Mullen Trucking, LP
Technical Review Comments

Bridge Strike & Collapse
Mt. Vernon, WA
05/23/2013

HWY-13-MH-012
(51 Pages)

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January 2, 2014

Mr. Robert Accetta
Investigator-in-Charge
Office of Highway Safety
National Highway Transportation Board
490 L'Enfant Plaza, SW
Washington, DC 20594

Re: Collapse of Bridge Span
May 23, 2013, Mr. Vernon, Washington
NTSB Investigation: HWY13MH012

Dear Mr. Accetta:

Thank you for your e-mail last month forwarding draft factual reports from the referenced investigation and inviting our technical review and comment on or before January 6, 2014. It is obvious from these draft reports that you and your team have worked hard to assemble the necessary foundation for analysis of the incident and recommendations as to how such incidents might be avoided in the future. Mullen is pleased to be part of this process and to offer the following suggestions:

There are several suggestions that require more investigation. We do not think that any of these recommendations ought to unduly delay the completion of the investigation. In each instance, Mullen would be pleased to take the lead, under your team's guidance and observation, or to support your efforts in any way that we can.

Thank you once again for this opportunity to participate. We look forward to discussing our comments and suggestions.

Very truly yours,

[redacted]

Randy Mercer
Director of Safety
Mullen Trucking LP

Human Performance Factors Draft Factual Report

- **Page 8: 1.2.7: Post-Accident Toxicology, Law Enforcement:**

  Note is made on pages 8 and 9 that the urine sample provided by the 2010 Kenworth driver to the DOT was negative for amphetamines, marijuana, opiates, cocaine, and phencyclidine and that a blood sample tested by the Civil Aerospace Medical Institute at the request of the NTSB was negative for alcohol and drugs. Somewhat curiously, however, note is also made at 1.2.7.1 that results of similar testing by the Washington State Patrol have not been received:

  > 1.2.7. Post-accident Toxicology
  >
  > 1.2.7.1. Law Enforcement
  >
  > Following the accident, the 2010 Kenworth driver voluntarily provided a blood sample to the Washington State Patrol. Results of that testing have not been received.

  We recommend, for completeness, that these results be obtained and included.

- **Page 12: 1.4.1 Task Factors, Accident Trip:**

  The second full paragraph on page 12 begins: "According to the 2010 Kenworth driver, a white tractor-trailer combination vehicle, possibly another Kenworth, came up on his right; the driver described the other truck as moving 'fast' and stated it 'squeezed' him."

  > According to the 2010 Kenworth driver, a white tractor-trailer combination vehicle, possibly another Kenworth, came up on his right; the driver described the other truck as moving "fast" and stated it "squeezed" him. His first indication that something

  This sentence should have the truck coming up on the driver's left rather than his right.

- **Page 24: 3.3 Witness Statements:**

  Two thirds of the way down this page is the reference "1.1.1 Southbound 2000 Kenworth Driver". This reference should likely be 3.3.2 rather than 1.1.1.

  > 3.3. Witness Statement(s)
  >
  > 3.3.1. Southbound 2001 Ford Ranger Driver

  > 1.1.1. Southbound 2000 Kenworth Driver

- **Pages 24 & 25: 3.3.2 Witness Statements: Southbound 2000 Kenworth Driver.**

  Footnote 41 references the transcript of the police interview of this driver, which will be Attachment 12 to this Factual Report.

  > [41] See Human Performance Factual Report Attachment 12: Transcript of Police Interview of 2000 Kenworth Driver.

Mullen has not seen this transcript and for that reason cannot comment on the factual accuracy of much of this section of the Report. Are you able to provide us with a copy?

We also note that this section concludes on page 25 with the note: "NTSB investigators attempted to reach the driver of the 2000 Kenworth to conduct a follow-up interview but were unsuccessful."

> NTSB investigators attempted to reach the driver of the 2000 Kenworth to conduct a follow-up interview but were unsuccessful.

On December 17 we advised Dennis Collins that this driver and his company are represented by Mark Scheer of the Scheer Zehnder Law Firm at 701 Pike Street in Seattle (206-223-9232, mscheer@scheerlaw.com). Given the thoroughness of the balance of the investigation, particularly as to the motor carriers involved, it would seem very worthwhile that a follow-up interview either be conducted or some explanation be provided as to why one was not.

Materials Laboratory Draft Factual Report

- **Page 3, Description of the Bridge, last paragraph of the section:**

  Specified material properties are provided in this paragraph for the steel on the bridge:

> The materials of the truss were specified as either ASTM[1] A7[2] carbon steel or ASTM A242[3] low alloy steel. ASTM A7 had a specified tensile strength of 60 to 72 ksi[4] and a specified minimum yield strength of 50% of the tensile strength but not less than 33 ksi. A242 specifies a steel with a minimum tensile strength of 70 ksi and a yield strength not less than 50 ksi. All of the fracture critical members were specified as A242 steel. In addition, A242 was specified for the end diagonals in each span. This included the north and south portals.

  We suggest that material property tests be performed on material removed from a representative sample of bridge evidence to confirm the specified properties and to eliminate any potential contribution from substandard materials to the bridge span failure. We would be pleased to assist with this process, or take the lead under NTSB supervision.

- **Page 4, Initial Examinations, second paragraph from the bottom:**

  Information is provided in this paragraph concerning the condition of the north end pin attachments to the pier:

> The lower chords were mostly under water except for end portions that were leaning on the sides of the respective piers. On the north end, the lower chords of the east and west truss were visible and appeared intact between nodes 6 and to near nodes 5. The north end fixed pin assemblies were attached on both sides to the lower chords at nodes 6. The fasteners attaching the pin assemblies to the pier were present and the corresponding areas of the pier were fractured consistent with the rotation of the north portal. At the south end of span 8 a portion of the west truss lower chord was visible from node L0W to slightly past node L1W. The remaining length of the west lower chord and the entire eastern lower chord were underwater and not visible.

  There is no mention of the observed conditions of the pin connections to the **south** pier of span 8 at nodes L0E and L0W. We believe these conditions will be important if any stress analysis or modeling of the 05/23/2013 failure is performed. If the NTSB has any notes or photographs of these conditions, we recommend that they be included in this factual report.

- **Page 4, Initial Examinations, bottom paragraph:**

  Based on the photographs taken and shown in Figure 5, we believe that the bottom chords were visible at node 5 and for some distance south toward node 4. If this is correct, and if NTSB has any additional photographs or inspection data, we recommend that that they be included in this factual report.

Materials Laboratory Report Figure 5, Top View of collapsed span 8 from downstream (west) side. Red circles added at what appear to be node L5E and L5W.

- **Page 6, Detailed Examinations:**

This paragraph boldly proclaims that the examinations of the span 7 and 8 structures did not reveal any instances of significant pre-existing corrosion or cracking and that all fractures and cracks noted in any of the members were consistent with overstress force:

> **Detailed examinations**
>
> No instances of significant pre-existing corrosion or cracking were noted at any location during the examinations of the span 7 and 8 structures. Further, all fractures and cracks noted in any of the members were consistent with overstress forces. All measured components and subcomponents were consistent with drawing requirements.

We are surprised to see such a statements of opinion in a factual report. We recommend that they be removed.

The analysis of the surveillance video performed by the NTSB shows that the connection between the west sway brace 4 to the vertical member U4W-L4W catastrophically failed during the initial stages of the collapse. For reference, here is the node drawing from page 27 of the Highway Report (red circle added):

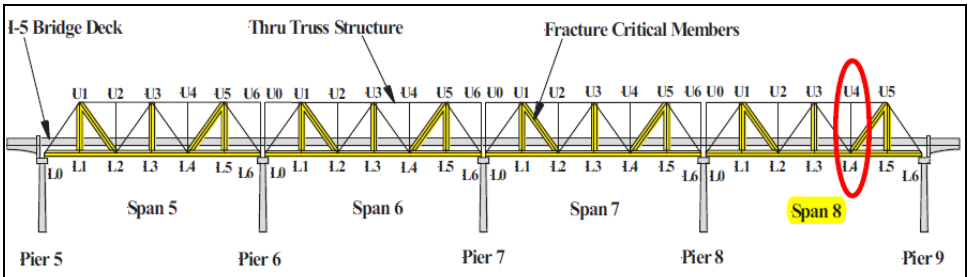


Figure 4 – Location of the Fracture Critical Members of the I-5 Bridge over the Skagit River

Frame	Seconds	Feature
0980	0.00	Oversize load approaches the north portal of the truss spans.
0998	0.72	Load through the north portal.
1018	1.52	Front of load at Span 8 node 4 west.
1020	1.60	First deflection noted in upper chord at U4W.
1022	1.68	First noted deflection of vertical member at Node 4W.
1024	1.76	More deflection of upper chord at U4W.
1030	2.00	Load passes span 8 node 4W.
1036	2.24	Deck and lower chord begin deflecting. Node 4 sway brace visible.
1042	2.48	Continued downward movement of west truss. Tractor nears span 7.
1048	2.72	Continuing truss deformation. Camper trailer approaches north portal.
1053	2.92	Load is off of span 8.
1058	3.13	First movement of east side of portal. Load approaches Span 7 U4W. End of video.

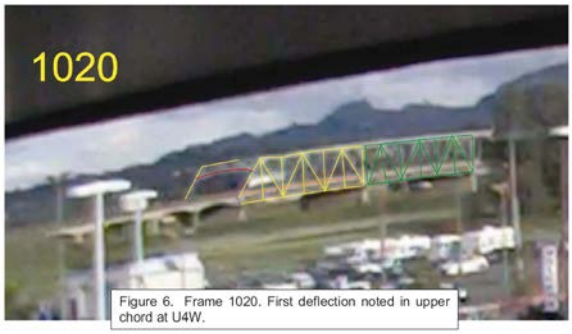


Figure 6. Frame 1020. First deflection noted in upper chord at U4W.

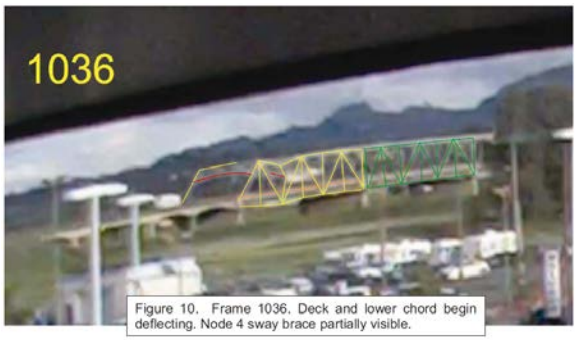


Figure 10. Frame 1036. Deck and lower chord begin deflecting. Node 4 sway brace partially visible.

Figure 7. Frame 1022. First noted deflection of vertical member at node 4W.

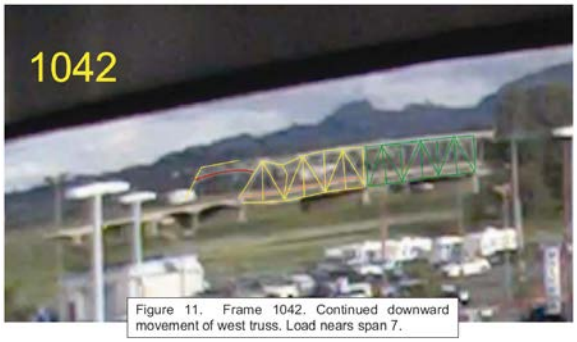


Figure 11. Frame 1042. Continued downward movement of west truss. Load nears span 7.

