

**Chicago Transit Authority (CTA) - Articulating North American Bus  
Industries, Inc (NABI) Bus Fleet  
Trip Summary Report  
April 7, 2009**

- Attendees:
  - NHTSA – Bill Collins (Vehicle Research and Test Center) and Paul Simmons (Office of Defects Investigation) – Washington DC
  - CTA – Terrance J. Muellner (Chief Mechanical Officer), John A. Hruby(Vice President Rail Operations), and Michael G. Gorman (General Manager – Bus Maintenance)
  
- Buses Inspected:
  - Test Bus - From 6 Post Shaker
    - 150, 000 Miles Simulated
    - 100, 000 Miles Driven on Streets of Chicago
  
  - Fleet Sample Bus
    - 172K Street Miles
  
  - Separated Articulating Joint
    - Vin – 1N90600203A140242
    - Mileage 151,900

Inspection Summary:

The separation of the NABI articulating bus was a result of a weld failure that occurred in the parent metal of the rolled plate bracket. The fracture occurred just beyond the weld line where the bracket welds to the articulating joint casting. The fatigue fracture appeared to be caused by torsional force loading through the joint configuration. Bending moment fatigue initiated the fracture caused by fore and aft rotational loading that could be generated by, among other forces, both positive and negative wheel torque (acceleration and braking). A visual evaluation of the surrounding structure suggests that several welded members form a box beam and are intended to react to the torque and prevent the main structural weld from bending, but the unreinforced materials appear to be inadequate for the forces generated in this application.

## 1. Test Simulation Bus:

This bus had approximately 100,000 street miles and 150,000 simulated miles from a six post shaker at a test facility. The bus was inspected and showed signs of structural modification. Representatives from CTA confirmed this vehicle had been the subject of laboratory durability testing and that during the testing steel plates had been added across several structural members in close proximity to the main connecting weld in question. Evidence of previous scientific testing was corroborated based on the presence of abandoned strain gages, labeled areas, and other similar cues consistent with structural monitoring. At least one crack was identified on this bus at the cast receiving member. The crack was located toward the outside of the vehicle, just after the termination of the connection to the Hubner Joint. To the unaided eye, the main weld between the cast receiving member and the rolled structural plate appeared continuous and uninterrupted (figure 1).



Figure 1 Hubner Joint Weld

## 2. Fleet Sample Bus:

The "Fleet Sample Bus" was the second bus inspected and was randomly chosen by CTA from the fleet's subject NABI articulating bus population. This vehicle showed no signs of immediate structural cracking at or adjacent to the subject structural member. To the unaided eye, the main weld between the cast receiving member and the rolled structural plate was continuous and uninterrupted.

## 3. Separated Articulating Joint

The third bus inspected was the subject bus that suffered catastrophic failure of the weld between the front and rear parts of the bus. The joint that failed connects the articulating joint (Hubner Joint) to the rear (trailer) portion of the bus. Representatives from CTA informed us the bus was in an undisturbed condition; no modification, repairs, or dismantling had been attempted. Upon inspection, it was immediately obvious that the main weld between the cast receiving member and the rolled structural plate had failed (figure 2). Other damage noted (but was not limited to) included peripheral broken welds for the rear floor pan and broken welds from various lesser cross member joints adjacent to the casting receiver. Additionally, the cast receiver had fractured at both ends, just after the termination of the connection to the Hubner Joint. The fractures were consistent with the location of the crack in the first bus inspected.

The fracture of the main weld on the subject bus could be characterized as a fatigue fracture that initiated toward the center of the bus and propagated in both directions outward. This was evident by the presence of advanced corrosion at the center, which tapered off to lighter corrosion as it worked outward. The final fracture point in the last half inch of weld appeared to be overloaded and was free of any corrosion. Penetration on the casting appeared adequate; however the size of the weld bead exceeded the thickness of the adjacent rolled structural plate, leading to a concern that this metal may have been embrittled during the manual Gas Metal Arc Weld process due to excessive heating.

