VEHICLE FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

Bridge Collapse
Mount Vernon, WA; 05/23/2013

HWY13MH012

(23 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C. 20594

A. ACCIDENT

LOCATION:	Interstate 5 at Milepost 228.25 over the Skagit River, in Mount Vernon, Skagit County, Washington.
VEHICLE 1:	2010 Kenworth Truck Tractor and 1997 Aspen Flatbed Semitrailer, Hauling an Oversize Load
OPERATOR:	Mullen Trucking LP, Aldersyde, Alberta, Canada
VEHICLE 2:	1997 Dodge Ram Pickup Truck, Piloting the Oversize Load
OPERATOR:	G&T Crawlers, Olympia, Washington
VEHICLE 3:	2000 Kenworth Truck Tractor and 1996 Utility Refrigerated Semitrailer
OPERATOR:	Motorways Transport LTD, Surrey, British Columbia, Canada
VEHICLE 4:	2010 Dodge Ram Pickup Truck and 2009 Jayco Travel Trailer
OPERATOR:	Private owner
VEHICLE 5:	2013 Subaru VX Crosstrek
OPERATOR:	Private owner
VEHICLE 6:	1995 BMW 525i
OPERATOR:	Private owner
DATE:	May 23, 2013
TIME:	Approximately 7:05 p.m. PDT
FATAL:	0
INJURIED:	3 minor, 5 uninjured
NTSB #:	**HWY13MH012**

B. VEHICLE FACTORS GROUP

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C. ACCIDENT SUMMARY

For a summary of the accident, refer to the *Accident Summary* report, which is available in the docket for this investigation.

D. DETAILS OF INVESTIGATION

The Vehicle Factors Group Chairman's Factual Report is a collection of factual information regarding the vehicles involved in this accident. This report focuses on details obtained during the inspection of the oversize 2010 Kenworth truck tractor and trailer combination unit which impacted the bridge (accident combination unit) as well as the pilot car that was leading the oversize load. Following the initial on-scene phase of the investigation, another commercial truck tractor and trailer combination unit was identified as being involved in the accident, general information about that vehicle, as well as general information about the passenger vehicles involved in this accident, is also included in this report.

The Washington State Patrol (WSP) conducted an initial inspection of the accident combination unit on the night of the accident while it was still located just south of the bridge.[1] The accident combination unit remained secured onsite by the WSP until it was then driven to a secure location in Mount Vernon, Washington on May 24, 2013 where it was inspected by the NTSB until it was released back to Mullen Trucking on May 31, 2013.

During the inspection of the accident combination unit all major mechanical systems were examined, including steering, braking, and suspension systems. The overall accident damage was documented, as well as any damage or anomalies within the major vehicle mechanical systems. Supporting photographs, vehicle specifications, maintenance records, and prior annual inspection reports were collected and will be referred to throughout this report.

[1] See Vehicle Attachment 1 – Washington State Patrol Post-Crash Driver/Vehicle Examination Report for the 2010 Kenworth Combination Unit

E. VEHICLE INSPECTION

1. VEHICLE 1: 2010 Kenworth Truck Tractor and 1997 Aspen Flatbed Semitrailer Hauling an Oversize Load

1.1 GENERAL INFORMATION

TRUCK TRACTOR:[2]
Make/Model: Kenworth T800B
VIN: [3] 1XKDDB0X4AJ**xxxxxx**
Company Unit #: 270

Date of Manufacture:	March 2009
GVWR:[4]	62,000 lbs
GAWR (front axle):[5]	16,000 lbs
GAWR (second axle):	23,000 lbs
GAWR (third axle):	23,000 lbs
Engine:	Caterpillar C15 Acert
Transmission:	Fuller 18-Speed Manual

SEMITRAILER:[6]
Make/Model: Aspen SD40-3TR
(3-axle, expandable length trailer, with the locking pins engaged in the fully expanded position)
VIN: 2A9PF4033VN1**xxxxxx**
Company Unit #: 48TX07

Date of Manufacture:	July 1997
GVWR:	98,636 lbs
GAWR (per axle):	20,062 lbs

LOAD:[7]
Make/Model: Thunder & Lightening Welding LTD, Interior Casing Shed
(Built for Alaskan drilling operators to house threaded pipes)

Overall length:	60 feet
Overall width:	11feet 6 inches
Overall height:	12 feet 3 inches
Overall weight:	44,000 lbs

[2] See Vehicle Attachment 2 – 2010 Kenworth Truck Tractor Specifications
[3] Vehicle Identification Number (VIN), the last 6 digits of all VINs are redacted in this report
[4] Gross Vehicle Weight Rating (GVWR) is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself plus fuel, passengers, and cargo
[5] Gross Axle Weight Rating (GAWR) is the maximum distributed weight that a given axle is designed to support
[6] See Vehicle Attachment 3 – Aspen Semitrailer Specifications
[7] See Vehicle Attachment 4 – Casing Shed Specifications

1.2 DAMAGE DESCRIPTION

In the descriptions that follow the left side is oriented to the driver's side of the combination unit. Axles are ordered sequentially from front to back with axles 1 through 3 located on the truck tractor and axles 4 through 6 located on the trailer.

The accident combination unit consisted of a commercial truck tractor in combination with expandable length trailer carrying a casing shed, and was signed as an oversize load.[8] The casing shed was a rectangular, heavy steel box structure with the left and right sides open, intended for use as a portion of a modular shelter used in oil field work. The accident combination unit sustained damage to the upper right front corner of the casing shed (the load). There were also scratches and dents present along the entire length of the right top edge of the load.[9] There were also a set of scratches noted on the upper left front side of the load.[10]

The overall frame of the load was distorted rearward, most noticeably at its corners where slight buckling was observed. The chain at the right front lower corner and a 4-inch webbed tie down that was across the lower forward section of the load were both found broken loose after the accident.[11] Chain links and sections of the webbed tie down were found on the bridge deck south of the collapsed section.[12] Induced damage was present at the rear inside top corners as a result of the bending and distortion of the load's frame. The load was found shifted to the left on the trailer surface, at the front of the trailer, but did not appear to have shifted to the rear.[13] Minor leftward shifting of the trailer frame rails relative to its suspension was also noted.

The truck tractor showed no signs of damage as a result of the accident. The engine and electrical systems remained intact and functional. The air system for the brakes and suspension for both the truck and the trailer also remained intact and functional.

