VCU

Virginia Commonwealth University

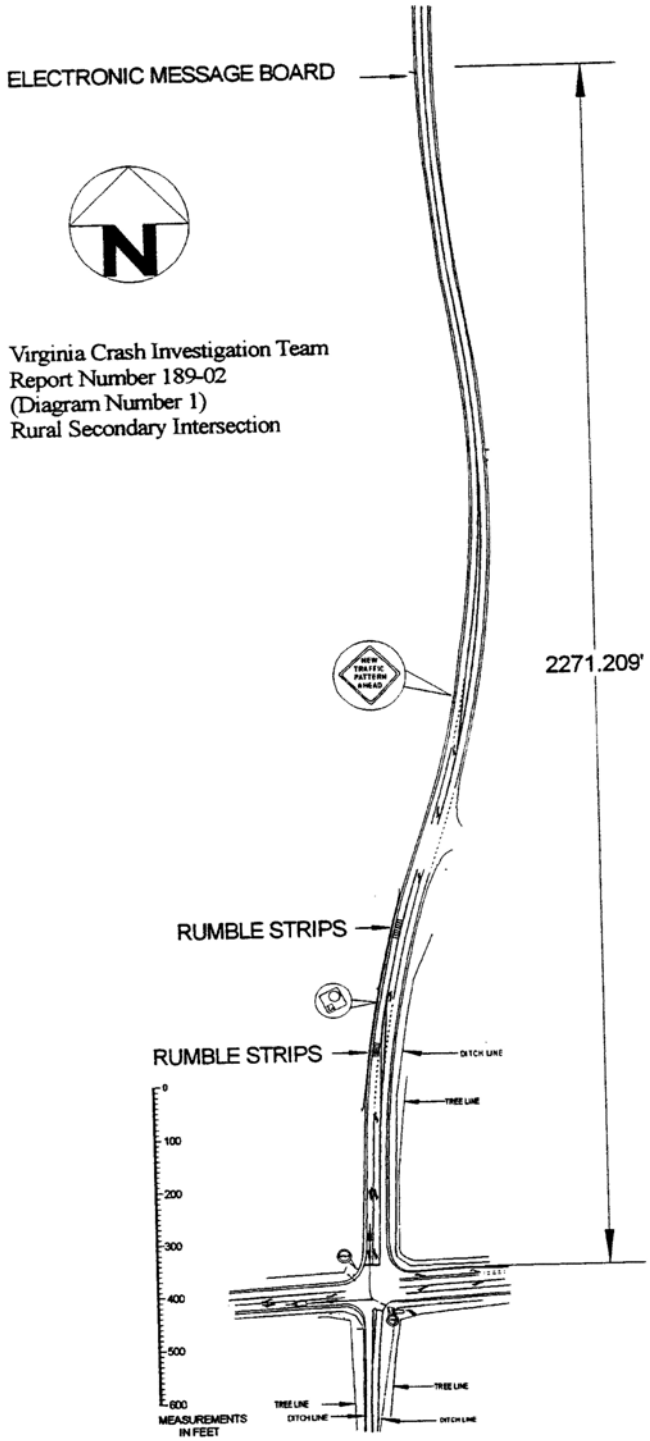
Virginia Commonwealth University
Transportation Safety Training Center
Crash Investigation Team

Report Number 189-May 2002

ABSTRACT

The crash described in this report occurred on a rural, undivided two-lane secondary highway intersection with another two-lane facility. The recently constructed four-leg crossroad intersection had just opened to traffic 20 days prior. The collision occurred between a pickup truck driven by a 19 year old male and a light duty delivery truck driven by a 50 year old male. The pickup, occupied by three teenage males, was southbound and ran a stop sign where it struck the eastbound delivery truck, which had the right-of-way. The severe impact resulted in deaths of the delivery truck driver and two passengers inside the pickup and extensive property damage. In the intervening weeks after this crash, the roadway intersection underwent a series of signing/warning changes after several other traffic crashes occurred at this location.

This report illustrates the hazards of motorists not paying attention to their driving tasks and the dangers created by new highway warning-regulatory signs on unsuspecting drivers. Also mentioned is the importance of motorists wearing their available safety belts and the need for highway transportation authorities to be constantly vigilant of changing traffic patterns at new roadways so that modifications can be made quickly and efficiently if problem patterns emerge. Also illustrated in this crash are the potential highway safety hazards caused by vandals removing or destroying important highway signing.


