# ANALYSIS OF ACCIDENTS INVOLVING <br> BREAKAWAY-CABLE-TERMINAL END TREATMENTS 

by<br>Jerry G. Pigman<br>Chief Research Engineer<br>Kenneth R. Agent<br>Senior Transportation Research Engineer<br>and<br>Tom Creasey<br>Transportation Research Engineer<br>Kentucky Transportation Research Program<br>College of Engineering<br>University of Kentucky<br>Lexington, Kentucky<br>in cooperation with<br>Transportation Cabinet<br>Commonwealth of Kentucky<br>and<br>Federal Highway Administration<br>U.S. Department of Transportation

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| 16. Abstract <br> This report includ terminal (BCT) end tre terminal (BMCT) end tr accident records for 1980 and after 1982. report, photographs, <br> Results showed tha properly in most accid it was designed with the vehicle. Only four performed properly in analysis, the BCT perf <br> The MBCT end treat Problems related to st impact angles are shal MBCT designs from gore A new turned-down end installations. | analysis of 50 accident ts and 19 accidents invo nts. The primary data ba ars 1980-82; with select empt was made to documen maintenance repair form. <br> breakaway-cable-termina (72 percent); that is, th oden posts breaking away cts were known to involv of those accidents. If properly in 63 percent <br> performed properly in 50 ess of the end treatment A recommendation was mad locations and replace t ment design was proposed | nvolving breakaw ng median-break consisted of Ken accidents inclu ach accident wi <br> ad treatment per end treatment pe the guardrail nall cars and the cks are excluded the collisions. <br> rcent of the ac most apparent <br> o remove any exis with a crash cu $r$ consideration | y-cable- <br> vay-cable ucky <br> d before <br> a polic <br> ormed <br> formed a <br> directin <br> BCT <br> from the <br> dents. <br> n <br> ting <br> hion. <br> at median |
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George Asbury, Chairman, Division of Maintenance, Kentucky Department of Highways
Grover Ethington, Division of Traffic,Kentucky Department of Highways
E. B. Drake, Division of Design, Kentucky Department of Highways
C. S. Layson, Assistant State Highway Engineer, Kentucky Department of Highways
B. L. Wheat, Assoc. Assistant State Highway Bngineer, Kentucky Department of Highways
Bill Netherton, Kentucky Department of Highways
Bill Bensing, Federal Highway Administration

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## 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 (5). Results included in NCHRP Report 129 were 12 new guardrail terminal and 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 BCT. 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 $B C T$ 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 $B C T$ using subcompact cars also were performed. High rates of deceleration were measured during impacts with the small cars. Results indicated that the $B C T$ neither eliminated nor increased the danger during small-car endterminal collisions. Modifications to the end treatment were made to include a concrete footing and a drilled hole in the second post. Additional modificatons
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 $6 \times 8$ 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 $B C T$ components, and snagging of a subcompact vehicle's underside by steel-post $B C T ' s$. 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 headmon impacts.

Documentation of field performance of $B C T$ 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 $B C T$ 's (11). A total of 13 vehicular impacts into $B C T ' s$ 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 $B C T$ 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 endon 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 $B C T$ 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 $B C T$ 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 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 $B C T$ and MBCT accidents for 1981 and 1982. An inventory of all Kentucky routes having $B C T$ 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 $B C T$ and $M B C T$ 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 $B C T$ and $M B C T$ end treatment accidents.

## BCT End-Treatment Accidents

A summary of the performance of $B C T$ 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. BCI 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 $B C T ' s$ 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.

A summary of the performance of $M B C T$ 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 $B C T$ end treatment performed properly is 63 percent of the collisions. Improper performance of the BCT was generally related to either 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 $B C T$ 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. Any installation of $a \operatorname{BCT}$ 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 $B C T$ 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-byside 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.


