

**CONTRACT CHANGE ORDER MEMORANDUM**

TO: Tony Anziano, Program Manager /			FILE: E.A. 04 - 0120F4	
FROM: Darryl Schram, Senior TE			CO-RTE-PM SF-80-13.2/13.9	
FED. NO. No				
CCO#: 314	SUPPLEMENT#: 4	Category Code: CHXX	CONTINGENCY BALANCE (incl. this change) <b>\$21,137,172.42</b>	
COST: <b>\$800,000.00</b> INCREASE <input checked="" type="checkbox"/> DECREASE <input type="checkbox"/>			HEADQUARTERS APPROVAL REQUIRED? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
SUPPLEMENTAL FUNDS PROVIDED: <b>\$0.00</b>			IS THIS REQUEST IN ACCORDANCE WITH ENVIRONMENTAL DOCUMENTS? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
CCO DESCRIPTION: Additional Funds Pier E2 Rod Testing			PROJECT DESCRIPTION: CONSTRUCT SELF-ANCHORED SUSPENSION BRIDGE	
Original Contract Time: <b>2490</b> Day(s)	Time Adj. This Change: <b>DEF</b> Day(s)	Previously Approved CCO Time Adjustments: <b>501</b> Day(s)	Percentage Time Adjusted: (including this change) <b>20</b> %	Total # of Unreconciled Deferred Time CCO(s): (including this change) <b>37</b>

**THIS CHANGE ORDER PROVIDES FOR:**

Providing additional funds to perform sampling and testing of rods.

Contract Plan Sheets 884R1 "Pier E2 Bearing Details No. 2" and 887R2 "Pier E2 Shear Key Details No. 1" identify the anchor bolts for the Pier E2 Shear Keys and Bearings as 76 mm A354 Grade BD Bolts. These plan sheets require the bolts to be tensioned to 0.70 Fu (70% of their ultimate strength). Special Provisions Sections 10-1.47 "Spherical Bushing Bearing (Pier E2)" and 10-1.50 "Shear Key (Pier E2)" provide the specification requirements for the anchor bolts. Both of these specifications refer you to Special Provisions Section 10-1.59 "Steel Structures" which in turn refers you to various ASTM specifications including ASTMs A123, A153, A143, A354, etc. which provide further specifications for the manufacture and testing of the anchor bolts and hardware. While these references provide for the final mechanical properties and processes for the manufacture of the bolts, they do not specifically require hydrogen embrittlement testing for the anchor bolts.

Within days after tensioning was performed, the anchor bolts in the shear keys directly below the Eastbound and Westbound Orthotropic Box Girder (OBG) structures (known as Shear Keys S1 and S2) began to fail. A total of 32 out of the 96 anchor bolts broke before the Department directed the Contractor to reduce the anchor bolt tension to prevent further failures. A forensic metallurgic examination was jointly performed with both the Contractor's and Materials Engineering and Testing Services' (METS) metallurgical experts. It was determined that while the failed bolts' material properties did meet the contract specifications, the hardness properties were at the upper limit and the ductility and toughness properties were at the lower limit. Taking this high end hardness and low end ductility into account and combining it with a high tensile stress (0.70 Fu) makes this material more susceptible to the effects of hydrogen cracking (also known as hydrogen embrittlement). The metallurgical examination indicated that the bolts were susceptible to hydrogen embrittlement due to a lack of uniformity in the microstructure of the rods.

The anchor bolts at Shear Keys S1 and S2 are uniquely different from the anchor bolts at the remaining shear keys and bearings (known as Shear Keys S3 and S4 and Bearings B1, B2, B3, and B4) in that they were manufactured in 2008 as opposed to the remaining ones in 2010. In addition, due to physical limitations the anchor bolts at Shear Keys S1 and S2 have their anchors fully cast into the Pier E2 cap and are not replaceable, as opposed to the remaining shear keys and bearings which are thru bolted and thus replaceable. As such, Shear Keys S1 and S2 will require an alternate anchorage solution.