ELECTRONIC MESSAGE BOARD
N
Virginia Crash Investigation Team
Report Number 189-02
(Diagram Number 1)
Rural Secondary Intersection
2271.209'
RUMBLE STRIPS
RUMBLE STRIPS
DITCH LINE
TREE LINE
0
100
200
300
400
500
600
MEASUREMENTS IN FEET
TREE LINE
DITCH LINE
TREE LINE
DITCH LINE

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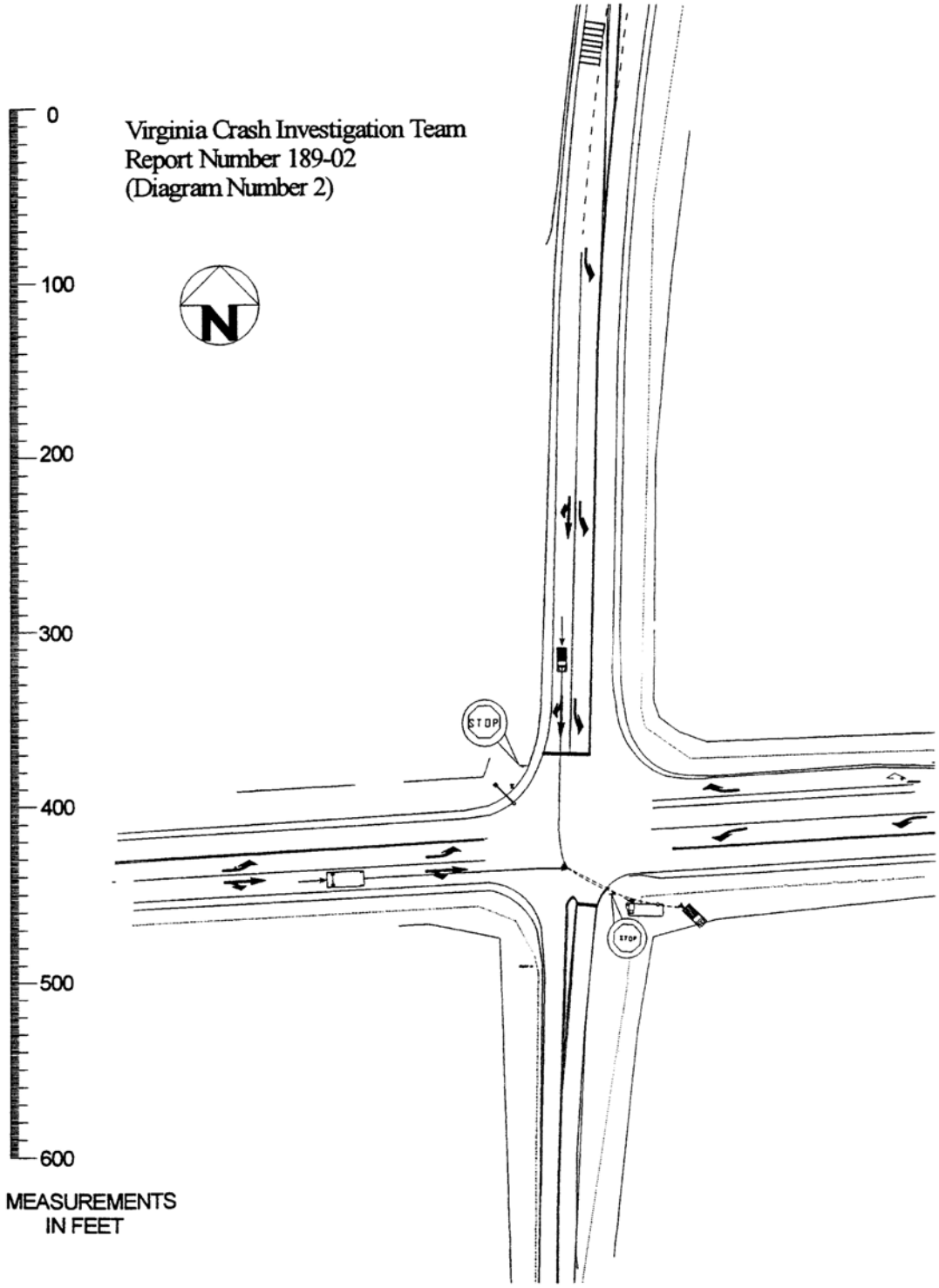
SYNOPSIS

Day, Time, Season:	Wednesday, 12:15 p.m., Winter
Vehicles Involved:	1979 Chevrolet Custom Deluxe 10 pickup truck 1991 Chevrolet Step Van delivery truck
Summary:	The pickup failed to stop at a stop sign at a rural crossroad intersection and consequently struck right front to left front the delivery truck that had just entered the intersection.
Severity:	Three fatalities, one injury and extensive property damage
Probable Cause:	The 19 year old pickup driver, who was unfamiliar with the recently installed stop sign at the intersection, was either distracted by the presence of his passengers and/or was not paying attention to driving task, thus causing him to fail-to-stop before entering the intersection.
Significant Points:	Probable driver inattention/distraction; new traffic construction and opening of intersection; new and different highway controls; vandalism of highway signs; traffic accident patterns; crash avoidance maneuver; human factors associated with driver expectancy, perception and reactions; highway controls related to positive guidance; need for selective enforcement at certain problem locations; need for highway safety officials to continuously monitor this intersection (and similar ones) for future crash/conflict patterns.