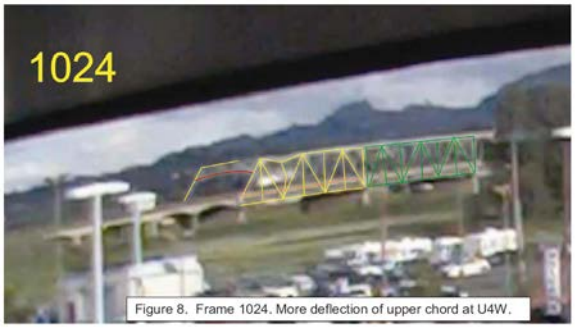


Figure 8. Frame 1024. More deflection of upper chord at U4W.

Figure 12. Frame 1048. Continuing truss deformation. Camping trailer (red arrow) approaches north portal.

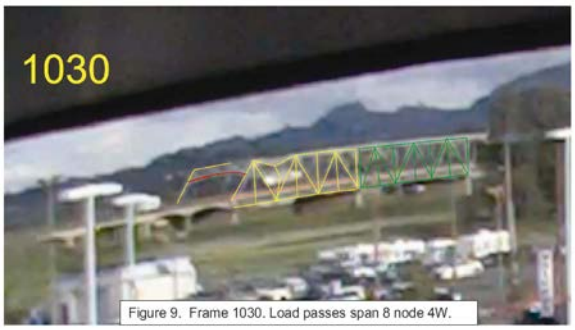


Figure 9. Frame 1030. Load passes span 8 node 4W.

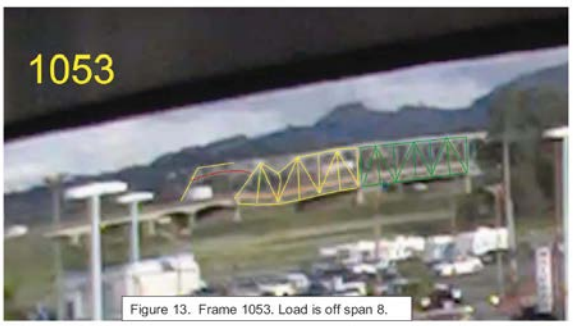


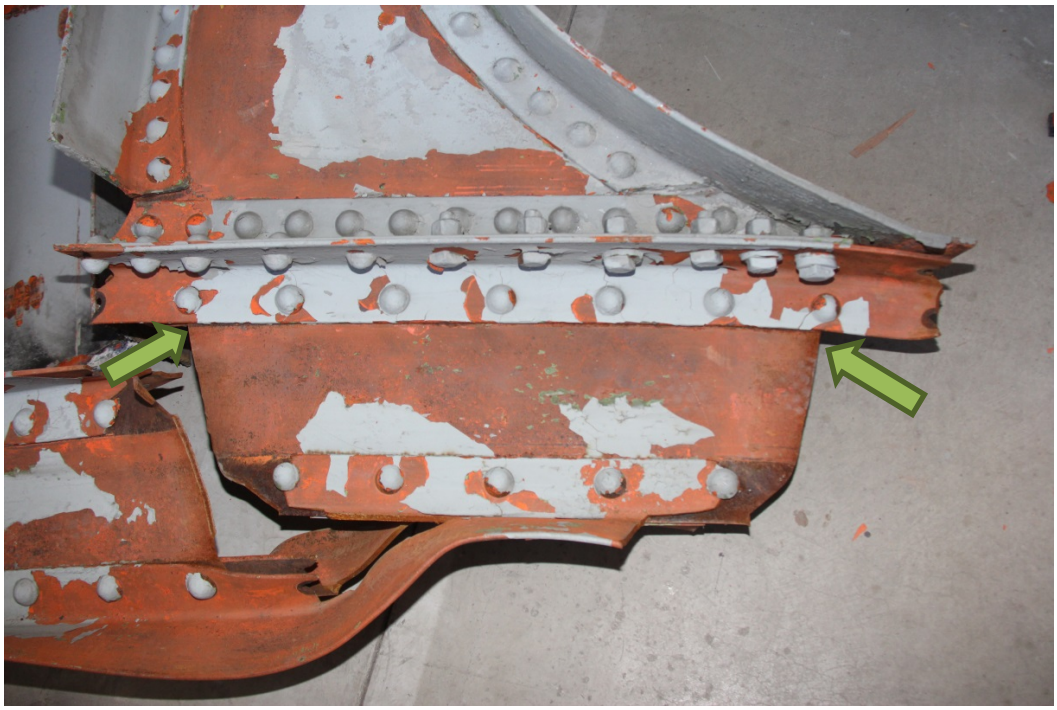
Figure 13. Frame 1053. Load is off span 8.

This connection between sway brace 4 and the vertical member U4W-L4W exhibits significant differences relative to a similar connection between sway brace 3 and the vertical member U3W-L4W, which also sustained heavy impact from the load during the event. Also, a nearly identical connection between sway brace 4 and the vertical member U4W-L4W on span 7 was severely impacted by the load; however, span 7 did not catastrophically fail.

In light of the above observations, we believe a thorough examination of the fractures, materials and fasteners at the connections to the vertical member U4W-L4W are warranted to uncover any potential pre-existing issues that may have contributed to the failure. In addition, historical information on repairs and damage would provide valuable information for the analysis. **The fact that similar connections on span 8 and other spans on the Skagit bridge did not fail in the same manner after the sway brace was impacted indicates that the span 8 to U4W-L4W vertical connections, or other connections that are configured the same, may well have been susceptible to failure.**

With all this in mind, we respectfully suggest that there is insufficient information currently available to determine that "all of the fractures and cracks were consistent with overstress forces."

Significant portions of the fracture surfaces around the connection of sway brace 4 to member U4W-L4W cannot be examined because they are underneath or obscured by other component members (please see photographs 1 and 2 below). **There is no question that this is a critical fracture area and that it is a key to understanding the sequence of events and failure. It cannot be fully evaluated by visual examination alone. We recommend detailed visual, microscopic and laboratory examination.** We would be pleased to assist with this process, or take the lead under NTSB supervision.



Photograph 1: Overview of connection of sway brace 4 with the U4W-L4W vertical. Note that the web of member U4W-L4W is fractured at riveted connections (arrows) that cannot be visually examined without additional work.

Photograph 2: Close up of the lower portion of the critical fracture on member U4W-L4W showing that fracture cannot be visually examined. The area is between and obscured by the two "L" brackets (arrow).

- **Page 6, Detailed Examinations, U3W:**

  Consistent with our recommendation to further examine the connections around sway brace 4 to U4W-L4W, we suggest examining and obtaining more specific information from laboratory examination on the condition and failure of the connections of sway frame 3 to the vertical U3W-L3W. We believe that comparison of this connection to the failed connections of sway frame 4 may be critically important in evaluation of the failure mode and sequence of events. We would be pleased to assist with this process, or take the lead under NTSB supervision.

- **Pages 6 & 7, Detailed Examinations, U4W:**

  As noted above, we believe this area is important to understand the overall 05/23/2013 failure because it appears to be one of the initiating failure points as clearly identified in the draft Material Laboratory Factual Report, page 7, Figure 7. Consistent with our comment for the overall detailed examination recommended above, we believe that the connections of sway frame 4 and connections of the U4W-L4W vertical to nodes are important to evaluate further. In particular we believe a detailed laboratory examination should be conducted at the location noted at the end of the section that include the partial separation of the U4W-L4W at the top edge of the sway brace, the complete fracture at the east flange and web, and the complete fracture at the lower edge of the sway brace attachment area. We would be pleased to assist with this process, or take the lead under NTSB supervision.

  We also note that many of the rivets at the connection of sway brace 4 to the U4W-L4W vertical appear to have been replaced with bolts at some time in the past (see Photographs 3 and 4 below). A total of 12 of 22 of the fasteners connecting the flange of the U4W-L4W vertical to sway brace 4 were bolted. In comparison, it is our understanding that one of the 22 fasteners connecting the flange of sway brace 3 to the U3W-L3W vertical was bolted. **This suggests that previous repairs had been made in this area or that a systemic**

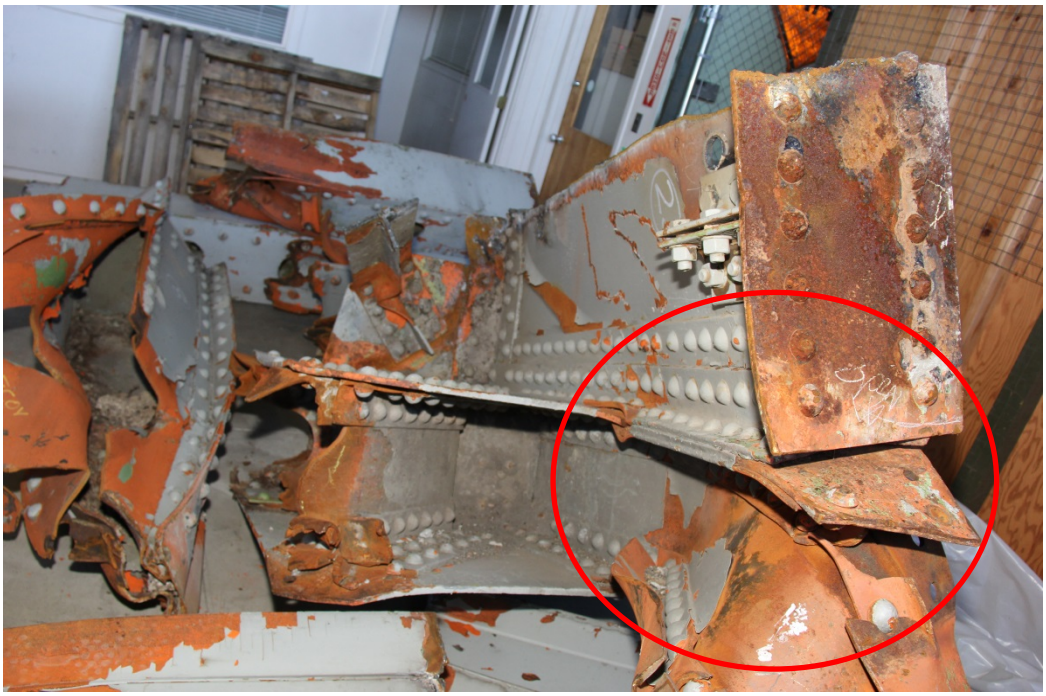
issue exists at connections with the same configuration as sway brace 4 on span 8. We respectfully suggest that the reason for the rivet replacement should be investigated and that the connection area and related fracture surfaces be examined in a laboratory. We would be pleased to assist with this process, or take the lead under NTSB supervision.

Photograph 3: The connection of sway brace 4 to the U4W-L4W vertical. Note the bolts and washers toward the lower part of the connection (arrows).

Photograph 4: Opposite side of the connection from that shown in Photograph 3. Note the bolted connections with washers toward the lower part of the connection.

- **Page 7, Detailed Examinations, L4W:**

  Detailed examination of the connection of the U4W-L4W vertical to L4W node and any associated lateral or rotational displacement will be important for any modeling of the span.



Photograph 5: Node L4W. The area of connection with the U4W-L4W vertical is shown in the circled area.

- **Page 7, Detailed Examinations, L4W: Two Functionally Missing Rivets**

  In the midst of examination of accident damage to L4W, it was discovered that at least two rivets at the top of U4W-L4W connection to the L4W node were actually cut and did not extend through the connections. Photographs 6 and 7 below show one of these two cut rivets. Despite the cuts, the rivet heads were left in place, making it impossible to know that there were functionally no rivets in place.

  We request that the factual report make note of these cut rivets and the inability to know how many other such cut rivets the structure may contain.

Photograph 6: The rivet at the connection of U4W-L4W at the top of node L4W was cut (arrow) with no connection to the mating material.

