SHERMAN, TEXAS FATAL MOTOR COACH ACCIDENT
HIGHWAY FACTORS FACTUAL REPORT
AUGUST, 08, 2008
HWY-08-MH022
(18 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, DC 20594
August 8, 2008

HIGHWAY FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

A. ACCIDENT

NTSB #:	**HWY-08-MH-022**
Date and Time:	August 8, 2008 at 12:30 a.m.
Description:	Run Off Roadway Bridge and Rollover
Location:	U.S. Highway 75 Northbound at Milepost 208.0236 0n Post Oak Creek Bridge
Vehicle:	2002, 56-Passenger MCI Motorcoach
Motor Carrier:	Iguala BusMex

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C. ACCIDENT SUMMARY

About 12:45 a.m., central daylight time, on Friday, August 8, 2008, a 2002, 56-passenger Motor Coach Industries, Inc. (MCI), motorcoach, operated by Iguala BusMex, Inc., was northbound on U.S. Highway 75 when it was involved in a single-vehicle, multiple-fatality accident in Sherman, Texas. The chartered motorcoach had departed the Vietnamese Martyrs Catholic Church in Houston, Texas, at approximately 8:30 p.m. on August 7, 2008, with a driver and 55 passengers onboard, en route to the Marian Days Festival in Carthage, Missouri. When the accident occurred, the motorcoach had completed about 309 miles of the approximately 600-mile-long trip.

Before the crash, the motorcoach was traveling in the right lane of the four-lane divided highway. As the motorcoach approached the Post Oak Creek bridge at a speed of about 68 mph, its right steer axle tire failed. The motorcoach departed the roadway on an angle of about 4 degrees to the right, overrode a 7-inch-high, 18-inch-wide concrete curb, and struck the metal bridge railing. After riding against the bridge railing for about 120 feet and displacing approximately 136 feet of railing, the motorcoach went through the bridge railing and off the bridge. It fell about 8 feet and slid approximately 24 feet on its right side before coming to rest on the inclined earthen bridge abutment adjacent to Post Oak Creek. As a result of the accident, 17 motorcoach passengers died; 12 passengers were found to be fatally injured at the crash site, and 5 others died at area hospitals. In addition, the 52-year-old driver received serious injuries, and 38 passengers received minor-to-serious injuries.

D. INTRODUCTION

This report provides the reader with a factual record of the highway conditions that existed at the time of the accident. For a better understanding of all the circumstances and facts readers are encouraged to also examine the Vehicle and Recorder Group Factual Report, the Human Performance Factual Report, the Bus Driver's Medical Records Factual Report, the Survival Group Report, and the Motor Carrier Operations Group Report

This report is organized in the following manner: First an outline is provided showing what details will be covered. Then prefatory data and highway data will be presented along with detailed information about the bridge rail design and maintenance.

E. DETAILS OF THE INVESTIGATION

Prefatory data was obtained that included construction history, average daily traffic, vehicle classification data, traffic accidents, and fatal accidents.

Highway data was obtained that included the functional classification, highway design, posted speed limit, 85th percentile speed[2], and existing signage on the U.S. Highway 75 (US-75) northbound lanes in the vicinity of the accident. Other highway data obtained included highway markings, design speed, horizontal and vertical geometry of the U.S.75 northbound lanes. Also skid test data was obtained, and detailed information about the bridge rail was documented.

F. PREFATORY DATA

US 75 in the accident area along with the Post Oak Creek Bridge for the northbound lanes was originally constructed in 1958. The facility was a 4-lane highway with the dual north and southbound lanes separated by an earthen median and a 32-inch-high, Jersey shaped concrete median barrier. The dual lanes in each direction are delineated by dashed, white pavement striping. The 9.0 foot-wide shoulders on the northbound approach to the bridge have alert grooves cut into the pavement and the shoulder is delineated from the main travel lanes by a solid white pavement stripe. The right-hand shoulder narrows to 30-inches wide on the bridge deck. The left-hand or median shoulder is 4 feet-wide and is delineated from the travel lane by a solid yellow pavement stripe. The left-hand shoulder narrows to 22 inches wide on the bridge deck.

The main lanes of traffic had a 4-inch overlay with a two-inch overlay placed on the bridge deck in 1989. A 3/8-inch micro overlay was placed on the lanes in 1998 and again in 2002, using state traffic maintenance funds.

G. TRAFFIC COUNTS & ACCIDENT HISTORY

Annual Average Daily Traffic (AADT) counts in 2007 showed that 46,961 vehicles a day used US 75 in Sherman, Texas near the accident location. The Texas Department of Transportation (TXDOT) indicated that the commercial vehicle AADT was approximately 16 percent of this total. (See Attachment B TXDOT Traffic Counts for more Details) The northbound bridge had an ADT of 21,000 Vehicles per day averaged over 2007 and 2008.

Accident history along a one-mile section of US 75 on the approach to the accident was requested. TXDOT provided a list of the accidents from State Highway 56 near the accident location to Farm-to-Market (FM) road 1417 in the years 2003-2008.

In 2003 six accidents occurred in this highway segment. Two of these accidents involved truck tractor semi-trailers and passenger vehicles. One of those was a fatal accident and the other resulted in incapacitating injuries. The other four accidents involved passenger vehicles, trucks, and a motorcycle. They were all minor injury accidents. No buses were involved

In 2004 five accidents occurred in this segment. They resulted in minor injuries or property damage with no fatalities. No truck tractor semi-trailers or buses were involved.