The tires on all 6 axles of the accident combination unit remained inflated. There were minor cuts noted on the outside sidewalls of the outside tires on both sides of axle 4. Tire contact marks were observed inside the top of the wheel wells on axles 4, 5, and 6, with more dark and obvious marks on the left side of the trailer than on the right side of the trailer.[14]

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[8] See Vehicle Photo 1 – 2010 Kenworth combination unit, oversize load
[9] See Vehicle Photo 2 – Damage to the upper right front corner and along the right top edge of the oversize load
[10] See Vehicle Photo 3 – Damage to the upper left front side of the oversize load
[11] See Vehicle Photos 4 and 5 – Broken chain at the right front corner of the oversize load, and broken tie down across the lower forward section of the oversize load
[12] See Vehicle Photo 6 – Chain links and sections of the webbed tie down found on the bridge deck, south of the collapsed section of the bridge
[13] See Vehicle Photo 7 – Lower right edge of the oversize load, showing the leftward shift toward the front of the trailer
[14] See Vehicle Photo 8 – Tire contact marks inside of the wheel well on the left side of axle 4 of the oversize load

1.3 WEIGHTS AND MEASUREMENTS

1.3.1 Accident Combination Unit

The WSP weighed the accident combination unit using certified portable scales on the night of the accident while it was still on scene at the south side of the bridge. This location was at a slight downgrade. **Table 1** contains the axle weights that were measured.

Table 1: Accident Combination Unit Weight

	Axle	Weight (lbs)	
		Left	Right
Truck	1	7,000	7,500
	2	7,400	8,100
	3	7,600	7,800
Trailer	4	7,000	7,500
	5	6,700	7,600
	6	7,100	7,400
Total Weight: 88,700 lbs			

Once the accident combination unit was moved to the inspection site, it was placed on a level surface. The WSP and NTSB collected height measurements taken at the four top corners of the load using a height stick and metal tape measure. Since the height stick was only 15 feet long, the metal tape measure was used to measure the additional distance from the bottom of the height stick to the ground. **Table 2** contains the measurements at the top four corners of the accident load. Since these measurements were taken after the accident, with the load damaged and distorted, the measurements do not reflect exact pre-crash conditions.

Table 2: Accident Combination Unit – Load Height Measurements

	Left	Right
Front	15' 10 $^{7}/_{8}$"	15' 11 $^{1}/_{16}$"
Rear	15' 6 $^{13}/_{16}$"	15' 5 $^{5}/_{8}$"

As a result of the damage and distortion to the load, wood shims were replaced between the bed of the trailer and the bottom of the load to help steady it for transport post-accident. These wood shims are used to steady the load left-to-right of a center pivot pin connection that is located at the rear of the trailer. The post-accident replacement wood shims were measured to be 1 ½ inches thick on the left and ¾ inch thick on the right, and were in place only at the rear of the trailer. The height at the back of the trailer, from the ground up to the bottom of the load, was measured to be about 43 inches including the wood shims. It is not known what exact shimming was in place prior to the accident, but it would have only been in place at the rear of the trailer.

Additional measurements were taken of the accident combination unit. **Figure 1** depicts left side and rear dimensions of the accident combination unit as it was documented during the post-crash inspection. Additional dimensions and documentation of the accident combination unit are contained in the *Technical Reconstruction Group Chairman's Factual Report*, which can be found in the docket for this investigation.

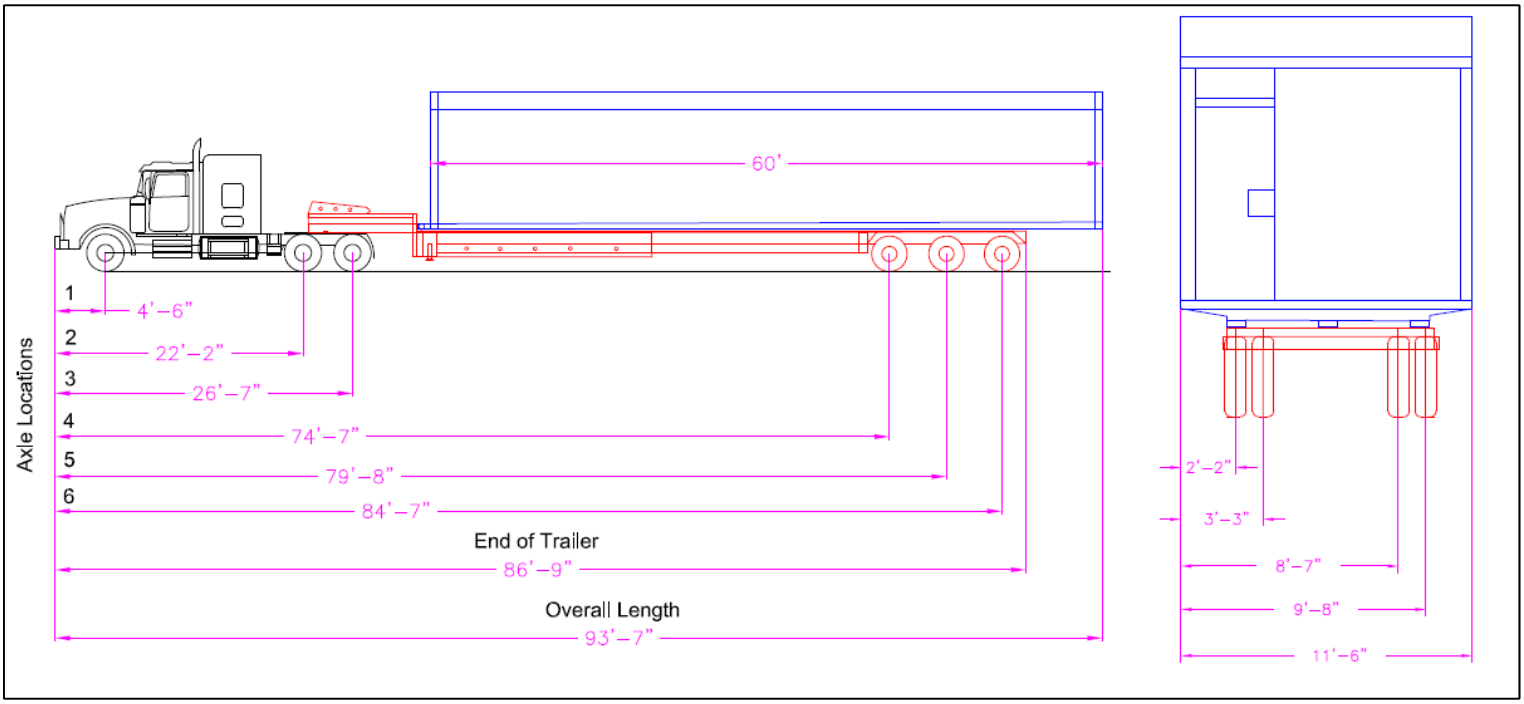

Figure 1. Diagram of the 2010 Kenworth combination unit, showing left side and rear dimensions

