Response to CHRSA letter, "Response for Stop Work Order"

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August 27, 2018

To: Frank Vacca
CHSR Authority Chief Program Officer
Rail Operations Branch
770 L Street, Suite 620
Sacramento, Ca. 95814

RE: CHSRA DID NOT DESIGN SAFE AND RELIABLE HIGH-SPEED RAIL CURVES NEAR THE SAN JOAQUIN RIVER. THIS IS A SECOND REQUEST FOR IMMEDIATE STOP WORK ORDER FOR MERCED TO FRESNO SECTION.

Dear Mr. Vacca,

On April 11, 2018, Mr. Brian Kelly, Chief Executive Officer for the California High-Speed Rail Authority (CHSRA) was sent an email with the title, "Request for Stop Work Order for Merced to Fresno Section." On April 17, 2018, each member of the CHSRA Board also received a copy of the same report at the California High-Speed Rail Board meeting held in Los Angeles. At the end of the meeting, I had the opportunity to discuss my concerns with Mr. Kelly.

The initial report demonstrated that the HSR track curve designs were so poorly engineered that the opportunity for derailment was an imminent hazard if the construction of the bridges near the San Joaquin River was not stopped immediately. Attached to the report were over twenty pages of documents and photos related to the track curve designs near the San Joaquin River north of Fresno. Also attached was an article from the New Yorker magazine regarding the 2013 train derailment in Spain; the article contained an excellent explanation of centrifugal forces. See attachments 4 & 5, "The Physics of High Speed Trains." This centrifugal force, inherent in all train movements through curves, was not properly addressed in the CHSRA final curve designs.

On July 25, 2018, you responded on the behalf of Mr. Kelly with a two-page letter, which listed seven concerns you felt were raised by my memo, a copy of the memo is attached. Of the concerns listed, only the first item was addressed. "The alignment is not straight." At the bottom of the first page was an explanation as to why the tracks have curves, but this explanation does not discuss why the dangerous curve designs are used throughout the Merced to Fresno segment of the corridor. In total, there are approximately eleven bad curve designs in this sixty mile segment. All of these curves designs should be carefully reviewed.

You also did not address the other six items on your list.

On the second page of your response, you summarized the 2013 high-speed derailment in Spain, focusing on the speed of the train and the operator error. The New Yorker article was submitted because of the excellent explanation of centrifugal forces. You overlooked that information in your response.

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Here are the highlighted quotes about centrifugal force from the article:

- “High-Speed rail…must be carefully designed to handle the physical forces imposed upon them by multi-ton trains moving at high-velocity.”
- “One of those forces is centrifugal (“to flee from the center”) force, the inertia that makes a body on curved path want to continue outward in a straight line.”
- “As it increases, more and more of the weight of the train is transferred to the wheels on the outermost edge of the track, something even the best-built trains have trouble coping with. That’s where the concepts of minimum curve radius and super-elevation, or banking, come in.”
- “Banked curves, in which the outer edge of the track is higher than the inner edge, balance the load on the train’s suspension. Since gravity pulls a train downward and centrifugal force pulls it outward, a track banked at just the right angle can spread the forces more evenly between a train’s inner and outer wheels, and help to keep it on the track.”

For further clarification, see Attachment 1, Diagram for the Superelevation of Tracks.

Written Correspondence by the Authority staff:

On August 2, 2018, Annie Parker, Information Officer II for the California High-Speed Rail Authority, sent a short email with this further explanation in support of your memo;

“We wanted to check in with you regarding the response letter we sent you on July 25th regarding your question to CEO Brian Kelly. After further discussion with the team, we wanted to let you know our engineering consultants have assured us that our design standards are equal to or more conservative than prevailing Federal Railroad Administration and European and Asian practices, and that the instances in question that you raised concerns about are fully within our standards. Moreover, our ride quality standards as relates to side and vertical accelerations are conservative and add an extra level of safety assurance.”

And again, on August 2, 2018, Annie Parker sent a second email with an additional statement in bold highlights:

“Apologies for the multiple emails.”