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[2]The 85th percentile speed is the speed at which 85% of the vehicle traffic is traveling either at or below that speed or, 15% of the vehicle traffic is traveling above that speed.

In 2005 another five accidents occurred. No truck tractor semi-trailers or buses were involved and there were two minor injury accidents and three property damage accidents.

In 2006, 11 accidents occurred along this segment. They resulted in four incapacitating injury accidents and seven minor injury or property damage accidents. Two truck tractor semi-trailers were involved. No buses were involved

In 2007 nine accidents occurred along this segment. They resulted in two incapacitating injuries and the remaining accidents were minor injury or property damage only. Two involved truck tractor semi-trailers and the rest were passenger vehicles, trucks or motorcycles. None involved buses.

In 2008 six accidents excluding this accident occurred. They were all minor injury or property damage, and did not involve truck tractor semi-trailers or buses. (See attachment C TXDOT Accident History for more details)

In summary 43 accidents occurred along this one-mile-long area of highway in the preceding five years and 8 months.

The last recorded accident involving damage to the bridge rail occurred in 2001. In that accident a truck tractor semi-trailer struck the rail. Repair records showed that two 30-foot sections of bridge rail on the north end of the bridge were replaced.

H. GENERAL HIGHWAY DATA AND DESIGN INFORMATION

US 75 in the accident area was functionally classified as a principal urban arterial. The last speed limit sign before the accident location was posted about one mile south of Post Oak Creek. The speed limit was 70 mph daytime and 65 mph nighttime. The design speed for this segment of highway was 65 mph[3]. The interchange for FM 1417 and US 75 was illuminated by overhead interchange lighting. The accident location was not illuminated. Continuous highway safety lighting began about one mile north of the accident location where the roadside environment was more built up with businesses and frequent interchanges.

A speed survey was conducted in the week after the accident. The survey showed that the 85th percentile speed was 72 mph, (See Attachment D for more Details). Skid testing was also performed by TXDOT on August 14th at speeds of 40, 50, and 60 mph on both wet and dry surfaces at the accident site using both a ribbed and smooth tire. The wet pavement testing showed that with a ribbed tire the pavement had skid numbers that ranged in average from 58-51 at speeds of 40-60 mph respectively. With a smooth tire they ranged in average from 44 to 36 at those same speeds. The dry pavement testing was unable to be completed. National Transportation Safety Board (NTSB) testing in the past has shown that typical vehicle tire testing on dry asphalt ranges skid numbers between 70-85 and these numbers are further reduced by 20 percent to account for commercial tire properties. On wet pavement where the water pavement depth exceeds the tread depth at an accident site, ribbed tire wet skid numbers may

[3] Texas Roadway Design Manual specifies a usual radius of 2445 feet for a 65 mph curve with a minimum absolute radius of 1485 feet. The curve preceding the accident area was 2.3 degrees or 2273-foot-radius.

need to be reduced as much as 50 percent to account for the differences in commercial vehicle tires.[4] See the chart below for water flow rates and pavement texture depths.

Bus Accident Test Site on US 75, near Sherman, TX

This is summary of data collected by John Wirth and Juan Gonzalez from the TXDOT Pavement Systems Branch on August 14 and 15 of 2008.

At approximately 2 pm on 8/14/2008, data collection started using TXDOT Skid System 295770H (calibrated at the Central/Western Field Test and Evaluation Center, Texas Transportation Institute, in November 2007). This unit is a locking wheel friction measurement system that gathers data in the left wheel path. Data was gathered using standard TXDOT procedures for both the Smooth and Ribbed tires at 40, 50, and 60 miles per hour. Note that data collection at 60 mph is not standard practice; however, the proper water flow was determined and the data was collected using the other normal standard practices.

The Results from 8/14/08 data collection is presented in the tables below (with water flow):

	Ribbed Tire				Smooth Tire		
40 MPH	**DMI_1**	**DMI_2**	**Skid#**	**40 MPH**	**DMI_1**	**DMI_2**	**Skid#**
	0.0002	0.0481	55		0.0004	0.0519	45
	0.1058	0.1444	60		0.1061	0.1457	43
	0.2054	0.2458	60		0.2059	0.2454	44
	0.3058	0.3469	58		0.3060	0.3521	47
	0.4061	0.4470	58		0.4060	0.4462	44
		Average	**58.2**			**Average**	**44.6**

	Ribbed Tire				Smooth Tire		
50 MPH	**DMI_1**	**DMI_2**	**Skid#**	**50 MPH**	**DMI_1**	**DMI_2**	**Skid#**
	0.0000	0.0529	54		0.0000	0.0516	34
	0.1071	0.1543	53		0.1067	0.1526	30
	0.2072	0.2556	54		0.2072	0.2545	43
	0.3071	0.3526	57		0.3071	0.3519	47
	0.3698	0.4169	55		0.4070	0.4535	42
		Average	**54.6**			**Average**	**39.2**

	Ribbed Tire				Smooth Tire		
60 MPH	**DMI_1**	**DMI_2**	**Skid#**	**60 MPH**	**DMI_1**	**DMI_2**	**Skid#**
	0.0002	0.0640	47		0.0005	0.0616	32
	0.1086	0.1637	51		0.1093	0.1659	33
	0.2086	0.2672	51		0.2088	0.2583	35
	0.3086	0.3654	54		0.3088	0.3630	43
	0.4086	0.4670	54		0.4088	0.4661	37
		Average	**51.4**			**Average**	**36.0**

[4] See NTSB Highway Accident Report Hewitt, Texas 2003

Profile Depth (MPD) of .070 inch (1.778 mm) through the specified test section (208 +.570 to 208 +.196).

