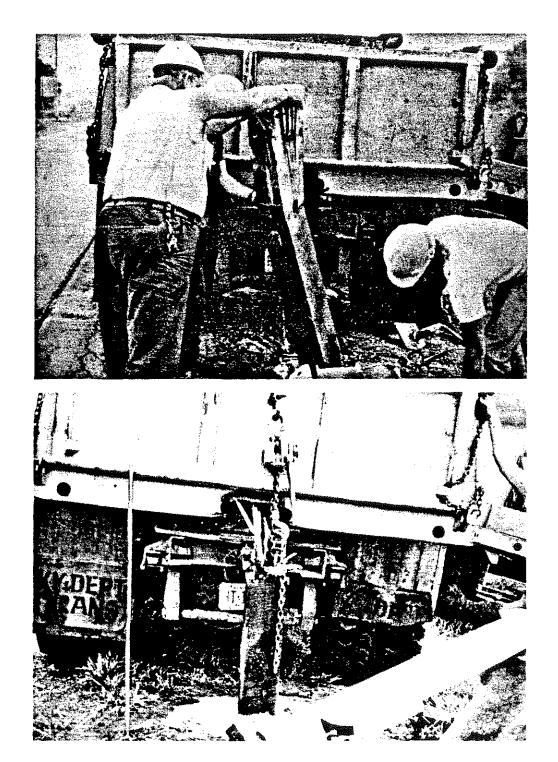


Figure B13. Accident Number 029, Boone County, I 75, MP 181.257, KY 18 Exit Ramp.

LOCATION: COUNTY - Boone

ROUTE - I 75 MILEPOINT - 175.764

DATE OF ACCIDENT: 5/6/83

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1976 Ford van, left the roadway, striking the guardrail end at an angle with the front end. The van broke through the guardrail on the right shoulder and continued another 186 feet before coming to a stop. The van sustained considerable damage to the front end on the driver's side. Neither the driver nor any of the six passengers was injured. No one was wearing a safety belt. Twenty feet of guardrail was damaged, indicating that both wooden posts were broken.

DIAGRAM:

T75
Point of impox t

LOCATION: COUNTY - Boone

> ROUTE - I 75 MILEPOINT - 181.400

DATE OF ACCIDENT: 5/7/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The guardrail bent outward toward the roadway between the second wooden post and first steel post. The first wooden post was partially broken while the second wooden post did not break. The concrete footing failed.

Investigation of the site showed tire marks leading into the guardrail end from behind the guardrail, suggesting that the vehicle had run off the road and was in the process of recovering before the impact. This is supported as the photographs show the end bent back toward the roadway. The driver was injured slightly. He was not wearing a safety belt. The vehicle was a 1980 Chevrolet Monza.

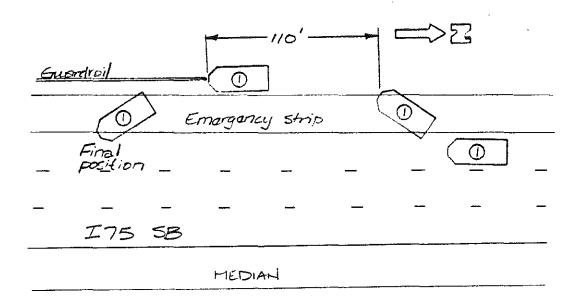






Figure B14. Accident Number 031, Boone County, I 75, MP 181.400.

LOCATION: COUNTY - Boone

ROUTE - I 75

MILEPOINT - 175.364; KY 338 Exit Ramp

DATE OF ACCIDENT: 4/5/83

END TREATMENT: Type 4

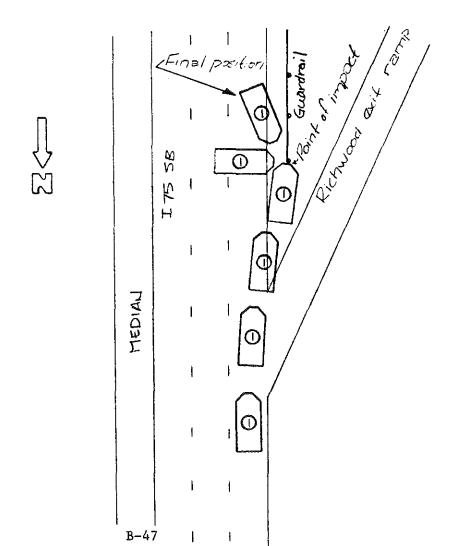
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1981 Ford pickup, went out of control, swerving across the roadway before going off the roadway on the right-hand side. The truck impacted the guardrail end with the right front at a shallow angle and then spun clockwise around the guardrail approximately 150 degrees before coming to rest. All 4 tires blew out as a result of the vehicle spinning out. The posts did not break. The only damage was to the nose terminal.

The driver received an incapacitating head injury. She was not wearing a safety belt. There was disabling damage to the vehicle.



LOCATION: COUNTY - Boone

ROUTE - I 75

MILEPOINT - 181.257; KY 18 Exit Ramp

DATE OF ACCIDENT: 5/29/82

END TREATMENT: Type 4

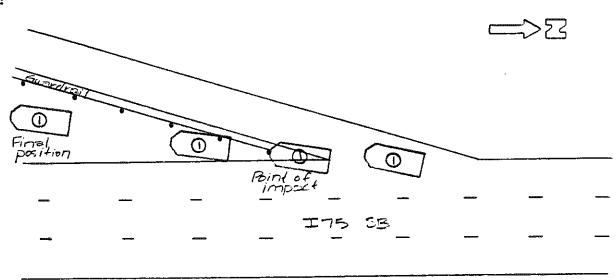
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1969 4-door Oldsmobile, impacted the guardrail in the gore area head-on at a shallow angle and broke through the end treatment, where it continued for approximately 195 feet before stopping.

Disabling damage was done to the front end of the vehicle, but the driver was not injured. She was not wearing a safety belt. The police diagram indicates that both wooden posts were broken.



