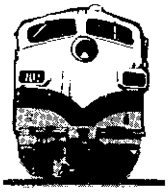
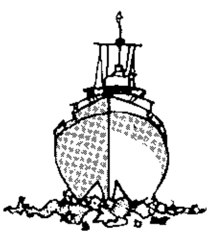
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594



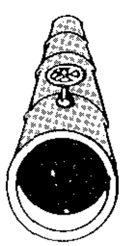
RAILROAD ACCIDENT REPORT



UNION PACIFIC RAILROAD FREIGHT TRAIN DERAILMENT

HASTINGS, NEBRASKA

AUGUST 2, 1976



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15. Supplementary Notes

16 Abstract

About 3:40 p.m., on August 2, 1976, 39 cars of Union Pacific Railroad freight train Extra 2800 East derailed near Hastings, Nebraska. Damage was estimated to be about $1,155,010. No one was injured.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the previously disturbed track structure to withstand the lateral forces generated by the 42nd, 43rd, and 44th cars of the train. The lateral forces resulted from a run-in of disproportionately heavy cars in the rear portion of the train.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: March 31, 1977

UNION PACIFIC RAILROAD
FREIGHT TRAIN DERAILMENT
HASTINGS, NEBRASKA
AUGUST 2, 1976

SYNOPSIS

About 3:40 p.m., on August 2, 1976, 39 cars of Union Pacific Railroad freight train Extra 2800 East derailed near Hastings, Nebraska. Damage was estimated to be about $1,155,010. No one was injured.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the previously disturbed track structure to withstand the lateral forces generated by the 42nd, 43rd, and 44th cars of the train. The lateral forces resulted from a run-in of disproportionately heavy cars in the rear portion of the train.

INVESTIGATION

The Accident

The Union Pacific Railroad (UP) assembled freight train Extra 2800 East at its Bailey Yard in North Platte, Nebraska. The brakes were inspected before the train departed in compliance with the Federal Power Brake Law. No exceptions were taken to the brakes' condition. The front brakeman told the engineer of Extra 2800 East that the train had heavy cars on the rear.

The train departed Bailey Yard at 1:15 p.m., August 2, 1976, for Marysville, Kansas. It first stopped at Cozad, Nebraska, where the engineer initially reduced the brake pipe air pressure by 6 to 7 pounds. After allowing the brake pipe pressure to equalize, he made a further reduction to stop the train. As the train slowed to a stop, he gradually reduced the throttle to the idle position.

At Alfalfa Center, Nebraska, a trainmaster had placed two signal torpedoes 1/ on the rail to test the engineer's compliance with operating rules. The explosion of two torpedoes requires that an engineer immediately reduce his train's speed to 20 mph or less and to maintain that speed for 1 mile; if no restrictive situation is encountered, he may resume speed. When

1/ Small explosive charges used for signalling which, when fastened to a rail and overridden by a train, explode loudly.

Extra 2800 East struck the torpedoes, the engineer immediately made an initial brake pipe reduction of about 10 pounds. After the brake pipe pressure equalized, he further reduced the air pressure by 8 or 9 pounds. When the train's speed was reduced to about 10 mph, the engineer released the brakes and the train continued eastward at that speed. The engineer increased the train's speed after the 1-mile point. Neither the conductor nor the rear brakeman thought that the train was handled badly at Cozad or Alfalfa Center.

When the brakes were released, the trainmaster and a road foreman of engines observed slack action in the train about 75 to 80 cars from the engine. Neither man considered the slack action significant. The trainmaster took no exceptions to the manner in which the train was handled during the test.

The train approached the highway grade crossing 4.25 miles west of Hastings at a speed of 52 mph. The engineer saw persons on the track and earthmoving equipment near the north side of the track. He became alarmed and immediately made an 8- to 9-pound brake pipe reduction to prepare for an emergency application. He left the throttle in running position No. 7.

As the train approached closer to the crossing, the engineer thought that he saw someone wave a yellow flag, which he interpreted to be a warning signal. However, he made no further adjustment to the train brakes. Before the train reached the crossing, the engineer realized that a signal had not been given. One person did not get off of the track until the train was about 650 feet to 700 feet from the crossing. The engineer released the train brakes when he saw that the track was clear and when the locomotive was at the crossing. The train's speed had been reduced to about 45 mph. He reduced the throttle from position No. 7 to position No. 6 and immediately felt two surges of forward and backward motion in the train; this was immediately followed by an automatic emergency brake application from the train which was caused by the derailment. The engineer then released the locomotive brakes and closed the throttle.