On 8/15/2008 the area had received rain over night, which was continuing in the morning. The rain did stop at approximately 9:45 am and Dry Skid testing was attempted starting at approximately 11:20 am. After 4 attempted passes at 60 mph and slower speeds, data collection was aborted as the dry skid numbers were off the chart (above 99). Also the tire was smoking and leaving visible skid marks on the roadway, which can influence the accuracy of measurements at this level. To enable TXDOT data collection at these high levels requires a modification to the TXDOT data collection software. Since Dry Skid Testing is not normal for TXDOT data collection and skid numbers above 99 creates concerns about validity.

Before leaving the Sherman Area Office, the skid truck was prepared for normal skid testing. While returning to Austin, data was collected normally to check out the Skid System and all systems appeared to operate normally. On 8/18/2008 the operation of the Skid System was again verified, using the local verification test section and appears to be functioning properly.

I. ROADWAY GEOMETRY

About ½ mile south of the accident site a curved right descent began; the design plan profile showed the roadway had a 3.75 percent downgrade for 1600 feet in a 2.3 degree curve to the right that was 1,389 feet long. Next, the roadway became tangent or straight for a short distance and then a 1.5-degree, left-hand curve, 768-foot-long began (see Figure 1).

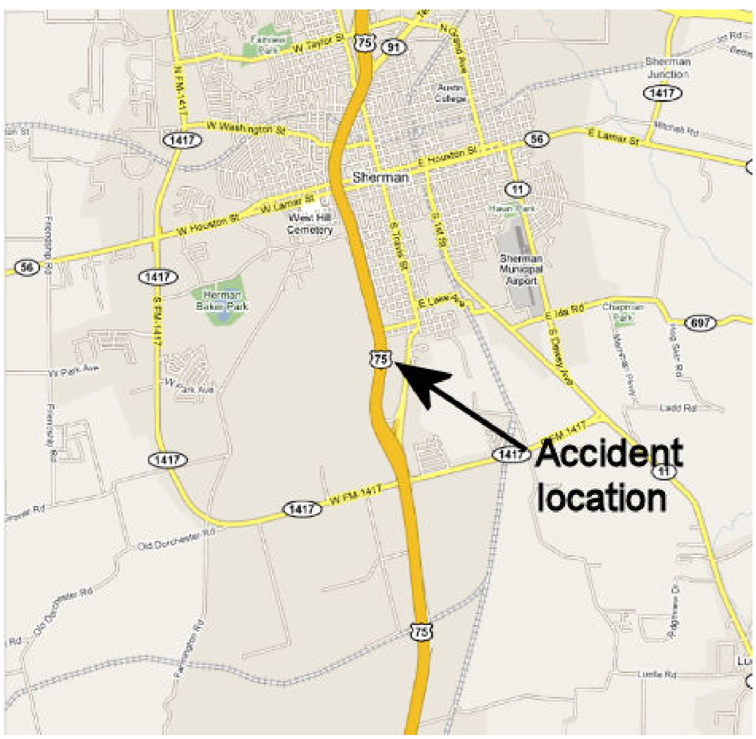

Figure 1 - Accident location

The south approach end of the bridge was equipped with a 27-inch-high metal beam guard fence (MBGF) that had a guard rail extruder terminal (GET) safety end treatment. The total length of the guard rail was 279 feet long. The safety end treatment was 47 feet long followed by a 180-foot-long main element. Next there was a 25-foot-long transition area into the bridge end followed by a 27-foot-long turned down end piece that was anchored into the bridge rail curb. The safety end treatment area of the guard rail had blocked wooden blocks for support and the main element had 28 blocked metal posts spaced at 6-foot-six-inch intervals. The transition area into the bridge end had eight metal blocked posts at 3-foot, 1.5-inch intervals to stiffen the barrier in case of impact close to the bridge. There were scrapes and gouges on the main element of the rail indicating previous impacts and one impact area on the transition section of the rail.

SCENE DOCUMENTATION

Following the collision, the accident scene and related physical evidence was examined and evaluated by members of the Sherman, TX Police Department (SPD). Using a total station, the accident scene was documented by the SPD, and the SPD was contacted and a request was made for the data obtained during their mapping of the accident scene, see Figure 2. Based on data obtained from the Engine Control Module (ECM) in the Vehicle Group Chairman's report the relative time and distance from the beginning of the tire mark to the impact with the bridge rail was determined, see Figure 3.