Photograph 7: Closer view of the rivet at the connection of U4W-L4W at the top of node L4W was cut with no connection to the mating material.

We further note that the 2/25/2012 Fracture Critical Inspection Remarks section for span 8, West, U5-L4 (at Page 30 of the draft Highway Factors Report), state that "L4 is full of dirt and vegetation. The connection cannot be inspected."

8	West	U5-L4	Diagonal Member	L4 is full of dirt and vegetation. The connection cannot be inspected.

This remark is also provided for several other lower members in the report. This indicates the actual condition of the U5W-L4W member was not inspected in February of 2012 and that other joints at the lower west node 4 were also not visible. Given this situation, we recommend that a detailed visual, microscopic and laboratory examination of the connections at the L4W node be conducted. We would be pleased to take the lead with this work, or to assist the NTSB as they do so.

- **Page 7, Detailed Examinations, U5W:**

We believe that U3W-U4W reference in the second paragraph below should be **U3W-U5W**.

> **U5W**
>
> Member U3W-U5W was severely damaged and partially fractured about 2 feet south of the U5W node gusset plates. The lower cover plate and both "C" sides of the chord were completely fractured. The upper cover plate was fractured between the west edge and a hand hole and only the eastern ligament remained intact and holding the north and south side of the upper chord together. This ligament was later fractured during recovery. See Figure 10 Upper.
>
> The "C" channel sides and lower cover plate of U3W-U4W were deformed adjacent to the fracture consistent with down and east movement of the U4W node. However, fracture features were more consistent with upward movement of the south end. The overall fracture and deformation pattern were consistent with an initial south end down motion deforming the chord followed by a south end upward motion fracturing the deformed structure. See Figure 10 Lower.

- **Page 7, Detailed Examinations, U3E:**

We believe the member referenced in the first paragraph below should be **U3E-U5E**, and the member referenced in the second paragraph below should be **U3E-L4E**.

> **U3E**
>
> Member U3W-U5W was bent north end down about 4 feet from the north edge of the node with partial fracturing of the top and bottom chord cover plates. The lower plate showed buckling deformation and the top plate was tension-fractured. See Figure 11.
>
> U3E-L4W was disconnected from the node and rested on other structure to the west of the node. All of the gusset plate rivets were fractured with only a few remaining in either the
>
> member or the gusset plates. The upper ends of the "C" channel side plates of the member were deformed and the area between the gusset plates was damaged consistent with the member being forced upward.

- **Page 8, Detailed Examinations, U4E:**

  We believe the member referenced in the paragraph below should be **U3E-U5E** and not U3W-U5W.

> **U4E**
>
> The U4E node was visible resting just above the water line. The upper chord, U3W-U5W, was bent more than 90° at node 4E with the majority of the deformation at the north edge of the node. The deformation was very similar to that seen at the U4W node and included severely folded and "S"-bent "C" channels and top cover plate consistent with compression buckling of the chord followed by bending. Small local fractures were present and several rivets were separated at some areas of severe deformation. See Figure 12.

- **Page 9, Sway Frames Span 8, Sway Frame 4:**

  In the last paragraph of this section, measurement of the permanent deflection of sway frame 4 is provided and shown in Figure 16.

> The entire lower chord of the sway frame was deformed and bowed to the south centered at the tear across the width of the traffic lane. The permanent deflection from straight measured about 24 inches at the tear. The lower chord of the sway brace remained attached to the vertical. However, the vertical was fractured as noted in a previous section. See Figure 16 Lower.

Figure 16. Impact damage to sway brace 4 above with extent of bowing depicted below.

While we do not disagree with the measured approximation of the deflection in sway brace 4, we think it is important to identify and discuss that the deflected condition as measured is post incident and post recovery. Although not specifically stated in the report, we believe that the observed and recorded deflection of span 8, sway brace 4, will be compared with the deflection and damage of the sway braces on span 7, which can be attributed almost exclusively to impact with the load. Figure 28 on page 36 implies that a comparison can be drawn by showing the

deflected condition of both the span 7 and span 8 sway braces relative to a dashed line. We believe this has the potential to mislead the reader.

We request that notation be made that the damage and deflection observed post-recovery in the sway braces on span 8 is likely a combination of (1) impact with the load, (2) the forces of the span collapse itself, and (3) recovery efforts.

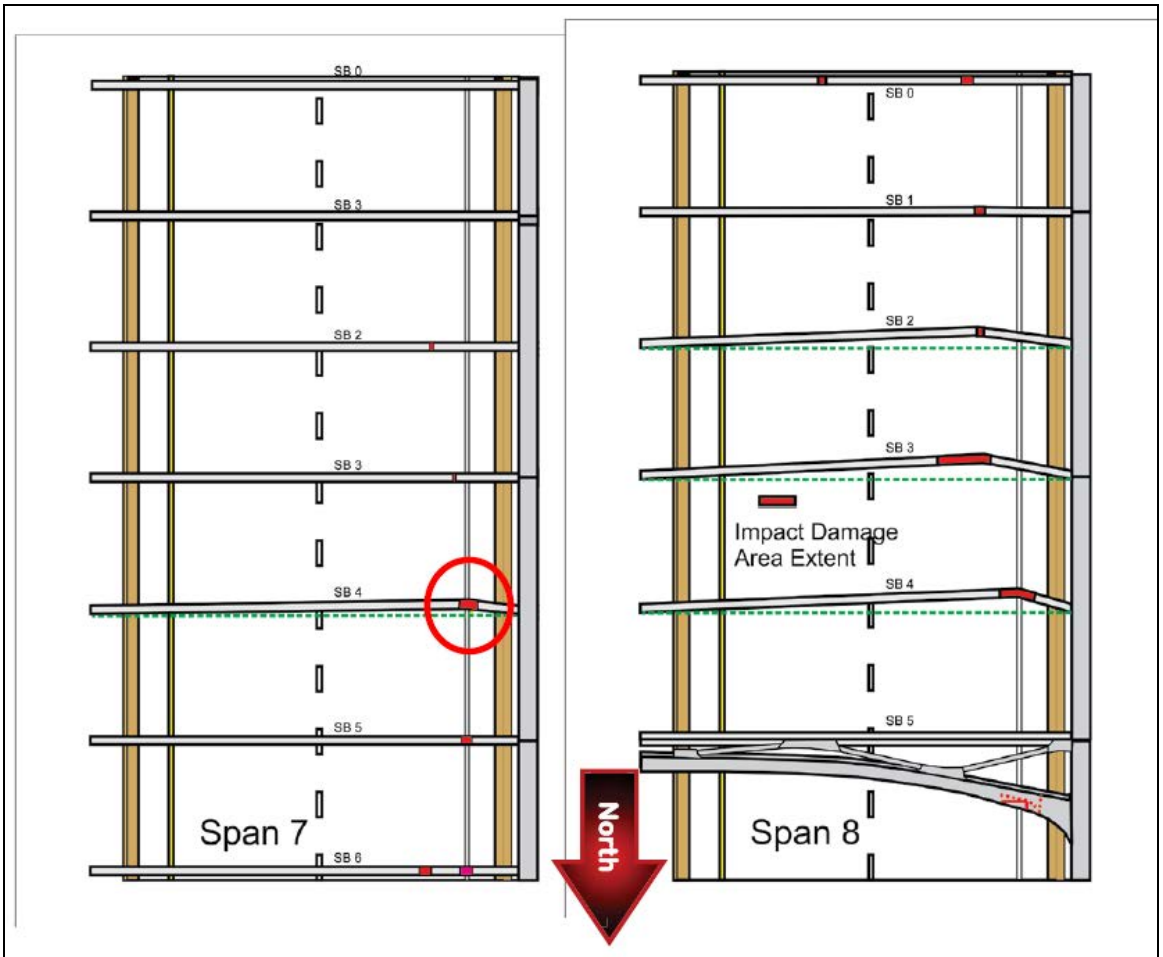


Figure 28. Top view summaries of damage to the span 7 sway braces at left with span 8 damage at right.

- **Page 11, Sway Frames Span 7, Sway Frame 4:**

  Sway brace 4 on span 7 is very similar to the configuration of sway brace 4 on span 8 and the damage from load impact is also similar. We believe that more data specific to the deformation, damage and displacement of sway brace 4 on span 7 and the associated members and connections may be helpful for possible future comparative analysis with sway brace 4 on span 8. Sway brace 4 on span 7 appears to have been impacted in a similar way yet bridge span 7 remains standing. We would be pleased to assist with this process, or take the lead under NTSB supervision.

Sway Frame 4

Sway frame 4 and the associated U4W-L4W vertical member were heavily damaged. The sway brace was impact damaged beginning at about 30 inches from the vertical and extending to at least 65 inches. In this area the lower north flange was rolled down and to the south with blue paint transfers noted on the north edge and top surface of the flange. The lower north flange was horizontally torn between 38 and 55 inches with a missing section centered at 45 inches. See Figure 24.

The sway frame was distorted and bowed to the south beginning near the vertical and across about 25% of the width of the span. The distortion bowed the sway brace an estimate 12 inches to the south.

The U4W-L4W vertical member was distorted to the south and east centered at the sway brace attachment area. The deflection was estimated to be about 12 inches to the south and several inches to the east. See Figure 24 Upper and Figure 25.

- **Page 12, Oversized Load:**

Note is made that there was damage to the upper right corner of the box structure and that the normally rectangular casing shed was racked from front to back with the roof displaced rearward:

Oversize Load

Inspection of the oversize load (casing shed) revealed impact damage to the upper right corner of the box structure. In addition, the normally rectangular casing shed was racked from front to back with the roof displaced rearward. See Figure 29. The exterior of the load was painted blue consistent with the blue paint transfers found on various components of span 7 and 8.

We recommend that a description of the damage of the rest of the load be provided. This information could be important in determining the overall energy imparted to the bridge components.

Racking of the load is shown in Figure 29 on page 37:

No specific information is provided on the measured angular displacement of the casing shed in the report. Red dotted lines at a right angle are superimposed over the photo, presumably to provide the reader with some reference as to the extent of the racking. Because the casing shed is shown in an oblique view rather than straight-on or orthogonal, however, the superimposed right angle inappropriately accentuates the racking: the angle depicted in Figure 29 measures approximately 5.5 degrees whereas the actual angle of the accident load racking was approximately 3 degrees (See photographs 8 to 12 below).

Photograph 8: Side view of the front of the load.

Photograph 9: Digital level positioned to obtain angle of trailer which is a similar angle as the base of the load.

Photograph 10: Trailer is sloping 1.1 degrees downward toward the front of the trailer.

Photograph 11: Digital level positioned to obtain the angle of the front surface of the load.

Photograph 12: Angle of the front surface of the load is 88.1 degrees (1.9 degrees from vertical) tilted toward the rear of the trailer. The total approximate angle is 3.0 degrees (1.1 plus 1.9).

While the 2.5 degree difference between the 3.0 degree actual scope of the racking and the 5.5 degrees shown in Figure 29 may not seem significant to the casual reader, the amount of energy required to achieve the relative different degree of deformation is substantial. In order not to mislead the reader, we suggest removing the red dotted lines and including the above photographs and analysis.

- **Page 20, Figure 9, Top Photograph;**

  The node in the photograph below appears to be **L4W**, not U3W. (The label in the photo is mis-labeled. The caption is correct.)

Figure 9. At left, node L4W being recovered attached to floor beam 4. Below, two views of bending overstress fractured member L4W-L6W.

- **Page 22, Figure 11**

  The node in the photograph below appears to be **U3E**, not U5W. The caption refers to the node as U5E. This is also incorrect. The node is **U3E**.

Figure 11. Node U5E with separated member U3E-L4E.