“We wanted to check in with you regarding the response letter we sent you on July 25th regarding your question to CEO Brian Kelly. After further discussion with the team, we wanted to let you know our engineering consultants **high-speed rail experts from England, France, Taiwan and Germany** have assured us that our design standards are equal to or more conservative than prevailing Federal Railroad Administration and European and Asian practices, and that the instances in question that you raised concerns about are fully within our standards. Moreover, our ride quality standards as relates to side and vertical accelerations are conservative and add an extra level of safety assurance.”

This email states that the CHSRA design standards are equal to the ones used in Europe. That appears to be true, as track design is fairly universal the world over. The HSR track design standards, or criteria, are not in question. It is the final track design that is fatally flawed because the curves do not adhere to that same criteria. At present, all the curves from Fresno to Merced do not follow the criteria and each remain a safety hazard. A more detailed explanation of these facts can be found in my original Stop Order Request to Brian Kelly.

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Vacca and MacAdams phone call:

We spoke by phone on August 7, 2018. You stated that the curve designs were only at the ten-percent level and the final track designs will not be finished for several years.

This statement seems to be lacking in sound transportation practice. Track designs on all transportation projects are the first designs to be finalized; the track alignment forms the backbone of any rail transportation system. The structural elements, such as the aerial decks and support columns, are measured using the alignment drawings. This includes the elevation, or profile, which is a critical element in this discussion. After the track design is fully vetted by the combined disciplines of structural, geotechnical, mechanical, operations and maintenance, the project can move from preliminary to final construction. The current designs of the high-speed rail tracks from Merced to Fresno do not seem to have been properly vetted, especially by operations and maintenance. Each of the eleven curves poses additional dangers that straight tracks do not.

To determine if a curve design poses a safety hazard, long discussions are held between various engineering disciplines, where the combined knowledge includes years of hands on experience with track design and maintenance. These discussions are usually held behind closed doors so as not to alarm the public. Those designs that pose derailment hazards are tabled and alternative alignments are investigated.

Unfortunately, your lack of clarity on addressing my concerns is forcing me to speak publicly about these matters. For the Merced to Fresno Section, the track designs are identical for the Draft, Final and Construction phases of the project, not a standard practice; there are no variations in the track designs, as if no discussions took place.

How and why the train will derail at the bridge structure near the Fresno River

Scenario 1:

When trains travel between 150-220 mph, this exceeds jetliner take off runway speed which is between 150 mph to 180 mph. Light aircraft, such as a Cessna 150, take off at around 63 mph.

A high-speed rail vehicle is somewhat like the fuselage of a jet airliner: a long slender metal projectile carrying passengers, only without the wings. As the train enters the curve in question (see memo to Kelly dated 3/21/18, attached) the train will encounter a combination of vertical and horizontal curves. See Attachment 2, Vertical and Horizontal Curve Combination. As a general practice, track curve design criteria does not allow this combination of vertical and horizontal curves. This combination is not allowed for light rail, heavy rail, freight rail or highways. When we had our brief phone conversation earlier this month, you disagreed on this topic.

This combination of vertical and horizontal curvature is also not allowed by the CHSRA Alignment Criteria for High-Speed Trains Operations, except at the beginning of the curves in the transitional areas. The curve in question combines both horizontal and vertical curves throughout their entire lengths.

North of Herndon Drive in Fresno, the northbound train travels on top of sixty to one-hundred-foot structures. See Attachment 3, HSR Structure near the San Joaquin River. Using the northbound train in this example, the train enters a vertical curve, where the tracks rise up slightly, then descends at a more rapid rate. As the train enters this vertical rise, a horizontal spiral is introduced, the tracks start to curve to the right and the track begins to super-elevate. The outside left rail eventually rises six inches more than the inside, or right rail. This horizontal spiral is the transition between a tangent track and the actual curve. It is where the centrifugal forces begin to take effect.

