Please accept NTSB's formal request for documentation for the Tempe accident investigation. Embedded in this request are several questions that are we likely will discuss in an upcoming interview(s), a roadmap, if you will, of what is on our mind and areas of discussion that would be helpful to us. Please consider those questions as you are gathering and researching for our document request. We do not need formal answers to the questions now.

A. Information specific to how the bridge failed. (Video request was discussed and approved, we will forward separately for your review)
B. General design and number of bridges in the UP System that are or not load path redundant – definition will be provided
C. Bridge Inspection information
D. Risk Assessment information

A. 1. UPRR should provide a design drawing of the old bridge and the new bridge design with the joints numbered for the east and west truss (i.e.: U1E L1W etc...) destroying the TSTT. **Provided old bridge drawings for Steel Trusses (all spans). Link to location of the drawings:**
Link to UPRR Drawings (https://updrop.upcorp.ad.uprr.com/)

Overall Bridge Layout Sheet 32 of 72
100' Spans 1 & 9 – Sheet 37 of 72 Joint Layout As shown below Details sheets 37-47 (east truss)
150' Spans – Joint Layout Sheet 48 of 72 Details sheets 48-59 (west truss)
160' Spans – Joint Layout Sheet 60 of 72 Details sheets 60-72 (not involved in derailment and rebuild)

2. If the on-scene inspectors were able to determine the mode of failure i.e.: which joint of the truss was impacted; that is needed to describe the mode of failure. Additionally, I'm guessing that after the through truss collapsed then multiple cars fell and impacted segment E, TST or timber stringers in segment E. (**Any photographic documentation gathered by UP personnel on this topic would be helpful and is requested**) **The inspectors on scene were not able to determine the mode failure or which joint of the truss was impacted first. There were many members damaged with multiple impacts and the team was not able to determine which member may have caused the structural failure. Pictures after the derailment are included in: Email: Tempe (919.13 Phoenix Sub.) – A2**

3. What was the engineering rational for the replacement spans being a new design? In other words, was it a safety related decision or one involving being able to make repairs more quickly and economically? **The new bridge design was selected based on the spans that were damaged beyond repair and the requirements of the city of Tempe. The portion of the new bridge is designed to the most current Union Pacific standards.**

B. 1. The number of bridges in the UP system is requested along with a breakdown by type of the 32 superstructure span descriptions listed in the Bridges Safety Management Program Manual (BSMP) Also indicate which type of superstructures are load path redundant. (Follow the following definition of load path redundancy found in the AASHTO Load Resistance Factor Design Manual (LRFD)) **Union Pacific follows AREMA recommended practice and we use ASD code for design. There are selected bridges with multi beams that may be considered as "load path redundant" (LPR). They are included in the email with summary and marked in the LPR column.**

Bridge Span Type	Bridge Span Descriptions	LPR	Not LPR	Total	
BM	Steel Beam Span	4,604	730	5,334	
BMC	Steel Beam Span Continuous	1,412	14	1,426	
CAB	Concrete Arch Bridge	-	196	196	
CBDY*	Car Body	-	262	-	
CEB	Concrete Encased Beam	-	334	334	
CTG	Concrete Through Girder	-	46	46	
DPG(M)	Deck Plate Girder	942	3,999	4,941	Movable and Not Movable
DTP	Deck Truss Pinned	9	23	32	
DTR	Deck Truss Riveted	33	67	100	
PCB	Prestressed Concrete Box	12,720	-	12,720	
PCI	Prestressed Concrete I-Beam	256	-	256	
PCS	Prestressed Concrete Slab	3,652	-	3,652	
PCT	Prestressed Concrete Tee	2,284	-	2,284	
PTC	Post Tension Concrete	109	-	109	
PTP	Pony Truss Pinned	1	-	1	
PTR(M)	Pony Truss Riveted	8	19	27	Movable and Not Movable
RCS	Reinforced Concrete Slab	7,288	-	7,288	
RCT	Reinforced Concrete Tee	3,978	-	3,978	
RG	Rail Girder	211	1	212	
RT	Rail Top	1,004	-	1,004	
SAB	Stone Arch Bridge	34	-	34	
TPG(M)	Through Plate Girder	2,052	-	2,052	Movable and Not Movable
TSG	Timber Stringers – Glulam	4,670	-	4,670	
TST	Timber Stringers	20,904	-	20,904	
TTP(M)	Through Truss Pinned	162	-	162	Movable and Not Movable
TTR(M)	Through Truss Riveted	594	-	594	Movable and Not Movable
WAG*	Wagon Bridge	-	-	-	*Non-Rail Bridges