Page 31, Figure 21:

Two damage locations are shown on sway frame S8U0. While the reference to this damage implies that it is accident related, the distance from the inboard damage (circled in red) to the road surface (likely approximately 18 feet) would seem to make it unlikely that it is related to the 05/23/2013 accident. Is there any evidence that this inboard damage is from the subject accident? If not, we recommend that reference to the damage be removed from the report or it be noted that this damage is not likely accident related.

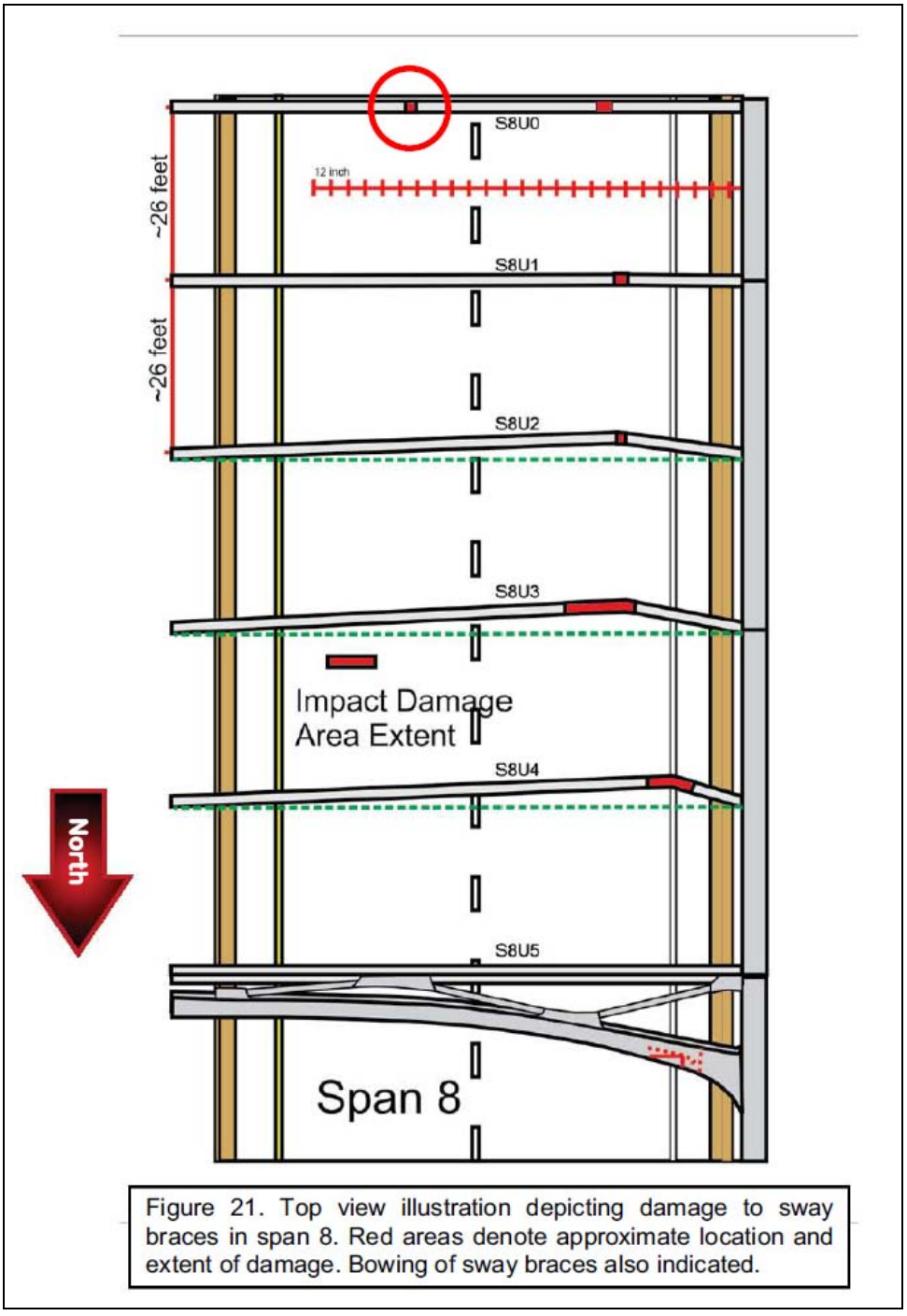


Figure 21. Top view illustration depicting damage to sway braces in span 8. Red areas denote approximate location and extent of damage. Bowing of sway braces also indicated.

- **General notes for Materials Laboratory Factual Report:**

  There are a number of specific measurements and distances provided throughout the report (i.e. page 9, North Portal section). We have no reason to believe the measurements are inaccurate; however, we have not performed our own independent analysis as verification.

  In some report sections such as Detailed Examination sections U5W and U4E, initial conclusions concerning the motion of the members and nodes during the event are made based on the configuration of deformation and fracture after the event. It is possible that the observed damage could have been created by alternate motions of the nodes and members during the event.

Materials Laboratory Draft Factual Report re Security Camera

- **Page 3: Results:**

  Reference is made on page 3 to the casing shed having two open sides with the interior painted white as well as a white trailer was on the east side of the casing shed, making it easily visible on the video.

> as an oversize load consisting of an oil field well casing shed. The casing shed (more fully described elsewhere) had two open sides with the interior painted white. Further a white trailer was on the east side of the casing shed making it easily visible on the video. From frame 0980 onward, changes in the locations and shapes of west truss

  The description accompanying Figure 3 on page 5, however, notes only the oversize load (with an arrow and blue box) but is silent about the white trailer on the east side of the load that is actually more prominently featured in the photo:

Figure 3. Frame 0980. Oversize load (arrow and blue box) approaches the north portal of the truss spans.

  Given the prominent role that both play in the accident, and that both are clearly visible, we respectfully suggest that the description be changed to read:

  Figure 3. Frame 0980. Oversize load and white trailer (arrow and blue box) approach the north portal of the truss spans.

Motor Carrier Factors Draft Factual Report

- **Page 25: 5.1 Vehicle Dimensions:**

Footnote 46 notes that the load sustained some damage both to the top and base and that the post-accident heights cannot be assumed to be the pre-accident heights:

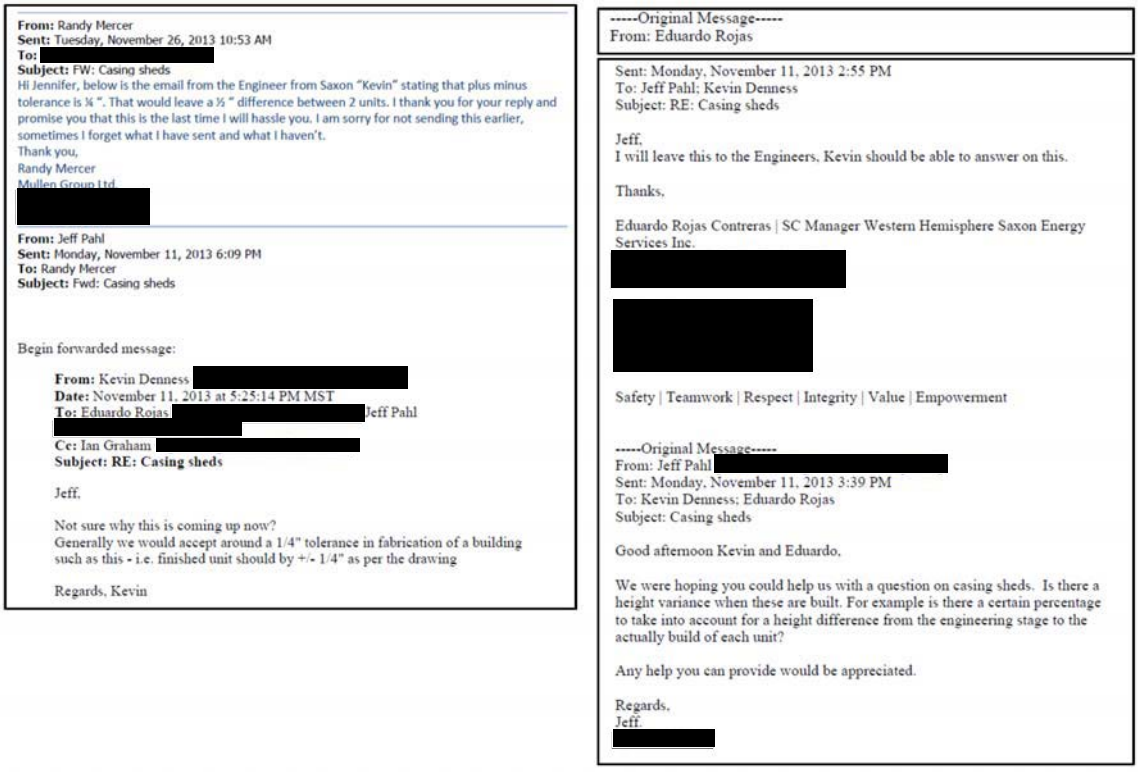
> The Vehicle Group Chairman measured the accident vehicle on level ground (post-accident) and determined the following heights:[66]
>
> - Left Front 15-ft $10^{7/8}$-in
> - Right Front 15-ft $11^{1/16}$-in (damaged from collision)
> - Left Rear 15-ft $6^{13/16}$-in
> - Right Rear 15-ft $5^{5/8}$-in
>
> [64] See Motor Carrier Attachment #14 – Accident and Post-Accident Trip Permits
> [65] See Motor Carrier Attachment #11 - Bill of Lading. The manufacturer indicated a weight of 40,000 lbs. and the bill of lading indicted a weight of 44,000 lbs.
> [66] Note – The load sustained some damage both to the top and base and cannot be assumed to be the pre-accident heights

- **Page 26: 5.1 Vehicle Dimensions:**

Height measurements are provided on page 26 from what are described as an exemplar vehicle and load. Footnote 67, however, limits the definition of exemplar to vehicles and vehicle components:

> The Vehicle Group Chairman also measured the trailing exemplar vehicle[67] and load on level ground and determined the following heights:
>
> - Left Front 15-ft $11^{7/8}$-in
> - Right Front 16-ft $^{3/8}$-in
> - Left Rear 15-ft $7^{5/8}$-in
> - Right Rear 15-ft 7¾-in
>
> [67] 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.

The referenced exemplar load, however, was another section of casing shed being transported by Mullen Trucking. Unlike vehicles, which are mass produced one after another on an assembly line, the casing shed sections at issue were individually fabricated to a tolerance of plus-or-minus 1/4 inches.



From: Randy Mercer
Sent: Tuesday, November 26, 2013 10:53 AM
To: [redacted]
Subject: FW: Casing sheds
Hi Jennifer, below is the email from the Engineer from Saxon "Kevin" stating that plus minus tolerance is ¼ ". That would leave a ½ " difference between 2 units. I thank you for your reply and promise you that this is the last time I will hassle you. I am sorry for not sending this earlier, sometimes I forget what I have sent and what I haven't.
Thank you,
Randy Mercer
Mullen Group Ltd.
[redacted]

From: Jeff Pahl
Sent: Monday, November 11, 2013 6:09 PM
To: Randy Mercer
Subject: Fwd: Casing sheds

Begin forwarded message:

From: Kevin Denness [redacted]
Date: November 11, 2013 at 5:25:14 PM MST
To: Eduardo Rojas [redacted] Jeff Pahl [redacted]
Cc: Ian Graham [redacted]
Subject: RE: Casing sheds

Jeff,

Not sure why this is coming up now?
Generally we would accept around a 1/4" tolerance in fabrication of a building such as this - i.e. finished unit should by +/- 1/4" as per the drawing

Regards, Kevin

-----Original Message-----
From: Eduardo Rojas

Sent: Monday, November 11, 2013 2:55 PM
To: Jeff Pahl; Kevin Denness
Subject: RE: Casing sheds

Jeff,
I will leave this to the Engineers, Kevin should be able to answer on this.