Ficure 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).

| 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 | Automobile, size unknown |
|  | SUT | Single-unit trucks (2-axle, 6 tires or larger) |
|  | Comb | Combination tractor and semitrailer 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 <br> damage slight or moderate damage to guardrail; and/or slight or no injury (Injury 3, 4, or 5) |
| Impact Angle | Shallow | 0-15 degrees |
|  | Moderate | 16-45 degrees |
|  | Sharp | > 45 degrees |
| Guardrail | RHS | Right-hand shoulder (mainline) |
| Placement | RHS/R | Right-hand shoulder (ramp) |
|  | LHS | 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 |
|  | Plym | Plymouth |
|  | Pont | Pontiac |
|  | Suba | Subaru |
|  | Volks | Volkswagen |
|  | Volvo | Volvo |
|  | White | White Truck |


| VARIABLE | CATEGORY | DESCRIPTION |
| :---: | :---: | :---: |
| Vehicle Style | 2-DR-SD | 2-Door sedan |
|  | 4-DR-SD | 4-Door sedan |
|  | SW | Station Wagon |
|  | PU | Pickup |
|  | SD | Sedan |
|  | Semi | Combination tractor \& semi trailer |
|  | Truck | Truck |
|  | Van | Van |
| Injury Severity | 1 | Fatal |
|  | 2 | Incapacitating injury |
|  | 3 | Non-incapacitating injury |
|  | 4 | Possible injury |
|  | 5 | No injury |
| Vehicle Action After Impact | STOP | Stopped immediately upon contact |
|  | SP-CW-D | Spun clockwise D number of degrees |
|  | SP-CCW-D | Spun counterclockwise D number of degrees |
|  | OVER | Overturned |
|  | RAMP | Ramped |
|  | BT | Broke through |
|  | SS | Sideswiped guardrail |
|  | RB-I | Rebounded left |
|  | RB-R | Rebounded right |
|  | RB-B | Rebounded back |
|  | SPEAR | Guardrail end speared vehicle |
| End Ireatment Performance | Proper | End treatment performed as |
|  |  | designed; posts broke away or guardrail redirected vehicle. |
|  | Improper | 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 |
|  | 2 | Non-Functional Damage |
|  | 3 | Functional Damage |
|  | 4 | Disabling Damage |

Figure 8. Proposed Median Turned-Down End Treatment



## ELEVATION



Not To Scale -
POST DETAIL

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

TYPE OF END TREATMENT

|  | BCT |  | MBCT |  |
| :--- | :---: | :---: | :---: | :---: |
| YEAR | NUMBER | AVERAGE UNIT |  |  |
| PRICE (DOLIARS) |  |  |  |  |$\quad$ NUMBER | AVERAGE UNIT |
| :---: |
| PRICE (DOLIARS) |

* Weighted average.

