AL TRANSPORTATION SAFETY BOARD

RAILROAD ACCIDENT REPORT

PENN CENTRAL TRANSPORTATION COMPANY

FREIGHT TRAIN DERAILMENT
PASSENGER TRAIN COLLISION
WITH HAZARDOUS MATERIAL CAR
SOUND VIEW, CONNECTICUT
OCTOBER 8, 1970

NATIONAL TRANSPORTATION SAFETY BOARD

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Washington, D. C. 20591

REPORT NUMBER:NTSB-RAR-72-1

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ADOPTED: DECEMBER 22, 1971

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16. Abstract

At 8:50 p.m., October 8, 1970, Penn Central Transportation Company's freight train derailed near Sound View, Connecticut. Freight cars obstructed track in the path of Penn Central passenger train. The passenger train struck the freight cars, puncturing an LPG tank car designated as "empty." The derailed units of the passenger train passed through ignited gases from the punctured tank car and crossed a railroad bridge. Train crewmembers and passengers were injured. The Safety Board has determined that the probable cause of the derailment of the freight train was the breakage of a truck side of a car on the freight train which followed a progressive fatigue crack failure. The breakage of the truck side resulted in damage to a turnout, which caused derailment of the following cars. The cause of the collision to the passenger train was the obstruction of track No. 2 by cars of the freight train. The Board concluded industry controls to prevent application of improper car components are inadequate, empty tank cars may be hazardous, and suggested that the industry should incorporate crashworthy concepts, improve communication and equipment design, and controls over maintenance, retirement, and testing of equipment components. The Board requested that bridge standards and joint corridor usage be reviewed.

17. Key Words Railroad Passenger and Freight Train Accidents, Accident Investigations, Derailments, Hazardous Material Tank Car, Puncture, Ignited LPG Gas, Railroad Bridge, Locomotive Design, Caboose Design, Truck Side, Component Parts Testing and Retirement, Communications Joint Corridor Usage, Excursion	18. Distribution Statement Released to Public Unlimited Distribution

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FOREWORD

The investigation was conducted by the National Transportation Safety Board in cooperation with the Federal Railroad Administration (FRA) This report of facts and circumstances and determination of cause by the Safety Board is based on the facts developed in the investigation of the accident at Sound View, Connecticut, October 8, 1970.

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I SYNOPSIS

Eight cars of the westbound freight train Advance CB-1 derailed at Sound View, Connecticut, at approximately 8:50 p.m. on October 8, 1970. The derailment occurred immediately prior to the arrival at Sound View of east-bound passenger train No. 174. The locomotive of No 174 struck several derailed freight cars, including a liquefied petroleum gas (LPG) tank car (designated as empty), and the caboose of Adv. CB-1. The entire passenger train was derailed The passenger train then continued, while derailed, through flames from the ignited gases of the punctured tank car, across a railroad bridge over Cross Road.

The accident resulted in minor injuries to several passengers on the train, and more severe injuries to the crews of the two trains. The nose of the lead locomotive unit of the passenger train was severed, and six cars of freight train Adv CB-1 were severely damaged

The National Transportation Safety Board determines that the probable cause of the derailment of the freight train was the breakage of a truck side frame of a car on the freight train which followed a progressive fatigue crack failure. The fatigue crack was probably caused by increased shock loading on the side frame due to improper application of a 40-ton spring package in a car which carried 50 tons. The breakage of the truck side resulted in damage to a turnout, which was the immediate cause of derailment of the following cars.

The cause of the collision, derailment, and damage to the passenger train was the obstruction of track No 2 by derailed cars of the freight train. The cause of injuries to the crew of the passenger train locomotive and to the crew of the freight train caboose was the absence of systematic crash protection design of the railroad equipment

II. FACTS AND CIRCUMSTANCES

A. Location and Method of Operation

The derailment occurred 367 feet east of Sound View Station which is located between New London and New Haven, Connecticut, on the Penn Central Railroad. Sound View is located on the Shore Line of the Penn Central Transportation Company's Northeast Region, New Haven Division, which extends eastward from New Haven, Connecticut, to Boston, Massachusetts.

The railroad at Sound View is a double track line running approximately east and west. From the north the tracks are designated as No. 1 (westward) and No. 2 (eastward). A westbound train passes over a 3,557-foot tangent, a 1,723-foot righthand curve, a 449-foot tangent, a 2,105-foot lefthand curve;

and a tangent of 296 feet to the Sound View Station and 1,665 feet beyond. Details of the track layout in the accident area are shown in Figure 1. The Average grade from the west to Sound View station is 0.13 percent ascending and from Sound View Station eastward, the average grade is 0.54 percent ascending.

A hand-operated, trailing-point switch is located in track No. 1, 276 feet east of Sound View Station. This switch leads to a 600-foot siding, located on the north side of and parallel to track No. 1.

The maximum authorized speed in this area is 70 miles per hour for passenger trains and 50 miles per hour for freight trains.

In the accident area there is an automatic-block signal system supplemented by a continuous, inductive, cab-signal system. The method of train operation is by signal indication with the current of traffic and by manual-block signal rules against the current of traffic.

B. Description of the Accident

1 Description of the Trains and Crews Involved

a. Train No. Adv CB-1

Train No. Adv. CB-1, a westbound freight train consisting of two diesel-electric units, No. 2782 and No. 1330, one freight car, and one caboose, No. 586, departed from Boston, Mass., at 5:15 p.m., on October 8, 1970, en route to New Haven, Connecticut. The lead unit of freight train Adv. CB-1 was equipped with a radio in good working condition. The caboose of Adv. CB-1 had no radio. The crew of Adv. CB-1, consisting of a locomotive engineer, a firemen, a head brakemen, a flagman, and a conductor, were qualified in accordance with carrier rules and applicable laws for the services they were performing.

(1) Caboose 586

Caboose 586, an all-welded steel car, insulated throughout and woodlined, was built by Pullman Standard Car Manufacturing Co. in 1944. Average light weight was 43,500 pounds. It was equipped with Westinghouse Air Brake Company's "AB" brakes. Lighting was provided by wick-burner oil lamps (see Appendix 1).

Adv. CB-1 made its first stop at New London, Connecticut, 12 miles east of Sound View Station, where it picked up 49 cars which were received in interchange from the Central Vermont Railway at approximately 7 p.m. on October 8, 1970. These 49 interchange cars received a standard interchange inspection by Penn Central car inspectors before they were added to the train directly ahead of the caboose. Results of the brake tests were satisfactory, and Adv. CB-1 departed from New London with 50 cars and caboose at 8:30 p.m. on track No. 1.

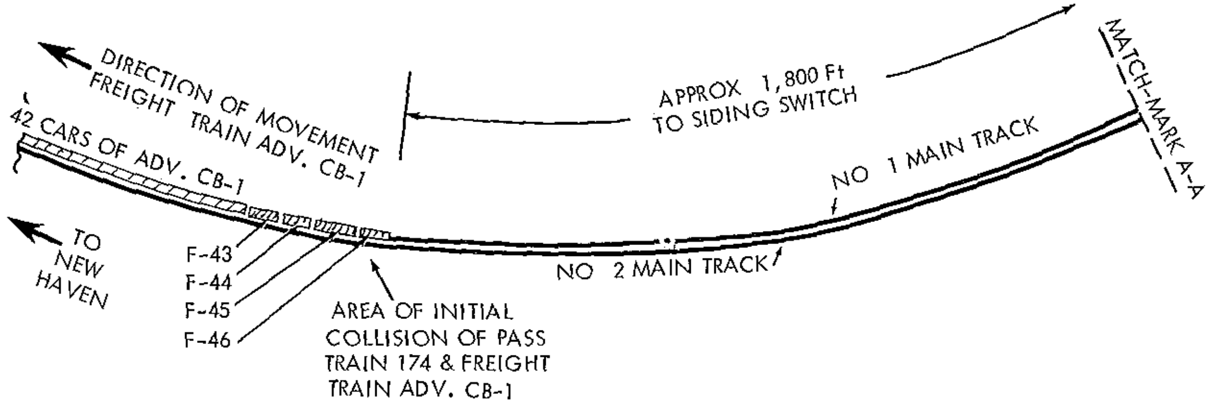
Included in the cars from the Central Vermont were ATSF car 19334 and NATX tank car 34473.

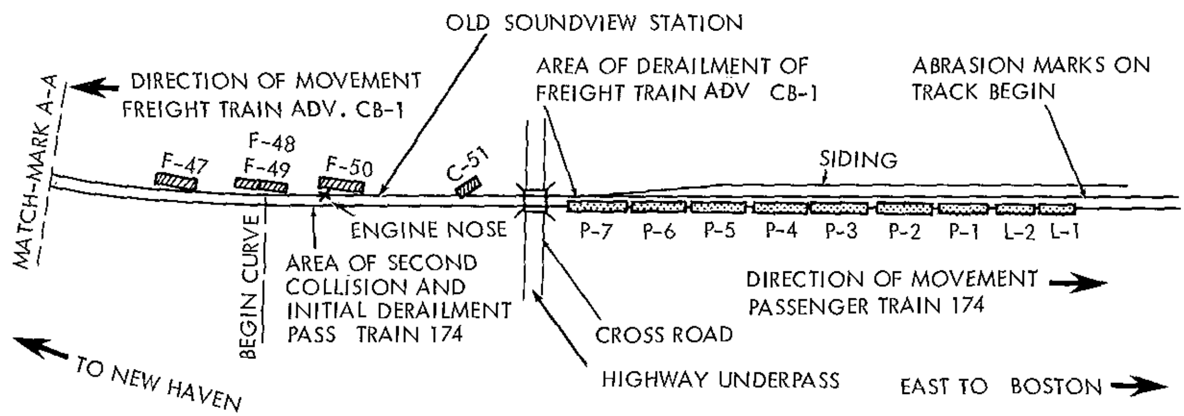
(2) Tank Car NATX 34473

The 50th car of Adv. CB-1 leaving New London, NATX 34473, was an ICC 112A340W specification tank car, with a capacity of 33,856 gallons, built in March of 1969. The shipper, the American Propane Corporation, had received the car, containing an estimated 31,184 gallons of propane, on October 2, 1970. A total of 30,734 gallons of propane was removed from the tank car on October 2 and 5, 1970, at Montville, Connecticut, leaving an estimated residue of 450 gallons. The car was released and delivered to the Penn Central Railroad on October 7, 1970, by the Central Vermont Railway. The car, at that time, was designated as empty. It was placed in the train at New London immediately ahead of the caboose which housed two of the crewmembers.

(3) ATSF Car 19334

Atchison, Topeka & Santa Fe Railway Company (ATSF) car 19334, the 43rd car of Adv. CB-1, was among the 49 cars picked up at the New London interchange. The interchange cars were inspected by Penn Central car inspectors, who did not report any defect in the truck side frame of ATSF 19334. This car





KEY TO EQUIPMENT LOCATION		
DESIGNATION	NUMBER	TYPE
L-1	7547	LOCOMOTIVE
L-2	7542	LOCOMOTIVE
P-1	544	BAGGAGE CAR
P-2	7177	PARLOR CAR
P-3	7130	PARLOR CAR
P-4	3212	COACH
P-5	1485	COACH
P-6	1519	COACH
P-7	1544	COACH
F-43	AT & SF 19334	BOX CAR
F-44	NP 8798	BOX CAR
F-45	PRR 256062	HOPPER
F-46	C & O 17861	BOX CAR
F-47	PRR 259981	HOPPER
F-48	CGW 5040	BOX CAR
F-49	M & STL 50428	BOX CAR
F-50	NATX 34473	TANK CAR
C-51	NH-586	CARBOOSE

SCALE

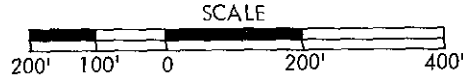


Figure 1

LOCATION OF EQUIPMENT AFTER ACCIDENT

SOUND VIEW, CONN

was a steel boxcar built in 1930 by Pullman Standard. It was rebuilt in 1956. At the time of the accident, the car was 44 feet 7 inches long, 13 feet 4 and 1/8 inches high, and 10 feet wide. The car weighed 52,400 pounds. Its load limit was 124,600 pounds, with a normal capacity of 110,000 pounds.

On the day of the accident, the car contained 1,062 bags of asbestos fibre, weighing 107,262 pounds. The car was loaded at Danville, Quebec, Canada, on October 5, 1970, destined for McNair, North Carolina. The car was moved from Danville to St. Albans, Vermont, by way of the Canadian National Railway, and was interchanged to the Central Vermont Railway. Central Vermont Railway interchanged the car to Penn Central at New London, Connecticut.

The car had two 50-ton four-wheel trucks, with a truck wheelbase of 5 feet 6 inches. The trucks were 31 feet 1½ inches apart at their centers. This was a 50-ton type truck, with size 5½ by 10-inch friction-type bearings. The spring arrangement found on the car is designated as ASF 402 (springs 3126, 3127 and 3141). The truck side frame that was found broken was a Dalman type, size 5½ by 10 inches, manufactured in May 1929 by the American Steel Foundries (ASF). Manufacturing cast-in letters designated the truck as ASF 7707 R/CS 533 (see Figure 2).[1]

The broken truck side frame (see Figure 3) was one of 20,282 castings manufactured between January of 1927 and August of 1959. Of these castings 20,100 were furnished for new equipment in 1927, 1928, and 1929 The remaining 182 were manufactured for stock and repairs. This type of truck side frame has not been manufactured since August of 1959. The truck side frame was originally designed to accommodate the spring grouping portrayed in *Car Builder's Encyclopedia,* pages 773, 774, and 775 (see Appendix 2 and Figure 4).

The manufacturer of the truck side frame has stated that:

"A review of the original design stress sheet for this pattern discloses that the values of combined stress meet all modern standards. Although in 1927 no general industry-wide standards were available, several of the individual railroads had design and test specifications of their own. These became the basis for the ARA 1929 rules, later refined and added to, to become the AAR-1939, and subsequently AAR-1947. This last specification date added a dynamic test requirement for truck side frames, and installed an identification number system to recognize designs tested/approved to that specification.

"This type of frame dynamic testing has been in use by ASF since 1921. This frame, pattern 7707, underwent a fatigue test, 3/14/27, the results of which were satisfactory. This test was an ASF internal test at that time, but was quoted to the AAR in 1949 when an official approval was sought, under the newest specification. Also, in 1929 this frame design had been statically tested in accordance with the then-proposed 1929 ARA requirements. These tests easily met all the AAR static requirements. An officially witnessed AAR static test was made on 10/6/49, and subsequently the AAR assigned Identification No. 548. This approval was restricted, for repairs only, as the rail clearance demension did not meet the modern requirements."

The specifications of the Association of American Railroads (AAR)[2] for steel castings and the specifications for truck side frames, cast steel, are set forth in *Association of American Railroad's Specifications M-201* steel castings and *M-203* truck side frames, cast steel (see Appendix 3). These specifications state that tests of truck side frames should be made in accordance with the spring grouping and spring arrangement. It is not known what the requirements of ASF were at the time the

[1]Observation and identification made by Federal Railroad Administration.