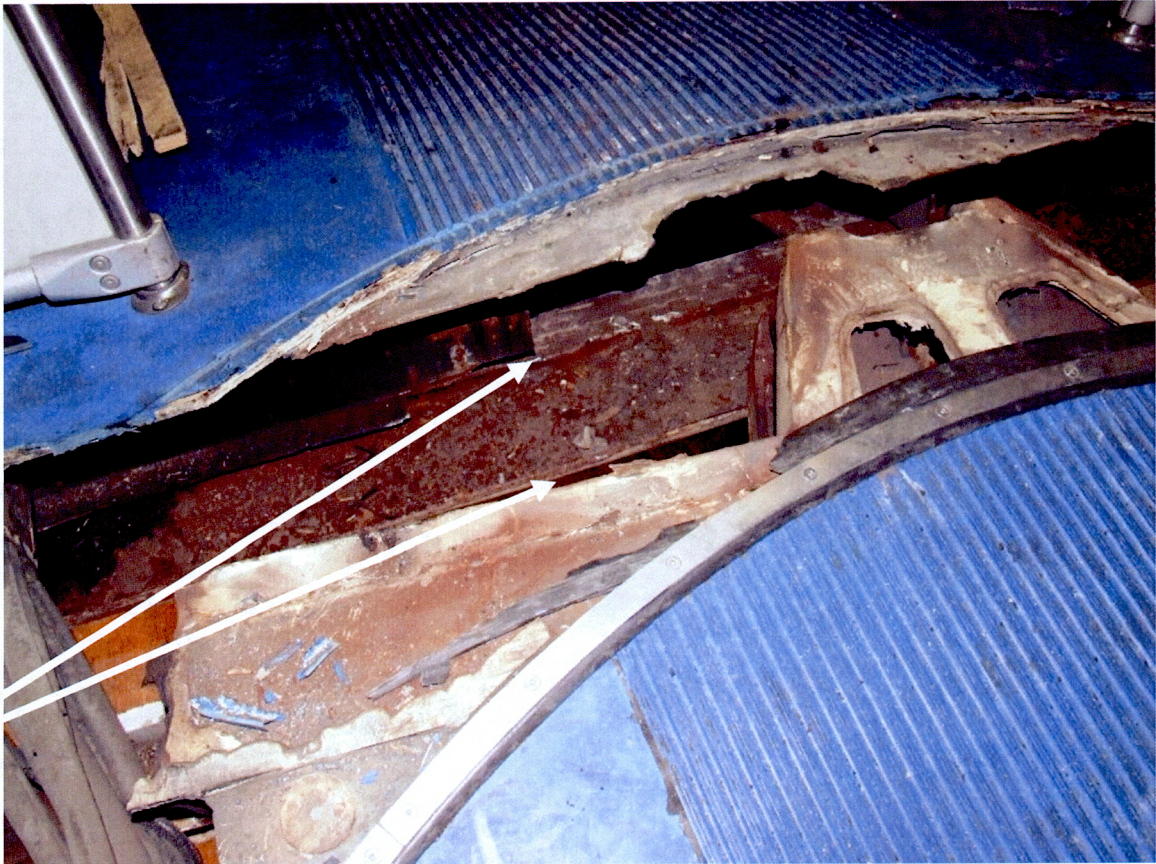


Figure 2 Weld separations from bracket

Consistent with that concern, the weld failure occurred in the parent metal of the rolled plate. The fracture occurred just beyond this weld (figure 3).