TABLE 2. SUMMARY OF ACCIDENT LOCATIONS AND INFORMATION AVAILABLE

| $\begin{gathered} \text { ACCIDENT } \\ \text { NUMBER } \end{gathered}$ | DISTRICT | COUNTY | ROUTE | MILEPOINT | TYPE OF END TREATMENT | DATE | INFORMATION AVAILABLE |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | ACCIDENT |  | REPAIR |
|  |  |  |  |  |  |  | REPORT | PHOTOGRAPHS | FORM |
|  | 1 | Livingston | I 24 | 30.9 | MBCT | 12/19/80 | $\mathbf{x}$ |  |  |
| 002 | 1 | McCracken | I 24 | 2.8 | BCT | 2/13/79 | $x$ |  |  |
| 003 | 1 | McCracken | I 24 | 13.4 | MBCT | 2/13/79 | x |  |  |
| 004 | 1 | Marshall | I 24 | 27.7 | MBCT | 11/09/80 | x |  |  |
| 005 | 2 | Christian | I 24 | 85.5 | BCT | 3/--/82 |  |  | x |
| 006 | 2 | Christian | I 24 | 85.6 | BCT | 7/28/84 | $x$ |  |  |
| 007 | 2 | Christian | I 24 | 85.6 | BCT | 9/04/80 | x |  |  |
| 008 | 2 | Christian | I 24. | 85.9 | MBCT | 6/18/77 | x |  |  |
| 009 | 2 | Henderson | 9005* | 0.1 | BCT | 1/--/84 |  | x | x |
| 010 | 2 | Hopkins | 9004* | 44.1 | ${ }_{\text {BCT }}$ | $1 / 27 / 84$ | $\underset{X}{x}$ | x | ${ }_{\text {x }} \mathrm{x}$ |
| 011 | 3 | Todd | US 68 | 1.3 3.6 | ${ }_{\text {BCT }}$ | 1/31/80 | $\frac{\mathrm{x}}{\mathbf{x}}$ |  | x |
| 013 | 3 | Todd | US 68 | 2.2 | ${ }_{B C T}$ | 11/29/78 | $\frac{\mathrm{x}}{\mathrm{X}}$ |  | X |
| 014 | 5 | Bullitt | I 65 | Unknown | MBCT | Unknown |  | x |  |
| 015 | 5 | Bullitt | I 65 | 11.6 | MBCT | $17--/ 84$ |  | ${ }_{\text {x }}$ |  |
| 016 | 5 | Bullitt | I 65 | 117.8 | BCT | 3/30/81 | $\mathbf{x}$ |  |  |
| 017 | 5 | Bullitt | I 65 | 105.0 | BCT | 5/11/81 | x |  |  |
| 018 | 5 | Bullitt | I 65 | 104.8 | BCT | 6/16/80 | $\mathbf{x}$ |  |  |
| 019 | 5 | Jefferson | I 65 | 128.3 | BCT | 4/--/83 |  | x |  |
| 020 | 5 | Jefferson | I 65 | 128.3 | BCT | 4/18/83 | X |  |  |
| 021 | 5 | Jefferson | I 65 | 128.2 | BCT | 4/04/81 | x |  |  |
| 022 | 5 | Jefferson | I 71 | 4.0 | $\mathrm{BCT}^{\text {B }}$ | 9/03/82 | x | x | ${ }^{x}$ |
| 023 | 5 | Jefferson | I 2641 E | 17.9 | BCT | 10/--182 |  | x | x |
| 025 | 5 | Jefferson | US 42 | 5.5 | BCT | 4/02/83 |  | $\frac{\mathrm{X}}{\mathrm{X}}$ |  |
| 026 | 5 | Shelby | I 64 | 29.0 | MBCT | 12/--/83 |  | $\mathbf{x}$ |  |
| 027 | 5 | Shelby | I 64 | 30.0 | BCT | 8/--183 |  | x |  |
| 028 | 5 | Shelby | I 64 | 34.0 | BCT | 11/19/83 | x | x |  |
| 029 | 6 | Boone | I 75 | 181.3 | BCT | 8/19/83 | x | $\mathbf{x}$ |  |
| 030 | 6 | Boone | I 75 | 175.8 | BCT | 5/06/83 | x |  |  |
| 031 | 6 | Boone | I 75 | 181.4 | BCT | 5/07/83 | x | x |  |
| 032 | 6 | Boone | I 75 | 175.4 | BCT | 4/05/83 | $\underline{x}$ |  |  |
| 033 | 6 | Boone | I 75 | 181.3 | BCT | 5/29/82 | X |  |  |
| 034 | 6 | Boone | I 75 | 175.3 | BCT | 7/22/81 | x |  |  |
| 035 | 6 | Boone | I 75 | 178.1 | MBCT | 1/01/81 | x |  |  |
| 9005 - Audubon Parkway <br> 9004 - Pennyrile Parkway |  |  |  |  |  |  |  |  |  |