[2]The American Railway Association (ARA) was merged into the Association of American Railroads (AAR) in Oct. 1934

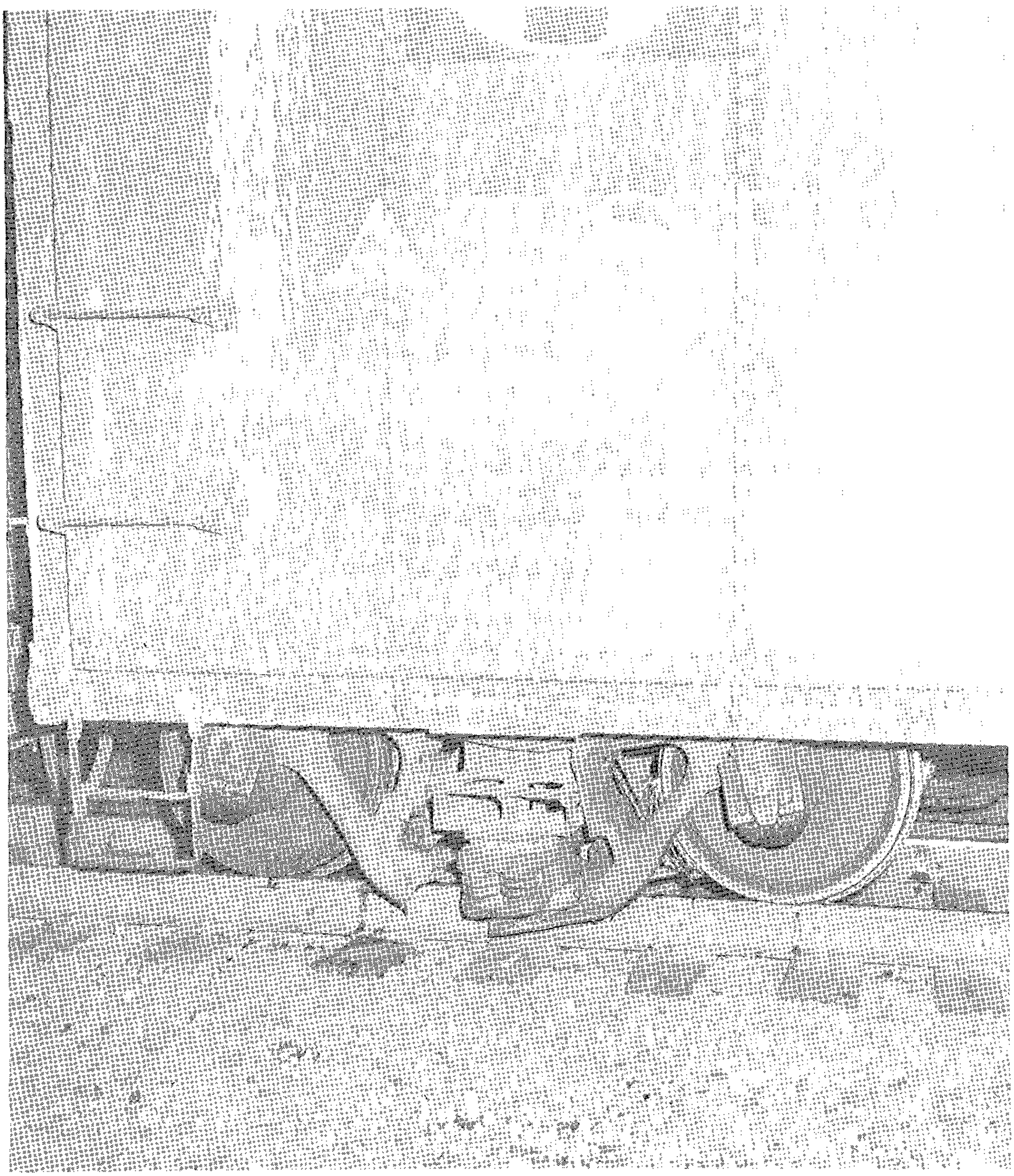


Figure 2.–Broken truck side frame of ATSF 19334 with spring package No 402

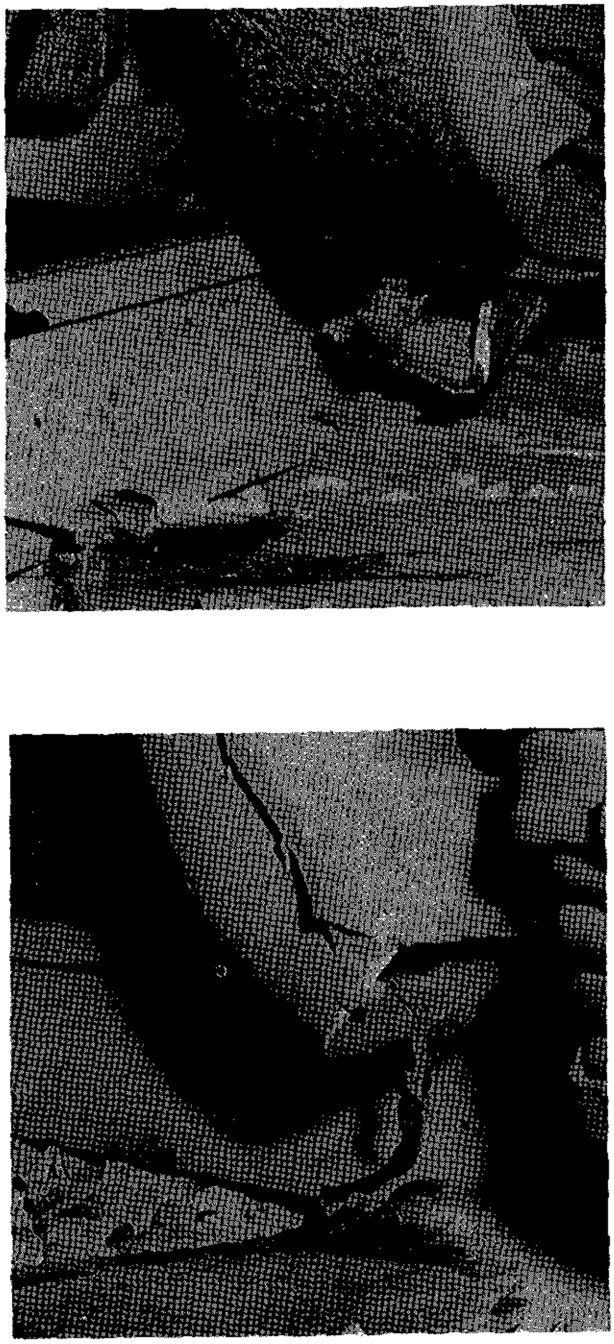


Figure 3.—Closeups of broken truck side frame showing prior break

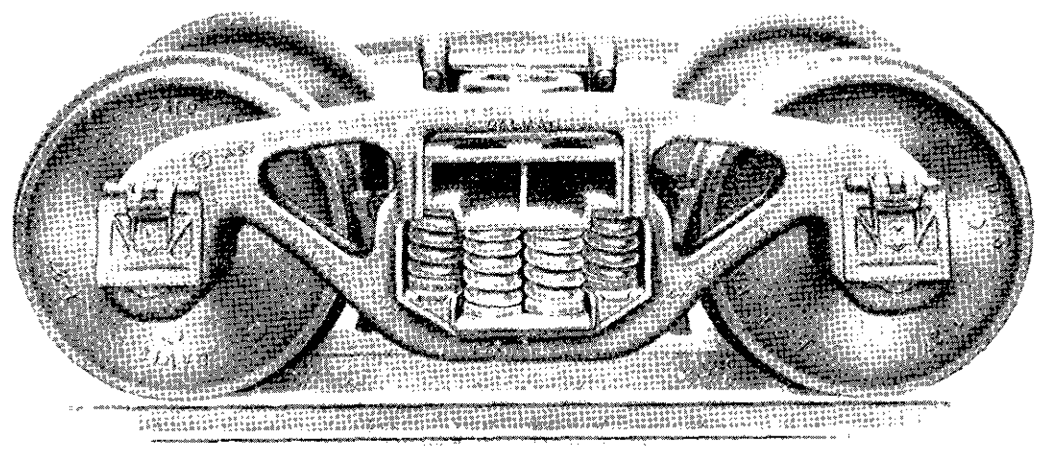


Figure 4 –Side frame with spring arrangement similar to 7707 Photo of truck side frame from The Car Builder's Encyclopedia, 1928, depicting original spring arrangement on the 7707 side frame

dynamic tests were performed on a side frame of this design in 1927. It will be noted that this test was cited to the AAR in 1949 when approval was sought under the AAR-1947 requirements.

ATSF 19334 underwent general repairs in 1956, at which time spring package No. 510 was installed in the trucks. Spring package No 510 is designed for car trucks of 50-ton capacity (5½ by 10-inch journals). This spring package was introduced in an industry attempt to improve the quality of spring performance The manufacturer advised the Board:

> "Road tests, laboratory tests and service evaluation installation tests were performed on various sizes and types of spring package units, on then-common truck arrangements....The lab testing involved fatigue testing, static testing to determine capacities, bounce testing to verify energy absorption requirements, and wear testing to determine life. Road testing involved use of package arrangements in trucks under the ASF test train cars, and the necessary test train runs to determine ride qualities as compared to old style unsnubbed trucks as well as compared to the modern Ride Control type trucks."

There is no evidence that spring package No. 510 has ever been tested on a Dalman type 5½ by 10-inch journal, ASF pattern 7707 side frame.

ATSF was unable to furnish information regarding the date that the No 402 spring package was installed in the side frame which broke It apparently was installed in the side frame some time between the time the car was rebuilt in 1956 and the date of the accident

In answer to the question as to whether the American Steel Foundries recommended the use of this spring package in a Dalman truck side frame 7707, and what was their recommended application for spring package No 402, they responded:

> "ASF does not recommend the use of spring package no. 402 for this truck design The 402 package is rated for 40-ton (5 inch X 9 inch journals), and this car's trucks are 50-ton (5½ inch X 10 inch). ASF furnished the 402 spring package only to the AT & SF, and on May 25, 1955 furnished them a copy

of our application drawing 2-7510 which refers to their car series: 31656-32655, 32656-33155, 33156-33655. These cars used ASF side frame patterns 21267-L, 21362-F or 21456."

It will be noted that ATSF 19334, with side frame pattern 7707 is not included in the foregoing recommended applications.

ATSF advised that there are 1,124 cars equipped with the pattern 7707 side frame, and that no cars of this design, to their knowledge, were presently equipped with the spring package No. 402.

"...because spring pac 402 is designed for 40-ton cars whereas side frame 7707 is for 50-ton cars, and car ATSF 19334 was a 50-ton car."

American Steel Foundries was the only supplier who manufactured spring package No. 402 for ATSF. Use of No. 402 spring package in 50-ton truck sides was not recommended practice of the ATSF. ATSF furnished its maintenance personnel information concerning its recommended usage in the *Car Diagram Book and Spring Folio* ATSF did not perform research on the performance of this spring package on Dalman trucks of this design, and commented:

"Since spring capacity was too little for the 50-ton car, doubtless the springs went solid many times and the resultant shock loading may have contributed to failure of the side frame."

The ASF concurred in this statement, and advised:

"...the use of the 40-ton rated package decreased the spring group capacity to 47,400 #, and therefore allowed the spring group to go solid with much greater frequency. These solid blows are damaging to a truck side frame. Our 50-ton capacity Ride Control package group (no. 510) has 2½" travel springs and 60,360# solid capacity."

A review of spring package No. 510 and No. 402 specifications indicates that they are similar in appearance in a great many respects. There are lugs designed to prevent misapplication; however, it is possible to interchange two spring package units in the pattern 7707 side frame.

The side frame was chemically analyzed by Penn Central laboratories at Collinwood, Ohio, to determine whether the truck side frame's properties conformed with AAR-M-20 chemical specifications. The composition of the side frame was found to be within the AAR specified limits.

"Chemical analyses of samples from an area adjacent to the failure were found to comply with AAR Specification M-201-66 for steel castings and are tabulated below:

	Mang	Phos.	Sul.	Silicon	Carbon
AAR M-201	85% max	05% max	05% max	–	–
ATSF 19334	60%	036%	03%	37%	26%

"The failure occurred in the lower central or spring seat portion of the side frame. Details of the fractured areas are illustrated by the enclosed photographs.

"The fracture faces were found to display evidence of pitting due to corrosion on the lower section (tension element of the member) and progressive crack growth on the upper section (compression element of the member). These findings indicate that the crack in the lower section had been open for a period sufficient to develop the corrosion pits while the upper section acted as a hinge so that more typical fatigue crack growth occurred."[3]

b Train No 174

Train No. 174, a first-class passenger train originating in Washington, D.C., departed

[3]Penn Central Transportation Company's letter to The National Transportation Safety Board, June 22, 1971.

Washington on October 8, 1970, at 1:40 p.m; e.d t on time, en route to Boston, Massachusetts. The crew of No 174 at the time of the accident consisted of an engineer, a fireman, a ticket collector, a baggageman, a flagmen, and a conductor The crewmembers were qualified in accordance with the carrier rules and applicable laws for the service they were providing. Passenger train No 174 had no radio equipment

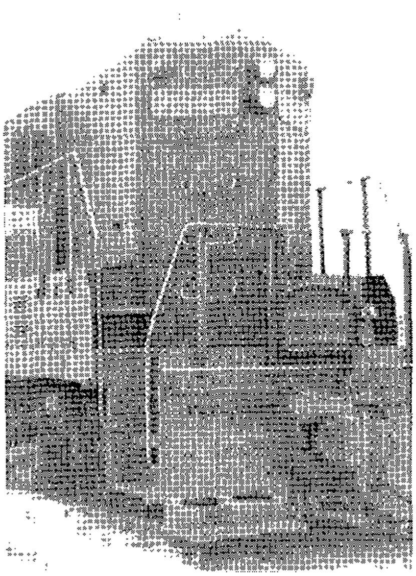


Figure 5.—Short hood end of Type ERS-17 Locomotive

After making several scheduled station stops, No 174 arrived at New Haven at 7:55 p.m. At New Haven, an electrical locomotive and baggage car were removed from the train, two diesel-electric locomotives were attached to the train, and the required standing brake test was made The consist of No 174 leaving New Haven was diesel-electric locomotives No. 7547 and No. 7542; one baggage car, loaded with mail; two parlor cars; and four steel passenger coaches equipped with emergency tools and emergency lights. The train left New Haven on track No. 2 at 8:04 p m., 15 minutes late.

The leading diesel-electric locomotive unit was type ERS-17, 1750 hp , and was being operated with the short hood (stem boiler) end leading The locomotive was equipped with a speedometer and a speed recorder The locomotive weighed 258,700 pounds, and was 56 feet 2 inches in length and 15 feet in height The locomotive was equipped with fire extinguishers, cab signals, a steam generator, and 24 RL brakes The unit was equipped with two dual headlights (32 volt, 200 watt) with a 5° spread in all directions from the center line These headlights were focused for 800 feet

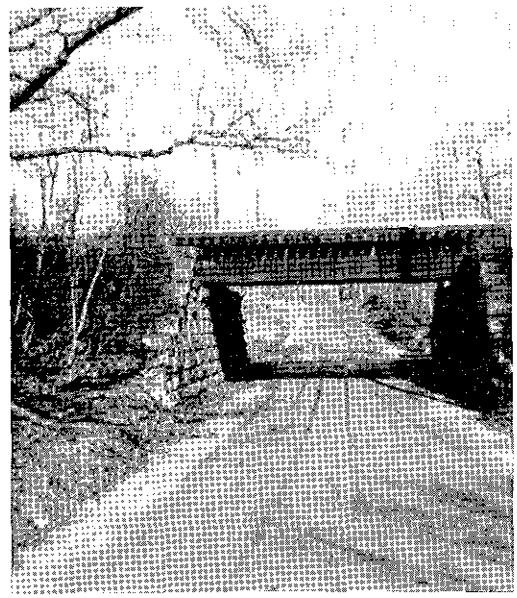


Figure 6.—Railroad bridge over Cross Road

forward in a straight line, and were 230,000 candlepower. The locomotive units were equipped with type "F" couplers. The pilot consisted of a breast plate with foot boards either riveted or welded to the frame of the locomotive The locomotive had a fuel tank capacity of 800 gallons (see Figure 5 and Appendix 4).

2 Description of Track and Surrounding Physical Features

The track centers of the two main tracks in the derailment area were 12.83 feet apart No 1 track was 132-pound RE rail, laid in 39-foot

Figure 7.–Track No. 1, looking east, showing the *switch leading to siding and bridge.*

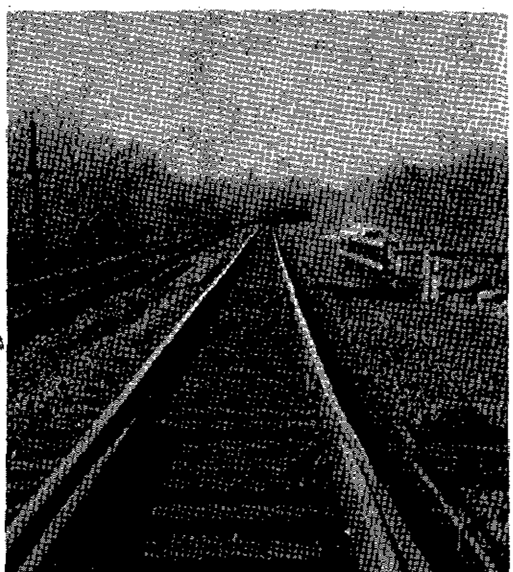


Figure 8.–Track No. 1, looking west, showing the direction of the freight train switch points to siding, the point of derailment, and bridge.[4]

Figure 9.–Track No. 2, looking east, showing railroad *bridge and the direction of the passenger train.*

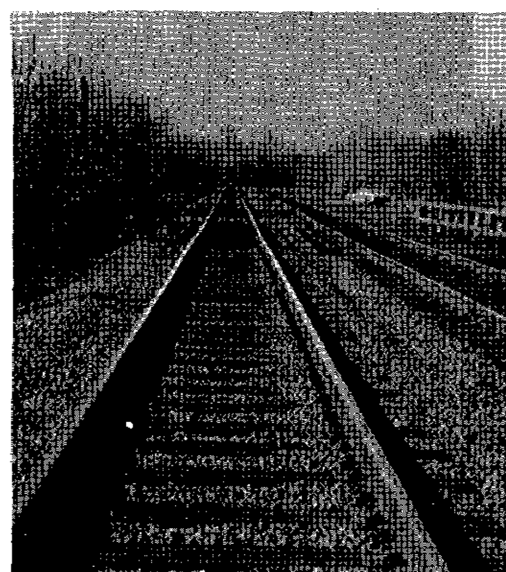


Figure 10.–Track No. 2, looking west, showing bridge.