LOCATION: COUNTY - Boone

ROUTE - I 75

MILEPOINT - 175.364; KY 338 Exit Ramp

DATE OF ACCIDENT: 7/22/81

END TREATMENT: Type 4

PHOTOS: Not Available

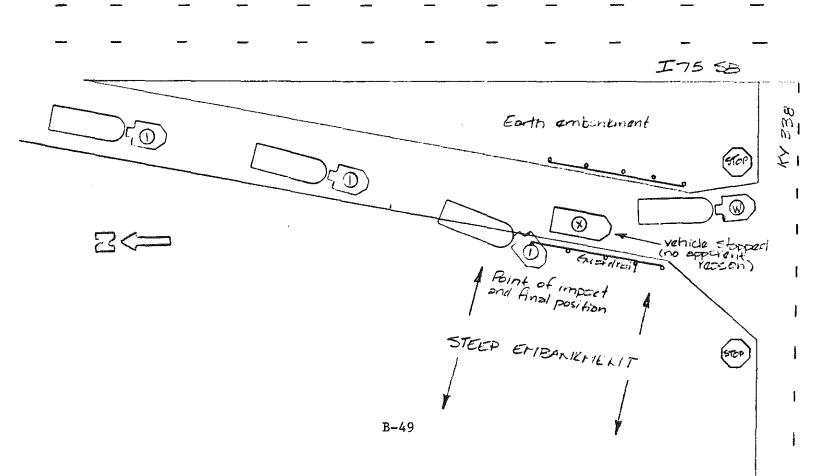
ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1979 International tractor and semitrailer, ran off the exit ramp in an attempt to avoid collision with other vehicles stopped at the intersection. The truck impacted the guardrail end head-on at a shallow angle, broke through the two wooden posts and rode on top of the rail, flattening it underneath. Disabling damage was done to the front of the vehicle. The driver received non-incapacitating leg injuries. He was wearing a lap belt.

DIAGRAM:

MEDIAN



LOCATION: COUNTY - Boone

ROUTE - I 75

MILEPOINT - 178.083

DATE OF ACCIDENT: 1/1/81

END TREATMENT: Type 6

PHOTOS: Not Available

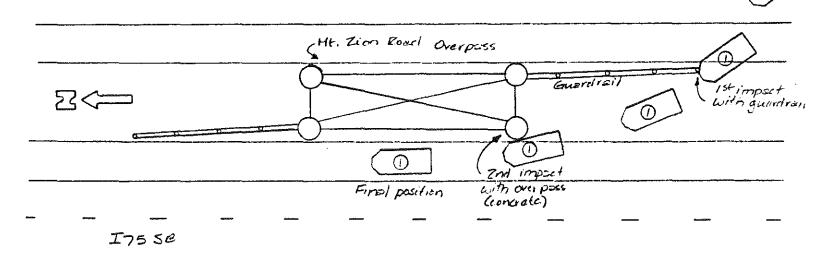
ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1975 2-door Chevrolet, lost control and left the roadway on the left-hand side. It struck the MBCT end treatment with the front end at an angle of approximately 45 degrees, broke completely through and continued on, sideswiping the corner of the overpass structure with its passenger side before coming to rest in the inside emergency lane on the opposite side of the interstate. The vehicle received disabling damage to the right front end. The driver was uninjured and was cited for public intoxication. He was not wearing a safety belt.

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LOCATION: COUNTY - Boone

ROUTE - I 275

MILEPOINT - 10.600

DATE OF ACCIDENT: 1/10/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1983 International tractor and semitrailer lost control of his truck on ice. The trailer jackknifed, causing the vehicle to leave the roadway on the right-hand side and strike the guardrail end with the trailer. The trailer then rode up onto the guardrail before the truck came to a halt. Both wooden posts were broken and the first two metal posts were bent substantially. About 30 feet of guardrail was damaged as the truck flattened the guardrail after breaking through the wooden posts. The truck was disabled. The driver suffered possible leg injuries. He was not wearing a safety belt.

DIAGRAM:

I 275

234



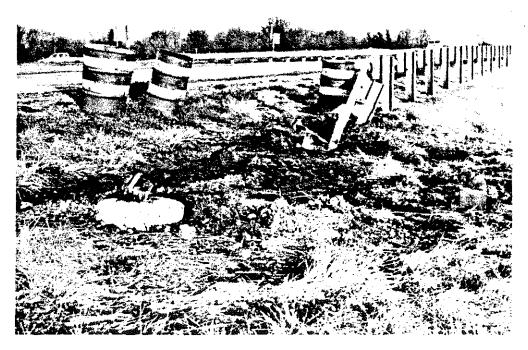


Figure B15. Accident Number 036, Boone County, I 275, MP 10.600.

LOCATION: COUNTY - Campbell

ROUTE - I 275

MILEPOINT - 74.813; I 471 SB Exit Ramp

DATE OF ACCIDENT: 2/4/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

A 1974 AMC Gremlin lost control on a patch of ice and ran off the right-hand side of the road, striking the guardrail with the left front of the car. Impact with the guardrail was of a moderate angle. The first post was broken and the guardrail was bent back around the second post. The second post did not break, but was loosened slightly from the concrete footing.

The driver of the vehicle received possible injuries to the legs and back. He was not wearing a safety belt. The vehicle received significant damage.



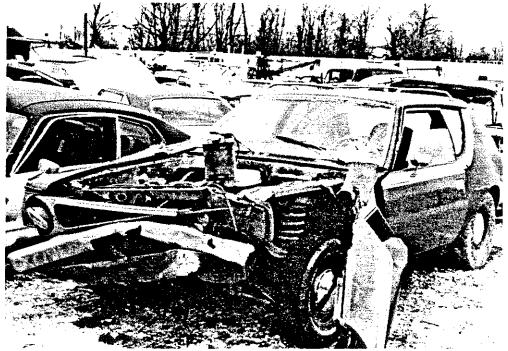


Figure B16. Accident Number 037, Campbell County, I 275, MP 74.813, I 471 SB Exit Ramp.

LOCATION: COUNTY - Carroll

ROUTE - I 71

MILEPOINT - 42.986; KY 389 Exit Ramp

DATE OF ACCIDENT: 2/26/84

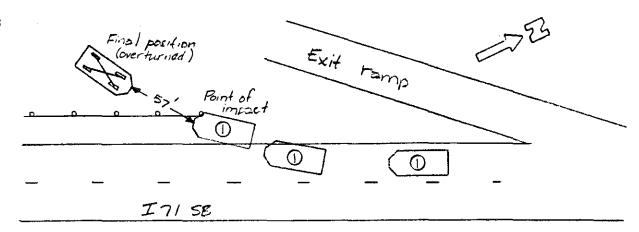
END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1981 Ford Fairmont stated that he fell asleep at the wheel. The vehicle ran off the right-hand side of the road, struck the end treatment head-on, broke through the end treatment and travelled down the slight embankment where it overturned. The car sustained disabling damage. Extensive damage was done to the guardrail as the two wooden posts were broken and a steel post was bent over. The driver suffered non-disabling multiple injuries, while his wife suffered a non-disabling head injury. Neither occupant was wearing a safety belt. The deep wheel ruts in the photographs are not from the car, but were probably caused by the wrecker that towed the car from the scene.