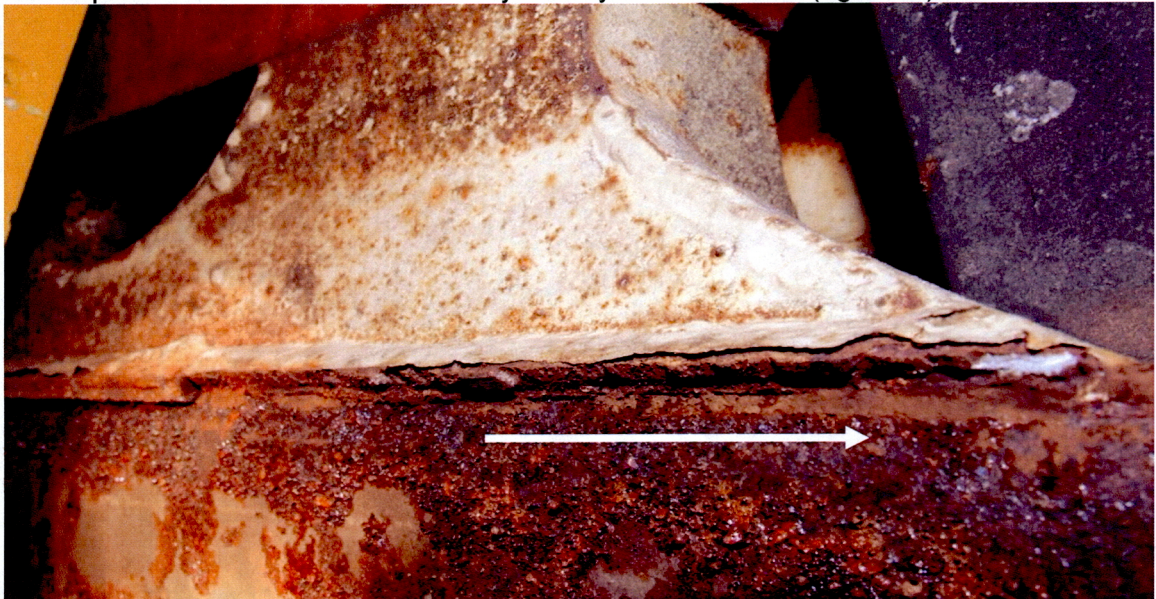


Figure 3 Weld separation spreading outward

The fatigue fracture appeared to be generated by a torsional loading configuration. This would suggest the bending moment that initiated the fatigue was delivered by fore and aft rotational loading that could be generated by, among other forces, both positive and negative wheel torque (acceleration and braking). A cursory evaluation of the surrounding structure suggests that several welded members form a box beam that is intended to react to the torque and prevent the main structural weld from bending but the unreinforced materials appear to be inadequate for the forces generated in this application (figure 4).

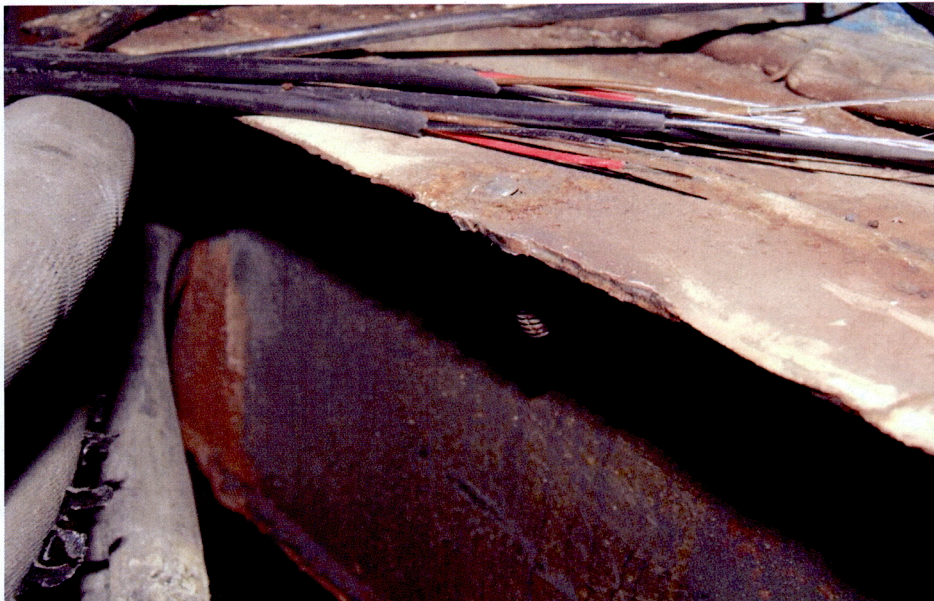


Figure 4 Floor plate separation

In addition to a physical inspection of the bus which suffered the separation, CTA showed a video of the last trip of the bus. The video showed strong rotational, torsional, and fore-aft forces generated during normal operation due to the rear mounted (pusher) engine configuration.

#### ACTION TAKEN:

Since NHTSA's visit to CTA, NABI has issued a recall notice (573) which includes CTA buses and all other buses with similar articulating weld attachment designs (total 579). Models affected by this recall are the 60BRT (352), 65BRT (1), and 60 LFW (226). All affected buses were built from January 1, 2003 through September 30, 2007. Later buses had a design change to the affected area and have not suffered the failures. CTA is the owner of all 226 "LFW" buses. NABI will arrange to have the buses repaired by the addition of reinforcement of the affected joint.