[4]*The two views of track No 1, Figures 7 and 8, at the* bridge over Cross Road were taken after the bridge was repaired

lengths, and No. 2 track was 140-pound RE continuous welded rail. The track structure passed over Cross Road on a deck plate girder (open deck) bridge, 34 feet long and 31 feet wide (see Figure 6). At the time of the accident, inner track guardrails existed for both tracks, extending beyond the bridge for a distance of 39 feet

A pedestrian walkway was provided on one side of the bridge only, the north side of No. 1 track It had a railing to prevent the users of the bridge from falling to the highway below Additionally, railings were provided to protect either end of the bridge abutment (see Figures 6 through 10). On the south side of the bridge, there was no pedestrian walkway, nor pedestrian railing. There are no Federal or industrywide standards for railroad bridge design, construction, installation of safety equipment, maintenence, or retirement

The track in the accident area was in a side-hill cut with an 11-foot bank on the south side and a 1½-foot drop to the surrounding terrain on the north side.

There were no dragging equipment or hot box detectors between New London, Connecticut, and Sound View. At Clinton, Connecticut, 16 miles west of Sound View, there was a hot box detector and a dragging equipment detector.

3 Weather and Time

The weather conditions were clear and dry at the time of the accident The temperature range on the day of the accident was 51° to 71°. The accident occurred after dark, at 8:50 p.m., e d t

4 The Initial Derailment

Adv CB-1 had departed New London, Conn , at 8:30 p m. on track No. 1, and approached "Nan" (East Lyme or Niantic) drawbridge interlocking, 6 miles east of Sound View, at 8:41 p.m The railroad operator at "Nan" drawbridge, located on the north side of track No. 1, signalled the three crewmembers (the engineer, fireman, and brakeman) in locomotive No 2682 to proceed. The operator visually inspected the train as it passed "Nan," and, since he noted no defects, he signalled the flagman and conductor in the caboose of Adv. CB-1 to proceed.

The flagmen and the conductor of Adv. CB-1 both noted the proceed signal given by the operator, and acknowledged the signal. They observed the train between "Nan" and Sound View

The engineer, head brakeman, and fireman had observed the train several times on both sides between New London and Sound View, and had noted nothing unusual in the condition of the train.

The conductor descended from the cupola and was making out his delay report when he became aware of the derailment of the caboose. As he was going to the emergency brake valve in the caboose, the train brakes went into emergency

At an undetermined point east of Sound View, the truck side frame on the north side of the trailing truck of the 43rd car in the train, ATSF 19334, fractured through the lower member of the truck side frame that supports the spring plank seat (see Figure 2). An examination of the newly fractured member showed progressive fatigue; about 70 percent of the fracture occurred at some time prior to the day of the accident A photograph of the broken truck side shows that the frame crack passed through two imcompletely fused casting marks, that appear as circular indentations in the fracture surface, which resulted from the suspension of the casting sand mold by wires. There is also a 5/8-inch- diameter drain in the bottom of the lower member in the area of the fracture

The truck side frame then dropped sufficiently to permit contact with the rail and track structure and sheared bond wires on the outside of the north rail, 650 feet east of the frog of the siding. The truck side struck the frog of the siding, then dragged between the switch point and the stock rail, spreading them far enough to allow the derailment of the following seven cars and caboose of the train. Subsequent to the derailment of these cars, the train separated between the 46th car, C&O 17861, and the 47th car, PRR 259981, causing Adv. CB-1 to go into an emergency brake application.

Forty-three cars and the two locomotive units remained on the track. Three derailed cars, the 44th through the 46th, remained attached to the train and were dragged for about 1,231 feet. The 45th and 46th cars, though coupled, veered far enough to foul No. 2 track. As Adv. CB-1 was stopping, train No. 174, going in the opposite direction on No. 2 track, passed Adv CB-1's locomotives. No one on Adv. CB-1's locomotive gave a warning signal to the engine crew of No. 174.

5 The General Derailment and the Resulting Fire

Passenger train No. 174 departed New Haven on Track No. 2 at 8:04 p.m. At Clinton, Connecticut, the dragging equipment detector was activated by train No. 174, and the train was stopped at the interlocking signal at Old Saybrook, Connecticut. The train crew inspected the train and found the metallic steam connector between the second diesel unit and the baggage car unsupported by the supporting chain and ring. The crew of No. 174 recoupled the steam connectors.

After a scheduled stop at Old Saybrook Station, 6 miles west of Sound View, train No. 174 departed at 8:44 p.m., 20 minutes late. Immediately before the accident, as No. 174 approached Sound View, the conductor was seated in the drawing room of the third car, a parlor car, on the north side; the baggage master was seated in a compartment in the second car, a parlor car, on the north side; the ticket collector was seated in the fourth car, a coach, on the south side; and the flagman had just entered the third car, a parlor car, from the fourth car. The engineer was in his position at the controls on the south side of the leading locomotive; the fireman had risen from his seat before the train passed the locomotives of Adv. CB-1, and moved to the center of the cab, next to the control stand.

Train No. 174 approached the curve at Sound View at 60 miles per hour as indicated by the speedometer. The engineer had made a timed test of the speedometer at East Haven and again at Guilford. The engineer of No. 174 said that he noticed the headlight of Adv. CB-1 as he rounded the curve, but he did not receive a stop signal from the crewmembers on the locomotive of Adv. CB-1. The Engineer of No. 174 noticed that Adv. CB-1 was slowing down, but that it definitely had not stopped. The cab signal was green on the lead unit of No. 174.

Moments after he passed the lead units of Adv. CB-1, the engineer and fireman of No. 174 felt and heard the impact as the locomotive of No. 174 struck (sideswiped) a derailed car or cars, presumed to have been the derailed 45th and 46th cars of Adv. CB-1. The engineer of No. 174 immediately placed his brake valve in the emergency position.

As train No. 174 rounded the curve at Sound View, the headlight illuminated a boxcar fouling track No. 2. This boxcar was probably the 48th car of Adv. CB-1, CGW 5040. The force of the impact of No. 174 on the car drove the 48th car into the 49th car of Adv. CB-1, MSTL 50428. The 49th car of Adv. CB-1 was driven back. Parts of boxcars clung to the locomotive of the passenger train. When the locomotive struck the tank car, NATX 34473, on the west end, the pilot of the locomotive was severed, the front truck was struck, and the entire passenger train was derailed. A cylinder was imbedded in the tank car, and the tank car was punctured (see Figure 11).

The steps of the lead locomotive unit of train No. 174 were torn loose and caught on the tank car. The locomotive nose section was severed, and most of the cab section was destroyed. The steam generator, which is housed in the short hood, broke loose from its mountings and was imbedded in the rear wall of the locomotive cab section, behind the seat of the fireman (see figure 12). The engineer and fireman were injured. The fuel tank of the locomotive was punctured, and a fire started from the diesel fuel that leaked out of the tank.

Figure 11.–Tank car NATX 34473, showing point of puncture (1) and last car of the passenger train (2)

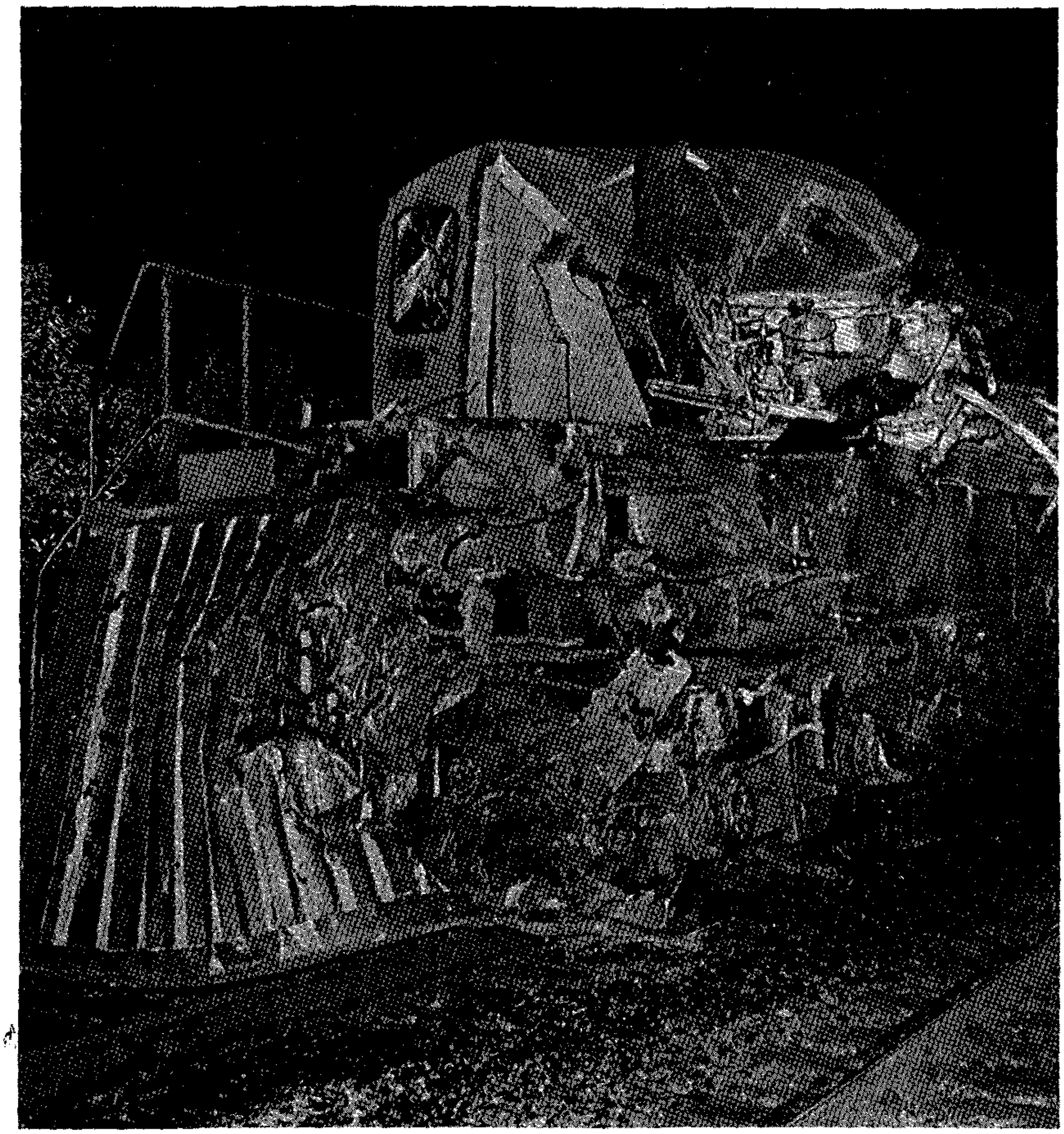


Figure 12.—Lead locomotive of passenger train No. 174, parts of boxcar on front of locomotive; front steps, pilot and entire nose section severed; steam generator shown imbedded in rear wall of cab compartment.

The tank car or the engine of No. 174, or both, struck the caboose of Adv. CB-1, injuring the flagman, who fell from the cupola, and the conductor. An entire section of the caboose was destroyed. The wood-lined interior of the caboose was shattered. The platform and a corner section were severed. The superstructure crumbled and separated from the frame (see Figure 13)

The tank car was punctured with subsequent ignition and fire following escape of the liquefied petroleum gas. The locomotive and the passenger cars of No. 174, while derailed, continued through the derailment area, and passed through the flaming gas escaping from the punctured LPG tank car These flames were observed on both sides of the passenger train by crewmembers and passengers in the cars. The fire burned about 2½ hours before being extinguished.

The passenger train, while derailed, continued on the track structure across the bridge over Cross Road. The train stopped clear of the bridge, 290 feet from the burning LPG tank car The passengers on the train were calmed by the train crew and instructed to remain in the cars.

C Post-Derailment Activities

1 Railroad Personnel

After the derailment caused a separation of the cars, and an emergency brake application had been noted in the cab of the lead locomotive unit, the engineer of Adv CB-1 reduced the throttle and released the locomotive brakes. Passenger train No 174 was seen by the crew of Adv CB-1 The fireman and head brakeman of Adv. CB-1 did not alert the engineer of No. 174 before the locomotive passed; however, they were able to give the rear end of No. 174 a stop signal The fireman and brakeman on Adv CB-1 saw the flash of fire when the tank car, NATX 34473, was punctured. The head brakemen of Adv. CB-1 proceeded to the rear of the train; the fireman proceeded westward with flagging equipment to protect track No 2. The engineer of Adv CB-1 radioed the dispatcher at Groton to hold all trains, east and west, and asked him to contact the operator at Saybrook and advise him of the situation.

The conductor and flagman of Adv CB-1 were in the derailed, detached caboose of their train when the caboose was struck. The conductor and the flagman of Adv CB-1 were proceeding toward the telephone when they became aware that the flagman was injured; therefore, they went down to the road, and stopped the first passing car. They were met shortly thereafter by an ambulance. The conductor of Adv. CB-1 then returned to the track structure to assist the conductor of No. 174

As No. 174 stopped, the locomotive engineer attempted to escape through the door, but found it jammed He then went out the engineer's window and dropped to the roadbed. Realizing that the fireman had not escaped, he climbed back into the smoke filled cab through the window and found the fireman between the water cooler and the electrical cabinet With the assistance of the baggagemaster, he succeeded in getting the door open and removing the fireman from the locomotive. They went down the bank, where they were met in a short time by an ambulance

The conductor of No. 174 was seated in the drawing room of the second parlor car, the third car of the train, and recalled receiving a severe jolt. The train continued on the rails for some distance, and the car began to tilt back and forth Tables and other materials in the drawing room were thrown from one end of the room to the other The conductor recalled passing flaming debris, and described it as "quite a conflagration." The lights in the two parlor cars and four coaches remained on after the accident After the train stopped, the conductor proceeded to the engine, where he heard the engineer calling for an ambulance. He immediately ran down the embankment to a private home and asked the residents to call an ambulance. He then called the dispatcher at Boston, Mass., and advised him of the

Figure 13.--Damaged caboose No. 586

situation. The dispatcher informed him that buses had already been dispatched to the scene, and he returned and advised the passengers of No 174 that buses had been dispatched to transport them.

The ticket collector of No. 174, seated in the first coach, the fourth car of the train, became aware that the train was in trouble when rough motions were felt in the car. Passengers began to get out of their seats, and he promptly instructed them to sit down He said "We went through a wall of flame." He quieted the passengers and instructed them to remain in their seats.

The baggagemaster of No. 174 was in a parlor car, the second car of the train. He noticed that the train had gone into emergency and saw the fire, which he described as "a great ball of fire going by the window." He quieted one of the passengers, detrained, saw the engineer on the ground, and assisted the engineer in removing the injured fireman from the cab of the lead locomotive unit of No. 174.

2 Nonrailroad Personnel

In the Sound View area, witnesses recalled hearing the noise of the derailment and seeing flames in the air. They immediately contacted the police and other emergency units The Sound View Fire Department, which is located only a few blocks from the accident site, responded to the emergency call. They were assisted by the fire departments of Old Lyme, Flanders of East Lyme, Niantic, Old Saybrook, and Clinton

The Sound View Fire Chief said that by the absence of a placard and the low intensity of the fire, he assumed that the tank car was empty A short time later, a member of the train crew of Adv. CB-1 informed him that the car was designated empty. A foam truck was dispatched from New London, but was not used; water was used to put out the fire. When the Sound View Fire Chief ascertained that the tank car was empty and that it was the residue that was afire, his first decision was to let it burn out, but he later decided to put out the fire. A hazardous vapor detector was subsequently used and it was determined that the car still contained high concentrations of vapors. The car was then ordered purged with water to make it safe for handling.

State and local police departments also responded to the emergency. Immediately after the police personnel arrived at the site of the accident, the area was closed to all unauthorized persons. The Penn Central did not immediately notify the Bureau of Explosives as required by 49 CFR 174 508.

D Casualties and Damages

The accident caused injuries to the conductor and the flagman of Adv CB-1 and to the fireman, the engineer, and the car attendant of No 174 Two of the train's passengers were treated at the hospitals The injured were taken to the Lawrence Memorial Hospital and the Yale New Haven Hospital.