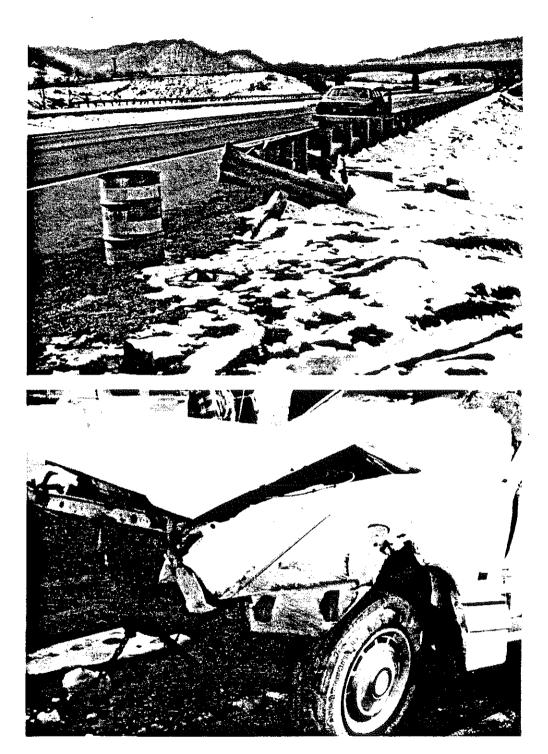


Figure B17. Accident Number 038, Carroll County, I 71, MP 42.986, KY 389 Exit Ramp.

LOCATION: COUNTY - Kenton

ROUTE - I 75 (SB @ I 275)

MILEPOINT 184.716

DATE OF ACCIDENT: 1/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: A single-unit state maintenance truck with a snowplow attached to the front lost control on the icy roadway. The

truck struck the guardrail end, breaking both wooden posts and damaging two metal posts. The truck then overturned.



Figure B18. Accident Number 039, Kenton County, I 75, MP 184.716.

LOCATION: COUNTY - Kenton

ROUTE - I 75

MILEPOINT - 184.5; I 275 WB Exit Ramp

DATE OF ACCIDENT: 11/5/83

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The guardrail penetrated the passenger compartment of this small pickup truck (a 1979 Chevrolet Luv) entering from the front windshield and extending through the rear window. It appears that the truck struck the end treatment head-on, with no inication of skid marks prior to impact. The wooden posts apparently broke away, but instead of being crushed by the front end of the truck, the guardrail end rode over the front end of the truck (truck underrun) and penetrated through passenger compartment. There was alcohol involvement for both the driver and the passenger. The passenger sustained fatal head injuries, while the driver received incapacitating head injuries. Neither occupant was wearing a safety belt although the penetration of the guardrail into the passenger compartment would have negated the effectiveness of safety belts.

DIAGRAM:					⇒23	
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<u>Hedish</u> wa	1)	Traffic sign have		To 127	⁷ 5	enes.
Ramp fi	om Ky	1236 WE				



Figure B19. Accident Number 040, Kenton County, I 75, MP 184.5, I 275 WB Exit Ramp.

LOCATION: COUNTY - Kenton

ROUTE - I 75

MILEPOINT - 184.5; I 275 WB Exit Ramp

DATE OF ACCIDENT: 11/13/82

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1973 Volkswagen Beetle, hit the Type 6 end treatment head-on. There was no evidence of skid marks leading up to the end treatment. The police report indicated that the driver apparently fell asleep and chemical tests show alcohol involvement. Only the first wooden post was broken and the guardrail penetrated the vehicle. The impact angle would approach zero degrees. The driver sustained fatal injuries to the head and chest. He was not wearing a safety belt.

DIAGRAM:

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Front of impact and final partien

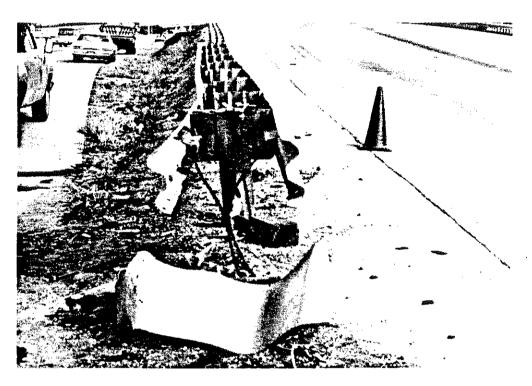


Figure B20. Accident Number 041, Kenton County, I 75, MP 184.5, I 275 Exit Ramp.

LOCATION: COUNTY - Kenton

ROUTE - I 75

MILEPOINT - 184.5; I 275 WB Exit Ramp

DATE OF ACCIDENT: 6/23/82

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Not Available

COMMENTS: Only a repair form was available for this accident.

The repair form indicated that the entire end treatment had to be replaced, suggesting heavy damage. Vehicular action after impact, occupant injury severity, and YC C

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vehicular damage are unknown.

LOCATION: COUNTY - Kenton

ROUTE - I 75

MILEPOINT - 184.5; I 275 WB Exit Ramp

DATE OF ACCIDENT: 4/82

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Not Available

COMMENTS: Only a repair form was available for this accident.

The repair form indicated that the entire end treatment had to be replaced, suggesting heavy damage. Vehicular

action after impact, occupant injury severity, and

vehicular damage are unknown.

LOCATION: COUNTY - Kenton

ROUTE - I 75

MILEPOINT _ 184.5; I 275 WB Exit Ramp

DATE OF ACCIDENT: 2/82

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Not Available

COMMENTS: Only the repair form was available for this accident.

The repair form indicated that the entire end treatment had to be repaired, suggesting heavy damage. Vehicular action after impact, occupant injury severity, and

vehicular damage are unknown.

LOCATION: COUNTY - Kenton

ROUTE - I 275

MILEPOINT - 82.475; US 42 Exit Ramp

DATE OF ACCIDENT: 7/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS:

No accident report could be located. Photographs show that the guardrail was struck directly on the end, deforming the buffered end section and cracking the first wooden post. The guardrail was slightly bent at the second wooden post, but the post did not break. No other damage to the guardrail was evident. The extent of vehicle damage and occupant injury is unknown. It appears that the guardrail end received only a light hit. The vehicle probably proceeded on and no accident report was filed.