Multiple change orders will be issued for the alternate shear key solution including:

- CCO 312 furnish rods for testing and to replace removed rods
- CCO 313 procure long lead time materials
- CCO 314 S0, S1, S2, and S3 perform work to remove and test rods
- CCO 319 fabricate saddles
- CCO 320 shim temporary bearings
- CCO 325 perform concrete and rebar demolition
- CCO 326 core drill through pier cap
- CCO 327 S0, S1, and S2 install temporary work platforms, falsework, saddles, CCO 312 permanent rods, CCO 363 caps, and dust covers. Remove CCO 338 shims and CCO 337 temporary anchor rods.
- CCO 328 furnish and install bar reinforcement
- CCO 329 S0 and S1 place shear key concrete
- CCO 330 furnish and install post tensioning

**CONTRACT CHANGE ORDER MEMORANDUM**

EA: 0120F4 CCO: 314 - 4

DATE: 5/6/2014

Page 2 of 2

- CCO 331 plan sheets
- CCO 337 furnish and install temporary rods
- CCO 338 shim permanent bearings
- CCO 363 furnish corrosion protection caps

This change order (CCO 314 S4) will provide additional funds to modify test rigs and perform tests on rods furnished under CCO 312 to verify their material properties and suitability for the project.

The total cost of this change order is \$800,000.00 force account, which can be financed from the contingency fund. A detailed cost analysis is on file. The cumulative total of CCO 314 S0, S1, S2, S3, and S4 is \$5,700,000.00.

Consideration of a time adjustment will be deferred until completion of the work specified herein. Determination of a commensurate time adjustment will be made in accordance with Section 10-1.13, "PROGRESS SCHEDULE (CRITICAL PATH METHOD)" and Section 10-1.14, "TIME-RELATED OVERHEAD" of the Special Provisions, as well as Section 8-1.07, "LIQUIDATED DAMAGES", of the Standard Specifications

The Toll Bridge Project Oversight Committee (TBPOC) initially (April 11, 2013) approved \$4.3 million to continue work on the Shear Key S1 & S2 anchor rod replacement strategy solutions and to procure long lead time materials. The TBPOC revised this approval (May 9, 2013) to include all E2 shear key anchorage work within the approved \$4.3 million funding. At the June 6, 2013 TBPOC meeting the TBPOC revised this approval to \$7.5 million. At the July 10, 2013 TBPOC meeting the TBPOC revised this approval to \$18 million. At the January 27, 2014 TBPOC meeting the TBPOC revised this approval to \$25 million. CCO's 313, 319, 320, 325, 326, 327, 328, 329, 330, 337, 338, and 363 are specific to this approval.

In addition, for the anchor rods test program TBPOC also approved \$1 million on May 9, 2013, an additional \$2.7 million on October 3, 2013, an additional \$1.4 million on November 5, 2013, and an additional \$800,000 on April 11, 2014 for a total approval of \$5.9 million. CCO's 312 and 314 are specific to this approval.

The SAS Third Quarter 2013 risk register is carrying the risk "Fabricate and Install a Retrofit for Shear Key bolts at Pier E2" in the range of \$2.5M to \$6.4M and was created to address the fabrication and installation of the new saddle. The SAS risk register is also carrying the risk for the testing of ASTM A354 Grade BD Rods in the range of \$3.6M to \$16.25M to address testing and remedial actions as necessary.

This change order has concurrence from William Casey (Supervising TE), Tony Anziano (Program Manager), Rich Foley (HQ Oversight), Wenyi Long (Bridge Design), Lina Ellis (Maintenance), and Jing Chen (District Design).

CONCURRED BY:		ESTIMATE OF COST	
Construction Engineer: William Casey, Sup TE	Date 4/28/14	THIS REQUEST	TOTAL TO DATE
Bridge Engineer:	Date	ITEMS	\$0.00
Project Engineer:	Date	FORCE ACCOUNT	\$800,000.00
Project Manager: TB Program Manager, Tony Anzian	Date 4/30/14	AGREED PRICE	\$0.00
FHWA Rep.:	Date	ADJUSTMENT	\$0.00
Environmental:	Date	<b>TOTAL</b>	<b>\$800,000.00</b>
Other (specify): HQ, Rich Foley	Date 4/29/14	<b>FEDERAL PARTICIPATION</b>	
Other (specify):	Date	<input type="checkbox"/> PARTICIPATING <input type="checkbox"/> PARTICIPATING IN PART <input checked="" type="checkbox"/> NONE <input type="checkbox"/> NON-PARTICIPATING (MAINTENANCE) <input type="checkbox"/> NON-PARTICIPATING	
District Prior Approval By:	Date	FEDERAL SEGREGATION (if more than one Funding Source or P.I.P. type)	
HQ (Issue Approve) By:	Date	<input type="checkbox"/> CCO FUNDED PER CONTRACT <input type="checkbox"/> CCO FUNDED AS FOLLOWS	
Resident Engineer's Signature:	Date	FEDERAL FUNDING SOURCE	PERCENT
	5-12-14	_____	_____
		_____	_____