The 43rd through the 51st cars of Adv. CB-1 were damaged; four of these cars were destroyed (see Appendix 5). The lead locomotive of passenger train No. 174 was destroyed Approximately 800 feet of track No 2 were damaged to the extent that realignment and new crossties were required. Approximately 1,500 feet of track No 1 were completely torn out. The hand-operated switch immediately east of the bridge, the track guardrails, and bridge timbers were also extensively damaged

III ANALYSIS

A The Freight Train

1 The Truck Side

The dynamic tests on Pattern 7707 truck side frames in the 1920's were undoubtedly made with loads in accordance with the six-spring grouping designed for the wide-bolster side frame. The static tests in the 1940's were made with loads to conform with the original spring grouping. When the design was changed by the insertion of the Ride Control spring package, dynamic and static tests were not performed to determine the effects of the concentration of the load in the center portion of the lower member of the side frame. We do not know the significance of the failure to perform static tests with loads to conform to the 50-ton Ride Control spring package. It appears that the concentration of loads in the middle portion of the side frame would subject the member to stress patterns not contemplated in the original tests.

There is little doubt that the use of the No. 402 spring package in a truck designed for a 50-ton car contributed to the failure of the truck side. The No. 402 spring package would have been deflected 20 percent more than the 50-ton spring when fully loaded, and therefore there was less space before the coils closed up. This allowed the spring to go solid with much greater frequency, thus imparting shocks to the side frame and contributing to its failure. Although the use of the incorrect spring package produced much more frequent shock loads on the truck side, there is no direct evidence to indicate when the fatigue crack was initiated.

The absence of information about how and when the misapplication of the No. 402 spring package occurred indicates a need for measures to prevent this type of error. Critical components can be designed so that they are not physically interchangeable between sets with different capacity ratings. There are other critical components of cars that can also be applied inadvertently to a car and change its safe capacity. For example, there have been cases where the wrong wheels and/or journal bearings were applied to cars.

The truck side frame that failed was manufactured in May 1930, over 40 years ago. It is not possible to determine the quality and quantity of service to which this component was subjected during that period; however, since this component performed service during the heavy demands of World War II and thereafter, the question of service life arises.

There are no specifications by AAR or by individual carriers pertaining to the useful life of truck side frames. The existing requirement that certain truck side frames be retired by a certain date relates to their having been manufactured before AAR required static and dynamic testing of them. There is a finite life in all steel castings for stresses above the endurance limit, but that life has not been determined for truck side frames and many other components.

Critical components may be used in several different cars during their service life. For instance, a truck side which begins its history as part of one car may become part of another car if it is still serviceable when the first car is retired or destroyed. What is needed is the development of useful criteria that would take into consideration as many environmental factors as possible, followed by the development of a system of monitoring and controlling the critical components of the system in accordance with the chosen criteria.

Present inspection procedures at interchange and wayside stations and by operating train crews are inadequate to detect the fatigue failure of a critical component prior to its break in train operations. It is impractical to rely on these existing inspection procedures alone as a control over in-service failures of critical components. There are many areas of the truck hidden from view, and visual inspection is hampered additionally by the presence of dirt, grease, rust, paint, ice, and snow. The growth of a crack can go undetected for a long time with the present method of inspection.

2. The Tank Car

The escape and ignition of the flammable cargo contained in the tank car, during the course of the accident, did not increase the losses in the accident. However, the accident indicates that risks associated with the transportation of "empty" tank cars, while not as great as loaded tank cars, warrant attention.

The "empty" tank car contained the equivalent of approximately 1,150 gallons of liquefied propane. "Empty" is not defined in 49 CFR 170-179 The designation and movement as an empty car, under rule 35, section 7 of Uniform Freight Classification No. 10, conformed to economic rather than safety criteria. Under the terms of rule 35, no charge is made for the movement of a tank car when the substance remaining in the car or tanks does not exceed 3 percent of the weight of the last loaded movement, or if no commercial consideration is given to the substance remaining in the car.

For a liquid with a boiling point above atmospheric temperature, the quantity of residual hazardous product which is available in an "empty" car to cause damage in an accident consists of the small puddle of liquid along the bottom of the tank However, when the boiling point of the hazardous product is lower than ambient temperatures, the liquid in the container will boil until the pressure in the container reaches the vapor pressure of the product at the ambient temperature The lower the boiling point of the hazardous product, the greater will be the pressure in the container. The greater the pressure, the greater will be the amount of product in the container in the gaseous form When the temperature of the liquid portion of the product is at ambient temperatures, the quantity of the hazardous product increases as the volume of the gaseous space in the container increases. Thus, the amount of gaseous product above the liquid in a loaded car increases substantially as the car is emptied, if the internal pressure in the container is not vented.

This accident illustrates the significance of this behavior. The consignee reported unloading approximately 30,734 gallons of the 31,184 gallons shipped, leaving a residual quantity of 450 gallons of liquid along the bottom of the car. Assuming both the liquid and gas in the car were at the minimum accident (51°F.), the vapor pressure of the ambient temperature on the day of the product in the car would have been nearly 100 pounds per square inch The gaseous space above the liquid (approximately 33,000 gallons) in this "empty" car would have contained the gaseous equivalent of over 700 gallons of propane, resulting in a total quantity of hazardous product in the car of over 1,150 gallons If the car had been only 97 percent unloaded, the quantity of hazardous product in the car would have been about 1,700 gallons, or the equivalent of a loaded small LPG delivery truck. The stored energy equivalent for this quantity of propane is substantial – over 150 million B.t.u.'s - and merits attention

The collision and fire in this accident suggest that risks [5] resulting from the movement of so called "empty" tank cars containing certain hazardous commodities are real and warrant concern. The fire from this large "empty" tank car burned almost 2½ hours, projecting flames across the track over which the passenger train had passed. The increased losses which would have occurred had the passenger train come to rest in the path of the flame is not difficult to imagine. This suggests that the economic basis used for defining an empty car may not be satisfactory for safety purposes for some commodities or some tank car sizes. A better approach for safety purposes might be based on the magnitude of the damage which an "empty" tank car could inflict in the event of an accident, and the mode by which losses could occur. Identification and placarding of "empty" cars, which can precipitate a large loss, could be required without economic difficulty The current legends on the reverse side of the "dangerous" placard (49 CFR 174 563), commonly used in the railroad industry, are not satisfactory for some "empty" cars because they do not indicate the extent of the risk which may be present in accident situations.

[5] See the National Transportation Safety Board Special Study STS-71-1, *Rick Concepts in Dangerous Goods Transportation Regulations*

3 The Caboose

The caboose of Adv. CB-1 was severly invaded and destroyed in this derailment. The splintering of the wooden interior clearly indicates that this structure was not built in keeping with modern standards of passenger packaging. There were no seat belts in the cupola, and the flagman fell from his position as a result of the impact.

The caboose was not equipped with communications equipment to alert responsible parties of the conditions in the derailment area. It was necessary for the crewmembers to walk to a telephone in order to communicate with the responsible authorities. It has already been noted that the lack of a radio on the caboose resulted in a delay in the notification that a derailment had occurred.

B. The Passenger Train

1. The Locomotive

The impact of the locomotive of the passenger train with the derailed equipment of the freight train almost completely destroyed the front end section of the locomotive, and clearly demonstrates that the locomotive crew compartment ineffectively withstood the stresses to which it was subjected. The locomotive of passenger train No. 174, for the most part, absorbed the major forces involved in the crash, and cleared the right-of-way in advance of the passenger cars. It cannot be said that the design of the locomotive contributed to the severity of injury to the passengers of the train; however, the crashworthiness of the cab compartment is another matter. Locomotive crews, in most crash situations, have several seconds of forewarning of an impending collision. If a crashworthy section of the cab could be provided, this forewarning time could provide crews with an opportunity to protect themselves. In this accident, the crew members in the passenger locomotive survived the impact in the single section of the cab that remained intact.

It is the practice for firemen on trains to move out of their seats to the right side or the middle of the cab while passing freight trains, particularly at night and on curves. This practice was lifesaving in this instance because the fireman's seat area was obliterated. Locomotive crews are acutely aware of the possibility of a shifted load on a freight train, an offcenter car, a loose freight car door and the lack of a crashworthy cab. The left front cab section of the locomotive is almost always more severely damaged in impacts with trains on adjacent track. The right side of the cab, in this instance, provided protection to save the lives of the crew; there is no assurance that present design will provide sufficient protection in impact situations. There is a definite need to strengthen the cabs of existing locomotives, and to consider crashworthiness in the design stage of new locomotives in order that they may be strong enough to provide protection for the crew.

The pilot of the passenger train locomotive was severed in the accident, and permitted the lead truck of the locomotive to strike debris on the track, thus increasing the likelihood that the locomotive would be derailed. Federal standards for the design of the locomotive pilot do not include specifications for its strength. (See Figure 14.)

The locomotive fuel tank on this type of engine is located a few inches above the rail and protrudes from the locomotive side. When the locomotive derailed, the tank came into contact with debris in the wreck area and was subsequently punctured, permitting the diesel fuel to spill. (See figure 15). This created a fire hazard in the proximity of the locomotive crew compartment.

If the passenger train locomotive had been equipped with a radio, it probably would not have prevented passenger train No. 174 from striking the derailed equipment that remained attached to Adv. CB-1. However, a radio message from the crew in the derailed caboose of Adv. CB-1 may have given the engineer of No. 174 several additional seconds of warning. Assuming that the conductor had a means of emergency communication with opposing train

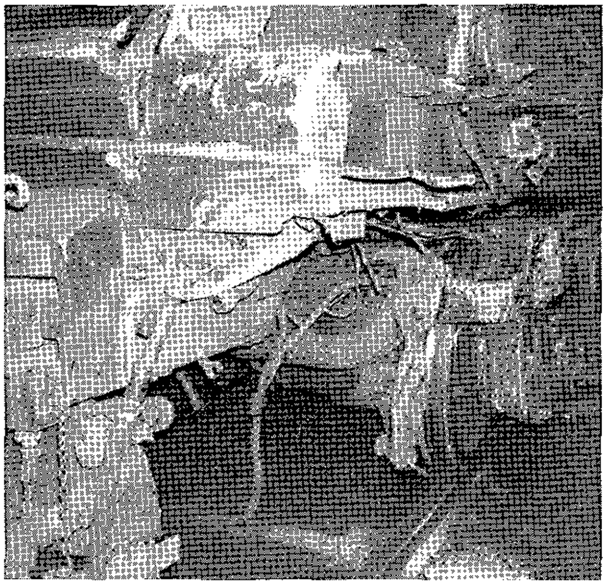


Figure 14.–Damaged pilot of locomotive No. 7547

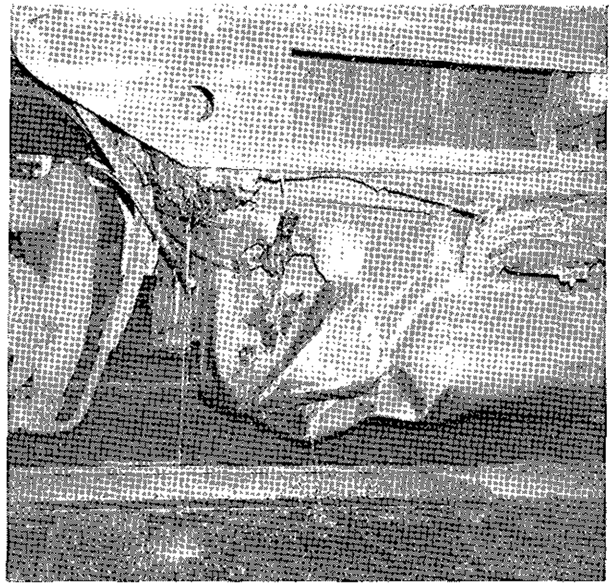


Figure 15.–Punctured fuel tank of locomotive No 7547

movements, and he had transmitted an emergency warning to passenger train No 174 at the moment he knew the caboose had derailed, it is conceivable that the passenger train's speed could have been greatly reduced, or perhaps even stopped, before it reached the major derailment area at Sound View. The freight train was travelling at 42 miles per hour and had almost come to a complete stop before the passenger train passed its locomotives This would indicate that about 1 minute had elapsed since the freight derailed. The position of the passenger train at the time of the derailment of the caboose can be assumed to have been 1 mile in advance of the initial freight derailment area. The caboose crew had no radio to transmit a warning of the derailment. The passenger train did not have radio equipment to receive the warning were it transmitted by the caboose crew. The freight train had radio equipment but it was not used instantly to transmit a warning of the impending collision.

The engineer's field of vision to the left was obstructed for a distance of approximately 300 feet in advance of the locomotive, due to the curvature of the track and the forward portion of the locomotive He could not have detected an obstruction on the track within the distance of 300 feet. The engine crew could not see the first object struck by No. 174 because of the short hood, the position of the fireman, and the curve.

The cab signal in the locomotive cab indicated clear because those derailed freight cars fouling the passenger track did not interrupt the track circuit

This type of locomotive is operated generally with the forward or short hood end leading and with the engineer's controls on the right side Some locomotives are arranged for the operation with the long hood forward. It will be noted from the photographs of the locomotive that the rear section of this locomotive remained intact (see Figure 16) On some railroads, it is the practice to run the short hood forward; on others, the long hood is placed in the forward position. When the locomotive is operated with the short hood forward, visibility of the crew members for forward operation is enhanced, the noise level in the cab compartment may be reduced, and the crew is less likely to be exposed to exhaust fumes. On the other hand, the operation with the short hood end forward places the locomotive crew in the impact area in the event of collision.

There is an inconsistency in design objectives of locomotives in that they do not provide for the fulfillment of all operator needs simultaneously, but require a compromise that is unnecessary. Proper design criteria, and an identification of the tasks the locomotive and the locomotive crew perform, and their relationship to the transportation system in which they operate, is warranted.

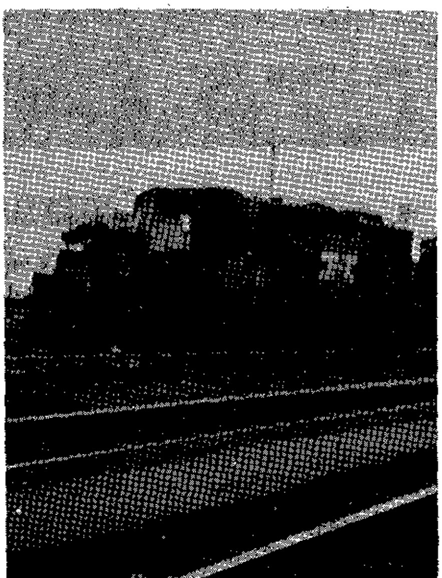


Figure 16.–Locomotive No. 7547, showing minor damage to rear section

2. The Passenger Cars

The weight of the locomotives of passenger train No. 174 was sufficient to deflect the derailed tank car from the path of the cars that were carrying passengers. The passenger cars thus were not subjected to the severe forces that were abosrbed by the lead locomotive unit. They did not leave the track structure, and the tight-lock couplers performed their function of keeping the train in alignment. This markedly reduced the severity of injury to the occupants of the passenger cars. Federal standards do not specify the types of coupling devices to be used on passenger cars and passenger locomotives.

The passenger cars successfully traversed the flaming gases and were strong enough to protect the passengers in this instance. The cars prevented burns to the occupants of the passenger train. All passenger coaches of passenger train No. 174 were equipped with emergency lighting systems that functioned properly and provided light to the passengers in the cars even though the lead locomotive units were shut down. Emergency tools were provided in these passenger cars; the doors and traps were not sprung and were easily operated.

C. The Bridge

The original design of the bridge track structure anticipated and allowed for the eventuality of derailed cars on the track structure. This was evidenced by the installation of guardrails between the rails on tracks No. 1 and No. 2 across the bridge. One factor that may explain why the freight train cars did not jackknife in an accordion arrangement on the west side of the bridge may be that the track guardrails on No. 1 track prevented excursion of the freight cars as they were crossing the bridge.

The derailed passenger train encountered the guardrails, which it is believed contributed to the passenger train's maintaining its alignment while crossing the bridge. The track guardrails contributed to the prevention of the passenger car's leaving the bridge structure; all passenger cars, as well as the locomotives, while derailed, crossed the bridge succesfully and came to a stop in an upright position on the east side of the bridge. They did not fall off the bridge to the highway below, and they did not strike the support structure for the bridge. The prevention of these occurrences minimized the severity of injuries to the passengers and the crew of the train.

Photographs taken of the bridge structure subsequent to the accident indicate that the guardrails on the bridge structure, which probably played a critical role in preventing the passenger train from leaving the track structure in this derailment, have not been replaced. This is in keeping with Penn Central Transportation Company's present policy of removing guardrails, or not replacing damaged guardrails on bridge structures under 60 feet long

For many years, guardrails have been used on most aerial railroad track structures There has been some skepticism about the usefulness of guardrails in preventing excursion from the right-of-way. Some believe that inner guardrails in some instances may even have contributed to derailments. There have been instances of derailed cars riding over an inner guardrail, and being forced out of alignment as they reached the opposite, tapered end of the guardrail. Additionally, some derailments have been cuased by the inner bridge guardrail catching dragging equipment. The Safety Board knows of no experimentation or analysis of guardrail performance to optimize the design.

