



U.S. Department
of Transportation

Federal Highway
Administration

Memorandum

Subject: **ACTION:** Non-Destructive Testing of
Fracture Critical Members
Fabricated from AASHTO M244 Grade
100 (ASTM A514/A517) Steel

Date: December 13, 2021

From: Hari Kalla
Associate Administrator, Office of
Infrastructure

In Reply Refer To:
HIBS

To: Division Administrators
Directors of Field Services

The purpose of this memorandum is to provide direction regarding the in-service inspection, inventory, and testing of butt welds in fracture critical members fabricated from AASHTO M244 Grade 100 (ASTM A514/A517) steel, more commonly known as “T-1” steel.

Constructed between 1960-1961, the I-64 Sherman-Minton Bridge is a fracture critical bridge which consists of two 800-foot tied arch truss main spans that carry six lanes across the Ohio River between Louisville, Kentucky, and New Albany, Indiana. As the result of a 2011 in-service inspection of the bridge, several cracks were found in the butt welds, or their associated heat-affected zones, of the tension ties of both spans, which were fabricated from T-1 steel. Discovery of the cracking resulted in the closure of the bridge. It was subsequently determined that the cracking was very likely caused by hydrogen that was introduced into the weld as the result of inadequate fabrication procedures.

In response to issues discovered on the Sherman-Minton Bridge, FHWA issued Technical Advisory 5140.32 which included recommendations to verify through visual and non-destructive testing, unless this verification had been previously conducted, the soundness of all butt welds in tension components fabricated from T-1 steel where cracks due to a lack of hydrogen control during welding had previously been found.

Constructed in 1973, the I-40 Hernando de Soto Bridge is also a fracture critical tied arch truss bridge that consists of two 900-foot main spans and carries four

lanes across the Mississippi River between Memphis, Tennessee, and West Memphis, Arkansas. As with the Sherman-Minton Bridge, the box-shaped tension ties of the main spans of the Hernando de Soto Bridge were fabricated from T-1 steel. On May 11, 2021, a fracture was discovered in one of the main span tension ties at the location of a butt weld. As a result, the bridge was immediately closed to ensure safety.

An evaluation of this fracture identified hydrogen cracking as the probable cause. Non-destructive testing on other butt welds in the T-1 steel of the main span tension ties found 12 other butt welds with hydrogen cracking that was unable to be detected through a visual inspection.

Both bridges were fabricated before the “Fracture Control Plan for Fracture Critical Bridge Members” was implemented first in the 1978 AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members, and later in 1995 as a standard incorporated into the ANSI/AASHTO/AWS D1.5-95 Bridge Welding Code as the “AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members”. The purpose of the FCP is to ensure proper welding procedures and post-welding testing to prevent defects like hydrogen cracking from being inadvertently incorporated into an in-service highway bridge.

The Sherman-Minton Bridge was closed for approximately 5 months while repairs were made to address the hydrogen cracking. The Hernando de Soto Bridge was closed for approximately 2½ months while the partially fractured tie girder and additional locations with hydrogen cracking were repaired. These significant disruptions to the Interstate system had profound effects on the lives and livelihoods of the traveling public, the regional and national mobility of freight, and the vitality of the local and regional economies. As a result, to best ensure a similar event does not again occur elsewhere, pursuant to 23 CFR 1.36, 650.313 and 650.315, the following actions are provided:

1. State DOTs must:
 - a. Review the inspection records of their inventory of bridges to identify fracture critical members that were fabricated with T-1 steel and without a requirement to meet the provisions of an AASHTO fracture control plan first implemented by AASHTO as a Guide Specification in 1978 and adopted as a standard by AASHTO/AWS in 1995.
 - b. Document the members identified in paragraph 1(a) in the fracture critical member inspection procedures.
 - c. For the fracture critical members identified in paragraph 1(a), ensure that they have been regularly and appropriately inspected in accordance with the National Bridge Inspection Standards (23 CFR

- Part 650) and that any critical findings have been properly identified and addressed. For these fracture critical members:
- i. An appropriate level of hands-on inspection includes a visual inspection verifying the soundness of all butt welds in tension supplemented by non-destructive testing (NDT) conducted a minimum of 48 hours after original welding for joints up to 2 inches thick, or 72 hours after original welding for joints over 2 inches thick, unless this verification has previously been documented.
 - ii. All rejectable indications identified using AASHTO/AWS NDT acceptance criteria during this testing are to be considered critical findings.
2. State DOTs are also required to report an inventory of the structures identified in paragraph 1(a) to the Federal Highway Administration that includes:
- a. The structure number of the bridge,
 - b. If completed, the month and year when the soundness of all butt welds in tension were verified using non-destructive testing in accordance with paragraph 1(c)(i),
 - c. Whether the verification testing or subsequent inspection identified rejectable indications, and
 - d. If rejectable indications were identified, the month and year when follow-up actions were taken to resolve the critical findings identified in paragraph 2(c).

State DOTs are required to report the information requested in paragraph 2 for the inventory of bridges identified in paragraph 1(a) by March 31, 2022. For bridges with butt welds in tension that have not yet been verified to be sound using NDT, State DOTs are required to perform that testing and report the information requested in paragraphs 2(b), 2(c) and 2(d) by March 31, 2024. State DOTs are required to update the information requested in paragraph 2 for the inventory bridges at six-month intervals until all testing and documentation is completed.

A State DOT's failure to take the above actions could unreasonably put such structures at risk of failure and may result in liability for the State DOT in the event of failure.

Please convey the important requirements of this memorandum to your respective State DOT to ensure they take the actions listed by the required deadlines. These actions are critical to maintaining safety, avoiding similar closures of important structures, and the major disruption that follows.

Should you or your staff have any questions, please contact Derek Soden at (202) 493-0341 or derek.soden@dot.gov or Joseph Hartmann at (202) 366-4599 or joey.hartmann@dot.gov

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