1.3.1.1 OVERSIZE LOAD Permit

Due to the size of the accident combination unit, Mullen Trucking was required to obtain various permits along its intended route.[15] In Washington State, permits are required for vehicles exceeding 14 feet in height, 8 feet 6 inches in width, and for trailers exceeding 53 in length.[16] At nearly 16 feet tall and 11 feet 6 inches wide, and with a trailer 70 feet 11 inches long, the accident combination unit required a permit for its height, width, and length. Permits are also required for rear overhangs (the distance from the center of the rear axle to the rearmost point on the trailer or load) exceeding 15 feet. The accident combination unit had a rear overhang of approximately 9 feet, and did not require a permit for its rear overhang.

The maximum gross vehicle weight limit in Washington State is 105,500 lbs; however the weight limit of a given vehicle is also dictated by its tire size, axle weight, and axle spacing.

[15] More information about the route and permitting process is contained in the Motor Carrier Group Chairman's Factual Report, which can be found in the docket for this investigation

[16] According to the 2012 - 2013Washington State Commercial Vehicle Guide, M 30-39.03, chapter 4

According to these items, the weight limit for the accident combination unit was 95,680 lbs.[17] The accident combination weighed approximately 88,700 lbs and did not require a permit for its weight.

The permit that the accident combination unit was operating under at the time of the accident listed a height of 15 feet 9 inches, a width of 11 feet 6 inches, a trailer length of 70 feet 4 inches, and a rear overhang of 6 feet 4 inches. After the accident this permit expired and another permit was obtained to move the accident combination unit to its final destination. The post-accident permit for the accident combination unit listed a height of 16 feet, a width of 11 feet 8 inches, a trailer length of 72 feet, and a rear overhang of 9 feet 2 inches.[18] The dimensions of this post-accident permit were increased in part due to it being transported by a larger truck tractor that had three rear drive axles, known as a tri-drive, after the accident.

1.3.2 Exemplar[19] Combination Unit

An exemplar trailer, also an Aspen SD40-3TR,[20] carrying an exemplar load was located at a scale house approximately 6 miles north of the accident location.[21] The accident truck tractor was driven to the scale house and coupled to the exemplar trailer and load.[22] The exemplar combination unit was then moved to a level surface and weighed using certified portable scales supplied by the WSP. **Table 3** contains the axle weights of the exemplar combination unit.

Table 3: Exemplar Combination Unit Weight

	Axle	Weight (lbs)	
		Left	Right
Truck	1	7,100	7,100
	2	8,300	7,700
	3	8,000	7,600
Trailer	4	7,500	7,000
	5	7,500	7,000
	6	7,600	7,100
Total Weight: 89,500 lbs			

[17] Found by adding 18,180 lbs for the steer axle (rated at 600 lbs per square inch of tire width), plus 34,000 lbs for the tandem axle on the tractor and 43,500 for the 3axle set within 10 feet of each other on the trailer

[18] Copies of the permits are included in the docket as Motor Carrier Attachment 14 – Washington State and Canadian Permits

[19] The term "exemplar" refers to a vehicle or vehicle component that is of the same make, model, or build as the subject vehicle or vehicle components involved in the accident, but not necessarily identical, and is used as a model or example of pre-crash vehicle features.

[20] Exemplar trailer VIN: 2A9PF4031VN**xxxxxx**, with the same GVWR and GAWR as the accident trailer and also an expandable trailer with the locking pins engaged in the fully expanded position

[21] Bow Hill Scale, located on southbound I-5 at mile marker 235

[22] See Vehicle Photo 9 – Exemplar combination unit, consisting of the 2010 Kenworth truck tractor of the accident combination unit and exemplar oversize trailer and load

With the exemplar combination unit on a level surface height measurements were taken at the four top corners of the undamaged load using the same method with the height stick and metal tape as when measuring the accident combination unit. **Table 4** contains the measurements at the top four corners of the exemplar load.

Table 4: Exemplar Combination Unit – Load Height Measurements

	Left	Right
Front	15' 11 7/8"	16' 3/8"
Rear	15' 7 5/8"	15' 7 3/4"

1.3.2.1 OVERSIZE LOAD Permit

Similar to the accident combination unit, permits were required for the exemplar combination unit. The exemplar trailer and load were being transported by the same larger tri-drive truck tractor that later transported the accident trailer and load after the accident. As a result, the permit dimensions of the exemplar combination unit were larger than the accident combination unit. The original permit for the exemplar combination unit listed a height of 15 feet 11 inches, a width of 11 feet 8 inches, a trailer length of 71 feet 9 inches, and a rear overhang of 6 feet 9 inches. After the accident this permit expired and another permit was obtained to move the exemplar trailer and load to its final destination. The post-accident transport of the exemplar trailer and load was again done with the larger tri-drive truck tractor. The post-accident permit for the exemplar trailer and load listed a height of 16 feet, a width of 11 feet 8 inches, a trailer length of 72 feet, and a rear overhang of 9 feet.

1.4 DRIVER CONTROLS

The inside cab of the accident truck tractor was inspected and photographed. There was no damage noted to the driver seat and restraint, steering wheel, foot pedals, or dash control panels. The truck was equipped with power windows and power door locks.

The truck was started and allowed to idle, which resulted in reaction from the voltage, temperature, and tachometer gauges in the center and to the left side of the dash. Air pressure gauges to the right of dash also reacted to engine power and rose to approximately 130 pounds per square inch (psi) of available air pressure for both the primary and secondary air systems. There were no warning or malfunction lights illuminated in the dash when the truck was idling or when it was driven after the accident.

1.5 SIDE REAR VIEW MIRRORS

The truck was equipped with both a driver side and passenger side set of rear view mirrors. The driver side mirror set included four total mirrors: a rectangular 7 inch by 16 inch flat mirror, a 6 inch diameter circular convex mirror mounted above the flat mirror, an 8 inch circular convex mirror mounted below the flat mirror, and a 6 inch diameter circular convex

mirror mounted on an extendable arm further outboard of the other mirrors. The passenger side mirror set included three total mirrors: a rectangular 7 inch by 16 inch flat mirror, a 5 inch by 6 inch rectangular convex mirror mounted above the flat mirror, and an 8 inch circular convex mirror mounted below the flat mirror.