TABLE 2. SUMMARY OF ACCIDENT LOCATIONS AND INFORMATION AVAILLABLE
INFORMATION AVAILLABLE

|  | $\begin{aligned} & \text { ACCIDENT } \\ & \text { NUMBER } \end{aligned}$ | DISTRICT | COUNTY | ROUTE | MILEPOINT | TYPE OF <br> END TREATMENT | DATE | $\begin{aligned} & \text { ACCIDENT } \\ & \text { REPORT } \end{aligned}$ | PHOTOGRAPHS | REPATR |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 036 | 6 | Boone | I 275 | 10.6 | BCT | 1/10/84 | $\frac{\mathrm{x}}{\mathrm{x}}$ | ${ }_{\text {x }}{ }^{\text {x }}$ |  |
|  | 037 | 6 | Campbell | I 1775 | 74.8 43.0 | ${ }^{\text {BCT }}$ | 2/04/84 | x | x |  |
|  | 039 | 6 | Kenton | I 75 | 184.7 | BCT | 4/01/84 | $x$ | $\frac{\mathrm{x}}{\mathrm{x}}$ |  |
|  | 040 | 6 | Kenton | I 75 | 184.5 | MBCT | 11/05/83 | x | X |  |
|  | 041 | 6 | Kenton | I 75 | 184.5 | MBCT | 11/13/82 | x | X |  |
|  | 042 | 6 | Kenton | I 75 | 184.5 | MBC' | 6/23/82 |  |  | x |
|  | 043 | 6 | Kenton | I 75 | 184.5 | MBCT | 4/--182 |  |  | X |
|  | 044 | 6 | Kenton | I 75 | 184.5 | MBCT | $2 /=-182$ |  |  | X |
|  | 045 | 6 | Kenton | I 275 | 82.5 | BCT | 17/--183 |  | x |  |
|  | 046 | 6 | Kenton | I 275 | 0.0 | BCT | 12/--1/82 |  | x |  |
| N | 047 | 6 | Kenton | I 275 | 79.0 | BCT | 1/09/83 | x |  |  |
| ur | 048 | 6 | Kenton | KY ${ }_{\text {I }} 1501$ | 2.4 85.0 | ${ }_{\text {BCT }}$ | 1/09/82 | $\frac{\mathrm{x}}{\mathrm{x}}$ | ${ }_{\text {x }} \mathrm{X}$ |  |
|  | 049 | 7 | Fayette | I 64 | 85.0 84.9 | BCT | $4 / 18 / 82$ $1 / 21 / 79$ | x x | x | X |
|  | 051 | 7 | Fayette | I 75 | 106.3 | MBCT | 1/--/84 |  | x |  |
|  | 052 | 7 | Fayette | I 75 | 110.0 | MBCT | 10/30/83 | x |  |  |
|  | 053 | 7 | Fayette | I 75 | 103.9 | BCT | 12/07/82 | x |  | x |
|  | 054 | 7 | Fayette | I 75 | 116.1 | BCT | 7/09/82 | X |  | x |
|  | 055 | 7 | Fayette | I 75 | 105.8 | BCT | 6/12/80 | x | x |  |
|  | 056 | 7 | Fayette | KY 4 | 4.8 | MBCT | 11/05/82 | x |  | x |
|  | 057 | 7 | Fayette | KY 4 | 9.3 | BCT | 3/30/82 | x |  | X |
|  | 058 | 7 | Madison | I 75 | 90.0 | BCT | 12/--/82 |  | x |  |
|  | 059 | 7 | Woodford | US 60 | 11.7 | BCT | 4/21/84 | x | x |  |
|  | 060 | 8 | McCreary | KY 92 | 17.6 | BCT | 12/--1/83 |  | ${ }^{x}$ |  |
|  | 061 | 8 | Rockcastle | I 75 | 69.2 | BCT | 1/16/82 | X | $x$ |  |
|  | 062 | 11 | Harlan | US 119 | 18.7 | BCT | 9/27/80 | x |  |  |
|  | 063 | 11 | Harlan | KY 413 | 0.9 | BCT | 12/10/81 | X | X | $x$ |
|  | 064 | 11 | Wayne | KY 90 | 13.7 | BCT | 8/12/77 | X |  |  |
|  | 065 | 11 | Whitley | I 75 | 2.7 | MBCT | 9/22/82 | X |  | x |
|  | 066 | 11 | Whitley | I 75 | 2.0 | BCT | 7/01/81 | ${ }^{x}$ | ${ }^{\mathbf{x}}$ | X |
|  | 067 | 11 | Whitley | I 75 | 2.0 | BCT | 12/18/80 | x | x | x |
|  | 068 | 11 | Whitley | I 75 | 6.4 | MBCT | 12/06/80 | X |  |  |
|  | 069 | 11 | Whitley | I 75 | 6.4 | MBCT | 12/16/79 | X |  | x |



* 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 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | PROPER |  | IMPROPER |  |
| VARIABLE | CATEGORY | NUMBER | PERCENT | NUMBER | PERCENT |
| Impact | Severe | 24 | 71 | 10 | 29 |
| Severity | Non-Severe | 9 | 75 | 3 | 25 |
| Impact | Shallow | 11 | 58 | 8 | 42 |
| Angle | Moderate | 13 | 72 | 5 | 28 |
|  | Sharp | 2 | 100 | 0 | 0 |
| End | Slight | 5 | 62 | 3 | 38 |
| Treatment | Moderate | 4 | 50 | 4 | 50 |
| Damage | Heavy | 10 | 91 | 1 | 9 |
|  | Extensive | 10 | 91 | 1 | 9 |
| Vehicle | Small Auto | 2 | 50 | 2 | 50 |
| Size | Large Auto | 14 | 61 | 9 | 39 |
| Category | Truck | 5 | 83 | 1 | 17 |



* Refer to Figure 7 for explanation of codes.