The desirability of keeping passenger trains on bridges is obvious The desirability of preventing excursion of railroad equipment from aerial structures is unquestionable. If the use of inner guardrails does not fulfill all of the objectives, then new ways might be explored to prevent excursion or railroad vehicles, as suggested by the Safety Board in another report. [6]

D Joint Corridor Usage

Freight cars in derailment generally can be expected to leave the track structure and assume a jackknife position sometimes referred to as an "accordion" arrangement [7] . The Safety Board has observed this phenomenon in many railroad derailments While the excursion of rail cars in this accident, in terms of distance, is not as great as it is in many derailments, it will be noted that the heavy railroad freight cars and equipment were sufficiently distant from the track to foul track No. 2 and obstruct the movement of the passenger train.

Pathways of passenger trains must be unobstructed for safe operation because (1) confined to fixed guideways, operators cannot avoid accidents by steering away from obstructions, and (2) trains characteristically decelerate relatively slowly. Interference with the passenger train pathway can take numerous forms, some of which were illustrated in this accident For example, interference in the form of wrecked cars and debris fouling the track and flames from a hazardous material in an "empty" car both were demonstrated here.

The excursion of railroad equipment from its right-of-way is a predictable occurrence, and should be anticipated [8] It is of particular concern in view of the anticipated expanded use of railroad rights-of-way as corridors for urban mass transportation systems [9] The Safety Board, in its October 1970 study of the Washington Metropolitan Area Transit Authority's Safety Procedures for the Proposed Metro System [10] commented on its concern for the risks assumed in joint corridor usage of the railroad pathway. This accident demonstrates the cause of the Safety Board's concern. While the probability of a serious accident involving the intrusion of a car containing a flammable hazardous material into loaded passenger train cars on an adjacent track is low, the consequences of such an intrusion would be unacceptable if a fire occurred.

The railroad right-of-way can provide a safe pathway for multiple usages of transportation

[6] Southern Railway Company Train 154-Derailment, Laurel, Mississippi, BSTS Oct 6, 1969

[7] FRA and NTSB Railroad Accident Reports

[8] In recent years, the length of freight cars has been increasing; many now exceed 80 feet

[9] National Transportation Safety Board Special Study of Rail Rapid Transit Safety, NTSB-RSS-71-1

[10] National Transportation Safety Board report RSS-70-1--Study of Washington Metropolitan Area Transit Authority Safety Procedures for the Proposed Metro System.

if the proper safeguards are provided to minimize the likelihood of a major collision due to excursions into adjacent pathways for each usage and for the interfaces between modes.

E. Emergency Procedures in Railroad Accidents Involving Passengers and Hazardous Materials

The use of radio in this accident considerably lessened the time lapse between the occurrence of a railroad accident and the notification of the accident to appropriate authorities. The engineer of Adv. CB-1 used the radio to notify the operator and dispatcher that an accident had occurred, and alerted them to hold all trains approaching the accident area. Responsible railroad personnel used this information to alert rescue units and to put into effect emergency procedures for the transportation of passengers and crewmembers. The citizens of Sound View and the surrounding area effectively utilized emergency procedures to bring rescue equipment into the area. Prior to the accident the fire department personnel at Sound View had not received educational information from the Penn Central Railroad concerning rail hazardous material spills or fires from these spills.

IV. CONCLUSIONS

1. The Dalman truck side, pattern 7707, was approved for use by the AAR based on static and dynamic tests made with the original spring arrangement.
2. The No. 510 spring package, which produced a load pattern on the truck side different from the originally approved spring arrangement, was put into service without conducting static and dynamic tests with loads in accordance with the No. 510 spring grouping.
3. The use of the No. 402 spring package on the truck side pattern 7707 resulted in the bottoming out of the spring and much more frequent shock loadings on the truck side. Industry controls to prevent the application if improper components, such as the No. 402 spring package in the truck side, pattern 7707, are inadequate.
4. There is no industry policy controlling the retirement of freight car truck sides based on anticipated service life. This assumes that service life of truck sides, as to fatigue stress, is infinite.
5. The fatigue crack in the truck side which led to the complete failure was not detectable by the normal interchange inspection.
6. Residual hazardous products in some tank cars classified as "empty" under tariff rules create risks which indicate a need for reconsideration of the use of this econimic classification scheme for safety regulations.
7. Under present rules, "empty" tank cars which last contained compressed gas may constitute a hazard for the train crew when they are located adjacent to an occupied caboose.
8. The caboose does not incorporate crashworthiness concepts in its design; it would benefit from a design review that would consider the application of present technology to specific problems, such as passenger packaging and communications capabilities.
9. The communications equipment available to the train crews was not sufficient to provide the necessary communications between crewmembers on the caboose and the locomotive, in that it did not allow forewarning, which may have resulted in the reduction of speed of the passenger train prior to reaching the major derailment area.
10. The head end of the locomotive, including the cab and fuel tank, was not designed to withstand the impacts incurred in this collision.
11. The pilot, nose and cab, and fuel tank of the locomotive of the passenger train

failed to withstand the stresses to which they were subjected in the collision.

12. The presence of the massive locomotive on the head of the passenger train assured the movement of the train through the impact area. A lighter train, or a train made up of self-propelled cars, might have been damaged over its entire length.
13. The rear portion of the lead locomotive of the passenger train was not materially damaged due to the fact that the impact was concentrated in the forward end of the locomotive. If the locomotive had been operated with the long hood end forward, the crew compartment would not have been in the impact area.
14. The industry's present practice of using interlocking couplers on the passenger train kept the cars together and in line, and thus minimized passenger injury
15. The track guardrail over the bridge prevented the excursion of the derailed passenger train; the level of injury to the passengers and the crews of the two trains was low because the excursion was prevented
16. There are no mandatory industrywide Federal safety requirements for railroad aerial track structures; the Federal Railroad Safety Act of 1970 provides the Federal Railroad Administration with the authority to establish safety standards for these structures.
17. The Fire Department at Sound View had not received educational materials from the railroad company concerning management of hazardous materials spills and emergency procedures.
18. The joint usage of a railroad right-of-way by passenger and freight trains constitutes a hazard to the passenger train unless positive means of preventing interference between modes is provided.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the derailment of the freight train was the breakage of a truck side of a car on the freight train which followed a progressive fatigue crack failure. The fatigue crack was probably caused by increased shock loading on the side frame due to improper application of a 40-ton spring package in a car which carried 50-tons The breakage of the truck side resulted in damage to a turnout, which was the immediate cause of derailment of the following cars.

The cause of the collision, derailment, and damage to the passenger train was the obstruction of track No. 2 by derailed cars of the freight train The cause of the injuries to the crew of the passenger train locomotive and to the crew of the freight train caboose was the absence of systematic crash protection design of the railroad equipment.

VI. RECOMMENDATIONS

The Safety Board recommends that

1. The Federal Railroad Administration

   a. To the extent that data is available, promulgate regulations to insure the retirement of critical car components before normal service failure.
   b. Where data regarding useful safe life of critical car components is not available, initiate programs to determine the data required to promulgate regulations in those areas.
   c. Promulgate regulations to prevent misapplication of critical components

   One recommended approach in the formulation of these regulations would be to use the existing history or experience data, and to develop criteria to assure the replacement of critical components before normal wear life has expired and the component fails This could be undertaken by such steps as:

(1) A review of accident experience.
(2) Identification of component failures that caused the accidents and failures that aggravated the accidents which made them more serious.
(3) Designation of these components as critical components.
(4) A review of maintenance records to determine average failure rates of these components.
(5) Establishment of a maintenance schedule for inspection and replacement of these components on a regular interval prior to expiration of useful life.
(6) Establishment of an inventory or recordkeeping system that would assure that replacement is made by installing new components at proper intervals.

These steps should be followed by a safety analysis of the operational system to determine what component failures, human errors, and conditions, or combinations of these, could cause accidents to occur. The results of this analysis will provide management visibility of hazards, high-risk assumptions, and areas for effective resource allocation to reduce risks. Because other possible approaches exist, a range of approaches should be studied.

2. The Federal Railroad Administration promulgate regulations requiring interlocking couplers on all passenger-carrying equipment including the passenger locomotive.

3. Federal Railroad Administration initiate studies to identify the hazards involved in the joint use of tracks by passenger and freight trains as a means of understanding the risks assumed. This study should be done jointly with the Urban Mass Transportation Administration and should include, but not be limited to, clearance, means of keeping derailed cars in line, danger of shifted lading, and systems for detecting when track space has been violated.[11]
4. The Federal Railroad Administration include in its research the determination of the value of track guardrails to keep derailed equipment in line with the track, and the development of safety standards for railroad aerial track structures.
5. The Federal Railroad Administration continue to a conclusion its recently initiated efforts in the matter of the improvement of the design of locomotive operator compartments to resist crash damage, and, in conjunction with the Association of American Railroads, undertake a review of modern design crashworthiness concepts in an effort to identify areas of applicability in the railroad industry.
6. The Federal Railroad Administration, in collaboration with the U. S. Coast Guard, develop a definition for an "empty" tank car for safety regulations, taking into account the potential losses attributable to various hazardous substances remaining in tank cars after unloading, and initiate rulemaking action to incorporate this definition and such related requirements as may be found necessary into 49 CFR 170-179.
7. The Federal Railroad Administration review the testing procedures of critical components in the industry, and determine where Federal standards may be required to assure the adequacy of the tests.
8. The Federal Railroad Administration consider the problems found in this accident in their current review of railroad communication systems and establishment of standards.

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[11] National Transportation Safety Board Speical Study of Rail Rapid Transit, *op cit*, Recommendation 8.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M LAUREL
Member

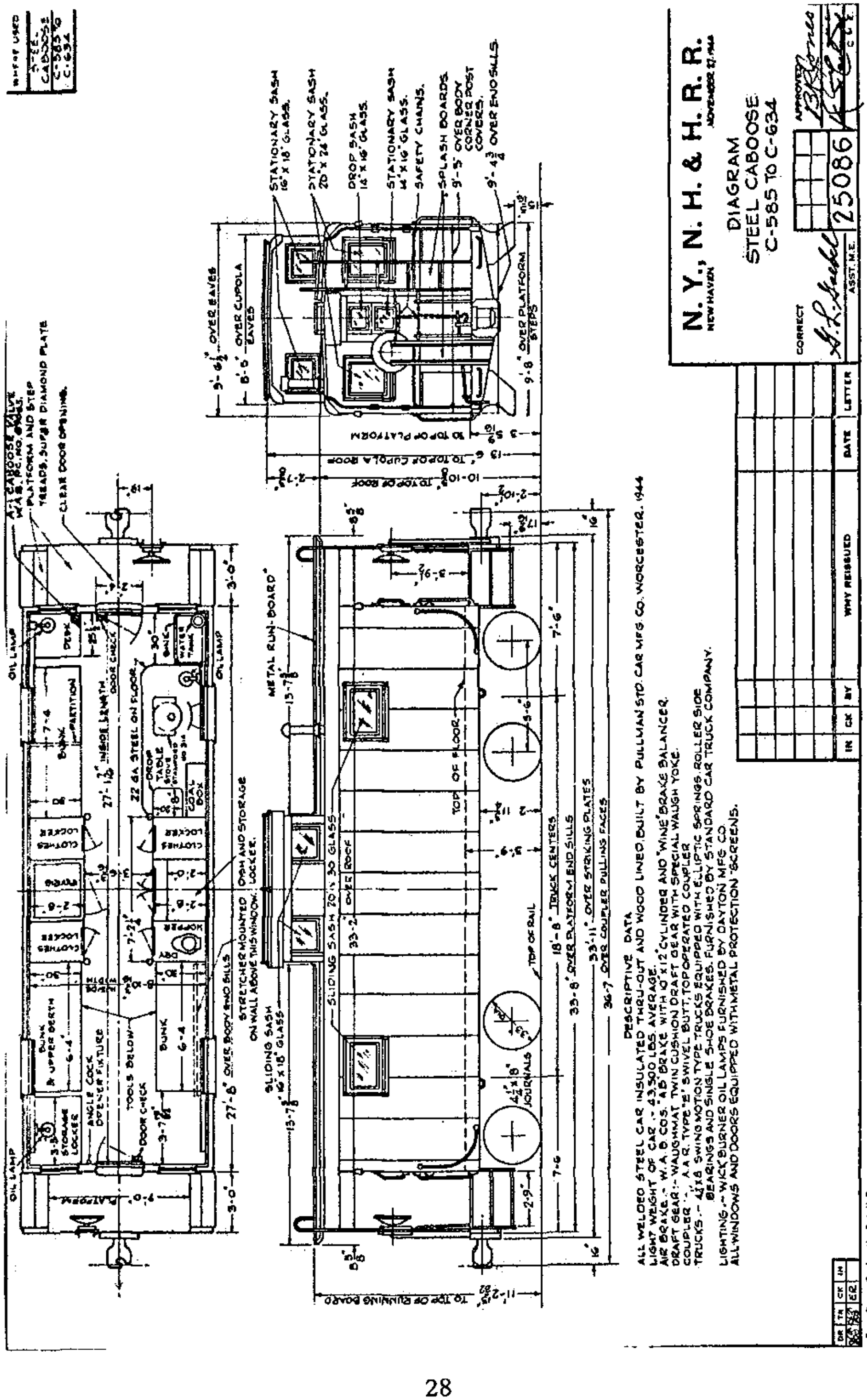
/s/ FRANCIS H McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

December 22, 1971

APPENDIX I


N. Y., N. H. & H. R. R.
NEW HAVEN
DIAGRAM
STEEL CABOOSE
C-585 TO C-634
25086
DESCRIPTIVE DATA
ALL WELDED STEEL CAR INSULATED THRU-OUT AND WOOD LINED. BUILT BY PULLMAN STD. CAR MFG. CO. WORCESTER, 1944
LIGHT WEIGHT OF CAR :- 43,500 LBS. AVERAGE.
AIR BRAKE :- W.A.B. CO'S. "AB" BRAKE WITH 10"X12" CYLINDER AND "WINE" BRAKE BALANCER.
DRAFT GEAR :- WAUGHMAT TWIN CUSHION DRAFT GEAR WITH SPECIAL WAUGH YOKE.
COUPLER :- A.A.R. TYPE "E" SWIVEL BUTT, TOP OPERATED COUPLER
TRUCKS :- SWING MOTION TYPE TRUCKS EQUIPPED WITH ELLIPTIC SPRINGS, ROLLER SIDE BEARINGS AND SINGLE SHOE BRAKES. FURNISHED BY STANDARD CAR TRUCK COMPANY.
LIGHTING :- WICK BURNER OIL LAMPS FURNISHED BY DAYTON MFG CO.
ALL WINDOWS AND DOORS EQUIPPED WITH METAL PROTECTION SCREENS.

Bettendorf Dalman Type Trucks

The Bettendorf Dalman Type Freight Car Truck, in common with other types of Bettendorf Trucks has been designed with a thorough scientific knowledge of the service conditions now being encountered in railway practice

The outstanding feature of the Bettendorf Dalman Type Truck is a combination of the advantages of the unit type of construction with the Dalman method of spring arrangement.

Under the Dalman method two additional coils are added to the A R A spring group with the result that an added spring capacity is afforded to meet adequately the present practices of heavier car loading Whereas the A R A spring group shows a deficiency in spring capacity, the Dalman group offers a reserve capacity scientifically determined for cars of various capacities

The additional springs introduced in the Dalman type trucks are placed at a higher level than the central group in order that the side frame metal can be distributed along the lines of force in the side frame structure in such a way as to avoid an increase in stresses due to the greater bolster opening required by the added springs

The chief advantage of the Bettendorf Dalman Type Truck lies in its ability to absorb destructive shocks even under conditions of maximum loading The relation of adequate spring action to the life of rolling stock is self evident

The conditions which have necessitated the improvement characterized by the Dalman method arise from the fact that freight cars are being marked to axle capacity rather than nominal loads By this method a car formerly having a rated capacity of 100 000 lb and weighing approximately 45 000 lb can now be loaded with 124,000 lb At the same time conditions have developed whereby trains are moved at higher speeds and over greater distances—all of which have increased the amount of work that must be done by the truck springs

The result has been that due to the fact that springs employed in truck construction have always been stressed to a point very closely approaching the limits of safety, and in many instances being actually overloaded, these springs are now under present conditions hopelessly inadequate This has resulted in failures of truck springs to an extent that is highly alarming

A recognition of the need for increased spring capacity has led the railroads to accept in an increasing measure the Dalman type side frame with its important contribution to the lengthened life and improved functioning of freight cars

Bettendorf Dalman Type Trucks have been in use since 1922 Constant observation of the many thousands of these frames which have gone into service since that time has established the complete fulfillment of the superior functioning promised by their design The same high standards of design, material and workmanship which have ever characterized Bettendorf Trucks play their part in the complete satisfaction which the railroads have derived from Bettendorf Dalman type trucks

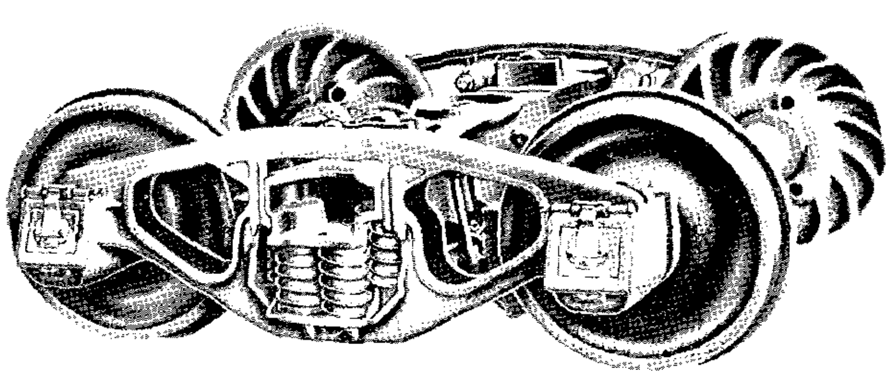


Fig 2139 Bettendorf Dalman Type Freight Car Truck with L Section One Piece Side Frames

For other products and branch offices see classified and alphabetical indexes

THE BETTENDORF COMPANY, BETTENDORF, IOWA

NTSB NOTE: The material contained in this appendix refers to the original spring grouping of the truck side discussed on page 4 of the report.