Thanks,

Eduardo Rojas Contreras | SC Manager Western Hemisphere Saxon Energy Services Inc.
[redacted]

Safety | Teamwork | Respect | Integrity | Value | Empowerment

-----Original Message-----
From: Jeff Pahl [redacted]
Sent: Monday, November 11, 2013 3:39 PM
To: Kevin Denness; Eduardo Rojas
Subject: Casing sheds

Good afternoon Kevin and Eduardo,

We were hoping you could help us with a question on casing sheds. Is there a height variance when these are built. For example is there a certain percentage to take into account for a height difference from the engineering stage to the actually build of each unit?

Any help you can provide would be appreciated.

Regards,
Jeff
[redacted]

When height measurements are set forth for comparative purposes in 1/8-inch increments, we respectfully suggest that unless detailed measurements of the "exemplar" casing shed were taken, this tolerance may be very important. If, for instance, the casing shed section in the accident was 1/4 inches under the design specification and the "exemplar" shed section was 1/4 inches taller than the design specification, each would be within the fabrication tolerances, but the comparative difference would be 1/2 inches. This, of course, is four times the 1/8 inch increments being measured and reported. Given this situation, we respectfully request that the following footnote be inserted after the word "load" in the first line of page 26:

The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches.

- **Page 26: Post-Accident Transportation:**

  This section provides a comparison of the heights set forth for the pre and post-accident permits for the accident vehicle and load and the exemplar vehicle and load:

5.2 Post-Accident Transportation

The accident load and the exemplar load were required to obtain new permits to move the loads to their destination in Vancouver WA because the time limits on the pre-accident permits in Washington had expired. These permit dimensions were re-measured by the carrier with other than the accident tractor or exemplar tractor attached. The Safety Board obtained copies of those permits that listed the following dimensions:

Accident Vehicle

Accident Permit
Height. 15 ft. 9 in.
Width 11 ft. 6 in.
Length 70 ft. 4 in.

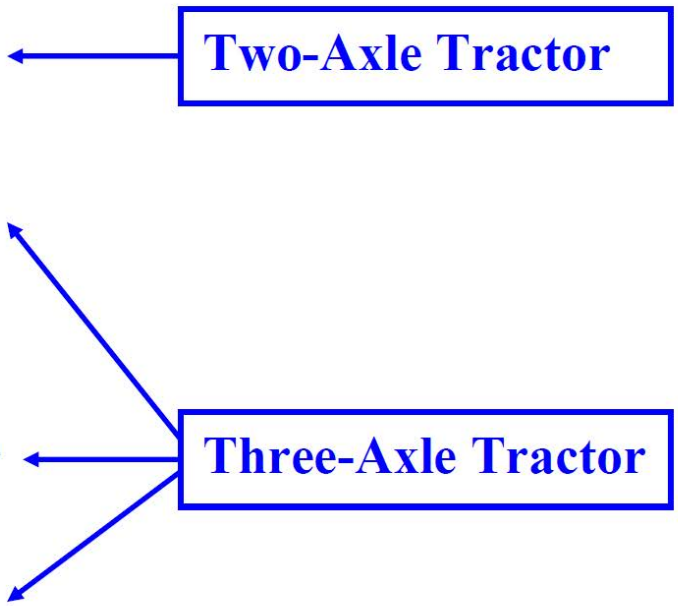
Post-Accident Permit
Height. 16 ft. 0 in.
Width 11 ft. 8 in.
Length 72 ft. 0 in.

Exemplar Vehicle

Pre-Accident Permit
Height. 15 ft. 11 in.
Width 11 ft. 8 in.
Length 71 ft. 9 in.

Post-Accident Permit
Height. 16 ft. 0 in.
Width 11 ft. 8 in.
Length 72 ft. 0 in.

(See Vehicle Group Chairman's Factual Report for additional information.)



(Arrows and text boxes in blue added)

Unfortunately, the accident permit was based upon the load being pulled by a two-axle tractor but the other three permits were based upon a three-axle or "tri-drive" tractor. The tri-drive tractor is larger than the double-axle tractor. These differences are particularly apparent when the accident permit length of 70 ft. 4 in. is compared with the length in the other three permits: 72 ft. 0 in.; 71 ft. 9 in.; and 72 ft. 0 in.

This discrepancy is partially noted at page 8 of the draft Vehicle Factors Report, 1.3.1.1 Accident Combination Unit, Oversize Load Permit:

1.3.1.1 OVERSIZE LOAD Permit

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.

Further reference to this issue is found on page 9 of the draft Vehicle Factors report, 1.3.2.1 Exemplar Combination Unit, Oversize Load Permit

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.

We respectfully suggest that the dimensional mis-match of tractors used for these measurements, in two instances combined with an exemplar load that could well be as much as ½ inches taller or shorter than the accident load, renders any comparison of the heights of the combined load-plus-tractor dimensions misleading. If the comparisons are to remain in the Motor Carrier and Vehicle Factors Reports (our preference is that they be removed), we request that the text above be included in the Motor Carrier Report or that the following footnote be added:

The three-axle tractor used for the accident-load post-accident permit and both of the exemplar-load permits was larger than the two-axle tractor pulling the accident load at the time of the accident.

Reconstruction Factors Draft Factual Report

- **Page 13, Vehicle Documentation, Accident Vehicle and Cargo:**

  Information on the measured distortion of the load and the shift of the load would be helpful under this heading. In this regard, our measurements indicate that the front of the load was shifted approximately 5 inches to the driver side from the centered position.

- **Page 17: 2. Vehicle Documentation:**

  Figure 15 on page 17 highlights a scrape on left the side of the casing shed:

Figure 15: Rearward termination point of longest damage on left side of casing shed.

This scrape is referenced in the report on page 15 as follows:

> The casing shed also exhibited scrape marks along a portion of the left side upper sidewall. These marks consisted of gouging to the painted surface with some indentation and tearing of the steel at the forward left corner. At the forward end, the contact damage terminated at multiple points with three individual areas being discernible. The areas of damage were longitudinally oriented and extended rearward along the face of the upper sidewall at an apparent uniform spacing. The marks also exhibited a change in vertical height as they progressed longitudinally.

The report goes on to reference and provide 3D post-accident scans of the involved 2013 Subaru Crosstrek (2.3 on pages 18 & 19) and Dodge Pickup Truck (2.4 at pages 20 & 21). No reference, photos or 3D scans, however, are found of the involved 2000 Kenworth truck tractor and 1996 utility refrigerator semi-trailer also involved (and referenced in the Motor Carrier Factors Report at pages 24 & 25 and the Vehicle Factors Report at pages 18 & 19). We respectfully suggest that

reference to this other vehicle be made and that some photographs be included. Here are four photographs from the investigation that are submitted for possible inclusion:

Here is the description of the blue paint transfer on the 2000 Kenworth combination unit from pages 18 and 19 of the Vehicle Factors Report that we recommend be included in this factual report:

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

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

- **Page 18: 2.2 Exemplar Transport Vehicle and Load:**

This report refers to the exemplar casing shed as an "identical" casing shed and the exemplar trailer as a "sister" trailer:

> 2.2 Exemplar Transport Vehicle and Load
>
> For comparison and documentation of an undamaged load and transport vehicle, an identical casing shed secured atop a sister trailer was coupled to the accident tractor. The exemplar combination was measured, photographed and scanned (using nine stations).

The Motor Carrier and the Vehicle Factors Reports, however, refer to the vehicle and casing shed both as "exemplars":

Motor Vehicle Factors Report at page 26:

> The Vehicle Group Chairman also measured the trailing exemplar vehicle[67] and load on level ground and determined the following heights:

Vehicle Factors Report at page 8:

> **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.

We recommend that the Reconstruction Factual Report replace "identical" and "sister" with "exemplar" and that it insert the definitional footnote for "exemplar" from the Motor Carrier and Vehicle Factors Reports:

> [67] 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.

> [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: 2A9PF4031VNxxxxxx, 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

At the same time, and as noted above, however, the referenced "exemplar load" was another section of casing shed being transported by Mullen Trucking. Unlike vehicles, which are mass produced one after another on an assembly line, the casing shed sections at issue were individually fabricated to a tolerance of plus-or-minus 1/4 inches. (See e-mails from the fabricator inserted above).

The Reconstruction Factors Draft Factual Report does not go on to make any use of the measurements involving the exemplar load that are referenced in the Motor Carrier and Vehicle Factors Draft Reports. In anticipation of the reconstruction analysis doing so, we note again that this plus-or-minus 0.25 inch tolerance may be very important. If, for instance, the casing shed section in the accident was 1/4 inches under the design specification and the "exemplar" shed section was 1/4 inches taller than the design specification, each would be within the fabrication tolerances, but the comparative difference would be 1/2 inches. This, of course, is four times the 1/8 inch increments being measured and reported. Given this situation, we respectfully request that the following footnote be inserted after the phrase "[exemplar] casing shed" in the second line of page 18:

The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches.

- **General notes for Technical Reconstruction Group Chairman's Factual Report**

  There are a number of specific measurements, weights and other technical data provided throughout the report. We have no reason to believe the measurements are inaccurate; however, we have not performed our own independent analysis as verification.

Survival Factors Draft Factual Report

- **Page 17: 3.0 Other Statements**

The report notes that the drivers (sic) of the 2000 Kenworth combination unit gave a statement to the Washington State Police which is summarized in Attachment 13:

> **3. Other Statements**
>
> The NTSB conducted interviews of the 2010 Kenworth combination unit driver (oversize load) and the 1997 Dodge Ram (pilot car) driver, and information is available in the Human Factor Group Chairman's Factual Report. The drivers of the 2000 Kenworth combination unit and the 1995 BMW gave statements to the Washington State Police, which are summarized in Attachment 13.[23]

We recommend changing "drivers" to "driver".

Mullen has not seen the transcript of the statement or the referenced summary. Are you able to provide us with a copy?

Vehicle Factors Draft Factual Report

- **Page 5, Damage Description:**

  Information on the measured distortion of the load and the shift of the load would be helpful in paragraph 3 under this heading.

> **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.

  Our measurements indicate that the front of the load was shifted approximately 5 inches to the driver side from the centered position.

- **Page 6: 1.3.1 Weights & Measurements – Accident Combination Unit**

  The report provides height measurements to the nearest 1/16 of an inch of the Accident Combination Unit, but then goes on to note that since the measurements were taken after the accident, with the load damaged and distorted, they do not reflect the "exact" pre-crash conditions:

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"

Given the measurements to the nearest 1/16 of an inch and the amount of damage to the load, particularly to the right front corner, we respectfully request that the characterization of the measurements not reflecting "exact" pre-crash conditions be replaced by a statement that the measurements simply do not reflect the pre-crash conditions (we request that the word "exact" be removed).

We note, in this regard, that the same measurements are referenced on page 25 of the Motor Carrier Draft Factual Report without any characterization as to how accurate or not they may be. Below is footnote 66 from that report: "Note – the load sustained some damage to both the top and base and cannot be assumed to be the pre-accident heights."