TABLE 6. MBCT END-TREATMENT PERFORMANCE*

| ACCIDENT | VEHICLE | IMPACT | IMPACT | GUARDRAIL | VEHICLE |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NOMMBER | SIZE | SEVERITY | ANGLE | PLACEMENT | CONTACT | VEHICLE ACTION | AFTER IMPACT | END TREATMENT |
| PERFORMANCE |  |  |  |  |  |  |  |  |$\quad$ END PREATMENT

* Refer to Figure 7 for explanation of codes.
** Assessment of performance not possible because of insufficient data.

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


* Refer to Figure 7 for explanation of codes.





## - 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, Reinforcernent, and all other incidentals necessary to complete the instal lation.

Use Term. Sect. with $1-3^{\prime \prime}$ radius when adjoining system has wood or concrete posts. Use Term. Sect. with l'-I' radius when adjoining system has steel posts. With adjoining steel post system the wood offset blocks shall be turned with $8^{\prime \prime}$ dimension paraltel to traffic.

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

al Blox will plis 2 2f Sted Treeded Rod, Mus, and wasters or $\frac{5}{6} \times$ Post and Block width plts $2^{4}$ Button or Hex Head Bolt, Mut, and Washer. Threaded Rod shall hove same strength requirements as bolt. Formed $6 \frac{1}{2} " x 8 \frac{1}{2}$ " socket to receive 6 " $\times 8$ " post, the void shall be filled with sond or place concrete around the post wrapped with one foyer of $\frac{1}{4}$ thick expanded polystyrene foam sheeting. The sand or foam sheeting shall extend to within I' of the top, this shall be filled with Butyl Rubber Caulking (commercial grode) or other approved waterproof material.
Form the top $4^{\prime \prime}$ of the concrete encosement and crown $\frac{1^{\prime}}{2}$ to drain. A construction joint will not be permited in the encasement.


- EL EVATION.


DETAILED DESCRIPTION OF END TREATMENT ACCIDENTS

## ACCIDENT NUMBER: 001

```
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 counterclockwise 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.

DIAGRAM:


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.

DIAGRAM:


MEDIAN

## ACCIDENT NUMBER: 003

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


ACCIDENT NUMBER: 004
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.

DIAGRAM:

n

```
ACCIDENT NUMBER: 005
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.
```

```
DIAGRAM: Not Available
```

```
DIAGRAM: Not Available
```


## ACCIDENT NUMBER: 006

```
LOCATION: COUNTY - Christian County
    ROUTE - I 24
    MLLEPOINT - 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:


ACCIDENT NUMBER: 007
$\begin{array}{ll}\text { LOCATION: } \begin{array}{l}\text { COUNTY } \\ \text { ROUTE }\end{array} \text { - Christian } \\ & \text { MILEPOINT - } 24 \\ & \text { - } 85.563 \text { Entrance Ramp from US } 41 \mathrm{~A}\end{array}$
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.

DIAGRAM:


## ACCIDENT NUMBER: 008

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.

DIAGRAM:

Iマ4

LOCATION: COUNTY - HendersonROUTE - Audubon Parkway 9005MILEPOINT - 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 involvedwas initially bound for an exit ramp and swerved across thegore area back toward the mainline, striking the guardrailend from the backside in the process. Both wooden postswere broken and the guardrail was bent outward toward theroadway. Injury to vehicle occupant(s) and extent of damageto the vehicle is unknown.
DIAGRAM: Not Available


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

## ACCIDENT NUMBER: 010

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 tomerge into the deceleration lane approaching the upcoming exitramp when he lost control of the vehicle and left the ramp onthe left-hand side, striking the exit sign and then the end ofthe guardrail head-on with the front of the truck. The truckbroke the first post and travelled approximately 18 feetbefore 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


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.

DIAGRAM:


ACCIDENT NUMBER: 012

| 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.

DIAGRAM:


ACCIDENT NUMBER: 013
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.

DIAGRAM:


## ACCIDENT NUMBER: 014

LOCATION: | COUNTY | - Jefferson Bul/t |
| :--- | :--- |
| ROUTE | $-I 65$ |
|  | MILEPOINT -128 |

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.