Virginia Crash Investigation Team
Report Number 189-02
(Diagram Number 2)
N
0
100
200
300
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MEASUREMENTS
IN FEET
STOP
STOP

Crash Description

On a clear, dry Wednesday afternoon at about 12:15 p.m., a 1979 Chevrolet pickup was traveling south on a two-lane undivided highway. The pickup was being driven by its belted 19-year-old owner who was accompanied by his 14-year-old brother and his 13-year-old male cousin. Both of these passengers were unbelted and occupied the front bench seat beside the driver. The driver was a resident in the area and lived about five miles away. The three occupants were en route to the driver's father's house located nearby to pick up some cables to use with their video game equipment that they had received the day before.

The roadway is a typical, winding, rural state secondary road with gentle grades. The facility had been widened and improved over the years, due to heavy population growth. The asphalt pavement is in excellent condition and is marked appropriately with standard yellow centerlines, solid white edgelines and had been widened to accommodate turn lanes at appropriate locations. The roadway is posted almost exclusively with 45 mph speed limit signs; however, about 1½ miles prior to the crash location, the speed limit was 55 mph. Bordering each side of the generally level roadway were gently sloped grass and dirt shoulders adjacent to heavily wooded landscapes. Located on the road's west shoulder for southbound traffic, about 2300 feet before the intersection, was a variable electronic message board, advising motorists that the roadway had changed and they should proceed with caution. However, vandals had cut the cables for this electronic warning (and slashed the sign trailer's tires). The sign was not working when the pickup passed by it. Located nearly 1200 feet further south was the first fixed warning sign, also located on the west shoulder, denoting "New Traffic Pattern Ahead." This diamond shaped, orange sign displaying the message in black letters is attached to a wooden post which also had two orange flags connected to the assembly. Located approximately 420 feet further south is a series of eight, white, one-inch raised rumble strips placed perpendicular across the southbound lane. The purpose of these strips is to alert drivers through road vibrations and noise that changes

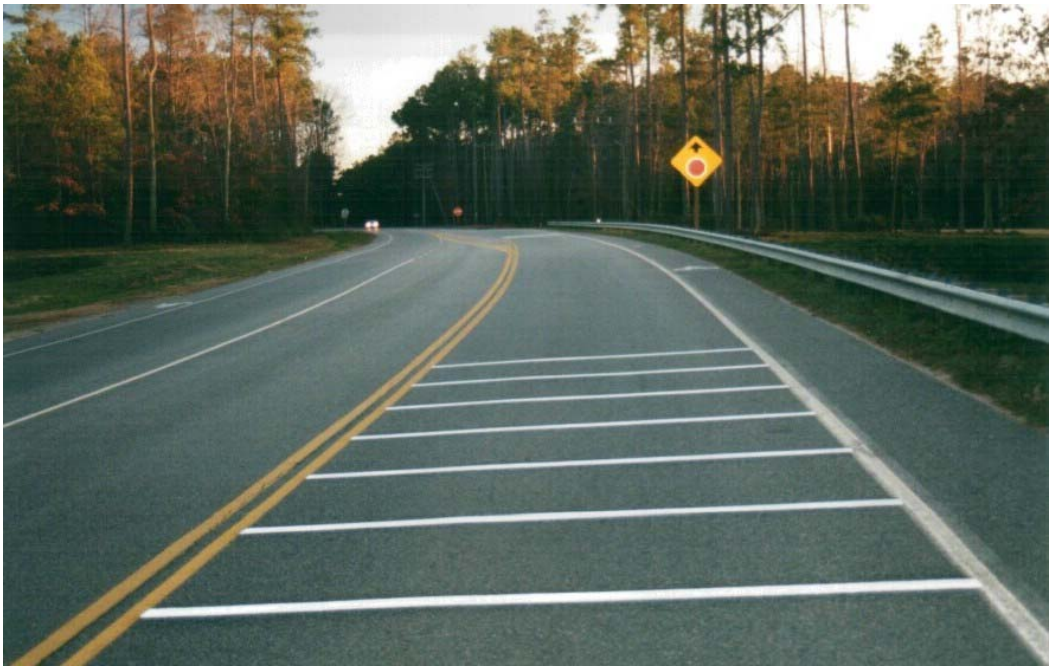
in road conditions are ahead. Located 135 feet beyond this point, or about 600 feet before the intersection, a graphic "Stop Ahead" sign is posted on the shoulder, followed 123 feet later by a second set of rumble strips. The southbound lanes at this point widen to include a left turn lane and a straight through/right turn lane denoted by pavement markings and arrows on the roadway. Approximately 20 feet before the crossroad intersection is painted a two-foot wide white stop line accompanied by an oversized stop sign. These roadway markings and devices were all installed together when the new intersection was opened to traffic 20 days before the crash.

1. View looking south, direction the pickup driver was traveling prior to impact. Note the "New Traffic Pattern Ahead" warning sign with accompanying flags placed about 1100 feet before the intersection. This was the first of six warnings that he would have seen/felt while approaching the intersection, including the vandalized electronic message board.