The Vehicle Group Chairman measured the accident vehicle on level ground (post-accident) and determined the following heights:[66]

- Left Front 15-ft $10^{7/8}$-in
- Right Front 15-ft $11^{1/16}$-in (damaged from collision)
- Left Rear 15-ft $6^{13/16}$-in
- Right Rear 15-ft $5^{5/8}$-in

[64] See Motor Carrier Attachment #14 – Accident and Post-Accident Trip Permits
[65] See Motor Carrier Attachment #11 - Bill of Lading. The manufacturer indicated a weight of 40,000 lbs. and the bill of lading indicted a weight of 44,000 lbs.
[66] Note – The load sustained some damage both to the top and base and cannot be assumed to be the pre-accident heights

- **Pages 8 & 9: 1.3.1& 1.3.2 Weights & Measurements – Oversize Load Permits for the Accident & Exemplar Combination Units**

As noted in our recommendations concerning the Motor Carrier Draft Factual Report, the accident permit was based upon the load being pulled by a two-axle tractor but the other three permits were based upon a three-axle or "tri-drive" tractor. The tri-drive tractor is larger than the double-axle tractor. These differences are particularly apparent when the accident permit length of 70 ft. 4 in. is compared with the length in the other three permits: 72 ft. 0 in.; 71 ft. 9 in.; and 72 ft. 0 in.

This discrepancy is partially noted at page 8 of the draft Vehicle Factors Report, 1.3.1.1 Accident Combination Unit, Oversize Load Permit:

> **1.3.1.1 OVERSIZE LOAD Permit**

> 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.

Further reference to this issue is found on page 9 of the draft Vehicle Factors report, 1.3.2.1 Exemplar Combination Unit, Oversize Load Permit

> **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.

We respectfully suggest that the dimensional mis-match of tractors used for these measurements, in two instances combined with an exemplar load that could well be as much as ½ inches taller or shorter than the accident load, renders any comparison of the heights of the combined load-plus-tractor dimensions misleading. We recommend that the comparisons be removed.

- **Page 8: 1.3.2 Weights & Measurements – Exemplar Combination Unit**

As noted above, the Report at page 8 refers to the vehicle and casing shed both as "exemplars":

> **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.

It includes a definitional footnote for "exemplar":

> [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: 2A9PF4031VNxxxxxx, 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

As noted twice above, however, the referenced "exemplar load" was another section of casing shed being transported by Mullen Trucking. Unlike vehicles, which are mass produced one after another on an assembly line, the casing shed sections at issue were individually fabricated to a tolerance of plus-or-minus 1/4 inches. (See e-mails from the fabricator inserted above).

We note again that if, for instance, the casing shed section in the accident was 1/4 inches under the design specification and the "exemplar" shed section was 1/4 inches taller than the design specification, each would be within the fabrication tolerances, but the comparative difference would be 1/2 inches. This, of course, is four times the 1/8 inch increments being measured and reported. Given this situation, we respectfully request that the following footnote be inserted after the phrase "exemplar load" in the first line of section 1.3.2 "Exemplar Combination Unit" on page 8:

The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches.

- **Page 13: 1.8 Braking**

The report announces on page 13 that the truck did not pass a post-accident low pressure warning test on the braking system and that, had this test been administered with this result prior to the accident, the truck would have been taken out of service according to CVSA Out-of-Service Criteria:

> 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.

We request that the following footnote be added to this section, or to any analysis that may eventually be associated with it:

There is no indication that brake failure or malfunction played any role in this accident.

- **Page 16, Vehicle 2 (Pilot Car) Section 2.2, Damage Description**

Note is made that the pole measured 16 feet 0 inches from the ground to its top when the Washington State Police measured it on the scene of the accident. Note is also made, however, that the NTSB measured the pole at 16 feet 2 inches on June 2, some ten days after 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 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]

There is no explanation as to the two inch discrepancy. To the extent that one exists, we recommend that it be included.

Note is also made that the pole on the Pilot Car was leaned 2 feet 1 inch in toward the center of the car:

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.

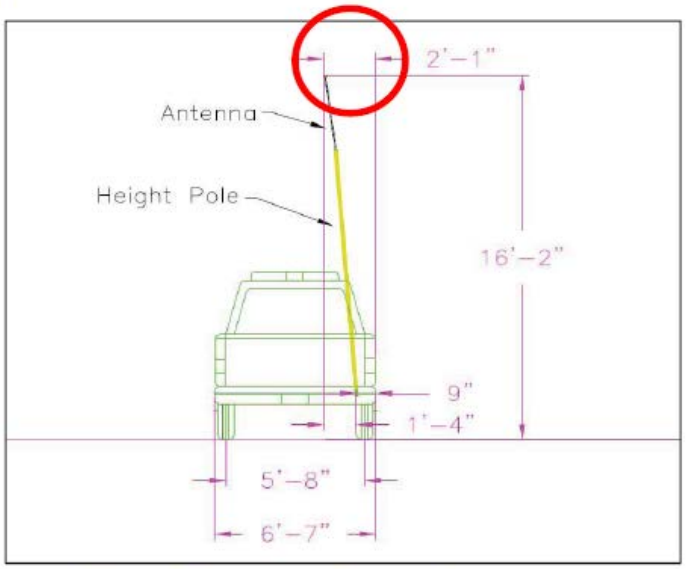
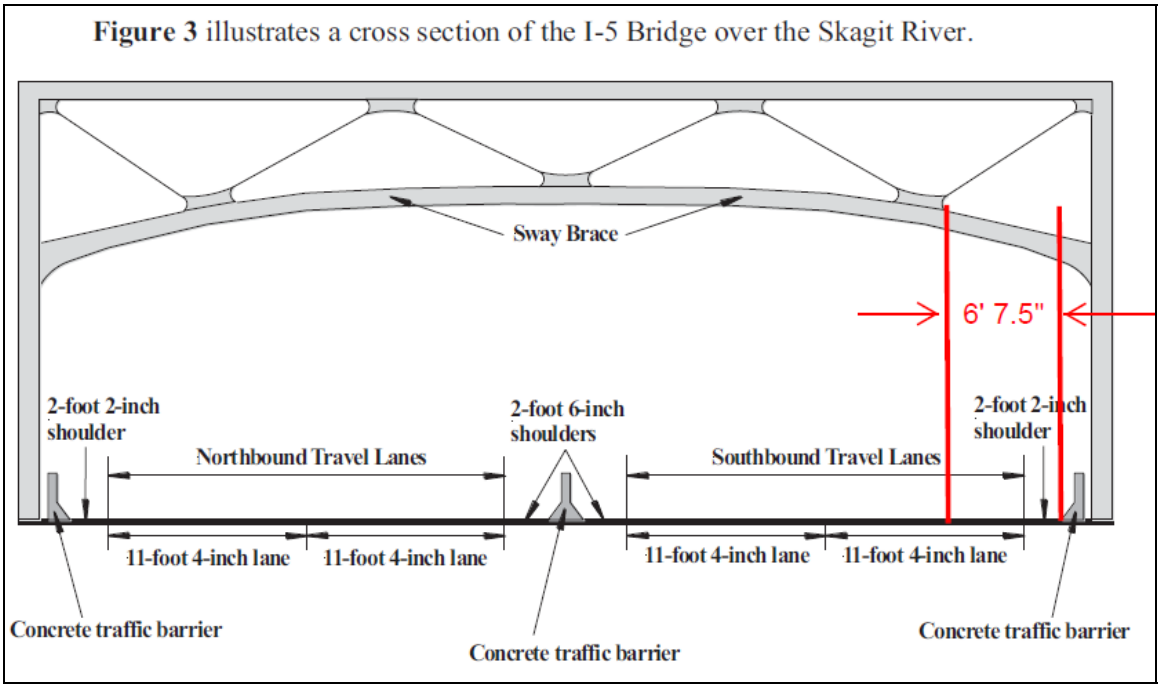


Figure 2. Rear view diagram of the pilot car

We recommend that a comparison be inserted in this report as to the height of the pole as compared with clearances at various locations within the southbound lanes and the sway braces at issue, taking into account the 2 feet 1 inch offset from the right side and possibly using both the 16 feet 0 inch and the 16 feet, 2 inch heights.

Consider Figure 3 from page 13 of the Highway Report, a copy of which is below. If, for instance, the 6-foot-7-inch wide pole car was in the center of the 11-foot-4-inch right south-bound lane, there would have been 2 feet 4.5 inches before the 2-foot-2-inch shoulder, ending at the concrete traffic barrier. But with the pole another 2 feet 1 inch toward the center of the pole car, the pole itself would have been at least 6 feet 7.5 inches from the concrete barrier (2 feet 4.5 inches + 2 feet 2 inches + 2 feet 1 inch). The red lines have been added to this Figure.

Figure 3 illustrates a cross section of the I-5 Bridge over the Skagit River.



While we do not know the heights from the roadway of span 8 to the sway brace 4, we do have those measurements from the roadway of span 7 to sway brace 6 from Table 13 on page 39 of the Highway Factors Report. This is the closest sway brace for which we have measurements to the accident location.

Table 13 – Survey of Vertical Height Clearances on the I-5 Bridge over the Skagit River

		Southbound Direction								Northbound Direction							
Span	Brace	Outside Concrete Traffic Barrier Edge	Edge Line - Solid White Line	Mid-Point Right Lane	Lane Line Broken White Line	Mid-Point Left Lane	Edge Line - Solid Yellow Line	Median Concrete Traffic Barrier Edge	Evidence of High Load Hits	Median Concrete Traffic Barrier Edge	Edge Line - Solid Yellow Line	Mid-Point Left Lane	Lane Line Broken White Line	Mid-Point Right Lane	Edge Line - Solid White Line	Outside Concrete Traffic Barrier Edge	Evidence of High Load Hits
	U6 Sway Brace	15.05	15.79	16.96	17.75	18.13	18.14	18.13	Yes	18.08	18.09	18.03	17.74	16.90	15.54	14.99	

From these two figures is clear that if the pilot car was in the middle of the right southbound lane, its pole was between what Table 13 refers to as the "Edge Line – Solid White Line" and the "Mid-Point Right Lane." The clearances for these two locations on span 7, sway brace 6, were 15 feet 9.5 inches (15.79 feet) and 16 feet 11.5 inches (16.96 feet), respectively

With the load on Vehicle 1 being 11 feet 6 inches wide (see page 4 of the Vehicle Factors report), the lanes being 11 feet 4 inches wide, and Vehicle 3 in the left lane immediately adjacent to Vehicle 1, it is likely that the load was to some extent in the shoulder area of the roadway. We note that for span 7, sway brace 6, the clearance at the outer edge of the shoulder (the Outside Concrete Traffic Barrier Edge) was only 15 feet 0.5 inches (15.05 feet). The oversized load permit was predicated upon a height of 15 feet 9 inches.

- **Page 18, Section 3, Vehicle 3:**

  Detailed information is provided concerning the weight configuration and damage for Vehicle 1, the Mullen Trucking 2010 Kenworth Truck Tractor with Aspen Flatbed Semitrailer and load. We understand that the evaluation of Vehicle 3, the second tractor/trailer that was overtaking Vehicle 1, was not conducted until it was located at a later date. However, we believe that data on the load, axle weights, and configuration would still be helpful in determining any contribution Vehicle 3 may have had on bridge member stresses and the dynamic response of the bridge during the event.

  In addition, more details on the observed damage to Vehicle 3 would help determine the sequence of events and the contribution that Vehicle 3 may have had on the position of Vehicle 1, the forces exerted on the Vehicle 1 load, and the location and distance of the impacts to the sway braces relative to the edge of the roadway. More specifically, if Vehicle 3 had not been immediately adjacent to Vehicle 1, Vehicle 1 may have been able to move toward the center of the bridge after the initial impact with the first sway brace, potentially reducing the severity or eliminating impacts to the other sway braces. More detailed information on the damage to Vehicle 3 could be used for a future analysis and reconstruction effort.

- **General Notes for Vehicle Factors Group Chairman's Factual Report**

  There are a number of specific measurements, weights and other technical data provided throughout the report. We have no reason to believe the measurements are inaccurate; however, we have not performed our own independent analysis as verification.