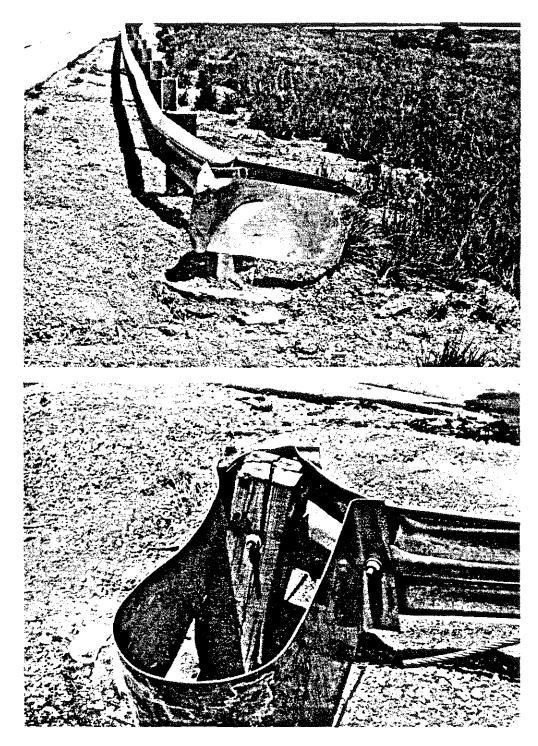


Figure B21. Accident Number 045, Kenton County, I 275, MP 82.475, US 42 Exit Ramp.

LOCATION: COUNTY - Kenton

ROUTE - I 275

MILEPOINT - 0.000; I 75 Exit Ramp

DATE OF ACCIDENT: 12/82

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS:

No accident report was filed. Accident was said to have been caused by slick roads during the winter as the trailer on a combination tractor and semi-trailer skidded sideways off the left-hand side of the road and bumped broadside against the guardrail end. Photographs show that only the rounded end of the guardrail was damaged. The concrete footing under the first post was pushed over slightly, but neither wooden post was broken. Apparently the trailer was not damaged.

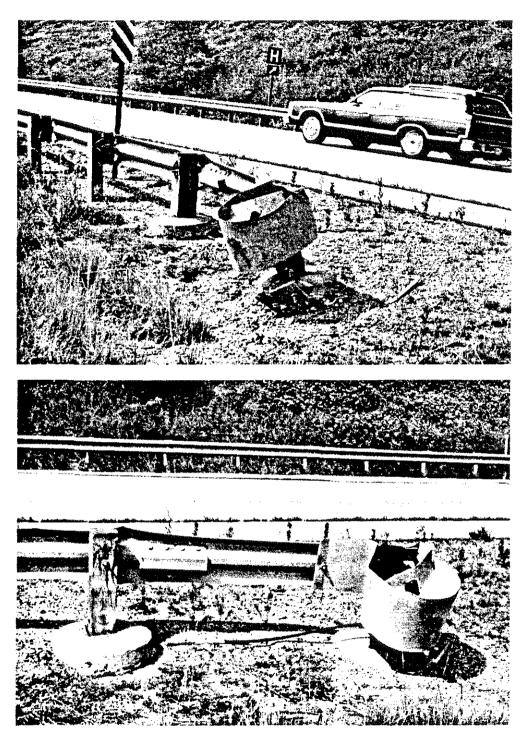


Figure B22. Accident Number 046, Kenton County, I 275, MP 0.000, I 75 Exit Ramp.

LOCATION: COUNTY - Kenton

ROUTE - I 275

MILEPOINT - 79.0; Near US 25 interchange

DATE OF ACCIDENT: 1/9/83

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1973 Mercury Cougar, was found abandoned at the scene with extensive damage to the front end and the entire left side. The driver fled the scene at the time of the accident; the extent of any possible injuries cannot be determined from the police report.

The report states that 10 to 15 feet of guardrail was damaged substantially and two wooden posts were broken. Also, another 100 feet of rail was damaged.

LOCATION: COUNTY - Kenton

ROUTE - KY 1501

MILEPOINT - 2.4

DATE OF ACCIDENT: Unknown

END TREATMENT: Type 4

PHOTOS: Available

COMMENTS:

ACCIDENT REPORT: Not Available

No accident report was found. The first wood post splintered down the middle; half of the post remained intact and the concrete footing was displaced. The second wood post cracked longitudinally near the bottom, but did not break. The rail buckled between the first and second wood posts. The

vehicle rebounded after impact.

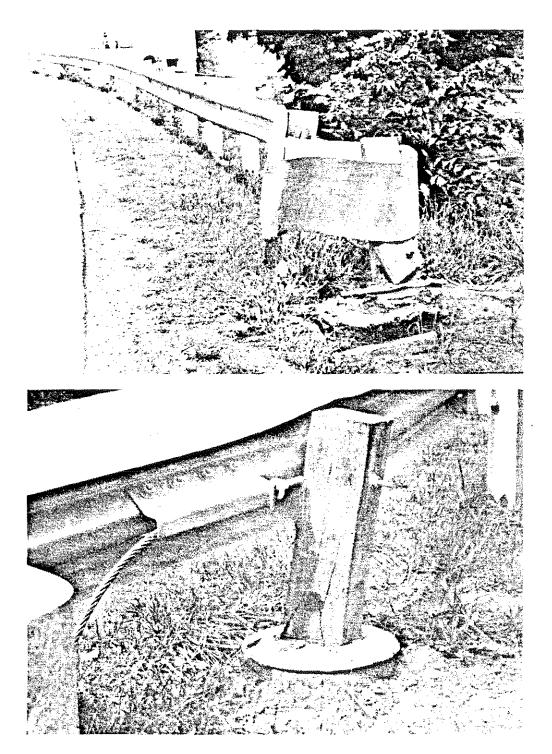


Figure B23. Accident Number 048, Kenton County, KY 1501, MP 2.4.

LOCATION: COUNTY - Fayette

ROUTE - I 64 MILEPOINT - 85.037

DATE OF ACCIDENT: 4/18/82

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle, a 1979 Pontiac Grand Prix, struck the guardrail end head-on with its front end near the left-hand headlights. The accident report states that the vehicle impacted the end after approaching at a shallow angle (verified by the photographs) and then vaulted over the guardrail, overturning twice before coming to rest on its wheels.

The front end of the car suffered extensive damage, as did the guardrail end treatment. The driver of the car was killed. Two of the passengers received multiple disabling injuries, while a third passenger received a non-incapacitating head injury. None of the occupants were wearing safety belts.

Both wooden posts broke away, but the guardrail did not wrap back around the steel posts after impact. Instead, the guardrail appears to have vaulted the car after initial impact. The photos show oil splattered over the entire guardrail end treatment.

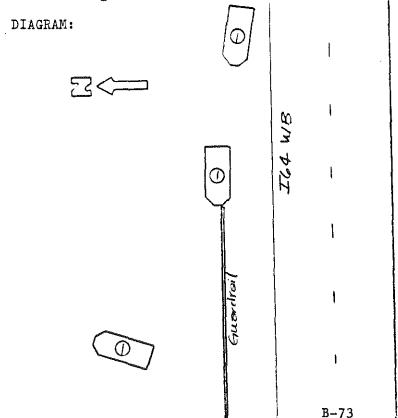




Figure B24. Accident Number 049, Fayette County, I 64, MP 85.037.