After the pickup had passed the warnings signs approaching the intersection and negotiated without mishap two gentle curves leading up to the crash site, it was on a direct collision course with an eastbound delivery truck that was also entering the intersection. As the pickup was crossing the white stop line, its driver suddenly realized that he was running a stop sign as he saw the delivery truck simultaneously enter the intersection. As a result, the pickup's driver steered hard to his left and braked in an emergency, unsuccessful attempt to avoid a collision. With the pickup's weight now shifting onto its right side tires, the left front tire made a curved skid mark about 48 feet long. This skid mark then abruptly changed directions from southeast to east near the

center of the eastbound lane within the intersection, denoting the point of impact between the two vehicles.

The 1991 two-axle, six-tire delivery truck was a medium duty, step-van vehicle, driven by its 50-year-old owner, who was unbelted. The lone driver, who resided in the area, was reportedly in good health and was familiar with his vehicle and the roadway. He was on routine work duty delivering snack foods to grocery/convenience stores and his truck was partially loaded with goods. As the truck entered the intersection, its driver saw the approaching pickup. As a result, he hit his brakes just as the vehicles collided, leaving only short dual tire skid marks squarely in the eastbound lane.

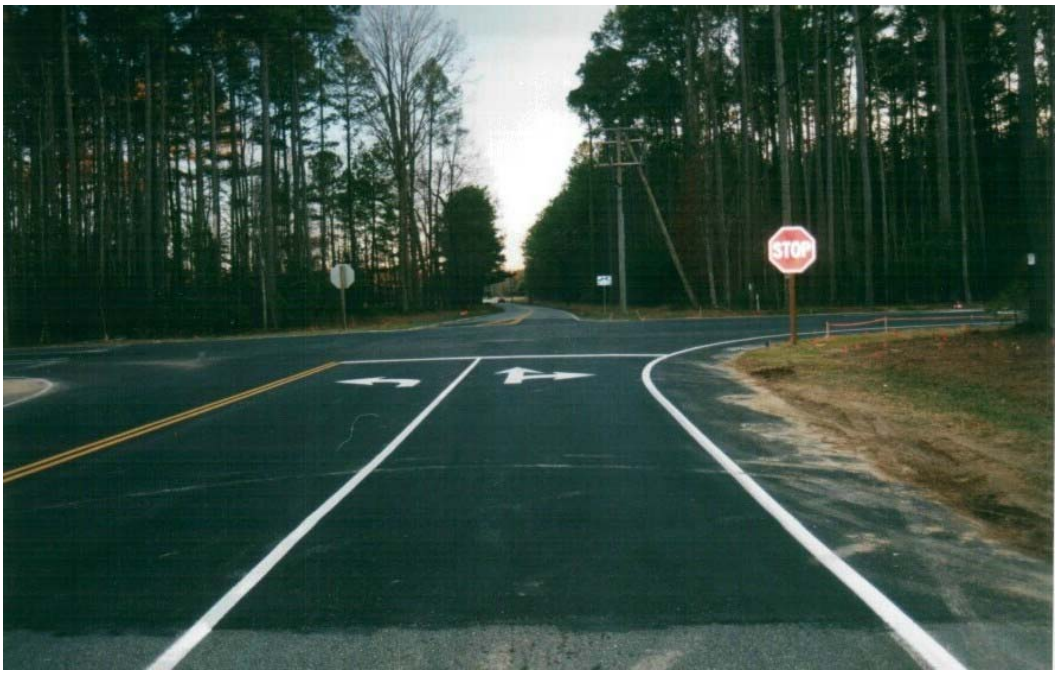


2. Closer view looking south at the intersection showing the first of two sets of rumble strips and the graphic "stop ahead" sign placed about 650 and 530 feet respectively before the intersection. All of these pre-warnings were in effect when the west leg of the intersection was opened to traffic 20 days prior to the first fatal crash occurring.

The pickup's right front fender and wheel collided with the truck's left front corner, directly in front of and beside where the truck driver was seated. Because both vehicles struck at a sharp angle, their original directions of travel were immediately altered, causing the vehicles to collide a second time. The secondary collision occurred between the pickup's full right side and the truck's left side. The two severe collisions and the sudden direction change of the truck caused it to rollover onto its left side, where it struck and slid down the pickup's right rear bed rail. As the vehicles

disengaged, they traveled off the pavement and crossed a grassy berm located in the southeast quadrant of the intersection.

The pickup stayed on its wheels and struck a large tree with its left front, which stopped its forward movement. The truck slammed to the ground with its left side and as it slid in the mud and grass, it also rotated clockwise until it stopped, facing nearly 180 degrees from its original heading. The pickup had rotated counterclockwise and was facing nearly 45 degrees from its original heading.