Thirty-nine cars--the 42nd through the 81st--derailed immediately east of the crossing. No one was injured. Only the west trucks of the 42nd car derailed.

The track is straight from milepost 16.5 west of Hastings through the derailment area and is built on slight cuts and fills (See figure 1.) The track is maintained to the Federal Railroad Administration (FRA) Class 5 track standard.

Beginning about milepost 5.25, west of Hastings, the track is on a 0.48 percent grade that descends to the east. Between milepost 4.5 and milepost 4.25 at the crossing, the grade changes to 0.0 percent (level) which continues east through the crossing. Approximately 1,200 feet east of the crossing, the grade descends 0.17 percent.

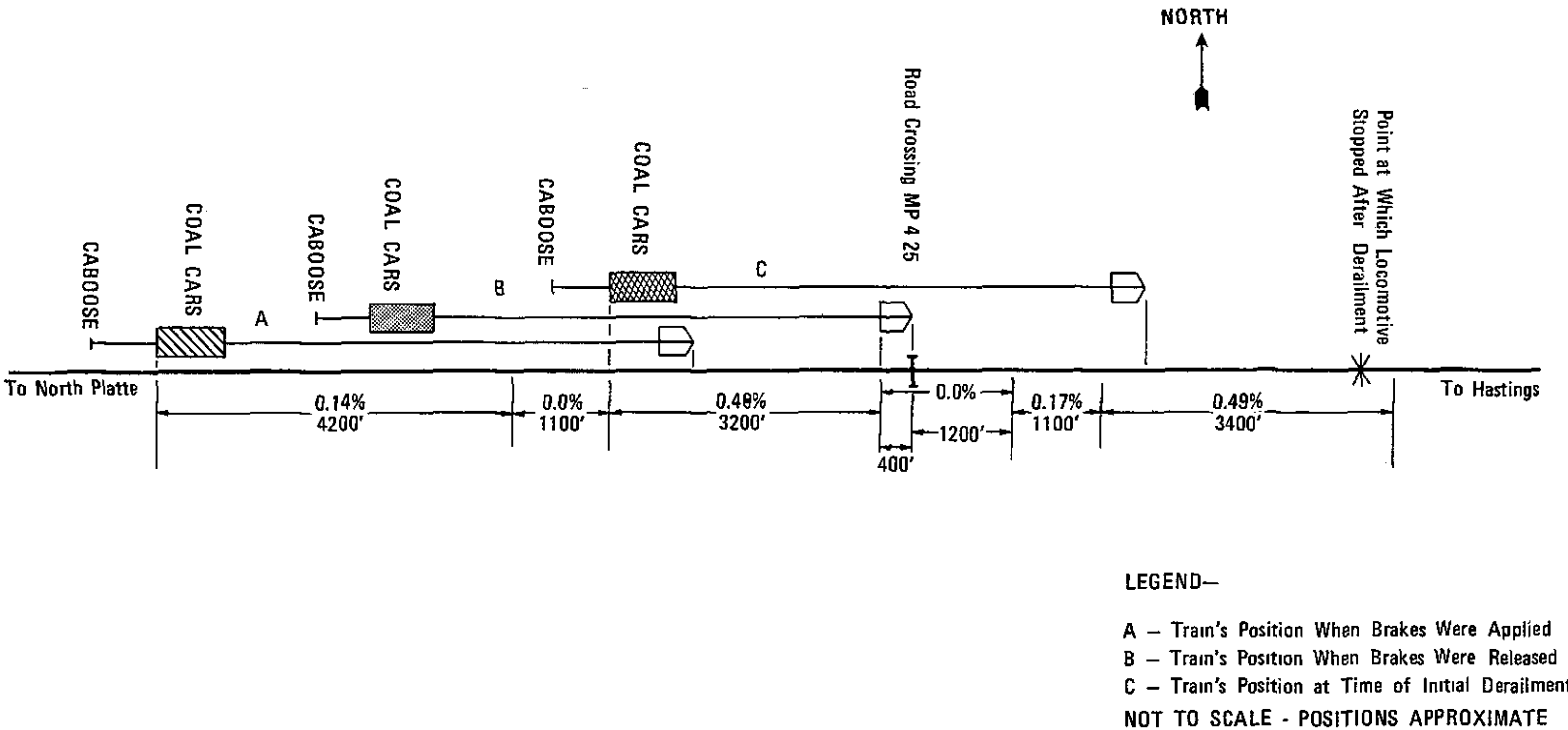

Figure 1. Plan of accident site.