2. Number of Bridges replaced each year. 10 to 20 years.

YEAR	Bridges Replaced
2011	63
2012	86
2013	67
2014	130
2015	133
2016	197
2017	240
2018	228
2019	228
2020	155
TOTAL	**1,527**

3. Number of FRA reportable derailments in close proximity to a bridge. You may define proximity as within 50 feet of the bridge as indicated in AREMA inner Guardrail specifications. **Unknown.**

4. Number of known collapses resulting from a derailment with railroad equipment striking the superstructure. **Eight, including the event last year in Tempe.**

5. Similar to AASHTO, does AREMA or the FRA recommend using a load path redundant bridge as a replacement when the railroad elects to replace a bridge or builds a new bridge? Describe examples of when or where UP would design redundant load path bridges or currently has those in service (i.e., multiple track configuration, metropolitan environment with roadway underpasses?) **Neither AREMA nor FRA makes any recommendations addressing type of bridge to be used.**

C. 1. Please provide the UPRR standard practice for installation of the inner guardrails. (We have the copy of the UP Standard for inner guard rails, what does UP's Standard Practice or Standard Procedures describe to those who install inner guard rails?)? **UPRR Engineering Track Maintenance Field Handbook contains the following in section 4.3.**

4.3 Inside Guard Rails

Refer to Engineering Standard Drawing Nos. 4000 to 4004 to determine which structures require inside guard rails. Refer to Engineering Standard Drawing Nos. 4005 to 4008 to determine turnout guard rail use. These drawings also show construction details.

Follow these guidelines for keeping inside guard rails fully plated, bolted and spiked:

1. On tangent track, spike the inside guard rail with two spikes per plate on each rail on the tangent portion, and four spikes per plate on each rail on the curved portion.
2. On curved track, spike the entire inside guard rail with four rail spikes per plate on each rail.
3. Do not install joints in the curved portion of the inside guard rail except where an insulated joint is required in signalized territory.
4. The rules with regards to Torch Cut Rail and Torch Cut Bolt Holes do not apply to inside guard rails. Inside guard rails may be torch cut to fit and can utilize torch cut bolt holes.

2. Please research how this practice came into being and when. In other words, see if you can determine when AREMA began recommending this to railroads and when did UP initially placed this in their policies. (If different from the date on UP's Standard Plan for inner guard rails). **We were unable to determine when the use of Inner Guard Rail (IGR) was first mentioned in AREA (Currently AREMA). The earlier records that we were able to find date to 2004 and current language was adopted in 2016. Please see: Appendix A for details.**

3. Please determine how many other locations where the inner guardrails have not been installed as recommended. **The Inner Guard Rail is installed when new ties are installed on the bridge. The Inner Guard Rail has not yet been installed in 209 locations out of a total of 635.**

IGR Installed	IGR not installed
426	209

4. Determine whether this bridge ever had an inner guard rail, or it was removed etc.… and when. **The bridge had an Inner Guard Rail before the derailment on July 26, 2020. Around July 8, 2020 approximately 53' of the end of the south approach section of the IGR was temporarily removed in order to allow tamping of the track. That portion had not yet been reinstalled prior to the derailment on July 7th.**

5. Determine if this is a standard item of inspection that bridge inspectors are supposed to look for. And when did it become an inspection item if it was an add-on item. (Training module info) **Yes, this is a standard item of inspection on bridges that Union Pacific bridge inspectors look for. This has been a requirement since 2009. See inspection report in Appendix B with highlighted record where the IGR inspection is noted.**