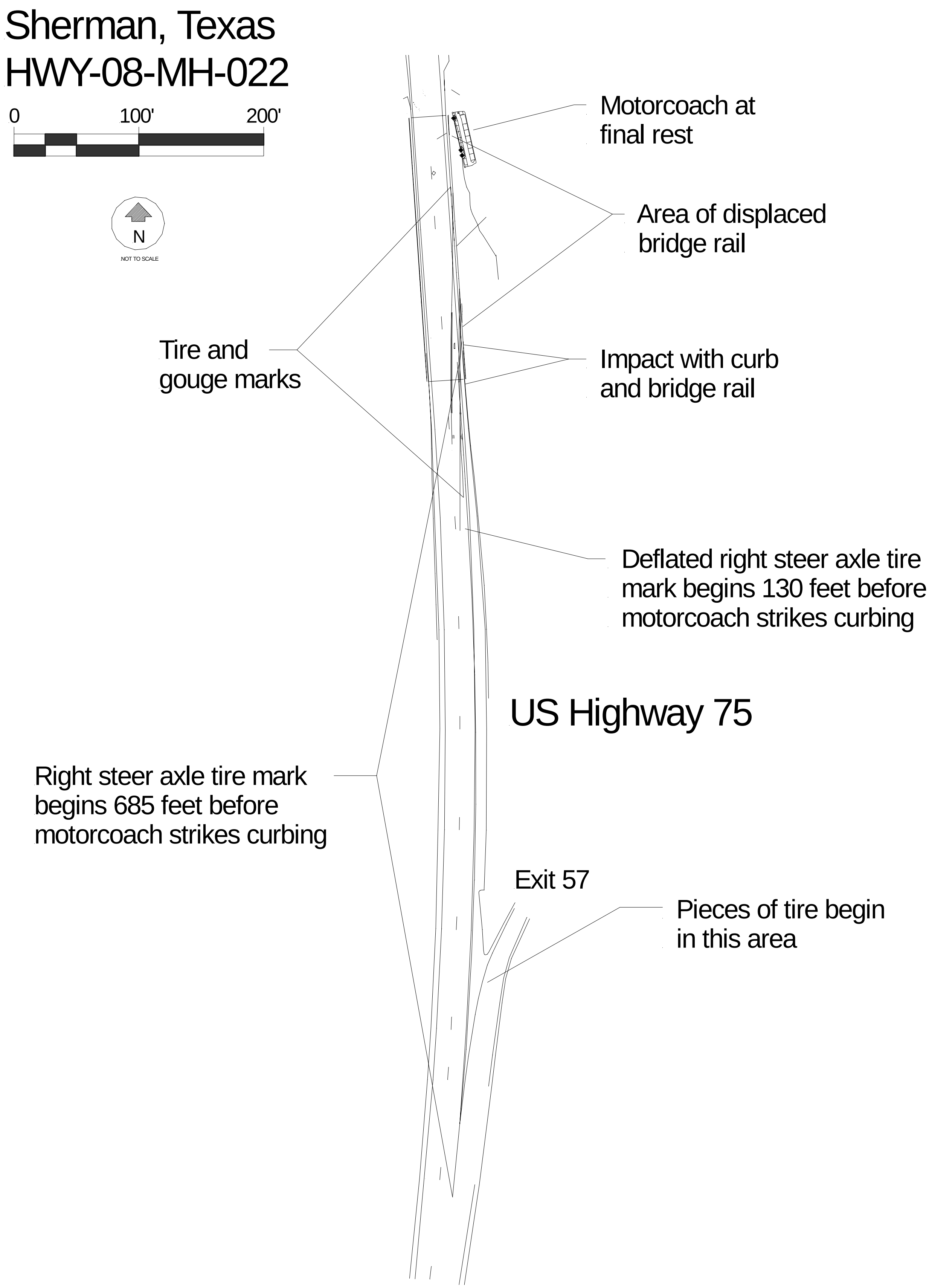

Figure 2 - Map of Accident Scene

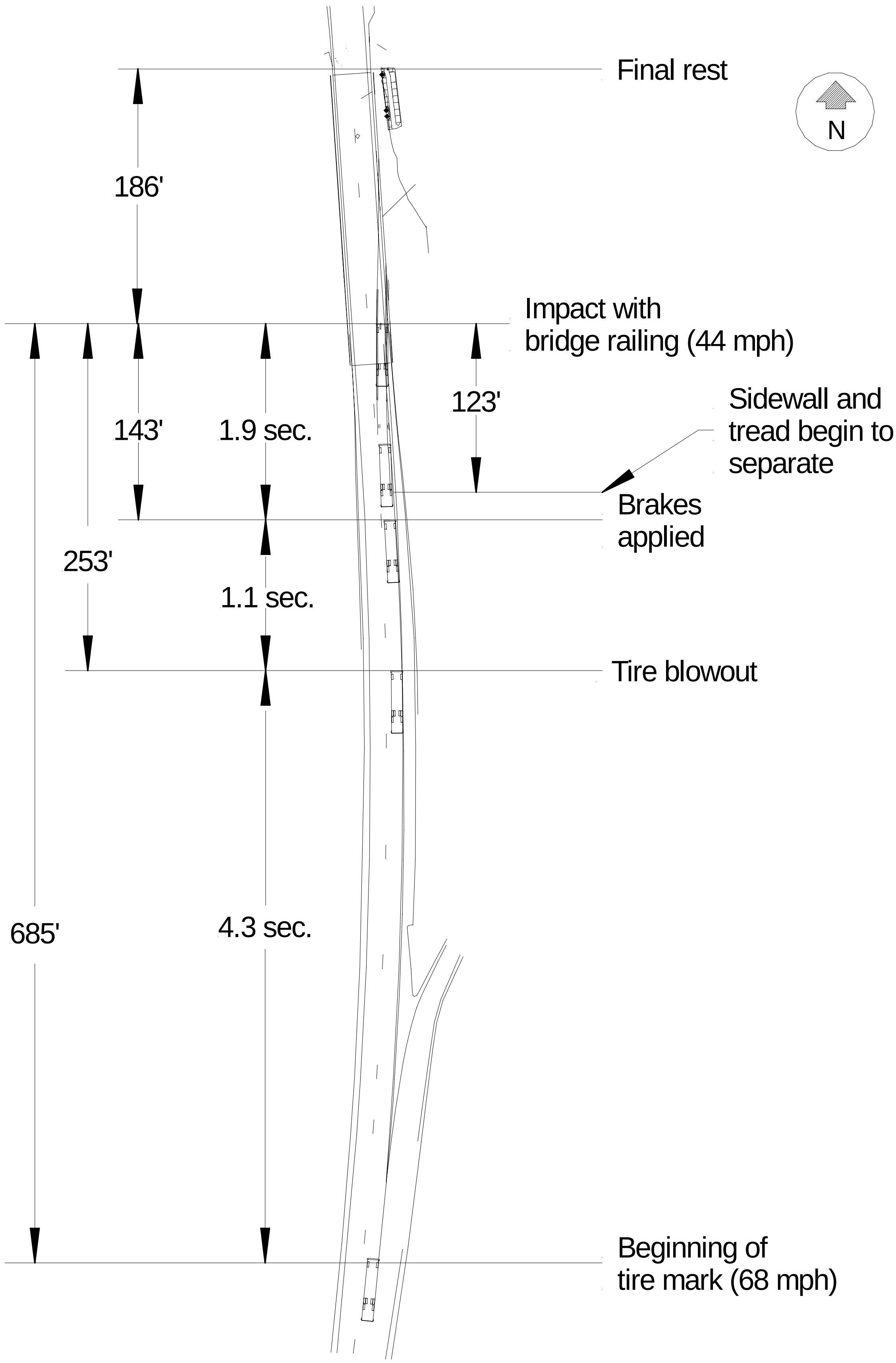

Figure 3 - Time and Distance to Impact with Bridge Rail

K. BRIDGE RAIL DESIGN

Design sheets from TXDOT showed the bridge rail was a Type II rail designed in 1954 according to the 1953 American Association of State Transportation Officials (AASHTO) Bridge Specifications manual. Other manuals used to evaluate the bridge rail design were the TXDOT Bridge Railing Manual (available at http://onlinemanuals.txdot.gov/txdotmanuals/rlg/index.htm), (See Attachment J) the 2006 edition of the AASHTO Roadside Design Guide (See Attachment I), Guidance memorandums from the Federal Highway Administration (FHWA), the 1989 AASHTO Guide Specifications for Bridge Rails, (See Attachment A). The AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications (See Attachment G), the 2007 bridge inspection of the bridge over Post Oak Creek (Attachment F), and the National Cooperative Highway Research Program Report (NCHRP 350), (See Attachment K).

Field measurements showed the concrete curb was 18 inches wide and 7 inches high above the bridge deck. The 12-inch-wide, ¼-inch thick rail was 23 ¾-24 inches above the curb height. The back of the rail was connected to the curb with 36-inch-long by 5-inch wide steel I-beams that were bolted to the rail with 4 bolts. There were 5 I-beam supports on each 30-foot section of rail. The I-beams were secured by 7/8-inch by 18-inch long bolts that were cast into place in the curb during the 1958 construction project. There were 7, 30-foot long sections to the rail that had a nominal one-inch space between rail elements for expansion, (See Attachment A sheets 116 and 117 Federal Aid Project No F539 (18) 4U539 (19) dated 1/6/1958 fore more details).