Both sets of side mirrors were centered at about 20 inches outboard of the truck cab. The circular convex mirror on the extendable arm on the driver side of the truck was centered at about 30 inches outboard of the truck cab.

1.6 STEERING AND SUSPENSION

The accident truck was equipped with dual front axle steering which included TRW steering gear boxes, pitman arms, drag links, and steering knuckles at both sides of the front axle. No damage was noted to any of the steering linkage or steering system components. All connections were solid and free of wear or excessive play. Full rotation of the steering wheel from far left to far right resulted in movement of the front axle tires without restriction or binding.

The front axle suspension consisted of 3-ply leaf springs and shock absorbers mounted aft of the axle. The suspension on axles 2 and 3 consisted of solid axle supports, sway bars, torsion bars, and air cushions mounted aft of each axle. The air suspension leveling valve at the left side of axle 3 appeared intact and undamaged. The suspension on axles 4, 5, and 6 consisted of solid axle supports, shock absorbers mounted forward of the axles, and air cushions mounted aft of the axles. The frame of the trailer was noted to be shifted about ½ inch to the left on the lower slide rails. However, all suspension components were intact and undamaged, and free of wear or excessive play.

A pressure regulator for the trailer air suspension system was located on the left side of the trailer, just forward of axle 4. When the truck was running and connected with air supplied to the trailer suspension, the regulator displayed a pressure of 60 psi. Tire clearance above the wheels (from the top of the tire to the top of the wheel well) at 60psi ranged from approximately 4 ¾ inches at axle 4, to 3 ¼ inches at axle 6. Releasing the air from the trailer suspension to 0 psi at the pressure regulator resulted in the trailer resting on and compressing the tires and an overall 2 to 3 inch lowering of the rear of the trailer (2 inch lowering at axle 4, 3 inch lowering at axle 6). Releasing the air from the trailer suspension did not result in notable lowering at the front of the trailer.

1.7 TIRES AND WHEELS

Table 5 includes the tire and wheel information documented at the time of inspection. Tire size and inflation recommendations for the accident truck suggested 385/65R22.5 tires mounted on 22.5X12.25 rims for the front axle, and 11R24.5 tires mounted on 24.5X8.25 rims for axles 2 and 3. Recommended tire pressure was 95 psi for the front axles, and 110 psi for axles 2 and 3. Tire size and inflation recommendations for the trailer suggested 275/70R22.5 size tires mounted on 8.25X22.5 rims, to be inflated at 100 psi for all trailer axles.

Table 5: Accident Combination Unit Tire Information

Front Axle	**Left**		**Right**	
Tire Make	Bridgestone M844 (J)[23]		Bridgestone M844 (J)	
Tire Size	385/65R22.5		385/65R22.5	
Pressure	96		98	
Tread Depth	16/32		15/32	
Axle 2	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Tire Make	Michelin XDS2 (H)	Michelin XDS2 (H)	Michelin XDS2 (H)	Michelin XDS2 (H)
Tire Size	11R22.5	11R22.5	11R22.5	11R22.5
Pressure	95	95	96	96
Tread Depth	17/32	17/32	20/32	18/32
Axle 3	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Tire Make	Michelin XDS2 (H)	Michelin XDS2 (H)	Michelin XDS2 (H)	Michelin XDS2 (H)
Tire Size	11R22.5	11R22.5	11R22.5	11R22.5
Pressure	96	96	90	96
Tread Depth	18/32	17/32	17/32	17/32
Axle 4	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Tire Make	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)
Tire Size	275/70R22.5	275/70R22.5	275/70R22.5	275/70R22.5
Pressure	96	100	98	96
Tread Depth	20/32	21/32	18/32	18/32
Axle 5	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Tire Make	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)
Tire Size	275/70R22.5	275/70R22.5	275/70R22.5	275/70R22.5
Pressure	96	96	96	74
Tread Depth	17/32	17/32	16/32	15/32
Axle 6	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Tire Make	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)	Bridgestone R250 (J)
Tire Size	275/70R22.5	275/70R22.5	275/70R22.5	275/70R22.5
Pressure	96	94	96	96
Tread Depth	11/32	10/32	10/32	11/32

[23] Indicates Load Range

Other than the previously mentioned minor sidewall cuts and wheel well tire contact marks, all tires were undamaged. The tires on axles 2 and 3 were size 11R22.5 instead of the recommended 11R24.5, meaning they were sized for and mounted on rims that were 2 inches smaller in diameter.

Tire pressure measurements were taken using a commercial grade tire pressure gauge. All tires were found to be inflated to pressures near what was recommended, beside one, the right outside tire on axle 5 was at 74 psi, about 26% below the recommended pressure. The Commercial Vehicle Safety Alliance (CVSA) Out-of-Service criteria does not consider a tire to be out-of-service until it is 50% less than the maximum inflation pressure listed on the side wall of the tire, 120 psi in this case. The tire would not have been considered out-of-service.

Tread depth measurements were taken in 3 locations within the major tread grooves of a given tire, the lowest of which is entered in the **Table 5**, and represents the minimum tread depth. All tread depths measured were within the minimum tread depth regulation for commercial vehicle tires, which is 4/32 of an inch for the steer axle and 2/32 of an inch for all other axles.[24]

A rolling radius of 19 inches was measured for the front axle, 21 inches for axles 2 and 3, and 18 inches for axles 4, 5, and 6 of the accident combination unit.

1.8 BRAKING

The accident truck tractor and trailer were equipped with pneumatic drum brake system on all axles. The accident truck was equipped with size 24 service brake chambers (Type 24) on the front axle. Axles 2 through 6 were equipped with size 30 service and parking brake chambers (Type 30/30). Axles 1, 2, and 3 on the truck tractor were equipped with 5 ½ inch automatic slack adjusters. Axles 4, 5, and 6 on the trailer were equipped with 6 inch automatic slack adjusters.

Brake pushrod stroke measurements were taken for the truck tractor by building air pressure to over 100 psi, releasing the parking brakes, marking the pushrods, and then applying the foot valve to its maximum 85 psi for application pressure. Brake pushrod stroke measurements were taken for the trailer using the same method and applying the trailer brake lever on the steering column. The distance the pushrod traveled during the brake applications is recorded as "Pushrod Stroke" in **Table 6**, along with the adjustment limit for Type 24 and Type 30/30 brake chambers, which is 2 inches.[25] None for the brakes were found to be out-of-adjustment.