Highway Factors

- **Page 24 & 26: Sections 3.7 & 3.8: Bridge Damages**

  Section 3.7 describes in detail an 11/29/2012 northbound high load hit on the subject bridge that significantly damaged the first portal and two sway braces.

  Section 3.8 quotes an 8/25/2012 WSDOT routine bridge inspection report noting various sway and portal damage as a result of high load hits and then goes on to note that prior bridge inspection reports dating back to 9/14/2003 note similar damage:

> The WSDOT routine bridge inspection report dated 8/25/2012 for the I-5 Bridge over the Skagit River indicated the following:
>
> *"The following sways and portals have high load hits:*
>
> *Span 5 U1 portal has a small dent.*
> *Span 6 U2 sway is bent 1" over a 12", see photo #72.*
> *Span 6 U5 sway is bent 1" over 8".*
> *Span 7 U4 sway is bent 2-1/2" over 10".*
> *Span 7 U5 sway is bent 1/2" over 4".*
> *Span 8 U0 sway is bent 1" over 15".*
> *Span 8 U3 sway has two small nicks.*
> *Span 8 U5 portal is bent 1/2" over 4" in two places."*
>
> The WSDOT routine bridge inspection reports mention high load hits on the sways and portals on each of the routine bridge inspection reports dating back to 9/14/2003.

  Given this information, and the evidence of prior damage and repair to the critical U4W node, we would like to know if the NTSB did what they consider to be an exhaustive search for evidence of any prior repairs. If not, we would be pleased to take the lead with this work, or to assist the NTSB as they do so.

- **Page 30, Section 3.10, Fracture Critical Inspection Report dated 8/25/2012, Table 10:**

  We note the 2/25/2102 Fracture Critical Inspection Remarks section for span 8, West, U5-L4, state that "L4 is full of dirt and vegetation. The connection cannot be inspected."

8	West	U5-L4	Diagonal Member	L4 is full of dirt and vegetation. The connection cannot be inspected.

  This remark is also provided for several other lower members in the report. This indicates the actual condition of the U5-L4 member was not inspected and that other joints at the lower west node 4 were also not visible. This supports our previous recommendation that the fracture surfaces and connections at the lower west node 4 location be further examined for potential contribution to the 05/23/2013 failure. We would be pleased to take the lead with this work, or to assist the NTSB as they do so.

In general, we noted multiple locations in identified in Table 10 on the remaining spans of the bridge, and at the north pier for span 8 where lower connections at nodes, were not visible due to dirt, debris and vegetation. These conditions would likely be a source of moisture and could result in premature corrosion. This further supports our recommendation that the fracture surfaces and connections at the lower west node 4 location be further examined for potential contribution to the 05/23/2013 failure.

- **Page 40, Section 5.1**

It would be helpful to know specifically where the minimum low clearance applies relative to the roadway surface and/or what the definition of the road surface is. For instance, Table 13 on page 39, shows that the minimum vertical height clearances on the southbound and northbound spans 5 through 7 of the Skagit Bridge are 14 feet 9 inches (14.75 feet) and 14 feet 8 inches (14.67 feet), respectively, at the outside concreted traffic barrier edges:

Table 13 – Survey of Vertical Height Clearances on the I-5 Bridge over the Skagit River

		Southbound Direction								Northbound Direction							
Span	Brace	Outside Concrete Traffic Barrier Edge	Edge Line - Solid White Line	Mid-Point Right Lane	Lane Line Broken White Line	Mid-Point Left Lane	Edge Line - Solid Yellow Line	Median Concrete Traffic Barrier Edge	Evidence of High Load Hits	Median Concrete Traffic Barrier Edge	Edge Line - Solid Yellow Line	Mid-Point Left Lane	Lane Line Broken White Line	Mid-Point Right Lane	Edge Line - Solid White Line	Outside Concrete Traffic Barrier Edge	Evidence of High Load Hits
5	U1 Portal Brace	14.88	15.80	16.98	17.76	18.02	17.96	17.91		17.93	17.95	17.89	17.65	16.90	15.53	14.85	Yes
	U2 Sway Brace	14.90	15.83	17.09	17.74	18.04	18.04	18.04		18.02	18.05	17.95	17.71	16.93	15.57	14.87	Yes
	U3 Sway Brace	14.83	15.78	17.06	17.73	18.03	18.03	18.02		18.03	18.04	17.97	17.67	16.93	15.61	14.81	Yes
	U4 Sway Brace	14.84	15.78	17.02	17.70	17.99	18.01	18.00		18.00	18.00	17.94	17.67	16.92	15.57	14.75	
	U5 Sway Brace	14.80	15.74	17.01	17.73	18.06	18.07	18.06	Yes	18.04	18.06	18.01	17.69	16.95	15.52	14.67	
	U6 Sway Brace	14.93	15.76	17.04	17.65	18.03	18.04	18.04		18.04	18.07	18.03	17.75	16.96	15.55	[illegible]	
6	U0 Sway Brace	14.87	15.72	16.99	17.71	17.97	18.02	18.01		18.01	18.02	18.00	17.69	16.90	15.55	14.79	
	U1 Sway Brace	14.86	15.77	17.00	17.82	18.01	18.04	18.04		18.04	18.06	17.97	17.67	16.86	15.49	14.82	
	U2 Sway Brace	14.80	15.69	17.01	17.76	18.07	18.07	18.07	Yes	18.06	18.08	18.03	17.70	16.89	15.46	14.77	
	U3 Sway Brace	14.87	15.75	17.03	17.79	18.03	18.04	18.02		18.03	18.05	18.02	17.73	17.02	15.53	14.87	
	U4 Sway Brace	[illegible]	15.75	16.96	17.70	18.01	18.03	18.01		18.01	18.03	17.99	17.72	16.88	15.50	14.78	
	U5 Sway Brace	14.75	15.69	17.01	17.75	18.02	18.05	18.04	Yes	18.01	18.05	17.99	17.65	16.86	15.53	14.98	
	U6 Sway Brace	[illegible]	15.65	16.97	17.71	18.02	18.01	18.01		18.01	18.01	17.95	17.69	16.89	15.51	14.84	
7	U0 Sway Brace	14.83	15.65	16.98	17.71	18.01	18.02	17.99	Yes	17.98	18.00	17.98	17.67	16.93	15.55	14.71	
	U1 Sway Brace	14.84	15.70	16.99	17.72	18.00	18.05	18.04		18.01	18.02	17.96	17.68	16.90	15.57	14.87	
	U2 Sway Brace	14.84	15.71	16.98	17.70	18.03	18.08	18.08	Yes	18.06	18.07	17.98	17.66	16.88	15.56	14.86	
	U3 Sway Brace	14.94	15.66	17.01	17.72	18.06	18.09	18.11	Yes	18.07	18.09	18.00	17.69	16.88	15.55	14.93	
	U4 Sway Brace	14.99	15.88	17.06	17.84	18.10	18.12	18.11	Yes	18.06	18.07	18.00	17.72	16.90	15.56	14.80	
	U5 Sway Brace	15.01	15.75	17.02	17.76	18.06	18.10	18.09	Yes	18.06	18.07	17.98	17.68	16.87	15.55	14.88	
	U6 Sway Brace	15.05	15.79	16.96	17.75	18.13	18.14	18.13	Yes	18.08	18.09	18.03	17.74	16.90	15.54	14.99	
	Minimum	14.75	15.65	16.96	17.65	17.97	17.96	17.91		17.93	17.95	17.89	17.65	16.86	15.46	14.67	
	Maximum	15.05	15.88	17.09	17.84	18.13	18.14	18.13		18.08	18.09	18.03	17.75	17.02	15.61	14.99	
	Standard Dev	0.07 ft	0.06 ft	0.03 ft	0.04 ft	0.04 ft	0.04 ft	0.05 ft		0.03 ft	0.03 ft	0.03 ft	0.03 ft	0.04 ft	0.03 ft	0.08 ft	

This is about 6 inches below the 15 feet 3 inch clearance level that a warning sign is required per the 2011 WSDOT Traffic Manual (referenced on page 40):

> **5. WSDOT Low Clearance Policy**
>
> **5.1 WSDOT Traffic Manual**
>
> The WSDOT Traffic Manual[14] indicated the following regarding low clearance warning signs:
>
> *"(6) Low Clearance*
>
> *LOW CLEARANCE (W12-301) warning signs shall be installed where there is 15'3" or less of vertical clearance between the roadway surface and an overhead obstruction such as an overpass.*
>
> *The maximum legal vehicle height permitted on state highways is 14 feet (RCW 46.44.020). At the direction of the MUTCD, and through operational experience, a 15-inch buffer (which includes 3 inches for frost heave) has been added to the 14-foot maximum legal height, setting the minimum LOW CLEARANCE signing threshold at 15'3". Appendix 2-10 shows signing details.*

It is about 1 foot 3 inches below the 16 foot minimum mandated in the 2011 AASHTO document *A Policy on Geometric Design of Highways and Streets* (referenced on page 54):

> The AASHTO 2011 *A Policy on Geometric Design of Highways and Streets*[21] (or commonly known as the Green Book) recommended the following regarding vertical clearance:
>
> *"8.2.9 Vertical Clearance*
>
> *The vertical clearance to structures passing over freeways should be at least 4.9 m [16 ft] over the entire roadway width, including auxiliary lanes and the usable width of shoulders with consideration for future resurfacing. In highly developed urban areas, where attaining a 4.9 m [16 ft] clearance would be unreasonably costly, a minimum clearance of 4.3 m [14 ft] may be used if there is an alternative freeway facility with a minimum 4.9 m [16 ft] clearance.*