The 2006 Roadside Design Guide (RDG) indicated that bridge rail designs that pre dated 1964 typically are considered substandard in that they have not been crash tested in accordance with either National Cooperative Highway Research Project Report (NCHRP) 230 or 350. The RDG and guidance from FHWA enumerated below indicate that bridge rails along the NHS must be crash tested in accordance with NCHRP 350. The 2006 RDG also states, “Although objective warrants for the use of higher performance barriers do not presently exist, subjective factors most often considered for new construction or safety upgrading include:

High percentage of heavy vehicles in traffic stream
Adverse Geometries, such as sharp curvature, which are often combined with poor sight distance, and
Severe consequences associated with of a barrier by a large truck

FHWA requirements for new construction are summarized on their website http://safety.fhwa.dot.gov/roadway_dept/road_hardware/bridgerailings.htm
where it notes “Since August 28, 1986, the FHWA has required that bridge railings used on Federal-aid projects meet full-scale crash-test criteria.”[5]

[5] See Table G2.7.1.3.2 in 1989 AASHTO Guide Specifications for Bridge Railing, to estimate the appropriate performance level for Bridge Railing.

In an FHWA policy memo “Identifying Acceptable Highway Features” dated July 25, 1997, which may be found at http://safety.fhwa.dot.gov/roadway_dept/docs/accept.pdf (See attachment A), it is stated that “all new or replacement safety features on the NHS covered by the guidelines in the NCHRP Report 350 that are advertised for bids… on or after October 1, 1998, are to have been tested and evaluated and found acceptable in accordance with the guidelines in the NCHRP Report 35.”