From the New Yorker Article:

"The faster the train, the greater the centrifugal force. As (the speed) increases, more and more of the weight of the train is transferred to the wheels of the outermost edge of the track, something even the best-built trains have trouble coping with."

In this case, the HSR train is traveling at a speed greater than a jetliner taking off from a runway. The train is going uphill and simultaneously, the left side of the vehicle is tilting higher on one side than the other to accommodate the centrifugal forces.

Then the vertical curve descends, goes downwards, and the left side of the train, the outside flange of the wheel, is still climbing the rail to accommodate for the centrifugal forces. When the rail begins its descent down the vertical curve, the left side of the train keeps rising off the top of the rail.

Imagine the jet airliner that reaches critical take-off speed and the runway slowly drops away beneath the plane and the airliner becomes airborne. The same thing will happen in this curve. The train will take flight from the structure and travel straight forward like a speeding bullet. The vehicle also begins to twist, the left side still rising, because what is set in motion, continues to stay in motion. In an eight vehicle train, the first three vehicles fly over the southbound track as the head vehicle, the HSR signature locomotive, takes out a string of catenary poles and wires. Gravity begins to take over and pull each vehicle downwards. The middle vehicle hits the southbound bridge deck sideways and get sheared in half, longitudinally. The last three vehicles jack knife behind the middle vehicle and travel like shrapnel in all directions, potentially landing on top of Highway 99, which runs parallel and adjacent to the UPRR tracks. The greatest damage could be caused by the first vehicles that fall in-between the two sets of support structures: the UPRR bridge over the San Joaquin, and the HSR structures. Both sets of infrastructure could be critically damaged by the derailed vehicles that could hit the bridge abutments at the speed of a missile. The front vehicle, now encased in catenary poles and wires, may continue straight forward until it collides with the 80 foot embankment of the San Joaquin River, crush like a soda can and compress inside a tangled web of catenary poles and wires, collapse down the hillside and fall into the river and sink. Safety personnel are unable to reach the site because of all the adjacent critical infrastructure is shut down. There are no survivors.

Scenario 2:

In response to my original report, several engineers stated that the trains would go slower thorough this curve. Let's look at that. When the trains travel between 90-150 mph, the same scenario applies. Only this time, the trains will not fly from the bridge deck like missiles. The vehicles will leave the track in the same location as Scenario 1, but instead of becoming airborne, start to lift off the rails, derailing one by one, each vehicle twisting clockwise to the right. The vehicles will tumble off the bridge deck, 60 to 100 feet, potentially continuing to rotate through the air and land upside-down. Other passenger vehicles will crash on top of the first. No survivors.

Scenario 3:

Speeds between 60-90 mph do not pose a threat of derailment, but the passengers will feel a great deal of discomfort and a sense of vertigo at the same location where the faster vehicles would derail. The slower speeds will tilt the vehicle too much on one side where the vertical curve begins descending. As a result, cell phones would slip from the tray table. Crash. Then the laptops would cascade onto the floor, followed by the cups of coffee. All of these items will collect on the corner on the right-hand side of the vehicle. Passengers will never ride the train again.