[24] Measured in two adjacent tread grooves at any location on the tire, according to the Federal Motor Carrier Safety Regulations, Title 49 of the US Code of Federal Regulations, Part 393.75 (49 CFR 393.75)

[25] According to the CVSA Out-of-Service Criteria, pushrod strokes have to be 1/8 inch or more beyond the adjustment limits to be counted towards the allowable 20% defective brakes before a vehicle is considered to be out-of-service.

Table 6: Accident Combination Unit Brake Information

All measurements in inches		Brake Type	Pushrod Stoke (**2 inch max.**)
Front Axle	Left	24	1 5/8
	Right	24	1 5/8
Axle 2	Left	30/30	1 ¾
	Right	30/30	1 ¾
Axle 3	Left	30/30	1 5/8
	Right	30/30	1 5/8
Axle 4	Left	30/30	2
	Right	30/30	1 7/8
Axle 5	Left	30/30	1 7/8
	Right	30/30	1 7/8
Axle 6	Left	30/30	1 ¾
	Right	30/30	1 7/8

As part of the post-crash inspection, the dust covers on the back of each wheel were either partially removed or the inspection ports were used to visually inspect the brake drums and brake pads. The brake pad lining thickness was observed to be in the range of ½ to ¾ inch thick at all wheel locations. All brake pads were found to be in excess of the minimum thickness limit of 1/4 inch.[26] No brake pad or brake drum cracks or defects were observed.

Low air pressure warning tests were conducted on the accident combination unit. A leak was introduced by disconnecting the air service line glad hand at the front of the trailer (left side, red glad hand). Once the leak was introduced air pressure gauges in the dash were observed to drop. Red low air warning lights illuminated once the pressure was below 60 psi.[27]

The tractor protection valve is designed to keep at least 20 psi of air supplied to the tractor for a controlled stop in the event of a sudden loss of air. After the leak was introduced and the low air warning lights came on at 60 psi, air continued to escape below 20 psi, and the air supply to the tractor dropped down to 0 psi. The failure of the tractor protection value to close before the pressure dropped below 20 psi is violation of the Federal Motor Carrier Safety Regulations (FMCSRs),[28] and would have placed the accident truck out-of-service according to the CVSA Out-of-Service Criteria.

There were also three minor audible air leaks found at 1) a repair connection in the trailer application line between the truck cab and the trailer, 2) the right side of the glad hand connection forward of axle 4, and 3) the top gasket on the dump valve located in front of the air tank between axles 5 and 6. These air leaks are violations of the FMCSRs,[29] but would not have

[26] 49 CFR Part 393.47(d) states 1/4 inch minimum for air-braked non-steering axles, or 3/16 inch minimum for air-braked front steering axle brakes
[27] In compliance with low air warning devices specified in 49 CFR 393.51 (c)
[28] 49 CFR Part 393.43 (b)
[29] 49 CFR Part 393.43 (a)

placed the accident truck out-of service since the air loss rate was not greater than what the air compressor could maintain.

1.8.1 Anti-lock Braking Systems (ABS)

All air braked truck tractors manufactured after March 1997, and all other commercial vehicles (such as trailers) manufactured after March 1998, are required to be equipped with anti-lock braking systems (ABS).[30] The accident truck tractor was equipped with ABS sensors in place on axles 1 and 3. There were no ABS malfunction indicator lights illuminated in the dash of the accident truck at the time of the inspection. The trailer was not equipped with ABS, nor was it required to be, since it was manufactured before March 1998.

1.9 VEHICLE RECORDED EVENT DATA

The accident truck was equipped with an electronically controlled Caterpillar C15 Acert engine. The engine control module (ECM) has the capability to record "critical events" which often include vehicle speed, engine rpm, brake circuit status, throttle percentage, and other associated data in the event of a sudden decelerations or hard braking. The ECM was downloaded by WSP on May 24, 2013, the day after the accident, prior to the key being cycled or the engine being started after the accident had occurred.[31]

The download was initiated at 3:06 p.m. at which time the ECM date/time stamp was 7:31 p.m., a time difference of about 4 hours 25 minutes. There were no critical events stored in the ECM; however, diagnostic code and engine configuration data were obtained. There were no active diagnostic codes at the time of the download. Engine configuration data included a total engine run time of 9,533 hours and 27 minutes, a total distance of 340,910 miles, a vehicle speed limit of 99 mph, a lower cruise control speed limit of 15 mph, and an upper cruise control speed limit of 67 mph.

1.10 MAINTENANCE HISTORY

Maintenance and inspection records for the accident truck and trailer were obtained from Mullen Trucking. The accident truck last passed an annual Government of Alberta Commercial Vehicle Inspection on May 24, 2012. This inspection was due to expire at the end of May 2013, but was valid at the time of the accident.[32] Prior inspections were conducted May 11, 2011, May 3, 2010, and April 4, 2009 with no defects noted. The accident trailer last passed an annual inspection on September 18, 2012.[33]

Maintenance files for the accident truck noted mostly routine maintenance items such as tire replacements, fluid checks, greasing of joints, and replacing lights and windshield wipers. Maintenance files for the accident trailer also noted routine maintenance items in addition to

[30] 49 CFR Part 393.55 (c)
[31] See Vehicle Attachment 5 – 2010 Kenworth Truck Tractor Caterpillar Engine Data
[32] 49 CFR 396.17, annual inspections are valid for a period of 12 months commencing from the last day of the month in which the inspection was performed
[33] See Vehicle Attachment 6 – Annual Inspections for the 2010 Kenworth Combination Unit

brake repairs and replacements. No routine manual adjustment of the automatic slack adjusters, a discouraged practice, was noted.

1.10.1 Recalls and Warranty Claims

The National Highway Traffic Safety Administration (NHTSA) recall website, lists 7 recalls for 2010 Kenworth Model T800 truck tractors, however, according to Kenworth, none were applicable to the accident truck. A listing of warranty claims for the accident truck was obtained from Kenworth and reviewed. There were 21 warranty claims for the accident truck between March 2009 and April 2011 for a variety of vehicle systems including the air compressor, the exhaust, and the auxiliary transmission. The NHTSA website lists no recalls for Aspen model SD-40 trailers. Warranty claims for the 1997 model year trailer were not requested.