LOCATION: COUNTY - Fayette

ROUTE - I 64

MILEPOINT - 84.9

DATE OF ACCIDENT: 1/21/79

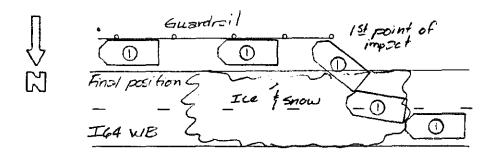
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1978 Chevrolet pickup attempted to change lanes and struck a patch of ice and snow, causing him to lose control and strike the end of the guardrail at a moderate angle with the right front end of the truck. The vehicle was then redirected along the guardrail before coming to a stop. The driver and passenger both received non-incapacitating injuries (neither wore safety belts). The truck suffered disabling damage to the bottom and passenger side. It is difficult to determine the damage sustained by the end treatment from the accident report alone. However, the damage to the bottom of the vehicle indicates at least one wooden post was broken as the vehicle rode on top of the guardrail a short distance while it was being redirected.



LOCATION: COUNTY - Fayette

> ROUTE - I 75

MILEPOINT - 106.287; KY 1927 Underpass

DATE OF ACCIDENT: Unknown

END TREATMENT: Type 6

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS:

No accident report could be found for this location. It appears from the photographs that a vehicle impacted the end treatment at a moderate angle and broke through causing the first post to break away at the base and the rails to be deflected approximately 45 degrees. Damage to the end treatment was moderate. Occupant injury severity

and degree of vehicle damage are unknown.





Figure B25. Accident Number 051, Fayette County, I 75, MP 106.287, KY 1927 Underpass.

LOCATION: COUNTY - Fayette

ROUTE - I 75

MILEPOINT - 110.019

DATE OF ACCIDENT: 10/30/83

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1967 Plymouth 2-door sedan ran off the roadway into the median, struck the guardrail at a moderate angle with the front end of the car and overturned. The driver received incapacitating injuries. He was not wearing a safety belt. The car received disabling damage to the front end. Extent of damage to the guardrail was not documented on the police report. However, the post-crash position of the vehicle indicates an abrupt stop. The vehicle evidently did not simply break through the guardrail end.

DIAGRAM:

Final position (overturned)

Grass median

Point of impart

I75

LOCATION: COUNTY - Fayette

ROUTE - I 75

MILEPOINT - 103.890; KY 18 Exit Ramp

DATE OF ACCIDENT: 12/7/82

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1978 Mercury Zephyr fell asleep at the wheel, causing the vehicle to run off the road and strike the guardrail head-on. The driver received a non-disabling injury. He was not wearing a safety belt. The vehicle was disabled with front-end damage. The breakaway portion of the end treatment, both posts and 12.5 feet of guardrail, had to be replaced. This indicates that the end treatment probably

did break away.

LOCATION: COUNTY - Fayette

ROUTE - 1 75 MILEPOINT - 116.1

DATE OF ACCIDENT: 7/3/82

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1976 Plymouth 4-door sedan ran off the right-hand side of the road and struck the end of the guard-rail at an angle with the front end of the car. The car broke through the guardrail before it came to rest. The car was disabled. The driver received non-incapacitating head injuries. He was not wearing a safety belt. Extensive damage was done to the guardrail as the entire end treatment, along with three metal posts and additional guardrail, had to be replaced. The damage indicates the end treatment did break away as designed.

DIAGRAM:

I 75 NB

Point of Guardreil

Final position

LOCATION: COUNTY - Fayette

ROUTE - I 75 MILEPOINT - 105.800

DATE OF ACCIDENT: 6/12/80

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1979 tractor and semi-trailer stated that he was forced off the right shoulder of the road after being bumped by an unidentified vehicle. The truck impacted the guardrail end at an angle with its front end and proceeded through the guardrail, where it then overturned. Eighty feet of guardrail were damaged by the truck. The end treatment was broken away. The driver received incapacitating leg injuries. He was not wearing a safety belt. The vehicle suffered frontend damage from overturning.

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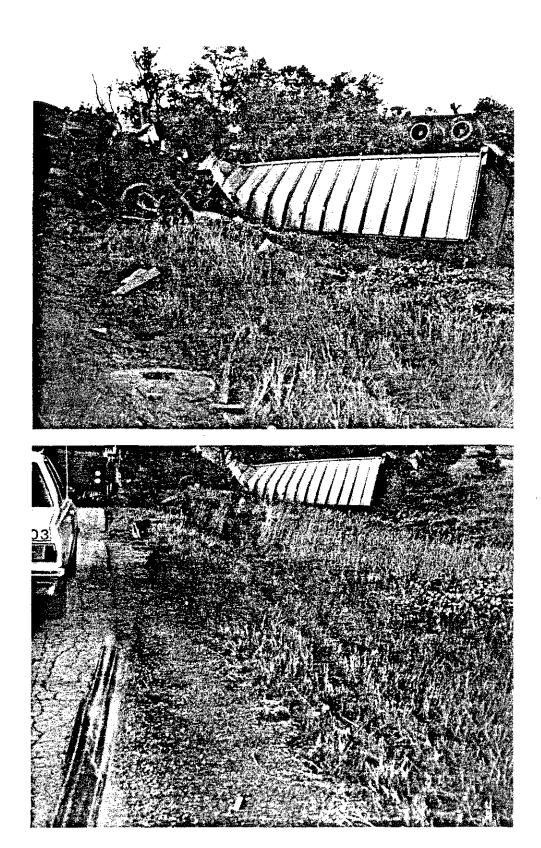


Figure B26. Accident Number 055, Fayette County, I 75, MP 105.800.

LOCATION: COUNTY - Fayette

ROUTE - KY 4 MILEPOINT - 4.832

DATE OF ACCIDENT: 11/5/82

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1974 Ford station wagon ran off the roadway, into the median and struck the guardrail at an angle with the right front corner of the car. The car then spun clockwise approximately 180 degrees and overturned. The driver suffered a non-incapacitating head injury. He was not wearing a safety belt. The car suffered disabling damage to the front, sides and top. The Type 6 end treatment had to be completely replaced.

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Final position (aertumed)	Hedian	0			
	Point of	impac ^L			
	****	New Circle 120a			

LOCATION: COUNTY - Fayette

ROUTE - KY 4

MILEPOINT - 9.324; KY 922 Exit Ramp

DATE OF ACCIDENT: 3/30/82

END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1981 Chevrolet van states that he was on an exit ramp when strong winds caused him to lose control and veer to the right where he subsequently struck the guardrail end with the right front of the van. The van was disabled. The driver was not injured. He was not wearing a safety belt. The breakaway end treatment along with 25 feet of guardrail

had to be replaced.