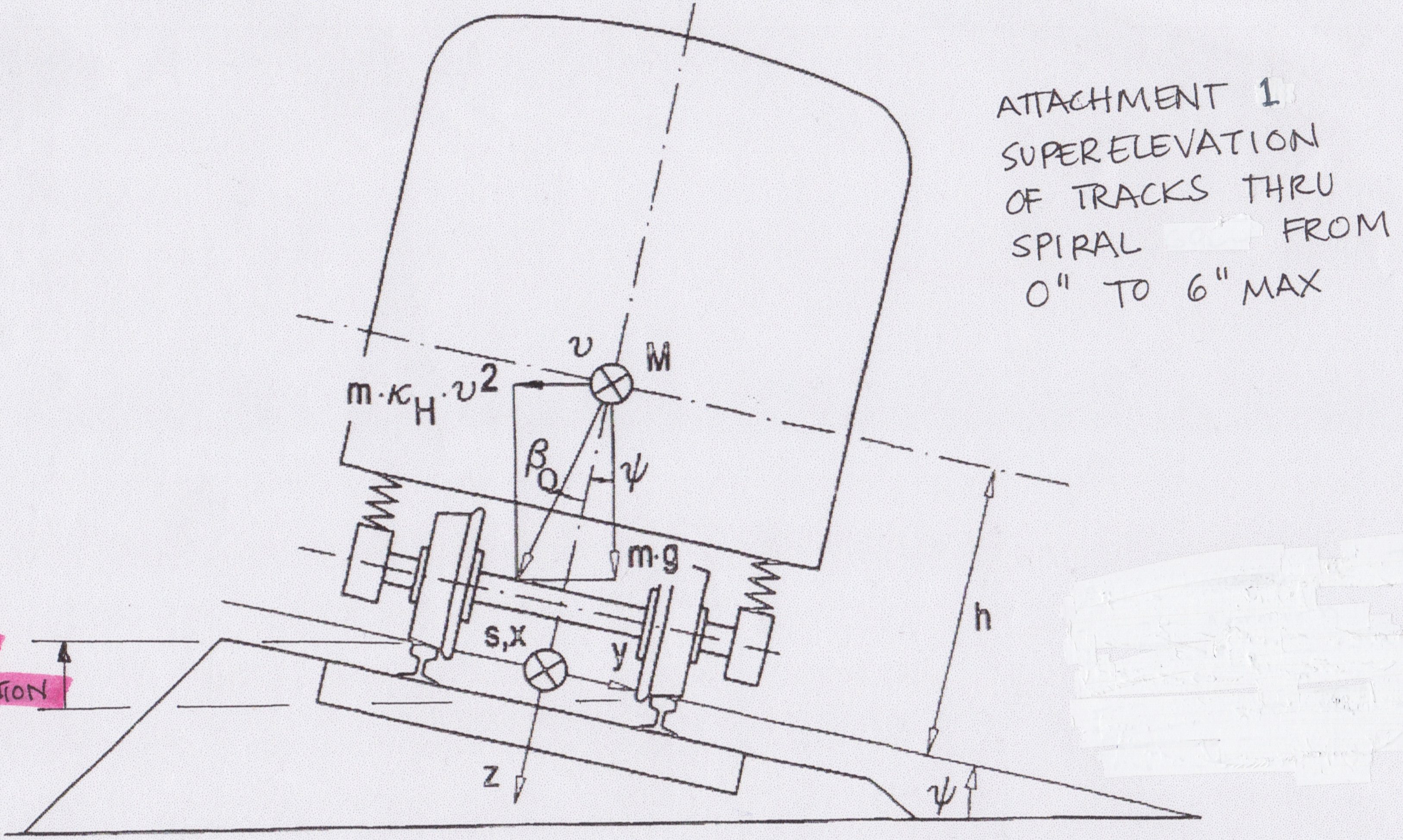
In summary Mr. Vacca, your letter is unresponsive to the concerns raised. The Spanish accident had nothing to do with the design issues in questions and the article was attached to the original report because of its pitch perfect description of what causes derailments. Trains derail because of centrifugal forces that are not held in check by the alignment. The original article does have a link to the video, which is important to review because the derailments over the San Joaquin River could be far worse.

Have you asked your consultants to review the issues that were raised and after doing so received their written assurance that these concerns have been addressed? My qualifications in this category should not be overlooked.

As a reminder, there was a second report distributed on April 17, 2018 to the CHSRA Board during the meeting in Los Angeles. This report was in response to the new CHSRA Business Plan. The costs for relocating the High Voltage Towers across the State of California are not included. Billions of dollars are missing from the estimate. As a reminder to follow through on this item, please respond to the report sent to Mr. Kelly, "Fairmead Missing Utility Costs Comment to Business Plan."