DIAGRAM: Not Available


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 photographsindicate impact sufficient to break the first wooden post.It appears that a new buffered end was installed for safetypurposes until the post could be replaced. Extent of injuryor damage to the vehicle remains unknown.
DIAGRAM: Not Available


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

## ACCIDENT NUMBER: 016

```
LOCATION: COUNTY - Bullitt
    ROUTE - I }6
    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.

DIAGRAM:


## ACCIDENT NUMBER: <br> 017

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.

DIAGRAM:


Median

## ACCIDENT NUMBER: 018

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: Availalbe

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.

DIAGRAM:

ACCIDENT NUMBER: ..... 019
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 heavydamage. The angle of impact appeared to be moderate and theimpact was severe. No accident report was available toobtain additional information. Performance of the endtreatment was unknown.
DIAGRAM: Not Available


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.
```

DIAGRAM:


LOCATION: | COUNYY | - Jefferson |
| :--- | :--- |
|  | ROUTE |
|  | MILEPOINT -125 |
|  |  |

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 afterstriking a pool of water and slid sideways into the guardrail,striking it just past the end. It is impossible to determinefrom the report whether the car then jumped atop the rail orthe rail collapsed under the weight of the car. The diagramshows the car coming to rest on top of the rail with disablingdamage to the bottom of the vehicle. The driver of thevehicle was not injured. She was not wearing a safety belt.Damage to the end treatment was not documented.


## ACCIDENT NUMBER: 022

```
LOCATION: COUNTY - Jefferson
    ROUTE - I 71
    MILEPOINT - 4.000; Exit Ramp to I }26
DATE OF ACCIDENT: 9/3/82
END TREATMENT: Type
PHOTOS: Available
ACCIDENT REPORT: Available
COMMENTS: A }1978\mathrm{ 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.
```

DIAGRAM:


Final
rest


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

ACCIDENT NUMBER: 023

```
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
```



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

## ACCIDENT NUMBER: 024

```
LOCATION: COUNTY - Jefferson
    ROUTE - US 31E
    MILEPOINT - 1.9
```

DATE OF ACCIDENT: $12 / 83$

END TREATMENT: Type 4
PHOTOS: Available

ACCIDENT REPORT: Not Available
COMMENTS: No accident report could be found. The photographs show 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


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

```
ACCIDENT NUMBER: 025
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.
DIAGRAM: Not Available
```



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

## ACCIDENT NUMBER: 026

```
LOCATION: COUNTY - Shelby
    ROUTE - I }6
    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
```



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

```
ACCIDENT NUMBER: 027
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.
DIAGRAM: Not Available
```



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

ACCIDENT NUMBER: 028

```
LOCATION: COUNTY - Shelby
    ROUTE - I }6
    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.


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

```
ACCIDENT NUMBER: 029
```

```
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 $1-75$,
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.
DIAGRAM:



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

## ACCIDENT NUMBER: 030

```
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:


ACCIDENT NUMBER: 031
LOCATION: COUNTY - Boone
ROUTE - I 75
MILEPOINS - 181.400
DATE OF ACCIDENT: $5 / 7 / 83$
END TREATMENT: Type 4
PHOTOS: Available
ACCIDENT REPORT: Available
COMMENTS:
The guardrajil 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.

DIAGRAM:


MEDIAN


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

## ACCIDENT NUMBER: 032

```
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.

## DIAGRAM:



## ACCIDENT NUMBER: 033

```
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.

DIAGRAM:


LOCATION: | COUNTY | - Boone |
| :--- | :--- |
| ROUTE | $-I 75$ |
| MILEPOINT $-175.364 ; ~ K Y ~$ | -138 Exit Ramp |

DATE OF ACCIDENT: $\quad 7 / 22 / 81$
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 |
|  | 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.

DIAGRAM:


## ACCIDENT NUMBER: 036

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




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

## ACCIDENT NUMBER: 037

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 ranoff the right-hand side of the road, striking the guardrailwith the left front of the car. Impact with the guardrail wasof a moderate angle. The first post was broken and theguardrail was bent back around the second post. The secondpost did not break, but was loosened slightly from theconcrete footing.The driver of the vehicle received possible injuries tothe legs and back. He was not wearing a safety belt. Thevehicle received significant damage.

DIAGRAM: Not Available


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

## ACCIDENT NUMBER:

```
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.