The 133-pound continuous welded rails were set on 8-inch by 14-inch double-shoulder tie plates on 7-inch by 9-inch by 9-foot treated crossties. The rails were spiked with three lineholding spikes--one on the field side and two on the gage side--and one holddown spike on the gage side. The spiking pattern exceeded the requirements of the FRA Track Safety Standards. Channel-lock anchors were used to box every other crosstie.

Damage

Most of the 39 cars that derailed in the accident were heavily damaged. Track damage between milepost 4.3 and milepost 3.25 ranged from total destruction to damaged rails and crossties. The grade crossing was destroyed. Damage was estimated as follows:

Equipment	$ 603,100
Track	83,046
Other Costs	468,864
Total Damage	$1,155,010

Crewmember Information

The engineer of Extra 2800 East was employed as a fireman by the UP in August 1969. He was qualified on air brakes on April 22, 1973, and passed the operating rules examination for promotion to engineer on July 26, 1973. He was requalified on the operating rules on August 8, 1974, and he passed his last medical examination on January 1, 1975.

The engineer did not attend the UP training school for engineers at Cheyenne, Wyoming. Instead, he received on-the-job training under the supervision of "preferred" engineers 2/ supplemented by some classroom instruction. However, his supervisor, the road foreman of engines, had never supervised the engineer's operation of a train. The engineer attended rules and airbrake classes and received written information about operating procedures and the mechanical and electrical aspects of a locomotive. He was given written examinations covering airbrakes, machinery, and operating rules.

The airbrake instruction covered the use of dynamic brakes and how to prepare the train for braking. However, it did not give specific guidelines on when dynamic brakes should be used or for which braking technique to use when weight is unequally distributed in a train. The engineer said that he was advised to operate the train "very carefully" when heavily loaded cars were on the rear of the train.

Train Information

Extra 2800 East had three locomotive units. The lead unit, a General Electric model U-23-C with type 26-C airbrake system, was being

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2/ Engineers of proven ability who were used as instructors for engineer trainees.

operated with its short end forward. The other two units were General Electric model U-30-C with type 26-L airbrake equipment. The lead unit and the caboose were equipped with operable radios which were used twice during the train's operation from North Platte to the accident site. They were not used immediately before the accident at the crossing. The lead unit also was equipped with a speed recorder.

The train's 71 loaded and 45 empty cars extended more than 1 mile. Its total weight was 8,240 tons. A block of 14 cars of coal, each weighing about 130 tons, was positioned in the rear portion of the train, 12 cars from the rear. About 70 percent of the total tonnage was contained in the rear 74 cars. Many of the cars on the forward portion of the train were either empty or lightly loaded.

The cars of Extra 2800 East were grouped at Bailey Yard according to their destination and to expedite subsequent handling; car distribution by weight was not considered. In most instances the grouping complied with a request from the receiving railroad. The only restraints to train make-up that are normally observed at Bailey Yard are rules that govern cars that require special handling, such as high and wide cars, cars of excessive weight, cars that carry certain commodities, or the adjacent positioning of short and long cars within the train.

Method of Operation

Trains are operated over the track in the area by a centralized traffic control (CTC) system. The maximum authorized train speed is 65 mph. There are no cab signals or automatic train control.

A company airbrake rule prohibits an engineer from making a running release of train brakes if the brakes are applied with a brake pipe pressure reduction of less than 10 pounds. This reduces the possibility of sticking brakes and the development of undesired slack action within the train.

Meteorological Information

The accident occurred in daylight, the weather was clear, and the maximum temperature that day was 75° F.

Tests and Research

The exact initial derailment point could not be determined because the track was destroyed.

An inspection of the first six derailed cars, the 42nd through the 47th, revealed that the couplers were intact. Marks that indicated side impact from lateral movement of the coupler on the end casting assembly were evident only on the first three derailed cars. It could not be determined whether the impact marks were caused by couplers moving because of slack action or whether they were made as the cars were dragged down the roadbed after derailing. No marks that would have indicated dragging equipment before the accident were found west of the derailment area.