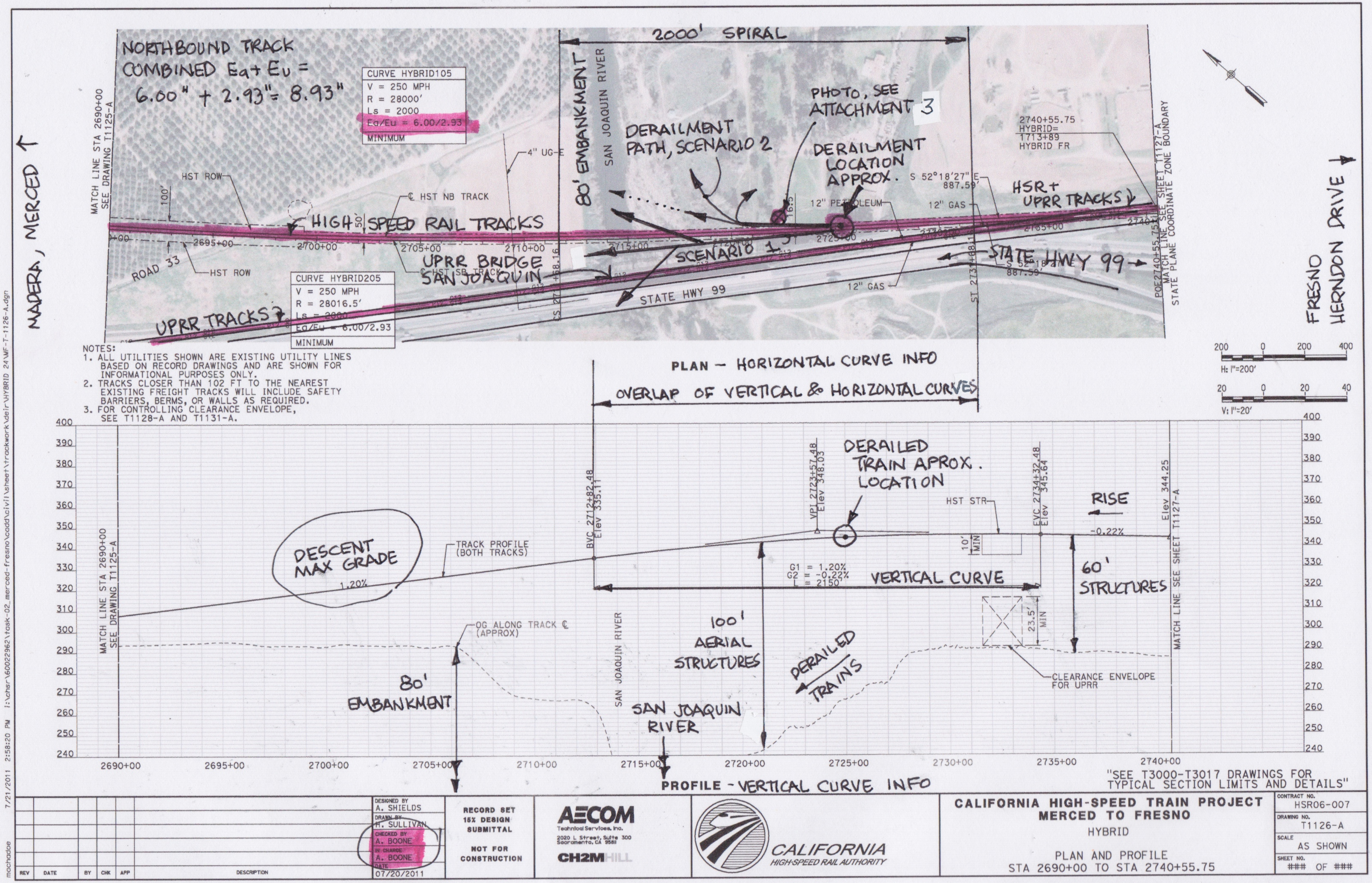
Thank you for your attention to this matter.