DIAGRAM:



Figure B17. Accident Number 038, Carroll County, I 71, MP 42.986, KY 389 Exit Ramp.
ACCIDENT NUMBER: ..... 039
LOCAMION: COUNTY - Kenton
ROUTE - I 75 (SB @ I 275)
MILEPOINT ..... 184.716
DATE OF ACCIDENT: ..... $1 / 84$
END TREATMENT: Yype ..... 4
PHOTOS: Available
ACCIDENT REPORT: Not Available
COMMENTS: A single-unit state maintenance truck with a snowplowattached to the front lost control on the icy roadway. Thetruck struck the guardrail end, breaking both wooden postsand damaging two metal posts. The truck then overturned.
DIAGRAM: Not Available


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

LOCATION: | COUNTY - Kenton |
| :--- |
|  |
| ROUTE |

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 Lav) entering from the front windshield and extending through the rear window. It appears that the truck struck the end treatment head-on, with no indication 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:


Ramp from KY 236 we


Figure B19. Accident Number 040, Kenton County, I 75, MP 184.5, I 275 WB Exit Ramp.
LOCATION: COUNTY - KentonROUTE - I 75MILEPOINT - 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:



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

## ACCIDENT NUMBER: 042

```
LOCATION: COUNTY - Kenton
    ROUTE = I 75
    MILEPOINT - 184.5; I 275 WB 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 vehicular damage are unknown.
vehicular damage are unknown.
DIAGRAM: Not Available

DIAGRAM: Not Available

DATE OF ACCIDENT: 6/23/82
END TREATMENT: Type 6
PHOTOS: Not Available
ACCIDENT REPORT: Not Available

## ACCIDENT NUMBER: 043

LOCATION: | COUNTY | - Kenton |
| :--- | :--- |
|  | ROUTE |
|  | MILEPOINT |
| - 75 |  |
|  | 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.

DIAGRAM: Not Available
ACCIDENT NUMBER: ..... 044
LOCATION: COUNTY - KentonROUTE- 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 treatmenthad to be repaired, suggesting heavy damage. Vehicularaction after impact, occupant injury severity, andvehicular damage are unknown.
DIAGRAM: Not Available
ACCIDENT NUMBER: ..... 045
LOCATION: COUNTY - Kenton
ROUTE ..... - I 275
MILEPOINT - 82.475; US 42 Exit Ramp
DATE OF ACCIDENT: ..... $7 / 83$
END TREATMENT: Type 4 ..... 4
PHOTOS: Available
ACCIDENT REPORT: Not Available
COMMENTS: No accident report could be located. Photographs showthat the guardrail was struck directly on the end, deformingthe buffered end section and cracking the first wooden post.The guardrail was slightly bent at the second wooden post, butthe post did not break. No other damage to the guardrail wasevident. The extent of vehicle damage and occupant injury isunknown. It appears that the guardrail end received only alight hit. The vehicle probably proceeded on and no accidentreport was filed.
DIAGRAM: Not Available


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

```
ACCIDENT NUMBER:046
```

LOCATION: COUNTY - Kenton
ROUTE - I 275
MILEPOINT - 0.000; I 75 Exit Ramp
DATE OF ACCIDENT: ..... 12/82
END TREATMENT: Type ..... 4PHOTOS: Available
ACCIDENT REPORT: Not Available
COMMENTS: No accident report was filed. Accident was said to havebeen caused by slick roads during the winter as the trailer ona combination tractor and semi-trailer skidded sideways offthe left-hand side of the road and bumped broadside againstthe guardrail end. Photographs show that only the rounded endof the guardrail was damaged. The concrete footing under thefirst post was pushed over slightly, but neither wooden postwas broken. Apparently the trailer was not damaged.
DIAGRAM: Not Available


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

## ACCIDENT NUMBER: 047

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 abandonedat the scene with extensive damage to the front end and theentire left side. The driver fled the scene at the time ofthe accident; the extent of any possible injuries cannot bedetermined 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.
DIAGRAM: Not Available

## ACCIDENT NUMBER: <br> 048

## LOCATION: COUNTY - Kenton ROUTE - KY 1501 MILEPOINT - 2.4

DATE OF ACCIDENT: Unknown
END TREATMENT: Type 4
PHOTOS: Available
ACCIDENT REPORT: Not Available
COMMENSS: 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.
DIAGRAM: Not Available


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

ACCIDENT NUMBER: 049

```
LOCATION: COUNTY - Fayette
    ROUTE - I }6
    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.