LOCATION: COUNTY - Madison

ROUTE - I 75

MILEPOINT - 90.0

DATE OF ACCIDENT: 12/82

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: No acci

No accident report was found, which was probably due to the minor nature of the impact. The guardrail on the median shoulder sustained damage to the buffered end. The first wood post was not damaged, but the second wood post had split longitudinally. However, it did not break at the concrete footing and remained intact with the guardrail. The extent

of vehicle damage and occupant injury is unknown.

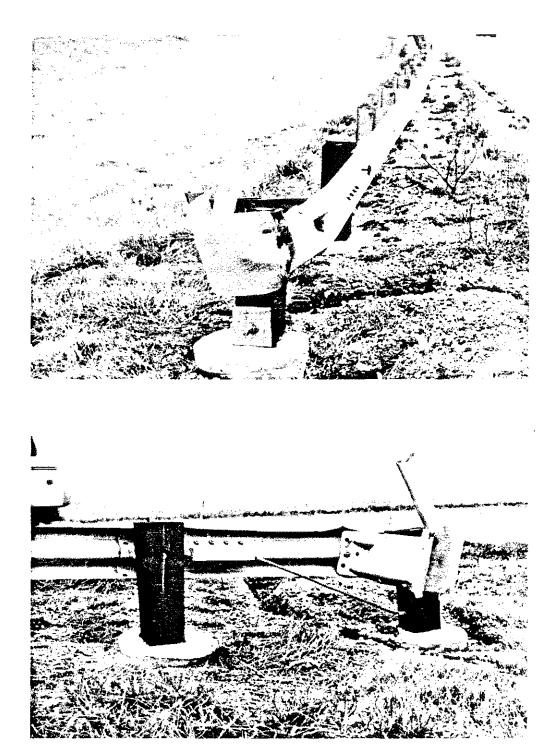


Figure B27. Accident Number 058, Madison County, I 75, MP 90.

- Woodford COUNTY LOCATION:

> ROUTE - US 60

MILEPOINT - 11.7

DATE OF ACCIDENT: 4/21/84

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1976 Volvo 265 DL station wagon stated that he fell asleep at the wheel and ran off the right side of the roadway, striking the end of the guardrail head-on. The car broke through both wooden posts and stopped just behind the guardrail. Disabling damage was done to the front of the vehicle. Neither the driver nor the front passenger were injured (both were wearing safety belts). Heavy damage was done to the guardrail end as both posts were completely broken away (the first post was shattered). Vehicle speed at impact was estimated to be approximately 40 mph.

DIAGRAM:

MEDIAN

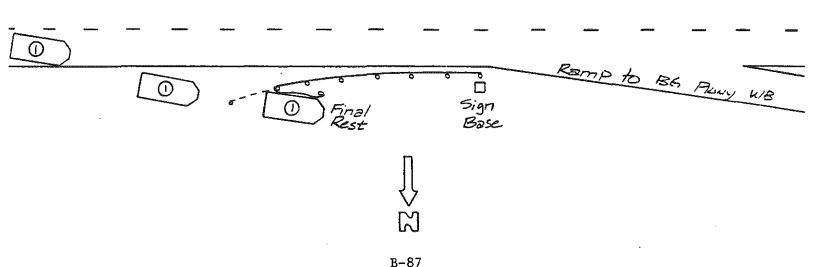




Figure B28. Accident Number 059, Woodford County, US 60, MP 11.7.

LOCATION: COUNTY - McCreary

ROUTE - KY 92 MILEPOINT - 17.578

DATE OF ACCIDENT: 12/83

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Not Available

COMMENTS: Photographs show that the first concrete footing was pulled out of the ground while the wooden post remained unbroken and firmly implanted in the footing. The second post was leaning slightly but was also not broken. No accident report was found which was probably related to the

relatively minor nature of the accident.



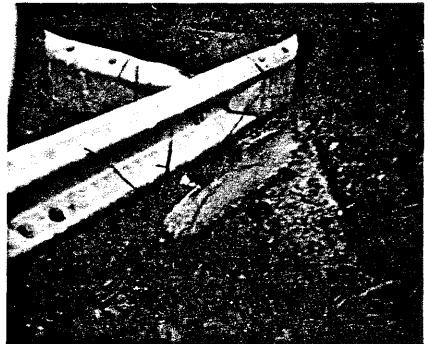


Figure B29. Accident Number 060, McCreary County, KY 92, MP 17.578.

LOCATION: COUNTY - Rockcastle

ROUTE - I 75 MILEPOINT - 69.2

DATE OF ACCIDENT: 1/16/82

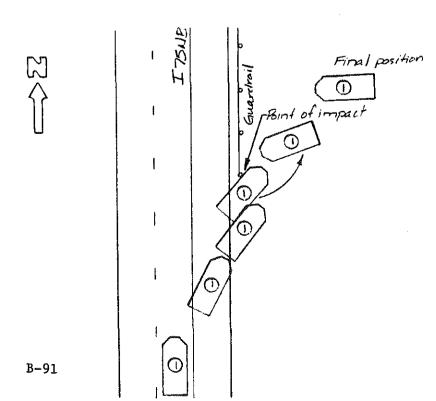
END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The vehicle ran off the road, slid sideways, and struck the guardrail end at the driver's door. The driver either went to sleep or was blown out of control by strong, gusty winds. The guardrail was then struck again by the left rear passenger door. The vehicle spun around and travelled backward 55 feet before coming to rest. Photos show that the first wooden post broke completely at ground level. The guardrail end wrapped around the second wooden post, which was cracked, but remained intact and upright. The vehicle was a 1978 Chevrolet 4-door (mid-size) sedan. It sustained disabling damage to the driver's side. The driver received a fatal neck injury. She was not wearing a safety belt. It appears that the guardrail end punched into the driver's door, causing the car to spin 180 degrees counterclockwise. The first wooden post broke off completely. The guardrail was bent more than 90 degrees around the second post, which was split longitudinally but was still intact with the concrete footing. The fatality was probably caused by the vehicle striking the guardrail end against the driver's door, which offers little protection compared to the front end.



