

National Transportation Safety Board

Office of Railroad, Pipeline and Hazardous Materials

Washington, DC 20594



RRD23FR013

MECHANICAL

Group Chair's Factual Report

November 15, 2023

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1 **A. ACCIDENT**

2 Location: Elliston, Virginia
3 Date: July 7, 2023
4 Time: 7:42 p.m. Local Time
5
6 Train: Norfolk Southern (NS) Train 814V404

7 **B. MECHANICAL GROUP MEMBERS**

8	Group Chair	James Southworth	
9		National Transportation Safety Board	
10		Washington, D.C	
11			
12	Specialist	Adrienne Lamm	
13		National Transportation Safety Board	
14		Washington, DC	
15			
16	Specialist	Nancy McAtee	
17		National Transportation Safety Board	
18		Washington, DC	
19			
20	Group Member	Tim Lynch	
21		Federal Railroad Administration	
22		Roanoke, VA	
23			
24	Group Members	Zacherus Shropshire	Dianne Barnett
25		Norfolk Southern	Norfolk Southern
26		Roanoke, Virginia	Atlanta, Georgia
27			
28	Group Member	Dennis Wilson	
29		Brotherhood of Railway Carmen	
30		Salisbury, North Carolina	

31 **C. SYNOPSIS**

32 On July 6, 2023, about 7:42 p.m. local time, eastbound Norfolk Southern Railway
33 (NS), train number 814V404, derailed on a single main track in Elliston, Virginia. As
34 a result of the derailment, 19 rail cars derailed upright and in line. There were no
35 reported fatalities or injuries, or fire. The weather at the time of the accident was
36 60°F and clear with no precipitation. There were no reported fatalities or injuries.
37

1 This portion of the Whitethorne District is owned by Virginia Passenger Rail
2 Authority and is operated and maintained by NS. This is not a passenger train route.
3 NS inspects and maintains the main track on the subdivision to FRA Track Safety
4 Standards for class 3 track, which allows for a maximum operating speed of 40mph
5 for freight trains. Generally, the main track leading up to the accident location was
6 constructed with standard crosstie/ballasted track construction and wood crossties
7 with 136lb. rail welded rail, fastened with standard cut spikes.

8
9 The segment consists of 28.7 miles of single track between milepost V- 279 in
10 Blacksburg VA and milepost V-250.3 in Salem, VA. There are two passing sidings
11 on this segment: North Fork (V-270.6) to Fagg (V-268.7) and Riverside (V-259.8) to
12 Kumis (V-261.7). North Fork to Fagg Siding has a length of 9,169 ft and Kumis to
13 Riverside Siding has a length of 9,292 ft. From the Yellow Sulfur hot bearing
14 detector (milepost V-276.3) to the point of derailment (POD milepost V-263.7) there
15 is one passing siding North Fork (V-270.6) to Fagg (V-268.7) and one switch to a
16 stub track at Ironton at the V-265.9.

17
18 Leading up to the POD, the train traversed 31 curves. The curve before the POD is
19 a 0.6-degree right hand curve with 1 inch superelevation. The second curve before
20 the POD is a 1.8-degree right hand curve with 1.5 inches of superelevation. The
21 track grade leading into the POD was a slight descending grade between 0.34-0.68
22 %. On average there are 5 trains that operate daily over the Whitethorne District
23 daily. The annual million gross tonnage is 26.45.

24
25 Wayside Detectors (Hot Box Detectors) and this investigation
26 The Norfolk Southern wayside Advance Train Control protocol at the time of the
27 accident was the following:

- 28
29 (170°F - 200°F) - Warm bearing - Critical - Stop and inspect
30 (>or= 115°F) - Difference from side to side on the same axle - Non-Critical - Stop
31 and inspect
32 (>170°F) - Critical (Stop and inspect vehicle)

33 **D. DETAILS OF THE INVESTIGATION**

34 **1.0 Train Consist**

35 The eastbound NS unit coal train consisted of 3 locomotives and 105 high side
36 gondolas loaded with coal. The train was 5,562 feet in length and weighed 14,158
37 tons including the locomotives.

38
39 Lead NS 1019 EMD SE70ACE 4300hp Built April 2011
40 2nd NS 7616 GE ESDC 4400hp Built November 2006
41 3rd NS 1141 EMD SD70ACE 4300hp Built December 2014

1 **2.0 Post Derailment Equipment Examination**

2 Cars 1-70 were positioned in NS' South Yard, Roanoke, VA - approximately 30
3 miles east of the derailment for mechanical inspection.

4
5 Cars 71-89 that derailed upright were positioned at Riverside Siding
6 approximately 17 miles east of the derailment for inspection.

7
8 Cars 90-105 were positioned in NS' South Yard, Roanoke, VA - approximately
9 miles east of the derailment for mechanical inspection.

10
11 All three locomotives were placed at Riverside Yard and inspected.

12
13 Rolling stock equipment and track damage is estimated by NS at \$159,750.

14
15 *NOTE: NTSB placed an investigative hold on the # 1 wheelset and all recovered*
16 *bearing and axle parts from railcar CR-507499, and all wheelsets from CR-507542.*

17
18 Investigators planned additional testing of components from these wheelsets and
19 worked with NS to ship held equipment (materials) to ESi in Omaha, Nebraska
20 (NTSB contracted laboratory - See ESi wheel set and bearing teardown report).

21
22 Inspection of all non-derailed cars (results/inspection reports) follow

23
24 Team for on ground inspections:

25
26 Dennis Wilson - TCU

27
28 Mike Weaver - NS

29
30 Tim Lynch - FRA

31
32 Zach Shropshire - NS

33
34 Jim Southworth - NTSB

1



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Figure 1: Photographs of Car CR 507499 - failed (burned off) journal bearing components

1 **3.0 Wheel Set and Bearing Details - Car CR 507499**

Car Number	CRDX3017	CRDX3017	CRDX3017	CRDX3017	CRDX3017	CRDX3017
Component Type	Wheelset	Axle	Bearing	Wheel	Bearing	Wheel
Truck	B	B	Bearing	B	B	B
Wheelset	1	1	1	1	1	1
Sub-Component Location		1	1	1	2	2
Component ID Number	8RIC0001804815	8RIC0001804815	8RIC0001804815	8RIC0001804815	8RIC0001804815	8RIC0001804815
Axel Nominal Journal Diameter		6.5				
Axel Nominal Journal Length		12				
Axle AAR Type		RWS - Raised Wheel Set				
Axle Body Design		F				
Axle AAR Condition Code		2 - Second Hand				
Wheel Stamped Month Year				2/8		2/8
Wheel Stamped Manufacture Code				SW - Standard Steel LLC		SW - Standard Steel LLC
Wheel Stamped Heat Treatment Class				C - Heat Treated Wheels		C - Heat Treated Wheels
Wheel Rim Thickness Side Scale Reading				36		36
Wheel Design Code (CH)				H-36		H-36
Wheel New or Turned				New		New
Bearing Reconditioned Classification			R - Reconditioned		R - Reconditioned	
Bearing Certificate			5 - Brenco (Green)		5 - Brenco (Green)	
Bearing Size Description			6.5		6.5	
Bearing Backing Ring Type			8TIM003 - Timken Sur-Fit		8TIM003 - Timken Sur-Fit	
Bearing Condition			R - Reconditioned		R - Reconditioned	
Mileage						
Mileage From Date						
Mileage to Date						

Figure 3 - Table depicting wheelset assembly. (Information provided by NS)

2
3
4 **4.0 Car Movement (and storage time) Information CR 507499**

5 Car CR 507499 originated on train 814V404 in Bluefield, WV and departed at
6 Bluefield at 2:39 p.m. The 814 received a Class 1 brake test (Initial Terminal
7 Inspection) at Lamberts Point on 6/30/23. Total mileage for CR 507499 since the

8
9 A review of car movement history of car CR 507499 since the wheel set and bearing
10 were installed indicates that CR 507499 was stationary in storage at Williamson Yard
11 in west Virginia for more than 5 months between September 26, 2022, and March
12 7, 2023 (162 days). CR 507499 was also bad ordered and stationary at Lamberts
13 Point, Virginia for over 14 months. From April 3, 2021, until June 9, 2022, the car
14 showed no movement for 431 days (see data chart below). Total mileage since the
15 installation of the wheel set is 173,554 miles.

1
2 Although movement is only recorded when equipment moves past a reader on the
3 mainline, cars can be moved within facilities or yards without being recorded.
4

5 Information on precipitation during stationary times and locations is being
6 reviewed/examined and is available in the accident docket.
7

496	BADO	CR 507499	LAMBERTS POINT, VA	BORD	6/9/2022 8:53 E	10000	005417	0001	6723316689
497	BFRM	CR 507499	LAMBERTS POINT, VA	BORD	6/9/2022 8:51 E	10000	005415	0001	6723316689
498	BADO	CR 507499	LAMBERTS POINT, VA	BORD	6/9/2022 8:50 L	10000	005413	0001	6723316689
499	BADO	CR 507499	LAMBERTS POINT, VA	BORD	6/9/2022 8:50 L	10000	005411	0001	6723316689
500	RMTY	CR 507499	LAMBERTS POINT, VA	820V301	4/3/2021 21:12 E	10000	024183	0661	
501	DUMP	CR 507499	LAMBERTS POINT, VA	820V301	4/3/2021 21:10 L	10000	024182	0661	6723316689
502	TKMV	CR 507499	LAMBERTS POINT, VA	MT22	4/3/2021 20:34 L	10000		0001	6723316689
503	BADO	CR 507499	LAMBERTS POINT, VA	BORD	4/3/2021 20:08 L	10000	000929	0001	6723316689

8
9
10 **5.0 Wheel Set and Bearing Examination**

11 The separation of the R1 journal of axle 1 on car CR 507499 resulted in the
12 derailment of the train in Elliston, Virginia on July 6, 2023. While on-scene
13 investigators identified the following components among the debris field:
14 separated axle journal, wheelset, outer seal, outer cone, bearing cup, inner cone,
15 inner seal, spacer, and several rollers. The backing ring and inner seal wear ring
16 were not found among the wreckage.
17

18 The NTSB put out an open call for bid and ultimately selected Engineering Systems,
19 Inc. (ESi) in Omaha, Nebraska to perform teardown and documentation of the
20 collected components and the remainder of the axle 1 wheel set. The teardown of
21 the wheel set occurred on September 13, 2023, in the presence of NTSB
22 investigators, technical advisors, and representatives of party members to the
23 investigation.
24

25 When the boxes containing the collected evidence were opened at the start of the
26 teardown, party members observed several components identified on scene were
27 missing, including the outer cone, outer seal, spacer, and inner seal. Party members
28 moved forward with the teardown of the components present at ESi while Norfolk
29 Southern personnel returned to the derailment site to perform a search. Using
30 photos taken by party members while on-scene, the Norfolk Southern personnel
31 located and photo documented the missing components, then secured and
32 shipped them to ESi for examination. This second examination occurred after the
33 party attended in-person teardown, but a work scope was agreed to by all party
34 members prior to the conclusion of the in-person teardown.
35

1 During the examinations, all legible part markings were recorded from the
2 components. The end cap and locking plate on the separated R1 bearing journal
3 were removed but no part markings were observed on that axle face; manufacturer
4 identification numbers on the axle were exposed when the end cap and locking
5 plate were removed from the mate end of the wheel set. The markings showed the
6 axle had been manufactured in April 1972 by Sumitomo Metal Industries - Osaka,
7 Japan. Markings on the wheels indicated they were cast wheels manufactured by
8 Standard Steel LLC - Burnham, Pennsylvania in December 2011 for the R1 side and
9 October 2011 for the L1 side. The R1 bearing cup had markings indicating it was
10 manufactured by Brenco in 1992, the L1 bearing cup had markings indicating it was
11 manufactured by Brenco in 1997. The locking plates showed the bearings were
12 reconditioned by Progress Rail - Little Rock, Arkansas in January 2012. Markings on
13 the wheelset indicated the bearings had been mounted at Progress Rail - Jackson,
14 South Carolina in February 2012.

15

16 The R1 bearing had extensive thermal damage, and no traces of the polymer seals
17 remained. The steel components within the reconditioned bearing had evidence of
18 melting, portions of components galled and melted together, and extensive rub
19 damage and plastic deformation. The cages for both the inner and outer roller
20 assemblies were comprised of steel. Spalling damage (imperfections on the surface
21 due to cyclical loading resulting in component fatigue damage) that occurred prior
22 to the accident was observed on the inboard race of the bearing cup.

23

24 The mate L1 bearing was still installed on the axle and typical disassembly
25 procedures outlined by Brenco, a bearing industry expert that the NTSB invited to
26 serve as a technical advisor for this investigation, were performed using a 90-ton
27 capacity bearing puller. Disassembly of the mate bearing proceeded smoothly
28 without the need for destructive methods.

29

30 During disassembly, a sample of grease was collected for further evaluation. After
31 disassembly, the mate L1 bearing parts were examined. Markings on the outer
32 cone, inner cone, cup, and spacer indicated all had been manufactured by Brenco
33 and had occurred in 1989, 1999, 1997, and 1994, respectively. Markings on the cup
34 indicated the bearing had been reconditioned by Progress Rail - Little Rock,
35 Arkansas in January 2012.

36

37 The cages for both the inner and outer roller assemblies were comprised of steel.
38 The outer cage was deformed, with five center ribs missing; only three ribs were
39 recovered following disassembly. The outer rollers had fragment indentations, one
40 roller was split horizontally, and another was cracked similarly.

41

42 The bearing for the inner roller assembly would not spin freely and feeler gauges
43 indicated possible internal damage. The team decided to destructively
44 disassemble the inner roller assembly by sectioning the cage in two locations to

1 expose the components. After disassembly, evidence of water etching was
2 observed on the race surface of the inner cone. Water etching was also present on
3 the rollers, and one roller was cracked.

4
5 The cup also showed signs of water etching. In addition, brinelling (damage from
6 repeated local impacts between rolling elements and the race of a bearing) was
7 observed on several locations of the cup race surfaces.

8
9 A full report of the teardown, attendees, and activities is attached in Appendix A to
10 this factual report.

11
12 The sample of grease collected from the mate L1 bearing was analyzed by SGS
13 North America in Vallejo, California. The sample was tested for compliance with
14 AAR M-942. Due to the sample size, the testing was limited to the following tests:
15 ASTM D6304: Standard Test Method for Determination of Water in Petroleum
16 Products, Lubricating Oils, and Additives by Coulometric Karl Fisher Titration;
17 ASTM D2265: Standard Test Method for Dropping Point of Lubricating Grease Over
18 Wide Temperature Range; ASTM D1403: Standard test method for cone
19 penetration of lubricating grease using one-quarter and one-half cone penetration
20 equipment.

21
22 The results of these tests met the listed acceptance criteria for AAR M-942 for
23 dropping point and cone penetration. Water content did not exceed the maximum
24 under the accepted criteria.

25
26 In addition to the specification testing, the sample was tested for the presence of
27 metals and other foreign materials using ASTM D7303: Standard Test Method for
28 Determination for Metals and Lubricating Grease by Inductively Coupled Plasma,
29 (ICP) Atomic Emission Spectroscopy. The presence of silicon indicated that there
30 may have been dirt in the lubricant. Evidence of bushing/bearing wear was also
31 found.

32
33 The sample was also analyzed using Fourier-transform infrared spectroscopy (FTIR).
34 The resulting spectrum was consistent with a mineral oil/lithium-based grease.

35
36 A full report of the grease analysis is attached in Appendix B of this report.

37
38 Submitted by:

39
40 James A. Southworth
41 Railroad Accident Investigator