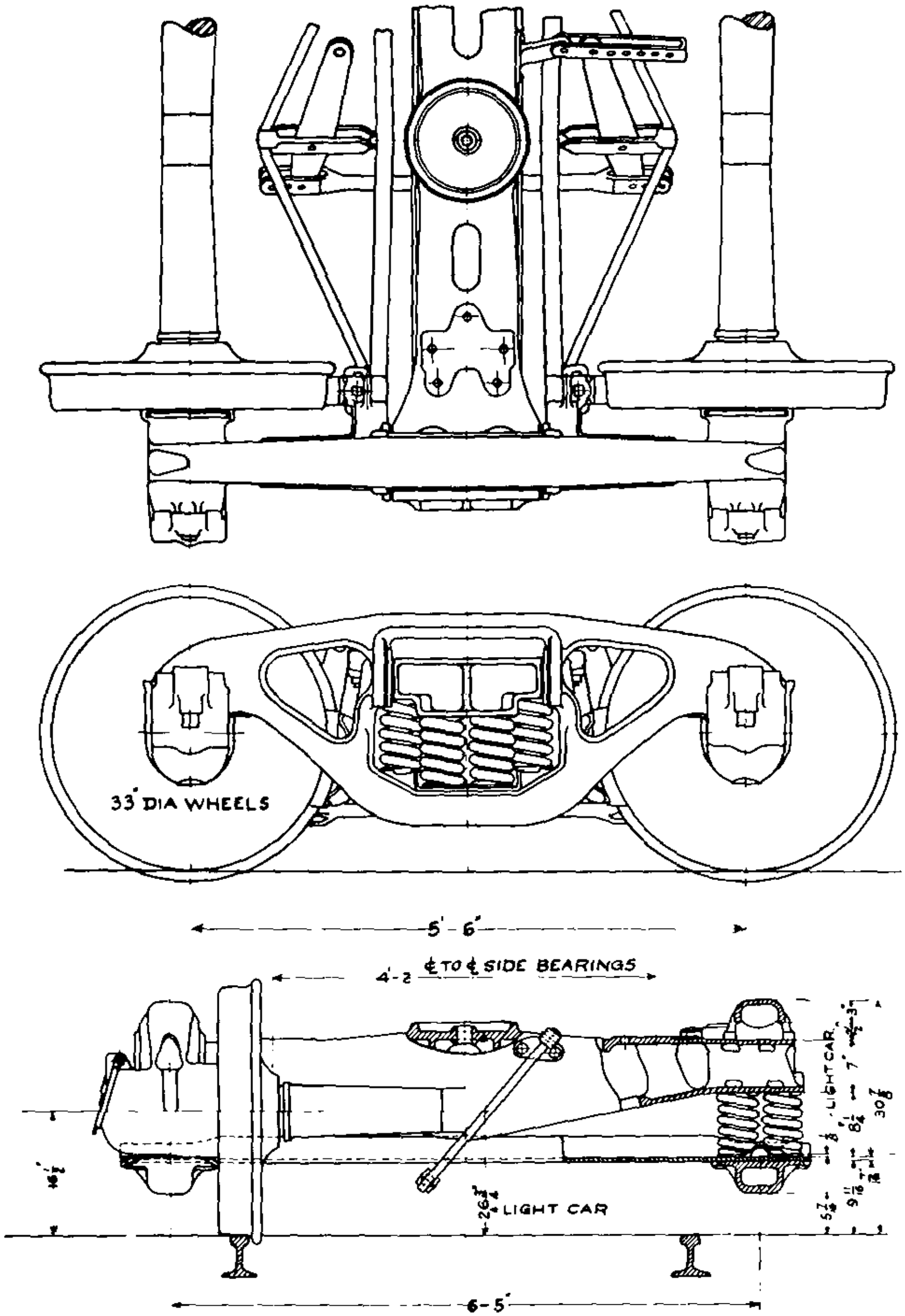


Fig 2140—Dalman Truck with Increased Spring Capacity

American Steel Foundries

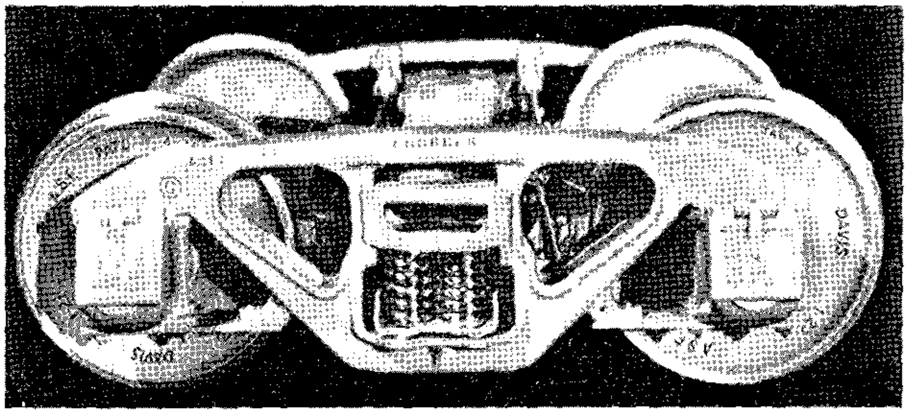


Fig. 2141 [illegible]

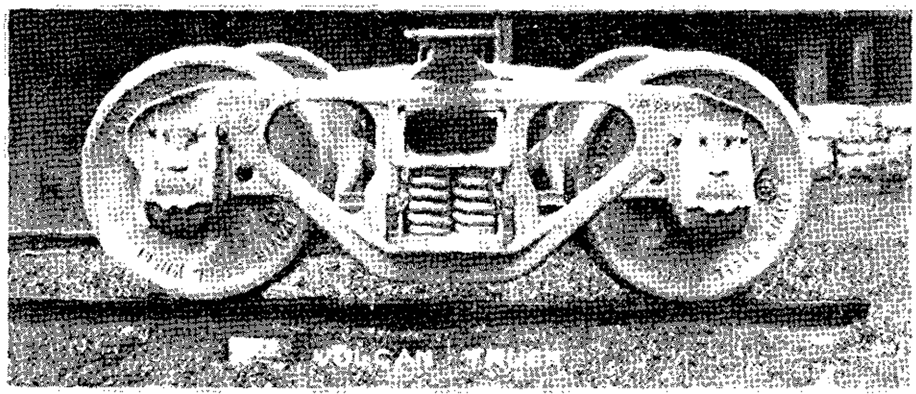


Fig. 2142 [illegible]

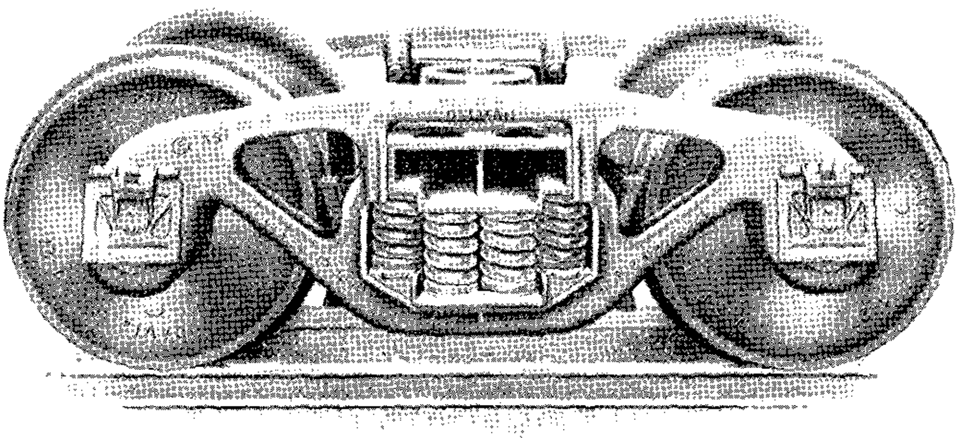


Fig. 2143 [illegible]

APPENDIX III

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT
MECHANICAL DIVISION

SPECIFICATIONS

M-201-66

STEEL CASTINGS

ADOPTED, 1923; REVISED, 1933, 1934, 1936, 1945, 1946, 1947, 1952, 1953, 1960, 1962, 1966

1 **Scope.**—These specifications cover carbon and alloy steel castings for locomotive and car equipment and for miscellaneous use, graded as A, B, C, D and E

2 **Basis of Purchase** —Grade A castings shall be furnished annealed or normalized, unless otherwise specified by the purchaser

Grade B castings shall be furnished annealed or normalized

Grade C castings shall be furnished normalized and tempered or quenched and tempered

Grades D and E castings shall be furnished quenched and tempered

MANUFACTURE

3 **Process.**—The steel may be made by one or more of the following processes: Open hearth, electric furnace, crucible, converter or basic oxygen

4 **Heat Treatment.**—Castings shall be allowed to cool after pouring to a temperature below the critical range They shall then be treated according to the following procedures appropriate to the requirements of Section 2:

(a) Full Annealing —The casting shall be heated to the proper temperature above the critical range for the required time and then be allowed to cool slowly in the furnace Unless otherwise required by the purchaser,the manufacturer has the option of normalizing instead of full annealing, where full annealing is specified

(b) Normalizing —The casting shall be heated to the proper temperature above the critical range for the required time and shall then be withdrawn from the furnace and permitted to cool in still air at room temperature

(c) Quenching —The casting shall be heated to the proper temperature above the critical range for the required time and upon removal from the furnace shall be subjected to accelerated cooling by immersion in a suitable liquid medium, by liquid spraying or by air blasting, at the option of the manufacturer, unless otherwise specified All quenched castings shall be tempered immediately following the quenching operation

(d) Tempering —Grade C, D, or E castings which have previously been normalized or quenched shall be furnace heated for the required time to a suitable temperature below the critical range but not lower than 400 deg F They shall then be allowed to cool in or out of the furnace at the manufacturer's option

Castings specified as annealed or normalized may at the manufacturer's option receive a subsequent tempering treatment

(e) Annealing Lugs —For castings specified annealed, normalized, or normalized and tempered, at least two and not more than four annealing lugs shall be cast on all castings 150 pounds and over and on such castings less than 150 pounds as required by the purchaser or his representatives The location of the annealing lugs shall be such that when removed by the inspector they shall be indicative of the character of heat treatment The standard annealing lug shall be 1 inch in height, 1 inch in width and ⅝ inch in thickness where it joins the casting

(f) If, in the opinion of the inspector, a casting is not properly heat treated, he may at his option require it to be re-heat treated

5. **Temperature Control.**—Furnace temperatures for heat treating shall be effectively controlled by pyrometers

Chemical Properties and Tests

6 **Chemical Composition** —(a) The steel shall conform to the following requirements as to chemical composition:

	Grades A and B	Grades C, D and E
Manganese, max , per cent	85	..
Phosphorus, max , per cent	05	05
Sulfur { Basic, max , per cent	05	05
Sulfur { Acid, max , per cent	06	.06

Note —Carbon max , per cent 0 35 for Grade C castings only.

(b) Unless otherwise specified, the content of elements other than those designated in Section 6 (a) shall be selected by the manufacturer to obtain the physical properties specified.

(c) The hardenability of Grade C steel shall not be greater than the jominy test at 10/16 in of 40 Rockwell C

7 **Ladle Analyses.**—An analysis of each heat of steel shall be made by, the manufacturer to determine the percentage of carbon, manganese, phosphorus, sulfur, silicon, and of the intentional alloying elements The result of this analysis shall be reported to the purchaser or his representative and shall conform to the requirements of Section 6 (a) This analysis shall be made from drillings taken at least ¼ inch beneath the surface of a test ingot obtained during the pouring of the heat

8 **Check Analyses** —An analysis may be made by the purchaser from the broken tension test specimen or from a casting representing each heat The chemical composition thus determined shall conform to the requirements

specified in Section 6 (a) Drillings for analysis shall be taken not less than ¼ inch beneath the surface, and shall be taken in such a manner as not to impair the usefulness of a casting

PHYSICAL PROPERTIES AND TESTS

9 **Tension Tests**—(a) The steel shall conform to the following minimum requirements as to tensile properties:

	Grade A Un-annealed	Grade A An-nealed	Grade B	Grade C	Grade D	Grade E
Tensile Strength, min p.s i.	60 000	60,000	70,000	90,000	105,000	120,000
Yield Point, min p s i	30,000	30,000	38,000	60,000	85,000	100,000
Elongation in 2 in, min, per cent	22	26	24	22	17	14
Reduction of Area, min, per cent	30	36	36	45	35	30

(b) The yield point shall be determined in accordance with the Standard Methods and Definitions for Mechanical Testing of Steel Products of the American Society for Testing and Materials, Designation A-370, latest issue.

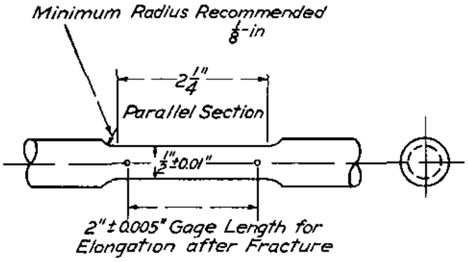
(c) The yield point shall be determined at a crosshead speed not to exceed ⅛ inch per minute For grades A, B and C castings, the drop of the beam method, the halt of the gage method, or the divider method may be used at the option of the purchaser For grades D and E castings, the extensometer method shall be used

(d) The tensile strength shall be determined at a crosshead speed not exceeding 1½ inches per minute

10 **Test Specimens**—(a) One or more test coupons sufficient in size and number to provide the required test specimens shall be cast attached, near each end of each casting, where practicable, weighing over 500 lbs each, excluding truck side frames, truck bolsters, draft sill or body center castings, except as otherwise specifically provided for in these specifications These test coupons shall remain attached to the castings throughout the heat treatment and until the castings are presented for inspection If the design of the casting is such that the test coupons cannot be attached, they shall be cast in runners outside of the casting, but attached to it to represent each heat The location of the test coupons, as well as the method of casting such coupons, shall be subject to mutual agreement by the inspector and the manufacturer In the case of orders for castings weighing under 500 lbs each, the physical properties required in Section 9 shall be determined from an extra or spare test coupon attached to another casting from the same heat.