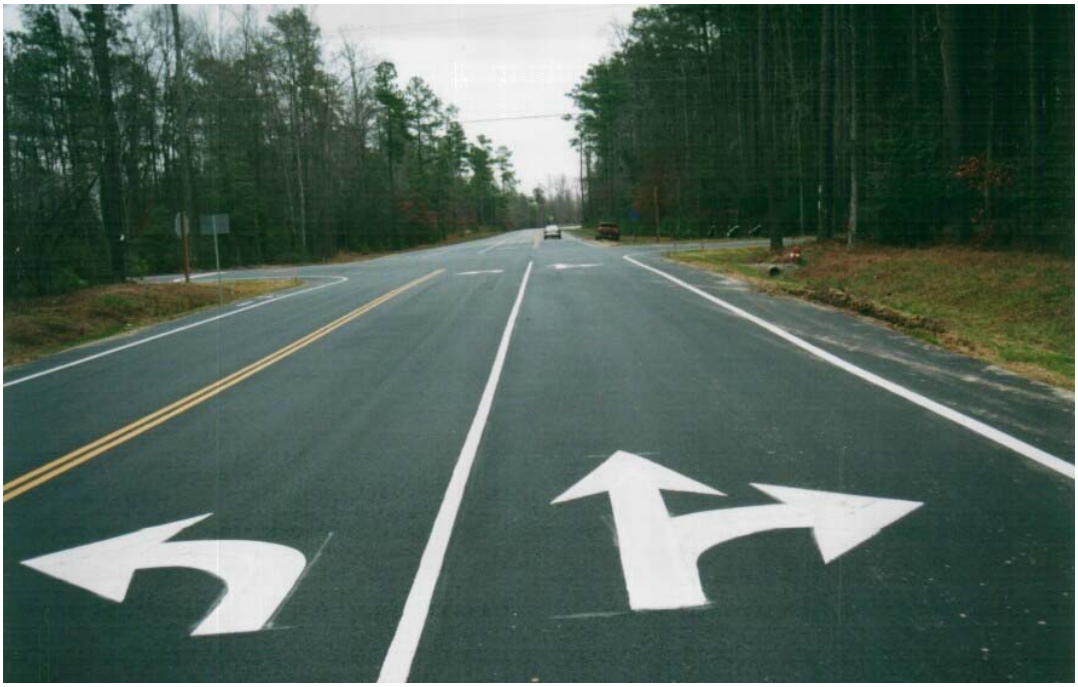


3. View looking south, about 100 feet before the stop sign. Just after the pickup crossed the arrow and stop line located in the right lane, it was braked and steered hard to the left in an attempt to evade the truck, which was approaching from the right.

At final rest, the truck had traveled a total distance of about 80 feet from the point of impact and the pickup about 90 feet. The truck driver, because he was not wearing his lap belt, was found partly outside the vehicle, resting in the window opening between the door and the ground. He died instantly in the collision from head and body trauma. The two unbelted pickup passengers remained inside their vehicle but were found by rescue workers in the floor/seat area having sustained massive head, neck, and body injuries. They also died instantly in the collision. The pickup driver, because he was properly wearing his lap and shoulder safety belt, rode down the collision forces in relative safeness, upright in his seat behind the steering wheel. He incurred moderate bruising from the collision and lacerations from the flying glass and debris. He was able to unbuckle his belt and exit the vehicle under his own power although he was

assisted by passersby. The local rescue squad was called by motorists with cell phones and arrived within 10 minutes. The pickup driver was transported to a local hospital where he was admitted and stayed for several days for treatment.

The Investigating Trooper was notified via his dispatcher of the crash and responded within minutes, arriving as the rescue squad was attending to the pickup driver. He was assisted by county law enforcement officers with accident investigation and crowd control duties. The medical examiner's office was contacted and the bodies were removed by a local service. Two wreckers were later dispatched to remove the vehicles and the scene was cleared and opened to traffic about three hours later. No witnesses to pre-crash events were found, and no unusual problems were encountered at the scene. The Investigating Trooper, after completing his at-scene investigation, interviewed the pickup driver at the hospital and at his home several weeks after the crash. He was charged with reckless driving and later convicted. The driving actions on the part of the delivery truck driver and/or the condition of his truck did not contribute to the cause or severity of this crash. The State Police Bureau of Criminal Investigation assisted the Trooper in attempting to locate the identity of the vandal(s) who had earlier cut the cables to the variable message warning board. At the time of this report's final printing, no arrests had been made.



4.View looking east, direction the truck driver was originally traveling. This view is about 200 feet prior to the intersection. The pickup was approaching from the left. After the collision, both vehicles struck a second time and traveled southeast off the pavement where the pickup collided with several trees and the truck rolled onto its left side.