2. VEHICLE 2: 1997 Dodge Ram Pickup Truck (Pilot Car)

2.1 GENERAL INFORMATION

Make/Model: Dodge Ram 2500 ST Club Cab 4x4[34]
VIN: 3B7KF23D0VMxxxxxx
Engine: 5.9L Inline-6 Turbo Diesel
Transmission: 4-speed Automatic

Date of Manufacture:	December 1996
GVWR:	8,800 lbs
GAWR (per axle):	4,500 lbs
Overall length:	244.10 inches
Overall width:	79.40 inches
Overall height:	77.10 inches
Front Trackwidth:	66.90 inches
Rear Trackwidth:	68.00 inches
Wheelbase:	154.70 inches
Weight:	5,244 lbs

2.2 DAMAGE DESCRIPTION

The 1997 Dodge Ram pickup truck (referred to as the pilot car) was driving ahead of and piloting the oversize load, described as Vehicle 1 above, the accident combination unit. The pilot car was undamaged, as it did not come into contact with the bridge or any other vehicles involved in the accident.

NTSB investigators photographed and took measurements of the pilot car on June 2, 2013. No mechanical inspection of the pilot car was conducted. The pilot car was equipped

[34] See Vehicle Attachment 7 – 1997 Dodge Ram Pickup Truck Specifications

with a roof mounted light bar, oversize load banner, and a single height pole.[35] The height pole was attached to the front bumper of the pickup truck, about 9 inches in from the right side. The height pole consisted of a yellow plastic telescoping pole with a 39-inch black radio antenna attached to the top of it. On top of the antenna was a ½-inch diameter red rubber ball. When NTSB investigators examined the pilot car, the vertical distance from the top of the height pole (rubber ball) to the roadway surface was found to be 16-feet 2-inches.

While still on the on scene of the accident at the south side of the bridge, WSP measured the height from the ground to the top of the pilot car height pole and found it to be 16 feet.[36]

The attachment point where the height pole was secured onto the front bumper of the pickup truck was a metal tube (holder), which was leaned slightly in toward the center of the vehicle. As a result, the height pole also leaned in toward the center of the vehicle, with the rubber ball at the top of the pole being about 1 foot 4 inches inward from the holder, or just over 2 feet inward from the right side of the pickup truck. **Figure 2** depicts a rear view of the pilot car and dimensions of the vehicle and height pole as they were documented during the inspection.

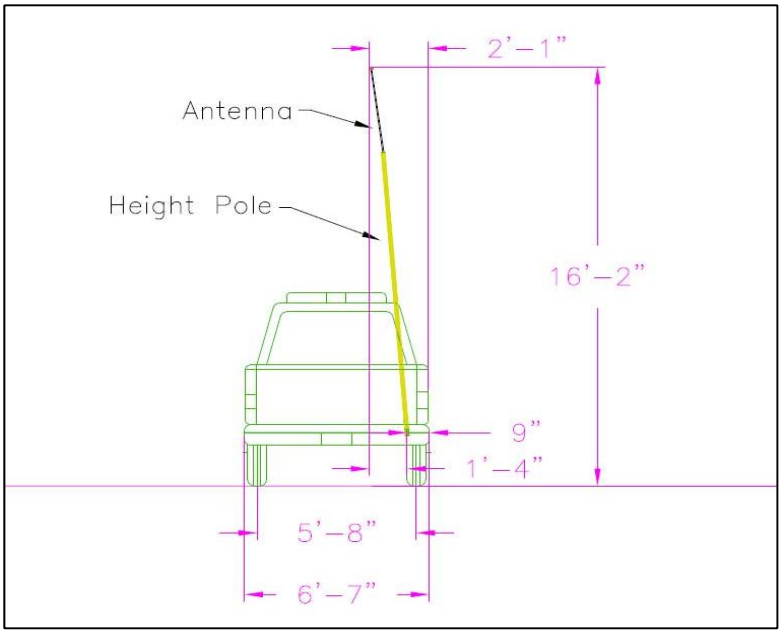

Figure 2. Rear view diagram of the pilot car

2.3 HEIGHT POLE GUIDELINES

Requirements for pilot and escort vehicles, along with the Washington Pilot Car Certification Program, Washington Administrative Code (WAC) 468-38-100, the Certified

[35] See Vehicle Photo 10 – 1997 Dodge Ram pickup truck, pilot car, note that the "OVERSIZE LOAD" banner that was present on the roof of the pickup truck at the time of the accident is not shown in this photo
[36] See Vehicle Attachment 16 – Washington State Patrol Commercial Vehicle Enforcement Report of Investigation, Narrative, Page 3.

Pilot/Escort Vehicle Operator Handbook, and the Pilot Car Escort Best Practices Book, are described in detail in the *Motor Carrier Group Chairman's Factual Report*.

In regard to the height pole, WAC 468-38-100, section 14, states that a height-measuring device (height pole), which is nonconductive and nondestructive to overhead clearances, is required equipment when escorting oversize loads in excess of fourteen feet six inches in height, and that the height pole must extend between three and six inches above the maximum height of the oversize load.[37]

The Certified Pilot/Escort Vehicle Operator Handbook (the handbook)[38] also recommends that height poles be constructed of "nonconductive and nondestructive" material to prevent electrical currents from entering the vehicle and to prevent damage to overhead wires and signals. In section 4.13 the handbook states that "The height pole, when mounted on the vehicle, should be not less than three inches above the permitted load height or greater than six inches above the maximum height of the permitted load." When using the height pole, the handbook provides a guideline to measure bridge lanes from their midpoint.

Further recommendations regarding the height pole include that it should not break if it hits an overpass or bridge structure, should be constructed so that one section will slide into another to allow for adjustments and storage, and that its mount can absorb stress from constant wind load and possible overhead impacts, but be rigid enough to prevent any changes in the elevation or attitude of the height pole. The handbook also states that although height poles are commercially available, it is more cost effective for operators to construct their own height poles and mount them to their vehicles. The handbook recommends that the height poles be mounted on the left side of the vehicle to provide the operator visual alignment with the overhead obstructions.

According to the National Pilot Car Safety Institute (NPCSI), state laws generally echo what is stated in the Operator Handbook, requiring "a height-measuring pole made of a non-conductive, non-destructive, flexible or frangible material…" when escorting a load exceeding a certain height.[39] The Pilot Car Escort Best Practices Book, published in 2004, contains similar guidance in reference to the height pole, stating that it should be set in cooperation with state laws and with the load driver.[40]

The NPCSI website provides an equipment link to Barney's online pilot car superstore where height poles and accessories are available for purchase.[41] On this site height poles range in price from about $150 to $200. Height pole mounts varied in cost from $40 to $500 depending if they were a single mount, dual-pole mount, or incorporated into a front brush guard. The majority of mounts found online were single pole mounts, and most showed the height pole mounted to either the center or right side of the vehicle.