Susan MacAdams
Track and Alignment Expert
Secretary of the Board, Los Angeles Union Station Historical Society
Board Member, Train Riders Association California, TRAC
Former High Speed Rail Planning Manager,
Los Angeles County Metropolitan Transportation Authority (Metro)
Metro Red, Blue and Green Lines, Los Angeles
Trackwork Instructor to Metro Blue Line and San Diego Light Rail Management and Construction Teams
Light and Heavy Rail Track Design and Construction: Baltimore, Boston, & Washington DC

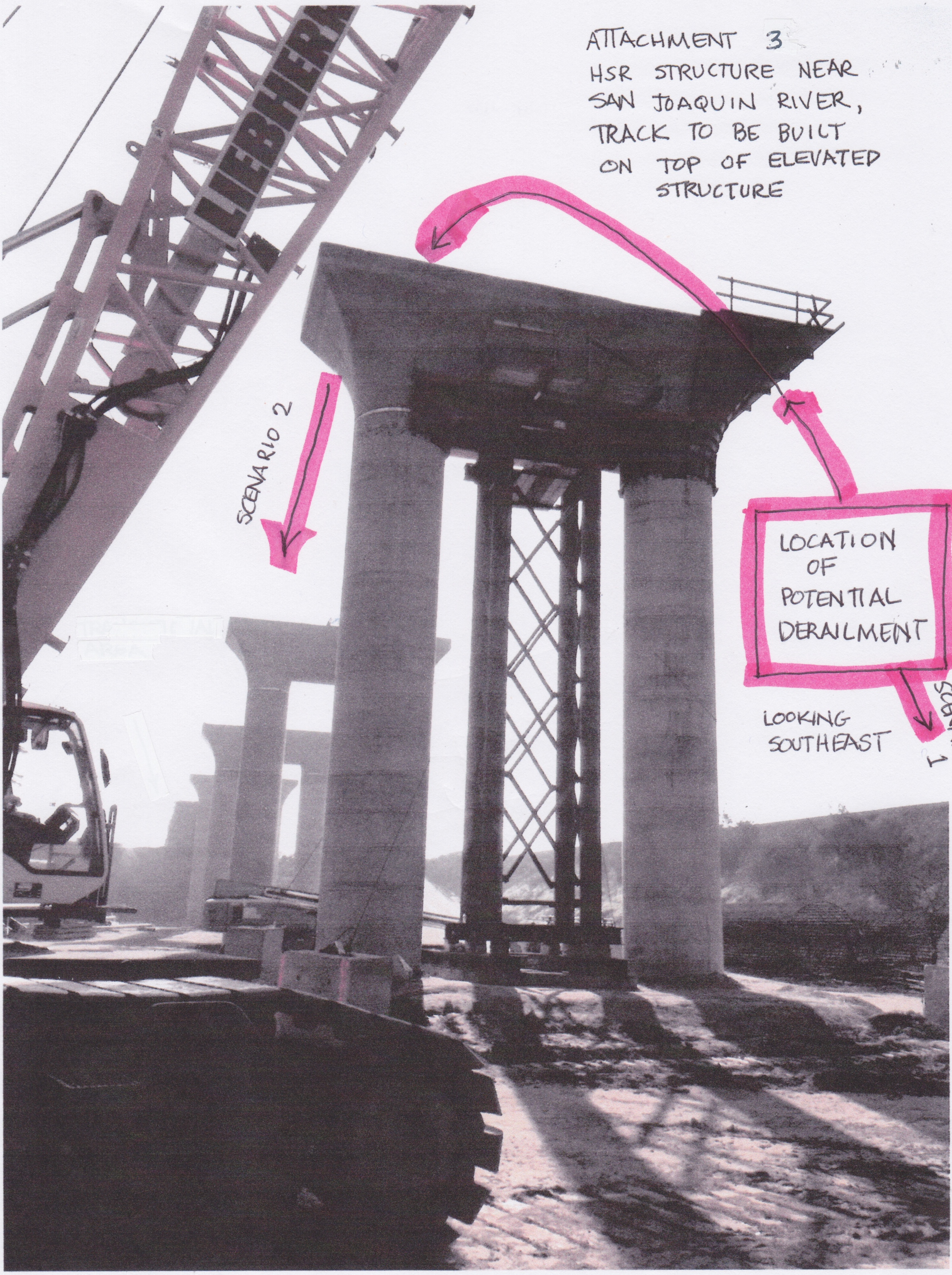


$$\kappa_H(s) = \frac{\kappa_C}{\psi_C} \cdot \psi(s) - h \cdot \frac{d^2\psi}{ds^2} \qquad (1)$$