Both requirements clearly state that the requirement is limited to the construction of new bridges and/or new bridge railings.

That same memorandum also states “The FHWA does not intend that this requirement (that new highway safety features installed on the NHS be proven crash worthy in accordance with the guidelines in the NCHRP Report 350) result in the replacement or upgrading of any existing installed features beyond what would normally occur with planned highway improvements. On the other hand, a State should have a rational, documented policy for determining when an existing non-standard feature should be upgraded.” Texas does have a policy of upgrading bridge railing outside of planned rehabilitation projects. District engineers may seek bridge maintenance funds to perform bridge railing upgrades.

Finally, the Bridge Rehabilitation and Replacement program, 23CFR650.405 states:

“(2) *Rehabilitation* The project requirements necessary to perform the major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects are eligible except as noted under ineligible work. Bridges to be rehabilitated both on or off the F-A System shall, as a minimum, conform with the provisions of 23 CFR part 625, Design Standards for Federal-aid Highways, for the class of highway on which the bridge is a part.”

(FHWA interpretation) this means that if any Bridge Rehab funds were used on this structure then the safety appurtenances, including the parapets and approach guardrail, were to have been upgraded.

Engineers from the TXDOT bridge division indicated that this rail had never been crash tested and does not meet present day standards. Additionally, the 2007 Bridge inspection report for this structure shows that the rails are substandard and the transition from guardrail to bridge rail was substandard. TXDOT engineers also use the 2008 Manual for Assessment of Safety Hardware (MASH) which has not yet been published by AASHTO. This reference may be published in 2009.

On June 15, 2009, TXDOT indicated that a construction project had been let to upgrade the bridge railing on the Post Oak Creek Bridge and several other bridges on US 75. The bridge railing selected was TL-4 railing.

In 1989 AASHTO published the Guide Specifications for Bridge Railings (GSBR) as a supplement to the fourteenth edition of the AASHTO Standard Specifications for Highway Bridges. The guide has suggested performance levels of PL-1, PL2, and Pl-3 that vary according to the approach geometry, design speed, average daily traffic, percent trucks, accident history, height of bridge, encroachment frequency, angle, speeds, and severity. The guide shows examples of defaults used with a Benefit Cost Analysis Program (BCAP) to select different performance level barriers based of the foregoing criteria

The AASHTO 2007 LRFD Bridge Design Specifications provide further guidance on the selection of bridge railing to protect users of highway bridges,(See Section 13 LRFD).

The GSBR was the only document found that provided detailed guidance on selection procedures.

The 2006 TXDOT Bridge Rail Manual recommends that designers on retrofit and rehabilitation bridge projects consider the following elements of location when selecting a design:

1. Bridge height above terrain or waterway
2. Approach roadway alignment and grade
3. Average daily traffic of nearby roads
4. Average daily traffic, design speed and percent of trucks on bridge
5. Accident History

However, at present time there are no published warrants that dictate or recommend when a higher performance barrier, such as, the TL-4, TL-5, or TL-6 shall or should be used. But, TXDOT recently identified a need for a research project with the Texas Transportation Institute at Texas A&M University to establish criteria and warrants for the installation of high-performance barrier. This is a barrier that typically conforms to test levels 4-6 in NCHRP 350. However, at present time Texas feels that action is needed at the national level to identify warrants for higher performing barrier selection. For instance, in this crash the accident bus had a gross vehicle weight rating of 54,000 pounds. To safely re-direct the bus in accordance with the specifications in NCHRP 350 the barrier would have to be tested to test level 5, which is typically a reinforced 42-inch high or higher concrete barrier. However, test levels 4-6 in NCHRP 350 and MASH do not require that the test vehicle remain upright during the test, allowing a quarter roll, which may increase occupant risk.

Research activities as part of National Cooperative Research Report (NCHRP) 22-12(2) at the University of Nebraska investigated developing warrants for when to use higher performance roadside safety hardware, but did not include bridge rails. This research work was recently published in NCHRP Report 638, “Guidelines for Guardrail Implementation”. TXDOT sees a need for a similar research effort for bridge rails at the national level.

Additionally, TXDOT provided the number of bridges in Texas that are estimated to have superseded bridge rail. Texas has a total of 33,081 bridges on the state highway system, which includes Interstate, US Highways, State Highways, and the Farm-to-Market road system. Texas has 17,448 bridges on its city streets and county roads for a total of 50,529 bridges statewide. There are 15,235 bridges on the state system that were built before 1964. There are 4,185 bridges off the state system that were built before 1964 for a total of 19,420 bridges built before 1964. Bridges on the state system that are coded with superseded guard rail total 14,854 bridges, and bridges on the off state system that are coded with superceded bridge rail total 12,546 bridges for a total of 27,400 bridges in Texas that are coded as having superceded bridge rail.

BRIDGE RAILS ON THE NATIONAL HIGHWAY SYSTEM

Traffic safety features of bridge rails, guardrail and their end treatments, and transitions from approach rails to bridge rails on the NHS are evaluated by the following FHWA guidelines;

Item 36 - Traffic Safety Features 4 digits

Bridge inspection shall include the recording of information on the following traffic safety features so that the evaluation of their adequacy can be made.