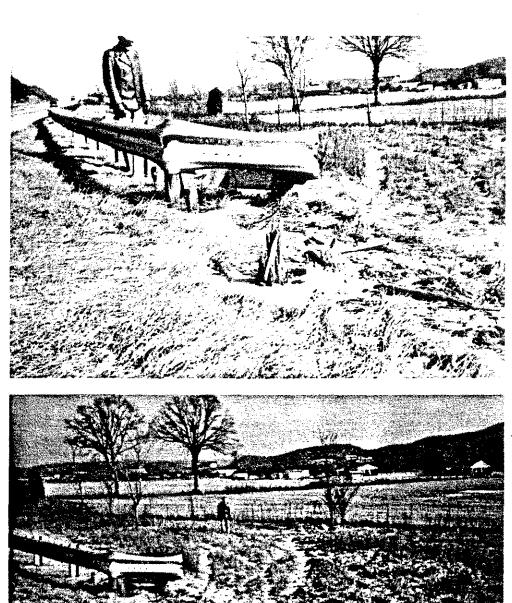


Figure B30. Accident Number 061, Rockcastle County, I 75, MP 69.2.

LOCATION: COUNTY - Harlan

ROUTE - US 119 MILEPOINT - 18.7

DATE OF ACCIDENT: 9/27/80

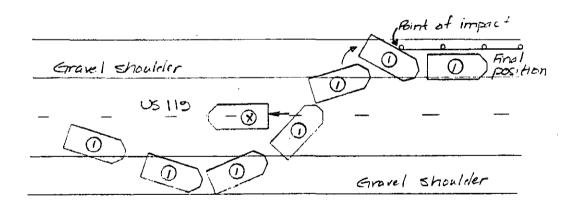
END TREATMENT: Type 4

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1978 Dodge pickup stated that he went off the right side of the road after a near-collision with an unidentified vehicle, then overcorrected, crossed the road, and ran into the guardrail on the left-hand side. The truck slid sideways and struck a guardrail end on its left side; it rebounded from the rail and stopped on the shoulder. The driver received no injuries. He was not wearing a safety belt. The truck received disabling damage to the entire left side. The extent of damage to the end treatment was not documented.



LOCATION: COUNTY - Harlan

ROUTE - KY 413 MILEPOINT - 0.963

DATE OF ACCIDENT: 12/10/81

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

COMMENTS:

The driver lost control on a curve and the vehicle struck the guardrail end with its front end. The vehicle, a 1979 GMC pickup, sustained disabling damage to the front end as it impacted the guardrail end at an angle and proceeded down an embankment. after impact. The driver received no injuries. He was not wearing a safety belt.

Both wooden posts were broken off at ground level and 15 feet of rail were damaged. The rail was bent around behind the first metal post.

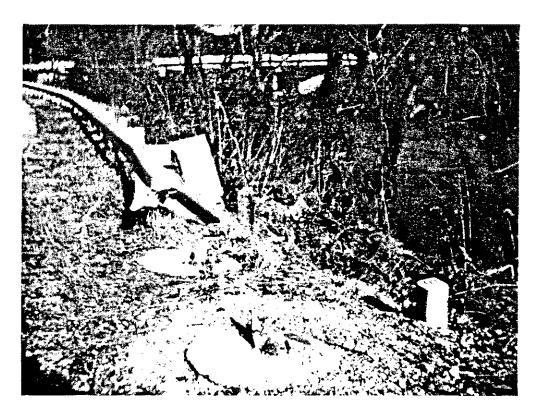


Figure B31. Accident Number 063, Harlan County, KY 413, MP 0.963.

LOCATION: COUNTY - Wayne

ROUTE - KY 90

MILEPOINT - 13.722; at KY 1275

DATE OF ACCIDENT: 8/12/77

END TREATMENT: Type 4

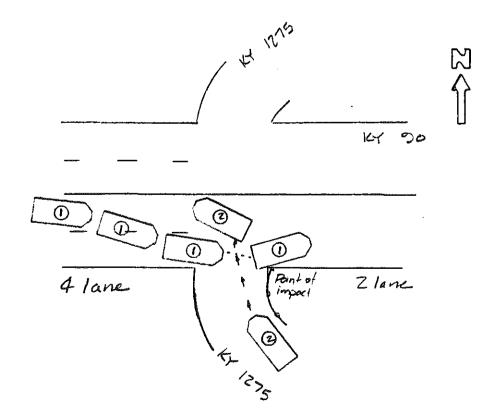
PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1976 Ford pickup impacted the guardrail end at an intersection after a previous collision with another vehicle. The vehicle skidded approximately 105 feet before colliding with the first vehicle and skidded an additional 35 feet after the

first impact before hitting the guardrail. The vehicle appears to have slid sideways into the guardrail, striking it near the right rear tire. The driver was not injured. He was not wearing a safety belt. Extent of the damage to the guardrail is not known. However, it appears that the impact with the guardrail end was minor.



LOCATION: COUNTY - Whitley

ROUTE - I 75 MILEPOINT - 2.7

DATE OF ACCIDENT: 9/22/82

END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

The driver of a 1979 2-door AMC stated that he fell asleep and ran off the road into the median. The vehicle travelled 300 feet before striking the end of a Type 6 end treatment near the left front tire. The vehicle stopped at the impact point with the guardrail end. The driver suffered a non-incapacitating leg injury (he was not wearing a safety belt). The vehicle received significant but non-disabling damage. The police report states that two feet of guardrail were damaged. The repair form indicates that at least one wood post was replaced.

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Bint of impact	0		0		
	_ _	_	_	_	

LOCATION: COUNTY - Whitley

ROUTE - I 75

MILEPOINT - 2.0; Rest Area Parking Lot

DATE OF ACCIDENT: 7/1/81

END TREATMENT: Type 4

PHOTOS: Available

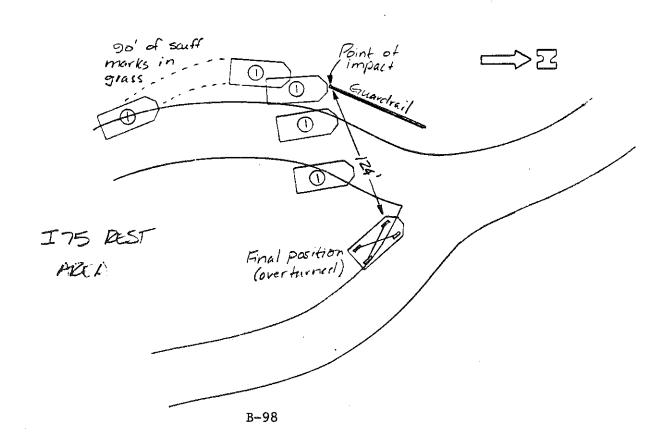
ACCIDENT REPORT: Available

COMMENTS:

The vehicle struck the guardrail end head-on at a high rate of speed according to the police report. Both wooden posts were broken. The guardrail was pushed back beyond the first metal post. The vehicle then rebounded sideways out into the roadway and overturned. The vehicle was a 1970 2-door Chevrolet and sustained heavy damage to the front end. The driver died of head injuries. He was not wearing a safety belt.