ATTACHMENT 2 - VERTICAL & HORIZONTAL CURVE COMBINATION AT THE SAN JOAQUIN RIVER



ATTACHMENT 3
HSR STRUCTURE NEAR SAN JOAQUIN RIVER, TRACK TO BE BUILT ON TOP OF ELEVATED STRUCTURE



ATTACHMENT 4

The New Yorker

The Physics of High-Speed Trains

By Patrick Di Justo
July 25, 2013

On Wednesday evening, a train travelling from Madrid to Ferrol, in northwestern Spain, derailed just as it was about to enter the Santiago de Compostela station. At least seventy-eight people were killed, and dozens were injured. **Video of the accident** shows the train entering the curve at what seems to be a high speed; the passenger cars detach from the engine and derail, while the engine stays on the tracks for a few more seconds before it, too, leaves the rails and hits a wall. Unofficial reports claim that the train was going as fast as a hundred and twenty miles per hour on track rated for only fifty m.p.h.

Unlike Japan's Shinkansen or France's T.G.V., which run on dedicated tracks, the Madrid-Ferrol route is a hybrid line, much like Amtrak's Acela Express. Only part of the track is configured for high-speed travel; the rest is shared with slower trains, and can handle only their more restricted speeds.

High-speed rail is a catchall term with several definitions. The Federal Railroad Administration says it starts at a hundred and ten m.p.h., while the International Union of Railways says a hundred and fifty-five. But whichever definition one favors, the rails themselves **must be carefully designed to handle the physical forces imposed upon them by multi-ton trains moving at high velocity.**

One of those forces is centrifugal ("to flee from the center") force, the inertia that makes a body on a curved path want to continue outward in a straight line. It's what keeps passengers in their seats on a looping roller coaster and throws unsecured kids off carousels. Centrifugal force is a function of the square of the train's velocity divided by the radius of the curve; the smaller and tighter the curve, or the faster the train, the greater the centrifugal force. **As it increases, more and more of the weight of the train is transferred to the wheels on the outermost edge of the track, something even the best-built trains have trouble coping with. That's where the concepts of minimum curve radius and super-elevation, or banking, come in.**

Banked curves, in which the outer edge of the track is higher than the inner edge, balance the load on the train's suspension. Since gravity pulls a train downward and centrifugal force pulls it outward, a track banked at just the right angle can spread the forces more evenly between a train's inner and outer wheels, and help to keep it on the track.

But banking the tracks isn't a cure-all—a passenger train can tilt only so far before people fall out of their seats. So the minimum curve radius comes into play. Imagine that a curved portion of track is actually running along the outer edge of a large circle. How big must that circle be to insure that a train's centrifugal force can be managed with only a reasonable amount of banking?

It's relatively easy to calculate these forces and the ways to counteract them, so it's relatively easy to set a safe maximum speed for a certain kind of track. Yes, badly maintained tracks, trains, or signals can sometimes contribute to a derailment. Historically, however, many of the world's worst train accidents on sharp curves—the 1918 Malbone Street wreck in the New York City subway system, which killed at least ninety-three people (figures vary), or the Metro derailment in Valencia, Spain, in 2006, which killed forty-three—were simply caused by the trains going too fast.

That seems to be the case in the Santiago de Compostela accident: tracks rated for fifty miles per hour need almost no banking and can have a curve radius of fifteen hundred feet, while a train traveling at a hundred and twenty miles per hour needs a track with significant banking, and a minimum curve radius of more than a mile and a half. The laws of physics all but insured that in this particular battle between gravity and centrifugal force, the latter would win.