(A) Bridge railings: Some factors that affect the proper functioning of bridge railing are height, material, strength, and geometric features. Railings must be capable of smoothly redirecting an impacting vehicle. Bridge railings should be evaluated using the current AASHTO Standard Specifications for Highway Bridges, which calls for railings to meet specific geometric criteria and to resist specified static loads without exceeding the allowable stresses in their elements. Bridge railing should be crash tested per FHWA policy. Railings that meet these criteria and loading conditions are considered acceptable. Other railings that have been successfully crash tested are considered acceptable even though they may not meet the static loading analysis and geometric requirements. Acceptable guidelines for bridge railing design and testing are also found in the AASHTO Guide Specifications for Bridge Railings 1989. Additional guidance for testing is found in National Cooperative Highway Research Program - Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features 1993.

(B) Transitions: The transition from approach guardrail to bridge railing requires that the approach guardrail be firmly attached to the bridge railing. It also requires that the approach guardrail be gradually stiffened as it comes closer to the bridge railing. The ends of curbs and safety walks need to be gradually tapered out or shielded.

(C) Approach guardrail: The structural adequacy and compatibility of approach guardrail with transition designs should be determined. Rarely does the need for a barrier stop at the end of a bridge. Thus, an approach guardrail with adequate length and structural qualities to shield motorists from the hazards at the bridge site needs to be installed. In addition to being capable of safely redirecting an impacting vehicle, the approach guardrail must also facilitate a transition to the bridge railing that will not cause snagging or pocketing of an impacting vehicle. Acceptable guardrail design suggestions are contained in the AASHTO Roadside Design Guide and subsequent FHWA or AASHTO guidelines.

(D) Approach guardrail ends: As with guardrail ends in general, the ends of approach guardrails to bridges should be flared, buried, made breakaway, or shielded. Design treatment of guardrail ends is given in the AASHTO Roadside Design Guide.

The data collected shall apply only to the route on the bridge. Collision damage or deterioration of the elements are not considered when coding this item. Traffic safety features is a 4-digit code composed of 4 segments.

Segment	Description	Length
36A	Bridge railings	1 digit
36B	Transitions	1 digit
36C	Approach guardrail	1 digit
36D	Approach guardrail ends	1 digit

The reporting of these features shall be as follows:

Code	Description
0	Inspected feature does not meet currently acceptable standards or a safety feature is required and none is provided.*
1	Inspected feature meets currently acceptable standards.*
N	Not applicable or a safety feature is not required.*

* For structures on the NHS, national standards are set by regulation. For those not on the NHS, it shall be the responsibility of the highway agency (state, county, local or federal) to set standards.

FHWA counts from 12/31/2007 showed that there were 116,144 bridges on the NHS. There were 29,579 bridges with bridge rails that do not meet current standards. There were 37,105 bridges that had transitions that did not meet current standards, there were 20,990 bridges that had guardrails not meeting current standards, and there were 27, 142 bridges that had end treatments on their approach guardrails that did not meet current standards. (See Attachment E for Specific Statistics)

Total counts for bridges in the United States on the Non-NHS roads follow:

Total Number of Bridges	483,621
Bridges with substandard rails	257,890
Bridges with substandard transitions	277,548
Bridges with substandard approach guardrails	254,805
Bridges with substandard end treatments on guardrails	275,325

When these subtotals are added it shows that there are 599,765 bridges in the United States and nearly half of all bridges do not meet current safety design standards on their bridge rails, transitions, approach guardrails, or approach guardrail end-treatments. But these totals include all of the county and municipal bridges.

L. BRIDGE DAMAGE DESCRIPTION

Tire marks from the failed right front tire of the motorcoach began about 85 feet south of the bridge in the right hand lane and continued approximately 130 feet to where the bus tire mounted the curb and impacted the bridge rail at about a 3 degree angle. The curb impact was about 29 feet north of the south deck expansion joint. The first impact on the rail occurred about midway along the second 30-foot section of rail or about 47 feet from the beginning of the northbound bridge rail. This was evident from the tire marks and the paint transfers on the rail. Next, the bus bowed in the second section of rail about 32 inches and struck the leading edge of the 3rd rail section at the expansion space. The bolts at the bottom of the I-beam sheared away and the 3rd rail section came to rest 25 feet below in the waters of Post Oak Creek. All metal connections were examined and no corrosion was found. All of the bolts sheared away from ductile overstress. On the first support of rail section 4 the support was bent inward 3 inches at a point 17 ½ inches from the top of the rail. This section was found in two pieces. The first part was found on the north creek bank and the second part was found in the roadway. The first part was 14-feet-long and had three I-beams attached to it. The second part was 17 feet 8 inches long and had no I-beams attached to it.

This section of rail was bowed nearly double along a 32-inch-long section at the beginning of the rail. The second I-beam on this rail has a 3 ½-inch-long by 2 ½-inch-wide tire rubber smear at the top of the I-beam flush against the bottom of the rail. About two foot south of the third I-beam on this rail there was an impact gouge in the rail.

Bridge rail section five was found in two pieces. The first part was 16 feet 6 inches long. It had a 4-inch-long tear in the leading edge of the rail. Also it was bent double at a point 5 feet six inches from the trailing edge. The second piece of section five was connected to section six. Both of these pieces were bent double at numerous locations. They were found forward and to the right of where the bus came to rest.

Section seven was in two pieces. The second piece remained on the bridge. It was 16 feet 3 inches long and had three I-beams attached to it. The second piece was 17 feet 10 inches long, including a spice plate. It also had a three foot-section that was bent double. In all, 136 feet of bridge rail was displaced from the deck.

M. Bridge Inspection Record

The last bridge inspection was performed on Bridge 132 or Post Oak Creek Bridge on June 10, 2007 by Barnhardt Engineering in subcontract to Maverick Engineering. The Professional Engineer noted in Reference Feature item 3 (Roadway Other) that the repairs to the bridge railing on the north end of the span were marginal. The marginal repair referred to was a 12-inch X 24-inch X ¼-inch thick steel plate bolted to the curb and welded to the C-channel support in an effort to equal the original tension of the cast in-place 18-inch long bolts that had to be screwed into the concrete during repair. The Professional Engineer gave them a condition rating of 5 or fair, and recommended that the railing be retrofitted, possibly as part of a bridge-widening project.

N. Corridor Improvement

TXDOT has identified a need for a corridor improvement on U.S. Highway 75 along a 3.5-mile section from FM 1417 north to Travis Street. The improvement plans to add additional main lanes, widen existing lanes, improve alignment, and replace 21 bridges that are eligible for replacement. The cost for the improvement is approximately 125 million dollars and has not been funded. Planned funds have already been committed up through the year 2012 by TXDOT. So this corridor will have to be funded at some point in the future.

O. Additional Research

Bridge Rail Policies in the states bridge design manuals that were available on the internet were examined to determine what warrants or design guidelines for high performance bridge rails some states had developed. All states are required to use at least TL-3 barriers on new construction and rehabilitation projects on NHS. The manuals in twenty-two states were not available on the internet or did not contain sufficient detail to determine the policy. Eleven states required TL-4 barriers on the NHS. Three states indicated all designs followed current AASHTO Policy or were approved by the state bridge engineer. Seven states including Arizona, Iowa, Maine, Massachusetts, New York, Oregon, and Pennsylvania either had a requirement for TL-5 barriers on interstate highways or very specific guidance on when to select TL-5 barriers. For example the Maine bridge design manual had a calculation procedure used to determine when TL-5 barriers were warranted. This calculation procedure was very similar to the procedures recommended in the 1989 AASHTO Guide Specifications for Bridge Railings (GSBR). Except, that in the Maine procedure the manual does not specify that the designer may limit the construction year ADT or (ADTCY) to 10,000 Vehicles per Day per lane (VPD).

The following data and environment existed for the Post Oak Creek Bridge in Sherman:

1. Northbound ADT on four-lane divided highway with two lanes on each parallel bridge = 21000 VPD
2. Shoulder width less than 3 feet
3. ADT adjusted for level approach on 1.5 degree curve with structure height less than the 35-foot level assumed with no deep water or traffic lane beneath bridge, and no built-up area beneath bridge = 14,700
4. Heavy Truck and Bus ADT = 16 percent
5. Design Speed = 70 mph (72 mph = 85th percentile)

In the table below from the Maine Bridge Design Manual it can be seen that these conditions would warrant the installation of a TL-4 level bridge railing if complete bridge reconstruction were to occur at this location. However, a TL-5 selection could be warranted given the two commercial vehicle penetrations through the rail in the preceding 7 years, but there are no clear guidance policies on the number or severity of accidents that would have to occur before a TL-5 barrier would be selected.

Design Speed (mph)	Percent Trucks	Shoulder Width (ft)	Adjusted ADT for which a TL-4 or TL-5 is required					
			Divided or 5 + lanes		Undivided 4 lanes or less		One Way	
			TL-4	TL-5	TL-4	TL-5	TL-4	TL-5
60	0	0-3	3200	***	2000	***	1600	***
		3-7	3600	***	2300	***	1800	***
		7-12	4400	***	2900	***	2200	***
	5	0-3	3000	107300	1900	70300	1500	53700
		3-7	3300	126300	2100	82800	1700	63200
		7-12	4100	158400	2700	105600	2100	79200
	10	0-3	2800	39600	1800	25000	1400	19800
		3-7	3100	47500	2000	29300	1600	23800
		7-12	3900	53100	2500	33700	2000	26600
	15	0-3	2700	24300	1700	15200	1400	12200
		3-7	2900	29300	1900	17800	1500	14700
		7-12	3700	31900	2400	20000	1900	16000
	20	0-3	2500	17500	1600	10900	1300	8800
		3-7	2800	21100	1800	12800	1400	10600
		7-12	3500	22800	2200	14300	1800	11400
70	0	0-3	2200	191400	1300	165000	1100	95700
		3-7	2400	379100	1500	301500	1200	189600
		7-12	2800	***	1700	402400	1400	256400
	5	0-3	2100	63100	1300	42200	1100	31600
		3-7	2300	80000	1400	51600	1200	40000
		7-12	2700	96400	1600	64000	1400	48200
	10	0-3	2000	32100	1200	20000	1000	16100
		3-7	2300	38500	1400	22900	1200	19300
		7-12	2600	42200	1600	26700	1300	21100
	15	0-3	2000	21500	1200	13100	1000	10800
		3-7	2200	25300	1300	14700	1100	12700
		7-12	2600	27000	1600	16900	1300	13500
	20	0-3	1900	16200	1200	9700	1000	8100
		3-7	2100	18900	1300	10800	1100	9500
		7-12	2500	19900	1500	12300	1300	10000

//END of REPORT//