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[37] See Motor Carrier Attachment 17B – Washington State Pilot Car Requirements - WAC 468-38-010
[38] See Motor Carrier Attachment 17A – Excerpts From Washington State Pilot-Escort Driver Certification Operator's Manual
[39] http://www.npcsi.net/
[40] See Page 8, section E of Motor Carrier Attachment 17 – Pilot Car Driver Best Practices Book
[41] http://www.barneyspilotcar.com/

3. VEHICLE 3: 2000 Kenworth Truck Tractor and 1996 Utility Refrigerated Semitrailer

3.1. GENERAL INFORMATION

TRUCK TRACTOR
Make/Model: Kenworth T600
VIN: 1XKADR9X0YJxxxxxx
Company Unit #: 206

SEMITRAILER:
Make/Model: Utility Refrigerated Semitrailer
VIN: 1UYVS2481TUxxxxxx
Company Unit #: R203

After the accident witnesses reported that another commercial combination unit had been present on the bridge, in the left lane next to the oversize load, just prior to the bridge collapse.[42] No other commercial vehicles stopped after the accident to self-report their presence on the bridge. A list of commercial vehicles known to be in the immediate area was compiled from weight station data of vehicles headed southbound through Bow Hill Scale, located approximately 6 miles north of the Skagit River Bridge.[43] Surveillance camera footage from nearby businesses and a dash-mounted camera in a WSP patrol car that was in the area were also reviewed for documentation of commercial vehicles traveling in close proximity to the accident combination unit.

The collected information led investigators to this second commercial vehicle involved in the accident.[44] When the subject 2000 Kenworth combination unit passed through Bow Hill Scale again on June 26, 2013 it was pulled in and given a CVSA Level II- walk-around inspection.[45] The commercial vehicle inspectors did not note any obvious damage to the combination unit at that time. They did note that the rear doors on the trailer were red. The driver was later interviewed by the WSP on July 26, 2013 and the vehicle was inspected more closely for damage on July 31, 2013.

3.2. DAMAGE DESCRIPTION

During the July 31, 2013 inspection the WSP noted blue paint transfer along the top right side metal edge rail of the trailer, towards the rear of the trailer.[46] As well as blue paint transfer at the edge of the upper right trailer door hinge. The paint transfer skipped on and off for a distance of about 211 inches from the rear of the trailer forward on the right side only, and was

[42] Reported by the drivers of Vehicle 1 (the oversize load), Vehicle 2 (the pilot car), and Vehicle 4 (the 2010 Dodge Ram pickup truck with the travel trailer).
[43] See Vehicle Attachment 8 – Bow Hill Scale Data for May 23, 2013 from 1850 to 1900 hours
[44] See Vehicle Photo 11 – 2000 Kenworth combination unit
[45] See Vehicle Attachment 9 – Washington State Patrol Post-Crash Driver/Vehicle Examination Report for the 2000 Kenworth Combination Unit
[46] See Vehicle Photos 12 thru 14 – Paint transfer along the top right side trailer edge rail and upper right trailer door hinge of the 2000 Kenworth combination unit

only present at the very top edge. No other damage was noted. The mechanical systems of the vehicle were not inspected.

4. VEHICLE 4: 2010 Dodge Ram Pickup Truck and 2009 Jayco Travel Trailer

4.1. GENERAL INFORMATION

PICKUP TRUCK:[47]
Make/Model: Dodge Ram 1500 SLT Quad Cab 4x4
VIN: 1D7RV1GT8ASxxxxxx
Engine: 5.7L V8 MDS VVT Gasoline
Transmission: 5-speed Automatic

Date of Manufacture:	November 2009
GVWR:	6,700 lbs
GAWR (per axle):	3,900 lbs
Overall length:	229 inches
Overall width:	79.40 inches
Overall height:	75.70 inches
Front Trackwidth:	68.20 inches
Rear Trackwidth:	67.50 inches
Wheelbase:	140.50 inches
Weight:	5,271 lbs

TRAVEL TRAILER:[48]
Make/Model: Jayco Jay Flight 19BH
VIN: 1UJBJ02K097xxxxxx

Date of Manufacture:	March 2009
GVWR:	6,000 lbs
GAWR (per axle):	3,500 lbs
Overall length:	22 feet 5 inches
Overall width:	8 feet
Overall height:	10 feet 10 inches
Unloaded Weight:	3,730 lbs

4.2. DAMAGE DESCRIPTION

The pickup truck was found in the debris of the bride in the river, facing south, near the sound end of the collapsed section, on the concrete center median of the bridge. On May 27, 2013, the truck was removed from the river using a crane and two chain loops positioned just forward of the rear axle and just aft of the front axle. The primary damage was to the front bumper and the roof of the pickup truck.[49] There were scrape marks and orange paint in the areas of damage. The front bumper was deformed near the center on the left side. The roof was deformed downward in the center. Additional documentation of the roof damage is contained in

[47] See Vehicle Attachment 10 – 2010 Dodge Ram Pickup Truck Specifications
[48] See Vehicle Attachment 11 – 2009 Jayco Travel Trailer Specifications
[49] See Vehicle Photo 15 – 2010 Dodge Ram pickup truck

the *Survival Factors Group Chairman's Factual Report*, which can be found in the docket for this investigation. The travel trailer was found in the river trapped in the debris of the bridge truss structure. The trailer was destroyed and removed from the river in pieces.[50] Mechanical inspections were not conducted on the pickup truck or the travel trailer.