DIAGRAM:



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

## ACCIDENT NUMBER: 050

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.

DIAGRAM:


ACCIDENT NUMBER:
051
LOCATION: COUNTY - Fayette $\begin{array}{ll}\text { ROUTE } & \text { - I } 75 \\ & \text { MILEPOINT }\end{array}$
DATE OF ACCIDENT: Unknown

END RREATMENT: 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.

DIAGRAM: Not Available


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

```
ACCIDENT NUMBER: O52
```

LOCATION: | COUNTY | - Fayette |
| :--- | :--- |
| ROUTE | $-I 75$ |
|  | MILEPOINT -110.019 |

DATE OF ACCIDENT: $10 / 30 / 83$
END MREATMENT: 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:


## ACCIDENT NUMBER: 053

```
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.

DIAGRAM: Not Available

## ACCIDENT NUMBER: 054

```
LOCATION: COUNTY - Fayette
    ROUTE - I 75
    MLLEPOINT - 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:


ACCIDENT NUMBER: 055

```
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.

DIAGRAM:


MEDAAR


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

ACCIDENT NUMBER: 056

LOCATION: | COUNTY | - Fayette |
| :--- | :--- |
|  | ROUTE |
|  | MILEPOINT |

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.

DIAGRAM:

ACCIDENT NUMBER: ..... 057
LOCATION: COUNTY - Fayette
ROUTE - KI 4MILEPOINT - 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 onan exit ramp when strong winds caused him to lose control andveer to the right where he subsequently struck the guardrailend 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 guardrailhad to be replaced.
DIAGRAM: Not Available
ACCIDENT NUMBER: ..... 058
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 accident report was found, which was probably due tothe minor nature of the impact. The guardrail on the medianshoulder sustained damage to the buffered end. The firstwood post was not damaged, but the second wood post had splitlongitudinally. However, it did not break at the concretefooting and remained intact with the guardrail. The extentof vehicle damage and occupant injury is unknown.
dIagram: Not Available


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

| LOCATION: | COUNTY |
| :--- | :--- |
|  | - Wood ford |
|  | ROUTE |
|  | - US 60 |
|  |  |

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.

## ACCIDENT NUMBER: 060

LOCATION: | COUNTY | - McCreary |
| :--- | :--- |
|  | ROUTE |
|  | 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 waspulled out of the ground while the wooden post remainedunbroken and firmly implanted in the footing. The secondpost was leaning slightly but was also not broken. Noaccident report was found which was probably related to therelatively minor nature of the accident.
DIAGRAM: Not Available


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

| LOCATION: | COUNTY |
| :--- | :--- |
|  | ROUTE Rockcastle |
|  | MILEPOINT -175 |
|  | -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.

DIAGRAM:



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

## ACCIDENT NUMBER: <br> 062

```
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.

DIAGRAM:


## ACCIDENT NUMBER: 063

```
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.
```

DIAGRAM: Not Available


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

## ACCIDENT NUMBER: <br> 064

```
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.

DIAGRAM:


## ACCIDENT NUMBER: 065

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.

DIAGRAM:
$\qquad$
$\qquad$ - - - -

$\qquad$ -
$\qquad$

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 $2-d o o r$ Chevrolet and sustained heavy damage to the front end. The driver died of head injuries. He was not wearing a safety belt.

DIAGRAM:



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

ACCIDENT NUMBER: 067
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.

DIAGRAM:



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

## ACCIDENT NUMBER: 068

```
LOCATION: COUNTY - Whitley
    ROUTE - I 75
    MILEPOINT - 6.400
```

DATE OF ACCIDENT: $3 / 6 / 80$

## 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.

DIAGRAM:


## ACCIDENT NUMBER:

LOCATION: | COUNTY | - Whitley |
| :--- | :--- |
| ROUTE | $-I 75$ |
|  | MILEPOINT |

DATE OF ACCIDENT: $12 / 46 / 79$
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.

DIAGRAM:


