National Transportation Safety Board

Washington, D.C. 20594

Response to Petition for Reconsideration

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In accordance with Title 49 *Code of Federal Regulations* (CFR) 845.41, the National Transportation Safety Board (NTSB) has reviewed the August 28, 2008, petition for reconsideration and modification of certain findings and the probable cause filed by the Norfolk Southern Corporation with regard to the NTSB's final report on the investigation of the derailment of Norfolk Southern Railway Company (NS) train 68QB119 in New Brighton, Pennsylvania, on October 20, 2006.[1] The NTSB also has reviewed the responses filed by the parties to the investigation, including the October 27, 2008, response from the Brotherhood of Maintenance of Way Employes Division and the October 30, 2008, response from the Brotherhood of Locomotive Engineers and Trainmen. Based on this review, the petition is granted in part and denied in part. Changes have been made to the factual and analysis portions of the accident report and to conclusion 6. No change has been made to the probable cause.

Background Information

About 10:41 p.m. eastern daylight time on Friday, October 20, 2006, NS train 68QB119, en route from the Chicago, Illinois, area to Sewaren, New Jersey, derailed while crossing the Beaver River railroad bridge in New Brighton, Pennsylvania. The train consisted of a 3-unit locomotive pulling 3 empty freight cars followed by 83 tank cars loaded with denatured ethanol, a flammable liquid. Twenty-three of the tank cars derailed near the east end of the bridge, with several of the cars falling into the Beaver River. Of the 23 derailed tank cars, about 20 released ethanol, which subsequently ignited and burned for about 48 hours. Some of the unburned ethanol liquid was released into the river and the surrounding soil. Homes and businesses within a seven-block area of New Brighton and in an area adjacent to the accident were evacuated for 2 days. No injuries or fatalities resulted from the accident. The NS estimated total damages to be $5.8 million.

[1] See *Derailment of Norfolk Southern Railway Company Train 68QB119 with Release of Hazardous Materials and Fire, New Brighton, Pennsylvania, October 20, 2006*, Railroad Accident Report NTSB/RAR-08/02 (Washington, DC: National Transportation Safety Board, 2008), which is available on the NTSB website at <http://www.ntsb.gov/>.

As a result of its investigation, the NTSB concluded that the derailment occurred when the north rail of track 1 separated under the load of the accident train. Segments of the broken rail were recovered and sent to the NTSB's Materials Laboratory for detailed examination. The NTSB concluded that the failure of the north rail of track 1 was precipitated by a detail fracture (fatigue crack) that originated from shelling[2] on the rail head, reached critical size, and caused a piece of rail to break out under the accident train. The investigation also revealed that the rail was significantly worn, as about 40 percent of the head area had been worn away or removed by a combination of wear and rail grinding.

Sperry Rail Service (Sperry) had inspected the rail for internal defects using an instrumented inspection vehicle on August 1, 2006, about 2 1/2 months before the accident, and the inspection vehicle operator had not identified any internal rail defects at the site of the subsequent rail failure. The Sperry rail inspection vehicle utilized a B-scan ultrasonic and induction system. The B-scan system has two additional "side-looking" modified 70-degree probes that look at each railhead at a lateral angle for vertical separations and an additional nine transducers to include: one 0-degree or vertical-looking probe, one forward-looking and one rear-looking transducer nominally aligned at 37 degrees, and six 70-degree probes. The induction test method works by inducing electrical current into the rail head. The current is induced past coils at a fixed distance above the rail head, and any distortion within the magnetic field is measured by these coils and then presented on the test monitors. Surface conditions can cause reflections or distortions that increase the difficulty of detecting internal defects using both ultrasonic and induction equipment.

A correlation between the August 1 inspection data and recovered rail segments showed that the failure occurred within a 9-foot length of rail where the ultrasonic inspection equipment had received only intermittent signal returns from the bottom of the rail. The NTSB attributed this intermittent loss of bottom signal to poor rail surface conditions, which included shell flakes, spalling, and open shell cracks along the length of the rail. The following conclusions were among those adopted in the NTSB's final report on May 13, 2008:

> 6. Rail surface conditions prevented the effective transmission of the ultrasonic signals, and the defect (fatigue crack) that led to the derailment may not have been large enough at that time to be reliably detected by the inspection vehicle.
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> 7. NS procedures that do not require a re-examination of rail where there is a signal loss during ultrasonic inspection means that those segments of rail can remain uninspected and in service indefinitely.
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> 8. The Federal Railroad Administration's (FRA) oversight of the NS's and other railroads' internal rail inspection processes was inadequate.
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> 9. The NS did not conduct internal rail inspections frequently enough to reliably detect an internal defect before it could grow to critical size in the significantly worn rail.

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[2] *Shelling* is surface cracking by metal fatigue near the gage corner caused by repetitive shearing stresses. It is a progressive separation that may crack out at any level on the gage side of the rail but generally at the gage corner.

10. The FRA's required minimum intervals for internal rail inspections are inadequate because they do not take into account the effect of rail wear, which can allow undetected internal rail defects to grow to critical size between required inspections.

11. In the absence of a damage-tolerance-based program, rail can remain in use with excessive accumulated wear, which increases the risk of rail failure from rapid growth of undetected internal defects.

12. Downward deformation of a severely worn rail head can affect the measurement of rail head wear using a rail wear template and may cause a railroad to underestimate the actual amount of wear.

The NTSB determined that the probable cause of the accident was:

the Norfolk Southern Railway Company's inadequate rail inspection and maintenance program that resulted in a rail fracture from an undetected internal defect. Contributing to the accident were the FRA's inadequate oversight of the internal rail inspection process and its insufficient requirements for internal rail inspection.

When the NTSB conducted its investigation, all the participants (including Sperry and NS representatives) thought that the inspection vehicle had traversed the accident area only one time on August 1, 2006. However, shortly after the final accident report was adopted, Sperry discovered data showing that the inspection vehicle had traversed the accident area a second time on the same day. Data from the second pass showed no loss of bottom signal and no defect indications at the location where the rail subsequently failed. The NS petition for reconsideration is based in part on this new evidence. During the NTSB review of these newly discovered data, additional data were uncovered that showed that the inspection vehicle had traversed the area a third time on the same day; data from the third pass also showed no loss of bottom signal and no defect indications at the location where the rail subsequently failed. Each of the NS arguments is summarized below, followed by the NTSB's response.

NS Argument: The newly discovered preaccident test data from August 1, 2006, confirm that the NS rail testing program was not at fault

The NS asserts that the new data confirm that a valid continuous search of internal rail defects, as required by FRA regulations, was conducted on August 1, 2006, and that the continuous bottom signal and the non-detection of defects during the second pass of the inspection vehicle confirm that the defect that caused the accident was either too small to be detected or did not exist at that time. The NS asks that the NTSB delete the statement in conclusion 6 that rail surface conditions prevented effective transmission of ultrasonic signals and change the remainder of the conclusion to say that the defect "was not" (rather than "may not have been") large enough to be detected. The NS also asks that the probable cause be revised to remove the negative reference to the NS inspection and maintenance program.

NTSB Response

The NTSB acknowledges that the newly discovered data show no loss of bottom signal and no defect indications during the second and third passes of the inspection vehicle. The NTSB is disappointed that complete information from all three passes of the Sperry inspection vehicle was not available at the time of the investigation, and that it only came to light after publication of the final report. Nevertheless, the NTSB does not agree that the new data eliminate the possibility that the rail conditions at that time prevented effective transmission of ultrasonic signals, nor does the NTSB agree that the new data eliminate the possibility that a potentially detectable defect existed at the time. Significant evidence indicates that the rail had surface shelling that could have interfered with the ultrasonic sensors on the inspection vehicle. For example, shortly after the accident, Sperry informed the NS that the severity of the rail head surface condition in the area of the track failure was sufficient to account for the intermittent loss of bottom signal encountered during the inspection.[3]

Even though there was no interference with the 0-degree ultrasonic sensor and thus no loss of bottom signal during the second and third passes, the NTSB notes that the 0-degree sensor is the only one that can be monitored for such signal interference. Because the side sensors are not oriented to provide a return signal from the bottom of the rail in the absence of interference, it is unknown whether the rail surface conditions interfered with the ultrasonic sensors on the gage side of the rail and prevented the signal from those sensors from penetrating the rail during the second and third passes.

Therefore, it is possible that the defect could have been detectable if the surface rail shelling had not been present. As explained in the report, at the time of the inspection the estimated size of the defect that ultimately led to the track failure was between 8 and 14 percent of a new rail head.[4] A 1999 study by the Transportation Technology Center, Inc., (TTCI) shows that the overall probability of an inspection vehicle detecting a flaw covering 8 percent of a new rail head is 64 percent.[5] The fact remains that the detail fracture defect that resulted in the subsequent rail failure was located in this area of shelling and within an area that had a loss of bottom signal during the first pass. The NTSB continues to believe that the loss of bottom signal during the first pass was most likely a result of the rail surface conditions[6] and cannot rule out the possibility that the conditions interfered to some extent with sensor performance during the second and third passes. In sum, the NTSB believes that a defect did exist at the time of the last inspection; however, the defect may not have been large enough at that time to be reliably detected.

Therefore, based on the new data, the NTSB will revise the text of the report to refer to the new data. The NTSB also will revise conclusion 6 to state that rail surface conditions <u>may have</u> prevented the effective transmission of the ultrasonic signals during the first inspection and that crack growth calculations and ultrasonic equipment detection capabilities indicate that the defect that led to the derailment may not have been large enough at that time to be reliably detected. The new data do not detract from the NTSB's overall concerns about the frequency of

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[3] Letter dated October 26, 2006, from Sperry's vice president of systems integrity to NS senior rail test engineer.

[4] NTSB/RAR-08/02, p. 26.

[5] NTSB/RAR-08/02, p. 32.

[6] Another possible cause is misalignment of the 0-degree sensor (the only sensor that registers a bottom signal or loss thereof) during the first run. But the NTSB could not determine from its review of data whether the 0-degree sensor was in the same alignment with the rail during the second pass of the inspection vehicle on August 1, 2006, as it was during the first. (According to Sperry, any adjustments in sensor alignment by the operator are not recorded.)

internal rail inspections and the fact that the NS does not include wear as a parameter in determining inspection frequency. Accordingly, no changes will be made to the probable cause.

NS Argument: The first pass on August 1, 2006, constituted a continuous search under 49 CFR 213.237(a)

The NS points out that both the induction and the ultrasonic test technologies were operating simultaneously on the Sperry test vehicle. Even though the 0-degree ultrasonic sensor lost the bottom signal during the first pass, the NS claims that the induction technology (which is designed to detect transverse defects, such as the one that caused this accident) by itself constituted a continuous search because it was not affected by loss of bottom signal or any malfunction in ultrasonic equipment. In addition, the NS argues that the 0-degree transducer is designed to detect longitudinal defects, not transverse defects, so that the sensor's loss of bottom signal did not impair the ability of the other ultrasonic sensors to search for transverse defects. Further, the NS argues that rail surface conditions did not prevent the effective transmission of ultrasonic signals during the first pass or otherwise prevent a valid continuous test of rail, pointing out that neither the subsequently discovered data showing additional passes of the inspection vehicle nor the NTSB's postaccident testing showed interference from shelling or surface conditions.

Finally, the NS analyzed the transcript of the interview of the staff director for the FRA Track and Structures Division and concluded that he was unfairly characterized in the NTSB report as having stated that a search that allowed a 5-foot loss of bottom signal would not constitute a continuous search for defects as defined by the FRA.

NTSB Response

The NS arguments are not persuasive. The NTSB does not believe that either the ultrasonic or the inductive tests were effective because of the rail surface condition. Regarding the adequacy of the first pass of the inspection vehicle as a valid continuous search, the FRA regulations and guidance make clear that by itself, the first pass does not qualify as a valid continuous search. Title 49 CFR 213.237(a) requires operators to conduct "a continuous search for internal defects." The FRA's *Track Safety Standards Compliance Manual* defines "continuous search" as "an uninterrupted search by whatever technology is being used, so that there are no segments of rail that are not tested." If the test is interrupted (for example, as a result of rail surface conditions that inhibit the transmission or return of the signal) then the test over that segment of rail is not valid because it was not continuous. Title 49 CFR 213.237(d) states that: "If the person assigned to operate the rail defect detection equipment being used determines that, due to rail surface conditions, a valid search for internal defects cannot be made over a particular length of track, the test on that particular length of track cannot be considered as a search for internal defects… ." The data for the first pass of the inspection vehicle showed an intermittent loss of bottom signal over a 9-foot length of track, with the longest continuous loss being about 7 inches. Thus, under the FRA regulation and guidance, the first pass does not qualify as a continuous search because the ultrasonic technology encountered interruptions that inhibited the transmission or return of the signal. Such a conclusion is consistent with the statement made by the staff director for the FRA Track and Structures Division that was cited in the report. The NTSB acknowledges that he expressed uncertainty in other parts of his interview.

But his opinion is not the determining factor on this point, and the NTSB would have reached the same conclusion even without his opinion.

Sperry's vice president of systems integrity acknowledged that if the ultrasonic equipment loses a bottom signal, it is possible that the other signals are also being lost.[7] He further explained that if the 0-degree sensor loses its bottom signal,

> there's no way we can definitely determine if we got a good reading [on the other channels, that is the 70- and 37-degree channels that are designed to detect transverse defects]. The only channel we utilize that we can monitor that its working properly … is the 0 channel. … [O]ur operators do utilize [the 0 channel] to determine if they are getting a valid test. If they suspect they are not that's the channel they would monitor.

Further, contrary to the NS's suggestion, the implications of a 0-degree loss of bottom signal can go beyond the detection of longitudinal defects. As already noted, Sperry's vice president of systems integrity acknowledged that if the ultrasonic equipment loses a bottom signal, it is possible that the other signals used to detect transverse defects also are being lost.[8]

Therefore, there is ample evidence from the investigation to indicate that the first pass of the inspection vehicle, including both of the ultrasonic and induction tests, standing alone, was not a valid continuous search for defects because one of the technologies being used was interrupted and because the operator attributed the response to rail surface conditions and wear considered sufficient to mask an underlying defect. However, the NTSB will add explanatory text to the report regarding the broader significance of the 0-degree sensor.

Regarding the surface conditions, Sperry's vice president of systems integrity told investigators shortly after the accident that the surface condition of the track at the accident location (specifically, shelling on the gage side of the rail head) was severe enough to mask an underlying defect.[9] In a October 26, 2006, letter to an NS rail testing engineer, he pointed out that the test data from near the failure location showed multiple intermittent equipment responses, two of which were the 0-degree ultrasonic and induction sensors and that the operator attributed them to the presence of rail head surface anomalies and worn rail conditions. His letter went on to say that the investigation confirmed the severity of the rail head surface condition was sufficient to account for that equipment response.[10] This information regarding intermittent equipment responses, including the induction sensors, and the operator's attribution of these responses to rail surface conditions and wear that was considered severe enough to mask an underlying defect is contrary to the NS argument that the induction test conducted on August 1, 2006, consitutes a continuous search. The fact that the NTSB was able during postaccident testing to get an ultrasonic reading without loss of bottom signal does not discount this. It should be noted that the NTSB's postaccident test was performed using a hand inspection tool, which is

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[7] See transcript of interviews of Sperry's vice president of systems integrity, October 23, 2006, pp. 19–20, and January 30, 2007, p. 9.

[8] See transcript of interviews of Sperry's vice president of systems integrity October 23, 2006, pp. 19–20 and January 30, 2007, p. 9.

[9] See transcript of October 23, 2006, interview of Sperry's vice president of systems integrity, p. 33.

[10] Letter dated October 26, 2006, from Sperry's vice president of systems integrity, to NS senior rail test engineer.

more likely to yield valid signals than vehicle-mounted inspection equipment. Thus, there is sufficient evidence to conclude that rail surface conditions could have interfered with ultrasonic signals during the first pass of the inspection vehicle. The NTSB will revise page 16 of the final report to say that Sperry representatives told NTSB investigators that surface conditions on the rail head "could" (instead of "would") have interfered with the ultrasonic signal.

NS Argument: NS's April 27, 2005, procedure requiring a retest of track with a loss of bottom signal of 5 feet or greater was developed to require more, not less, than FRA regulations require

As discussed in the NTSB's final report, an April 27, 2005, letter from the NS to Sperry informed Sperry of new inspection procedures for detecting vertically oriented rail head defects. The letter stated,

> Any rail tested that does not encompass an area where a switch component or track structure is present (point, frog, etc.), and produces a zero degree ultrasonic loss of bottom equipment response exceeding *five feet in length or greater,* alone or in conjunction with another test channel, is to be repeated (rerun) by the detector car operator. All efforts are to be made to clear any equipment responses of this nature that are caused by alignment or foreign matter (grease, snow debris, etc.). [Emphasis added.]

First, the NS claims that in light of the new data showing no loss of bottom signal at the accident location, the 2005 procedure is irrelevant in that there was no causal relationship between it and Sperry's inability to detect a defect. Next, the NS explains that the procedure was developed in response to the January 2005 Creighton, Pennsylvania, derailment, which was caused by a longitudinal defect. Longitudinal defects are detected by the 0-degree ultrasonic transducer, and the NS concluded that such defects do not typically result in failure until they are significantly longer than 5 feet. According to the NS, operators felt they could exercise their discretion in disregarding extended areas of loss of bottom, and the 2005 procedure was an attempt to correct that. The NS states that neither Sperry nor the NS intended or understood it to be an exception to FRA requirements for a continuous inspection.[11] The NS points out that in earlier guidance to Sperry, issued in 2001, it stated that "every effort must be made by rail test car operator to ensure that a valid search is made ... this may mean rerunning a section several times in order to clean the top of the rail... or it may mean stopping and hand testing short segments."[12]

The NS states that because the 0-degree transducer does not detect transverse defects, the 2005 procedure did not have any effect on the detection of transverse defects, such as the one that caused the New Brighton accident. Thus, the NS strongly disagrees with the NTSB's statement on page 33 of the final report: "Although the new procedures were designed to address a different type of defect, the procedures were applied to the entire inspection process and thereby also affected the detection of transverse defects."

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[11] After the NTSB final report was adopted, the NS amended the procedure to say it is not an exception to FRA standards and is to be followed in addition to, not in place of, FRA requirements, and that even when the loss of bottom is less than 5 feet the operator must still be satisfied he has conducted a valid search for internal defects.

[12] The NTSB notes that, according to the NS, an operator's belief that he or she had discretion to ignore loss of bottom of less than 5 feet would have been inconsistent with the 2001 instruction.

NTSB Response

The NS arguments are not persuasive. The 2005 procedure could be construed as permission to ignore the loss of bottom of less than 5 feet; in fact, the Sperry operator who conducted the August 1, 2006, test did so. He told investigators that he had interpreted the procedure to mean that he did not have to retest any area where the continuous loss of bottom signal was less than 5 feet.[13] This interpretation of the procedure presents a safety concern because, as noted above, a loss of bottom signal from the 0-degree sensor could mean a loss of other signals from other sensors as well. Further, ignoring an extended area of loss of bottom signal that is due to rail surface shelling can result in ignoring an area especially prone to transverse defects (detail fracture from shelling). This would significantly compromise the effectiveness of the ultrasonic testing. Thus, the NTSB continues to believe, as stated on page 34 of its final report, that "exempting any length of rail from a valid inspection could result in missing a defect that could grow to critical size before the next inspection and lead to a rail failure under a train." Therefore, no change to the challenged statement on page 33 is warranted on this point.

NS Argument: Rail wear, although not used as a basis for determining inspection frequency, is a factor in NS's track safety program

The NS asserts that it does frequent searches for defects and has a track replacement program based on wear. Specifically, it points out that geometry cars measure wear 2 to 3 times a year on main lines with freight volumes exceeding 5 million gross tons, such as the accident line. The NS asserts that its rail testing frequency is determined using a risk-based model that exceeds FRA requirements.[14] The NS believes that rail wear is not a reasonable basis for determining track inspection frequency because rail wear varies significantly within a particular route or track segment. Further, the NS asserts that studies from the U.S. Department of Transportation (DOT) recommend a risk-based model but do not mention wear as a factor.

Conclusion 10 is shown below:

> 10. The FRA's required minimum intervals for internal rail inspections are inadequate because they do not take into account the effect of rail wear, which can allow undetected internal rail defects to grow to critical size between required inspections.

The NS asks that the NTSB modify conclusion 10 to recognize that rail wear measurements are too variable over a route to be useful in determining rail test frequency for a route. Conclusion 11 is shown below:

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[13] See transcript of January 30, 2007, interview of the Sperry operator who conducted the August 1, 2006, test pp. 11, 19–20, 34.

[14] The FRA method is based primarily on volume and requires that the accident track be inspected two times a year. The NS risk-based model (based on annual tonnage, maximum train speeds, track class, signaling, hazardous materials transport, and rate of detected defects and service failures) resulted in inspections being done twice as often.

> 11. In the absence of a damage-tolerance-based program, rail can remain in use with excessive accumulated wear, which increases the risk of rail failure from rapid growth of undetected internal defects.

The NS asserts that conclusion 11 is also incorrect because NS rail does not remain in service with excessive accumulated wear and a damage-tolerance-based program for determining test frequency is not necessary to accomplish this end. Finally, the NS asserts that its hand measurements are done with horseshoe gages, which are not affected by deformation like the ones criticized in the NTSB's report and asks that conclusion 12, shown below, be deleted as not pertinent.

> 12. Downward deformation of a severely worn rail head can affect the measurement of rail head wear using a rail wear template and may cause a railroad to underestimate the actual amount of wear.

NTSB Response

The DOT studies cited in the NTSB's final report indicate that rail wear increases crack growth rate and decreases the critical size at which rail fracture is expected under the next train.[15] As the NTSB's final report stated, the rail wear measurements (and sample rail sections) taken at the point of derailment exceeded even the NS's threshold for rail removal from a heavily used main track:

> NS standards allow rail head (top-vertical) wear of 11/16 (0.6875) inch for 140-pound rail in main line service with accumulated tonnage of more than 5 [million gross tons] before the rail is recommended for replacement, that is, listed for future replacement. If vertical wear exceeds 13/16 (0.8125) inch, trains are to be put under a slow order until the rail is replaced. An NS chief engineer stated that the NS standard for 140-pound rails allows 1/2 (0.5) inch of gage face wear before the rail is recommended for replacement. If gage face wear exceeds 10/16 (0.6250) inch, trains are put under a slow order until the rail is replaced.
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> Measurements of vertical head loss of the rail pieces examined in the Safety Board's Materials Laboratory showed rail head losses ranging from 0.38 to 0.70 inch. When measured with a rail wear template of the type that railroads used to evaluate rail wear, the vertical head loss was indicated to be about 1/8 (0.1625) inch less than the actual loss.[16]

The NS's own periodic rail inspection process failed to identify this hazardous rail wear condition before Sperry conducted the rail tests mentioned elsewhere in this letter. The NTSB continues to believe that a damage-tolerance approach that takes into account such critical

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[15] The studies cited on page 25, footnote 37, are: (a) D.Y. Jeong, T.H. Tang, O. Orringer, and A.B. Perlman, *Propagation Analysis of Transverse Defects Originating at the Lower Gage Corner of Rail,* U.S. Department of Transportation, DOT/FRA/ORD-98/06 (1998). (b) D.Y. Jeong, *Analytical Modeling of Rail Defects and Its Applications to Rail Defect Management,* U.S. Department of Transportation, Research and Special Programs Administration, Volpe National Transportation Systems Center (2003).

[16] NTSB/RAR-08/02, p. 25.

factors as rail wear would help establish an inspection frequency that allows internal rail defects to be identified before they reach critical size.

The NS's challenge to conclusion 10 is tantamount to a challenge to the feasibility of the accompanying recommendation to the FRA.[17] The NTSB allows petitions for reconsideration of only the NTSB's findings and probable cause. Therefore, a petition for reconsideration is not the appropriate vehicle for challenging the feasibility of a recommendation. The NTSB finds no basis for modifying the accident report on the issue of rail wear. Conclusions 10 and 11 remain accurate statements of the NTSB's position on this matter.

Regarding the wear template, the NTSB notes that conclusion 12 is a generic statement that remains accurate regardless of whether the NS uses that type of template and that the conclusion supports the accompanying recommendation to the FRA.[18] However, the NTSB will delete the statement on page 37 of the report that this type of template could have caused the NS to underestimate the amount of wear.

NS Argument: NTSB incorrectly assumes that once a defect reaches a specified "critical" size the rail will fail

The NS claims that no proven technology exists that ensures the detection of every internal defect, accurately predicts the growth rate, or determines the critical size at which failure will occur. Thus, the NS asserts it is not possible to guarantee the detection of all defects before they cause failure. Conclusion 9 is shown below:

> 9. The NS did not conduct internal rail inspections frequently enough to reliably detect an internal defect before it could grow to critical size in the significantly worn rail.

The NS asks that the NTSB eliminate the conclusion or revise it to say that the critical size is not necessarily predictable and may be too small to detect.

NTSB Response

The NS's challenge to conclusion 9 is again tantamount to a challenge to the feasibility of the accompanying recommendation issued to the FRA (Safety Recommendation R-08-10). The fact remains that between inspections a defect grew from a size that could not be reliably detected to a size that covered 78 percent of the remaining head area. A rail head with 78 percent of the head area compromised by a defect has a high probability of failure, and inspections should be scheduled in a way that ensures defects are reliably detected before they reach that

[17] Safety Recommendation R-08-10 asked the FRA to "require railroads to develop rail inspection and maintenance programs based on damage-tolerance principles, and approve those programs. Include in the requirement that railroads demonstrate how their programs will identify and remove internal defects before they reach critical size and result in catastrophic rail failures. Each program should take into account, at a minimum, accumulated tonnage, track geometry, rail surface conditions, rail head wear, rail steel specifications, track support, residual stresses in the rail, rail defect growth rates, and temperature differentials."

[18] Safety Recommendation R-08-11 asked the FRA to "require that railroads use methods that accurately measure rail head wear to ensure that deformation of the head does not affect the accuracy of the measurements."

size. Conclusion 9 remains an accurate statement of the NTSB's position on this matter, and no change will be made to the report.

Summary

As a result of the new information presented in the NS petition for reconsideration, the NTSB will revise the final accident report as follows:

Changes to factual section titled NS Internal Rail Inspection History (beginning with fourth paragraph on page 16):

A review of the data from the August 1, 2006, inspection for internal rail defects showed that the inspection vehicle traversed the area where the derailment later occurred three times. Evidence gathered during the initial investigation included only the first pass of the inspection vehicle. However, in June of 2008, after the NTSB's final report had been adopted, the NTSB was informed that Sperry's director of research and development discovered additional recorded data that showed that the rail inspection vehicle had traversed the derailment area twice on August 1, 2006. The NTSB's further examination of the data showed that the rail inspection vehicle traversed the derailment area three times on August 1, 2006. On the first pass there was an intermittent loss of bottom signal ~~as the inspection vehicle moved~~ over about a 9-foot length of track 1 in the area of the derailment that coincided with detail fracture rail defects and the subsequent broken rail. The longest continuous loss encompassed about 7 inches of track. Sperry's vice president of systems integrity ~~representatives~~ told Safety Board investigators that the loss of bottom signal on the zero-degree channel indicates that the sound did not reflect from the bottom of the rail, which is indicative of a possible surface condition on the rail that could mask an underlying defect. He also stated that there was fairly severe gage side shelling on the rail head surface of the recovered rail from the area of the derailment that ~~w~~could have interfered with the ultrasonic signal ~~returning from the base of the rail, causing an intermittent loss of bottom signal~~. A review of the ultrasonic inspection data showed that the location of the largest defect in the recovered rail was within a 2-inch ~~area~~ region that had a loss of bottom signal in the August 1, 2006, inspection data from the first pass of the inspection vehicle. On the second and third passes there was no loss of bottom signal in the area of the derailment.

Sperry's vice president of systems integrity stated that detail fractures (transverse oriented defects in this case) are detected utilizing the 70-degree ultrasonic channels and the induction channels. He stated that the zero-degree channel is not utilized to detect transverse oriented defects. There were no indications of a transverse defect in the 70-degree ultrasonic channel data for any pass of the inspection vehicle in the area of the derailment. However, he indicated that the system does not have the capability to determine if a good reading is available from the 70-degree sensor. The only channel that can be monitored for rail penetration is the zero-degree channel, because that signal is reflected from the base of the rail.

The Sperry operator initially told investigators ~~stated~~ that he did not stop the inspection vehicle to conduct a reinspection or to hand inspect the rails in the area of the intermittent loss of bottom signal because the area of continuous loss was less than 5 feet and thus did not, according to his interpretation of the NS instructions, require reinspection. The NS has informed the NTSB that its instructions, which were developed with Sperry, were not intended to instruct operators to disregard a loss of bottom signal of less than 5 feet and that the instructions address only a loss of bottom signal exceeding 5 feet. However, the inspection vehicle operator told NTSB investigators that he interpreted the instructions to mean that he did not have to retest any area in which there was a continuous loss of bottom signal of less than 5 feet.

Changes to analysis section titled Rail Defects and Ultrasonic Inspection (starting with the third paragraph on page 32 and continuing to page 33):

The rail had been inspected for internal defects about 2 1/2 months before the accident using an instrumented vehicle. At that time, the vehicle operator did not identify any internal rail defects in these sections of rail. The investigation determined that the site of the rail failure was within a 9-foot length of rail where, most likely because of rail surface conditions, the ultrasonic inspection equipment during the first pass of the inspection vehicle ~~had~~ received only intermittent signal returns from the bottom of the rail. During the second and third passes there was no loss of bottom signal.

Based on defect (crack) growth calculations, at the time of the August 1, 2006, rail inspection, the size of the largest defect, which initiated the rail fracture, would likely have been approximately 8 to 14 percent of a new rail head area.[19] Based on Safety Board laboratory evaluations and the TTCI data in table 1, the size of the initiating defect was likely too small[20] at that time to be reliably detected. Also, the shelling that was evident on the rail surface as well as the crack patterns from flaking that were observed on a cross section of the accident rail could have prevented ultrasonic signals sent from the running surface from detecting locations of the recovered rail from the area of the derailment showed that the location of the initiating defect was within a 2-inch area that had a loss of bottom signal during the first pass of the inspection vehicle. The NTSB recognizes that there was no loss of bottom signal during the second and third passes of the inspection vehicle; however, that does not rule out the possibility that the rail surface conditions interfered with the effective transmission of the ultrasonic signal on the gage side of the rail during those passes as well. The Safety Board therefore concludes that rail surface conditions may have prevented the effective transmission of the ultrasonic signals during the August 1, 2006,

[19] Defect size is typically given as a percentage of the rail head area of a new rail. The area of the largest defect at the time of the August 1 rail inspection would likely have covered approximately 13 to 23 percent of the existing worn rail head.

[20] The TTCI data estimates a 64-percent probability of detection for a defect size of 8 percent of the rail head using an inspection vehicle.

inspections, and crack growth calculations and ultrasonic equipment detection capabilities indicate that the defect (fatigue crack) that led to the derailment may not have been large enough at that time to be reliably detected by the inspection vehicle.

FRA regulations require that all railroads conduct a “continuous search” when inspecting rail for internal defects. In the FRA’s interpretation of the regulations, any rail inspection that is interrupted “as a result of rail surface conditions that inhibit the transmission or return of the signal” is not considered to be continuous under the regulation and therefore is not to be considered a valid inspection of the affected rail segment.

About a year and a half before the accident and without consulting the FRA, the NS gave its inspection contractor (Sperry) new procedures for inspecting rail for internal defects. In effect, the new procedures permitted the equipment operator to ignore any loss of bottom signal as long as the continuous loss-of-signal distance did not exceed 5 feet of linear rail length. The new procedures were intended to address the detection of vertically oriented longitudinal rail head defects, not transverse defects. Although the new procedures were designed to address a different type of defect, the procedures were applied to the entire inspection process and thereby could also affect~~ed~~ the detection of transverse defects.

The point of derailment was within a rail segment about 9 feet long where, during the first pass of the August 1 ultrasonic inspection, the inspection equipment had encountered an intermittent loss of bottom signal. Sperry initially provided the NTSB with information indicating that ~~B~~because the longest loss of bottom signal distance was only about 7 inches of linear rail length (which did not exceed the 5-foot minimum specified by the NS that would have required a repeat inspection), this rail segment was not examined further. However, Sperry subsequently produced data which, upon examination by the NTSB, was found to indicate that the rail segment was traversed during two additional passes on the same day during which there was no loss of bottom signal and no sign of defects.

The flaking and shelling conditions found on the recovered rail head likely blocked the ultrasonic signals at several locations, ~~and~~ caus~~ed~~ing the intermittent loss of bottom signal during the first pass of the inspection vehicle. Because the NS procedure was interpreted by the operator as ~~did~~ not requir~~e~~ing ~~the contractor to~~ a repeat ~~the~~ inspection of ~~the rail at these locations, the~~ any area in which the loss of bottom signal was less than 5 feet, this area could potentially have ~~was~~ not been examined further by Sperry, and the internal condition of the rail at these locations ~~was~~ would have been left undetermined. ~~The NS exception to the continuous search requirement eliminated an opportunity to detect the defect that led to the derailment by rerunning the inspection vehicle or by using more effective handheld inspection equipment.~~ Even though in this case the area was traversed in multiple passes, the lack of a clear requirement in the NS procedure to retest in the event of a loss of bottom signal less than 5 feet still presents a safety concern. If shelling is the reason for the loss of bottom signal, the operator cannot be confident that the side sensors are working to detect transverse defects.

Change to analysis section titled Rail Defect Management (last paragraph on page 37):

As this accident shows, accurately measuring the level of rail wear is important in order to determine the appropriate frequency for conducting internal rail inspections. When investigators measured the accident rail using a template of the type typically used by railroads to measure rail head wear, they found that the rail head vertical loss appeared to be about 1/8 inch less than was actually measured. Because of downward deformation of the worn rail head under loads, the rail head on both sides of the rail web extended below the profile of new or less worn rail. ~~The rail wear template fits under the rail head, and the downward displacement could have caused the NS to underestimate the amount of wear.~~ The Safety Board concludes that downward deformation of a severely worn rail head can affect the measurement of rail head wear using a rail wear template and may cause a railroad to underestimate the actual amount of wear. The Safety Board believes that the FRA should require that railroads use methods that accurately measure rail head wear to ensure that deformation of the head does not affect the accuracy of the measurements.

Changes to Conclusion 6 (page 40):

6. Rail surface conditions may have prevented the effective transmission of the ultrasonic signals during the August 1, 2006, inspections, and crack growth calculations and ultrasonic equipment detection capabilities indicate that the defect (fatigue crack) that led to the derailment may not have been large enough at that time to be reliably detected by the inspection vehicle.

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in the disposition of this petition for reconsideration.