The speed recorder tape indicated the stop at Cozad, the speed reduction at Alfalfa Center, and the emergency stop at Hastings. It showed a speed decrease of 8 mph over a distance of 1 mile at Cozad, 9 mph over 1 mile at Alfalfa Center, and 7 to 8 mph over one-half mile at Hastings.

Other Information

The track workers arrived at the highway grade crossing about 8:30 a.m. to replace crossties and to raise the track through the crossing. The men wore yellow hard hats as part of their safety equipment. No slow order was issued or flag protection provided to protect the workers.

A UP instruction prohibits the replacement of more than three adjacent crossties at a time if the rail temperature is less than 100° F. (See appendix A.) The replacement of more than nine crossties in a 39-foot rail length is also prohibited. The instruction requires track workers to check the rail temperature before beginning work and requires the issuance of a slow order. However, the instruction does not apply to crosstie replacement through a highway grade crossing. (See appendix B.)

Another UP instruction prohibits raising the track more than 1 1/2 inches in one operation at any rail temperature. (See appendix C.) Track workers had raised the track in the crossing by 3 inches.

During the day, the ambient temperature reached a maximum of about 75° F. Track workers in the accident area usually assume that the rail temperature will be about 15° F higher than the ambient temperature thus making a working temperature of about 90° F. The rail thermometer provided to the section foreman for determining the actual rail temperature was not used on the day of the accident.

The track workers proceeded with the work by replacing two crossties at a time, completing work on each pair before replacing the next two. They replaced 14 crossties within the crossing and replaced 4 on the west end and 6 on the east end of the crossing. By 2:00 p.m., all 24 crossties were in place, the ballast had been replaced in the cribs, and the ends of the crossties were covered.

After 2:00 p.m., two freight trains--one eastbound and one westbound--passed over the crossing without incident. Neither train used its brakes at that point. About 3:40 p.m., when Extra 2800 East approached the crossing, all work had been completed except for replacing and spiking the crossing boards.

The track workers witnessed the derailment but none could estimate the distance east of the crossing where the point of derailment was.

The section foreman had 2 1/2 years experience as a track worker, 1 1/2 years experience as a track force foreman, and 1 1/2 years experience as a section foreman. He received on-the-job training and had passed a written examination on general track structures and an oral examination on operating rules. His portable radio was tuned to the frequency that is used by main line freight trains, but he did not use it. Its use is not required during track work.

ANALYSIS

When a brake application is made by the engineer, the brakes apply on the cars in sequence from front to rear. This causes unbraked or less effectively braked trailing cars to close up on the forward cars where the brakes have already become effective. The individual braking of light cars is more effective than the braking of heavy cars. When brakes are first effectively applied, the initial retardation of light cars is greater than heavy cars. Add this effect to the normal run-in which results from sequential front to rear effective braking and it becomes apparent that blocks of heavy cars should not be placed behind light cars.

The arrangement of cars in Extra 2800 East concentrated slightly more than twice the tonnage in the trailing 74 cars than was in the lead 42 cars. When one considers that about 75 percent of those cars behind the first 42 cars, including the block of 14 130-ton cars of coal, were on the 0.48 percent descending grade when the engineer made the brake application, it is not unexpected to find evidence of undue lateral forces on the couplers of the 42nd, 43rd, and 44th cars. Considering these factors and the fact that the 42nd car's trailing truck was still on the rails after the accident, one can conclude that the compressive forces generated by the unequal braking of the light and heavy cars reached the highest magnitude in the 42nd, 43rd, and 44th cars.

The speed recorder tape indicated a deceleration rate in a half mile at Hastings which was about twice that previously developed at Cozad and at Alfalfa Center. This suggests that the brake pipe reduction to accomplish the reduction in speed at Hastings was considerably more than the 10-pound reduction reported by the engineer. This heavier braking on the descending grade increased the probability of a severe run-in by the heavily loaded cars in the rear of the train. The running release may have increased the slack action in the train.

Since the engineer had not been evaluated by his supervisor, the Safety Board cannot characterize his ability as an engineer. However, the lack of formal training at the carrier's school at Cheyenne, the absence of personal supervision of the engineer's performance by a road foreman of engines, and his short experience raises the question of whether the engineer was capable of predicting the dynamic action of the train. Certainly a general admonition to "handle it carefully" and a brakeman's advice that the train had heavy cars on the rear were insufficient information to an engineer of this training and experience to prevent damaging slack action when braking this train.