4.3. VEHICLE RECORDED EVENT DATA

The WSP downloaded the pickup truck's airbag control module (ACM), which in the event of airbag deployments, or near deployments, can capture vehicle speed, throttle, braking, and other event data. The airbags of the pickup truck did not deploy as a result of the accident. The ACM download indicated that no events were recorded.[51]

5. VEHICLE 5: 2013 Subaru VX Crosstrek

5.1. GENERAL INFORMATION

Make/Model: 2013 Subaru XV Crosstrek 2.0i[52]
VIN: JF2GPACC8D2xxxxxx
Engine: 2.0L 4 cylinder Subaru BOXER
Transmission: 5-speed Manual

Date of Manufacture:	October 2012
GVWR:	4,343lbs
Overall length:	175.2 inches
Overall width:	70.1 inches
Overall height:	63.6 inches
Front Trackwidth:	60 inches
Rear Trackwidth:	60 inches
Wheelbase:	103.7 inches
Weight:	3,142 lbs

5.2. DAMAGE DESCRIPTION

The Subaru was found in the debris of the bridge in the river, facing north, and on the west side of the collapsed truss. On May 27, 2013, the vehicle was removed from the river using a crane and two chain loops positioned through the front and rear windows. The primary damage to the vehicle was at the front and the right rear corner.[53] The hood was crumpled with the front bumper displaced from the vehicle. The front damage was worse on the driver side, with the headlight missing and the left front wheel dislocated from the transaxle. There were scrape marks and orange paint found in the damaged region at the front of the vehicle. The damage on right rear corner of the vehicle was concentrated in the upper portion, with extensive scrape marks and torn metal with orange paint transfer. The Subaru airbags were found in the

[50] See Vehicle Photo 16 – 2009 Jayco travel trailer
[51] See Vehicle Attachment 12 – 2010 Dodge Ram Pickup Truck Airbag Control Module Data
[52] See Vehicle Attachment 13 – 2013 Subaru XV Crosstrek Specifications
[53] See Vehicle Photo 17 – 2013 Subaru Crosstrek

deployed condition, additional documentation of the airbags and vehicle interior is contained in the *Survival Factors Group Chairman's Factual Report*. A mechanical inspection of the Subaru was not conducted.

5.3. VEHICLE RECORDED EVENT DATA

Efforts were made to download the Subaru's airbag control module for any recorded event data since both the front and side airbags were found deployed as a result of the accident. Download efforts were unsuccessful due to damage resulting from the vehicle's submersion in water.[54]

6. VEHICLE 6: 1995 BMW 525i

6.1. GENERAL INFORMATION

Make/Model: BMW 525i[55]
VIN: WBAHD632XSGxxxxxx
Engine: 2.5L Inline-6 SOHC Gasoline
Transmission: 4-speed Automatic

Overall length:	185.80 inches
Overall width:	68.90 inches
Overall height:	55.60 inches
Front Trackwidth:	57.90 inches
Rear Trackwidth:	58.90 inches
Wheelbase:	108.70 inches
Weight:	3,560 lbs

6.2. DAMAGE DESCRIPTION

The driver of the BMW initially stopped just south of the bridge after the accident, but after speaking with the drivers of the oversize load and the pilot car, left the scene thinking that his vehicle was not damaged. While attempting to drive further south the vehicle began to make noises from its rear passenger side and the driver realized that it was damaged and not drivable. He reported the damage and involvement in the bridge collapse to the local sheriff's department and later to the WSP.

The WSP photographed and examined the BMW while loaded on a flatbed tow truck on May 24, 2013.[56] There was minor damage noted at the left front corner of the front bumper and at the driver side door. The WSP noted that there was undercarriage damage but did not document it in detail. The NTSB did not inspect the BMW.

[54] See Airbag Control Module – Specialist's Factual Report, which can be found in the docket for this investigation.
[55] See Vehicle Attachment 14 – 1995 BMW 525i Specifications
[56] See Vehicle Photo 18 – 1995 BMW 525i

F. ACCIDENT DOCKET MATERIAL

The following attachments and photographs have been referred to in this report and are included in the docket for this investigation:

LIST OF ATTACHMENTS

Vehicle Attachment 1 – Washington State Patrol Post-Crash Driver/Vehicle Examination Report for the 2010 Kenworth Combination Unit

Vehicle Attachment 2 – 2010 Kenworth Truck Tractor Specifications

Vehicle Attachment 3 – Aspen Semitrailer Specifications

Vehicle Attachment 4 – Casing Shed Specifications

Vehicle Attachment 5 – 2010 Kenworth Truck Tractor Caterpillar Engine Data

Vehicle Attachment 6 – Annual Inspections for the 2010 Kenworth Combination Unit

Vehicle Attachment 7 – 1997 Dodge Ram Pickup Truck Specifications

Vehicle Attachment 8 – Bow Hill Scale Data for May 23, 2013 from 1850 to 1900 hours

Vehicle Attachment 9 – Washington State Patrol Post-Crash Driver/Vehicle Examination Report for the 2000 Kenworth Combination Unit

Vehicle Attachment 10 – 2010 Dodge Ram Pickup Truck Specifications

Vehicle Attachment 11 – 2009 Jayco Travel Trailer Specifications

Vehicle Attachment 12 – 2010 Dodge Ram Pickup Truck Airbag Control Module Data

Vehicle Attachment 13 – 2013 Subaru XV Crosstrek Specifications

Vehicle Attachment 14 – 1995 BMW 525i Specifications

Vehicle Attachment 15 – Washington State Department of Transportation Report of Pavement Friction

Vehicle Attachment 16 – Washington State Patrol Commercial Vehicle Enforcement Report of Investigation

LIST OF PHOTOGRAPHS

Vehicle Photo 1 – 2010 Kenworth combination unit, oversize load

Vehicle Photo 2 – Damage to the upper right front corner and along the right top edge of the oversize load

Vehicle Photo 3 – Damage to the upper left front side of the oversize load

Vehicle Photo 4 – Broken chain at the right front corner of the oversize load

Vehicle Photo 5 – Broken tie down across the lower forward section of the oversize load

Vehicle Photo 6 – Chain links and sections of the webbed tie down found on the bridge deck, south of the collapsed section of the bridge

Vehicle Photo 7 – Lower right edge of the oversize load, showing the leftward shift toward the front of the trailer

Vehicle Photo 8 – Tire contact marks inside of the wheel well on the left side of axle 4 of the oversize load

Vehicle Photo 9 – Exemplar combination unit, consisting of the 2010 Kenworth truck tractor of the accident combination unit and exemplar oversize trailer and load

Vehicle Photo 10 – 1997 Dodge Ram pickup truck, pilot car

Vehicle Photo 11 – 2000 Kenworth combination unit

Vehicle Photo 12 – Rear view of the 2000 Kenworth combination unit trailer, indicating the locations of the blue paint transfers marks

Vehicle Photo 13 – Paint transfer marks along the top right side trailer edge rail of the 2000 Kenworth combination unit

Vehicle Photo 14 – Paint transfer marks at the top rear and upper right trailer door hinge of the 2000 Kenworth combination unit

Vehicle Photo 15 – 2010 Dodge Ram pickup truck

Vehicle Photo 16 – 2009 Jayco travel trailer

Vehicle Photo 17 – 2013 Subaru Crosstrek

Vehicle Photo 18 – 1995 BMW 525i

END OF REPORT

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