(b) When sufficient coupons have not been cast, a test specimen may be cut from a finished casting at a location mutually agreed upon by the inspector and the manufacturer

(c) Tension test specimens shall conform to dimensions shown in Fig 1



Note – The gage length, parallel section, and fillets shall be as shown, but the ends may be of any shape to fit the holders of the testing machine in such a way that the load shall be axial

Fig. 1. Standard Round Tension Test Specimen with 2-In. Gage Length

11 **Number of Tests** —(a) For castings weighing over 500 lbs each, excluding truck side frames, truck bolsters, draft sill or body center castings, one tension test shall be made from each end of one casting representing each heat and both tests shall meet the requirements of these specifications For castings weighing less than 500 lbs each, one tension test shall be made from one casting representing each heat except as provided in Section 12 (a)

(b) If any test specimen fails because of mechanical reasons, it may be discarded and another specimen taken

If the results of the physical tests of any test lot do not conform to the requirements specified because a flaw develops in the test specimen during testing, a retest shall be allowed

(c) If the percentage of elongation of any tension test specimen is less than that specified in Section 9 and any part of the fracture is more than ¾ inch from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed

(d) No part of these specifications shall operate to cause any one tension test to apply to more than 40 tons of castings as offered for inspection

12 **Number of Tests, Consecutive Heats of Miscellaneous Castings** — (a) After 15 consecutive heats, which may contain any or all grades of castings covered by these specifications on one or more orders have been tested and accepted in accordance with the above requirements, the manufacturer may group the succeeding heats in lots of five heats each, and in the case of electric furnace steel in lots of ten heats each, but each lot not to exceed 40 tons The entire group is to be accepted if the test specimen selected from the lot fulfills the chemical and physical requirements herein specified If this test fails, all heats of the group shall be tested individually If the failure was of the type covered by Section 11 (c), a retest will be

granted under the provisions of that Section Castings weighing over 500 lbs each, except truck side frames, truck bolsters, draft sills or body center castings are not applicable to Section 12 (a)

(c) If there is a period of more than six months between shipments of the grade of castings covered by these specifications, then each heat shall be tested individually until 15 consecutive heats have been accepted, after which the heats may again be grouped as in Section 12 (a)

(d) If one or more heats are rejected, each succeeding heat shall be tested individually until 15 consecutive heats have been accepted, after which heats may again be grouped as in Section 12 (a)

13 **Number of Tests, Small Orders** —In case of small orders for bolsters, truck sides, draft arms, yokes or castings weighing over 150 lbs where the size of the order and the available pattern and foundry equipment are such that not more than five castings can be cast in one heat, the physical properties, as required in Section 9, will be determined from an extra or spare test coupon cast with and attached to some other casting of the same heat

14 **Re-heat Treatment** —If the results of the physical test lot do not conform to the requirements specified, the manufacturer may re-heat treat such lot not more than twice and retests shall be as specified in Section 9

15 **Alternative Tests to Destruction** —In the case of orders including only castings not exceeding 150 pounds in weight, the test to destruction of one casting from each 100 castings or smaller lot may be substituted for the tension tests at the option of the inspector This test shall show the material to be ductile, free from injurious defects and suitable for the purpose intended

WORKMANSHIP AND FINISH

16 **Workmanship** —(a) All castings shall be made in a workmanlike manner, and shall conform substantially to the dimensions on drawings furnished by the purchaser before manufacture is started; or to the dimensions predicated by the pattern supplied by the purchaser, if no drawing has been provided

17 **Finish** —(a) The castings shall be free from injurious defects, and shall be thoroughly cleaned when offered for inspection

18 **Welding**—(a) With the consent of the purchaser's inspector, minor defects, which do not impair the strength of the casting, may be repaired by metal-electrode arc welding, using a process which results in sound metal deposits having, in the heat treated condition, minimum mechanical properties equal to those required for the parent metal If welded in the "green," casting shall receive, after the welding is completed, the type of heat treatment specified in Section 2 for the grade of casting involved If welded after heat treatment, no additional heat treatment is required

(b) With the consent of the purchaser's inspector, defects which might impair the strength of the casting, may be repaired by using a metal-electrode arc welding process which will result in sound weld deposit having, in the heat treated condition, minimum mechanical properties equal to the requirements for the parent metal Welding may be performed in either the "green" or "heat treated" state but, after welding is completed, the casting shall receive the type of heat treatment specified in Section 2 for the grade of steel involved

(c) Grade A or B castings shall not be welded while the temperature of the casting is below 40 deg F

(d) For welding grade "C" steel castings—(1) If shielded metal-arc process is used, the electrode shall be a low hydrogen coated type, AWS/ASTM Class E9015, E9016, E9018, or equivalent At the option of the manufacturer,

A—1967

an electrode of the AWS/ASTM Class E10015, E10016, E10018 or equivalent may be used for higher minimum mechanical properties after heat treatment

(2) If a gas shielded arc welding process is used, the shielding gas shall be a welding grade carbon dioxide or a more inert gas such as argon

(e) The welding materials used for the repair of defects in grades "D" and "E" steel castings shall be as agreed upon between the purchaser and the manufacturer

(f) When defects of the nature described in Section 18 (b) are present, grades C, D and E steel castings shall be preheated, preferably in a furnace for uniformity but local preheating will be permitted, to a temperature not to exceed 600 deg F for welding, and repair of defect accomplished while the casting is maintained at a temperature above 300 deg F

MARKING

19 **Marking.**—The manufacturer's name or identification mark, the pattern number and grade, and, when specified, the purchaser's initials, shall be legibly cast on all castings In addition, a serial number, the month and year when made, shall be legibly cast on all bolsters, truck side frames, wheel centers, crossheads, cylinders and similar castings The location and size of numbers shall be agreed upon by the manufacturer and the purchaser The heat number shall be legibly stamped on all other castings weighing over 150 lbs

All truck bolsters and side frames, Grades B and C steel shall have legibly cast thereon their respective A A R classification marking, as shown in Design Test Requirements, Specifications M-202 and M-203, each of latest revision

VARIATION IN WEIGHT

20 **Variation in Weight**—For the purpose of this requirement, the normal weight shall have been previously agreed upon between the purchaser and the manufacturer Shipment lots of castings may vary not more than 5 per cent above or 3 per cent below what has been determined as the normal weight for the castings

INSPECTION AND REJECTION

21. **Inspection**—(a) The inspector representing the purchaser shall have free entry, at all times while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered The manufacturer shall afford the inspector, free of charge, all reasonable facilities and necessary assistance to satisfy him that the material is being furnished in accordance with these specifications Tests and inspection shall be made prior to shipment at the place of manufacture unless otherwise specified

(b) The purchaser may make tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere Such tests shall be made at the expense of the purchaser

22 **Rejection**—(a) Material represented by samples which fail to conform to the requirements of these specifications will be rejected

(b) Material which, subsequent to test and inspection at the foundry or elsewhere and its acceptance, shows injurious defects will be rejected and the manufacturer shall be notified

23 **Rehearing**—Samples tested in accordance with these specifications which represent rejected material, shall be held for fourteen (14) days from date of the test report In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT
MECHANICAL DIVISION

SPECIFICATIONS

M-203-65

CONSIST:
Pages 1-2 M-203-65
A-1966
Pages 3-10, M-203 61
A-1962

TRUCK SIDE FRAMES, CAST STEEL

Approval Requirements

ADOPTED, 1926; REVISED, 1929, 1937, 1938, 1947, 1948, 1951, 1953, 1954, 1958, 1961, 1965

1 **Scope.** (a) These specifications cover all cast steel side frames for freight equipment

(b) All designs of truck side frames must be approved by the Committee on Freight and Passenger Car Construction before being placed in interchange freight service The basis for approval is provided by these specifications

(c) Application for approval shall be addressed to the Secretary of the Association of American Railroads, Mechanical Division, who will refer same direct to the Joint Subcommittee on Side Frames and Bolsters Application shall be submitted in quintuplicate and be accompanied by copies of detail construction drawings and full information with respect to composition of material and heat treatment employed

(d) Approval will be based upon the results of dynamic and static tests Or, the Joint Subcommittee may recommend approval of the design, material and heat treatment on the basis of previous satisfactory static and dynamic tests of similar designs, material and heat treatment

Waiver of tests should only be requested on the basis of a design previously approved as a result of official dynamic and static tests Waiver request should be accompanied by substantiating data covering new design and design being used as a basis for such request when there are differences not covered by Appendix "A"

2 **Material.** Shall be of cast steel in accordance with latest revision of A A R Specifications M-201, Grades B or C Preheating is not required when welding defects in Grade C castings unless the section to be welded exceeds 1-inch in thickness Electrodes used shall be as required in Section 18 (d), Specifications M-201

3 **Design** (a) All standard fundamental A A R requirements, in addition to those specifically mentioned herein, shall govern

(b) The basis for calculations and testing shall be the axle capacity "C" as given in Table I

TABLE 1

Size of Journal, In	Type of Truck	C-Axle Capacity, Lbs.
4¼ x 8	2B	24,000
5 x 9	2C	32,000
5½ x 10	2D	40,000
6 x 11	2E	50,000
6½ x 12	2F	60,000
7 x 12	2G	72,000

A—1966

(c) The vertical design load shall be taken as acting on the spring base (or its equivalent for test) and shall be 1 5 "C" The transverse load shall be taken as acting on the bolster guides, one-half on each guide on a line located above the nominal center line through the two axles an amount equal to the journal diameter of the axle less 1½ in and shall be 0 4 "C" The maximum combined unit stress in the design shall not exceed 16,000 lbs per sq in for Grade B steel, and 25,000 lb per sq in for Grade C steel

4 **Static Tests** (a) Two specimens of each design shall be tested in a suitable static testing machine under the supervision of a representative of the Joint Subcommittee The two specimens selected shall be good average product

(b) The side frames shall comply with the static test requirements of Table II The transverse and the vertical tests shall be made separately, but the same specimen may be used for both tests In the case of separable journal boxes the boxes and parts shall be assembled and bolted into place for the vertical test only

TABLE II
Static Tests

(c) Basis for computing test loads:

	Load in Pounds Grade B and Grade C Transverse	Load in Pounds Grade B and Grade C Vertical
Load for zero setting of instruments	5000	5000
Additional load for maximum deflection	0 60C	2 25C
Load for maximum permanent set	1 20C	4 50C
Elastic Limit, minimum		4 25C
Ultimate Load		12 50C

(d) Values from Paragraph 4 (c) as used in actual testing:

		4¼ x 8	5 x 9	5½ x 10	6 x 11	6½ x 12	7 x 12
Load	0 60C (Deflection) =	19,400	24,200	29,000	35,000	41,000	48,200
"	1 20C (Set) =	28,800	38,400	48,000	60,000	72,000	86,400
"	2 25C (Deflection) =	59,000	77,000	95,000	117,500	140,000	167,000
"	4 50C (Set) =	108,000	144,000	180,000	225,000	270,000	324,000
"	4 25C (Elastic Limit) =	102,000	136,000	170,000	212,500	255,000	306,000
"	12 50C (Ultimate) =	300,000	400,000	500,000	625,000	750,000	900,000

Test Requirements:

Wheel Base	Max Transverse Deflection for A Load of 0 60C Grade B	Grade C	Max Transverse Permanent Set at A Load of 1 20C Grade B	Grade C	Max Vertical Deflection for A Load of 2 25C Grade B	Grade C	Max Vertical Permanent Set at A Load of 4 50C Grade B	Grade C
5'-6"	.070"	.120"	010"	010"	040"	.055"	010"	.010"
5'-8"	070	.120	.010	.010	040	.055	.010	.010
5'-9"	.072	124	.010	010	041	057	.010	010
5'-10"	074	127	.011	011	042	.058	011	011
5'-11"	076	131	011	011	044	060	011	.011
6'-0"	078	135	011	011	045	.062	011	.011
6'-1"	081	138	012	012	046	.063	.012	012
6'-2"	083	142	012	012	047	065	012	012
6'-3"	085	146	012	012	049	.067	012	.012
6'-4"	.087	.150	.013	.013	.050	.069	.013	.013

4.25C Minimum Elastic Limit
12 50C Minimum Ultimate Load

A—1966

(e) The deflection measuring instruments shall be located midway between supports of specimen and shall be set at zero under an initial load of 5000 lbs In the vertical test only, a load of 20,000 lbs shall be applied to the side frame and then released to 5000 lbs for the zero setting of instruments

(f) The elastic limit shall be determined by the Johnson fifty per cent method. This may be defined as the point on the stress strain diagram at which the rate of deformation is 50 per cent greater than the initial rate of deformation

5 **Loading Diagrams for Static Tests** Figure I shows the method for transverse test loadings Figure II shows the method for vertical test loading Figure III shows the location of knife edges in the vertical tests for various spring groupings

6 **Dynamic Tests** (a) For approval, four (4) representative side frames shall be submitted for dynamic testing on either the American Steel Foundries' machine at Granite City, Illinois, or the Symington Wayne Corporation's, Symington Division, machine in Depew, New York, under the supervision of a representative of the Joint Subcommittee

(b) The dynamic test requirements are given in Table III

TABLE III

	Minimum Loadings Required When First Critical Crack is Recorded	
	Grade B	Grade C
Minimum loadings each specimen	50,000	75,000
Average loadings for specimens tested shall show not less than	100,000	125,000

Definition of a crack—Any break in the parent metal that has definite direction and a minimum length of ¼ inch The crack must work under test when sprayed with mineral spirits or suitable fluid

A crack is considered *longitudinal and non-critical* if it extends lengthwise of the member in which it is located

Definitions of a critical crack:

1 Any crack in a general transverse direction of a member that progresses during the test
   (a) For official recognition, a transverse crack must be at least ¼ inch in length and must show ¼ inch additional progress transversely
   (b) A transverse crack shall be recorded as critical at that number of loadings when it has progressed ¼ inch after initial recognition

2 *Any crack which, if discovered in service, would lead to condemnation* of a side frame for service

7 **Marking** (a) All approved cast side frames shall be legibly marked as follows:

(1) Coded Designs Apply proper Code Number that fully identifies design, including material and heat treatment Code Number system is shown in the A A R Code For Designating Design Features For Side Frames And Truck Bolsters Having Built In Snubbing Devices-Single Shoe Brakes

(2) Non-Coded Designs When Code Number is not applicable, apply identification number as follows:

Grade B steel: AAR-B- (identification number); foi example AAR-B-400

Grade C steel: AAR-C- (identification number); for example AAR-C-401.

(b) The markings specified above, when properly applied by the manufacturer, will serve as a positive means of certifying that the design has been approved and, by reference to the 1948 and subsequent D V circular reports of the Committee on Car Construction, the exact date of approval can be ascertained.

(c) The markings specified in Sections 7(a)(1) and 7(a)(2) are in addition to those required by A A R Specifications M-201 Location of markings is specified in Section D, A A R Manual

(d) The Code Number, when applicable, as well as the Identification Number shall be shown on the manufacturer's detail drawing.

APPENDIX III

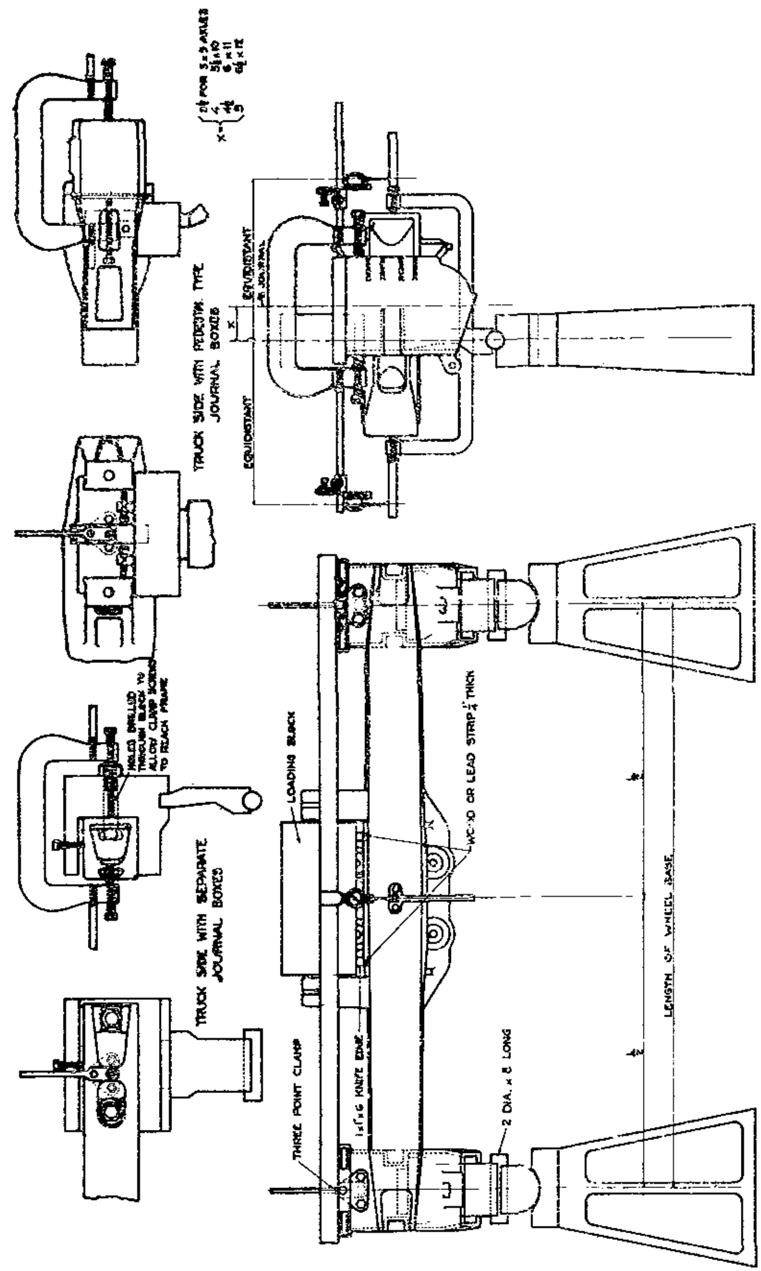
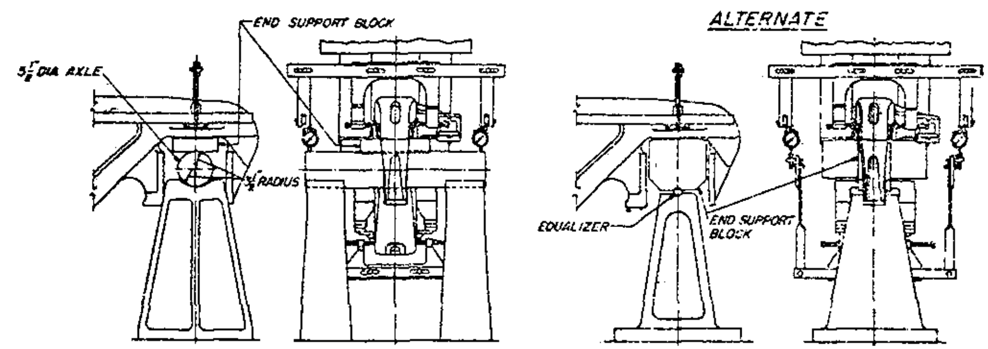