Track workers violated a UP instruction when they raised the track in the crossing more than 1 1/2 inches on the day of the accident. Safety Board investigators found no information that indicated the height restriction on the raising of track through a grade crossing had been waived in this case. The foreman also failed to use a track thermometer as required by UP instruction to determine the exact temperature of the rails; it is not likely that this had any bearing on the accident, however.

Although investigators were not able to determine the exact location of the initial derailment, it was obvious that the first cars derailed immediately east of the crossing. Undoubtedly the track in the worked section was less stable and, thus, was less able to withstand the lateral forces imposed by a train during a heavy brake application. Therefore, the Safety Board believes that the disturbed track was a factor in the cause of the derailment. Given the arrangement of the cars in the train, the track profile, the inherent nature of forces generated by freight train braking, and the disturbed track in that location, it is predictable that the disturbed track would tend to fail under the dynamic forces exerted on it by the train.

Although not required by UP instruction a slow order might have prevented the accident because the engineer could have been prepared for the activity at the crossing. Such a precaution would also give more protection to track and train personnel.

CONCLUSIONS

Findings

1. The engineer of Extra 2800 East knew that he was operating a long, heavy tonnage train and that much of the weight was located at the rear of the train.

2. The train was assembled at Bailey Yard without consideration for weight distribution.

3. The crewmembers did not notice any slack action or brake problems when the train stopped at Cozad or when the train's speed was substantially reduced at Alfalfa Center.

4. The trainmaster and a road foreman of engines saw slack action at Alfalfa Center, but did not report it.

5. The train's speed was reduced from 52 mph to 45 mph in approximately one-half mile as it approached the highway grade crossing at milepost 4.25.

6. The exact point of derailment could not be determined.

7. Analysis of the speed reduction recorded on the speed tape disclosed that the initial brake pipe air reduction made at Hastings was more than the 8- to 9-pound reduction that the engineer claimed he made. This indicated that the engineer did comply with the carrier's requirements for making a running release of brakes.

8. The slack generated in the train at milepost 4.25 was caused by a combination of automatic emergency brake operation, throttle reduction, track gradient, and weight distribution.

9. A Union Pacific instruction exempts highway grade crossings from restrictions that apply to crosstie replacement in other areas.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the previously disturbed track structure to withstand the lateral forces generated by the 42nd, 43rd, and 44th cars of the train. The lateral forces resulted from a run-in of disproportionately heavy cars in the rear portion of the train.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommended that the Federal Railroad Administration:

"Promulgate regulations to insure that the locations of heavily loaded freight cars in a train will not adversely affect the train's operation. (Class II, Priority Followup) (R-77-3)

"Require that trains operated over unstable track be limited by a slow order, verbal contact by radio, or by flag protection to speeds that will reduce the possibility of track buckling from forces that exceed the restraining ability of the track. (Class II, Priority Followup) (R-77-4)

"Require that locomotive engineers be instructed in the braking of trains for varied circumstances that may develop during a train's operation." (Class II, Priority Followup) (R-77-5)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

WILLIAM R. HALEY, Member, did not participate.

March 31, 1977

APPENDIX A

INSTRUCTION BULLETIN CE-74-106-T

UNION PACIFIC RAILROAD COMPANY

Office of Chief Engineer

INSTRUCTION BULLETIN

NO. CE-74-106-T April 15, 1974

Sheet 1 of 2 Sheets

To: Track Department Supervisors and Foreman

SUBJECT: Tie Renewals in Track Containing Continuous Welded Rail

To the extent possible, renewal of ties shall be avoided in track containing continuous welded rail when rail temperatures exceed 100° F. Foremen supervising tie renewal operations in continuous welded rail territories must use rail thermometers to continuously monitor the rail temperature.

When tie replacements are being made, the surface and alignment of track shall be disturbed as little as possible and no more ballast shall be removed from the ends of the ties being replaced, or from the cribs between the ties, then is absolutely necessary. Supervisor or Foreman in charge of the work shall check rail conditions regularly to insure that tie replacements can be made without hazard of the track kicking out of surface or line. If there is evidence that the rail is extremely tight such as lifting up in the tie plates and straining against the spikes, or having the appearance of being extremely kinky and binding against the shoulders of the tie plates, etc., no tie replacement work shall be undertaken.