D. Risk Assessments – Similar to looking at risks around an open deck bridge such as train traffic, adverse geometry, speed of trains, high hazmat volumes, height of bridge and other items used to justify the use of inner guard rails; does UP do a similar risk assessment when prioritizing bridge replacement? **Yes, Union Pacific uses a risk based assessment for prioritizing bridge replacements. Bridge replacement is primarily condition based driven. There are several other factors that influence the decision to replace structures. Those are: location of the structure, train tonnage that passes across the structure, frequency of maintenance responses, potential of drift, potential of fire, track alignment, and age of the structures (fatigue consideration).**

More specifically, does the railroad consider all of the items listed above and potential catastrophic consequences if a derailment with collapse occurred on a bridge that spans over populations at risk, such as schools, hospitals, nursing homes, and other critical infrastructure? **These factors would come into play only if two or more bridges being considered for replacement had similar conditions. In such cases, the priority would be given to the bridge located in the environments mentioned.**

We recognize this is probably part of an overall safety system policy question, but we needed to know if as part of policy consideration were given to replacement with a redundant load path bridge of the bridge being replaced spanned vulnerable populations etc.…Believe this an industry wide question. **Union Pacific, similar to other railroads, does not typically take redundancy into consideration when determining the type of structure to use. When decisions are made regarding span type, multiple issues are considered including the length of spans needed, construction methodology, access, … etc.**

Documents:

1. Description of Bridge Capital Asset replacement program should discuss both 5 year and 10-year plans. **Railroad replacement structures are chosen based on span length and depth requirements or restrictions. In addition, replacements are evaluated based on condition of the existing structures. Bridges are inspected bi-annually and are prioritized for replacement based on:**
    - **Condition of components(substructure and superstructure)**
    - **Horizontal alignment**
    - **Frequency of maintenance repairs**
    - **Drift risk**

- **Fire risk**
- **Potential of scour**
- **Frequency of train traffic and tonnage of the line**
- **Type of commodity transported**
- **Location of the structure with regards to human population**

Our capital plan is updated annually with a 3-year forward look. Exceptions may apply to high cost projects that require extra lead time with regards to permitting and material fabrication.

2. Description of how the bridge risk assessment program influences the Capital Planning process. **Please see above mentioned description.**

3. I am aware that UP has started developing a Safety Management System through its Office of Safety, what bridge programs, if any, are part of UP's SMS? **We contacted Dan Blank, our AVP and Chief Safety Officer, and he was unaware of this initiative.**

APPENDIX A

4.10.2 METAL GAGE SIDE GUARD RAILS (2004)

a. Consideration should be given to the use of metal inner guard rails taking into account the alignment, train speed, deck type, density and type of traffic, as well as height and length of bridge.

b. It is recommended that the inner guard rails, when used, be steel track rails not higher than the running rails. If 5 inches or more in height they should not be more than 2 inches lower than the running rails. If less than 5 inches in height they should not be more than 1 inch lower than the running rails. Normally, they will consist of two rails, spaced about 10 inches inside the running rails (measured between near sides of head) spiked to every tie and spliced with joint bars, fully bolted. The inner guard rails may be tie plated when deemed advisable. They must not contact tie plates of tracks carrying electric signal circuits. Where they protect against a hazard on one side only, a single line of rails may be used, adjacent to the running rail further from the hazard.

c. It is further recommended that where inner guard rails are used, they extend at least 50 feet beyond the end of the bridge or other structure. This distance may be increased where train speed, curves or other factors warrant the increase, and may be decreased on the leaving end where traffic is in one direction. The ends should run to the center of the track and be beveled, bent down or otherwise protected against direct impact. A filler block or plate should be provided at the meeting of the converging rails.

4.10.3 COMBINED USE OF GUARD TIMBERS AND GUARD RAILS (1988)

Where both guard timbers and inner guard rails are used they should be so spaced that a derailed truck will strike the inner guard rail and not the timber.