Remarks

It was determined that the 19 year old pickup driver, who lived and grew up near the crash site, had spent the previous two weeks at a relative's home in Florida. During this time, the roadway intersection was under final construction and opened to traffic. Prior to the crash date, when he had driven on the road on many other occasions, there never was a stop sign for south and northbound traffic through the intersection. The only control in effect for at least the last couple of years prior to the crash was a stop sign on the eastern leg of the intersection. The western leg had been under construction for several months and not open to traffic. The day of this crash was the first time that the pickup driver had been through the intersection and, as such, he was not expecting to see a stop sign and/or a four-way intersection when he approached them.

5. View of the 1979 Chevrolet pickup. The vehicle displayed major damage to its right side from the impacts with the truck and to its left front corner and right wheel areas from collisions with the trees.

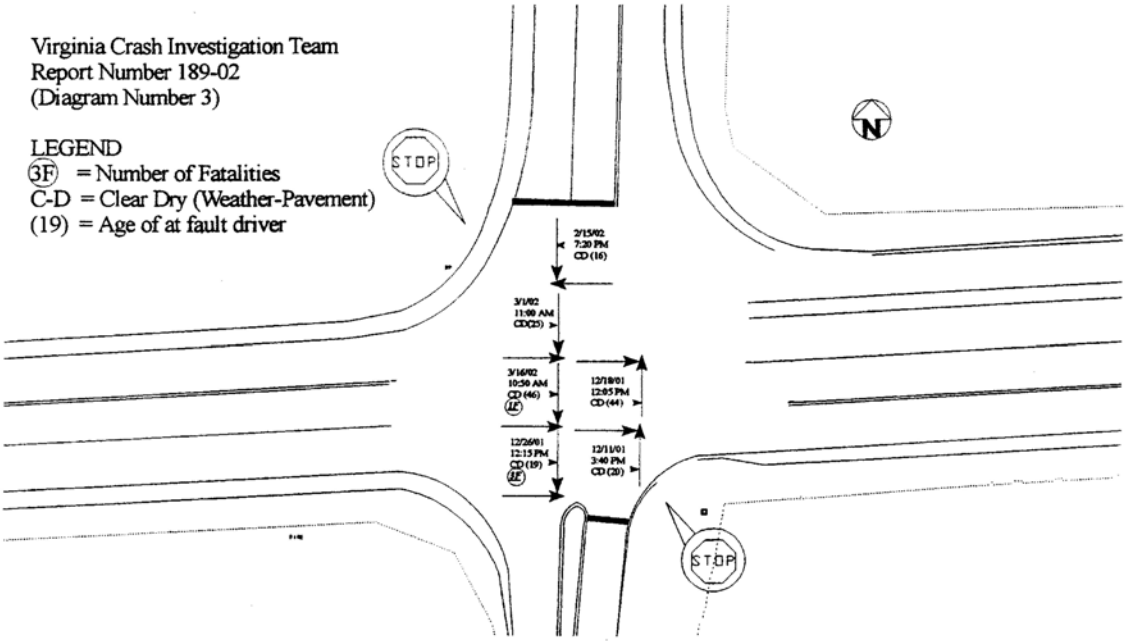
The pickup driver advised the Trooper that he believed he was traveling "about 45 mph" as he entered the intersection. He said he did not see the stop sign, the stop ahead sign or the other warnings to the intersection, including the rumble strips. He did

not detect the presence of the delivery truck until he saw a “white vehicle” out of the corner of his eye just prior to impact. The last events leading up to the collision seemed so fast that he felt he had no time to react to the truck’s presence. He further advised that he does not remember carrying on a conversation with his passengers as they entered the intersection, but he does recall playing music on the CD player.

Since the crash, when he travels through the intersection, the stop ahead and stop signs appear “huge” to him and, although they were present on the day of the crash, he wonders now how he could have missed them. It should be noted, however, that at the time of the crash, 12:15 p.m., the placement of the sun was directly ahead and above the driver’s eyes. This condition might have contributed to “washing out” the conspicuity of the stop ahead and stop signs. While they still would have been detectable, they would not have been as evident as at other times of the day when the ambient light conditions were not as bright.

According to recent traffic patterns in this area, it would appear that the pickup truck driver was not alone in his failure to properly detect and respond to the traffic controls placed before and at the intersection. According to official crash report data, during the 31 months before the four-way intersection was opened to traffic when the roadway was a “T” intersection a total of five crashes occurred. In all five crashes, westbound motorists failed to yield the right-of-way and collided with traffic on the north-south legs that were not required to stop. These crashes resulted in four injuries and no fatalities. In only three months after the intersection was opened to traffic six crashes have been reported at this intersection, two of which were fatal collisions (including the one highlighted in this report). These crashes resulted in a total of four deaths and eight injuries. An analysis of these crashes revealed that all of the at fault drivers were on sections of the road that originally had the right-of-way. Four of the six involved were southbound vehicles (the same direction as that of the pickup driver) and two involved were northbound vehicles. Five of the six crashes involved eastbound vehicles (the same direction of the delivery truck driver). Of the six at-fault drivers, two lived in the immediate area and four lived outside the county. Also of the six crashes, three of these drivers ran the stop sign (two were southbound) and three stopped at the stop sign and then, while pulling out, failed to yield the right-of-way (two were southbound). Of the total six at-fault drivers, three were aged 16 to 20 years, one was 25, and two were in their 40’s.