When rail temperature is 100° F or less, not more than three consecutive ties shall be replaced at a time, nor more than nine ties in any 39 foot length of track. During working hours while ties are being installed, train movements shall be restricted to a maximum of 40 mph speed over that portion of track where ties are to be installed during the day. If track conditions are satisfactory and rail temperature below 100° F at the end of the working day, this speed restriction shall be removed.

When rail temperatures are higher than 100° F, not more than two consecutive ties shall be replaced at a time, nor more than six ties in any 39 foot length of track. In addition, all train movements shall be restricted to a maximum of 40 mph speed during tie renewal operations and

INSTRUCTION BULLETIN

No. CE-74-106-T

Sheet 2 of 2 Sheets

for a period of 12 hours thereafter to consolidate and compact the disturbed ballast and thus assure a stable track condition at normal operating speeds.

Whenever the number of ties to be replaced exceed the limitations specified, this shall be accomplished by making two or more operations over the stretches of track involved, with a minimum lapse of time of 12 hours between consecutive operations over any segment of track.

Ties being removed and replaced must be flanked by good sound ties that are properly spiked, adequately anchored and firmly retained with sufficient ballast at the ends of the ties and in the cribs between the ties. All spikes must be fully drived, rail anchors applied, and full ballast section restored immediately as the new ties are installed.

/s/
R. M. BROWN
Chief Engineer

APPENDIX B

INSTRUCTION MESSAGE OF SEPTEMBER 12, 1974

NX5 HSJ1 0024 19:07 SEP 12 SKKS 0362 19:07

03 HASTINGS 12 1845

KCITY 3 JOW RSH WEW KANSAS CITY

(time stamp)
1974 SEP 12 PM 7 46

TOP LPP TOPEKA

MSVILLE 4 JOW HRB RLH PBA MARYSVILLE

OMAHA 2 HBD PBA OMAHA

HS01 2 WEW RLH HASTINGS

COPY HBD PBA OMAHA

MR. R. M. BROWN ADVISES THAT C. E. INSTRUCTION BULLETIN 74-106 WAS NOT INTENDED TO APPLY TO RENEWAL OF TIES IN ROAD CROSSINGS. NO SLOW ORDER IS REQUIRED WHEN RENEWING TIES IN ROAD CROSSING. EXTREME CAUTION SHOULD BE EXERCISED BY SECTION FOREMAN BY NOT REMOVING MORE THAN TWO TO THREE TIES AT ANY ONE TIME. THESE MUST BE FULLY SPIKED AND CRIBS FILLED IN AND TIES TAMPED BEFORE REMOVING ADDITIONAL TIES. IDEALLY EVERY THIRD TIE SHOULD BE REMOVED AND RENEWED THRU OUT THE CROSSING BEFORE STARTING THRU A SECOND TIME. THIS REQUIRES THREE PASSES THRU THE CROSSING TO RENEW ALL TIES IN THE CROSSING. ACKNOWLEDGE RECEIPT AND UNDERSTANDING.

WEW

APPENDIX C

INSTRUCTION BULLETIN CE-71-65-T

UNION PACIFIC RAILROAD COMPANY

Office of Chief Engineer

INSTRUCTION BULLETIN

No. CE-71-65-T May 21, 1971

Sheet 1 of 1

TO: Track Department Supervisors and Foremen

SUBJECT: Surfacing and Lining Continuous Welded Rail

Trackage containing continuous welded rail shall not be raised out-of-face until sufficient ballast has been uniformly distributed to assure having a full ballast section in accordance with CS-1 or CS-5 after the raise is made. In addition, rail anchors shall be adjusted to ensure full and proper bearing against ties to prevent rail movement.

If possible, out-of-face surfacing and lining in continuous welded rail territory should be avoided when rail temperatures exceed 90° F. When necessary to perform such work and rail temperatures are in excess of 90° F, the height of a single raise shall not exceed a maximum of 3/4 inch and all train movements shall be restricted to a maximum speed of 40 mph for a period of 48 hours after the track is raised to permit consolidation and compaction of the ballast and to assure track stability at normal train operating speeds.

The height of a single raise shall not exceed a maximum of 1-1/2 inches at any time, regardless of temperature. If a higher raise is required to meet the desired profile, additional raises shall be made with train traffic being operated over the track for a minimum of 24 hours between successive raises to fully compact the ballast.

/s/
R. M. BROWN
Chief Engineer

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