2.2.5.2 Inner (Gage Side) Guard Rails (2016)

a. Consideration should be given to the use of inner guard rails taking into account the bridge type, alignment, train speed, deck type, density and type of traffic, as well as the height and length of the bridge.

b. Inner guard rails should be steel track rails not higher than the running rails and not lower than 2 inches below the
running rail surface. Normally, they will consist of two rails, spiked to every tie and spliced with fully bolted joint bars and constrained from longitudinal movement as necessary. On open deck structures, the distance between the head of the running rail and head of the guard rail should be 10 inches. On ballast deck structures the distance may be increased to allow for mechanized tamping of track. This increase should not be so great as to permit a derailed car to strike the structure. Tie plates may be used with inner guard rails when deemed advisable but they must not contact the plates of the running rails carrying electric signal circuits. When the inner guard rail is intended to prevent contact on one side only, a single line of rails may be used, adjacent to the running rail furthest from the hazard.

c. Where inner guard rails are used, they should extend at least 50 feet beyond the end of the bridge or other structure being protected. This distance may be increased or decreased where train speed, curves or other factors warrant. The ends should run to the center of the track and be beveled, bent down or otherwise protected against direct impact. Where two inner guard rails are used, a filler block or plate should be provided at the meeting of the converging rails.

2.2.5.3 Combined Use of Tie Spacers and Inner Guard Rails (2016)

When inner guard rails are used in conjunction with continuous tie spacers fastened to the top of the tie, the tie spacers should be located a sufficient distance from the inner guard rail to prevent a derailed wheel from making contact with the tie spacer.

APPENDIX B

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PHOENIX SUB: Data last refreshed on 3/3/2021 7:56:41 AM.

B2>>> 913.91(1)   [SIMN] TEMPE  (MARICOPA, AZ)                                          OR   SB   SP   FS   PT
SNOOPER - S1 - Last Snooper Insp = 02/12/2020 - PLATE ID: 913.93                        556   5    5    5    5
Segment A      60'   PCB          2 spans   1990                                              6    6    0
Segment B     100'   TTROD        1 span    1912                                              5    5    5
Segment C     920'   TTPOD        6 spans   1912                                              6    5    5
Segment D     139'   PCB          5 spans   2020                                              6    6    0
Segment E     133'   TPG          1 span    2020                                              6    6    6
Segment F     179'   PCB          6 spans   2020                                              6    6    0
           -------
Total       1,531'

LAST INSP: A-7/9/2020; I-12/7/2020; Q-12/2/2015; S-2/12/2020; U-8/28/2019; O-9/10/2020

MGT:        4          TPD:  4          POSTED CLEARANCE:  16'4"
ACCESS:     ROW Road   PHOTOS:        11  (12/07/20)
LATITUDE:   33.43516   LONGITUDE:  -111.9441
TRESPASS:   SIGN(S) PRESENT - 2
UTILITIES:  Fiber Optics - Right

913.91(1)    [SIMN] TEMPE  (MARICOPA, AZ)   OVER: Salt River
SEGMENT A
(2)PCB-BD (Prestressed Concrete Box)      LENGTH: 60'   BUILT: 1990 / 1990

1      S C    O  O  O  O                          O       7'6"                            6

     C      PRESTRESSED CONCRETE BOX                             30                            6
2      S C    O  O  O  O                          O       16'7"X                          6

     C      PRESTRESSED CONCRETE BOX                             30                            6
ASBESTOS:          DOES NOT CONTAIN
PILING:            1-2                             (4)  SIZE: 14 x 73  HP  A-36  S
CAPS:              1-2                             (1)  32.0" X  32.0" X  14.8'  C
DECK FLOOR TYPE:   Concrete      THICKNESS: 30"
DECK WIDTH:        12'  5"
BALLAST DEPTH:     16"
BALLAST RETAINER:  18" high  Concrete
WALKWAY:           LEFT: Concrete;  RIGHT: Concrete
HANDRAIL:          LEFT: Steel Cable;  RIGHT: Steel Cable
APPROACHES LOW:    NO          RC: O
RAIL:              136 LB Continuously Welded
SPEED:             25 MPH (FREIGHT)
FRA CLAS:          4
ALIGN:             SPIRAL RIGHT 3 DEG
SUPERELEVATION:    BALLAST 0-1/4"
NO GUARDRAIL ON BRIDGE SEGMENT TRACK - Status Date: 05/23/16
BRIDGE PROFILE:    GOOD
NO STANDING WATER
UNDERWATER INSPECTION NOT REQUIRED
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