- **Page 62, Section 13, Inventory of Thru Truss Bridges in Washington State:**

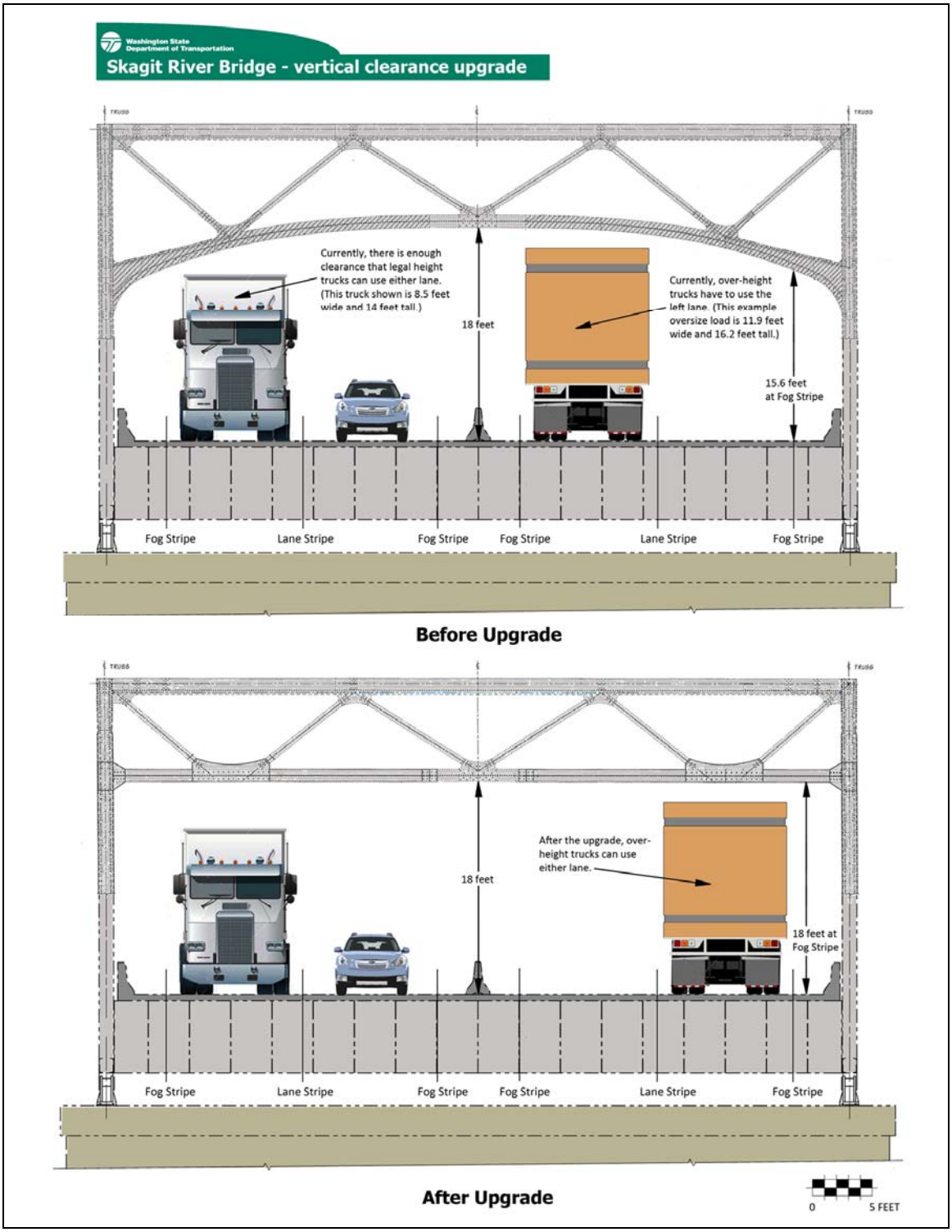
  The 5th line of the second paragraph states "…travel lanes and were **not** signed for low clearance" (emphasis added). We think it should state "…travel lanes and were signed for low clearance."

> **13. Inventory of Thru Truss Bridges in Washington State**
>
> **Table 17** provides an inventory of all thru truss bridges in Washington State sorted by Interstate, U.S. Highway, and State Highway. **Table 17** summarizes when each thru truss bridge was built, the minimum vertical clearance over the travel lanes, the minimum vertical clearance over the shoulder, and whether each thru truss bridge was signed for low clearance prior to the accident on May 23, 2013.
>
> Post-accident actions taken by the WSDOT included a review to determine if low clearance signs were installed for thru truss bridges with vertical clearances of 15'-3" or less over the travel lanes. Two (2) thru truss bridges, US-12 over Snake River Clarkston (#2348A) and SH-539 over Nooksack River (#3802B), had vertical clearances less than 15'-3" over the travel lanes and were not signed for low clearance. Six (6) thru truss bridges, US-101 over Sol Duc River (#3372A), US-101 over Sol Duc River #5 (#3372B), SH-109 over Humptulips River (#4874B), SH-203 over Skykomish River (#5294B), SH-410 over White River (#3523A), and SH-536 over Skagit River (#4400A), had vertical clearances of 15'-3" over the travel lanes and were not signed for low clearance. WSDOT has taken the steps to install low clearance signs at these locations.

- **Page 75, Section 15, Improvements made to the I-5 Bridge after the Incident:**

  Details on the retrofit to supports with reinforced steel components to add strength to the bridge in the event of another strike would be helpful in determining the potential areas of weakness and areas to concentrate any subsequent failure analysis.

> **15. Improvements made to the I-5 Bridge after the Accident**
>
> The WSDOT awarded a contract in August 2013 to upgrade the vertical clearance of the I-5 Bridge to 18 feet across all lanes in the remaining 3 thru truss spans (Spans 5, 6 and 7). The contract also included a proposal to retrofit several bridge supports with reinforced steel components to add strength to the bridge in the event it was struck again in the future. The work began on September 9, 2013 and the estimated completion date was late November 2013. **Figure 6** illustrates the vertical clearance upgrade to 18 feet across all lanes. The WSDOT project web page indicated the following:
>
> *"When crews finish raising and reinforcing the structure by November, the bridge will have an equal 18 foot vertical clearance across all lanes. Several bridge supports will also be retrofitted with reinforced steel components to add strength if the bridge is struck again."*



I-5 Bridge vertical clearance upgrade to 18 feet across all lanes.

(This is a cleaner copy of the Washington DOT illustration that forms the basis for Figure 6 from the NTSB draft Highway Factual Report. On the copy in the Report, the commentary is difficult to read.)

Video Study Factors Draft Factual Report

- **No comments or suggestions.**

Summary of Mullen Recommendations		
Report	**Report Page**	**Recommendation**
Human Performance	8	Add results of Washington State Patrol blood test of driver of Vehicle 1
	12	Change “right” to “left”
	24	Change “1.1.1” to “3.3.2”
	24	Provide copy of transcript of driver of Vehicle 3
	25	Interview driver of Vehicle 3 and report upon result
Materials	3	Perform material property testing on representative samples of bridge steel to confirm that it is, in fact, ASTM A7 carbon steel or A242 low alloy steel.
	4	Report upon condition of pin connections at south pier of span 8 at nodes L0E and L0W.
	4	Add photographs and inspection data from node 5
	6	Remove opinion that there was no pre-existing corrosion or cracking noted at any location on span 7 or 8.
	6	Remove opinion that all fractures and cracks were consistent with overstress forces
	6	Perform detailed visual, microscopic and laboratory examination of connection of sway frame 4 to the vertical member U4W-L4W, including the partial separation at the top edge of the sway brace, the complete fracture at the east flange and web, and the complete fracture at the lower edge of the sway brace attachment area (quantifying any lateral or rotational displacement).
	6	Perform detailed visual, microscopic and laboratory examination of connections at L4W node. This is particularly important given the notation in the 8/25/2012 WASDOT Fracture Critical Inspection Report (at page 30 of the draft Highway Factors Report) that the span 8, West, L4 node is “full of dirt and vegetation” and thus “cannot be inspected.”
	6	Perform detailed visual, microscopic and laboratory examination of connections to sway frame 3 to the vertical member U3W-L3W.
	7	Determine why the rivets at the connection of sway brace 4 to vertical member U4W-L4W were replaced with bolts.
	7	Determine what effect, if any, the replacement of rivets with bolts may have had on the failure of the connection of sway brace 4 to vertical member U4W-L4W.
	7	Determine why at least two rivets at the top of the U4W-L4W connection were cut and did not extend through the connections.
	7	Re-examine the connections at issue for any evidence of other cut rivets.
	7	Determine what effect, if any, these functionally missing rivets may have had on the failure of the connection of sway brace 4 to vertical member U4W-L4W.
	7	Change “U3W-U4W” to “U3W-U5W”
	7	Change “U3W-U5W” to “U3E-U5E”
	7	Change “U3E-L4W” to “U3E-L4E”
	8	Change “U3W-U5W” to “U3E-U5E”
	9	Include notation that the damage and deflection observed post-recovery in the sway braces on span 8 is likely a combination of (1) impact with the load, (2) the forces of the span collapse itself, and (3) recovery efforts.

Summary of Mullen Recommendations		
Report	**Report Page**	**Recommendation**
	11	Conduct a more thorough examination of the deformation, damage and displacement of sway brace 4 on span 7 for possible comparative analysis with sway brace 4 on span 8.
	12	Provide a description of damage to the load over and above the damages to the upper right corner and that it was "racked."
	12	Add the comment or footnote: "The Vehicle 1 Motor Carrier has submitted photograph comprising Figures 29a, 29b, 29c & 29d suggesting that the racking was approximately 3 degrees."
	20	Change "U3W" to "L4W"
	22	Change "U5W" tgo "U3E"
	31	Either remove reference to the inboard damage on sway frame S8U0, or note that the damage was not likely from this accident.
	37	Remove the red dotted lines in Figure 29
	37	Insert the photographs provided as Figures 29a, 29b, 29c & 29d, along with the provided captions and analysis.
Materials – Sec Cam	3	Change the description for Figure 3 to read "Frame 0980. Oversize load and white trailer (arrow and blue box) approach the north portal of the truss spans."
Motor Carrier	26	Insert footnote after the word "load" in the first line: "The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches."
	26	Either remove this Post-Accident Transportation section entirely or make specific note that (1) the Accident Vehicle Post-Accident Permit, (2) the Exemplar Vehicle Pre-Accident Permit and (3) the Exemplar Vehicle Post-Accident Permit were all based upon being transported by a three-axle tractor and add the footnote: "The three-axle tractor used for the accident-load post-accident permit and both of the exemplar-load permits was larger than the two-axle tractor pulling the accident load at the time of the accident."
Reconstruction	13	Add information on the measured distortion of the load and the shift of the load. In this regard, our measurements indicate that the front of the load was shifted approximately 5 inches to the driver side from the centered position.
	17	Add photographs of Vehicle 3.
	17	Add description of damage to Vehicle 3 from pages 18 & 19 of the draft Vehicle Factors Report
	18	Replace "identical" and "sister" with "exemplar"
	18	Add the following footnote the first time the word "exemplar" is used: "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 features."
	18	Insert footnote after the phrase "[exemplar] casing shed" in the second line of page 18: "The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches."
Survival	17	Change "drivers" to "driver"
	17	Provide copy of transcript of driver of Vehicle 3.
Vehicle	5	Add information on the measured distortion of the load and the shift of the load. Our measurements indicate that the front of the load was shifted approximately 5 inches to the driver side from the centered

Summary of Mullen Recommendations		
Report	**Report Page**	**Recommendation**
		position.
	6	Remove the word “exact” from the characterization of the measurements
	8 & 9	Either remove this Oversize Load Permits section entirely or make specific note that (1) the Accident Vehicle Post-Accident Permit, (2) the Exemplar Vehicle Pre-Accident Permit and (3) the Exemplar Vehicle Post-Accident Permit were all based upon being transported by a three-axle tractor and add the footnote: “The three-axle tractor used for the accident-load post-accident permit and both of the exemplar-load permits was larger than the two-axle tractor pulling the accident load at the time of the accident.”
	8	Insert the following footnote after the phrase “exemplar load” in the first line of section 1.3.2 “Exemplar Combination Unit” on page 8: “The casing shed fabricator advises that the manufacturing tolerance for the shed sections was plus-or-minus 1/4 inches.”
	13	Add the following footnote to this section, or to any analysis that may eventually be associated with it: “There is no indication that brake failure or malfunction played any role in this accident”
	16	Provide an explanation, if one exists, for the discrepancy between the 16 feet 0 inch pilot pole height measurement taken on the scene and the 16 foot 2 inch measurement taken approximately ten days later.
	16	Insert a comparison as to the height of the pole as compared with clearances at various locations within the southbound lanes and the sway braces at issue, taking into account the 2 feet 1 inch offset from the right side and possibly using both the 6 feet 0 inch and the 6 feet, 2 inch heights.
	18	Add any available information or data on the load, axle weights and configuration of Vehicle 3.
	18	Add more detailed information about the damage to Vehicle 3.
Highway	24	Please advise whether or not NTSB did what they consider to be an exhaustive search for evidence of prior repairs to the critical U4W node.
	40	Provide a table, figure or correlation between the minimum clearances relative to the roadway surface.
	62	Remove the word “not” from “travel lanes and were not signed for lower clearance.”
	75	Provide details of retrofit to supports with reinforced steel components.
	76	Use a higher-resolution copy of the Washington DOT illustration of the bridge upgrade. This illustration is available for download at http://www.flickr.com/photos/wsdot/9358520389/in/set-72157634783575356
Video Study	-	No comments or suggestions