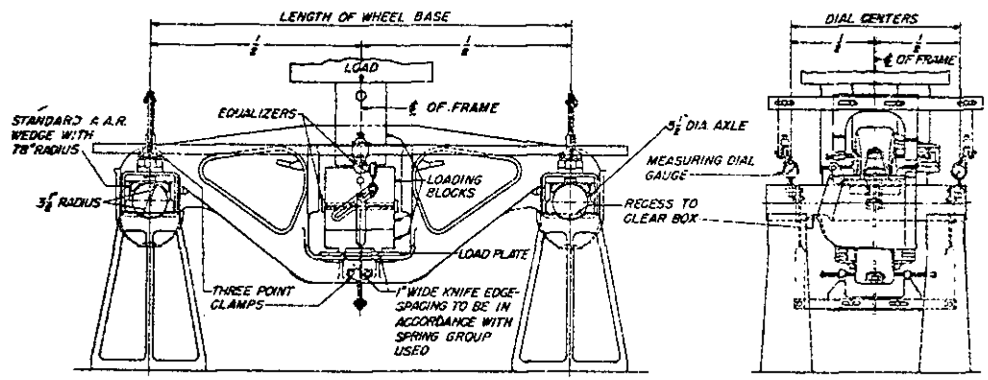
Fig I

A-1962

APPENDIX III



TRUCK SIDE FRAME WITH PEDESTAL TYPE JOURNAL BOXES



TRUCK SIDE FRAME WITH INTEGRAL JOURNAL BOXES

NOTE:
SETUPS ARE TYPICAL, VARIATIONS ARE PERMITTED IN DESIGN OF APPARATUS, ALSO TO SUIT DESIGN OF SIDE FRAME, PROVIDED TEST RESULTS ARE NOT AFFECTED.

Fig II

A-1962

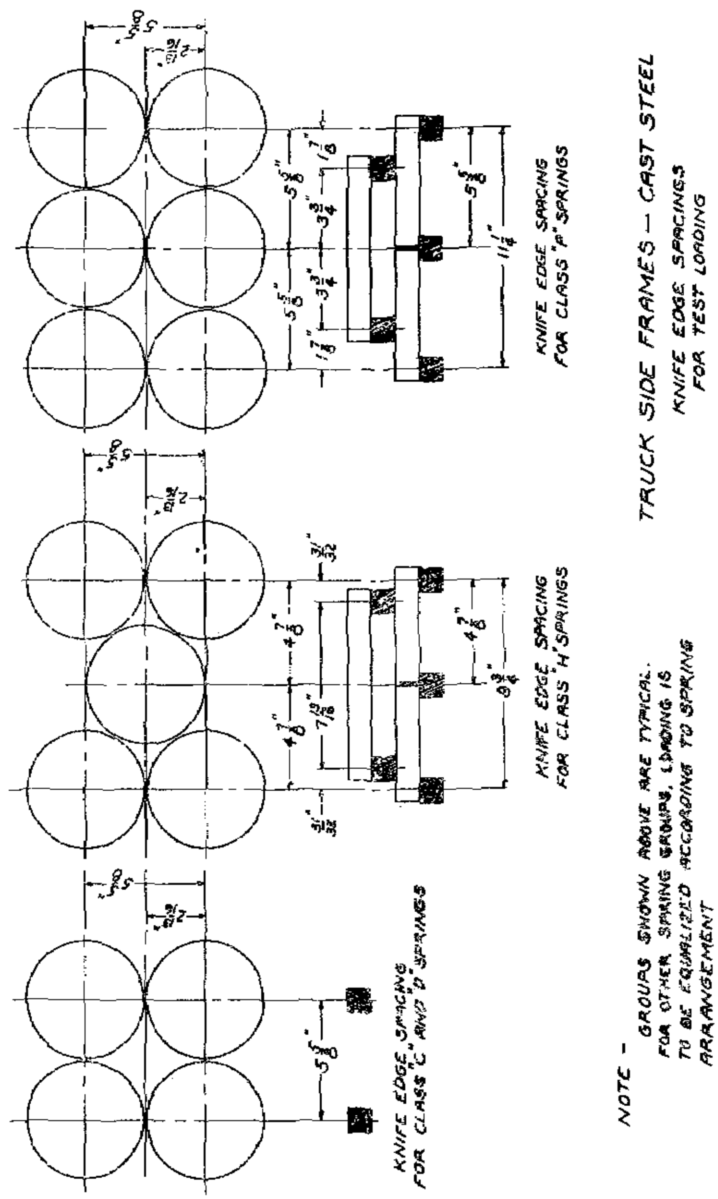


Fig III

A-1962

APPENDIX "A"

REGULATIONS GOVERNING APPLICATIONS FOR APPROVAL OF SIDE FRAME DESIGNS UNDER LATEST ISSUE OF SPECIFICATIONS M-203

I All designs that have been approved and listed in A A R Circular D V —1168 and subsequent annual reports of the Committee on Freight and Passenger Car Construction are to be considered approved, but the A A R. Joint Subcommittee reserves the right to further select truck side frames from production for subsequent static and dynamic tests at no cost to the manufacturer aside from furnishing the test specimens

II All base pattern designs not already approved shall be submitted to the A A R Joint Subcommittee on Side Frames and Bolsters through the Secretary of the Mechanical Division, for approval or advice that official static and dynamic tests are required

Approval of a design applies only to the manufacturer for whom it is approved; it does not cover an identical or similar design made by another manufacturer or the same design made of a different material by the same manufacturer

However, a design already approved for one manufacturer may be approved for another manufacturer without further tests provided the manufacturer seeking approval is an approved manufacturer To be an approved manufacturer a manufacturer must have satisfactorily completed a minimum of ten (10) official A A R dynamic approval tests on ten (10) different designs of side frames produced by said manufacturer Once a manufacturer is approved said manufacturer is considered approved for a period of three (3) years from the date of last satisfactory official A A R dynamic approval test on a side frame design produced by said manufacturer Dynamic retesting at the end of the three (3) year period for an extension of an additional three (3) years may be accomplished by making and passing an official A A R dynamic test on either an existing approved side frame, or a new design

III. When a base pattern design has been approved, such approval will also apply to any issues of that pattern when any of the following changes are made.

1. Brake hanger bracket (location and type), or removal of brake hanger bracket
2. Addition or removal of CRECO 4th point support bracket
3. Addition or removal of tie rod bracket
4. Addition or removal of UNIT brake beam guide bracket
5. Addition or removal of brake beam safety ledges
6. Addition or removal of journal box waste retaining ribs, or addition or removal of holes in side walls of journal boxes used for the application of journal stops
7. Location, omission, or addition of spring or spring plank bosses, providing bending moment at center of frame spring seat is not increased

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8. Change in journal box hinge lug design.
9. Addition or removal of pad used for stamping truck number.
10. Columns altered to make any of the following variations in design, provided there is no increase in width of bolster opening at the bottom:

    Conventional, Barber S-2, Ride Control, Double Truss Self-Aligning Spring Plankless, Double Truss with Spring Plank, Snub-Up, Cushion-Ride, Cardwell Stabilized, Basic and National C-1.

11 Modification in journal boxes to permit the use of solid cartridge type or roller bearing unit The modification may consist of removing the walls of dust guard portion of the journal box or removing the lower portion of the brass stop lugs, or providing a 3" opening in the lower front face of the journal box The modification may consist of any or all of the above alterations

12. Change in design of journal box to provide a removable lower portion to facilitate wheel changes. This change permitted only if reinforcement is provided at the outer corner of journal box where it merges with the compression member.

13. Change in design of journal box for application of wear plate in the roof of box, providing the design metal thickness of roof of box is maintained between side walls of compression member

IV. (a) Tests may be waived when the following conversions of approved designs are made, if the construction of the tension and compression members is kept identical:

(1) Wide Pedestal Jaw to Narrow Pedestal Jaw
(2) Wide Pedestal Jaw to Integral Journal Box
(3) Narrow Pedestal Jaw to Integral Journal Box

(b) Tests may be waived when the strength and design requirements of the Wide Pedestal Jaw have been anticipated, and when the strength in the critical areas of the converted design equals or exceeds the strength of the approved design Under these conditions the following conversions of approved designs may be made:

(1) Integral Journal Box to Narrow Pedestal Jaw
(2) Integral Journal Box to Wide Pedestal Jaw
(3) Narrow Pedestal Jaw to Wide Pedestal Jaw

(c) Tests may be waived when the strength and design requirements of the Narrow Pedestal Jaw have been anticipated, and when the strength in the critical areas of the converted design equals or exceeds the strength of the approved design Under these conditions the following conversion of approved designs may be made:

(1) Integral Journal Box to Narrow Pedestal Jaw

(d) Request for approval must be made in accordance with requirement of Section 1 — Scope Paragraph (d)

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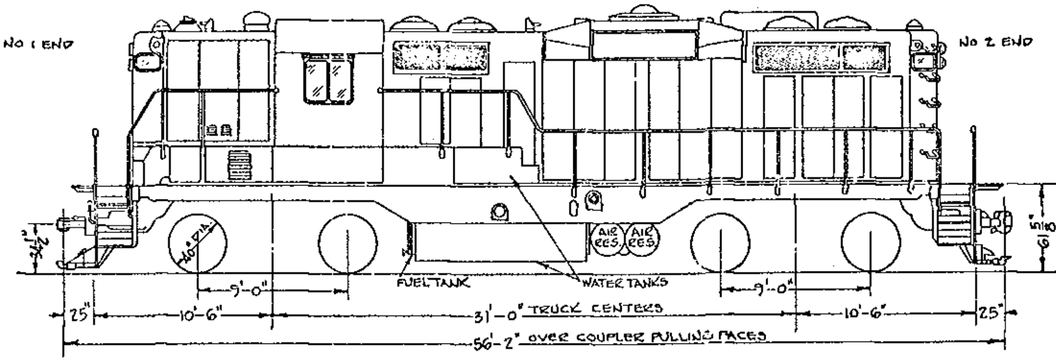
Test Specimens.—All test specimens presented for both static and dynamic testing shall be produced by the manufacturer's normal production methods and be representative of the manufacturer's average commercial product. The test specimens shall not be given any special preparation not given to all side frames in the course of regular production.

If the representative of the Joint Subcommittee rejects the test specimens due to apparent special preparation, he shall so inform the manufacturer. At the manufacturer's request and expense, an inspection of similar products ready for shipment will be made by such representative or by the Joint Subcommittee prior to testing to determine if the specimens presented for test are representative of the manufacturer's regular production. The Joint Subcommittee shall make the final decision in case of appeal.

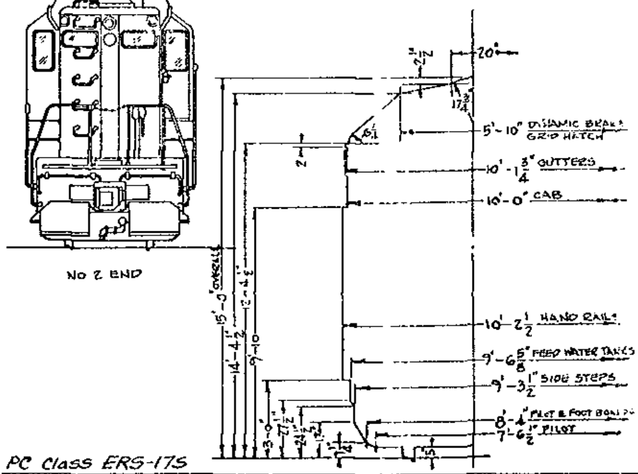
APPENDIX IV



130,700 LBS

128000 LBS

LIGHT WEIGHT 237,320 LBS
ACCESSORIES 21,380 LBS
WEIGHT IN WORKING ORDER 258,700 LBS



P.C. Nos. 7530 - 7559   PC Class ERS-17S

LOCO CLASS & NUMBERS	DERS-4, 1200-1229	STEAM GENERATOR-WITH REMOTE CONTROL-VAPOR OK 4625	
BUILDER, TYPE & YEAR	EMD, GP 9, 1956	STEAM GENERATOR FEED WATER CAPACITY	1200 GALS
MAXIMUM TRACTIVE EFFORT	63,500 LBS.	STAND-BY HEATING	VAPOR
MAXIMUM DESIGN SPEED	83 M.P.H	TRUCK JOURNAL BEARINGS	HYATT 6½"
MIN. CURVATURE WITH ONE CAR	39°	DRAFT GEAR	N.M. & S C CO. M-380
GEAR RATIO	59/18	COUPLER	TITELOCK TYPE "F"
DIESEL ENGINE-MAKE	EMD 567-C, "V"-TYPE-2 CYCLE	SANDERS	8-PRIME
DIESEL ENGINE-CYLINDERS	16-8½"x10"	SAND CAPACITY	1800 LBS
DIESEL ENGINE-HORSE POWER	1750 @ 835 R.P.M	SPEED INDICATOR	BARCO
MAIN GENERATOR	EMD TYPE D-4	WARNING HORNS	2-H.M.&M. FIG. 4700 3
AUXILIARY GENERATOR	EMD MODEL A-7159	BATTERIES	15 EXIDE, 15 GOULD
TRACTION MOTORS	4-EMD TYPE D-37	CAB SIGNAL	GRS-DUAL-DOUBLE END
ENGINE AIR FILTER	ROTONAMIC	FIRE EXTINGUISHERS	2-20 LB. ANSUL DRY POWDER
FUEL CAPACITY	800 GALS.	AIR FLOW INDICATOR	EMD TYPE
LUBE OIL CAPACITY	200 GALS	HEADLIGHTS-2 DUAL SEALED BEAM LAMPS-32 VOLT, 200 WATT	
COOLING WATER CAPACITY	227 GALS.		
AIR COMPRESSOR	GARDNER DENVER WXO		
AIR COMPRESSOR CAPACITY	235 C.F.M @ 835 R.P.M		
AIR BRAKES	24 RL		
BRAKE CYLINDERS	9"x8"		
BRAKE SHOES	A-31		

K	M	LH	TRACED	1-28-58	A
IN	CK'D	BY	WHY REISSUED	DATE	LETTER

N.Y., N.H. & H.R.R
NEW HAVEN JAN 28, 1958

DIAGRAM

CORRECT — E.E. | A 56521 | APPROVED — M.E.

DAMAGE TO EQUIPMENT OF TRAIN A/CB-1

EQUIPMENT	LOCATION AND EXTENT OF DAMAGE	
NH-C-586	Destroyed, "A" & "B" steps bent and torn, 2 trucks bent and broken, "A" side sheets torn, "A" side roof torn, "A" L, side sill torn, "A" L, end sill torn, "A" center sill bent	$ 5,000.00
NATX 34473	"B" end sill, bent and torn, body bolster bent and torn, end tank shell, bent and torn, "C" dome cover bent, "A" end sill bent and torn.	6,000.00
CGW 5040	Destroyed, "R" & "L" side sheets bent and torn, "A" & "B" ends bent and torn, roof bent and torn, center sill bent and torn, body bolster bent and torn, "A" & "B" trucks broken.	5,000.00
PRR 259981	"A" & "B" running board bent, safety appliance bent, hopper doors Mech., bent.	1,000.00
M&STL 50428	Destroyed, "A" & "B" end bent and torn, side sheet bent and torn, body bolster bent and torn, center sill bent and twisted, "A" & "B" trucks damaged.	5,000 00
C&O 17861	Destroyed, "A" & "B" side sheets bent and torn, ends bent and torn, center sill bent and torn, trucks, damaged.	5,000.00
PRR 256062	"B" end "L" corner post bent, side sill bent, 3 stifner post bent, "B" end sill bent.	500.00
NP 8798	"A" end 2 brake beams bent, "A" end "R" sill step bent, "A" end "R" & "L" 2 ladders bent	200.00
ATSF 19334	"A" and "L" side, truck side broken, "A" end 2 brake beams bent, 1 spring plank bent.	500.00
	TOTAL	$28,200.00

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