Five of these drivers were male and, in at least four cases, they had passengers in the vehicles. All six crashes occurred during dry conditions; five during daylight hours, and one at night. Four occurred between 10:50 a.m. and 12:15 p.m., one at 3:40 p.m., and one at 7:20 p.m.



The crash investigated in this report was extensively publicized in this area for the following reasons:

- the severity of the crash
- it occurred at a new intersection, just opened to traffic
- the problem of multiple crashes in a short time
- the problem of drivers failing to detect numerous warnings of the changes
- the hazardous situation of the sign vandalism
- the habituated drivers' resistance to traffic requirements at the new intersection

Although unproven, several citizens from the area told the Team that the vandalism might have been perpetrated by person(s) that did not want the north-south highway to be posted with stop signs. Since these approaches had always had the right-of-way, many motorists in the area felt it should continue to do so even though the new east-west route carries more traffic. At last count (one month after opening), the east-west route had the major traffic movement with a volume of 3,855 vehicles a day and the north-south route had the minor movement with a volume of 3,184 vehicles. Since the new leg was designed and located to replace a nearby paralleling state primary highway, it is anticipated that traffic volumes will only increase as more motorists learn of this route and growth in the area continues.

6. View of the 1991 Chevrolet Step Van delivery truck. Damage to its left front and side was attributed to both the collisions with the pickup and rollover.

A thorough traffic engineering evaluation by VDOT officials was conducted both before the intersection was opened and afterwards when crashes began to occur. Adhering to current standards, the roadway was properly marked and signed to alert motorists on the north-south approaches of the impending situation ahead. However, for whatever reason(s), motorists failed to properly detect and respond to the warnings and thus ran the stop signs. On two occasions when the Crash Investigation Team was on site, several motorists complained to the Team of the “dangerous conditions” at the intersection and that something “more” was needed to correct the problem. At least two

police officers reported that on the day following the opening of the roadway and after the stop signs were imposed, they nearly ran the stop signs because they were not expecting to see them. A "Highway Hazard Report" was filled out by a Trooper concerning the intersection and sent to VDOT for further analysis. As a result of these serious crashes occurring in such a short time period, citizens complained by writing numerous letters to local newspapers. At least one petition was started to persuade VDOT officials to install an "all-stop" control at the intersection, even though the warrants for this modification were not met. On several occasions, the local county law enforcement agency conducted selective enforcement details at the intersection to help influence motorists' compliance to the stop signs.

The first crash occurred five days after the intersection fully opened. One week after, the second one occurred and eight days later, the first fatal crash occurred (the subject of this report). In two of these first three crashes, southbound motorists ran the stop sign. As best as can be determined, the electronic message board was vandalized on the weekend, three days before the first fatal crash. After this fatal crash, which occurred 20 days after the intersection was opened, other changes to the roadway were incorporated. These included reducing the speed limit from 55 mph to 45 mph and installing dual flashing red beacons on the stop signs for the north-south approaches.

After these improvements were made, two other crashes occurred, one being the most recent fatal crash. In this crash, a southbound driver from an adjoining community, accompanied by his twin, eleven year old sons, ran the stop sign and struck an eastbound vehicle, resulting in the death of one of the children. Because of this latest fatality and the publicity surrounding this intersection, VDOT officials decided to place stop signs on all four legs with flashing red beacons on these signs. Included in this project were the addition of rumble strips on the east-west approaches and the same pre-stop warnings on these legs as those imposed on the north-south approaches. Requiring all four legs to stop at the intersection meant yet another change for east-west direction motorists who were briefly used to having the right-of-way at the intersection.

Approximately one week after these changes were made, after conducting a prospective traffic analysis, VDOT officials decided to install a fully actuated traffic signal, complete with applicable turn phases and pre-warnings. Overhead light luminaries have also been installed. Although the traffic warrants or standards needed for such a signal were not met at this time, it was felt that the signal should be installed

since some of the warrants would be realized in future years due to the area's rapid growth.

The main cause of the triple fatal crash (and almost all of the other crashes occurring at this location) was the failure of the southbound pickup driver to obey the stop sign. However, the historical background of this driver, compounded by the past controls on the roadway, may have led to a complex breakdown in the proper detection and decision-making tasks of an unsuspecting driver using this facility. For a multitude of reasons, the presence of the stop controls violated some drivers' "expectancy set". Human Factors specialists and Traffic Engineers have long known that "driver expectancy" relates to a driver's readiness to respond to situations, events and information in predictable and successful ways. It influences the speed and accuracy of drivers' information processing and is one of the most important considerations in the design and operation of highways and the presentation of information. When expectations are violated, their reaction times are longer, and they are more likely to become confused, act inappropriately or commit errors. In this case, the pickup driver was very familiar with the road, as he lived nearby and drove the facility nearly all his driving life. In all that time, he never encountered a stop sign on the north-south legs of the intersection. On his very first trip through the area, after the highway changes had been made, he approached the intersection in much the same way as on other occasions, in that he did not expect a change from his past driving experience. Hence, he failed to stop. While this type of driving response fits the classic mold of driver expectancy set, the 19-year-old driver likewise may have been distracted or preoccupied by the presence of his passengers.