DIAGRAM:

I 75 NB



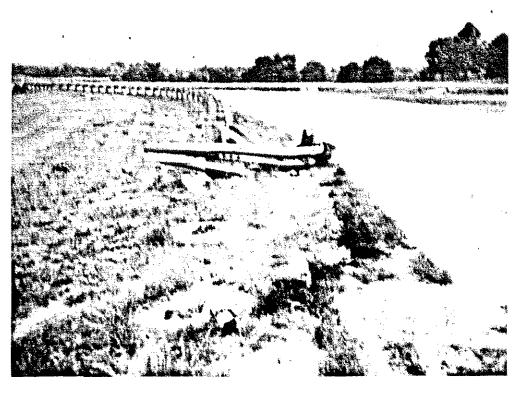


Figure B32. Accident Number 066, Whitley County, I 75, MP 2, Rest Area Parking Lot.

LOCATION: COUNTY - Whitley

ROUTE - I 75

MILEPOINT - 2.0; Rest Area Parking Lot

DATE OF ACCIDENT: 12/18/80

END TREATMENT: Type 4

PHOTOS: Available

ACCIDENT REPORT: Available

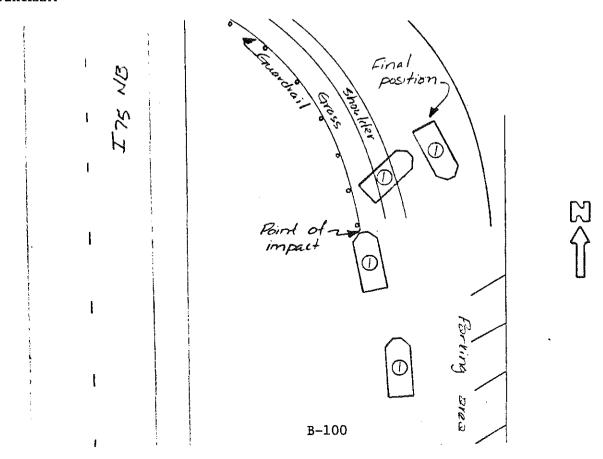
COMMENTS:

The vehicle, a 1979 2-door Subaru, impacted the guardrail end from a shallow backside angle as the vehicle was leaving the

parking lot of a rest area. The vehicle impacted the guardrail with its left front fender, then bounced off to the right and spun around 180 degrees counterclockwise

before stopping. It received disabling damage.

The driver received incapacitating injuries to the arms and legs, while the passenger received an incapacitating back injury. Neither occupant was wearing a safety belt. The first wooden post was broken while the second post was not damaged. The broken post and end terminal was pushed toward the roadway by the impact indicating the direction of the vehicle at impact.



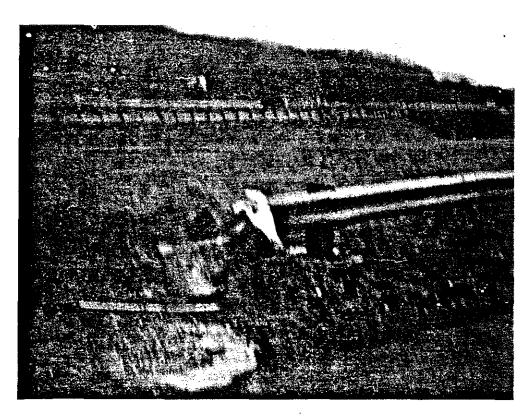


Figure B33. Accident Number 067, Whitley County, I 75, MP 2, Rest Area Parking Lot.

LOCATION: COUNTY - Whitley

> ROUTE - I 75

MILEPOINT - 6.400

3/6/80 DATE OF ACCIDENT:

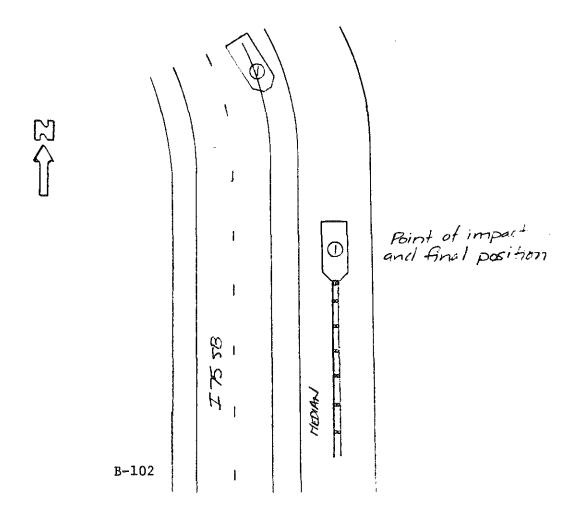
END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1979 Buick sedan ran into the median and collided headon with a Type 6 end treatment. The driver states he was asleep and ran into the median as he proceeded around a curve. The vehicle travelled 558 feet down the median before impact with the guardrail. The vehicle received disabling damage to the front end. The driver of the car sustained a nonincapacitating head injury (he was not wearing a safety belt). The vehicle stopped at its impact point with the guardrail end. No data was available to describe the extent of damage to the guardrail end. The vehicle received disabling damage.



LOCATION: COUNTY - Whitley

ROUTE - I 75

MILEPOINT - 6.4

DATE OF ACCIDENT: 12/16/79

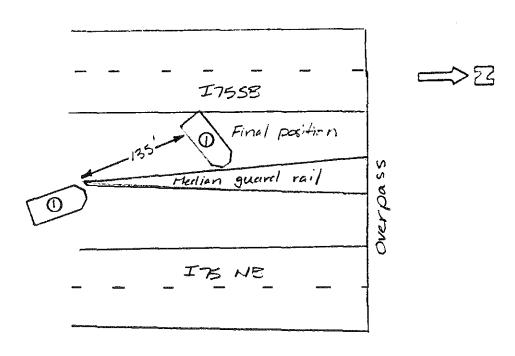
END TREATMENT: Type 6

PHOTOS: Not Available

ACCIDENT REPORT: Available

COMMENTS:

A 1970 Pontiac sedan ran off the road into the median, struck a Type 6 end treatment at an angle with the front end, overturned, and came to rest in the inside lane of the opposite roadway. The vehicle travelled 135 feet from point of impact with the guardrail end to its final resting position. The vehicle received disabling damage to the front end. The driver, cited for public intoxication, received multiple non-incapacitating injuries (he was not wearing a safety belt). Both wooden posts had to be replaced.



B-103