The Crash Team has investigated many crashes where drivers, especially younger and inexperienced ones (see Special Report Number 14, 2001), are negatively influenced by peer interaction, thus causing the drivers to become distracted and not focus fully on their driving tasks. Although the placement of all the redundant warnings to the upcoming roadway changes would appear to have been more than enough to prompt the driver to respond correctly in this case, their failure to overcome well-established expectancies is only reinforced by the occurrence of other drivers committing similar errors at this location. While the warnings and controls were warranted and well situated at the time of the roadway's opening, it is the Crash Team's opinion that the transition from stops required only on the east/west bound lanes to

stops required only on the north/south bound lanes would have been less hazardous if made gradually. Specifically, all 4 lanes approaching the intersection could have required stops for an interim time in order to create a new expectancy for north and southbound travelers without exposing them to severe consequences (i.e., collisions) for failure. After a time, the stop requirement could be lifted for east and westbound drivers. While these drivers would have to "unlearn" the anticipation of stopping, the Team feels the consequences of errors made under this expectancy set would carry a lower potential for security. The Team agrees with VDOT officials that the addition of the traffic signal should make the intersection safer and more forgiving, provided that motorists keep their attention on their driving tasks. However, the need for traffic engineering professionals to constantly monitor this location for the possibility of further changes is imperative.

Causal Factors and Conclusions

1. The 19 year old southbound pickup driver failed to stop at a new traffic intersection and, as a result struck an eastbound delivery truck within the center of the intersection.
2. At the last instant as the pickup was entering the intersection, it was braked and steered by its driver in an unsuccessful, emergency avoidance maneuver. The 50-year-old truck driver, after seeing the pickup, also attempted a last minute evasive action to avoid a collision but was also unsuccessful.
3. The driving actions of the delivery truck driver in no way caused or contributed to the occurrence of this crash. Both vehicles were in good mechanical condition and neither contributed to the cause or severity of the crash.
4. This angle collision resulted in the deaths of the truck driver and two teenage passengers inside the pickup. All three victims were unbelted.
5. The pickup driver, because he was belted, survived the collision with only minor injuries. Had the three fatal victims worn safety belts, their chances of surviving this crash would have increased.
6. After the initial collision, both vehicles struck each other a second time and ran off the road. The pickup truck then struck a tree and came to a sudden stop and the truck rolled over. These secondary impacts were also severe and life threatening events.
7. The pick up driver passed two warning signs, two sets of rumble strips, a stop sign and a painted stop line before entering the intersection. The reasons he failed to respond to these controls were a combination of his driver expectancy being violated, the likely interaction between his passengers and the possible glare from the sun reducing the conspicuity of the sign warnings.

8. The intersection, in its first three months of operation has experienced at least six reported crashes, two of which were fatal. These crashes occurring in such a short time period clearly indicates that something was out of the ordinary with the roadway's controls and/or the motorists using the road. As a result, numerous roadway changes have been instituted in an attempt to make the intersection safer.
9. Both drivers' records indicate they did not have any past driving problems prior to the fatal crash. The pickup driver had accumulated plus two driving points in his short career and the truck driver had plus five points within his longer driving career.
10. The electronic warning sign had been vandalized several days prior to the fatal crash and hence was not operational at the time. Its lack of warning probably did not influence the pickup driver's behavior. However, had it been operational, it may have alerted the driver of the roadway changes ahead so that he could have taken the proper driving actions.

Recommendations

1. The Virginia Department of Transportation use the findings in this report to:
   A. Continue to monitor this intersection and, if crash frequency/severity does not reduce, consider other remedial changes to the roadway, such as closing the south leg of the intersection
   B. Use this situation as a model for other similar intersections where possible driver expectancy problems may be anticipated.

2. Law enforcement agencies in the area should consider more selective enforcement and visibility patrols through this area to achieve better compliance to the traffic controls.

3. Those associated with highway safety use the findings in this report to:
   A. Continue advising motorists to constantly be vigilant to changing traffic situations and construction and to pay full attention to their driving tasks.
   B. Continue to advertise the benefits of safety belt usage.
   C. Younger/inexperienced drivers constantly need to be reminded that their crash risks are significantly increased when they are accompanied by their peers and that they must direct their full attention to their driving tasks, and be cognizant of the hazards of driving while distracted.
   D. Publicize to citizens the hazards of highway signing vandalism. The removal and/or damage to highway control signs can cause motorists (especially ones not familiar to a roadway or area) to miss important information and may contribute to highway crashes.